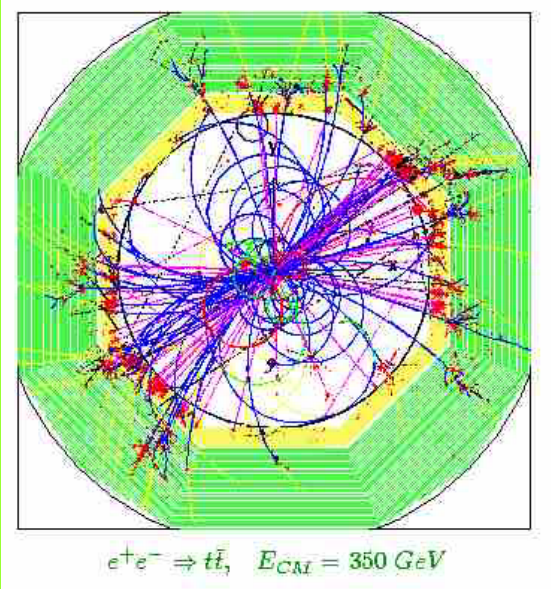
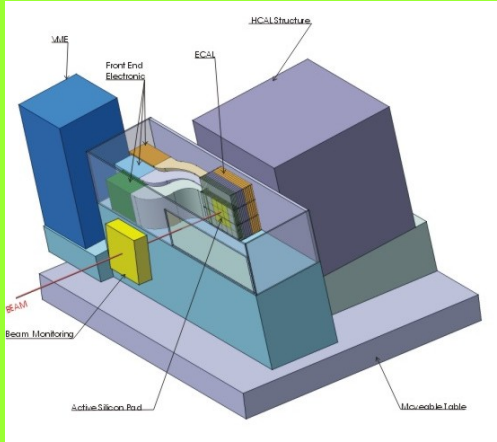
Test-beam Facilities at
DESY, Frascati and Serpukhov

What do we want to measure ?



1. Calorimetric response for all particle types
   --to test various ECAL/HCAL options and
   --get large quantities of data to
   - study optimal cluster reconstruction with data,
   - also at different incidence angles and
   - tune the simulation programs
   --statistics: 10^6 per setting, ~10^2 settings ?
2. Clustering studies in showers of individual particles
3. Jet resolution and separation studies,
   to test/tune particle flow reconstruction
   - different combinations of e, h, γ, μ combined to individual jet
   -2 or more jets overlayed with small opening angles $\geq$ 6 mrad
4. Sensitivity to detection/measurement of "Missing Energy"

What we ask for…



to consider for test beam to choose:

Criteria:

- Availability! *Need several month/year in 2005, 2006, ….?*
- Large Area (6x5 m^2), *for beam triggers, calorimeters on moving table, TC*
- Sufficient beam trigger rate, *~10^6 events/day ?*
- Cerenkov beam counters, *for selection of e, p, k, P ?*
- Hadron energy range 1 - ~80 GeV ?
- Electron energy range 1 - ~10 GeV ?
- Large tail catcher (>3 λ), available from NIU
- Wide area μ-beam (~1m^2), *for cell/tile calibration with MIPs*
- Local infra structure, *support in machining, installation, communications,…*
- Fast "global network" connections
- Remote detector control for experts from home-lab
- Acceptable visiting conditions (re-enterable visa etc.) for all TB collaborators !!!

DESY, Electrons only

Synchrotron DESY II

- accelerates/decelerates one bunch of $2*10^{10}$ electrons (resp $6*10^{9}$ positrons)
- frequency of 12.5 Hz up to 7 GeV (for HERA via PETRA).
- The revolution frequency is 1 MHz,
- the RF frequency 500 MHz, and thus
- the bunch length around 30 ps
- DESY II offers 3 test beams…
- Electrons or positrons, 1 to 6.5 GeV,
- also 2 e in 30 psec bunch possible (>>> ~12 GeV)

Possible use:

-- Electromagnetic energy resolution

-- shower width studies and

-- γ-cluster separation

For ECAL studies mainly,

also used for sub-volume of Tile-HCAL >> minical >>

Test beams at DESY

Beam Generation

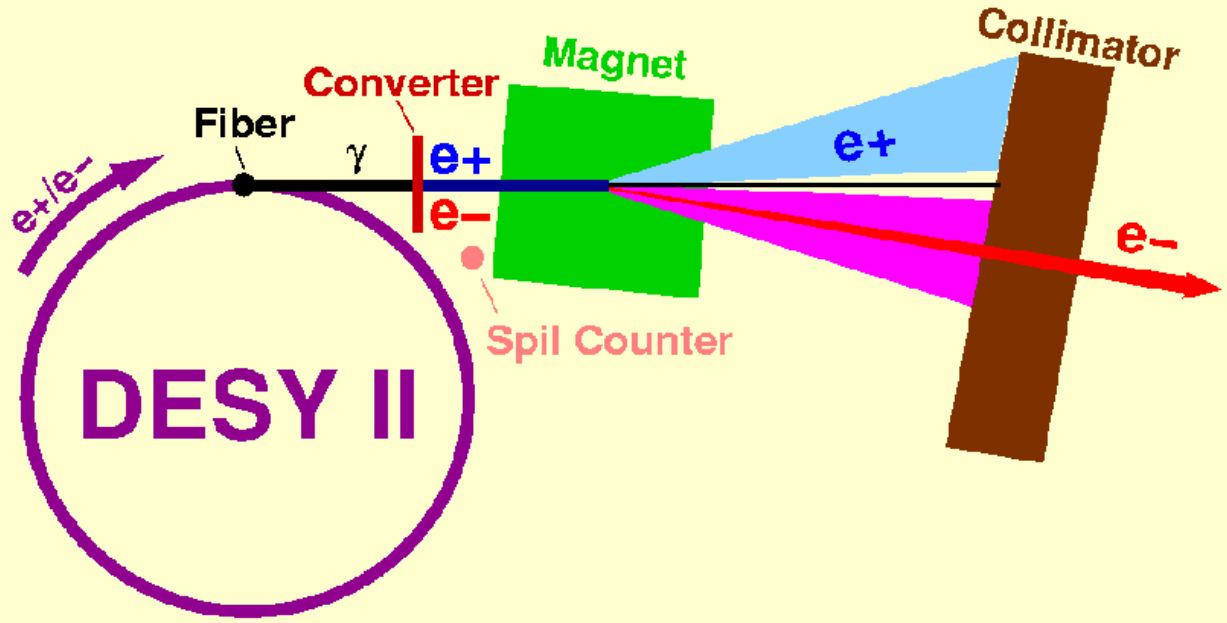


Fig. 1: Schematic Layout of a Test Beam at DESY (ps)

A bremsstrahlung beam is generated by a carbon fiber in the circulating beam of the electron/positron synchrotron DESY II. The photons are converted to electron/positron pairs with a metal plate. Then the beam is spread out into a horizontal fan with a dipole magnet. Like a slice, the final beam is cut out of this fan with a collimator.

DESY test beams, secondary beams

Rates

In table 1 you can find a rough estimate of the rates.

The rates are influenced by many parameters. In practice, the maximum rate around 1 kHz (3 GeV, 3mm Cu convert, Collimator ca. 5mm x 5mm, DESY II maximum energy at 7 GeV, no beam extraction, no DESY III ramp).

Rates	Target	
Energy	3mm Cu	1mm Cu
1 GeV	~330Hz	~220Hz
2 GeV	~500Hz	~330Hz
3 GeV	~1000Hz	~660Hz
5 GeV	~500Hz	~330Hz
6 GeV	~250Hz	~160Hz

More info at:
http://desyntwww.desy.de/~testbeam/ and Norbert.Meyners@desy.de

DESY, Strahl 21

Minical, 117 tiles

Last collimator

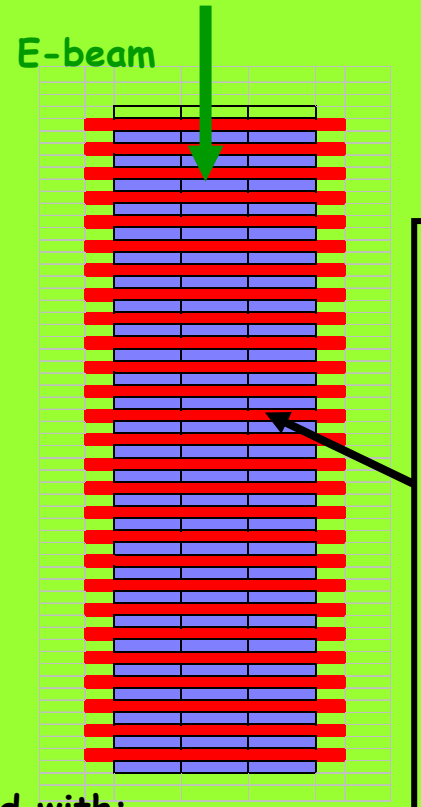
DESY, Strahl 21

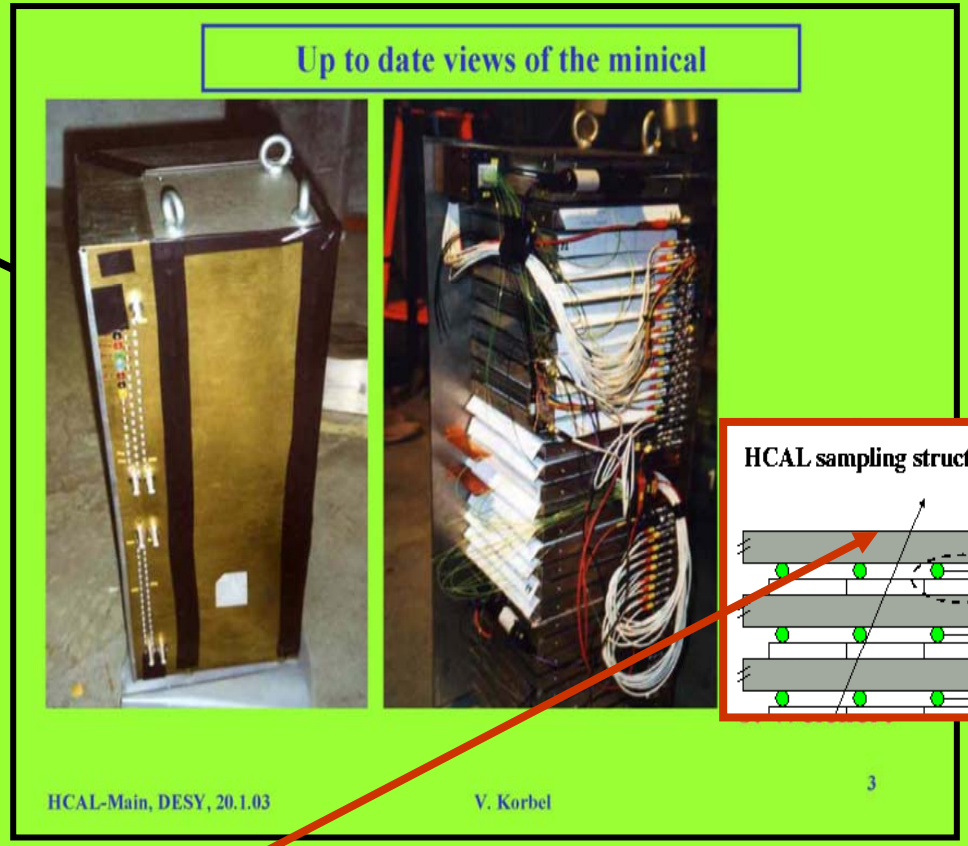
Minical, 117 tiles

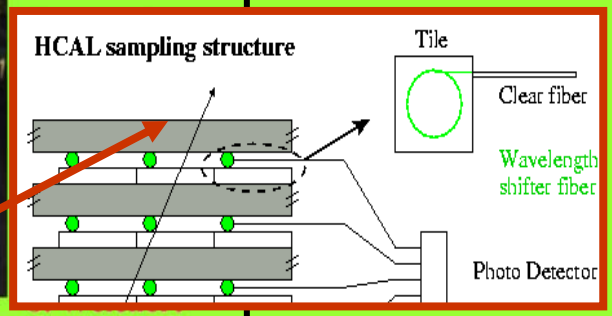
Trigger counter system

2 moveable platforms, 1 to

DESY, CALICE, minical array



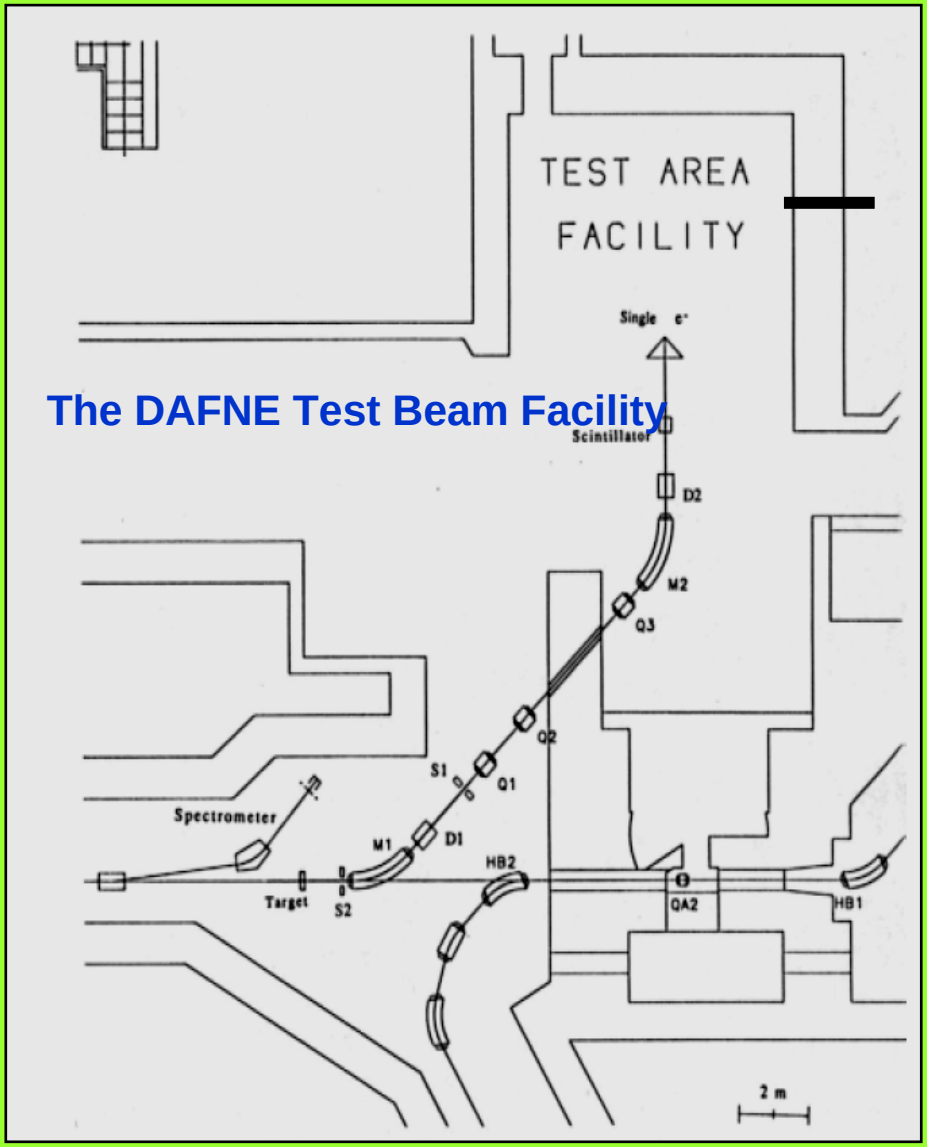




Assembled with:

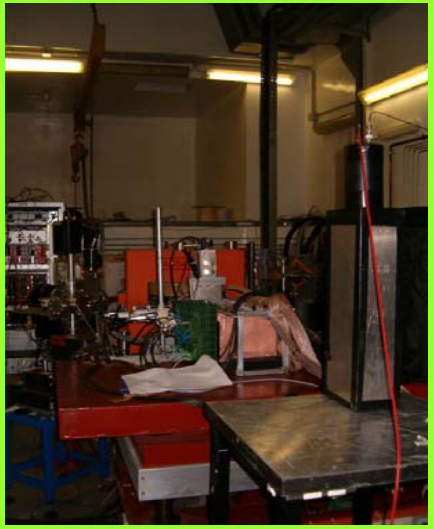
- 13 scintillator layers of 9 tiles each in cassettes,
- with 117 scintillator tiles and
- 117 Si-PM photo-detectors: 1 tile/Si-PM
- 14 scintillator layers, each 9 tiles
- 36 photodetectors:
  - APD's or
  - 3 MA-PMs, 16 pix each,
  - 3 tiles/pixel

Test beams at Frascati



The DAFNE Test Beam Facility

Energy Range 25-750 MeV e^-/e^+
Max. Repetition Rate 50 Hz
Pulse Duration 1-10 ns
Current/pulse 1 to 10^{10} particles
Allowed Current 10^3 pulses/sec
Test area ~6,5 x 8 m^2

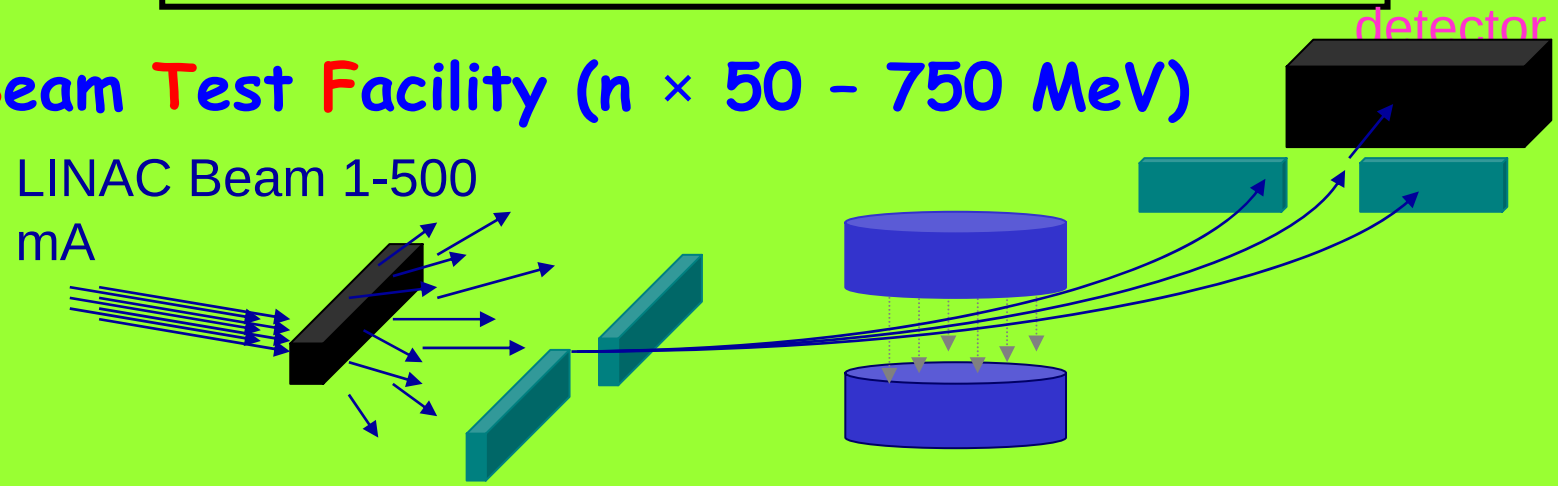


More info:

- http://www.lnf.infn.it/acceleratori/btf
- Nucl Instrum. Meth. A515 (2003) 516 and
- Stefano.Miscetti@lnf.infn.it

Test beams at Frascati

Beam Test Facility (n × 50 – 750 MeV)



Paolo Chechia, LCcal

it is possible to tune the multiplicity...

Proposal for a TESLA beam test zone at IHEP (Protvino)

Vladimir Obraztsov
Institute for High Energy Physics Protvino Moscow region, Russia
Presented in ECFA-DESY workshop, Prague, 2002

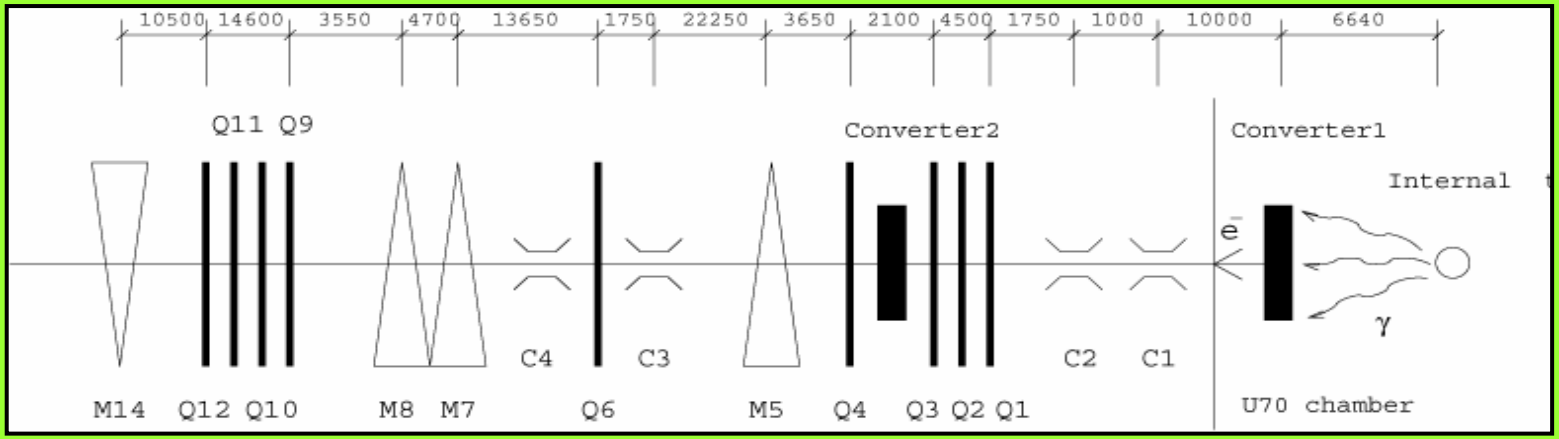
IHEP accelerator parameters:

- accelerator is a 70 GeV proton synchrotron
- intensity ~ $1 \cdot 10^{13}$ p/cycle
- cycle time - 10 s,
- spill time - 1.8 s
- RF structure: bunch length 40 ns, bunch spacing 160 ns
- beams are extracted protons from internal targets
- more info:

ammosov@mail.desy.de,
obraztso@oka.ihep.su

Protvino, beam line parameters

Electron beam

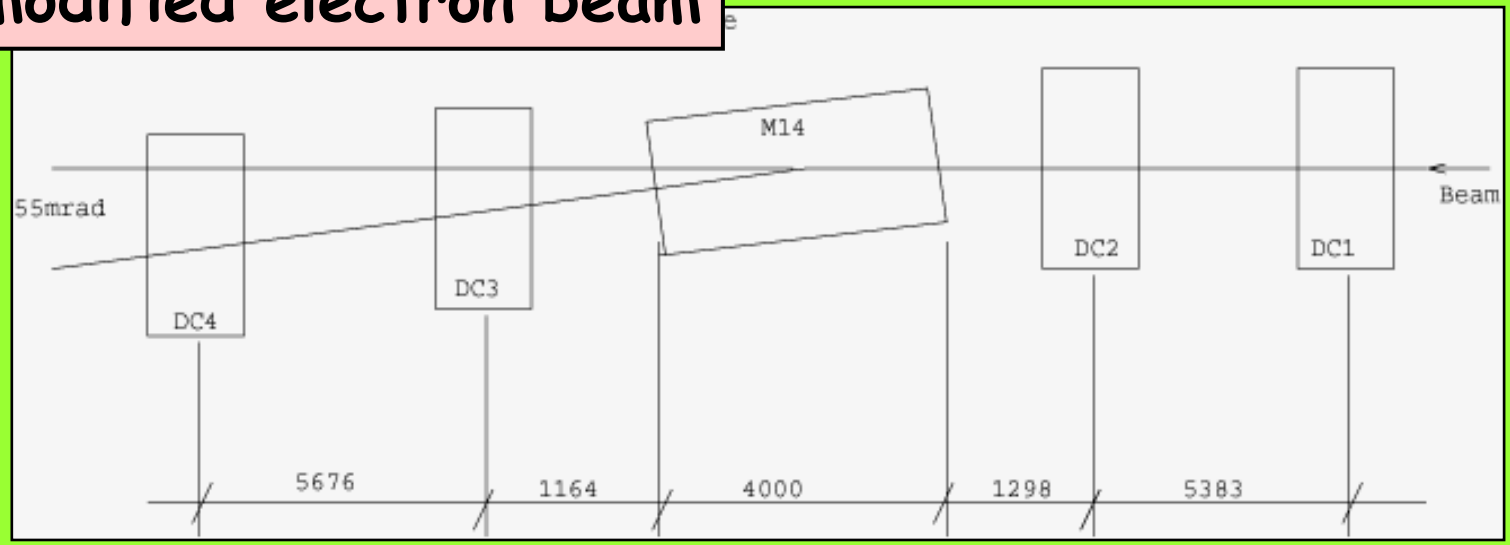


- Beam line #2B from internal target is used
- Negative beam
- Momentum range (1-45) GeV/c
- Beam energy spread to large,
  but ok for TESLA ECAL requirements?
- Improvement of beam momentum definition
- measurement by
  tagging system possible >>>>>

Energy, GeV	Beam resol., %	ECAL resol., %
1	4.3	11.0
2	5.5	7.8
5	5.6	4.9
10	3.8	3.5
27	1.2	2.1
45	1.0	1.6

Protvino, beam line parameters

modified electron beam



--Beam tagging system to improve resolution (BTeV PbWO4 coll., hep-ex/0208012)

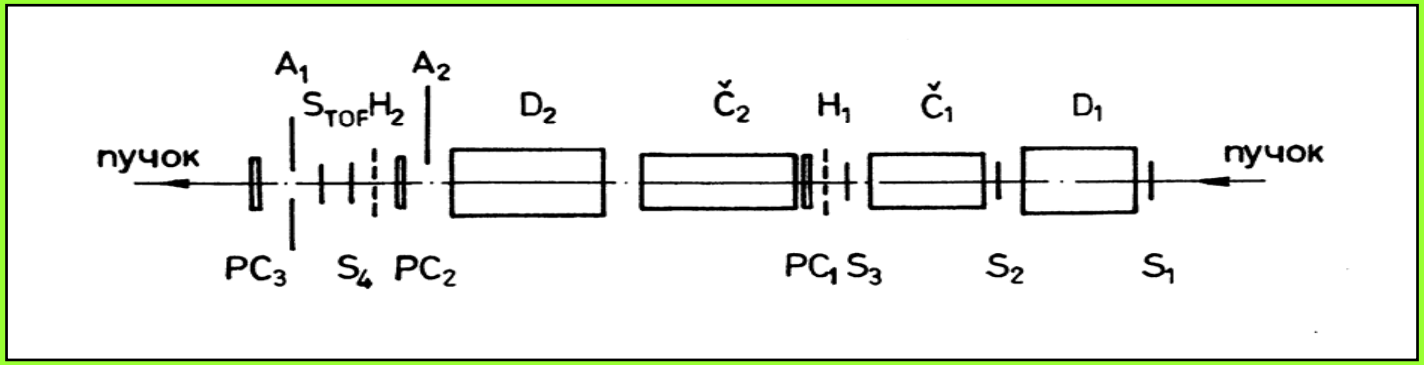
>>>

- Beam spot, ∅ ~ 3 cm

Energy, GeV	Beam resol., %	ECAL resol., %	BTS resol., %
1	4.3	11.0	2.05
2	5.5	7.8	1.03
5	5.6	4.9	0.43
10	3.8	3.5	0.24
27	1.2	2.1	0.15
45	1.0	1.6	0.13

Protvino, beam set-up

Beam detector system

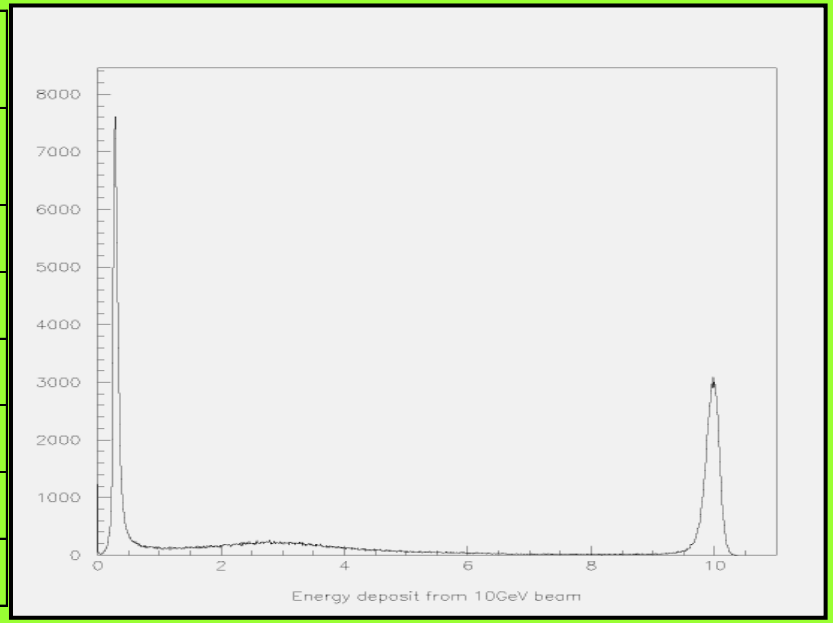


$S_1 \div S_4$, A_1 , A_2 - scintillation counters
PC_1 , PC_2 - proportional chambers
H_1 , H_2 - scintillation hodoscopes
C_1 , C_2 - threshold cherenkov counters
D_1 , D_2 - differential cherenkov counters
S_{TOF} - time-of-flight scintillation counter

Protvino, beam line parameters

Electron and hadron beam

Energy, GeV	Intensity in spill on 10^{12} pot	Content		
		e , %	μ , %	h , %
1	$4 \cdot 10^2$	82	10	5
2	$1 \cdot 10^3$	77	15	8
5	$2 \cdot 10^3$	50	32	18
10	$5 \cdot 10^3$	34	35	30
27	$4 \cdot 10^4$	77	9	13
45	$2 \cdot 10^4$	91	4	5



from PbWO4 array

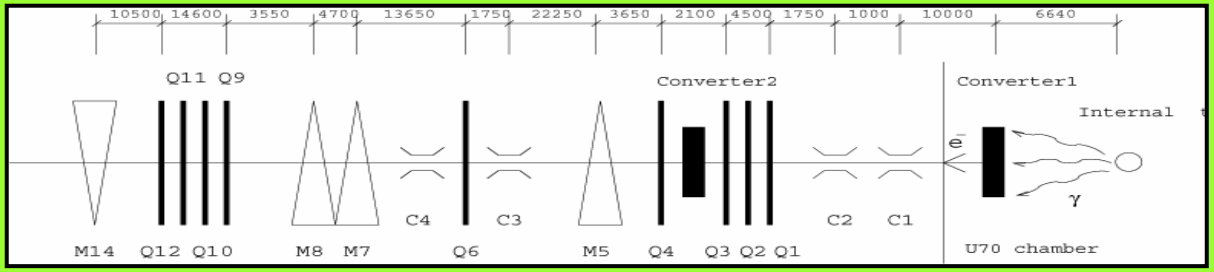
Admixtures of h^- and μ^-

allow to measure calorimetric response simultaneously

for e^- , h^- and μ^- using Cerenkov counters

Protvino, Beam line parameters

Special enriched hadron beam by modified converter area



Energy, GeV	Intensity in spill on 10^{12} pot
33	$1 \cdot 10^6$
40	$3 \cdot 10^6$
55	$2 \cdot 10^5$

- Neg. beam, momentum range 33-55 GeV/c
- Intensity for $\Delta p/p = \pm 1\%$
- Beam spot, ∅ ~ 2.5 cm
- Beam composition:

π^-	96.4 %
μ^-	1.0 %
k^-	2.3 %
p^-	0.3 %

All particles available:

Particle type	Electron beam range, GeV/c	Hadron beam range, GeV/c
e^-	1- 45	-
h^-	1- 45	33 - 55
μ^-	1- 45	33 - 55

Protvino test beams, conclusions:

Existing

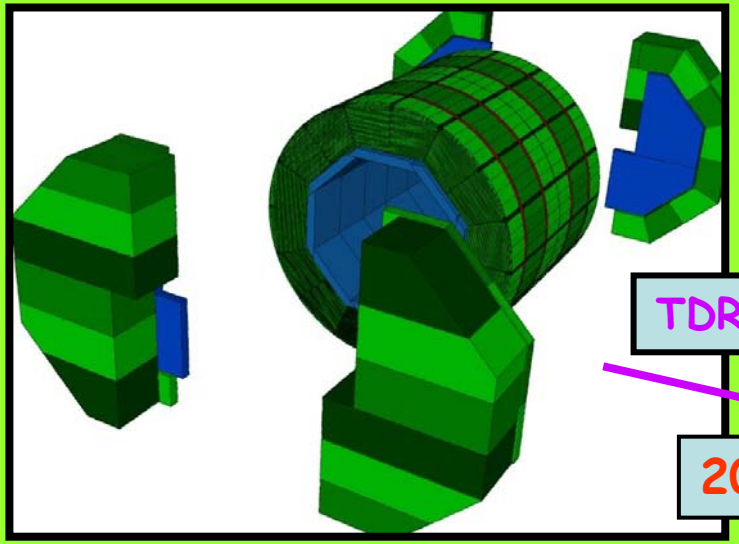
- beam line can be set up for electrons 1-45 GeV
- e-beam tagging system exists
- same beam line alternative for hadrons, 33-55 GV
- >> all tests can be done in 1 beam line
- beam set up ready in late 2004 ?
- good secondary particle identification with 4 Cerenkov counters
- all infrastructure available
- running costs for ~360 hours in 2005 and 2006 would be contribution from IHEP ! *(certainly more time needed)*

- large magnet available, ECAL would fit in…

My summary to conclude:

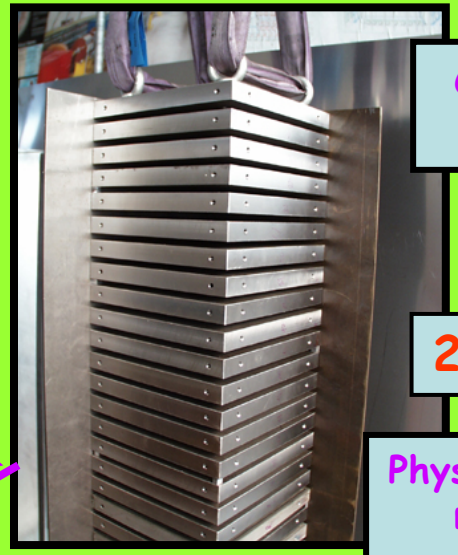
laboratory	DESY	Frascati	Serpuchov
particles	e^+, e^-	e^+, e^-	e,γ; π, k, p; μ
energie, electrons	1-6.5; (<12) GeV	20-750 MeV	1-45 GeV
energies, hadrons	-	-	1-45 GeV, 33-55 GeV
beam size	up to 35 x35 mm	2x2; max. 55x25mm^2	few cm^2
momentum definition	~3,1%	~1%	1, few %
beam height above ground floor	1,70 m	1,24 m	2,15 m
lateral space available (+/-x)	.+/- 2-3 m	3,8 m ?	. +/- 3 m
longitudinal space?	> 10 m	~8 m	> 10 m
beam trigger system	fingers, veto	Y	Y
crane available to move 6 to?	25 to	36 to	Y
separate counting house	several	Y	Y
e/π	no	no	see details
μ–bg for calibration/monitoring	no π's	no π's	1 m^2/ 10^6
Ethernet connections beam area	Y	Y	Y
internet, high speed	Y	Y	Y
beam, availability 2005	> 3 months/year	(6months typical)	2 months/year
beam availability 2006	> 3 months/year	(6months typical)	2 months/year
local support, experts	Y	Y	Y,?
remarks:	energy sufficient for ECAL	high intensity beam	all tests in 1 beam line
contact:	Norbert.Meyners@desy.de	Stefano.Miscetti@lnf.infn.it	obraztso@oka.ihep.su

Outlook



TDR-concept

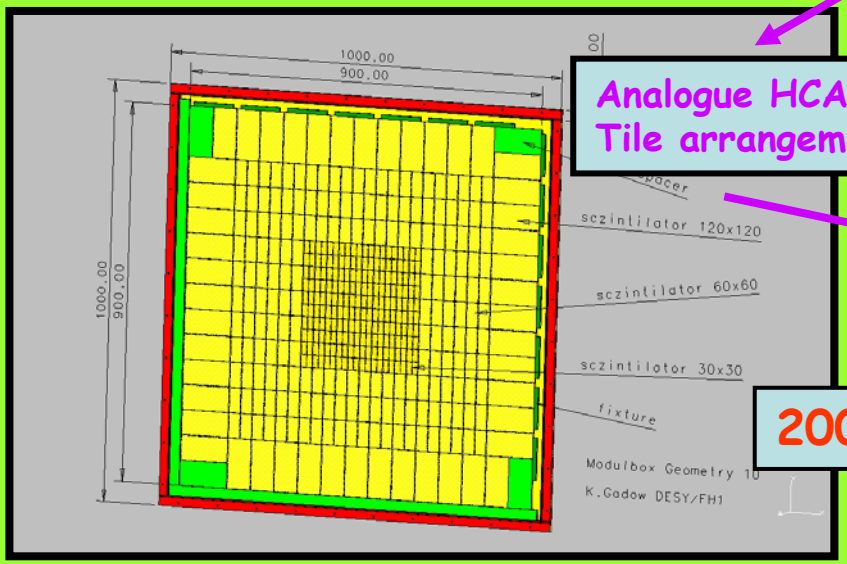
2000



CALICE minical at DESY

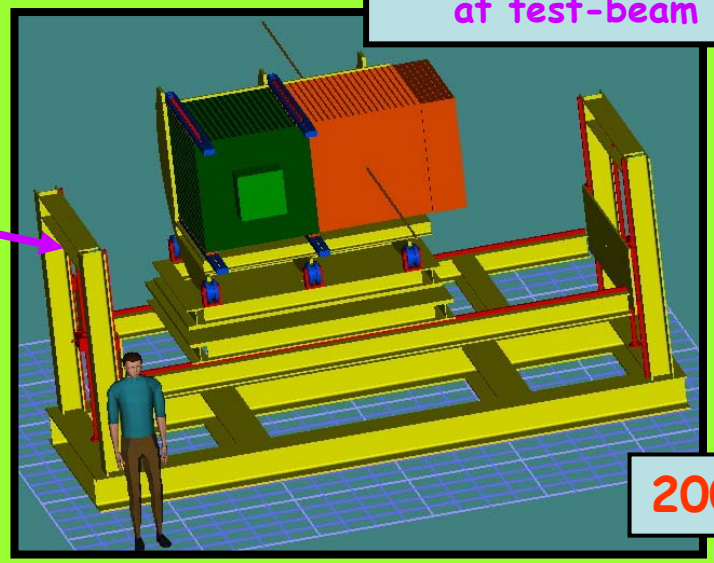
2003

Physics prototype on moving table at test-beam



Analogue HCAL Tile arrangement

2004



2005

Beam tests with calorimeter in magnet?

Improved particle flow studies needed???

Magnet available in Protvino !

--Parameters:

- 1,2 Tesla,
- 300 cm deep,
- 75 x 150 cm^2 aperture

Keep in mind!

Questions to study:

- Bending of low energy tracks,
- Increased track separation in jets
- widening of low energy clusters,
- Non vertex pointing clusters

Frascati, test beam area?

From Stefano.Miscetti@lnf.infn.it