Contribution ID: **28** Type: **not specified**

Plasma Wakefield Acceleration 1

Plasmas sustain electric fields far in excess of GV/m. These fields can be utilized for
the acceleration of charged particles to ultra-relativistic energies over distances several orders of magnitude shorter than in traditional acceleration schemes based on metallic radio-frequency cavities. Plasma-based electron accelerators rely on the excitation of strong plasma wakefields which can be, both, accelerating and linearly focussing. Such field configurations, in principle, enable the preservation of critical particle-beam properties such as their energy bandwidth and transverse phase-space density
allowing for ultra-compact applications in photon science, health, and future particle-physics experiments. High-intensity lasers and high charge-density particle beams act as drivers in this scheme. Controlling their properties on femtosecond and micrometer scales and tailoring of the plasma source characteristics provides control over the microscopic acceleration scheme and has pushed plasma accelerator technology closer to application readiness and operational maturity. This lecture will introduce the basics of plasma wakefield acceleration, and review recent advances and highlights in the field achieved in the laser- and beam-driven plasma accelerator program at DESY (Hamburg, Germany), and put these results into the context of the pursued applications. This includes plasma accelerator R&D on the path to novel medical imaging modalities, compact injector systems, and high-efficiency energy-booster modules suitable for upgrades of existing and future facilities in photon science and particle physics.

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