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GUEST EDITORIAL

Preface of the PHDIA FUSION 2021 Special Issue: Neutron diagnostics development for ITER, DEMO and IFMIF-DONES

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This special issue 'PHDIA FUSION 2021: Neutron diagnostics development for ITER, DEMO and IFMIF-DONES' contains selected invited papers presented at the occasion of the PhDia Summer School that I had the pleasure of preparing and chairing as Director of the School in collaboration with the Institute of Nuclear Physics Polish Academy of Sciences (IFJ PAN), which did a great job in the organisation of the event. The PhDiaFusion 2021 Summer School is a biannual scientific event, mainly focussed on a particular subject of prime interest for the fusion plasma community. The School is addressed to undergraduate, graduate and PhD students with their tutors. It is held in a spirit of "master and apprentice" approach. Lectures supported by hands-on tutorials are given by eminent world-class experts in the field of plasma physics. PhD students have an opportunity to present their recent work and achievements. The best students' contributions are awarded. In 2021 the 4th edition of the PhDiaFusion Summer School took place in the beautiful surrounding of the Royal Castle in Niepołomice, Poland on September 20–24, 2021. This edition of the school was focused on 'Neutron diagnostics development for ITER, DEMO and IFMIF-DONES', including application to magnetic and inertial confinement. The idea is indeed to cross-fertilize the different fields of application and benefit from the expertise of various community. This is also a great opportunity for the speakers to exchange ideas in a mini-workshop environment, and I should emphasize that this particular edition was greatly fruitful in that sense. The development of neutron diagnostics is an extremely important topic in fusion research. Indeed, the fusion power is inferred from neutron measurements and performances of a future reactor will be controlled through that measurement. Moreover, synthetic diagnostics for neutrons are an essential tool for design optimization of the neutron plasma diagnostics in their conceptual phase, for example to prepare the set of detectors for ITER (the International thermonuclear Experimental Reactor, a joint venture between Europe, Japan, Russia, USA, China, India and South Korea) but also DEMO, the next step fusion reactor that will deliver electrical power from fusion to the population.

We had the great honour to host Pr. Jean-Luc Schneider, Attaché for Scientific and Academic Cooperation of the French Embassy in Poland. During the event, Dr. Schneider gave a presentation underlining the importance of the existing Polish-French collaboration in the domain of research for producing energy and presenting the main tools for further cooperation.

I give in the following lines the kind words given by Prof. Schneider during his presentation:

'First of all, I would like to thank Dr Didier Mazon for inviting me to say a few words at the beginning of your summer school "PhDiaFusion 2021" dedicated to plasma diagnosis. I would like to welcome on behalf of the French Embassy in Poland.

Let me introduce myself. I am Jean-Luc Schneider, the new attaché for science and higher education at the French Embassy in Warsaw since September 1st. I am a full professor in Earth Sciences and come from the University of Bordeaux, France.

For us geologists, the physics of thermonuclear fusion is a priori a distant scientific field. We are used to working on large spatial and temporal scales, which can however lead us to be interested in stellar processes, as to understand the origin of the solar system and of the planet Earth. The Sun was born in a nursery of stars under the effect of the gravitational collapse of a cloud of gas and dust induced by the explosion of a supernova; geochemists and cosmochemists

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demonstrate this. After this "original ignition", thermonuclear fusion began in the Sun and is maintained in a stationary state under the effect of gravity which "confines" the system. The latter produces energy with high efficiency. Thus, the Sun is a formidable power plant and displays interesting similarities with your research topics. The Sun produces energy that reaches our planet where it fuels the motions of the atmosphere and oceans that control the climate. Solar energy also maintains life through the photosynthesis of plants, and even controls the erosion processes and the evolution of soils.

The objective sought in the field of thermonuclear energy is in a way to produce what happens within a star, but on a much smaller scale. This approach is being tried, and will be for sure successfully carried out in the future, in research reactors such as ITER, DEMO or IFMIF DONES. Compared to the Sun, the "confinement" is achieved with very strong magnetic fields!

Thus, you are faced with theoretical and technical challenges to achieve the "sequence of events" necessary for energy production, as in a star: ignition, reaching the stationary state and, in fine, obtaining a satisfactory energy yield.

I have a dream that one day you, physicists, will soon reach the ultimate goal by providing humans with a fantastic source of energy that will be welcome to face the present day problem of climate change. But I clearly understand as an average citizen that the goal is not achieved yet.

Among other central scientific questions, it is necessary to understand what happens within plasmas and their interactions with the reactor walls and subsequent damages. The analysis of neutron fluxes by different approaches, including spectroscopy, makes it possible to indirectly estimate essential parameters of the plasmas, such as electron density, energy and, finally, the density of impurities.

You all know this much better than I do, as I am discovering all these new developments with great curiosity. So, what is the reason for me to follow my little presentation? It is twofold. First of all, on behalf of the French Embassy in Poland, I would like to present you the assistance we can offer you and, second, give you a testimony of a successful project.

The French Embassy in Poland provides tools to help researchers in the framework of bilateral cooperation between France and Poland. These collaborations are very important. First of all for students and young scientists thanks to the French government scholarships. At the Master's level, Polish students can benefit from study stays in France, as well as at the doctoral level during the preparation of co-supervised theses. Young Polish researchers can also spend time in high-level French laboratories after obtaining their PhD degree.

Finally, the Hubert Curien "Polonium" Partnership aims to initiate research projects that must have the ambition to include young researchers and eventually lead to the development of a more ambitious project at the European level. Projects evaluation is made both by the French Ministries of Europe and Foreign Affairs and of Higher Education, Research and Innovation, and the Polish NAWA.

Our scientific and academic cooperation service of the French Embassy is of course ready to help you.

Now, a success story! A few years ago, Didier Mazon from the CEA and Marek Scholz from the IFEJ-PAN in Krakow, who both organize this summer school, carried out together a research project funded by a Hubert Curien Partnership "Polonium" supported by the French Embassy. They worked together on the tomographic inversion of the X-ray measurement. This project, modest at the beginning, was a great success. It led to the publication of more than ten high-level articles, to numerous presentations in conferences and to the support of a PhD student now recruited at the IFJ-PAN. Your summer school also testifies to this great success. For us, this collaboration is exemplary.

I would like to end my speech with a few words for the students. You are young and perhaps this summer school allow some of you to attend their first international scientific conference. Take full advantage of these days to share with other researchers, because you are already researchers. Do not be afraid to present the results of your work. There is no small discovery, all are important to build our common knowledge, which is grounded on sharing and sometimes even on controversy.

I wish you all fruitful work and a very successful summer school!'

To conclude this short introduction I would like to mention that the selected invited papers consist of original research and overviews. They have gone through a rigorous reviewing process as required by JOFE and I hope that the readers will appreciate the quality of their papers. Finally, I would like to thank very much again the French Embassy for their kind support and all the organizing Team from IFJ-Pan, in particular Prof. Marek Scholz, Dr Jakub Bielecki, Dr Axel Jardin, Dr Agnieszka Kulińska who really helped me make this event a success.