Test Beams at SLAC

SLAC has long encouraged and supported Research and Development in High Energy Physics through an active program of providing beams for the purpose of testing detector prototypes or for use in small experiments.

Use of SLAC’s test beams is open to all in the scientific community and proposals for their use are actively invited.

Through the clever use of parasitic beams, many such tests or small experiments have been successfully carried out during periods when the linac is dedicated to providing beam for others.

These parasitic beams of electrons are available in the Final Focus Test Beam tunnel and in End Station A.

SLAC provides beam time, mechanical support, technical support, computer and network Access.

T. Fieguth, 1/9/04 ALCPG04
7.2 BSY Tunnels
5-10% of SLC beam is scraped on sector 28-30 collimators. Bremsstrahlung photons go straight head downstream, through the bending magnets striking a 0.7 X0 copper target producing electron-positron pairs. Electrons that are within a fixed angular acceptance and adjustable momentum acceptance enter the A-line and are transported to End Station A (ESA).

* This method of obtaining test beams was suggested by A. Odian and developed by L. Keller and others.
Phots are Produced at Beam Halo Collimators in Linac Sectors 29-30

50B1 Dipole Separates Electrons, Positrons and Photons

e⁺ to SLC
e⁻ to SLC

Photo Production Target

B1 and B2 Dipoles
On ⇒ Direct e⁻ to ESA
Off ⇒ Direct e⁻ to FFTB

A Line Momentum Selection

Measured Electron Yield in Final Focus Test Beam with Closed Collimators

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Measured Achievable Electron Yield in End Station A

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Electrons / Pulse

Electronic Energy (GeV)
### Test Beams at SLAC, 1997 to present, ~35 experiments

| T418          | E-155 Spectrometer Calibration, R. Arnold, American Univ. (ESA). Ran December 1997 |
| T419          | Positron Polarization Measurement, H. Band, Univ. of Wisconsin. Ran June 1998         |
| T420          | GLAST Prototype Tests, W. Atwood, SLAC. Ran during October 1997                      |
| T423          | Neutron Yield in FFTB, W. Bugg & S. Rokni, KEK, Kyoto U., Univ. of Tennessee & SLAC. Ran for two weeks November 1-15, 1997 |
| T424          | RF Cherenkov Radiation Background Check, D. Beeson, Kansas Univ. & SLAC.              |
| T426          | SLD Compton Polarimeter Test, W. Bugg, Univ. of Tennessee. Ran June 1998              |
| T427          | Minos Nuclear Emulsion Module Test, L. Wai, S. Wojcicki, Stanford U., 6/98            |
| T429          | Test of GLAST Prototype, R. Arnold, American Univ., (e⁺ & γ in ESA); Preliminary run September 1999, Final one month run in December 1999. |
| T438          | STAR Endcap Calorimeter Test, L. Bland, IUCF (FFTB); Test prototype EMC, compare transverse shower profile with GEANT, discriminate π° photons. Ran October 1999 |
| T440          | Single Pulse Damage in Copper, M. Ross, SLAC (FFTB); Determine NLC beam parameters that are benign for X-Band RF structures. Ran February 2000 |
| T441          | Radiation Damage in Magnetic Material, M. Ross, SLAC, (ESA); Determine effect of high radiation on Strontium Ferrite Magnetic Material. Ran February 2000. |
| T442          | OTR Resolution Contributions in E-157, M. Hogan, SLAC (FFTB); Quantify contributions to Spot Sizes measured with E-157 Optical Diagnostics. Ran February 2000. |
| T443          | SPARC Pixel Telescope, G. P. Grim, UC Davis (FFTB); Understand Performance of Novel Tracking Device, 3 Planes of Silicon Pixel detectors. Ran August 2000 |
| T444          | Coherent Microwave Cherenkov Radiation, P. Gorham, JPL, Cal Tech (FFTB); Characterize coherent pulsed microwaves from EeV (10¹⁸ eV) Electromagnetic Showers. Ran August 2000. |


T452  STAR Endcap Calorimeter + Shower-Maximum Detector, L. Bland, IUCF, (FFTB); Compare transverse profile of EM shower measured by scintillator shower maximum detector to GEANT simulations, for STAR/RHIC. Ran Jan. 2001.

T453  Damage Test in Diamond for LCLS, P. Krejcik, SLAC, (FFTB); Determine damage to diamond crystal structure from single pulse. Ran Apr. 2001.


T455  Calorimeter for Local Polarimeter at PHENIX/RHIC, B. Fox & A. Deshpande, RIKEN-BNL, (FFTB); Calibrate the energy and position measurements of the calorimeter for the local polarimeter at PHENIX/RHIC. Ran Aug. 2001.


T457  Measurement of Neutron Energy Spectra Using Bonner Multi-Sphere Spectrometer, T. Nakamura (Tohoku University, Japan), S. Rokni (SLAC), FFTB. Measure neutron energy spectra outside the FFTB dump shield from thermal energies up to 800 MeV and compare with results from FLUKA code.

T460  Characterization of Askaryan Effect in Rock Salt, P. Gorham, University of Hawaii; Manoa, Honolulu, D. Saltzberg, FFTB. Measurement of Cerenkov radio emission and its polarization from electromagnetic showers generated by gamma rays in rock salt.

T461  High Atmosphere Fluorescence, P. Chen (SLAC), P. Sokolsky (University of Utah) FFTB. Measurement of detection efficiency for beam induced fluorescence of near atmospheric air. This is the first part of a series of investigations and more refined measurements of the light producing signal mechanisms of the HiRes Ultra High Energy cosmic ray detector.
Magnetization Dynamics of Soft-Magnetic Films, H. Siegmann, J. Stohr (SLAC) FFTB. Research on the response of magnetically soft films to the ultra short magnetic field pulses of the FFTB electron beam.

Correlation of Linac Transverse Deflection Cavity with FFTB Streak Camera, M. Hogan (SLAC) FFTB.

Magnetic Electron Pulse Duration Diagnostic, Roger Carr, Hans-Christof Siegmann (SSRL)

UCLA Electromagnetic Calorimeter Prototype, Prof. Charles A. Whitten Jr., UCLA
GAMMA-RAY LARGE AREA SPACE TELESCOPE

Exploded View: One of Forty-nine Towers

10 Layers of 0.5 rad Length Converter (pb)
12 Layers of XY Silicon Strips
Gamma Rays
 positrons/Electrons
Figure 2: A schematic drawing (not to scale) of the experimental set-up.
Test Beams in ESA

Primary Beams

- Up to 50 GeV,
- up to $6 \times 10^{11}$ electrons/pulse,
- up to 500 ns,
- high momentum resolution, <0.1\%
- 0.1-2.0 \% momentum acceptance
- Achromatic to 1\textsuperscript{st} order, no dispersion
- 1-30Hz typical, 120Hz possible but costly;
- polarized(optional),
- Positron beams are possible under certain circumstances

Secondary Beams

- These low intensity beams have been useful for many EMC tests and other tests.
- 500 MeV to 20 GeV (high energies costly)
- usually one electron/pulse, but
- 3-4 mm rms half-width spot,
- High momentum resolution
- 10-30 Hz.
- see SLAC-PUB-6387, E-146 Collaboration

Some measured yields of secondary electrons in ESA
Test Beams in ESA

Other Secondary Beams

- Tagged photons beams using secondary $e^-$ (see above) on a bremsstrahlung target with tagger magnet and detector in the end station.

- Hadrons for GLAST tests. A 0.5 r.l. Be target is insertable at the old position of PM3 in Beam switchyard (BSY)

- Positrons and hadrons are accepted into A-line at a 0.5 degree production angle. Small Acceptance 2.3x4 cm over 80 m drift.

- Averaging one particle/pulse allows use of TOF and Cherenkov techniques for particle identification for 5-20 GeV.

- At 14.5 GeV for 0.4 particles/spill total the yield was 0.25 $e^+/spill$, 0.17 hadrons($K^+,\pi^+$)/spill and 0.01 protons/spill. see GLAST 1999 test results, SLAC-PUB-8682
Figure 7: The total energy deposition in the calorimeter during a self-trigger test with the beam intensity varied between \(\sim 15\) and \(\sim 30\) positrons per pulse. Muon response is seen for a) the lowest energy range and for b) multi-positron response for the highest energy range.
Test Beams in FFTB

Primary Beams

• 28.5 GeV electrons
• 1-2 x 10^{10} per pulse.
• typically 3ps pulse,
• small emittance, σ_x=4µm, σ_y=2.5µm, or SPPS short pulse with larger energy spread, have achieved σ_x=20µm, σ_y=20µm and σ_z=90µm for T465 test beam,
• 1-30 Hz.
• Loss limited to 1 kW by shielding

Secondary Beams

• These low intensity beams have been useful for many EMC tests and other tests.
• 1 to 30 GeV,
• usually one electron/pulse,
• several mm spot,
• 10-30 Hz

Some measured yields of secondary electrons in FFTB
SLAC Test Beams in the Future

Near Term  ~two years

• The Sub-Picosecond Pulse Source will use most of the available beam time. However, there will be some time allocated for test beams in both FFTB and ESA. (at this time ESA and FFTB are precluded from simultaneous running)

• A possible test of the DIRC quartz bars for BaBar is being considered for running in ESA using a low energy secondary beam.

• EPAC decision (May 2004) concerning LC Beam Instrumentation Test in ESA (see M. Woods talk)

Mid Term

• LCLS construction will commence (2006). FFTB will no longer be available.

• It is possible that Test Beam opportunities may be available in ESA. In conjunction with continuing opportunities for the LC Beam Instrumentation tests.

• GLAST tests are being planned for ESA (perhaps summer 2006, flight schedule dependent).

Long Term

• Running Test Beams during the LCLS era is unsure. There may be technical and/or policy solutions to this problem but they are not clear. If interest is expressed by ALCPG, this may be useful in the considerations.