Dense high-energy monoenergetic proton beams are vital for wide applications, thus modern laser-plasma-based ion acceleration methods are aiming to obtain high-energy proton beams with energy spread as low as possible. In this work, we put forward a quantum radiative compression method to post-compress a highly accelerated proton beam and convert it to a dense quasi-monoenergetic one. We find that when the relativistic plasma produced by radiation pressure acceleration collides head-on with an ultraintense laser beam, large-amplitude plasma oscillations are excited due to quantum radiation-reaction and the ponderomotive force, which induce compression of the phase space of protons located in its acceleration phase with negative gradient [see the interaction scenario in Fig. 1]. Our three-dimensional spin-resolved QED particle-in-cell simulations [1-3] show that hollow-structure proton beams with a peak energy of about GeV, relative energy spread of few percents and number of $10^{10}$ can be produced in near future laser facilities, which may fulfill the requirements of important applications, such as, for radiography of ultra-thick dense materials, or as injectors of hadron colliders [4].

References