Ion Acceleration from Relativistic Laser Plasma: Progress and Perspectives

S. Ter-Avetisyan

Center for Relativistic Laser Science, Institute for Basic Science (IBS) &
Department of Physics and Photon Science, GIST

Recent advances in laser technology have led to laser systems with high contrast and extreme intensity values (beyond 10^{20} W/cm^2), which have opened up new perspectives in the field of laser–matter interaction and particle acceleration.

After reviewing the relevant theoretical and experimental backgrounds on ion acceleration scenarios this presentation will discuss the recently obtained experimental results where evidences of the transition to "new" regime of ion acceleration, so-called Radiation Pressure Acceleration (RPA) regime, and more favourable ion energy scaling with the laser intensity have been shown. If the RPA regime of ion acceleration still requires intensities higher than can be delivered nowadays available laser systems, recently proposed optimised laser-target concept predicts substantial increase of maximum proton energy with already existing laser systems.

These developments have stimulated the emergence of a new ideas and advanced diagnostics for measuring plasma effects and secondary source emission with high dynamic range, spatial and spectral resolution, on a single shot basis. We will discuss the comprehensive on-line diagnostic systems allowing an extensive and thorough research of relevant laser-plasma processes, through characterization of ion emission process and accelerated beam properties.

We will discuss also the perspectives for the proposed applications of laser driven ion beams which include e.g., isochoric heating of matter, fusion Energy ("fast ignitors" electron- or proton-driven), injection into conventional accelerators, cancer therapy, production of isotopes for PET (positron emission tomography), industrial applications (implantation, lithography), nuclear/particle physics applications, etc.

Although, these applications require performances exceeding present capabilities in terms of peak energy, and particle density, as peak laser intensities continue to rise it is expected that the near future will be characterized by a significant enhancement of the proton/ion cut off energy generated under tightly controlled interaction conditions. This will have an impact on many foreseen applications and will encourage further activities for the optimization of laser plasma-based accelerators.