5

But There Was More …

What secrets did Rolf take with him when he travelled to Switzerland to start his new life? The documents in the National Archives in Oslo contain nothing about that. The archives from Brown Boveri say something about the ideas he had in mind for what would become an industrial success story lasting many years. Patent documents in several countries can tell us about theories needing legal and economic protection. But it is not technology we are talking about now. A Norwegian who started working for the Luftwaffe in Germany during World War II on a top-secret arms project must have left traces in many contexts and many archives. Or did he manage to avoid that? If so, there must be an explanation for that too. As I discovered new sources, the question arose: How much did he know himself about what he had been drawn into? If he knew a lot, that is interesting. If he knew only a little, that too is interesting.

What did he know but not say? For example:

- ***that he was nearly arrested and sent to England?***
- ***that the project was taken out of the hands of the Nazi authorities?***
- ***that he knew his assistant would be set free?***
- ***that Hollnack & Co. fetched him from Oslo?***
- ***that Randers was working for the American intelligence services?***
- ***that Brown Boveri were in the picture all the time?***
- ***that there was a whole spider's web?***

Did he know but not say

- ***that he was nearly arrested and sent to England?***

A. Sørheim, *Obsessed by a Dream*, Springer Biographies,
https://doi.org/10.1007/978-3-030-26338-6_5

Rolf said nothing about the fact that when he left Germany shortly before the country capitulated, he only narrowly avoided being arrested. He said nothing about the fact that he and Hollnack had been under surveillance by the Allies. Hollnack, who knew that the British were approaching, gave him money and said 'Run! Go home while you have the chance.' The choice that faced Rolf in April 1945 was between travelling back to Oslo with the risk of being arrested by the Norwegian authorities, or staying in Germany with the probability of being arrested by the British and sent to England. Leaving Germany involved the same Catch-22 dilemma as had the original request to go there. Whatever he did would be wrong. Rolf never said anything subsequently about his difficult choices but as before, he decided to go.

Theodor Hollnack was a key person in both situations. He would have preferred to go to Norway with Rolf, but the German military authorities ordered him to stay.[1]

Also, he was an important agent for the British army and would secure the betatron, which for security reasons had been moved north towards the Danish border.

So who was Hollnack? Four years younger than Rolf, only 32 when the war broke out. Born in Halle outside Leipzig.[2] An all-rounder. Had studied both science and social subjects and also specialised in administration and marketing. He had been a fighter pilot early in the war, and when he came across Rolf he described himself as a businessman on a mission for the Luftwaffe.[3] Rolf had no clear picture of the man's activities outside their shared project, but it was obvious that he had many irons in the fire. He owned and managed a business in the aluminium sector and he had a number of good connections with high-ranking people in Berlin. He stressed that he had never belonged to any political party, but he had access to the right circles and a network of contacts with widespread ramifications.[4] Moreover, he was in a position where he issued or negotiated contracts to companies and individuals both for the Air Ministry and for other official organisations, and he knew about the authorities' interest in everything to do with atomic research and accelerator technology. He was also up-to-date on what the American, Kerst, had achieved on the accelerator front and he was excited about his own success in 'getting Field Marshal Milch to take a personal interest in this whole field.'[5]

With his wide background and organisational skills, Hollnack was perfectly suited for the role of head of administration in the group that was to develop the Luftwaffe's radiation-gun that the fantasists believed would be able to neutralise bombers—the scheme that would later end up as Rolf's betatron project.

Dinner with Hitler

Another person who had good connections in the higher echelons of the Nazi establishment was Ernst Schiebold, the professor who wanted to make X-ray cannons. At the start of 1943 the Air Ministry in Berlin was under pressure to produce a trump card. The timing was perfect for Schiebold. It is said that Field Marshal Milch dined with Hitler on 5th March 1943 and that the pair of them sat discussing war strategy till quarter past three in the morning. The defeat at Stalingrad had shocked them, and Milch's clear advice to Hitler was: You need to bring about something decisive to get Germany out of this war. It's still not too late, but it's urgent.[6]

So when an offer of help arrived on Field Marshal Milch's desk a month later, it was as if the trump card had been produced to order. In a pathetically courteous letter, Professor Schiebold said that he wanted to 'contribute his knowledge to the defence of the country as part of the total war effort,' something that Propaganda Minister Goebbels had been calling for. Several hundred of Schiebold's X-ray weapons could protect a whole city against allied bombers, and several thousand could defend the whole of Germany. Milch was impressed, gave the green light to proceed and allocated money. Schiebold had done work for the Air Ministry previously and was leader of a research institute in Leipzig, and Milch already knew him personally.

The ministry gave Schiebold permission to mention this strictly secret project to his friend Richard Seifert, proprietor and manager of the company Rich. Seifert & Co. that produced X-ray equipment for medical and industrial use. There was a condition attached to this permission, namely that the conversation would take place in the presence of engineer and Luftwaffe Captain Kurt Fennel. Schiebold and Seifert met on Saturday 17th April, with Fennel present. They decided that Schiebold would be scientific director and Seifert would be responsible for the technology. The purpose of the project was camouflaged behind the coded title 'X-ray inspection of armour plating.' The work was to start immediately, depending on official approval. A hand-written report was signed by all three, and a three page formal report with various attachments was put together afterwards.[7]

Things now happened quickly. The following Tuesday they were at a meeting in Milch's office in the Air Ministry where Schiebold presented his ideas and there was a request that Hollnack should also be present. There and then, an official research contract for the Luftwaffe was set up, with all four—Schiebold, Fennel, Hollnack and Fennel—jointly responsible. The contract was considered so vital for the war effort that it was given

Dringlichkeitsstufe, priority grade, DE 6224/0109/43. Hollnack was selected as administrator of Schiebold's top-secret project. Seifert was realistic enough to doubt whether it would be possible to have all the equipment and necessary accessories ready in the course of one to two years according to plan. Fennel was there as a matter of course. He appears to have been a wild card in the pack but he should not be ignored, even though—or perhaps exactly because—his role was unclear.[8]

Did the ray-gun fantasist Schiebold believe in the weapon himself, or did he just want to use the war effort to acquire research funds? Was he perhaps a servant of the Nazis wanting to show the required loyalty to atone for having helped a Jewish family? Pedro Waloschek, the retired particle physicist who wrote Widerøe's biography, had been researching for ten years when in 2004 he documented the story of Schiebold's death-ray idea.[9] Even he didn't find the answer to these questions, though as a reviewer wrote he 'partially lifted the cloak that had been cast over this obscure history.'[10]

The Death-Ray Weapon Becomes a Radiotherapy Machine

Whatever Schiebold himself may have thought, his colleagues soon realised that the machine that was supposed to be able to shoot down planes was just completely unrealistic fantasy. So the idea was dropped. Oddly, however, the project continued with a major change of direction. From now on, it was to concentrate entirely on building Rolf's betatron. The Germans' death-ray project had metamorphosed into Rolf's project. The objective was now no longer to fire lethal radiation at aircraft, but to fire lethal radiation at cancer cells to save the lives of patients. The change happened in autumn 1944 and the scale of the operation was apparently far beyond what Rolf had ever anticipated, irrespective of what reasons he had originally had for taking on the job with the Luftwaffe. Schiebold himself, whatever his intentions had been, probably also realised that his original proposal was totally impracticable.

The rationale for Rolf's ideas being incorporated into the military death-ray project was that it would require particles to be accelerated to very high energy. This was exactly what Rolf's betatron was intended to do. So the development of the betatron became an important part of Schiebold's project, and when the project was abandoned the Luftwaffe was still sponsoring

Rolf's betatron, which was being built at the Müller factory in Hamburg and would later be taken out of the city to a place of relative safety.[11]

That was how the relationship between Rolf and Hollnack started, but how did it end? When the betatron was moved from Hamburg to a safer location, where was Rolf? Was he in Wrist? The author of the biography says that he asked Rolf specifically about his several times and that Rolf had answered explicitly that he had never been at Wrist and therefore had not seen the betatron in its new location.[12] However, there is something not quite right here. In recently published letters from Rolf's assistant, Touschek, to his parents, it is stated that Rolf was both at Wrist and in the administrative office in Kellinghusen.[13] Touschek's relationship with the authorities in Berlin had been difficult since the beginning of 1945. They didn't like his involvement with the betatron project, and he made many telephone calls to Rolf to seek advice. From this, Rolf concluded that his own situation at the Müller factory had become too problematic and he decided to move out of the city to where the betatron was being installed.

On Thursday 15th March Rolf acted on his decision and moved to Kellinghusen where Touschek had a flat. An abrupt letter from the Müller management two days earlier may have precipitated this. The letter requested him to ensure that a folder with the construction plans was returned immediately. It had been removed without notice and it belonged to the company, not to him.[14] The letter was addressed to '*Arbeitsstab Dillenburg, zu Hd. Herrn Dr. Wideröe*' at '*Wrist/Holstein*.' So the Müller management knew that the calibration of the betatron was now taking place in Wrist and they reckoned that Rolf was there with his closest colleagues.

Touschek returned to Hamburg on the Friday evening. After a rather dramatic journey in a rickety lorry with an inexperienced driver, bomb alarms and various mishaps he reached home about midnight. At half past seven the next morning he was awakened by two Gestapo officers and arrested. He spent the next six weeks in various prisons in and around Hamburg.

There has been uncertainty about when Rolf came back to Norway, but around 11-12-13th April he was still in Germany, as he visited Touschek in prison during that time. It was probably soon after that when Hollnack gave him money and advised him to get out of Germany. Then on Monday 30th April Hollnack got Touschek out of prison. British troops took Hamburg on Thursday 3rd May, and a few days later they also controlled Kellinghusen and Wrist.

The End of the Double Game

Theodor Hollnack, who had been working not only for the Luftwaffe but also for the Allies, now turned immediately to the British special unit with whom who had been in contact, and followed the officers to the Müller factory. He showed them the laboratories and offices where the betatron had been developed. All the documents that were still there were confiscated. All activity within the factory had been banned, and the employees were not very happy about the situation. Having already invested heavily in betatron development, Philips the parent company was keen to carry on, and the management found it difficult to accept that activity had now been stopped.[15]

In Wrist, however, Rolf's team was allowed to carry on. Hollnack had arranged this with the British even before they arrived. So Kollath, Schumann and Touschek were able to continue testing equipment and writing reports in relative peace and quiet in Seifert's remote dairy. The activity was classified as a state secret by the British authorities, the only disadvantage of this being that Touschek couldn't use the material in the dissertation he was working on.[16] They did however face the same restrictions as everybody else at that time, in that they were not allowed contact with researchers at other German universities and institutes. Otherwise, the situation was as before.

Seifert was responsible for supply of materials, including transport. Hollnack managed the money and still had 200,000 Reichsmarks remaining in his budget when the war ended. Since the move to Wrist in March he had also been responsible for providing accommodation for all the staff. We don't know how long the funds from the Luftwaffe sustained the business, but it is reasonable to assume that the authorities in Berlin now stopped financing the project and the British more or less took over. Richard Seifert & Co. probably contributed money and contacts to ensure that the work continued and the Müller factory probably also had interests in contributing resources. In addition, the team at Wrist tried to generate income by developing and patenting products and continuing production. The situation in war-torn Germany was chaotic, and it was a question of finding whatever means possible to keep things going for these scientists, whose interest was first and foremost to continue their accelerator research.

In August Touschek travelled to Hannover and Göttingen where he had been invited to work on betatrons, but because he had come into conflict with Hollnack the British decided that he must stay in Wrist until

his situation had been clarified. In October the professors who wanted to recruit him, Jensen and Gentner, came to visit. In December the British decided that the betatron should be taken to England after New Year, but in February the decision was changed: The betatron was to be taken to Hamburg, together with the key workers in the project.[17]

In a monthly progress report covering the period from mid November to mid December, Kollath wrote that so far as he knew there was no further money in the budget from 1st January 1946, and without a guarantee that he would be able to pay salaries he didn't know if he could hold the team together in Wrist much longer. We don't know to whom the report was sent, but he did ask a Hr. Barns for written confirmation that it had been received, either directly or via the English.[18] This may have been a mistaken spelling of the name of a researcher at Woolwich Arsenal, the laboratory in England where the betatron was later sent as war booty. The physicist D. E. Barnes played a central role in all this. From what Rolf says in the biography, it appears that he himself thought that the machine had already been sent to England in December 1945.

The important thing was that the betatron was secure, rescued from both the Germans and the Russians, and that Rolf and his fellow-workers were safe. He had managed to get to Oslo shortly before Germany collapsed. The British were on the trail of both Rolf and Hollnack, and both of them had been put under surveillance.[19, 20]

Then one day Hollnack's double game came to an end. On 31st January 1946 he was arrested by the British and the following day he gave his full report to Colonel F. Read in BAOR, The British Army of the Rhine.[21] Theodor Hollnack had been working for the Allies for a long time. He had kept in with both sides, the Germans and the British. Now the game was over. All the cards were on the table, and the British grasped them eagerly.

In the National Archives in England there is a folder entitled 'Hollnack,' with the catalogue number FO 1032/230. It had very probably not been opened since it was put together in 1946.[22] Previously, access to most documents of this type was restricted for 30 years, and therefore many of them were listed for release in 1977. Some were to remain unopened longer, but when the Freedom of Information Act came into force in 2000, this changed. The thirty year rule was abolished, and documents were now assessed individually.[23] This led to an almost continuous process of previously closed archives being opened over the subsequent years.

In 1946, however, the documents were new, events were moving fast and the intelligence officers at British Army Headquarters in Germany who were working on the case looked at the contents of the documents as soon

as they came in. Hollnack's report of his activities was written in German, and the note sent to the translation office on 6th February 1946 said that an English version was required by the evening of the following day, 'as it is very urgently required.' The translators managed to meet this deadline, but in their covering letter they stress that 'because of the time pressure we have not had the translation thoroughly proof-read or edited and it therefore must be accepted that there may be both typographical and grammatical errors.' This is evident in the text, but the content was now accessible.[24]

Hollnack apparently reports quite freely—about the betatron and Rolf and everybody involved. The report contains a mass of information about things Rolf has never mentioned. What we are *not* able to know is whether Hollnack also knows more than he tells. As a double agent he was naturally exposed to huge pressures. It is difficult to judge how much his response at the time was influenced by this. He seems to have been a complicated person, kindly and argumentative at the same time. Capable, and with a sense of justice that could sometimes take the upper hand. But it would be a mistake to describe him as difficult, for to move in as many circles as he did he must have been adaptable.

'Kellinghusen's Mussolini'

Towards the end of the war and in the time immediately after, the people around Hollnack started reacting against his activities. The youth who had been recruited as courier subsequently admitted that he had suspected Hollnack of supplying information to the Allies. Rolf's assistant, Touschek, wrote in a letter to his parents that Hollnack had started having 'grandiose ambitions,' that he 'went to the media if he didn't get what he wanted,' and that some people actually referred to him as 'Kellinghusen's Mussolini.'[25] Hollnack probably did have a part in securing Touschek's release from prison, but Touschek wrote that he probably did not have as big a part as he claimed.

In the end, Hollnack himself was arrested by the British. It was all over when two officers from the Research Division in the British Military Section in Bad Oeyenhausen visited the laboratory in Wrist on 29th January 1946. They were the Head of Security himself, Dr. Ronald Fraser, and Colonel F. Read from the Allied Control Commission Their purpose was clear. They were there to 'look at the activities of Dr. Hollnack, who was Head of Administration and had been appointed by General Milch.' When he wrote his report, Colonel Read did not conceal his aversion to the man, whom he

described as 'a truculent character and resentful of the fact that his activities should be questioned.'[26] In the same report, he also wrote about the interrogation of a member of the Uranium Club, Dr. Kurt Diebner, who was considered suspect by the British occupying forces' local security office and who was among those later brought to England. But the British Research Branch Control Officer didn't think that Diebner was bad enough to be arrested and he just imposed a reporting order on him. He was, however, interested in Hollnack and he requested him to give a full account including details of all the employees and a complete list of the equipment for the Widerøe project.

Having interviewed the scientific personnel at Wrist and formed a first impression, the two officers agreed that 'the attitude of Dr. Hollnack was most unsatisfactory.' Fraser was concerned that he might try to sabotage the equipment. The next day, Read requested that arrangements be made to arrest both Hollnack and his 'male secretary.' This was set in hand, and the arrest was carried out next morning, 31st January 1946. The 'male secretary' was the courier, the youth who had claimed to be Dutch and operated under various identities.

On 4th February Colonel Read travelled to Hamburg again, to discuss Hollnack's interrogation. He learned that Major Coleman in the security office had personally interviewed Hollnack and had spoken with him on two or three occasions. Coleman 'didn't think that he was at all dangerous,' but he had got him to write his life history, as was usual with people who had been arrested. Read sent the biographical information together with several reports on the betatron project, the staff and the equipment to his superior officer. In the accompanying letter he said that he had decided to set Hollnack free but forbid him to enter the laboratory.

Read then went back to Wrist where he met Kollath, Rolf's deputy who was now also serving as chief since Rolf had left. Colonel Read wrote in his report: 'I explained everything to him and informed him that the place was to be closed and the staff were to be dismissed, apart from the few undermentioned: Dr. Kollath, Dr. Schumann, Dr. Touschek, Fräulein Bernhardt (Dr. Kollath's Secretary) Herr Schultz (Mechanic), Herr Shaelke (Mechanic), Frau Gärtke (Typist), Herr Gärtke (Cleaner).'

This inner core of named personnel was to be retained, and the Sergeant of the Watch was given orders that only these few should be given access to the building. Finally, Read advised Fraser that he would see to the 'disposal' of the betatron.

Hollnack was released quite quickly, but removed from the betatron project. He felt hurt and sad and, not least importantly for himself, he was without income. Two weeks later he complained to the security services that

Read had given orders that his personal finance should also be controlled by Kollath, who moreover was by then in process of leaving and had delegated the job to Hollnack's successor.[27] However, according to a letter Read wrote to the security section, they had no interest in Hollnack's private assets and had in fact never given any instructions to Kollath to freeze them. He made this clear in a letter to Major Coleman: 'Should Hollnack's assets be frozen, I should be very much obliged if you would take steps to unfreeze them.' He ended the letter by saying that he hoped they could have the site in Wrist closed the following week or thereabouts—that is to say, by the end of March 1946.[28]

Contact with Rolf Is Renewed

A year had now passed since Rolf had left the group in Wrist. It had been a busy and uncertain time for everybody, and neither he nor they had made contact in the meantime. Then on 30th March 1946 Kollath wrote a letter to Rolf. He said that it had only recently become possible to send letters abroad and he stressed that he hoped receiving post from Germany would not cause Rolf any difficulties. This letter is the first of several that Kollath wrote to update Rolf on the events of the previous year. Touschek had written the day before. He and Kollath had agreed that they should both write, independently of each other so that Rolf would get information from several viewpoints. Touschek's letter didn't reach Rolf until over three months later, on 8th July, by which time Touschek had already written two further letters. Seifert also wrote to Rolf and the four of them—Kollath, Touschek, Seifert and Rolf—now tried to piece together what had really happened. They had been close colleagues, and their need to tell their stories and release pent-up curiosity now boiled over. There are three main themes in their correspondence, and the letters say a lot both about the post-war chaos in Germany and about the close bonds between them.

Personal relationships: There is mention of food packages that Rolf and his wife sent to them, for which they are very grateful. Kollath's secretary has also received a very welcome parcel, and Touschek expresses thanks for the cigarettes and overtly asks for more. Sometimes they also mention their disappointment and concern about packages that have *not* arrived. Kollath asks Rolf for help to get his sick eleven year old son into an institution abroad where he can receive nutritious food and good care. Touschek asks for advice about a job offer from England. He says that the Englishmen have really helped him, that Rolf has helped him even more, and that he is in many

ways attracted to the idea but that he is wondering what it will be like to come to England as an 'ex-enemy.' Another factor he must take into account is that 'Without food you can't work.' All things considered, the three German colleagues are glad that it is now possible to renew contact with Rolf and they write that they hope they can arrange to meet when circumstances in Europe have returned to normal.

Updates: What had happened in Wrist since Rolf left them in 1945? The sequence of events was not immediately apparent from the correspondence. Replies to previous letters were crossing new letters in the post and nobody knew whether they were being censored or when they would be delivered. In fact, Kollath and Rolf started numbering their letters K1, K2, W1, W2 and so on. They were especially interested in the elusive Hollnack. Touschek expressed in strong terms how difficult Hollnack had been in the final days. Kollath, more diplomatically, wrote that Hollnack had caused him many headaches and had now broken all contact in a manner that left Kollath with no interest in taking it up again. He had tried for a long time to mediate between Touschek and Hollnack but had finally had to take a firm line. The core of the disagreement was who should manage personnel and resources.

The work on the betatron had in itself been difficult since May 1945. First it had had to be dismantled and hidden in a cellar. Then it had had to be reassembled in very difficult circumstances, though Kollath wrote that he would spare Rolf the details of that. He had also asked Sommerfeld the patents adviser to delay visiting them in Wrist until things became clearer. There were still bills that had not been settled, and he wanted to seek Rolf's advice about that first.

Research: Their day to day work, however, was in physics. Once they had been able to express their feelings of frustration and anger and had updated Rolf with their situation, gradually more and more of the content of the letters is about the application of their findings and how they could develop the betatron further. Another theme is their competitors at Siemens. The reports from Rolf's former co-workers indicate that the year had not run as smoothly as he later stated in his biography. They maintained professional contact for several years, and at one time there was talk of Kollath coming to work with Rolf in Switzerland. Seifert also wrote frequently. As a businessman he had a scent for possible sales opportunities, and he quite quickly suggested the USA as a potential market.[29]

Kollath was in Wrist until April 1946. For a year after that he was based at Hamburg University, working among other things on a project to build a 50-60 MeV betatron. He tried to stay in contact with former colleagues

both in the universities and at the Müller factory. A professor in Heidelberg was invited to come to Hamburg but eventually chose to go elsewhere. Kollath was also in communication with representatives from Brown Boveri Mannheim, whom he tried to persuade to come to a meeting with his former boss. Rolf's patent adviser was also involved in questions about when and how to apply for patent s. In June 1947 Kollath moved to England to work in the laboratory at Woolwich Arsenal where the betatron was now located. In February 1948 he moved back to a professorship in Hamburg.[30]

To Whom It May Concern

However, it was still a while after Kollath had left Wrist before a line could be drawn under the matter. In July the British Security Office issued a document 'to whom it may concern,' stating that the case regarding Hollnack had been 'satisfactorily concluded with full knowledge and approval from this office.'[31] Fully concluded it was not, however. The man was obviously a nuisance to the British, and on 25th July a sharp letter was sent to Kollath with orders that 'Herr Hollnack's personal papers must be returned to him immediately if there are no good grounds for keeping them.'[32]

However, by October Hollnack had still not been given back private possessions, papers, manuscripts and even clothes that had been confiscated in April. He complained again to Read, stating that his protest to the section in Kiel dealing with custody of confiscated assets had not helped, even though the head of the security office had assured him shortly before that there was no intention of doing anything with his possessions that they were holding. Hollnack emphasises that all he is concerned about is getting back his private papers, and he offers to have them always available for inspection. His tone has become sharper, and he now asks for a written response.[33]

Hollnack then disappeared from the picture for a while, until Rolf received a telephone call from him in 1947 asking to speak with him privately. They met in Germany, on a plain near Waldshut close to the Swiss border. Hollnack asserted that he had some claim over the patents that Rolf had taken out in the second half of the war and that now seemed to be quite valuable. But the German, who now called himself Kolberg, couldn't prove his claim. Rolf explained to him that the rights to the twelve patents from 1943 to 1945 belonged to Brown Boveri in Switzerland, where he was now employed. Hollnack, alias Kolberg, for one reason or another didn't want to have anything to do with the company, and Rolf later said that Hollnack left rather taken aback. It is very unlikely that Hollnack—of all people—didn't

know what Rolf's relationship with Brown Boveri had been during the war. He had probably just wanted to try his luck and he was not alone in the confused buzz round the war-time patents. This was the last time the two of them are known to have had anything to do with each other.

Hollnack was in poor health and appears to have become more and more desperate for money. In 1948 he turned to his old contacts in The British Army of the Rhine with a letter to the Regional Research Office in Kiel asking for a job. He received a standard reply to the effect that they had no suitable position available at the moment but that they would keep him in mind if anything cropped up.[34] He then disappeared from any connection with physics in Germany. He had managed to stir up quite a lot of activity and confusion in his wide circle of acquaintances and finally around his own person. People had not quite known where they stood with him or where to place him. The reply from BAOR signalled his exit from the scene.

In brief: So much confusion. So many different interests. People in transit, interrogated, imprisoned. People despairing, defending themselves, disappearing. Nobody is quite sure who is on what side among Jews, Nazis, allies and security services. Rolf is in the middle of it all. Without him there would have been no betatron project. He too was under surveillance, but he avoided arrest—only just. When the Allies arrived, he was already out of the country but his assistant and his boss were both arrested. Did he say anything about this afterwards? Did he recount the drama? No.

But there was more. In the report that led to Hollnack's arrest, two organisations are named in which Rolf was involved but about which he said nothing in his biography. This is remarkable when we see now how significant both organisations were in everything to do with his time in Germany during the war. He either didn't know about them or didn't want to tell about them. Both explanations appear strange, but one of them must be correct. Hollnack the double agent and '*Treuhänder*' had had several cards up his sleeve.

Did he know but not say

– ***that the project was taken out of the hands of the Nazi authorities?***

Rolf never mentioned that the name of the betatron project was changed in spring 1945. From then on it would be called '*MV-Forschungs-Vereinigung/MV-Research-Association*.' The full name was written thus, with an oblique slash and four hyphens, but it was generally shortened to 'Megavolt Association.' Even before the name was changed officially, the betatron group had often been called '*MV-Forschungs-Vereinigung*' or

similar names that combined the concepts of high energy and research.[35] More commonly it was referred to as 'The Widerøe Group' or '*Arbeitsstab Dillenburg*.'

The first half of the new name was in German, the second half in English. This was not just Teutonic attention to detail, but a clear signal of something new. It was not just a change of name, but the title of an Association with its own memorandum and articles of association and its own protocols. It had previously been a research project under the auspices of the Luftwaffe, set up on the initiative of the country's highest research council. Now it was to be a free and independent organisation with its own board of management. The change happened on 4th May 1945, just days before the German capitulation.

Why did Rolf not mention this? Did he not know about it? His name was on the distribution list for all the foundation documents and reports. The organisation was to concern itself with 'the construction of betatrons according to Widerøe's ideas and instructions.' But Rolf was out of the scene: somewhere in Denmark; on a train; at home with his family in Oslo; held in prison together with thousands of other Norwegians suspected of treason. He was somewhere or other, but not in Wrist. How could he know anything at all about what as going on there? The Allies probably knew much more than he did. It later became apparent that there was something he did know. What reason did he have for keeping silent?

One simple reason might be that if he revealed that the betatron project had been taken out of the hands of the Nazi authorities, he would have had to say more about how he came to be involved in the first place and he wanted to say as little about that as possible. Many of the sources indicate that Rolf didn't even mention it to Waloschek when he was writing his biography.

But there are other sources than the main protagonist himself. For example, Rolf's assistant wrote to his parents that they had tried to save the betatron and that he thought this would be possible. He mentioned in this context that they had set up a new organisation.[36] In a later letter he said that he had gone with Hollnack to Wrist and Kellinghusen where Rolf's other colleagues were already located. The aim had been to promote the continuation and further development of the project. To Rolf, he wrote that there was not much to do during these first months after the end of the war. The 30–35 employees in Wrist were writing weekly reports and putting them on Hollnack's table for the sake of appearance, and he had been giving them a lot of help with translation into English.[37]

Serving the Scientific Interests in the World

At the beginning of June 1945, four weeks after the establishment of the Megavolt Association, Hollnack put together a folder of documents for the British military authorities, describing how the organisation had come into being, who was behind it, what had been achieved and, not least, what future he and the others wanted for it following the German capitulation.[38] Rolf was named as the person in charge and was included on the distribution list. But at that point Rolf had been incarcerated in Ilebu since 24th May and he was hardly up to date with events. The folder is thick, and it includes a long covering letter, dated Kellinghusen 9th June 1945 and written in German.[39] In addition to pointing out that the new organisation is a further development of Rolf's project—though now taken out of the hands of the German authorities—the documents also cast light on Rolf's original Hamburg project and all of Hollnack's dealings with Rolf.

In the documents, Hollnack also refers to points from a previous letter, including the wish to continue the work on the betatrons pending a final decision from the Allies. He had also requested the necessary freedom of movement and approval to start negotiations about international agreements. He points out that it is all based on Rolf Widerøe's ideas, and that for the past couple of months he had been unable to make contact with the German patent office to discuss the rights. He stresses that he is acting as '*Treuhänder von Dr. Widerøe, Oslo*' and not as a representative for his own country, and asks that this be borne in mind in reading the documents. Finally, he confirms that everything is now in the hands of the Allies.

One of the documents he sent was a copy of the protocol constituting the new organisation. This was dated 4th May 1945, the day after Hamburg capitulated, and it took as its starting point the fact that Germany had now suffered defeat by the Western Allies. So science and technology now faced a new situation in relation to international connections and interests. This applied to the betatron project. The document emphasised that it was important to continue the development work in accordance with the original agreement with Rolf from 1st November 1943 and that the activity must be carried out in accordance with international scientific and economic obligations. What had up to then been formally called '*Arbeitsstab Dillenburg*' should be dissolved with immediate effect. It was a matter of making a start as soon as possible to solve scientific and technical questions together with physicists in other countries, and damaged equipment needed to be repaired as quickly as possible.

The protocol goes on to say that from the foundation date onwards, the work on the betatron should continue under the auspices of the Megavolt Association. The professional staff were in Wrist, and all the members of the original project committed themselves to entering contracts of employment with the new organisation. The Megavolt Association would guarantee 'scientific development opportunity independent of personal and industrial interests.' The organisation would resume relationships with the researchers who had been involved and ensure that all theoretical works and construction facilities would be restored. Then when contact with Rolf was resumed they would be ready 'to serve the scientific interests of the world.' The protocol is signed by Hollnack, with copies for Rolf, Kollath, Werner Bartelt the new business manager and 'other fellow-workers.'[40]

Who Is Doing What

A separate note attached to the protocol sets out a basic allocation of duties and responsibilities. Rolf heads the technical-scientific management, with his Oslo address given and with Kollath as second in command, followed by Schumann who is also a physicist, and Touschek the assistant. Also named are a workshop foreman, a laboratory engineer, a laboratory assistant, a mechanic, an instrument maker and an office worker. In addition to these, Hollnack has his own administrative secretariat of six or seven people including his personal secretary and the courier.[41] The legal responsibility will be clarified 'at a later date' and 'in agreement with Dr. Widerøe.' The note goes on to say that Hollnack will fill that role until formal arrangements have been completed. He will also attend to the question of continuing finance for the project once the political situation in Germany becomes clear. Finally, the note mentions the needs for Allied approval of the work schedule, for personnel recruitment and for continued contact with Rolf's patents adviser, Sommerfeld, about legal questions.

It is emphasised that the purpose and task of the organisation is to continue the research and development work on Widerøe's betatrons. As before, it is a matter of continuing the development of the 15 MeV betatron and the plans for the 200 MeV machine, and of starting work as soon as possible on the 30 MeV betatron in Wrist. Repeated assurances are given that everything will be done according to Rolf's designs and with his agreement. The document also says that necessary parts will be bought from Seifert's company. In respect of the 30 MeV machine, it is particularly specified that contact will be established with both science and industry in Germany.

Scientists from abroad are also being included, such as Niels Bohr in Denmark, Bragg in England and Serber in the USA. In addition, the document recommends contact with representatives from industrial interests, such as Brown Boveri in Switzerland and General Electric in the USA.—and 'if it is desirable,' the same applies to Russia.[42]

Still a '*Treuhänder*'

Another of the attachments to Hollnack's report is a three page document about the relationship between Rolf and himself. He says plainly about his own role: 'In 1943 I was given responsibility for research on the radiation transformer as built by Widerøe.' He gives an account of his work as '*Treuhänder*' and offers a high-sounding explanation of the proposed future programme:

> Following the end of this war it seems to me to be our obvious duty to make the results achieved till now available without restriction to scientific communities abroad. (…) Leading German scientists such as Professor Heisenberg in Berlin, Professor Bothe in Heidelberg and Professor Jensen in Hannover are being brought into the project, with guarantees of being able to work freely and independently.

He writes about Rolf's role thus:

> In1943, I was involved in engaging him to work in Germany. The motives for approaching him may call for a personal explanation. They are however honourable, as the conditions of the arrangement were such that a personality such as Dr. Widerøe could accept them with thought to his international reputation. As *Treuhänder*, I am under an obligation to continue to comply with the agreements we made, especially with Norway and Switzerland and thereby possibly with England.

He points out that the work is of interest for the whole of nuclear physics and he makes three requests to the British Military Government:

1. for opportunity to meet with authoritative officers and scientists in 2nd British Army to arrange all the agreements about rights etc. to be able to resume the work that had been interrupted by the British Military Government;

2. for approval to travel to Hamburg to set up international agreements;
3. for everybody working on the project, including himself, to be given freedom of movement within Germany to renew contacts, engage theoretical workers and obtain construction documents. He points out that the 200 MeV betatron is particularly dependent on this.

Hollnack declares himself willing to submit to control and supervision by the British Military Government. He also proposes that the activity in Wrist and Kellinghusen be protected by a guard and he adds: 'I am moreover prepared to undertake any journey within Germany under escort.'[43]

He attaches detailed technical documentation with diagrams and theoretical calculations, together with a copy of Rolf's doctoral thesis—plus both the articles submitted to the scientific journal during the war. He had written the formal documents himself. The more practical and technical descriptions of the work in progress were put together by Rolf's second in command.[44]

Hoping They Say Yes

By 26th May the organisation had its own official notepaper, and the acting scientific leader Kollath and the administrative manager Bartelt composed a document setting out plans for the organisation of the business. The first requirement was to set up a scientific board. A governing body had been set up a year before, but the needs were now different. Former political, scientific, and industrial interests among the membership must be done away with. It would now be possible to include people with the required professional skills from both within Germany and abroad, in a way that had not been possible during the war.[45]

By 29th May they were sending letters to Professors Heisenberg and Bothe, referring to discussions between them and Rolf and inviting them to join the board. The letters confirm that the intention had always been to reach out to a bigger circle of experts in fields such as nuclear physics, electrical engineering, biology and materials testing, but that the requirement for secrecy during the war had hindered this. The intention now was to set up a broadly based, scientific board, and the organisation's job in future would be 'to work for free and independent research and development.' Documents with guidelines for the work programme are attached, and the letter is signed by Kollath for the scientific management and Bartelt for the administrative management.[46] Ten other German professors and

several international big names also received invitations, including Bohr in Denmark, Bragg in England, Joliot in France Serber in the USA.[47]

Copies of the letters to Heisenberg and Bothe are included in the folder Hollnack sent to the British, together with proposals dated 26th May for the constitution of the scientific board. These proposals specify how many members should be on the board and their term of office, require minutes to be taken and give the members the right to know about all the activity.[48] There is also an invitation to the British to nominate a scientist to take part in the combined project 'to develop betatrons according to Dr. Widerøe's designs.'[49]

What should we make of this? Were they building castles in the air? Was the setting up of a new organisation intended as evidence that those sponsoring it had cut off links with their past? Or were they just doing the only sensible thing, reorganising to demonstrate that they were serious researchers?

Rolf's assistant, Bruno Touschek, also had a part in this. He was meeting an obligation towards Hollnack to take part in setting up the Megavolt Association, but he contributed only half-heartedly. His letters to Rolf and to his parents reveal that he was not really so interested in the new organisation, which he considered to be an ego-trip by Hollnack. Touschek still had three months of his contract of employment to fulfil and he would remain loyal for that time, but he restricted himself tightly to matters dealing with acquiring patents to ensure the finance. He was also responsible for contact with the English, i.e. with 'T-Force 2, British Army,' to whom Hollnack had sent all the information about the Megavolt Organisation. Touschek wrote:

'I took it upon myself to handle the negotiations with the military regime, and for a short time I acted as interpreter, and I also succeeded in having the project taken up by T-Force, something that seemed necessary in a situation beset by plundering and vandalism.'[50]

Top Secret

So what was this 'T-Force,' that Touschek refers to and to whom Hollnack had sent documents? Rolf tells us nothing about it. T-Force's activity was all either 'Secret' or 'Top Secret.' Until the late 1980s almost nobody had heard of this secret intelligence organisation that hunted for anything of scientific or military value that should be taken from the enemy. Its operations sometimes resembled those of the fictional secret agent, James Bond.

This resemblance was not just coincidental, as the originator of the Agent 007 stories, Ian Fleming, was also involved in the setting up of T-Force. Fleming was working with the defence services at that time, and he later used elements from that experience in the book 'Moonraker,'[51] a spy novel about the big rocket England was going to build. The technicians working on the rocket, however, were German and when a notebook disappeared shortly before the test flight it emerged that the rocket with an atomic weapon at its nose was programmed to land in Central London, and that the team leader was a German war veteran seeking revenge. It was obviously forbidden to reveal sensitive information at that time, and some of the people involved around T-Force have subsequently claimed to recognise themselves in certain episodes in the spy novel.

In due course the archives were opened and documentary books began to be written about T-Force. The British newspaper, 'The Guardian,' brought new material to light, and a new chapter was added to the history of World War II.[52] In brief, the story was as follows:

The responsibility for getting hold of the German scientists was given to a special British unit known as 'T-Force.' The unit was set up soon after D-Day, 6th June 1944, as a lightly equipped and very mobile force that went forward in advance of the Allied troops to identify objects of importance for science or for the intelligence services, before they could be sabotaged by fleeing Germans or captured by advancing Russians. The combined purposes were to build up the British economy after the war and to prevent Soviet Russia from getting hold of the Germans' scientific achievements.

So Target-Force, known as T-Force, was an elite force of the British Military Government, in charge of scientific and military intelligence. The British wanted to make as much use as possible of Germany's commercial and scientific abilities. The force consisted of scientists, bomb experts, engineers and technicians. Their missions were decided by the Combined Intelligence Objectives Sub-Committee, CIOS.[53] As soon as a group from T-Force took control of a factory or a site, CIOS was informed and investigators were sent immediately. When it was rumoured that the spies from T-Force were on their way, German scientists tried to remove as much as possible of their equipment and documents before they arrived. Tons of papers were burnt, hidden, buried in the ground or moved to less obvious places.

The British Army, Field Army 2, to whom Hollnack sent his reports, crossed the Rhine on 23rd March. They reached the River Weser on 4th April and the Elbe on 19th April. The army came to Lübeck on 2nd May, Hamburg capitulated on 3rd May and on 7th May they met the Red Army.

The German capitulation followed immediately after that. When peace was declared, T-Force was given the task of arresting German researchers. About 1,500 scientists were taken to England, where they were interviewed by their competitors, British colleagues in science and industry. Then as the Cold War developed it became increasingly important to prevent the Soviet Union from benefitting from the Germans' scientific and industrial secrets, and T-Force remained active for two years after the end of World War II.

Two organisations were responsible for carrying out abductions of personnel and information in the British controlled zone. These were BIOS (British Intelligence Objectives Sub-Committee) which reported directly to the Cabinet and FIAT (Field Information Agency Technical) which was a combined Anglo-American military intelligence unit that ear-marked researchers for forced evacuation from the American and French zones and from Berlin. FIAT travelled round with copying equipment and mobile microfilm apparatus to secure the best possible documentation. About 1,000 researchers and technicians, mostly in the fields of rocket science and atomic research, were recruited to the USA.[54] Most of these went over on their own initiative, but about a hundred were probably subject to compulsion.

When information about T-Force began to emerge towards the end of the 1980s, it was thought that German scientists had mostly gone over to the enemy willingly, in order to get off lightly. Then came reports indicating that the opposite may have been true[55]; that the British were desperate to get hold of the Germans' technical knowledge and were very eager to recruit these researchers. There were tales of nocturnal kidnappings and Gestapo-like methods.[56] Other, more moderately worded accounts are of persuasion, removal for interrogation and then return to Germany. Gentle pressure and not always entirely voluntary co-operation, in other words. Some British investigators have since been accused of being at least as much interested in acquiring their industrial rivals' intellectual property as in discovering more about the Nazis' military secrets. Personal reports also came to light, some to the effect that not all Germans were rabid Nazis whereas others said that they had been 'horribly' and 'shockingly' dealt with. It went both ways.

Rolf's assistant, Bruno Touschek, is one of those who reckoned it was all one whether he was in the hands of T-Force or the Gestapo. He had experienced both in the spring and summer of 1945. In fact, it appears that being taken prisoner by the British Army's T-Force was what made most impression on the young Jew. In a letter to the much older and greatly respected Professor Arnold Sommerfeld, he describes his internment by the British diplomatically, saying just that T-Force would not release him until the

Allied Commission had taken over the betatron.[57] To his father, however, he complains about his handling both by T-Force and by the Gestapo:

> I won't be allowed to leave Kellinghusen until the Allied Commission has made a decision about the betatron. So I am detained in Kellinghusen virtually as a prisoner. The food is bad, I have a cold and as before I am given very bad food and have hardly any clothes. The Gestapo have stolen many of my possessions and here there are only useless ration coupons. The German officers are only working for the Nazis, and the Englishmen clearly don't concern themselves with such trivia. Obviously there are exceptions.[58]

He had also felt that there was something wrong from the moment the betatron had been moved. There were people he didn't like, 'a group of not particularly pleasant people whom Hollnack had brought with him to Kellinghusen from various special agencies.'

The Link to Rolf

Northern Germany with its armaments factories and heavy industry, especially around Kiel and Hamburg, was an attractive target for the Allied intelligence services that were on the hunt for valuable scientific information. A T-Force report on investigations in Northern Germany between 2nd and 10th May 1945 states:

> The surrender of the German armed forces has opened up targets at almost overwhelming pace. The two main areas, Hamburg which had 104 listed targets and Kiel with 50, are proving of great value despite the severe air raid damage. Their assessment and detailed investigation is expected to take some time.[59]

The companies listed in Hamburg include the following: C. H. F. Müller and Philips; Shell; Standard Oil; and the arms giant Blohm & Voss. The section on the Müller factory, where Rolf had started building the betatron, said that research was being carried out on a 15 MeV appliance that was lying dismantled and that 'X-ray tubes of very fine design' were also produced. The report is addressed to several people within the army. The National Archives stamped 'Closed until 2046' on the cover, but the clause about secrecy for 100 years was later cancelled, and the original stamp has been over-stamped with 'Cancelled.'

A later report, for the period 19th and 20th May, includes a list of the places where items of interest had been found in the previous twelve days. Among these are Wrist and, once again, Hamburg. The entry about the research site at Wrist reads as follows:

> The "Megavolt Research Association" is a self-styled "anti-military, anti-industrial" alliance of physicists who were devoting themselves to pure atomic nuclear research. They had established numerous connections in neutral countries and were proceeding with very advanced research into nuclear physics using betatrons of equivalent voltage of 30 million volts. Their aim was to achieve a level of 200 million volts before getting on with what they called "more serious work." They also claim to have a good knowledge of general German research into atomic activity.

The Müller factory in Hamburg is specially mentioned and the head technician was interned. His specialty is given as 'many types of X-ray tubes & equipment for medical, industrial & scientific use.' Over 400 sites are reported to have been investigated since the crossing of the Rhine, and ca. 190 investigators are still at work in 21 Army Group's territory.

A report specifically about the Müller factory was sent from T-Force to the higher command in CIOS. This too is marked 'Confidential,' and the formal details are stated with military precision:

> Evaluation report no. 63.
> Target: C. H. F. Müller AG.
> Target no: 1/132e.
> Location: Hamburg-Fuhlsbuttel, Rontgenstrasse 24.
> Condition: Undamaged. All apparatus, documents, etc. are there.

The report confirms that watch is being kept in accordance with regulations and that the factory is being guarded by a T-Force troop. This is a very important case. The priority field is marked 'Top Priority.' Then there are lists of names of people who *have been* interviewed and people who *should* be interviewed.[60]

It states that the factory is owned by the Philips Group, and that the main product is X-ray equipment. That explains the finding of various types of X-ray tubes and diverse equipment for the manufacture of medical, industrial and scientific apparatus, high-voltage and electron accelerator equipment for nuclear research and relevant test apparatus. The production of

high-voltage equipment of up to 15 megavolts is particularly mentioned, plus the fact that a nearly complete installation of this type was still on site:

> A small circular-path accelerator of unknown performance, possibly used by Dr Wideroe, who is believed now to be in Oslo, was found in the factory.

The investigators also made arrangements for X-ray and high-voltage physics experts to come to take a closer look at the equipment, and name and dates for these inspections are specified.[61]

In Eminent Company

The report on activity at the Müller factory is in eminent company; it shares a folder with evaluation report no. 53b dated 18th June, of the interrogation of Albert Speer, Munitions Minister in Hitler's government from 1942 to 1945. Speer said plainly that he thought the Americans were well ahead of the Germans in developing an atom bomb. The Germans had indeed done quite a lot of research in this area, but nothing very practical had come out of it. 'They needed another ten years,' he said, referring to the research that had been led by Heisenberg in Berlin and Bothe in Heidelberg. He was also able to confirm that he had given high priority to the building of two cyclotrons in Heidelberg, and he referred to Luftwaffe Colonel Geist as formally responsible for several details of that project.[62] Geist was also the person whom Rolf thought was the most senior person responsible for his own project.

The same location in the archives also contains evaluation report no. 159 dated 30th June, an interrogation of Professor Walther Bothe. The machine he was working on is described and the report confirms that he had obtained parts from Krupp, from Siemens and from Brown Boveri in Mannheim. It also confirms that Bothe's machine was not significantly different from cyclotrons that had been built in America. It points out that Bothe had visited cyclotron installations in the USA before the war and that he appeared to know about Lawrence's work. Bothe had said that he had been working secretly on and had begun to construct another type of accelerator, the kind of apparatus that later came be called a betatron, but that this work had been cancelled because of the war. The three officers who signed the report also provided several other comprehensive technical reports about Bothe's work. The British and American intelligence organisations attached great importance to this.[63]

Several further investigatory visits to the Müller factory took place the following autumn, including one on 8th October. The report of this visit was also labelled as closed until 1977. Siemens and I. G. Farben were surveyed at the same time.[64] Siemens had a long-running rival betatron project, and I. G. Farben was the company that had taken over the running of the heavy water production plant at Vemork in Norway during the war. A further report on the subject of betatrons was also submitted to the Field Technical Information Agency, FIAT, as late as 1948.[65]

The investigations at the Müller factory and in Wrist are also discussed in Sean Longden's 2009 book about T-Force. He describes the Megavolt Association and tells that when the investigators checked the factory in Hamburg they came upon various pieces of X-ray equipment that were sent to England, including a prototype15 MeV betatron. He wrote that two had been ordered and one had been taken out of the city, so this must be the other one. He goes on to say that because of the heavy water project in Norway T-Force had been quick to undertake investigations in Norway and that these confirmed what other military intelligence services—both British and American—had all discovered: that the Germans had made 'little or no technical progress' in atomic research. Longden wrote that the people working at the betatron laboratory in Wrist maintained that they were engaged exclusively on pure research without military application. He also pointed out that this was research at a very advanced level.

The main source of information about the relationship between Rolf and the intelligence organisation T-Force is Theodor Hollnack, the man who was also Rolf's link with the Luftwaffe leadership. Hollnack also sent his reports directly to T-Force. We don't know when that started, but there are reasons to believe that he was communicating with them as early as December 1944.[66]

It is difficult to say who took the initiative, the British or Hollnack himself, but we can state confidently that he stayed in contact with T-Force for several months and supplied them with quite a lot of information about nuclear physics work in Germany. The most interesting question to us is where and when Rolf came into the picture and whether he himself was 'in on the game.' We could invent an exciting story of conspiracy, with Hollnack recruiting Rolf to team up with the British so that when Rolf signed up with the Luftwaffe he was doing so to become a British spy. As a pure researcher without political commitments or affiliations he would have been suitable for such a role. However, there is no foundation for such a story. Quite the contrary. What is in no doubt, is that Hollnack was using Rolf. Whether or not Rolf knew that is another question.

Hectic Peace

During these first weeks of peace, there was hectic activity in the hidden, temporary betatron laboratory in Wrist. In Rolf's absence, Kollath wrote a progress report in which he also summarised the whole history from 1943 onwards. The document is dated 6th June and describes the prior history of Rolf coming to Germany, the work at the Müller factory in Hamburg, the reconstruction of the machine after they evacuated to Wrist in Schleswig-Holstein in March and the programme for further work, mentioning the small, medium-sized and large betatrons. He emphasised that it was now extremely important to start work again on the agreed programme.

Only the smallest, 15 MeV, machine was ready, and at least two more of these were to be built. One was to be used for biological research on the effects of the radiation both on animals and on humans. Another was to be used for materials testing. Because of the hostilities, parts of the 15 MeV equipment had had to be packed away again after they came to Wrist and the design work on the bigger models had had to be stopped. It should now be started again. Above all, Kollath wrote, the work on the 30 MeV machine should be set in hand as soon as they had the necessary equipment. This machine would have adjustable energy levels and would be used for nuclear physics research in institutions. The actual construction of the machine could possibly be transferred to a company in Hamburg, such as Rich Seifert & Co. who would be supplying parts. But building it in Wrist was also being considered. The intention was to develop several different prototypes of this model.

Kollath's report also advises that planning for the very biggest machine, of 200 MeV, should also be resumed as quickly as possible. This machine should be built in Heidelberg, both because of the industrial contacts there and because Professor Bothe and his institute were there. The project team in Wrist was the same as it had been in Hamburg, but with several additional employees. The work schedule also points out the need to recruit the required tradespeople and scientists, such as glass-blowers, biologists, laboratory staff, instrument-makers and specialists in the development of the particular type of tube they needed and various other tools, etc.[67]

Alongside this, Kollath drew up a longer technical document describing the development of the betatron up till then, plus the future development plans. The title of this document is *Bericht über den Strahlentransformator nach Wideröe* ('Report on Widerøe's Radiation Transformer') Everybody who had anything to do with the project used this phrase, '*nach Wideröe*.' This

applied to German officials, the project's own employees, and others. At that time they still referred to the betatron as a 'radiation transformer,' which was Rolf's own expression.

Kollath's technical report also included sketches and equations and two interesting attachments. The first, stamped *Geheime Reichssache* ('State Secret') is the article that Rolf sent to the German professional journal, where it appeared in print in spring 1943. The second attachment is article number 2, which he submitted in summer 1943 but which was never printed.[68] Whereas the first has a line at the top of each page with the issue and page numbers, these are understandably absent from the second.[69]

Also associated with the technical report is a note tracing the threads of Rolf's work back to his predecessors such as the Americans Kerst and Serber, thereby setting it in a wider historical perspective.[70] All these are documents that were gathered together by Hollnack and sent to the British in early summer 1945, about eight months before he was arrested. The new organisation was in effect a continuation of the old one, but with a more clearly defined structure and strategy and, not least, an emphasis on independence.

In practice, things would not work out exactly as the reports and strategy documents predicted. In August Touschek was invited to Hannover and Göttingen to work on betatrons, but Hollnack forbade him to go. Then in September Hollnack created a new organisation, WTO, *Wirtschaftstreuhandorganisation* ('Economic Agency Organisation'), of which the Megavolt Association became a daughter company. Kollath was trying all the time to have normal work on the betatron resumed, but Hollnack insisted on leading in his own way even though he didn't officially have authority to do that. At the same time, Kratzenstein and Flegel were asserting themselves. They had both been Hollnack's fellow conspirators at the start of the project, and now they were trying to exclude Kollath from important decisions.

Then at New Year 1946 Hollnack was imprisoned. The others in the project thought at first that Kollath was to blame for Hollnack's arrest, and Hollnack's wife accused him directly of this. Kollath was later appointed trustee for the development work in Wrist.[71]

In brief: There is so much material—and more yet—to be found about the Megavolt Association, the new name for the Widerøe Group: in an archive set up by an American intelligence organisation (Alsos); and in documents addressed to a British intelligence organisation (T-Force)—sent there by a German (Hollnack) who was Rolf's boss in Germany on behalf of the Luftwaffe.

In other words, in Allied possession there is extensive documentation of the organisation '*MV-Forschungs-Vereinigung*/MV-Research-Association,' but the speech and writing of the main character himself contain no trace of it. No mention. Nothing about rearrangement or liberation from the Nazi authorities. Not once have I found the tiniest little hint of it between the lines. Yet Rolf is part of it, with his name listed in practically all the documents. Everything is 'according to Widerøe,' 'in agreement with Widerøe,' 'in understanding with Widerøe.' He is glued to the project and is on the copy distribution list of all the documents handed over to the British.

Did he ever see these papers himself? Maybe. He was out of the country—'for the time being,' it was stated. But he never came back. Communication between the previous occupying power and the previously occupied country of Norway was minimal, and his own situation with the treason case hanging over him and his passport confiscated made such communication improbable, if not to say impossible.

Did he know but not say

– ***that his assistant would be set free?***

Rolf must have known that Touschek was about to be released from prison. When he visited Touschek in prison before departing for home, Rolf told Touschek that help was on its way. Touschek later recounted that during one of his last visits to him in prison Rolf had reassured him that a courier was on his way from Berlin with release papers.[72] This visit probably took place on 11th April, which was a Wednesday. But where did Rolf get this information? He must have had contacts. Probably through Hollnack. Rolf never explained why he could be so confident that it would not be long before Touschek was released from prison. Rolf obviously knew that a reprieve was in hand. He may even have played a part in this process himself. Touschek writes something to this effect in a letter to his father, in which he first complains about the poor conditions in the various prisons where he had been kept and about the Gestapo's methods, the SS, inadequate food and a lot of marching. Widerøe, Seifert, Kollath and Hollnack are named as the only rays of hope in his situation. The leaders of the betatron project had come to the 24 year old student's support, especially Rolf who always brought cigarettes that could be used, among other things, to bribe the guards.

The three were already supporting him when he was called in by the Gestapo. All of them, including Touschek himself, were strong personalities who played their cards as best they could. Touschek had told Rolf of his wish for a single cell, and Rolf had made it clear to the official in charge that

none of them 'would take the responsibility' if Touschek was put in a communal cell. The colleagues had explained to the Gestapo that 'The nation's future for better or worse' depended on the research that Rolf had started. They also insisted that Touschek should be allowed to smoke, read and receive visitors.

Touschek's letter to his parents continues at a fast pace and with great intensity:

> On Friday I wanted to hang myself, and on Sunday Widerøe came to see me. From then on the situation got better. I had a 'decent' cell on the first floor and Widerøe brought me "Heitler's Quantum Theory of Radiation" and I started to read up about research on radiation-damping. W[iderøe] never forgot to bring me a packet of cigarettes inscribed with the important sign "Propellant for you." (…) I was treated relatively well because the frequent visits by important people earned me a certain respect.

Touschek was one of the lucky ones. He later said that he had not been treated as an ordinary prisoner and that, amazingly, he was allowed to continue his work for Rolf while he was in prison. 'We helped him as much as we could,' Rolf explained, 'though we couldn't get him released.' Rolf also provided him with food and even an occasional *schnaps*. Touschek was as diligent as his boss and he managed to write several reports on the betatron while he was inside, including one that he wrote with invisible ink in the margins of the physics book.

Touschek had a sanguine nature. In the letter he describes a forced march when, sick and miserable, he was ordered to walk all the way to a new prison with a heavy bag full of books, and then he continues:

> In the meantime people had come to see whether I was dead or alive. I tried to find a telephone to call Seifert and ask him for a car. Meanwhile, my head felt terrible and I managed to walk to the hospital in Langenhorn, I needed help. Thanks to Widerøe's message I didn't worry about that.[73]

This experience made a painful impression on him and it is the first thing he told Rolf about when they resumed contact with each other after the war. Touschek had great respect for Rolf, and there had been talk of him coming to Norway for further studies when the war was over. His plan was to do a Ph.D. in a Nordic country, probably in Oslo, and he said that Rolf had already mentioned this to Professor Hylleraas during the war.[74] Rolf and Hylleraas already knew each other *before* the Oslo University Professor was

nominated to the expert committee to advise the prosecuting authorities in the treason case against him after the war. So Hylleraas must have known something about what a resourceful person Rolf was.

Hollnack also supported young Touschek:

> A few days before the occupation of Hamburg, Hollnack came to take me out of prison, even though that was not done entirely legally. It was high time, as otherwise I would have been shot, at the best. Then I went to Kellinghusen by car and I am still there.[75]

But he is not over-enthusiastic about Hollnack and thinks it is an exaggeration when the German 'without having done anything for him for three weeks' maintains that he can take the credit for him not being shot.

Here is live human drama, with false names, arrests and releases, interactions with the Gestapo, operations at the edge of the law, money from high in the Nazi hierarchy, compassionate employment of persecuted Jews, a Luftwaffe representative linked up with the British Military Government—and a Norwegian who, apparently unaware, was named as the leader of an international research organisation that after the war would undertake free and independent research on betatrons, irrespective of national boundaries; an organisation founded in his name while he himself was fleeing from American and British authorities, and possibly from German and Russian too—right into the arms of the Norwegian prosecution.

How did Rolf get mixed up in all this, when all he wanted to do was research? One man knew more about this than anybody else, namely Theodor Hollnack. Eventually he told the story. Recorded it, what's more, in documents he gave to British officers in T-Force, who used it exactly as such information is used in the intelligence service. Then it came to rest in the National Archive of War Records and Military History. And there it lay—but only after the Americans had got a copy.

Delicate Manoeuvring

In a bulky collected document addressed to named officers, Hollnack writes about himself and what he is doing, especially in connection with the betatron project.[76] In his usual, systematic way he begins at the beginning and goes forward step by step. His personal report is at the same time a narration of Rolf's Luftwaffe project from start to finish—a finish that was dangerously close even when the project was only half-way through—and a story

that was not entirely as simple as Rolf made it appear. Whether Hollnack's account is objective and 'true' is difficult to prove. He appears as the snake, the apple and the redeemer in one and the same person.

His Interest

Hollnack claims that his main interest in the project is the finance and the associated scientific and technical problems. He says that the matter is complex and requires professional and effective management of all aspects. He adds that whoever is to manage such a big combined scientific and technical project must be independent of industrial connections. He says however that he runs an office that includes engagement in diverse fields: a company for setting up businesses, managed by himself; an office equipment company, in which he is a shareholder; a sub-committee of the German Metallurgical Association, where he sits on the board; and not least, the Betatron Project.

His 'Credo'

In elevated and rather self-important turns of phrase he expresses his management philosophy:

> The profit motive plays a decisive role for all companies, but there are some research and development tasks that cannot be measured by that standard. For reasons such as these, tasks of this kind are devolved to suitable institutions connected to particular industrial groups. In most situations the institutions do not control sufficient means to deal with such big tasks. Industry operates overwhelmingly with badly directed research and must therefore also adopt a corresponding standard.

His Role as 'Treuhänder'

He explains his role as *Treuhänder*, an administrative function to do with acting as a trusted negotiator between two parties. This is difficult to translate into English but possibly described as 'go-between' or 'honest broker,' though Hollnack appears to have brought to the role a large measure of his own entrepreneurial initiative. Hollnack tries to describe the delicate balancing act:

> … there are wide-ranging and important tasks whose undertaking cannot be justified purely on the basis of financial profitability. I therefore maintain the

> standpoint that there is a duty to defend science and technology in its own right, both as a stimulus to business and as an economic benefit to society. But it is not possible to carry out a major research and development enterprise without also having dedicated people who attend to the economic perspective and are committed to that. A '*Treuhänder*' is the intermediary between them, one who attends to the financing which is necessary to carry out far-sighted technical-scientific tasks.

In retrospect, we may wonder whether it may rather have been to save himself that Hollnack had reinvented himself as a humble go-between for Rolf and felt obliged to make himself useful as an administrator for the much more famous Norwegian.

His Background

What Hollnack writes about himself is infested with self-praise. He relates how from the experience of his earlier scientific and more general technical work in 1942 he came upon an interesting technical problem, 'a metallurgical process that would only succeed economically if I could apply my very sketchily businesslike theory also to this enterprise.' Yes, really. He then points out that during the war the only way he could continue was by teaming up with the Ministry of Armaments and War Production.

> Because of my work before the war, I had connections with the decision-making authority in the ministry, namely the head of the technical department, whom I knew personally. On 20th August 1942 the ministry gave me the task of carrying out this project.

He says that he got rid of unsuitable people and inappropriate outside interests among those involved, took care of what was viable, established industry and set up a sub-committee in the Metallurgical Association where he sat on the board. He reminds us that it was a matter of research and development work of a far-sighted type, where the Americans and the English were world leaders.

His Assessment of Schiebold's Ray-Gun

Before narrating his dealings with Rolf he rambles around a little, apparently because of a compelling need to go into detail about what he had done before and what contacts he had established, including contacts with Speer's

ministry and the Air Ministry, and how this led to a new, major contract. He knew how to adapt. He knew that the government had a special interest in the particular field of atomic physics and the construction of apparatus such as cyclotrons and betatrons to generate high-energy particles. He also knew that all research in physics was now under the direction of the National Research Committee which included influential scientists, Nobel Prize winners and others, including Walther Gerlach, Chair of the Research Committee. And not least, he knew the X-ray expert Schiebold, who wanted to build high voltage X-ray tubes to generate radiation of such intensity that it would be effective at very long range; an X-ray cannon.

> With this idea – that later turned out to be scientifically infeasible and was therefore dropped – I succeeded in getting Field Marshal Milch to take a personal interest in this area. I was given full authority to set in motion everything that was needed to carry out the project. I kept myself fully independent and avoided any integration into the ministry.
>
> My aim was to set up a research and development group that was independent of the responsible authorities, i.e. the National Research Committee. To avoid personal difficulties, I gave some rights of inspection to Professor Dr. Gerlach and to the head of research in the Luftwaffe. [namely, *Reichsminister der Luftfahrt und Oberbefehlshaber der Luftwaffe, Hermann Göring*]

His Main Achievement—Rolf

With the help of his contacts he found the man he needed, well aware that the big thing in physics at that time was the development of apparatus to produce high-energy radiation. Siemens were working on it, and AEG had the same ambition. He also knew about Kerst's betatrons and he had links with Heisenberg. Hollnack may be giving himself a more active role in the initial phase than he really had, for it is unclear who took the initiative, Hollnack or Heisenberg.

> I came across the name 'Widerøe' for the first time in a communication from Professor Heisenberg. In 1928, Widerøe had published his findings on radiation transformers, which were the starting point for Kerst's subsequent constructions and experimental work. So this appeared to be a very important man.
>
> Through a colleague, Dr. Kratzenstein, I got in touch with the secretary of VDG [*Verein Deutscher Giessereeifachleute* ('The German Metallurgy

> Association')], Berlin, Dr. Karl A. Egerer. He drew my attention to Dr. Widerøe's submitted but as yet unpublished work, parts 1-3, from 1943.
>
> From the work submitted it appeared that Rolf had already designed a 15 Mev and a 100 MeV transformer and that he also considered it technically and scientifically possible to build a 500–600 MeV machine. I then made personal contact with Dr. Widerøe in Oslo.

So it was Heisenberg himself, expert atomic physicist and Nobel Prize winner, who had recommended Rolf, and Hollnack was on safe ground both professionally and in terms of status when he entrusted his project to the Norwegian.

His View of Rolf's Motives

Hollnack then discloses that he had sensitive information about Rolf's family and gives his interpretation of Rolf's motives for coming to Germany. He had set a honey trap, linked moreover with an alluring organisational arrangement at arm's length from the German authorities:

> Widerøe had reasons to accept my offer for him to come to Germany. These were of an honourable nature, especially for a person such as Widerøe with regard to his international reputation. (…) Considering my professional experiences of solving major scientific and technical problems, I didn't wish to bring him into any sort of dependency on German industrial groups or ministries, and therefore I made a contract between Widerøe and myself with myself as '*Treuhänder*' on behalf of the state.
>
> Dr. Widerøe started his work in Germany. One of the first scientists to be recruited to the project was Dr. Eng. R. Kollath from Danzig. At that time he was working compulsorily in Norway. Moreover, I built around Widerøe a group of people whom I considered would faithfully and without self-interest contribute to this man's success.

His Break with the Luftwaffe

Towards the end of 1944 Rolf's 15 MeV machine was almost ready, and it had been confirmed that his ideas of how to construct it were correct. So far so good, until suddenly they hit an obstacle. Somebody was starting to oppose the project. The Luftwaffe wanted to reorganise it and put it under new management. Rolf should be taken off it. At best he would have been

made redundant, at worst arrested by the Nazi authorities, as Hollnack later wrote to the British:

> Through contacts with the Air Ministry, particularly the head of research in the Luftwaffe [Hermann Göring] and also with support from the National Research Committee, people in certain quarters tried to stop the work of the Widerøe group. This led to unfriendly opposition between the Luftwaffe and me. Widerøe's work was to be taken over by the Siemens factories and Widerøe himself dismissed or, if difficulties arose, arrested.

According to his own report, Hollnack calmed the situation down but realised that it was no longer possible to bring about any fruitful collaboration with the Luftwaffe. The stand-off dragged on for several weeks, until Rolf was due to go home to Oslo on holiday:

> When Widerøe was to take his agreed and pre-arranged holiday in Oslo, the Air Ministry forbade me to allow it. (…) Because of the tense relationship with the Luftwaffe that had now been going on for several weeks, I got in touch with Col. Dipl. Eng. Geist, head of the development department in the Arms Ministry. Colonel Geist was a very far-sighted and positive person, and he promised to take over responsibility for the technical-scientific aspects of the work.
>
> Then it came to a complete break from the Luftwaffe. The link to Speer's ministry was very loose and was apparently based on just one person. "*Arbeitstab Dillenburg*," which was the title being used at that time for Widerøe's project, now continued its activity under my sole direction.

Such was Hollnack's summary report to T-Force after the war about the disagreement, but he had already reported it to them six months before, making them aware that the project had been saved by Geist and Gerlach, both of whom were closely connected with it as members of the management board for the research institute at Grossostheim for so long as it had existed. At that time, Hollnack had written:

> In December 1944 relationships between the Luftwaffe and myself became strained. The Luftwaffe withdrew and left all further work to me. The technical responsibility was taken over by Col. Dip. Eng. Geist as a member of the board of the research centre at Grossostheim. He was head of development in RfRuk. That ensured research and development for several years to come.
>
> Professor Gerlach sent a proposal to Colonel Geist about the future organisation of the development group, recommending that I should take over the

> commercial leadership. (Letter dated 22.12.44) Taking into consideration my earlier experience, I couldn't accept Gerlach's proposal right away. The necessary discussions couldn't take place at the beginning of 1945 because of the way the war was going. The 15 MeV installation in Hamburg was almost ready.[77] Professor Gerlach had required a 200 MeV machine as the next project. Professor Bothe in Heidelberg was particularly interested in this project. In the meantime, the order for the construction was given to Brown Boveri, Heidelberg.[78]

Hollnack needed his friends, both powerful Gerlach in the National Research Committee and Geist, who was described by American intelligence as 'perhaps the only really capable liaison official who understood the various aspects of Germany's research needs.'[79] Hollnack gave no reasons for the opposition that had arisen in the Luftwaffe, and didn't say who in the Air Ministry or the National Research Committee had back-tracked. Stress levels were high in many quarters in Germany in the winter of 1944-1945, and Hollnack himself was not always an easy person to deal with.

It is difficult to say whether Rolf ever got to know how nearly the project had come to being abandoned, not to mention the personal danger he had been in. Perhaps Hollnack liked playing the big shot so much that he kept it to himself. Perhaps he had tactical reasons. Anyway, Rolf never mentioned any threat of being arrested by the Germans, nor that he would have been in danger of being taken by the British or the Russians. Maybe the talk of Rolf possibly being arrested by the Germans was just a dramatization that existed only in Hollnack's imagination. A man who had been brought to Germany with Heisenberg's and Speer's blessing was hardly at risk of being arrested by the Nazi authorities. Hardly anyone other than Hitler himself could displace someone who was under Speer's wing.

His New Offensive

Germany was syteadily approaching the inevitable collapse, and we may reckon that the time was ripe for Hollnack to make contact with T-Force, the intelligence organisation that was advancing relentlessly with the Allied troops. Perhaps he was driven by a duty of loyalty—but if so, to which side or what cause? In retrospect, Hollnack manages to make it appear like a planned operation: find Rolf in 1943; use him; secure the results; get him away to safety. He states that towards the end of the war he considered it his duty to ensure the safety of the betatron installation, the construction

records and the staff. In March 1945 he moved the administration office for the whole Hamburg project to Kellinghusen and Wrist in Schleswig-Holstein. Then he goes on to say that two new 15 MeV machines would be built by Müller and that were also plans for other, bigger betatrons, including a 30 MeV machine that would be developed by Rich. Seifert & Co. in Hamburg.

His Colleagues and Equipment

Hollnack was in full control. An organiser and fixer, wheeler and dealer and man of action with a network of contacts. Staff, equipment and formalities all taken care of. From what he says he appeared to be fully in control—unless he was bluffing:

> Seifert has been adviser on X-ray technology to the undersigned for the past few years. With a few exceptions, all the staff of the Widerøe group are now in Kellinghusen or Wrist. These are people without personal or political interests, who are in the project only to carry out their technical and scientific duties. What's more, there are some among them, such as for example the mathematician Touschek, who have been under observation by the Gestapo for a long time because of Jewish ancestry. Staff member Jan Gerritt Overbeek in my secretariat is of Jewish origin. He has been hiding from the secret police for years. Although he later decided to acquire a Dutch passport, he is originally German and is currently looking for his relatives in Holland.
>
> At the time when I had to plan for the possible effects of active hostilities in Schleswig-Holstein, I was working to secure the safety of the whole site. On 4th May 1945 it became clear that there was no need to fear fighting there. That same day, I decided to give Widerøe's development group a structure that was better suited to resolve the actual technical and scientific problems it was then facing. The '*Arbeitsstab*' was dissolved and the Megavolt Association established, under the technical and scientific leadership of Dr. Widerøe and his deputy Dr. Kollath. The day-to-day manager is Dip. Eng. Werner Bartelt. In addition, I am the *Treuhänder* with the task of securing and implementing international agreements.

His Agreements Concerning Rolf

He expands on the contract he had made with Rolf and also an agreement between himself and the German state defining his own position:

> I had money allocated from the *Reich* on the basis of an agreement between the *Reich* and myself in my capacity as *Treuhänder*. I was responsible for appropriate use of the resources. It was also my duty to guarantee the work and ensure compliance with the contracts.

It appears that a change had now been made to the system of payments, and that latterly Hollnack had waived personal remuneration and in addition, according to himself, met all payments. He may have been in a weakened position and trying to earn sympathy. Finally, in this long report, he points out that neither in its earlier nor its current form had the betatron project been about anything that was 'burdensome to people or to the situation.' Should that nevertheless be the case, he adds, 'I have been solely responsible.'[80]

The document is signed 'Hollnack' and dated 'Kellinghusen, 9th June 1945.' It is mainly about Rolf and the betatron, though Hollnack expresses himself as if he 'owns' the whole project. However, Rolf surely has a stake in it too, and they both had some rights.

Despite all that Hollnack says about what motivated him, all he knew and all he achieved, his motives are confusing. Was he a calculating, ice-cold businessman? Was he an opportunist who exploited the situation, an eccentric idealist, a narrow-minded petty bureaucrat, a power-seeker? A Nazi, an anti-Nazi or a chancer? Or was Hollnack just a self-important and slightly pathetic man with grand ideas of his own importance? The answer would undoubtedly be interesting, though it is not really of importance in trying to understand Rolf. But everything that can be documented about him is within Rolf's characteristic descriptions of him as 'remarkable' and 'somewhat overstrung.'

Hollnack was undoubtedly an ambitious man who acted powerfully and with great self-confidence. Otherwise he could never have achieved what he did. Clever in many things, but not in everything. Determined and purposeful. Cynical at times. But not just devious, also loyal. Sympathetic. He didn't have to help Rolf's assistant Touschek to get out of prison. He hadn't needed to offer to obtain a stipend for the courier, Overbeek, to study abroad. He hadn't needed to fight for the survival of Rolf's project when people were working against him. He probably chose to press for Rolf to be allowed to go home on his holiday as agreed and escape the risk of being arrested by the Germans. Nor had he needed at the very end to protect Rolf from possible arrest by the British so that he could go home to Norway for good.

In brief: Safely home, Rolf kept quiet about his sources of information about what he did know; for example the story behind the release of

his assistant. But that he had visited him in prison, taken books to him and put cigarettes in his pockets—that he did say. He explained about Touschek's Jewish background and that he had been arrested because he had sat in a library reading foreign journals. But any discussion of the more practical matter of collusion or conspiracy to have him freed by the use of cunning and contacts? No. Not a word to say that he had pleaded his case with the Gestapo. Perhaps he can be excused from saying how closely he had been involved.

Did he know but not say

– ***that Hollnack & Co. fetched him from Oslo?***

How could Rolf, a sober and respected citizen of Oslo with a wife and three children, become embroiled in such dramatic events? Not just a personal drama, not just during a world war, but right in the middle of one of the major issues of the war, the race between Germany and America to develop a nuclear weapon. Somebody must have had inside information about his research and realised that he was the man Germany needed. It sounds extraordinary, but that's how it was. But did Rolf say anything about that? No. He didn't say who contacted him that day in 1943, for example. Admittedly he didn't know the full story himself, but even so, he didn't tell all that he did know. Such reticence generates mystery and rumours.

What he has given us to work on is the little he declared when being interviewed by Waloschek for the German biography. He was taciturn and vague about how he came to be engaged by the Luftwaffe, and Waloschek who was writing the biography was obviously respectful of his fellow physicist and did not press him too hard. But if we read carefully we can read between the lines. The old man apparently said exactly what he planned to say and what he had always said, formulating his account just as he had done throughout the years since it all happened, until he came to believe it himself; that was how it should be said, that was how he remembered it, that was how it was.

At the very start of the story, Rolf is vague about exactly when he was contacted, and he 'doesn't remember' whether it was two or three Luftwaffe officers who came to Oslo to persuade him, but on the other hand he mentions a trivial detail of having to fix something on his bicycle before he could accompany them. Fair enough, but if my theory of who came is correct, at least two of them were people with whom he subsequently had dealings. So it seems unlikely that he 'didn't remember.' Not wanting to tell is another matter, and quite understandable from his point of view. If he had named them, he would have had to divulge the whole history. What he said was:

> Shortly after my article had been printed, something strange happened. One day – it must have been in March 1943 – some officers from the Luftwaffe came to NEBB wanting to speak with me. (…) I no longer remember whether there were two or three.[81]

If your country is occupied and enemy officers come looking for you in broad daylight, you will know clearly whether there are two of them or three who talk with you outside your office and then at the Grand Hotel. You will also remember whether it was in the month of March or at some other date. However, Rolf does indirectly give us a clue by putting together two pieces of information that would appear to the uninitiated to be unconnected. When he talks about the articles he sent to Egerer's journal in Berlin, both the first and the second one that he sent in July—and here he gives the date exactly—he then goes on to say something that makes it worth looking at the text and the context again:

> *Shortly after my article had been printed, something strange happened.*

Then follow the sentences saying that he had been visited and that it was either two or three officers who came:

> *One day – it must have been in March 1943 – some officers from the Luftwaffe came to NEBB wanting to speak with me. (…) I no longer remember whether there were two or three.*

He links the journal articles with the visit. At first glance this juxtaposition might seem coincidental, but not in the light of other knowledge and further reflection. Previous biographies may well have had a more epic and unquestioning tone, and we should remember that the interviewee was 91 years old, but these excerpts exemplify the slight naivety that characterises parts of Rolf's own account of his life. Rolf surely didn't reveal to the interviewer more than he wanted to, and Pedro Waloschek accepted his reticence. Today's generation of investigative journalists would have called this approach servile and uncritical. Waloschek, when he himself was almost 90, later expressed to me a more nuanced and critical view.

Rolf Widerøe took an active part in preparing his biography which was published in German in 1993. (*Photo* Pedro Waloschek)

However, there are other sources. What can we find in the newly opened British and American archives about this first wartime meeting between Rolf and representatives of Nazi Germany? Here we can read about a man who on behalf of Arms Minister Speer went to Norway to recruit Rolf to a secret German weapons project. The man was Theodor Hollnack. He was accompanied by two men who both had doctorates in physics; SS officers on a special mission. Just another wartime operation—but how did Rolf come into the picture?

As the discussions in Oslo appear to have been of a friendly nature, we may suppose that the delegation sent to recruit Rolf might have included a German expert already known to him. He could have slapped Rolf on the shoulder and said that he looked forward to working with him in Germany. One person who could have filled such a role was Rudolf Kollath. He was a promising accelerator expert who in 1941 had been sent compulsorily to Norway to work at the aluminium works in Sauda. He had done his doctorate at about the same time as Rolf before they both started working for AEG in Berlin. There must have been a basis for fruitful scientific collaboration, for they also continued working together after the war.[82]

Another person who may have been a member of the group sent to recruit Rolf was Hans Edvard Suess, a chemist and nuclear physicist. He was Germany's consultant for the production of heavy water at Vemork, and he lived for a while in Norway, seconded from his employment at the University in Hamburg. He was rumoured to be a communist, and according to Rolf was one of the people who said openly that he was an opponent of Hitler. 'I could speak freely with him,' Rolf said. 'He gave me the impression that the researchers were doing everything in their power to prevent the atom bomb being built in Germany. The only potential they saw in splitting uranium was as a possible future energy source.'[83]

Suess' anti-Nazi position is confirmed by the designer and manager of the heavy water plant at Vemork, Jomar Brun[84]:

> During one of my conversations with Suess (out on one of the balconies of the factory so as not to be overheard), he said that out of respect for my conscientious scruples he would tell me what the heavy water really was to be used for. It was not to do with weapons technology. The aim was to construct a uranium reactor for power production—based mainly on principles that had already been patented by Joliot-Curie (and which I also knew about). People reckoned that this would take so long that the project would not be completed until after the war, as it would require about 5 tonnes of heavy water. Suess asked me to keep absolutely quiet about his information, but after the war he said he had reckoned that I would pass it on to my friend Tronstad in Great Britain. This I did, though not until July when I was visited by a courier.[85]

Status

Connections with Rolf must have been considered prestigious, as several people claimed to have the idea of recommending that he be recruited to the German war effort. Among these were Seifert the factory owner and Egerer the journal editor. Richard Seifert could in theory have been in the group that went to Oslo, but there is no record of him having had any contact with Rolf before the war. During Rolf's time in Hamburg they became good and trusted colleagues, and this friendship continued for the rest of their lives.

Sources within the X-ray company Rich. Seifert & Co. claim that Richard Seifert junior played a major part in bringing Rolf to Germany, possibly even *the* major part.[86] Egerer maintained that he himself was the one who had given Field Marshal Milch the thought of including Widerøe's ideas in his *Aufstellungsbefehl* ('Deployment order') for the research programme.[87] Egerer was an adviser to Milch at that time and may have been the originator of the idea, but it could also be that the idea had been given to him by somebody else. In such a case, the most likely person would have been Seifert, who had wide-ranging authority to negotiate on behalf of the Air Ministry and who was connected with the Widerøe project from the start.[88]

Rolf was always on his guard not to say who took him to Germany. The ubiquitous Theodor Hollnack, absolutely not reluctant to talk about the matter, confidently claimed the honour himself. It was *he* who had made arrangements for Rolf to be brought to Germany and had actually gone to Norway to persuade him. So he said, and so he wrote in his report to the British T-Force.[89] He said that not only Heisenberg, but also Kratzenstein with whom he had worked previously, had pointed out Rolf's work. Kratzenstein put him in contact with Egerer, who knew Rolf, and Hollnack then got hold of Rolf[90]:

> In October 1943 I engaged Widerøe to work in Germany after I had visited him together with Dr. Kratzenstein and Dr. Egerer (Secretary of VDE Berlin). The contract was signed in Oslo 1.11.43.[91]

Yes, that is what it says. It could not be stated more clearly:

> *In October 1943 I engaged Widerøe to work in Germany after I had visited him together with Dr. Kratzenstein and Dr. Egerer.*

Hollnack may have been lying about who went with him to Oslo, but there is no known evidence that it was not Kratzenstein and Egerer. Also,

it is difficult to imagine what motive Hollnack could have had to falsify the names of his companions. These two were respected physicists, as Rolf immediately recognised.[92]

(After the war, both of their names appeared on a classified list of German research that American investigators thought was useful to American business and industry, in a report prepared for the Library of Congress. Under the heading 'X-ray Equipment' there is a study of materials testing by H. Kratzenstein[93] and an article by Egerer about X-radiation.[94] Even more interesting is that both their names appear in a more recent listing of Germans who had opposed the Nazi regime.)[95]

Otherwise, Kratzenstein seems rather anonymous. Egerer, on the other hand, pervades Rolf's life like a nemesis, from when his doctoral thesis was published in 1928 in the journal he edited, through a couple of articles Rolf had published there in the 1930s and the two articles he had submitted during the war and on until the visit to Oslo, the flight to Berlin and the time when Rolf comes across him in Hollnack's circle of acquaintances in Hamburg. The organisation of which Egerer was secretary was an important technical and scientific association specialising in electricity and electrical engineering, with the rather complicated name *Verband der Elektrotechnik Elektronik Informationstechnik* ('Association of Electro-technical Electronic Information Technology').

There is a lot of evidence to indicate that the three Germans who came to Oslo were Karl Egerer, Hermann Kratzenstein and Theodor Hollnack. Rolf knew the first of these from before. The second was apparently unknown to him. The third was the one who became his 'minder.' But all three of them knew a lot about *him*. They had done their homework, and they had a clear plan to fetch him, supported by orders from the highest level.

A weak point in the evidence of their identity is that Hollnack is the only source of the information he gave to the British. Another snag is that the biographer, Waloschek, states that Egerer was never in Oslo. Sadly, Pedro Waloschek died in spring 2012, before I could ask him about that in more detail. On the other hand, Egerer performed a role as an editor that a person such as Rolf knew about and could be reckoned to be interested in having more involvement with. However, what is more important than exactly who was in the delegation is the fact that they had influence and were sent by people who had influence, because it was important to recruit Rolf. Probably because of his circumstances at the time, Rolf must have had his own reasons for never saying who came for him.

The Griffin

In the history of wartime spying there is a famous parallel to Egerer. We now know that this was another editor in the same well-renowned publishing house, Springer. Paul Rosbaud was scientific editor of the journal *Naturwissenschaften* ('The Nature of Science') and operated under the codename 'Griffin.' Editors of scientific journals develop a good knowledge of the academic scene. They know which researchers are in the ascendant at any given time and which topics are 'hot.' So they can be useful in a war situation. Griffin gathered information from Norwegian Nazis and elsewhere, and with the help of resistance workers in the Norwegian Home Front he kept the Allies informed about German weapons development. It was he who gave the Allies vital information about the biggest threat of all, the work to develop a German atom bomb.

Speculation about Griffin's identity continued for over 30 years. His range of knowledge was such that not just anybody could have filled the role, and it is correspondingly surprising that his identity was not discovered. But the American physicist and author Arnold Kramish eventually managed to unravel the remarkable story and unveil Griffin's identity. In 1986 he published the book, 'The Griffin. The Greatest Untold Espionage Story of World War II.' The book had all the ingredients of a spy novel, but this was for real.

A Griffin is a fabulous animal, a mixture of a lion and an owl that has been used in many cultures throughout 5,000 years as a symbol of vigilance and attentiveness. Rosbaud lived up to the name in which he was cloaked, and Kramish's book was presented as 'the story of one of the best preserved secrets of the Second World War.'[96] The story of a forgotten hero, scientific editor, close friend of the leading physicists of the time, apparently a good Nazi pillar of society—but also a spy.

Arnold Kramish was an expert in nuclear research who had worked in the Manhattan Project. He had also had connections with the CIA, working on Soviet espionage. He was able to relate that Rosbaud had alerted the English at an early stage that a 'Uranium Club' had been set up in Germany with the task of creating an atom bomb. More importantly, however, he was the first to advise the head of scientific espionage in MI5 in England, R. V. Jones, that the German efforts to make the atom bomb would come to nothing.[97] He also knew that the Norwegian student, Sverre Bergh, was one of the couriers who smuggled Rosbaud's reports from Germany to Norway.

A few months before Kramish died, I managed to ask him whether he knew about Rolf. He did indeed, and he sent me an e-mail from hospital replying that 'I have always been interested in Widerøe's pioneering work on nuclear accelerators.' Sadly, he was too ill to take part in an interview and he wrote that he was sorry he didn't know very much about him. In his last e-mail he encouraged me to continue my research to find out more about Rolf and about what he called a 'most interesting project.'[98]

War Is War

Kramish's book includes people and events that cross Rolf's path from time to time and convey a picture of the world he lived in, without referring to him directly. In describing the setting in which Rolf and others were working, the book says something about how rumours arise and facts become uncertain in time of war. So healthy scepticism is also appropriate in assessing reports about Rolf.

Many people who were involved in the Second World War said nothing about it afterwards. When we had almost come to believe that there were no more stories left to publish, out came a book in 2006 about the Norwegian Sverre Bergh's double life as a student and an agent. After a fifty year silence he finally told his story when he was very ill, shortly before he died. He had taken seriously his vow of silence to the secret organisation of which he had been a member. The organisation was XU, later described by Kramish as 'the best organised and most productive intelligence organisation operating during the Second World War.'[99]

Some people thought that the vow of silence lasted for life, some for 30 and some for 50 years. There could be another war, and it would not be wise to disclose methods of operation. Berg hadn't signed anything, but he had an enduring loyalty and the work of intelligence services didn't suddenly stop when World War II ended and the geopolitical situation gradually morphed into the Cold War. There are still people coming forward to talk about what they have kept concealed for so many years for reasons that are more or less understandable to us—to us who were not them, there and then where war is war.

The book about the engineering student's contribution through XU to the British Intelligence Service ran into four editions the autumn it was published. People wanted to read about the 20 year old who took on the role of a spy, revealed the development of the German V2 rocket bomb and provided important reports about Hitler's atomic bomb project.

To the same extent as the heroes are reluctant to tell their stories, people are eager to learn about them. It has emerged that at the end of the war XU had about 1,500 agents throughout the whole of Norway and had developed a sophisticated courier system to pass information through Sweden and on to Britain. This mass of intelligence information gave the Allies a good knowledge of German forces in Norway. Most of XU's activity remained secret right up to 1988, and even after the then Norwegian Defence Minister, Johan Jørgen Holst released the members from their vows of silence, many continued to keep their contribution secret. It was a means of survival with memories that nobody else might understand, or that they could not talk about easily.

Young Sverre Burgh, alias Sigurd, was studying engineering in Dresden and had been instructed by his spymaster to find out everything about the Germans' atomic bomb programme and rockets. He was given a contact in the Springer publishing house in Berlin, in a department that published scientific articles about a range of subjects including atomic physics. The contact person was Paul Rosbaud. Along with Rosbaud, Bergh was the very first agent to report about the V2 rocket, its shape and size and the exact location of its launching station. Through radio transmissions from Britain, Bergh learned that the report had come through and he assumed that everything was in order. But then the British made a fatal error—they didn't believe it. He had risked his life, uncovered sensational information and ensured that the message got through—and had not been believed. He then lived to the age of 85 before the story became known to the public. The only people who had been in on his secret were his wife and an uncle who was a journalist, *Aftenposten's* foreign correspondent.[100]

Bergh was not the only agent to be recruited because of studying in Germany. The scientific editor at Springer, Paul Rosbaud, alias Griffin, had been in Oslo in 1939 before the war and discussed the founding of a new journal with Odd Hassel, a Norwegian chemist. They knew each other from when they had both been doctoral students in Germany. Rosbaud appears to have started using Hassel as a courier to the British intelligence service during the war, apparently without Hassel realising this himself at first. The material passed on in this way included what was known as The Oslo Report.

When Rosbaud came to Oslo in 1942, wearing Luftwaffe uniform and with permission from a high-ranking Nazi general, his official purpose was to visit another Norwegian chemist who was a good friend.[101] His real purpose was to pass on information about the development of the German atom bomb through XU to British intelligence. For this he used Hassel, who

now appeared to have understood and accepted his role as an intermediary. However, the contact was broken off early in autumn 1943.[102]

During his visit to Oslo Rosbaud had also met the nuclear physicist Harald Wergeland—also in XU—and told him that there was no danger of a German atom bomb. Wergeland had the information passed on to Leif Tronstad, the man who planned the attack on the heavy water plant at Rjukan.[103] Wergeland was later one of the expert witnesses in the case against Rolf after the war.

The Oslo Report

Editor Paul Rosbaud also had a long connection with the 'Oslo Report,' one of the most spectacular military intelligence leakages of the Second World War. The report brought together details of weapons and technical accessories developed by the German arms industry, including planes, torpedoes and radar equipment and the rockets being built at Peenemünde. The report was posted in two anonymous letters to the British Embassy in Oslo and sent on from there to MI6 in London for further analysis. The head of SIS, R.V. Jones, later commented in a book that the report must have been written by someone with a good scientific and technical background, and that it stood out from all the intelligence information he had seen so far. The identity of the source, however, was still a mystery to him when he published his book:

> Inevitably, the question will be asked regarding my own ideas about the identity of the Oslo author. I believe that I know, but the way in which his identity was revealed to me was so extraordinary that it may well not be credited. In any event, it belongs to a later period, and the denouement must wait till then.[104]

Sixteen years later the Norwegian resistance worker Arvid Brodersen wrote about how British intelligence received the report and he was able to reveal new details. The Oslo report and the story surrounding it was at that time not yet generally known about in Norway:

> The report took the form of two letters, posted in Oslo on 1st and 2nd November 1939 to the Marine Attaché at the British Legation, Captain Hector Boyes. The letters were unsigned, and the identity of the sender remained an unsolved mystery for many years. When the head of the Secret

> Intelligence Service, Dr. R.V. Jones, received and read the report he was immediately impressed by its high level of technical and linguistic skill and he was convinced of its authenticity. So the SIS complied with the sender's request for a coded receipt in the BBC News on a particular day.[105]

Then in 1967 Jones received a further letter, signed 'The Oslo Person,' in which the author of the report explained his motives for the apparently treasonous action of revealing secrets about German weapons: From his knowledge about the German military forces' new equipment he thought there was a risk that Hitler might win the war, and he wanted to prevent this. The report really had revealed secrets of great value to the Allied war effort. It was a breakthrough in scientific intelligence and it gave the British a good foundation on which to develop countermeasures against the weapons it described. When Jones wrote his book on British scientific intelligence services in 1978 he had good reason to include in the dedications 'The author of the Oslo report,' even though he didn't yet know his identity.

But Jones, head of scientific espionage in MI5, didn't give up. In a later book he was able to reveal the story of the author, who turned out to be the Technical Manager at Siemens, Dr. Hans Ferdinand Mayer. He had been on a business trip to Oslo, staying at the Bristol Hotel where he had written the report over two days on the hotel porter's typewriter.[106]

Cryptic and Conspiratorial

Rolf's rival and colleague Max Steenbeck at Siemens published his articles in *Naturwissenschaften* where Rosbaud, alias The Griffin, was editor. For a certain period of time Rosbaud had orders from his superiors not to publish material about the betatron. Like Rolf, Steenbeck had also submitted an article that wasn't printed. Rolf's editor in the same publishing house, Karl Egerer of the journal *Archiv für Elektrotechnik* was just as much a key person as Rosbaud, in a position to get hold of sensitive scientific information. Egerer had printed articles by Rolf in the 1920s, 30 s and 40 s and obviously knew the content of the latest article, the one that 'disappeared.' He can hardly have shown it to many people, but two people who would have known about it were Hollnack and Kratzenstein.

It is difficult to say how much Rolf knew about what was going on and whether they had previously met personally, but if the editor had as I believe visited Rolf in Oslo shortly after receiving the latest manuscript, Rolf must at any rate have known that. And if Hollnack was the one who provided

money to Rolf and administered his project in Germany, as they both confirm, then Rolf obviously knew that Hollnack was one of those who came to Oslo to recruit him. But Rolf said nothing about Hollnack having come to Oslo, nor about Kratzenstein, whose name he has never publicly mentioned.

It would be no surprise if sometime in the future somebody were to find a link to Rolf as an active player in the game he was caught up in. It would not seem unlikely, in the light of what else we know about wartime spying. No trace of any such link has been documented, however, and in fact Widerøe and the decisions and coincidences that directed the course of his life are just as interesting without it. If he had Nazi convictions it would not be surprising to go to Germany to contribute to weapons development during the war. Whether he was a declared Nazi or an Allied spy, he would have had a planned strategy and a programme to follow, and if he were a double-agent he would have had even less room to manoeuvre. Without such ties he is an ordinary person trying to get through as best he can, an illustration of how complex life can become. In an extraordinary situation a person of great talent can face correspondingly great challenges, especially if someone else wants to use him—and there are many who do.

Sometimes it is not easy for anybody to know what's what. In wartime, information is gathered and disseminated in the strangest ways. Giving it, obtaining it or just having it can be either lifesaving or lethal. It should be passed on to those for whom it is intended and to nobody else. Channels must be selected with great care, even cunning.

For example, in folder FO 1032/230 in the National Archives in London there is a cryptic note labelled 'Case: Hollnack,' written by Donald Fraser, Head of Security at the British Military Government's head office outside Hamburg. In June 1945 this T-Force officer was sent a strange, three-page text with obvious relevance to the matter he was working on, Rolf's betatron project. The text was artfully composed and contained an apparently heartfelt political message. It contained no specific names of people or places, but it was carefully written in a stylised form, as a play with two characters: a Norwegian and a German. The Norwegian is described as a technician and scientist; no description is given of the German. Time and place: 'Oslo, a house in the hills, October 1943.' Title: 'Conversation in Oslo October 1943.'

What was this about?

In the forwarding note that was addressed to Colonel Read and dated 10th February 1946, Fraser says that he has read 'with considerable interest' the proof copy of an article that he had been given to look through before it was to be printed in the little magazine, *Der Kreis*, ('The Circle'), and that

he specially wanted 'to draw your attention to two sentences on page 22, second paragraph.' Fraser had not taken time to send the German text to the translation office, and so had translated it into English himself:

> The German Government has proclaimed its right to play a leading part in Europe. Within my self-imposed limits I have made it clear to leading people in Germany, and will continue to do so, that to make demands for such a leadership cannot permanently be based on bayonets, but that first we must show the world what we stand for.[107]

Fraser had written a significant note in German in the margin of his own copy: '*Also! Marschiert DOCH das Herrenvolk!*' That is what people called the Nazi anthem, '*Die Fahne hoch! Marschier'n im Geist in unser Reihen mit.*' ('Raise the flag! March in spirit with us in our ranks.') In the covering letter to his superior, Read draws attention to the commentary he has written in the margin and he expands on what he means by adding:

> In other words, out of the morass of self-pity and masochism with which this production is filled from cover to cover, emerges this unmistakable indication of an utter lack of conversion to the idea of Germany taking her place in the world in equality with other nations – on the contrary, it is now through the power of thought and through cultural-humanistic propaganda that Germany shall dominate the world.

When Colonel Read received the letter, he consider the matter so important that he immediately sent a copy to Major Evans, with a commentary in the covering letter:

> This, of course, in no way means that our friend was or is a Nazi. It is merely indicative of the indigenous mental sickness that afflicts the German people.

From the context, there can be no doubt that 'our friend' refers to Hollnack. The article under discussion is no longer attached to its covering letter, but there is a copy of an English translation in American archives.[108] Alongside that is a letter that Fraser had received with the article, written and sent by—yes—Theodor Hollnack.[109]

The famous text was from the June issue of *Der Kreis* in 1945, which was published a month after the German capitulation and at the same time as the Widerøe group and Hollnack were in Kellinghusen summing up the betatron project. The publication date was 6th June. Three days later,

Hollnack wrote one of his very wide-ranging letters to the British with a big bundle of attachments, telling them about Rolf's project from A to Z. There, in the very last section of his ever so correct letter to T-Force 2, British Army, written on Hollnack's own notepaper, an attachment is mentioned that clearly differed from all the others. Hollnack's letter leaves little doubt that this remarkable text is about Rolf's betatron project:

> I am also sending you a copy of an article that is ready for printing in the magazine *Der Kreis*. To the people producing the article, it is about fellow-workers in MV-F.-V [The Megavolt Association]. The magazine is apparently for internal use and it indicates the ideas the group stands for. Moreover, approval will be sought from the British Military Government in Itzehoe before official publication. I venture to draw your attention particularly to "Conversation in Oslo 1943," on page 20.

Reading the text oneself, one experiences several revelations during the three and a half sides of dialogue. Rolf is definitely here. I have provided the English version, but from the context it appears to have been originally written in German:

Excerpt from the journal "DER KREIS" June 1945
Conversation in Oslo in 1943
Persons:

1) a Norwegian, a technical and scientific man
2) a German

Place and time: Oslo, a house in the mountains, in October 1943

The Situation:
Germany had pushed forward with a gigantic war-machinery and a dynamic never seen before, since 1939 in the East South and West. World seemed to be overcome. Germany seemed to be certain of its affair. Beginning 1943 and in the course of it Germany had to change from offensive into defensive and retreat began in the south and east. This, even to a critical German, could mean planning and self-restriction. The German press did the rest. From the point of view of the adversaries of Germany, the occupied and neutral states it was clear: the point of culmination of the German aggression had been exceeded. Here going back at all fronts, and therewith slow, but sure exhaustion; there a power of offensive of all rivals of German raising from month to month. According to this judgement the break down of Germany was still only a question of preparation and start of the invasion by England and America in the West. Even to the most non-critical member of a country occupied by Germany

it must appear a considerable risk to continue existing connections at the limit of its ability of aggression and, in the end, could not resist a pressure constantly getting greater. In October 1943 the dice against Germany had already been thrown from the point of view of foreign countries.

The Norwegian: I shall come to you to Germany, work there and realize my ideas. I am an engineer, my brain and my heart belong to mechanic and science. Except my wife, my children and my relations, work means everything to me. This work is my task of life. I believe that I have to give the world something and I have to fulfil my mission sooner or later.

The German: Man has in life only one duty, to recognize his mission and to fulfil it. The thorny way of mankind is called development. It can only be reached by giving away oneself without the rest to one's destination and by personal sacrifices. I shall give you the possibility to fulfil your duty to yourself to science and mechanics. Come to us to Germany!

The Norwegian: I know all that you tell me. Often enough I have examined myself. But just as to my work, I am connected to my wife and my children. Consider well, what you are offering me: certainly the immediate realization of my thoughts, but what does Germany mean to me! Germany is in war with nearly all the world. Till now Germany shed much blood, it has brought much suffering, misery and destruction to human being and the nations whom I am related to. It has invaded our country. The king, the leader of our nation had to escape and with him many of my compatriots. Thousands have been put to death, thousands dragged to a tribunal, only because they were good Norwegians. Your own compatriots have condemned my brother to 10 years in a house of correction only because he wanted to help good friends of his, he was accused of conspiring with England. My parents nearly broke down by that. And now you, as representative of this Germany, are coming to ask me to come to you. Surely, I like Germany. I know the Germans, and in your country I have many friends whom I appreciate very much and whom I would like not to loose. In Germany, I have studied and worked. Besides I know that it is not the real Germany which is causing this inferno to the world. It is just the depth and impenetrability of German soul made this people able and ready to give into the dynamic pressure of jugglers and hazarding creatures. Can you now imagine the conflict into which you are bringing me?

The German: You have showed Germany to me how it really is and like one can only judge men and things if one has the necessary distance from them. It must seem to everybody who does not know this people, that this land is the seat of the apocalyptic riders and that for cultural nations there is no more holy mission than to burn away this blister on the body of Europe. You see, I am a German and I like my country and my people just as you like yours. To love one's country does not mean to destroy that of other people. The more I am fond of this country, the more I can imagine and understand the virtues and faults of my nation, the more I am able to understand all human being that live under the same pains and sorrows. I do not see only their conflict, but I knew my own one, and I know that many Germans recoil at it the same myself. What are we to do? Shall we destroy the men who misuses a whole nation and who have founded their government on the most primitive instincts in man? This, and the possibilities hereto, no outsider can easily imagine. Not considering that I believe that such problems cannot resolved by the destroyment of single

men. Or are the German who overlook the evolution of things, to leave home, wife, children and their relations and join the army of the allied nations? Or shall we fight with ink and pen from a safe port and put the rotation-press of all countries into a furious movement against spiritless and tyranny? Or shall we be sitting during the act of this immense drama that now hurries over the stage of the world, as spectators in the parquette, tired and disinterested, terrified or intoxicated, applauding or rising tiresom, as if all this would be nothing to us? It would be more simple and straightforward, but not courageous and resolute. I do not see a martyr in a man who leave his nation in order to bring itself into safety. I believe that the real German grows up to the sense of sacrifice to know all this, to undergo the consequences of this attitude, and still to remain at his place and to do what duty demands from him.

The Norwegian: I must admit that I have not yet seen things in the way you are showing me. But if you please, what do you think to be your duty?

The German: I have said it already: to endure and to work, to undergo and suffer the horrors of this war, the bomb-nights same as millions of my people to whom help is necessary. To soften physical or soulish wounds of those families who lost their home, their relations or at least of some of them. To help people who are pushed out by reason of the politics of races, and thus are considered pariahs, only if it can only be a single one to whom one can be of use.

The Norwegian: That may be all quite right. But you spoke of the work. How is it possible at all to work in Germany under the existing conditions and how can one think of starting a task, which almost does not belong to the present development of war at any rate? Besides: Doe not every work lose its real sense and every justification under this point of view, in the present Germany?

The German: My answer to this shall justify my attitude stated above and that of any German as well. My own responsibility engages me to the following: to arrange for a problem, the results of work of which are highly exceeding the frame of the present war, to act for the solution of a matter which keeps its importance also after the end of the war and that really for all nations. Besides, we have to consider that after the end of this war Germany will be a poor, destroyed country. Therefore I consider it a demand of the hour that every German works according to this as far as his abilities and possibilities enable him. The German government has claimed to the leading in Europe. I have explained to leading persons of Germany and shall continue doing so that a claim to such a leadership ought not to be supported by bayonets for all time, but we have to prove at first our spirit to the world. Besides I know so well as you that one can be master of a people and likely of all the world for long years by force, but that at last justness will triumph. Besides I am seeing the time coming when present dream of a 1000 years' empire breaks down on account of its lack of supposition and conditions and that with this event new leaders are brought up, tolerated or moved by ambition; or nobody's blessing, neither for that of a real Germany nor for that of the world. Then we need creatures grown ripe by afflictions who have learned to keep silence and also can be silent, and speak only when truth and justice demand it. I follow the politic of the "Trojan horse" and hereby and in persecution of my zeal I make use of every means; every lie in this connection means a holy lie to me. I use those forces which I cannot and will not destroy, but I do not allow anything to make use of me.

The Norwegian: So you seem earnestly to believe that such an immense problem of research and development, as my work represents, could be executed with result in Germany?

The German: Yes, I am even convinced that, for the time being there is no better possibility of realizing your work of life than in Germany.

The Norwegian: This I do not quite understand.

The German: I will declare it to you. Germany, nearly without any exception, works on preparation-equipments. All proposals which are not in any connection to the war, are not allowed to be executed. A certain part of research and development, however, is kept, and those ideas which for the time being are executed, are carried out most urgently. Besides, my method guarantees a preferring attending to your problem, and moreover you will always meet at the responsible places some persons with whom a working together pays out. Please consider the difficulties arising for a researcher in most of the countries, same as formerly in Germany to execute a founding work which possibly requires a lot of money, and the many years which a researching personality sometimes has to spend useless before getting to the zeal of his desires.—All of us know the desire and the necessity for an inquirer to be and to remain independent. In each technical or economical connexion there is an extreme danger to one's own research and the evolution of it. Anyhow, I am absolutely convinced that considering the possibility that you could bring your problem nearer to a realization and that thus you would render inestimable service to your country as well as to other nations. I am fully aware of the fact that you will not find any especially good personal conditions and that you are put to certain dangers by your eventually working in Germany. Please also think of your brother whom possibly you might be able to help. My request to you "Come to Germany" means a sacrifice to you. But this sacrifice you ought to bring to your work, to Germany as you know it and as it really is, and besides to the world.

The Norwegian: Well, I am ready. I am coming to you to Germany.

How shall we begin to try making sense of this? First, three preliminary observations:

The role-play is written by someone who knows the topic well, either because the author was present at the conversation or because he has been thoroughly briefed on the subject. The German's responses are long and didactic, the Norwegian's short and personal. There is no doubt that 'The Norwegian' is Rolf and that the piece refers to an actual event. One obvious question is: 'Who is the German?' From what is known so far about who visited Rolf in Oslo, there are three possible candidates: Hollnack, Egerer and possibly Kratzenstein. But it is difficult from the content of the text to envisage any of these standing out as first choice for the role of the German. Another possibility is that all three are combined into a fictitious character as a literary effect.

Another question is: Who can have written a piece such as this? One possibility is that 'The German' is the author, someone who himself took part in the discussions in Oslo. Another possibility is that somebody who had heard the story retold it in his own way. In either case, the author has applied the literary technique of combining the people who were present at the real event into one character, 'The German.' Even though the text is not finely crafted literature, whoever wrote it knew about dramatic form. The content does have a certain philosophic sound, which leads us to think of Hollnack with his interest in Nietzche. Egerer with his editorial skills could possibly have been the author, but it is difficult to find indications of this. The other possibility, that someone put the story together without having been there in Oslo, opens up numerous possibilities.

It is not easy to throw light on this question by analysing the text, but one probable interpretation is that the source of the narrative was somebody who went to Oslo to fetch Rolf, and that this person was also the author. Hollnack, who also submitted the text to the British, is the most likely candidate. We don't know whether the British knew the identity of the author, as there is no documentation to that effect in the British security archives. However, two letters that Rolf received from his former assistant Touschek after the war state plainly that the author was Hollnack.[110]

The next question is: What did somebody want to achieve by publishing this? What message was somebody wanting to send, and to whom? I don't know whether the British officers who received the text knew about the magazine in which it was intended to be published. Hardly anybody knew about it, and that was the whole point; it was a closed forum. Only the Swiss editor and one other person would have had the list of subscribers, which amounted to only 200 people.

Der Kreis—Le Cercle—'The Circle,' which was its full name, was a magazine for intellectual, homosexual men and had an ambitious political and artistic aim. Homosexuals were suspect in Hitler's Germany and would be rooted out by the SS along with Jews. The subscribers comprised a secret club in which the magazine was an important channel of communication. At that time it published articles in German, English and French. Very many of the members and writers operated with pseudonyms. The editor and leader of the group was a playwright and wrote many of the articles himself.[111] He worked under several names, but in the magazine he always used the pseudonym 'Rolf,' a coincidence that might easily confuse us. On the other hand, it is conceivable that he could have been the author of the drama about the German and the Norwegian.

It is significant that Hollnack gave the text to the British, when there was no need for him to do so. What did he want to achieve, and by what means? Why did the author want to have it published in this way, in this very specialised magazine, and why would Hollnack bring it to the attention of the British? It seems odd that the British Military Government's office in Hamburg would recognise an article for such a publication. It suggests that somebody had a specific intention with it and wanted to report to somebody about the content.

I haven't found evidence that Hollnack was homosexual, although there are things that suggest this. Evidence to the contrary includes the fact that he was married. But his courier, the teenage boy with the many names, was homosexual, as he has said himself. Hollnack may have had a strange effect on those around him, but the courier's role seems even more mysterious. In his autobiography many years later the courier wrote that he had been Hollnack's *Günstling* ('Favourite') and that the others had therefore treated him with a certain respect:

> Nobody knew why I was there. So there must have been a very good reason for me being there.[112]

The courier himself thought that it was all very strange, and he was unhappy that all he basically had to do was to travel round delivering envelopes. After the war, when Hollnack tried to explain the situation by telling him about his work for the Allies and started talking about the members of his office staff who were Jewish, he didn't follow what it was all about. Then when Hollnack went on to assure him the English would value his contribution, he understood even less. He wondered what his role had been in the imbroglio, and whether he had been Hollnack's 'private Jew.' Though the thought crossed his mind, he didn't say anything about it at the time. He had obviously been kept in the dark, and he realised that the information he had been given was just spin.

He also realised though that he himself had been helped and that after the war, to be fair, it was his turn to show magnanimity and to protect his boss if necessary. 'Perhaps he had really been assisting the Allies while he was working for the Germans—and himself.'[113] This comment seemed like a significant revelation, though he didn't expand on it further. Kellinghausen had been full of British soldiers, and he had noticed that above the door of his lodgings there was now a notice: 'Eighth Army, T-Force, Keep Out.'[114]

After the war the courier moved to England and became a recognised author under the name Jacov Lind. His work has also been translated into Norwegian. His autobiography is a strange mixture of eroticism, rockets and a sort of politics, marking him out as a possible candidate to have written the pompous text for the homosexual magazine. However, he was only 18 when the war ended and at that time he hardly had the knowledge or the skill, or indeed the interest, to write about how Rolf came to Germany. So we must eliminate him as a possible author of the strange, dramatic dialogue.

The whole story about homosexuality may just lead to a blind alley, but everybody who receives a copy of the text and sees the accompanying notes both on the British security chief's covering letter and Hollnack's own, needs to ask: Why does the dialogue between 'The Norwegian' and 'The German' appear in a magazine such as this? Was it just a cloak of concealment for a channel being used to deliver information that should be kept hidden from anyone other than those for whom it was intended? That may be the case, but if so the question remains of whom the author was trying to reach and what he was trying to say. It is not immediately obvious, for example, where 'The German' is going with his quasi-philosophical reflections:

> Then we need creatures grown ripe by afflictions who have learned to keep silence and also can be silent, and speak only when truth and justice demand it. I follow the politic of the "Trojan Horse" and hereby and in persecution of my zeal I make use of every means; every lie in this connection means a holy lie to me.

Formulation such as this can point towards the mysterious Hollnack, who among many other things included public relations and marketing among his areas of expertise. This would confirm what Touschek had written to his parents. The literary technique of combining the real participants into one fictitious character in the narrative illustrates the conflict and sharpens the message.

But why in *Der Kreis*? That question will have to remain unanswered meantime. Even though the relevance of the dramatic text to our own story is unclear we have to mention it, because it is so clearly about Rolf. If nothing else, the text shows how complex and strange life round about Rolf was during the war. Perhaps one day an explanation will appear of why it was intended for that particular magazine.

The covering letter that Hollnack sent to the English security chief gives us no help in this, but clues are available if we delve into old archives and

find Touschek's letters to his former boss. We read there, in the first letter that Touschek wrote to Rolf after the war, that the play was indeed about a dialogue that was supposed to have taken place between Hollnack and Rolf, and that Hollnack himself was the author. Its purpose was to protect Rolf from accusations by the Allies. Touschek had protested against this at the time, he wrote, saying that 'If I were in your position I would decline such a justification.' In a later letter he was even more critical of the text, which he thought contained only hot air and moreover was badly written. In fact the whole magazine was full of bombastic writing, and Touschek had refused to write anything for it. But Hollnack obviously thought that it was important to do this, and he had persuaded several of his colleagues to submit articles, including Kollath—which surprised Touschek.[115]

In brief: It is well known that homosexuals were persecuted by Hitler's regime, and obviously a homosexual magazine with a very limited and defined readership could be a safe channel to pass on information one didn't want to go astray. In this context, the question of whether some of the Germans involved in or around the betatron project were themselves homosexual is immaterial. The interesting thing is that the story printed in the homosexual magazine was Rolf's story. Somebody knew it, was concerned about it and wanted to pass it on. For reasons unknown. Those who received it directly were members of a little group of intellectual homosexuals whose names were on a list known only to two people.

In addition to these, someone else received it indirectly; a security chief in the British Military Government was able to read it because Hollnack, who was probably the author, had sent it to him. The security chief sent it up the hierarchy to the control officer, who sent it further up to the Major. It was no less than the story of how Rolf Widerøe was taken to Germany to work in the Luftwaffe.

It was just as Hollnack himself had told T-Force; the story of three men—probably Hollnack, Kratzenstein and Egerer—who had travelled to Oslo to persuade Rolf to come to Germany. Just told slightly differently, in a separate document that also ended up in a folder in the USA among material classified as secret, collected and archived by the American intelligence organisation, Alsos.

Did he know but not say

– ***that Randers was working for the American intelligence services?***

Gunnar Randers crops up in the strangest times and circumstances of Rolf's life. It is difficult to say how long Randers had been shadowing him, but

that was part of his job as a member of the scientific intelligence organisation Alsos, to discover as far as possible what progress the Germans had made in atomic research. Who was closest to building an atom bomb, the Germans or the Americans? Books are still being written on this topic.

Alsos was set up to find out about German activity in this area and it started work in 1944. In July the following year Captain Gunnar Randers was in Norway to interview Rolf, who was detained in prison at the time. The Alsos agent came away from the interview with a thick folder of information about the betatron and about Rolf's work for the Germans.

Norway is a small country in a big world, but that is not the only reason why these two men's paths later crossed several times. They were both expert scientists at an international level, working in closely related fields. Their first meeting was when Rolf had recently returned to Norway and was in prison. Rolf was asked questions, answered them, handed over documents and was set free. Surely a major life-event for anybody? Rolf says hardly anything about this, nothing more than he has to. In the biography, Randers' visit to him in prison is described on page 100 in seven lines: three to explain who Randers was and why he came; two to describe the solar eclipse that day and the remaining two to tell us what Rolf said and what he thought about the meeting:

> I had a visit from the Norwegian physicist Gunnar Randers who had been in America for a while and then in Norway and had been working in astrophysics and nuclear physics. He had been given the job of speaking to me, apparently because of the V2 rockets. It's easy to find the precise date, because there was a solar eclipse that day and he had brought a smoked glass to look at the sun. I explained to him what I had been doing in Germany and – as I understand it anyway – we parted on good terms.

This short and practical extract from the biography could have been a minimalist statement of a sequence of events in an Old Norse Saga—if it were not for the human interpolation between the dashes at the end. 'Alsos' is not mentioned. No emotion. Dry. Factual. Mission accomplished. Message delivered. I've given the biographer what he wants. I was asked some questions. I explained what was what. We watched the eclipse. That's how it was. Nothing more to be said.

Really?

Rolf said everything and nothing, quite cunningly. He can't be accused of not mentioning the episode. Had he planned beforehand that was what he would say to his biographer and no more? Or did he tell all he knew in good

faith. As the biographer didn't press him any further, we can find no more help from that quarter. Alsos was not generally known about at the time of the interview in Ilebu prison. It was known about half a century later when Rolf was over 90, but he still didn't mention it.

When I Was Ready I Was Released

Nor did Rolf say anything about intelligence services and the hunt for German scientists when he took part in the seminar with Norwegian physicists in Oslo in the 1980s. In the verbatim transcription from the tape-recording of that interview he is either suppressing a very disturbing memory or simply describing the sequence of events:

> But there was something odd. Randers, he was given the job – he was away in America – of coming to Norway to question me. So I met him in the prison and we became quite good friends and we talked about all sorts of things. For you see, the reason I was in prison was that the neighbours in Røa, they had known that I knew about relays and so they thought that I was the inventor of the V2 bomb. That would obviously have been a terrible business. And so that was why I was in prison in Grini. And that was why Randers came to Norway to question me about it. And I was able to explain to him quite quickly, of course I told him everything just as it was, and he understood immediately that all this about the V2 bomb was just nonsense. So after that there were no great difficulties for me.[116]

As before, according to the record he had described his stay in the prison at Ilebu with a mere fifty words. The whole story of the report, his arrest, imprisonment, his feelings, the conditions. It could have filled a whole book of one humiliation after another. But this is how it was:

> And so I came home to Norway and when liberation came, then I went into Grini and I was very lucky because I was allowed to take all the notes about the betatron, and I sat there in Grini writing a paper about the betatron. And then when I was ready I was released.

Gunnar Randers had been on a scholarship in the USA before the war, but he moved to England in 1942 at the age of 28 to take part in the Norwegian Government-in-exile's work with the Norwegian forces. He was a pioneering astrophysicist who had been highly commended for his university exam, and

he had a knack of being where things were happening, or perhaps of being where he could make things happen. Later in his career he was one of the founders of the nuclear research reactor at Halden in Norway and he took part in establishing both the Norwegian Institute for Energy Technology and the Norwegian Defence Research Establishment. He had followed the race for the atomic bomb closely and he already had inside information about the American project when he joined Alsos as an intelligence officer and was assigned to Headquarters in Paris. As the Allies advanced, groups of two or three officers were sent forward from there to the front lines to look for both large and small German laboratories and find out what work had been going on and how far German scientists had come in their atomic research.[117]

Colleagues Meet

The Chief Scientist in Alsos, Professor Samuel A. Goudsmit, has described the particularly unusual situation that arose when the investigators and those under investigation were former fellow-students and colleagues.[118] He described for example what it was like to have to interrogate the legendary Professor Bothe, whom he knew well and who he thought was a declared non-Nazi and Germany's leading experimental nuclear physicist. That was in mid March 1945, when Alsos, close on the heels of the Allied troops, had crossed the Rhine and reached Mannheim and the university town of Heidelberg. This was an important target for Alsos, as it was the workplace of a big group of physicists around Bothe and his cyclotron—the milieu where Rolf's assistant, Touschek, was employed after the war. Alsos' first task here was to occupy the laboratory. Goudsmit was nervous and uncertain how to handle the situation. Fraternisation with the enemy was strictly forbidden:

> Here I was going to meet the first enemy scientist who knew me personally, a physicist who belonged to the inner circle of the German uranium project. (…) But how could I be authoritative with Bothe, who was not only an old acquaintance and colleague, but certainly my superior as a physicist? How did one command an older and respected colleague to turn over his papers?[119]

The Alsos Chief Scientist's task was to gather information about the Uranium Project, and his success in this depended largely on how this first meeting with Bothe worked out. Would he need to get soldiers to arrest

him? Would he need to extradite him to the USA? How did one order a senior and respected colleague to obey ones will?

However, it wasn't easy for the German colleague either. They both fumbled:

> Bothe greeted me warmly, and we shook hands, which was against the non-fraternizing rules.
>
> "I am glad to have someone here to talk physics with," he said. "Some of your officers have asked me questions, but it is evident that they are no experts on these subjects. It is so much easier to talk with a fellow physicist."

Goudsmit tells how he was shown round the laboratory and that they spoke about the work being done at the institute and the latest research results. Not least, they looked at the cyclotron that Bothe was obviously proud of, the only German cyclotron in operation as compared with the approximately twenty that were in use in nuclear research in the USA. Goudsmit was amazed at how much pure physics had been done during the war. There could hardly have been much time left over for military research. And then he came to the point:

> Finally I popped the question: "Tell me, Herr Kollege," I said, "how much did your laboratory contribute to war problems? It is obvious that not all your time was spent on the interesting work you have explained so far."
>
> Professor Bothe became nervous. "We are still at war," he said. "It must be clear to you that I cannot tell anything which I promised to keep secret. If you were in my position you would not reveal secrets, either."
>
> There was little I could say to that. I argued that the war in Europe was almost over anyway, and I dropped a few hints that I knew a lot about the uranium problem already. But the more I insisted, the more excited and angry Bothe grew. Plainly I was not getting anywhere with him.

Goudsmit changed tactic and tried to get hold of documents instead:

> Bothe shook his head. "I have no such papers," he said. "I have burnt all secret documents. I was ordered to do so."

The Alsos professor didn't believe him. He could have burnt official documents, but it was hard to believe that a physicist would have burnt the results of his elegant research however many times it was stamped '*Geheim*' and '*Secret*.' The German maintained that he was speaking the truth. He regretted his action, he said, but the order was clear.

Finally Goudsmit had to admit that his suspicion was ill-founded. Counter-espionage and a thorough search of the locality showed that Bothe *had* been telling the truth. In his book, Goudsmit maintains that Bothe was a man of his word and could be trusted. Nor did Bothe reveal anything more until the war was over. Then he wrote a report, but he obviously knew that the Americans knew much already. Goudsmit ends his assessment of Bothe by concluding that he was "a loyal German, but never a Nazi." He had lost his professorial chair at the University of Heidelberg when the Nazis moved the teaching programme to their capital city. He was given a position instead at the Kaiser Wilhelm Medical Institute, which was also in Heidelberg and where party politics had less influence.

The interrogation of Werner Heisenberg was another important occasion for Goudsmit. Allied intelligence had been hunting for Heisenberg for six months, but the meeting between the two professors was less dramatic than expected when it finally took place:

> I had just returned to Heidelberg when Heisenberg was brought in. I greeted my old friend and former colleague cordially. Purely on the impulse of the moment I said. "Wouldn't you want to come to America now and work with us?" But he was still too impressed by his own importance and that of his work, to which he ascribed his internment.
>
> "No, I don't want to leave," he said. "Germany needs me."[120]

It was sad and ironic to hear. Goudsmit felt sorry for the man who had visited him in the Netherlands when they were young and also several times later in the USA, most recently in July 1939 when he had even stayed in his house. He wrote that Heisenberg was dazzled by his own role but that he was still Germany's greatest theoretical physicist and one of the greatest in the world. He reminded himself that Heisenberg's contribution to modern physics was on a level with Einstein.

Goudsmit's meeting with Walther Gerlach in Heidelberg was rather different. They also knew each other but when they had last met, at a conference in England in 1938, Gerlach had been evasive and frightened to talk about anything connected with the political situation in Germany. Now he was much more open. He was another of the prominent physicists whom Goudsmit himself chose to interview. Gerlach explained how when he was appointed head of all physics research in Germany he had tried to speed up the research, which had stagnated under his predecessor. Gerlach was not a Nazi, Goudsmit concluded, though he did think that his judgement could sometimes be faulty. His only aim was to promote German research independently of the political regime.[121]

In one way it is easy to understand the relationships between these fellow-scientists when they meet. In another way it is more difficult. That's how things are in war. It is not for us to pass judgement. My intention is to try to sense and communicate a little of what it was like for people in these situations; what it was like to be a world-class researcher in atomic physics and accelerator technology during the race for the atomic bomb—during a world war.

Randers had the task of interviewing Rolf, who was in detention in prison by the time the interview took place. Despite the seriousness of the topic, the interview took the form of a friendly meeting between colleagues. Professionally they were on speaking terms and Captain Randers was genuinely curious about the betatron. Like his colleagues in the intelligence service, he probably had an outline plan for the interview. This started with a friendly approach based on the interviewee's scientific background, and particularly on the fact that it was not unusual among German researchers to realise that the battle was lost and that their only chance to continue their research activity in the next couple of years was to be on a good footing with American researchers. Thereby they could have the possibility either of carrying out new research in Germany after the war, or of being invited to join a research programme in America.[122]

> … after a couple of days discussion, I not only knew more about betatrons than before but also had become so interested that I had started thinking of including the building of a betatron as a research instrument in Norway as part of our plans in FOTU.[123]

The Atomic Age Comes to Norway

This was a high-level plan for collaborative research. FOTU stands for *Forsvarets Overkommandos Tekniske Utvalg* ('Defence Forces High Command Technical Commission'). During the war this organisation recruited many Norwegian researchers and engineers to work in British research laboratories. This activity was important for the rebuilding of Norway and the Commission became the forerunner of the Norwegian Defence Research Institute. Randers and Rolf were both enthusiastic and imaginative men, and it is no surprise that they came together.

Norway entered the atomic age in the early post-war years, and when the experimental nuclear reactor at Kjeller was completed in 1951 it was an international event. The names of the main participants in this are worth noting in relation to Rolf's role. The work had high status, and the research

that was carried out there received more public support than other scientific research, thanks to the Resistance Leader Jens Christian Hauge who became Defence Minister in 1945.[124]

> Hauge played a key role in the early phase of the Reactor Project. It was he who gathered the necessary funds and who together with Fredrik Møller, Gunnar Randers and Odd Dahl saw to it that atomic research in Norway was given a practical objective. (…)
>
> Through his discussions with Møller and Randers, Hauge had been convinced that it was of decisive importance for Norway's future security that the country acquired independent technical competence in the area of nuclear physics.[125]

The Reactor Project is considered to be the nearest that Norway came in the 1950s and '60 s to what physicists call 'Big Science.'[126] In a study of the growth of nuclear physics in Norway Rolf is spoken of alongside Randers and Dahl. All three were entrepreneurs who made things happen. Randers was described mainly as a research politician, an administrator of nuclear physics installations, whereas the two others were described as research technologists:

> Dahl played a leading role in building nearly all the nuclear research installations in Norway. Widerøe influenced accelerator design and development significantly and is often called 'the father of modern particle accelerators.' In contrast with Dahl, however, Widerøe had hardly any influence on the development of particle accelerators in Norway.[127]

The powerful people behind the building of the reactors at Kjeller and Halden and the establishment of the research institute at Kjeller wanted to include Rolf and they made contact with him. Gunnar Randers was one of these. Another was Fredrik Møller, an electrical engineer who had taken part in military technology research in England during the war and who had now taken over as leader of FOTU. Rolf responded positively. Nobody saw the potential benefits of atomic research for industry and society better than he did. Just six weeks after his release from prison, on 23rd August 1945, he wrote a long letter to Møller about his idea of establishing a research institute, inspired by the Niels Bohr Institute in Copenhagen. He puts forward his ideas in unrestrained 'Facebook' style about what he has achieved so far and how he can contribute in future to the benefit of industry and society. This is not the language of a defeated man. His patents, the 30-betatron, the 200-betatron, the competition and Brown Boveri are all mentioned,

including what he calls his forced removal to Germany. He argues that 'the industry together' should finance 'a new research institute which above all and on a broad basis should work on nuclear physics:'

> The new research institute that you and Dr. Randers have mentioned to me seems to me in many ways to offer possibilities for a solution to the tasks that I have listed here. At present I know too little about the new plans to be able to comment, but I did think that it could be of interest to you to have an insight into my own plans for these things before we have discussions together with Randers and Dahl about how we can best carry the matter forward.

Suddenly there was silence. The initiative that Randers and his colleagues had invited him to take part in was not followed up from their side. The active protagonists of research in general and in atomic power in particular suddenly stopped turning to Rolf. The Norwegian Defence Research Institute was established at Kjeller the following year, in April 1947, with Fredrik Møller as Director. This was a totally new type of research institute, quite different from the establishments in Bergen, Trondheim and Oslo.[128] Møller was an important member of the circle around Hauge who wanted to use research and technology to create new industry, and he became Chairman of the newly established Central Institute for Industrial Research in Oslo, now a part of SINTEF in Trondheim. He also became Chairman of Kongsberg Weapons Factory and Raufoss Ammunition Factory, among others—and Knight First Class in the Order of St. Olav.

Møller was succeeded as leader of the Defence Research Institute by Finn Lied, who played a central role in the politics of Norwegian research, industry and oil throughout the second half of the twentieth century. Lied followed Jens Christian Hauge as Chairman of Statoil [now 'Equinor'], and throughout three decades was a member of the Norwegian Technical and Scientific Research Council, which played an important part in the post-war development of research. He was also a Commander in the Order of St. Olav and a holder of the Defence Service Medal with Laurel Branch.

Rolf had been in good company until he ceased being part of the circle.

Alongside and always in close collaboration with the Defence Research Institute, the Institute for Atomic Energy (now the Institute for Energy Technology) was set up in 1948. This was the parent organisation of the Halden Project in which Gunnar Randers was the prime mover and Director. When the Atomic Branch of the Research Council was created just before that, Randers was obviously included, along with the three others who had sat on the expert committee advising on the treason case. All

of them were among the great and the good who would rebuild the country after the war on a basis of research and technology. Gunnar Randers, Odd Dahl, Fredrik Møller, Finn Lied. All reappointed to numerous scientific advisory committees and institutional boards of management over the next decades. Plus Tangen and Hylleraas and Wergeland from the expert committee.[129]

But not Rolf. Electrical engineer. Doctorate. Industrial contacts. He wanted to create a research institute to develop Norway, together with Møller and Randers and Dahl and the others but was no longer one of them. Not a word has been found anywhere to indicate that he resented that. There were other arenas. If not, he could create one. Problems are there to be overcome. The same Randers who had allowed himself to become fascinated by the betatron research that July day in Ilebu prison had a soul-mate.

Much of the information that is available today about Rolf's activity in Germany can be found in the material that Alsos had gathered with the help of Randers and others. Much of the information about the betatron that was confiscated by the British T-Force also ended up in the care of Alsos. But about co-operation between the two men to build up research and industry after the war, there is nothing to be found.

Hard Facts About Alsos

Operation Alsos, or Alsos Mission, was a top-secret operation set up jointly by the USA and Great Britain as a consequence of the Manhattan Project, the Americans' own atomic bomb project. The troops engaged in Alsos followed closely behind the front line, first through Italy and then through France and Germany, looking out for people, equipment, reports, material or sites that might have been involved in the development of atomic weapons. Their task was to map where any such evidence was found, ensuring that the Western Allies got news of it—and preventing it from falling into the hands of the Soviet Union. Or put another way: 'preventing what everybody most feared, that Hitler might deploy an atom bomb in a last desperate attempt to save his regime.'[130]

Alsos is sometimes mistakenly written with capital letters, on the supposition that it is an acronym. But *alsos* is Greek for the English word 'grove' and the name is a reference to the military head of the Manhattan Project, General Leslie M. Groves. The Chief Scientist was Robert Oppenheimer, and it is illustrative of how small this circle of experts was

that Oppenheimer's competitor for the job was the physicist from Berkeley, Ernest Lawrence, who had built upon the concept of the cyclotron in Rolf's doctoral thesis.[131]

Already on 29th November 1944, several months before Goudsmit's interviews in Heidelberg, members of the Alsos mission in Strasbourg had already arrested the first of the German scientists who had been working under the auspices of the Uranium Club.

In the course of spring 1945 Alsos took in many of the Germans who were on the wanted list. The Alsos agents confiscated documents and equipment, and destroyed what they could not take with them. In May 1945 they at last found Heisenberg, at his country house outside Munich. Not until the month of July did a little group get permission to enter Berlin. They were then able to put into place the last pieces in the jigsaw puzzle, which merely confirmed and did not alter the big picture.[132] Their main target was obviously the Kaiser Wilhelm Institute for Physics where the uranium research had started almost simultaneously with the start of the war. This was one of the few buildings that were still intact. But it was empty. The Russians had been there and had removed everything of value including the light switches and the electric cables.[133]

By the end of July 1945 Alsos' work was more or less complete. Even though German scientists had destroyed a lot of material, the Americans got hold of important reports and correspondence. The documents were mostly stamped 'secret' or 'top secret' and had had very limited distribution. All this material was now transferred to the USA to be examined and assessed. Taken together, it gave an overview of German atomic research. The material was returned to Germany in 1970, and since 1998 the Alsos material has been preserved in the archive in *Deutsches Museum* where it has been catalogued and made accessible. Historians and scientific historians have made use of the material and interpreted it in various ways. It demonstrates to the whole world that the fear of Hitler's atom bomb was greater than the real danger. Theatre and film have also gone to town on the topic, demonstrating that it has an appeal far beyond scientists' range of interest.

Operation Epsilon

Alsos' final task was given the code-name 'Operation Epsilon.' The ten German scientists whom the Allies thought had worked on Nazi Germany's nuclear research programme were taken to England and interned in Farm Hall, an almost palatial country house near Cambridge.[134] They were held

there for six months, from 3rd July 1945 to 3rd January 1946, well beyond the range of Russian intelligence services. Concealed microphones enabled everything that happened to be recorded and monitored. The personnel charged with the task of listening in were able to share in the internees' concern for their families, readings aloud from Dickens, Heisenberg playing Beethoven sonatas and the reaction of a Nobel Prize winner who only learned about his award when he read about it in the newspaper.[135] His whereabouts were unknown, and even the Swedish Academy was unable to send him a congratulatory telegram.[136]

The purpose of the exercise was obviously to listen to their conversations to find out more about how close the Germans had come towards constructing an atomic bomb. Few atomic secrets were revealed, but what did become apparent was that the German researchers were divided in their opinions and sometimes quite angry with each other. There were all shades of opinion from full agreement with Hitler to full opposition.

There was also much disagreement between those who wanted the project to succeed and believed that it could succeed, and those who had worked to hold it back.

In the midst of all this came news of the Americans' use of the atomic bomb over Hiroshima on 6th August 1945. This news came as a shock to the residents of Farm Hall. Again, opinions were divided. Some were disappointed that they had not managed to make an atom bomb for Hitler; others were glad that they had not succeeded.

Transcriptions of the conversations were sent to British military officers and on to the U.S. Department and then to General Groves in Washington as part of Operation Alsos. The transcriptions were declassified and published in February 1992 and were later dramatised on BBC Radio 4.[137]

Goudsmit, who had been Chief Scientist at Alsos, had already given his candid account in a book he published in 1947. He started from the point of view that the atom bomb was top secret and was a mystery even to high-ranking members of the military. The work of the Alsos organisation had therefore had to be shrouded in secrecy, but now he could tell the story and express his opinions quite freely. He acknowledged Germany as the most technically advanced country in Europe, and his key question was how the German research programme could fail, whereas the Allies succeeded. He was in no doubt about the answer:

> I think the facts demonstrate rather well that science under fascism was not and probably never will be on a level with science in a democracy.

He considered that the root cause of this was hero-worship and he illustrated this using Heisenberg as an example:

> Werner Heisenberg, for instance, was the foremost atomic physicist in Germany, a scientist of world repute, and no good young German scientist would think of questioning the word of the master. But science is not authoritarian, nor can scientific thought be dominated by a boss, however gifted he may be.

Others thought that Goudsmit had been too quick to jump to conclusions and pointed out that the idea that research couldn't flourish in a totalitarian regime did not tally with German advances in other areas. Who had developed the Messerschmitt Me 262, the world's first operational jet fighter? And the V2, the world's first ballistic rocket? The Soviet Union's development of nuclear weapons some time later was also cited in the debate. Whatever one's view of this, the point is that the Germans had not made much progress towards an atomic bomb. That was what Alsos and the other scientific intelligence organisations had confirmed.

Moreover, Heisenberg had visited the USA shortly before the outbreak of war. He had given lectures at the University in Michigan and had lodged at home with Goudsmit. He had shocked everybody by saying that he must return to Germany before the war started, a statement that has since been interpreted in many different ways, like much else of what he said and did during the war.[138]

Alsos' conclusion was that the Allies had overtaken the Germans in the nuclear arms race by 1942. The German Arms Minister, Albert Speer, confirmed this himself when he wrote his memoirs in 1970. He wrote about events in 1942:

> We abandoned the attempt to develop an atomic bomb, on the advice of our nuclear physicists. (…) Taking the costs into consideration, it would have been impossible to assemble everything that would be needed in the form of materials, workers and facilities.[139]

The Big Failure

Historians have given very varied interpretations of what the German scientists themselves thought about their project at the time. Goudsmit, however, shows little sympathy in his cynical description of the attitude among the German scientists while they were interned in England:

> It was then that some of the younger men hit upon a brilliant rationalization of their failure. They would turn that very failure to their advantage by denying that they had ever tried to make an atomic explosive. (…) They would stress the fact that they had been working only on a uranium machine, and forget that they had thought this would lead directly to the bomb. They would tell the world that German science never, never would have consented to work on such a horrid thing as the atom bomb.[140]

Gunnar Randers, the Norwegian, had thought along similar lines as the Alsos officers advanced through Germany:

> I gradually realised that the Germans had made considerably less progress than the Allies. Indeed, in reality they had apparently abandoned the project sometime after the sabotage operation at Vemork which deprived them of the heavy water production.[141]

He gave his opinion about why the Germans did not succeed in making an atomic bomb:

> It has since been claimed that the Germans refrained from building atomic bombs for moral reasons. Their active project in the first years of the war clearly shows that this was not the case. It was a combination of a lack of technical and economic investment and lack of scientific leadership (…) which led to the project never going beyond the laboratory stage.

It may seem curious that Randers wondered why all Alsos missions were carried out by agents wearing uniform, though he himself used his Norwegian badges of rank to the utmost. He explains this in his autobiography:

> It may seem strange that we were travelling about in uniform when our task was espionage, but it was really the only sensible way. Scientists shouldn't really spy, they should gather information in discussion with researchers. To travel in the vanguard wearing a hat and a suit was almost impossible. One would have stuck out in the crowd and risked problems of identification both on one's own side and with the enemy, and especially with the Allied transport organisations. German uniform was obviously not suitable for our purpose, so the solution was to wear our own uniform.
>
> So as not to stand out as a foreigner when we were in the field, I used an American battledress and helmet and carried a Colt 45 pistol like a normal American soldier. But it was better to transfer over my Norwegian badges of rank, as I wasn't really an American officer. When wearing battledress, the only

> badge of rank was often fastened to the helmet. I was now a captain, and so I put the three stars on the front of my helmet. This was sometimes very helpful for me among Allied troops, as three stars were the insignia of the highest rank of general, apart from Eisenhower himself, and without resorting to anything other than appearing important I could often acquire overnight lodging and transport that otherwise would have been unavailable to me.[142]

With even more enthusiasm than Randers, Goudsmit lambasts the organisation of German research and the fact that 'everybody had to be a director of something.'[143] The Luftwaffe was the exception:

> In contrast to the Army research it must be said that the German Air Force research under Goering was excellently organized and highly successful. There are several reasons for this, the principal being that the Air Force was interested in results and not politics. The committee in charge of Air Force research was selected on the basis of ability. With one lukewarm exception, the men were not Nazi party members. The men in charge were also aware of the great shortcomings of the other German research organizations and avoided as much as possible any contact with them. Thus, research on practically all subjects of interest to the Air Force was done by their own organization; they had divisions on radio, radar, aircraft engines, airborne armament, and so on.[144]

He also has something to say about Schiebold's vision of X-rays, and rather surprisingly he reaches out towards those who had opposed the man:

> The genuine physicists had a time of it not only in keeping ideas out of the fumbling grasp of the charlatans, but research funds and apparatus as well. They fought successfully a fantastic scheme promoted by the X-ray scientist, Schiebold. This gentleman wanted to use a new high-voltage X-ray machine, the so-called Betatron – an American invention – against allied bombers. For this pipe dream, he had actually obtained the support of Air Marshal Milch, not to mention his diverting important apparatus from the uranium project.[145]

This—no less. The great race to be first with the atom bomb. This was what Rolf had become caught up in. Not because he worked on the bomb, but just because he was who he was and did what he did. The folder that Randers delivered to the Alsos leadership after his mission includes a report of his conversations with Rolf after the liberation. The cover was labelled, 'Important.'

The report, which naturally enough was written in English, showed that Rolf had spoken much more clearly with Randers than he did later in his biography. This was certainly tactical, and perhaps he didn't really have very much choice. Perhaps he was told something like 'If you don't co-operate the Allies will come to arrest you, so just tell me.' Rolf was worried that American researchers might get hold of his results. Supported by his advocate, Oscar de Besche, he had a lot of discussion to and fro with Randers about which documents he should hand over. The discussions about that—or perhaps 'negotiations' would be a better word—went on for several days, not just a single day as Rolf implied in other communications. It also appears that Randers did not believe everything Rolf told him and that although Rolf could then be released from detention in custody pending trial, the talks did not release him from the risk of a possible prison sentence.

Here is an abbreviated version of the ten points in the report:

Captain Randers' Report

Report on visit to Widerøe in Oslo, July 1945

(Summarised and with headings added)
Dr. Widerøe and the German betatron development

(*Death rays*)

1. The German betatron project appears to have started from Professor Schiebold's rather fantastical idea of a powerful X-ray apparatus to be used against enemy planes. The radiation would be directed against the pilot, not the plane.

(*The American, Kerst*)

2. Rolf Widerøe—who at that time was employed in the Norwegian branch of Brown Boveri—had written his doctoral thesis at college in Aaachen on the topic of radiation transformers and had studied and lived in Germany for eight years before the war. In 1942, having read about the American Kerst's betatron project, he wrote two articles about radiation transformers and submitted them to *Archiv für Elektrotechnik*. Not all of the content of the first article was published in the journal. Some technical details and discoveries were omitted, but the whole text was printed as a secret military research report.

(*Got hold of Rolf*)

3. People in Germany who were interested in Schiebold and had heard of Kerst found that Rolf Widerøe's radiation transformer was exactly what they needed. They made contact with Widerøe and invited him to build his transformer in Germany, with German support. It may very well be true, as Widerøe says, that he was not informed at all about Schiebold's plans. He may have been compelled to go to Germany, as he himself maintains, since more or less all German invitations at that time could be understood

as commands. Nevertheless, my impression of Widerøe is that it didn't require much persuasion to get him to accept the offer. He is so absorbed in his work that even when he was in prison it seemed as if he was more concerned about having his new ideas tried out than about being released from captivity. The fact that he took up this work in 1943, when everybody with Nazi connections in Norway was frantically trying to come away from them, showed that he had poor judgement of the political situation. He also demonstrated this in his conversations with me, when for example he tried, through me, to renew contact with his German working partners while he was still in prison exactly because of his work with them.

(*Thumbs down for Schiebold*)

4. Widerøe said that he only came to hear of Schiebold's project accidentally, after he had been working in Germany for some time. The impossibility of Schiebolds' plan was apparent both to him and to most of the others relatively early, but the betatron project was continued with undiminished support. Professor Gerlach appears to have been mainly responsible for that. The reason was probably to a large extent the general interest in the development of betatrons, with obviously the secondary consideration of the possibility of making progress in the research work on atomic energy. It also seems that the fact that America was putting money and investment into betatron research was of great significance, at least in persuading the authorities that the work was worth the investment. Widerøe's insistence on the therapeutic value of his research may have been partly self-defensive and partly economic, as it appeared to be the only way he could ever expect to earn much money from his patents.

(*Successful work*)

5. The work at Widerøe's institute appears to have progressed rapidly. The 15 MeV transformer was built rapidly and gave results exceeding everybody's expectations. The 200 MeV transformer to be built at BBC Mannheim was only at the planning stage. My understanding of what Widerøe said was that he expected difficulties with the big transformer, and that the time required to build it would be significantly longer than assumed. Comprehensive reports of the progress on the technical side are provided by Hollnack, Kollath and Touschek in addition to Widerøe himself in the attached material and do not need to be evaluated here.

(*Arrested*)

6. When Widerøe left the job, and Germany, several days before the liberation of Norway, he took with him to Norway his own papers and all the correspondence for which he had obtained a sort of courier pass. I think the thought behind this was that even if everything that was left in Germany were to be destroyed, he would still have all the material he needed. Soon after the liberation, Widerøe was arrested, accused of having worked on the building of the V2 rockets. He was taken to Ilebu prison camp outside Oslo, where he applied himself to his 'collected works' on the radiation transformer and researched his as yet untried idea of magnetic 'supplementary fields' to bring electrons into an acceleration tube.

(*The latest ideas*)

7. His latest ideas, which he considered extremely important, on 'focusing of electrons,' are described in his own note 11.7.45, 'Arrangement for Introducing Electrons into Radiation Transformers' (written in Norwegian) and in the patent description (also in Norwegian) of the same date. The Norwegian texts are also attached, as the language in the patent description is practically impossible to translate into English.

(*A complicated case*)

8. Widerøe was released from prison while I was in Oslo. This does not mean that the case is concluded, but just that he is not considered to be a dangerous or serious criminal. Provided that his advocate can persuade the court that Widerøe can be considered as a 'forced labourer' in Germany, the charge against him will be fairly light, along the lines of having published articles in German journals, etc. This complicates the relationships a little, because I could have come into difficulties simply by taking the papers from him. Widerøe is very concerned about his patent rights and the information about his work. I had to argue with him and with his advocate for several days before they would give me full information. Their argument (which *can* have had support in Norway) was that Widerøe wanted to have his rights established before any information came out to the Americans—to be sure that his work didn't go straight to American researchers who would take out patents on his discoveries. By presenting the issue as a sort of patriotic concern for Norway's interests, he could perhaps have stopped me, or at least delayed me from sending on the documents for several months. On the other hand he is in a rather weak position, as I also said to him, as a statement from the Allies that his work was of great importance for the war would land him right back in prison. Finally I got all his papers, including the material that was not written in Germany and therefore was not in any sense work for the enemy. For my part, I promised not to allow his work to be published without acknowledging the source.

(*To remain in Norway*)

9. Widerøe said first of all that one of the reasons he didn't want the Allies to have his papers was that he feared being sent to England or to America to have to continue his research there. He wanted to stay and work in Norway. He wrote a letter in which he made it clear that he was willing to work for the Allies, but only if the work could be carried out in Norway. After his release, when he saw the way he was treated by neighbours and friends there, he became less convinced of his desire to stay in Norway. His wife—who was a very agreeable person and who had experienced two months as an outcast from society—strongly desired to get out of Norway.

(*Doubtful support*)

10. Widerøe was very curious about what the researchers in America were doing in his field. He appears to be a very able man who will undoubtedly do all in his power to be in a position to continue his work on the betatron one way or another. In the meantime he seems to be hoping for some Norwegian support to do this. Personally, I think that is very doubtful.[146]

The last point in Randers' report says it all. Rolf was talented, followed the research race closely, was obsessed about continuing his work on the betatron, and had wishful thoughts of Norwegian support which he would not get. The meeting with Randers had apparently not been so simple as Rolf made it out to be.

The Interview in the Prison

The account of Randers' interview with Rolf in the prison is just as interesting reading as his formal report. The discussion was about what the Germans wanted from Rolf and what Rolf wanted to achieve by going there. The transcript of the conversation is now stored together with the report in the Alsos folder in the Niels Bohr Library and Archives at The American Institute of Physics. It consists of seven questions and answers, dated 10th July 1945.[147] Randers visited Rolf in prison on 9th July, the day he was released. The note of their meeting appears to have been lightly edited by Rolf so that the technical details would be correct. He probably spent some considerable time on that. One of Rolf's documents that is included as an attachment in the folder is dated 11th July. So the two of them must have been in contact again after Rolf came out of prison. Rolf explains himself here more extensively than in any other known document:

INTERVIEW WITH DR. WIDEROE IN OSLO

1. What did the Germans expect of the development?

Dr. Wideroe—When I was brought to Germany, I was told they would use the betatron (*Strahlentransformator*) for scientific research generally, as well as for testing materials and for therapy. About the end of December 1943, I discovered by chance the pre-history and origin of the development which had been kept secret from me. In 1942, Professor Schiebold (Leipzig) suggested building an immense X-ray machine that would emit strong enough X-rays to hurt the crew of an aircraft. Professor Schiebold had received some support for his theory, but it was soon realized that the plans were impossible to carry through. By my articles in *Archiv für Elektrotechnik*, attention was brought to my betatron (*Strahlentransformator*), which the people interested in Schiebold's project believed might be used for the purpose. My first investigation, after I got to know about it was, of course to see whether such possibilities existed. I found that even under extremely favorable conditions all that might ever be

expected would be a faint and harmless radiation at a few hundred meter's distance. Independently, Professor Kuhlenkamp (Jena) came to the same conclusions in a thorough study (copy of which was in Wrist).
When these things became known,, the whole fantastic Schiebold story was buried in the beginning of 1944. At the same time it was, however, decided (Professor Gerlach) that the work with the betatron should proceed with undiminished energy in order to reduce the American lead suspected in this field, and to help physical research generally in this new and relatively unknown field.

2. Why did the Germans finance it?
Dr. Wideroe—The original reason follows from 1. Why the Germans continued to spend money on it is difficu1t to answer, and Hollnack would do that better than I can. My personal opinion is that everything that had any faint connection with nuclear physics was supported because one supposed that such investigations might sooner or later lead to results concerning the exploitation of nuclear energy. Among the scientists with whom I discussed, the opinion seemed to be that such results could hardly be expected during this war, and that the betatron would not bring them in any case. However, several scientists used this possibility as a "bait" for the authorities, to obtain means for continuing their scientific research. I assume this was also the case with the betatron.

3. What results did you personally expect?
Dr. Wideroe—First, a new, powerful means for physical research; second, a possible cancer treatment apparatus; third, a new apparatus for testing of materials. I am an engineer, not a physicist. My job is to construct apparatus for use by the physicists. However, I am interested in physics, and my opinion as an amateur is the following: Physics is just at the beginning of penetrating into a new field, nuclear physics, which is outside the field of present Quantum Mechanics (which fails at energies of about 70 MV). It started the discovery of pair formation of electrons, then came the mesotron, neutrino and the vague hypothesis about unknown elementary particles (Heisenberg, Møller, Rosenfeld, etc.). Most of this is still on the stage of "scientific poetry". The only experimental evidence comes from the greatly unknown cosmic radiation. In this field, the betatron is the ideal apparatus, and the only possibility for controlled experimentation. With a 200 MV betatron one would probably be in a position to create mesotrons and neutrinos at will. Such perspectives in themselves are according to my opinion sufficient to justify the expenditure of 1/2–1 million marks; which such an apparatus was estimated to cost.
Far more interesting results might be obtained with 2000 MV, at which energy one might expect to split (and possibly induce pair formations of) protons. However, it is doubtful whether such results can be achieved. The betatron gives us possibilities for studies of nuclear photo effects and beta- processes on a more detailed and accurate level that can be imagined today. The same applies to photo fission. However, I see no possibilities for starting chain reactions or in any way favour or induce the fission of uranium or similar nuclei by the betatron. It's use here is simply in helping increase our general knowledge of nuclear physics.
From what I have mentioned, I can very well understand the interest among German scientists for my work. I can also understand that many of them imagined for themselves possibilities that were not present.

4. What anti-cathode was used?
Dr. Wideroe—In the small transformer (15 MV betatron) we used a 1 mm thick tungsten sheet. For the big transformer (200 MV betatron) no definite plans existed. I was convinced that one could not dissipate the heat from an anti-cathode inside the tube, so I had thought out a method to get a great part of the electrons out of the tube as a ray. Outside the apparatus it would probably not be difficult to place a water-cooled Wolfram anti-cathode. According to Heitler (Qu. theory of Rad.) the range of 200 MV electrons in air should be about 400 m and we had planned to dig the big transformer into the ground and let the rays into a tunnel. Distant control to escape damage to operators was being talked about. All these questions were only loosely touched upon as yet.

5. What connection has the betatron with nuclear physics?
Dr. Wideroe–See 3. I had personally learned to know several scientists working in nuclear physics, among others:
Professor Jensen (Hannover), Professor Ott (Wirzburg), Professor
Bothe, Professor Dänzer,· Professor Hardeck, Professor Leuz, Dr. Süss (Hamburg), Dr. Gentner (Heidelberg), Professor Kuhlenkampp and Professor Räther (Jena).
It was, however, only incidental that we discussed the question of uranium fission (Professor Jensen, Hardeck and Dr. Süss).

6. What demands did the Germans make regarding results?
Dr. Wideroe - No special demands beyond making the transformer work, as well as possible and as fast as possible. I thought originally that it would be possible to make the small transformer work by the middle of 1944 (so that the experimental work· might begin). The big transformer I expected would need a year more to finish, if all demands concerning raw material and labour could be met. If the work could have proceeded unhindered in Hamburg, we would probably have been able to finish work and experiments with the small transformer during 1945. It was also planned to build a 30 MV transformer for the special purpose of investigating nuclear photo-effects. Whether actual building of the big transformer could be begun at all during this war was, according to my opinion, very doubtful.

7. What is especially remarkable about your apparatus?
Dr. Wideroe- The small transformer, built in Hamburg, was not much different from Kerst's apparatus of 1942. One difference was that we had introduced saturation in the guiding poles, which results in the electrons being forced outward after completed acceleration. This was done with a view to getting the electrons out eventually. The small transformer is relatively effective (judged by MV/kg), probably much more so than Kerst's transformer for 22 MV (19h2). It is interesting that our small transformer obtained such a good output at 50 periods. The output could probably be improved considerably (We experimented only for 2–3 months with this apparatus).

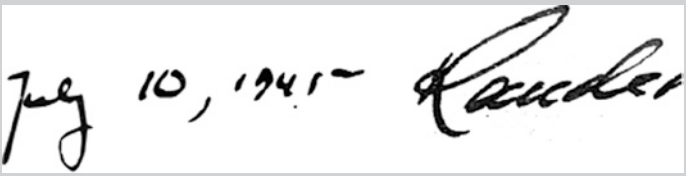
The circuit for obtaining electron emission of short duration was very successful.

The essential improvement. suggested by me in the later years is the stabilizing of the electron current bv lenses. This suggestion (which we unfortunately never got an opportunity to try) may be decisive for the building of large transformers.

In this connection I will also mention the suggestion to introduce the electrons by means of a magnetic "supplementary" field.

The last calculations have shown that it is probably impossible to introduce electrons into a lens field without such magnetic (or electrostatic) supplementary fields.

Essential for the building of large transformers is also the premagnetisation of the guiding field and counter-magnetisation of the induction flux. I am not in a position to know whether these things have been suggested by others. This goes also for my suggestion about changing the radius of the electron orbit by phase displacement between the guiding field and the induction field, as well as the idea to extract the electrons collected in a ray, a method to compensate for the radiation dampening in larger transformers.



The Rest of the Alsos Folder

But there was even more in the folder: the doctoral thesis; a smaller, technical document written by Rolf together with various sketches and an English translation probably done by Randers[148]; plus Rolf's own summary of his patent applications, in both language versions[149]; together with a number of other documents about the betatron and the work in Germany, mostly written by Rolf and all recorded in a separate list.[150] The most interesting of these is a 10 page note written by Rolf himself as early as 17th September 1943, in which he gives technical descriptions of the plans for both the 15 MeV and the 200 MeV betatron. This document is from early in the time of his work in Germany during the war, but was written while he was at home in Norway in a period of combined holiday and writing.[151]

The folder also contained various notes and reports written by Hollnack and Kollath, plus a list of 17 microfilmed documents. These included documents written by the renowned Professor Bothe, a report from Rolf to General Field Marshal Geist in the Air Ministry, a letter from Rolf to Professor Kuhlenkampff who torpedoed Schiebold's ray-gun, various notes from Rolf's assistant, Touschek and letters to Rolf from Heisenberg.[152]

In brief: The material that Alsos gathered was a combination of first hand information from either Rolf himself, Kollach his deputy or Hollnack his link with the Luftwaffe. To this was added the Alsos agent's own presentation and assessment of the matter. The documents from Hollnack and

Kollath were addressed to the British intelligence agency T-Force and then sent on to Alsos. How much Rolf knew about the American and British efforts to find out what he had been doing remains his own secret. However, in the light of what can now be found in the archives, there appear to be things Rolf knew about but didn't speak about publicly. We may ponder the chances and coincidences of life and wonder what would have happened if Randers had not come to question him. Would he have been held in detention longer? Would he have been released just the same because there was a maximum time limit on his detention order? Would he perhaps have suffered a more serious penalty? We shall never know.

Randers may in a sense have been his rescuer, even though as a member of the critically inclined expert committee he contributed to his fate. What is clear is that Rolf's betatron project was so important that Allied authorities had been watching him and that they eventually moved in on him. So what is missing from this already complicated picture for it to be complete?

Big business was undoubtedly a large part of the picture. Industrial companies with an interest in both short and long term business opportunities and sustainability nearly always play some part in a war. Here was revolutionary equipment with great market potential. The war would surely end sometime. A business that could survive in the short term and plan strategically for the long term might expect great rewards. Some were up to the challenge. The means and the motives could be more or less honourable and the boundaries difficult.

Did he know but not say

– ***that Brown Boveri was part of the picture all the time?***

Though Rolf never said so definitely, Brown Boveri was part of the jigsaw puzzle all the time. He did say clearly that he was an employee of Brown Boveri throughout the war, but he never said how much or how little the company was involved in what he was doing. He must have known, because Brown Boveri was included in his plans both during and after his time in Germany. Copies of notes of meetings, agreements and reports confirm that he was in communication with the head office in Switzerland, the company's factory in Germany and the Norwegian daughter company NEBB.

He mostly spoke clearly about Brown Boveri. He had worked for them even before he took on the assignment for the Luftwaffe, and the company remained an important part of his life, either in the background when he was working in Germany or in the foreground when he was working directly for them in Switzerland. However, he never gave a clear account of

the important, almost leading role that Brown Boveri played in parts of the betatron project during the war or of the links from the director of NEBB in Norway via the director in Heidelberg to the head office in Switzerland. He did speak about their investment and sometimes about details, but some things he omitted to say. Maybe he thought 'What purpose can it serve?' or perhaps 'It's best that doesn't come out.' There was so much to consider in his complicated situation but whatever the motives, there were things he deliberately didn't say.

Hollnack tells us more, however. For as long as he had dealings with Rolf he also had connections with Brown Boveri, both in Oslo and in Switzerland. When he was informing T-Force about the contract he had agreed with Rolf, he explained clearly:

> At the same time, I gave the NEBBC, Oslo, definite written guarantees regarding Swiss claims.[153]

A Brown Boveri daughter company in a German-occupied country was working with the parent company head office in neutral Switzerland—with Hollnack as the middleman representing the German authorities. It was not just a two-way relationship between Germany and Norway, but a triangular relationship including the Swiss parent company. Hollnack's courier also came to understand that the brown folders he had delivered to various places contained technical information about the secret betatron in Hamburg and that some of them were destined for Brown Boveri in Switzerland.[154]

Rolf had already been in contact with the parent company before the war, and according to Tor Brustad he had already made arrangements with the Swiss in 1942 about working together to develop practical applications of various discoveries within the field of betatron technology. This was confirmed after the war in a letter from NEBB to Rolf's advocate on 12th June 1946.[155] The Germans, however, did not like Rolf being in touch with the office in Switzerland. The patents were an important consideration in this respect:

> As part of this collaboration the company requested and reminded Widerøe that he must have his inventions patented in Germany, and perhaps also in the USA and England. This was normal company policy. In this way, the company could secure both independent professional evaluation of the inventions and protection of their own interests and rights. (…)[156] In the spring and summer of 1943 Widerøe was negotiating with BBC about the sale of some of his patents and about registering patents in English-speaking countries.[157]

In his big comprehensive report[158] to T-Force, Hollnack explained the role of both Brown Boveri's head office and its subsidiary companies in greater detail. Among other things, he wrote:

– about when he made contact with Rolf in Oslo in 1943:

> Widerøe was and is employed by NEBB in Oslo, a subsidiary company of the head office in Switzerland.
>
> The formalities of his temporary absence on service were established with Director Solberg in NEBB, in an agreement that recognised the rights of the head office in Switzerland.

– about formal contracts that Hollnack had agreed in his capacity of "*Treuhänder*" for the Widerøe project:

> Agreement with Brown Boveri Switzerland through NEBB Oslo.
>
> Development agreement with Brown Boveri Heidelberg. The work on the patent rights was done by patent advocate Dr. Eng. Sommerfeld (…) Berlin. This was a personal friend of Dr. Widerøe; they worked very closely together.

– about the plans for the 200 MeV machine after the 15 MeV betatron had to be evacuated from Berlin towards the end of the war:

> Design work on the 200 MeV installation continued at Brown Boveri Heidelberg, under the direction of Dr. Meyer-Delius. Because of the circumstances of the war, an agreement on the available draft design and a confirmation by us for this construction were no longer possible.

A Status Project—The 200 Mega-Electronvolt Machine

While so much interest was being focussed on the 15 MeV betatron, when it could be ready and what it could be used for, Rolf was quietly and unobtrusively working on plans for another, much bigger machine. He didn't much want to speak about this after the war, dismissing it as almost uninteresting

and something that didn't concern him. He even said that he didn't know whether Brown Boveri ever started work on building a 200 MeV betatron but that it was very unlikely. But he obviously must have known. This was a super-status project.

As soon as the first, small betatron was completed and ready for testing, the building of the bigger machine was the next project on the list, according with Rolf's plan. There was no doubt that this next step in the development process had political approval from above. It was no longer just an outline strategy drawn up at the start of the project and signed by Rolf Widerøe, Oslo, Norway. It was supported by the authority of Walther Gerlach himself, the new broom in the Physics Division of the National Research Council, appointed by Göring and a member of the Uranium Club, one of the men who after the war would be interned in England along with Heisenberg and others. There was significant interest in the project. Gerlach made a request for a 200 MeV machine, and Professor Bothe was very interested. In the meantime, the order for construction was given to Brown Boveri in Mannheim.[159]

Several researchers in Heidelberg were thinking about the questions involved with cyclotrons and betatrons, even though the boundaries between the various types of device overlapped and the nomenclature had still not crystallised. It is not always easy to say precisely which machine people were talking about. The fertile research environment that had developed in Heidelberg was the reason why the physicists wanted to locate the construction of Rolf's prestigious machine nearby, even though Ostgrossheim had originally been selected as the site. The respected Professor Bothe had already been working on a cyclotron in Heidelberg. Rolf would be in good company. Another expert, Wolfgang Gentner, was sent to Heidelberg towards the end of the war to assist Bothe with this cyclotron. Gentner was 'in secret a convinced anti-Nazi,' and he had worked for several years with Joliot in Paris and then with Lawrence at Berkeley.[160]

Rolf was also interested in what Bothe was working on. He wanted to be in contact with Bothe, and the interest was mutual. Before Christmas 1944 he sent Bothe an invitation to come to see the 15 MeV betatron. He also invited a professor from Frankfurt with whom Bothe worked on a 10 MeV betatron that they never managed to bring beyond the planning stage. On 23rd November 1944 Rolf received a polite reply from the Director, Prof. Dr. W. Bothe, *Kaiser Wilhelm-Institut für Medizinische Forschung, Institut für Physik.* Professor Bothe thanked Herr Professor Widerøe for his letter of the 13th with the invitation to him and his colleague to visit. They would be busy the next couple of weeks and so they asked to be able to return to

the matter when Rolf had come back from his visit to Oslo. A friendly and encouraging letter from Bothe, who obviously knows of the plan to build the large radiation transformer and wants to collaborate. He expresses respect and admiration for what Rolf is doing, adding that he would like to share some of his own expertise and that it would be foolish for each of them to continue his own work independently of the other. He emphasises that it must all be on Widerøe's terms and that they would respect the requirements for secrecy, rights and so on, and that it was not a question of money.

There was obvious engagement in both political and academic circles. Bothe and Rolf then each received a letter from the authorities, dated 4th December 1944.[161] The letter starts with 'Highly respected colleagues' and ends with '*Heil Hitler!*' The letter-heading oozes Nazi formality: *Reichmarchall des Grossdeutschen Reiches/Präsident des Reichforschungsrat/der Bevollmächtige*. The next line is difficult to read, but it appears to be the name of Professor Walther Gerlach the Chief Scientist for nuclear physics, with responsibility for all German nuclear physics and for the secret Uranium Project. There was no higher physicist in Hitler's hierarchy. In addition to being one of the powerful political elite, however, Gerlach was the member of that group who best understood from a scientific perspective what Rolf was working on. Unfortunately most of the text of the letter, which is rather long, is faded and unreadable. From what can be made out, however, it refers to discussions at Erlangen and to meetings and contacts following that and it expresses a desire to follow up various topics. In other words, Rolf has the blessing and approval of the authorities. Just carry on!

Hush-Hush

The project to construct the large betatron was very prestigious, and Brown Boveri in Germany was very keen to get the contract. It was all very hush-hush and it involved meetings with the authorities and with Rolf. His unpublished article for the physics journal contained just the ideas needed for such a giant betatron. Rolf himself, who never concealed his membership of and loyalty to Brown Boveri, also wanted it to be built by them. In his biography he says that NEBB in Oslo 'was my employer throughout the war, and I was compelled to work in Germany.'[162] Just as he had said in the interview with the physicists ten years before being interviewed for the biography, he said in the same breath that his connection with Brown Boveri had not been of any help to him in getting out of prison, but he stressed

that he had been on good terms with the chief himself, Sven Adolf Solberg, all the time.[163] The managing director had inherited the job from his father and grandfather and had studied civil engineering at the technical college in Zürich where Rolf later taught. Solberg jr. had worked for several years at the head office in Baden, but the German Nazi authorities didn't like dealing with the company's head office in Switzerland.

As early as 1942, Rolf had been in touch with Brown Boveri in Switzerland about industrial collaboration to develop practical applications for his various inventions. In the legal proceedings about patent rights after the war, this was an important point that was confirmed by Rolf's defence lawyer.[164]

During the preliminary hearing of his case, Rolf explained that throughout the whole spring and summer of 1943 he 'was engaged in negotiations with Brown Boveri in Switzerland about the sale of patent rights, so that the Swiss rights could be registered in English-speaking countries. This possibility was lost when the Germans confiscated the patents.'[165]

The director of NEBB in Oslo was one of the people Rolf kept informed about the police investigation after the war, and when Rolf was planning his first visit to Brown Boveri in Switzerland in spring 1946 he tried to arrange it so that they could both be there to take part in the meetings.[166]

Rolf wrote in an internal memo that in spring 1944 he was working on the plans for the 200 MeV machine, while the work on the 15 MeV machine was continuing at the C.H.F. Müller factory in Hamburg. Planning for the large betatron involved not only a big technical leap but also many conflicting interests and a difficulty in deciding where the work should be done. In February he had had thoughts of having the machine built in Oslo, but the original plan was to build it at Ostgrossheim:

> I have suggested that the machine should be built by BBC in Oslo. If this proposal is considered suitable both by the technical leadership and by other parties involved, its feasibility will be investigated in greater detail in Oslo in early March.[167]

But there were other possibilities. During a three day conference of the Brown Boveri management at the end of April, important discussions and site inspections took place in Weinheim and Heidelberg. On the morning of 29th April in the presence of all the people involved including the director himself, Meyer-Delius, a summary was drawn up. Details discussed in this document include a starting date and when people should be informed who would be taking part. Dr. Böcker, the high-tension expert who would

have overall responsibility on behalf of Brown Boveri, said that he found the project very interesting and that he would see to it that the work at Brown Boveri was completed rapidly and effectively. The group agreed that the next round of technical discussions should take place four weeks later. Both parties wrote notes of the meeting, and on 1st May Rolf wrote a summary report in which he said among other things that he had had meetings with the director, with Dr. Böcker and with an engineer in Weinheim who would be responsible for the technical aspects. He wrote:

> I mentioned that in the meantime either Seifert or the gentlemen from the Air Ministry should handle the negotiations about to what extent the work should be transferred to Heidelberg. Quite independently of these negotiations, Meyer-Delius reported that he had heard from Bothe and Gentner that they were continuing their plans for a radiation transformer. They had also received information, through Sweden, about the big American transformer that was said to have succeeded in bringing the electrons out of the tubes and sending light rays several hundred metres. I consider Bothe and Gentner to be Germany's most experienced scientists in this area. They can probably give valuable advice which will be useful in the building of the apparatus and can also say something about practical use of the radiant energy.[168]

Rolf prepared a supplementary note the same day, and a further report the following day.[169] The director prepared his own report of the meeting on the first day, 'Secret report from BBC meeting in Heidelberg,' which reveals that the people who were present apart from himself were Widerøe, Seifert and three further named people who probably represented the company. Most important of all, he announces that Seifert had given BBC a preliminary order from the Air Ministry to start the research and development work for such a machine.[170]

The Internal Report

Important decisions were taken in a meeting on the second day. Dr. Böcker recorded these in a useful report that outlined the way forward.[171] Among those present were the Brown Boveri director, 'Hollnack on a special assignment from the Air Ministry' and Rolf. Hollnack started by informing the meeting that the contract to develop the radiation transformer had now been awarded to BBC Mannheim. The reason for this choice was that as Rolf was employed by Brown Boveri, the work should be done under the

auspices of Brown Boveri. However, as the Germans could not use the services of the parent company in Switzerland it would need to be the subsidiary company in Germany. Several important points were dealt with:

Formalities

Hollnack pointed out that all development work in nuclear physics was under the leadership of Professor Gerlach. He assured them that everybody was endeavouring to achieve close co-operation among the research institutes and companies that were involved, and reminded them that when a project involved nuclear research, both the Air Ministry and the War Ministry were involved. Each of these ministries had an official with a remit for such research. In the Air Ministry this was Colonel Geist's area of responsibility, and in the War Ministry the official dealing with the Widerøe project was—interesting to note—Richard Seifert. Hollnack himself was the project's link person to both these ministries.

Staffing

The Brown Boveri director referred to the difficulties caused by the restricted availability of technical staff for the construction of transformers. They couldn't begin constructing the 200 MeV radiation transformer until they had the two technicians the company had been promised. Hollnack replied that they would have the first within 'a few days' and the second in the course of a fortnight.

Classification

According to the report, the project had a special status:

> On the question of classification of the work on the radiation transformer in the current programme, Hollnack said that MV programmes came under the category of very urgent measures that were given special priority by the Air Ministry and the War Ministry. Admittedly the work was not one of the immediate programmes, but its progress could nevertheless with special recognition by the relevant ministries always be accelerated.

The Forward Plan

The forward plan and the allocation of responsibilities were in place. The Air Ministry would within the next few days issue an official contract for the construction of radiation transformers. Hollnack would arrange finance. Brown Boveri would nominate someone to be responsible for the work on the radiation transformer. The person concerned would pay particular attention to ensuring progress and would be 'the link between relevant ministries and the Müller company (Dr. Widerøe) on the one side and Brown Boveri on the other.' In the course of the next few weeks Hollnack would put forward a proposal for a development contract with the Business and Industry Department, and he would prepare a note of the meeting and send it to those present.

Hollnack's Report

Hollnack's report, also marked 'Secret,' was more formally structured[172]:

Present:
Dir. Meyer-Delius, BBC
Dr. Böcker, BBC
Dr. Eng. Rolf Widerøe, *Fog* (*Forschungsstelle der Luftwaffe*—'Luftwaffe Research Establishment')
Hollnack, *Fog*

1. BBC states that it is ready to start work immediately on the construction of a 200 MeV transformer in accordance with Widerøe's plans.
2. BBC Mannheim immediately accepts from the Luftwaffe's Research Establishment an urgent grade development contract DE 1382/XII L/44, with Arms Minister Speer's approval through Colonel Dipl. Eng. Friedrich Geist, head of technical research and development in Speer's ministry, and agrees that this programme shall be carried out within the framework of BBC's above-named programme with the same degree of urgency. (…)
3. With regard to the secrecy of the development work, Meyer-Delius will be informed of the negotiations with BBC Oslo in accordance with the protocol of 30.10.1943.This regulates the relationships between RLM on one side and BBC Oslo and Baden together with Dr. Widerøe on the other. (…)
4. BBC Heidelberg will give somebody within BBC the task of being responsible for the development work. The construction will follow BBC's guidelines under the leadership of and according to the construction ideas from rights protection through Dr. Eng. Rolf Widerøe.

5. After the award of the contract to BBC through Fog, there follows a draft of the detailed terms of the contract, through the Industry and Business Office under R&L (GL/F 1 IV B).
6. BBC receives through Hollnack knowledge of a prompt employment of a constructor from Telefunken. Because of the difficulty in obtaining constructor number 2 Hollnack shall try to find a replacement not later than 20.7.44.

Dillenburg, 3.7.44
Hollnack

Here, Hollnack uses the formal title of the organisation Rolf and he represent, *Forschungsstelle der Luftwaffe*, shortened to *Fog*, the Luftwaffe Research Establishment. When writing about more practical, operational matters he usually refers to the Müller factory where the work took place.

There is also a carefully composed distribution list of the people *outside* Brown Boveri who are to have copies, in addition to the named people within BBC.

Herr Seifert, Hamburg
Dr. Widerøe
Fog Group Administration
RLM Industriwirtschaftsamt (GL/F 1IV B)
RfRuk TAE Oberst Dipl.Ing. Geist
Dr. Spengler Forschungsführing des Rdl.

A few days later, the Brown Boveri director sent a confidential internal memo to a group of trusted colleagues, informing them that the firm had got the job.[173] The is simply headed *Strahlentransformator Wideröe* and it starts with an official announcement:

BBC has received a contract from *Forschungsstelle der Luftwaffe* Gross-Ostheim for the construction of a Widerøe radiation transformer.

The note goes on to specify who is responsible for what, and stresses that the technical direction 'shall be carried out in accordance with Dr. Widerøe's instructions.' It urges strict confidentiality and specifies procedures for dealing with this:

All personnel taking part in this project are committed to tight secrecy, in relation to other BBC employees as well as to third parties. All correspondence,

whether in-house or external, shall be stamped 'Secret' and stored separate from other BBC documents.[174]

In autumn 1944 the discussions on how to build the 200 MeV machine turned to more practical details, and the reports became correspondingly more technical. In October, there was a further meeting in Heidelberg, where several possibilities were considered and detailed designs were presented. This meeting was attended by Meyer-Delius the Brown Boveri director and two of his employees, in addition to Rolf Widerøe and Rudolf Kollath.[175] The note of the meeting, which was written by Kollath, states explicitly that he and Rolf were representing the Widerøe project as workers for Brown Boveri. The meeting also discussed the progress being made by their competitor, Siemens.

On 6th December 1944 the Brown Boveri group visited Rolf at the Müller factory. Their purpose was to be shown the smaller machine, learn how a radiation transformer works and consider how to apply the experiences from the smaller installation to working together on a big, 200 MeV machine. Böcker, who was responsible for the project within Brown Boveri, had had a prior meeting the day before with Rolf, Kollath and selected other workers at Müller. Seifert was also there on the guided tour. There were intense discussions about the particular difficulties the development was facing at that time, and several technical points were discussed.[176]

By that time the Allied bombing, failure of the postal services and problems in moving around between German cities had become part of everyday life, or as Rolf expressed it diplomatically in a letter to the director on 20th December, 'For various reasons it is at present rather difficult for us to come to Heidelberg.' He added, 'Moreover, I hope that you by one means or another have survived the latest attacks and that things are going well for you and your family.' Then at the beginning of February Rolf at last received an important letter that had been written before New Year, from the director at Brown Boveri Mannheim. It was about calculations that were urgently required for the design of the 200 MeV transformer. In his response, Rolf enclosed diagrams and asked for a quick reply, preferably by telephone. He also suggested a meeting in Hamburg to discuss the design calculations in greater detail, because it was obviously easier to travel from Heidelberg to Hamburg than the other way round.[177]

The plans materialised, and on 3rd March there was a very up-beat technical article in Brown Boveri's in-house magazine about a new type of large transformer.[178] People in the USA also learned somehow that something was under way and that a contract had been placed with BBC Heidelberg to

build a 200 MeV betatron.[179] That seems strange when seen from the other side, as Rolf says in his biography that Brown Boveri was not represented in Heidelberg at that time. One of the directors lived there and some meetings had been held there, but that was all.[180] It was war.

But then …

In the midst of all this enthusiasm and intense activity, the plans suddenly came to a stop. It was all over before it had begun. Strangely, Rolf says very little about this when he discusses the 200 MeV machine in his biography. The project is only mentioned briefly, just before we are informed that he returned home for good in April 1945. He says very little, considering the dramatic turn of events, but just summarises the story in few words:

> I discussed the building of a 200 MeV betatron several times with the directors and the construction staff in Brown Boveri. Dr. Seifert had given the preliminary order for the construction works to the company Brown Boveri, as a commission from the Air Ministry. Several technical solutions were worked on, to the stage of producing detailed designs. (…) But at the end of the war all these plans were unrealisable. The BBC factory in Mannheim had been almost destroyed. When Germany was overrun by the Allies there was no more talk of the plans.[181]

Here too he says no more than he has to. He doesn't mention the enthusiasm from Brown Boveri, the interest shown by German experts or the impetus from the authorities, and in the end he almost trivialises the plans. For there had been active planning, and Rolf had been involved in it in 1943, 1944 and 1945.

Pedro Waloschek told me that during the many discussions he and Rolf had in connection with the biography, Rolf had only reluctantly talked about the 200 MeV machine. When Waloschek reminded him what he himself had written in a summary report about the betatron plans,[182] Rolf agreed to include it. But the fact was, thought Waloschek, that Rolf and his team of Kollath, Schumann and Touschek must have invested a lot of time in planning for this machine. He stated that apart from that one occasion Rolf told him nothing more either about this large machine or about anything else that was supposed to happen at Grossostheim. Waloschek wondered about this, because he thought that Rolf had seen it as prestigious. Perhaps the explanation of Rolf's reticence on the subject is no

more mysterious than frustration at having to give up after such intensive planning.

Waloschek considered it unlikely that the Luftwaffe had much interest at that time in far-sighted basic research into nuclear physics or improvements to medical apparatus for X-ray imaging or cancer treatment. So there must have been some special reasons for supporting the time-consuming and complicated construction of such a big radiation transformer.

Another consideration is that Rolf later realised that a 200 MeV machine was not the most suitable for medical use. Machines less than 50 MeV were sufficient and actually the best, and moreover were smaller and cheaper. The purpose in building a big machine was to promote research in atomic and nuclear physics, but other types of accelerators such as cyclotrons and synchrotrons were more successful in this application.

This tallies with what an American expert later wrote in an official report about the development of accelerators in Europe. Waloschek said that Rolf knew about this report and referred to it in their conversations on this topic. The author was a physicist in the U.S. Naval Research Laboratory in Washington DC and the report, which was released in January 1947, showed that he had remarkably good knowledge of the German work on betatrons. He called the 200 MeV machine the most important betatron project in Europe and thought that the Widerøe group was evidence of the high level in this field in Germany. He also wrote quite plainly that 'The construction plans for this apparatus were drawn up by Brown Boveri in Mannheim under the leadership of Rolf Widerøe and on instruction from the Luftwaffe.' He compared it with the 100 MeV machine that Kerst had made at General Electric, and went on to say that Rolf's machine had 'even more very interesting technical details' and that he saw traces of Rolf's experience as an electrical engineer.[183]

Why did it stop so suddenly? What became of the plans? Could the answer be that they were suddenly caught in the act when British troops moved into Heidelberg in spring 1944? The university town was seen by the Allies as a key location for nuclear physics and accelerator technology. It was here, for example, that they found Professor Bothe, who was interested in betatrons and wanted to be in touch with Rolf and who had considered similar plans but who during the war had continued working on a cyclotron, with encouragement from the authorities. This was the man whom Goudsmit the scientific head of Alsos found difficult to interview because they were former colleagues. Heidelberg was also one of the places Albert Speer named later when he was being interviewed, saying that he had given high priority to the building of cyclotrons.

Here it was that in April 1944, 6th Army Group's T-Section found both documents and personnel from Brown Boveri and I.G. Farben, both important intelligence targets. T-Section set up a special document centre in the university library to sort through all the material, which was then copied and sent on to various intelligence organisations, including those dealing with war crimes. When the centre was shut down, much of the confiscated material was sent to the USA where it was dealt with by a special section in the Pentagon. The original documents were later sent to the National Archives in England.[184]

Nor would it be unreasonable to suppose that the course of the war itself was the reason for abandoning the 200 MeV betatron. That was what Rolf said. He might also have spoken so little about it because he had lost faith in it himself, having far-sighted goals and not allowing himself to be distracted by short-term distractions and adversities. Whatever he may have thought then, after the war he opted for a medium sized machine of 31 MeV, a size that he found optimal for cancer treatment. This was the machine with which he was successful, 'the first betatron for medical research,' as it was described in Brown Boveri's in-house magazine.[185] The only scepticism about this claim was from the competing firm, Siemens.

Professor Tor Brustad at the Radium Hospital said that subsequent experience had shown that for radiotherapy for cancer patients there was little benefit to be gained from betatrons with a higher energy level than about 30 MeV. Also, radiation technology had advanced enormously, especially in England, and it was now possible to make small, compact linear accelerators that made it easier to direct the radiation to a particular site in a patient. Nuclear research, on the other hand, required particle radiation of much higher energy than had at that time been achieved with betatrons. In other words the classical, medium-sized betatron—both in radiotherapy and in nuclear physics—had a limited historical lifetime.

Cyclotrons and Betatrons

This is a good time to pause to look at the bigger picture of how this politically influenced and sometimes spy-ridden field of research developed. The 'Atomic Age' can be said to have started with Rutherford's work in the early 1900s. Then Niels Bohr from Denmark presented his theory of the structure of the atom. It was found that under very special conditions, electrons could be sent round and round in a tube and generate high energy, for example in a cyclotron. During the 1930s many researchers experimented with

this, including Bohr in Copenhagen, Joliot in Paris and Scherrer in Zurich. Bothe continued the work in Germany during the war.

The main difference between a betatron and a cyclotron is in the method used to accelerate and steer the electrons. It is worth repeating that though the first working betatron was built by Donald Kerst at the University of Illinois in 1940, the concept stemmed from Rolf Widerøe's work in the 1920s. When it became known that Kerst had built a functioning betatron in America, interest rapidly spread to Europe. In Norway, Rolf took up the development of betatrons again, 13–14 years after he had launched the theory of how it could be done. Max Steenbeck in Germany had already been working on a machine of this type in the 1930s, without ultimate success. Now all the leading nuclear physicists in Germany joined the wave of interest in this form of high energy: Heisenberg; Bothe; Kopfermann; Kulenkampff; Kollath; Schmellenmeier.[186] The topic was also followed up in Japan, especially in Osaka and Tokyo.[187]

Rolf was not alone in building betatrons, but the aim in this competition was always to be the first and the best. Before the war there were about twenty betatrons in the USA. In Europe, none.[188] By the time the war was over, two projects in Europe had succeeded: Steenbeck and Gund with their 6 Mev betatron for Siemens and Rolf with his 15 MeV machine. Some people would claim that it was really only Rolf who had succeeded, as only his betatron was completely ready.

Betatrons and cyclotrons are both types of accelerator in which electrons are propelled round and round on a circular course as in a carousel. The nomenclature for the different types of particle accelerator had not become fixed when the war started, and there was overlap in the designs of the different machines that were being developed. This made it difficult to categorise them. Here is a chronological overview of the most important descriptive labels used (in German and in English) for the machines by their respective inventors:

Gund/Steenbeck	*Elektronenschleuder*	Electron-centrifuge
Widerøe	*Strahlentransformator*	Radiation transformer
Gans/Schmellenmeier	*Rheotron*	Rheotron
Slepian	*Röntgenröhr*	X-ray tube
Kerst and Serber	*Induktionsbeschleuniger*	Induction-accelerator
Kerst	Betatron	which eventually became the usual name for all the types of apparatus listed above.

Betatrons Become Political

Building apparatus to accelerate electrons became prestigious both for nuclear physicists and for big industrial companies that wanted to demonstrate how technically advanced they were. There were also strong political overtones to this activity, which towards the end of the war made it easier to obtain funding.[189] In Germany, it became clear at a conference convened by Arms Minister Speer to review the status of research, that this applied even if a particular project was not of 'decisive importance for the war effort.'[190] A Siemens worker who was present later summarised the situation: Developing a cyclotron was now so important for Germany's technological reputation that even in a time of war it was necessary to press ahead with all available means.[191]

The whole sequence of developments had been initiated by the great scientists who in the early 1900s had started to understand the structure of the atom. Rutherford, Einstein and Bohr, standing on the shoulders of all who had preceded them in wondering about the inmost secrets of matter, had given laboratories throughout the world a big new field of research to explore. Some scientists then began to perceive the consequences of what was under way. But not the politicians and the military.[192] A month before the war started in September 1939, Einstein had already written his now famous letter to President Roosevelt, warning him of German advances in nuclear physics and what they could lead to. Six months before that the German War Ministry had been informed of the possibility of building a weapon of mass destruction.[193] Physicists visited the National Research Council to discuss whether one could build a 'uranium machine,' a reactor for military use. The Uranium Club was set up, Heisenberg was given 'call-up papers' to take part (though not as leader) and the German atomic project was under way.

The first job facing the researchers was to work out how they would fulfil the task they had been given, which was no small enterprise. It later became known that the Americans had spent almost six years on the building of their bomb, and they were significantly more in number, much better organised and backed by enormous financial investment. New results from atomic research stimulated not only a scientific race, but also a military one. Previously unimagined levels of energy could be released by splitting the atom. The country that could utilise this would be overwhelmingly powerful, and just days after this had been recognised the Germans' Uranium

Club was in existence.[194] The leading figure in atomic research was Werner Heisenberg, and speculations about his role still continue. To some, he was the Nazis' man, to others he was the one who probably scuppered the atom bomb project. But after two or three years German researchers and industry were complaining that investment in physics had *declined* rather than increased and were asking for measures to be taken to reverse this decline.

The war minister had indeed instructed the National Research Council that more money should be made available for nuclear physics and that the research should be more effective. The first leader of the council had tried to sort things out by rather simply saying that new projects must not be started until the previous ones had been completed.[195] However, he had had little influence on the development of new cyclotrons or of the betatron.[196] Under the leadership of his significantly more powerful successor, Gerlach, a giant betatron was to be built in Heidelberg under the auspices of *Heereswaffenamt (HWA)* ('The Army Weapons Agency'), *Kaiser-Wilhelm-Gesellschaft* ('The Kaiser Wilhelm Institute') and AEG. Key people in the council generally included several current or previous Nobel prize-winners, including Otto Hahn in Berlin, Walther Bothe in Heidelberg and Werner Heisenberg in Leipzig.

In May 1945 Gerlach was interned in France and Belgium by the British and American forces as part of Operation Alsos. From July until the end of the year he was at Farm Hall in England along with Heisenberg and others, under Operation Epsilon. In the 1950s he helped to draft and signed the Göttingen Manifesto against atomic weapons, a declaration initiated by 18 leading West German nuclear physicists opposing tactical atomic weapons. This was during an early phase of the Cold War, and it was the first time German researchers collectively demonstrated responsibility for political decisions and their consequences.

Bombs and Rockets

When looking at the history of these developments, we should note the distinction between 'nuclear research' and 'accelerator research.' At the end of the 1930s Germany was best at the former and the USA at the latter, but during the course of the war this situation was reversed. Non-physicists can easily confuse these two fields of science. So here is a short course on the difference between them:

Nuclear Research

The fact is that just before the war Germany was closer than anyone else to making an atomic bomb. The key factor in this was research on uranium. In 1938 the chemist Otto Hahn and physicists Lise Meitner and Otto Robert Frisch discovered atomic fission.[197] When uranium is bombarded with neutrons, uranium atoms split in two and energy is released. This discovery led directly to the work to create a nuclear weapon, also referred to as an atomic weapon.

Germany started the Second World War the following year and won initial victories with its superiority in military technology and resources. The Germans became over-confident, omitted to follow up the research on atomic fission and let their opportunity slip away. The USA, on the contrary, diligently followed up the German research group's discovery and eventually developed the atomic bomb. Rolf had no part in nuclear research.

Accelerator Research

Before the war, the USA was ahead of Germany in accelerator research, with a working cyclotron in 1933 (Lawrence) and a betatron in 1941 (Kerst). Then in 1944–1945 Rolf succeeded in building a working betatron in Germany. He had a major part in accelerator research.

Hitler Despised Physics

Hitler himself seldom mentioned physics. He had nothing but disdain for a science in which so many Jews were prominent. He was also accused of basing his opinion about nuclear research on popular fiction rather than professional expertise. Industry on the other hand, particularly Siemens, AEG and I.G. Farben, knew how to make money from physics by opening new markets and new possibilities. Not without commercial hostilities, though. They fought patent wars with each other, and the cleverest ones recruited the A-team. Rolf was involved in these hostilities and had a part in the drama that was being played out in politics, in industry and in research laboratories. Within his first year in Germany during the war he registered ten patents for Brown Boveri, and many more followed. The hot topic now was accelerators of all types including betatrons, cyclotrons and everything between. This research needed industrial backing, the industry needed

innovative researchers and the Nazi authorities found funding. It is not our present purpose to analyse this complicated situation and scrutinise motives, as many people have attempted that already. The point is that Rolf benefitted from the situation.

Pedro Waloschek said that the details surrounding the patents that were granted to Rolf during the war are unclear. According to him, the patents were officially registered for Brown Boveri. They were certainly confiscated by the Allies and later given back, but they were only released to public knowledge in the 1950s. The formal documents are now archived in *Deutsches Museum* in Munich among the papers bequeathed by Rolf's patent expert, Ernst Sommerfeld. The question is whether Rolf originally registered them for the company, or whether he first registered them in his own name and then transferred them to Brown Boveri. It is also conceivable that a transfer such as this could have happened *after* the war. However that may be, said Waloschek, they were applied for at the request of Brown Boveri. However you look at the picture, Brown Boveri is part of it. The former curator of the archive, Norbert Lang, says that all Rolf's patents were taken over by the company and are now listed in Brown Boveri's patent catalogue.[198]

The research race was also hard at a human level. One of those who fell by the wayside was Rolf's competitor, Konrad Gund, the engineer who was hired by Siemens to make betatrons. His first one was successful, and in 1946 another machine was put into therapeutic use in Göttingen. Konrad Gund got his Nobel Prize and was promoted. The machine was displayed at the International Exhibition in London in 1950 and was shown to the Queen Mother.

However he struggled with the next one, a 15 MeV machine intended to treat even deeper cancer tumours, the same strength as the machine Rolf had already made during the war. Early performance was promising, but then repeated problems arose with the ceramic vacuum tube. The technology could not keep pace with Gund's designs, and he wouldn't compromise in his attempt to meet the great expectations. He went back and forth, day and night, to the hospital where the machine was being installed. Then, one day in May 1953 when he was on his way to a conference in Amsterdam, he broke off his journey and turned back to the laboratory. The next morning he was found dead beside his betatron. He had taken a sleeping medicine and turned on the gas. Not only that, the following morning his wife was found dead in the kitchen with the gas turned on. She had followed her husband. The problem with the betatron was solved only a few weeks later, but Gund's fate made an impression on Rolf.

Scherrer the Spy

Even though Switzerland had remained neutral during the war, factories with German ownership connections were thoroughly investigated by Allied intelligence services once the war was over. Only a month before Rolf travelled to Switzerland in March 1946 for his first meeting with the Brown Boveri management, two British technicians visited the site in Baden and sent a report to The British Intelligence Objectives Sub-Committee ('BIOS').[199]

During the war the Swiss scientist Paul Scherrer, known for his cyclotron, had teamed up with the Americans and with Alsos. He had an enormous network of contacts, and from 1944 onwards he leaked information to the Americans about German research and German attempts to develop a nuclear weapon.[200] He was the initiator, for example, of a plot to lure Heisenberg to a conference in Zurich to meet Goudsmit, the head of Alsos. Heisenberg, whom OSS had given the code-name 'Christopher,' was on his guard and agreed to come only if it was guaranteed that they would not talk politics and that it would only be a small gathering. He did come. Among those sitting in the conference room was a man called Morris 'Moe' Berg, who was armed with a pistol and had orders to kill Heisenberg if necessary. Berg had been drilled in the theme of the conference and knew what Heisenberg might say in his lecture that would be the cue for him to shoot. It didn't happen. Perhaps Scherrer saved the life of his former colleague by managing to convince the Americans that Heisenberg didn't represent any threat, that he would not create any bomb and that he was in no way a Nazi as he had first thought.

Scherrer must have known about Rolf, for when the war was over he advised the management of Brown Boveri that they should get hold of the Norwegian. The Brown Boveri directors had agreed a policy statement in 1942, asserting that the most important thing the company could do to improve its prospects after the war was to maintain the technical status of its products. Their recruitment of Rolf is an example of this policy, which they also applied in their daughter companies in Germany. These had quite a free relationship with their parent company in Switzerland, and several of them had their own daughter companies. The factory in Mannheim had over 15,000 employees and only three of the nine directors of BBC Mannheim were Nazis, according to the independent Swiss report.

The role of neutral Switzerland during the war is a big topic that is still being explored. An independent expert commission prepared a report in

2002 on Switzerland and National Socialism. The report concluded that the war was still a sore point for Switzerland. A major part of the report is about Swiss industry's attitude to the Nazis and how the leaders of industry navigated between the shoals and skerries of keeping in with the Nazis, hiding away all political involvement, using forced labour, employing Jews and reacting to the Holocaust.[201]

In brief: The Swiss company Brown Boveri had a hand in all the exciting events in Rolf's field of work—before, during and after the war. He was employed by the Norwegian daughter company from June 1940. He continued to be formally employed by them while he was working for the Luftwaffe during the war, and he worked at the head office in Switzerland from 1946 until he retired with a pension. During the war, the Brown Boveri daughter company in the German town of Mannheim played an active and more or less independent role in betatron research. The mother company in Switzerland could be seen in the backdrop of this, though the Germans wanted to have as little to do with them as possible. Likewise, the Norwegian daughter company was in the wings. Brown Boveri was centre stage, but the company was not the sole player building betatrons in Europe during the war. There was strong competition, and Siemens and AEG were also important actors. The European companies were in competition both with each other and with American companies such as General Electric and Westinghouse.

Did he know but not say

– ***that there was a whole spider's web?***

As Rolf pursued his research, protected for better or worse by both Brown Boveri and the German authorities, there were many competing interests swarming around him. The industry had its own agenda, the scientists had theirs and the order of the day was determined by the course of the war. Everybody tried to juggle the various demands as best they could, in a confused buzz of genuine scientific interest, competing industrial giants and high-level technological competition between Germany and America, all with jangling undertones of fanaticism, naiveté, sheer nonsense, propaganda, idealism and global political strategy.

Rolf was caught in a spider's web spun by researchers, governments, high-ranking Nazis, intelligence agents, small private companies and major industries, each with its own network of real Nazis, Nazi sympathisers, agents, allies and sole players either pursuing self-interest or trying to remain neutral.

There is no lack of reasons for this situation: international politics; big science; war; political conflict; research competition; academic envy; industrial

and military espionage. It was an extreme situation both for individuals and for society as a whole. Vengeance, frustration, naiveté, denunciation, despair; all shaken by the course of events. Two or three generations later we can claim that detachment helps us to see the main themes more clearly, but we face further difficulties because the people it relates to were reluctant to talk about it and are now gone.

It is difficult to decide who was using others and who was being used, but fortunately that is not the purpose of this book. Our interest is in whatever to a greater or lesser degree concerned Rolf. That is complicated enough. Not everyone had cloaks that were black or white, or even grey. Some people had several, or stopped wearing the one they had. Amidst this confusion, one thing that is certain is that research labelled 'important for the war effort' got funding. Rolf found himself among people with the authority to make that happen, but he didn't particularly make an issue of it.

Today we can look at the situation from outside. We have access to many people's accounts of events and to documents that have finally become available. Secrecy clauses have expired, the Iron Curtain has been raised and participants have at last told their stories. This reveals a complex, multi-dimensional network.

The list on the next few pages is intended to give an overall impression of the extent of the gallery of people involved. Each word-picture contains two points. The first briefly summarises the person's official position, and the second indicates his connection to Rolf.

Top Nazi Officials Involved with Research and Physics

Göring

- Hermann Göring was *Reichsmarschall* and head of the Luftwaffe. He was second only to Hitler.
- Göring became President of the National Research Council when it was reorganised in 1942 on the initiative of Albert Speer. The intention was for Göring to lead the research council with the same discipline and effectiveness as he led the air force. Research needed to be accelerated, especially in arms development and nuclear physics. The label 'important for the war effort' released funds. The best scientists in Europe were needed, and Rolf was one of them.

Milch

- Erhard Milch was General Field Marshall and Inspector-General of the Air Force and one of the most trusted and influential men under Göring. He was of Jewish origin.

- Schiebold's 'death-ray project' that later morphed into Rolf's betatron project was set in motion by Milch, who knew Schiebold personally.

Speer

- Albert Speer was Arms Minister from 1942, with almost unlimited powers and resources within his remit.
- When T-Force interrogated him after the war, he said that they had done quite a lot of atomic research but that nothing really practical had come out of it. 'They needed another ten years.' He referred to the research that had been led by Heisenberg and Bothe[202] and confirmed that he had given high priority to the building of two cyclotrons in Heidelberg.[203] Heisenberg had recommended Rolf, and Bothe had expressed interest in Rolf's betatron and a desire to work with him.

Geist

- Friedrich Geist was head of technical research and development in Speer's Ministry of Munitions and War Production and Speer's right hand man, according to Heisenberg.
- Rolf considered Geist to be the person officially responsible for his work. Geist was a member of the management committee of Schiebold's research station at Grossostheim where Rolf's project influenced and later replaced Schiebold's work.

Good Scientific Contacts

Gerlach

- Walther Gerlach was Professor of Physics at Munich and along with Heisenberg was one of the most influential scientists in the Uranium Club. He was arrested by the Allies and among those interned and secretly recorded at Farm Hall in England after the war.
- Gerlach was Head of Political Policy in the Physics Section of the National Research Council, with responsibility for everything to do with nuclear research and for Rolf's betatron project. He was also Chairman of the Management Committee of the Luftwaffe Research Station at Grossostheim where it had originally been intended that Rolf's 200 MeV betatron would be built.

Schiebold

- Ernst Schiebold was Professor of Physical-Chemical Mineralogy in Leipzig. He introduced a method of using X-rays to investigate metals. He built up an institute for this type of materials testing. After this was bombed during the war he set up a research station at Grossostheim with what was left of the instruments.
- In 1943, he obtained funds from the Luftwaffe through Milch to develop his idea of an X-ray cannon that would take out enemy planes and crew. Rolf was employed as part of this death-ray project. Rolf said that he met

Schiebold once, at Hollnack's house. When the wonder-weapon turned out to be completely unrealistic and its construction was stopped the following year, the project was continued in the form of Rolf's work on the betatron.

Georgii

- Walter Georgii was Professor of Meteorology and Head of Department in the elaborately titled *Forschungsführung des Reichsministers der Luftfahrt und Oberbefehlshaber der Luftwaffe*.
- The Luftwaffe research station at Grossostheim was part of his remit, and it was he who sent the letter to Schiebold saying that the death-ray project must be abandoned but that Rolf's part of it, the betatron project, should continue. He was also a member of the management committee of the research station at Grossostheim where Rolf's project started.

Fennel

- Kurt Fennel was an engineer who was at the meeting where Schiebold's death-ray project was established on 17th April 1943. He was one of the trusted people who signed the foundation document and one of the four whom General Field Marshall Milch had personally authorised to act on behalf of the project. The other three were Hollnack, Seifert and Schiebold.
- Fennel was a member of the management committee of Schiebold's research station at Grossostheim where Rolf's project started. He was probably the formal recipient of the letter from the Air Ministry on 15th February 1944, intimating that the death-ray project at Grossostheim must be stopped. He was the authorities' representative in the project, but it is difficult to be specific about his role.[204]

Egerer

- Karl A. Egerer was a physicist who was Chief Editor of the scientific journal *Archiv für Elektrotechnik*, published by Springer in Berlin. He was a member of the scientific steering committee of the Luftwaffe research station at Grossostheim and an advisor to General Field Marshall Milch.
- Egerer's journal published Rolf's doctoral thesis and later published several other of his articles. The article Rolf submitted in spring 1943 was not printed, but the people who came to Norway to fetch Rolf knew about it.

Hollnack

- Theodor Hollnack had studied both scientific and social subjects and also specialised in organisation and marketing. He had close connections with the Nazi authorities and a large network of contacts within both business and academia.
- Through his semi-official company he was administratively responsible for Rolf's betatron project in Germany and was the link between Rolf and the Air Ministry. Hollnack attended to the practicalities of the Luftwaffe's

payments to Rolf. Rolf considered Hollnack to be a Nazi, but at the end of the war he revealed to Rolf that he had contacts among the British. He was a member of the management committee of the research station at Grossostheim where Rolf's project started.

Seifert

- Richard Seifert jr. had a doctorate in physics and managed the company Rich. Seifert & Co. that manufactured equipment for the X-ray industry.
- Seifert was a personal friend of Rolf, and their families continued in touch after the war. Seifert was technical advisor on X-rays in Hollnack's company. He was also a friend of Schiebold and technical manager first for the death-ray project and then for the betatron project, where he had full authority to act on behalf of the Air Ministry.

Kratzenstein

- Kratzenstein had a doctorate in physics. His forename was probably Hermann, but it may have been Marius.
- Hollnack described him as the 'instigator' of Rolf's Luftwaffe project. It was Kratzenstein who put Hollnack in contact with Egerer, who knew about Rolf's research through his work as an editor. Krtatzenstein was probably one of the people who came to Oslo to bring Rolf to Germany. He appears to have been of Jewish origin and he is mentioned in a book published in 2004 about Germans who opposed the Nazis.

Three Key People in the Widerøe Group

Kollath

- Rudolf Kollath had a doctorate in physics and had worked at the aluminium smelter in Sauda in Norway and at AEG's research laboratory in Berlin. He faced problems in Nazi Germany because his wife was of Jewish origin. So he could not be appointed to a university or to public office but had to either work in industry or do compulsory labour for the war effort.
- Kollath was one of the key members of Rolf's team in Hamburg and he served as Rolf's deputy. Rolf described him as 'a good fellow-worker and colleague.' He moved to Kellinghausen/Wrist when the betatron was evacuated there in spring 1945. He wrote several detailed technical reports about the betatron immediately after the war ended. These ended up in the hands of the Allies, and when the betatron was removed to England as war booty Kollath was also there for a while. He and Rolf maintained personal contact after the war.

Schumann

- Gerhard Schumann had a doctorate in physics.
- He was a core member of Rolf's team, along with Kollath and Touschek. He moved to Kellinghausen/Wrist when the betatron was evacuated there in spring 1945.

Touschek

- Bruno Touschek was a gifted mathematician and physics student from Austria. Because his mother was Jewish he had been expelled from schools and universities.
- At the age of 22 he became Rolf's assistant, having been recruited by Egerer who had previously given him a job first in the company he worked for himself and then with the journal where he was editor. Touschek lodged at home with Professor Lenz, where Rolf met him for the first time in August 1943. He was allowed to attend Professor Jensen's lectures even though he could not be registered as a student. During his time working for Rolf, Touschek was arrested both by the Gestapo and by the British. When he came out of prison in May-June 1945 he lay in hiding with the Seifert family in Kellinghausen. He later became a greatly respected accelerator physicist in Italy. He said he owed some of the credit for his success to Rolf, as likewise Rolf acknowledged his indebtedness to Touschek.

German Physicists with Various Connections to the Uranium Club and to Rolf's Project

Heisenberg

- Werner Heisenberg was one of the great physicists of the twentieth century, a Nobel prize-winner at the age of 31 and a key member of the German Uranium Club. He was a professor in Munich and a member of the National Research Council. He was arrested by the Allies and was one of the people interned and secretly monitored in England after the war. There is still much speculation about Heisenberg, particularly about what he really thought of Hitler.
- Heisenberg is said to have been the person who advised that Rolf should be brought to Germany. He was also a member of the committee of Schiebold's research station at Grossostheim where Rolf's project started.

Bothe

- Walther Bothe was a professor in Heidelberg, an important member of the Uranium Club and a member of the National Research Council. Along with his assistant, Gentner, in 1941 he was given the job of building a cyclotron for Brown Boveri. He told Speer that the machine would only be for medical and biological use. Bothe was opposed to the Nazis. He was later awarded the Nobel Prize for Physics.
- Bothe was one of the nuclear researchers whom Rolf knew personally. They both worked on the development of betatrons. He tried to make contact with Rolf to develop ideas about a 200 MeV betatron. He himself worked on a 200 MeV cyclotron. Together with his colleague Dänzer, Bothe had plans for a 10 MeV betatron.

Gentner

- Wolfgang Gentner was a professor in Heidelberg and a member of the Uranium Club.

- Gentner was one of the German nuclear researchers Rolf knew personally during the war. He was Bothe's assistant in the work on a cyclotron for Brown Boveri. He had previously worked with Joliot in Paris and Lawrence at Berkeley. Gentner was a friend of the spy Paul Rosbaud ('The Griffin') and in secret he was a convinced anti-Nazi.[205]

Kulenkampff

- Helmuth Kulenkampff had a doctorate in physics and was recognised for his work on X-rays and on betatrons.
- Kulenkampff and Rolf both had the right to attend and speak at meetings of the steering committee of the Luftwaffe research station at Grossostheim. After a conversation with the committee chairman, Kulenkampff warned the person in highest authority in relation to the death-ray project, General Field Marshall Milch, that Schiebold's X-ray cannon was totally unrealistic. Indirectly, he prepared the way for Rolf's project proceeding independently.

Lenz

- Wilhelm Lenz was Professor of Physics and Director of the Institute of Theoretical Physics at the University of Hamburg. Together with Otto Stern and others he built the institute up to become a centre of nuclear research.
- Rolf knew Lenz personally, and Rolf's assistant, Touschek, lodged with him.

Jensen

- Hans Johannes Daniel Jensen was a professor in Hamburg and received a Nobel Prize. He described himself as a socialist, but was said to have really been a communist. After the war he moved to the USA.
- Jensen was one of the nuclear researchers Rolf knew personally during the war. They met each other at Lenz's house. Jensen and Lenz both allowed Rolf's assistant Touschek—who was banned from university because he was Jewish—to attend their lectures without being a registered student.

Suess

- Hans Edvard Suess was a chemist and nuclear physicist. He was employed at the Institute for Physical Chemistry at the University of Hamburg, where he worked with Jensen and others. During the war he was at Vemork in Norway as the German advisor on the production of heavy water. After the war he moved to the USA, where he became a professor at the University of California.
- Rolf first met Suess at Lenz's house. According to Rolf, Suess was one of those who said openly that he opposed Hitler.[206]

Sommerfeld snr.

- Arnold Sommerfeld was Professor of Theoretical Physics in Munich and was considered one of the most important physicists of his time. Along with

Heisenberg he was one of the first to realise that Schiebold's death-ray cannon was a flight of fantasy.
- He was dismissed from his position because of his opposition to the Nazis. He was in the USA during the war and supplied Rolf with information about the research being done there.

Sommerfeld jnr.

- Ernst Sommerfeld was an engineer specialising in patent registration. He was a respected patent advisor in Berlin, and son of the famous physicist Arnold Sommerfeld.
- Sommerfeld jnr. and Rolf were close friends. He dealt with all the legal and formal aspects of Rolf's patents. He was very probably subject to surveillance by the Nazi authorities, who thereby would get insight into Rolf's work.

Gund

- Konrad Gund was an engineer and X-ray specialist. He worked for Siemens on both a 6 MeV betatron and a 25 MeV one, based on Steenbeck's ideas and designs.
- Gund and Rolf were 'colleagues' and competitors. They both received official support from Nazi Germany for their betatron projects.

Steenbeck

- Max Steenbeck was a professor of physics who had written his doctoral thesis while he was in the research department at Siemens. At the end of the war he was arrested by the Russians and sent to Moscow, where he worked on the Russian atomic bomb project and became a declared communist. He later became a professor in the German Democratic Republic and expressed criticism of his previous time at Siemens.
- At the time when Rolf was working on his doctoral thesis about betatrons, Steenbeck had already developed his ground-breaking ideas about a cyclotron—and also a first sketch of a synchro-cyclotron. Rolf knew Steenbeck slightly because of his experimental work on betatrons at Siemens, initially with Gund and later also with Kopfermann and Paul.

Kopfermann

- Hans Kopfermann was a professor of nuclear physics and a member of the Uranium Club. In 1941 he was appointed Dean of the University in Kiel where he was employed. In this position, he was required to join the Nazi party.
- He and Paul worked for a long time trying to develop their own betatron in Göttingen, but when they heard of Gund and Steenbeck's project for Siemens they offered their assistance there instead. The researchers at Siemens were Rolf's only real competitors.

Paul

- Professor Wolfgang Paul in Berlin worked for a long time together with his teacher, Kopfermann, to develop their own betatron, but eventually they both joined Gund and Steenbeck's project at Siemens. Paul later shared a Nobel Prize.
- Paul and Rolf were 'colleagues' in betatron research. Paul wrote a historical review of developments in accelerator research, in which he described two researchers as prominent, namely Rolf and also Steenbeck, with whom he later worked himself.

Nuclear Physicists Abroad Whose Work Influenced the German Physicists

Lawrence, USA

- Ernest O. Lawrence invented the cyclotron in 1930.
- He got the idea from studying the sketches and equations in Rolf's doctoral thesis from 1927.

Kerst, USA

- In 1941, Donald Kerst was the first person in the world to succeed in constructing a betatron that worked.
- This was based on the principles set out in Rolf's 1927 doctoral thesis. When Rolf heard of it, he resumed the research on betatrons that he had set aside for several years while he was working on electrical relays and power distribution networks.

Bohr, Denmark

- Niels Bohr was one of the most famous physicists of the twentieth century and known as the founder of quantum mechanics. He was awarded the Nobel Prize in 1922 for his study of the structure of the atom and of atomic radiation. Heisenberg was one of his students. Bohr had Jewish ancestry, and during the war he fled to the USA where he took part in the Manhattan Project.
- Bohr had been a pupil of Rutherford in England. Rutherford, who was also a great inspiration to Rolf, had started the atomic age by managing to split an atomic nucleus. Bohr followed this up in theory and Rolf in practical application.

Scherrer, Switzerland

- Paul Scherrer was a nuclear physicist and Professor of Experimental Physics at the college in Zürich where he taught for 40 years. In 1940 he built the first Swiss cyclotron. He was also involved in setting up the CERN laboratory. From 1944 onwards he leaked information to the USA about German

research and the attempt by German scientists to develop atomic weapons. He was also responsible for the plot to lure Heisenberg to Zürich as part of *Operation Alsos.*[207]

- It was Scherrer who advised the owner of Brown Boveri in Switzerland to recruit Rolf. The three of them met in Baden shortly before Easter 1946 to discuss Rolf's appointment to the head office. About the same time as Scherrer retired from his teaching post at the college in Zürich, Rolf started lecturing there. Scherrer has an internationally recognised research institute named after him, the Paul Scherrer Institute, PSI, which is situated close to Nussbaumen where Rolf lived during most of his time in Switzerland.

Major, research-intensive international industries were also racing to build accelerators:

Brown Boveri

Brown Boveri played a very particular role, in that Rolf was employed there before, during and after the war. The company was a party to Rolf's contract to do research for the Luftwaffe during the war. Brown Boveri had its head office in Switzerland and subsidiary companies in both Germany and Norway. The German company was closely involved in the second phase of Rolf's project, the design of the 200 MeV betatron to be built at their factory in Mannheim. Rolf developed almost a hundred betatrons for them after the war, contributing to the company's great international success.

Philips–Müller

C.H.F. Müller in Hamburg belonged to the Philips Group. The company designed and manufactured X-ray tubes and other X-ray equipment. During the war they also produced sonic apparatus for underwater use. When the war started the company had 500 employees. 20 of these were in the high-voltage department, whose activities included the work on the betatron. 160 worked purely with X-ray equipment and the others were engaged in various related technologies. The factory narrowly avoided being damaged by the bombing raids on Hamburg, and when the Allied investigators arrived in spring 1945 they found the equipment mostly intact.[208]

Under the heading 'Ultra high voltage equipment,' the CIOS investigators wrote in their summary report: 'C.H.F. Müller who are working in Wrist in collaboration with and under the leadership of "*MV Forschungs-Verein*/MV Research Association" completed the construction of a 15 MeV betatron.'[209]

The report goes on to say that in December 1944 the M.V. Research Association completed the calculations and designs for a 200 MeV betatron with an estimated weight of 30 tonnes, to be built at Brown Boveri in Mannheim.[210]

A chapter about the medical use of the betatron describes the remarkable procedures hospitals could now use. It explains how X-rays can be used in cancer treatment, killing cancer cells without overdosing the surrounding healthy cells. It refers to how this technology was 'invented' at the end of the 1920s but not 'proven' until 1941, when the American, Kerst, managed to get Rolf's betatron theory to work. There is no doubt, therefore, that what the investigating officers had discovered was Rolf's betatron project. Nor is there any doubt that they understood that it was of great medical significance.

Hans Ritz, the manager of the Müller factory, was an electrical engineer though X-ray tubes were not really his area of special expertise. He was one of the inner circle round Schiebold, the man with the idea of the death-ray weapon. Ritz had previously been employed at AEG, until he was appointed manager of C.H.F. Müller for political reasons. As a foreign-owned enterprise, part of the Philips Group, the factory was subject to obligatory control under *Zwangs- und Fremdvervaltung* and could be compelled to do particular jobs with the help of specified people. A few weeks after the end of the war, Ritz and two others were dismissed by the management of Philips, because they had been active members of the Nazi party.

Albert Kuntke was a completely different type, and was more important for the practical work on the betatron. He was head of the high-voltage laboratory and did important precision work. Rolf described him as very capable, gave him credit for his contribution to the success of the 15 MeV betatron and visited him at home several times. Kuntke took part in meetings and visits when representatives from Brown Boveri came to plan the development of the 200 MeV betatron. He had been an apprentice at Seifert and when he started at Müller he was given help to train further and qualify as an engineer. Kuntke was among those who were questioned thoroughly by the scientific intelligence agents in the spring and summer of 1945. A summary report from the British Intelligence Objectives Sub-Committee, BIOS, says that 'Müller, working with a Norwegian, had built a 15 MeV betatron' and adds that 'It has been moved to Wrist.'

Dr. Werner Fehr, an X-ray specialist, was deputy manager at Müller and another person with whom Rolf worked closely. When he was questioned by the British while they were investigating the site, he told them that the betatron 'was something the Luftwaffe had been experimenting with in the hope of being able to generate a death-ray for use in an anti-aircraft gun.' For reasons unknown, there is a question-mark in brackets after the word 'hope.'[211]

Rolf later met Fehr again several times and he particularly mentioned that Fehr several years later sent him a photo of the Hamburg betatron, and that he had written an interesting little leaflet on the history of the C.H.F. Müller factory.[212]

Fehr and a couple of other employees at the Müller factory later claimed that they had realised right from the start that Schiebold's X-ray cannons were not a realistic prospect.[213]

In their eyes, Schiebold was just a pompous eccentric whose ideas were wide of the mark. The only reason his project was interesting to them was that it gave the factory work with high war priority. Müller was well in on the act, and even though their work with Rolf went well most of the time, Schiebold's project eventually failed.

General Electric

The American physicist, Donald Kerst, had connections with General Electric. GE had custom-built the doughnut-shaped glass tube he used in his first betatron. Together with General Electric he then set about developing his design further to 20 and 100 MeV machines. He succeeded in making his second machine, 20 MeV, in 1942 and GE completed a 100 MeV machine in 1945. In the meantime Kerst had been called back to the University of Illinois where he built an 80 MeV prototype betatron and a gigantic 300 MeV version which was and

remains the biggest machine of this type ever made and is considered the final step in betatron development.

Westinghouse

In the USA, Westinghouse with physicist *Joseph Slepian* were also in the race. Slepian modestly described his 1922 apparatus as an X-ray tube. Westinghouse's daughter company, National Industry, had head-hunted Rolf to their branch in Oslo in 1937.

AEG

AEG, Allgemeine Elektricitäts-Gesellschaft, was a prominent company in the electrical industry, with traditions just as long as Brown Boveri. They played a major role in the development of cyclotrons. The company was ambitious and was awarded contracts from the highest authorities. AEG together with the Kaiser-Wilhelm Company undertook for the army munitions office the building of a 'giant cyclotron' for the Uranium Club.

Among other things, AEG supplied equipment to Schiebold's death-ray project. Seifert as technical director of the Widerøe project switched over to ordering glass tubes from AEG, after originally buying them from the Müller factory. Work was also done on plans for a 20 MeV betatron from AEG but that came to nothing.[214] AEG collaborated with General Electric in the USA for as long as that was possible. Many of the people who later became important in betatron research, both in Siemens and in Brown Boveri, had come from AEG. Rolf himself had worked there when newly qualified, before he moved back to Norway. Rolf's deputy, Kollath, was recruited from AEG's research division, though the two of them were not there at the same time. Gans was in the same department before Siemens engaged him and the manager of the Müller factory, Hans Ritz, was also from AEG.

Siemens

Siemens was already a big company and was Brown Boveri's main challenger in betatron technology. The principal researchers in this field at Siemens were *Konrad Gund* and *Max Steenbeck*, later joined by *Wolfgang Paul* and *Hans Kopfermann*.

For Siemens as for AEG and Brown Boveri, the interest in high voltage equipment was very timely. This was the newest thing in their field, and they needed to be assertive. It was obviously important that research on electron accelerators was classified as important for the war effort, as there had been a lack of research during the first phase of the war and both physicists and industry had started looking around for money. Walther Gerlach, the man who took over as the national head of physics research towards the end o the war, had for example given Siemens three betatron contracts.[215, 216]

When the Americans arrived to investigate Siemens, they confirmed there had been work on two small betatrons and that there were plans for a slightly bigger one, similar to Rolf's first one rated at 15 MeV. Siemens told the investigators that their interest in betatrons was directed purely at cancer therapy.[217] The Americans confiscated a small, 6 MeV machine. Orders were given for it to be destroyed, but Paul and Kopfermann managed to prevent that through their contacts in the British military regime.[218]

The theoretician behind the Siemens project, Max Steenbeck, later said that 'The betatron was certainly not important for the war effort,' and that the investment was directed by business interests. He maintained that as the Americans were working on betatrons, the Germans had no choice but to press on with a view to entering the market as soon as possible after the war.[219]

Rich. Seifert & Co

During the war, Rich. Seifert & Co. were the biggest producers of industrial X-ray equipment in Germany, and they also made apparatus for medical use. Seifert bought components from their competitors Siemens, Müller and AEG. The company had about 350 employees when the American intelligence services investigated the factory and they interviewed the owner Richard Seifert and several of his staff.[220] The company still exists. It was bought by Agfa in 2001 and is now part of the GE group.

Seifert's firm merits special mention. At the same time as they were supplying equipment, the owner was employed by the Luftwaffe as technical director first in Schiebold's death-ray project and then in Rolf's betatron project. He was a qualified physicist and had inherited the well-run company from his father. He had previously been advisor in X-ray technology for Hollnack's company and Rolf thought that it was Hollnack who had brought Rolf and Seifert together, though he couldn't exactly remember how they first met.[221] Seifert was also a friend of Schiebold, and when Schiebold first told the authorities about his secret death-ray project he was given special permission to tell Seifert about it. Seifert was then brought into the project management team. Not only that, Seifert had a foot in the Air Ministry. He represented the ministry when the contract for the 200 MeV betatron was being awarded to Brown Boveri. He was also an important part of the Hollnack-Schiebold-Seifert triumvirate who ensured contact high in the Nazi hierarchy and secured mandates and means for Rolf's work on betatrons. As Rolf himself said:

> My first and by far the most important contact in Hamburg was Dr. Richard Seifert, a very sound and able person whom I greatly respected. He actively helped and supported me in my special situation.[222]

Seifert was thought to be a Nazi,[223] but Rolf's mind was obviously on other things and he either didn't see or he deliberately ignored the political manoeuvring. Seifert was a necessary contributor to the job in hand, both because of his professional ability as a physicist and as a supplier of equipment to Luftwaffe projects. His key role and his many connections provide

a good example of how difficult it was at that time to specify and label people's positions on the network, when many people held several posts and some didn't quite seem to fit in anywhere. Even from today's perspective it is difficult to trace the strands in the complex, multi-dimensional network. Although Rolf spoke familiarly with the Nazi opponent Hans Suess during the war, he also remained a personal friend of Seifert for the rest of his life. Such apparent contradictions don't make the unravelling any easier.

What Became of Them

After the war, Rolf often expressed concern about the people who had worked with him in Germany. He wondered what had become of them, and he kept in touch with many, including employees at the Müller factory who had become involved in the situation not on their own choice but who had nevertheless worked loyally with him. Hollnack's organisation vanished from sight. Schiebold, who had started the whole thing with his ideas about death-rays, moved to the GDR where he was dismissed from his first post because of his political history but finally got a professorial appointment elsewhere. Gerlach, the very influential research politician, signed the Göttingen Manifesto along with other leading German physicists. Steenbeck, the researcher at Siemens, became a communist and settled first in the Soviet Union and then in the GDR. Rolf's two closest colleagues, Kollath and Schumann, continued their research careers in West Germany and maintained contact with Rolf, as did his business contact and friend, Seifert.

Then there was his assistant, Touschek, the student with a Jewish background who had benefitted from the professional opportunity and had survived under Rolf's nurturing and protection. Whenever Rolf later spoke about the people he had worked with and had contact with at that time, he always made special mention of Touschek.

This was the gifted youth, born in Vienna in 1921, who had to come out of further education because his mother was Jewish. He was offered a post in England after the war, but he chose to work in Göttingen where he installed the Siemens betatron that somebody had managed to rescue. Then he was in Glasgow, and in the 1950s he came to Rome where he established his reputation as a theoretical physicist. Ten of his colleagues composed a tribute in the form of an article entitled 'A Stolen Nobel Prize,' where they asserted that Touschek had obviously deserved a Nobel Prize.[224] After his death a colleague at The Frascati National Laboratory accorded him the epitaph 'Strong professionally, undoubtedly talented and very entertaining.'

Touschek had a tragic end, however. He became alcoholic and died at the age of 57, three or four months after being appointed as a professor. Rolf met Touschek several times after the war, the latest occasion being in 1975. The difference in age was such that Rolf could have been his father. They had a close relationship, and the time they had spent working together was important to both of them.

Since the time Touschek and Rolf had discussed Rolf's vision of the clouds colliding, Touschek had continued working on the problem of how to steer particles against each other, and he succeeded as the first person in the world to build an effective storage chamber. There was still a little friendly rivalry between Rolf and his former assistant. When Touschek made his break-through in 1960, the master congratulated his pupil but couldn't quite restrain himself from mentioning his own contribution:

> This working storage ring was the first in the world, and so that was the first time my patented ideas from 1943 had been applied in practice.[225]

Research based on Rolf's ideas is still being pressed forward. All over the world, lectures are being published on the internet about the importance of Rolf's work and the betatron's place in the history of science. Each new batch of physicists who need to grasp accelerator technology studies the line of development from when Rolf formulated his first theses, through the successors who built on his theories, and on to today. As recently as 2011 two Italian physicists brought to light new details about Rolf's work and his collaboration with his assistant, based among other things on the recent discovery of letters that Touschek had sent to his parents during and shortly after the war.[226]

In 2015 the Norwegian journal 'Technical Weekly' published an article saying that the University in Oslo was planning to build up expertise in particle acceleration based on recently developed technology. The article also pointed out the paradox of Norway's lack of expertise in this field:

> Norway has areas of strength in particle physics that have grown up around the activity at CERN, but we are weak in one field. In contrast with most European countries, we do not have much expertise in accelerators. Rather strange, perhaps, as from a historical point of view we have strong traditions of building them.
>
> The technology was first developed by the Norwegian Rolf Widerøe who published his ground-breaking results as long ago as 1928. We now find them in all particle accelerators throughout the world, irrespective of whether the radiation travels in a circle or in a straight line.[227]

Not just physicists, but also scientific historians, local historians and amateur researchers together with some charlatans and fantasists continue the story in various ways, expanding this web of people interested and involved. Some find previously unknown threads, others spin new ones. South-East of Frankfurt, around Grossostheim, the wildest rumours circulated about the mystique of what was supposed to have happened during the war at the abandoned airbase. There was a bunker that nobody was allowed to approach. Some people suggested that it was intended as a concentration camp. Others thought that sinister research went on behind its metre-thick walls.

After the war the curiosity just continued to grow. The myth-enshrouded bunker where radiation was to be generated and which nobody was allowed to approach drew the interest of experts and amateur historians to this little village. They unravelled the stories both of the X-ray-cannon-professor Schiebold who wanted to build a laboratory on their airbase and of the Norwegian who had a brother in a German prison and who was to build a giant betatron there. In spring 1944 Schiebold's machine hall had stood ready to receive a betatron, due to arrive from the Müller factory in Hamburg in the summer—they thought. But then the barrier came down on Schiebold's activity. Rolf, on the other hand, was allowed to continue his project in Hamburg where he had started.

The plans for Grossostheim had been grandiose, but nothing came of them. What happened there has now become the theme for a museum. The people of the town have been able to fill their local gap in the history of the war with documented facts, imaginatively put together with fragments of archive material, reminiscences and not least, Pedro Waloschek's book about the death-rays.[228]

But not all the interest leads to such useful outcomes. Themes such as forces that are unseen but we know are there, set people thinking far beyond the technological milieu. When a topic is speculative and is in the borderland of comprehension for ordinary people, and especially when it involves documents marked *Geheim* and 'Secret' and *Heil Hitler*, all in an obscure context, it invites us to create narratives within the realm of science fiction. There is a whole industry of conspiracy-theory writings making a business out of people's interest in this 'something more' between heaven and earth. Even when the authors pile on names and facts that in some instances are correct, or at least look plausible, the information is not always what it appears to be. Schiebold's 'death-rays' have obviously found a place here. What is worse is that Rolf and his betatron have also been drawn into tales of Nazi occultism, possible UFOs and levitation.

The Spider

What was happening round about Rolf didn't need such over-dramatization, however. What he was working on was exciting enough in itself. As was the race against other researchers, cheered on by industries trying to survive and earn money and a government and military powers trying to win the war. Then the drama increased further as people added further threads to the web. A Hollnack; an Egerer; and others with their own agendas. It has been difficult to know what descriptive label to apply to many of the people in the list of *dramatis personae*.

Hollnack told the British his version. It may not necessarily be accurate, but it is difficult to doubt the essence of the information he provided. Rolf told his version to the Americans. Nor is this necessarily a correct objective account. But that was what he said, and that was also what he wrote. His second-in-command, Kollath, wrote detailed reports for the British. The newly appointed head of intelligence services did the same when peace came. From meetings between Brown Boveri, German authorities and the Widerøe project there are minutes and personal summaries. The Allied scientific intelligence officers sent their reports and documents back and forward across the Atlantic.

Although Hollnack claimed a principal role for himself, he was not necessarily the one at the centre of the web. The real spider could be someone else. Egerer, the journal editor who took possession of Rolf's latest article, has a key role irrespective of whether he was directing or being directed. The most speculative scenario would be that the spider managed to remain in hiding. Perhaps a Seifert, who is consistently omnipresent. Or Kratzenstein, whom Hollnack hardly names in his report. Perhaps a Fennel, who at the start always had to be at the meetings with officials but who then disappeared into the wings, only to reappear at the end.

But do we really need to know who the spider was, in order to understand Rolf's situation? The point is that it was a web.

In brief: It is difficult to disentangle what were the various motives of the people in this network. This part of the story cannot be summarised in one or two excerpts. The answer may be the unexciting one that most of them were just trying to get by and cope as best they could in a difficult situation. But there were principles to be considered too. What is expected of you when your country is at war? Rolf hardly knew himself how many different interests were involved in his project. He was focussed on the research. He could see that he was held in a network, but he had no way of seeing the

whole pattern. And if he did know anything, he didn't care to talk about it. Or he couldn't. Always uncertainty. War is war.

He could obviously feel honoured that it was Heisenberg who had recommended him—if he knew. The people who brought him to Germany had contacts right at the top of the hierarchy. This too was an honour, in a sense. But it is not at all certain that he knew. How could he? His job description came from the Luftwaffe, as did the money. The person who negotiated the job and acted as paymaster was called Hollnack. That much he knew. But there was more, much more, that he didn't say.

The whole history of nuclear research in Germany during the war is enveloped in mystery, propaganda, faith and doubt. A good illustration that where facts are lacking, fears and rumours arise. There was a belief that whoever made an atom bomb first, would win the war. Quite early on, the Allies knew more than the Germans—that there really wasn't so much to know about on the German side. But the Germans didn't know that the Allies knew this. So they put in support, step by step, to find their ultimate weapon, the wonder-weapon, a *Wunderwaffe* that had to be found if the atom bomb was not ready in time. But there was also an economic war, an industrial war—about rights, patents, licences, about the bottom line after the war; and for that they needed the best.

It was inevitable that Rolf would have a part on the wartime world stage, because he happened to have had an idea about one of the main themes of the plot; because he sketched it in a thin, square-lined notebook as early as 1922, while he was student; and because he continued to work on his idea. Continued on and on. Looked neither to right or left. Kept his eyes on the target, that was both so simple and so complex—like Rolf's own story.

Following on from his idea, physicists will continue to explore the potential of atomic power. Accelerator technologists throughout the world will go on crossing boundaries of knowledge. Scientific historians, politicians and most people will look for connections past and future. But life is lived forwards and must be handled from day to day without being able to see connections in all directions. And the higher the stake, the greater the possible gains or losses. In Rolf's case, he had to live with the consequences of his choice. So we may all ponder what he said or didn't say about what he lived through, for example why he never said:

– that he was nearly arrested both by the British and by the Russians;
– that his project continued, away from he hands of the Nazi authorities, after he went home;
– that he knew his assistant would soon be released from prison;

– that he must have known the identity of the SS officers who visited him in Oslo;
– that the physicist who interviewed him in prison represented high level American intelligence services;
– that Brown Boveri was part of the picture all the time;
– that there was a web of Nazis, Nazi sympathisers, anti-Nazis, secret agents and Allies behind his project.

He *must* have known some of this. How much, will remain his secret. It was his decision that it should be thus, and we just have to live with that. His posthumous reputation has had to endure censure and speculation, misinterpretation and defence. Nor has the history of atomic bomb research in Nazi Germany reached its final conclusion, despite continuing input—and there is little likelihood that it ever will. Experts advise healthy scepticism and an open mind about both the accelerator programme and Germany's weapons programme during the Second World War.[229]

***

Rolf's decision to go to Germany had its price, and he accepted the consequences. With straight arm and back, stiff lip and head held high. With his gaze fixed high in the distance. Right through the treason proceedings, imprisonment, a fine and harmful rumours. He stood by his decisions, whatever happened. He also had to live with the uncertainty about what more there was to know, the responsibility for not telling everything that he did know and the result that people therefore just thought whatever they wanted.

But what did *he* think about why he had submitted himself to all that? … Oh, if only we could know.

Notes

1. National Archives FO 1032/230. 3A: '*Daten und Tätigheit*' ('Dates and Activity') and 4A 'Curriculum Vitae' (English translation) sent to T-Force 1st February 1946.
2. National Archives FO 1032/230. 3A: '*Daten und Tätigheit*' ('Dates and Activity') and 4A 'Curriculum Vitae' (English translation) sent to T-Force 1st February 1946.
3. The biography.
4. Alsos, 'Visit to Widerøe in Oslo. July 1945. Capt. G. Randers,' the document. '*Bericht über die historisch-organisetorische Entwicklung*' ('Report of the historical and organisational development') written by Theodor Hollnach,

pkt. 'Vorgeschichte,' 9th June 1945, Niels Bohr Archives, American Institute of Physics.

5. Alsos, 'Visit to Widerøe in Oslo. July 1945. Capt. G. Randers,' the document '*Bericht über die historisch-organisetorische Entwicklung*' ('Report of the historical and organisational development') written by Theodor Hollnach, pkt. 'Vorgeschichte,' 9th June 1945, Niels Bohr Archives, American Institute of Physics.
6. David Irving: 'The Rise and Fall of the Luftwaffe. The Life of Field Marshal Erhard Milch,' Focal point, 14 Total War, February-March 1943, pp. 226–227.
7. Waloschek: Schiebold, E.: *Niederschrift über die Besprechung Seifert-Fennel-Schiebold vom 17. April 1943* ('Transcript of the Seifert-Fennel-Schiebold discussion on 17th April 1943') in Hamburg, NES ♯75 to 77.
8. Waloschek: '*Todesstrahlen*'.
9. Waloschek: '*Todesstrahlen*'.
10. '*Schiebold's braune Sciencefiction',* 2004 Leipziger Volkzeitung 16th/17th April 2004, review of Pedro Waloschek's book '*Todesstrahlen als Lebenretter*' ('Death-rays as Lifesavers'), 2004.
11. Waloschek: *Todesstrahlen.*
12. Waloschek: *Todesstrahlen.*
13. Luisa Bonolis and Giulia Pancheri, Theory Group—Research Division, INFN Frascati National Laboratories, Frascati, Italy. 'Bruno Touschek: Particle Physicist and Father of the $e^+e^÷$ Collider', 14th March 2011. Letter from Bruno Touschek to his parents 17th November 1945. The letter was translated into English by Giulia Pancheri.
14. Waloschek: *Todesstrahlen.*
15. Pedro Waloschek, who had met several former employees when he was writing the book about Schiebold's death-ray project, in conversation with me in connection with my book.
16. Luisa Bonolis and Giulia Pancheri, Theory Group—Research Division, INFN Frascati National Laboratories, Frascati, Italy. 'Bruno Touschek: Particle Physicist and Father of the $e^+e^÷$ Collider', 14th March 2011. Letter from Bruno Touschek to his parents 17th November 1945. The letter was translated into English by Giulia Pancheri.
17. ETH Library Zurich HS 903:203, Letter from Touschek to Widerøe 29th March 1946.
18. ETH Library Zurich HS 903: 28, Kollath: '*Bericht über die Arbeiten am Betatron in Wrist für die Zeit vom Mitte November bis Mitte Dezember 1945',* ('Report of the work on the betatron at Wrist for the period from mid November to mid December 1945') *'MV-Forschungs-Vereinigung',* Wrist, 11.12.1945.
19. National Archives FO 1032/230. 3A: '*Daten und Tätigheit*' ('Dates and Activity') and 4A 'Curriculum Vitae' (English translation) sent to T-Force 1st February 1946.

20. AB 12/4 ACAE Nuclear Physics Sub-Committee Accelerating Systems Panel: minutes 1945–1946.
21. British Army of the Rhine (BAOR) was the new name for what was originally called Supreme Headquarters Allied Expeditionary Force (SHAEF), led by Field Marshal Montgomery and established in London in July 1943. SHAEF had consisted mainly of British and Canadian troops and had been responsible for Operation Overlord, the codename for the overall plan for the liberation of North-West Europe that started with D-Day and the invasion of Normandy. From June 1944 until the end of the war the group was called the 21st Army Group and operated in Northern France, Luxembourg, Belgium, the Netherlands and Germany. After the war, the name of the force changed to BAOR and it continued to be called by this name throughout the Cold War. (In some countries a Field Marshal is the highest military rank, above a general. In Germany and some other countries the equivalent rank is called General Field Marshal.)
22. National Archives FO 1032/230. Subject: Hollnack. 7A: 20th Feb. 1946. To Brigadier C.F.C. Spedding. Written by Colonel F. Read, Mil. Gov. Econ 4 (Research), Block L., Mudra Barracks, Minden, B.A.O.R.
23. All documents in the National Archives have a reference number with three parts: a departmental code, for example WO for War Office; a category code which usually has three digits; and an individual number that usually has four or five digits. Older documents can differ in the number of digits.
24. National Archives FO 1032/230. 3A: '*Daten und Tätigheit*' ('Dates and Activity') and 4A 'Curriculum Vitae' (English translation) sent to T-Force 1st February 1946. 2A: Translation 6th February 1946 Sign. Econ. 5A: Translations. 7th February 1946. Chief Interpreter. 5B: Covering sheet 7th February 1946.
25. Luisa Bonolis and Giulia Pancheri, Theory Group—Research Division, INFN Frascati National Laboratories, Frascati, Italy. 'Bruno Touschek: Particle Physicist and Father of the $e^+e^\div$ Collider', 14th March 2011. Letter from Bruno Touschek to his parents 17th November 1945. The letter was translated into English by Giulia Pancheri.
26. National Archives FO 1032/230 Hollnack: 7A: 20th Feb. 1946. To: Brigadier C.F.C. Spedding. Written by Colonel F. Read, Mil. Gov. Econ 4 (Research), Block L., Mudra Barracks, Minden, B.A.O.R. Report of visits to Hamburg 28th Jan and 4th Feb 46.
27. National Archives FO 1032/230 Hollnack. 6A: Letter to Read. Subject: Mr. Hollnack. 25.2 1946. From Major Coleman, ASO, Hamburg. FO 1032/230 Hollnack. 6B German (English without a number). To Read. Letter. Written in Kellinghausen 18 Feb. 46 From Hollnack.
28. National Archives FO 1032/230 Hollnack. 8A: To Coleman. From Read. 20.3 1946. For the attention of Major Coleman. Written by F. Read, controller, Research Branch.

29. Letters from Touschek to Widerøe 29th March 1946, ETH Library Zurich Hs 903: 203; 20th May 1946 Hs 903: 205; 28th September 1946 Hs 903: 212; 19th November 1946 Hs 903: 207; 6th April 1957 Hs 903: 215.
    Letters from Kollath in Wrist/Kellinghausen/Hamburg to Widerøe 30th March 1946 ETH Library Zurich Hs 903: 119; 30th May 1946 Hs 903: 120; 14th July 1946 Hs 903: 124; 20th July 1946 Hs 903:126; 21st July 1946 Hs 903; 127; 29th August 1946 Hs 903: 130; 4th September 1946 Hs 903: 129.
    Letter from Widerøe to Kollath 16th September 1946 ETH Library Zurich Hs 903: 131.
    Letter from Meyer-Delius in BBC to Widerøe 7th August 1947 ETH Library Zurich Hs 903: 234.
    Letters from Kollath in London to Widerøe 1947–1948 ETH Library Zurich Hs 903: 138–160.
    Letters from Kollath in Hamburg to Widerøe 1951–1953 ETH Library Zurich Hs 903: 408–432.
    Letter from Widerøe to Sommerfeldt 14th June 1952 ETH Library Zurich Hs 903: 508.
    Letter from Sommerfeldt to Widerøe 17th June 1952 ETH Library Zurich Hs 903: 509.
    Letters from Seifert to Widerøe 1951–1953 ETH Library Zurich Hs 903: 486–504.
    Letters from Wolfgang Gentner to Widerøe 1950–1953 ETH Library Zurich Hs 903: 346–352.
30. In the biography it is said that Kollath followed the betatron to London around the turn of the year 1945/46. However, this does not tally with the information in Kollath's letters to Widerøe in the period 1946-1948.
31. National Archives FO 1032/230 Hollnack. 9C: Attachment 1: 3rd July 46. written by Major A. Battegal for Lt. Col. 16 (Hamburg) Int. Office: Thedor Hollnack—to whom it may concern.
32. National Archives FO 1032/230 Hollnack. 9C: Attachment 2: 25th July letter from Major Wallis to Dr. Eng. R. Kollath, Hamburg-Fuhlssbüttel, Erdkampsweg 16.
33. National Archives FO 1032/230 Hollnack. 9B: To Read from Hollnack, German version, 20.10.1946 on Hollnack's own writing paper.
    FO 1032/230 Hollnack. 9A To Read from Hollnack, English version 22.10.1946, also on Hollnack's own writing paper. (Does this mean that he had written the English version himself?) On the English version the name 'Groves' is hand-written at the top of the sheet. This might be a coincidence, but Leslie Groves was the name of the leader of the American Manhattan Project that developed the first atom bomb.
34. National Archives FO 1032/230 Hollnack. To Hollnack. Subject: Graded Scientists. 12th April 1948. Signed by Barnes.

35. National Archives FO 171/5211: 'T-Force intelligence summary for period 2nd May to 10th May 1945'.
36. Letter 22nd June 1945.
37. ETH Library Zurich HS 903:203 Touschek in letters to Widerøe 29.03.46 and 20.05.46.
38. Folder marked 'Alsos' (material gathered by Captain Gunnar Randers), in Niels Bohr Archives, American Institute of Physics. 'Visit to Widerøe in Olso. July 1945. Capt. G. Randers'.
39. The letter was dated Kellinghausen 9th June 1945 and was formally addressed to 'T-Force, 2. Britische Armee, Hamburg.'
40. Niels Bohr Archives, American Institute of Physics: 'Protokoll *MV-Forschungs-Vereinigung*/MV Research Association.' Alsos/Capt. G. Randers: Re: Betatron (for further evaluation).
41. The following are named in addition to Rolf's close co-workers: Schulz (workshop foreman); Flegel (laboratory engineer); fru Gärtke (office worker), frk. Goos (laboratory assistant); Rümling (mechanic); Luhn (mechanic); and frk. Lindemann and Walter (instrument makers). The last four of these are listed as Seifert's co-workers. The day to day manager is dipl.eng. Wernwer Bartelt. The following are listed in the administrative management: Januszak; Köchig, frk. Borchedt; frk. Lochmann; frk. Lucas and Klyne (?) (indistinctly). In addition, Hollnack has his own secretariat consisting of frk. Blome; Kirchner; frk. Bernhardt; Overbeek and Helffenbein/Meier/Vrana.
42. Niels Bohr Archives, American Institute of Physics, Attachment I-1-2, Alsos/Capt. G. Randers: Re: Betatron for further evaluation.
43. Niels Bohr Archives, American Institute of Physics, 'No. 1. Report," Alsos/Capt. G. Randers: Re: Betatron for further evaluation.
44. Niels Bohr Archives, American Institute of Physics: '*Bericht über die historisch-organisatorische Entwicklung des Entwicklungsvorhaben Dr. Widerøe, Oslo, in Deutschland*' ('Report on the historical and organisational development in Germany of the development project led by Dr. Widerøe of Oslo.')
    'Protocol' (Foundation document with 13 appendices).
    '*Tätigheitsbericht und Programm für die Weiterarbeit der MV-Forschungs-Vereinigung/MV Research Organisation. Bericht über den Strahlentransformator nach Dr Widerøe.'* ('Activity report and programme for the further work of the MV-Forschungs-Vereinigung/MV Research Organisation. Report on the radiation transformer after Dr. Widerøe.')
    '*Für die in der MV-Forschungs-Vereinigung betriebene Entwicklung sind und waren folgende Mitarbeiter Tätig'* (List of workers).
    All the documents are in the Alsos folder, Capt. G. Randers: Re: Betatron for further evaluation.

45. Niels Bohr Archives, American Institute of Physics: '*Beschlussfassung*' ('Decision') Alsos/Capt. G. Randers: Re: Betatron for further evaluation.
46. Similar letters to Prof. Dr. Heisenberg and Prof. Dr. Bothe, Niels Bohr Archives, American Institute of Physics, Alsos/Capt. G. Randers: 'Re: Betatron for further evaluation,' Niels Bohr Archives, American Institute of Physics.
47. Letter with invitation sent to 10 professors, Niels Bohr Archives, American Institute of Physics, Alsos/Capt. G. Randers: Re: Betatron for further evaluation. Thomas Powers: Heisenberg's War, 1993.
48. Niels Bohr Archives, American Institute of Physics, Attachments II-1-11 and II-1-12, Alsos/Capt. G. Randers: Re: Betatron for further evaluation.
49. Niels Bohr Archives, American Institute of Physics: '*Einladung eines Englischen Wissenschaftlers des einschlägigen Gebietes zur Mitarbeit*' ('Invitation to an English scientist in the relevant field to work together') (Prof. Dr. Bragg), Alsos/Capt. G. Randers: 'Re: Betatron for further evaluation'.
50. ETH Library Zurich HS 903:203 Touschek in letters to Widerøe 29.03.46 and 20.05.46. Letter from Touschek to his father 17.11.45, Louisa Bonolis and Dr. Giulia Pancheri, Theory Group—Research Division, INFN Frascati National Laboratories, Italy. 'Bruno Touschek: Particle Physicist and Father of the $e^{+}e^{\div}$ Collider,' 14th March 2011. Letter from Bruno Touschek to his parents 17th November 1945. The letter was translated into English by the Italian Professor Dr. Giulia Pancheri.
51. 'Moonraker,' 1955.
52. Sean Longdens T-Force: 'The Race for Nazi War Secrets,' 1945. Constable. London. 2009. 'How T-Force Abducted Germany's Best Brains for Britain.' By Ian Cobain. The Guardian, 29th August 2007. How Britain Put Nazi's Top Men To Work. By Stewart Payne. The Telegraph, 30th August 2007. Tom Bower: 'The Paperclip Conspiracy: The Hunt for the Nazi Scientists,' Little, Brown, 1987.
53. T-Force units were linked to three army groups on the Western Front: Sixth United States Army Group, 21st Army Group and 12th Army Group.
54. The 6860th Headquarters Detachment Intelligence Assault Force (from the Internet).
55. Tom Bower; 'The Paperclip Conspiracy: The Hunt for the Nazi Scientists,' Little, Brown, 1987.
56. Ian Cobain, The Guardian 29th August 2007.
57. Bruno Touschek in a letter to *Geheimrat* Professor Dr. A. Sommerfeld 28th September 1945. The letter was translated into English by the Italian Professor Giulia Pancheri.
58. Luisa Bonolis and Giulia Pancheri, Theory Group—Research Division, INFN Frascati National Laboratories, Frascati, Italy.'Bruno Touschek:

Particle Physicist and Father of the $e^{+}e^{\div}$ Collider', 14th March 2011. Letter from Bruno Touschek to his parents 17th November 1945. The letter was translated into English by Giulia Pancheri.

59. The National Archives: WO 171/5211: 'T-Force Intelligence Summary for period 2nd May—10th May 1945.' Closed until 2046. Cancelled. 620/1. 5th British Kings Regt. Pkt. 1.
60. The people who *had* been interviewed were Otto Gundermann (administrator/manager?) and Dr. Ritz (research director). The people who *should* be interviewed were Deert Jacobs (research director), Alfred Kun(t)ke (high voltage physicist) and Dr. Müller (electron optics).
61. 6th May 1945: Radio tube experts F/Lt. F.R. Holt M.A.P. and Captain W.H. Horner R.A., and 7th May: Major J.H. Arthur, U.S. Signal Corps; Lt/Com De Baun U.S.N.; F/Lt. E.R. Holt M.A.P., Lt L. Strauss U.S.N.R.
62. Eval. Report 534 (b): 18th June 1945. Interrogation of Albert Speer. Target No 28/5.01. 3rd Session—11.00 to 12.30, Tuesday 29th May 1945. Sign Hausell, Slatery, Sanabria. 'Bode' is named, but perhaps that should be 'Bothe.' There was a Volkhard Bode who together with Gerhard Kaiser wrote *Raketenspure: Peenemunde 1936–1944*, ('Missile Tracks: Peenemunde 1936–1944') Berlin 1995.
63. WW2 European Theater Army Records, Historical Division: Records, 1941–1946, p. 53, NARA, Record Group 498, 2011.
    Cyclotron Investigation Heidelberg, Item no. 21&24, file no. XXIX-47, Combined Intelligences Operatives Sub-Committee (CIOS).
64. National Archives WO 232/92: Subject: BIOS and FIST field team reports. Jan–Jul 1946. (With the date 3.3.1978 handwritten on the cover.) Summary no. 7 of reports from BIOS Field Teams 6th February 1946. Group 2 Metallurgy: 'Visit to "C.H.F. Müller," reported by C.G. Lloyd 8 Oct 1945. Group 1': Ultra-sonic research and development in x-ray equipment Siemens-Reiniger Werke A.G. Erlangen. Reported by G.J. Thiesen. A visit to I.G. Farben is also mentioned.
65. Written by the German atomic physicist Wolfgang Paul, later Nobel Prize winner, and Hans Kopfermann, who both were connected with the early years of CERN.
66. National Archives FO 1032/230 Hollnack 2a and 3a pkt. 10.
67. Niels Bohr Archives, American Institute of Physics, Alsos/Capt. G. Randers:
    Re: Betatron for further evaluation, Progress Report. Attachment II-2. *Tätigkeitsbericht und Programm für die Weiterarbeit der 'MV-Forschungs-Vereinigung.'* ('Progress Report and Programme for the Further Work of the 'Megavolt Research Organisation') Kollath 6.6.45.
68. According to Dr. Giulia Pancheri, Theory Group—Research Division, INFN Frascati National Laboratories, Italy.

69. *Archiv für Elektrotechnik. Der Strahlentransformator (1. Teil)* ('The Radiation Transformer, Part 1'), submitted 15.09.42 marked *Geheime Reichssache!* ('State Secret') *Der Strahlentransformator II* ('Radiation Transformer II'), submitted 12.07.43.
70. *Zur Theorie des Strahlentransformators* ('On the Theory of Radiation Transformers'), Alsos/Capt. G. Randers: 'Re: Betatron for further evaluation,' Niels Bohr Archives, American Institute of Physics.
71. Letters from Touschek to Widerøe 29th March 1946, ETH Library Zurich HS 903:203; 20th May 1946 Hs 903:205; 28th September 1946 Hs 903:212; 19th November 1946 Hs 903:207.
    Letters from Kollath to Widerøe 30th March 1946 ETH Library Zurich Hs 903:119; 30th May 1946 Hs 903:120; 14th July 1946 Hs 903:124; 20th July 1946 Hs 903:126; 21st July 1946 Hs 903:127; 29th August 1946 Hs 903:130; 4th September 1946 Hs 903:129.
72. It says in the biography that Rolf returned home to Norway in March but this can't be right, because he was still in Hamburg on 11th April. The quotation from Touschek is taken from his letter to his father on 17th November 1945.
73. Touschek in a letter to his father 17th November 1945.
74. Touschek in a letter to his parents 22nd June 1945.
75. Touschek in a letter to his parents 22nd June 1945.
76. Hollnack: *Bericht über die historisch-organisatorische Entwicklung* ('Report of the historical and organisational development') Written for T-Force 9.6.45. Alsos/Capt. G. Randers: 'Re: Betatron for further evaluation,' Niels Bohr Archives, American Institute of Physics.
77. The report says 5 MeV, but it is probably meant to be 15.
78. National Archives FO 1032/230. 3A: '*Daten und Tätigheit*' ('Dates and Activity') and 4A 'Curriculum vitae' (English translation) sent to T-Force 1st February 1946, Alsos/Capt. G. Randers: Re: Betatron for further evaluation.
79. Samuel Goudsmit: Alsos, p. 240.
80. Hollnack: *Bericht über die historisch-organisatorische Entwicklung* ('Report of the historical and organisational development') Written for T-Force 9.6.45. Alsos/Capt. G. Randers: 'Re: Betatron for further evaluation,' Niels Bohr Archives, American Institute of Physics.
81. The biography.
82. Rudolf Kollath's obituary, Phys. Today 31 (12), 73 (1978); https://doi.org/10.1063/1.2994891. Widerøe in the interview with the physicists.
83. The interview with the physicists.
84. Jomar Brun: *Brennpunkt Vemork 1940–1945* ('Focal Point Vemork'), p. 31, *Universitetsforlaget* 1985.
85. Jomar Brun: *Brennpunkt Vemork 1940–1945* ('Focal Point Vemork'), pp. 28–31, *Universitetsforlaget* 1985.

86. Waloschek: *Todesstrahlen.*
87. Waloschek: *Todesstrahlen.*
88. Waloschek: *Todesstrahlen.*
89. Hollnack: *Bericht über die historisch-organisatorische Entwicklung* ('Report of the historical and organisational development') Written for T-Force 9.6.45. Alsos/Capt. G. Randers: 'Re: Betatron for further evaluation,' Niels Bohr Archives, American Institute of Physics.
90. National Archives FO 1032/230, Hollnack, 2A and 3A: '*Daten und Tätigheit*' ('Dates and Activity') and 4A 'Curriculum vitae' (English translation) sent to T-Force 1st February 1946.
91. National Archives FO 1032/230. 3A: '*Daten und Tätigheit*' ('Dates and Activity') and 4A 'Curriculum vitae' (English translation) sent to T-Force 1st February 1946. pkt 9.
92. The biography.
93. *Kratzenstein, H.: PB1755is21* (V-200) *Praxis zerstörungsfreier Werkstoff Prüfung* ('The practice of non-destructive examination of materials'). Text in German 1941. FIAT FR536, Supp.21. IP $.25. PB81500. Department of Commerce. W. Averell Harriman, Secretary: 'Classified List of OTS Printed Reports.' A List of Reports on German and Japanese Technology Prepared by American Investigators Which Are Available in Printed Form From the Office of Technical Services. Property of Technical Reports Section. Science and Technology Division. Library of Congress. Office of Technical Services. John C. Green, Director. Compiled by O. Willard Holloway and Oliver B. Isaac. Reports Division. October 1947.
94. Egerer and others. PB 17551-S12 (V-200) Rb'ntgenraumsicht (Stereoscopic X-rays). Aug 1914. FIAT FR 5345, Supp. 12. 2p $.25. [That is how it is written.]
95. '*Widerstand in Berlin gegen das NS-Regime 1933 bis 1945*'—A biographical dictionary in 12 volumes, *ISBN 3-89626-350-1, Trafo Verlag* 2002–2006. Kratzenstein, Hermann; 21.1.1893 -? is listed in Volume 4. http://www.trafoberlin.de/widerstand_in_berlin/Widerstand_startseite.htm Editor Dr. Hans-Joachim Fieber. Publisher: *Geschichtswerkstatt der Berliner Vereinigung ehemaliger Teilnehmer am antifaschistischen Widerstand, Verfolgter des Naziregimes und Hinterbliebener (BV VdN) e.V.* In the foreword it says:
'The biographical dictionary "*Widerstand in Berlingegen das NS-Regime 1933 bis 1945"* was published between June 2002 and June 2006. This biographical dictionary is so far unique among publications about resistance to the Nazi regime in Berlin, and indeed among publications about resistance to the Nazi regime in general. For the first time—so far as is known till now—over 13,000 people were named who had shown opposition to Hitler's regime in Nazi Germany's capital city between 30th January 1933 and 8th May 1945, with whatever political intention and in

whatever way, in whatever circumstances and irrespective of whether they had been born in Berlin or elsewhere.'
Kratzenstein is named in volume 4. Egerer is named in volume 4, p. 157. (I assume that H. Kratzenstein is identical with Hermann Kratzenstein.)
There is also a Marius Kratzenstein in Hamburg, who wrote about similar themes, including an article in *Zeitschrift für Physik,* Volume 93, Number 5, 6th May, 1935. As Kratzenstein's forename is not given, it could alternatively be him.

96. Arnold Kramish: 'The Griffin. The Greatest Untold Espionage Story of World War II,' Houghton Mifflin Company, Boston, 1986.
97. The Security Service in Britain, known as MI5 (Military Intelligence, Sect. 5), looks after inland counterespionage and security. The Secret Intelligence Service (SIS or MI6) deals with threats from abroad.
98. In e-mail from Arnold Kramish 16th October 2009. In an e-mail on 11th September that year he also asked me to pass greetings on to Olav Riste, historian and expert on Norwegian secret services, with whom he had been in contact while working on his book about the spy Paul Rosbaud.
99. Svein Sæter: *Spion I Hitlers rike. Student og agent Sverre Berghs dramatiske dobbeltliv* ('A Spy in Hitler's State. The Dramatic Double Life of Student and Agent Sverre Bergh.'), Damm, Oslo 2006.
100. Theo Finndahl.
101. Victor Goldschmidt.
102. Edgeir Benum: *En forskerskole bygges. Odd Hassel og strukturkjemien 1925–1943* ('Building a Research School. Odd Hassel and Sructural Chemistry 1925–1943') *Historisk tidskrift* vol. 88, pp. 639–670*, Universitetsforlaget 2009*. Kramish 1986 (Norwegian edition): 42–43, 64, 69, 79–80, 83–85, 110, 133, 157, 178–180, 197, 224.
103. Jomar Brun: *Brennpunkt Vemork 1940–1945* ('Focal Point Vemork'), p. 31, *Universitetsforlaget* 1985.
104. R.V. Jones: 'Most Secret War. British Scientific Intelligence 1939–1945,' Hamish Hamilton, London 1978.
105. Arvid Broderson: *Siemens direktøren—Oslo-rapporten* ('The Siemens Director—The Oslo Report'), *Forskningspolitikk* ('Research Policy') 2/1994. Broderson was professor at the New School of Social Research in New York.
106. R.V. Jones: 'Most Secret War. British Scientific Intelligence 1939–1945,' (1978) and 'Reflections on Intelligence' (1989).
107. 'Die deutsche Regierung hat den Führingsanspruch auf Europa proklamiert. Ich habe es im Rahmen der mir selbst gezogenen Grenzen führenden Männern Deutschland klargemacht und werde es weiterhin tun, dass ein Anspruch auf eine solche Führung sich nicht ständig auf Bajonette stützen kann, sondern dass wir der Weilt zuerst unseren Geist entgegenzusetzen haben.'

('The German Government have proclaimed their right to the leadership of Europe. I have explained to leading personalities in Germany, within my own self-delineated limits, and will continue to do so, that a claim to such leadership cannot base itself permanently upon bayonets, but that we have first to impose our spirit upon the world.') [Official translation, in archive material].

108. Alsos/Capt. G. Randers: 'Re: Betatron for further evaluation,' Niels Bohr Archives, American Institute of Physics.
109. Letter to T-Force from Hollnack 9th June 1945, Alsos/Capt. G. Randers: 'Re: Betatron for further evaluation,' Niels Bohr Archives, American Institute of Physics.
110. ETH Library Zurich HS 903:203, Letters from Touschek to Widerøe 29.3.46 and 20.5. 46.
111. The Swiss editor Karl Meyer.
112. Jacov Lind, *Selbstporträt* ('Self-portrait'). S. Fischer, London, 1970, p. 147.
113. Touschek's autobiography, p. 158.
114. Touschek's autobiography, p. 160.
115. ETH Library Zurich HS 903:203, Letters from Touschek to Widerøe 29.3.46 and 20.5. 46.
116. Question from Jan Vaagen, transcript of interview.
117. Randers: *Lysår* ('Light Years'), Gyldendal, 1975, p. 75.
118. Samuel A. Goudsmit: Alsos (Samuel A. Goudsmit American institute of Physics Woodbury, New York Library of Congress Cataloging-in-Publication Data ISBN 1-56396-415-5).
119. Goudsmit, pp. 77–80 and Thomas Powers: 'Heisenberg's War,' pp. 411–412.
120. Goudsmit, pp. 112–113.
121. Goudsmit, pp. 120–121.
122. Randers: *Lysår* ('Light Years'), p. 76.
123. Randers: *Lysår* ('Light Years'), p. 86.
124. Hans Skoie: *Norge—en atommakt?* ('Norway—an Atomic Power?') Forskningepolitikk 2/2006. Olav Njølstad: *Jens Chr. Hauge—Fullt og helt,* Aschehoug, 2008.
125. Olav Njølstad: *Jens Chr. Hauge—Fullt og helt,* Aschehoug, 2008.
126. Olav Njølstad: *Jens Chr. Hauge—Fullt og helt,* Aschehoug, 2008.
127. Roland Wittje (Dr. philos.—history of science and technology) History of Science Unit, University of Regensburg, Germany: 'Nuclear Physics in Norway, 1933-1955,' *Physis in Perspektive* ('Physics in Perspective'), Birkhäuser Verlag, Basel, 2007, pp. 406–433.
128. Olav Wicken to the newspaper *Forskning* ('Research'), no. 6, 1997. Olav Wicken and Olav Njølstad: *Kunnskap som våpen. Forsvarets forskningsinstitutt 1946–1975* ('Knowledge as a Weapon. The Defence Research Institute 1946–1975'), Tano Aschehoug, 1996.

129. Asbjørn Barlaup (ed.): *Norges Teknisk-Naturvitenskapelige Forskningsråd 1946–1956* ('The Norwegian Technical and Scientific Research Council 1946–1956').
130. David Cassidy in the foreword to the 1996 edition of Goudsmit's book, 'Alsos'.
131. David Bodanis: *En biografi om verdens mest berømte ligning*, Gyldendal, 2001. Original title: $E=mc^2$ A Biography of the World's Most Famous Equation, Walker Publishing Company, Inc., USA, 2000.
132. Goudsmit, p. 123.
133. Goudsmit, p. 125.
134. Erik Bagge, Kurt Diebner, Walther Gerlach, Otto Hahn, Paul Harteck, Werner Heisenberg, Horst Korsching, Max von Laue, Carl Friedrich von Weizsäcker, Karl Wirtz.
135. Otto Hahn.
136. Bernstein, Jeremy (2001). Hitler's Uranium Club: the secret recordings at Farm Hall. New York: Copernicus. p. 281. ISBN 0-387-95089-3.
137. BBC Radio 4, 15th June 2010 in 'Nuclear Reactions,' written by Adam Ganz.
138. Thomas Powers: Heisenberg's War. The secret story of the German bomb, 1993. Samuel Goudsmit: Alsos.
139. Eric Tunstad, 12th September 2002, http://www.forskning.no/Artikler/2002/september/1031815152.4.
140. Goudsmit pp. 138–139.
141. Randers, p. 79.
142. Randers, p. 77.
143. Goudsmit, p. 140.
144. Goudsmit, p. 147.
145. Goudsmit, p. 154.
146. 'Report of the visit to Widerøe in Oslo, July 45. By Capt. G. Randers R.N.A. of ALSOS,' Niels Bohr Archives, American Institute of Physics.
147. 'Interview with Dr. Widerøe in Oslo, July 1945,' Niels Bohr Archives, American Institute of Physics. The questions and answers in this document appear again later in the form of Documents 14 and 15 in the case folder in the Norwegian National Archives Treason Section.
148. 'Arrangement for Introducing Electrons into a Radiation Transformer (Betatron)'.
149. Patent Claims. Originally written by Rolf and translated from Norwegian into English, probably by Randers. Dated Oslo, 11th July 1945, a rough page, in 10 points.
150. Copies of papers:
    (1) *Bericht über die Entwickelung von Strahletransformatoren* ('Report of the development of the radiation transformer') by Widerøe 27/2/44.

(2) *Angaben* ('Information') *for Dr. Boersch* (who was the electron optics man in Vienna) 13/3/44.
(3) *Bericht über den Besuch bei B.B.C. vom 27 bis 29 April 1944* (Report of the visit to Brown Boveri Company from 27th to 29th April 1944), by Widerøe.
(4) Comparative figures from Kerst's 20 and Widerøe's 15 MV apparatus, 9/6/1944.
(5) *Theoretischee Untersuchungen für das MV-Verfahren in Hamburg während der Zeit May bis September 1944* ('Theoretical examination of the MV Process in Hamburg during the period May to September 1944'). A summary by Widerøe and Touschek.
(6) *Über die Erzeugung von Röntgenstrahlen* ('About the generation of X-rays'), by Widerøe 8/2/44, Niels Bohr Archives, American Institute of Physics.

151. Rolf Widerøe: *Denkschrift über die Weiterentwicklung des Strahletransformators* ('Thoughts about the further development of radiation transformers'). A 10 page technical description of the15 MV and 200 MV betatrons, Oslo, 17.9.43, Niels Bohr Archives, American Institute of Physics.
152. List of contents of microfilms:
(1) Complete summary and description in detail of Widerøe's radiation transformer (betatron) written by Widerøe during his stay in Ilebu concentration camp near Oslo during May, June and July 1945. (Both the theoretical and the practical questions of construction are included. The paper was not considered by Widerøe as completed yet. This probably means mainly that his new ideas have not been worked out. Also figures are missing; these may be obtained, if wanted, from Widerøe in a month or so, according to his own estimate.)
(2) Document written by Professor Bothe.
(3) Letter dated 12/12/1944 from Widerøe to Prof. Kuhlenkamp.
(4) Letter dated 19/10/1944 from Heisenberg to Widerøe (suggesting 150MV as target for the big betatron).
(5) Report up to 15/9/44 on the progress of the betatron work.
(6) Letter report Widerøe to Col. Geist 15/12/44.
(7) Report from meeting in Erlangen 31/10/44 by Widerøe.
(8) Report on conference at B.B.C Heidelberg 2/11/44.
(9) *Der Ablenktheorie der Schleuderelektronen* ('The theory of electron beam deflection') by Dänzer 19/1/1945.
(10) *Bemerkungen zur Vorstehenden Arbeit* ('Comments on the above-named work') by Bothe.
(11) *Die elektrostatische Stabilusierung*), *Die Lisenstrasse* ('Electrostatic stabilisation, The road to patenting') by Dr. Müller 29/11/43.
(12) *Führungsproblem der Elektronen* ('The problem of steering electrons') by Touschek.

(13) *Die magnetische Fokusierung* ('Magnetic focussing') by Touschek.
(14) *Die Maximalverteilung* ('Maximum distribution') 8/1/44, by Touschek.
(15) *Zur Theorie der Wideröeschen Strahlungstransformator* ('On the theory of Widerøe's radiation transformer') by Touschek.
(16) *Theorie des ebenen Einschiessens* ('The theory of destroying planes from the ground') and *Wahrscheinlichkeitsbetrachtungen zum vorgang des Einschiessens* ('Probability considerations in relation to shooting.') by Touschek 5/12/1944.
(17) *Theorie des Einschiessvorganges* ('Theory of shooting') and *Wachtstumseffekte* ('The growth effect') probably by Touschek, Niels Bohr Archives, American Institute of Physics.

153. National Archives FO 1032/30. 3A *Daten und Tätigheit* ('Dates and activity') and 4A Curriculum Vitae (English translation) sent to T-Force 1st February 1946, pkt. 9.
154. Jacov Lind: *Selbsporträt* (Self-portrtait).
155. Tor Brustad; Why is the Originator of the Science of Particle Accelerators so Neglected, Particularly in his Home Country? Extended version. Scandinavian University Press 1998. ISSN 0284-186X footnote 24. (An abridged version of this paper, without inter alia, is in press in *Acta Oncologica* 1998, 37.)
156. Why is the Originator … Footnote 25.
157. Why is the Originator … Footnote 26: An interrogation carried out by advocate G.B. Dreyer on 4th July 1946 revealed the following: 'During the whole of spring and summer 1943, the interviewee explained that in negotiations with BB&C in Switzerland he had agreed to sell the company patents, so that via Switzerland these could be patented in English-speaking countries. This opportunity disappeared when the German countries confiscated the patents (…).'
158. Hollnack: *Bericht über die historisch-organisatorische Entwicklung* ('Report on the historical and organisational development') written for T-Force. 9.6.45.
159. National Archives FO 1032/30. 3A *Daten und Tätigheit* ('Dates and activity') and 4A Curriculum Vitae (English translation) sent to T-Force 1st February 1946, 8, Niels Bohr Archives, American Institute of Physics: Alsos/Capt. G. Randers: Re: Betatron for further evaluation.
160. Kramish p. 148.
161. *Reichmarchall des Grossdeutschen Reiches/Präsident des Reichforschungsrat/der Bevollmächtige* (The rest of the letter-heading is illegible): Letter to Bothe and Widerøe 4th December 1944. Niels Bohr Archives, American Institute of Physics: Alsos/Capt. G. Randers: Re: Betatron for further evaluation.
162. Kramish p. 148.
163. The interview with the physicists.

164. Letter from NEBB to High Court Advocate Oscar de Besche 12th June 1946.
165. Note of the interview of Rolf Widerøe by Junior Police Prosecutor G.B. Dreyer 4th July 1946.
166. Letter from Rolf Widerøe to S.A. Solberg 22nd January 1946, ETH Library Zürich, HS 903:79–80.
167. Rolf Widerøe: *Bericht über die Entwicklung von Strahlentransformatoren* ('Report on the development of the radiation transformer'), 27th February 1944. ETH Library Zürich, Hs 903:49.
168. Rolf Widerøe: *Berichte über Besuche bei BBC in Weinheim vom 27. bis 29. April 1944* (Report of the visit to BBC in Weinheim from 27th to 29th April 1944), written on 1.5.44, ETH Library Zürich, Hs 903: 62 and 63.
169. Rolf Widerøe: *Niederschrift* ('Notes'), Heidelberg 29th April, dated 2nd May 1944.
170. In conversation with Pedro Waloschek. The thee others were Kade, Weiss and Kneller.
171. BBC note: *Grosser Strahlentransformator Wideröe, Besprechung in Heidelberg am 30.6.44* ('Widerøe's larger radiation transformer, discussions in Heidelberg on 30.6.44'). BBC-note *EB-Bericht nr 71—'Geheim'.* ('EB-report no. 71 - Secret'). Written by *Böcker,* who was responsible for the project in BBC. Dated 3rd July 1944. The note states that the relevant department will write a separate report of the technical discussions with Widerøe on 1st July. Niels Bohr Archives, American Institute of Physics.
172. Theodor Hollnack: Über Besprechung am 30.6.44 bei BBC Heidelberg. Geheim ('Regarding discussions on 30.6.44 at BBC Heidelberg. Secret'). Dated 3rd July 1944, Niels Bohr Archives, American Institute of Physics.
173. The people who received the note were Director Deichmann and Dr. Kade, and also the departments Gr v/Martens, Hfk v/Weiss and EB v/Dr. Böcker.
174. BBC note: Concerning: *Strahlentransformator Wideröe. Geheim* ('Widerøe's radiation transformer. Secret'). Written by Meyer-Delius. Dated 7th July 1944, Niels Bohr Archives, American Institute of Physics, Alsos/Capt. G. Randers: Re 'Betatron for further evaluation.'
175. Otto Weiss and Helmut Böcker.
176. BBC note. *EB-Bericht nr. 71/1* ('E.B. Report no. 71/1'). Böcker. Mannheim, 20th December 1955.
    Concerning: Radiation transformer 15 MeV. Discussions at C.H.F. Müller, Hamburg-Fuhlsbüttel, Niels Bohr Archives, American Institute of Physics.
177. Letter from Rolf Widerøe to BBC Director Meyer-Delius, Heidelberg, Hamburg, 12th February 1945, Alsos/Capt. G. Randers: Re: Betatron for further evaluation, Niels Bohr Archives, American Institute of Physics.
178. The Brown Boveri Review: 'New designs of transformers and choke coils,' no. 3, March 1945.

179. Kaiser, H.F. (U.S. Naval Research Lab., Washington, D.C.): 'European Electron Induction Accelerators,' Journal of Applied Physics. 18, 1-17 (1947).
180. According to RW there was no BBC representation in Heidelberg at that time. One of the directors lived there, and a few meetings were held in Heidelberg. (Pedro Waloschek).
181. The biography.
182. This refers to the plan Rolf wrote on 6th November 1943.
183. Kaiser, H.F. (U.S. Naval Research Lab., Washington, D.C.): 'European Electron Induction Accelerators,' Journal of Applied Physics. 18, 1–17 (1947).
184. The 6860th Headquarters Detachment Intelligence Assault Force (T-Force).
Les Hughes. 1997. Hochwald, Jack, 'The U.S. Army T-Forces: Documenting the Holocaust,' American Jewish History, Vol. LXX, No. 3, March 1981.
185. *Brown Boveri Hauszeitung* 1972, No. 2.
186. *Sonderdruck Technikgeschichte,* Band 55 (1988) *Hft 1, VDI Verlag, Anmerkung* 15.
187. Gordon Fraser (author), Egil Lillestol (author), Inge Sellevag (author), Stephen Hawking (introduction): *Auf der Suche nach dem Unendlichen* ('The Search for Infinity: Solving the Mysteries of the Universe') Among others, the Japanese Hideki Yukawa developed Heisenberg's theories further.
188. Goudsmit p. 254.
189. *Sonderdruck Technikgeschichte,* Band 55 (1988) *Hft 1, VDI Verlag, Anmerkung 87.*
190. Speer: *Erinnerungen* ('Memories'). Frankfurt/M 1969, p. 240. *Zur Politik des HWA genüber dem Uranverein vgl.* Walker, M: p. 67ff. (*Sonderdruck Technikgeschichte,* Band 55 (1988) *Hft 1,VDI Verlag, Anmerkung* 88).
191. *Sonderdruck Technikgeschichte,* Band 55 (1988) *Hft 1, VDI Verlag, Anmerkung 89.*
192. Operation Epsilon: *Jakten på Tredje Rikets atomhemligheter* ('The Hunt for the Third Reich's Atomic Secrets'), tomaslindblad.se (Swedish freelance science journalist).
193. The advice came from Paul Harteck at the University of Hamburg, one of the researchers Rolf later came to know.
194. Rainer Karlsch: 'Hitler's Bomb.' *Die geheime Geschichte der deutschen Kernwaffenversuche Deutsche Nuklearwaffenforschung.* ('The Secret History of the German search for a nuclear weapon; German Nuclear Weapon Research'). DVA, 2005. 416 pages. ISBN 3-421-05809-1. (http://sandammeer.at/rezensionen/hitlersbombe.htm).
195. Esau, A: *Ergebnisbericht der Arbeitsgemeinschaft Nutzbarmachung der Atomkernenergie vom 24.11.1942* ('Report of the results from the working

party on atomic energy from 24.11.1942'). Esau, A: *Bericht über den Stand der Arbeiten auf dem Gebiet der Kernphysik vom 1.6.43* ('Report on the state of the work in the field of nuclear physics from 1.6.43'), Irving Papers, *Sondersammlungen des Deutschen Museums* ('German Museum Collections').

196. *Sonderdruck Technikgeschichte,* Band 55 (1988) *Hft 1, VDI Verlag, Anmerkung 93: Bothe baute in seinem Institut an einem Betatron, das vom Oberkommando der Wehrmacht gefördert wurde. Vgl. Bothe Nachlass 62, Bothe an Vogler am 20.1.1943. Die von Wideröe 1941* (Editorial correction: 1943) *bei der Hamburger firma C.H.F. Müller begonnene Entwicklung eines 15 MeV Betatron, das noch vor Kriegsende fertiggestellt wurde und die Planung einer 100 MeV bzw. 200 MeV Maschine wurde von der Luftwaffe unterstützt. Vgl. SAA La/84.* ('…') Report no. 148: German Betatrons. British Intelligence Objectives Sub-Committee.
197. Otto Hahn worked with Lise Meitner and Fritz Strassmann. Hahn and Strassmann were awarded the Nobel Prize in Chemistry in 1944 for the discovery of fission, and many people think that Meitner should have shared the prize too. In 1966 all three of them were awarded the American Atomic Energy Commission's prize, the Enrico Ferni Prize, for the same discovery.
198. In 1986 BBC/ABB's particle accelerator division was sold to the American company, Medical Systems. Conversation during preparation of the book 29th August 2011.
199. National Archives BT 211/15: 'Visits to Switzerland by British technicians to investigate German owned plants etc. SC/ZH.' BIOS Investigations—Switzerland. 9th February 1946. Wood. Maunsell. Preserve permanently. Closed until 1977. Registered 15.2.46.
200. *Weltwoche* no. 32/2011 and 33/2011. *Der Spiegel* no. 23, 24, 25, 26, 27 and 28, 1967. Thomas Powers. 'Heisenberg's War,' Goudsmit: 'Alsos'.
201. Switzerland—National Socialism and the Second World War, Final Report of the Independent Commission of Experts Switzerland—Second World War/*Schlussbericht der Unabhängingen Expertenkommission Schweiz—Zweiter Weltkreig/Rapport final de la Commission Indépendente d'Experts Suisse—Seconde Guerre Mondiale—Rapporto finale della Commissione Indipendente d'Esperti Svizzera—Seconda Guerra Mondiale*.
Unabhängingen Expertenkommission Schweiz—Zweiter Weltkreig, Jean-François Bergier (Chairman), Editorial Team/Co-ordination: Mario König, Bettina Zeugin, Pendo Verlag GmbH, Zürich 2002 ISBN 3-85842-603-2.
202. It reads Bode, but it is possible it should be Bothe. There was a Volkhard Bode who together with Gerhard Kaiser wrote: *Raketenspure: Peenemunde 1936-1944*, Berlin 1995.
203. National Archives, Eval. Report 53 (b): 18th June 1945. Interrogation of Albert Speer. Target No. 28/5.01. 3rd Session—11.00 to 12.30, Tuesday 29th May 1945. Sign Hausell, Slattery, Sanabria.

204. Waloschek: *Todesstrahlen.*
205. Arnold Kramish, p. 148.
206. The interview with the physicists.
207. *Weltwoche* nos. 32/2011 and 33/2011. *Der Spiegel* nos. 23, 24, 25, 26, 27 and 28, 1967. Thomas Powers: 'Heisenberg's War.' Goudsmit: 'Alsos.'.
208. 'The X-ray Industry in Germany,' Combined Intelligence Objectives Sub-Committee, Item nos. 1, 9 & 21, file no. XXVIII-31, reported by: Caperton B. Horsley, U.S. Civilian on behalf of the U.S. Technical Industrial Intelligence Committee, CIOS Target nos. 1/32e, 1/144, 1/246, 9/37, 9/147, 21/180 Radar, Physical and Optical Instruments & Devices, Metallurgy, August 1945.
209. 'The X-ray Industry in Germany'.
210. Waloschek: *Todesstrahlen.*
211. National Archives, BIOS, Final report no. 210, item no. 1, 7, 21, Visit to C.H.F. Müller A .G., Reported by: C.G. Lloyd—Canadian G.E., G.J. Thiesen—N.R.C., BIOS Target Numbers 1/32e, C7/193, C21/744.
212. Fehr, Werner: 'C.H.F. Müller … *Mit Röntgen begann die Zukunft: Überliefertes und Erlebtes,'* ('The future began with Røntgen: Tradition and Experience.'), Hamburg 1981.
213. The two others were Bergmüller and Reineger, according to the interview with Pedro Waloschek.
214. Professor Ludwig Biermann, AEG. 'The X-ray industry in Germany, Combined Intelligence Objectives Sub-committee, Item no. 1, 9 & 21, file no. XXVI-II-31, Reported by: Caperton B. Horsley, U.S. Civilian on behalf of the U.S. Technical Industrial Intelligence Committee, CIOS Target nos. 1/32e, 1/144, 1/246, 9/37, 9/147, 21/180 Radar, Physical and Optical Instruments & Devices, Metallurgy, August 1945.
215. To build a small 5 MeV apparatus, start research and development work for a medium-sized electron accelerator of 20-25 MeV and prepare plans for a large 100 MeV apparatus.
216. Sonderdruck *Technikgeschichte, Band 55 (1988) Heft 1, VDI Verlag: Kernphysikalische Grossgeräte zwischen naturwissenschaftlicher Forschung, Industrie und Politik. Zur Entwicklung der ersten deutschen Teilchenbeschleuniger bei Siemens 1935-45 von Maria Osietzki. (Dieser Aufsatz entstand in einem von der Stiftung Volkswagenwerk finanzierten Forschungsprojekt.) note 96:SAA 35 Lg/84, Durschriften der Aufträge Walter Gerlachs, September 1944.*
217. 'The X-ray Industry in Germany'.
218. Paul, Wikipaedia.
219. Max Steenbeck, p. 124 (footnote 97 in VDI-pamphlet).
220. 'The X-ray Industry in Germany'.
221. The biography.
222. The interview with the physicists. The biography.

223. Pedro Waloschek told me in a conversation that he thought Seifert really was a Nazi.
224. Giovanni Maria Piacentino wrote the tribute.
225. The biography.
226. Luisa Bonolis and Dr. Giulia Pancheri, Theory Group—Research Division, INFN Frascati National Laboratories, Italy: 'Bruno Touschek: Particle physicist and father of the electron positron collider.' The article was marked 'To be published in EGJH' and was dated 14th March 2011, draft ('Bruno Touschek: Particle physicist and father of the $e^+e^÷$ collider.') Letter from Bruno Touschek to his parents. Translated to English by Giulia Pancheri.
227. *Teknisk Ukeblad* 19th January 2015, article by Odd Richard Valmot who interviewed Assistant Professor Erik Adli at the University of Oslo: http://www.tu.no/industri/2015/021/19/ny-teknologi-gir-elektroner-enorm-energ.
228. The secret projects in the research bunker in the former airfield at Grossostheim are discussed in in the book '*Grossostheim in den Kriegsjahren 1939-1945,*' chapter *Fliegerhorst* 207X11, p. 94 ff. They are also discussed by Peter Hepp and Klaus Sauerwein in '*Die Geheimprojekte des Fliegerhorstes Grossostheim.* The airbase at Grossostheim (now known as Ringheim) is also described in '*Fliegerhorst in Grossostheim-Ringheim: Hiere wollte Hitler seine irre Geheimwaffe bauen!'* by Bernd Hilla, co-editors Klaus Sauerwein, Peter Hepp.
www.primavera24.de/lokalnachrichten/aschaffenburg/10850 *27 Mai 2011.* Rolf's biographer was Professor Pedro Waloschek, who later wrote the book '*Todesstrahlen als Lebensretter,'* German edition 2004 and updated, English edition 2012.
229. David Porter: World War II Data Book. Hitler's Secret Weapons 1922–1945. The essential facts and figures for Germany's secret weapons programme, Amber Books, 2010.