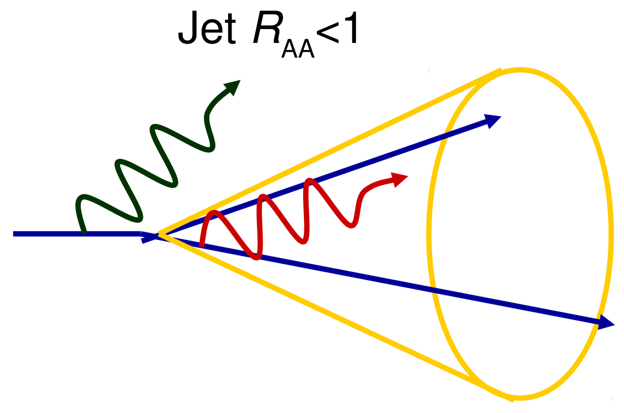
Measurement of jet spectra with charged particles in Pb-Pb collisions at $\sqrt{s_{NN}}$=2.76 TeV with the ALICE detector

Marta Verweij[a] for the ALICE collaboration
[a]Utrecht University

Jets in heavy-ion collisions

Highly energetic partons are produced in hard scatterings in the early stage of the collision. A parton traversing the hot medium, created in heavy-ion collisions will radiate gluons induced by interactions of the parton with the medium. This results in **modified jets** due to jet quenching: broadening of the jet energy profile and/or suppression of the yield due to out-of-cone radiation. The amount of medium-induced gluon radiation depends on the coupling strength of the parton to the medium.

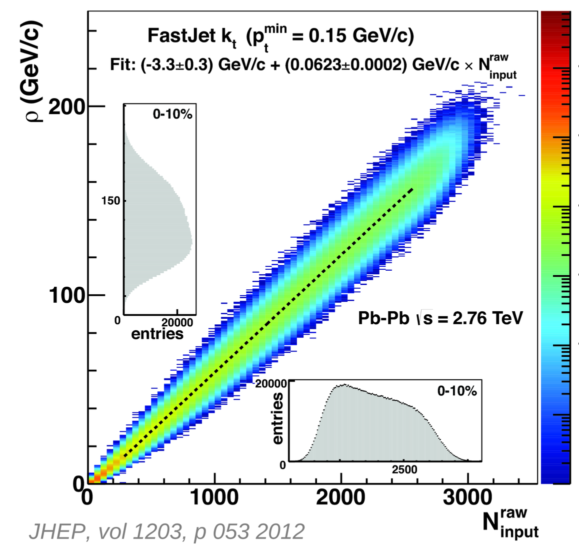


Experimental challenge in heavy-ion collisions:
Separate jet signal from large soft background originating from bulk

Event background

1) Event-by-event background subtraction

$$\rho = \text{median}\left(\frac{p_T^{\text{jet},i}}{A_i^{\text{jet}}}\right)$$

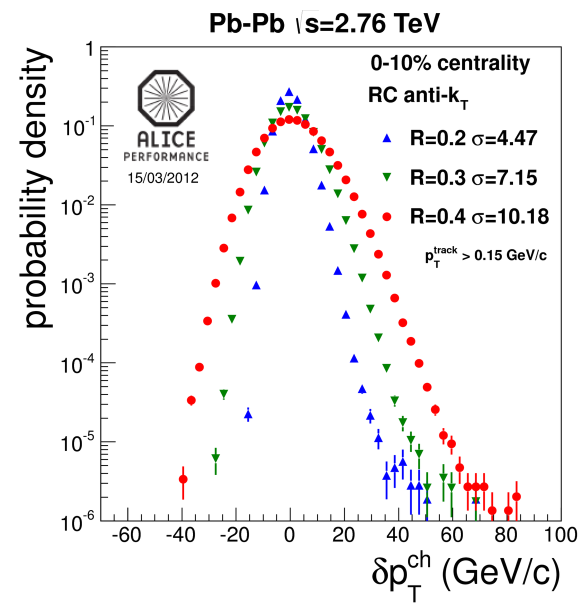


Average background density measured event-by-event scales linearly with multiplicity.

2) Background fluctuations

Quantified by embedding high p_T probes in measured Pb-Pb events.

$$\delta_{p_T} = p_{T,\text{jet}}^{\text{rec}} - \rho A - p_T^{\text{probe}}$$



Background fluctuations are asymmetric due to overlapping jets (high p_T tail)

Jet reconstruction with charged particles at ALICE

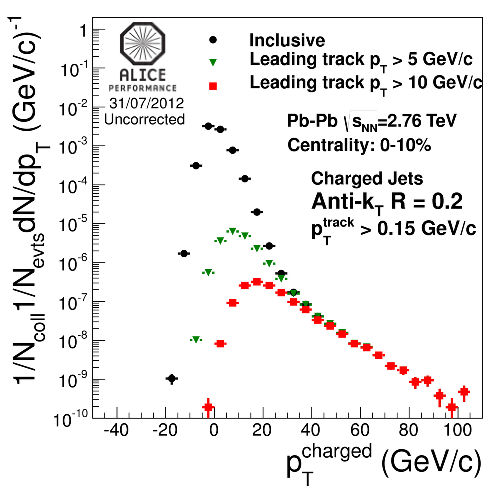
Charged jet reconstruction with tracks reconstructed in the Time Projection Chamber (TPC) and Inner Tracking System (ITS):

- High precision on particle level
- Uniform η-φ acceptance: |η|<0.9 0<φ<2π
- Neutral energy n, π^0, γ not included

Tools:

- Jet finding - FastJet package [1]
  - k_T and anti-k_T jet finder with resolution parameter R=0.2 and R=0.3
  - Boost invariant p_T recombination scheme
  - Transverse momentum track cut-off p_T > **150 MeV/c**

Selection:
Tracks: full azimuth and |η|<0.9. Jets: |η| < 0.5



Inclusive raw jet spectra without requirement on the leading hadron and with a leading hadron with at least 5 and 10 GeV/c

Unfolding background fluctuations & detector effects

Truth → (RM_{det}) D → ($RM_{\delta pT}$) Measured

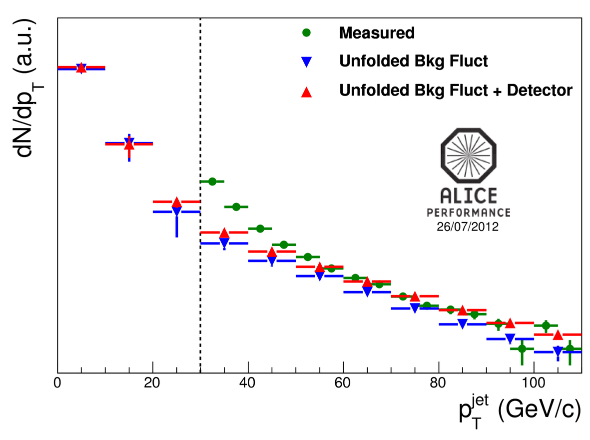


Illustration of unfolding p_T ranges

Unfolding done with χ^2 minimization method

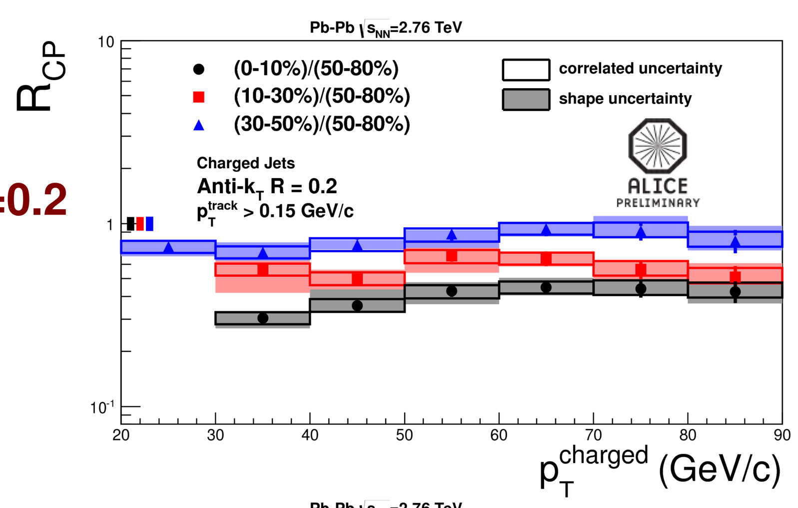
$$\chi^2 = \underbrace{\sum_{\text{refolded}}\left(\frac{y_{\text{refolded}} - y_{\text{measured}}}{\sigma_{\text{measured}}}\right)^2}_{\chi^2\text{-term}} + \underbrace{\beta \sum_{\text{unfolded}}\left(\frac{d^2 \log y_{\text{unfolded}}}{d \log p_T^2}\right)^2}_{\text{Regularization/penalty}}$$

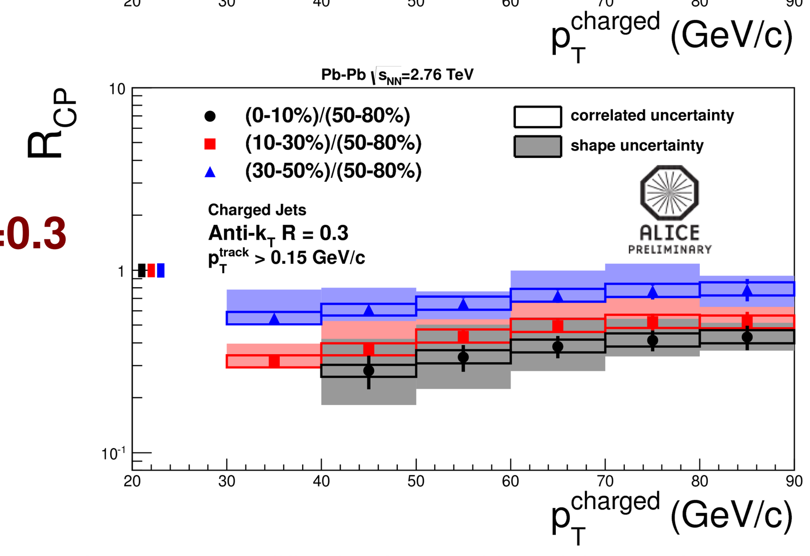
Choice of p_T ranges in unfolding and systematic uncertainties

- Measured spectrum: Suppression of background jets by $p_{T,\text{meas}}$ > 5σ(δp_T).
- Feed in from low p_T. Unfolded spectrum starts at p_T=0 GeV/c
- Regularization strength: systematic uncertainty on extracted jet yield 10% for central events and 4% for peripheral events
- Jet energy scale correction from detector effects: ~10%

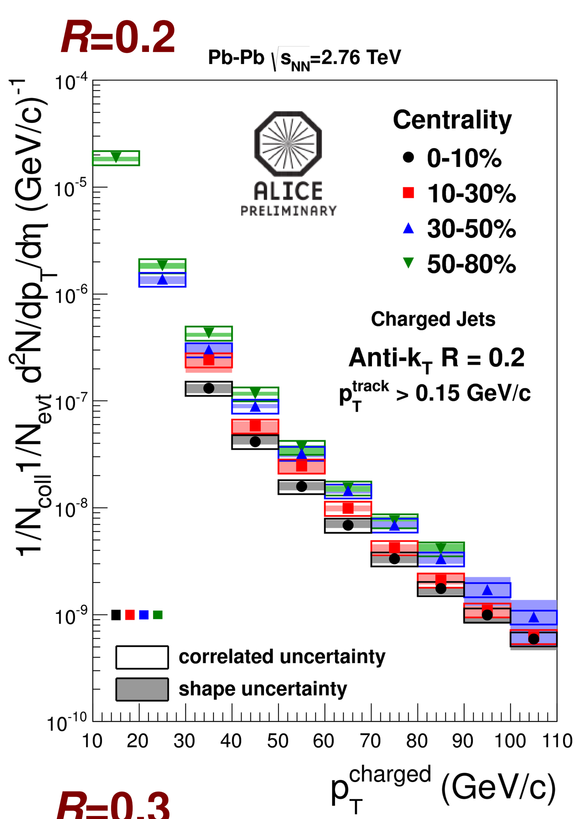
Inclusive jet spectrum and suppression in Pb-Pb

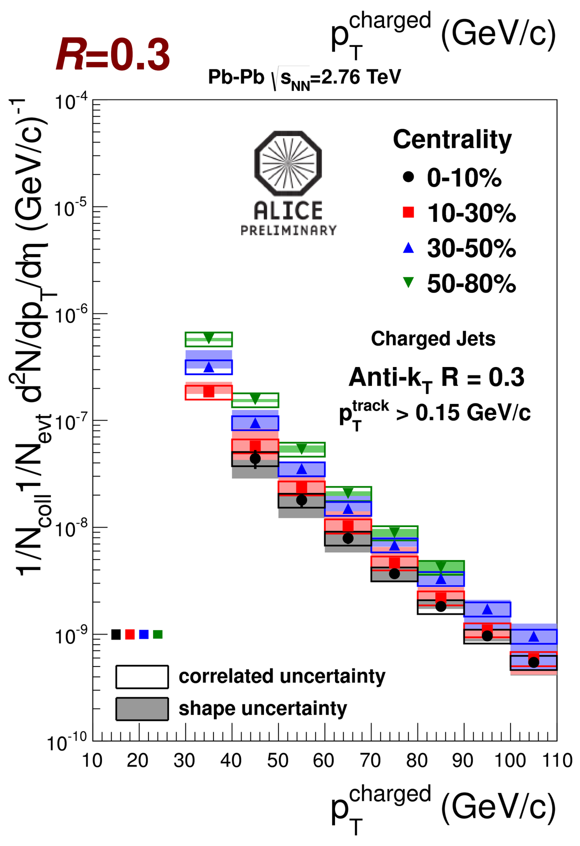
Jet spectra measured for 2 cone radii (0.2 and 0.3) and 4 centrality classes.
Minimum p_T of jet constituents 150 MeV/c.





Jet nuclear modification factor with peripheral reference.

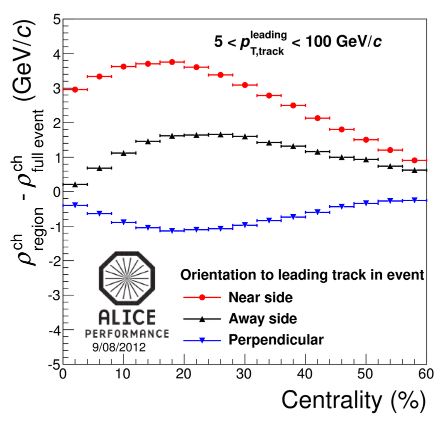


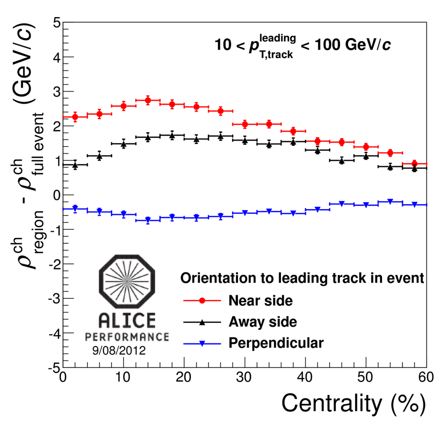


Inclusive jet spectra in Pb-Pb collisions

Strong jet suppression is observed.
Jets in central events more suppressed than in peripheral events.
Energy is radiated out of the jet cone.

Jets triggered by a high p_T hadron



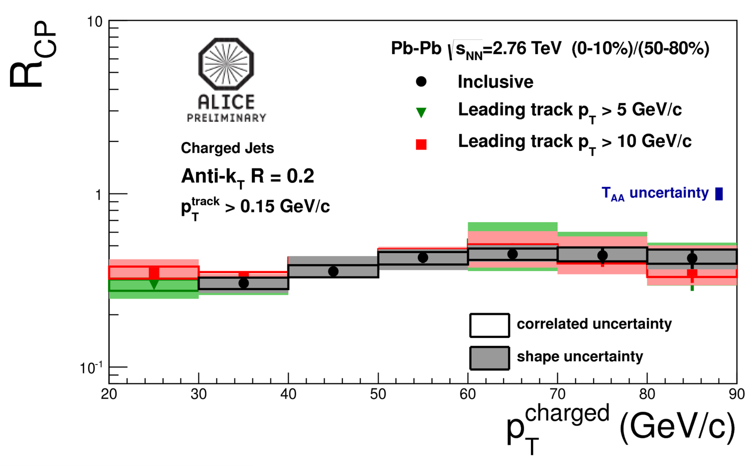


Background momentum density as function of centrality for different orientations to the leading track in the event.

Requirement of high p_T hadron reduces the contribution from soft clusters which do not originate from a hard process to the raw inclusive jet spectrum.

Flow bias: high p_T hadron correlated to event and participant plane. Background density per unit area below jet is larger. Magnitude of bias on inclusive jet spectra depends on p_T of trigger.
Hadron triggered jet spectra are corrected for the flow bias.

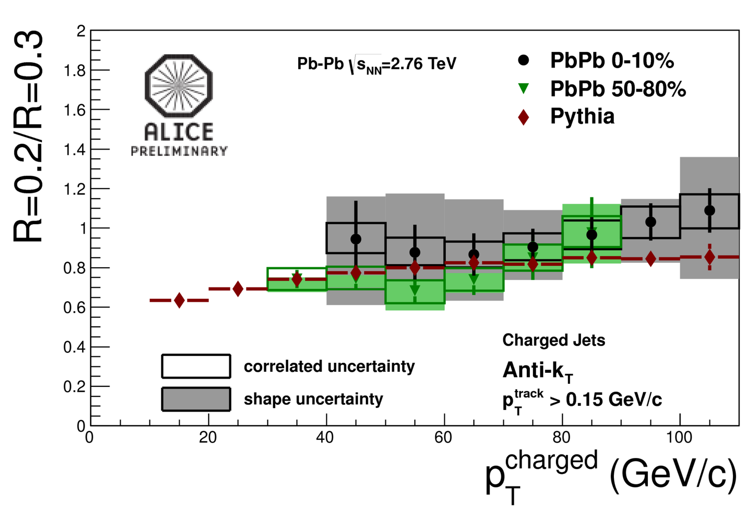
Inclusive jet R_{CP} is compared to R_{CP} from jets containing a high p_T track. No difference in suppression observed for p_T>30 GeV/c



Jet broadening?

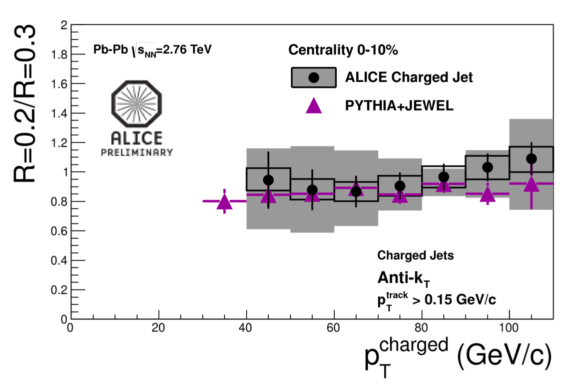
Ratio of the jet cross section between R=0.2 and R=0.3 in Pb-Pb collisions is consistent with vacuum jets for peripheral and central collisions.

No significant jet broadening is observed

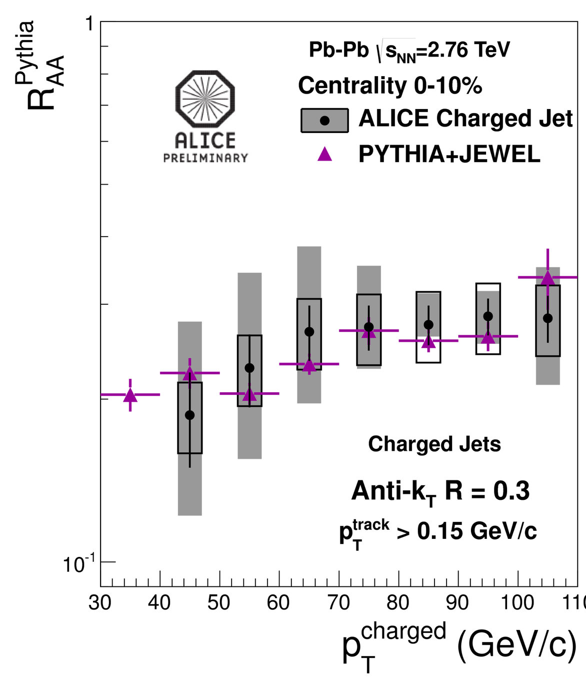


Model comparison

Inclusive jet measurements are compared to jet quenching Monte Carlo generator JEWEL [2,3].



Ratio of R=0.2 and R=0.3 jet cross section



R_{AA} with reference from Pythia-Perugia0

A **good agreement** is observed between the jet energy loss MC JEWEL and the charged jet results from ALICE.

References
[1] M. Cacciari, G.P. Salam, G. Soyez, Fastjet package
[2] K.C. Zapp, F. Krauss, U.A. Wiedemann, arXiv:1111.6838
[3] K.C. Zapp, private communication