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Prospects for Plasma Wakefield Acceleration at the MAX IV Laboratory

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MAX IV Laboratory is a Swedish national laboratory providing scientists with brilliant X-rays. The Linear Accelerator is used both for top-up injection into two storage rings, and as a high brightness source for the Short Pulse Facility (SPF). Using a photo-cathode injector, and two double achromats for compression, it can produce bunches of accelerated electrons with energy above 3 GeV, emittance below 1 mm.mrad, charge above 100 pC, and duration well below 100 fs (down to 10 fs are obtained in simulations).

We explore the possibility to adapt the existing infrastructure for beam-driven plasma wakefield acceleration (PWFA) at the SPF. Beam dynamics simulations in ELEGANT show that it is possible to transport two electron bunches within one RF period from the photo-cathode, through the entire length of the accelerator. The effects of coherent synchrotron radiation and cavity wakefields can be controlled and limited. After compression, the bunches are separated by a controllable delay of a few hundred femtoseconds. Plasma simulations in CALDER-Circ show that at an optimized density, the first bunch can drive a non-linear plasma wake, in which the second bunch experiences a substantial energy gain equivalent of several GeV/m.

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