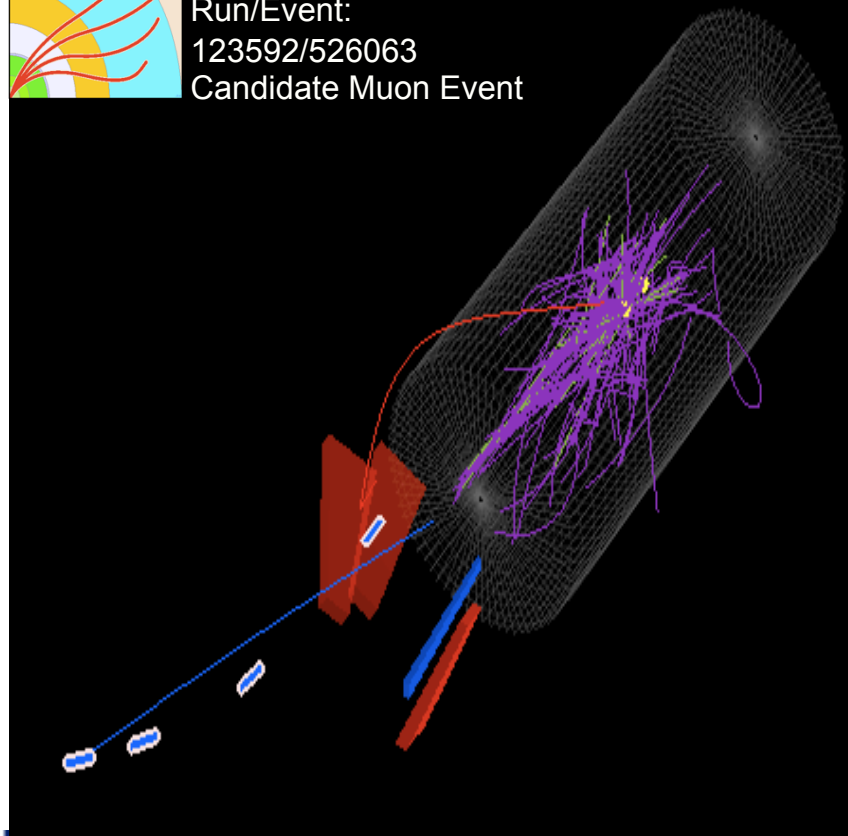


LHC Physics Challenges and the First Results



CMS Experiment at the LHC, CERN
Run/Event:
123592/526063
Candidate Muon Event

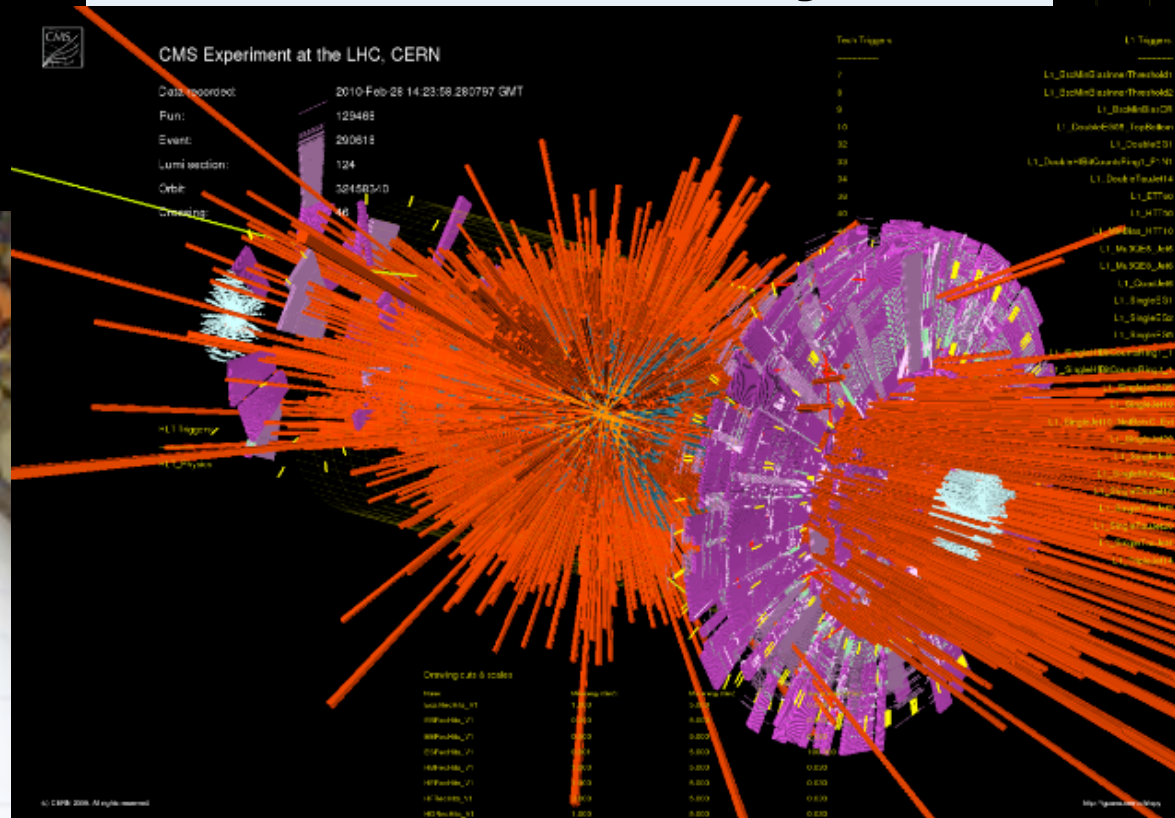
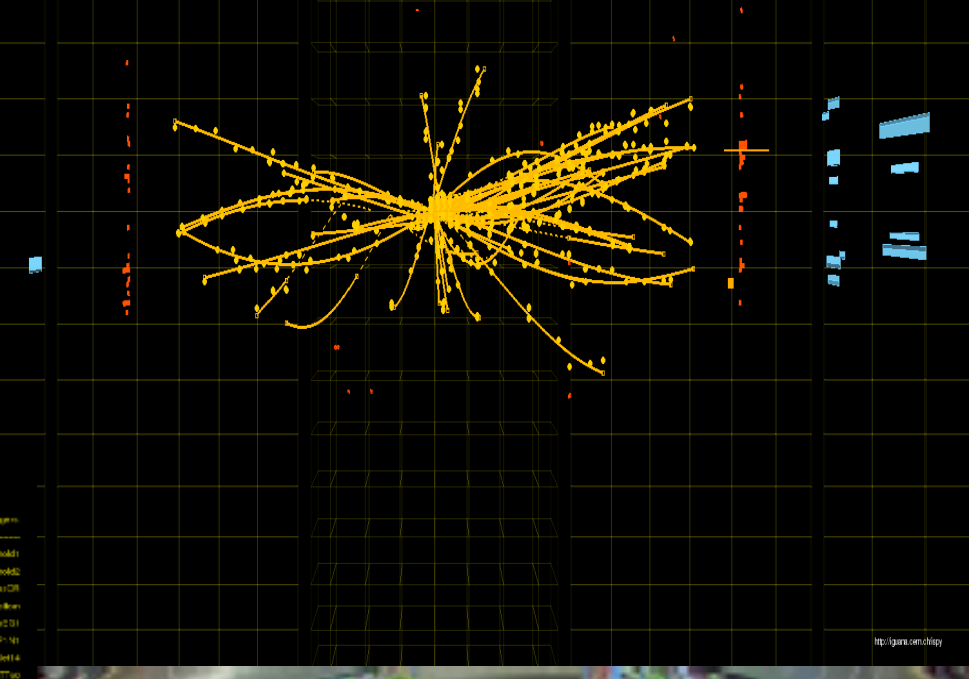


Slawek Tkaczyk
FNAL
Representing CMS/Atlas collaborations
LATTICE 2010
June 14-19, Villasimius, Sardinia, Italy



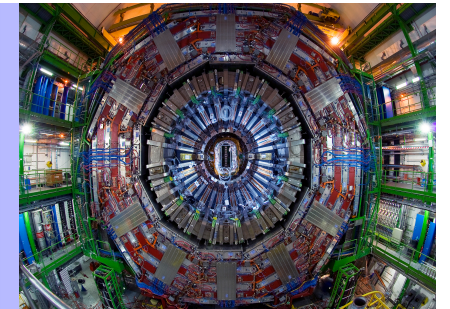
CMS Experiment at the LHC, CERN

Data recorded: 2009-Dec-06 04:14:38.495180 GMT
Run: 123592
Event: 2003169
Lumi section: 13
Orbit: 12844883
Crossing: 51





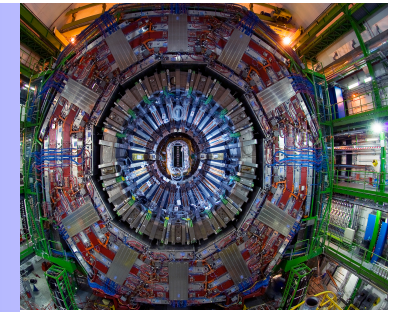
OUTLINE



- **Introduction**
 - **Machine Status**
- **From Commissioning to Operations and Analyses**
 - **First LHC beams**
 - **LHC Physics Run 2010 @7TeV**
- **Conclusions**



Physics Cruxes of Today



- How do particles acquire mass?
 - What is the origin of the spontaneous symmetry breaking?
 - Is the Universe super-symmetric?
 - What explains dark matter?
 - Are there extra dimensions?
-
- **IMPORTANT** unsolved questions need **POWERFUL** apparatus to look for answers!

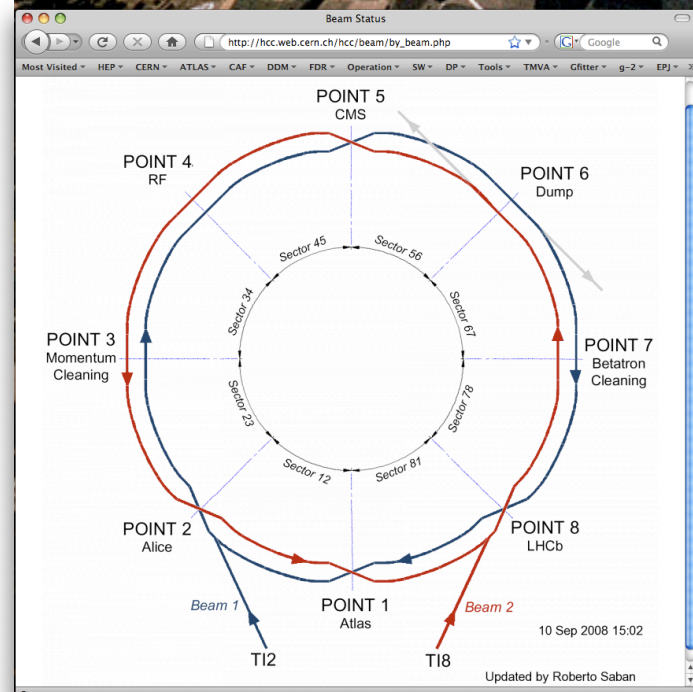


CERN LARGE HADRON COLLIDER

27 km circumference
1200 dipole magnets

- 14m long
- 8.4 T field
- Dual aperture

Proton-Proton collisions at 14 TeV
25ns between beam crossings
Peak Luminosity $10^{34} \text{s}^{-1} \text{cm}^{-2}$
20 collisions per beam crossing



CMS

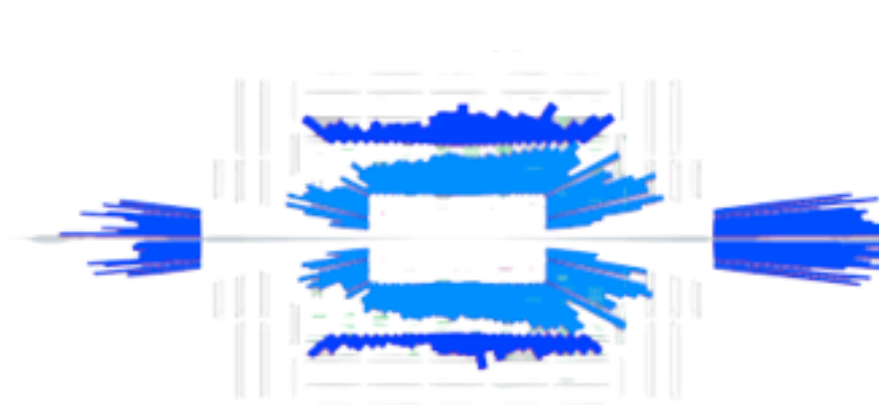
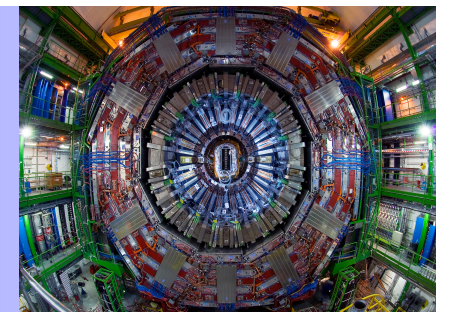
LHCb

ALICE

ATLAS



LHC First Beams Timeline



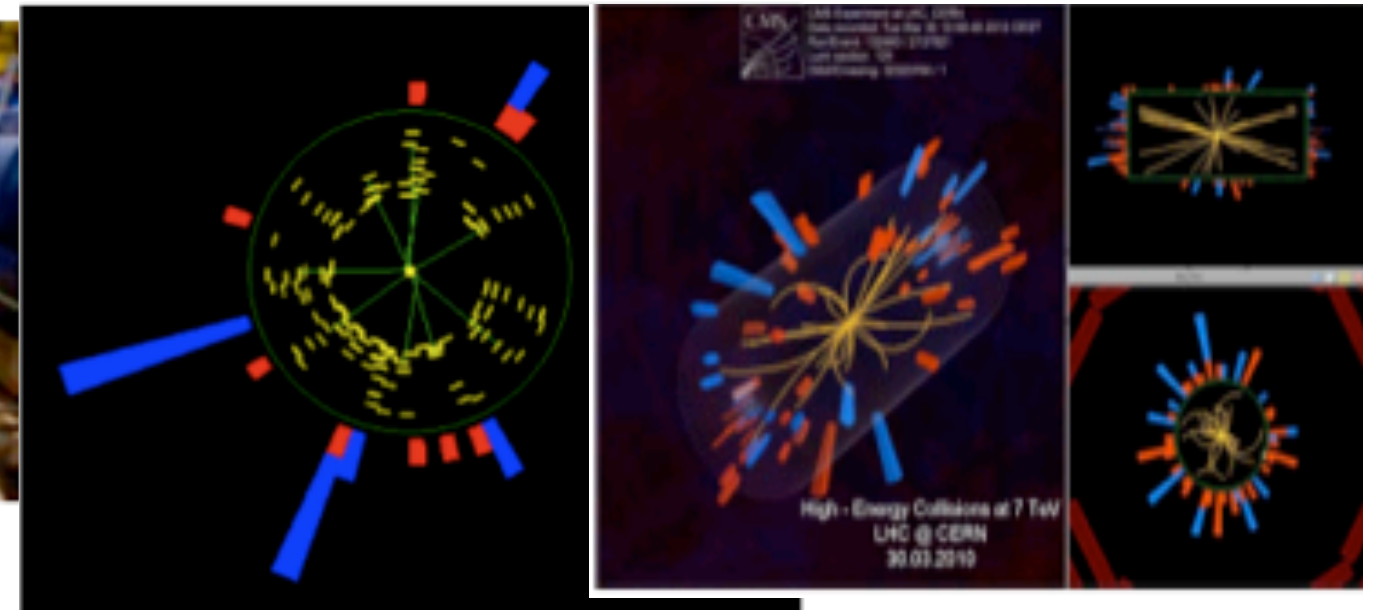
Sep 2008

First beam splashes



Jul 2009

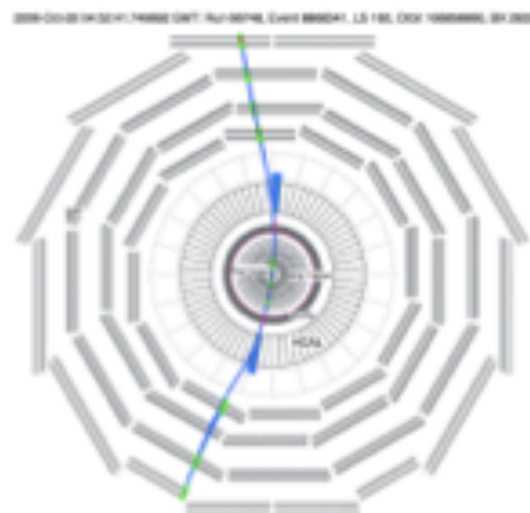
Repairs in the LHC finished



Dec 2009

First 0.9 & 2.36 TeV collisions

2008 Cosmic Data
@3.8T Field



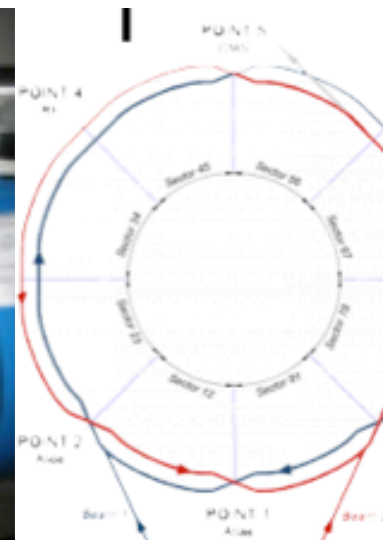
Sep 2008

Magnet incident, one year long LHC set back beams



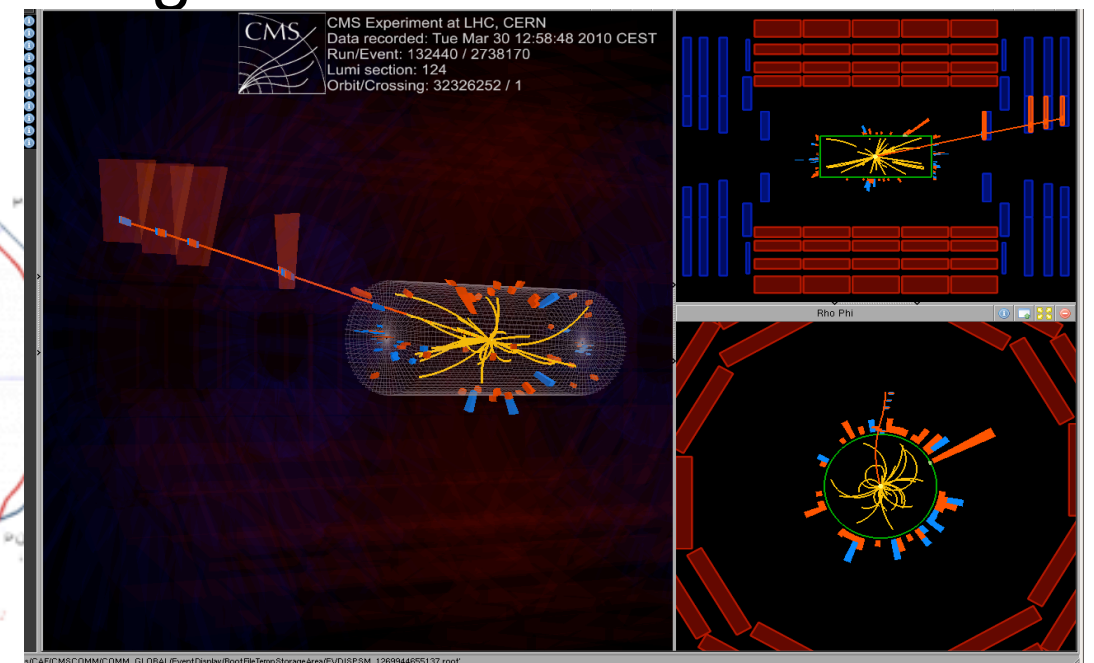
Nov 2009

Two circulating beams



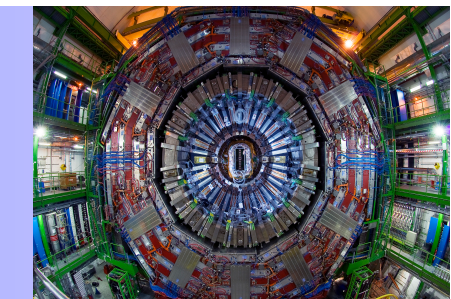
Mar 2010

7TeV collisions





A Couple of Good Weekends

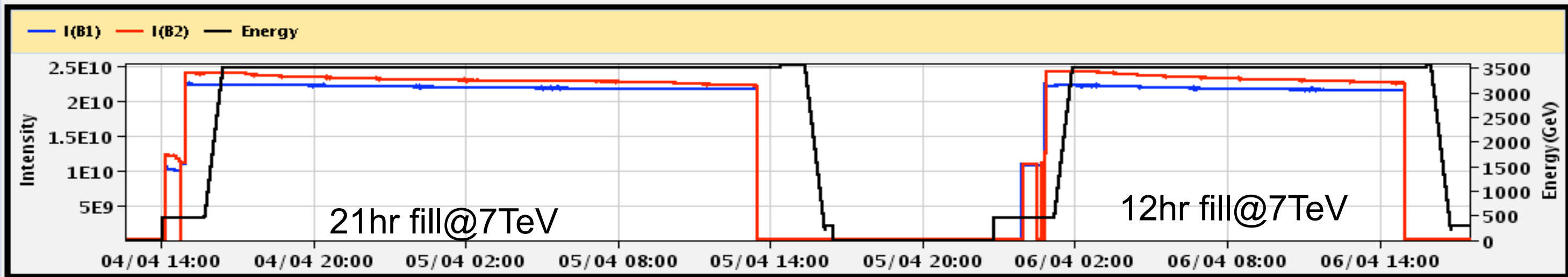


06-Apr-2010 17:27:13 Fill #: 1023 Energy: 297.4 GeV I(B1): 1.55e+08 I(B2): 7.01e+07

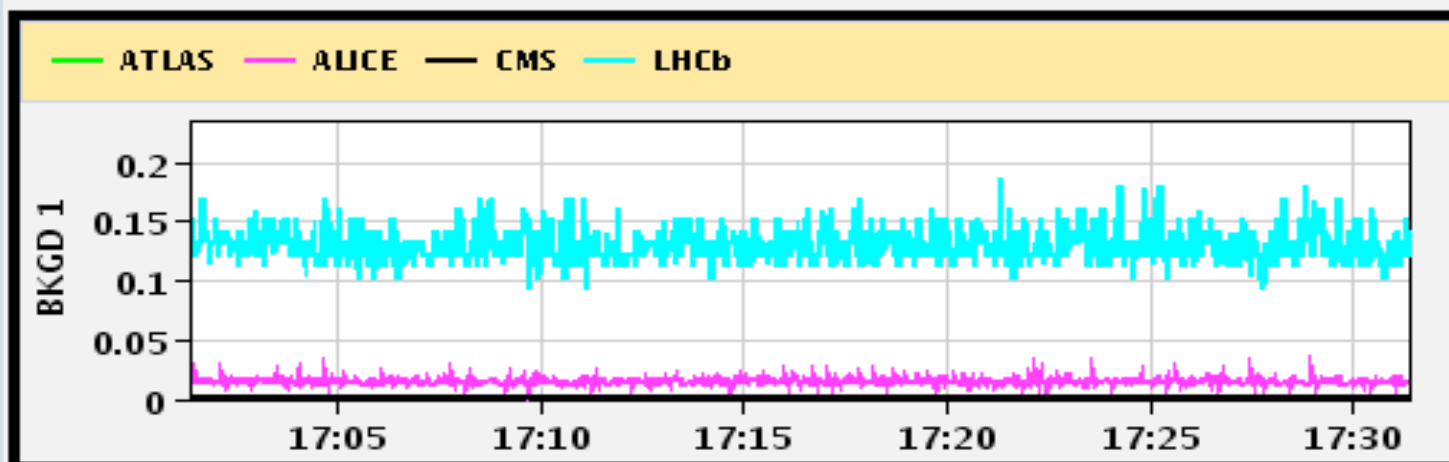
	ATLAS	ALICE	CMS	LHCb
Experiment Status	STANDBY	NOT READY	STANDBY	STANDBY
Instantaneous Luminosity	0.000e+00	0.000e+00	0.000e+00	8.989e-04
BRAN Count Rate	3.229e-07	4.059e-32	2.086e-11	1.635e-32
BKGD 1	0.002	0.014	0.002	0.131
BKGD 2	0.000	0.000	0.002	0.002
BKGD 3	0.000	0.005	0.003	0.037

LHCf **STANDBY** Count(Hz): 0.000 | LHCb VELO Position **OUT** Gap: 58.0 mm | TOTEM: **CALIBRATION**

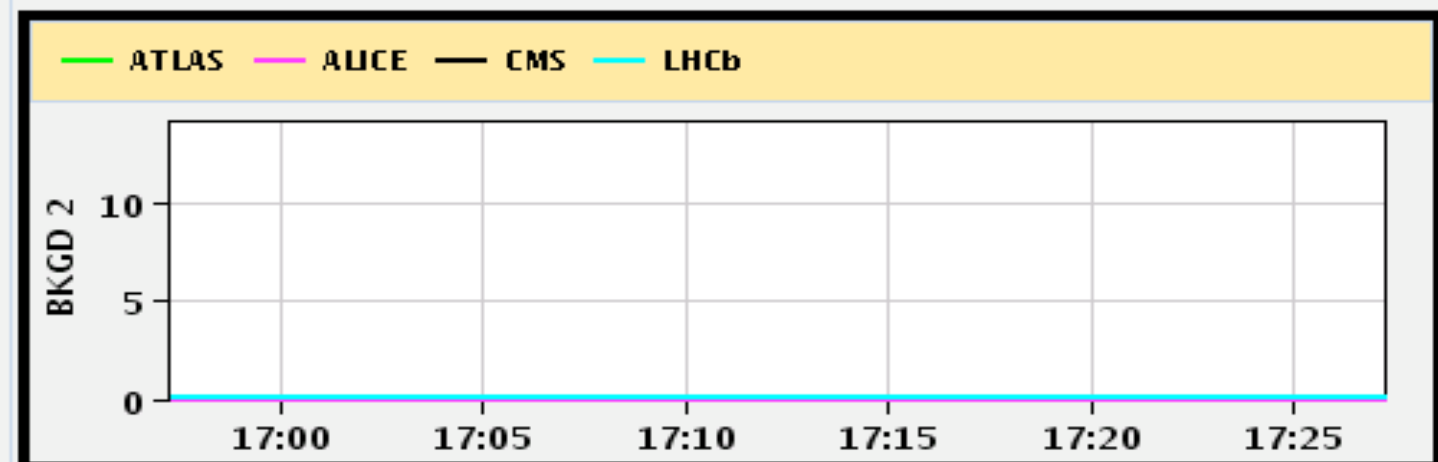
Performance over the last 12 Hrs



Background 1

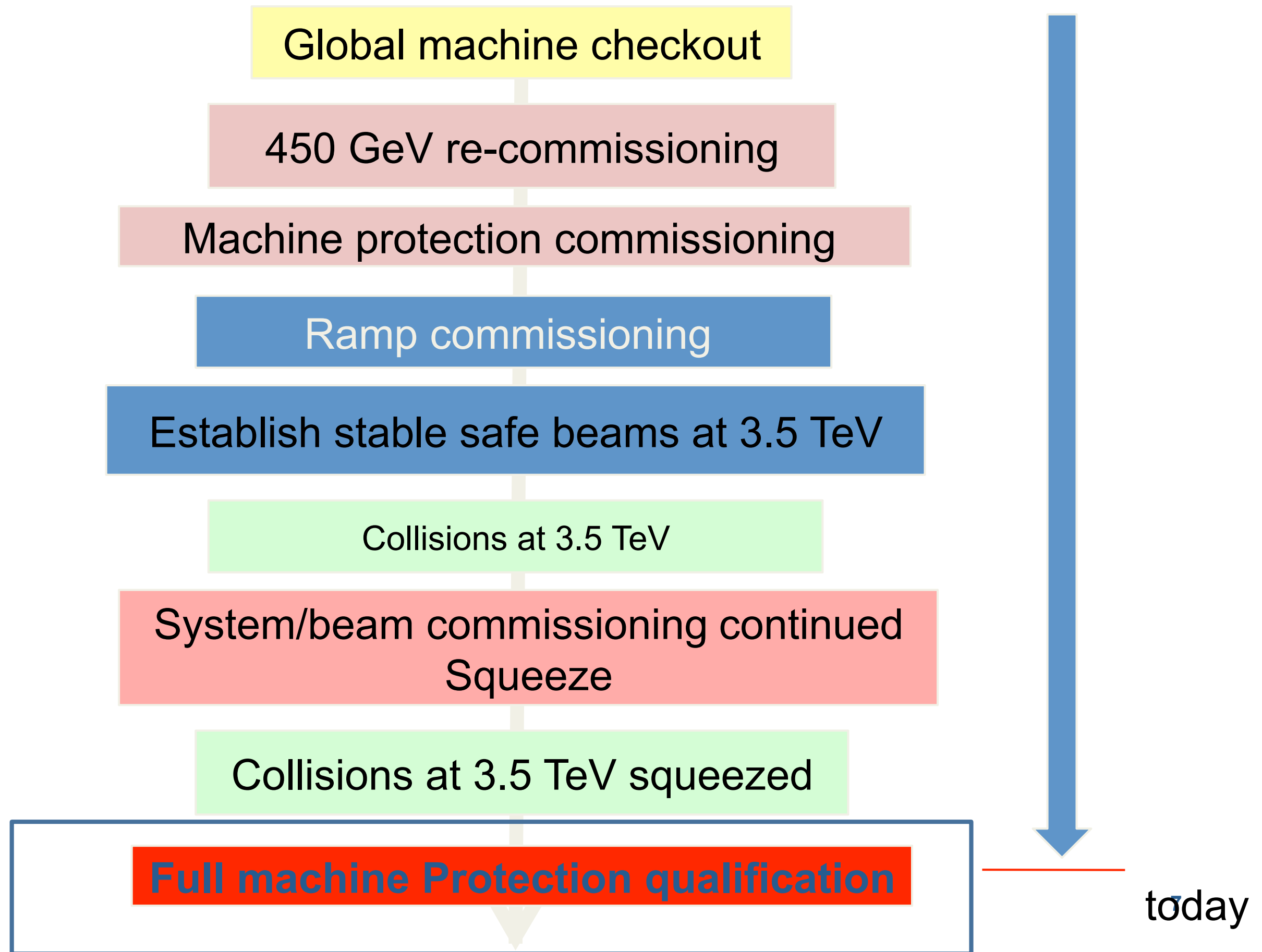
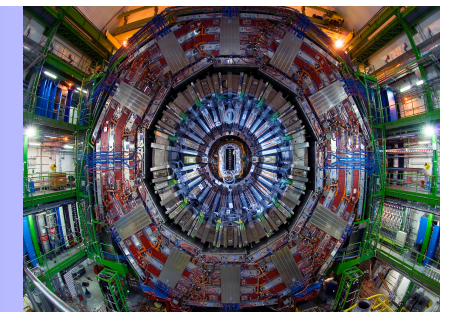


Background 2





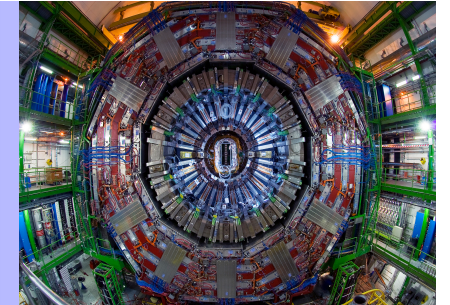
Beam Commissioning in 2010



Finish This!!



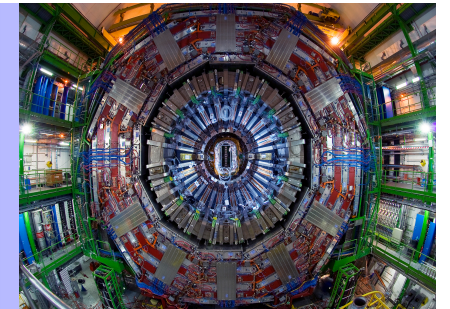
LHC Status



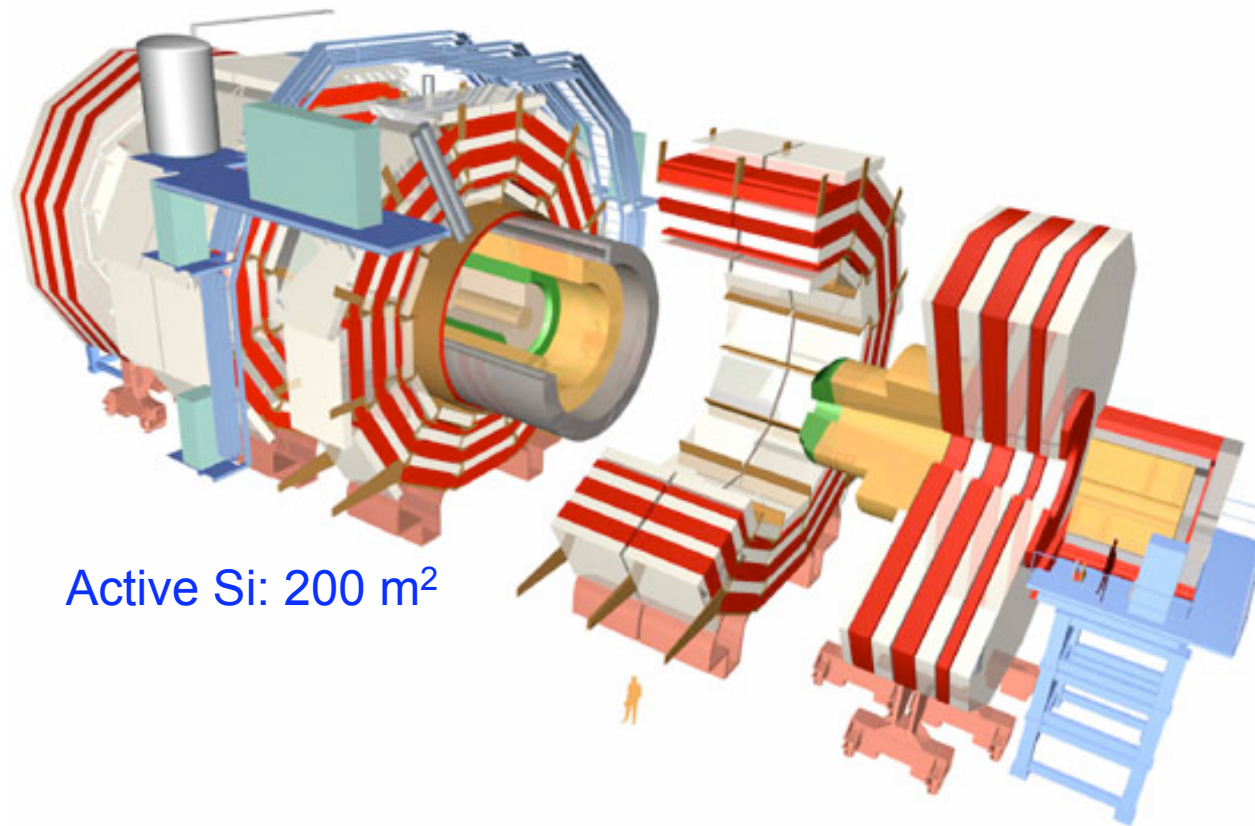
- **Remarkable knowledge of the LHC magnet model**
 - A key to successful commissioning with beams
 - Tunes, energy matching, optics close to the LHC model
- **Bunch intensities: 1.1E11 with excellent emittance**
- **Ramp&squeeze for physics @3.5TeV at higher intensities**
- **Machine protection super critical element**
- **Goal: delivery of 1fb⁻¹ to the experiments by the end 2011**
 - 2010 Target: 3.5TeV, $\beta^*=2\text{m}$, with/w-out crossing angle
 - 2011 Target: 3.5TeV, $\beta^*=2\text{m}$, with crossing angle
- **Flat out running at 1-2x10³²cm⁻²s⁻¹ in 2011**
 - Correspond to 8E10 ppb, 700 bunches, with a stored energy of 35 MJ (with $\beta^*=2$ m and nominal emittance).



LHC Experiments

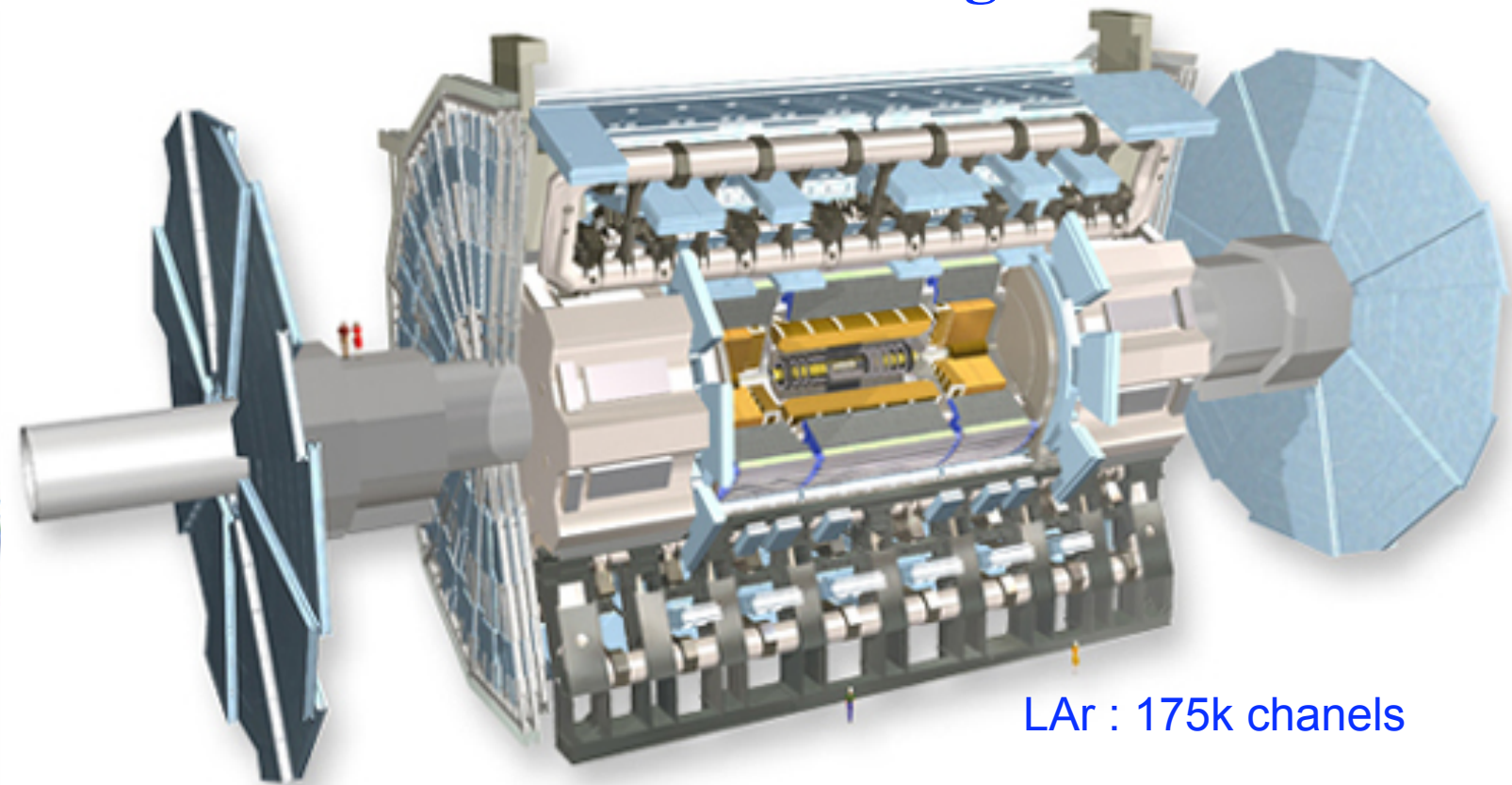


CMS - compact



Active Si: 200 m²

ATLAS - Huge



LAr : 175k chanel

Tracking: $|\eta| < 2.5$, $B = 3.8T$

- Si pixels and strips

Calorimetry: $|\eta|^{\text{em}} < 2.5$ $|\eta|^{\text{had}} < 5$

- EM: homogeneous PbWO_4 crystals
- HAD: Cu-Zn/scint. + Fe/Quartz

Muon Spectrometer: $|\eta| < 2.7$

- Solenoid return yoke instrumented

Tracking: $|\eta| < 2.5$, $B = 2T$

- Si pixels and strips
- Transition radiation detector

Calorimetry: $|\eta| < 5$

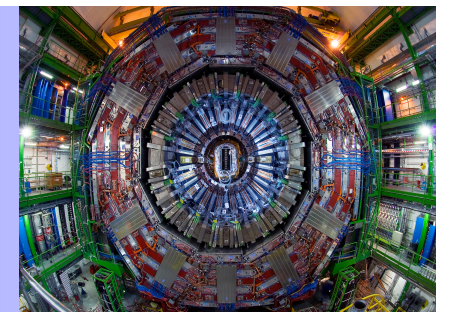
- EM: sampling; Pb/LAr accordion
- HAD: Sampling Fe/scint. + Cu-W/LAr

Muon Spectrometer: $|\eta| < 2.7$

- Air-core toroids with muon chambers

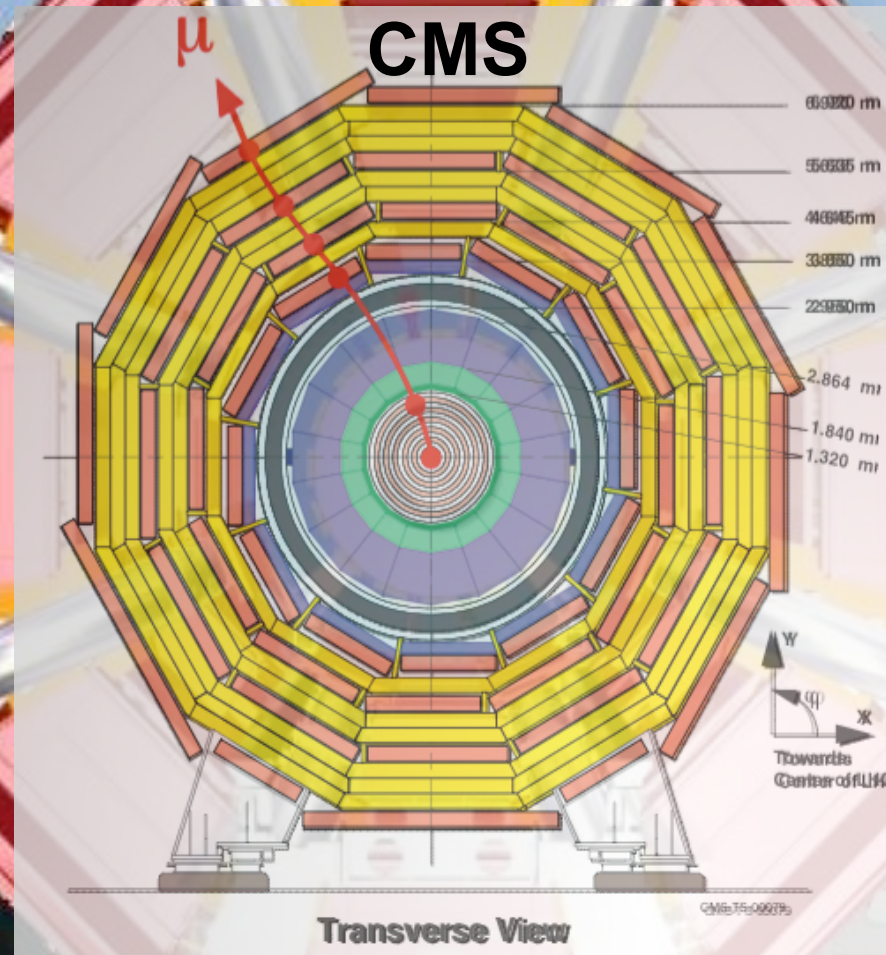
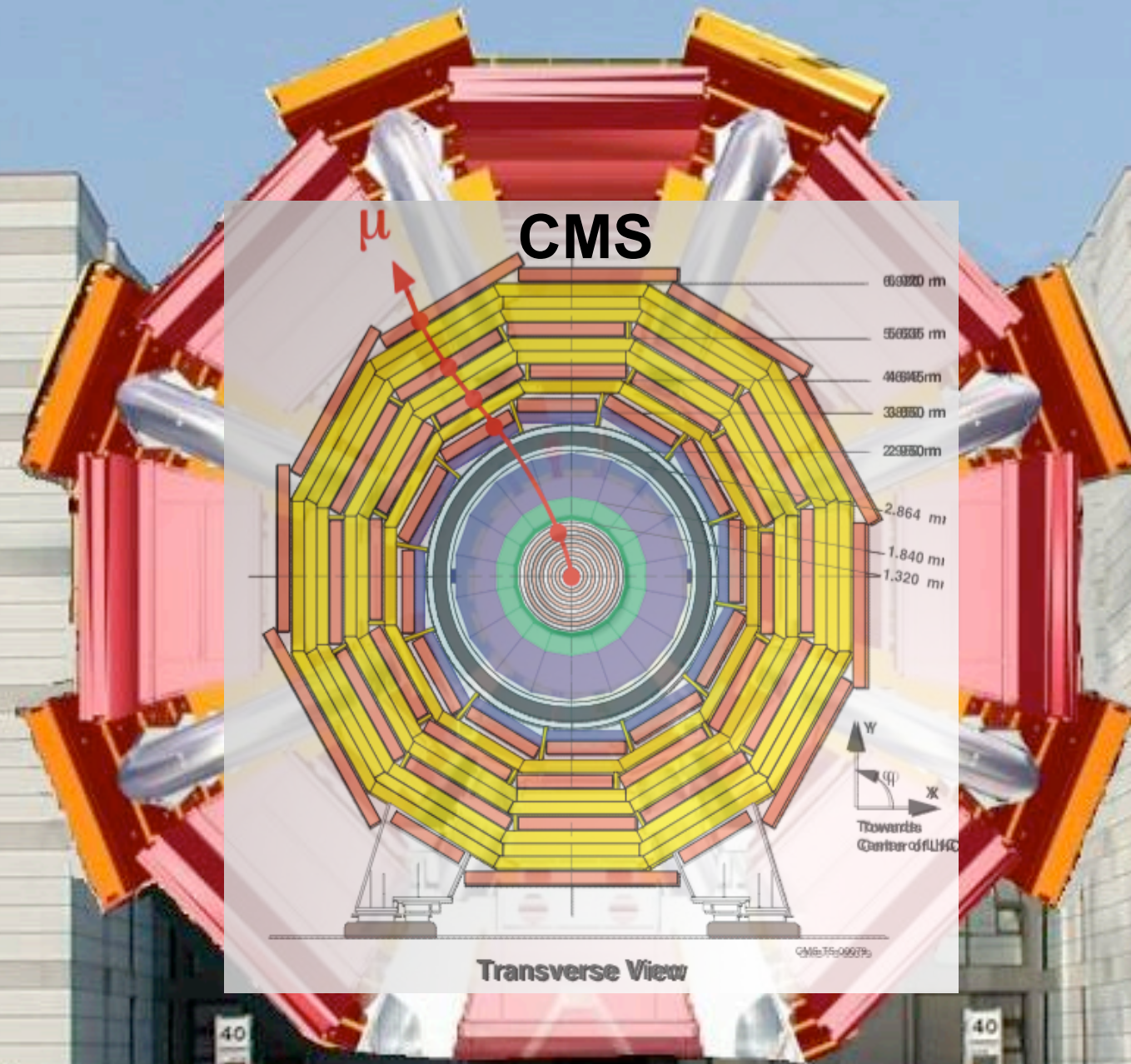


LHC Experiments



BLDG 40

ATLAS



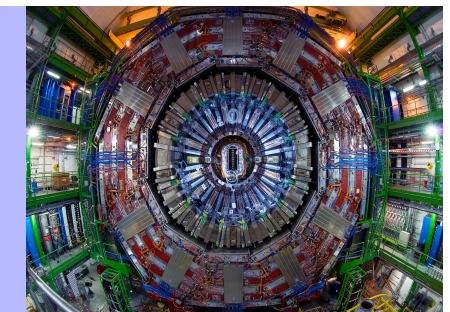
CDF





Aerial view of CMS Site@P5 - 1998

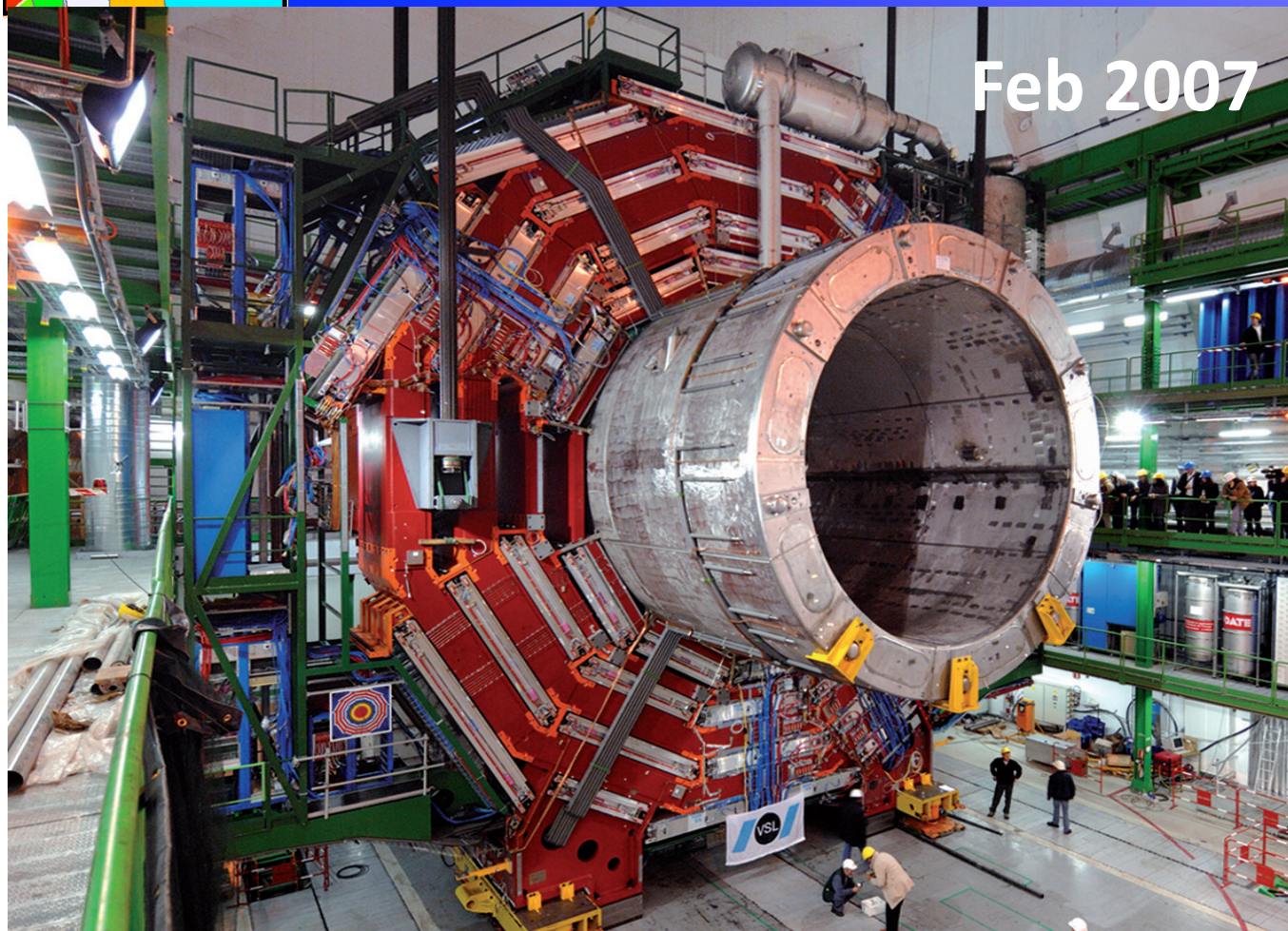
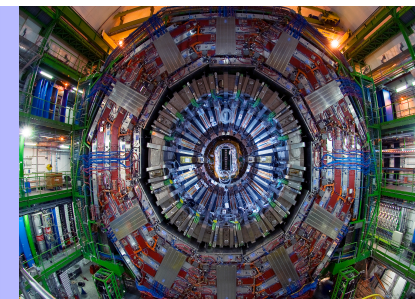
Gallo Roman vestiges



Point 5 -Excavation commencement of PM54 shaft - July 09, 1999 - CERN ST-CE

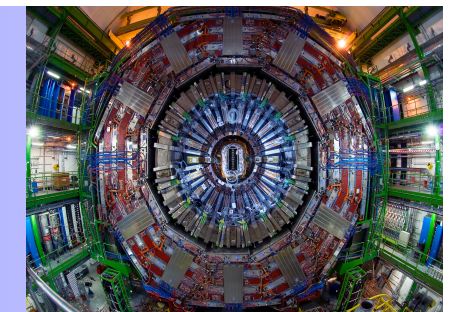


CMS Closed 3rd Sep 2008



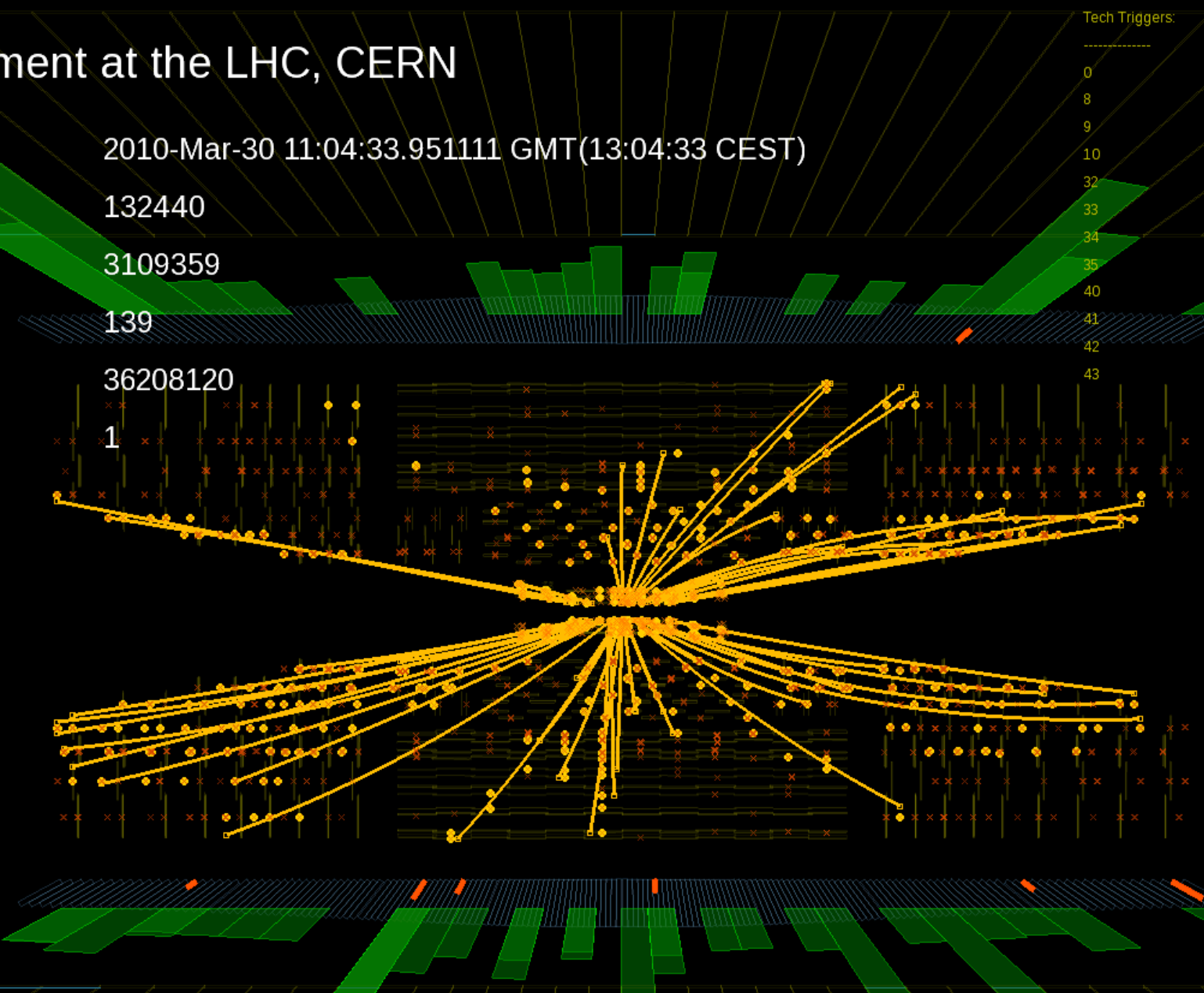


30 March 2010 – First 7 TeV Collisions



CMS Experiment at the LHC, CERN

Data recorded: 2010-Mar-30 11:04:33.951111 GMT(13:04:33 CEST)
 Run: 132440
 Event: 3109359
 Lumi section: 139
 Orbit: 36208120
 Crossing: 1



Tech Triggers:
 0
 8
 9
 10
 32
 33
 34
 35
 40
 41
 42
 43

L1 Triggers:
 L1_BptxMinus
 L1_BptxPlus
 L1_BptxPlusORMinus
 L1_Bsc2Minus_BptxMinus
 L1_Bsc2Plus_BptxPlus
 L1_BscHighMultiplicity
 L1_BscMinBiasInnerThreshold1
 L1_BscMinBiasInnerThreshold2
 L1_BscMinBiasOR
 L1_BscMinBiasOR_BptxPlusORMinus
 L1_MinBias_HTT10
 L1_SingleForJet2
 L1_SingleHitCountsRing1_1
 L1_SingleTauJet2
 L1_SingleTauJet4
 L1_ZeroBias_Ext

HLT Triggers:

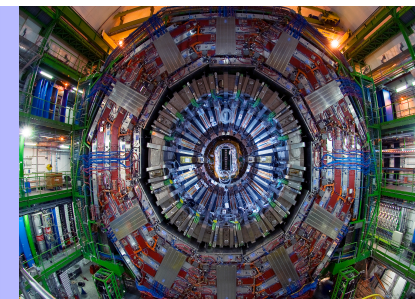
 HLT_Activity_PixelClusters
 HLT_L1SingleForJet
 HLT_L1SingleForJet_NoBPTX
 HLT_L1SingleTauJet
 HLT_L1SingleTauJet_NoBPTX
 HLT_MinBiasBSC
 HLT_MinBiasBSC_NoBPTX
 HLT_MinBiasBSC_OR
 HLT_MinBiasHcal
 HLT_ZeroBiasPixel_SingleTrack
 HLT_MinBiasPixel_SingleTrack
 HLT_MinBiasPixel_DoubleTrack
 HLT_HighMultiplicityBSC
 HLT_SplashBSC
 HLT_L1_BscMinBiasOR_BptxPlusORMinus
 HLT_L1_BscMinBiasOR_BptxPlusORMinus_NoBPTX
 AICa_EcalPhiSym
 HLT_L1_HFTech
 HLT_L1Tech_HCAL_HF_coincidence_PM
 HLT_HFTThreshold10

Drawing cuts & scales

Name	Min energy (GeV)	Energy scale (GeV)
EBRecHits_V2	0.250	1.000
EERecHits_V2	0.800	1.000
ESRecHits_V2	0.001	100.000
HBRecHits_V2	0.750	0.005
HERecHits_V2	0.750	0.005
HFRRecHits_V2	3.000	0.005
HORecHits_V2	3.300	0.005

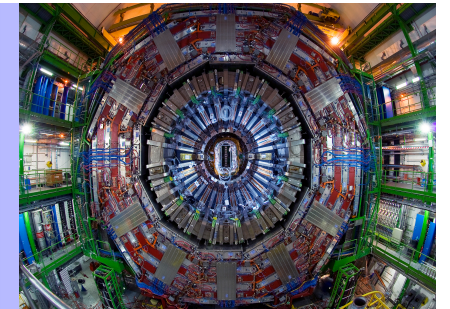


Unforgettable KODAK Moments





10Sep 08, 23Nov 09, 30Mar 10 – Media Splash Events



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[article](#) [discussion](#) [view source](#)

Large Hadron Collider

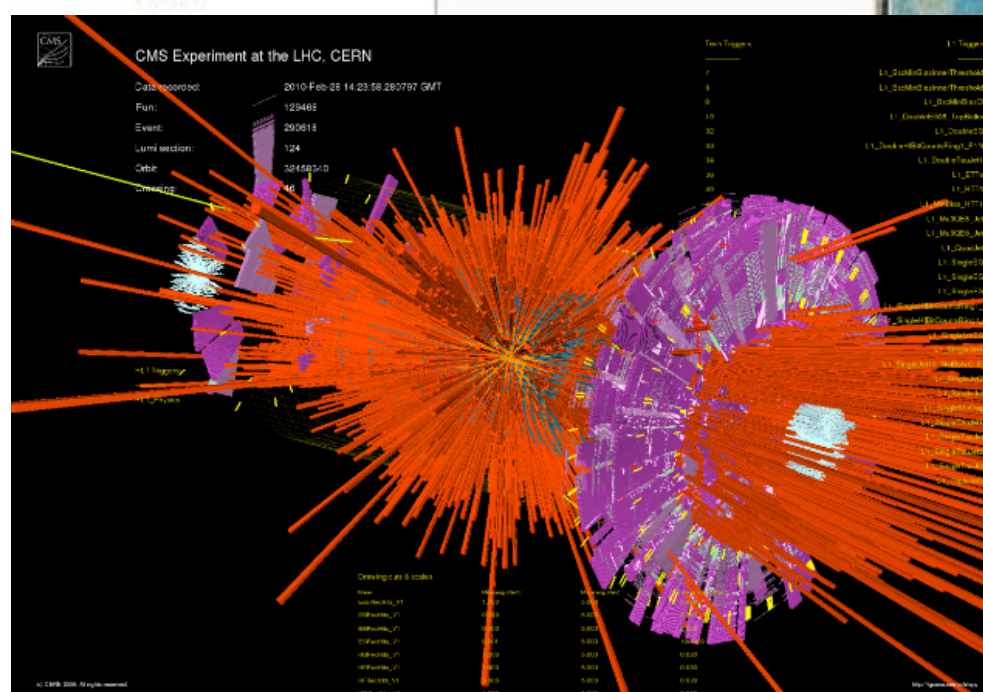
From Wikipedia, the free encyclopedia

WE WILL DIE!!!!

WIKIPEDIA
The Free Encyclopedia

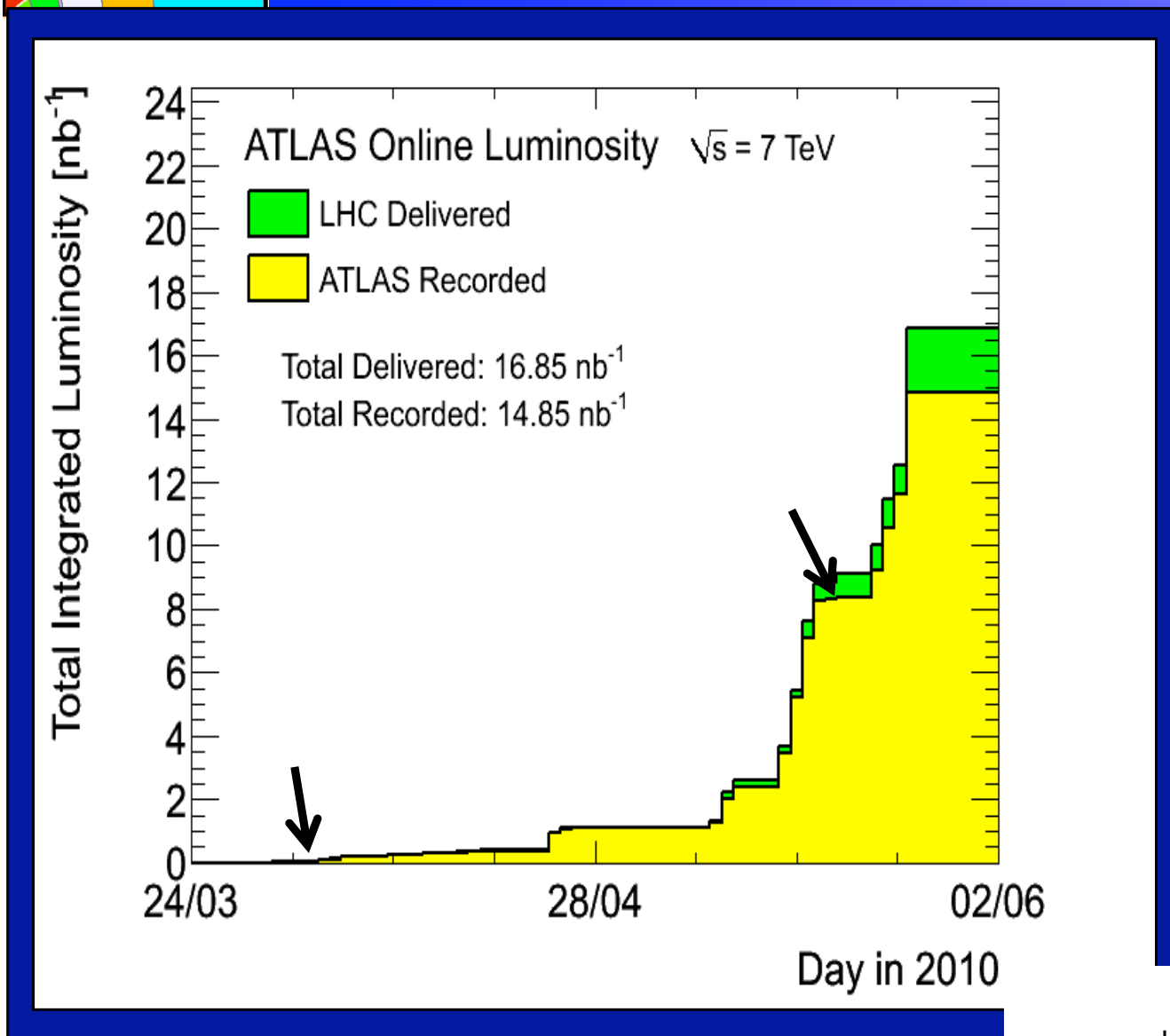
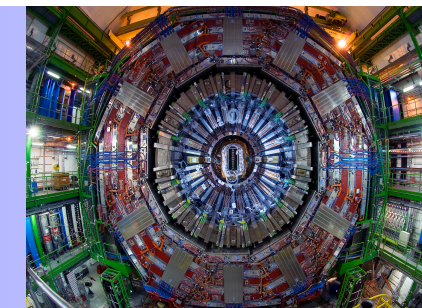
navigation

- Main page

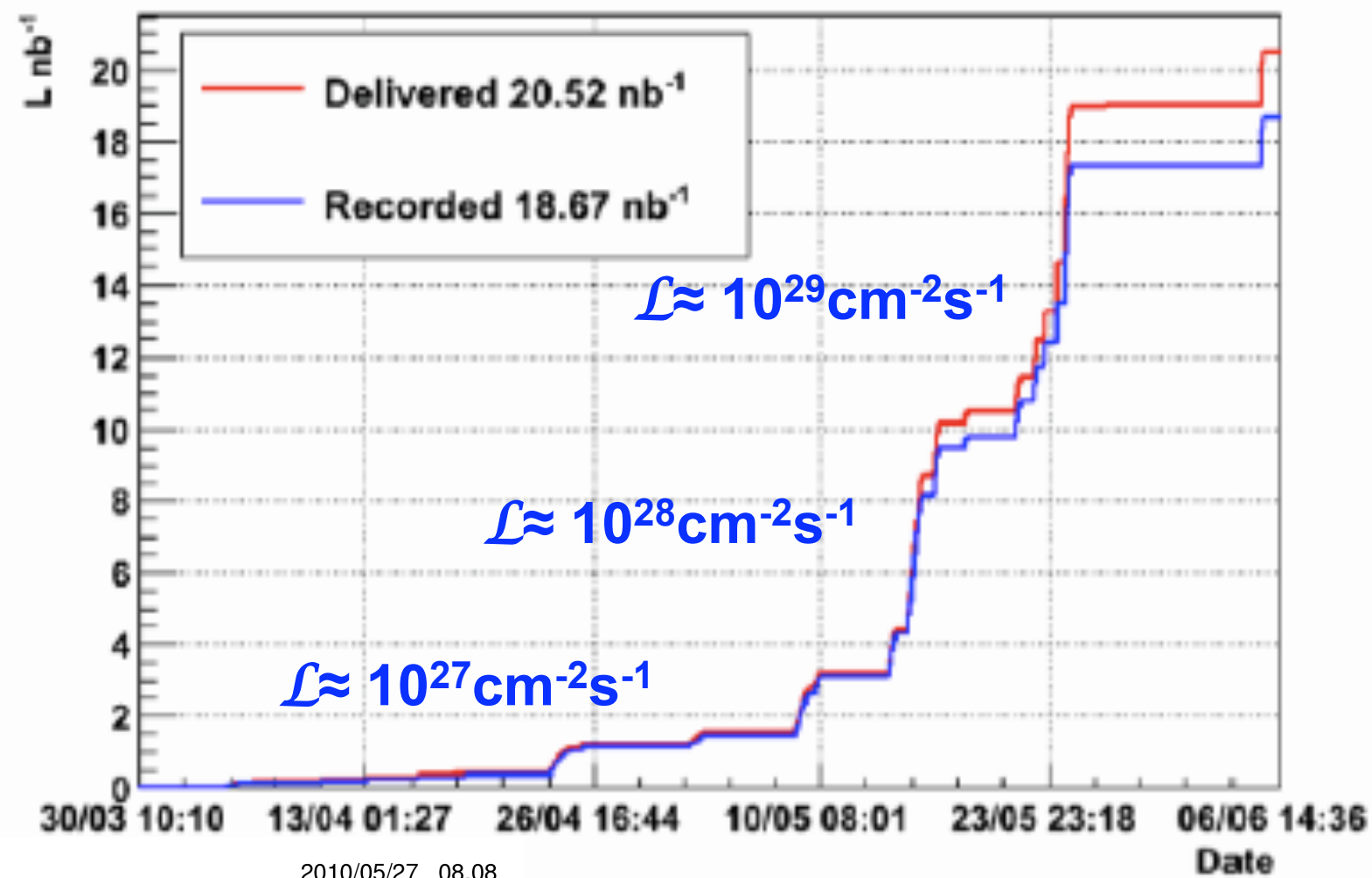




First 2 Months of Operation

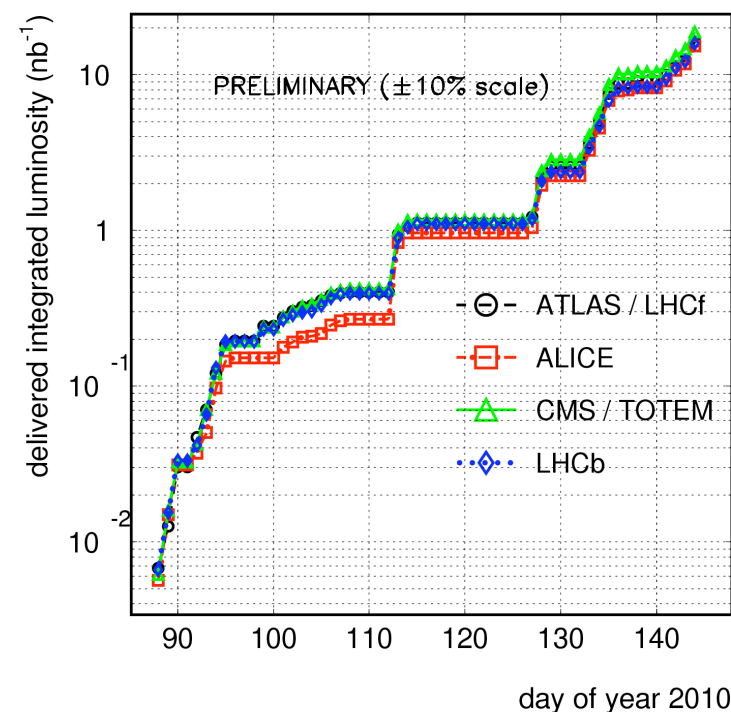


CMS: Integrated Luminosity 2010



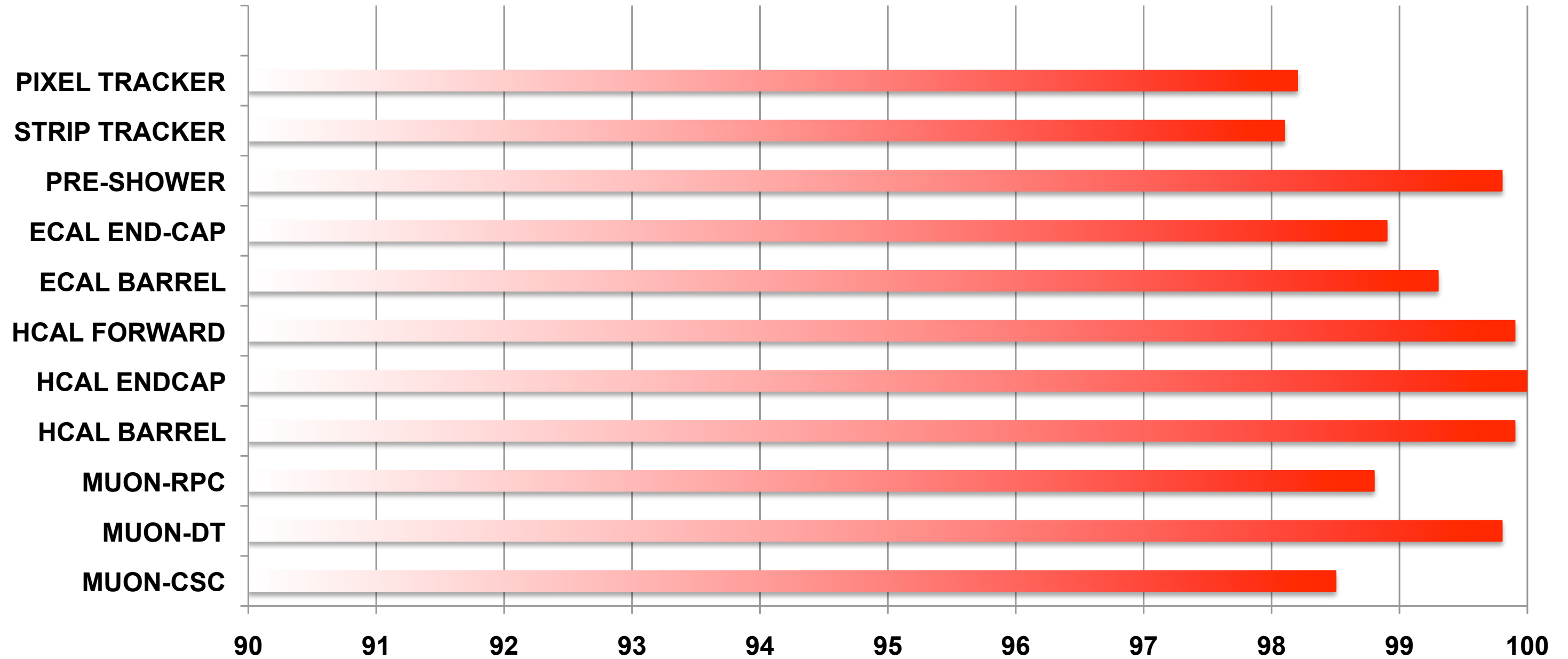
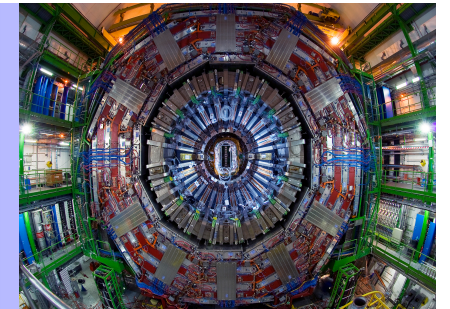
- **Reliable operation with $\sim 21/\text{nb}$ delivered**
- **Overall data taking efficiency $>90\%$**
- **Results based on luminosities**
 - up to $\sim 7.9/\text{nb}$ – ATLAS
 - $17/\text{nb}$ – CMS

LHC 2010 RUN (3.5 TeV/beam)





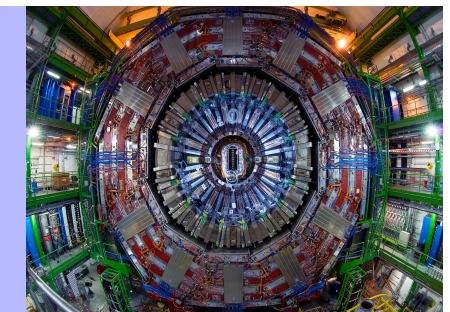
CMS Sub-detector Status



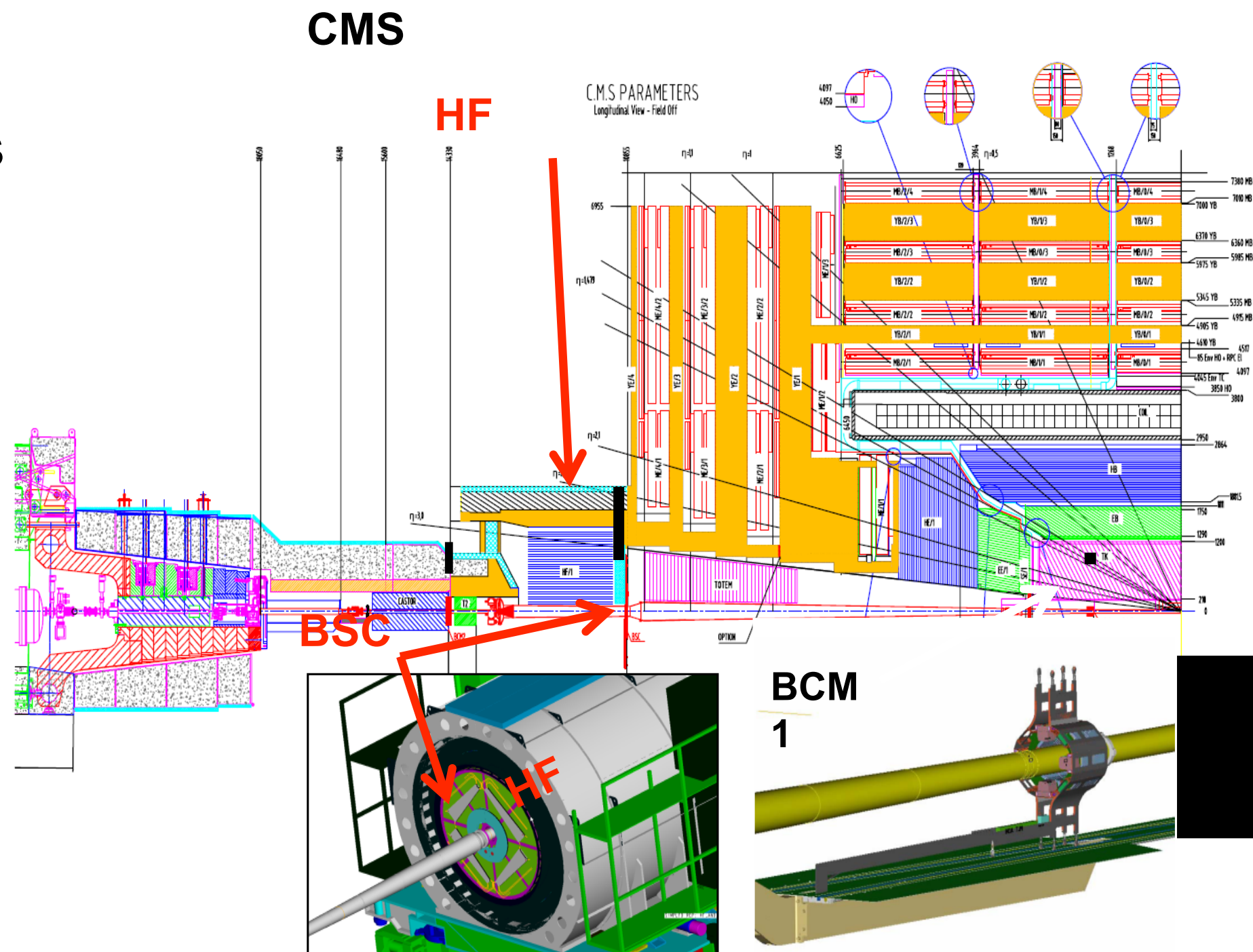
	MUON-CSC	MUON-DT	MUON-RPC	HCAL BARREL	HCAL ENDCAP	HCAL FORWARD	ECAL BARREL	ECAL END-CAP	PRE-Shower	STRIP TRACKER	PIXEL TRACKER	
Series1	98.5	99.8	98.8	99.9	100	99.9	99.3	98.9	99.8	98.1	98.2	



Zero and MinBias Triggers

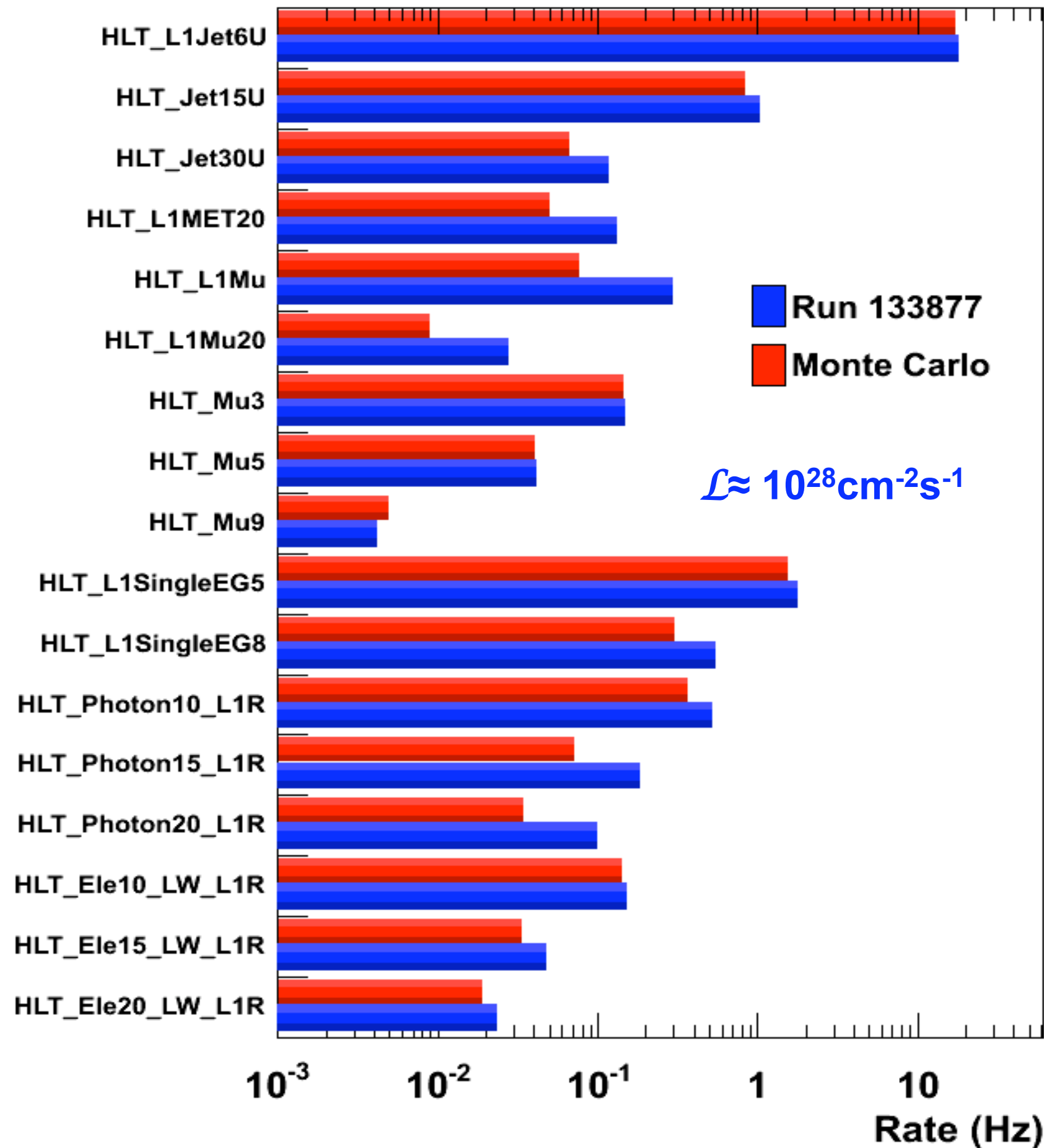
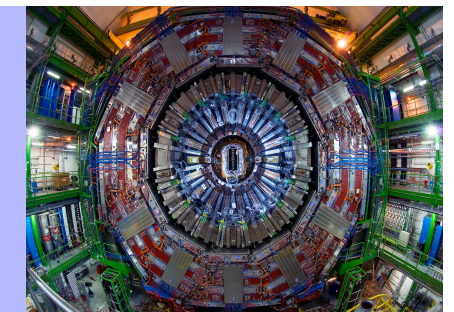


- Beam Pick-up Timing
 - BPTX: $\pm 175\text{m}$ from IP
- Beam Scintillator Counters
 - BSC: $\pm 10.5\text{m}$ from IP
- HCAL Forward
 - HF: $2.5 \leq |\eta| \leq 5$.
- Trigger: Min Bias & Zero Bias
 - L1 Beam Scintillator Counters
 - L1 Trigger “BPTX” prescaled
- Minimum Bias selection:
 - BSC (OR 2 planes) + vertex: $\epsilon \sim 90\%$
 - HF ($E > 3\text{ GeV}$ both sides): $\epsilon \sim 90\%$





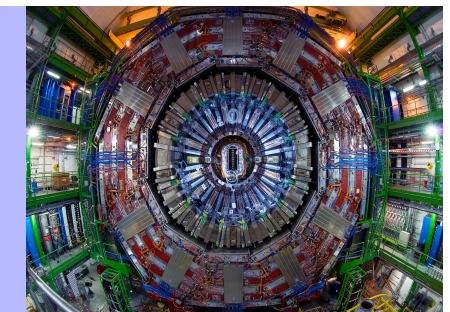
CMS DAQ, L1 and HLT



- **L1/DAQ RUNS VERY WELL**
 - L1 ~ 1KHz, <500 kB/evt,
 - HLT ~ 2% CPU loaded
- **HLT**
 - Farm Capacity ~ 100 ms/evt
 - 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 $10^{30} \text{cm}^{-2} \text{s}^{-1}$ on average
- **Deployed trigger menus for $10^{27}, 10^{28}, 10^{29} \text{cm}^{-2} \text{s}^{-1}$ (in development for $10^{30}-10^{31} \text{cm}^{-2} \text{s}^{-1}$)**
 - Rate predictions based on MC & data
 - Primary datasets for $10^{29} \text{cm}^{-2} \text{s}^{-1}$



DATA Acquisition



3/30/10 10:05:11 AM, 9.0, 901, 29/03/10 Mon 14:37

30/03/10 Session DAQ state Run Number Lv1 rate Ev. size DeadTime(AB) Acc. Hz(%) <HLT CPU>
 Tue 13:17:05 126284 Running 132440 1.044 kHz 495.9 kB 0.0% 1043.8(100.0) 1.47%

lhc1

Comments 30-03-2010 13:16:51:
 Preparing for stable beams!
 Preparing to move collimators IN

BIS status and SHP flags

Link Status of Beam Permits	B1	B2
Global Beam Permit	OK	OK
Setup Beam	OK	OK
Beam Presence	OK	OK
Movable Devices Allowed In	OK	OK
Stable Beams	OK	OK

LHC Operation In CCC : 77600, 70480 PM Status B1: ENABLED PM Status B2: ENABLED

Data to Surface

Sub-System	State	FRL	FED	IN
TRG	Running	3	3	3
CSC	Running	9	9	9
DAQ	Running	0	0	0
DQM	Running	0	0	0
DT	Running	11	11	11
ECAL	Running	54	54	54
ES	Running	40	40	40
HCAL	Running	32	32	32
PIXEL	Running	40	40	40
RPC	Running	3	3	3
SCAL	Running	1	1	1
TRACKER	Running	250	440	438
CASTOR	Running	3	3	3
	X	0	0	0

SM streams

Stream	No.Events	Rate (Hz)	BnW (MB/s)
Calibration	379.676E+3	97.52	16.62
EcalCalibrati	379.676E+3	97.56	2.02
A	262.205E+3	112.70	20.95
Express	48.716E+3	37.87	7.55
ALCAPHISYM	7.090E+3	5.53	0.02
HLTMON	3.303E+3	2.02	0.39
ALCAP0	684.000E+0	0.38	0.00
OnlineErrors	26.000E+0	0.03	0.01
RPCMON	15.000E+0	0.00	0.00
Error	0.000E+0	0.00	0.00

Data Flow

#LS: 171 LHC_RAMPING: false
 PHYSICS_DECLARED: true
 PIX_HV_ON: true
 TK_HV_ON: true
 CalibCyc ON

#Lv1(GT): 3909384
 Lv1 Rate: 1.044 kHz

Pending Lv1: 114131
 #Frag. in RU: Max 103, Min 42
 FBI occ. %: Max 0, Min 0
 FBO occ. %: Max 0, Min 0

BnW (MB/s): 501
 EvSize (kB): 496.7

Events in BU: 0
 <Ev.>: 0
 Pending Req.: 15989
 <#P>: 23.8
 #Running FUs: 4704, 100.00%

Acc.Rate: 1043.792 Hz
 <FU-CPU>: 1.47%

BnW MB/s: 47.4
 EventRate Hz: 364.1
 Disks usage: % log scale
 <SM-CPU>: 5.77%
 Free space TB: 229

Time to fill disk 2 of srv-c2c07-17 > week
 Stored: 1092490

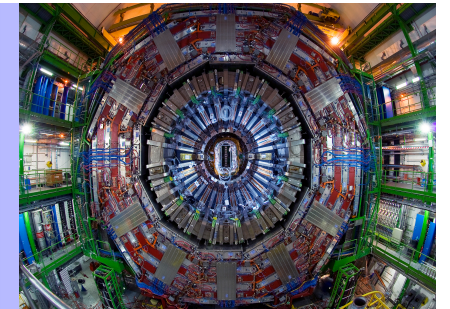
[Rate(kHz) | Stored | Accepted% | CPU%] / Time

UTC time 30/03/10 11:17:05

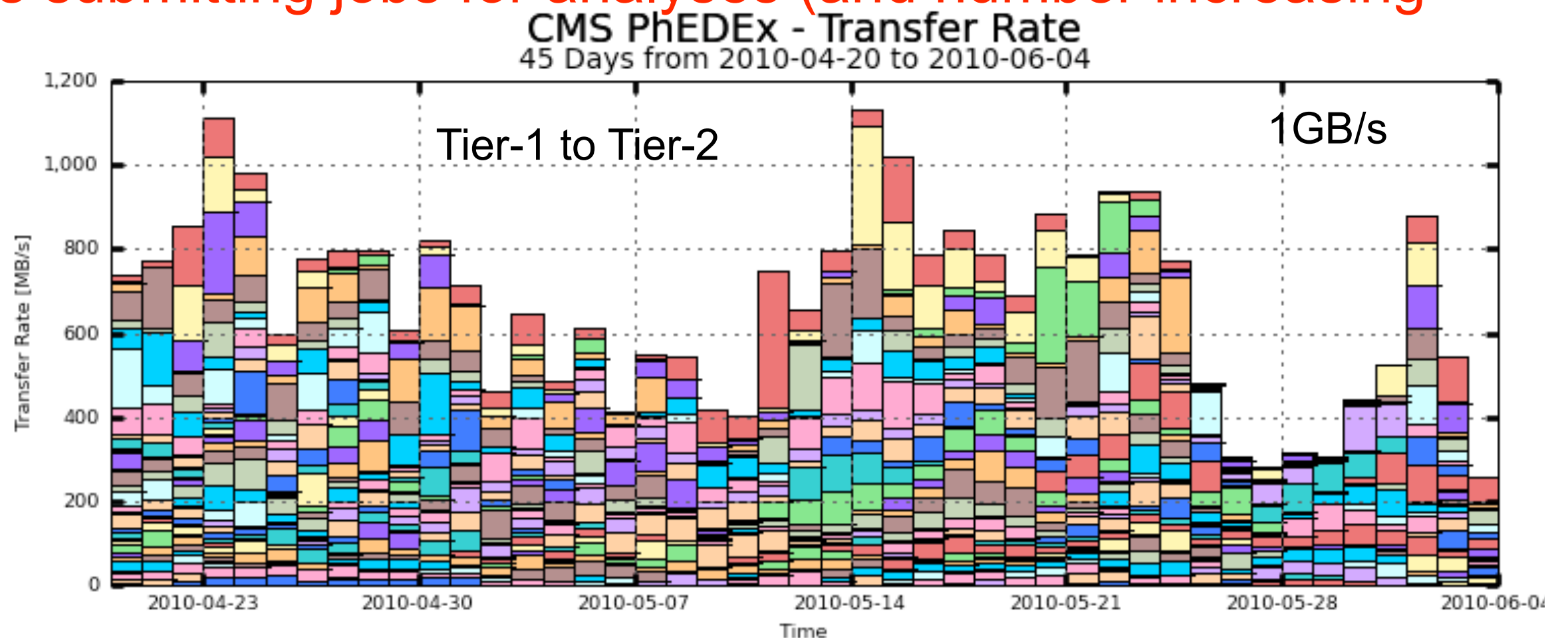
Local time: Geneva 13:17, Los Angeles 04:17, Chicago 06:17, Moscow 15:17, Beijing 20:17



CMS Computing

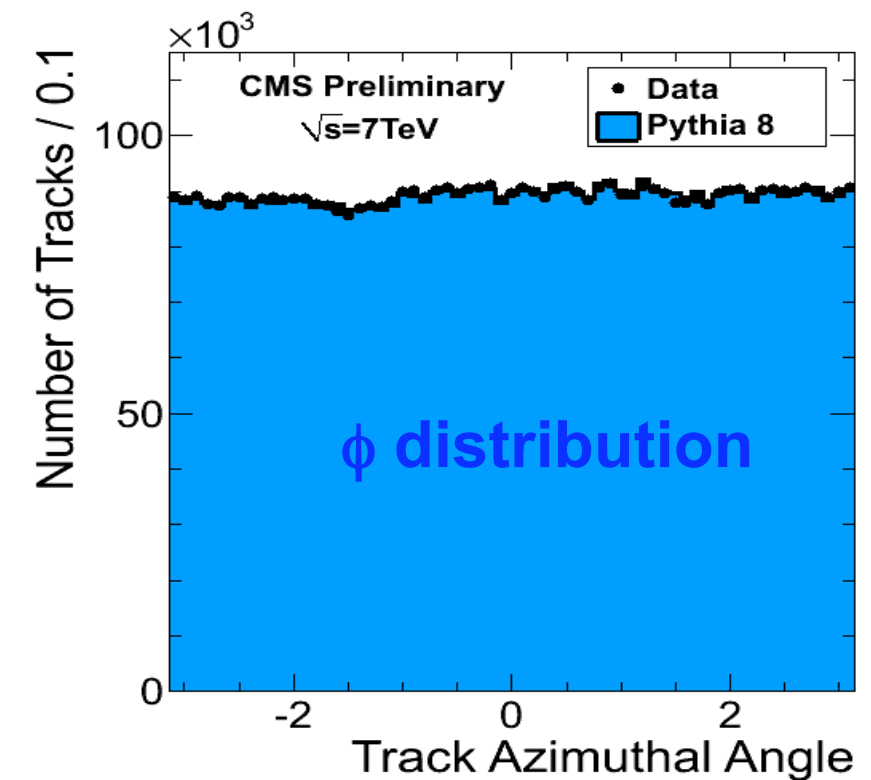
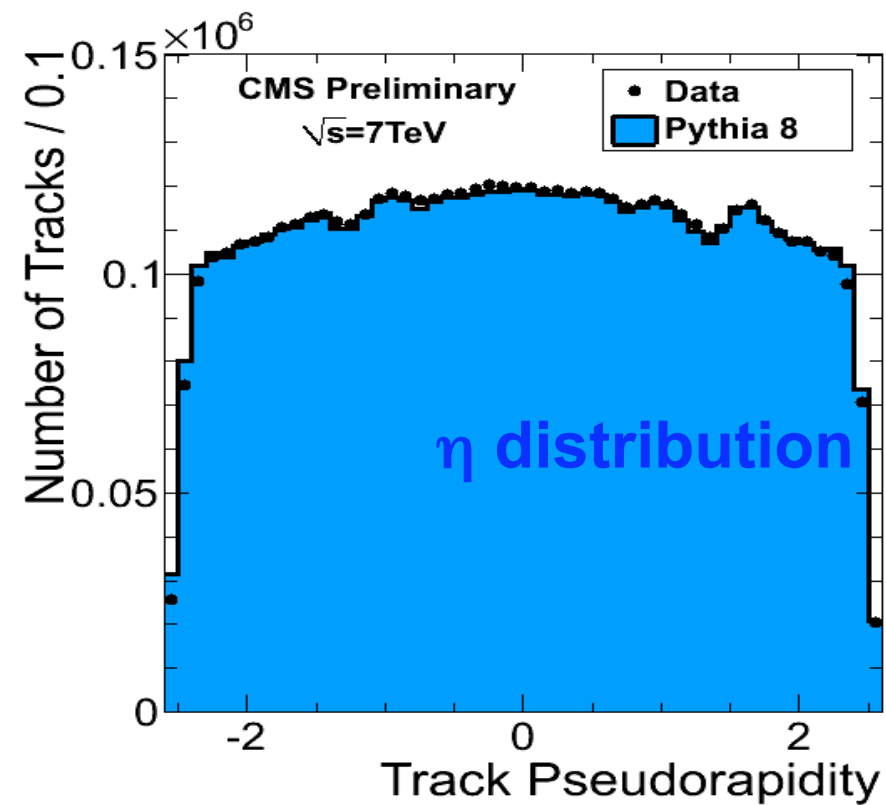
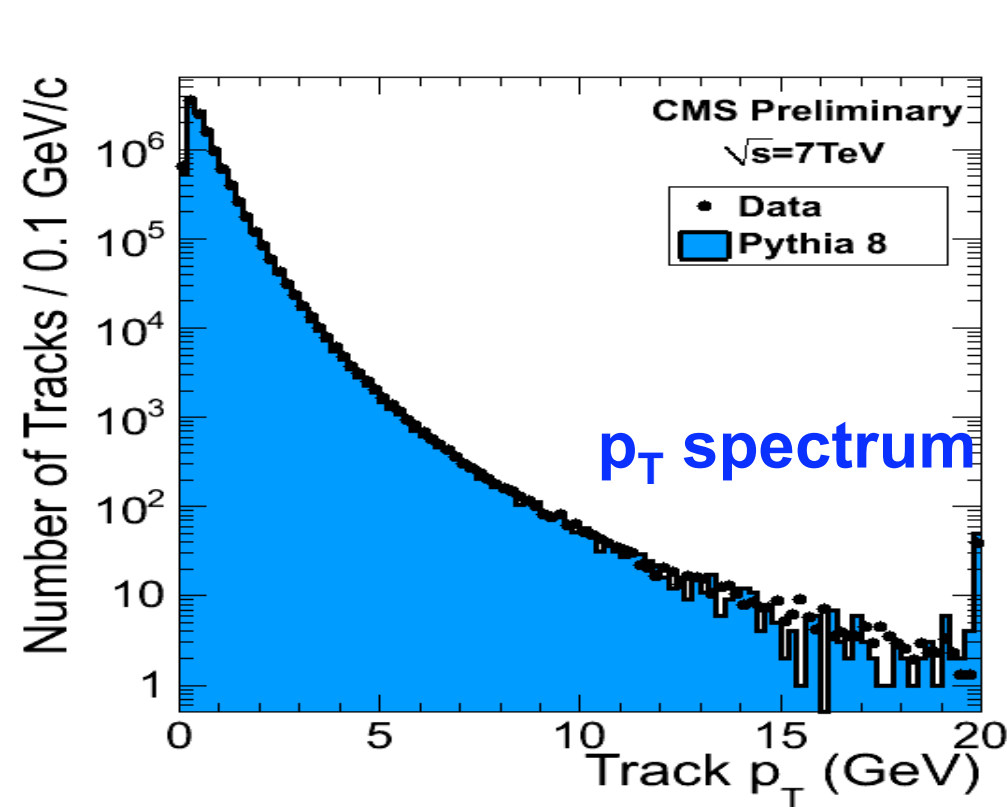
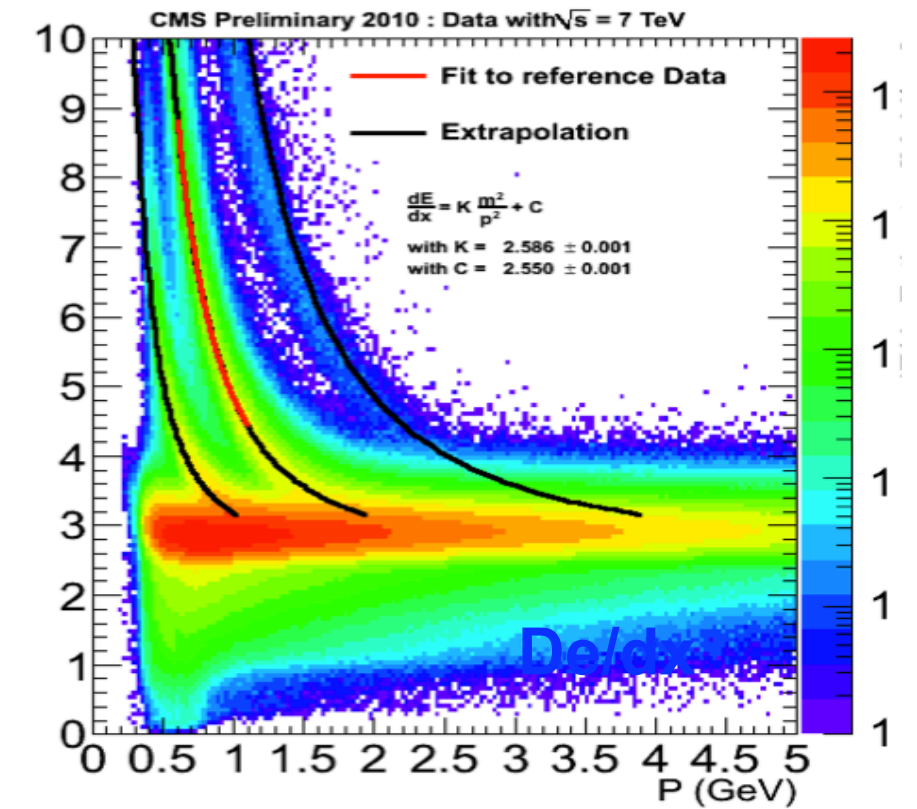
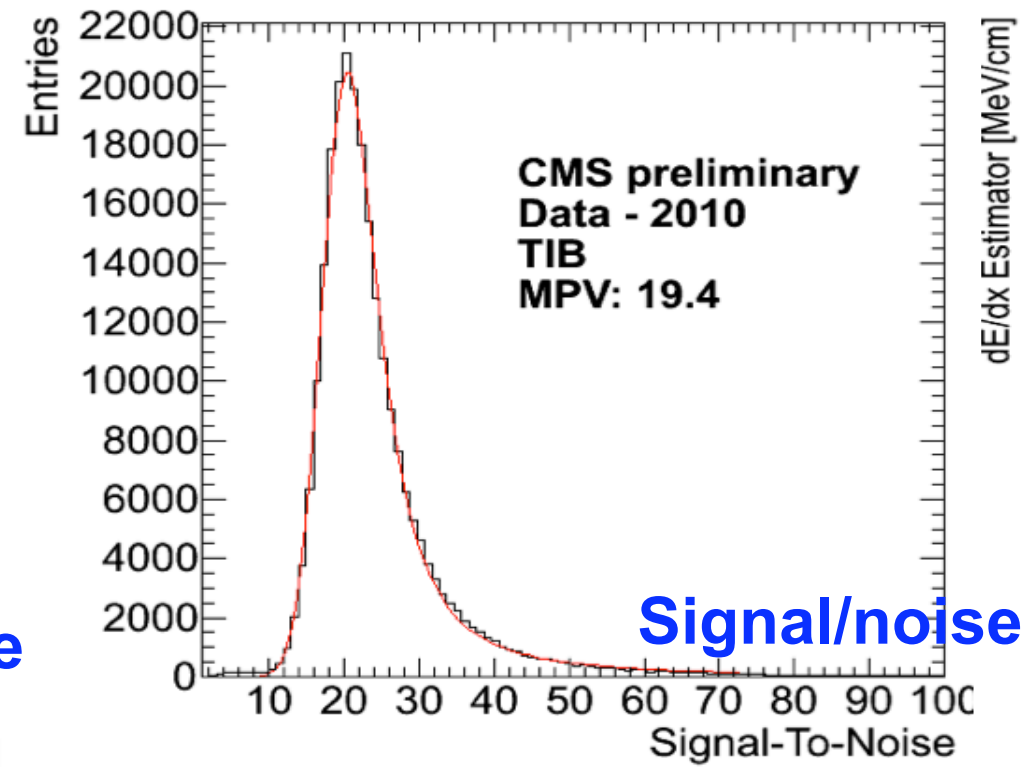
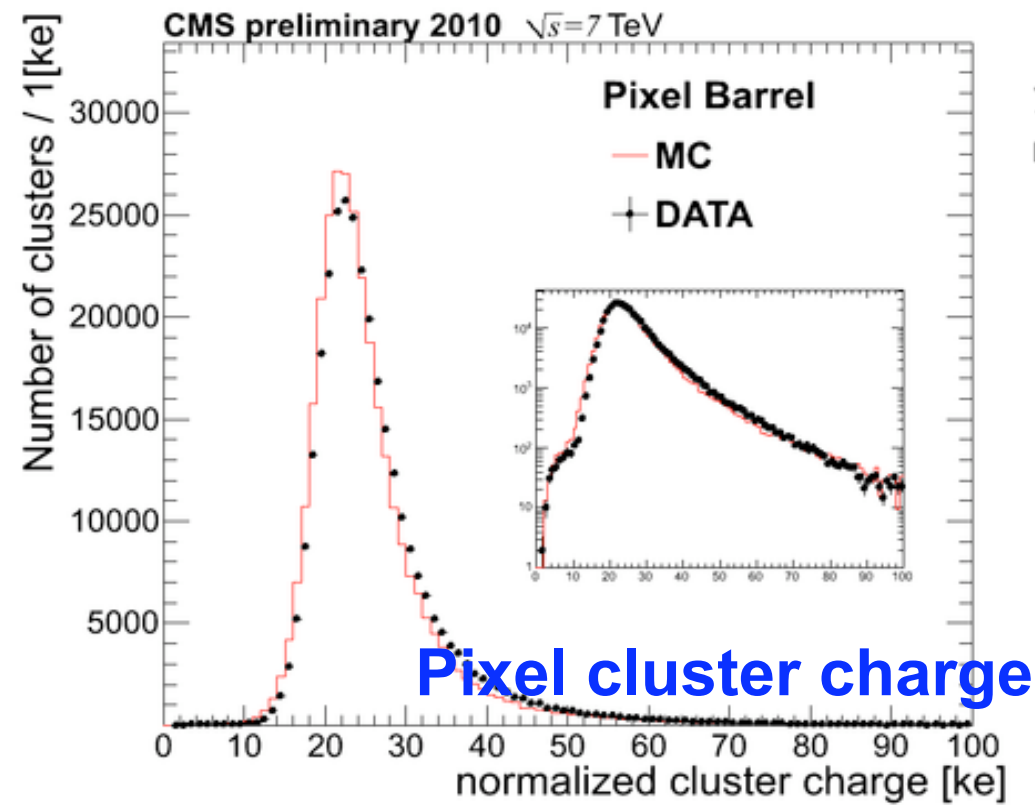
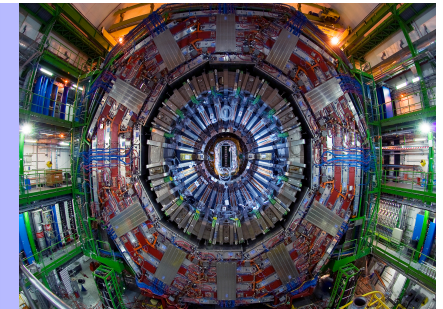


- Smooth Data Handling
 - Over 2 billion RAW events processed
 - Stable Software and Reliable Infrastructure @Tier-0
- Tier-1s and Tier-2s making reliable contributions
 - All 7 Tier-1 fully participating (FNAL, CNAF, FZK, IN2P3, RAL, PIC, ASGC)
 - Many re-processing cycles handled very well
 - 49 T2s received collision data and 57 T2s participate in MC simulation
- > 465 users submitting jobs for analyses (and number increasing weekly)



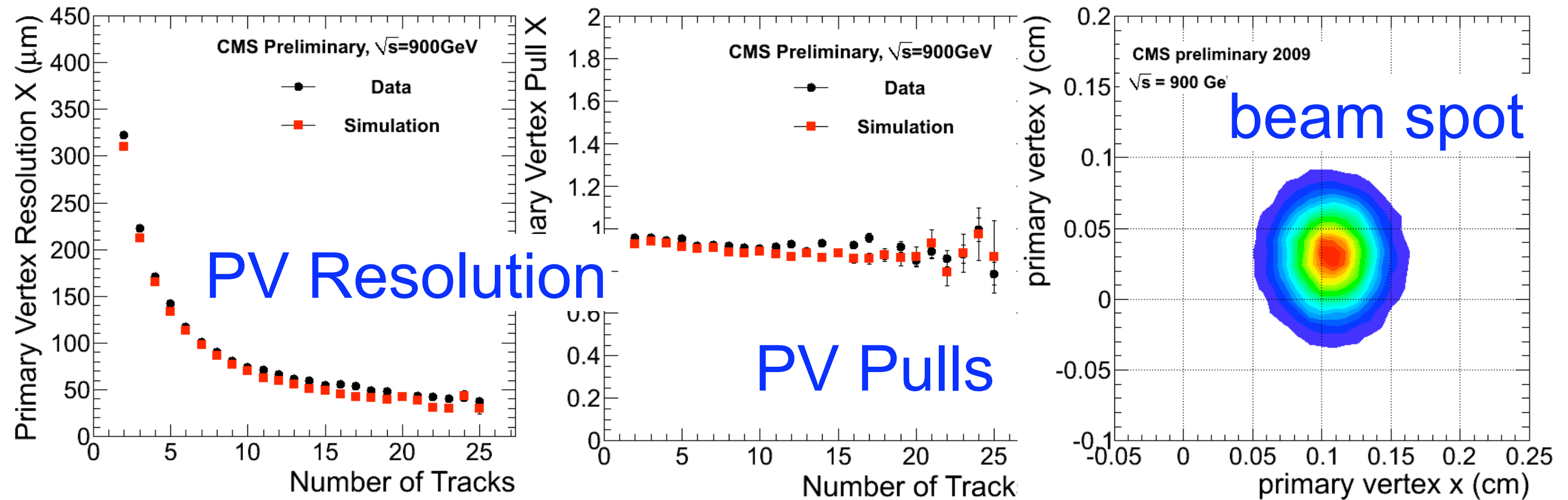
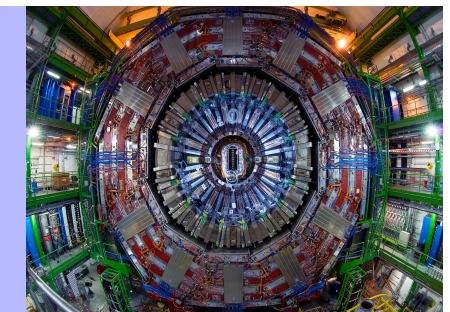


Tracker Performance





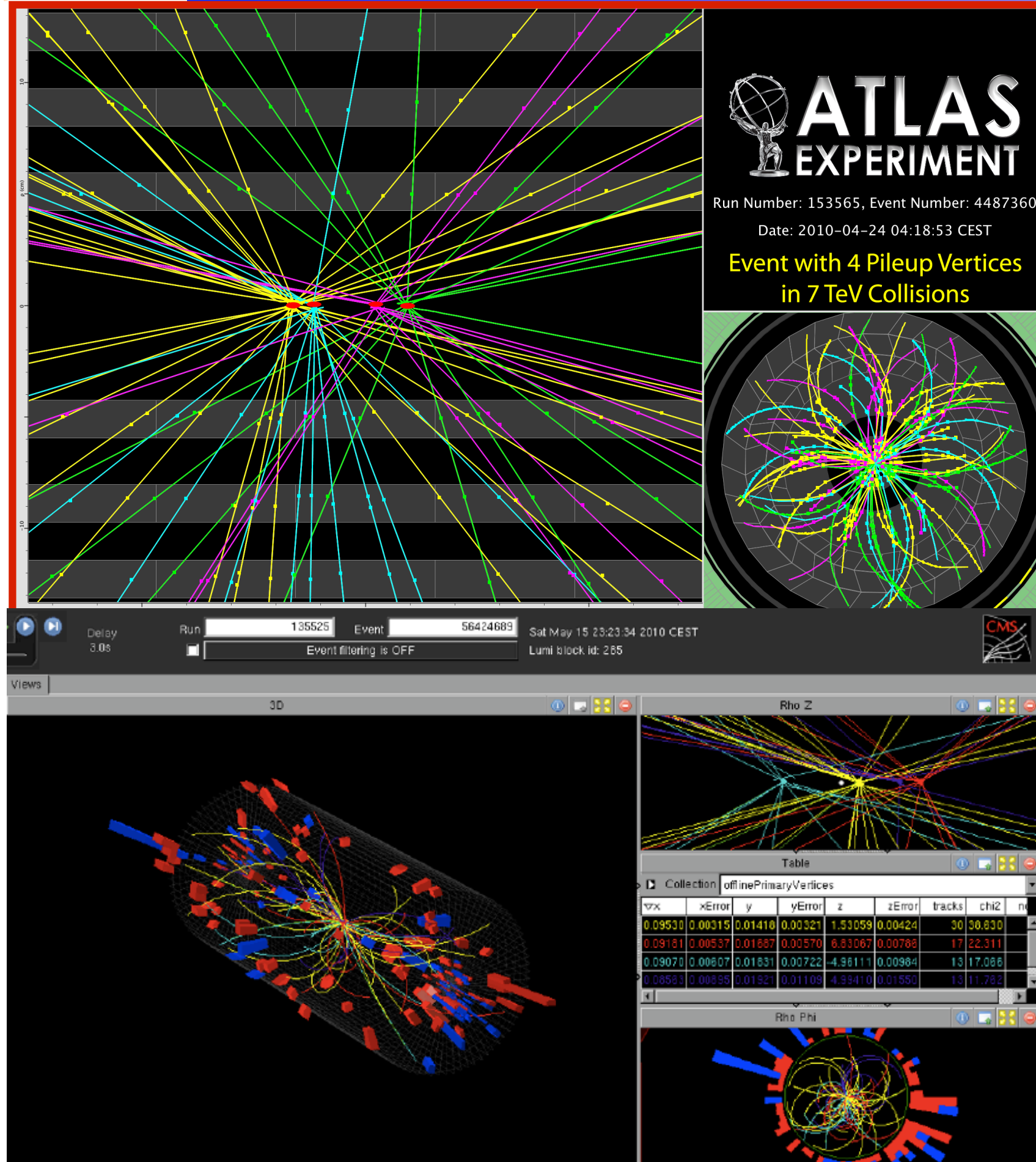
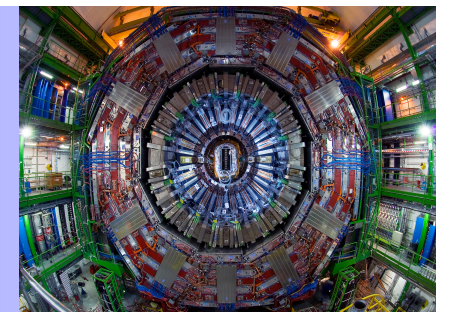
Primary Vertices



- Well understood uncertainties in tracking/vertexing
- Primary vertex resolution well modeled in simulation



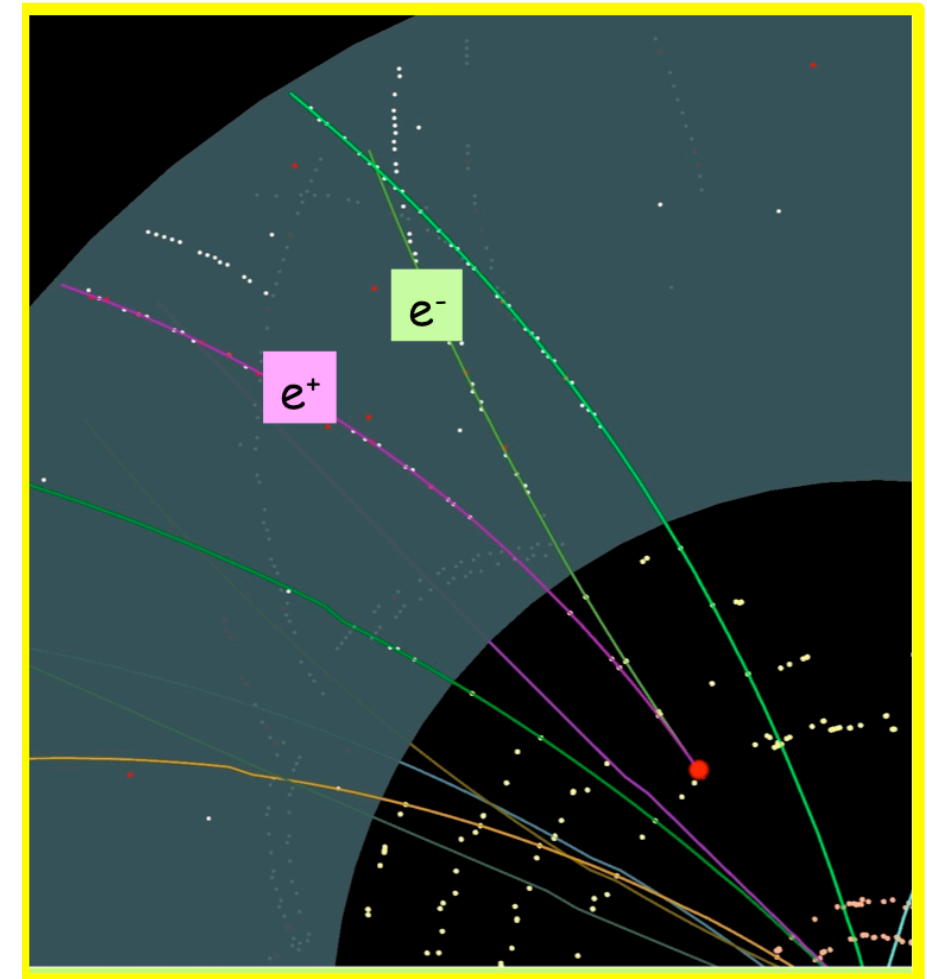
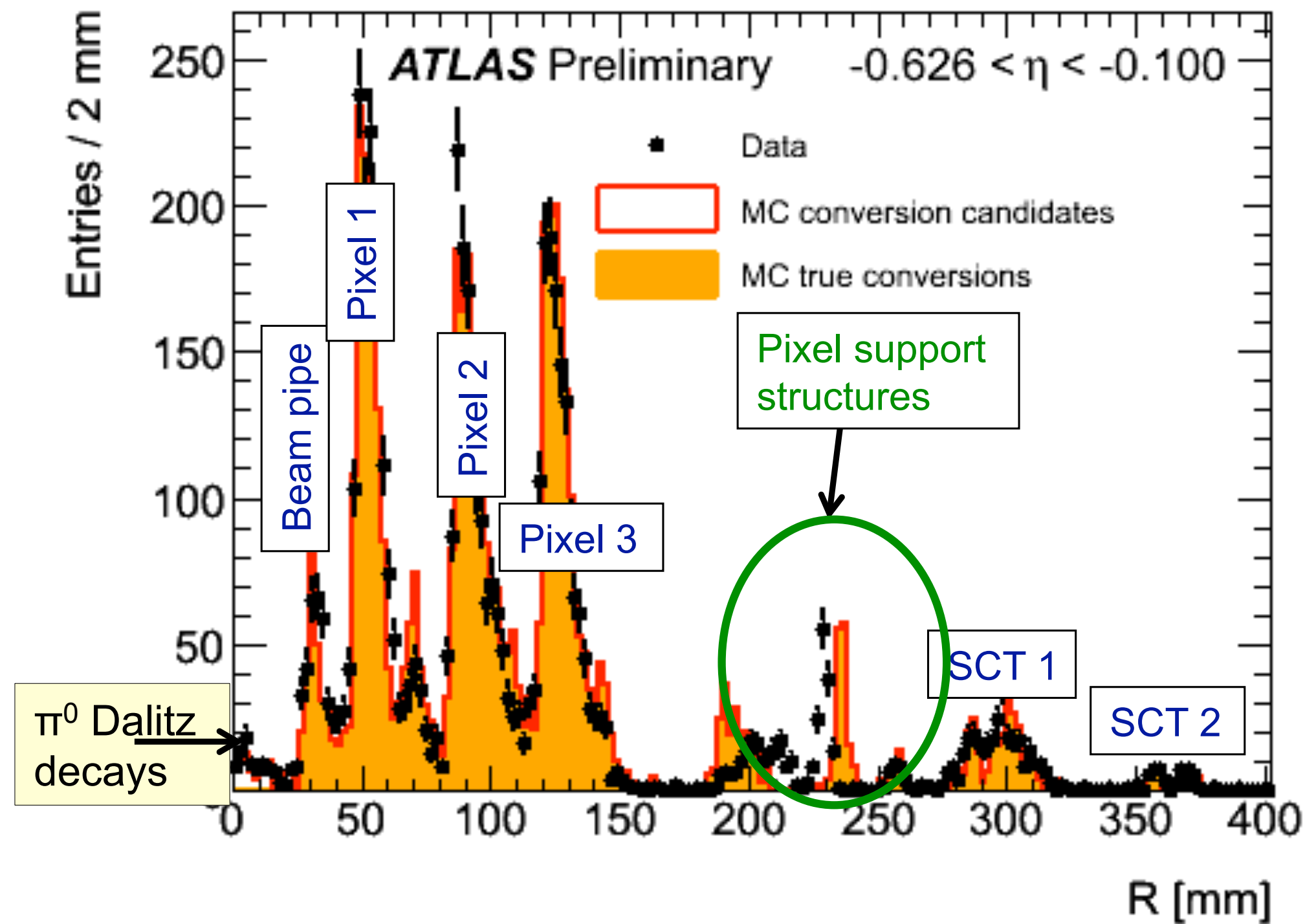
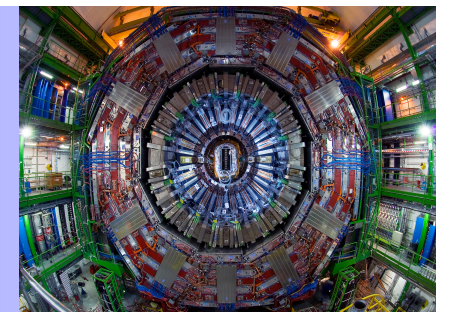
PILE UP EVENTS @ $\mathcal{L}=10^{27}$!



- Preparing for the future:
 - pile up reconstruction of 4 pp interactions in one bunch crossing
- Still rare but showing up
- Soon might become a major issue
- Plans for the luminosity increase of the machine seem to prefer 50ns high intensity bunches scheme.



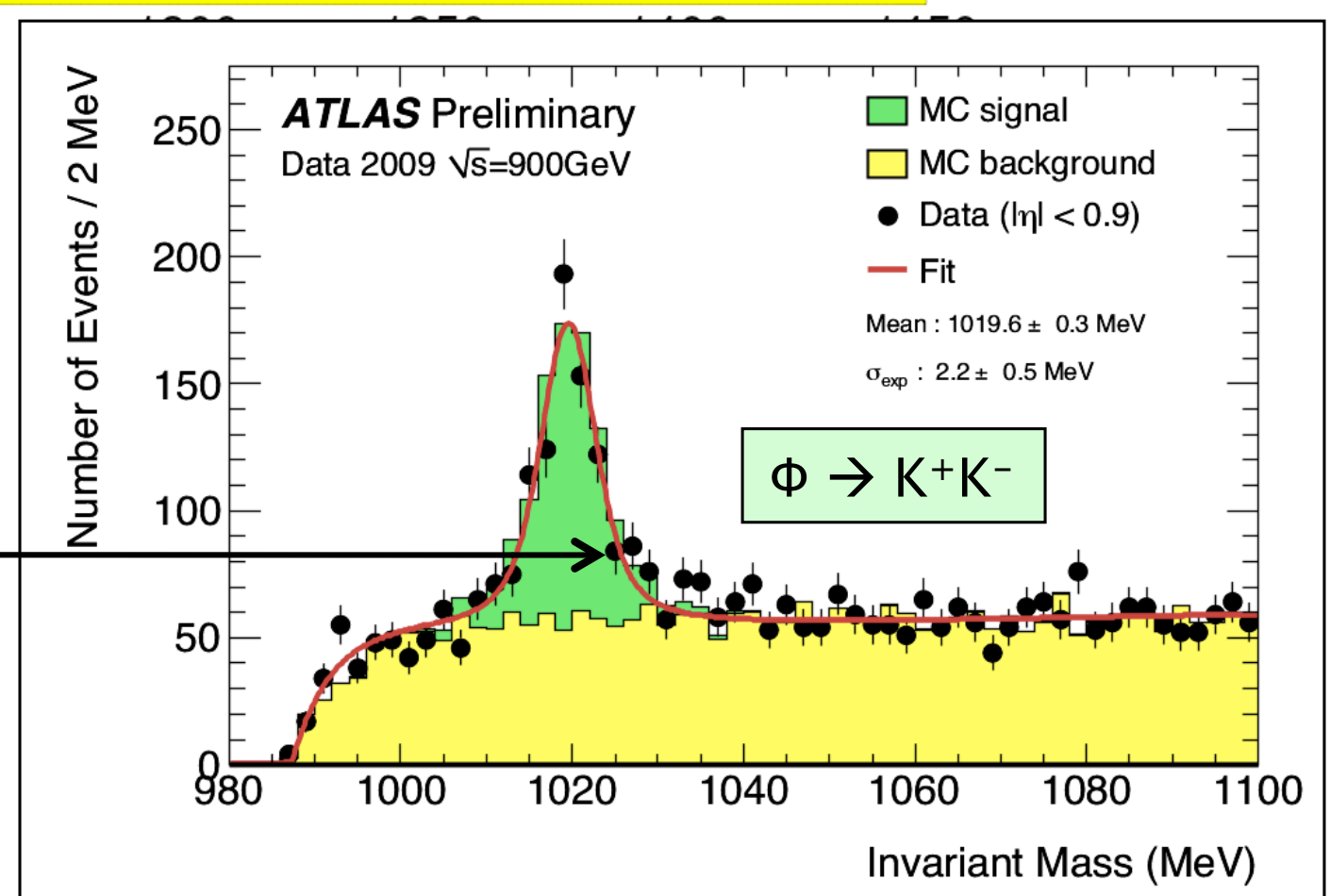
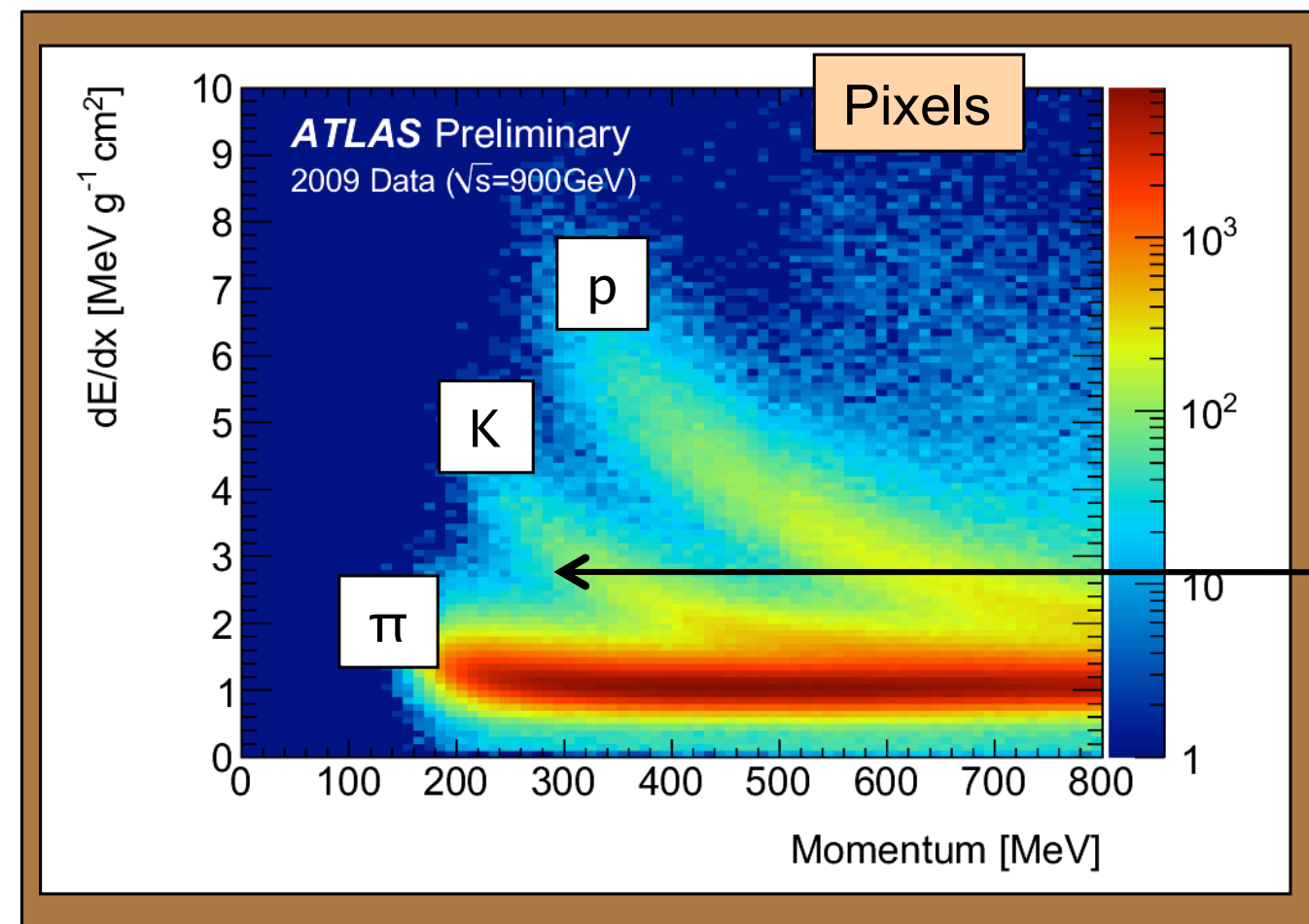
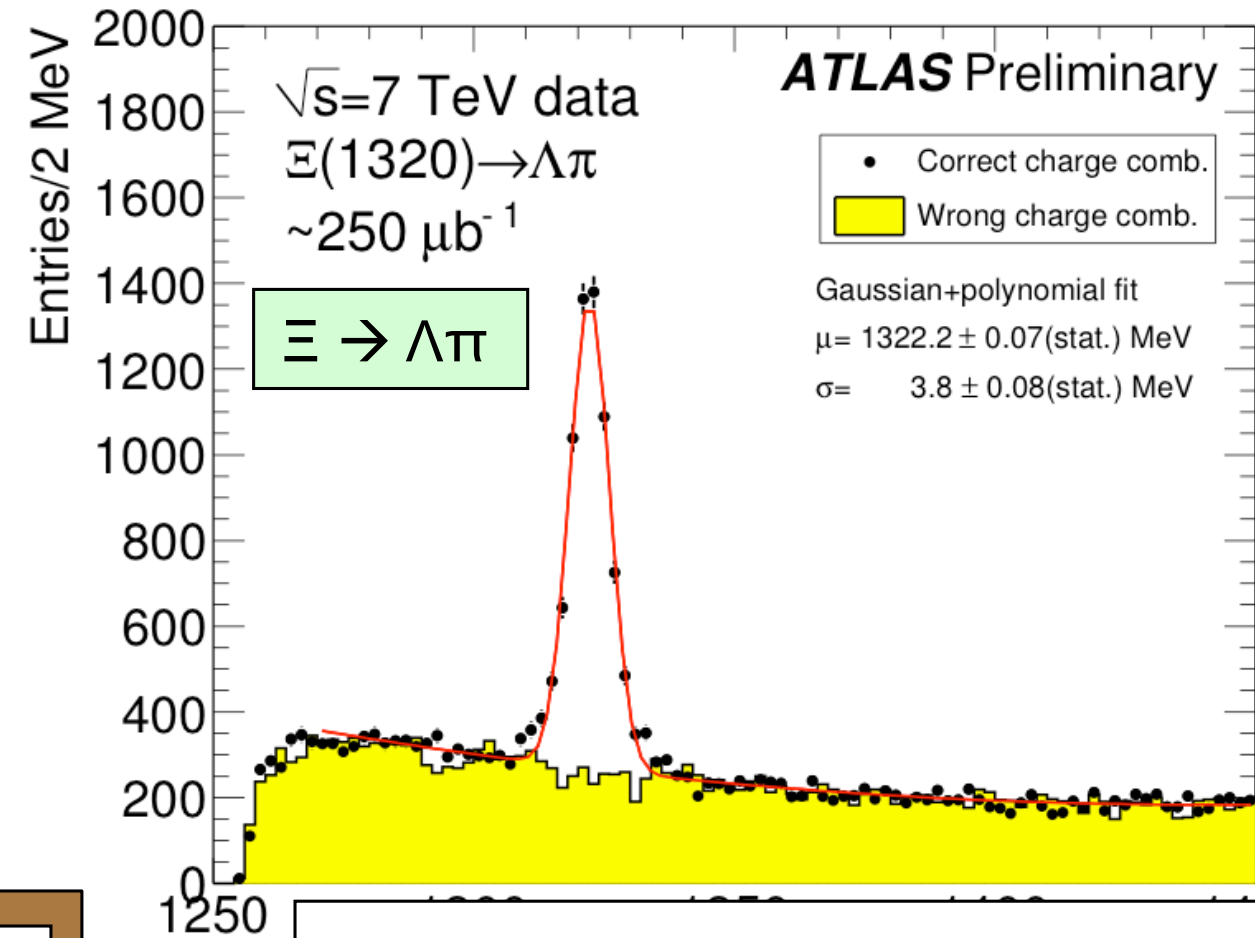
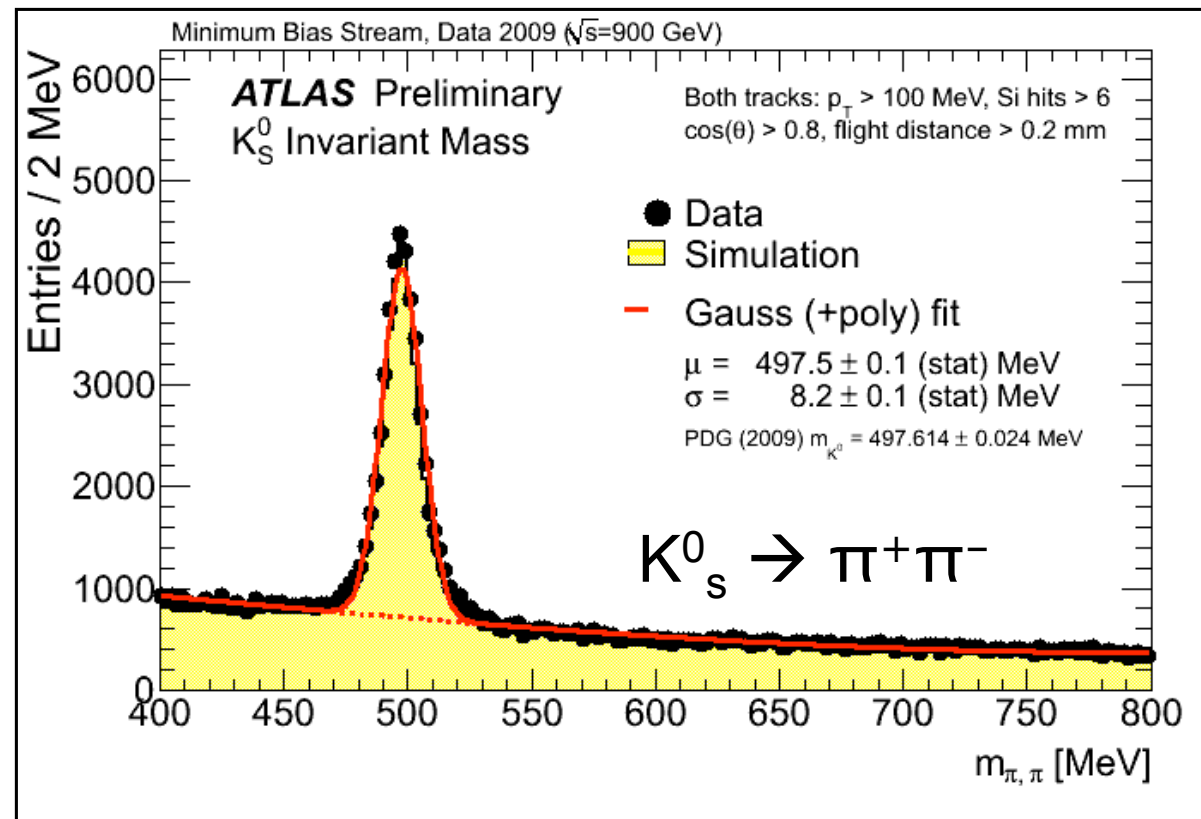
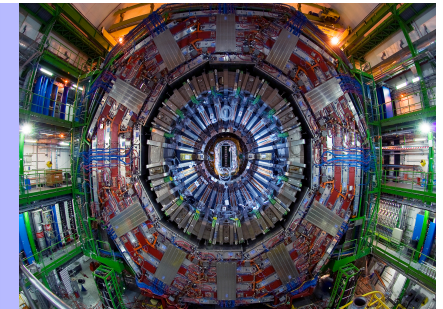
Mapping Inner Detector Material with converted γ



- Goal is to map ID material to better than 5% (using several methods)
- Reconstruction efficiency for Dalitz decays used to constrain beam-pipe thickness (in turn used as reference to estimate material in other layers)

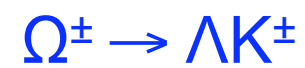
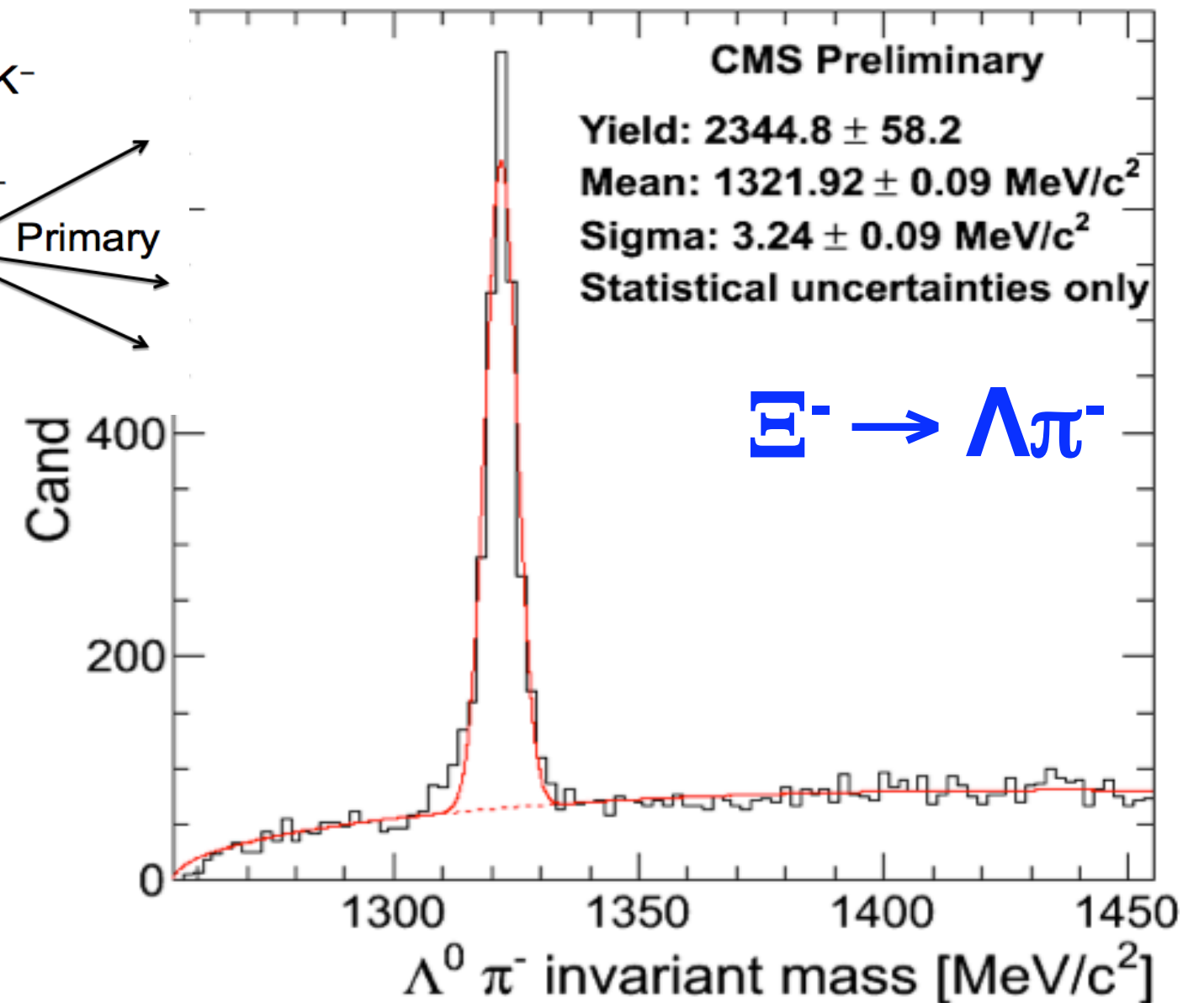
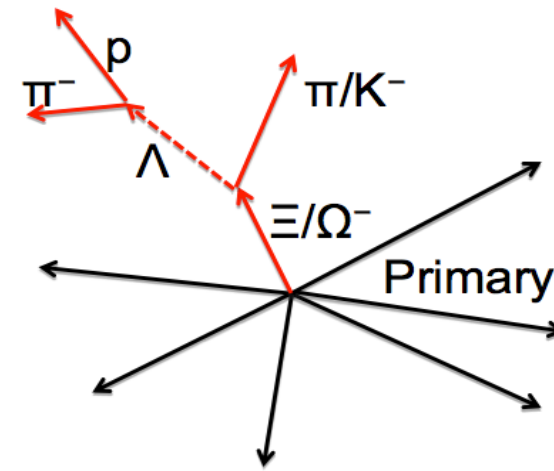
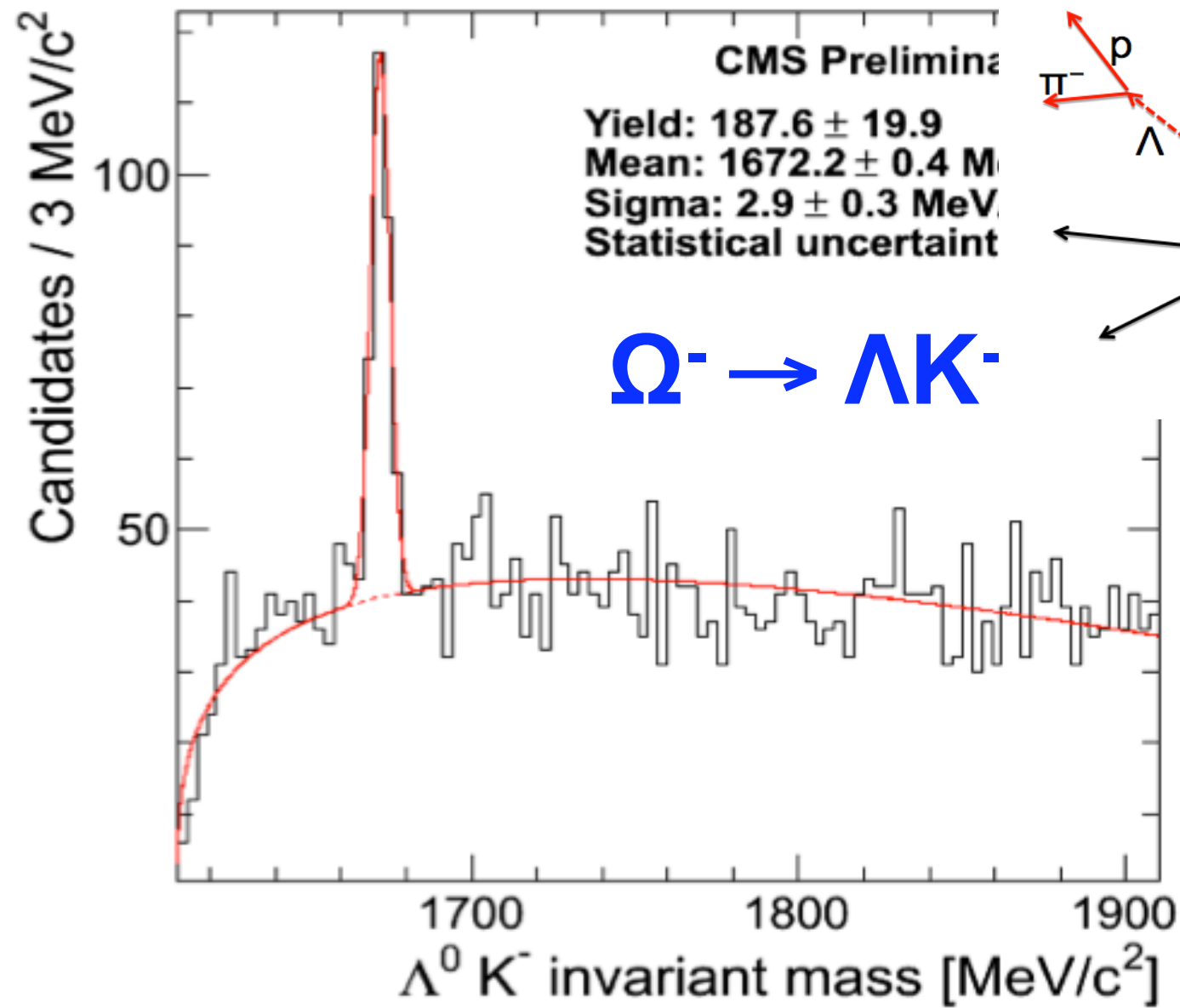
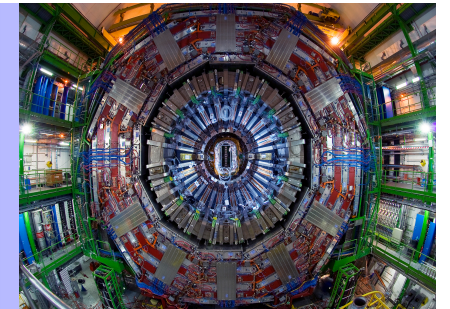


ATLAS Tracker Performance





Low Mass Resonances



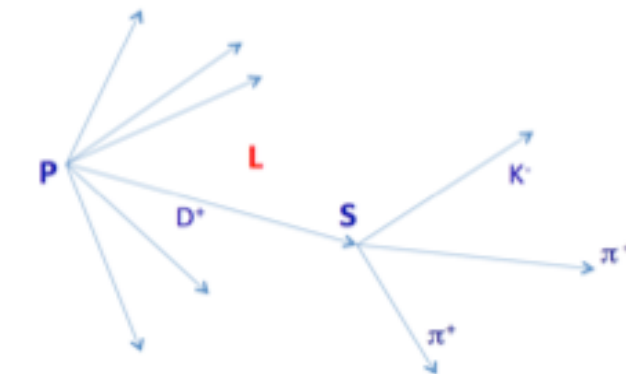
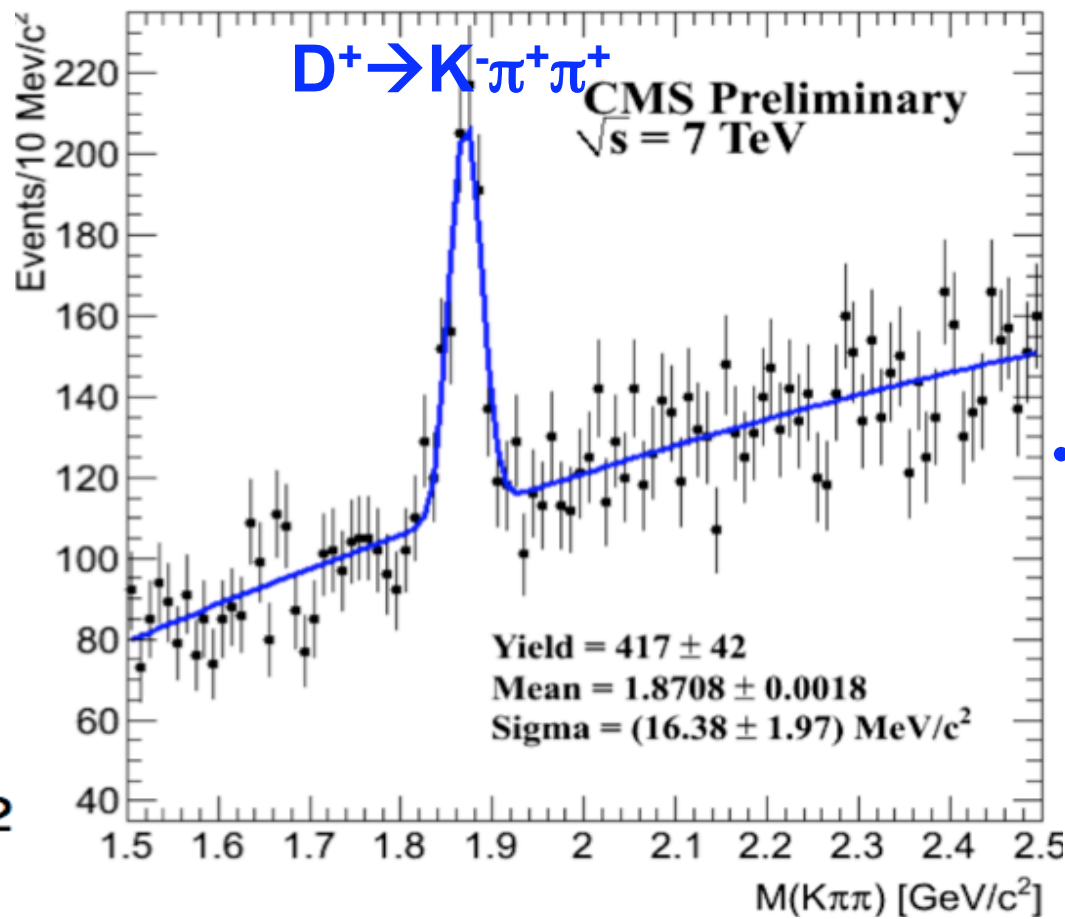
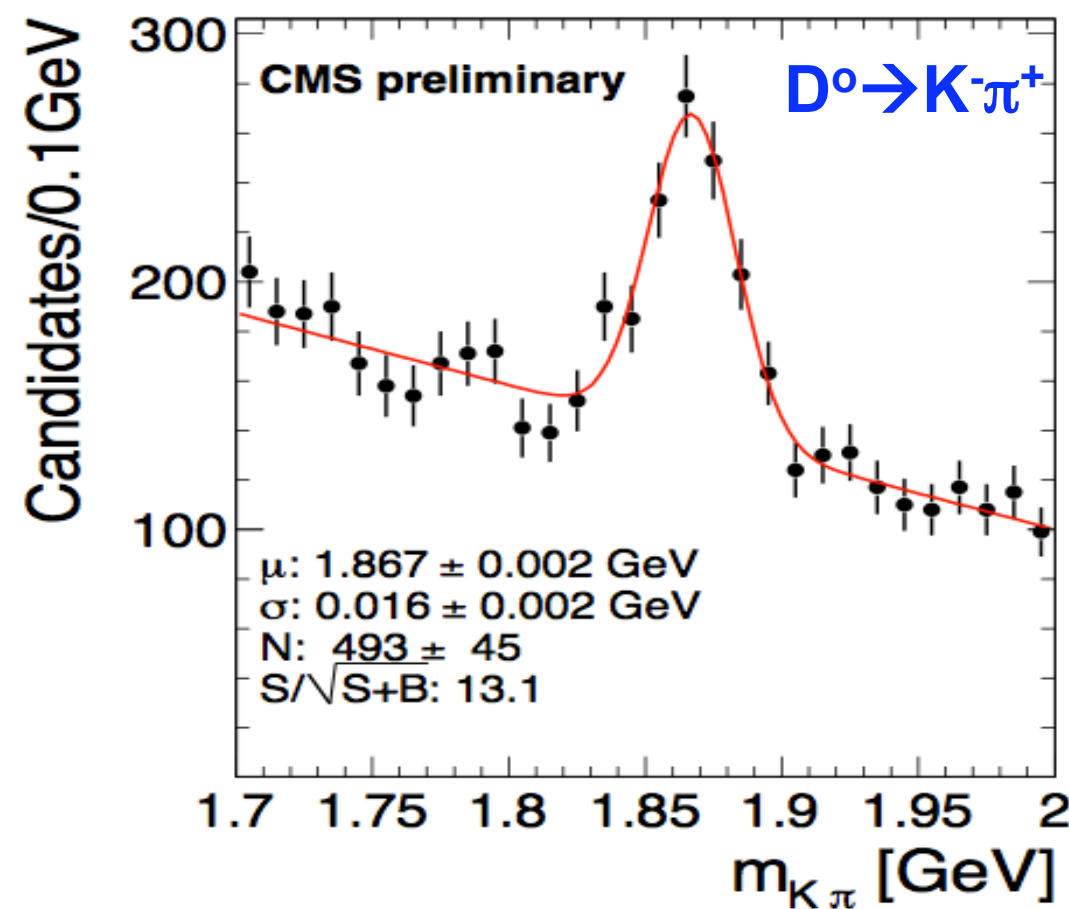
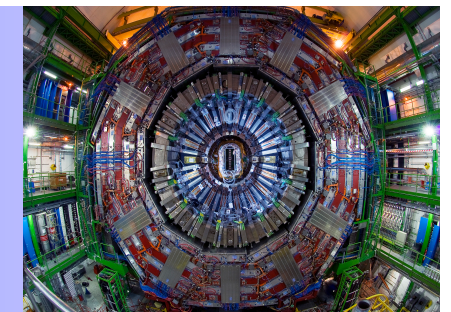
- ΛK^- or anti- ΛK^+
- combinations fit to a common vertex



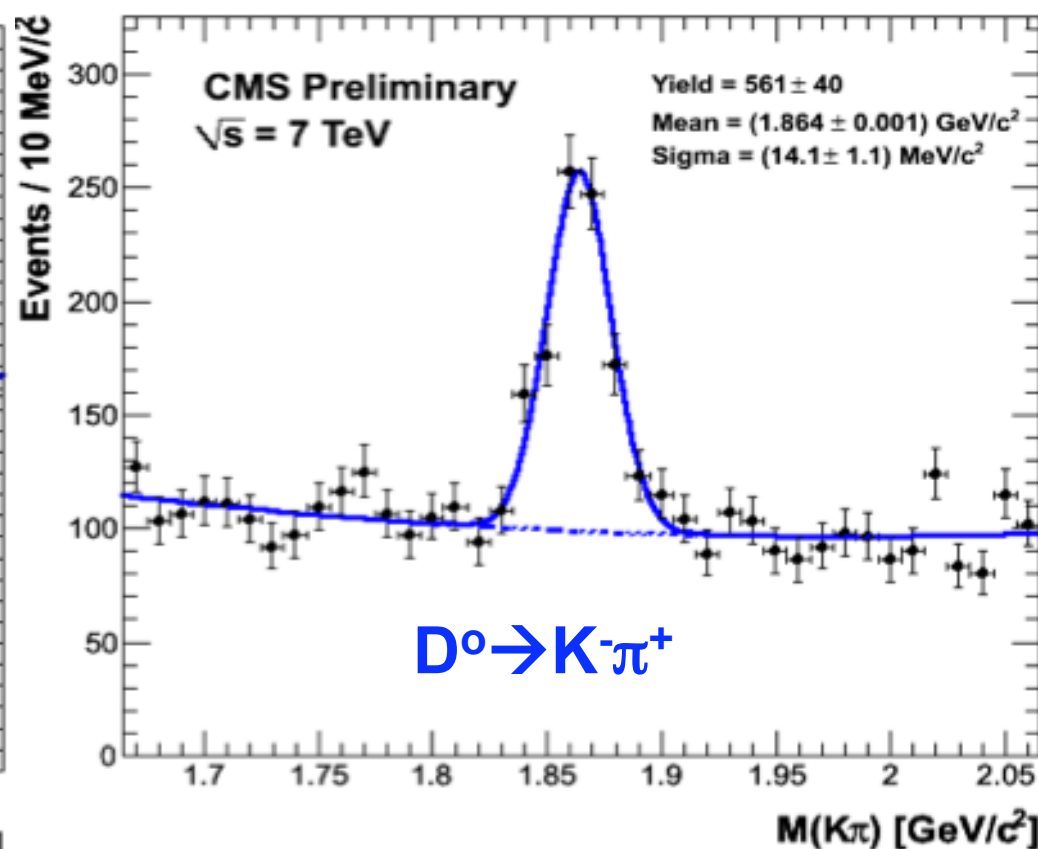
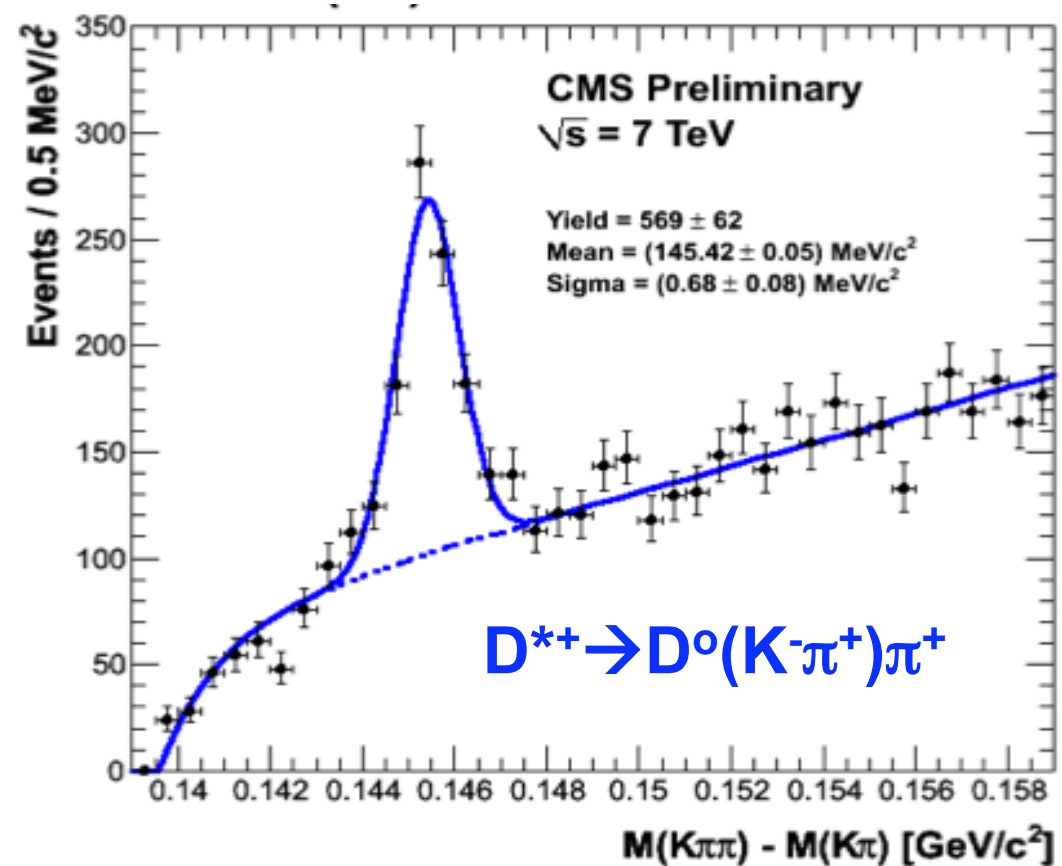
- tracks displaced from primary vertex ($d_{3D} > 3\sigma$)
- Common displaced vertex ($L_{3D} > 10\sigma$)



Reconstruction of Charm Mesons

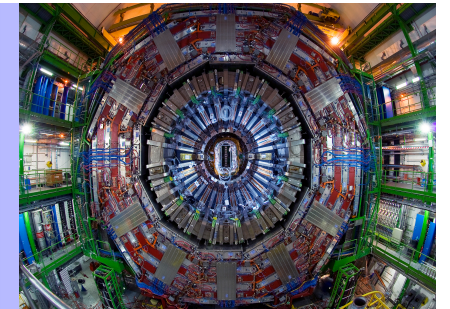


- Ongoing studies:
 - momentum scale corrections and fine tuning the material description at few % level;
 - Material description photon conv., nuclear interactions, multiple scattering, energy loss
 - Track reconstr. efficiency
 - Ratios of rates $D^0 \rightarrow K\pi / D^0 \rightarrow K\pi\pi\pi$ (+ other methods)

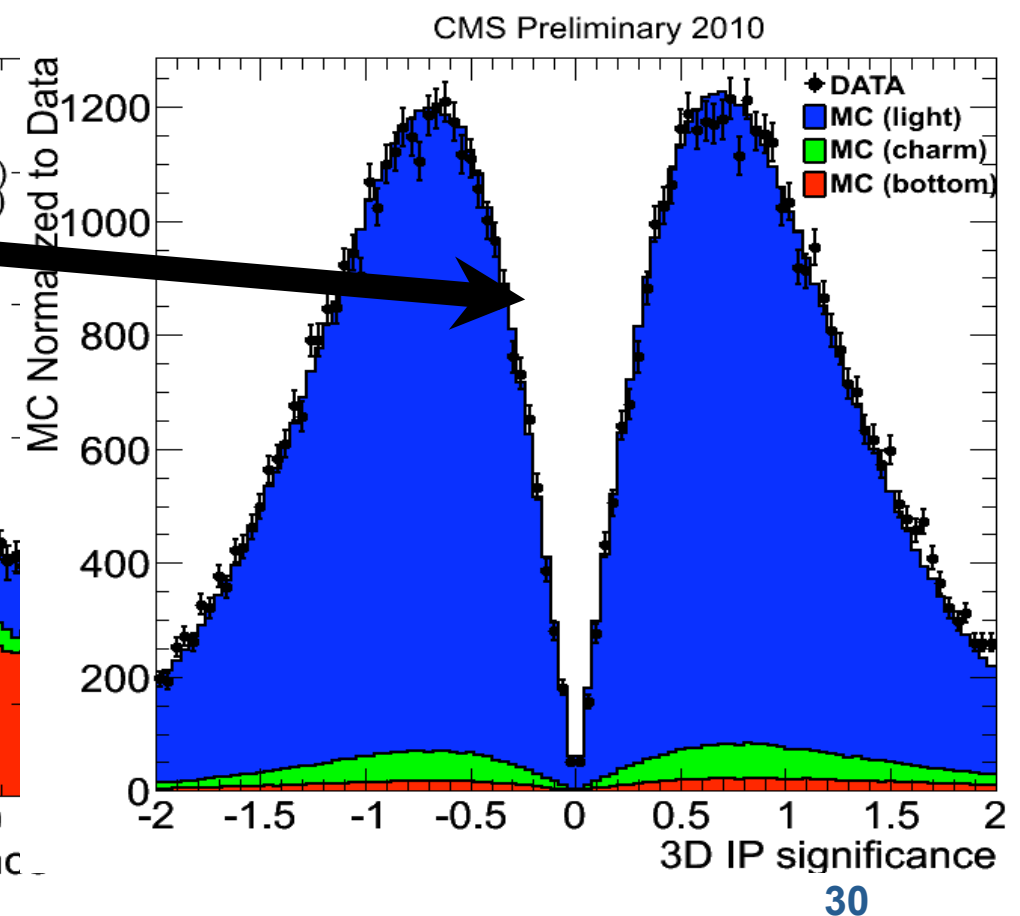
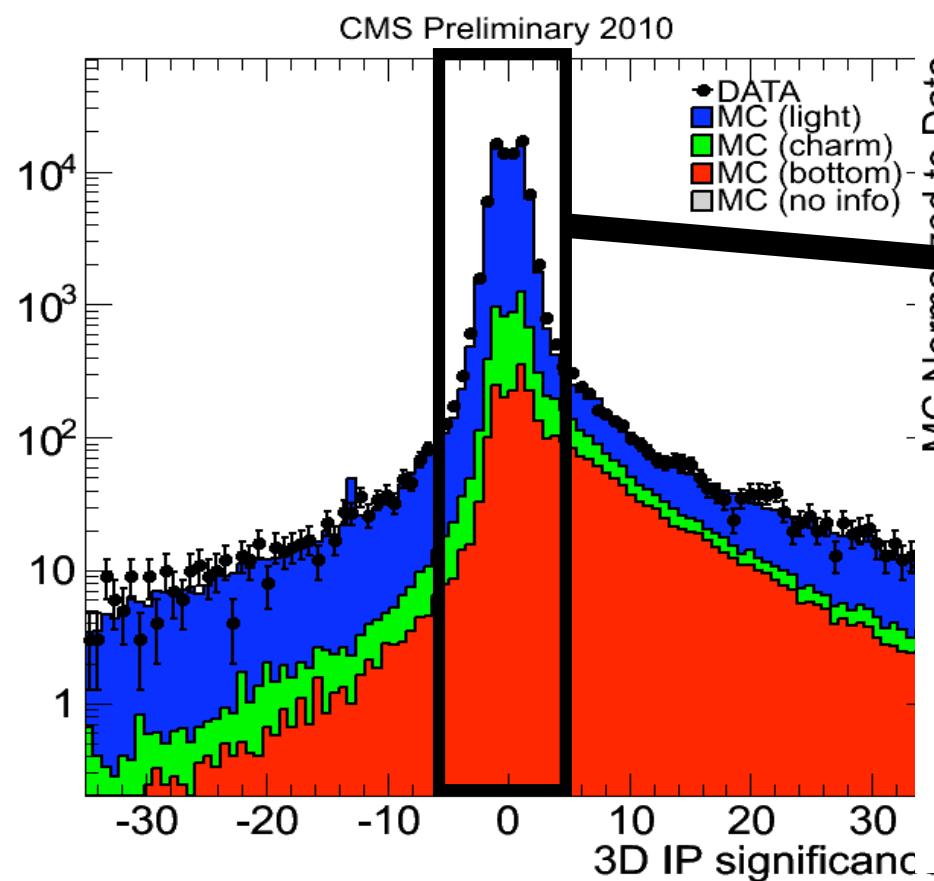
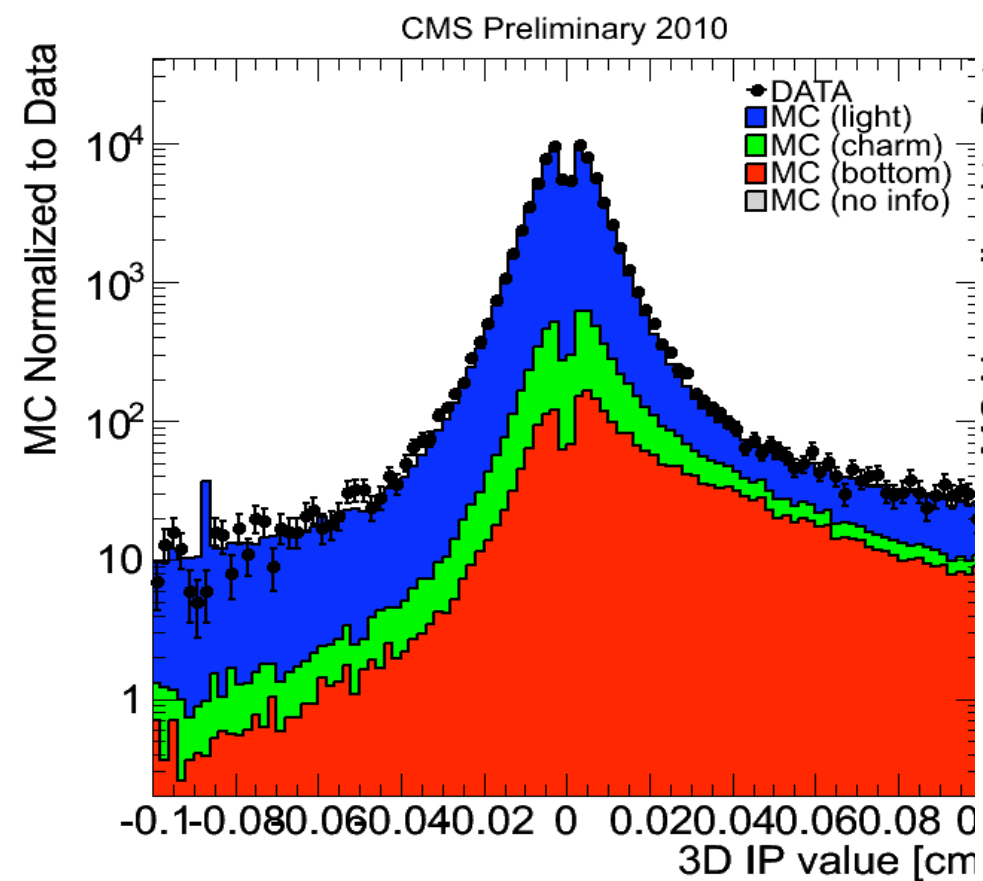
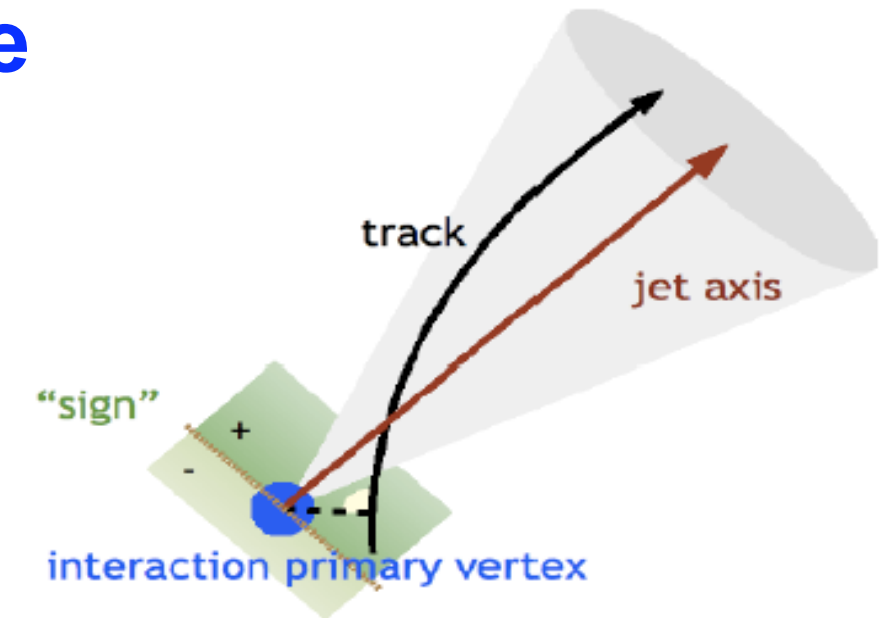




B Tagging

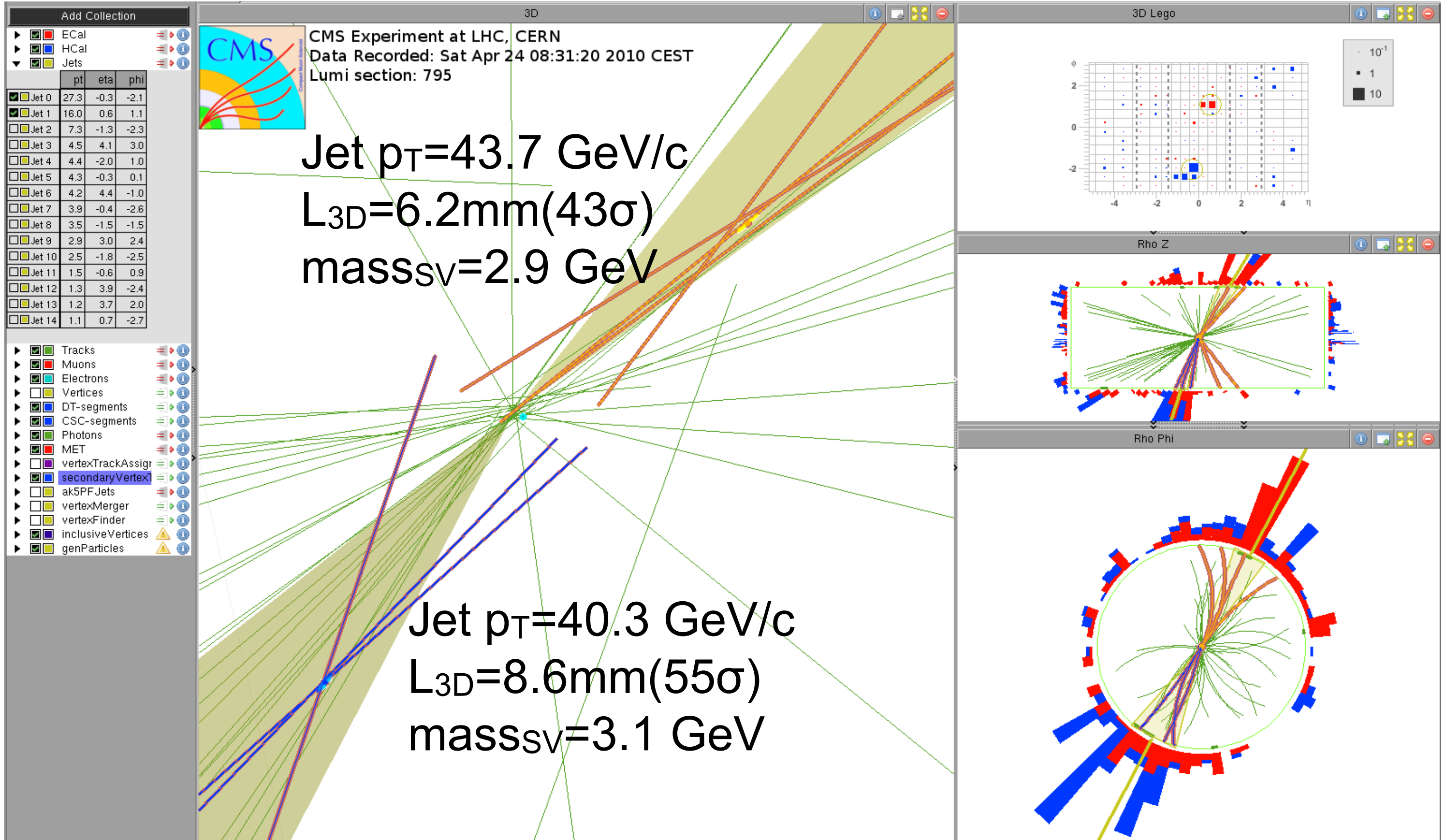
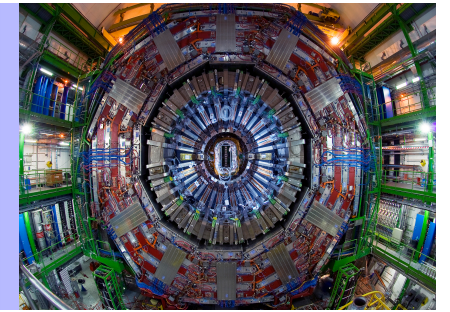


- 3D Impact parameter value and significance
- Selection:
 - tracks with $P_t > 1 \text{ GeV}$ belonging to jets with $p_T > 40 \text{ GeV}$ and $|\eta| < 1.5$ (*PFlow Jets anti- k_T $R=0.5$*).



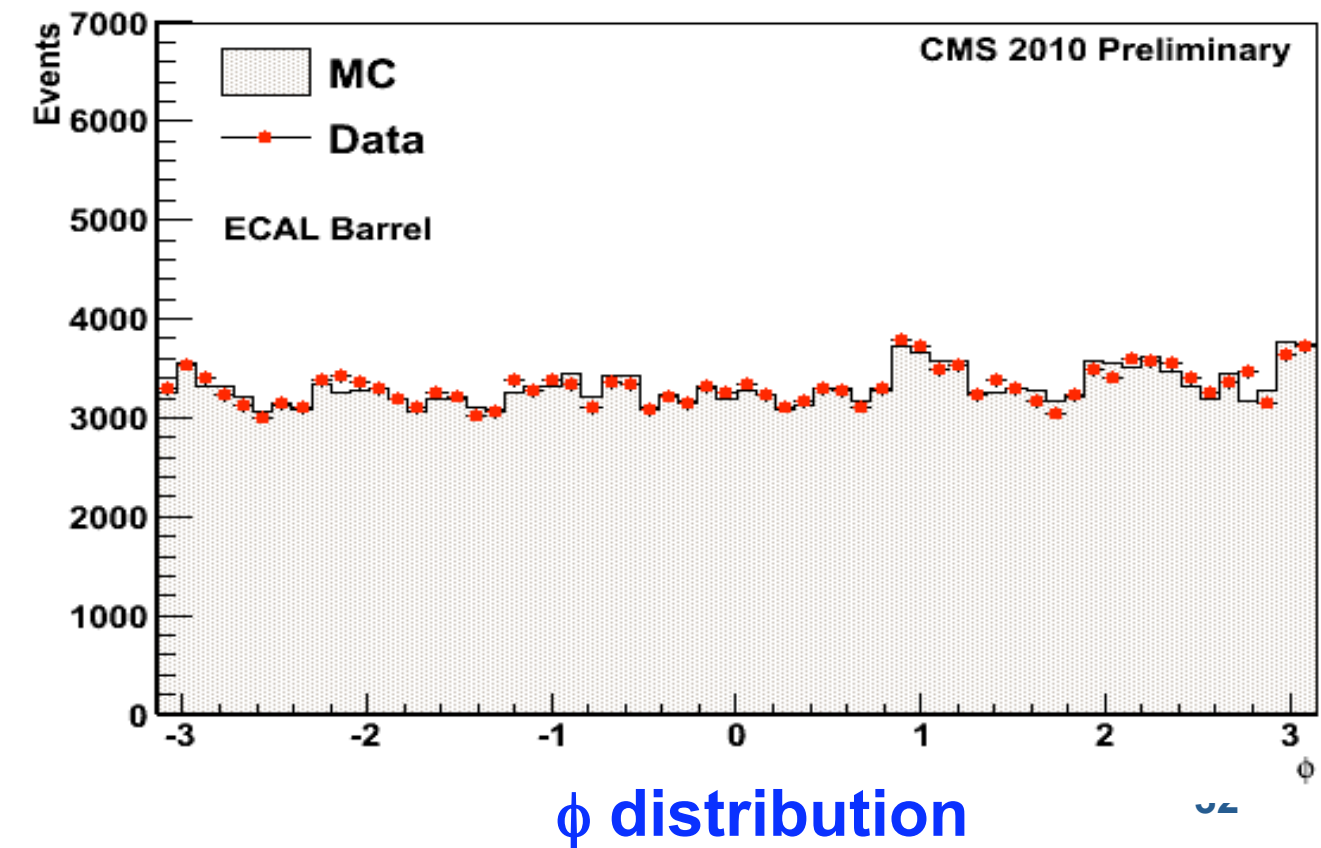
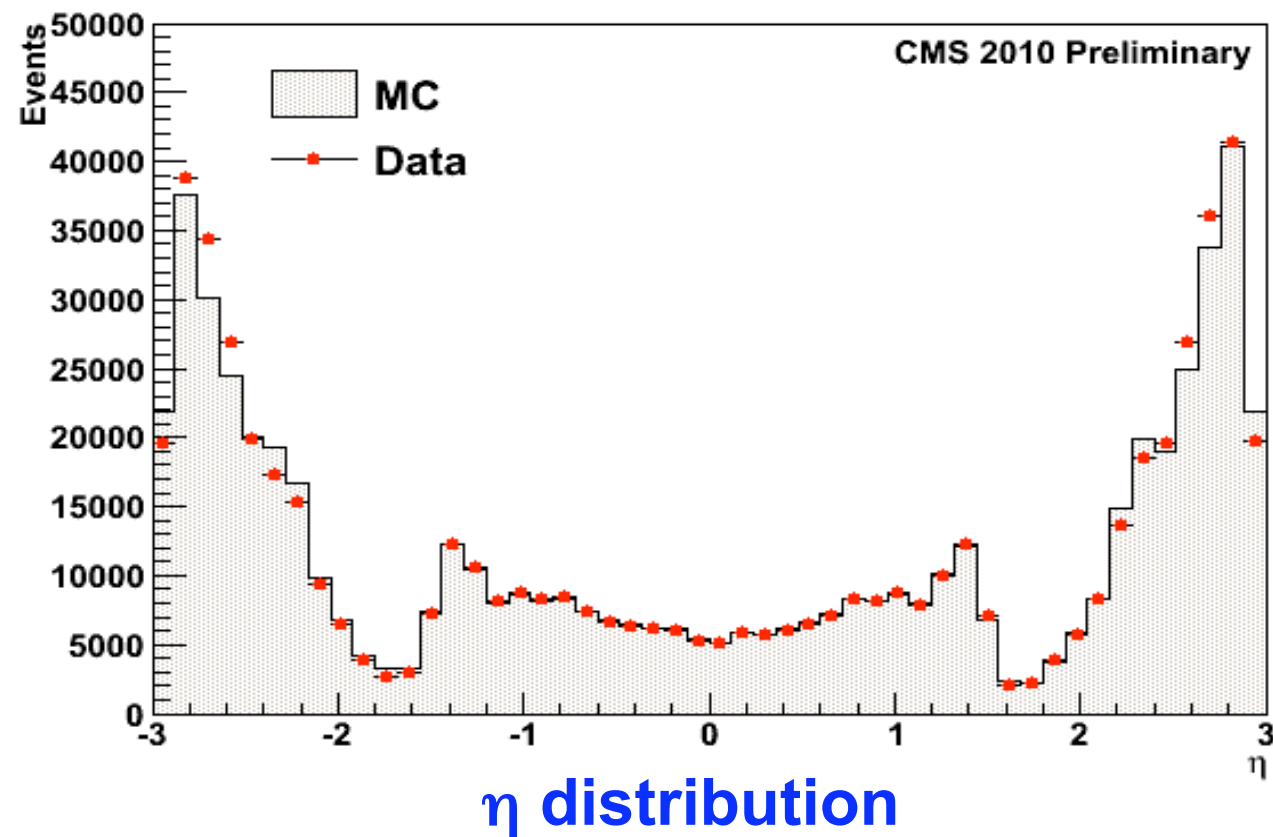
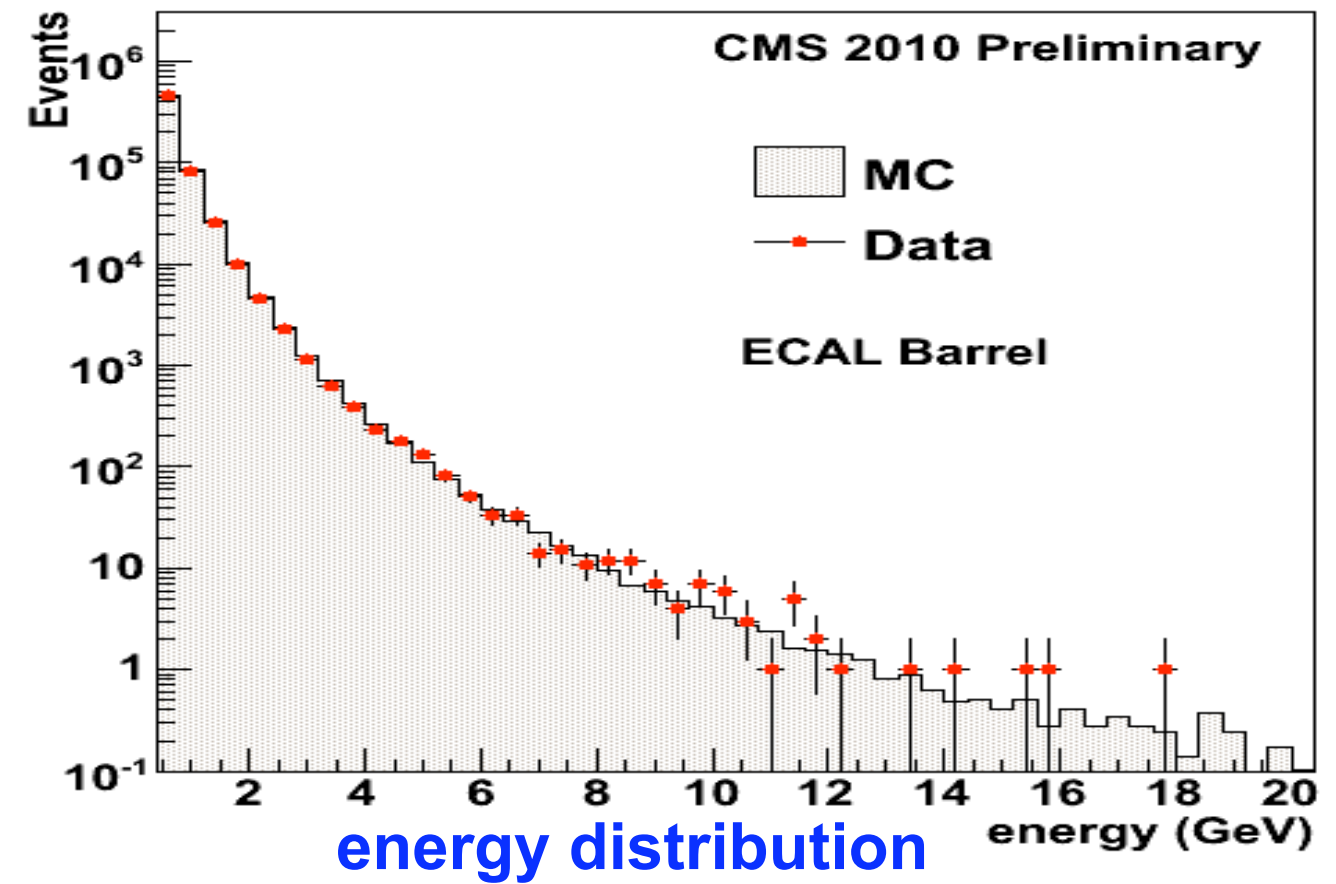
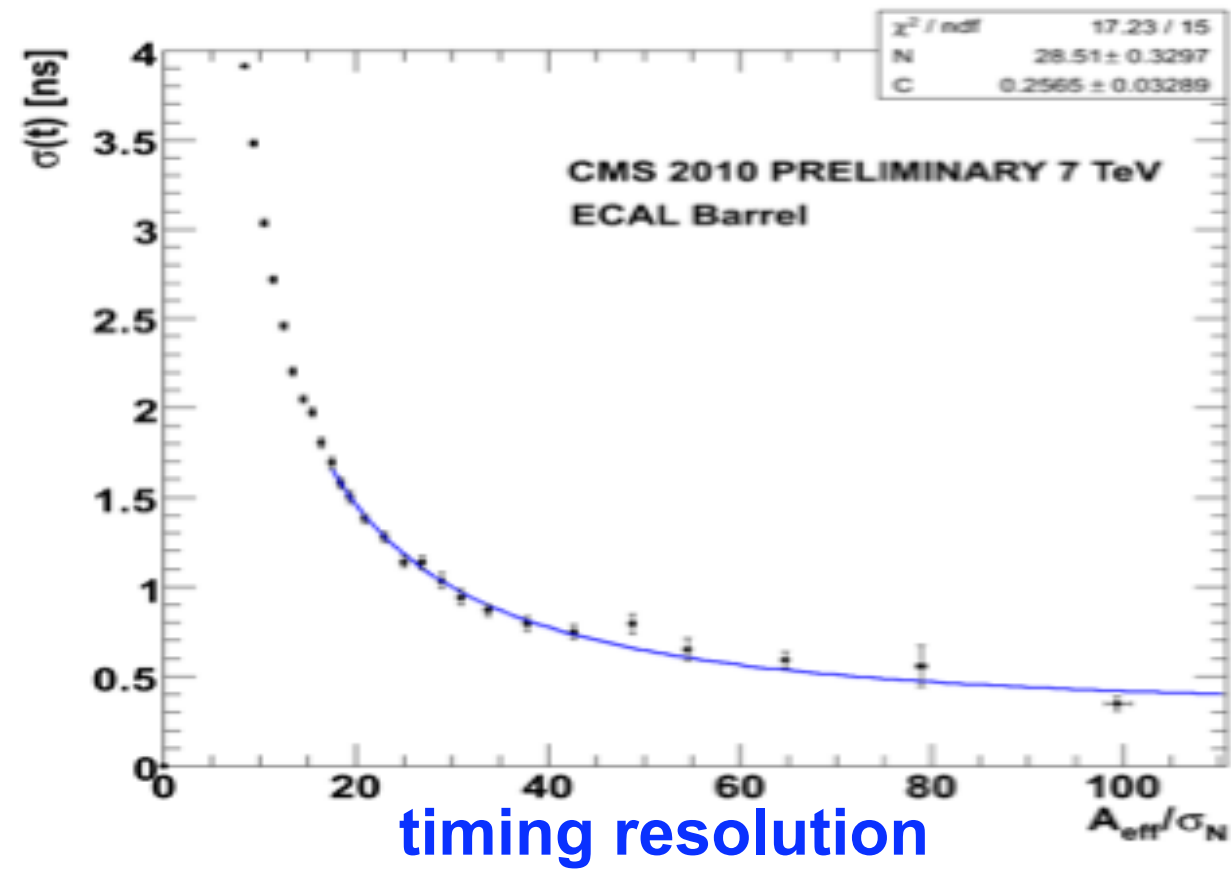
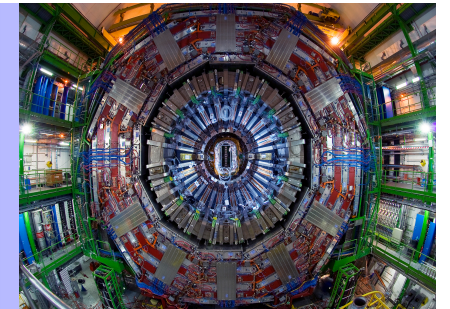


Two Tagged b-jets Candidate



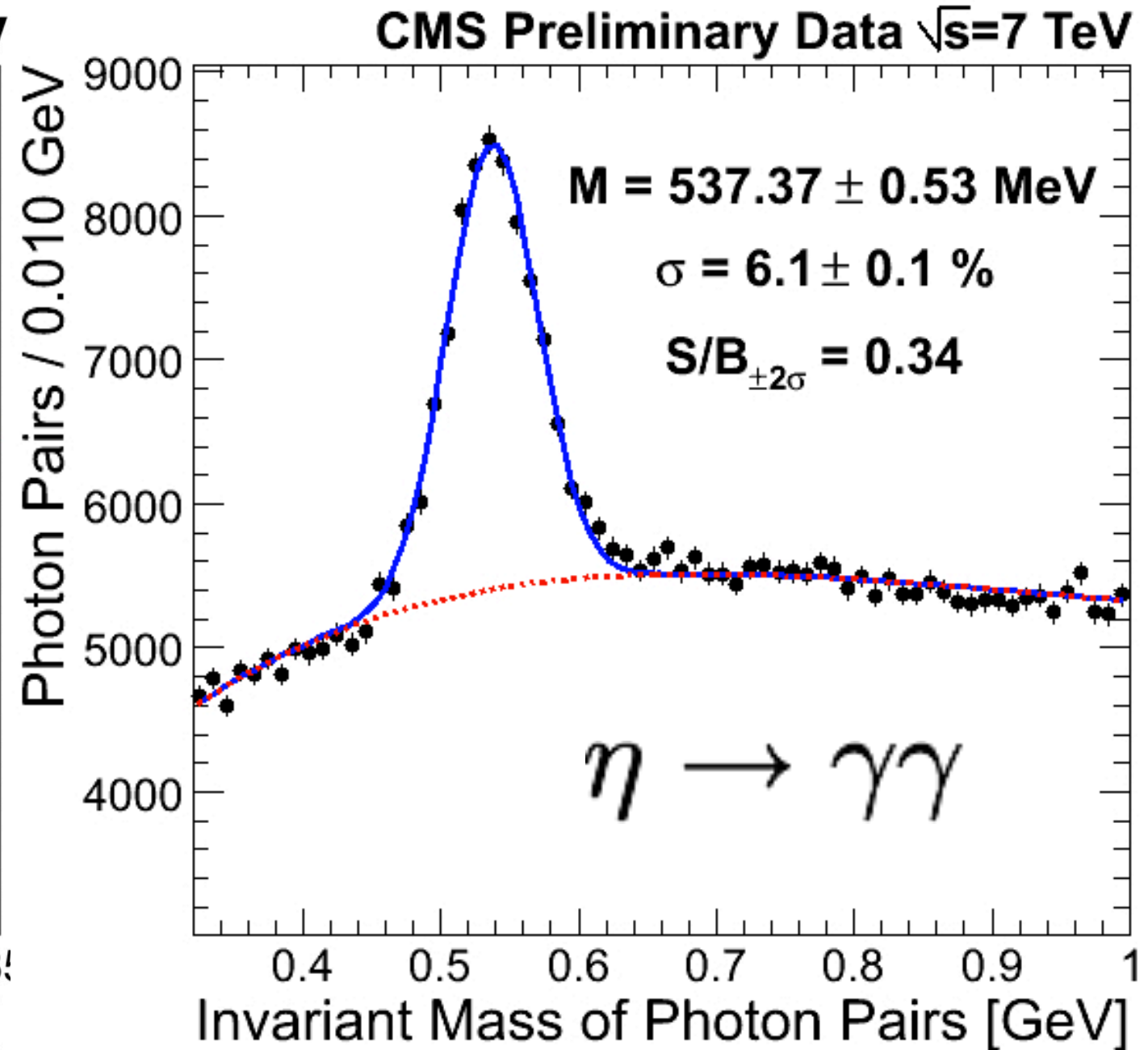
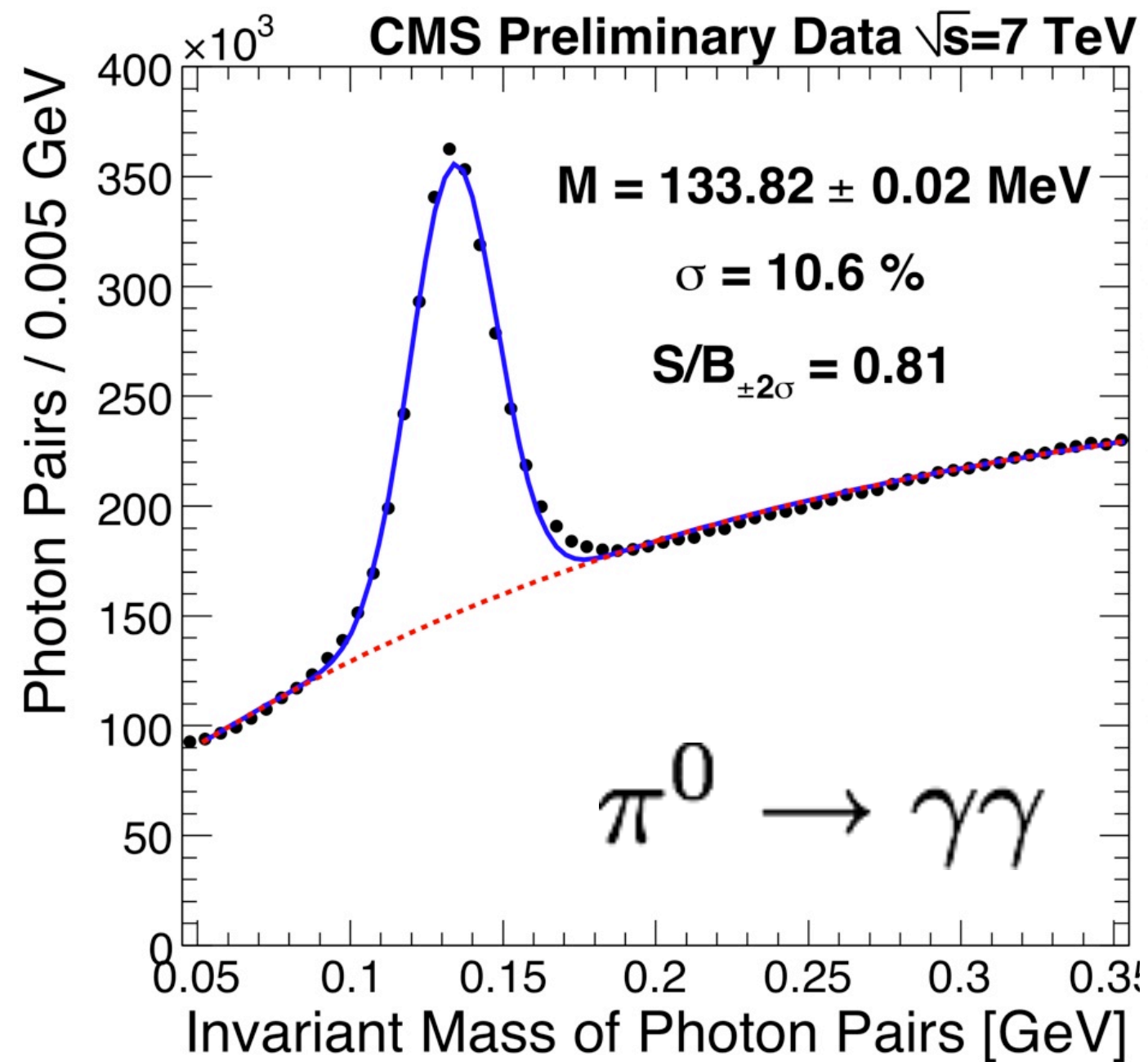
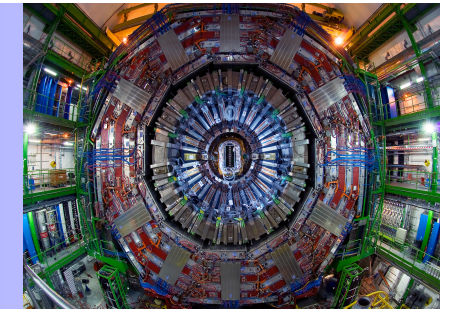


ECAL Clusters (e & γ)





ECAL Calibration

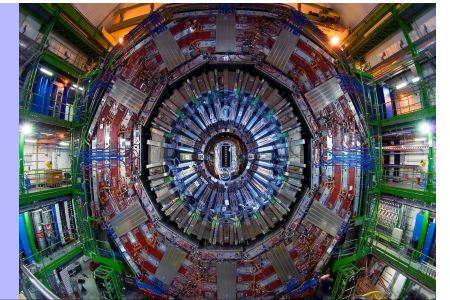


Agreement on energy scale at $\sim 1\%$ level (width well modeled)

π^0 and η samples to improve further calibration and monitoring



JET Reconstruction



- Three different Jet Reconstruction methods:

- **Calorimeter Jets:**

Based on calorimeter tower

- **Jet-plus-tracks Jets**

a posteriori corrections to calorimeter using tracks

- **Particle flow Jets**

a priori use of tracks and calorimeter

Identify charged hadrons, photons, electrons, neutral hadrons

Default Jet Algorithm:

Anti-kT, R=0.5



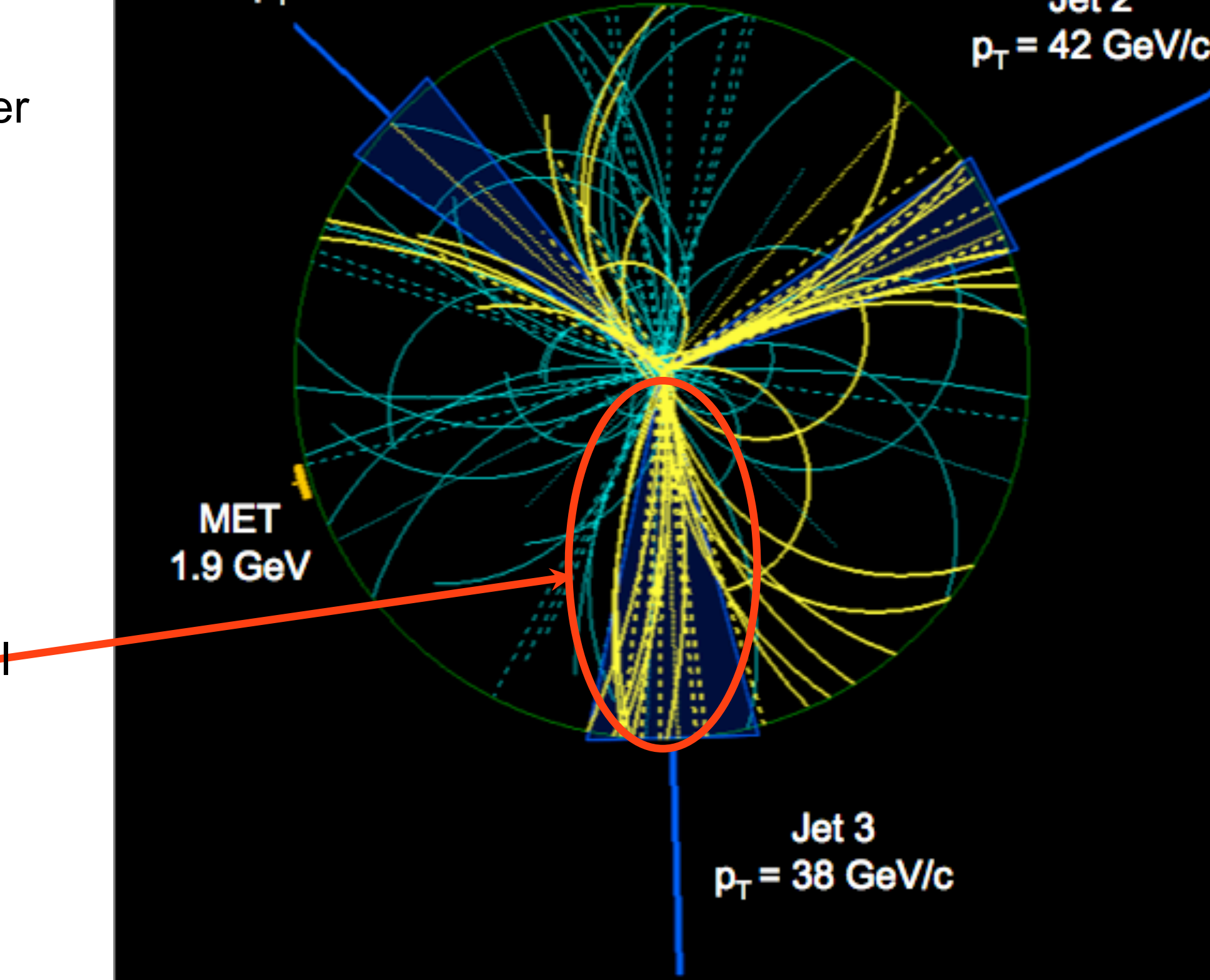
CMS, December 2009, 2.36 TeV
Run 124120 / Event 6613074
Particle Flow Reconstruction

Jet 1 $p_T = 22 \text{ GeV}/c$

Jet 2
 $p_T = 42 \text{ GeV}/c$

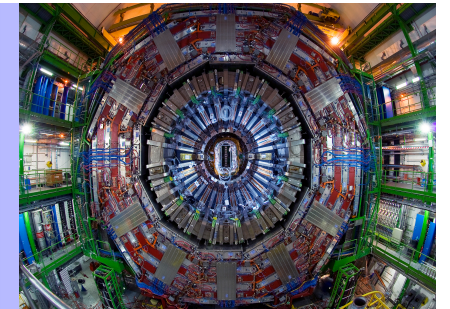
MET
1.9 GeV

Jet 3
 $p_T = 38 \text{ GeV}/c$



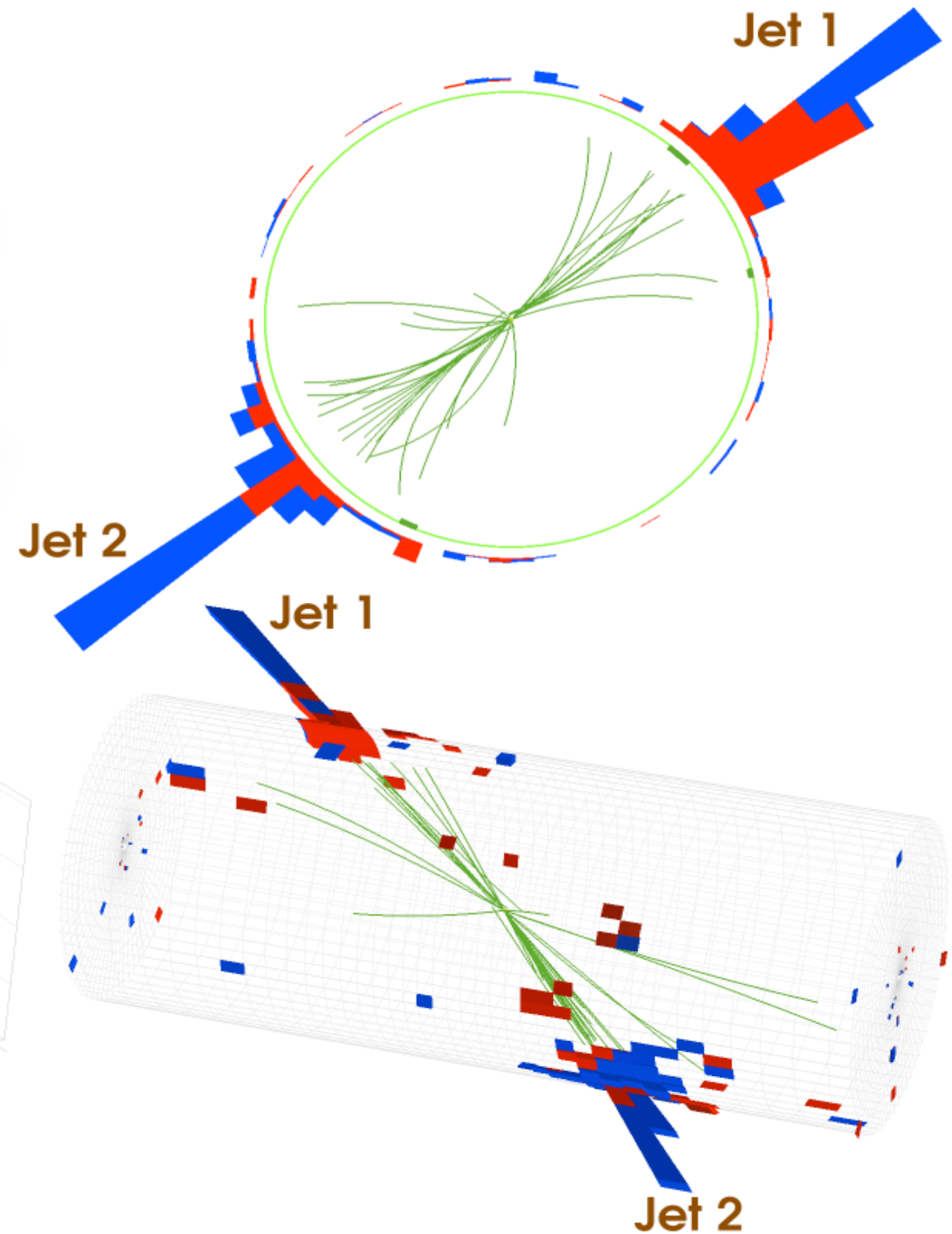
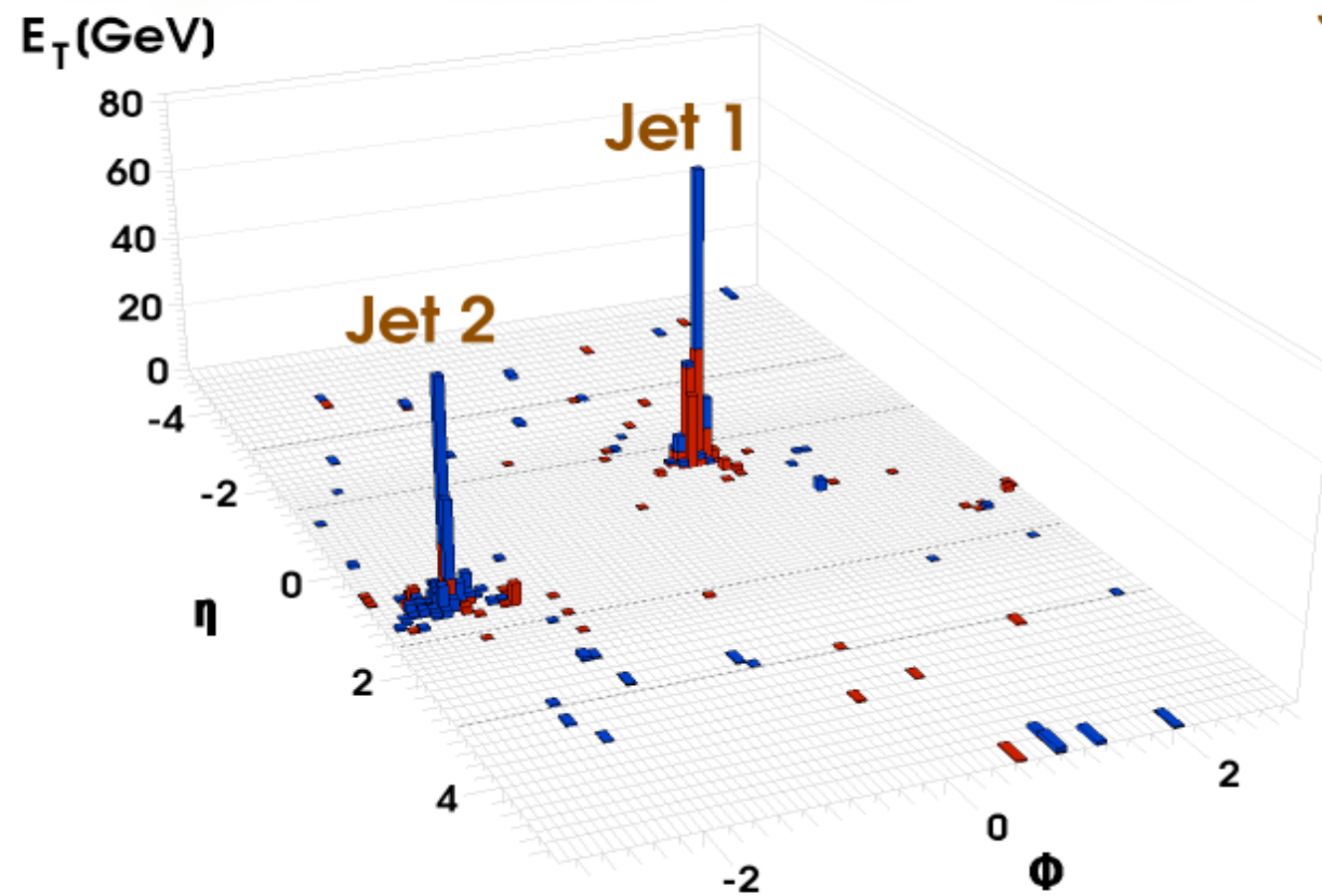


Di-jet Candidate Events



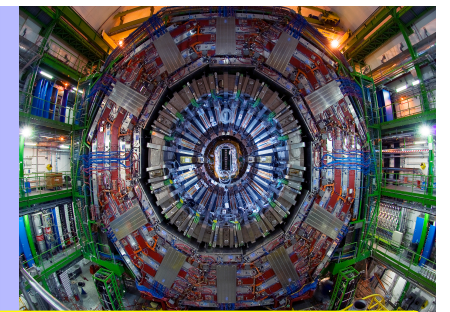
CMS Experiment at LHC, CERN
Run 133450 Event 16358963
Lumi section: 285
Sat Apr 17 2010, 12:25:05 CEST

Jet 1 p_T : 253 GeV
Jet 2 p_T : 244 GeV
Dijet mass : 764 GeV



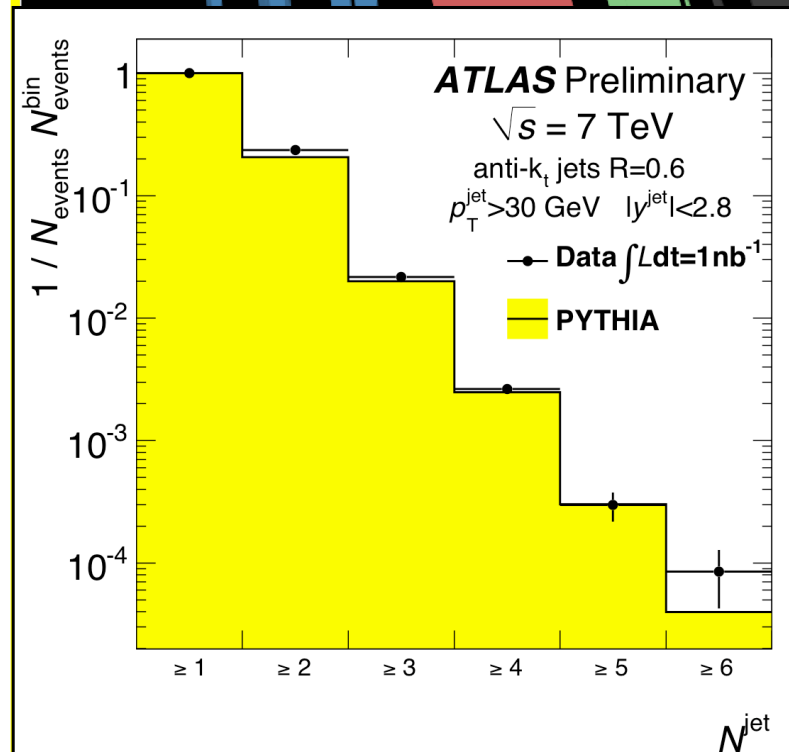
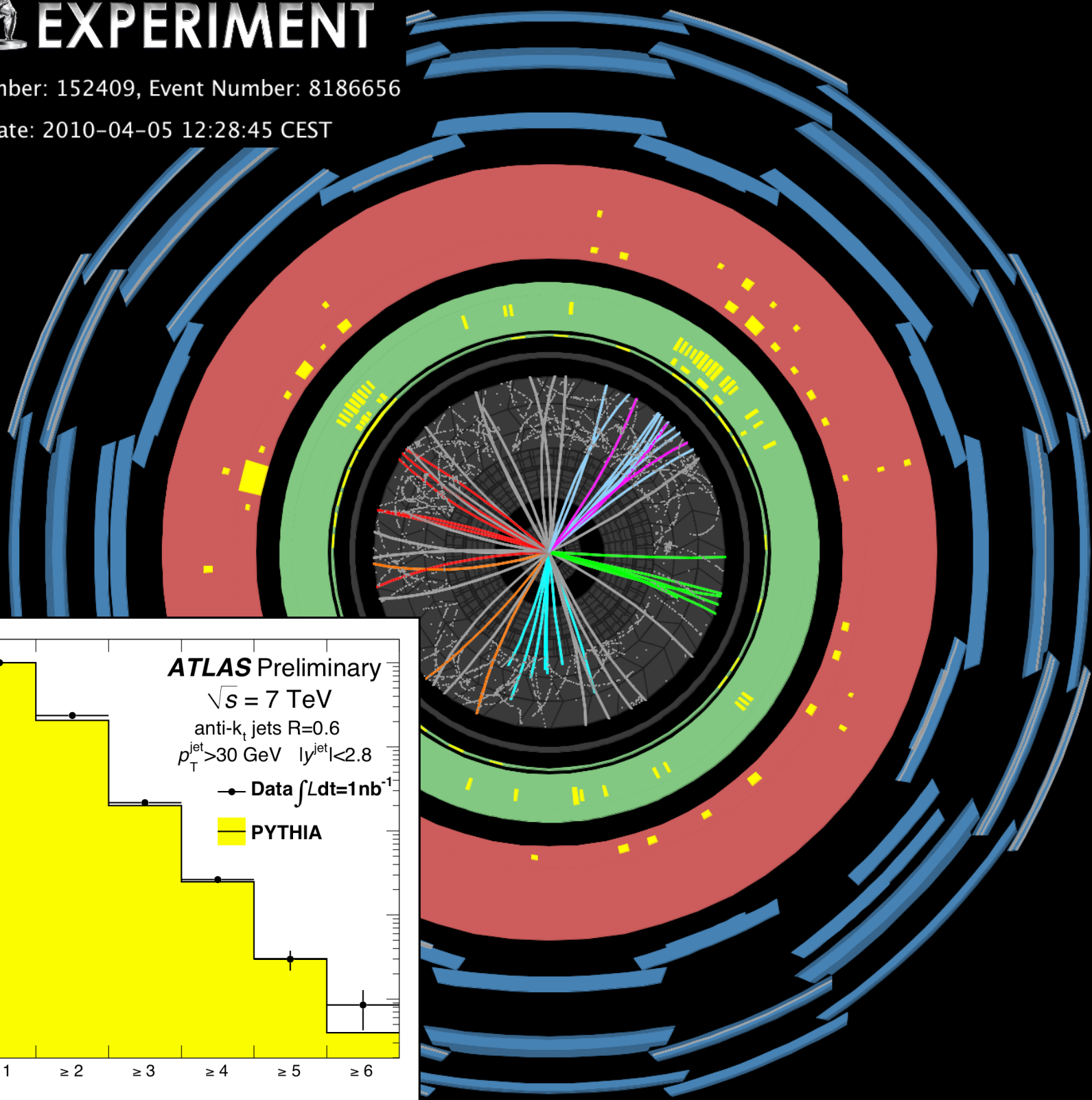


Jets in ATLAS

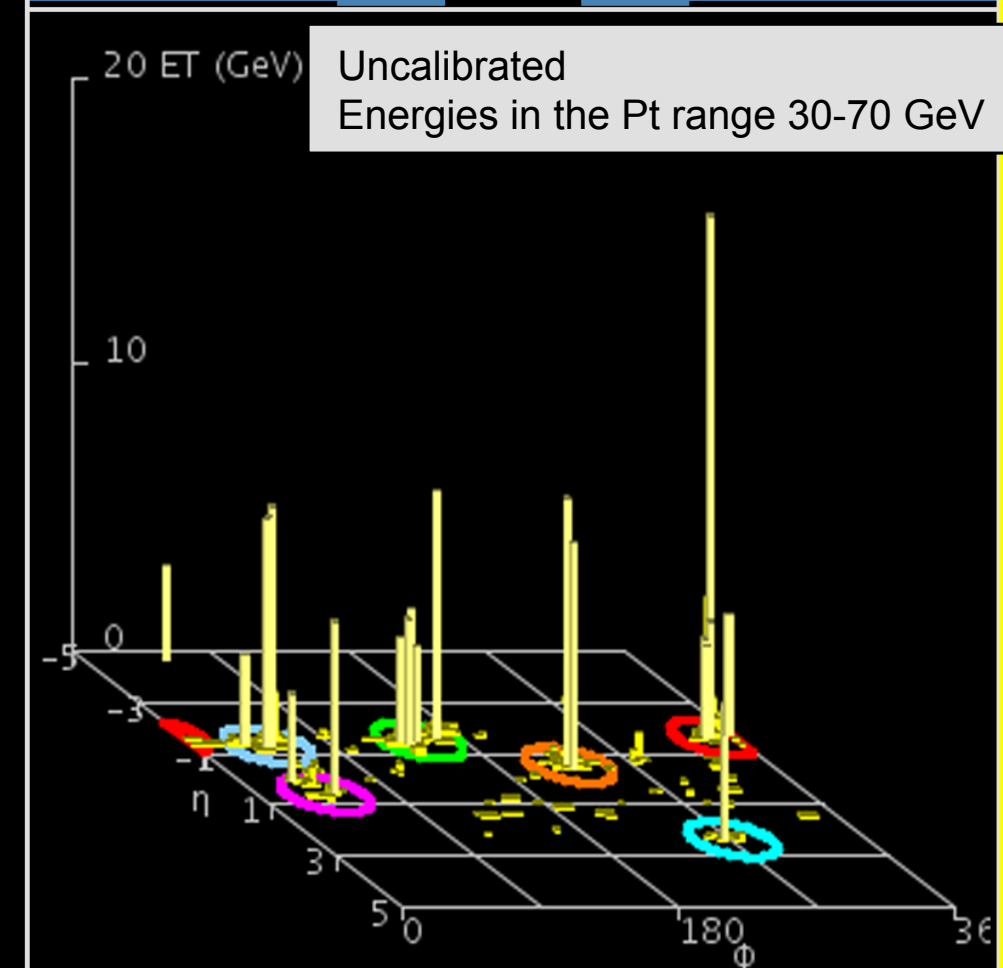
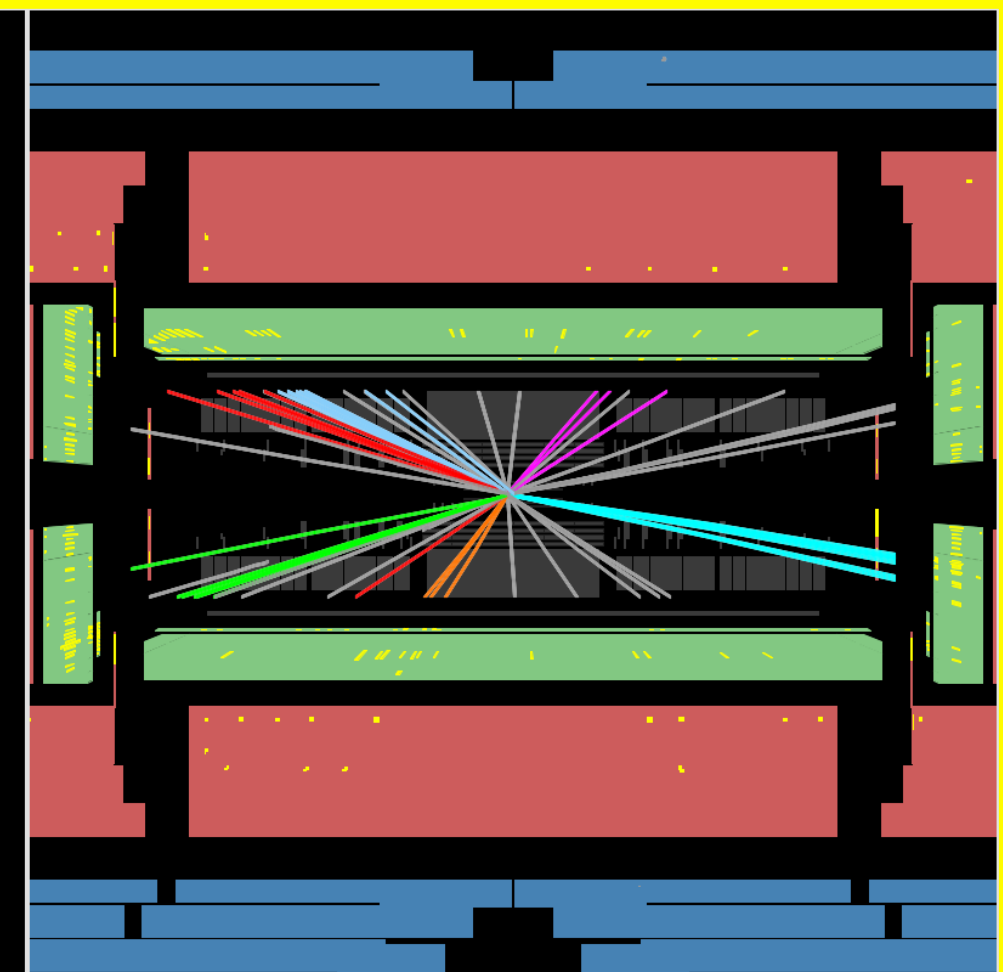


Run Number: 152409, Event Number: 8186656

Date: 2010-04-05 12:28:45 CEST

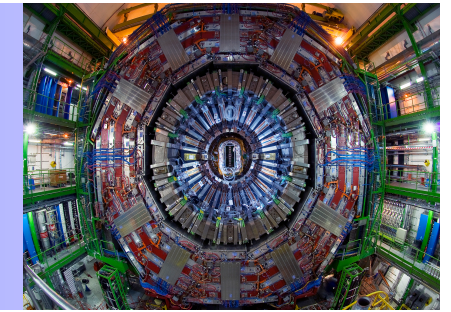


6 Jet Event in 7 TeV Collisions





CMS Dijet Distributions



- Jets reconstructed with the anti- k_T $R=0.5$ algorithm
- Dijet selection : Jet $P_t > 25$ GeV, $\Delta\Phi > 2.1$, $|\eta| < 3$
- Loose ID cuts on number of components
- Three different approaches: pure calorimetric, track corrected calo and particle flow.

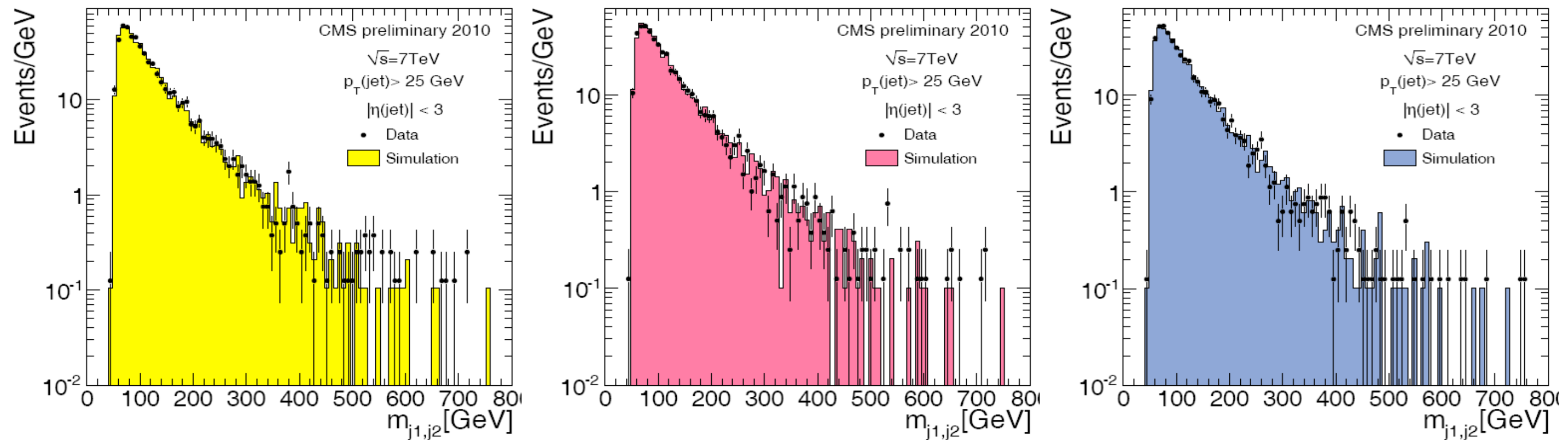
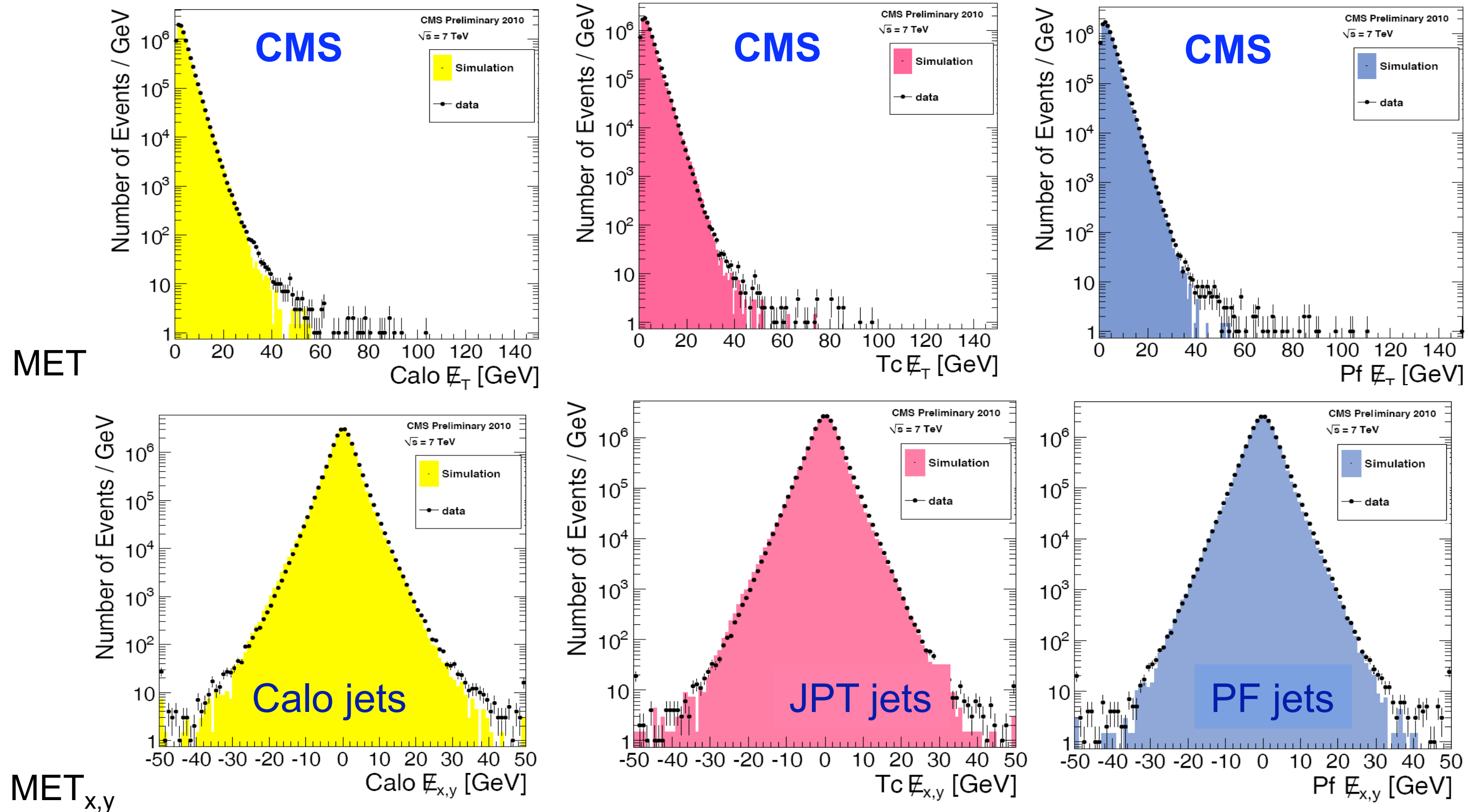
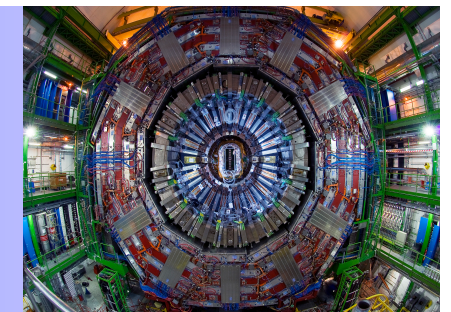


Figure: Data vs MC: Di jet mass m_{j_1, j_2} for Calorimeter Jets, JPT jets, PFjets.



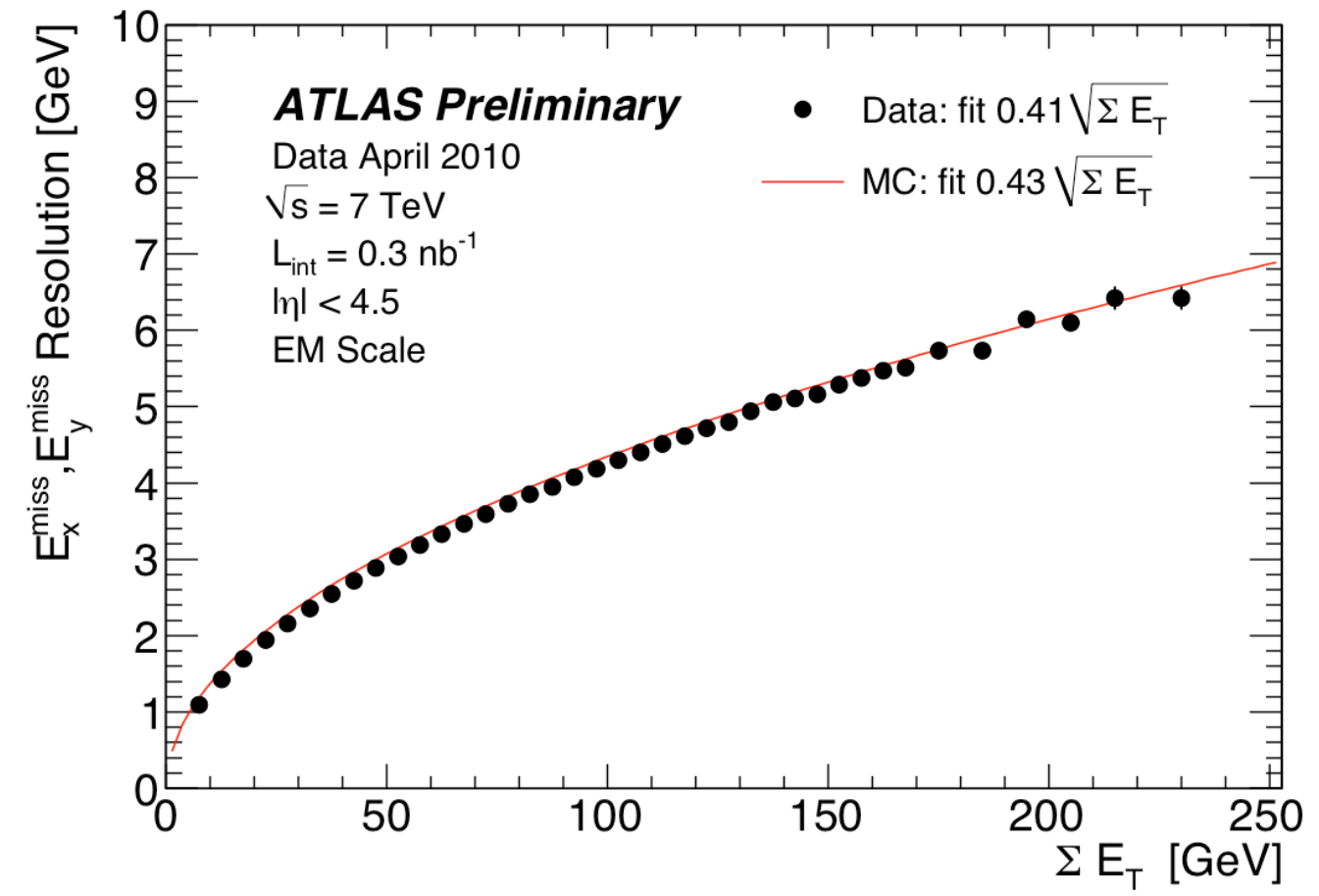
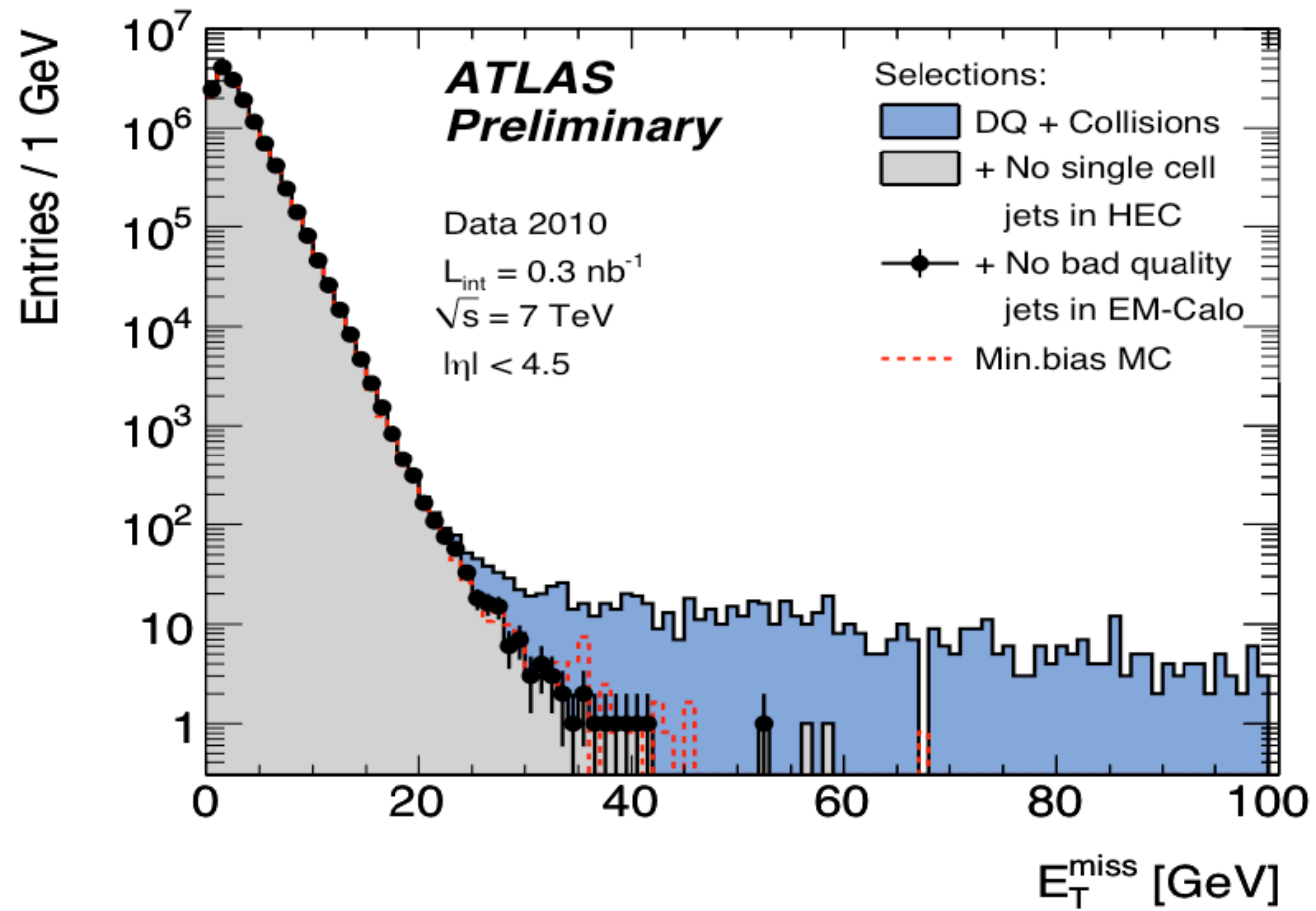
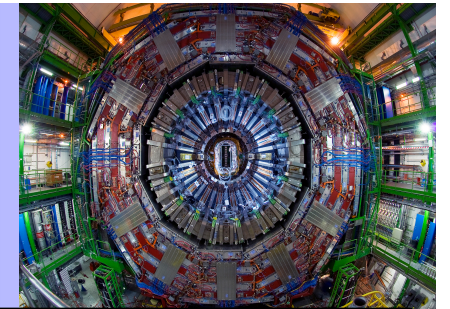
Missing Transverse Energy (MET)



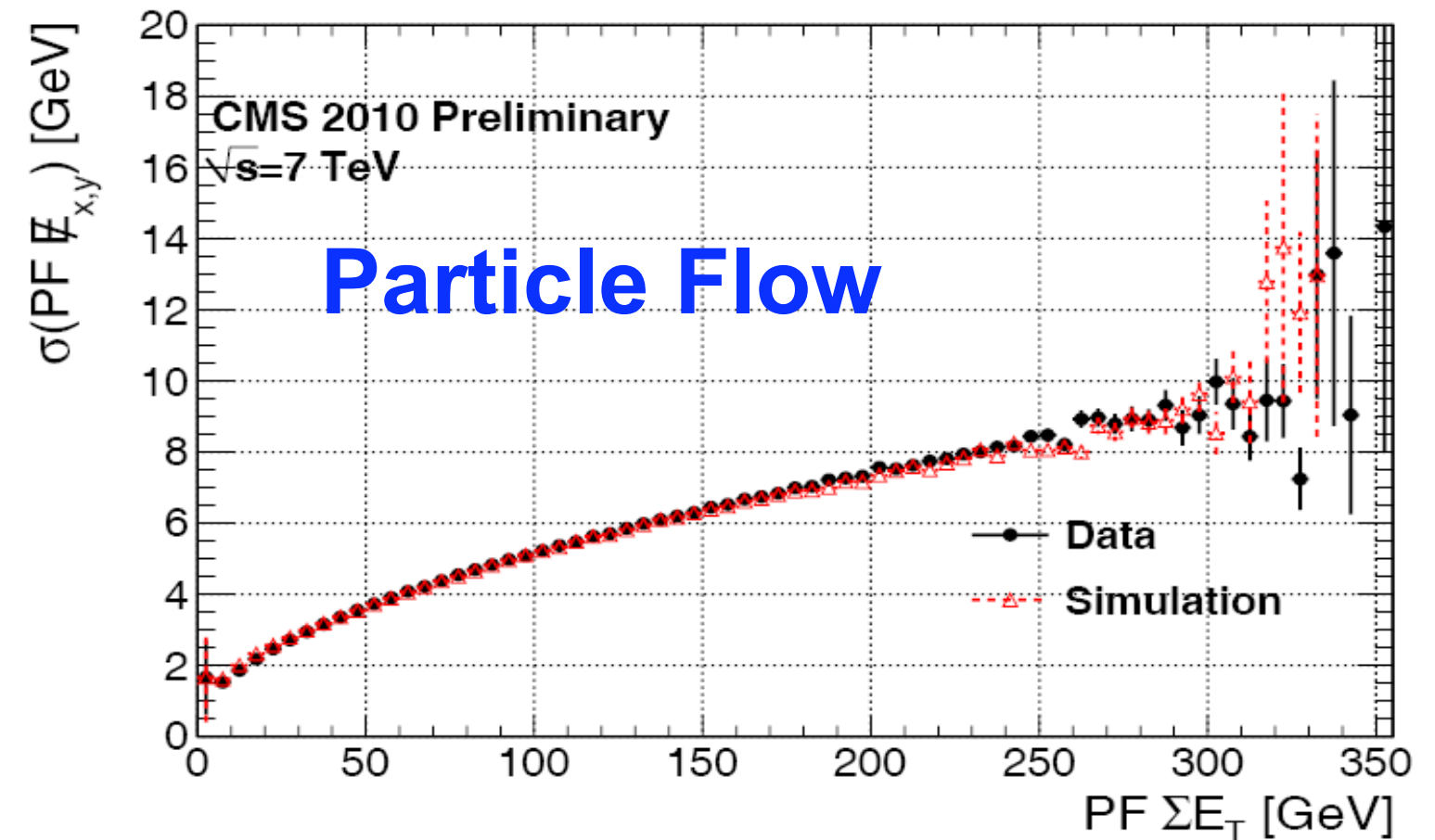
- MB studies - monitoring of core and tails (noise dominated)
- Good agreement with MC over many orders of magnitude
- Continuous improvement of MET tails



MET Resolutions

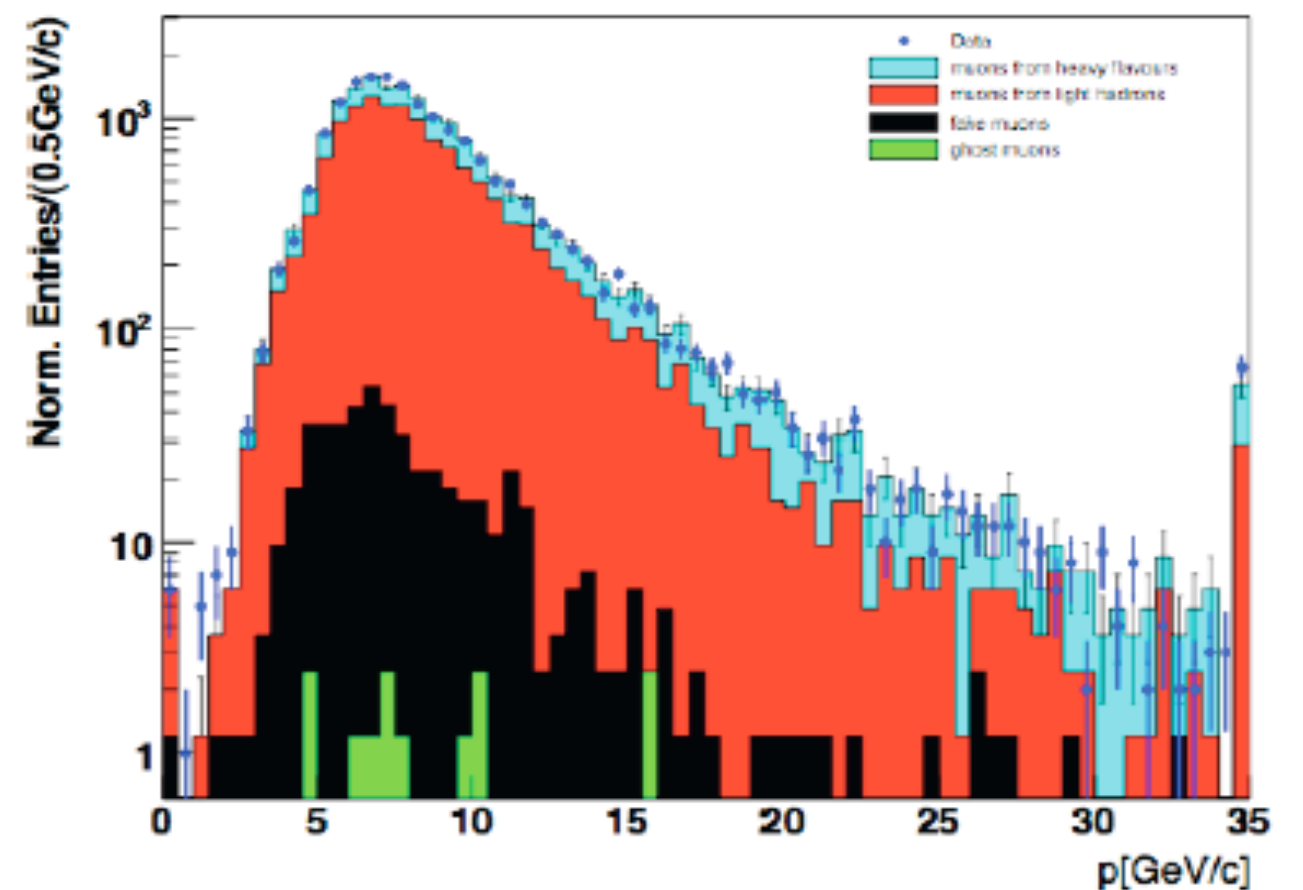
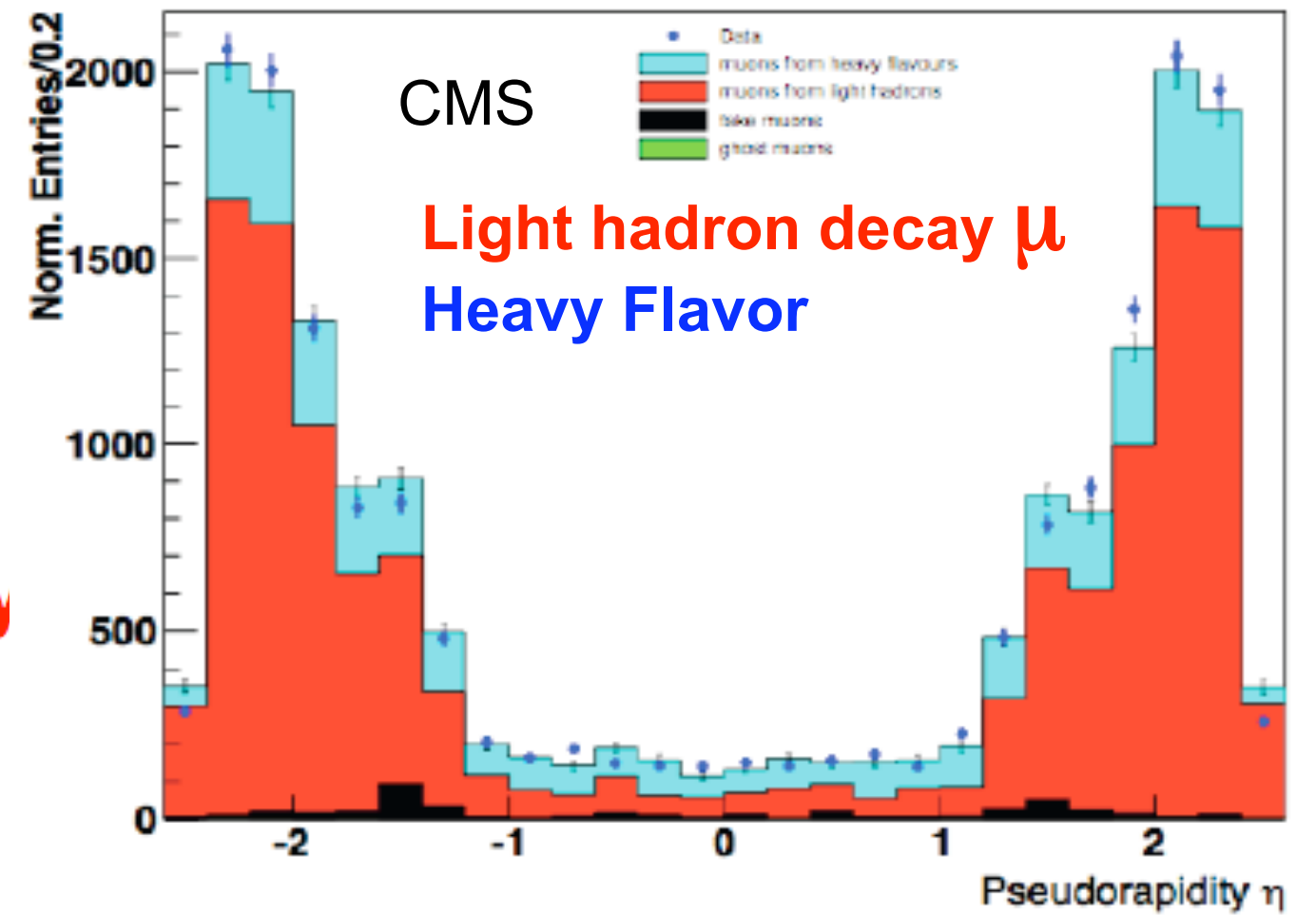
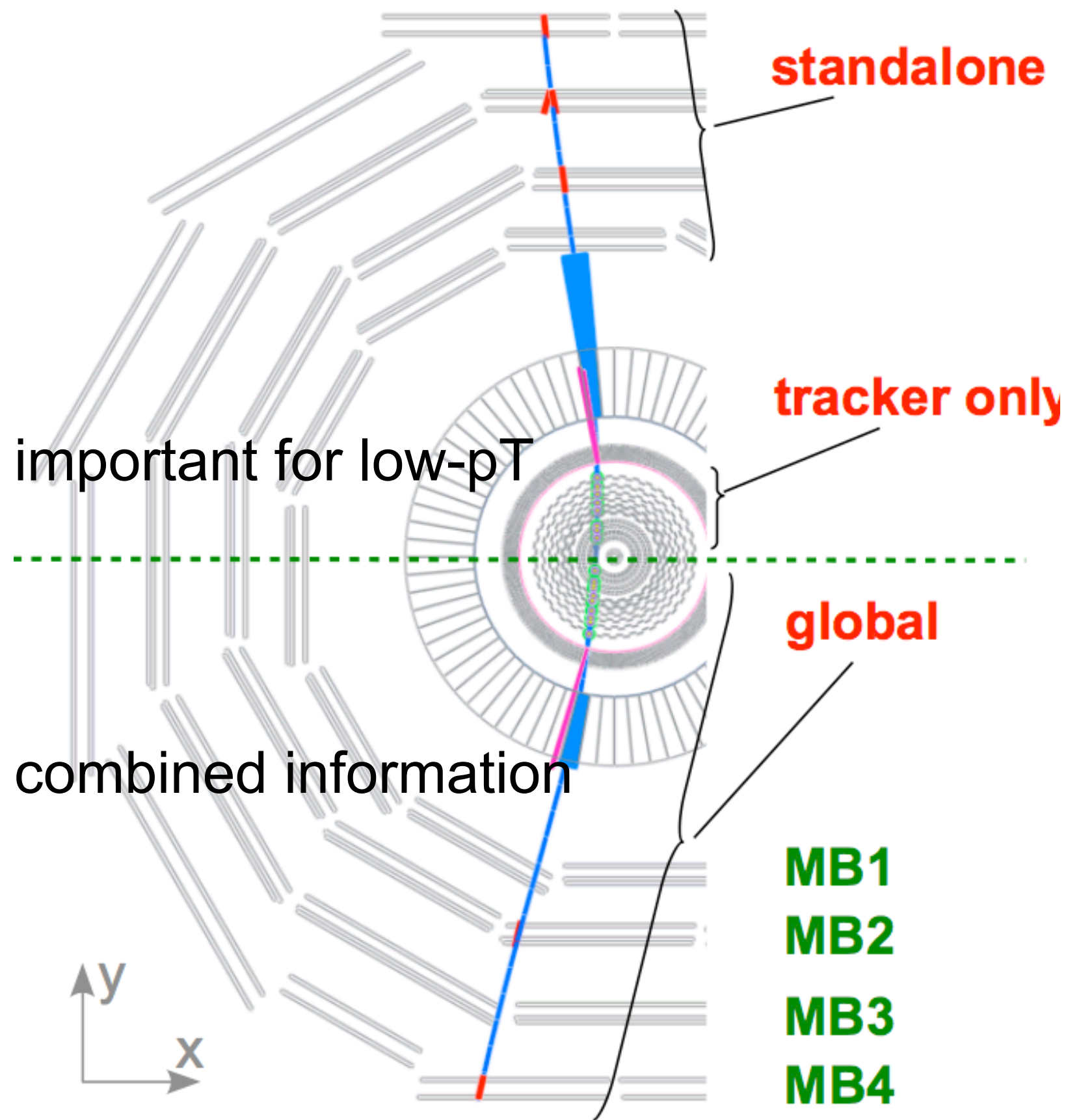
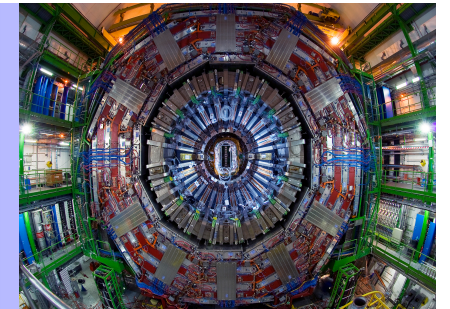


- E_T^{Miss} sensitive to calorimeter performance: noise, dead cells, cracks, mis-calibrations, beam backgrounds



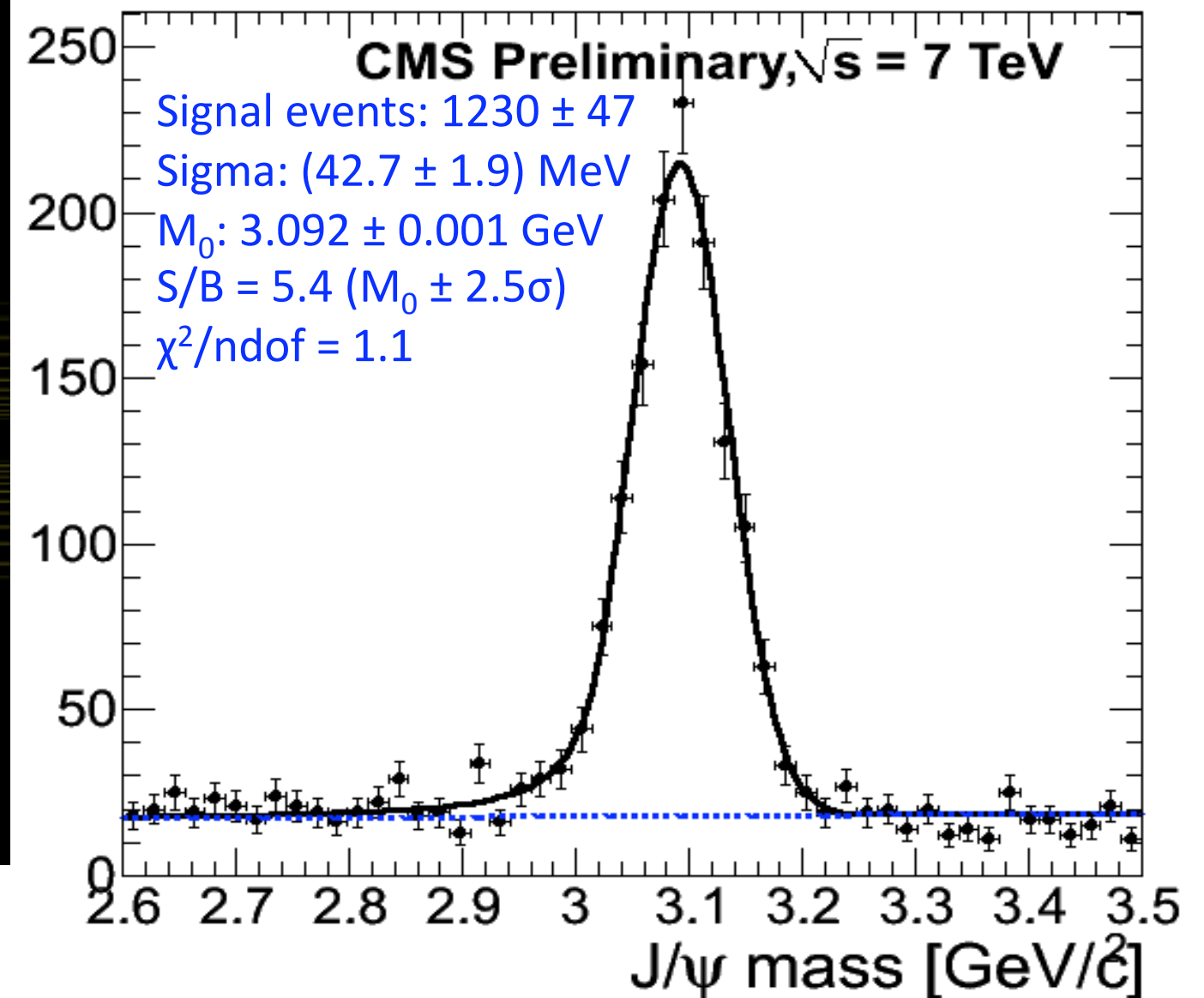
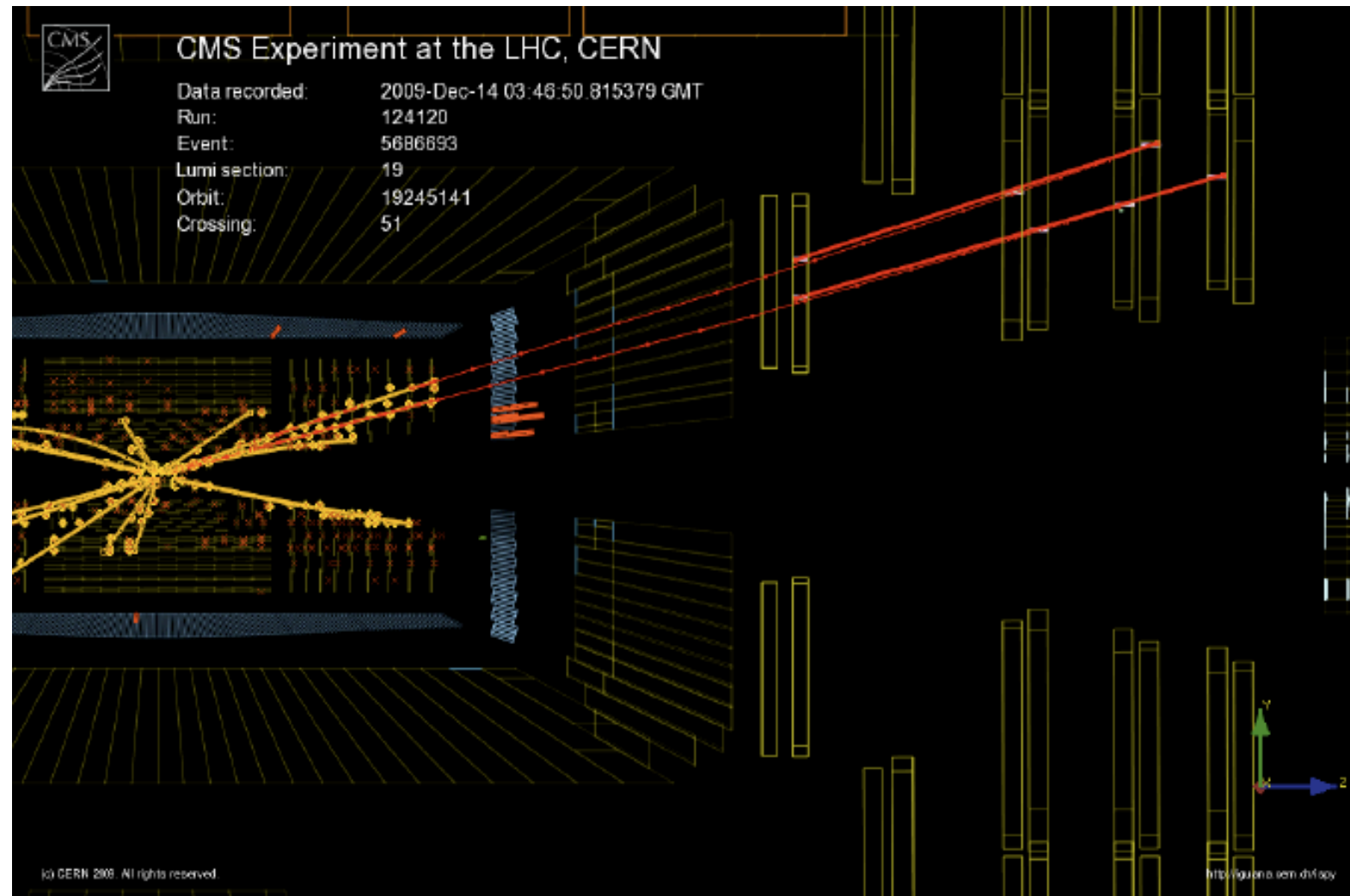
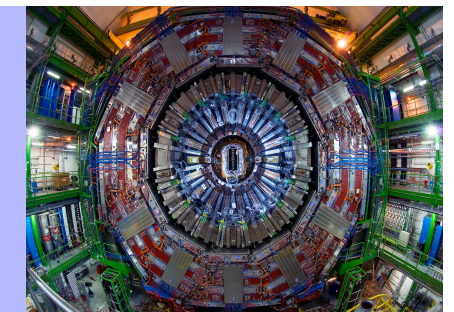


MUON Reconstruction





$J/\psi \rightarrow \mu^+ \mu^-$ Reconstruction



Excellent signal for :

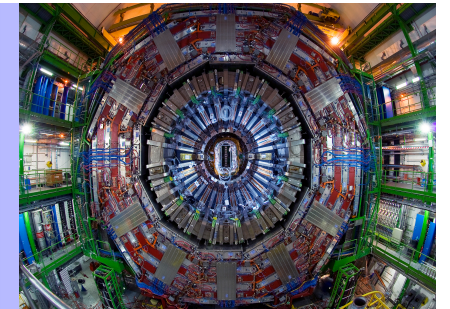
Calibration - momentum scale, reconstruction efficiency

Physics - J/ ψ production properties, B- \rightarrow J/ ψ X

reconstruction, lifetime measurements

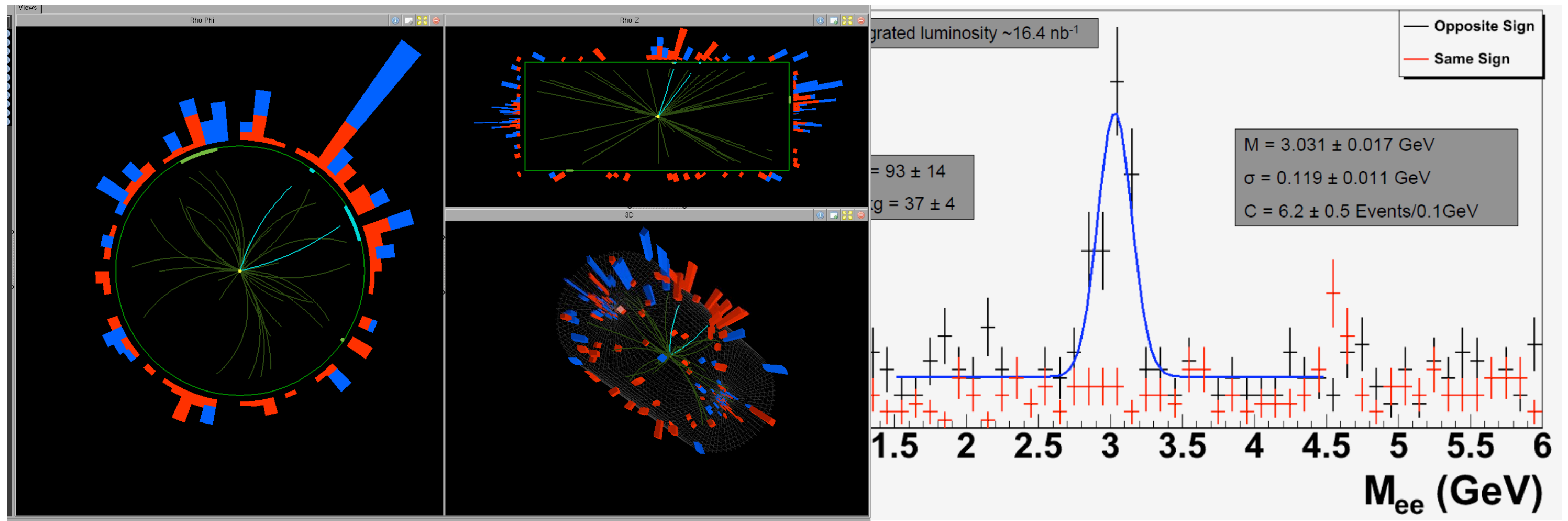


$J/\psi \rightarrow e^+e^-$ Reconstruction



Event Selection: loose electron requirements

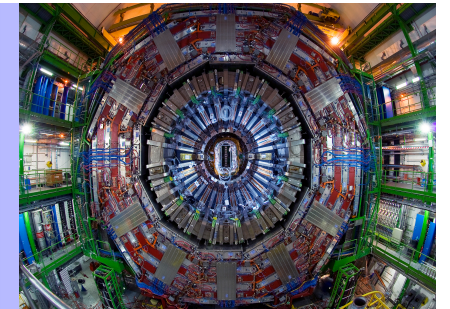
More difficult: larger backgrounds; tighter selections; reduced signal



~93 events



$W^{\pm} \rightarrow e^{\pm} \nu$ Candidate Events



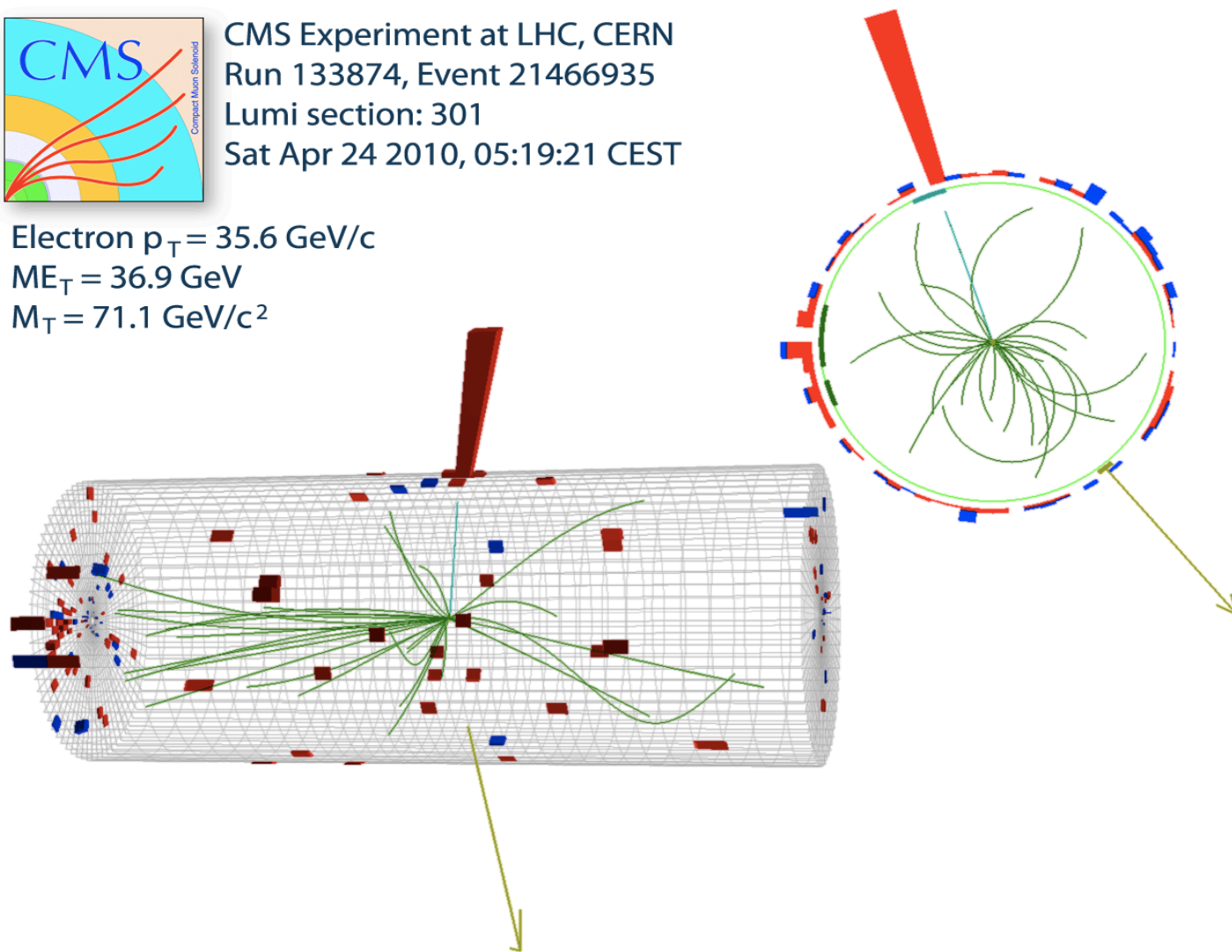
Event Selection: Basic Electron ID, no MET

MC cross sections: normalized to 12nb-1 integrated luminosity

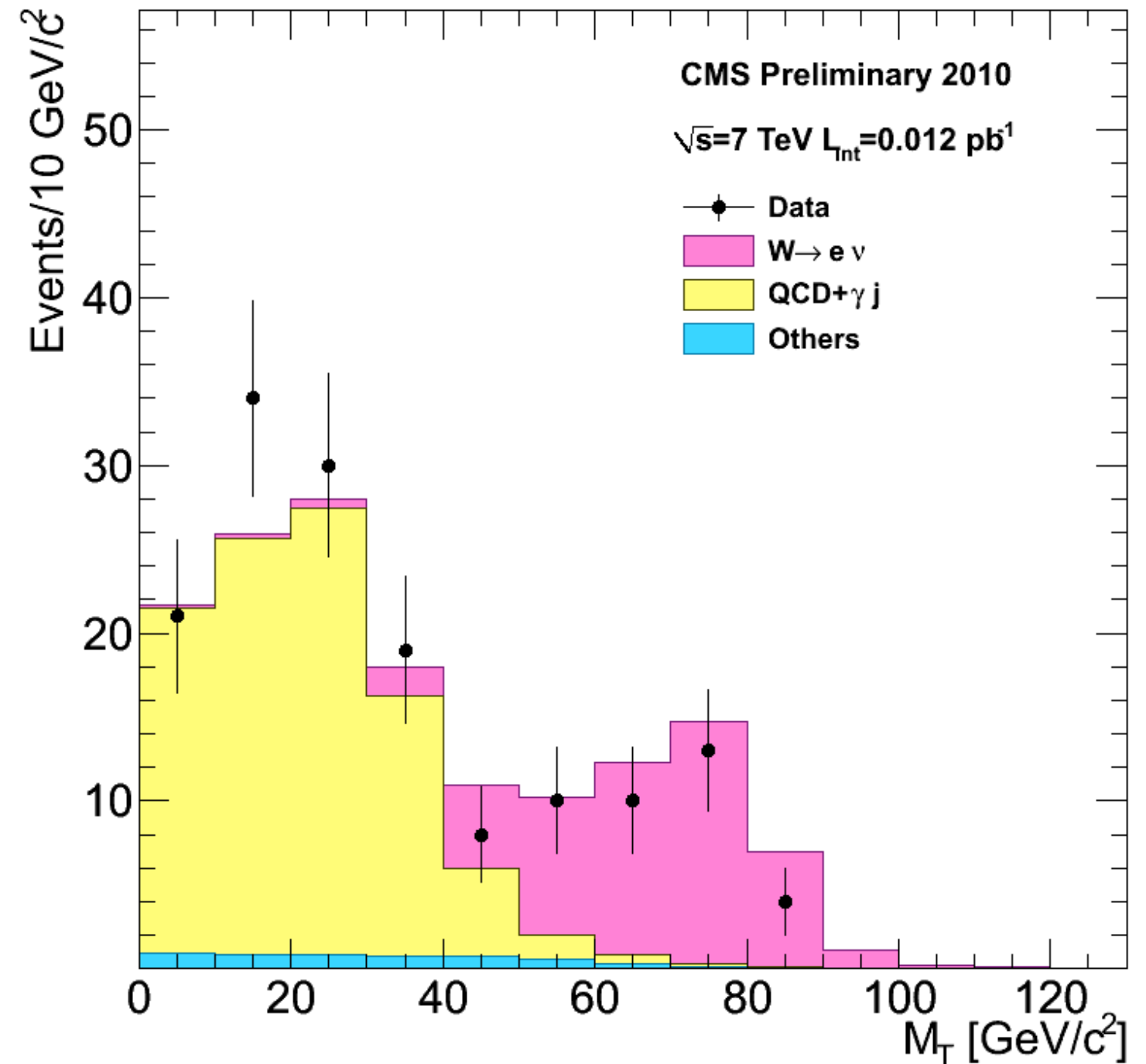


CMS Experiment at LHC, CERN
Run 133874, Event 21466935
Lumi section: 301
Sat Apr 24 2010, 05:19:21 CEST

Electron $p_T = 35.6$ GeV/c
 $ME_T = 36.9$ GeV
 $M_T = 71.1$ GeV/c²



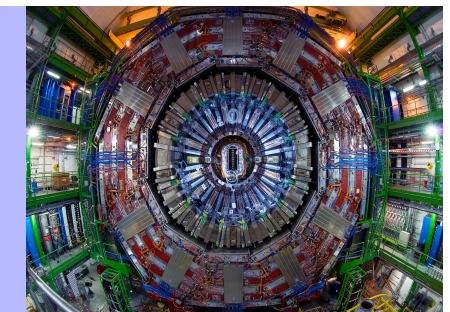
Candidate events inspected in detail for: timing, lepton reconstruction quality, event topology



37 W candidate events w/ $M_T > 50$ GeV



$W^{\pm} \rightarrow \mu^{\pm} \nu$ Candidate Events

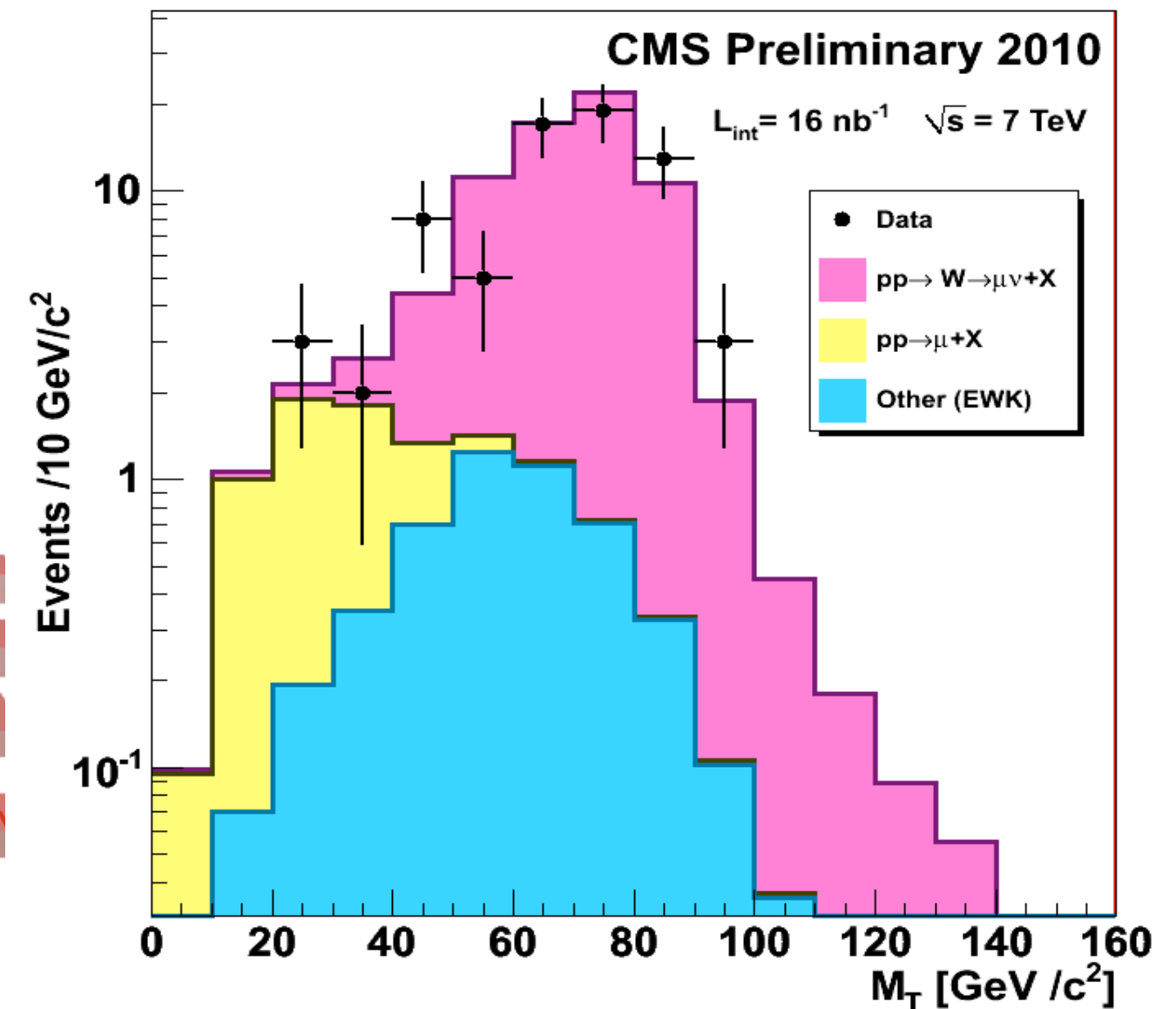
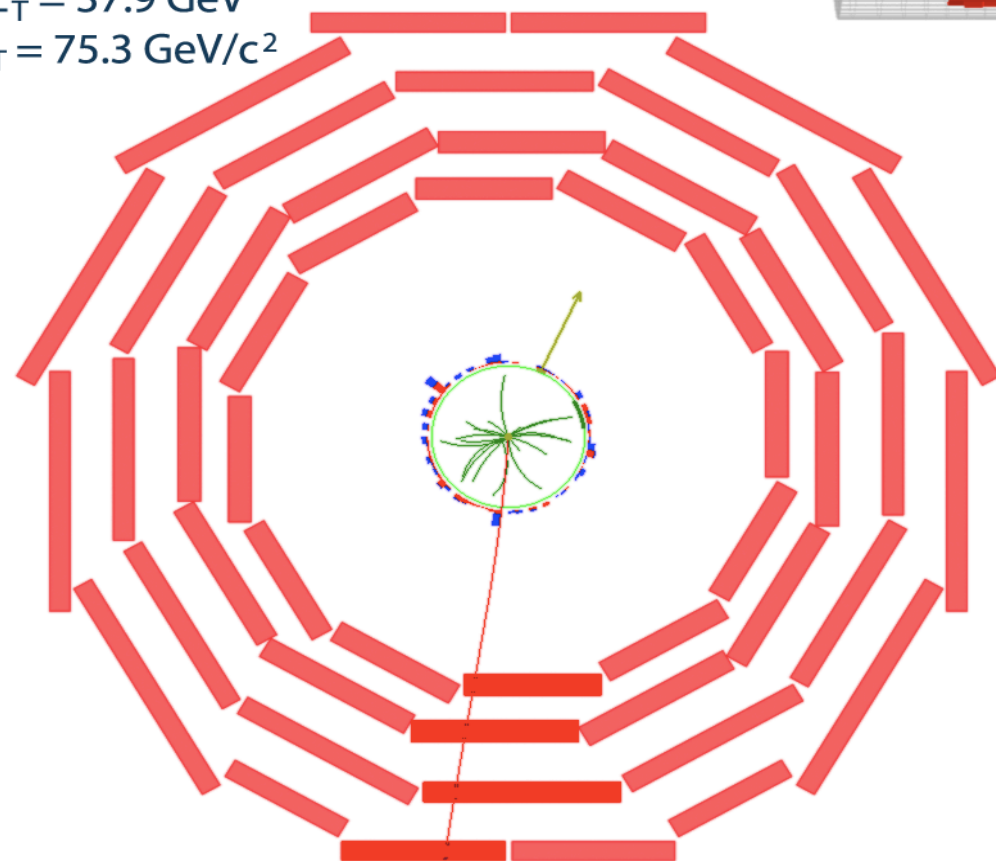
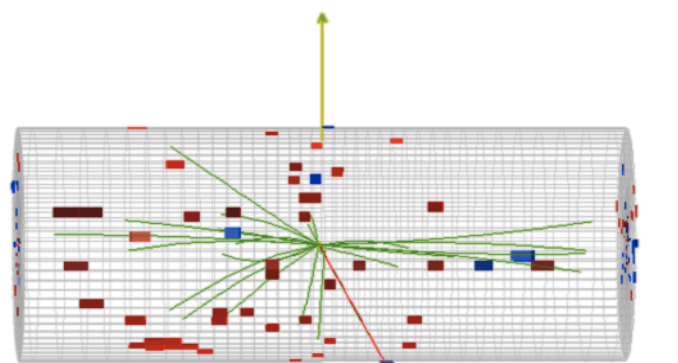


Event Selection: Muon ID (Global+Tracker Mu), $|\eta| < 2.1$, Pt, Isolation
MC cross sections: normalized to 16nb⁻¹ integrated luminosity



CMS Experiment at LHC, CERN
Run 133875, Event 1228182
Lumi section: 16
Sat Apr 24 2010, 09:08:46 CEST

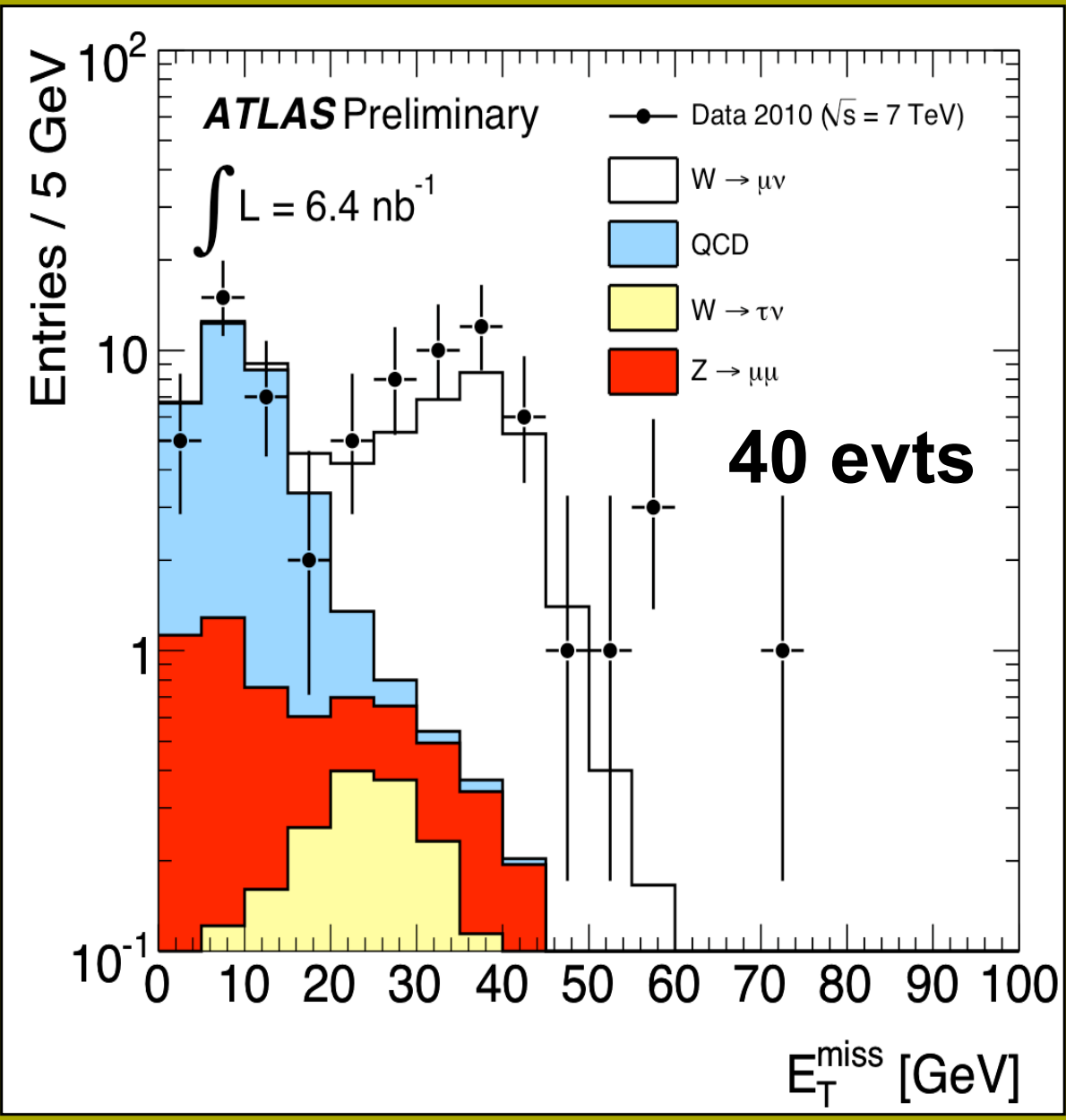
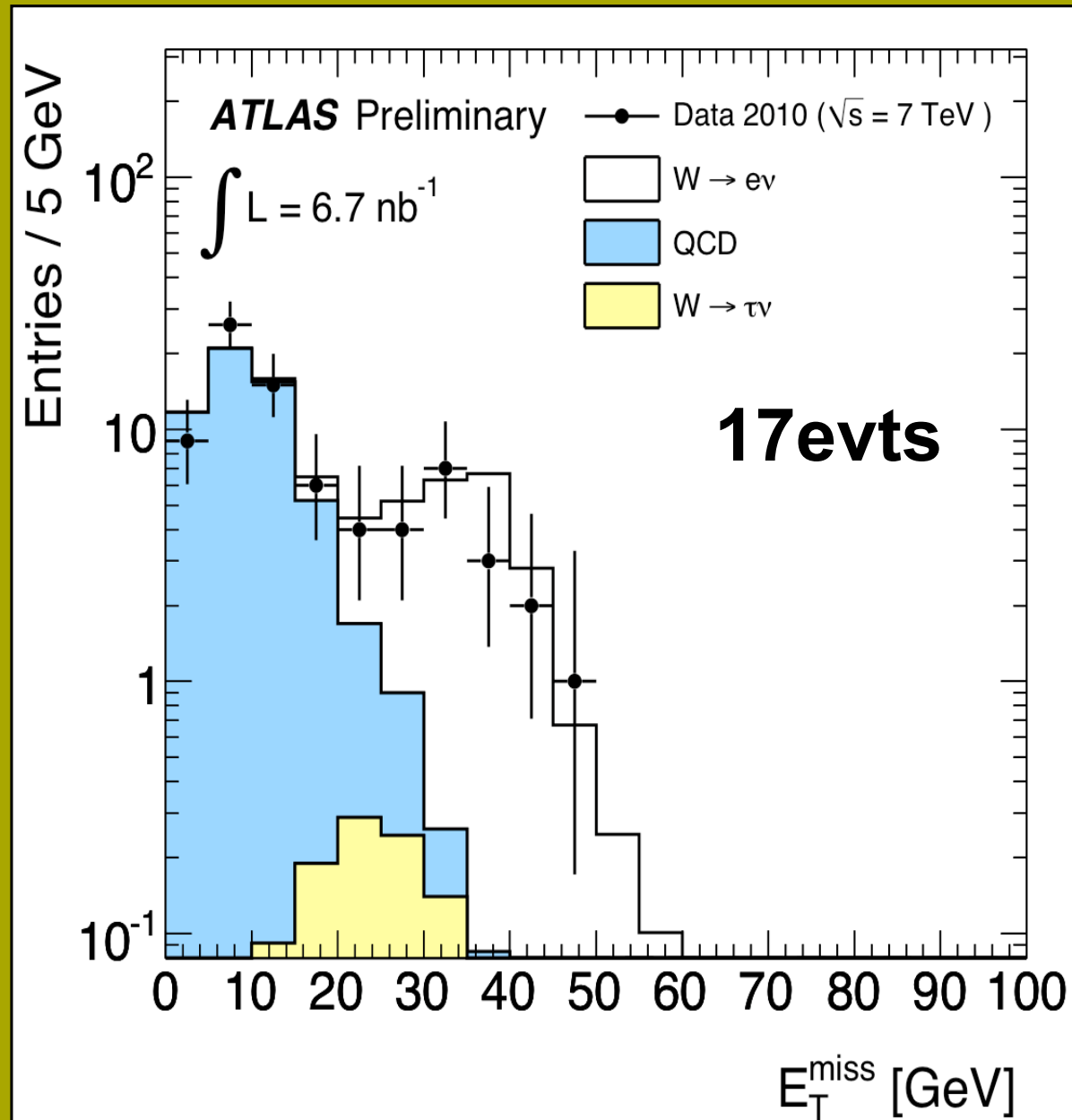
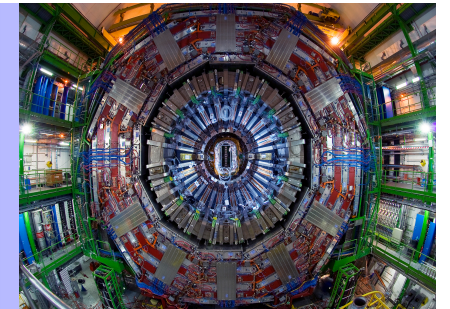
Muon $p_T = 38.7$ GeV/c
 $ME_T = 37.9$ GeV
 $M_T = 75.3$ GeV/c²



57 W candidate events w/ $M_T > 50$ GeV



ATLAS W Candidates

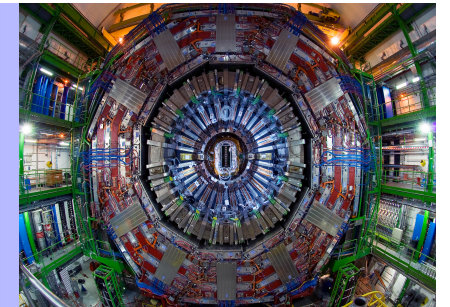


After all cuts
but E_T^{miss} and m_T

- **Ongoing detail inspection:**
 - **Reconstruction quality**
 - **Event topology**
 - **Timing**



Z- $\rightarrow\mu^+\mu^-$ Candidate Events



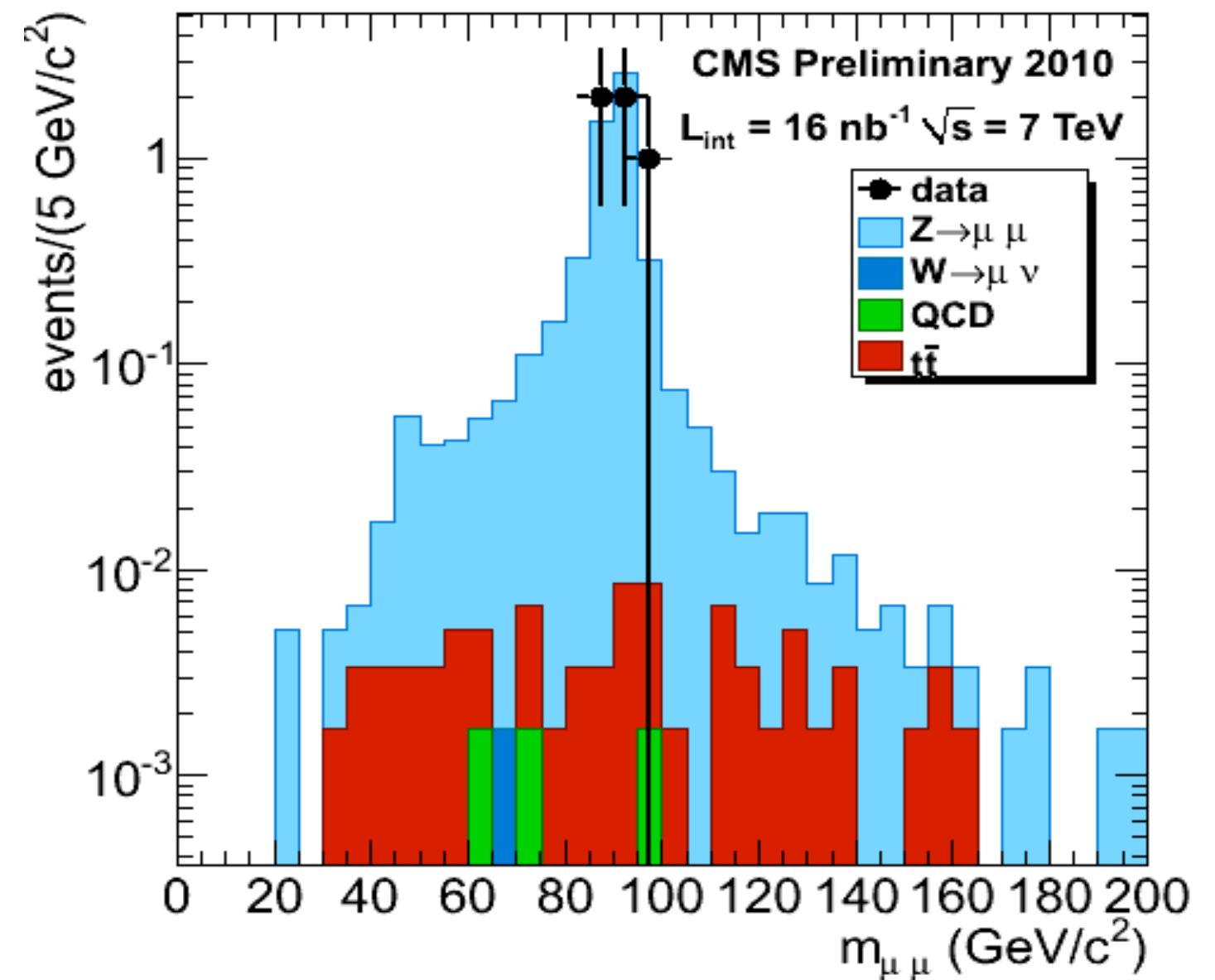
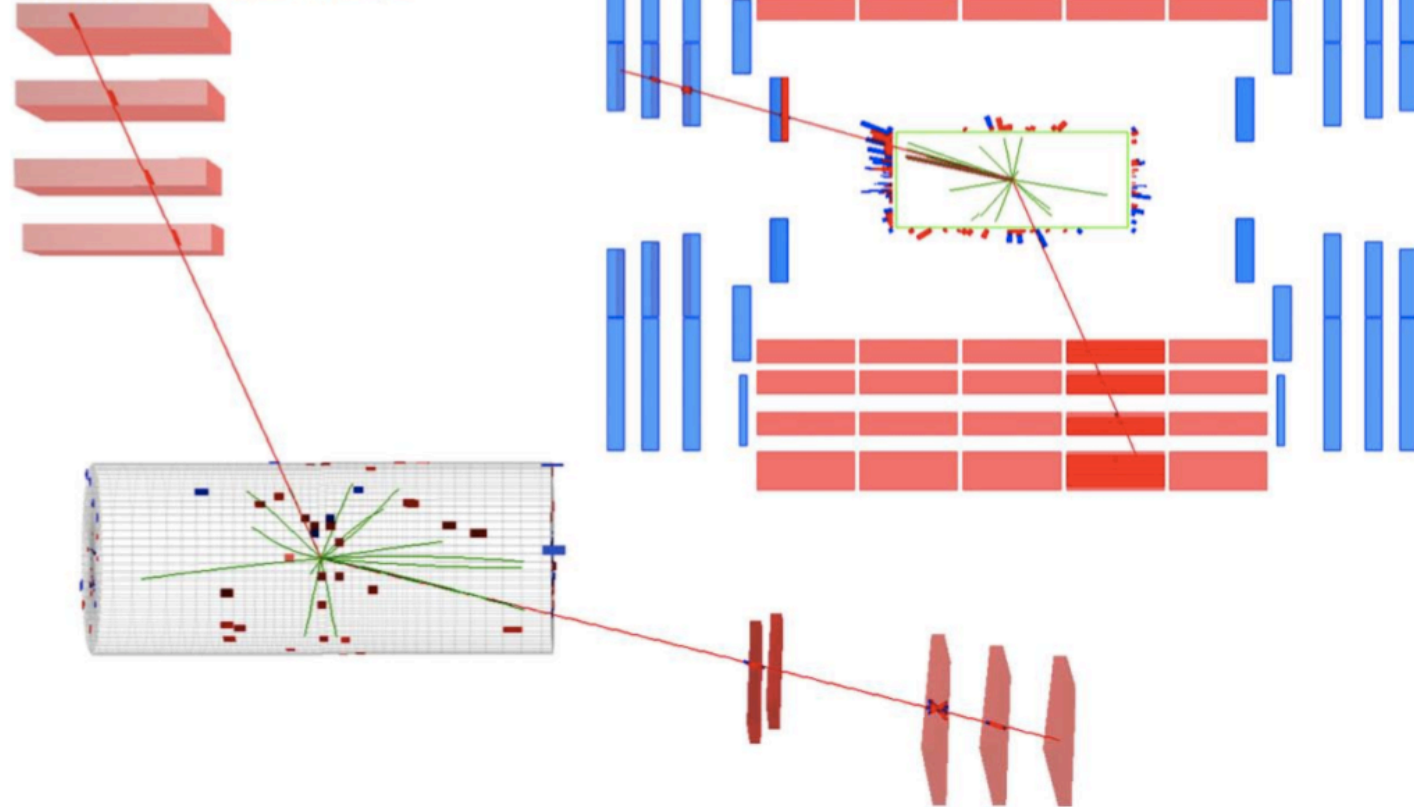
Event Selection: Loose Pt, Isolation and Muon id selection(Global +Tracker Mu), $|\eta| < 2.1$

MC cross sections: normalized to 16nb⁻¹ integrated luminosity



CMS Experiment at LHC, CERN
Run 136087 Event 39967482
Lumi section: 314
Mon May 24 2010, 15:31:58 CEST

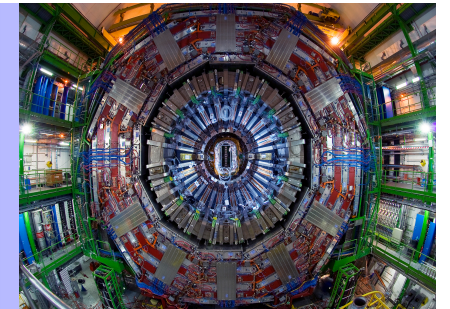
Muon $p_T = 27.3, 20.5$ GeV/c
Inv. mass = 85.5 GeV/c²



3 Z $\rightarrow\mu^+\mu^-$ candidate events



Z → e⁺e⁻ Candidate Events



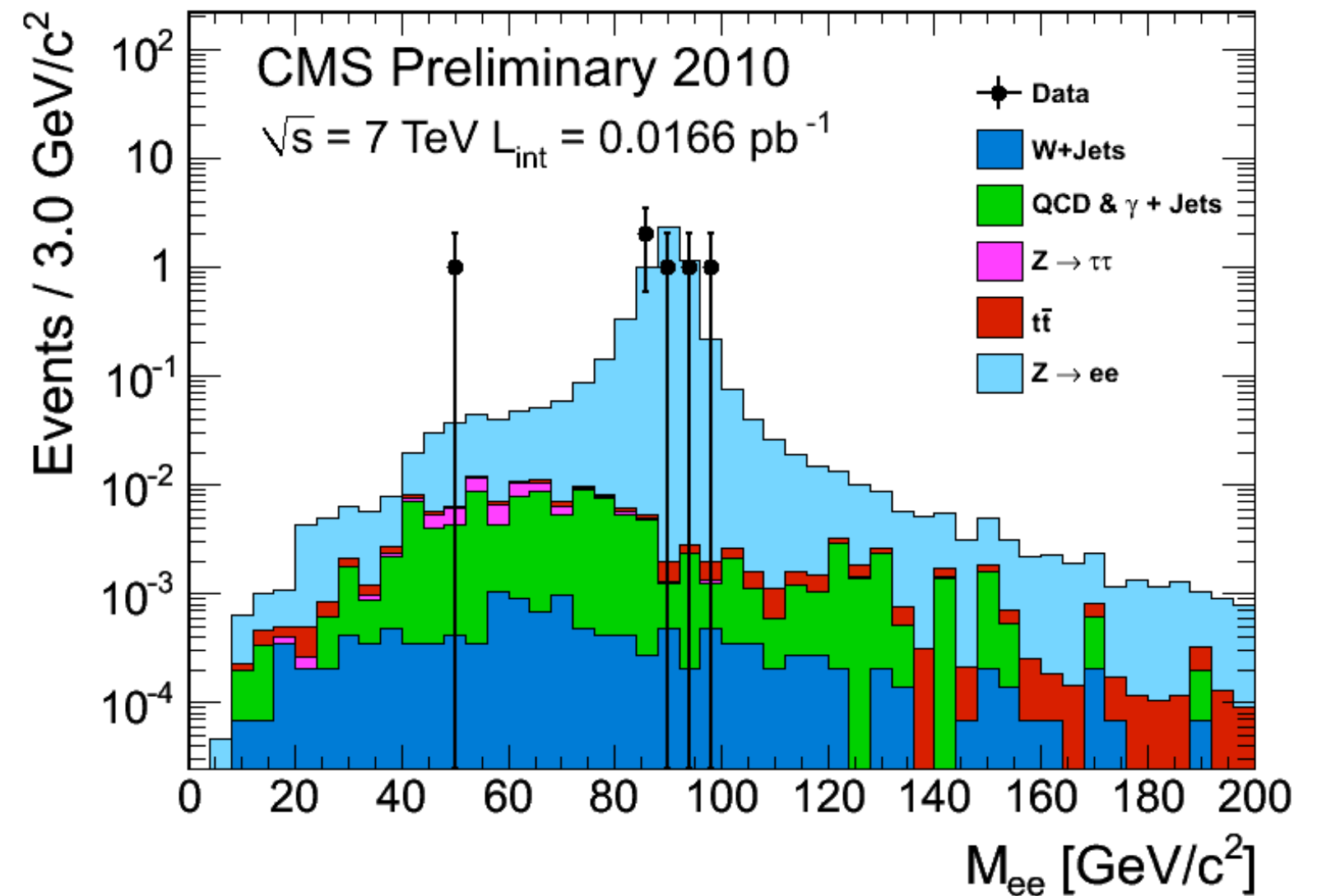
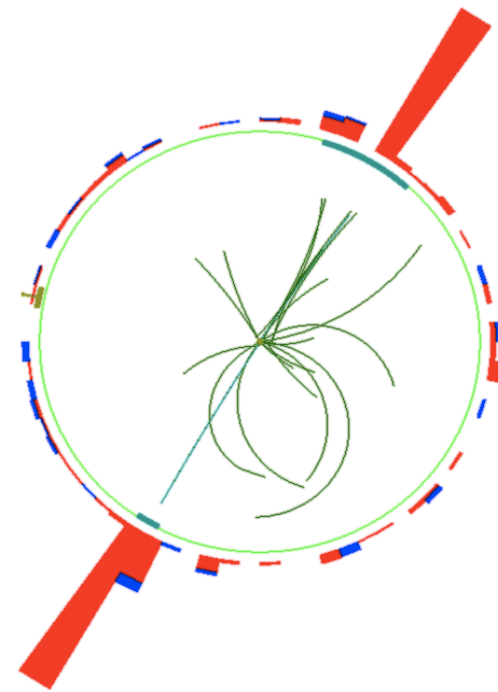
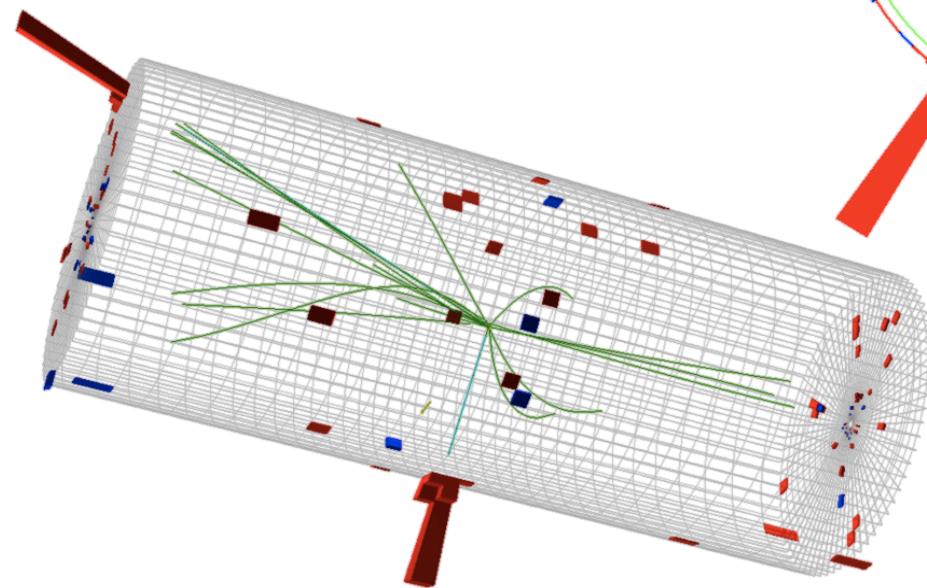
Event Selection: Two super-clusters with $E_t > 20 \text{ GeV}$

MC cross sections: 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

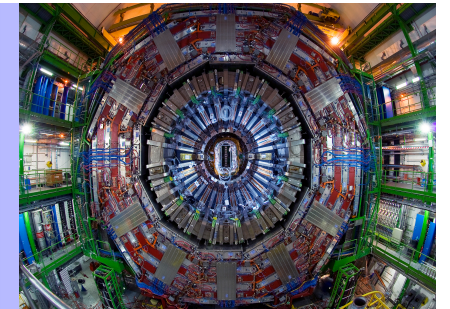
Electrons $p_T = 34.0, 31.9 \text{ GeV}/c$
Inv. mass = $91.2 \text{ GeV}/c^2$



5 Z → e⁺e⁻ candidate events

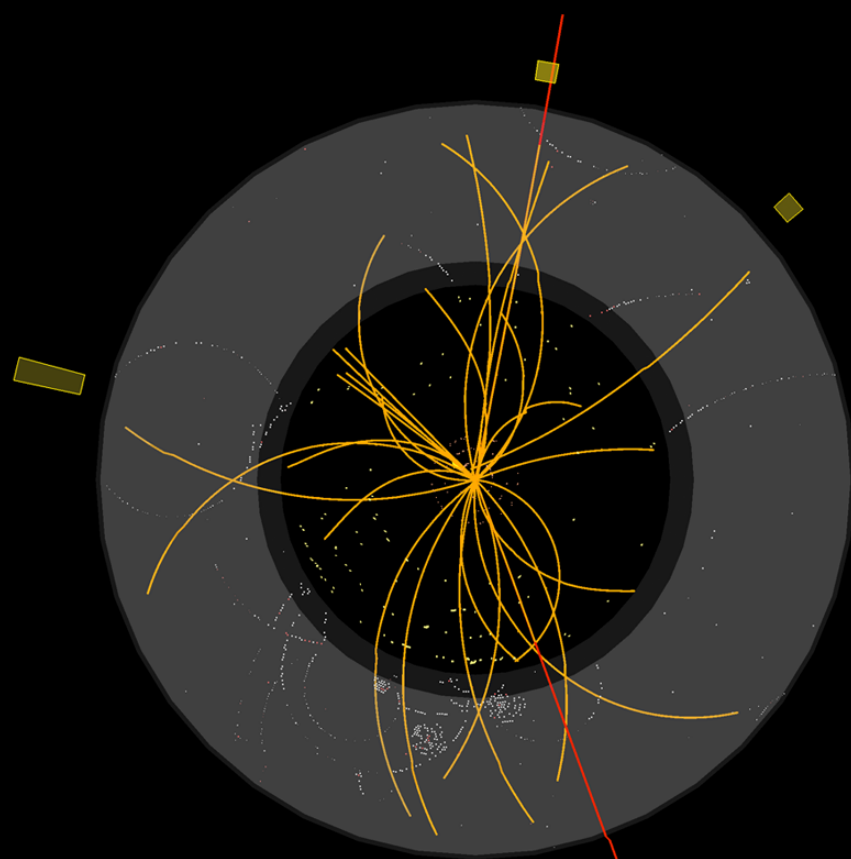


ATLAS Z candidate



ATLAS EXPERIMENT

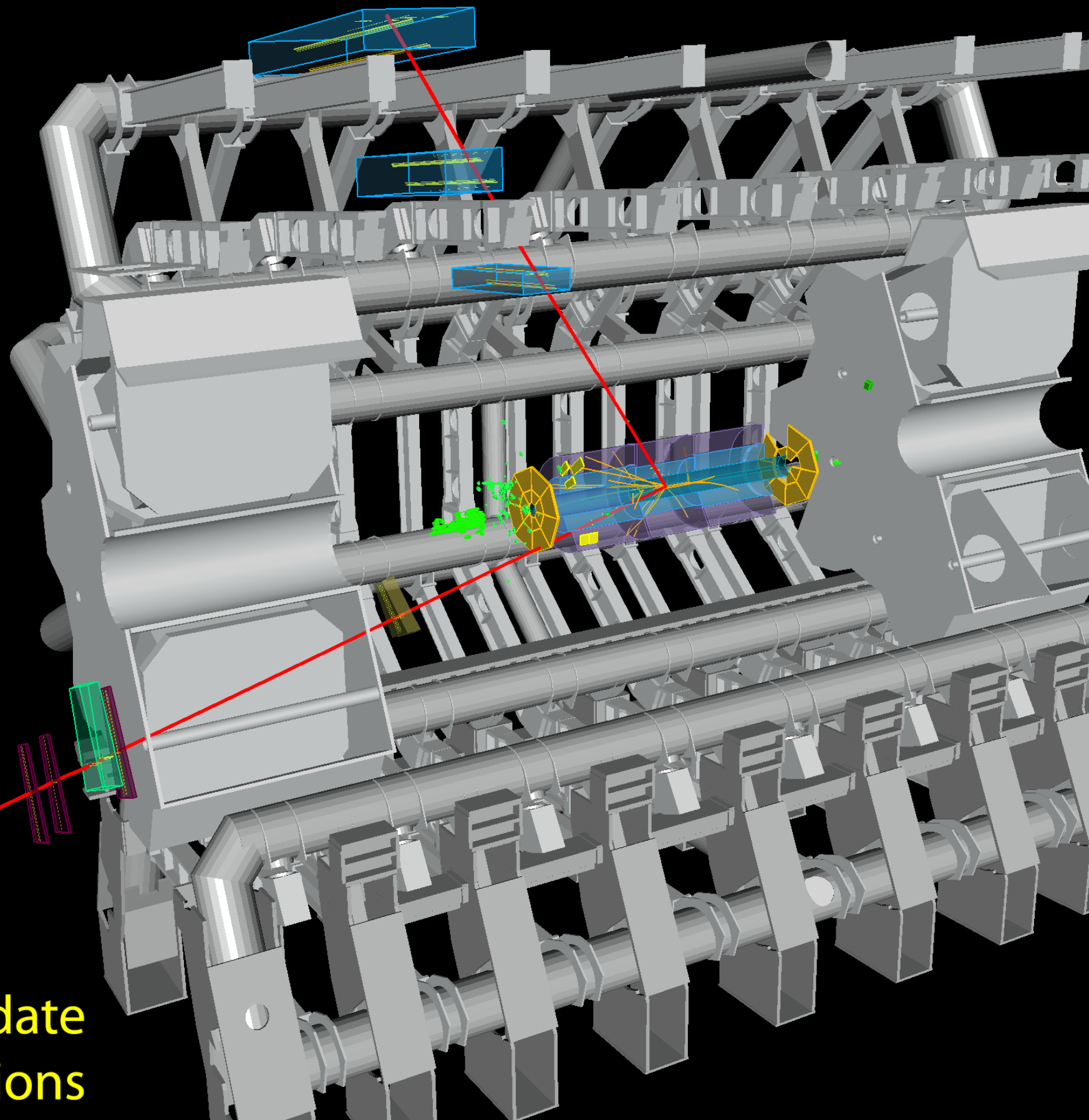
Run: 154822, Event: 14321500
Date: 2010-05-10 02:07:22 CEST



$p_T(\mu^-) = 27 \text{ GeV}$ $\eta(\mu^-) = 0.7$
 $p_T(\mu^+) = 45 \text{ GeV}$ $\eta(\mu^+) = 2.2$

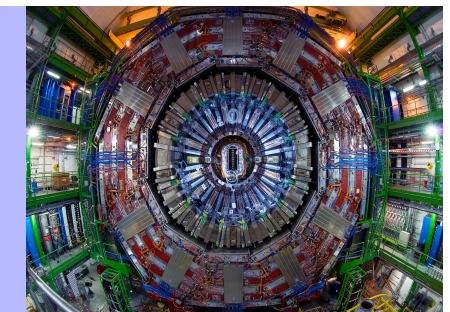
$M_{\mu\mu} = 87 \text{ GeV}$

**Z $\rightarrow\mu\mu$ candidate
in 7 TeV collisions**

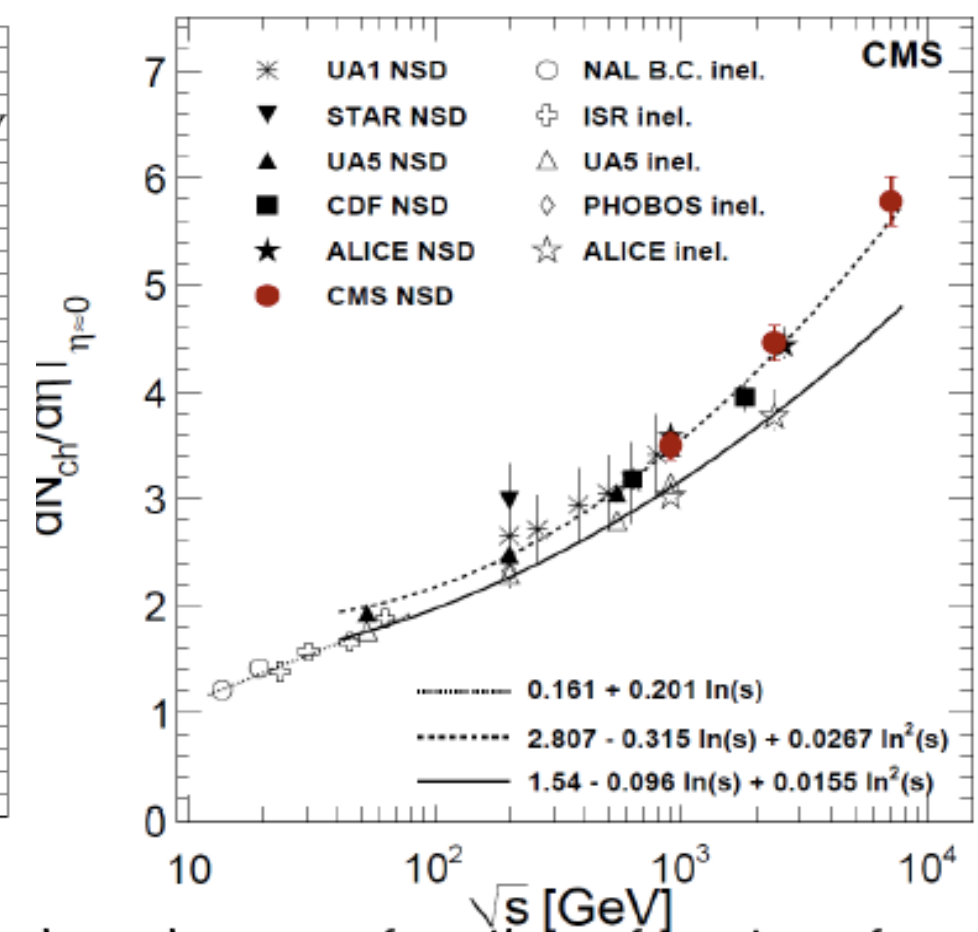
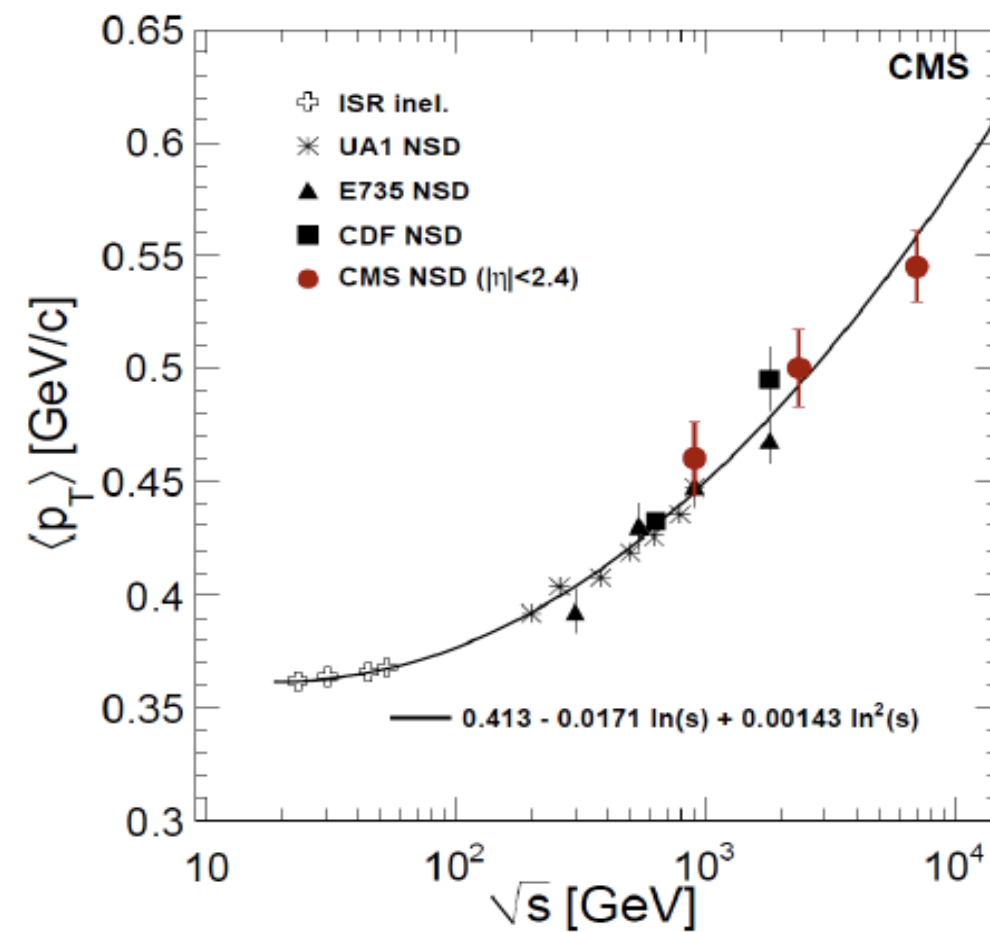
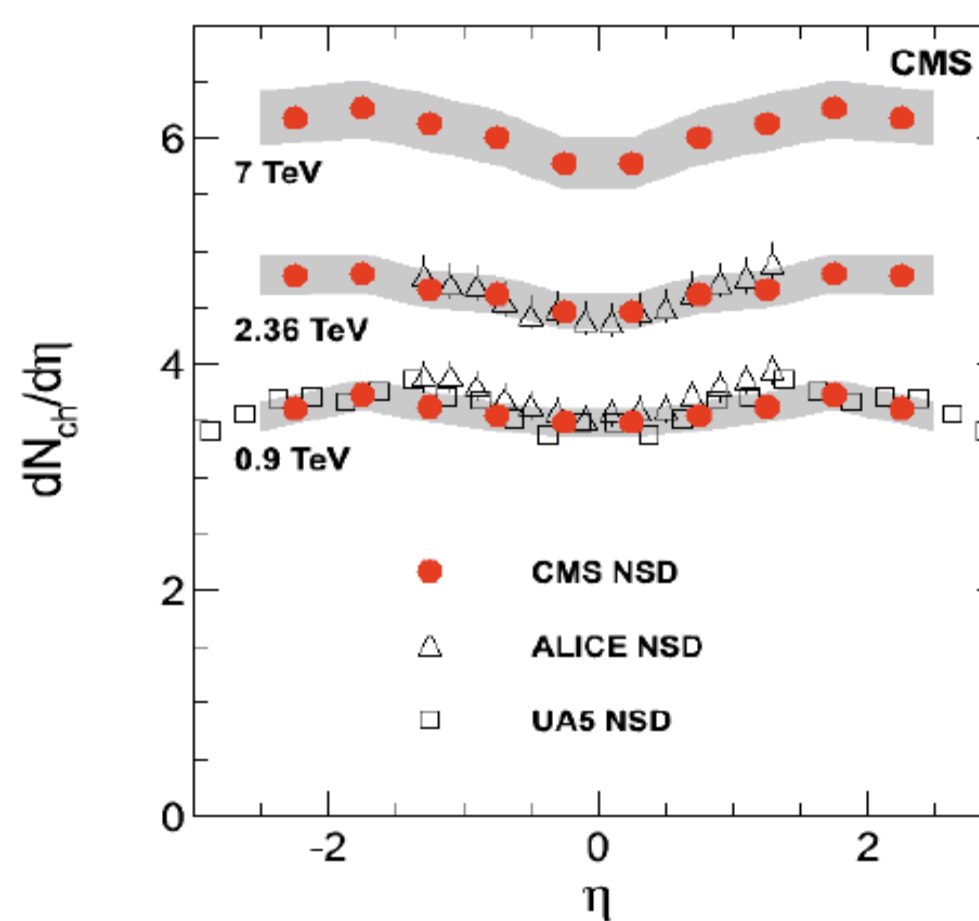




First CMS Publication @7TeV



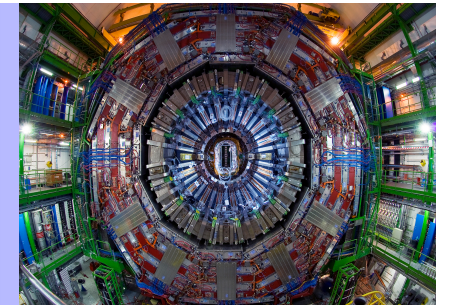
“Transverse Momentum and Pseudorapidity Distributions of Charged Hadrons in pp Collisions at $\sqrt{s}=7\text{TeV}$ ” arXiv:1005.3299 in PRL on 18 Jun 2010



- Rise of the particle density at (2.36) 7 TeV steeper than model predictions
- Need for ongoing tuning of MC generators



First Physics Run 2010-2011

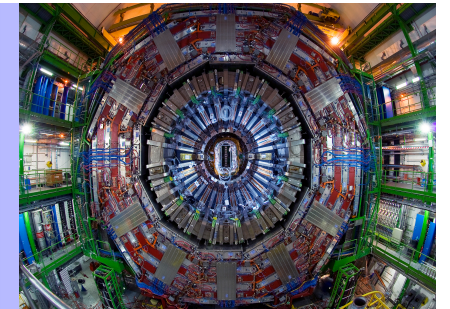


Integrated L	SM Object	SM Use	Search Strategy
mb^{-1} (1)	UE, MB	Tune MC	
μb^{-1} (10^3)	Jets, Heavy flavor	Align. dE/dx Calib, trigger valid, MET c, b tag leptons	
nb^{-1} (10^6)	W Z	Cross section, charge Mass scale, resolution	<u>We are here!</u>
1 pb^{-1} (10^9)	Top pairs	Leptons + J + true MET	Dijet & HSCP exceed Tevatron
10 pb^{-1}			Dijet $M > 2 \text{ TeV}$, LQ exceed Tevatron
100 pb^{-1} (2010)			$M > \text{TeV } W', Z', \text{ ED}$ New range for SUSY
1000 pb^{-1} (2011) (10^{12})			SUSY – TeV mass scale Higgs @ 95% CL, (140,190) GeV, BH, Technicolor

**PLAN: Rediscovering the Standard Model, followed by precision measurements...
Then launch searches, starting with strongly produced final states.**



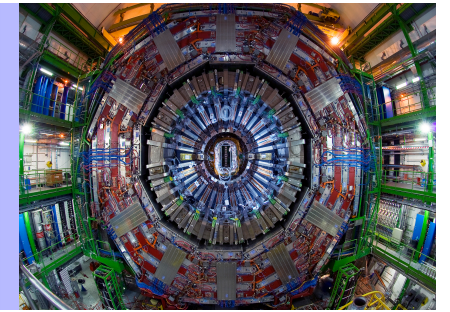
Conclusions



- **Rapid Commissioning of the LHC and Experiments with Beams and Increased Luminosity**
- *Thank you to the LHC Team for Excellent Performance and Operation for Physics!*
- **LHC's leaps in energy and luminosity present enormous exploration opportunities**
- **Rediscovery of the Standard Model underway with First LHC Publications**
- **Excitement of Discoveries is arriving!**
- I would like to thank G.Tonelli, F. Gianotti, A. de Roeck, D. Green and others for ⁵¹ material



Backup slides



END of presentation