ATLAS STATUS AND RECENT RESULTS

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Abstract. The Large Hadron Collider at CERN has resumed its operation in 2011 by showing a stable world-record-breaking performance at 3.5 TeV per proton beam energy. ATLAS is one of four major experiments accumulating data since the LHC start-up. The status of the detector and its performance are presented in this talk. The main results are summarized, including soft- and hard-QCD processes, W and Z boson production, as well as search for new physics.

1 ATLAS detector

The ATLAS is a general-purpose detector designed to explore the full discovery potential of the Large Hadron Collider (LHC), including searches for the Higgs Boson, SUSY particles, new heavy Gauge bosons (W, Z), etc.

The detector consists of two cylindrical magnetic spectrometers, electromagnetic and hadronic calorimeters with a pseudorapidity coverage up to 4.9 as can be seen in Figure 1 [1]. The vertices and tracks of charged particles are reconstructed in the inner detector consisted of silicon pixel, silicon strip and transition radiation detectors located in a 2 T magnetic field provided by a superconducting solenoid. The tracking detector covers pseudorapidity range ± 2.5 . It is surrounded by a calorimeter system. Highly granular liquid argon (LAr) electromagnetic sampling calorimetry together with LAr hadronic end-caps and Fe-scintillating tiles provide an excellent performance for reconstruction of electromagnetic and hadronic showers. The muon spectrometer is positioned outside the calorimeters. The air-core toroid system has a strong bending power with an average magnetic field integral of about 3 Tm. The drift tubes and cathode strip chambers provide a precise coordinate measurements while the resistive-plate chambers are used for triggering.

2 Physics performance

Thanks to the excellent work of the LHC machine the experiment has recorded about 3 fb^{-1} of integrated luminosity at a center of mass energy of 7 TeV by the end of summer 2011.

Since the start of LHC at the end of 2009 the ATLAS data taking efficiency has been higher than 95% and the fraction of operational channels is very close to 100%. The ATLAS detector physics performance is illustrated in Figures 2 and 3 by the agreement between the data and Monte-Carlo simulation for J/Ψ and Z-boson decays. These plots show a good linearity and accuracy of the momentum and energy measurements in the ATLAS detector from the Z mass scale down to a few GeV.

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Figure 1: Cut away view of the ATLAS detector [1].

Figure 2: Calibrated $J/\Psi \rightarrow ee$ invariant mass for an initial integrated luminosity of 39 pb^{-1} [2].

Figure 3: Invariant mass resolution for combined muons for an initial luminosity of 205 pb^{-1} [3].

3 Summary of the selected physics results

Minimum bias events are used to compare the data and non-perturbative QCD calculations. The charged particle multiplicity as a function of the transverse momentum was compared in various kinematic ranges of rapidity and transverse momenta with predictions of different Monte-Carlo models [4]. It was shown that no single Monte-Carlo generator reproduces all the data very well, but the agreement becomes better for higher minimum p_T cutoff or for a reduced diffractive component [5].

Jet physics is under study in the ATLAS experiment in a new energy regime and unexplored kinematic areas. The analysis [6] has covered two orders of magnitude of the jet transverse momenta where the inclusive jet cross section value has changed by nine orders. NLO calculations for perturbative QCD (pQCD) were found to be in a very good agreement with experimental data. A good agreement was also observed for the di-jet and multi-jet cross sections [7].

Figure 4: Summary of several Standard Model total production cross section measurements compared to the corresponding theoretical expectations. The dark error bar represents the statistical uncertainty. The red error bar represents the full uncertainty, including systematics and luminosity uncertainties. All theoretical expectations were calculated at NLO or higher [8].

Figure 5: The combined upper limit on the Standard Model Higgs boson production cross section divided by the Standard Model expectation as a function of m_H is indicated by the solid line. The dotted line shows the median expected limit in the absence of a signal and the green and yellow bands indicate the corresponding 68% and 95% expected [9].

Highlights of electroweak physics are summarized in Figure 4 [8] where the measured cross sections of the main EW processes are presented together with theoretical predictions. The measurements were made with the 2010 and the 2011 datasets. We are probing the cross sections at the level down to 10 pb. The remarkable success of NNLO pQCD calculations and the present knowledge of PDFs has been demonstrated.

Experiments at the Tevatron have achieved the best accuracy in the Top quark mass measurements and dominate the world average. The Top mass was also measured in ATLAS using the lepton plus jets channel and found to be $169.3 \pm 4.0(stat) \pm 4.9(syst)$ GeV [10]. By the end of 2012 we expect to have 6 times more events than the Tevatron and anticipate for much more accurate analyses of the Top quark properties.

Higgs search remains among the main goals of the ATLAS experiment. A wide range of Higgs search channels covering Higgs masses from 110 to 600 GeV are under study [9]. Figure 5 shows the combined upper limit of the Standard Model Higgs boson production cross section divided by the Standard Model expectation as a function of m_H . The ATLAS experiment has overtaken Tevatron sensitivity by excluding the SM Higgs at 95% CL in two mass ranges: 155 GeV to 190 GeV and 295 GeV to 450 GeV. Also analysis is continuing to study an excess corresponding to a 2.7σ fluctuation above the expected background for a Higgs mass between 130 GeV and 150 GeV.

Searches beyond the Standard Model are continuing in the ATLAS experiment for many different signatures. The highest di-jet invariant mass

value measured in the ATLAS detector is 4 TeV. The di-jet mass spectra was examined and no sign of resonant behavior was found. The analysis [11] has excluded several exotics models and, in particular the "excited quarks" with mass $M(q^*) < 2.91$ TeV.

A search for a heavy gauge boson W' [12] also revealed no bumps in the transverse mass spectrum which excludes $m(W') < 2.15$ TeV for SM couplings combining e and μ decay modes. A search for a heavy gauge boson W' [12] using both the e and μ decay modes found no enhancement in the transverse mass spectrum and excluded $m(W') < 2.15$ TeV for SM couplings.

4 Conclusions

ATLAS is showing an excellent and stable performance since 2009: twice more data than planned for the whole 2011 have already been collected. Many interesting results have been presented at the summer conferences, some new and updated analyses were reported at this Conference.

We are probing Standard Model processes in unexplored kinematical regimes with higher than ever sensitivity. So far the experimental data show no sign of disagreement with the SM expectations.

We also making wider the exclusion regions for the SM Higgs boson masses.

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