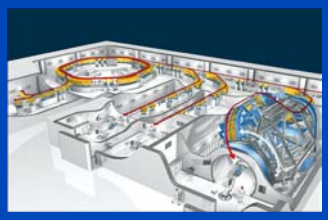
Analytical probabilistic uncertainty management for carbon ion treatment planning

PhD project

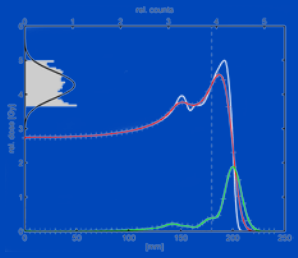
Project background

Uncertainties are ubiquitous in radiation treatment planning. Among others, patient immobilization is error-prone, patient anatomies change during irradiation - even tumor delineation itself is subject to uncertainty. In current clinical practice, however, uncertainties are only considered indirectly. Especially the variability of important medical quality indicators is not quantified. This means variability in the patients' treatment is not sufficiently part of the planning process. Especially for particle therapy, where uncertainties may have pivotal impact, the lack of adequate uncertainty modeling limits clinical application.



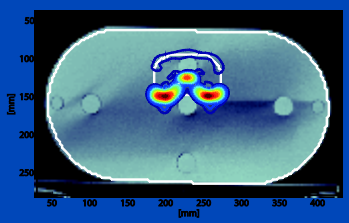
Your PhD project

At DKFZ we are working on analytical probabilistic models in order to implement a comprehensive probabilistic treatment planning workflow. We aim to overcome limitations of existing approaches which exclusively rely on worst case estimations or sampling, i.e. the repeated simulation assuming different treatment scenarios. The successful candidate will extend this work regarding the quantification and minimization of the variability of the relative biological effectiveness for carbon ion therapy. By developing an adequate and efficient representation of uncertainties during treatment planning for Carbon ion therapy, you will deliver a tangible benefit for clinical decision making.



$$\sum \frac{w_i \omega_{ik}}{\sqrt{2\pi\left(\delta_{ik}{}^2 + \sigma_i{}^2\right)}} e^{-\frac{(x-\mu_{ik})^2}{2\left(\delta_{ik}{}^2 + \sigma_i{}^2\right)}}$$

$$\sum \frac{w_i \omega_{ik} w_j \omega_{jl}}{\sqrt{|\Delta^{ijkl} + \Sigma^{ij}|}} e^{-\frac{1}{2}(x_{ij}-\mu_{ijkl})(\Delta^{ijkl}+\Sigma^{ij})^{-1}(x_{ij}-\mu_{ijkl})^T}$$



Your working environment

You will be joining the research group “Optimization algorithms” within the department of Medical Physics in Radiation Oncology at the German Cancer Research Center in Heidelberg. We focus on the design, implementation, and evaluation of quantitative models in radiation therapy. The project includes funding for two three months stays in the research group of Dr. Philipp Hennig at the MPI for Intelligent Systems, which provides expertise in the incorporation of uncertainty in numerical problems. Together with our clinical partners at the Heidelberg Ion-Beam Therapy Center, we offer a unique opportunity for interdisciplinary research and training in radiation therapy, medical physics, probabilistic modeling, and beyond.

Your profile

We are looking for a candidate with a genuine interest in the design, implementation, and evaluation of probabilistic models in radiation therapy. You should have a strong background in physics, mathematics, and/or computer science. Experience in scientific programming is required; experience in medical physics as well as numerical optimization and/or machine learning would be an advantage.

Your application

Please submit your documents including CV and transcript of records via email. Applications will constantly be reviewed until the position is filled.

Dr. Mark Bangert

m.bangert@dkfz.de

+49 6221 42 2418