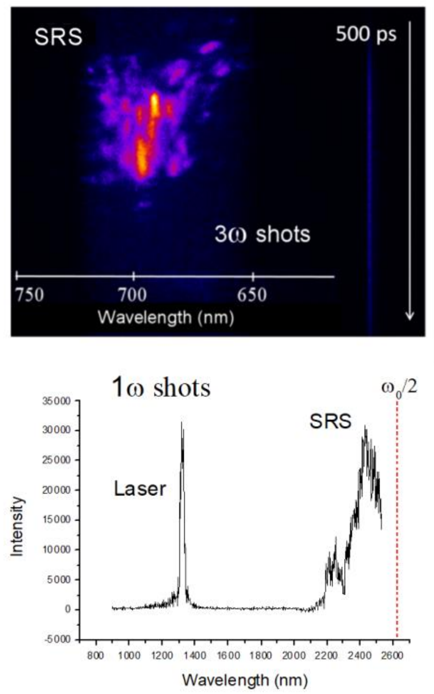
Experimental investigation on parametric instabilities in a regime relevant for shock ignition at PALS

G. Cristoforetti[1], L. Antonelli[2], S. Atzeni[3], F. Baffigi[1], F. Barbato[4], D. Batani[5], G. Boutoux[5], A. Colaitis[5], F. D'Amato[1], J. Dostal[6,7], R. Dudzak[7,6], L. Juha[7,6], P. Koester[1], M. Krus[6], D. Mancelli[5,9], O. Renner[7,6], J. J. Santos[5], M.M. Skoric[10], S. Viciani[1], L.A. Gizzi[1]

1 *National Institute of Optics, CNR, Pisa and Florence, Italy*
2 *York Plasma Institute, department of Physics, University of York, UK*
3 *Dipartimento SBAI, Università di Roma "La Sapienza", Roma, Italy*
4 *Empa Swiss Federal Laboratories for Materials Science and Technology, 8600 Dübendorf, Switzerland*
5 *Université Bordeaux, CNRS, CEA, CELIA, UMR 5107, Talence, France*
6 *Institute of Plasma Physics, Czech Academy of Sciences, Prague 8, Czech Republic*
7 *Institute of Physics, Czech Academy of Sciences, Prague 8, Czech Republic*
8 *INFN, Laboratori Nazionali di Frascati, Frascati (Roma) Italy*
9 *Donostia International Physics Center (DIPC), 20018 Donostia/San Sebastian, Basque Country, Spain*
10 *National Institutes of Natural Sciences, Tokyo, Japan*

A major issue in the Shock Ignition scheme for Inertial Confinement Fusion (ICF) is the relevance of parametric instabilities (LPI), as Stimulated Brillouin Scattering (SBS), Stimulated Raman Scattering (SRS) and Two Plasmon Decay (TPD), and the role of generated hot electrons. Here we present the main results of several campaigns at the PALS facility, where parametric instabilities at laser intensities (0.2-2)x10^{16} W/cm^2 at 1ω and 3ω irradiation (438 and 1314 nm, 250 ps) have been investigated in planar geometry. Such an intensity settles the interaction in a regime relevant for Shock Ignition. Time-resolved spectroscopy and calorimetry of scattered light and characterization of hot electrons via K_α and bremsstrahlung emission spectroscopy allowed a detailed description of LPI and hot electron generation. Experimental data show that the energy transfer is limited by laser light reflection and SBS rather than by SRS in all the irradiation conditions. As expected, Backward Raman Scattering grows by 1-2 orders of magnitude passing from 3ω to 1ω irradiation and the region where it is driven moves toward higher density plasma, due to the higher plasma temperature obtained at 1 irradiation. Hot electron temperature (30-40 keV) and flux are compatible with a predominant generation via SRS rather than via TPD, despite the data suggest the presence of a component of high energy hot electrons (Thot>100 keV), which could be possibly generated by TPD or hybrid TPD/SRS. SRS reflectivity exhibits spikes both in the spectral and temporal domains, suggesting that the process is dominated by kinetic effects. Results are compared to hydrodynamic simulations using a code that includes self-consistent calculations of non-linear laser plasma interactions and accounts for the laser intensity statistics contained in the beam speckles. Fully kinetic simulations of laser plasma interaction at different times of irradiation are also in progress.



Top: Time-resolved SRS spectrum from 3ω irradiation. Below: SRS spectrum from 1ω irradiation.