MAT Ionenstrahlworkshop 2025
September 22-24, 2025 at GSI, Darmstadt

Contribution ID: **108** Type: **Oral**

Ion microbeam for biological heavy ion research

Tuesday, September 23, 2025 4:30 PM (20 minutes)

Cancer is one of the main causes of death worldwide, and radiotherapy (RT) is one of the prominent modalities in the fight against it. From a biological perspective, the main target of RT is the DNA of cancer cells due to its radiosensitivity. To conduct fundamental research into radiation effects at sub-cellular scales, highly precise cell irradiation with micrometer- and nanometer-sized beams is essential. The BIOMICRO project, carried out by a multidisciplinary team, aims to design and construct a new ion microbeam beamline at the 6 MV Tandetron accelerator facility of the Ion Beam Center (IBC) of the Helmholtz-Zentrum Dresden-Rossendorf (HZDR).

The system will focus 10 MeV protons to spot sizes down to ~300 nm, delivered in microsecond bunches, enabling the simulation of heavy ion track structures (36 MeV Carbon) with high spatial and temporal precision. Advanced electrostatic and magnetic optics, together with fast pulsing electronics and real-time dosimetry, ensure sub-cellular targeting and reproducible single-particle delivery. This technical capability allows the controlled irradiation of specific cell compartments (e.g. nucleus vs. cytoplasm) to link microdosimetric track structures with biological outcomes such as DNA damage complexity, repair kinetics, and cell survival.

The project is a collaboration between HZDR, GSI Helmholtz Center for Heavy Ion Research, TUM Klinikum Rechts der Isar, and Universität der Bundeswehr München. Physicists and engineers are responsible for beamline development, including magnets, lenses, and the exit nozzle, as well as the control and analysis software, while biologists will conduct systematic experiments at this facility. Together, these efforts will provide a versatile and affordable platform for heavy ion radiobiology, advancing our understanding of radiation-induced damage at the nanoscale and contributing to the optimization of RT, radiation protection in space, and the development of new technologies.

Author: MALLOUSIS, Nikolaos (Universität der Bundeswehr München)

Co-authors: NEUBAUER, Jessica (Universität der Bundeswehr München); Prof. REINDL, Judith (University of Oslo, Universität der Bundeswehr München); Dr HELLER, René (Ion Beam Center,Helmholtz-Zentrum Dresden-Rossendorf); Mr REISDORF, Robert (Ion Beam Center, Helmholtz-Zentrum Dresden-Rossendorf); NNEDU ONOH, Selina Jasmin (Klinik und Poliklinik für RadioOnkologie und Strahlentherapie, TUM Klinikum Rechts der Isar); Prof. SCHMID, Thomas (Klinik und Poliklinik für RadioOnkologie und Strahlentherapie, TUM Klinikum Rechts der Isar)

Presenter: MALLOUSIS, Nikolaos (Universität der Bundeswehr München)

Session Classification: Talks

Track Classification: Annual Workshop on Ion and Particle Beams (Ionenstrahl Workshop)