FACET-II Long-term planning

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“Long-term planning”

- Here “long-term” refers to the next year or so
- Previously we went through this process in January 2024 and August 2024
  - Nothing really changed between January and August 2024, so I waited a year to do this again - we have made progress!
- Changes to FACET-II require lots of planning, waiting on downtimes, time from outside groups, data collection and analysis
- Example: Install Be window on mover upstream of IP
  - Sounds simple!
  - Multiple complications: we rely on the hole for differentiable pumping, so the beam has to be stable. Were planning on BBA/Coasting beam so beam would have moved…
- Today we start a plan of what we are going to do for the next year

Questions to prime discussion

- What are the high-level scientific goals?
- What are your target (high-impact) publications and time frame?
- What data do you have what analysis has been done?
- What data and analysis is missing to reach that (high-impact) publication?
- What went well? What could go better? How does this run compare to the last run (Oct 2023 - July 2024)?

What science did we say we would do?

Plasma wakefield acceleration (PWFA):

- Developing PWFA as multi-GeV/m accelerator technology aligned with HEP roadmaps

PWFA Applications:

- Brightness booster, Attosecond X-rays pulses as near term (pre-collider) demonstration applications

Strong Field Quantum Electrodynamics (SFQED):

- Stable high-energy beams and multi-TW laser for precision probing of SFQED

High-field Physics:

- Beam fields > 1V/Å enable unique studies in astrophysics, material science and beam physics

AIML, Diagnostics & Beam Physics:

- Harnessing new initiatives in AIML to diagnose and control beams with unprecedented intensities aligned with GARD ABP roadmaps

Category	Exp. Num.	Status	Topic
PWFA	E300	Published	Diagnostics and first PWFA interactions FACET-II
	E300	Published	Generation of meter scale hydrogen plasmas and efficient pump depletion
	E300	Data in hand?	Mapping of wakefields using two bunches
	E300	Collect data in Spring 2025	Pump depletion and emittance preservation
	E301	Data in hand, drafted	Generation of wide plasma for PWFA in noble gases
	E301	Data in hand, drafted	Refraction effects in Li plasmas
PWFA App	E304	Publication submitted	Density down ramp injection
	E304/E338	First data Fall 2025	Compression of injected bunches
SFQED	E305	Published	Probing strong-field QED in beam-plasma collisions
	E305	Data in hand	Observation of the transition between wakeless and blowout regime
	E320	Data in hand	Observe change from perturbative QED to non-perturbative
	E320	Data in hand?	Measure change in rate of positron production between perturbative and non-perturbative regimes
High-field	E305	Published	Spatiotemporal dynamics of ultra relativistic beam-plasma instabilities
	E332	Data in hand, drafted	Demonstrate transition radiation focusing using multiple foils
AIML	E326	Data in hand, drafted	Single shot, non-intercepting diagnostic
	E338	Published	Generation of short bunches using laser heater
	E338	Collect final data in Winter 2024	Spectral characterization of short bunches

What did we say we needed to do? - Challenges

- Goals and upgrades were broken down into Challenges -> Projects -> Measurements
  - Projects is not the SLAC definition of project

Challenges

	Name	Projects	Measurements	FACET-II Tasks
1	Emittance increases along the linac	L2 RF Upgrade for better control/stability - 3 stations (Energy fee DL10 Dispersion quad does more than dispersion Reduce corrector strengths, align linacs Are the orbits in the bunch compressors right? FF Style TCAV Measurements	BPM Trust Measurement Coasting beam in LINAC (elec RF Kick Measurement BBA (electric to magnetic) in I Sextupole centers	Commission New Phase Ma BBA of FF and Spectromete BBA of BC20 BBA of L3 Ballistic/Coasting Beam Ma
2	Feedbacks and Stability	X Orbit + Energy in BC20 We cannot send rate to the SCAV line DL10 Dispersion quad does more than dispersion Plasma sources Longitudinal Feedbacks	BPM Trust Measurement Dispersion in BC11/BC14/B20	Feedback Commissioning X orbit vs Energy Feedback Feedback Commissioning -
3	Cannot resolve short bunches at FACET-II	More Power for XTCAV Revive TCAV3 Finalize BLEN 20 FF Style TCAV Measurements	SYAG Tomography TCAV Measurements GUI Microbunching Contribution	Preparations for SLED insta Commission XTCAV SLED Examine Astigmatism In Wa Establish Gold Orbit Notch Configuration
4	How to do more experiments	THz Table new IP Upgrade Probe Too much B-integral in the guillotine window Adjustable R56 in W chicane Using BPMs to measure ns bunch separations Plasma sources	Probe wavefront	
5	Measurements aren't consistent across beam time, groups and people	DAQ + SCP BPMS Make the DAN more user friendly Waist transverse location shifts in IP when changing FF Reduce corrector strengths, align linacs Upstream BE window causes too much background	Coasting beam in IP (electrica BPM Trust Measurement Characterize Beam Shift in IP Jitter waist location (beta star	

What did we say we needed to do? - Projects

	Name	Notes		Status	Challenges	Measurements
1	Reduce corrector strengths, align linacs	For better control of the dispersion we need to reduce the corrector strength by centering magnets in the FF and along the linac as necessary.	10	In progress	Emittance increases along Measurements aren't con	Coasting beam in IP (elec Coasting beam in LINAC (BBA (electric to magnetic RF Kick Measurement Sextupole centers
2	Upgrade Probe	Discuss in FACET Laser Meeting Target install in Summer 2025	9	In progress	How to do more experime	Probe wavefront
3	DAQ + SCP BPMS	https://docs.google.com/document/d/1jlg2qUw6WSLkqd9UMao__5G1IYBTwnW60PNErNIC0iw/edit?tab=t.0	9	Done	Measurements aren't con	Sextupole centers Coasting beam in IP (elec RF Kick Measurement Dispersion in BC11/BC14/E
4	X Orbit + Energy in BC20	https://docs.google.com/document/d/1XydmZYj97no0-4HLvoo8IRZaV5xFf3jcV1j47LgAMlU/edit?tab=t.0	9	In progress	Feedbacks and Stability	BPM Trust Measurement
5	We cannot send rate to the SCAV line	Discussions are on-going in small meeting. This would allow us to have better energy control and orbit control. There is a suspected ...	9	In progress	Feedbacks and Stability	
6	Revive TCAV3	Goal: Revive TCAV3 so the we can measure bunch length out of BC14 as well as two bunch separation. Every single experiment would...	8	In progress	Cannot resolve short bun	TCAV Measurements GUI

What did we say we needed to do? - Projects

7	Waist transverse location shifts in IP when changing FF	https://docs.google.com/document/d/1UAi_e0nL-gKa6gS7MmeJBfPKdwHHBUU694ZOO4DdbCo/edit?tab=t.0 Experiments that need to mov...	8	Done	Measurements aren't con	BPM Trust Measurement Characterize Beam Shift i Jitter waist location (beta Coasting beam in IP (elec BBA (electric to magnetic
8	Upstream BE window causes too much background	We have all the parts to do this, we just have to decide to do it and deal with the process of creating a hole. E320 would not care about thi...	8	Done	Measurements aren't con	
9	Too much B-integral in the guillotine window	Experimenters are seeing that the laser is not ionizing as easily. Robert has a design and parts have been ordered.	8	In progress	How to do more experime	
10	Finalize BLEN 20		7	In progress	Cannot resolve short bun	TCAV Measurements GUI
11	THz Table new IP	Trying to add a new area to do science because the traditional IP area is heavily impacted.	7	In progress	How to do more experime	
12	L2 RF Upgrade for better control/stability - 3 stations (Energy feedback)		6	In progress	Emittance increases along	
13	More Power for XTCAV	https://docs.google.com/document/d/1QDiZ59VhcCGLMaXiMX2Xht-j-lcHsxIk-LhZr0XgA7o/edit?tab=t.0#heading=h.t7olpl7tvh0y	5	In progress	Cannot resolve short bun	TCAV Measurements GUI
14	DL10 Dispersion quad does more than dispersion	The quad between the two magnets in the dogleg is supposed to correct only dispersion. It does more than just dispersion. The goal here is to figure out why and how to fi...	5	In progress	Feedbacks and Stability Emittance increases along	BPM Trust Measurement Dispersion in BC11/BC14/B BBA (electric to magnetic
15	Longitudinal Feedbacks		5	Done	Feedbacks and Stability	
16	Make the DAN more user friendly		3	In progress	Measurements aren't con	
17	Goose Trigger	https://docs.google.com/document/d/1ogeJwYVZ_wgtkhLVZ4hjAjU42Xfyl-FgR0Fu61cbdmA/edit?tab=t.0	1	Done		

What did we say we needed to do? - Measurements

	Name	Priority	Status	Link to Confluence/Procedure	Notes
	BPM Trust Measurement	10	In progress	Brendan is working on this. It is tricky but progress is being made.	Fix 3156!! ...
2	BBA (electric to magnetic) in IP Area	9	Done	https://confluence.slac.stanford.edu/display/FACET/FACET+BBA	This measures whether the beam is actually going through the magnet center of all the quads....
3	Coasting beam in LINAC+BC20 (electrical to mechanical)	9	In progress	https://confluence.slac.stanford.edu/display/FACET/Meeting+Slides?...	This measures the absolute location of quad w.r.t pipes. When done properly you reduce the amou
4	Coasting beam in IP (electrical to mechanical)	8	Done	https://confluence.slac.stanford.edu/display/FACET/Meeting+Slides?...	This measures the absolute location of quad w.r.t pipes. When done properly you reduce the amou
5	Characterize Beam Shift in IP when changing FF	8	Done	https://docs.google.com/document/d/1sQKOPvaiFm8-4mFnq8f9hWrpanq...	We do scans of both energy and waist location b changing the FF. We want to measure how the tra
6	Probe wavefront	8	In progress		We need a procedure for measuring the probe wa in the tunnel.
7	RF Kick Measurement	7			This measures whether we are centered in all the
8	Jitter waist location (beta star, beta)	7	Done	I know Ole has a draft. Isn't this in regular use now?	This uses a DESY technique to measure beam th location.
9	Emittance of narrow energy spread beams in spectrometer	6	In progress	https://docs.google.com/document/d/1ppiRnOX4aKYuOn_AuJLJsoWoRYV...	We want to be able to routinely measure the X er of narrow energy spread beams in the spectrome
10	Sextupole centers	5	In progress	https://docs.google.com/document/d/1QkWVrwTuijZwudSBI-00iQJ8xuIAu...	We want to know how to routinely find the center sextupoles because we use them heavily and hav
11	Dispersion in BC11/BC14/B20	5	In progress		We need to be able to measure dispersion throug machine in order to understand whether tasks tha
12	SYAG Tomography	5			Revive process of SYAG tomography from FACET. have to be a revive of the same software.

I immediately see somethings are missing: Comparison of S2E simulation with the machine. RF jitter measurements.

Let’s get to planning!