

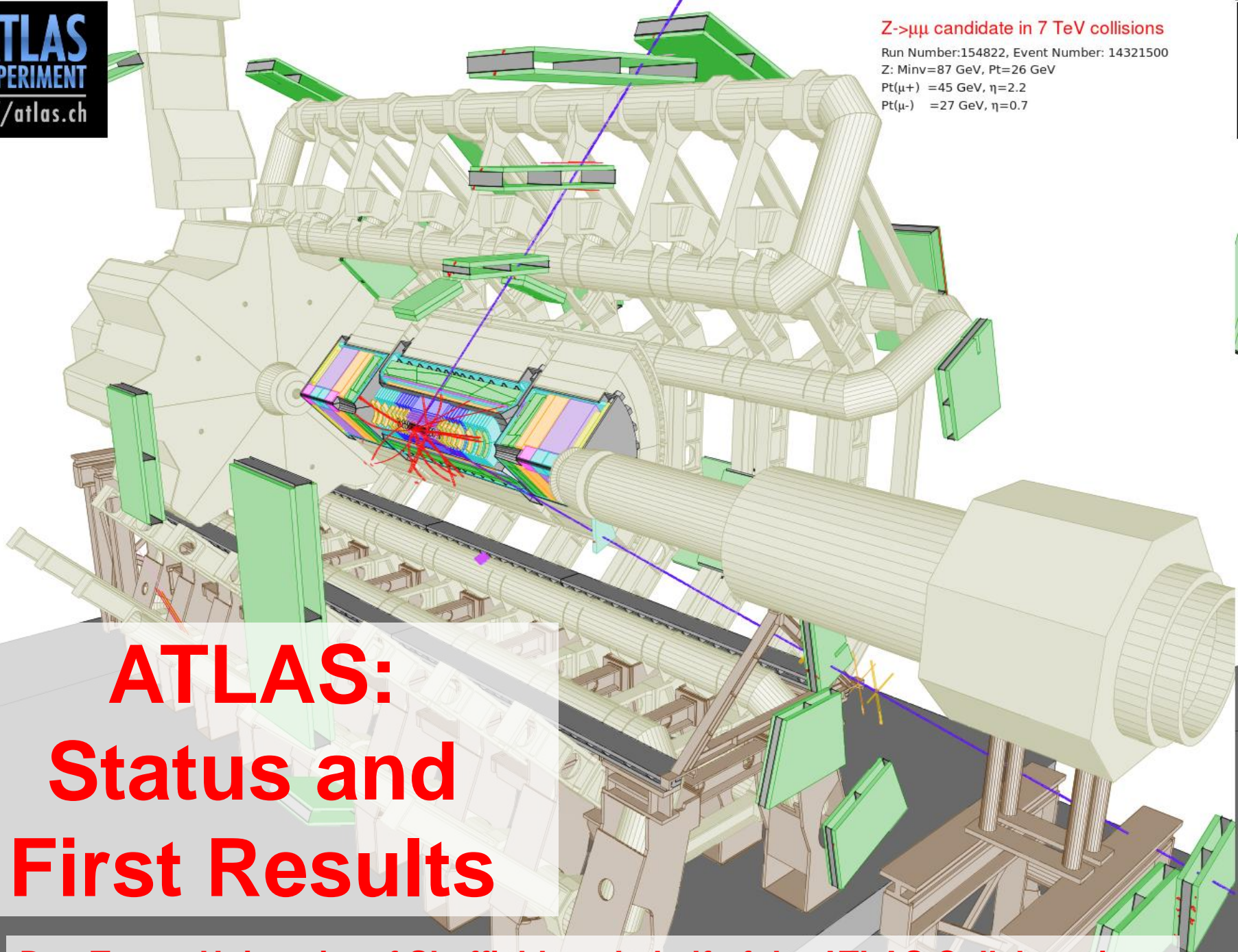
Z $\rightarrow\mu\mu$ candidate in 7 TeV collisions

Run Number:154822, Event Number: 14321500

Z: Minv=87 GeV, Pt=26 GeV

Pt(μ^+) =45 GeV, $\eta=2.2$

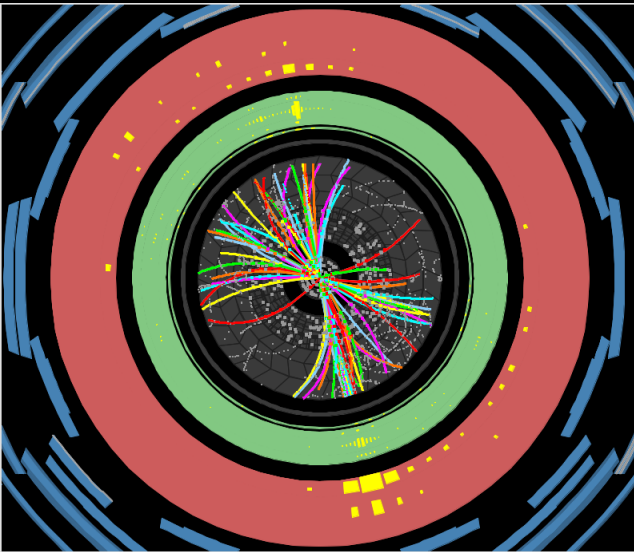
Pt(μ^-) =27 GeV, $\eta=0.7$



ATLAS: Status and First Results

Dan Tovey, University of Sheffield, on behalf of the ATLAS Collaboration

- Overview of the ATLAS detector
- Status of the experiment
- Performance and physics results in the first six months
- Future milestones

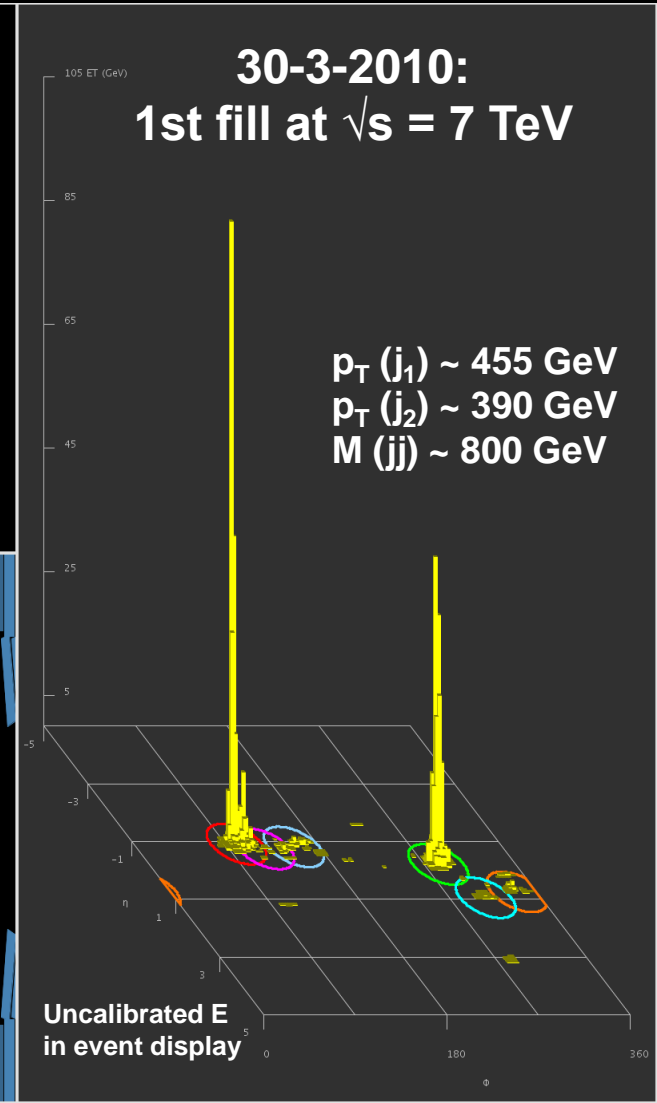
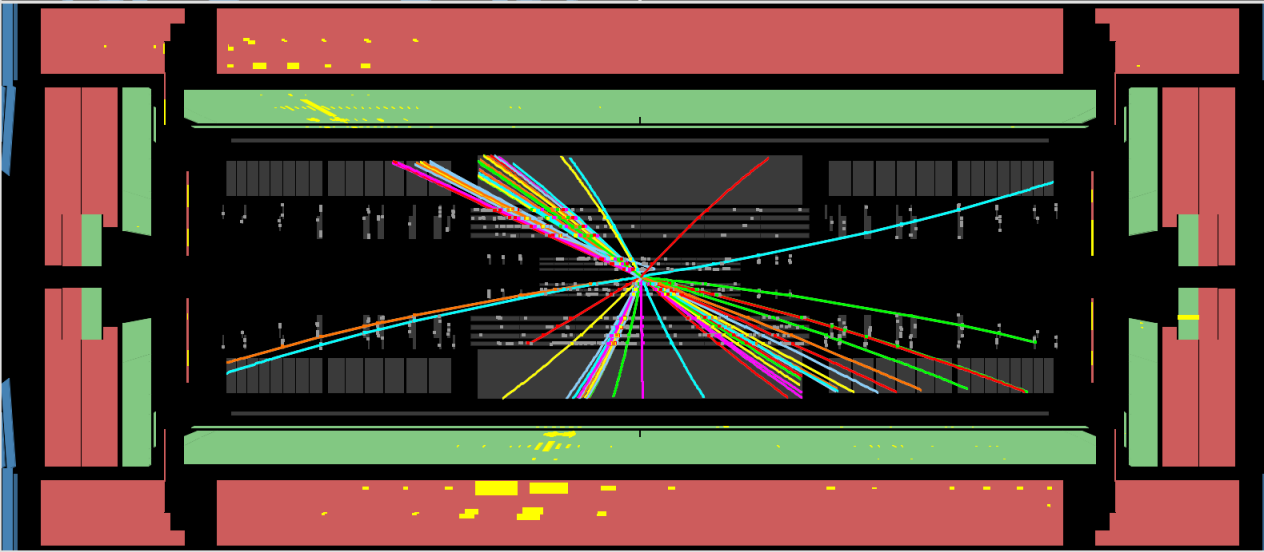


ATLAS EXPERIMENT

Run Number: 152166, Event Number: 810258

Date: 2010-03-30 14:56:29 CEST

Di-jet Event at 7 TeV





~3000 physicists
37 countries
173 institutes

ATLAS Collaboration

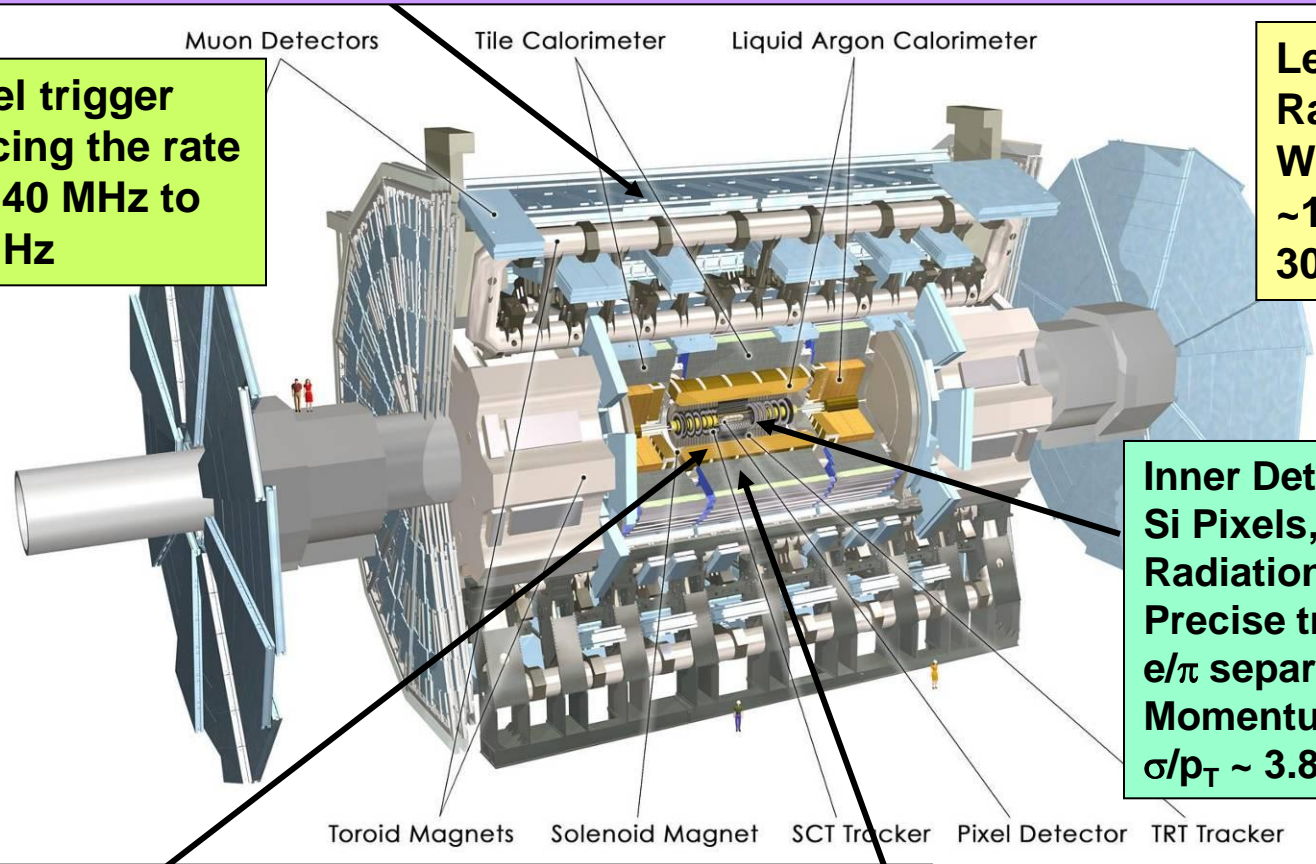


The ATLAS Detector

Muon Spectrometer ($|\eta| < 2.7$) : air-core toroids with gas-based muon chambers
Muon trigger and measurement with momentum resolution $< 10\%$ up to $E_\mu \sim 1$ TeV

**3-level trigger
reducing the rate
from 40 MHz to
 ~ 200 Hz**

Length : ~ 46 m
Radius : ~ 12 m
Weight : ~ 7000 tons
 $\sim 10^8$ electronic channels
3000 km of cables



Inner Detector ($|\eta| < 2.5$, $B=2$ T):
Si Pixels, Si strips, Transition Radiation detector (straws)
Precise tracking and vertexing, e/π separation
Momentum resolution ($\eta=0$):
 $\sigma/p_T \sim 3.8 \times 10^{-4} p_T$ (GeV) \oplus 0.015

EM calorimeter: Pb-LAr Accordion
 e/γ trigger, identification and measurement
E-resolution: $\sigma/E \sim 10\%/\sqrt{E}$

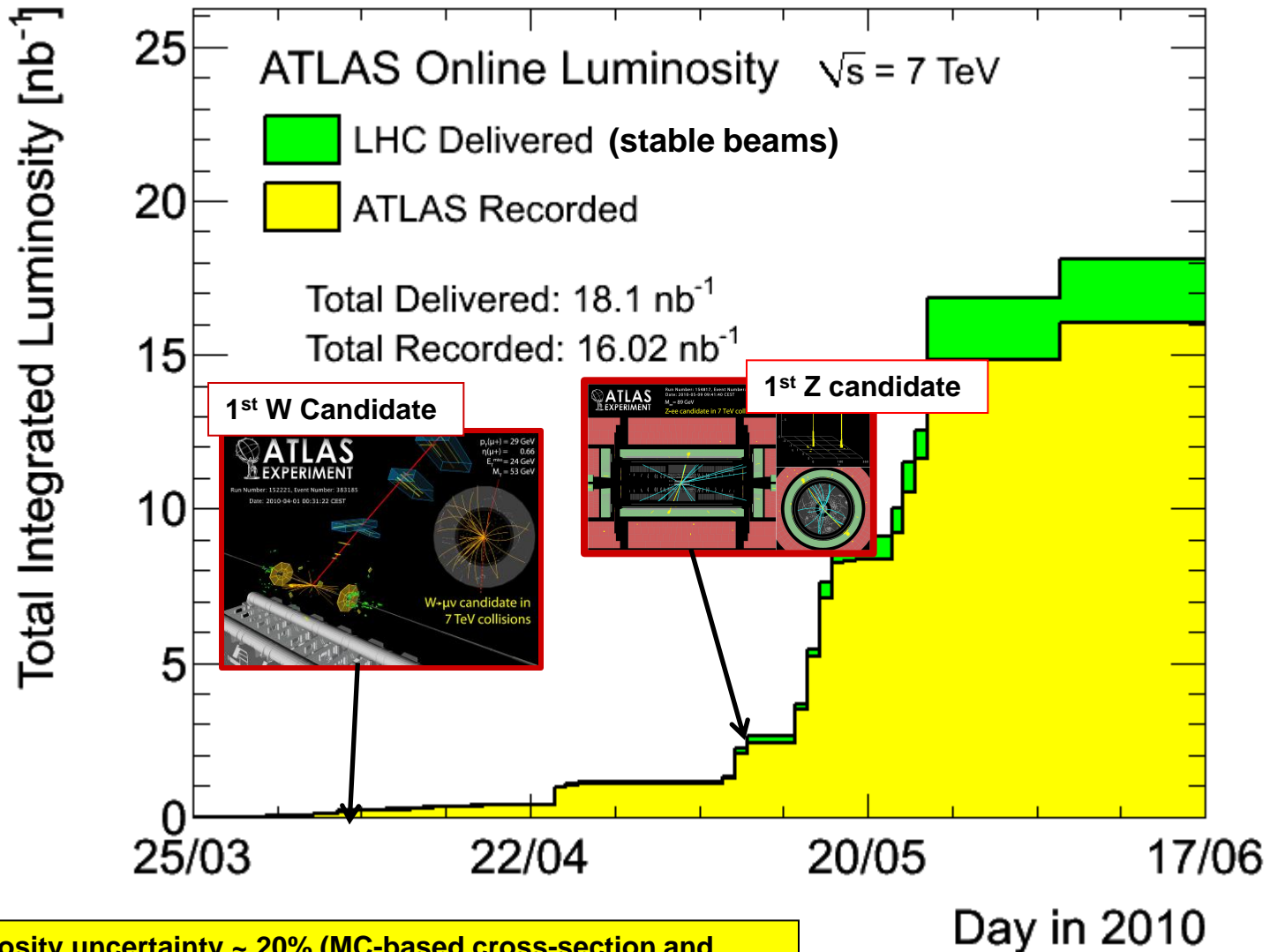
HAD calorimetry ($|\eta| < 5$)
Fe/scintillator Tiles (central), Cu/W-LAr (fwd)
Trigger and measurement of jets and missing E_T
E-resolution: $\sigma/E \sim 50\%/\sqrt{E} \oplus 0.03$

First Six Months of Operation



- **20 Nov – 23 Dec :**
 - First physics run at $\sqrt{s} = 900$ GeV (few hours $\sqrt{s} = 2.36$ TeV)
 - ATLAS recorded $\sim 12 \mu\text{b}^{-1}$, 0.5M events
- **16 Dec- 28 Feb:**
 - Winter technical stop
- **Since 30 March:**
 - LHC running at $\sqrt{s} = 7$ TeV

Data-Taking Status



Absolute luminosity uncertainty $\sim 20\%$ (MC-based cross-section and acceptance of luminosity detectors) $\rightarrow <10\%$ soon (Van der Meer scans)

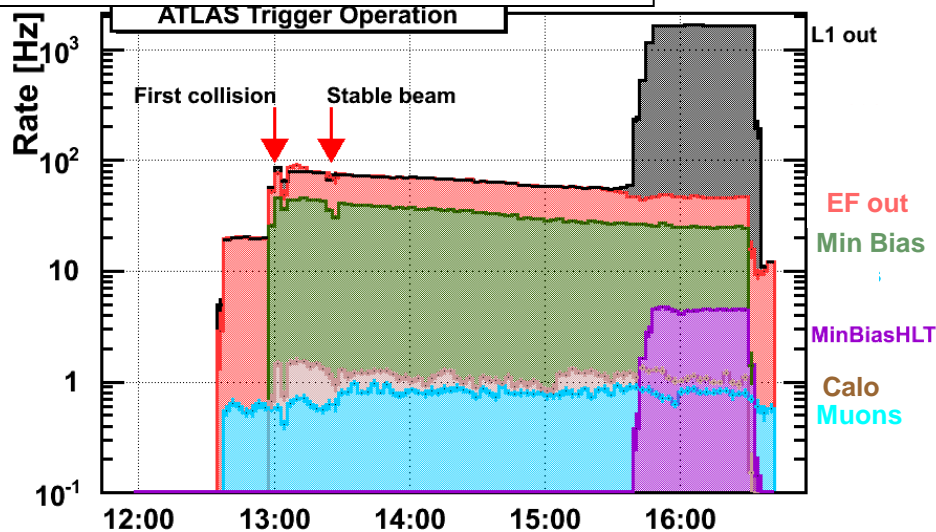
Detector Status

Subdetector	Number of Channels	Approximate Operational Fraction
Pixels	80 M	97.5%
SCT Silicon Strips	6.3 M	99.3%
TRT Transition Radiation Tracker	350 k	98.0%
LAr EM Calorimeter	170 k	98.5%
Tile calorimeter	9800	97.3%
Hadronic endcap LAr calorimeter	5600	99.9%
Forward LAr calorimeter	3500	100%
LVL1 Calo trigger	7160	99.8%
LVL1 Muon RPC trigger	370 k	99.7%
LVL1 Muon TGC trigger	320 k	100%
MDT Muon Drift Tubes	350 k	99.7%
CSC Cathode Strip Chambers	31 k	98.5%
RPC Barrel Muon Chambers	370 k	97.3%
TGC Endcap Muon Chambers	320 k	98.8%

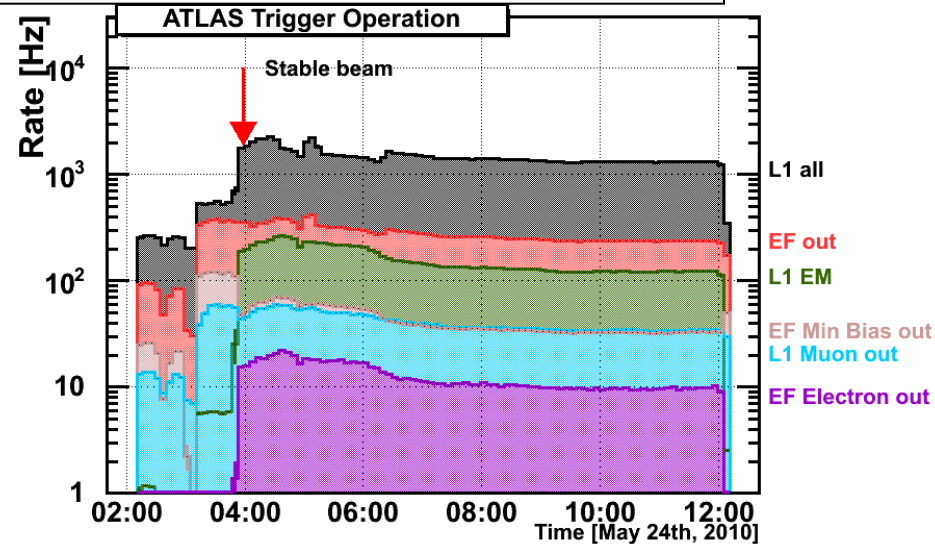
- **Overall data taking efficiency: ~ 92%**
- **Recorded with all detectors at nominal voltage (including Pixels): ~ 88 %**

Trigger Status

First fill at 7 TeV: $L \sim 8 \times 10^{26} \text{ cm}^{-2} \text{ s}^{-1}$

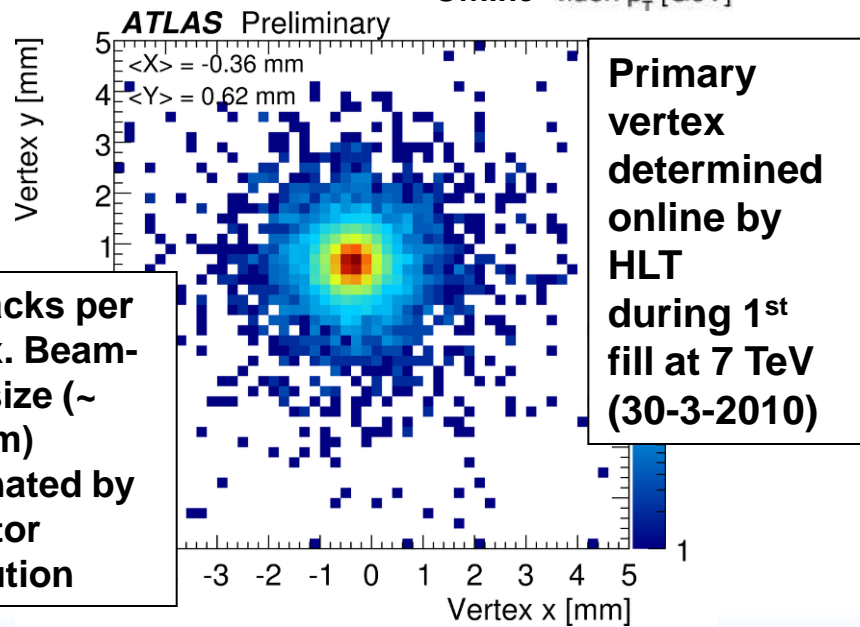
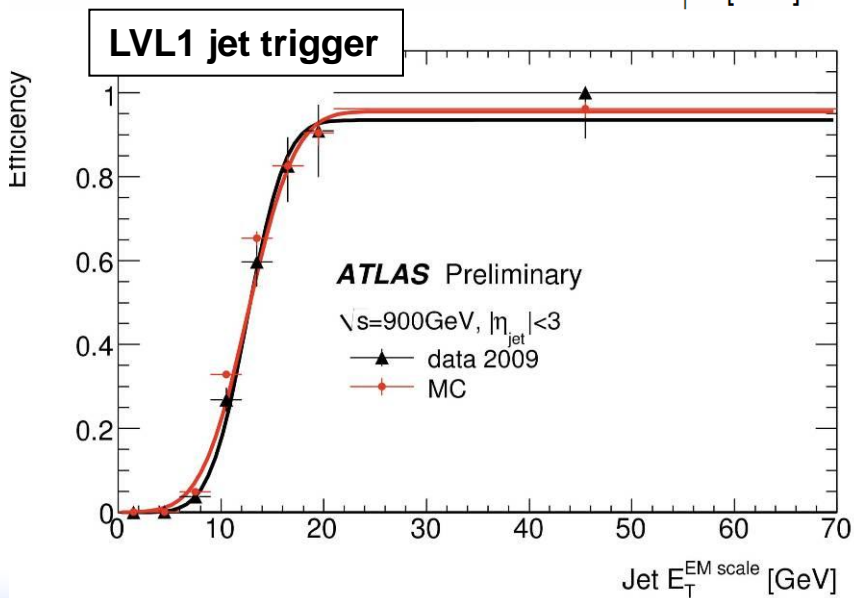
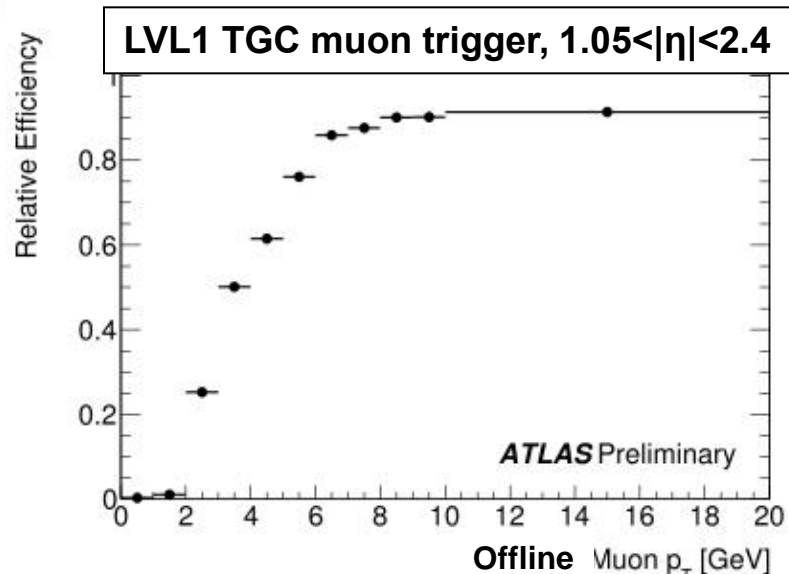
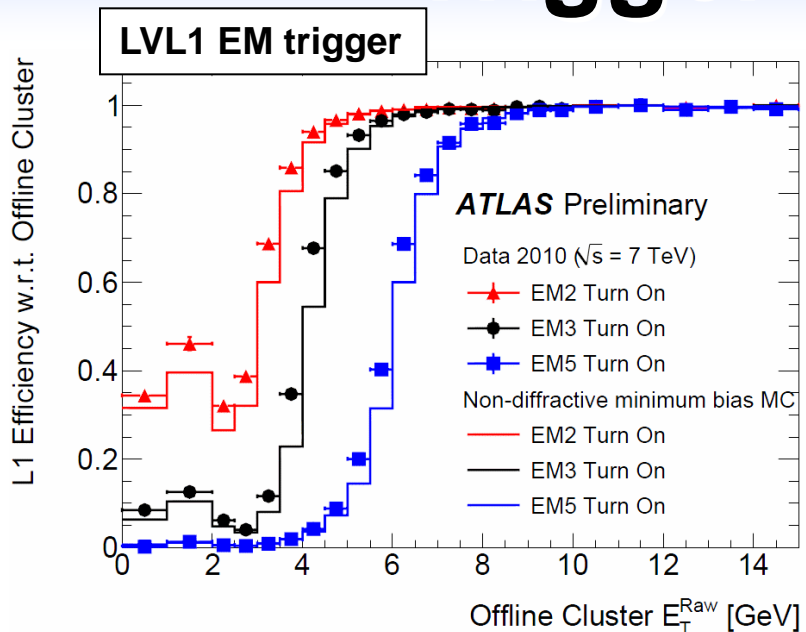


Record fill at 7 TeV: $L \sim 2 \times 10^{29} \text{ cm}^{-2} \text{ s}^{-1}$



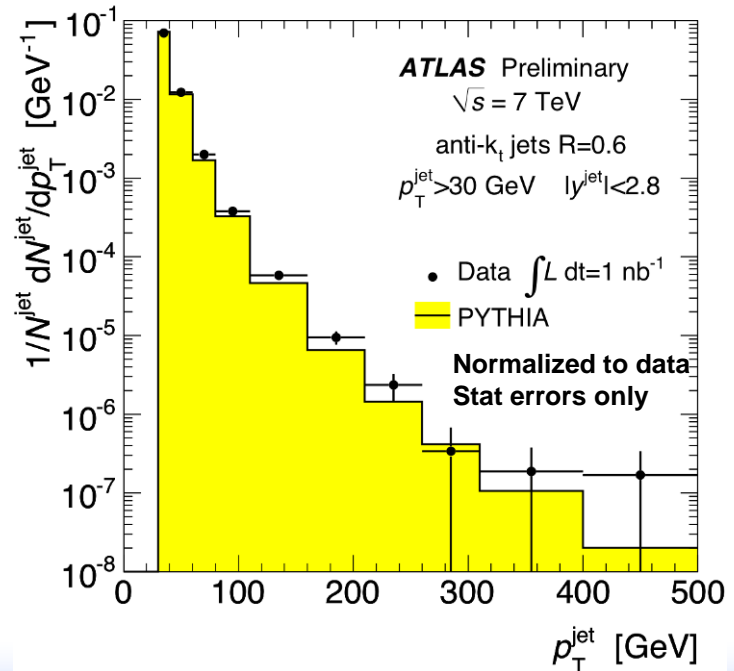
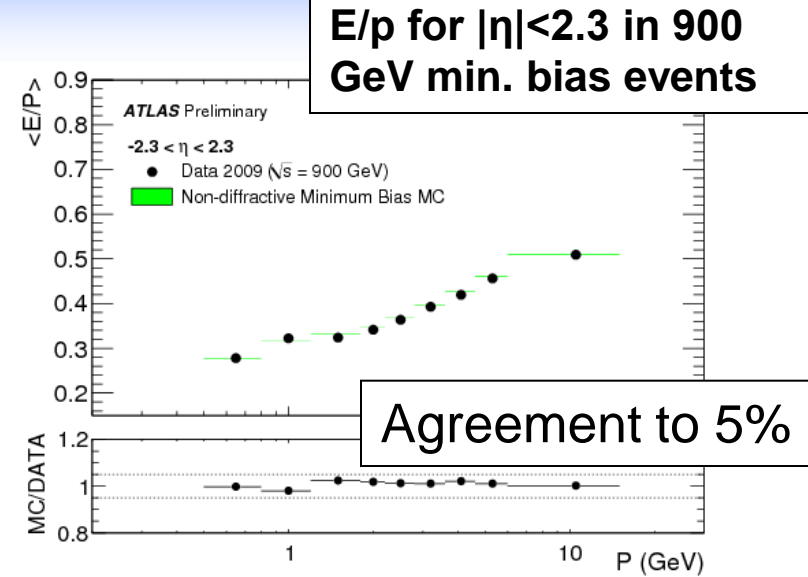
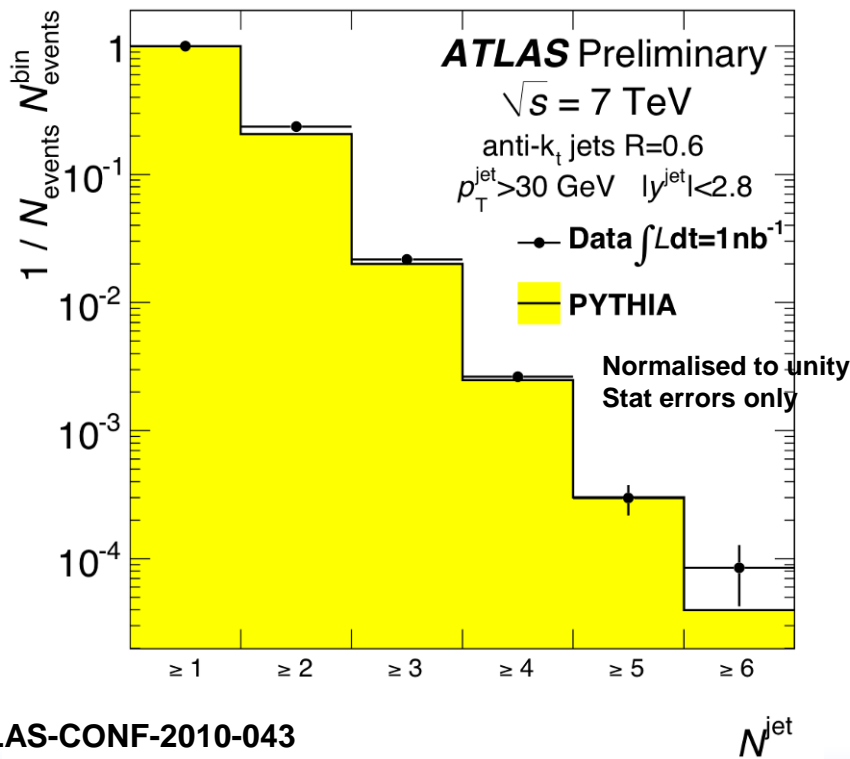
- Trigger output rate: typically 200-300 Hz (up to ~350 Hz)
- $L < \text{few } 10^{27} \text{ cm}^{-2} \text{ s}^{-1}$:
 - (un-prescaled) minimum-bias LVL1 trigger based on hits in scintillator counters (MBTS) located at $Z = \pm 3.5$ m from collision centre
 - LVL1 muon and calo (EM, jets, ..) triggers also active
 - HLT (LVL2+EF) commissioned by running mostly in pass-through mode
- $L > \text{few } 10^{27} \text{ cm}^{-2} \text{ s}^{-1}$: MBTS trigger pre-scaled
- $L > 10^{29} \text{ cm}^{-2} \text{ s}^{-1}$: e/ γ HLT chain activated in rejection mode to be able to run with lowest-threshold EM LVL1 item (3 GeV)

Trigger Performance



Jets

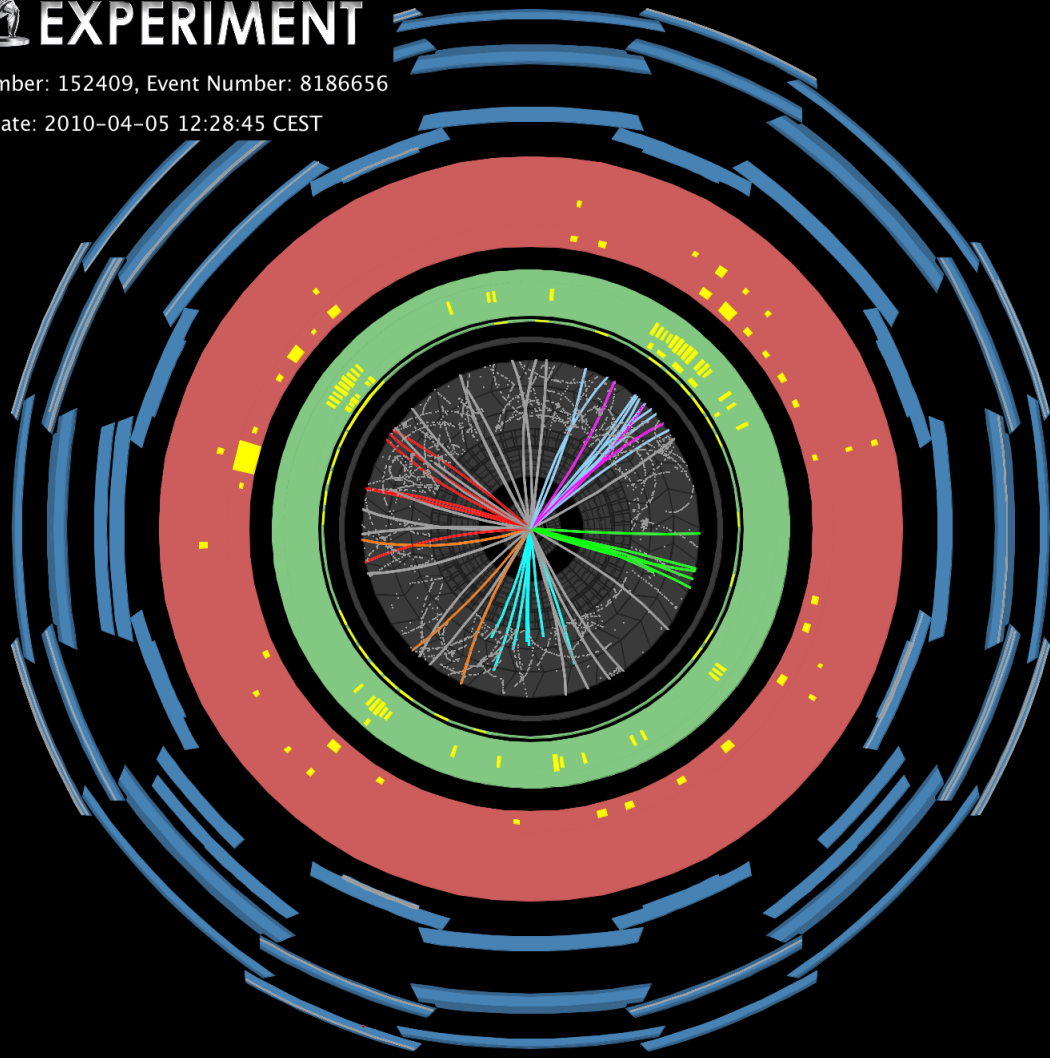
- Jets reconstructed with Anti-k_T algorithm, calibrated with simple η/p_T -dependent corrections from test-beam, track E/p, MC \rightarrow 7% scale uncertainty
- Good agreement with LO+PS MC



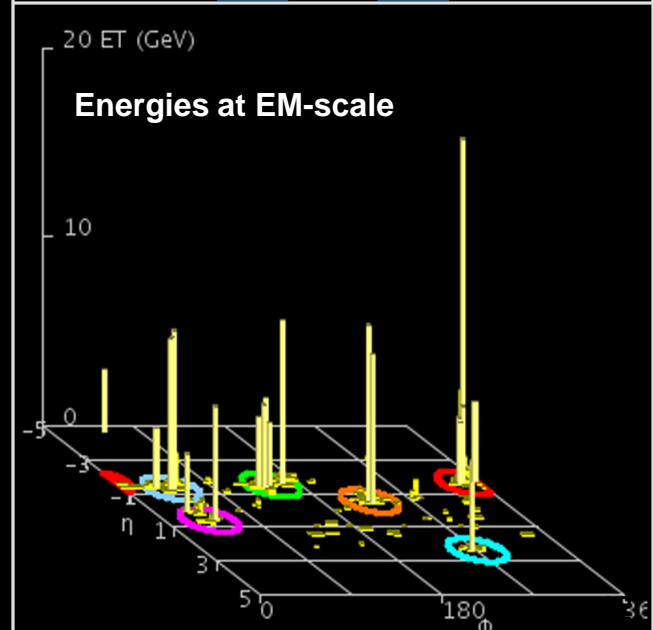
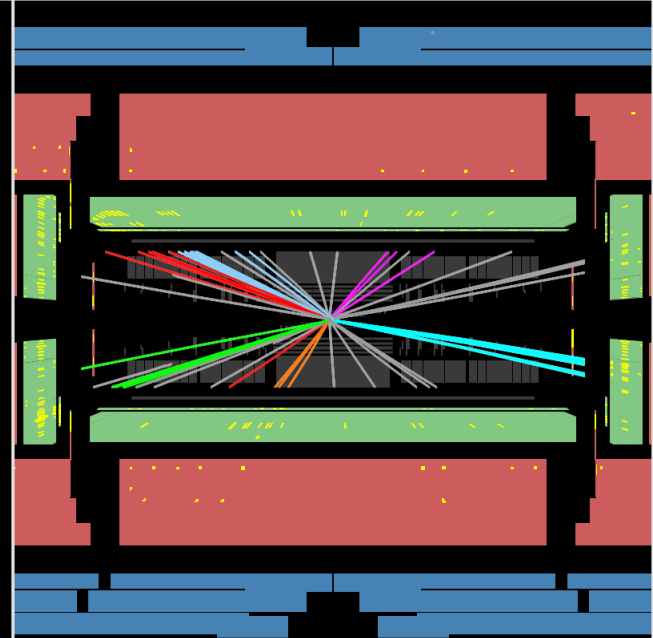
ATLAS-CONF-2010-043

Run Number: 152409, Event Number: 8186656

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

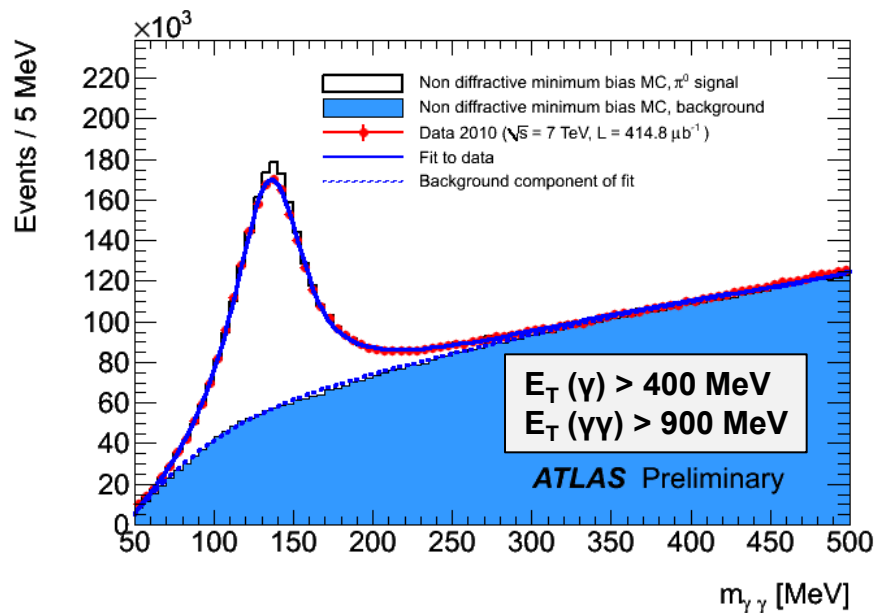


6 Jet Event in 7 TeV Collisions

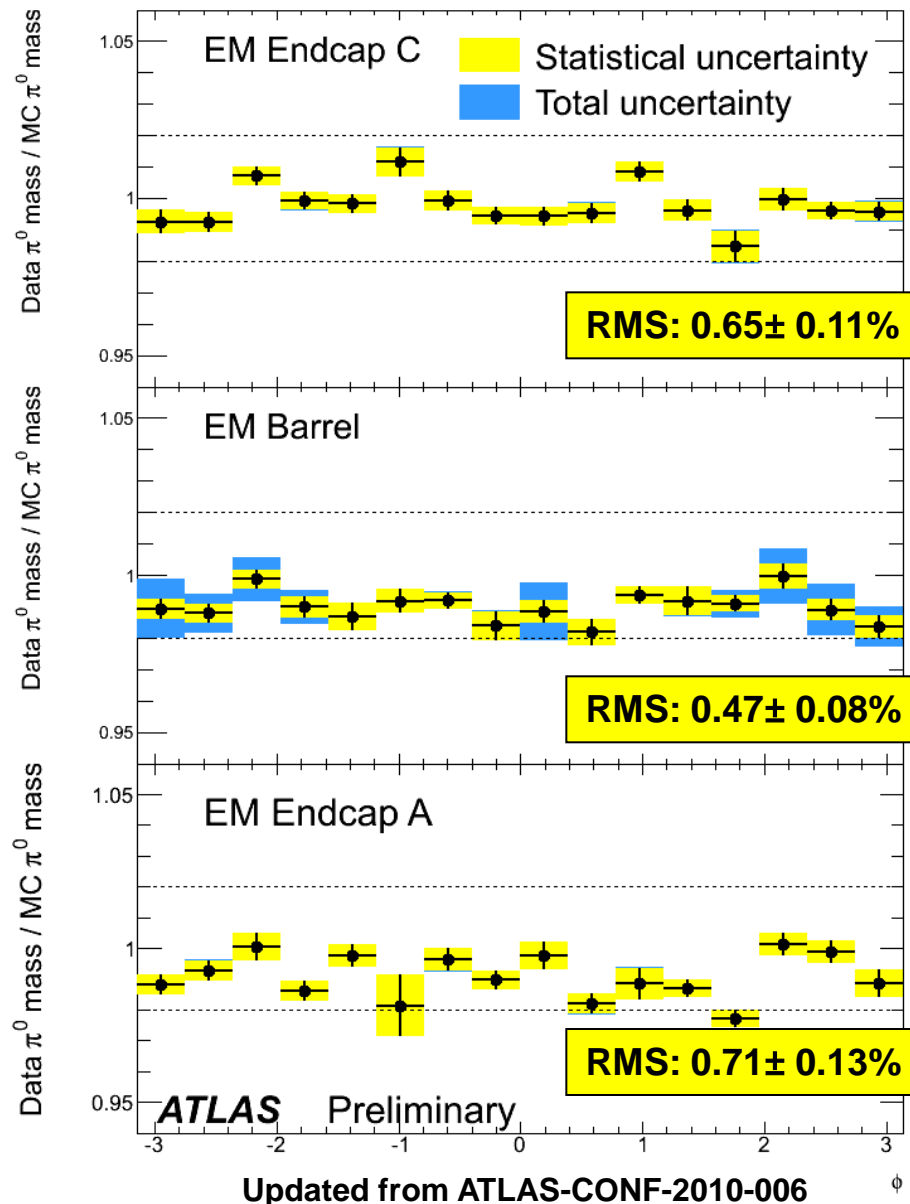


$\pi^0 \rightarrow \gamma\gamma$ Reconstruction

- Key benchmark for EM reconstruction
- Tool for measuring calorimeter scale and uniformity
- Energy scale measured to $\sim 2\%$

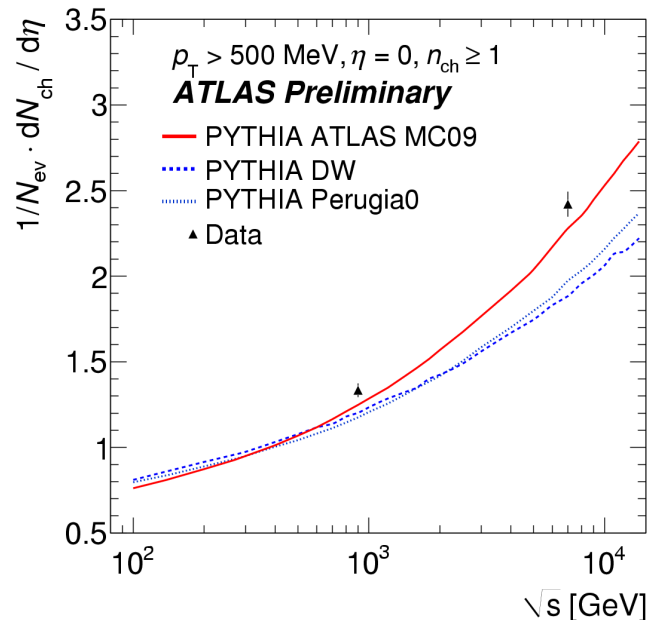
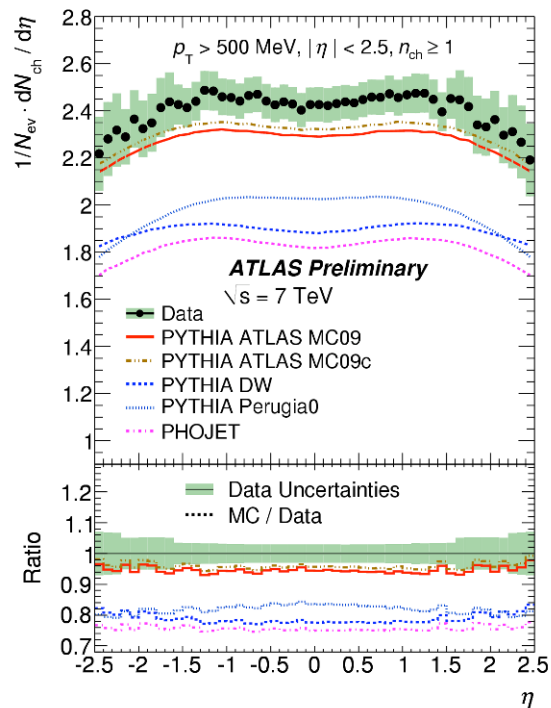


Mass peak: 135.05 ± 0.04 MeV (PDG: 134.98)
Width: ~ 20 MeV
Systematics: $m: 1\%$; $\sigma \sim 10\%$

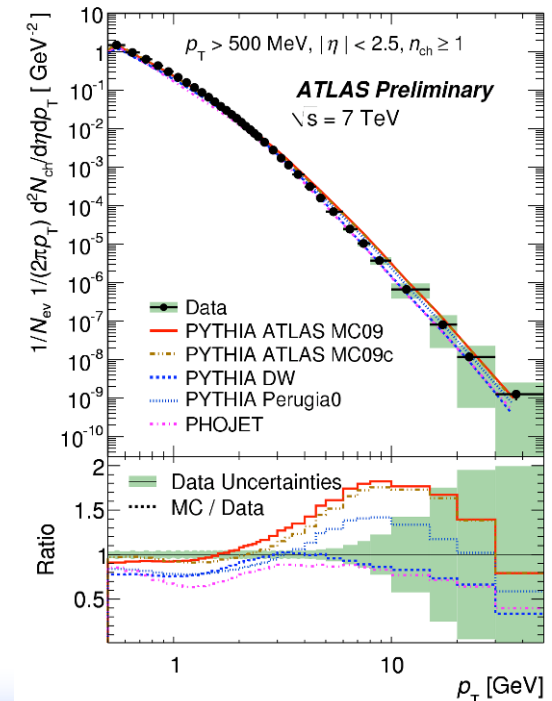


Minimum Bias with Tracks

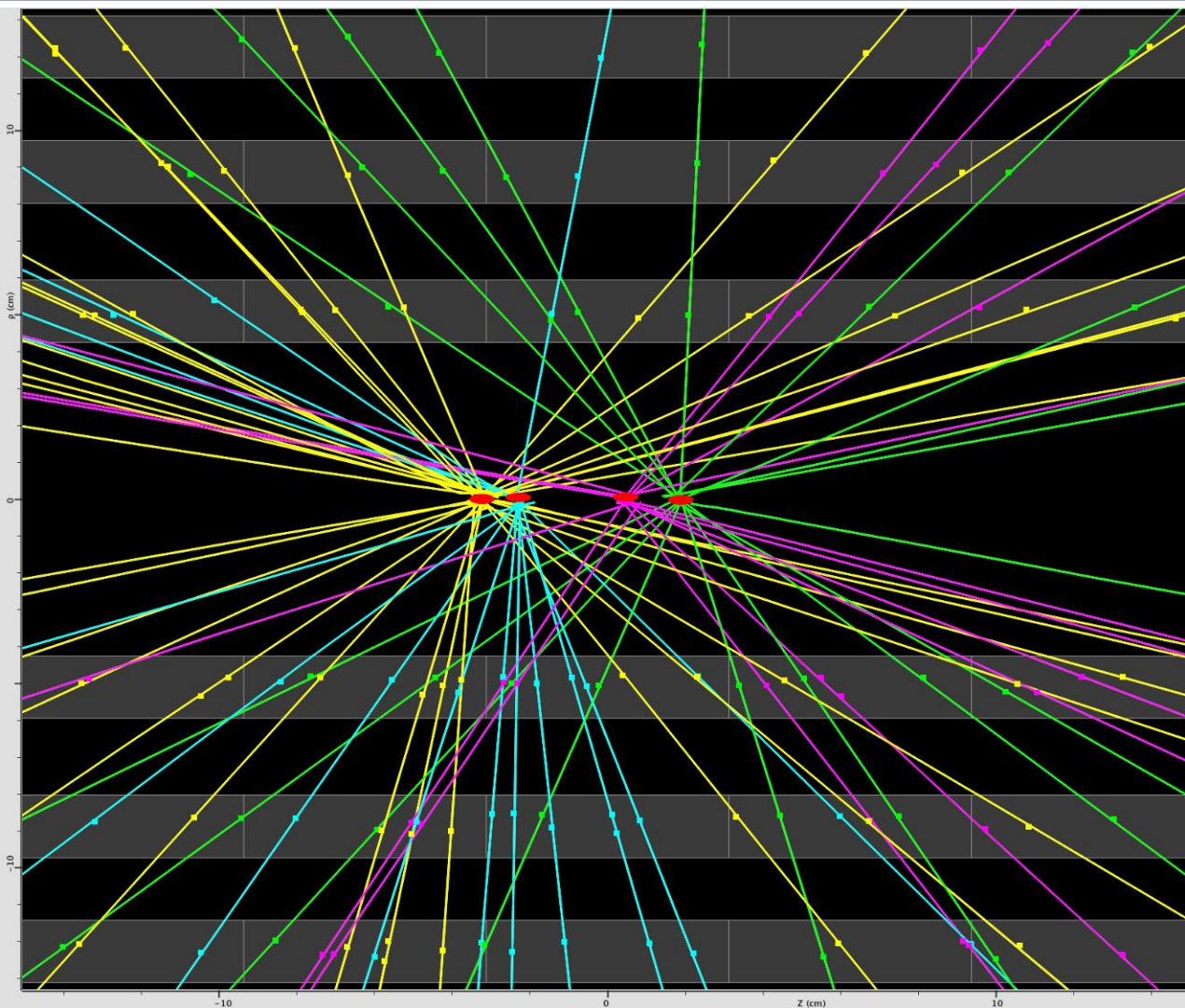
- **Inclusive, model-independent measurement from inelastic events:**
 - Well-defined kinematic region: ≥ 1 charged particle $p_T > 500$ MeV, $|\eta| < 2.5$
 - Single-arm scintillator trigger with high acceptance in above phase-space
 - No removal of single/double diffractive components
 - Distributions corrected back to hadron level
- **Excess above MC observed \rightarrow new tune required (ditto UE studies)**
- **Results at $\sqrt{s} = 900$ GeV published in Phys. Lett. B688 (2010) 1**



ATLAS-CONF-2010-024



Primary Vertex Reconstruction

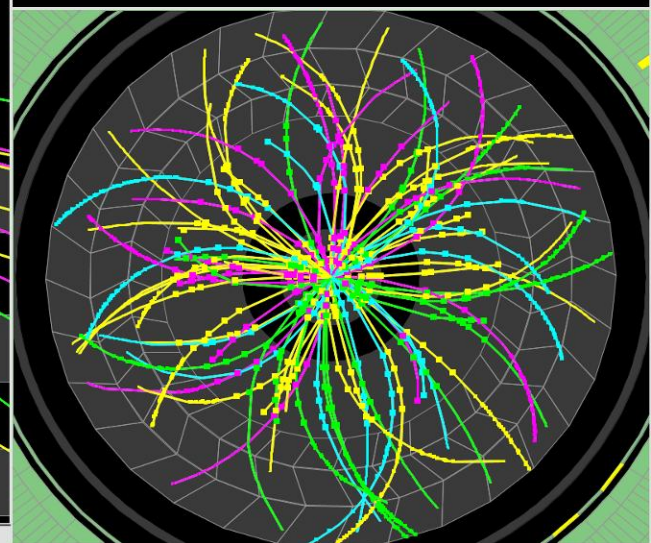


ATLAS
EXPERIMENT

Run Number: 153565, Event Number: 4487360

Date: 2010-04-24 04:18:53 CEST

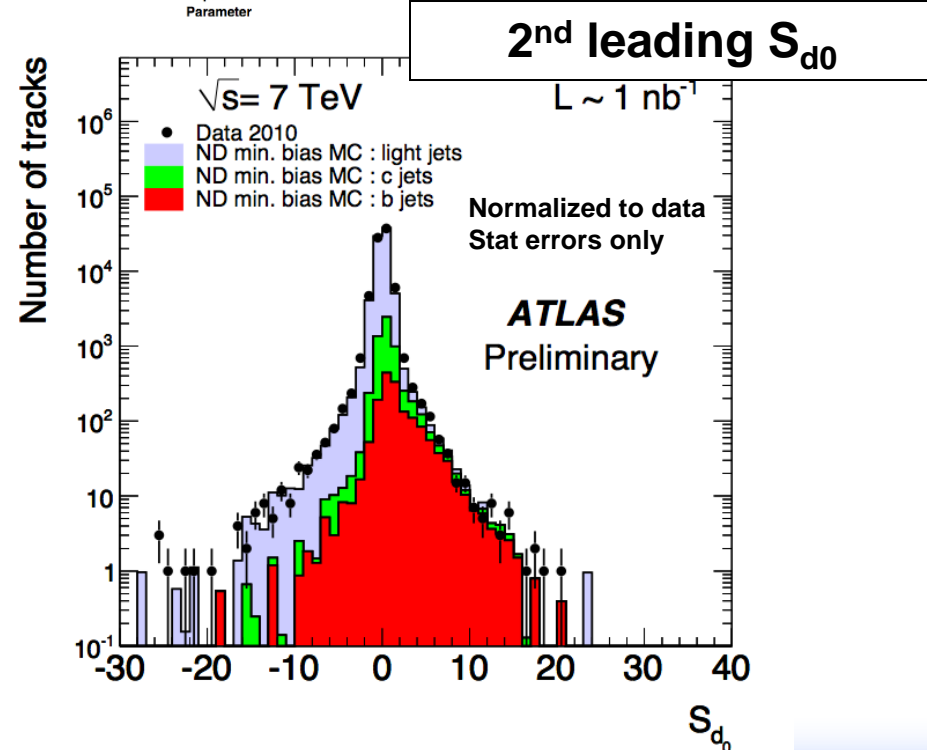
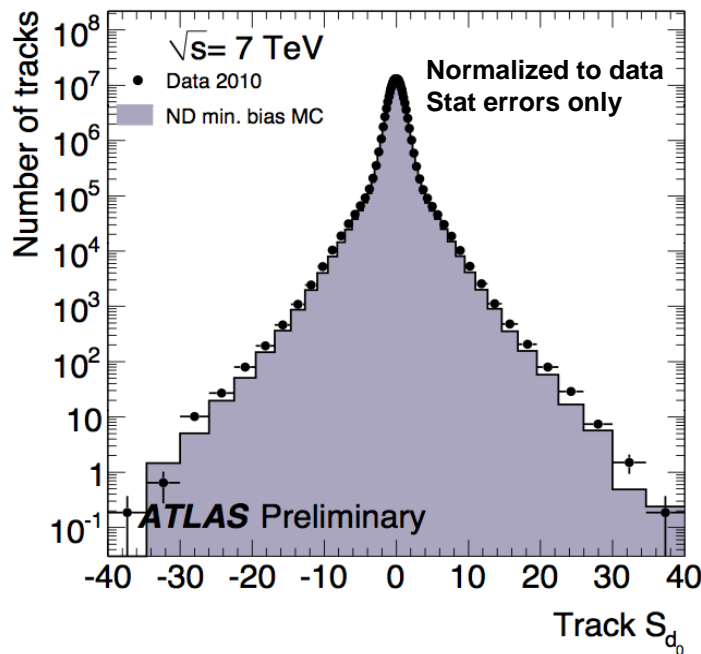
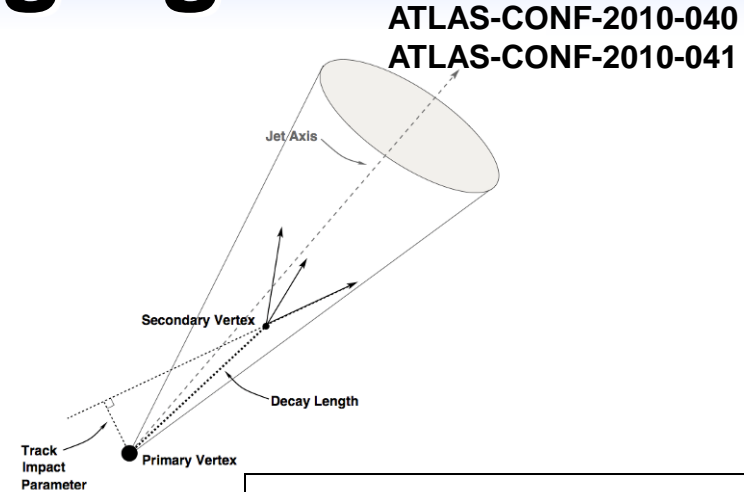
**Event with 4 Pileup Vertices
in 7 TeV Collisions**



- ~ 10-45 tracks with $p_T > 150$ MeV per vertex
- Vertex z -positions : -3.2, -2.3, 0.5, 1.9 cm (vertex resolution better than ~ 200 μm)
- Expect handful of 4-vertex events in this run

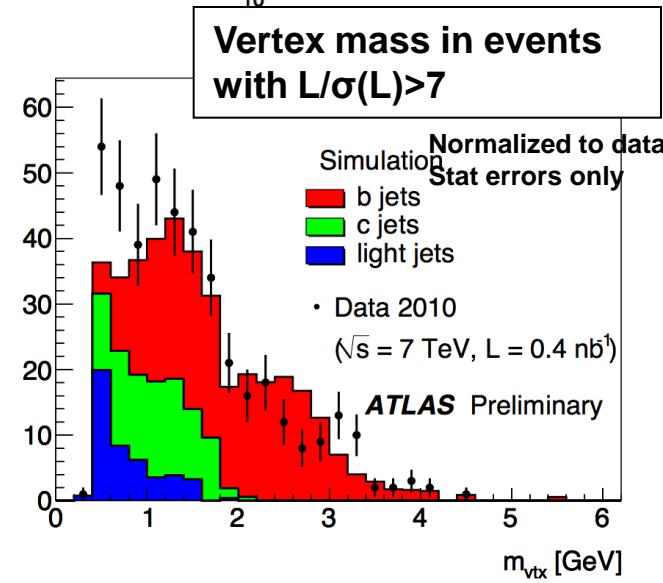
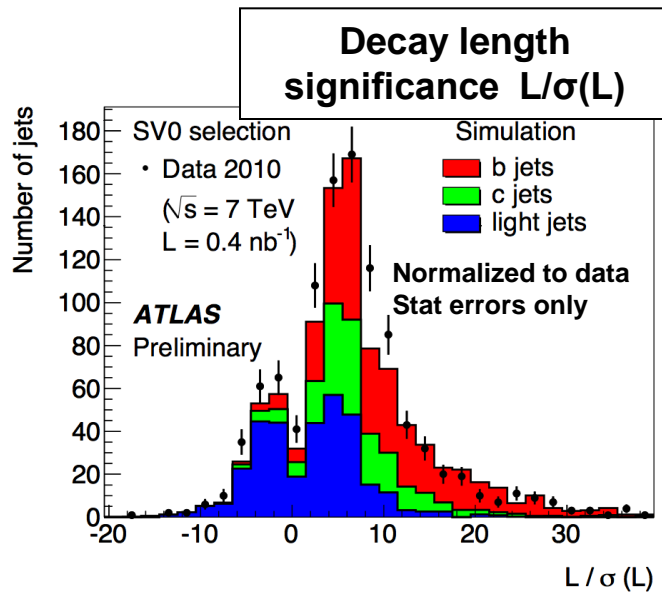
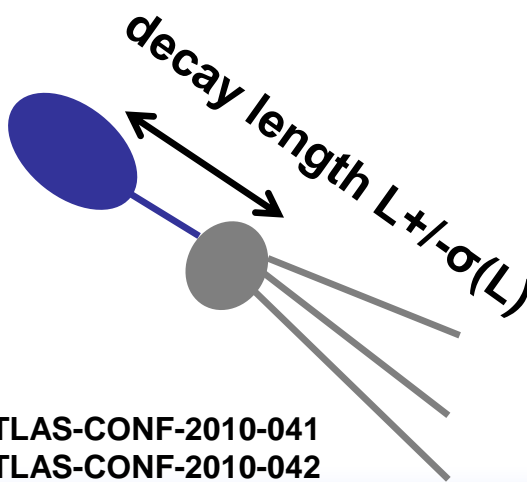
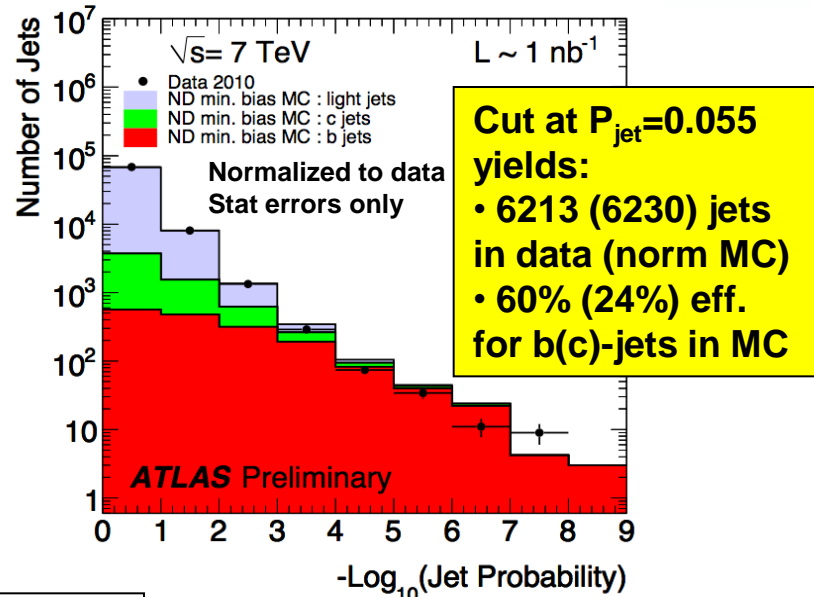
Flavour Tagging

- Several different taggers under study
- Impact parameter tagger
 - Simple and robust
 - Use track transverse impact parameter significance S_{d0}
 - Tag if 2nd highest $S_{d0} > \text{Threshold}$



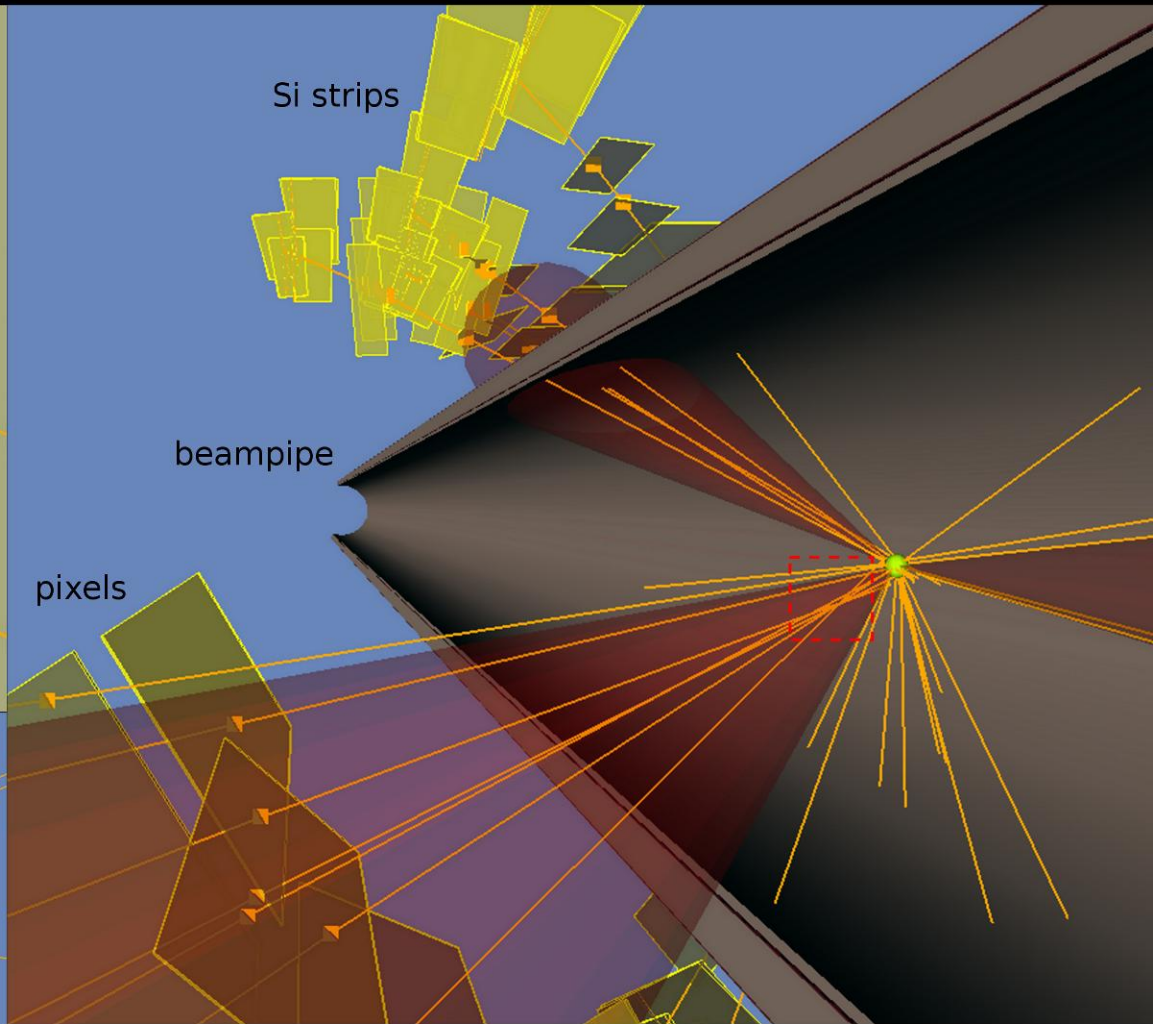
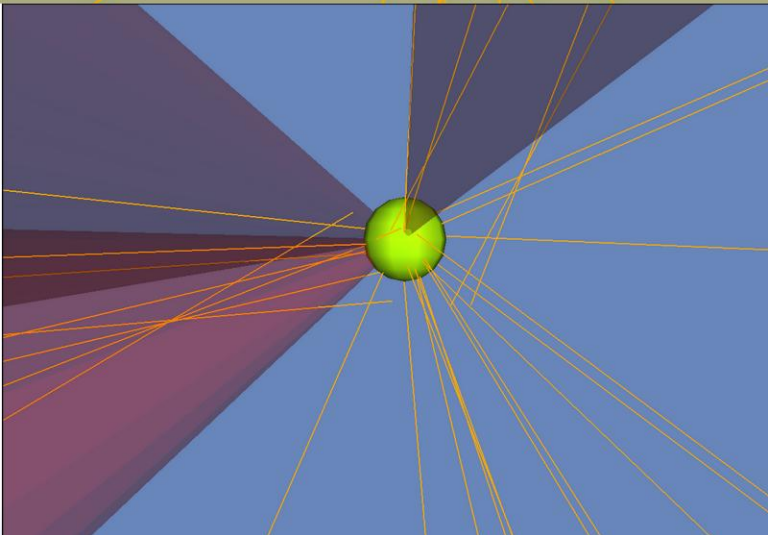
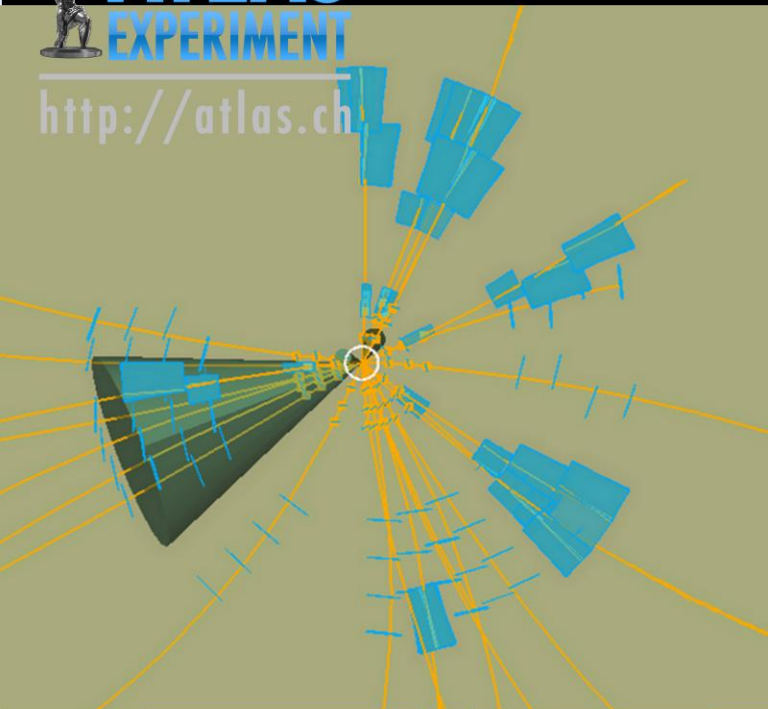
Flavour Tagging

- **Jet probability tagger:**
 - Construct combined probability of tracks to be associated with PV
- **Secondary vertex tagger:**
 - Reconstruct SVX and cut on decay length significance
- **Data/MC agreement very encouraging at such an early stage: bodes well for b-jet physics**



ATLAS-CONF-2010-041
ATLAS-CONF-2010-042

<http://atlas.ch>

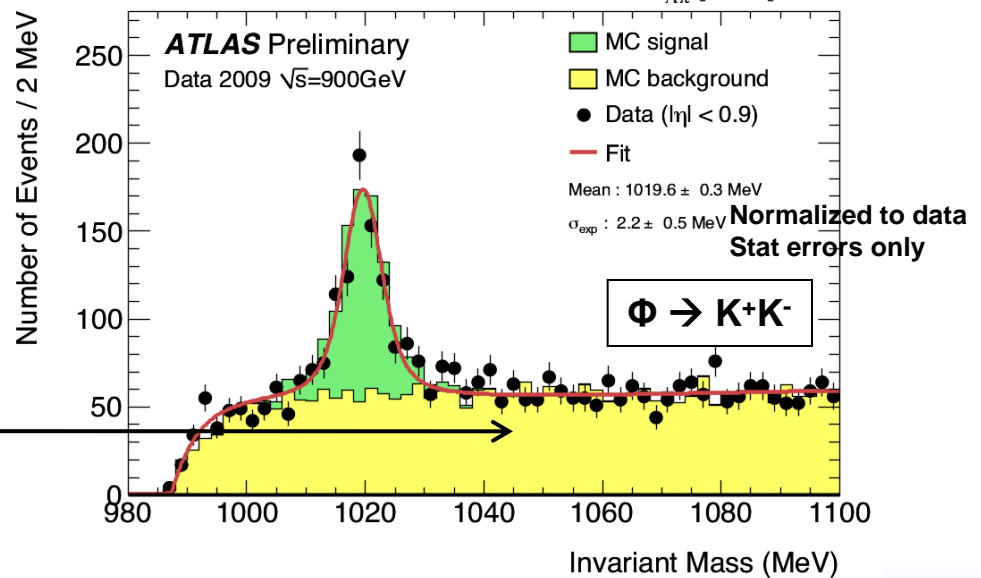
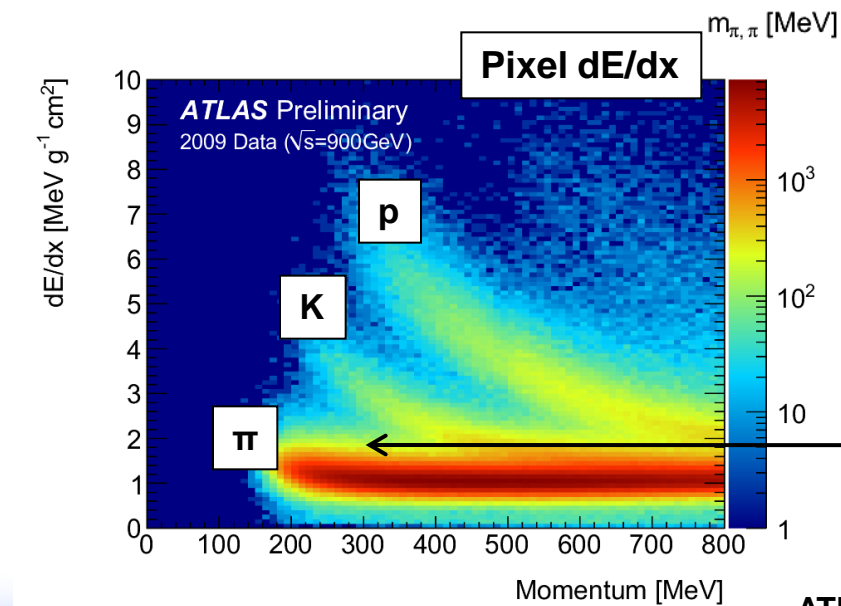
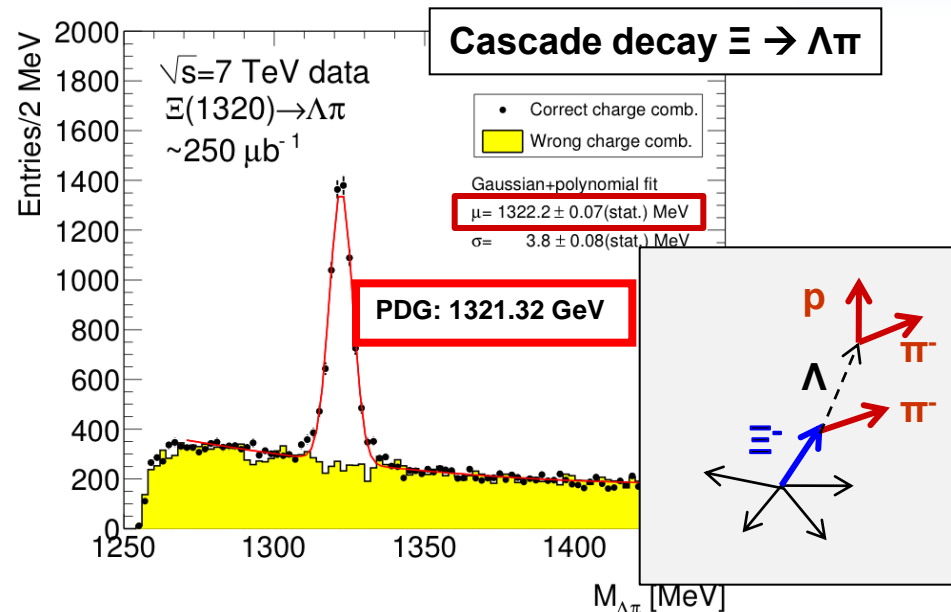
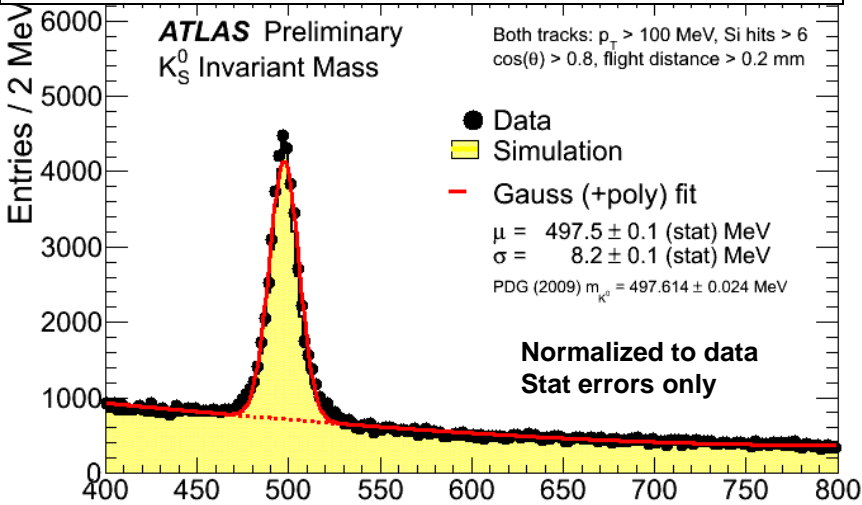


jet
 $p_T = 19$ GeV (measured at electromagnetic scale)

4 b-tagging quality tracks in the jet

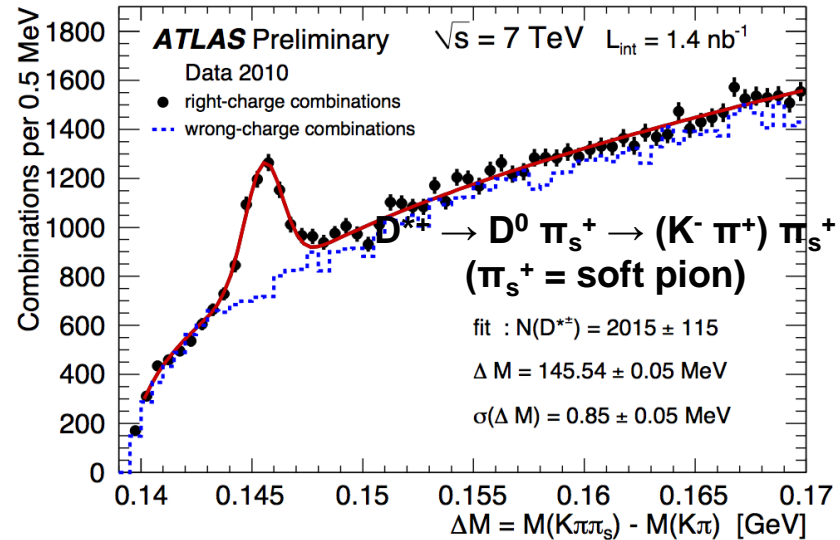
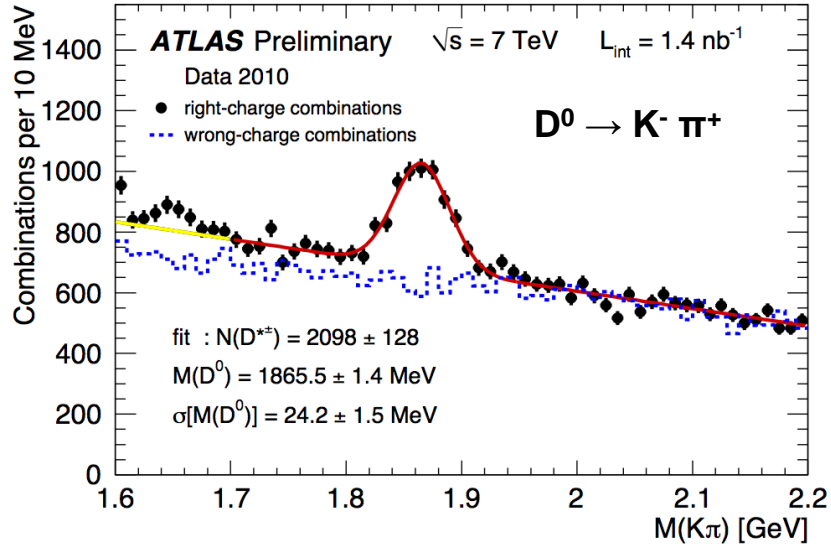
Hadron Spectroscopy

Early $K_S^0 \rightarrow \pi^+\pi^-$ observed in Dec 2009, a few days after first collisions

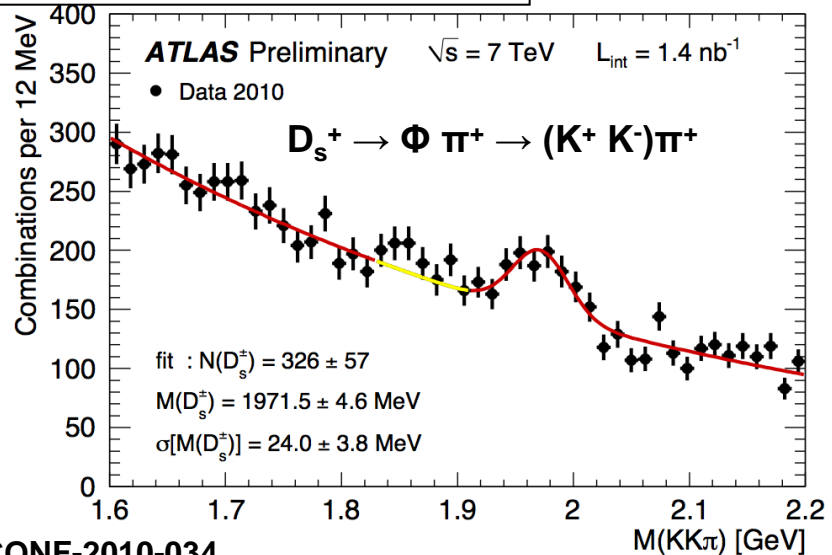
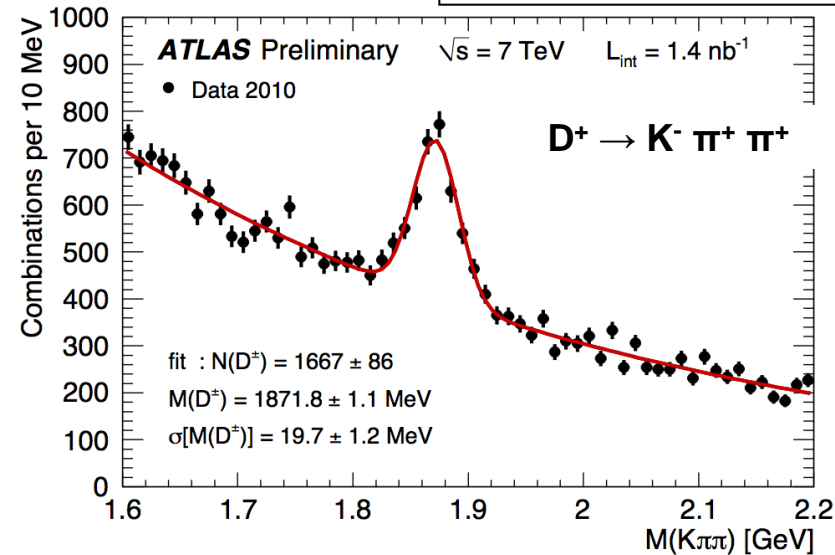


ATLAS-CONF-2010-032, ATLAS-CONF-2010-033, ATLAS-CONF-2010-023

D(*) Meson Reconstruction



For more details see Eleni Mountricha's talk

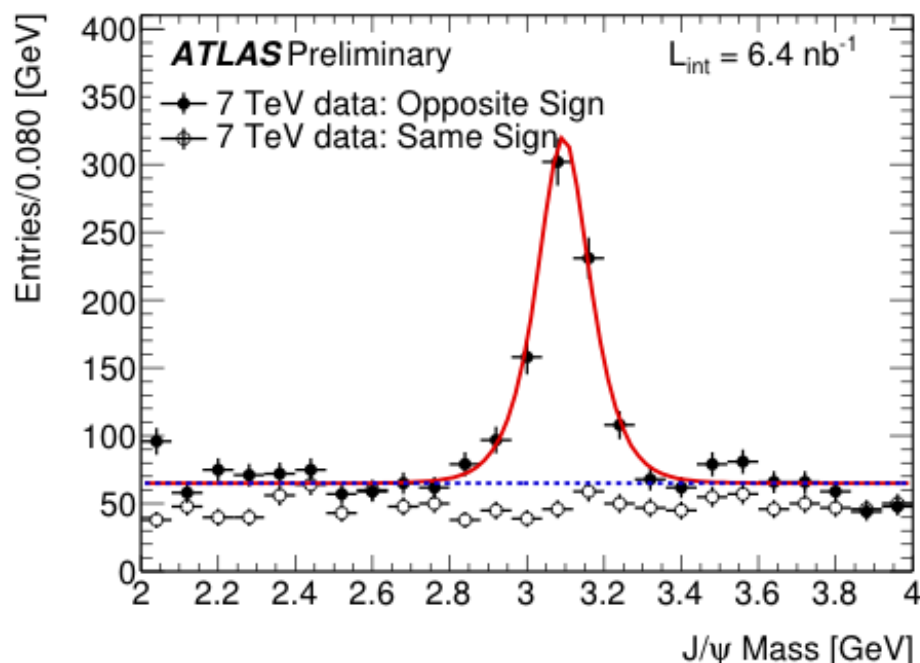


ATLAS-CONF-2010-034

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

ATLAS-CONF-2010-045

- **Key milestone for commissioning and physics**
 - QCD test with J/ψ differential cross section, polarization...
 - Crucial to understand detector performance
 - Crucial for B-physics
- **Uses combined-combined and combined-tagged muon pairs (1:3)**
- **Mass consistent with PDG, width well modelled by simulation**
- **For more details see Maria Smizanska's talk**



Very loose_selections:

- min-bias trigger at LVL1 plus HLT muon (\rightarrow sensitive to $p_T(\mu)$ as low as $\sim 1 \text{ GeV}$)
- 2 muons with opposite sign fitted to common vertex
- $p_T(\text{ID track}) > 0.5 \text{ GeV}$

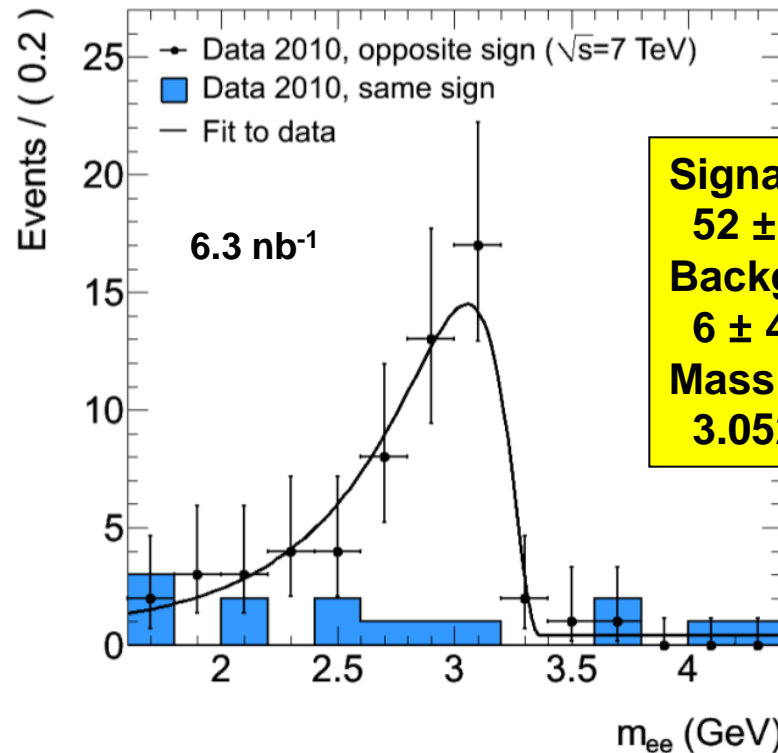
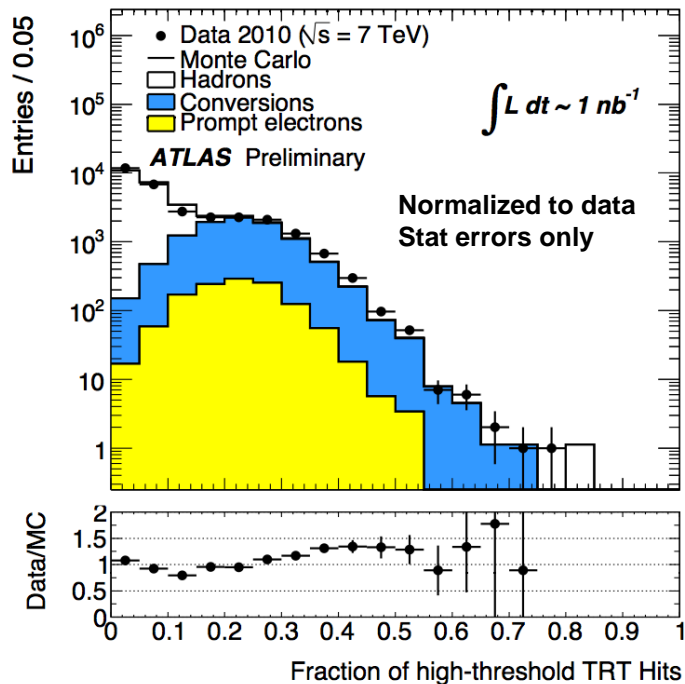
Signal : 612 ± 34 events
Background : 332 ± 9 events
Mass peak: $3.095 \pm 0.004 \text{ GeV}$ (PDG: 3.097)
Mass resolution: $82 \pm 7 \text{ MeV}$ (MC: 74 ± 0.4)

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

- More challenging due to large background and signal electron bremsstrahlung
- Mass from tracks, currently uncorrected for brem effects
- For more details see Maria Smizanska's talk

Quite strong selections:

- LVL1 EM2 trigger (3 GeV threshold)
- p_T (clusters) > 4, 2 GeV
- 2 EM clusters matched to tracks
- Track quality, calo shower shapes
- Key handle: large transition radiation in TRT

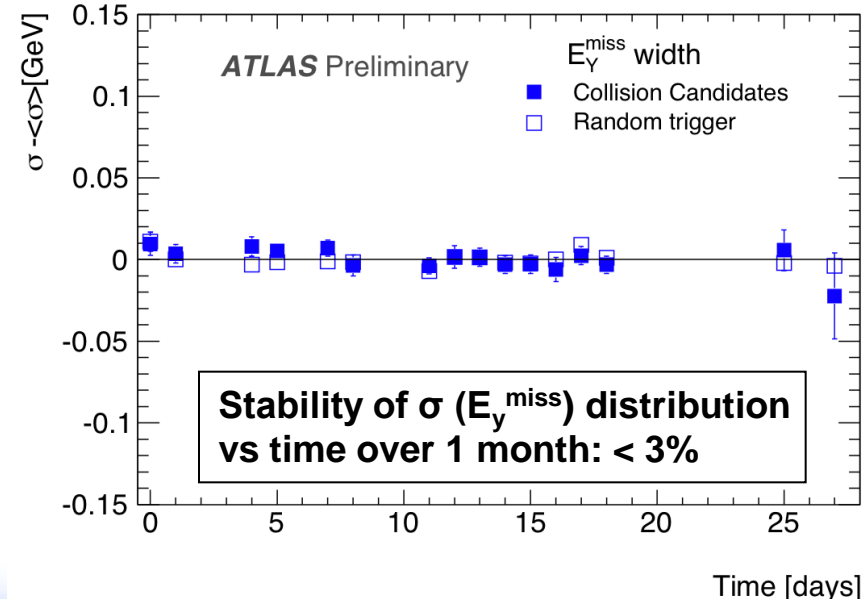
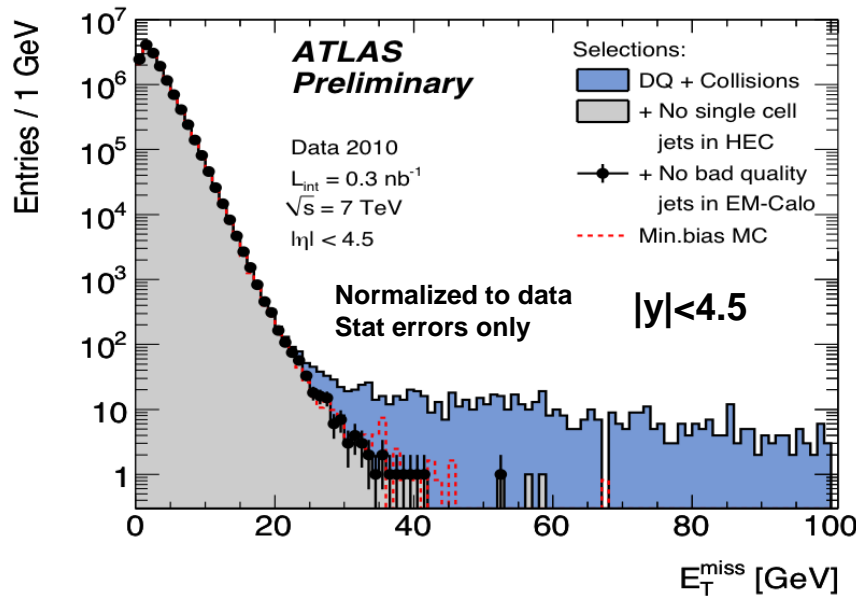
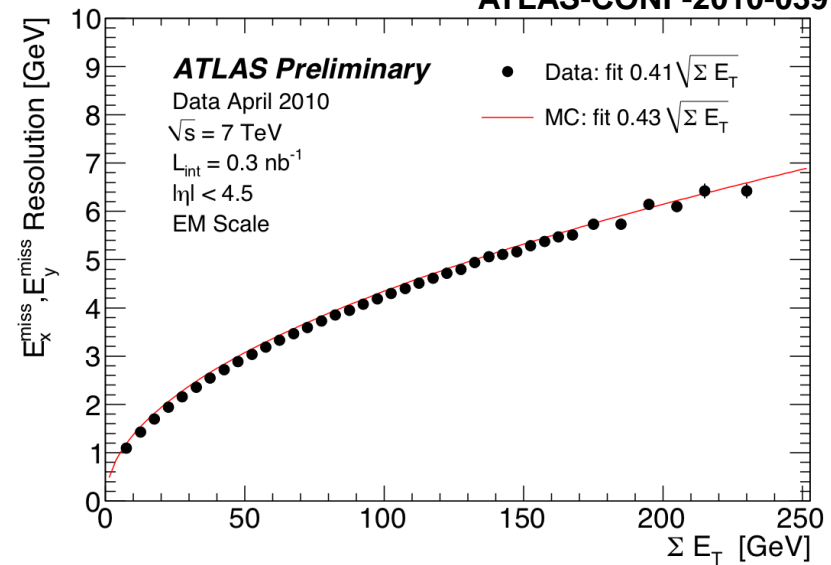


Signal:
 52 ± 8 events
Background:
 6 ± 4 events
Mass peak:
 $3.052 \pm 0.006 \text{ GeV}$

Missing Transverse Energy

ATLAS-CONF-2010-039

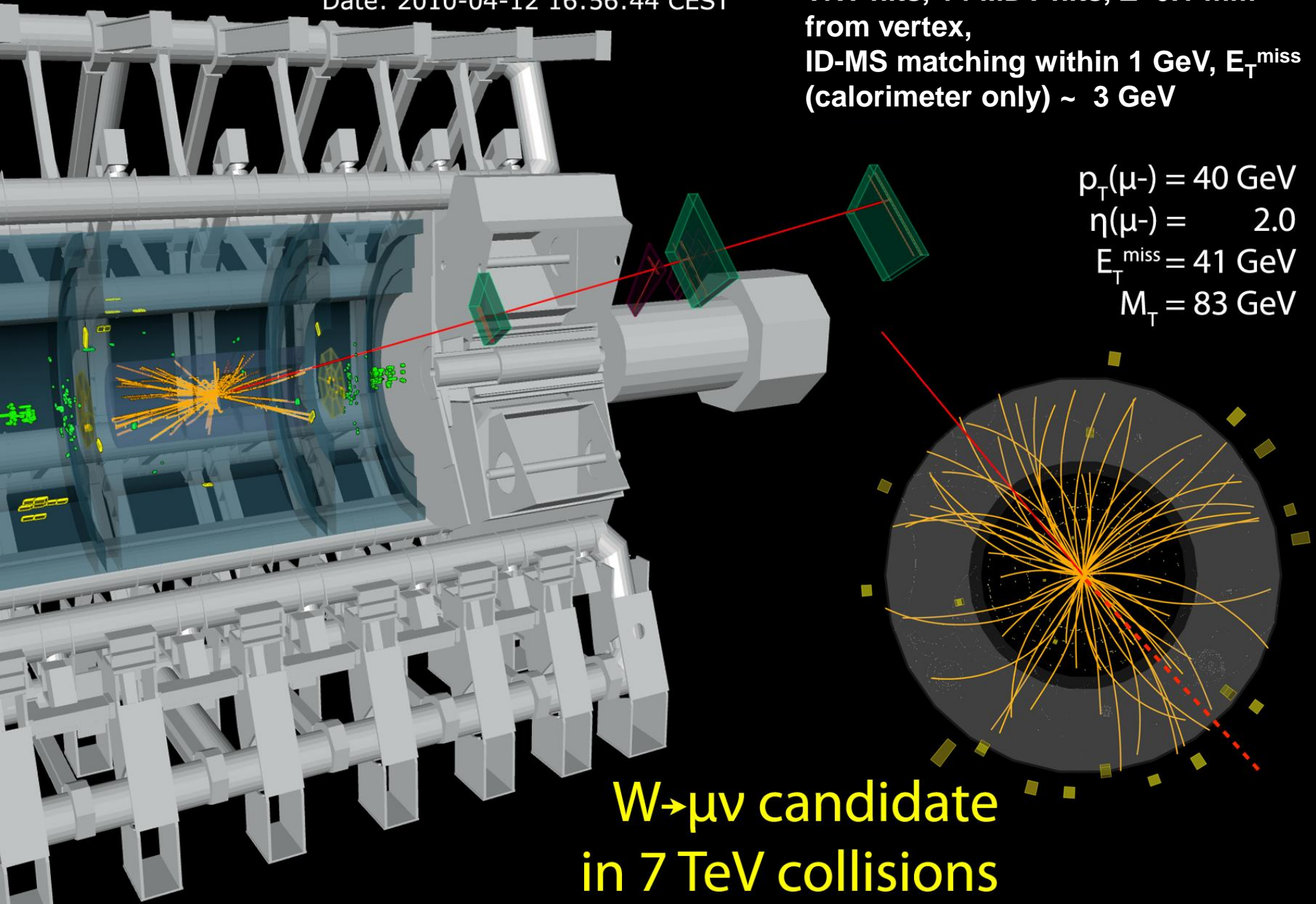
- Sensitive to calorimeter performance (coherent noise, dead/hot cells, miscalibration, cracks etc.) and cosmics and machine backgrounds → strong test
- Calibrated at EM scale currently
- Clean and stable



Run: 152845, Event: 3338173
Date: 2010-04-12 16:56:44 CEST

Muon: 3 Pixel hits, 8 SCT hits, 17
TRT hits, 14 MDT hits, $Z \sim 0.1$ mm
from vertex,
ID-MS matching within 1 GeV, E_T^{miss}
(calorimeter only) ~ 3 GeV

$p_T(\mu^-) = 40$ GeV
 $\eta(\mu^-) = 2.0$
 $E_T^{\text{miss}} = 41$ GeV
 $M_T = 83$ GeV



$W \rightarrow \mu\nu$ candidate
in 7 TeV collisions

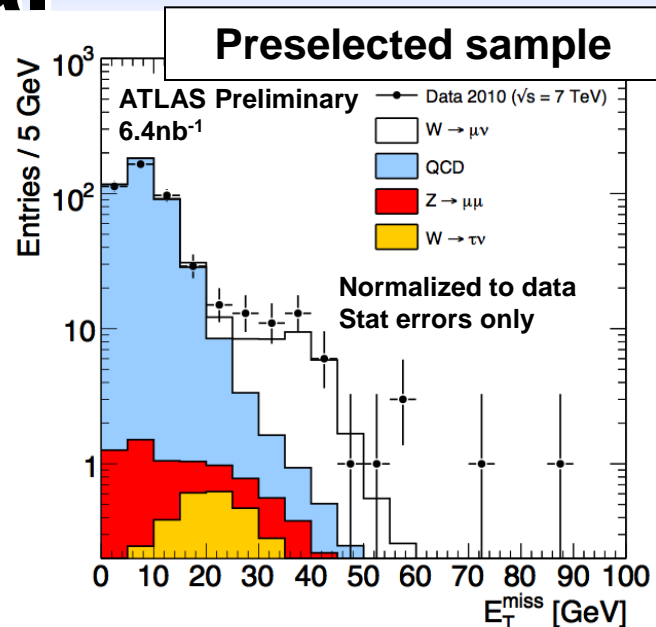
W → μν Signal

Event Selection

- Level 1 muon trigger (no p_T threshold)
- One PV with 3 tracks, consistent with BS
- 1 combined MS+ID muon, $p_T(\text{combined}) > 15$ GeV, $p_T(\text{MS}) > 10$ GeV
- $|p_T(\text{combined}) - p_T(\text{MS})| < 15$ GeV
- $|z_\mu - z_{\text{PV}}| < 1$ cm, $|\eta| < 2.4$
- Any jets must pass quality cuts

Tight selection

- $p_T > 20$ GeV and relative track isolation < 0.2 in $\Delta R = 0.4$

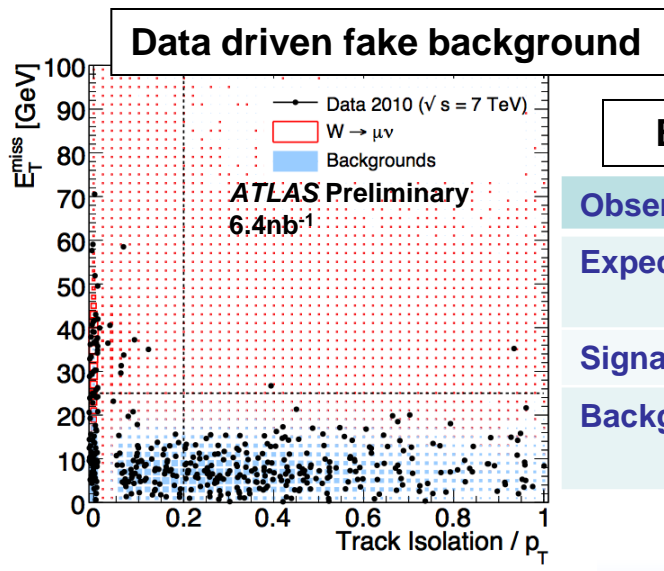
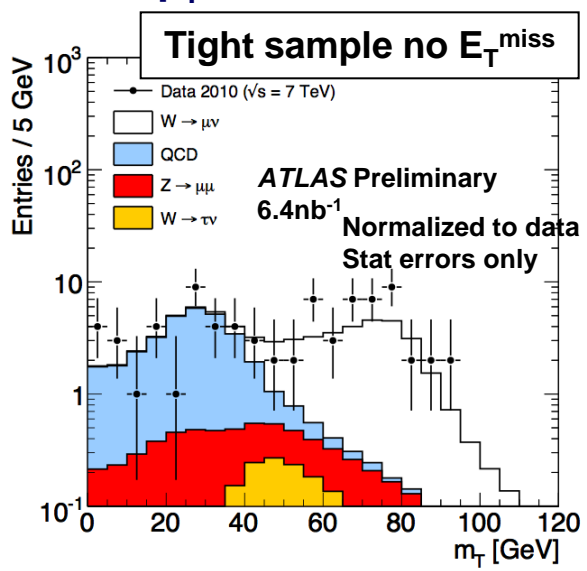


$\sigma^{\text{NNLO}}(W \rightarrow l\nu) = 10.45 \text{ nb}$

$E_T^{\text{miss}} > 25 \text{ GeV}, m_T > 40 \text{ GeV}$

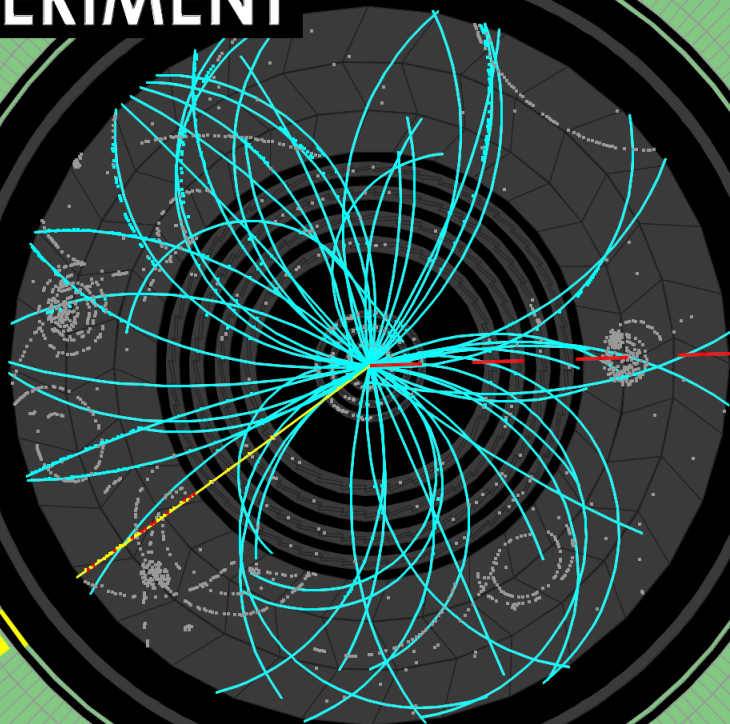
Observed	40
Expected	$28.7 \pm 0.5(\text{stat}) \pm 3.9(\text{syst}) \pm 5.7(\text{lumi})$
Signal	$25.9 \pm 3.6(\text{syst}) \pm 5.2(\text{lumi})$
Background	$2.8 \pm 0.5(\text{stat}) \pm 0.8(\text{syst}) \pm 0.6(\text{lumi})$

ATLAS-CONF-2010-044





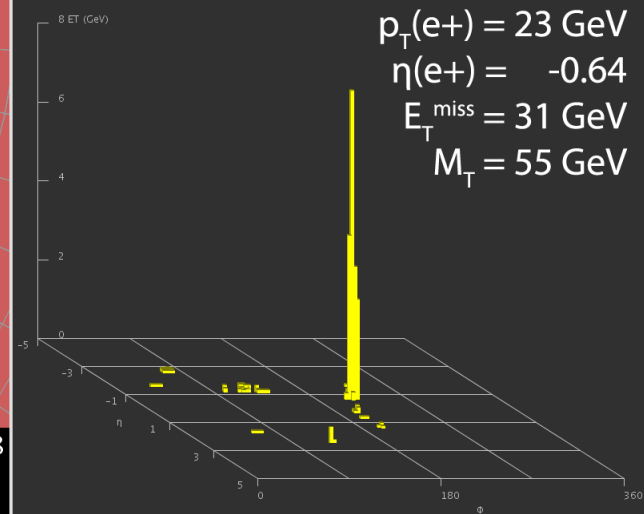
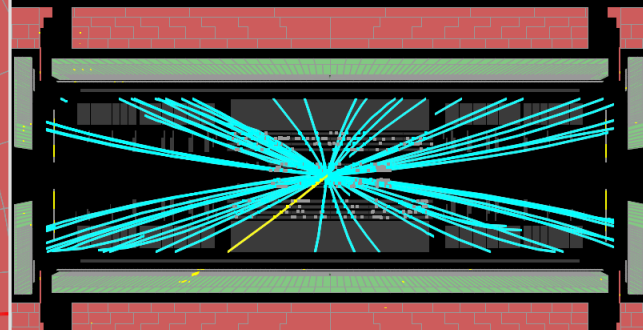
ATLAS EXPERIMENT



Run Number: 152777, Event Number: 3276028

Date: 2010-04-10 12:07:39 CEST

**W \rightarrow ev candidate in
7 TeV collisions**



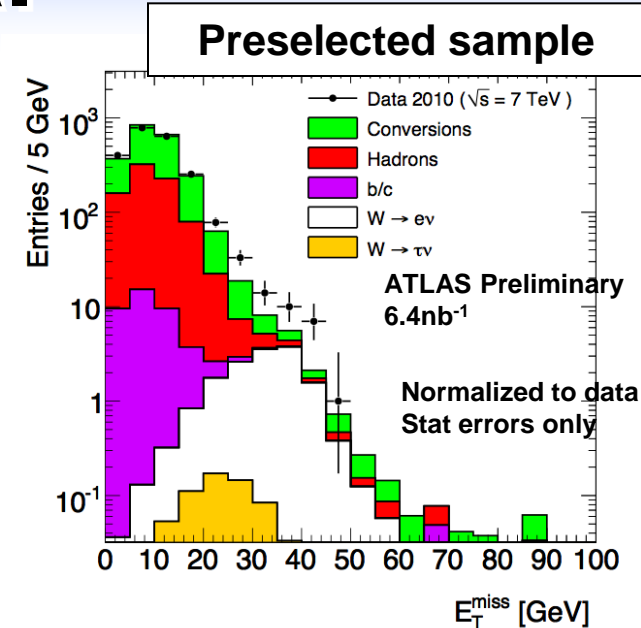
W → eν Signal

Event Selection

- Level 1 EM trigger (~ 2 GeV E_T threshold)
- One PV with 3 tracks, consistent with beam spot
- One loose electron with: ID track matching EM calo cluster, selection on the shower shape in the 2nd calo layer, energy in 1st had layer, cluster E_T > 20 GeV
- Any jets must pass quality cuts

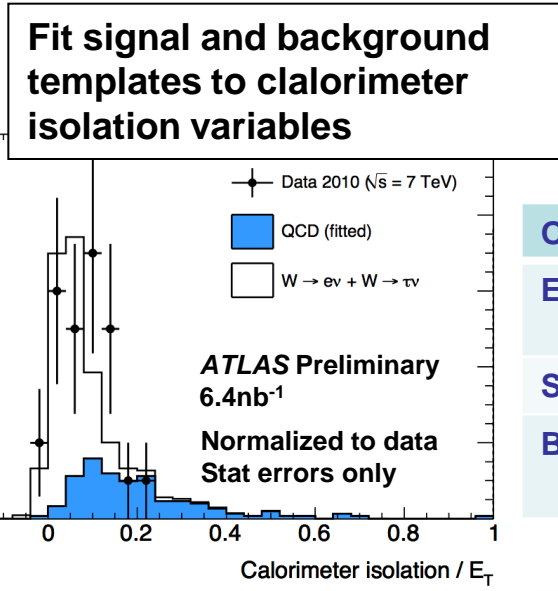
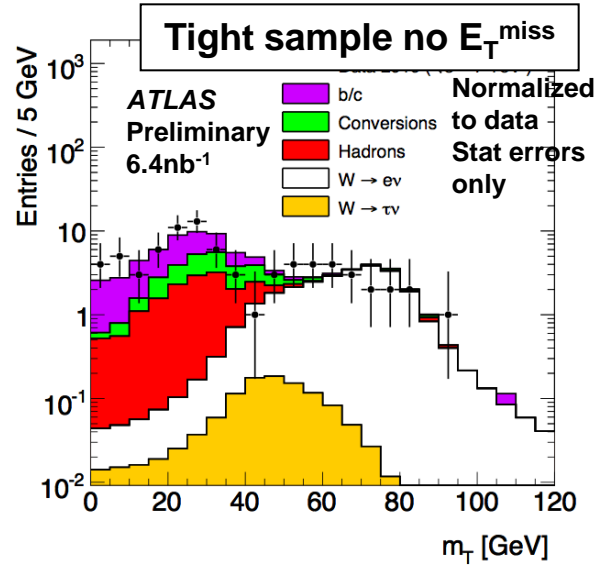
Tight selection

- Full electron ID with TRT HT hits,
- Conversion veto, detailed shower shape, impact parameter requirements



$\sigma^{\text{NNLO}}(W \rightarrow l\nu) = 10.45 \text{ nb}$

$E_T^{\text{miss}} > 25 \text{ GeV}, m_T > 40 \text{ GeV}$



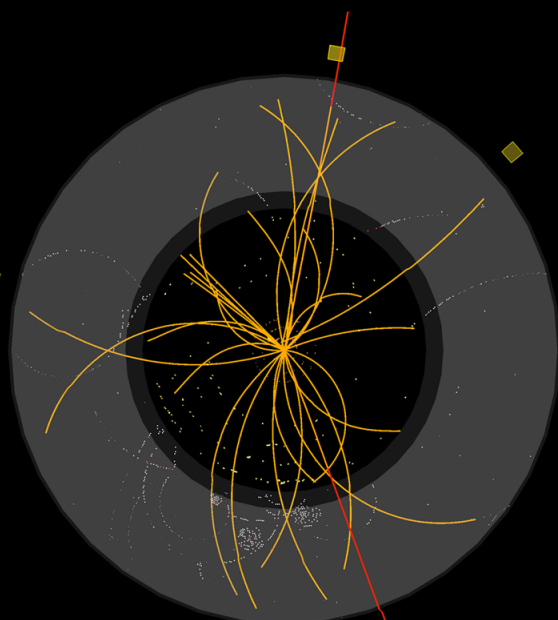
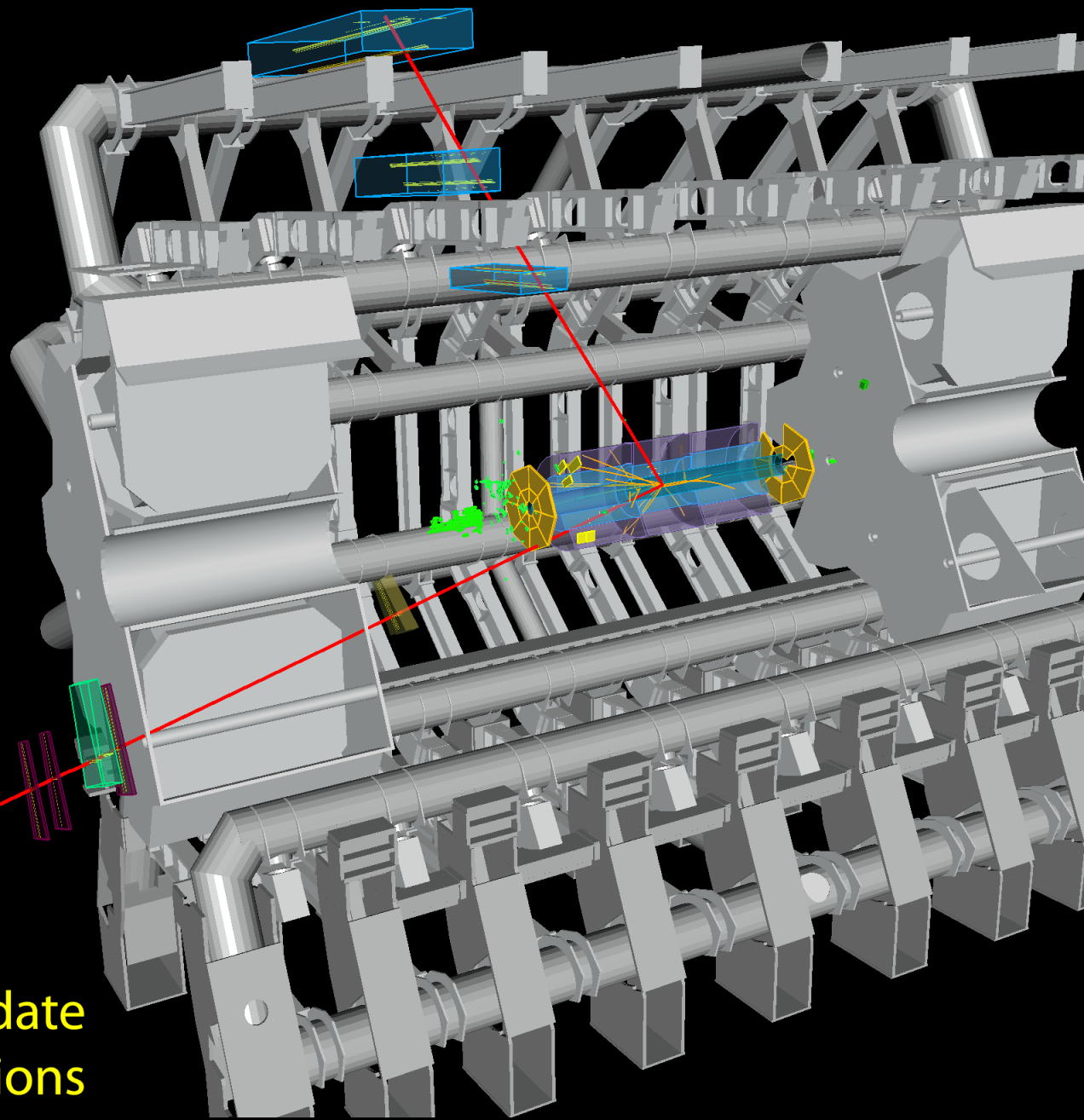
Observed	17
Expected	23.1 ± 1.2(stat) ± 1.7(syst) ± 4.6(lumi)
Signal	20.7 ± 1.5(syst) ± 4.1(lumi)
Background	2.4 ± 1.2(stat) ± 0.4(syst) ± 0.5(lumi)

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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**

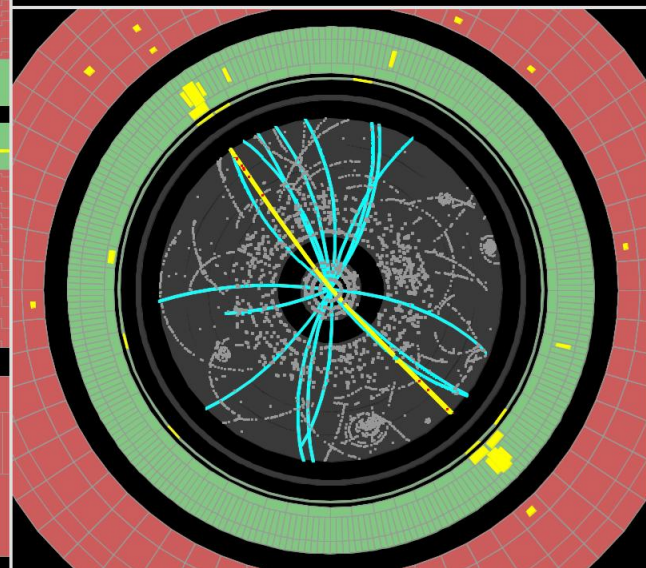
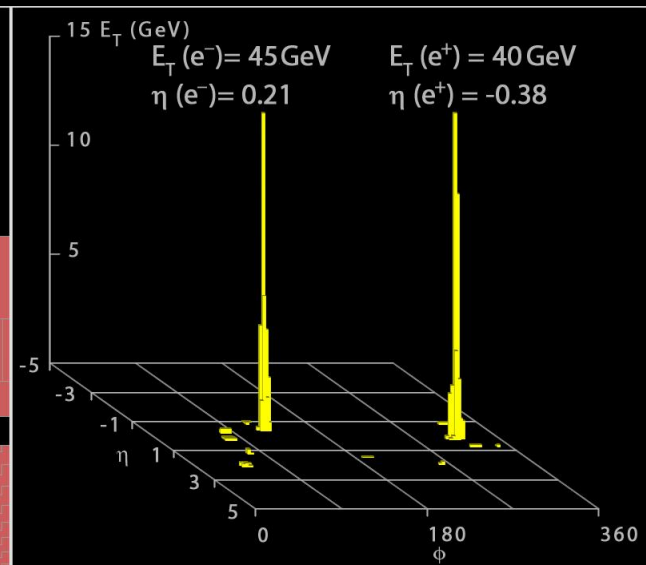
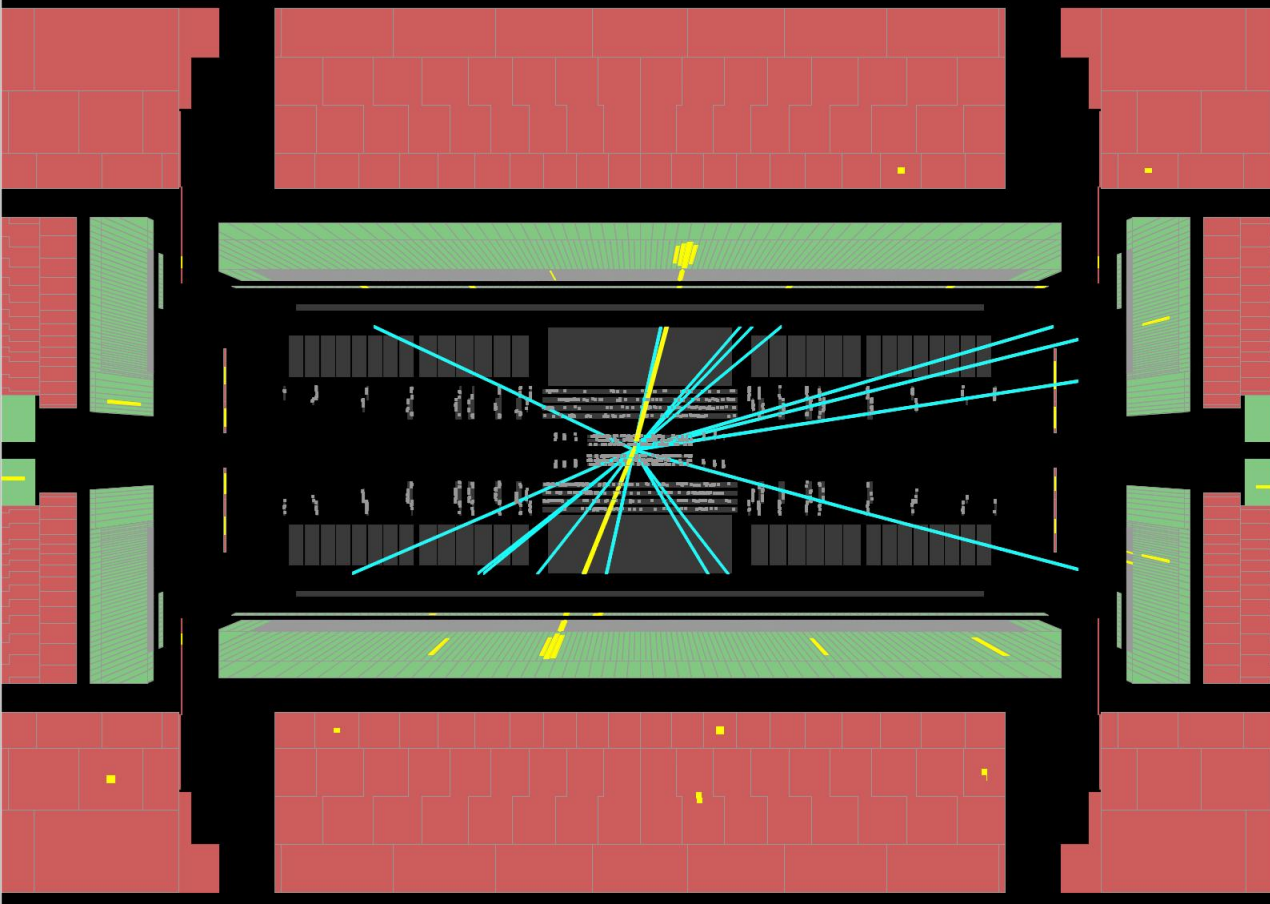


Run Number: 154817, Event Number: 968871

Date: 2010-05-09 09:41:40 CEST

$M_{ee} = 89 \text{ GeV}$

$Z \rightarrow ee$ candidate in 7 TeV collisions



Z⁰ Candidates

$$\sigma^{\text{NNLO}}(Z/\gamma^* \rightarrow \ell\ell) = 0.99 \text{ nb}$$

- Electron channel**

- Same preselection as for W
- Tight selection is loosened
- Both electrons are “medium”
- Opposite charge

- Muon channel**

- Same preselection as for W
- Tight selection is loosened
- Leading (second) muon p_T>20 (15) GeV
- Second muon has |η|<2.5
- Relative track isolation

	Z → e ⁺ e ⁻	Z → μ ⁺ μ ⁻
Analysed Integrated Luminosity	6.7nb ⁻¹	7.9nb ⁻¹
Observed 80 GeV – 100 GeV	1	2
Observed outside 80 GeV – 100 GeV	0	1
Total expected	1.6 ±0.1(syst)±0.3 (lumi)	3.2 ±0.7(syst)±0.6 (lumi)
Background	<0.2 events From combination of MC and data driven technique	<0.01 events From Monte Carlo
Reconstructed masses	91.4 GeV	87.6 GeV, 80.2 GeV

- Main systematic uncertainties on prediction:**

- Luminosity (20%), Acceptance (5%), Trigger efficiency (4-7%), electron ID (5%), muon ID (10%)

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Prospects for 2010/11

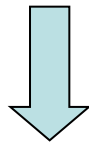
In 2010/11 we expect to record up to 1fb^{-1} of integrated luminosity at 7 TeV

Standard Model

- $W \rightarrow l + \nu$ (4M events)
- $Z \rightarrow ll$ (400k)
- $t\bar{t} \rightarrow l + \text{jets}$ (6k)
- $t\bar{t}$ dilepton (2.5k)

Discovery Potential

- Susy 5σ discovery above Tevatron limit with a few 100pb^{-1}
- $Z' \rightarrow \mu\mu$: sensitive up to 1.5TeV
- Higgs: 3σ evidence in the mass range 145-180GeV



Further Detector Commissioning
Standard Model measurements

Conclusions

- **ATLAS detector commissioning with 7 TeV data is ongoing**
 - First 16 nb^{-1} of recorded luminosity.
 - Profound thanks to the machine for such rapid progress
- **All detectors are performing remarkably well**
 - Performance confirmed to match simulation in most cases
 - Excellent stability
- **Physics analysis progressing to progressively heavier / more challenging signals**
 - Min bias and underlying event studies
 - Resonances and hadron spectroscopy
 - J/ψ in electron and muon channels \rightarrow flavour programme
 - First W and Z candidates in both electron and muon channels
- **We expect to record up to 1 fb^{-1} by the end of 2011**
- **ATLAS is ready for the exciting discoveries to come!**