

Proton-driven Wakefield Acceleration

Partners so far:

Max Planck Institute for Physics (Caldwell, Muggli)

Karlsruhe Institute of Technology (Fuchs)

U. Duesseldorf (Pukhov)

Projects:

AWAKE - realization of beam merging region

ALIVE - further development of LEP-3 high energy operation concept

EIC - energy corrector for full energy electron bunches

PDPWA idea: use an energetic driver!

- Accelerate protons in circular accelerator
- Transfer energy to electrons/positrons in a plasma section
- In principle, no staging required (from energy considerations).

Solutions for the Proton Driver

1) The  scheme

- Plasma design/commissioning/operation
- EIC Injector energy corrector

2) The  scheme

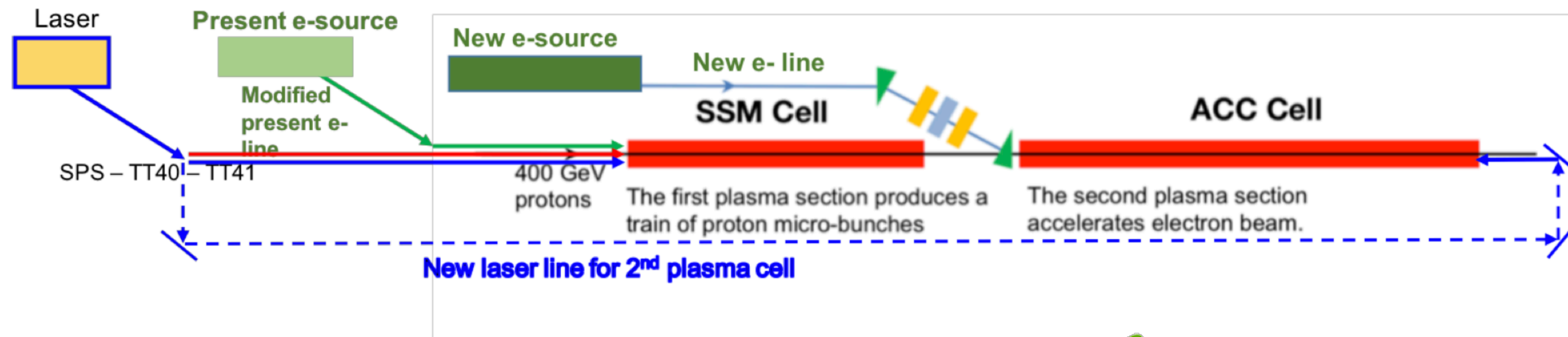
Application development: LEP-3

Run 2 (2021-)

Goals:

stable acceleration of bunch of electrons with high gradients over long distances
'good' electron bunch emittance at plasma exit
Be prepared to start particle physics experiment after Run 2

Baseline design

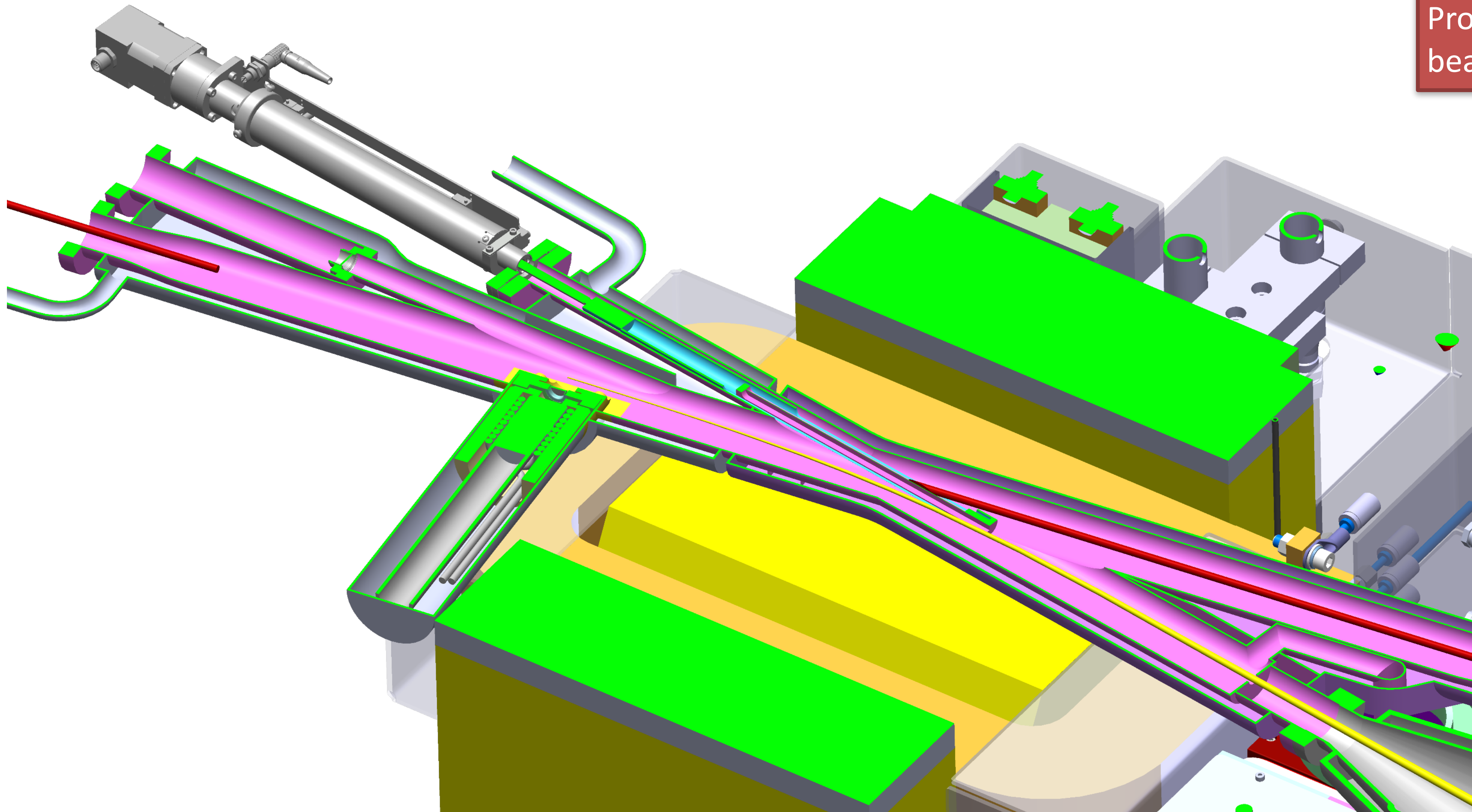


Four phases:

- seeding the SSM with an electron bunch (2021-2022) ✓
- plasma cell with density step to freeze the modulation structure (2023-2024) ✓
- inject electrons & accelerate without emittance blowup (2028-)
- implement scalable plasma cell technologies (2028-)

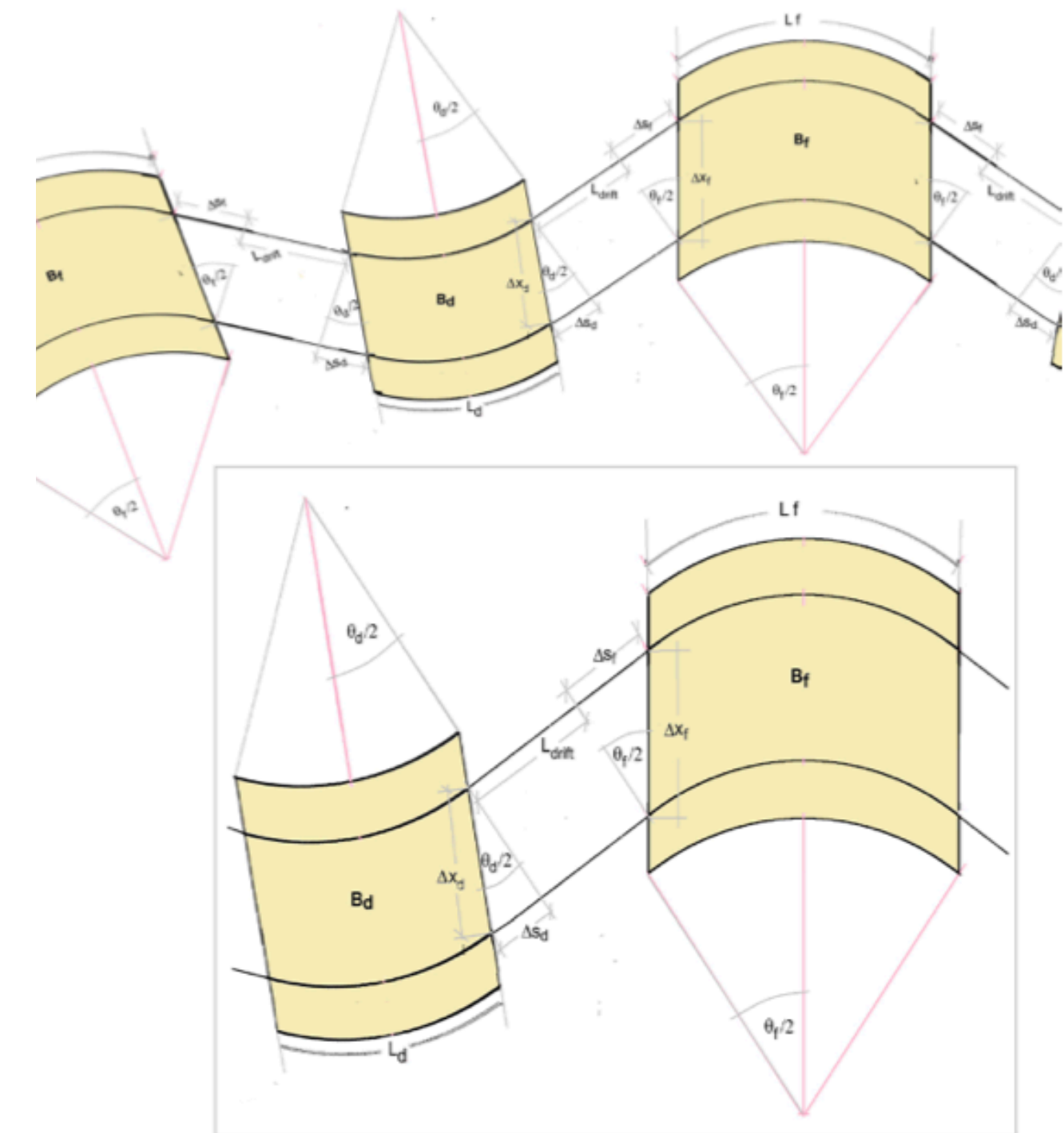
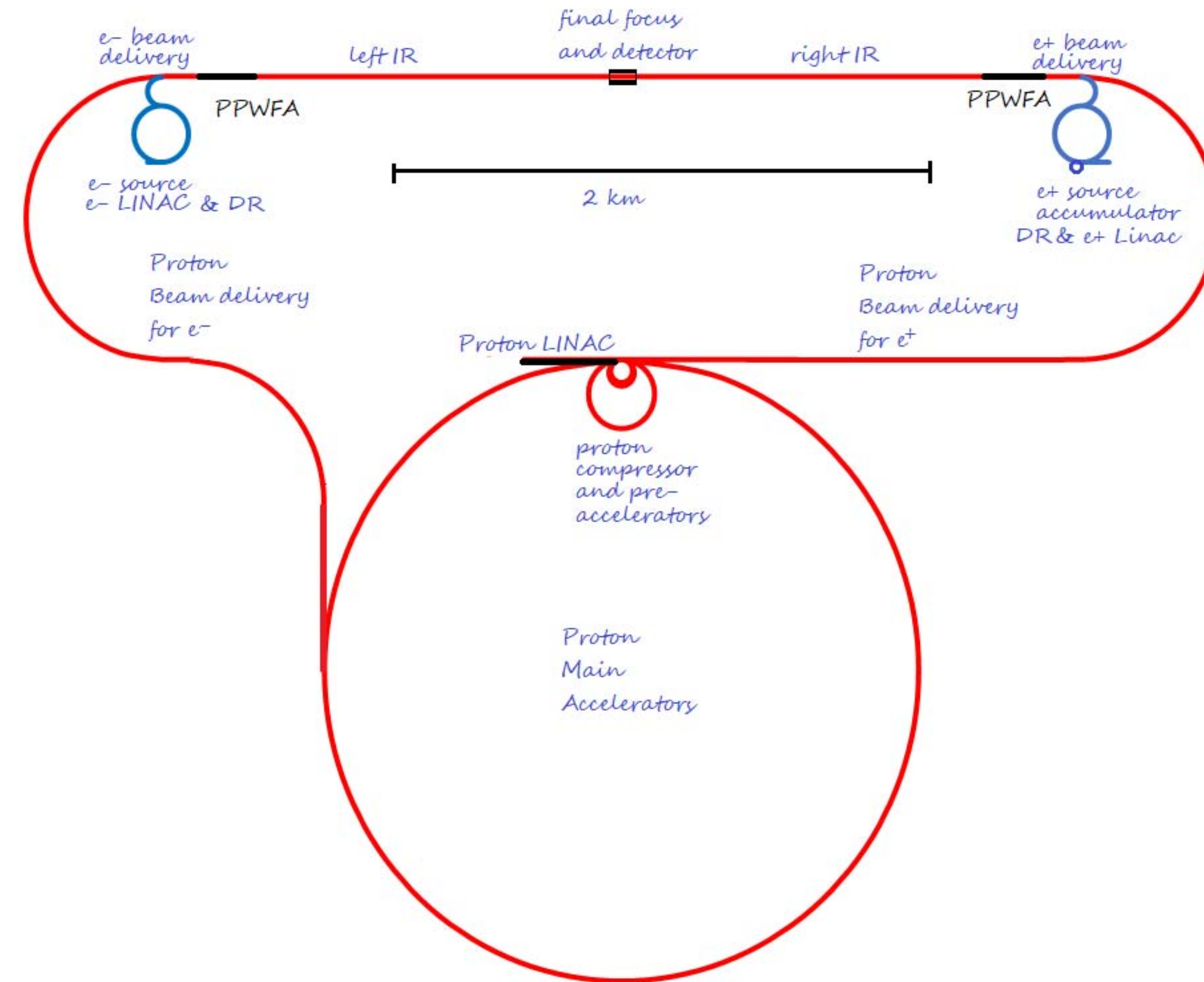
Beam merging scheme

Project: realization of this
beam merging region



ALiVE - FFA Scheme

- FFA concept developed by **Ferdinand Willeke** (BNL).
- Would allow for high repetition rate of short proton bunches
- see <https://www.osti.gov/biblio/3028973>



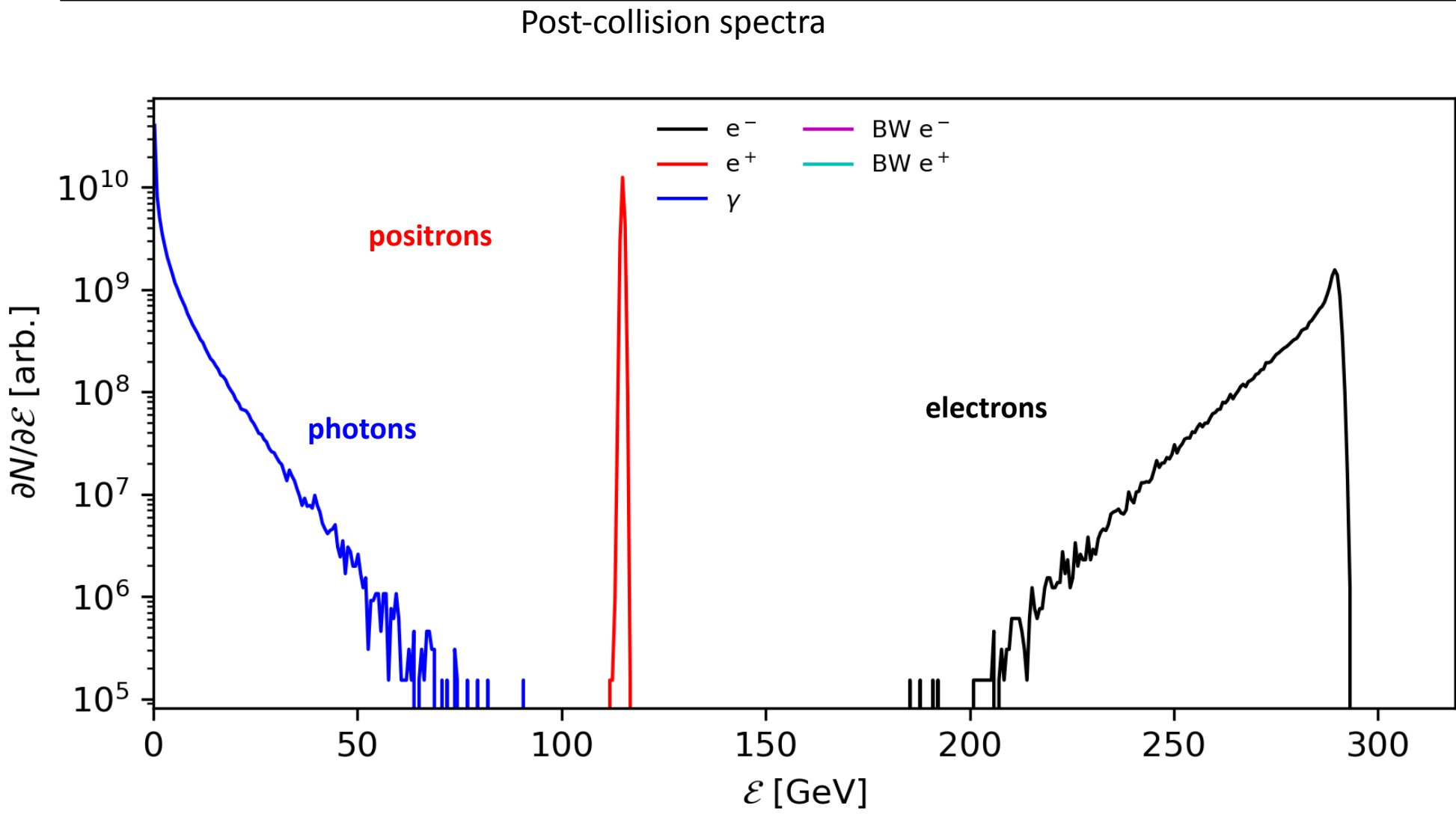
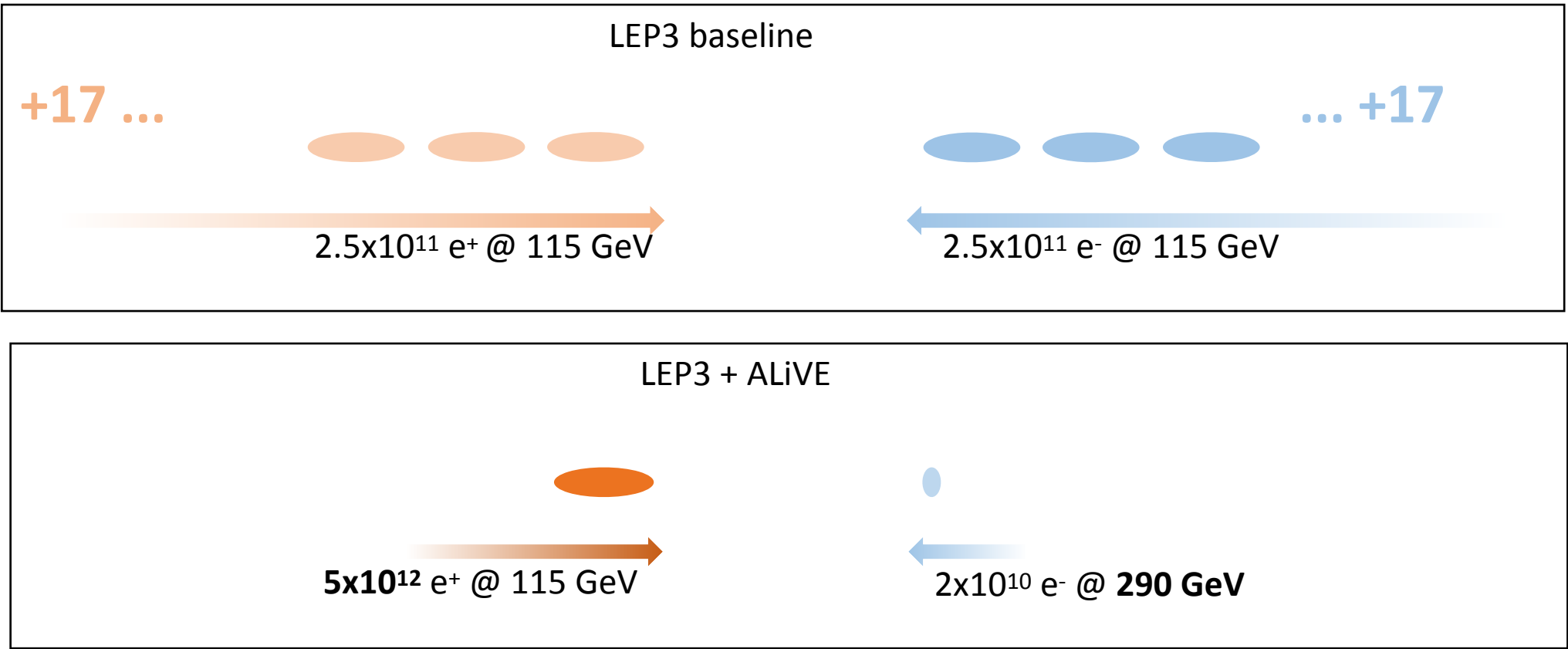
Study of a Fixed Field Accelerator as a Driver for Proton Driven Plasma Wakefield Acceleration

F. Willeke, Brookhaven National Laboratory, Brookhaven, US

Bring LEP-3 to the $t\bar{t}$ threshold

A GuineaPig++ simulation was performed to assess the possible performance of this scheme, the results show:

	LEP3 baseline	LEP3-ALiVE
COM energy	230 GeV	365 GeV
Total luminosity	1.6x10 ³⁴ cm ⁻² s ⁻¹	1.8x10 ³³ cm ⁻² s ⁻¹
Top 1% luminosity	1.6x10 ³⁴ cm ⁻² s ⁻¹	1.3x10 ³³ cm ⁻² s ⁻¹
e ⁺ beam-beam (x / y)	0.07 / 0.10	0.01 / 0.01
e ⁻ beam-beam (x / y)	0.07 / 0.10	526 / 1



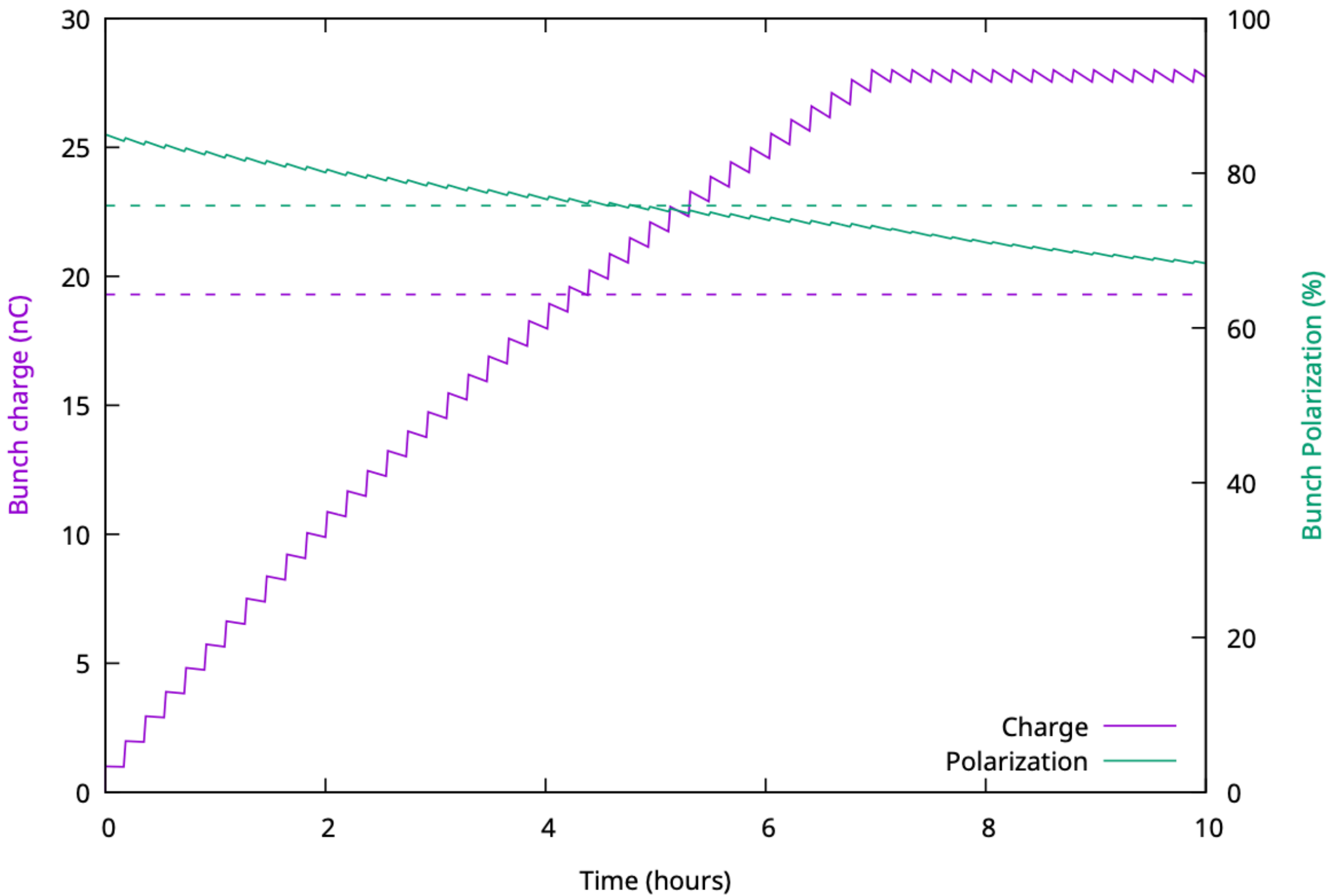
Project: Develop this scheme further (simulations)

EIC Electron Injector

arXiv:2605.07929v1

An electron injector for the Electron-Ion Collider based on proton-driven plasma wakefield acceleration

J. P. Farmer,^{1,*} H. Jaworska,^{2,†} A. Caldwell,¹ N. Lopes,³
A. Pukhov,² L Reichwein,^{2,4} F. Willeke,⁵ and M. Wing^{6,7}



Project: design of this energy corrector

