Laser ion acceleration using the Draco Petawatt facility at HZDR - experiments and radio-biological application

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Demanding applications like radiation therapy of cancer are pushing the frontier of laser driven proton accelerators with controlled and well-defined proton beam properties. This talk will give an overview of recent achievements at the high-contrast high power laser source DRACO at the HZDR in Dresden (Germany). The laser system was recently upgraded by an additional Petawatt (PW) amplifier stage and new front end components finally providing high contrast pulses of >500 TW on target at 1 Hz pulse repetition rate. In first experiments the delivery of these pulses on target was demonstrated and the feasibility of worldwide first controlled volumetric irradiation of a specifically developed tumor model, grown on the ears of nude mice with laser-accelerated protons was investigated. In order to efficiently capture and shape the divergent TNSA proton beam, a setup of two pulsed high-field solenoid magnets will be presented to reliably generate homogeneous dose distributions in lateral direction and in depth.

The performance of laser based proton and ion acceleration and the scaling of the laser energy to achieve increased ion energies strongly depend on the laser temporal contrast and its effect on the target plasma scale length. Plasma mirror setups have proven to be a valuable tool to significantly improve the temporal contrast by reducing pre-pulse intensity and steepening the rising edge of the main laser pulse. Re-collimating single plasma mirror devices have been implemented into the Draco laser beam lines and the talk will summarize on measurements of the resulting contrast enhancement comparing different techniques. With the achieved contrast enhancement, laser proton acceleration and proton energy scaling were investigated within the TNSA regime using ultra-thin foil targets and implications for the radiobiological experiments will be discussed.