Jet Measurements with the ALICE detector at the LHC

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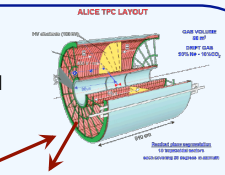
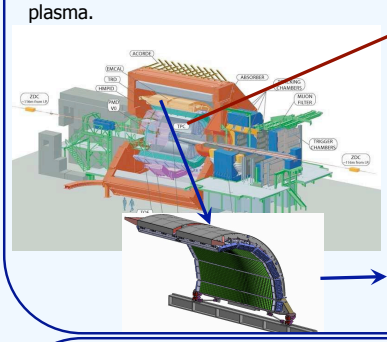
ALICE Experiment

➢ALICE is built to exploit the unique physics potential of heavy-ion collisions at the LHC and measure the properties of the hot, dense and strongly interacting matter – the quark-gluon plasma.





➢The ALICE central barrel is used to measure the momentum of **charged particles** with great resolution down to 150 MeV/c.

➢$|\eta|<0.9$, $0<\varphi<2\pi$

➢A Pb-scintillator sampling Electromagnetic Calorimeter (EMCal) is used to measure the energy of **neutral particles**.

➢$|\eta|<0.7$, $1.4<\varphi<3.14$

Why measure jets in HI collisions?

Jet quenching

➢QCD predicts that highly energetic partons lose energy in a quark-gluon plasma.

Full jet reconstruction

➢Enables a ***direct study of jet quenching*** due to jet-medium interaction.

➢Allows for detailed studies of ***modification to the energy flow*** from fragmenting partons as opposed to hadronic observables which suffer from geometric biases.

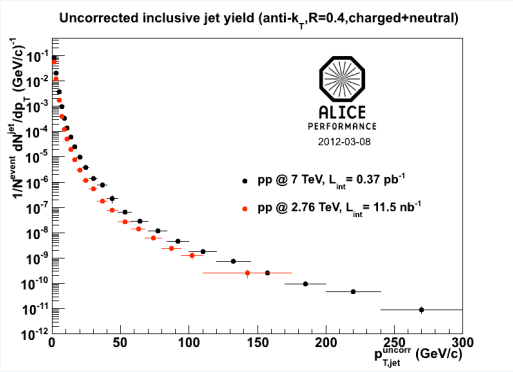
Jet measurement at ALICE

➢Jets can be measured in pp at both 7 TeV and 2.76 TeV.

➢Detailed jet structure measurement down to very low p_t.

➢Handle on background fluctuations in Pb-Pb collisions.

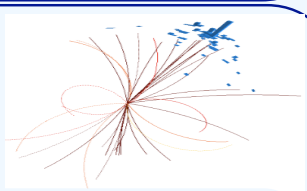
Uncorrected raw jet yield



➢***Jet definition***[1]

➢***anti-k_T, R=0.4***

➢***BIpt-recombination scheme***



➢Jet quality cut

➢$|\eta| < 0.3$, $1.8 < \phi < 2.7$

➢Fraction of jet p_t carried by the leading particle: $Z_{leading} < 0.98$

➢**EMCal Level-0 trigger** is used in data taking. This trigger ***greatly extends the kinematic reach of jets***. However, it also induces ***bias on the jet population***. We compare the raw jet yields at high p_t in the triggered sample and the Minimum-Bias (MB) sample, and extract the scaling factor to normalize the triggered sample.

➢Left plot shows the raw jet yield in both 2.76 TeV and 7 TeV pp collisions by combining the MB and triggered samples with appropriate normalization.

➢The pp measurement at 2.76 TeV is an essential reference for the jet measurements in Pb-Pb collisions at the same $\sqrt{s_{NN}}$.

Jet energy scale & jet energy resolution

Jet energy scale: the measured jet energy can shift from the true energy in the collision. The main causes are

➢Missing neutrons and K^0_L's: corrected from models.

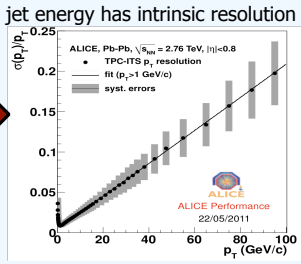
➢Tracking inefficiency: only a fraction of charged particles can be detected in the central barrel. Estimated from simulation.

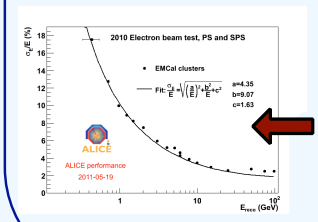
➢Energy double-counting: charged particles also shower in EMCal. Correction to EMCal showers is needed to avoid double counting of charged energy which causes a shift of the jet energy.

➢Non-linearity of EMCal energy measurement.

Jet energy resolution: the measured jet energy has intrinsic resolution

➢Charged tracking resolution: increases with track p_t. At $p_t \sim$ 50 GeV/c, the resolution is about 10%.





➢EMCal energy resolution from test beam: decreases with energy. For E > 5GeV/c, the resolution is < 5%.

➢Residual resolution from corrections of jet energy scale.

Outlook for jet measurement in Pb-Pb

Event background fluctuations have a large impact on jet measurements in Pb-Pb collisions.

➢Correlated region-to-region fluctuations

➢Upward fluctuations due to hard processes

➢Random fluctuations of particle number and momentum

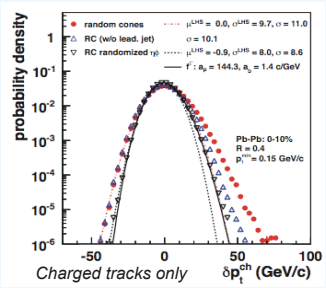
Assess fluctuations

➢Random Cone (RC) with R=0.4 is placed in 10% most central Pb-Pb events.

➢Calculate the difference between summed pt of all the tracks in the cone and the expected background:

$$\delta p_t^{ch} = \sum_i p_{t,i} - A \cdot \rho$$

with ρ is the background density.



➢Fit left-hand-side of red curve with a Gaussian function yields typical background fluctuations of ~ 10 GeV/c.

Outlook

➢Jet spectrum and detailed jet structure study in pp collision.

➢Inclusive jet spectrum in Pb-Pb collision is underway.

[1]M. Cacciari, G.P.Salam and G.Sovez, FastJet package.