



Contribution ID: 259

Type: **Contributed Oral**

Plasma heating and expansion in PWFA experiments FACET

Monday, 7 November 2022 14:00 (15 minutes)

In PWFA experiments, like at FACET, most of the beam energy can be transferred into the wake and trailing plasma oscillations. These oscillations in turn lead to intense plasma heating and expansion. As a practical matter, to reach high average current the heat must be removed between electron bunches. Interestingly, the rapid plasma expansion is unstable and can produce filamentary structures and corresponding large magnetic fields. These types of magnetic field structures are studied in astronomical phenomena but difficult to produce in the laboratory. In our case, the magnetic filamentary structures are embedded in the plasma and last longer than the plasma recombination time. This allows the structures to be imaged along the beam axis by observing the hydrogen plasma recombination fluorescence at 656 nm. The images show helical structures consistent with radial expansion and plasma filamentation instability.

Acknowledgments

DOE Grant DE-SC0010064

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Session Classification: WG4: Beam-Driven Acceleration

Track Classification: Working Group Parallel Sessions: WG4 Oral: Beam-Driven Acceleration