- IFSA2025 –

A parametric study of stimulated Raman side-scattering on directly-driven experiments

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Direct-Drive is the primary scheme considered to achieve viable Inertial Fusion Energy, offering several advantages compared to the Indirect-Drive approach, such as higher laser-plasma energy coupling, less challenging targetry, ... However this approach also faces significant issues limiting the achievable thermonuclear gain, for instance laser-plasma instabilities (LPIs).

Despite reports of relatively low levels of Stimulated Raman back-scattering (back-SRS) in initial experiments, it was recently observed that stimulated Raman side-scattering (side-SRS) leads to energetically significant losses. Side-SRS involves a particular wave coupling geometry, scattering light perpendicularly to the local density gradient. This side-scattered light is strongly affected by refraction as it propagates out of the plasma, leading to a wavelength dependent emission profile, over a very broad volume. Usual diagnostic methods have a limited angular coverage and thus cannot accurately characterise this instability. Therefore, its impact on the implosion is not properly understood yet.

To address these limitations, a new fibre-based diagnostic method has been specifically developed and implemented on the Vulcan laser facility to measure the scattering profile, spectrum and energy over a π area. Using a dedicated laser irradiation geometry separating plasma creation from LPI growth, a parametric study was performed. Side-SRS has been characterised over a range of laser intensities (from conventional Direct-Drive up to Shock Ignition relevant), for two laser polarisations and several plasma density scale-lengths. The competition with back-SRS for different intensities, and the moderate impact of the density scale-length, among others results, will be discussed during this presentation.