On-shot dosimetry and beam monitoring for radiobiology studies on volumetric in-vivo samples with laser accelerated proton beams.

M. Reimold[1,2], C. Bernert[1,2], E. Beyreuther[1,3], F.-E. Brack[1,2], L. Karsch[3,4], S.Kraft[1], F. Kroll[1], J. Metzkes-Ng[1], A. Nossula[1,2], J. Pawelke[4,3], H.-P. Schlenvoigt[1], M. E. P. Umlandt[1,2], K. Zeil[1], T. Ziegler[1,2] and U. Schramm[1,2]

1) Helmholtz-Zentrum Dresden – Rossendorf, Institute of Radiation Physics, 01328 Dresden, Germany

2) Technische Universität Dresden, 01062 Dresden, Germany

3) OncoRay – National Center for Radiation Research in Oncology, Faculty of Medicine and University Hospital Carl Gustav Carus, TU Dresden and Helmholtz-Zentrum Dresden – Rossendorf, Dresden, Germany

4) Helmholtz-Zentrum Dresden – Rossendorf, Institute of Radiooncology - OncoRay, 01328 Dresden, Germany

Petawatt (PW) lasers can generate intense multi-10 MeV proton bunches. These unique sources enable radiobiological studies on ~mm-sized 3D in-vivo samples at dose rates exceeding 10^8 Gy/s to explore ultra-high dose rate effects, such as FLASH. At Helmholtz-Zentrum Dresden-Rossendorf, we successfully developed and now routinely operate a dedicated setup for radiobiological in-vivo studies. The setup comprises the proton source driven by the Draco PW laser, followed by the ALBUS-2S beamline consisting of pulsed solenoids for beam transport and dose formation and finished by the in-air irradiation site equipped for dosimetry and beam monitoring.

We present our dosimetry system combining established dosimetric devices, radiochromic films and ionization chambers, with a transmission scintillator-based time-of-flight spectrometer optimized for the specific conditions at laser-driven sources. It enables the required single-shot spectral monitoring of every proton bunch applied to the sample. Calibration of the spectrometer against radiochromic film stacks in combination with Monte-Carlo simulations allow for the prediction of the depth-dose distribution applied to the sample.

It will be discussed how the use of the three independent device types, radiochromic films, ionization chambers and scintillator-based time-of-flight spectrometer, enables a precise control of the irradiation procedure in spite of the individual limitations.