FACET-II | Facility for Advanced Accelerator Experimental Tests

Experimental science goals, beam requirements, detection/hardware needs

2019 FACET-II Science Workshop

Mark J. Hogan

October 29, 2019

U.S. DEPARTMENT OF ENERGY
Office of Science

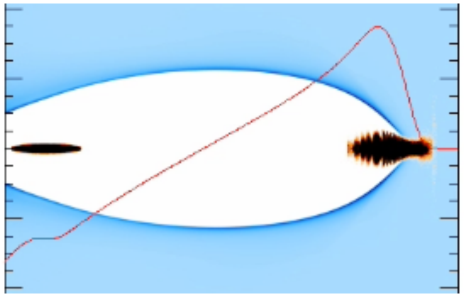
SLAC NATIONAL ACCELERATOR LABORATORY

FACET-II Call for Proposals Produced Strong Interest

https://portal.slac.stanford.edu/sites/ard_public/facet/newnav/Pages/tf/facet/FACETCurrentResearch.aspx

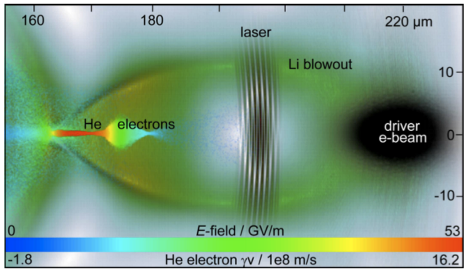
PWFA Beam Quality (5 proposals, 2 'Excellent')

- PIs: Andonian, Joshi/Rosenzweig (UCLA), Hogan (SLAC), Litos (UC Boulder), Adli (U Oslo), Nagaitsev (FNAL), Gessner (CERN)



PWFA Injection (6 proposals, 1 'Excellent')

- PIs: Hidding/Ullmann/Habib (U Strathclyde), Vafei (Stony Brook), Zhang/Xu (UCLA), Corde (Ecole Polytechnique), Rosenzweig (UCLA)

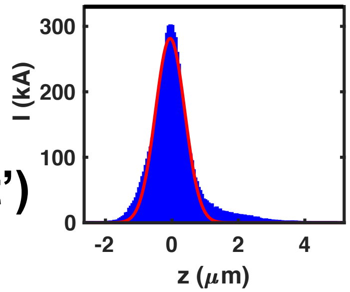


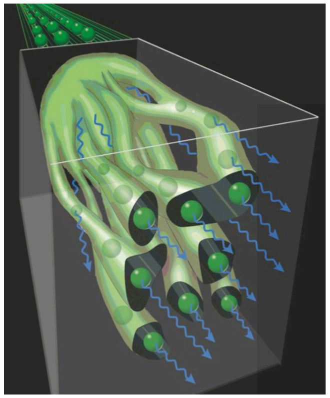
PWFA Other (9 proposals, 2 'Excellent')

- PIs: Corde (Ecole Polytechnique), Joshi/Marsh/Rosenzweig (UCLA), Litos (UCBoulder), Fiuza/Marinelli (SLAC), Heinemann (DESY), Hidding/Habib (U Strathclyde)

Machine Learning & Diagnostics (11 proposals, 1 'Excellent')

- PIs: Osterhoff (DESY), Marksteiner/Scheinker (LANL), Emma/O'Shea/White (SLAC), Downer (UTAustin), Hidding/Scherkl/Sutherland (U Strathclyde), Fiorito, Andonian/Ruelas (Radiabeam)



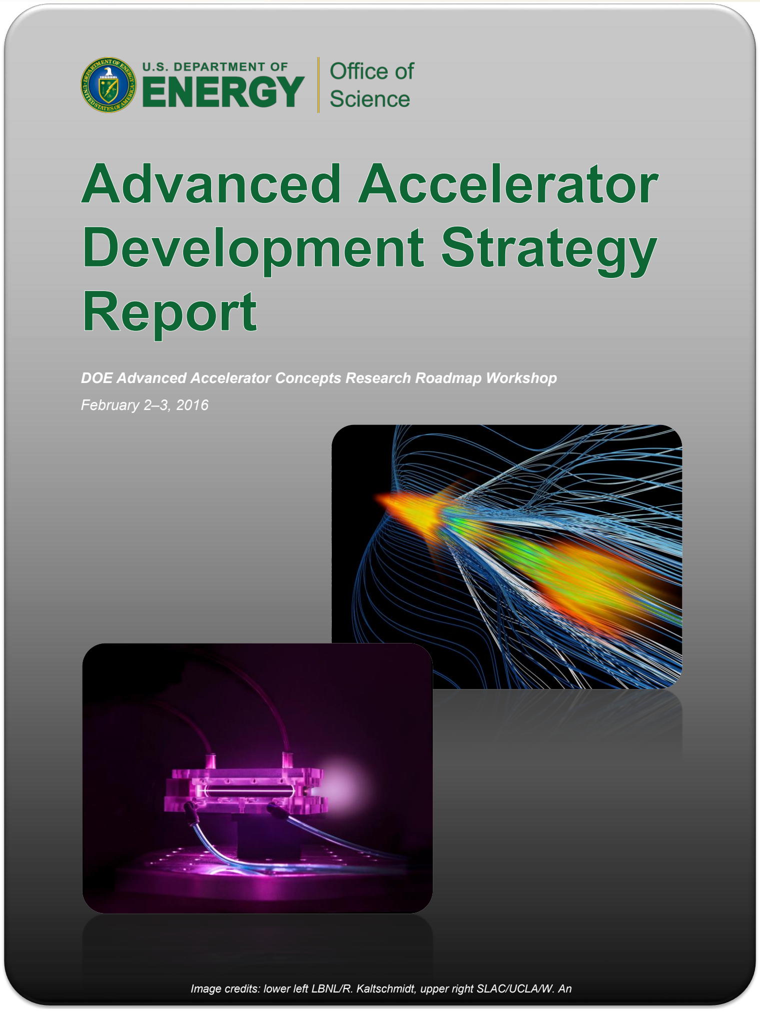


Other: Dielectrics, Extreme Beams…(4 proposals, 1 'Excellent')

- PIs: Meuren (PPPL), Litvinenko (Stonybrook), O'Shea (SLAC), Rosenzweig (UCLA), Chen (UPenn)

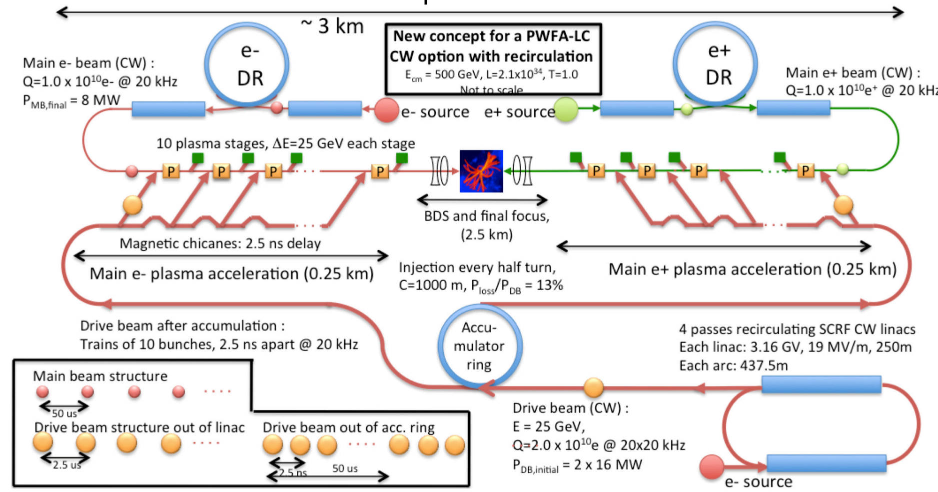
FY20 experimental schedule will be organized around the seven experiments that received an 'Excellent' ranking by the FACET-II PAC

PWFA Experimental Program at FACET-II is Motivated by Roadmap for Future Colliders Based on Advanced Accelerators



http://science.energy.gov/~/media/hep/pdf/accelerator-rd-stewardship/Advanced_Accelerator_Development_Strategy_Report.pdf

A Conceptual PWFA-LC



E. Adli et al., ArXiv 1308.1145
J. P. Delahaye et al., Proceedings of IPAC2014

Key elements for the next decade:

- Beam quality – focus on emittance preservation at progressively smaller values
- Positrons – use FACET-II positron beam identify optimum regime for positron PWFA
- Injection – ultra-high brightness sources, staging studies with external injectors

E-300: Energy Doubling of Narrow Energy Spread Witness Bunch while Preserving Emittance with a High Pump-to-Witness Energy Transfer Efficiency in a Plasma Wakefield Accelerator

See presentation by Chan Joshi today 4:00PM

Boulder UCLA SLAC

Science deliverables:

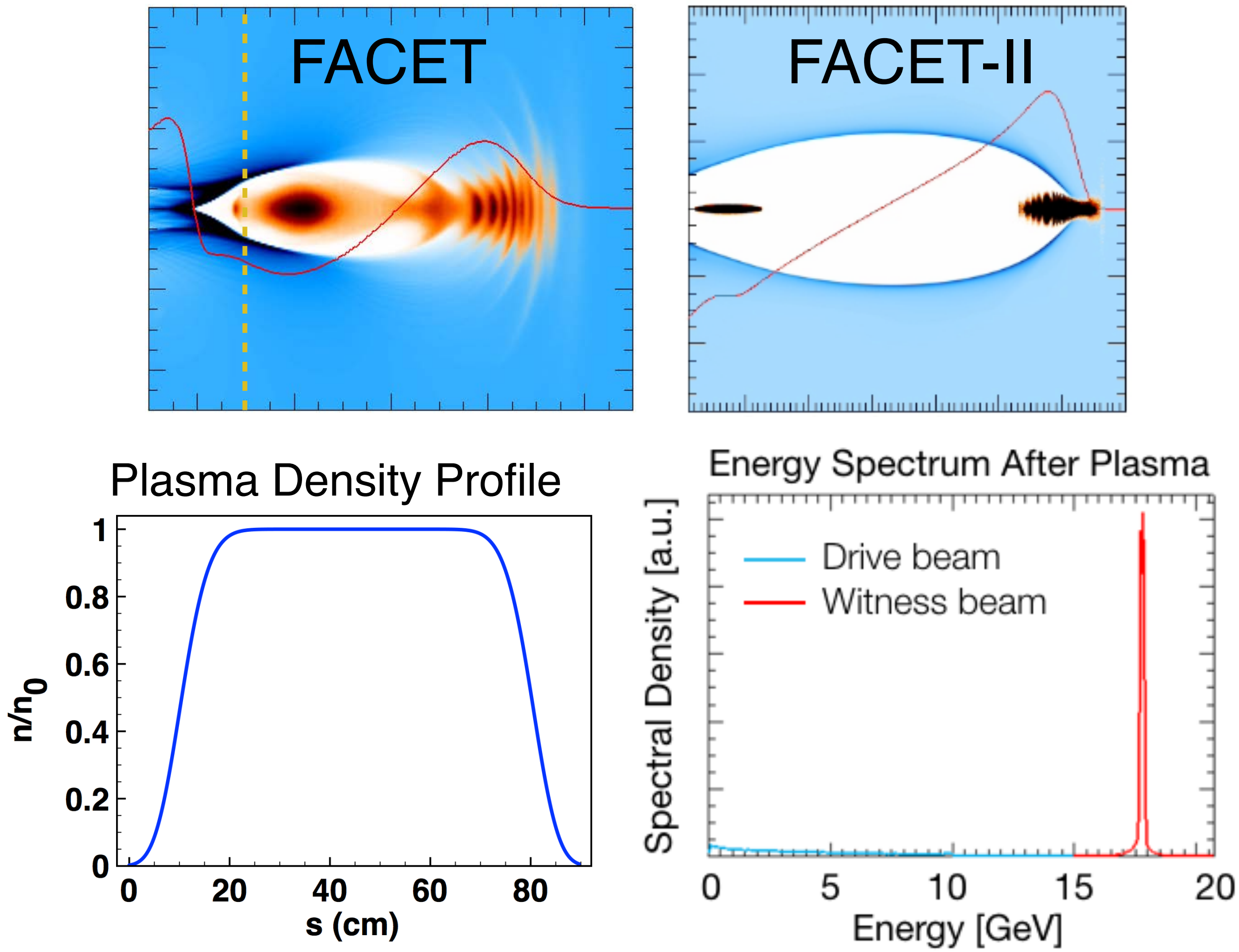
- Pump depletion of drive beam with high efficiency & low energy spread acceleration
- Beam matching and emittance preservation

Key upgrades:

- Photoinjector beam
- Matching to plasma ramps
- Differential pumping
- Single shot emittance diagnostic

Plasma source development:

- Between 10-20μm emittance, beam expected to ionize He in down ramp
- Next step laser ionized hydrogen source in development through E-301

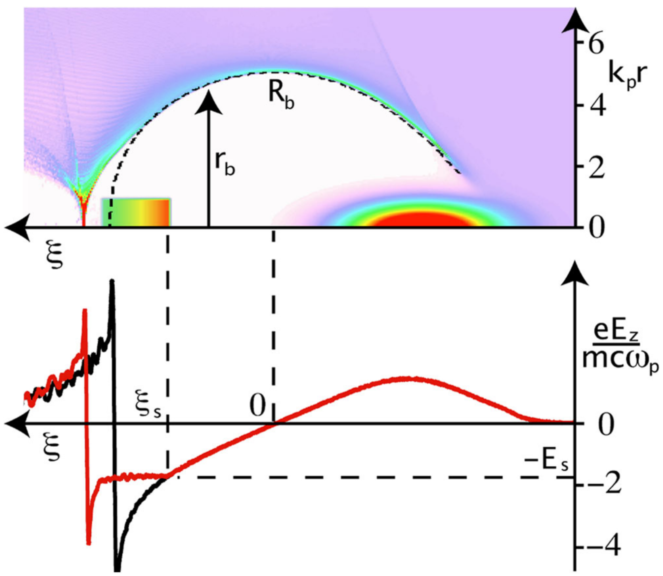


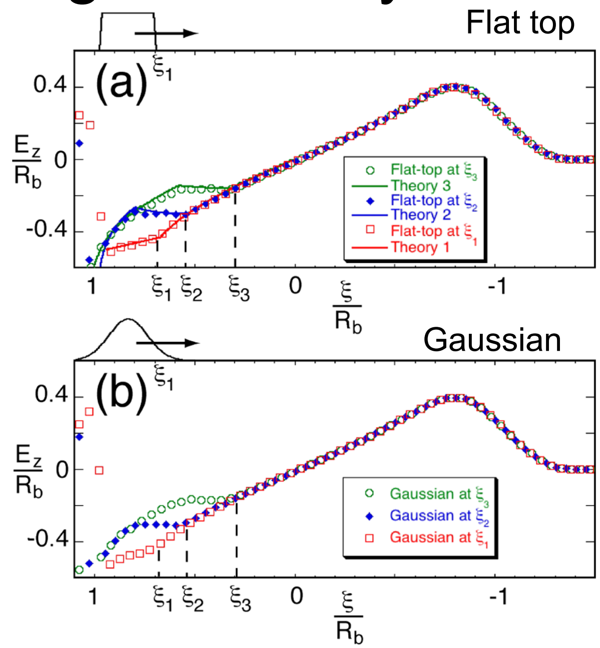
C Joshi et al 2018 Plasma Phys. Control. Fusion 60 034001

Flexibility of the photo-injector allows optimal beams for PWFA studies

Beam Loading in Non-linear Wakes

Theoretical framework, augmented by simulations, provides a recipe





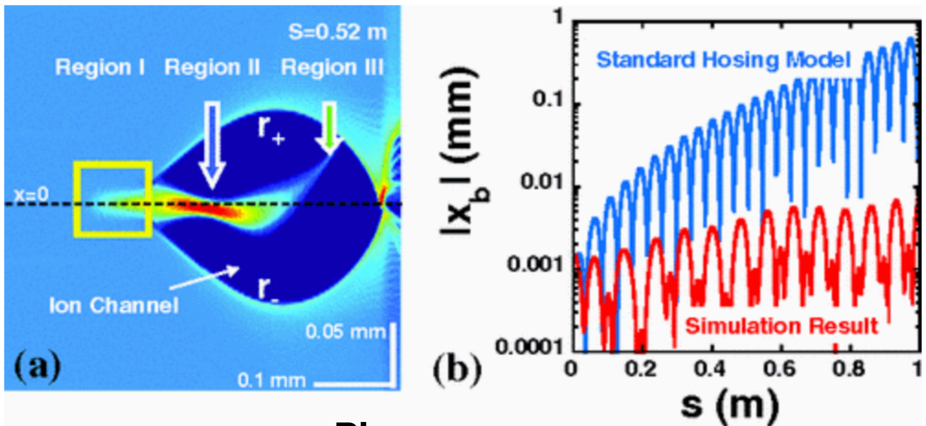
Roadmap emphasizes the need to answer the question: Is it possible to strongly load the longitudinal wake without strong transverse wakes and BBU?

- Relativistic Beams provide a non-evolving wake
- Possible to nearly flatten accelerating wake – even with Gaussian beams
- Gaussian beams provide a path towards $\Delta E/E \sim 10^{-2}$ - 10^{-3}
- Applications requiring narrower energy spread, higher efficiency or larger transformer ratio → Shaped Bunches

$$\mathcal{L} = \frac{P_b}{E_b}\left(\frac{N}{4\pi\sigma_x\sigma_y}\right)$$

See: M. Tzoufras et al, Phys. Plasmas ***16****, 056705 (2009); M. Tzoufras et al, Phys. Rev. Lett.* ***101****, 145002 (2008); W. Lu et al., Phys. Rev. Lett.* ***96****, 165002 (2006) and References therein*

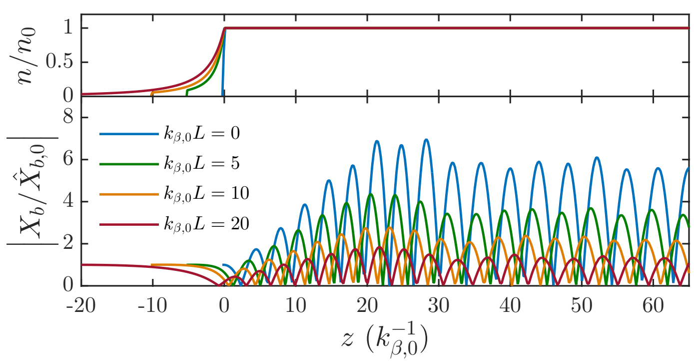
E-302: Transverse Wakefields and Instabilities in Plasma Wakefield Accelerators



Many **mechanisms of emittance growth** have been put forward, e.g. ion motion, hosing…

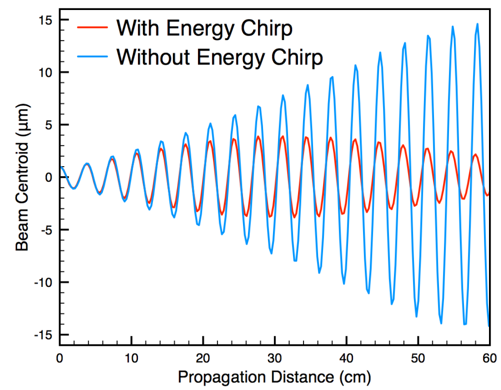
D. Whittum et al. PRL 67, 991 (1991) **LBNL/SLAC**
J. Rosenzweig et al., 95, 195002 (2005) **UCLA**
C. Huang et al., PRL 99, 255001 (2007) **UCLA**
V. Lebedev et al., PRST-AB 20, 121301 (2017) **FNAL**

Plamsa ramps

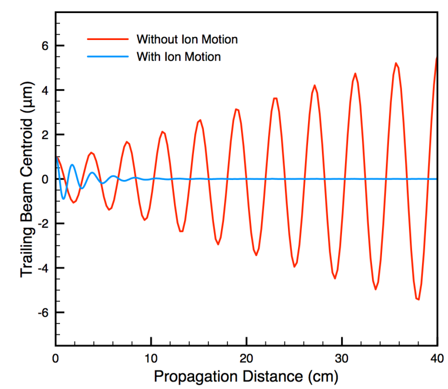


T. Mehrling et. al., PRL 118, 174801 (2017) **DESY/LBNL**

Energy Spread



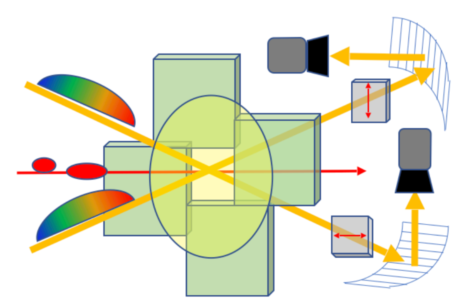
Ion Motion



W. An et al. PRL 118, 244801 (2017) **UCLA**

Proposed **techniques for mitigation** need to be tested experimentally

Quadrant EOS to measure r-t beam correlations



Goal is to measure correlation along ~1ps long bunch

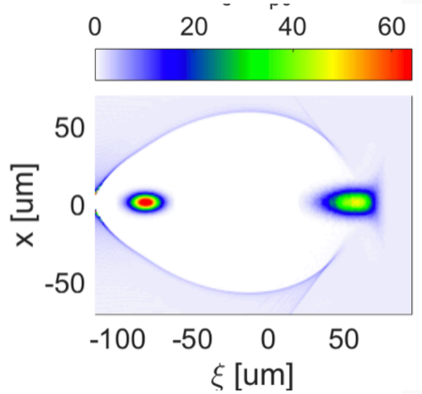
Benchmark theoretical and numerical predictions will be a strong component of FACET-II Program

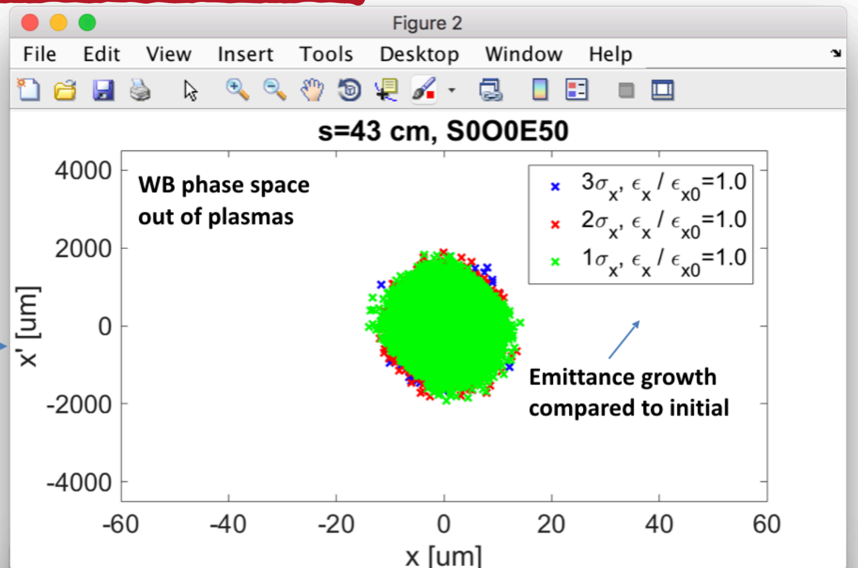
Instability Possibly Strong Enough to Measure – Need Good Diagnostics and Development of New Techniques

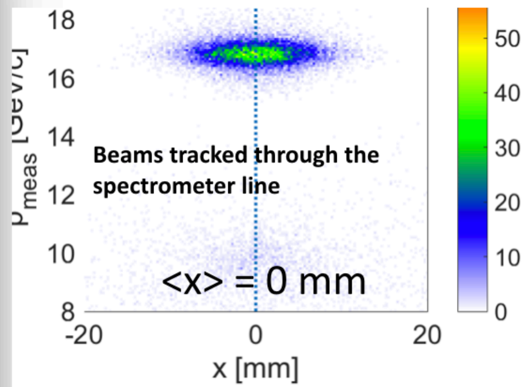
See presentation by Mike Litos Wed. 11:00AM

Observability in experiment:

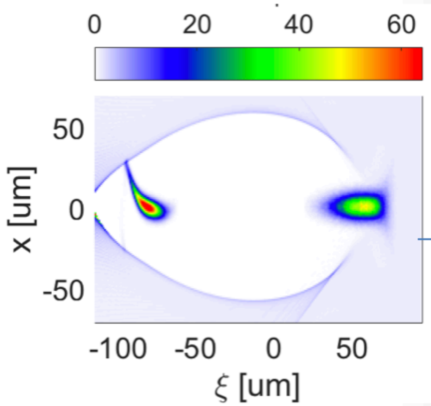
Case 1: On-axis MB

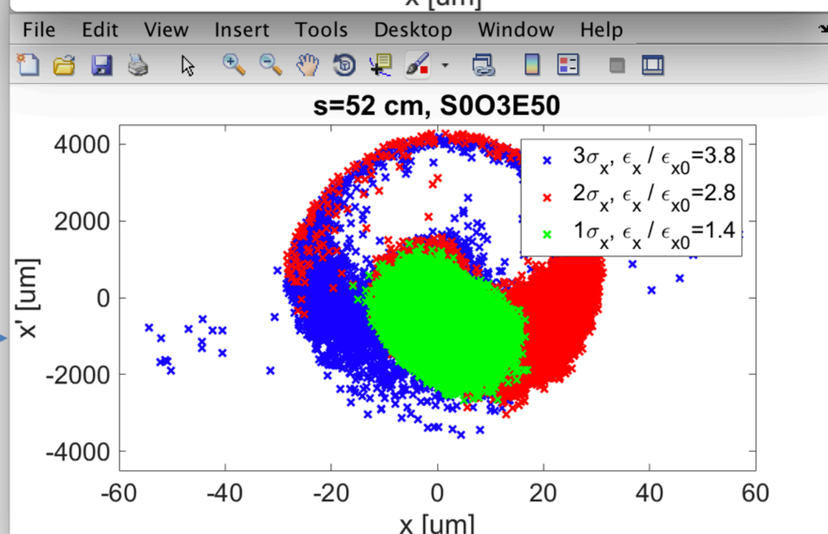


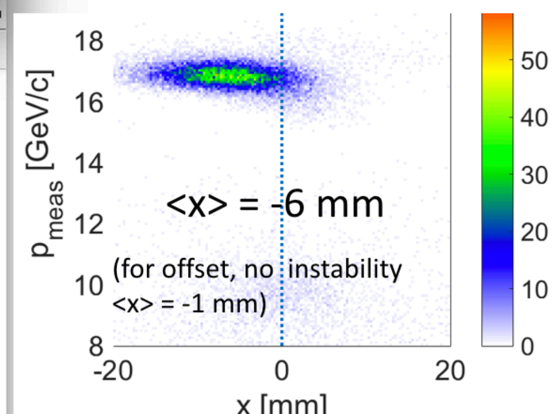




case 2: Off-axis MB







A factor 3 of emittance growth for 2σ_z of beam is significant, but may be hard to distinguish from other sources (e.g. mismatch). Similar arguments situation for σ_x (directly observable on profile monitors)

Observables:

- emittance
- spot sizes
- kicks
- as function of energy

Optical Measurements of Nanosecond-scale Plasma Channel Evolution Excited by Beam-driven Plasma Wakes at FACET (E224)

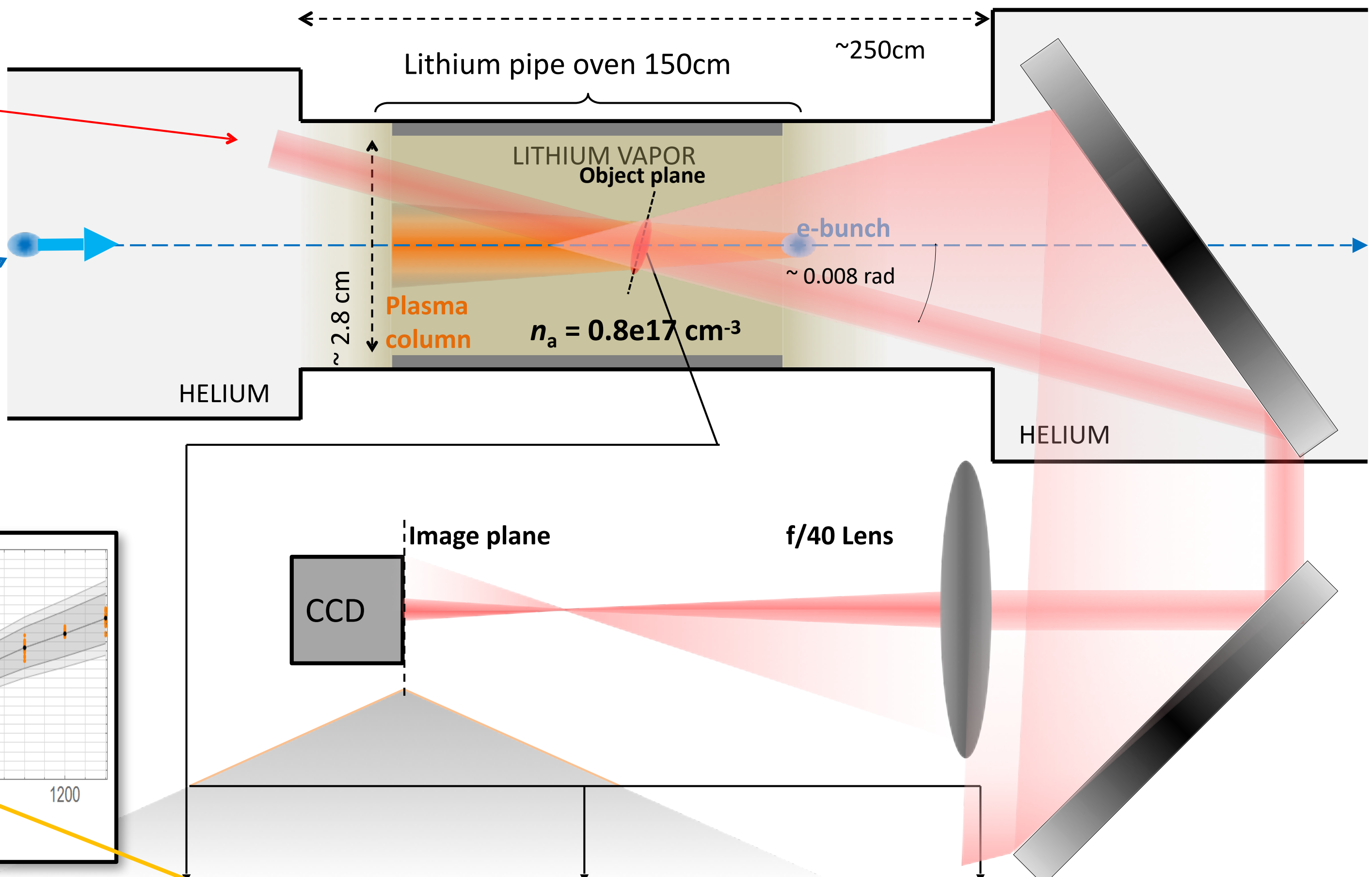
See presentation by Mike Downer Wed. Noon

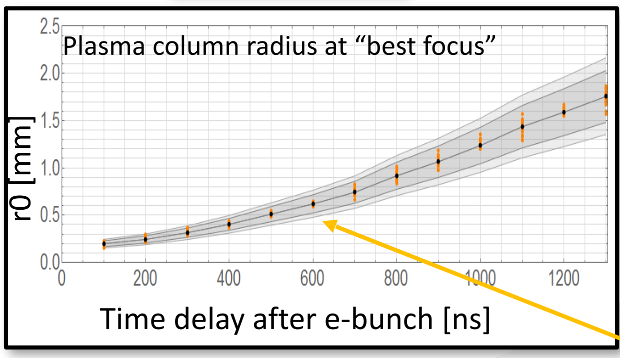
Laser probe

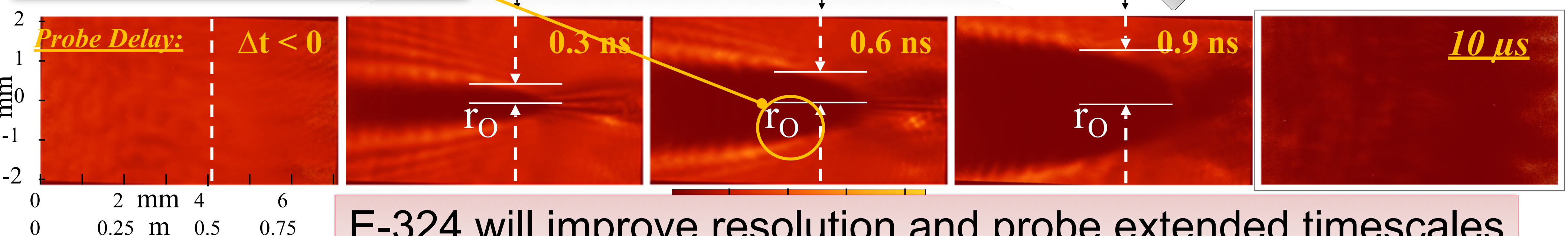
E_{pr} = 1 mJ
λ_{pr} = 800 nm
w_p = 2.5 mm
τ_{pr} = 70 fs
jitter ~ 0.1 ps

FACET e-bunch

E_e = 20 GeV
Q = 2.4 nC
Σ_r = 30 µm
σ_z = 55 µm







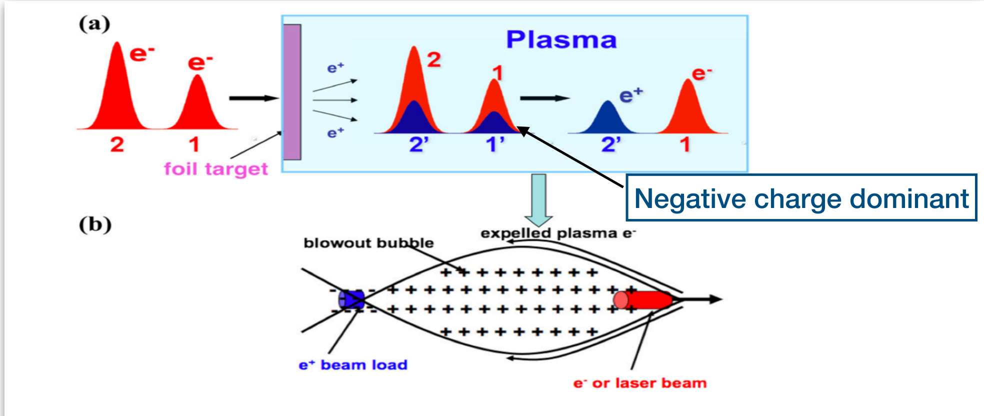
E-324 will improve resolution and probe extended timescales

E-303: Generation and Acceleration of Positrons at FACET-II

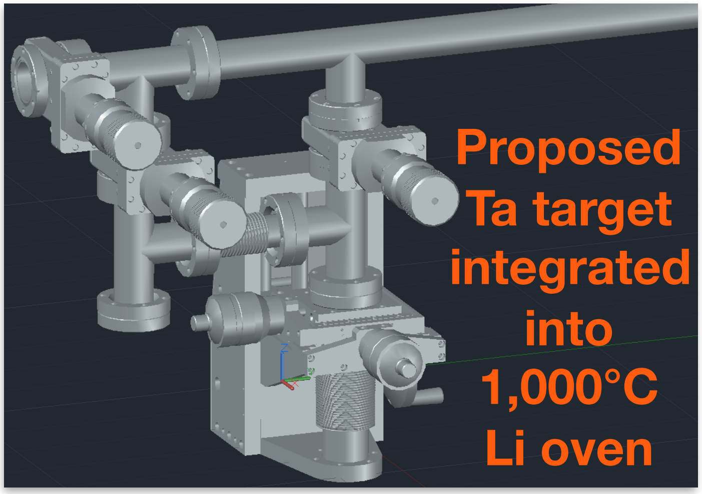
See presentation by Ken Marsh Wed. 1:30PM

High-Quality Positron Beams Will Be a Unique Feature of FACET-II – but not available until 2022

- Several candidate regimes for positron acceleration in plasmas but much of the physics remains unstudied experimentally
- Proposal to use two-bunch setup and thin converter target to shower positrons into accelerating phase of plasma wake
- Start-to-end simulations predict this is not a path to collider relevant positron beam parameters – off by order(s) of magnitude in intensity & quality



X. Wang, et. al., Positron Injection and Acceleration on the Wake Driven by an Electron Beam in a Foil-and-Gas Plasma, Phys. Rev. Lett. **101**, 124801 (2008)

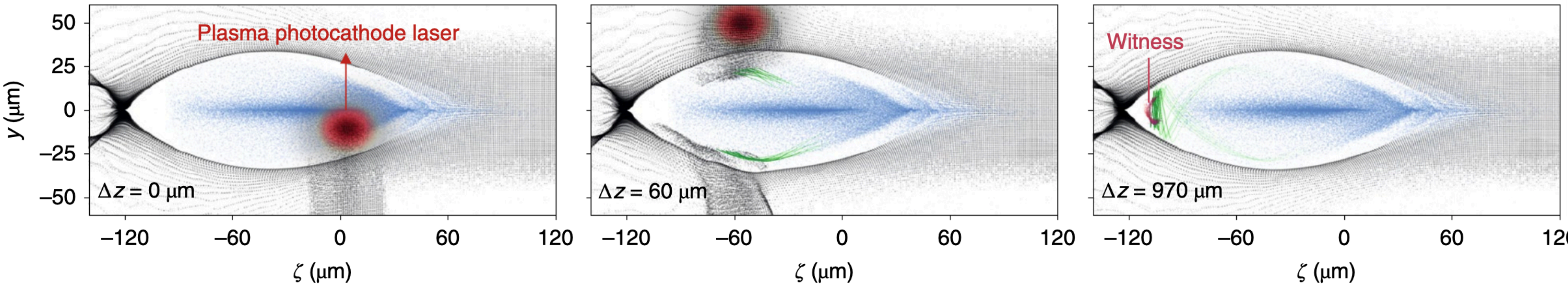


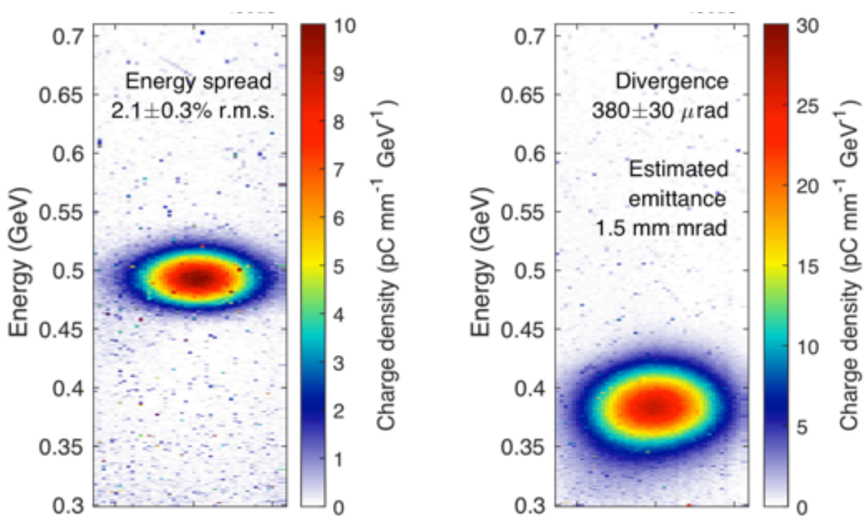
This technique should make for a good for PhD thesis but is not adequate for addressing roadmap goals

Development of High-Brightness Electron Sources e.g. Laser Triggered Injection in Electron-beam Driven PWFA

'Trojan Horse' Injection

See presentation by Bernhard Hidding Wednesday 3:30PM





A. Deng et al. *Nature Physics* August 2019

- Team of students and postdocs developed the techniques to align, synchronize injection and characterize the injected beams
- Measured beam parameters inline with expected values from simulations
- Experiments at FACET-II will optimize this technique (co-linear injection)

Success of E-210 has generated a family of follow-up proposals for FACET-II:
E-31X: Trojan Horse-II, Plasma Torch, Dragon Tail, Plasma Afterglow, Icarus

Development of High-Brightness Electron Sources e.g. Laser Triggered Injection in Electron-beam Driven PWFA

'Trojan Horse' Injection

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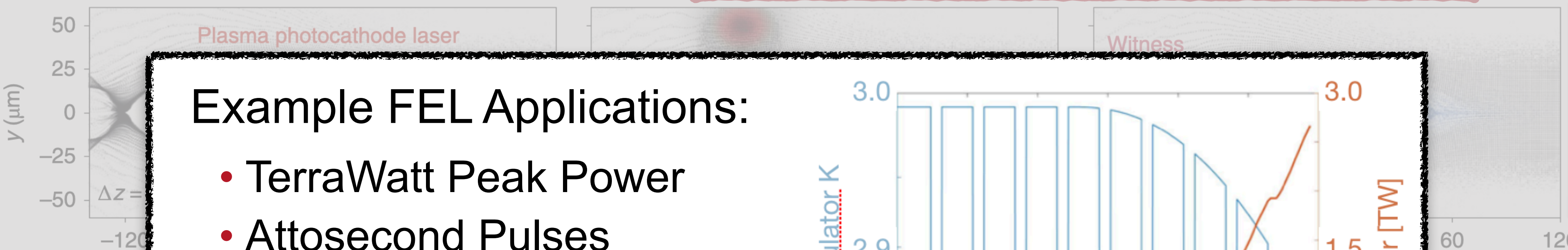
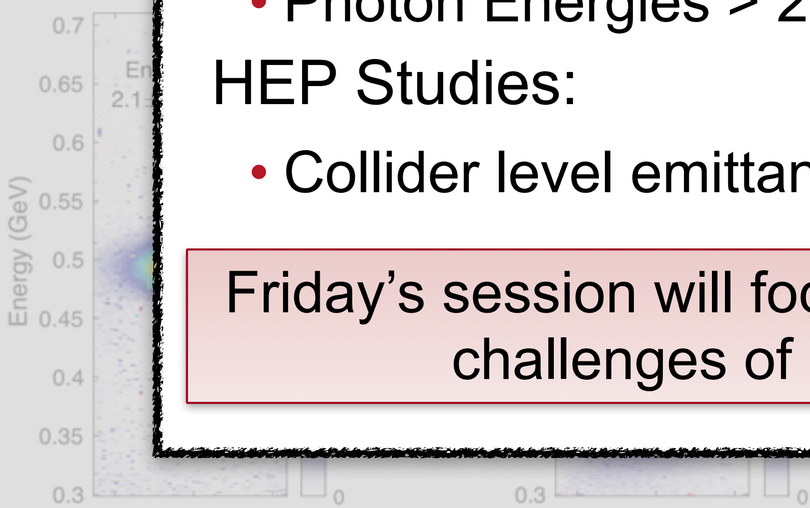


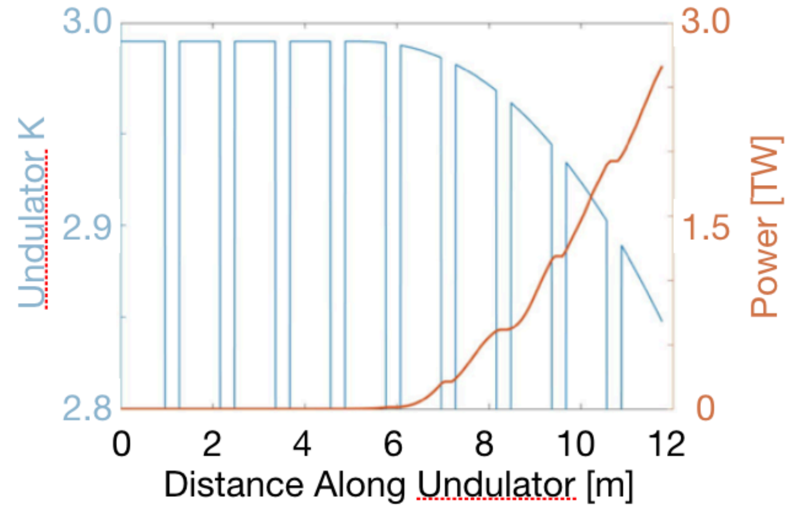


Example FEL Applications:

- TerraWatt Peak Power
- Attosecond Pulses
- Photon Energies > 20keV

HEP Studies:

- Collider level emittance



Friday's session will focus on the opportunities and common challenges of plasma based FEL concepts

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- Path to collider level 10-100nm emittance beams without damping rings

A. Deng et al. *Nature Physics* August 2019

Success of E-210 has generated a family of follow-up proposals for FACET-II: E-31X: Trojan Horse-II, Plasma Torch, Dragon Tail, Plasma Afterglow, Icarus

See presentation by Sebastien Corde Wednesday 2:00PM

E-305: Beam Filamentation & Bright Gamma-ray Bursts

INSTITUT POLYTECHNIQUE DE PARIS UCLA SLAC

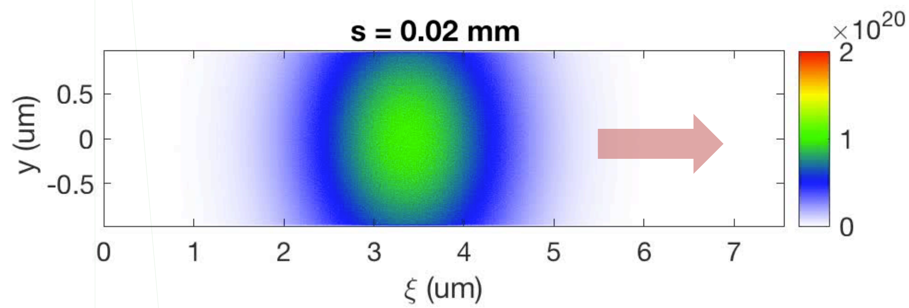
Relativistic streaming instabilities are pervasive in astrophysics

Transverse beam stability:

- If $k_p\sigma_r \leq 1$ the beam is focused towards a stable equilibrium: stable plasma-wave excitation.
- If $k_p\sigma_r > 1$ the beam undergoes transverse instabilities.

E-305 experiment

FACET 10 GeV Electron Bunch
Evolution during propagation over 1.5 mm of Al ($1.8 \cdot 10^{23}$ cm^{-3})



Charge	Normalized emittance	Angular spread	Beam size	Bunch length	Peak current
2 nC	3 mm.mrad	68.74 μrad	2.23 μm	1.5 μm	150 kA

Plasma return current flows inside the relativistic e⁻ beam.
Two inter-penetrating e- flows.

Large variety of EM-modes can develop from noise
Weibel (CFI), Oblique, Two-stream
They break up the beam.

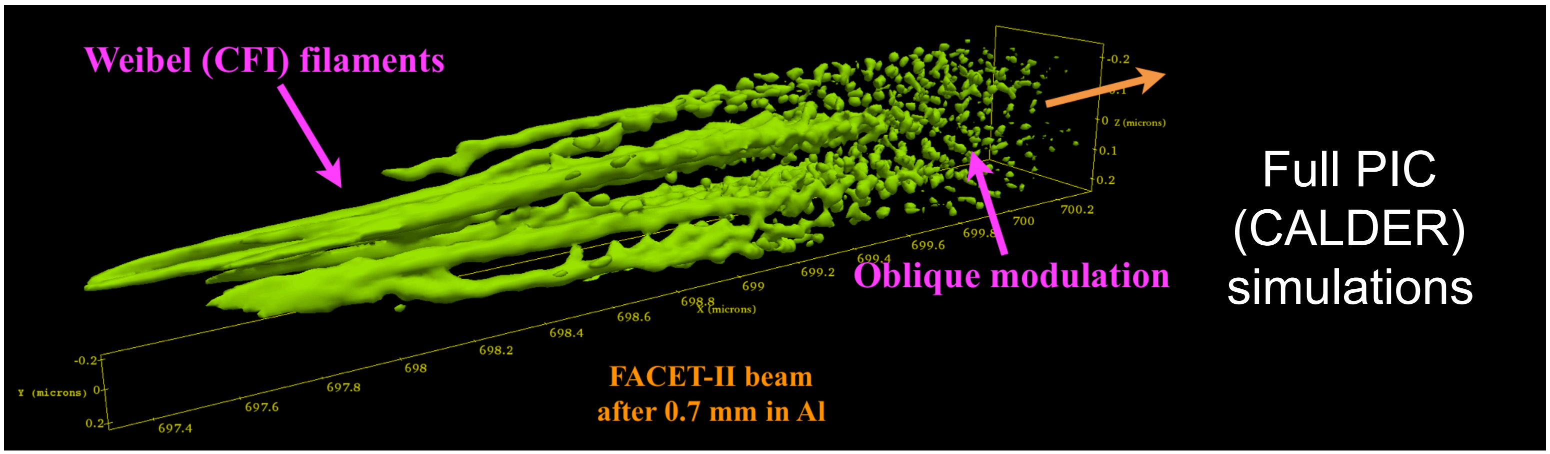
Which mode has the fastest growth rate?
What is the amplitude of those modes?
How do they affect the beam?

FACET-II beam allows exploration of high γ and wide range of n_b/n_p (10^{-4}-1), which is ideal to explore growth and interplay between the two instabilities

E-305: Beam Filamentation Instabilities and γ-ray Generation

Gamma rays in solids

Once filamentation instability has developed, beam electrons experience large electromagnetic fields, bending their trajectories, and leading to synchrotron-type gamma-ray emission.



Potential for giant gamma-ray bursts:

- Study of gamma-ray yield as a function of plasma density and n_b/n_p
- Wakefield versus filamentation regime
- Could exceed 10% conversion efficiency from electrons to gamma rays, with unique opportunities for gamma-ray source applications and for 2-step positron sources

Collaboration combines interests of several groups in astrophysical plasma instabilities, plasma focusing, novel positron production experiments

E-320: Probing Strong-field QED at FACET-II
Collision of ~10^{20} W/cm² laser pulses with 10-13 GeV electrons

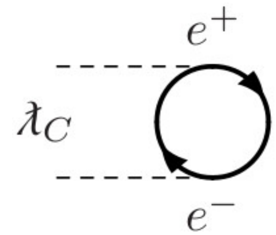
See presentations at ExHILP2019: https://web.stanford.edu/group/pulse_institute/exhilp/

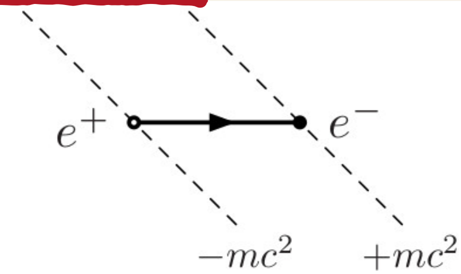
SLAC

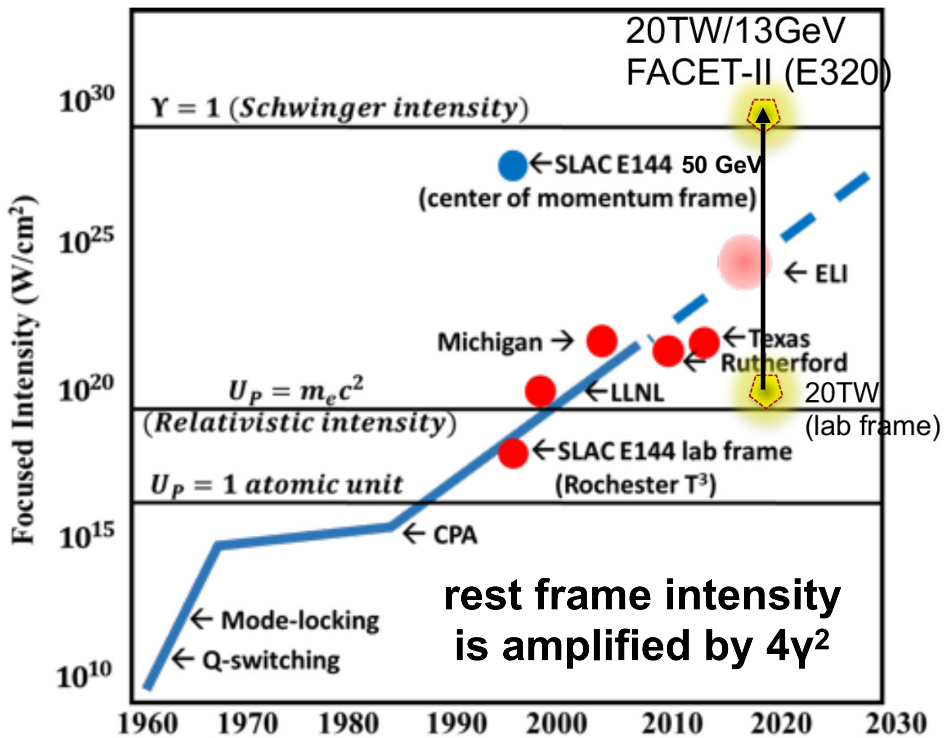
QED critical field: $E_{cr} = mc^2/e\lambda\!\!\!^{-}_C \sim 10^{18}$ V/m

Energy: mc^2 ~ MeV; **Length**: $\lambda\!\!\!^{-}_C = \hbar/mc \sim 10^{-13}$ m;

Vacuum fluctuations: uncertainty principle limits extent to $\lambda\!\!\!^{-}_C$, critical field can transfer mc^2: real pair

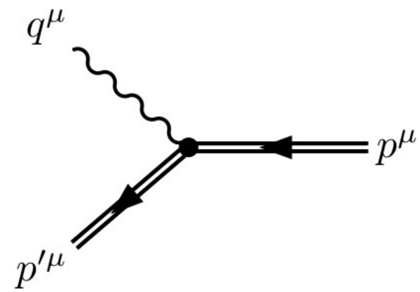




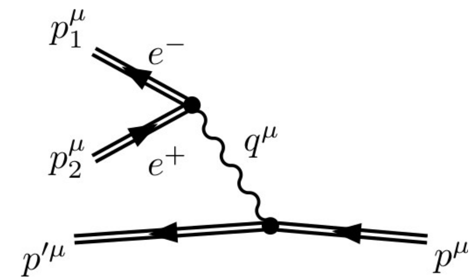


Critical intensity: ~10^{29}W/cm², can be achieved in the rest frame of ultrarelativistic electrons: $\chi = \Upsilon \sim \gamma E/E_{cr}$ (γ: Lorentz factor; E: electric field)

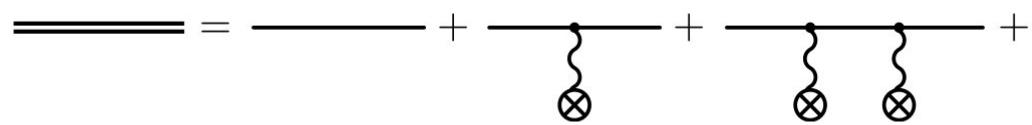
Fundamental Strong-field QED processes



Photon emission



Electron/positron pair production



Dressed states ($a_0 \gtrsim 1$): laser nonperturbative: concerted interaction with multiple laser photons

Quantum regime ($\chi = \Upsilon \gtrsim 1$): stochastic photon emission & recoil disruption of trajectories; pair production no longer exponentially small

E-320: Probing Strong-field QED at FACET-II
Collision of ~10^{20} W/cm^2 laser pulses with 10-13 GeV electrons

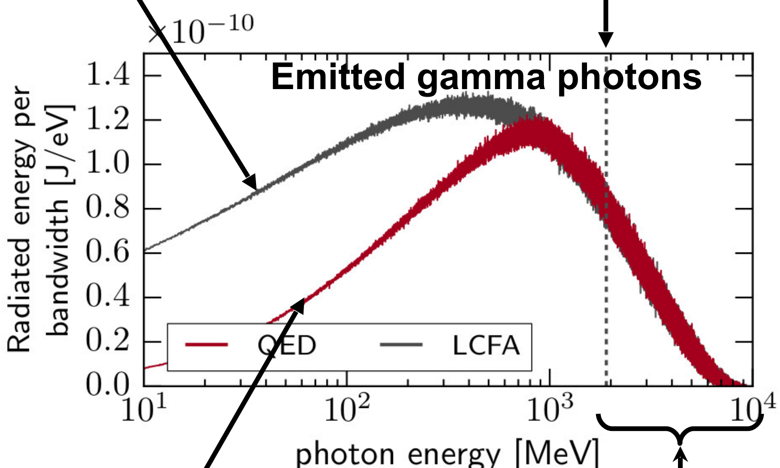
See presentation by Sebastian Meuren Wednesday 9:30AM

SLAC

<u>Aim:</u> measuring emitted gamma photons + scattered electrons and produced positrons

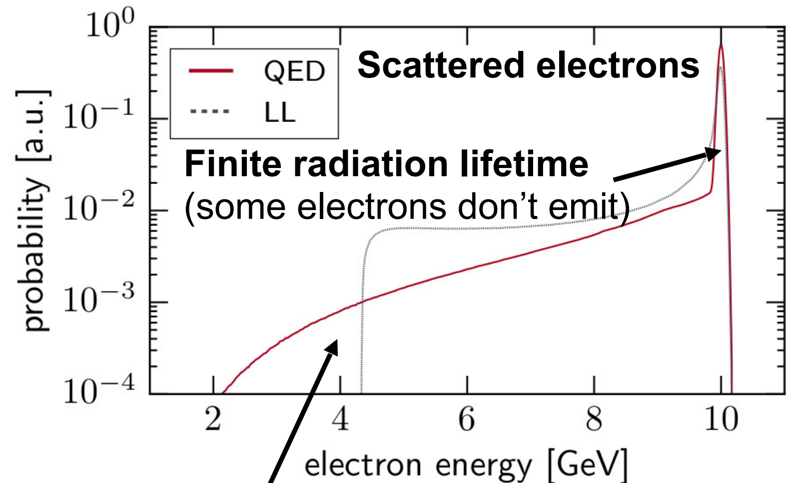
Standard numerical code:
local constant field approximation

single-photon Compton
scattering edge

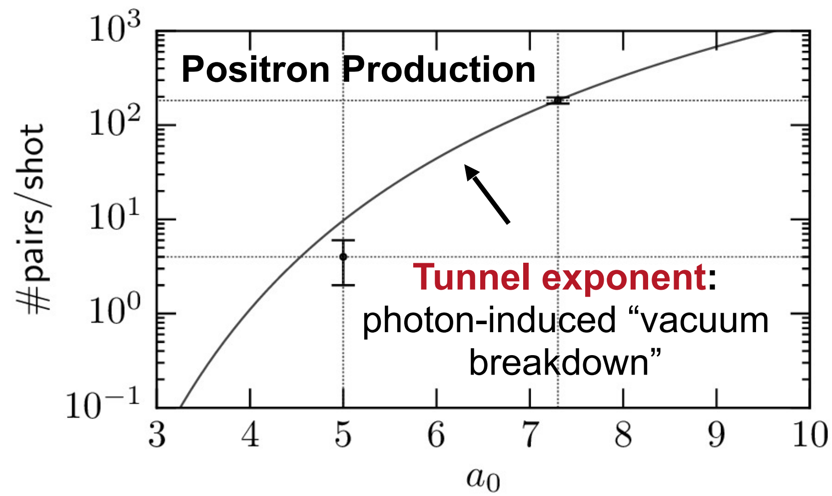


LCFA breakdown:
formation length comparable
with laser wavelength

"**high harmonics**":
requires absorption of
multiple laser photons



Radiation reaction (emission of multiple photons)
Classical (Landau/Lifshitz): sharp edge (cooling)
Quantum (QED): stochasticity (diffusive behavior)



<u>Timeline:</u> Spring 2020: backgrounds (positrons) & first measurements (electrons), Summer/Fall 2020: pair production. Future: laser upgrade, gamma spectrum, etc.

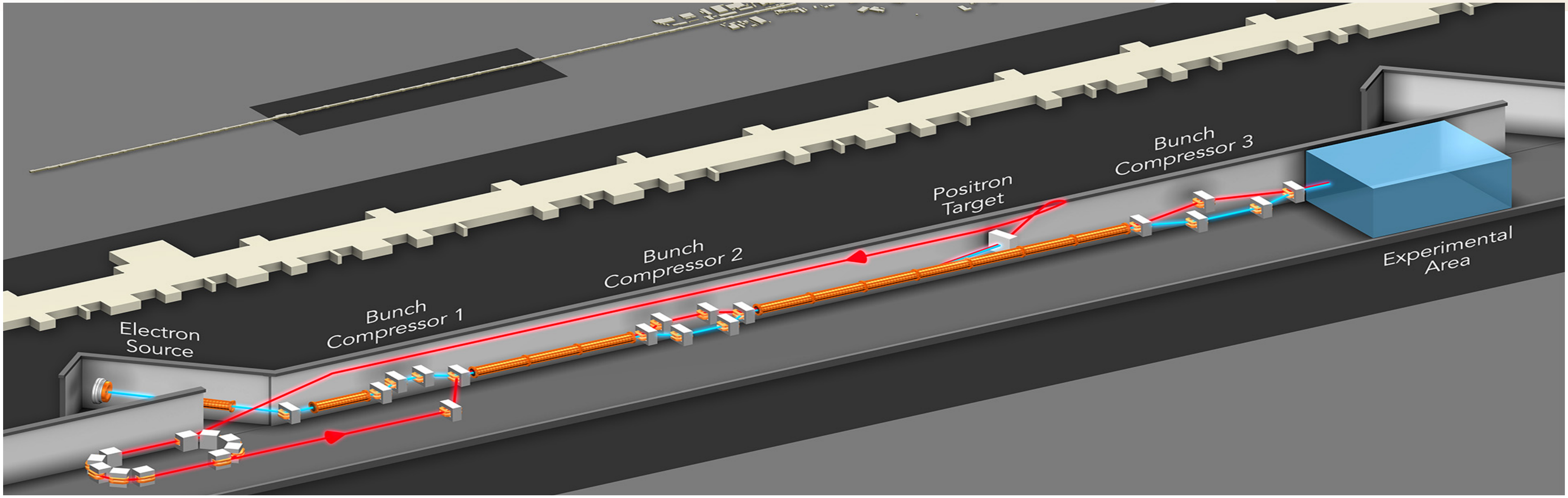
<u>Collaboration:</u> Carleton (Canada); Aarhus (Denmark); École Polytechnique (France); MPIK & HI Jena (Germany); Lisboa (Portugal); Imperial & Belfast (UK); Cal Poly & Colorado & LLNL & Nebraska & SLAC & UCLA (USA)

Simulations: M. Tamburini (Heidelberg) & M. Vranic (Lisbon)

FACET-II Layout and Beams

See presentation by Jerry Yocky Tuesday 11:00AM

SLAC



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

Science Program is Centered Around the Seven Proposals That Received an “Excellent" Ranking from the FACET-II PAC

See presentation by Glen White Tuesday 10:00AM

SLAC

Three machine configurations have been identified and are being developed to satisfy all seven experiments:

- **Two-bunch (1.3/0.6nC, 30/15kA , 150µm separation, 5-50cm betas)**
  - PWFA emittance preservation under high beam-loading (E-300)
  - PWFA hosing suppression (E-302)
  - PWFA positron injection (E-303)
  - Wake imaging (E-324)
- **Single bunch with high peak current (50-300kA, 0.1-10m betas)**
  - Filamentation & gamma-ray bursts (E-305)
  - ‘Trojan Horse’ Injection (E-310)
  - Wake imaging (E-324)
- **Highest Energy low backgrounds and well characterized (13GeV, σ_z = 100µm, 1m betas)**
  - HFQED (E-320)

Minimize configuration changes and gradually introduce new (more extreme) capabilities in the beams and hardware

See presentation by Nate Lipkowitz Tuesday 12:00PM

FACET-II Stage 1 Diagnostics Overview

Standard e- beam diagnostics (existing and new)

	Injector	L1 & BC11	BC14	L2 & L3	BC20 & IP	Total (Stage 1)
BPM	12	6 + 3	4 + 2	66	19	**112**
Toroid	3	1	1		5	**10**
Wire scanner	1	1		4 + 4	2	**12**
Profile monitor	5	2	2	1	8	**18**
TCAV	1 S		1 S		1 X	**3**
Bunch Length	1	1	1		1	**4**
Collimator		1	2	2	1	**6**

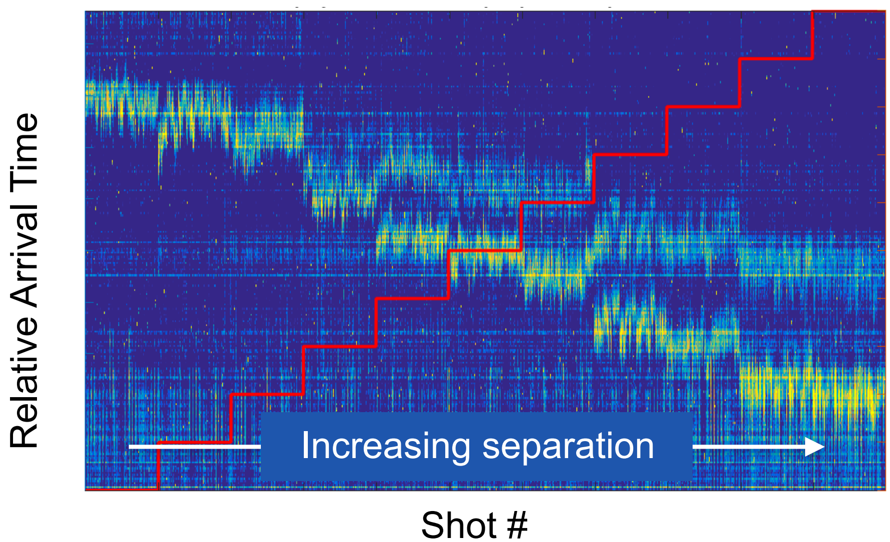
FACET-II re-uses existing FACET electron beam diagnostics where possible

Diagnostics are Joint Development Effort Between Users & Operations (EOS, Profile monitors…)

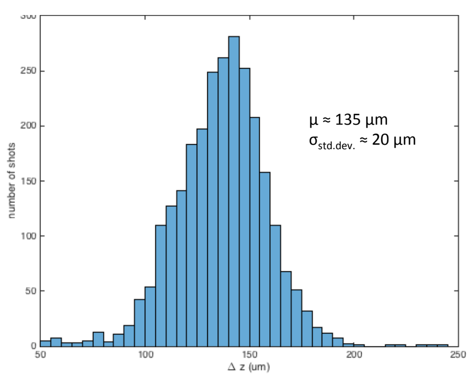
See presentations by Claudio & Doug Today, Mike Litos Wednesday

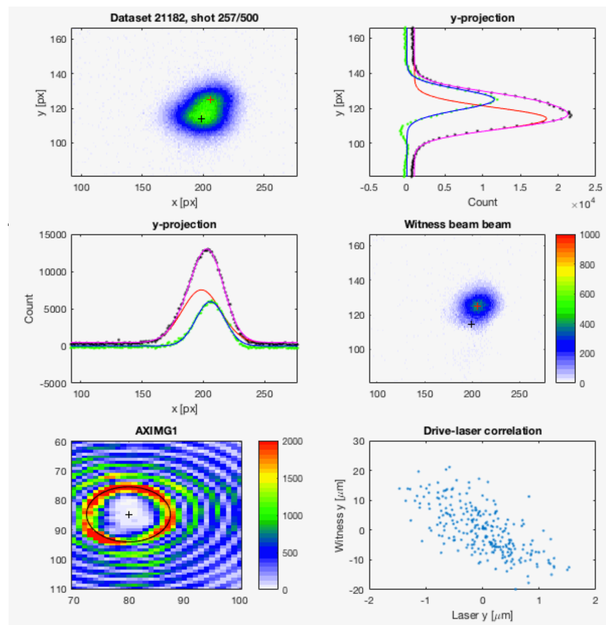
SLAC

EOS tracking of 5,000 consecutive shots
Variable bunch separation from 0-450μm



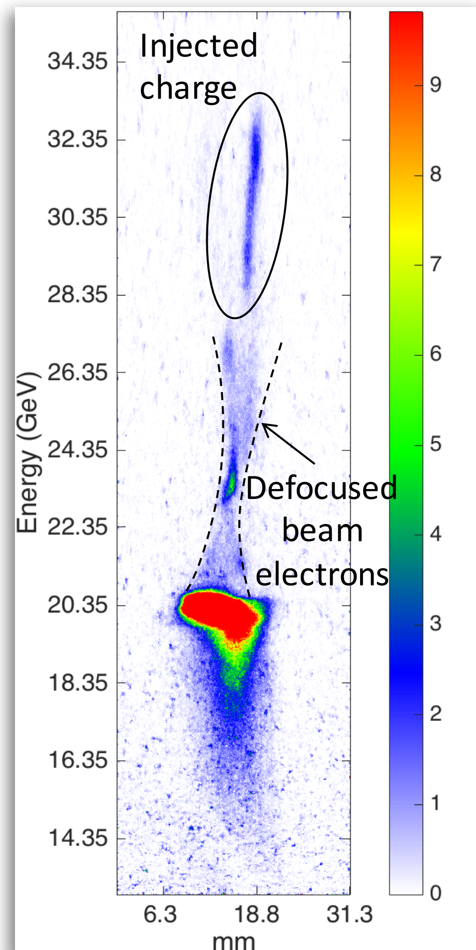
Single shot measurements for data sorting and run statistics





Profile monitors provide pointing and offset information w.r.t. each other and ionization laser

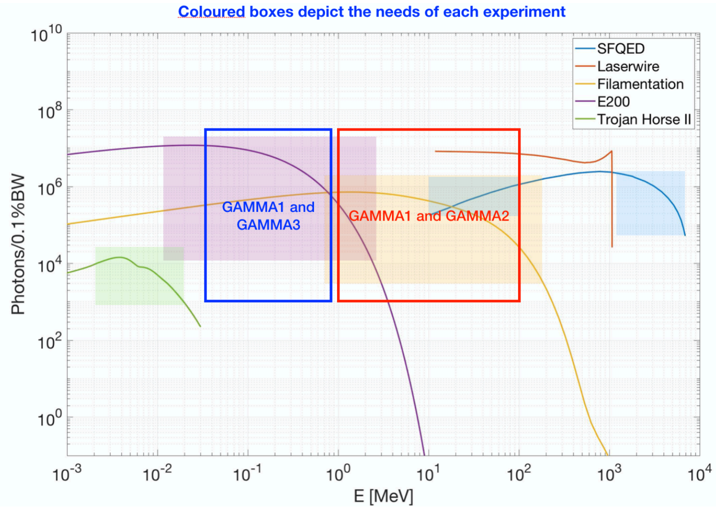
Spectrometer provides energy, energy spread, divergence…



FACET-II BC20 Enabled Beams Require Novel Diagnostics

FACET-II Will Achieve Experimental Efficiencies Through Collaboration Between Groups on Common Hardware

See presentation by Doug Storey Tuesday 1:50PM



Experiment	Needs	Gamma-ray spectrum	Radiated energy, # of photons	Typical divergence	Detectors under consideration	Comments
E200 PWFA	Angular and spectral, from 10 keV to MeV	Broadband from keV to MeV	1 mJ energy, 5×10^{10} photons	mrad	Gamma1, bent-crystal spectrometer, Gamma2/3, stack	
Filamentation	Angular and spectral, from MeV to 100 MeV	Broadband from MeV to 100 MeV	10 mJ energy or higher, 10^{10} photons or higher	mrad	Gamma1, pair spectrometer, Gamma2/3, stack	Address issue of damaging detectors if signal too intense
Trojan Horse II (and other high brightness injectors)	Angular and spectral, from keV to tens of keV	Betatron fundamental and harmonics in the keV to 100 keV range		50 urad	Bent-crystal spectrometer, Gamma1	Measurement below 20 keV requires a new design for exit window
SFQED	Spectral in 10-100 MeV and 1-10 GeV range, angular profile	Broadband from keV up to 8 GeV, peaked around 1 GeV	Joule energy, few 10^{10} photons	100-600 urad	Pair spectrometer (2-stage), Gamma1 with CsI, bent-crystal spectrometer	Need extremely quiet environment for GeV range, and/ or single-particle detectors for pair tracking.

	Plasma		Picnic Basket Stuff					Dump Line Diagnostics										
	Li Oven	**H2**	**Gas Jets 10^{18} -10^{20} e-/cc**	**Single EOS**	**Quad EOS**	**Axilens/ Lens**	**DP**	**Butterfly**	**CHER 8-10+ GeV**	**WLAN 3-10+ GeV**	**500 MeV e-**	**G1**	**G2 >MeV**	**G3 <MeV**	**1-30keV Bent Crystal**	**30-500keV Bent Crystal**	**0.5-30 MeV Compton (1st Gen)**	**0.001-10 GeV Compton + Pair**
E300 – Two Bunch PWFA	Y	O	N	Y	N	Y	Y	Y	Y	Y	N	Y	HD	HD	O	HD	O	N
E302 – PWFA Wakefields	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	HD	HD	O	HD	O	N
E303 – Positrons																		
E305 – Filamentation	N	N	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y	O	HD	Y	HD
E310 – TH-II	N	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	O	O	RF		N	N
E320 – SFQED	N	N	O	Y	N	Y	N	Y	Y	Y	N	Y	Y	Y	N		HD	RF
E324 – Imaging	Y	Y	N	O	N	Y	Y	Y	Y	Y	N	Y	N	N	N	N	N	N
Yes	Required for beam time																	
No	Not useful																	
RF	Required for final run																	
Optional	Will provide additional useful information																	
HD	Not required for initial run but highly desired																	

Working Groups provide input to design diagnostics and experimental hardware that simultaneously benefit multiple experiments

FACET-II Experimental Laser Requirements Discussed in Collaboration and Topical Zoom Meetings e.g. Plasma Sources

	Energy [mJ]	Pulse Length FWHM [fs]	Wavefront Control	Probe Laser
E300 Energy Doubling	30	70	Yes	No
E301 Hydrogen PWFA	500	70	Yes	No
E302 Transverse Wakefields in PWFA	30	70	Yes	Yes
E303 Positron Generation & Acceleration	30	70	Yes	No
E305 Filamentation & Gamma Bursts	150	70	Yes	No
E310 Trojan Horse II	30/500	70	Yes	Yes
E320 Strong Field QED	>600	35	Yes	No
E324 Plasma Imaging	N/A	35	Yes	Yes

See presentation by Brendan O’Shea Tuesday 2:10PM

FACET Experimental Ti-Sapph Laser Upgrades

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Improved pointing stability

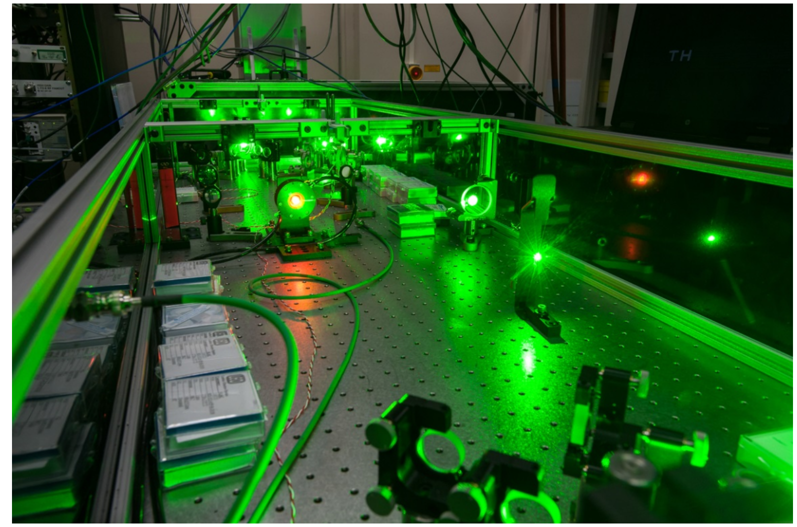
- ✓ Pointing diagnostics & feedbacks for experimental laser transport line
- Re-building problematic mounts
- Temperature control for transport system

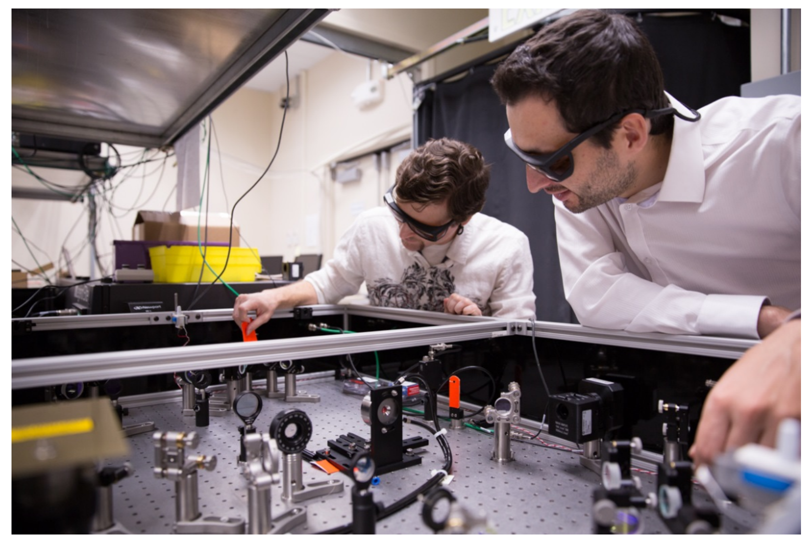
Improved mode quality in IP area

- ✓ Deformable mirror(s)

Higher Intensity

- ✓ Laser system will be upgraded to achieve >15TW at 10Hz (e.g. 0.6J/35fs)
- 100TW class upgrade possible at ‘moderate’ cost with upgrades to the laser, transport, and delivery systems





Design and operations support provided by experienced LCLS Laser Science & Technology Division

Agenda & Session Topics

SLAC

Tuesday | Wednesday | Thursday | Friday

Facility Status, capabilities and upgrade plans: On the first day we will present and discuss what we expect to be available upon construction of FACET-II as well as capabilities enabled by future upgrades.

To listen in via zoom meeting: **https://stanford.zoom.us/j/514840095**

Start Time	Presentation	Presenter	Affiliation
09:00 am	Facility status (run schedule for 2020)	Vitaly Yakimenko	SLAC
09:30 am	Experimental science goals, beam requirements, detection/hardware needs	Mark Hogan	SLAC
10:00 am	Beam configurations for different experiments	Glen White	SLAC
10:30 am	**Coffee Break**		
11:00 am	Commissioning status & beam parameters for 2020	Jerry Yocky	SLAC
11:30 am	Machine learning experiments	Claudio Emma	SLAC
12:00 pm	Linac Diagnostics	Nate Lipkowitz	SLAC
12:30 pm	**Lunch**		
01:30 pm	Experimental area	Mark Hogan	SLAC
01:50 pm	Dump table	Doug Storey	SLAC
02:10 pm	Laser status & possible future upgrades	Brendan O'Shea	SLAC
02:40 pm	**Coffee Break**		
03:10 pm	Future upgrades:		
03:10 pm	Higher Ipk (Laser heater, S20 chicane, linearizer)	Glen White	SLAC
03:40 pm	Positrons and Sailboat/UFO	Glen White	SLAC
04:00 pm	E-300: Two-bunch pump depletion and emittance preservation	Chan Joshi	UCLA
05:00 pm	Discussion		
05:30 pm	**Adjourn**		
06:00 pm	**Reception @ The Dutch Goose**		

Accelerator

Experimental Area

Enhancements

Jump start on tomorrow

Agenda & Session Topics (*Note later start Wednesday*)

Tuesday | **Wednesday** | Thursday | Friday

Experimental installation readiness & run plans for 2019/2020: On the second day we would like experiments to present a description of an engineering solution for how the experiment will be installed, a plan for execution and a description of the observables. Presentations should conclude with a clear definition of success for the first phase of the experiment.

To listen in via zoom meeting: **https://stanford.zoom.us/j/514840095**

Start Time	Presentation	Presenter	Affiliation
09:30 am	E-320: Probing Strong-field QED at FACET-II	Sebastian Meuren	SLAC/Stanford
10:30 am	**Coffee Break**		
11:00 am	E-301: Tailored Plasma Sources for Emittance Preservation in PWFA and High-Brightness Plasma-Injected Beams	Mike Litos	CU Boulder
12:00 pm	E-324: Optical visualization of beam-driven plasma wakefield accelerators	Michael Downer	UT Austin
12:30 pm	**Lunch**		
01:30 pm	E-303: Generation and Acceleration of Positrons at FACET-II	Ken Marsh	UCLA
02:00 pm	E-305: Beam filamentation and bright gamma-ray bursts	Sebastien Corde	Ecole Polytechnique
03:00 pm	**Coffee Break**		
03:30 pm	E-310: Trojan Horse-II	Bernhard Hidding	University of Strathclyde
04:30 pm	Experimental Safety Review Status	Christine Clarke	SLAC
05:00 pm	**Adjourn**		

Agenda & Session Topics

Tuesday | Wednesday | Thursday | Friday

Developing the science case for positrons and other upgrades: On the third day, the first goal is to clarify the science case for positrons. The second goal is to discuss ideas for new experiments and to understand the match to FACET-II capabilities. We hope through discussions to see an evolution of the experimental needs that improve chances for a positive review of potential proposals at the next Program Advisory Committee Meeting.

To listen in via zoom meeting: **https://stanford.zoom.us/j/514840095**

Start Time	Presentation	Presenter	Affiliation
09:00 am	Summary of FNAL Crystal Workshop & Opportunities @ FACET-II	Vladimir Shiltsev	FNAL
09:30 am	Roadmap towards linear colliders based on plasma accelerators	Mark Hogan	SLAC
09:45 am	New directions in positron acceleration research	Spencer Gessner	SLAC
10:30 am	**Coffee Break**		
11:00 am	Transversely tailored plasmas	Severin Diederichs	LBNL/DESY
11:30 am	Transversely tailored plasmas	Shiyu Zhou	UCLA
12:00 pm	Non-linear hollow channel plasmas	Spencer Gessner	SLAC
12:20 pm	**Lunch**		
01:20 pm	Attosecond science	Agostino Marinelli	SLAC
01:50 pm	Positron production and capture from a foil	Hiroki Fuji	UCLA
02:10 pm	Quasi-hollow channels + other IST ideas	Thales Silva	IST
02:50 pm	**Coffee Break**		
03:20 pm	Neutral beam filiamentation	Frederico Fiuza	SLAC
03:50 pm	Experimental progress in LWFA to PWFA staging	Sebastien Corde	Ecole Polytechnique
04:20 pm	Machine/physics studies towards FACET-III stability	Claudio Emma	SLAC
04:50 pm	Discussion towards new directions		
05:30 pm	**Adjourn**		

Agenda & Session Topics

SLAC

Tuesday | Wednesday | Thursday | **Friday**

Assessment of plasma driven FELs: Plasma accelerators, both PWFA and LWFA, are being investigated as enabling technologies for 5th generation light sources. The large accelerating fields afford compact GeV beams and are predicted to produce beams with unprecedented brightness. On the fourth day we hope to discuss both the promise of this new technology as well as the practical challenges that must be addressed.

Plasma accelerators are already producing beams approaching the quality needed for FELs. This session will discuss the practical challenges of transitioning these beams to User experiments and FELs. We will seek to define common challenges that need to be addressed and what details need to be reported to allow members of the FEL community to judge ore progress.

To listen in via zoom meeting: **https://stanford.zoom.us/j/514840095**

Start Time	Presentation	Presenter	Affiliation
09:00 am	User needs - an LCLS perspective	Agostino Marinelli	SLAC
09:30 am	General introduction to challenges	Mark Hogan	SLAC
10:00 am	Progress towards seeded LWFA-based FEL and lessons learned	Sebastien Corde	Ecole Polytechnique
10:30 am	**Coffee Break**		
11:00 am	The LUX Facility	Andreas Maier	University of Hamburg/DESY
11:30 am	A Compact Laser-Plasma- Accelerator-Based FEL for Ultra-Fast Hyper-Spectral Experiments	Jeroen van Tilborg	LBNL
12:00 pm	Optimization of parameters for EuPRAXIA	Phu Anh Phi NGHIEM	CEA-IRFU
12:30 pm	**Lunch**		
01:30 pm	NeXource and the STFC PWFA-FEL program	Bernhard Hidding	University of Strathclyde
02:00 pm	UCLA DDR FEL Start to End Simulations progress	Xinlu Xu	SLAC
02:30 pm	Discussion of challenges: stability, pointing, matching…	All	
03:00 pm	**Adjourn**		

Following the Workshop

- FY20 experimental schedule will be developed based on readiness reported at this workshop, aligned with resources and project schedule
- Experimental safety reviews will continue to be coordinated by Christine
- IP area build out in parallel to the above through early next year
- We report the outcome of this workshop to DOE through a written summary report and presentation
  - We need your help and all slides posted so that we can help you
- Next year we expect another PAC following first beam time

Goals for this 4th workshop: communicate the facility status, review experimental readiness, develop the science case for positrons and assess the opportunities and challenges of plasma driven FELs.

All Work and No Play…

In addition to the full science agenda, we have opportunities for further collaboration development

- Tuesday evening (tonight!)
  - @ The Dutch Goose
  - 3567 Alameda de Las Pulgas, Menlo Park, CA 94025