TPC in Run 3

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Outline

- TPC calibration flow in run 3
- Integrated digital currents
- Space charge calibration procedure
- 1Dx1D vs 2D cluster finder
- Further investigations for tracking in run 3
- TPC in AliceO^2
- Issues summarised under 'Run3 preparation' in JIRA, filter: https://alice.its.cern.ch/jira/issues/?filter=10708

TPC calibration flow in run 3

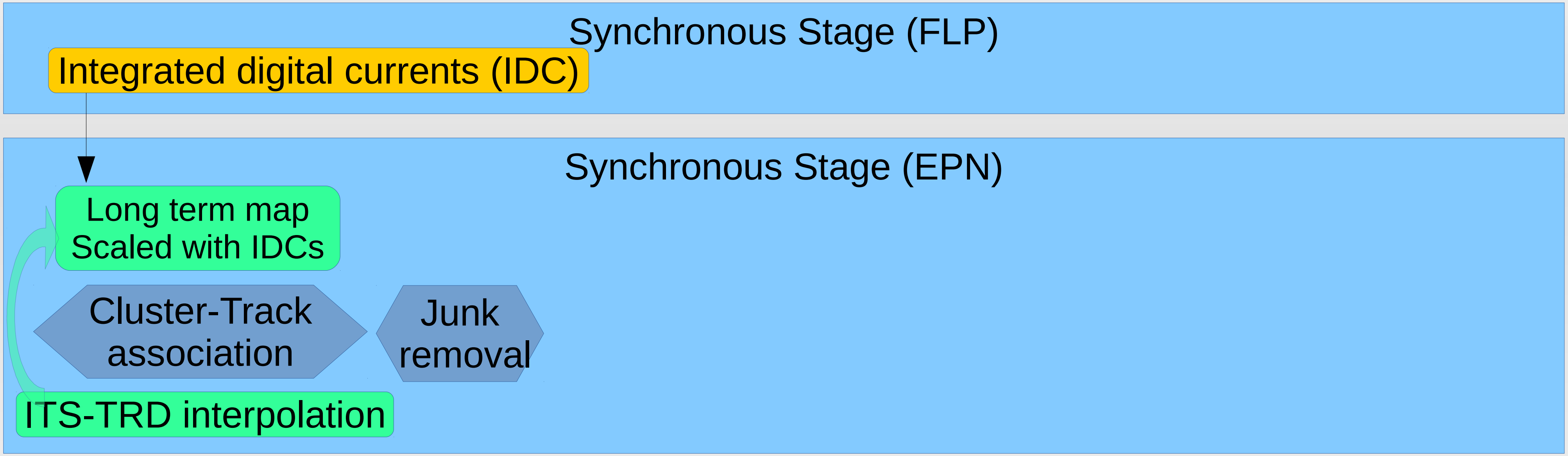
Overview

Synchronous Stage (FLP)

Integrated digital currents (IDC)

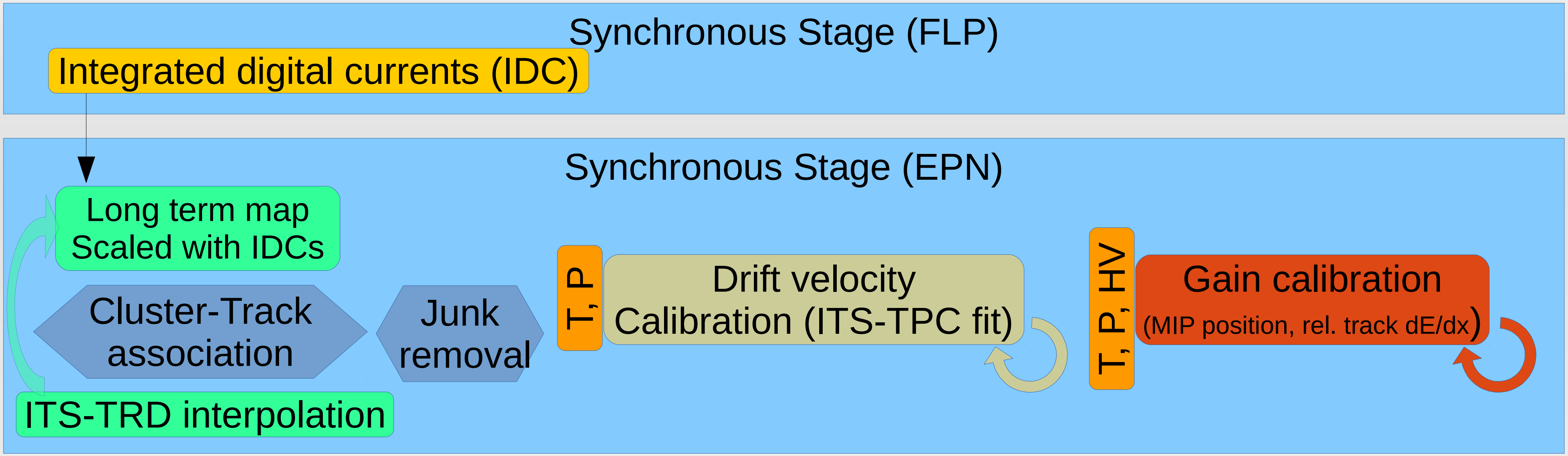
TPC calibration flow in run 3

Overview



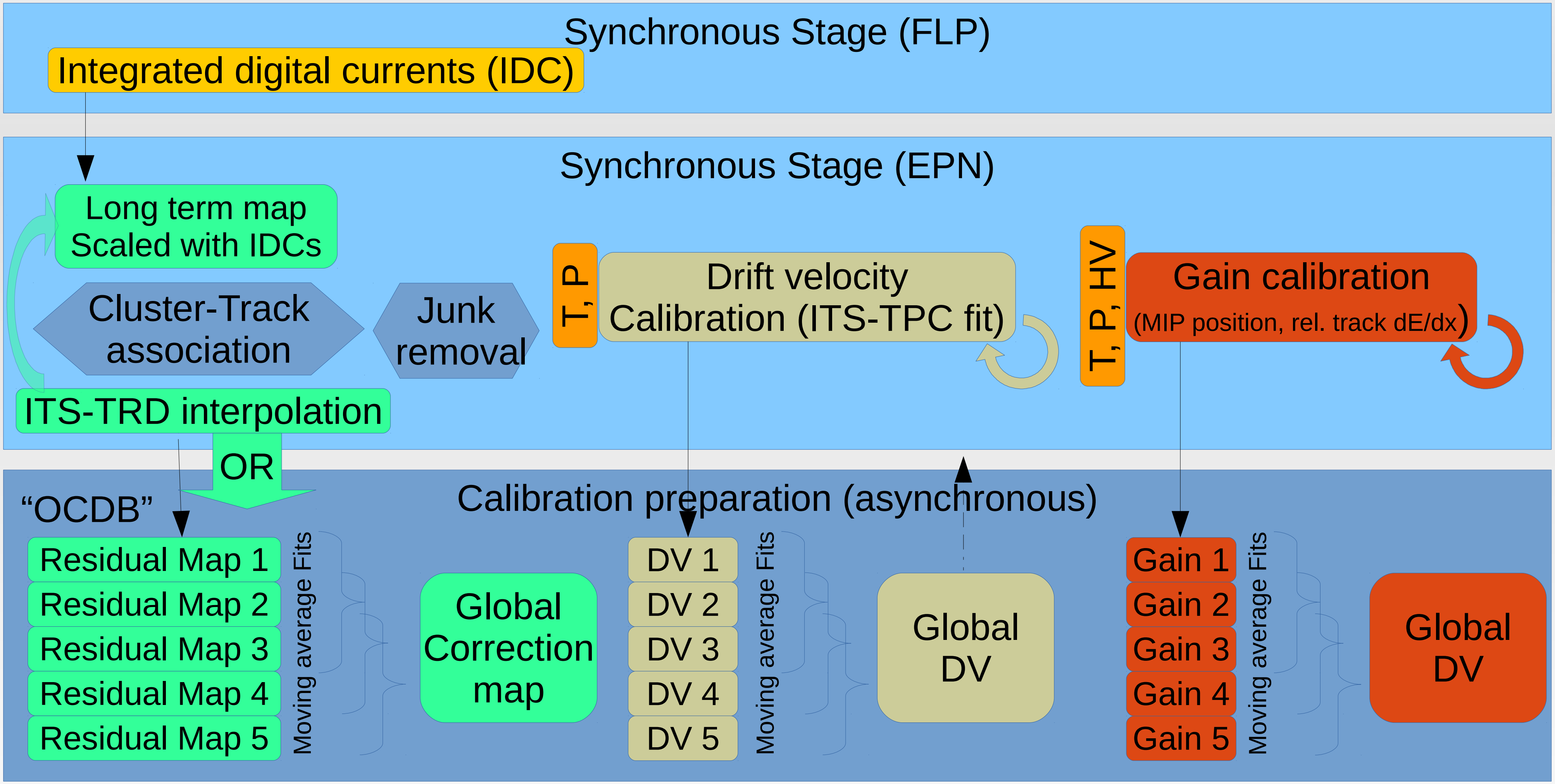
TPC calibration flow in run 3

Overview



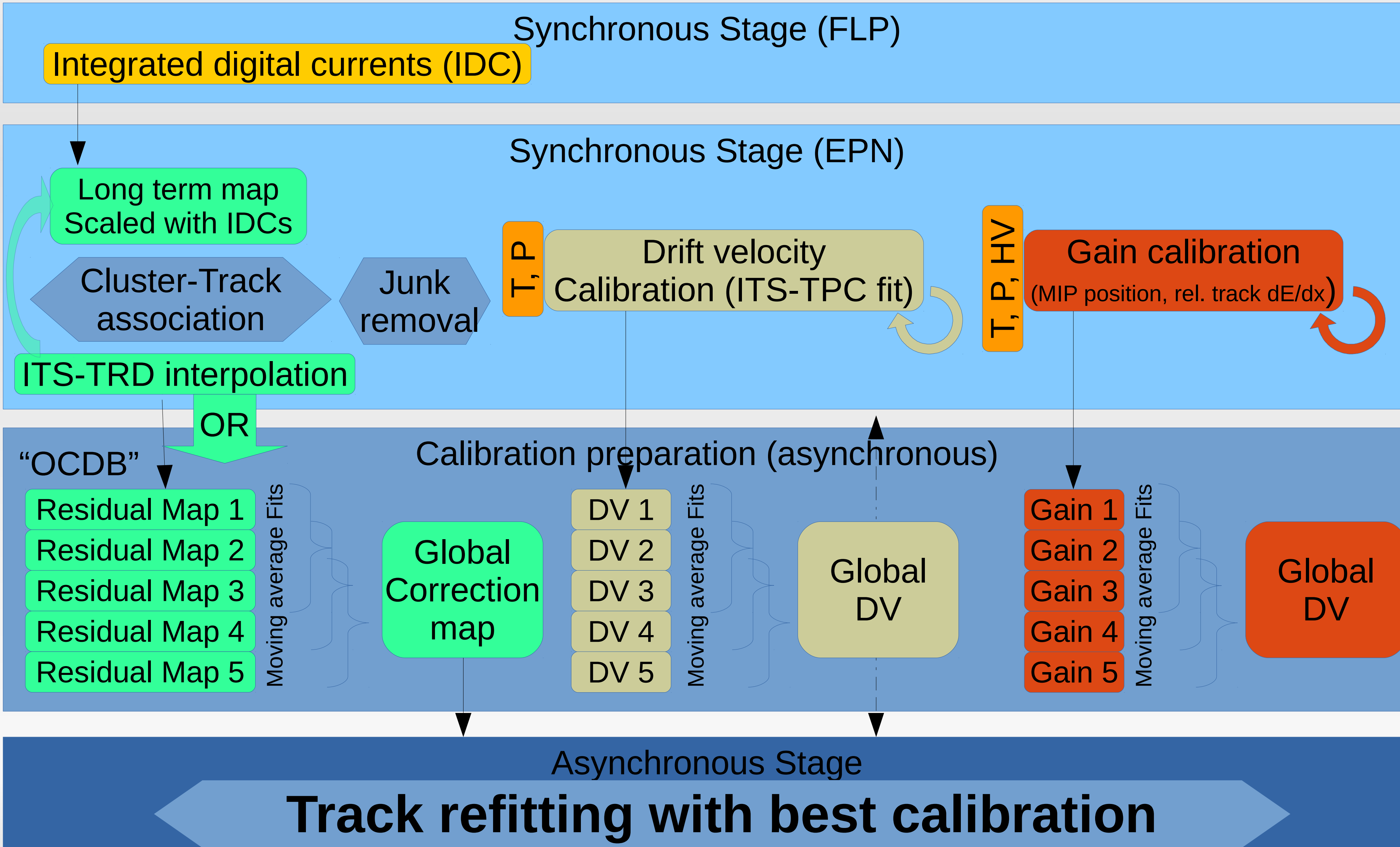
TPC calibration flow in run 3

Overview



TPC calibration flow in run 3

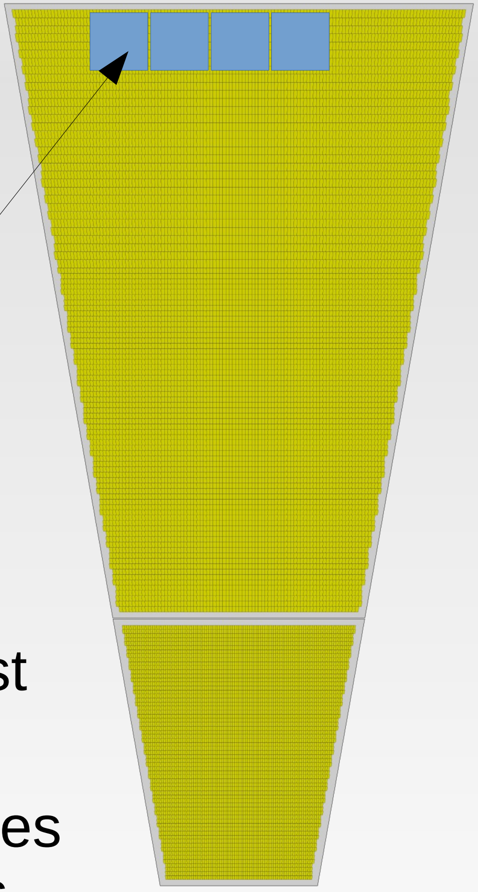
Overview



TPC calibration flow in run 3

Integrated digital currents

- Integrated digital (ADC) currents (IDCs) required in the data stream
- Proposed procedure
  - On FLP integrate ADC counts per pad over 1ms
  - Build robust average (e.g. median) over group of channels
  - Inject to the data stream
- Complication:
  - The SCD depend on the ion density history of the last 160ms (ion drift from read out to cathode)
  - FLPs need to (circularly) buffer the last 160 IDC values and attach it as payload to the data sent to the EPNs
- Should be integrated into the AliceO^{2} framework



TPC calibration flow in run 3

Long term map scaled with IDCs

- Long term average distortion map
  - Distortion vectors in r,φ,z bins (72*181*166)
  - Memory representation float → 25MB
  - Update interval few minutes
  - + scaling matrix elements (depends on dimensionality, 0D, 1D, 2D, 3D, static more or less, few tens of MB)
  - Usage of IDCs

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

https://alice.its.cern.ch/jira/browse/ATO-134

TPC calibration flow in run 3

Fine granular calibration – ITS-TRD interpolation

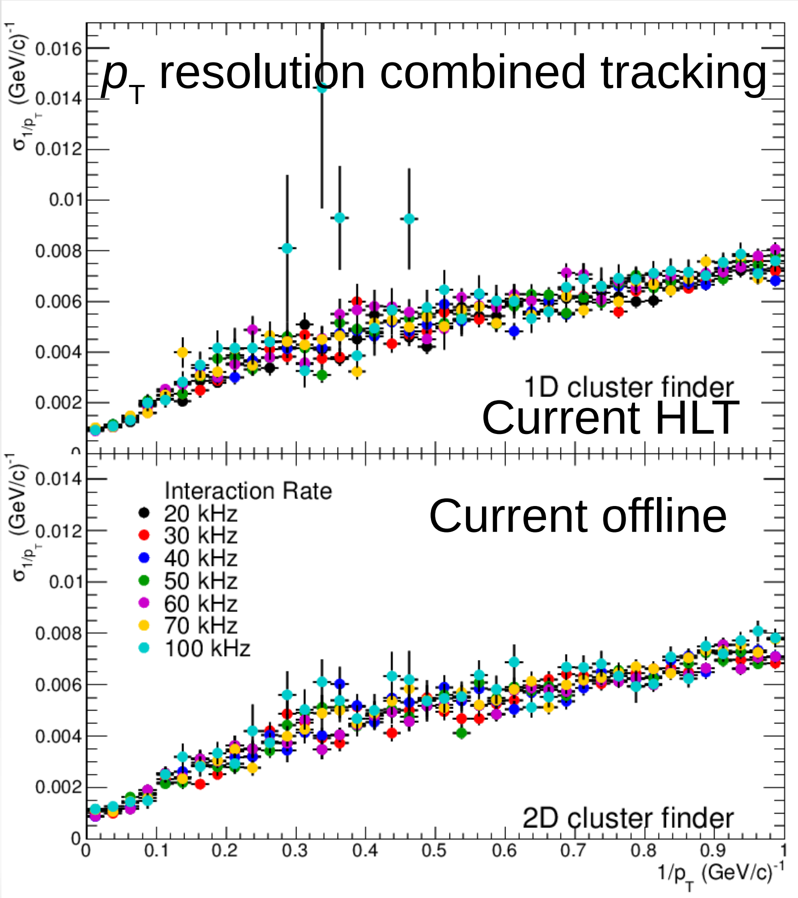
- From ITS TRD interpolation
  - Only residual miscalibration map on top of scaled average
  - → The better the scaling, the better the possible compression
  - Much coarser granularity than distortion map
  - Used for the TDR: r,φ,z bins 10*144*50 → 0.6 MB (uncompressed, float representation)
  - Extraction of final calibration requires access to 'histograms' from adjecent TFs (interpolatin – moving average)

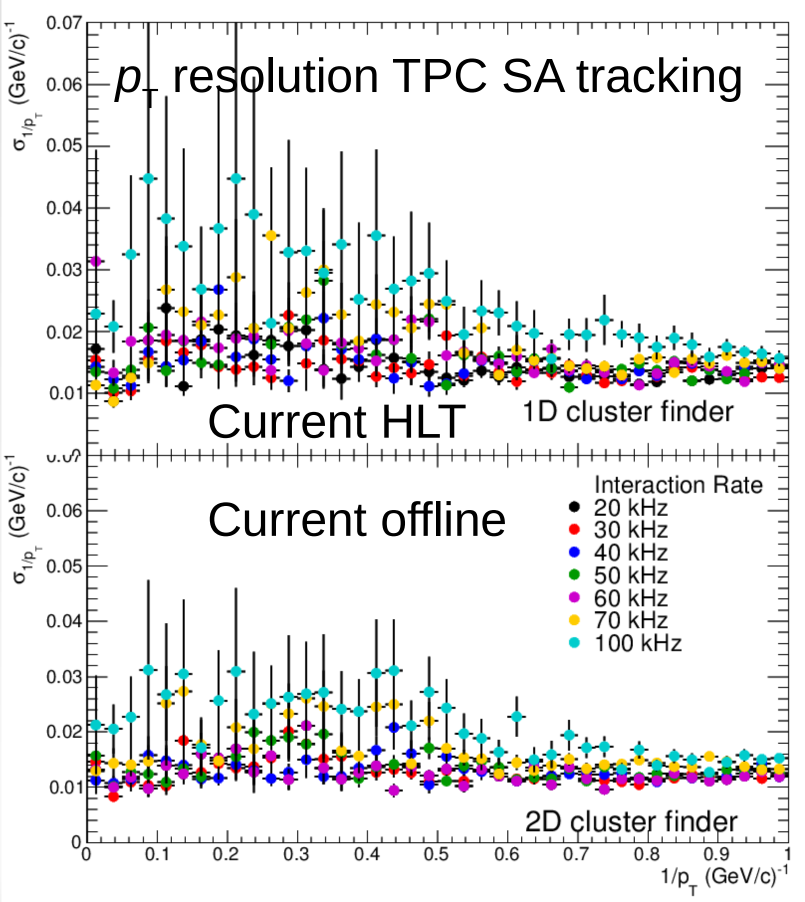
https://alice.its.cern.ch/jira/browse/ATO-108

Cluster finder 2D vs. 1Dx1D

Computing requirements – Synchronous reconstruction

- Up to 100kHz IR
  - Studies ongoing → Service task: Edgar Perez Lezama





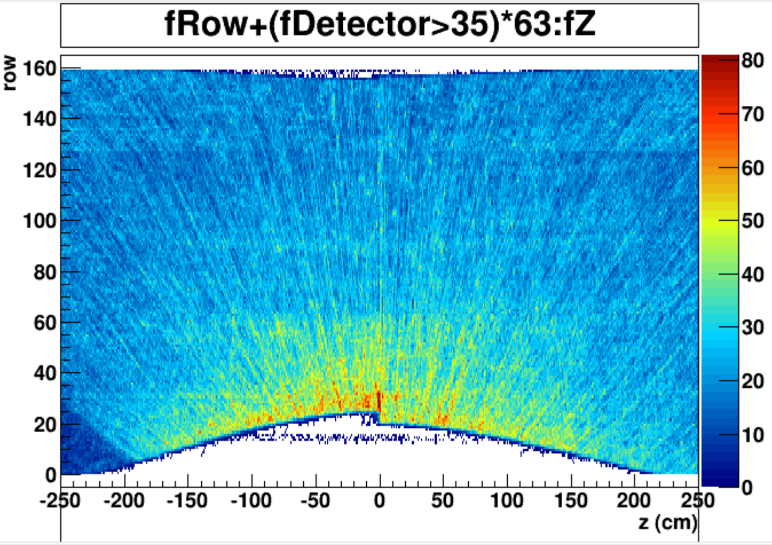
- Limited statistics
- Currently only global track parameters
- Cluster QA tbd

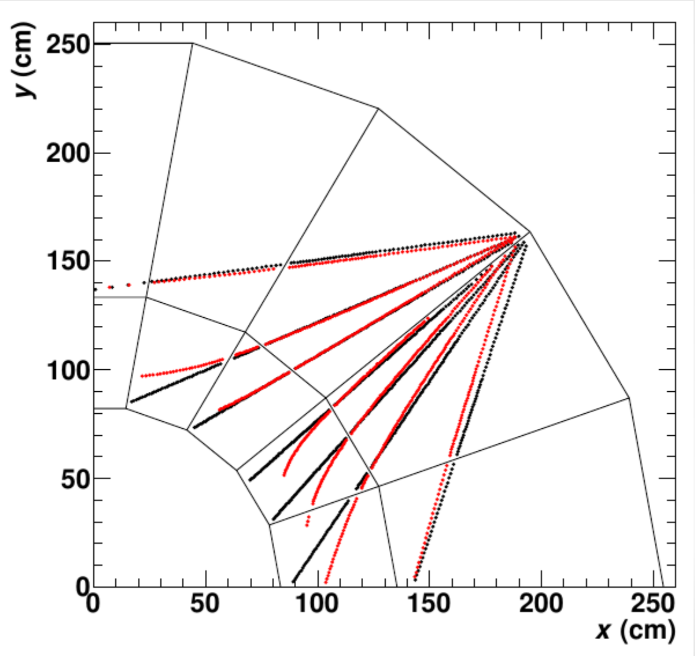
https://alice.its.cern.ch/jira/browse/ATO-144

Tracking in run 3

Further investigation

- Full distortions in AliRoot
- Test if cluster to track association works with full distortions (no correction) with current HLT code
- → might ease reconstruction

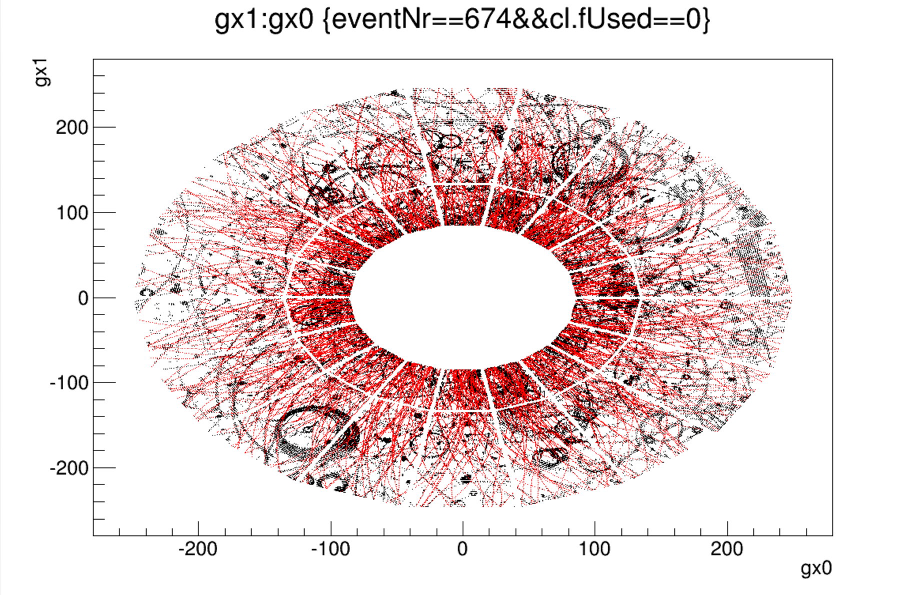




https://alice.its.cern.ch/jira/browse/ATO-38

Workflow in run 3 – lossy compression – potential

- Category 1: f1 ~70 % of background clusters
  - low momenta loopers to be signed and then rejected (if not overlap with category 2) - m1(0 bits) to represent
  - → Loop finder efficiency (ε) to be validated (ε*f1)
- Category 2: f2 ~30% of remaining will be close to the tracks (more than one cluster should be allowed to be attached)
  - to be compressed to m2(~30) bits per cluster – expected
  - → m2 expectation to be validated
- Category 3: rest ~ f3 (1-10%) will be not assigned to any topology above to be compressed to m3 bits (~40.)
- With this strategy factor 20 will be reached



Clusters belonging to physics tracks
Clusters of non-physics tracks

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

Short term goals

TPC in AliceO²

- Material + geometry ported
- Hit creation being worked on
  - Requires many classes from AliRoot
  - → Detector description classes
- Quite some work, especially if new coding conventions should be met
- Realistic implementation of distortions challenging
  - Required to develop calibration procedures
- For physics simulation parametrised distortions should be enough

```
/// Create the detector materials
virtual void createMaterials();

/// Construct the detector geometry
void constructDetectorGeometry();
```

```
Bool_t  Detector::ProcessHits(FairVolume* vol)
{
  //
  // Called for every step in the Time Projection Chamber
  //


  //
  // parameters used for the energy loss calculations
  //
  const Float_t prim = 14.35; // number of primary collisions per 1
  const Float_t poti = 20.77e-9; // first ionization potential for Ne
  const Float_t wIon = 35.97e-9; // energy for the ion-electron pair
  const Float_t kScalewIonG4 = 0.85; // scale factor to tune kwIon fo
  const Float_t kFanoFactorG4 = 0.7; // parameter for smearing the nu
  const Int_t   kMaxDistRef =15;     // maximal difference between 2
  // Float_t prim = fTPCParam->GetNprim();
  // Float_t poti = fTPCParam->GetFpot();
  // Float_t wIon = fTPCParam->GetWmean();

  const Float_t kbig = 1.e10;

  Int_t id,copy;
  Float_t hits[5];
  Int_t vol[2];
  TLorentzVector p;

  vol[1]=0; // preset row number to 0
  //
  if (!fPrimaryIonisation) TVirtualMC::GetMC()->SetMaxStep(kbig);
```

https://alice.its.cern.ch/jira/browse/ATO-157

Further work

- Compression studies (loss-less + lossy)

  https://alice.its.cern.ch/jira/browse/ATO-101
  https://alice.its.cern.ch/jira/browse/ATO-73

- Digitisation simulation (SAMPA chip)

  https://alice.its.cern.ch/jira/browse/ATO-123

- Development of ITS-TRD/TOF interpolation

  https://alice.its.cern.ch/jira/browse/ATO-108

- Methods for fast space charge disortion calculation/correction

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

Backup

TPC calibration flow in run 3

Integrated digital currents

- Size estimates of IDCs
- Most conservative: Integration for every readout pad
  - → 560k*4byte → 2.1MB / ms
  - → 320MB per header information
  - → fractional input on (compressed) data: ~4%
- More realistic estimate:
  - Grouping in r,φ with granularity of the distortion map: 26k → 0.1MB / ms

Calibration requirements

General remarks

- Calibrations have two categories
  - Static (over periods or longer)
    - → Not considered problematic at all in terms of disk space, memory consumption, CPU requirements
  - Time dependent (ms to minute level)
    - → Mainly unproblematic
    - → Space-charge distortion main impact
- All will be described in a note

Calibration requirements

Static calibrations

Type	Memory size [MB]	Update interval	Input
Pedestal / Noise	2.2 / 2.2	Per fill	Raw data
Gain Map*	2.2	yearly	^{83}Kr + tracks
Alignment	50	yearly	Tracks (low intensity run, high statistics)
contingency	100	Per fill	

- No real impact on computing
- *Gain Map: Assumes no relevant local gain fluctuations
  - → To be shown from test beam data taken this week
  - Worst case, gain map update on sec. level, store wrt. Average → high compression (few bits per channel)

Calibration requirements

Time dependent calibrations

Type	Memory size [MB]	Update interval	Input
Drift velocity*	0.004	~15 min	ITS-TPC matching
Gain variation**	0.004*72	~15min	Tracks (MIP)
SCD (sync)	25	Few minutes	→ next slides
SCD (async)	0.6 (+sync)	5ms	→ next slides
contingency	100	~15min	

- *) will be most probably fitted with SCD (space-charge distortions) – interdependent
- **) See previous slide

Calibration requirements

SCD async

- From ITS TRD interpolation
  - Only residual miscalibration map on top of scaled average
  - → The better the scaling, the better the possible compression
  - Much coarser granularity than distortion map
  - Used for the TDR: r,φ,z bins 10*144*50 → 0.6 MB (uncompressed, float representation)
- Computing impact
  - ITS-TRD interpolation
  - Filling and analysing of residual histograms per cell → CPU to be estimated