ATLAS Status and First Results

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On behalf of the ATLAS Collaboration





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Overview

• Status of the ATLAS experiment

- Trigger
- Inner detector (due to the topic of this workshop, I will put a bit more emphasis here)
- Calorimeter
- Muon system

Selected performance and first physics results

- Can only show a small fraction of recent results (cf 2 plenary plus 17 parallel talks at "Physics at the LHC 2010")
- Many updates and new results in preparation for ICHEP 2010
- Martin zur Nedden will cover "B physics prospects" and results specifically of interest for flavor physics

A Very Exciting Time!

- Cosmic rays until Nov 20, 2009
 - 216 million events
- 900 GeV run Nov/Dec 2009
- 2.36 TeV few fills mid of Dec 2009
- 7 TeV run since March 30, 2010

Integrated luminosity recorded by ATLAS in 2009: (Systematic uncertainties of up to 30%)		
At 900 GeV: - Peak lumiosity - Integrated luminosity - With stable beams	~7 x 10^{26} cm ² s ⁻¹ 20 μ b ⁻¹ 12 μ b ⁻¹ (538,000 collision cand.	
At 2.36 TeV: - Collision candidates	34,000	

(For luminosity at 7 TeV in 2010 see next slide.)







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Data Sample at $\sqrt{s} = 7$ **TeV**



 Expect ~10% soon with recent Van der Meer beam separation scans

and corresponding selection efficiencies

Today



ATLAS Detector



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Overall Detector Status

Subdetector	Number of Channels	Approximate Operational Fraction
Pixels	80 M	97.4%
SCT Silicon Strips	6.3 M	99.2%
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	99.9%
LVL1 Muon RPC trigger	370 k	99.5%
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	97.0%
TGC Endcap Muon Chambers	320 k	98.6%

Status as of June 25, 2010





Trigger Commissioning

- L < few 10²⁷ cm⁻² s⁻¹:
 - Non-prescaled minimum-bias
 L1 trigger based on hits in
 scintillator counters (MBTS) on
 LAr EC at ±3.5m from IP
 - L1 muon and calo triggers also active
 - High-Level Trigger (HLT: L2 + Event Filter) commissioned by running in pass-through mode
 - Prescaled beam-pickup trigger
- At L > few 10²⁷ cm⁻² s⁻¹, start to prescale MBTS trigger
- At L > ~10²⁹ cm⁻² s⁻¹, activate e/γ HLT chain in rejection mode

Trigger Performance



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Inner Detector



Pixel detector

- 3 barrel layers, 2x3 disks
- $-\sigma(r\Phi) = 10 \ \mu m, \ \sigma(z) = 115 \ \mu m$

• Silicon strip detector (SCT)

- 4 barrel layers, 2x9 disks
- Pairs of single-sided sensors
- $\sigma(rΦ) = 17 µm, \sigma(z) = 580 µm$
- Transition Radiation Tracker (TRT)

 σ(rΦ) = 130 μm
- Covers |η| < 2.5 (2.0 for TRT)
- 2 T solenoidal field

Nominal resolution:

 $\frac{\sigma(p_T)}{p_T} \approx 3.4 \cdot 10^{-4} (p_T/GeV) \oplus 0.015$

 $\sigma(d_0) \approx 10 \mu m \oplus 140/(p_T/GeV) \mu m$



Tracking



- Inner detector alignment already close to ideal
- Tracking and reconstruction
 well understood
 - Now down to p_{T} of 100 MeV
- Particle ID via transition radiation working



Material Mapping with Converted Photons



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Vertexing and Beam Spot



- Prompt reconstruction of beam spot from distribution of primary vertices
- Measured beam spot size agrees very well with expectations from measured LHC parameters (emittance, β*)
 - Size measurement requires resolution subtraction

First Events with Pileup





Mass Peaks





- K⁰_s, K*(892), Λ, Ξ, Ω, Φ, D mesons all reconstructed in Inner Detector
- Fitted invariant masses agree with PDG values
- See Martin's talk

First ATLAS Physics Paper!

Physics Letters B 688 (2010) 21-42			
	Contents lists available at ScienceDirect		
	Physics Letters B		
ELSEVIER	www.elsevier.com/locate/physletb		
Charged-particle multiplicities in <i>pp</i> interactions at $\sqrt{s} = 900$ GeV measured with the ATLAS detector at the LHC $^{\frac{1}{2},\frac{1}{2}\frac{1}{2}}$			
ATLAS Collaboration			

- Measure charged-particle multiplicities with minimal model dependence for |η| < 2.5, p_T > 500 MeV, n_{ch} ≥ 1
 - Single arm MBTS trigger (maximize σ_{vis})
 - No subtraction of single-diffractive part
- Updated analyses: 7 TeV, new PYTHIA6 tune
 - ATLAS-CONF-2010-024 7 TeV
 - − ATLAS-CONF-2010-031 $n_{ch} \ge 6$
- Compare with models and tunes
- First tuning of PYTHIA6 to LHC data at 900 GeV and 7 TeV ("AMBT1")





Charged Particle Multiplicities at 7 TeV (n_{ch} ≥6)





Charged Particle Multiplicities at 7 TeV (n_{ch} ≥6)



PYTHIA tunes overshoot p_T **spectrum above 4 GeV**

Calorimeter System



EM Calorimeter: $\pi^0 \rightarrow \gamma \gamma$





Run Number: 152409, Event Number: 8186656

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

6 Jet Event in 7 TeV Collisions



Calibrated jet p_T in the range 30 to 70 GeV



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Jets ($p_T^{jet} > 30 \text{ GeV}$)



Only statistical errors are shown. Systematic uncertainty on jet energy scale ~7%. Monte-Carlo data from ATLAS MC09 tune.

Missing $\mathbf{E}_{\mathbf{T}}$ in Minimum Bias Events at 7 TeV

- Understanding of missing E_T crucial for new physics discoveries
- Already excellent data/MC agreement over 6 orders of magnitude





Muon System





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Muon Performance



- Muon reconstruction is working well (both standalone and combined with Inner Detector)
- Described well by simulation
- Details on J/ψ in Martin's talk



Rediscovering the Standard Model





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W Observation at 7 TeV

σ^{MUO} (N 7 ... W \rightarrow ev (L_{int} = 6.7 nb⁻¹ ± 20%)

- Track pointing to EM cluster
- E_T > 20 GeV
- Shower shape & leakage cuts
- TRT e[±] probability > 90%



 $W \rightarrow ev (L_{int} = 6.7 nb^{-1} \pm 20\%) \qquad W \rightarrow \mu v (L_{int} = 6.4 nb^{-1} \pm 20\%)$

- Isolated combined track (ID-MS)
 - p_T > 20 GeV



• After final cuts on E_{τ}^{mss} > 25 GeV and M_{τ} > 40 GeV (both e and μ channel):

	$W \to e \nu$ channel	$W \to \mu \nu$ channel
Observed	17	40
Expected	23.1 ± 1.2 (stat) ± 1.7 (syst) ± 4.6 (lumi)	$28.7 \pm 0.5(\text{stat}) \pm 3.9(\text{syst}) \pm 5.7(\text{lumi})$
Signal	20.7 ± 1.7 (syst) ± 4.1 (lumi)	$25.9 \pm 3.6(\text{syst}) \pm 5.2(\text{lumi})$
Bkg	2.4 ± 1.2 (stat) ± 0.4 (syst) ± 0.5 (lumi)	$2.8 \pm 0.5(\text{stat}) \pm 0.8(\text{syst}) \pm 0.6(\text{lumi})$



Z Observation at 7 TeV

σ^{WO} (ZIV^{*} 7^W Z \rightarrow ee (L_{int} = 6.7nb⁻¹ ± 20%)

- 2 tracks with opposite charge pointing to EM clusters
- E_T > 20 GeV
- Shower shape & leakage cuts
- 80 GeV < m_e < 100 GeV
- Observed 1, expected 1.6 ± 0.3
- Reconstructed mass: 91.4 GeV

- $Z \rightarrow \mu \mu$ (L_{int} = 7.9nb⁻¹ ± 20%)
- 2 isolated combined track (ID-MS) with opposite charge
- p₁₁ > 20 GeV, p₁₂ > 15 GeV
- 80 GeV < $m_{\mu\mu}$ < 100 GeV
- Observed 2, expected 3.2 ± 0.9
- Reconstructed mass: 87.6, 80.2 GeV



Conclusions

- After 15 years of preparation, the ATLAS detector performs beautifully
 - Data taking efficiency > 90%
 - Detector generally very well described by simulation and its response remarkably well understood at this early stage
- First physics measurements have been made
 - Minimum bias and soft QCD
 - Rediscovery of the standard model in progress (J/ ψ , W, Z, ...)
- Moving from performance and re-observations to increasingly precise physics measurements
 - Next: rediscovery of top quark, cross sections at 7 TeV, ...
- Looking forward to MUCH more data
 - $\sim 100 \text{ pb}^{-1}$ by end of 2010? (factor of 2,000 more than today!)
 - − ~1 fb⁻¹ in 2011?





... and hopefully discoveries soon!



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Backup Slides



Inner Detector Layout

