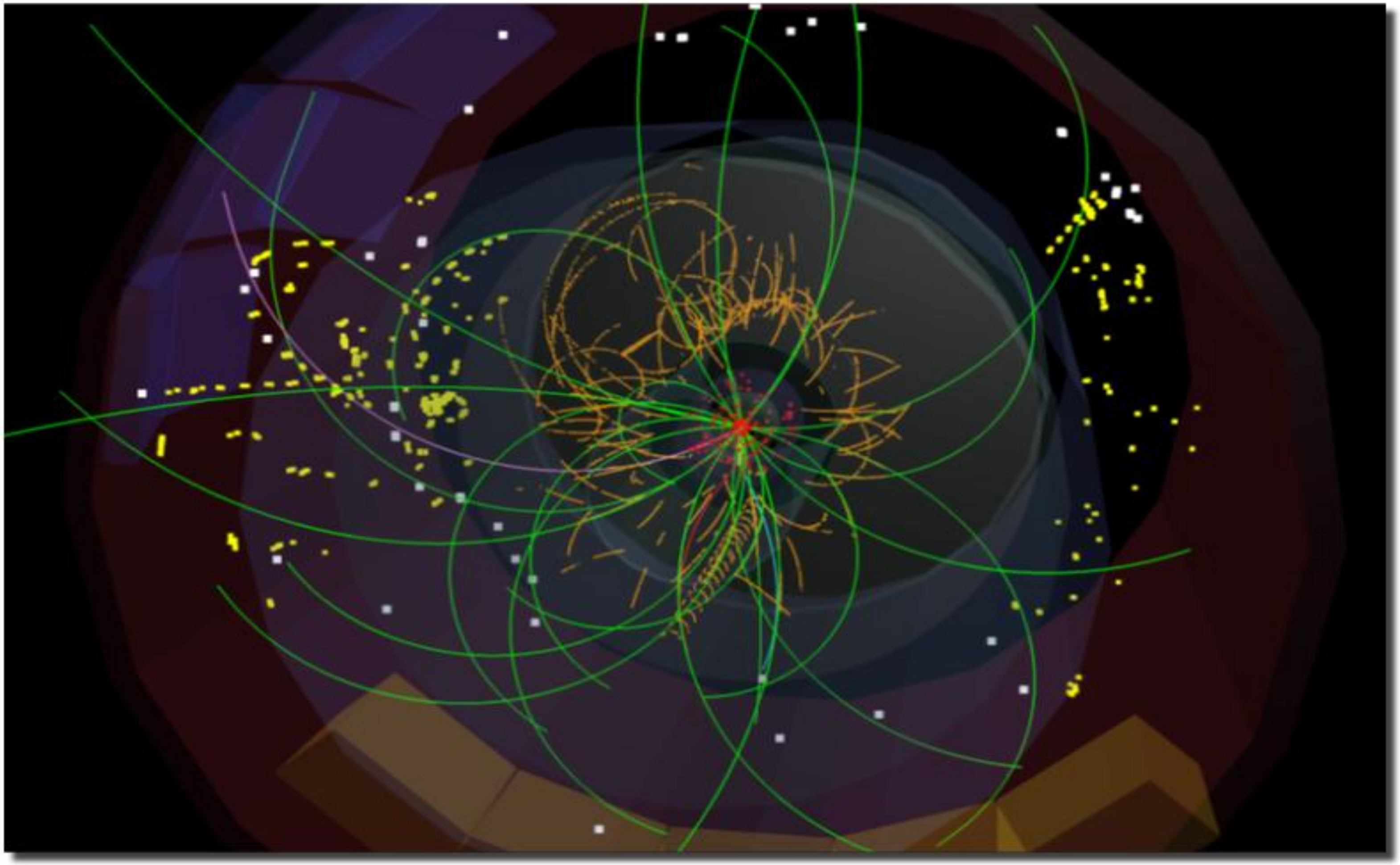
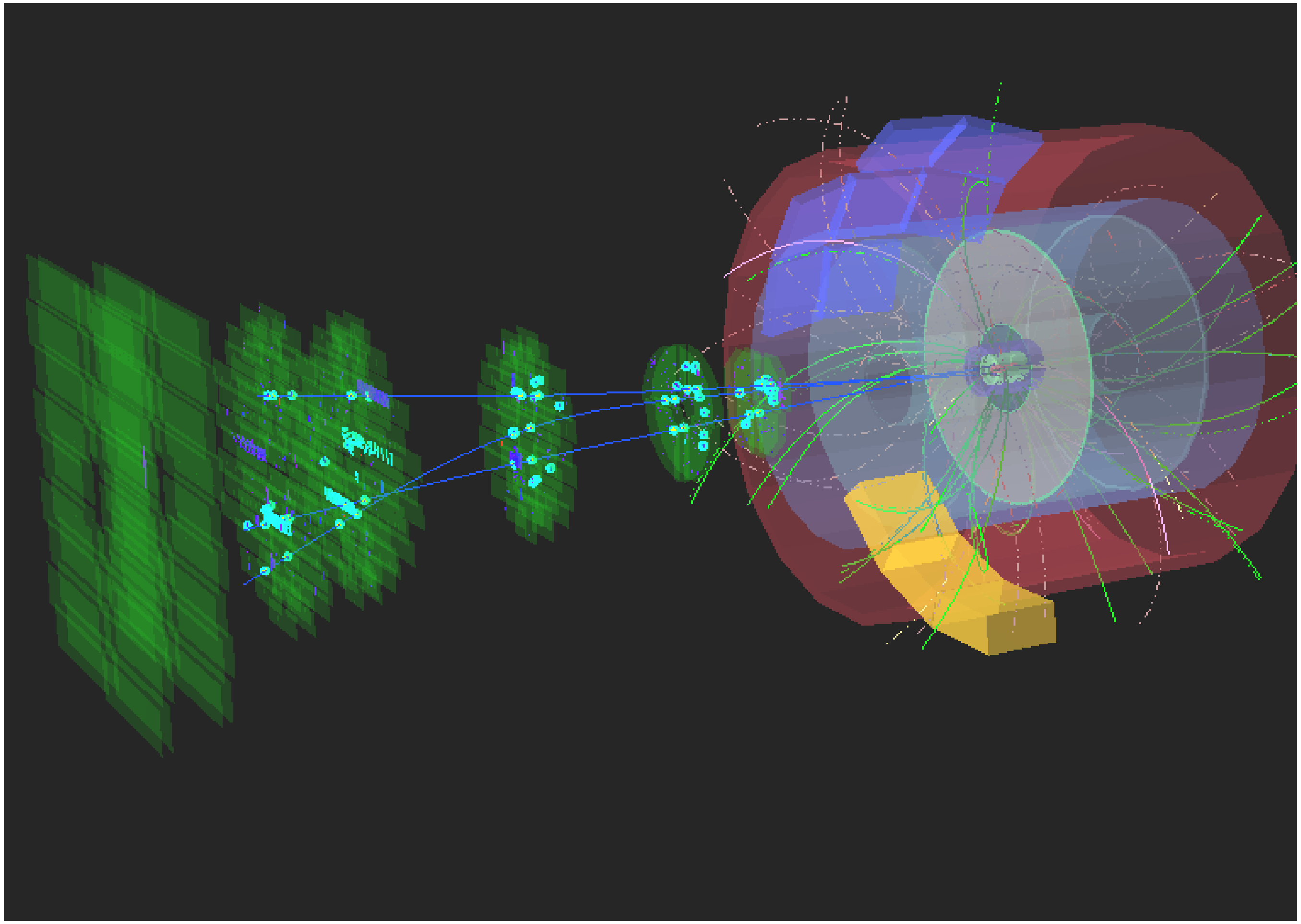


Il Commissioning di ALICE

Stefania Beole' for the ALICE Collaboration

The ALICE experiment

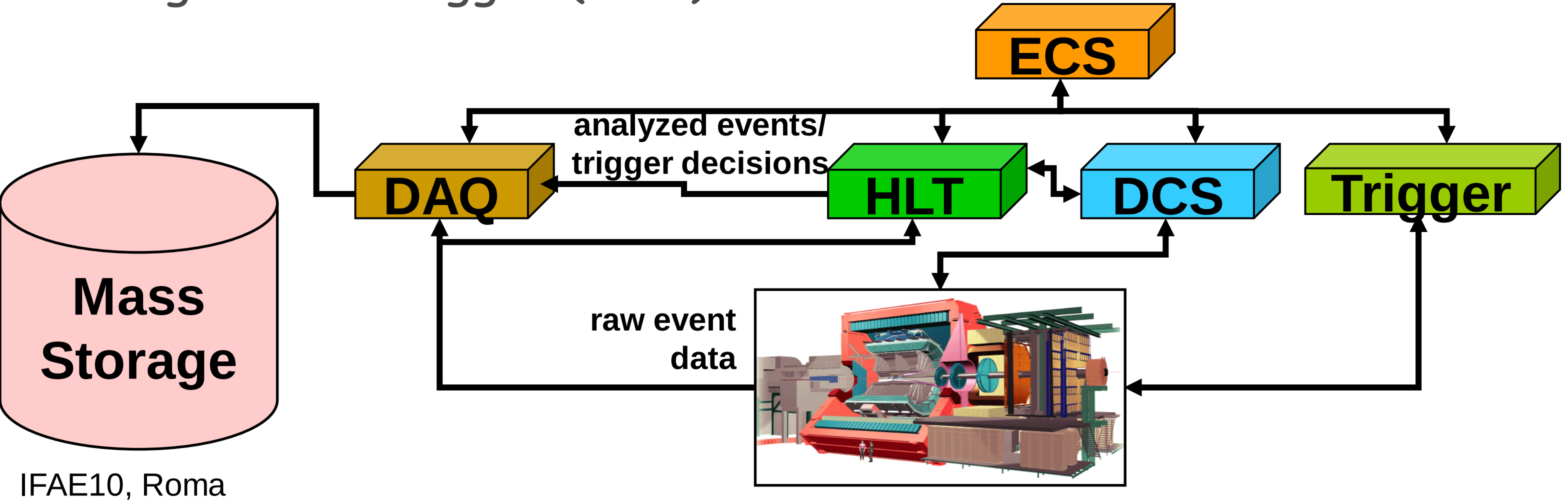


ALICE tools for Data Taking, Online Calibration and DQM

- Experiment Control System (ECS)
- Detector Control System (DCS)
- Trigger configuration + High Level Trigger (HLT)
- Detector calibration
- Data Quality (DQ) monitoring

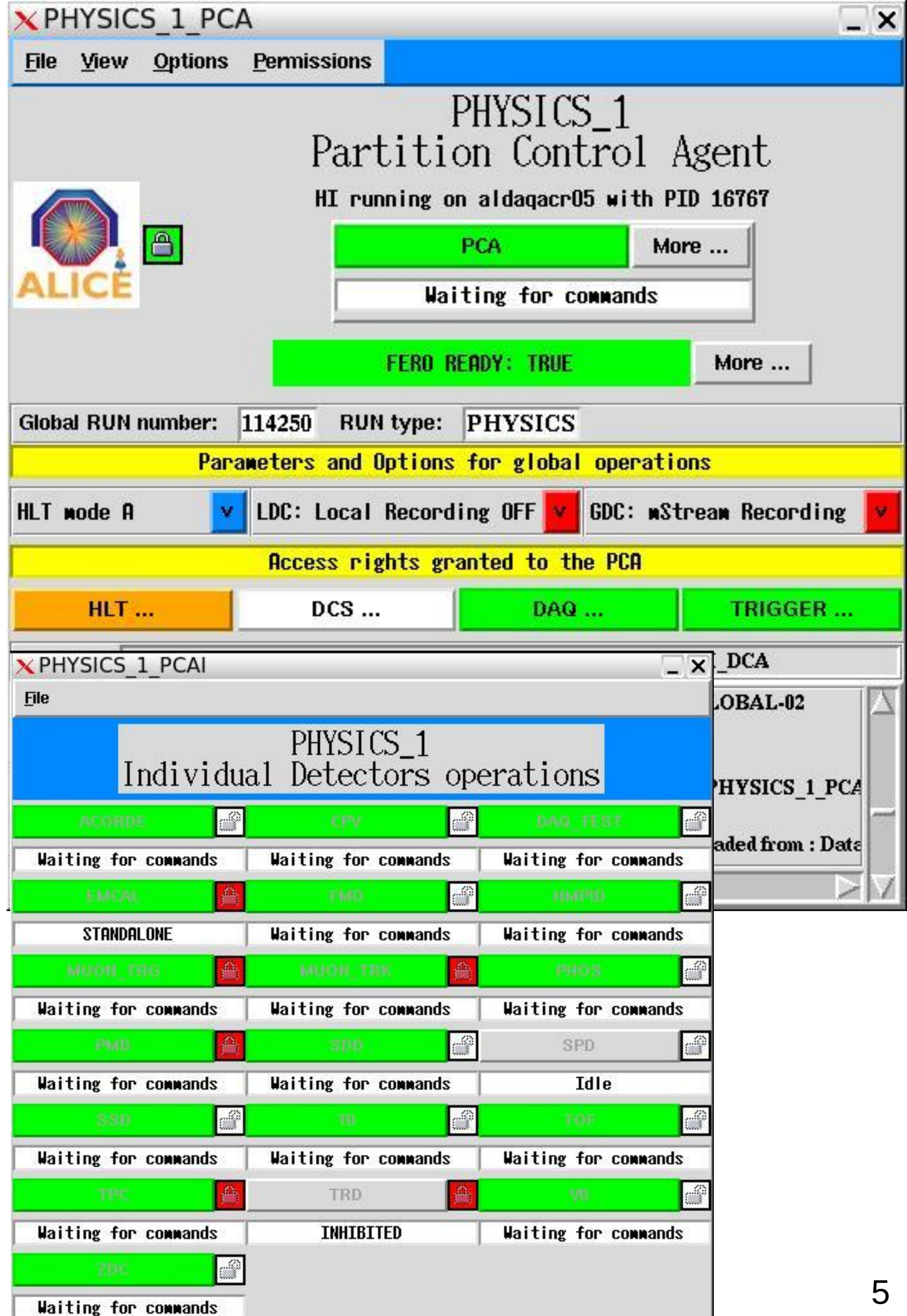
Experiment Control System

- The experiment is run via the Experiment Control System (ECS).
- The ECS is a layer of software which coordinates various independent online systems dedicated to different domains:
  - Detector Control System (**DCS**)
  - Data Acquisition (**DAQ**)
  - Trigger system (**TRG**)
  - High Level Trigger (**HLT**)



ECS

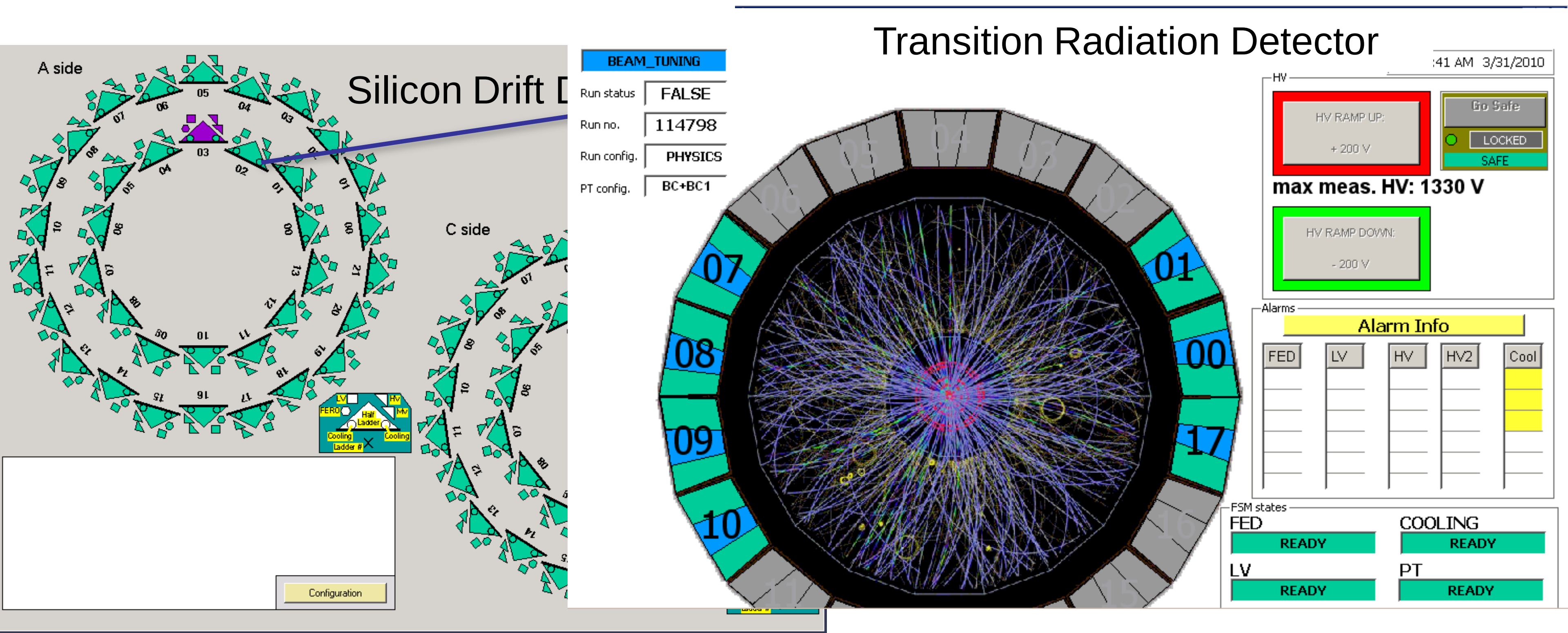
- ECS manages independent data taking runs via "partitioning"
  - ⇨ partition is a group of detectors :
    - ✓ *'Active' detectors*
    - ✓ *'excluded' detectors*
  - ⇨ Two types of operations:
    - ✓ ***Global :all the active detectors***
    - ✓ ***Individual : one single detector***
    - ✓ ***Global individual detector operatiand on are mutually exclusive***
  - ⇨ the Trigger Partition Agent (**TPA**) connects the partition to the Central Trigger Processor (**CTP**)



DCS individual detectors

DCS controls and monitors for each detector several working parameters

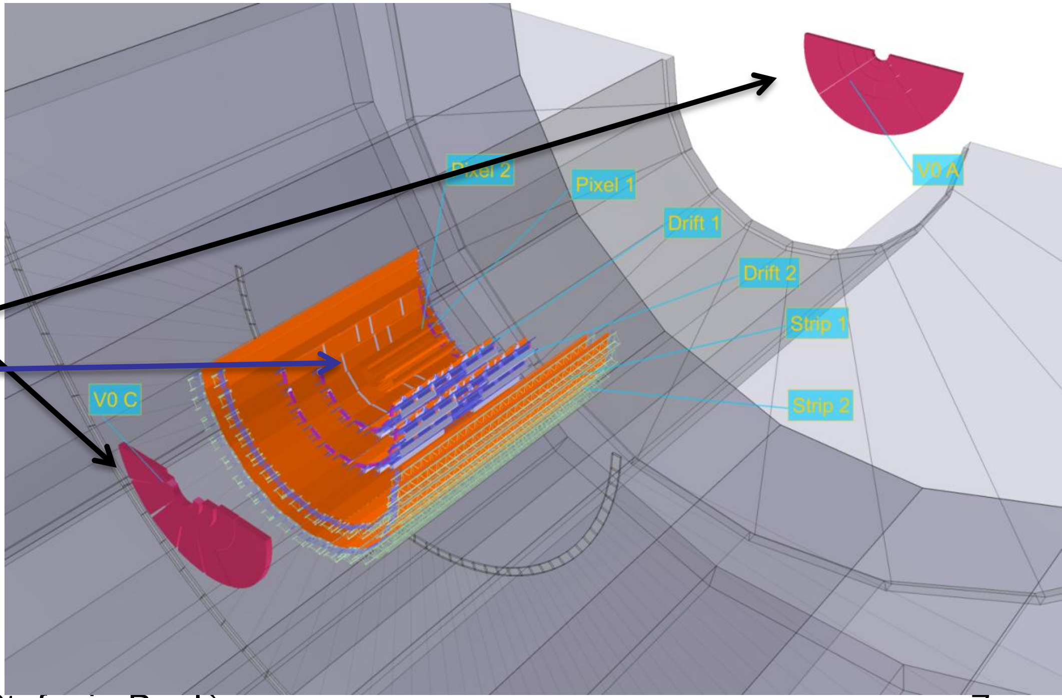
- The supervision and operation programs are implemented via a Finite State Machine
- Intuitive and generic method to model the behaviour of a system or a device
- An object has a well defined collection of *states*
- Moves between states by executing *actions*
  - ✓ ***Triggered by an operator or an external event***



TRIGGER

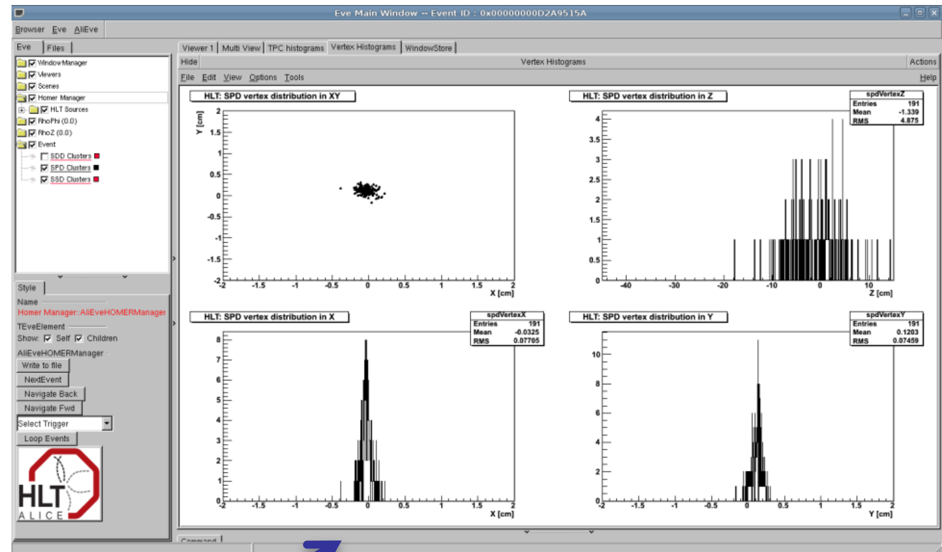
- ALICE is mainly a Minimum Bias experiment
- Trigger detectors
  - ⇨ Silicon Pixel Detector (SPD) Fast OR
  - ⇨ V0 (scintillators providing MB trigger for the ALICE barrel)
  - ⇨ Time Of Fligth (TOF)
  - ⇨ EMCAL
  - ⇨ Zero Degree Calorimeter (ZDC)
  - ⇨ MUON TRG
  - ⇨ ACORDE

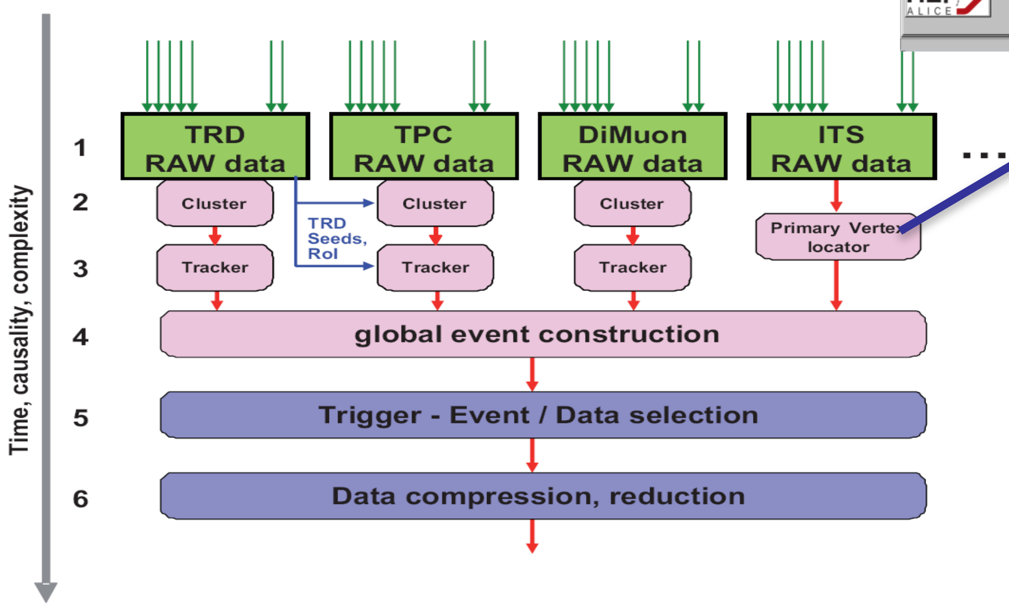
- Trigger classes based on different combination of the above dets
  - ⇨ Minimum Bias (based on V0 and SPD)
  - ⇨ High Multiplicity
  - ⇨ Rare signals (dimuon, electrons, jets)
- Calibration triggers



High Level Trigger

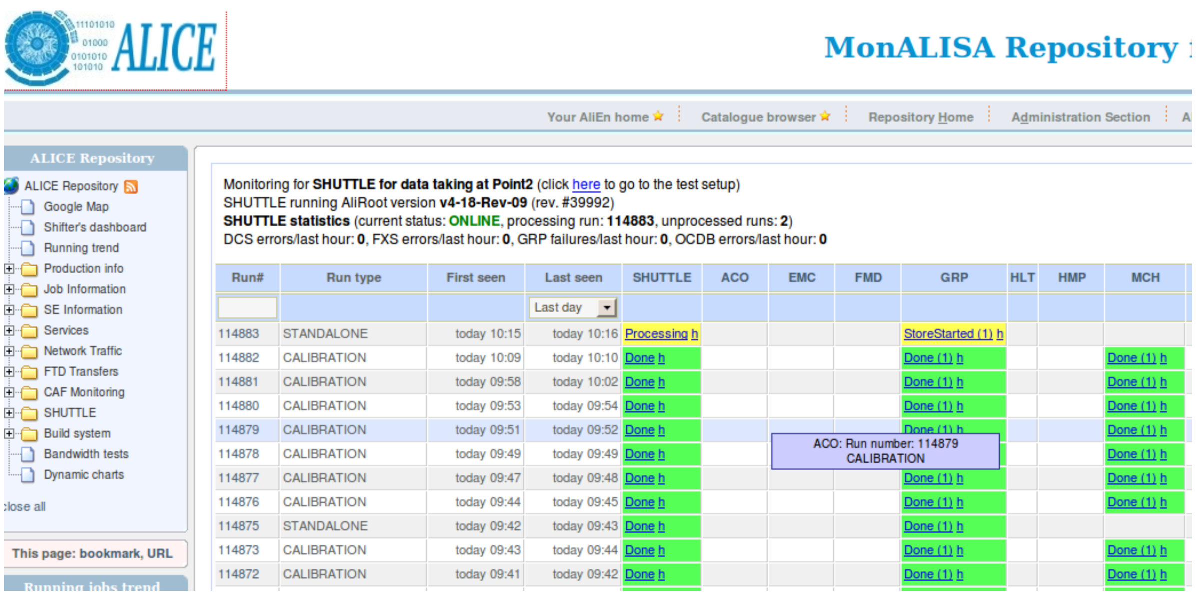
- Purpose:
  - Online event reconstruction and analysis
  - Providing of trigger decisions
  - Selection of regions of interest within an event
  - performance monitoring of the ALICE detectors
  - Online production of calibration data





Calibration

- Dedicated calibration runs or dedicated triggers in physics runs
- *"Detector Algorithms" (DA)* run on Local Data Concentrators (before event building)
  - Compute Calibration values (e.g. baselines, gain, noisy channels, drift speeds,…)
  - DAs are integrated in the offline framework (AliRoot)
- *A system called **Shuttle*** moves calibration values and selected DCS data points to the Offline Conditions DB (OCDB)
  - Objects = Standard root files registered in the GRID catalogue with an appropriate versioning system (run validity range, version number)
- Obtained calibration parameters available on the GRID after few minutes
  - checked by the shifter to validate the calibrations before starting physics data taking



Monitoring for **SHUTTLE for data taking at Point2** (click here to go to the test setup)
SHUTTLE running AliRoot version **v4-18-Rev-09** (rev. #39992)
SHUTTLE statistics (current status: **ONLINE**, processing run: **114883**, unprocessed runs: **2**)
DCS errors/last hour: **0**, FXS errors/last hour: **0**, GRP failures/last hour: **0**, OCDB errors/last hour: **0**

Run#	Run type	First seen	Last seen	SHUTTLE	ACO	EMC	FMD	GRP	HLT	HMP	MCH
			Last day								
114883	STANDALONE	today 10:15	today 10:16	Processing h				StoreStarted (1) h			
114882	CALIBRATION	today 10:09	today 10:10	Done h				Done (1) h			Done (1) h
114881	CALIBRATION	today 09:58	today 10:02	Done h				Done (1) h			Done (1) h
114880	CALIBRATION	today 09:53	today 09:54	Done h				Done (1) h			Done (1) h
114879	CALIBRATION	today 09:51	today 09:52	Done h				Done (1) h			Done (1) h
114878	CALIBRATION	today 09:49	today 09:49	Done h				[illegible]			Done (1) h
114877	CALIBRATION	today 09:47	today 09:48	Done h				Done (1) h			Done (1) h
114876	CALIBRATION	today 09:44	today 09:45	Done h				Done (1) h			Done (1) h
114875	STANDALONE	today 09:42	today 09:43	Done h				Done (1) h			
114873	CALIBRATION	today 09:43	today 09:44	Done h				Done (1) h			Done (1) h
114872	CALIBRATION	today 09:41	today 09:42	Done h				Done (1) h			Done (1) h

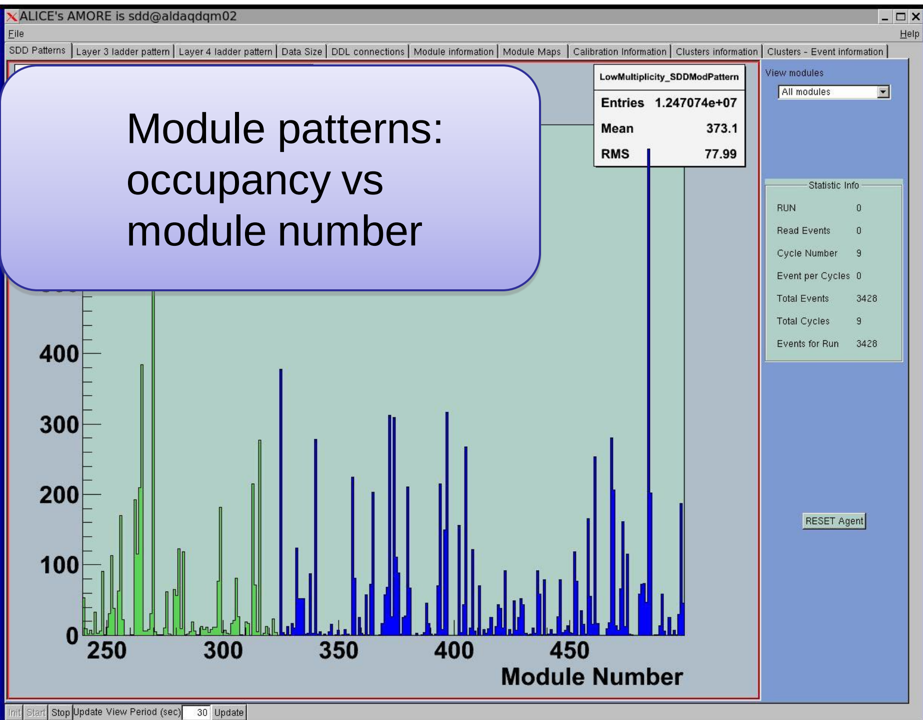
OFFLINE calibration

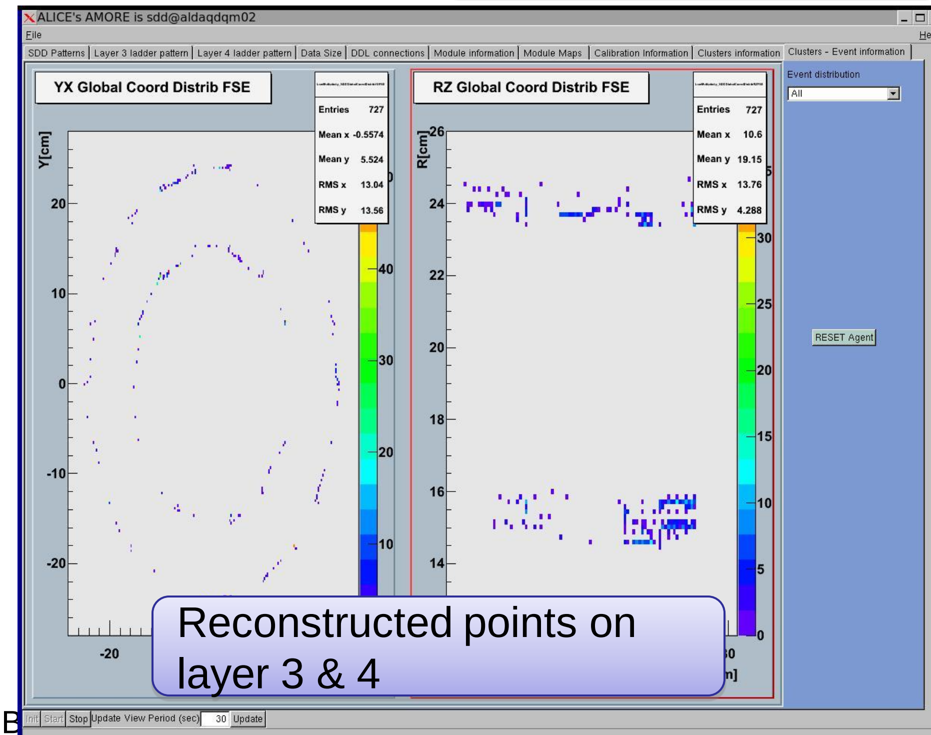
- Not all the parameters can be obtained via simple DA on limited statistics
- Calibration task (train) currently under study

AMORE

- AMORE (Automatic MOnitoRing Environment) is the tool for Detector and Data Quality Monitoring
  - ⇨ Monitoring raw quantities on single subdetectors, e.g. hit maps, data size, detector occupancy
  - ⇨ Plots of local reconstruction results (e.g. spacial distributions of reconstructed points, drift time distributions,…) .
    - ✓ ***Reconstruction performed online on dedicated machines***
  - ⇨ Output is available for the shifter

Examples from Silicon Drift Detectors



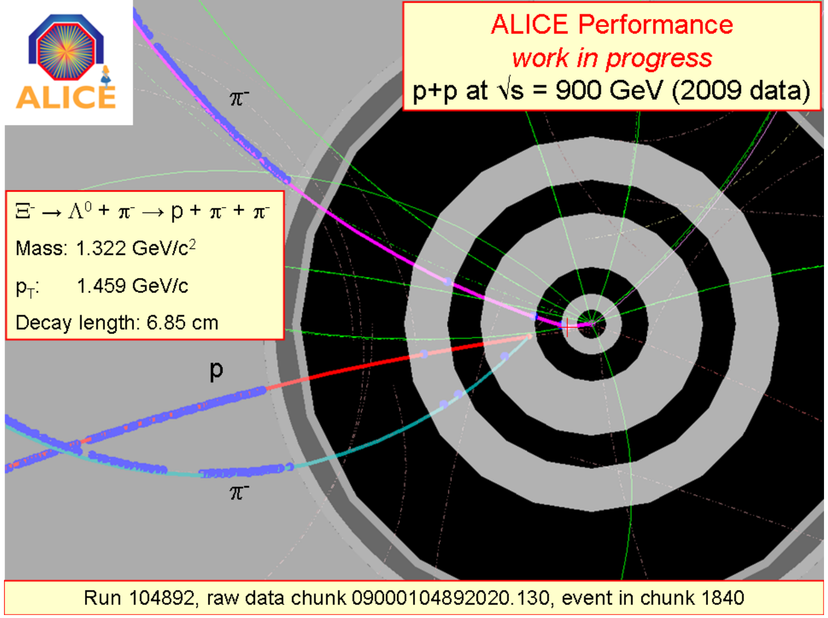


Fast Offline & performances

Selected examples (Inner Tracking System, Time projection Chamber, Time Of Flight detectors) concerning:

- calibration
- reconstruction
- alignment

Event Reconstruction



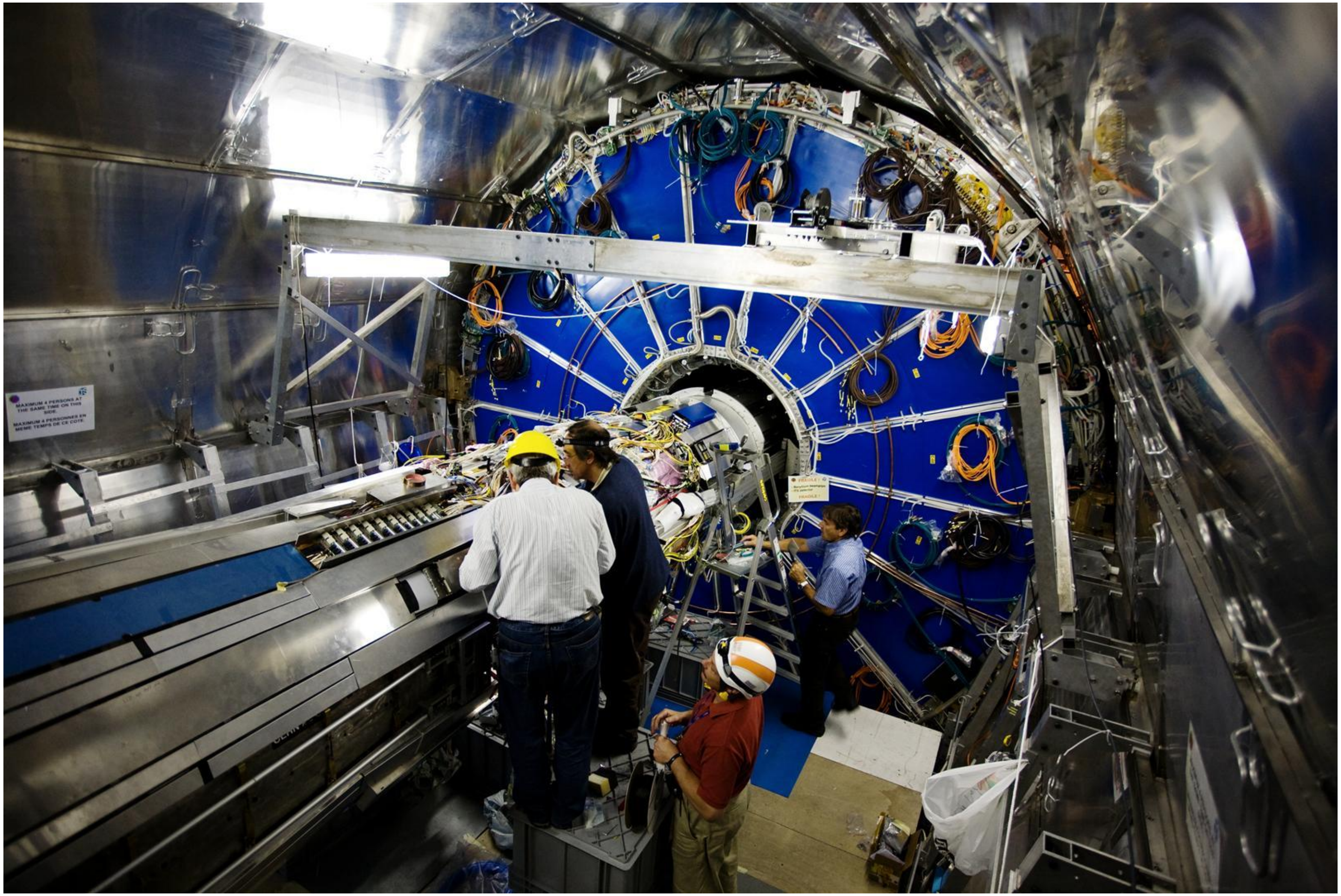
- Online event reconstruction and analysis, visualization (fast tracking) and vertexing -> HLT

- Fast offline:
  pass 1 reconstruction → immediately after data taking
  - Data -> (via Shuttle) Castor (Mass storage @Tier0)
  - Local reconstruction detector by detector
  - Event building
  - Vertexing & pile up detection
  - Tracking (barrel and muon arm)
  - V0 and Kink finding

- EventSummaryData + ESD friends
  - Vertex spd
  - Vertex tracks
  - Tracks
  - Rec points associated to tracks….

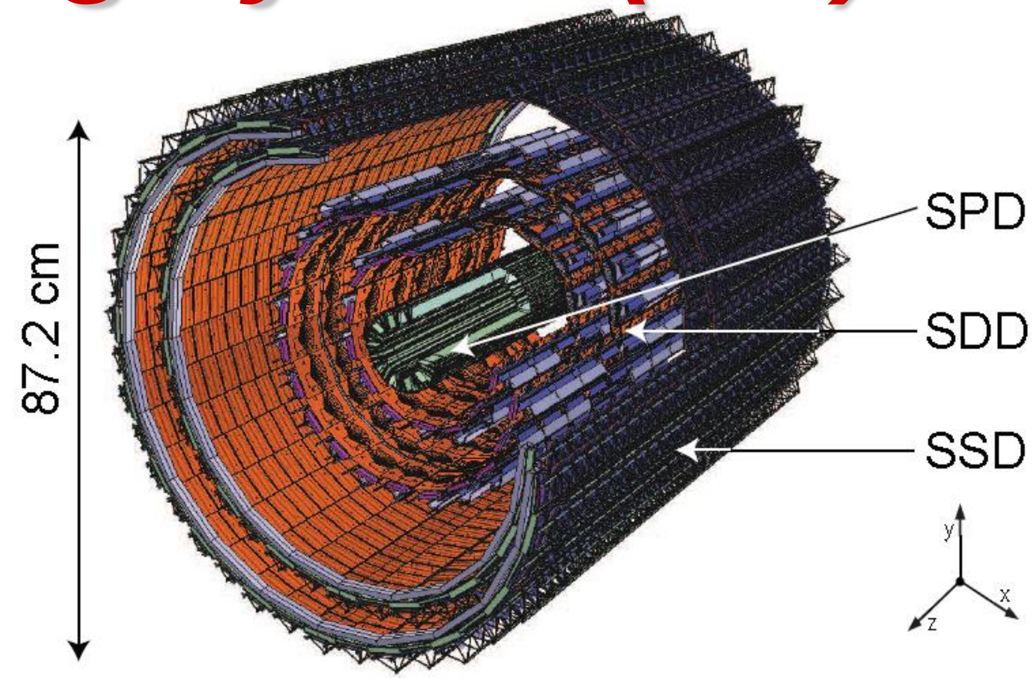
Preliminary results presented by R. Nania & C. Bianchin

Inner Tracking System ITS



Inner Tracking System (ITS)

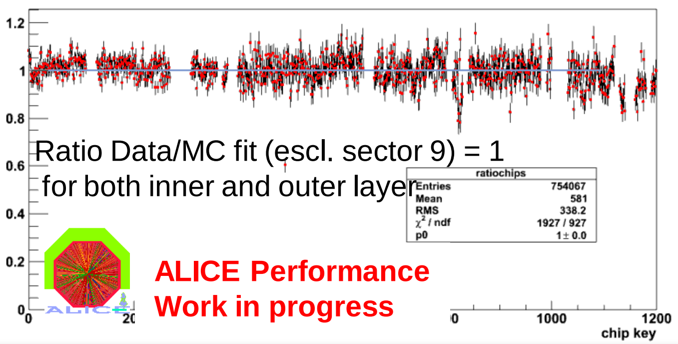
- Six layers of silicon detectors
  - ⇨ Coverage: $|\eta|<0.9$
- Three technologies
  - ⇨ Pixels (SPD) 9.8 M channels
  - ⇨ Drift (SDD) 133 k channels
  - ⇨ Double-sided Strips (SSD) 2.6M channels
- Design goals
  - ⇨ Optimal resolution for primary vertex and track impact parameter
  - ⇨ Minimize
    - ✓ *distance of the innermost layer from beam axis ($\langle r\rangle \approx 3.9$ cm)*
    - ✓ *material budget (1% X/X0 per layer)*
  - ⇨ Maximum occupancy (central PbPb) < few %
  - ⇨ 2D devices in all the layers
  - ⇨ dE/dx information in the 4 outermost layers for particle ID in $1/\beta^2$ region



Layer	Det. Type	Radius (cm)	Length (cm)	Resolution (µm)	
				rϕ	Z
1	SPD	3.9	28.2	12	100
2	SPD	7.6	28.2	12	100
3	SDD	15.0	44.4	35	25
4	SDD	23.9	59.4	35	25
5	SSD	38.0	86.2	20	830
6	SSD	43.0	97.8	20	830

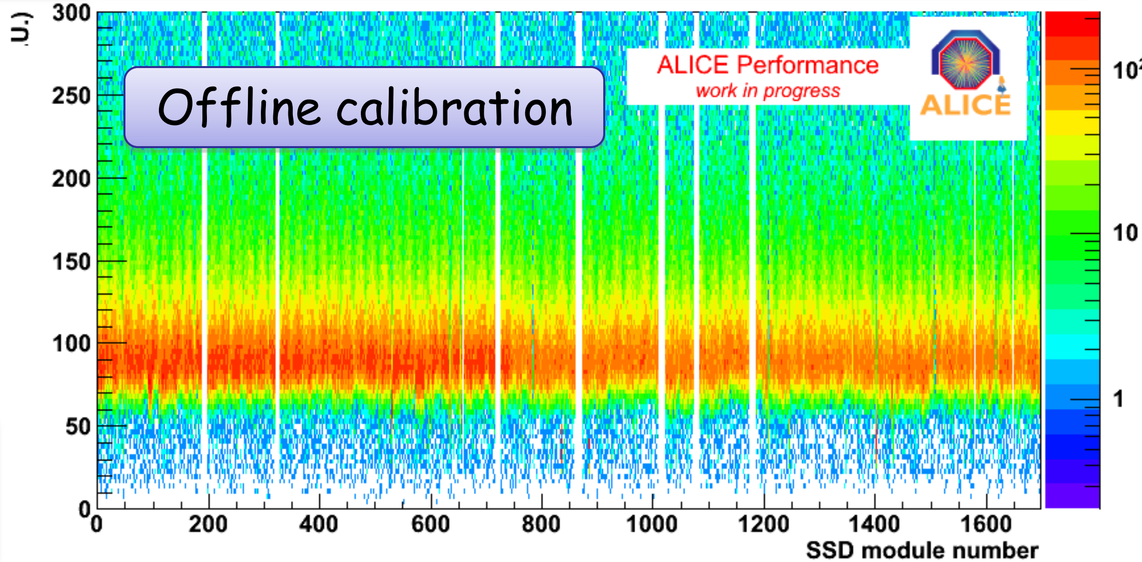
ITS operation and calibration

SPD efficiency in Data and in MC:



SPD: for details see posters by V. Altini, R. Ferretti, C. Terrevoli

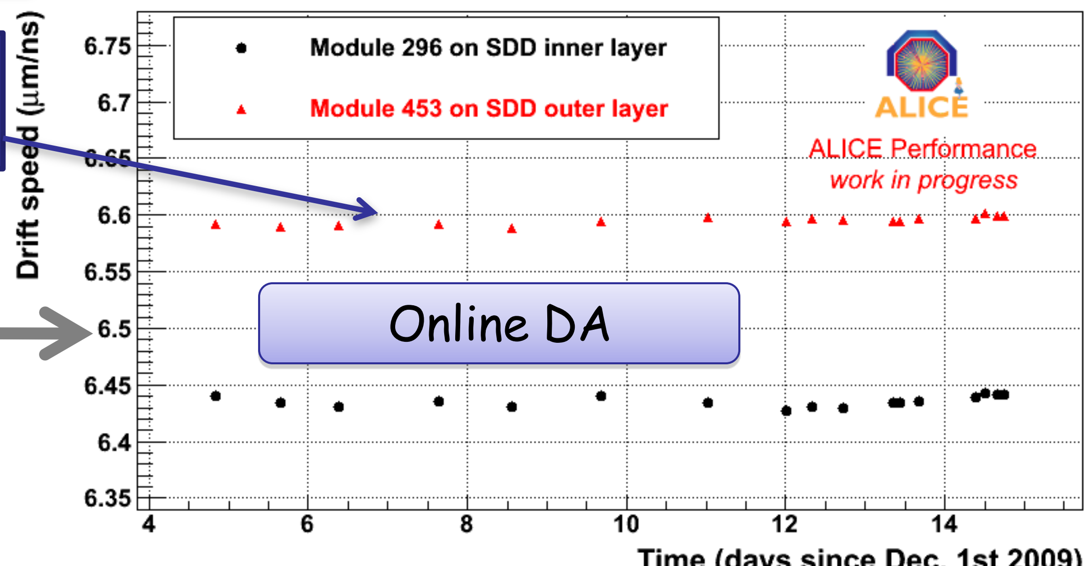
SSD: module-by-module charge distribution



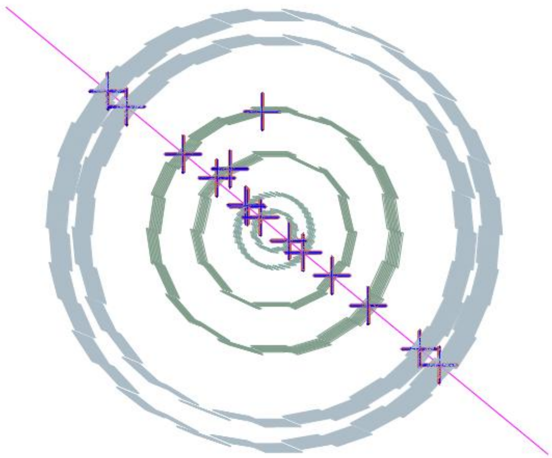
drift speed measured via integrated charge injectors

SDD: drift speed vs. time during p-p run in Dec. 2009

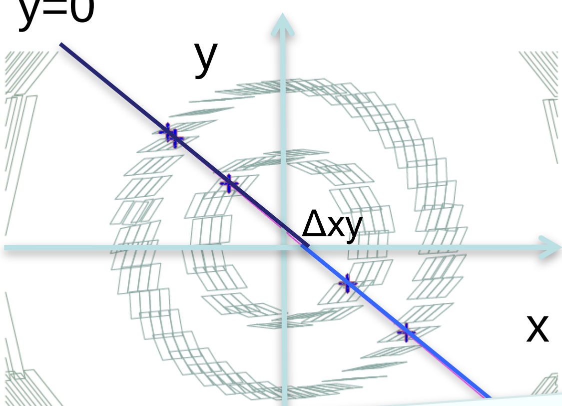
→ drift speed stability better than 0.15% for most SDD modules



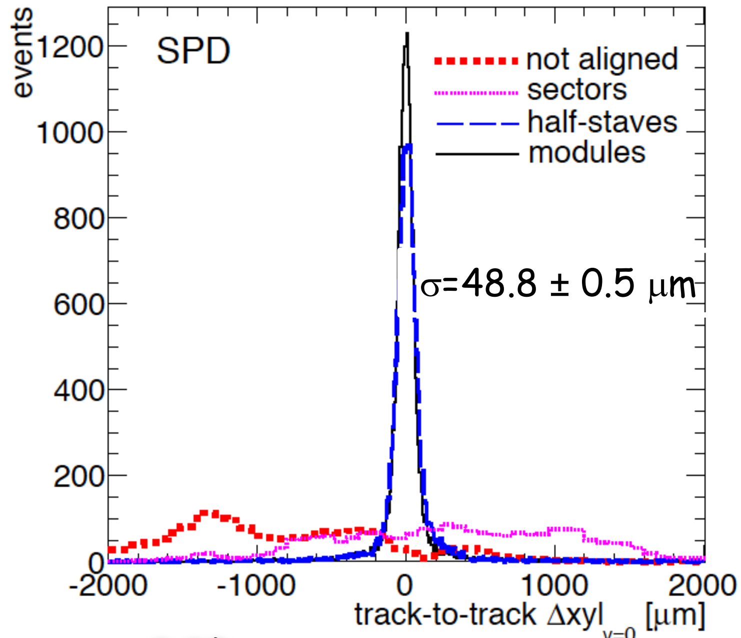
ITS Alignment: results



$\Delta xy \rightarrow$ distance between 2 half tracks in the xy plane at y=0



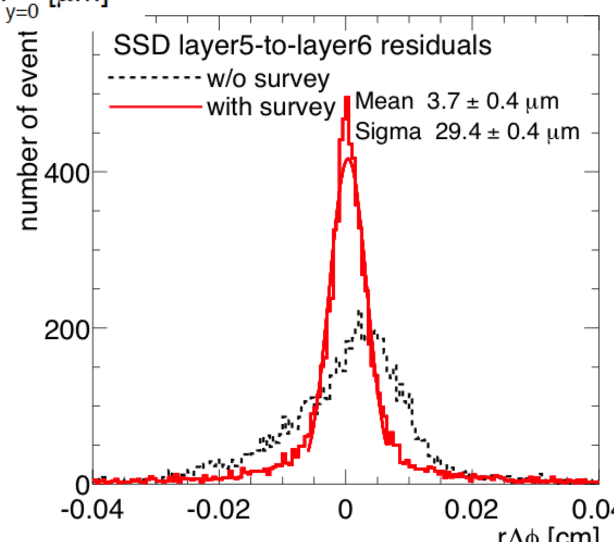
Alignment of the ALICE inner tracking system with cosmic-ray tracks
ALICE collaboration 2010 JINST 5 P03003



Alignment with Millipede for **SPD** → hierarchical approach

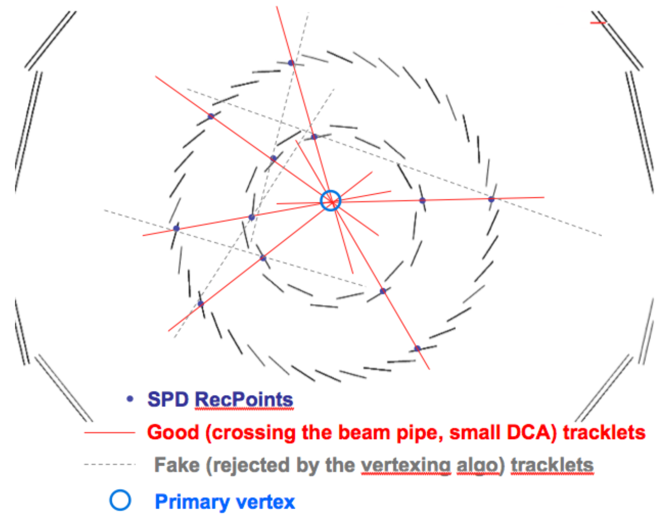
SSD

- Good alignment with survey
- Millepede with cosmics used mostly to align the whole SPD barrel w.r.t. SSD



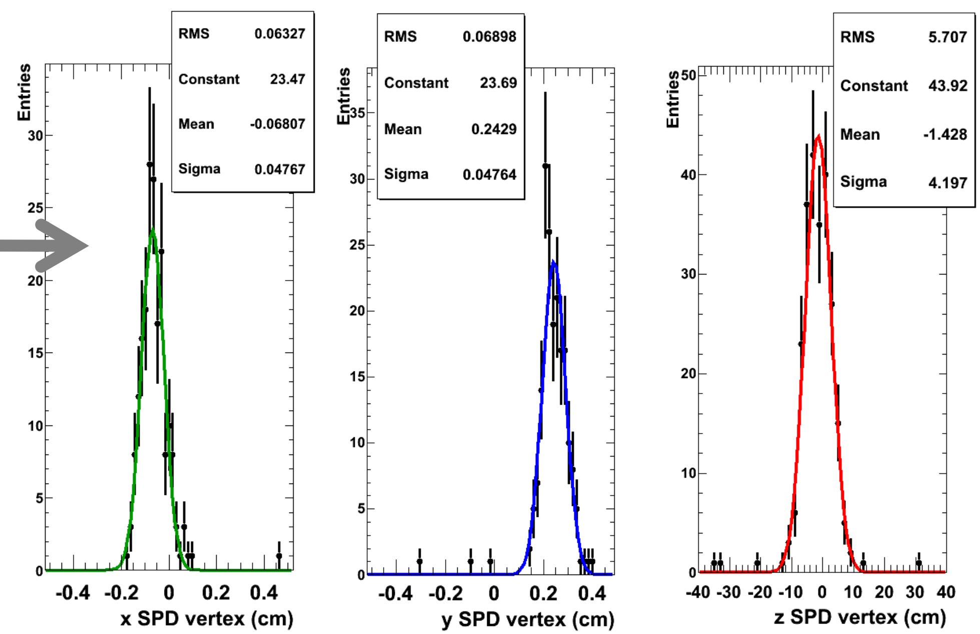
Primary Vertexing in ALICE

- First reconstruction of interaction vertex from SPD **tracklets** (pairs of points in 2 innermost ITS layers), before tracking (**VERTEX SPD**)
  - ⇨ Initiate barrel tracking + multiple scattering correction in muon arm
  - ⇨ Monitor the interaction diamond position quasi-online
  - ⇨ dN/dη measurement with SPD
- Second reconstruction of interaction vertex from **tracks** reconstructed in the barrel (**VERTEX TRK**)
  - ⇨ Accurate determination for physics analysis (e.g. D mesons) cfr. Talk by C. Bianchin

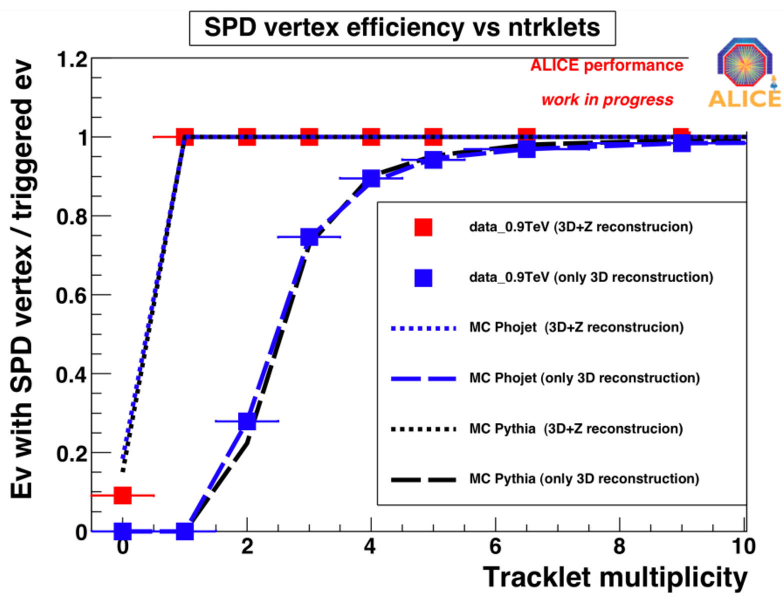


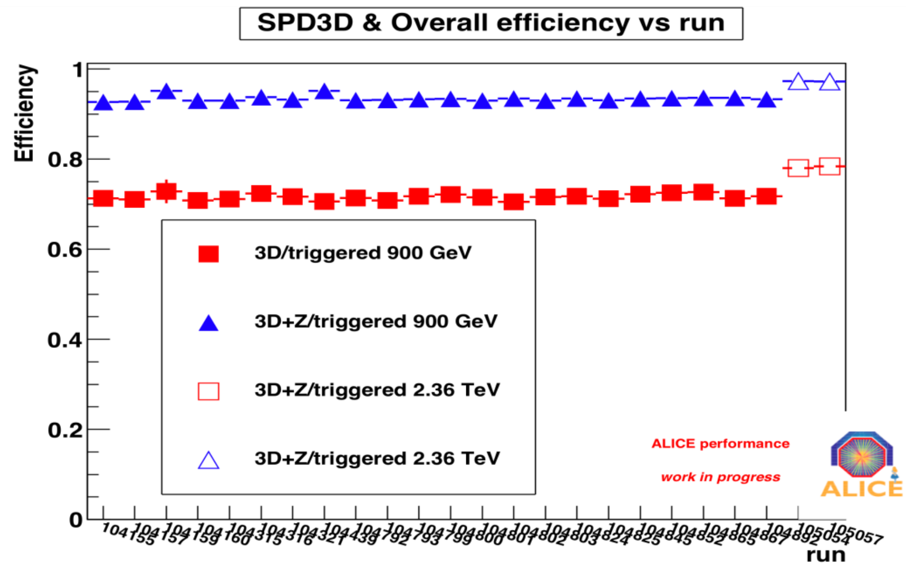
Coordinates of SPD vertices

- From first p-p run (Nov 23,2009)
- Vertex reconstruction efficiency= 94%



Vertex efficiency and resolution

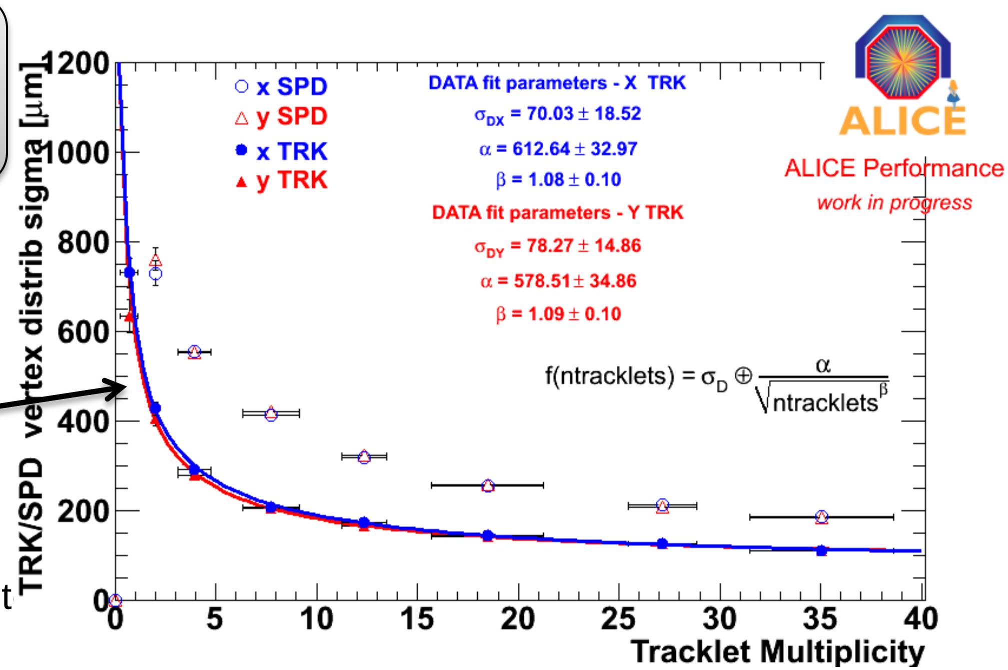




Multiplicity integrated	900 GeV	2.36 TeV
3D reconstruction	≈ 71 %	≈ 78 %
3D+Z reconstruction	≈ 93 %	≈ 97 %

SPD & TRK vertex - 3 param fit function 2.36 TeV

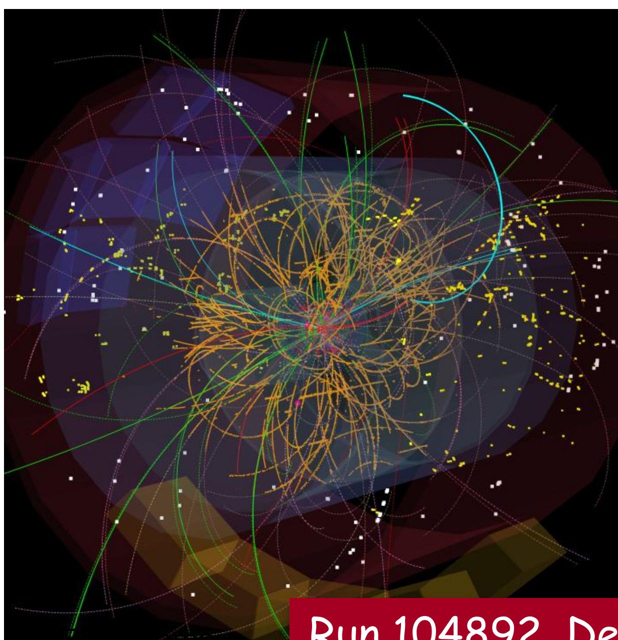
Good agreement DATA vs MC
(not shown in the plot)

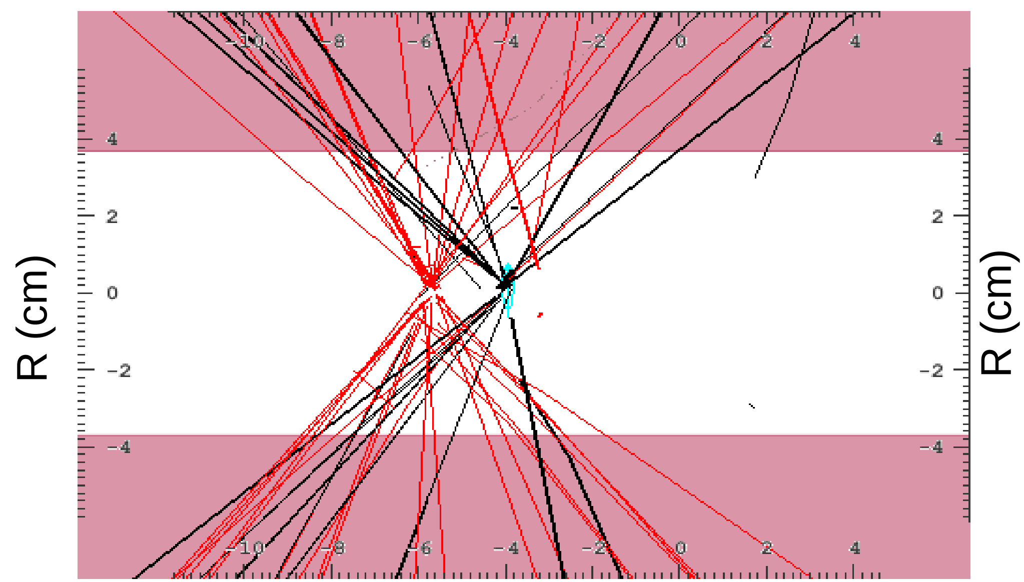


Pileup detection

- Interactions occurring in a time window of 100 ns (4 bunch crossings) pile-up in the SPD
- The SPD vertexer can be used to tag pile-up events
  - ⇨ After finding the first vertex, the tracklets which are not pointing to this ("main") vertex are used to check if there are other vertices originating particles

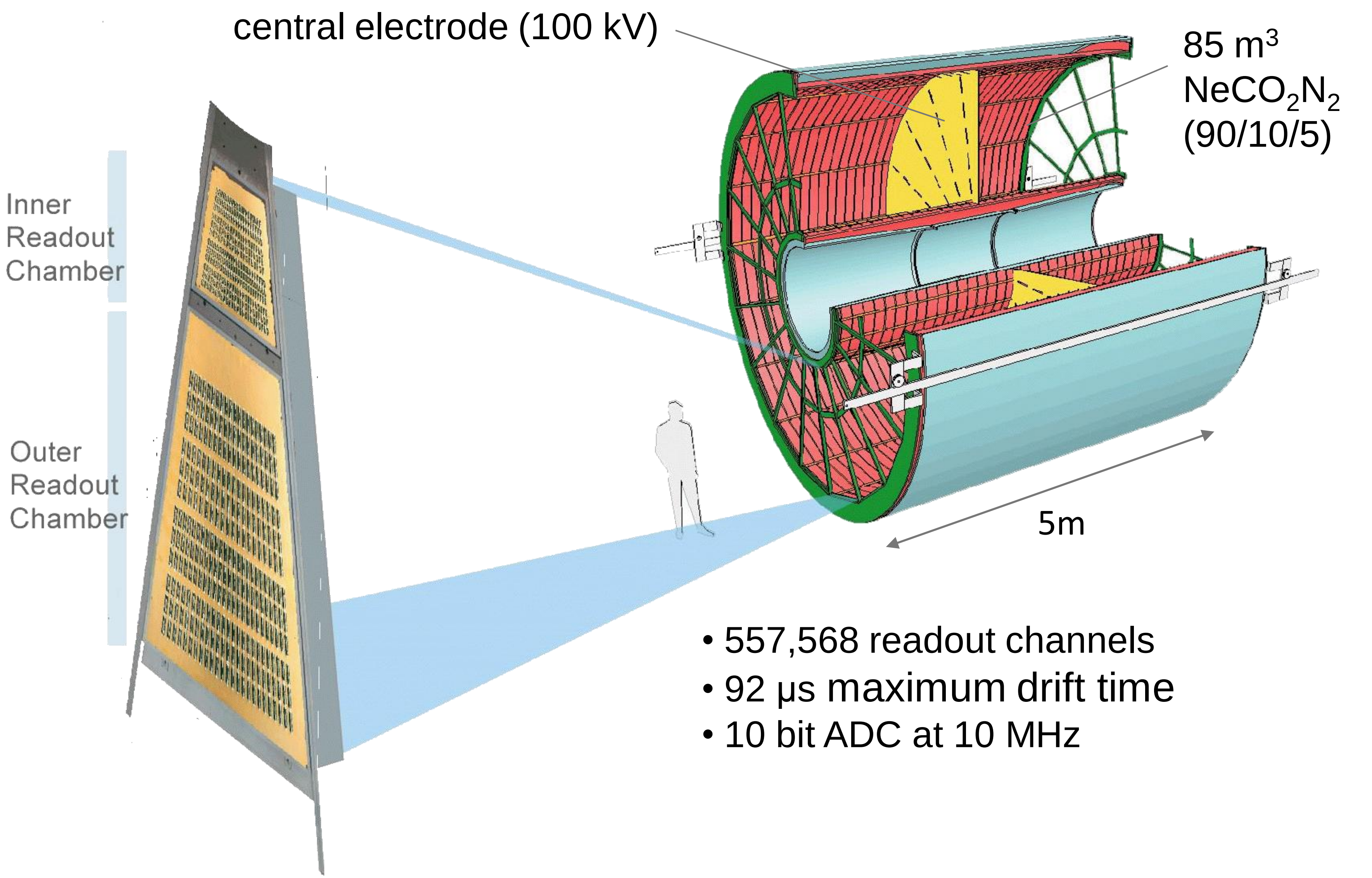
Event display of a pile-up event at 900 GeV





Run 104892, Dec 12th 2009, 8:47pm

Time Projection Chamber TPC

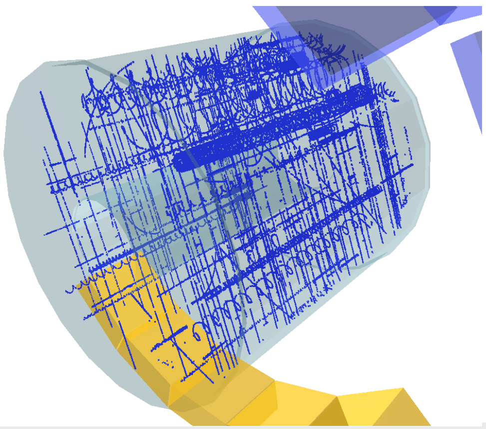


- 557,568 readout channels
- 92 μs maximum drift time
- 10 bit ADC at 10 MHz

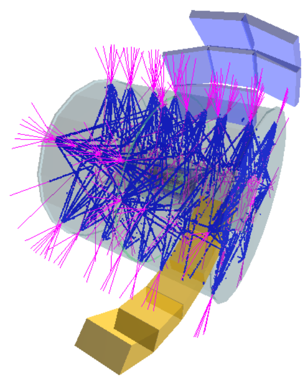
TPC calibration

- TPC installed in ALICE since 2007, running continuously from May to October 2008 and since August 2009
- > 750 million events (cosmics, krypton, and laser) recorded, with and without B
- first round of calibrations (dE/dx, momentum, alignment, gain) completed before collisions

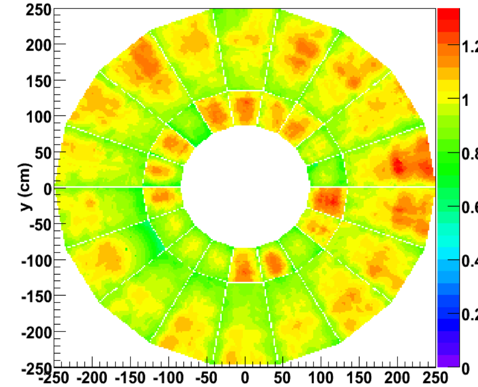
cosmic shower event



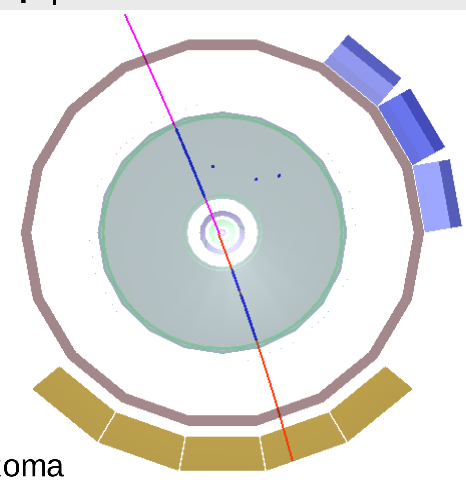
laser event

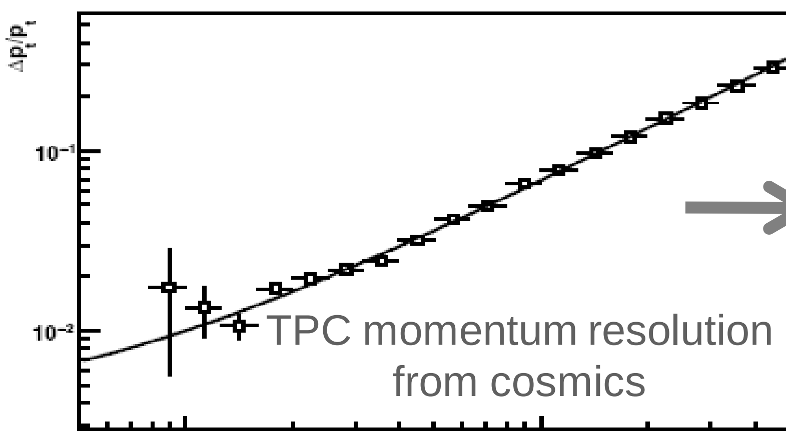


^{83}Kr gain map



p_T resolution from cosmics: match track segments of upper and lower half

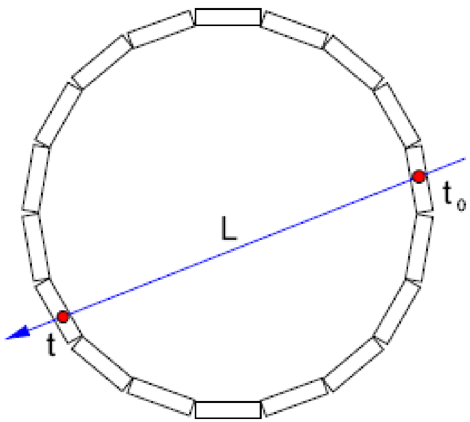




Preliminary p_T resolution: ≈ 7% at 10 GeV/c
→ design value (5% at 10 GeV/c)

J. Alme et al., TPC collab., arXiv:1001.1950

TOF performance

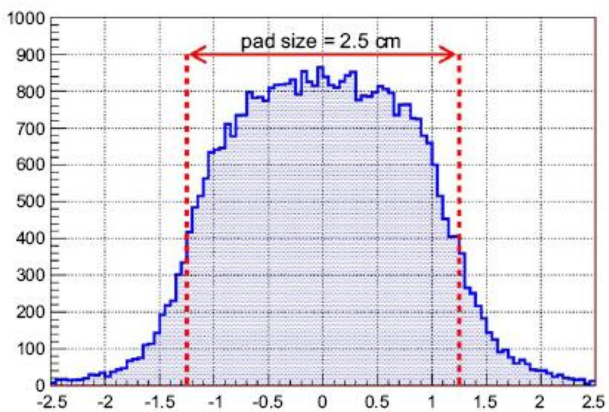


$\tau_{meas}=t-t_0$

$\Delta t=\tau_{meas}-t_{corr}$

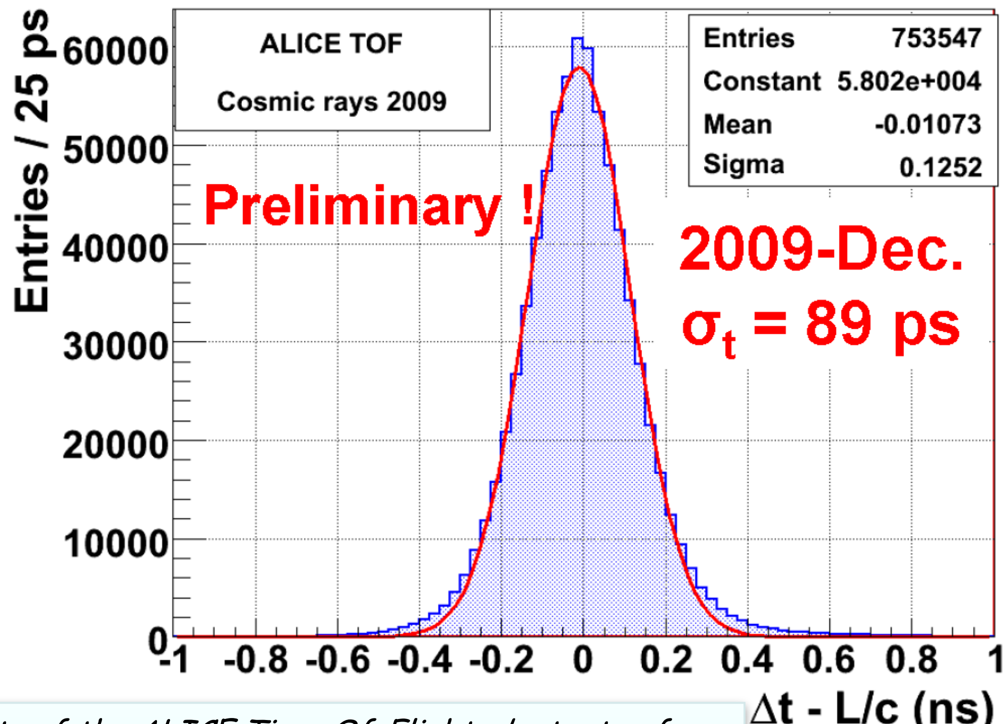
$\tau_{real}=L/c$

- Track Matching with TPC
  - FWHM = PAD size 2.5 cm
  - Smearing due to resolution on extrapolated track from TPC



Distanza TPC track – TOF hit

- Time resolution from cosmics
  - First corrections already implemented in 2008 σ=130 ps
  - After 2009: new calibration, more statistics, track quality selection -> σ=89 ps

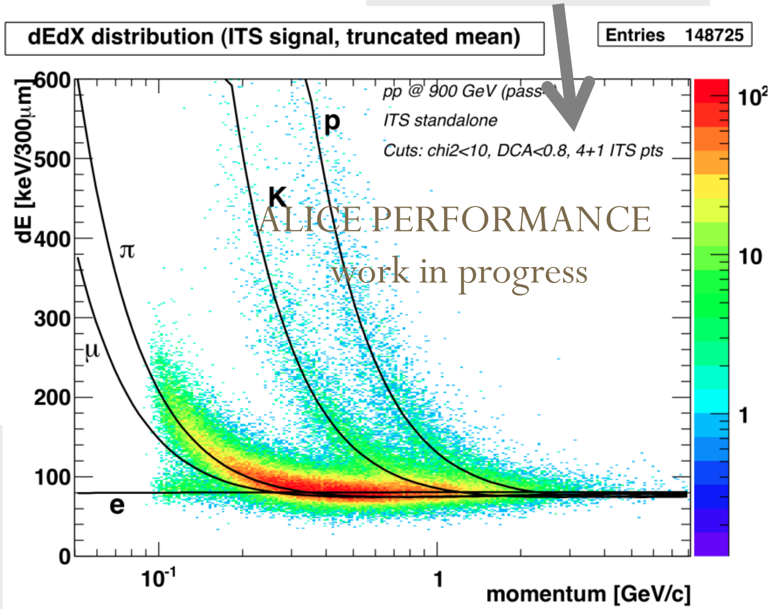


Results of the ALICE Time-Of-Flight deetector from the 2009 cosmic-ray data taking
ALICE-TOF collaboration Accepted by EPJC

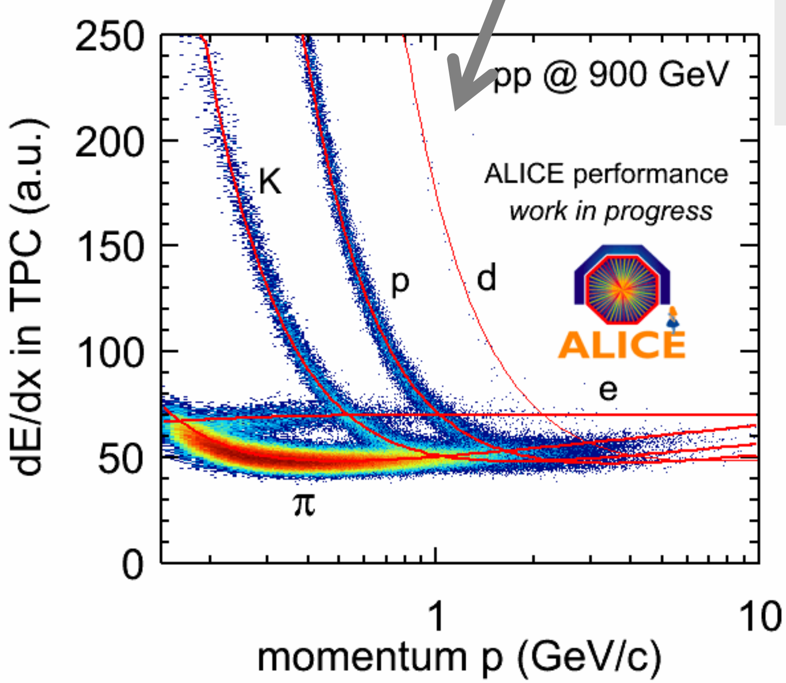
Conclusions

- Long way to commission, calibrate and align several detectors with different characteristics
- Results are paying off!

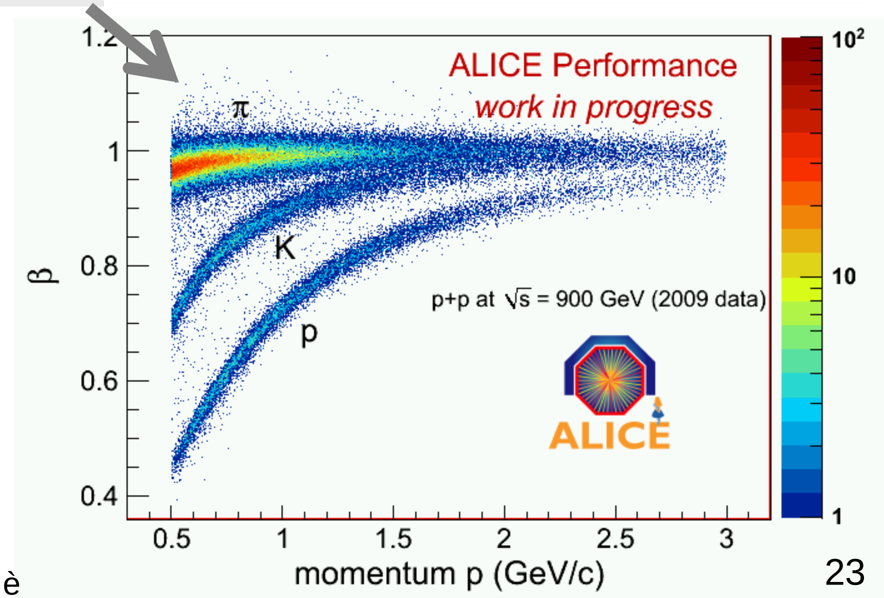
ITS dE/dx
→ down to 100 MeV/c



TPC dE/dx



TOF
→ ideal for high momenta



Backup

ITS alignment strategy

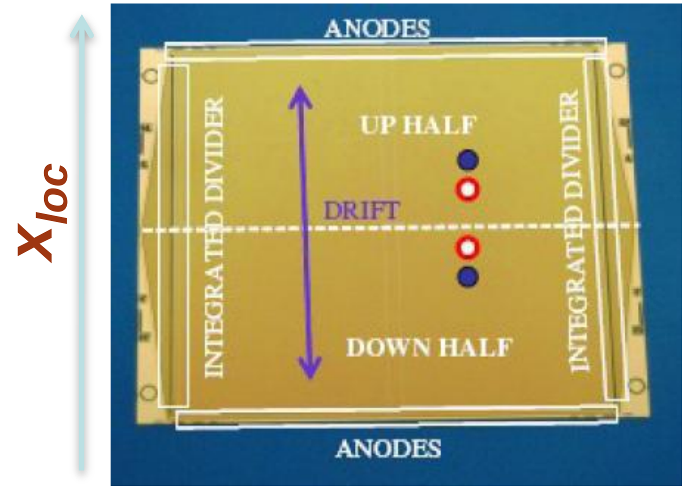
- Data sets: cosmics + first pp collisions (and beam gas)
  - ⇨ use cocktail of tracks from cosmics and pp to cover full detector surface and to maximize correlations among volumes
- Start with B off, then switch on B (pp)
  - ⇨ possibility to select high-momentum (no multiple scattering) tracks for alignment
- **General strategy**:
  - ⇨ validation of survey measurements with cosmics
  - ⇨ start with layers easier to calibrate: SPD and SSD
    - ✓ ***good resolution in rϕ (12-20 μm), worse in z (120-830 μm)***
  - ⇨ global ITS alignment relative to TPC (already internally aligned)
  - ⇨ finally, inclusion of SDD, which need longer calibration (interplay between alignment and calibration)
- Two independent track-based alignment methods:
  - ⇨ global: Millepede (default method)
  - ⇨ local: iterative method based on residuals minimization

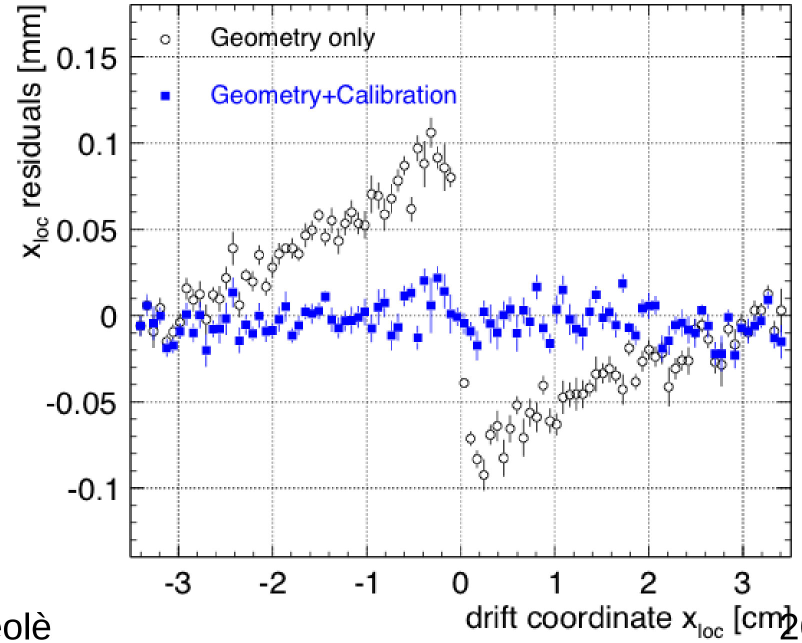
Alignment for Silicon Drift Detectors

- SDD → the two intermediate layers
- In SDD, local x determined from drift time:

  $$x_{loc} = (t - t_0) \times v_{drift}$$

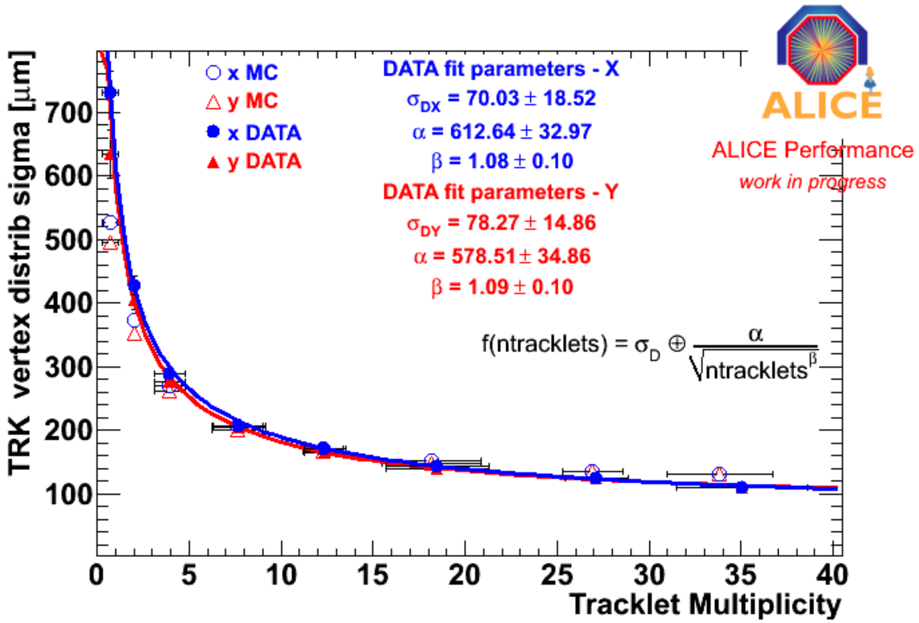
  ✓two calibration parameters: t_0 and v_{drift}
- Interplay between alignment and calibration
- t_0 and v_{drift} (also obtained from injectors) as additional parameters in Millepede

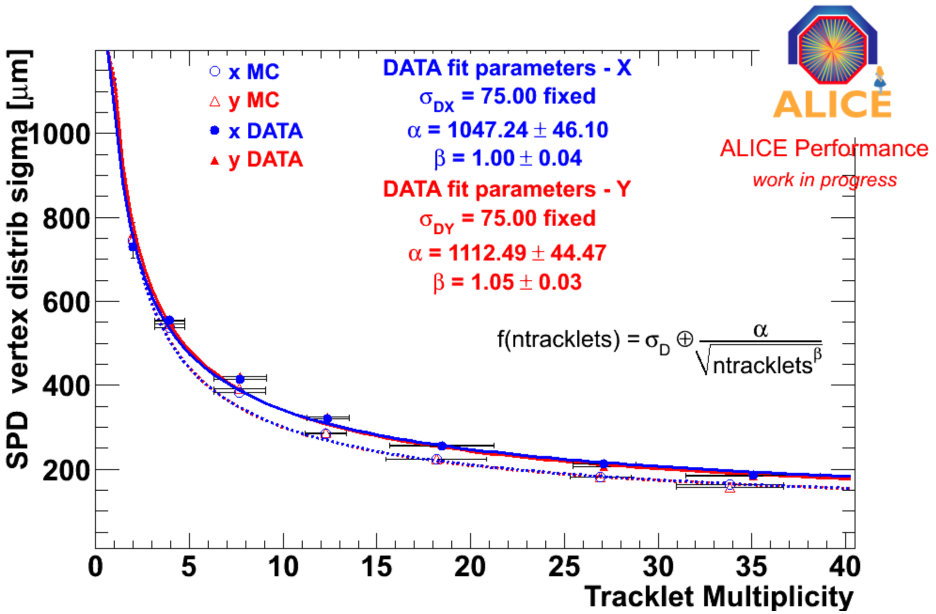




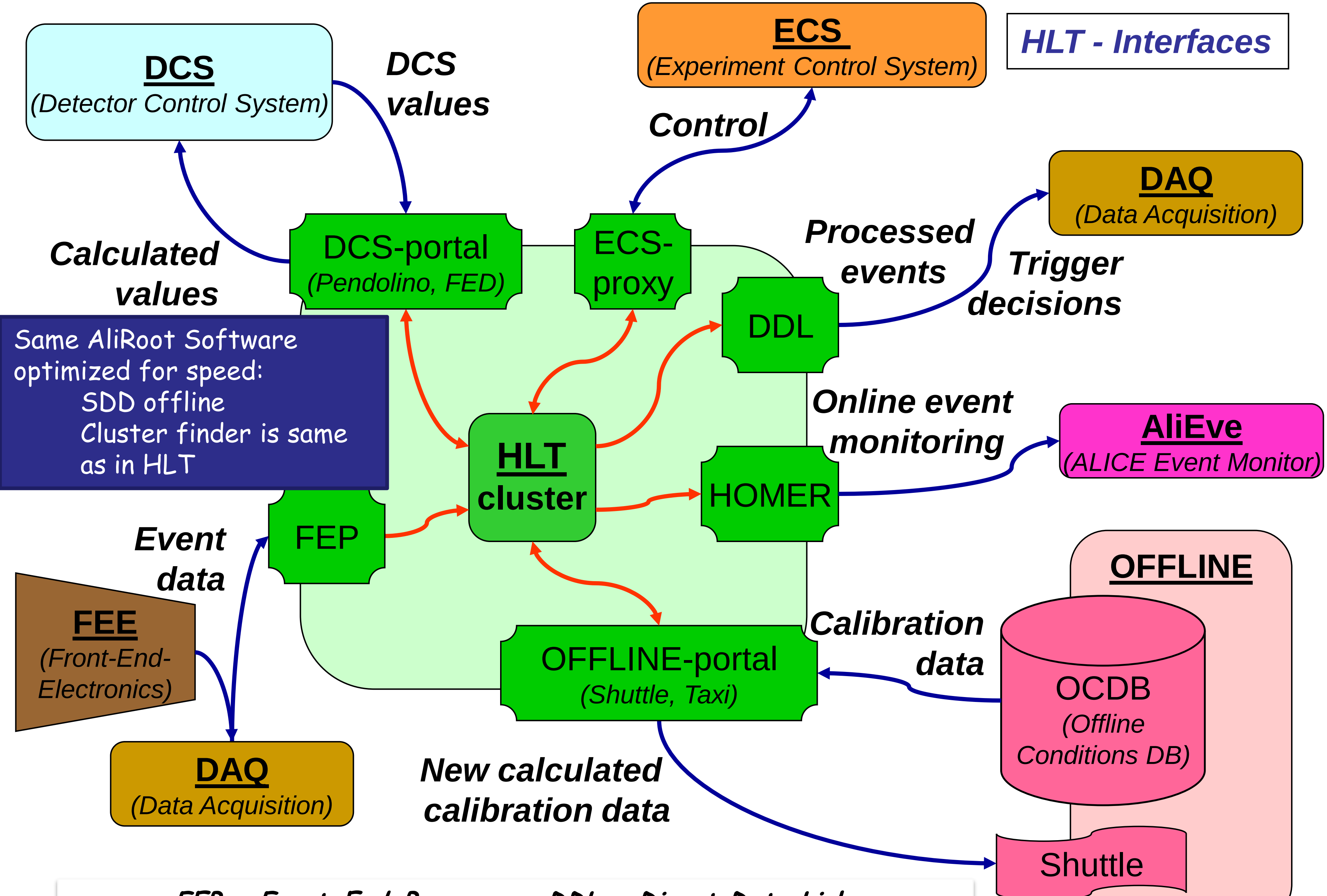
Comparison DATA – MC @ 2.36 TeV

- σ for VERTEX TRK and SPD vs tracklet multiplicity





HLT - Interfaces



Same AliRoot Software optimized for speed:
- SDD offline Cluster finder is same as in HLT

FEP = Front-End-Processor; DDL = Direct Data Link;
HOMER = HLT Online Monitoring Environment including ROOT

AMORE

Online Data Quality Monitoring Framework