Status and Prospects of the ATLAS Experiment at the LHC

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For the ATLAS Collaboration
The LHC and ATLAS

First collisions in 2010

Large Hadron Collider

Geneva

ATLAS

Diameter 25 m
Length 46 m
Overall weight 7000 Tons

7 TeV

p ⇔ p

18/05/2010, USTC

Eric Lançon / CEA-Saclay
• Chronology of an escalation we were waiting for more about 20 years:
  – 20 November 2009: first beams circulating again in the LHC
  – 23 November 2009: first collision at $\sqrt{s}=0.9$ TeV
  – 6 December 2009: stable beams → experiment’s Inner Trackers 100% ON
  – 8,14,16 December 2009: few hours of collisions at $\sqrt{s}=2.36$ TeV
  – 16 December 2009: end of the first LHC run
  – 30 March 2010: proton proton collisions at 7 TeV!
CERN: March 30th, 2010, 12:57
LHC collisions p-p at $\sqrt{s} = 7$ TeV:
HEP is finally in the new era!

Outline

• Status and Plans of the Large Hadron Collider for 2010 and 2011

• Status of the ATLAS experiment
  – Detector performance results @ $\sqrt{s} = 0.9$ & 7 TeV
  – First ATLAS Physics Results

• Physics Prospects for 2010-2011 run period

• Conclusions

Warm thanks to my ATLAS colleagues for helping me with this talk, in particular Aleandro Nisati and Luc Poggioli
I. The Large Hadron Collider status and plans

<table>
<thead>
<tr>
<th>parameter</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(design) CM energy</td>
<td>14 TeV</td>
</tr>
<tr>
<td>Luminosity</td>
<td>$10^{34}$ cm$^{-2}$ s$^{-1}$</td>
</tr>
<tr>
<td>Bunch crossing spacing</td>
<td>24.95 ns</td>
</tr>
<tr>
<td>Protons per bunch</td>
<td>$1.15 \times 10^{11}$</td>
</tr>
<tr>
<td>Beam radius</td>
<td>16.7 µm</td>
</tr>
<tr>
<td>Main Dipoles</td>
<td>1232</td>
</tr>
<tr>
<td>Dipole field</td>
<td>8.33 T</td>
</tr>
<tr>
<td>Smaller magnets</td>
<td>7000</td>
</tr>
<tr>
<td>Stored energy</td>
<td>360 MJ/beam</td>
</tr>
</tbody>
</table>

The megajoule (MJ) is equal to one million joules, or approximately the kinetic energy of a one-ton vehicle moving at 160 km/h (100 mph).
Incident location

incident during the LHC Commissioning (September 2008) ...
New Quench Protection System (QPS) fully deployed and tested in 2009
Massive job, limited resources, very tight schedule
All magnet circuits qualified for 3.5 TeV
Main bends and quads to 6000 A
Beam commissioning strategy 2010

- Global machine checkout
- 450 GeV re-commissioning
- Machine protection commissioning
- Ramp commissioning
- Establish stable safe beams at 3.5 TeV

30 Mar 2010
- Collisions at 3.5 TeV
- System/beam commissioning continued
  - Squeeze

24 Apr 2010:
- $L \sim 1.2 \times 10^{28} \text{ cm}^{-2} \text{ s}^{-1}$
- Collisions at 3.5 TeV squeezed
- Full machine protection qualification

18/05/2010, USTC
Easter Week-end; 21 hours colliding run at 7TeV cm

05-Apr-2010 21:47:42  Fill #: 1022  Energy: 0.0 GeV  I(B1): 1.54e+08  I(B2): 6.79e+07

- **Experiment Status**
  - ATLAS: STANDBY
  - ALICE: STANDBY
  - CMS: STANDBY
  - LHCb: STANDBY

- **Instantaneous Luminosity**
  - ATLAS: 3.157e-05
  - ALICE: 0.00e+00
  - CMS: 0.00e+00
  - LHCb: 0.00e+00

- **BRAN Count Rate**
  - ATLAS: 2.00e-323
  - ALICE: 1.402e-16
  - CMS: --
  - LHCb: 3.485e-06

- **BKGD**
  - BKGD 1: 0.002
  - BKGD 2: 0.014
  - BKGD 3: 0.002

- **LHCf**
  - Count(Hz): 0.000

- **LHCb VELO Position**
  - OUT
  - Gap: 58.0 mm

- **TOTEM**
  - STANDBY

---

**Performance over the last 12 Hrs**

**Intensity**

- I(B1)
- I(B2)
- Energy

**Background 1**

- ATLAS
- ALICE
- CMS
- LHCb

**Background 2**

- ATLAS
- ALICE
- CMS
- LHCb
LHC @ 3.5 TeV

• Excellent stability and reproducibility
  – Good lifetimes
  – No signs of transverse diffusion
  – Some bunch length increase
  – Orbit – rock solid
  – Optics within tolerance and reproducible

• Machine protection has caught everything so far
  – Set-up and tests still in progress
Next steps

• Next steps to increase
  – Higher intensity injection, up to $10^{11}$ p/bunch
    • Today $\sim 10^{10}$ p/bunch, Nominal $10^{11}$ p/bunch
  – More bunches in the beams
    • Today 1-3 bunches, Nominal 2800 bunches
• But, again, machine safety is the priority!
• Learning curve quite steep ⚠️⚠️⚠️

Goal: $1fb^{-1} @$ end 2011
II. The ATLAS Detector: Status and Performance

\[ \eta = -\ln(\tan(\Theta/2)) \]
• Two tracking devices

• Inner detector
  – Solenoidal 2T field
  – \( R = 1.2 \text{ m} \)

• Muon spectrometer
  – Toroidal \( \sim 0.5 \text{T field} \)
  – \( R : \sim 4 - 10 \text{ m} \)
Muon trigger and momentum resolution $< 10\%$ up-to $E_\mu \sim \text{TeV}$
Coverage: $|\eta| < 2.7$

\[ \eta = -\ln(\tan(\frac{\theta}{2})) \]
Trajectory of particles

Longitudinal view

Transverse view

Bend
Calorimeters

**EM Calo:** LAr/Pb
|\eta|<3.2
\sigma(E)/E (e/\gamma) ~ 10%/\sqrt{E}+0.7%

**Hadronic barrel:** Scin/Fe
|\eta|<1.7
\sigma(E)/E (jet) ~ 50%/\sqrt{E}+3%

**Hadronic endcap:** LAr/Cu
1.5<|\eta|<3.2
\sigma(E)/E (jet) ~ 50%/\sqrt{E}+3%

**Hadronic Forward:** LAr/Cu,W
3.1<|\eta|<4.9
\sigma(E)/E (jet) ~ 100%/\sqrt{E}+10%
Tracking system

Purpose: charged-particle tracking, particle ID
Coverage: |\eta|<2.5
Embedded in 2T solenoidal field

\[ \sigma(p_T)/p_T \sim 3.4 \times 10^{-4} (p_T/\text{GeV}) \oplus 0.015 \]
\[ \sigma(d_0) \sim 10 \oplus 140/(p_T/\text{GeV}) \, \mu\text{m} \]
Tracking system

\[ \frac{\sigma}{p_T} \sim 3.4 \times 10^{-4} (p_T/\text{GeV}) \oplus 0.015 \]
\[ \sim 10 \oplus 140/(p_T/\text{GeV}) \text{ } \mu\text{m} \]
The ATLAS Collaboration

37 Countries
173 Institutes
~ 2900 authors
(1000 students)
~ 2988 Active physicists:
   -- ~ 1900 with a PhD, for M&O share
   -- ~ 1100 students

173 Institutions
37 Countries
## Operational fraction of Detectors in 2010

<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>97.5%</td>
</tr>
<tr>
<td>SCT Silicon Strips</td>
<td>6.3 M</td>
<td>99.3%</td>
</tr>
<tr>
<td>TRT Transition Radiation Tracker</td>
<td>350 k</td>
<td>98.0%</td>
</tr>
<tr>
<td>LAr EM Calorimeter</td>
<td>170 k</td>
<td>98.5%</td>
</tr>
<tr>
<td>Tile calorimeter</td>
<td>9800</td>
<td>97.3%</td>
</tr>
<tr>
<td>Hadronic endcap LAr calorimeter</td>
<td>5600</td>
<td>99.9%</td>
</tr>
<tr>
<td>Forward LAr calorimeter</td>
<td>3500</td>
<td>100%</td>
</tr>
<tr>
<td>LVL1 Calo trigger</td>
<td>7160</td>
<td>99.8%</td>
</tr>
<tr>
<td>LVL1 Muon RPC trigger</td>
<td>370 k</td>
<td>99.7%</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>99.7%</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>97.3%</td>
</tr>
<tr>
<td>TGC Endcap Muon Chambers</td>
<td>320 k</td>
<td>98.8%</td>
</tr>
</tbody>
</table>

**Notes:**
- Muons do not include the EE chambers (under installation).
- High operational fractions of all detector systems

18/05/2010, USTC
Collision Event at 7 TeV with Muon Candidate

ATLAS Trigger

- Organized in three levels: LVL1, LVL2 and EventFilter (EF); reduces the rate from 40 MHz to 75 (→ 100) KHz (LVL1), to 200 Hz (EF).
- DAQ output: up to 320 MB/s; event size: ~1.5 MB (planned to be reduce to 1.2 MB)
  - Important trigger elements during 2009 run: Beam Pickups & Trigger Scintillators
    - BPTX: beam pickup timing devices
    - Electrostatic beam pickup located at ±175m from interaction point
    - Minimum Bias Trigger Scintillators (MBTS)
      - Mounted on LAr calo-endcaps, at ±3.56m from IP
      - 16 scintillators per disk, 2.1 < |η| < 3.8
    - Sensitive to minimal forward activity: collisions, beam gas, beam halo
How to select collision events

separation of beam backgrounds and collisions based on timing measurements on both endcaps: MBTS and LAr (calorimeter) systems;

Collision candidates peak at zero ns

Minimum Bias Trigger Selection: require 1 or more counter from either side above threshold (L1_MBTS_1)
Beam background < 1% for typical collision run
Peak Luminosity

410M collision events collected

7.1 nb⁻¹ recorded
Detailed studies on data – Monte Carlo comparison

Dedicated care that Monte Carlo samples reflect conditions during data taking;
• beam spot position, inactive modules, noisy channels, ...

in general, there is an excellent agreement between data and Monte Carlo

<table>
<thead>
<tr>
<th>Cut</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum $p_T$</td>
<td>500 MeV</td>
</tr>
<tr>
<td>Maximum $z$</td>
<td>250 mm</td>
</tr>
<tr>
<td>Maximum $\eta$</td>
<td>2.7</td>
</tr>
<tr>
<td>Maximum $d_0$</td>
<td>10 mm</td>
</tr>
<tr>
<td>$N_{\text{Pixel and SCT Hits}}$</td>
<td>$&gt;6$</td>
</tr>
<tr>
<td>$N_{\text{Pixel Hits}}$</td>
<td>No Cut</td>
</tr>
<tr>
<td>$N_{\text{Shared Hits}}$</td>
<td>$&lt;4$</td>
</tr>
<tr>
<td>$N_{\text{Pixel Holes}}$</td>
<td>$&lt;3$</td>
</tr>
<tr>
<td>$N_{\text{SCT Holes}}$</td>
<td>$&lt;3$</td>
</tr>
<tr>
<td>$N_{\text{Double Holes}}$</td>
<td>$&lt;2$</td>
</tr>
</tbody>
</table>
Tracking performance

**ATLAS Preliminary**

**$K^0_S$ Invariant Mass**

- Data
- Simulation
- Gauss (+poly) fit
  - $\mu = 497.5 \pm 0.1$ (stat) MeV
  - $\sigma = 8.2 \pm 0.1$ (stat) MeV
  - PDG (2009) $m_{K^0_S} = 497.614 \pm 0.024$ MeV

$K^0_S \rightarrow \pi^+\pi^-$

Event with $K_S \rightarrow \pi^+\pi^-$ Candidate
Particle Identification in Inner Detector

- use analog pixel readout to perform dE/dx measurement
Material in the Inner Detector

\( \gamma \rightarrow e^+e^- \)

- \( p_T(e^+) = 1.75 \) GeV, 11 TRT high-threshold hits
- \( p_T(e^-) = 0.79 \) GeV, 3 TRT high-threshold hits

\( \gamma \) conversion point
- \( R \sim 30 \) cm (1\(^{st}\) SCT layer)
Material in the Inner Detector

$\gamma \rightarrow e^+e^-$

**Beam pipe**

**Pixel 1**

**Pixel 2**

**Pixel 3**

**SCT 1**

ATLAS Preliminary

- Data 2009 ($\sqrt{s} = 900 \text{ GeV}$)
- MC conversion candidates
- MC true conversions
- MC true Dalitz decays

(Non-diffractive minimum bias MC)
$W^+ \rightarrow e^+\nu$ candidate

$W\nu$ candidate in 7 TeV collisions

$p_T(e^+) = 34$ GeV

$\eta(e^+) = -0.42$

$E_T^{\text{miss}} = 26$ GeV

$M_T = 57$ GeV
γγ mass spectrum

\[ E_T^{\text{cluster}} > 0.8 \text{ GeV} \]
\[ p_T^{\text{pair}} > 2.2 \text{ GeV} \]

Track veto cluster with matched track

Data: \( m_{\eta^0} = 527 \pm 11_{\text{stat}} \text{ MeV} \)

MC: \( m_{\eta^0} = 544 \pm 3_{\text{stat}} \text{ MeV} \)

The Monte Carlo simulation sample is normalized to the number of entries in the distribution for data.

Width and position well described
Electron identification

Ratio, $E/p$, between cluster energy and track momentum for electrons (top left) and converted photons (bottom left).

transverse energy for all candidates
Hard di-jet event: un-calibrated jet transverse energies: ~300 GeV
JETS

- Jets from calorimeters
- Identified objects: Photons, Electrons
- Calorimeter clusters
Calorimeter: raw cell energy distribution

Excellent data Monte Carlo comparison

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**Occupancy per event in first EM barrel layer**
- Data
- Non diffractive minimum bias MC

**ATLAS Preliminary**

**ATLAS Preliminary**

**ATLAS Preliminary**

**EM scale**

**ATLAS Preliminary**

**EM scale**

**ATLAS Preliminary**

**ATLAS Preliminary**
Calorimeter: Jets and Missing $E_T$

$p_T^{jet} > 20$ GeV

Delta(Phi)

Missing $E_T$
4\textsuperscript{th} observed candidate: 12 April

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

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

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

Muon: 3 Pixel hits, 8 SCT hits, 17 TRT hits, 14 MDT hits, Z\textasciitilde3mm from vertex, good tracker-spectrometer momentum match, $E(\text{calo}) \sim 4$ GeV (as expected)
Observation of $J/\psi \rightarrow \mu\mu$

- Require one muon be “combined” (matched tracks in MuonSpectrometer and Inner Detector).
- The other muon can be “combined” or “tagged” (Inner Detector track matched to segment in MuonSpectrometer).
- Perform vertex fit to two Inner Detector tracks (no mass or pointing constraint).

**Gaussian-mean mass:** 3.06±0.02 GeV  
**Resolution:** 0.08±0.02 GeV  
**Number of signal events:** 49±12  
**Number of background events:** 28±4  
**Signal and background are computed in a mass range:** 2.82-3.30 GeV (3σ around the peak).
III. The ATLAS Detector
Early Physics Results
Charged-particle multiplicities in pp interactions at $\sqrt{s} = 900$ GeV

Measure primary charged particle multiplicity distributions from inelastic events.

\[
\frac{1}{N_{ev}} \cdot \frac{dN_{ch}}{d\eta} \quad \frac{1}{N_{ev}} \cdot \frac{dN_{ev}}{dn_{ch}} \quad \frac{1}{N_{ev}} \cdot \frac{1}{2\pi P_T} \cdot \frac{d^2N_{ch}}{d\eta dp_T} \quad \langle p_T \rangle \text{ vs } n_{ch}
\]

Results are compared with PYTHIA 6.4.21 tunes, PHOJET 1.12 + PYTHIA 6.4.21, and other measurements.

Published by Phys Lett B 688, Issue 1, 21-42

First ATLAS Paper!
Trigger & Offline selection

**Trigger:** single-arm: select events firing one of the two scintillator systems (MBTS)

**Offline selection:**

- Track selection for analysis:
  - \( p_T > 500 \text{MeV} \)
  - \( |\eta| < 2.5 \)
  - Number of Pixel Hits \( \geq 1 \)
  - Number of SCT Hits \( \geq 6 \)
  - \( |d_0^{PV}| < 1.5 \text{ mm} \)
  - \( |z_0^{PV} \sin(\theta^{PV})| < 1.5 \text{ mm} \)
  - Inside out track reconstruction

- Event selection:
  - Primary vertex without beam-spot constraint and including three or more tracks \( (p_T > 150 \text{MeV}) \).
  - Number of selected tracks \( (n_{\text{Sel}}) \geq 1 \)

- 326201 events and 7904122 tracks pass this selection.
Particle $\eta$ and $p_T$ spectrum

Height and width of (pseudo)rapidity plateau

$p_T$ spectrum

Particle production measured up to $p_T \sim 15$ GeV

Systematic uncertainties dominated by material uncertainties
Particle multiplicities

Charged particle multiplicity distribution

Average particle $p_T$ versus the particle multiplicity
Charged-particle multiplicities for events with $n_{ch} \geq 1$ within the kinematic range $p_T > 500$ MeV and $|\eta| < 2.5$ at $\sqrt{s} = 7$ TeV compared to the published results at $\sqrt{s} = 900$ GeV. The panels compare the charged-particle multiplicities as a function of the charged-particle multiplicity (left), and the average transverse momentum as a function of the number of charged particles in the event (right).

Next step: perform the data analysis reducing the minimum track $p_T$ to about 100 MeV.
IV. The ATLAS Detector: Physics Prospects

Machine plan:

2010: \( L = \sim 10^{27} \rightarrow 10^{32} \text{ cm}^{-2} \text{s}^{-1} \rightarrow \text{total of 100-200 pb}^{-1} \)

2011: \( L = 1 \rightarrow \text{few } 10^{32} \text{ cm}^{-2} \text{s}^{-1} \rightarrow \geq 100 \text{ pb}^{-1} \text{ per month} \rightarrow \text{total of } \sim 1 \text{ fb}^{-1} \)

2012: shut-down
Roadmap for 2010/2011 Run

- Continue the validation of the detector and physics objects performance with (more) collision data and through well known processes
  - expects ~25,000 Z’s and ~250,000 W’s (for each flavor) every 100 pb⁻¹
- Establish the detector energy scale (leptons, jet scale, $E_T^{\text{miss}}$, $\tau$)
- Extensive studies of Standard Model signatures
  - these are backgrounds for SM Higgs and New Physics Searches
Physics landscape

• few pb-1 (Now)
  – study J/Ψ and Y resonances.
  – start studying W/Z and high PT jet production.

• O(few10 pb-1 ) (This summer)
  – observe top pair events.

• 100-200 pb-1 (end 2010)
  – able to start measuring most of the known standard model signatures.

• 1 fb-1 (end 2011)
  – precise SM measurements.
  – opening up a window to searches:
    • High mass dilepton resonances
    • SUSY, Extra Dimensions
Note: with 1 fb\(^{-1}\) (end 2011):
expected number of tt \(\rightarrow\) l+jets events in ATLAS is \(\sim\) 2 times larger than CDF or D0
with 10 fb\(^{-1}\) \(\sim\) expected “analyzable” luminosity at Tevatron by end 2011
• **Z cross section measurements**
  • With ~100 pb\(^{-1}\) for \(Z(\mu\mu)\):
    • \(\Delta\sigma/\sigma=0.008(\text{stat})\pm0.04(\text{sys})\pm0.1(\text{lumi})\)
      – not statistically limited
      – Experimental syst. uncertainties ~ 1% (efficiencies, backgrounds)
      – “Tag and Probe” to determine *lepton* efficiency.
      – Limited by luminosity uncertainty: ~10%
  • With 1 fb-1 large enough statistics to calibrate the detector to the “ultimate” precision: e.g. ECAL inter-calibration ~ 0.5%, absolute E/p momentum scale to ~ 0.1%,

• **W cross section measurement**
  • With ~100 pb\(^{-1}\) for \(W(e\nu)\):
    • \(\Delta\sigma/\sigma=0.002(\text{stat})\pm0.05(\text{sys})\pm0.1(\text{lumi})\)
      – More abundant backgrounds than for the Z
      – Larger systematic errors.
    • With ~100 pb\(^{-1}\) experimental uncertainties on \(m_W\) controlled at the level of statistical error (~100 MeV)
Standard Model Higgs (1)

LEP limit and Indirect Searches

- LEP direct searches for a SM Higgs boson:
  - \( m_H > 114.4 \text{ GeV} @ 95\% \text{ C.L.} \)
- Indirect searches constraints and global EWK fits seem to prefer a light Higgs boson:
  - \( 114.4 < m_H < 186 \text{ GeV} @ 95 \% \text{ C.L.} \)
  - [http://lepewwg.web.cern.ch/LEPEWWG](http://lepewwg.web.cern.ch/LEPEWWG)

SM Higgs search at Tevatron

First joint CDF&D0 publication on SM Higgs search (PRL 104 061802 2010)

95\% CL mass exclusion: \( 162 < m_H < 166 \text{ GeV} \)

“We with 12 fb-1 by 2012, Tevatron would either exclude Higgs mass up to 180 GeV/c2 @ 95\%CL or find some evidence.”
Standard Model Higgs (2)

- Based on fast simulation studies;
- Channels considered: 0-jet; 1-jet; 2-jet;
- An integrated luminosity $L \sim 2 \text{ fb}^{-1}$ should allow a 5σ sensitivity for $m_H$ around 160 GeV;

The challenge: Understand the backgrounds

Adding other channels like $H \rightarrow ZZ$ and $H \rightarrow \gamma \gamma$ helps to improve in the high and low mass region.
Standard Model Higgs (3)

• With a well understood dataset of $1 \text{ fb}^{-1}$ at 7 TeV (end 2011), a Higgs with $140 < M_H < 185 \text{ GeV}$ could be excluded at 95% C.L.

• The Tevatron sensitivity could be matched with $300 \text{ pb}^{-1}$

• Adding additional channels, like $H \rightarrow ZZ$ and $H \rightarrow \gamma\gamma$ and $\tau\tau$, will significantly improve the sensitivity at high and low masses

• *It cannot be excluded a priori that ATLAS and CMS combined could discover a Higgs with a mass $M_H$ around 160 GeV by the end of 2011*
Exotics: W’ and Z’

- $Z' \rightarrow e^+e^-$, $Z' \rightarrow \mu^+\mu^-$; very clean signatures; it is important to have the ultimate muon system calibration and alignment; however an early observation can be made also with the preliminary muon system settings currently available.
- Main background: Drell-Yan processes.

- Backgrounds
  - Main background: SM Drell-Yan
  - $t\bar{t}$, dijets, W+jets, gamma+jets

- Selection
  - 2 isolated leptons
  - $|\eta|<2.5$, $p_T>50$ GeV
New Physics: approximate LHC reach $\sqrt{s} = 7$ TeV (one experiment) for some benchmark scenarios

**$Z'$ (SSM):** Tevatron limit $\sim 1$ TeV (95% C.L.)
- $50 \text{ pb}^{-1}$: exclusion up to $\sim 1$ TeV (95% C.L.)
- $500 \text{ pb}^{-1}$: discovery up to $\sim 1.3$ TeV
- $1 \text{ fb}^{-1}$: discovery up to $\sim 1.5$ TeV

**$W'$:** Tevatron limit $\sim 1$ TeV (95% C.L.)
- $10 \text{ pb}^{-1}$: exclusion up to 1 TeV
- $100 \text{ pb}^{-1}$: discovery up to $\sim 1.3$ TeV
- $1 \text{ fb}^{-1}$: discovery up to $\sim 1.9$ TeV

**SUSY ($\tilde{q}, \tilde{g}$):** Tevatron limit $\sim 400$ GeV (95% C.L.)
- $100 \text{ pb}^{-1}$: discovery up to $\sim 400$ GeV
- $1 \text{ fb}^{-1}$: discovery up to $\sim 700$ GeV

LHC will start to compete with the Tevatron in 2010, and should take over in 2011 in most cases.

Fabiola Gianotti, CERN LHCC 5th May 2010.
Conclusions

• The ATLAS detector operated efficiently, from data taking at the pit, to data processing and transfer worldwide, to fast delivery of first results

• Preliminary results indicate that the performance of the detector, as well as the simulation and reconstruction tools, are far better than expected at this (initial) stage

• The LHC running at $\sqrt{s}=7$ TeV, assuming an integrated luminosity of $\sim 100$ pb-1 can provide preliminary data sufficient for preliminary ATLAS detector calibrations and for early physics analyses
  – $B$-hadrons, top production and heavy bosons production will be important to understand the detector, to provide new physics measurements and to study the background processes to new physics searches

• with $L \sim 1$ fb-1 of data, the LHC at $\sqrt{s}=7$ TeV offers good potential for New Physics discoveries with ATLAS, as well as for SM Higgs searches
  – In addition the data will be sufficient to allow calibrations close to reach the ultimate performance of the detector

• The physics reach will be competitive with the Tevatron in 2010, but will be superior for “New Physics” with an integrated luminosity around 1 fb$^{-1}$. 
謝謝