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Design of an Ion-Acoustic Proof-of-Principle Experiment for LhARA

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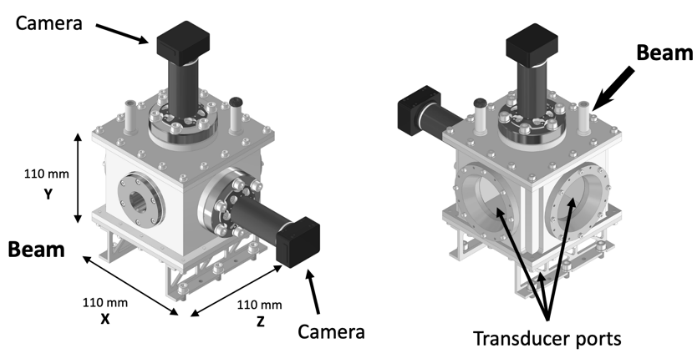
Introduction

LhARA, the Laser-hybrid Accelerator for Radiobiological Applications[1], is a proposed facility for the study of radiation biology. The accelerator will deliver ions at ultra-high dose rates and hence requires real-time measurement of the dose distribution. A proposed experiment is presented that exploits the acoustic waves and luminescence generated by the beam's energy deposition to obtain a calibrated 3D dose map[2]. The experiment will be performed at the Laser-Driven Ion Accelerator at the Center of Advanced Laser Applications in Munich[3].

Methods

A water-based phantom, the SmartPhantom, features a beam entry window sealed with Kapton. Three ports located on orthogonal sides mount ultrasonic transducer arrays for detecting the acoustic waves. To calibrate their response, a liquid scintillator is added to the water and the luminescence arising from the energy deposited by the beam is imaged by two cameras, positioned perpendicularly to it. The performance of the experiment has been evaluated in a series of simulations using BDSIM[4], Geant4[5], k-Wave[6] and OpticStudio[7].



External view of the Computer-Aided Design (CAD) of the SmartPhantom.

Results & Discussion

The simulations indicate a high degree of precision in reconstructing the three-dimensional energy deposition profile through the combined use of the acoustic and optical detection systems.

Conclusion

The proposed instrumentation is designed to provide a calibrated 3D dose map in the experiment. Further development of the system can lead to a real-time pulse-to-pulse dose deposition mapping system for LhARA.

References

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