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TPC in run 3

ALICE offline week
19.-21.11.2014

Jens, Marian, Kai

People involved

- Many people are involved in these activities
- Not individually listed on the slides

Alexandru B., Chiara Z., Ernst H., Haavard H., Jens W., Jonas B., Kai S., Marian I., Martin L., Matthias R., Mikolaj K., Mohammad A., Peter C., Peter H., Rifki S., Ruben S., Sergey G., Vytautas V., ...

Outline

- Reminder: Space charge distortions
- Short term goals (O^2 TDR)
  - Dedicated meeting between TPC and O^2 8.-10.10.14

    https://indico.cern.ch/event/343578/
  - Next meeting: 28.11.14

    https://indico.cern.ch/event/354265/
- Mid- to long term goals
- Issues summarised under 'Run3 preparation' in JIRA, filter: https://alice.its.cern.ch/jira/issues/?filter=10708

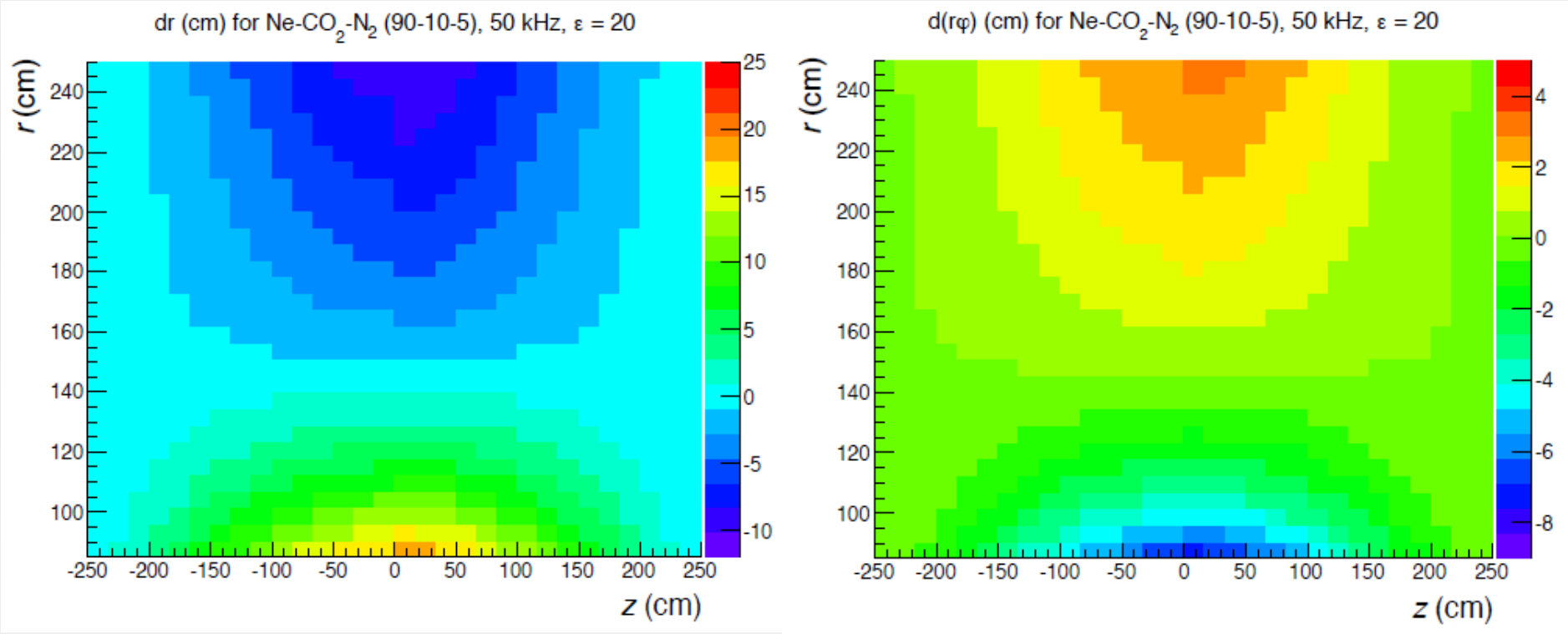
Space-Charge Distortions

General remarks

- Space-Charge Distortions (SCD) are the main challenge for the run3 calibration
  - Large distortions, large residual fluctuations
- Better understanding of SCD + build up
- Efficient methods to calculate SCD and store correction maps

Space charge distortions

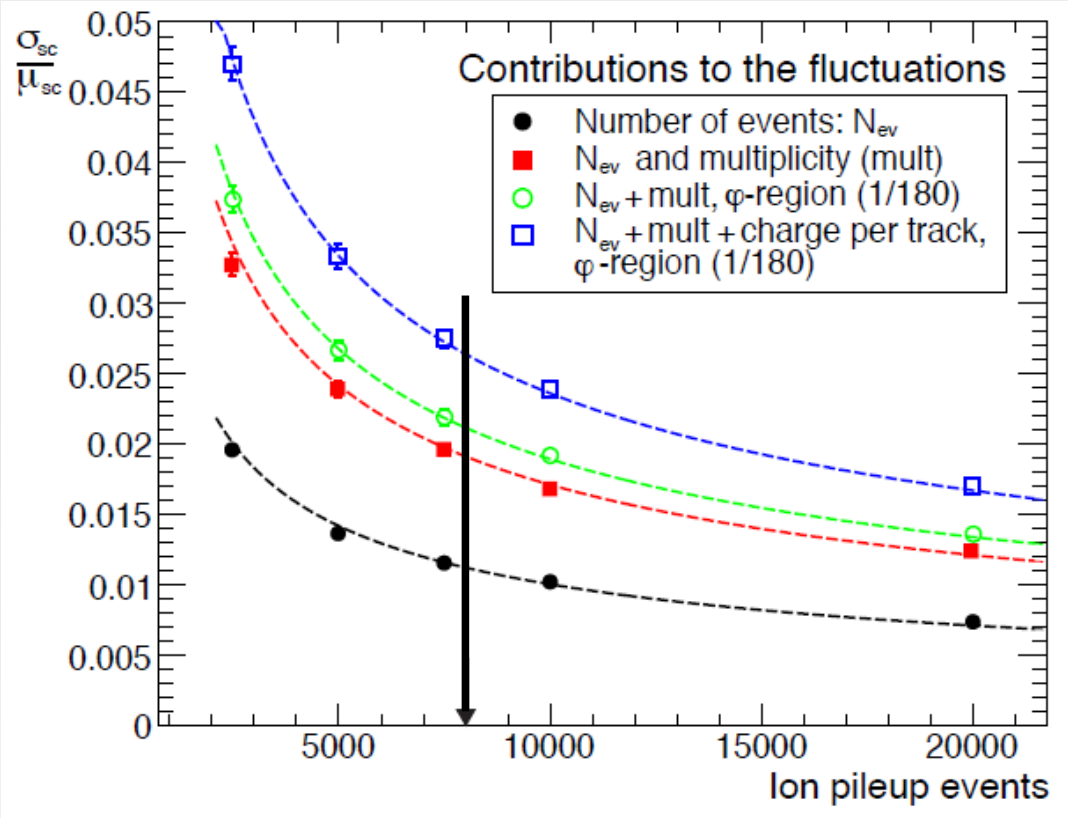
Magnitude of the distortions



- 50kHz Pb-Pb, gain = 2000, IBF=1% (ε=20)
- Distortions up to dr ≈ 20cm drφ ≈ 8cm (small *r* and *z*)
  - Final calibration to ~10^{-3} required (~200-500µm)

Space charge fluctuations

Magnitude of fluctuations



- Space-charge fluctuations at the level of 3%
- With knowledge of the average space-charge density (ρ_{av}) this leads to
  - Max ± 6mm residual distortion in *r*
  - Max ± 2.5mm residual distortion in *rφ*

- Space-charge fluctuations are dominated by event and multiplicity fluctuations
- Must be taken into account for distortion corrections
  - Sets constraints on the update interval → 5ms

Short term goals (O^2 TDR)

Outline

- Computing requirements (CPU/GPU/memory)
  - Data transport
  - Reconstruction (Synchronous / Asynchronous)
  - Calibration (Synchronous / Asynchronous)
- Data compression
  - Clusterisation, data format
  - Cluster removal
- Calibration strategy demonstrator (physics performance)

Short term goals

Computing requirements - data transport

- Assemble realistic input for ALFA to check transport times
  - Use current HLT clusters to inject inside 'FLP'
    - Non-distorted clusters → timing should not depend too much on this
    - Distorted clusters (if time allows) → should be slightly smaller size
  - Make full transport through the system

Short term goals

Computing requirements – Synchronous reconstruction

- cluster finder efficiency 2D vs. 1Dx1D for up to 100kHz interaction rate → Service task, still open
- HLT tracking performance to low p (<150 MeV/c)
  - Values from TPC LOI to be verified
  - Determine cluster association efficiency, fake cluster efficiency, tracking efficiency
  - Overhead due to tracklet merging at time boundaries

https://alice.its.cern.ch/jira/browse/ATO-103

Short term goals

Computing requirements – Asynchronous reconstruction

- Estimate of additional requirements not done in synchronous stage for physics ready data
  - dE/dx calculation, full B map, material budged – simplified geometry, ...
  - Use estimates from offline code → requires realistic speed-up of the procedures

https://alice.its.cern.ch/jira/browse/ATO-109

Short term goals

Computing requirements – calibration

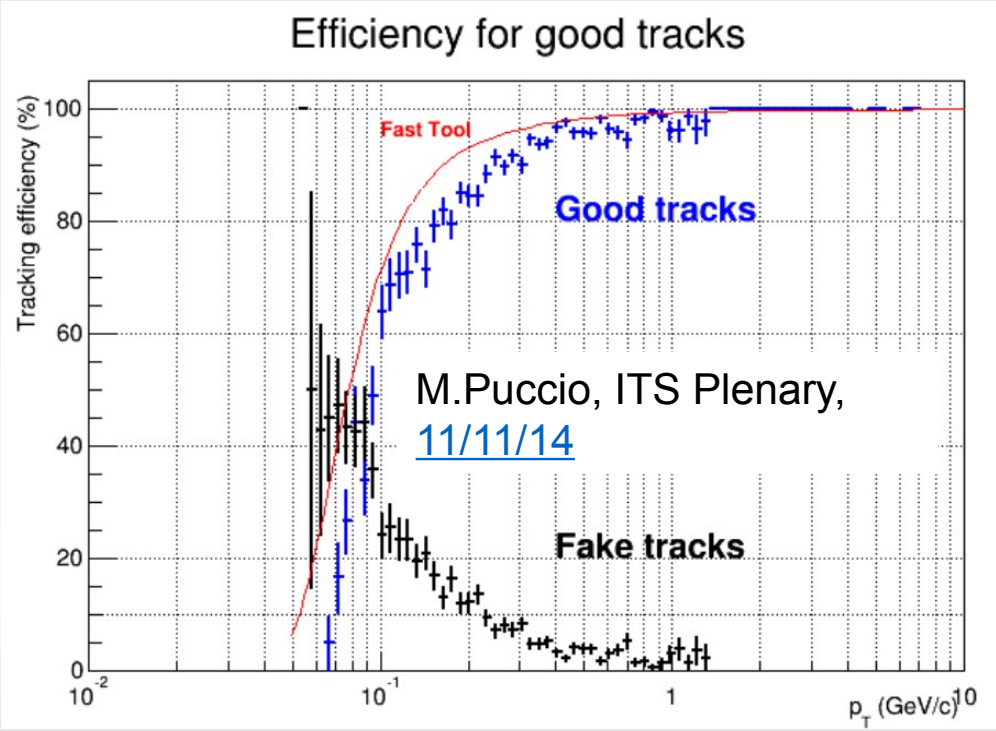
- ITS-TRD interpolation
  - For high p_T track sample (synchronous, update on minutes level, negligible?)
  - For 5ms update interval (asynchronous)
  - storage of correction maps on 5ms level possible?
- Integrated digital currents inside the data stream (required for scaling of the SCD maps)
- Computation time required to get SCD from ion densities

https://alice.its.cern.ch/jira/browse/ATO-109

Short term goals

Computing requirements – ITS SA reconstruction (CA)

- Efficiency approaches to target value but problem with cluster attachment efficiency should be solved (tracks are shorter than they could be)
- CPU timing: ~0.8 / 1.9 s for single/two iterations W/O noise clusters
- For TPC calibration purposes speed is much higher (no need of low pT tracks)
- First estimates of reconstruction WITH noise in progress



Short term goals

Computing requirements – TRD SA reconstruction (CA)

- The main topics to be answered
  - efficiency of the tracker
  - momentum cut-off
  - position resolution/systematic performance
  - possible data filtering

- Preparation/production the MC data set (with online-tracklets and digits)

- First prototype will be macro based using the full functionality of Kalman filter but flexible for fast development. The steps to be done are
  - Creation of likelihood distributions for online tracklet identification
  - testing the procedure -> this will provide a first hint on the efficiency

- Time estimate for 1st prototype: End of November - Beginning of December

Short term goals

Data compression

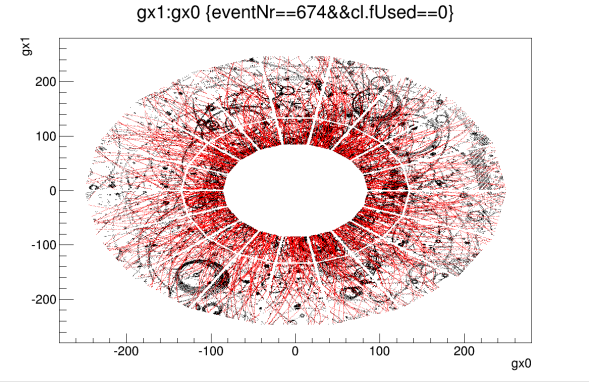
- Data compression → factor 20 to be verified
  - Cluster format + cluster to track compression

    https://alice.its.cern.ch/jira/browse/ATO-73

  - Removal of non physics data (low p_T loopers, noise)
  - Loop detection + delta ray finder

    https://alice.its.cern.ch/jira/browse/ATO-101

  - Check numbers also for pp (base on run1 for different beam background)

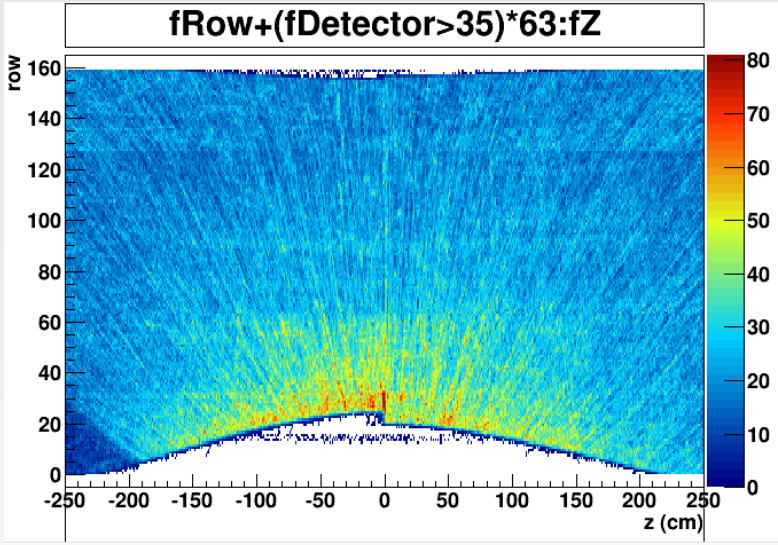


Data Format	Reduction Factor	Event Size (MB)
Raw Data	1	700
Zero Suppression (FEE)	35	20
Clusterisation	5-7	~3
Remove clusters not associated to physics tracks	2	1.5
Data format optimisation	2-3	<1

Short term goals

Calibration strategy demonstrator

- Full distortions in AliRoot
- New ITS geometry (not done for TDR)
- TODO
  - Tracking with large distortions
  - TPC tracking with T_0 estimate
  - Verify fiducial volume



https://alice.its.cern.ch/jira/browse/ATO-110

https://alice.its.cern.ch/jira/browse/ATO-38

Mid to long term goals

Outline

- Full continuous readout simulations
- Better understanding of space charge distortions
- Calibration of dE/dx with distortions
- Efficient methods for space charge distortion calculations based on ion densities and readout currents

Mid to long term goals

Full continuous readout simulations

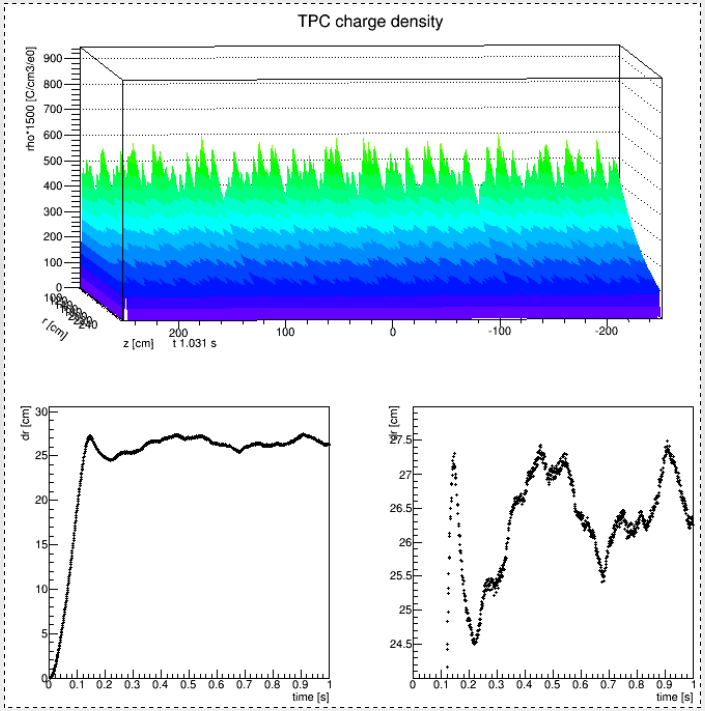
- Continuous readout not implemented in AliRoot
- New framework required
  - Assess possibility to use developments done for FAIR experiments
  - First meeting with FAIRRoot experts (7.11.14, Mohammad, Florian, Marian, Jens)
  - Porting of ITS code nearly finished
  - Porting of TPC code to be done → Requires more manpower

https://alice.its.cern.ch/jira/browse/ATO-114

Mid to long term goals

Better understanding of space charge distortions I

- Realistic built up of space charge
  - Feedback loop
- Implementation ion drift

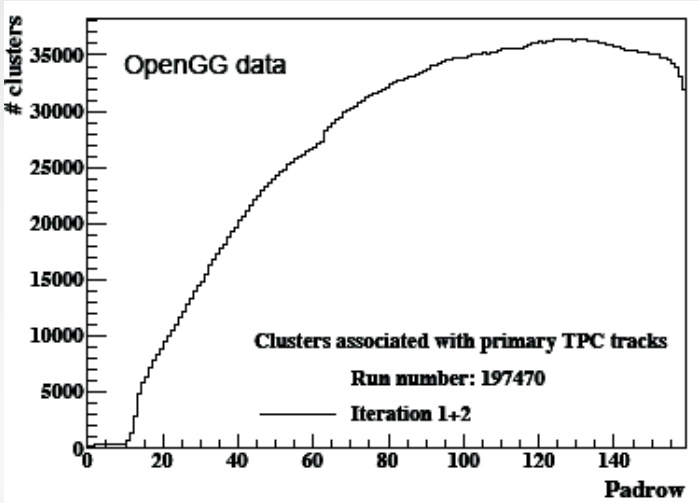


https://alice.its.cern.ch/jira/browse/ATO-10

Mid to long term goals

Better understanding of space charge distortions II

- Use open Gating Grid data to study SCD effects with real data
  - Found that SCD are of similar order by chance
  - Good playground to test the procedures



https://alice.its.cern.ch/jira/browse/ATO-16

Mid to long term goals

Calibration of dE/dx with distortions

- Proper normalisation to effective pad-length required → needs distortion correction
- dE/dx resolution
  - fewer clusters (worse resolution)
  - but total charge is preserved
  - For low eta even larger effective track length (clusters from outside active are)

https://alice.its.cern.ch/jira/browse/ATO-58

Mid to long term goals

Efficient methods

- Efficient methods for storage
- Efficient methods for SCD calculation base on ion density (poisson relaxation?)
  - Base on CPU
    - Lund group started with optimisations of the current code
  - Based on GPU
    - Lipi group (Rifki) will start working on this
- SCD estimates base on currents

$$\vec{\Delta} = \vec{\Delta}_{\mathrm{ref}} + \sum_i \frac{\partial \vec{\Delta}_{\mathrm{ref}}}{\partial \rho^i_{\mathrm{sc}}} \delta \rho^i_{\mathrm{sc}}$$

Summary

- Most crucial constraints for TPC calibration / reconstruction in Run 3 is given by space charge
- Main goals identified
- On many topics manpower is welcome