

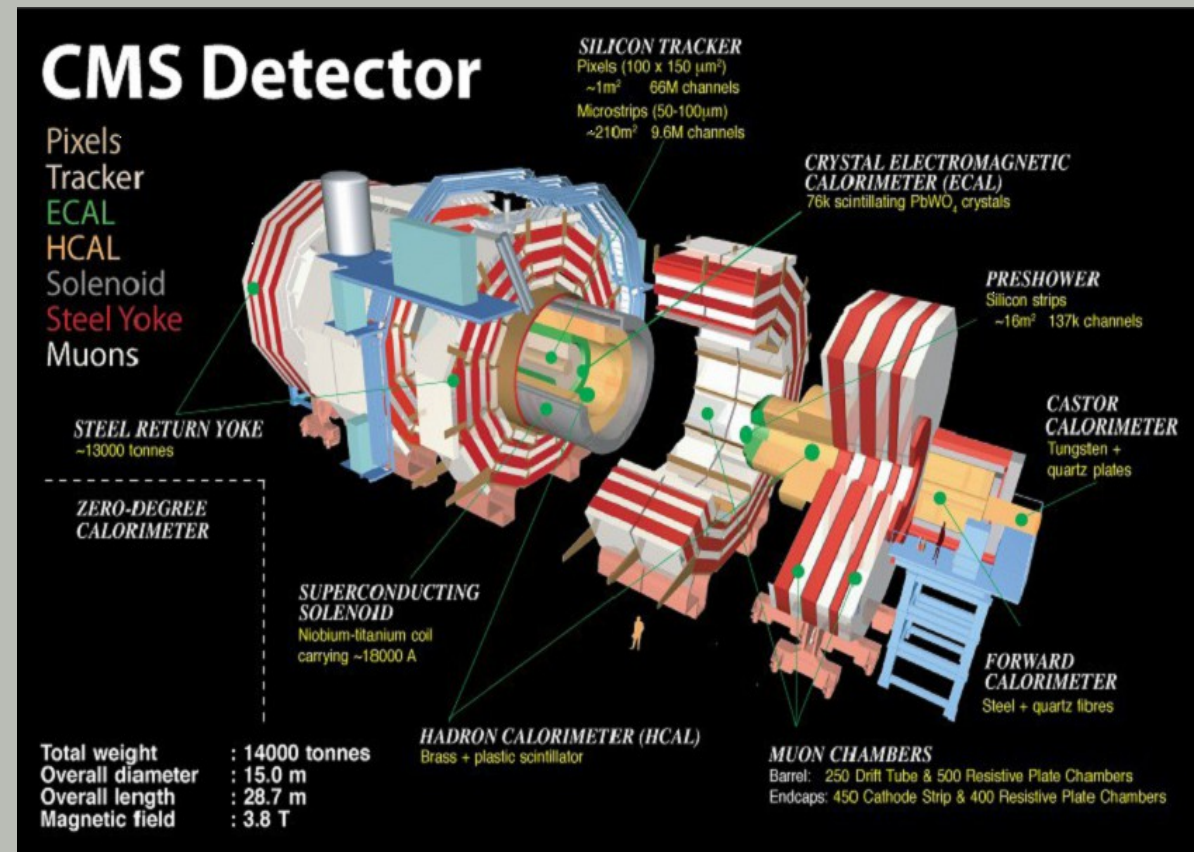
Performance and calibration of CASTOR calorimeter at CMS

Ekaterina Kuznetsova (DESY)
for CMS-CASTOR collaboration

TIPP 2011

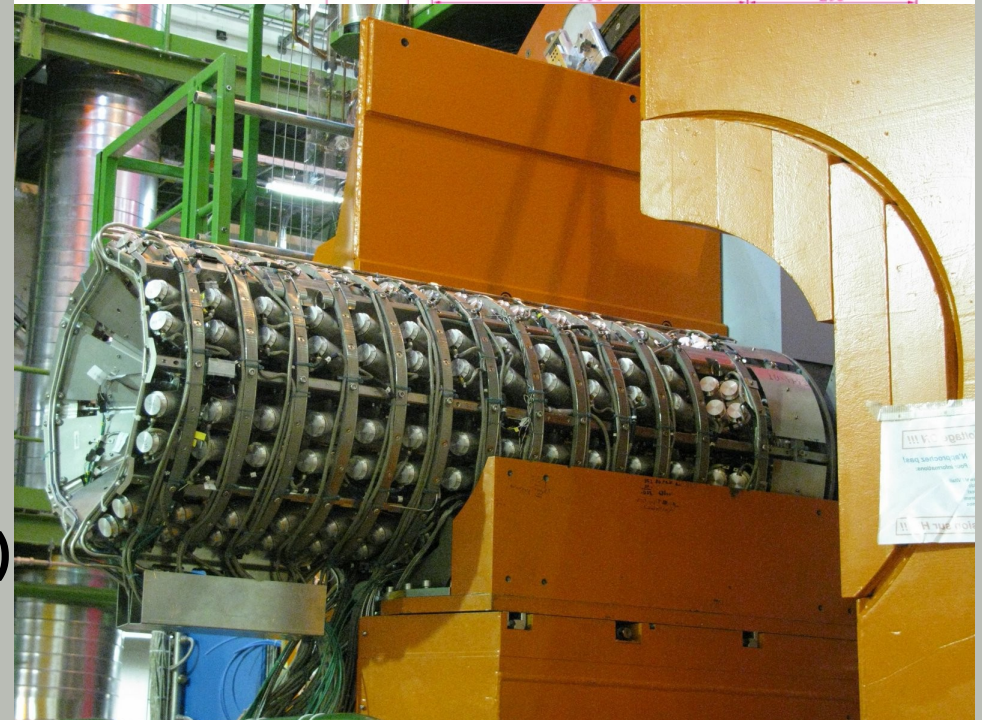
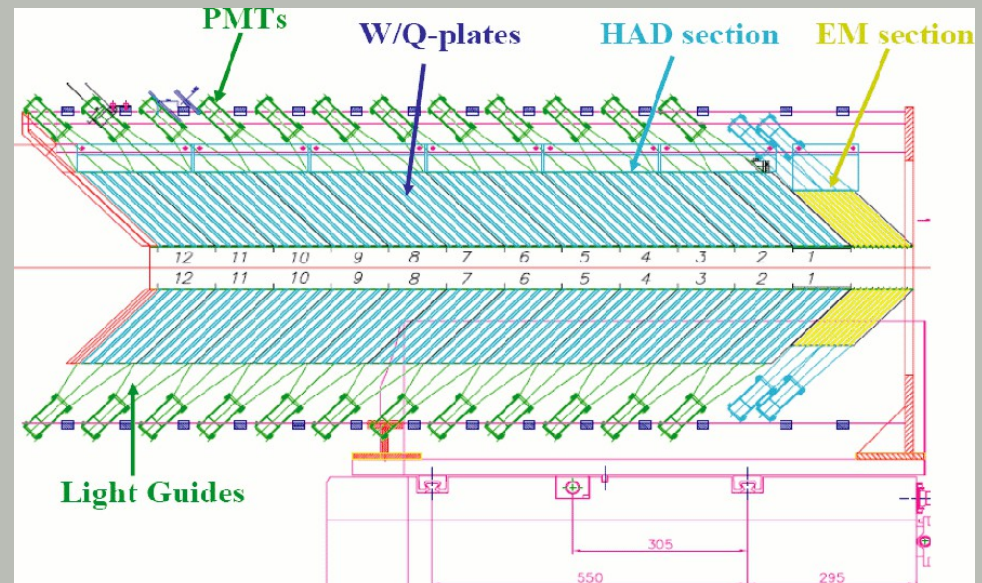
CASTOR calorimeter at $-6.6 < \eta < -5.2$

- **Low-x dynamics**
 - proton structure, BFKL/CCFM/DGLAP dynamics
 - parton saturation
 - multi-parton scattering and underlying event
- **Diffraction**
- **Measurements for cosmic ray data analysis**
- **Forward energy and particle flows, minimum bias event Structure**
- **Forward physics in pA and AA collisions**
- **New forward physics phenomena**



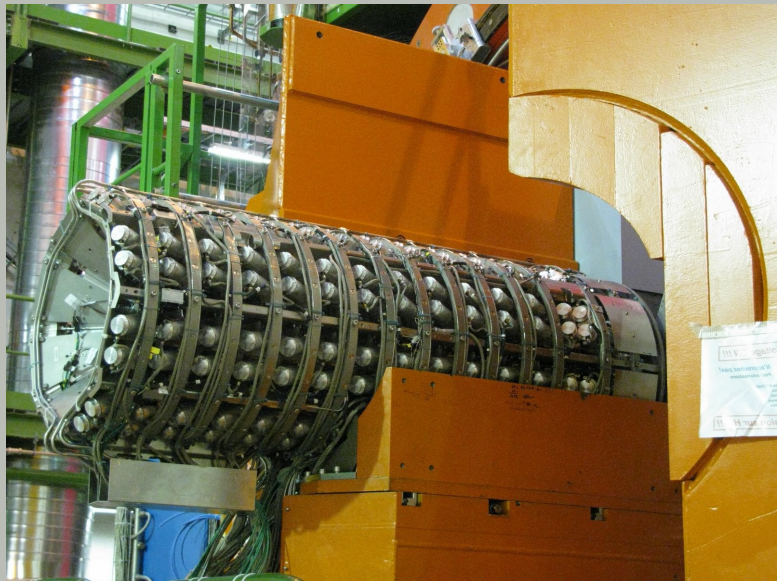
CASTOR

- ✓ Čerenkov calorimeter with tungsten-quartz plates
- ✓ Located at 14.4m from the interaction point
- ✓ Covering $-6.6 < \eta < -5.2$
- ✓ Longitudinal segmentation: electromagnetic(x2) and hadronic(x12) "modules"
- ✓ ϕ segmentation: 16 "sectors"
- ✓ Read-out: 224 channels with fine-mesh PMT (Hamamatsu R5505)

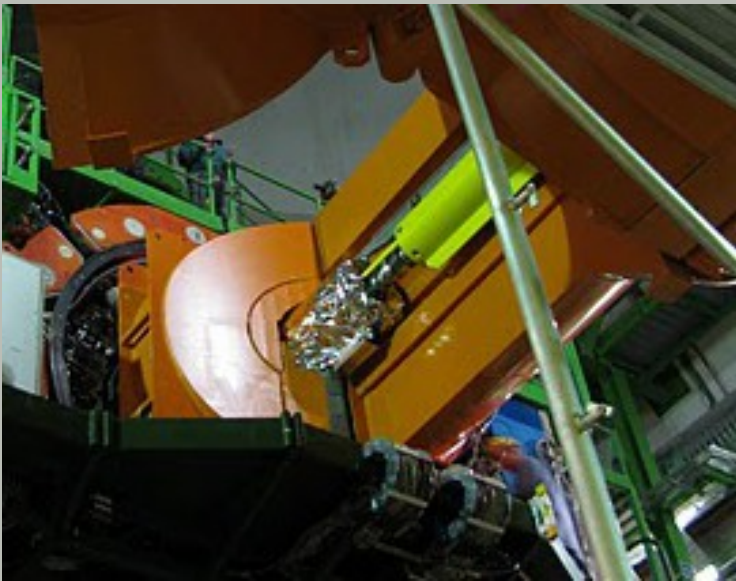


CASTOR shielding:

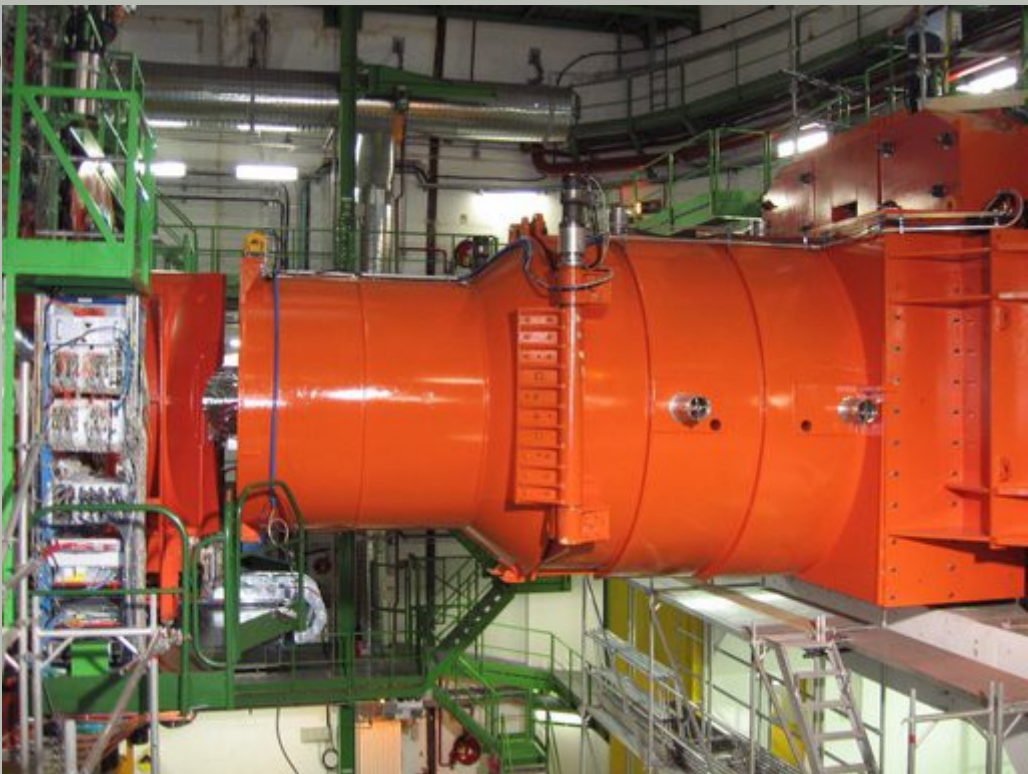
1)



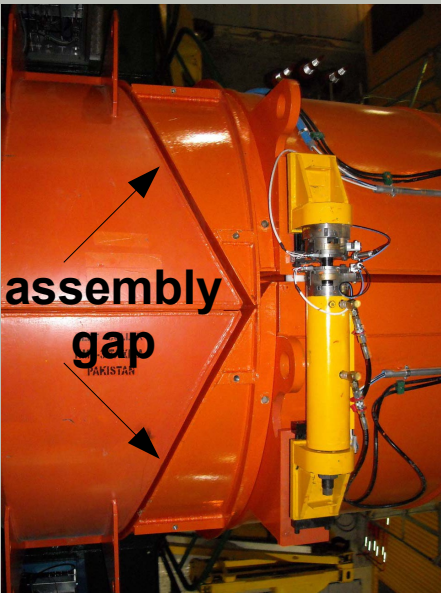
2)



3)



Top view final assembly:

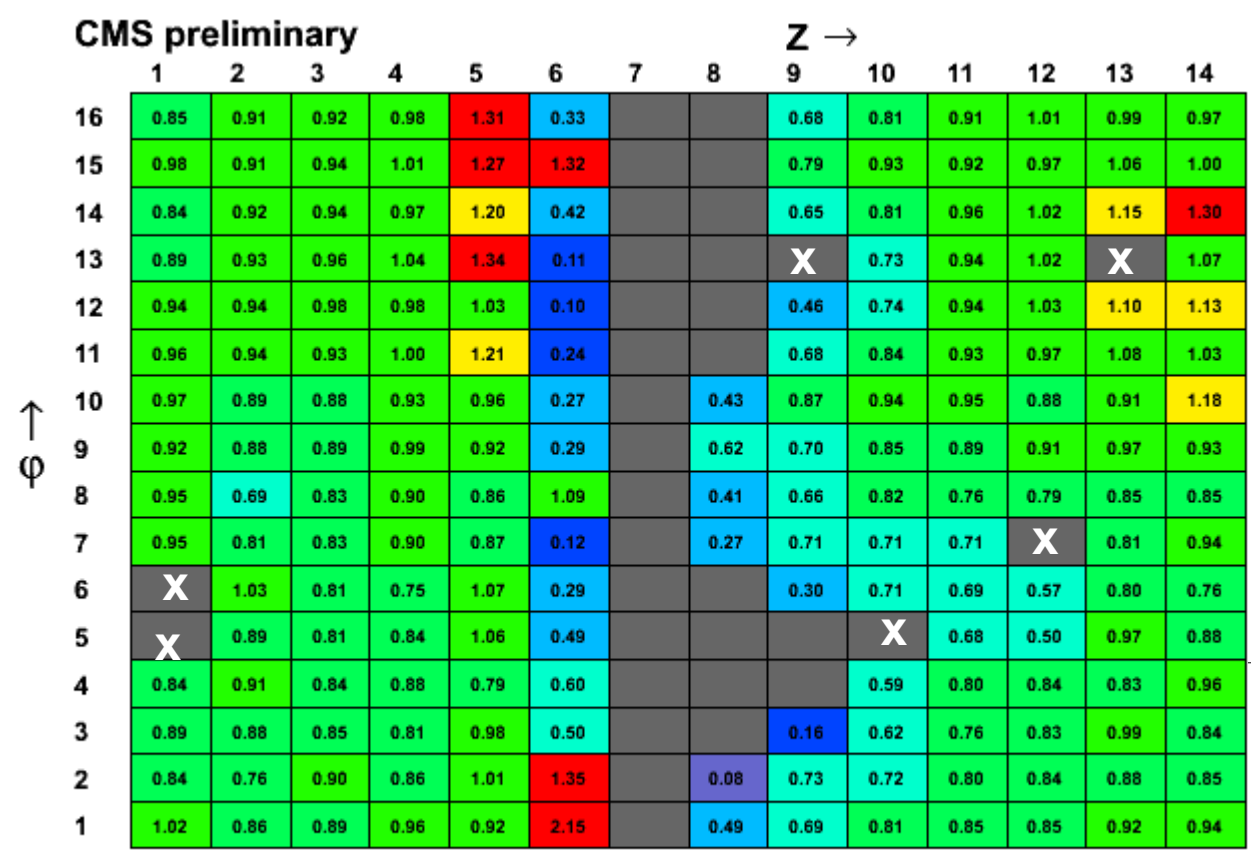


Magnetic field influence:

In the gap region:
absolute value is less than 0.2T, but the angle is varying...

Minimum Bias data 2010 (pp collisions):

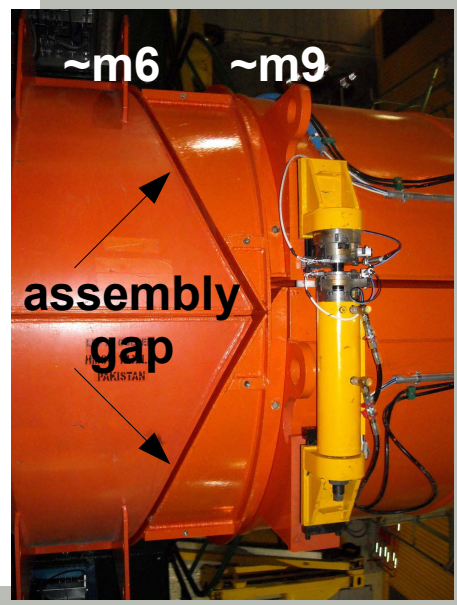
Signal(3.8T)/Signal(0T)



Minimum bias data: run 133046 (Nominal B-field) / run 133239 (B = 0 T)

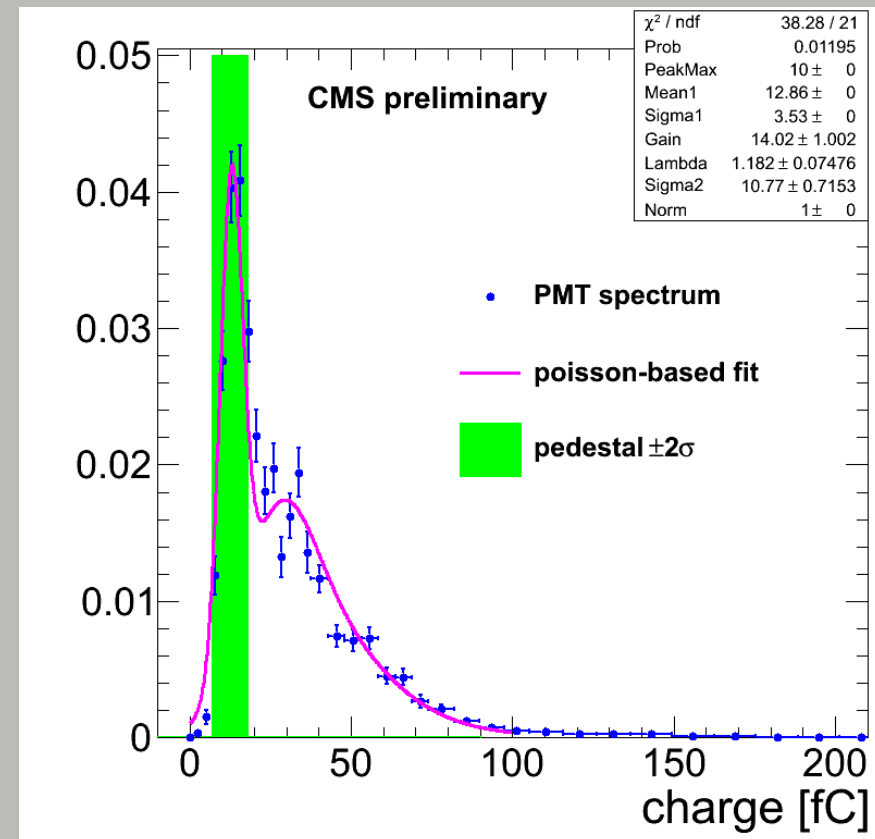
- gray - no data
- dead channels (marked with cross)
 - suppressed due to the magnetic field

Castor shielding:



CASTOR intercalibration with halo muons:

- ✓ self-triggering during circulating, non-colliding beams
- ✓ trigger on an isolated penetrating particle
- ✓ offline selection:
 - ✓ isolated sector with at least N-3 modules with signal, $N=f(\phi)$ due to dead regions
 - ✓ to avoid bias: For each module in the sector: at least N-3 without this module
- ✓ Total statistics (2010, sept-nov): 2.3k-0.7k per sector (ϕ -dependent)
- ✓ **Muon spectrum (example):**
 - ✓ Low number of photoelectrons (1-4)
 - ✓ Average signal with mean of spectra
 - ✓ Mean from Poisson-based fit
(simple approximation) as
Poisson $\otimes$ Gauss (no tails)
- ✓ Fit and spectrum mean values are comparable => no long tails
- ✓ => muon showering is negligible



Intercalibration coefficients from halo muon runs:

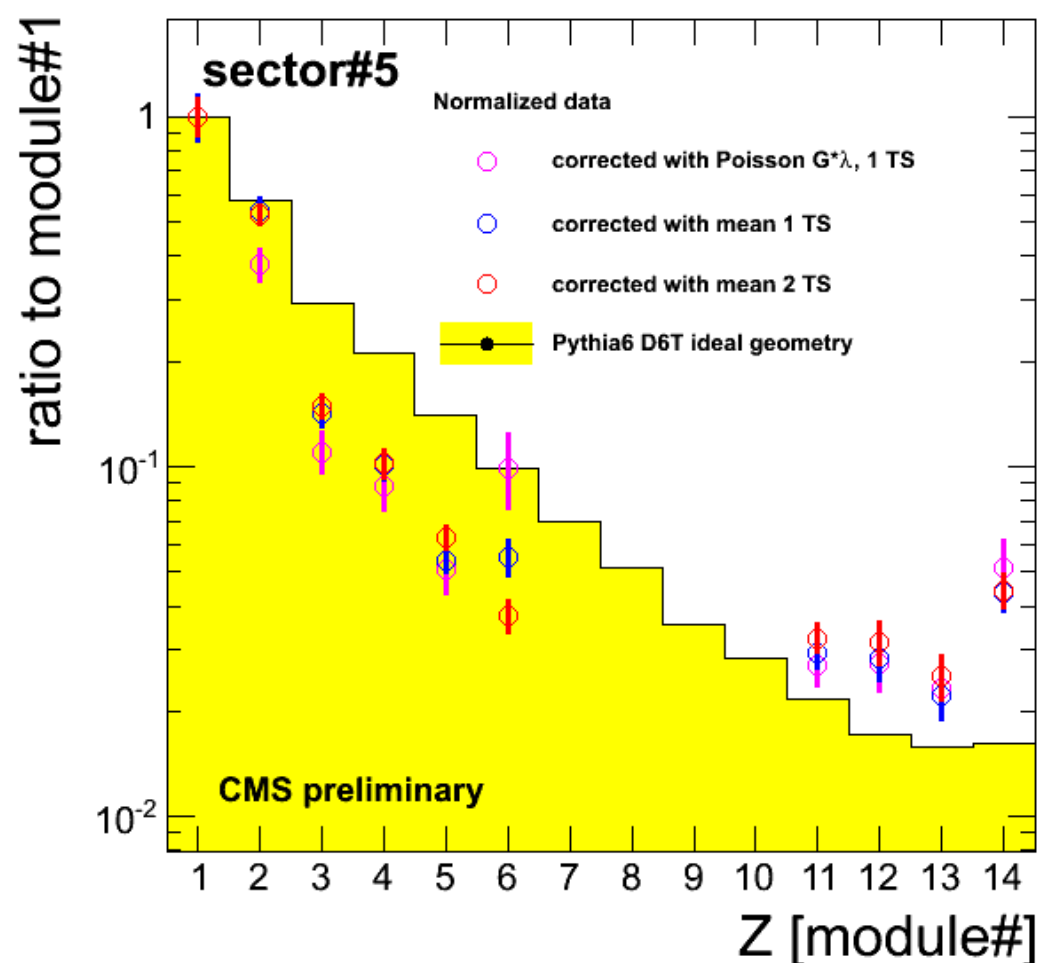
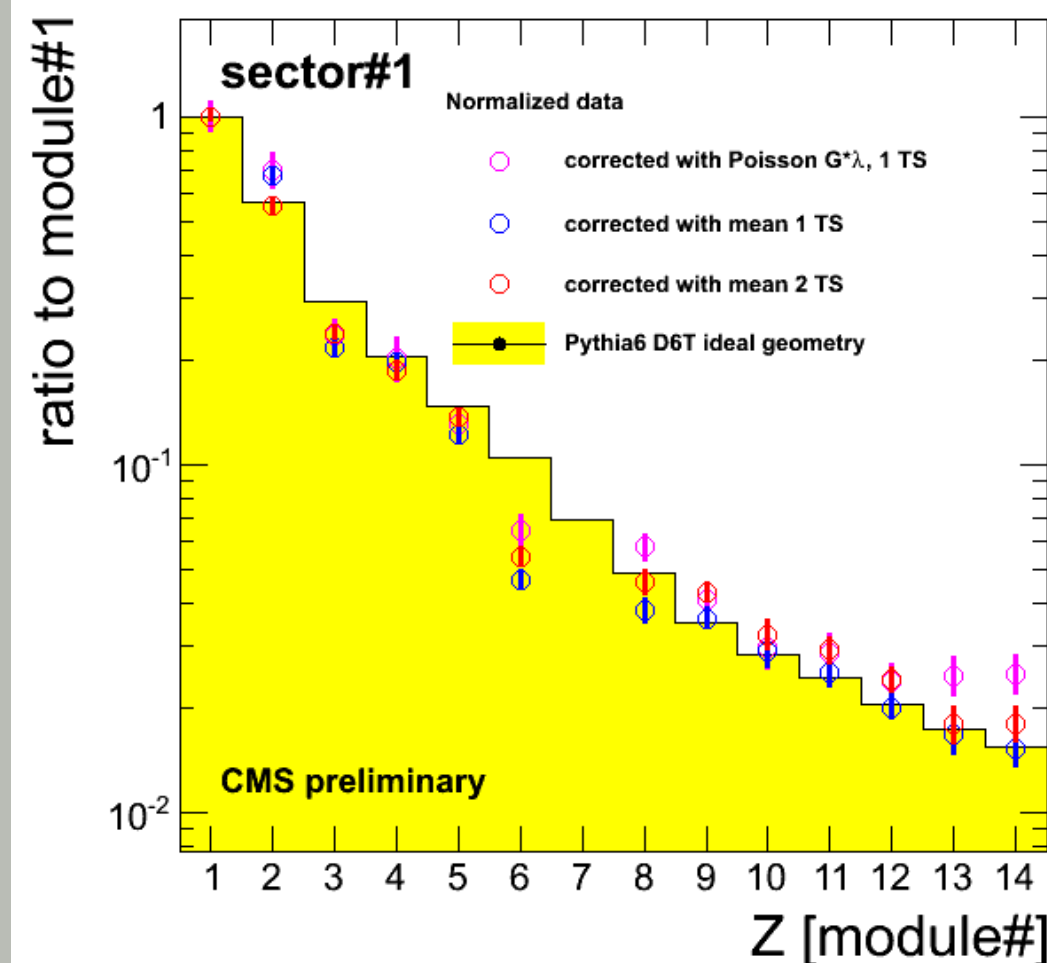
Minimum Bias data corrected with

mean from muon spectra fit (25ns integration = "1TS")

mean from muon spectra (25ns integration = "1TS")

mean from muon spectra (50ns integration = "2TS") → **final choice**

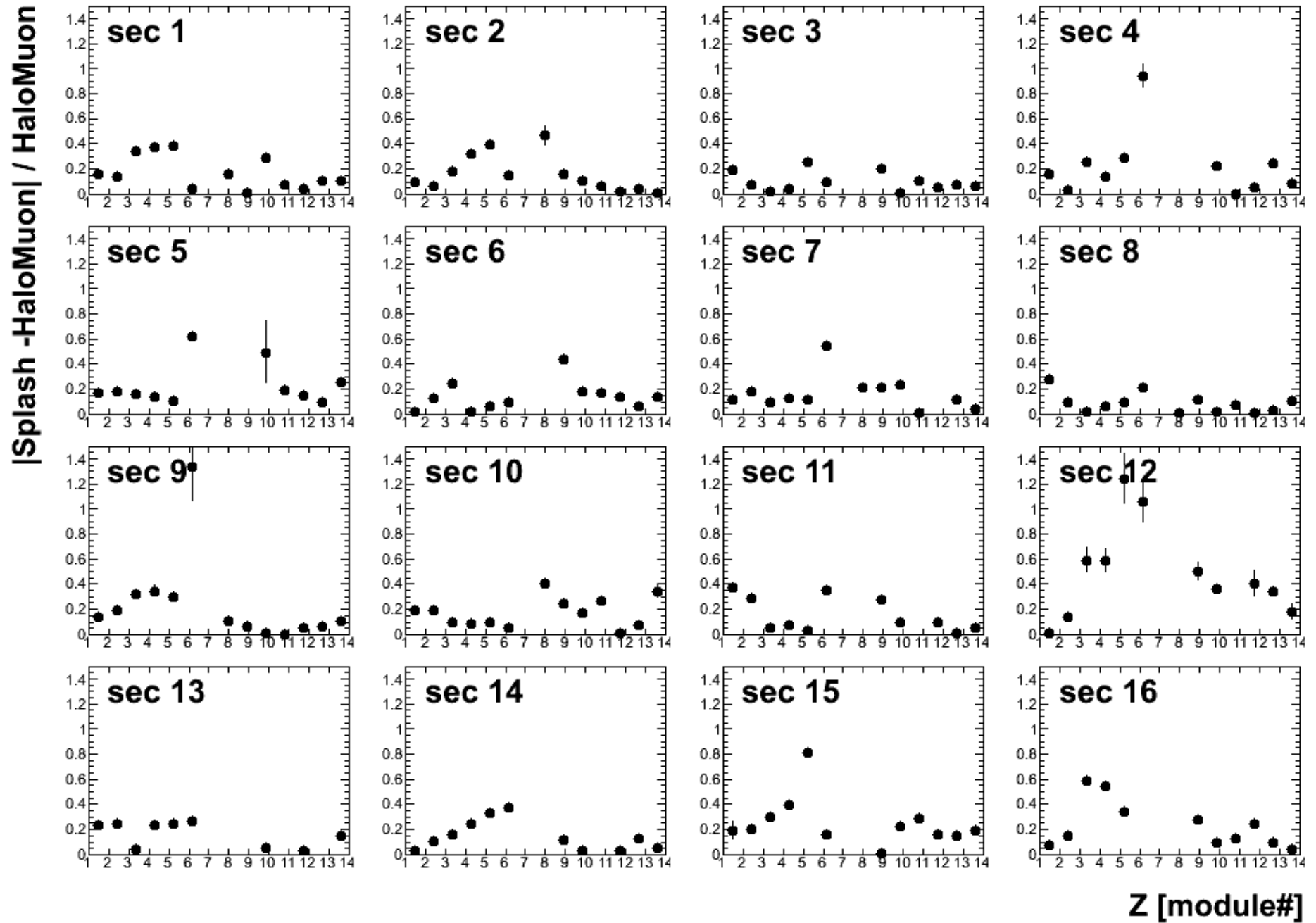
compared to MC:



“SPLASH” run as a cross-check for halo muon results:

- ✓ Beam 1 steered into collimator ~150 meters from CMS
- ✓ large amount of muons per one event
- ✓ ϕ -dependent => only longitudinal “intercalibration”
- ✓ small contribution from hadrons is possible
(larger signals in first CASTOR modules)
- ✓ **Still useful as qualitative cross-check for halo muon:**
Comparison of normalized mean signals -
splash vs halo muon (sectorwise).
The halo muon data are corrected for PMT gain difference in respect to the splash run.
- ✓ **Rough estimate of systematics for halo-muon mean signal values**

CMS preliminary



Intercalibration with muons for Minimum Bias data:

Minimum Bias data

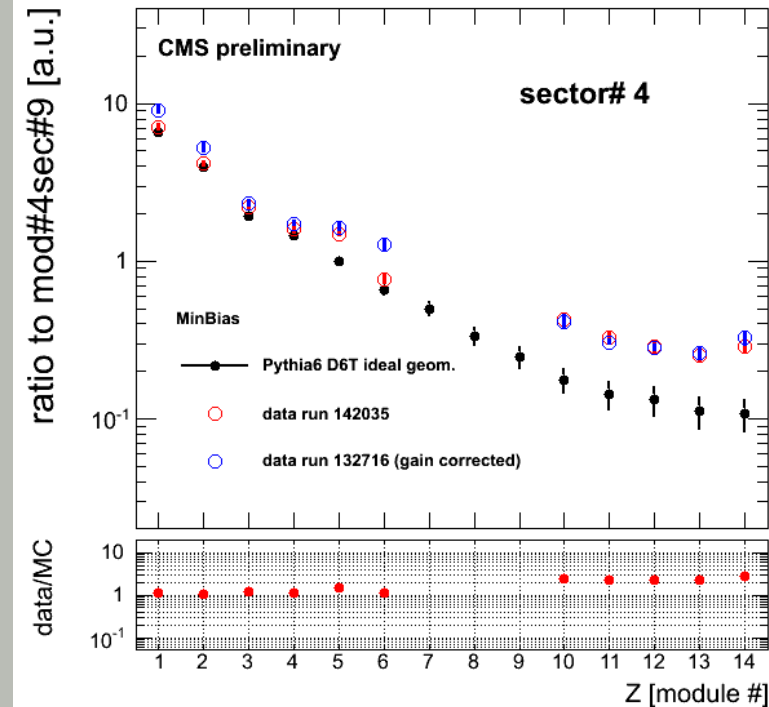
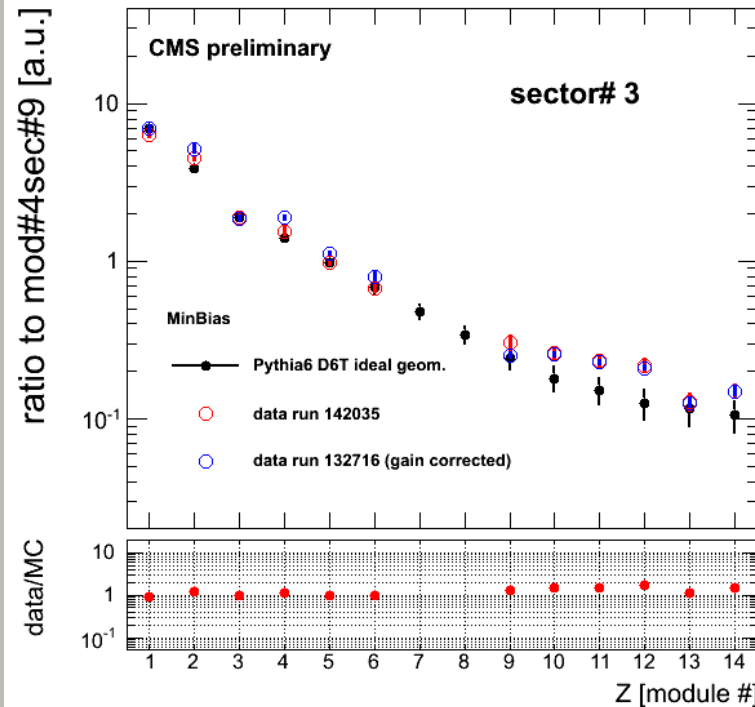
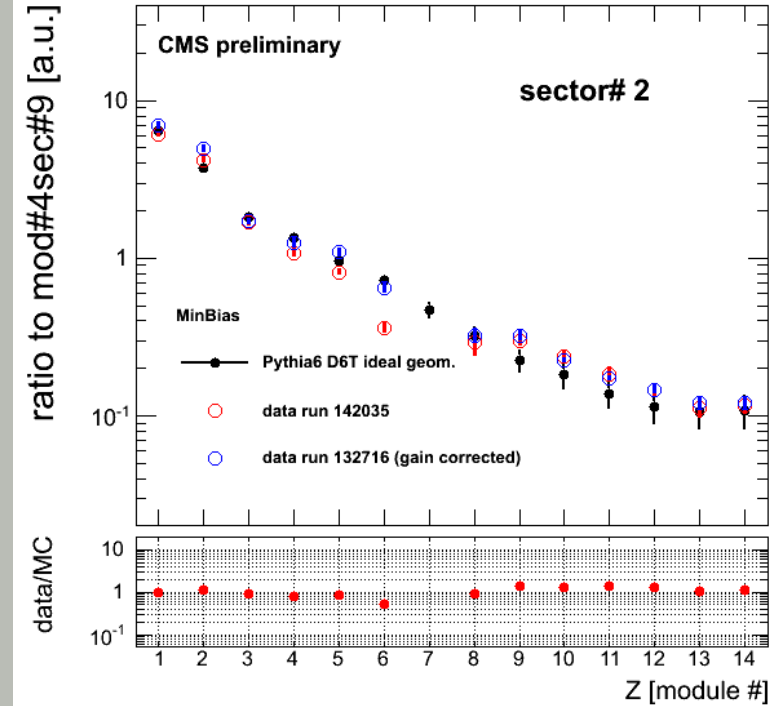
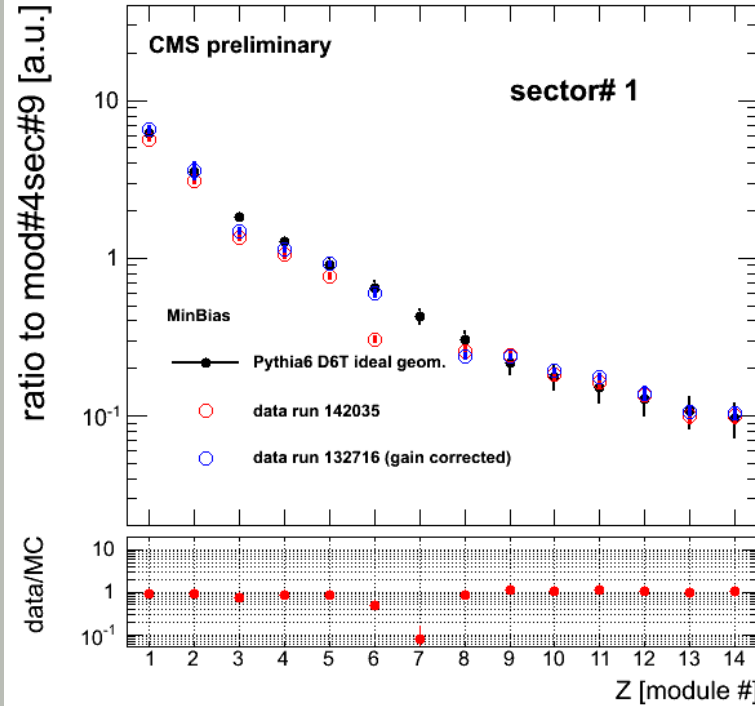
x

muon

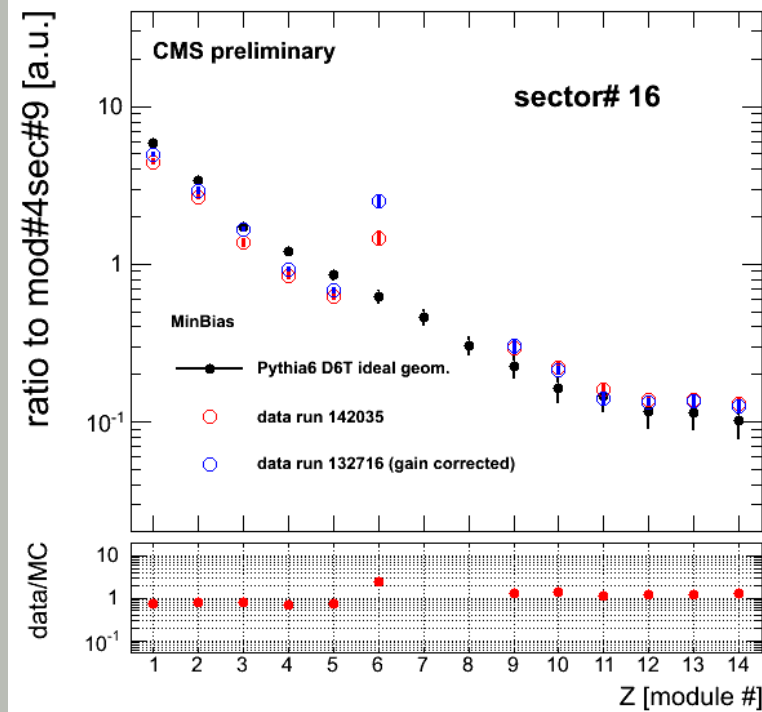
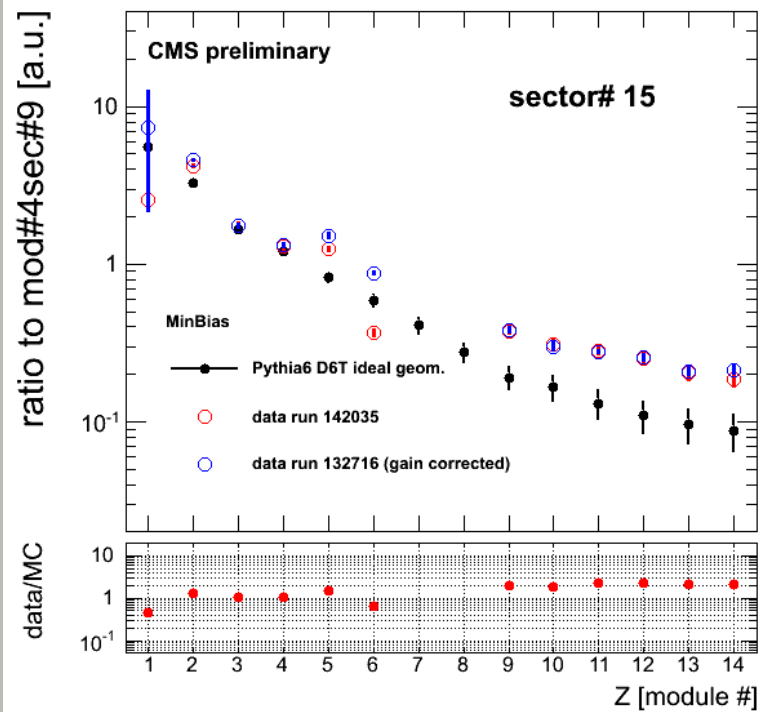
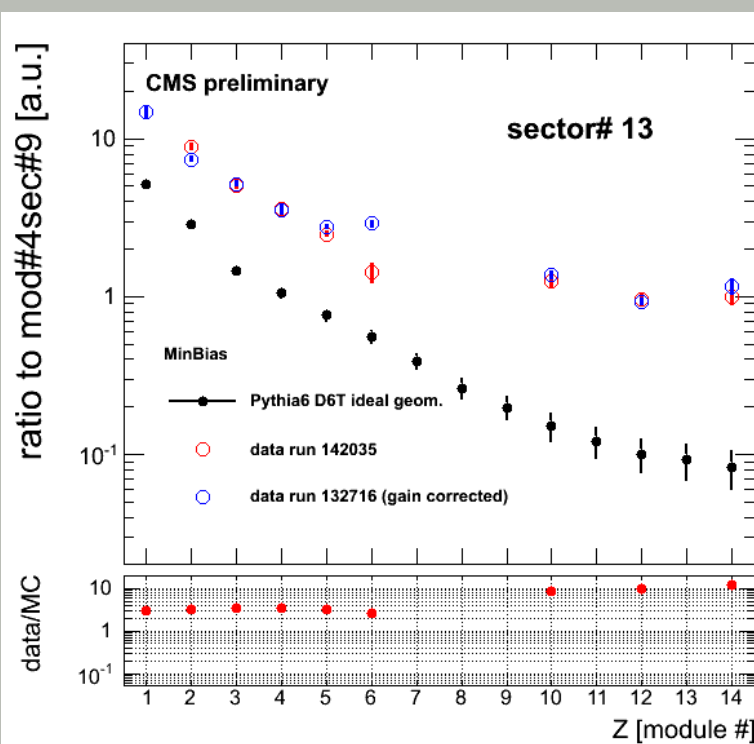
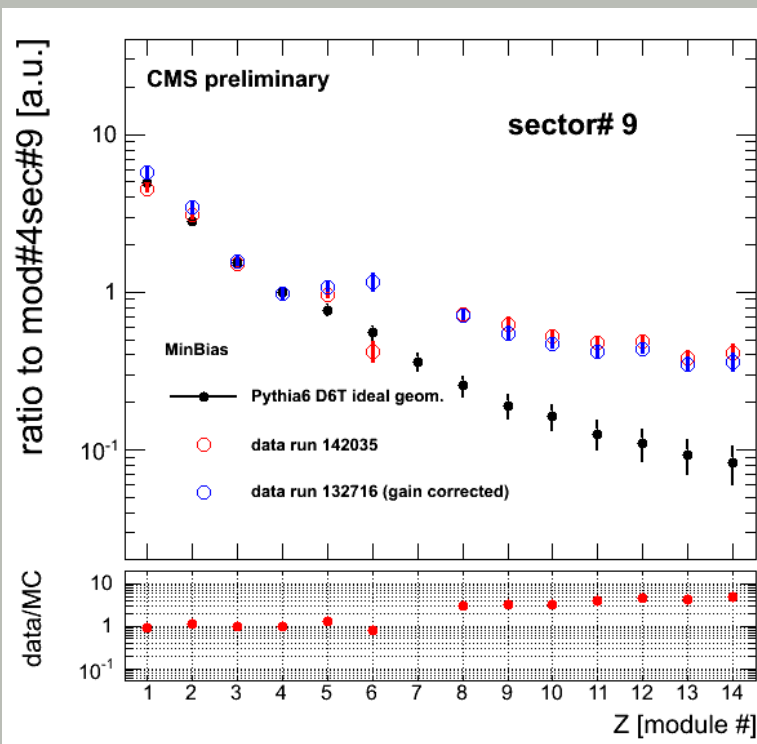
intercalibration

(in respect to
a fixed channel)

- ✓ Data taken with
"muon" PMT gain
- ✓ Data taken with
"physics" PMT gain
with gain correction
- ✓ Monte Carlo
(ideal
CASTOR alignment)



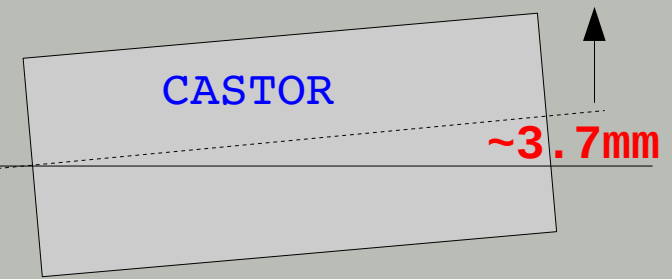
Intercalibration with muons for Minimum Bias data:



Discrepancy to MC:

? not perfectly aligned CASTOR ?

+Z, IP



Influence of CASTOR position on MinBias data:

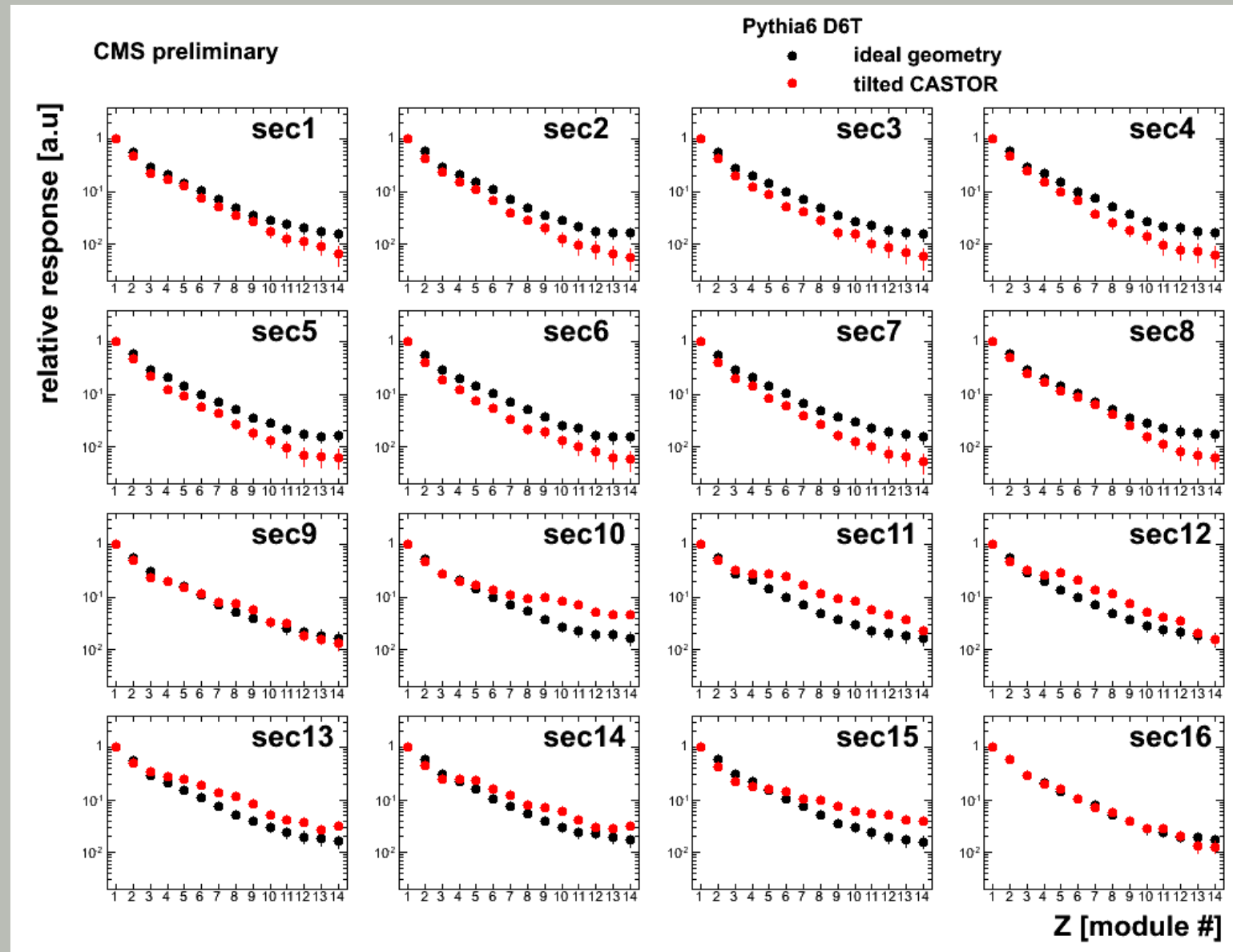
Monte-Carlo study:

rough tilt
(y direction only)

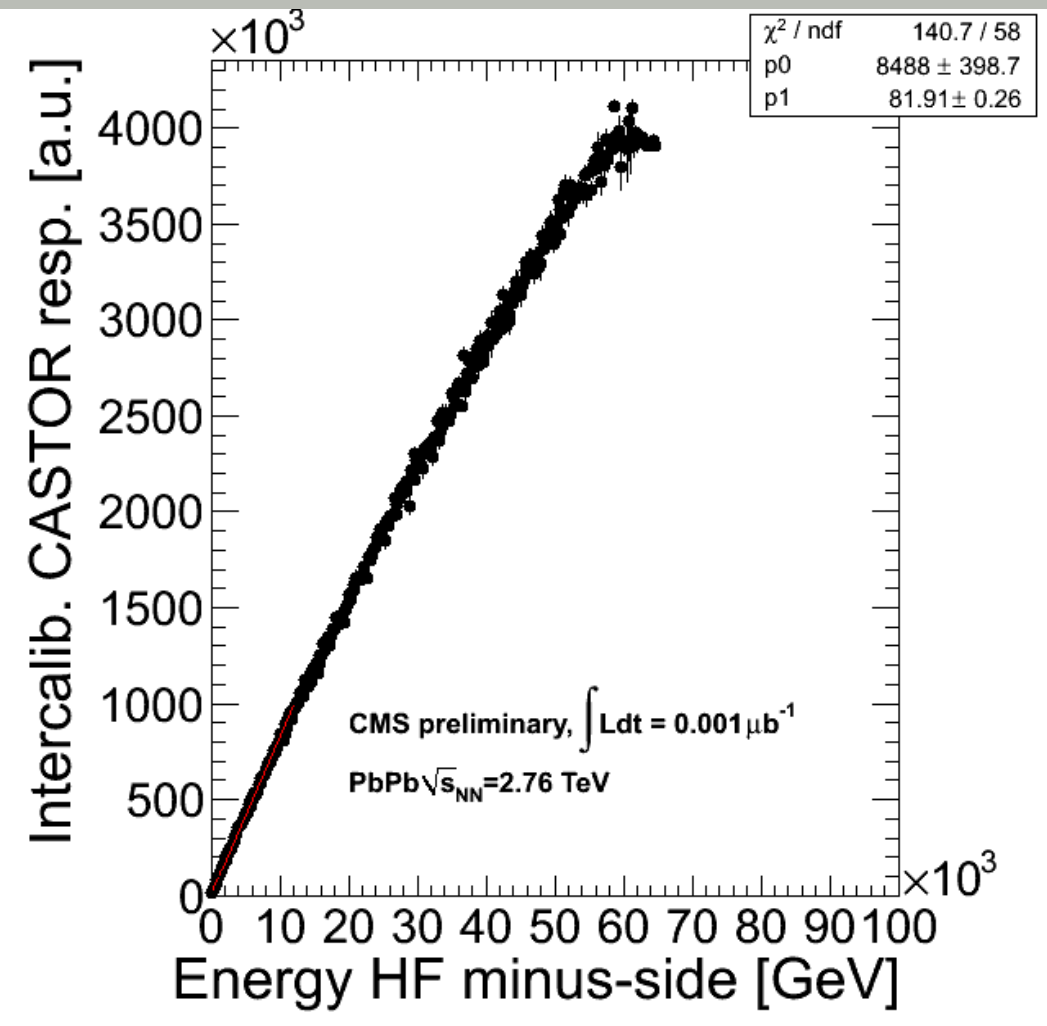
VS
nominal position

=>

realistic CASTOR
position to be
implemented in MC



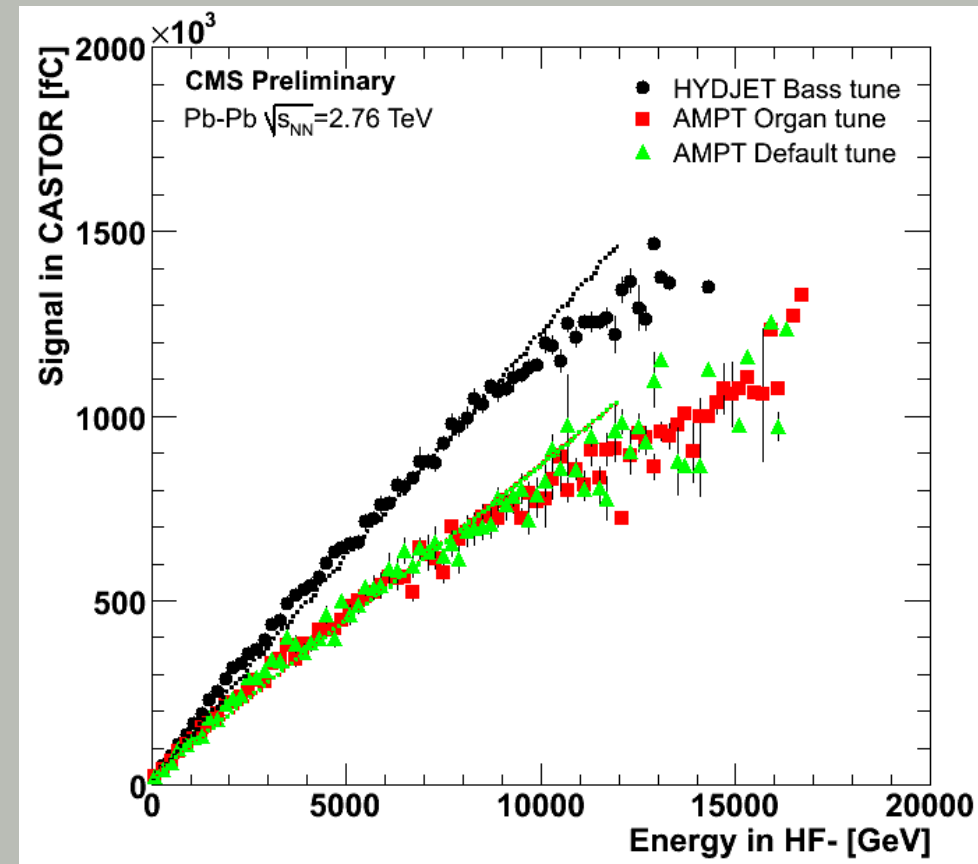
Performance at Heavy Ion collisions (Minimum Bias):



total CASTOR response
vs HF-minus energy

$\leq$ HI data 2010

Monte-Carlo study:

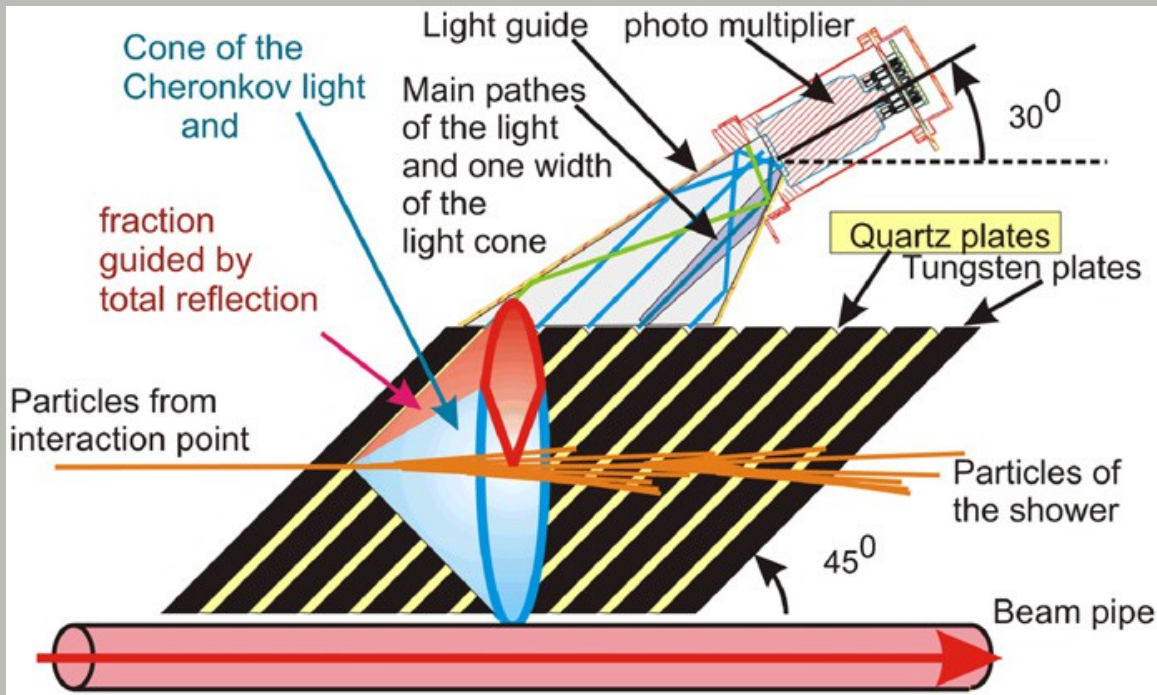


CONCLUSION

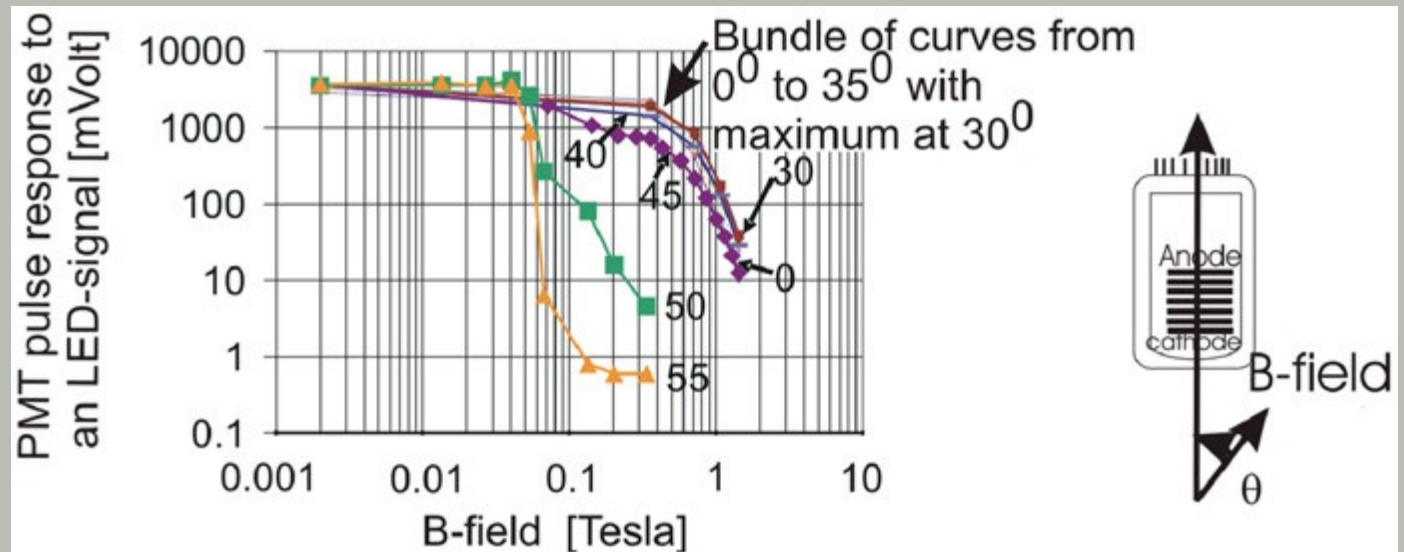
- ✓ CASTOR calorimeter has been designed, studied in beam tests, installed, commissioned and fully integrated into CMS in a record time. Detector took good quality pp-data at centre-of-mass energies 900, 2360 and 7000 GeV, heavy-ion data at 2.76 TeV per nucleon pair.
- ✓ Due to the location in the very forward region and nonuniform magnetic field, CASTOR calibration is challenging.
- ✓ Intercalibration with halo muons is the first step towards a full calibration of CASTOR.
- ✓ CASTOR response to halo muons also provides valuable input to understanding of the calorimeter performance.
- ✓ Further calibration studies are ongoing.

BCKUP

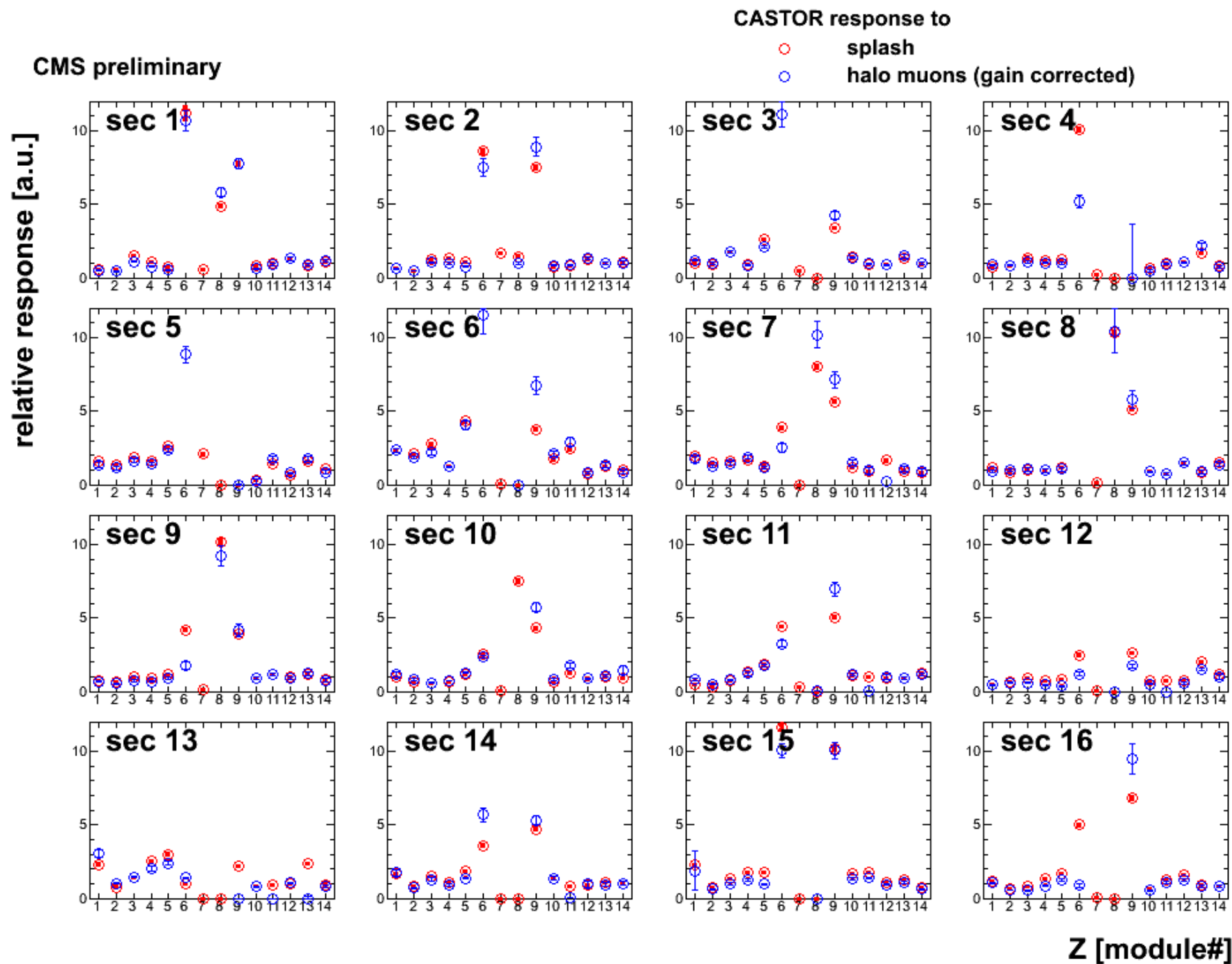
CASTOR construction



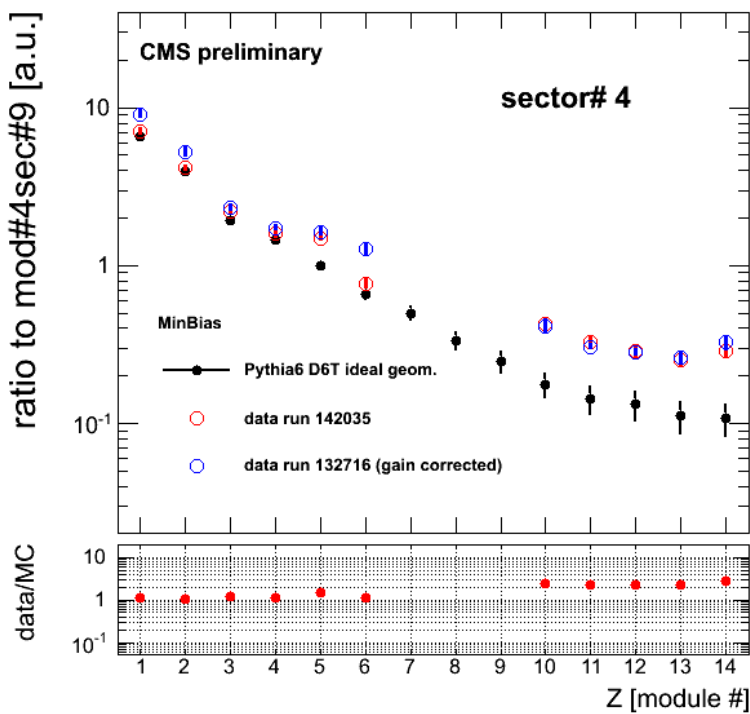
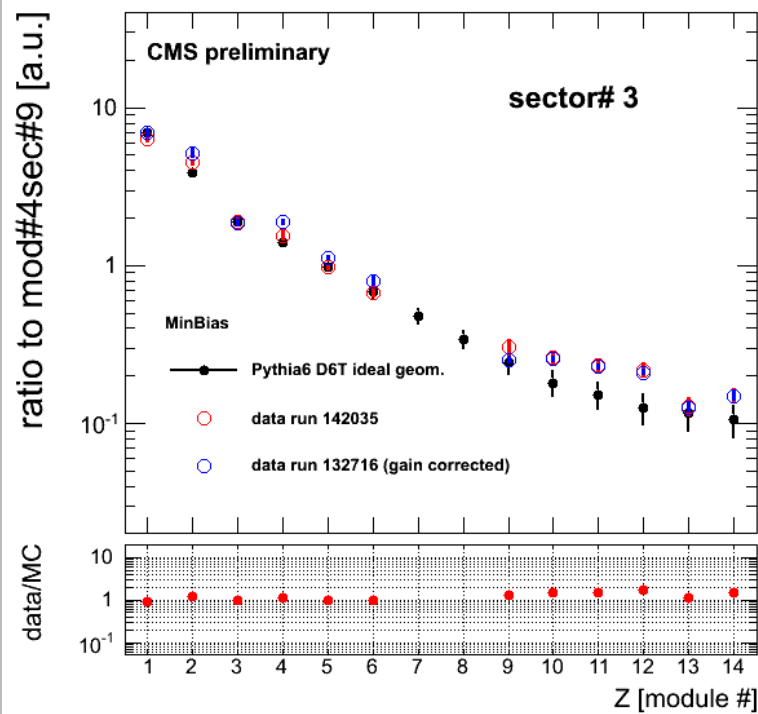
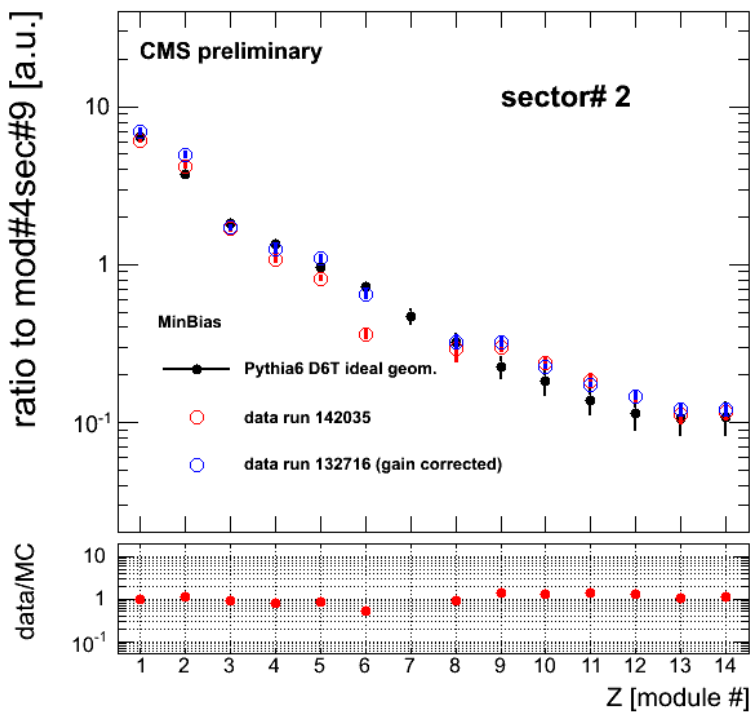
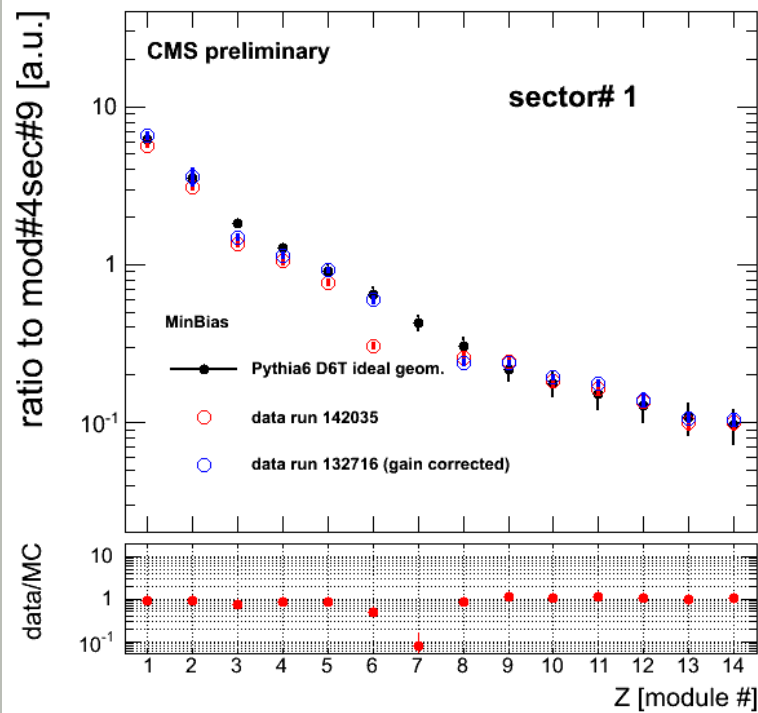
R5505 performance under magnetic field



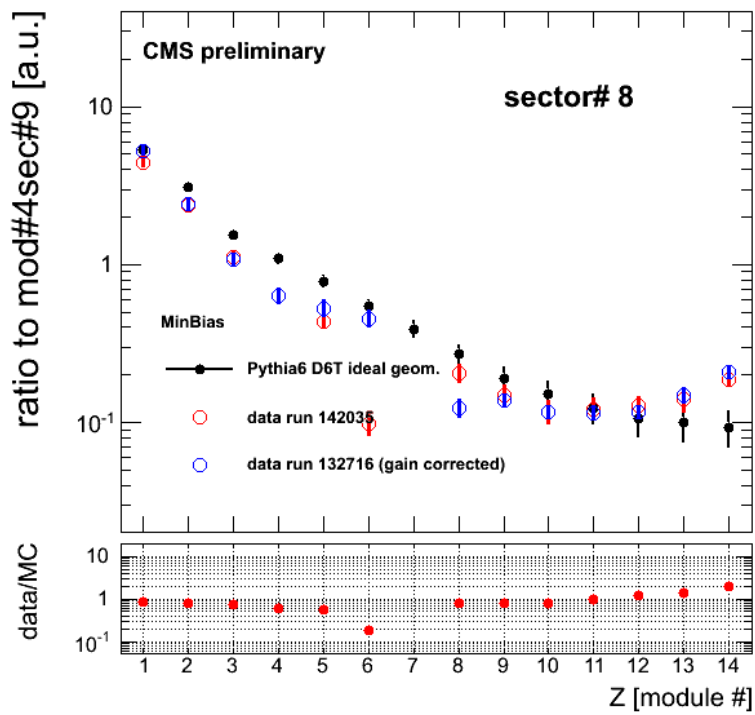
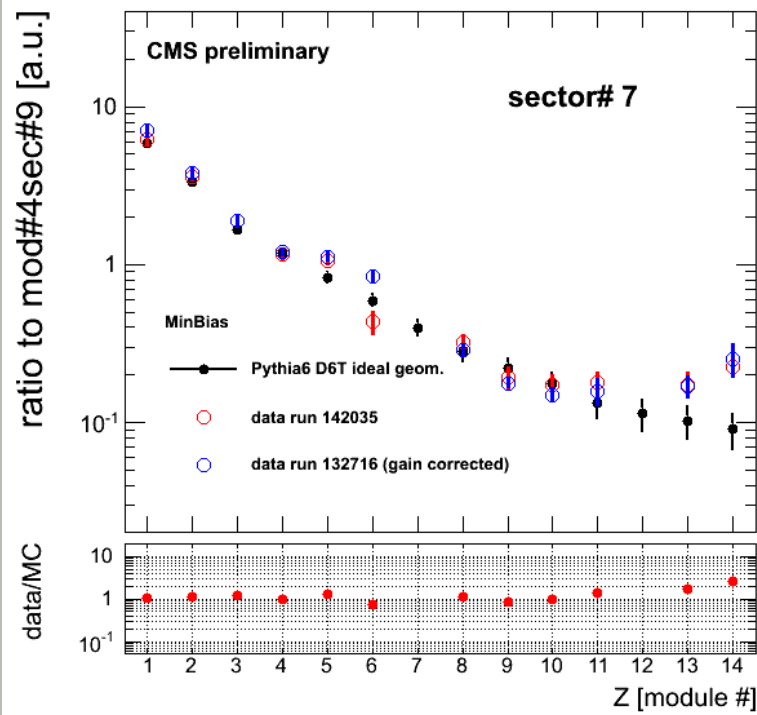
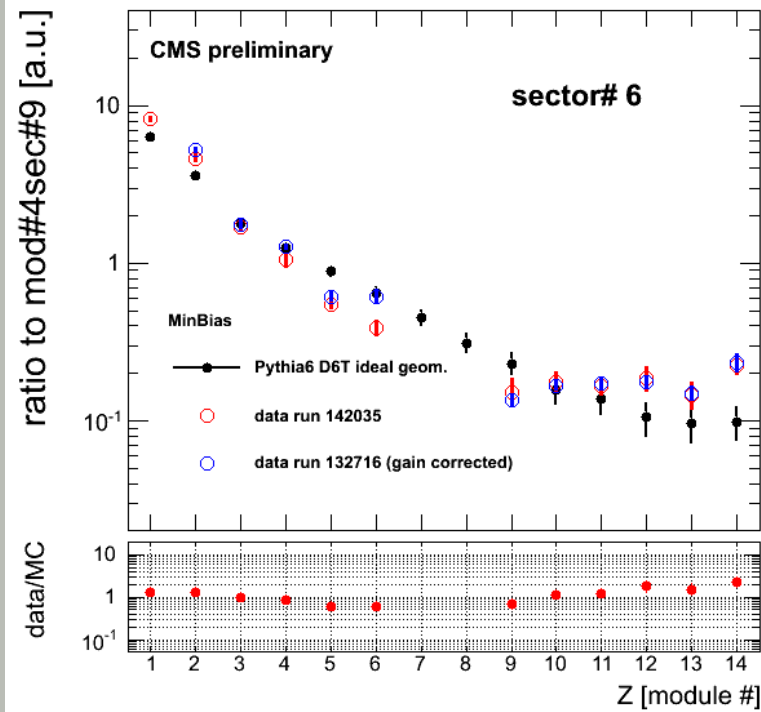
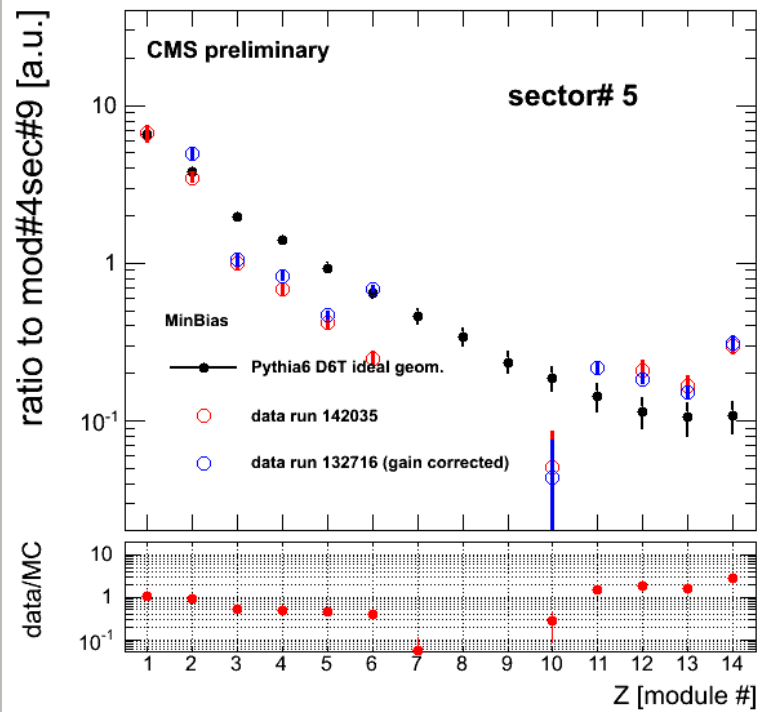
(sectorwise, normalized to weighted mean of rear modules (10-14)):



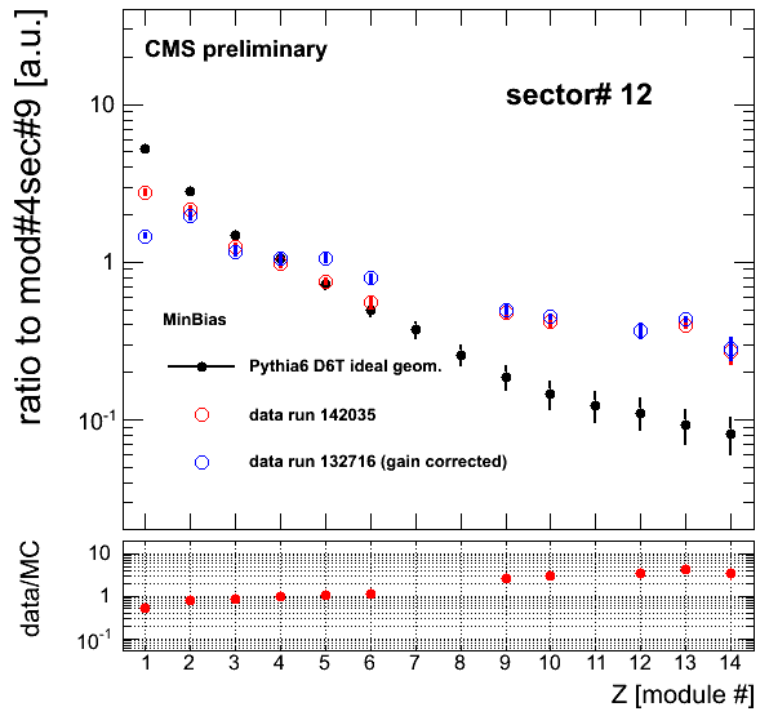
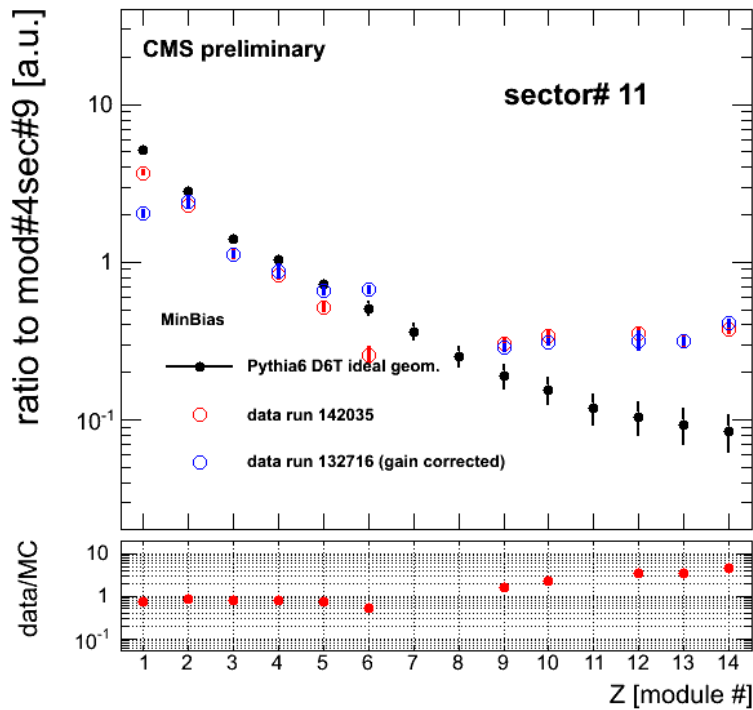
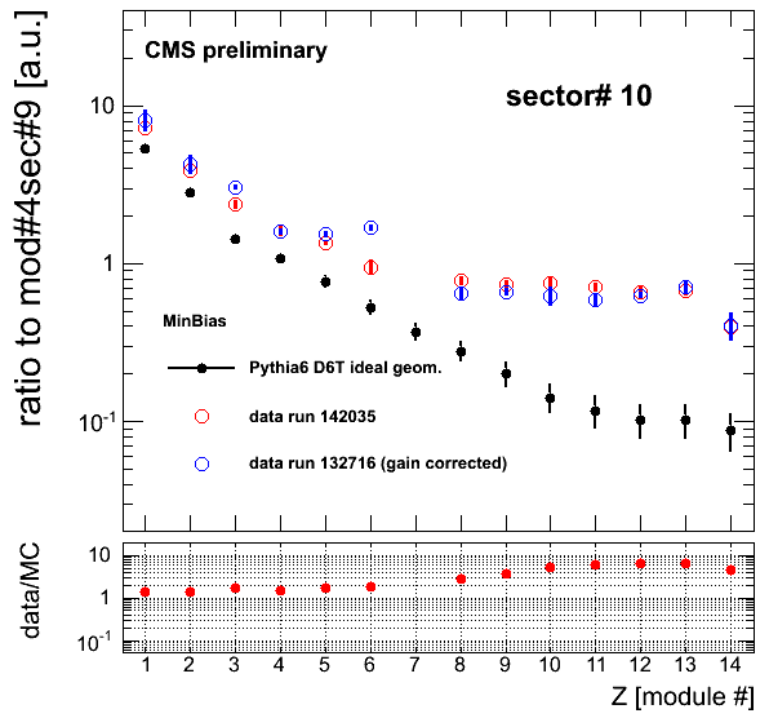
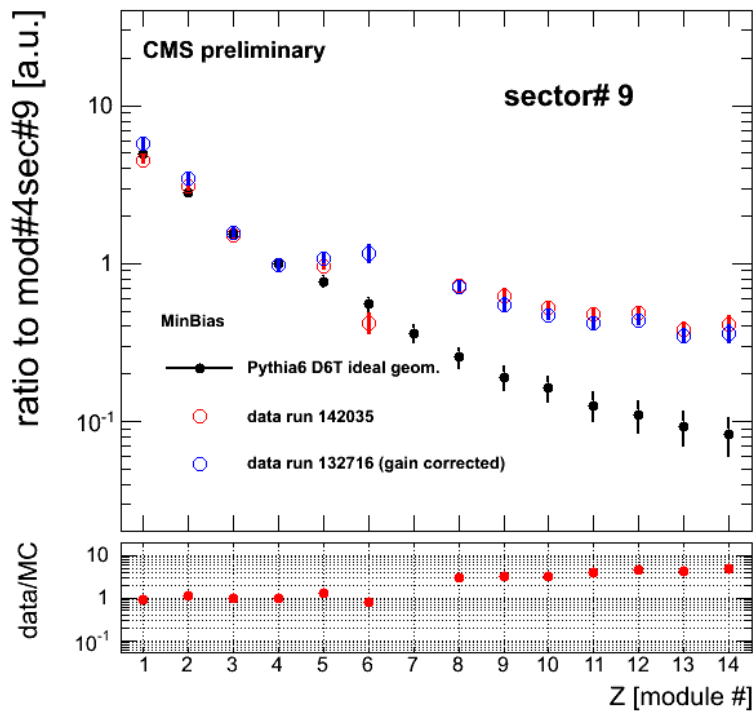
Intercalibration with muon data:



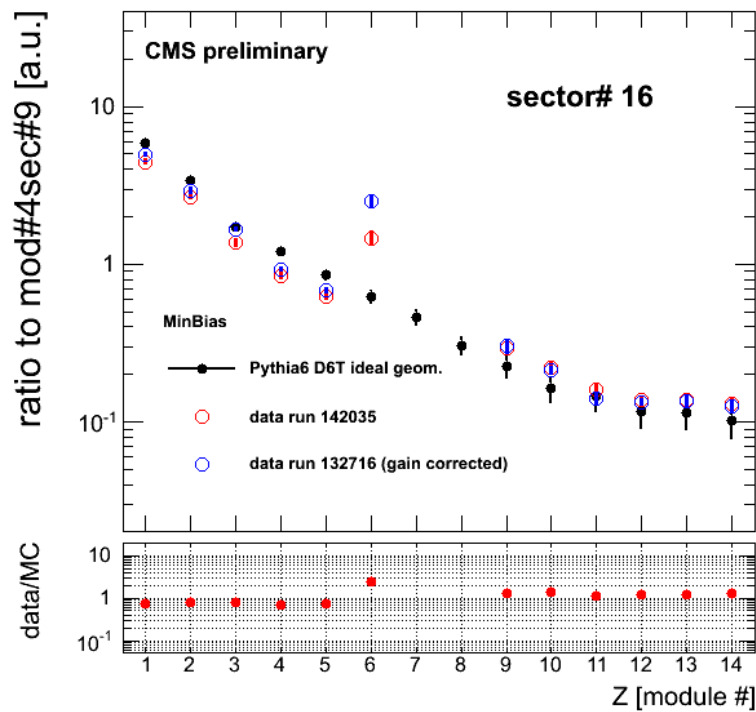
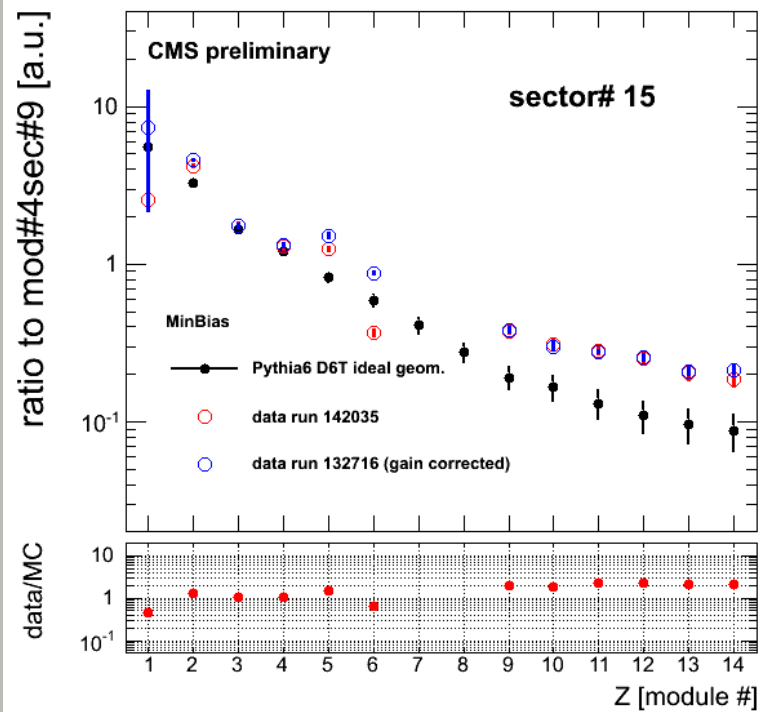
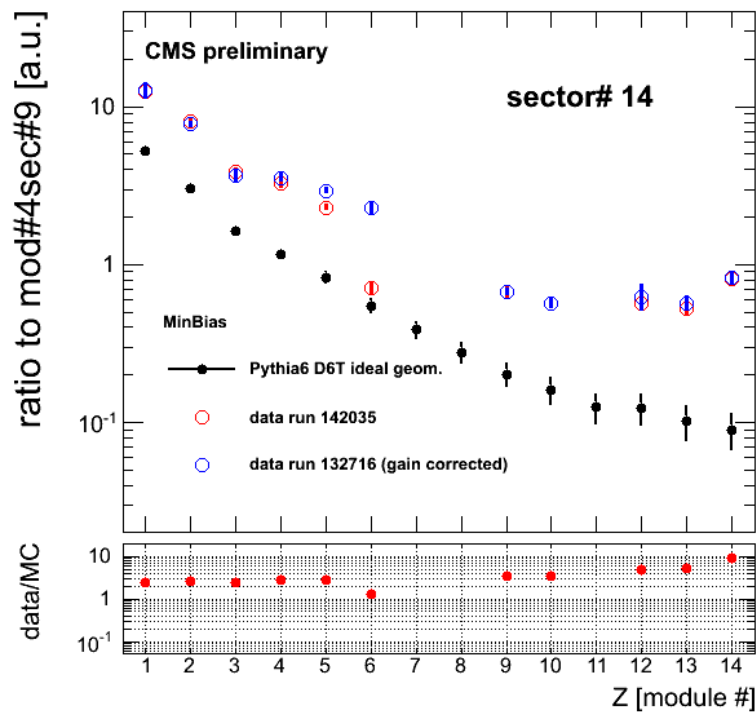
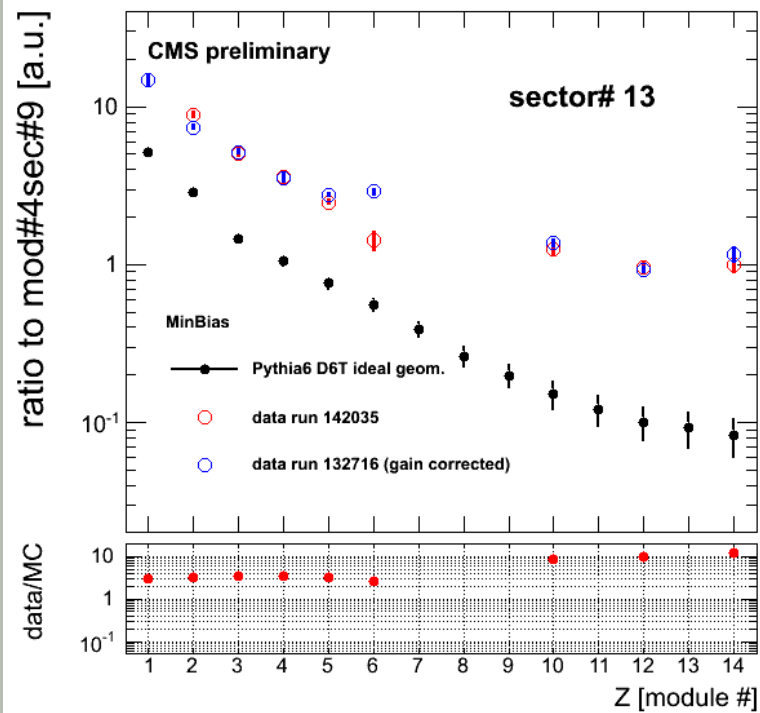
Intercalibration with muon data:



Intercalibration with muon data:



Intercalibration with muon data:



Performance at HI :

