Tata Institute of Fundamental Research
Survey No. 36/P, Gopanpally Village, Serilingampally, Ranga Reddy Dist., Hyderabad – 500 046

Internal Seminar

Towards a 100s of MeV, multi-kHz laser plasma accelerator at TIFR – Hyderabad

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Ultrashort pulse (<100 fs) driven high rep. rate (>kHz) laser plasma particle acceleration (LPA) holds promise for a compact, tabletop, university-scale particle accelerator which could advance real-time applications and fundamental physics as well. Such a tabletop accelerator requires short-pulse laser operation at high repetition rates. Current Ti: Sapphire-based high-power lasers face limitations in pulse energy and repetition rate, restricting the accelerator scalability to advance applications. Multi-pass gas cell (MPC) is an excellent tool for the high repetition rate spectral broadening, pulse shortening, and stability. So that, the psec, Joule class, high rep. rate lasers could be compressed to <100 fs, even <10 fs. For a higher-power laser with energies >10s of mJ, a larger MPC would be required. This power to compression length scaling is linear. To understand and engineer: the pulse compression efficiency, power scalability, pulse energy range of the MPC, the gas-dependent spectral broadening, and pulse duration measurements were carried out. Optimisation and tunability of the pulse parameters, like beam quality, amplitude, and spectral phase, to ensure stable operation of the accelerator at high repetition rates, is an important aspect of the investigation. This work demonstrates the pulse compression of 180 fs, 10 kHz (and 25 fs, kHz) laser pulses to <50 fs, 10 kHz (and <8 fs, kHz) using a single-stage 1-metre-long multi-pass gas cell and, design and implementation of targets for the kHz electron operation. Pre-plasma tailored electron acceleration studies are being carried out with the compressed kHz, sub-8 fs pulses with a methanol jet as a target, where electrons are accelerated to 100's of keV energies.

Friday, May 16th 2025

14:30 Hrs

Seminar Hall, TIFRH