3rd Asia-Pacific Conference on Plasma Physics, 4-8,11.2019, Hefei, China

Quasimonoenergetic proton bunch via interactions of micron-scale hydrogen cluster targets with PW-class laser pulses

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The recent advancements in both laser and target fabrication techniques have led to the enhancement of the accelerated proton cutoff energies close to 100 MeV. However, the energy spectra show a wide spread, which reduces the effective beam current to be utilized. In order to widen the possibility for high energy proton acceleration, here, we consider a different approach using micron-scale spherical hydrogen clusters, alternative to that using solid thin film targets.

Recently, we have presented a new scheme using prominent characteristics of cluster targets for achieving to the level of 300 MeV quasimonoenergetic proton bunch acceleration with a low angular divergence by utilizing the internal degree of freedom (d.o.f.) [1]. In this scheme, the collisionless shock dynamics inside the micron-scale cluster subsequently coupled with relativistically induced transparency (RIT) effect of high-intensity laser plays an important role. The external d.o.f. associated with the cluster expansion due to the sheath field is also incorporated. These multiple processes can be synchronized in a self-consistent manner once suitable conditions for the laser and the cluster are satisfied, leading to the quasimonoenergetic proton bunch acceleration.

The result of a proof-of-principle experiment for the quasimonoenergetic proton bunch acceleration via interaction of micron-scale hydrogen cluster targets [2,3] with PW-class laser pulses, conducted using the J-KAREN-P laser facility at KPSI-QST [4,5], will be presented. Furthermore, possible future applications of high-repetitive, multi-MeV, impurity-free proton beams will be discussed.

References

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