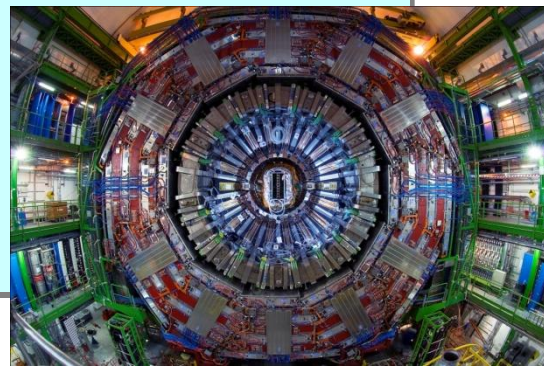
Status of CMS and First Results

Cristina Biino* - INFN Torino

BEACH 2010 – IX International Conference on Hyperons, Charm and Beauty Hadrons
Perugia, 21-26 June, 2010

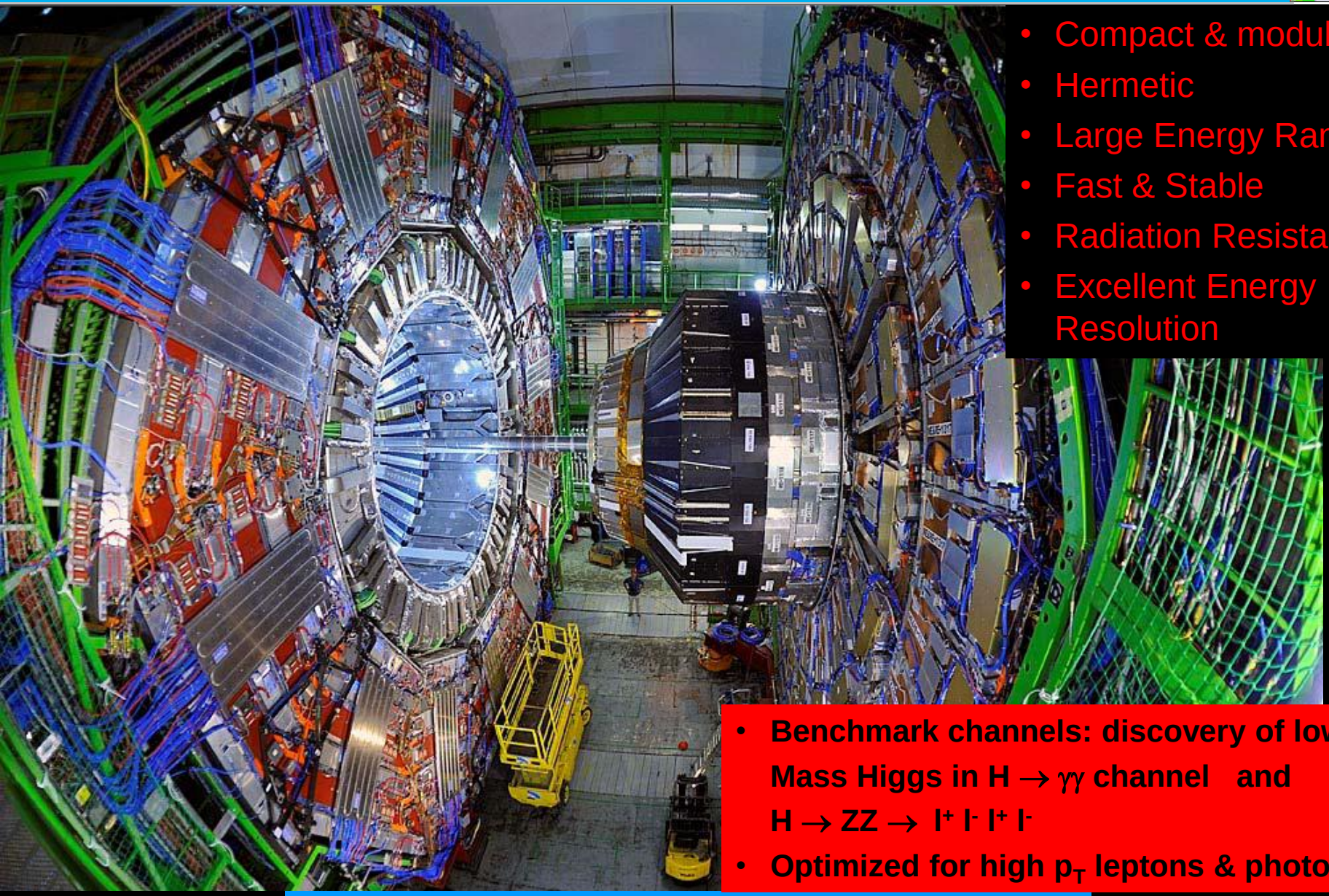
*On behalf of the CMS collaboration
and Physics Overview Group



Outline

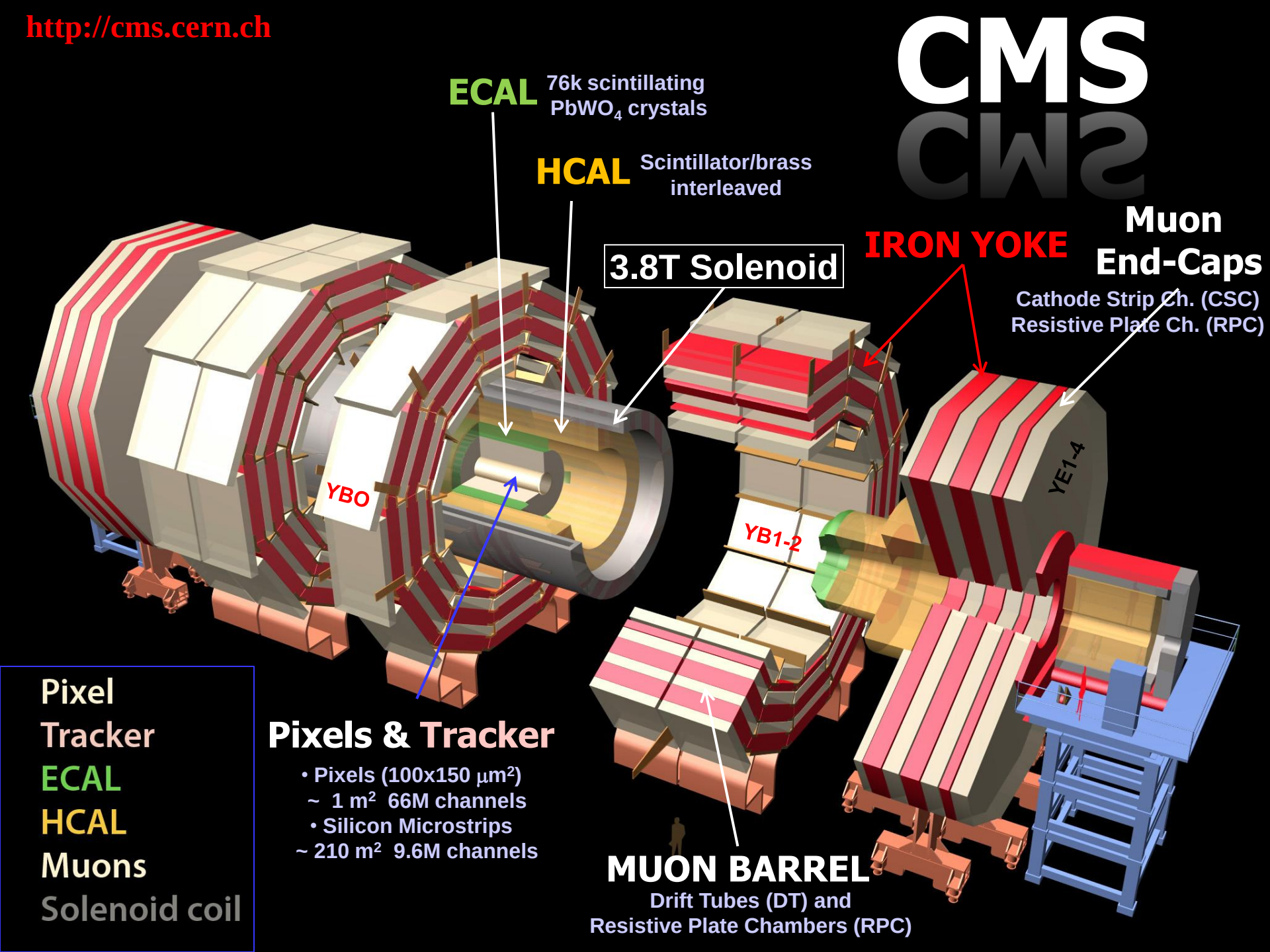
- CMS Detector Overview
- Commissioning
  - Cosmics runs
  - 2009 Pilot Run @ 900GeV and 2.36TeV
  - Collisions @ 7 TeV
- Detector Performance
- First Physics Results
- Plan for 2010 and 2011

The CMS detector requirements



- Compact & modular
- Hermetic
- Large Energy Range
- Fast & Stable
- Radiation Resistant
- Excellent Energy Resolution

- **Benchmark channels: discovery of low Mass Higgs in $H \rightarrow \gamma\gamma$ channel and $H \rightarrow ZZ \rightarrow l^+ l^- l^+ l^-$**
- **Optimized for high p_T leptons & photons**


http://cms.cern.ch
CMS
ECAL 76k scintillating PbWO4 crystals
HCAL Scintillator/brass interleaved
3.8T Solenoid
IRON YOKE
Muon End-Caps
Cathode Strip Ch. (CSC)
Resistive Plate Ch. (RPC)
YBO
YB1-2
YE1-4
Pixel
Tracker
ECAL
HCAL
Muons
Solenoid coil
Pixels & Tracker
• Pixels (100x150 μm²)
~ 1 m² 66M channels
• Silicon Microstrips
~ 210 m² 9.6M channels
MUON BARREL
Drift Tubes (DT) and
Resistive Plate Chambers (RPC)

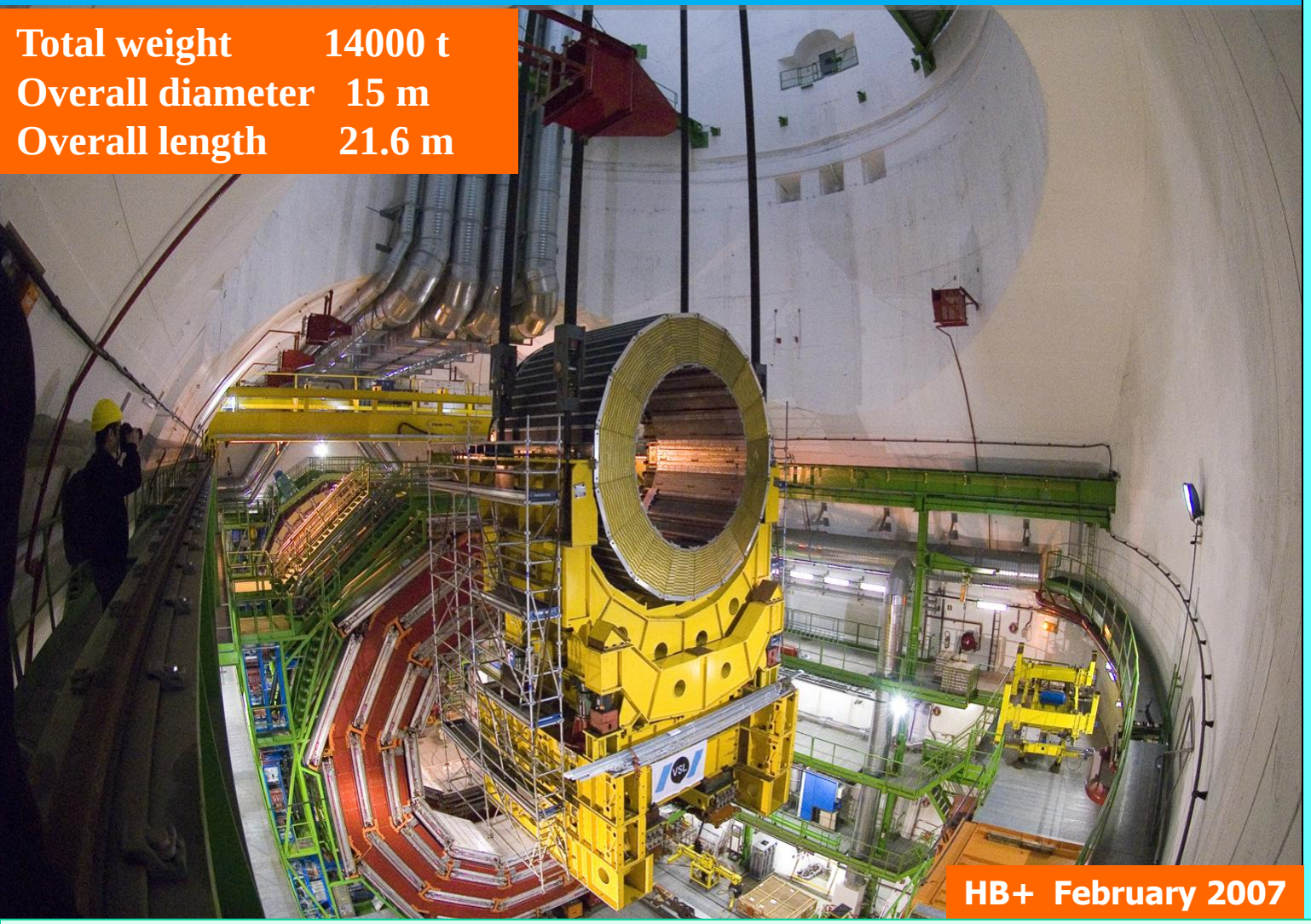
The CMS Collaboration

The CMS Collaboration: >3000 scientists and engineers,

>700 students from 182 Institutions in 39 countries .

CMS going underground

Total weight	**14000 t**
Overall diameter	**15 m**
Overall length	**21.6 m**



HB+ February 2007

CMS experiment @ LHC

~20 years

from early design to 1rst collisions

CMS comprises 66M pixel channels, ~10M Si microstrip ch, ~75k crystals, 150k Si preshower ch, ~15k HCAL ch, 250 DT chambers (170k wires), 450 CSC chambers (~200k wires), ~ 500 Barrel RPCs and ~ 400 endcap RPCs, muon and calorimeter trigger system, 50 kHz DAQ system (~ 10k CPU cores), Grid Computing (~ 50 k cores), offline (> 2M lines of source code).

Data collected so far

Cosmic Ray Runs:

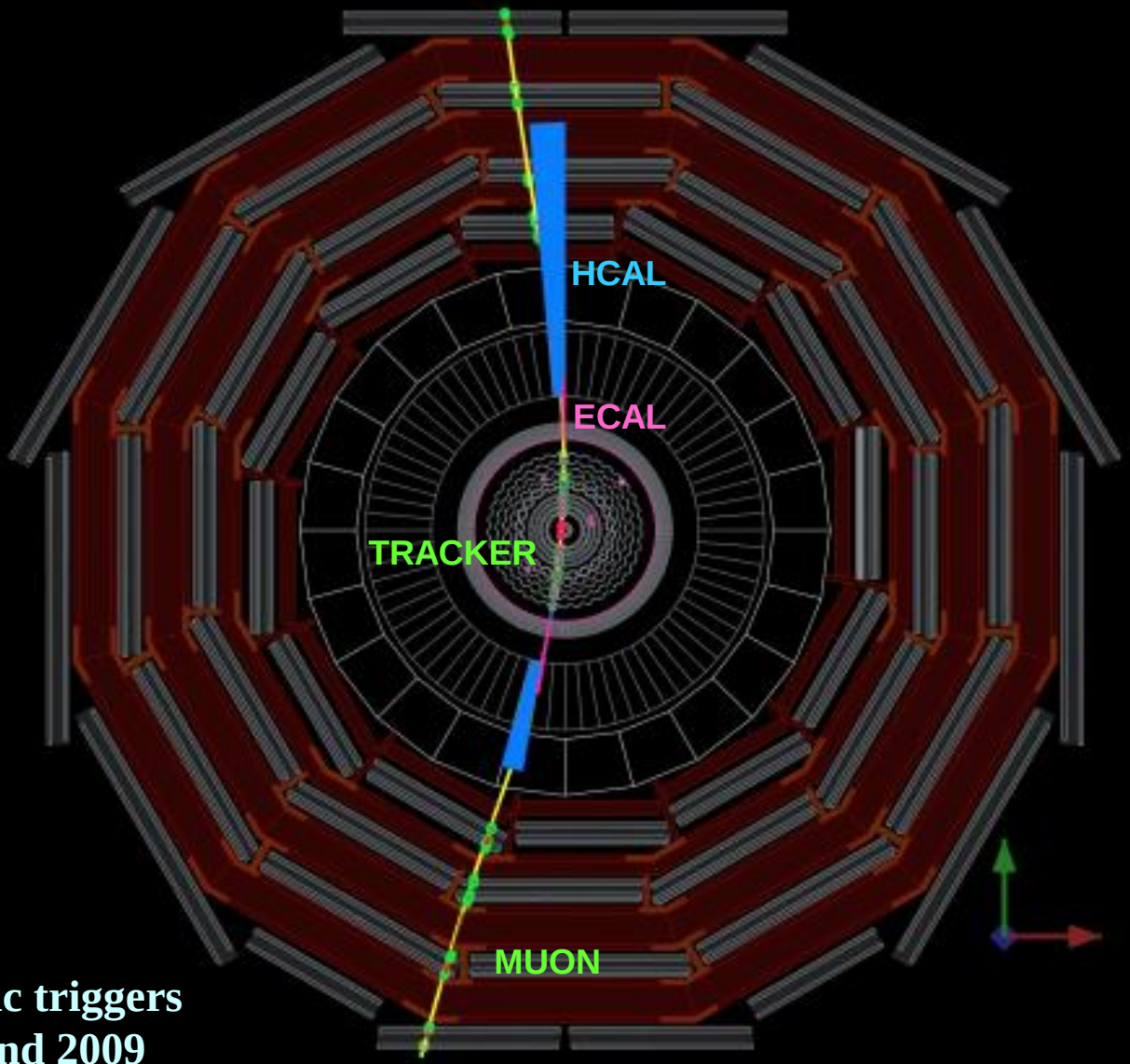
- MTCC 06' (25M mu's) + CRAFT 08' (270M mu's)
  - Before collisions, detailed detector studies with cosmic muons events
  - World most precise measurement of charge ratio of atmospheric muons.

Beam Collisions :

- $\sqrt{s}$=900 GeV @ LHC injection energy 300K events
  - First LHC collisions December 2009 (~15 μb^{-1}/10μb^{-1})
  - First physics papers and lots of calibrations
- $\sqrt{s}$=2.36 TeV 20K events
  - Delivered/recorded ~ 1.2μb^{-1}/0.4μb^{-1}
  - First glimpse to high energy events and further understanding of detector
- $\sqrt{s}$=7 TeV Start of LHC Run I
  - running since 30 March 2010 ~ 20nb^{-1}

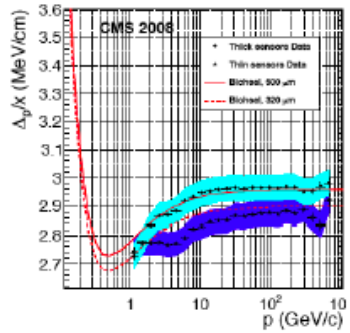
Commissioning with Cosmics

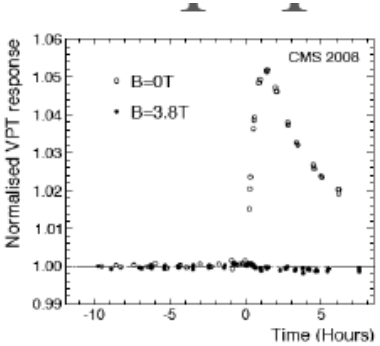
Cosmic
Runs
At
Four
Tesla

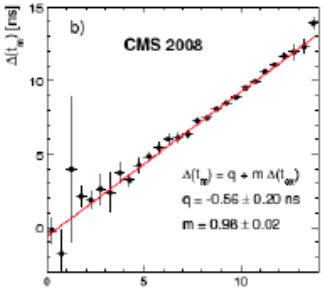


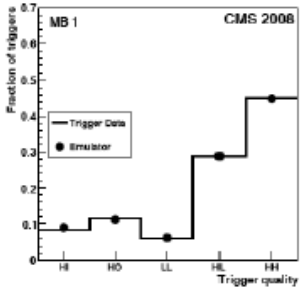
In total > 1 billion cosmic triggers collected between 2008 and 2009

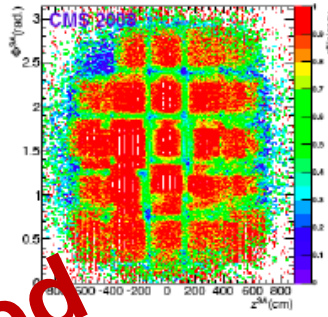
Before collisions

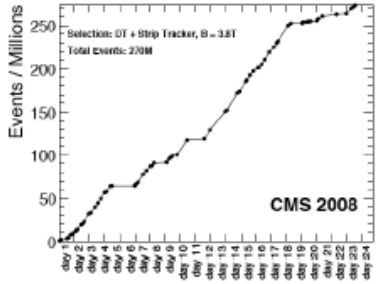


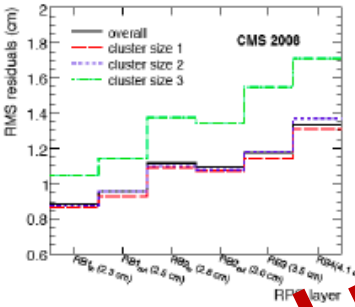


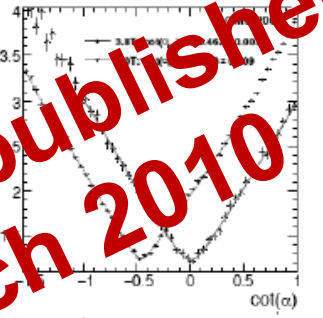


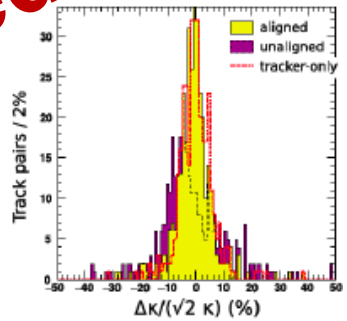


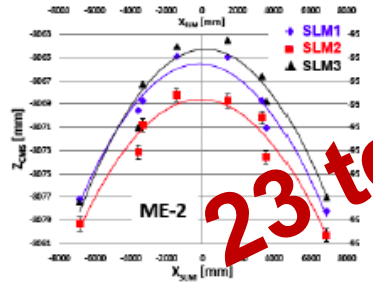


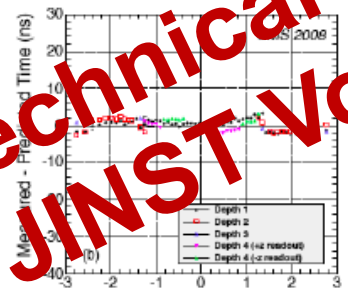


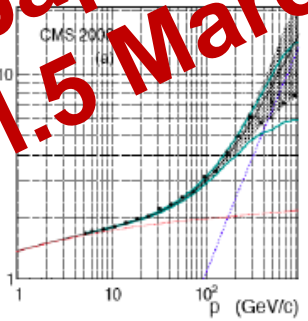


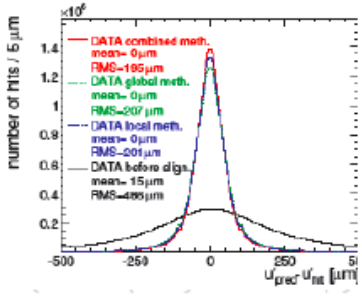


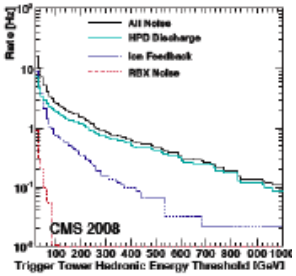


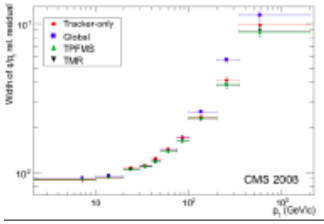


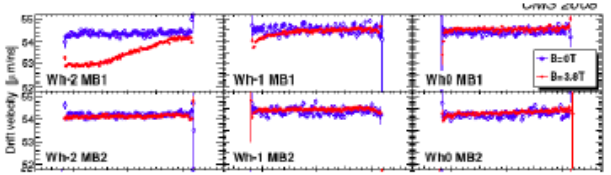


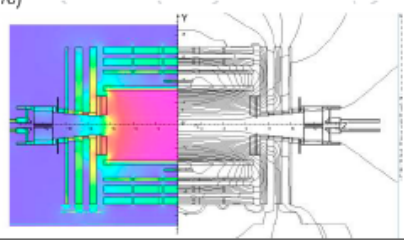


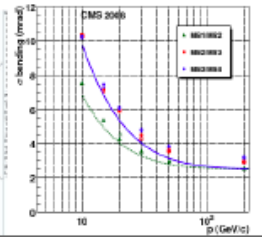










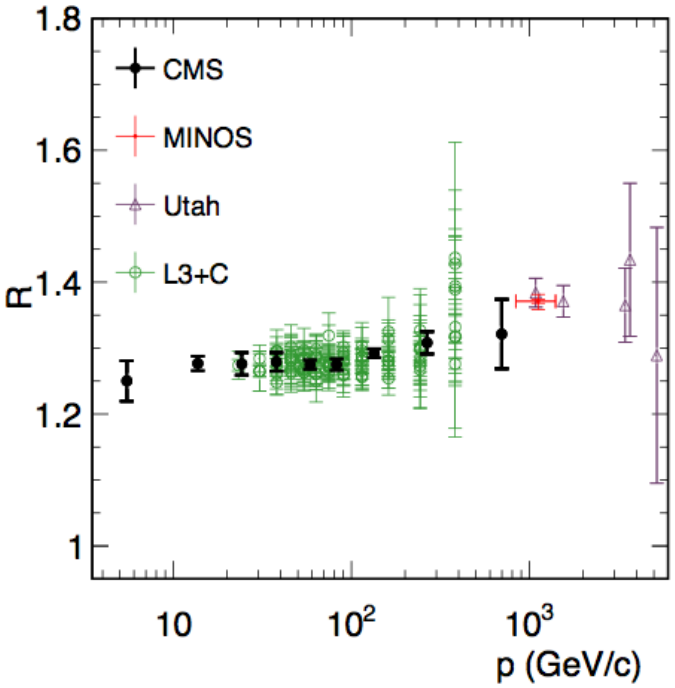


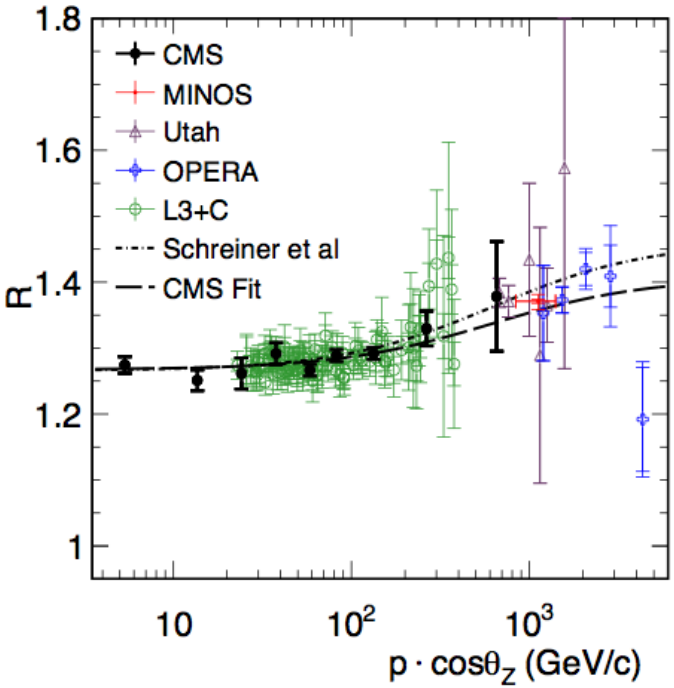
23 technical papers published JINST Vol.5 March 2010

Charge Ratio of Atmospheric Muons

"Measurement of the Charge Ratio of Atmospheric Muons with the CMS Detector"

Submitted to Physics Letters B





Muon Charge ratio = 1.2766 ±0.0032(stat) ±0.0032(syst)

- **Ratio of positive to negative charge cosmic muons, as a function of the muon p.**
- **We have obtained he most precise measurement to date of the charge ratio in the regions $p \cdot \cos\theta_z < 650$ GeV/c and $p < 850$ GeV/c.**
- **The measurement implies a good understanding of the muon reconstruction in the full momentum range, the (L1) trigger efficencies and muon tracking alignment.**

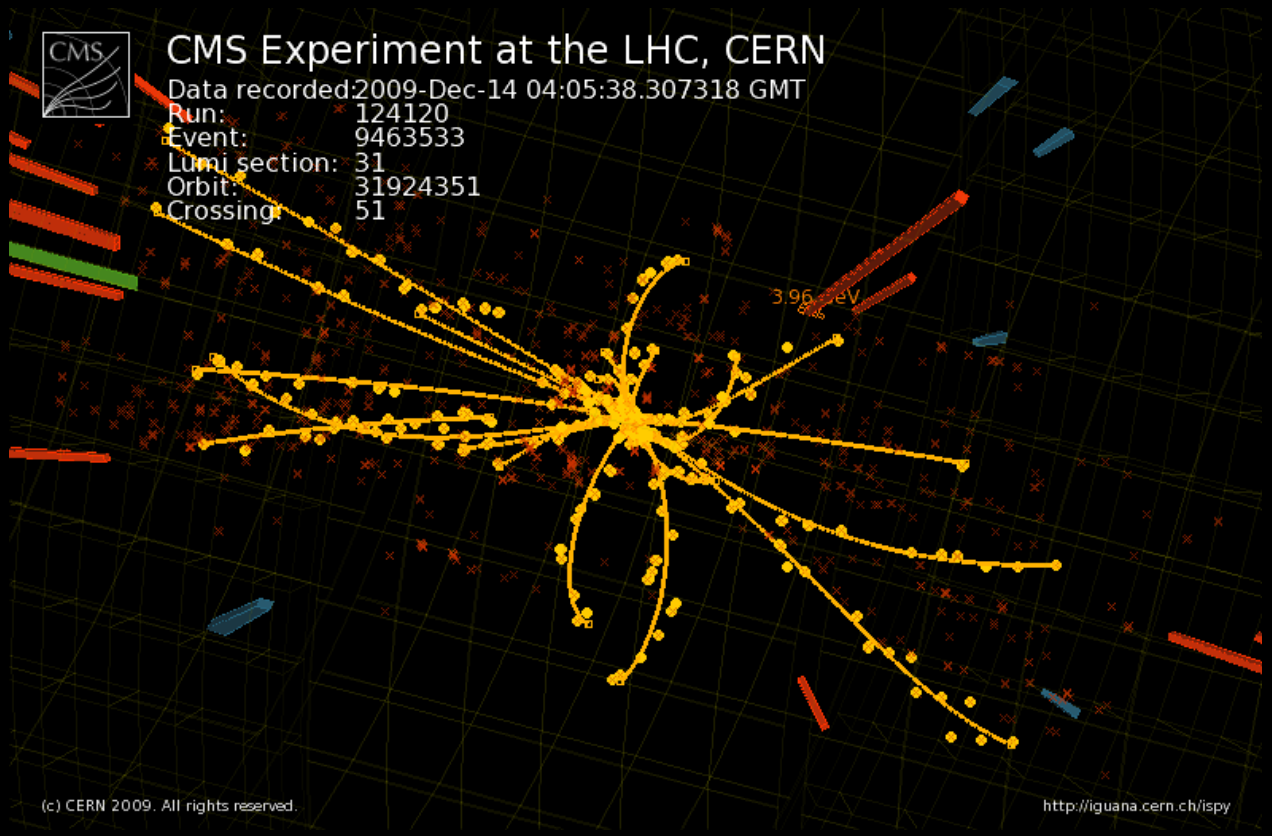
Commissioning with Collisions

LHC Pilot Runs
(23 Nov-16 Dec 2009)

√s = 900 GeV
&
2.36 TeV

Physics Run Start-up
(30 March 2010-…)

√s = 7 TeV

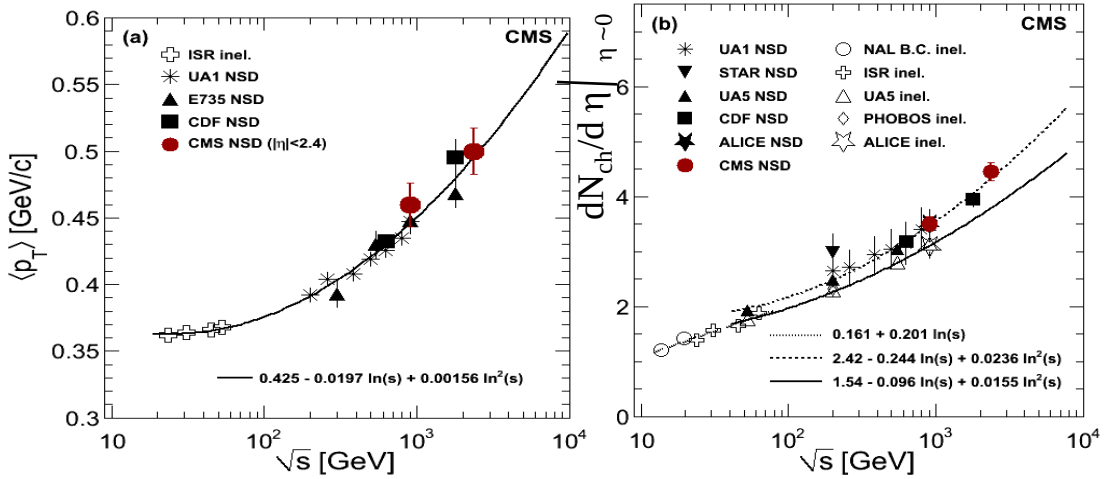


e.g. First collision at record √s = 2.36 TeV

First CMS publications

The scientific production of CMS has started within weeks

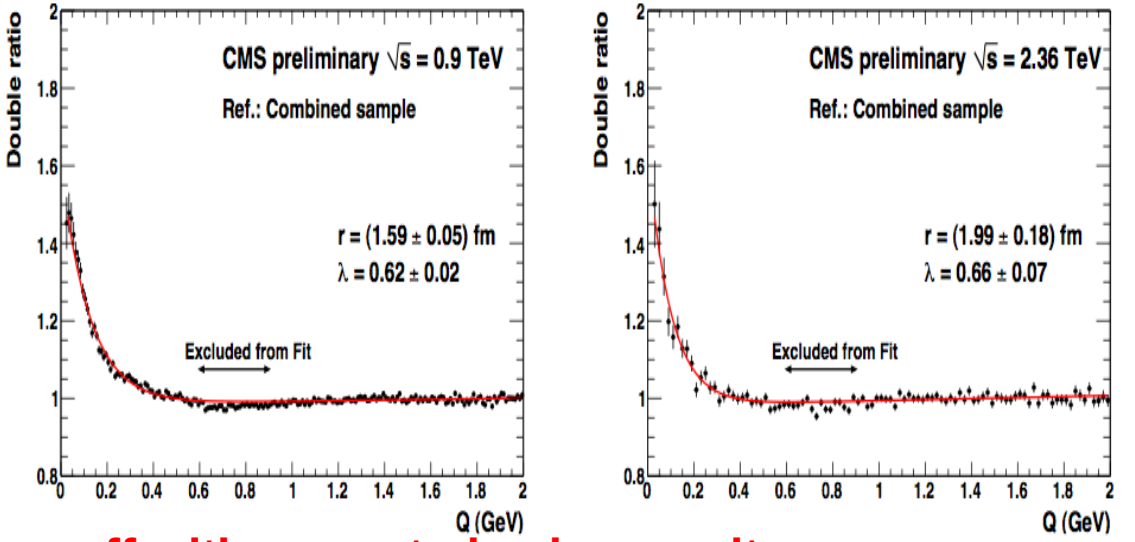
"Transverse momentum and pseudorapidity distributions of charged hadrons at √s =900 GeV and 2.36TeV" JHEP02(2010)041



"Bose-Einstein Correlations in 0.9 and 2.36 TeV Proton-Proton Collisions with the CMS Experiment."

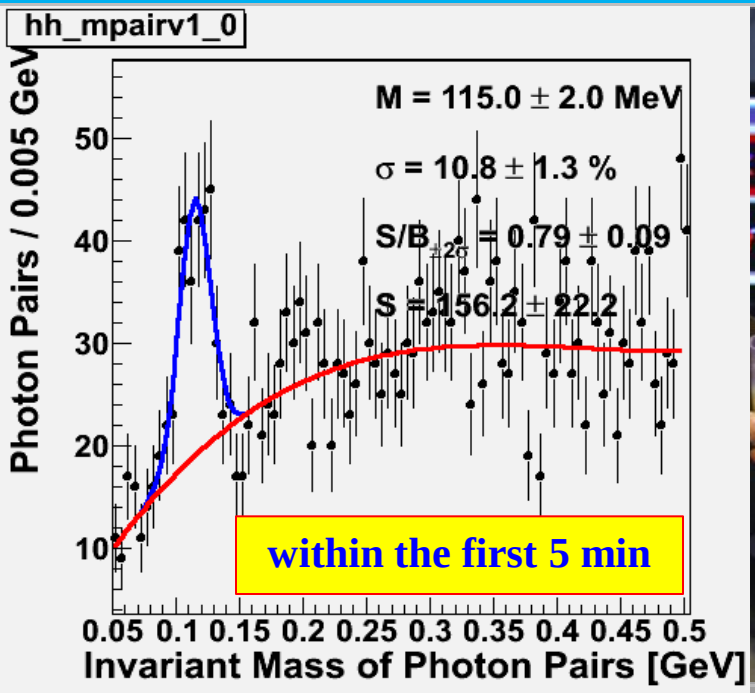
Submitted to Physical Review Letter

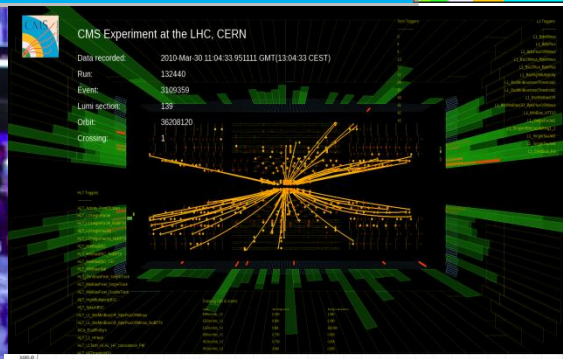
Other papers in the pipeline.

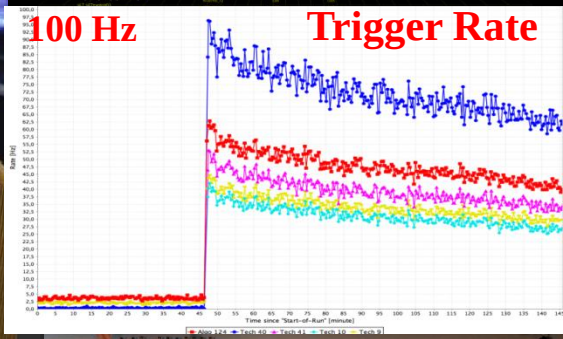


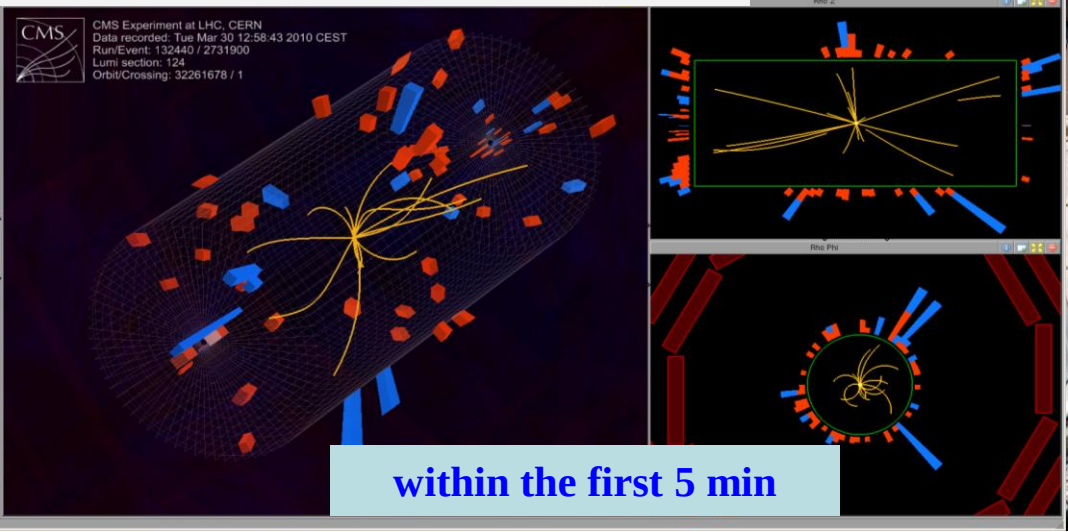
Years of preparation pay off with prompt physics results.
Good agreement with previous data. The rediscovery of SM begins…

March 30 at 12:58: First 7 TeV Collisions

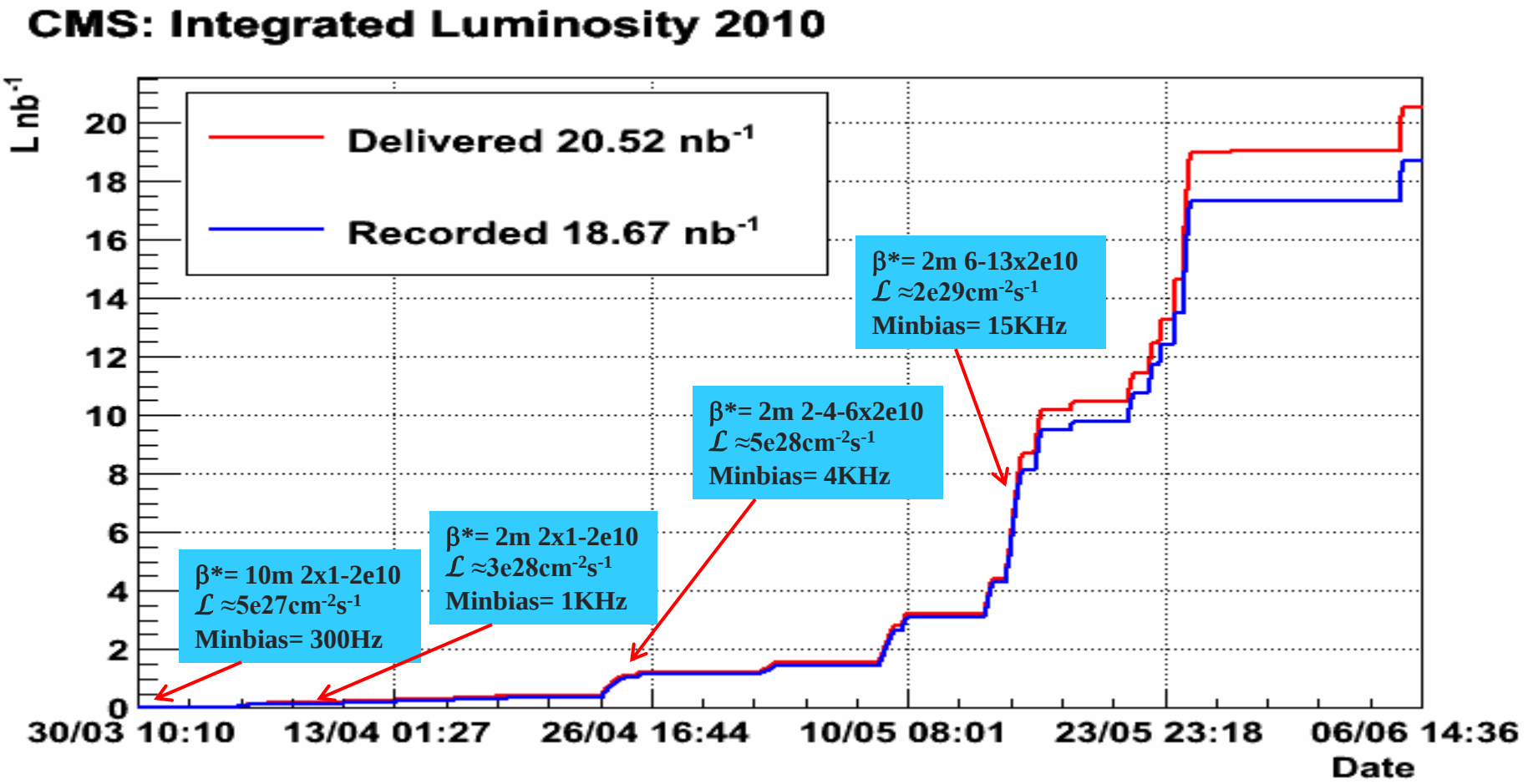








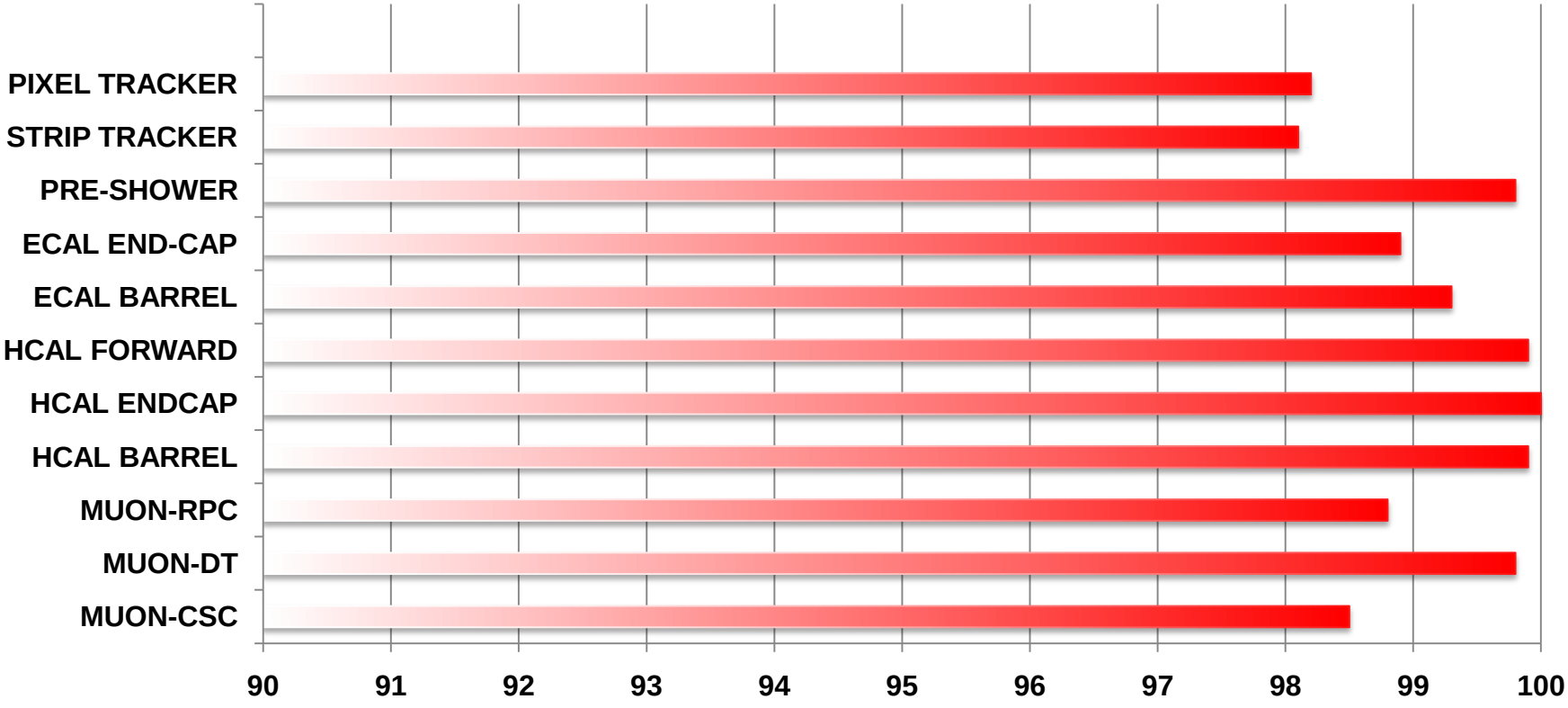
First 2.5 months of 7 TeV operations



Reliable operations with ~20nb^{-1} delivered by LHC and ~18nb^{-1} of data collected so far. Overall data taking efficiency > 91%. After quality flags and data certification for physics (~95%) we end up with ~17nb^{-1} of good data for physics.

Status of Sub-detectors Operation

Global operation efficiency:

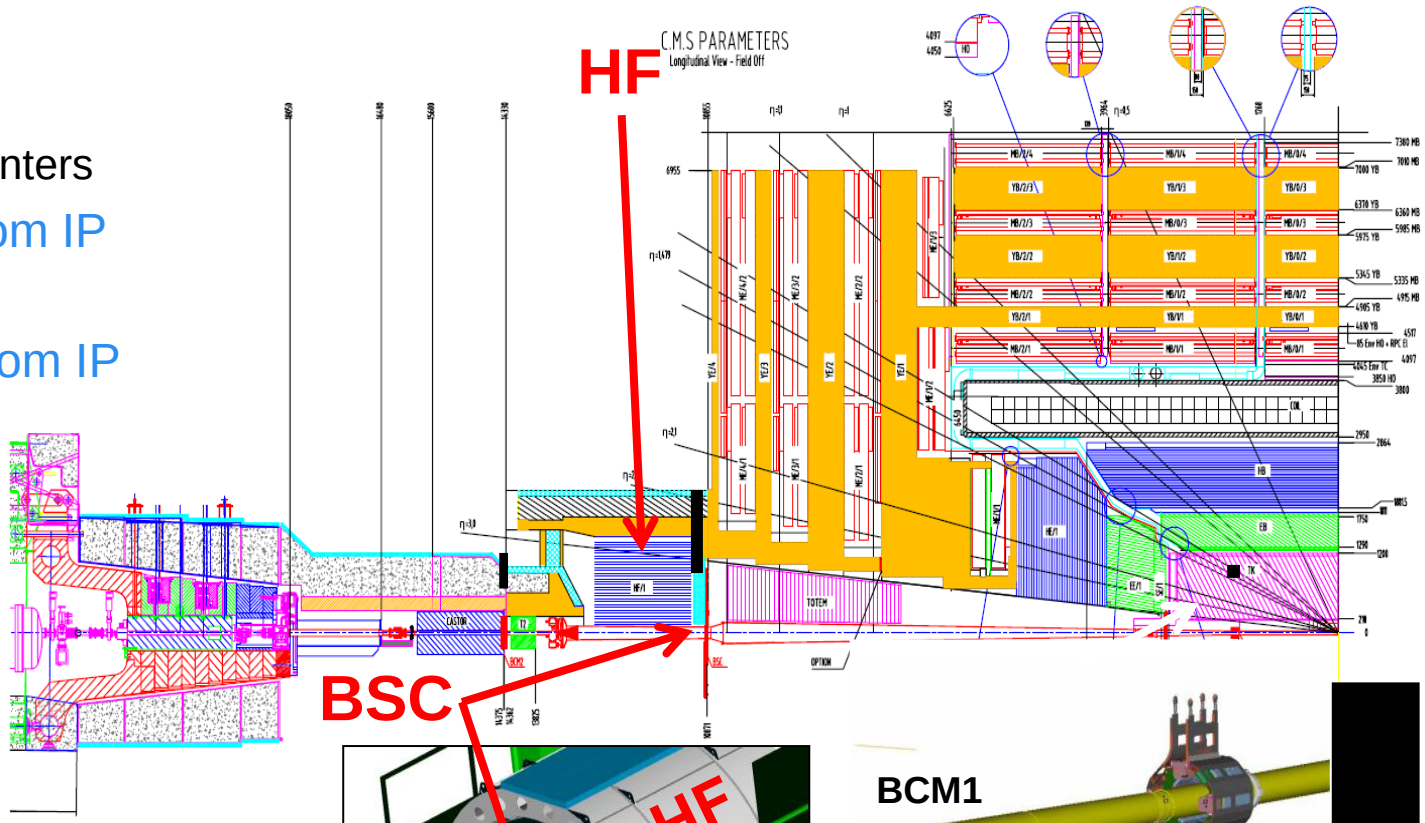


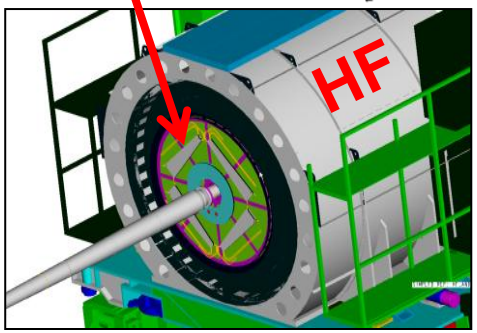
	MUON-CSC	MUON-DT	MUON-RPC	HCAL BARREL	HCAL ENDCAP	HCAL FORWARD	ECAL BARREL	ECAL END-CAP	PRE-SHOWER	STRIP TRACKER	PIXEL TRACKER	
Series1	98.5	99.8	98.8	99.9	100	99.9	99.3	98.9	99.8	98.1	98.2	

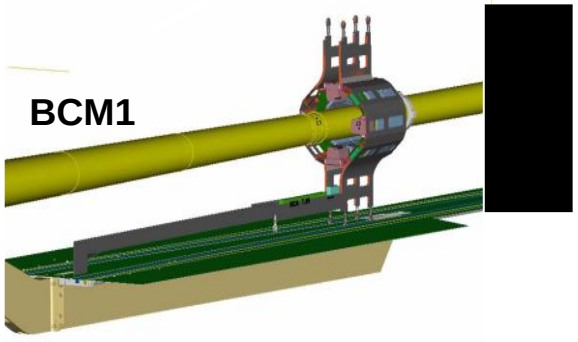
All subsystems over 98% functional.

Minimum Bias Trigger

- Hadronic Forward
  - HF: 2.5 ≤ |η|≤ 5.
- Beam Scintillator Counters
  - BSC: ± 10.5 m from IP
- Beam Pick-up Timing
  - BPTX: ± 175 m from IP



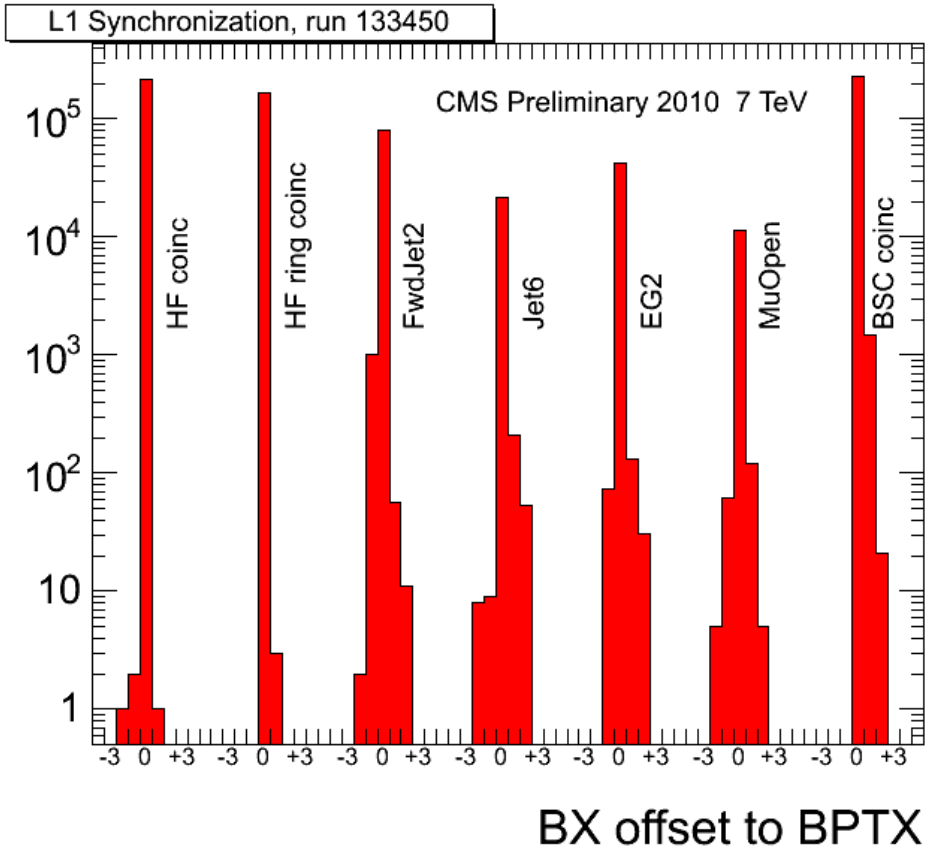




- Trigger: Minimum & Zero Bias
  - L1 Beam Scintillator Counters
  - L1 Trigger “BPTX” prescaled
- Minimum Bias Offline selection:
  - BSC (OR of 2 planes) + vertex: ϵ ~ 90%
  - HF (E > 3 GeV both sides): ϵ ~ 90%

Physics triggers are now deployed based on calorimetry and muons

L1 Trigger Time Alignment



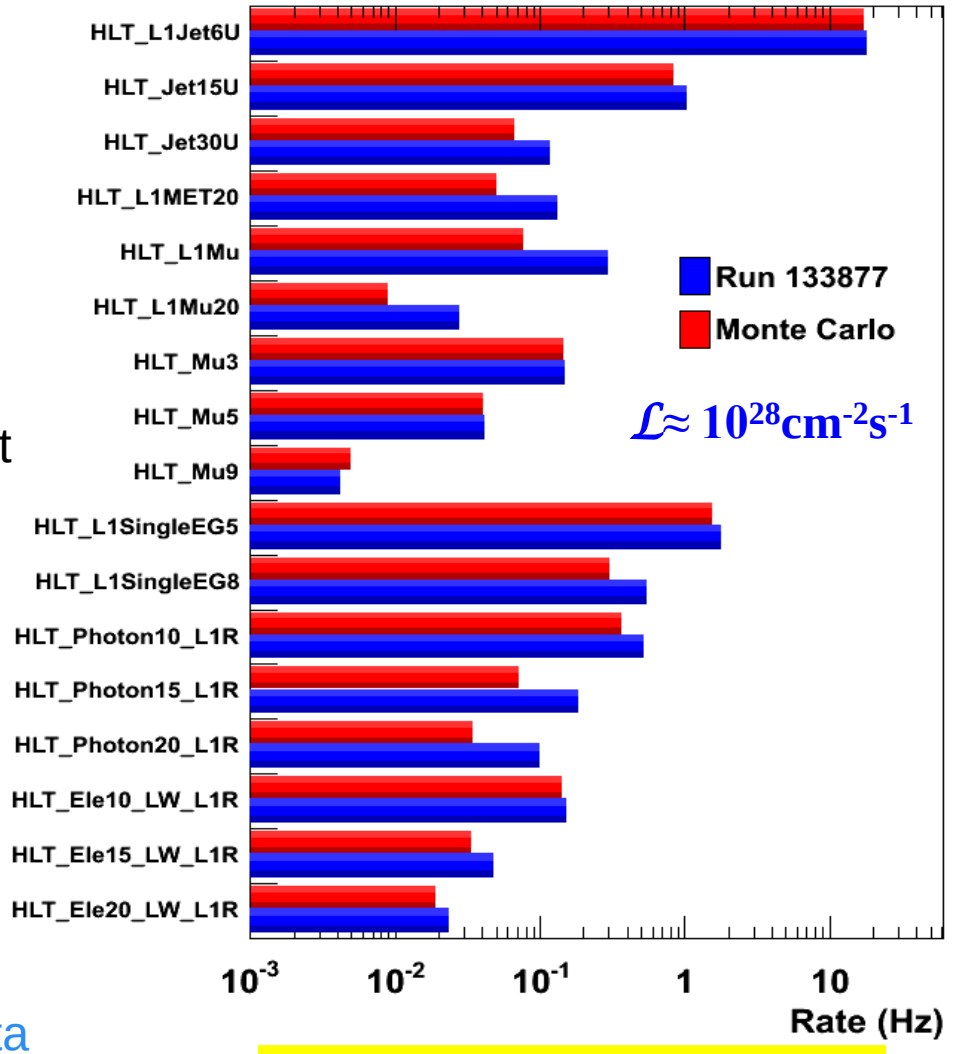
(25 nsec units)

Timed-in L1 algorithms deployed in the trigger.
Still, at the highest luminosity seen so far, 2×10^{29} $cm^{-2}s^{-1}$,
we have passed the full minbias rate to the HLT.
Dynamic prescaling is now ready to be deployed.

DAQ, L1 and HLT Triggers

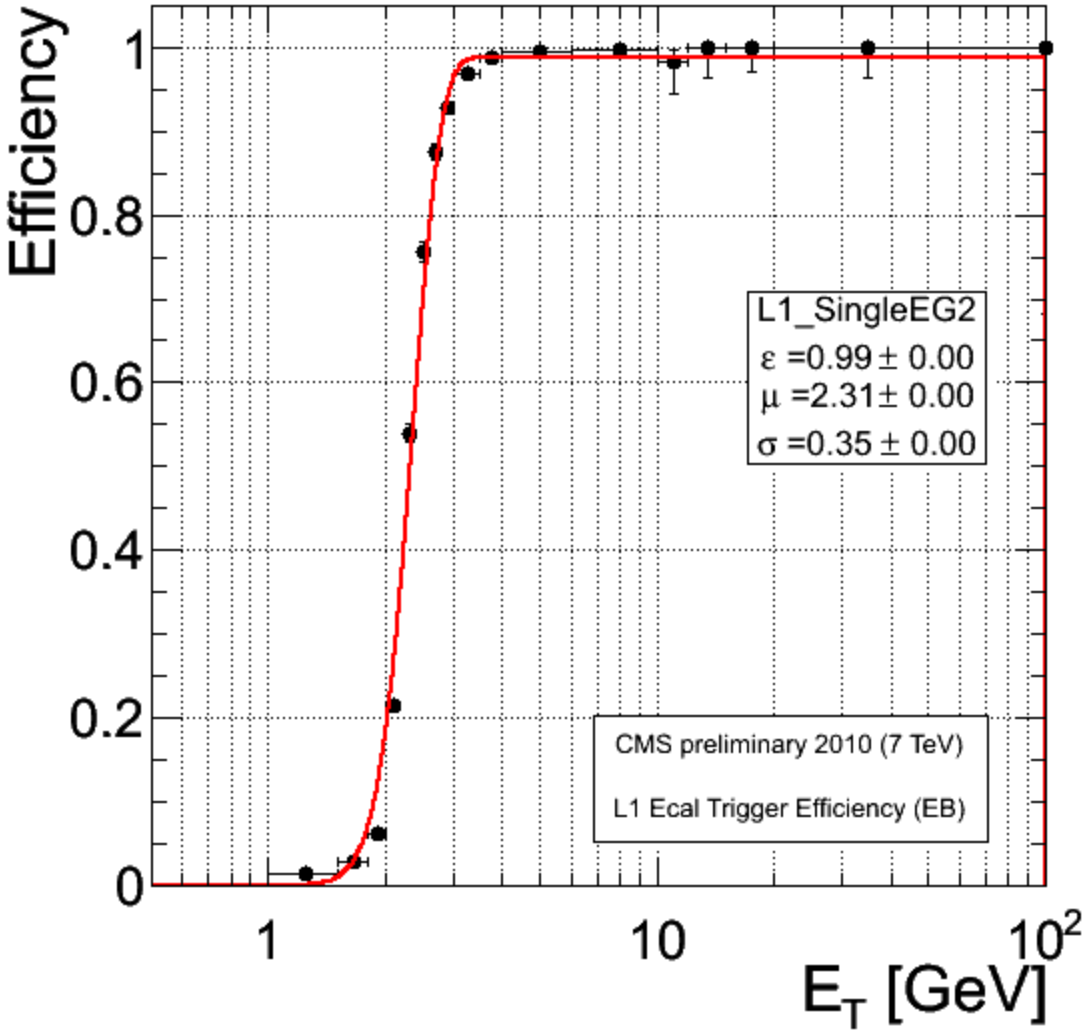
- L1/DAQ RUN FLAWLESSY
  - L1 ~ 1KHz,
  - Event size <500 kB/evt,
  - CPU load ~ 2% @ HLT farm
  - Farm Capacity ~100 msec/evt
    - Average CPU processing time at L1 rate of 50 KHz
  - Up to now we have spent ~15 ms/event (min bias dominated)
  - Expect ~ 40 ms/event for a lumi of 10^{30} $cm^{-2}s^{-1}$ on average

- Deployed trigger menus for 10^{27}, 10^{28} , $10^{29}cm^{-2}/s$ (in development for 10^{30} - $10^{31}cm^{-2}/s$)
  - Rate predictions based on MC & data
  - Primary datasets for $10^{29}cm^{-2}/s$



High Level Trigger rates Data vs. MC

Triggers commissioning

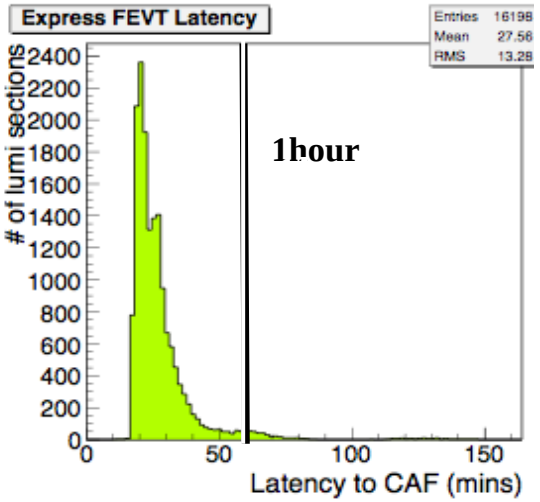


By taking millions of MB events, with the triggers in "mark and pass", the low Pt triggers have been validated. Then when they are implemented at higher luminosity, the higher Pt triggers will, in turn, be put in mark and pass - bootstrap.

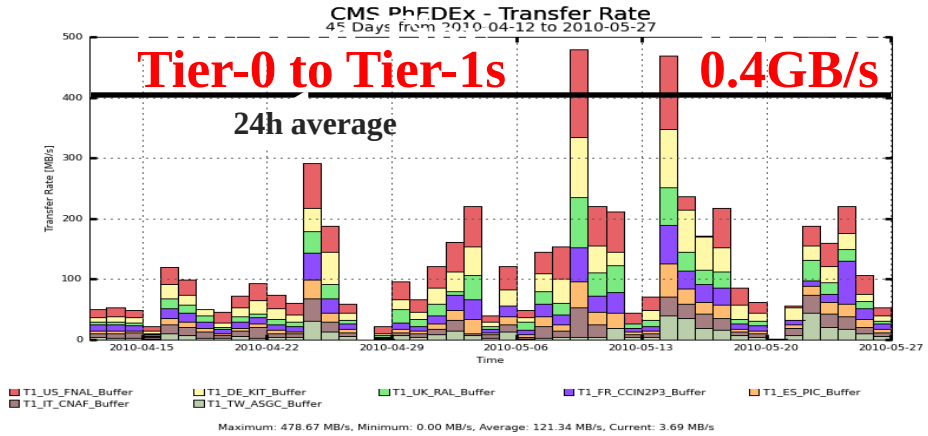
L1 turn on curve
electron-photon trigger with $E_t > 2$ GeV

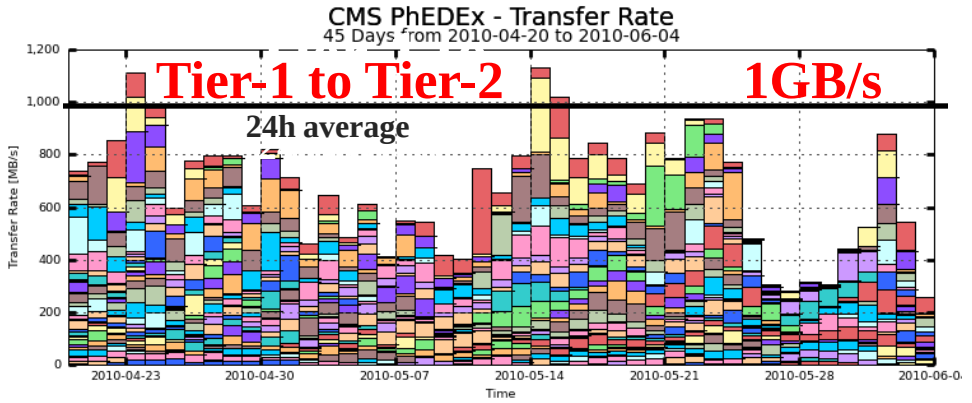
Computing Processing/Transfer

- Data processing proceeds very smoothly.
  - Tier-0: software and infrastructure are stable
- Tier-1s and Tier-2s making reliable contributions
  - All 7 Tier-1s fully participating.
  - Many re-processing cycles handled very well so far .
- 49 Tier-2s received collision data and 57 Tier-2s participate to simulation
- > 465 users submitting jobs for analyses (and number increasing weekly)

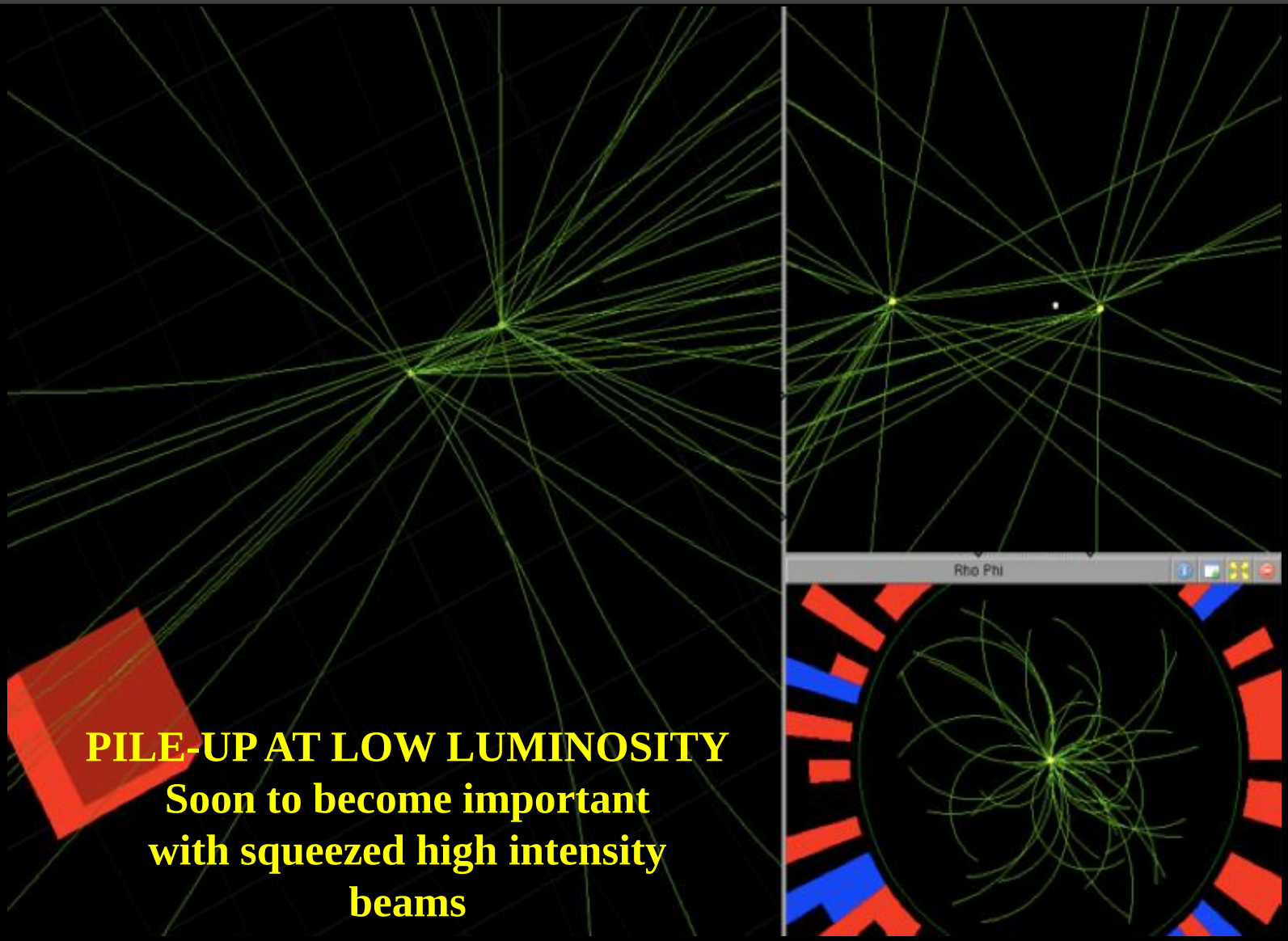


(a) Express Latency



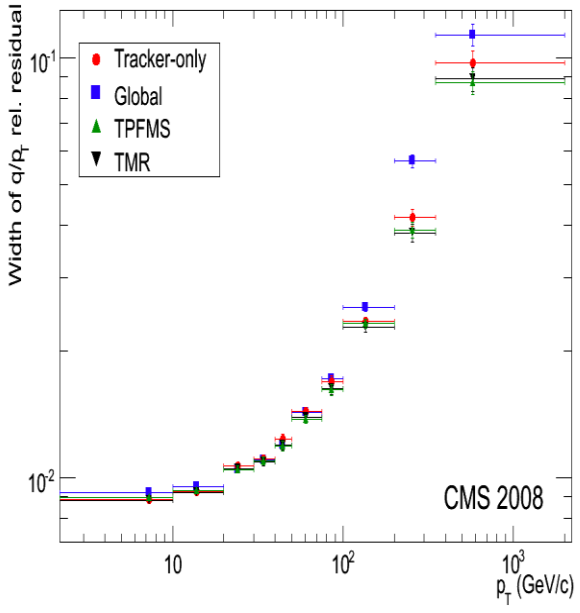


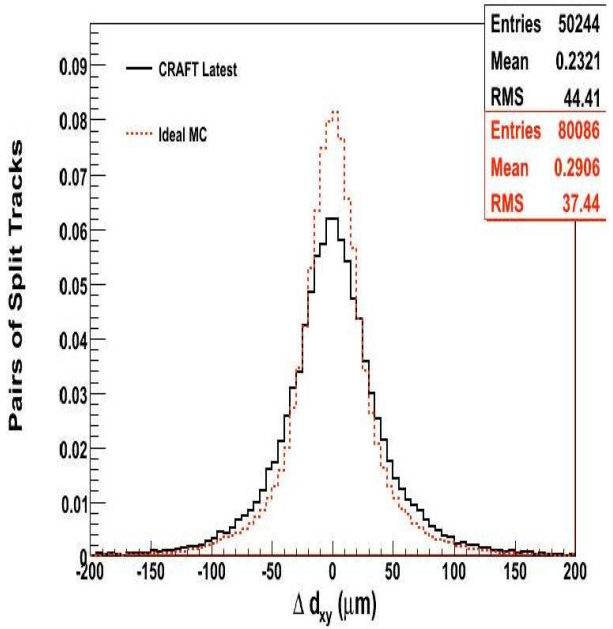
Pile-up at low luminosity



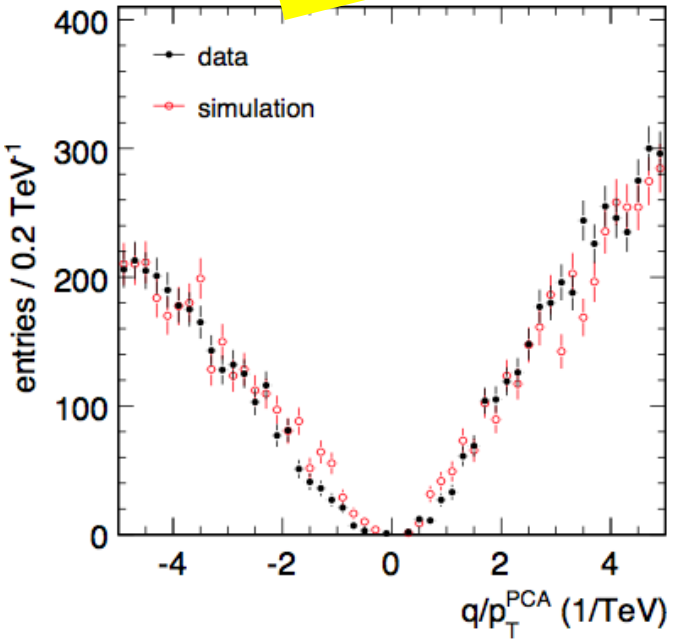
PILE-UP AT LOW LUMINOSITY
Soon to become important with squeezed high intensity beams

CMS detector performance





CRAFT DATA



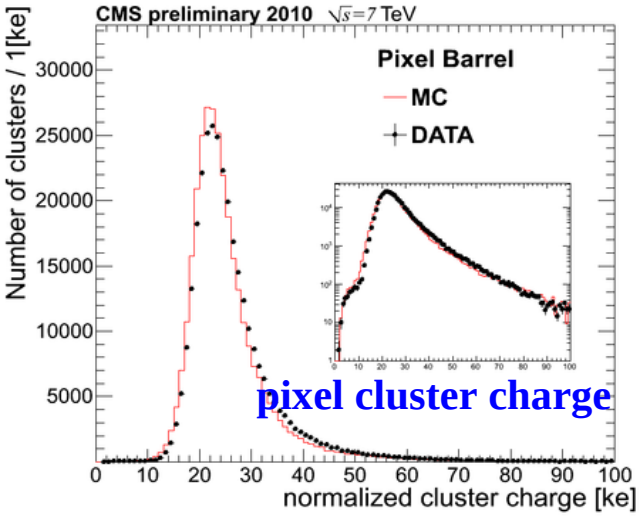
Momentum resolution vs p_T with 2-leg muons.

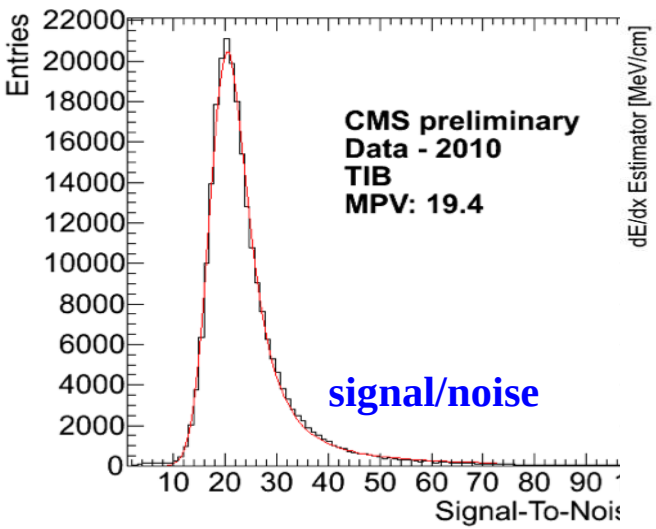
Distance of minimal approach with split tracks.

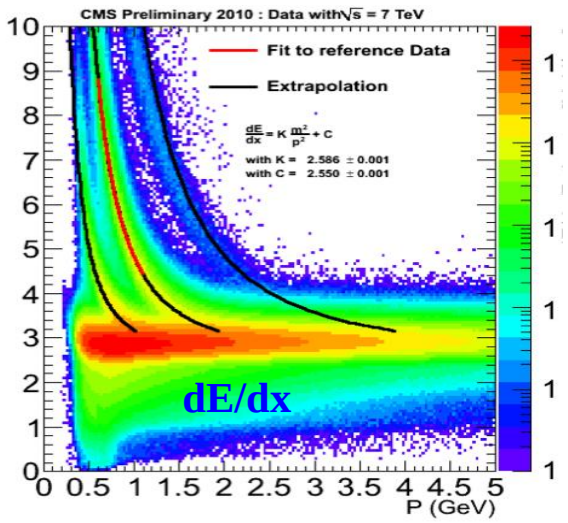
Excellent control of the momentum scale.

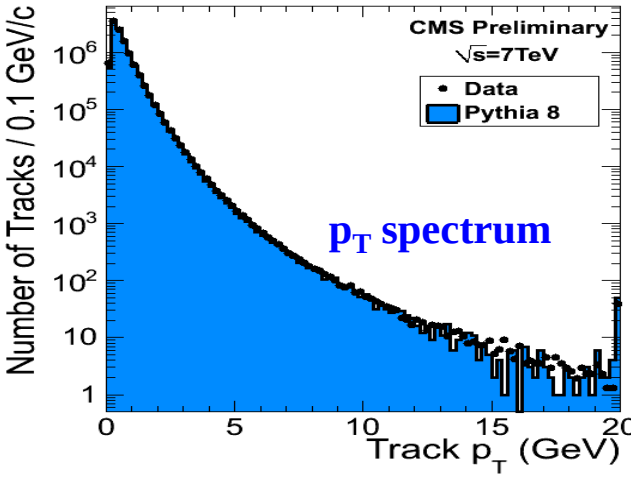
Good understanding of alignment and magnetic field; good description of the detector. Most of the tracker aligned at what was expected after 10pb^{-1} of collision data. Performance not too far from ideal.

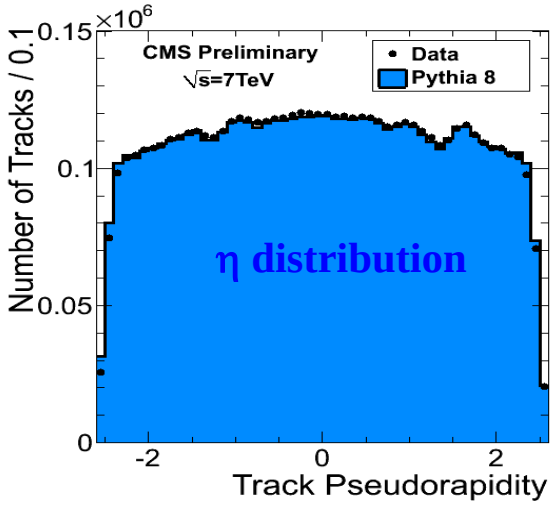
Tracker performance

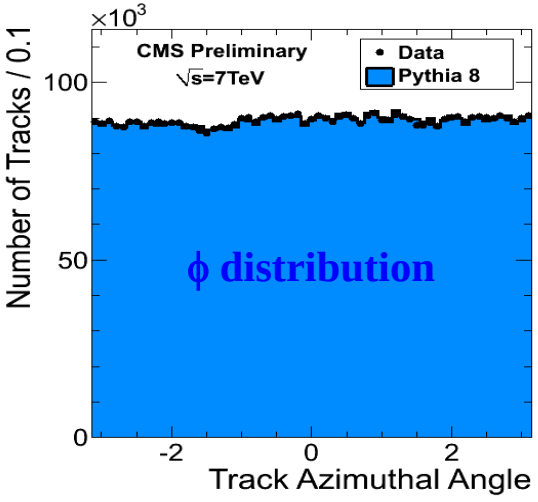


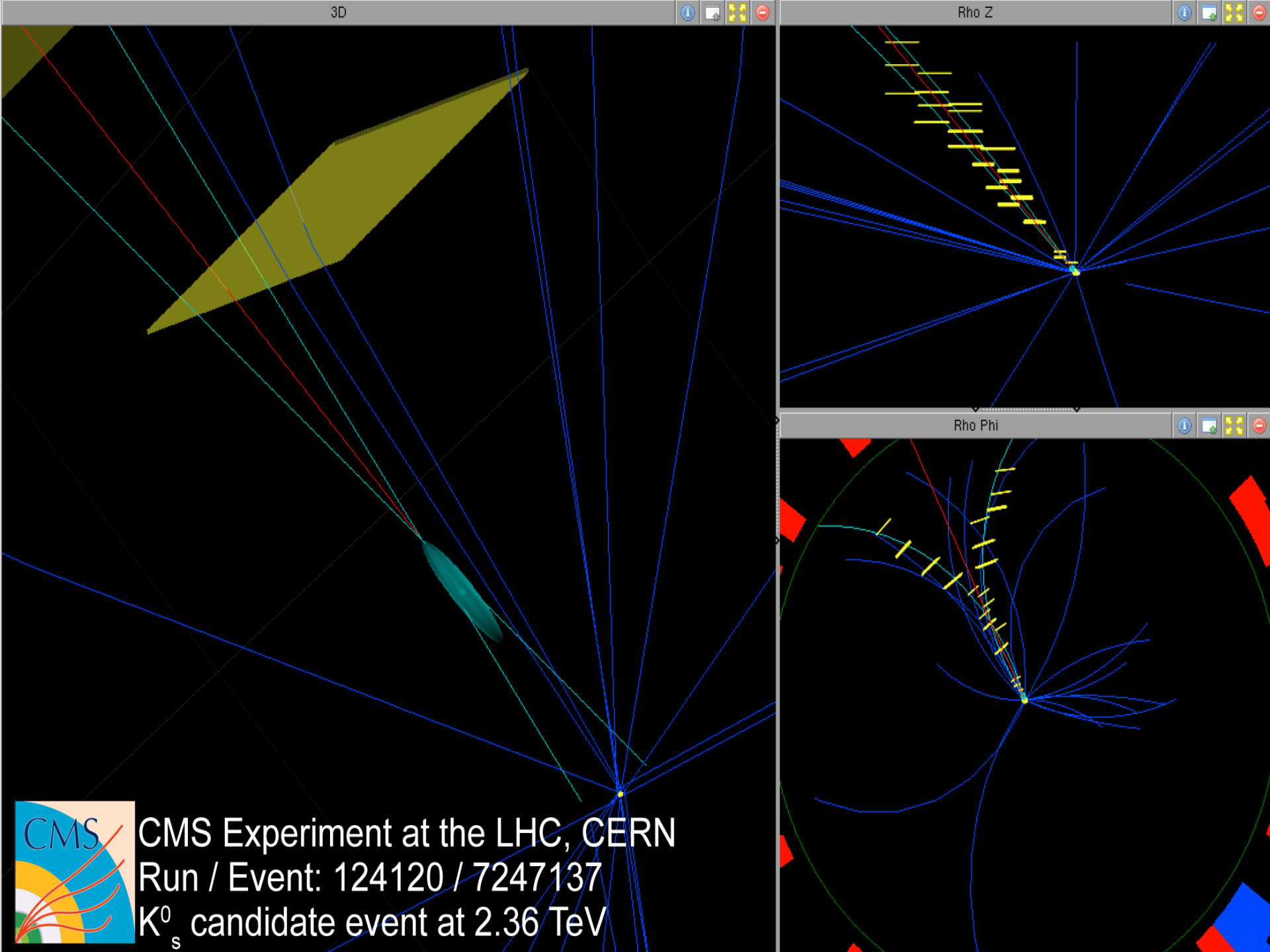




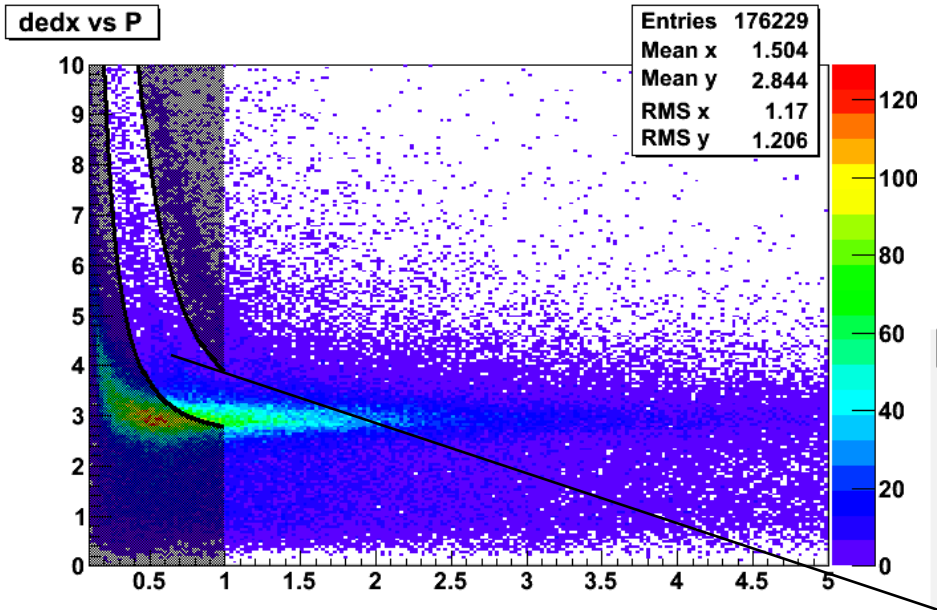




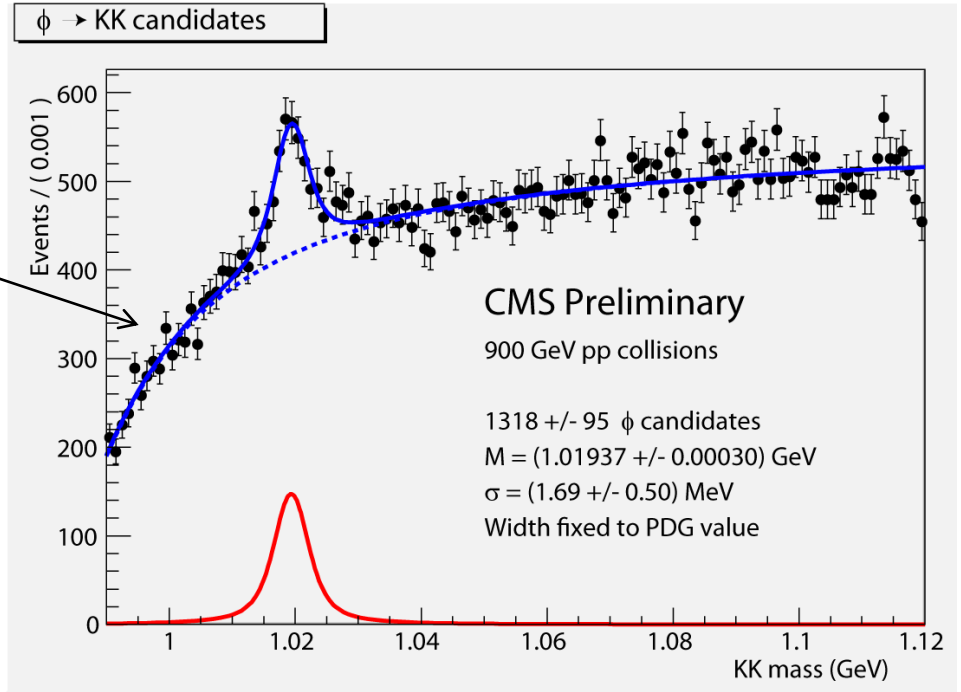



3D
Rho Z
Rho Phi
CMS
CMS Experiment at the LHC, CERN
Run / Event: 124120 / 7247137
K^0_s candidate event at 2.36 TeV

$\Phi \rightarrow K^+ K^-$ using dE/dx



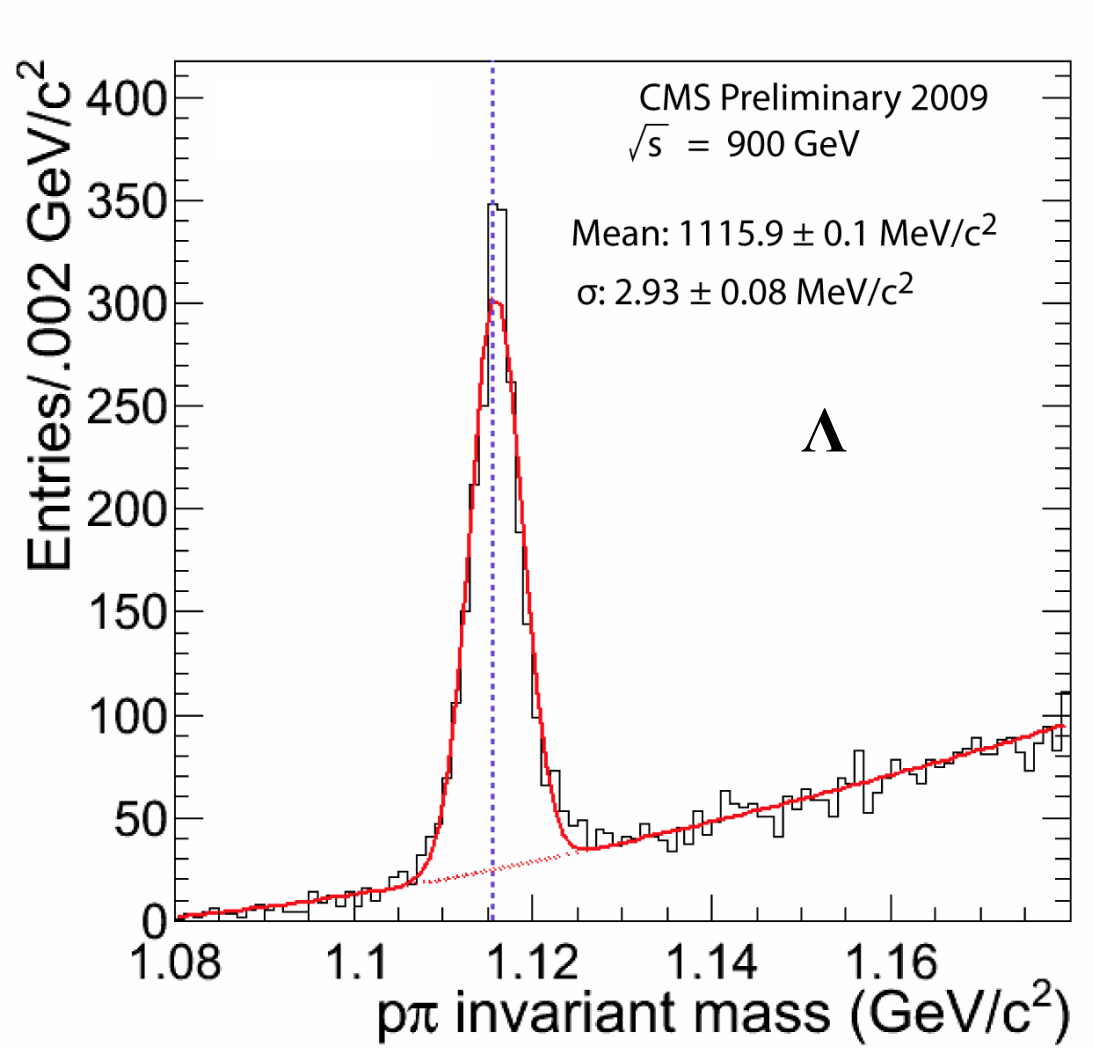
Tracker



K^0_s, Λ, ϕ …

- **Validate**
  - **Tracking Reconstruction**
  - **Secondary Vertex Finding**
  - **Magnetic Field**
  - **Material**
  - **Momentum scale**
- **Validation of MC**

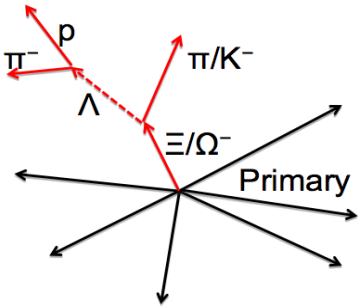
Tracker – Decay vertex commissioning



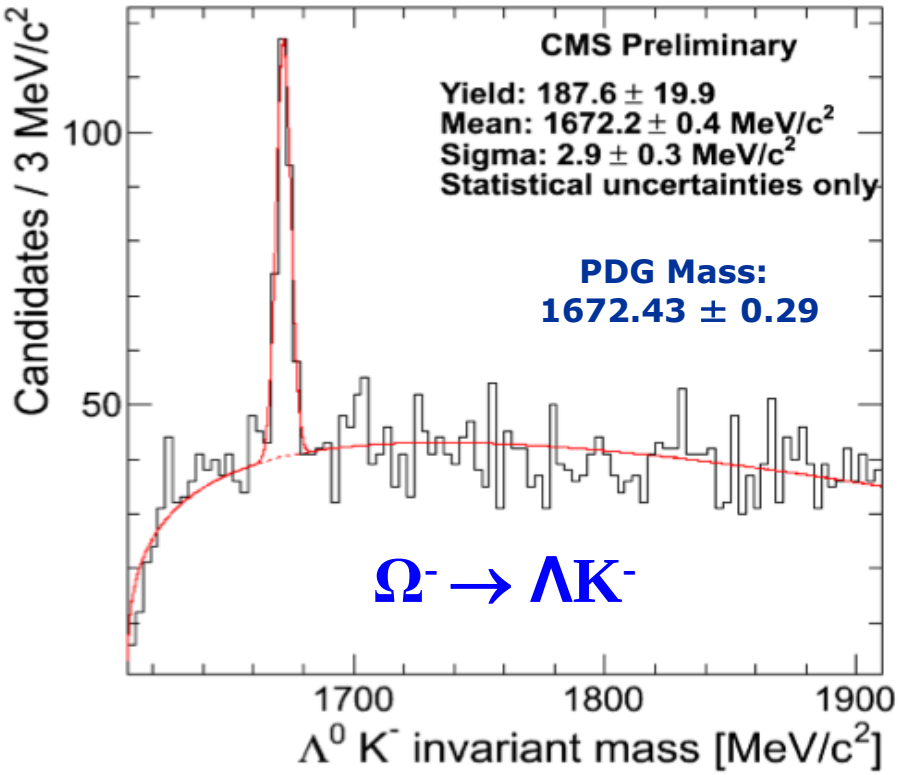
- **Test of the primary and decay vertex finding**
- **Check on the tracker momentum scale**
- **Check on the tracker momentum resolution**

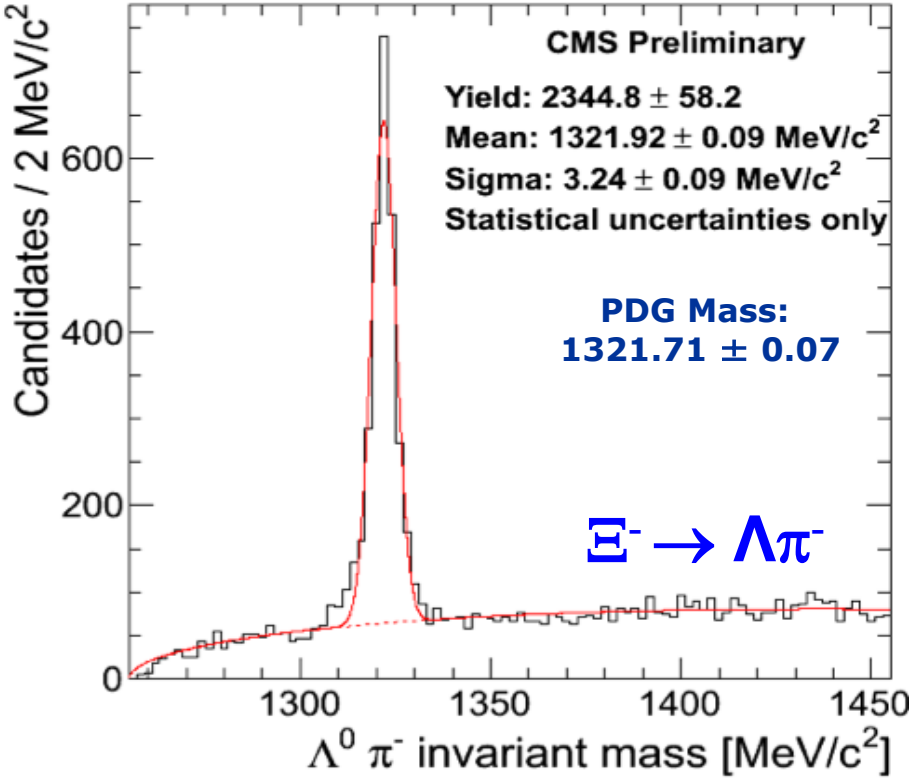
Tracker - Low mass resonances

- **Tracks displaced from primary vertex ($d_{3D} > 3\sigma$)**
- **Common displaced vertex ($L_{3D} > 10\sigma$)**



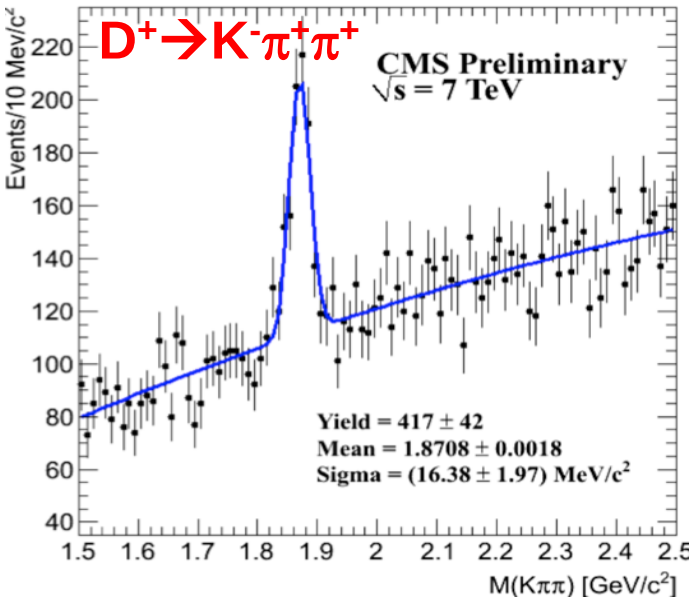
Invariant mass distribution for different combinations ($\Omega^{\pm} \to \Lambda K^{\pm}$ or $\Xi^{\pm} \to \Lambda\pi^{\pm}$) fit to a common vertex.

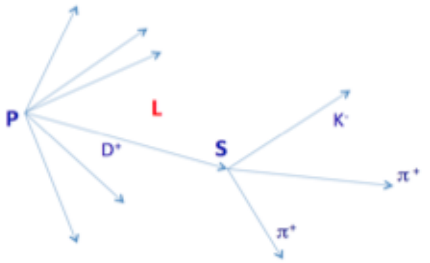


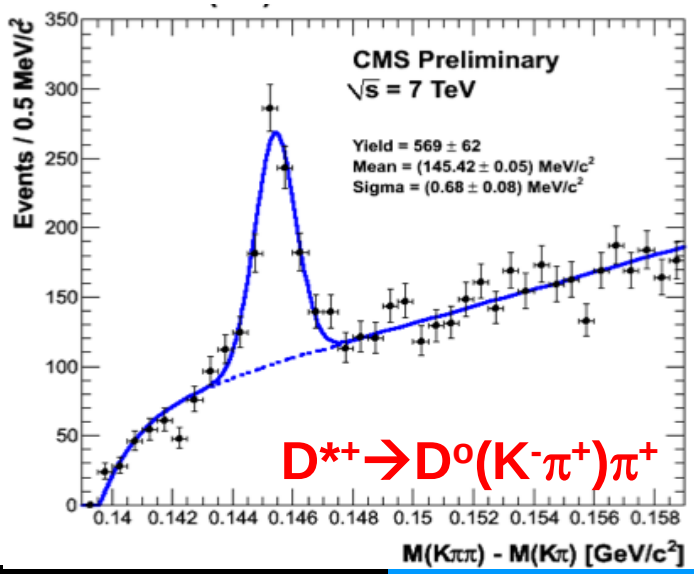


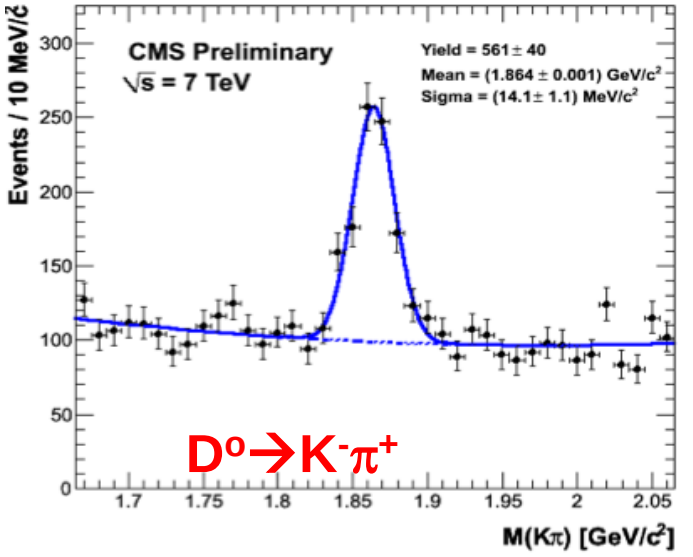
Charm physics in MB events

These "reference" open charm decays validate the tracker pattern recognition, momentum resolution and secondary decay vertex quality.



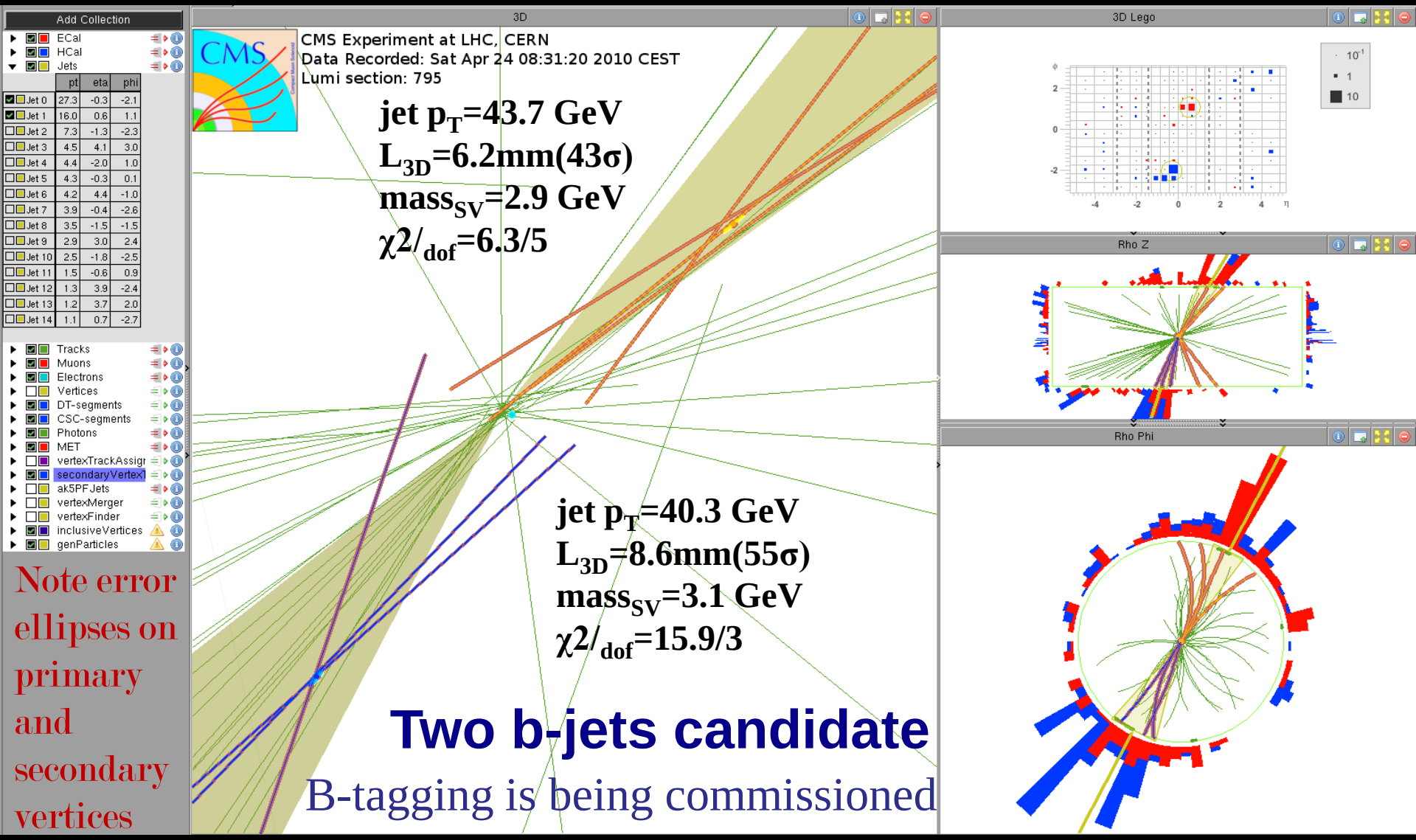






- **Good agreement with PDG values**
  - **B field and p scale well understood**
- **Resolution as expected from MC**
  - **Good alignment**

Heavy Flavour

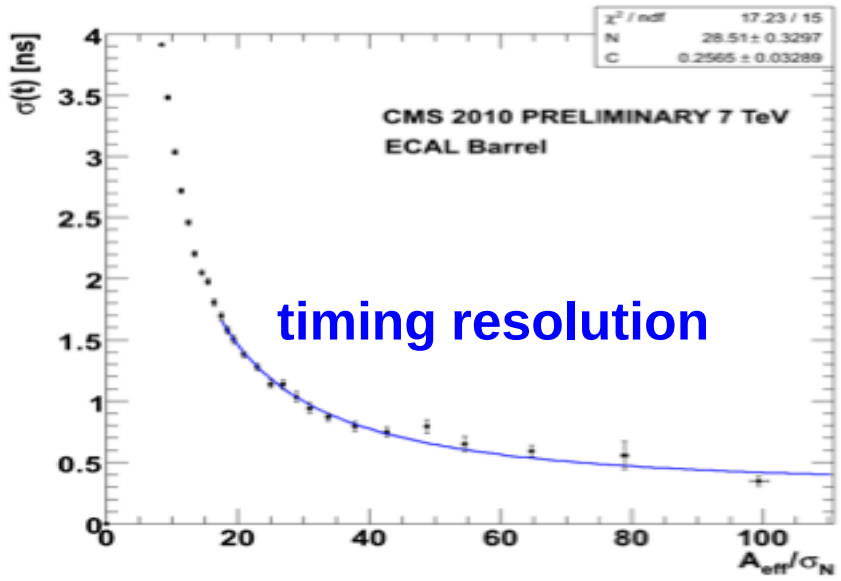


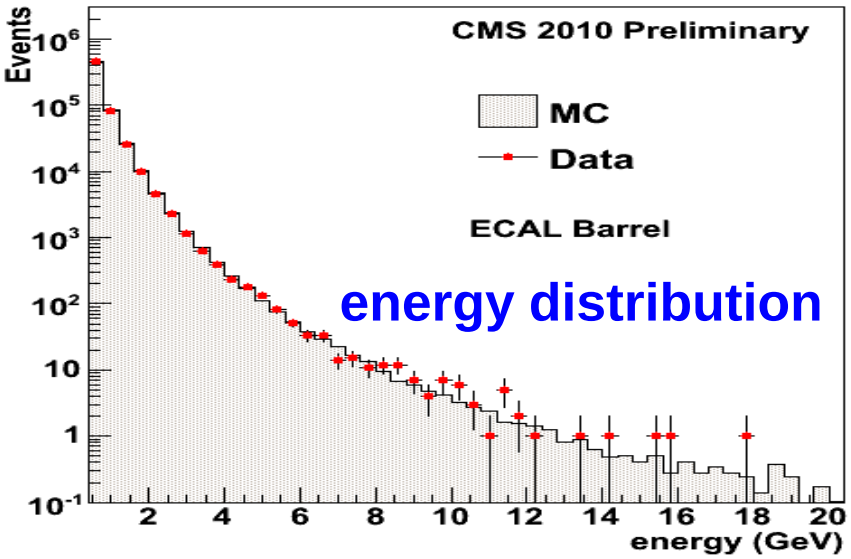
Note error ellipses on primary and secondary vertices

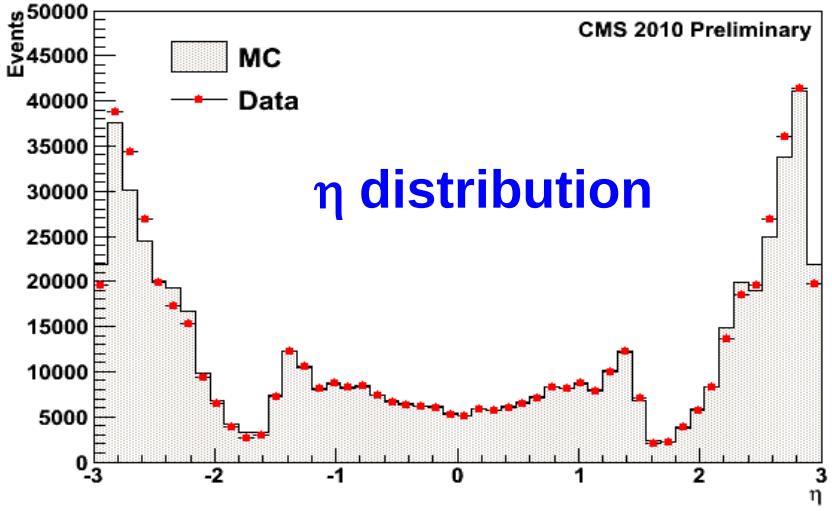
Two b-jets candidate

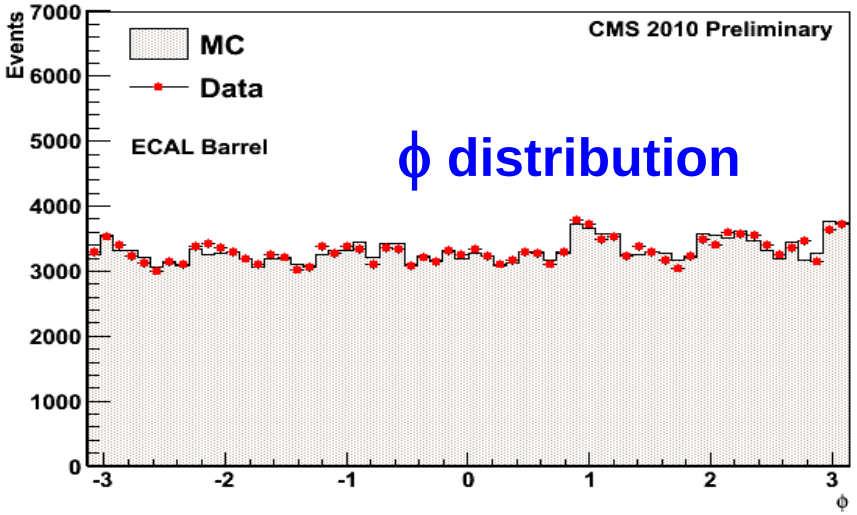
B-tagging is being commissioned

ECAL Performance



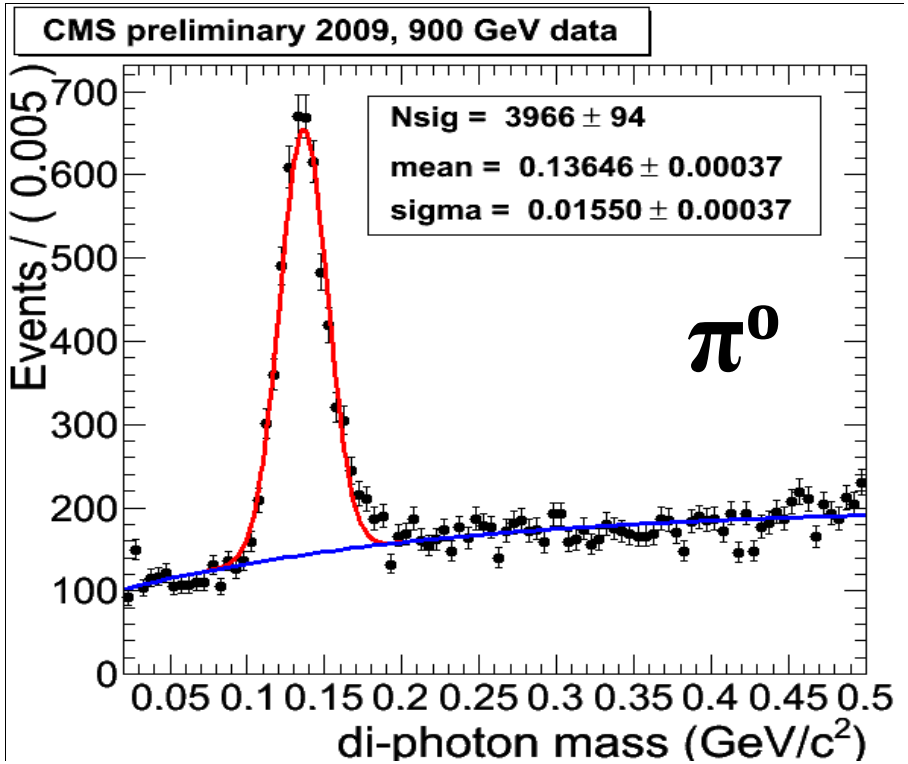






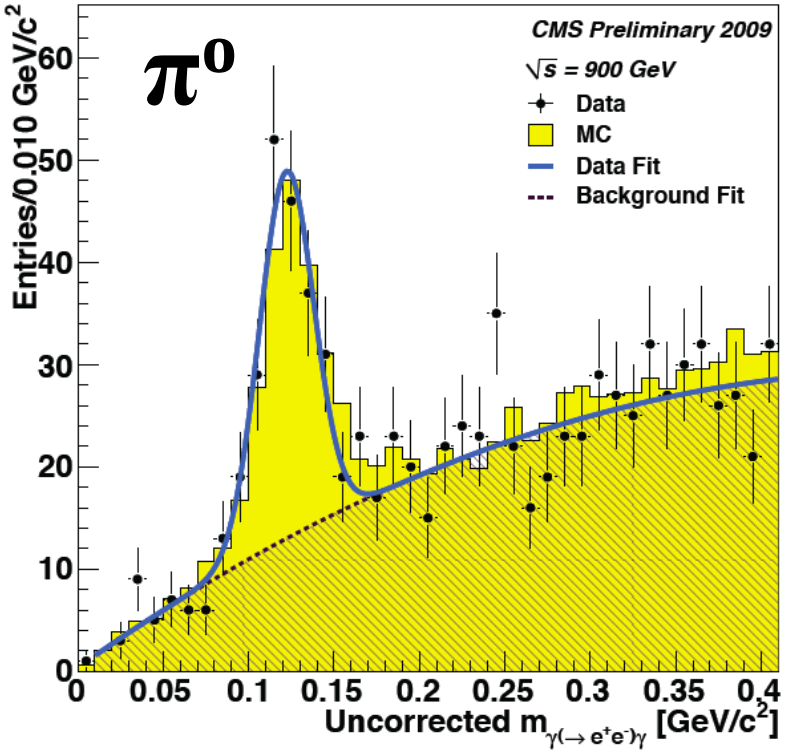
First γγ Resonances in ECAL

First π^0 peak shown already the 27th of November !



With "Out of the box" MC corrections: within 2% of PDG mass …

ECAL



π^0 with one leg reconstructed (track-driven) as conversion !

Calibration of the calorimeters comes from test beams, cosmic rays and then in situ reconstructions of known resonances. Later the γ + Jet reaction will be used to transfer calibration to hadron calorimeter.

π^0 and η Peaks for Inter-Calibration

The excellent ECAL performance allows the clean reconstruction of π^0 and η signals.

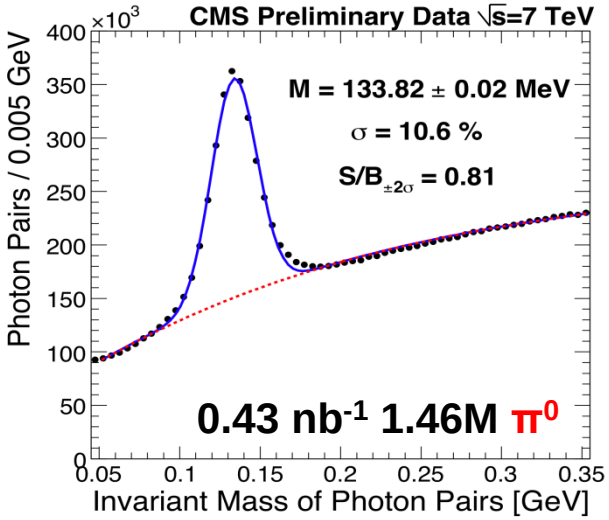
1.46M of $\pi^0 \rightarrow \gamma\gamma$

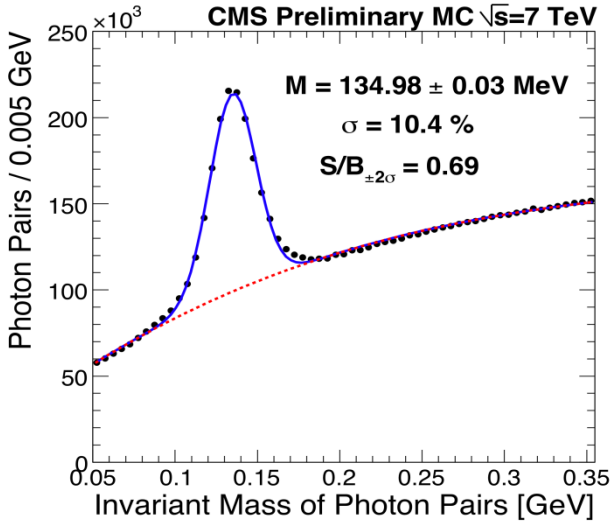
$P_T(\gamma) > 0.4$ GeV,
$P_T(pair) > 1$ GeV

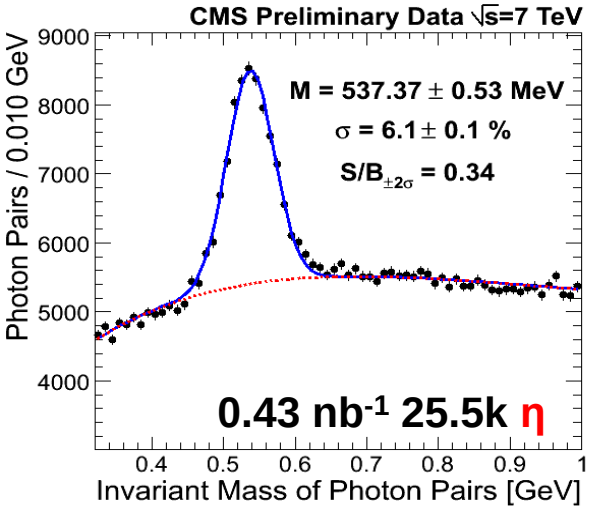
25.5K of $\eta \rightarrow \gamma\gamma$

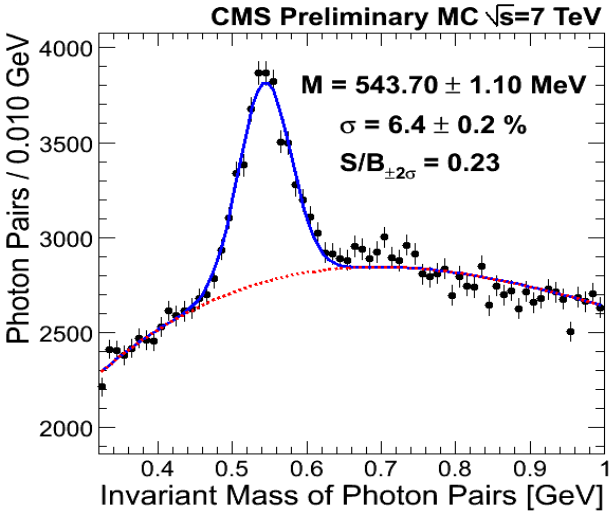
$P_T(\gamma) > 0.5$ GeV,
$P_T(pair) > 2.5$ GeV

- **Numbers refer to ~5% of the currently available statistics.**
- **Very useful data to intercalibrate the crystals.**
- **MC based correction applied according to cluster η and energy.**









Data **MC**

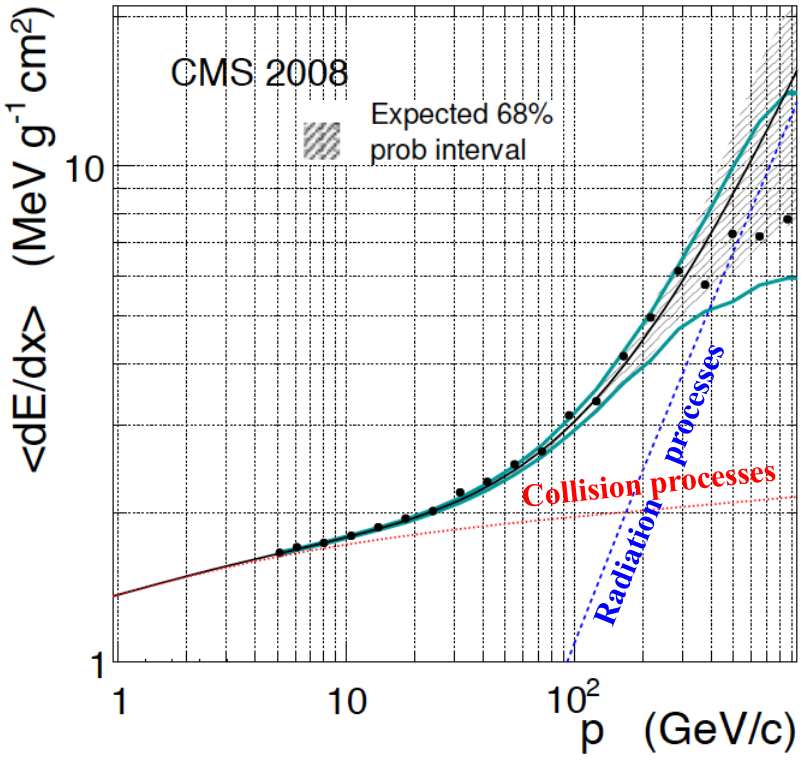
ECAL: μ Stopping Power

Reminder:

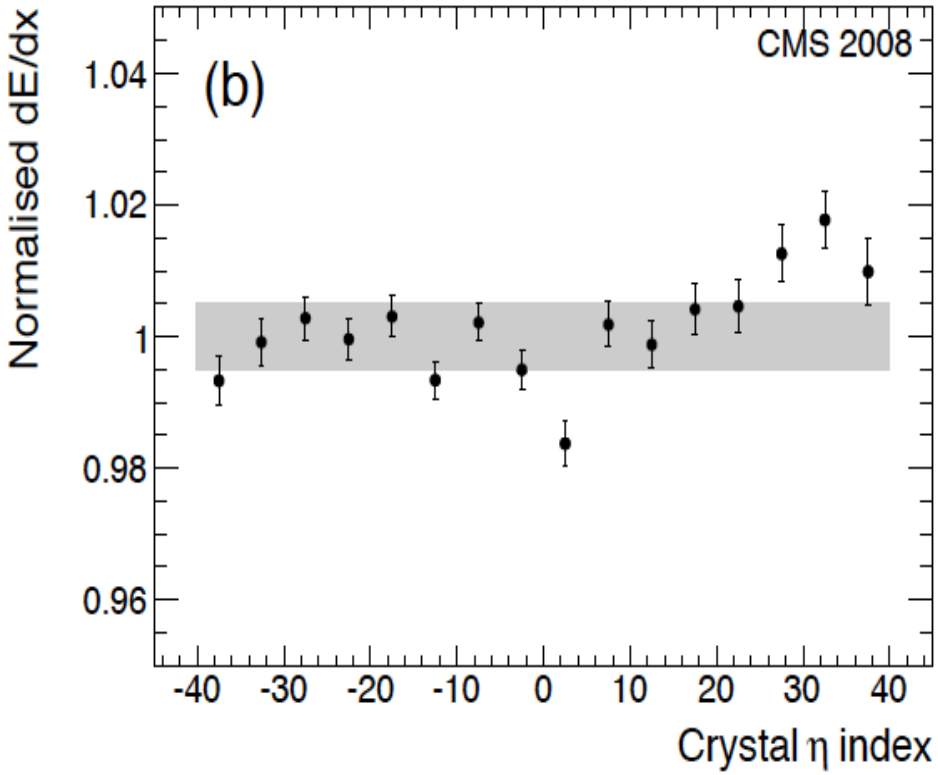
CRAFT DATA

- **4 SM (1700 channels each) have been calibrated with electrons**
- **Transferred to all 36 barrel SM by means of cosmic ray inter-calibration**

⇔Typical single channel uncertainty of 1.5%



2010 JINST 5 T03010

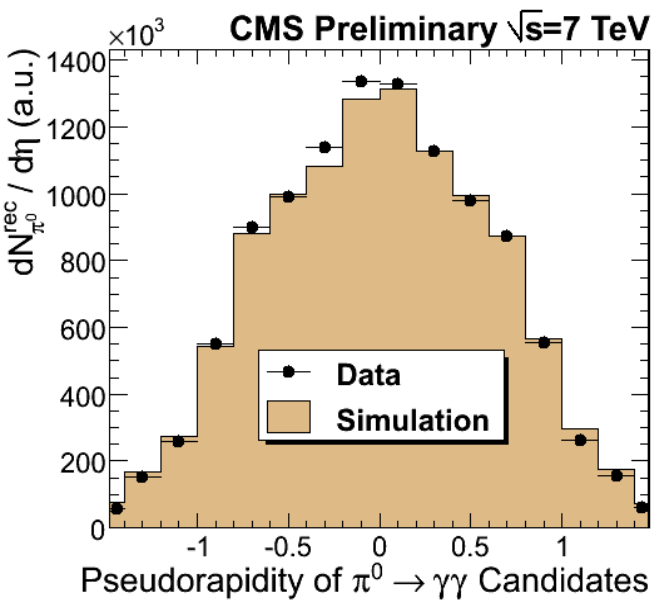


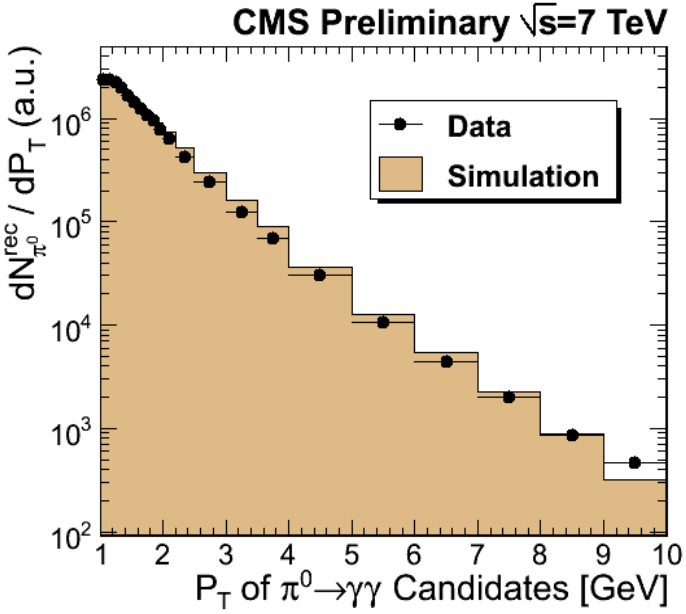
2010 JINST 5 P03007

π^0s and ECAL Calibration

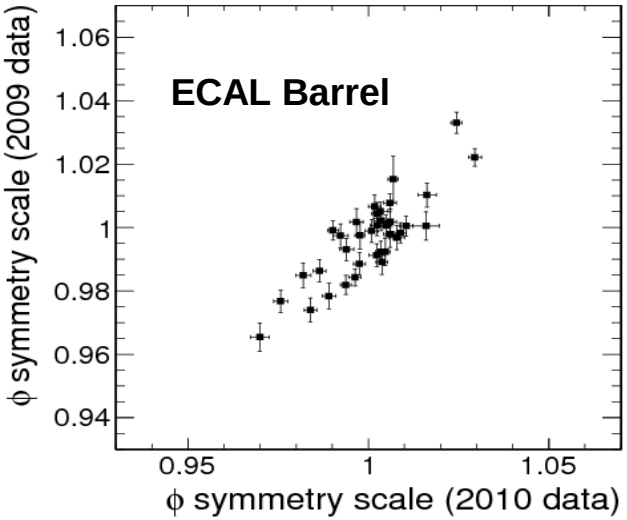
$\pi^0 \rightarrow \gamma\gamma$

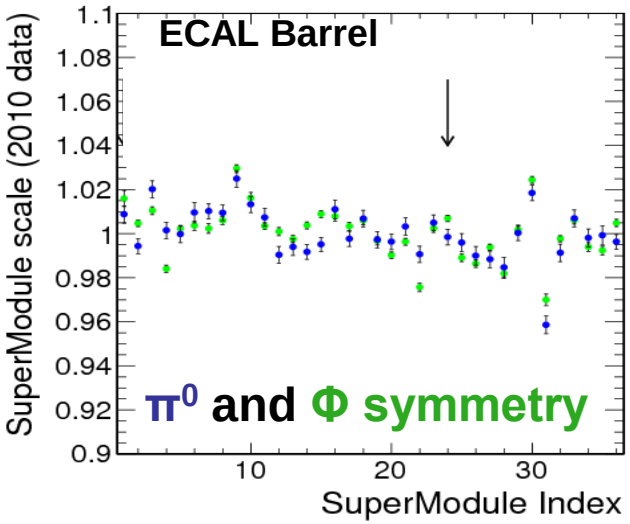
η, Φ distributions



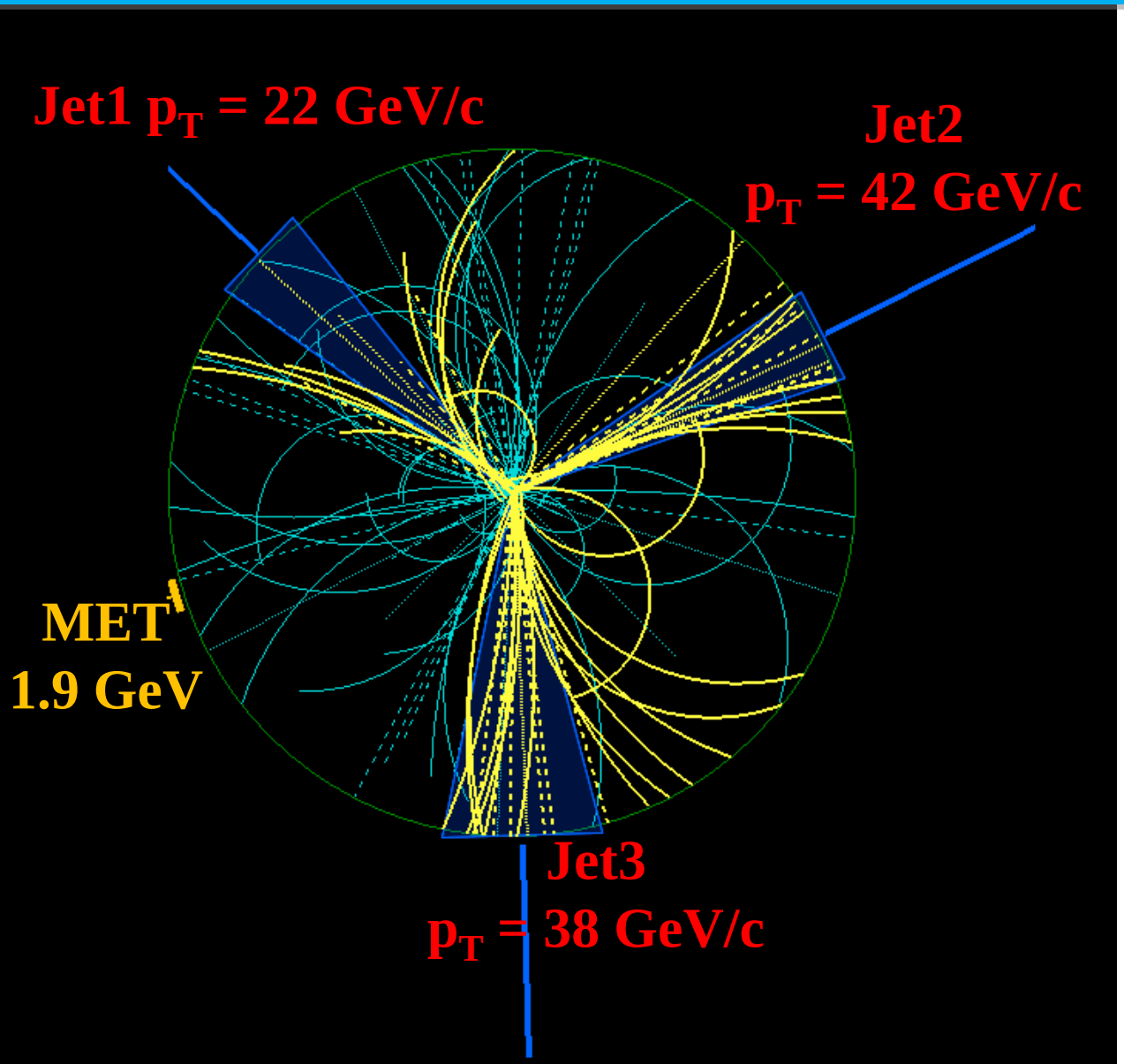


Relative calibration precision ~ 2%
Target ~ 0.5% at 10pb^{-1}





Multi Jet Event @ 7 TeV

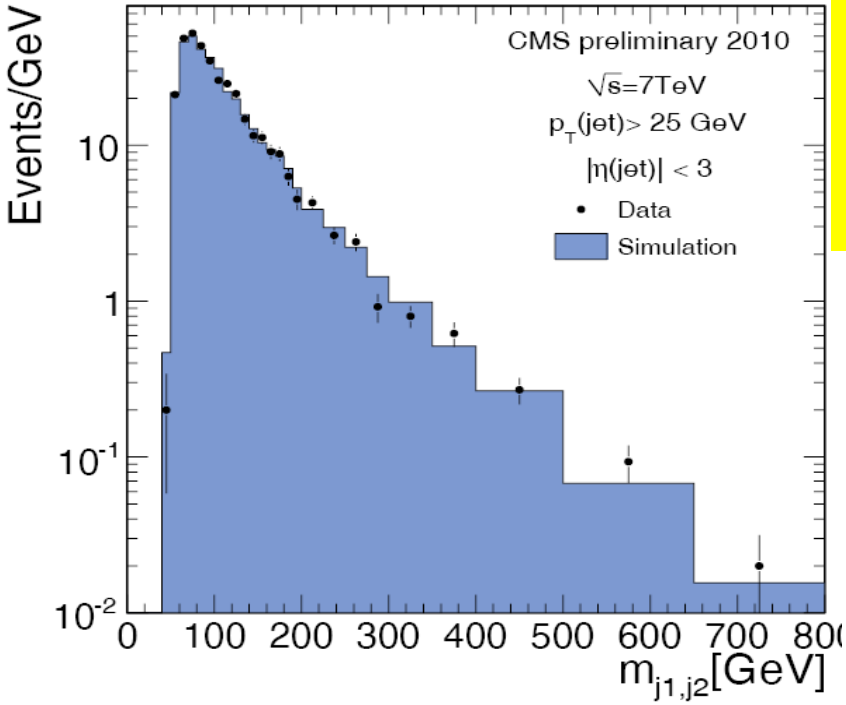


Default Jet Algorithm: anti-kT, R=0.5

Three different Jet reconstruction methods:

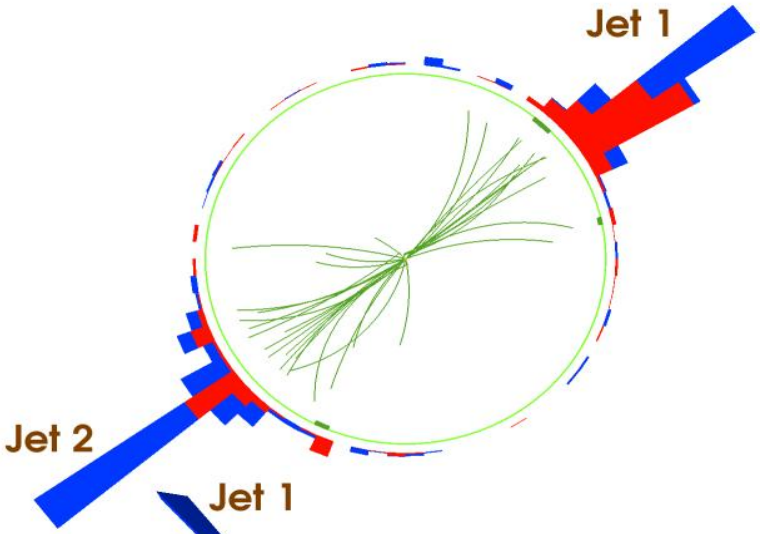
- **Calorimeter Jets** based on calorimeter towers
- **Jet-Plus-Tracks Jets** a posteriori corrections to calorimeter using tracks
- **Particle Flow Jets** a priori use of tracks and calorimeter. Identify charged/ neutral hadrons, photons, electrons

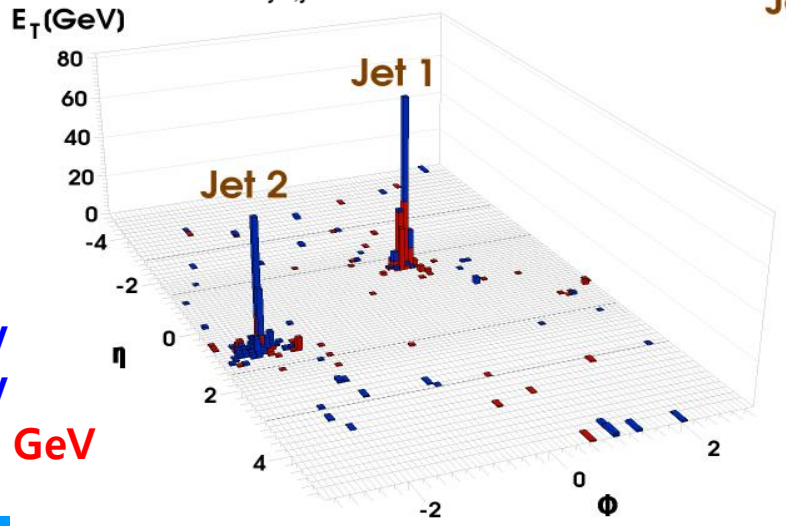
High Mass Di-Jets Event

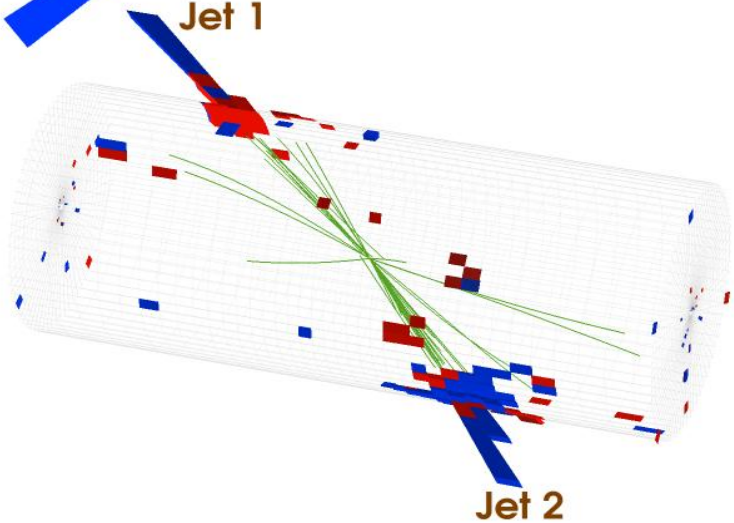


With ~ 1 nb^{-1} of logged data, the dijet mass spectrum is approaching ~ 1 TeV.

CMS Experiment at LHC, CERN
Run 133450 Event 16358963
Lumi section: 285
Sat Apr 17 2010, 12:25:05 CEST





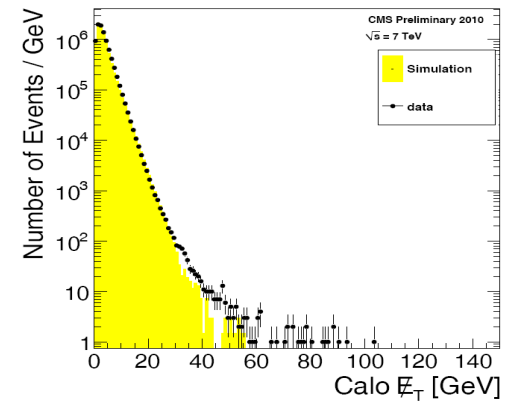


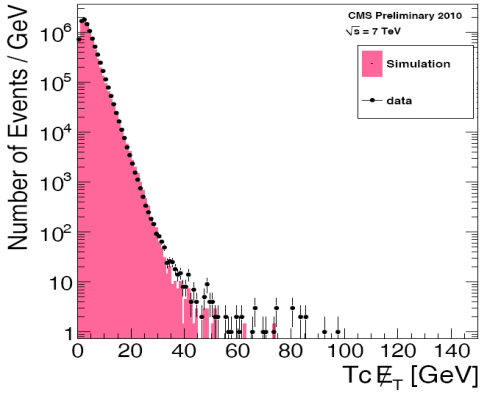
Jet1 p_T : 253 GeV
Jet2 p_T : 244 GeV
Dijet Mass : 764 GeV

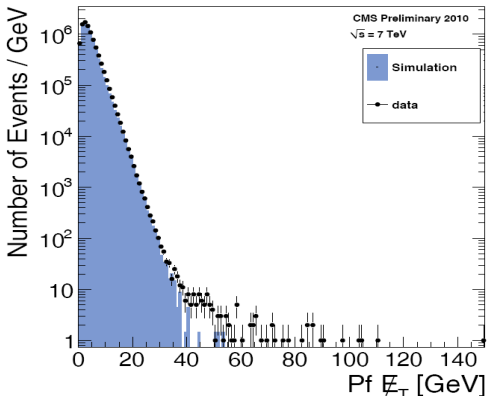
MET in inclusive jet selection

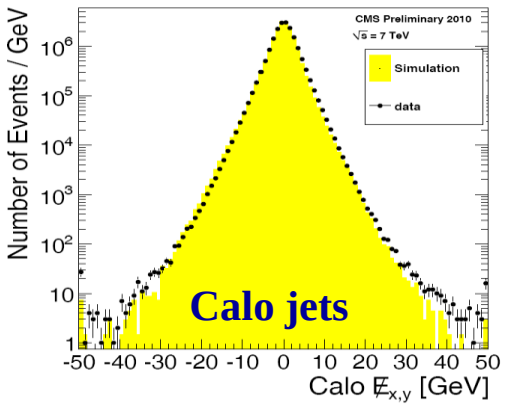
CMS has made a special effort to commission MET as soon as possible since it is crucial to many searches for new physics, e.g. SUSY. In dijet events there is ~ no true MET and there is a ~ 6 order of magnitude smooth fall of the observed MET. The tails are being explored and a successful cleaning strategy is in train – in time for ICHEP in July.

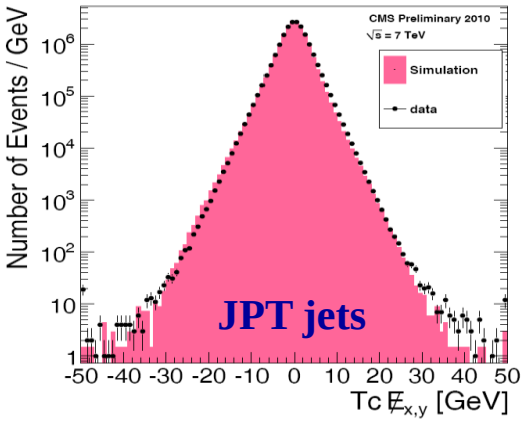
MET in inclusive jet selection is being commissioned

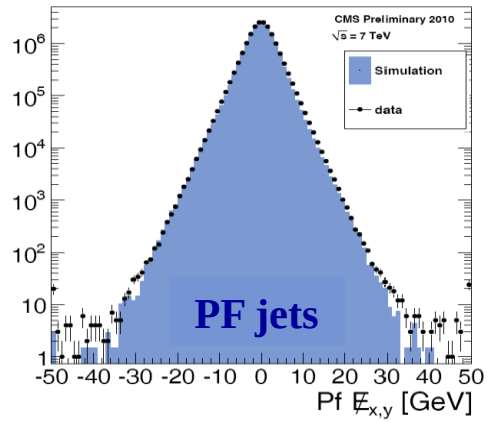








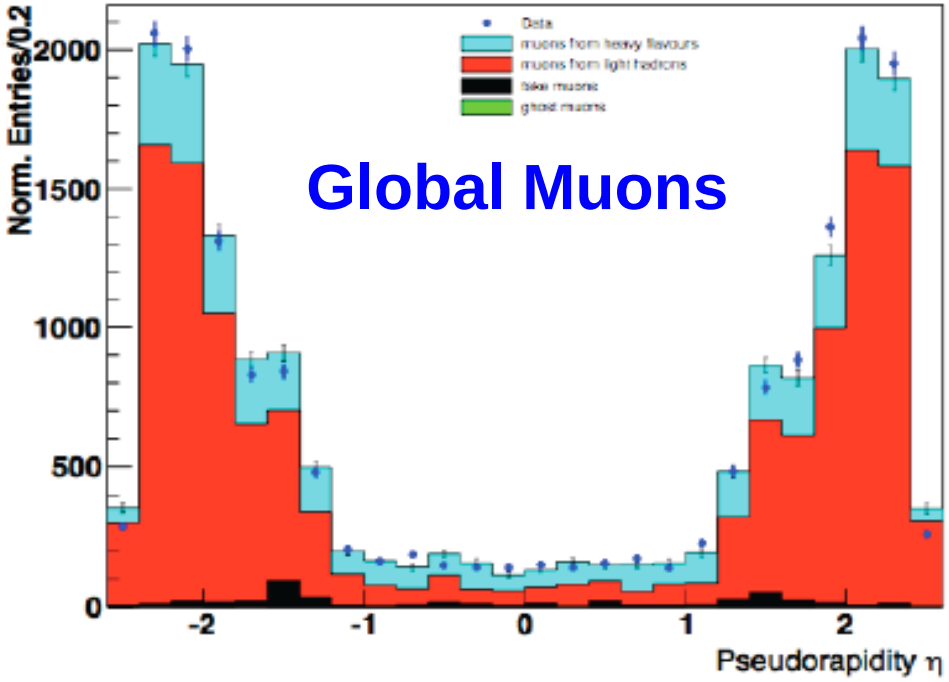


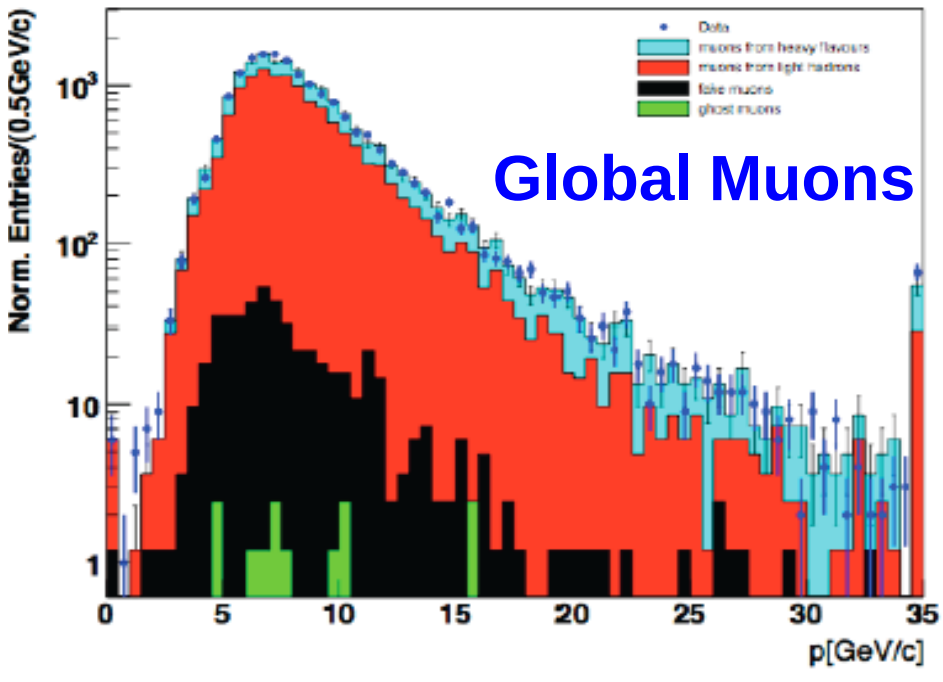


- ***Monte-Carlo reproduces data over 5 orders of magnitudes***
- ***MET tails understanding is in progress (still work to do)***

Muons

“Global Muons” matched tracks from Muon system and Tracker
“Tracker Muons” tracker tracks matched to one Muon station segment





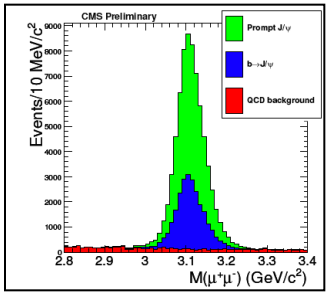
η and p_T distributions dominated by light hadron decay muons (red), good agreement with MC prediction including heavy flavor decays (blue), punch-through (black) and fakes (green).

Roadmap to discoveries with leptons at LHC

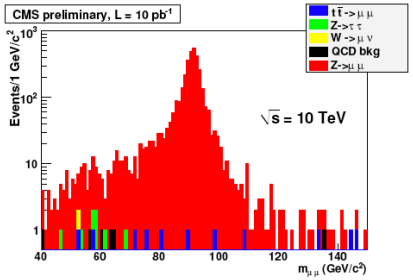
0 10 20 30 40 50 60 70 80 90 100 110 120 130

$\int \mathcal{L}dt\ (\mathrm{pb}^{-1})$

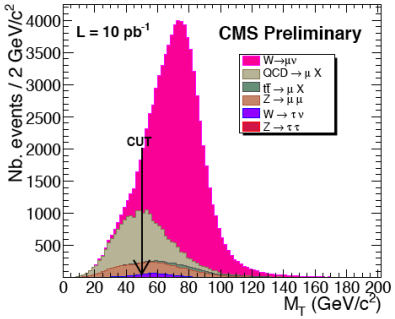
J/Ψ & Υ resonances (few pb^{-1})



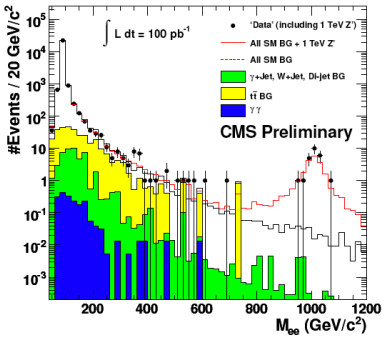
Z peak ($10pb^{-1}$)



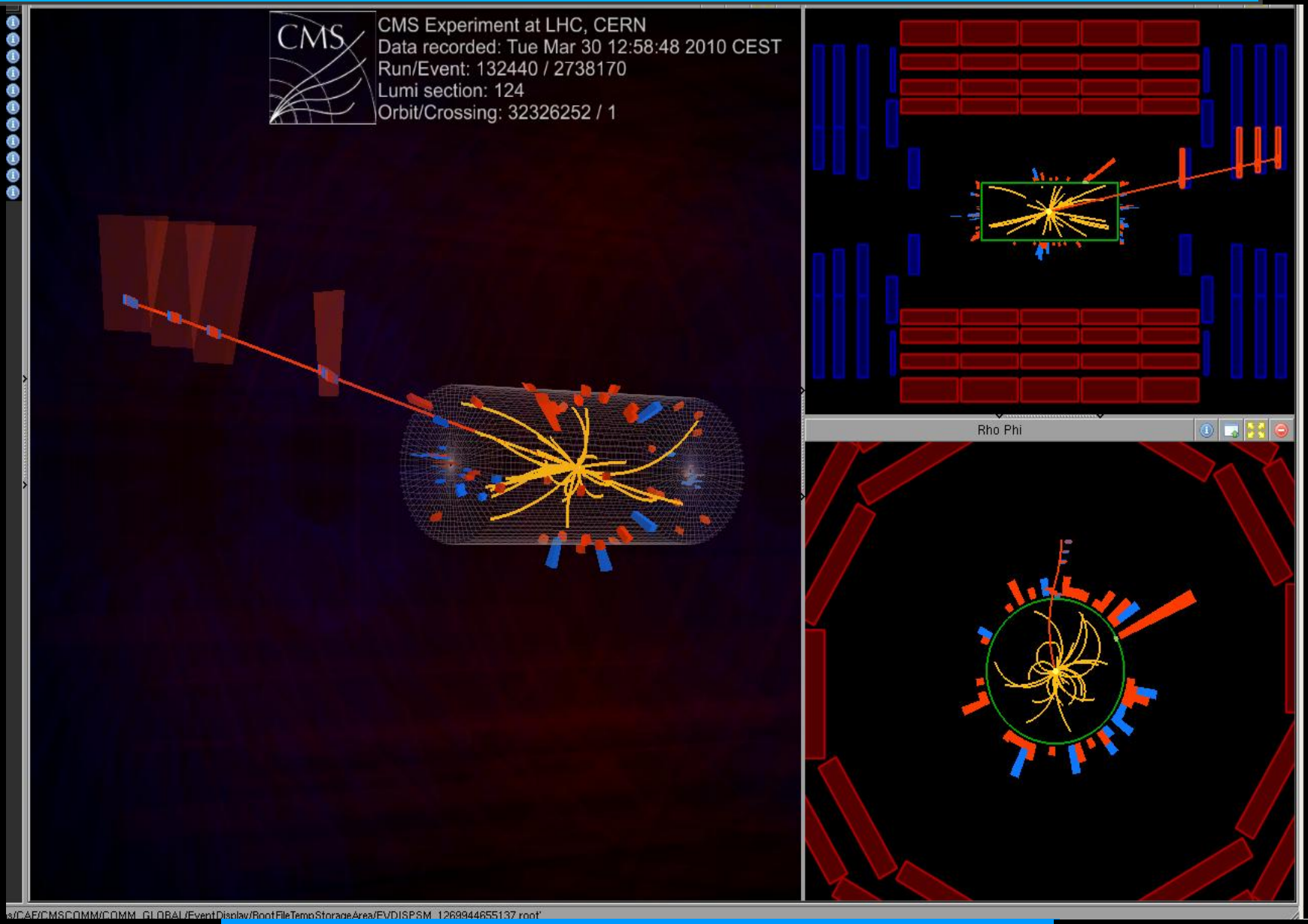
W cross-section measurement



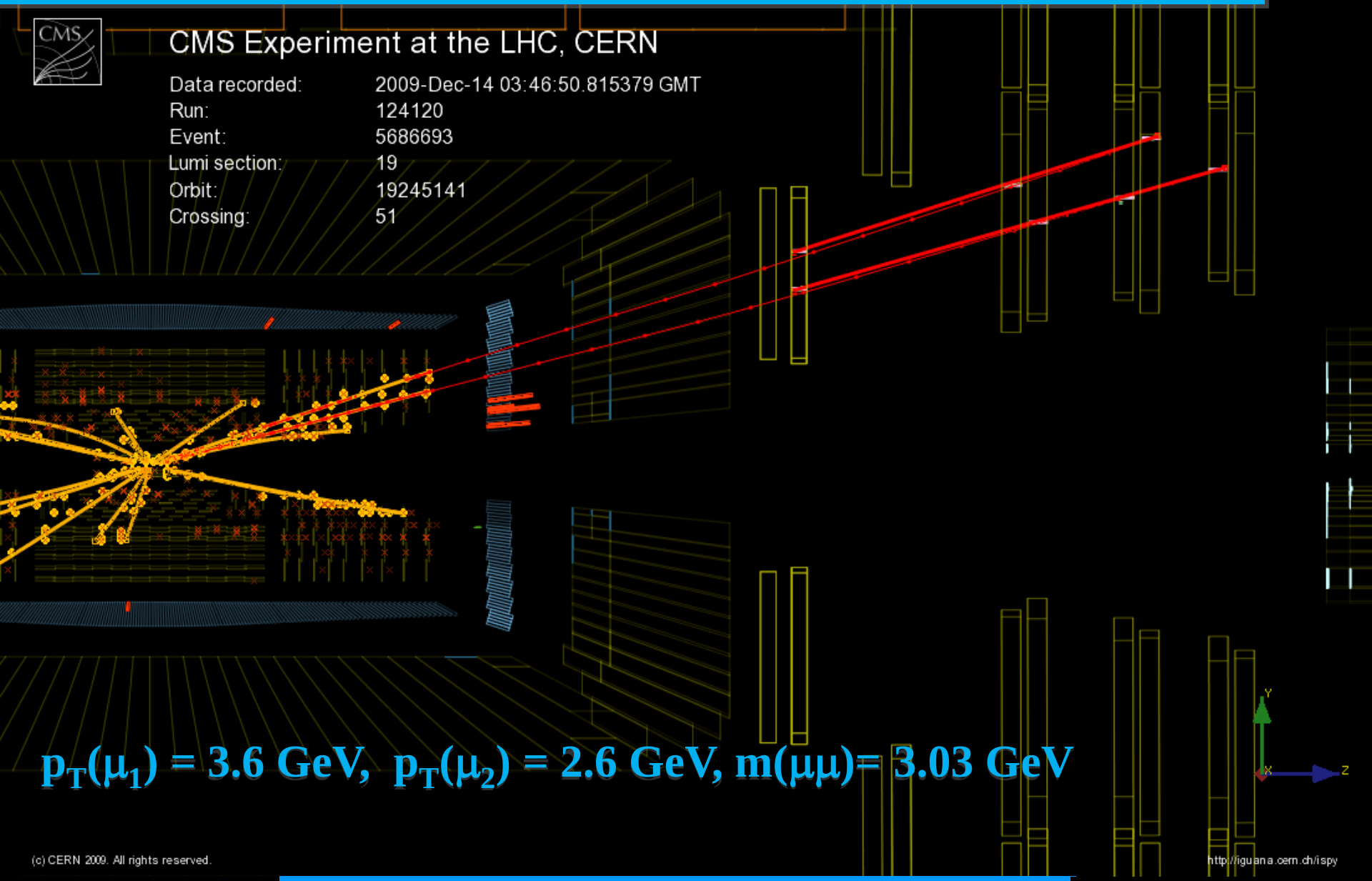
Look @ DY spectrum beyond M_{ll}> 700 GeV/c²



Observation of Isolated Muons….



…Low Mass Dimuons Resonances



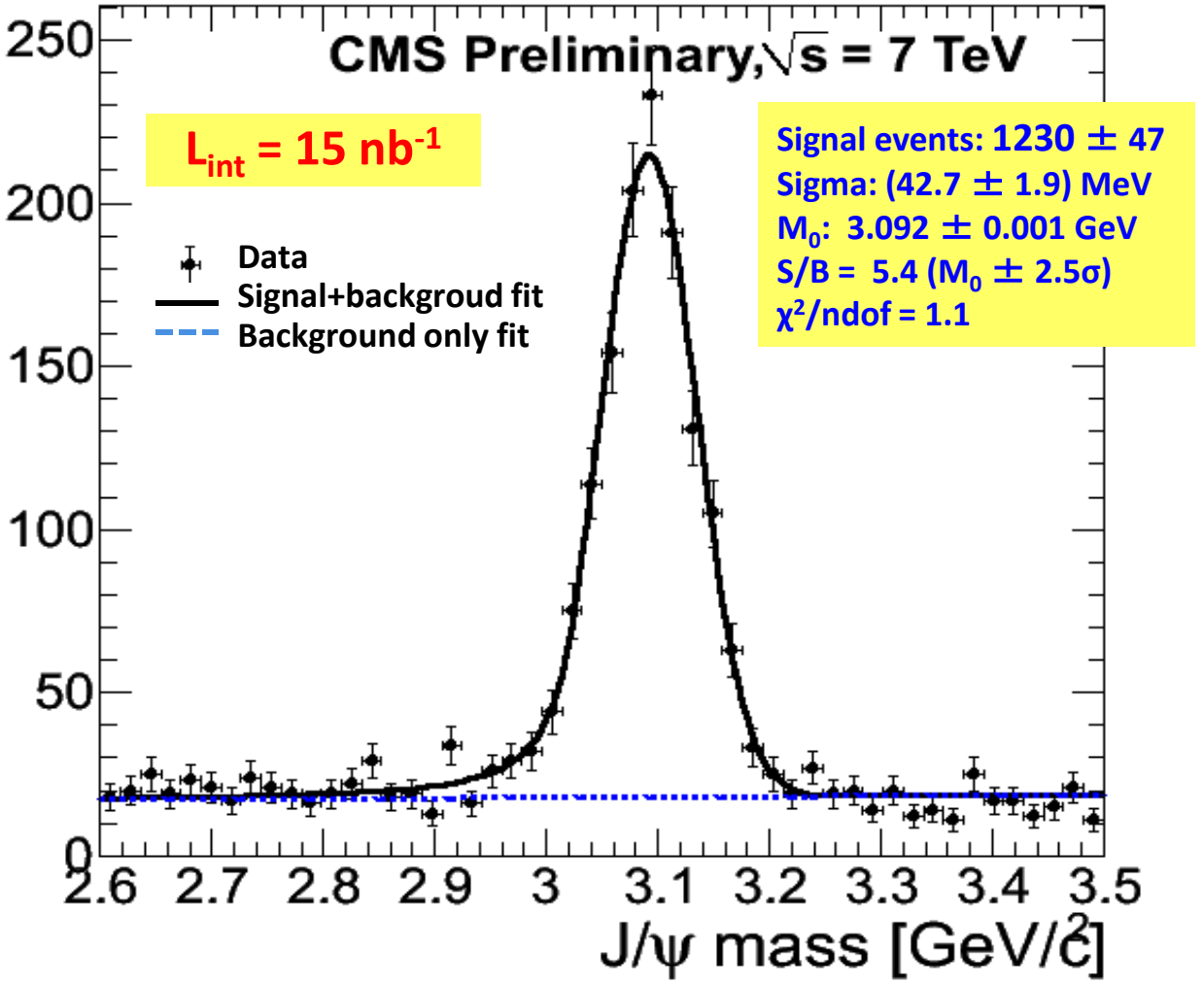
$p_T(\mu_1) = 3.6$ GeV, $p_T(\mu_2) = 2.6$ GeV, $m(\mu\mu) = 3.03$ GeV

Dimuons resonances: $J/\Psi \rightarrow \mu^-\mu^+$

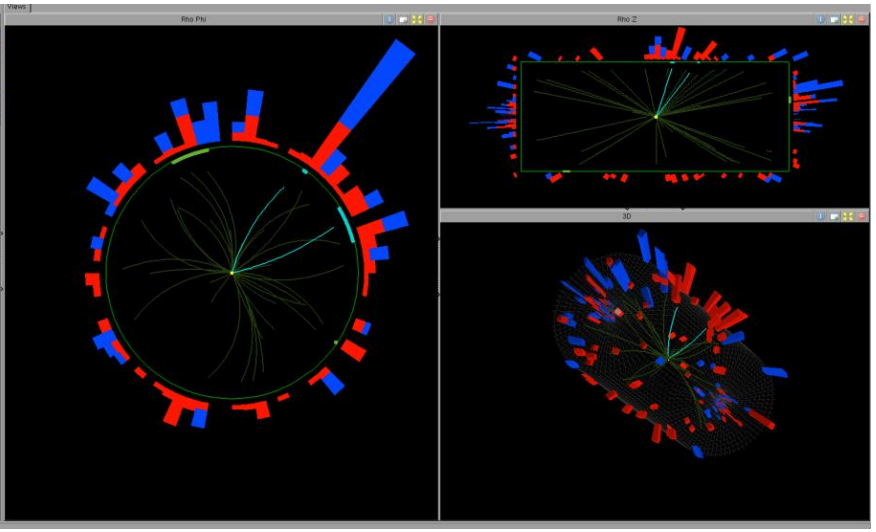
- ***All muon tracks, Nhits ≥ 11 (≥ 2 in Pixels)***

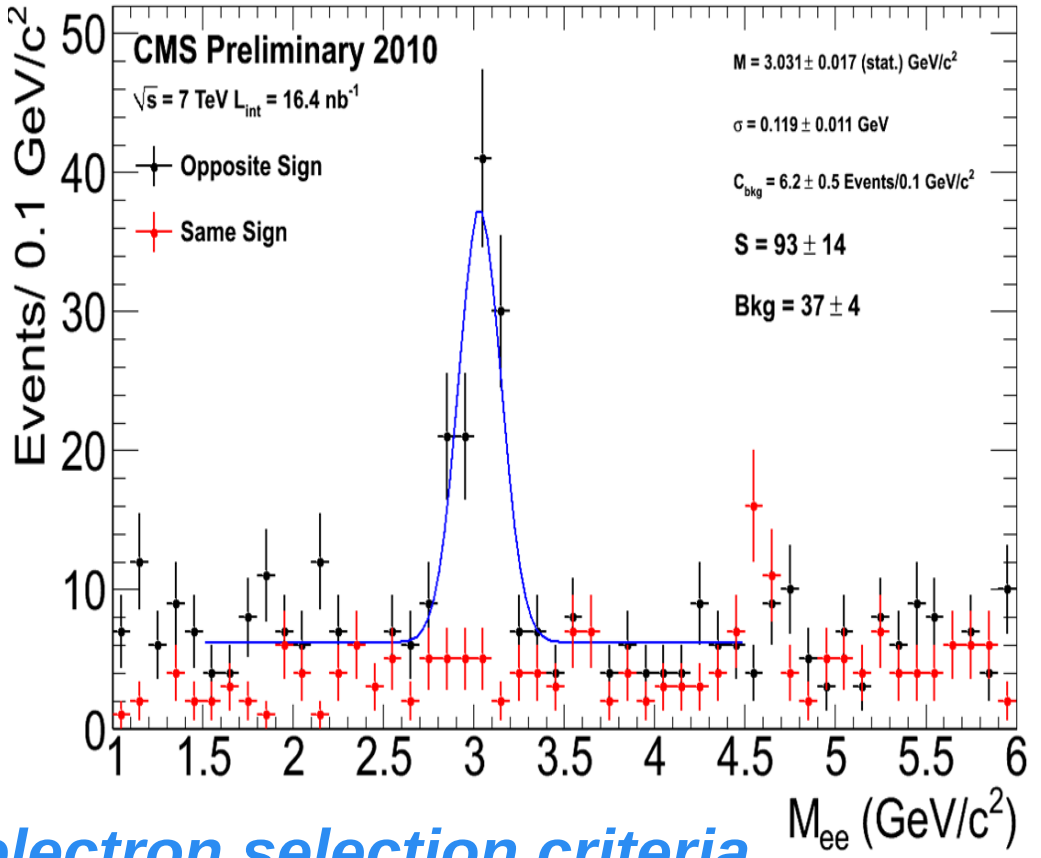
On going studies:

- **Mass w.r.t. η and Pt → *track momentum scale***
- **Prob and Tag rates → *tracking efficiency***
- **Flight distance → *prompt and decay J/Ψ from* Υ and B→ J/ψ + K**



Low Mass Resonances: $J/\Psi \rightarrow e^- e^+$





- ***Loose low mass cuts in electron selection criteria.***
- ***Challenging analysis: very promising preliminary results.***

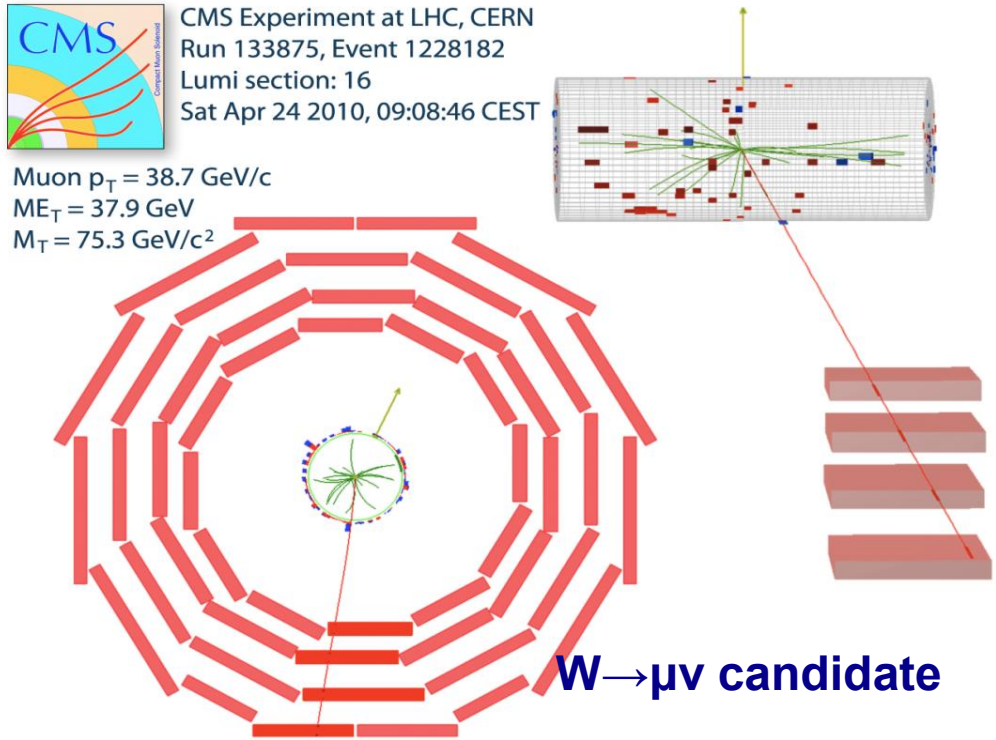
Observation of $W^{\pm}$ to Muon

Event selection:

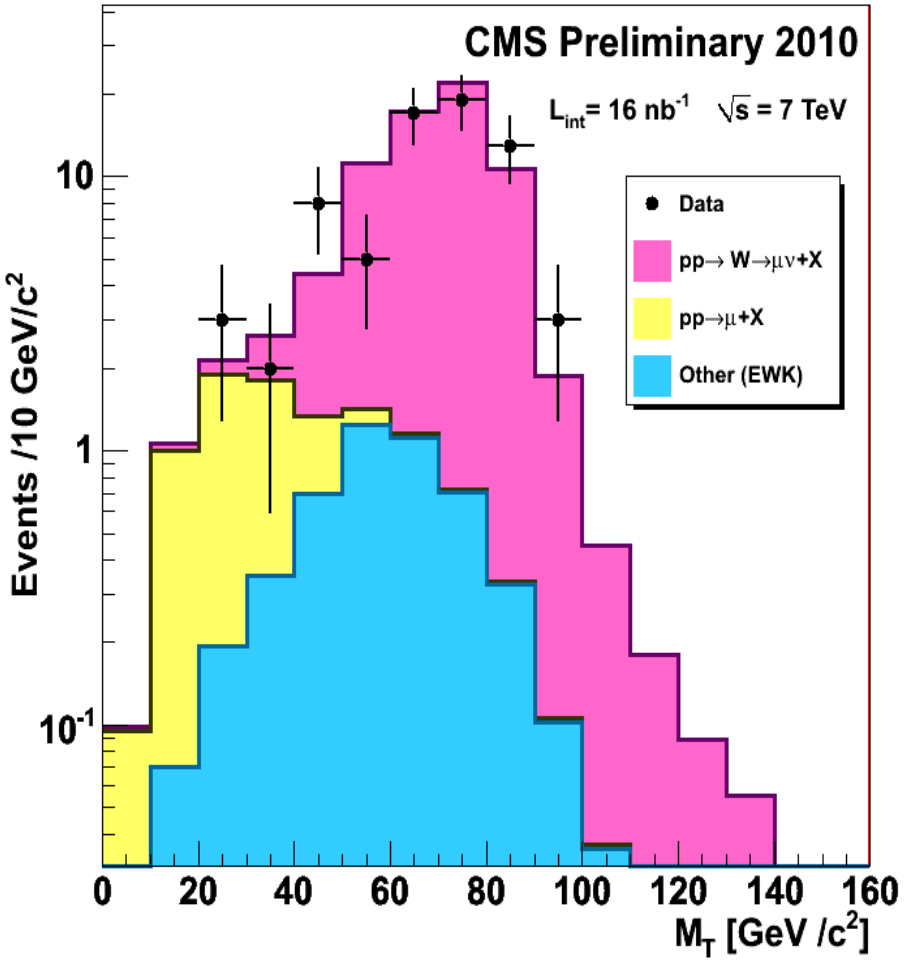
Muon id cuts (global and tracker muons), Isolation, p_T cut and MET

Monte Carlo:

cross section normalized to 16 nb^{-1} integrated luminosity



W→μν candidate



57 candidates with M_T > 50 GeV

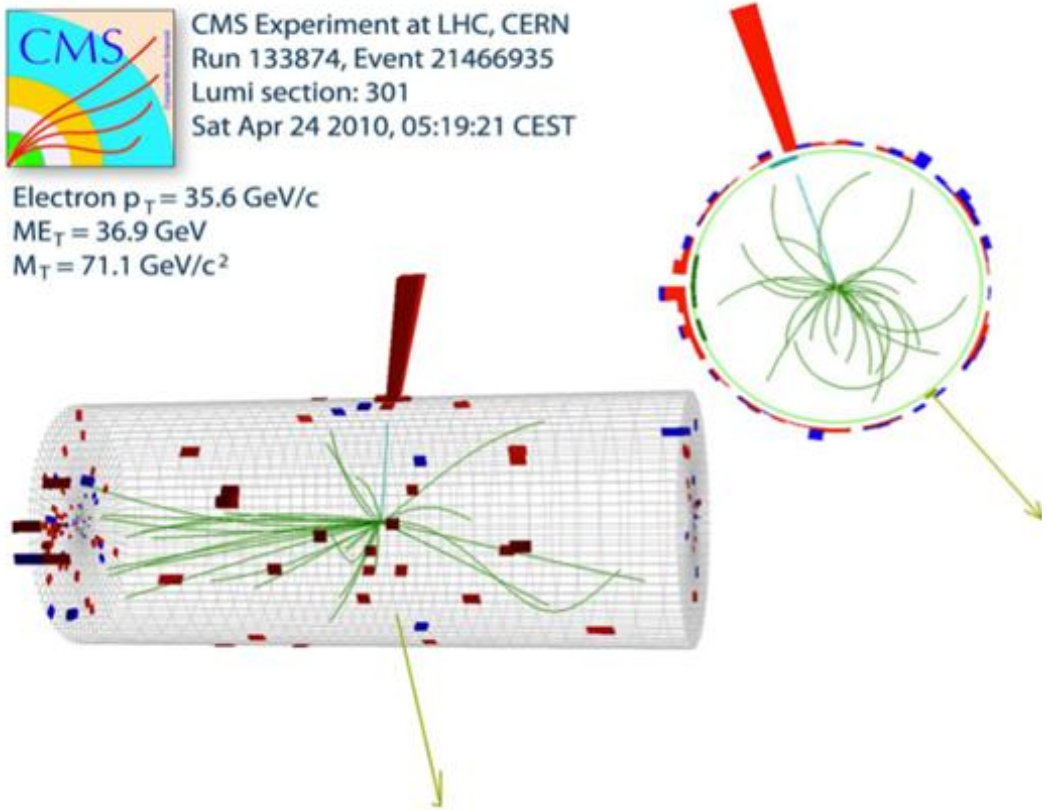
Observations of $W^{\pm}$ to Electron

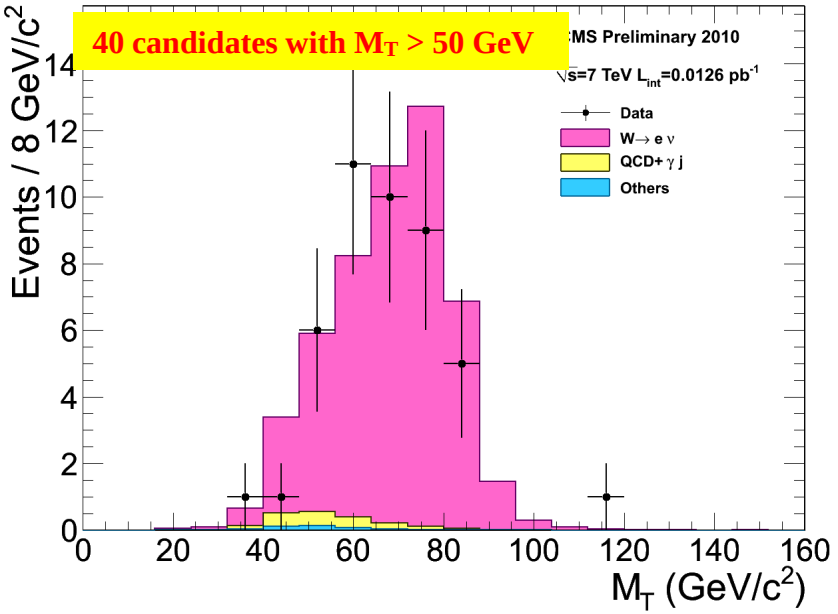
Two event selections:

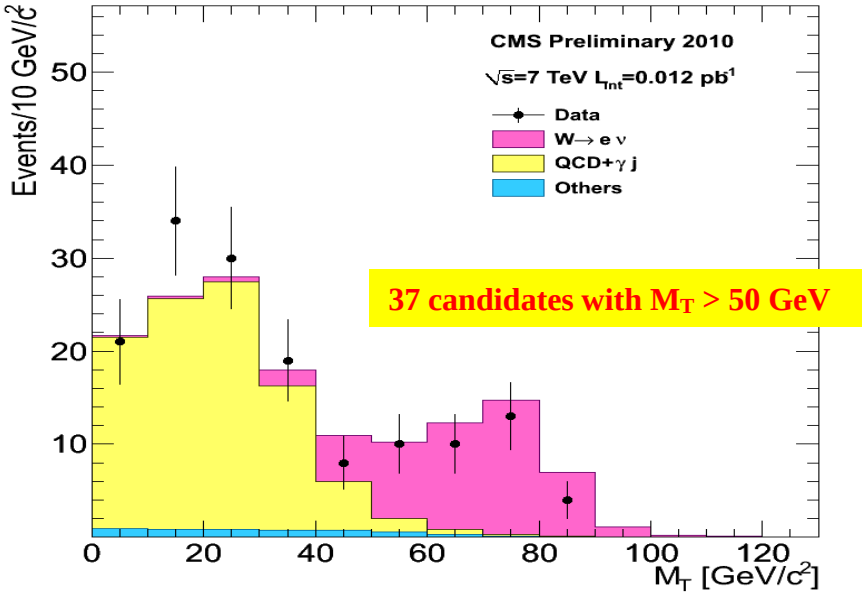
- ***more complex electron id, cuts on E_T, MET and ΣE_T***
- ***basic electron id and no MET cut***

Monte Carlo:

cross section normalized to 12 nb^{-1}







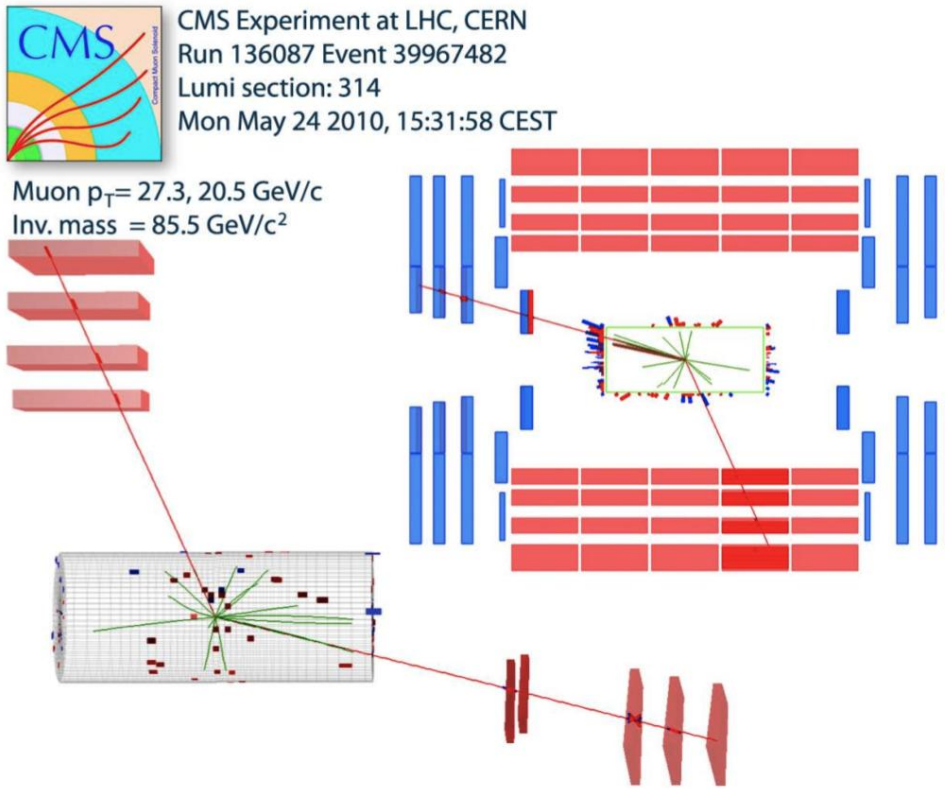
Observation of $Z^0 \rightarrow \mu^+\mu^-$

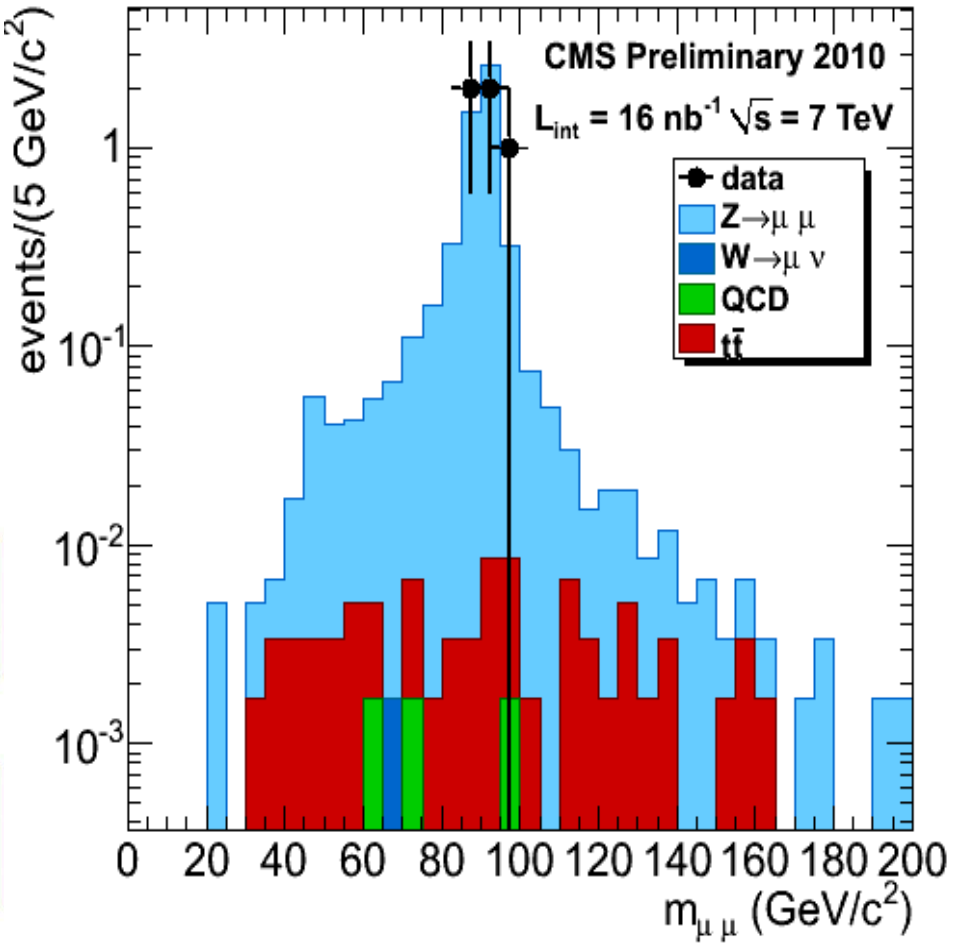
Event selection :

muon id selection (global and tracker muons) ; loose Isolation, pT cut.

Monte Carlo:

cross section normalized to 16 nb^{-1} integrated luminosity.





5 $Z^0 \rightarrow \mu^+\mu^-$ candidates

Observation of $Z^0 \rightarrow e^+e^-$

Event selection:

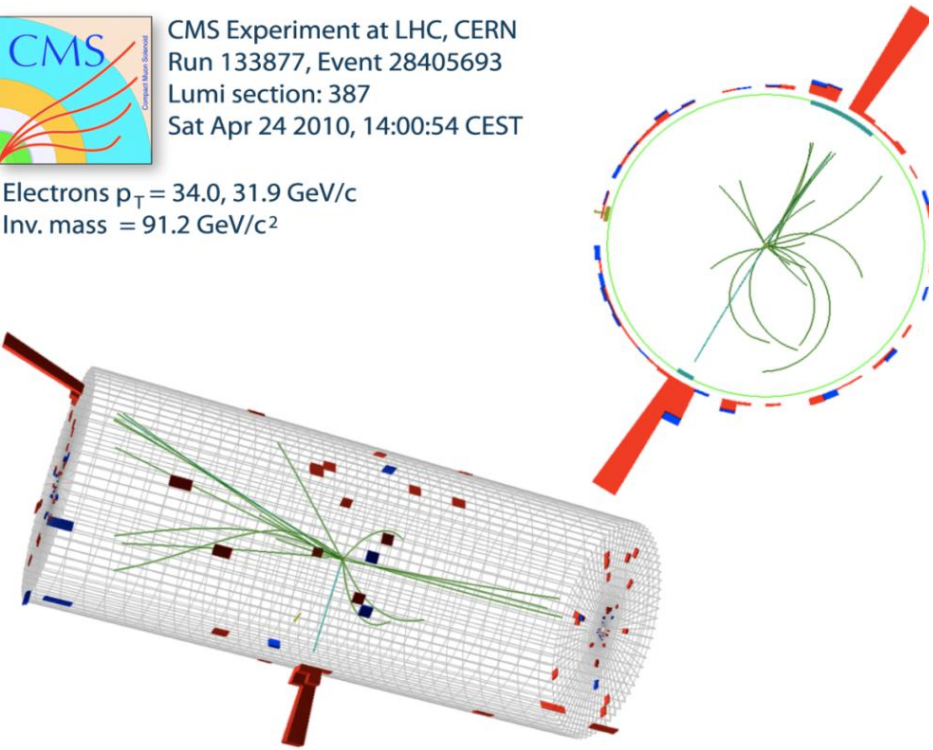
both electrons with a SuperCluster with Et > 20 GeV

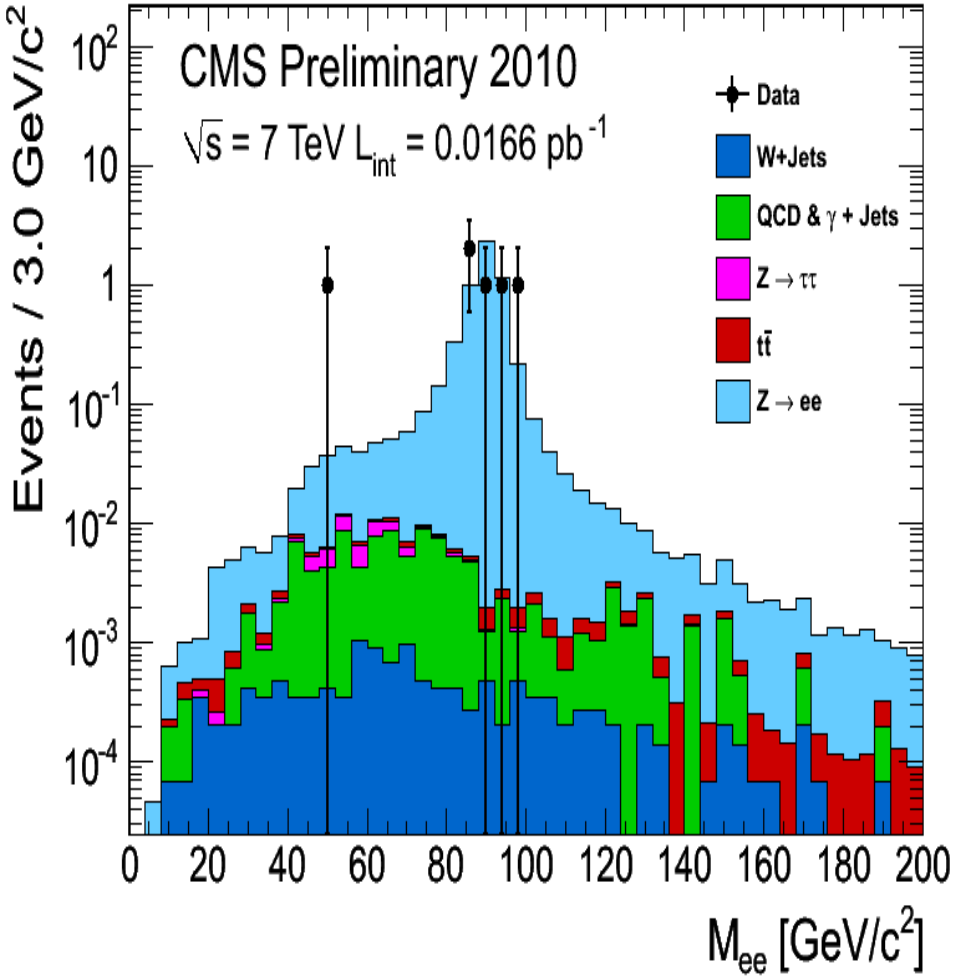
Monte Carlo:

cross section normalized to 17 nb^{-1} integrated luminosity

CMS Experiment at LHC, CERN
Run 133877, Event 28405693
Lumi section: 387
Sat Apr 24 2010, 14:00:54 CEST

Electrons p_T = 34.0, 31.9 GeV/c
Inv. mass = 91.2 GeV/c^2

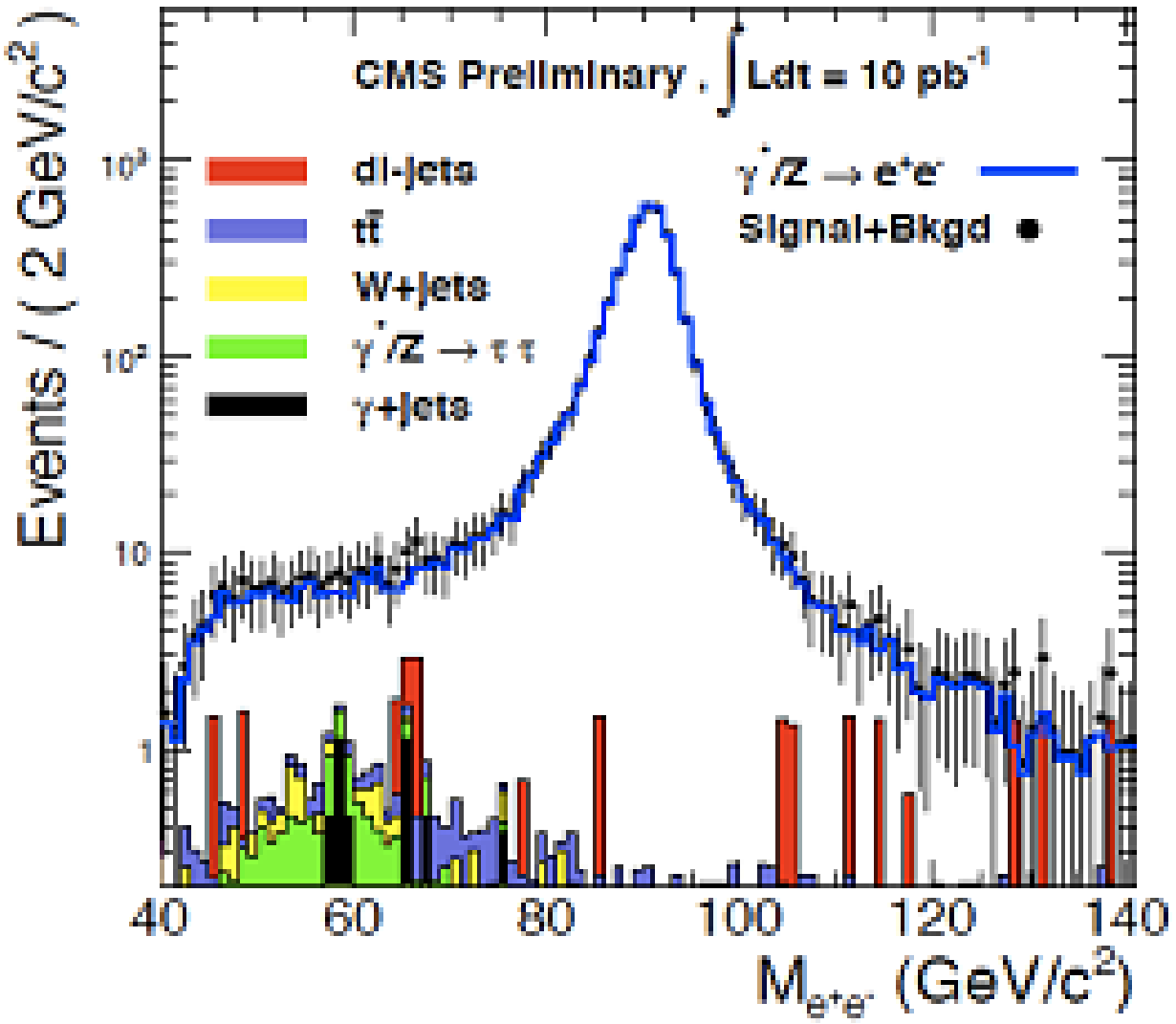




5 $Z^0 \rightarrow e^+e^-$ candidates

Z Decays into Lepton Pairs

MC data

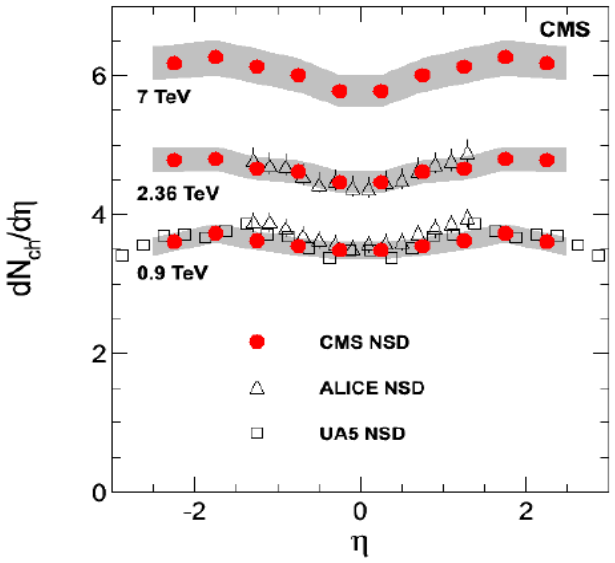


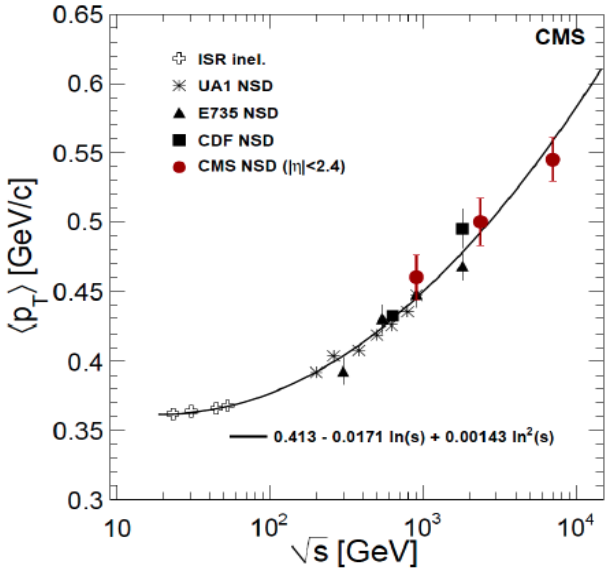
Use dilepton "tag and probe" method to extract data driven efficiencies for leptons – e.g. e trigger efficiency. Backgrounds are small so purity for clean tagging is very high.

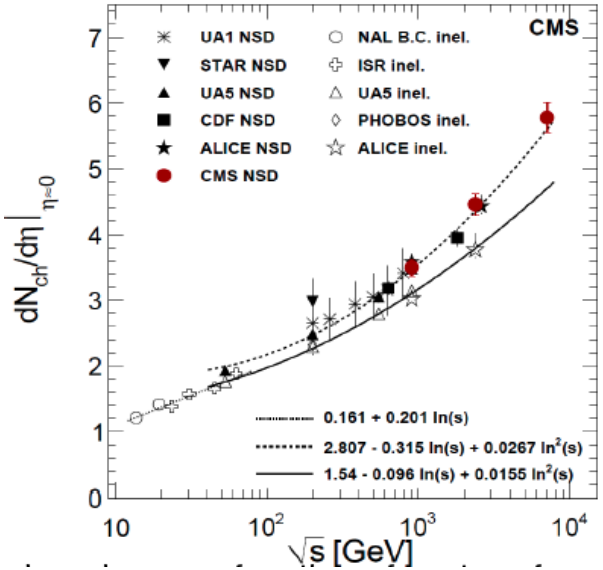
Then look in the high mass tail…. Z recurrence ?

First 7 TeV paper accepted a few days ago. It will appear in PRL on June 18.

"Transverse Momentum and Pseudorapidity Distributions of Charged Hadrons in pp Collisions at √s=7TeV"

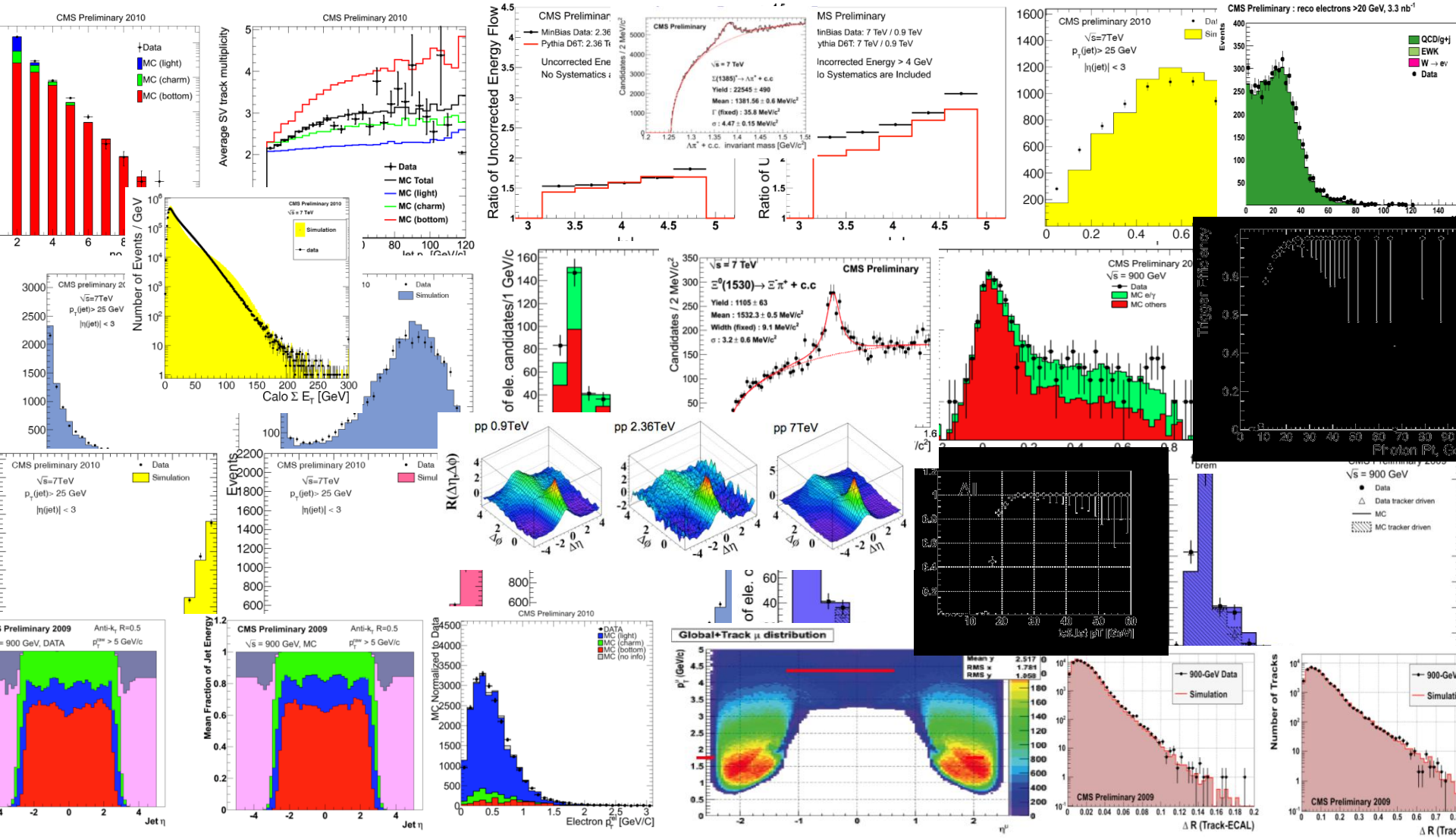






Rise of the particle density at (2.36) 7 TeV steeper than in model predictions. Careful tuning effort of the MC generators is ongoing.

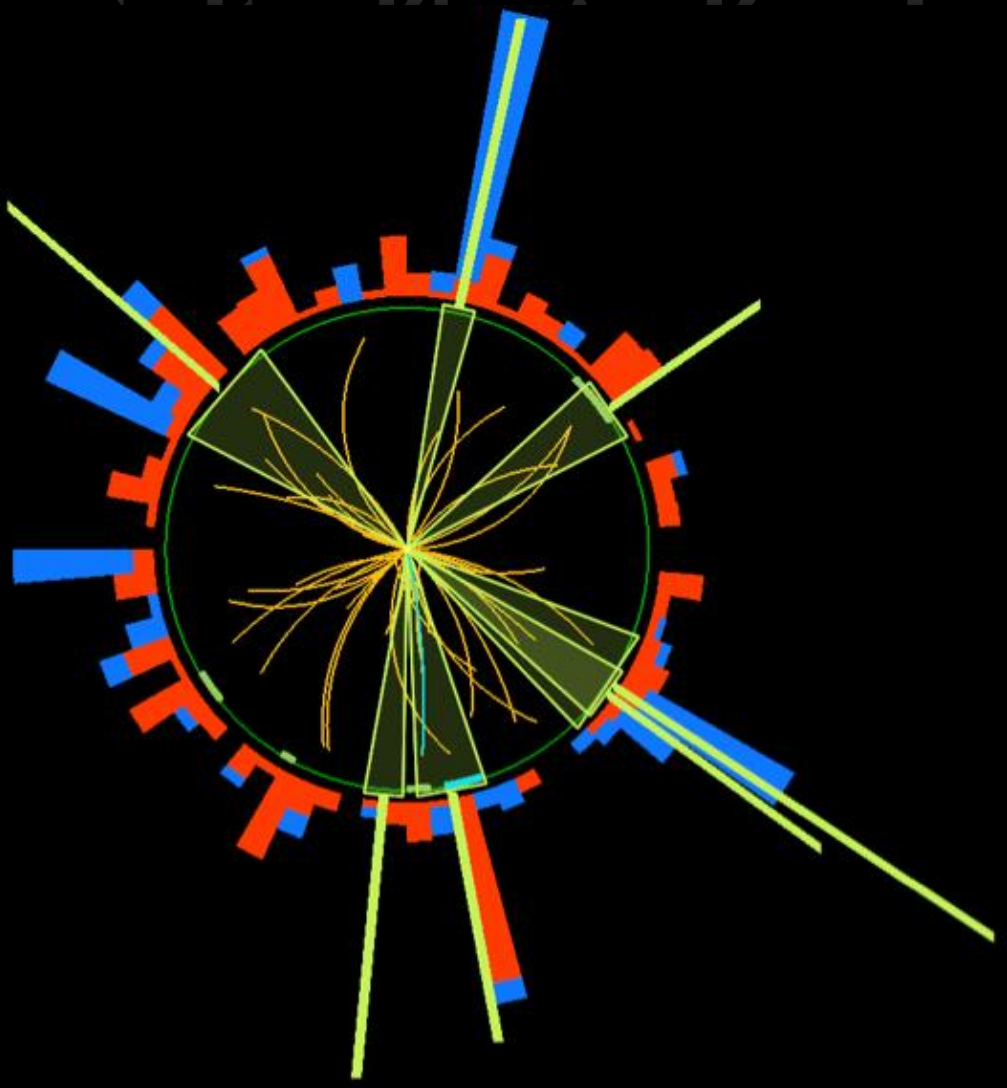
New results coming along…..



Prospects For Physics Run I

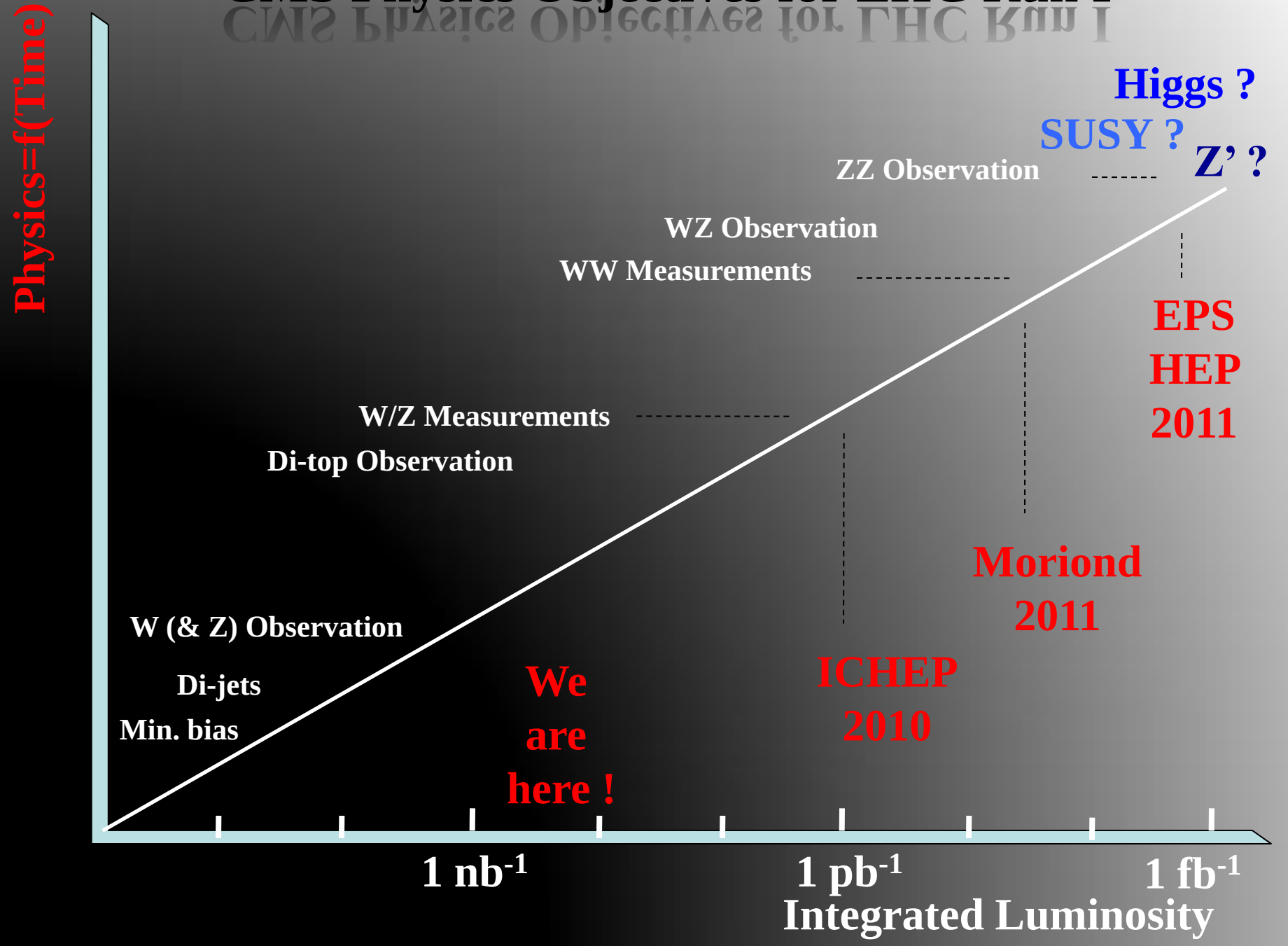
LHC
Physics Run I

$\sqrt{s} = 7$ TeV
$\mathcal{L} = 1$ fb^{-1}



Multi Jet Event at 7 TeV

CMS Physics Objectives for LHC Run I



Conclusions

- **CMS has profit from extensive Cosmic Data taking campaigns in 2008 and 2009 for detector commissioning.**

- **Data taking with LHC Pilot runs in December 2009 was a great success, with performances validated to expectations within hours, and extensive analyses performed within O(day)'s**

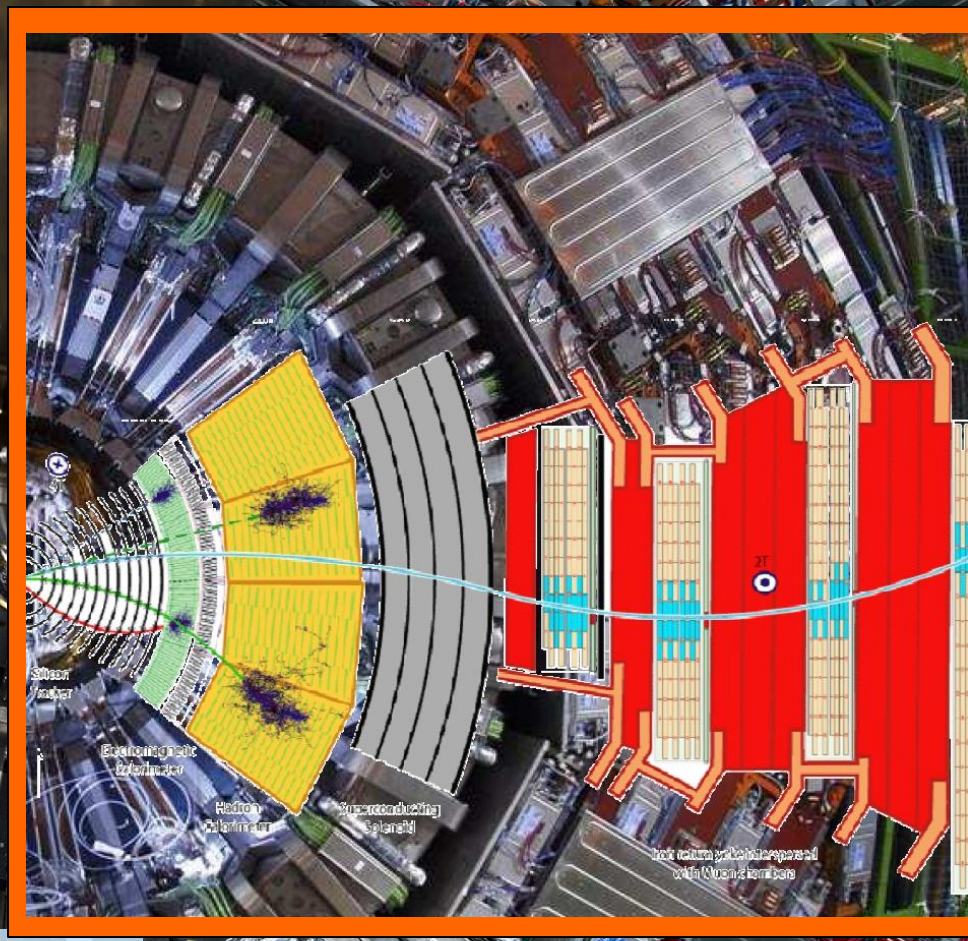
- **CMS has operated with high efficiency since the start of 7 TeV operations on March 30, 2010: recording 91% of the delivered luminosity and all subdetectors operating with an active channel fraction greater than 98%.**
  The detectors have been timed in to the LHC beam: L1 triggers have been deployed and high level trigger are actively selecting events for storage.

- **The experiment currently runs with LHC collisions at $\sqrt{s} = 7$ TeV and first EWK Boson candidates have been observed**

- **Physics papers are being published on LHC collisions data.**

- **Looking forward to the next step in luminosity from LHC, CMS prepare for the first SM physics measurements to be presented at ICHEP 2010.**

CMS talks



Additional information in:

- **Muon commissioning and exclusive B production at CMS with the first LHC data** by S.Taroni
- **Low mass di-muons at CMS** by T.N.Kypreos
- **Expectations for first measurement of t-tbar pair production using early CMS data** by C.LeBihan

A big draw: physicists portrayed by children

Two of the drawings of physicists produced by children involved in the "Dessine-moi un physicien" project run by CERN

Spares

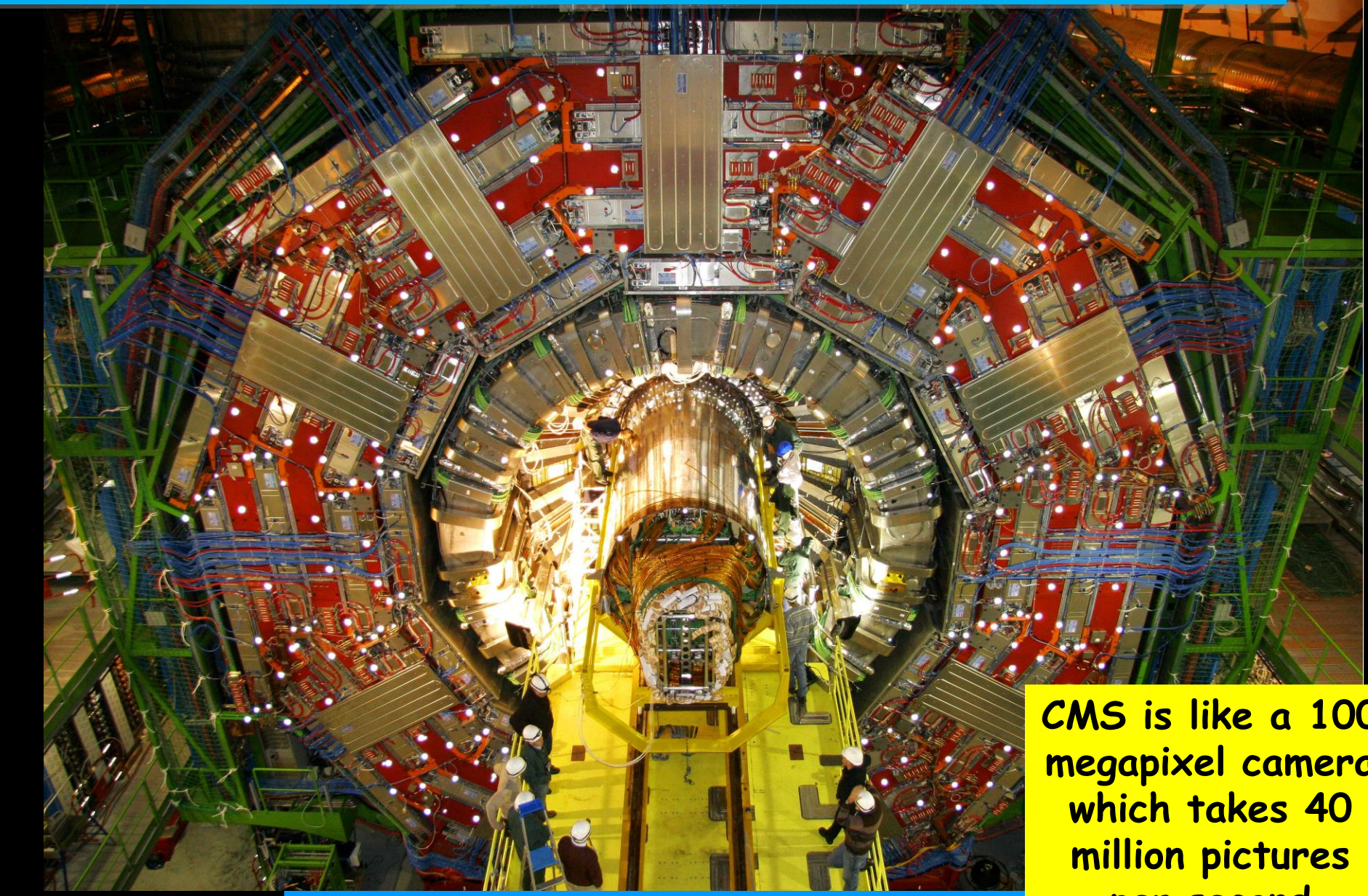
Early Physics Programme

- Detector commissioning – much already done using cosmics/testbeam,..
- Early beam: splash events, first collisions at injection energy, then at 7 TeV
  - Detector synchronization, alignment with beam-halo events, minimum-bias events. Earliest in-situ alignment and calibration
- Early beam - collisions, up to 10-20 pb^{-1} @ 7 TeV
  - Commission trigger, start "physics commissioning" – "rediscover SM":
    - Physics objects; measure jet and lepton rates; observe W, Z, top
    - And, of course, first look at possible extraordinary signatures…
- 7 TeV, up to 100 pb^{-1} measure Standard Model, start searches
  - Per pb^{-1}: 3000 $W \rightarrow l \nu$ ($l = e, \mu$); 300 $Z \rightarrow ll$ ($l = e, \mu$); 5 ttbar $\rightarrow \mu$+X
    - Improved understanding of physics objects; jet energy scale from $W \rightarrow j j'$; extensive use (and understanding) of b-tagging
    - Measure/understand backgrounds to SUSY and Higgs searches
  - Early look for excesses from SUSY & Z' resonances.
- Collisions at higher energy: extend searches;
  - Explore large part of SUSY and resonances at ~ few TeV
  - ~ 1000 pb^{-1} entering Higgs discovery era

CMS plan for 2010 & 2011

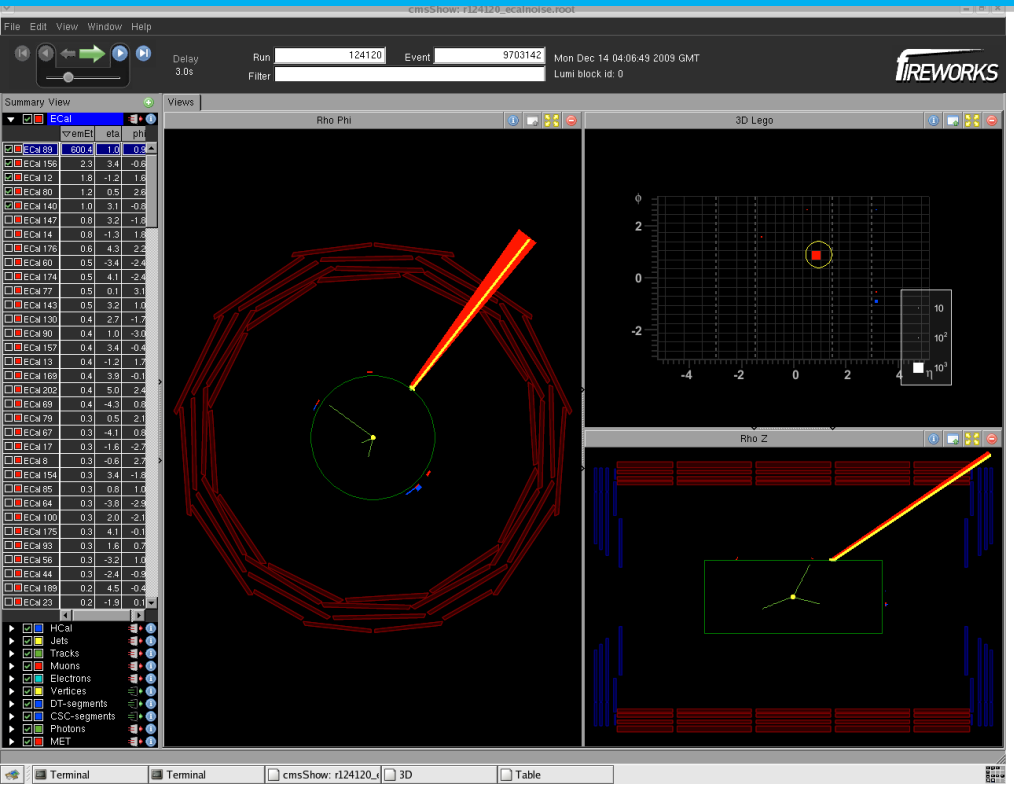
Integrated L	SM Object	SM Use	Search Strategy
mb^{-1} (1)	UE, MB	Tune MC	
ub^{-1} (10^3)	$K_s, \Lambda, \Xi, \Omega, \phi, K^*$ Jets, π^o, η Heavy flavor ψ, Υ	Align. dE/dx Calib, trigger valid, MET c, b tag leptons	
nb^{-1} (10^6)	W Z	Cross section, charge Mass scale, resolution	←
1 pb^{-1} (10^9)	Top pairs	Leptons + J + true MET	Black holes
10 pb^{-1}			Dijet M > 2 TeV HSCP, leptoquarks
100 pb^{-1} (2010)			M > TeV W' , Z' New range for SUSY
1000 pb^{-1} (2011) (10^{12})			SUSY – TeV mass scale Higgs @ 95% CL, (140,190) GeV

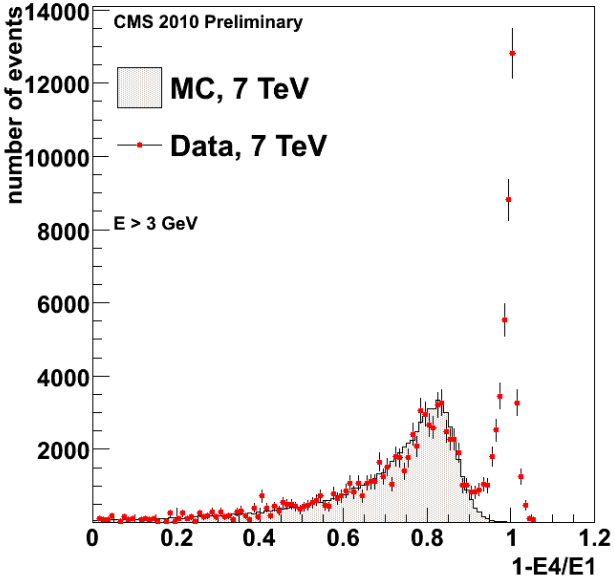
The CMS detector

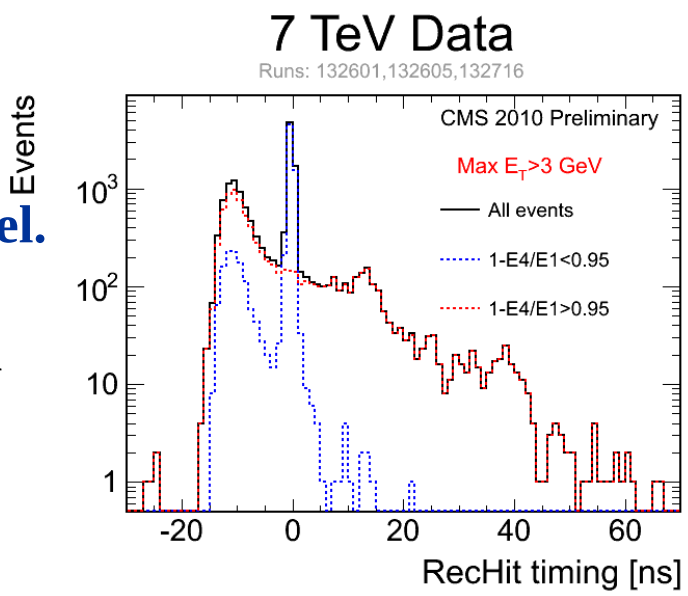


CMS is like a 100 megapixel camera which takes 40 million pictures per second

Anomalous signals in ECAL







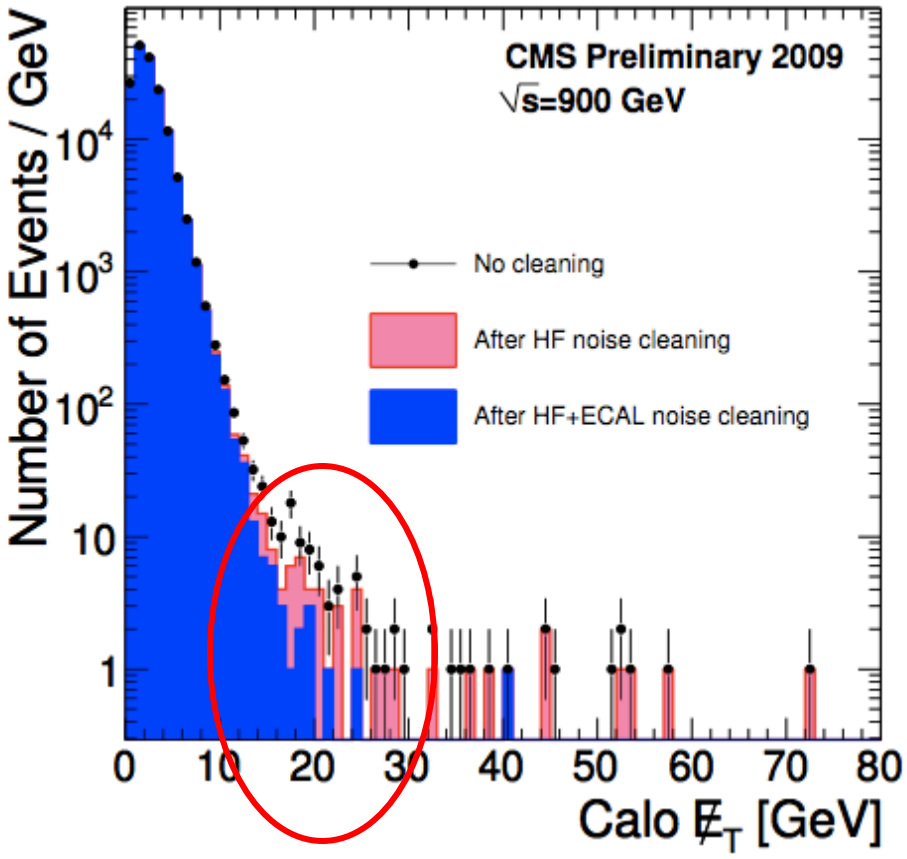
Large energy deposits in single crystals in barrel.

Barrel uses avalanche photodiodes (APD).

Origin: deposits by heavily ionizing particles in APDs.

Rate at √s=900GeV: 1 event per 10^3 minimum bias collisions.

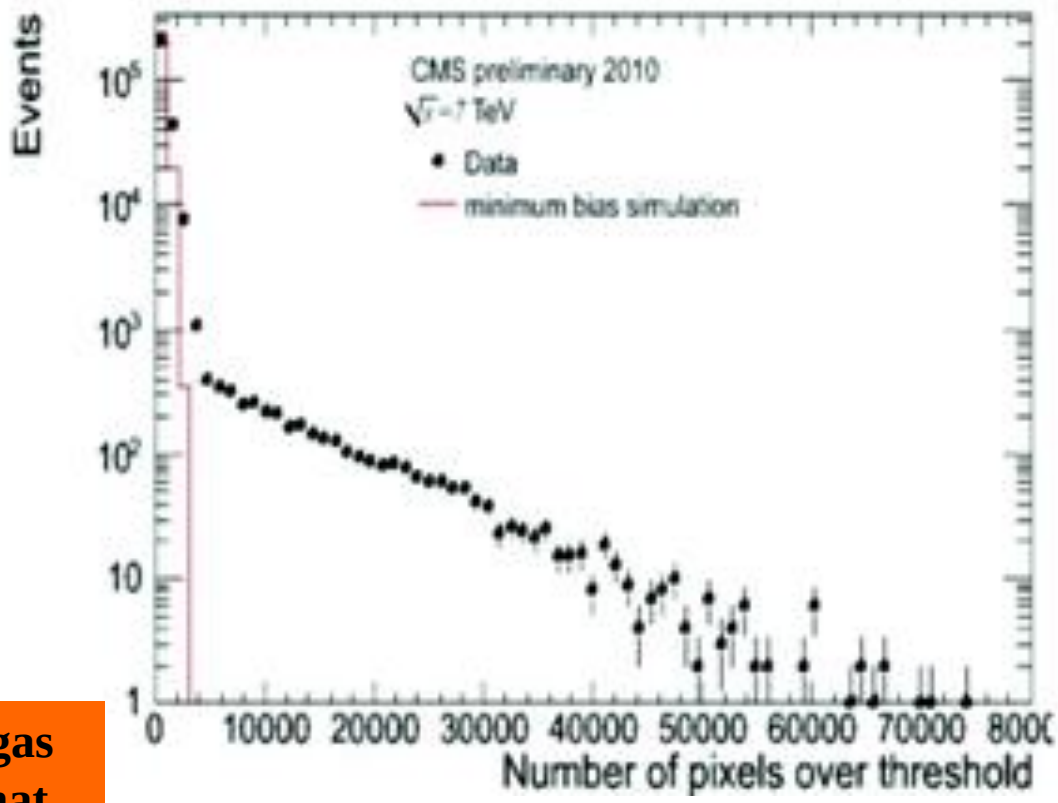
Clean-up of anomalous signals in ECAL



- **Missing ET is a good variable to show the effects of the noise clean-up.**
- **Only filters for HF and ECAL noise has been applied in these plots.**
- **Events in the tail are reduced.**
- **Detail studies to understand and filter noise are underway**
- **Take advantage of detector timing and topology selection.**

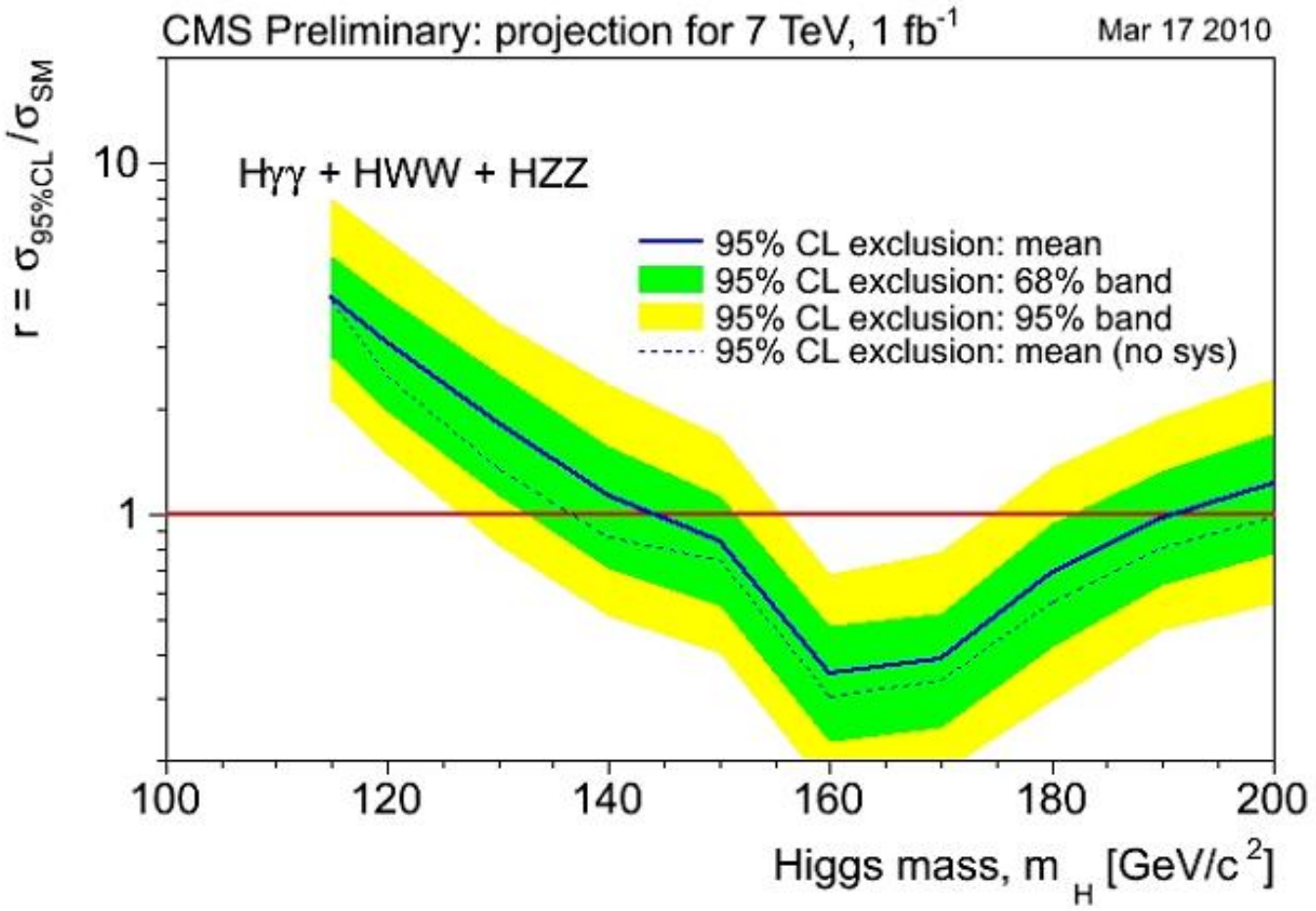
Beam Gas Interactions

Events with occupancy much larger than expected from minbias events seen in the pixel detector.
Tracks parallel to the barrel pixel modules – source along beam line.
Readout of these high occupancy events in the pixels takes long time.
Readout and recovery modified in frontend readout firmware.
The source of large pixel events is beam-gas interaction outside detector area.



Simulation of beam-gas interactions shows that the rate and radial distributions of particles are qualitatively in agreement with the observations.
More details in

CMS @ 7 TeV: reach for Higgs in 2011



In 2011 CMS will delve deeper into the > TeV mass range and begin to make contributions to the Higgs search.