Contribution ID: **42** Type: **Oral talk**

Systematic Investigation of Density Fluctuations in Laser Wakefield Accelerators on the Properties of the Accelerated Electrons

Tuesday, 10 June 2025 15:50 (20 minutes)

Fundamental questions on the nature of matter and energy have found answers thanks to the use of particle accelerators. However, the accelerating field in superconducting radio-frequency cavities due to electrical breakdown is limited to about 100 MV/m. This limits the amount of acceleration over any given length, requiring very long accelerators to reach high energies. To overcome this limitation, novel acceleration techniques are being explored, including plasma wakefield acceleration, that can exceed an accelerating gradient of $E > 100$ GV/m.

Until now, almost all Laser Wakefield Acceleration (LWFA) simulations have assumed smooth plasma density profiles, but recent few-cycle shadowgraph imaging of the acceleration process has revealed small density fluctuations in the plasma profile. The main focus of this project is on a simulation study of the nonlinear laser-plasma interaction using the particle-in-cell code PIConGPU, and based on measured density profiles, we want to determine the difference in electron beam quality after the LWFA process caused by the non-smooth density.

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Session Classification: Physics of Nuclei and Elementary Particles

Track Classification: Physics of Nuclei and Elementary Particles