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Measurements of the amplitude of plasma wakefields using plasma light

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Measuring the amplitude of plasma wakefields is challenging. It is however essential for AWAKE [1], since the proposed self-modulation mechanism suggested to drive large amplitude wakefields [2] with a long particle bunch must be seeded to be reproducible in phase [3,4] and in amplitude. Also, the amplitude of the wakefields evolves significantly during the growth of the self-modulation process from seed wakefields, to saturation and beyond [5,6]. Numerical simulation results suggest that this evolution can be influenced with a plasma density step to force wakefields to maintain a large amplitude over a long distance beyond their saturation point [7]. Previous experimental results suggest that the amount of atomic plasma light emitted as wakefields dissipate, is proportional to the energy deposited by the drive bunch in the plasma [8]. Local plasma light measurements could then yield local measurements of the amplitude of wakefields.
Preliminary experimental results show that the amplitude of plasma light signals measured at the plasma entrance and exit indeed depends on whether the self-modulation process is seeded or not. It also depends on the amplitude of seed wakefields and on the amount of proton bunch charge that drives wakefields.
We will introduce the experimental setup, display preliminary results, and present the measurement plan to extract in future experiments [9] essential information about self-modulation physics.

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