

## Education & Experience

- since 9/2019 **Research 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”
- 7/2025 – 8/2025 **Visiting Researcher,** *Department of Accelerator and Medical Physics, National Institutes for Quantum Science and Technology, Chiba, Japan,*  
working on computational and radiobiological modeling for ion therapy
- 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 **Visiting Researcher,** *Group Probabilistic Numerics, Max Planck Institute for Intelligent Systems, Tübingen,*  
working on the development of analytical probabilistic models for radiotherapy treatment plan quality indicators
- 6/2015 – 7/2015 **Visiting Researcher,** *Group Probabilistic Numerics, Max Planck Institute for Intelligent Systems, Tübingen,*  
working on numerical methods for accelerated analytical probabilistic dose calculation
- 1/2015 – 7/2018 **Doctoral Studies,** *Division of Medical Physics in Radiation Oncology, German Cancer Research Center – DKFZ & Heidelberg University, 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,** *Heidelberg University, 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 Heidelberg University*
- 2008 – 2018 **Student assistant,** “Explore Science”, Mannheim,  
yearly educational event at the behest of the Klaus Tschira Foundation (KTS)
- 4/2008 – 10/2011 **IT Assistant,** *HierEDV, Heidelberg*
- 10/2007 – 5/2011 **Bachelor Studies,** *Heidelberg University, 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

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## Community, Outreach, Memberships

- 2025 Co-organizer of the SynthRad2025 challenge on AI-generation of synthetic CTs
- since 2024 Member of the AI subcommittee of the Particle Therapy Co-Operative Group (PTCOG)
- 2024 Chair of the ESTRO Physics Workshop 2024 Topic on “Resource sharing: open-source software & development in radiotherapy”
- since 2023 Corresponding member of the American Association of Physicists in Medicine (AAPM)
- 2023 Course lead for the 5<sup>th</sup> Summer School in Medical Physics: Data Science and Machine Learning in Radiotherapy, Heidelberg/Online
- 2023 Co-organization of a high school students day on particle physics within the MINT100 program, Heidelberg
- 2021 Organization of the first HITRIplus 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 Radioonkologie (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 Heidelberg University
- 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)

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## Third-party Funding & Projects

- 2023 – 2026 **German-Israeli Cooperation in Cancer Research Project Ca 216**, *Development of Advanced PI Feasibility, Superiorization and Optimization Methods for Complex Inverse Treatment Problems in Radiation Therapy Treatment Planning*, ca. 126 000 €, Principal Investigator
- 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 – 2025 **DFG project support grant No. 443188743**, *Sustainable development of the open source radiotherapy dose calculation and optimization toolkit matRad*, ca. 315 000 €, Principal Investigator

- 2021 – 2025 **DFG New Instrumentation for Research grant No. 457509854, HELIOS – Developing a**  
 PI *HELium Imaging Oncology Scanner for Range Guided Radiotherapy (RGRT) for Non-Small Cell Lung Carcinoma (NSCLC)*, ca. 187 000 € (of total project funds of ca. 950 000 €), Principal Investigator (Other PIs: Prof. Joao Seco, Prof. Oliver Jäkel)
- 2021 – 2025 **HIDSS4Health Project, Inverse Radiotherapy Treatment Planning using Machine Learning**  
 CI *Outcome Prediction Models*, 1 fully-funded PhD position, Co-Investigator (PIs: Prof. Martin Frank, Prof. Oliver Jäkel)

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## Awards, Honors, Appointments, Positions

- Appointment Associate Editor “International Journal of Particle Therapy” for the Special Issue “AI in particle therapy”, 2025
- Appointment Associate Editor “Medical Physics”, since 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

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## Invited & International Presentations

- Workshop The 11<sup>th</sup> Annual Loma Linda workshop on Particle Imaging and Radiation Treatment Planning, Loma Linda, 2025
- Seminar Seminar for Department of Accelerator and Medical Physics, National Institutes for Quantum Science and Technology, Chiba, Japan, 2025
- Symposium 31<sup>st</sup> DEGRO Congress, Artificial Intelligence in Radiotherapy, Dresden, 2025
- Seminar MIRO Seminar, Université catholique de Louvain, Brussels, 2025
- Seminar Physics Seminar, University of Bonn, 2025
- Seminar Biomedical Physics Seminar, University of Tübingen, 2025
- Seminar Memorial Sloan Kettering Cancer Center Medical Physics Seminar, New York City, 2024
- Seminar Harvard Mass General Radiation BioPhysics Seminar, Boston, 2024
- Symposium XChange 2024 – Artificial Intelligence in Radiation Oncology, München, 2024
- Symposium Hadron Therapy Symposium: Treatment Planning MasterClass, Thessaloniki, 2024
- Winter School Winterschule Pichl für Medizinische Physik, Pichl, 2024
- Workshop The 9<sup>th</sup> Annual Loma Linda workshop on Particle Imaging and Radiation Treatment Planning, Loma Linda, 2023
- Course 3<sup>rd</sup> HITRIplus School – Specialised Course on Clinical Aspects of Heavy Ion Therapy Research, Online, 2023
- Seminar Harvard Mass General Radiation BioPhysics Seminar, Boston (Online), 2023
- Seminar U3 Seminar LMU München (Klinikum), München (Online), 2023
- Winter School Winterschule Pichl für Medizinische Physik (Spring Edition), Pichl, 2023
- Summer School Summer School in Medical Physics 2023 in Chile: The role of imaging in the radiotherapy process, Santiago de Chile, 2022
- Workshop Scientific multi-disciplinary workshop at the Clínica Alemana (CAS), Santiago de Chile, 2022
- Workshop Emerging Techniques in Radiotherapy & Hands-on matRad Tutorial (Pontifical Catholic University of Chile), Santiago de Chile, 2022
- Summer School 4<sup>th</sup> 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
- Winter School Winterschule Pichl für Medizinische Physik (Summer Edition), Pichl, 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/Harvard 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 3<sup>rd</sup> Virtual Summer School in Medical Physics: Applied Computational Methods for Radiotherapy, Heidelberg/Online, 2021
- Summer School HITRPlus 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 7<sup>th</sup> Annual Loma Linda workshop on Particle Imaging and Radiation Treatment Planning, Loma Linda (Online), 2021
- Workshop The 5<sup>th</sup> Annual Loma Linda workshop on Particle Imaging and Radiation Treatment Planning, Loma Linda, 2019
- Highlight Highlight presentation at the 19<sup>th</sup> 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 1<sup>st</sup> ESTRO Physics Workshop, Glasgow, UK, 2017
- Seminar UniversitätsSpital Zürich, Switzerland, 2017
- Seminar Universitair Medisch Centrum Utrecht, Netherlands, 2014

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## Teaching Experience & Student Supervision

## Student supervision (Co-)supervision of the following theses projects;

T. Becher (PhD): *Advanced Optimization and Superiorization methods for radiotherapy treatment planning* (ongoing),  
 S. Facciano (PhD): *Particle therapy treatment planning with nano-dosimetric ionization detail* (ongoing),  
 R. Cristoforetti (PhD): *Biological and physical robustness in joint optimization of mixed-modality treatment plans* (ongoing),  
 J. Hardt (PhD): *Dose simulations and treatment planning strategies using mixed Helium-Carbon Beams* (ongoing),  
 T. Ortkamp (PhD): *Inverse Radiotherapy Treatment Planning using Machine Learning Outcome Prediction Models* (ongoing),  
 V. Santiago (MSc): *Developing BayesDose: An uncertainty-aware AI-based dose-calculation engine* (ongoing),  
 F. Leininger (MSc): *Direct NTCP planning for Deep-Learning based outcome models* (ongoing),  
 M. Palkowitsch (MSc): *Robustness in jointly optimized mixed-modality treatment plans* (ongoing),  
 A. Bennan (PostDoc): *Sustainable development of the open source treatment planning toolkit matRad* (2025),  
 N. Homolka (PhD): *Intensity-modulated dose calculation & treatment planning for carbon ions* (2025),  
 L. Bucher (BSc): *Sequential Deep Neural Network Models for Proton Dose Calculation* (2024),  
 L. Seckler (BSc): *LET optimization in mixed-modality treatment plans* (2024),  
 T. Becher (MSc): *Pareto trade-offs in joint optimization of mixed-modality treatment plans* (2023),  
 P. Stammer (PhD): *Uncertainty quantification in Monte Carlo dose calculation algorithms for proton therapy* (2023),  
 L. Voss (BSc): *Bayesian LSTM networks for proton dose prediction* (2023),  
 J. Hardt (MSc): *Efficient effect-based optimization strategies for (N)TCP based treatment planning* (2022),  
 A. Bennan (PhD): *Joint optimization of combined photon & carbon ion therapy* (2022, co-supervision),  
 J. Kunz (BSc): *Accelerating the open-source treatment planning toolkit matRad with GPGPU computations* (2022),  
 M.W. Kheshfeh (BSc): *Development of an Unit-Testing-Framework for the open-source toolkit matRad* (2021),  
 R. Yulvina (BSc): *A bi-directional Python binding for the open-source toolkit matRad* (2021),  
 C. Hormazábal (MSc): *Dose and grading uncertainties in Xerostomia prediction using Machine Learning classification* (2020),  
 P. Meder (MSc & res. ass.): *Heterogeneity corrections for analytical proton dose calculation algorithms* (2020),  
 A. Neishabouri (MSc & res. ass.): *Performing proton dose calculation using Artificial Neural Networks*, (2019, co-supervision),  
 A. Sage (MSc): *Efficient uncertainty propagation through MC dose calculations for radiation therapy*, (2019, co-supervision)

2020, 2022, 2024 **Weiterbildung Medizinische Physik für PhysikerInnen**, *lectures on dose calculation & optimization in an advanced training course for medical physics for physicists*, Heidelberg University

Summer terms 2019 – 2025 **Physics of charged particle therapy**, *three lectures & three practical courses for physics master students in the course of Prof. Joao Seco*, Heidelberg University

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

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, Heidelberg University

Summer terms 2016 – 2013 **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, Heidelberg University

Winter term 2012/2013 **Basic course on key competences**, *continued supervision of a students group in 20 tutorials teaching key competences for study managing*, Department of Physics & Astronomy, Heidelberg University, included a three-days certified tutor qualification course

Winter terms 2012/2013 – 2011/2012 **Beginner's practical physics course**, *supervision & evaluation of experiments on fourier optics & RLC circuits for 20 student groups (per course)*, Department of Physics & Astronomy, Heidelberg University

## Peer-reviewed Publications

research article 2025 J. J. Hardt, A. A. Pryanichnikov, O. Jäkel, J. Seco, and **N. Wahl**, "Helium range viability for online range probing in mixed carbon–helium beams", *Medical Physics* **52**, e70194.

research article 2025 F. Xiao, D. Radonic, **N. Wahl**, N. Delopoulos, A. Thummerer, S. Corradini, C. Belka, G. Dedes, C. Kurz, and G. Landry, "Deep learning-based synthetic-CT-free photon dose calculation in MR-guided radiotherapy: A proof-of-concept study", *Medical Physics* **52**, e70106.

- research article 2025 L. Sommer, T. Chemnitz, **N. Wahl**, A. B. A. Bennan, S. E. Combs, and J. J. Wilkens, "A Monte Carlo dose engine for fast neutron therapy and boron neutron capture therapy for matRad", *Biomedical Physics & Engineering Express* **11**, 065023.
- dataset article 2025 A. Thummerer, E. Van Der Bijl, A. J. Galapon, F. Kamp, M. Savenije, C. Muijs, S. Aluwini, R. J. H. M. Steenbakkers, S. Beuel, M. P. Intven, J. A. Langendijk, S. Both, S. Corradini, V. Rogowski, M. Terpstra, **N. Wahl**, C. Kurz, G. Landry, and M. Maspero, "SynthRAD2025 Grand Challenge dataset: Generating synthetic CTs for radiotherapy from head to abdomen", *Medical Physics* **52**, e17981.
- research article 2025 D. Borys, J. Gajewski, T. Becher, Y. Censor, R. Kopec, M. Rydygier, A. Schiavi, T. Skóra, A. Spaleniak, **N. Wahl**, A. Wochnik, and A. Rucinski, "GPU-accelerated FREDopt package for simultaneous dose and LETd proton radiotherapy plan optimization via superiorization methods", *Physics in Medicine & Biology* **70**, 155011.
- research article 2025 R. Cristoforetti, J. J. Hardt, and **N. Wahl**, "Scenario-free robust optimization algorithm for IMRT and IMPT treatment planning", *Medical Physics* **52**, e17905.
- research article 2025 A. A. Pryanichnikov, J. J. Hardt, E. A. DeJongh, L. Martin, D. F. DeJongh, O. Jäkel, **N. Wahl**, and J. Seco, "Feasibility study of using fast low-dose pencil beam proton and helium radiographs for intrafractional motion management", *Physica Medica* **133**, 104959.
- research article 2025 A. C. Sevilla, G. Cabal, **N. Wahl**, M. E. Puerta, and J. C. Rivera, "A robust optimization model for intensity-modulated radiotherapy: Cheap-Minimax", *Medical Physics* **52**, 3360–3376.
- research article 2025 A. C. Sevilla-Moreno, M. E. Puerta-Yepes, **N. Wahl**, R. Benito-Herce, and G. Cabal-Arango, "Interval Analysis-Based Optimization: A Robust Model for Intensity-Modulated Radiotherapy (IMRT)", *Cancers* **17**, 504.
- research article 2025 M. Sitarz, M. G. Ronga, F. Gesualdi, A. Bonfrate, **N. Wahl**, and L. De Marzi, "Implementation and validation of a very-high-energy electron model in the matRad treatment planning system", *Medical Physics* **52**, 518–529.
- research article 2024 F. Xiao, D. Radonic, M. Kriechbaum, **N. Wahl**, A. Neishabouri, N. Delopoulos, K. Parodi, S. Corradini, C. Belka, C. Kurz, G. Landry, and G. Dedes, "Prompt gamma emission prediction using a long short-term memory network", *Physics in Medicine & Biology* **69**, 235003.
- research article 2024 D. Radonic, F. Xiao, **N. Wahl**, L. Voss, A. Neishabouri, N. Delopoulos, S. Marschner, S. Corradini, C. Belka, G. Dedes, C. Kurz, and G. Landry, "Proton dose calculation with LSTM networks in presence of a magnetic field", *Physics in Medicine & Biology* **69**, 215019.
- research article 2024 N. Harrison, M. Kang, R. Liu, S. Charyyev, **N. Wahl**, W. Liu, J. Zhou, K. A. Higgins, C. B. Simone, J. D. Bradley, W. S. Dynan, and L. Lin, "A novel inverse algorithm to solve IPO-IMPT of proton FLASH therapy with sparse filters", *International Journal of Radiation Oncology, Biology, Physics* **119**, P957–967.
- research article 2024 J. J. Hardt, A. A. Pryanichnikov, N. Homolka, E. A. DeJongh, D. F. DeJongh, R. Cristoforetti, O. Jaekel, J. Seco, and **N. Wahl**, "The potential of mixed carbon-helium beams for online treatment verification: a simulation and treatment planning study", *Physics in Medicine & Biology* **69**, 125028.
- research article 2024 B. Faddegon, M. Descovich, K. Chen, J. Ramos-Méndez, M. Roach III, **N. Wahl**, P. Taylor, K. Griffin, and C. Lee, "A digital male pelvis phantom series showing anatomical variations over the course of fractionated radiotherapy treatment", *Medical Physics* **51**, 3034–3044.
- research article 2024 F. Gesualdi and **N. Wahl**, "Cumulative Histograms under Uncertainty: An Application to Dose–Volume Histograms in Radiotherapy Treatment Planning", *Stats* **7**, 284–300.
- research article 2024 Y. Han, C. Geng, S. Altieri, S. Bortolussi, Y. Liu, **N. Wahl**, and X. Tang, "Combined BNCT-CIRT treatment planning for glioblastoma using the effect-based optimization", *Physics in Medicine & Biology* **69**, 015024.
- research article 2023 F. Barkmann, Y. Censor, and **N. Wahl**, "Superiorization of projection algorithms for linearly constrained inverse radiotherapy treatment planning", *Frontiers in Oncology* **13**, 10.3389/fonc.2023.1238824.

- research article 2023 B. A. Faddegon, E. A. Blakely, L. N. Burigo, Y. Censor, I. Dokic, J. N. D-Kondo, R. Ortiz, J. Ramos-Mendez, A. Rucinski, K. E. Schubert, **N. Wahl**, and R. W. Schulte, "Ionization detail parameters and cluster dose: a mathematical model for selection of nanodosimetric quantities for use in treatment planning in charged particle radiotherapy", *Physics in Medicine & Biology* **68**, 175013.
- research article 2023 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* **116**, P949–959.
- research article 2023 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* **473**, 111725.
- research article 2022 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.
- research article 2021 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.
- research article 2021 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* **111**, 559–572.
- research article 2021 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.
- research article 2021 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.
- research article 2020 **N. Wahl**, P. Hennig, H.-P. Wieser, and M. Bangert, "Analytical probabilistic modeling of dose-volume histograms", *Medical Physics* **47**, 5260–5273.
- research article 2020 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.
- research article 2018 **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.
- research article 2018 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.
- research article 2017 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.
- research article 2017 **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.
- research article 2017 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.
- research article 2016 **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.

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## Monographs

- textbook C. Kommer, T. Tugendhat, and **N. Wahl**, *Tutorium Physik fürs Nebenfach, Übersetzt aus dem Unverständlichen*, 3rd ed. (Springer Berlin Heidelberg, Berlin, Heidelberg).  
 2025
- textbook C. Kommer, T. Tugendhat, and **N. Wahl**, *Tutorium Physik fürs Nebenfach*, 2nd ed. (Springer Spektrum, Berlin, Heidelberg).  
 2019
- phdthesis **N. Wahl**, “Analytical Models for Probabilistic Inverse Treatment Planning in Intensity-modulated Proton Therapy”, PhD thesis (Ruprecht-Karls Universität Heidelberg, Heidelberg).  
 2018
- textbook C. Kommer, T. Tugendhat, and **N. Wahl**, *Tutorium Physik fürs Nebenfach*, 1st ed. (Springer Spektrum, Berlin, Heidelberg).  
 2015

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## Preprints and other Publications

- preprint (arXiv) R. Cristoforetti, P. Süß, T. Becher, and **N. Wahl**, *Trading robustness: a scenario-free approach to robust Multi-Criteria Optimization for Treatment Planning*, <http://arxiv.org/abs/2510.12519>, pre-published.  
 2025
- preprint (arXiv) P. Stammer, **N. Wahl**, J. Kusch, and D. Lathouwers, *A high-order deterministic dynamical low-rank method for proton transport in heterogeneous media*, <http://arxiv.org/abs/2508.04484>, pre-published.  
 2025
- preprint (arXiv) T. Ortkamp, H. Sallem, S. Harrabi, M. Frank, O. Jäkel, J. Bauer, and **N. Wahl**, *Let's play POLO: Integrating the probability of lesion origin into proton treatment plan optimization for low-grade glioma patients*, <http://arxiv.org/abs/2506.13539>, pre-published.  
 2025
- preprint (arXiv) L. Seckler, A. B. A. Bennan, and **N. Wahl**, *LET-modifying joint optimization for mixed-modality photon-proton treatment planning*, <https://arxiv.org/abs/2505.15482v1>, pre-published.  
 2025
- preprint (arXiv) S. Facchiano, R. Ortiz, R. Cristoforetti, N. D-Kondo, O. Jaekel, B. Faddegon, and **N. Wahl**, *An ion treatment planning framework for inclusion of nanodosimetric ionization detail through cluster dose*, <http://arxiv.org/abs/2505.09667>, pre-published.  
 2025
- preprint (arXiv) P. Stammer, T. Burlacu, **N. Wahl**, D. Lathouwers, and J. Kusch, *A Deterministic Dynamical Low-rank Approach for Charged Particle Transport*, <http://arxiv.org/abs/2412.09484>, pre-published.  
 2025
- preprint (arXiv) L. Voss, A. Neishabouri, T. Ortkamp, A. Mairani, and **N. Wahl**, *BayesDose: Comprehensive proton dose prediction with model uncertainty using Bayesian LSTMs*, <http://arxiv.org/abs/2307.01151>, pre-published.  
 2023
- 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, <https://www.estro.org/About/Newsroom/Newsletter/Physics/Efficient-uncertainty-quantification-for-Monte-Car>.  
 2021
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