ATLAS Status Report

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University of Oxford
Open LHCC Session
23.03.2011
Activities during 2010/2011 Technical Stop

- Maintenance and consolidation
  - cooling, ventilation, cryogenics, magnets, UPS …
  - Installation of Roman Pots (ALFA)

- End-cap calorimeters opened and closed → many repairs, including
  - liquid-argon EM calorimeter optical links
  - Tile calorimeter LVPS
  - Muon chambers specific repairs
    - ~3800 HV RPC connectors substituted, …
  - Magnets bus-bars

<table>
<thead>
<tr>
<th>Subdetector</th>
<th>Number of Channels</th>
<th>Approximate Operational Fraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pixels</td>
<td>80 M</td>
<td>97.2%</td>
</tr>
<tr>
<td>SCT Silicon Strips</td>
<td>6.3 M</td>
<td>99.2%</td>
</tr>
<tr>
<td>TRT Transition Radiation Tracker</td>
<td>350 k</td>
<td>97.5%</td>
</tr>
<tr>
<td>LAr EM Calorimeter</td>
<td>170 k</td>
<td>99.9%</td>
</tr>
<tr>
<td>Tile calorimeter</td>
<td>9800</td>
<td>98.8%</td>
</tr>
<tr>
<td>Hadronic endcap LAr calorimeter</td>
<td>5600</td>
<td>99.8%</td>
</tr>
<tr>
<td>Forward LAr calorimeter</td>
<td>3500</td>
<td>99.9%</td>
</tr>
<tr>
<td>LVL1 Calo trigger</td>
<td>7160</td>
<td>99.9%</td>
</tr>
<tr>
<td>LVL1 Muon RPC trigger</td>
<td>370 k</td>
<td>99.5%</td>
</tr>
<tr>
<td>LVL1 Muon TGC trigger</td>
<td>320 k</td>
<td>100%</td>
</tr>
<tr>
<td>MDT Muon Drift Tubes</td>
<td>350 k</td>
<td>99.8%</td>
</tr>
<tr>
<td>CSC Cathode Strip Chambers</td>
<td>31 k</td>
<td>98.5%</td>
</tr>
<tr>
<td>RPC Barrel Muon Chambers</td>
<td>370 k</td>
<td>97.0%</td>
</tr>
<tr>
<td>TGC Endcap Muon Chambers</td>
<td>320 k</td>
<td>99.1%</td>
</tr>
</tbody>
</table>
Access to the calorimeter front-end electronics

7 weeks of intense mechanical work
open and close the detector

3 weeks work on calorimeter electronics:

LAr front-end electronics repaired
Tiles front-end repaired

: 54 OTXs exchanged, 11 electronics boards
: 23 LVPS repaired/exchanged, 16 drawers
(3 drawers failed after closing)
ALFA Roman Pots: Installation

ALFA := 4 Roman Pot Stations for luminosity measurement
± 240 m from ATLAS IP

December: all 4 stations with Roman Pots installed and bake out finished
January: 8 fibre detectors, front-end electronics, cabling & infra-structure, laser survey finished
February, March Commissioning:
- readout and latencies with LEDs inside RPots
- DCS/TDAQ integrated into central ATLAS

Plans 2011:
- scraping for alignment & positioning with beams
- implementations of ALFA triggers in menu
- move out of garage for detection of halo particles
- physics run close to beam with high $\beta^*$
Luminosity weighted relative detector uptime and good quality data delivery during 2010 stable beams in pp collisions at \( \sqrt{s} = 7 \) TeV between March 30th and October 31st (in %). The inefficiencies in the LAr calorimeter will partially be recovered in the future.
Improved Luminosity Measurement

Thanks to LHC team and ATLAS efforts

- Improved determination
  - LHC bunch currents: 10% → 2.9%
- ATLAS vdM scan analysis
  - length scale: 2% → 0.3%
  - emittance growth: 3% → 0.5%
  - mu dependence: 2% → 0.5%
  - fit model: 1% → 0.1%
  - beam centering: 2% → 0.1%

van der Meer Scans
5 lumi detectors and up to 5 algorithms

Uncertainty reduced 11% → 3.4%
Electron Performance Results

Z mass resolution
\[ \sigma_{\text{data}} = 1.73 \pm 0.08 \text{ GeV} \]
\[ \sigma_{\text{MC}} = 1.49 \pm 0.02 \text{ GeV} \]

J/ψ Resolution
\[ \sigma_{\text{data}} = 132 \pm 2 \text{ MeV} \]
\[ \sigma_{\text{MC}} = 134 \pm 1 \text{ MeV} \]

Calibrated at Z peak
Excellent linearity

forward-central Zs
electrons above the tracker acceptance
ID and Muon Combined Performance Results

Low $p_T$ efficiency from $J/\psi \rightarrow \mu\mu$ decays

High $p_T$ efficiency from $Z \rightarrow \mu\mu$ decays

Efficiency understood down to very low $p_T$

Improve momentum scale and resolution

Muon scale uncertainty is < 1%

Dimuon mass resolution 1.8% barrel and 3% end-cap

Smear MC hit uncertainties

$$\sigma = a \ast \sigma + c$$

$\sigma = 1$

Present understanding of ID alignment

<table>
<thead>
<tr>
<th>Detector</th>
<th>coordinate</th>
<th>Barrel</th>
<th>End-caps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pixel</td>
<td>local $x$</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>local $y$</td>
<td>18</td>
<td>35</td>
</tr>
<tr>
<td>SCT</td>
<td>local $x$</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>TRT</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
Measuring $\psi$ and $B^\pm$ production is an important test-bed for a variety of QCD models. Measurements made in slices of $\psi$ $p_T$ from 1 to 70 GeV and in 4 rapidity slices from 0 to 2.4. One rapidity slice shown here (0.75-1.5).

Reconstruction of an exclusive $B$ decay mode

$B^\pm \rightarrow \psi K^\pm$
35 pb$^{-1}$:

$260000 \ W \rightarrow l \nu$

$25000 \ Z/\gamma^* \rightarrow ll$

$W/Z \rightarrow e\nu\mu\mu$ Candidate
**W and Z Inclusive Cross-Section – 33-36 pb⁻¹**

- **Main improvements** wrt 0.3pb⁻¹ measurement (JHEP, 12:060, 2010)
  - Systematic uncertainties diminished (/3): $\sigma(Z \rightarrow ll) 1.2\%$, $\sigma(W \rightarrow l\nu) 2.4\% + \text{lumi}$
  - Experimental uncertainties smaller than theory uncertainties in fiducial regions
  - $\sigma(Z \rightarrow ee)$ extended up to $|\eta| \sim 4.9$

**NNLO predictions consistent with data**

Remarkable success of pQCD and PDFs
W Charge Asymmetry (muon channel)

\[ A_\mu = \frac{d \sigma_{W \mu^+} / d \eta_\mu - d \sigma_{W^-} / d \eta_\mu}{d \sigma_{W \mu^+} / d \eta_\mu + d \sigma_{W^-} / d \eta_\mu} \approx \frac{d(x)}{u(x)} \]

- Measurement constrains PDFs
  - \(10^{-3} \leq x \leq 10^{-1}\)

\(\chi^2 = 8.8\)
WW → eνμν Candidate

Run 167576  Event 120642801
Time 2010-10-24 13:06:00 EDT

<table>
<thead>
<tr>
<th>$p_T^{\mu^-}$ [GeV]</th>
<th>$\eta^{\mu^-}$</th>
<th>$\phi^{\mu^-}$</th>
<th>$p_T^{e^+}$ [GeV]</th>
<th>$\eta^{e^+}$</th>
<th>$\phi^{e^+}$</th>
<th>$E_T^{\text{miss}}$ [GeV]</th>
<th>$\phi_{E_T^{\text{miss}}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>67.8</td>
<td>-0.63</td>
<td>0.20</td>
<td>21.2</td>
<td>-1.56</td>
<td>-0.56</td>
<td>68.8</td>
<td>-3.08</td>
</tr>
</tbody>
</table>
Diboson Production

- **WW Production**
  - Test non-abelian nature of EW sector
  - Sensitive to **Triple Gauge Couplings**
  - Main background to $H \rightarrow WW$
  - NLO prediction: $46 \pm 3 \text{ pb}$
  - Results:
    \[
    \sigma_{WW} = 40^{+20}_{-16} (\text{stat}) \pm 7 (\text{syst}) \text{ pb}
    \]
  - 8 events observed, $1.7 \pm 0.6$ bkg expected
  - Dominated by statistical uncertainty $44\%$

- **W/Z+γ Production**
  - Sensitive to Triple Gauge Couplings
  - Important test of SM

---

<table>
<thead>
<tr>
<th>Process</th>
<th>$\sigma^{\text{total}}<a href="%5Ctext%7Bmeasured%7D">\text{pb}</a>$</th>
<th>$\sigma^{\text{total}}<a href="%5Ctext%7Bpredicted%7D">\text{pb}</a>$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$pp \rightarrow e\nu\gamma$</td>
<td>$73.9 \pm 10.5(\text{stat}) \pm 14.6(\text{syst}) \pm 8.1(\text{lumi})$</td>
<td>$69.0 \pm 4.6(\text{syst})$</td>
</tr>
<tr>
<td>$pp \rightarrow \mu\nu\gamma$</td>
<td>$58.6 \pm 8.2(\text{stat}) \pm 11.3(\text{syst}) \pm 6.4(\text{lumi})$</td>
<td>$69.0 \pm 4.6(\text{syst})$</td>
</tr>
<tr>
<td>$pp \rightarrow e^+e^-\gamma$</td>
<td>$16.4 \pm 4.5(\text{stat}) \pm 4.3(\text{syst}) \pm 1.8(\text{lumi})$</td>
<td>$13.8 \pm 0.9(\text{syst})$</td>
</tr>
<tr>
<td>$pp \rightarrow \mu^+\mu^-\gamma$</td>
<td>$10.6 \pm 2.6(\text{stat}) \pm 2.5(\text{syst}) \pm 1.2(\text{lumi})$</td>
<td>$13.8 \pm 0.9(\text{syst})$</td>
</tr>
</tbody>
</table>
SM Higgs $\rightarrow$ W W* $\rightarrow$ lν lν (l = e, μ)

- Strong sensitivity in $120 < m(H_{SM}) < 200$ GeV
- Cut-based analysis
- Combining H + 0 jet, H + 1 jet and H + 2 jet

... will be catching up with the Tevatron very soon.

**Upper limit on $\sigma \times BR(H \rightarrow WW^*)$**
- $m_H=120$ GeV : 54 pb
- $m_H=160$ GeV : 11 pb
- $m_H=200$ GeV : 71 pb

**Data-driven estimation**
- WW, tt, W+jets, Z+jets backgrounds

**ATLAS** Preliminary

Transverse mass (H+0 jets)

- ATLAS Preliminary
- Data
- H→WW ($m_H=170$ GeV)
- W+jets
- top
- WW
- Z+jets
- WZ/ZZ/Wγ

Integral $L dt = 35$ pb$^{-1}$
- $\sqrt{s} = 7$ TeV

95% CL Limit on $\sigma/\sigma_{SM}$
- $\int L dt = 35$ pb$^{-1}$
- $\sqrt{s} = 7$ TeV
- Transverse mass (H+0 jets)

Tevatron $<L> = 5.9$ fb$^{-1}$
- 2010 Tevatron Exclusion
- Observed CLs
- Expected CLs
SM: $H \rightarrow \gamma\gamma$

- Mass range: 110 GeV - 140 GeV
- Data-driven estimation of all background components
  - $\gamma\gamma$, $\gamma j$, $jj$
- Inclusive
  - only discriminant diphoton inv. mass

Sensitivity close to Tevatron
Exploring new mass reach! $H \rightarrow ZZ \rightarrow lll\ell$, llqq, llνν

ATLAS - CONF - 2011 - 026

ATLAS Preliminary
$H \rightarrow llqq$ ($m_H = 400$ GeV)

ATLAS Preliminary
$H \rightarrow llνν$ ($m_H = 400$ GeV)

ATLAS Preliminary
$H \rightarrow ZZ \rightarrow lll\ell$

ATLAS Preliminary
$\int L dt = 35$ pb$^{-1}$, $\sqrt{s} = 7$ TeV

ATLAS Preliminary
$\int L dt = 40$ pb$^{-1}$, $\sqrt{s} = 7$ TeV

95% C.L. limit on $\sigma/\sigma_{SM}$

Observed (PCL)
Expected (PCL)
$\pm 1\sigma$
$+ 2\sigma$
Observed CLs
Expected CLs

95% C.L. limit on $\sigma/\sigma_{SM}$

Observed
Expected
$\pm 1\sigma$
$+ 2\sigma$

$\int L dt = 35$ pb$^{-1}$, $\sqrt{s} = 7$ TeV

$\int L dt = 40$ pb$^{-1}$, $\sqrt{s} = 7$ TeV

$H \rightarrow ZZ \rightarrow lll\ell$, llqq, llνν
First step to $H \to \tau\tau$

- $\mu + \text{had}$, 22.5%
- $\text{had} + \text{had}$, 42.0%
- $e + \text{had}$, 23.1%
- $e + \mu$, 6.2%
- $\text{had} + \text{had}$, 42.0%
- $ee$, 3.2%
- $\text{emu}$, 3.0%
- $\mu\mu$, 6.2%

**Events / 5 GeV**

- $m_{\text{vis}}(\mu, \tau_h)$ [GeV]
- $m_{\text{vis}}(e, \tau_h)$ [GeV]
Neutral MSSM Higgs: $A/H/h \to \tau_\ell \tau_h$

- **Inclusive cut based search** (semi-leptonic decay channel only)
  - no jet or $b$-jet multiplicities requirements
  - Data-driven background estimation for $Z$+jets, QCD, $W$+jets

Exclusion reach better than at Tevatron
Extra Gauge Bosons (l\(l\) + l\(\nu\))

**ATLAS**
- **W' \rightarrow ev**
- \(\sqrt{s} = 7\) TeV
- \(\int L dt = 36\) pb\(^{-1}\)

**Tevatron Limit:**
- \(M(W') > 1.490\) (1.450) TeV
- \(M(Z') > 1.048\) (1.084) TeV

Submitted to PLB; arXiv:1103.1391
Searches with Di-Photons

**Diphoton Resonance Search (36pb⁻¹)**

**LIMITS 95% C.L:**
- \(M(G) > 545 \text{ GeV} \) (\(k/MPL = 0.02\))
- \(M(G) > 920 \text{ GeV} \) (\(k/MPL = 0.1\))

Previous Tevatron limit (D0):
- \(M(G) > 1.050 \text{ GeV} \) (\(k/MPL=0.1\))

**NEW**

**Diphoton + Met Search (3 pb⁻¹)**

**Universal Extra Dimension**
- KK-\(g/q\rightarrow \gamma^* \rightarrow \gamma + G \) (x2 per event)
  - observe: \(\gamma\gamma + \text{ETmiss} (+ \text{other SM})\)

**Limit:** \(1/R > 728 \text{ GeV} \) (95% C.L.)

Previous Tevatron limit (D0): \(1/R > 477 \text{ GeV} \)

*Most stringent limits to date*

**ATLAS-CONF-2011-044**
Highest-mass dijet event recorded in 2010

\[ m_{jj} = 4.0 \text{ TeV} \]
\[ (p_T^1, y^1) = (510 \text{ GeV}, -1.9) \]
\[ (p_T^2, y^2) = (510 \text{ GeV}, 2.2) \]
Jet Energy Scale

Evaluated up to 3.5 TeV in energy and $|\eta|<4.5$

<table>
<thead>
<tr>
<th>$\eta$ region</th>
<th>Maximal relative JES uncertainty</th>
</tr>
</thead>
<tbody>
<tr>
<td>$</td>
<td>\eta</td>
</tr>
<tr>
<td></td>
<td>4.6%</td>
</tr>
<tr>
<td>2.1&lt;</td>
<td>$\eta$</td>
</tr>
<tr>
<td>3.6&lt;</td>
<td>$\eta$</td>
</tr>
</tbody>
</table>

Improved by factor of 2

ATLAS Preliminary

In-situ calibrations
Jet Energy and Etmiss Resolutions

Advanced calibrations → improve resolution by 10-30%

Monte Carlo agrees with data within 10%

PbPb data only sample reaching this high in $\Sigma E_T$
Inclusive Jet Differential Cross Sections

Our first measurement Sep 2010

\[ \frac{d\sigma}{dp_T} \quad \text{[pb/GeV]} \]

\[ |y| < 2.8 \]

\[ \int L \, dt = 17 \text{ nb}^{-1} \quad (\sqrt{s} = 7 \text{ TeV}) \]

\[ \text{ATLAS} \]

Data/Theory

\[ p_T \quad \text{[GeV]} \]

\[ 0 \quad 100 \quad 200 \quad 300 \quad 400 \quad 500 \quad 600 \]

\[ 0 \quad 0.5 \quad 1 \quad 1.5 \quad 2 \]

\[ \text{Systematic Uncertainties} \]

\[ \text{NLO pQCD (CTEQ 6.6) x Non-pert. corr.} \]

\[ \text{anti-}k_T \text{ jets, } R=0.6 \]

The European Physical Journal

Particles and Fields
Inclusive Jet Cross Section Kinematic Reach

ATLAS Preliminary

Inclusive jet cross section kinematic reach

- Summer 2010, $\int L \, dt = 17 \text{ nb}^{-1}$
- Winter 2011, $\int L \, dt = 37 \text{ pb}^{-1}$

$\sqrt{s} = 7 \text{ TeV}$

anti-$k_t$ jets, $R = 0.6$
Inclusive Single Jet Double-Differential Cross Section

- Full 2010 data: 37 pb⁻¹
- 20 GeV < pₜ < 1500 GeV
- 7 rapidity bins, |y|<4.4
- 10-12 orders of magnitude in cross section
- Total uncertainty 50-10%
  - Dominated by JES

Good agreement btw data and NLO pQCD with various PDFs
Inclusive Double-Differential Di-Jet Cross Section

Inclusive Jet Cross Sections Summary

- Probing truly new, large kin. region
- Expanded to very forward region
  - $|y|$ up to 4.4 (1st time at a hh collider)
- Uncertainty greatly reduced
  - 50% → 20% (central)
- Good agreement btw data and NLO pQCD with various PDFs

Breakthrough: POWHEG comparisons
Many More SM Jet Results


Dijet azimuthal decorrelations: Accepted by PRL; arXiv:1102.2696 [hep-ex]

Multijets: ATLAS-CONF-2011-043

Z+jets: ATLAS-CONF-2011-042

Dijet production with a jet veto: ATLAS-CONF-2011-038
Dijet Resonance Searches in ATLAS

Submitted to NJP; arXiv:1103.3864

Search for a BUMP
Nothing found
p-value = 0.39

95% C.L LIMITS Observed (Expected)

<table>
<thead>
<tr>
<th>Mass (GeV)</th>
<th>0.03</th>
<th>0.05</th>
<th>0.07</th>
<th>0.10</th>
<th>0.15</th>
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<tbody>
<tr>
<td>600</td>
<td>434</td>
<td>638</td>
<td>849</td>
<td>1300</td>
<td>1990</td>
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<tr>
<td>700</td>
<td>409</td>
<td>530</td>
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<tr>
<td>800</td>
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<td>1100</td>
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<td>1200</td>
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<tr>
<td>1400</td>
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<tr>
<td>1500</td>
<td>24</td>
<td>27</td>
<td>30</td>
<td>39</td>
<td>40</td>
</tr>
<tr>
<td>1600</td>
<td>21</td>
<td>25</td>
<td>29</td>
<td>36</td>
<td>40</td>
</tr>
</tbody>
</table>

Excited quarks (q*): M > 2.15 (2.07) TeV
Quantum Black Holes: M > 3.67 (3.64) TeV
Axigluons: **NEW** M > 2.10 (2.01) TeV
Also 1st time more model Independent limits

Lower limits on Nobs (95% C.L.)
**Dijet Angular Distribution Searches**

Submitted to NJP; arXiv:1103.3864

NEW

**Summary of Dijet Search Reach (mass + angular)**

<table>
<thead>
<tr>
<th>Model and Analysis Strategy</th>
<th>95% C.L. Limits (TeV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected</td>
<td>Observed</td>
</tr>
<tr>
<td>Resonance in $m_{jj}$</td>
<td>2.07</td>
</tr>
<tr>
<td>$F_\chi(m_{jj})$</td>
<td>2.12</td>
</tr>
</tbody>
</table>

Randall-Meade Quantum Black Hole for $n = 6$

| Resonance in $m_{jj}$       | 3.64                  | 3.67 |
| $F_\chi(m_{jj})$            | 3.49                  | 3.78 |
| $\theta_{np}$ Parameter for $m_{jj} > 2$ TeV | 3.37                  | 3.69 |

$11$-bin $\chi$ Distribution for $m_{jj} > 2$ TeV

| Resonance in $m_{jj}$       | 3.36                  | 3.49 |

**Axigluon**

<table>
<thead>
<tr>
<th>Contact Interaction $\Lambda$</th>
<th>Expected</th>
<th>Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F_\chi(m_{jj})$</td>
<td>5.72</td>
<td>9.51</td>
</tr>
<tr>
<td>$F_\chi$ for $m_{jj} &gt; 2$ TeV</td>
<td>5.24</td>
<td>6.76</td>
</tr>
</tbody>
</table>

$11$-bin $\chi$ Distribution for $m_{jj} > 2$ TeV

| $F_\chi(m_{jj})$              | 5.40     | 6.58     |

**Most stringent limits to date**
tt Production Cross Section with 35 pb$^{-1}$

**l+jets**

**l+jets with b-tag**

**dilepton**

\[
\sigma(t\bar{t}) = 180 \pm 9 \pm 15 \pm 6 \text{ pb} \\
[10\% \text{ total uncertainty}]
\]
Top Properties in 35 pb$^{-1}$

- **Top Mass**
  - $m(t) = 169.3 \pm 4.0 \pm 4.9$ GeV
  - Measured in lepton+jets channel
  - Dominant uncertainty due to JES
  - Uses ratio of reconstructed top to W mass

$R_{32} - \mu$+jets channel

- **W helicity in top decays**
  - Sensitive to anomalous couplings
  - $F_L = 0.59 \pm 0.12$
  - $F_0 = 0.41 \pm 0.12$
  - Stat. limited, approaching Tevatron precision

$\cos(\theta^*)$ l+jets channel

- $m(t) = 169.3 \pm 4.0 \pm 4.9$ GeV

---

**Figure**: Histograms showing distributions for $m(t)$ and $R_{32}$. The top panel displays histograms for different templates, while the bottom panel shows a comparison of data with fitted templates and background distributions.
Top Physics with ATLAS

- The era of top physics at the LHC has started
- Pair-production cross-section
  - QCD
  - Study different decay channels
- Single top production
  - EWK
  - s-channel, Wt-channel, t-channel
- Properties:
  - mass, width, charge, spin
- Wtb vertex
  - W helicity, anomalous coupling
- Anomalous production
  - Resonances, modified final state

Statistics limited analysis will become attractive this year
2011: the year of precision top measurements at the LHC
Searches for 4th Generation Quarks in Dilepton Channel, 37 pb⁻¹

ATLAS-CONF-2011-022

First dilepton u₄ search!

\[ M(Q_4) = 350 \text{ GeV} \]

**NEW**

**LIMIT 95% C.L. Obs (Exp):**
\[ M(Q_4) > 270 \ (284) \text{ GeV} \]

Limit with 5.6 fb⁻¹ (CDF): \[ M(u_4) > 356 \text{ GeV} \]
Limit with 4.8 fb⁻¹ (CDF): \[ M(d_4) > 372 \text{ GeV} \]

(CDFNote CDF/PUB/TOP/PUBLIC/10110, arXiv:1101.5728)
Search for 1\textsuperscript{st} and 2\textsuperscript{nd} gen Leptoquarks

95\% C.L. LIMITS Observed (Expected) [GeV]

1\textsuperscript{st} Generation: $M > 376$ (387) GeV $\beta=1$
$M > 319$ (348) GeV $\beta=0.5$

2\textsuperscript{nd} Generation: $M > 422$ (393) GeV $\beta=1$
$M > 362$ (353) GeV $\beta=0.5$

Significantly extending search reach
Very sensitive to strong production of \( \tilde{q} \) and \( \tilde{g} \)
- SM background from \( W(l\nu)/Z(vv)+jets, \) QCD, top
- 4 signal regions to cover maximum of the phase space
  - See no excess
- Interpret in Phenomenological simplified MSSM
  - If \( m=\tilde{m}(\tilde{q})=\tilde{m}(\tilde{g}) \),
    - exclude \( m<870 \) GeV
  - Exclude \( m(\tilde{g})<500 \) GeV

Most stringent limits to date
SUSY: 1 lepton + Etmiss + jets

- Robust
- Isolated lepton ease triggering and QCD reduction
- Expect ~4 events and see 2 events
- Interpret in mSUGRA

Reach well beyond LEP and Tevatron
Many More SUSY Searches

2-lepton + Etmiss

Stable Massive Particle
(1103.1984, submitted to PLB)

1bjet + Etmiss; submitted to PLB

\( m_{\tilde{g}} \) [GeV]

\( m_{\tilde{\chi}^0_1} \) = 60 GeV, \( m_{\tilde{\chi}^\pm_1} \) \( \gg m_{\tilde{g}} \)

ATLAS

b-jet channel, 0-lepton, 3 jets

ATLAS

\( \int L dt = 35 \text{ pb}^{-1}, \sqrt{s} = 7 \text{ TeV} \)

Observed limit 95% C.L.

Expected limit 95% C.L.

\( \bar{b} \rightarrow b \tilde{\chi}^0_1 \rightarrow b \tilde{\chi}^\pm_1 \tilde{\chi}^0_2 \)

CDF \( \bar{b} \bar{b} \rightarrow 2.65 \text{ fb}^{-1} \)

D0 \( \bar{b} \bar{b} \rightarrow 5.2 \text{ fb}^{-1} \)

CDF \( \bar{g} \bar{g} \rightarrow 2.5 \text{ fb}^{-1} \)

Reference point

e\mu resonances

ATLAS Preliminary

\( \sqrt{s} = 7 \text{ TeV} \)

\( \int L dt = 35 \text{ pb}^{-1} \)

Theory \( \lambda_{111} = 0.6 \text{ fb}^{-1} \)

Theory \( \lambda_{111} = 0.0 \text{ fb}^{-1} \)

Observed Limit

Expected Limit

Expected Limit \pm 1 \sigma

Expected Limit \pm 2 \sigma
Summary

- Detector performed beautifully
- 2010 work/results foundation for 2011
  - Rediscovered SM and pushing the “precision frontier”
  - Extended the reach in many channels beyond Tevatron
  - 25 papers submitted and 11 in the pipeline
- Great Thank You to the LHC Machine Team

Notes for Winter Conferences

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ATLAS Online Luminosity $\sqrt{s} = 7$ TeV

- Total Delivered: 20.2 pb$^{-1}$
- Total Recorded: 18.6 pb$^{-1}$
- Efficiency: 91.8%
Backup Slides
First measurements of asymmetric dijets in lead-lead collisions at $\sqrt{s_{NN}}=2.76$ TeV

First measurements of $J/\psi$ and $Z$ yields in lead-lead collisions: systematic suppression of $J/\psi$, but insufficient statistics for any conclusion on the $Z$
Dijet Angular Distribution Searches

- Gain sensitivity by looking at rapidity

  \[ y^* = \frac{1}{2} \ln\left( \frac{1 + |\cos \theta^*|}{1 - |\cos \theta^*|} \right) \]

- Observables

  \[ \chi = \exp\left( |y_1 - y_2| \right) = \exp\left( 2 |y^*| \right) \]

  \[ F_{\chi}(m_{jj}) = \frac{N_{\text{events}}(|y^*| < 0.6)}{N_{\text{events}}(|y^*| < 1.7)} \]