

SciFi Simulation Reconstruction and First Tracks

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Clermont LPC, IN2P3, CNRS

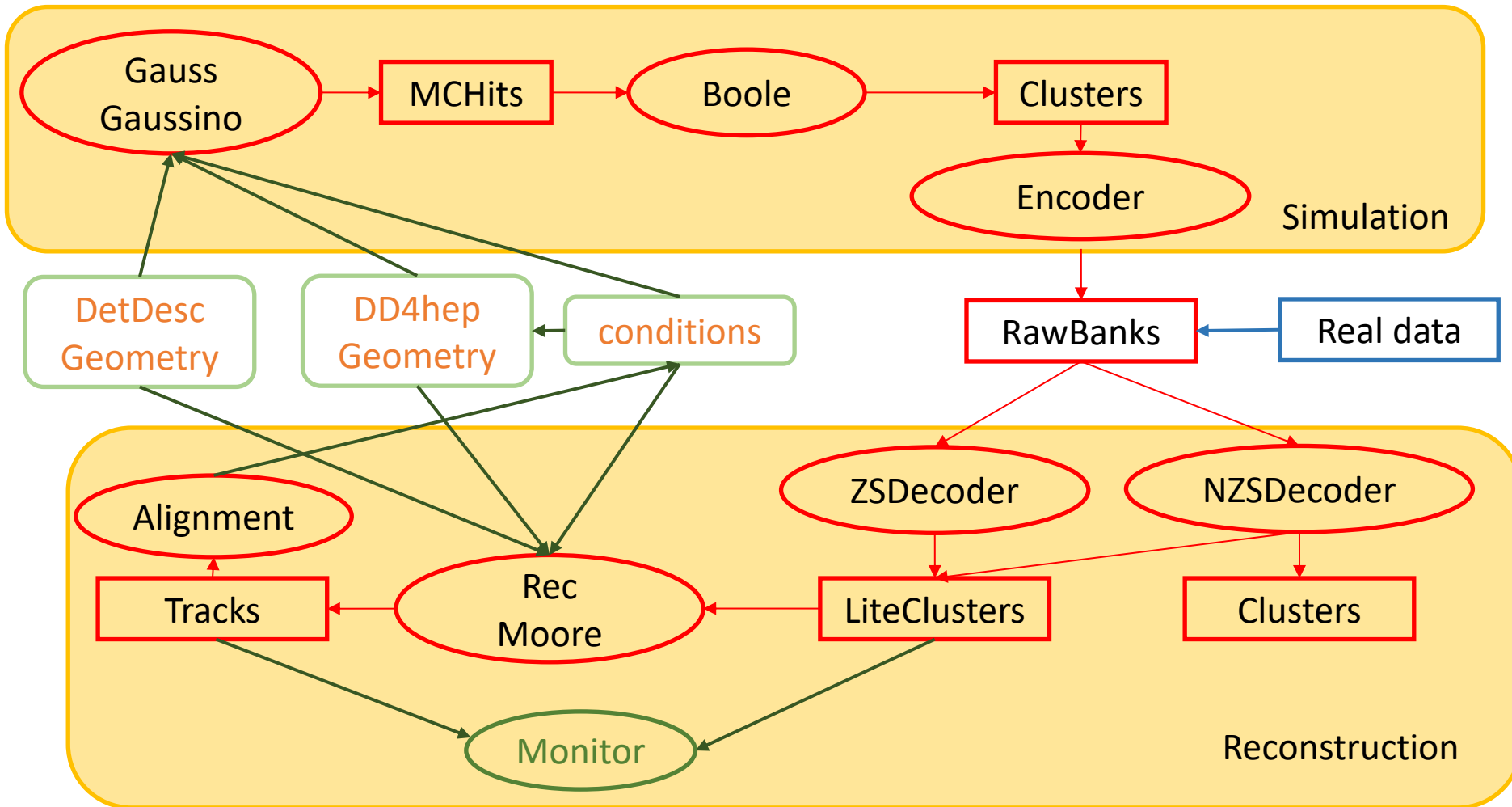
105th LHCb Week
September 5, 2022

Overview

- SciFi simulation and reconstruction:
 - Group meeting, Mondays at 1:00 PM;
 - [Twiki](#);
 - Mail list: lhcb-upgrade-ft-software

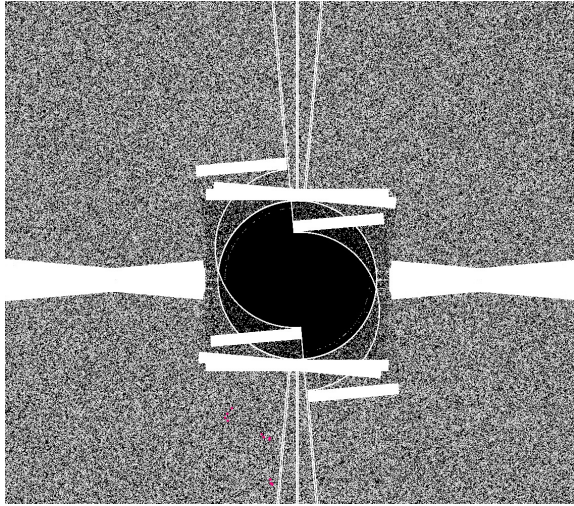
- Summary of key updates since [last LHCb week](#);
 - Simulation:
 - DD4hep migration
 - Overlapping fixed in Geometry
 - Reconstruction
 - Decoding
 - Monitor
 - Track reconstruction using real data

General frame of SciFi software



Mainly progresses on **DD4hep Geometry**, **Decoder**, **Monitors**

Simulation

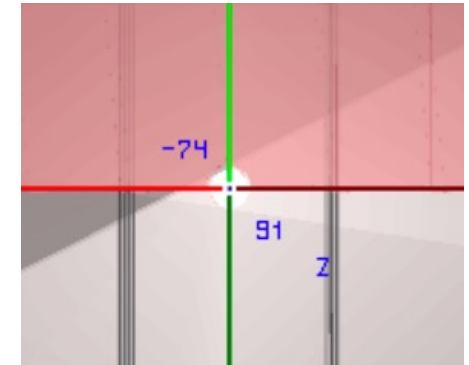


➤ Motivation:

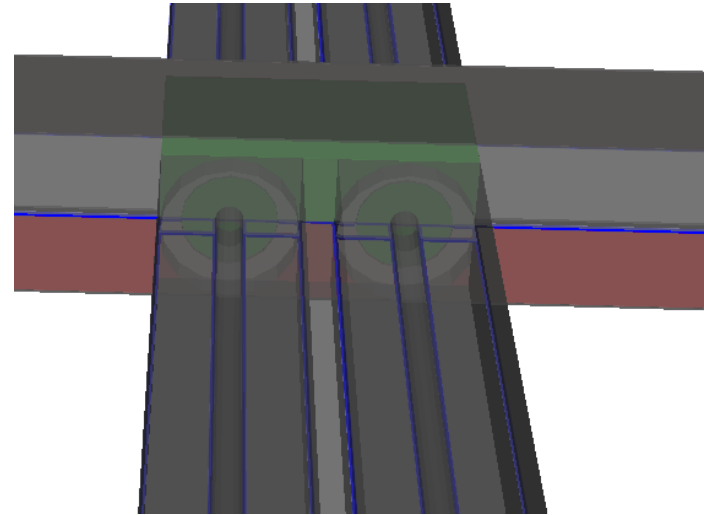
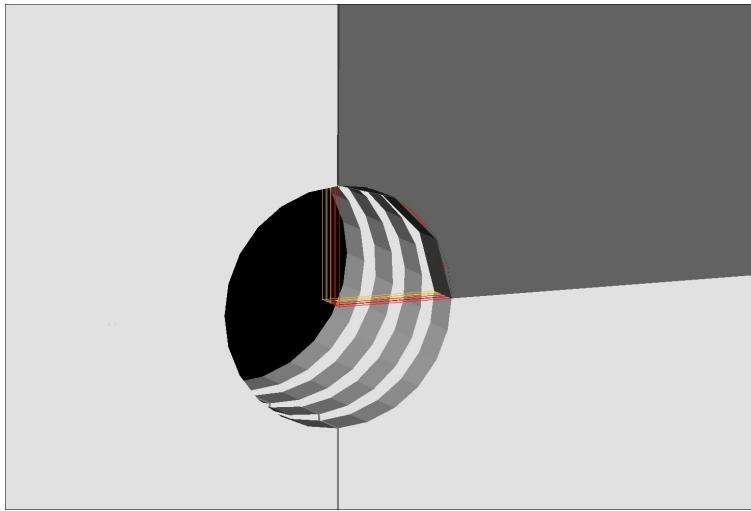
- No track reconstructed using DD4hep geo
- Misalignment of V-layer in the Gauss check

➤ Solutions:

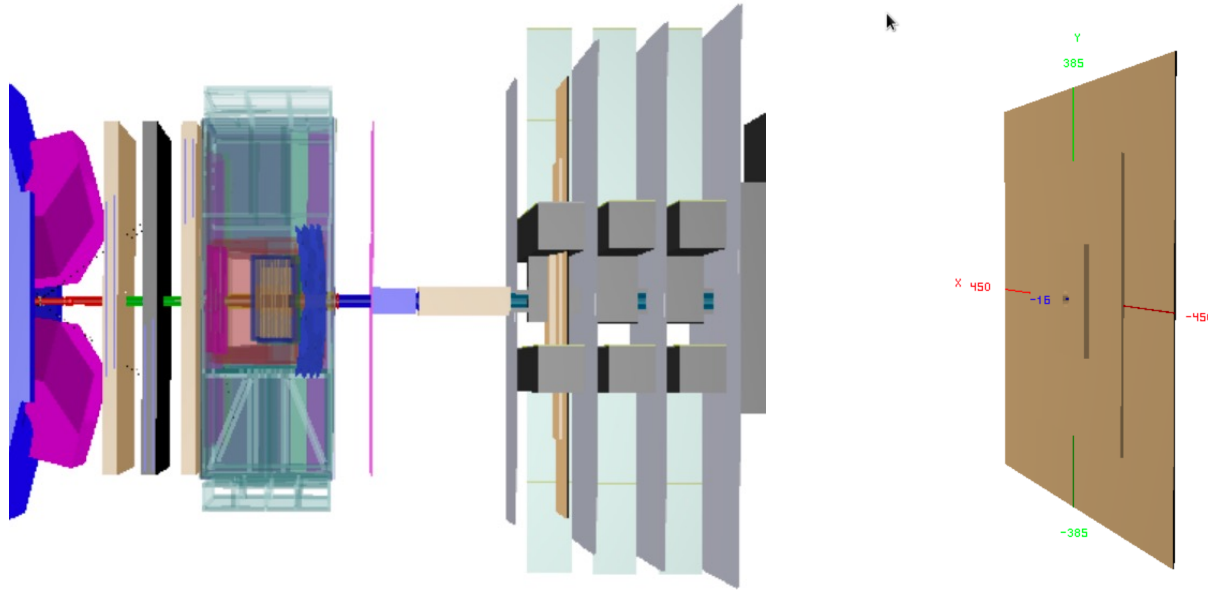
- A rotation issue when constructing Quarters in DD4hep
- V-layer hole position recalculated
- Detector: [MR! 271](#), [MR! 273](#)
- Tracking efficiency improved



```
BestLongTrackerChecker INFO Results
BestLongTrackerChecker INFO **** BestLong
BestLongTrackerChecker INFO 01_long : 34 from 37 [ 91.89 %]
BestLongTrackerChecker INFO 02_long_P>5GeV : 20 from 20 [100.00 %]
BestLongTrackerChecker INFO 03_long_strange : 2 from 3 [ 66.67 %]
BestLongTrackerChecker INFO 04_long_strange_P>5GeV : 2 from 2 [100.00 %]
BestLongTrackerChecker INFO 07_long_electrons : 2 from 2 [100.00 %]
BestLongTrackerChecker INFO 10_long_strange_P>3GeV_Pt>0.5GeV : 1 from 1 [100.00 %]
BestLongTrackerChecker INFO 6 ghosts [13.33 %], Event average 13.33 % ****
BestLongTrackerChecker INFO 0 clones [ 0.00 %], purity:100.00 %, hitEff: 96.87 %
BestLongTrackerChecker INFO 0 clones [ 0.00 %], purity:100.00 %, hitEff: 96.38 %
BestLongTrackerChecker INFO 0 clones [ 0.00 %], purity:100.00 %, hitEff: 98.21 %
BestLongTrackerChecker INFO 0 clones [ 0.00 %], purity:100.00 %, hitEff: 98.21 %
BestLongTrackerChecker INFO 0 clones [ 0.00 %], purity:100.00 %, hitEff:100.00 %
BestLongTrackerChecker INFO 0 clones [ 0.00 %], purity:100.00 %, hitEff: 96.43 %
```



- Overlapping might lead to produce wrong or repeated MCHit in Simulation
- Two sources of overlapping detected:
 - Layer geometry and hole subtraction
 - Overlapping in the SciFi frame (vertical bar and horizontal carrier) geometry
- Solutions:
 - DDDDB (DetDesc): [MR!109](#) (Under review)
 - Detector (DD4hep): [MR! 240](#) (Merged)



- Neutron shielding lost when comparing Geo in DD4hep & DetDesc
- Neutron shielding is used to protect SciFi (SiPMs)
- Solutions:
 - Detector (DD4hep): [MR! 276](#)
 - This check does not affect hits producing in Gauss and track reconstruction in Rec/Moore

DD4hep migration

Current status of DD4hep migration from last Detector software operation meeting (Need some updates)

Geometry check-point	BCM	RMS	PLUME	SMOG2	VELO	RICH	UT	FT	CALO	MUON
DetDesc description in DDDDB project	Done	Not yet	N/A	N/A	Done	Done	Done	Done	Done	Done
↪ merged in DDDDB upgrade/master	Done	Not yet	N/A	N/A	Done	Done	Done	Done	Done	Done
DetDesc description complete	In progress	Not yet	N/A	N/A	In progress	In progress	In progress	In progress	Done	Done
DetDesc description overlap-checked (TransportSvc, ROOT, pyg4ometry)	Not yet	Not yet	N/A	N/A	In progress	In progress	In progress	In progress	In progress	In progress
Alignment conditions associated with DetDesc detelem's	N/A	N/A	N/A	N/A	Done	Done	In progress	In progress	Done	Done
DD4hep description in Detector project	Done	Not yet	Done	Done	Done	Done	Done	Done	Done	Done
↪ merged in Detector master	Done	Not yet	In progress	Not yet	Done	Done	Done	Done	Done	Done
DD4hep description complete	In progress	Not yet	Not yet	In progress	In progress	In progress	In progress	In progress	In progress	In progress
DD4hep description overlap-checked (TransportSvc, ROOT, pyg4ometry)	Not yet	Not yet	In progress	In progress	In progress	In progress	In progress	Done	In progress	In progress
DD4hep validated against DetDesc (pyg4ometry)	Not yet	Not yet	N/A	N/A	In progress	In progress	Not yet	Not yet	Not yet	Not yet
Alignment conditions associated with DD4hep DetElems's	N/A	N/A	In progress	N/A	Done	Done	In progress	In progress	In progress	In progress
Conditions needed for reconstruction migrated to YAML database	N/A	N/A	Not yet	N/A	Done	Done	In progress	In progress	In progress	Done
Reconstruction software updated to use YAML conditions	N/A	N/A	Not yet	N/A	Done	Done	In progress	In progress	In progress	In progress
DD4hep and DetDesc cross-checked in G-on-G	Not yet	Not yet	N/A	N/A	In progress	Not yet	In progress	In progress	Not yet	Not yet
DetDesc detector elements in LHCb	N/A	N/A	N/A	N/A	Done	Done	Done	Done	Done	Done
↪ merged in LHCb master	N/A	N/A	N/A	N/A	Done	Done	Done	Done	Done	Done
DD4hep detector element skeleton in Detector	N/A	N/A	Done	N/A	Done	Done	Done	Done	Done	Done
↪ merged in Detector master	N/A	N/A	In progress	N/A	Done	Done	Done	Done	Done	Done
DD4hep detector elements fully populated in Detector + derived conditions in LHCb (if applicable)	N/A	N/A	Done	N/A	Done	Done	In progress	Done	In progress	In progress
↪ merged in Detector/LHCb master	N/A	N/A	In progress	N/A	Done	Done	In progress	Done	In progress	In progress
DD4hep & DetDesc detector elements compared	N/A	N/A	N/A	N/A	In progress	In progress	Not yet	Not yet	Not yet	Not yet

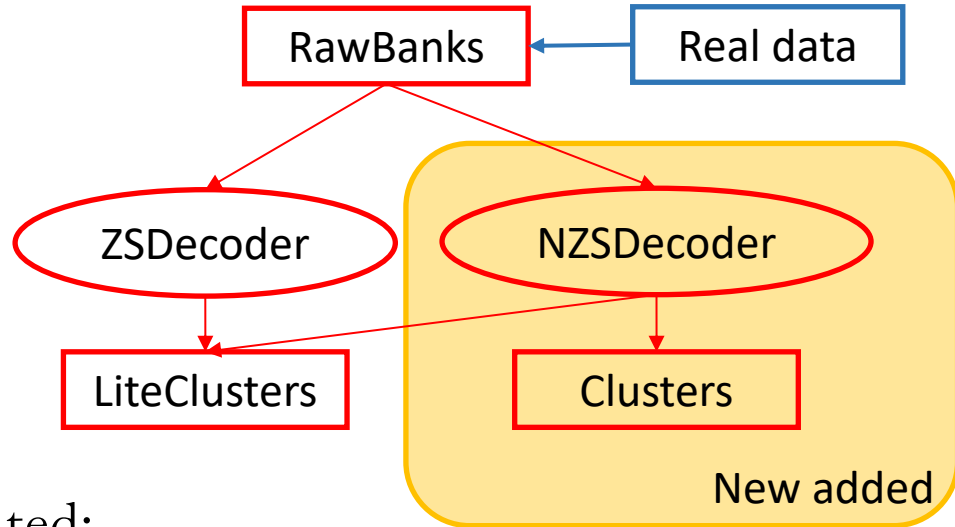
- Promise the completion after the overlapping check and DetDesc/DD4hep comparison
- Validate the alignment conditions both in DetDesc and DD4hep using Alignment

Reconstruction

- [LHCb#246](#): lots of clusters are marked “corrupt”. This is because currently the firmware is using decoding v5!
 - Choice to be made: decoding v7 could be ‘downgraded’ to read those clusters, but lose the parallelization, or we ask to change the FPGA.
- [LHCb#247](#): lots of segfaults.
 - SOLVED! Sometimes a given bank sends nonsensical data, added tests and monitoring.
 - Still needs to be investigated why.
- [LHCb#248](#): cluster ordering can not be obtained through remapping yet
 - Still open. Will be reconsidered when we have the time.
- Overall:
 - Decoding CPU and GPU have been **verified to give the same clusters**.
 - Decoding works. Open issue of the large clusters to be solved, and cluster bias needs to be discussed further.

➤ Motivation:

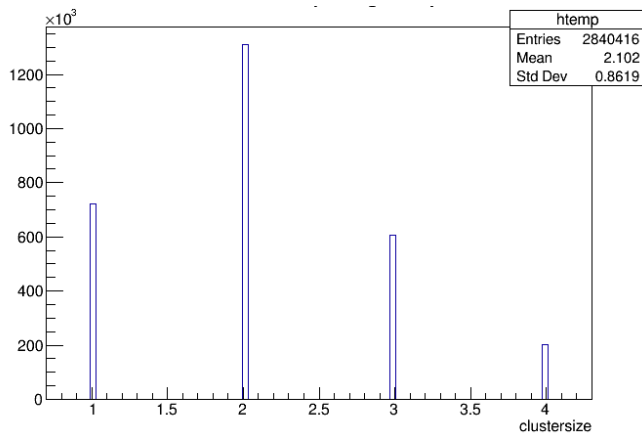
- Previous NZS Decoder used to produce LiteClusters
- Not Lite Clusters required when studying the detailed clusters using real data



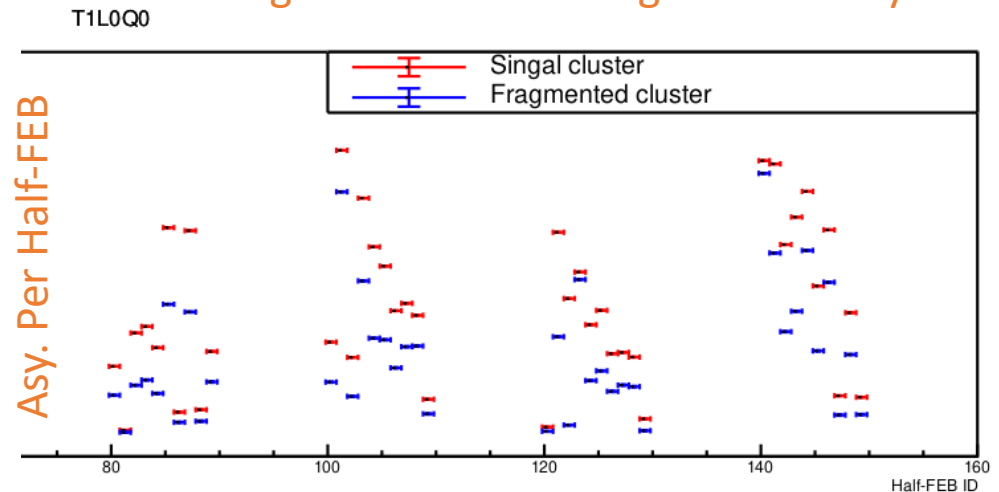
➤ A new NotLiteDecoder implemented:

- LHCb: [MR !3747](#)
- Works well locally, need to rebase before merging

e.g. Fraction of width of cluster in real data



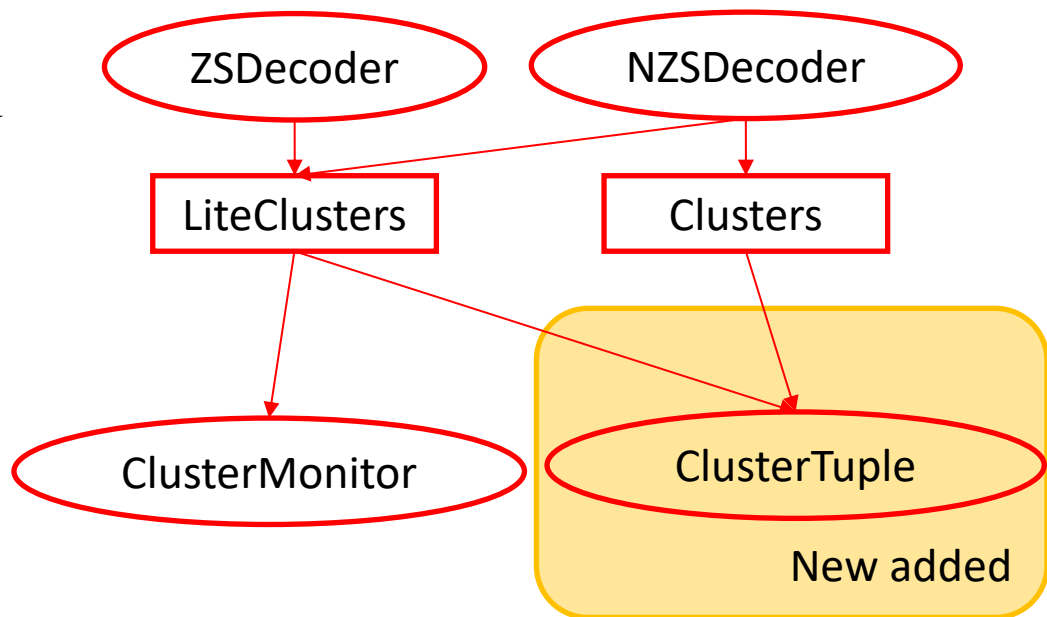
e.g. Detailed time-alignment study



- Cluster Monitor updated for time alignment study, some new functions implemented:

- Added correlation plot
- Added mean TAE shift histograms/profiles
- Added new tags in options
- ...

Rec: [MR!3083](#)

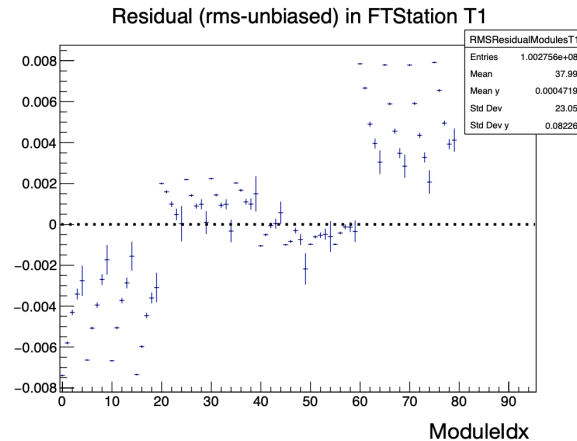
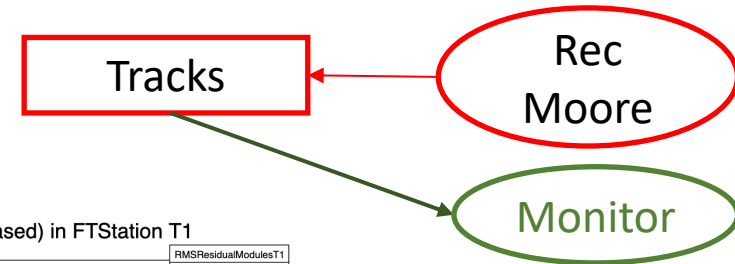


- ClusterTuple implemented:

- Save the LiteClusters and Clusters into tuples, convenient for detailed offline study (e.g. time alignment)
- Rec: [MR !3747](#)

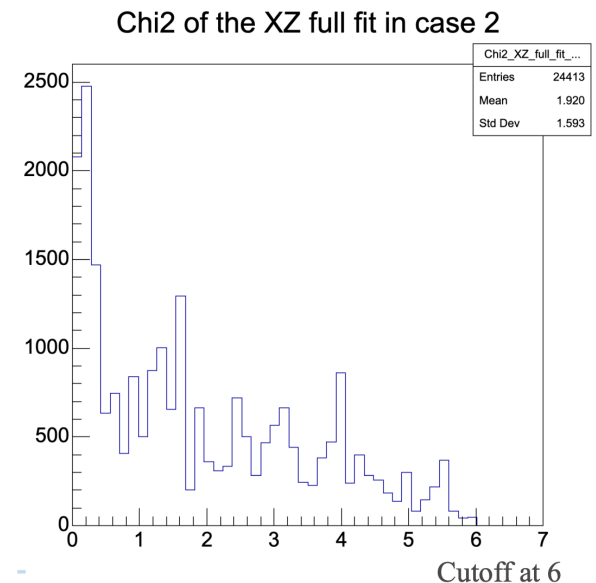
- Update long track monitor:
 - New output tuple mode for track information and hit information
 - Some development is ongoing

Rec: [MR!3080](#)



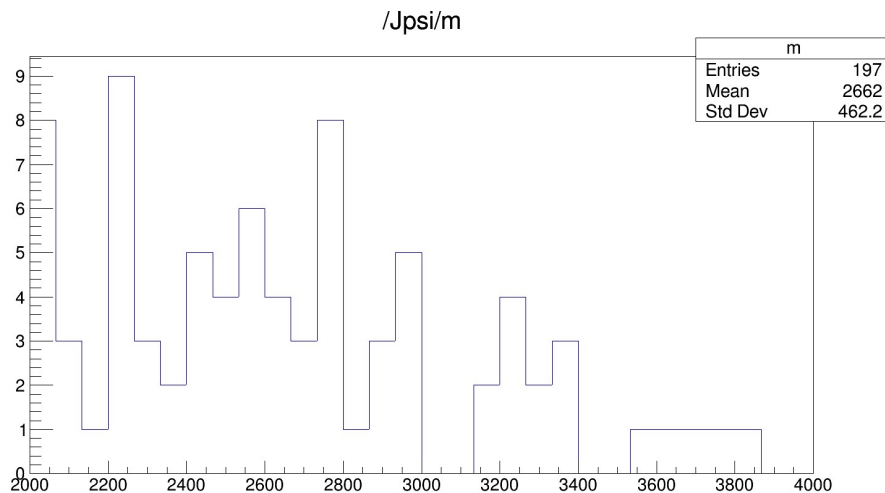
- New function to monitor the seeding performances, put variable in histograms:

- Very useful when study the tracking performance using real data
- Rec: [MR !3086](#)



Tracking using real data

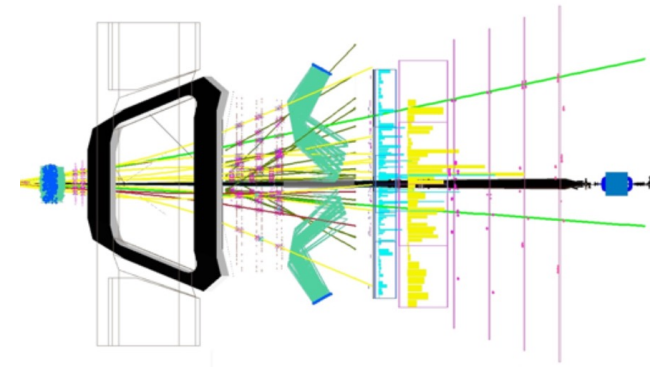
- Muons reconstructed from “SeedMuon” tracks in Muon and “HybridSeed” tracks in SciFi:



Run : 243277

Mag: Done

1 billion events with CaloActivity trigger

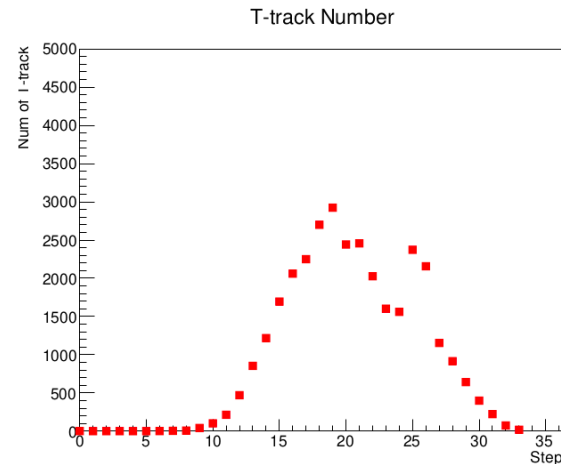
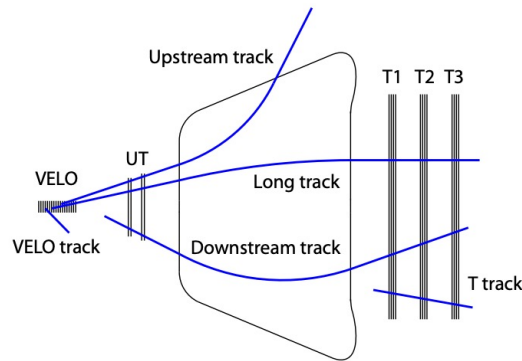


- No obvious peak now:

- No supersize, T track rec. efficiency expected very small due no alignment performed;

- Motivation:
 - TA (time alignment) might affect tracking significantly (SciFi Hits efficiency)
 - Check the performance of recent survey
 - Try to understand why no track now
- Reconstructed T tracks using beam scan data, using **HybridSeeding** Alg

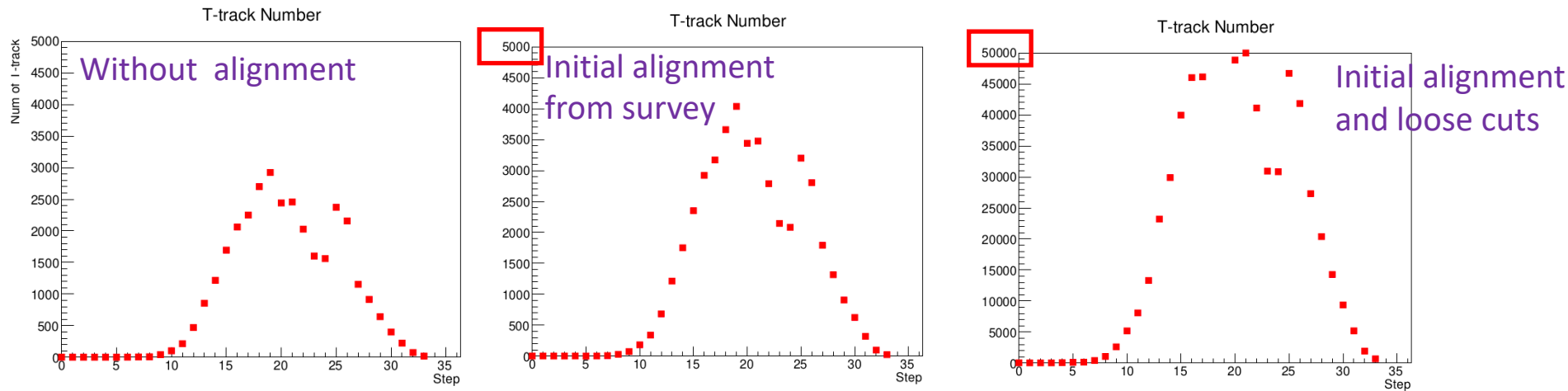
Run : 241680; Mag: Done; 2.5 M events per step (Only C-side)



- Time alignment has **significant effect** on the track reconstruction;

T-tracks initial alignment and Loose cuts Louis, Zehua

- After a rough time alignment, the track efficiency is still very small (More check after initial alignment)



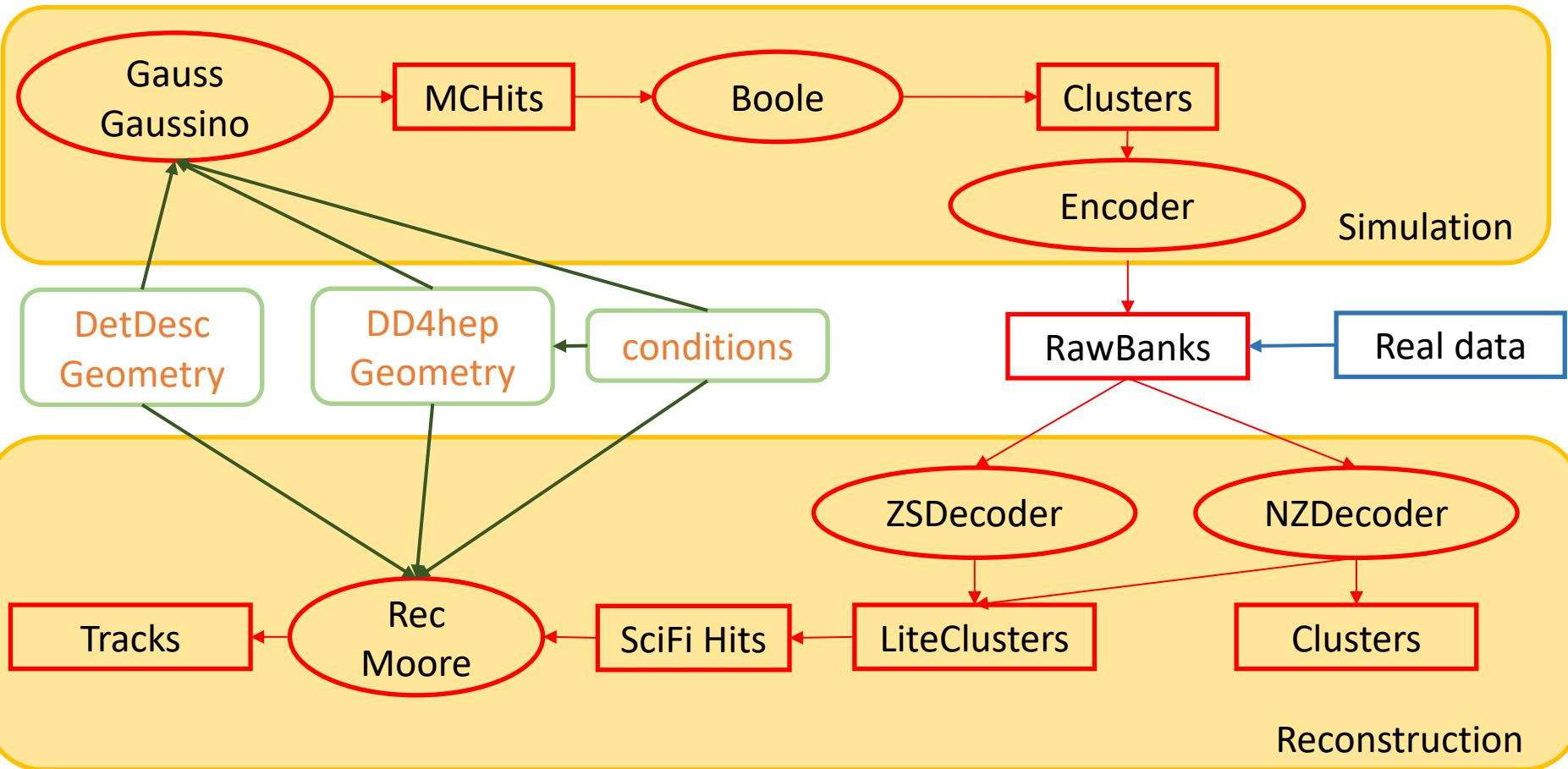
- Very initial alignment (from survey) helps the tracks reconstruction;
- Loose cuts (in PybridSeeding) help reconstruct more tracks, detailed alignment **might significantly affect** tracking efficiency

Summary and plans

- Simulation:
 - Progress:
 - All detector elements migrated to DD4hep;
 - Overlapping fixed;
 - Initial tests in Gauss/Rec/Moore are good
 - Plan, fully comparison between DetDesc and DD4hep
 - Check the conditions
 - Validate DD4hep in Gauss/Boole and Rec/Moore (with Sim/RTA)
- Decoding
 - Progress:
 - Fix some issues in Decoder v7;
 - Add a new NZS Decoder
 - Plan: Fix the noticed issue, e.g. the corrupt cluster in large segments
- Monitor: add more when required, demand-driven
- First Tracks:
 - First tracks reconstructed from SciFi
 - Initial time alignment and position alignment improve the tracking efficiency

Backup

SciFi software overview



General framework of SciFi software

Decoder update

Reminder:

Decoding v5: only edges of the large clusters are transmitted.

Decoding v6: edges of large clusters are encoded with the fraction and size bits to signify [BEGIN] and [END]. This allows to parallelise decoding over clusters.

Decoding v7: v6 but with link mapping.

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Choice to be made: decoding v7 could be ‘downgraded’ to read those clusters, but lose the parallelisation, or we ask to change the FPGA.

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Still needs to be investigated why.

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Still open. Will be reconsidered when we have the time.

Decoding CPU and GPU have been verified to give the same clusters.

Overall: decoding works. Open issue of the large clusters to be solved, and cluster bias needs to be discussed further.

Strategy-update

The same physical performance for 4 different geometry constructions:

DetDesc without halflayer:

- Overlapping check(Passed)
- Alignment conditions associated(Yes)
- Physical hit check(Ongoing)

=

DD4hep without halflayer:

- Overlapping check(Passed)
- Alignment conditions associated(Yes)
- Physical check (G-on-G)

||

||

DetDesc with halflayer:

- Overlapping check(Passed)
- Alignment conditions associated (Yes)
- Physical hit check(Ongoing)

=

DD4hep with halflayer:

- Overlapping check(Passed)
- Alignment conditions associated(Yes)
- Physical check (G-on-G)

Might need to update the channleID logic with halflayer element

Overlapping issue fixed

Recent overlapping check in DD4hep for FT:

```
Info in <TGeoManager::CloseGeometry>: 4427 nodes/ 96 volume UID's in Geometry imported from GDML
Info in <TGeoManager::CloseGeometry>: -----modeler ready-----
Info in <TGeoManager::SetVisLevel>: Automatic visible depth disabled
Info in <TGeoNodeMatrix::CheckOverlaps>: Checking overlaps for world_volume and daughters within 0.1
Warning in <TGeoMatrix::dtor>: Registered matrix was removed0:00
Warning in <TGeoMatrix::dtor>: Registered matrix was removed
Warning in <TGeoMatrix::dtor>: Registered matrix was removed
Warning in <TGeoMatrix::dtor>: Registered matrix was removed
Warning in <TGeoMatrix::dtor>: Registered matrix was removed
Warning in <TGeoMatrix::dtor>: Registered matrix was removed
Check overlaps:      [=====] 4427 [100.00 %]
Info in <TGeoNodeMatrix::CheckOverlaps>: Number of illegal overlaps/extrusions : 0
```

Loose HybridSeeding cuts

```
seedtracks.MinXPlanes=3
seedtracks.maxChi2HitsX=(20.,20.,20., 20.)
seedtracks.MinChi2HitFullRemove=(50., 50., 50., 50.)
seedtracks.MinChi2PerDofFullRemove=(50., 50., 50., 50.)
seedtracks.MaxChi2PerDofFullLow=(50., 50., 50., 50)
seedtracks.MinChi2PerDofYRemove=(50., 50., 50.,50.)
seedtracks.MaxChi2PerDofYLow=(50., 50., 50., 50)
seedtracks.MaxChi2PerDofYHigh=(50., 50., 50., 50.)
seedtracks.minUV6=(3,3,3)
seedtracks.minUV5=(3,3,3)
seedtracks.minUV4=(3,3,3)
seedtracks.Recover_minUV=(3,3,3)
seedtracks.TolXRemaining=(3., 3., 3.)
seedtracks.L0_tolHp=(560., 1080., 2160.)
seedtracks.L0_AlphaCorr=(200., 700., 1000.)
```