End Station Test Beam (ESTB) at SLAC

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LCWS2010 Beijing

March 29, 2010

SLAC NATIONAL ACCELERATOR LABORATORY

PPA Particle Physics & Astrophysics

End Station Test Beam (ESTB) Will Restore Test Beams at SLAC

* **There is a Long History of Linear Collider studies at ESA and FFTB**
  - Final Focus feedback studies
  - Beam Energy Spectrometers
  - MDI, Collimator Wakefields, Beam Pickup

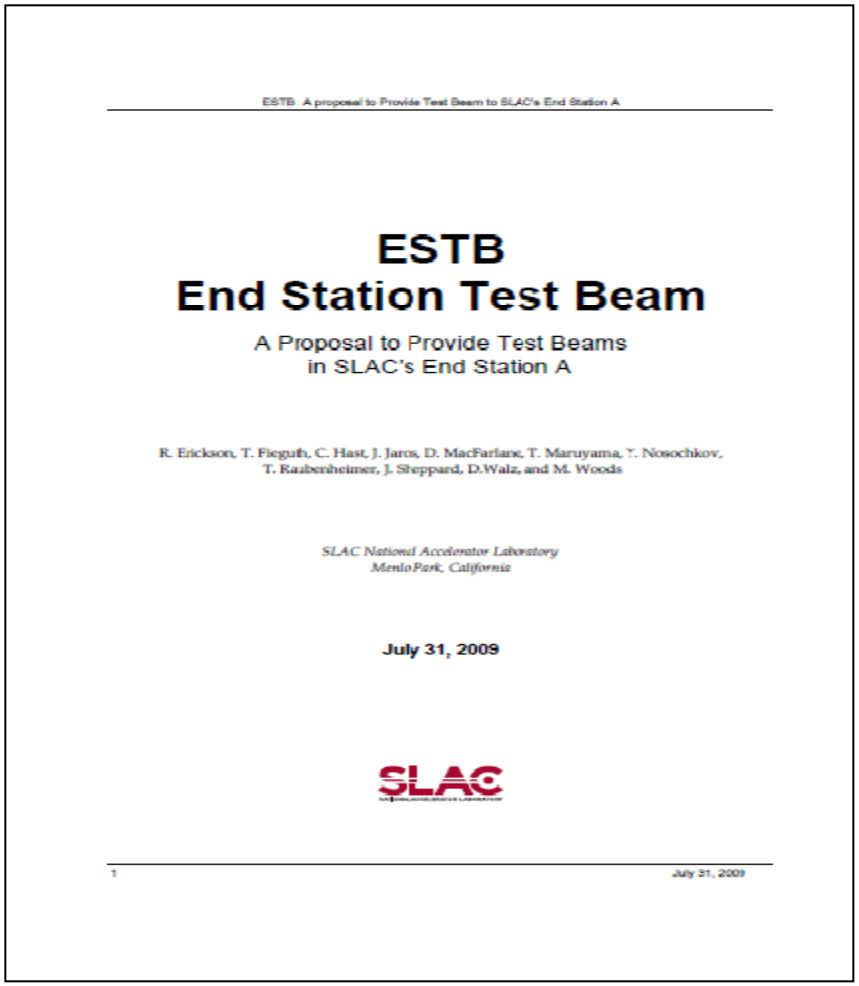
* **Test Beam Activities at SLAC were Interrupted by Installation and Operation of LCLS, SLAC's X-ray Laser.**

* **ESTB Stage I provides High Energy e+e- Beams (Under Construction)**
  - World's only high-energy primary electron beam for large scale Linear Collider MDI and beam instrumentation studies

  - Exceptionally clean and well-defined secondary electron beams with known timing, for detector development and calibration for LC, SLHC, Super B, and Particle Astro experiments

* **ESTB Stage II provides hadron beams (Proposal Pending)**

ESTB Proposal Approved


ESTB: A proposal to Provide Test Beam to SLAC's End Station A

ESTB
End Station Test Beam

A Proposal to Provide Test Beams
in SLAC's End Station A

R. Erickson, T. Fieguth, C. Hast, J. Jaros, D. MacFarlane, T. Maruyama, Y. Nosochkov, T. Raubenheimer, J. Sheppard, D.Walz, and M. Woods

SLAC National Accelerator Laboratory
Menlo Park, California

July 31, 2009

SLAC

1 July 31, 2009

Proposal submitted last August. Stage I was approved in January and work has begun.

Co-Authors

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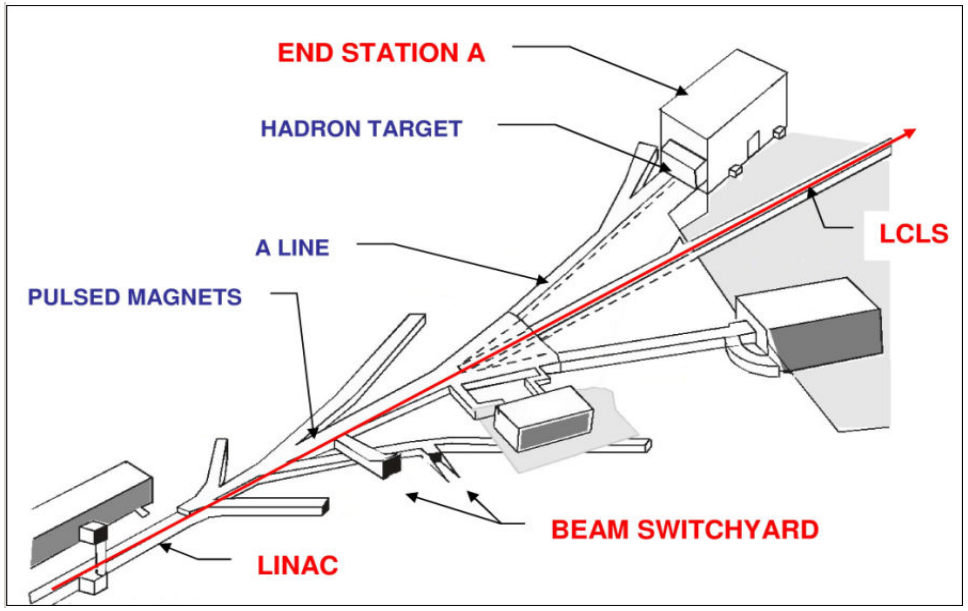
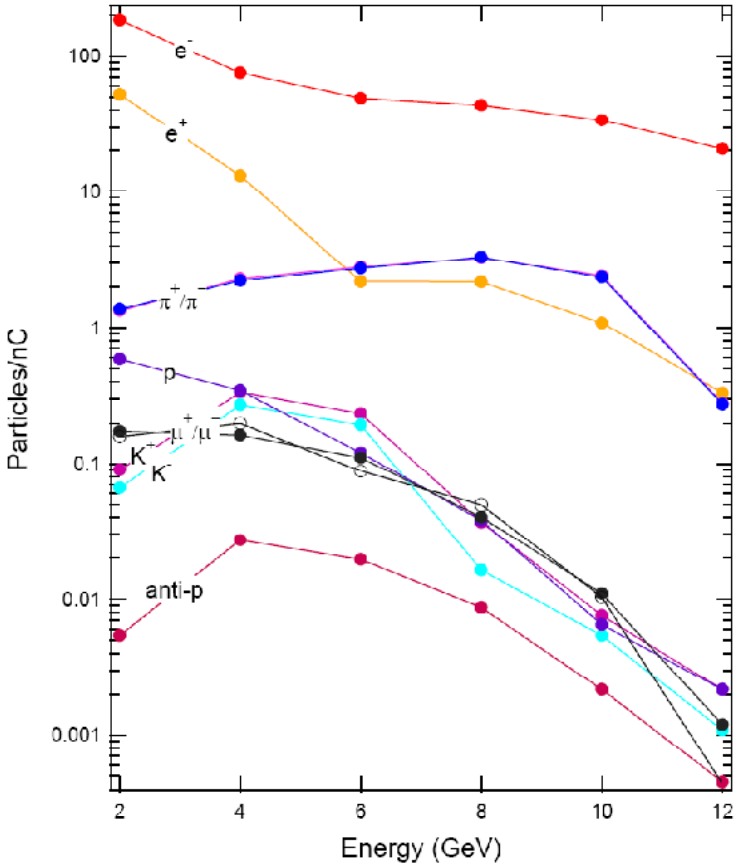
ESA Test Beams Can Provide Electrons/Hadrons up to 13.6 GeV, from single particles to full beam intensity

- **Kick 13.6 GeV LCLS beam to ESA**
  5 Hz, 2 x 10^9 e^-/ pulse primary beam
- **Clean secondary electrons/positrons**
  p<13.6 GeV, 0.1/pulse to 2 x 10^9 e^-/pulse
- **Secondary hadrons**
  ~1 π / pulse < 12 GeV/c



Secondary Particle Yields



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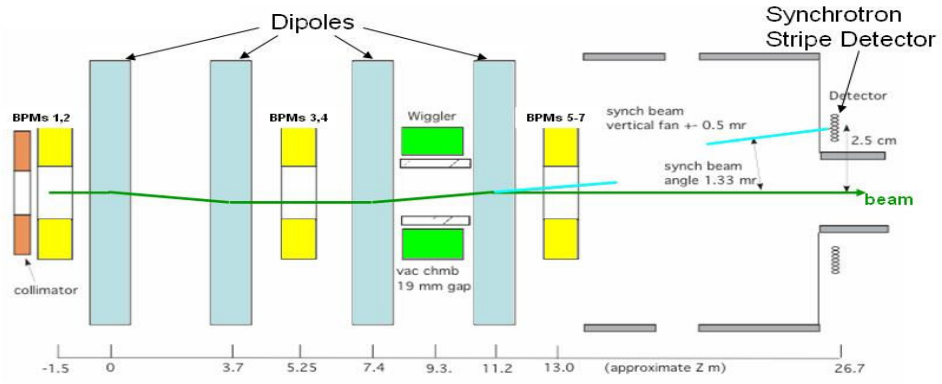
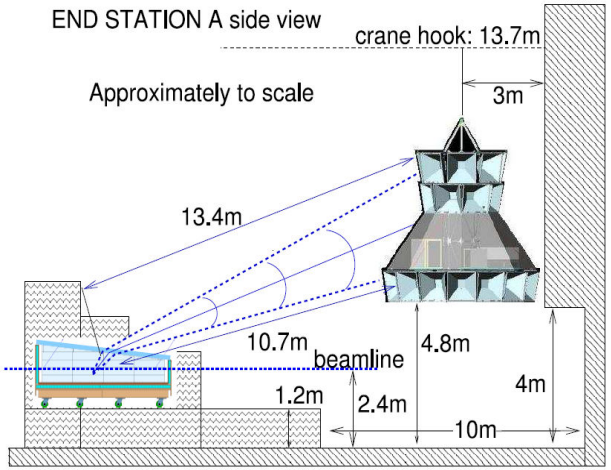
ESTB Motives
LC Beam Instrumentation, MDI, Detector R&D

LC Beam Energy Measurement



Calibrate Anita with Full Beam into Ice



Ideal for LC Detector R&D

- LC beam timing—precisely known arrival time
- Ultra-clean, known momentum electrons for ECal studies
- Tagged photon beam possible
- ~12 GeV/c hadrons for tracker, vertex detector studies. Multiple scattering negligible at these momenta.
- Hadrons suitable for Hcal studies at the low and intermediate energies which dominate ILC jets.

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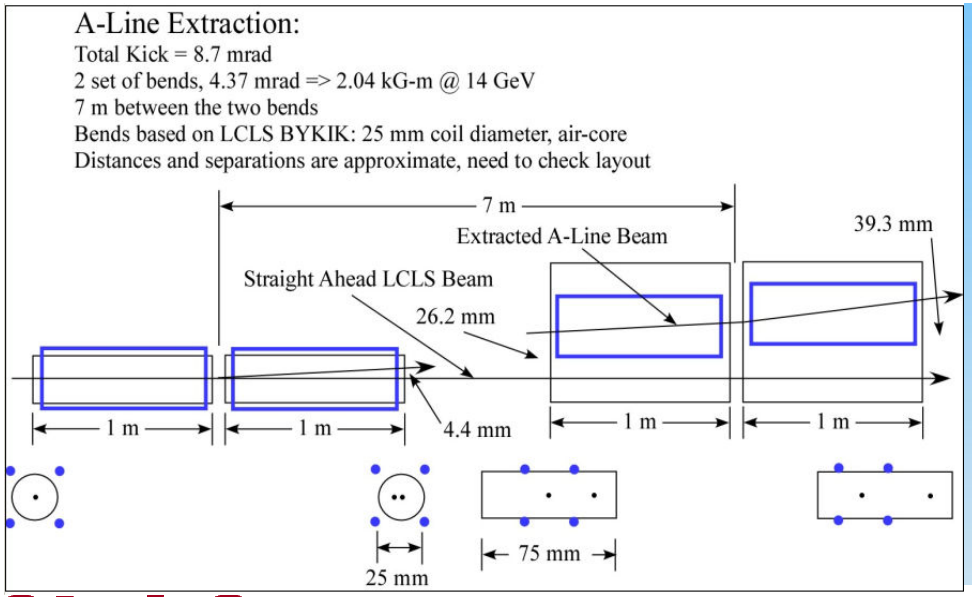
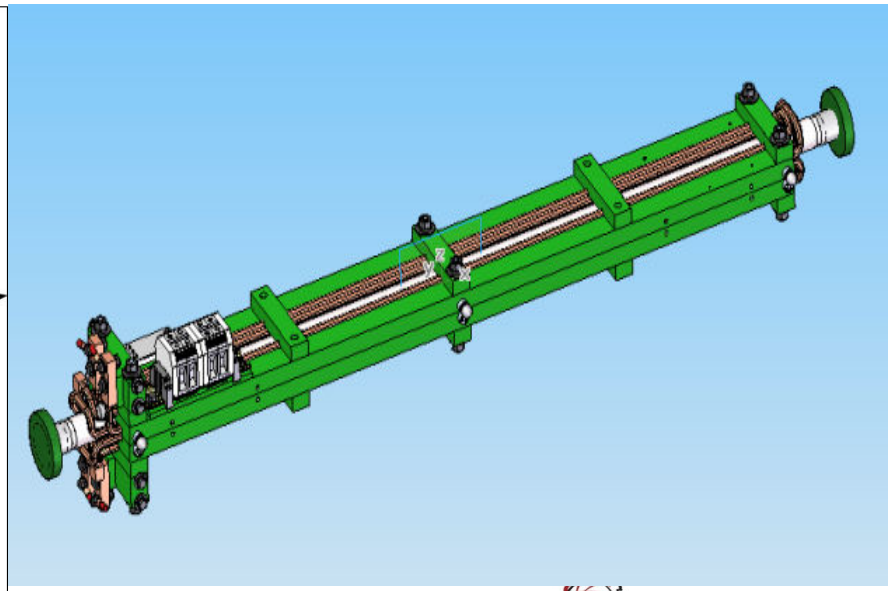
ESTB Stage I

* Construct kicker magnets and vacuum chamber for BSY
* Update PPS System and install new beam dump for ESA
* Update MPS and Controls as needed
* Schedule: Construction 2010, Beams by ~Spring 2011.

Use LCLS Kicker Magnets in BSY





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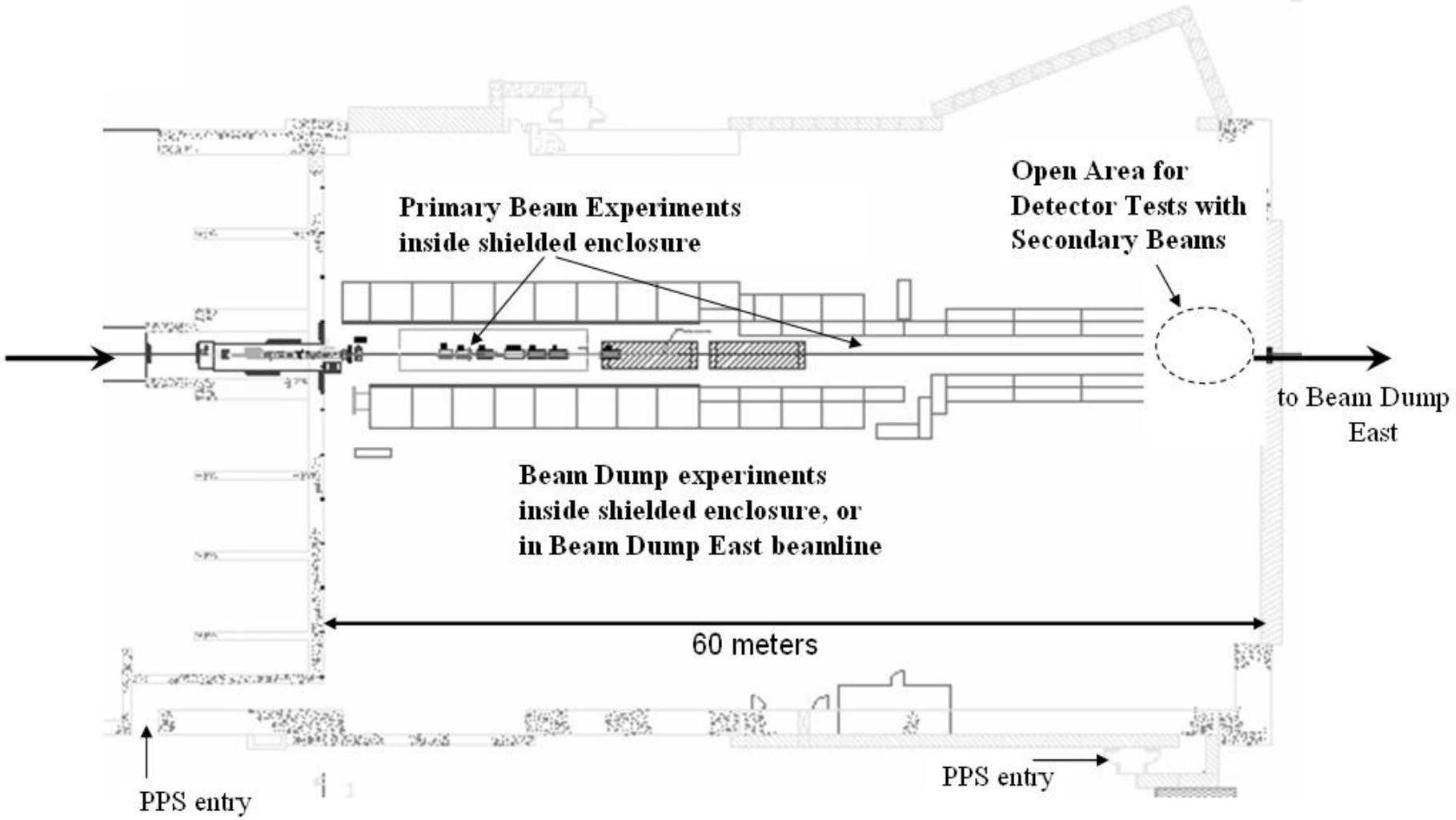
Primary Electron Beam Properties

Energy	13.6 GeV
Repetition Rate	5 Hz
Charge per pulse	0.15 to 0.6 x 10^{10} (1 nC) e-
Momentum spread rms	<0.058%
Bunch length rms	280 μm
Emittance rms ($\gamma\varepsilon_x$ $\gamma\varepsilon_y$)	(4,1) x 10^{-6} m rad
Spot size at waist ($\sigma_{x,y}$)	~10 μm
Momentum dispersion η and η'	<10mm
Drift space available for experimental apparatus	60 m
Transverse space available for experimental apparatus	5 x 5 m

Lots of room for apparatus

ESA Experimental Area



ESA Infrastructure

Available Instrumentation

Trigger counters; Halo veto counters; High resolution beam hodoscope; Particle ID (Cerenkov, TOF, shower counter); Small, high field solenoid; sturdy support table with remote movers

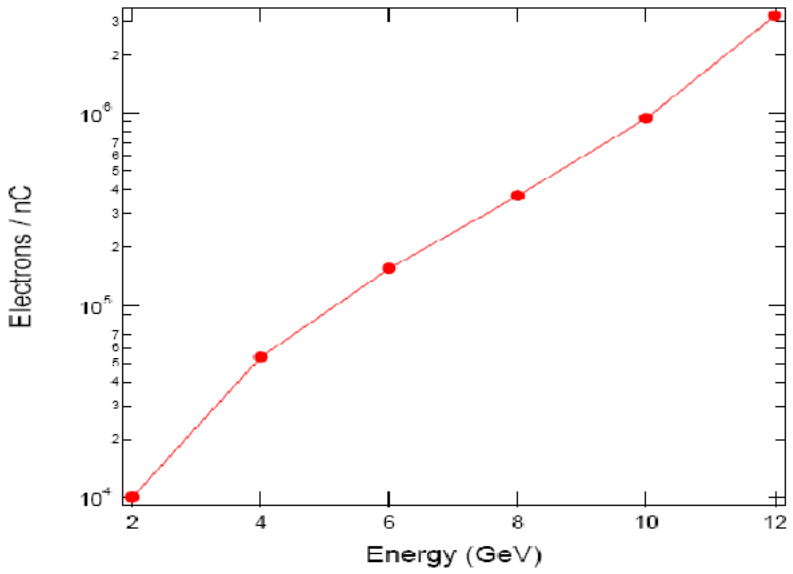
Cranes

15 and 50-ton cranes available

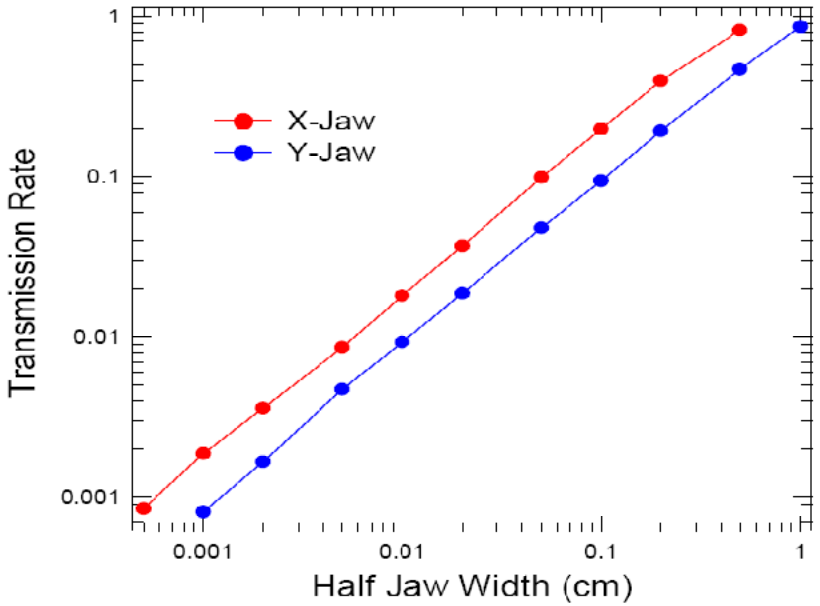
Secondary Electrons and Positrons

* Inserting a thin foil in the transport line to ESA, and using the beamline as a spectrometer, creates a clean secondary electron/positron beam over the full range of energies (<13.6 GeV/c) and a wide range of intensities down to ~1/pulse.

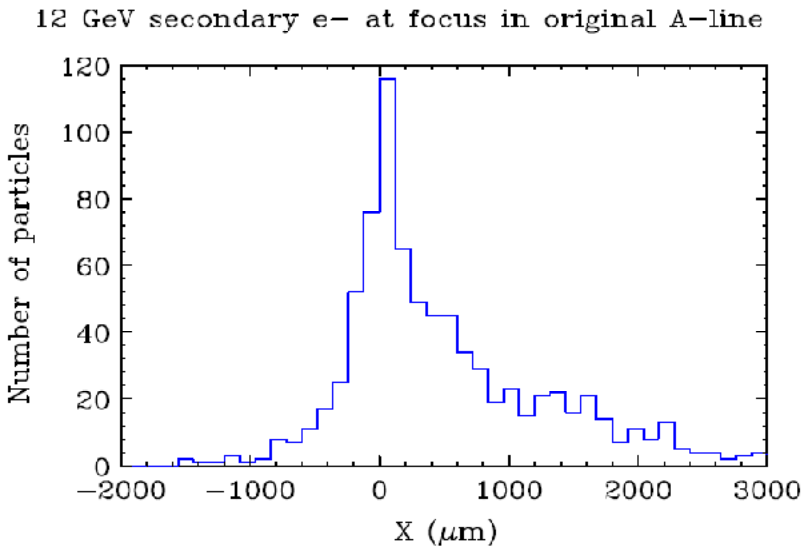
Production Rate from Foil

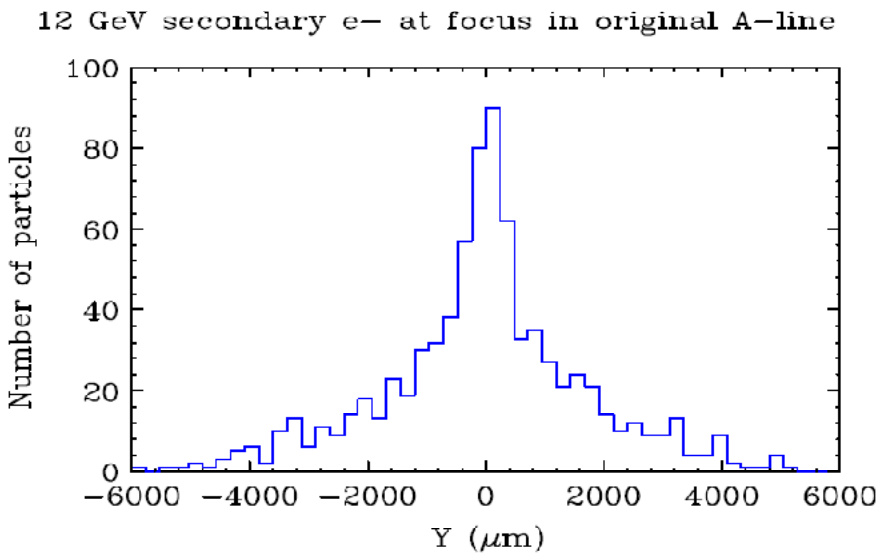


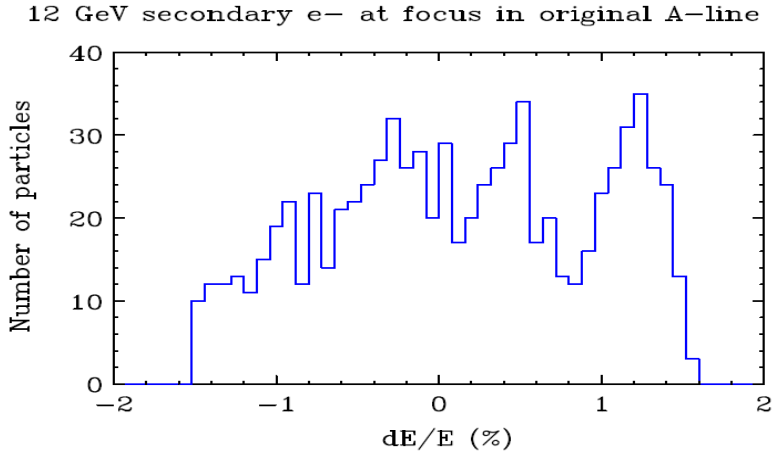
Attenuate up to Factor 10^6



Secondary Electron Beam Properties







$\sigma_{x,y}$~ 1 mm

$\Delta p/p \sim \pm 1\%$

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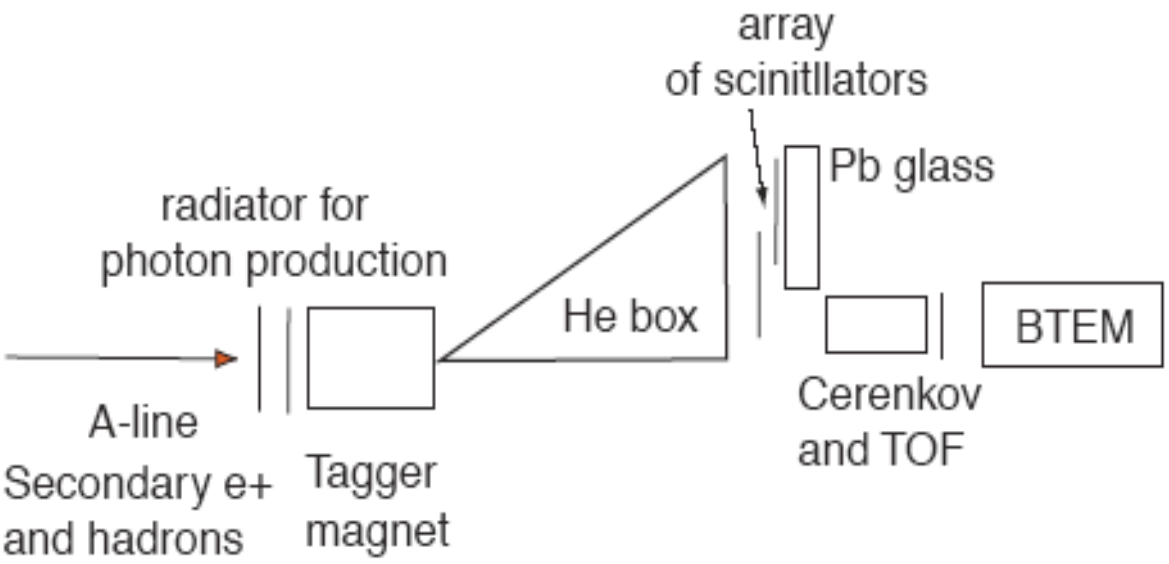
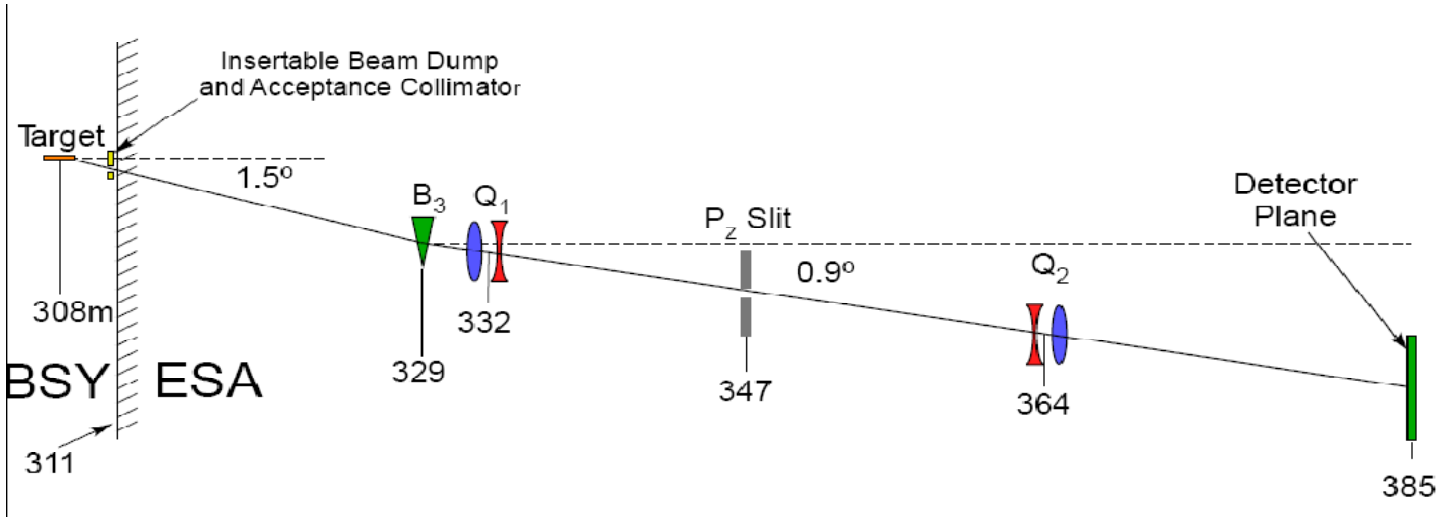
Photon Beam Possible

Clean electrons plus tagging system provides photon beam capability

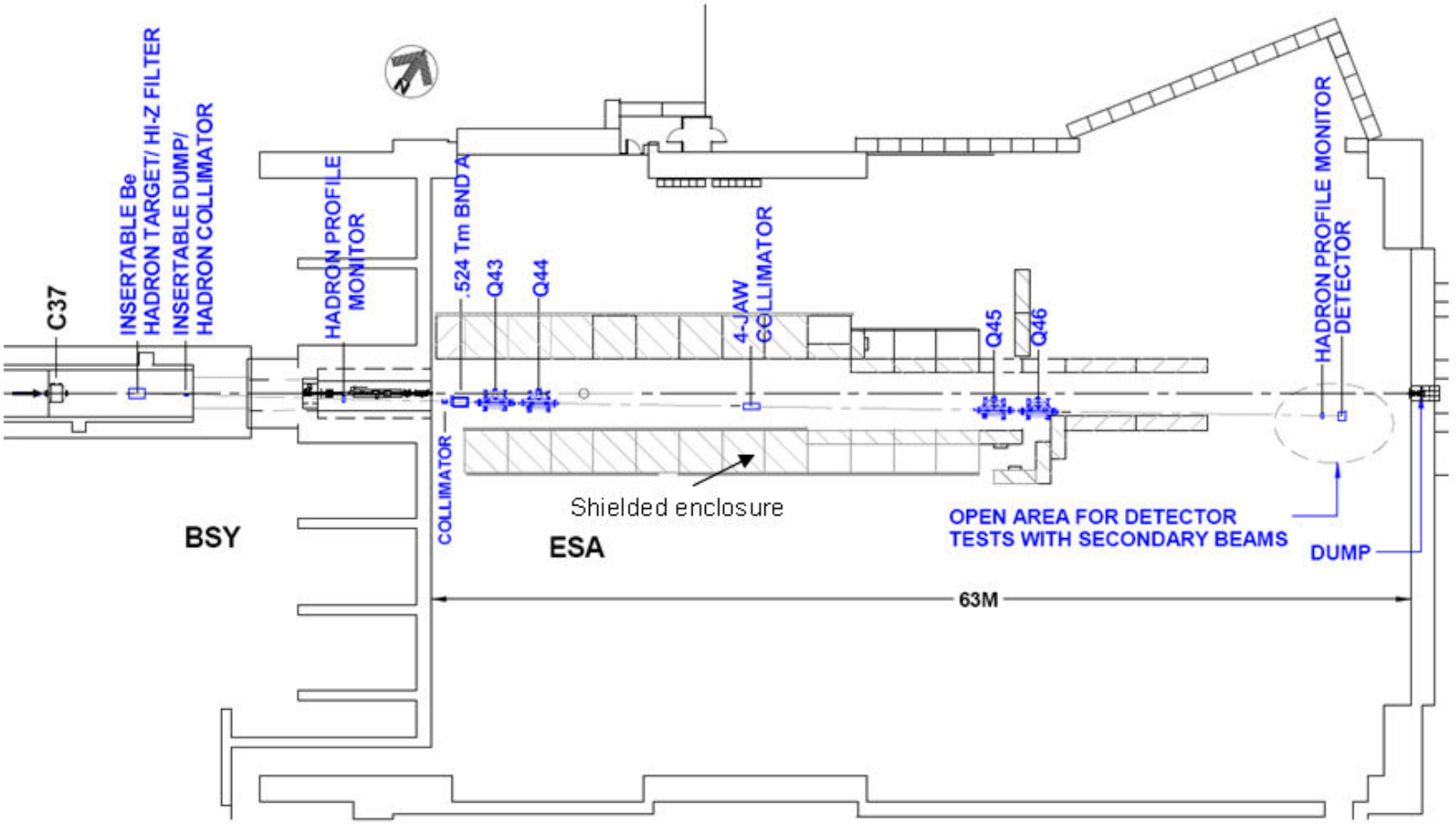


ESTB Stage II Hadron Production

Add Be target, beam dump, analyzing magnet, momentum slit, and quadrupole doublets to produce a secondary hadron beam in ESA. Production angle = 1.5^{o} and Acceptance = 10 μsr



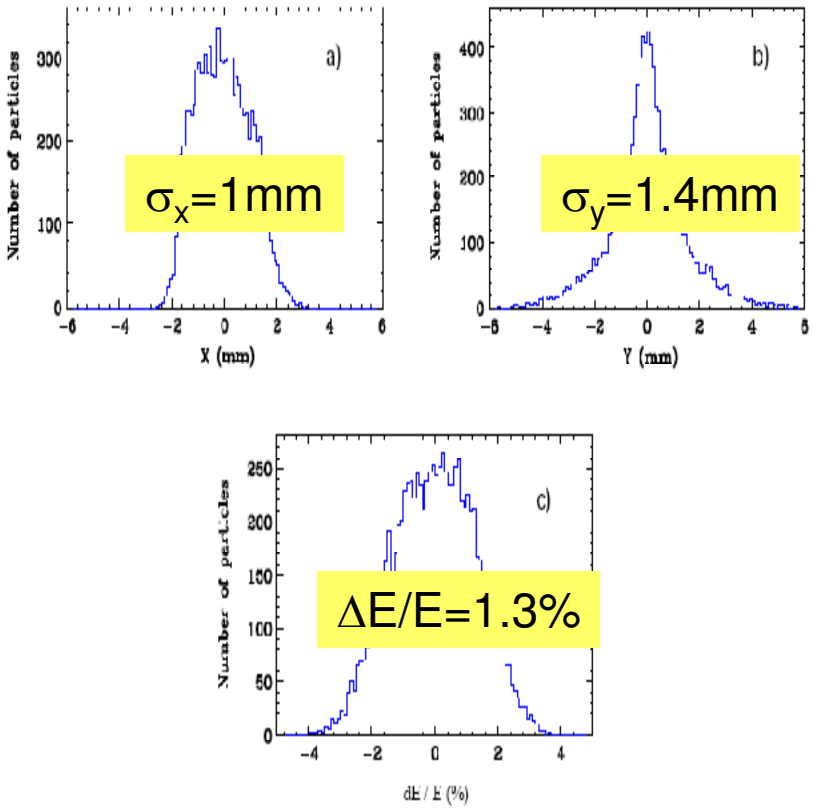
ESTB Stage II Hadron Production



Secondary Hadron Beam Properties

Energy	0.1–12 GeV
Particles per pulse	0.1–10 π/ nC
Bunch repetition rate	5 Hz
Precise beam trigger	Yes
rms x, y spot size	1-2 mm
Momentum analysis	$\Delta p/p \sim 1\%$
X,y,z space available	5 m, 5 m, 15 m
Rate for p, K, μ	0.1-0.01/π

Beam Properties at Detector Plane



SLAC Test Beam Conclusions

* SLAC is restoring test beam capability to ESA, making use of pulses borrowed from LCLS.
* ESTB's high energy primary electron beam will allow unique studies of LC beam instrumentation and MDI.
* An extremely clean electron/positron beam can be delivered over all the available energies (<13.6 GeV) and a very wide range of intensities, suitable for detector R&D.
* A hadron beam is planned for the future, with energies up to 12 GeV, suitable for tracker, vertex detector, and calorimeter R&D.
* Electron beams should be available by Spring, 2011.