Positron Plasma Wakefield Acceleration @

FACET·II

Facility for Advanced Accelerator Experimental Tests

Spencer Gessner, CERN

February 9th, 2018

Thanks to:

Vitaly Yakimenko
Glen White
Mark Hogan
&
Chan Joshi

For generous use of slides

FACET-II

Timeline:

- ✓ **Nov. 2013, FACET-II proposal, Comparative review**
- ✓ **CD-0 Sep. 2015**
- ✓ **CD-1 Oct. 2015 *(ESAAB, Dec.2015)***
- ✓ CD-2/3A Sep. 2016
- CD-3B Sep. 2017
- CD-4 2022

Experimental program (2019-2026)

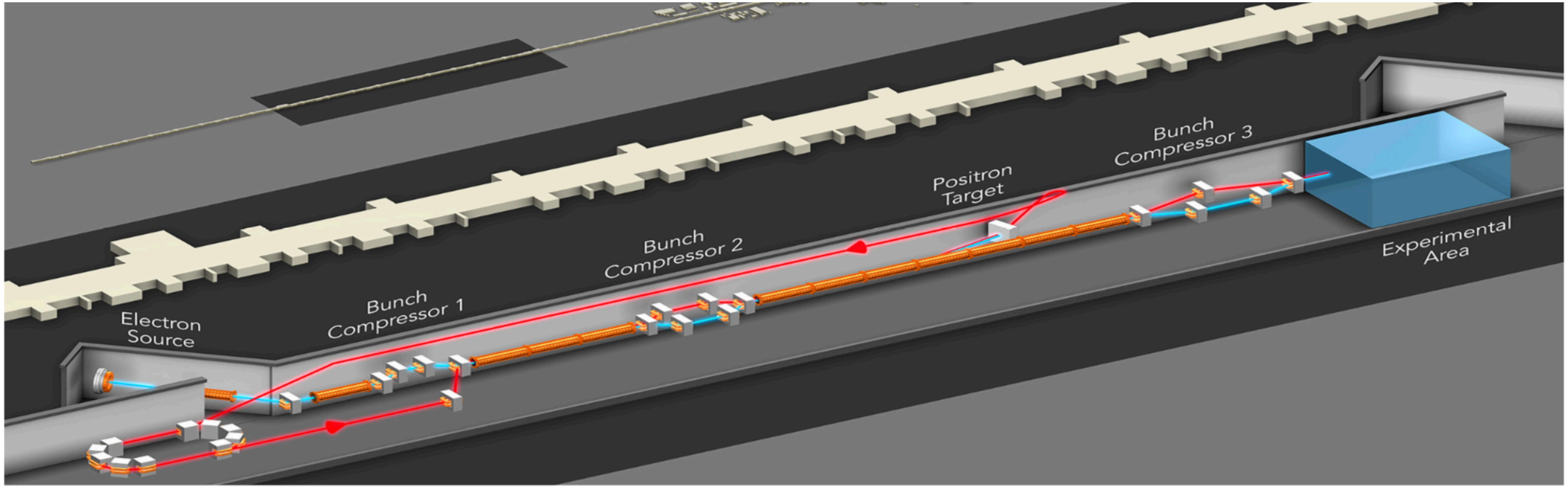
Key R&D Goals:

- Beam quality preservation, high brightness beam generation, characterization
- e^+ acceleration in e^- driven wakes
- Staging challenges with witness injector
- Generation of high flux gamma radiation

Three stages:

- Photoinjector (e- beam only) FY17-19
- e+ damping ring (e+ or e- beams) FY18-20
- “Sector 20 Positrons chicane (e+ and e- beams)

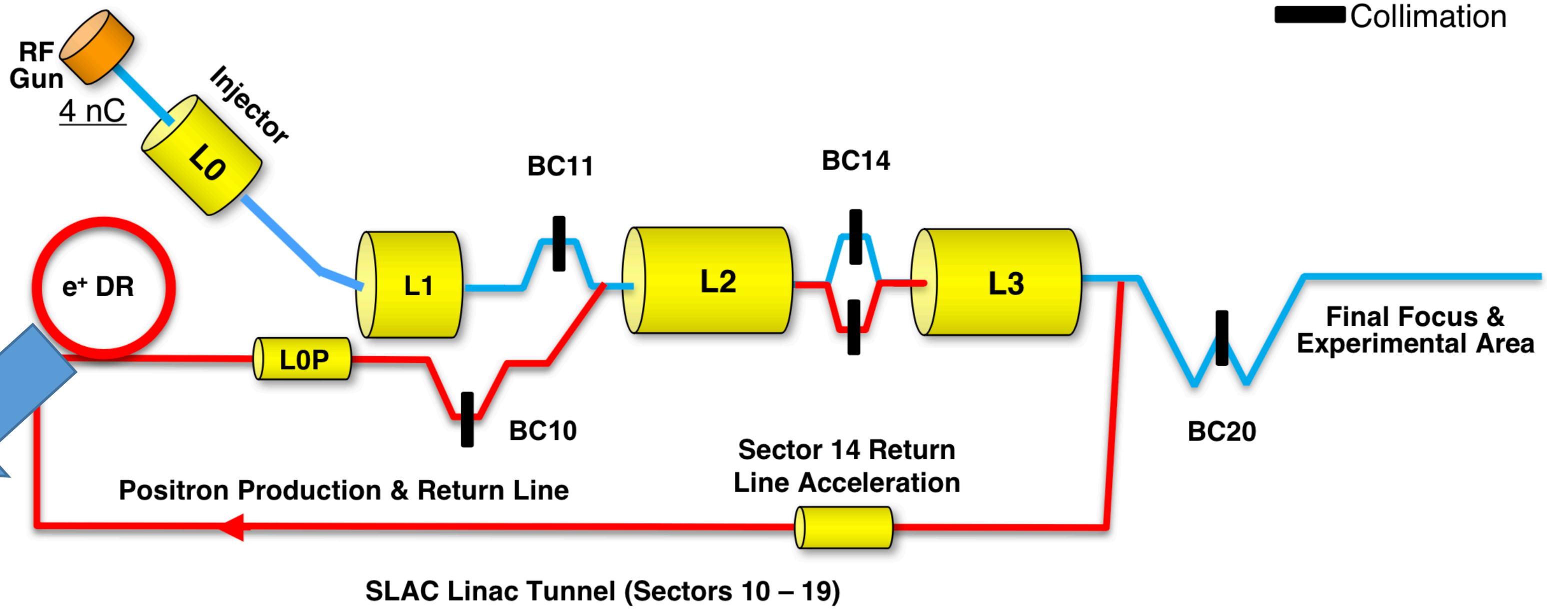
Beam Parameters

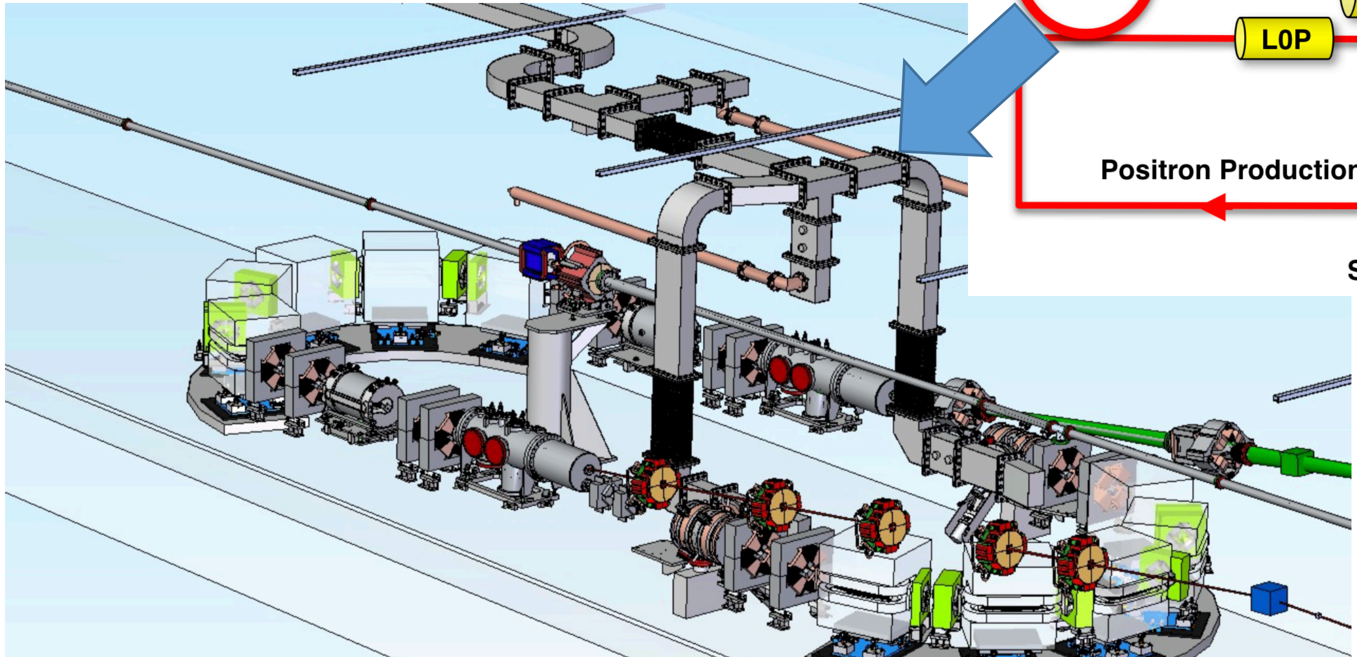


Electron Beam Parameter	Baseline Design	Operational Ranges
Final Energy [GeV]	10	4.0-13.5
Charge per pulse [nC]	2	0.7-5
Repetition Rate [Hz]	30	1-30
Norm. Emittance $\gamma\varepsilon_{x,y}$ at S19 [μm]	4.4, 3.2	3-6
Spot Size at IP $\sigma_{x,y}$ [μm]	18, 12	5-20
Min. Bunch Length σ_z (rms) [μm]	1.8	0.7-20
Max. Peak current I_{pk} [kA]	72	10-200

Positron Beam Parameter	Baseline Design	Operational Ranges
Final Energy [GeV]	10	4.0-13.5
Charge per pulse [nC]	1	0.7-2
Repetition Rate [Hz]	5	1-5
Norm. Emittance $\gamma\varepsilon_{x,y}$ at S19	10, 10	6-20
Spot Size at IP $\sigma_{x,y}$ [μm]	16, 16	5-20
Min. Bunch Length σ_z (rms)	16	8
Max. Peak current I_{pk} [kA]	6	12

FACET-II Positron System



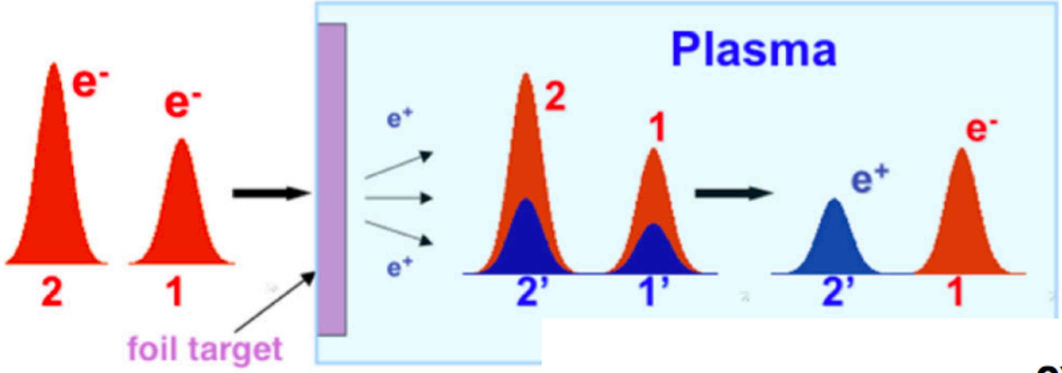


- 2.9 m diameter ring
- Vertical injection & extraction
- SLC septa, kickers & RF
- New combined-function arc magnet designs

FACET-II Positron Experiments

1. In-situ positron generation
2. Advanced hollow channel experiements
3. Electron drive/positron witness

In-Situ Positron Generation



PRL 101, 124801 (2008) PHYSICAL REVIEW LETTERS week ending 19 SEPTEMBER 2008

Positron Injection and Acceleration on the Wake Driven by an Electron Beam in a Foil-and-Gas Plasma

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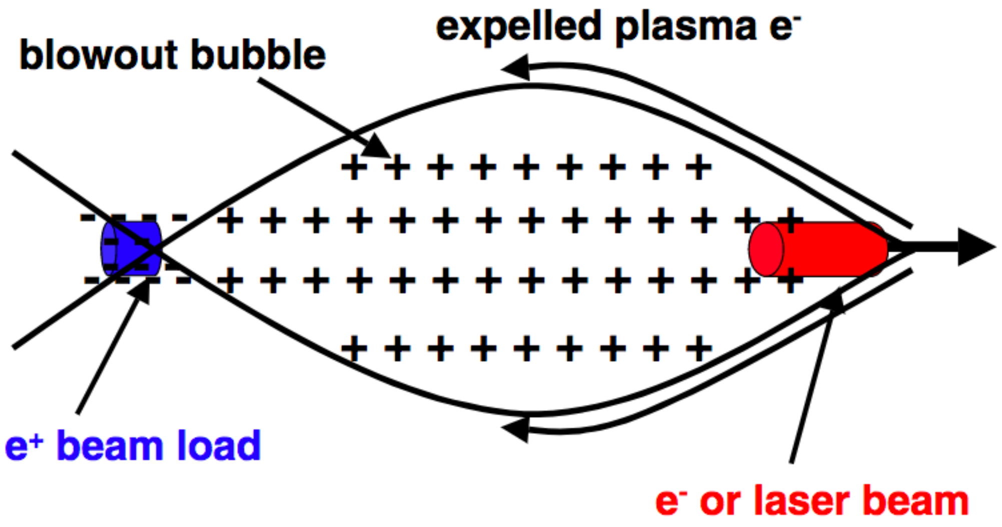
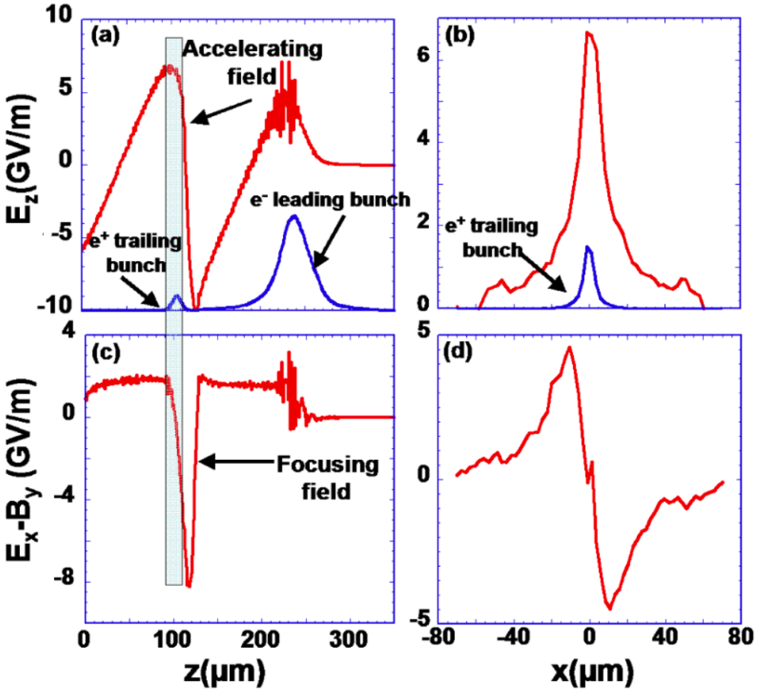
(Received 11 March 2008; published 17 September 2008)

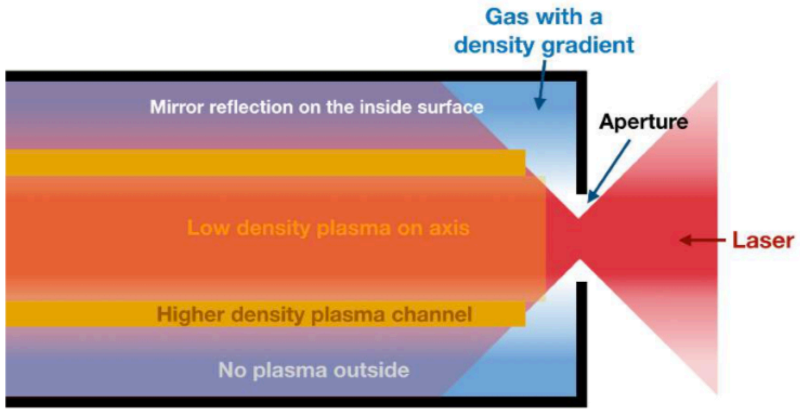




Next-Gen Hollow Channel

Creating a vacuum on axis

- Eventually, we need to have a vacuum on axis, to avoid beam ionisation.
- **Centrifuge technique**, where the gas density is approximately exponentially decaying towards the axis.
- **Cryo-cooled gas cluster** technique (used for corrugated plasma channels by H. Milchberg)
- These ideas can potentially be tested in the laser labs at UCLA or UC Boulder.



Gas centrifuge

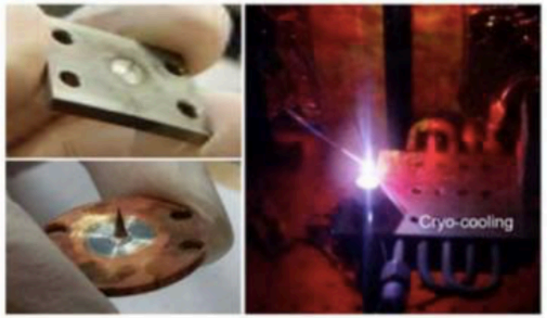


Image source:
H. Milchberg (Uni Maryland), EAAC2017 talk

C. Lindstrom

Electron Drive-Positron Witness