R&D at FACET toward FCC

FACET-II

Facility for Advanced
Accelerator Experimental Tests

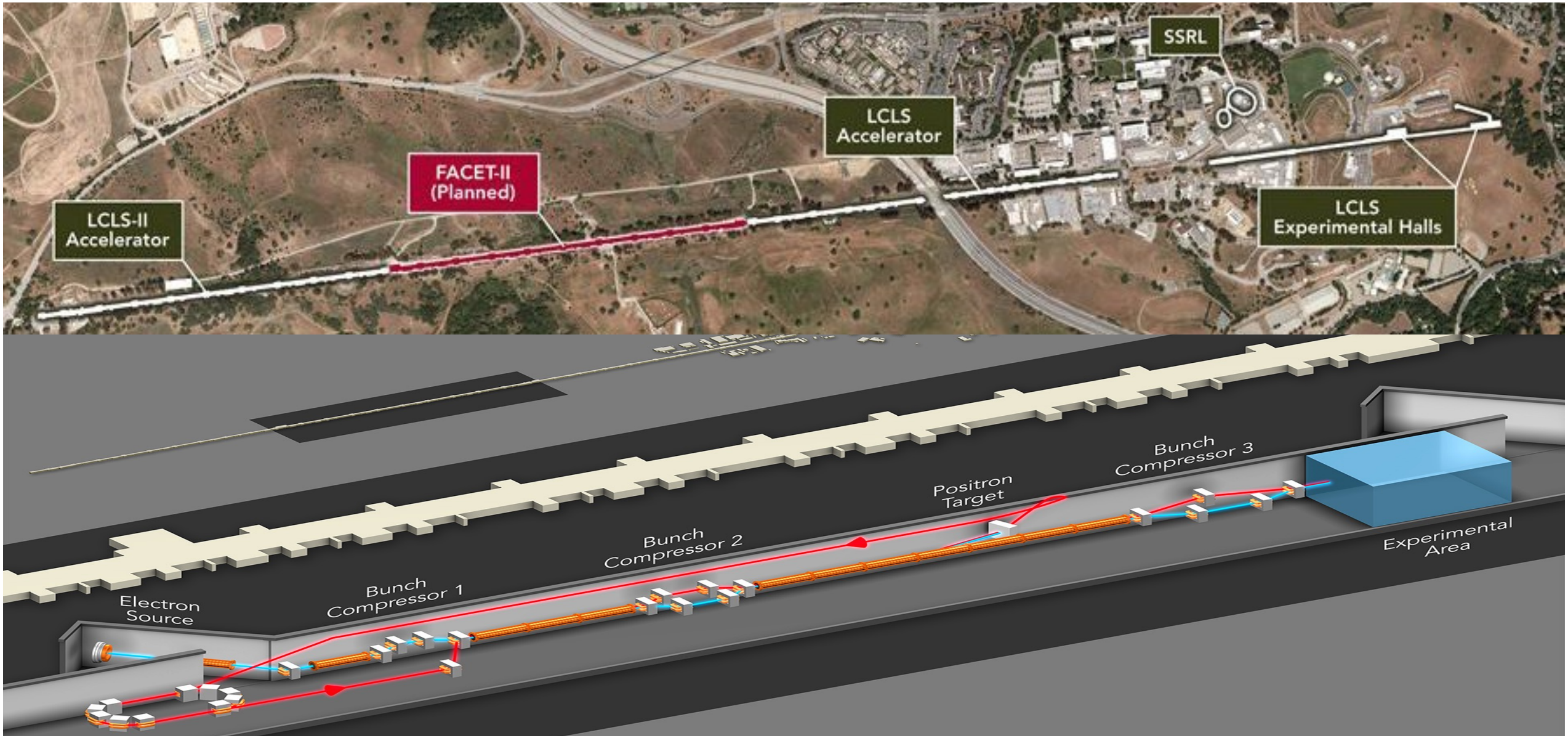
Brendan O'Shea / FACET-II Division Director

2026 Fourth US FCC Meeting

SLAC NATIONAL ACCELERATOR LABORATORY

Stanford University | U.S. DEPARTMENT OF ENERGY

FACET-II Facility

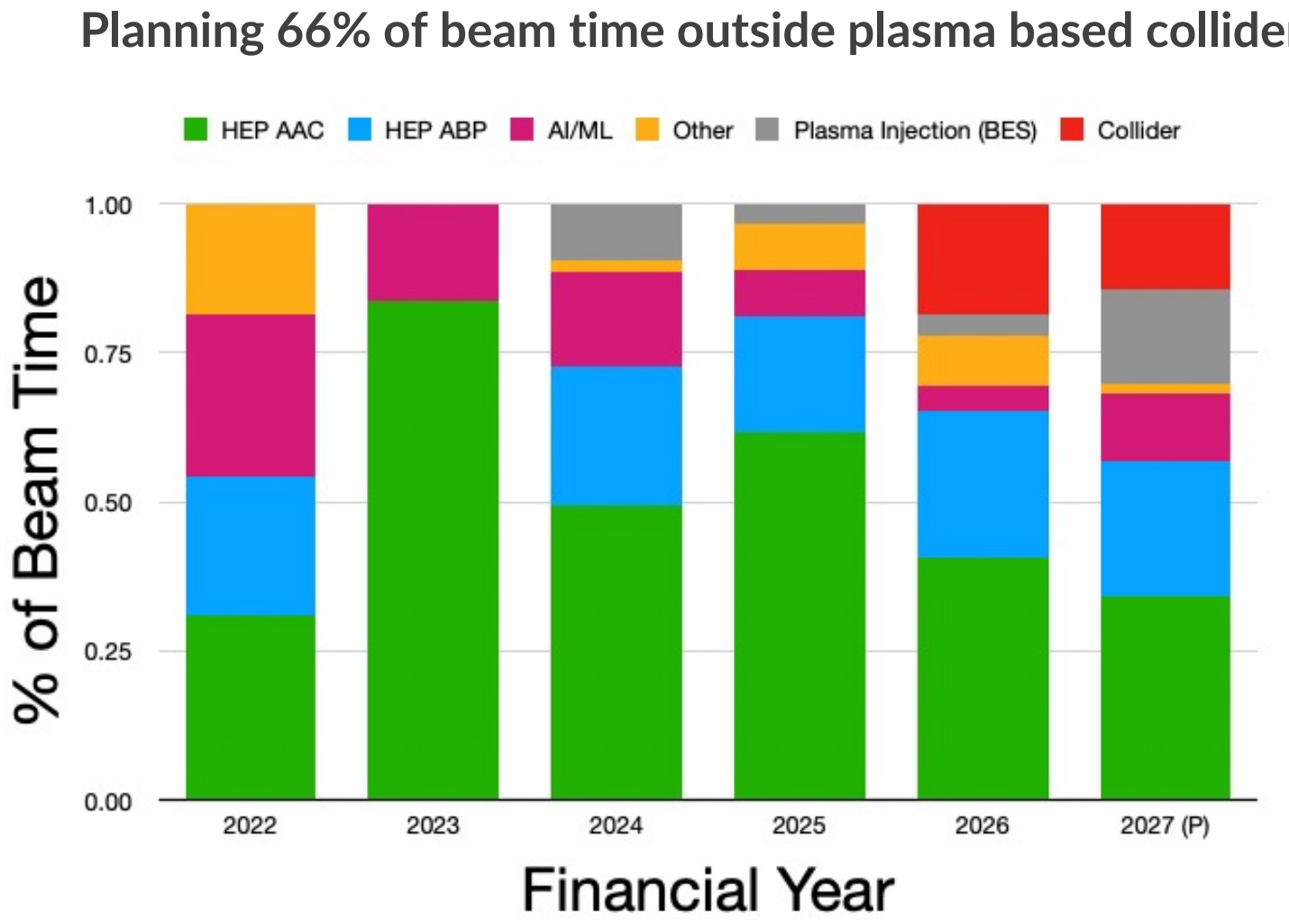


FACET-II Electron Beam Parameters

- Three beam configurations: Long bunch, short bunch and two bunch
- Parameters are not all independent!
- + indicates more values outside experience are possible, but no one has asked

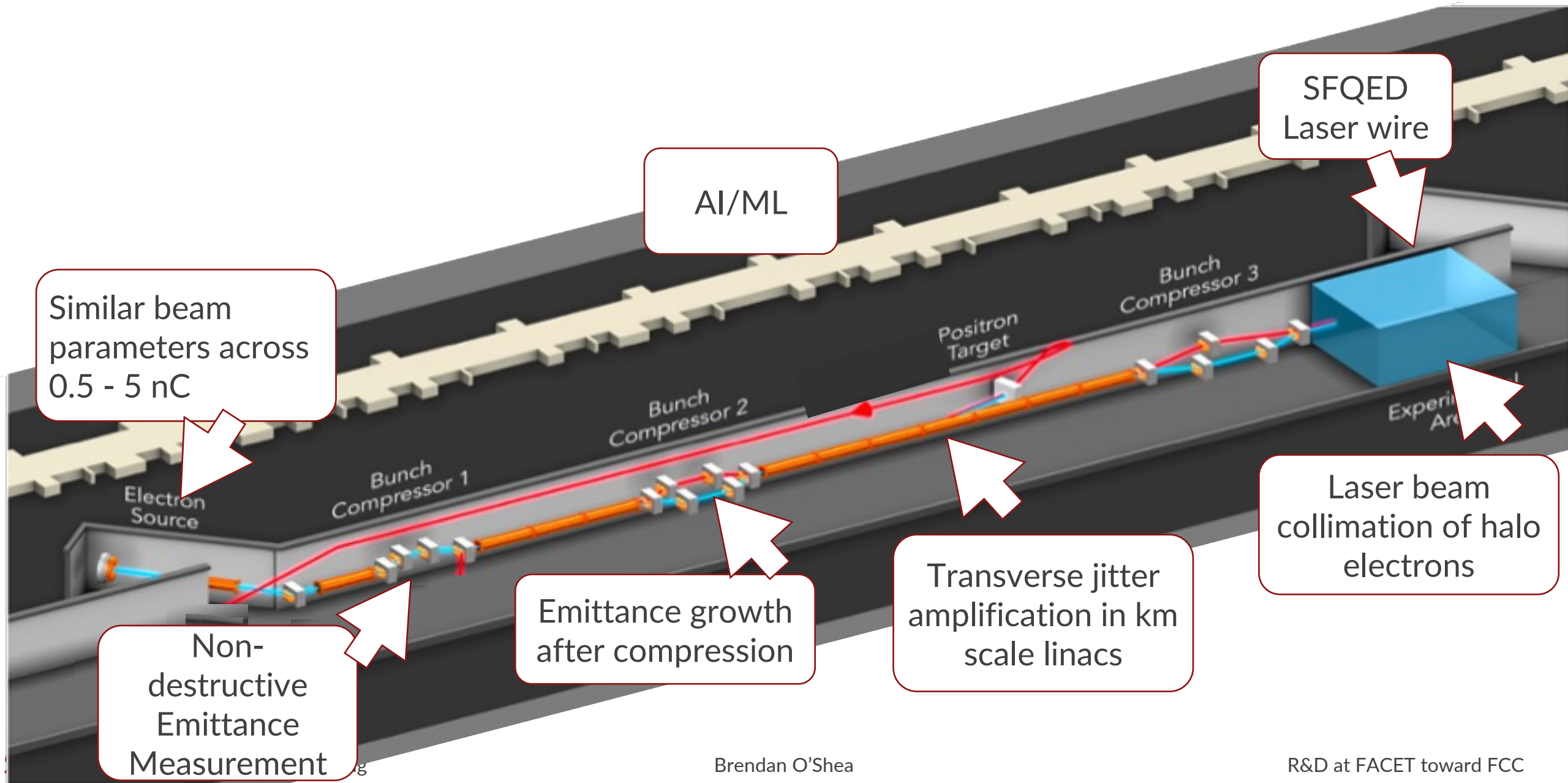
Parameter	Units	Nominal	Range
Repetition Rate	Hz	10	1 - 30
Charge	nC	1.6	0.7 - 5
Energy	GeV	10	4 - 13.5
Bunch Length	μm / fs rms	20 / 67	20 / 67 - 150 / 500+
Transverse Size at IP	μm	20	10 - 100
Beam Current	kA	10	1 - 100+
Normalized Emittance	μm	10	—
Energy Spread	%	2	—

Always looking for more experiments!

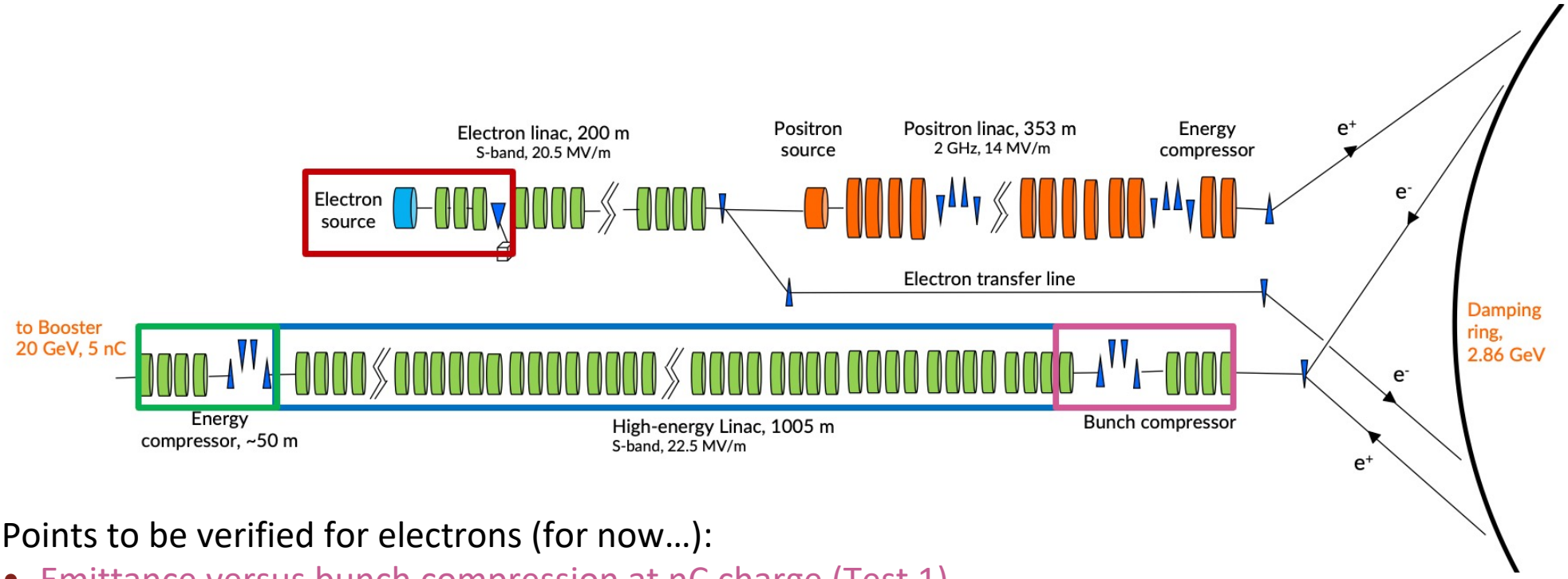


Would like to increase collider share – more users make that possible

FACET-II Collider Related R&D



FCC-ee Injector Studies at FACET-II



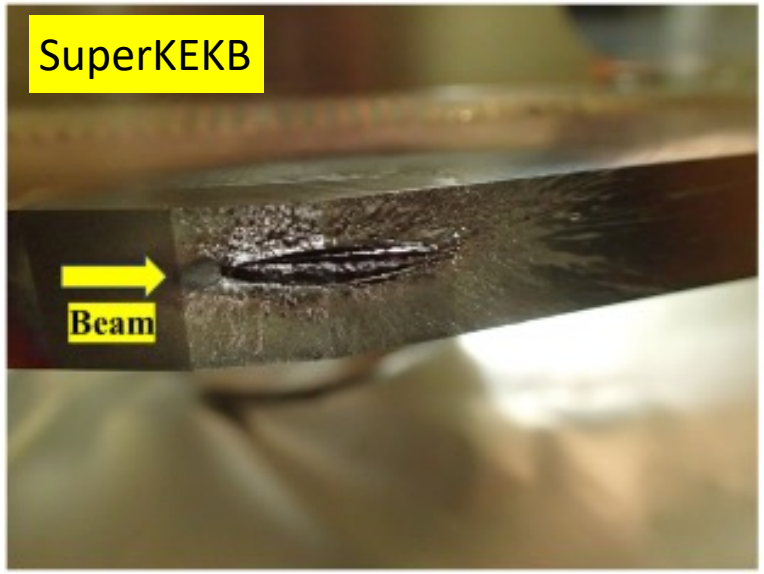
Points to be verified for electrons (for now…):

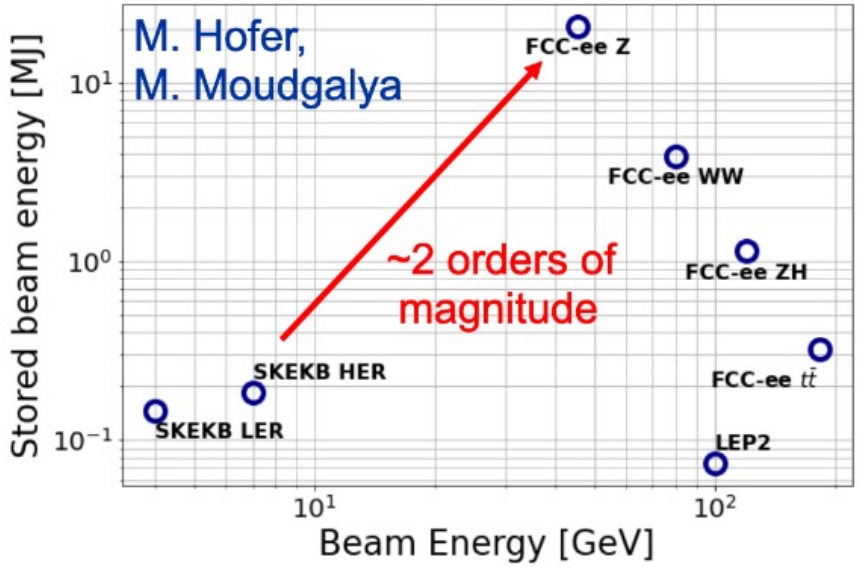
- Emittance versus bunch compression at nC charge (Test 1)
- Transverse jitter amplification and damping (Test 2)
- Bunch generation for top-up injection: charge scan from 0 to 5 nC (Test 3)
- Test of energy compressor (Bonus)

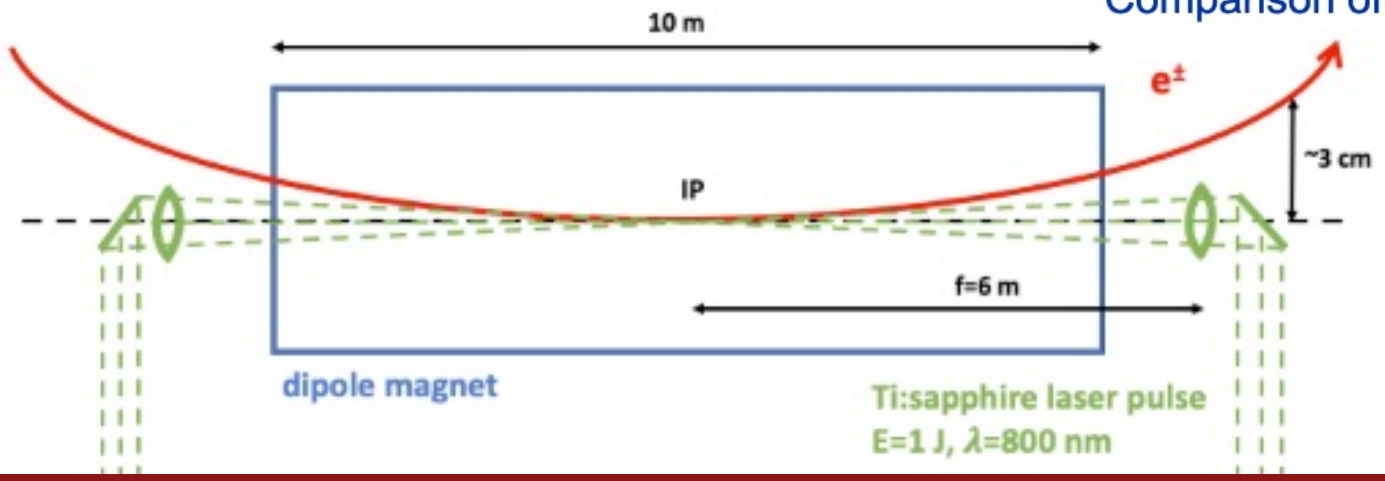
FACET-II in unique position to test FCC-ee design

Laser Control and Collimation of Particle Beams for Higgs Factories

- Builds on existing experimental apparatus that collides laser with electron beam.
- Modify setup to turn Gaussian beam into doughnut beam.
- Laser capable of targeting individual beams



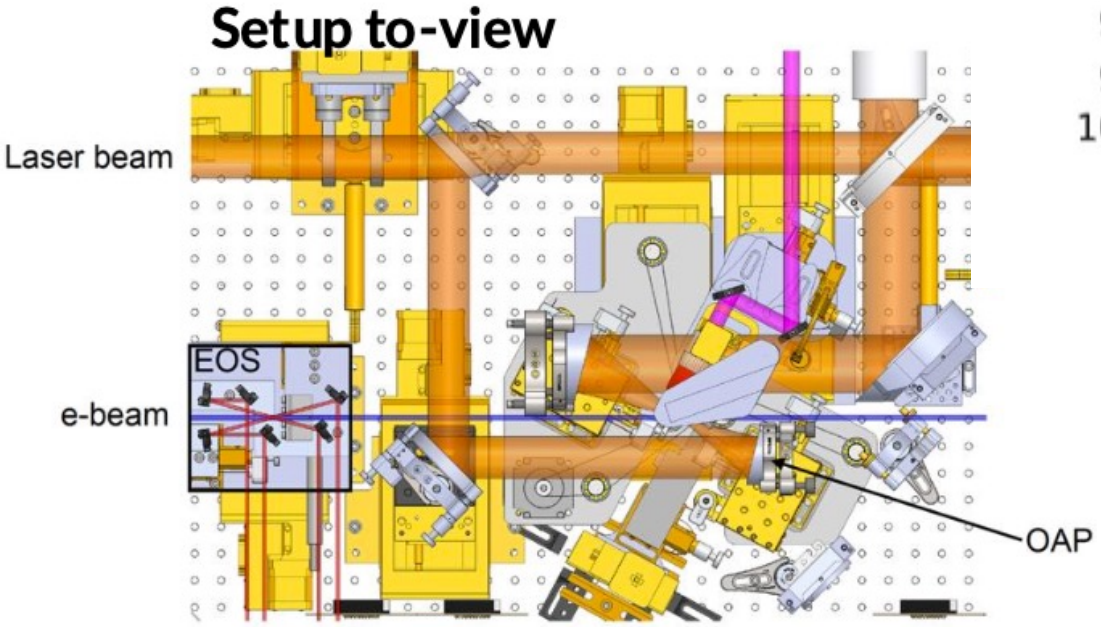


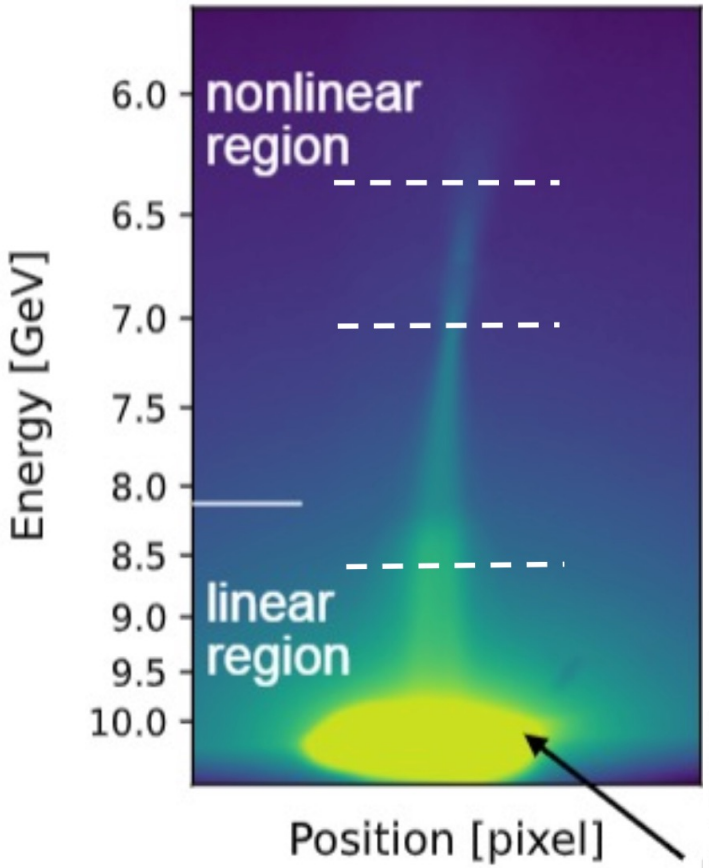


Develop an "indestructible" collimator, manage halo and bunch charge

SFQED and Laser Wire

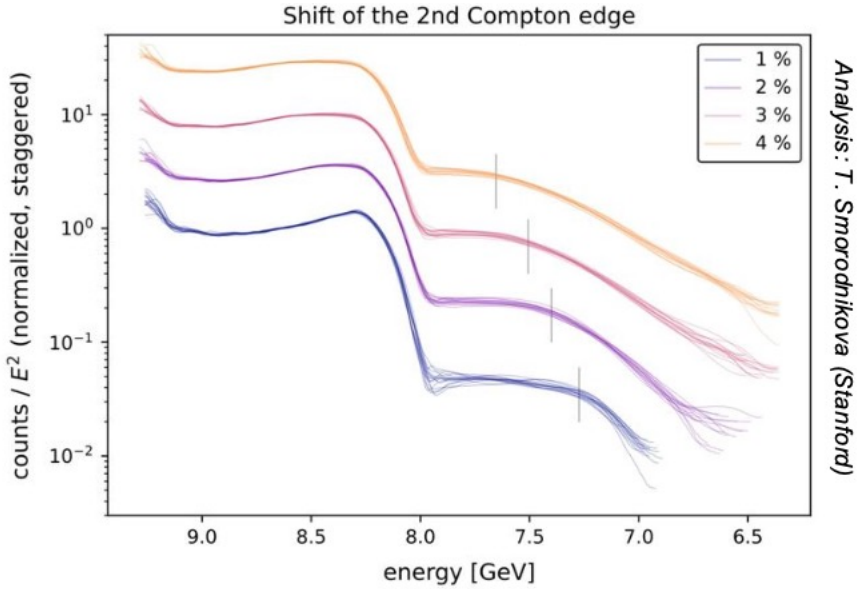
- Measure shifts in Compton edge and pair creation
- Laser wire
  - Only the highest field interacts non-linearly which makes the laser effectively very small





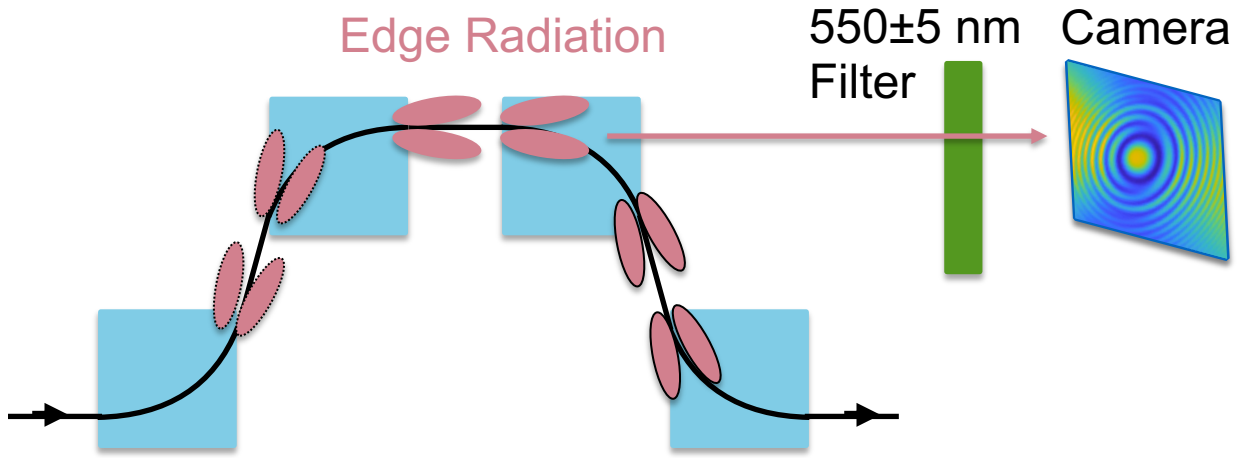
- FACET-II Advantages:
  - High beam energy
  - High certainty in beam energy

$$\chi = \frac{E_{beam}\hbar\omega}{{m_e}^2}(1 + cos\theta)a_0$$



Edge Radiation as a Diagnostic

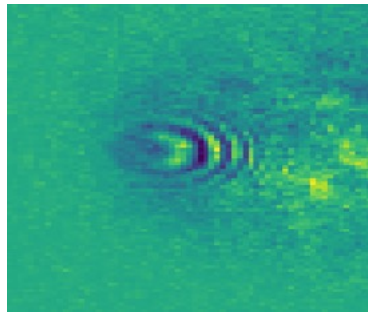
- Non-intercepting diagnostics are key for doing online analysis and control
  - Measure emittance continually without intercepting the beam
- Beam information encoded in interference pattern (inverse problem)

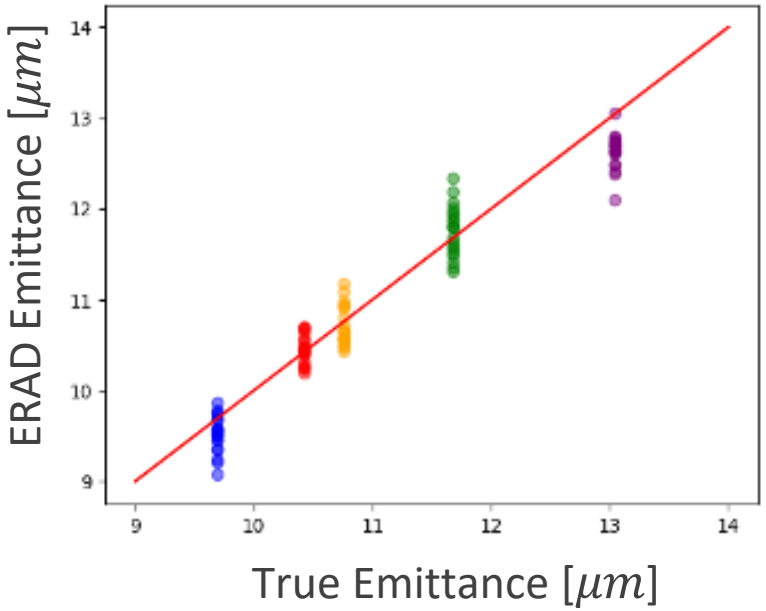


Inverse Problems

$$I(x) = |\int E(x - x')\rho(x)\mathrm{d}x|^2$$

Solve for ρ





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Thank You!