CALICE testbeam 2008 FNAL

The installation

- Equipment ready by 25th of April – Ready to accept beam on the 29th of April

- Setup – Combined effort of DESY, Uni Heidelberg, NIU, LLR, LAL and FNAL

- Setup comprises SiW Ecal, Ahcal and TCMT plus beamline equipment

- Installation Phase: 7/4/08 – 25/4/08

- Commissioning Phase: 28/4/08 – 7/5/08

- “Physics Runs” Phase: 7/5/08 - 27/5/08

Remarks on operation

Machine:

- Day operation – Beam between ~6m and 6pm
- Testbeam delivery interrupted by "Shot Setup" for TEVATRON experiments ~2 hours during our running
- No major machine downtime
  Some failures towards the end of the running
  Compensated by two extra half days on 26/5/08 and 27/5/08 – Running 6am – 12pm
  Agreement on short notice

FERMILAB provides excellent support for our running

Detector:

- detectors running smoothly
- repairs and calibrations after evening end of beam
- noisy ECAL layers/chips (most will be recovered in analysis)

Remote operation

- Live demonstration (planned)
  Place yourself to
  http://calice-cam01.fnal.gov:8080
  http://calice-cam03.fnal.gov:8080

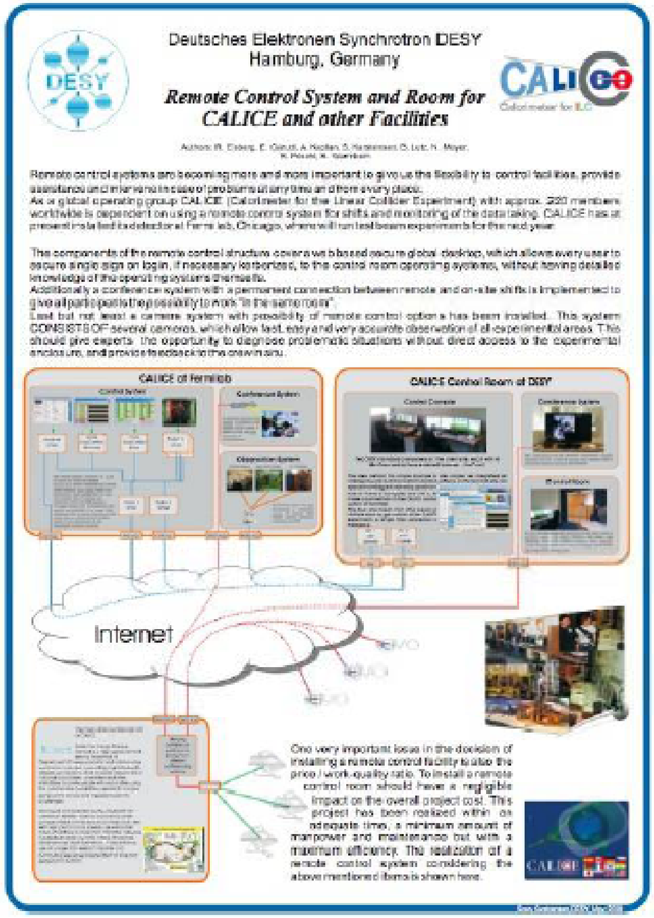
- Conferencing system

  - Daily operations meeting
  - Regular communication between calice control room at FNAL and 2nd Control room at DESY or colleagues elsewhere in the world

- Portal service (live demonstration planned)

  https://calice-portal01(2).fnal.gov

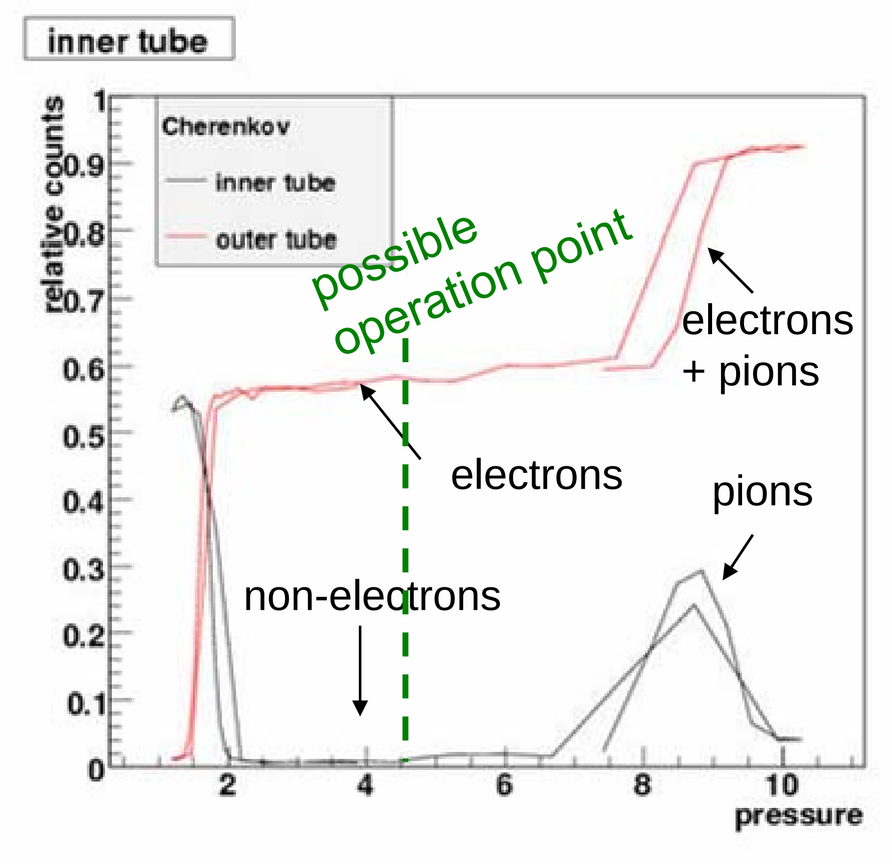
CALICE has implemented a first GDN foreseen for future ILC (and beyond) experimentation
Main responsible Sven Karstensen (DESY)

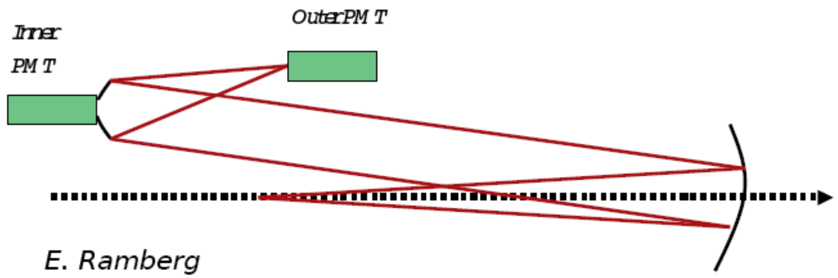


Cherenkov detector

for Ebeam < 6 GeV electron content > 50%, rapidly increasing for lower energies
➔ need to tag pion sample

differential counter with 2 diaphragm apertures: inner and outer ring, r/o via PMT





pressure scan for 10 GeV beam to determine best separation point

the scan has to be repeated for each beam energy
➔ leads different operation pressures

Trigger timing

Due to finite propagation time Trigger Signal from Cerenkov arrives ~60 ns (~10 DAQ clock ticks) after the '10x10 coincidence' –
Trigger 'working horse'

- 10x10 Trigger signal has to be delayed

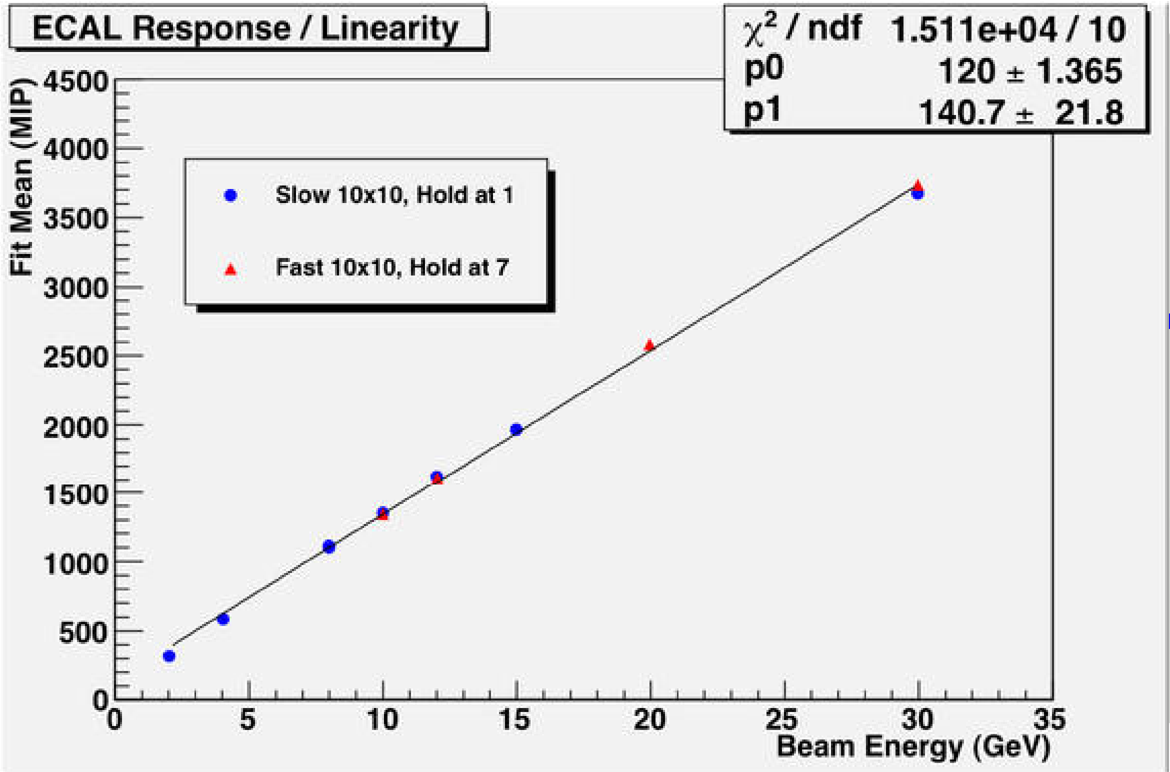
Example of Coincidences between:

10x10A 10x10B
Cerenkov
100x100B (Muon Trigger)

Trigger Mix lead to "pure" pion sample at ~200 Events/Spill
Partially large muon contamination

➔ No consequences for HCAL/TCMT
➔ ECAL is running with too short latency (~ 40ns off peak maximum)

ECAL linearity check

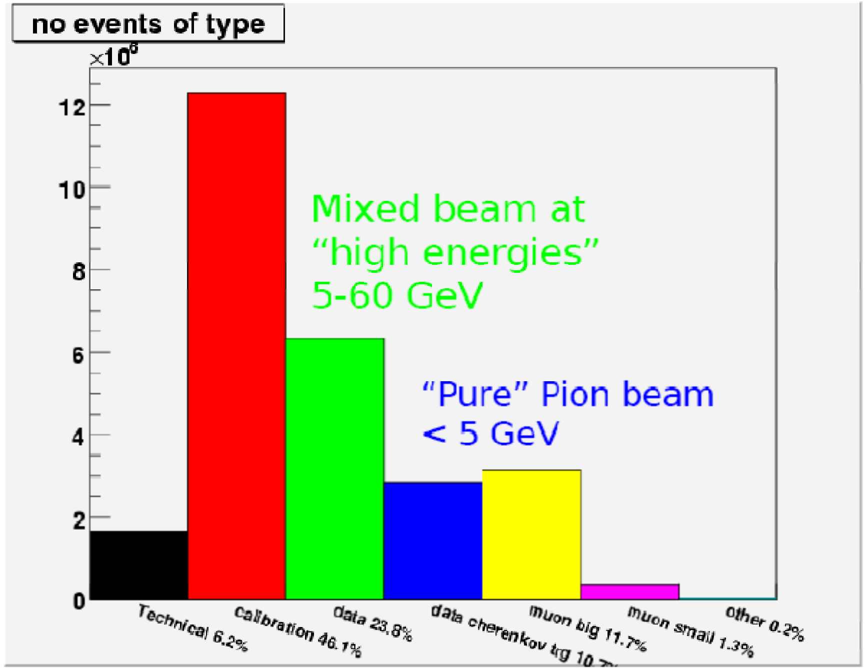


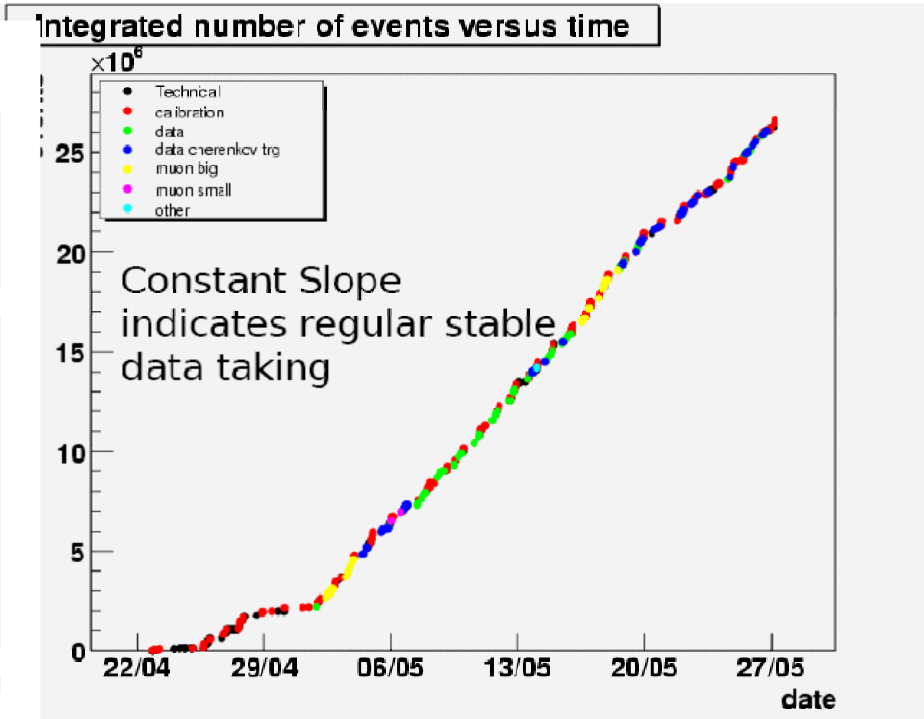
Run	Energy	Hold Value	Tigger
500138	16	7	10x10 fast
500151	10	7	10x10 fast
500164	12	7	10x10 fast
500165	20	7	10x10 fast
500167	30	7	10x10 fast
500169	30	1	10x10 slow
500185	8	1	10x10 slow
500189	4	1	10x10 slow
500191	2	1	10x10 slow
500192	8	1	10x10 slow
500196	10	1	10x10 slow
500199	12	1	10x10 slow
500200	15	1	10x10 slow

linearity in slow and fast trigger mode looks good… noise still to be checked
same calibration applied to both data sets

➔ missing crosscheck points at E<10 GeV (July program)

Data collected in May





- slower data taking than at CERN
- data sample dominated by calibration runs
- smooth data taking without problems

Data collected in May

energy	mixed beam	mainly pions
-1 GeV	500271(100k)	
+1 GeV		500481(44k) -v25(10x10 &! C2 &! 100x100)
-2 GeV	500253(17k)	500358(63k) -v31
	500191(247k)	500359(23k) -v25(10x10 &! C2 &! 100x100)
+2 GeV		500409(65k) -v25(10x10 &! C2 &! 100x100)
		500479(10k) -v25(10x10 &! C2 &! 100x100)
-3 GeV	500268(65k)	500372(20k) -v31
	500269(66k)	500376(12k) -v25(10x10 &! C2 &! C1)
	500270(187k)	
+3 GeV		500387(12k) -v31
		500390(33k) -v31
		500398(11k) -v25(10x10 &! C2 &! 100x100)
		500399(33k) -v31
-4 GeV	500189(249k)	500246(13k)
	500250(71k)	
+4 GeV		500406(61k) -v31
		500407(77k) -v25(10x10 &! C2 &! 100x100)
-6 GeV	500266(51k)	500267(55k) -v31
	500259(204k)	
+6 GeV		500410(109k) -v25(10x10 &! C2 &! 100x100)
-8 GeV	500184(140k)	500386(70k) -v27
	500192(153k)	500385(75k) -v31

low stat. samples 2-6 GeV with both negative and positive beam.

+

8-30 GeV with negative beam

+

30-60 GeV with positive beam

NOTE:
below 32 GeV beam polarity can be switched at any time above 32 GeV it requires ~1/2 day of access to the beamline

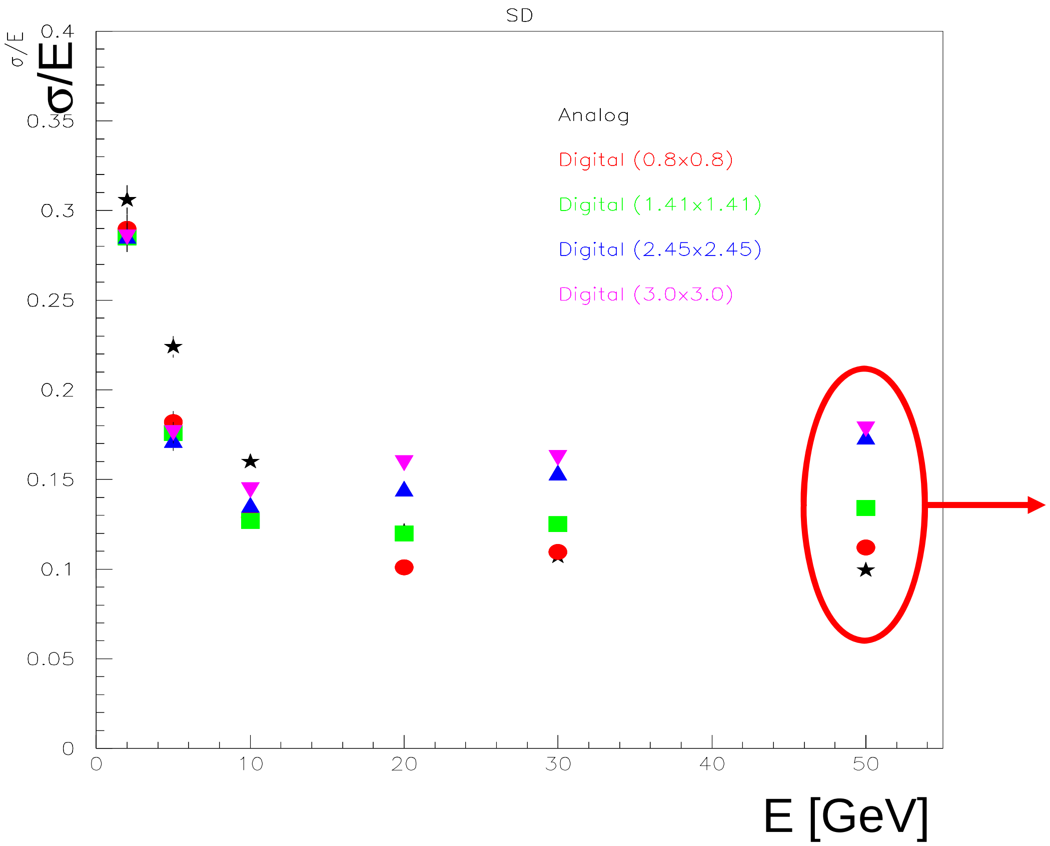
July run – main objectives

- repeat detectors calibration
- complete crosscheck sample for ECAL at low energy electron
- additional statistics to low energy pion run (0 deg. angle)
- data taking in rotated positions (20, 30 deg. angle)
- good coverage of high energy ➔ technology comparison
- dedicated runs for PFA studies (x-y scan)
- pion/proton separation
- positive/negative polarity

Schedule:

- open access 1-4 July
- run time 5th July – 1st August

analog/digital comparison

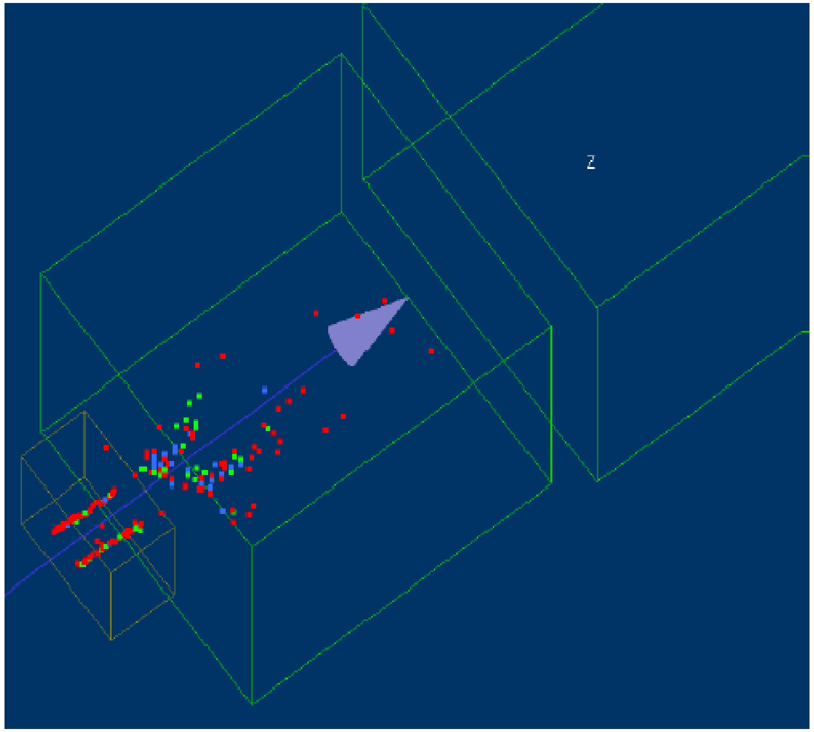


at high energy analog better than digital

we have CERN data up to 120 GeV but from FNAL only:

+30 GeV		500345(149k) -v30
		500354(156k) -v30
+40 GeV		500340(227k) -v30
		500339(100k) -v23
+50 GeV		500332(200k) -v30
+60 GeV		500317(119k) -v30
		500319(110k) -v30

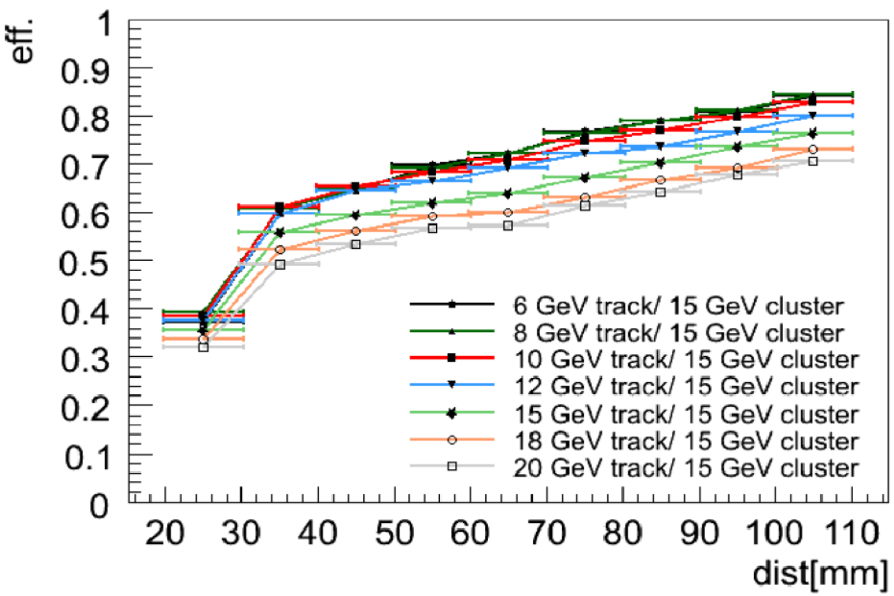
shower separation analysis



tested separation of showers up to 11 cm distance
➔Pflow advantages expected at ~ 15-20 cm

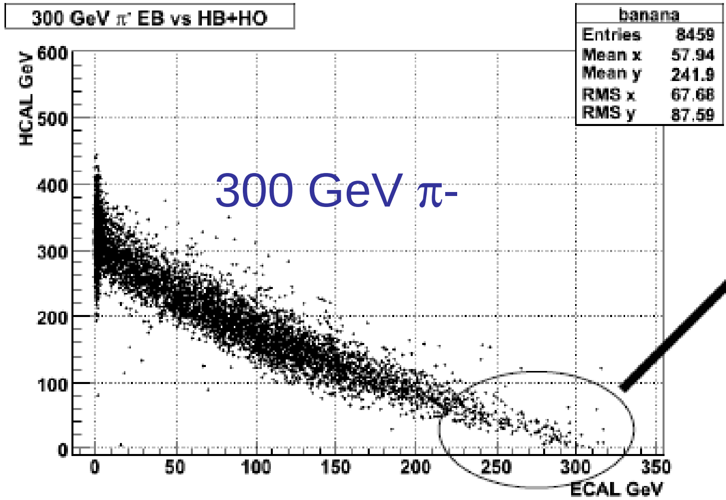
possible within HCAL high granular core
but need to keep ECAL in beam centre
to minimize leakage effects

$$\mathrm{eff} = \frac{\int_{-3\sigma}^{+3\sigma} E_{cluster}}{\int_{-\infty}^{+\infty} E^{1}_{calo}}$$



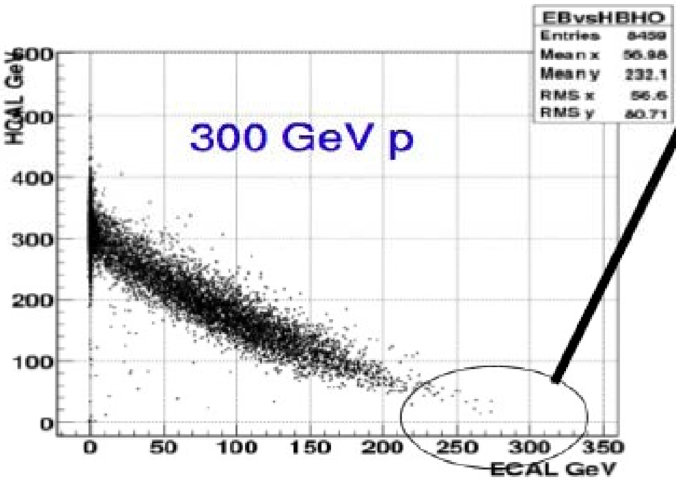
pion/proton separation

π^-/p Response Ratio



Charge exchange reaction:
$\pi^-(\bar{u}d) + p(uud) \rightarrow \pi^0(u\bar{u}) + n(udd)$.

But baryon number conservation prevents π^0 creation when the showers are initiated by protons.
$p(uud)+n(udd) \rightarrow p(uud)+n(udd)$
$p(uud)+p(uud) \rightarrow p(uud)+n(uud)$
---> production of π^0 is not favored.



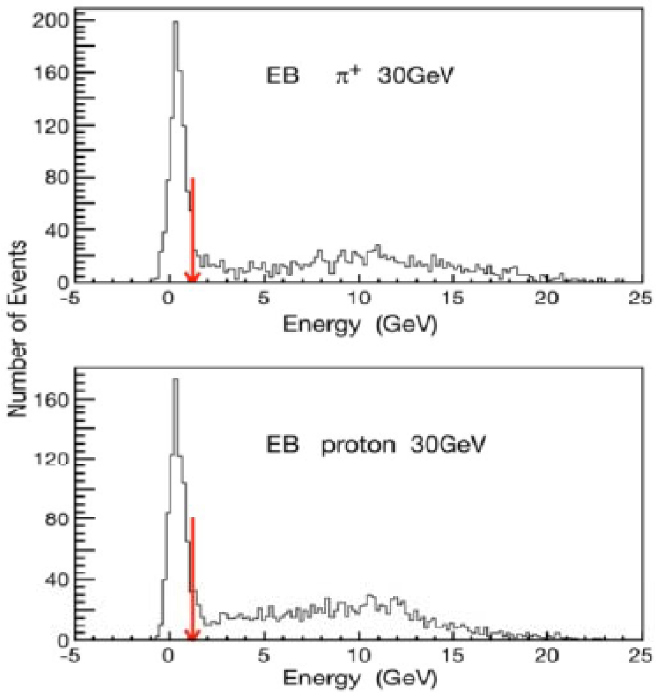
- Response to protons is systematically are smaller than that of π^-

CMS TB results

pion/proton separation

π/p Response Ratio

- Larger fraction of baryons start showering in EB since the total cross section for p > π⁻.
- fraction of particles passing through EB without interacting
  - pions: 41%
    - produce more π^0. Even though fewer π^- interact, those that interact have larger signal
  - protons: 35%
- The effective thickness of EB
  - pions: $0.89\lambda_I$
  - protons: $1.05\lambda_I$



CMS TB results

positive/negative polarity

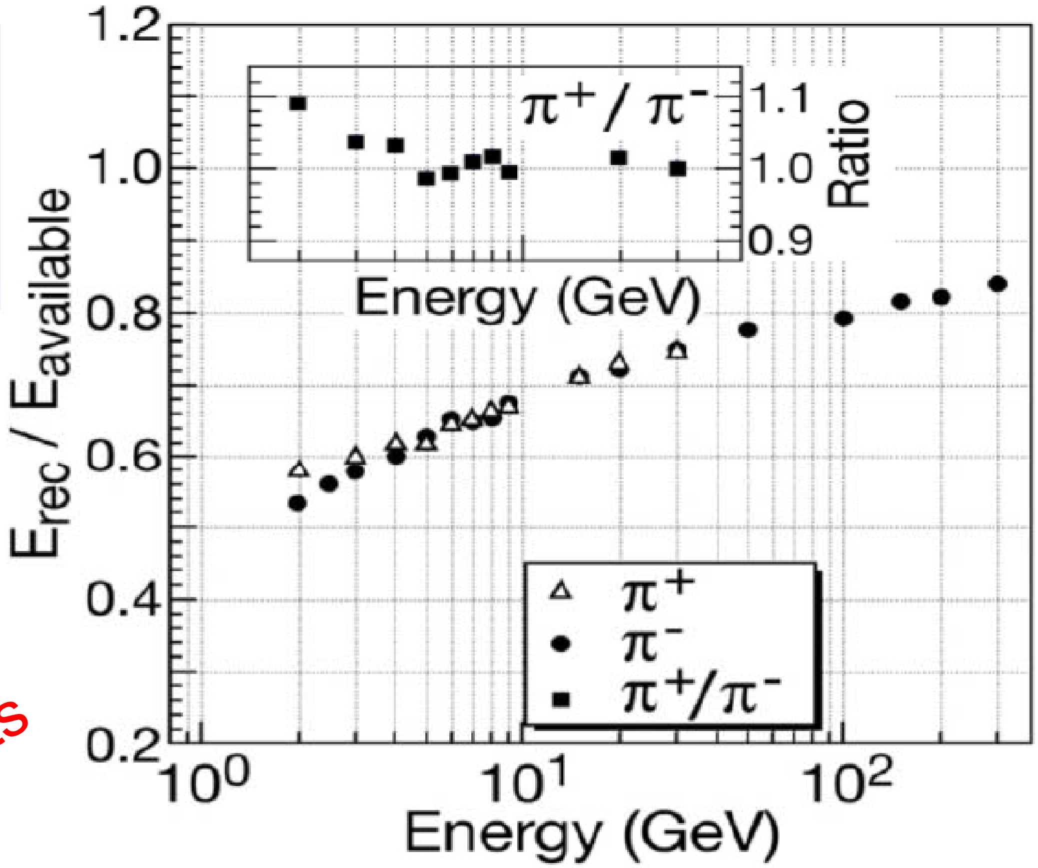
- Response to π^+ > response to π^- increasing with decreasing energy → at 2 GeV π^+ is 10% greater than π^-

Charge exchange reactions:

$\pi^+ + n \rightarrow \pi^0 + p$ (1)

$\pi^- + p \rightarrow \pi^0 + n$ (2)

The heavy nuclei in the calorimeter material has 50% more neutrons than protons -- the effect of reaction 1 is larger than 2.



CMS TB results

July run plan

July 5-7:	Muon calibration (at two latency settings)
July 8-9:	low energy electron for ECAL (fast trigger)

➔switch to slow trigger

July 10-16:	pion run at 0 deg. E=2-60 GeV (negative ?)
July 17:	x-y scan on HCAL front with ECAL centred w.r.t. beam
July 18-24:	rotated positions (3 days at 20 deg. + 3 days at 30 deg.)
July 25-26:	extra time for combined program (maybe switch to positive beam, only interesting if proton/pion separation is possible)

➔remove ECAL

July 27-Aug. 1	HCAL only run main focus: low energy pion 2-10 GeV
for July run:	favour high statistics in fewer energy points

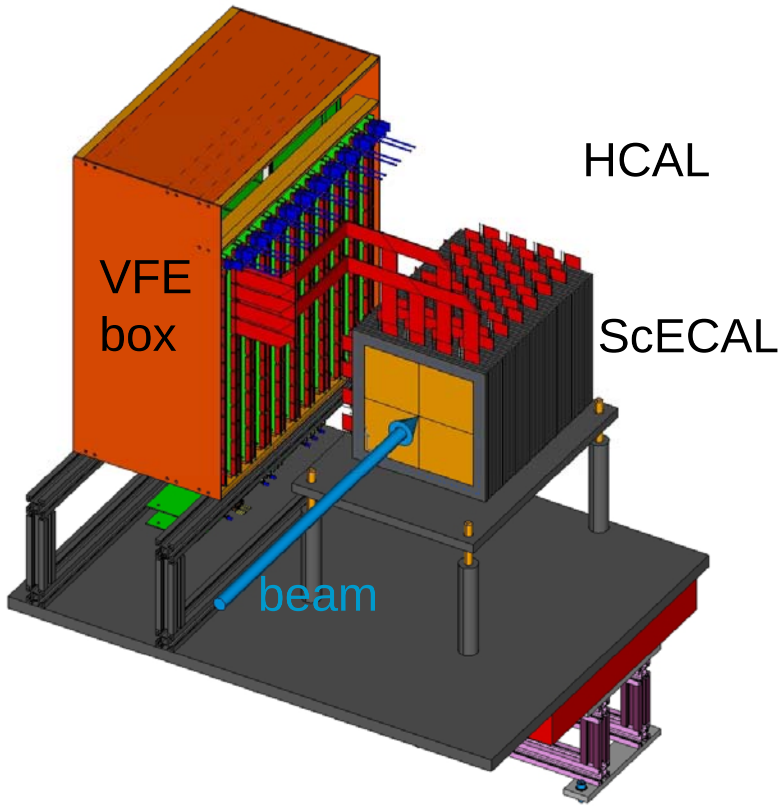
September run

- exchange Si-W ECAL with Sci-W ECAL (ScECAL)
- installation starts on 17th of Aug.
- data taking 1-26 Sep.

- the HCAL will run behind the ScECAL in normal configuration

main focus of this run period:

- commissioning of ScECAL
- electron runs
- π^0 runs



Get more info on the running test beam

1) read the elog:
https://ttfinfo.desy.de/CALICEelog-sec/index.jsp
and find special installation docu in: FNAL_ducu

2) join the daily meeting with FNAL:
6:00-6:30 pm every working day
connect via EVO http://evo.caltech.edu/evoGate or
telephone (+1 510 883 7860, conference number: 85225423#)

3) join the shifts in the remote control room at DESY

4) don't forget your shifts!
shift schedule:
http://www-flc.desy.de/hcal/fnaltestbeam/shift_schedule_2008.php.htm