Presenter: Ahmad Fahim Habib

Title: Ultrahigh 6D brightness electron beams from a single plasma acceleration stage

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Abstract
The plasma photocathode method (aka "Trojan Horse") enables a path towards ultrahigh 5D-brightness electron beams ("witness beam") with nm-level normalised emittance and kA peak currents [1,2]. However, the GV/m-accelerating gradient leads to substantial energy chirp and spread in plasma accelerators. This large energy spread is a major obstacle towards applications such as Free-electron-laser, Inverse-Compton scattering and High energy physics. Here, we show a novel energy chirp compensation technique realised in a single plasma accelerator stage. The ultrahigh 5D-brightness witness beam is accelerated to relativistic energies. Further, a second photocathode laser pulse liberates an additional population of electrons which we call "escort beam" at the later phase of acceleration. This high charge escort beam reverses the accelerating field at the witness beam trapping position and counter-rotates the accumulated negative energy chirp. The ultrahigh 5D-brightness remains unaffected due to the relativistic energy of the witness beam. At the optimum dechirping point the relative energy spread is reduced by an order of magnitude. Hence, ultrahigh 5D-brightness combined with low energy spread leads to unprecedented 6D-brightness electron beams [3]. This approach has the potential to open a path for compact X-ray free-electron lasers and other applications.

[1] Hidding, B. et al., Phys. Rev. Lett. 108, 035001 (2012)

[2] Deng, A. and Karger, O. et. al, Electron bunch generation from a plasma photocathode. Submitted to Nature, (2018)

[3] Manahan, G.G. and Habib, A.F. et al. Nat. Commun.8,15705 (2017)