Temporally resolved diagnostics, based on probe beam, of laser produced plasma for electron acceleration to be implemented at ELI-NP

L. Neagu[1,2], R. Ungureanu[2], G. Cojocaru[2], M. Serbanescu[2], G. Giubega[2], O. Tesileanu[1] and C. Diplasu[2]

[1] *Extreme Light Infrastructure - Nuclear Physics (ELI-NP)/ Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering, Ilfov, Romania*

[2] *National Institute for Laser, Plasma and Radiation Physics, Ilfov, Romania / CETAL-PW Laboratory*

The interaction of high power lasers with gas targets (gas cell or gas jet) is one of the main processes that will be used in the experimental program of Extreme Light Infrastructure - Nuclear Physics facility, especially in E6 and E7 interaction area. This is motivated by the fundamental problems of laser driven nuclear physics [1], high field physics and quantum electrodynamics [2]. Such kind of experiments require a deep knowledge of the transient plasma properties for understanding of the acceleration process itself or for efficiency optimization, control and monitoring of the electron beam formation from the laser generated plasma. The most important plasma parameter is the electron density and its dynamics in the sub-picosecond time scale, which determines the dephasing length, the pump depletion length, and the maximum amplitude of nonlinear plasma waves generated during the laser pulse propagation. Commonly, the electron density dynamics in laser generated plasmas is measured using nonperturbative laser interferometry [3].

In this work we intend to use a probe pulse as a fraction picked-up from the main laser pulse, which is under test at NILPRP - CETAL facility in Magurele. Similar to the method described in [4], this pulse is spectrally broadened via self-phase modulation in a hollow core fiber filled with argon or other noble gases. Then, in order to obtain a transform-limited pulse of few optical cycles the beam is temporally compressed via chirped mirrors in order to create a probe beam for plasma diagnostics with few-fs temporal resolution. The probe pulse is delayed at different time within hundreds of fs (with respect to the pump beam) in order to analyse the plasma wave evolution on subsequent shots assuming each produces a repeatable interaction. Finally the probe beam transversally propagates with respect to the pump pulse in order to illuminate the laser plasma interaction. Due to the length of the laser chain and the resulting timing jitter between shots, the probe pulse is splitted off from the main pulse as close as possible to the interaction point to ensure excellent pulse synchronization.

Agnoledgemts: Research funded by Institute of Atomic Phisics (IFA) under contract #24 in the program ELI-RO 2016

[1] Roth M. et al., Laser driven nuclear physics at ELI-NP, technical design report, ELI-NP (2016)

[2] Jaroszynski, D. et al., High field physics and QED experiments at ELI-NP, technical design report, ELI-NP (2016)

[3] G. R. Plateau, et al., REVIEW OF SCIENTIFIC INSTRUMENTS 81, 033108 2010

[4] B. M. Welsh, B. L. Ellerbroek, M. C. Roggemann, and T. L. Pennington, Appl. Opt. 34, 4186 1995.