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Jet and Photon Physics with ALICE: First Results from the pp Runs ☆

A. Morsch for the ALICE Collaboration
CERN, PH Division, Geneva, Switzerland

Abstract

During the first year of data taking ALICE has collected large data samples from pp collisions at the LHC ($\sqrt{s}$ = 900 GeV and 7 TeV). They allowed us to have a first look at high-p_{T} phenomena in a new energy regime. We give an overview of first results from the study of jet-like correlations and neutral meson production.

Keywords: LHC, ALICE, pp, jets, photons, 2-particle correlations

1. Introduction

Hadron jets are the manifestation of high-p_{T} partons produced in parton-parton scatterings with high transverse momentum transfer. In heavy-ion collisions, these partons are produced at the very early stage of the reaction. Therefore, prior to hadronisation, they interact with the high colour-density medium resulting in a loss of energy due to gluon radiation and multiple collisions. Through the observation of changes in the yield and fragmentation function of jets produced in heavy-ion collisions as compared to more elementary collisions (pp, pA) the properties of the medium can be studied [1, 2, 3]. Moreover, the analysis of γ-jet correlations serves to relate the jet energy to the original parton energy using the energy of the recoiling γ that does not interact strongly with the medium [4].

In central Pb–Pb collisions at the LHC, jet rates are high at energies at which jets can be reconstructed over the background energy of the underlying event. Hence, event-by-event reconstruction of jets with good energy resolution will be possible providing the necessary lever arm to measure the energy dependence of medium induced jet modifications [5].

ALICE (A Large Ion Collider Experiment) is the general purpose experiment at the LHC optimized for the study of heavy-ion collisions [6, 7]. As regards jet and photon physics, it is the goal of ALICE to analyse high statistics triggered jet and γ-jet samples from pp, proton-nucleus and nucleus-nucleus collisions using a combination of tracking and calorimetric measurements [8, 9]. The ALICE central tracking system covers the pseudo-rapidity range $|\eta| < 0.9$ and full azimuth. It has excellent momentum resolution for charged particles from 100 MeV/c to 100 GeV/c sufficient to measure the full range of fragment momenta for the highest energy jets accessible in heavy-ion collisions. To provide trigger capabilities and to improve the jet energy resolution an electromagnetic Pb-scintillator sampling calorimeter (EMCal) will be used. EMCal covers the region $|\eta| < 0.7$, $\Delta\phi = 110^\circ$ using 13k towers in Shashlik geometry with APD photosensors ($\Delta\eta \times \Delta\phi = 0.014 \times 0.014$). It has a design energy resolution of $\Delta E/E < 15\%/\sqrt{E} + 2\%$. High precision direct-photon identification up to $E_\gamma = 100$ GeV is achieved with PHOS (PHOton Spectrometer), a single-arm high-resolution electromagnetic calorimeter of high granularity covering $200^\circ < \phi < 340^\circ$ and $|\eta| < 0.2$.

During the first year of LHC operation ALICE has been running with a not yet completely installed electromagnetic calorimeter system (EMCAL: 4 out of 10 supermodules, PHOS: 3 out of 5 supermodules). ALICE has collected

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large statistic minimum bias data samples of pp ($\sqrt{s}$ = 0.9 and 7 TeV) and Pb–Pb ($\sqrt{s_{\rm NN}}$ = 2.76 TeV) collisions. High-$p_{\rm T}$ jet and photon triggers will be active in the upcoming 2011 pp runs.

Not feeling limited but rather excited to look at the first data taken in a new energy regime we started to study jet structures via charged hadron correlations and evaluated the performance of charged jet reconstruction. Last not least neutral meson production which is the dominant background for the direct γ measurement has been studied in the 2γ decay channel and invariant production cross-sections were compared to NLO calculations. Instead of a full account of the expected ALICE capabilities for jet and photon physics we present here the results from the first year of pp data taking. We will conclude with a short outlook on the 2011 capabilities.

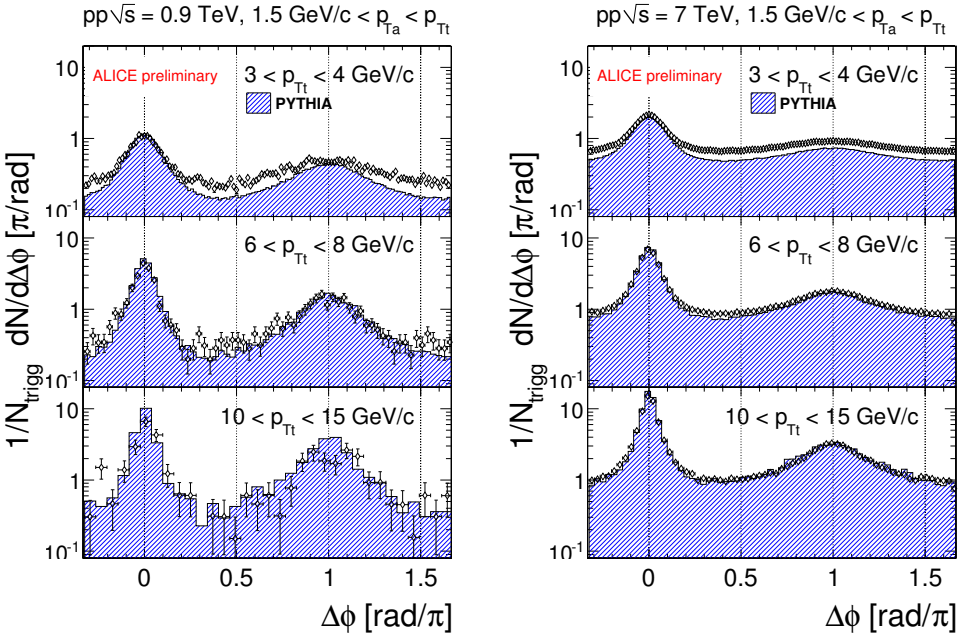

Figure 1: 2-particle azimuthal correlations for three different ranges of trigger $p_{\rm T}$ at $\sqrt{s}$ = 900 GeV (left) and $\sqrt{s}$ = 7 TeV (right) compared to a Pythia8 [12] simulation.

2. Particle Correlations

Particle correlations are used to measure jet properties on an inclusive basis in kinematic regions where full jet reconstruction is difficult [10, 11]. They are studied by plotting the azimuthal angle difference $\Delta\phi$ between a trigger particle and associated particles satisfying a combination of transverse momentum cuts ($p_{\rm Tt}$, $p_{\rm Ta}$). As can be seen from Fig. 1, one observes the so called near-side ($\Delta\phi$ = 0) and away-side peaks separated by 180° reminiscent of the fact that in leading order partons are produced exactly back-to-back. The net parton pair transverse momentum $k_{\rm T}$, in particular from initial state radiation, causes a broader away-side peak. Additional smearing comes from the fragmentation of partons into hadrons, mainly seen as the width of the near-side peak. Last not least the two peaks are sitting on the flat uncorrelated background of the underlying event (UE).

The characterization of the underlying event of hard collisions in terms of particle and momentum density has itself gained substantial interest. These quantities can not be derived from first principles. However, they are modeled