
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)
- 1/2015 – 7/2018 **Doctoral Studies**, *Division of Medical Physics in Radiation Oncology, German Cancer Research Center – DKFZ & University of Heidelberg*, in Physics, including **two three-month research stays** at the Max Planck Institute for Intelligent Systems, Tübingen, 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

- since 2021 Associate Editor “Medical Physics”
- 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, Physica Medica: European Journal of Medical Physics, Physics in Medicine and Biology, International Journal of Radiation Oncology*Biophysics, 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 Participating in & 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
 - CI
- 2022 **Mathworks Community Toolbox Development Support**, *Development sparse linear algebra and DICOM plugins for matRad*, \$20 500, Principal Investigator
 - PI
- 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
 - PI
- 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)
 - PI
- 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)
 - CI

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

- 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
Workshop	Course – Proton Therapy: the challenges and the opportunities, UT Austin Portugal Programm, Online, 2021
Workshop	The mathematics of modern radiation therapy, Medellin (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	3 rd 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 7 th Annual Loma Linda workshop on Particle Imaging and Radiation Treatment Planning, Loma Linda (Online), 2021
Workshop	The 5 th Annual Loma Linda workshop on Particle Imaging and Radiation Treatment Planning, Loma Linda, 2019
Highlight	Highlight presentation at the 19 th 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 st ESTRO Physics Workshop, Glasgow, UK, 2017
Seminar	UniversitätsSpital Zürich, Switzerland, 2017
Seminar	Universitair Medisch Centrum Utrecht, Netherlands, 2014

Teaching Experience & Student Supervision

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), 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), 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)
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
2015 – 2017	programme, German Cancer Research Center – DKFZ

Winter term 2015/2016	Practical physics course for students of biotechnology , <i>supervision & evaluation of experiments on radioactive decay of 14 student groups</i> , Department of Physics & Astronomy, University of Heidelberg
Summer terms 2016 2013 2012	Practical physics course for medical students , <i>supervision & evaluation of experiments on optics, acoustics, hydrodynamics & electronics for 17 student groups (per course)</i> , Department of Physics & Astronomy, University of Heidelberg
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

Peer-reviewed Publications

- Journal Article Vargas-Bedoya, E., Rivera, J. C., Puerta, M. E., Angulo, A., **Wahl, N.** & Cabal, G. Contour Propagation for Radiotherapy Treatment Planning Using Nonrigid Registration and Parameter Optimization: Case Studies in Liver and Breast Cancer. *Applied Sciences* **12**, 8523. doi:10.3390/app12178523 (17 2022)
- Journal Article Marc, L., Fabiano, S., **Wahl, N.**, Linsenmeier, C., Lomax, A. J. & Unkelbach, J. Combined proton-photon treatment for breast cancer. *Physics in Medicine & Biology* **66**, 235002. doi:10.1088/1361-6560/ac36a3 (2021)
- Journal Article Stammer, P., Burigo, L., Jäkel, O., Frank, M. & **Wahl, N.** Efficient uncertainty quantification for Monte Carlo dose calculations using importance (re-)weighting. *Physics in Medicine & Biology* **66**. Comment: 29 pages, 8 figures, 7 tables, 205003. doi:10.1088/1361-6560/ac287f. arXiv: 2106.11885 (2021)
- Journal Article Bennan, A. B. A., Unkelbach, J., **Wahl, N.**, Salome, P. & Bangert, M. Joint optimization of photon – carbon ion treatments for Glioblastoma. *International Journal of Radiation Oncology*Biophysics*Physics* **111**, 559–572. doi:10.1016/j.ijrobp.2021.05.126 (2021)
- Journal Article Neishabouri, A., **Wahl, N.**, Mairani, A., Köthe, U. & Bangert, M. Long short-term memory networks for proton dose calculation in highly heterogeneous tissues. *Medical Physics* **48**. Comment: 21 Pages, 15 figures, 4 tables. To appear in the Proceedings of the ESTRO 2020 conference, 28 November – 1 December 2020, Vienna, Austria, 1893–1908. doi:10.1002/mp.14658. arXiv: 2006.06085 (2021)
- Journal Article **Wahl, N.**, Hennig, P., Wieser, H.-P. & Bangert, M. Analytical probabilistic modeling of dose-volume histograms. *Medical Physics* **47**. Comment: 24 pages, 5 figures, 5260–5273. doi:10.1002/mp.14414. arXiv: 2001.04884 (2020)
- Journal Article Wieser, H.-P., Karger, C. P., **Wahl, N.** & Bangert, M. Impact of Gaussian uncertainty assumptions on probabilistic optimization in particle therapy. *Physics in Medicine & Biology* **65**, 145007. doi:10.1088/1361-6560/ab8d77 (2020)
- Journal Article Wieser, H.-P., **Wahl, N.**, Gabryś, H. S., Müller, L.-R., Pezzano, G., Winter, J., Ulrich, S., Burigo, L. N., Jäkel, O. & Bangert, M. matRad - an open-source treatment planning toolkit for educational purposes. *Medical Physics International Journal* **6**, 119–127 (2018)
- Journal Article **Wahl, N.**, Hennig, P., Wieser, H.-P. & Bangert, M. Analytical incorporation of fractionation effects in probabilistic treatment planning for intensity-modulated proton therapy. *Medical Physics* **45**, 1317–1328. doi:10.1002/mp.12775 (2018)
- Journal Article Wieser, H.-P., Cisternas, E., **Wahl, N.**, Ulrich, S., Stadler, A., Mescher, H., Müller, L.-R., Klinge, T., Gabrys, H., Burigo, L., Mairani, A., Ecker, S., Ackermann, B., Ellerbrock, M., Parodi, K., Jäkel, O. & Bangert, M. Development of the open-source dose calculation and optimization toolkit matRad. *Medical Physics* **44**, 2556–2568. doi:10.1002/mp.12251. pmid: 28370020 (2017)
- Journal Article Wieser, H.-P., Hennig, P., **Wahl, N.** & Bangert, M. Analytical probabilistic modeling of RBE-weighted dose for ion therapy. *Physics in Medicine and Biology* **62**, 8959–8982. doi:10.1088/1361-6560/aa915d (2017)

- Journal Article **Wahl, N.**, Hennig, P., Wieser, H.-P. & Bangert, M. Efficiency of analytical and sampling-based uncertainty propagation in intensity-modulated proton therapy. *Physics in Medicine and Biology* **62**, 5790–5807. doi:10.1088/1361-6560/aa6ec5 (2017)
- Journal Article **Wahl, N.**, Bangert, M., Kamerling, C. P., Ziegenhein, P., Bol, G. H., Raaymakers, B. W. & Oelfke, U. Physically constrained voxel-based penalty adaptation for ultra-fast IMRT planning. *Journal of Applied Clinical Medical Physics* **17**, 172–189. doi:http://dx.doi.org/10.1120/jacmp.v17i4.6117 (2016)

Peer-reviewed Conference Contributions

- Poster Stammer, P., Burigo, L., Jäkel, O., Frank, M. & **Wahl, N.** *PO-1728: Efficient modeling and quantification of time-dependent errors in IMPT in Radiotherapy and Oncology* ESTRO. **170** (Elsevier, Copenhagen, 2022), S1529–S1531. doi:10.1016/S0167-8140(22)03692-1
- Oral Presentation Foka, P., Mamaras, A., Skrijel, D., Seco, J., Graeff, C., Pulia, M., Wieser, H.-P. & **Wahl, N.** *Particle therapy masterclass in EPJ Web of Conferences A Virtual Tribute to Quark Confinement and the Hadron Spectrum (vConf21)*. **258** (EDP Sciences, 2022), 01002. doi:10.1051/epjconf/202225801002
- Oral Presentation Palkowitsch, M., Bennis, A. B. A. & **Wahl, N.** *The role of uncertainties in jointly optimised mixed carbon/photon treatments* DGMP 2021. Online. 20.09.21
- Oral Presentation Stammer, P., Burigo, L., Jäkel, O., Frank, M. & **Wahl, N.** *Efficient uncertainty estimates in Monte Carlo dose calculation using importance reweighting* PTCOG 59. Online. 2021
- Oral Presentation Homolka, N., Meder, P. A., Burigo, L., Wieser, H.-P., Bangert, M., Jäkel, O., Ellerbrock, M. & **Wahl, N.** *Degradation of particle depth dose in lung tissue: An efficient and consistent model for Monte Carlo and analytical dose calculation* PTCOG 59. Online. 2021
- Poster Marc, L., Fabiano, S., Wahl, N., Linsenmeier, C., Lomax, A. & Unkelbach, J. *PO-1905: Combined proton-photon treatment for breast cancer using a fixed proton beamline in Radiotherapy and Oncology* **161** (Elsevier, 2021), S1625–S1627. doi:10.1016/S0167-8140(21)08356-0
- Poster Homolka, N., Wieser, H.-P., Bangert, M., Ellerbrock, M. & **Wahl, N.** *PO-1490: Lung degradation effects on RBE-weighted dose in proton, carbon and helium treatment plans in Radiotherapy and Oncology* ESTRO. **152** (Online, 2020), S801–S802. doi:10.1016/S0167-8140(21)01508-5
- Poster **Wahl, N.**, Wieser, H.-P., Burigo, L. & Bangert, M. *PO-1377: Monte Carlo vs. pencil-beam dose calculation for uncertainty estimation in proton therapy in Radiotherapy and Oncology* ESTRO. **152** (Online, 2020), S731. doi:10.1016/S0167-8140(21)01395-5
- Symposium Bangert, M., **Wahl, N.** & Wieser, H.-P. *SP-0469: Mitigation of range uncertainties with probabilistic IMPT optimization in Radiotherapy and Oncology* ESTRO. **133** (Milan, 2019), S241. doi:10.1016/S0167-8140(19)30889-8
- Oral Presentation **Wahl, N.**, Doerner, E., Burigo, L. N., Ramirez, D., Neishabouri, A., Bennis, A. B. A., Wieser, H.-P. & Bangert, M. *Development report for the open source dose calculation and optimization toolkit matRad* 19th ICCR. Montréal. 2019
- Oral Presentation **Wahl, N.**, Hennig, P., Wieser, H.-P. & Bangert, M. *Confidence constraints for probabilistic radiotherapy treatment planning* 19th ICCR. Montréal. 2019
- Oral Presentation Wieser, H.-P., **Wahl, N.**, Hennig, P. & Bangert, M. *OC-0088: Simultaneous consideration of biological and physical uncertainties in robust ion therapy planning in Radiotherapy and Oncology* ESTRO. **127** (Barcelona, 2018), S46–S47. doi:10.1016/S0167-8140(18)30398-0
- Poster **Wahl, N.**, Hennig, P., Wieser, H.-P. & Bangert, M. *EP-1898: Smooth animations of the probabilistic analog to worst-case dose distributions in Radiotherapy and Oncology* ESTRO. **127** (Barcelona, 2018), S1028–S1029. doi:10.1016/S0167-8140(18)32207-2
- Poster **Wahl, N.**, Hennig, P., Wieser, H.-P. & Bangert, M. *PO-0909: Analytical probabilistic models for dose quality metrics and optimization objectives in Radiotherapy and Oncology* ESTRO. **127** (Barcelona, 2018), S486–S487. doi:10.1016/S0167-8140(18)31219-2

- Oral Presentation Wieser, H.-P., **Wahl, N.**, Hennig, P. & Bangert, M. *Analytical probabilistic modeling of range and setup uncertainties in carbon ion therapy planning* in *Proceedings of the 18th ICCR* (London, 2016)
- Oral Presentation **Wahl, N.**, Hennig, P. & Bangert, M. *Probabilistic proton treatment planning using accelerated analytical probabilistic modelling* 18th ICCR. London. 2016
- Poster **Wahl, N.**, Kamerling, C. P., Heinrich, H., Hennig, P. & Bangert, M. *Robust Planning for Intensity-modulated Proton Therapy using Analytical Probabilistic Modeling* in *International Journal of Particle Therapy* PTCOG & PTCOG-NA. 2 (San Diego, 2015), 314f. doi:10.14338/IJPT.15-PTCOG-NA.1

Books & Monographs

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

Preprints and other Publications

- Preprint Barkmann, F., Censor, Y. & **Wahl, N.** *Superiorization as a novel strategy for linearly constrained inverse radiotherapy treatment planning* 2022. doi:10.48550/arXiv.2207.13187. arXiv: 2207.13187 [physics]
- Preprint Liu, R., Charyyev, S., **Wahl, N.**, Liu, W., Kang, M., Zhou, J., Yang, X., Baltazar, F., Palkowitsch, M., Higgins, K., Dynan, W., Bradley, J. & Lin, L. *An Integrated Biological Optimization framework for proton SBRT FLASH treatment planning allows dose, dose rate, and LET optimization using patient-specific ridge filters* 2022. doi:10.48550/arXiv.2207.08016. arXiv: 2207.08016 [physics]
- Preprint Stammer, P., Burigo, L., Jäkel, O., Frank, M. & **Wahl, N.** *Multivariate error modeling and uncertainty quantification using importance (re-)weighting for Monte Carlo simulations in particle transport* Comment: 26 pages, 10 figures. 2022. arXiv: 2202.02379 [physics, stat]
- Online Article Stammer, P., Burigo, L., Jäkel, O., Frank, M. & **Wahl, N.** *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> (2022)
- Online Article Bangert, M., Jäkel, O., **Wahl, N.** & Wieser, H.-P. *Developing matRad, an Open-Source Dose Calculation and Optimization Toolkit for Radiation Therapy Planning* MathWorks Technical Articles and Newsletters. <https://www.mathworks.com/company/newsletters/articles/developing-matrad-an-open-source-dose-calculation-and-optimization-toolkit-for-radiation-therapy-planning.html> (2020)