Run III Strategy and Plans

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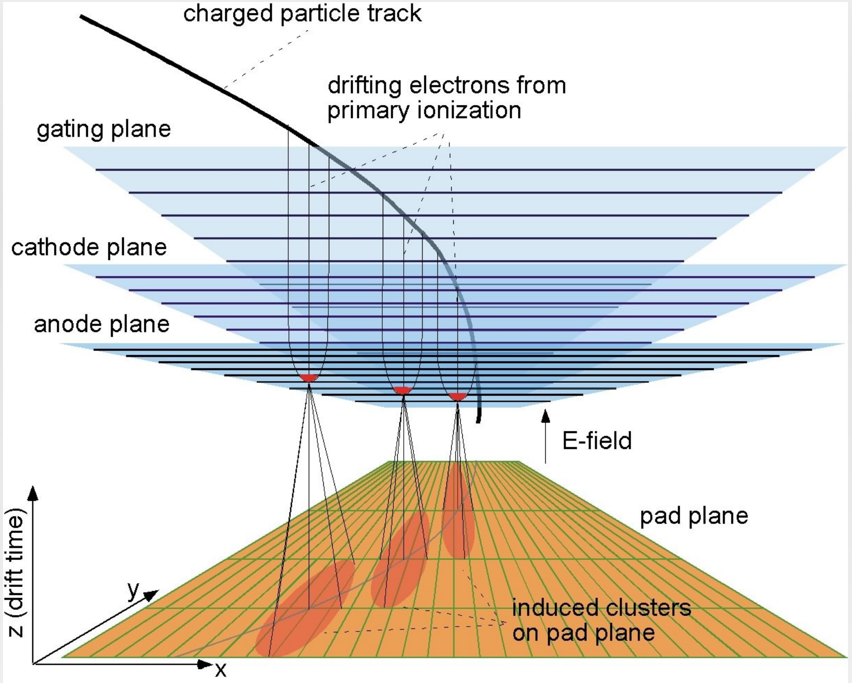
Introduction I

- Goal: go to 50kHz interaction rate in Pb-Pb
- Current limitations:
  - MWPG requires Gating Grid for efficient ion blocking (closing time 180us) → Limits rate to 100us (e^--drift) + 180us : 3.5kHz
  - Further limitation due to electronics: 250 Hz
- Solution:
  - Change detector technology to GEMs → Intrinisic ion blocking

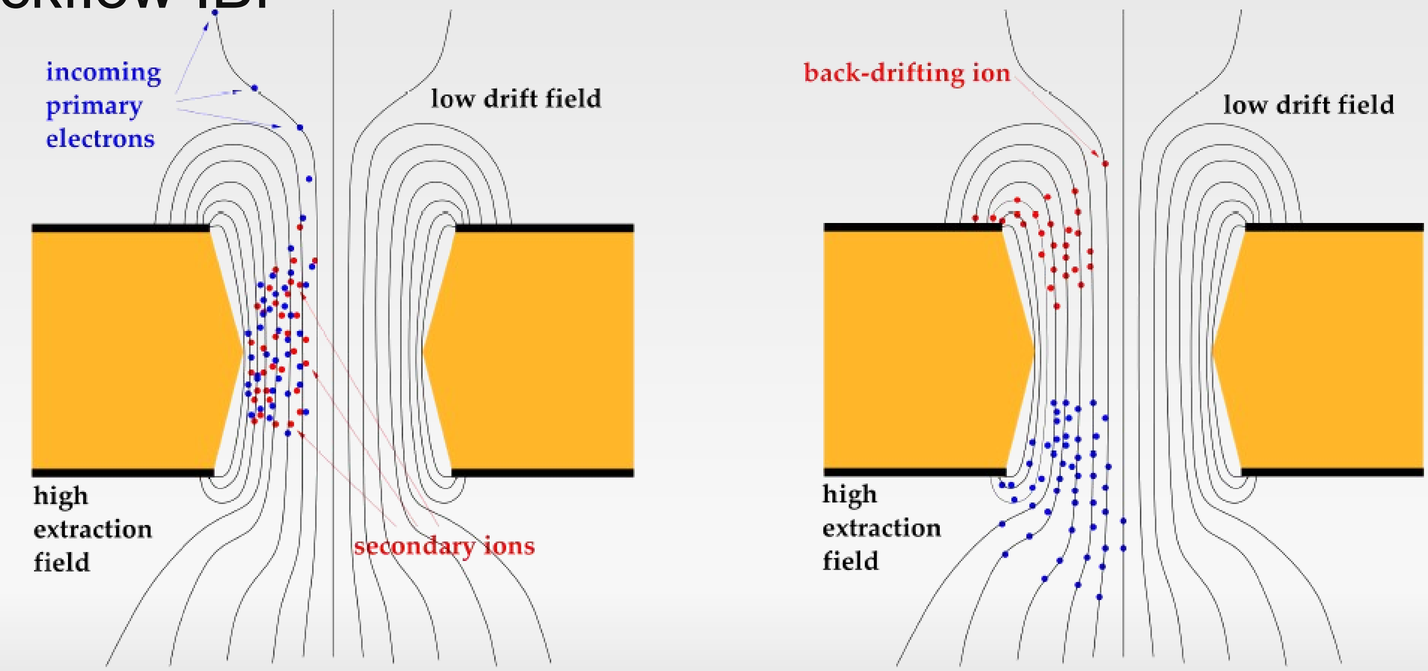


Introduction II

- Challenge: Minimize IBF – space charge in drift region!
- Low ion density in drift region requires
  - low primary ionization n_{ion}
  - low gain G_{eff}
  - low ion backflow IBF

$$n_{tot} = n_{El} \times IBF \times G_{eff}$$

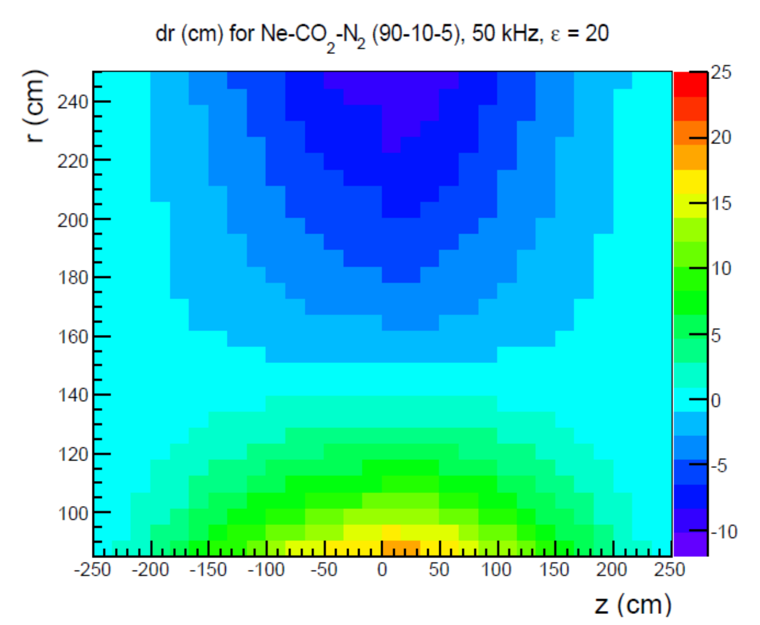
$$\varepsilon = IBF \times G_{eff} - 1$$

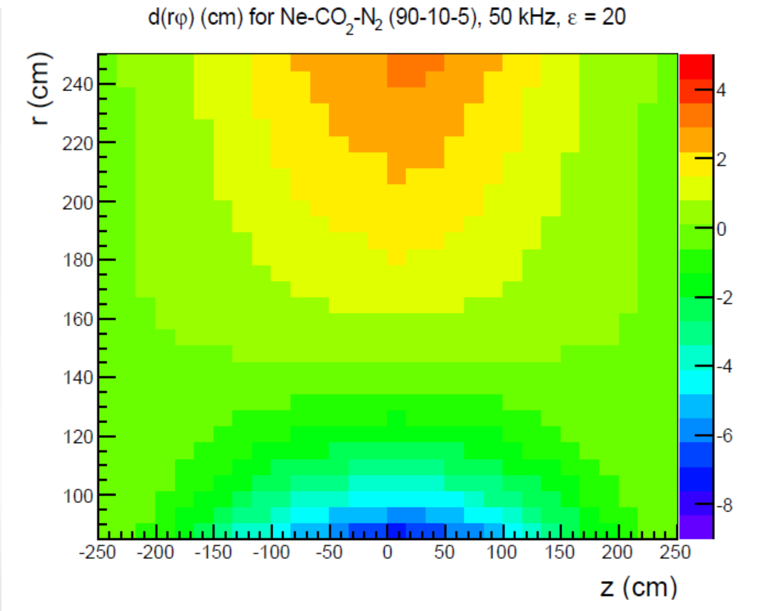


Introduction III

- Current assumptions:
  - IBF = 1%
  - Gas gain 2000 (might be lower)
  - ε = gain * IBF = 20 (back drifting ions per incoming electron)
  - Factor 100 better than standard MWPC
- Still leads to sizeable space charge (SC) in the drift volume

Introduction IV

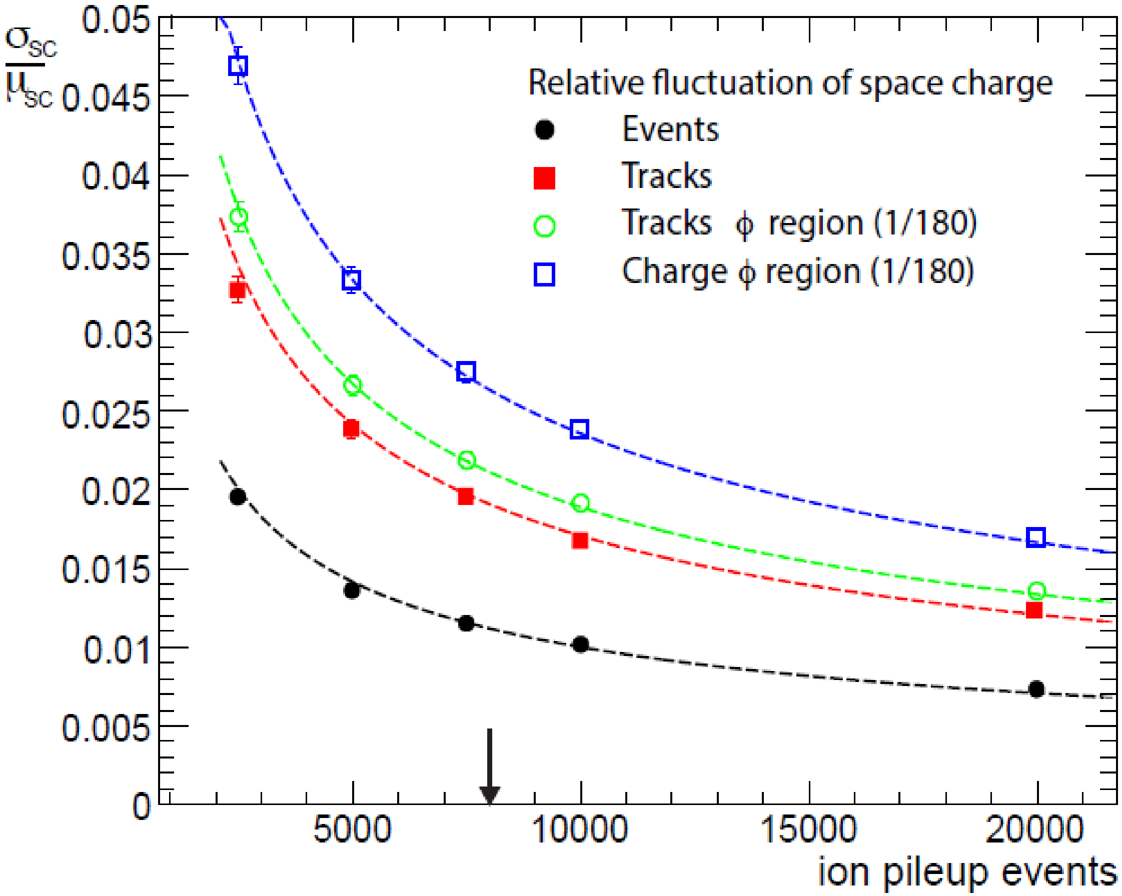




- Expected distortions due to space charge (ε = 20)
- Up to (max) 20cm in radial direction
- Up to (max) 8cm in rφ
- Current requirement → final correction to the intrinsic resolution of 200um

Introduction V

Space charge fluctuations



Considerable fluctuations of the space charge density expected: ~3% (→ distortions: several mm)

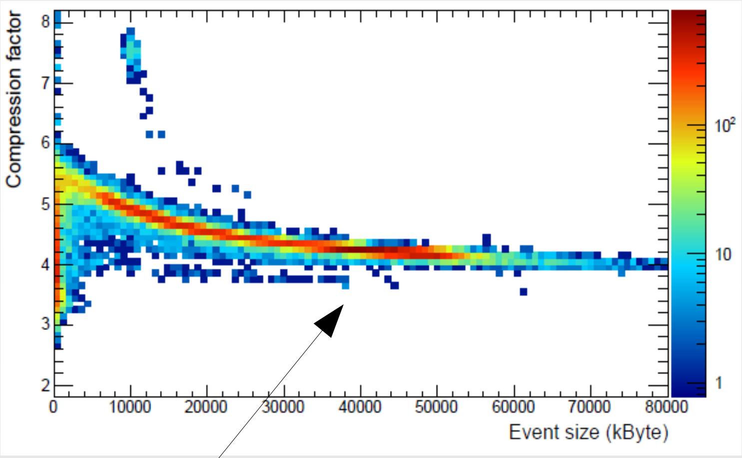
~2% are from fluctuations of N_{ev} and event multiplicity
→ relatively easy to follow

rest is „topological“
→ requires more complex calibration scheme

Requires online estimate of events and event multiplicity

Introduction VI

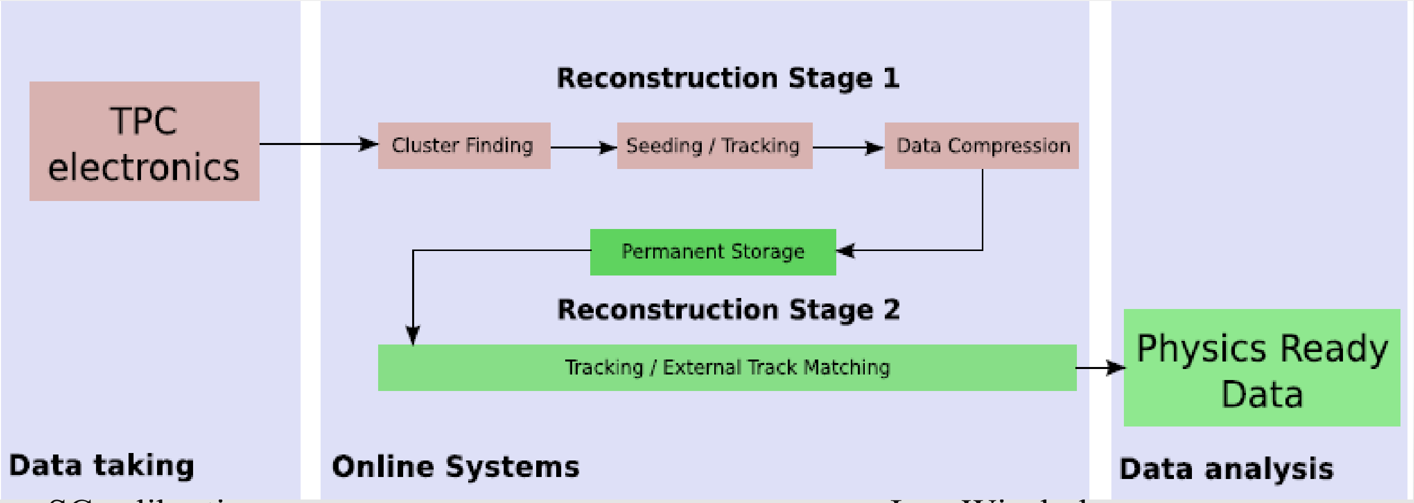
- Huge data volume:
  - 1 zero suppressed Pb-Pb event ~20MByte
  - At 50kHz ~1TByte/s
  - → Not storable
  - → plan to suppress by factor 20 online
  - → requires online reconstruction



Data Format	Data Compression Factor	Event Size (MByte)
Zero Suppression (FEE)		20
Clusterization	5-7	3
Remove clusters not associated to relevant tracks	2	1.5
Data format optimization	2-3	< 1

Reconstruction strategy

- Two step process:
  - First step for online tracking and compression
    - requires less calibration precision (level of the intrinsic single cluster resolution O(1mm))
    - Obtained with pure online information → average SC map
  - Second step
    - Requires matching to external detector
    - Needs final precision
    - Update of SC maps on the level of ~5ms



Reconstruction strategy
First step

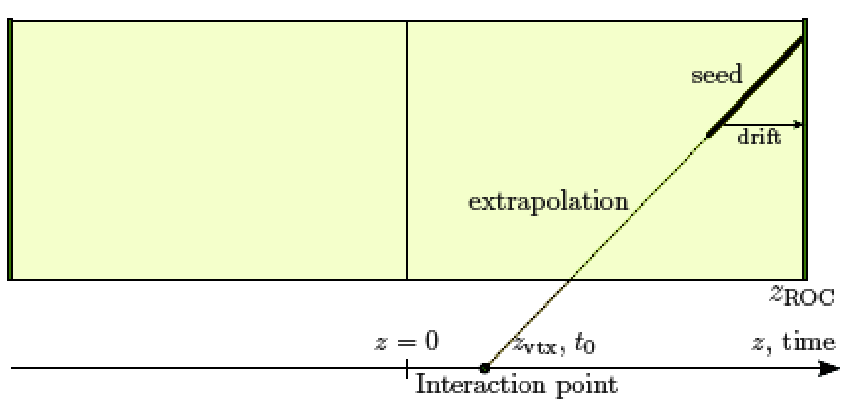
Goals:
- efficient cluster association to allow data compression
- enable matching to external detectors i.e. ITS, TRD

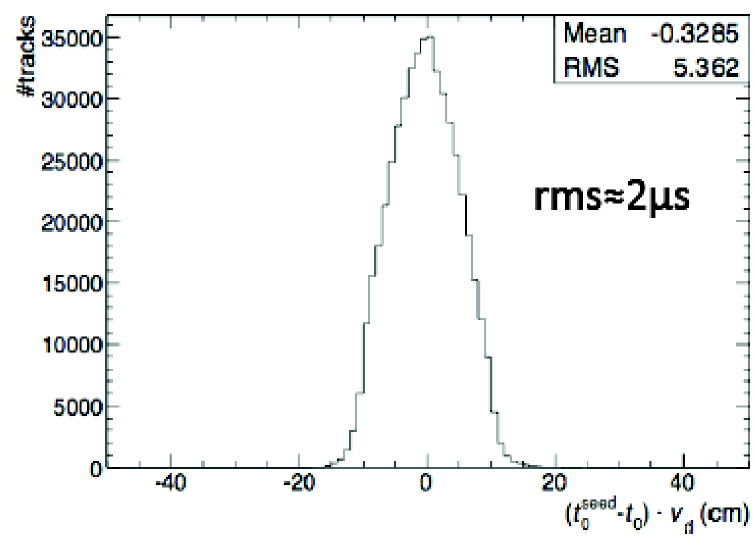
1. ad-hoc correction assuming eta=0.45 for each cluster (minimizing maximal distortions)

2. Search seeds (10-15 clusters) in low-distortion region

3. Obtain t_0^{seed} from extrapolation to x=y=0, assuming $z_{vtx} = 0$.

Option: match t_0^{seed} to „real“ t_0 from list (average spacing 20 µs, but bunch train structure)

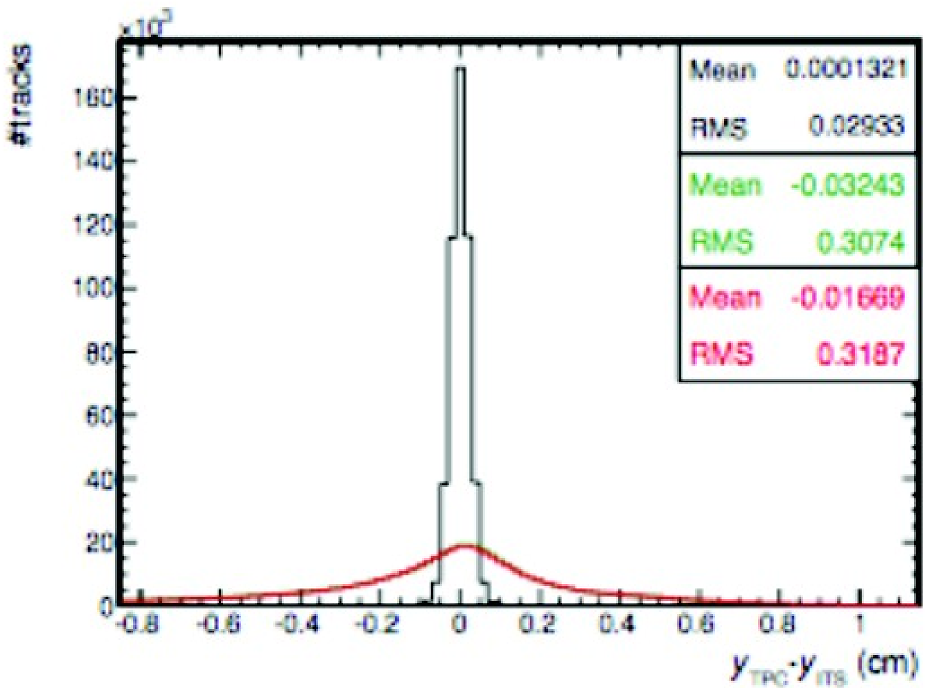




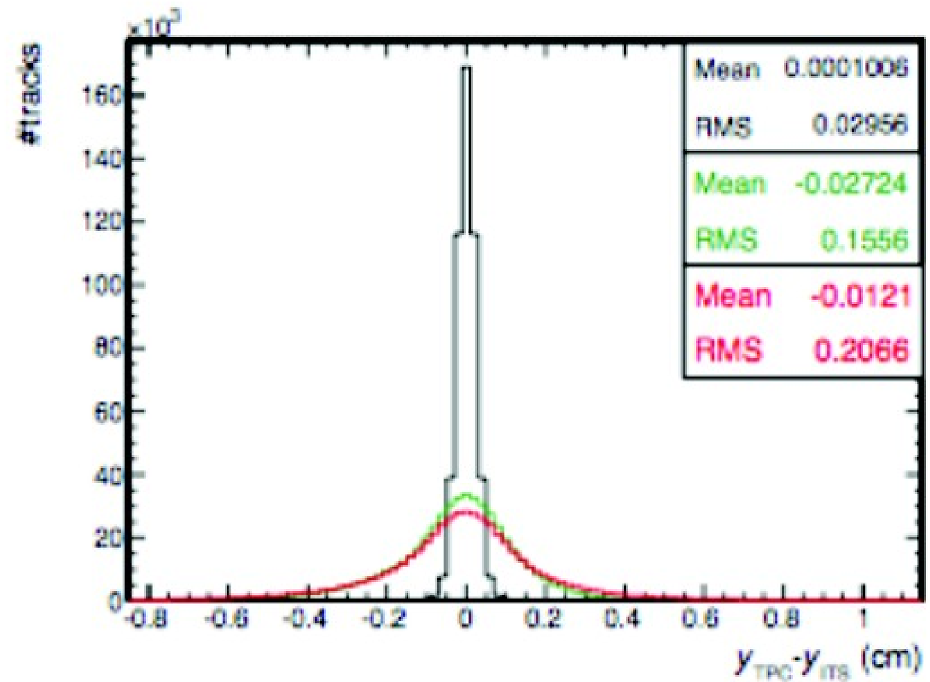
Reconstruction strategy

First step – matching precision

TPC-ITS matching at TPC inner radius



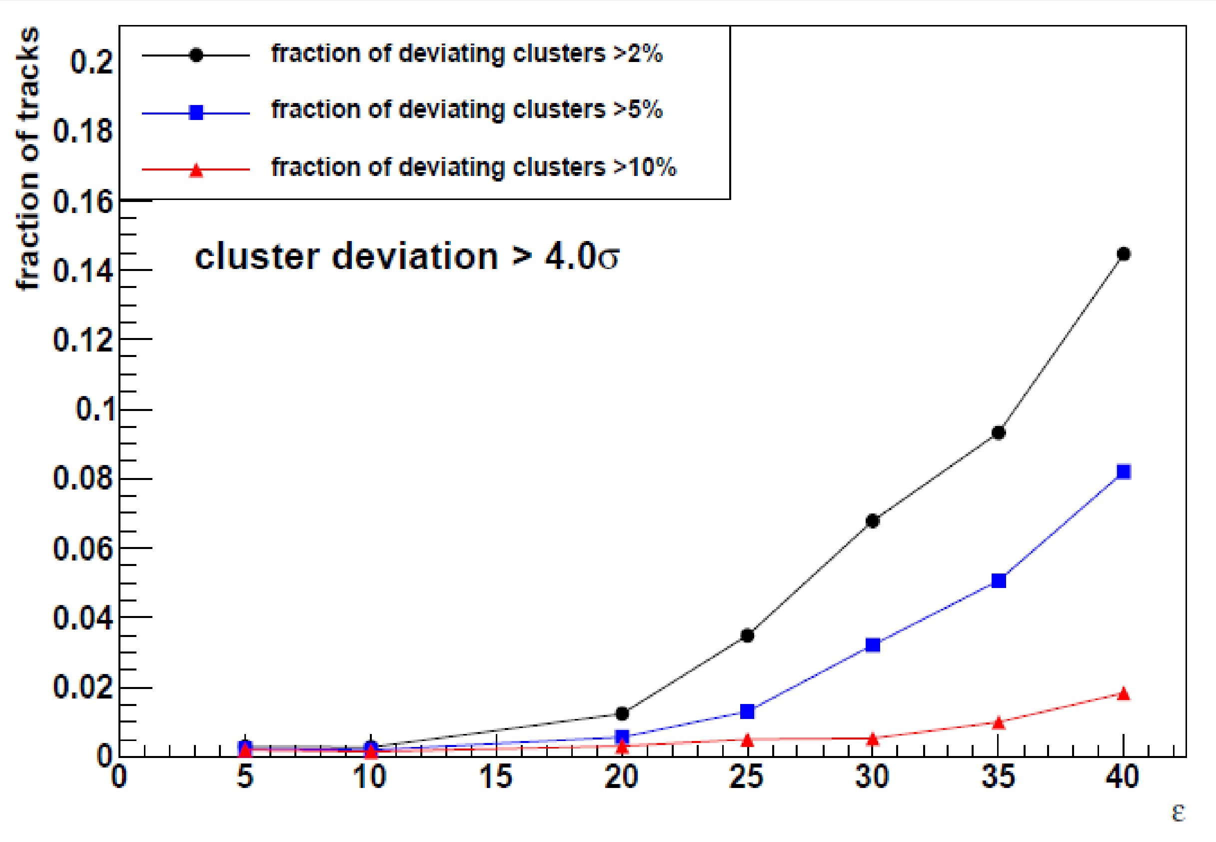
new: including fluctuations (ε=20)
using average map (2.) for correction
red: using t_0^{seed}
green: using exact t_0



new: including fluctuations (ε=20)
using scaled map (3.) for correction
red: using t_0^{seed}
green: using exact t_0

Reconstruction strategy

First step – cluster association efficiency



Not yet final

Reconstruction strategy

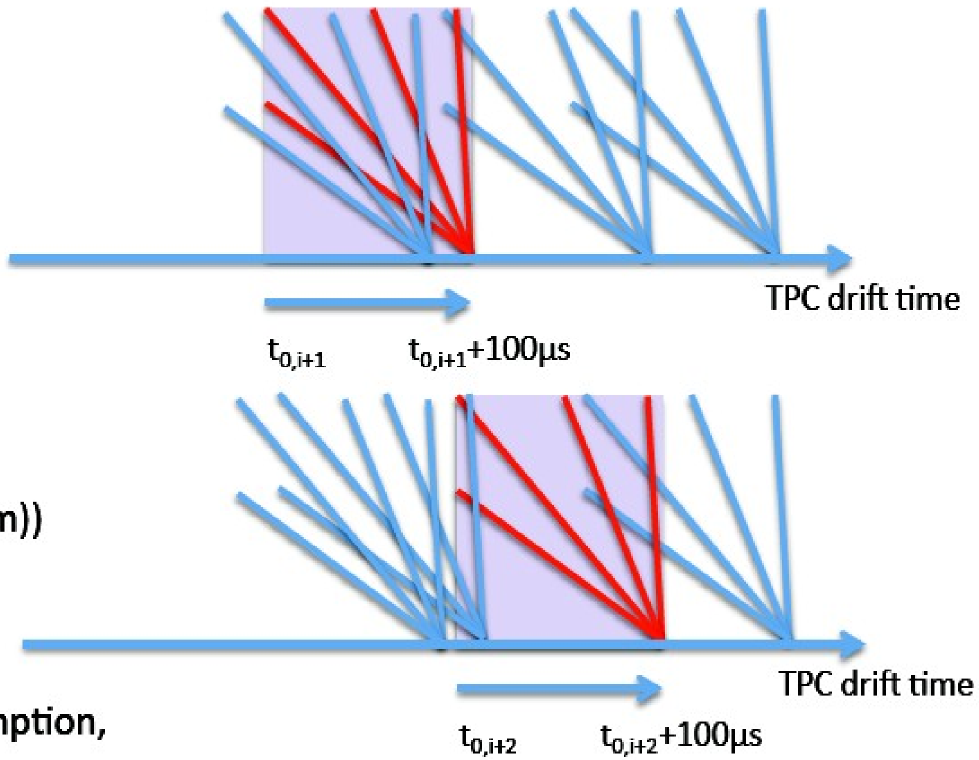
First step – alternative method

Stage 1: alternative method

Scan the list of event $t_{0,i}$ and correct all clusters in a $t_{0,i}$+100mus window according to a given t_0

- Clusters belonging to the proper event are corrected properly, others not → background in this event

- Distortion correction based on average map, residual distortions (fluctuations) remain (O(mm))



Advantage:

- Straight forward tracking scheme (vertex assumption, no iterative correction update needed)

Disadvantage:

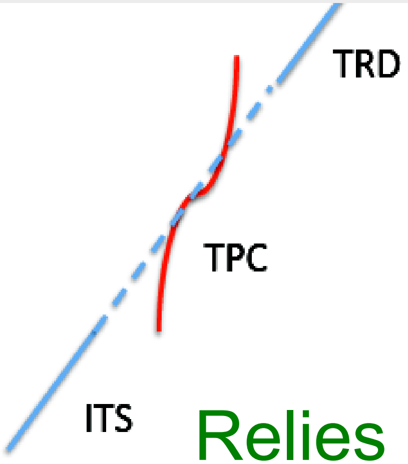
- Clusters are corrected multiple times

→ Requires application of residual distortion to existing full simulation chain including pile-up.
Tracking performance will be evaluated for TDR.

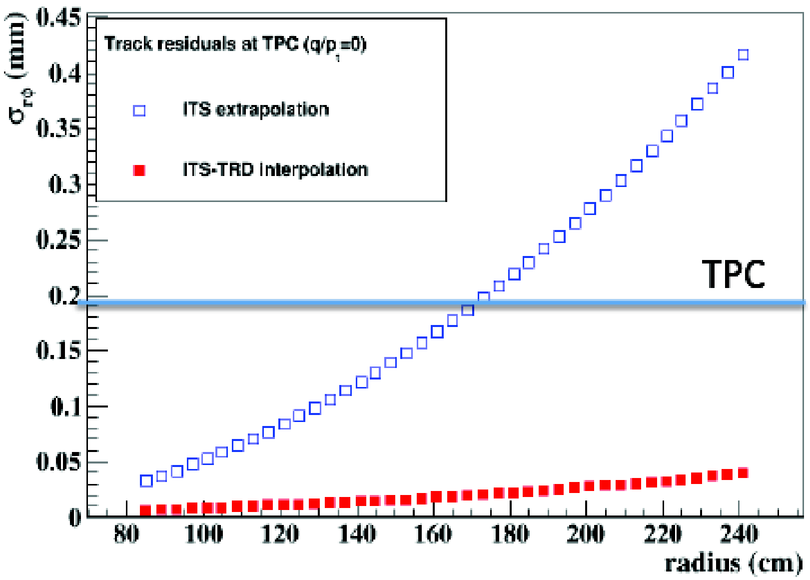
Reconstruction strategy

Second step – final calibration

Strategy: external track matching (ITS-TRD)



Relies on
- ITS standalone tracking
- ITS+TRD tracking



What is the required granularity?
Depends very much on the precision of the map

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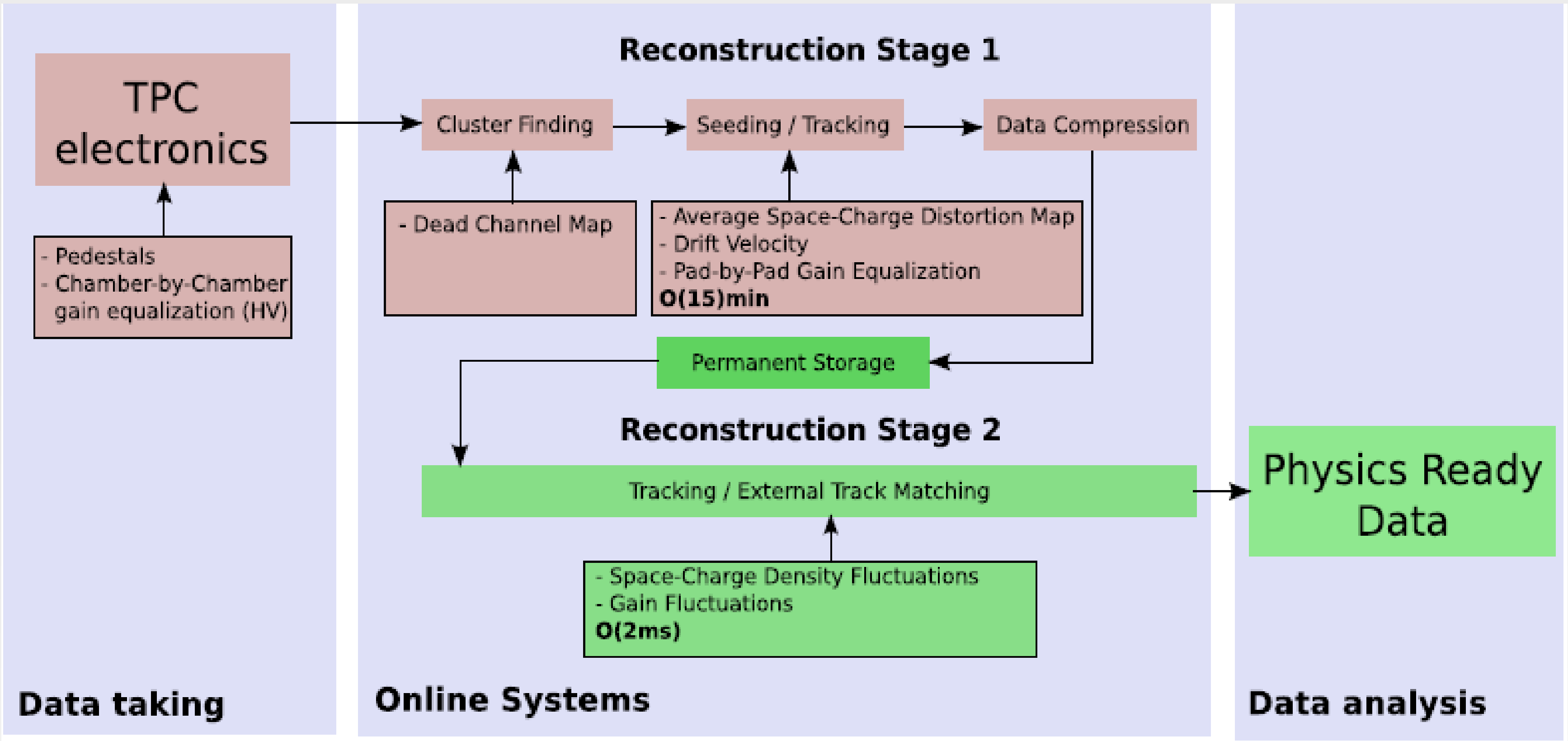
Calibration strategy



Here all implications of feed-back loops enters (see Jochens talk)
Most important: good online QA to decide the quality of the data compression
→ Worst case: Store all clusters, do tracking 'offline' which would result in a factor 3-4 larger data volume

Calibration strategy

SC map requirements

1. Reference map
   - assuming „geometric" acceptance
   - updated with known gain and epsilon variation and dead regions from ROC DB
   - from MC

2. Average map
   - „long-term" average, updated several times per fill
   - accounts for slow variations: luminosity, p/T, malfunctioning sectors
   - from high-statistics (~1 min) external track sample,
   - extraction of 3D-residual map wrt 1.

3. Scaled map
   - same as 2., but scaled by instantaneous „current" (last 160 ms)
     from collision counter, centrality measure,
     r and phi-averaged charge or signals in the TPC
   - to be used for first online reconstruction step

4. High-resolution map
   - same as 3., but containing r-phi differential current information (from TPC)
   - to be used for final calibration step (if necessary)

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Summary

- Current assumption:
  - Two step reconstruction
    - First step for data compression
      - Calibration updates O(1s- 1min)
      - TPC should be able to match with external detectors
    - Second step for final calibration
      - Calibration update O(5ms)
      - Relies on tracking with external detectors (ITS-TRD)
- Alternative method for first step 'brute force'