Test Beam Capabilities at SLAC

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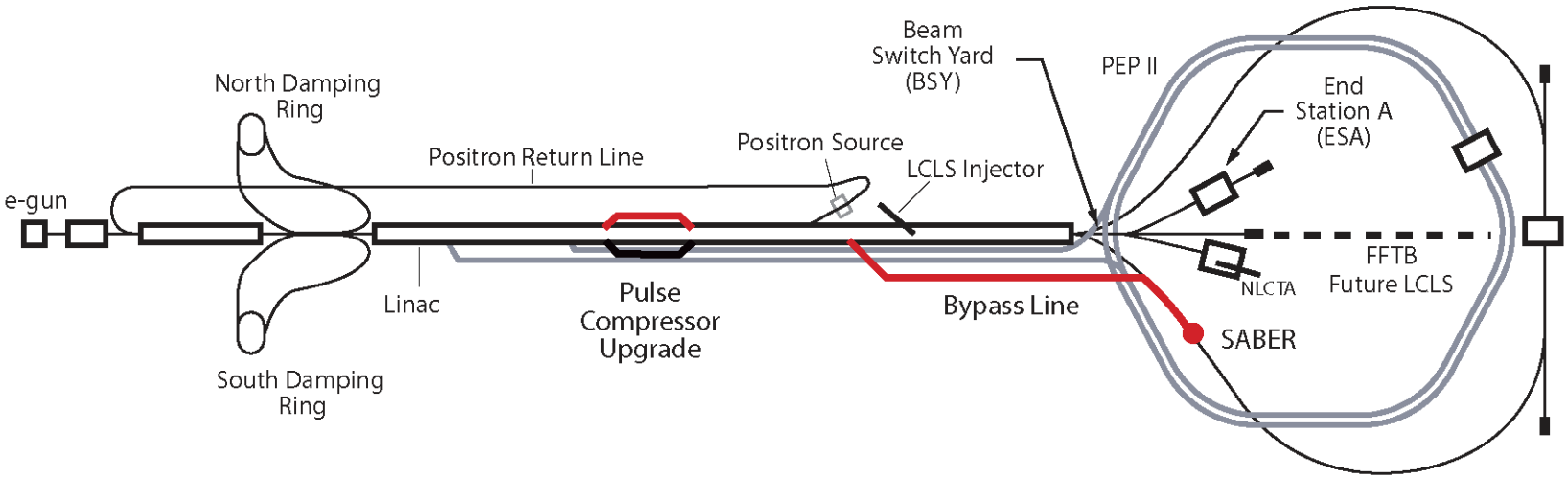
Stanford Linear Accelerator Center

- SABER, a new facility in the South Arc (South Arc Beam Experimental Region)
- End Station A (ESA)
- Test Beams beyond 2008 in the LCLS Area

Test Beams at SLAC



SABER

South Arc Beam Experimental Region

Beam has a downward pitch of 3.730 deg

Beam position rather close to wall and floor:

- 42 inches above the tunnel floor
- 39 inches from south tunnel wall

Experimental section is about 100 feet long and can be developed

No crane, it's a little cumbersome to bring heavy equipment into the tunnel
(There are ideas to enlarge the tunnel in the experimental area)

Hope for approval of SABER this year

SABER

Mainly a facility for accelerator physics (Plasma-Wakefield)
Primary Electron or Positron beams with low emittance and compressed bunches

- **Energy:** 28.5 GeV with PEP-II or LCLS with bypass line
- **Charge per pulse:** 2 (3.5) x 10^{10} e^- or e^+/pulse with full (without) compression
- **Pulse length:** σ_z < 30 (45) μm with 4% (1.5%) momentum spread
- **Spot size at IP:** 10 μm nominal;
  $\sigma_{x,y}$ < 7 μm achieved in computer simulations
- **Momentum spread:** 4% (<0.5%) full width with full (without) compression
- **Momentum dispersion at IP:** $\eta = 0$ and $\eta' = 0$

Test beams can either use the primary beam
with reduced charge if necessary
or it can be collimated down to a few electrons or positrons per pulse
Secondary Electron or Positron Beams are possible
a few or 1 or less than 1 particles per pulse (few GeV to 10 -- 15GeV)
Secondary hadrons are very unlikely

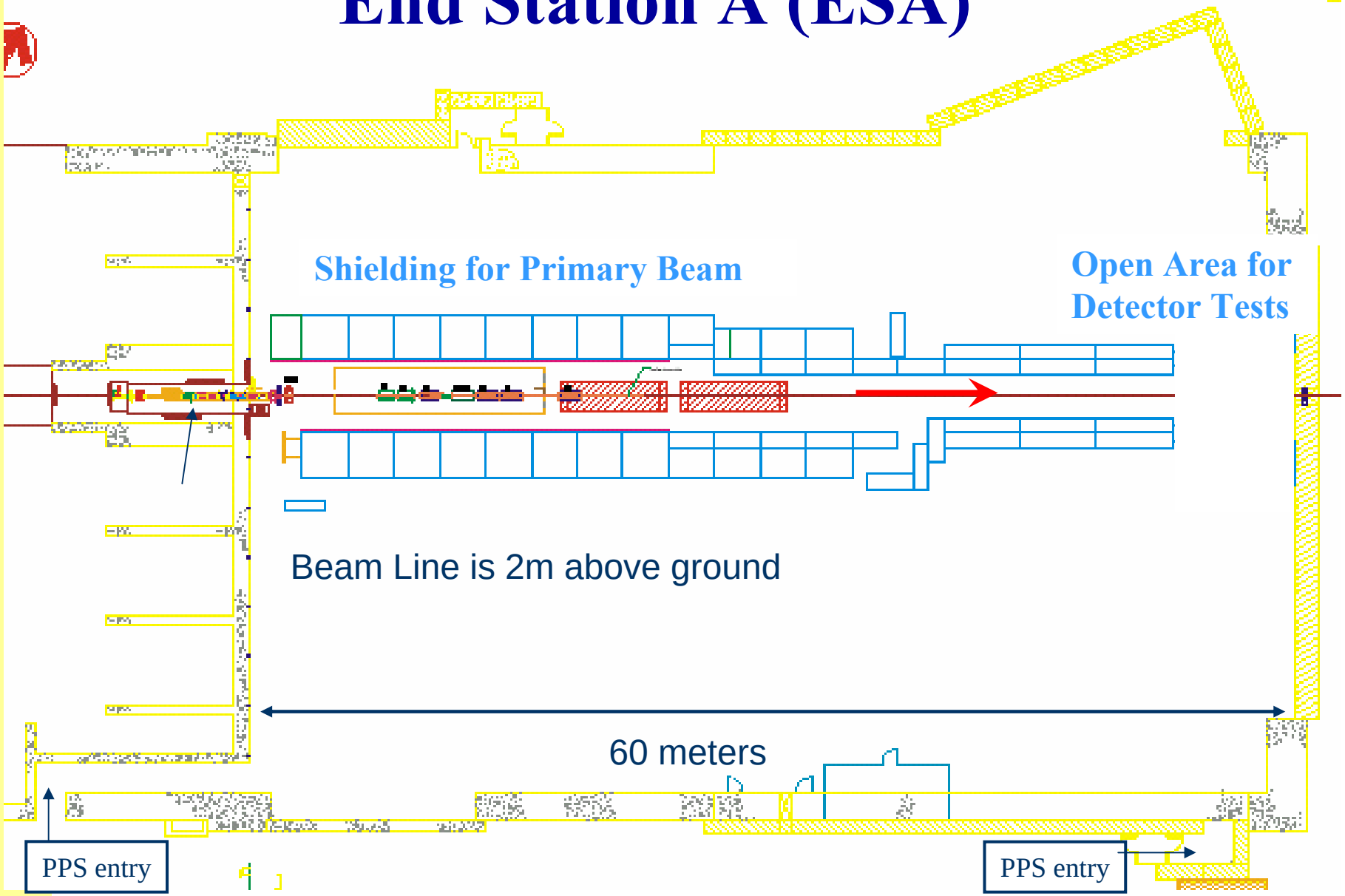
End Station A (ESA)

- ESA is large (60m x 35m x 20m)
- 50/10 t crane
- Electrical power, cooling water
- DAQ system for beam and magnet data
- Experiments typically bring their DAQ

End Station A (ESA)

ANITA
Calibrated in 2006

End Station A (ESA)



End Station A (ESA)

primary electron beam

Parameter	ESA
Repetition Rate	10 Hz
Energy	28.5 GeV
Bunch Charge	2.0 x 10^{10}
Bunch Length	300-1000 μm
Energy Spread	0.2%
rms Spotsize (x,y)	100,600 μm

ESA has
excellent momentum resolution
great timing resolution
great infrastructure

ANITA (2006)

ILC-MDI:
BPM energy spectrometer (T-474/491)
Synch Stripe energy spectrometer (T-475)
Collimator design, wakefields (T-480)
Bunch length diagnostics (w/ LCLS, T-487)
IP BPMs/kickers—background studies (T-488)
LCLS beam to ESA (T490)
Linac BPM prototypes
EMI (electro-magnetic interference)

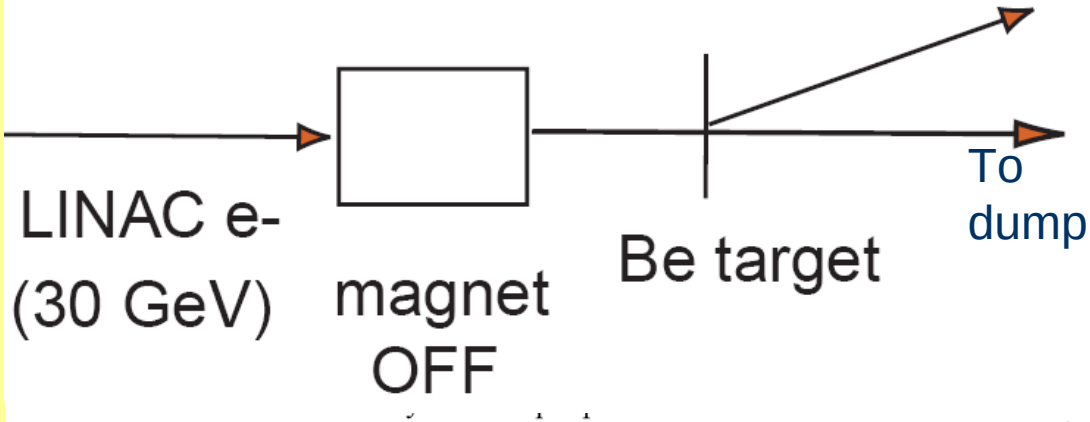
All run in 2006
2007 Runs (dates tentative):
March 7-26, Run 3
July 5-8, T490 w/ LCLS beam
July 9-22, Run 4
+ requesting two 2-week runs in FY08

T-489 Measurement of induced and residual Activity (SLAC Rad. Physics Group), 2 weeks in 2007

End Station A (ESA)

secondary beams

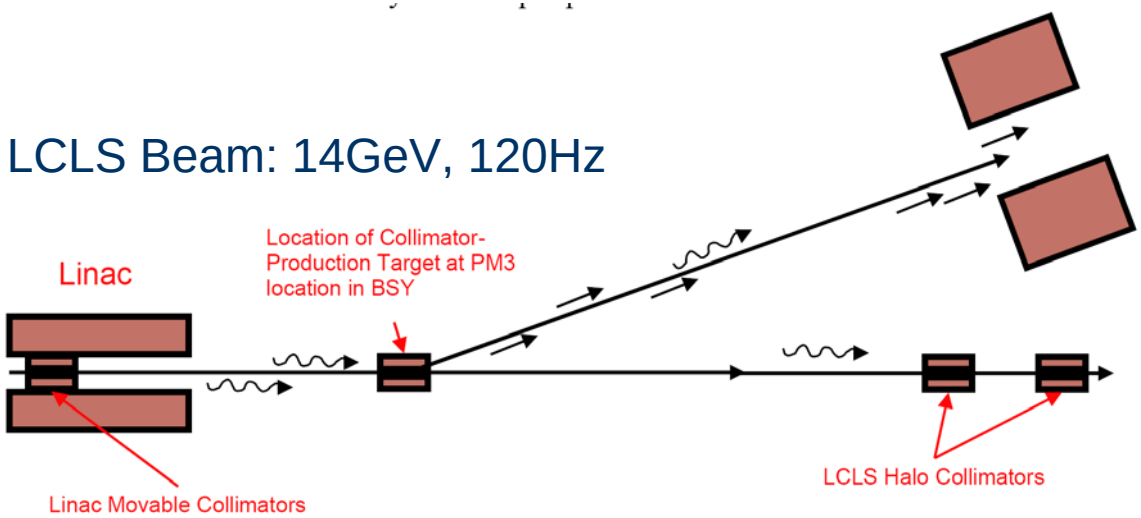
Secondary hadrons and positrons to ESA



At 14.5 GeV for 0.4 particles/puls total, the yield was:
0.25 e+
0.17 hadrons(K+,π+)
0.01 protons

30GeV/13GeV A-line
0.5 e+
0.5 pions (kaons<0.01)
0.04 protons

LCLS Beam: 14GeV, 120Hz



During LCLS:
2nd electrons all year
2-12 GeV
max of 10 to 0.1 particles/pulse

End Station A (ESA)

secondary beams

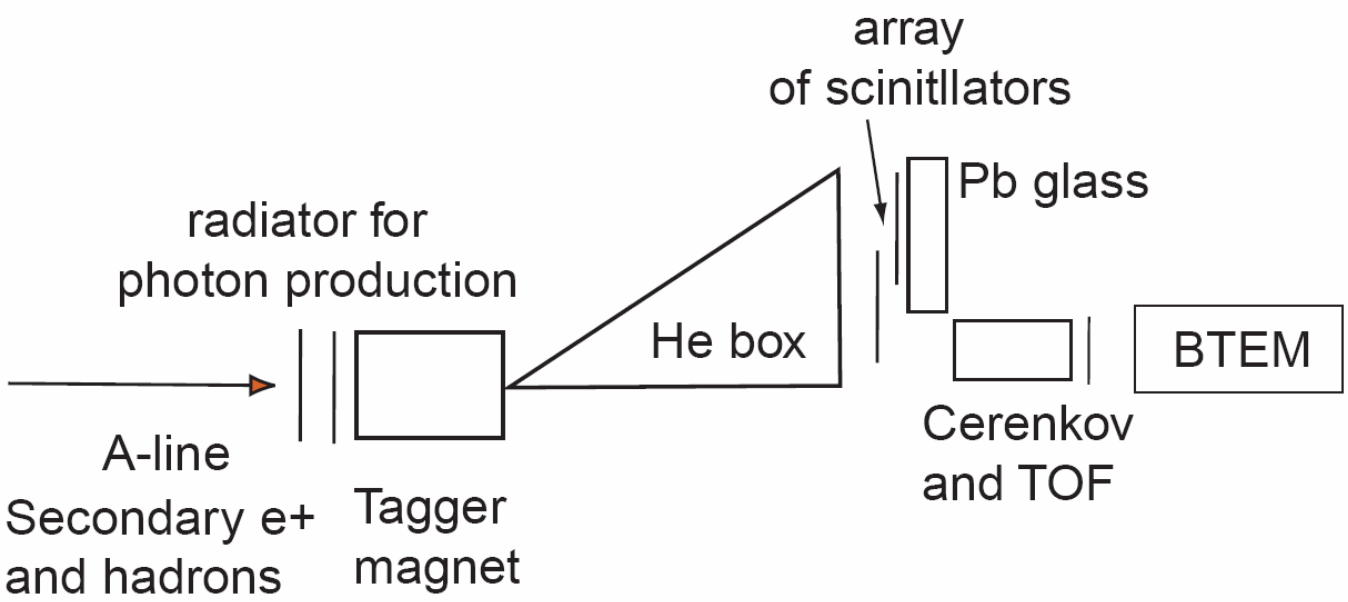
T-469 Fast Focusing Cherenkov Detector (based on BaBar Design) + Photodetector R&D 64-pixel MCP-PMT, trying to get a timing resolution of 10-15ps
2006, 2007 2 x 1 week, 2008 ?

T-479 ILC Si –Tungsten Calorimeter
2007

More opportunities for test beam requests

End Station A (ESA)

Tagged Photon Beam inside ESA



Beam setup for GLAST calibration a few years ago:
Use a secondary positron beam
Produce photons in a radiator inside of ESA
Tag the positrons to measure the photon energy
Calibrate your calorimeter with photons

Test Beams at SLAC until end of FY 2008

- PEP II will be running until end of 2008
  - 28.5 GeV electron beam is available for SABER and ESA with a typical rate of 10 Hz
- LCLS starts commissioning soon
  - Availability of primary beams will be limited for ESA and SABER but my guess is that there will be quite some beam time available
- End Station A will run as described until end of PEP
- If SABER is approved it comes online this/next year and can deliver primary beams and secondary electrons
  - Infrastructure has to be build
  - Secondary hadron beam is unlikely

All ILC test beam requests until end of 2008 can be handled in ESA

Test Beams at SLAC in LCLS Era

- **LCLS** starts full operation in 2009 (10 month/year)
  - Uses last 1/3 of Linac
  - Basically no primary beams available for anything else

- **SABER**
  - If approved, some minimal running in 2007, some accelerator R&D in 2008
  - Difficult to predict how much beam time in 2009
  - A bypass line is planned to be installed in 2009 which would make SABER operation independent of LCLS
  - Starting in 2010 up to four month/year of operation is planned
  - Primary e- or e+ and secondary e- or e+ (no hadrons) available for accelerator R&D and test beam requests

- There is currently no commitment of SLAC to run **ESA** at all
  - PPS System needs to be upgraded
    - That would allow using parasitic secondary beam from LCLS all the time at 120 Hz
  - Revival and upgrade of kicker magnets (10Hz of LCLS beam to ESA)
    - 15GeV primary electron beam
  - Possible extension of SABER bypass line into ESA
    - 30GeV primary beam and secondary electrons and hadrons (10Hz)

Test Beams at SLAC in LCLS Era

A study group is preparing a document to discuss the future of test beams with SLAC directorate. Due end of this month. User requests from this workshop will make major impacts.

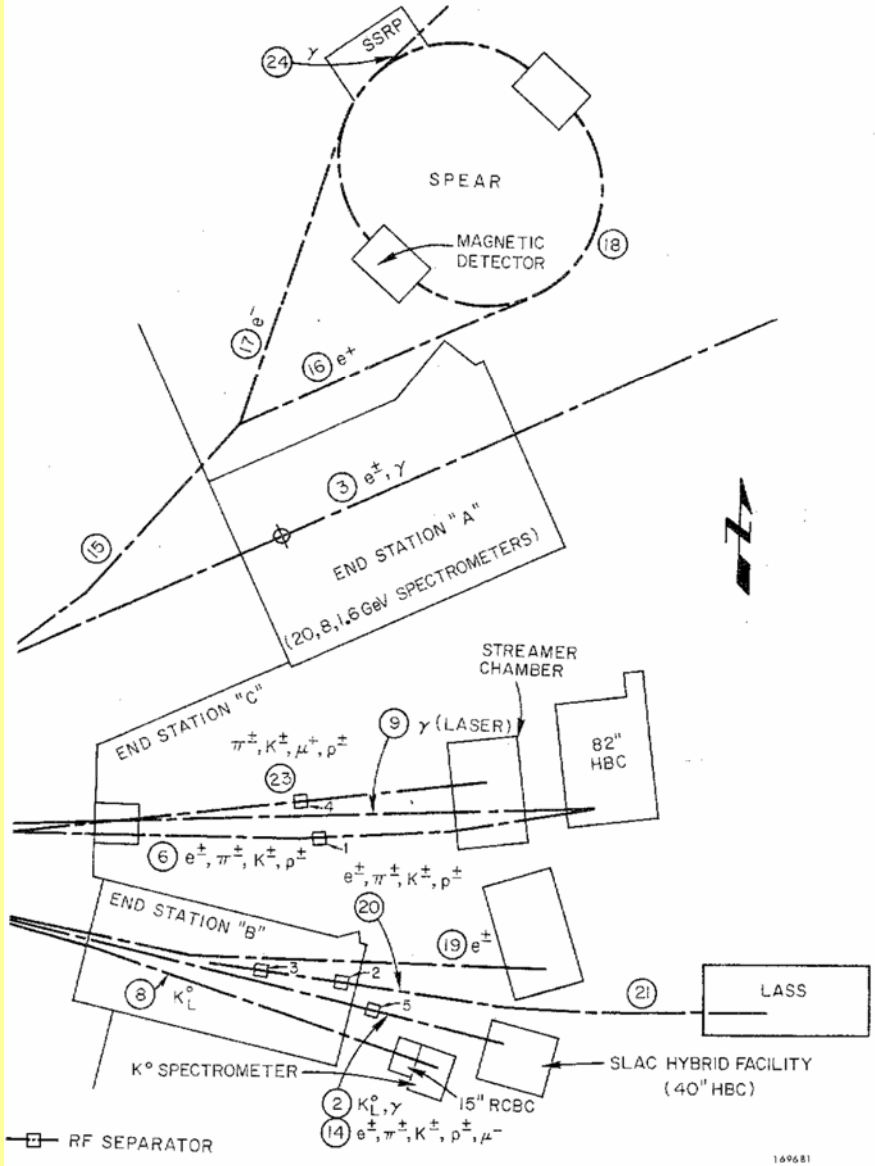
Good chances to get a 120 Hz secondary beam from the LCLS beam halo into ESA for 10 month per year starting 2009

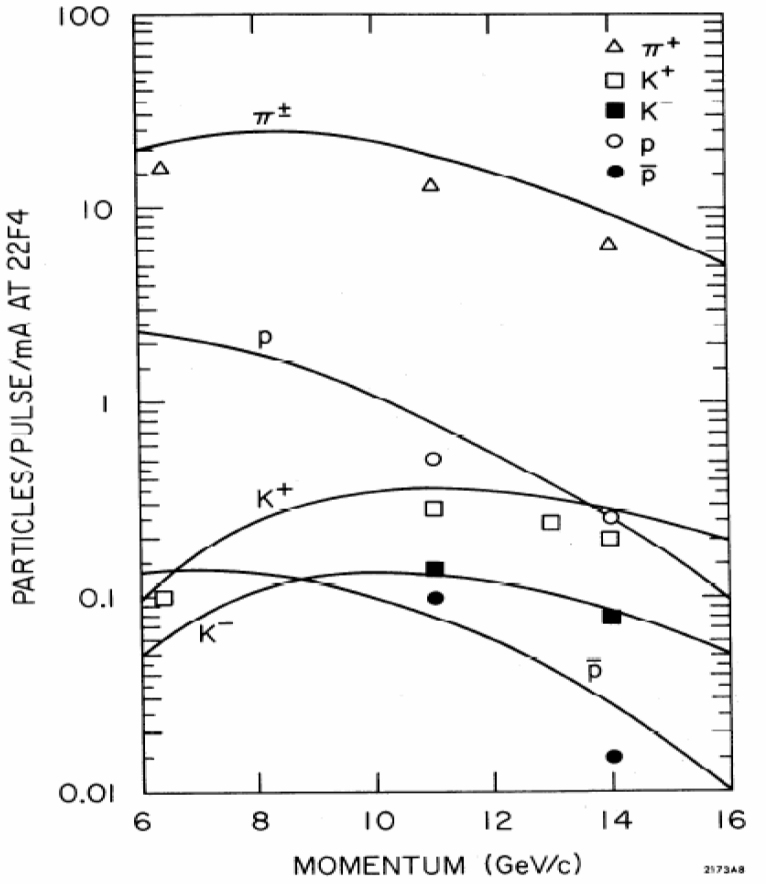
Hopefully starting 2010 SABER and ESA can get 10-30 Hz beam independent of LCLS for a combined beam time of up to 4 month per year

Additional Information

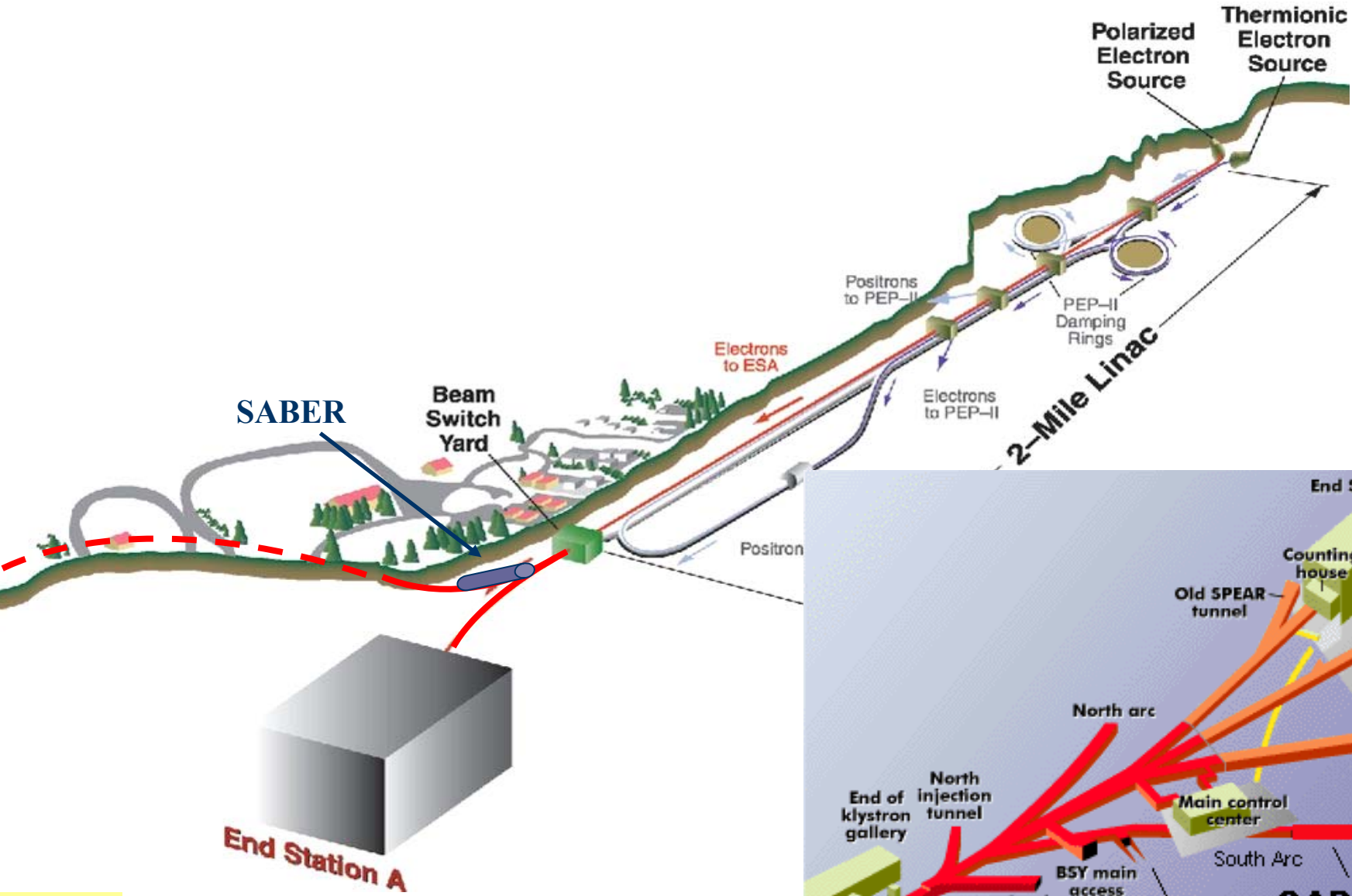
End Station A (ESA)

secondary beams



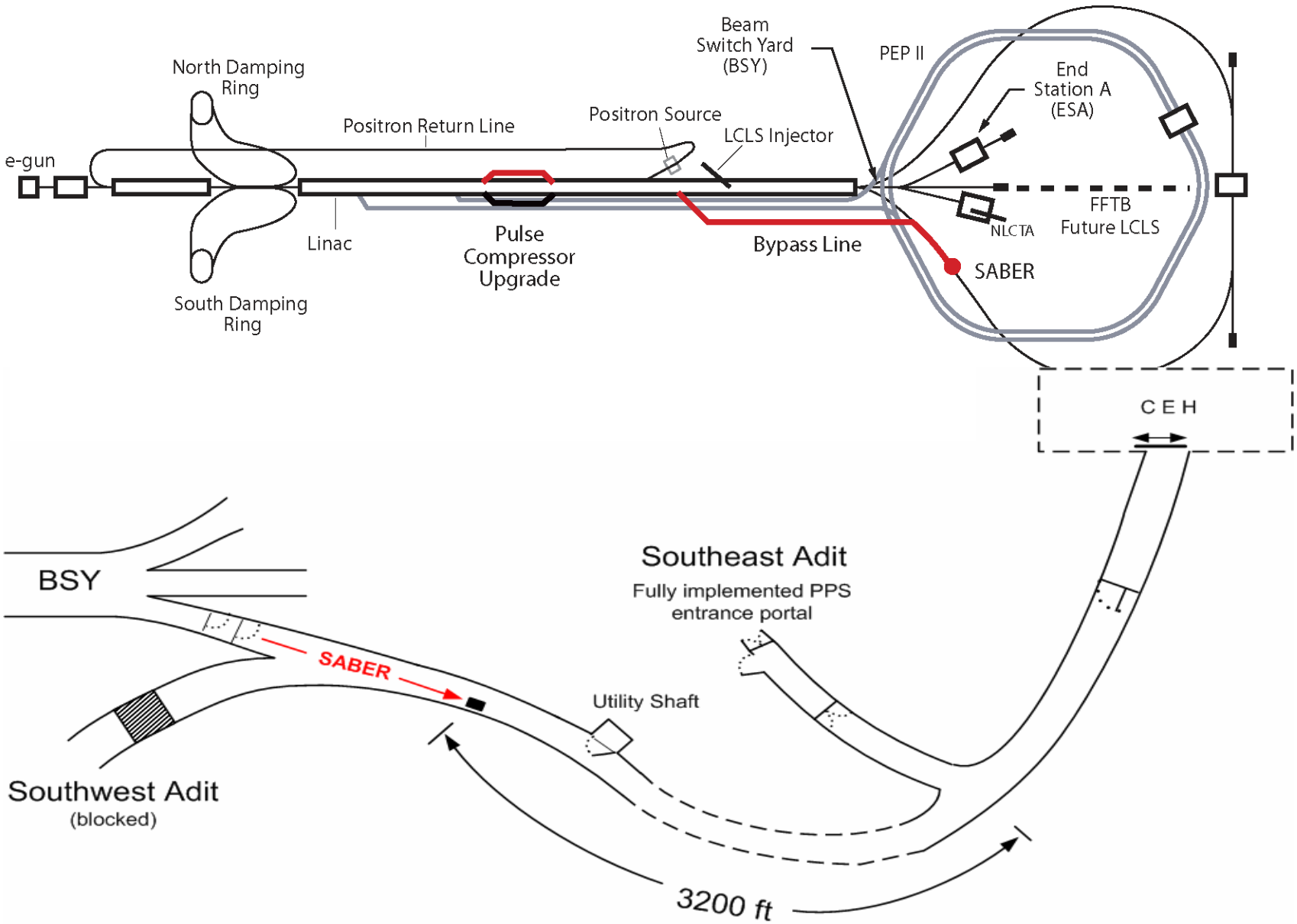


Primary beam energy is 19.5 GeV. Production target is 0.87 r.l. Be and production angle is 1.5deg. Momentum acceptance is +-2% Δp/p. Pulse length is 1.6 μs so that 1mA corresponds to $1 \cdot 10^{10}$ electrons per pulse.


Polarized Electron Source
Thermionic Electron Source
Positrons to PEP–II
PEP–II Damping Rings
Electrons to ESA
Electrons to PEP–II
2–Mile Linac
SABER
Beam Switch Yard
Positron
End Station A

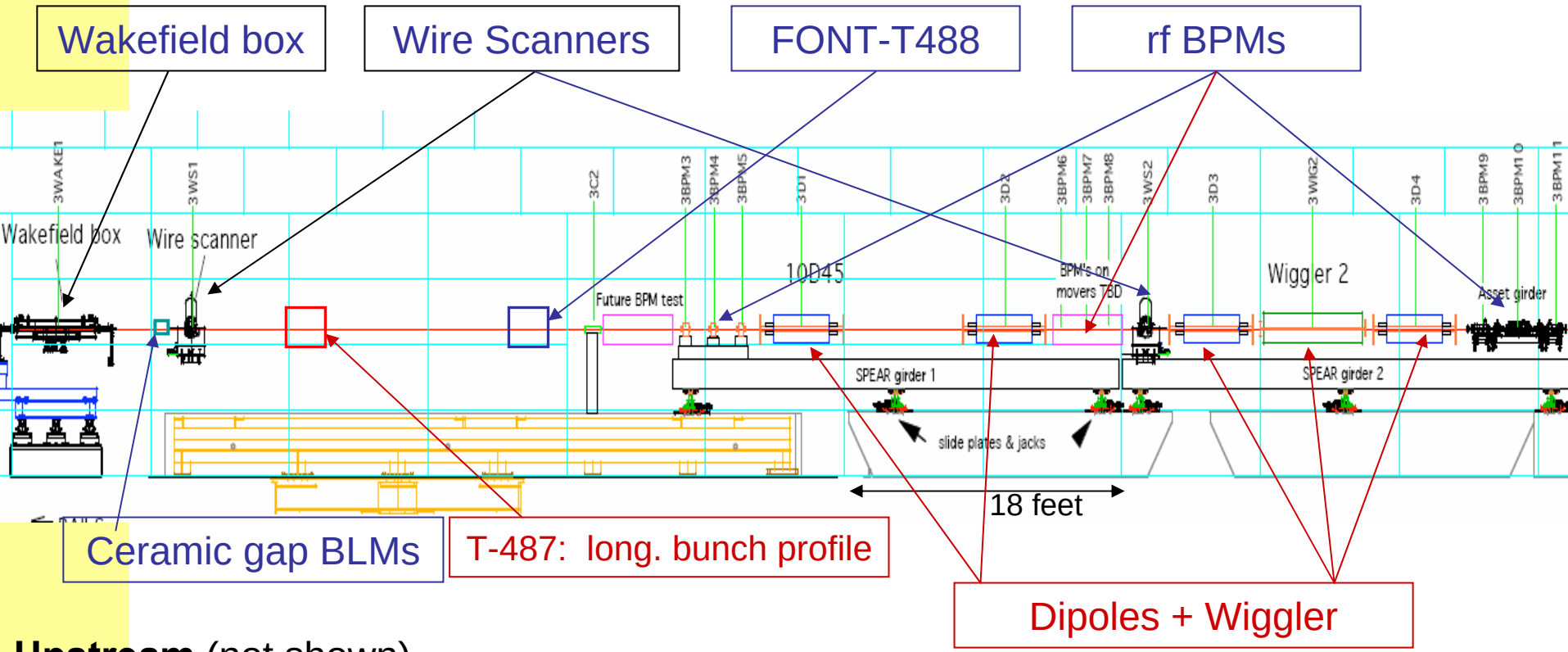
End Station A
Counting house
Old SPEAR tunnel
Final focus test beam
North arc
End of klystron gallery
North injection tunnel
Main control center
End Station B
South Arc
BSY main access
South injection tunnel
SABER
New PPS Gate
Accelerator housing

SABER


Beam
Switch Yard
(BSY)
PEP II
End
Station A
(ESA)
North Damping
Ring
Positron Return Line
Positron Source
LCLS Injector
e-gun
Linac
Pulse
Compressor
Upgrade
Bypass Line
NLCTA
FFTB
Future LCLS
SABER
South Damping
Ring
CEH
BSY
Southeast Adit
Fully implemented PPS
entrance portal
SABER
Utility Shaft
Southwest Adit
(blocked)
3200 ft

End Station A (ESA)

blue=FY06
red=new in FY07



Upstream (not shown)

4 rf BPMs for incoming trajectory
Ceramic gap w/ rf diode detectors (16GHz, 23GHz, and 100GHz) and 2 EMI antennas

Downstream (not shown)

Ceramic gap for EMI studies
T475 Detector for Wiggler SR stripe

EGS4 Simulation of Secondary Electron and Positron Yields in ESA

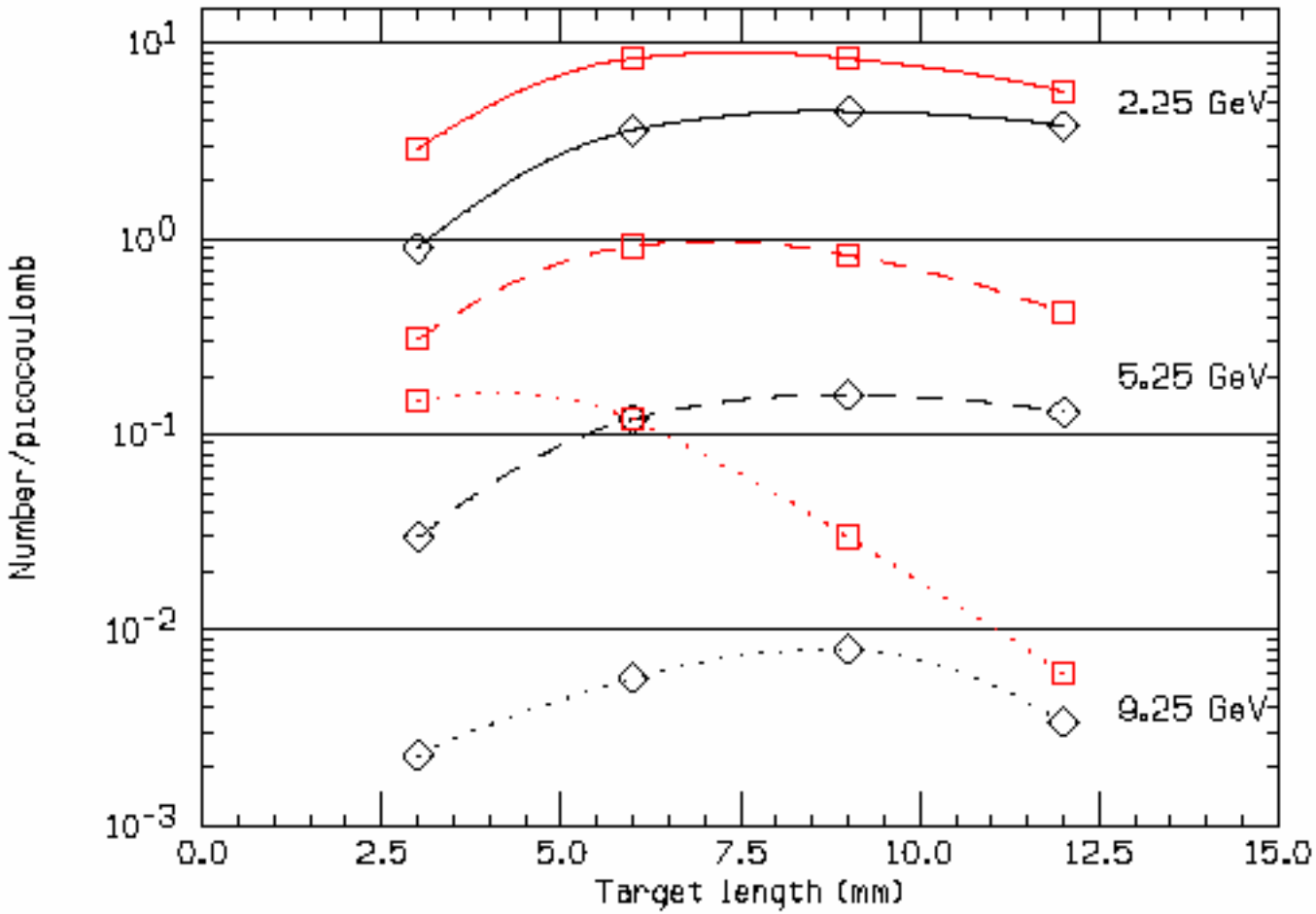
L. Keller
Jan. 2007

Conditions:

1. 14.1 GeV LCLS halo on tungsten target
2. 1/2 degree production angle
3. 0.14 μsr , ΔE/E = 0.02

electrons

positrons



EGS4 Simulation of Secondary Electron and Positron Yields in ESA

L. Keller
Jan. 2007

Conditions:

1. 14.1 GeV LCLS halo on tungsten target
2. 1/2 degree production angle
3. 0.14 μsr , ΔE/E = 0.02
4. 9 mm tungsten target

electrons

positrons