Efficient and stable ion acceleration from nanometer targets

X.Q.Yan, Peking University, China
C. H. Nam, GIST, Korea

Radiation Pressure Acceleration (RPA) is efficient for ion acceleration, especially in Phase Stable regime, however, an ultra-high intensity, ultra high contrast laser pulse with steep front is required. By both 3D particle-in-cell(PIC) simulation and analysis, a plasma lens with near critical density is proposed. When the laser passes through the plasma lens, **the transverse self-focusing, longitudinal self-modulation and prepulse absorption** can be synchronously happened. If the plasma skin length is properly chosen and kept fixed, the plasma lens can be used for varied laser intensity above 10^{19}W/cm^{2}. Simulation shows by combining the carbon nanometer foam and DLC target, both acceleration efficiency and ion energy can be about 3 times higher than in RPA regime.

Experiments were performed using CoReLS PW Laser in Korea, it shows 600 MeV carbon beam can be generated with the two layers nanometer targets. Monoenergetic ion beam was also observed when LP laser pulse hitting only DLC single foil. It was observed for the first time the ionization process dynamics can automatically result in a mass limited target of Oxygen (H2O) attached to DLC foil, which leads the ion peak spectrum. The spectra of the different Oxygen (O6+,O7+,O8+) ions and carbon ions are in a good agreement in both experiments and simulations.

Recent a project called Compact LAser plasma Proton Accelerator (CLAPA) is approved by MOST in China. A prototype of laser driven proton accelerator with irradiation chamber (1~15MeV) is built at Peking University. **It shows 15MeV proton beam can be generated when high contrast laser interacting with a nanometer foil without plasma mirror**, there it can be operated with good repeatability(for example energy stability of proton beam is better than 3%). CLAPA will be used for the applications such as cancer therapy, plasma imaging and fast ignition for inertial confine fusion.