

Abstract Title:

Development of an Ion-Acoustic Dose-Deposition Mapping System for LhARA

Abstract Content (max 1200 characters):

LhARA, the Laser-hybrid Accelerator for Radiobiological Applications¹, is a proposed facility for the study of proton and ion radiation biology. The accelerator is designed to deliver a variety of ion species over a wide range of spatial and temporal profiles at ultra-high dose rates. The facility requires that the deposited dose distribution be measured in real-time. For this purpose, an ion-acoustic dose mapping system has been developed that, exploits the ultrasound waves generated by the ion beam². The feasibility of this approach is being evaluated using a two-stage simulation.

A water phantom modelled in Geant4³ with beam energies up to 250 MeV is used to calculate the energy deposited by the beam as a function of position and time. The time-dependent 3D energy distribution is then used as the source in k-Wave⁴ to simulate the ion energy generation of acoustic (pressure) waves and their propagation in the three-dimensional space. A hemispherical acoustic sensor array is also simulated and its ability to reconstruct the generated pressure distribution is evaluated.

The results show that the 3D deposited-energy distribution can be reconstructed with sub-millimetre accuracy and suggest, that further development of the system can lead to real-time, non-invasive Bragg peak localization and dose deposition profile measurement during ion-beam therapy.

Footnotes:

1. Aymar G. *et al. Front Phys.* 2020;0:432.
2. Haffa D. *et al. Sci Rep.* 2019;9(1):6714.
3. Allison J. *et al. Nucl. Instrum. Meth. A.* 2016;835:186-225.
4. Treeby BE, Cox BT. *J. Biomed. Opt.* 2010;15(2):021314.

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