Experimental evidence of collective speckle behavior for SRS development in picosecond laser-plasma interaction

K. Glize¹, C. Rousseaux¹, S. Baton², L. Lancia³, V. Dervieux¹

¹ CEA, DAM, DIF, F-91297 Arpajon, France
² LULI, Ecole Polytechnique, 91128 Palaiseau Cedex, France
³ Università di Roma « La Sapienza », Via Scarpa 14-16, 00161 Roma, Italy

Recent 2D particle-in-cell simulations [1,2] have demonstrated a collective speckle behavior for stimulated Raman scattering (SRS) excited in the speckle pattern of the focal spot spatially smoothed by a random phase plate (RPP). A weak intensity hot spot, stable if in isolation, could turn out to be unstable with respect to SRS if the intensity of only a few neighboring hot spots becomes greater than SRS threshold. To understand large scale and complex (nanosecond pulse and multispeckles) configuration from large laser facility (LMJ, NIF), reduced scale experimental investigations are needed.

The experiment has been performed at the ELFIE facility from LULI laboratory. Two independently laser beams, 1.5 ps FWHM at 1.06 µm wavelength are fired into a preformed, 300 eV, 0.06 nₑ electron density, He gas jet plasma. The intensity of the first beam is high enough to generate SRS that drives electron plasma waves, scattered electromagnetic waves and suprathermal electrons via Landau damping. The intensity of the 2nd beam is adjusted to be near SRS threshold if in isolation, and is focused laterally at ~ 90 µm from the first one. The time delay between the two beams has been varied. Both crossed and parallel polarizations have been chosen to discriminate kinetic contribution from electromagnetic one. It is shown that the weak hot spot exhibits SRS instability exclusively in the presence of the strong one, up to a time-delay of 20 ps in our experimental conditions. In order to better compare our two-beam experiment with multispeckle configuration, the single, weak hot spot has been substituted by a weak, spatially averaged intensity speckle pattern produced by a RPP. Again, the experiment unambiguously evidences a significant increase of SRS driven by the low intensity laser beam in the presence of the high intensity one.