Preparations and Target Fabrication for Investigating the Peeler Scheme at JETi200

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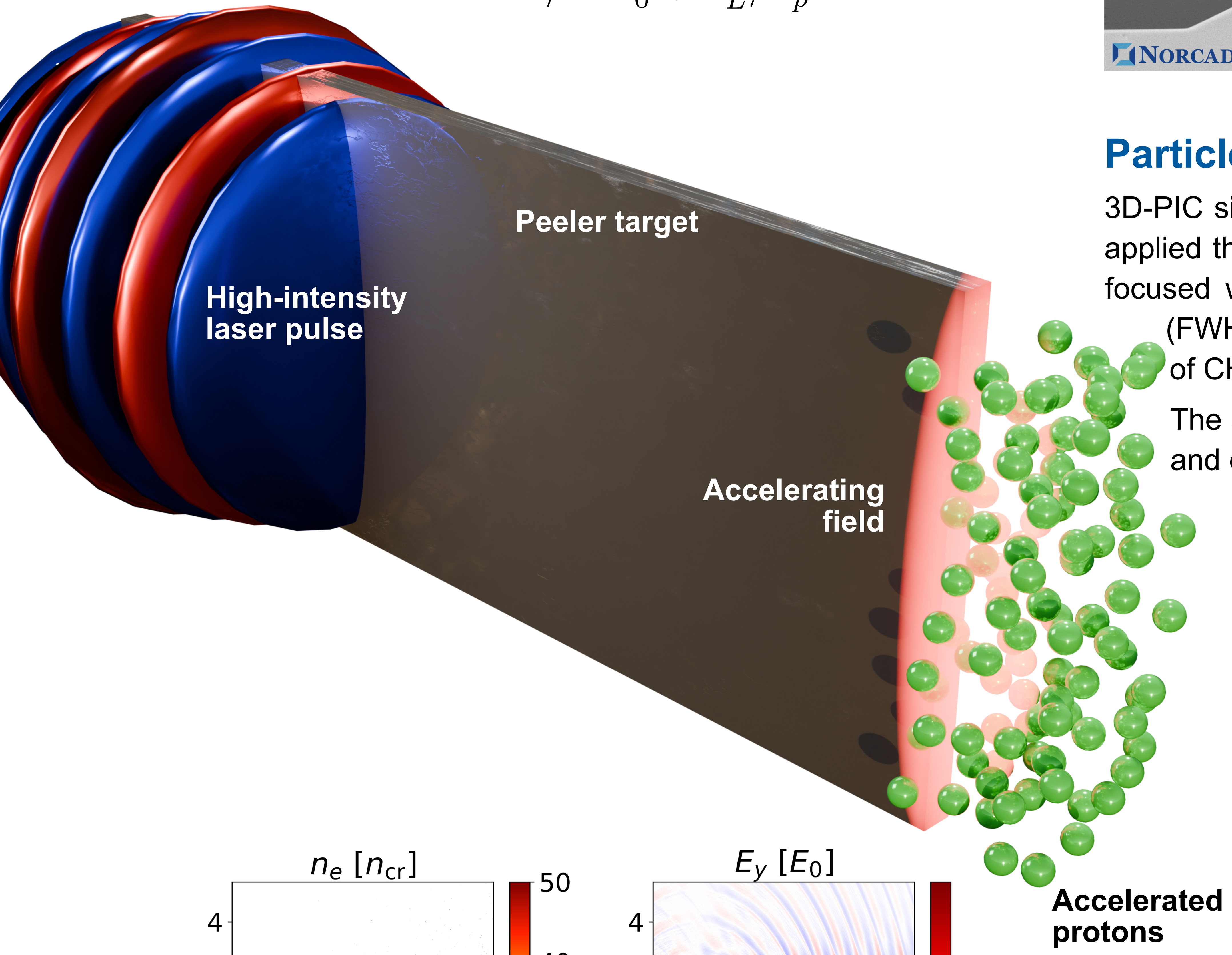
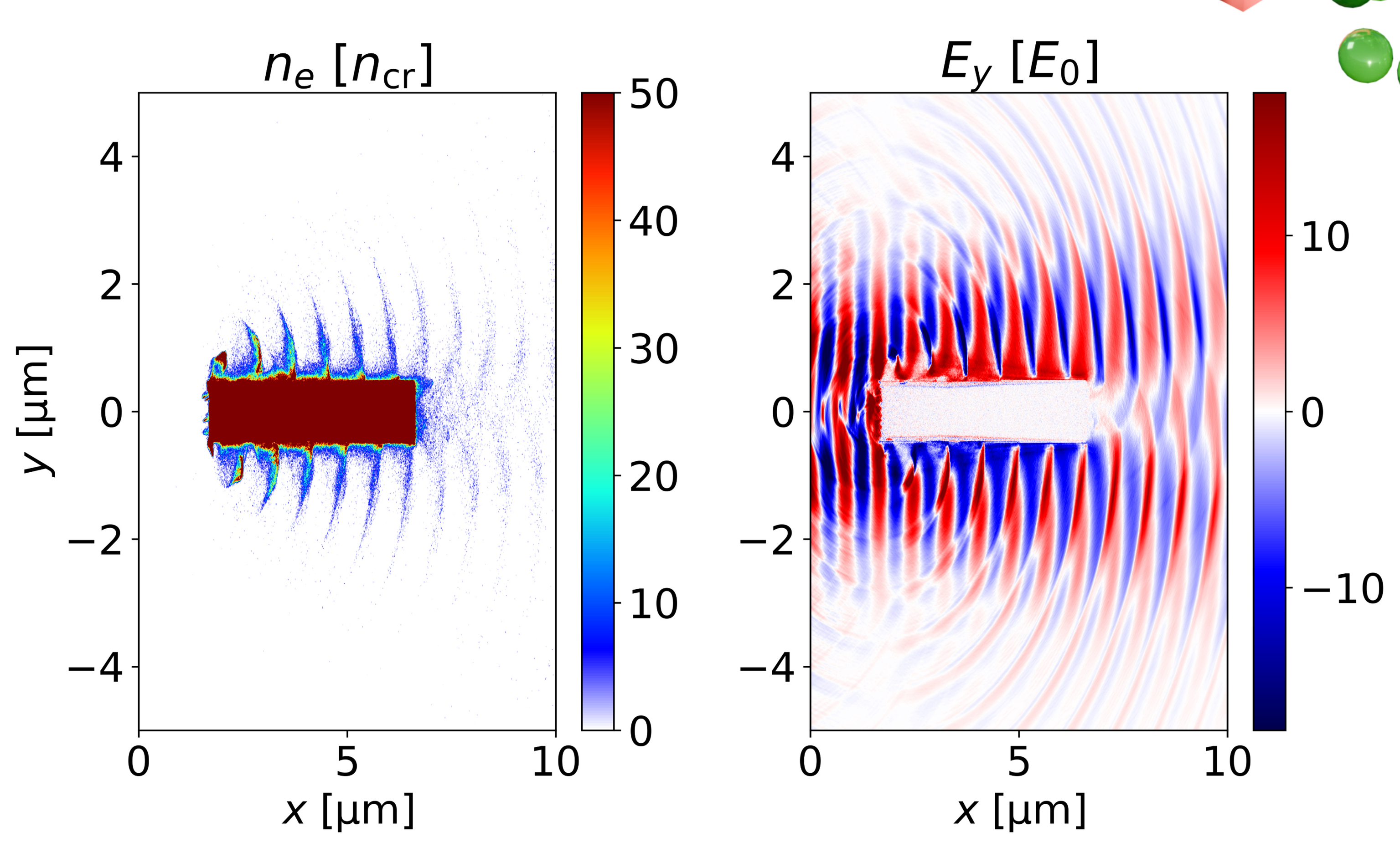
We present the preparations for the experimental investigation of the peeler scheme using silicon-based foils at the JETi200 laser system. A high-intensity laser pulse irradiates the solid foil along its edge, peeling the electrons and driving them forward. At the rear edge, the resulting field accelerates a high-quality proton beam. We detail aspects of targetry, as well as results of preliminary 3D-PIC simulations in order to assess the feasibility of the scheme using the available laser system.

The peeler mechanism

When a strong laser pulse interacts with the sharp edge of an overdense plasma surface with $\omega_p \gg \omega_L$, the dielectric function of plasma $\varepsilon(\omega) = 1 - \omega_p^2/\omega_L^2$ takes negative values across the vacuum-target interface. This allows the excitation of surface plasma waves (SPWs) along the edge [1]. Matching the resonance conditions, the SPW is coupled to the laser fields over the course of the dephasing length L_d [2], serving like a driver to the peeled electrons over the surface,

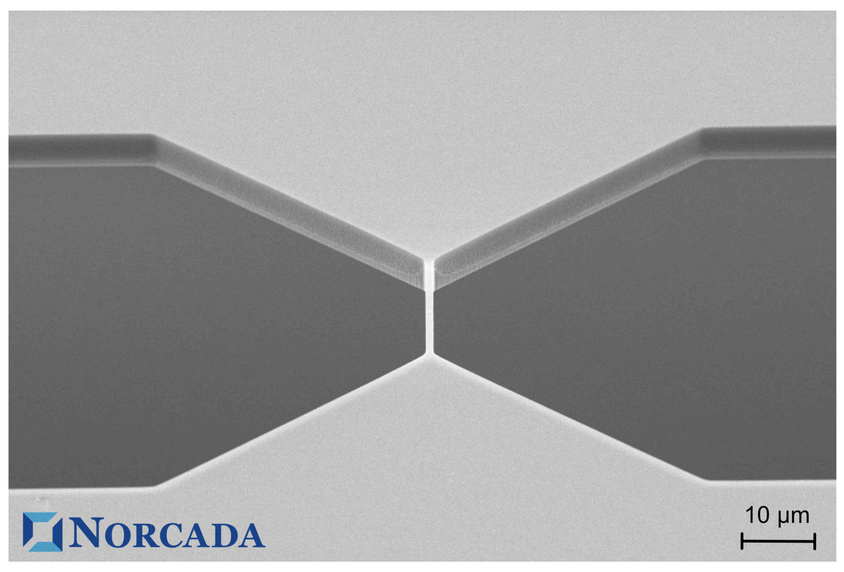
$$L_d \approx \lambda \frac{1}{\lambda^2/\pi^2 w_0^2 + \omega_L^2/\omega_p^2} \ .$$

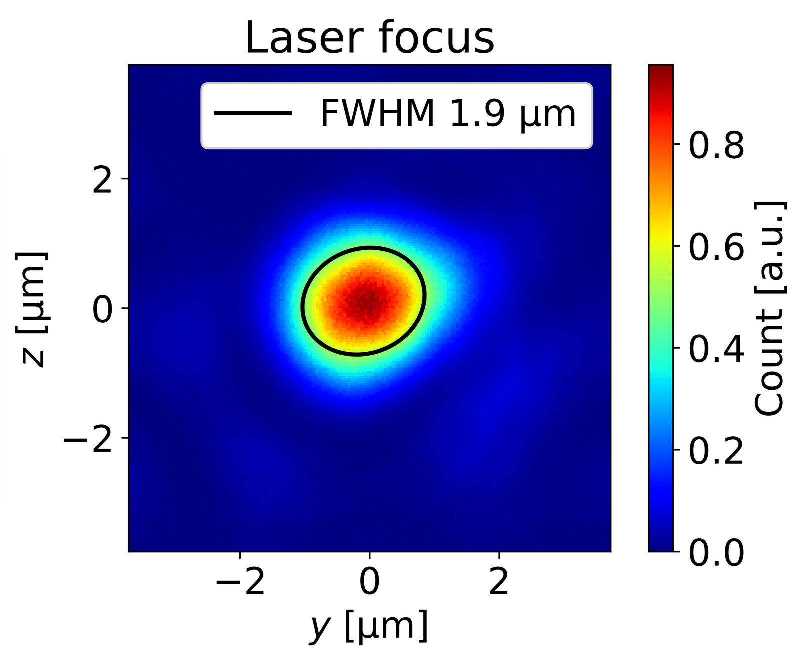




Target preparation

From an experimental perspective, the generation of SPWs relies on several critical parameters, including the alignment of the target's front edge with the focal plane and maintaining a normal incidence angle of the laser. However, the primary challenge is achieving the ideal target geometry required for peeler acceleration. The figure shows the single-crystal silicon target coated with 50 nm parylene to be used in the upcoming beamtime.

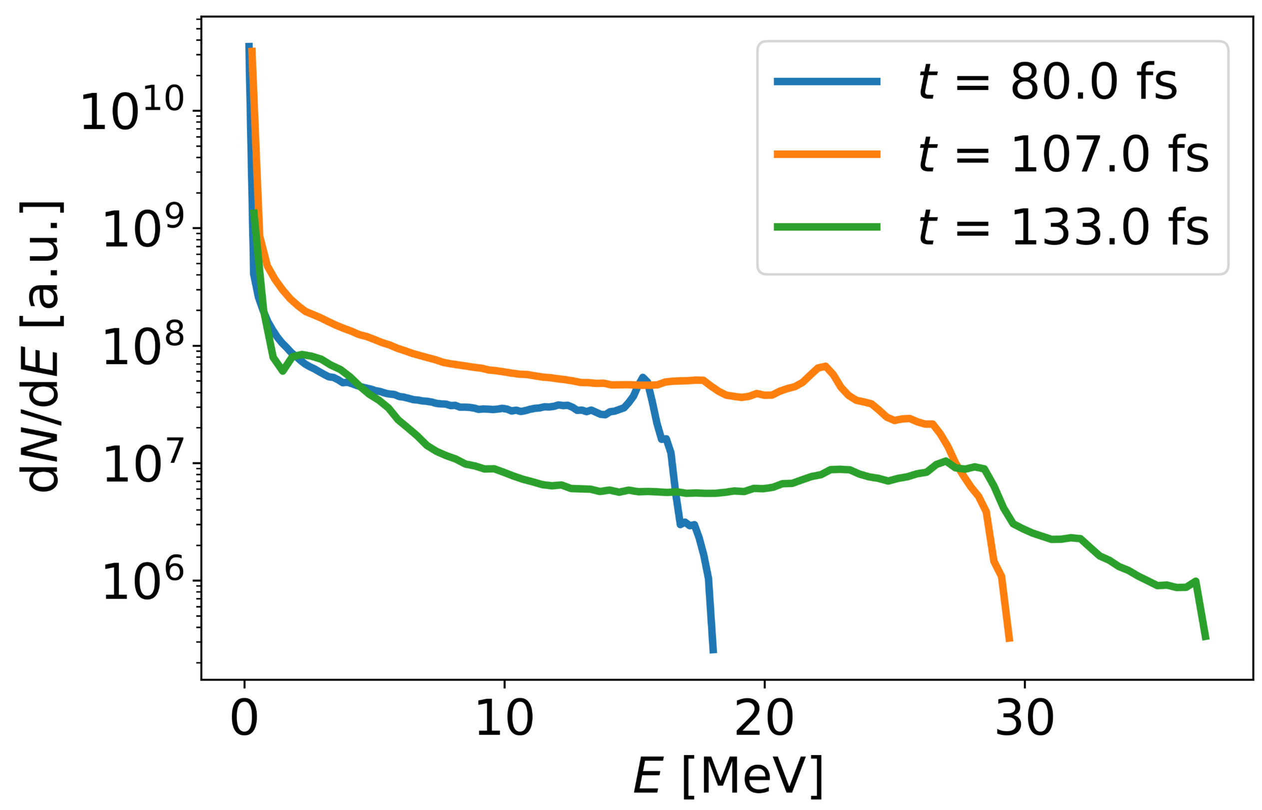




Particle-in-cell simulations

3D-PIC simulations were conducted using the code VLPL. We have applied the JETi200 laser parameters of τ_L= 25 fs and λ = 800 nm, focused with f/1.5 OAP, resulting in a focal spot diameter 1.8 μm (FWHM) and a_0 = 30. The target is modelled as a 5 μm long slab of CH-coated silicon of 1 μm width.

The simulations show that proton beams with tens of pC charge and energies up to approx. 35 MeV can be obtained.



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