Pulsed High-Field Magnets for laser-driven Ion Beam Shaping and Laboratory Astrophysics

Florian-Emanuel Brack[1,2], Florian Kroll[1,2], Josefine Metzkes-Ng[1], Lieselotte Obst[1,2], Stephan Kraft[1], Martin Rehwald[1,2], Hans-Peter Schlenvoigt[1], Leonhard Karsch[1,3], Jörg Pawelke[1,3], Sergei Zherlitsyn[1], Thomas Herrmansdörfer[1], Karl Zeil[1], Ulrich Schramm[1]

[1] *Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany*

[2] *Technische Universität Dresden, Germany*

[3] *OncoRay - National Center for Radiation Research in Oncology*

Pulsed high-field magnets have become a common, versatile research tool. We present a pulsed magnet technology platform that opens up new areas of application in the field of laser-driven plasma physics. Compact high-field magnets, generating ms-long magnetic field pulses with amplitudes ranging as high as 20 T, have been developed for operation under high vacuum and in close vicinity to the harsh laser-plasma environment. The combination of the presented magnet technology and portable pulsed power systems paves the way for novel experiments in laboratory astrophysics and enables unique studies on beam optics for laser-driven ion sources. We implemented a pulsed beamline at the Dresden laser acceleration source *Draco* consisting of two pulsed solenoids for shaping laser-accelerated ion beams spatially and spectrally for application. The bunches remain intense, leading to high dose rates when stopped in matter. These dose rates make special demands for dosimetry and are of major interest for radiobiological studies. We performed experiments with the PW beam of *Draco* to investigate the feasibility of worldwide first controlled volumetric in vivo tumour irradiations in a dedicated mouse model with laser-accelerated protons. The study shows the reliable generation of homogeneous dose distributions laterally and in depth. Practical issues, like magnet repetition rate and stability, mean dose rate and future radiobiological challenges will be discussed and an outlook on the volumetric tumour irradiation experiments will be given.

Furthermore, a split-pair coil was developed that can be used for the investigation of magnetized plasma in the frame laboratory astrophysical phenomena. The magnet provides optical access to the magnetized laser-driven plasma via two bores perpendicular to the coil axis. These openings enable optical and X-ray probing as well as insertion of obstacles and/or laser targets.