The
End Station Test Beam (ESTB)
at SLAC

Carsten Hast

For the everlasting never giving up SLAC Test Beam Gang

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

LCTW 09 Orsay
November 4th, 2009

SLAC
NATIONAL ACCELERATOR LABORATORY

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 have been interrupted by ending PEP II operation and start of LCLS

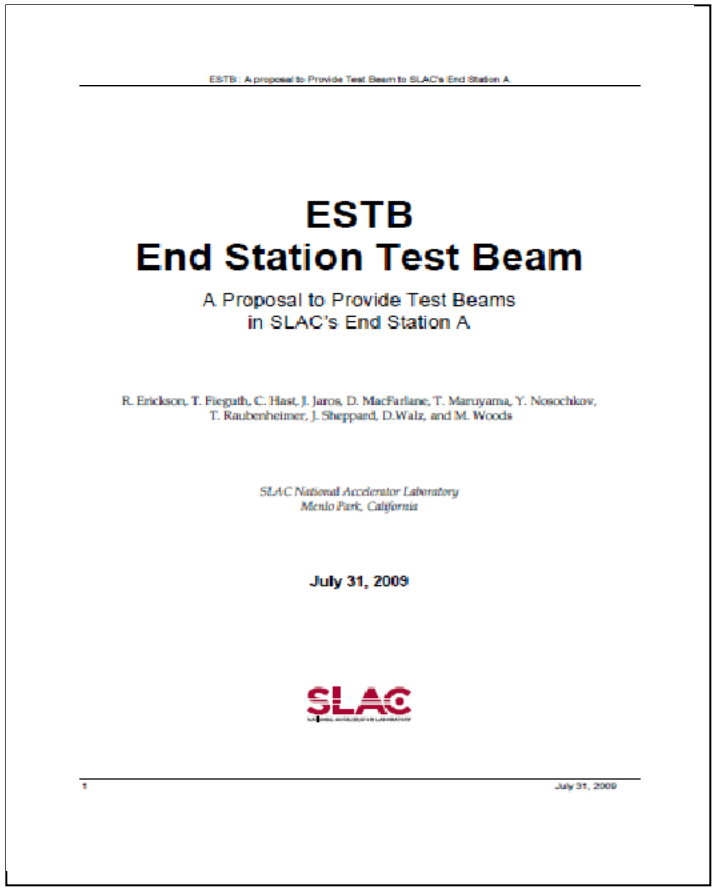
ESTB will be a unique HEP resource

- 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, secondary hadron beams, and photon beams available for detector development and calibration for LC, SLHC, Super B, and Particle Astro Physics

- Huge experimental area, existing DAQ and conventional facilities, and historically broad user base

ESTB Proposal Submitted to DOE



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. Fiegath, C. Hast, J. Jaros, D. MacFarlane, T. Maruyama, Y. Nosochkov,
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SLAC National Accelerator Laboratory
Menlo Park, California

July 31, 2009

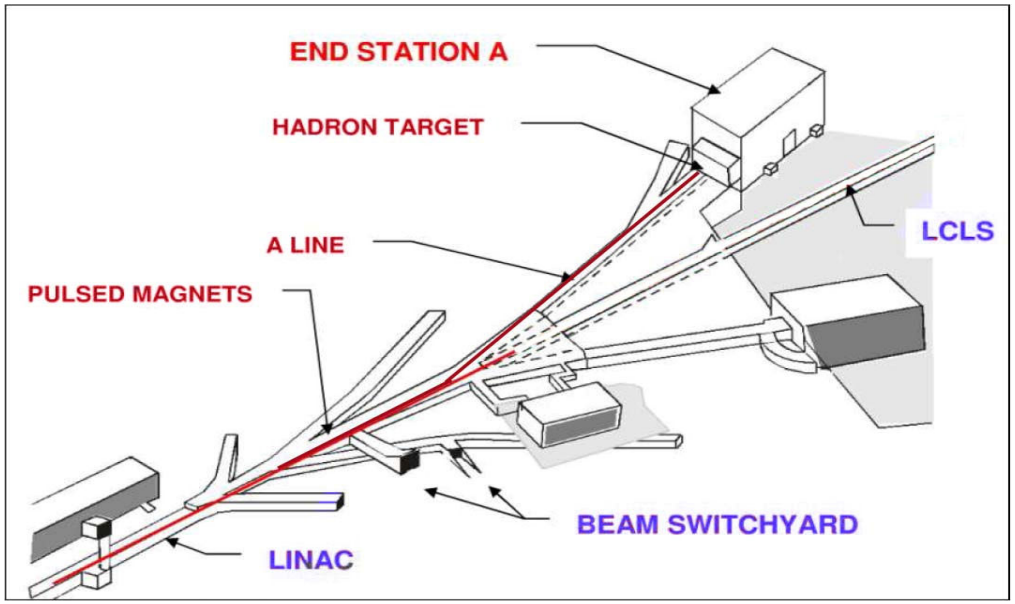
SLAC

- Proposal submitted early August
- Has been reviewed
- Positive feedback end October
- Last Friday we discussed a funding profile
- Funding might start January 2010

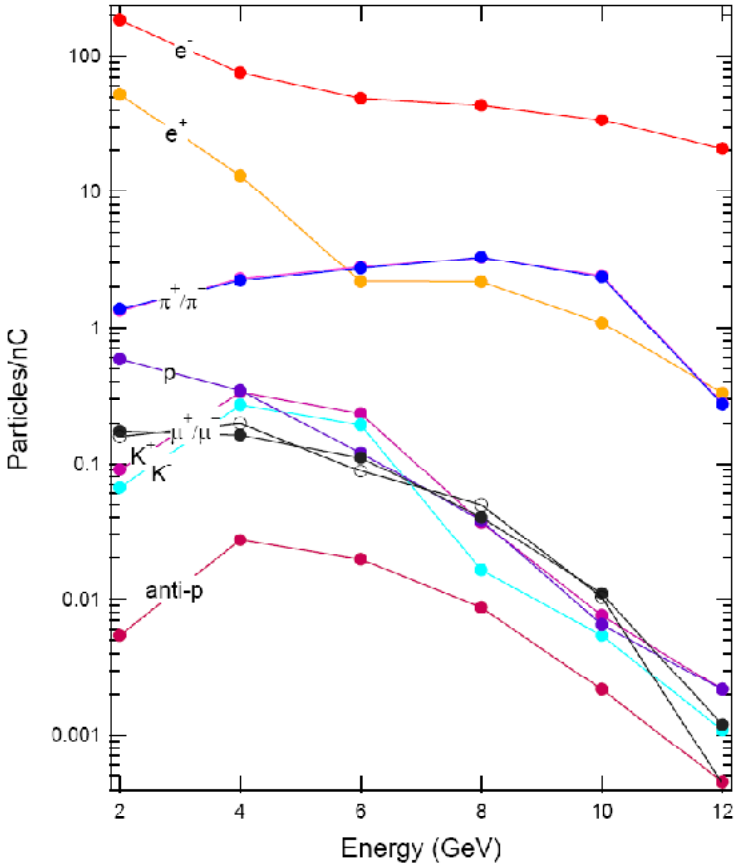
http://www-project.slac.stanford.edu/ilc/testfac/ESA/files/LCLS-U2/ESTB_Proposal/ESTB_Proposal-July31.pdf

ESA Test Beam Provides 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 - 6 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

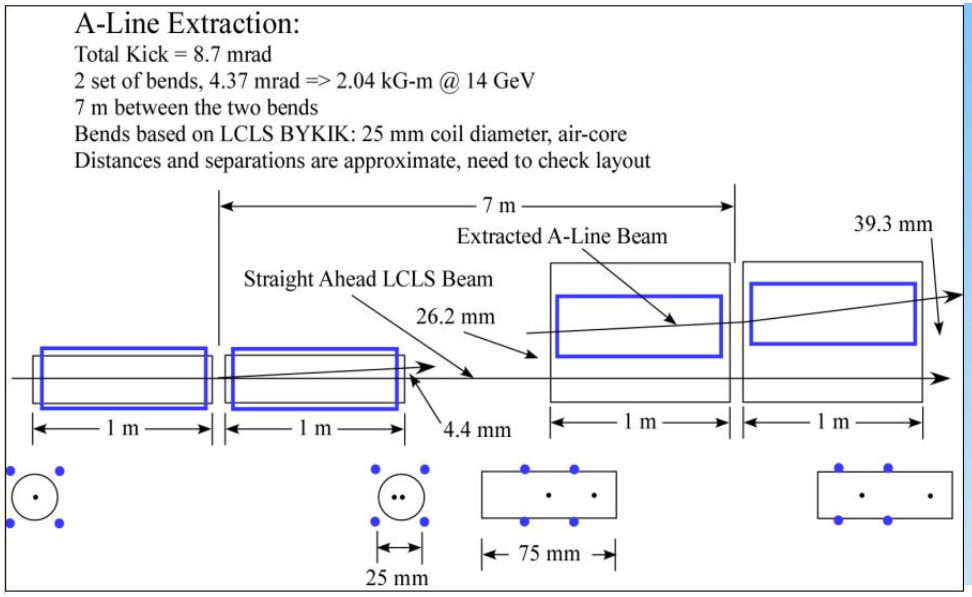


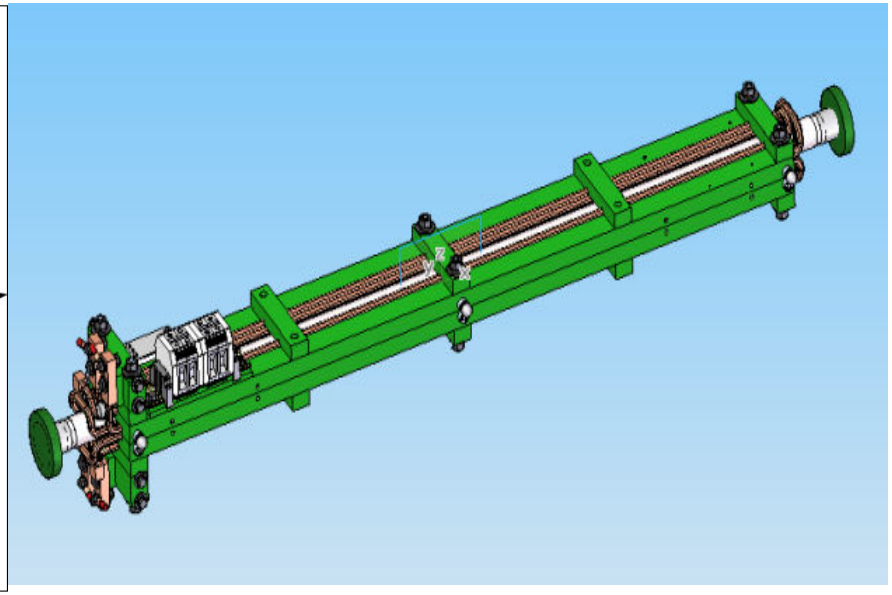
Secondary particle yields



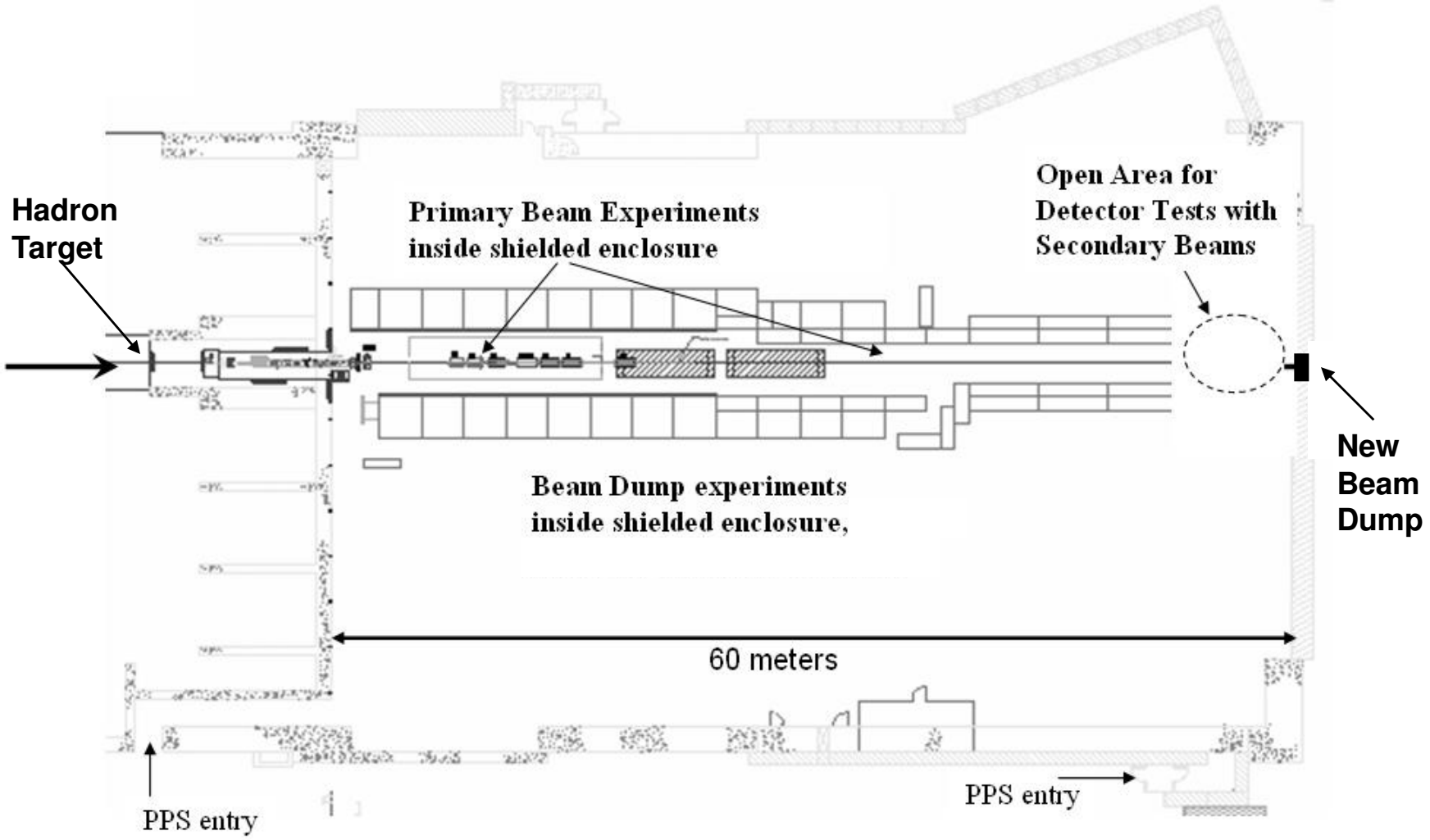
ESTB Stage I

- Construct kicker magnets and vacuum chamber for Beam Switch Yard
- Update PPS System and install new beam dump for ESA
- Update MPS and Controls as needed
- Build new kicker power supplies





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

Primary Electron Beam Properties

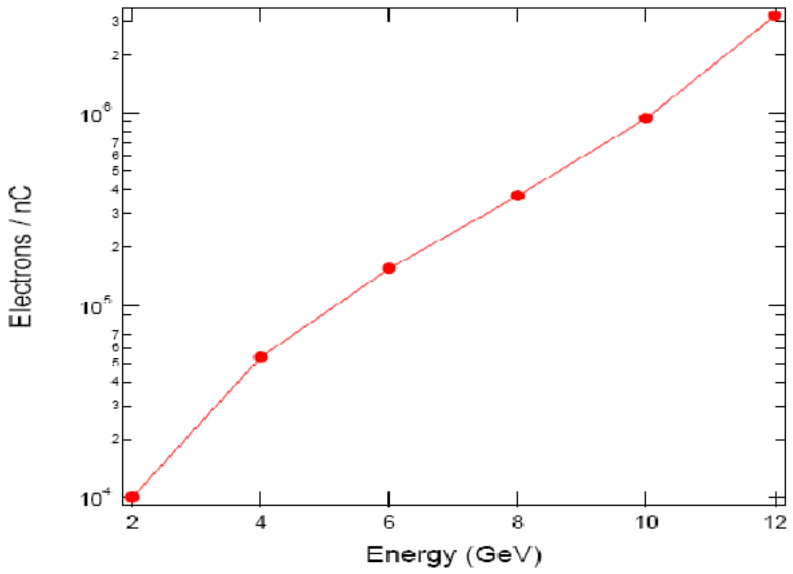
Energy	13.6 GeV
Repetition Rate	5 Hz
Charge per pulse	1.5 to 6 x 10^9 (1 nC) e^-
Momentum spread rms	<0.058%
Bunch length rms	280 μm
Emittance rms ($\gamma\varepsilon_x$ $\gamma\varepsilon_y$)	(4 ,1) x 10^{-6} m rad
Spot size at waist ($\sigma_{x,y}$)	~10 μm
Momentum dispersion η and η'	<10mm
Drift space available for experimental apparatus	60 m
Transverse space available for experimental apparatus	5 x 5 m

Lots of room for apparatus

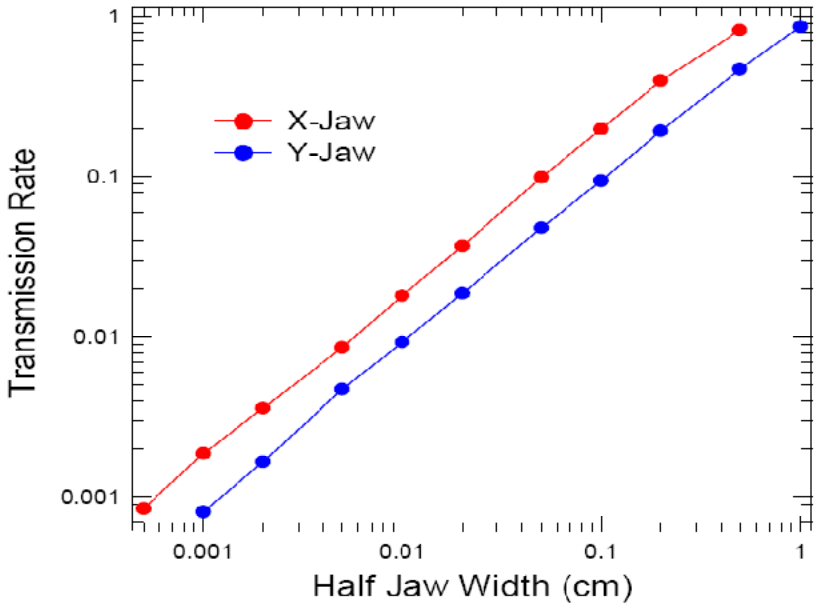
Secondary Electrons and Positrons

- 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) and a wide range of intensities down to ~1/pulse

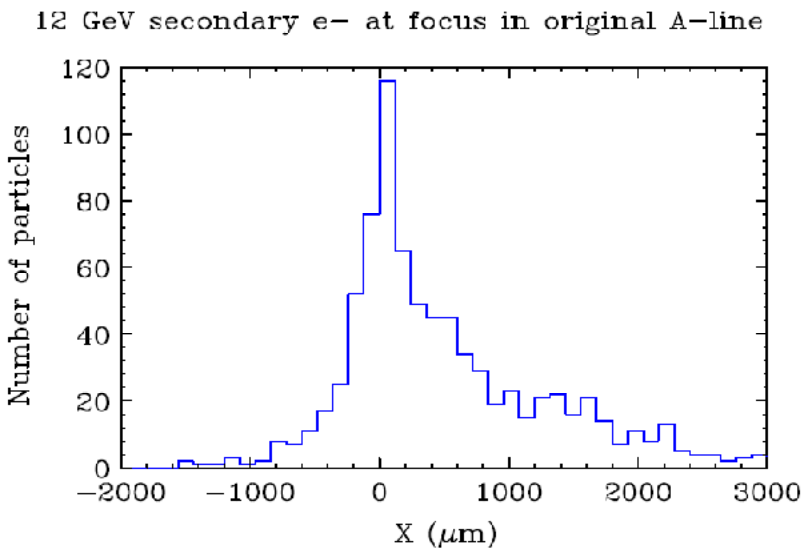
Production Rate from Foil

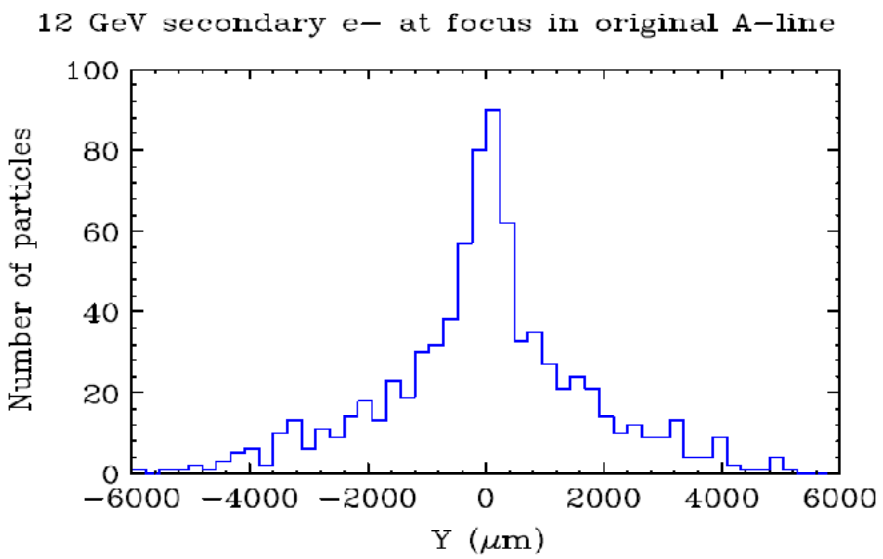


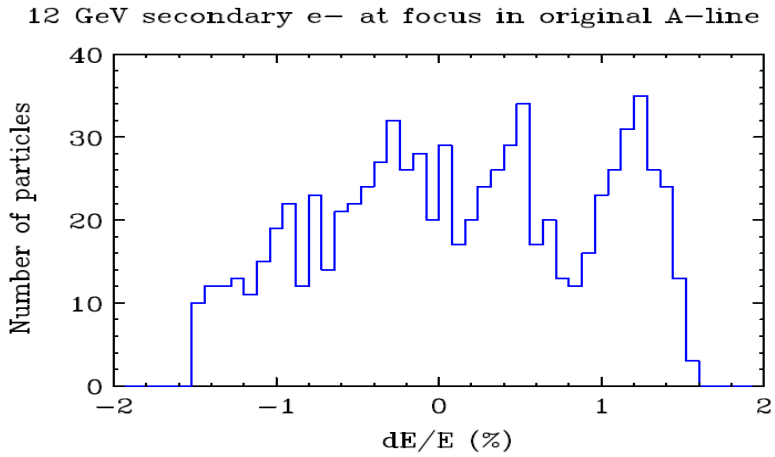
Attenuate up to Factor 10^6



Secondary Electron Beam Properties





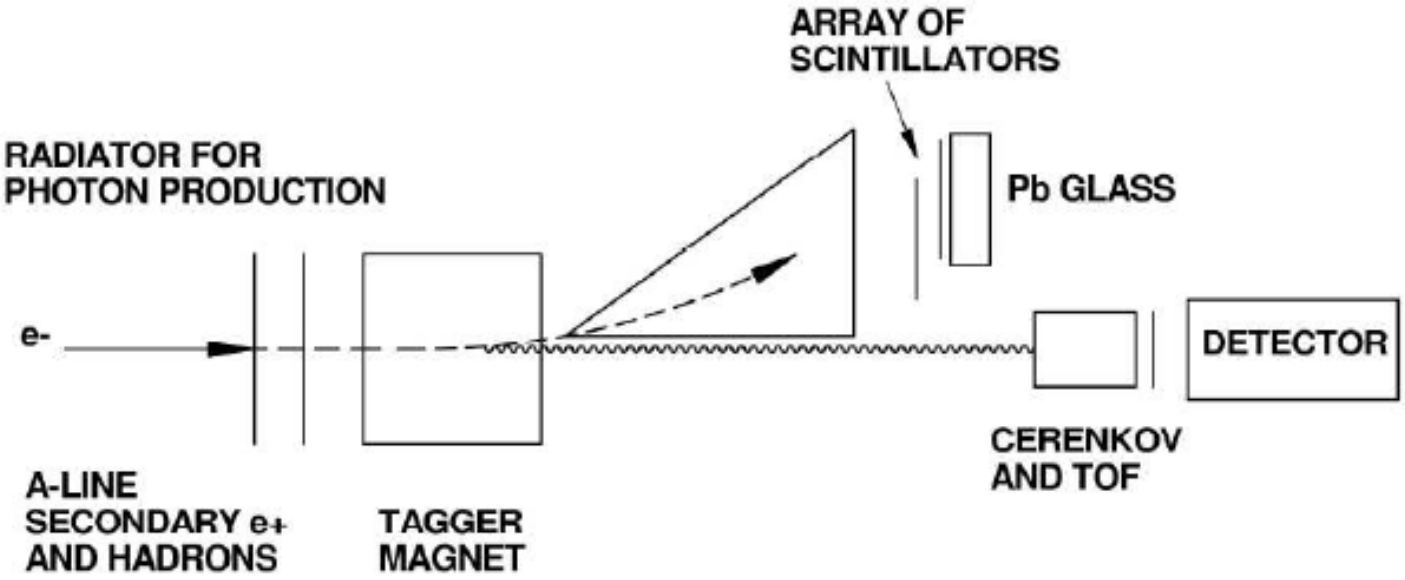


$\sigma_{x,y}$~ 1 mm

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

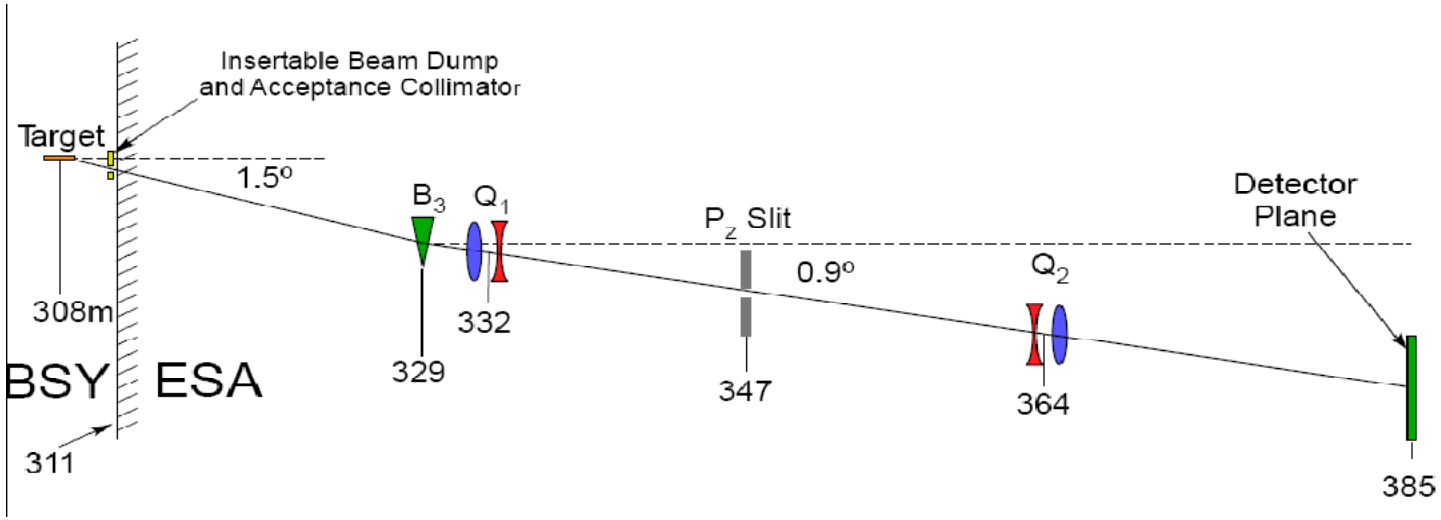
Photon Beam Possible

Clean electrons plus tagging system provides photon beam capability

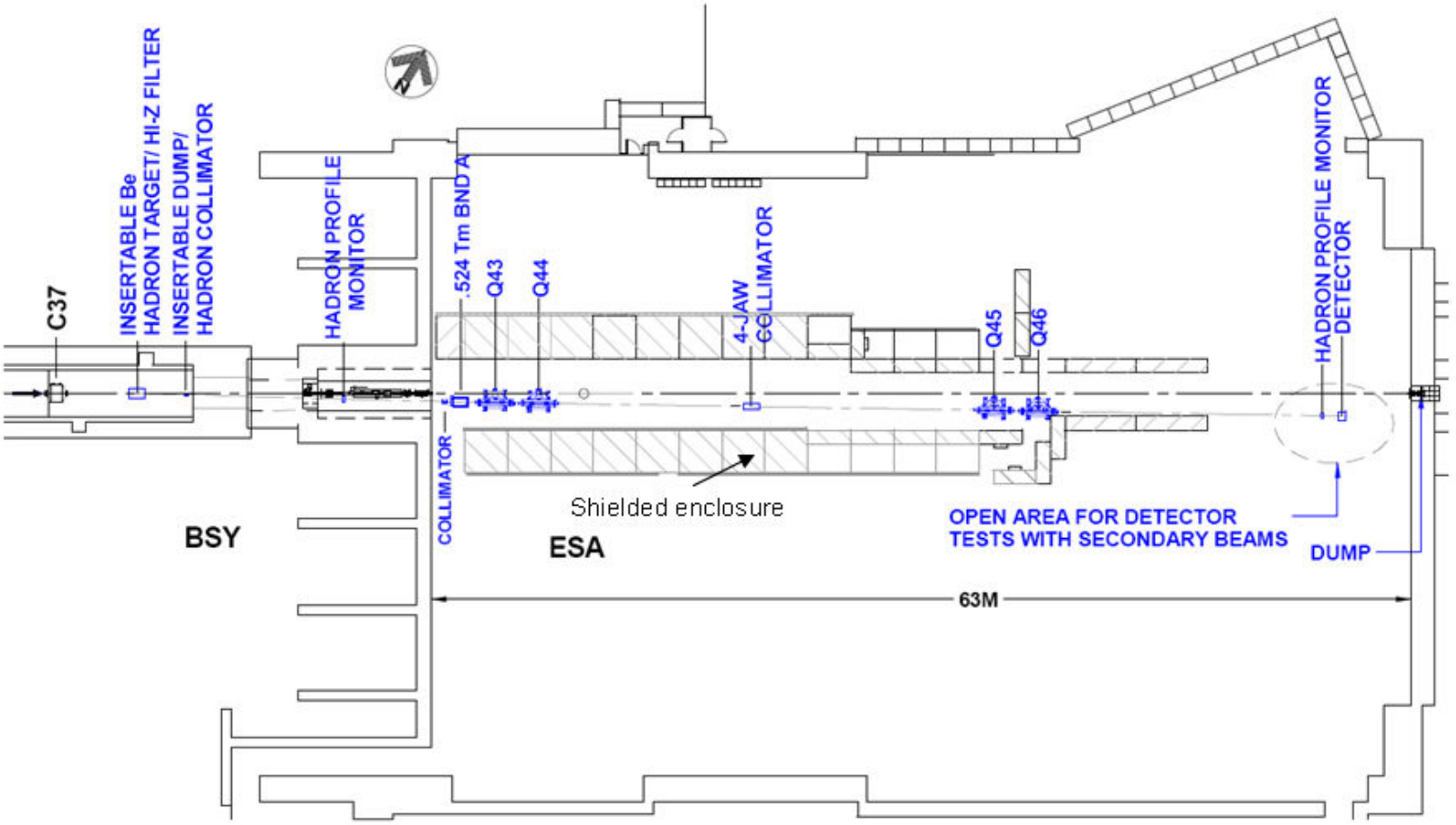


ESTB Stage II
Hadron Production

- 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



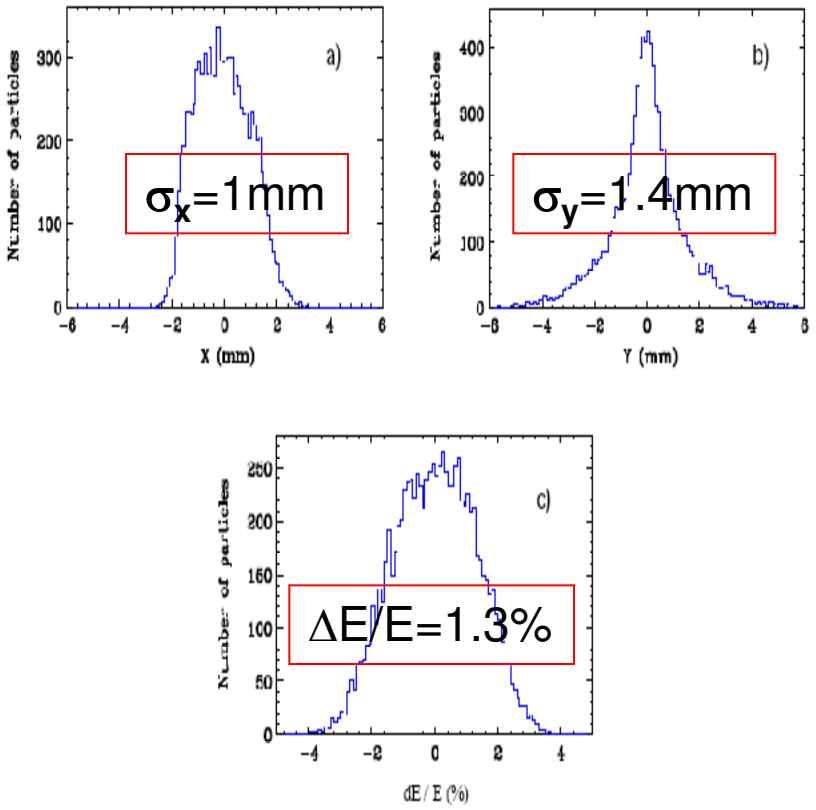
ESTB Stage II Hadron Production



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	Δp/p ~ 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



ESTB Time Line Stage I

Stage I funding available January 4th 2010

- **During SLAC downtime (until April 1st 2010)**
  - Remove existing kicker magnets and Be target from BSY
  - Prepare area for easy install of new kickers
  - Install 1.5º hadron beam pipe between A-line and ESA for Stage II
- **January – March 2010**
  - Order ceramic vacuum chambers and magnet coil material
  - Design magnets and supports, kicker power supplies and controls
  - Radiation Physics studies for new dump and insert-able foil for secondary electrons and positron
- **May to September**
  - Dust off ESA
  - Install new beam dump
  - Install kicker magnets and power supplies on RODs
  - Kick LCLS beam into A-line for the first time
- **PPS System**
  - Well, that's another story since there is a long cue of projects ahead of us
  - With some optimism and creativity we hope to get that done during 2010

Beam to ESA Winter 2010/2011

ESTB Time Line Stage II

Stage II funding available October 1st 2010

- October to November 2010
  - Design hadron target modifications, collimator and insert-able dump
  - Design hadron beam line magnet supports in ESA
- October to December 2010
  - Build what needs to be build and purchase what needs to be purchased
- During short winter shutdown 2010/2011
  - Install target, insert-able dump in A-line
- January to March 2011
  - Install complete hadron beam line in ESA

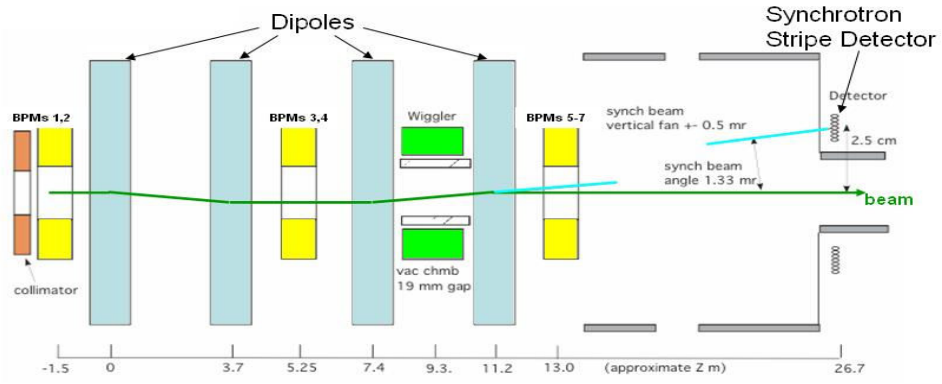
Hadron Beam to ESA April 2011

SLAC Test Beam Conclusions

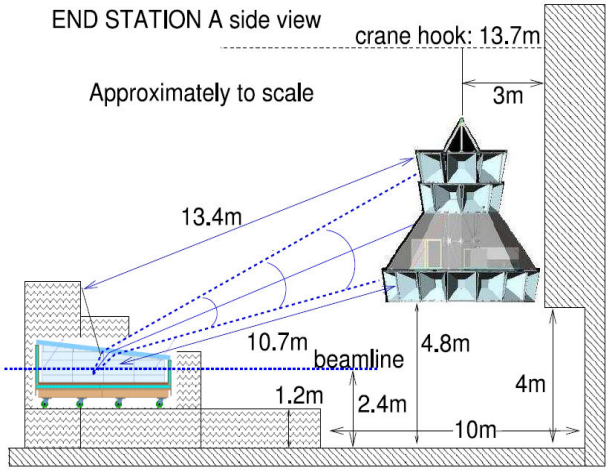
- SLAC proposed to restore test beam capability to ESA, making use of pulses borrowed from LCLS
- Project is (nearly) approved
- Unique high energy primary electron beam will allow continued studies of LC beam instrumentation and MDI
- An extremely clean electron/positron beam can be delivered over all the available energies (<13.6 GeV) and a very wide range of intensities, suitable for detector R&D starting late 2010
- A hadron beam is planned for 2011, with energies up to 12 GeV, suitable for tracker, vertex detector, and calorimeter R&D
- (I might suggest to rename ESTB to ESA-TB)

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