Abstract submitted to
Applications of Laser-driven Particle Acceleration (ALPA 2015)
International Symposium
19.11.2015 – 21.11.2015

Potential Applications of Laser-Driven Accelerators in Particle Imaging

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Imaging with charged particles, mostly for medical applications, was first proposed by physicist Alan Cormack in the early 1960. Charged particle imaging was off to a slow start, except for the relative fast development of electron microscopy. During the last decade, with the new developments in particle detectors, fast data acquisition systems, and proton gantries becoming increasingly available in hospitals, proton imaging systems, able to produce 2D radiographic and 3D tomographic images of patients, have been developed as a promising tool for improved particle treatment planning, pre-treatment verification, and plan adaptation. It has become apparent by now that proton radiography and CT are low-dose imaging modalities that provide more accurate definition of relative stopping power and water-equivalent thickness than x-ray radiography and CT. The remaining challenges ahead of us involve the development of compact and low-cost beam lines for delivering protons or ions for imaging. Here laser-driven particle acceleration offers a potential avenue. During this future-directed presentation, first the basics principles of imaging with charged particles will be presented followed by an exploration of concepts how laser-driven particle accelerators could be integrated with modern therapeutic particle accelerator beam lines.