ATLAS results from Pb-Pb collisions at 2.76 TeV

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Selected results of the analyses of the data from ATLAS detector from Pb-Pb run in 2010 are presented. During that run, an integrated luminosity of 9 μb^{-1} was delivered out of which 8 μb^{-1} were collected with and 1 μb^{-1} without magnetic field.

The ATLAS detector at LHC

The ATLAS detector [1] is one of three detectors at LHC taking data during the Pb-Pb run in 2010. The universality of the ATLAS detector makes it suitable for a wide range of measurements of interest in heavy ions physics. All three main detector subsystems (tracking, calorimetry, muons spectrometer) were used in analyses. The forward detectors, Min-Bias Trigger Scintillators and Zero-Degree Calorimeter (ZDC) were used for triggering [7, 3, 5].

Centrality determination

In order to study systematically the properties of collisions the total cross section is divided into bins of collision centrality. The centrality is determined from the transverse energy deposit at EM scale in the very forward calorimeters $\sum E_T^{FCal}$ $(3.2 < |\eta| < 4.9)$. The whole spectra is conventionally divided into percentiles where the 0-10% denotes 10% of events with highest $\sum E_T^{FCal}$ corresponding to the events with the smallest impact parameters. Since various measurements are expressed as a function of number of participating or colliding nucleons (N_{part} and N_{coll} respectively) the correspondence between $\sum E_T^{FCal}$ bins and these two parameters is determined done by fitting the experimental $\sum E_T^{FCal}$ spectra to the same spectra measured during the p-p run at $\sqrt{s} = 2.76TeV$, convoluted with the results from the Glauber MC [2]. The MC assumes transverse energy to scale like $(1-x)N_{part}/2 + xN_{coll}$, with the x as a free parameter which can be extracted from the data. Figure 1 shows the result of the Glauber MC approximation to the data and division into centrality bins.

Azimuthal event shapes

Azimuthal anisotropies are among the most important global event characteristics in heavy ion collisions. They were studied using the event plane method and two-particle correlation method. Both deliver compatible results, which are similar to the measurements from RHIC as presented in Fig. 1. The event plane was measured using FCal and tracks were reconstructed in the ATLAS Inner Detector tracking system [5]. Flow coefficients v_n defined in [5] measured in (0-5)% most central collisions are shown in the right panel of fig. 1 for the particles with $2GeV < p_T < 3GeV$. As one can see the v_2 flow coefficient is smaller than the third v_3. This effect is even more pronounced in the 1% most central collisions. Only weak dependence of the elliptic flow on rapidity was measured at the LHC energy.

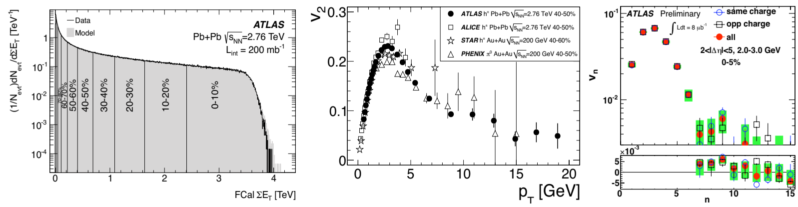

Figure 1: **Left:** Spectra of $\sum E_T^{FCal}$ and the centrality bins. **Center:** Elliptic flow coefficient v_2 measured by ATLAS compared to the results measured by RHIC experiments. **Right:** All flow coefficients for 5% of most central events.

Charged particles multiplicity and spectra

The measurement of charged particles multiplicity produced in Pb-Pb collisions was performed using the data sample taken with the ATLAS solenoidal field switched off to lower the p_T threshold of registered particles. Three methods were used to measure the number of tracks. The first two were based on so-called tracklets where tracks were assumed to be straight lines spanning the primary interaction vertex and clusters in the two innermost layers of the Pixel detector. In one of them the fake rate was suppressed by the tracklet ordering and estimated from the MC while in the other it was measured from the data itself. The third method was based on standard ATLAS tracks reconstructed in the Pixel detector. Results are presented in figure 2 and details given in [3].

The spectra of charged particles was measured using the data sample taken with solenoid magnetic field on. Measured spectra are harder than those observed at RHIC at $\sqrt{s_{NN}} = 200\ GeV$ and the suppression of the yield is most pronounced for the tracks with $p_T = 7\ GeV$. No strong pseudo-rapidity dependence is seen in the data as shown on Fig. 2 [4].

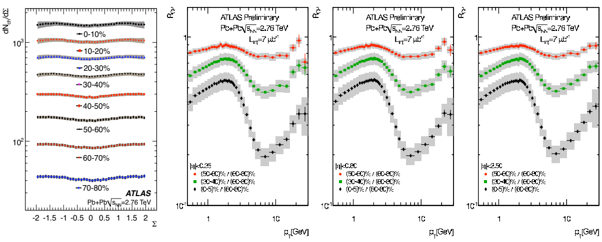

Figure 2: **Left:** The η dependence of the charged particles multiplicities for eight centrality bins. **Right:** The nuclear modification factor (central/peripheral) $R_{CP} = \frac{N_C^{coll}}{N_P^{coll}} \frac{N_P^{evt}}{N_C^{evt}} \frac{d^2 N_C/d\eta dp_T}{d^2 N_P/d\eta dp_T}$ for charged particles in three pseudo-rapidity ranges.

The jet quenching and structure

The ATLAS experiment published the first observation of the centrality dependence of the di-jet energy asymmetry in HI collisions [7]. No clear evidence of jets structure modification is observed which challenges the medium influence on the parton shower. The jet fragmentation functions were measured in [8] and presented here in Fig. 3.

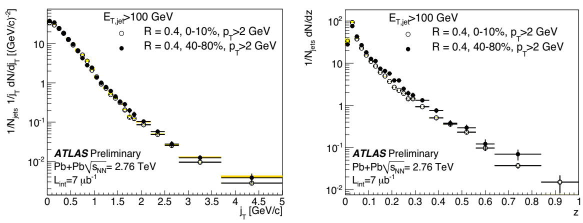

Figure 3: **Left:** The transverse component $j_T = p_T^{frag} cos(\Delta R)$ of fragmentation function for two centrality bins. **Right:** The longitudinal component $z = p_T^{frag} sin(\Delta R)/E_T^{jet}$.

The J/ψ, Z^0 and $W^{\pm}$ yields

For the yields measurement of J/ψ and Z^0 the $\mu^+\mu^-$ decay modes were used [6]. Muons were measured in the barrel part of the spectrometer and associated with ID tracks. The peaks in the di-muon mass spectra were used to measure the particle yields. The $W \to \mu\nu$ measurement would require precise measurement of the missing energy which is not possible in the environment of the HI collisions. Instead, the shape of the inclusive muon spectra was approximated by a combination of the functional form reflecting the background from heavy flavor quark decays and the templates worked out from the MC studies of W decays. So obtained yields were scaled with the number of binary collisions in each centrality bin.

The results are compatible with suppression of the J/ψ and no evidence of such effect for the W and Z bosons as presented on figure 4.

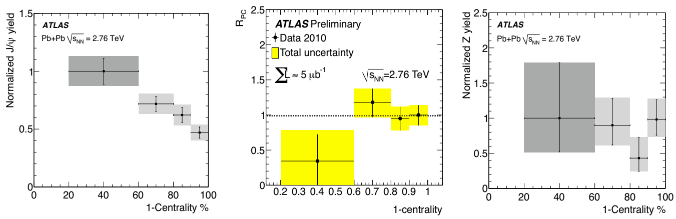

Figure 4: Relative yields as a function of centralities. **Left:** The $J/\psi \to \mu\mu$ ($p_T^\mu > 3GeV$, $|\eta| < 2.5$). **Center:** $W \to \mu\nu$ (note ratio of yields in peripheral to central is presented). **Right:** $Z \to \mu\mu$.

References

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[2] M. L. Miller, K. Reygres, S.J. Sanders, P. Steinberg, Ann. Rev. Nucl. Part. Sci. **57** (2007) 205-243.

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[7] ATLAS Collaboration, Phys. Rev. Lett., **105**, 18 (2010).

[8] arXiv:1108.5191v1 [nucl-ex].