Test Beam Session

Two parts:

A) An overview of available test beam facilities – to map the available TB capacities for the LC detector R&Ds

TB Facilities in Asia	Yasuhiro Sugimoto
Fermilab Meson Test Beam Facility	Erik Ramberg
SLAC and other North American TB Facilities	Carsten Hast
TB Facilities at DESY, Serpukhov and Frascati	Volker Korbel
CERN TB Facilities	Michael Hauschild

Test Beam Session

B) Detector R&D requirements: needs and plans of different working groups

Interaction Point & Beam Instrumentation R&D	Mike Woods
Vertex R&D: CMOS Beam Tests	Damien Grandjean
Tracking R&D	Bruce Shumm
Calorimeter R&D	Felix Sefkow
Muon R&D	Marcello Piccolo
Discussion	mediated by Erik Ramberg

Interaction Point & Beam Instrumentation R&D

Mike Woods informed that group of physicists submitted the proposal to DOE:

Y. Kolomensky
University of California, Berkeley

Beam Instrumentation Tests for the Linear Collider using the SLAC A-Line and End Station A

University of Iowa

D. J. Miller
University College London

http://www.slac.stanford.edu/grp/rd/epac/LOI/LOI-2003.2.pdf

M. Hildreth
University of Notre Dame

27 physicists
10 institutions

J. Clendenin, L. Keller,
T. Markiewicz, T. Maruyama, K. Moffeit, M. Ross, J. Turner, M. Woods
SLAC

W. Oliver
Tufts University

G. Bonvicini, D. Cinabro
Wayne State University

LC-LEP Measurement Goals

Luminosity, Luminosity Spectrum

- Total cross sections: absolute $\delta L/L$ to ~0.1%
- Z-pole calibration scan for Giga-Z: relative $\delta L/L$ to ~0.02%
- threshold scans (ex. top mass): relative $\delta L/L$ to 1%
  +L(E) spectrum: core width to <0.1% and tail population to <1%

Energy

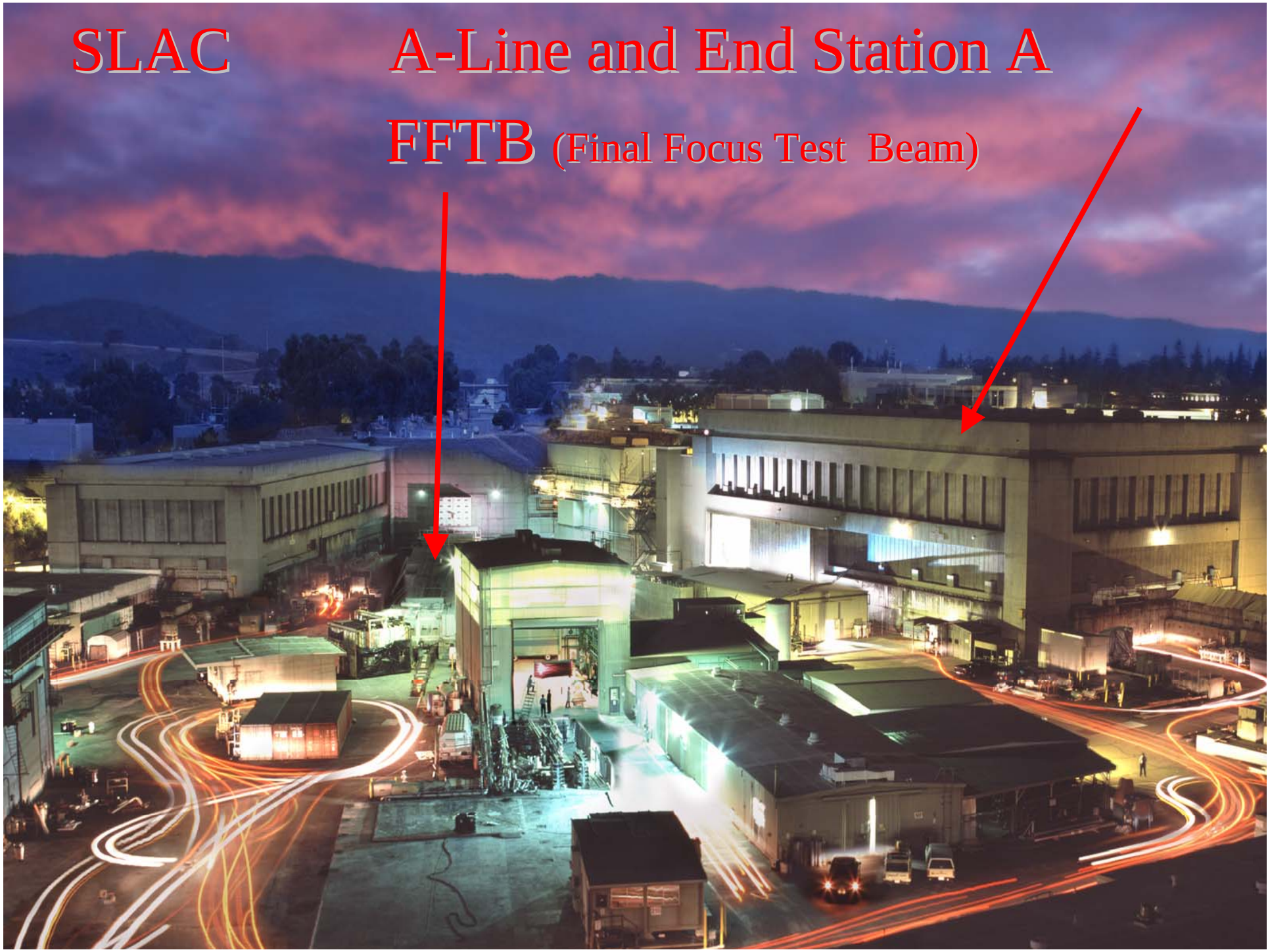
- Top mass: 200 ppm (35 MeV)
- Higgs mass: 200 ppm (25 MeV for 120 GeV Higgs)
- W mass: 50 ppm (4 MeV) ??
- 'Giga'-Z A_{LR}: 200 ppm (20 MeV) (comparable to ~0.25% polarimetry)
  50 ppm (5 MeV) (for sub-0.1% polarimetry with e+ pol) ??

Polarization

- Standard Model asymmetries: < 0.5%
- 'Giga'-Z A_{LR}: < 0.25%

SLAC A-Line and End Station A

FFTB (Final Focus Test Beam)



Beam Parameters at SLAC ESA, NLC-500, and TESLA-500

Parameter	SLAC ESA	NLC-500	TESLA-500
Charge/Train	**5×10^{11}**	**14.4×10^{11}**	
Repetition Rate	**10-30 Hz**	**120 Hz**	**5 Hz**
Energy	**25-50 GeV**	**250 GeV**	**250 GeV**
e^- Polarization	**85%**	**80%**	**80%**
Train Length	**270ns / 340ns**	**267ns**	**1 ms**
Microbunch spacing	**0.3ns / 340ns**	**1.4ns**	**337 ns**
Bunches per train	**2**		**2820**
Bunch Charge	**2.0×10^{10}**		**2.0×10^{10}**
Energy Spread	**0.15%**	**0.3%**	**0.1%**

➔ ESA in number of parameters suits the RD requirements

Other SLAC TB Facilities

Carsten Hast provided an additional information about SLAC TB possibilities:

Final Focus Test Beam

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_s=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

SLAC Test Beams in the Future

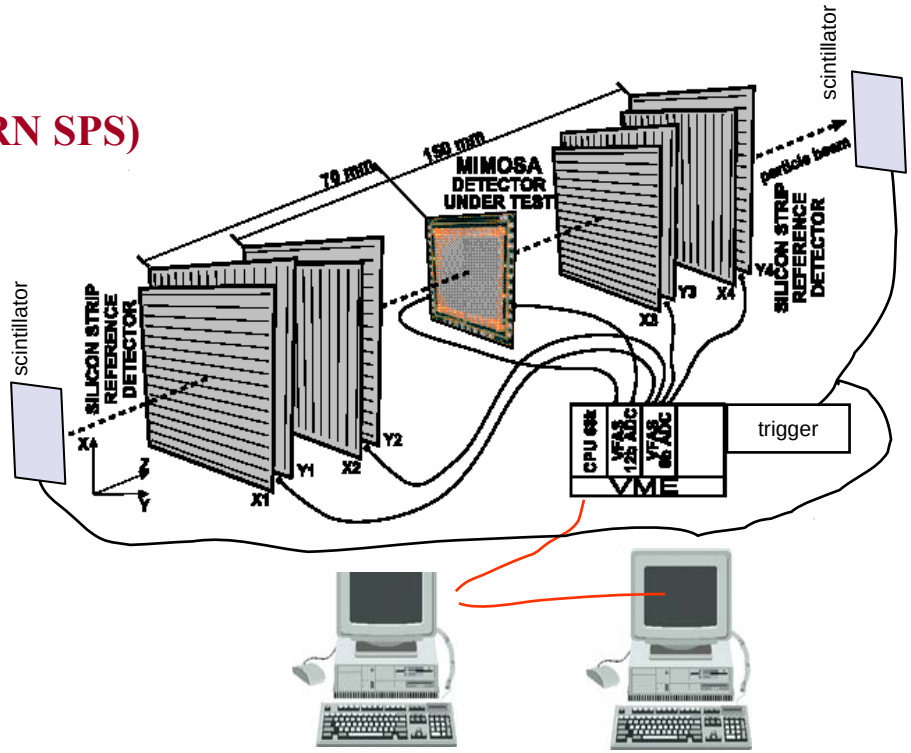
- **Running of ESA or FFTB are mutually exclusive**
- **FFTB will go away in 2006 to make place for LCLS**
- **Until then there are many opportunities to schedule beam tests in FFTB**
- **ESA is in principal available for high power or single particle tests starting this summer**

For all tests which take a significant amount of beam (= electrical power and time) there is some formality to be dealt with: at least a Test Beam Request for something short (a week or so) or an EPAC presentation

Vertex Detectors

Damien Grandjean informed about experience with Mimosa irradiations at CERN

- **Why do we do the beam tests ?**
  - The best way to have M.I.P
    - pions or muons ~ 120 GeV/c (at CERN SPS)
  - We can investigate:
    - Charge collection
    - Detection efficiency
    - Single point resolution
  - We can do this for :
    - Different temperatures (cooling system)
    - Different beam incidence angles
- **Telescope :**
  - 8 reference detectors (silicon strip)
    - 4 in x direction
    - 4 in y direction
  - 2 coincidence scintillators (trigger)



Acquisition and monitoring PC

Analysis offline PC

Vertex Detectors

Mimosa plans:

- **2004 (SPS CERN):**
  - **Mimosa 5b (big chip 1M pixels 2×2 cm^2)**
  - **Mimosa 9 (small chip with opto technology + 20 μm epitaxy)**
  - **Mimosa 7 (small CP chip photoFET)**
  - **MimoStar 1(small chip proto for STAR upgrade)**
    - **About 50 days from May 10th to November 2nd, 2004**
    - **Most of the time in parasitic mode (LHCB velo, RD 42)**
- **2005 (DESY ?):**
  - **CP chip (Mimosa 8)**
  - **Mimosa 10**
  - **MimoStar 2**

- 2006 (DESY ?) :
  - 3 different chips

Mimosa experience can be valuable also for other R&D groups

Tracking Detectors

Bruce Schumm collected information about plans from different R&D groups:

Primary activities:

- **Si sensor development (Korea)**
- **Gaseous tracking (TPC) R&D, including readout, electronics, gas mixture, etc. (multi-regional)**
- **Long shaping-time silicon readout (US, Europe)**

Asian/European gaseous tracking R&D: roughly five groups seeking testbeam within next year:

- **In few GeV range; mostly π/μ, some electrons**
- **Envision using CERN, DESY, KEK facilities**

European (SiLC) testbeam needs not yet thought through.

Tracking Detectors

Guesstimate Use Schedule (North-American Groups) by B.S.:

All groups request ~2 week runs (1 wk setup, 1 wk actual running with various conditions

Requests vary from once/year to 2-3 times/year, with intervals to be used for studying acquired data

Anticipation of need for first beams now a bit vague, but probably some in 2005 and most in 2006.

For 3-year period 2004-6; corrected for under-reporting

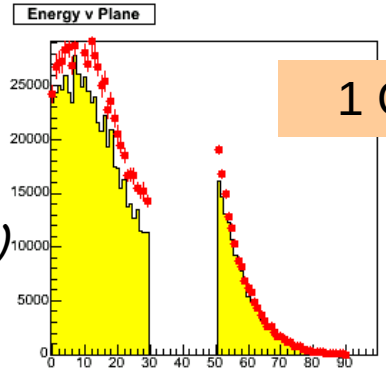
YEAR	ANTICIPATED WEEKS OF RUNNING
2004	0
2005	16 weeks
2006	24 weeks

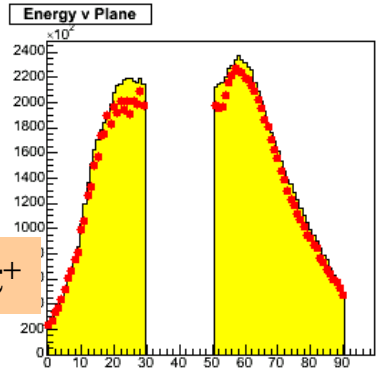
Calorimetry

Felix Sefkow illustrated needs of beams of different particles in wide interval of energies of ≈ 1-100 GeV

10 000 particles, compare Geant 3 (histo) vs. Geant 4 (points)

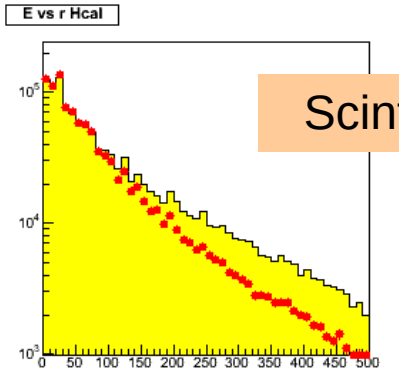
longitud. (ECAL+HCAL)

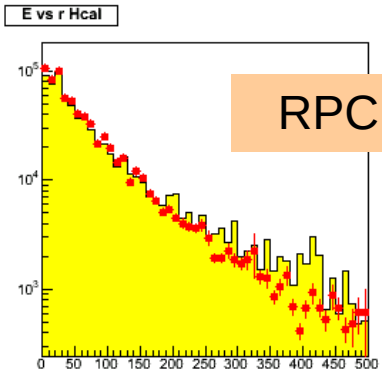




(study by D.Ward)

transverse in HCAL





5 GeV π^+

- **differences vary with energy, particle type, detector material,…**

Calorimetry

More requitements on beams, infrastructure, test beam time, etc.:

- energy spread <2%
- rate ~1kHz (<100 Hz for RPCs)
- Electrons and photons, pions and protons, muons
- tracking (need ~1mm: wire chambers or Si telescope)
- particle ID (Cerenkov)
- infrastructure (crane, cooling, gas, computing & network)
- space (6m wide)
- magnet? (4T @ DESY, cosmics only, for small ECAL or RPCs)

- several phases of running time
- $O(10^2)$ configurations * $O(10^4)$ events * $O(10^2)$ bins = 10^8 events = 1-10 days running time = several weeks of real time each

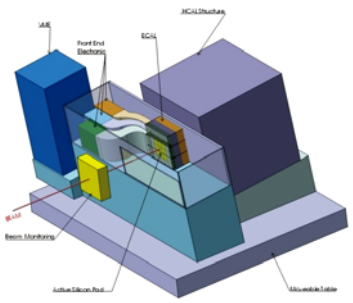
Calorimetry

Plans in Asia, US and Europe:

- Asian groups were planning to finalize ECAL tests in spring 2004
- report at this conference
- further plans being discussed

- US groups plan to start with ECAL options at SLAC in 2005,
- all HCAL options till 2008

- Forward calorimeter groups plan
  - high intensity e beam at Frascati 2005-06
  - high energy e beam > 2008 (CERN?)



- CALICE prepares beam test series in 2005-06
- ECAL and HCAL together, different options
  - SiW ECAL
  - HCAL with scintillators, RPCs or GEMs

Muon Detector

Marcello Piccolo collected information about muon detector test beam plans:

- Test beams for muons – concerted effort with calorimeters:
  - Muon detector should be considered in some extent as a part of the calorimetric system.
- Objectives: Muons – Check timing, pedestals, pulse height, etc. for minimum ionizing particles. Measure efficiencies, (u,v) tracking, multiple hit capability, etc.

  Hadrons: Measure calorimetry capabilities with other calorimeters upstream (utility as a shower tail-catcher).
- Beam Conditions: E = few – 100 GeV; e, π, p, μ. Beam rate < 10^6 Hz.
- DAQ: FE will be custom development with FPGA logic and digitization, using CAMAC and LINUX software debugged in cosmic ray running.
- Dates: Earliest is probably late 2005.
- Where: Fermilab – Mtest.

Test Beam Facilities in Asia

Yasuhiro Sugimoto informed about test beam facilities in Asia. His Summary:

KEK PS	0.2 – 4 GeV	e, μ, π, K, p, p-bar	– Summer 2005
KEK Linac	0.1 – 4 GeV (➔8 GeV?)	e, μ(?), π, K, p, p-bar(?)	Fall 2006 –
IHEP-Beijing	0.2 – 1.2 GeV	e, π, p	Available now Users wellcome
J-PARC	0.2 – 2 GeV (➔10 GeV?)	e, μ, π, K, p, p-bar	2008 – Pressure wellcome
Tohoku STB	0.06 – 1.2 GeV	e, tagged-γ	Available now Users wellcome

Status of Fermilab Test Beam

Erik Ramberg reported about the status of the Fermilab Testbeam. His Summary:

- Several experiments have taken data or are currently doing so. Other experiments will be installing in the summer.
- 120 GeV, 66 GeV and 33 GeV beams have been delivered. Both fast extraction and slow spill have been tested.
- A low-rate, broad-band muon beam has been established.
- Tracking and DAQ near completion

Summary of Operational Characteristics:

- Either fast spill (0.4-1.6 msec) or slow spill (.02-.6 sec)
- Typical operation of 1 spill/minute. Can request higher rates.
- ~50 K protons/spill at 120 GeV
- ~3 K secondary beam/spill at 66 GeV
- Lower momenta will give lower rates
- Muon filters decrease beam by ~10-3
- Beam spot sizes of ~3 mm square at 120 GeV

Relevant beam line facilities are available: Cerenkov counters, x&y silicon strip detectors, MWPC and corresponding DAQ, cranes, etc.

Test Beams at CERN

Michael Hauschild's report :

PS East Hall (Meyrin site, Switzerland)

- **4 test beam lines (T7, T9, T10, T11), 1 – 10,15,7,3.5 GeV/c**

SPS West Area (Meyrin site, Switzerland)

- **2 test beam lines (X5, X7), 5 – 250 GeV/c**

SPS North Area (Prevessin site, France)

- **4 test beam lines (H2, H4, H6, H8), 10(2) – 400(450) GeV/c**

Irradiation facilities

- **Gamma Irradiation Facility (GIF), SPS West Area**
  - **Cs137 source, 662 keV photons, 720 GBq + parasitic muons from X5 test beam**
- **Proton/Neutron irradiation facilities, PS East Hall**
  - **24 GeV/c primary protons from PS, 2 * 2 cm2 beam spot, 2.5 * 1011 protons/spill**
  - **neutrons from proton beam dump, spectrum similar to LHC environment**

Test Beams at CERN

PS East Hall beam characteristics:

Momentum range:

min. 1 GeV/c (all beams)

max. 3.5 GeV/c (T11), 7 GeV/c (T10), 10 GeV/c (T7), 15 GeV/c (T9)

Spill structure from PS:

400 ms spill length, typical 2 spills every 16.8 s, more on request

Particle type and intensity: electrons (lower momenta), hadrons, muons

Max. 1-2 * 10^6 particles/spill, typically 103 – 104 used

SPS North Area:

H2, H4 and H8 beams

10 - 400 GeV/c, up to 10^8 particles/spill (π+)

H4 can be set-up for very clean electron beam (up to ~300 GeV/c)

H2 and H8 also have low energy tertiary beams (2 – 10 GeV/c)

H6 beam: 10 – 205 GeV/c, up to 10^8 particles/spill (π+)

Test Beams at CERN

Time Schedule

Beam requests should be submitted until October of the foregoing year

2004

- **PS East Hall and SPS West + North Area running from May – October**
- **end of 2004: SPS West Area is closing and will be dismantled**

2005

- **NO BEAM at PS and SPS**

2006

- **PS East Hall + SPS North Area running (?) (under revision...)**

2007

- **LHC start, PS East Hall + SPS North Area running**

Worldwide Linear Collider Test Beam Report

Report on Worldwide Linear Collider Test Beam Effort

Worldwide LC Test Beam Working Group

Abstract

This report summarizes the needs for the test beam facilities to satisfy current beam instrumentation and detector R&D deve[illegible]forts in the world-wide LC community. This document is to provide the summar[illegible]ectors of test beam facilities to anticipate and prepare f[illegible]e needs. This document sho[illegible]ollider detector R&D groups, organize ourselves for a concerted effort of all different test beam activities in

Draft

http://www-lc.fnal.gov/lc_testbeams/tbpage.html

Test Beam discussion list:

lc-testbeam@fnal.gov

Please subscribe to the list by sending an e-mail to listserv@fnal.gov a subjectless message with the following in the body

subscribe lc-testbeam you@e-mail.add firstname lastname

Conclusions

- ❖ The worldwide detector R&Ds are ramping up their efforts
- ❖ The significant rise of Test beam activities is expected in 2006 and after

- ❖ To facilitate these efforts the world wide test beam discussion list was established
- ❖ The document mapping TB needs and possibilities is under preparation

Calorimetry

CALICE near and medium term plans:

- start with ECAL end 2004 at DESY
- then integrate (scintillator) HCAL with ECAL

- goal: move both to hadron beam in 2005
  - and high energy e beam, …
- vary readout options: 2006 +
- possible scenario:

Year	Calorimeter	Beam time request
2005	ECAL (CALICE)	3 weeks (electrons)
	Analog HCAL	4 weeks (hadrons, muons)
2006	Digital HCAL (RPCs)	4 weeks (hadrons, muons)
	ECAL + Analog HCAL + Tail catcher	5 weeks (hadrons)
	ECAL + Digital HCAL + Tail catcher	5 weeks (hadrons)
	ECAL (US)	3 weeks (electrons)
2007	ECAL + Analog HCAL + Tail catcher	5 weeks (hadrons)
	ECAL + Digital HCAL + Tail catcher	5 weeks (hadrons)
	Digital HCAL (different active media)	8 weeks (hadrons, muons)
2008	ECAL + Digital HCAL + Tail catcher	5 weeks (hadrons, muons)