CASTOR forward calorimeter: beam tests 2007

PH-CMG Meeting

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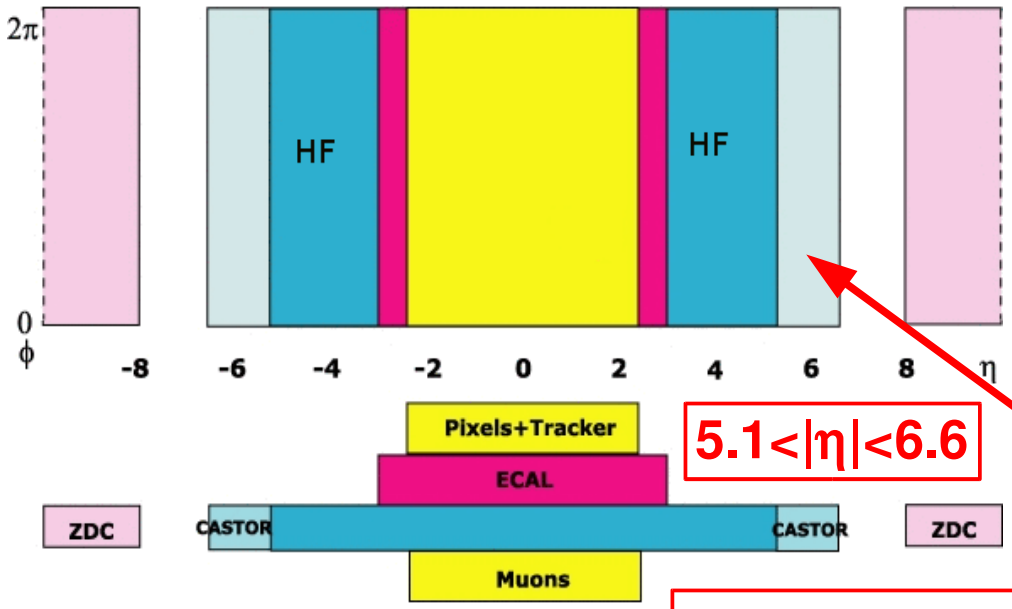
Overview

- CMS forward detectors. CASTOR HAD/EM calorimeter.
- Physics with CASTOR
- Phase I: Quartz plates cutting/polishing/lapping
- Phase II: CASTOR (HAD section) elements
- Phase III: Reflecting foil around Q-plates edges
- Phase IV: Mounting of prototype
- Phase V: Transport of prototype
- Phase VI: Final installation at H2 Line
- Phase VII: Shifts taking during beam-tests
- Phase VIII: Some (online) results
- Summary

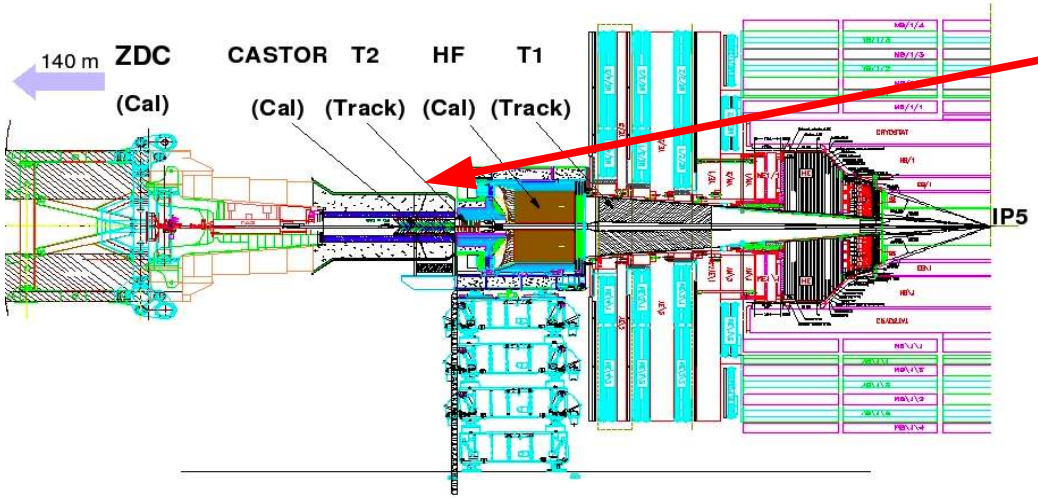
CMS forward detectors

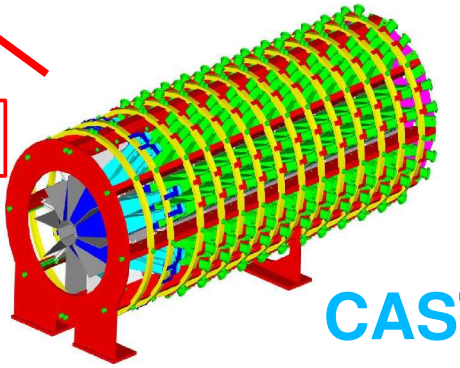


5.1<|η|<6.6

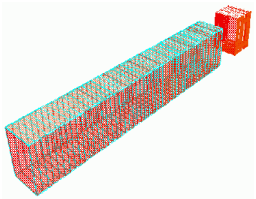
H(adron)F(orward)

~14.4 meters from IP5





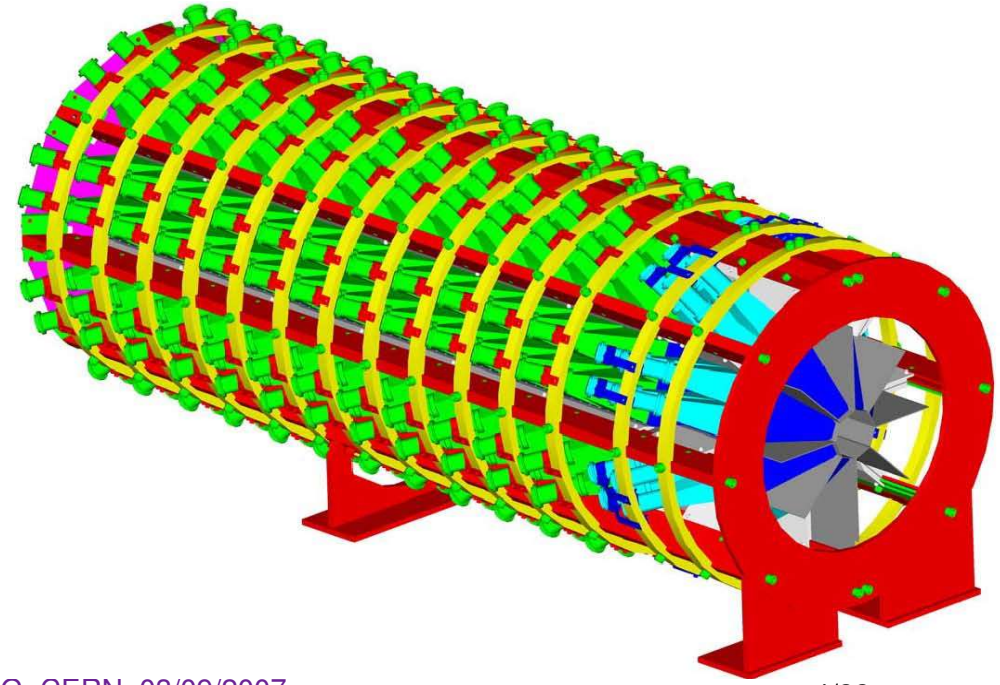
CASTOR

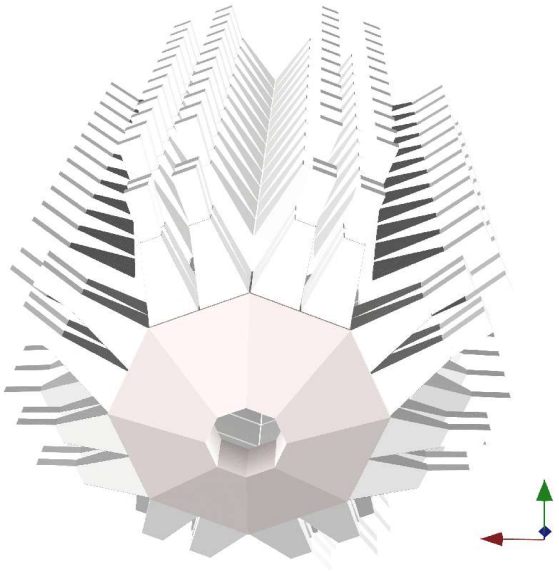


ZDC

CASTOR HAD/EM Calorimeter (I)

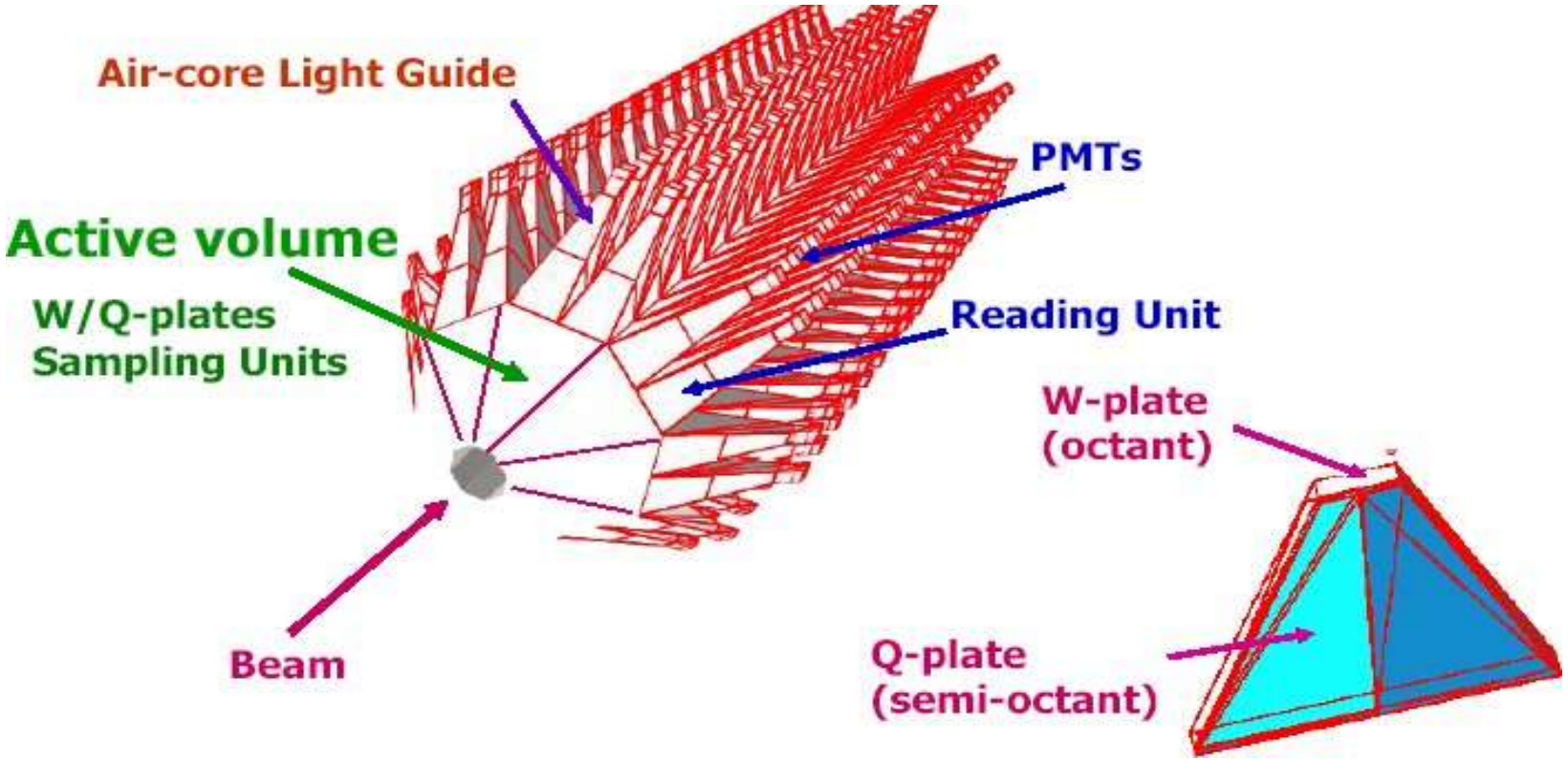
- CASTOR = Tungsten (W) + Quartz (Q) sampling calorimeter
- Dimensions: Total length: 1.36 m ($10 \cdot \lambda_I$):
  EM [11.2 cm ~ 20.12 X_0, 0.792 λ_I]: 5mm W + 2mm Quartz
  HAD [1.35 m ~ 9.5 λ_I]: 10mm W + 4mm Quartz
- Segmentation: 16 azimuth, 14 longitudinal sectors (2 EM + 12 HAD)
- Num. of channels: 224 (32 EM, 192 HAD)





CASTOR HAD/EM Calorimeter (II)

- Why Quartz as active material ? Optimal material for forward region:
  - Radiation-hard (10-1000 MGy accumulated)
  - Fast response (< 10 ns), and compact dimensions
  - Cerenkov light emission (45°) from relativ. particles traversing Q- plates (collected by light-guides into PMTs)



Physics with CASTOR (I)

[Details in D.d'E: "Forward Physics at the LHC" arXiv:0708.0551]

1. Beyond Standard Model (BSM) physics: "New physics" signals are characterized by a large amount of missing transverse energy (MET). CASTOR will extend the hermiticity of CMS from $\Delta\eta$~10 to $\Delta\eta$~13 allowing to measure more precisely the amount of MET.

2. Higgs physics: Higgs boson production in Vector-Boson-Fusion characterized by the emission of two jets at forward/backward rapidities (pp→jj H X). CASTOR will extend h range (beyond that of the currently considered HFs). *[Eve Le Menedeu, last week presentation]*

3. Low-x QCD: The measurement of forward jets (pp→j X), photons (pp→g X), or Drell-Yan pairs (pp→l+l- X) in CASTOR allows one to study the proton Parton Distribution Functions at very small parton momentum fractions (x~10^{-6})

Physics with CASTOR (II)

[Details in D.d'E: “Forward Physics at the LHC” arXiv:0708.0551]

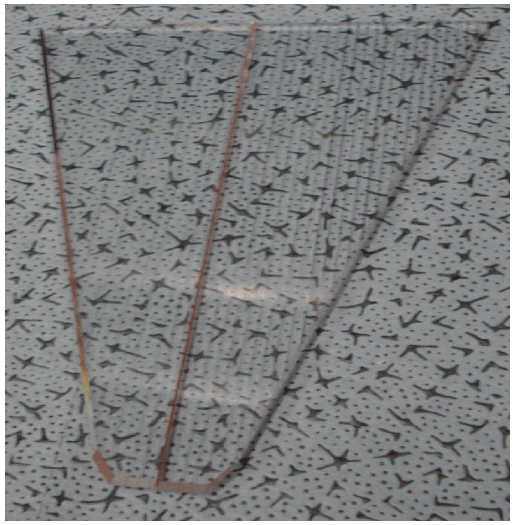
4. Diffractive QCD: CASTOR is a precious tool for diffractive physics as it extends 3 extra units of pseudo-rapidity to tag/veto rapidity-gaps.

5. Cosmic-ray physics: E_{lab}(LHC)~100 PeV fixed-target collisions. The CASTOR measurement of the (p-p,p-Pb,Pb-Pb) forward energy & particle flows will provide valuable information to test/tune the models of “Extended Air Showers”). Also: study of anomalous EM-to-HADR energy-deposti profiles observed in cores of 10^{15}-10^{17} eV cosmic-ray showers (“Centauro” events).

6. Heavy-ion physics: Basic Level-1 trigger and centrality determination detector for heavy-ion collisions. Also: measurement of forward energy in Pb-Pb collisions.

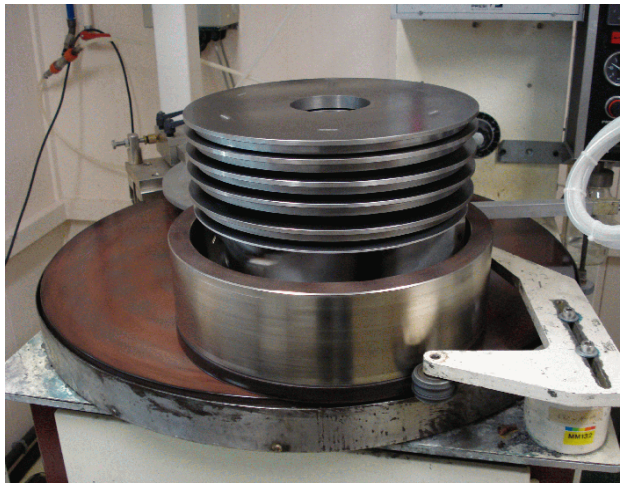
Phase 1: Quartz plate cutting/polishing/lapping

- Quartz plates were extracted from DELPHI experiment and were cut/lapped/polish to match CASTOR specifications.
- We helped in various steps (cleaning, polishing) of this mechanical process.

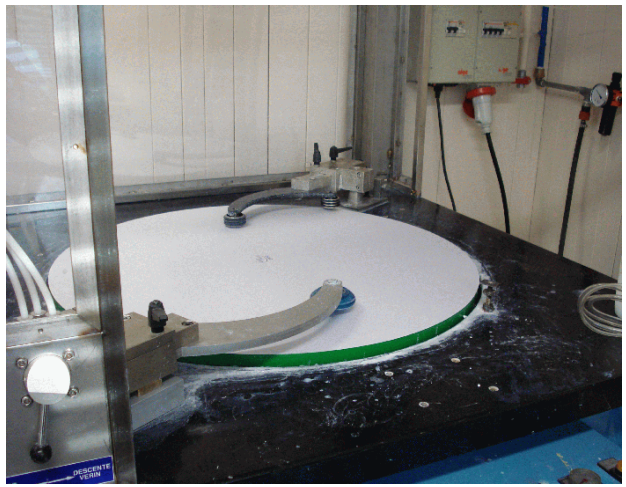


CUTTING

LAPPING

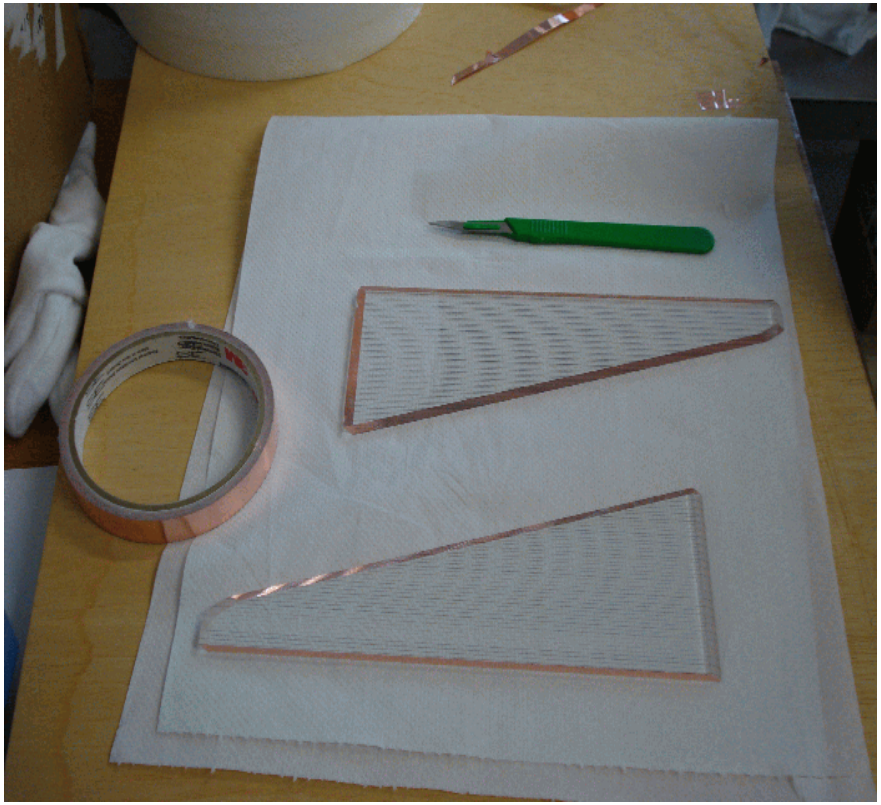


POLISHING

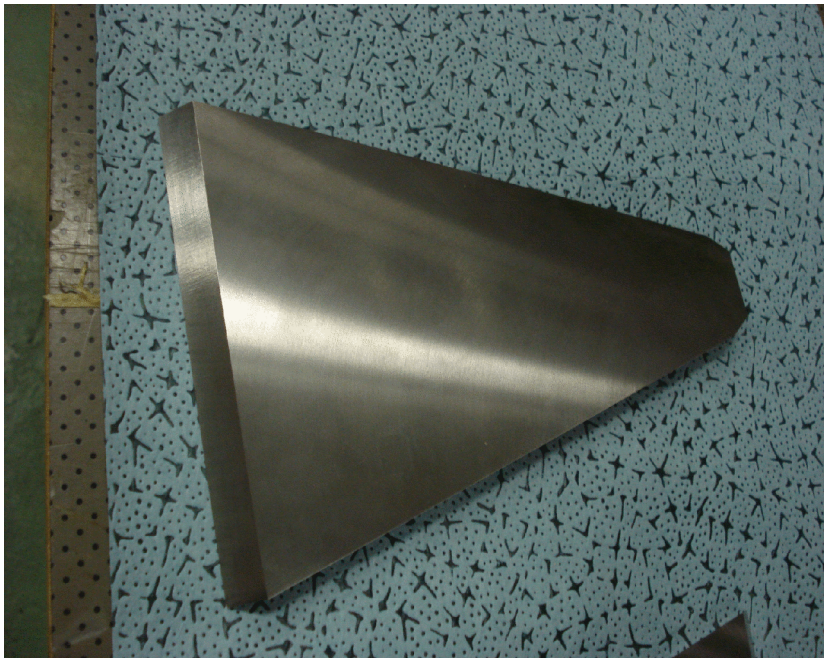


Phase 1 (end): CASTOR (HADR section) elements

- Quartz plates (4 mm)



- Tungsten plates (10 mm)

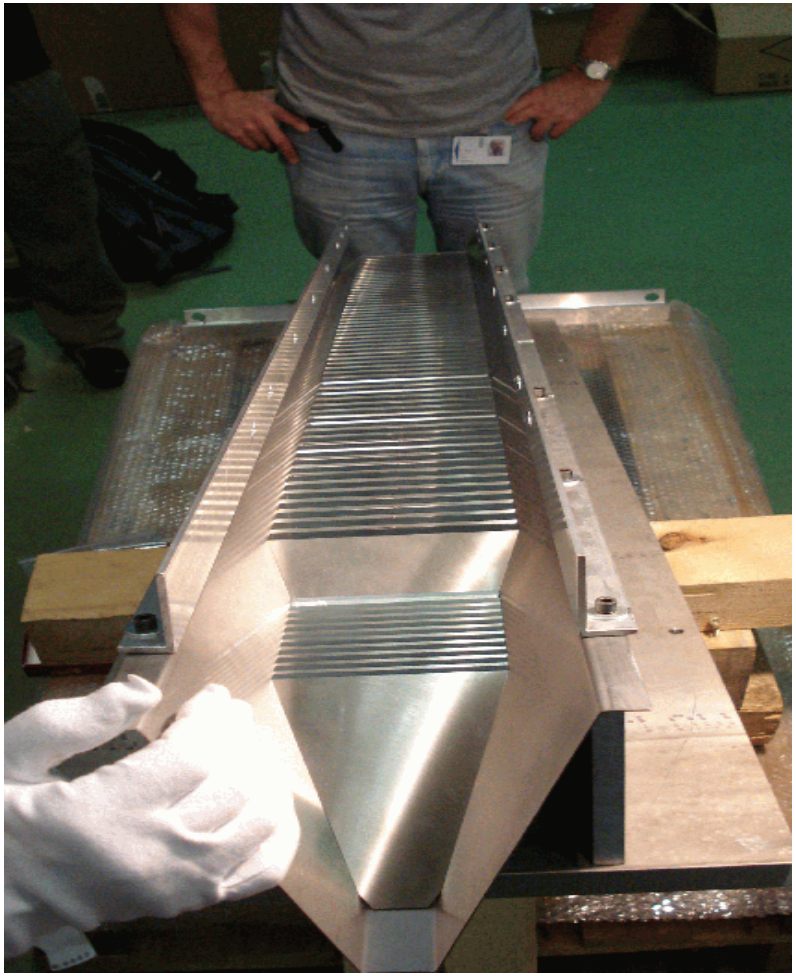


Phase 2: Reflecting foil around quartz edges

- Reflecting copper foil needs to be glued to the Q-plate edges to avoid light “cross-talk” between left-right plates.

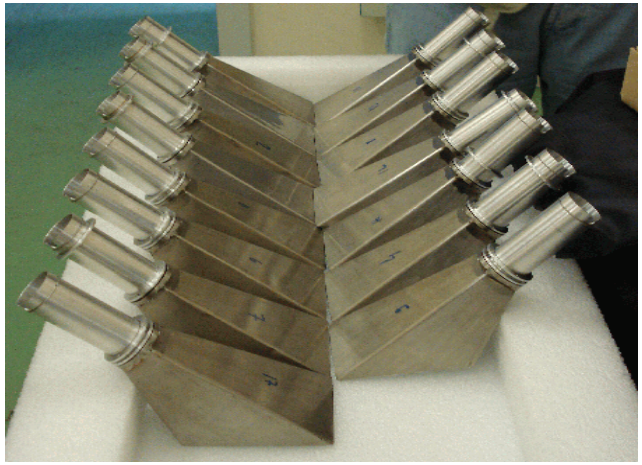
Phase 3: Mounting of prototype (I)

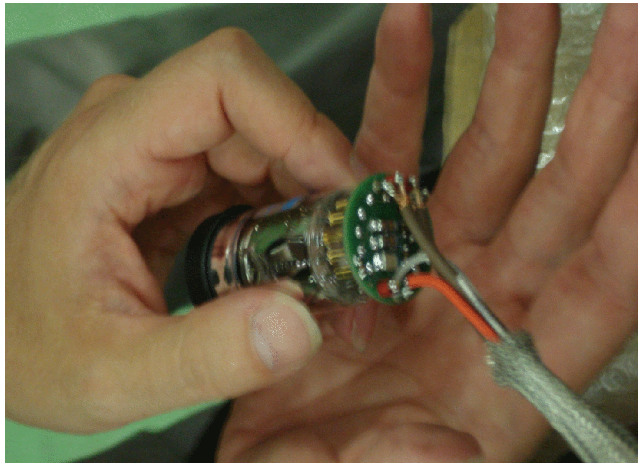
- Positioning of Tungsten & Quartz plates on support

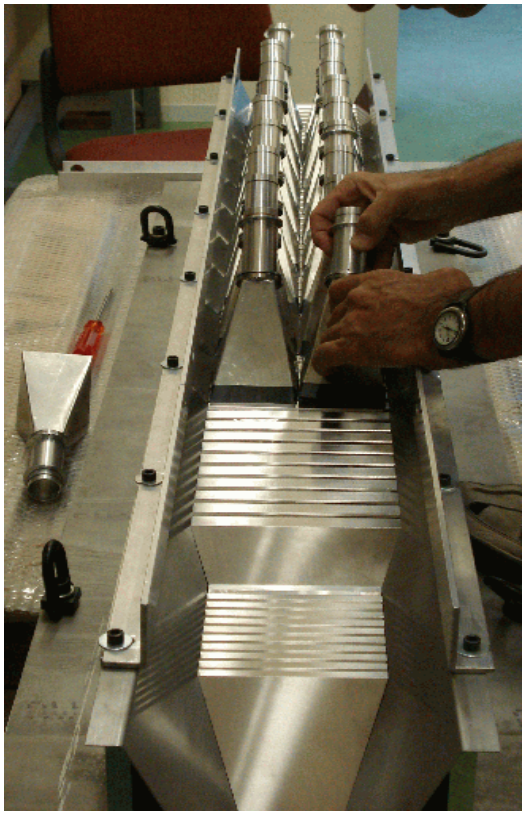


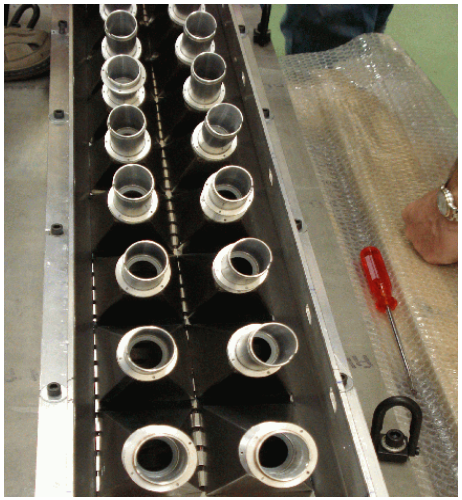
Phase 3: Mounting of prototype (II)

- Positioning of light-guides, PMTs (cases, bases) on top of plates:





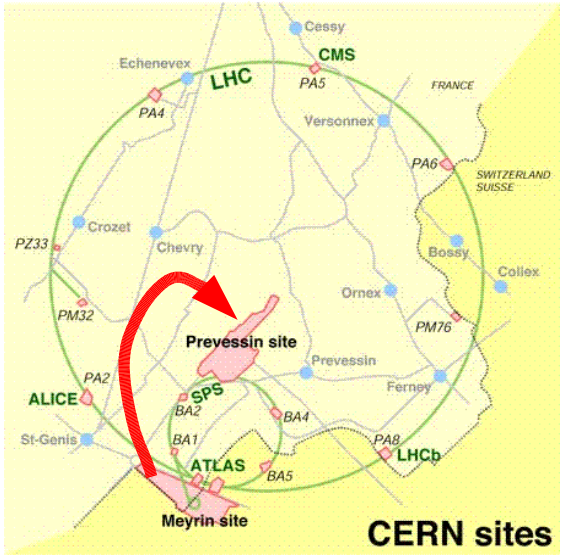




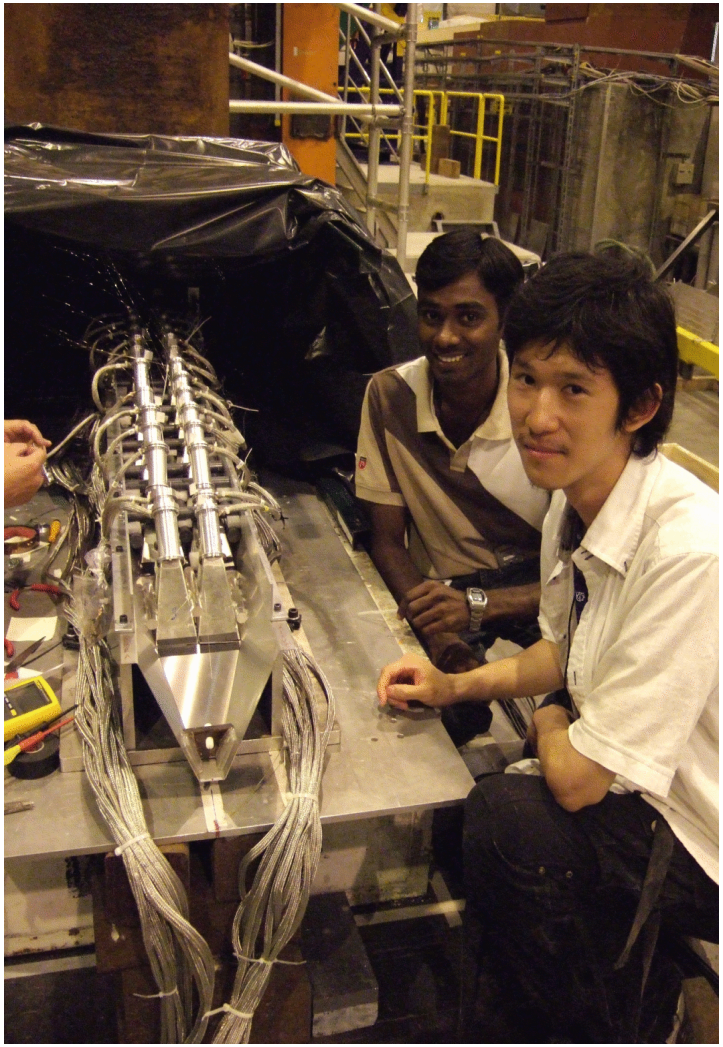
Phase 3 (end): CASTOR octant prototype (ISR lab)

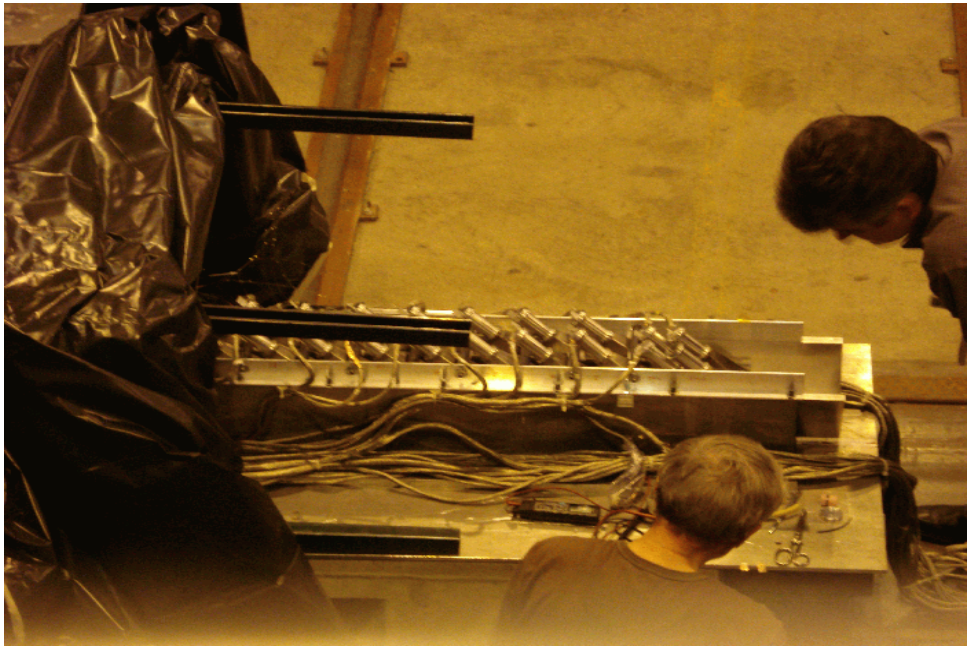
Phase 4: Transport of prototype

- From “ISR lab” (mounting) to Prevessin site (beam-test)

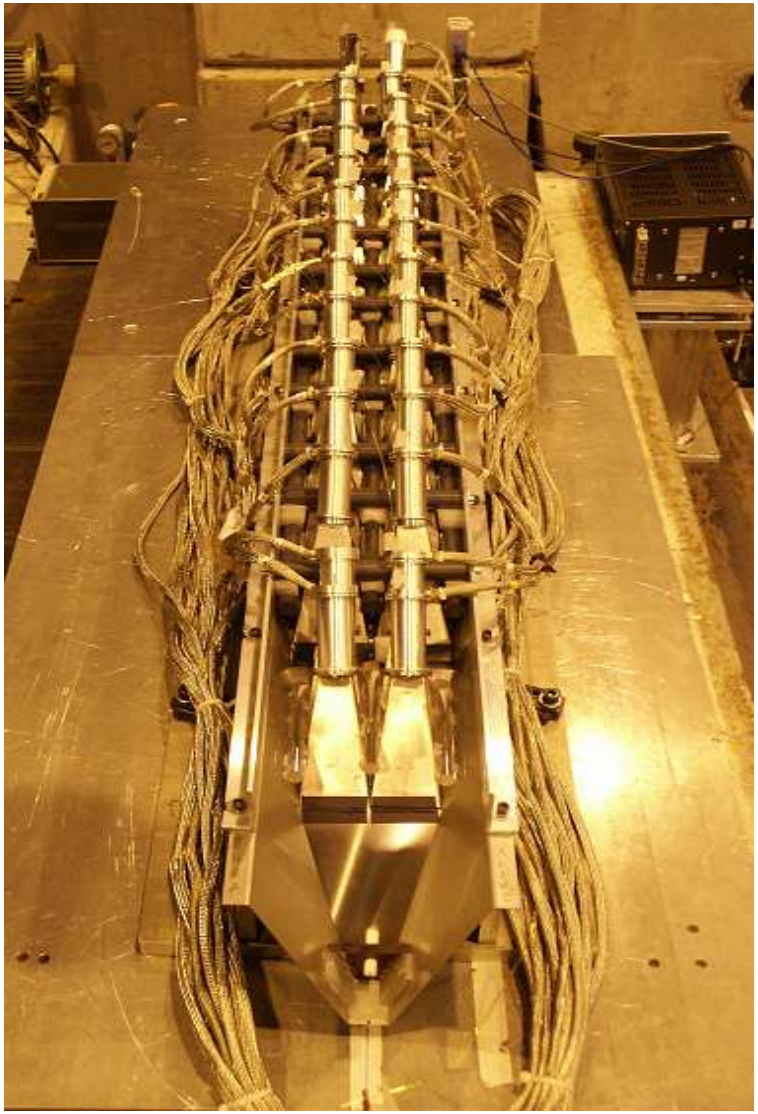


Phase 5: Final installation at H2-line

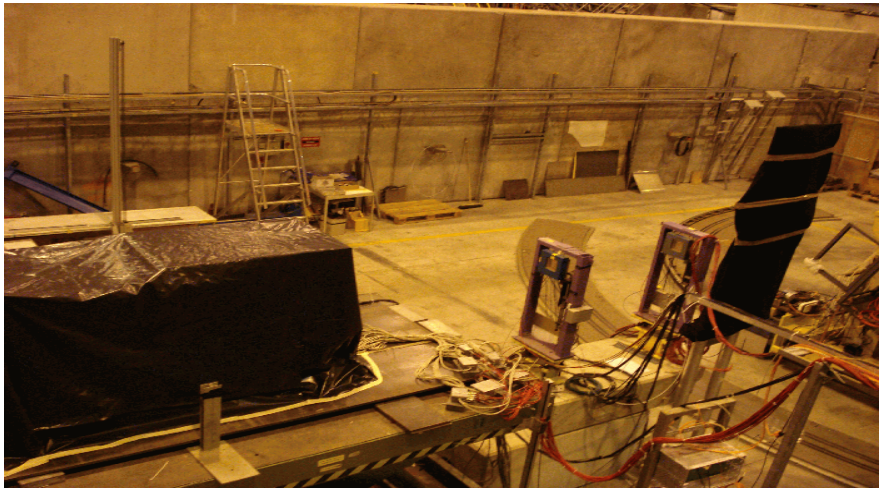




Phase 5 (end): CASTOR octant installed at H2-line

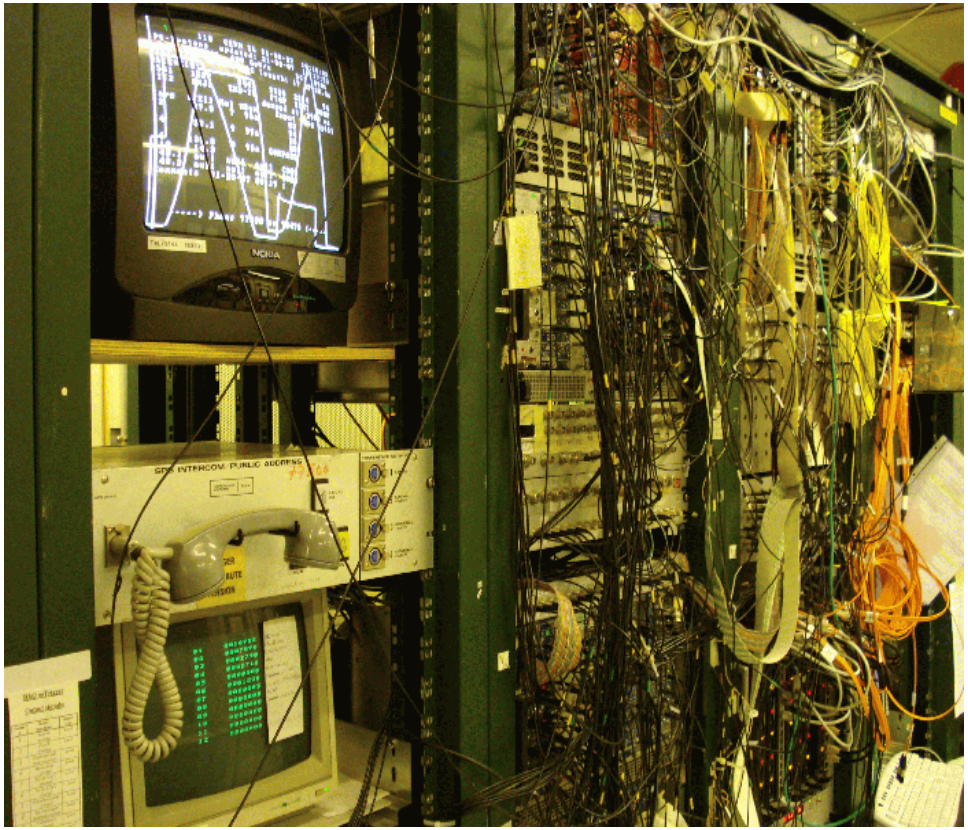


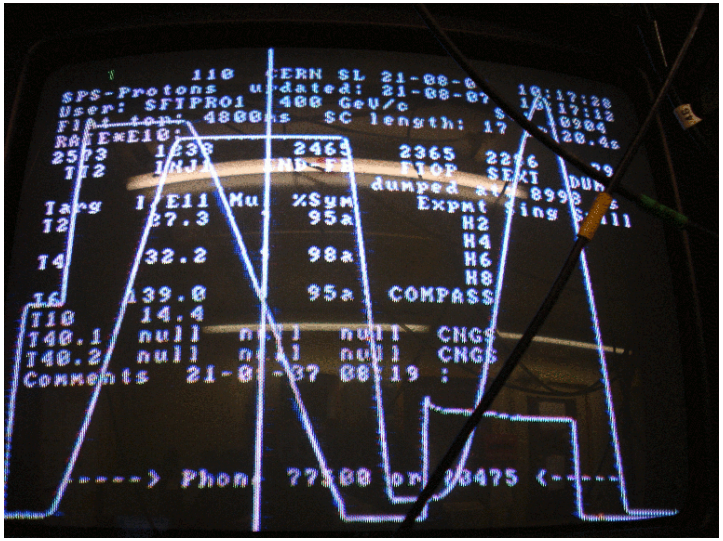
Phase 6: Beam-tests

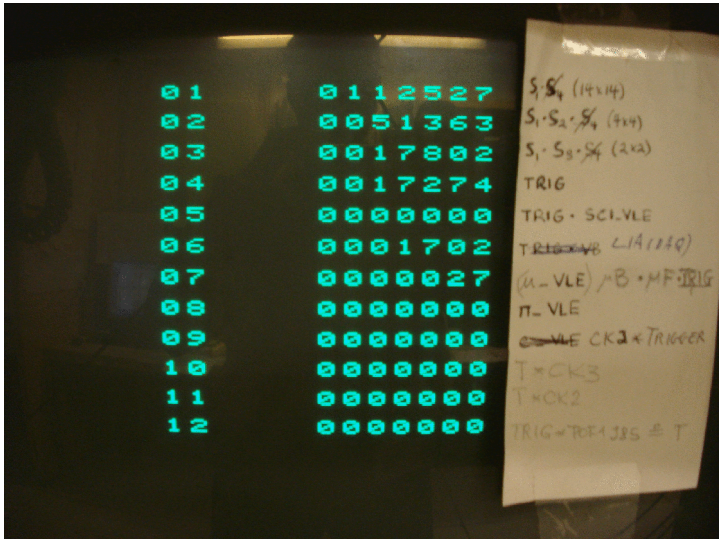


Phase 6: Taking shifts during beam-tests

- H2-line counting room:

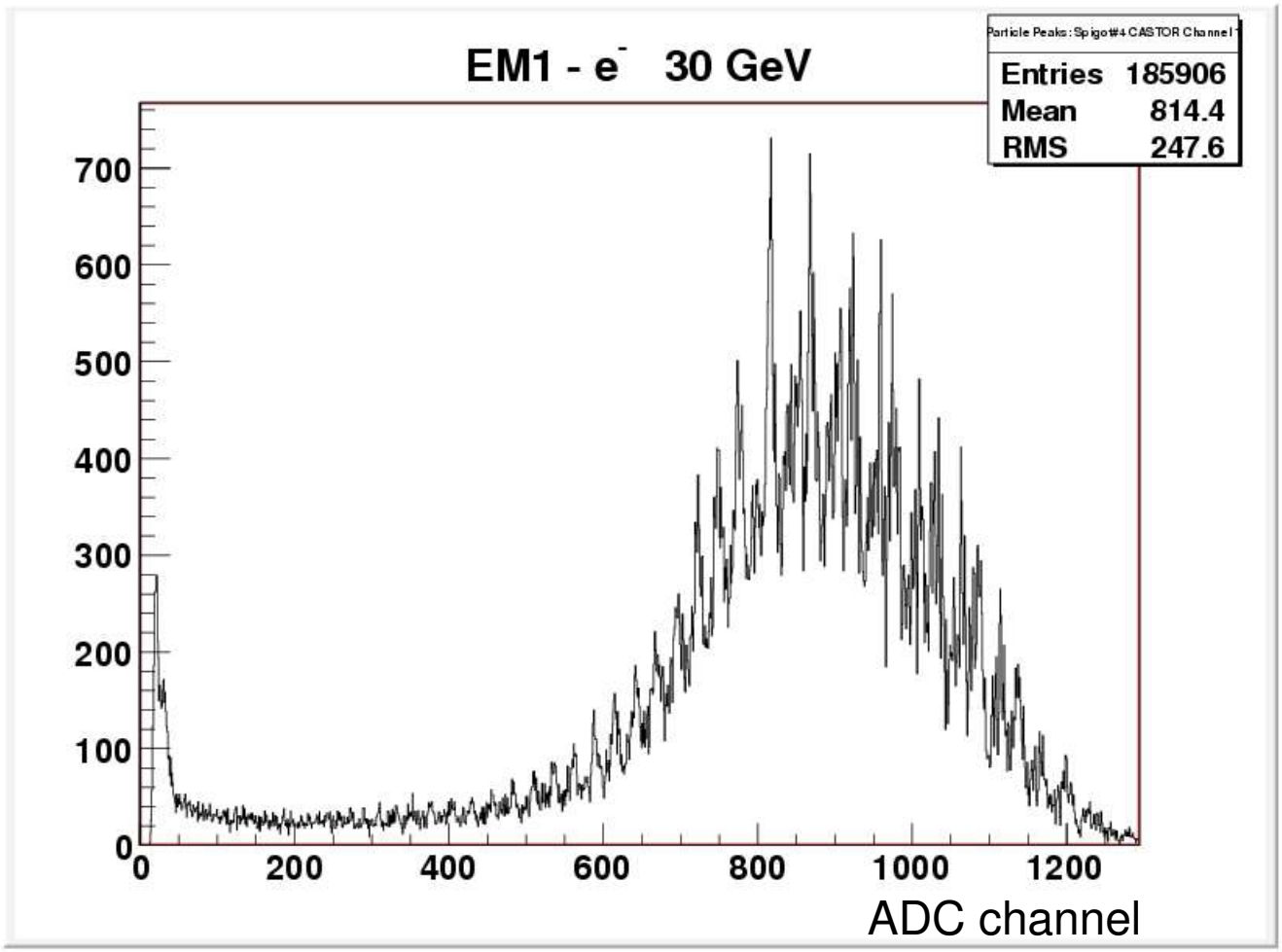






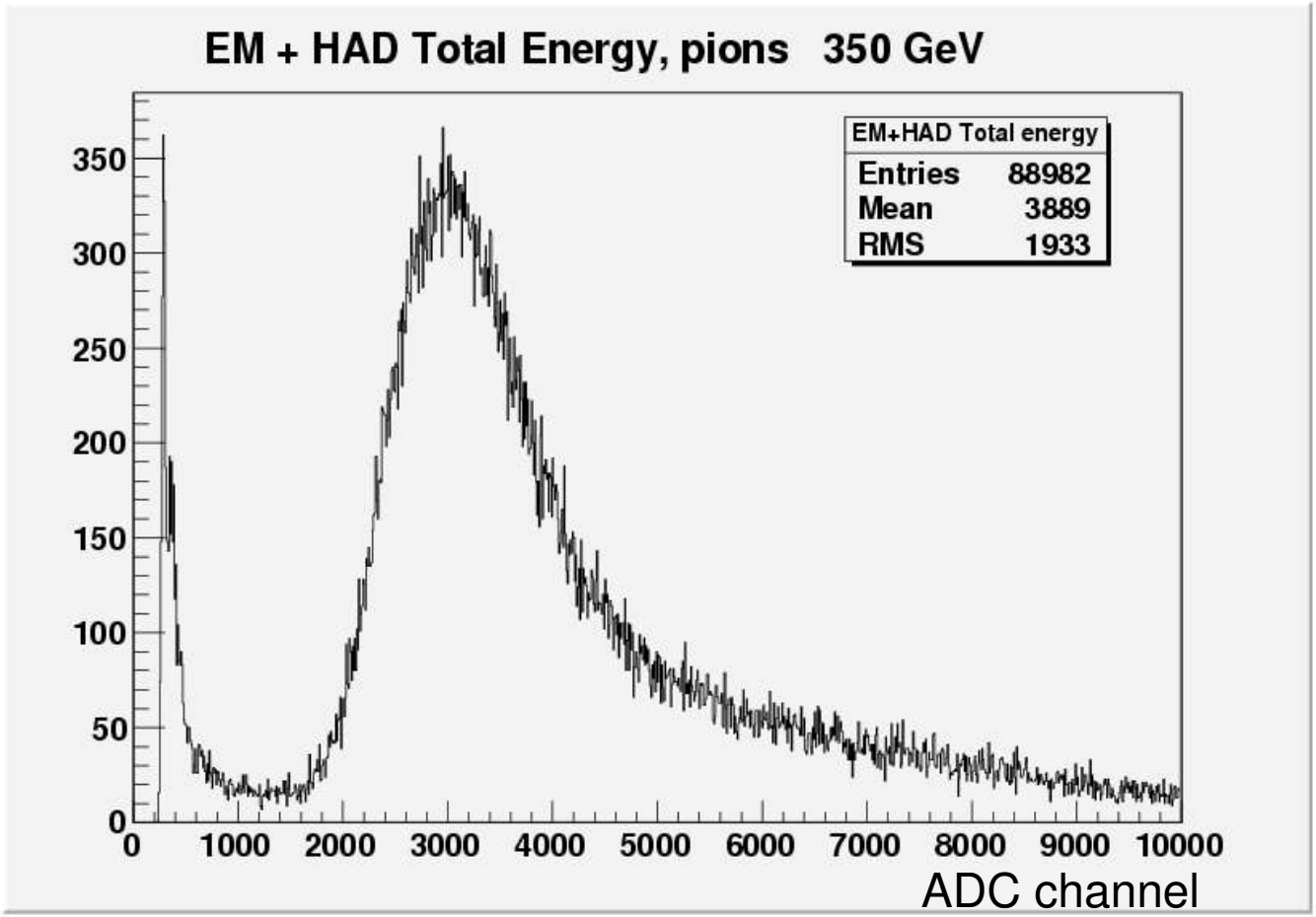
Phase 7: Some (online) results (I)

- Energy deposited in plate-1 of EM section (e- beam, 30 GeV)



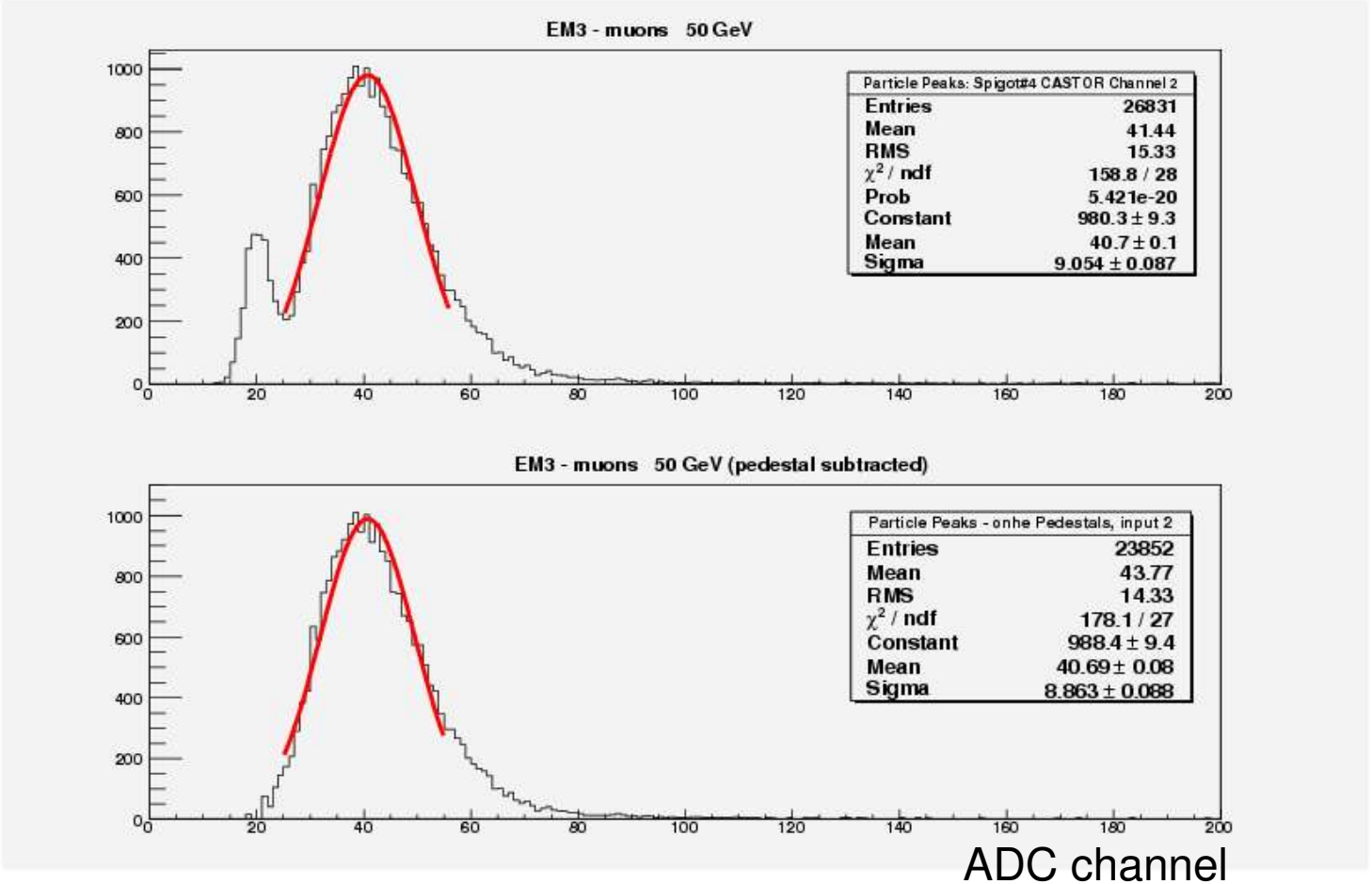
Phase 7: Some (online) results (II)

- TOTAL energy deposited in EM+HAD sections (pions, 350 GeV)



Phase 7: Some (online) results (II)

- Energy deposited in plate-3 of EM section (muon beam, 50 GeV)



Summary

- We have participated in the summer'07 CASTOR beam-tests: detector mounting/assembly and shifts. [The tests ended just yesterday at midnight !]
- Energy & position were scanned for each beam: e, π, μ (10 – 350 GeV).
- Several modifications (cutting of Quartz plate edges) of the calorimeter will be done to increase the light efficiency (HAD section).
- All the data will be analyzed to have a clear picture of energy linearity and resolution as well as position resolution for electromagnetic and hadronic particles and muons.

Backup slides