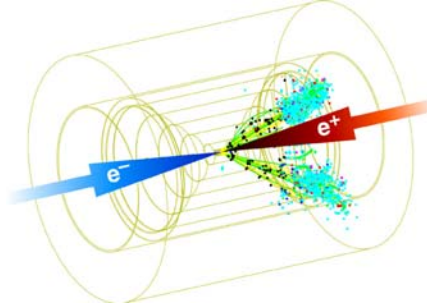# Beam Tests for the Machine-Detector Interface and Beam Delivery System

Mike Woods, *SLAC*

Some References:

i.   1st ILC Workshop at KEK, Nov. 2004, WG4.
      What Beam Tests are Critical? (M. Woods, SLAC and S. Kuroda, KEK)
      http://lcdev.kek.jp/ILCWS/WG4.php

ii.   ILC-Asia Review, Feb. 2005: ***ATF status*** (K. Kubo) and
      ATF2 project plans (T. Tauchi). http://lcdev.kek.jp/review.php

iii. SLAC ILC Planning Talk, Sept. 2004: ***ILC Beam Tests using SLAC ESA***
      (M. Woods). http://www-project.slac.stanford.edu/ilc/talks/technologytalks.htm
      and ALCPG-IPBI March 2005 meeting: ***Update on ESA Beam Tests***
      http://www.slac.stanford.edu/xorg/lcd/ipbi/meetings.html

Beam Test Activities by European Groups

EUROTeV

Work Package 5: Beam Diagnostics
- Laserwire (at HERA and ATF); emittance measurements
- nano-BPMs (at ATF)
- Energy (at ATF and SLAC ESA); BPM-spectrometer
- Bunch length; electro-optic sampling and Smith-Purcell radiation

Work Package 2: Beam Delivery System
- IP Beam Stabilization Feedback (at ATF and SLAC ESA)
- Collimator Wakefield Tests (at SLAC)
- Crab cavity design (possible beam/component tests later)

UK LC-ABD (Linear Collider – Accelerator Beam Delivery)

Includes many of the Beam Diagnostic and BDS components of the
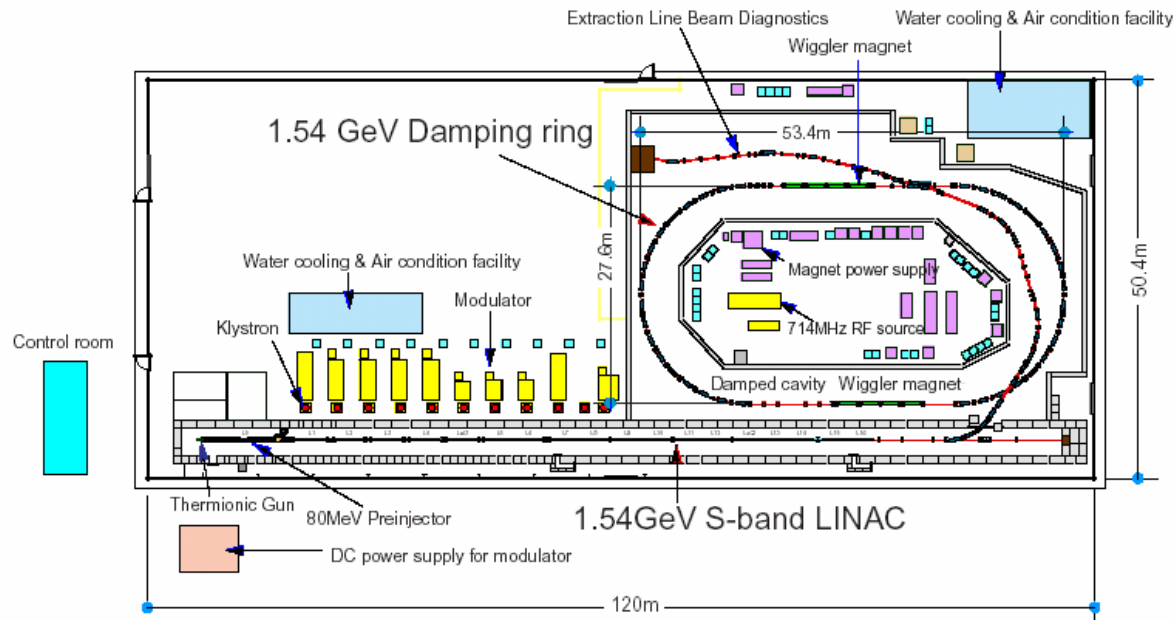   EUROTeV Work Package items
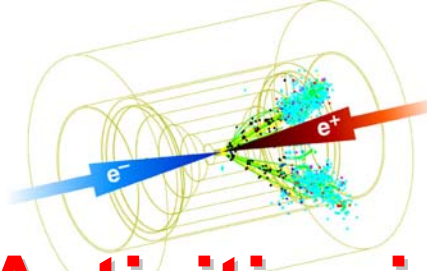
Beam Test Activities in Asia at KEK ATF in Japan

Laserwire (beam spotsize and emittance, energy spread)
Nano-BPMs (for FF optics test, energy spectrometer)
IP Beam stabilization (FONT/FEATHER + for FF optics test)
**Compact Final Focus optics** (proposed)

UK: Pulsed Laser-wire at the ATF Extraction Line

- *University of Oxford:*
  N. Delerue, B. Foster, D. Howell, A.Reichold
  I. Ross (CCLRC)
- *Royal Holloway University London:*
  I. Agapov, G. Blair, G. Boorman, J.Carter, C. Driouichi, M.Price
- *University College London:*
  S. Boogert, S. Malton
- *KEK:*
  H. Hayano, P. Karataev, K. Kubo, J.Urakawa
- *SLAC:*
  J. Frisch, M. Ross

Start in March and full system commissioning by December
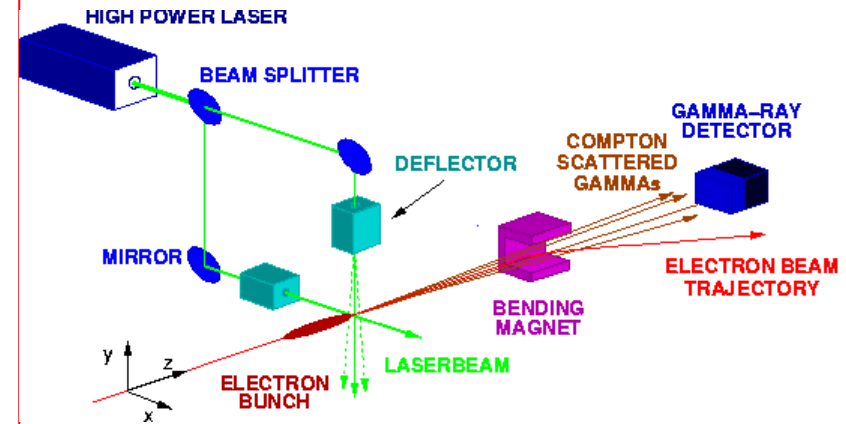
- Goal: Measure the electron beam profile with a resolution of ~1 μm.

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G. Blair

Fast FB (Intra-pulse orbit feedback) International Collaboration

- ## FONT:

    Queen Mary: Philip Burrows, Glen White, *Glenn Christian*, *Hamid Dabiri Khah*, Tony Hartin, Stephen Molloy, *Christine Clarke*

    Daresbury Lab: Alexander Kalinin, Roy Barlow, Mike Dufau

    Oxford: Colin Perry, Gerald Myatt

    SLAC: Joe Frisch, Tom Markiewicz, Marc Ross, Chris Adolphsen, Keith Jobe, Doug McCormick, Janice Nelson, Tonee Smith, Steve Smith, Mark Woodley

- ## FEATHER:

    KEK: Toshiaki Tauchi, Hitoshi Hayano

    Tokyo Met. University: Takayuki Sumiyoshi, Hiroyuki Fujimoto

- ## Simulations: **Nick Walker (DESY), Daniel Schulte (CERN)**

Possible Future Beam Feedback Tests

Short-term: expect to finish FONT3 in 2005

Long-term:

demonstrate robust intra-train FB system for ILC, based on digital signal processing, and ideally test with beam:

requires long bunchtrain with 337 ns bunch spacing

**2005-6:** FONT4: 3 bunches x 150 ns at ATF would allow first tests:

stabilise last bunch at 100 nm level (?) as part of Nano project

also feed-forward studies ring -> extraction line?

2007: FONT5: 20 bunches x 337ns at ATF/ATF2 would allow FB algorithm development

Summary-2 : Role of ATF in the next stage of the ILC project

- Beam dynamics study
  - emittance tuning and coupling control $\rightarrow$ 1 pm-rad
  - performance with wiggler
  - fast ion instability
- Extraction kicker RD – aimed at the damping ring 'footprint' decision – Snowmass 08.05
- Extracted beam
  - precision instrumentation
    - cavity BPM's, laser-based profile monitors
  - feedback / stabilization
    - fast 'within the train' feedback
    - laser-interferometric geodesic structure
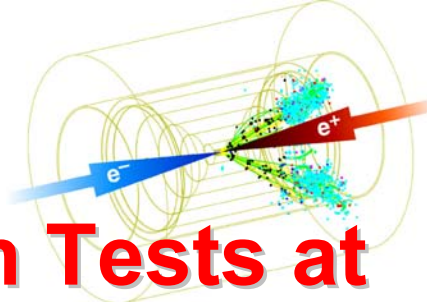- Small, stable ATF beam is a unique resource
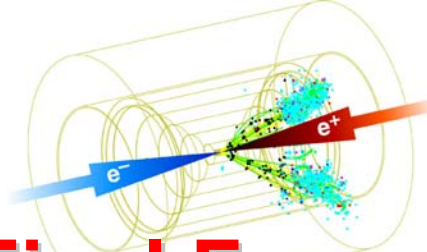
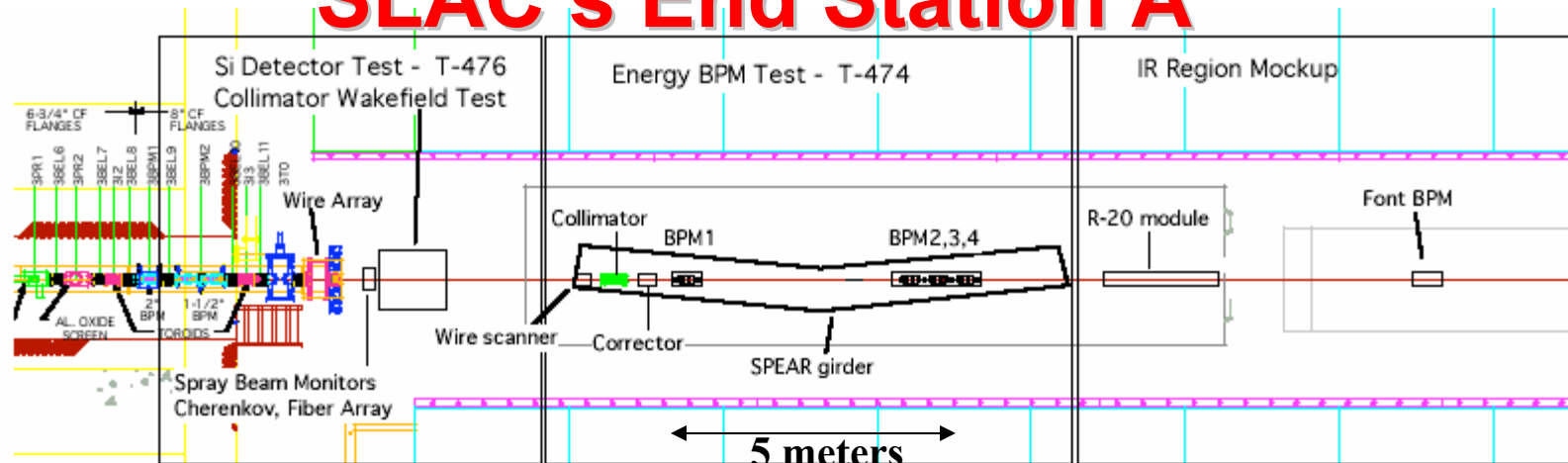# Proposed ATF2 Final Focus Test
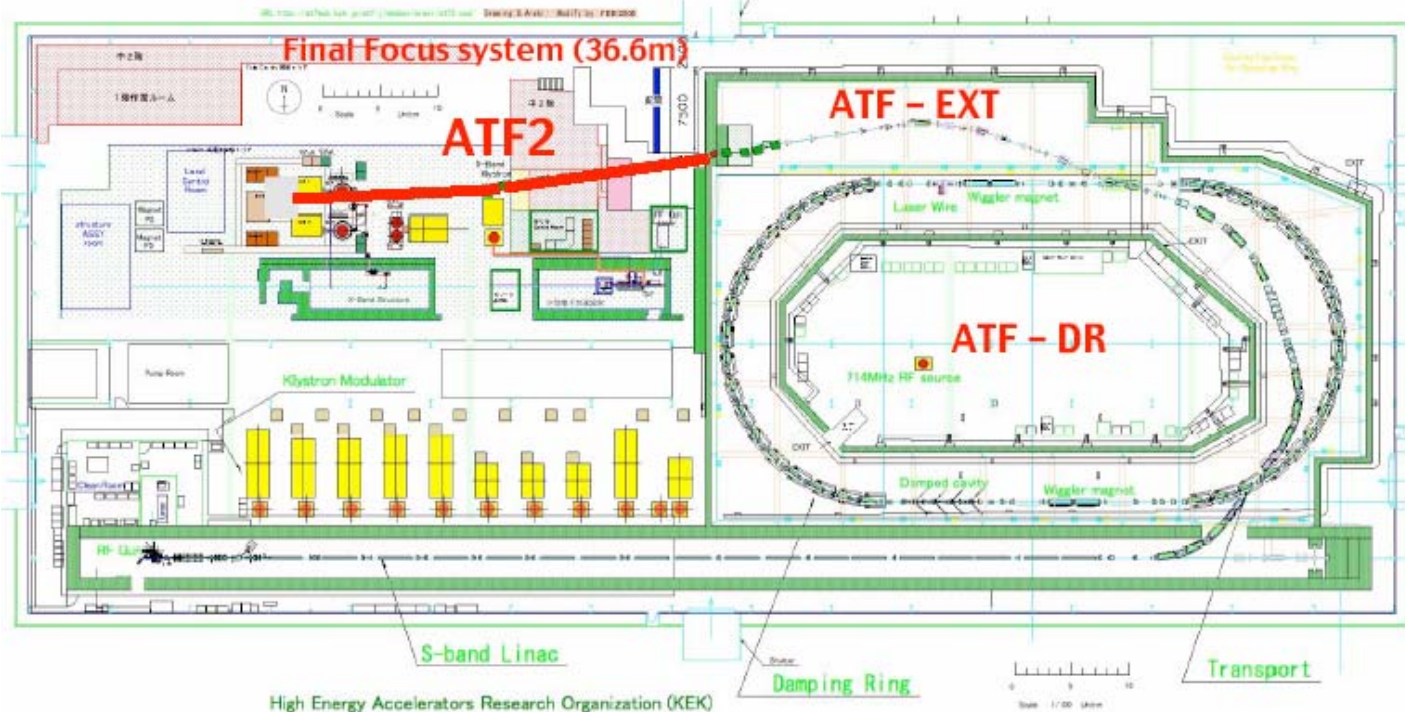
Primary Goals

- 35-nm rms vertical spotsize
- Test compact final focus optics and local chromatic corrections
- Test FF tuning algorithms and diagnostics
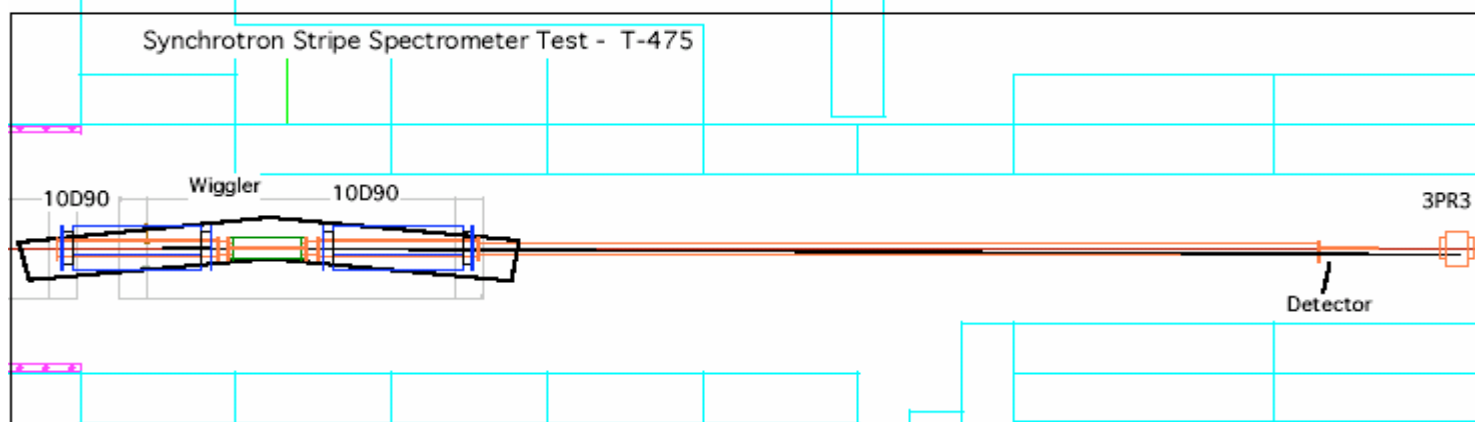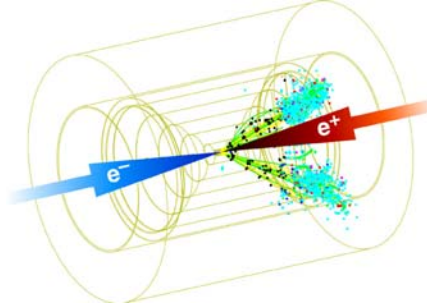- nm-level beam stabilization using nanoBPMs
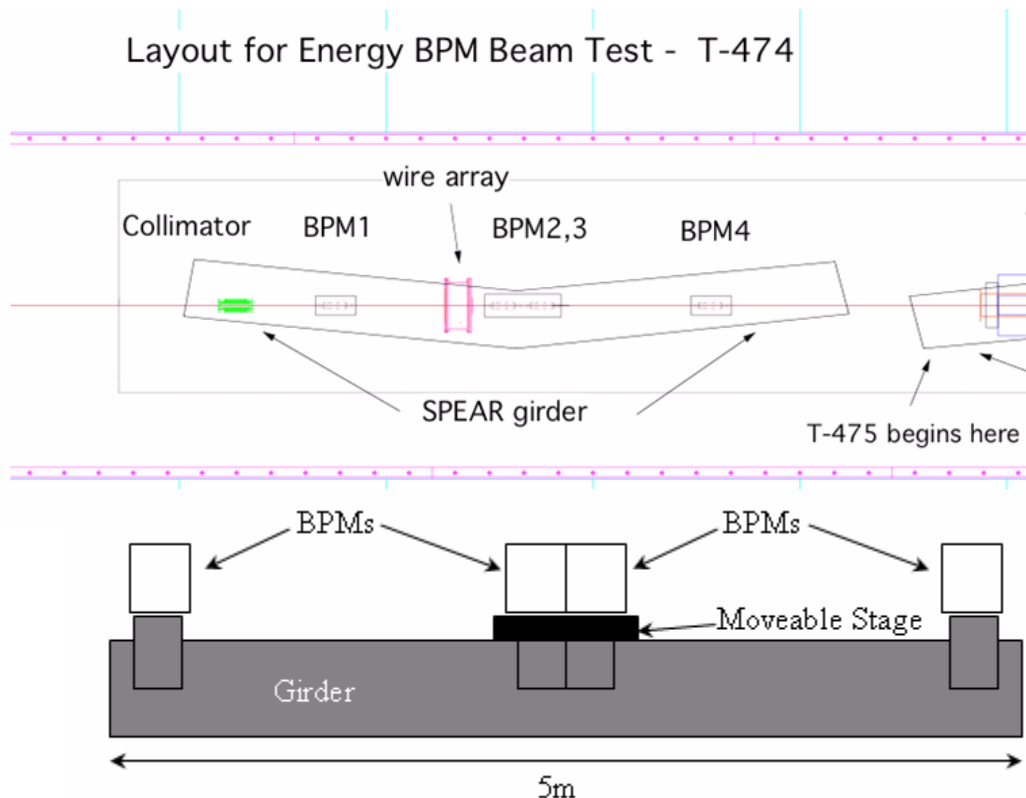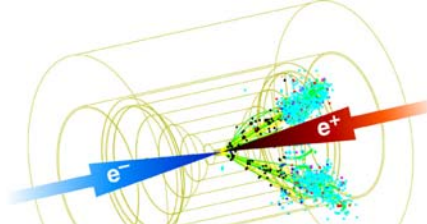
Beam Tests at SLAC's End Station A

T-474: BPM Energy Spectrometer Development

Spokesperson: Mike Hildreth, U. of Notre Dame
Collaborators: U. of Notre Dame, UC Berkeley, UC London, U. of Cambridge, SLAC

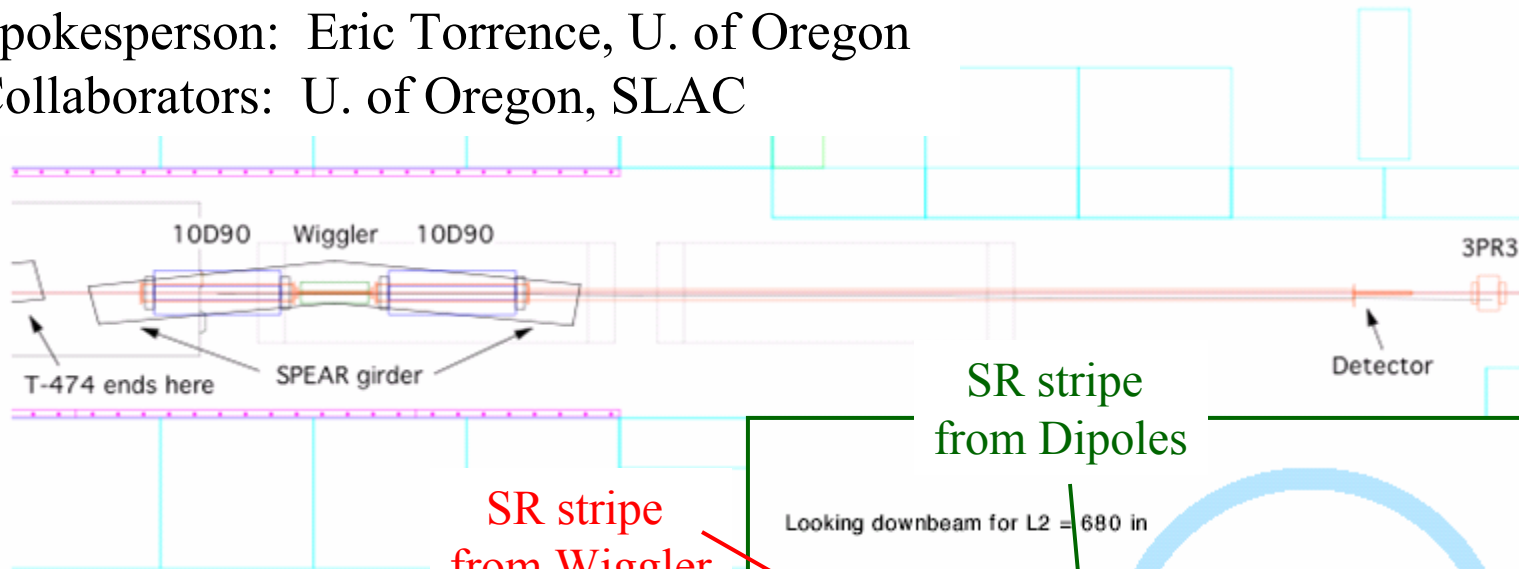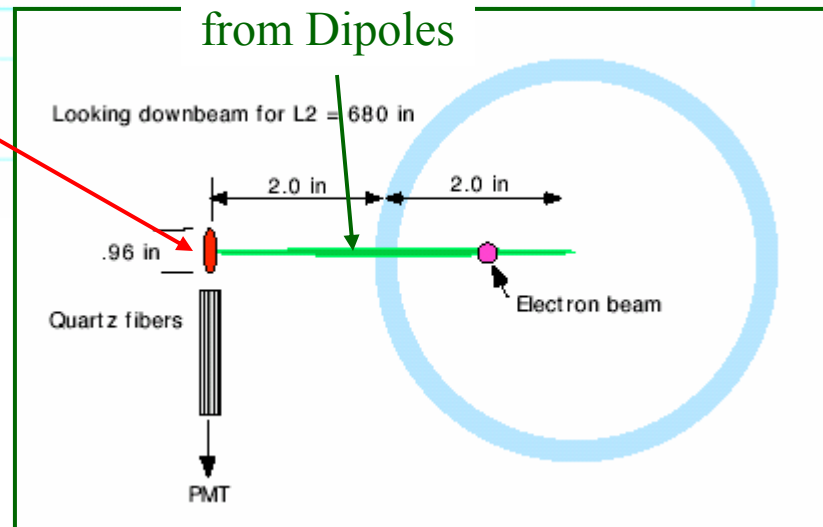Layout for Energy BPM Beam Test - T-474

T-475: Synchrotron Stripe Energy Spectrometer Development

Spokesperson: Eric Torrence, U. of Oregon
Collaborators: U. of Oregon, SLAC

SR stripe from Dipoles

SR stripe from Wiggler

Looking downbeam for L2 = 680 in

2.0 in   2.0 in

.96 in

Quartz fibers

Electron beam

PMT

10D90 Wiggler 10D90

T-474 ends here   SPEAR girder

3PR3
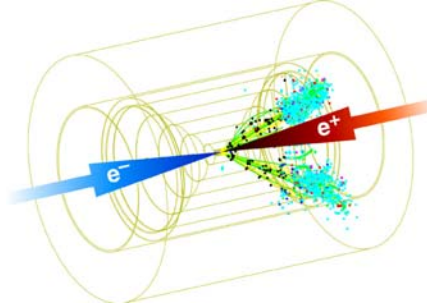
Detector

3 SLAC Test Beam Requests submitted:

T-474: BPM energy spectrometer

T-475: Synchrotron stripe spectrometer

T-476: Fast Si Detectors for Beam Profile, Luminosity

T-474 and T-475 were approved February 2005.

T-476 is deferred since it primarily addressed the warm LC design.

Scheduling of T-474 and T-475 is not yet addressed. Will approach lab about this once PEP-II/BaBar and FFTB operations resume.

ESA beam tests to address R&D issues for Beam Delivery and Machine-Detector Interface are one of SLAC's ILC priorities, and budget has been allocated for this in FY05.
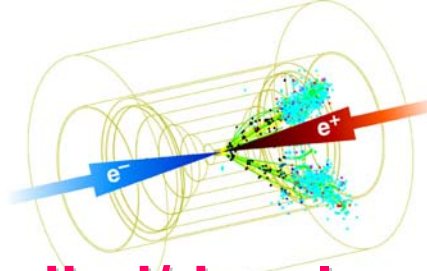
Other proposals being studied/developed:

1. **Collimator Wakefield Measurements**
   - In collaboration with UK groups, with Nigel Watson as PI
   - Also investigating possibility for material damage tests relevant for passive (and possibly consummable) collimators/spoilers
   - See talks by Nigel and Deepa at recent collimator meeting, http://www.astec.ac.uk/ap/collider/collimmeet15Feb05/index.html

2. **EMI tests with SLD's VXD3/R20**
   - In collaboration with UK and Japan groups
   - LCFI group in UK developing a proposal for funding request by early april
   - 0th-order tests: test rf antenna pickups in FFTB
   - 1st tests: with VXD3 mounted in R20 module and also on simple beampipe, with outer clamshell to mimic inner wall of drift chamber; simple DAQ monitoring and additional rf antenna pickups
      - Goal to reproduce failure mode observed in SLD and determine if source of problem is local to R20 or upstream

3. **FONT BPM tests; sensitivity to pair backgrounds, EMI**
   - use either "spray beam" or ~5% r.l. target in ESA to mimic pair backgrounds