Contribution ID: **290** Type: **talk**

Mitigation of the hose instability in plasma-wakefield accelerators

Wednesday, 27 September 2017 12:00 (30 minutes)

The hose instability is a long standing challenge for plasma-wakefield accelerators (PWFAs). It is seeded by initial transverse asymmetries of the beam or plasma spatial or momentum distributions.
According to current models, the beam centroid displacement is amplified exponentially during the beam propagation in the plasma, resulting in an unstable acceleration process or in beam-breakup. However, particle-in-cell (PIC) simulations indicate that these models overestimate the hosing growth rates as soon as the drive-beam energy change becomes significant. This intriguing result suggests that the blowout regime in PWFA can provide saturation mechanisms for the hose instability, which strongly damp the beam centroid oscillations during propagation.
In this contribution, we present a model which describes the saturation mechanisms in excellent agreement with PIC simulations, thereby demonstrating for the first time the possibility of stable beam acceleration in PWFAs over long distances [T. Mehrling et al., PRL 118 174801 (2017)]

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Session Classification: Plenary 6

Track Classification: Invited Plenary Talk