SDHCAL Reconstruction Software & Data Quality Control

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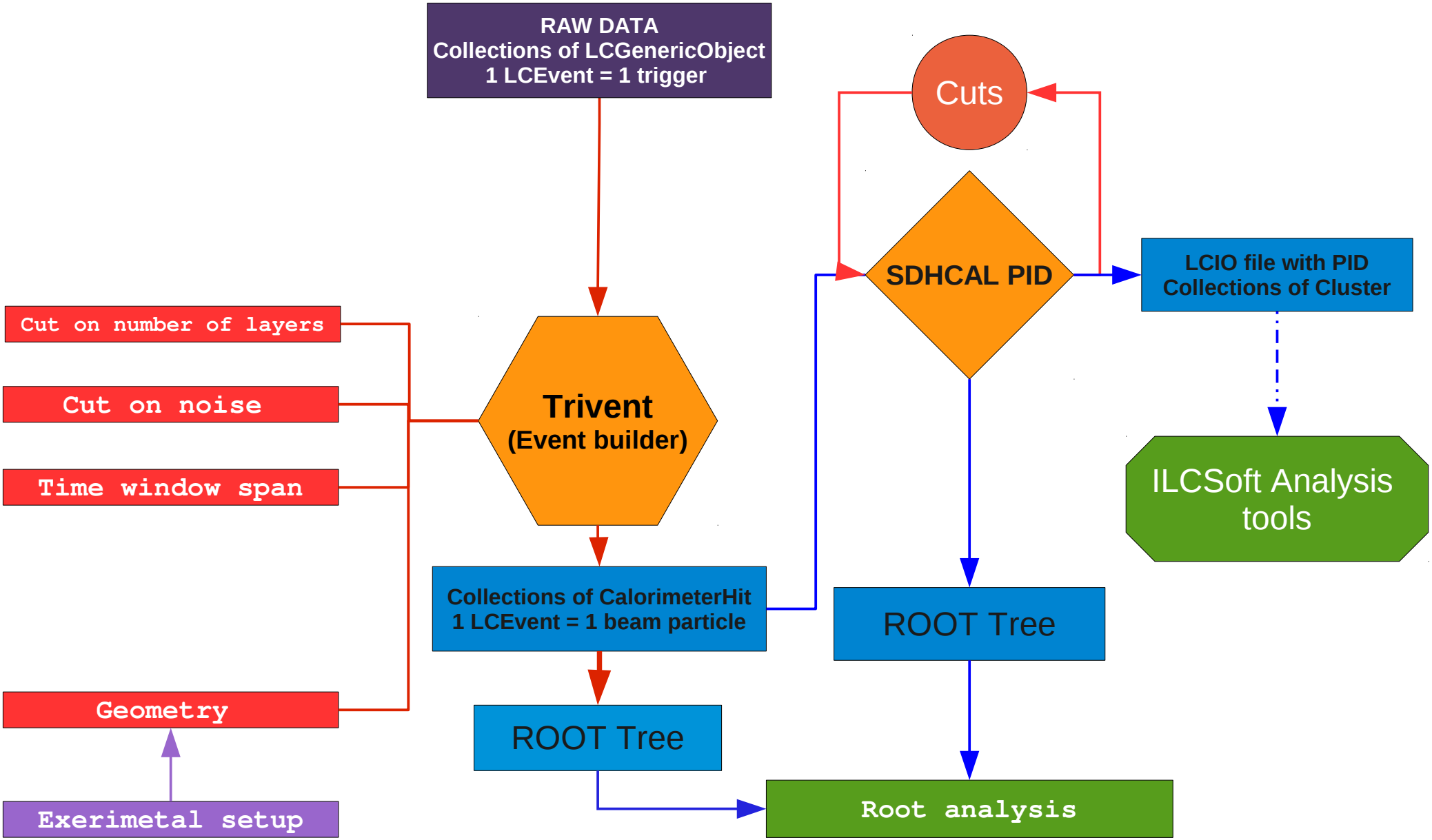
Outline

- Raw Data format.
- Data Reconstruction
- Data Quality
- Simulation
- Summary

Raw Data format

- The DAQ saves all hits (in trigger-less mode) with corresponding information on one time window (= 1 « Trigger »).
- The end of the trigger is the time of full memory of one of the detector ASICs.
- The dead time (~100ms) between two sucessive triggers is the time needed to transfer data from all ASICs.
- The raw data is first saved in a LCIO file as "LCGenericObject" with all information and environemental condition (temperature ...)

Summary Diagram of SDHCAL Data Reconstruction

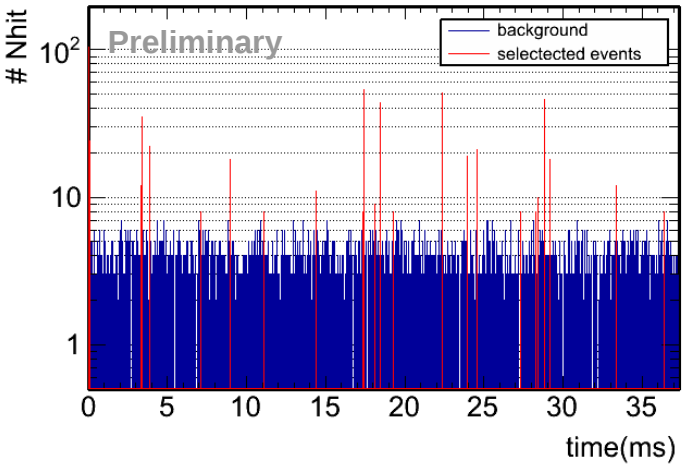


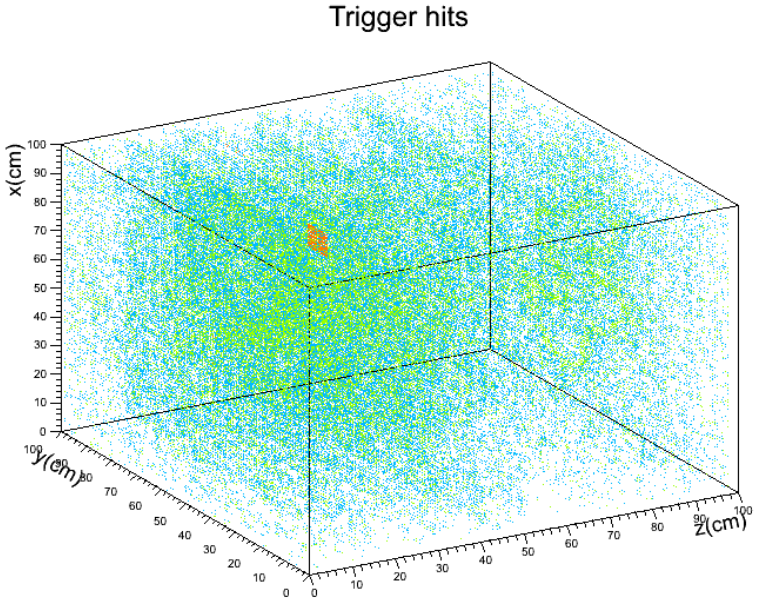
Data reconstruction Algorithm

- To select the physical events, a framework called Trivent has been developed based on marlin processor.
- Trivent selects the hits clusterised in time
- This selection follows 3 steps :
  - Determine the peaks on time spectrum with :

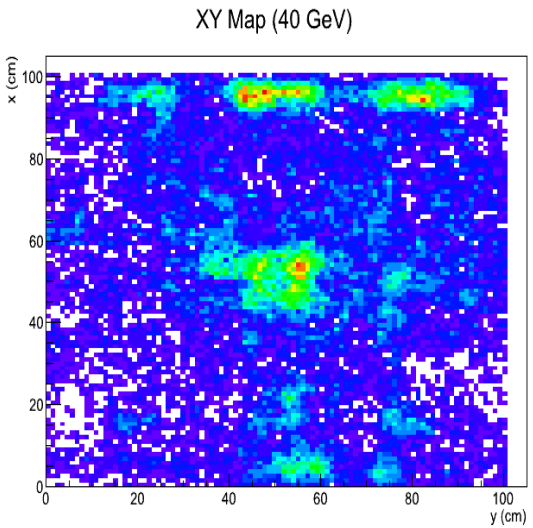
    Nhit > noise_cut
  - Select the hits in the time window :

    t_peak ± window_size
  - The selected hits are saved in the new LCIO file as CalorimeterHit collection.
- Cut to take only the physical events :
  - Number of layers> 7 (example)
- Add PID selection variables to tag events by type (on going).

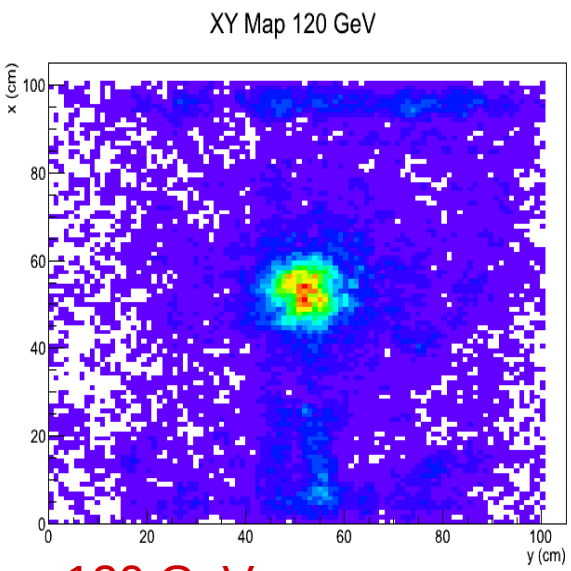




Number of fired layer cut



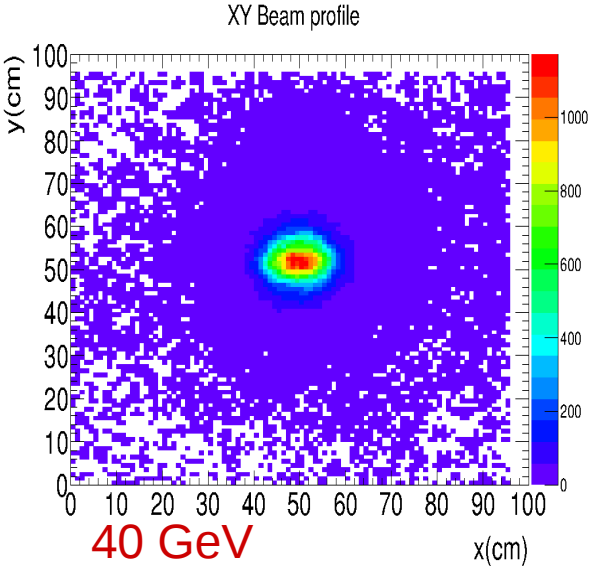
40 GeV



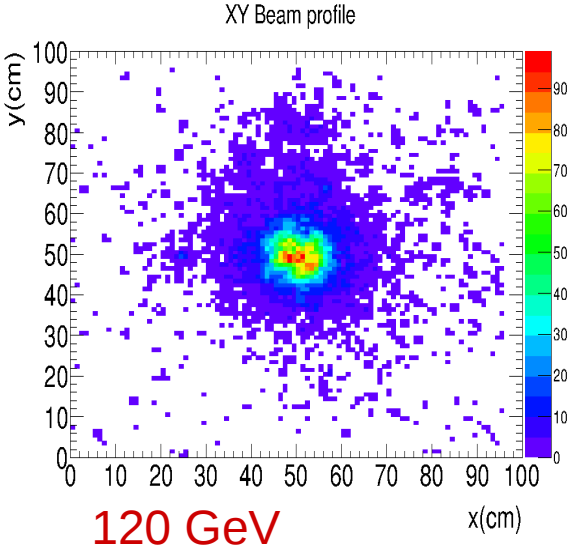
120 GeV

More than few layers
must be hit at the same time

- This cut reduces significantly the noise.



40 GeV



120 GeV

Where is the framework & Data ?

- The SDHCAL reconstruction framework is available on DESY SVN repository :

  https://svnsrv.desy.de/viewvc/trivent/

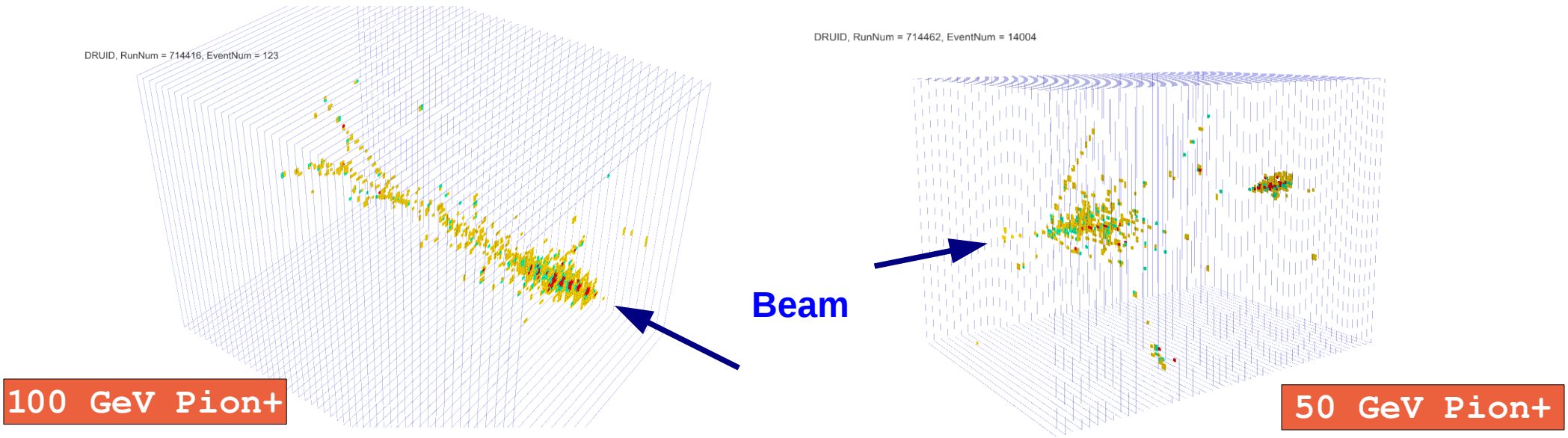
- The instructions for installation can be found in the README file.
- The user manual :
  https://twiki.cern.ch/twiki/pub/CALICE/SdHCal/Trivent_user_manuel.pdf
- **The Data are available on the CALICE Grid in the following folders for each period (PS & SPS) :**

```
/grid/calice/SDHCAL/TB/CERN/PS_April2012
                      ......  /SPS_May2012
                      ......  /SPS_AugSep2012
```

SDHCAL Event display "Druid"

Druid is an ILCsoft package used to display the events from a LCIO file.

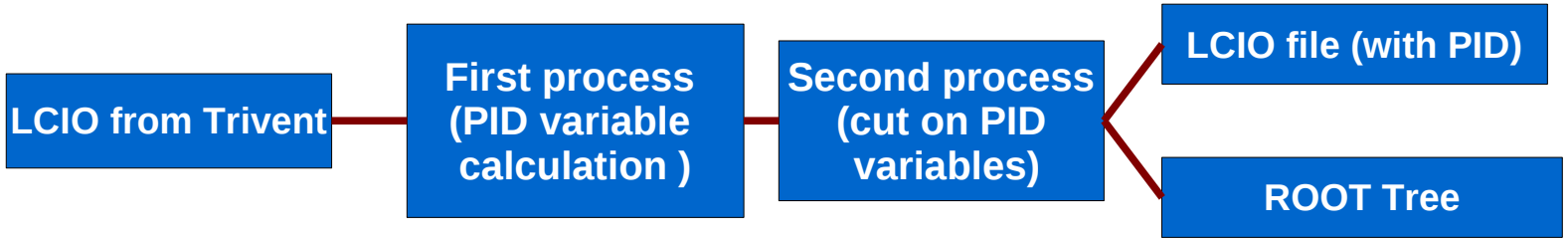
The folowing pictures are examples of 2 reconstructed events.



- The colours correspond to different thresholds.

SDHCAL preliminary PID

- A Module of PID is also under development to tag the event with the particle type. For testbeam events, the PID is performed on a cluster containing all the hits of the event, some cuts on PID variable define the kind of incoming particle.



- Number of Fired Layers : Nrpc
- Total Number of hits (Nhits) and for each threshold Nthr
- Maximum of Shower logitudinal profile :

$$N_{max} = max\ \{N_{hit}(K)\ |\ K \in [1,\ 50]\}$$

- Shower maximum position :

$$Z_{max} = Z(N_{hit} = N_{max})$$

- Shower begin position :

$$Z_{begin}\ with\ N_{hit}(Z = Z_{begin}) \geq 5$$

- Ellipsoid parameters
  - Principle axes
  - Center of gravity
  -
- Fractal dimension

$$FD_{\beta} = \left\langle \frac{\log R_{\alpha\beta}}{\log \alpha} \right\rangle + 1\ \ with\ \ R_{\alpha\beta} = {}^{N_{\alpha}}\!/_{N_{\beta}}$$

  - Ref : Fractal dimension analysis in a highly granular calorimeter Dr M Ruan *et al* 2012 J. Phys.: Conf. Ser. 368 012038

Data Quality Checks

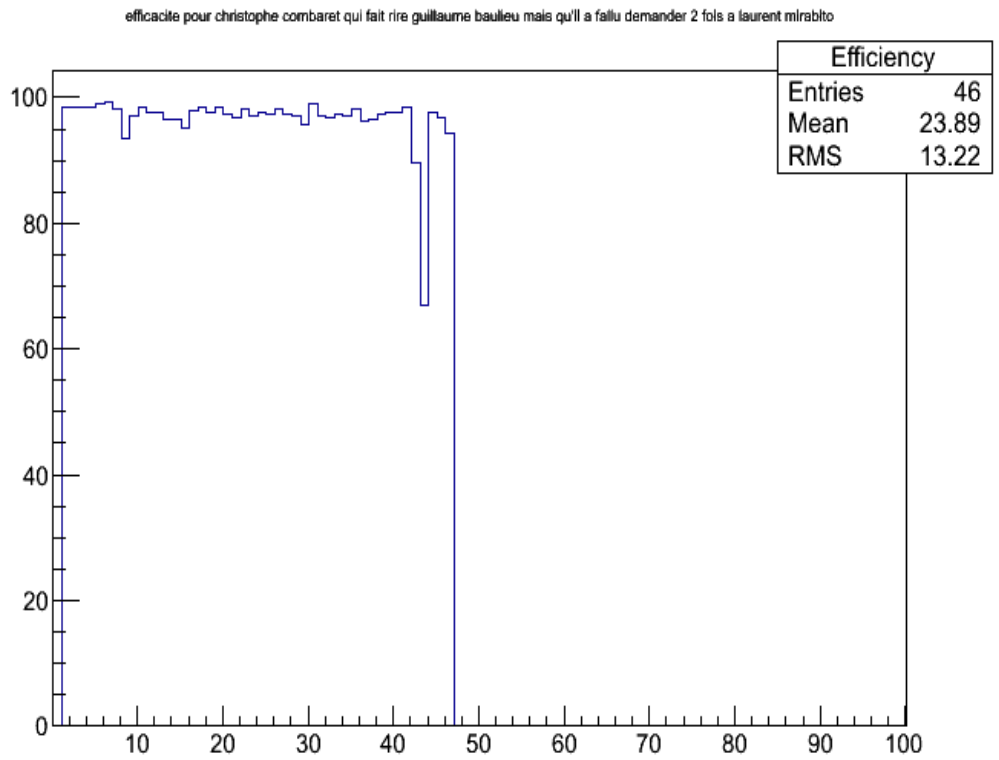
Data quality (DQ) check

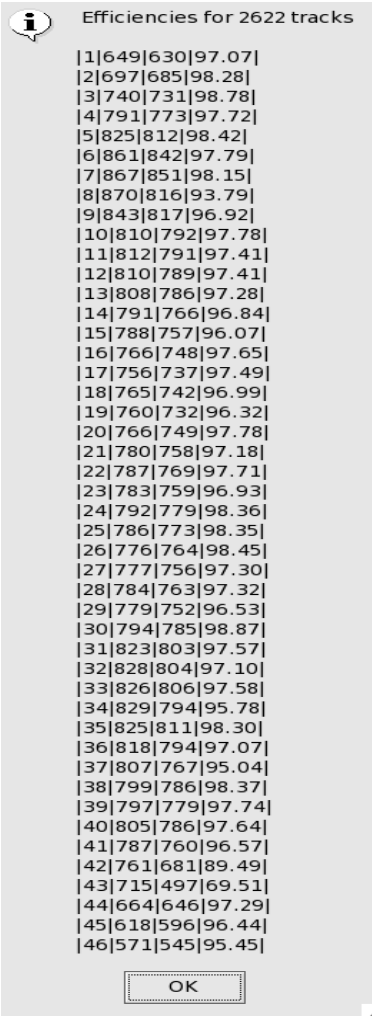
Two checks :

- Online DQ check
- Offline DQ check

The first DQ check is done directly by monitoring the data acquisition during the run by some control histograms.

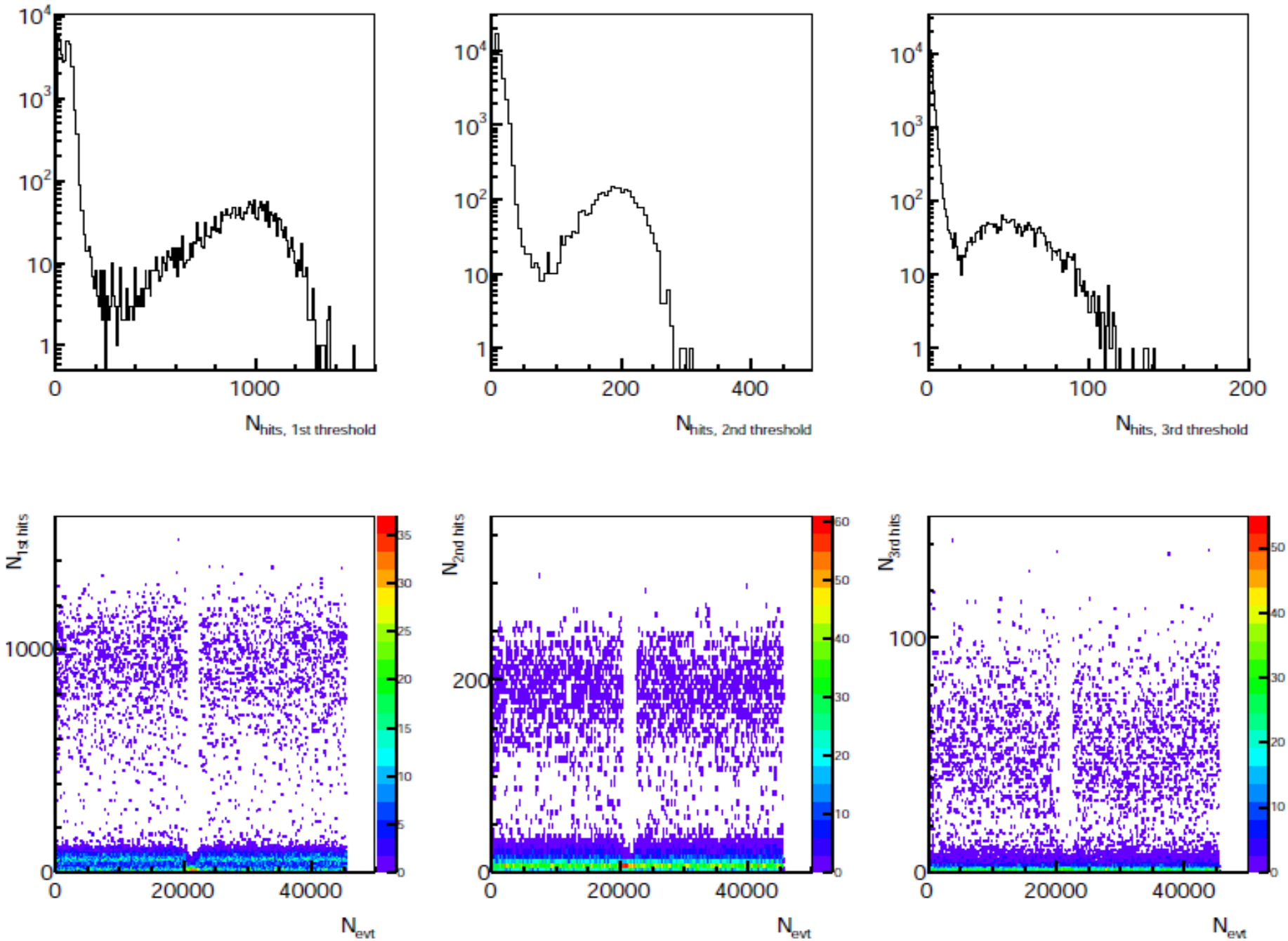
- Asic & Occupancy (noise)
- Efficiency by layer
- RPC position map



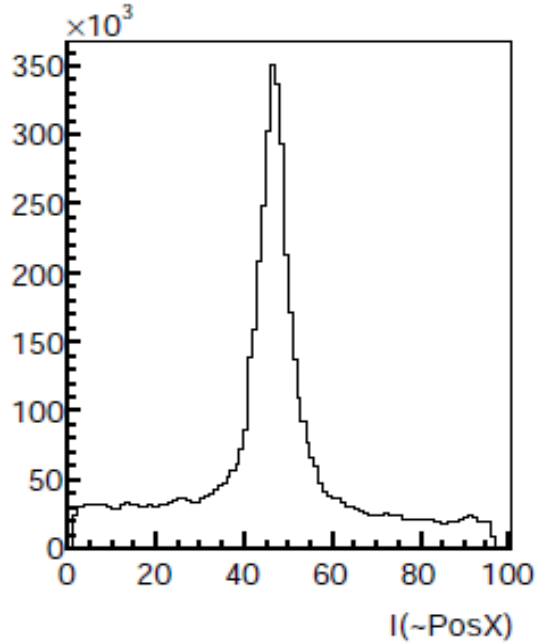


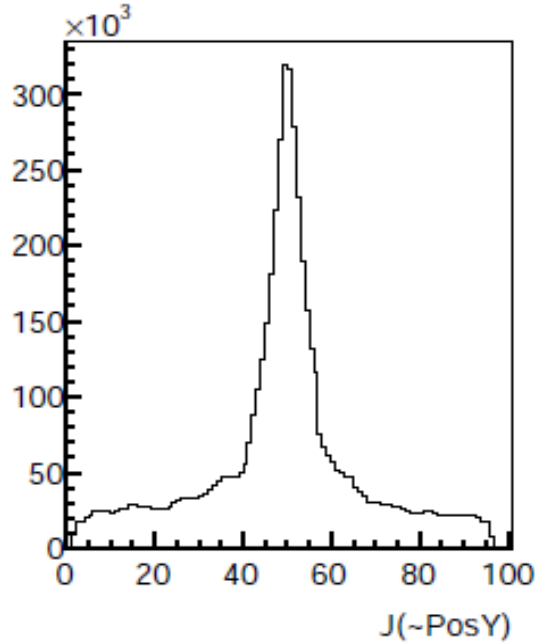
Offline DQ

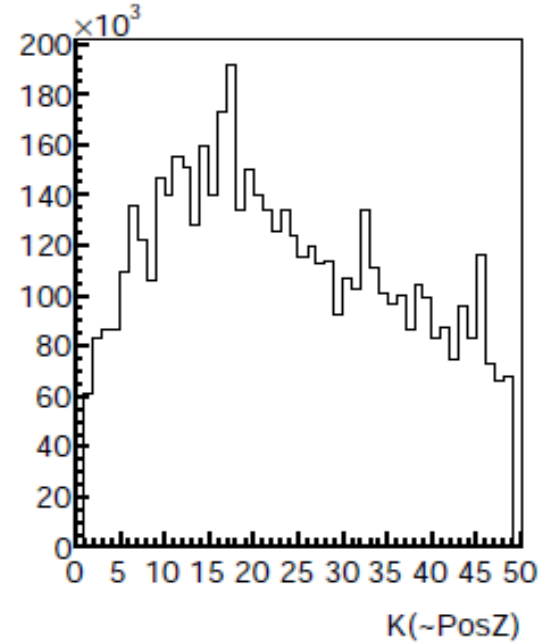
90GeV 714525_I3

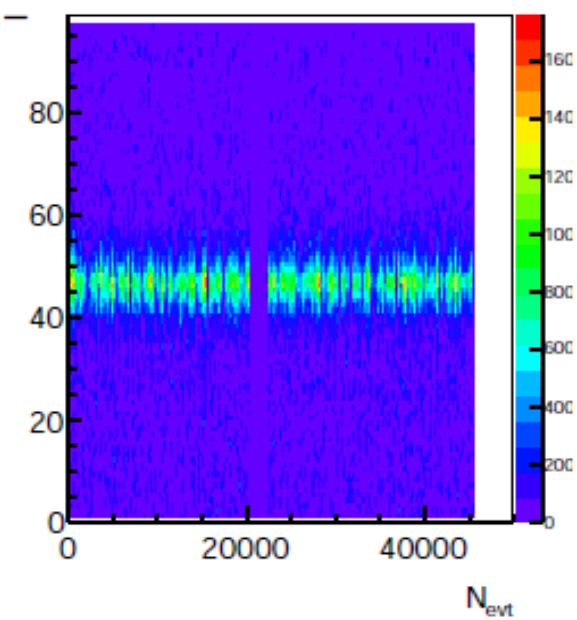


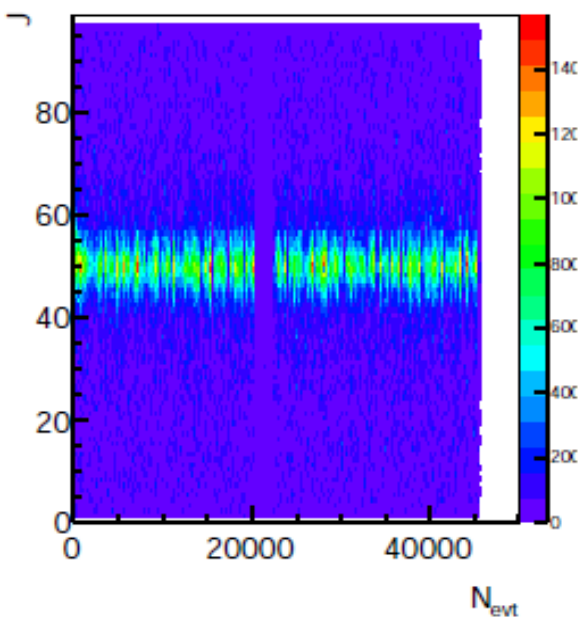
Offline DQ

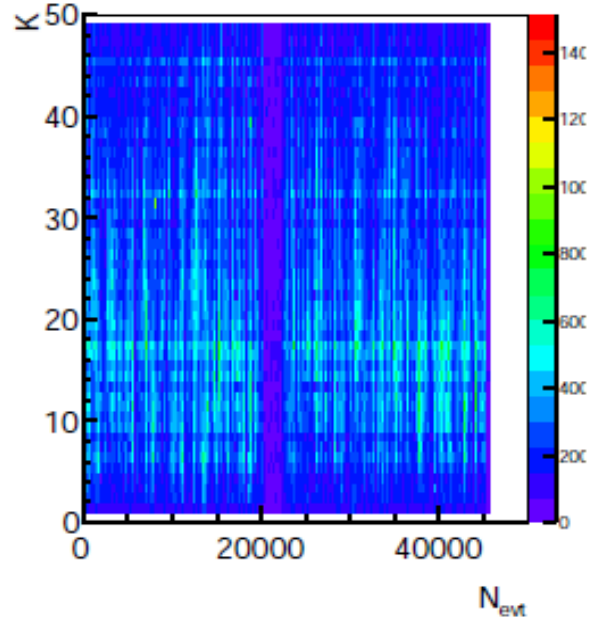




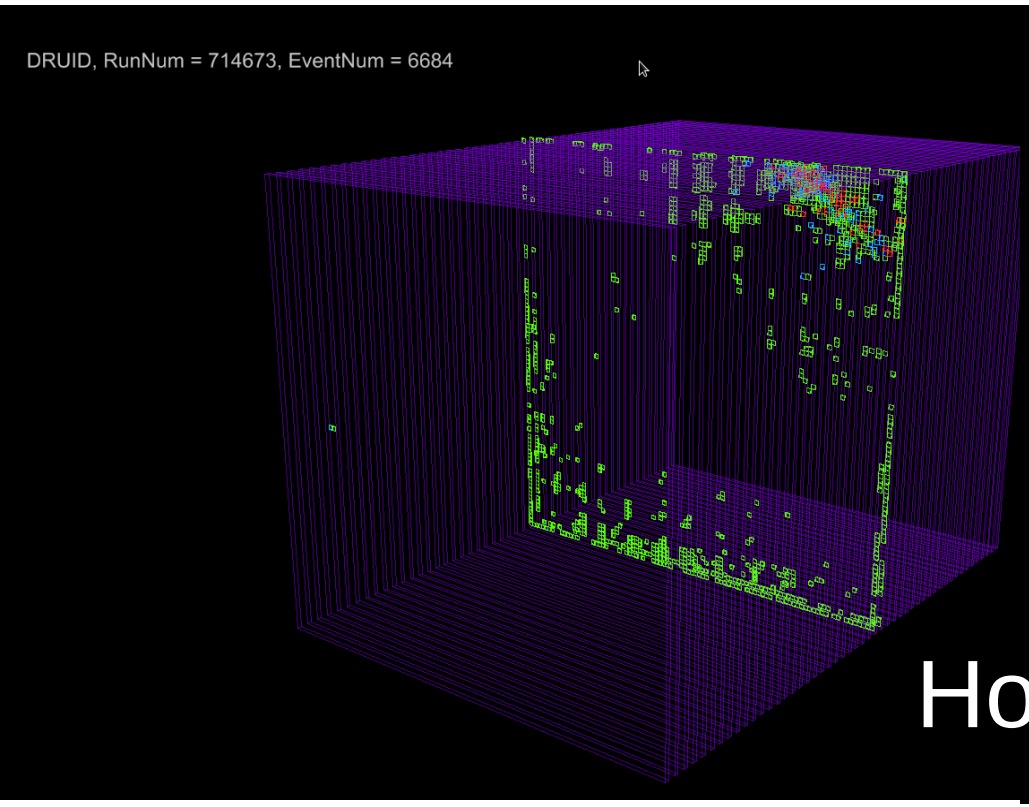


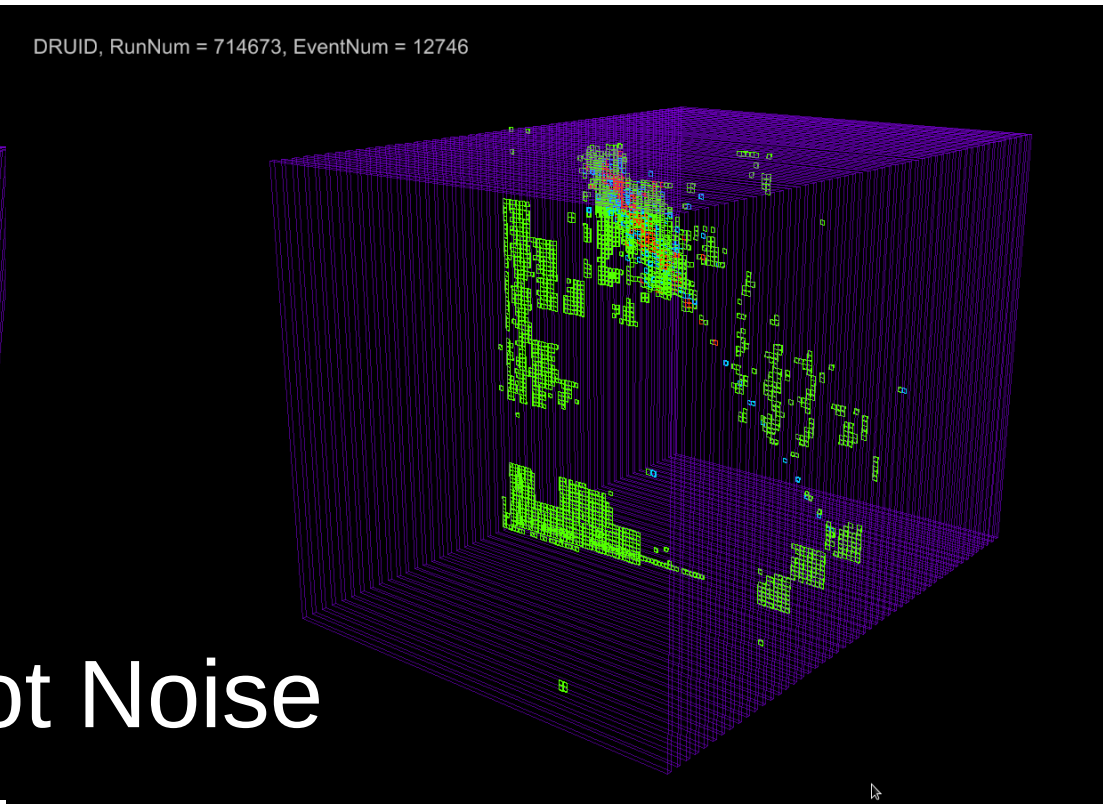






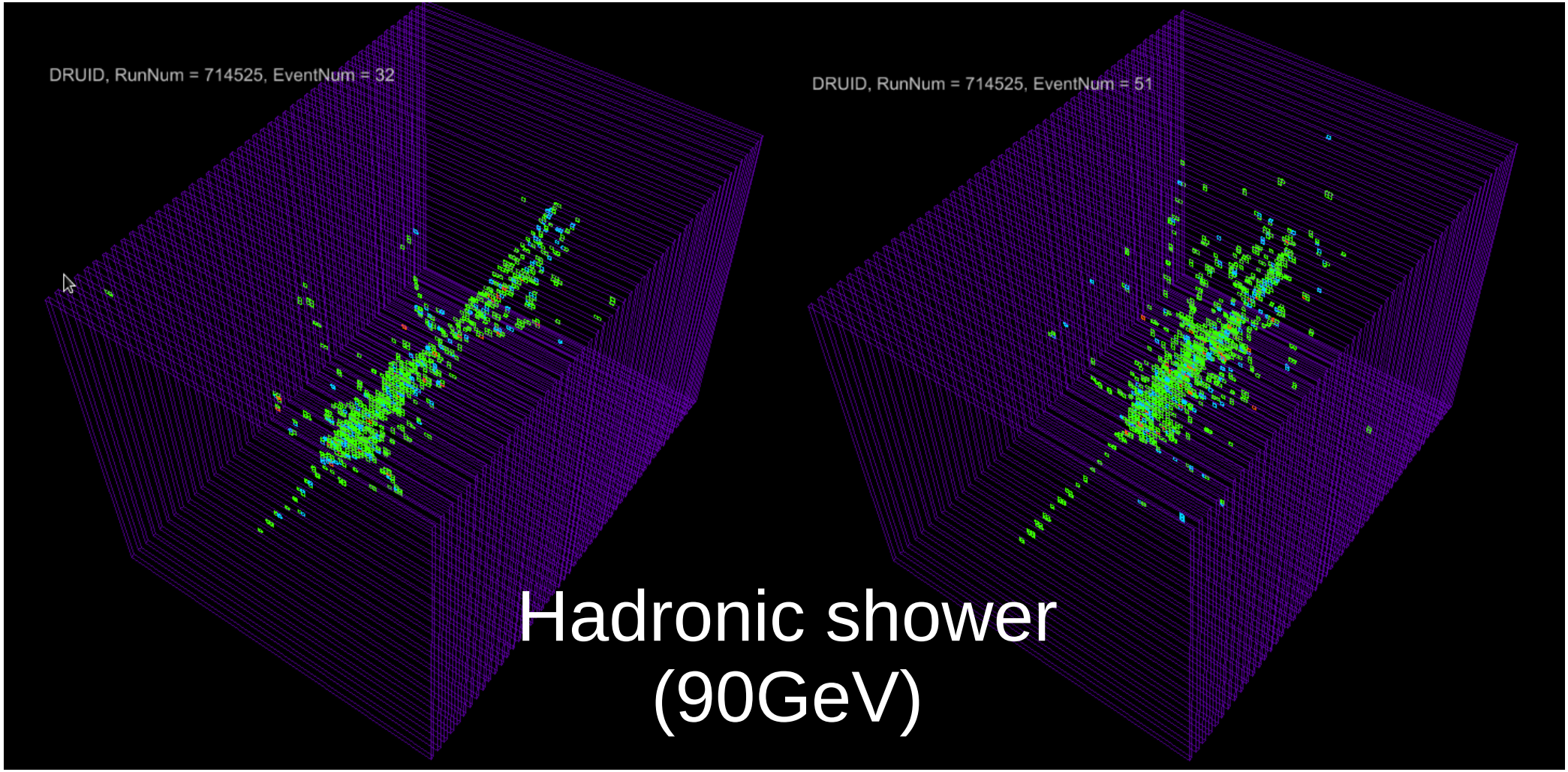
Example of abnormal events





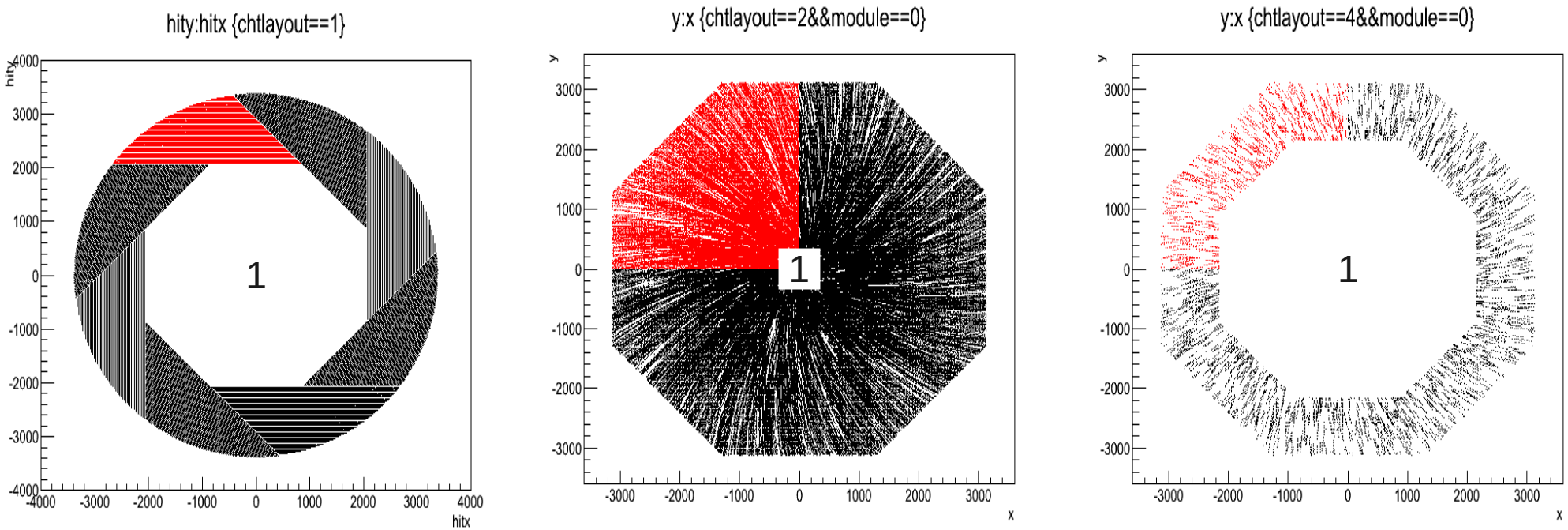
Hot Noise

Standard events



Simulation

- Videau geometry in Mokka has been validated (ILD_o2_v05 model) including the steps stored in lcio SimCalorimeterHit.
- Check using the SDHCAL digitizer (SimDigital) in MarlinReco

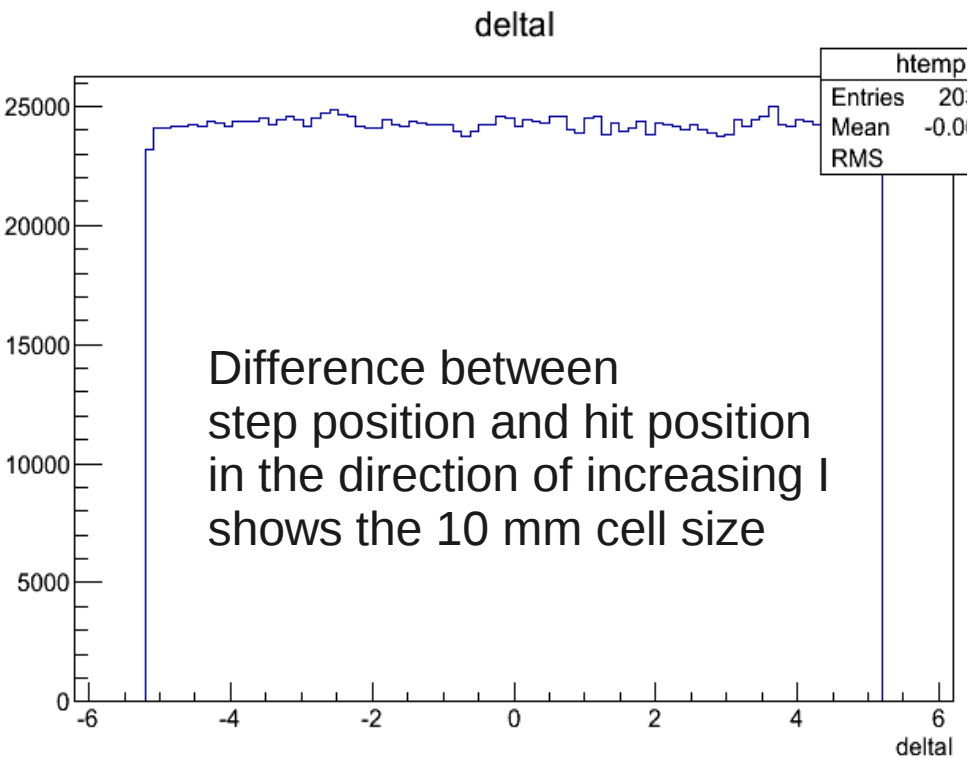


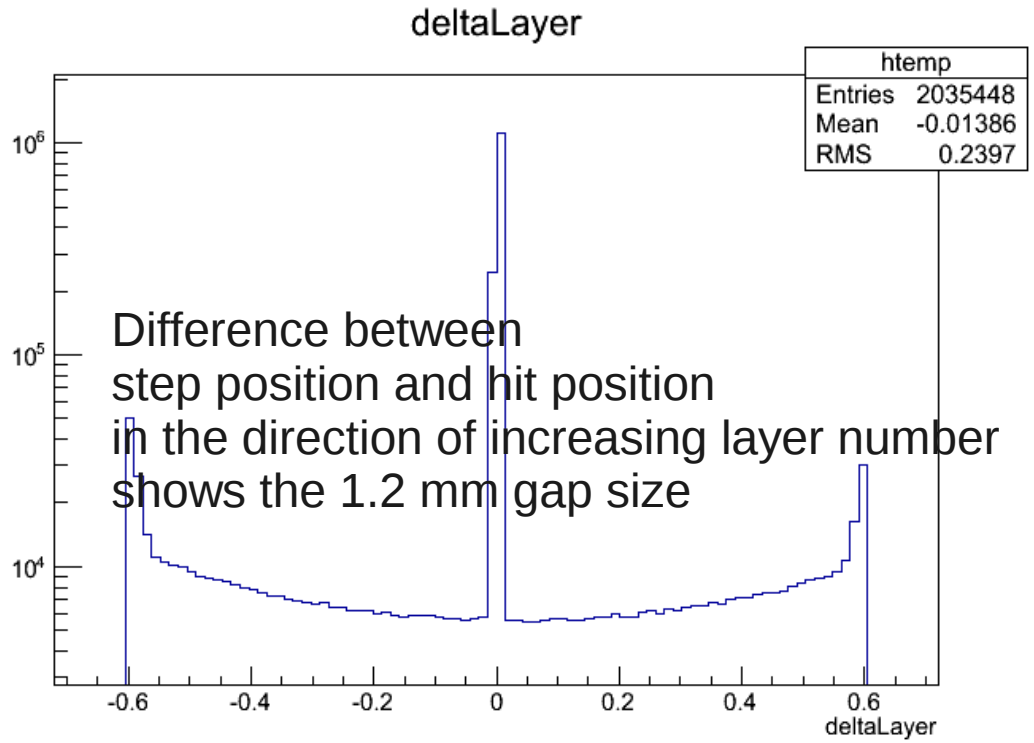
Hit position in SDHCAL (red=stave 1)

Have been checked : no overlap, hit positions, geometry sizes, cellID values, step positions

Simulation step position check

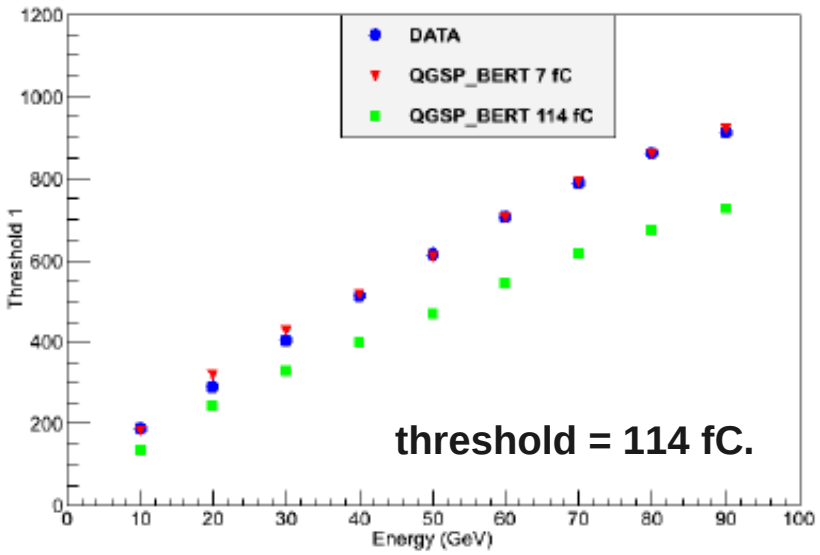
- Check step position compared to cell position.
- We upgraded our standalone prototype detector simulation so that it produces SimCalorimeterHit with step information checks done the same way.





Digitizer tuning

- We are tuning the digitizer's parameters so that the simulation reproduces what is observed in the testbeam data both for generic digitizer (see Manqi's talk) and for SDHCAL digitizer (Work ongoing) using upgraded prototype simulation.



Summary

Reconstruction software & TB analysis:

- A version of data reconstruction framework is ready.
  - based on ILCSoft (LCIO, Marlin, ...)
- The Raw & Reconstructed data are available for all CALICE collaboration on Grid.
- The SDHCAL reconstruction framework is available for whole collaboration in DESY svn repository.
- To come soon: DQ reference table
  - Quality, flag to potential problems, Statistics, Composition, ...
- Common ROOT files are produced.
- The PID will be included soon

Simulation :

- Finish the digitizer tune so as to be able to reproduce the testbeam data as well as possible.
- Calibration of simulation as has been done for data (see SDHCAL session talk)
- Provide xml steering file for SDHCAL ILD reconstruction.
- Medium term plan :
  - Incorporate prototype simulation in Mokka.