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Laser-accelerated proton beam handling for cell irradiation studies

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Proton acceleration by laser-plasma interaction is gaining scientific interest thanks to recent developments in laser technology. Laser-produced ion beams are reliable enough to envision multiple applications, such as experiments of dose deposition into living cells. The study of radiation biology on laser based accelerators is most interesting due to the unique irradiation conditions (high current and short bunch duration) that can be reached.

However, laser-accelerated proton beams have intrinsic characteristics that are not suitable for direct use in practical applications. An appropriate beamline is required to produce clean and controllable irradiation conditions from the wide energy spectrum and large angular divergence produced by the target normal sheath acceleration (TNSA) regime. For in vitro radiobiology studies, it is necessary to provide a wide irradiation surface and uniform dose distribution.

We present the realisation of a beam transport system to shape and control the proton beam for in vitro irradiation. A set of four permanent magnet quadrupoles, designed by INFN-LNS, is used to transport and focus the beam, efficiently cleaning the spectrum and providing with a large and uniform irradiation surface. Shot-to-shot dosimetry is implemented and calibrated for absolute dose deposition evaluation in the irradiation volume. Preliminary results in radiation biology will also be presented, comparing cell response to proton beam irradiation from laser accelerators and conventional sources.

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