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Quasi-monochromatic carbon ion beams with the "peeler" acceleration scheme

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The "peeler" scheme, originally proposed for proton acceleration, involves irradiating the narrow (sub-micron) side of a solid tape target. A large number of electrons are extracted by the laser pulse and travel to the target rear, creating a strong space charge field. This accelerates and collimates hydrogen ions found in the contaminant layer, resulting in a proton beam with an energy spectrum peaked near the maximum energy. However since heavier ions, such as carbon, have a lower charge-to-mass ratio, they are more difficult to accelerate and still show an exponentially decaying energy spectrum in the standard case.

Using full 3D simulations with the particle-in-cell code SMILEI, we optimize this process in order to obtain high peak energy, quasi-monochromatic and low divergence carbon ion beams. This is achieved by placing low density carbon structure, with dimensions on the order of a few hundred nanometers, at the target rear, replacing the contaminant layer as the ion source. Potential applications for these ion beams include radiotherapy, fast ignition studies, and nuclear physics.

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