Overview talk on CMS detector performances in Run II

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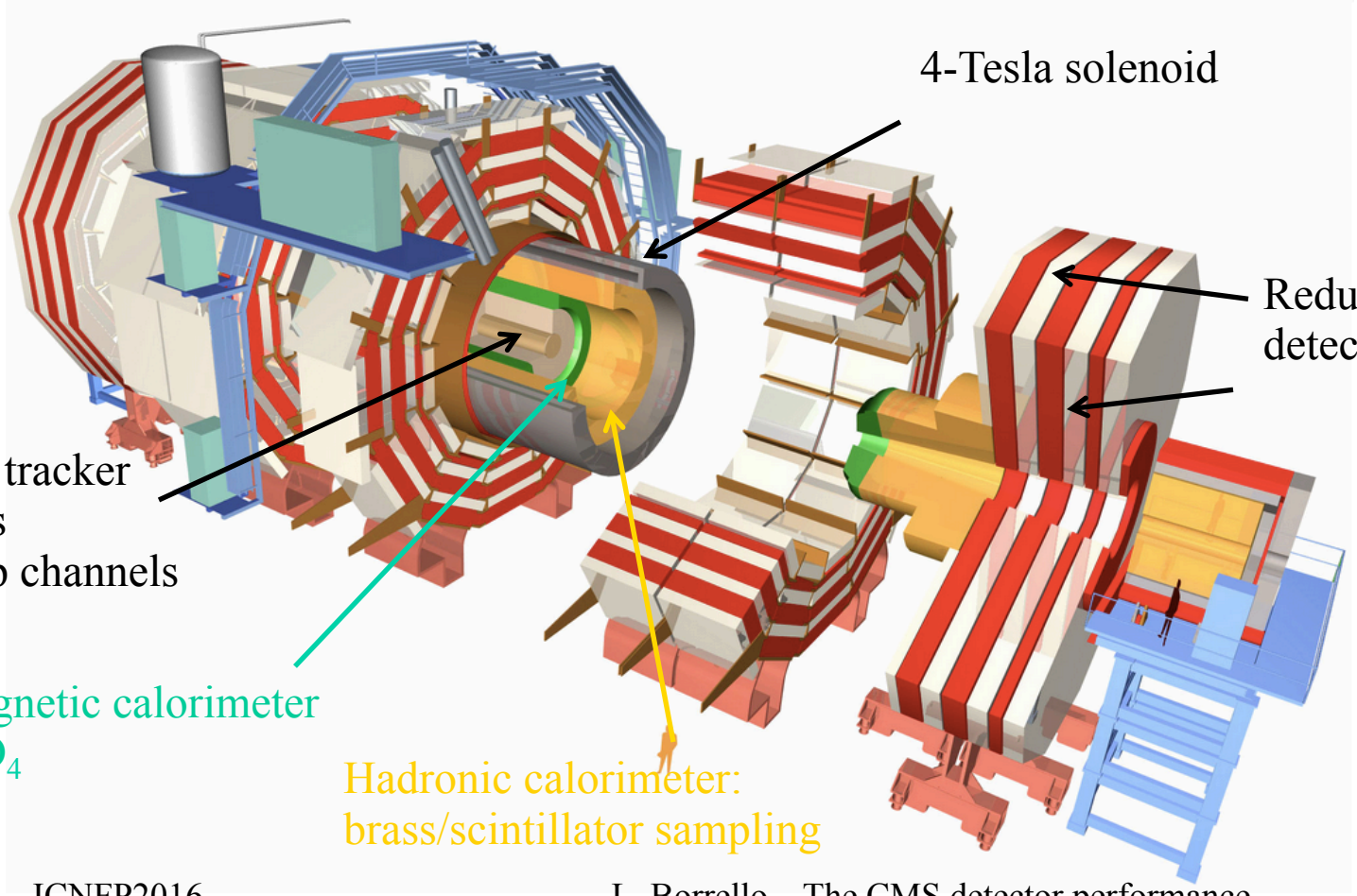
The CMS detector at the LHC

CMS (Compact Muon Solenoid) is a multipurpose detector built to exploit physics at LHC

- pp collisions at a center of mass energy 7, 8 and 13 TeV
- PbPb collisions at a center of mass energy of 2.76 TeV per nucleon

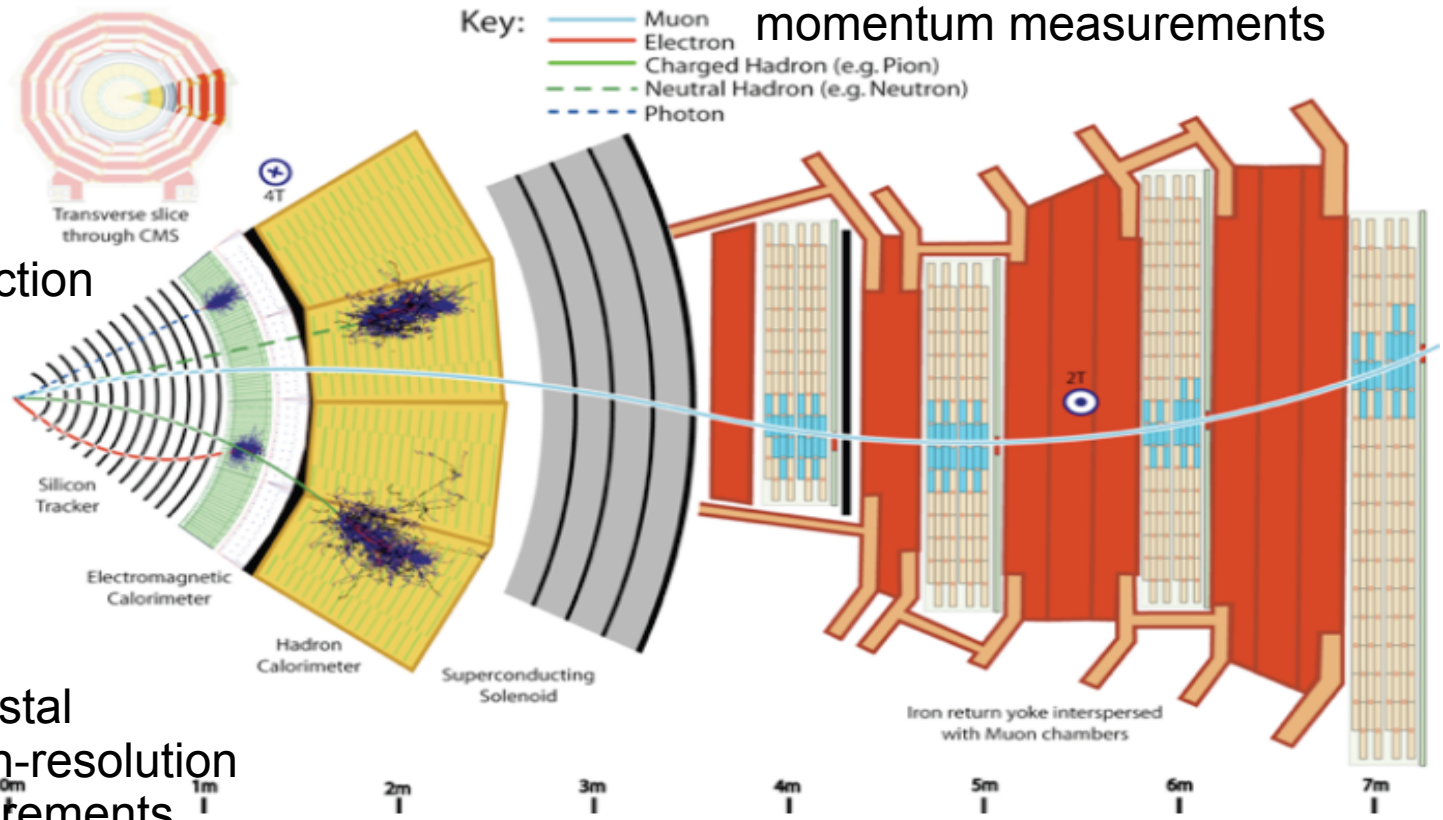


The CMS detector

CMS consists of multiple subdetectors to fully reconstruct tracks, electrons, photons, hadrons and muons

4-Tesla solenoid for high-resolution momentum measurements

All-silicon tracker for track reconstruction



Lead tungstate crystal calorimeter for high-resolution EM shower measurements

Hermetic hadron calorimeter

Muon coverage up to $|\eta|<2.4$

CMS operation in 2016

Main goals for 2016 operation:

- Re-establish efficient operation after Year End Technical Stop (YETS)
  - detector and magnet intervention
- Commissioning of Level-1 (L1) Trigger
  - completely new system for 2016
- Ensure high data taking and data quality efficiency

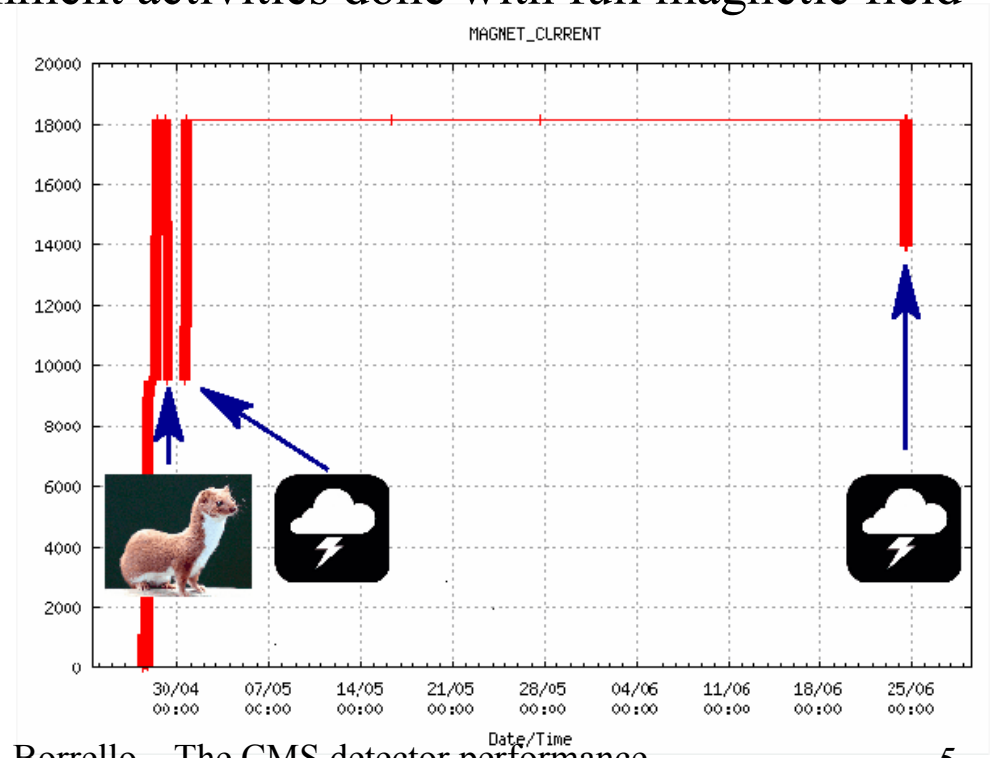
Magnet status

Refurbishment of the magnet system was successful

- Cold box was cleaned to remove traces of Breox contaminants
- Primary oil removal system was replaced

Magnet is fully operational since April 28th

- Operational parameters of cryogenic system are stable
- Detector commissioning and alignment activities done with full magnetic field
- Working stably for proton-proton physics despite natural events

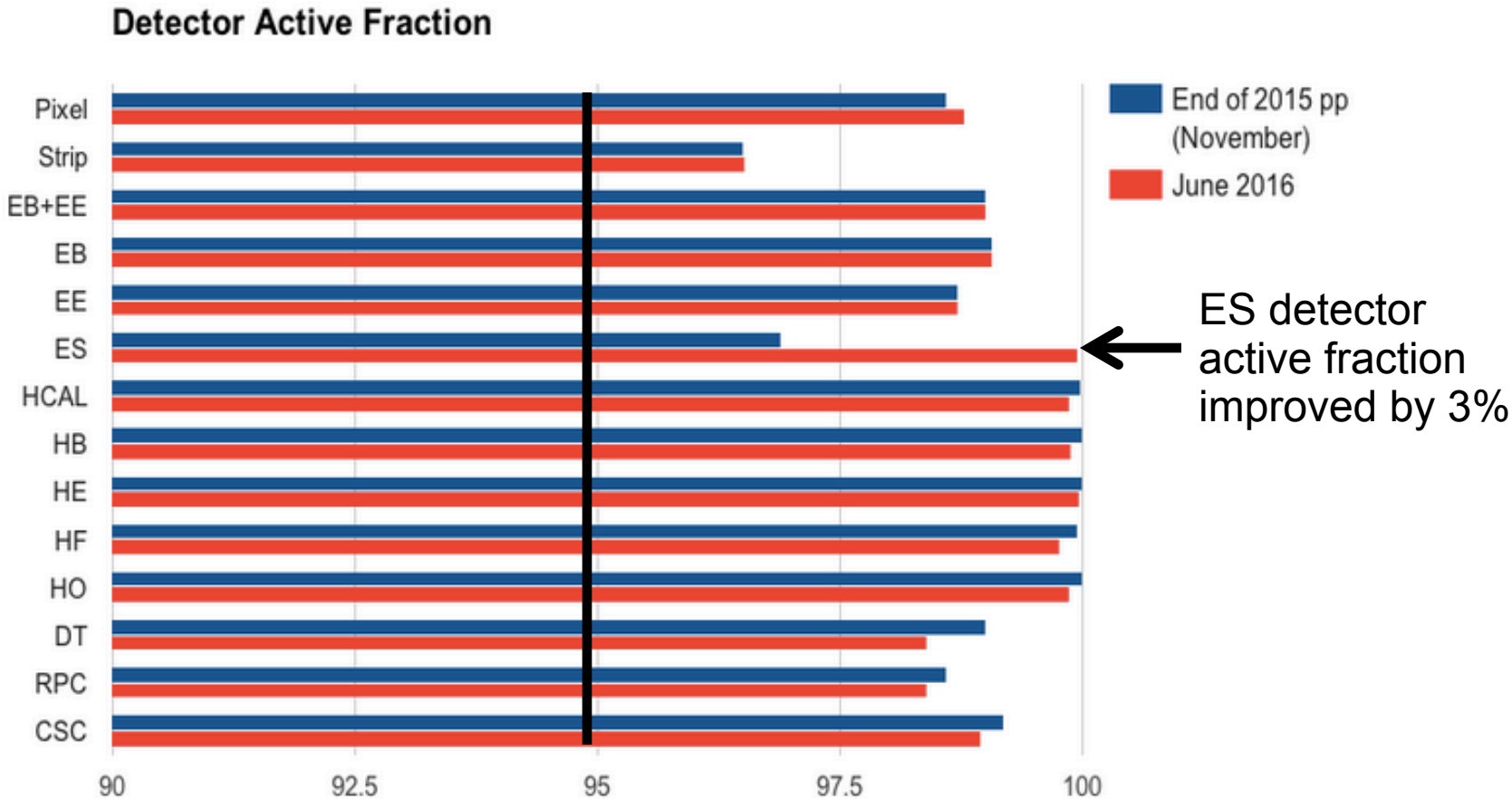


Magnet current versus time

Overall detector performance

Many activities done during the winter shutdown to keep or improve detector performance with respect to 2015

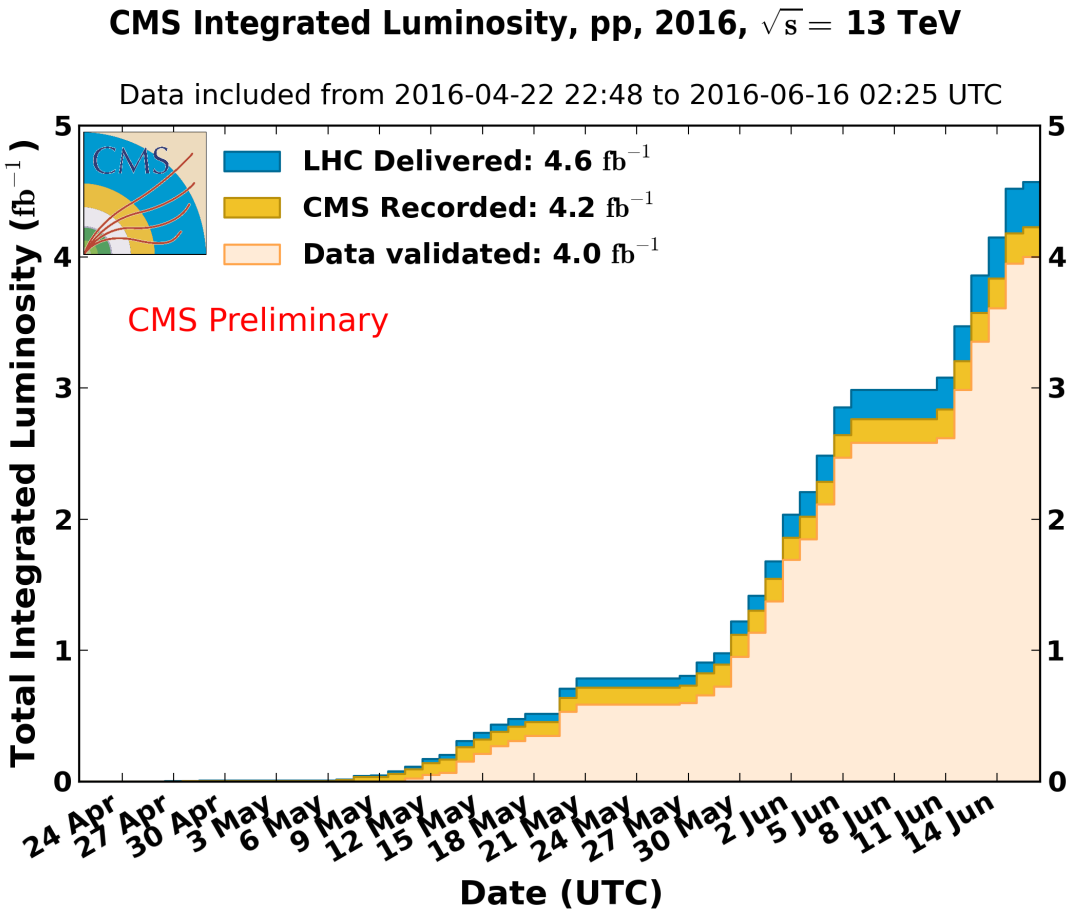
- main improvement for Preshower sub-detector (ES) where 3% of dead channels were recovered



Data taking efficiency

CMS is efficiently recording physics data

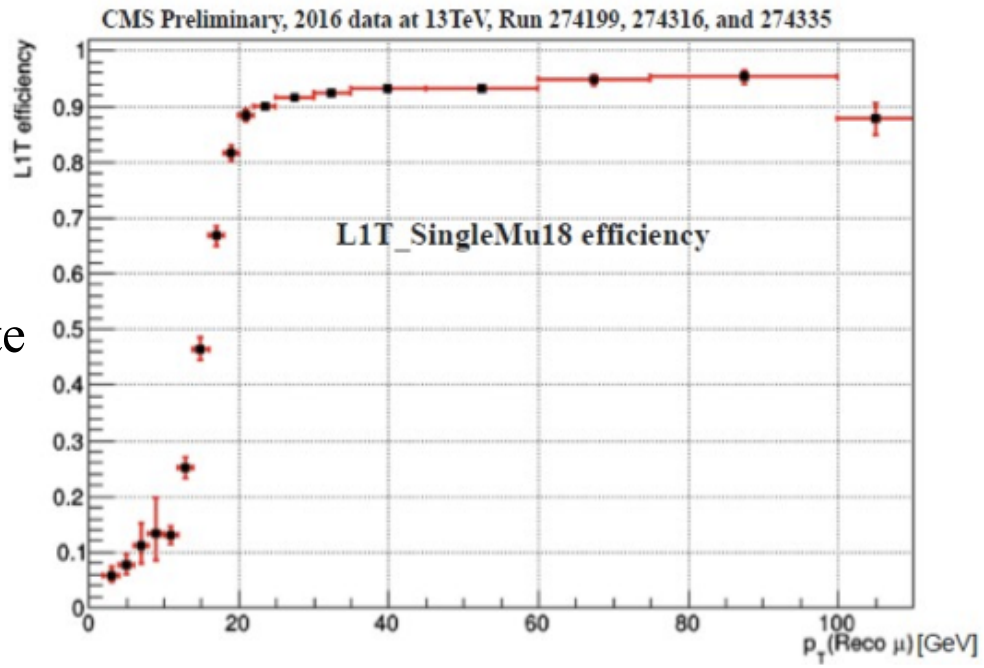
- data recording efficiency > 90%
- data validated for physics > 95%



L1 trigger: Muon

- L1 Trigger has been completely upgraded for 2016 runs
  - New more flexible and powerful electronics
  - Larger data bandwidth using optical links
  - More flexibility in the algorithm

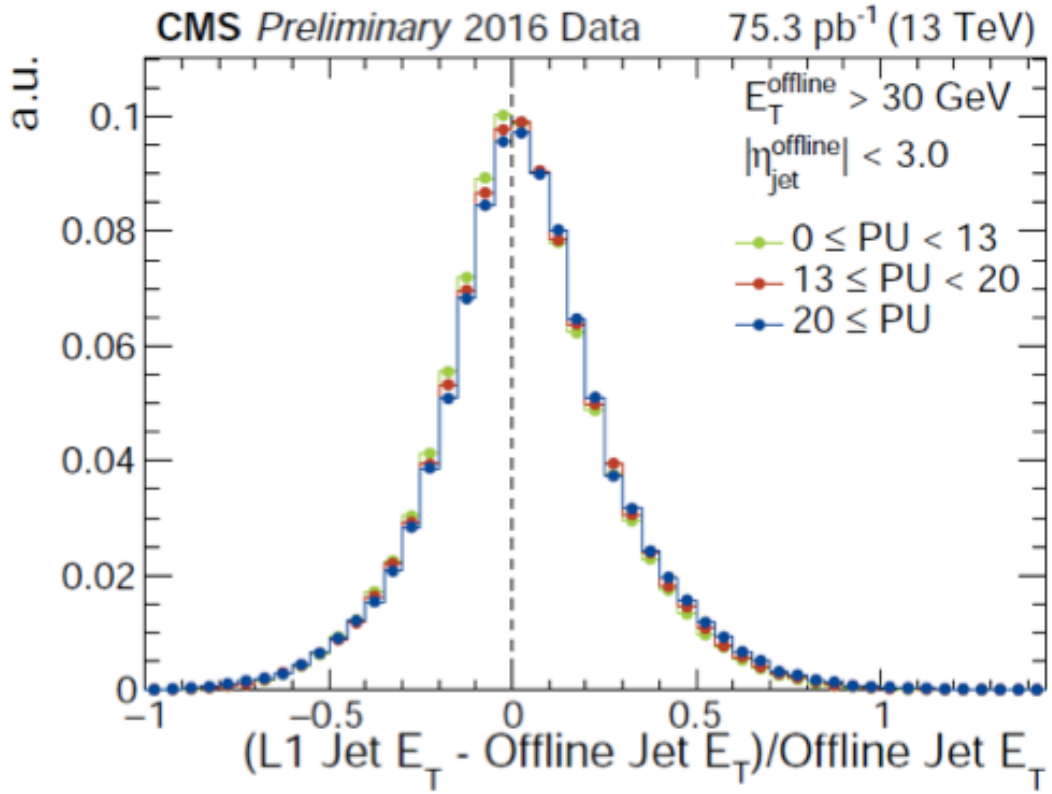
- New muon trigger system
  - 3 regional track finder based on different eta region to exploit detector redundancy
  - a Global muon trigger as collector and for merging and removal duplicate tracks



L1 calorimeter trigger

- L1 calorimeter trigger has been fully upgraded
  - Full tower level information used by the algorithm
  - Better energy and position resolution

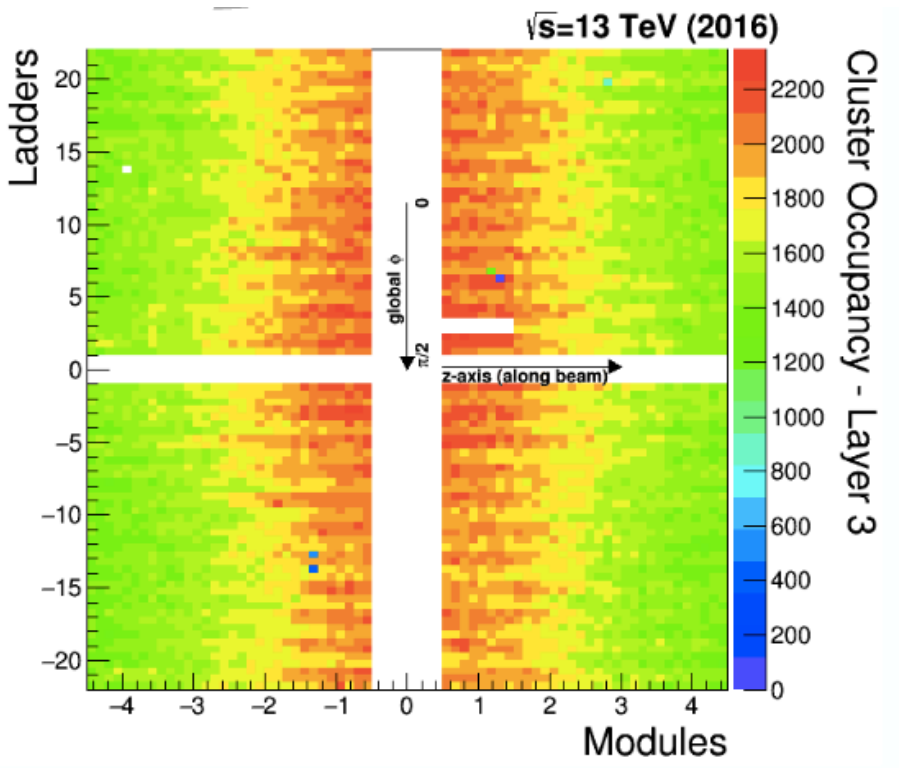
- L1 and offline jet energy are consistent
- Robust against pile-up

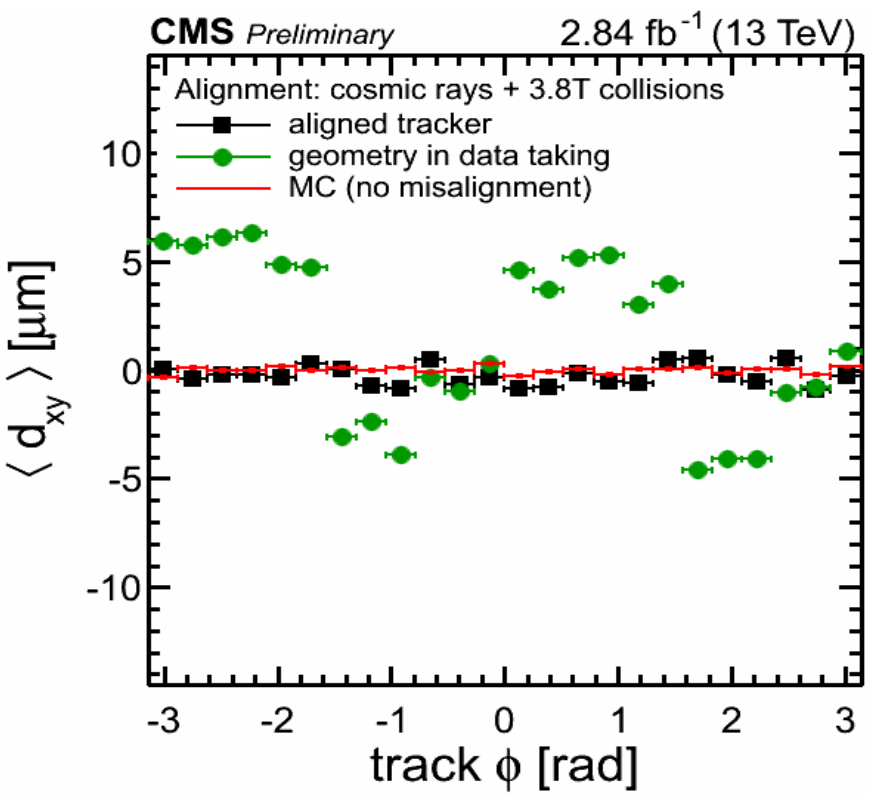


- More details in the talk of Riccardo Manzoni

Tracker

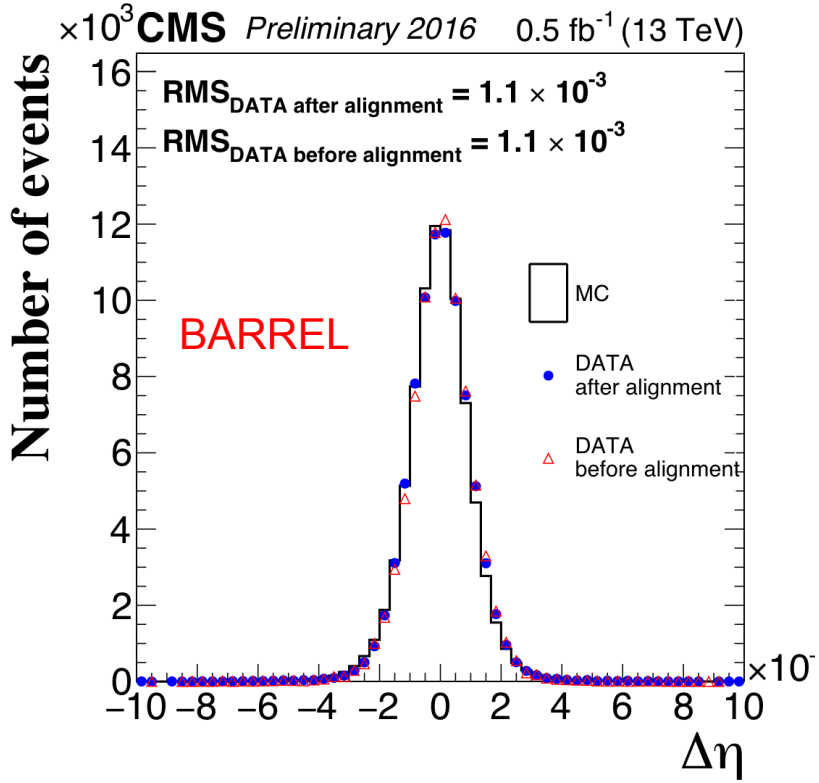
- Since 2015, Tracker detector is operated at low temperature
  - Pixel at -10°C, Strip at -15°C
- Cosmics and collision data used to optimize the timing and update the alignment

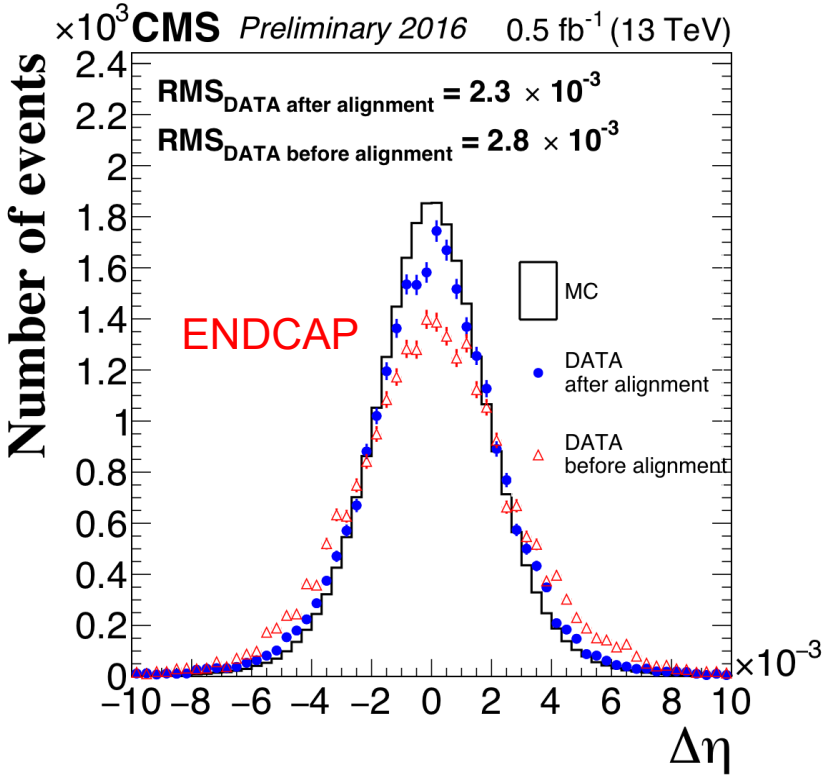




Electromagnetic Calorimeter (ECAL)

- In 2016 new readout settings have been deployed to cope with higher pile-up
- Calibration streams and data being analysed to update alignment and inter-calibration constants

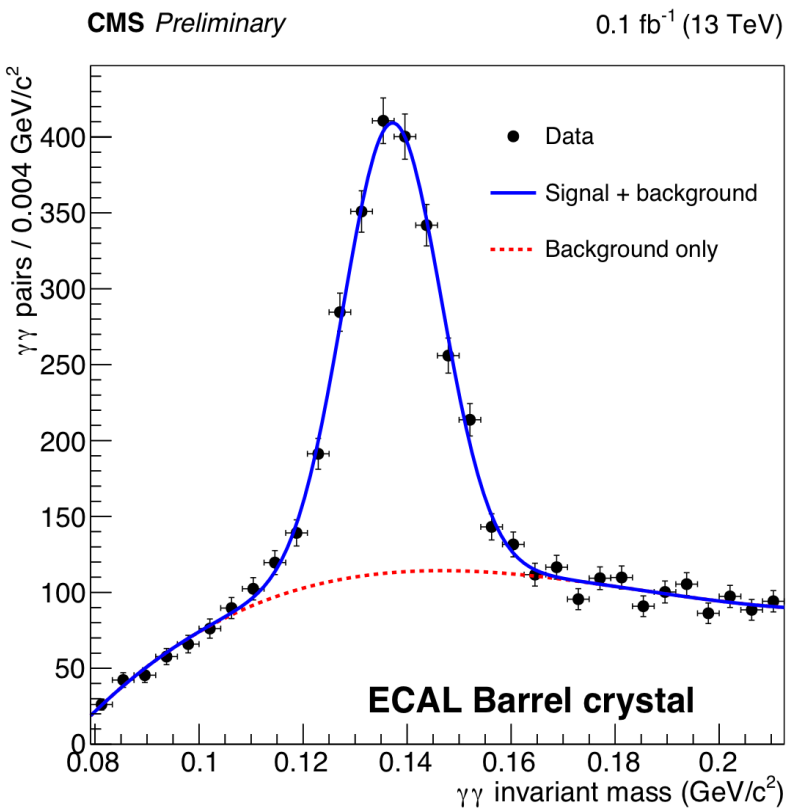




Photons

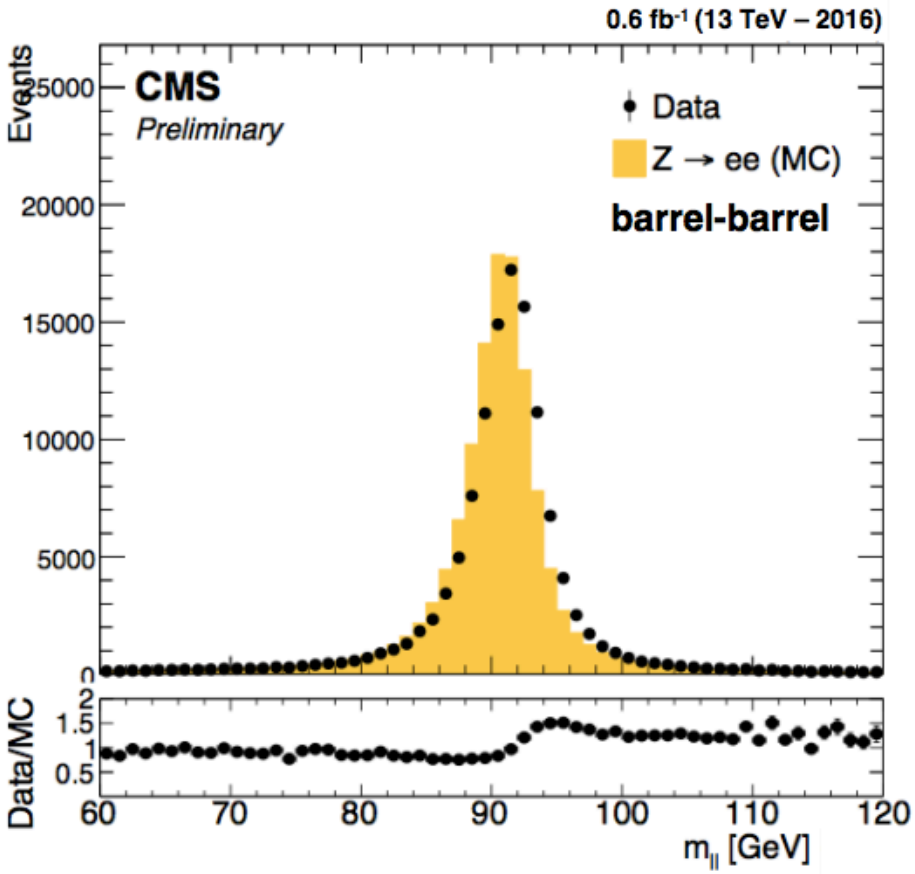
Invariant mass of photon pairs reconstructed in the ECAL Barrel crystal

- used as prompt feedback to monitor the laser monitoring calibration and to inter-calibrate the energy of ECAL crystals



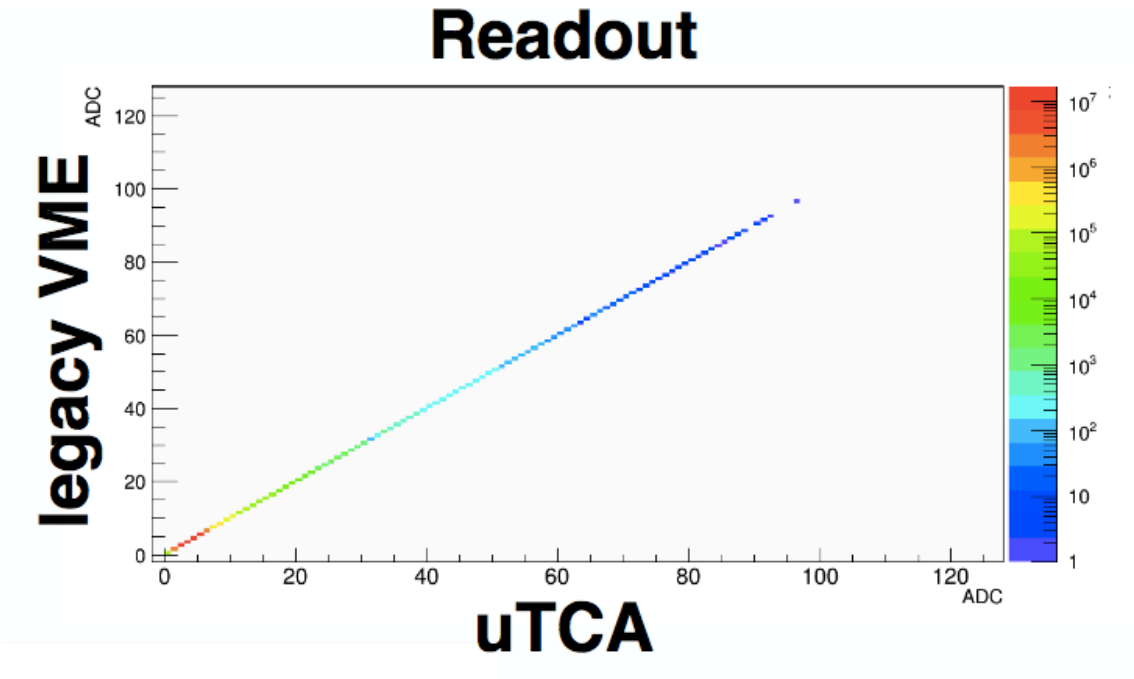
Electrons

- Di-electron invariant mass for barrel-barrel electron pairs:
  - data and MC comparison done with 2015 calibration
  - Energy shift is observed in data since ECAL calibration has not been yet updated to 2016 conditions



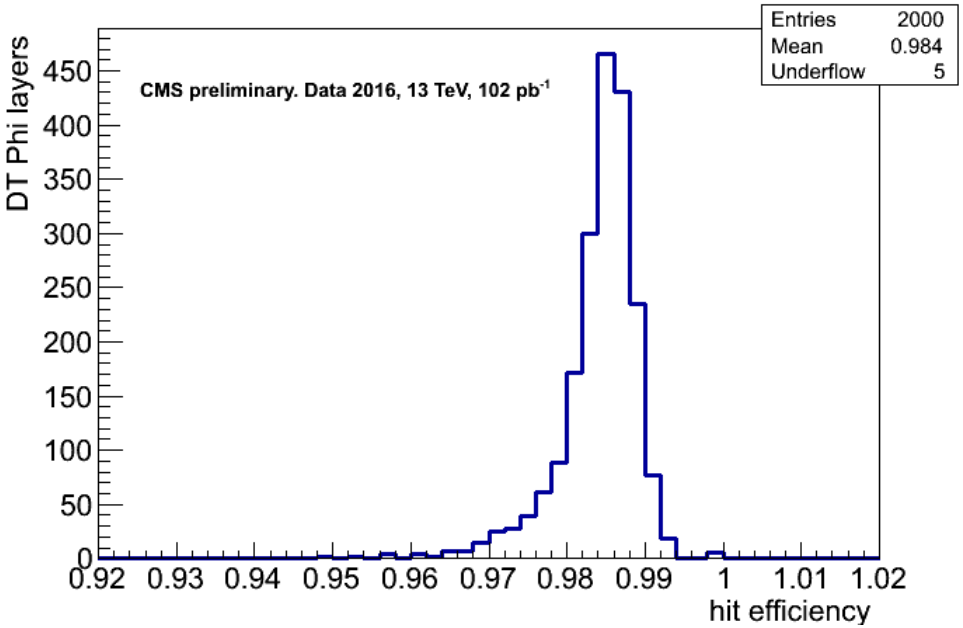
Hadron Calorimeter (HCAL)

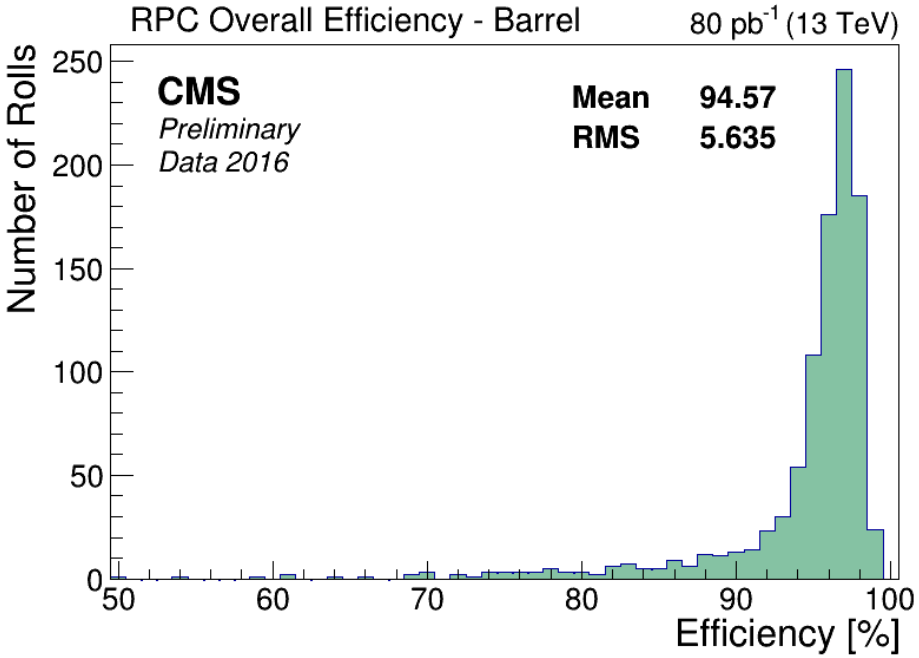
- Many updates deployed during the winter shutdown
  - New uTCA-based readout for HB and HE (10Gb/s links)
  - Switched to updated L1 trigger (uTCA inputs from HB, HE, HF)
- Data checks with collisions data
  - HCAL timing synchronisation confirmed
  - Good matching of data and trigger primitives from new and previous readout



Muon detectors: efficiency

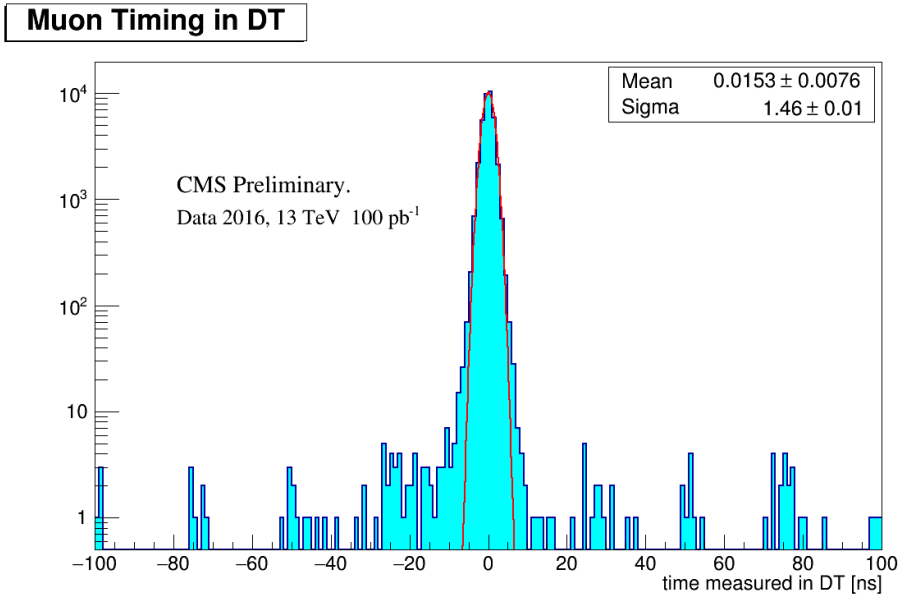
- Muon detectors operation are smooth for all detectors:
  - Drift Tube (DT), Cathode Strip Chamber (CSC), Resistive Plate Chamber (RPC)
  - Efficiencies are very good
    - DT and RPC efficiency are shown for 2016 data

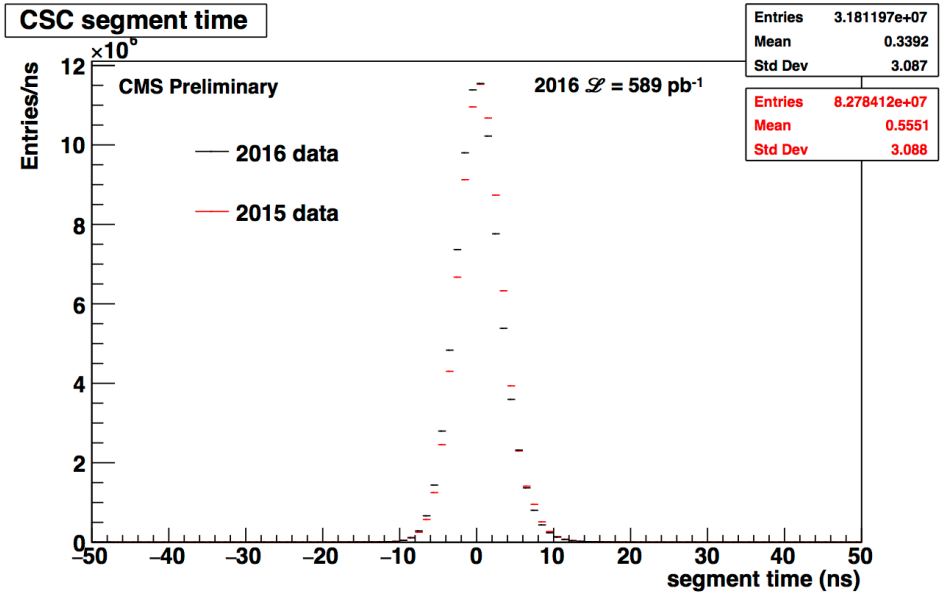




Muon detectors: timing

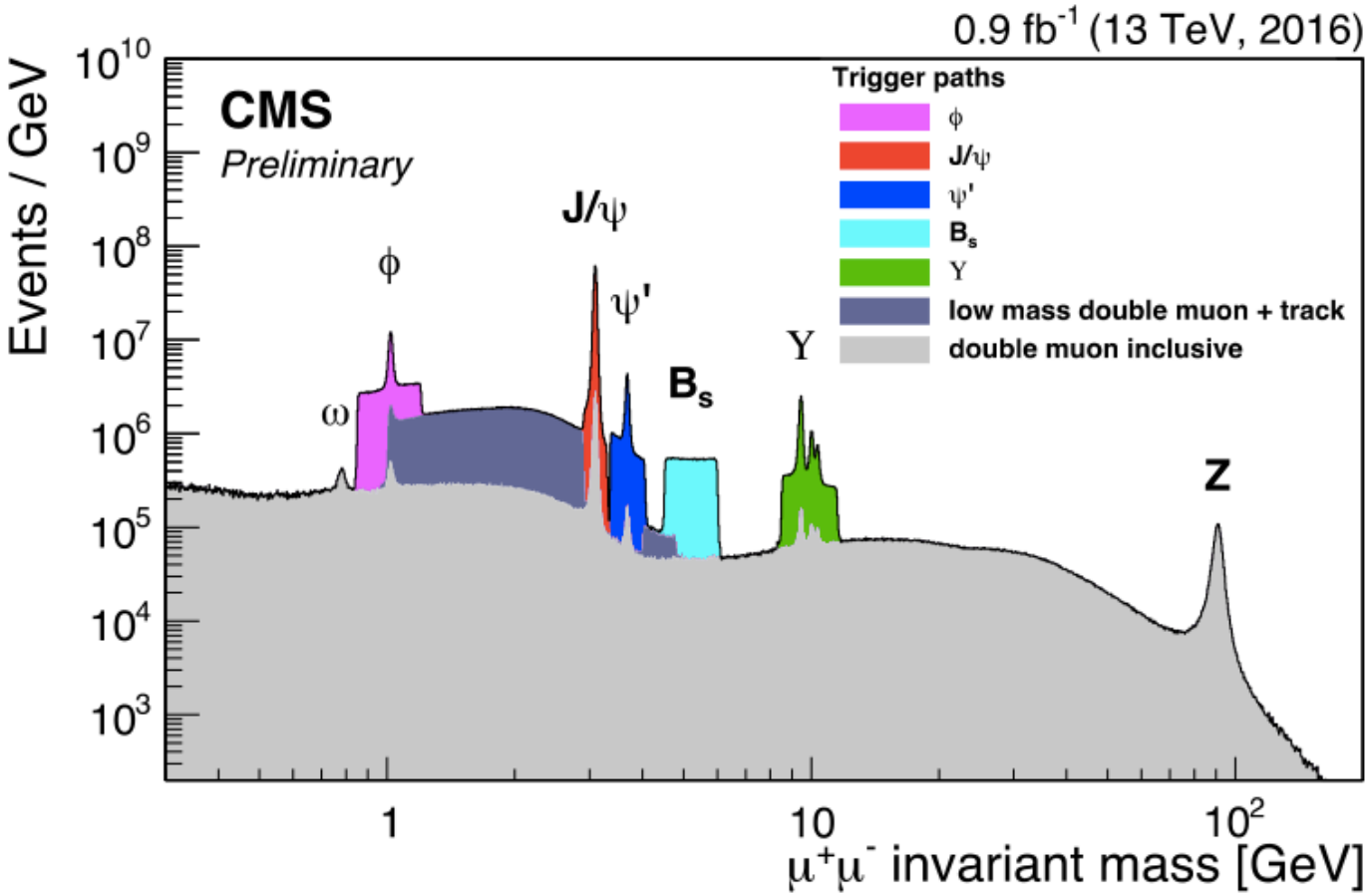
- Time resolution is good
  - σ(DT) = 1.4 ns
    - better performance than in 2015 data (2 ns)
  - σ(CSC) = 3.1 ns
    - comparable to 2015 data





Muon performance

The dimuon invariant mass spectrum shows the different resonances collected with various dimuon triggers

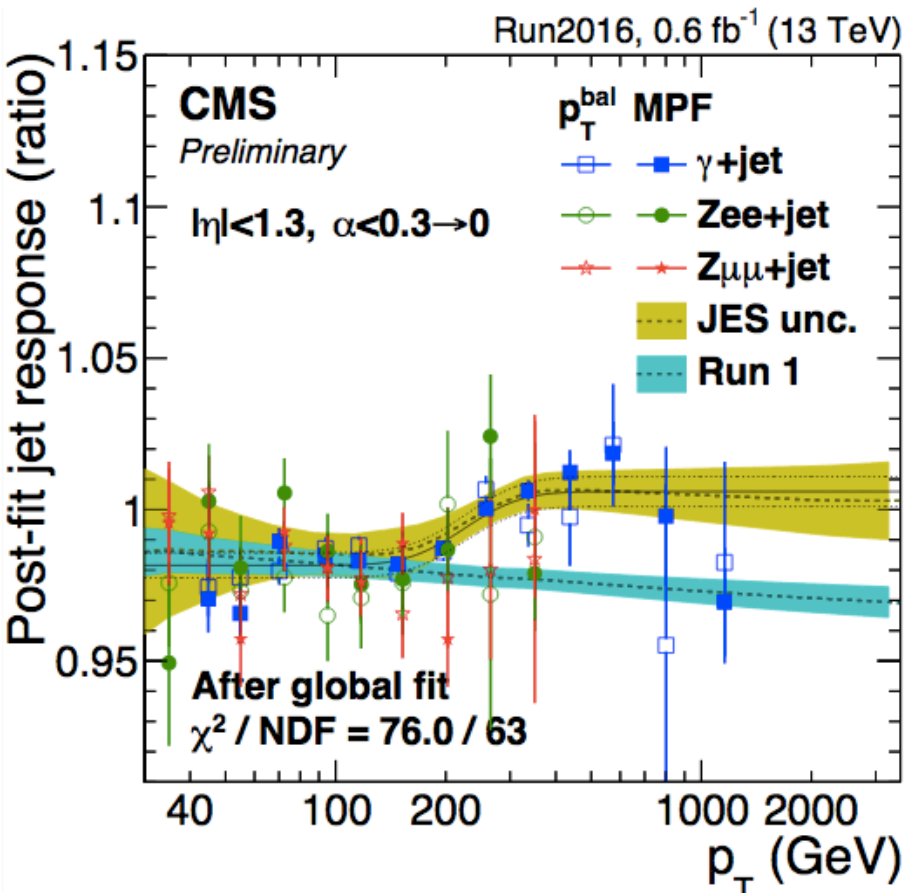


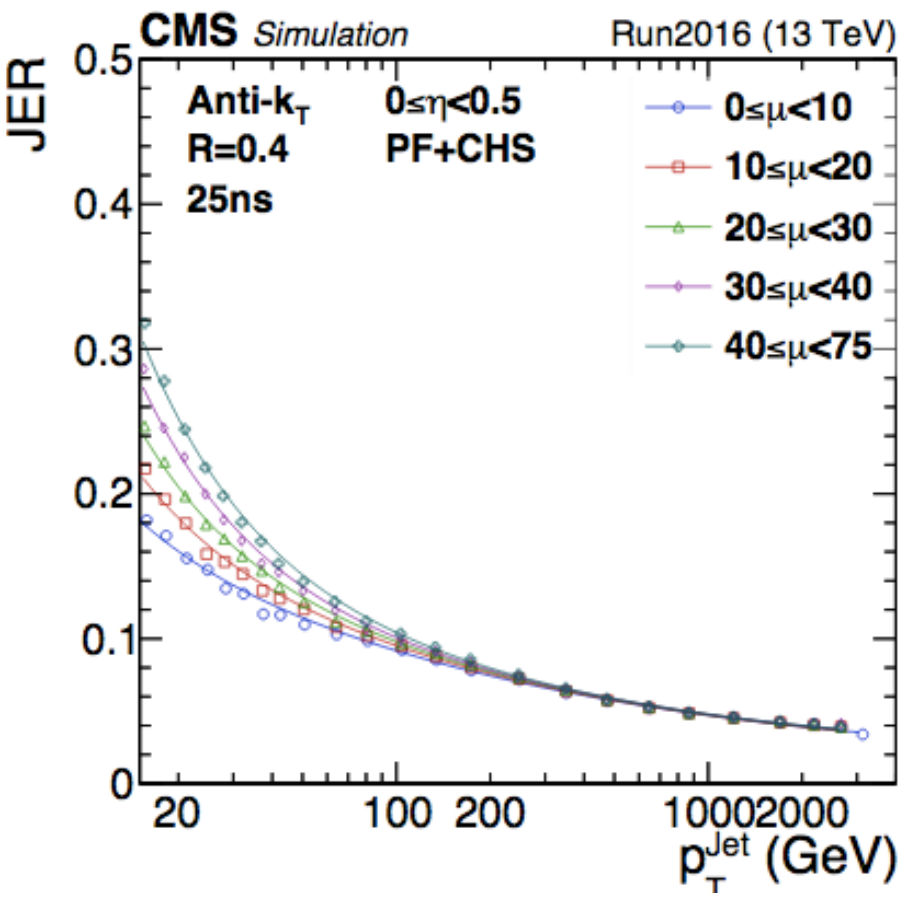
Jets reconstruction

Jet energy scale calibrated using Z/photon + jets

- similar performance as in Run1

Jet energy resolution robust against pile-up above 100 GeV

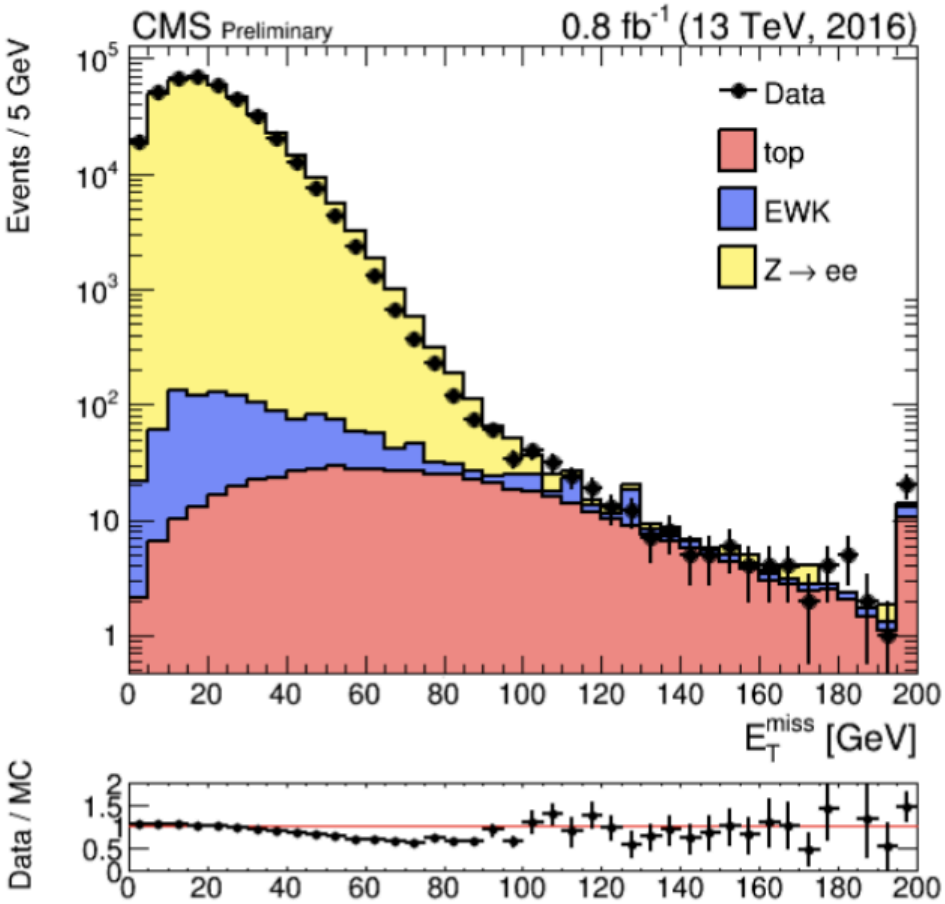


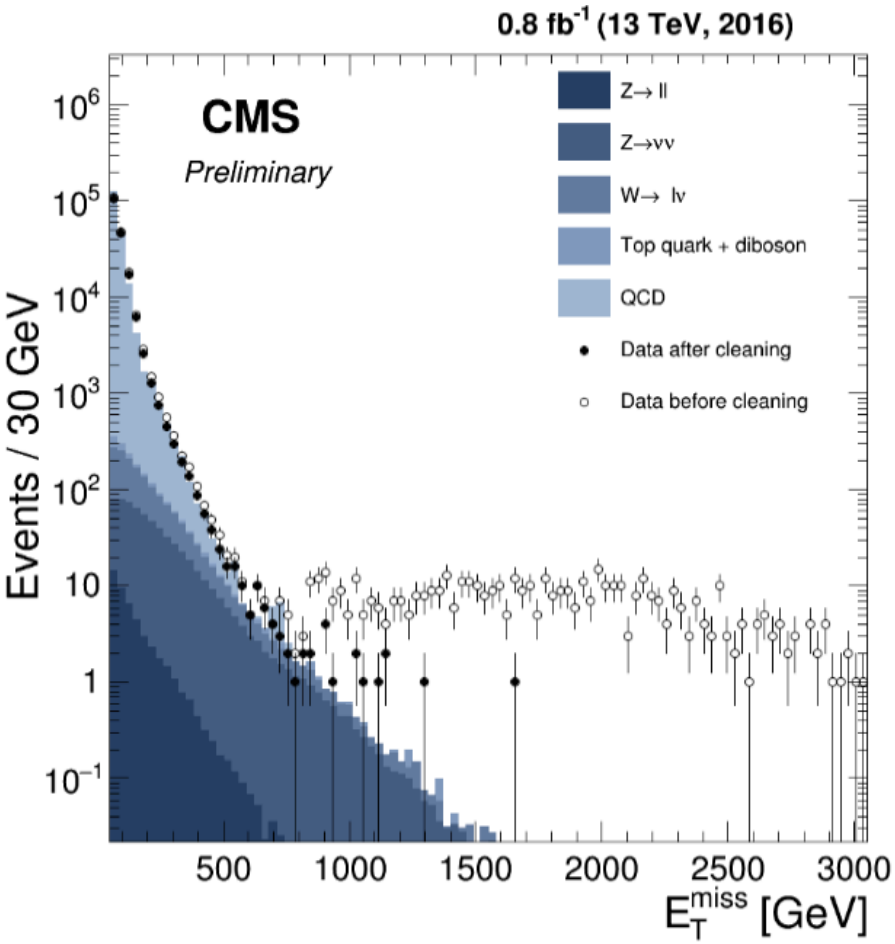


Missing Transverse Energy (MET)

Data-MC in good agreement
- similar performance to Run1

Data cleaning is effective to remove long MET tails

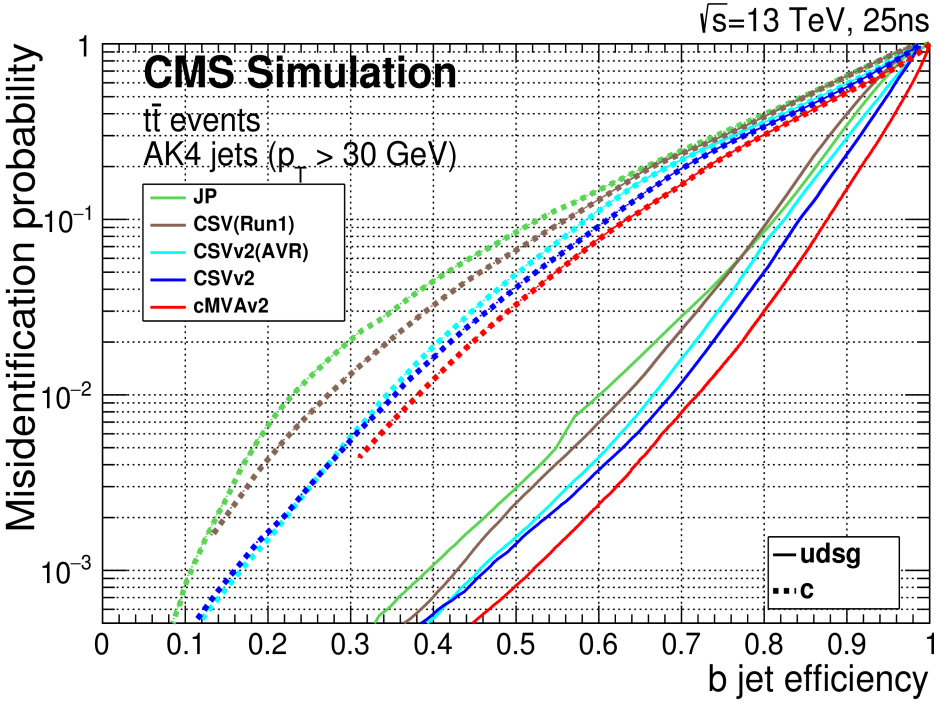




B tagging

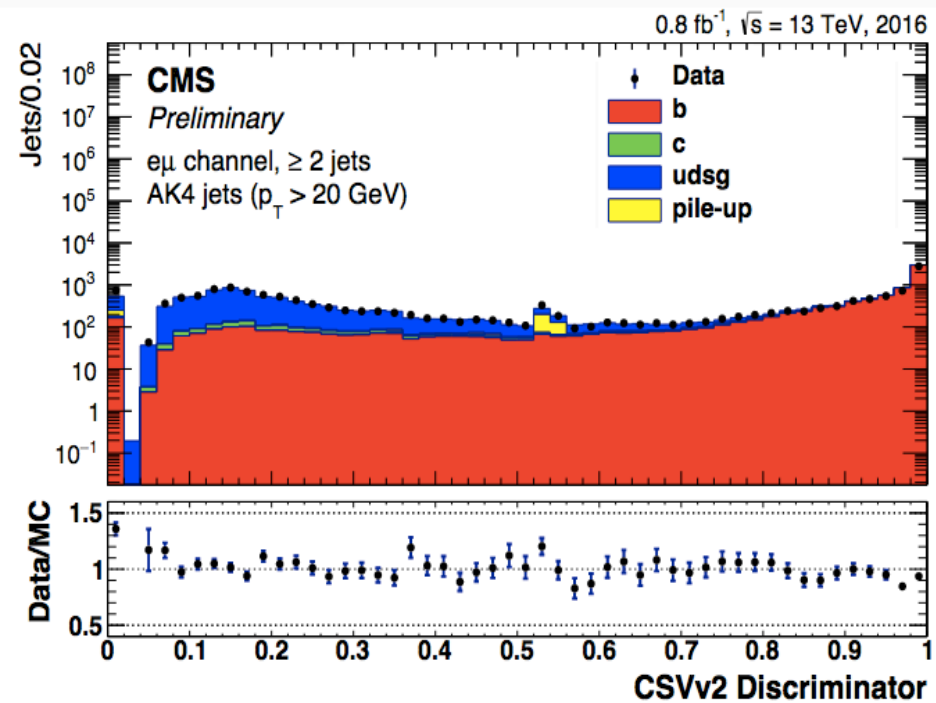
Algorithms performance improved in Run 2

- 10% higher b-jet efficiency for a misidentification probability of 1%



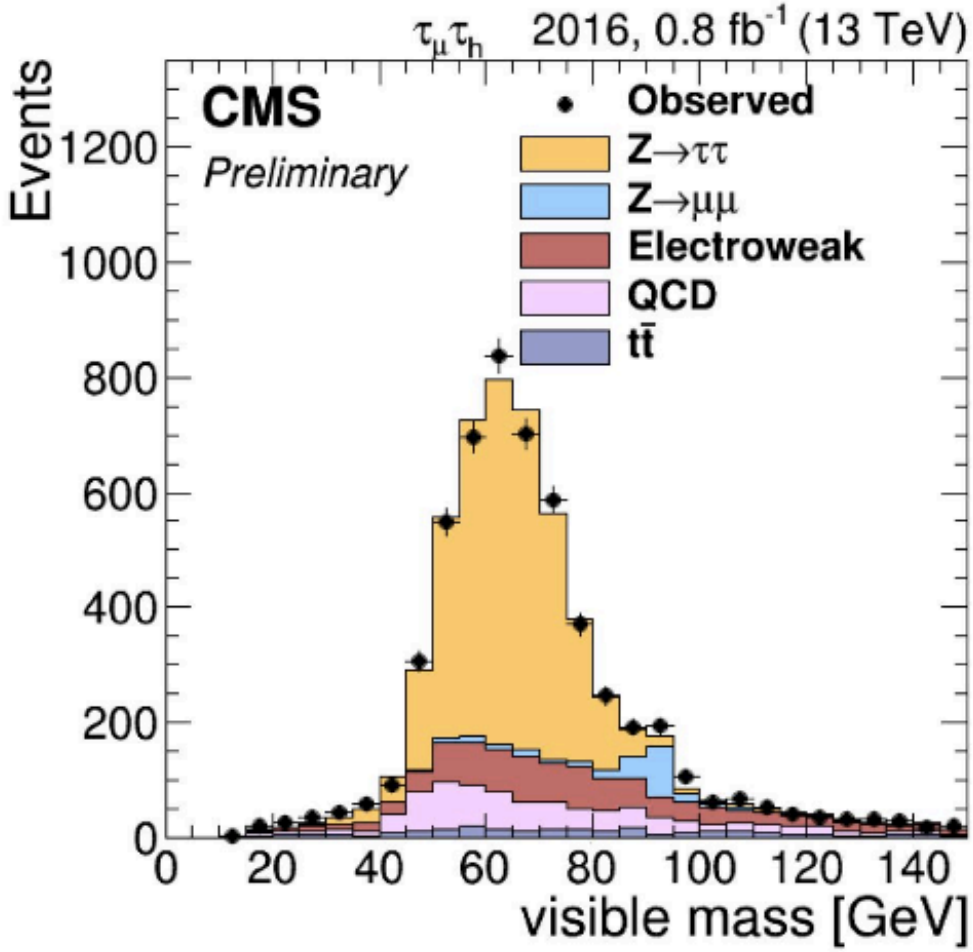
Good agreement of data and MC

- Distribution of CSVv2 discriminator in top quark pair dilepton events



Tau reconstruction

Tau reconstruction well understood in MC



Summary

CMS detector has stable and excellent performance

- Magnet is operated stably at 3.8T
- New Level-1 trigger system deployed with improved performance
- All sub-detectors are running smoothly
- Physics Object performing as expected

- CMS is ready to exploit full physics potential collecting and analyzing the large datasets provided by the LHC in 2016
  - Many thanks to the LHC team for the great performance of the accelerator
    - More than 8 fb^{-1} delivered up to end of June

The CMS Collaboration

More than 4000 people among scientists, engineers, students from 200 institutions around the world

Back-up slide