
Education & Experience

- since 9/2019 **Research Scientist & Group Leader “Radiotherapy Optimization”**, *Division of Medical Physics in Radiation Oncology, German Cancer Research Center – DKFZ, Heidelberg*,
leading a research team focusing on the development and implementation of physical, biological and numerical models in the context of radiotherapy treatment planning and maintaining the open source dose calculation and treatment planning toolkit “matRad”
- 8/2018 – 8/2019 **Postdoctoral Researcher & Project Coordinator**, *Division of Medical Physics in Radiation Oncology, German Cancer Research Center – DKFZ, Heidelberg*,
research in uncertainty quantification and probabilistic/robust treatment planning for particle therapy, maintenance of the open source toolkit “matRad”, and coordination of the Chilean-German Consortium for Medical Physics in Radiation Oncology (CGCoMPRO)
- 5/2017 – 7/2017 **Research Stay**, *in the Group Probabilistic Numerics, Max Planck Institute for Intelligent Systems, Tübingen*,
working on the development of analytical probabilistic models for radiotehrapy treatment plan quality indicators
- 6/2015 – 7/2015 **Research Stay**, *in the Group Probabilistic Numerics, Max Planck Institute for Intelligent Systems, Tübingen*,
working on numerical methods for accelerated anayltical probabilistic dose calculation
- 1/2015 – 7/2018 **Doctoral Studies**, *Division of Medical Physics in Radiation Oncology, German Cancer Research Center – DKFZ & University of Heidelberg*, in Physics,
awarded the degree of Dr. rer. nat. graded *summa cum laude* for the thesis titled “Analytical models for Probabilistic Inverse Treatment Planning in Intensity-modulated Proton Therapy”
- 7/2014 – 9/2014 **Research assistant**, *German Cancer Research Center – DKFZ, Heidelberg*
- 2012 – 2017 **Freelancer**
Metadata Annotation, Web-Programming, Research consulting.
- 10/2011 – 3/2014 **Master Studies**, *University of Heidelberg*, in Physics,
graduated M.Sc. with overall grading *very good*, master thesis: “Automated Voxel-based Penalty Adaption for ultra-fast Treatment Planning in Intensity-modulated Radiation Therapy”
- 2010 – 2014 **Student teaching assistant** for practical physics courses on a regular basis, *Department of Physics & Astronomy at the University of Heidelberg*
- 4/2008 – 10/2011 **IT Assistant**, *HierEDV, Heidelberg*
- 10/2007 – 5/2011 **Bachelor Studies**, *University of Heidelberg*, in Physics,
graduated B.Sc. with overall grading *good*, bachelor thesis: “Performance of the local on-line Tracking and of a Track-based Jet Trigger Algorithm for the ALICE TRD on the Basis of Monte-Carlo Simulations”
- 10/1999 – 6/2007 **Abitur**, *Dietrich-Bonhoeffer-Gymnasium, Weinheim*,
higher education entrance qualification with overall grading of 1.4

Community & Outreach

- 2023 Course lead for the 5th Summer School in Medical Physics: Data Science and Machine Learning in Radiotherapy, Heidelberg/Online
- since 2021 Associate Editor “Medical Physics”
- 2021 Organization of the first HITRlplus Heavy Ion Therapy Masterclass School

- since 2019 Organization of a weekly Medical Physics Seminar with invited (international) speakers for the Research Program “Imaging and Radiooncology” at DKFZ
- since 2019 Establishing a “Particle Therapy Master Class” for school children (in cooperation with CERN, GSI & the Heidelberg Life Science Lab) with the first successful pilot in March 2019
- since 2019 Member of the Deutsche Gesellschaft für Radiooncologie (DEGRO)
- since 2019 Member of the Deutsche Gesellschaft für Medizinische Physik (DGMP)
- 2018 – 2020 Project coordinator within the Chilean-German Consortium for Medical Physics in Radiation Oncology (CGCoMPRO) sponsored by the German Federal Ministry of Education and Research, organizing multiple workshops in Santiago de Chile
- since 2018 Occasional reviews for Medical Physics, International Journal of Radiation Oncology*Biophysics, Physics in Medicine and Biology, Radiation Oncology, Physica Medica: European Journal of Medical Physics, and Strahlentherapie & Onkologie
- since 2017 Member of the European Society for Radiotherapy & Oncology (ESTRO)
- 2016 Referee for “Jugend forscht”, Europe's biggest youth science & technology competition
- since 2015 Co-hosting a YouTube channel (Physiktutorium) with instructional physics videos for students
- since 2015 Continuous contribution to the open source radiation therapy treatment planning toolkit matRad (<http://www.matrad.org>)
- 2015 Supporting the organization of the Machine Learning Summer School (MLSS), Tübingen
- 2009 – 2017 Helper in the International Summer School for German Language and Culture at the University of Heidelberg
- 2008 – 2018 Assisting at “Explore Science”, a yearly educational scientific event at the behest of the Klaus Tschira Foundation
- since 2007 Member of the German Physical Society (DPG)
- 2003 Participation in a one-month school exchange with Hunterdon Central Regional High School, NJ, USA, within the German American Partnership Program (GAPP)

Third-party Funding & Projects

- 2022 – 2027 **NIH Award R01CA266467**, *Ionization Detail – Biologically based treatment planning for particle therapy beyond LET-RBE*, \$308 650 awarded to DKFZ, Principal Investigator: Prof. Jäkel, other Co-Investigator: Prof. Karger
- 2022 **Mathworks Community Toolbox Development Support**, *Development sparse linear algebra and DICOM plugins for matRad*, \$20 500, Principal Investigator
- 2021 – 2024 **DFG project support grant WA 4707/1-1**, *Sustainable development of the open source radiotherapy dose calculation and optimization toolkit matRad*, 315 000 €, Principal Investigator
- 2021 – 2024 **DFG New Instrumentation for Research grant WA 4707/3-1**, *HELIOS – Developing a HELium Imaging Oncology Scanner for Range Guided Radiotherapy (RGRT) for Non-Small Cell Lung Carcinoma (NSCLC)*, 187 000 € (of total project funds: 950 000 €), Principal Investigator (Other PIs: Prof. Joao Seco, Prof. Oliver Jäkel)
- 2021 – 2024 **HIDSS4Health Project**, *Inverse Radiotherapy Treatment Planning using Machine Learning Outcome Prediction Models*, 1 fully-funded PhD position, Co-Investigator (PIs: Prof. Martin Frank, Prof. Oliver Jäkel)

Awards, Honors, Appointments & Positions

- Position Associate Editor “Medical Physics”, since 2021
- Honor “Distinguished Reviewer” for the Medical Physics journal, 2021
- Position Considered for an independent research group leader position at the University of Tübingen (no exact ranking communicated), 2020
- Dissertation Award DEGRO Dissertation Award, 2019
- Poster Prize DKFZ PhD Poster Award, 2017

Presentation Award Science Slam, NCRO Meeting Dresden, 2016
 School Award Jugend denkt Zukunft, national winning team, 2006

Invited & International Presentations

- Summer School 4th Virtual Summer School 2022: Radiobiology and Radiobiological Modelling for Radiotherapy, Heidelberg/Online, 2022
 - Course ECMP Refresher Course: Radiotherapy – Open Source Software for Radiotherapy Physics Research, Dublin, 2022
 - Course ESMPE European School for Medical Physics Experts: Adaptive Radiotherapy: Pros and Cons of In-room versus Out-of-Room Imaging, Dublin, 2022
 - Course Specialised Hadron Therapy Training Course, Online, 2022
- Workshop The mathematics of modern radiation therapy, Medellin (Online), 2021
- Workshop Course – Proton Therapy: the challenges and the opportunities, UT Austin Portugal Programm, Online, 2021
- Seminar Medical Physics Seminar, Brigham and Women's Hospital/Dana-Farber Cancer Institute/Havard Medical School, Boston (Online), 2021
- Summer School Virtual Summer School 2021: Image Guided Radiation Therapy (IGRT) and Advanced Treatment Techniques, Heidelberg/Online, 2021
- Summer School 3rd Virtual Summer School in Medical Physics: Applied Computational Methods for Radiotherapy, Heidelberg/Online, 2021
- Summer School HITRIplus Heavy Ion Therapy Masterclass School, Sarajevo/Online, 2021
 - Public Interactive introduction of Ion Therapy to the General Public within the program "Physik am Samstag" at University of Mainz (Online), 2021
- Workshop The 7th Annual Loma Linda workshop on Particle Imaging and Radiation Treatment Planning, Loma Linda (Online), 2021
- Workshop The 5th Annual Loma Linda workshop on Particle Imaging and Radiation Treatment Planning, Loma Linda, 2019
- Highlight Highlight presentation at the 19th ICCR, Montréal, 2019
- Workshop DGMP – Working Group Computer, Aachen, 2019
- Symposium ESTRO 38, Milan, Italy, 2019 (as co-author)
- Seminar Karlsruhe Institute of Technology, Germany, 2019
- Workshop 1st ESTRO Physics Workshop, Glasgow, UK, 2017
- Seminar UniversitätsSpital Zürich, Switzerland, 2017
- Seminar Universitair Medisch Centrum Utrecht, Netherlands, 2014

Teaching Experience & Student Supervision

- Summer terms 2019 – 2022 **Physics of charged particle therapy**, *three lectures & three practical courses for physics master students in the course of Prof. Joao Seco*, University of Heidelberg
- since 2017 **Spezialkurs Partikeltherapie**, *yearly hands-on particle treatment planning course for professionals*, German Cancer Research Center – DKFZ
- since 2020 **Treatment Planning Course**, *yearly course for students within the Major in Cancer Biology programme*, German Cancer Research Center – DKFZ
- 2015 – 2017
- Winter term 2015/2016 **Practical physics course for students of biotechnology**, *supervision & evaluation of experiments on radioactive decay of 14 student groups*, Department of Physics & Astronomy, University of Heidelberg
- Summer terms 2016 **Practical physics course for medical students**, *supervision & evaluation of experiments on optics, acoustics, hydrodynamics & electronics for 17 student groups (per course)*, Department of Physics & Astronomy, University of Heidelberg
- 2013
- 2012

Winter term 2012/2013	Basic course on key competences , <i>continued supervision of a students group in 20 tutorials teaching key competences for study managing</i> , Department of Physics & Astronomy, University of Heidelberg, included a three-days certified tutor qualification course
Winter terms 2012/2013 2011/2012	Beginner's practical physics course , <i>supervision & evaluation of experiments on fourier optics & RLC circuits for 20 student groups (per course)</i> , Department of Physics & Astronomy, University of Heidelberg
Student supervision	(Co-)supervision of the following theses projects: A. Bennan (PostDoc): <i>Sustainable development of the open source treatment planning toolkit matRad</i> (ongoing), S. Facchiano (PhD): <i>Particle therapy treatment planning with nano-dosimetric ionization detail</i> (ongoing), R. Cristoforetti (PhD): <i>Biological and physical robustness in joint optimization of mixed-modality treatment plans</i> (ongoing), J. Hardt (PhD): <i>Dose simulations and treatment planning strategies using mixed Helium-Carbon Beams</i> (ongoing), T. Ortkamp (PhD): <i>Inverse Radiotherapy Treatment Planning using Machine Learning Outcome Prediction Models</i> (ongoing), P. Stammer (PhD): <i>Uncertainty quantification in Monte Carlo dose calculation algorithms for proton therapy</i> (ongoing), N. Homolka (PhD): <i>Intensity-modulated dose calculation & treatment planning for carbon ions</i> (ongoing), T. Becher (MSc): <i>Pareto trade-offs in joint optimization of mixed-modality treatment plans</i> (ongoing), L. Voss (BSc): <i>Bayesian LSTM networks for proton dose prediction</i> (ongoing), M. Palkowitsch (MSc): <i>Robustness in jointly optimized mixed-modality treatment plans</i> (ongoing), J. Hardt (MSc): <i>Efficient effect-based optimization strategies for (N)TCP based treatment planning</i> (2022), A. Bennan (PhD): <i>Joint optimization of combined photon & carbon ion therapy</i> (2022, co-supervision), J. Kunz (BSc): <i>Accelerating the open-source treatment planning toolkit matRad with GPGPU computations</i> (2022), M. W. Kheshfeh (BSc): <i>Development of an Unit-Testing-Framework for the open-source toolkit matRad</i> (2021), R. Yulvina (BSc): <i>A bi-directional Python binding for the open-source toolkit matRad</i> (2021) C. Hormazábal (MSc): <i>Dose and grading uncertainties in Xerostomia prediction using Machine Learning classification</i> (2020), P. Meder (MSc & res. ass.): <i>Heterogeneity corrections for analytical proton dose calculation algorithms</i> (2020), A. Neishabouri (MSc & res. ass.): <i>Performing proton dose calculation using Artificial Neural Networks</i> , (2019, co-supervision), A. Sage (MSc): <i>Efficient uncertainty propagation through MC dose calculations for radiation therapy</i> , (2019, co-supervision)

Peer-reviewed Publications

- Research article R. Liu, S. Charyyev, **N. Wahl**, W. Liu, M. Kang, J. Zhou, X. Yang, F. Baltazar, M. Palkowitsch, K. Higgins, W. Dynan, J. Bradley, and L. Lin, "An Integrated Physical Optimization framework for proton SBRT FLASH treatment planning allows dose, dose rate, and LET optimization using patient-specific ridge filters", *International Journal of Radiation Oncology, Biology, Physics*, 10.1016/j.ijrobp.2023.01.048 (2023) 10.1016/j.ijrobp.2023.01.048.
- Research article P. Stammer, L. Burigo, O. Jäkel, M. Frank, and **N. Wahl**, "Multivariate error modeling and uncertainty quantification using importance (re-)weighting for Monte Carlo simulations in particle transport", *Journal of Computational Physics*, 111725 (2023) 10.1016/j.jcp.2022.111725.
- Research article E. Vargas-Bedoya, J. C. Rivera, M. E. Puerta, A. Angulo, **N. Wahl**, and G. Cabal, "Contour Propagation for Radiotherapy Treatment Planning Using Nonrigid Registration and Parameter Optimization: Case Studies in Liver and Breast Cancer", *Applied Sciences* **12**, 8523 (2022) 10.3390/app12178523.
- Research article A. B. A. Bennan, J. Unkelbach, **N. Wahl**, P. Salome, and M. Bangert, "Joint optimization of photon – carbon ion treatments for Glioblastoma", *International Journal of Radiation Oncology*Biophysics*Physics* **111**, 559–572 (2021) 10.1016/j.ijrobp.2021.05.126.
- Research article L. Marc, S. Fabiano, **N. Wahl**, C. Linsenmeier, A. J. Lomax, and J. Unkelbach, "Combined proton-photon treatment for breast cancer", *Physics in Medicine & Biology* **66**, 235002 (2021) 10.1088/1361-6560/ac36a3.
- Research article A. Neishabouri, **N. Wahl**, A. Mairani, U. Köthe, and M. Bangert, "Long short-term memory networks for proton dose calculation in highly heterogeneous tissues", *Medical Physics* **48**, 1893–1908 (2021) 10.1002/mp.14658.
- Research article P. Stammer, L. Burigo, O. Jäkel, M. Frank, and **N. Wahl**, "Efficient uncertainty quantification for Monte Carlo dose calculations using importance (re-)weighting", *Physics in Medicine & Biology* **66**, 205003 (2021) 10.1088/1361-6560/ac287f.

- Research article **N. Wahl**, P. Hennig, H.-P. Wieser, and M. Bangert, “Analytical probabilistic modeling of dose-volume histograms”, *Medical Physics* **47**, 5260–5273 (2020) 10.1002/mp.14414.
- Research article H.-P. Wieser, C. P. Karger, **N. Wahl**, and M. Bangert, “Impact of Gaussian uncertainty assumptions on probabilistic optimization in particle therapy”, *Physics in Medicine & Biology* **65**, 145007 (2020) 10.1088/1361-6560/ab8d77.
- Research article **N. Wahl**, P. Hennig, H.-P. Wieser, and M. Bangert, “Analytical incorporation of fractionation effects in probabilistic treatment planning for intensity-modulated proton therapy”, *Medical Physics* **45**, 1317–1328 (2018) 10.1002/mp.12775.
- Research article H.-P. Wieser, **N. Wahl**, H. S. Gabryś, L.-R. Müller, G. Pezzano, J. Winter, S. Ulrich, L. N. Burigo, O. Jäkel, and M. Bangert, “matRad - an open-source treatment planning toolkit for educational purposes”, *Medical Physics International Journal* **6**, 119–127 (2018).
- Research article **N. Wahl**, P. Hennig, H.-P. Wieser, and M. Bangert, “Efficiency of analytical and sampling-based uncertainty propagation in intensity-modulated proton therapy”, *Physics in Medicine and Biology* **62**, 5790–5807 (2017) 10.1088/1361-6560/aa6ec5.
- Research article H.-P. Wieser, E. Cisternas, **N. Wahl**, S. Ulrich, A. Stadler, H. Mescher, L.-R. Müller, T. Klinge, H. Gabrys, L. Burigo, A. Mairani, S. Ecker, B. Ackermann, M. Ellerbrock, K. Parodi, O. Jäkel, and M. Bangert, “Development of the open-source dose calculation and optimization toolkit matRad”, *Medical Physics* **44**, 2556–2568 (2017) 10.1002/mp.12251.
- Research article H.-P. Wieser, P. Hennig, **N. Wahl**, and M. Bangert, “Analytical probabilistic modeling of RBE-weighted dose for ion therapy”, *Physics in Medicine and Biology* **62**, 8959–8982 (2017) 10.1088/1361-6560/aa915d.
- Research article **N. Wahl**, M. Bangert, C. P. Kamerling, P. Ziegenhein, G. H. Bol, B. W. Raaymakers, and U. Oelfke, “Physically constrained voxel-based penalty adaptation for ultra-fast IMRT planning”, *Journal of Applied Clinical Medical Physics* **17**, 172–189 (2016) 10.1120/jacmp.v17i4.6117.

Peer-reviewed Conference Contributions

- Oral Presentation **N. Wahl**, “The Particle Therapy Masterclass for targeted education and outreach on real-world application of fundamental physics”, Oral Presentation, DPG SMuK Frühjahrstagung (Dresden), 2023.
- Oral Presentation P. Foka, A. Mamaras, D. Skrjijel, J. Seco, C. Graeff, M. Pulia, H.-P. Wieser, and **N. Wahl**, “Particle therapy masterclass”, in *EPJ Web of Conferences*, Vol. 258 (vConf21, Online, 2022), p. 01002, 10.1051/epjconf/202225801002.
- Oral Presentation N. Homolka, P. A. Meder, L. Burigo, H.-P. Wieser, M. Bangert, O. Jäkel, M. Ellerbrock, and **N. Wahl**, “Degradation of particle depth dose in lung tissue: An efficient and consistent model for Monte Carlo and analytical dose calculation”, in *Proceedings to the 59th Annual Conference of the Particle Therapy Cooperative Group (PTCOG59 2021 Online)*, *International Journal of Particle Therapy (PTCOG 59, Online, 2022)*, pp. 23–24, 10.14338/IJPT-22-PTCOG59-9.3.
- Oral Presentation P. Stammer, L. Burigo, O. Jäkel, M. Frank, and **N. Wahl**, “Efficient uncertainty estimates in Monte Carlo dose calculation using importance reweighting”, in *Proceedings to the 59th Annual Conference of the Particle Therapy Cooperative Group (PTCOG59 2021 Online)*, *International Journal of Particle Therapy (PTCOG 59, Online, 2022)*, p. 24, 10.14338/IJPT-22-PTCOG59-9.3.
- Poster P. Stammer, L. Burigo, O. Jäkel, M. Frank, and **N. Wahl**, “PO-1728: Efficient modeling and quantification of time-dependent errors in IMPT”, in *Radiotherapy and Oncology*, Vol. 170 (ESTRO, Copenhagen, 2022), S1529–S1531, 10.1016/S0167-8140(22)03692-1.
- Oral Presentation **N. Wahl** and H.-P. Wieser, “Scenario-free probabilistic proton dose optimization using expected dose influence and total variance”, Oral Presentation, PTCOG 60 (Miami), 2022.
- Poster L. Marc, S. Fabiano, **N. Wahl**, C. Linsenmeier, A. J. Lomax, and J. Unkelbach, “PO-1905: Combined proton-photon treatment for breast cancer using a fixed proton beamline”, in *Radiotherapy and Oncology*, Vol. 161 (ESTRO, Online, 2021), S1625–S1627, 10.1016/S0167-8140(21)08356-0.

- Oral Presentation M. Palkowitsch, A. B. A. Bennan, and **N. Wahl**, “The role of uncertainties in jointly optimised mixed carbon/photon treatments”, Oral Presentation, DGMP 2021 (Online), 2021.
- Poster N. Homolka, H.-P. Wieser, M. Bangert, M. Ellerbrock, and **N. Wahl**, “PO-1490: Lung degradation effects on RBE-weighted dose in proton, carbon and helium treatment plans”, in Radiotherapy and Oncology, Vol. 152 (ESTRO, Online, 2020), S801–S802, 10.1016/S0167-8140(21)01508-5.
- Oral Presentation A. Neishabouri, **N. Wahl**, L. N. Burigo, U. Köthe, and M. Bangert, “OC-0215: LSTM networks for proton dose calculation in highly heterogeneous tissues”, in Radiotherapy and Oncology, Vol. 152 (ESTRO, Online, 2020), S108–S109, 10.1016/S0167-8140(21)00239-5.
- Poster **N. Wahl**, H.-P. Wieser, L. Burigo, and M. Bangert, “PO-1377: Monte Carlo vs. pencil-beam dose calculation for uncertainty estimation in proton therapy”, in Radiotherapy and Oncology, Vol. 152 (ESTRO, Online, 2020), S731, 10.1016/S0167-8140(21)01395-5.
- Symposium Presentation M. Bangert, **N. Wahl**, and H.-P. Wieser, “SP-0469: Mitigation of range uncertainties with probabilistic IMPT optimization”, in Radiotherapy and Oncology, Vol. 133 (ESTRO, Milan, 2019), S241, 10.1016/S0167-8140(19)30889-8.
- Oral Presentation **N. Wahl**, E. Doerner, L. N. Burigo, D. Ramirez, A. Neishabouri, A. B. A. Bennan, H.-P. Wieser, and M. Bangert, “Development report for the open source dose calculation and optimization toolkit matRad”, Oral Presentation, 19th ICCR (Montréal), 2019.
- Oral Presentation **N. Wahl**, P. Hennig, H.-P. Wieser, and M. Bangert, “Confidence constraints for probabilistic radiotherapy treatment planning”, Oral Presentation, 19th ICCR (Montréal), 2019.
- Oral Presentation H.-P. Wieser, P. Hennig, **N. Wahl**, and M. Bangert, “Closed-form modeling of biological uncertainties in carbon ion therapy”, Oral Presentation, 19th ICCR (Montréal), 2019.
- Oral Presentation H.-P. Wieser, C. P. Karger, **N. Wahl**, and M. Bangert, “Impact of Gaussian uncertainty assumptions for probabilistic optimization considering range errors”, Oral Presentation, 19th ICCR (Montréal), 2019.
- Poster **N. Wahl**, P. Hennig, H.-P. Wieser, and M. Bangert, “EP-1898: Smooth animations of the probabilistic analog to worst-case dose distributions”, in Radiotherapy and Oncology, Vol. 127 (ESTRO, Barcelona, 2018), S1028–S1029, 10.1016/S0167-8140(18)32207-2.
- Poster **N. Wahl**, P. Hennig, H.-P. Wieser, and M. Bangert, “PO-0909: Analytical probabilistic models for dose quality metrics and optimization objectives”, in Radiotherapy and Oncology, Vol. 127 (ESTRO, Barcelona, 2018), S486–S487, 10.1016/S0167-8140(18)31219-2.
- Oral Presentation H.-P. Wieser, **N. Wahl**, P. Hennig, and M. Bangert, “OC-0088: Simultaneous consideration of biological and physical uncertainties in robust ion therapy planning”, in Radiotherapy and Oncology, Vol. 127 (ESTRO, Barcelona, 2018), S46–S47, 10.1016/S0167-8140(18)30398-0.
- Oral Presentation **N. Wahl**, P. Hennig, and M. Bangert, “Probabilistic proton treatment planning using accelerated analytical probabilistic modelling”, Oral Presentation, 18th ICCR (London), 2016.
- Oral Presentation H.-P. Wieser, **N. Wahl**, P. Hennig, and M. Bangert, “Analytical probabilistic modeling of range and setup uncertainties in carbon ion therapy planning”, Oral Presentation, 18th ICCR (London), 2016.
- Poster **N. Wahl**, C. P. Kamerling, H. Heinrich, P. Hennig, and M. Bangert, “Robust Planning for Intensity-modulated Proton Therapy using Analytical Probabilistic Modeling”, in International Journal of Particle Therapy, Vol. 2, 1 (PTCOG & PTCOG-NA, San Diego, 2015), 314f, 10.14338/IJPT.15-PTCOG-NA.1.

Monographs

- Textbook C. Kommer, T. Tugendhat, and **N. Wahl**, *Tutorium Physik fürs Nebenfach*, 2nd ed. (Springer Spektrum, Berlin, Heidelberg, 2019), 10.1007/978-3-662-47244-6.
- PhD thesis **N. Wahl**, “Analytical Models for Probabilistic Inverse Treatment Planning in Intensity-modulated Proton Therapy”, PhD thesis (Ruprecht-Karls Universität Heidelberg, Heidelberg, 2018), 10.11588/heidok.00025127.
- Textbook C. Kommer, T. Tugendhat, and **N. Wahl**, *Tutorium Physik fürs Nebenfach*, 1st ed. (Springer Spektrum, Berlin, Heidelberg, 2015), 10.1007/978-3-662-47244-6.

Preprints and other Publications

- Preprint (arxiv) N. Harrison, M. Kang, R. Liu, S. Charyyev, **N. Wahl**, W. Liu, J. Zhou, C. Simone, J. Bradley, W. S. Dynan, and L. Lin, *Solution to the integrated optimization of dose, dose rate, and LET for proton FLASH therapy using a distributed parallel computing framework*, 2023, 10.48550/arXiv.2302.11546, <http://arxiv.org/abs/2302.11546> (visited on 03/31/2023), preprint.
- Preprint (arxiv) F. Barkmann, Y. Censor, and **N. Wahl**, *Superiorization as a novel strategy for linearly constrained inverse radiotherapy treatment planning*, 2022, 10.48550/arXiv.2207.13187, <http://arxiv.org/abs/2207.13187> (visited on 07/28/2022), preprint.
- Online Article P. Stammer, L. Burigo, O. Jäkel, M. Frank, and **N. Wahl**, *Efficient uncertainty quantification for Monte Carlo dose calculations using importance (re-)weighting*, ESTRO Physics Newsletter, 2021, <https://www.estro.org/About/Newsroom/Newsletter/Physics/Efficient-uncertainty-quantification-for-Monte-Car> (visited on 03/23/2022).
- Online Article M. Bangert, O. Jäkel, **N. Wahl**, and H.-P. Wieser, *Developing matRad, an Open-Source Dose Calculation and Optimization Toolkit for Radiation Therapy Planning*, MathWorks Technical Articles and Newsletters, 2020, <https://www.mathworks.com/company/newsletters/articles/developing-matrad-an-open-source-dose-calculation-and-optimization-toolkit-for-radiation-therapy-planning.html> (visited on 12/12/2020).