STRONG-FIELD SCIENCE AND TECHNOLOGY AT ADVANCED PHOTON RESEARCH CENTER, JAERI

H. Daido
[1]Advanced Photon Research Center, Kansai Research Establishment
Japan Atomic Energy Research Institute
daido@apr.jaeri.go.jp

Recently, ultra-high intensity short pulse lasers have been applied to the fields of hard x-ray generation and high energy particle generation [1,2]. The essence of the laser- produced plasma is that a high intensity laser can feed its ultra-high energy density into the matter via the ponderomotive heating of electrons. Then the electron energy is transferred into the atoms and ions, which include excitation, ionization by collisions. The electron energy is also converted into energetic ion energy by electro-static potential driven by electron ejection from a plasma. Subsequently, high flux few tens of MeV x-ray can drive nuclear reactions, which open up the new fields of plasma physics and applications. The ultra-high intensity short pulse lasers will also contribute to the cancer therapy as a source of energetic particle source. We are now characterized laser-driven ion source [3] in collaboration with several domestic Institutes and Universities. The basic laser-plasma interaction study with a practical point of view opens up the new attractive fields not only the practical applications but also new aspects of the basic sciences such as control of a high temperature and high-density relativistic plasma. The high intensity physics experiments of this project are schematically shown in Fig. 1.

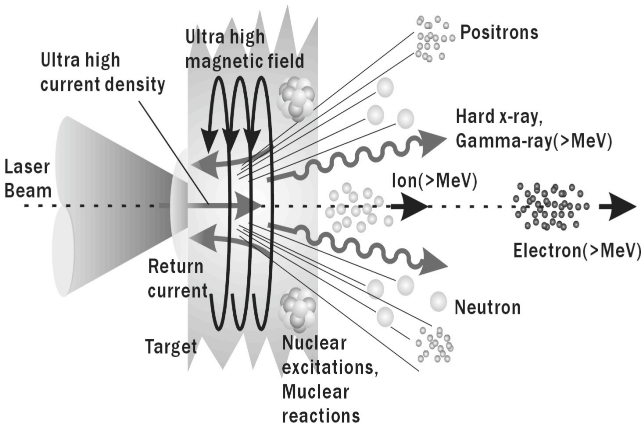

Fig. 1 Schematic diagram of the ultra-intense laser-matter interaction.

For the cancer treatment, desired properties of an ion source for patients are listed as follows;
(1) 10^9 heavy ions per second, $10^{10\text{-}11}$ protons per second,
(2) the particle energy of ~100 MeV/nucleon for a carbon ion and the total energy of >1GeV are necessary. At present, a carbon ion source for cancer treatment is too expensive to be built in a medium size hospital. To reduce the size of the machine, we are developing the compact therapy machine as shown in Fig. 2. At the injector the ions in the co-axial direction of the laser illumination are most useful to be transferred into the next beam cooling and acceleration stages. The issues to be studied are listed below.
1st: Efficient conversion of laser energy into the energetic electrons, which are created via relativistic laser-plasma interactions. We are very much interested in the high-energy tail of the electron distribution functions which may be play significant role to accelerate ions.