Preliminary Tests and Beam Dynamics Simulations of a Straight-Merger Beamline

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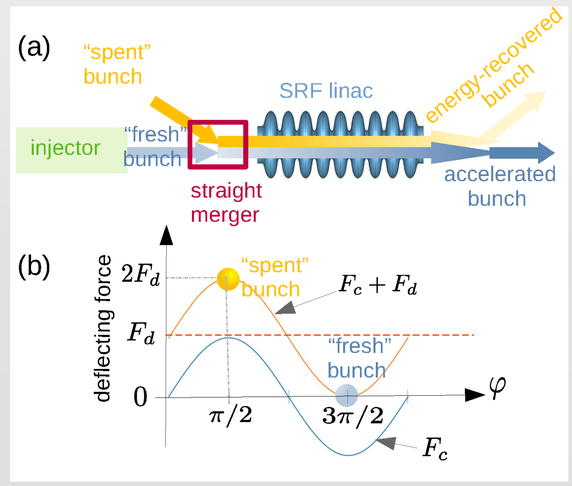
Introduction

- Beamlines capable of merging beams of different energies are critical to many applications (e.g. ERLs).
- A straight-merger system composed of a selecting cavity with a superimposed dipole magnet was proposed and recently tested at the Argonne Wakefield Accelerator (AWA).
- Study detailed beam dynamics of the merger concept and its ability to conserve the beam brightness of the fresh bunch.

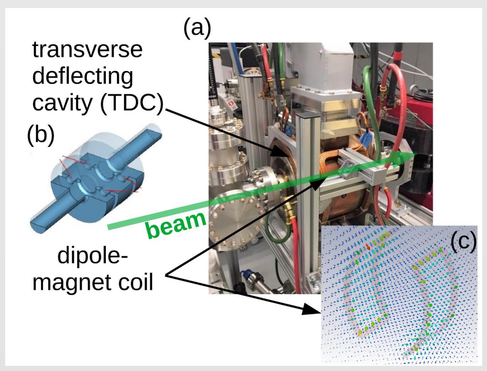
Straight-Merger (SM) at AWA

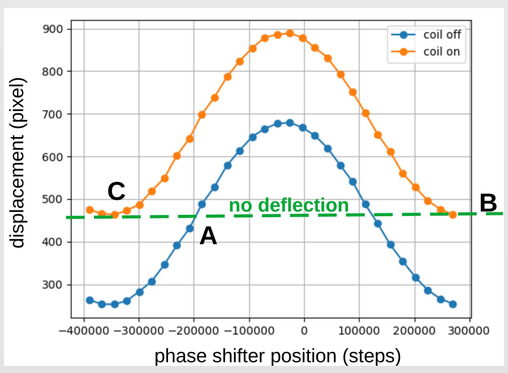
- Proposed for ERLs to merge the injected bunch onto the linac axis with minimal bending and beam degradation.
- The SM superimposes a deflecting $F_c(t)$ of a transverse deflecting cavity (TDC) with a magnetostatic transverse F_d of a dipole magnet.
- A recirculated bunch experiences maximum force → deflected.
- The deflecting force vanishes for a fresh injected → undeflected.
- Dipole field is set to compensate for the kick provided by TDC.



PoP SM Experiments at AWA

- The SM beamline includes:
  - A three-cell (1/2+1+1/2-cell) TDC cavity operating on the TM_{110}, π mode at $f_0 = 1.3$ GHz.
  - Surrounded by a dipole magnet composed of two coils.
- The beam is accelerated up to 40 MeV and injected in the merger.
- Successfully commissioned and acquired some preliminary data.

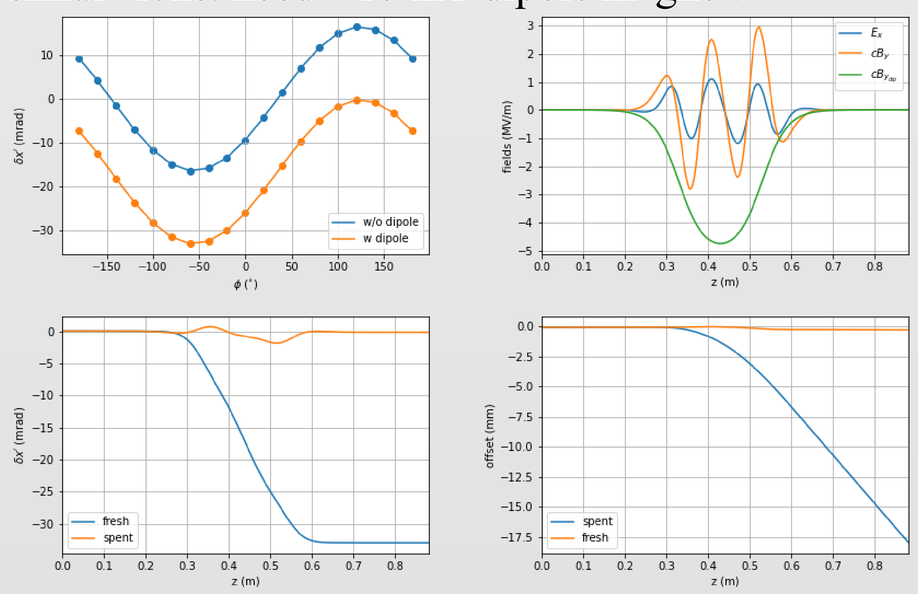




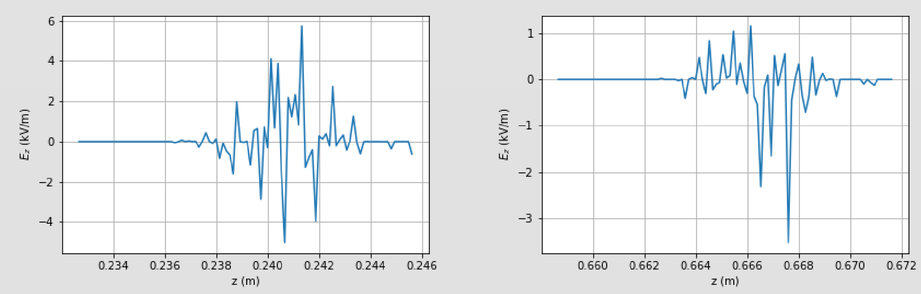
- Qualitatively demonstrated that the SM does not disturb the beam when operated in transparent mode:
  - The transverse distribution of the injected beam at $\varphi = \pi/2$ is compared to that when the SM is turned off (i.e. $F_c = F_d = 0$).
  - Within the shot-to-shot noise, the resulting distributions are indiscernible.

Simulations by LW3D Code

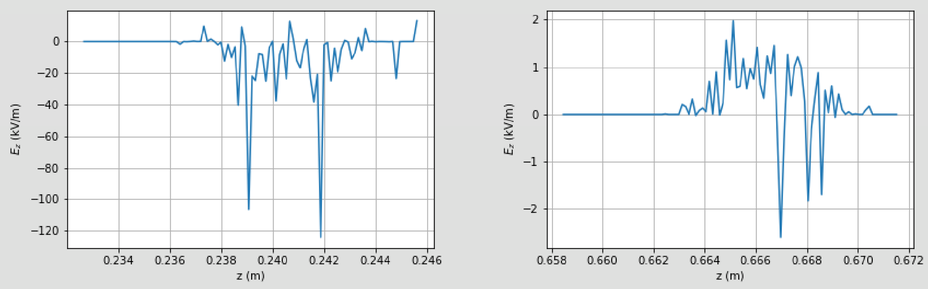
- The LW3D code, a first-principle physics code, by R. Ryne, that computes the 3D fields directly from N particles in the bunch using Liénard-Wiechert equations.
- Initial simulations: need a 17 mT dipole magnet.



- Radiation by the fresh undeflected bunch:



- Radiation by the spent deflected bunch:



- The L3WD can simulate any system (all other CSR codes focus on the steady state system, i.e. dipole magnets).

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