Contribution ID: **24** Type: **Oral presentation**

A compact x-ray source for microbeam and minibeam radiation therapy in the making

Thursday 21 March 2024 15:55 (20 minutes)

Purpose:
Microbeam and minibeam radiotherapy are the most extreme forms of spatially fractionated photon radiotherapy. Both techniques may improve cancer treatment substantially because they preclinically demonstrated high dose tolerances of normal tissue at similar tumor control rates as conventional radiotherapy. However, until now, suitable clinical treatment facilities are lacking, which produce high-dose rate orthovoltage x-rays shapeable into planar, micrometer-wide beamlets. The line-focus x-ray tube (LFxT) is the only suitable compact treatment machine for clinical translation.

Methods:
We developed and built a preclinical prototype of the LFxT, designed to a power of 90 kW at a 300 kVp spectrum. By exploiting the heat capacity limit, the prototype can deliver dose rates >10 Gy/s from a 50 µm-wide focal spot without destroying the rapidly (>200 Hz) rotating x-ray target. We designed multi-slit collimators and a robotic arm on a linear stage to characterize the x-ray field.

Results:
We installed the LFxT prototype that we currently put into operation. We have reached an ultra-high vacuum (<10-8 mbar), performed high-voltage conditioning, target rotation and balancing, and cathode heating. The multi-slit collimators split the x-ray field into microbeams or minibeams with high-dose peaks (40 µm or 200 µm wide) separated by low-dose valleys (peak-to-peak distance 320 µm or 800 µm). The collimator slits account for the divergent beam and the viewing angle onto the focal spot of 45°. Monte Carlo simulations resulted in a peak-to-valley dose ratio for microbeam radiotherapy of >25 throughout 50 mm water.

Conclusion:
We will combine all subsystems to create the first x-ray beam, characterize the microbeam and minibeam fields, and start with biological proof-of-principal experiments. The robotic arm will serve as a sample holder for in-vitro and in-vivo experiments. This lays the foundation for a more powerful clinical LFxT at dose rates >100 Gy/s with a 600 kVp spectrum.

Primary author: Dr WINTER, Johanna (Department of Radiation Oncology, School of Medicine and Health and Klinikum rechts der Isar, Technical University of Munich (TUM), Munich, Germany)

Co-authors: Dr DIMROTH, Anton (Research Centre Jülich, Jülich, Germany); Mr PETRICH, Christian (Department of Radiation Oncology, School of Medicine and Health and Klinikum rechts der Isar, Technical University of Munich (TUM), Munich, Germany); Dr BEISER, Thomas (Accelerator Design and Integrated Detectors, Helmholtz Institute Mainz, Mainz, Germany); Mr RAVICHANDRAN, Mahadevan (Laboratory for Product Development and Lightweight Design, School of Engineering and Design, Technical University of Munich, Munich, Germany); Prof. ZIMMERMANN, Markus (Laboratory for Product Development and Lightweight Design, School of Engineering and Design, Technical University of Munich, Munich, Germany); Prof. AULENBACHER, Kurt (Accelerator Design and Integrated Detectors, Helmholtz Institute Mainz, Mainz, Germany); Prof. COMBS, Stephanie E. (Department of Radiation Oncology, School of Medicine and Health and Klinikum rechts der Isar, Technical University of Munich (TUM), Munich, Germany); Prof. WILKENS, Jan J. (Department of Radiation Oncology, School of Medicine and

Health and Klinikum rechts der Isar, Technical University of Munich (TUM), Munich, Germany); Prof. BUTZEK, Michael (Research Centre Jülich, Jülich, Germany); Dr BARTZSCH, Stefan (Department of Radiation Oncology, School of Medicine and Health and Klinikum rechts der Isar, Technical University of Munich (TUM), Munich, Germany)

Presenter: Dr WINTER, Johanna (Department of Radiation Oncology, School of Medicine and Health and Klinikum rechts der Isar, Technical University of Munich (TUM), Munich, Germany)

Session Classification: Technologies of Particle Minibeam production and application

Track Classification: Technologies of Particle Minibeam production and application