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

Internal Seminar

Development of high rep.rate laser plasma accelerator platform at TIFR - Hyderabad

Yembadi Rakesh Kumar

TIFR, Hyderabad

Compact laser-plasma accelerators (LPAs) offer a promising alternative to conventional km-scale accelerators, enabling electron acceleration in laboratory-scale systems with exceptionally high accelerating gradients. Current laser-plasma research spans a broad range of topics, including relativistic electron acceleration, ion acceleration, betatron and inverse-Compton x-ray generation, Thomson-scattering-based photon sources, and emerging concepts for plasma-driven injectors and free-electron lasers. Among the available mechanisms, laser wakefield acceleration (LWFA) is the most advanced and competitive, with demonstrated gradients reaching > 10's of GeV/micron regime and recent university-scale experiments producing electron beams up to 10 GeV from acceleration lengths on the order of 10 cm. Despite these remarkable achievements, two major challenges continue to limit broader deployment: the driving laser pulse diffraction and the low repetition rate of present-day systems. These limitations constrain beam quality, average flux, and practical usability for applications.

Among the most promising approaches to overcome the diffraction barrier is plasma-waveguide-based guiding, particularly hydrodynamic optical-field-ionized (HOFI) channels, which can sustain long-distance propagation of intense laser pulses. In parallel, multi-pass cell (MPC) compressor technology provides a route toward high-average-power, short-pulse laser systems operating at kHz-class repetition rates. The combination of MPC-based, >kHz short-pulse lasers with HOFI channel guiding therefore, offers a compelling platform for next-generation LPAs. In this seminar, I will present our ongoing efforts at TIFRH toward developing a >kHz repetition-rate laser-plasma accelerator platform.

Monday, May 25th 2026

11:30 Hrs

Seminar Hall, TIFRH