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Characterization of Hot Electrons Generated by Stimulated Raman Side-Scattering in Shock-Ignition Relevant Regimes

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Laser-plasma instabilities (LPI) remain a major obstacle to achieving inertial confinement fusion (ICF), particularly at intensities relevant to shock ignition. Among these, side-stimulated Raman scattering (SSRS) has attracted increasing attention due to its potentially greater impact on laser light scattering and plasma wave excitation compared to Raman backscatter, which has traditionally been more extensively studied. These plasma waves can accelerate electrons to super-thermal energies, resulting in undesirable preheating of the fusion fuel. Accurately characterising the flux and temperature of these hot electrons is therefore essential for understanding and mitigating instability growth.

In our recent experiments at the Prague Asterix Laser System (PALS), we investigated how laser focal spot geometry influences hot electron generation. Elliptical focal spots with controlled orientation were produced using different random phase plates, allowing us to study how the alignment of the spot’s short axis, either parallel or perpendicular to the laser polarisation, affects instability development.

To diagnose hot electrons, we deployed an array-based hard X-ray spectrometer (named sub-MeV bremsstrahlung cannon) with an optimised filter set designed to resolve electron temperatures below 100 keV. Our analysis, supported by optical diagnostics (full-aperture backscatter (FABS) and angular-resolved spectroscopy), suggests that the observed hot electrons primarily originate from SSRS. Moreover, we observed that under the same laser intensity, focal spots with the short axis aligned perpendicular to the laser polarisation resulted in lower hot electron temperatures and energies compared to the parallel configuration. In this talk, we will discuss how these findings are consistent with theoretical predictions of convective SSRS growth and how focal spot geometry can influence the resonance length and instability development.