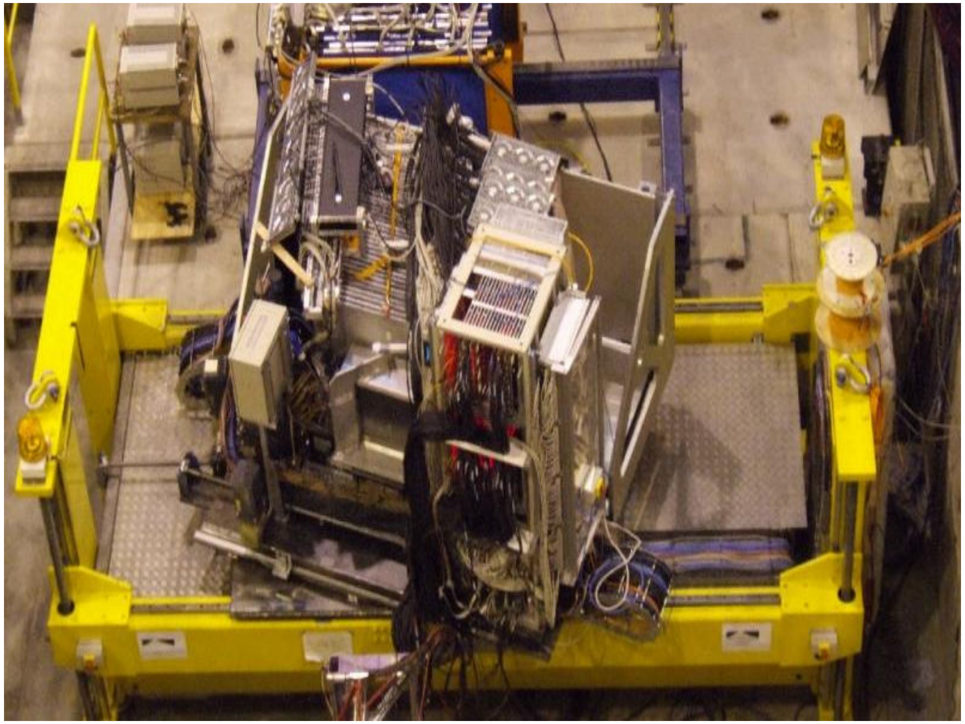
AHCAL installation and commissioning experience



Erika Garutti - DESY

AHCAL installation

- Mechanics

  - 1 day for heavy crane work: positioning of absorber plates pre-mounted, positioning of rack(s), module boxes, first unpacking
  - 2 days for module insertion (with crane) & cabling
  - 2 days for installation of trigger system (?) and cabling + MWPC cabling

- Electronics

  electronics rack cabled up from DESY
  - 1 day for installation of VME cards and cabling + trigger logic
  - connections to the control room: 2x 50 m optical fibers (DAQ + CANBUS)
  - power supply for triggers and MWPC

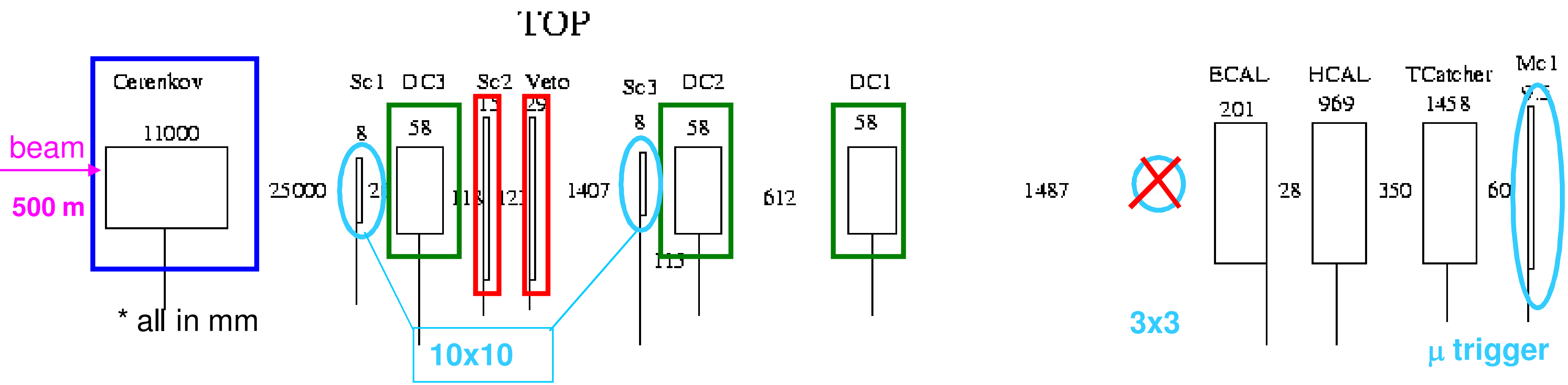
- Computers

  - installation of computers in control room (DAQ, SC, ana., …)
  - register computers to CERN, connection to dcache
  - data storage (disk array ?)
  - communication system (video conference, webcams, …)

Commissioning DAQ / data transfer

- End of Day 4: first DAQ run
  - check VME alive, CRC noise, data storage, transfer, conversion (Angela)
- End of Day 5: first noise run
  - check VFE electronic noise level, chip alive
  - check TDC readout
  - update online monitor (MWPC mapping)
- Day 6 start Calorimeter commissioning (~3 days)
  - power SiPM, check SiPM alive
  - check LED system
  - first round of calibrations
- At day ~8 parasitic beam request for few hours
  - commission trigger system
  - commission MWPC

Beam instrumentation description



News on the beamline

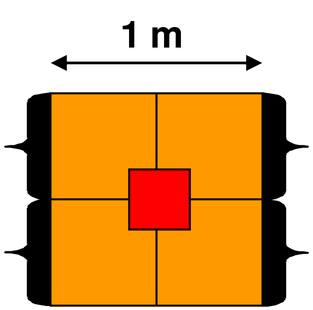
1) beam info from CERN database available from run 330411

2) Cherenkov operated for e/π and π/p separation

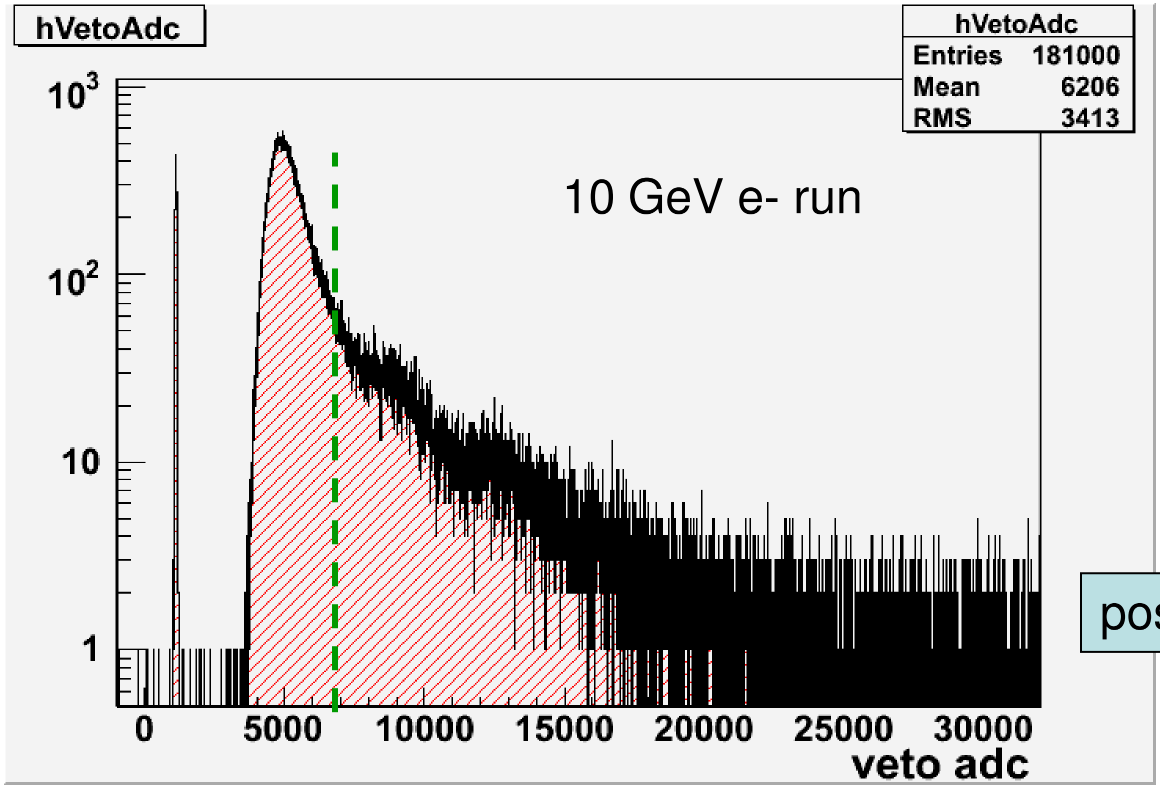
3) 3 x/y pairs of MWPC with double readout

4) 10x10 cm trigger only (no 3x3)

5) amplitude r/o of 1cm thick scint. counter (20x20 inner veto)
+ outer veto with 20x20 cm hole to tag double particle



The inner veto counter

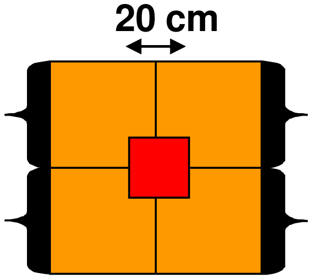


20x20 cm^2 veto counter amplitude readout

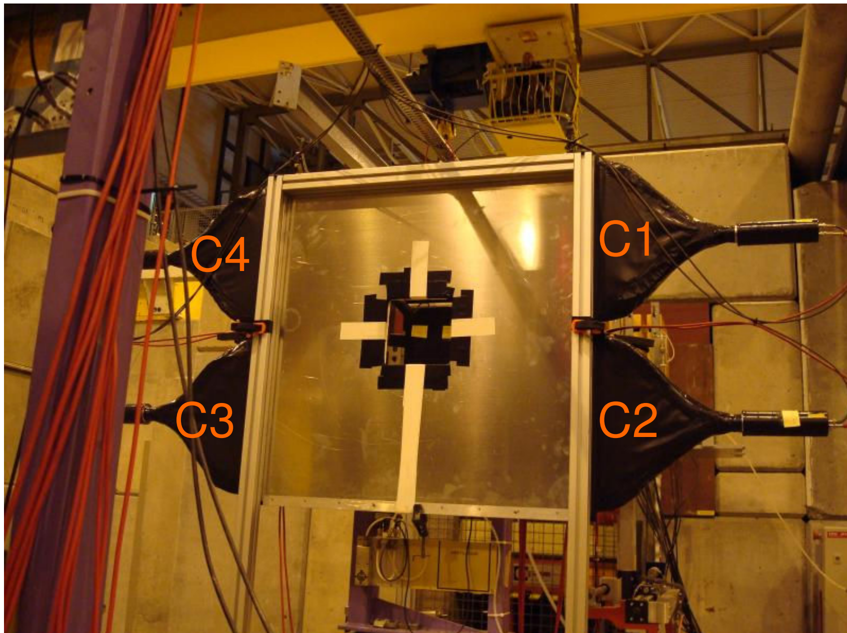
available only from run 330924 on

possible cut veto < 7000 ADC ch

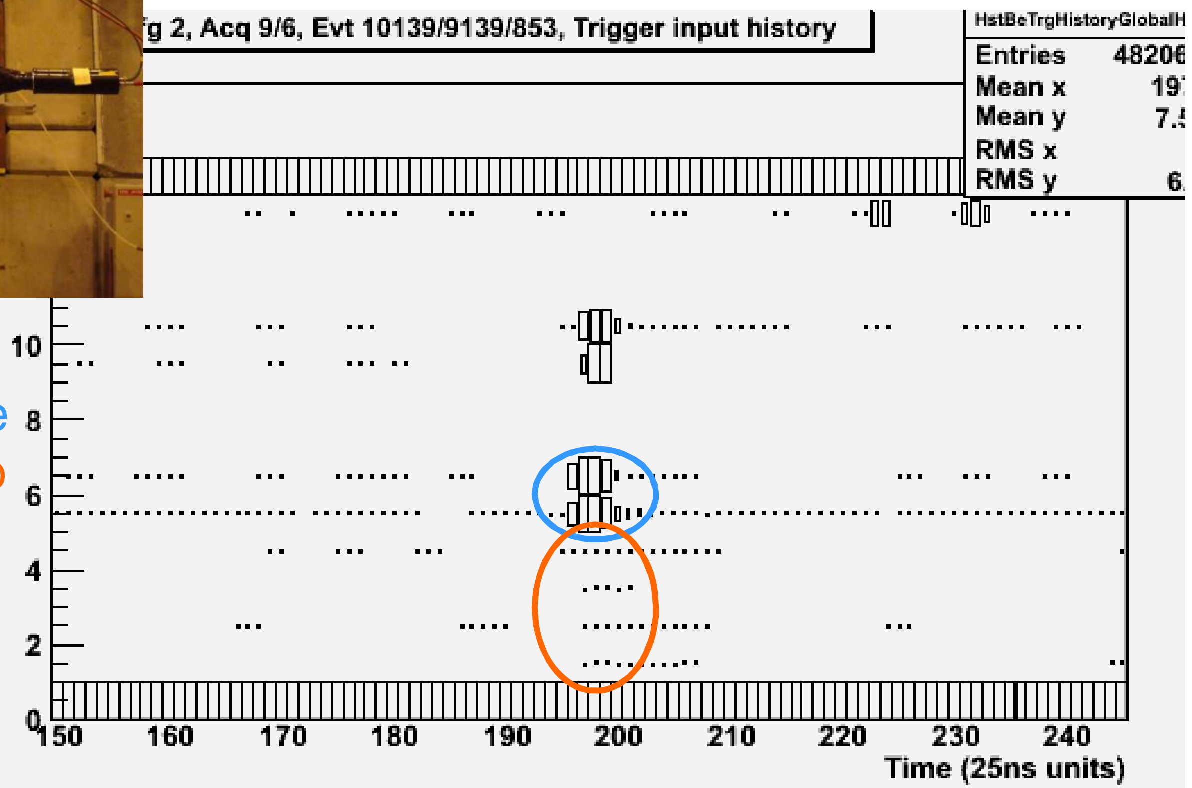
for analysis use analog readout in
crate / slot / fe / chip / chan : 172 / 12 / 4 / 0 / 17



The outer veto



outer veto rate:
$(C_1 \| C_2 \| C_3 \| C_4)\ \&\ (T_1\ \&\ T_2)$
normally < 1-2%

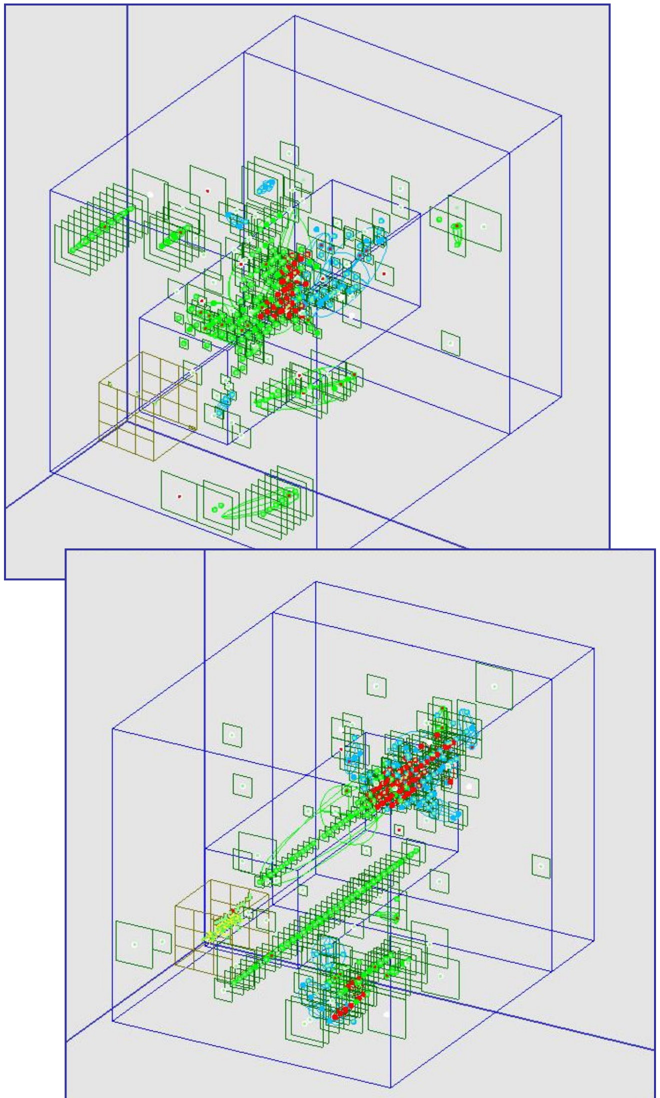


in binary files:
bit 5 & 6 = 10x10 trig coincidence
bit (1 or 2 or 3 or 4)&(5&6) = veto

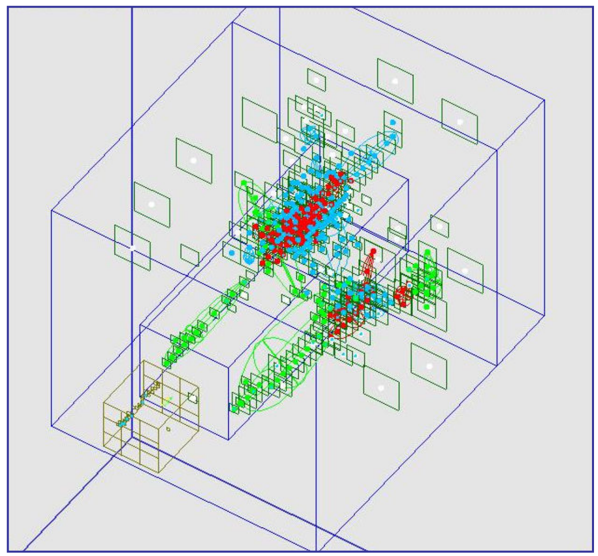
in LCIO files:
isVetoXY(), X=D, U (Down, Up)
Y=L, R (Left, Right)

E. Garutti

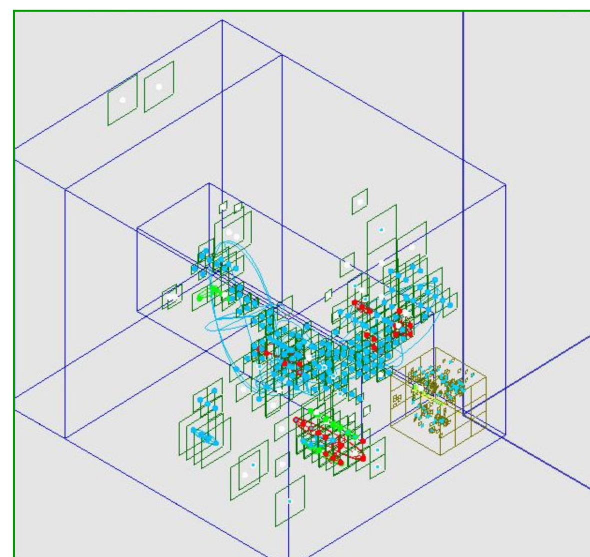
Clean-up examples



events cut by
no-outer-veto OR



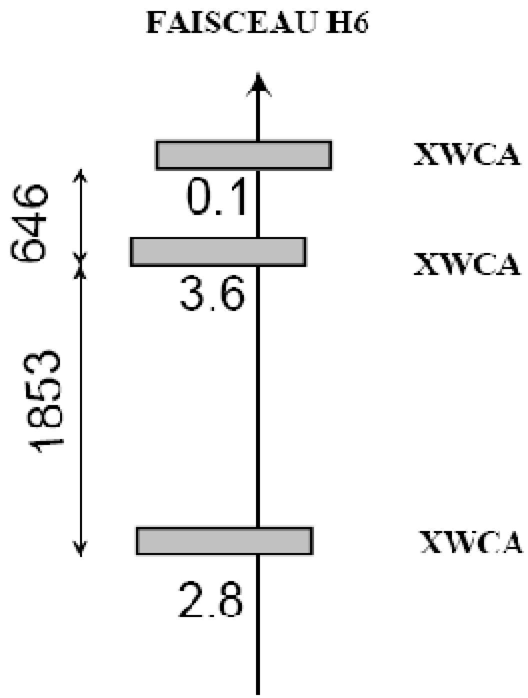
events cut by inner-veto
Ampl<7000 ADC ch.



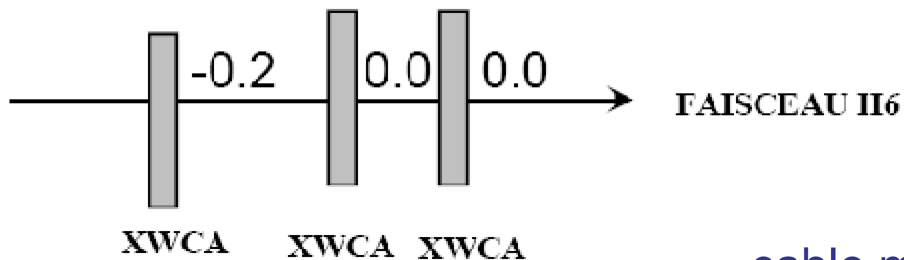
maybe interesting event
selected (?!) with
outer-veto

MWPC alignment

TOP VIEW (radial)



SIDE VIEW (hauteur)



cable mapping

MWPC	TDC#	TDC channel#
1-left	0	0
1-right	0	1
1-down	0	2
1-up	0	3
2-left	0	4
2-right	0	5
2-down	1	1
2-up	1	0
3-left	1	2
3-right	1	3
3-down	1	4
3-up	1	5

alignment performed by CERN survey group

* all units in mm

Commissioning DAQ / data transfer

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- Day 6 start Calorimeter commissioning (~3 days)

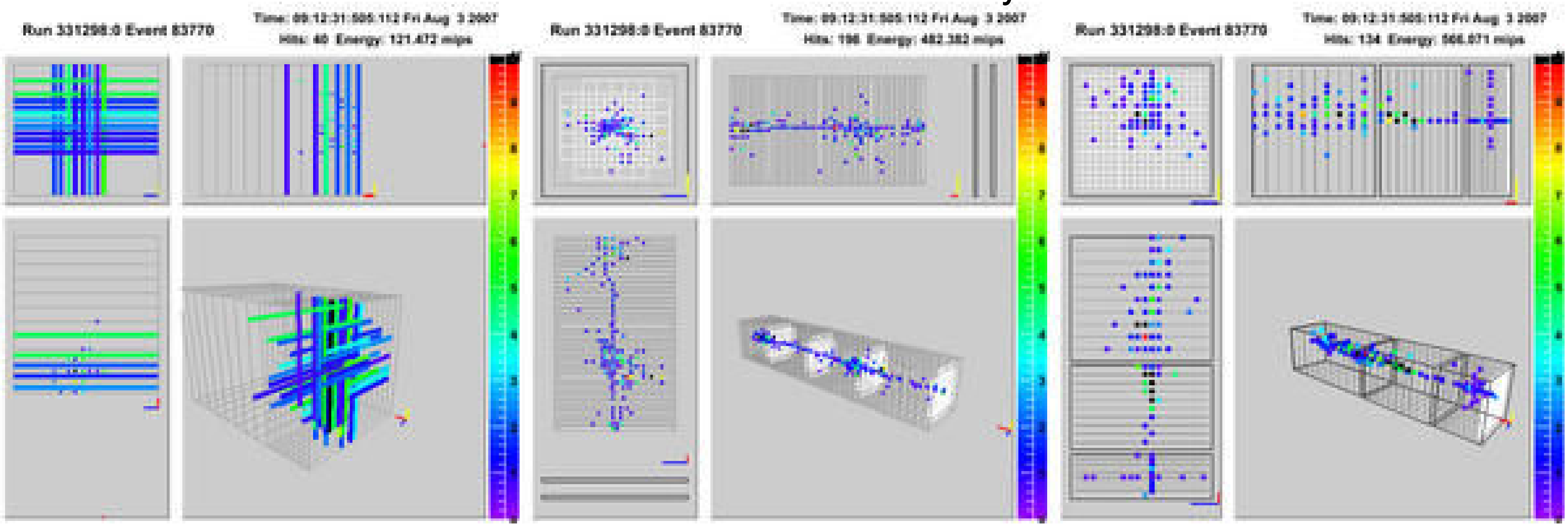
  - power SiPM, check SiPM alive
  - check LED system
  - first round of calibrations
- At day ~8 parasitic beam request for few hours

  - commission trigger system
  - commission MWPC
  - see first events

← Safety inspection + survey alignment

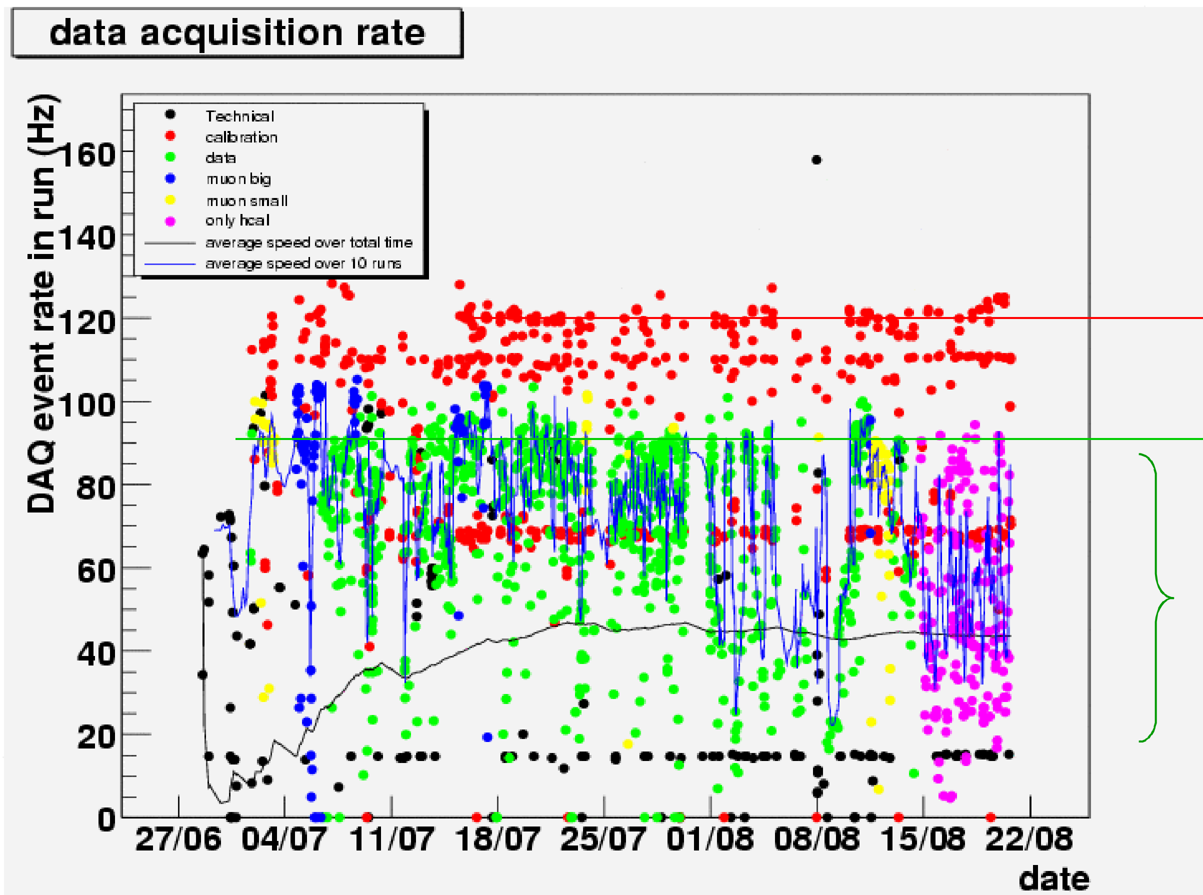
Detector performance (2007)

Online monitor on the first day of beam on



Total data taking time	7 weeks
SPS uptime	80.7 %
Beam controlled by H6B	76.1 % (94.4 % of uptime)
DAQ on beamData	60.2% (**79.1 %** of beam in H6B)
DAQ on calibration	7.8 %

DAQ performance



120 Hz limit of DAQ out of spill

90 Hz limit of DAQ in spill

limited by beam rate

Commissioning with beam

The first steps with beam:

- Trigger commissioning
- Hold scan ➔ fix latency of chip w.r.t. beam trigger (changes with new trigger plates + cables)
- Muon calibration ➔ ~2 M muons needed (100x100 cm^2 trigger ?)
- (Adjustment of working point ?)

~ 4(-6) days

➔ Start of physics program

➔ In addition ~ 30 min LED calibration runs every ~ 8 h (3 time /day)

Shift organization

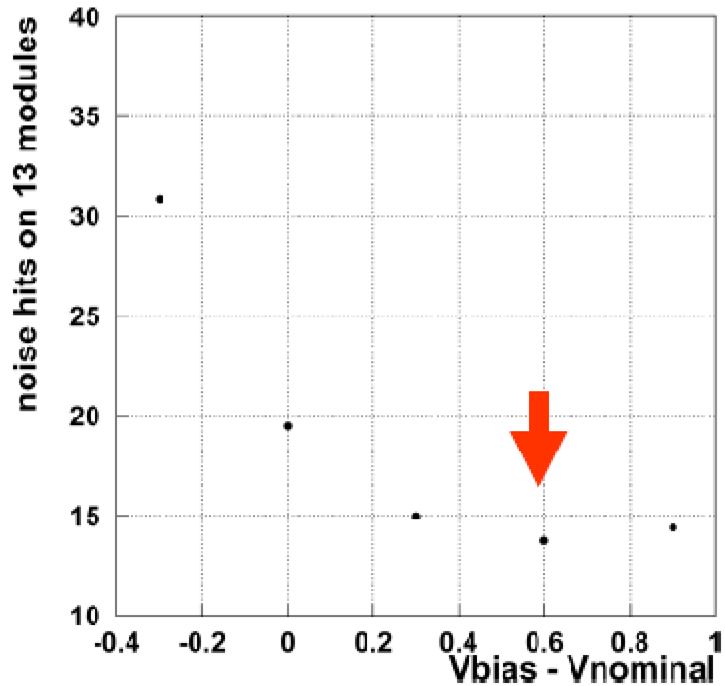
- 2 people on shift minimum:
  - HCAL expert
  - DAQ / beam instrumentation

- 3 shifts / day
- Documentation available (shift guide)
- 2 or 3 shift training / week (for new comers)
- Expert on call (can the expert be remote?)

  - positive experience with remote control room & DAQ remote expert

Working point optimization

TB 2006 optimisation



Overall Calorimeter Optimisation

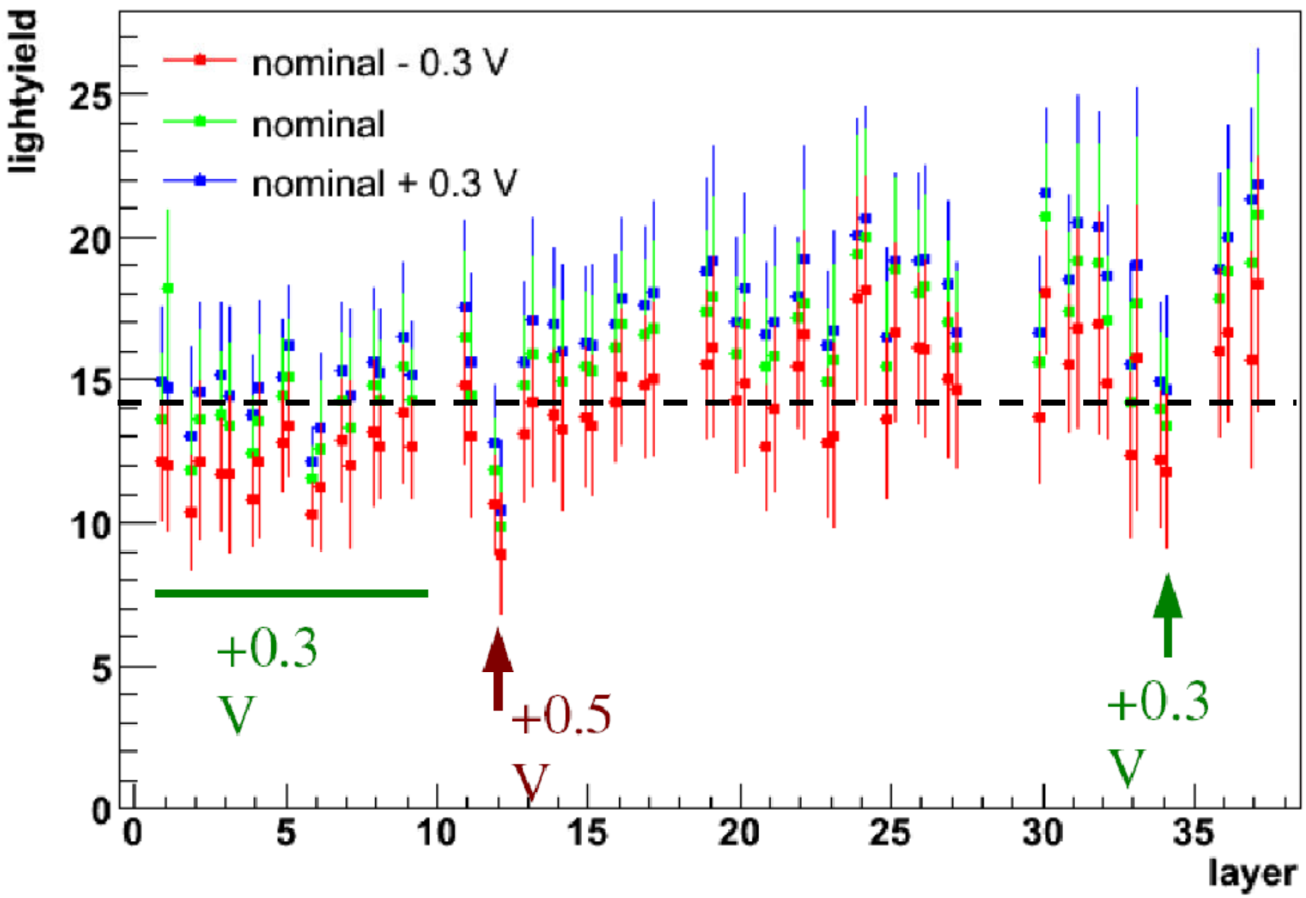
• applied overall HV correction

compensation of temperature increase and HV drop

• used average mip dependence
no new calibration used

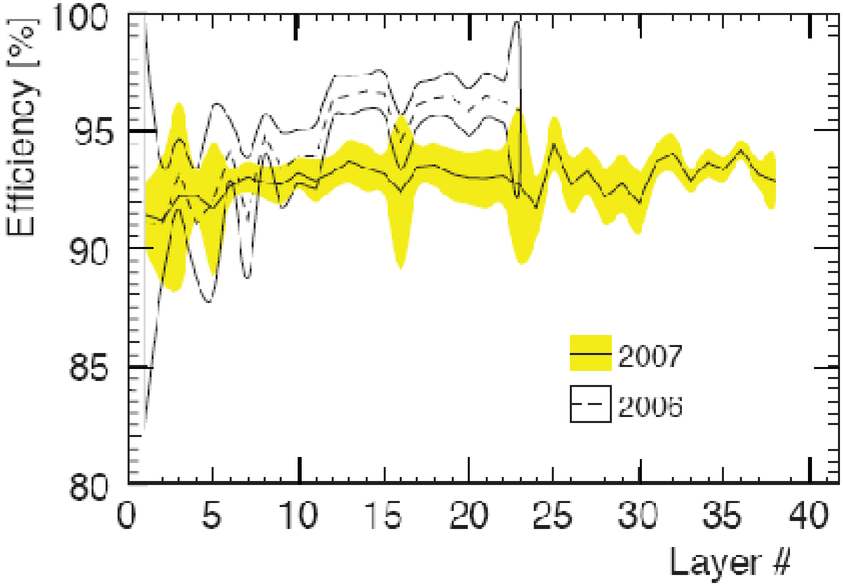
• single channel DAC correction only in case of very high signal due to long-discharge applied

Voltage scan with muon data (2007)

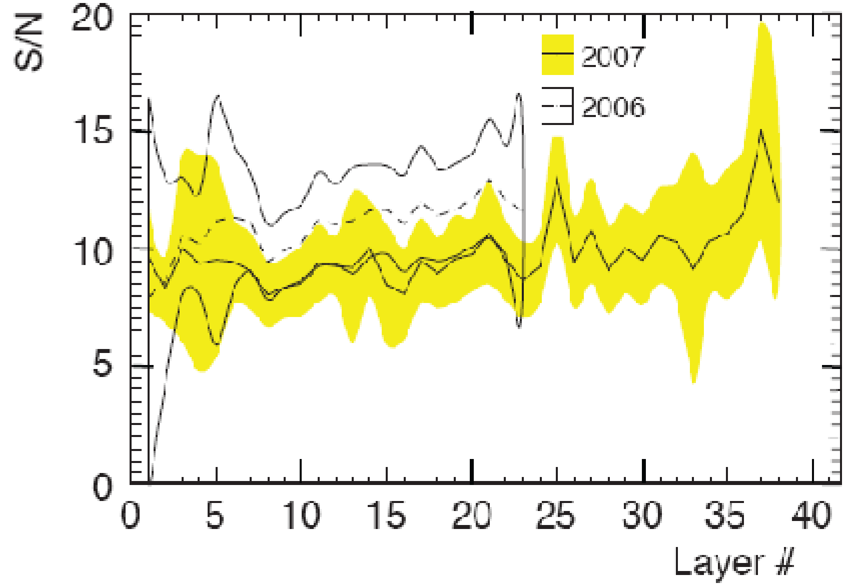


MIP calibration

Calibration obtained at CERN with ~2 M muon events (80 GeV)
- broad beam covering the whole 1x1 m^2 calorimeter face
- minimum 500 events required for a good fit in one cell



MIP detection efficiency above 0.5 MIP threshold ~ 93%



Signal to noise ratio ~ 10

summary

- Time schedule:
- 1 week installation + 1 week commissioning proved to be sufficient
- Golden numbers for the run plan:

  SPS uptime ~ 80%

  detector uptime ~ 100% / detector on physics data ~80%

  data rate ~60Hz (beam run)

- Open issues:

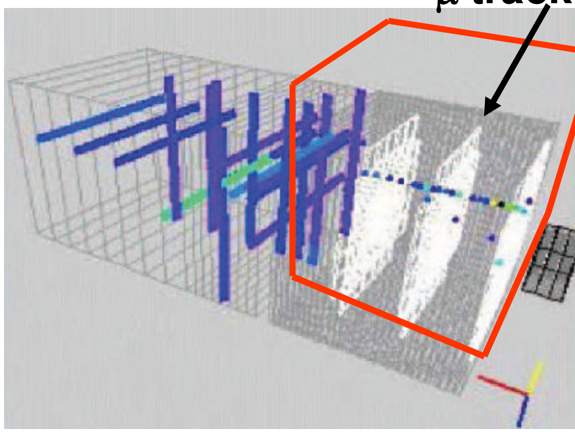
  trigger system?

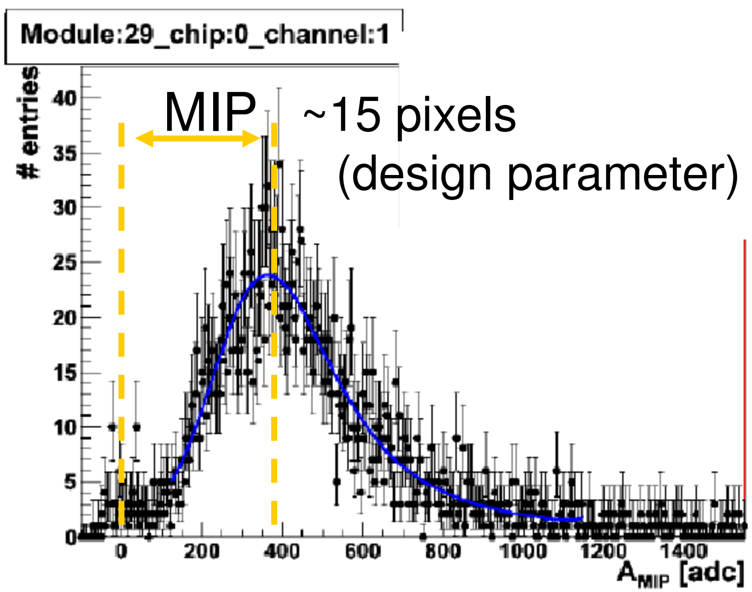
  tracking system? ➔ integration into DAQ

Backup

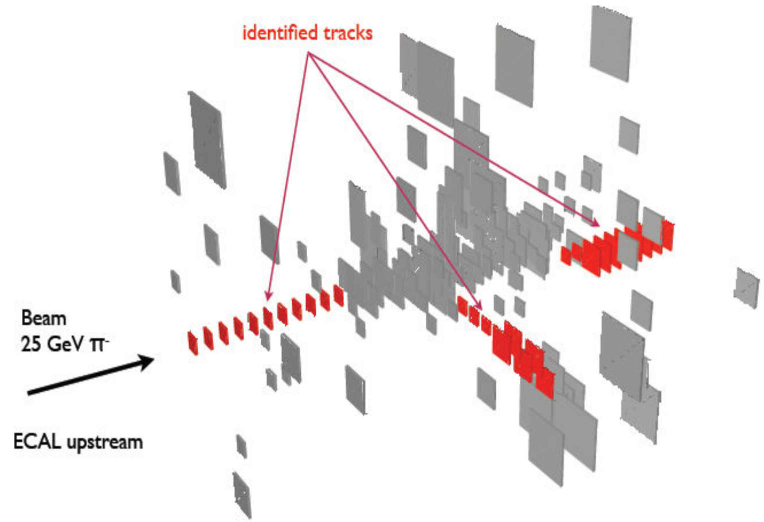
Cell response equalization with MIP

Using muon signal





Using pion shower
select MIP stubs using the high granularity of the HCAL



Luminosity requirement for in-situ calibration with MIP stabs from jets (ILC detector)

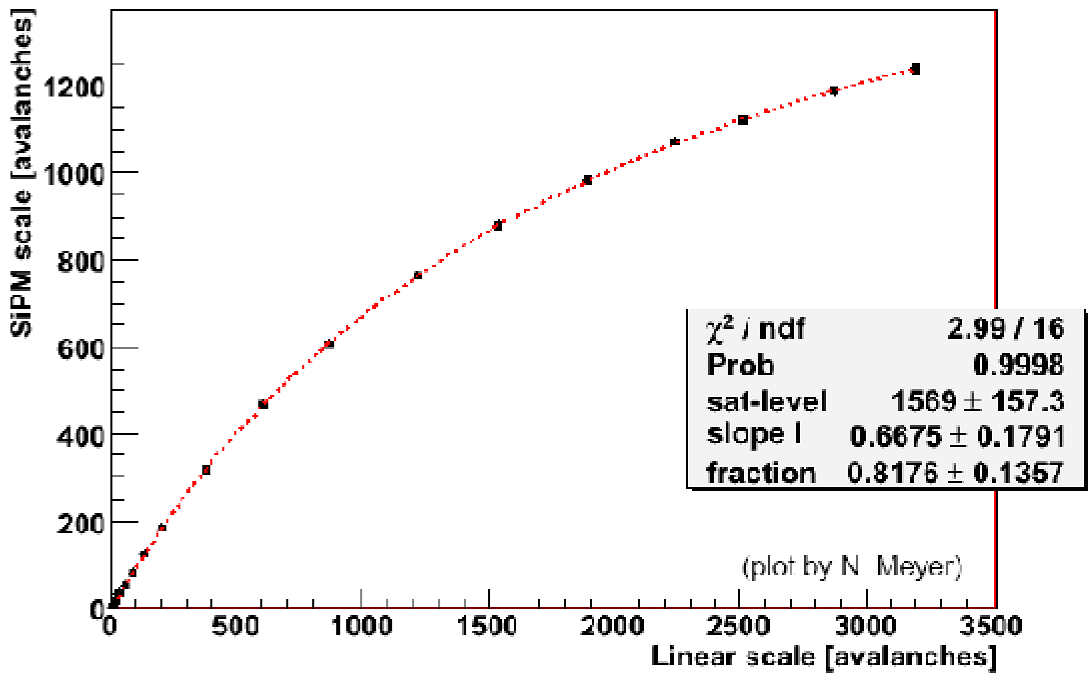
	Luminosity at 91 GeV	Luminosity at 500 GeV
layer-module to 3% to layer 20	1 pb^{-1}	1.8 fb^{-1}
layer-module to 3% to layer 48	10 pb^{-1}	20 fb^{-1}
HBU to 3% to layer 20	20 pb^{-1}	36 fb^{-1}

more statistics obtained from $Z_0 \rightarrow \mu\mu$ events

SiPM response function

- assume two pixel types (use sum of two exponentials)
- Parametrisation: $$A_{SiPM}=A_{max}\cdot\left(r_1\cdot\left(1-\exp\left(\frac{-A_{lin}\cdot s_1}{r_1 A_{max}}\right)\right)+r_2\cdot\left(1-\exp\left(\frac{-A_{lin}\cdot s_2}{r_2 A_{max}}\right)\right)\right)$$
  - $1=r_1+r_2$
  - $s_2=\frac{1-r_1\cdot s_1}{1-s_1}$

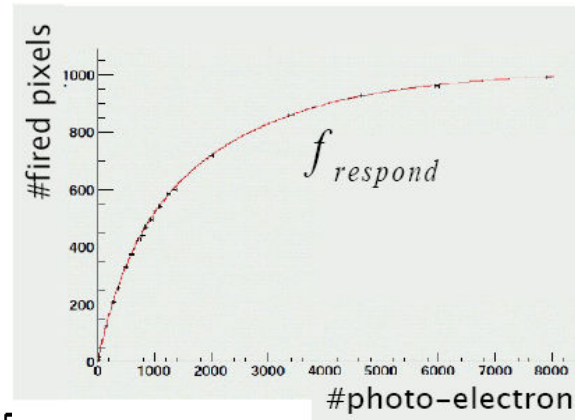
→ fit works good for > 95% of channels, the others need to be checked



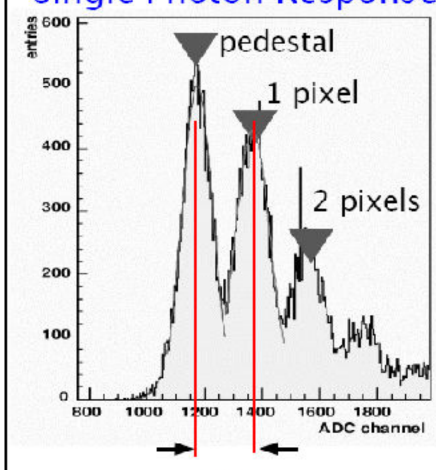
all curves for ~8000 SiPM measured (in ITEP) before installation on tile

Importance of monitoring/calibration

SiPM response is non-linear



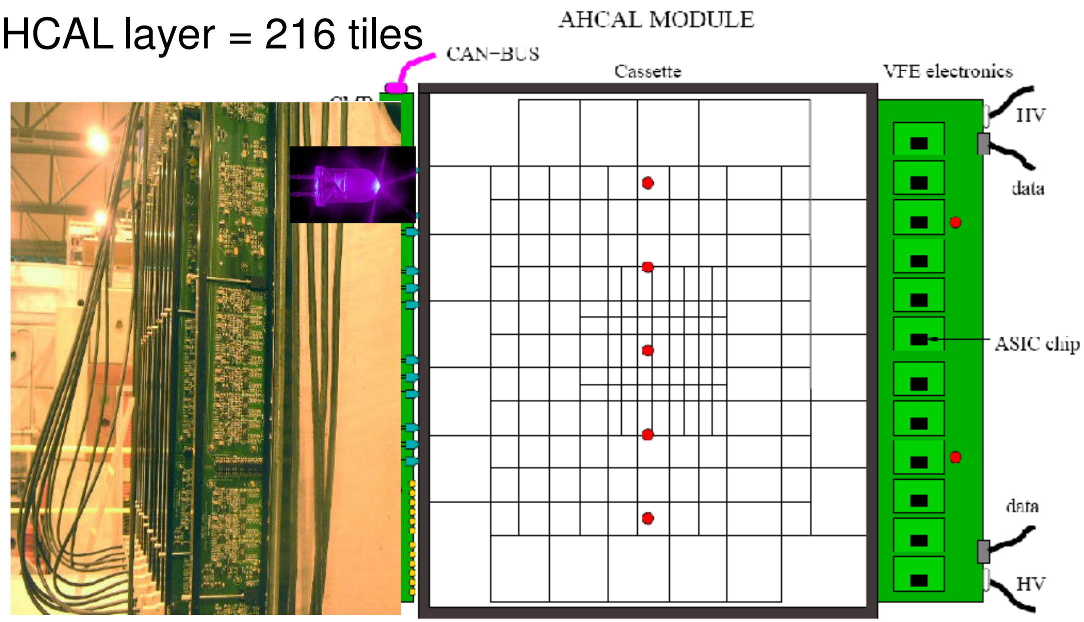
Single Photon Response



Conversion ADC ch.→pixels

Redundant calibration system delivers:
- -Low intensity light for SiPM Gain calibration
- -High intensity of light for saturation monitoring
- -Medium intensity light for electronics intercalibration

AHCAL layer = 216 tiles

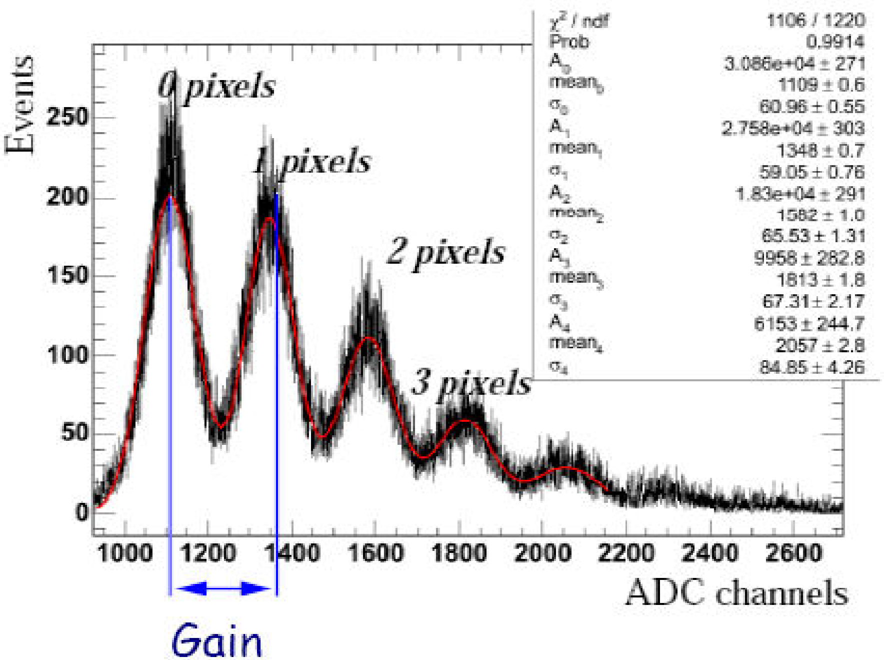


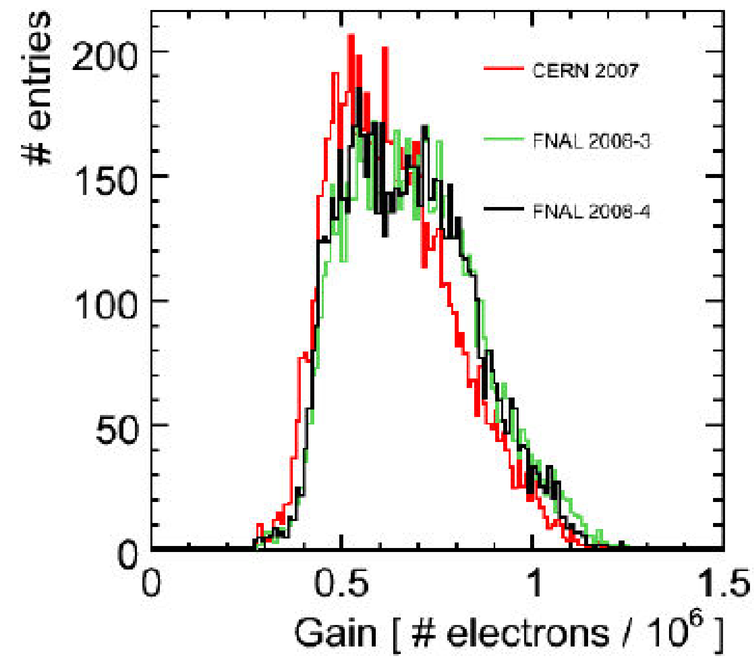
Light intensity for 8000 channels within factor 2

>94% calibration efficiency on full calorimeter

SiPM gain calibration

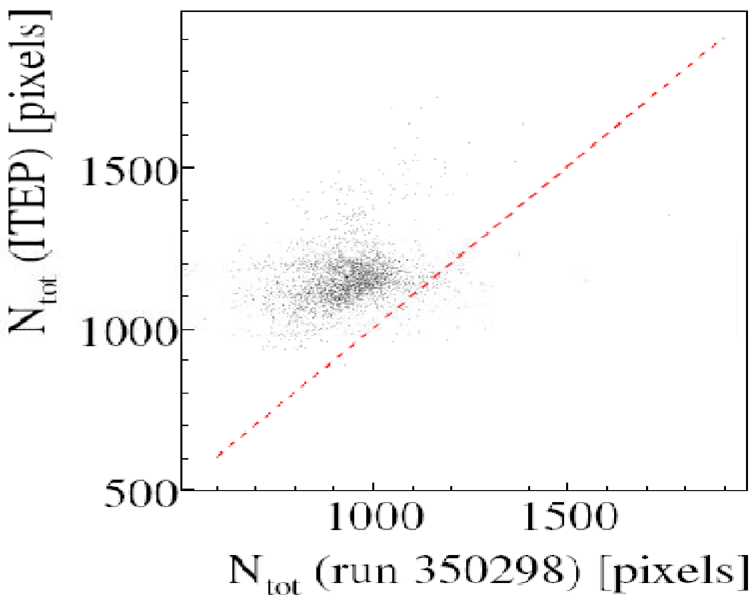
- Gain extracted from a multi-Gaussian fit to LED calibration data
- ~15 min data taking necessary for one gain scan
- Repeated ~every 6-8h during data taking
- Efficiency (#ch. calibrated):
- CERN 96.4%, FNAL 97% ➔ Mainly quality of LED system

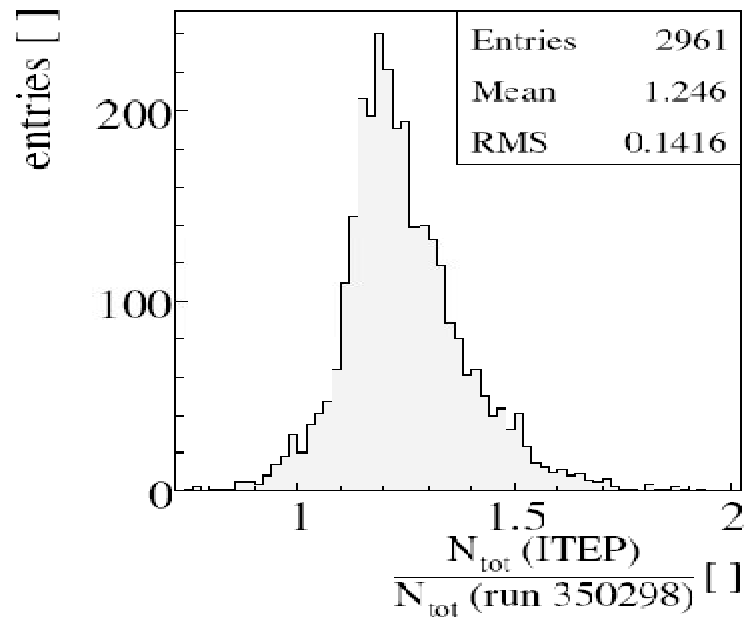




In-situ check of saturation point

The saturation level is independent on bias voltage and stable in time (no ageing effects)



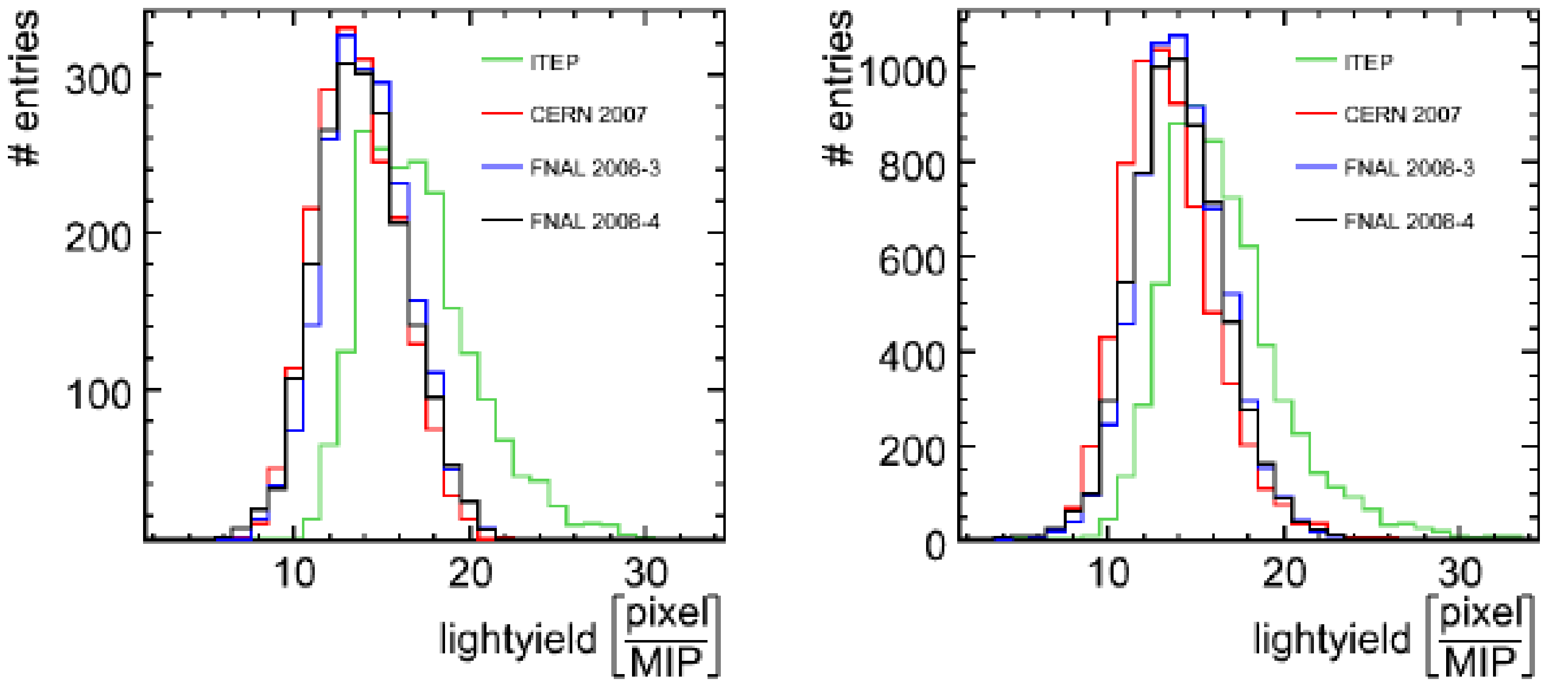


Saturation point measured on SiPM installed on tile is ~80% lower than on bare SiPM (ITEP measurement)

➔Explained by geometrical match of 1mm Ø fiber to 1mm^2 SiPM

➔ Later verified in the lab at ITEP with measurements on tile

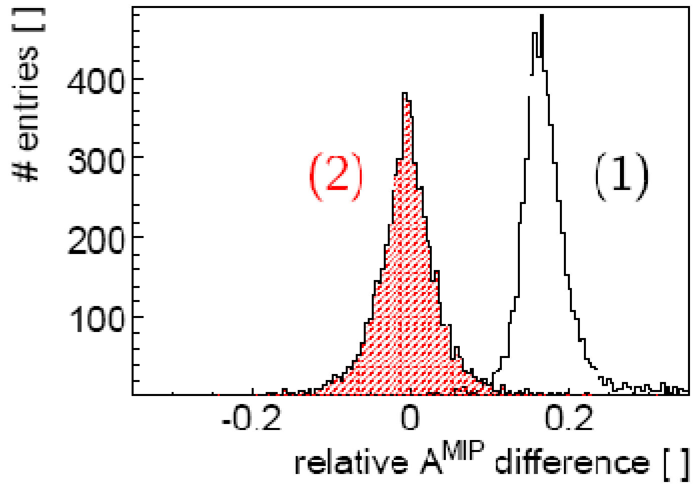
Figure of merit: light yield

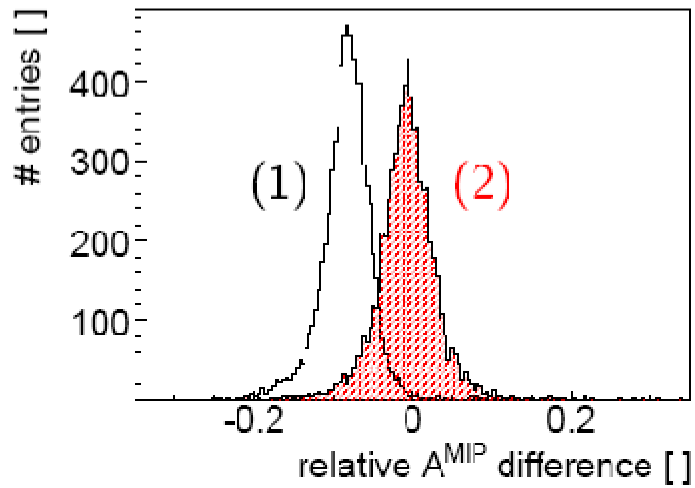


- Adjustment requires the knowledge of SiPM response - T & V -
- Remaining discrepancy due to different MIP sources
  ---> to be validated with MC

MIP: muon 80 GeV (CERN), muon 32 GeV (FNAL), Sr-source (ITEP)

HV Adjustment vs T-Correction





- U adjustment: $\frac{\mathrm{d}G}{\mathrm{d}U} \rightarrow \frac{\mathrm{d}A^{MIP}}{\mathrm{d}U}$
- U_{bias}, $U_{bias} + 300\,\mathrm{mV}$:
  - (1) $A^{MIP}_{pred} - A^{MIP}_{meas}$ $\rightarrow$ 17 %, spread 3 %
  - (2) $A^{MIP}_{pred} - A^{MIP,adj}_{meas}$ $\rightarrow$ 0 %, spread 4 %

- T correction: $\frac{\mathrm{d}G}{\mathrm{d}T} \rightarrow \frac{\mathrm{d}A^{MIP}}{\mathrm{d}T}$
- $\overline{T}_1 = 21.9\,^\circ\mathrm{C}$, $\overline{T}_2 = 24\,^\circ\mathrm{C}$:
  - (1) $A^{MIP}_2(T_2) - A^{MIP}_1(T_1)$ $\rightarrow$ -8.2 %, spread 3 %
  - (2) $A^{MIP}_2(T_1) - A^{MIP}_1(T_1)$ $\rightarrow$ -0.7 %, spread 3.4 %

predictions of voltage adjustment effects match measured results

The modular run plan

- Based on last year experience the run plan has to be flexible!
- The run plan will evolve depending on beam conditions / agreements with other users / other unpredicted constraints
- The run plan is defined in packages
- We identified two class of priorities for energies and angles:
  - Priority I
    - Low E: 6, 10, 15, 20 GeV
    - High E: 20, 30, 50, 80 GeV
    - Angles: 0, 20, 30 deg
  - Priority II
    - Low E: 8, 12, 18 GeV
    - High E: 25, 40, 60, 120 GeV
    - Angles: 10, 15 deg
  - If more time available at one given angle, high statistic has priority over more energy points
  - Note: beam tuning has not been taken into account in the time estimate

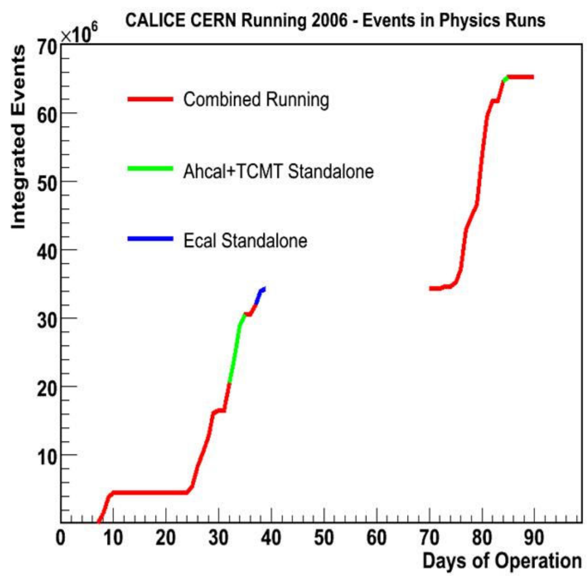
Low and high refer to the energy of the secondary beam required to cover the points (<120 or >120 GeV)

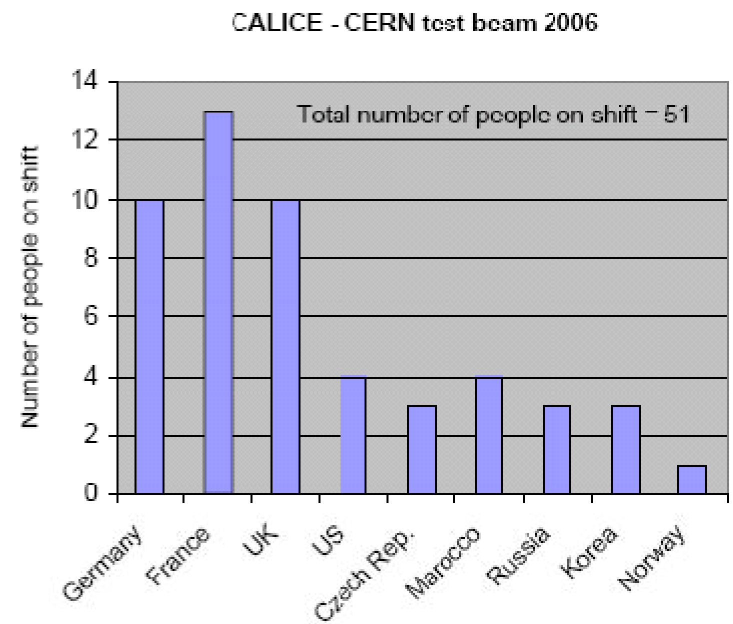
Low energy packages

- LE1) – Combined physics package (Pr I)
  - π, 1M evts, 6/10/15/20 GeV, 0 deg
  - π, 500k evts, 6/10/15/20 GeV, 20, 30 deg
    - Duration: ~5 days
  - Minimum required for combined physics run
- LE2) – ECAL physics package (Pr I)
  - e, 1M evts, 6/10/15(/20) GeV, 0 deg
    - Duration: ~1.5 days
  - Alignment; repeats last year's conditions
- LE3) – PCB irradiation (Pr I)
  - e, 1M evts, 10/50 GeV, 0 deg
    - Duration: ~1 day
  - Beam positioned on ASIC chip; position scanning

CALICE @ CERN 2007

Last year we did great !





2007 has to be greater !!!