

Emergency Information



Fire

- Evacuate. Be aware of building exits.
- Follow building residents to the assembly area.
- Do not leave until you are accounted for, and have been instructed to.

Earthquake

- Remain in building: duck, cover, and hold position.
- When shaking stops: evacuate building via a safe route to the assembly area.
- Do not leave until you are accounted for, and have been instructed to do so.



FACET-II | Facility for Advanced
Accelerator Experimental Tests

Facility Status

2019 FACET-II Science Workshop

Vitaly Yakimenko
October 29, 2019



FACET Celebration Party - April 2016



FACET: A National User Facility based on high-energy beams and their interaction with plasmas and lasers



Primary Goal:

- Demonstrate a single-stage high-energy plasma accelerator for electrons

Timeline:

- Construction, Commissioning (2008-2011)
- Experimental program (2012-2016)

A National User Facility:

- Externally reviewed experimental program
- >200 Users, 25 experiments, 8 months/year operation

Key PWFA Milestones:

- ✓ Mono-energetic e⁻ acceleration
- ✓ High efficiency e⁻ acceleration (*Nature* 515, Nov. 2014)
- ✓ First high-gradient e⁺ PWFA (*Nature* 524, Aug. 2015)
- ✓ Demonstrate required emittance, energy spread
(*Nature Physics*, Aug. 2019)

Premier R&D facility for PWFA: Only facility capable of e⁺ acceleration
Highest energy beams uniquely enable gradient > 1 GV/m

Continued science output by analyzing data from FACET



• Atomic 'Trojan Horse'

- Demonstrated plasma photocathode technique for creating brighter electron beams
- Optimizing the process will be a focus of FACET-II program
- A. Deng, et al., Electron bunch generation from a plasma photocathode, *Nature Physics*, 1745-2481 (August, 2019)

• GeV/m Dielectric Accelerators

- Damping of THz waves observed in silicon-dioxide structures
- Advanced materials and novel structures needed for GeV/m will be tested at FACET-II
- B. O'Shea et al., Conductivity induced by high-field terahertz waves in dielectric material, *Physical Review Letters* (September 2019)

• Visualization and understanding of wakes in plasma

- Identified principal physical mechanisms by which highly nonlinear e-beam driven plasma wakes release their stored electrostatic energy into the surrounding medium
- R. Zgadzaj et al., Dissipation of electron-beam-driven plasma wakes, *submitted Nature Communications* (Aug. 2019)

• Compensating transverse wakes in slab-geometry

- Demonstrated suppression of deflecting forces by shaping structure and beam
- Preservation of beam quality using high-gradient (GV/m) at meter scale next step for FACET-II
- B. O'Shea et al., Suppression of Deflecting Forces in Planar-Symmetric Dielectric Wakefield Accelerating Structures with Elliptical Bunches, *submitted Physical Review Letters* (Oct. 2019)

• Diagnostic for time/space overlap of electron and laser beams

- new approach to measuring the overlap of an ultrashort pulse laser and a high energy electron beam in both space and time using excitation of the laser plasma filament by the e-beam.
- P. Scherkl et al., Plasma-photonic spatiotemporal synchronization of relativistic electron and laser beams (Nov. 2019)



FACET results are analyzed and published - time for new experiments

FACET-II Annual Science Workshops

December 2012, October 2015, 2016, 2017...2019

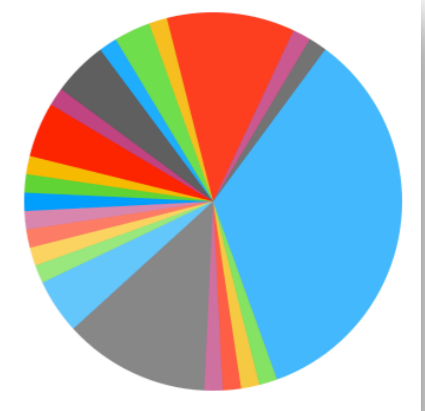


FACET-II WebEx Meeting Agenda 21-DEC-2012

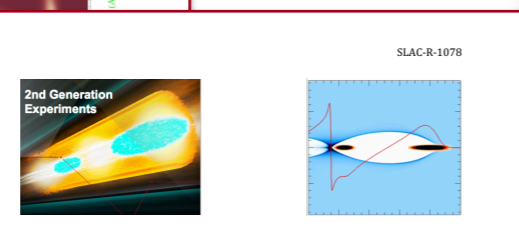
Start Time	Duration	Participant
9:00 AM	0:20	Vitaly
9:20 AM	0:30	Mark
9:50 AM	0:20	Danie
10:10 AM	0:20	Bernh
10:30 AM	0:20	Patric
10:50 AM	0:20	Claud Zhiro
11:10 AM	0:20	Herm
11:30 AM	0:20	
11:50 AM	0:20	Gerar
12:10 PM	0:30	Jamie
12:40 PM	0:20	Vitaly
1:00 PM	0:20	Jamie
1:20 PM	0:20	Chan
1:40 PM	0:20	Vladir

- ANL
- Princeton
- DOE
- Fermilab
- John Adams Institute
- RadiaBeam Technologies, LLC.
- SLAC
- Tech-X Corporation
- Tsinghua University
- University of Colorado Boulder
- University of Strathclyde
- UPenn

- BNL
- DESY
- Ecole Polytechnique
- Instituto Superior Técnico
- LBNL
- RadiaSoft LLC
- Stony Brook University
- The University of Chicago
- UCLA
- University of Oslo
- University of Victoria

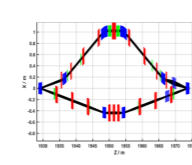


FACET-II Science Opportunity Summary Report
 October 12-16, 2016
 Editor: Nan Phinney
 Publication Date: March 2017



FACET-II Science Workshop Summary Report
 October 17-19, 2016
 Editors: Mark J. Hogan and Nan Phinney
 Publication Date: May 2017

SLAC National Accelerator Laboratory
 2575 Sand Hill Road
 Menlo Park, CA 94025

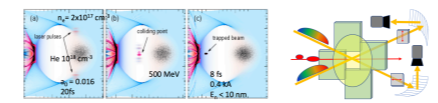


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FACET-II Science Workshop Summary Report
 October 17-20, 2017
 SLAC-R-1087
 Editor: Mark J. Hogan
 Publication Date: January 30, 2018

SLAC National Accelerator Laboratory
 2575 Sand Hill Road
 Menlo Park, CA 94025



Next Science Workshop October 2019 to discuss:

- Facility status
- Technical readiness of first experiments
- Science case for positrons & new ideas
- FEL applications

- Call for proposals in June 2018
- Program Advisory Committee Meeting October 9-12, 2018

Second Program Advisory Committee Meeting is planned for October 2020

FACET-II: 1st Program Advisory Committee Meeting



35 proposals (for Stage 1 only) were reviewed at a recent PAC:

- 7 received “Excellent” ranking
- 23 were ranked “Very Good” or “Good”
- 2 proposals were ranked “Fair”
- 3 were not ranked and are encouraged to resubmit

Proposals represent:

Proposals with “Excellent” ranking:

- Energy Doubling of Narrow Energy Spread Witness Bunch while Preserving Emittance with a High Pump-to-Witness Energy Transfer Efficiency
- Transverse wakefields and instabilities in PWFA
- Generation and Acceleration of Positrons at FACET II
- Optical visualization of beam-driven PWFA
- Trojan Horse-II
- Beam filamentation and bright Gamma ray Burst
- Probing Strong-field QED at FACET-II



FACET-II program is structured around 7 experiments with “Excellent” ranking and scheduled to start commissioning in February 2020

FACET-II Planned Schedule

Dec. 2019 **PPS/BCS complete**, pre-beam system checkouts

Jan. 2020 ARR and Photocathode laser cleaning

Feb. 2020 **Start of commissioning**: 5 days/week, 16 hours

- Checkout and correcting hardware Sectors 10 - 20
- High charge to Sector 11 (335 MeV)

Mar. 2020 Commissioning (10 GeV)

- Sector 14 and 20 chicanes, deflector cavities
- Beam to Sector 20 beam dump
- **KPP verified**
- First time for users (backgrounds, alignment, etc ...)

Apr. 2020 Commissioning

- Beam quality
- Test of various beam configurations
- **Project closeout - CD-4 equivalent**

May - Sep. 2020 **Regular operations**: 6 days/week, 24 hours

- 2 extended (~2 weeks) downtime are expected

FACET-II Personnel Protection and Beam Containment Systems and Accelerator Readiness Review



UPDATED: 10/25/2019 13:31

Milestones	Initial Date	New Date 10/21	% done	Total hrs	Hrs Left	Comments	Task Type
✓ Logic updated for S10 Inj	8-Aug	30-Aug	100%	80	0	Complete	ESD
✓ Logic updated for CCR	15-Aug	4-Oct	100%	80	0	Complete	ESD
✓ Secure/Set entry loop design	22-Aug	22-Aug	100%	80	0	Complete	ESD
✓ S10 Inj ESD draft	22-Aug	6-Sep	100%	40	0	Complete	ESD
BCS System Specification Update	28-Aug	8-Nov	50%	80	40		BCS
✓ Linac West ESD draft	29-Aug	19-Sep	100%	40	0	Complete	ESD
Install BCS Laser Shutter & SBTCv2	31-Aug	15-Nov		80	80	Awaiting Personnel	BCS
✓ Linac reconfiguration drawings done	6-Sep	2-Oct	100%	80	0	Complete	DWG
BCS Shutoff Chassis Installed	12-Sep	15-Nov		40	40	Awaiting Personnel	BCS
✓ Final Draft S10 Inj ESD	13-Sep	20-Sep	100%	40	0	Complete	ESD
✓ RSC	17-Sep					Complete	REV
Inj IAT procedure draft	18-Sep	15-Nov		40	40	Delayed by BSY IAT	IAT
✓ Final Draft Linac West ESD	20-Sep	18-Oct	100%	40	0	In Review	ESD
✓ Secure/Set entry Drawings Updated	20-Sep	28-Aug	100%	60	0	Complete	DWG
S10 Injector drawings complete	20-Sep	8-Nov	50%	128	64	In Progress	DWG
✓ PPS Peer Review	20-Sep	24-Sep				Complete	REV
Ops procedures complete	20-Sep	30-Oct	90%	400	40	Awaiting Final Specs	
BCS Certification procedure Draft	26-Sep	9-Dec		40	40	Awaiting Personnel	BCS
Global IAT procedure Draft	28-Sep	20-Nov		80	80	Delayed by BSY IAT	IAT
Inj IAT procedure complete	29-Sep	27-Nov		40	40	Delayed by BSY IAT	IAT
PPS Hardware installed	30-Sep	6-Dec				Awaiting Personnel	
PPS PLC Code Review	4-Oct	30-Oct					REV
✓ PLC programming definitions	8-Oct	18-Oct	100%	120	0	Complete	PLC
S10 CAMAC->Beckhoff	9-Oct	23-Nov	50%	72	36		
Update BCS IOC & EDM software	10-Oct	1-Dec		80	80		BCS
e+ vault BSOIC	16-Oct	30-Oct	20%	64	51		
PPS-BCS Interface drawings complete		15-Nov		52	52		DWG
Global CCR drawings complete		15-Nov	10%	268	241		DWG
PPS Final Design Review	18-Oct	15-Nov					REV
S10-20 IAT update	20-Oct	5-Nov		40	40		IAT
Miscellaneous drawings complete		22-Nov	10%	30	27		DWG
BCS Certification Complete	21-Oct	19-Dec		40	40		BCS
Global IAT procedure complete	28-Oct	7-Dec		80	80		IAT
PLC programming complete	29-Oct	7-Nov	70%	240	72	In Progress	PLC
Certification Start	11-Nov	9-Dec					

- Design efforts reassigned to FACET-II operations team members + former safety group head (50% time)
- Safety group involved through consultations and reviews and will own systems after completion
- Hardware installations mostly planned with Test Facilities personnel
- Keeping specialists from reassignment to LCLS-II subproject is key challenge

Current Plan:

- FDR Nov. 15, 2019
- PPS/BCS Dec. 20, 2019
- ARR Jan. 15, 2020

Availability of resources is main limiting factor for progress on PPS/BCS and main risk to AAR in January and start of commissioning in February

Regular Zoom meetings

Particle and gamma diagnostics working group: Most of experiments

FACET-II Plasma source working group:

- E-300: Two-bunch pump depletion PWFA in Li
- E-301: Two-bunch pump depletion PWFA in Hydrogen
- E-302: Transverse wakefields and instabilities in PWFA
- E-305: Beam filamentation
- E-31x: Trojan Horse-II ...
- E-324: Optical visualization

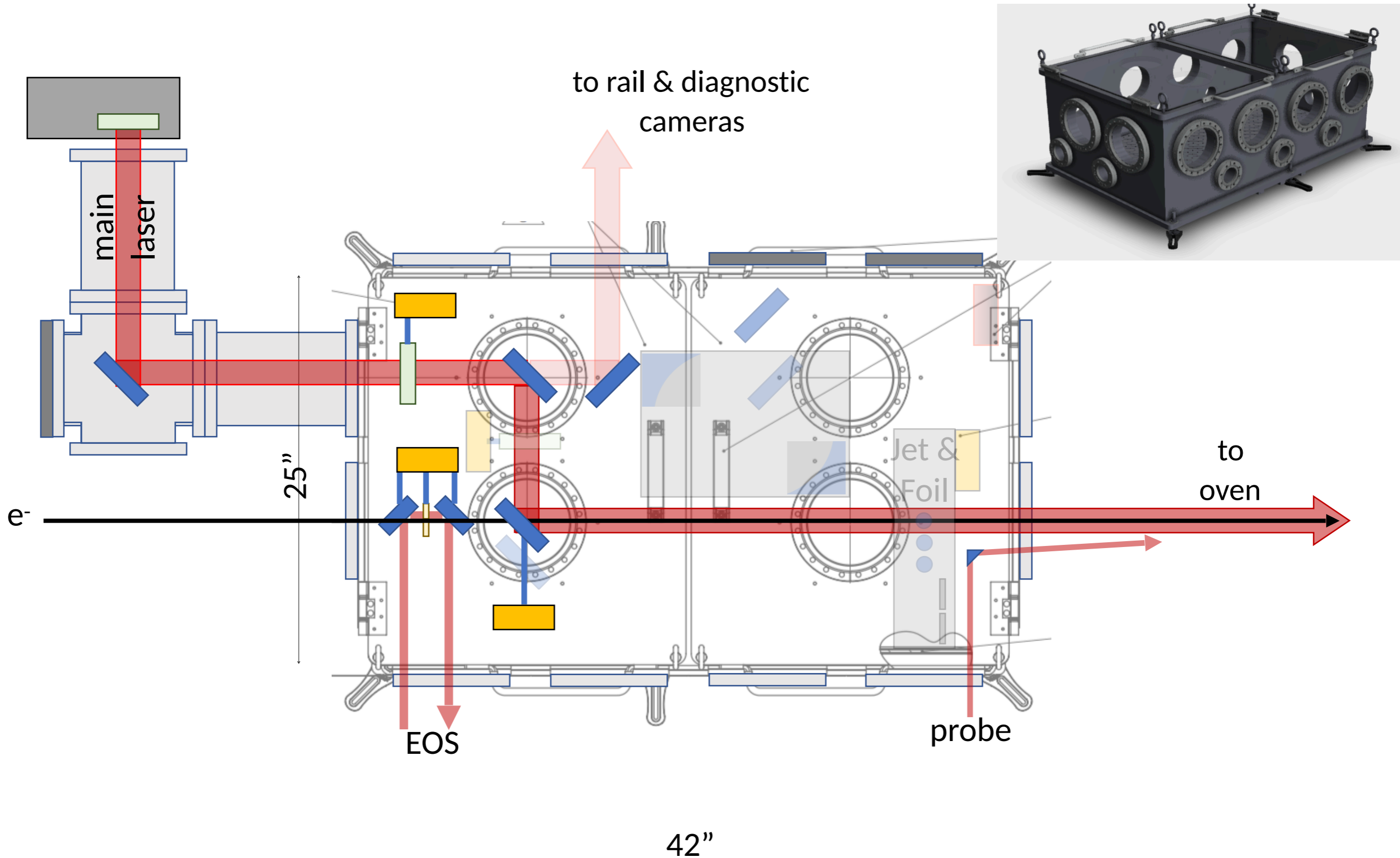
Future working groups: Laser, DAQ, ...

Experiment specific:

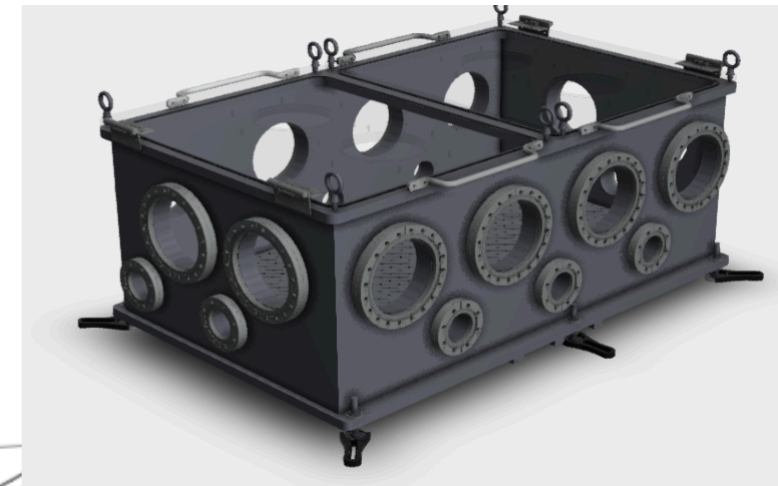
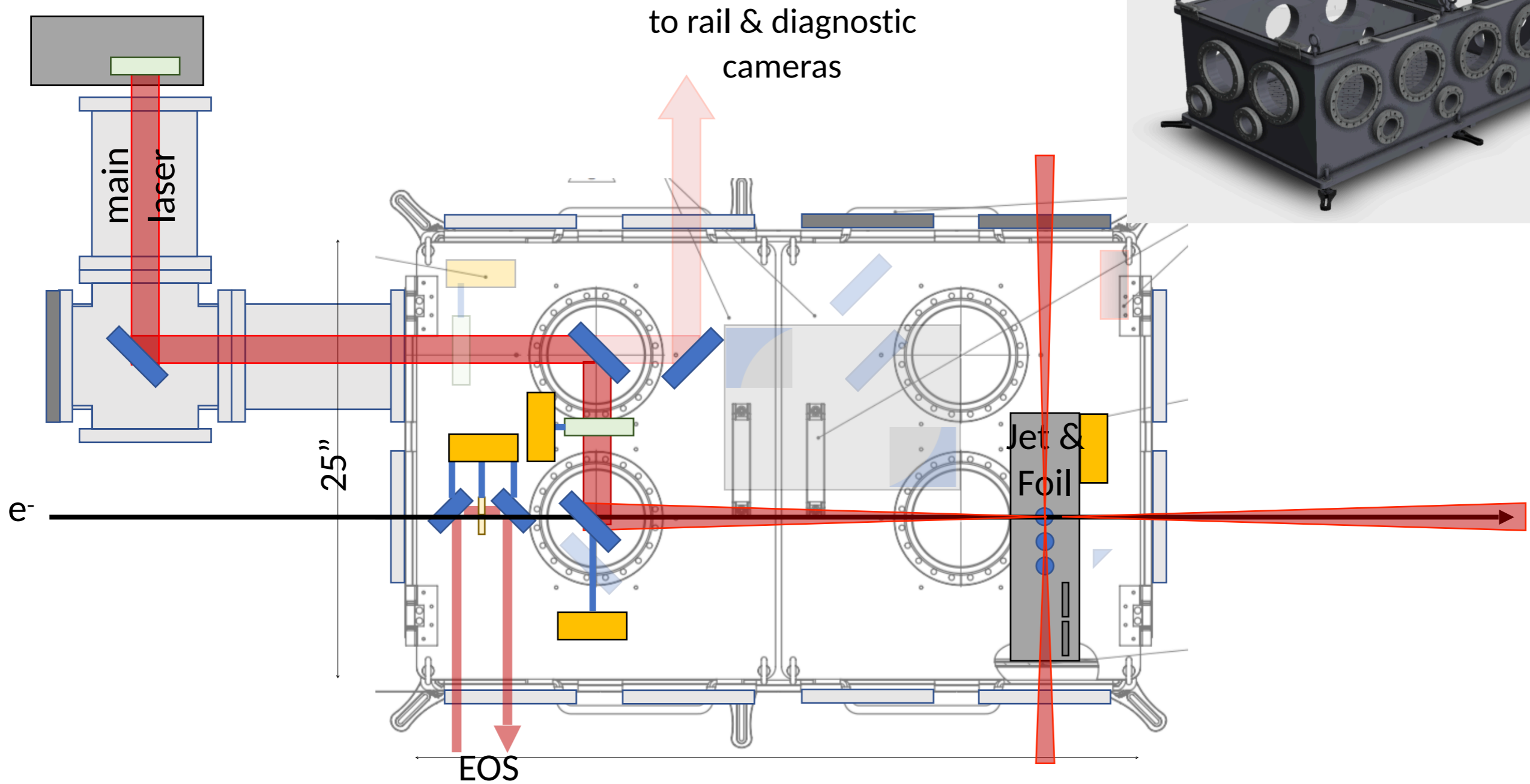
- E-300: Collaboration meetings (Two-bunch pump depletion PWFA)
- E-305: Meeting (Filamentation)
- E-31x: Meeting (Trojan Horse-II ...)
- E-320: Meeting (SFQED)

Coordination and cooperation between user groups and facility staff is working well

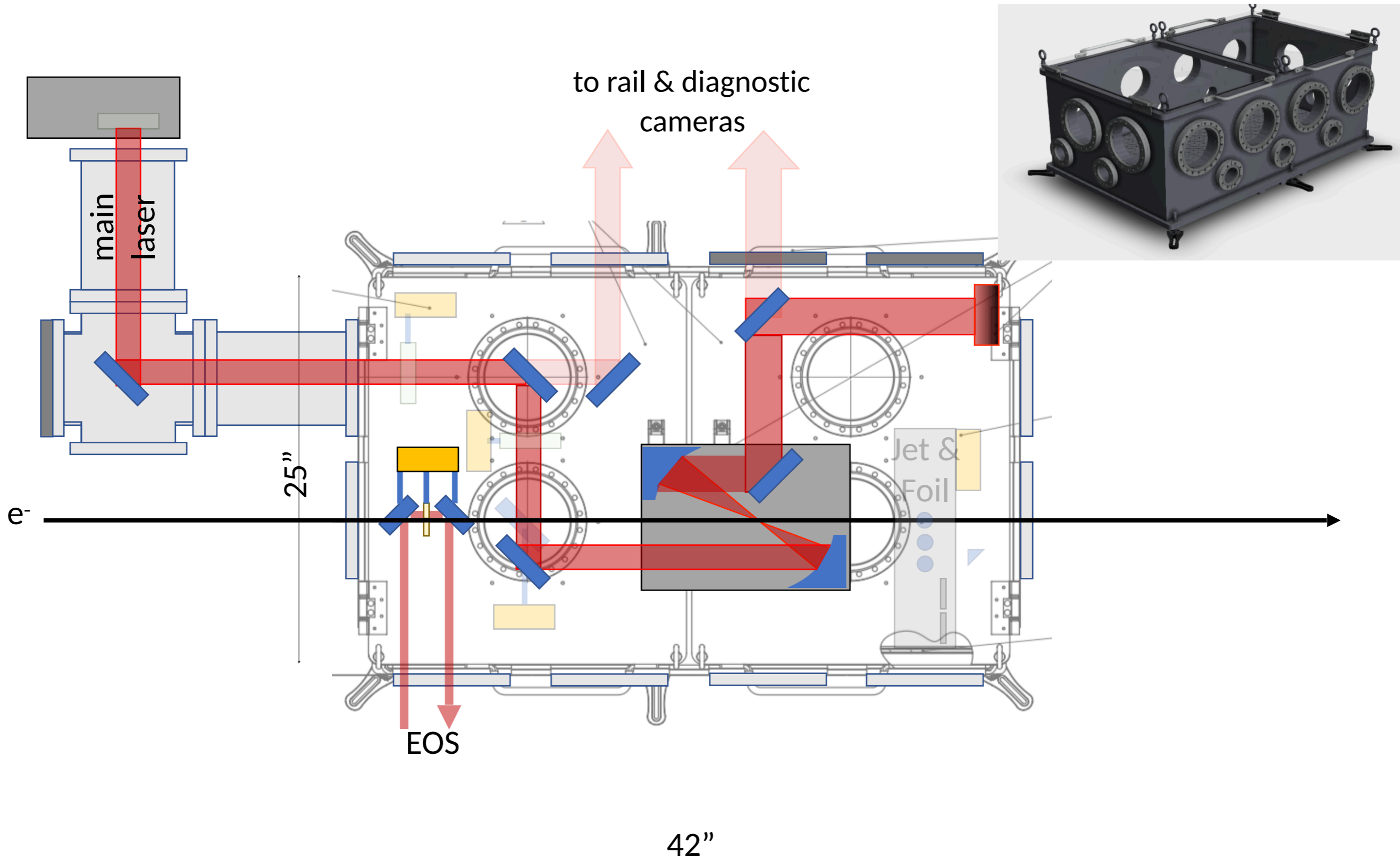
Efficient (remote) switching between 11 experiments



Efficient (remote) switching between 11 experiments

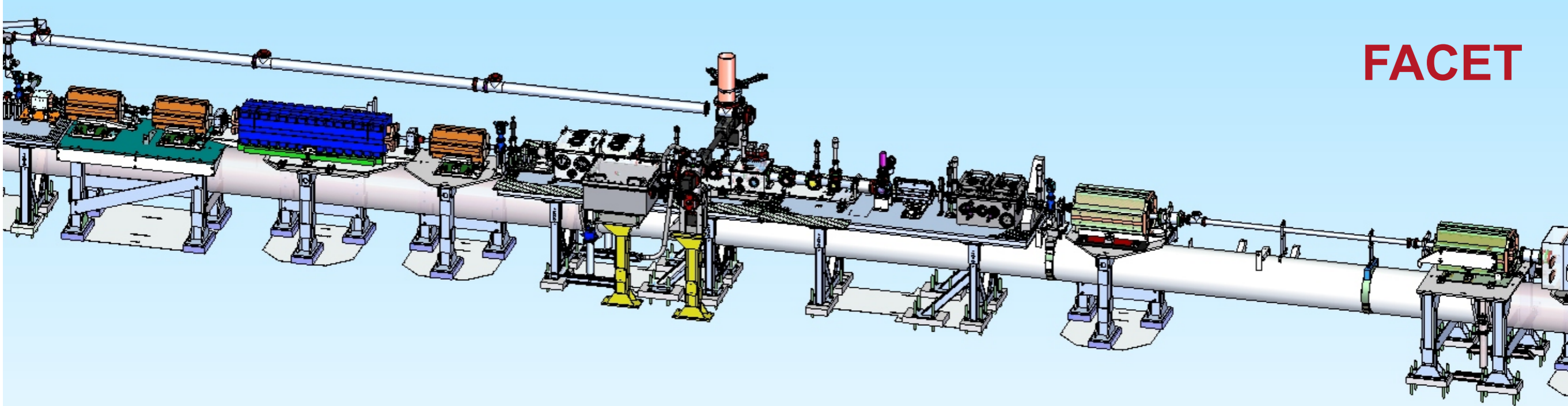


Efficient (remote) switching between 11 experiments

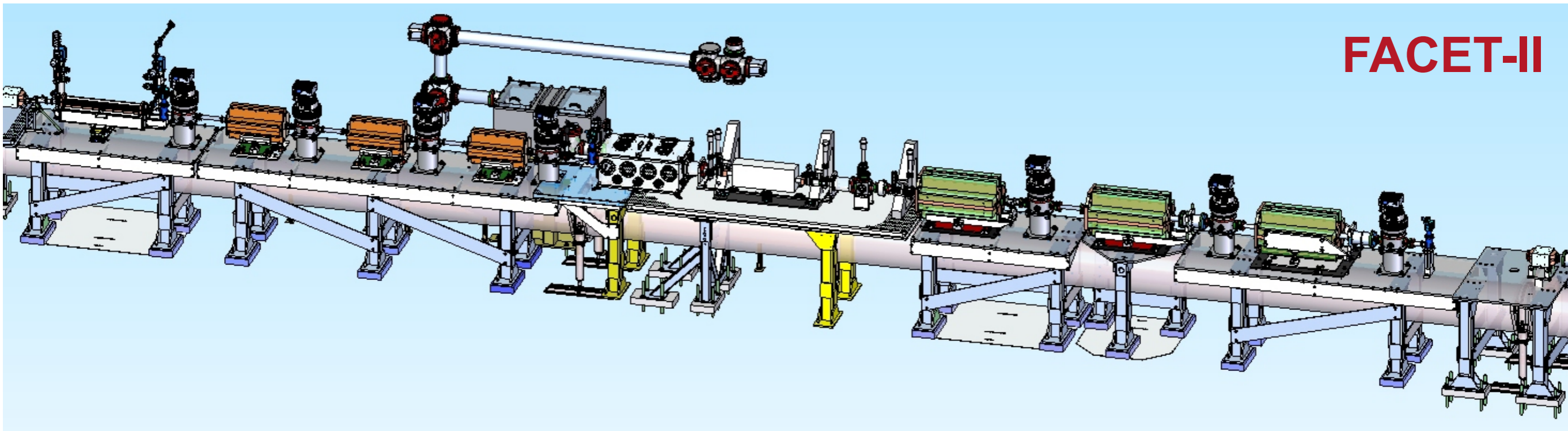


FACET-II experimental area:

Laser compressor is moved

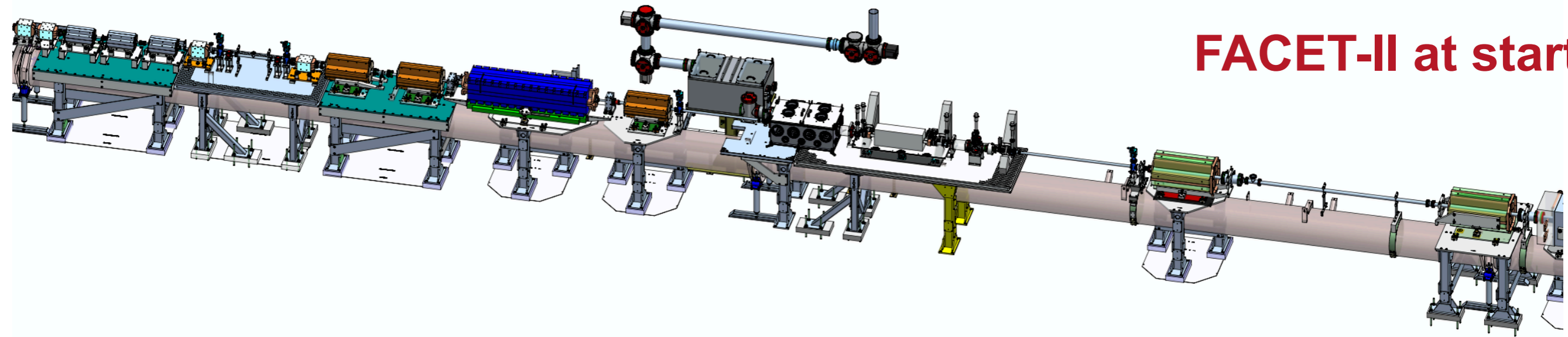


FACET

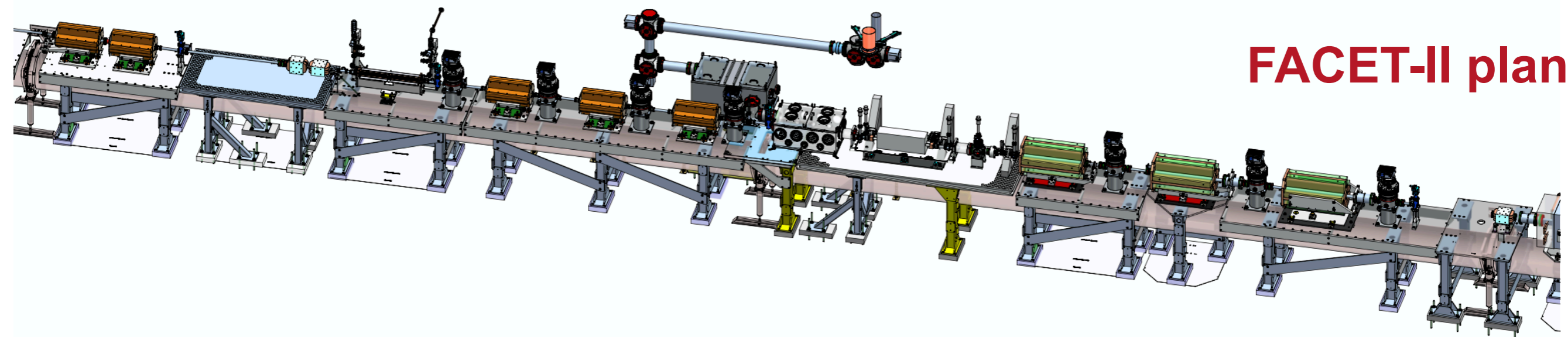


FACET-II

FACET-II experimental area



FACET-II at start



FACET-II plan

List of AIPs towards beam quality

Sector 20 Final focus:

- **Electron beam spectrometer focusing**
 - Compatibility with round beams and differential pumping
- **Final Focus**
 - Compatibility with differential pumping
- **Differential pumping**
 - Windowless operations with intense low emittance beams
- **Deflector cavity relocation**
 - Horizontal deflection -> single shot longitudinal phase space measurement

Installation time in the accelerator tunnel ~ three weeks for all of these tasks

Sector 20 chicane upgrade (electron arm)

- Improved beam quality enabling compression to extreme beam currents

Sector 10 Injector Laser heater

- Control and beam quality for compression for two beam operations

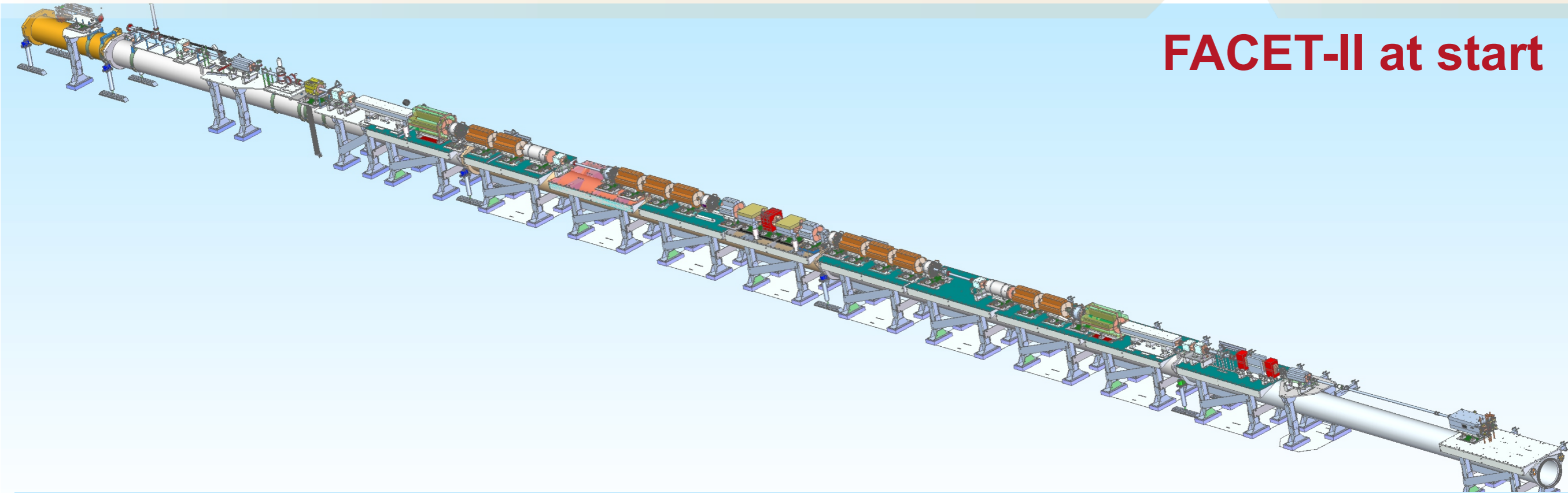
Sector 11 X-Band linearizer

- Control and beam quality for compression to extreme beam currents

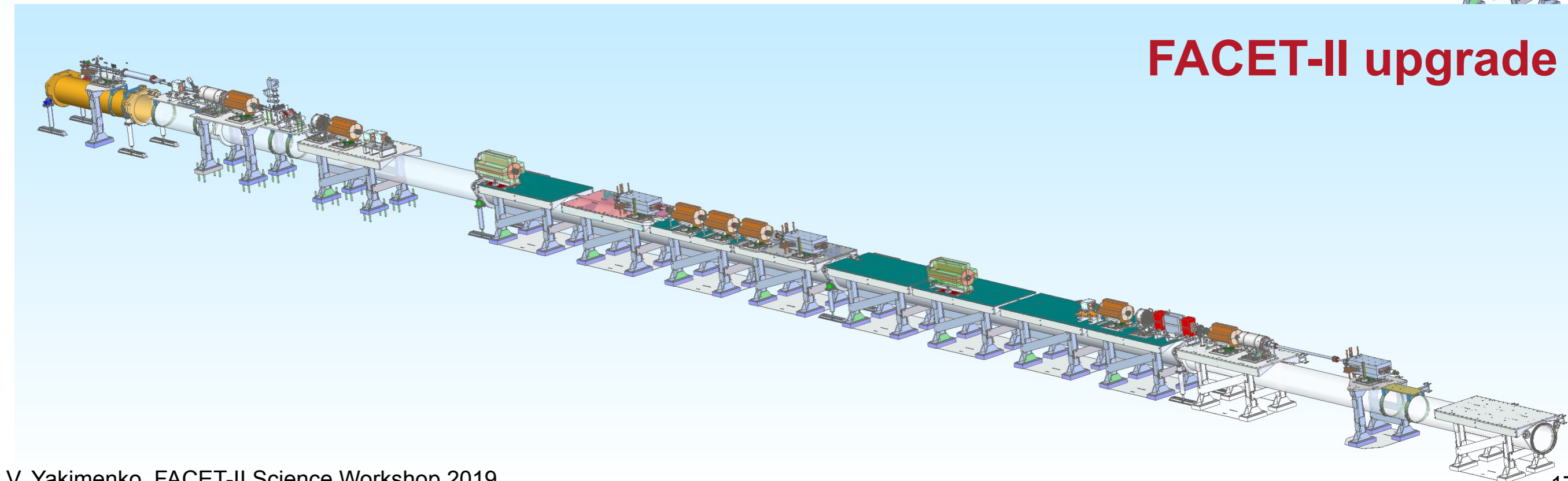
Sector 20 Chicane Upgrade (Electron Arm)

SLAC

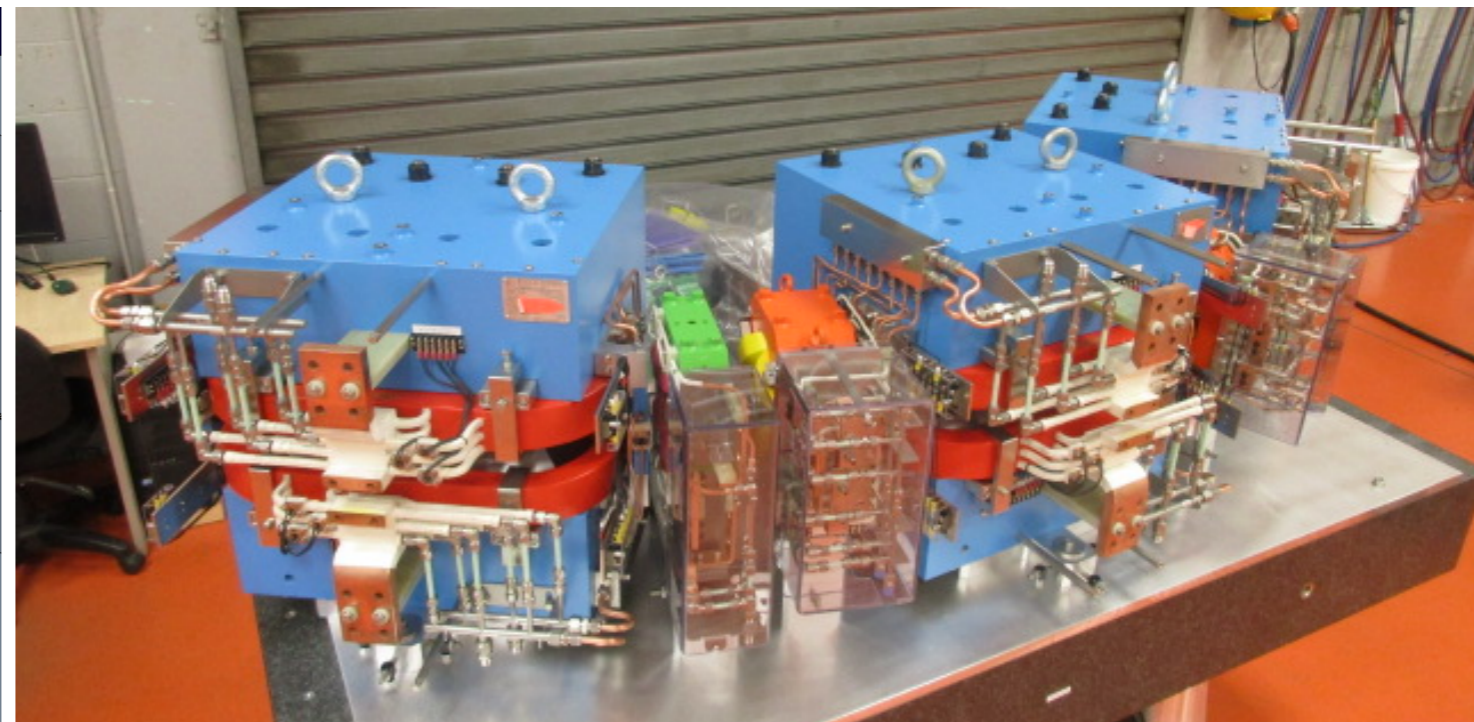
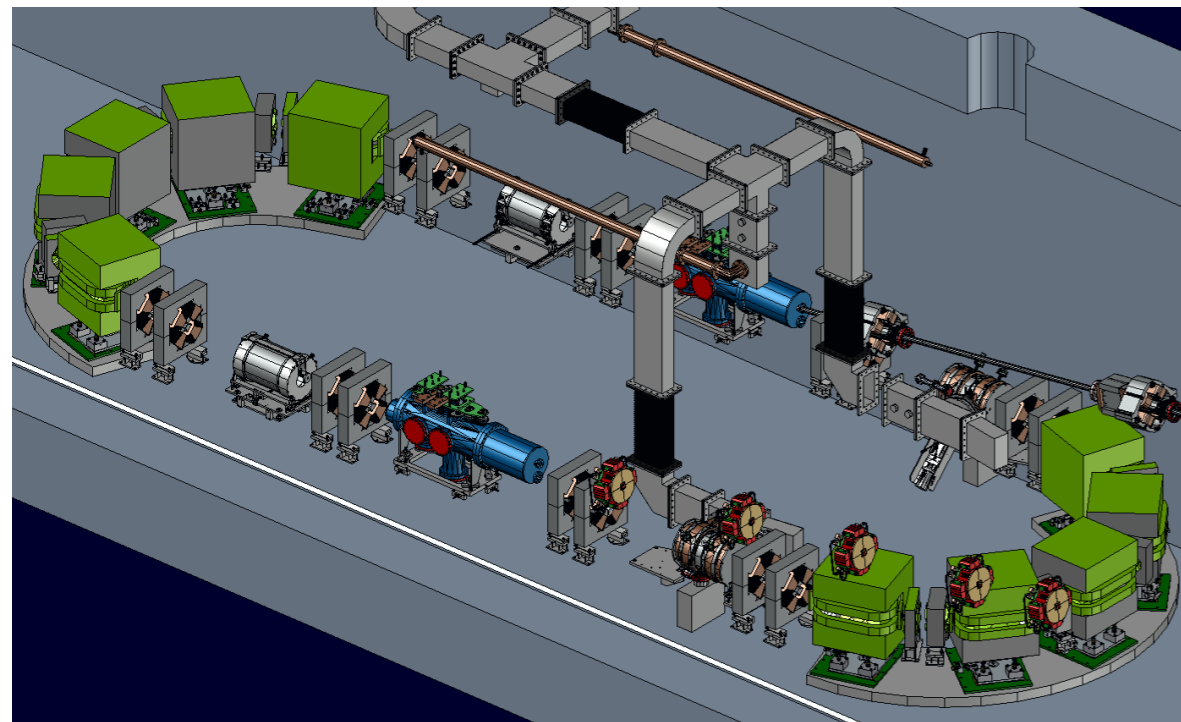
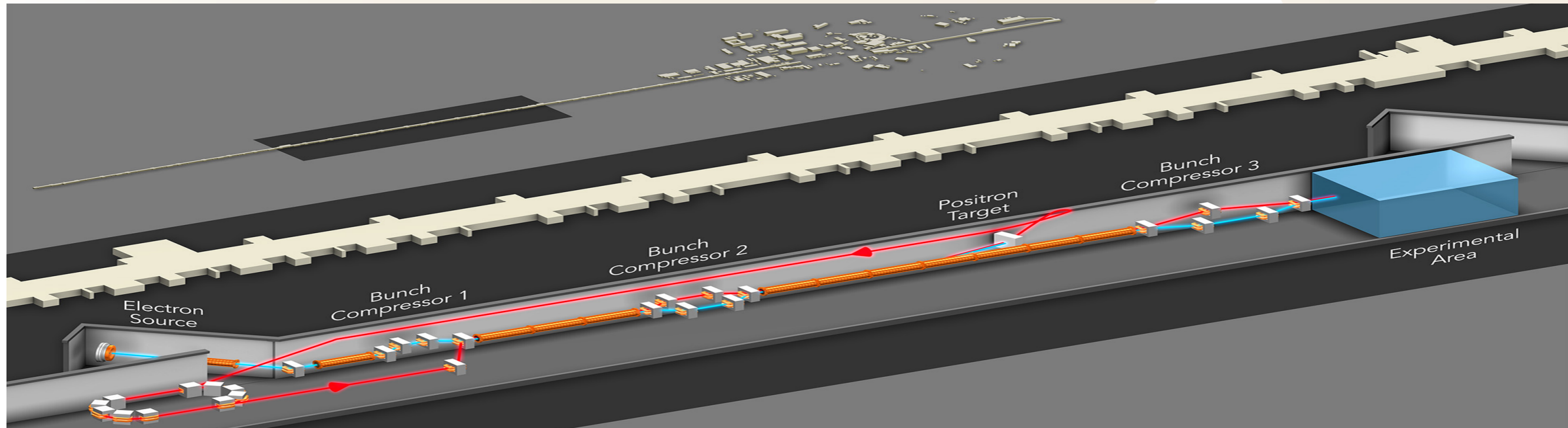
FACET-II at start



FACET-II upgrade



FACET-II Stage-II (positrons)



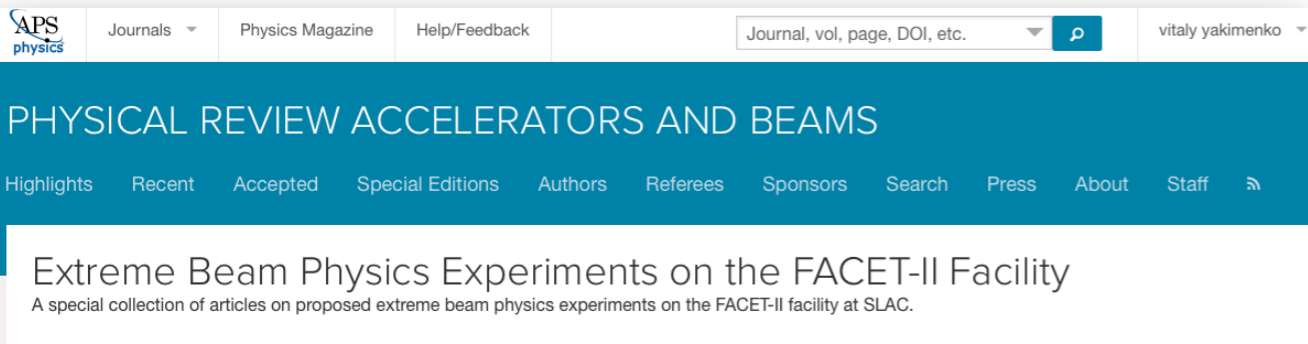
Positron Capability is Designed and Prototyped

Phys. Rev. Accelerators and Beams Special Issue: Extreme Beam Physics Experiments on the FACET-II Facility



- A special collection of articles on proposed extreme beam physics experiments on the FACET-II facility at SLAC
- Papers evaluated by PRAB individually with usual review process
- 3 accepted, 5 under review and 2 planned

FACET-II facility for advanced accelerator experimental tests	SLAC	Published
Transverse beam dynamics in a plasma density ramp	E-300	Published
Positron beam extraction from an electron-beam-driven plasma wakefield accelerator	E-303	Published
Shaping trailing beams for beam loading via beam-induced ionization injection at FACET-II	E-307	Accepted
Emittance preservation through matching the witness beam in plasma wakefield acceleration	E-300	Submitted
Automatic tuning for non-invasive diagnostics and high gain, low energy spread, and low variance plasma wakefield acceleration at FACET-II	E-325/ E-327	Submitted
Laser-ionized, beam-driven, underdense, passive thin plasma lens	E-300/ E-308	Submitted
Effect of fluctuations in the down ramp plasma source profile on the emittance and current profile of the self-injected beam	E-304	Submitted
Ultra-High Brightness Beams from Plasma Photons	E-310	Submitted
Electron beam diagnostics at FACET-II using novel plasma geometries	E-310	Planned



High quality of submitted proposals led to suggestion of FACET-II PRAB special issue

Workshop presentations and summary

Presentations will be linked on the workshop website

Summary of the workshop presentations and discussions will be assembled and communicated with SLAC management and funding agencies

Workshop presentation are expected to be treated and cited similar to PRL guidelines:

- accurately reflects the scientific results; work of the listed authors; all of the authors contributed significantly to the concept, design, execution; all those who made significant contributions were offered the opportunity to be listed as authors
- the workshop participants accept the established procedures by selecting to participate in the workshop

PWFA Program Plan

(as Shown December 2012)



FY	Facet Run	LCLS off	PWFA goal
13	2/1 - 6/30	8/6 - 9/30	2 beam generation, laser commissioning, 2 beams with laser -> mono energetic acceleration
14	10/15 - 12/20 2/1 - 6/30	8/1 - 9/30	2 beams with laser-> mono energetic acceleration , positron commissioning, positron PWFA, high brightness PWFA injector
15	10/15 - 12/20 2/1 - 6/30	8/1 - 9/30	positron PWFA , one stage, efficiency, high brightness PWFA injector
16	10/1 - 4/4	S0-10 D&D	Finalizing the program, emittance preservation (Single stage: energy spread, emittance, efficiency)

ALL DELIVERED