

CASTOR calorimeter status report

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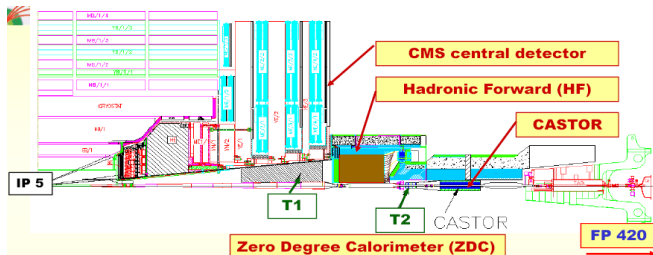
DESY

CMS Hamburg/DESY meeting, 22nd April 2009

Outline

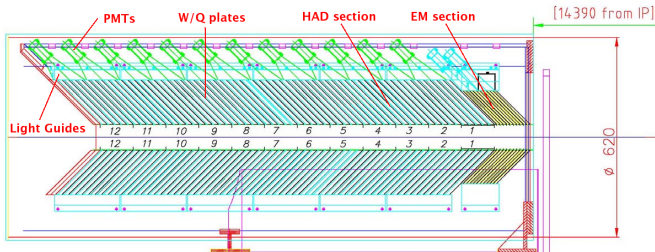
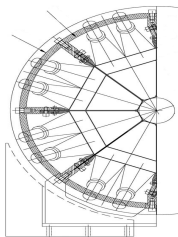
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CMS forward calorimeter



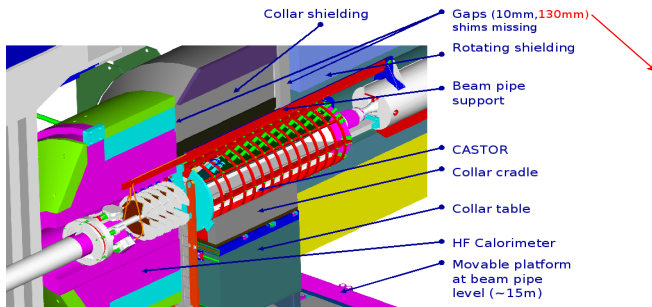
- Forward calorimeter for such topics as low- x parton dynamics, minimum bias event structure, diffraction, cosmic ray related physics in proton- proton and heavy-ion collisions
- Design challenges: restricted space available, high radiation level (≤ 20 kGy in 2009/10), operation in magnetic field (≤ 0.16 T)

CASTOR design



- Forward ($5.2 < \eta < 6.6$) Čerenkov quartz-tungsten sampling calorimeter for CMS@LHC with **quartz plates** as active medium and tungsten as absorber → compact, radhard and fast
- 16 azimuthal **sectors** (semi-octants) mechanically organised in two half calorimeters; every sector = EM section (2 readout units) + HAD section (12 units); EM = $0.7\lambda_I = 20X_0$; HAD = $12 * 0.7 = 9.24\lambda_I$; overall depth = **$10\lambda_I$**

CASTOR vs CMS magnetic field



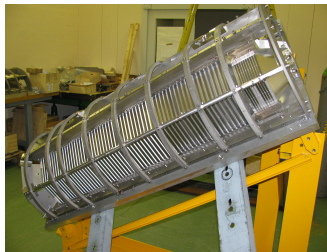
- Autumn last year: CASTOR in position on beam pipe, tests at P5... but unexpected motions observed... hence de-installed
- Shield gaps, high stray magnetic field (up to 0.7 T vs 0.0010 T according to simulation), field direction varies ($\theta \sim 15 - 35^\circ$)

CASTOR vs CMS magnetic field (cont'd)

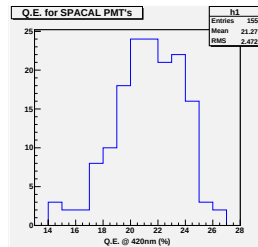
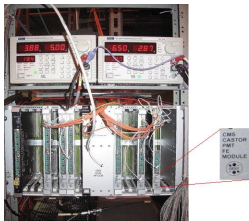
- Solutions:
 - H1 SpaCal fine-mesh PMT's (tolerate ≤ 0.5 T, should survive radiation corresponding to $\sim 800 \text{ pb}^{-1}$)
 - Redesign of air-core light guides to account for field direction
 - Close shield gaps (field ≤ 0.16 T)
- Green light for modifications of forward region:
Engineering Change Review (end of January 2009)

Mechanics

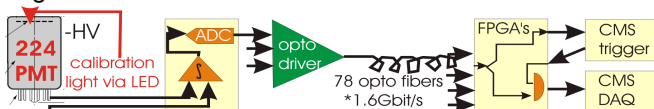
- Both half-calorimeter skeletons designed and produced at DESY (including cooling)
- Light guides redesigned and to be produced by DESY
- Both skeletons now at CERN filled with tungsten and radhard quartz plates (tungsten wrapped with Al/Tyvek, quartz painted to enhance light collection)



Electronics/data acquisition

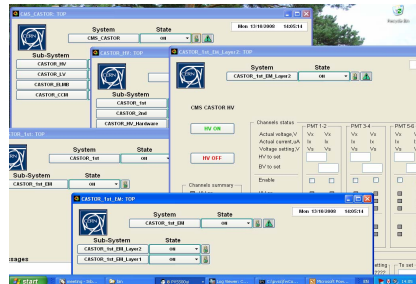
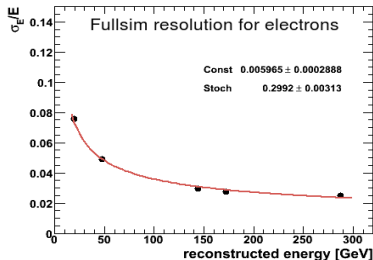


- Front end cards produced at DESY, tested at CERN, stress-tested during test beam 2008
- SpaCal PMT's tested at CERN, PMT bases in production by Moscow State Uni
- Trigger/DAQ card under development in Antwerp, LED system being finalised at ITEP/Moscow

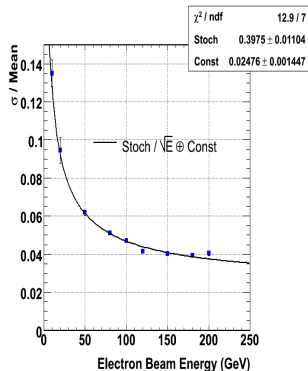
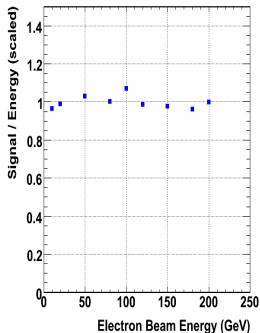
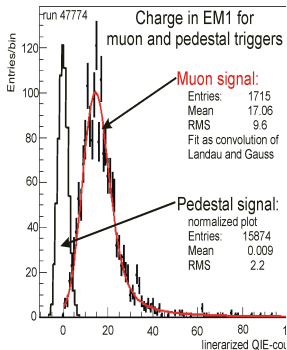


Software

- Full simulation released in CMSSW_3_1_0, (very) fast simulation released even earlier
- Shower library, offline database still need polishing
- Slow control: basic machinery works in test stand installation

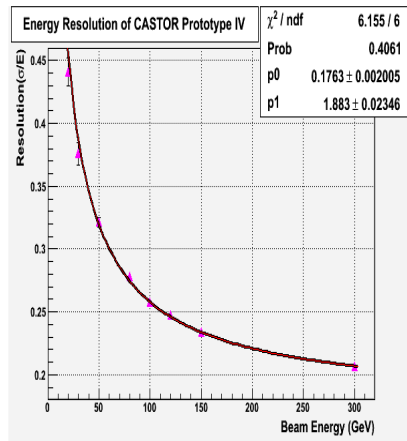
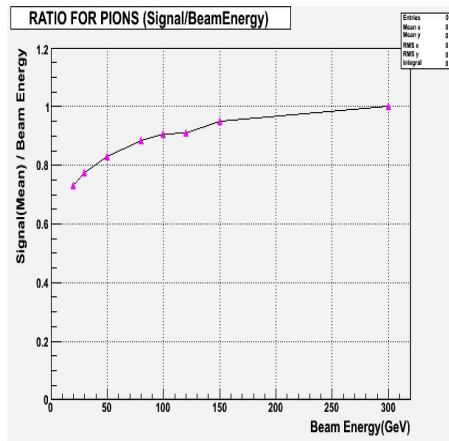


Test beam 2008: muons and electron energy scan



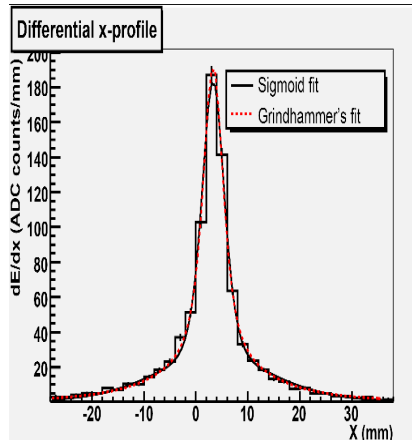
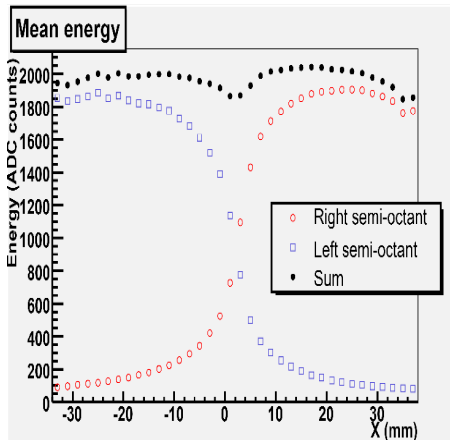
- TB2008: full-length prototype tested with μ , e , π in wide energy range

Test beam 2008: pion energy scan



- Čerenkov calorimeter is non-compensating: $e/\pi \sim 2.6$

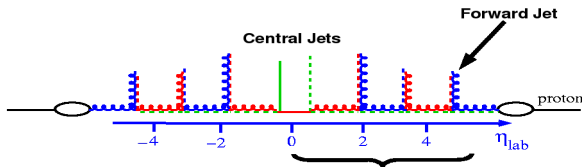
Test beam 2008: pion X-position scan



- Differential x-profile: Full Width at Half Maximum = 6 mm → compact lateral shower size

Physics with CASTOR

- Can do physics with 1st arriving inverse picobarns:
 - Small- x QCD dynamics
 - Multiparton interactions/Underlying event studies
 - Diffraction



Going low in x

Jets in CMS Hadronic Forward Calorimeter
($3 < \eta < 5$)
 $x \sim 10^{-5}$

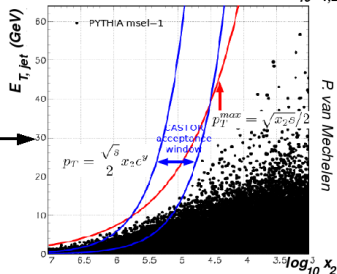
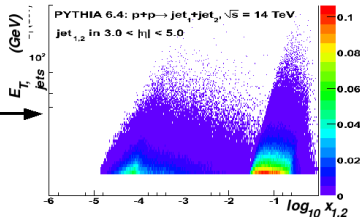
Dijets, at least one jet in HF
CMS note PAS-FWD-08-001

2 units in rapidity



Roughly 1 magnitude in x

Dijets with at least one jet in CASTOR
($5.2 < \eta < 6.6$)
 $x \sim 10^{-6}$



Physics with 1st pb^{-1}

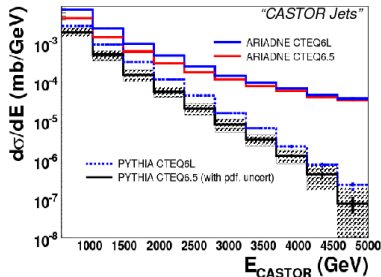
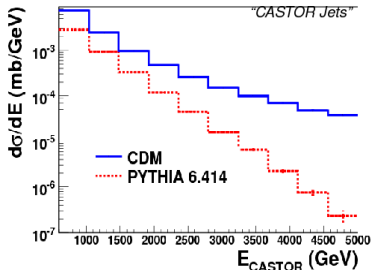
-Instead of conventional jet algorithm:

“CASTOR Jets”: Jet reconstruction

(most active segment+neighbors)

-Particle energy smeared according to test beam data

-Noise cut of particles ($E_{\text{particles}} > 1 \text{ GeV}$)



- ➔ With “CASTOR Jets” we can make **measurements that distinguish between the different QCD models** (DGLAP/non-DGLAP).
- ➔ At high energy DGLAP/non-DGLAP separation $\gg$ PDF uncertainty/sensitivity
- ➔ Study made at $< 1\text{pb}^{-1}$. One of the first topics to be analysis by using CASTOR

Summary

- New PMT's call for another week of test beam in May with two equipped octants of one half calorimeter
- On 5th of June two fully equipped half calorimeters to be installed at ground level of P5
- Installation to be followed by magnet tests
- Looking forward to extensive low luminosity pp -physics program