Documents, Beams and the Americans

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Documents

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Contributions by many members

of the

Worldwide Calorimeter Test Beam Working Group

(WWCTBWG)

Submitted to FNAL management

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Fermilab FNAL-TM-2291

International Linear Collider Calorimeter/Muon Detector Test Beam Program
(A Planning Document for Use of Meson Test Beam Facility at Fermilab)

February 22, 2005

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For the ILC Calorimeter Test Beam Group

Abstract

The linear collider requires a detector with excellent performance to fully exploit its physics potential. In particular, requirements from the measurement of hadronic jet energies indicate a goal of developing the calorimeter with an unprecedented jet energy resolution of 30%/√E or better. In order to meet this challenge, novel technologies and reconstruction techniques are being developed, which need to be tested with particle beams. The recent decision by the International Technology Recommendation Panel (ITRP) concerning the linear collider accelerator technology imposes a time scale of at most a few years for the basic detector design choices. A vigorous test beam program over the next few years is necessary to provide a solid basis for these decisions. In this regard, the International Linear Collider Calorimeter and Muon Detector Test Beam Group submit this planning document to Fermilab. The main goals of the test beam program outlined in this document are to evaluate the different choices of technologies proposed for the calorimeter and to understand, validate and improve the Monte Carlo modeling and simulation of hadronic showers. This document contains a description of fourteen distinct calorimeter and muon detector/tail-catcher groups and their requirements for specific test beam resources. This planning document also lays out time scales and institutional responsibilities for the proposed test beam program. It provides plans for the users of the Fermilab Meson Test Beam Facility, and needs for upgrades to particle energy ranges and intensities, and associated engineering and computing support services.

Planning document

25 pages

Provides overview of testbeam plans for the LC calorimeter

To be followed by concise MoUs for individual tests

Abstract

Includes 11 projects

Calorimeter	Project	Lead institution
ECAL	Silicon-Tungsten (CALICE)	LLR
	Silicon-Tungsten (US)	SLAC, Oregon
	Scintillator-Tungsten	Shinshu
	Scintillator-Tungsten	Colorado
	Scintillator-Silicon-Tungsten	Kansas
	Scintillator-Silicon-Lead	Padova
HCAL	Scintillator-Steel	DESY
	RPC-Steel	ITEP, ANL
	GEM-Steel	UTA
Muon-detectors/tail catcher	Scintillator-Steel	DESY/FNAL/NIU
	RPC-Steel	Frascati

28 institutions from 3 regions

Timetable

	2005 B	2006 A	2006 B	2007 A	2007 B	2008 A
CALICE ECAL	x					
Other ECALs			x	x		
AnalogHCAL	x	x	x			
Digital HCALs			x	x	x	
Combined tests	x	x	x	x	x	x

Generic beam requests

Particle	Energy range
Electrons	3 – 20 GeV → 1 – 20 GeV
Pions	3 – 66 GeV → 1 – 66 GeV
Protons	3 – 66 GeV, 120 GeV
Muons	3 – 20 GeV, momentum selected
Muons	Not momentum selected

Both polarities
Rates in part not to exceed 100 Hz

Duty cycle

Limits in DAQ (CALICE ECAL)
Recharge time of RPCs

} Limit rates to 100 Hz

Request total of 10^8 events

Different particles, energies, angles, configurations

Time in test beam = (Number of events)/Rate*(duty cycle)

Assume 1% duty cycle

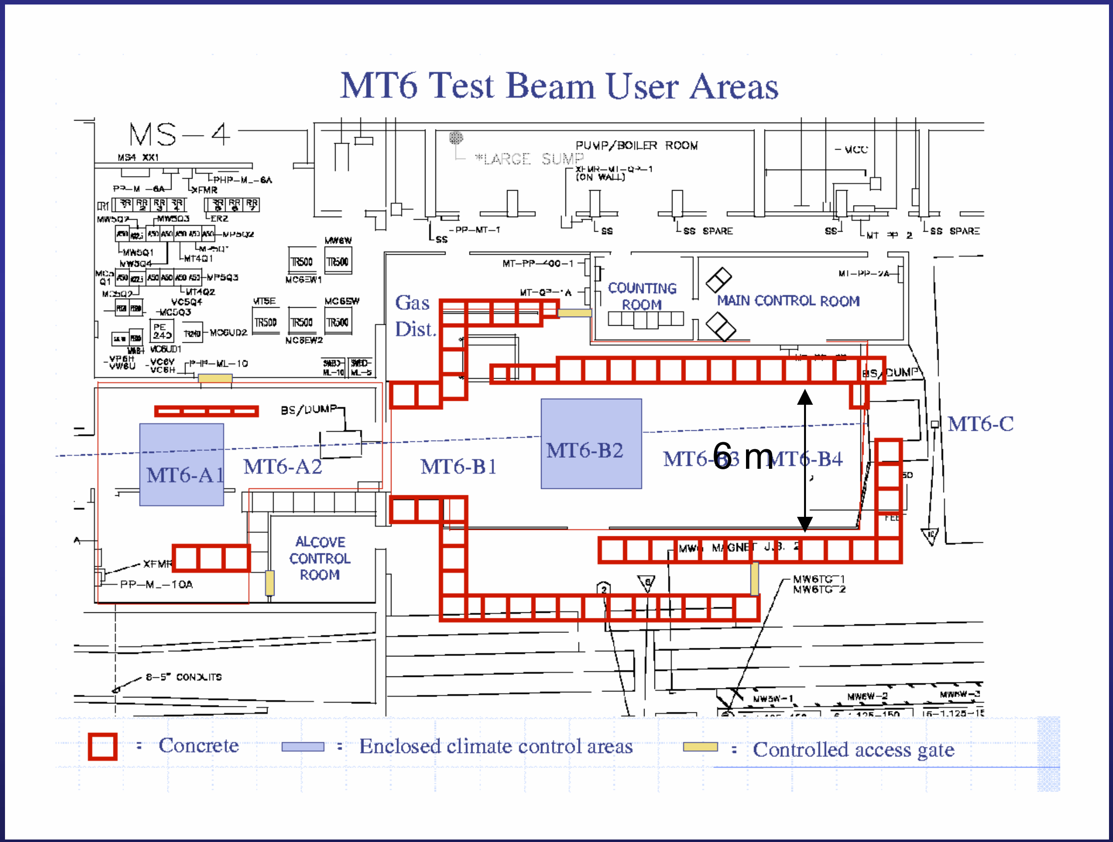
Time in test beam $\rightarrow 10^8$ s or 3 years corresponding to >10 years of data taking

Minimum duty cycle of 5% requested

Beams

Report from FNAL
Based on talk by E Ramberg from March 14, 2005
See http://nicadd.niu.edu/calice/ for more details

Meson Test Beam Facility



Beam from Main Injector

Proton Mode

- 120 GeV protons
- 200,000 p/spill maximum
- Low rates possible

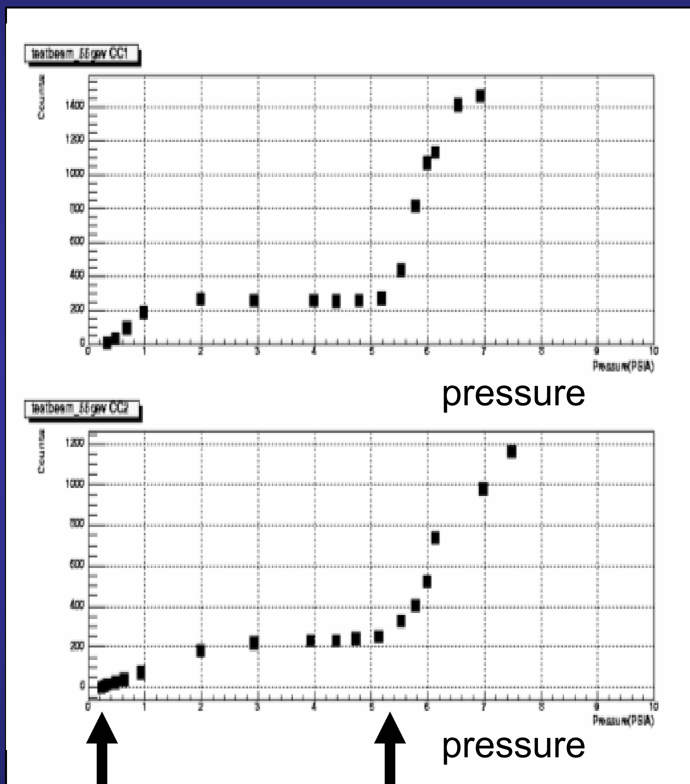
Secondary mode

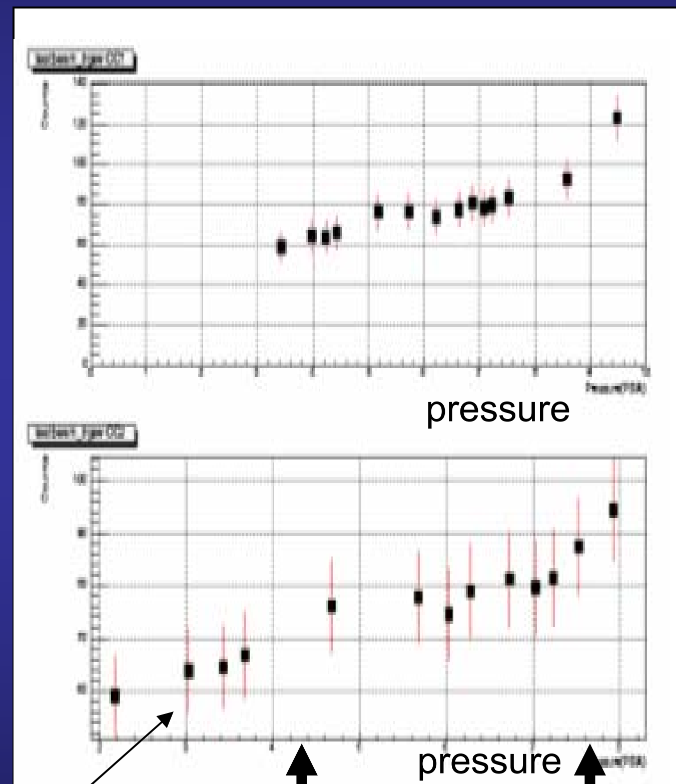
- Target upstreams
- Secondary particles w/ p<66 GeV/c
- 40,000 particles/spill maximum
- Lowest stable operation at 8 GeV/c

Measurements with Čerenkov counters

66 GeV/c

8 GeV/c





π threshold

p threshold

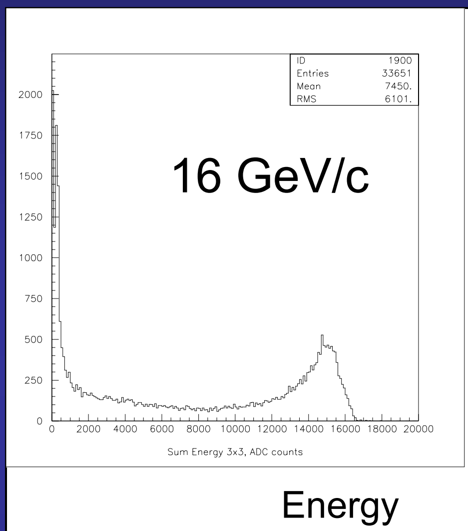
electrons

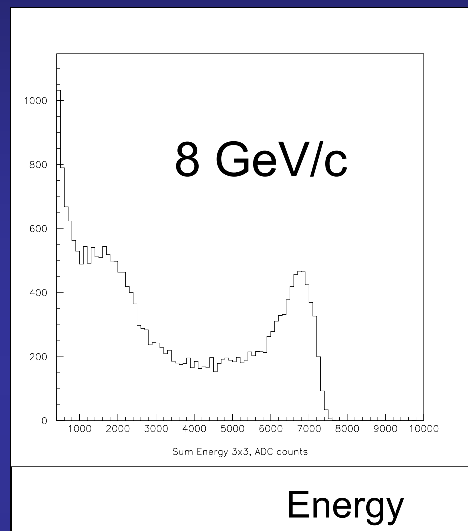
μ threshold

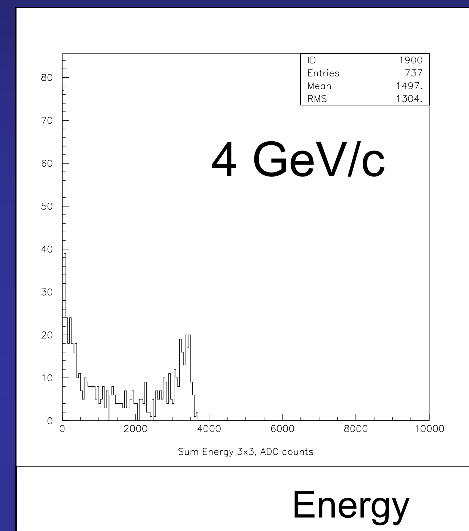
π threshold

Electrons at MBTF

Measurement with BTeV EMCAL prototype







2% electrons
~90/spill

10% electrons
~40/spill

25% electrons
~10-20/spill

Significant material (air, counters) in beam line
Needs vacuum (44 feet), helium bag

Easily factor of 2 improvement

Other limitations

Duty cycle

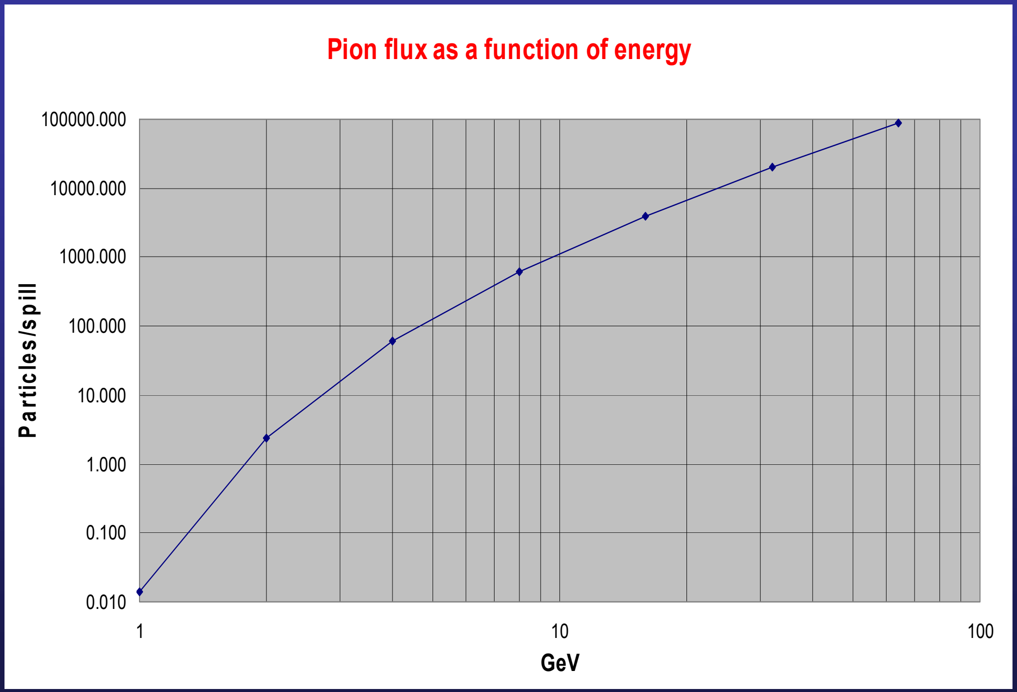
Past operation: 10 spills of 0.6 s per minute ⇨ **10%**

From April on: 1 spill of 4.0 s per 2 minute ⇨ **3%**

Low energy π

Length of beam line (400 m) reduces π flux at momenta below 4 GeV/c

Need to investigate possibility to modify beam line for higher rates (safety issue)



The Americans

Overview of American testbeam needs for calorimetry

Project	Institutions	Earliest test beam needed
Silicon-Tungsten ECAL	SLAC, Oregon, BNL	1/2007
Scintillator-Tungsten ECAL	Colorado	
GEM-Steel DHCAL	FNAL,UTA, Washington	4/2007
RPC-Steel DHCAL	ANL Boston, Chicago, FNAL, Iowa	1/2007
Dual readout HCAL	Iowa State,Texas Tech, UC San Diego	
Muon-tracker/tail catcher	FNAL, NIU	3/2006