Jet measurements in proton-proton collisions with the ALICE experiment at LHC

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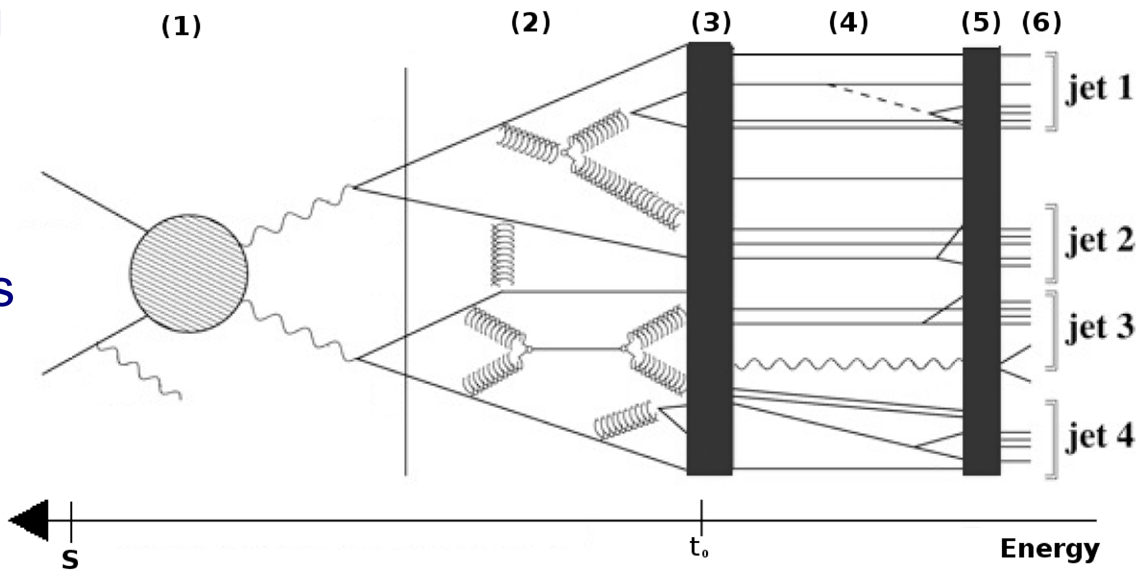
on behalf of the *ALICE* collaboration

Outline

- Motivation
- Analysis details
- Charged jet spectrum measurements
- Jet shape observables
- Summary

Jet Definition

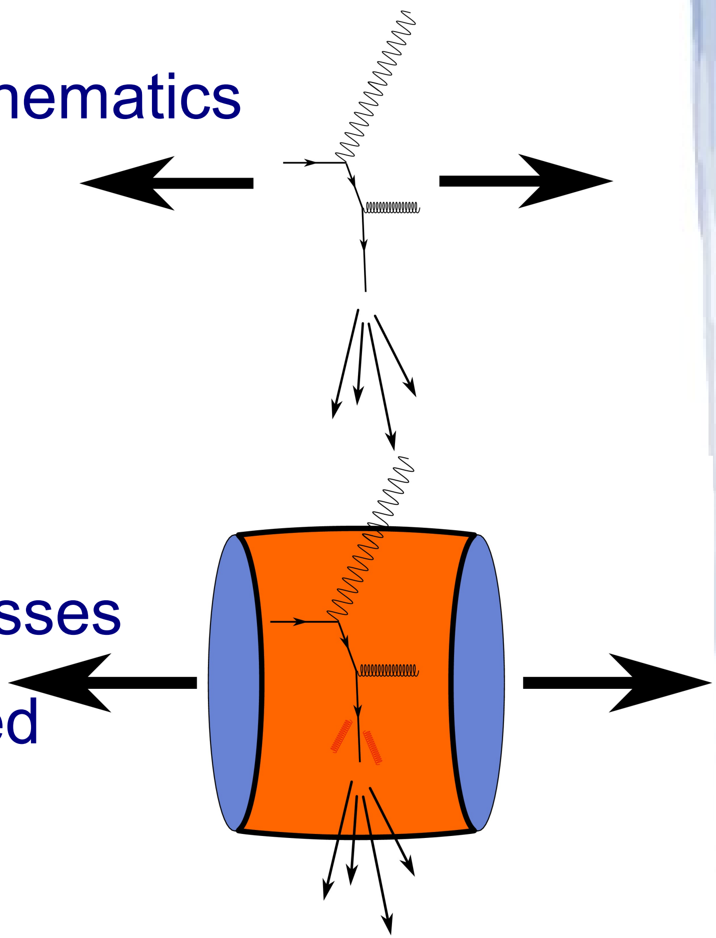
- from *theory*:
  - final state of parton scattered in collision
- from *experiment*:
  - spray of collinear particles
- production follows:
  - (1) Hard scattering
  - (2) Fragmentation
  - (3) Hadronisation
  - (5) Detector effects



Use of Jets

- experimental tools to examine parton kinematics
  - comparison to pQCD
  - study of fragmentation functions
  - hadronisation

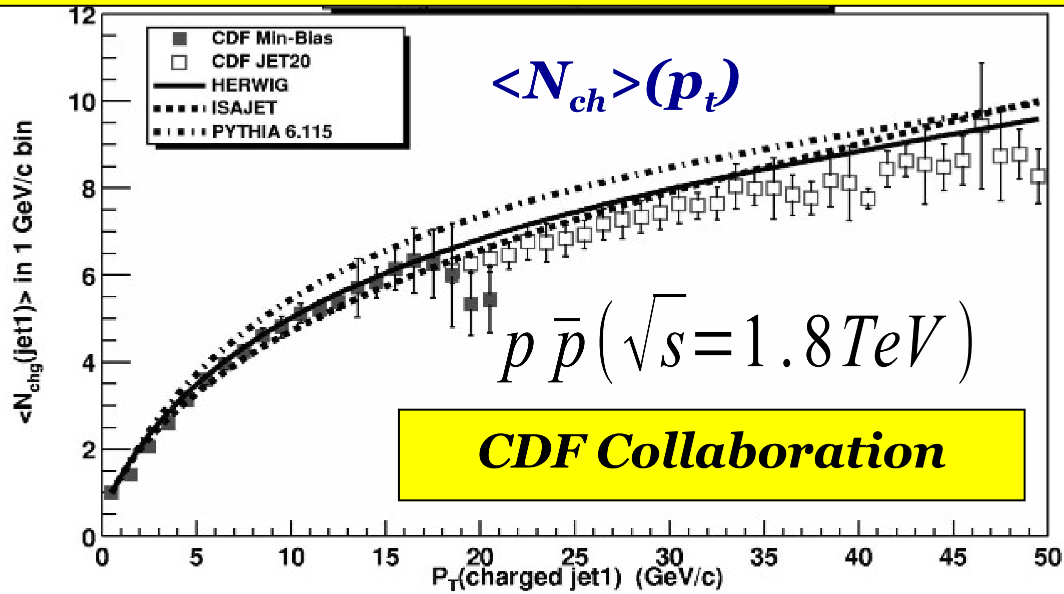
- study effects of medium on these processes
  - proton-proton baseline is required

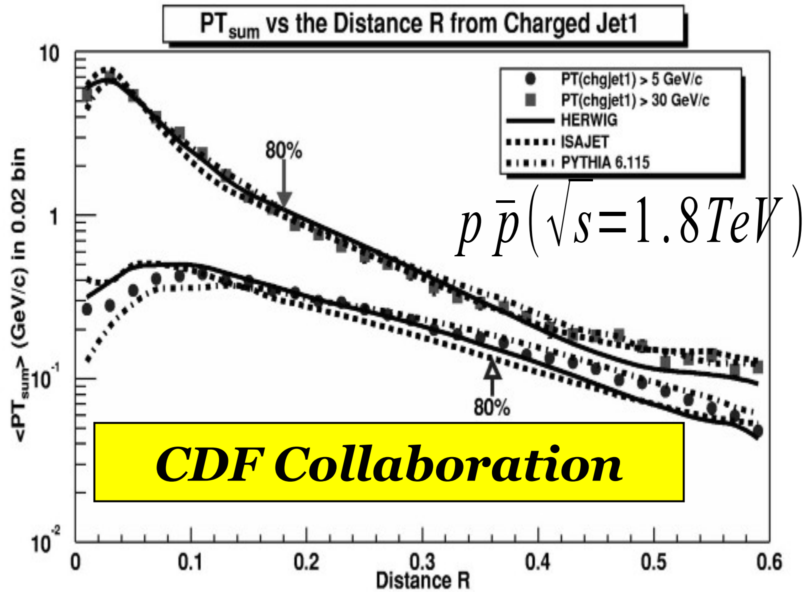


Jet Shape Observables

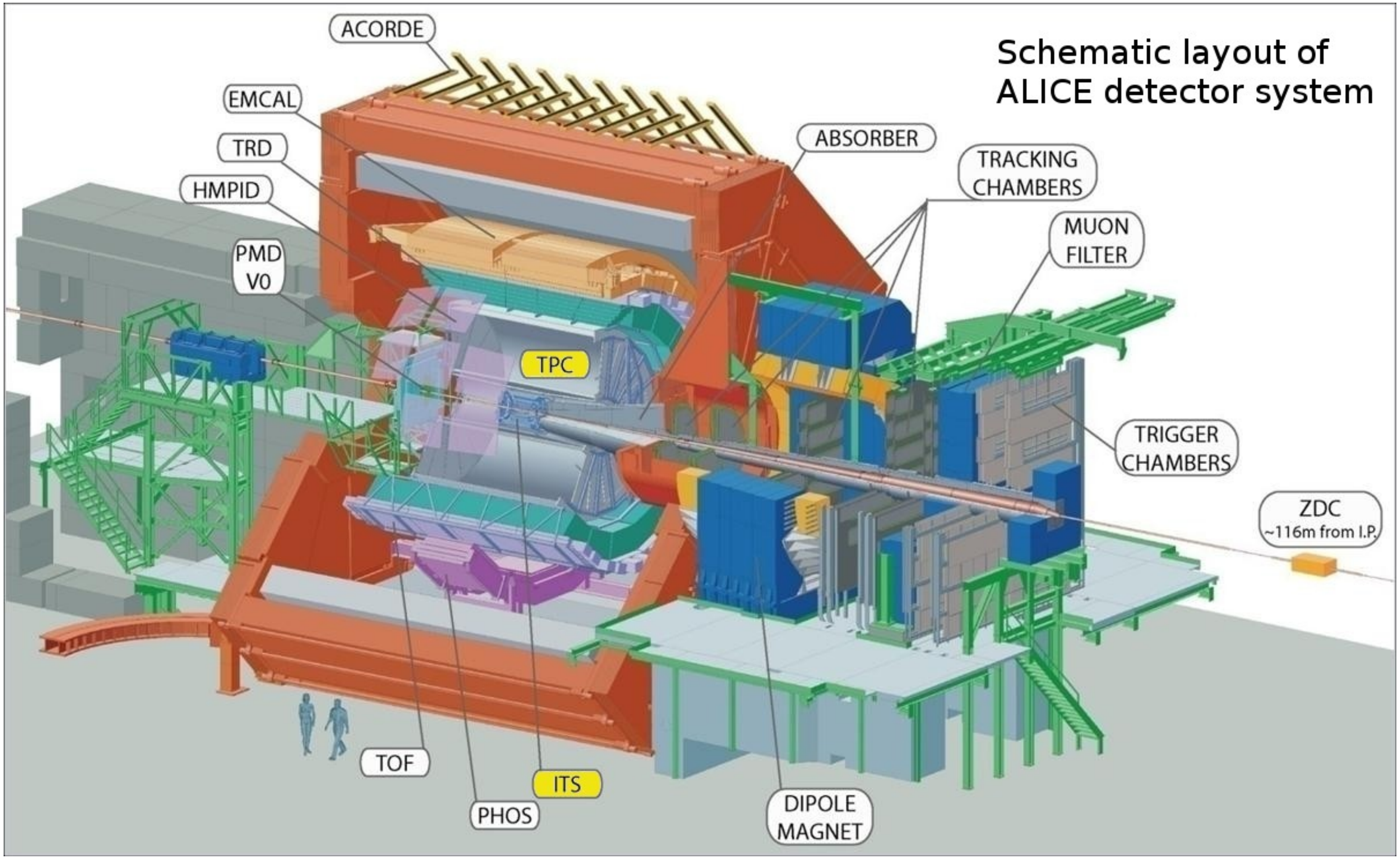
- provide details on parton fragmentation
  - number of charged tracks in charged jet
  - radial distribution of p_T about jet axis

CDF Collaboration, Phys. Rev. D 65 092002





A Large Ion Collider Experiment



ITS+TPC tracking detectors

Analysis Selection Details

Event selection

- minimum bias offline trigger selection
- at least 2 contributors to primary vertex
- vertex z-position within 10 cm from nominal interaction point

Jet selection

- charged tracks:
  - ITS-TPC
  - $|\eta_{track}| < 0.9$
  - $p_{T,track} > 0.15$ GeV/c
- charged jets:
  - FastJet*: Anti-k_T & k_T
  - R = 0.2, 0.4, 0.6
  - $p_{T,jet} > 5$ GeV/c
  - $|\eta_{jet}| < 0.9 - R$

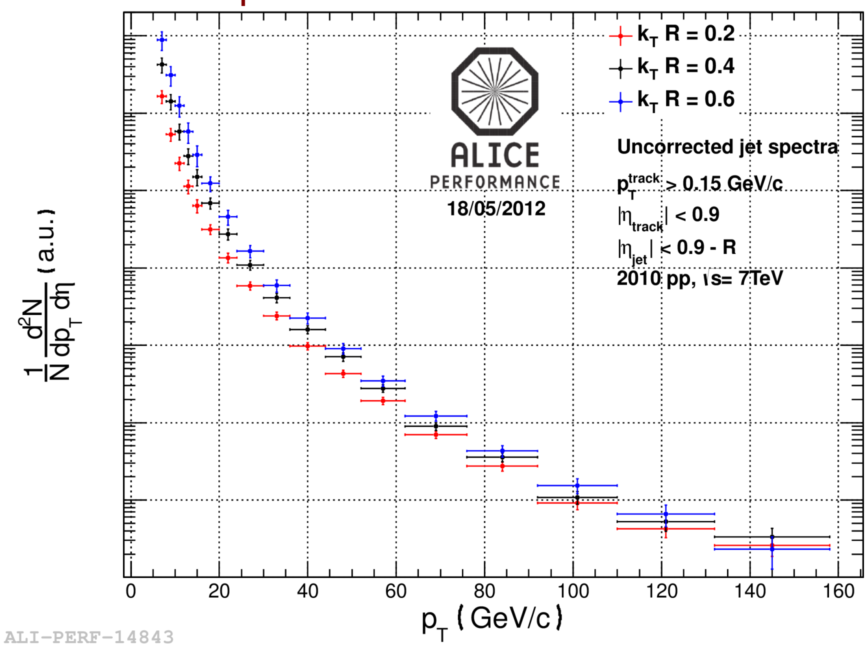
*[M. Cacciari and P. Salam, arXiv:0802.1189v1[hep-ph], 2008]

(Anti-)k_T Algorithm

- jet definition depends on choice of algorithm
- sequential recombination of tracks
- $d_{ij} = min\left(k^p_{T,i}, k^p_{T,j}\right)\left(\Delta\eta^2_{ij} + \Delta\varphi^2_{ij}\right)/R^2$
  - R is resolution parameter
  - p = 2, k_T algorithm – soft particles merged first
  - p = -2, anti-k_T algorithm – hard particles merged first

Raw Charged Jet Spectrum

- year 2010 data
- proton-proton collisions
- E_{CMS} = 7 TeV
  - **k_T jets**



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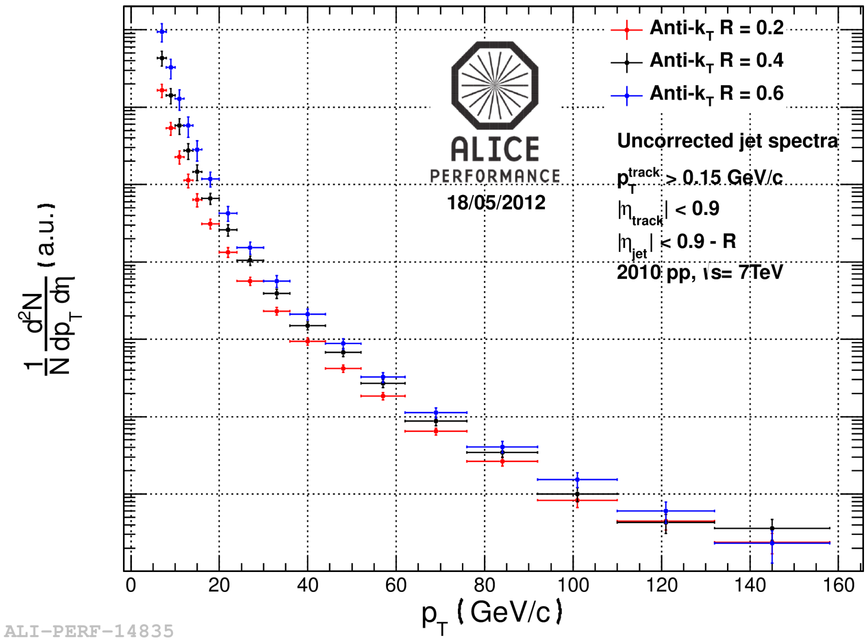
- **Anti-k_T jets**



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- 16.5 million min. bias events
- 13.3 million events accepted

Unfolding Methods

- unfolding has to be done to correct spectra for detector effects
- Bin-by-bin correction

  - correction using known simulated jet spectra on level of particle generator and track level after Geant detector simulation
- Bayesian unfolding*

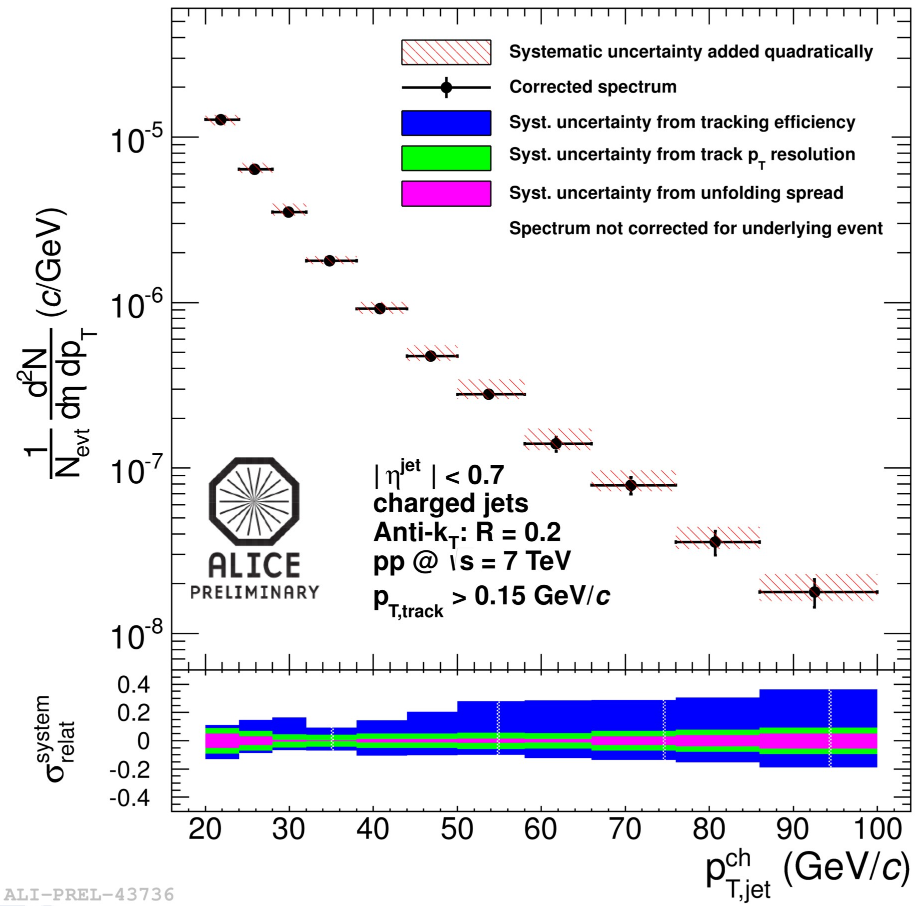
  - utilizes Bayes' theorem to invert response matrix
- SVD unfolding**

  - singular value decomposition of response matrix

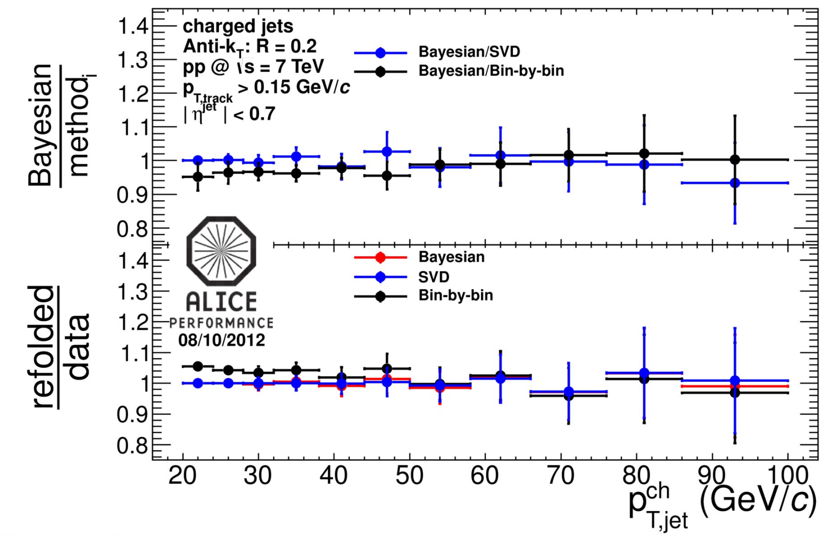
* G. D'Agostini, A multidimensional unfolding method based on Bayes theorem, NIM A 362 (1995) 487.

** A. Höcker and V. Kartvelishvili, SVD Approach to Data Unfolding, NIM A 372 (1996) 469

Corrected Charged Jet Spectra

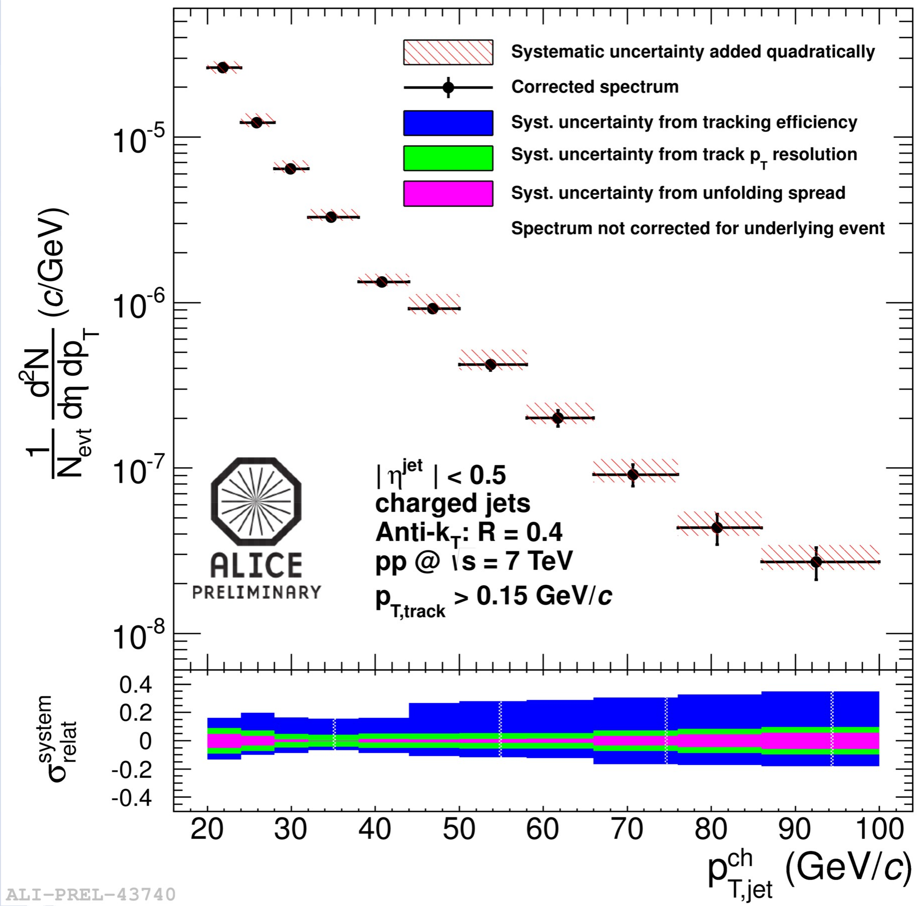


- **Anti-k_T: R = 0.2**
- not corrected for underlying event
- comparison of different methods
- performance of refolding

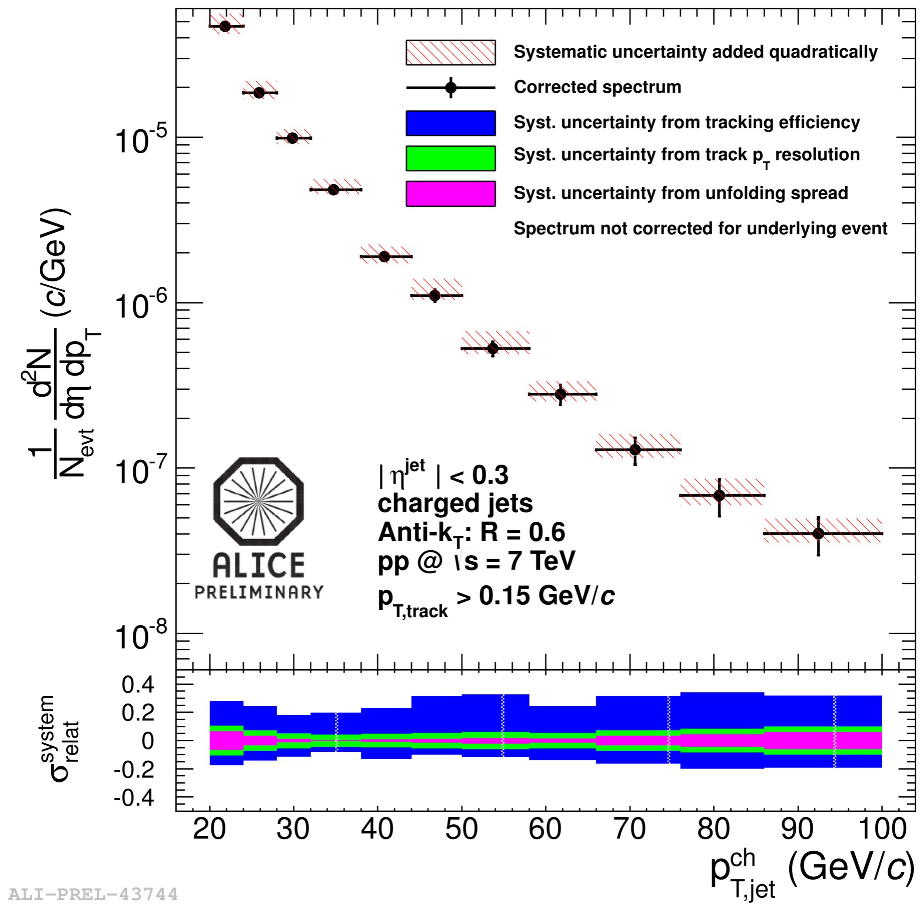


Corrected Charged Jet Spectra

- **Anti-k_T: R = 0.4**

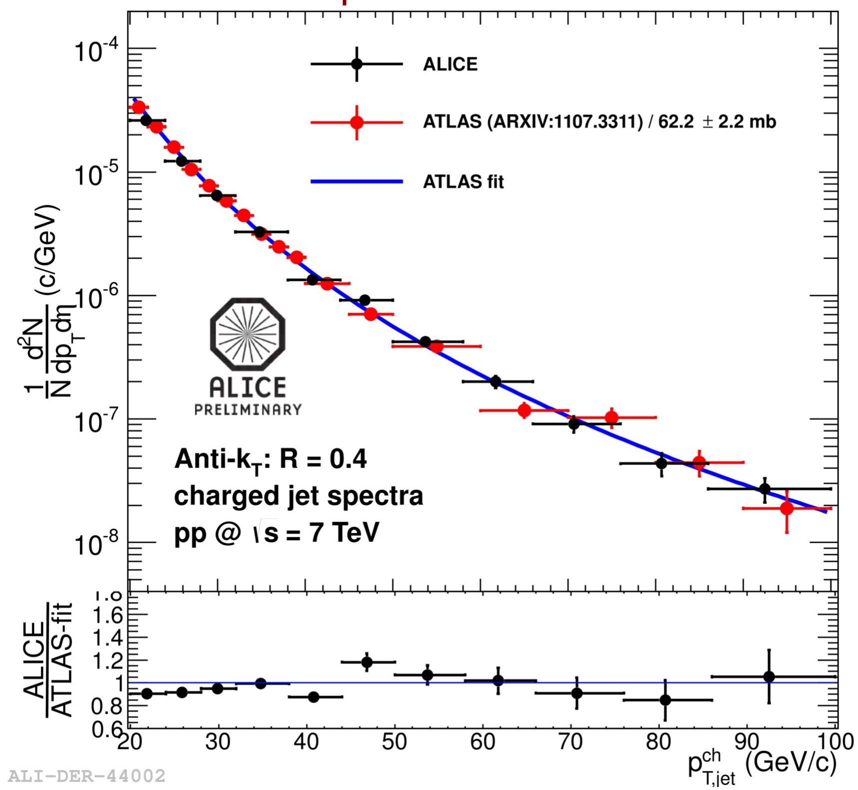


- **Anti-k_T: R = 0.6**

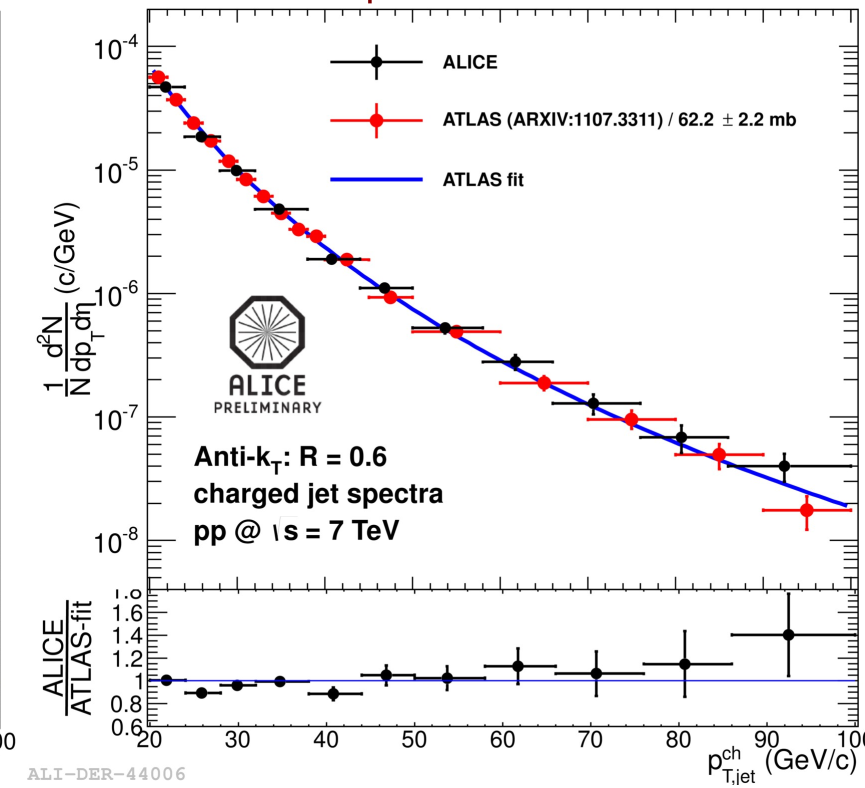


Comparison to ATLAS

- **Anti-k$_T$: R = 0.4**

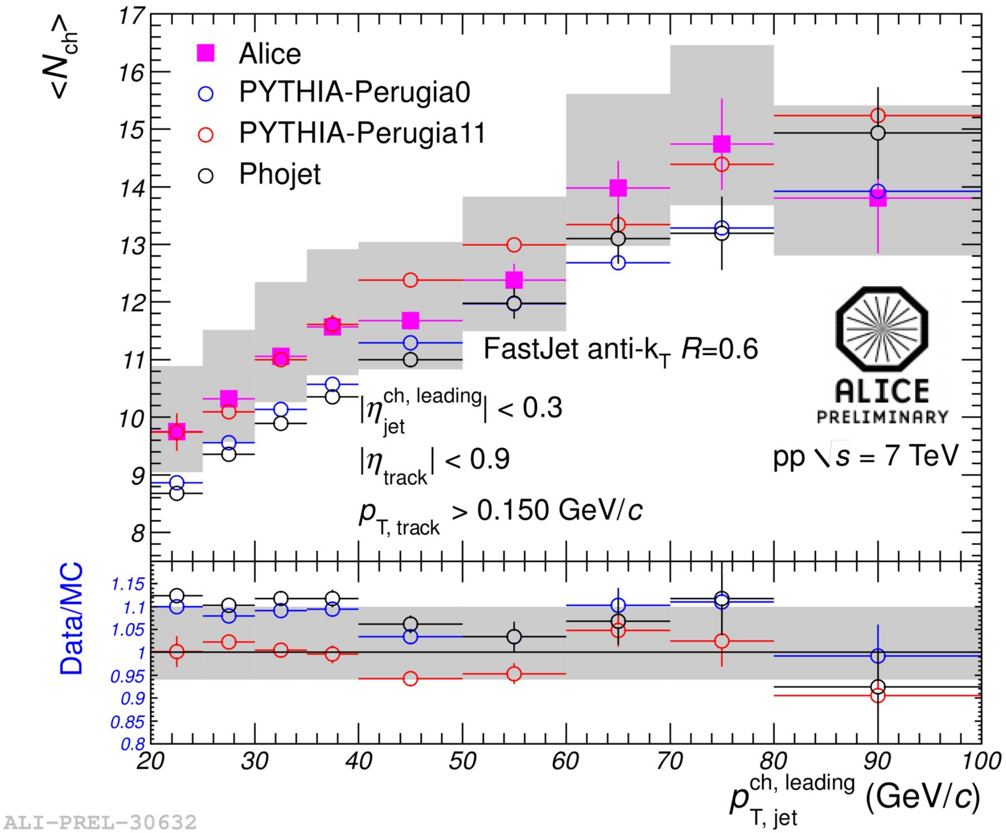


- **Anti-k$_T$: R = 0.6**



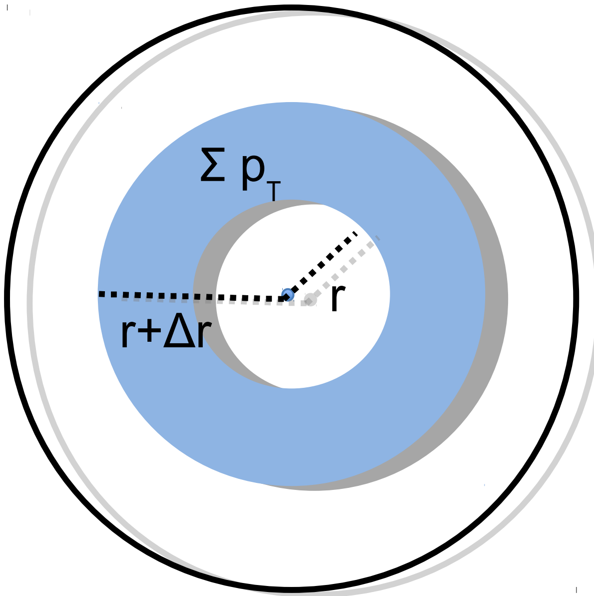
- ATLAS results from *PRD84 (2011) 054001*
- good agreement of ALICE and ATLAS results

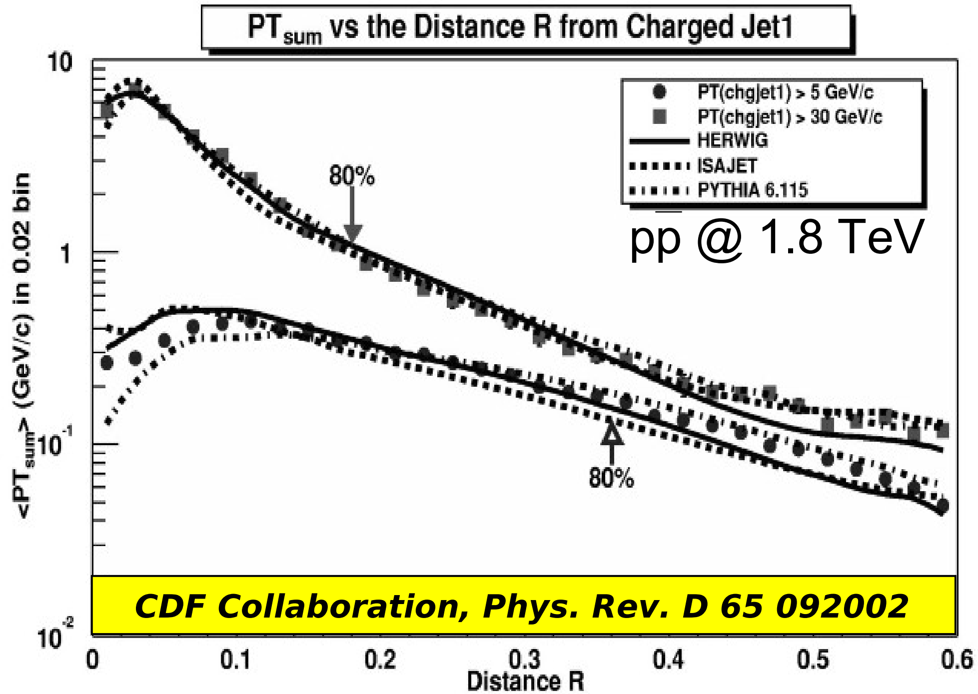
Number of Tracks per Jet



- charged track multiplicity inside jets increases with increasing jet p_T
- bin-by-bin correction is done using PYTHIA (Perugia0).
- good agreement between data and PYTHIA (within ±10%).
- gray bands show systematic uncertainty (mostly coming from uncertainty in tracking efficiency).

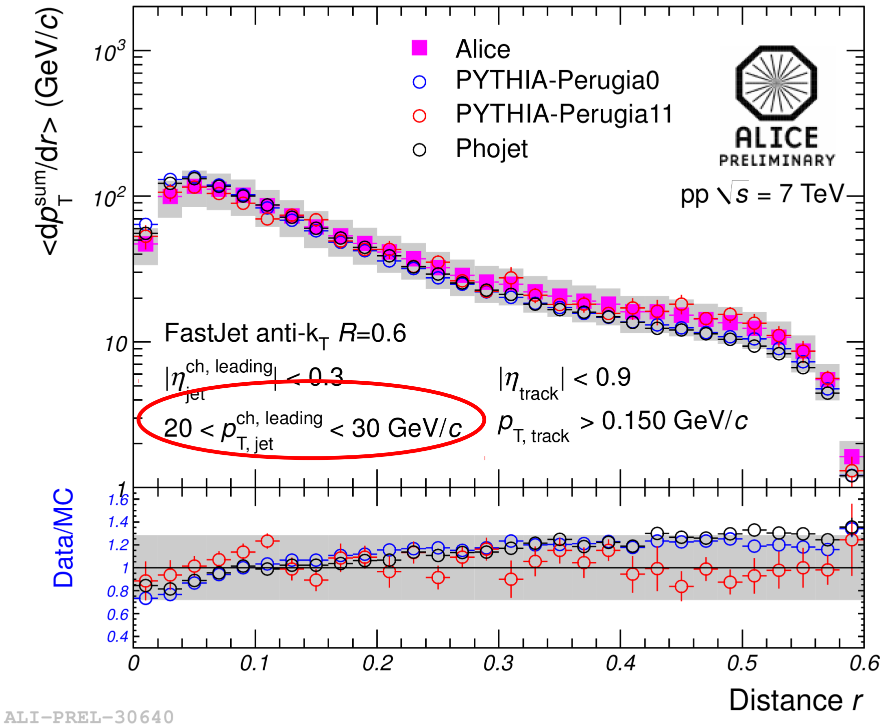
Radial Momentum Density

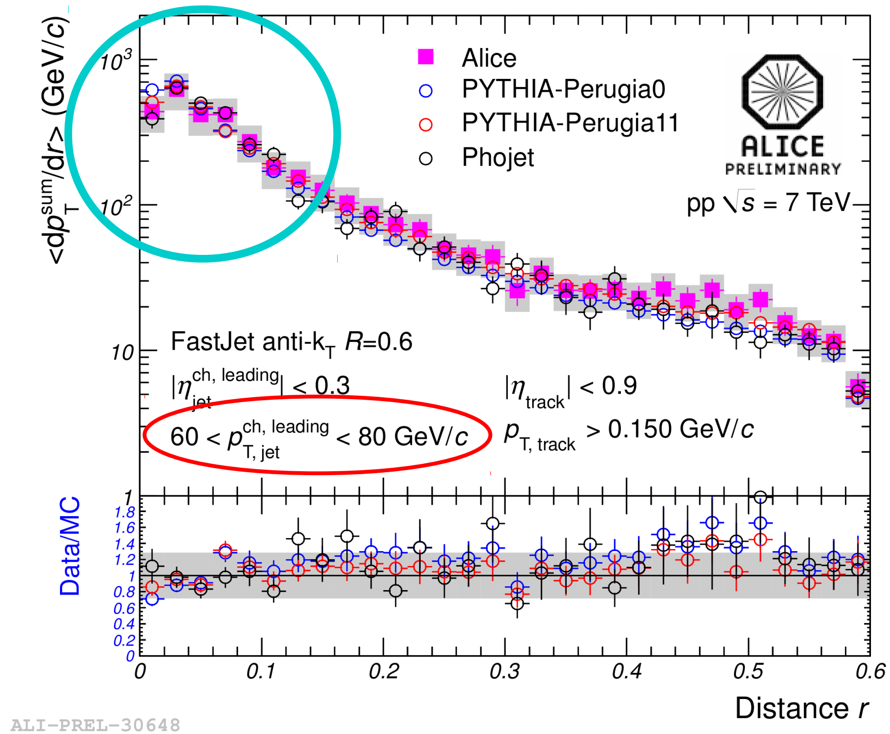




- sum p_T of tracks in *Δr* semi-circle
- given as a function of *r*
- done for all jets
- normalized to number of jets

Radial Momentum Density





- bin-by-bin correction using Pythia-Perugia0
- good agreement with Pythia
- jets with higher p_T are more collimated

Summary

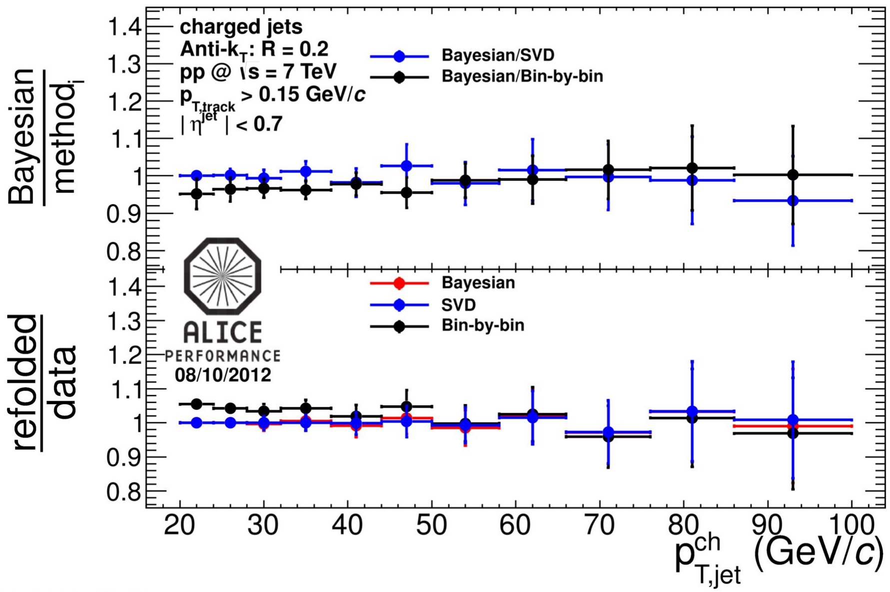
- charged jet spectra in p+p collisions at 7 TeV with ALICE were presented
    - systematic studies of jet algorithms and unfolding methods
    - evolution of jet spectra with resolution parameter R studied
    - ALICE and ATLAS charged jet spectra are in a very good agreement

- detailed studies of charged jet shapes in p+p collisions at 7 TeV
    - charged track multiplicities increase with jet momentum consistently with CDF measurements
    - jets are more collimated with increasing jet p_T
    - jet shape variables are consistent with predictions from Pythia-Perugia0

Thank You for Your attention and this opportunity to present our results

Backup

Performance



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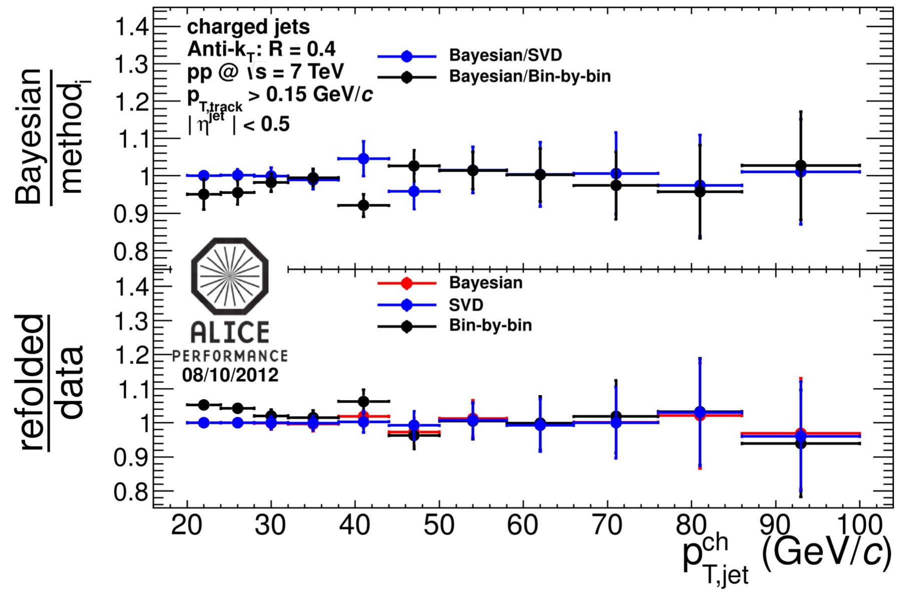

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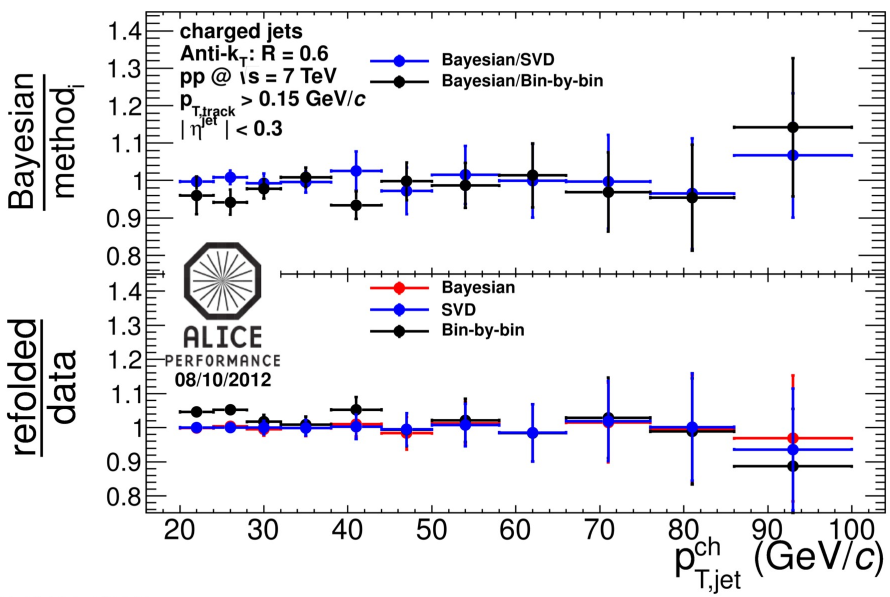

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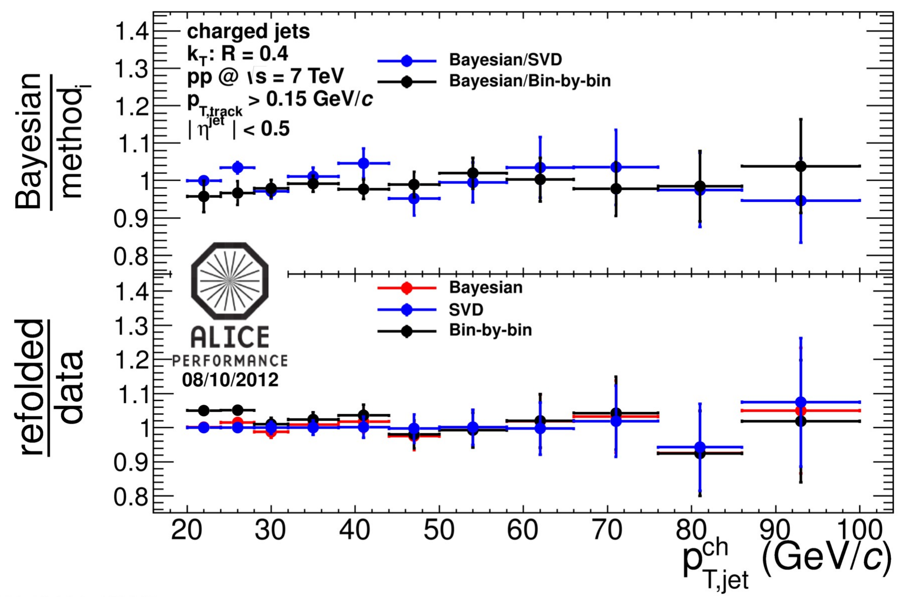

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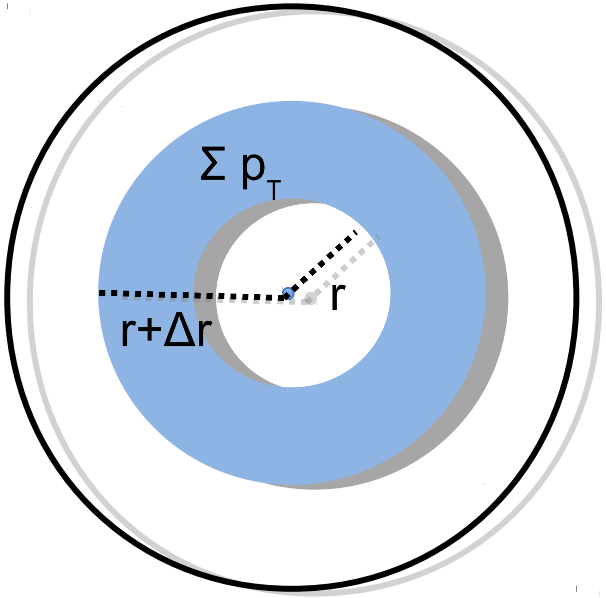
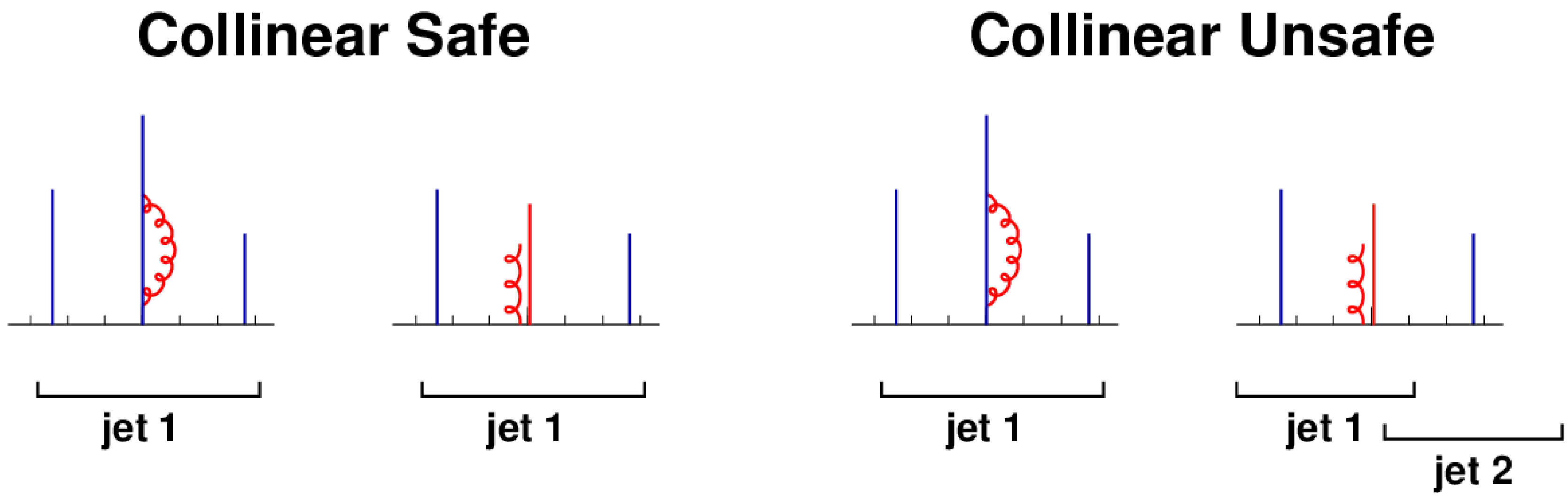
Radial Momentum Distribution

- **Radial distribution of transverse momentum about the jet axis:**

$$< p_t^{sum} > (r) = \frac{\sum_{jets} (\sum p_t)}{N_{jets}}$$

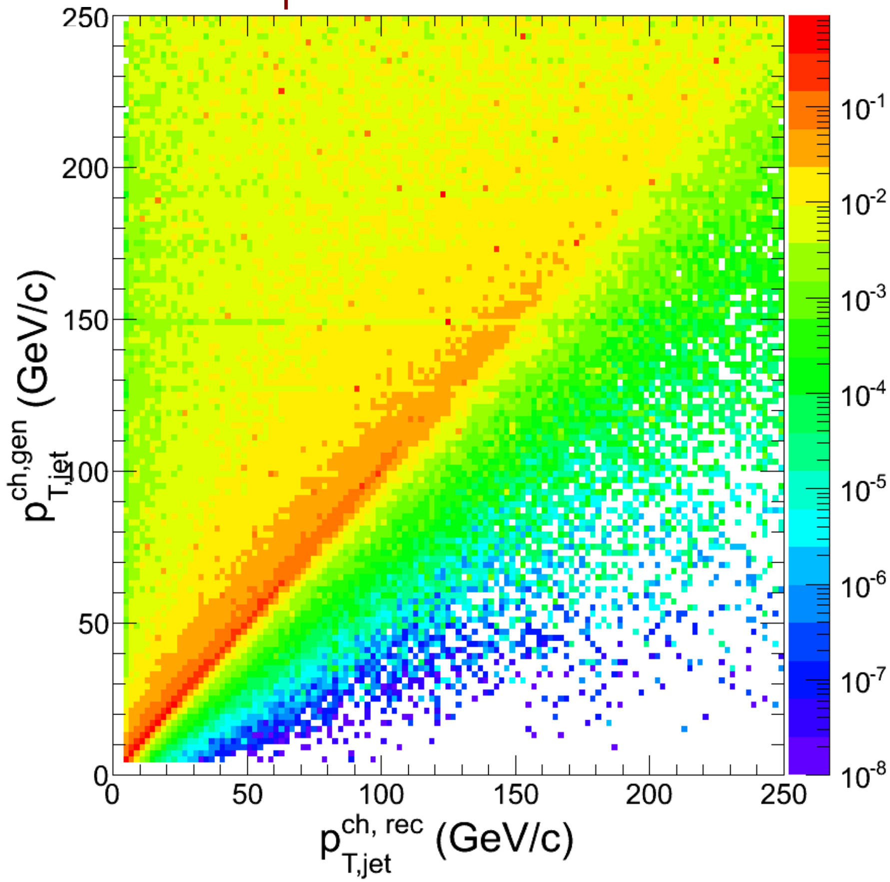


Collinear Safety



Response matrix

- k_T: R = 0.4



- Anti-k_T: R = 0.6