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First Physics measurements: $dN_{ch}/d\eta$ with pixels

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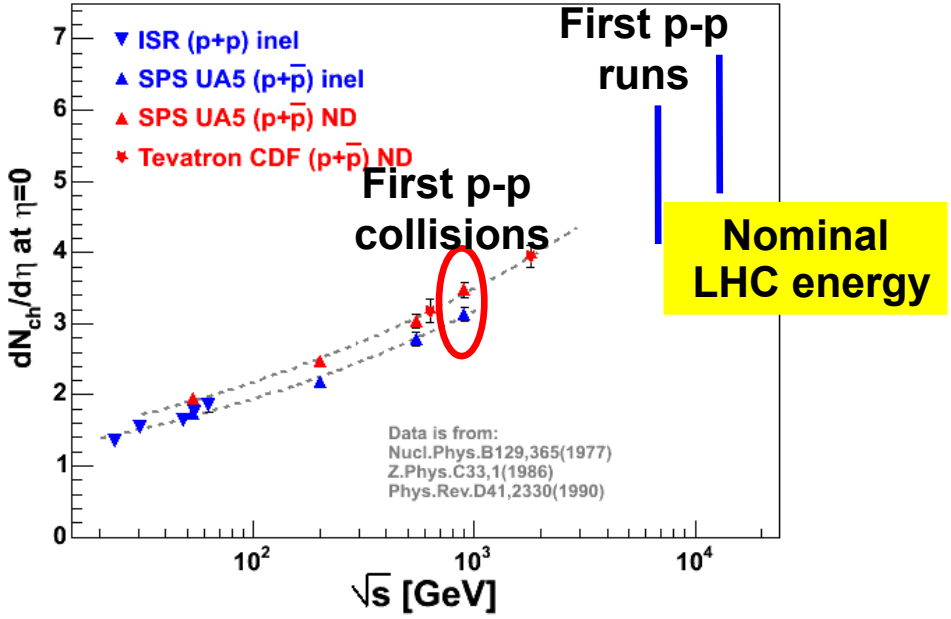
Contents

- First physics with ALICE
  - charged-particle multiplicity and pseudorapidity density
  - first physics papers in preparation within the First Physics Task Force
    1) Charged-particle pseudorapidity density in proton-proton collisions at √s = 900 GeV/10 TeV with ALICE at LHC
    2) Charged-particle multiplicity distribution in proton-proton collisions at √s = 900 GeV/10 TeV with ALICE at LHC
- Charged-particle pseudorapidity density
  - role of the SPD for first data
  - charged multiplicity reconstruction
    - ✓ procedure: the "tracklet" algorithm
    - ✓ optimization of the algorithm and cuts used
  - from the measured to the physical distribution
  - results on the last official Monte Carlo samples
- Conclusions and outlook

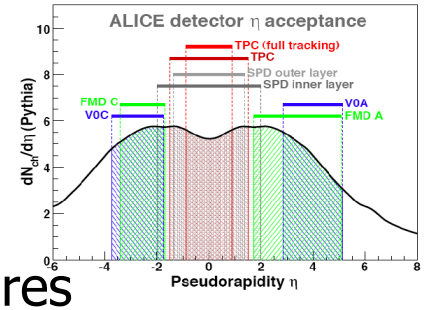
Introduction

- Charged-particle multiplicity and pseudorapidity density:
  - first measurements (in p-p collisions) → first physics papers
  - global event characterization:
    - collisions at 900 GeV → comparison with existing measurements, sistematics
    - collisions at 7/10/14 TeV → MC configuration, energy dependence



Detectors for "First Physics":
- ITS, TPC, V0

SPD for First Physics results

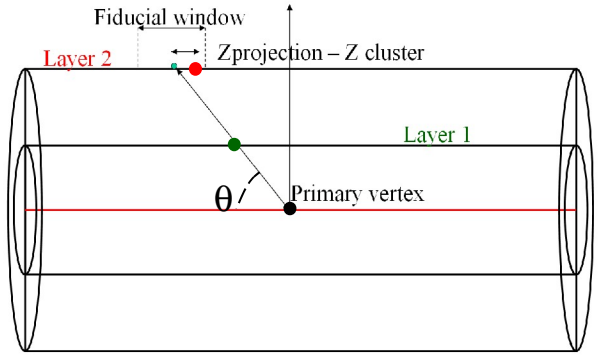


- Advantages (over ITS+TPC full track reconstruction)
  - larger acceptance in η and p_T (down to ~ 30 MeV/c)
  - simpler and faster alignment and calibration procedures

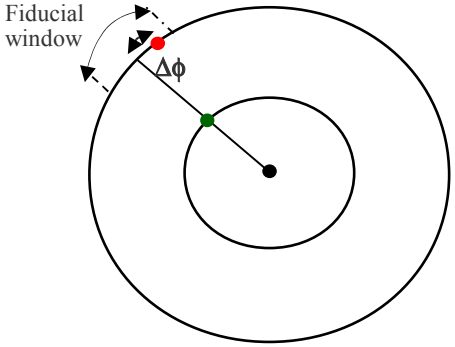
First results with ~ 10^4-10^5 collisions
- after few days of data taking at 900 GeV
- after **few hours** of data taking at 7/14 TeV !

- SPD will allow to
  - reconstruct points produced by charged particle crossing the detector
  - use them to find the interaction vertex position
  - use both reconstructed points and vertex to reconstruct charged primary tracks produced in the collision (next slide)
  - contribute to event selection with the FastOr (however triggering on bunch crossing is assumed for first collisions)

Track finding with SPD



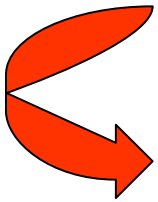
- "Tracklet" reconstruction algorithm
  - looks for pairs of clusters (inner/outer layer) aligned with the reconstructed primary vertex within fiducial windows in z and ϕ
  - option: outer layer clusters can be used in more than one tracklet



- Measured quantities
  - multiplicity = number of tracklets
  - pseudorapidity η ➔ θ angle cluster inner layer
- Cuts applied
  - need to optimize them (both in p-p and Pb-Pb) wrt
    - efficiency
    - background contamination

Algorithm performance study

- Cut optimization study finalized, main conclusions:
  - p-p: small improvement wrt default cuts
  - Pb-Pb: completely different tuning needed (reference cuts defined)
  - additional emerged features:
    - ✓ dependence of results on the cluster ordering
    - ✓ higher efficiencies with multiple use of outer layer clusters



try to improve the algorithm performance

- New algorithm implemented and tested:
  - iterative algorithm keeping the basic structure of the previous one with cut in $\Delta\phi$ and $\Delta\theta$
  - committed to AliRoot v4-17-Release

See: *http://indico.cern.ch/conferenceDisplay.py?confId=61615*
http://indico.cern.ch/materialDisplay.py?materialId=slides&confId=63865

$dN_{ch}/d\eta$ analysis

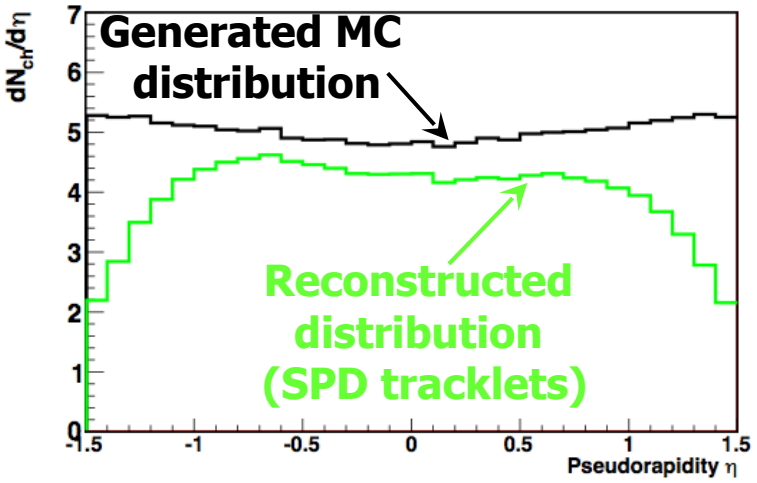
- Definition:

$dN_{ch}/d\eta$ = <charged primaries per event>

Charged primaries:
- particles produced in the collision
- products of strong and em decays

- Corrections needed to get all the charged primaries in the SPD acceptance from the reconstructed tracklets:
  - background from secondaries
  - tracklet algorithm and detector inefficiency
  - detector acceptance
  - particles not reaching the sensitive layers
  - vertex reconstruction inefficiency
  - minimum bias trigger inefficiency

60k p-p events @ 7 TeV B=0.5 T (PYTHIA)



$dN_{ch}/d\eta$ analysis: corrections

- What do we need to identify?
  - among the generated primary particles:
    - ✓ **Reconstructed** → *particle having a tracklet associated*
    - ✓ **Reconstructable** → *particle producing a signal on both layers*
    - ✓ **Detectable** → *particle crossing both SPD layers*

- What do we need to calculate corrections?

from ESDs	**from MC**
tracklet η and labels	MC particles
tracklet multiplicity	track references
SPD vertex	MC vertex
	process type

$dN_{ch}/d\eta$ analysis: correction matrices

Track level

- Background
  primReconstructed

$$BkgCorrW(\eta, z_v) = \frac{\sum_{iEv} \#\, prim\,\mathrm{Re}\, constructed(\eta_{MC}, z_{MC})}{\sum_{iEv} \#\, tracklets(\eta_{rec}, z_{rec})}$$

- Algorithm and SPD ineff.
  primReconstructed
  primReconstructable

$$EffCorrW(h, z_v) = \frac{\sum_{iEv} \#\, prim\,\mathrm{Re}\, constructable(h_{MC}, z_{MC})}{\sum_{iEv} \#\, prim\,\mathrm{Re}\, constructed(h_{MC}, z_{MC})}$$

- SPD acceptance
  primReconstructable
  primDetectable

$$AccCorr(\eta, z_v) = \frac{\sum_{iEv} \#\, prim\,\mathrm{Re}\, constructable(\eta_{MC}, z_{MC})}{\sum_{iEv} \#\, primDetectable(\eta_{MC}, z_{MC})}$$

- Disappeared particles
  primDetectable

$$DisPartCorrW(\eta, z_v) = \frac{\sum_{iEv} \#\, prim(\eta_{MC}, z_{MC})}{\sum_{iEv} \#\, primDetectable(\eta_{MC}, z_{MC})}$$

- Vertex and trigger ineff.

$$TriggVtxCorrW(\eta, z_v) = \frac{\sum_{allEvts} \#\, prim(\eta_{MC}, z_{MC})}{\sum_{trigg\&recVtxEvts} \#\, prim(\eta_{MC}, z_{MC})}$$

$dN_{ch}/d\eta$ analysis: correction matrices

Event level

- Vertex inefficiency

$$CorrW(multSPD, z_v) = \frac{\sum_{triggEvts} \#events(multSPD, z_{MC})}{\sum_{trigg\&vtxEvts} \#events(multSPD, z_{MC})}$$

Triggered events with vertex

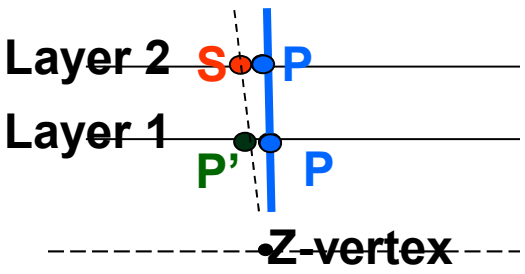
Triggered events

- MB trigger inefficiency

$$CorrW(multSPD, z_v) = \frac{\sum_{allEvts} \#events(multSPD, z_{MC})}{\sum_{triggEvts} \#events(multSPD, z_{MC})}$$

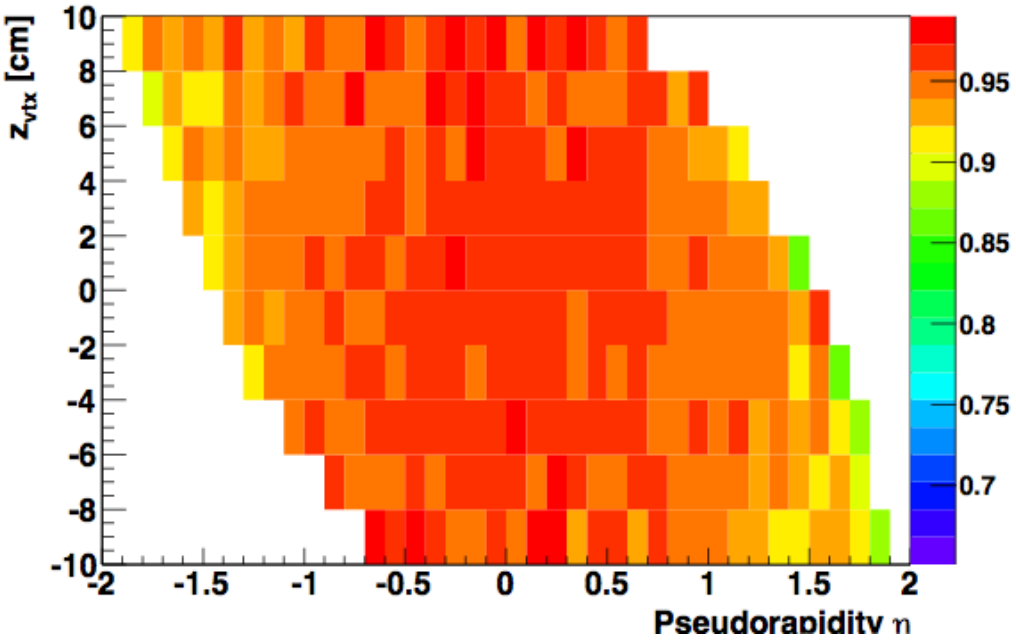
All events generated for a certain event class

Background correction



$$BkgCorrW(\eta, z_v) = \frac{\sum_{iEv} \#\, prim\,\mathrm{Re}\, constructed(\eta_{MC}, z_{MC})}{\sum_{iEv} \#\, tracklets(\eta_{rec}, z_{rec})}$$

Overall bkg fraction (SS tracklets+comb): 5%

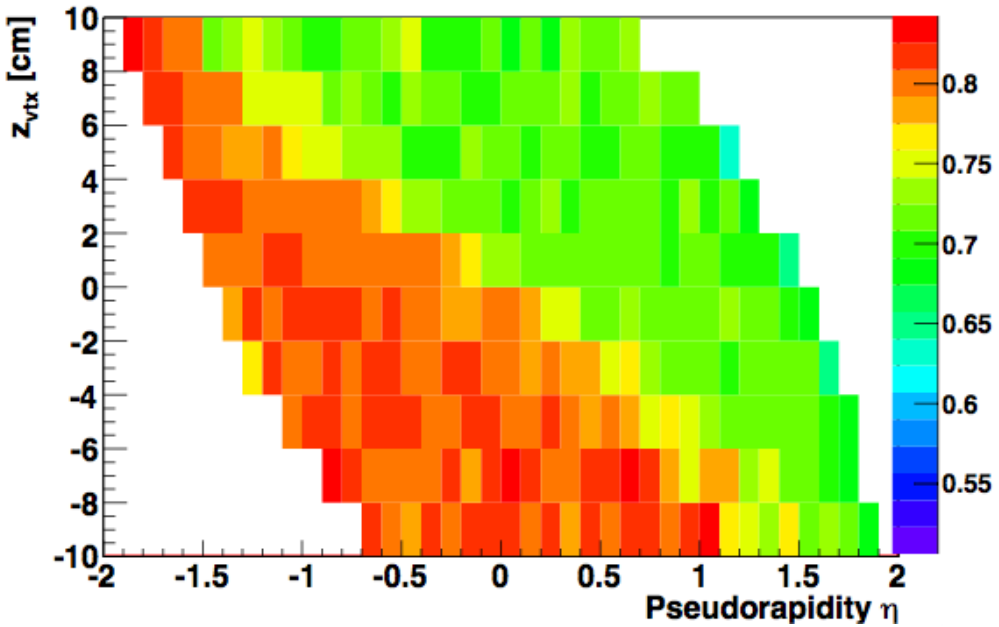


Efficiency correction

SPD + reconstruction algorithm inefficiency

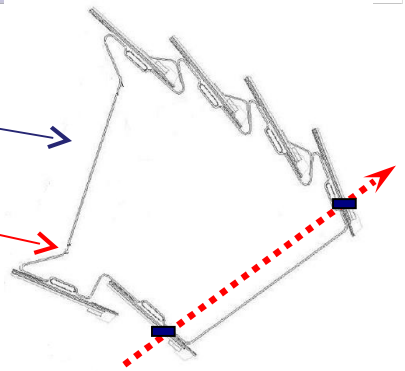
$$EffCorrW(\eta, z_v) = \frac{\sum_{iEv} \#\, prim\,\mathrm{Re}\, constructable(\eta_{MC}, z_{MC})}{\sum_{iEv} \#\, prim\,\mathrm{Re}\, constructed(\eta_{MC}, z_{MC})}$$

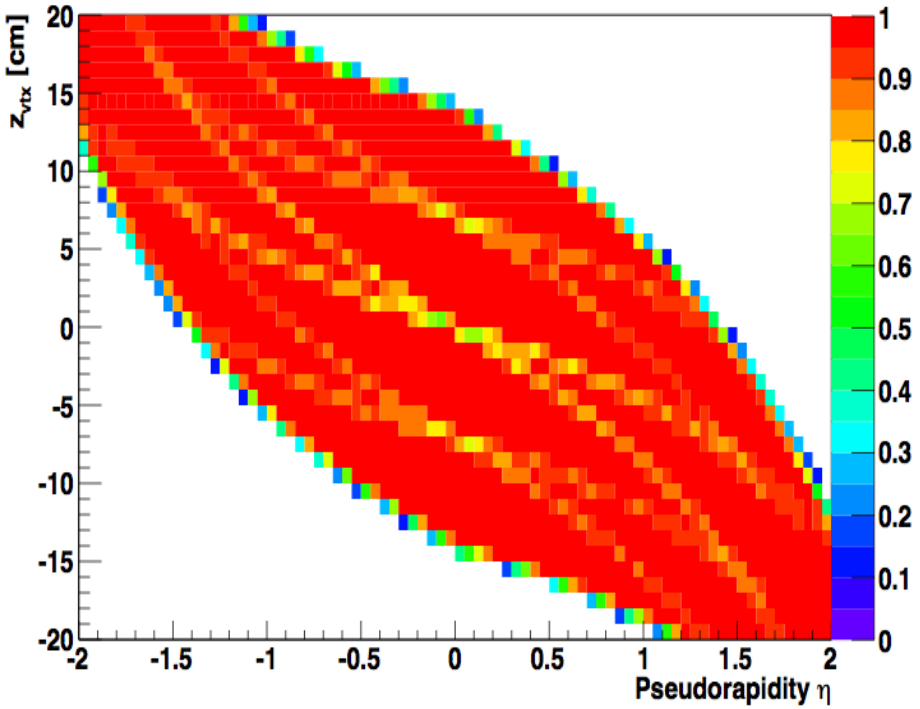
Overall algorithm inefficiency: 2%
Detector inneficiency: 13% (15 fully dead half-staves assumed)



SPD acceptance correction

$$AccCorr(\eta, z_v) = \frac{\sum_{iEv} \#\, prim\,\mathrm{Re}\, constructable(\eta_{MC}, z_{MC})}{\sum_{iEv} \#\, primDetectable(\eta_{MC}, z_{MC})}$$



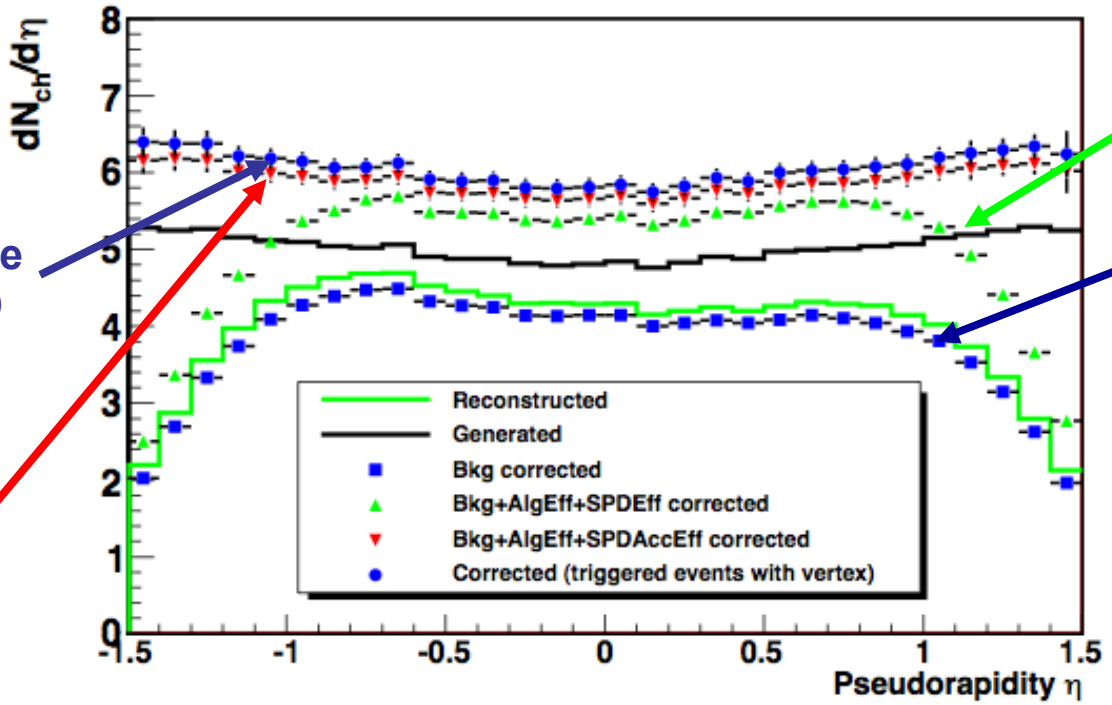


Applying corrections to data

$dN_{ch}/d\eta$ in triggered events with vertex reconstructed

Adding particle disappeared before reaching the SPD (decays and sec Interactions)

Applying acceptance correction



Applying efficiency correction

Backgound subtraction

Data matrices→**PYTHIA**
Corr. matrices→**PYTHIA**

Vertex and trigger corrections

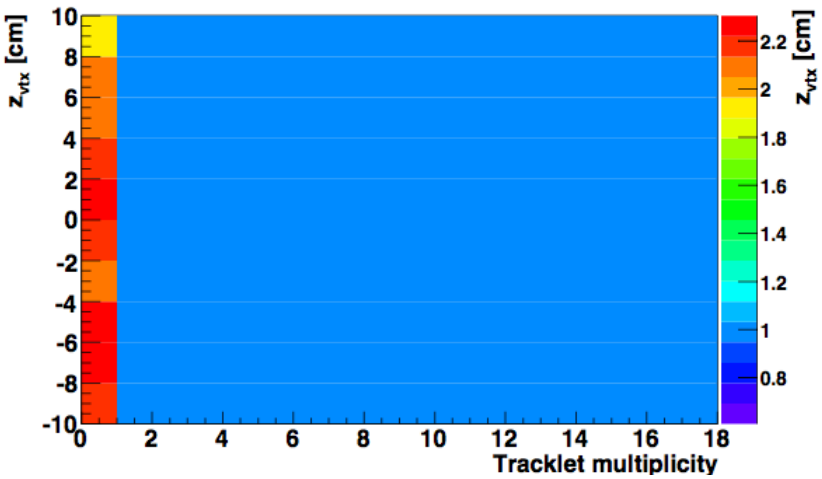
Vertex

Events used in the analysis to fill data matrices:
triggered events with vertex in $|z_{recVtx}| < 10$ cm and at least one tracklet reconstructed

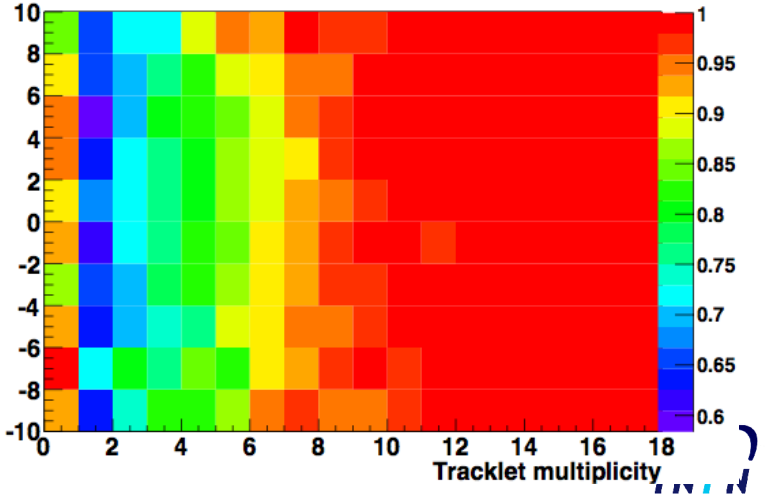
Trigger

Two different event classes considered:
Inelastic (INEL) and Non Single Diffractive (NSD)

Event level corrections



INEL

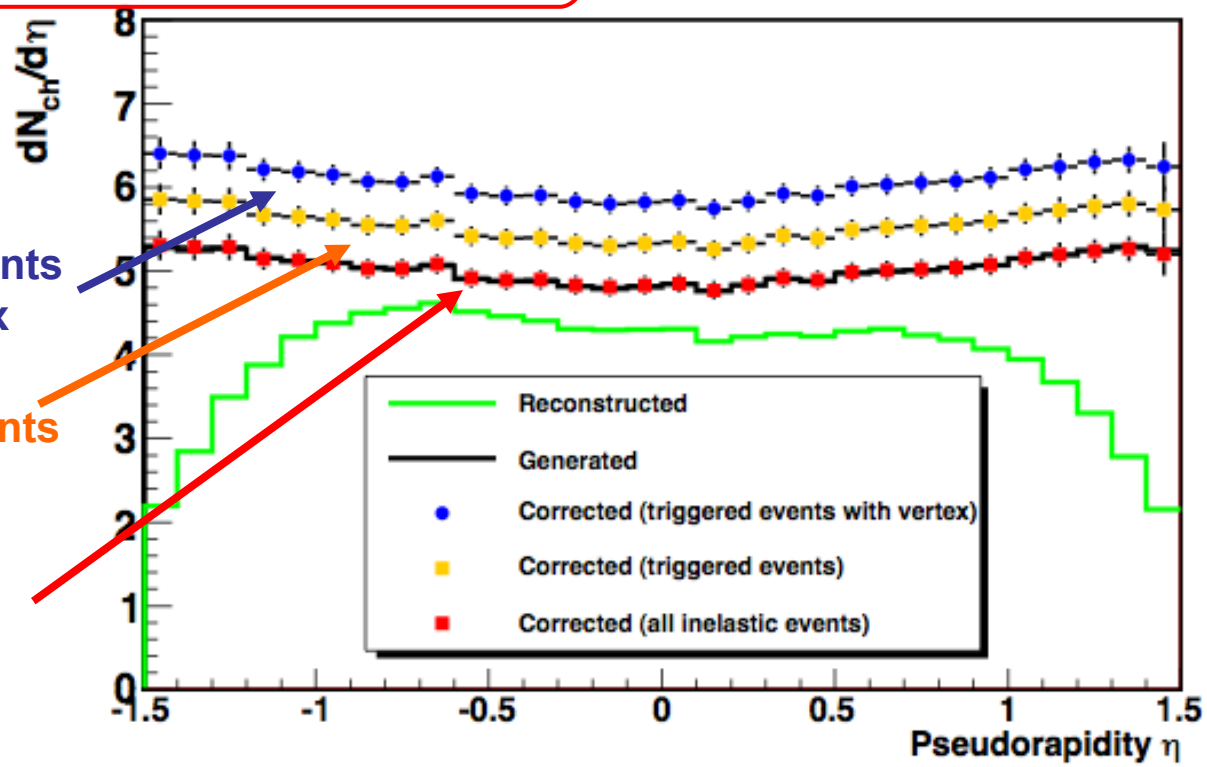


NSD

Applying corrections

Final $dN_{ch}/d\eta$ distribution

Assumed trigger condition:
`MB1=(GFO.or.V0OR).and.notBG`



Triggered events with vertex

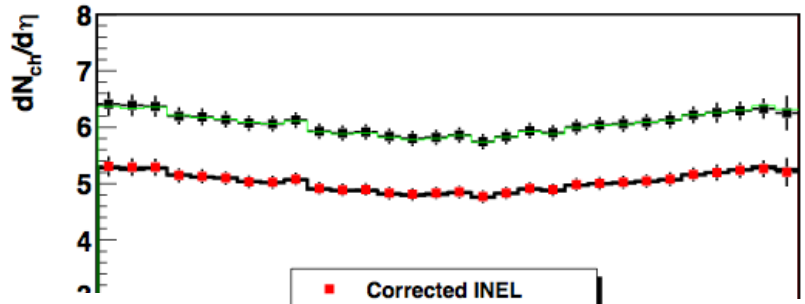
Triggered events

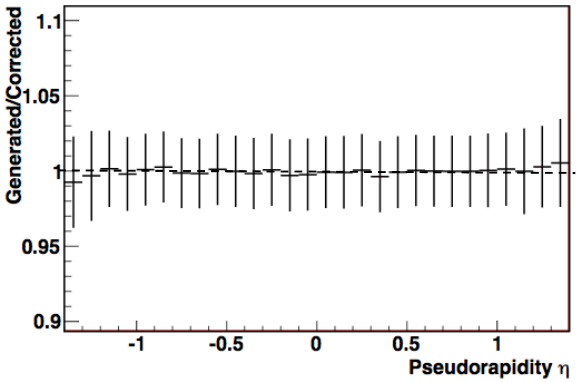
Final distribution

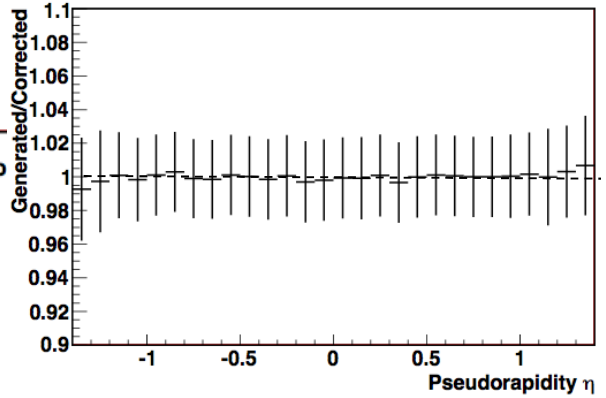
Data matrices→**PYTHIA**
Corr. matrices→**PYTHIA**

Applying corrections

Final $dN_{ch}/d\eta$ distribution







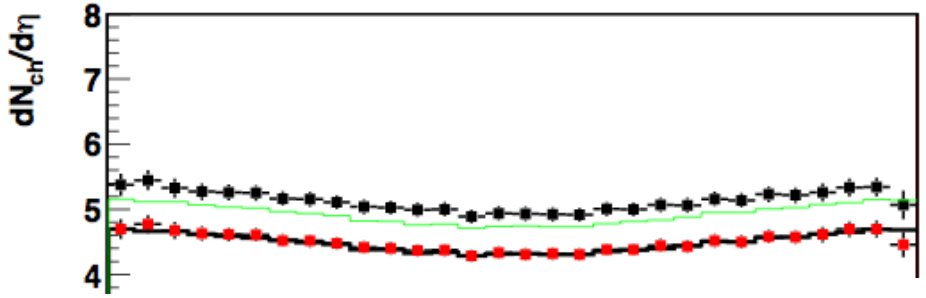
INEL

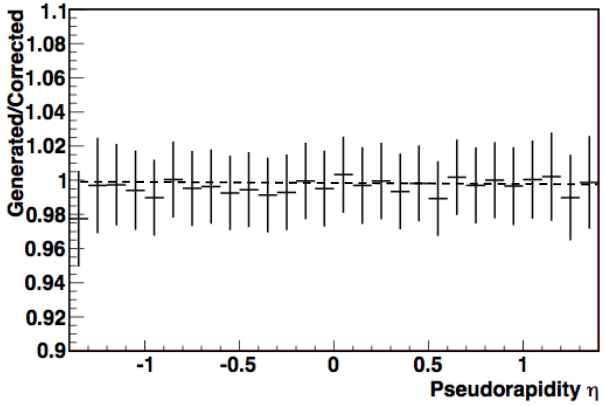
Data matrices→**PYTHIA**
Corr. matrices→**PYTHIA**

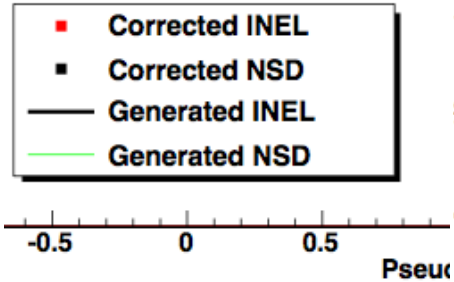
NSD

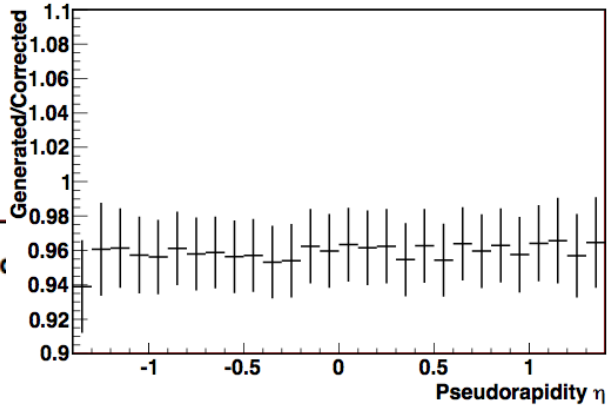
Applying corrections

Final $dN_{ch}/d\eta$ distribution









INEL

Data matrices→**PhoJet**
Corr. matrices→**PYTHIA**

NSD

Conclusions and outlook

- $dN_{ch}/d\eta$ measurement with pixels:
  - immediately available with the first data
  - status of reconstruction and analysis tools:
    - ✓ fully developed within the First Physics Task Force
    - ✓ tested on MC official productions on the CAF
    - ✓ "tracklet" algorithm improved (committed to AliRoot v4-17-Release)
    - ✓ analysis code, continuously updated, committed to AliRoot
    - ✓ added to the official "*analysis train*" for the organized analysis
- Outlook:
  - apply the correction chain to the first data
  - complete first physics papers (and try to be first at LHC...)
  - extend the analysis tools to the first heavy ion data (ongoing)

Back-up slides

Optimized algorithm

AliITSMultReconstructor

1. Find partners
   - Loop over all clusters in L0
   - For each cluster C0 in L0 loop over clusters in L1
   - Find best matching cluster C1 in L1
     - Store C1 as partner to C0
     - If there is already a partner, store only in case the new pair is better (= smaller distance) than the previous stored pair
     - If no partner is found remove C0 from list
1. Save tracklets
   - Save tracklets for all pairs
   - Remove used clusters
1. Go to 1) until no new tracklets are found