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Inclusive Muon Production in 900 GeV p-p Collisions with ATLAS Detector

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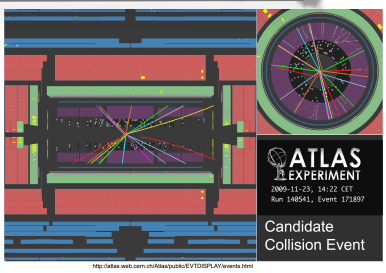
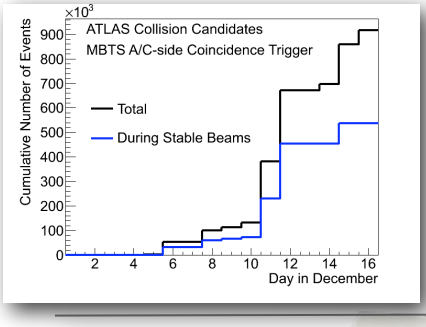
The First LHC Collisions

In December 2009 ATLAS observed the first LHC proton-proton collisions at 900 GeV of center of mass energy.
Several proton fills, with a number of bunches up to 16 per beam, were injected and the beams steered to collide

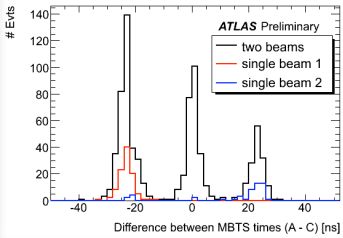


Triggering Collision Events

Two detectors were used to apply a minimum bias request trigger and select collision candidate events:
- Beam Pickup Timing Devices (BPTX): electrostatic beam pickups located at ±175m from interaction point
- Minimum Bias Trigger Scintillators (MBTS): 32 scintillators covering 2.09 < |η| < 3.84 located at ± 3.56m in z from the interaction point



Number of Collision Candidates in 2009 @ 900 GeV: 917000
Full Detector On: 538000



Selecting Collision Events

Beam halo, beam gas events and cosmic muons are the main background in collision events. To reduce them event selection is applied:

- ✓ *at least one MBTS hit on each ATLAS side*
- ✓ a time coincidence between the hits in the two sides
- ✓ at least 3 good tracks in the Inner Detector (more than 6 Sil hits)
- ✓ at least one track with a momentum grater than 4 GeV/c

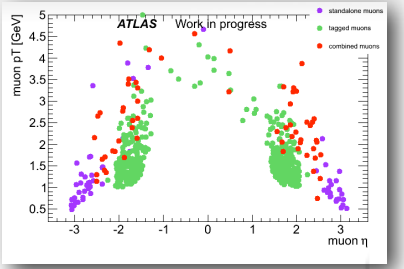
Looking for Muons

The ATLAS detector is able to reconstruct muons in three different configurations:

Combined muons: combining tracking information from both muon spectrometer and the inner tracker, this provides the best quality muons

Standalone muons: using only the muon spectrometer, thought to have the best performance at high luminosity, when the Inner Tracker has a very high occupancy, and an optimal resolution up to p_T ~ 1 TeV

Tagged muons: combining an inner detector track with calorimeter measurements or the first muon spectrometer station, optimizes the reconstruction of low-p_T muons that do not reach all three muon spectrometer stations

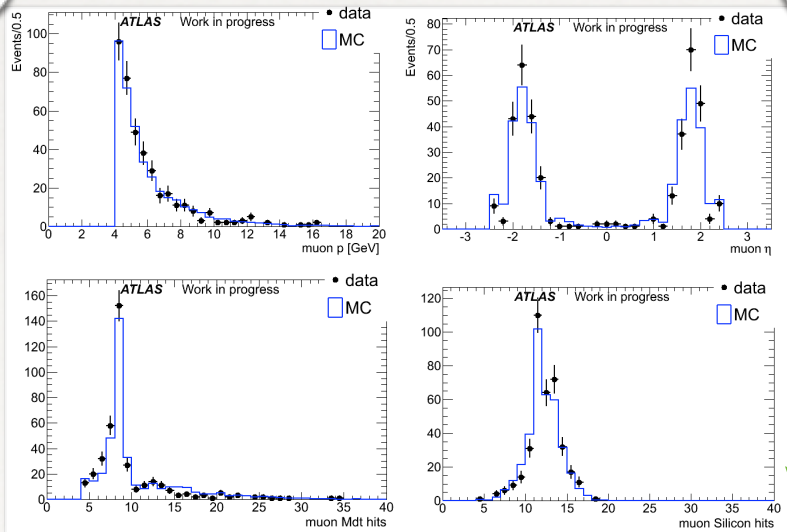


Data - Monte Carlo Comparison

Once the events are selected it's possible to compare the reconstructed muon kinematical distributions with the *non-diffractive minimum bias Monte Carlo* sample expectations. The single-diffractive and double-diffractive contributions turned out to be negligible (less than 1% correction).
Only runs with the magnetic field on are used.

To do that muons are required to satisfy some quality criteria to guarantee the best performance: this is because muons coming from minimum bias events are concentrated in a difficult kinematical region of the detector, that is in the forward region with very low transverse momentum.

Muon quality criteria : |η| < 2.5 and p > 4 GeV/c



Normalization

Monte Carlo expectations are rescaled to the data luminosity, taking into account the different cross-sections.

The chosen normalization is the data integrated luminosity after the MBTS trigger selection

$$w = \frac{N_{mc}}{L_{data}\epsilon_{trig}\sigma_{mc}}$$

MC weight — processed MC events — MC cross-section (34.4 mb) — data integrated luminosity — MBTS trigger efficiency (97.7%)

	Data	Monte Carlo
Processed data (after trigger cut)	207959	4875000
# reconstructed muons after quality criteria	385	373 ± 4 (stat)
Estimated data luminosity	~ 5000 mb^{-1}	

Mdt hits: muon spectrometer precision chamber hits associated to the track
Silicon hits: inner tracker silicon hits associated to the track

Some considerations

The luminosity estimation is very preliminary and can be affected by an uncertainty up to 20%. The trigger efficiency is also not well estimated yet.
Taking into account the normalization uncertainties and the fact that a good muon selection is still under development from the first comparisons the ***Monte Carlo describes pretty well the kinematical distributions of the muons and also the detector response***