
References

- Abramowitz M, Stegun IA (1970) Handbook of mathematical functions with formulas, graphs and mathematical tables. National Bureau of Standards, Applied Mathematics Series 55, Washington
- Agawal BK (1991) X-ray spectroscopy, Springer Series in Optical Sciences, vol 15. Springer, Berlin
- Andia BI (2000) Nonlinear backprojection. Dissertation, University of Notre Dame, Indiana
- Azizi SA (1987) Entwurf und Realisierung digitaler Filter. Oldenbourg, Munich
- Barrett HH, Swindell W (1981) Radiological imaging: The theory of image formation, detection, and processing. Academic, San Diego
- Berger MJ, Coursey JS, Zucker DS ESTAR, PSTAR, and ASTAR: Computer programs for calculating stopping-power and range tables for electrons, protons, and helium ions (version 1.2.2). National Institute of Standards and Technology, Gaithersburg; Available from <http://physics.nist.gov/PhysRefData/Star/Text/contents.html>
- Bergmann L, Schäfer C (1999) Lehrbuch der Experimentalphysik, Elektromagnetismus, vol 2, de Gruyter, Berlin
- Blanck C (1998) Understanding helical scanning. Williams and Wilkins, Baltimore
- Bluestein LI (1970) A linear filtering approach to the computation of discrete Fourier transform. IEEE Trans Audio Electroacoust AU-18:451
- Bouman CA, Sauer K (1996) A unified approach to statistical tomography using coordinate descent optimization. IEEE Trans Image Process 5:480
- Bracewell RN (1965) The Fourier transform and its applications. McGraw-Hill, New York
- Bracewell RN (2003) Fourier analysis and imaging. Kluwer Academic/Plenum, New York
- Bronstein IN, Semendjajew KA (1979) Taschenbuch der Mathematik. Teubner, Leipzig
- Brooks RA, DiChiro G (1976) Statistical limitations in X-ray reconstructive tomography. Med Phys 3:237–240
- Brunst B (2002) High resolution digital flat panel detectors for X-ray applications – basics. In: Niederlag W, Lemke HU (eds) Medical imaging. Health Academy 02:63
- Bushong SC (2000) Computed tomography. Essentials of Medical Imaging Series. McGraw-Hill, New York
- Bushong SC (2001) Radiologic science for technologists. Mosby, St. Louis
- Bushberg JT, Seibert JA, Leidholdt EM, Boone JM (2002) The essential physics of medical imaging. Lippincott, Williams and Wilkins, Philadelphia
- Clack R, Defrise M (1994) Cone-beam reconstruction by the use of radon transform intermediate functions. J Opt Soc Am A 11:580
- Cormack AM (1963) Representation of a function by its line integrals with some radiological applications I. J Appl Phys 34:2722
- Cormack AM (1964) Representation of a function by its line integrals with some radiological applications II. J Appl Phys 35:195

- Cormack AM (1982) Computed tomography: Some history and recent developments. *Proc Symp Appl Math* 27:35
- Cunningham IA (2000) Computed tomography. In: Bronzino JD (ed) *The biomedical engineering handbook*, volume I. CRC, Boca Raton, pp 62–61
- Curry TS III, Dowdey JE, Murry RC (1990) *Christensen's physics of diagnostic radiology*. Lippincott, Williams and Wilkins, Philadelphia
- David B, Barschdorf H, Doormann V, Eckart R, Harding G, Schlomka J-P, Thran A, Bachmann P, Flisikowski P (2003) Liquid metal anode x-ray tube. In: Kyrala G, Gauthier J, McDonald C, Khounsary A (eds) *Laser-generated and other laboratory X-ray and EUV sources, optics, and applications*. SPIE 5196, pp 432–443
- David B, Thran A, Eckart R (2004) Modeling and experimental investigation of X-ray spectra from a liquid metal anode X-ray tube. In: McDonald CA, Macrander AT, Ishikawa T, Morawe C, Wood JL (eds) *X-ray sources and optics*. SPIE 5537, pp 45–56
- Deans SR (1983) *The Radon transform and some of its applications*. Wiley, New York
- De Clerck NM, van Dyck D, Postnov AA (2003) Non-invasive high-resolution μ CT of the inner structure of living animals. *Microsc Anal* 1:13
- Defrise M, Clack R (1994) A cone-beam reconstruction algorithm using shift-variant filtering and cone-beam backprojection. *IEEE Trans Med Imaging* 13:186
- Dempster AP, Laird NM, Rubin DB (1977) Maximum likelihood from incomplete data via the EM algorithm. *J R Stat Soc B* 39:1
- Demtröder W (2000) *Experimentalphysik 3, Atome, Moleküle und Festkörper*. Springer, Berlin
- Dössel O (2001) *Bildgebende Verfahren in der Medizin*. Springer, Berlin
- Dove EL (2001) Notes on computerized tomography, script 51:060. *Bioimaging Fundamentals*, The University of Iowa, College of Engineering, 2001.
- Edholm PR (1977) Tomogram reconstruction using an opticophotographic method. *Acta Radiol* 18:126
- Epstein CL (2003) *Introduction to the mathematics of medical imaging*. Pearson, Upper Saddle River
- Feldkamp LA, Davis LC, Kress JW (1984) Practical cone-beam algorithm. *J Opt Soc Am A* 6:612
- Fessler JA (1996) Mean and variance of implicitly defined biased estimators (such as penalized maximum likelihood). *IEEE Trans Image Process* 5:1346
- Feynman R (1966) *Lectures on physics*, vol 1. Addison-Wesley, Massachusetts
- Fichtenholz GM (1982) *Differential- und Integralrechnung*. VEB Deutscher Verlag der Wissenschaften, Berlin
- Gay SB, Matthews AB (1998) Ten reasons why spiral CT is worth a million bucks. *Diagn Imaging* 20:111
- Glover GH, Pelc NH (1981) An algorithm for the reduction of metal clip artifacts in CT reconstructions. *Med Phys* 8:799
- Grangeat P (1990) Mathematical framework of cone-beam 3D reconstruction via the first derivative of the Radon transform. In: Herman GT, Louis AK, Natterer F (eds) *Mathematical methods in tomography*. Springer, Berlin, p 66
- Grangeat P (1997) Indirect cone-beam three-dimensional image reconstruction. In: Roux C, Coatrieux J-L (eds) *Contemporary perspectives in three-dimensional biomedical imaging*. IOS, Amsterdam
- Grass M, Köhler T, Proksa R (2000) 3D cone-beam CT reconstruction for circular trajectories. *Phys Med Biol* 45:329

- Green PJ (1990) Bayesian reconstruction from emission tomography data using a modified EM algorithm. *IEEE Trans Med Imaging* 9:84
- Grossmann G (1934) Procédé et dispositif pour la représentation radiographique des sections des corps. French Patent No. 771887
- Hajnal JV, Hill DLG, Hawkes DJ (2001) Medical image registration. CRC, Boca Raton
- Härer W, Lauritsch G, Mertelmeier T, Wiesent K (1999) Rekonstruktive Röntgenbildgebung. *Phys Bl* 55:37
- Härer W, Lauritsch G, Mertelmeier T (2003) Tomographie – Prinzip und Potential der Schichtbildverfahren. In: Schmidt T (ed) *Handbuch diagnostische Radiologie*. Springer, Berlin
- Harris FJ (1978) On the use of window functions for harmonic analysis with the discrete Fourier transform. *Proc IEEE* 66:51
- Hebert T, Leahy R (1989) A generalized EM algorithm for 3D Bayesian reconstruction from Poisson data using Gibbs priors. *IEEE Trans Med Imaging* 8:194
- Heinzerling J (1998) Röntgenstrahler. In: Ewen K (ed), *Moderne Bildgebung*. Thieme, Stuttgart, p 77
- Helgason S (1999) *The Radon transform*, 2nd edn. Birkhäuser, Boston
- Herman GT (1980) *Image reconstruction from projections: The fundamentals of computerized tomography*. Academic, New York
- Heuser H (1992) *Funktionalanalysis: Theorie und Anwendung*. Teubner, Stuttgart
- Hidajat N (2001) *Bestimmung und Optimierung der Strahlendosis des Patienten bei der Computertomographie – Methoden, Probleme und Lösungsmöglichkeiten*. Habilitationsschrift, Klinik für Strahlenheilkunde der Medizinischen Fakultät Charité der Humboldt-Universität zu Berlin
- Hofer M (2000) *CT-Kursbuch*. Hofer, Düsseldorf
- Horn BKP (1979) Fan-beam reconstruction methods. *Proc IEEE* 67:1616
- Hounsfield GN (1973) Computerized transverse axial scanning (tomography). I. Description of system. *Br J Radiol* 46:1016
- Hsieh J (2004) *Computed tomography, principles, design, artifacts and recent advances*. SPIE, Bellingham
- Huesman RH, Gullberg GT, Greenberg WL, Budinger TF (1977) *Users manual: Donner algorithms for reconstruction tomography*. Berkeley Laboratory, University of California, http://cfi.lbl.gov/cfi_software.html
- Huda W, Slone R (1995) *Review of radiologic physics*. Lippincott, Williams and Wilkins, Philadelphia
- ICRP (International Commission on Radiological Protection) (1991) Publication 60, recommendations of the International Commission on Radiological Protection 60, *Ann ICRP*, vol 21/1–3
- Ingerhed M (1999) *Fast backprojection for computed tomography; implementation and evaluation*. Linköping Studies in Science and Technology 759. Department of Electrical Engineering, Linköping University
- Jacobson C (1996) *Fourier methods in 3D reconstruction from cone-beam data*, dissertation. Linköping Studies in Science and Technology 427. Institute of Technology, Linköping University
- Jan J (2006) *Medical image processing, reconstruction and restoration*. CRC/Taylor and Francis, Boca Raton
- Kachelrieß M, Schaller S, Kalender WA (2000) Advanced single-slice rebinning in cone-beam spiral CT. *Med Phys* 19:864

- Kachelrieß M, Fuchs T, Schaller S, Kalender WA (2001) Advanced single-slice rebinning for tilted spiral cone-beam CT. *Med Phys* 28:1033
- Kaczmarz S (1937) Angenäherte Auflösung von Systemen linearer Gleichungen. *Bull Acad Pol Sci Lett A35:355*
- Kak AC, Slaney M (2001) Principles of computerized tomographic imaging. *Classics in Applied Mathematics* 33. IEEE, New York
- Kalender WA (2000) Computertomographie. Publicis MCD, Munich
- Kalender WA (2003) Der Einsatz von Flachbilddetektoren für die CT-Bildgebung. *Radiologe* 43:379
- Kalender WA, Seissler W, Vock P (1989) Single-breath-hold spiral volumetric CT by continuous patient translation and scanner rotation. *Radiology* 173:414
- Kamm K-F (1998) Grundlagen der Röntgenabbildung. In: Ewen K (ed) *Moderne Bildgebung*, Thieme, Stuttgart, p 45
- Katsevich A (2001) Exact FBP-type inversion algorithm for spiral CT. 3D-2001. Proceedings of the Sixth International Meeting on Fully Three-Dimensional Image Reconstruction in Radiology and Nuclear Medicine. Asilomar, Pacific Grove, p 3
- Kiencke U (1998) Signale und Systeme. Oldenbourg, Munich
- Kimke T, Tuytschaever T (2006) Increasing the number of gray shades in medical display systems – how much is enough? *J Digit Imaging* 20:422
- Klingen B (2001) *Fouriertransformation für Ingenieur- und Naturwissenschaften*, Springer, Berlin
- Köhler T, Proksa R, Grass M (2000) A fast and efficient method for sequential cone-beam tomography. *IEEE Trans Med Imaging* 2:110
- Köhler T, Proksa R, Bontus C, Grass M, Timmer J (2002) Artifact analysis of approximate helical cone-beam CT reconstruction algorithms. *Med Phys* 29:51
- Kramers HA (1923) On the theory of X-ray absorption and of continuous X-ray spectrum, *Philos Mag* 46:836–871
- Krestel E (ed) (1990) *Imaging systems for medical diagnostics*. Siemens, Berlin
- Kudo H, Saito T (1994) Derivation and implementation of a cone-beam reconstruction algorithm for nonplanar orbits. *IEEE Trans Med Imaging* 13:196
- Kudo H, Noo F, Defrise M (1998) Cone-beam filtered-backprojections algorithm for truncated helical data. *Phys Med Biol* 43:2885
- Lange K, Fessler JA (1995) Globally convergent algorithm for maximum a posteriori transmission tomography. *IEEE Trans Image Process* 4:1430
- Lange K, Bahn M, Little R (1987) A theoretical study of some maximum likelihood algorithms for emission and transmission tomography. *IEEE Trans Med Imaging* 6:106
- Laubenberger T, Laubenberger J (1999) *Technik der medizinischen Radiologie. Diagnostik, Strahlentherapie, Strahlenschutz*. Deutscher Ärzte, Cologne
- Lee SW, Cho G, Wang G (2002) Artifacts associated with implementation of the Grangeat formula. *Med Phys* 29:2871
- Lehmann T, Oberschelp W, Pelikan E, Reppes R (1997) *Bildverarbeitung für die Medizin*. Springer, Berlin
- Leroy C, Rancoita P-G (2004) *Principles of radiation interaction in matter and detection*. World Scientific, London
- Lewitt RM (1990) Multidimensional digital image representations using generalized Kaiser-Bessel window functions. *J Opt Soc Am A*, 7(10):1834–1846
- Lewitt RM (1992) Alternatives to voxels for image representation in iterative reconstruction algorithms. *Phys Med Biol* 37(3):705–716

- Lin W-T (1999) A computational-efficient cone-beam CT reconstruction algorithm using circle-and-line orbit. *SPIE* 3659:933
- Lossau N (1995) Röntgen. Eine Entdeckung verändert unser Leben. vgs Verlagsgesellschaft, Cologne
- Lüke HD (1999) Signalübertragung. Springer, Berlin
- Magnusson M (1993) (Seger), linogram and other direct Fourier methods for tomography reconstruction, dissertation. Linköping Studies in Science and Technology 320. Institute of Technology, Linköping University
- Messiah A (1981) Quantenmechanik. De Gruyter, Berlin
- Morneburg H (ed) (1995) Bildgebende Systeme für die medizinische Diagnostik. Publicis MCD, Munich
- Mudry KM (2000) X-ray. In: Bronzino J (ed) The biomedical engineering handbook, vol I. CRC, Boca Raton, p 61-1
- Müller J (2006) Metal artefact reduction for X-ray computed tomography in combination with iterative reconstruction algorithms. Thesis, RheinAhrCampus Remagen
- Nagel HD (ed) (2002) Strahlenexposition in der Computertomographie, 3rd edn. CTB, Hamburg
- Natterer F (1999) Numerical methods in tomography. *Acta Num*
- Natterer F (2001) The mathematics of computerized tomography. *Classics in Applied Mathematics* 32. IEEE, New York
- Natterer F, Wübbeling F (2001) Mathematical methods in image reconstruction. *SIAM Monographs on Mathematical Modelling and Computing*, Philadelphia
- Netzel U (1998) Grundlagen der digitalen Bildgebung. In: Ewen K (ed) *Moderne Bildgebung*, Thieme, Stuttgart, p 63
- Nilsson S (1999) Application of fast backprojection techniques for some inverse problems of integral geometry. Dissertation, Linköping Studies in Science and Technology, Thesis No. 499, Linköping University
- Nuyts J, Michel C, Dupont P (2001) Maximum-likelihood expectation-maximization reconstruction of sinograms with arbitrary noise distribution using NEC-transformations. *IEEE Trans Med Imaging* 20:365–375
- Oehler M, Buzug TM (2007) Statistical image reconstruction for inconsistent CT projection data. *J Methods Inform Med* 3:261
- Oppenheim AV, Schafer RW (1999) *Zeitdiskrete Signalverarbeitung*. Oldenbourg, Munich
- Orlov SS (1975) Theory of three dimensional reconstruction. I. Conditions for a complete set of projections. *Sov Phys Crystallogr* 20:312
- Otendal M (2006) A compact high-brightness liquid-metal-jet X-ray source. Thesis, Stockholm
- Papula L (2000) *Mathematische Formelsammlung*. Vieweg, Braunschweig
- Parzen E (1961) Mathematical considerations in the estimation of spectra. *Technometrics* 3:167
- Pfoh AH (2002) Volume computer tomography (VCT) – a new diagnostic imaging technique on the basis of high-resolution flat-panel detectors. In: Niederlag W, Lemke HU (eds) *Medical imaging*. *Health Acad* 02:7
- Pol MJ, Rogers JV II, Kobayashi Y, Jacobs LL (2000) Computed tomography of an anolis lizard in Dominican amber: Systematic, taphonomic, biogeographic, and evolutionary implications. *Palaeontol Electron* 5:13
- Press WH, Flannery BP, Teukolsky SA, Vetterling WT (1990) *Numerical recipes in C: The art of scientific computing*. Cambridge University Press, Cambridge

- Proksa R, Köhler T, Grass M, Timmer J (2000) The n-Pi-method for helical cone-beam CT. *IEEE Trans Med Imaging* 19:848
- Radon J (1917) Über die Bestimmung von Funktionen längs gewisser Mannigfaltigkeiten. *Berichte der mathematisch-physikalischen Kl. Sächsischen Gesellschaft der Wissenschaften* 59. Leipzig, p 262
- Ramachandran GN, Lakshminarayanan AV (1971) Three-dimensional reconstruction from radiographs and electron micrographs. *Proc Acad Sci USA* 68:2236
- Ramm AG, Katsevich AI (1996) *The Radon transform and local tomography*. CRC, Boca Raton
- Romans LE (1995) *Introduction to computed tomography*. Lippincott, Williams and Wilkins, Philadelphia
- Rosenfeld A, Kak AC (1982) *Digital picture processing*. Academic, New York
- Ruhlmann J, Oehr P, Biersack HJ (1998) *PET in der Onkologie – Grundlagen und klinische Anwendung*. Springer, Heidelberg
- Sassov A (1999) Desktop X-ray micro-CT. In: *Computerized tomography for industrial applications and image processing in radiology*. Proc DGZIP BB67-CD, Berlin, p 165
- Sassov A (2002) Desktop X-ray micro-CT instruments. *Proc SPIE* 4503:282
- Sassov A (2002) Comparison of fan-beam, cone-beam and spiral scan reconstruction in X-ray micro-CT. *Proc SPIE* 4503:124
- Sauer K, Bouman C (1993) A local update strategy for iterative reconstructions from projections. *IEEE Trans Signal Process* 41:533
- Schlegel W, Bille J (eds) (2002) *Medizinische Physik, vol 2*. Springer, Berlin
- Schramm N (2001) *Entwicklung eines hochauflösenden Einzelphotonen-Tomographen für kleine Objekte*. Dissertation, Berichte des Forschungszentrums Jülich 3841
- Schumacher H, Fischer B (2007) A new approach for motion correction in SPECT imaging. *Proceedings of the BVM*, Springer, Berlin, p 51
- Seeram E (2001) *Computed tomography*. Saunders, Philadelphia
- Sergé E (1965) *Nuclei and particles*. Benjamin, New York
- Shepp LA, Logan BF (1974) The Fourier reconstruction of a head section. *IEEE Trans Nucl Sci* 21:21
- Shepp LA, Vardi Y (1982) Maximum likelihood reconstruction for emission tomography. *IEEE Trans Med Imaging* 1:113
- Stearns SD, Hush DR (1999) *Digitale Verarbeitung analoger Signale*. Oldenbourg, Munich
- Sternberg S (2000) CT scans: A very high-dose diagnosis. *USA Today*, Nov. 20
- Stevens GM (2000) *Volumetric tomographic imaging*. Dissertation, University of Stanford
- Stierstorfer K, Flohr T, Bruder H (2002) Segmented multiple plane reconstruction – a novel approximate reconstruction scheme for multislice spiral CT. *Phys Med Biol* 47:2571–2581
- Tam KC. Three-dimensional computerized tomography scanning method and system for large objects with small area detectors. US Patent 5,390,112
- Thomsen D, Klein K, Oehler M, Pfinninger S, Reich F, Buzug TM (2003) Computertomographie in der Archäologie. In: *Physikalische Methoden der Laser- und Medizintechnik*. VDI Fortschritt-Bericht, Reihe 17: Biotechnik/Medizintechnik, Nr. 231. VDI, Düsseldorf, p 156
- Tisson G (2006) *Reconstruction from transversely truncated cone beam projections in micro-tomography*. Thesis, University of Antwerp
- Toft P (1996) *The Radon transform. Theory and implementation*. Thesis, Technical University of Denmark

- Turbell H (1999) Three-dimensional image reconstruction in circular and helical computed tomography. Linköping Studies in Science and Technology. Thesis No. 760, Linköping University
- Turbell H (2002) Cone-beam reconstruction using filtered backprojection. Linköping Studies in Science and Technology 672. Dissertation, Linköping University
- Tuy H (1983) An inversion formula for cone-beam reconstruction. *SIAM J Appl Math* 43:546
- Wang G, Lin TH, Cheng PC (1995) Error analysis on a generalized Feldkamp's cone-beam computed tomography algorithm. *Scanning* 17:361
- Wang G, Zhao S, Cheng P-C (1998) Exact and approximate cone-beam X-ray microscopy. In: Cheng PC, Huang PP, Wu JL, Wang G, Kim HG (eds) *Modern microscopes (I) – instrumentation and image processing*. World Scientific, Singapore
- Watson GN (1966) *A treatise on the theory of Bessel functions*, 2nd edn. Cambridge University Press, Cambridge
- Webb S (1990) *From the watching of shadows*. Hilger, Bristol
- Weisser G (2000) Technische Grundlagen der EBCT. In: Gaa J, Lehmann K-J, Georgi M (eds) *MR-Angiographie und Elektronenstrahl-CT-Angiographie*. Thieme, Stuttgart, p 145
- Werner M (2000) *Signale und Systeme*. Vieweg, Braunschweig
- Wilting JE (1999) Technical aspects of spiral CT. *Medicamundi* 43:34
- Yang X, Horn BKP (2002) Cone-beam reconstruction – present and future
- Yendiki A, Fessler JA (2004) A comparison of rotation- and blob-based system models for depth-dependent detector response. *Phys Med Biol* 49(11):2157–2168
- Zankl M, Panzer W, Drexler G (1991) The calculation of dose from external photon exposures using reference human phantoms and Monte Carlo methods. Part VI. Organ doses from computed tomographic examinations, GSF-Report 30/91, GSF Research Centre, Oberschleißheim
- Zylka W, Wischmann HA (1996) On geometric distortions in CT images. Proceedings of the 18th International Conference of the IEEE. EMBS, Amsterdam

Subject Index

- 180°LI 315
- 360°LI 314

- Abel transform 132, 133, 200
- absorbed energy 486
- absorption 31
 - coefficient 33, 36
 - edges 37
 - probability 66
- acceleration voltage 7, 16
- acquisition time 500
- ADC (analog–digital converter) 404
- adjoint
 - Radon transform 206, 207
 - reconstruction problem 209
- AEC (automatic exposure control) 493, 494
- afterglow 50, 73, 404
 - artifact 437
- algebraic reconstruction technique (ART)
 - 201, 202, 211, 216
- algorithm layer 404
- aliasing 136
 - artifact 454
- amalgam 42, 439
- Ambrose, J.* 6
- Americium source 82
- amplitude spectrum 141
- analog tomography 77, 78
- analog–digital converter (ADC) 404
- angiographic CT (CTA) 481
- angular dose modulation 495
- annihilation 39, 96
 - radiation 39
- anode surface 25
- antenna characteristic 26
- anti-scatter grid 51, 404, 444, 445
- anticathode 19

- anvil 400
- aperture angle 265, 266, 320
- apparent spot size 25
- approximate reconstruction 366
- ART (algebraic reconstruction technique)
 - 201, 211, 215, 216, 218
- artifact
 - afterglow 437
 - aliasing 435, 454
 - beam-hardening 30, 46, 425
 - cone-beam 458
 - cupping 427
 - electronic 435
 - interpetrous lucency 430
 - metal 438, 455
 - motion 432, 450
 - partial volume 423, 446
 - ring 435
 - sampling 435, 454
 - scalloping 456
 - scatter 443
 - slice shearing 451
 - spiral CT related 456
 - staircasing 448
 - streak 438
- asymmetrical detector 301
- attenuation coefficient 33
- Auger
 - electron 22, 36
 - process 20, 22
- autocorrelation function 141
- automatic exposure control (AEC) 493, 494
- axial
 - aperture 447
 - slice 9
- a priori* model 235

- backprojection operator 207
- backscattering 25, 38
- band-limited projection 259
- Bayesian estimation 235
- beam
 - profile 26
 - quality 24
- beam collimation 404
- beam-hardening 29, 201, 404
 - artifact 426
 - correction 73
- beam-wise correction 211
- beating heart 433
- Bernoulli
 - detectors 64
 - distribution 61, 67, 69
- Bessel function 126, 128, 131, 189, 221
- Bethe–Bloch equation 22
- binding energy 17
- binomial
 - coefficient 61
 - distribution 63
 - series 67
- biograph 97
- biological
 - effect 486
 - weighting 486
- bismuth germanate 50
- Blackman window 246
- blank scan 73
- blob 220, 221
- blob-based reconstruction 219
- Bluestein identity 149
- blurring angle 78
- Bockwinkel, H.B.A.* 6
- bone
 - removal 481
 - window 476, 478–480
- bounded input–bounded output 106
- bowtie filter 73, 497
- Bracewell, R.N.* 4, 6, 113
- brain window 480
- bremsstrahlung 20, 21, 26
- Brooks' formula 469, 493, 502

- C-arm 59
- cadmium tungstate 50
- calcium scoring 482
- capacity 23

- capture efficiency 48
- cardiac imaging 499
- cardio CT 482
- cascaded Poisson process 65, 230
- CAT (computerized axial tomography) 1, 79
- cathode surface 17
- Cauchy's fundamental theorem 133
- causality 106
- CBF (cerebral blood flow) 482
- CBV (cerebral blood volume) 482
- CCD (charge-coupled device) 94
- central limit theorem 71
- central section theorem 329, 331, 350
- ceramic material 50
- cerebral blood flow (CBF) 482
- cerebral blood volume (CBV) 482
- cesium iodide 50, 53, 58
- characteristic line spectrum 20
- charge-coupled device (CCD) 94
- Chebyshev polynomials 198
- chirp z -transform 147, 148, 171
- circular 369
 - harmonics 196, 198
 - path 311
 - trajectory 261, 366, 371, 393
- Clack, R.* 357, 387
- clique 236
- coherent scattering 34
- coin-throwing experiment 61
- coincidence
 - detection 39
 - measurement 96
- collimator 51, 79, 84, 305, 316, 317
 - lamella 51
- colon peristalsis 433
- comb function 136, 139
- complementary
 - rebinning 270, 315
 - X-ray source 271
- Compton
 - collision 38
 - electron 38
 - scattering 31, 38, 40, 426, 430
- Compton, A.H.* 38
- computed tomography dose index (CTDI) 489
- computerized

- axial tomography (CAT) 1, 79
- transaxial tomography (CTAT) 79
- concentric squares 169
- conditional
 - distribution 236
 - probability 64
- cone angle 372, 388, 395
- cone-beam
 - CT 400
 - detector 52
 - geometry 53, 91, 336, 340, 345, 355, 366, 371, 395, 400, 458
- conservation of energy 16
- consistency condition 311
- contrast 405, 409, 467
 - reserve 501
- convergence-generating function 183
- conversion
 - efficiency 21
 - factor 491
- convolution
 - kernel 183, 245, 250, 252, 273, 278
 - theorem 124, 126, 134, 188, 191, 356
- Cormack transform 195, 198, 200
- Cormack, A.M.* 5
- coronal slice 9
- correction function 359
- covariance matrix 238, 239
- Cramer, H.* 6
- cross-section 38, 39
- CT microscopy 93
- CTA (angiographic CT) 481, 482
- CTAT (computerized transaxial tomography) 79
- CTDI (computed tomography dose index) 489
- cupping artifact 427
- curved detector array 272
- cyclic path 371
- cylindrical detector 388, 391

- DAS (data acquisition system) 72
- DAT (digital axial tomography) 79
- data acquisition system (DAS) 72
- deceleration cascade 21, 26
- deconvolution 188–190
- defective beams 436
- Defrise, M.* 357, 387
- Delbrück scattering 40

- δ -distribution 103, 109, 111, 112, 323
- δ -line 114, 203
- density function 72
- dental
 - fillings 438
 - radiology 79
- design matrix 205
- detective quantum efficiency (DQE) 422
- detector
 - afterglow 437
 - failure 437
 - fan 89
 - layer 404
 - quarter shift 261
 - sensitivity profile 309
 - size 468, 469
 - surface normal 330
- DFT (discrete Fourier transform) 144
- diagnostic energy window 39
- digital axial tomography (DAT) 79
- digitalization layer 404
- dipole layer 17
- Dirac comb 112
- Dirac's delta impulse 109
- Dirac, P.A.M.* 39
- direct
 - inversion 210
 - reconstruction 168
- directional interpolation 441
- discrete Fourier transform (DFT) 144
- discretization 202, 243, 287, 403
- display layer 404
- divergent integral 122
- DLP (dose length product) 491, 492
- dose 422, 469, 485
 - free-in-air 491
 - length product (DLP) 491, 501
 - plateau 489
- DQE (detective quantum efficiency) 422
- dual-energy method 430
- dual-source CT 31, 434, 498, 499

- EBCT (electron beam computerized tomography) 89, 434
- ECG-trigger 316, 433, 495
- edge
 - filter 104
 - preserving 237
- Edholm, P.R.* 83, 98

- effective
 - CTDI 490
 - dose 486, 492
- Ehrenfest, P.* 6
- eigenvalue problem 116
- Einstein, A.* 36
- elastic scattering 34
- electric dipole 19
- electromagnetic spectrum 15
- electron
 - avalanche 72
 - beam 25
 - beam computerized tomography (EBCT) 89, 434
 - optics 17, 19
 - velocity 16
- electron-positron pair 39
- electron-impact 15
 - source 425
- electron-nucleus collision 20
- electronic
 - artifact 435
 - defect 435
 - layer 404
- EM (expectation maximization) 227
 - algorithm 227
- energy
 - conservation of 16
 - conversion 51
 - density spectrum 141
 - dose 486
- equivalent dose 486
- exact 3D reconstruction 357
- expectation
 - maximization (EM) 227
 - value 62, 63, 67–69, 223, 225, 230, 231, 421
- exposure time 23
- ¹⁸F-FDG 96
- false alarm probability 423
- fan-beam geometry 84, 85, 153, 262, 263, 274, 281
- fast Fourier transform (FFT) 168
- FCD (focus center distance) 261
- FDK reconstruction 372, 386–388
- FDK-SLANT method 393, 394
- Feldkamp, L.A.* 371, 386
- FFT (fast Fourier transform) 168
- field-of-view (FOV) 501
- filament 17
- fill factor 52, 55, 56
- filter kernel 501
- filtered
 - backprojection 179, 183, 185, 190, 191, 194, 235, 257, 272, 326, 327, 357, 365, 378, 386, 419, 424
 - layergram 190
 - projection 182, 243
- fine structure 37
 - constant 22
- finite beam width 223
- finite DFT 146
- first generation CT 80, 241
- first moment 68
- fixpoint iteration 227, 233, 234
- flat-panel detector 53, 57, 58, 93, 304, 337, 345, 351, 373, 401
- fluorescence time 437
- flying focus 26, 242, 435
- focal
 - line 23
 - spot 23, 30, 403, 412, 413, 446
- focus
 - center distance (FCD) 261
 - diameter 25
 - line 28
- focusing cup 17
- forward projection 211, 215, 216, 229
- Fourier
 - coefficients 196
 - slice theorem 163, 165, 175, 181, 326, 327, 333, 352
 - transform 117–121, 123, 124, 132, 136, 146, 164, 210, 242
- Fourier–Abel–Hankel cycle 132, 133
- Fourier–Bessel transform 128
- fourth generation CT 87, 88, 241
- fourth power law 469, 502
- FOV (field-of-view) 501
- frequency variable 166, 327
- fundamental signals 102
- gadolinium oxysulphide 50
- gantry 90, 155
 - tilt 7, 451, 474
- gas detector 48
- gate property 107

- Gaussian
 - blurring 407
 - distribution 71
 - function 102
 - MRF 237
- Geiger-Müller counter 48
- generalized
 - Gaussian MRF (GGMRF) 237
 - Radon transform 331
 - value 122
- geometric
 - efficiency 49, 51
 - enlargement 86
- geometrical design 241
- German Employer's Liability Insurance Association 2
- GGMRF (generalized Gaussian MRF) 237
- Gibbs
 - distribution 236, 237
 - phenomenon 252
 - potential 236
- grad operator 228, 234
- gradient method 227
- Grangeat method 350
- Grangeat, P. 341, 345, 354
- Gray 486
- gray-value discrimination 476
- great circle 335, 336
- Grossmann tomograph 76, 77
- Grossmann, G. 76

- hammer 400
- Hamming window 246
- Hankel transform 128, 131, 132, 189, 199, 200
- Hanning window 246
- head scanner 80
- heat
 - capacity 24
 - load 23
 - units 23
- Heaviside step function 102
- Heel effect 27
- helical
 - cone-beam reconstruction 394
 - CT 90
 - trajectory 311
- Hertzian antenna 26

- Hessian
 - matrix 226, 232
 - normal form 157, 176, 192
- high-pass filter 126, 183
- Hilbert transform 133, 134, 194
- hot spot 97
- Hough transformation 160
- Hounsfield
 - bars 430
 - unit (HU) 475
- Hounsfield, G.N. 5, 81
- HU (Hounsfield unit) 475
- human
 - jaw 400
 - visual system 476
- hybrid Radon transform 331, 334, 335, 352
- hyperplanes 212

- ICRP (International Commission on Radiological Protection) 42
- ideal low-pass filter 140
- identity operator 133
- ill-conditioned 209
 - problem 205
- ill-posed problems 235
- ILST (iterative least squares techniques) 211
- image
 - chain 405
 - deterioration 412
 - processing 404
- imaging quality 410
- impulse
 - response 104, 106, 107, 115, 116, 178, 407, 409, 413
 - train 113
- incoherent scattering 38
- incomplete
 - data 459
 - Radon data 371, 387
- inconsistency 311, 424, 427, 447, 456
- inconsistent projection data 317
- inherent beam weighting 201, 440
- integrating detector 72
- International Commission on Radiological Protection (ICRP) 42
- interpolation 313
- inverse
 - fan 88

- problem 3, 4, 234, 235
 - Radon transformation 163, 169
 - squares 170
- inversion formula 329
- irregular sampling 358
- iso-dose line 41, 487
- iso-surface 304, 460, 482
- isotropic voxel 320
- iterative
 - ART 211
 - fixpoint solution 237
 - least squares techniques (ILST) 211
- Jacobian 129, 179, 274, 281, 325, 326, 332, 340, 377
- jinc function 128
- jitter 136
- joint probability 224, 230
- k*-space 117
- Kaczmarz's method 211
- Kaiser–Bessel window 220
- Kalender, W.* 91, 309
- kerma 490
- Klein–Nishina equation 38, 431
- Korenblum, B.I.* 6
- Kramers 21
- Kudo, H.* 357
- Kuhn–Tucker conditions 226, 233
- λ^3 dependence 36, 426
- Lakshminarayanan, A.V.* 244, 252, 253
- Lambert–Beer's law 33, 46, 68, 230, 233, 425
- Laplace transform 122
- least squares minimum norm 206
- likelihood function 225, 231
- LIMAX (Liquid Metal Anode X-ray) 31
- line
 - pairs 404
 - spread function 411
- linear
 - detector array 280
 - frequency ramp 242, 248, 256, 278, 285, 354, 381
 - interpolation 314
 - system 104
 - system of equations 201
 - transmission 106
 - linear interpolation 417, 441
- linogram 354
 - method 170, 171
 - sampling 148
- liquid metal 24
- Liquid Metal Anode X-ray (LIMAX) 30, 31
- log likelihood function 225, 227, 232, 234, 235, 237, 239
- Logan, B.F.* 245, 249, 252, 253
- longitudinal dose modulation 493, 494
- Lorentz, H.A.* 6
- low-pass filter 126, 136, 248
- LTI systems 105
- lung emphysema 482
- MAP (maximum *a posteriori*) 235
- Markoff
 - process 236
 - random field (MRF) 236
- mAs product 468, 499
- mass attenuation coefficient 33, 37, 42
- mass–energy equivalency 39
- maximum *a posteriori* (MAP) 235
- maximum likelihood
 - expectation maximization (MLEM) 60
 - method 223, 225, 228, 231
- maximum-intensity projection (MIP) 481
- mean 421
 - transit time (MTT) 482
- measurement field diameter (MFD) 259
- measuring interval 269
- meridian surface 348
- metal
 - artifact 438, 455
 - artifact reduction 442
 - filter 496
 - shadow 438
- MFD (measurement field diameter) 259
- micro-CT 93, 337, 338
- micro-focus tube 93
- MIP (maximum-intensity projection) 481
- mirror-image force 17
- missing data 366, 440
- MLEM (maximum likelihood expectation maximization) 60, 440
- modulation 405
 - transfer function (MTF) 25, 93, 296, 404, 406, 410, 413

- Moiré
 effect 136
 pattern 437
- Moore–Penrose inverse 206
- Moseley’s law 21
- most probable solution 225, 231
- motion
 artifact 84, 311, 433, 450
 correction 433
 parameter 358
- MPR (multi-planar reformatting) 9, 11, 310
- MRF (Markoff random field) 236
- MSAD (multiple scan average dose) 489
- MSCT (multi-slice CT) 52, 337
- MTF (modulation transfer function) 25, 296, 404, 409, 410, 412, 466
- MTT (mean transit time) 482
- multi-line detector array 93, 319
- multi-planar reformatting (MPR) 9, 11, 310
- multi-row arrays 52
- multi-slice
 CT (MSCT) 52, 337
 detector 12
- multiple scan average dose (MSAD) 489
- N chooses n 61
- n -PI method 398
- NDT (nondestructive testing) 2
- nearest neighbors method 208
- NEC (noise-equivalent count) 73
 scaling 73
 shifting 73
- neutrino 96
- neutron 96
- Newton–Raphson method 240
- Nobel Prize 6, 15, 36, 38, 81
- noise 235, 252, 422, 462, 466
- noise-equivalent count (NEC) 73
- non-Poisson statistics 72
- non-radiative process 22
- non-square integrable function 247
- nondestructive testing (NDT) 2
- normal distribution 71
- normalized CTDI 491
- nuclear resonance scattering 40
- number of
 detectors 259
 projections 259
- Nyquist
 criterion 135, 258, 305
 frequency 136
- object thickness 500
- optical
 focus 25
 reconstruction method 98
 transfer function (OTF) 410
- organ dose 491
- Orlov’s sufficiency condition 335
- orthogonal
 matrix 207
 reformatting 10, 449
- orthopan tomography 79
- OTF (optical transfer function) 410
- over-determined 208, 218
 system 205
- overview scan 7, 9, 471, 472
- pair production 31, 39, 40, 96
- parallel-beam
 geometry 263, 269
 rebinning 265
- paranasal sinuses 474
- parenchymatous organs 476
- Parseval’s theorem 125
- partial volume artifact 446, 456, 461
- partition function 236, 237
- Parzen window 246
- Pascal’s triangle 61
- patient overview 9
- penalty term 235
- pencil-beam geometry 33, 79, 153, 258, 262, 265, 272
- penetration depth 26
- penumbra fringe 24
- perfusion 482
- PET (positron emission tomography) 39, 96, 204, 223
- PET-CT 96
- petrous bones 430
- phase transfer function (PTF) 411
- photo disintegration 40
- photoelectric absorption 31, 36, 40, 426, 430
- photomultiplier 72
- photon detector 50

- photon–matter interaction 47, 430
- physical layer 403
- PI
 - method 396
 - window 395
- pilot
 - scan 472
 - view 186
- pitch 7, 316–318, 320, 395, 432, 449, 456, 489, 501
- pixel 53, 218, 219
 - noise 465
- pixel-wise correction 211
- planar detector 372, 390
- planigraphy 78
- planning overview 186
- pleura window 478, 479
- point-slope form 214, 329
- point-spread function (PSF) 115–117, 178, 410
- Poisson
 - distribution 63, 65, 69, 70, 224, 230, 239, 421, 440, 462
 - source 65
- polar coordinates 129
- polychromatic
 - spectrum 201
 - X-ray 29, 427
- position invariance 105
- positron 39, 96
 - emission tomography (PET) 39, 96
 - emitter 96
- power
 - of four law 469, 502
 - theorem 125
- practical CTDI 490
- preprocessing chain 73
- principal
 - quantum number 21
 - sections 9
- prior 236
- probability density function 63
- projection
 - integral 156, 323, 462
 - pattern 187
 - surface 322
- pseudo
 - inverse 207
 - sharpness 411
 - solution 206, 218
- PSF (point-spread function) 178, 187, 410, 411
- PTF (phase transfer function) 411
- QED (quantum electrodynamics) 22
- quantum
 - efficiency 23, 49, 50, 57
 - electrodynamics (QED) 22
 - noise 462
- quarter detector shift 242, 298, 435
- radiation
 - energy 16
 - weighting factor 487
- radiation-free transition 36
- Radon
 - inversion 328
 - inversion formula 350, 353, 357, 399
 - space 160, 161, 163, 184, 205, 264, 270, 290, 315, 369, 371, 459
 - sphere 341–343, 348, 357, 360, 364
 - transform 161, 213, 321, 323, 341, 343, 345, 348, 355
- Radon's solution 151, 191, 327
- Radon, J.* 5, 7, 151, 193
- Ramachandran, G.N.* 244, 252, 253
- ramp filter 279, 286, 289, 386, 389, 392, 419
- rank 203, 208
- ray-by-ray reconstruction 211
- Rayleigh
 - scattering 31, 34, 40
 - theorem of 125, 465
- rebinning 265, 266, 269, 272, 290, 390, 392
 - of the fan beams 265
- receiver operating characteristic (ROC) 422
- reconstruction layer 404
- rectangular function 102
- reduced energy 38, 431
- registration 96
- regridding 168, 175
- regular sequence 122, 123, 183
- regularity conditions 151
- regularization 209, 234–237, 247
 - parameter 236, 237

- relaxation parameter 215
 residual inconsistency 441
 respiration 433
 Richardson–Dushman equation 19
 ring artifact 86, 435
 ROC (receiver operating characteristic)
 422, 423
Röntgen, W.C. 5, 7
 rotating
 anode disk 23
 unit vectors 157
 rotation invariance 105

 S-FDK (sequential FDK) 393
 sagittal section 9
Saito, T. 357
 sampling
 aperture 319
 artifact 435
 disk 155, 157
 theorem 135, 136, 260, 294–297, 306,
 316, 435
 unit 90
 scaling property 110
 scalloping 456
 scanogram 9, 186, 471
 scatter
 coefficient 33
 diagram 41
 scattering 31, 34
 scintillator
 detector 50
 layer 55
 scout view 9, 186, 471
 second central moment 68
 second generation CT 83, 241
 secondary reconstruction 8, 304, 454
 segmentation inaccuracy 459
 self absorption 27
 sensitivity 422
 profile 317, 318, 413, 423, 435
 sequential FDK (S-FDK) 393
 method 393
 seventh generation CT 92
 shadow zone 369–371, 387, 390, 459
 shah 113
 Shannon's theorem 135, 242, 296
 Shannon–Whittaker interpolation 140
 shaped filter 497

Shepp, L.A. 245, 249, 252, 253
 Shepp–Logan 288, 420
 shock room 1
 sidelobes 128, 245
 Sievert 486
 sift property 110, 114, 139, 160, 178, 194, 323
 signal mean 68
 signal transmission 403
 signal-to-noise ratio (SNR) 68, 70, 421,
 468, 493
 signum function 121, 134
 simple backprojection 175, 183, 185, 187,
 207
 sinc function 102, 121, 245
 singular value 207, 209
 decomposition (SVD) 207
 sinogram 160, 161, 205
 sinusoidal trace 162
 sixth generation CT 90
 slice
 collimation 404
 direction 9
 sensitivity profile (SSP) 313, 318, 456
 thickness 7, 500
 slip-ring 90, 91, 262, 311
 slope-intercept form 213
 SNR (signal-to-noise ratio) 421, 422, 469
 sodium iodide 83
 soft tissue window 476, 478
 solid metal anode 16
 solid-state detector 50
 source trajectory 357, 358
 sparse matrix 205, 210
 spatial
 frequency 94, 117, 242
 resolution 93, 235, 252, 404, 466
 signal 102
 specificity 422
 specimen disk 93
 SPECT (single photon emission computed
 tomography) 204, 223
 spectral weighting function 242
 spherical coordinates 325
 spiral
 CT 90, 309, 312, 313, 317, 395, 456
 path 311
 spiral-groove bearing 24
 split detector 432

- square integrable function 183
- SSP (slice sensitivity profile) 318
- staircasing artifact 449
- standard
 - deviation 68, 421, 463
 - kernel 252
- stationary detector ring 87
- statistical
 - photon model 60
 - reconstruction 201, 225
- step function 107, 108
- Stirling equation 70
- stirrup 400
- stochastic
 - fluctuation 462
 - process 236
- stratigraphy 78
- StratonTM X-ray tube 31
- sub-second scanners 90
- sufficiency condition 336, 359, 371
- supplementary helix 314, 315, 317
- surface
 - integral 321
 - rendering 455, 459, 481
 - segmentation 305
- surrogate data 440
- SVD (singular value decomposition) 207, 209
- symmetry properties 181
- system
 - matrix 205, 208, 210, 213, 218, 221
 - of equations 208
- T-FDK (tent-FDK) method 392
- table deformation 454
- Tam–Danielsson window 396
- target area 25
- temporal dose modulation 495, 497
- tent-FDK (T-FDK) method 392
- TFT (thin-film transistor) 53
- theorem of Thales 160, 172, 342, 360, 367
- thermal
 - electron 16
 - noise 462
- thin-film transistor (TFT) 53
- third generation CT 85, 87, 241, 261
- Thomson
 - cross-section 34
 - scattering 34, 40
- time to peak (TTP) 482
- tissue
 - mass 486
 - weighting factor 487
- tomography 78
- tomosynthesis 77, 336
- topogram 9, 186, 471
- torus 369
- tracer 96
- translation invariance 105
- transmission
 - probability 66
 - system 104
- triangle function 102, 417
- triangulation inaccuracy 459
- triplet production 39
- TTP (time to peak) 482
- tube
 - current 7, 467
 - voltage 500
- Tuy–Smith
 - condition 369
 - sufficiency condition 346, 368, 371, 387
- unit
 - of dose 486
 - sphere 328, 335, 336
 - vector 322, 350
- variance 68, 69, 463
 - of the origin 465
 - of the Radon transform 462
 - of the reconstruction 464
- VCT (volume CT) 337
- vessel analysis 482
- virtual
 - detector 281, 341, 373, 391, 396
 - endoscopy 481
 - linear detector 267, 280
- volume
 - CT (VCT) 337
 - rendering 310, 449, 459, 479, 481
- voxel 219, 221, 309, 310
- voxel-based reconstruction 219
- water correction 427
- Wehnelt cylinder 17, 18
- weighted
 - CTDI 490

- filtered backprojection 279
- least squares 238, 239
- MLEM 441
- whole body scan 12
- Wiener–Khintchine theorem 141
- window
 - function 244
 - level 476
 - width 476, 501
- Wold, H.* 6
- wolfram target 90
- X-ray 15
 - anode 24
 - detector 64
 - focus 24
 - quanta 230
 - shielding 33, 40
 - transform 339, 341, 345
 - tube 16
 - tube current 70
- X-ray imaging layer 403
- xenon 49
- Yang Hui’s triangle 61
- Z^4 dependence 36, 438
- z -transform 147
- Ziedses des Plantes, B.G.* 78