Test beams around the world

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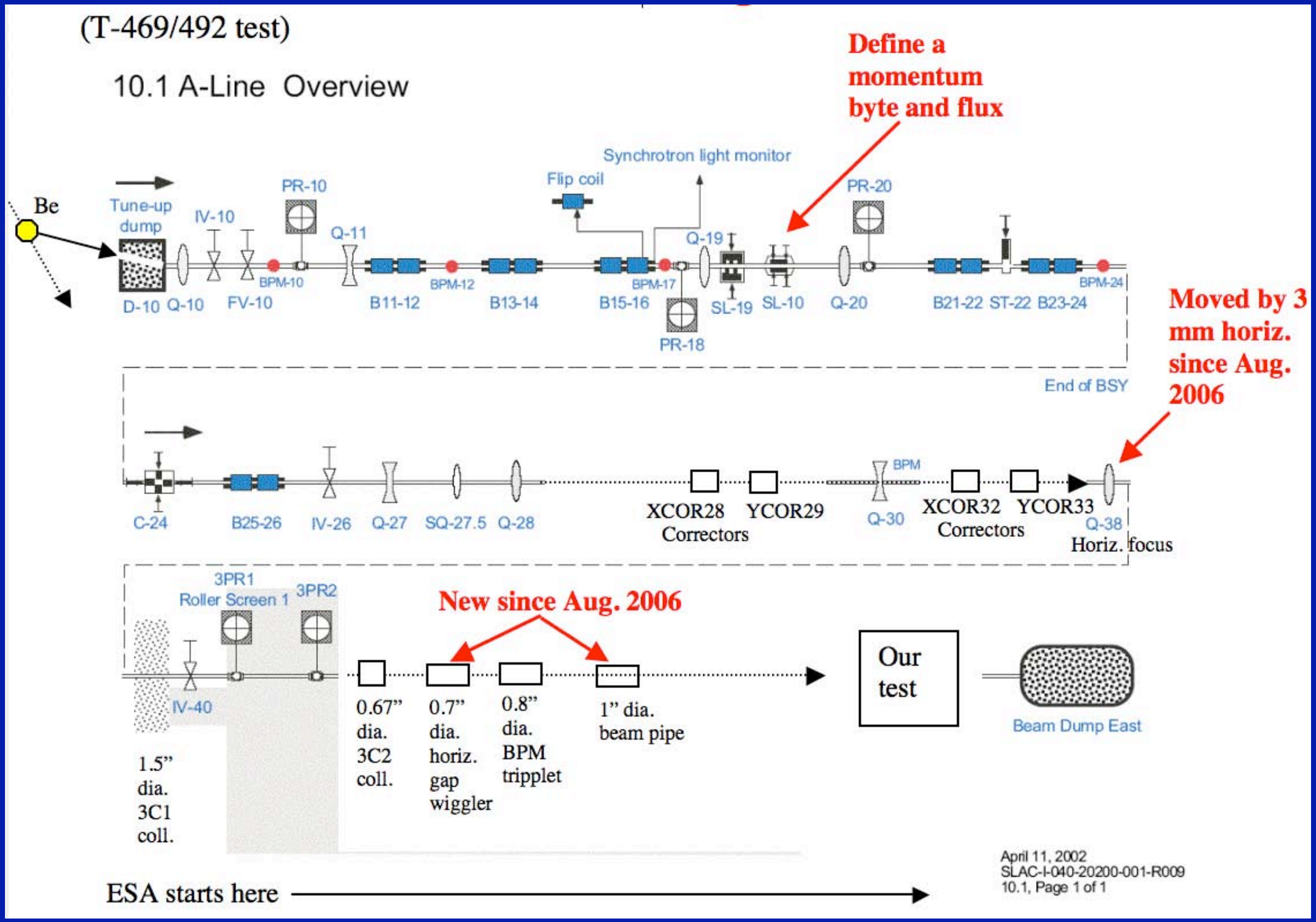
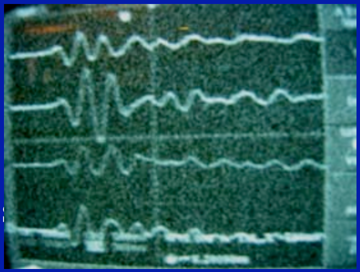
End Station A (ESA) beam line



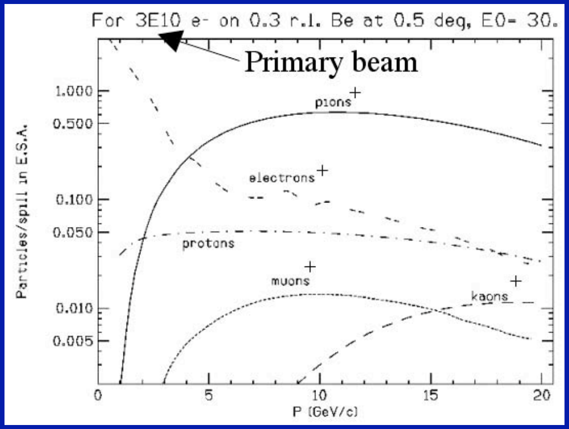
- Configuration during the last FDIRC test.
- We use it as a secondary beam running electrons off the Be target.
- Use correctors XCOR32 & YCOR33 to move the beam at our test end.

Running conditions during our test

- The ESA secondary electron test beam momentum was set to **10 GeV/c**, with LCLS beam energy of **14.5 GeV/c**. Previously we were always running **28 GeV/c** primary electron beam. Until this run it was not clear (a) if it is even possible to run parasiting with the LCLS operation, and (b) if the particle yield is sufficient at such a low LINAC energy. We proved that it is possible, and that we get a good rate of **0.2-0.3 ppp** with a momentum byte of **+-0.2%**, that we get a good beam spot of **σ = 1-2 mm** at far end of ESA, and good cleanliness judging from the lead glass spectrum.
- **Monitoring of the primary LINAC beam by MCC operators:**
  - Monitoring the primary SEM electrodes on the on Be target
  - Plus a usual LINAC monitoring
- **In addition we have provided these items for the operators:**
  - Scalars indicating a particle flux going through our test
  - Our own monitoring histograms, such beam spots in the hodoscopes, lead glass rates, etc.

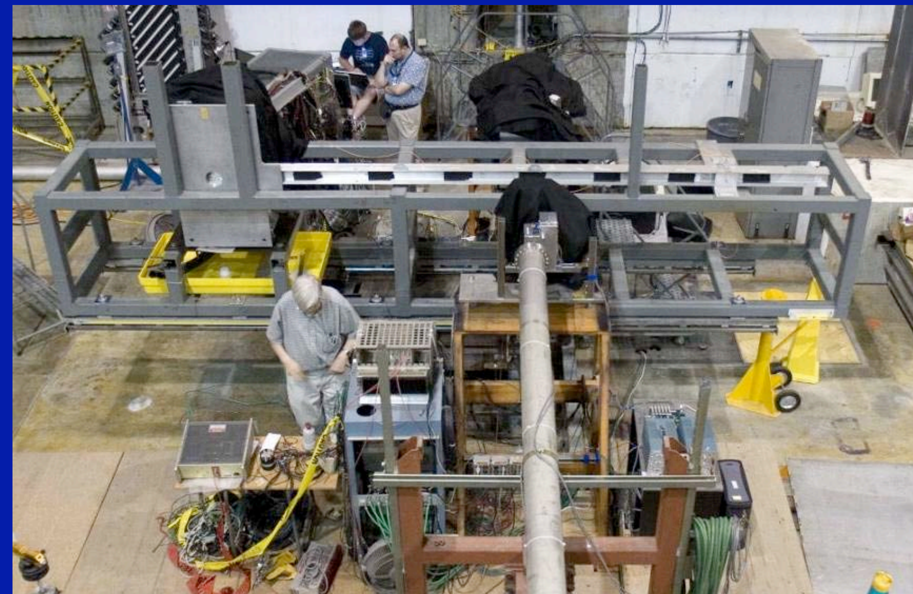


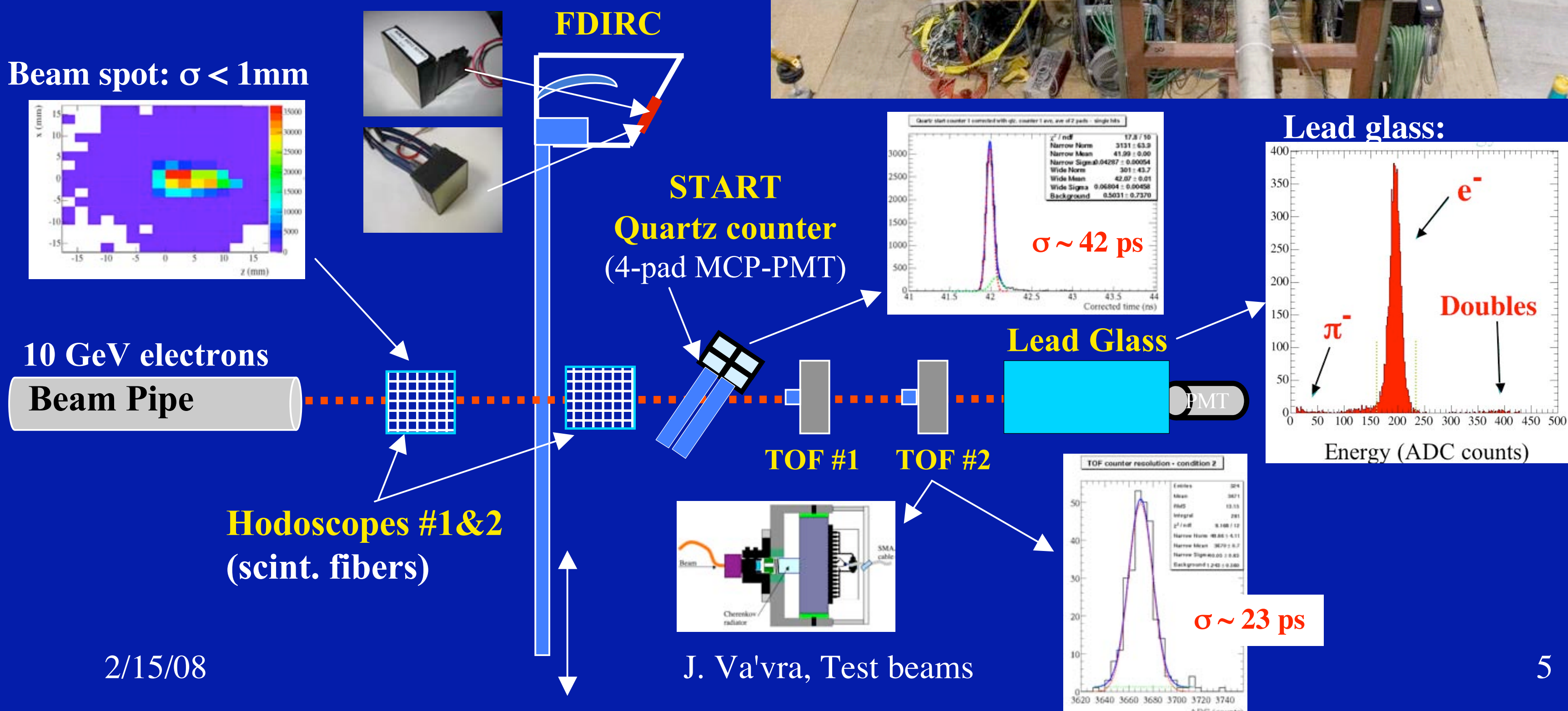
- **Particle yields:**
  - For negative beam one gets mostly electrons
  - Hadrons are possible for positive polarity
  - Generally MCC people encourage negative beam polarity i.e., one needs some political umpf to re-cable magnets into the positive polarity and spend a week to tune the beam; the last test to do this was the Glast experiment.



Run 4: SLAC ESA test beam setup in 2007

- **Instrumentation:**
  - 2 x-y scintillating fiber hodoscopes
  - START Quartz counter to monitor flux
  - Time start from the LINAC RF signal, but correctable with a local START #1 counter
  - Lead glass to monitor beam multiplicity (very important in SLAC's beam)
  - Two TOF counter prototypes



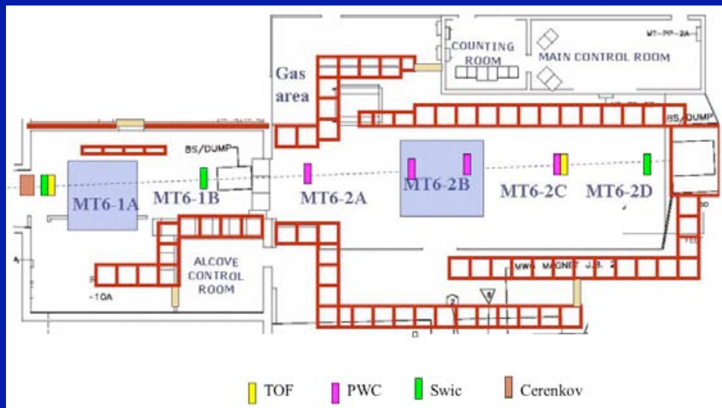


SLAC ESA: Summary of beam parameters during the last FDIRC test

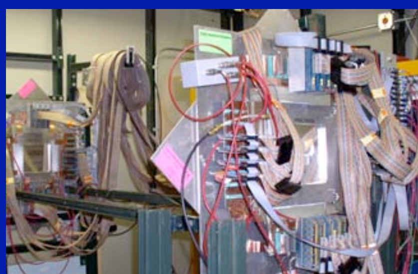
a) Height from the floor:	**7 feet ± 2 inches**
b) Total left-right clearance:	**> 10 meters**
c) Beam spot size at the bar entrance:	**~1 mm**
d) Beam position knowledge:	**± 1mm** (after tuning correctors)
e) Beam divergence:	**± ~0.6mrad** (based on the hodoscopes)
f) Particle type:	**Mostly electrons** (for negative polarity)
g) Polarity:	**Negative** (typically; can request positive)
g) Particle flux during the test:	**~ 0.2 ppp**
h) Rate:	**10 - 30 Hz**
i) Secondary beam momentum:	**10 GeV/c**
j) Primary beam momentum:	**14.5 GeV/c** (when LCLS is controlling)
k) Target:	**~1 ft-long 0.3 r.l. Beryllium**
l) Production angle:	**0.5^0**
m) Timing signals:	**AB01-8-09 , AB01-8-10** (programmable)

Fermilab Meson test beam facility - hadrons

From Erik Ramberg & http://www-ppd.fnal.gov/mtbf-w:



Spot size measured by MWPCs:



120 GeV: σ ~7mm
8 GeV: σ ~a few cm
2 GeV: total mush

Rates:

Rates* without lead scatterer

Beam Energy (GeV)	Rate at Entrance to Facility (per spill)	Rate at Exit of Facility (per spill)	%Pions, Muons**	% Electrons**
16	132,000	95,000	82%	18%
8	89,000	65,000	42%	58%
4	82,000	51,000	26%	72%
2	88,000	38,000	34%	65%
1	79,000	23,000	<50%	>50%

Rates* with lead scatterer

Beam Energy (GeV)	Rate at Entrance to Facility (per spill)	Rate at Exit of Facility (per spill)	%Pions, Muons**	% Electrons**
16	86,000	59,000	100%	0%
8	31,000	18,000	95%	5%
4	5,400	1,300	73%	16%
2	6,000	480	51%	42%
1	5,000	120	~60%	~40%

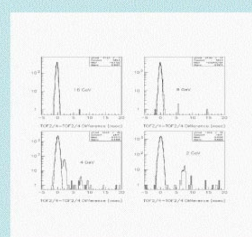
*Rates here are normalized to 1E11 at MW1SEM

**Measured at exit of facility with PbG calorimeter

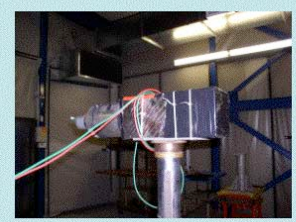
Beam line well instrumented to measure the particle composition:

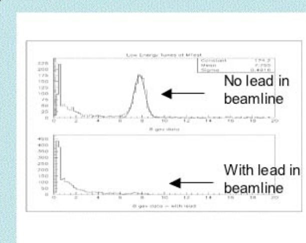
- New differential Cerenkov detector can resolve beam composition at entrance to hall:

- Time-of-flight system works below 4 GeV:



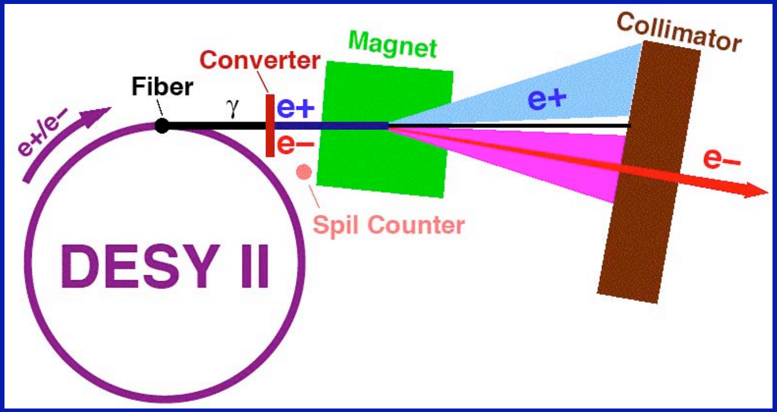
- Lead glass calorimeter at end of user area can resolve beam composition there.





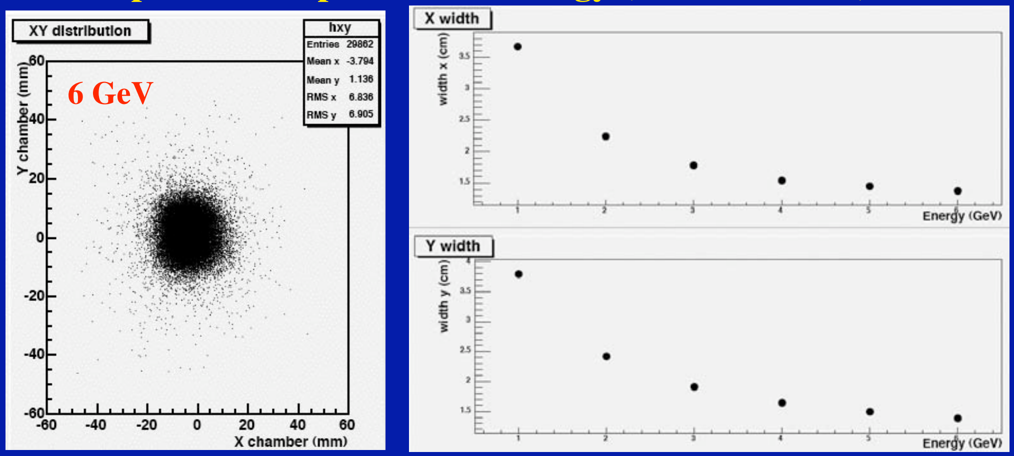
DESY test beam - electrons

A bremsstrahlung beam is generated by a carbon fibre:

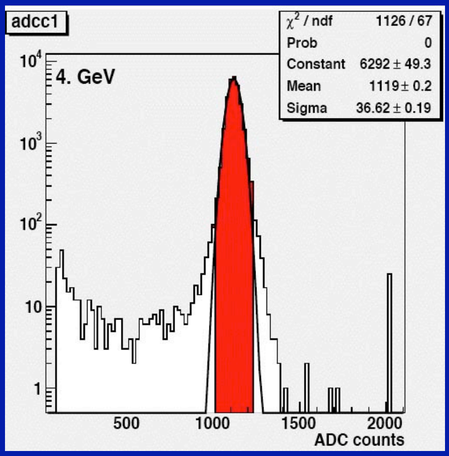


1. Three lines: T21, T22, T24
2. Energy: 1-6 GeV/c
3. Energy spread: 5%
4. Divergence: ~2 mrads
5. Flux: 0.3-1 kHz/cm^2

Beam profile is dependent on energy (T24 beam line):



Lead glass at 4 GeV/c:



- No test beams until August, 2008

http://adweb.desy.de/~testbeam/

KEK test beam - hadrons

From Peter Krizan:

Electron test beams (converted bremsstrahlung photons from the KEK-B storage ring) in the Fuji hall.
Flux: up to 200 particles per second (MC estimate) over 2x2 cm2.
Energies from 0.5 to 3.4 GeV,
Energy spread: ~0.4%

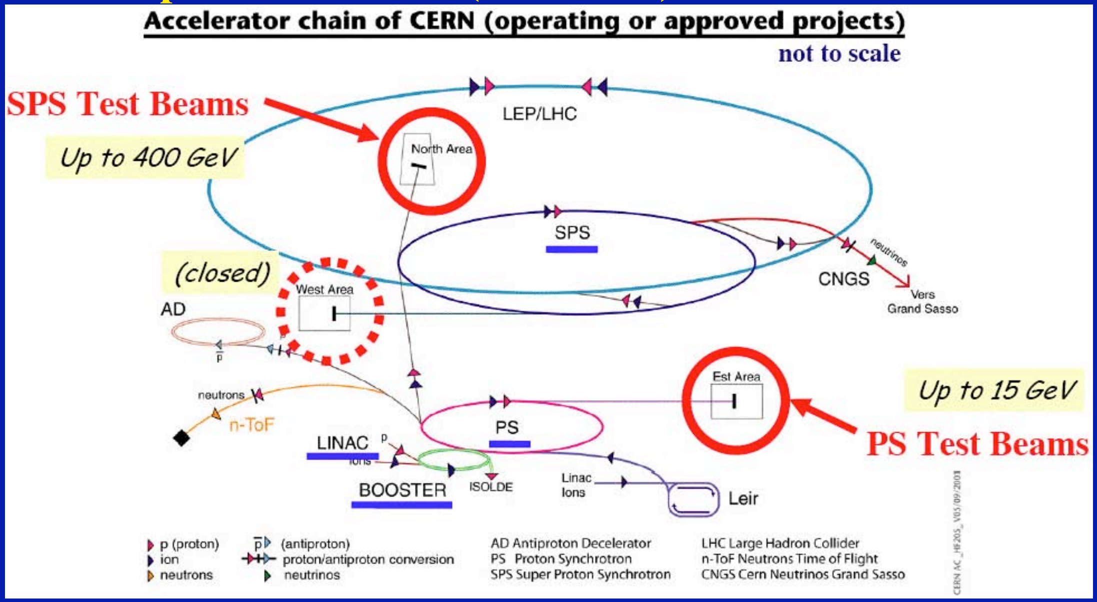
Space: along the beam 2.5m, transverse: few m on one side.

Status: under commissioning.

Available from April 2008, ~30 weeks per year (depending on available funding = running of KEK-B), no operation over summer (July-Sept.).

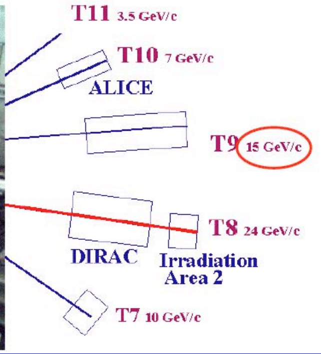
CERN test beams

Two experimental halls (PS & SPS):



PS hall: lines T7 - T11

- Electrons, hadrons, muons (up to 1-2 * 10^6 / spill)
- 2 spills of 400 ms, every 16.8s
- Minimum momenta 1 GeV, maximum up to 15 GeV

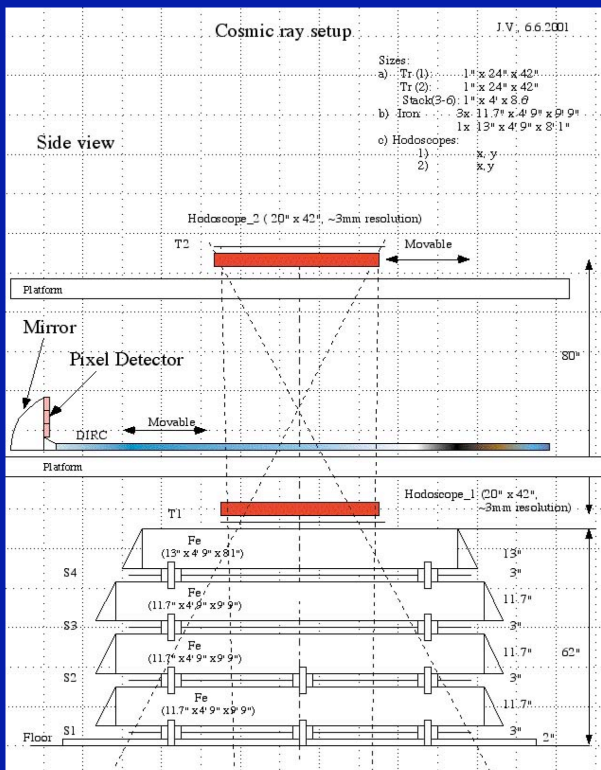


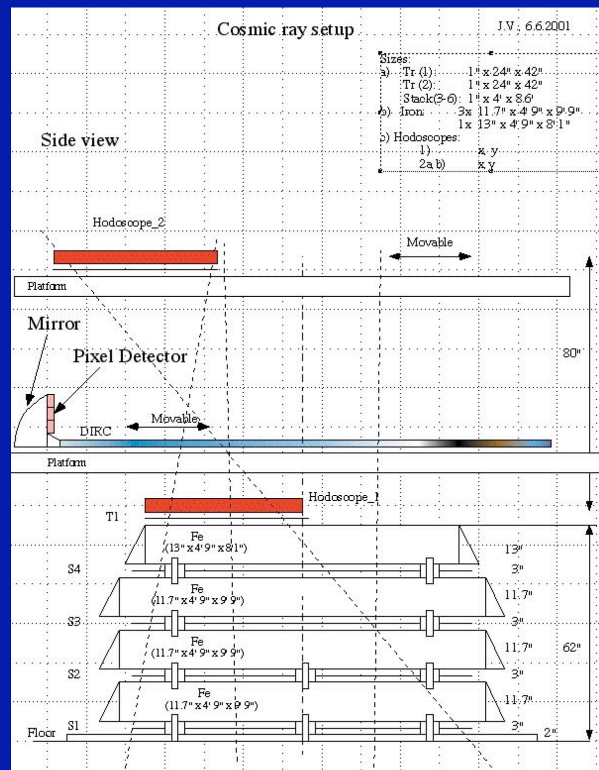
Cosmic ray telescope at SLAC

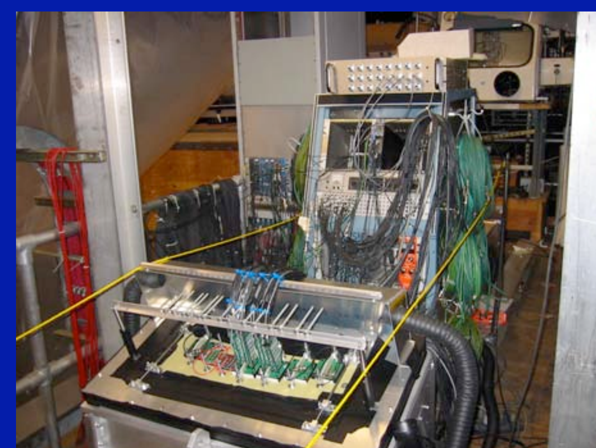
http://www.slac.stanford.edu/~jjv/activity/dirc/cosmic_ray_telescope.pdf

Location: bldg 121:

The telescope was used for an engineering run of the FDIRC prototype before we moved it to the beam line.







Absorber: ~ 4 ft thick steel
Tracking resolution: ~1 mrads.

Backup slides

Comments on test beam in ESA at SLAC, while parasiting with the LCLC operation

- The A line was originally designed for the primary electron beam, and there is plenty of instrumentation to monitor a high current running, such as screen monitors. However, at present, it is clearly under-instrumented for low flux running. Luckily, we had two fiber hodoscopes in our experiment, but elsewhere we had no idea how far we are from various obstructions left from earlier high intensity running (for example, wiggler magnet with a 0.67 inches aperture, or 1 m-long 1 inch dia. pipe). From time to time, we have noticed a deterioration of the lead glass spectrum, presumably due to a slight scraping some obstruction, or due to steering changes in front of the Be target. We knew that such a change occurred at our end, but operators did not know what to do about it as they did not have a sufficient monitoring available. To make this beam line more user friendly, the operators need a better feedback from an instrumentation sensitive to low flux. According to Mike Woods, there is a plan to add a counter to improve monitoring in the middle of the line,
- Similarly, we found that the alignment reference scribe marks on ESA floor and wall are as much as 1-2 cm off !! This makes it difficult to align your instrument precisely ahead of time, especially if it has a small aperture. I think that the reason why marks on the ESA floor are so much off is that the beam position at far end of ESA depends on the LINAC lunching angle towards the Be target. We had one more shift of running, which was separated by 2 more days of LCLS tuning. For exactly the same magnet settings in A-line, the beam was again ~1.5 cm away compared to a run two days earlier. We had to re-tune the x & y correctors (32&33) again to get the beam into the same hodoscope spot. So, a scribe line on the floor would be stable if the LINAC's lunching angles would stay the same.
- Because ESA was designed for high current running, it has a complicated access through various interlocks. Each access takes at least 45 min. There is no possibility to be on the floor while beam is on, and therefore the test has to be well debugged ahead of running. We have 10 coax cables available to monitor essential signals in bldg. 420. The computer on the floor digest the data and is connected via a UNIX. Typically we sit upstairs in the central lab to run shifts, one person is in MCC, and we go to ESA only for hardware adjustments.
- Anyway, now that FDIRC has run 3 times, we started to get a pretty good feel for the ESA running. However, any novice, if he comes to such a test facility, would probably mess up initially. One definitely needs a help of somebody familiar with A-line, such as Rick Iverson, and a liaison person in the LINAC control room.