Future Continuation of Test Beams at SLAC's End Station A

11th BTTBW, DESY

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SLAC NATIONAL ACCELERATOR LABORATORY

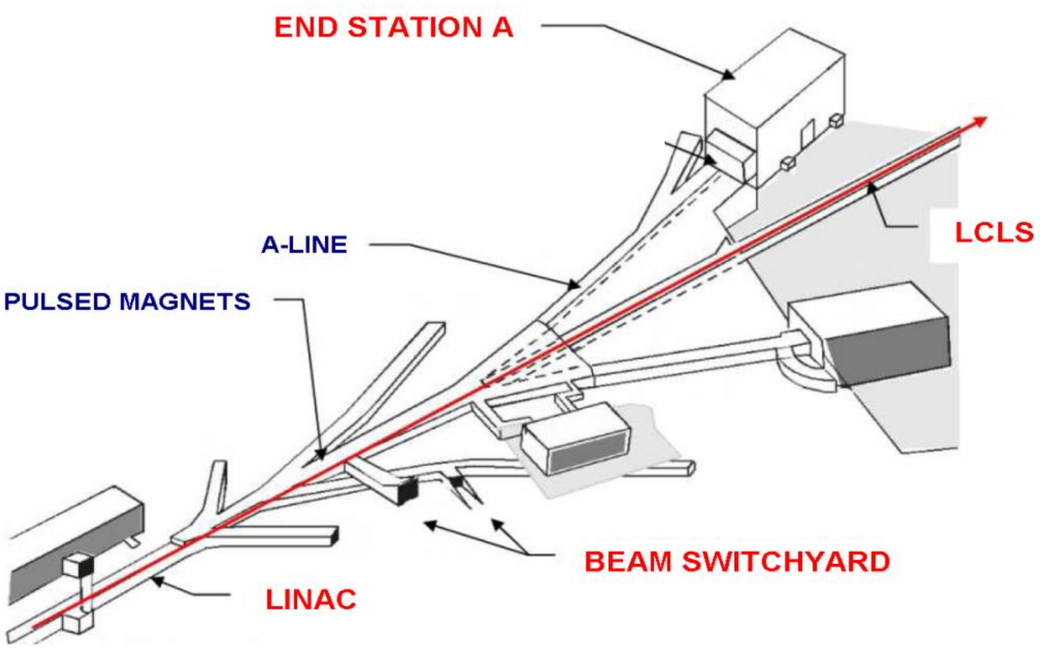
Stanford University | U.S. DEPARTMENT OF ENERGY

10 GeV
FACET-II
ASTA
UED
4 (8) GeV
single e-
ESA
NLCTA
SLAC NATIONAL ACCELERATOR LABORATORY
Stanford University
U.S. DEPARTMENT OF ENERGY

End Station Test Beam (ESTB) 2013-2018

- LCLS beam was deflected to ESTB at 5Hz
- LCLS Cu Beam Energy 3-16GeV
- Secondary particle production target in BSY
  - Just kick beam onto 6mm of Cu
  - Secondary electrons up to <15GeV
- Beam is bend by 24.5^{O} into ESA

Fiscal Year	# Experi-ments	# Users
2013	6	91
2014	11	207
2015	6	54
2016	15	140
2017	7	74
2018	6	49
2019	8	86
Total	58	701

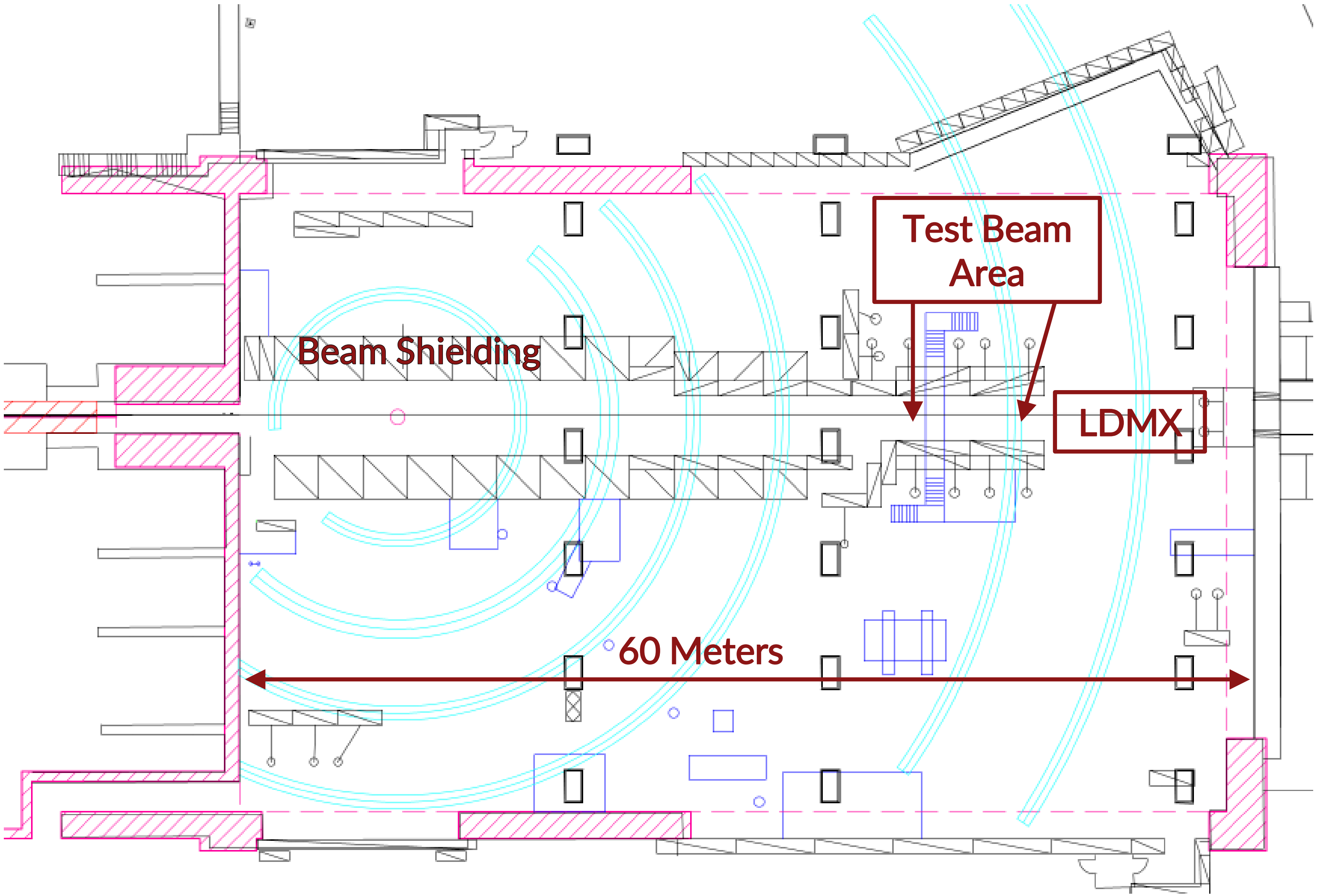


- Highlights:
  - g-2 calorimeter calibration
  - LANL electron radiography
  - Atlas silicon tracker development
  - Cosmic neutrino/air showers
  - Electron Channeling Studies

I gave an overview talk @ BTTB4 Orsay 2016

Widely Successful

Building 61: End Station A (ESA)

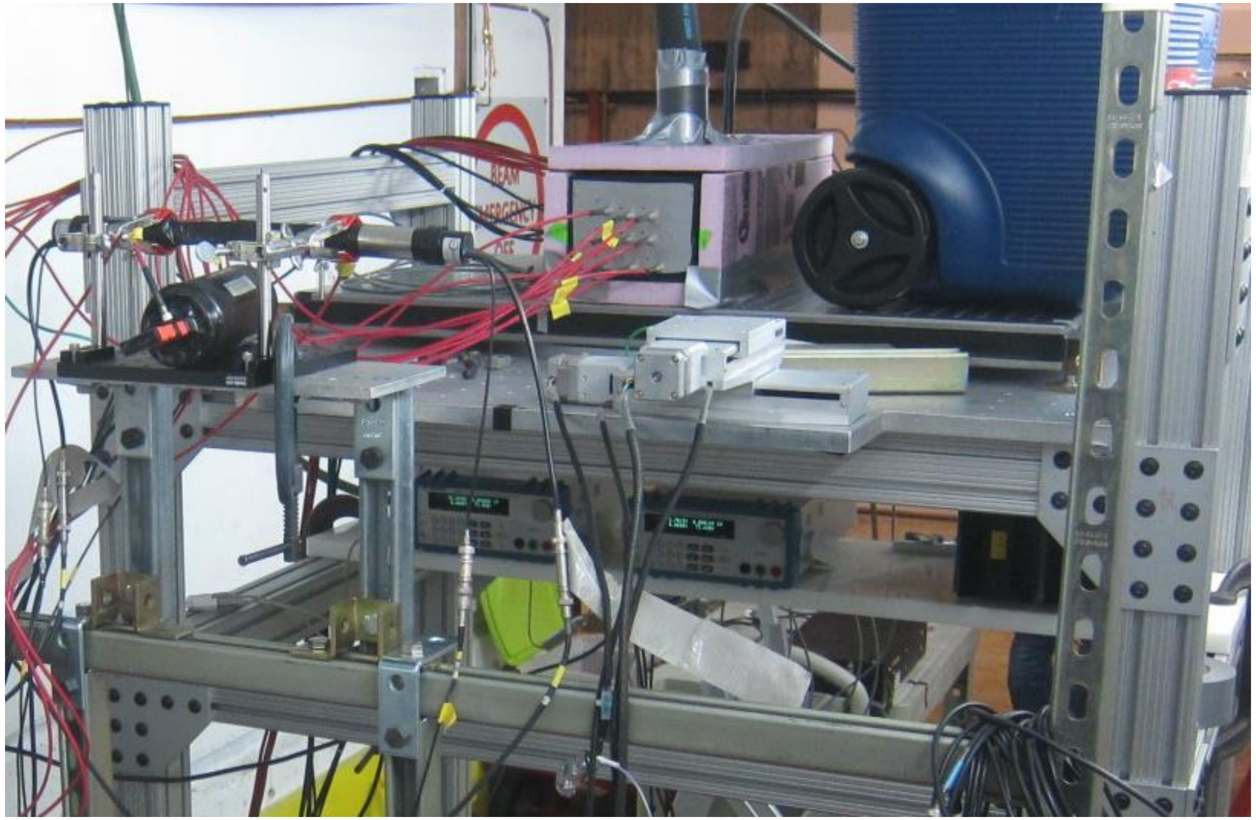


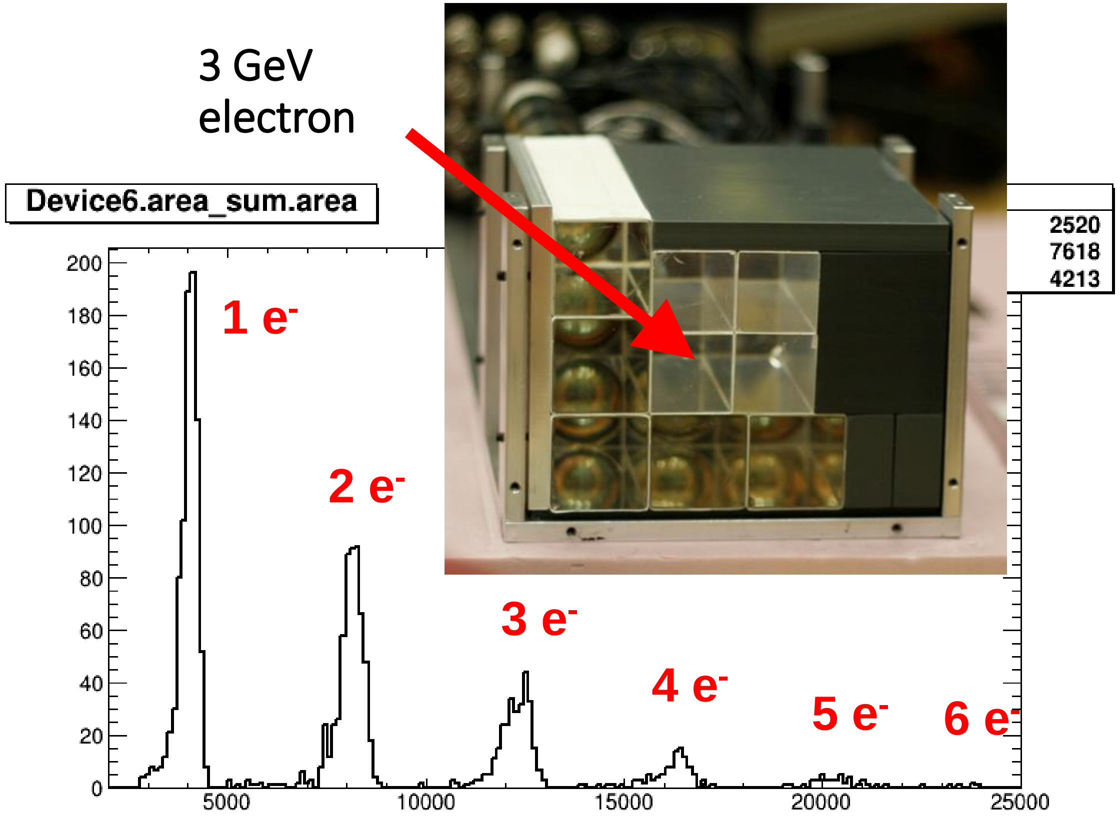
End Station A (ESA)

- ESA has massive shielding
- Crane coverage
- Pretty good temperature stability
- Test-Beam Beam line is at 4’10”=150cm height above ground (inside bunker)
- Vacuum up to your experiment
- Beam path is straight for about 150m after the last bend magnet in A-line
  - We will have some quads in ESA to make the beam larger for LDMX, can be turned off
  - Very effective collimator system in A-Line
- Divergence is < 0.1mrad
- Energy resolution is in the per mill range

Typical Experimental Setup (g-2 Calorimeter)

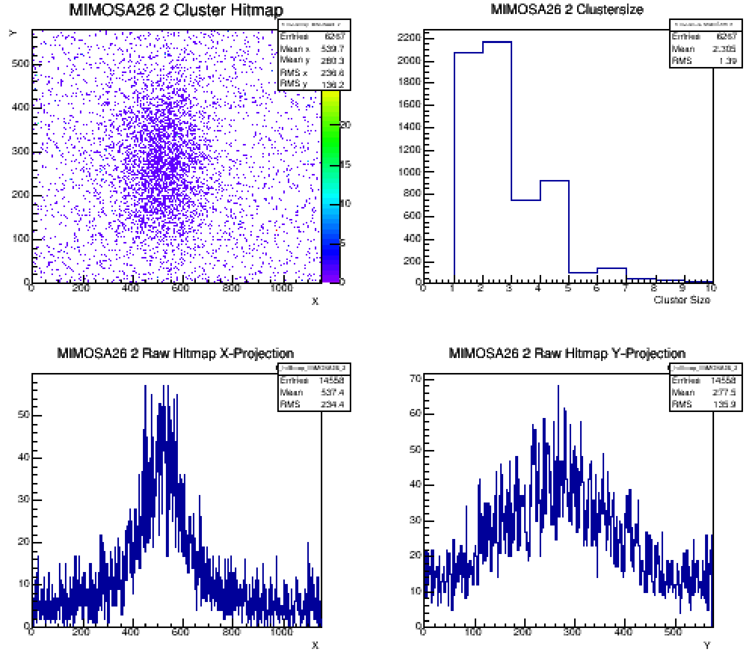
- Single electrons 2-6Gev @ 5Hz
- Used our large movable stage to position calorimeter

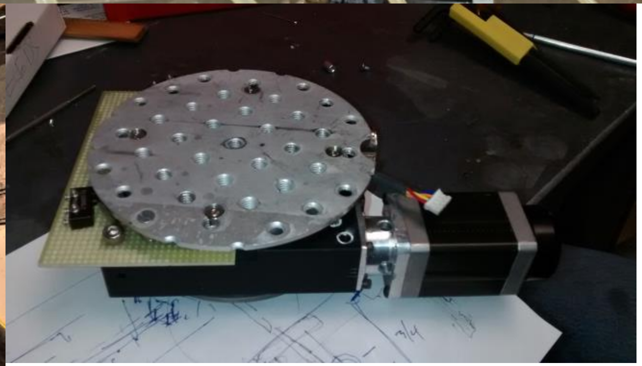




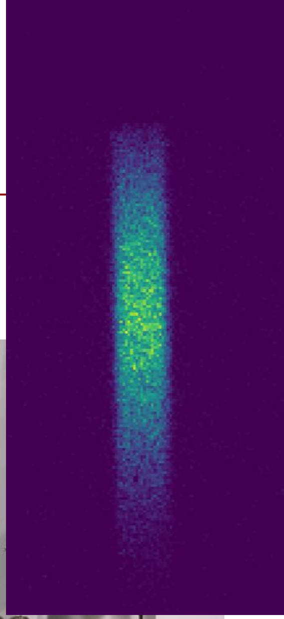
Typical Experimental Setup (Caladium)

- Caladium (EUDET) telescope on loan from Carleton Uni.
- Did plenty of ATLAS and other Silicon beam tests
- Mounted on movers for easy positioning in beam
- Rotation stage for DUT
- Worked quite well

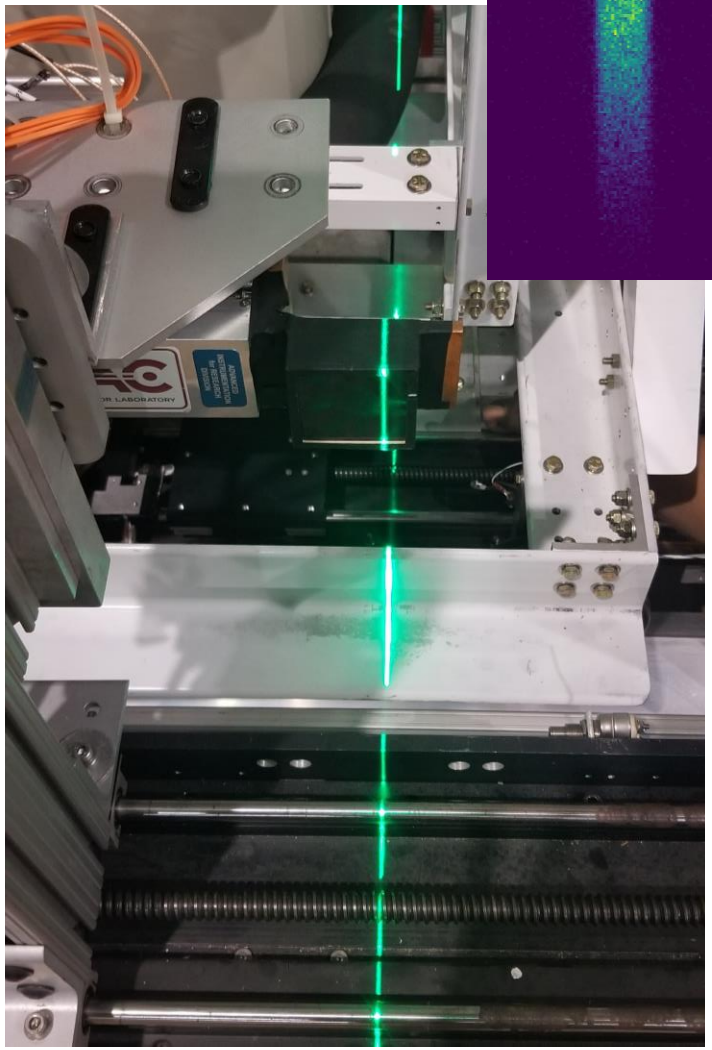


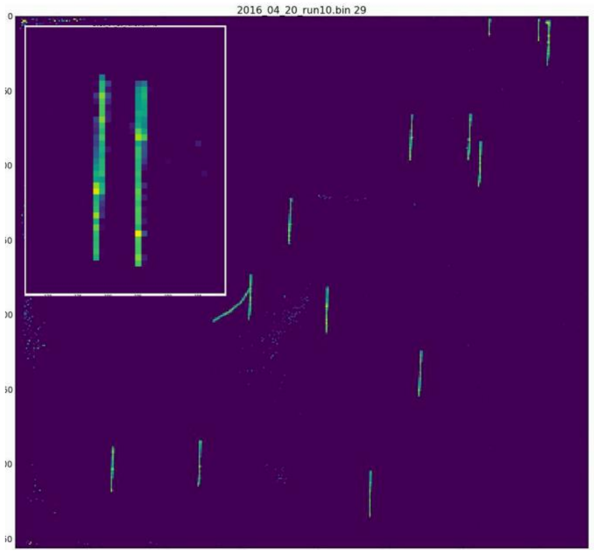


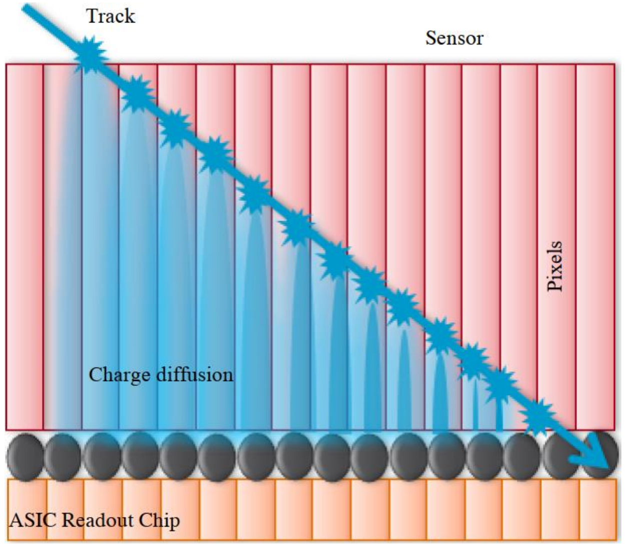
Typical Experimental Setup (ePix 100a)

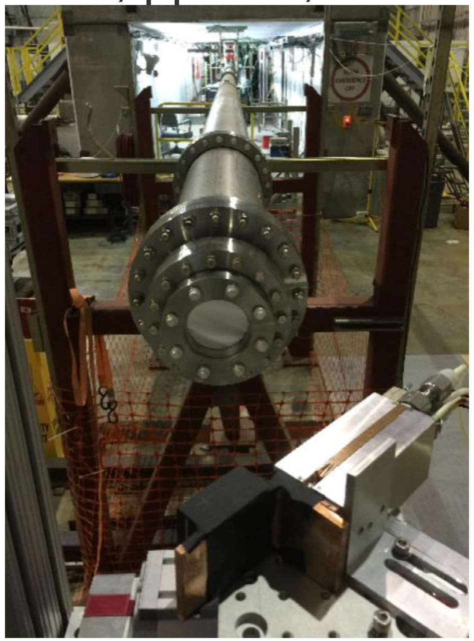


- We built a modified version of an ePix camera
  - Moved electronics by 90 degrees to reduce material after sensor
- Mounted on x/y movers, incorporated into experimental setup for T-530: Microwave Cherenkov Calorimeters for Ultra-high Intensity Beams, Peter Gorham (Univ. of Hawaii)
- Did some 45^{O} measurements
  - “3D Electron Tracking and Vertexing in Single Plane Pixel Detectors”, G.Blaj et.al. *(NSS/MIC/RTSD)*, Strasbourg, France, 2016, pp. 1-6, doi: 10.1109/NSSMIC.2016.8069688.



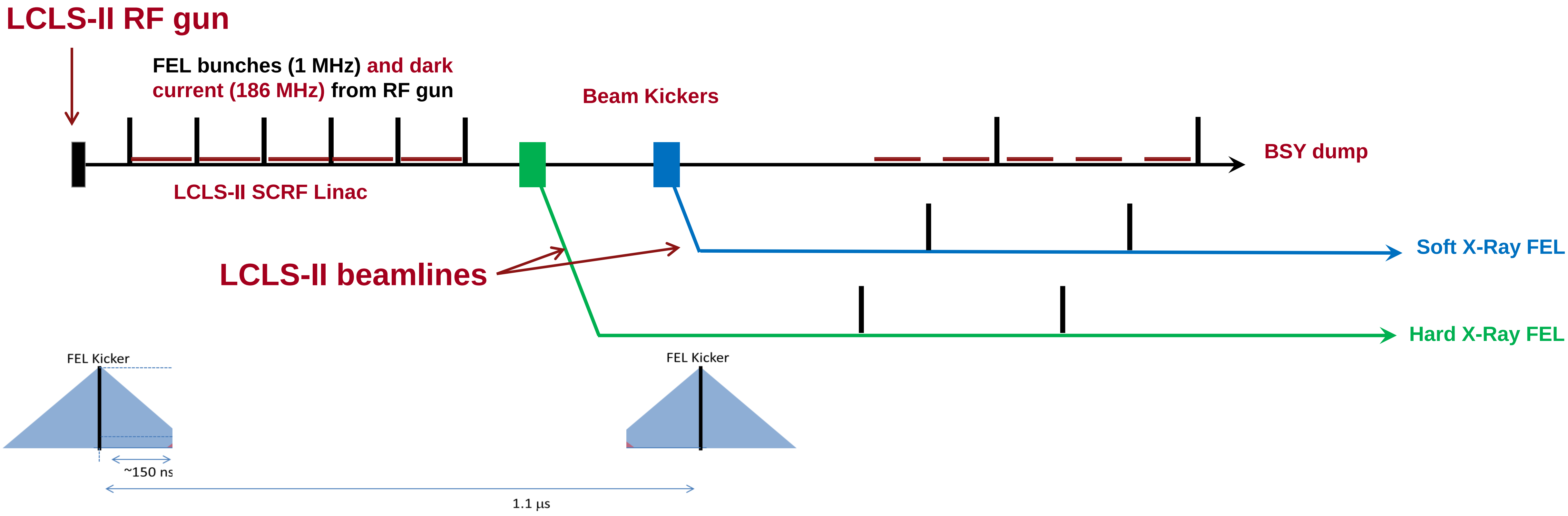




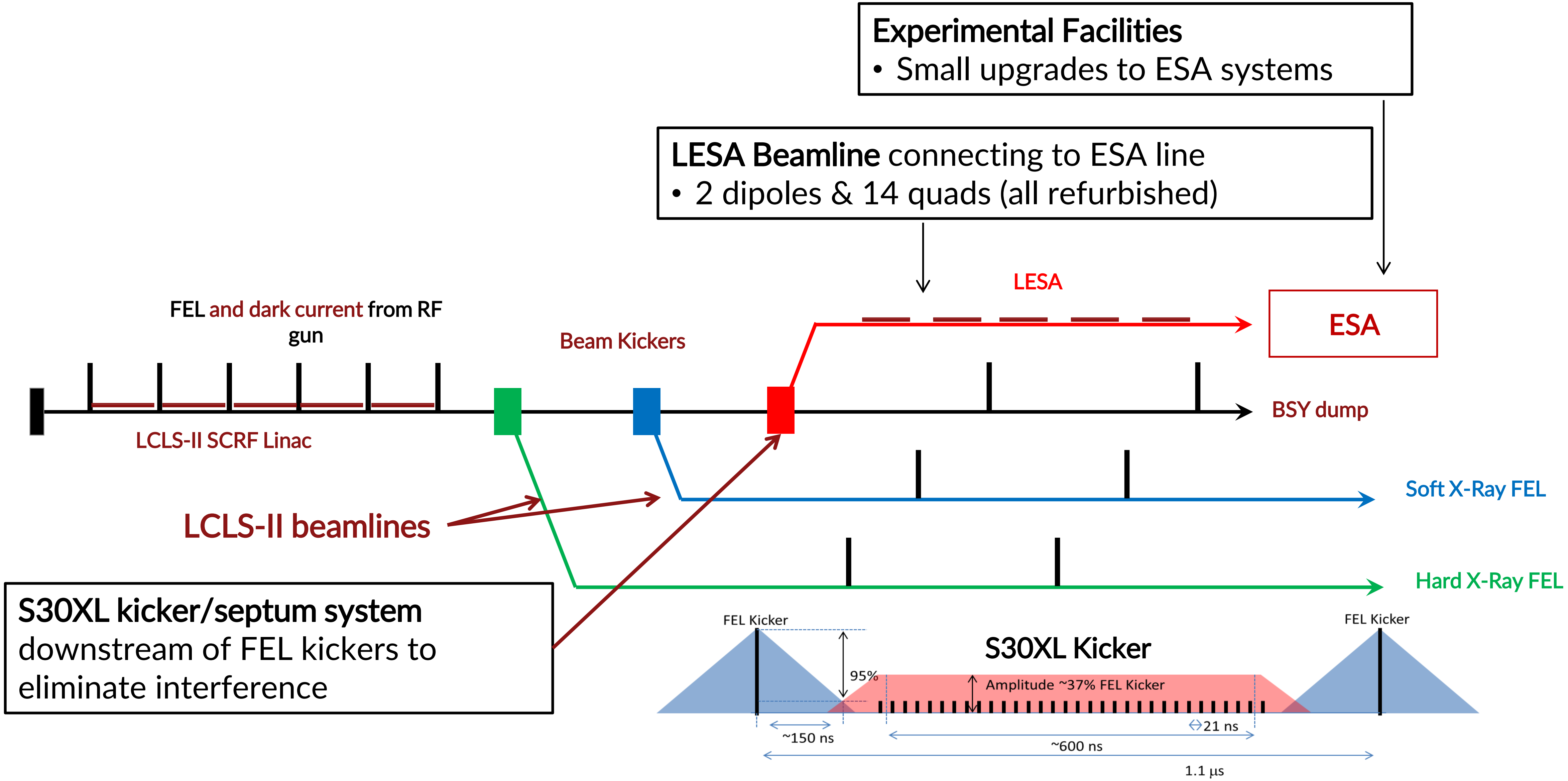


Backbone: LCLS-II Super Conducting RF Linac

- 4 GeV SCRF Linac delivering ~1 MHz electron bunches for photon science
- Short pulsed kickers divert individual bunches to FEL lines
- Unclaimed bunches and "empty" (dark current) RF buckets between them to dump line in BSY



Linac to End Station A (LESA) Concept with Dark Current



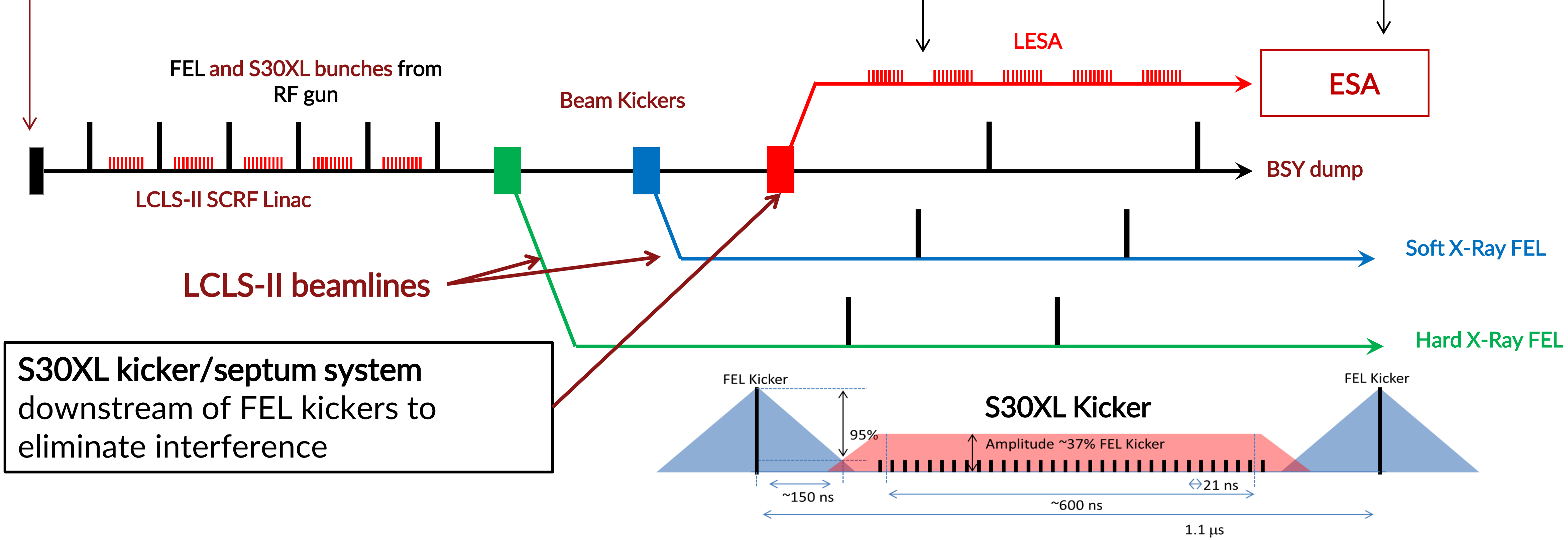
LESA + Laser Concept

Experimental Facilities
- Small upgrades to ESA systems

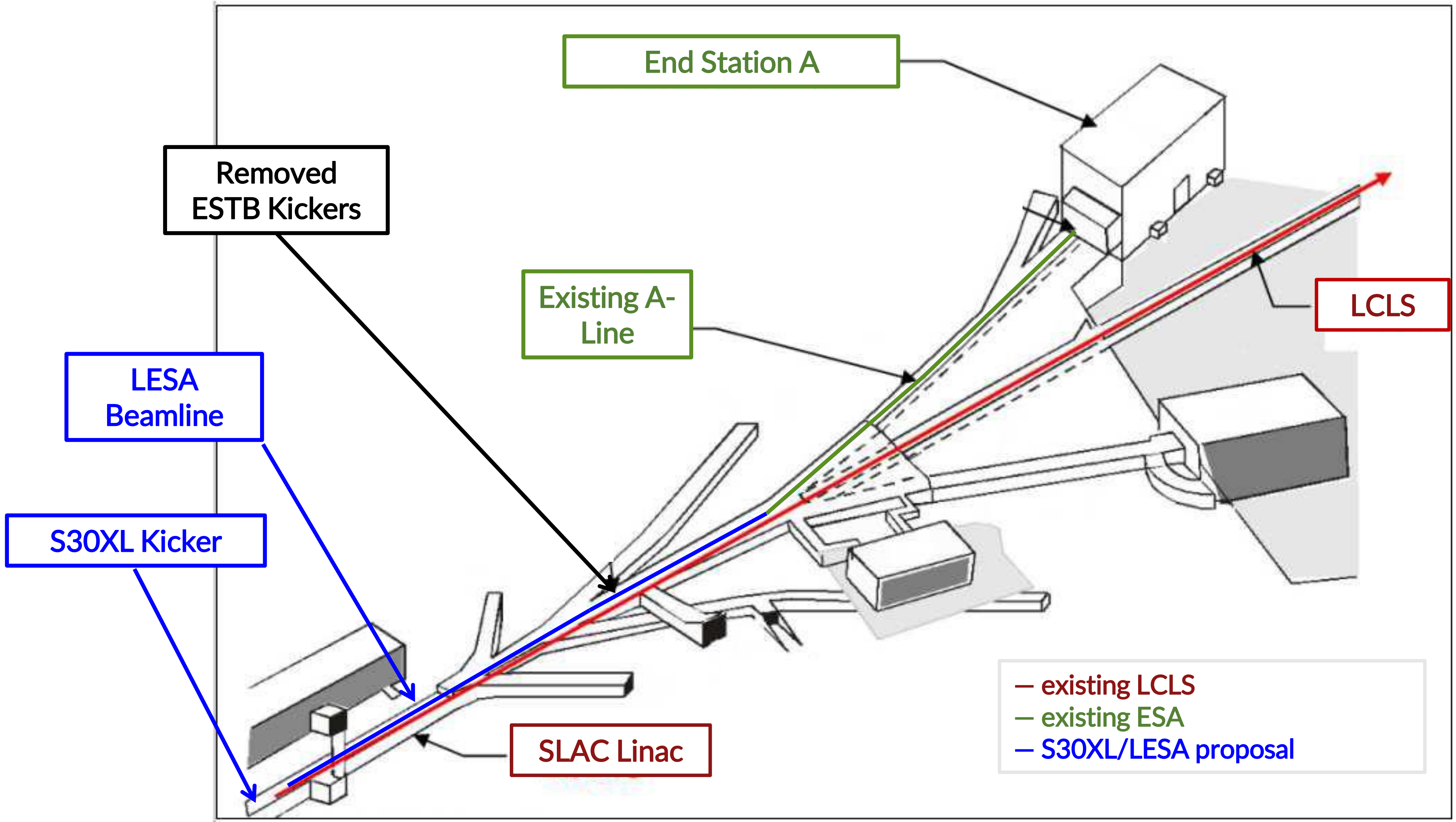
Laser system to fill “unused” buckets with electrons at 46 MHz

LESA Beamline connecting to ESA line
- 2 dipoles & 14 quads (all refurbished)

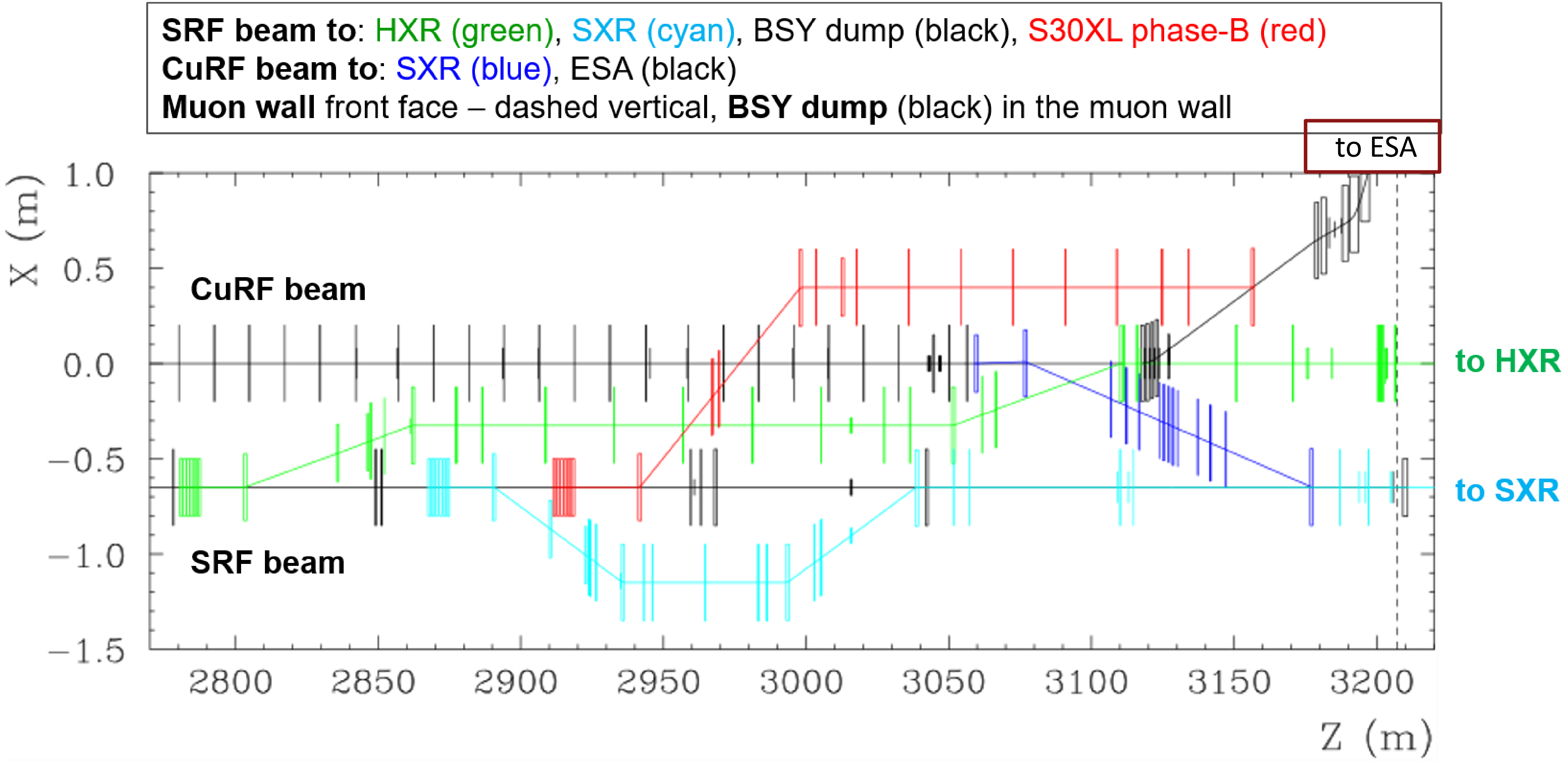
S30XL kicker/septum system downstream of FEL kickers to eliminate interference



Linac to End Station A (LESA) at SLAC as Electron Test Beam



LESA layout (top view)



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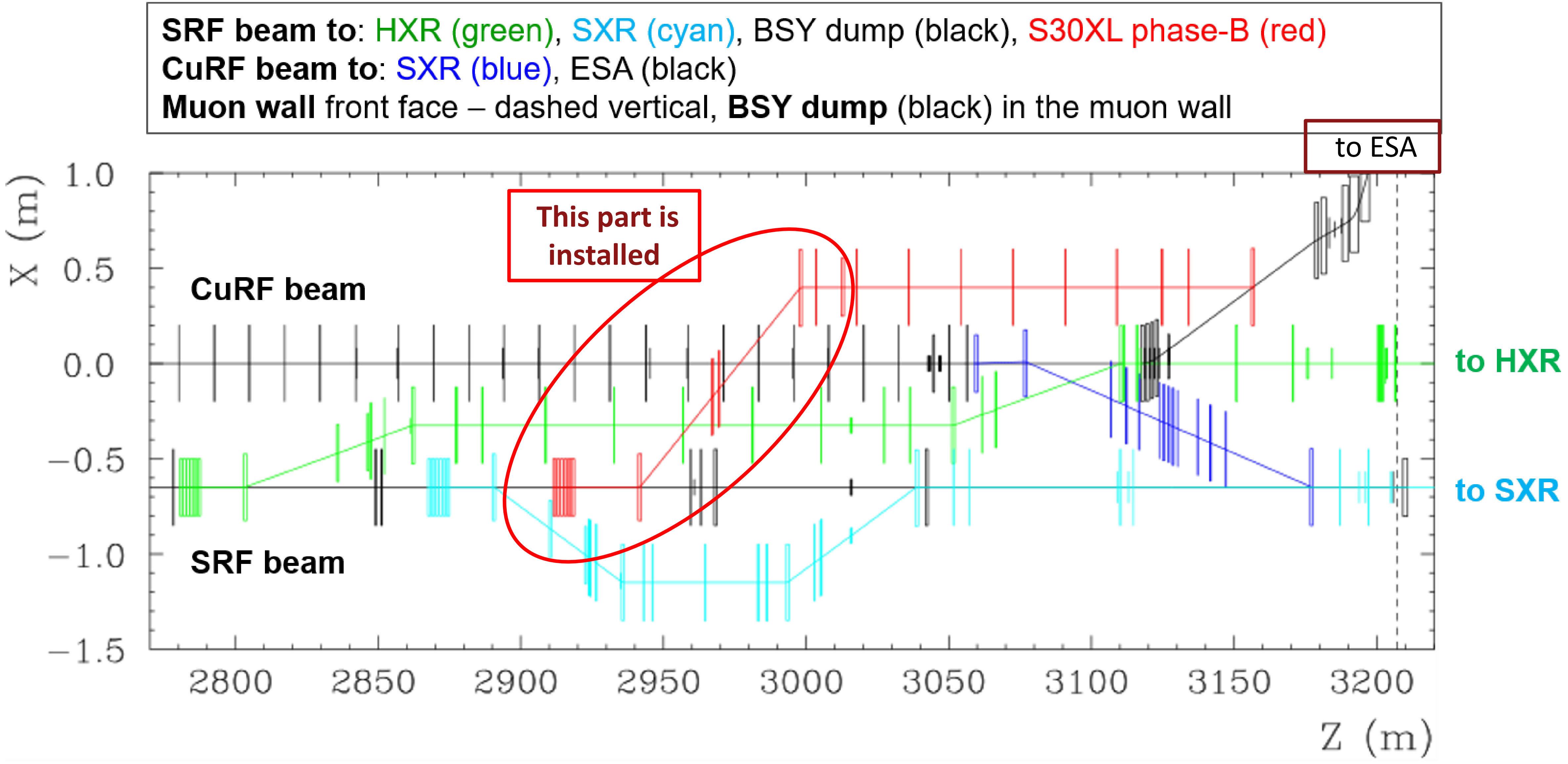
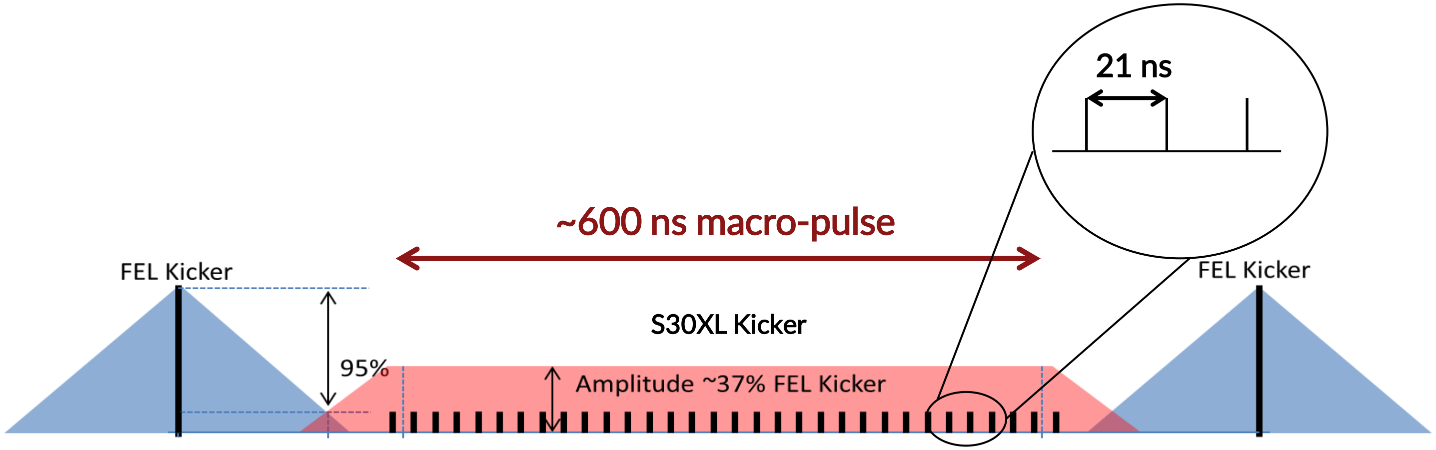


LESA Features for Test Beams

- High Repetition Rate
  - Up to 1 pulse every 21 ns (46 MHz) with 50% macro-pulse duty cycle
  - Allows direct study, in test beam, of high-rate performance and Out-Of-Time pile-up
  - Allows rapid integration of statistics – up to 10^7 bunches per second
  - Can reduce rate, while maintaining well defined time structure, by filling specific buckets in each macro-pulse and/or decreasing kicker repetition rate (macro-pulse repetition rate)
  - Use laser to prepare specific fill pattern
- Short Pulses
  - sub-ps length pulses
  - Unique capability of short pulses for fast timing detector tests



- Beam Energy
  - Pegged to LCLS-II
  - 4 GeV and then 8 GeV with LCLS-II-HE
  - Can tune energy lower in A-Line (when making secondaries: a few to << 1 e^- per pulse)
- Variable Current
  - Up to 25 nA (3000 e−/bunch) with 50% duty cycle (useful for irradiation tests, testing integrating detectors)
  - Down to Poisson average < 1 e^- per pulse

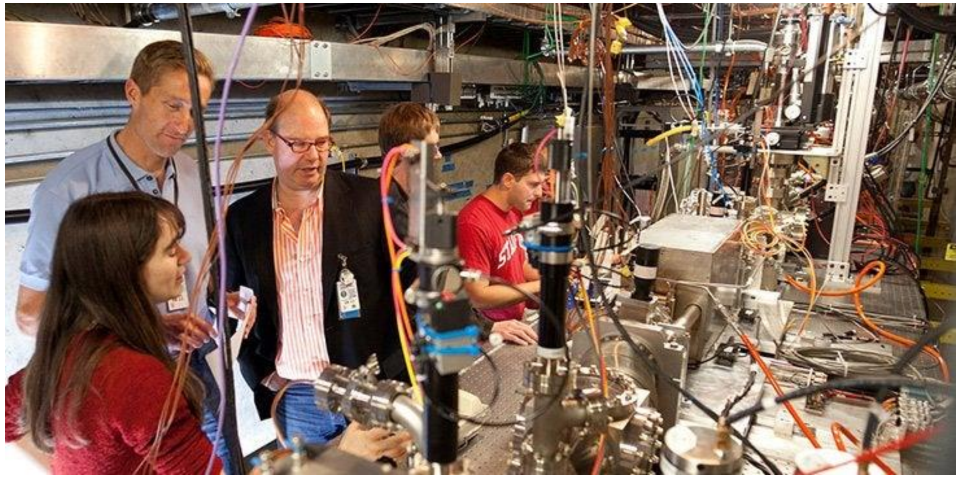
Schedule and Beam Availability

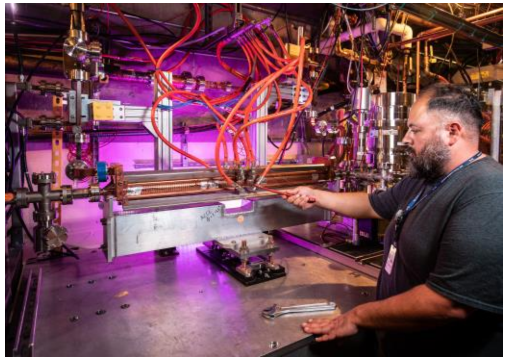
- LCLS-II commissioning to start soon
- Possibly install rest of LESA beam line this summer and next year during summer down times
- Some chance to get first beam (4 GeV) late 2024/first half of 2025
- Long down time summer 2025 to summer 2026 for LCLS-II-HE (8 GeV) installation
- LESA beam delivery is concurrent with normal LCLS-II(-HE) operations
  - High beam availability ~250+ days/year is anticipated (after 2026)
  - This will be shared between test beams and other HEP applications (Dark Matter Searches)

There should be plenty of beam time for everybody

FACET-II is Looking for a User Manager (SLAC Staff Scientist)

- Being the Liaison between SLAC and FACET-II Users Develop and implement policies and procedures for experiment safety and experimental readiness review Arrange site and remote access for Users Arrange training of FACET-II Users and ensure completion prior to engaging in related activities Communicate results of proposal review, schedule and all information and concerns related to safety to the Users Communicate needs of the Users to supporting groups at SLAC Preparation of a document summarizing each experiment to the Radiation Physics department at SLAC for review Maintain FACET-II User Facility website.
- Participate in development and installation of experimental hardware and execution of the FACET-II experimental programs Plan and coordinate experimental support between FACET staff, SLAC shops and Users Work with existing FACET-II collaborations to ensure efficient and successful execution of experiments Carry out active theoretical and experimental research in areas of Advanced Accelerator R&D at FACET-II aligned with SLAC and sponsor goals Note: Appointment to the Staff Scientist level requires a review and evaluation of documented scientific achievement. Applicants should include a cover letter, a statement of research including brief summary of accomplishments, a curriculum vitae, a list of publications, and names of three references for future letters of recommendation with the application.
- Ph.D. in physics, applied physics, or related fields, with a minimum of four years of relevant experience in user facilities. Familiarity with beam-line hardware, including high vacuum systems, magnetic optics, S-band and X-band rf structures, and picosecond to femtosecond TW-class laser systems, Electron beam-based radiation generation and detection from THz to Gamma-ray radiation generation and detection, as well as image processing and interferometric analysis techniques; Ultra-fast electron beam/laser/plasma diagnostics and measurement techniques. etc. (some of these needed and some desired)
- https://careers.slac.stanford.edu/
- **Search for FACET-II User Manager or job # 5291 or 5292**





LESA Summary

- SLAC is starting operations of LCLS-II SCRF Linac now
- Linac to ESA beam line is partly installed
- Hope to complete by late 2024
- Beam has
  - Precision timing (sub-ps)
  - High repetition rate 46MHz @ 50% duty cycle
  - Flexible bunch charge structure
  - 4 GeV or 8 GeV primary beam energy, or smaller if making secondaries in A-Line
- Beam will be shared between
  - LDMX dark matter search (or other follow-on experiments)
  - Test Beams

I Hope We Can Continue Electron Test Beams at SLAC's ESA Soon

Questions?

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