Measurement of high-p_{T} neutral mesons with a high-energy photon trigger in ALICE

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ALICE, one of the experiments at the Large Hadron Collider (LHC) at CERN, is aimed at studying heavy-ion collisions and the properties of a deconfined state of matter, the quark-gluon plasma (QGP)[1]. High-p_{T} particle production is a powerful tool for characterizing the QGP because the interaction between its fast partons depends on the QGP transport properties. The hadron yields in heavy-ion collisions can be quantified by the nuclear modification factor (R_{AA}), which is the ratio of the particle yield in heavy-ion collisions normalized by the number of inelastic nucleon–nucleon collisions to the yield in pp collisions. Previous experiments have shown that R_{AA} at high p_{T} is significantly smaller than 1, which can be explained by the energy loss of fast partons traversing in QGP.

The ALICE experiment includes a high-resolution and high-granularity electromagnetic calorimeter called PHOS[1]. One of the main physics goals achievable by PHOS is the study of energy loss through the measurement of high-p_{T} neutral mesons (π^0 and η). Three PHOS modules are installed in the ALICE experiment, which covers azimuthal angles in the range $260^\circ < \phi < 320^\circ$ and pseudorapidity $|\eta| < 0.125$. PHOS provides a photon trigger (PHOS trigger) by requiring the measured energy to be above a threshold. The threshold was set to be 2 and 4 GeV in pp collisions at $\sqrt{s} = 8$ TeV. By using the PHOS trigger, high-p_{T} neutral mesons can be efficiently measured in the ALICE experiment. This paper discribes the analysis status of neutral-pion production measured with the PHOS trigger and minimum-bias (MB) trigger data in pp collisions. Further, neutral-pion production in pp collisions at $\sqrt{s} = 8$ TeV are compared with results for other LHC energies (0.9, 2.76 and 7 TeV)[2)3)]. In this analysis, $0.3nb^{-1}$ and $70nb^{-1}$ MB-trigger and PHOS-trigger data respectively, in pp collisions at $\sqrt{s} = 8$TeV are used.

The invariant cross-section can be calculated as

$$E\frac{d^3\sigma^{pp\to\pi^0X}}{dp^3} = \frac{1}{2\pi}\frac{1}{p_{\mathrm{T}}}\frac{\sigma_{\mathrm{MB}}}{N_{evt}}\frac{1}{\varepsilon\times Acc}\frac{1}{\mathrm{BR}}\frac{N^{\pi^0}}{\Delta y\Delta p_{\mathrm{T}}} \quad (1)$$

Here σ_{MB} is the cross-section of minimum-bias (MB), N^{π^0} is the number of reconstructed neutral pions, and Acc is the PHOS acceptance correction. N_{evt} is the number of analyzed events in the minimum-bias trigger data analysis. In case of the PHOS trigger data analysis, it is the number of analyzed PHOS trigger events times the rejection factor. In the minimum-bias trigger data analysis, ε indicates the reconstruction efficiency, whereas in the PHOS trigger data analysis, it indicates the reconstruction efficiency times the trigger efficiency for a neutral-pion meson.

The invariant cross-section of a neutral pion in pp collisions at LHC energies are shown in Fig. 1. As shown in Fig. 1, the 0.9, 2.76 and 7 TeV analyses used only minimum-bias (MB) trigger data, but the 8 TeV analysis (this analysis) used not only minimum-bias but also PHOS trigger data. The very-low p_{T} ($\sim 1\mathrm{GeV}/c$) region cross-section was measured by the Photon Conversion Method (PCM)[2] with the tracking detectors of the central burrel[1]. For the 8 TeV result, the minimum-bias and PHOS trigger data were combined to measure the very wide p_{T} range neutral-pion meson. The dashed line denotes the result fitted to Tsalis functions.

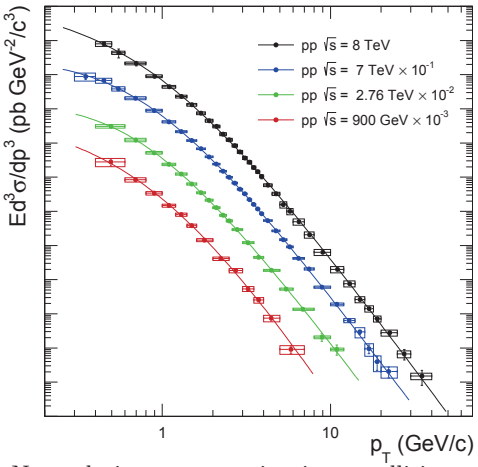

Fig. 1. Neutral-pion cross section in pp collisions at LHC energies.

By comparing the results for different LHC energies, pertubative Quantum Chromodynamics (pQCD) can be tested at LHC energies and the fragmentation function (FF) of gluon to the neutral-pion model can be restricted. Further, this comparison can help predict a neutral-pion production cross-section in pp collisions at other energies. This has not been measured yet and more precise references to study phenomena induced by AA collisions can be estimated for QGP study.

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References

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