

CASTOR: A Calorimeter for Heavy Ions at LHC

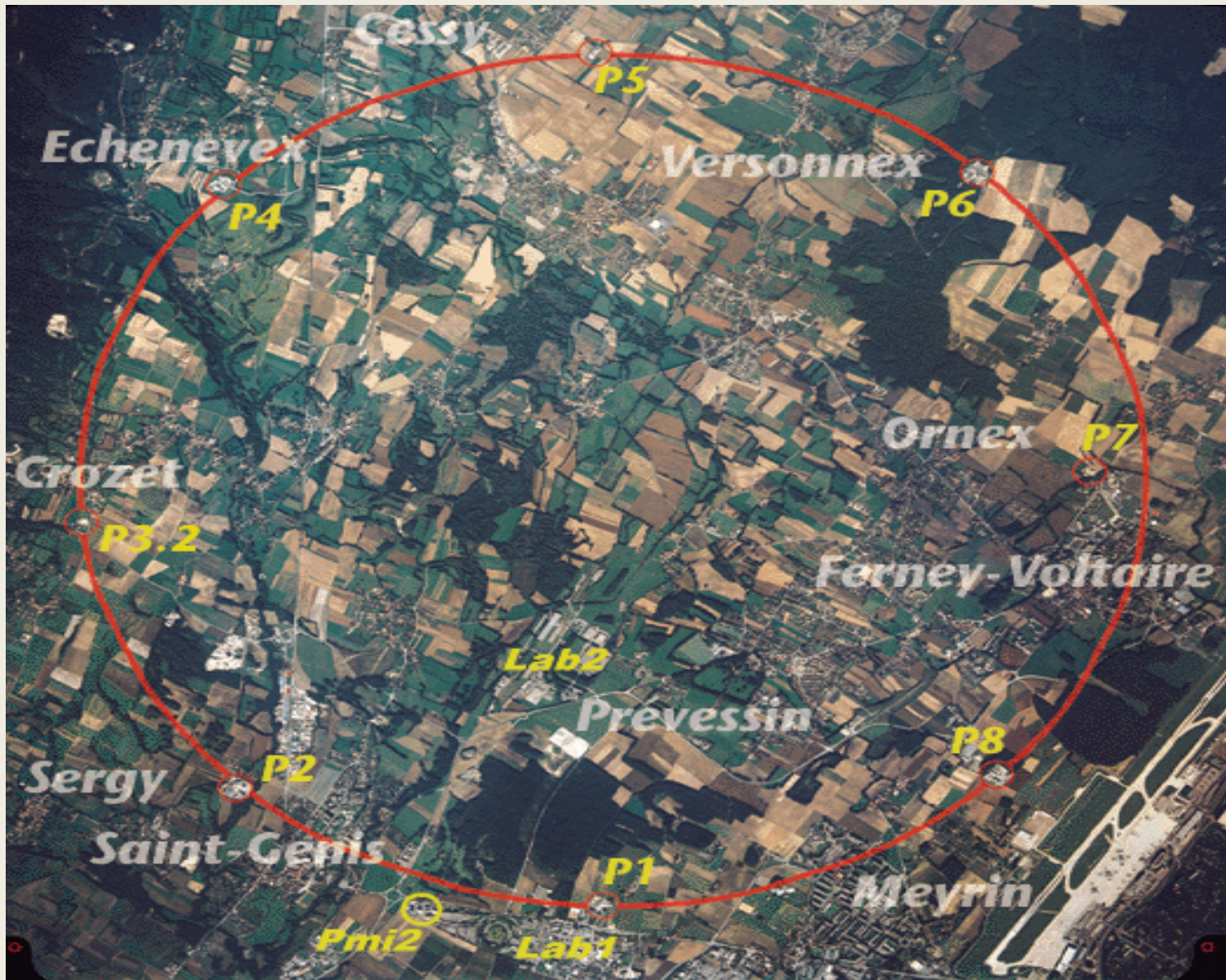
X. Aslanoglou

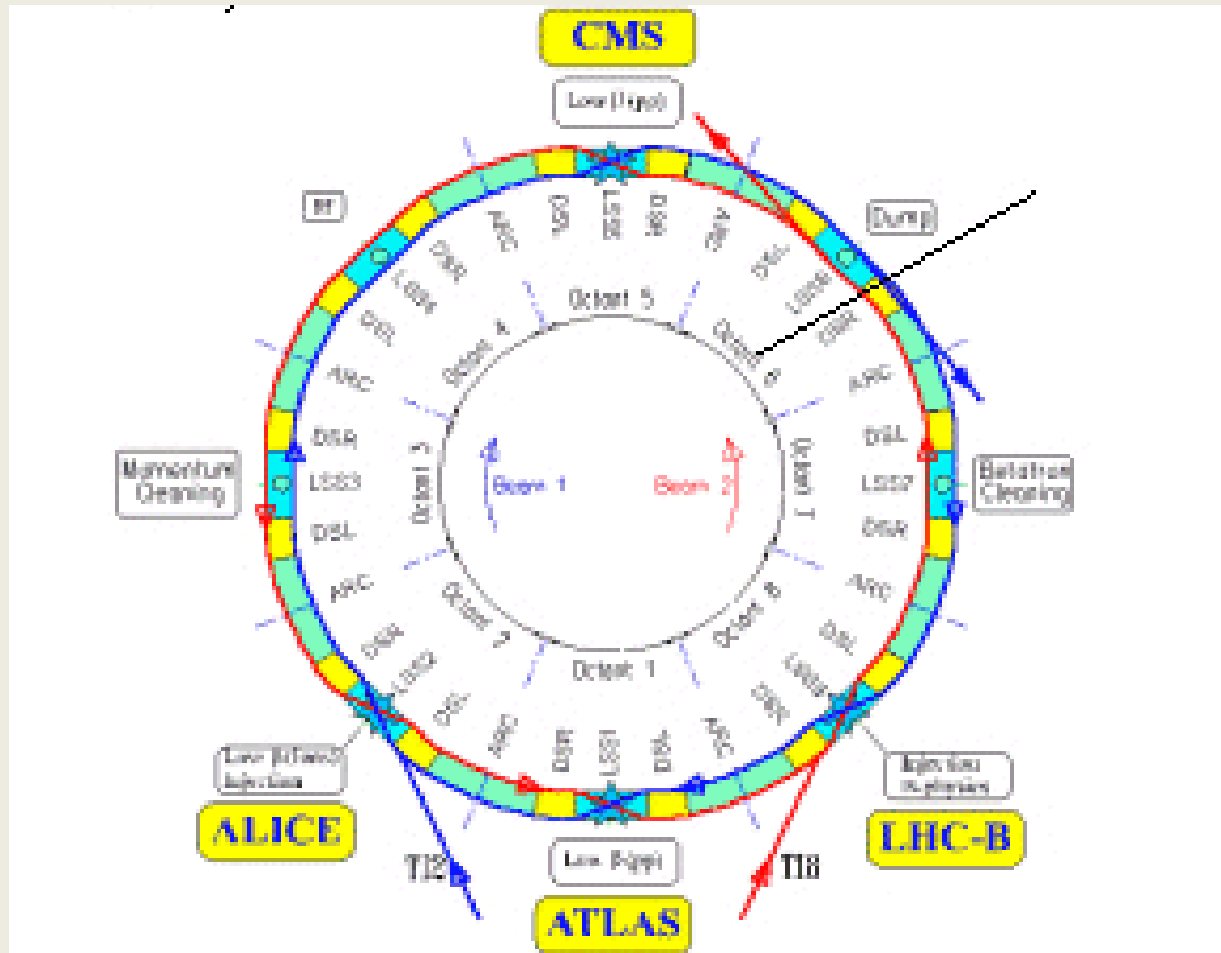
University of Ioannina,

for the CMS-CASTOR group.

CASTOR: Centauro And Strange Object Research

- CASTOR is an EM/H calorimeter system, conceived and proposed for the H. I. Physics Program at the LHC.
- It is designed for potential discovery of “New Physics” such as “Centauro” and “Strangelets”, in addition to “mainstream” Physics.
- It has been adopted for very forward pp Physics studies.





CMS Detector



Pixels
 Tracker
 ECAL
 HCAL
 Solenoid
 Steel Yoke
 Muons

SILICON TRACKER
 Pixels ($100 \times 150 \mu\text{m}^2$)
 ~1m² 66M channels
 Microstrips (50-100 μm)
 ~210m² 9.6M channels

CRYSTAL ELECTROMAGNETIC CALORIMETER (ECAL)
 76k scintillating PbWO₄ crystals

PRESHOWER
 Silicon strips
 ~16m² 137k channels

CASTOR CALORIMETER
 Tungsten + quartz plates

STEEL RETURN YOKE
 ~13000 tonnes

ZERO-DEGREE CALORIMETER

SUPERCONDUCTING SOLENOID
 Niobium-titanium coil
 carrying ~18000 A

FORWARD CALORIMETER
 Steel + quartz fibres

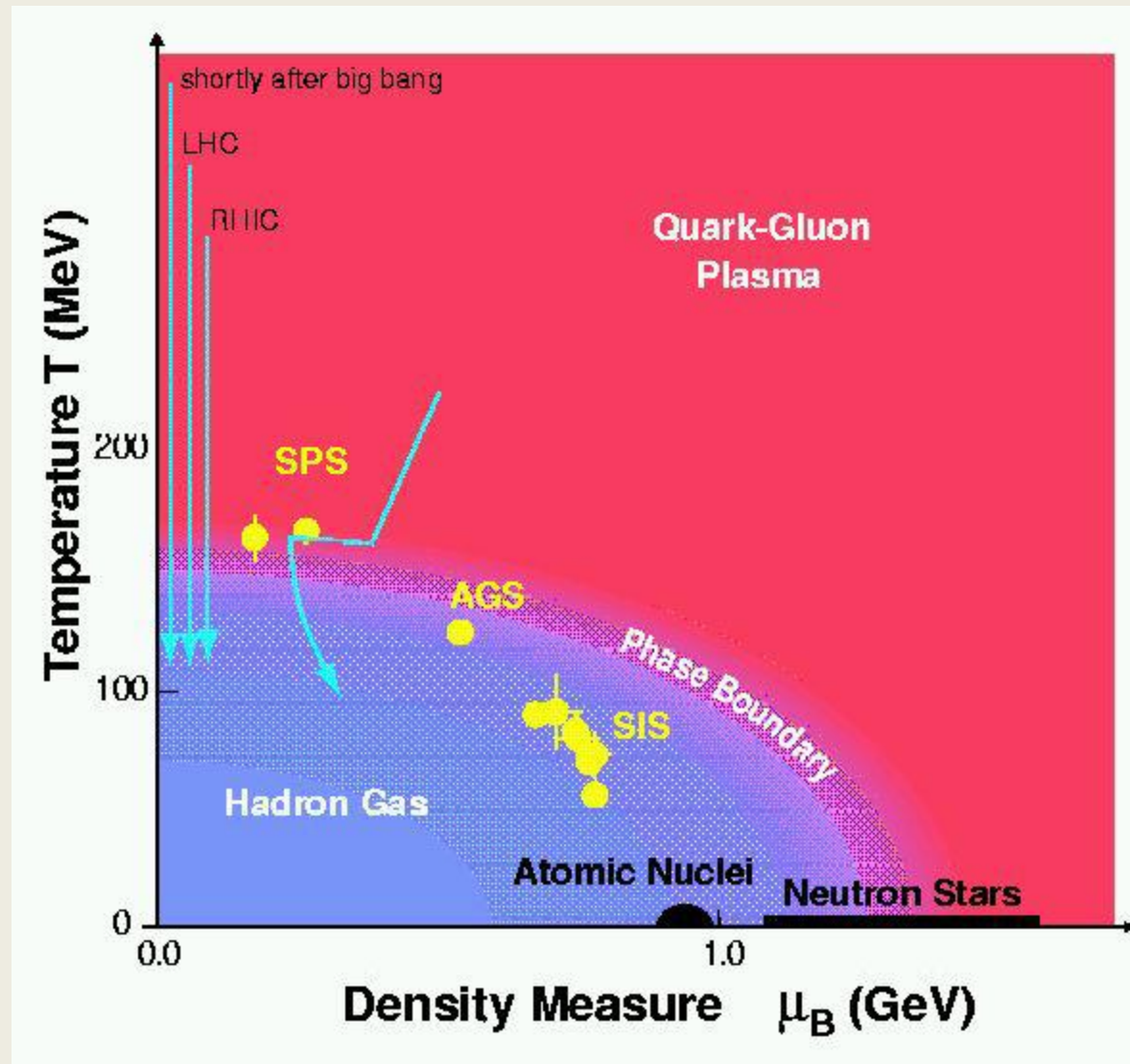
HADRON CALORIMETER (HCAL)
 Brass + plastic scintillator

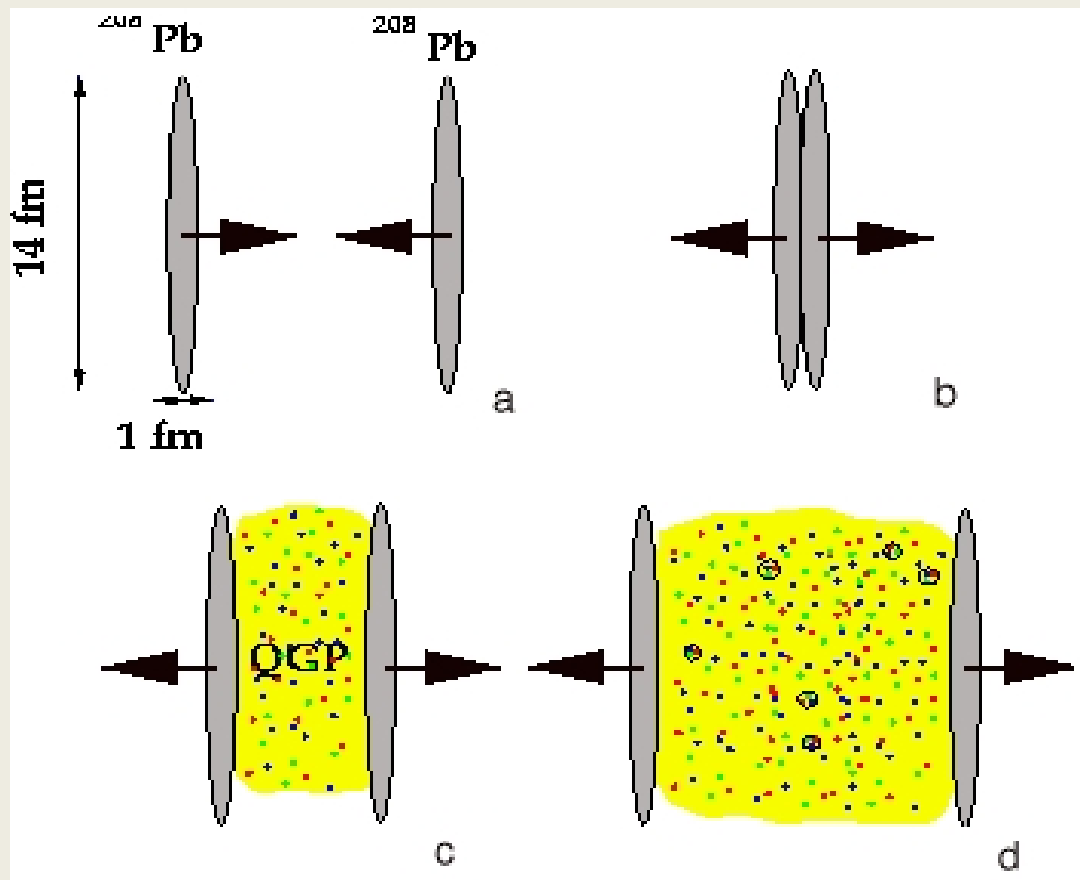
MUON CHAMBERS

Barrel: 250 Drift Tube & 500 Resistive Plate Chambers
 Endcaps: 450 Cathode Strip & 400 Resistive Plate Chambers

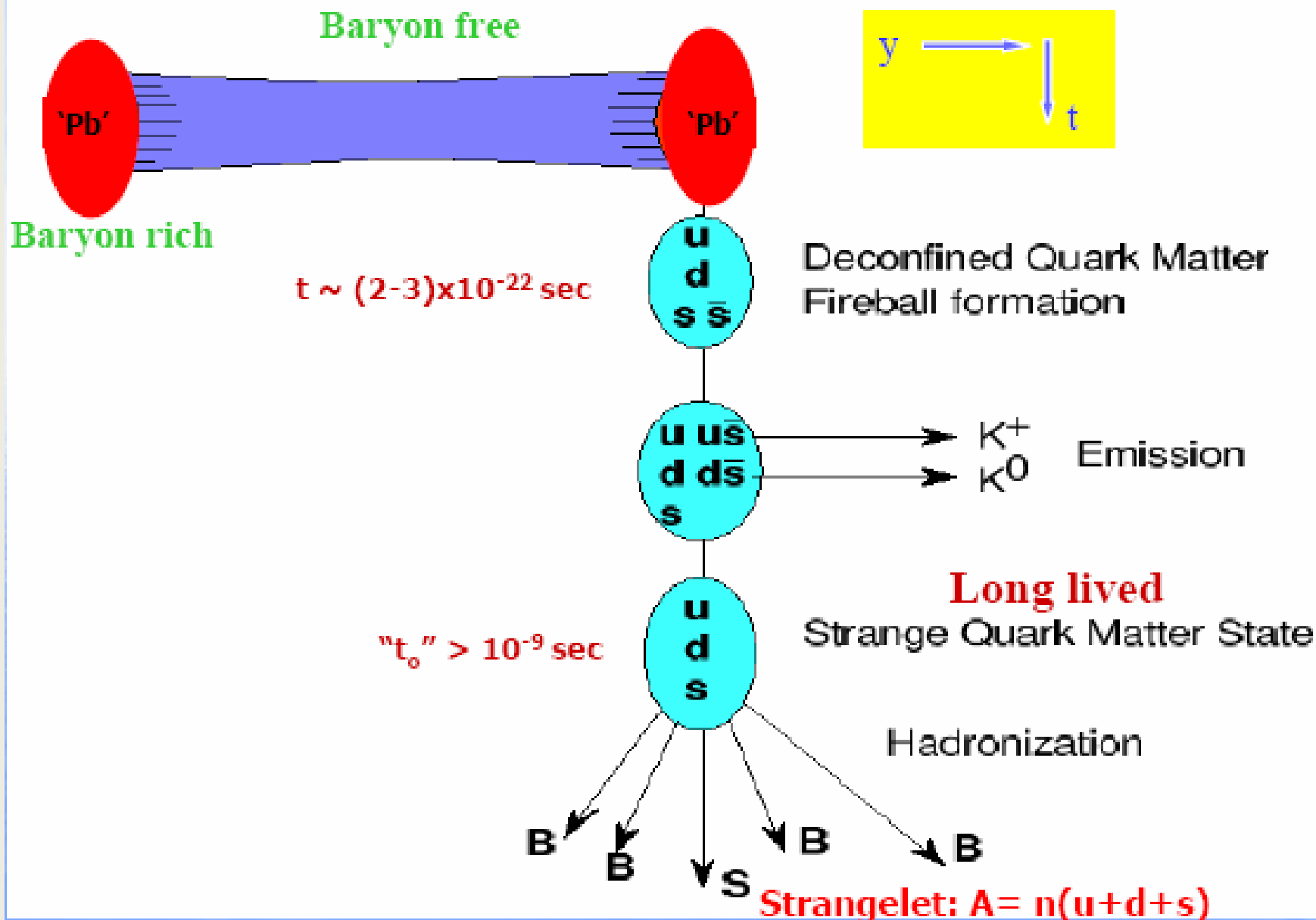
Total weight : 14000 tonnes
Overall diameter : 15.0 m
Overall length : 28.7 m
Magnetic field : 3.8 T

- Strangelets: Clusters of more than 3 quarks ($A=20-100$)
- Enhanced Strangeness

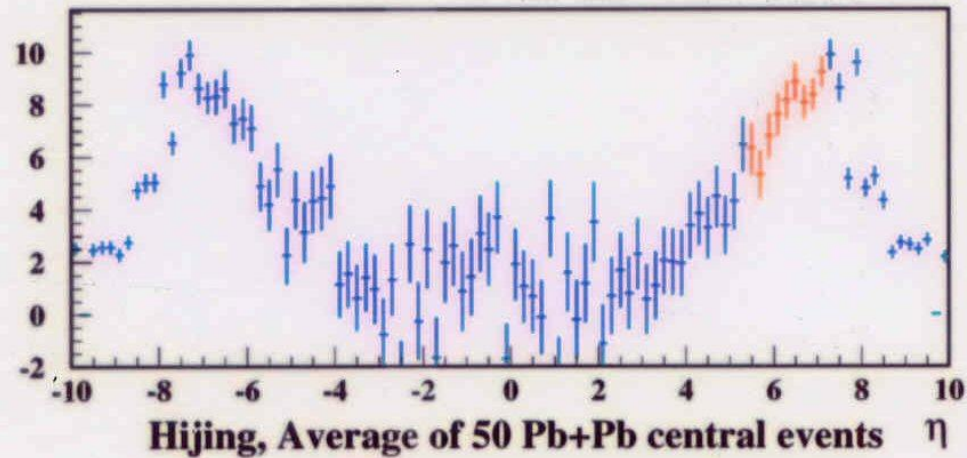
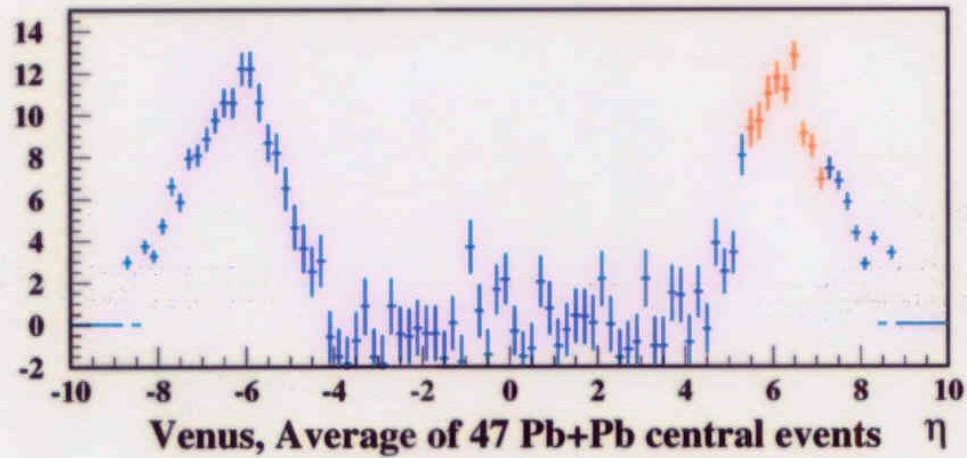




Schematic Representation of the Centauro Model



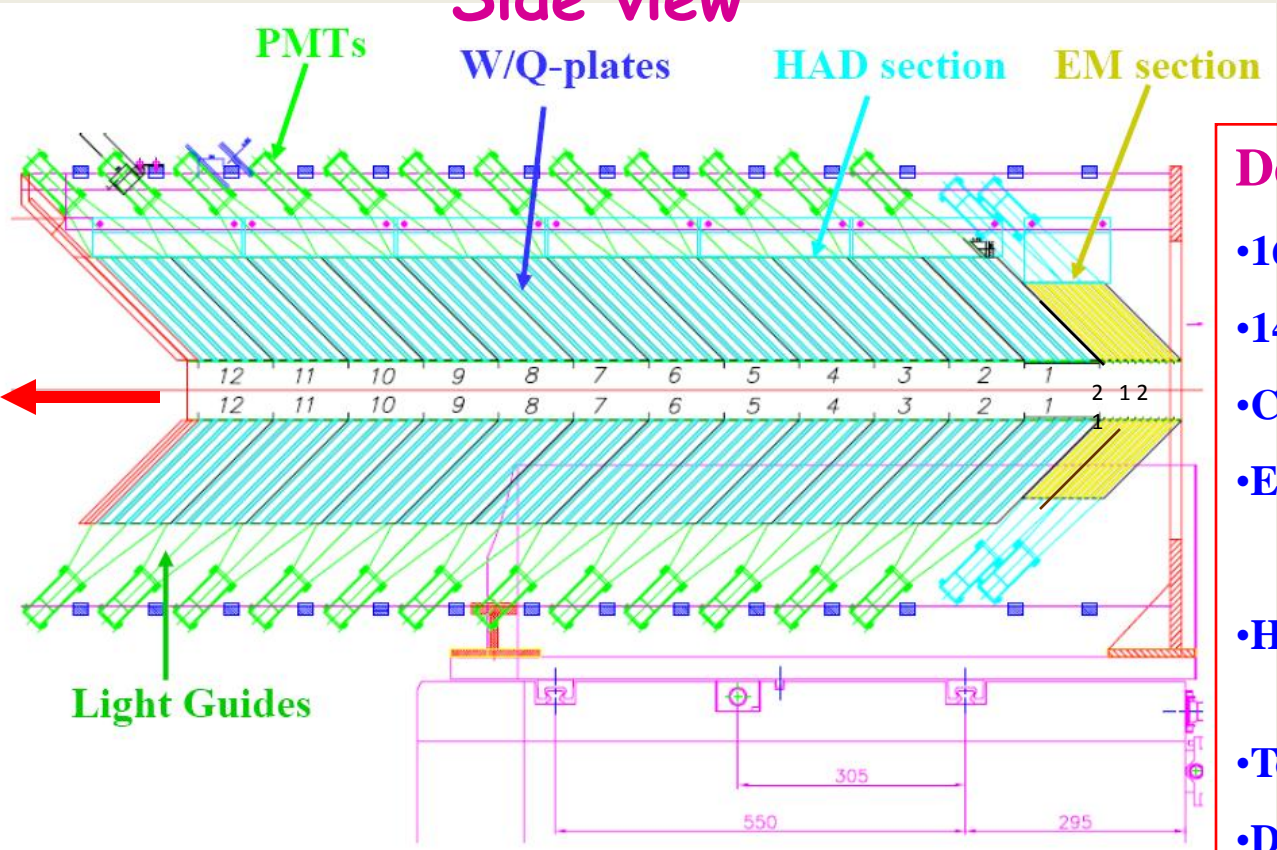
Baryon Number at the LHC In Red the CASTOR Acceptance





CASTOR Calorimeter: Design Parameters

Side view

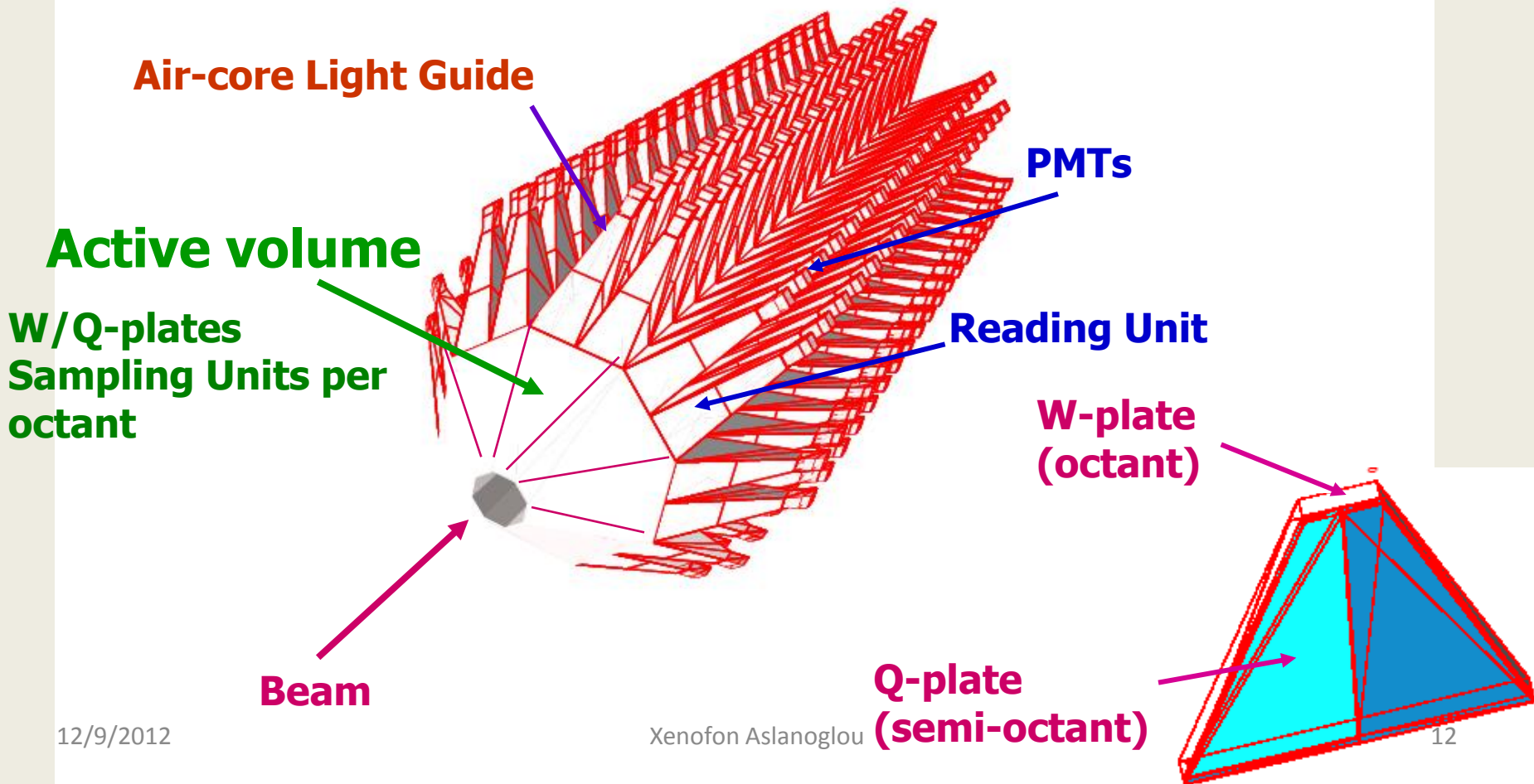


Design Parameters

- 16-fold azimuthal segmⁿ
- 14-fold longitudinal segmⁿ
- Channels = 16 x 14 = 224
- EM-section: 2 x 10 X₀ → 0.77 λ_I
W/Q-plates = 5/2mm
- HD-section: 12 x 0.77 λ_I → 9.24 λ_I
W/Q-plates = 10/4mm
- Total Length = 1616 mm
- Diameter = 560 mm



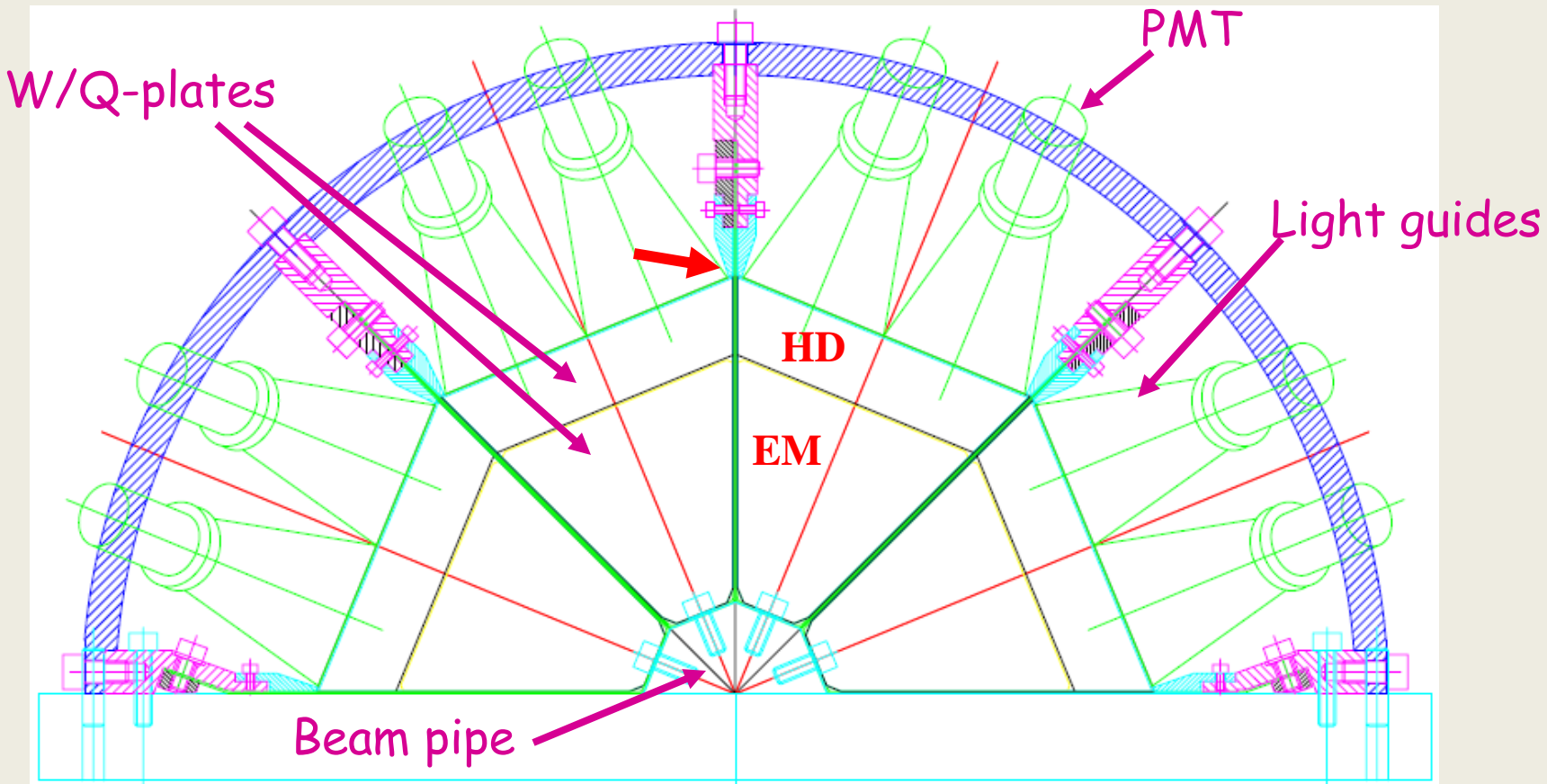
CALORIMETER CONCEPTUAL DESIGN



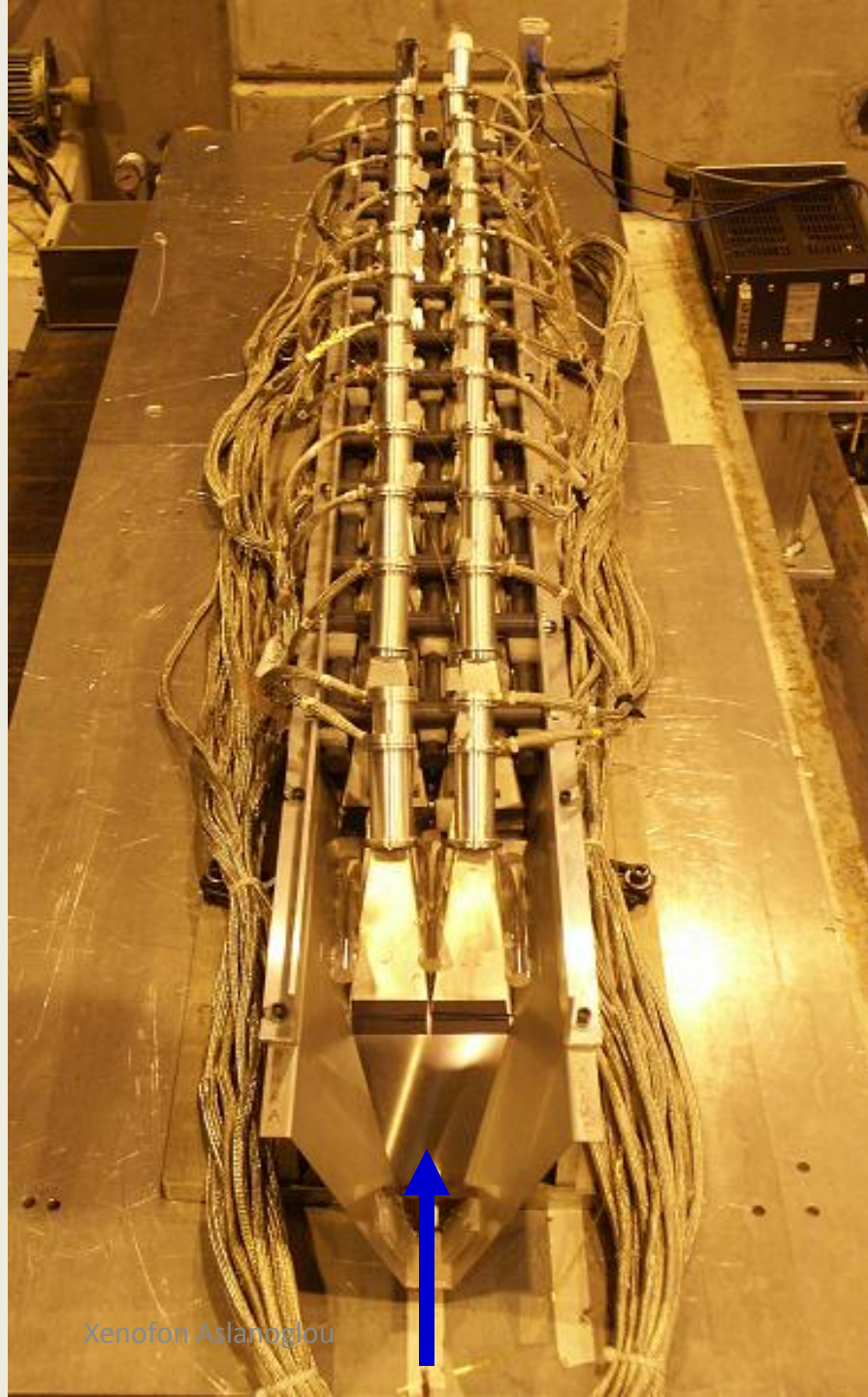
CASTOR Calorimeter Design

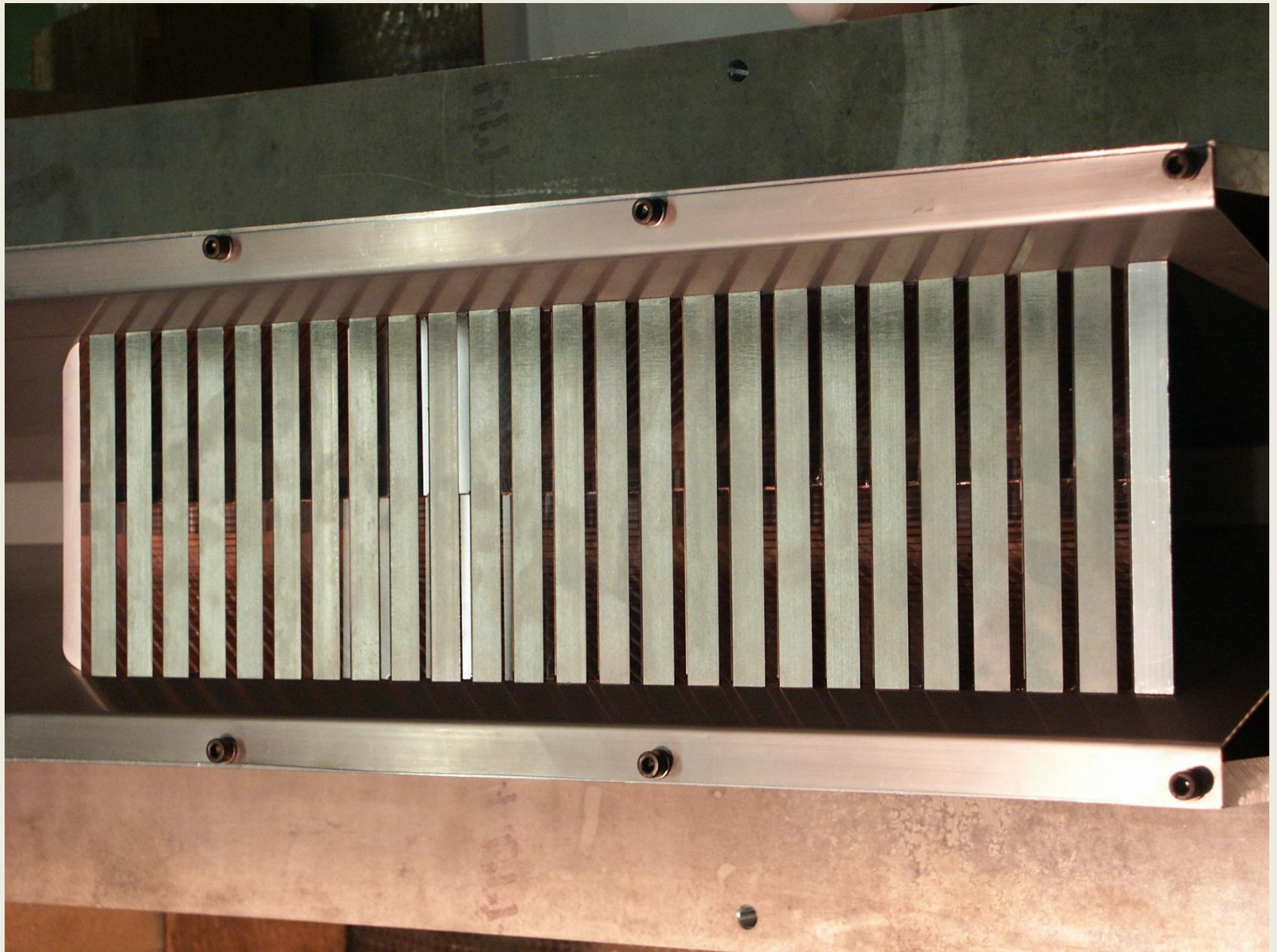


Front view



One Sector Prototype





Behavior of individual elements for electrons and pions



Electron beam studies

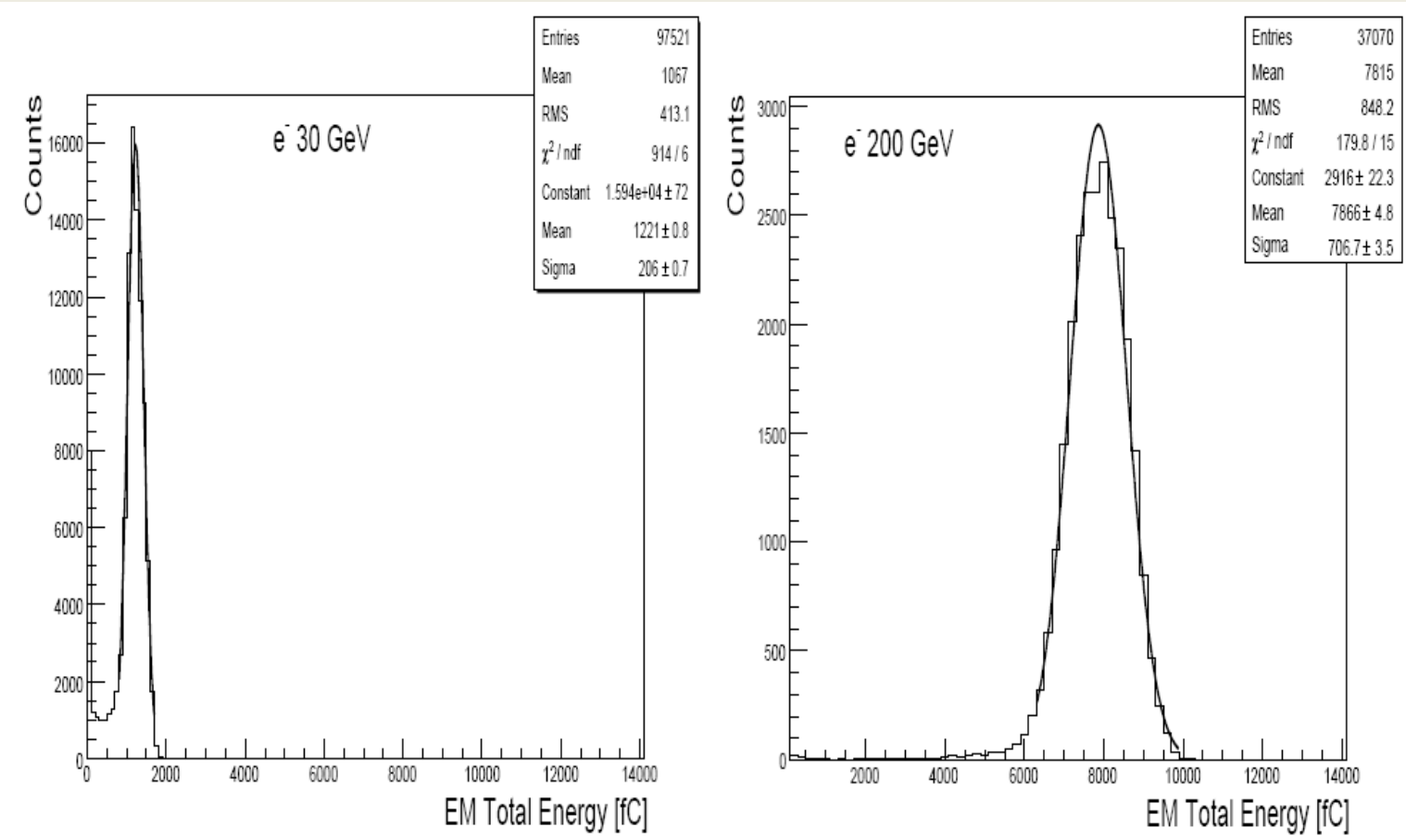
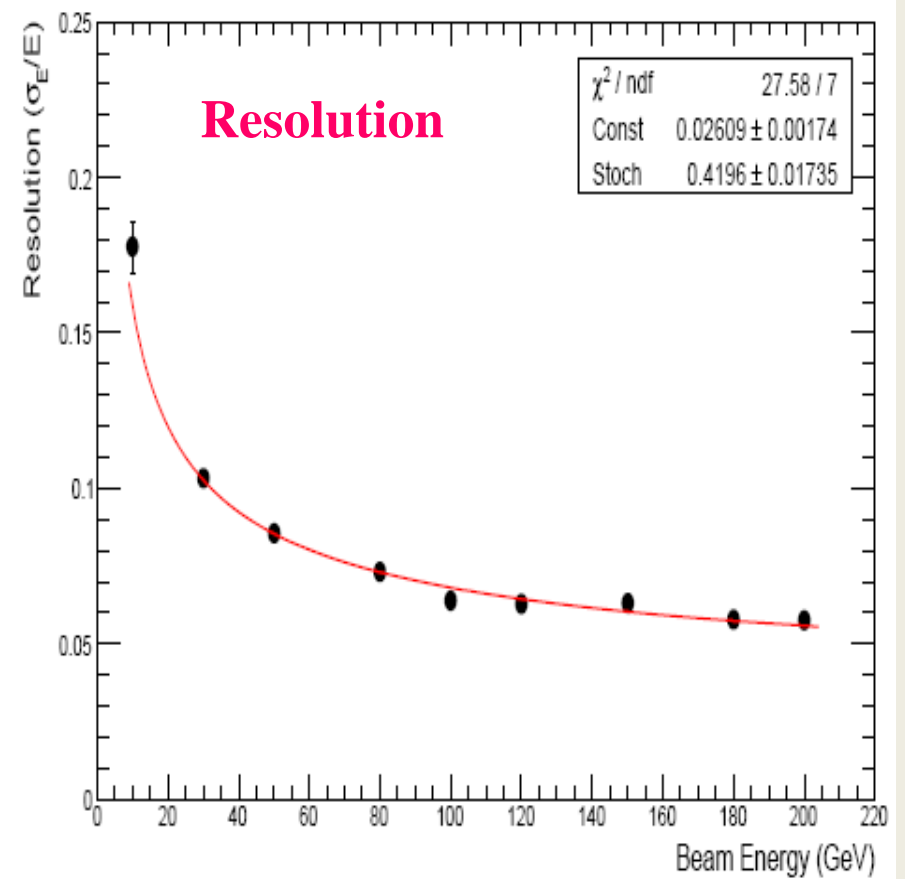
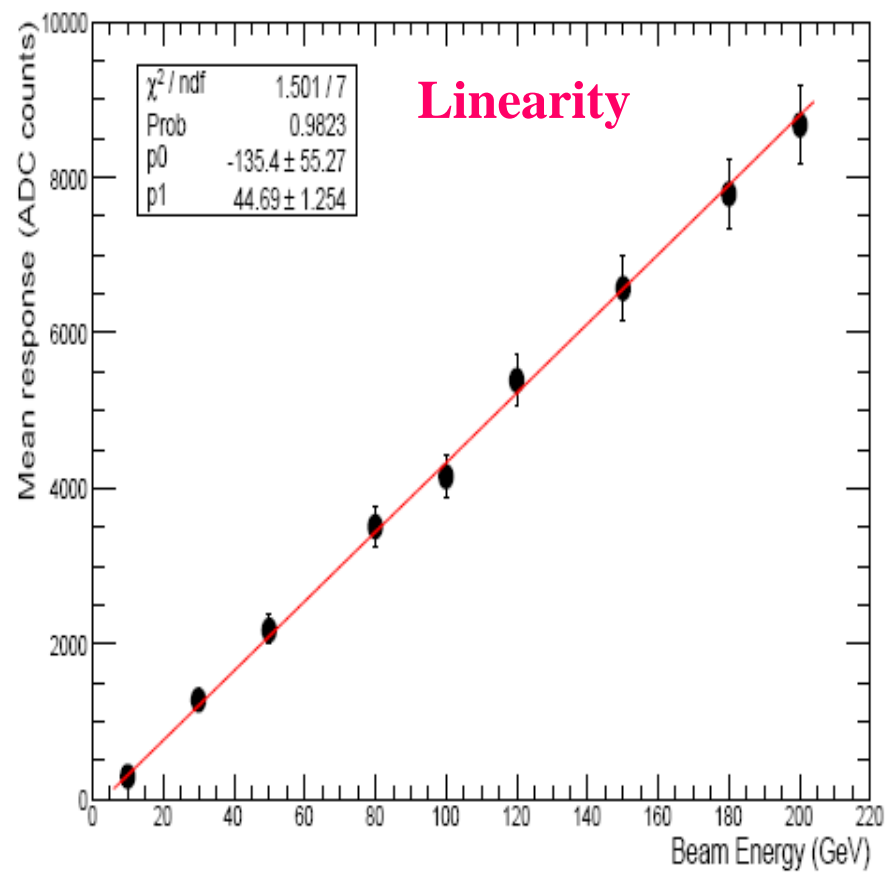


Figure 11: Energy response of the EM calorimeter, equipped with Hamamatsu PMTs, to 30 GeV (left) and 200 GeV (right) electrons. The signal amplitudes are fitted by Gaussian distributions.



Electron beam studies





Pion beam studies

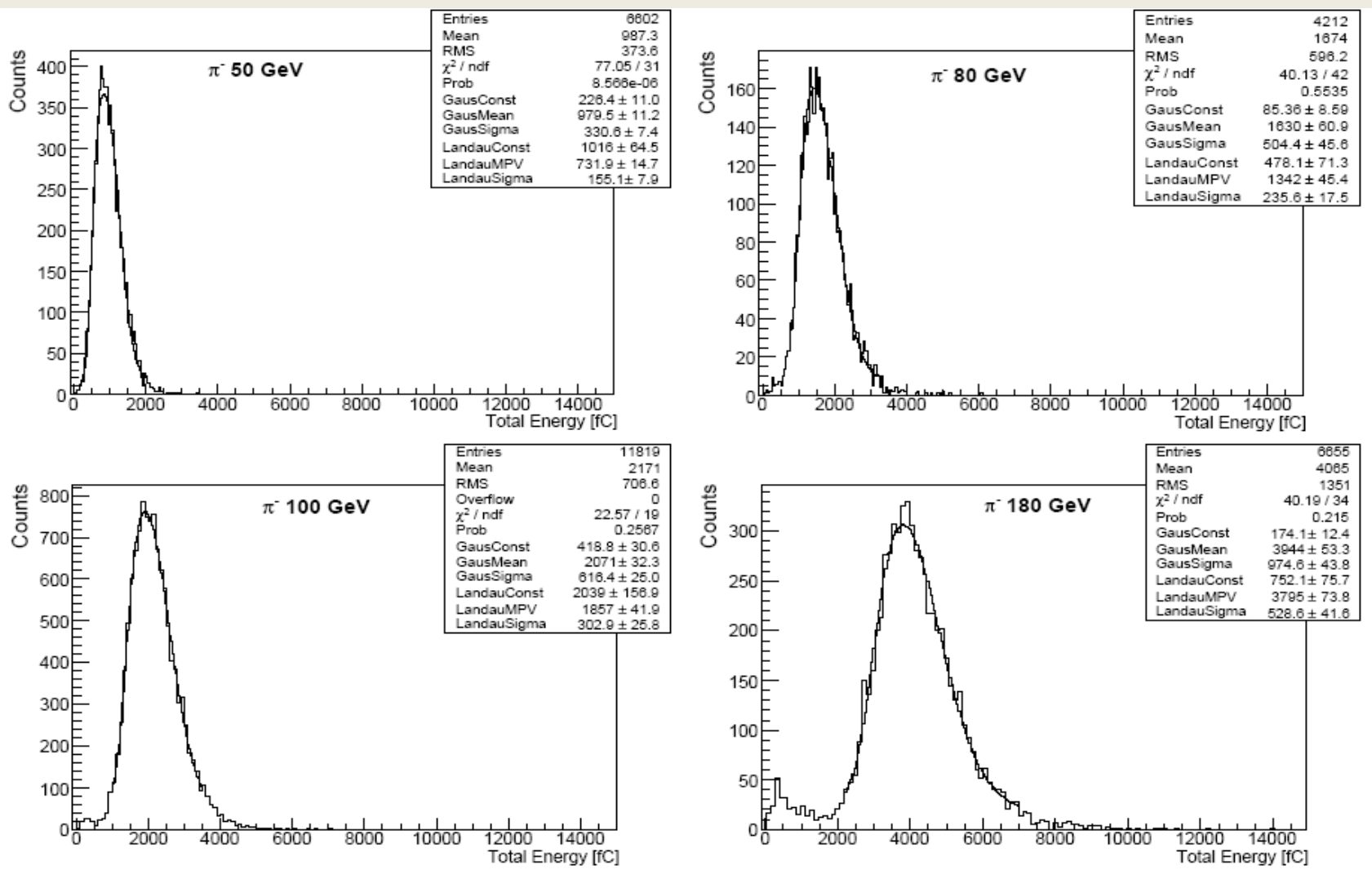
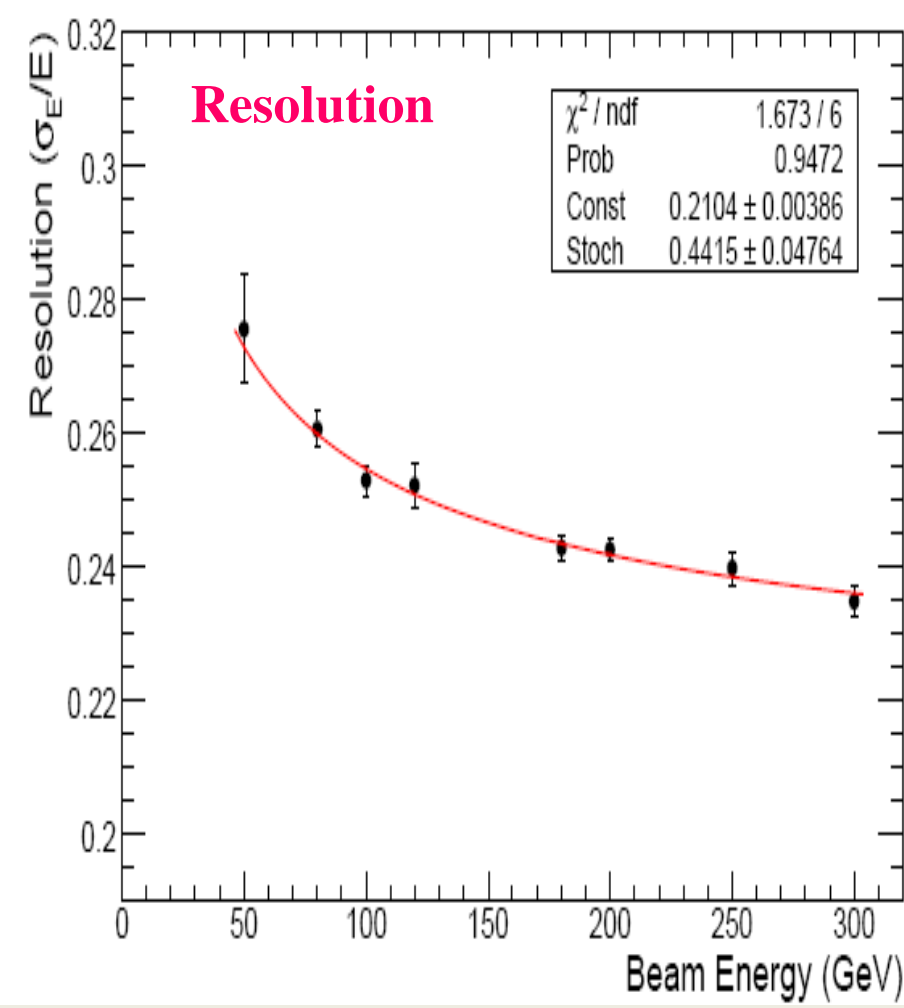
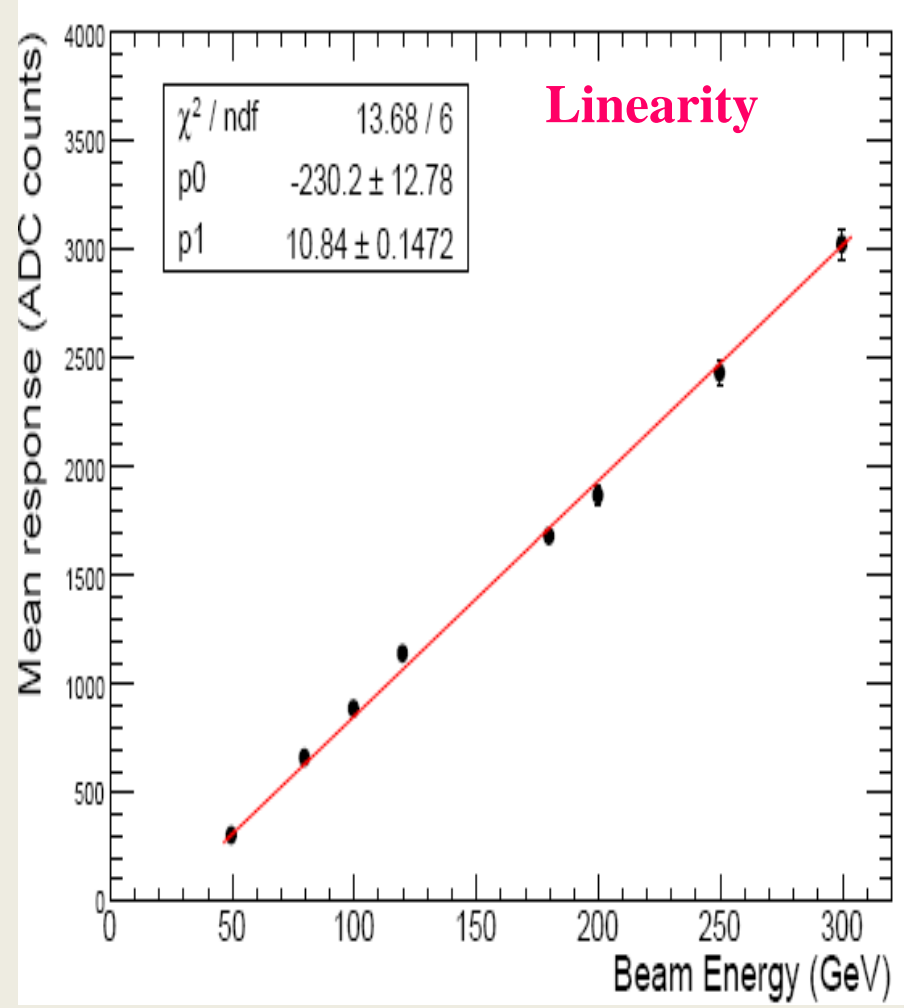


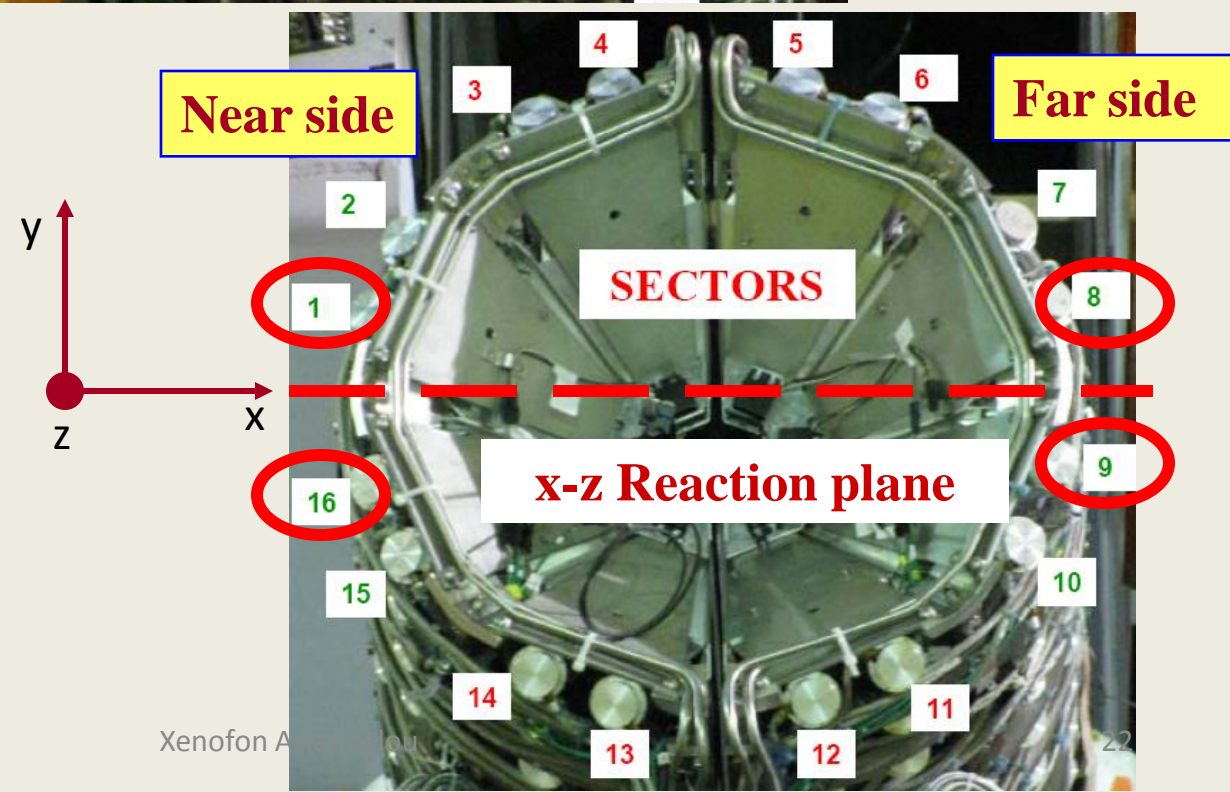
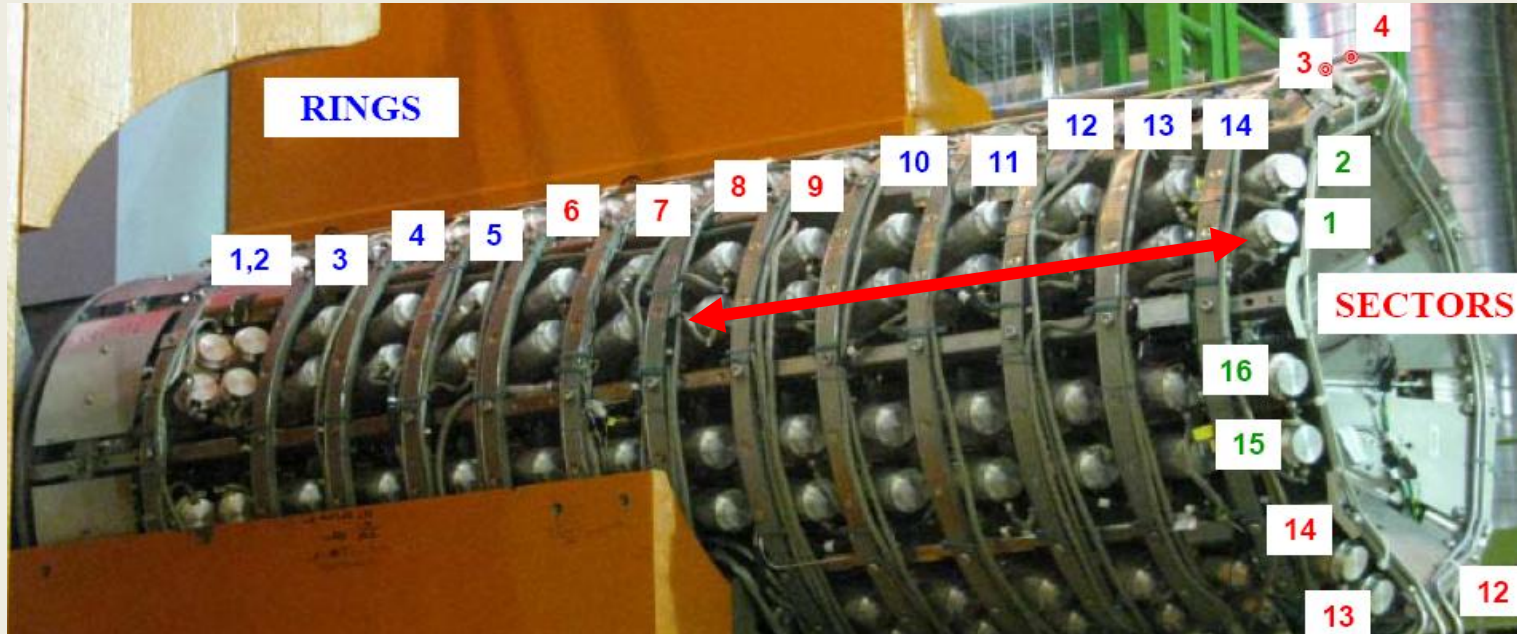
Figure 20: Total energy spectra (fC), measured in the final CASTOR prototype, after pedestal subtraction, for the 50, 80, 100 and 180 GeV pion beam. The pion peak is fitted to a convoluted Landau and Gaussian curve with fit parameters reported in the inset.

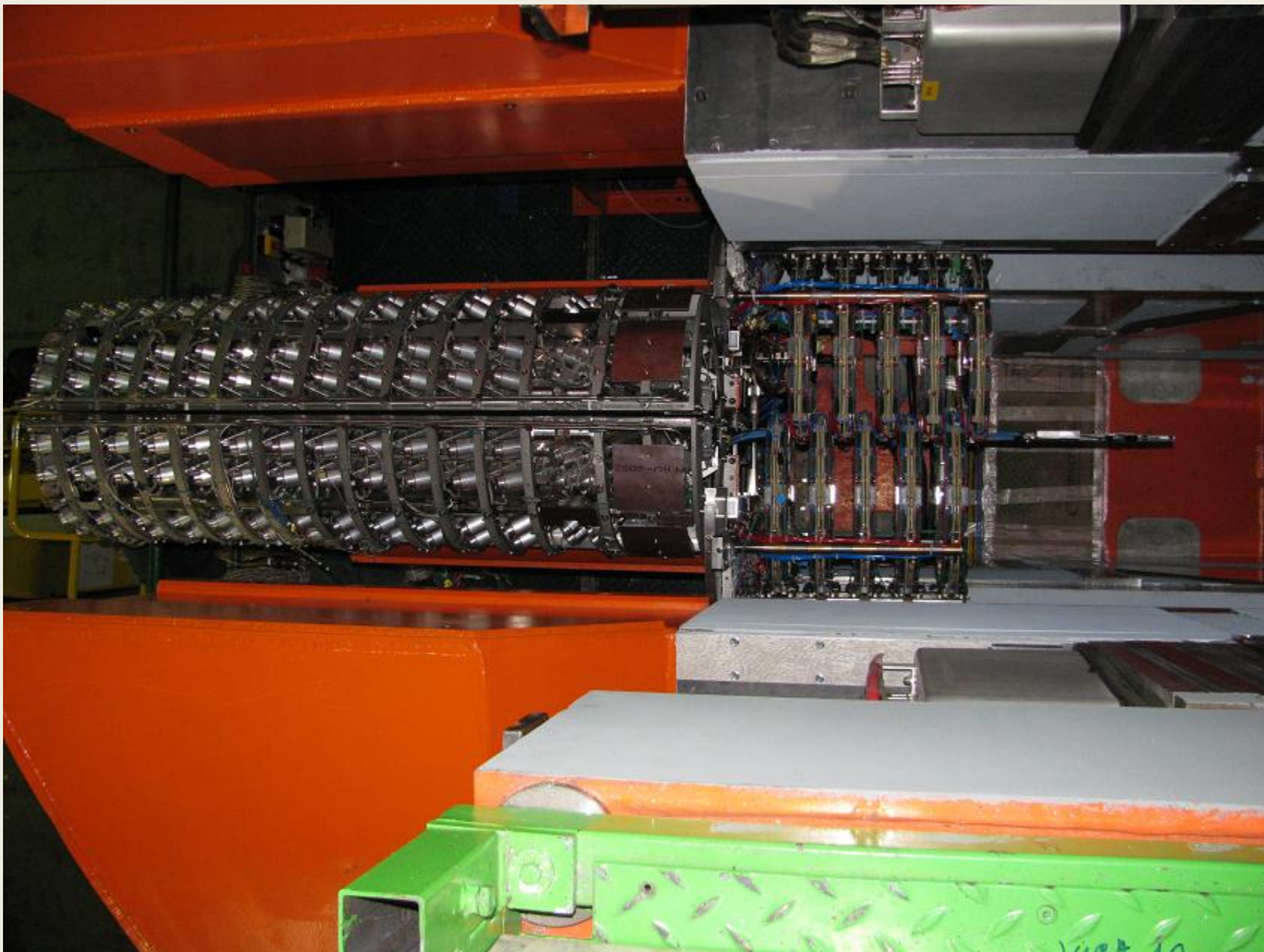


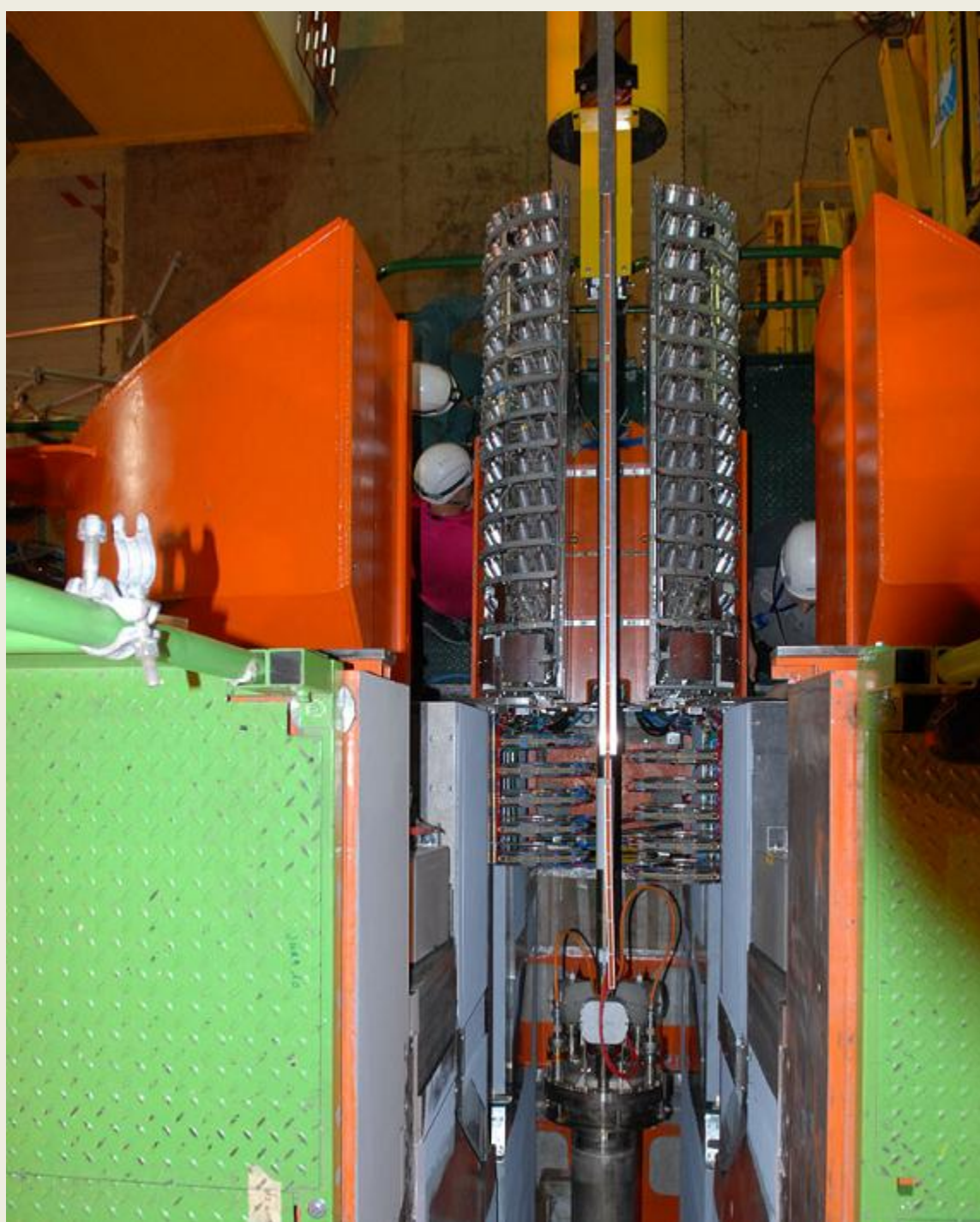
Pion beam studies

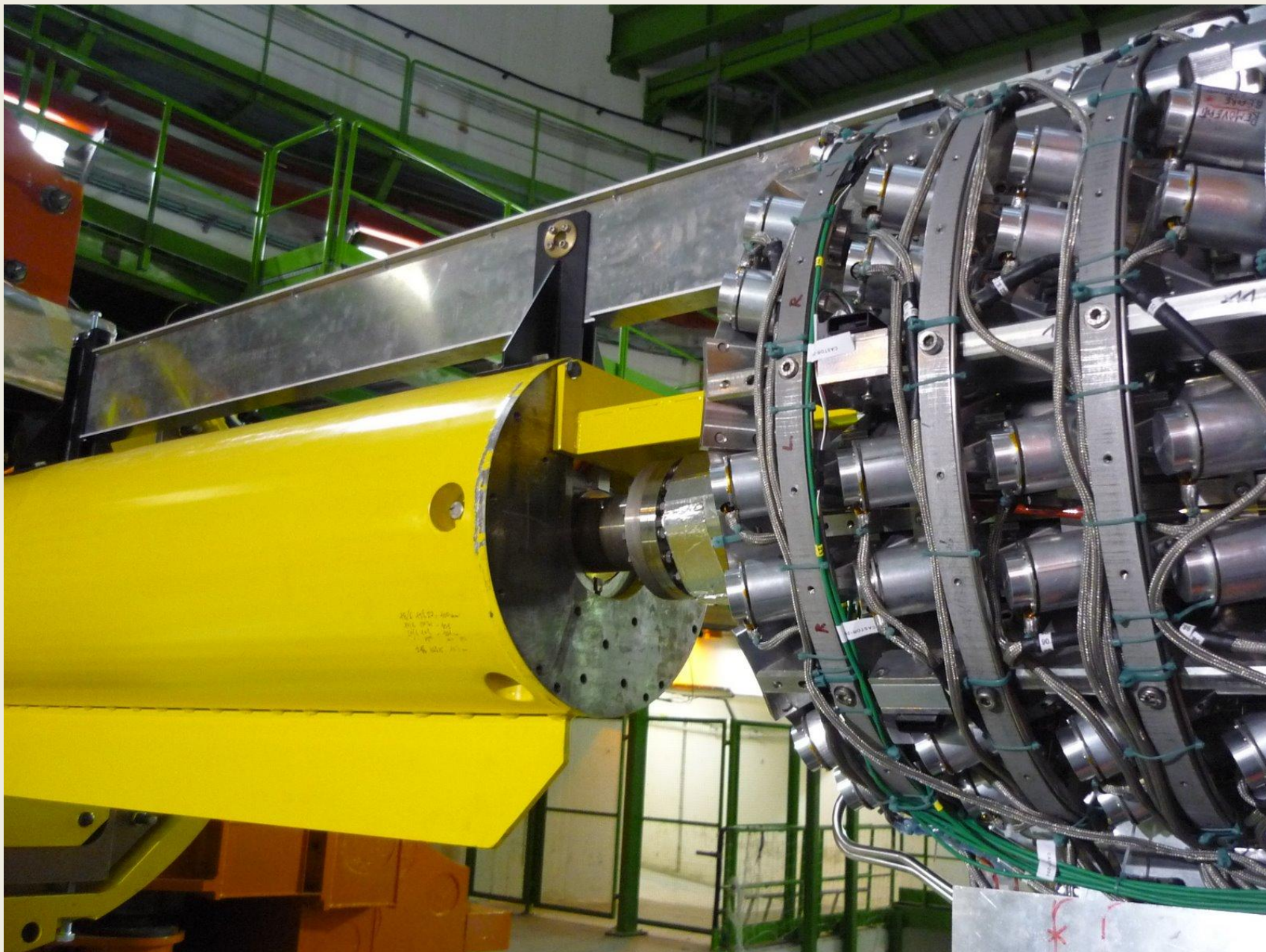


CASTOR was integrated in the CMS detector on October 2009 and is collecting data in p-p and HI since then.









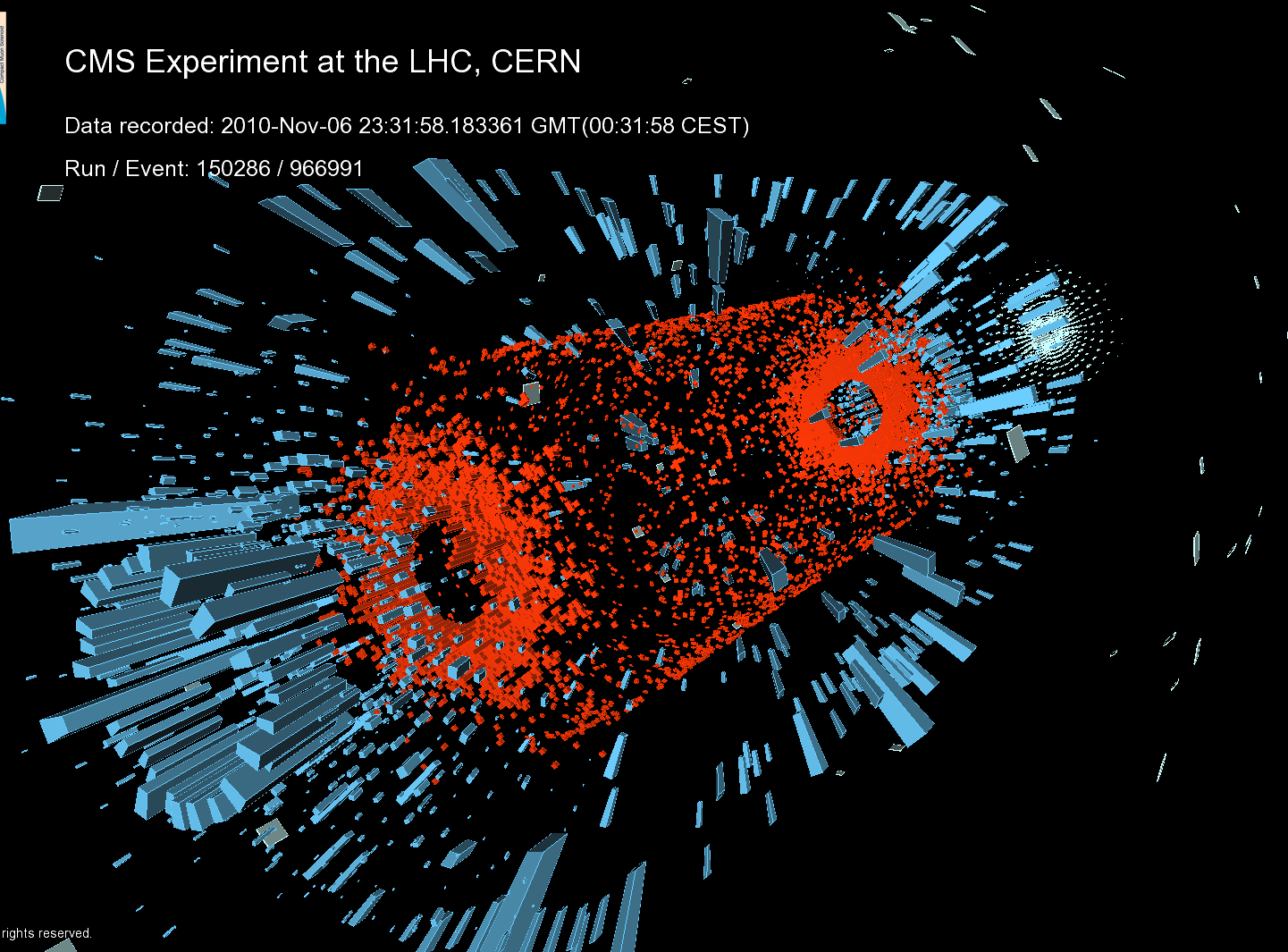
Pb+Pb event, $T=2.7$ TeV/A
2,000 particles emitted



CMS Experiment at the LHC, CERN

Data recorded: 2010-Nov-06 23:31:58.183361 GMT(00:31:58 CEST)

Run / Event: 150286 / 966991

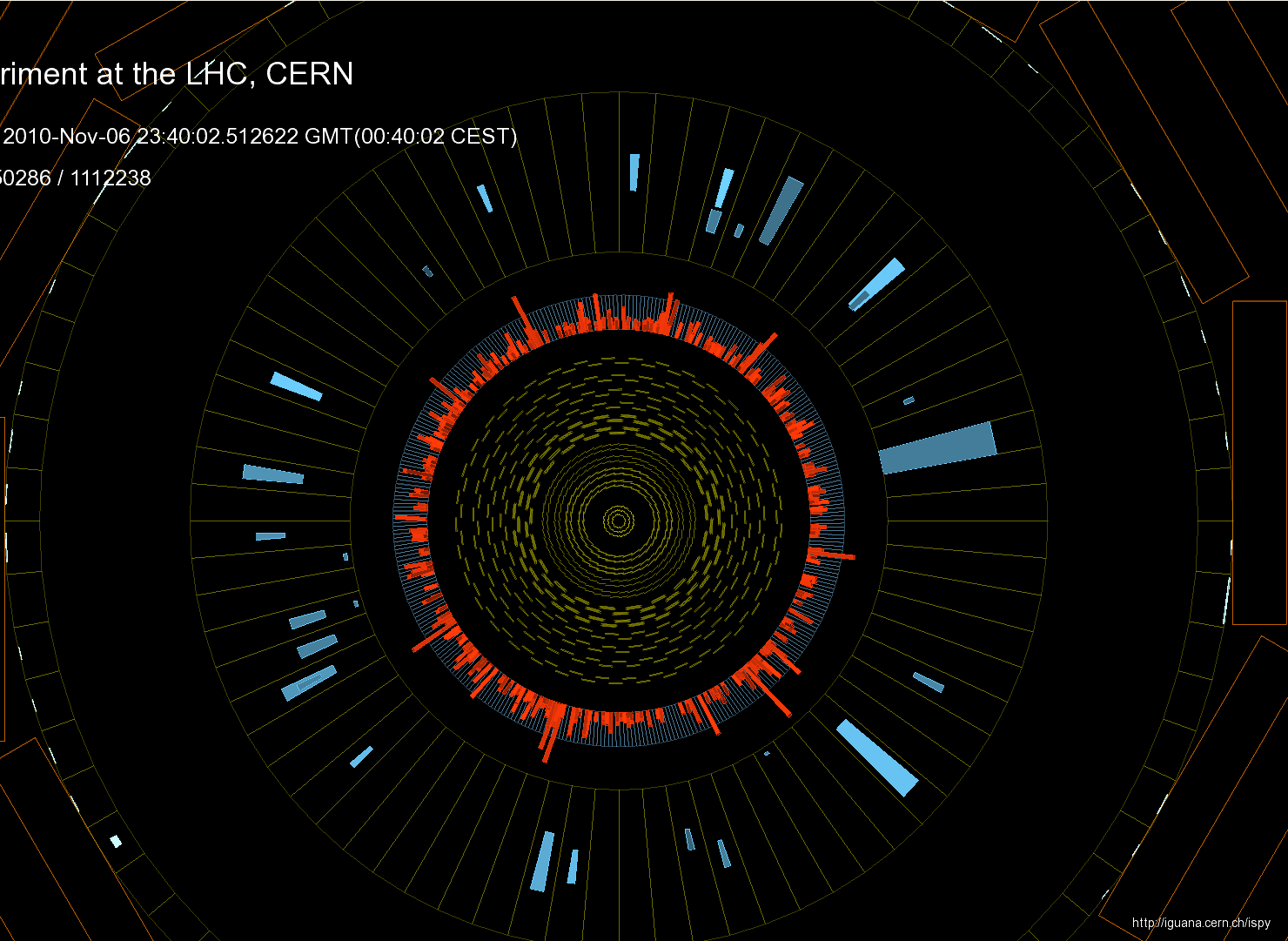




CMS Experiment at the LHC, CERN

Data recorded: 2010-Nov-06 23:40:02.512622 GMT(00:40:02 CEST)

Run / Event: 150286 / 1112238

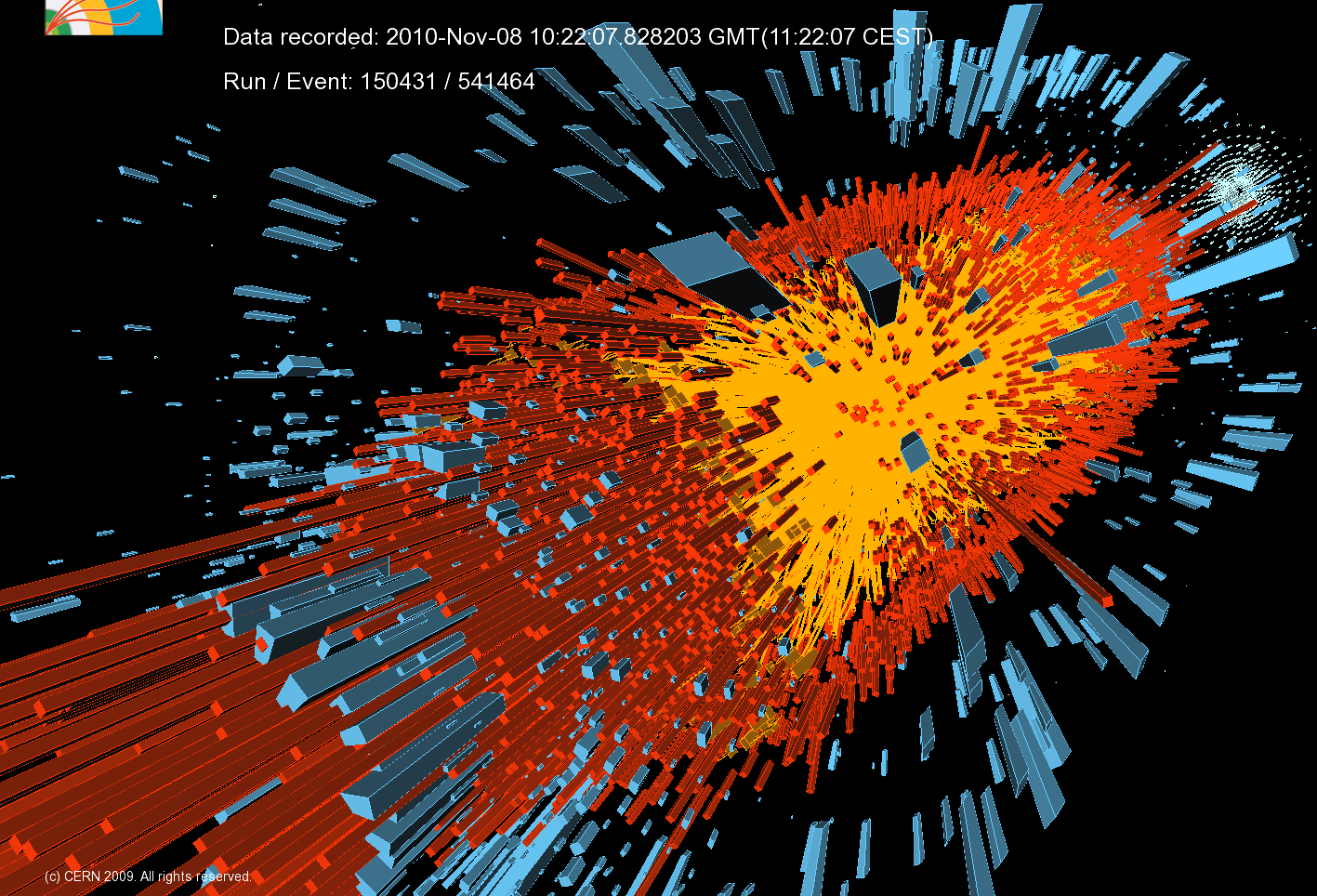




CMS Experiment at the LHC, CERN

Data recorded: 2010-Nov-08 10:22:07.828203 GMT(11:22:07 CEST)

Run / Event: 150431 / 541464



(c) CERN 2009. All rights reserved.

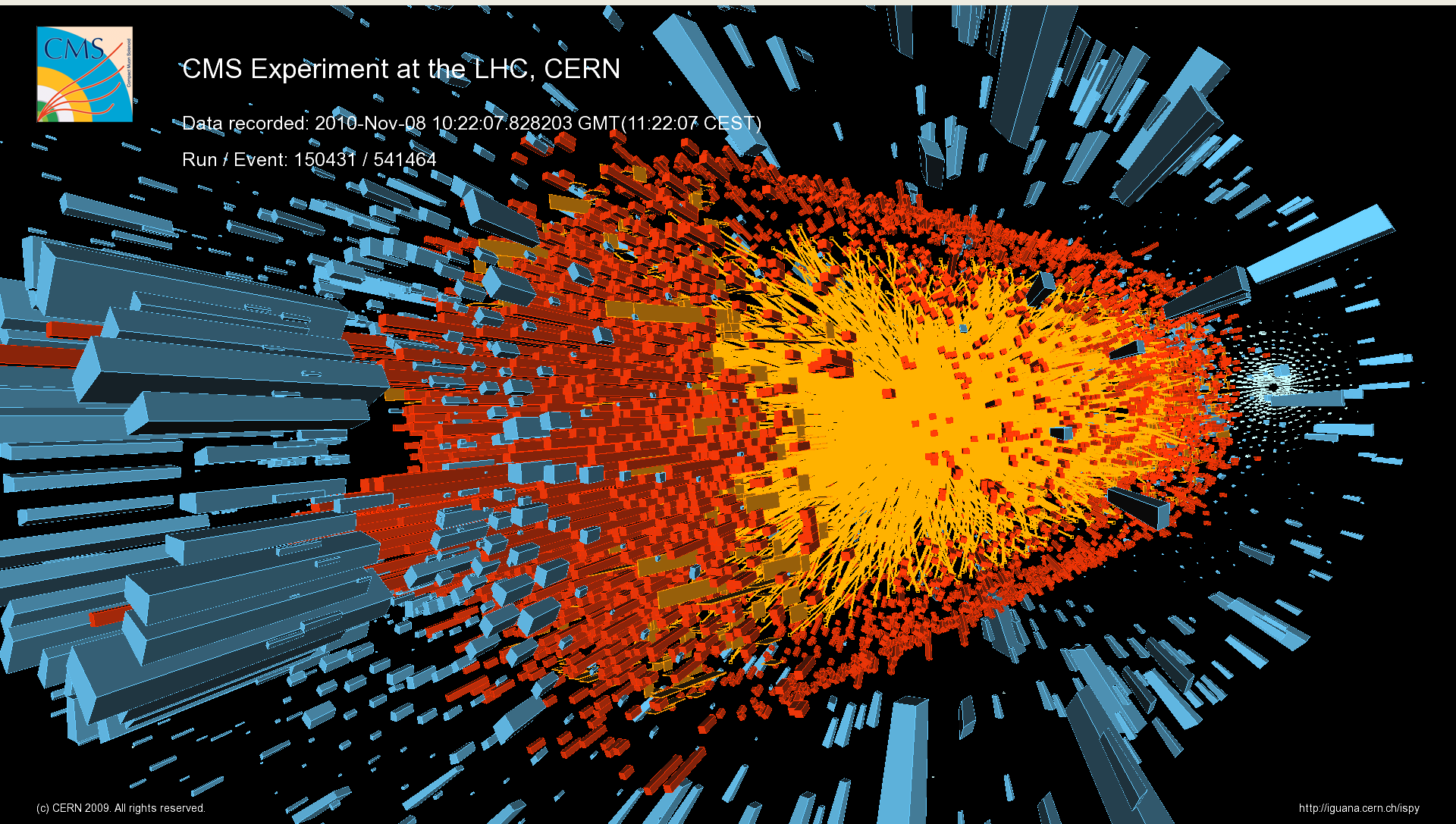
<http://iguana.cern.ch/ispv>



CMS Experiment at the LHC, CERN

Data recorded: 2010-Nov-08 10:22:07.828203 GMT(11:22:07 CEST)

Run / Event: 150431 / 541464



(c) CERN 2009. All rights reserved.

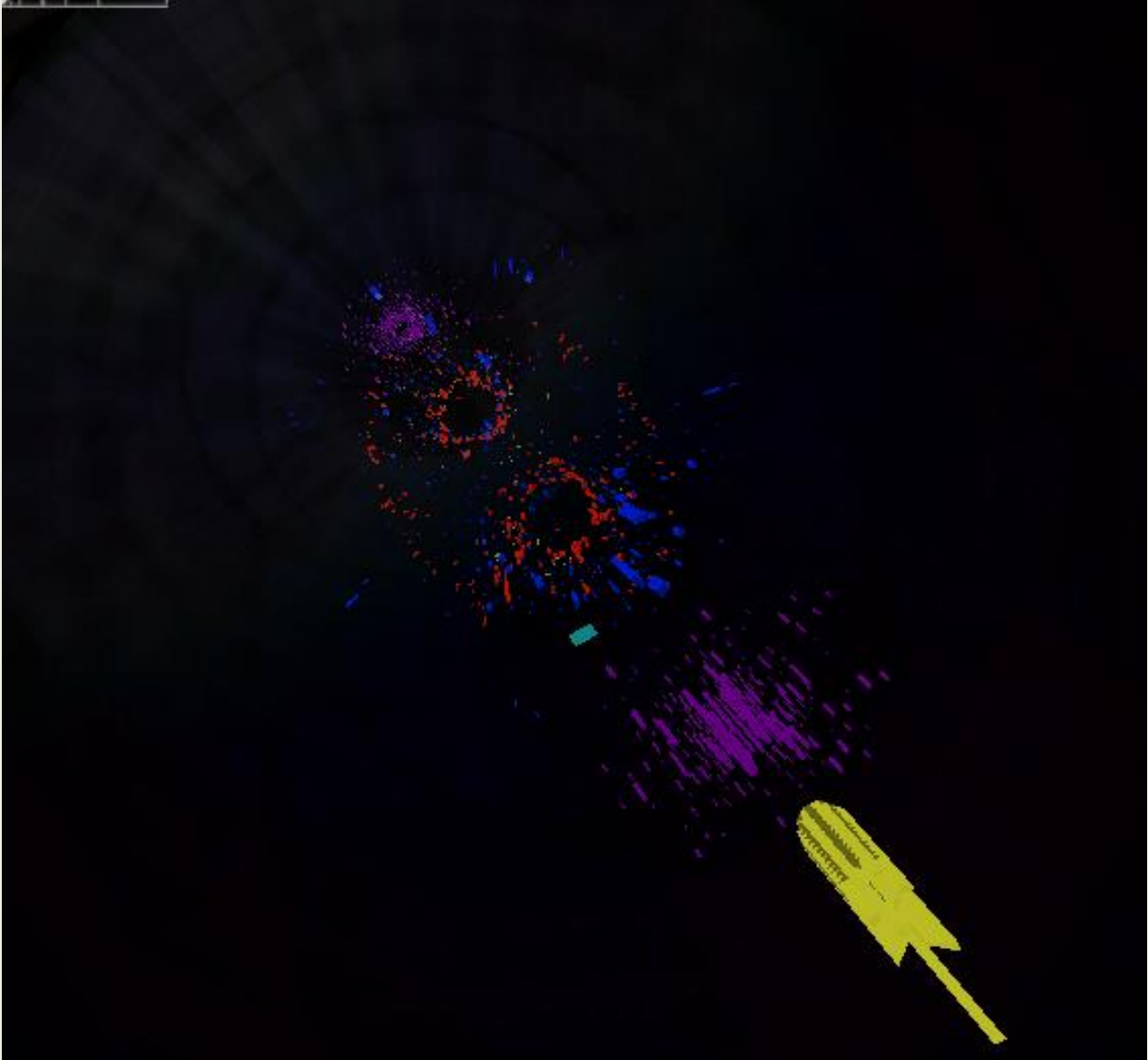
<http://iguana.cern.ch/ispv>



Pb+Pb events in CASTOR

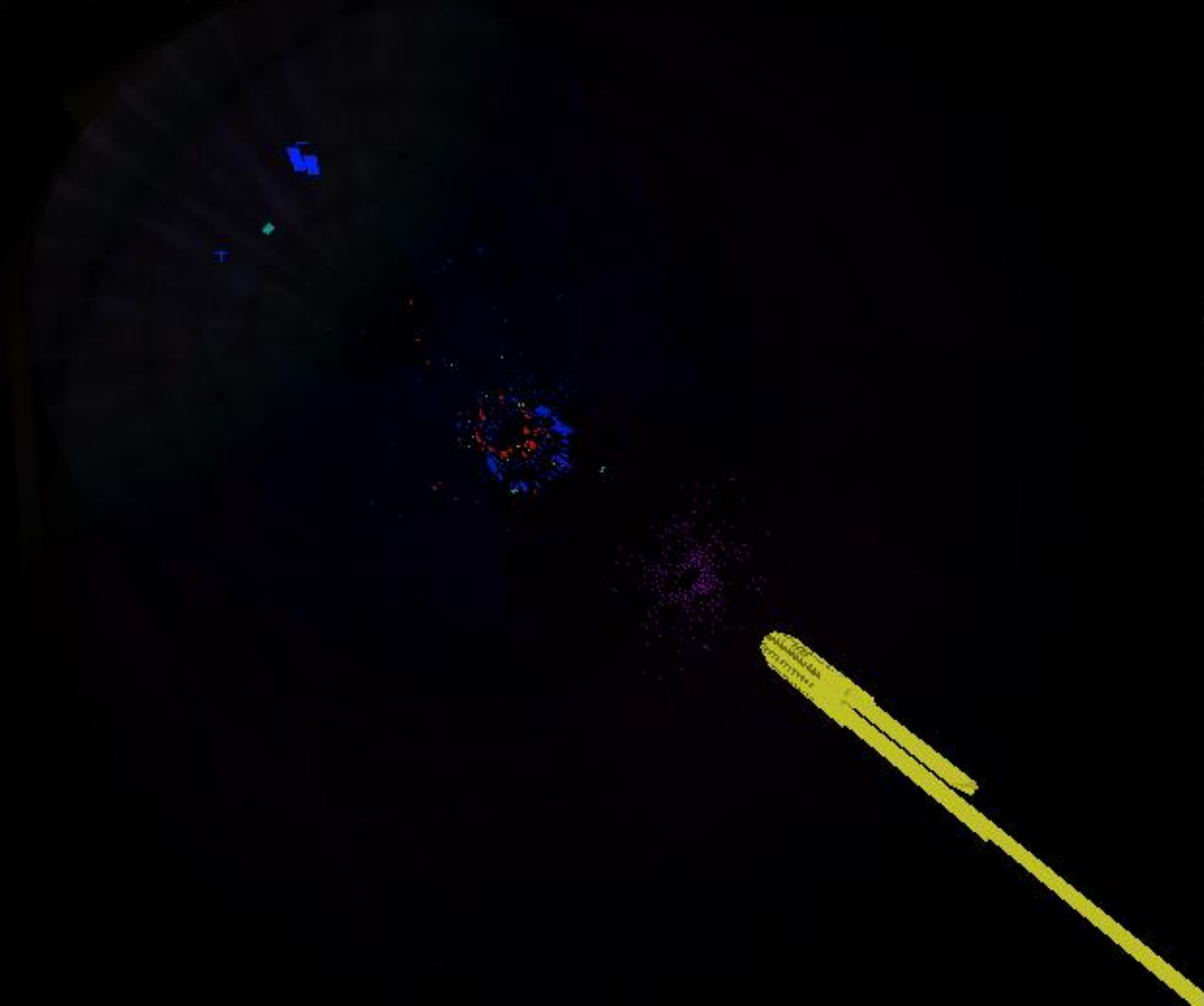


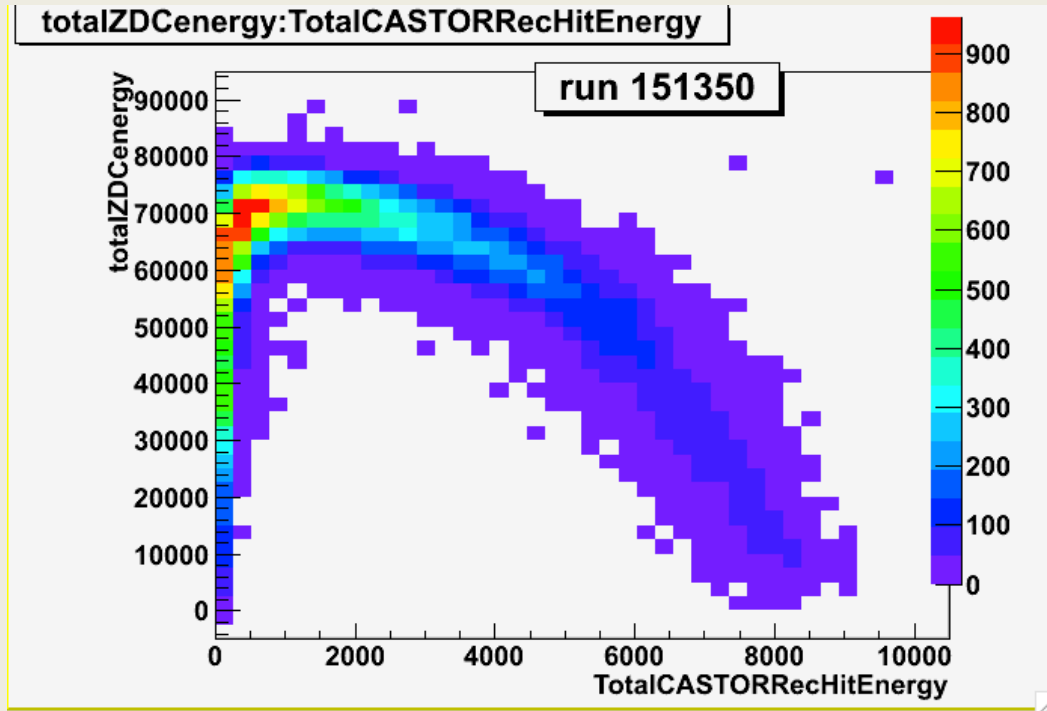
CMS Experiment at LHC, CERN
Data recorded: Fri Nov 12 06:09:24 2010 CEST
Run/Event: 150887 / 2476272
Lumi section: 657



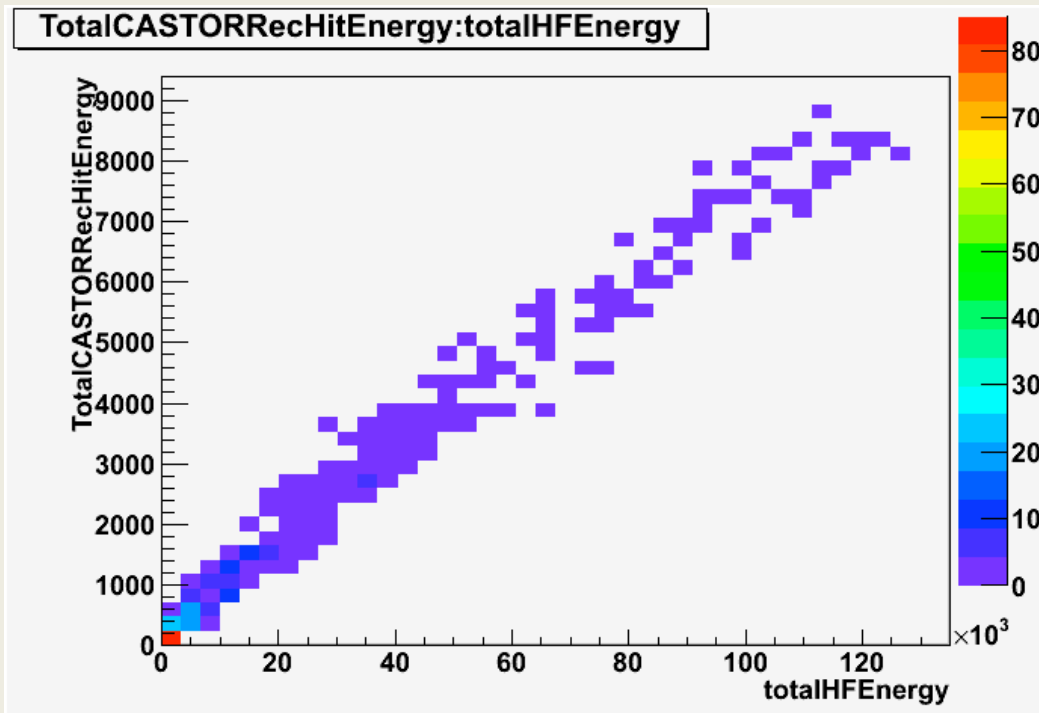


CMS Experiment at LHC, CERN
Data recorded: Wed Nov 17 02:27:22 2010 CEST
Run/Event: 151352 / 197335
Lumi section: 34





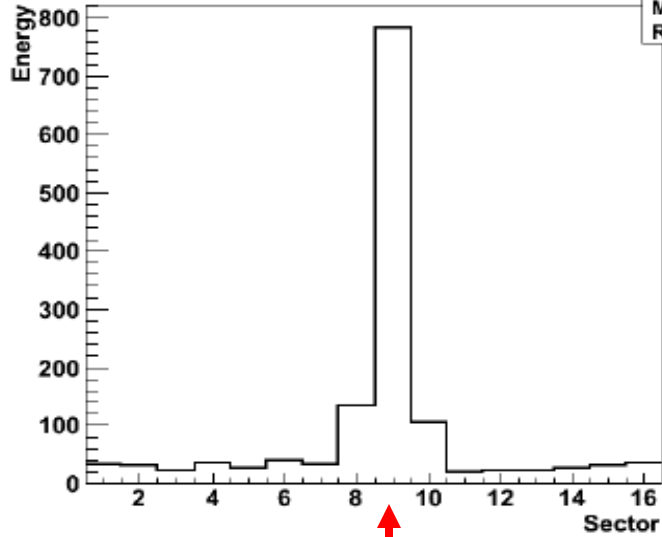
Run 151350
“Colliding”
Trigger



Far side

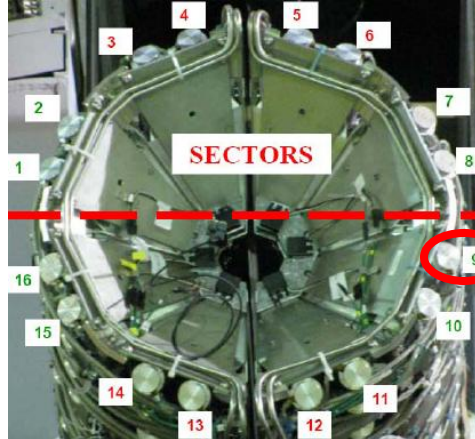
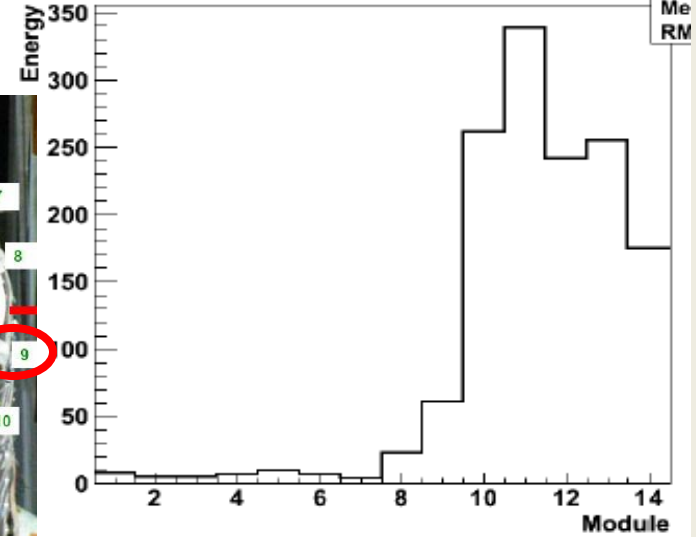
Event # 1184765

TotalEnergyPerSector



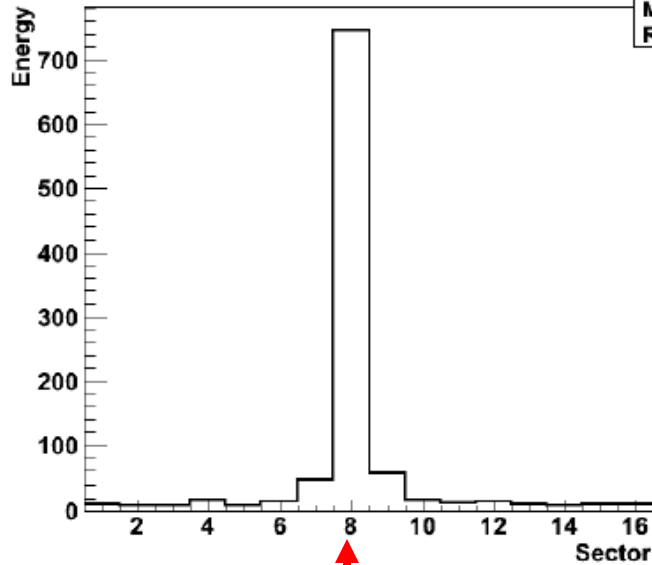
TotalEnergyPerSector	
Entries	16
Mean	8.744
RMS	2.744

TotalEnergyPerModule



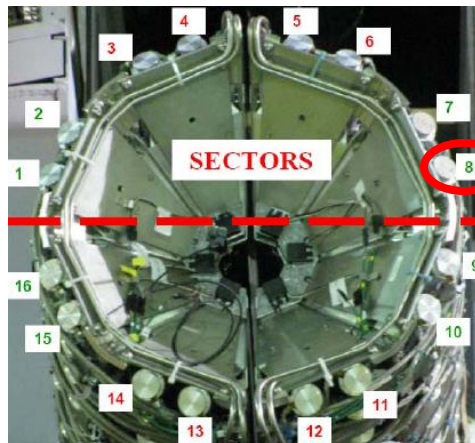
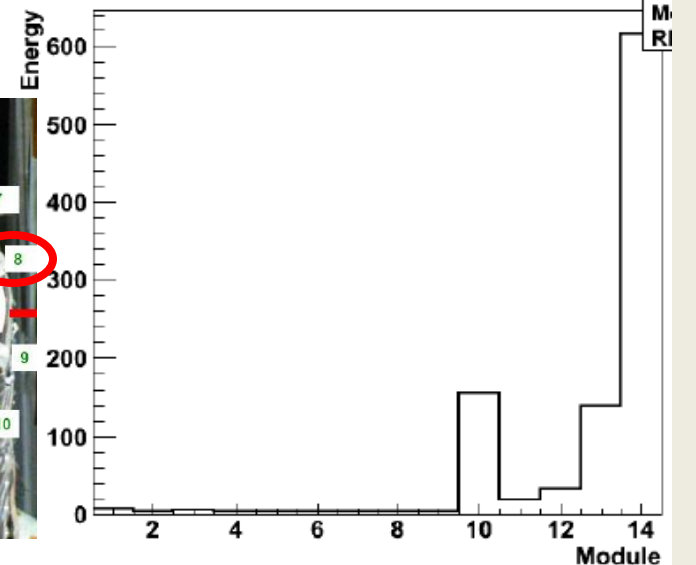
Event # 406373

TotalEnergyPerSector



TotalEnergyPerSector	
Entries	16
Mean	8.116
RMS	1.935

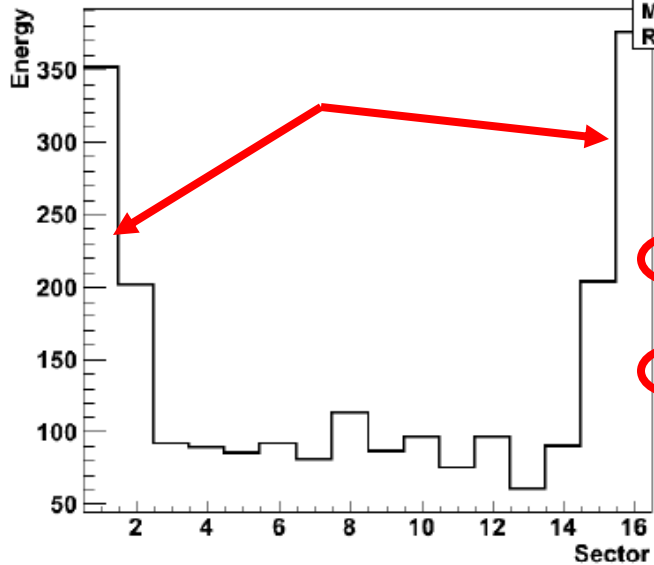
TotalEnergyPerModule



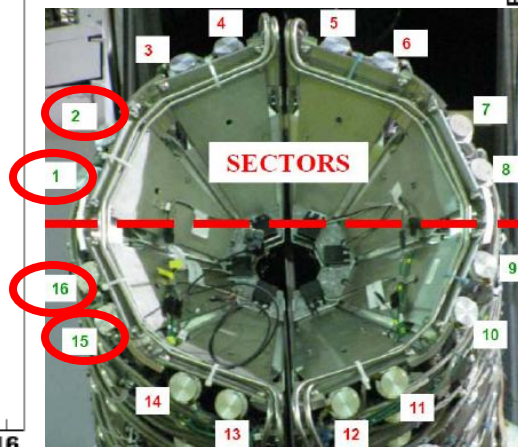
Near side

Event # 407575

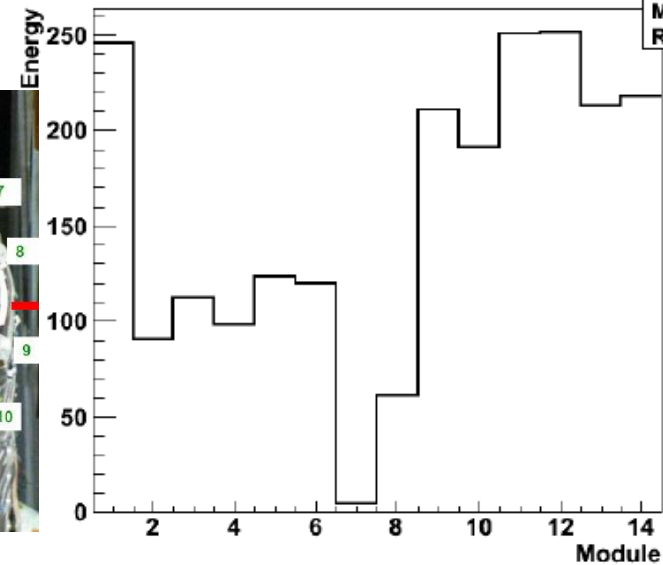
TotalEnergyPerSector



TotalEnergyPerSector
Entries 16
Mean 8.532
RMS 5.667

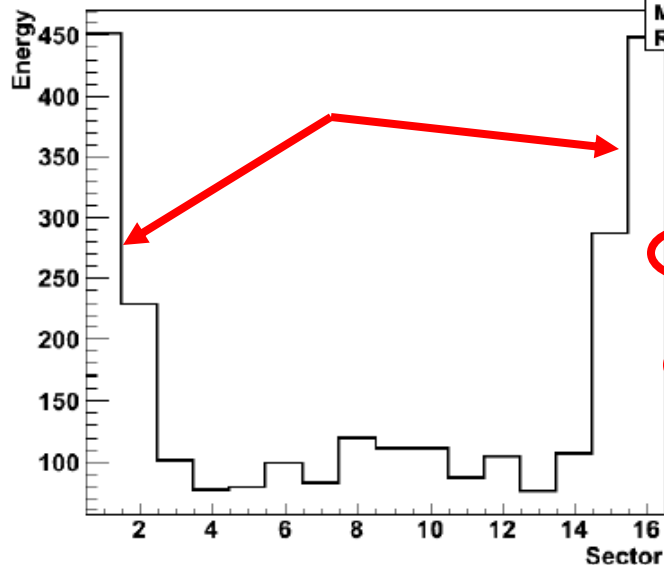


TotalEnergyPerModule

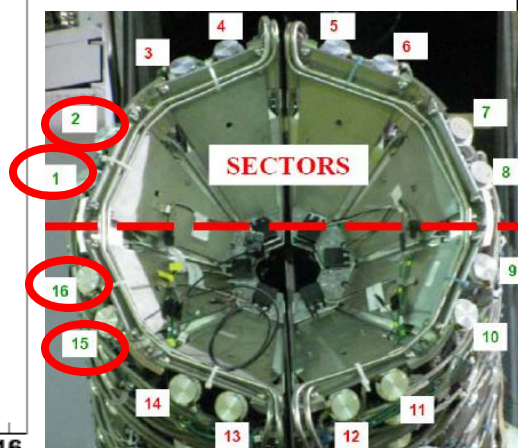


Event # 636495

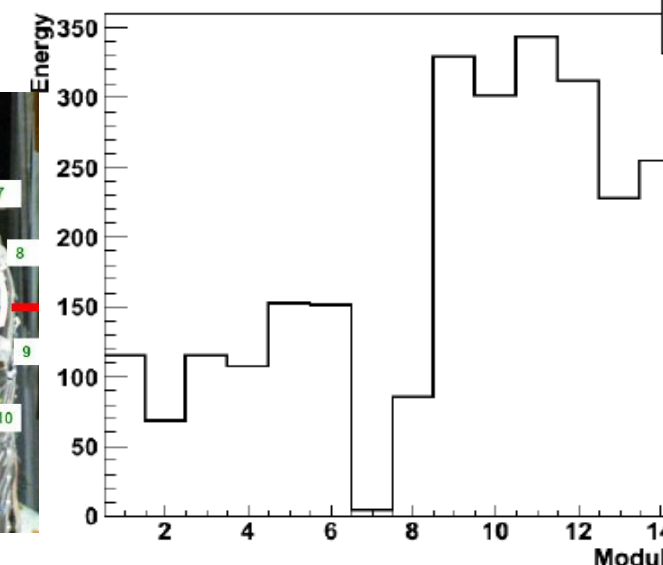
TotalEnergyPerSector



TotalEnergyPerSector
Entries 16
Mean 8.684
RMS 5.775



TotalEnergyPerModule



Major Hardware modifications in 2012

Heavy Ion Run in January (One Month)