Status of the software development for SπRIT-TPC

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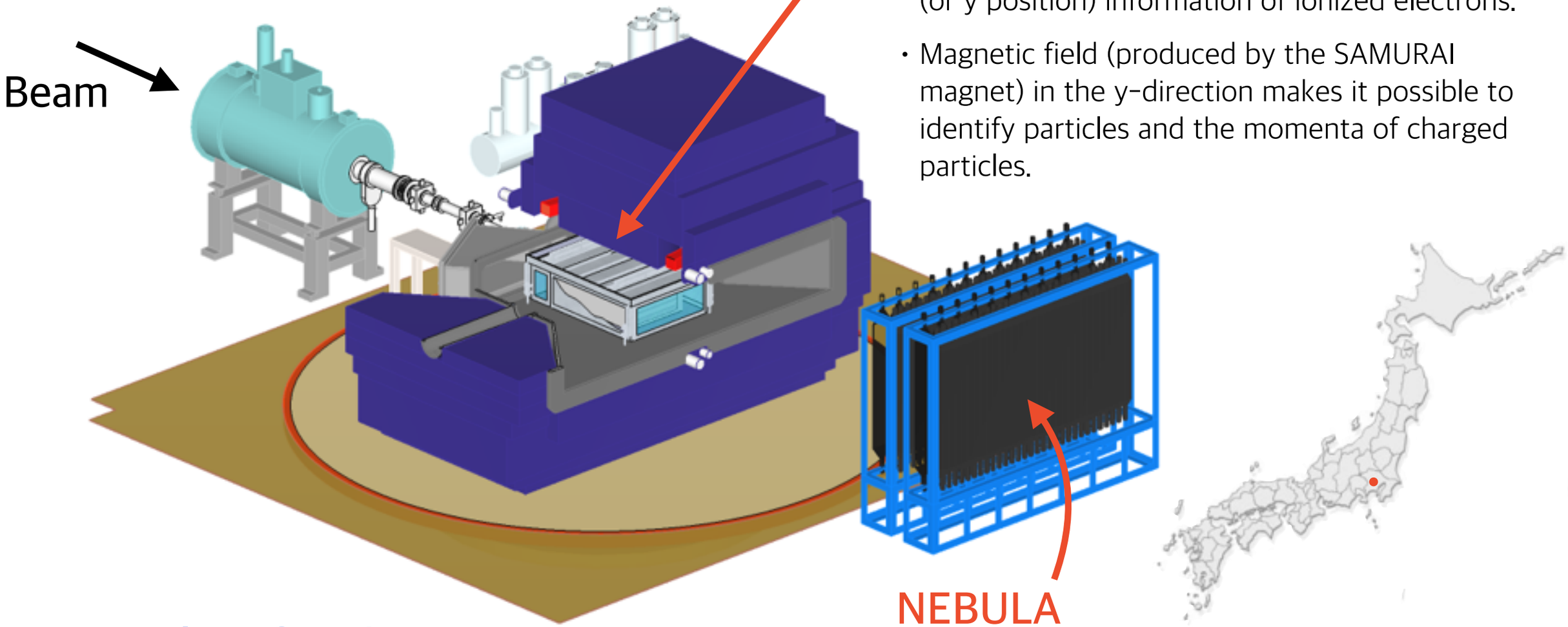
SπRIT Experiment

Examples of Reaction (Beam + Target)

- $^{132}Sn + ^{124}Sn$
- $^{124}Sn + ^{112}Sn$



SπRIT-TPC

- Pad plane of TPC gives x,z position information and the electric field in y-direction gives the time (or y position) information of ionized electrons.
- Magnetic field (produced by the SAMURAI magnet) in the y-direction makes it possible to identify particles and the momenta of charged particles.

Examples of Probes

- π^-/π^+ ratio
- n/p ratio
- $^3H/^3He$ ratio

→ **sensitive to symmetry energy!**

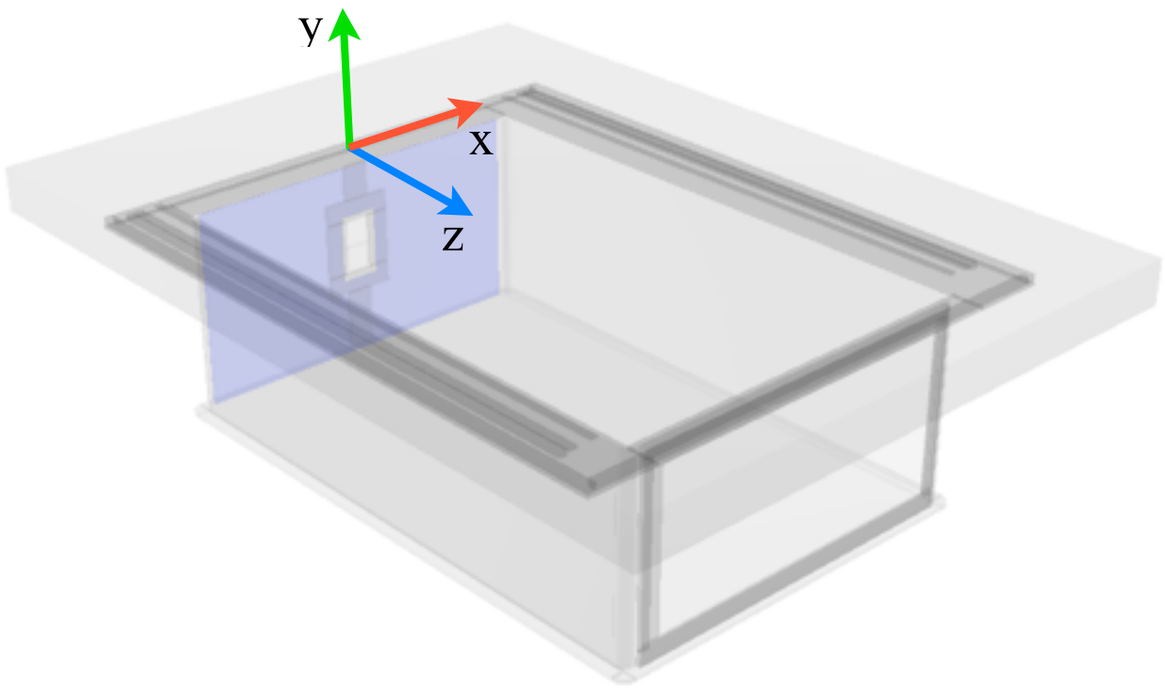
NEBULA

- One neutron detector layer has 30 scintillator bars with dimension, 12 cm × 12 cm × 180 cm.
- Array of scintillator is placed after filtering the charged particles by magnet.

General Information

SπRIT-TPC

- Size (mm) : 966.1 × 510.1 × 1446.4
- Magnetic Field : 0.5 Tesla (+y)
- Electric Field : 131 V/cm (-y)
- Gas : P10(Ar 90% + CH_4 10%) at 1 atm
- High voltage wire amplification.



FairSoft

- All the necessary basic packages are collected.
- **Included packages :**
  - GEANT3, GEANT4, ROOT, VMC, etc.
  - GENFIT2 packages added for SπRITROOT.

FairRoot

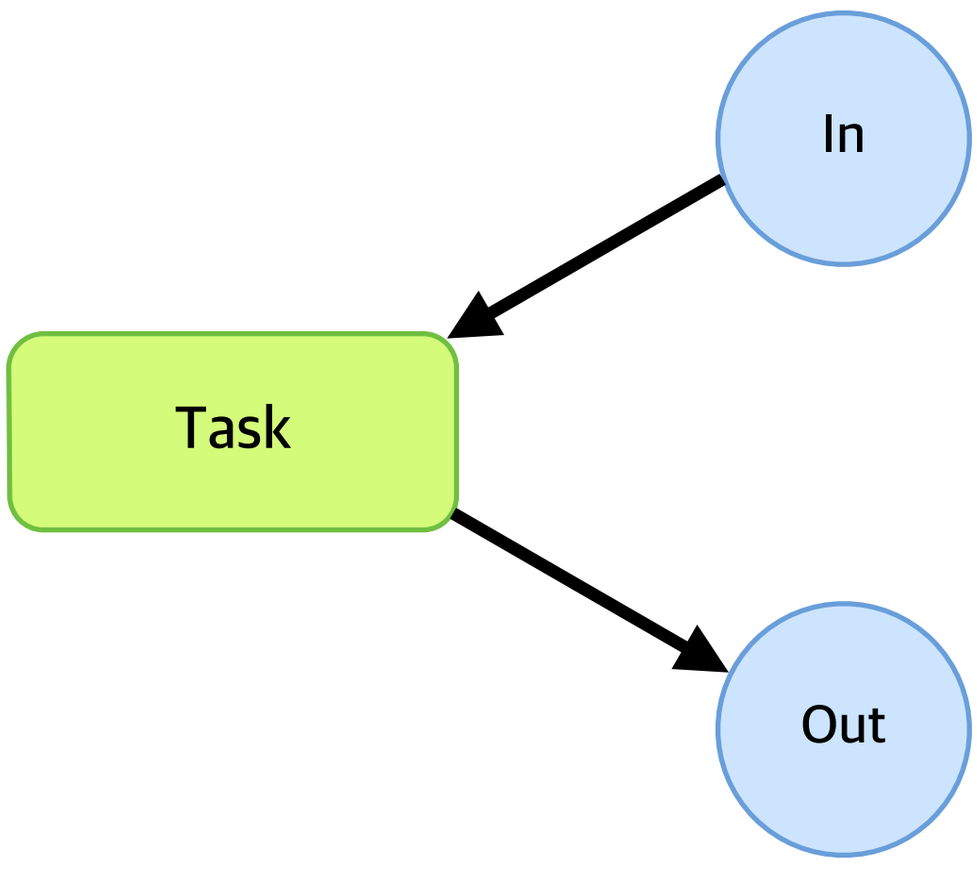
- A framework containing base classes for running simulation, reconstruction and analysis.

SπRITROOT

- A framework containing specific modules for SπRIT experiment on top of FairRoot.
- Composed of **task-based modules**, geometry and steering macros.
- Github is used for repository(private).

Task-Based Modules

- Easy to turn on and off.
- Easy to debug and maintain.



- ASCII
- GRAW
- ROOT
- An object on memory (TClonesArray)

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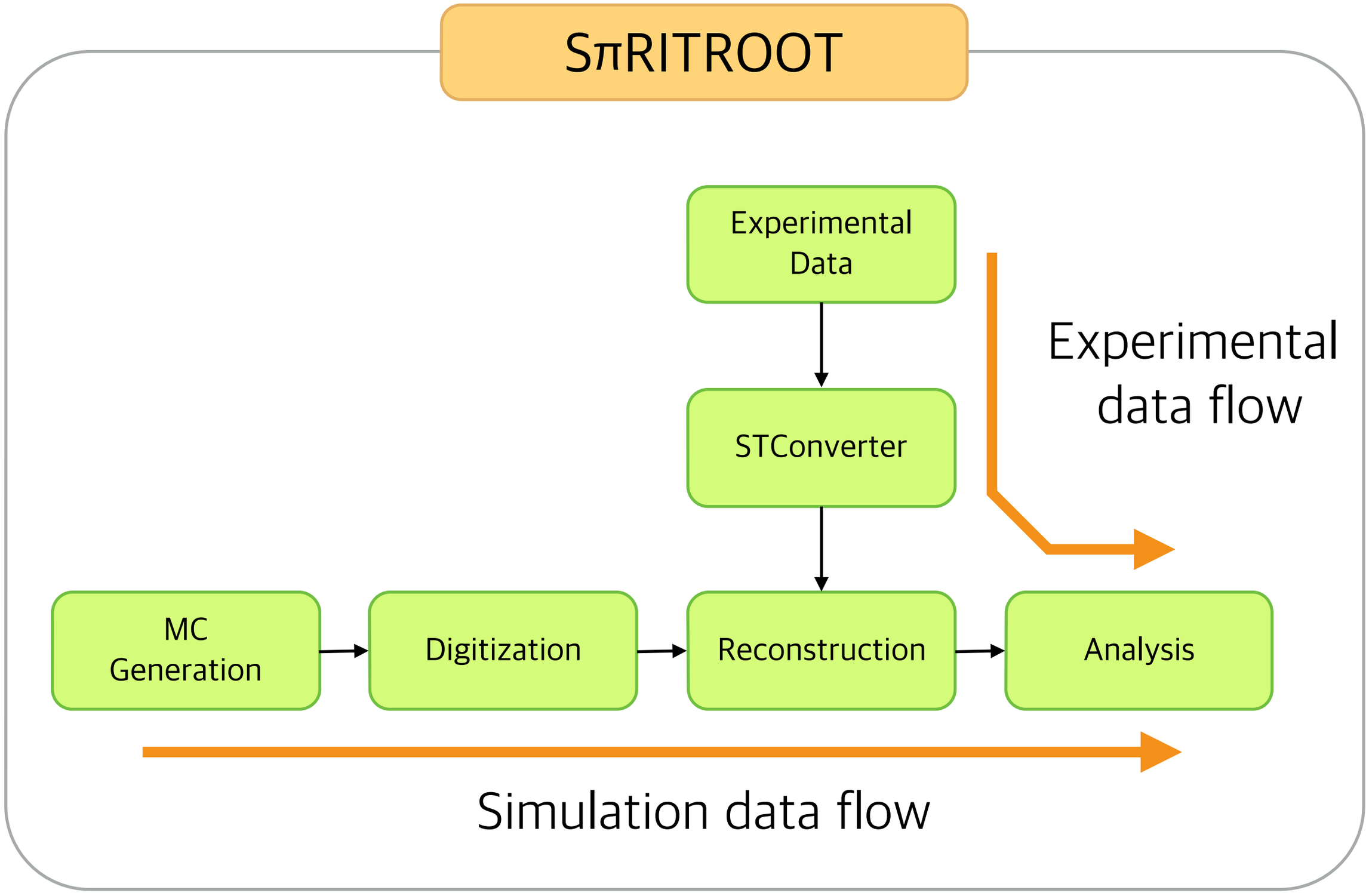
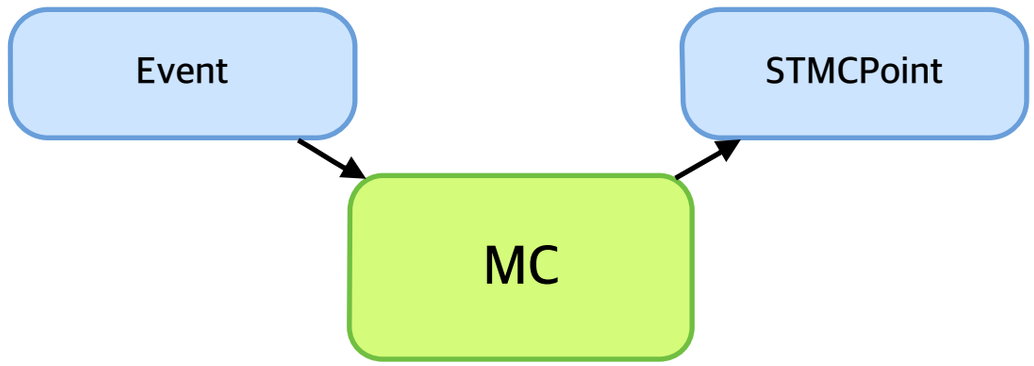
Schematics of SπRITROOT



Monte-Carlo Generation

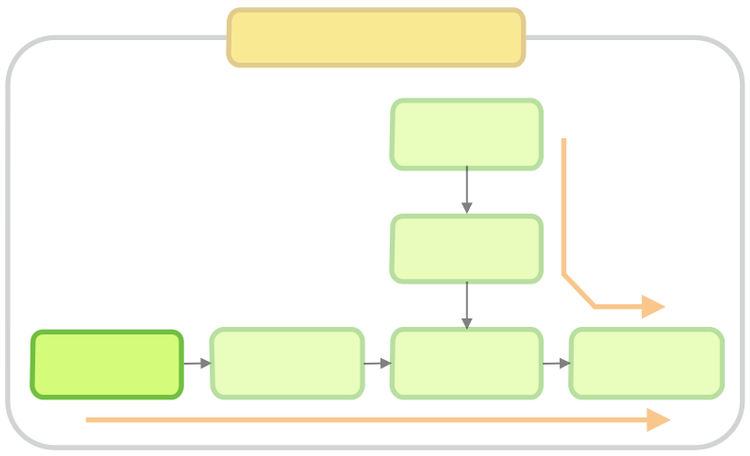


Transportation

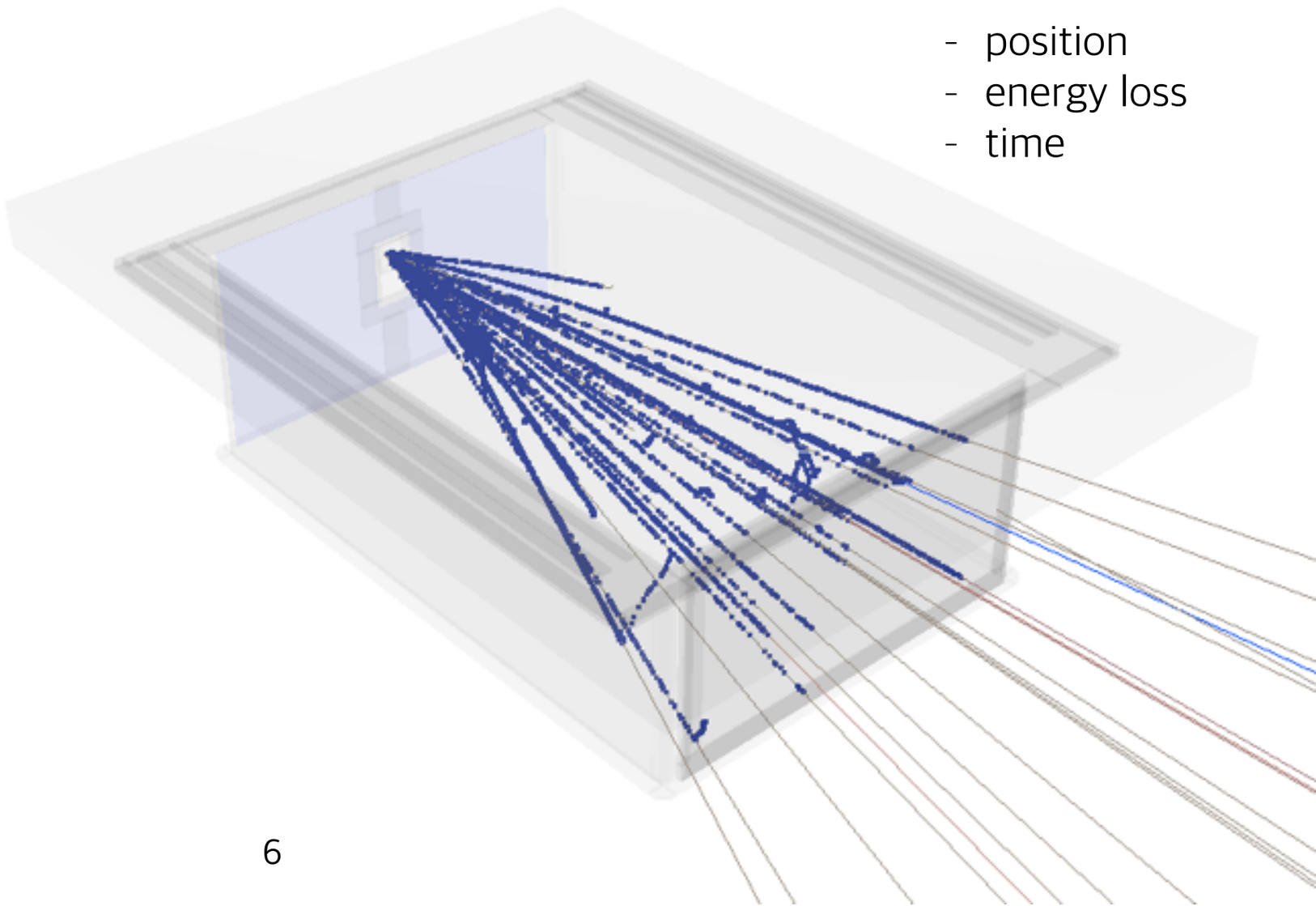
- **Geant4**
- Geant3

Event Generators

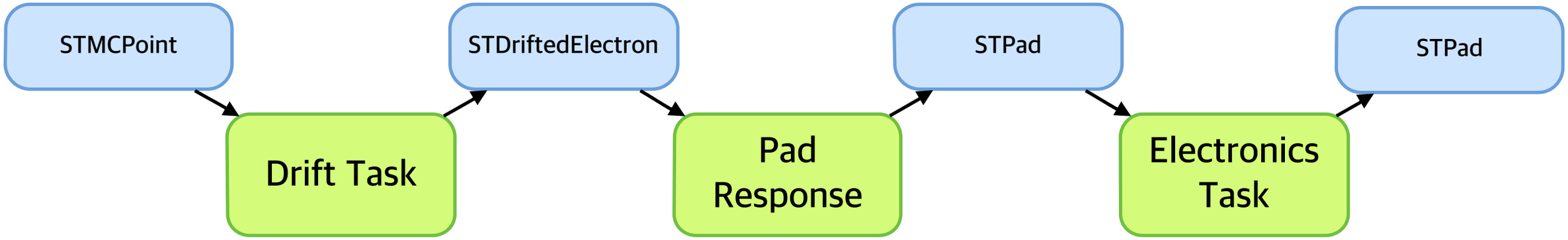
- **UrQMD**
- PHITS
- PBUU



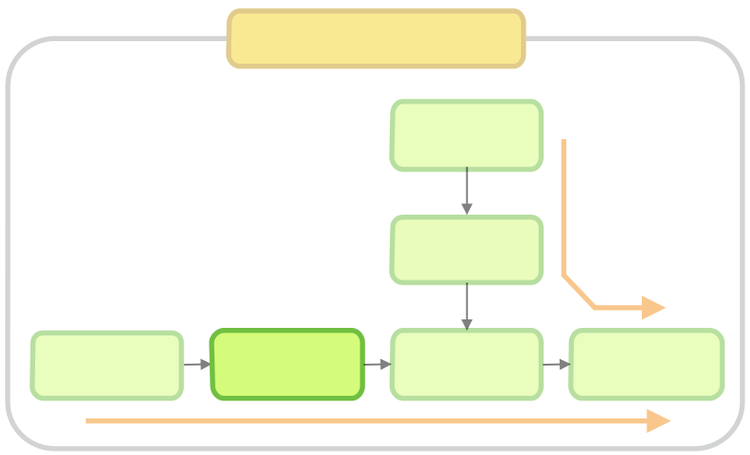
- MC Hit
  - position
  - energy loss
  - time



Digitization



- STMCPoint gives position, time and energy loss.
- Using energy loss and mean ionization energy of gas, we can calculate the number of created electrons.
- Through the digitization process, electrons are converted into pad signals.



- MC Hit
  - position
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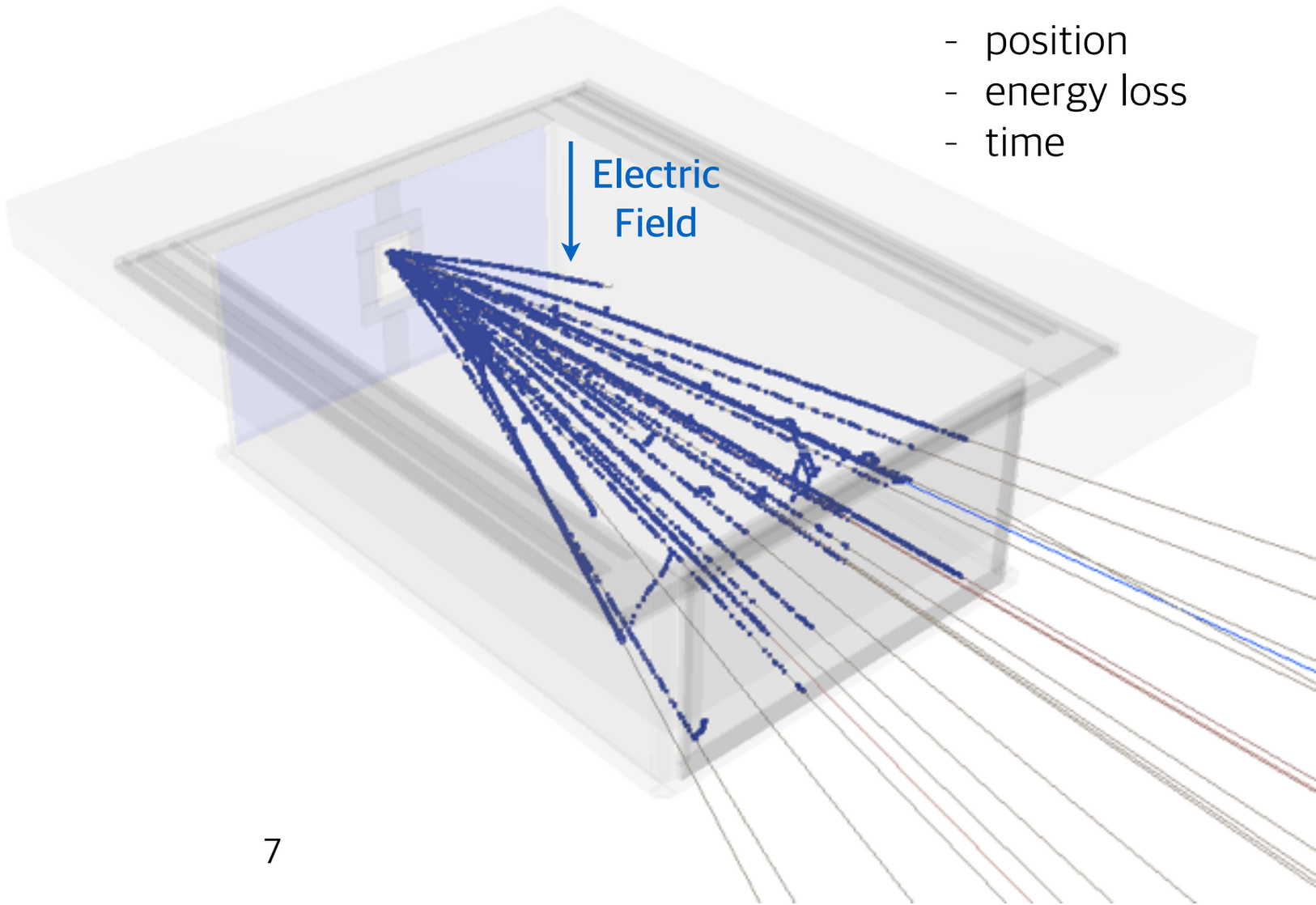
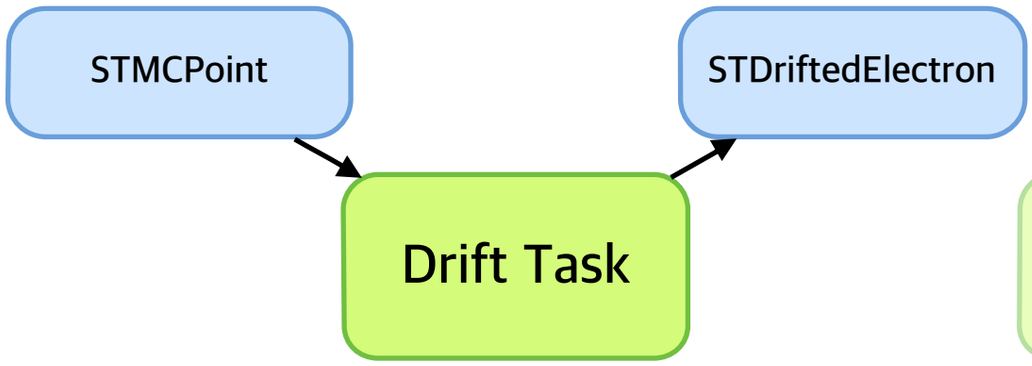
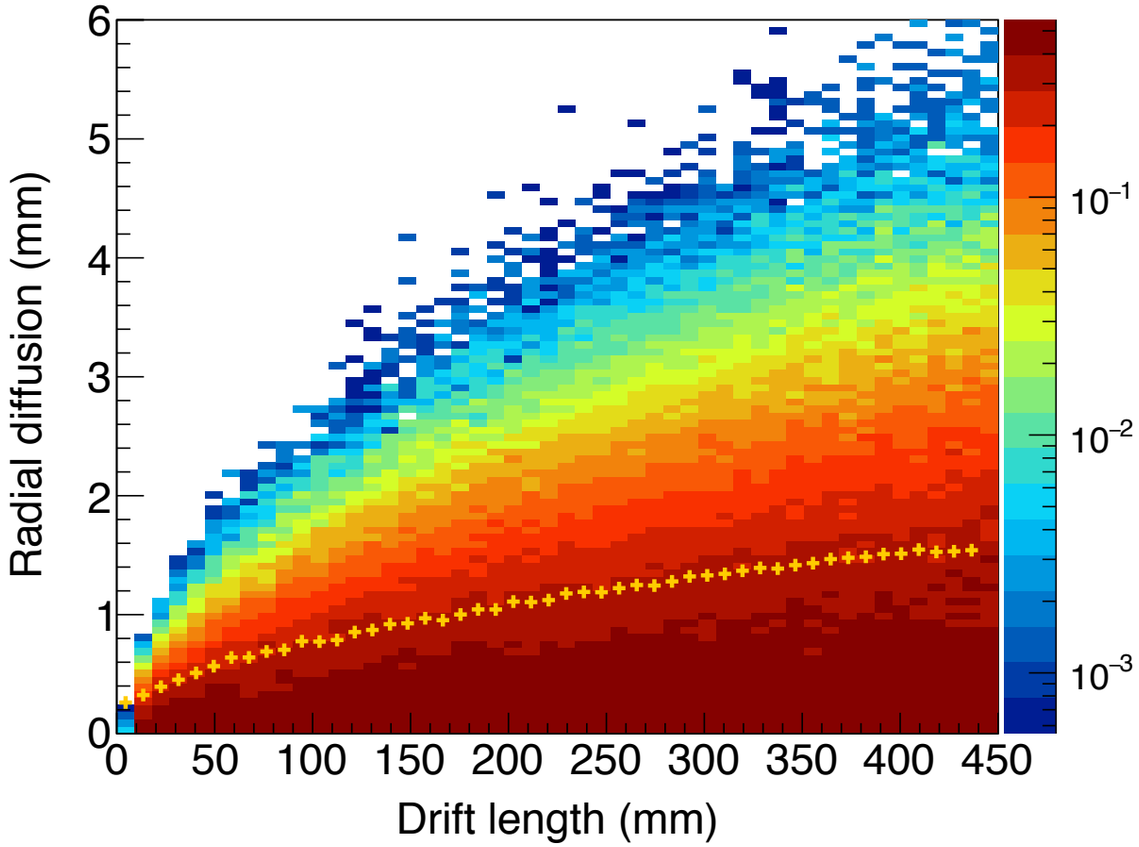


Digitization - Drift Task

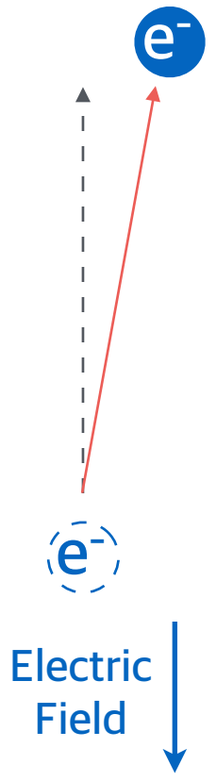


Pad Response

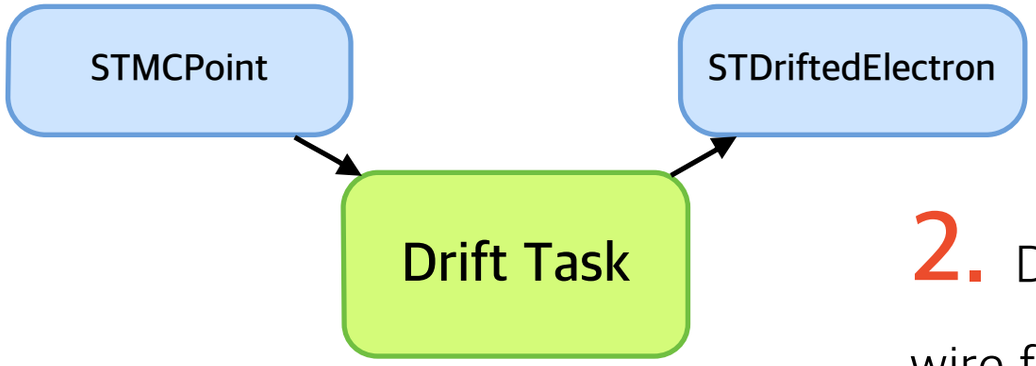
Electronics Task

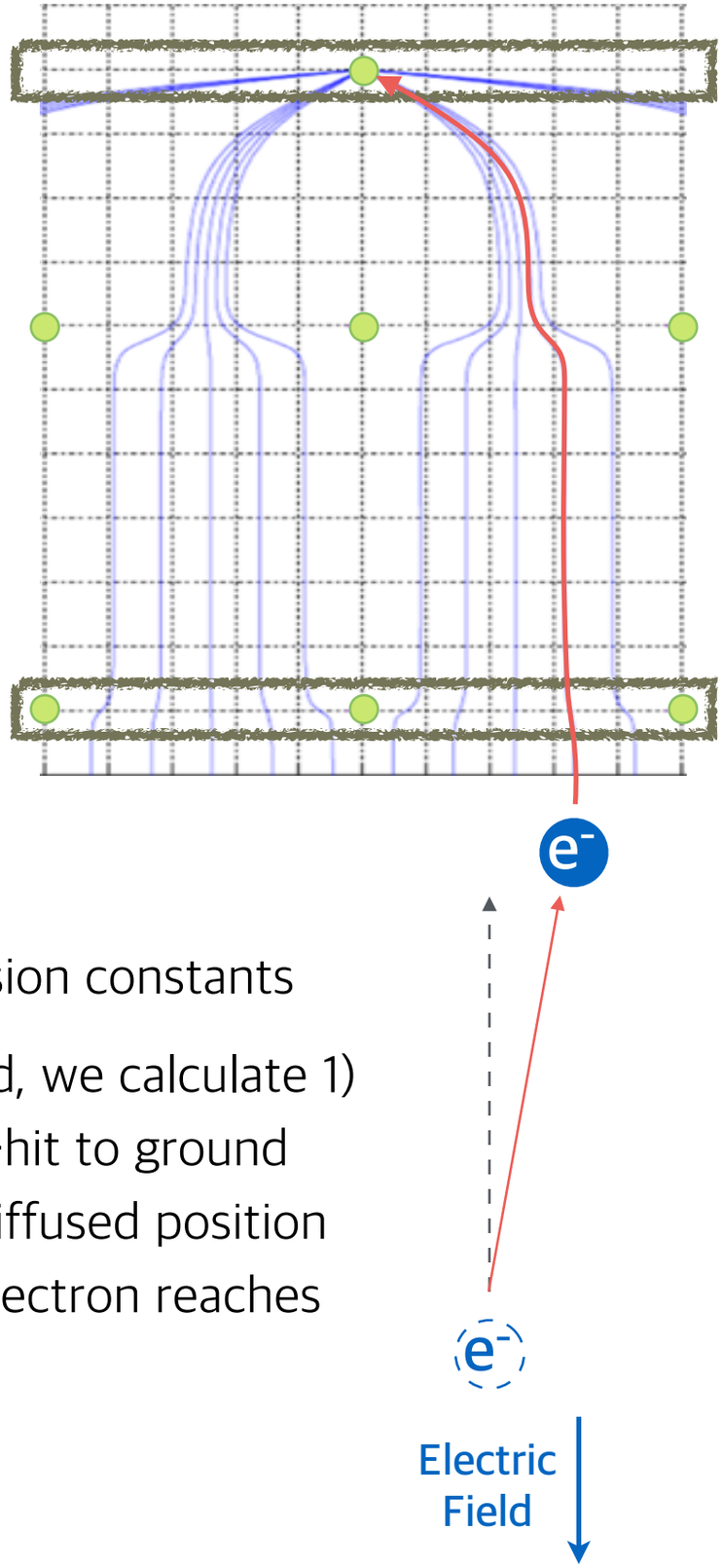


1. Using the diffusion constants obtained by Garfield, we calculate 1) drift time from MC-hit to ground wire plane and 2) diffused position in xz-plane when electron reaches ground wire plane.



Digitization - Drift Task





2. Determine the nearest anode wire for drifted electron. The electron will be absorbed in corresponding wire and the pad response function is determined.

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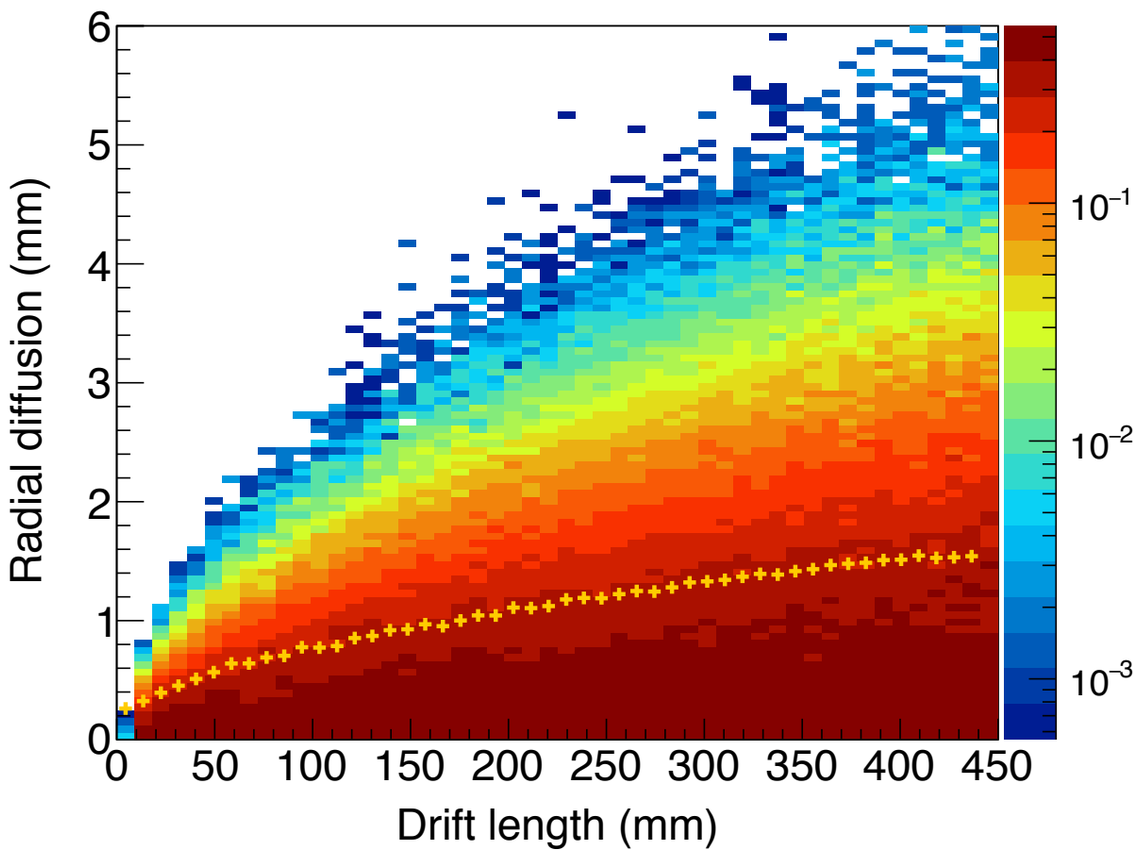
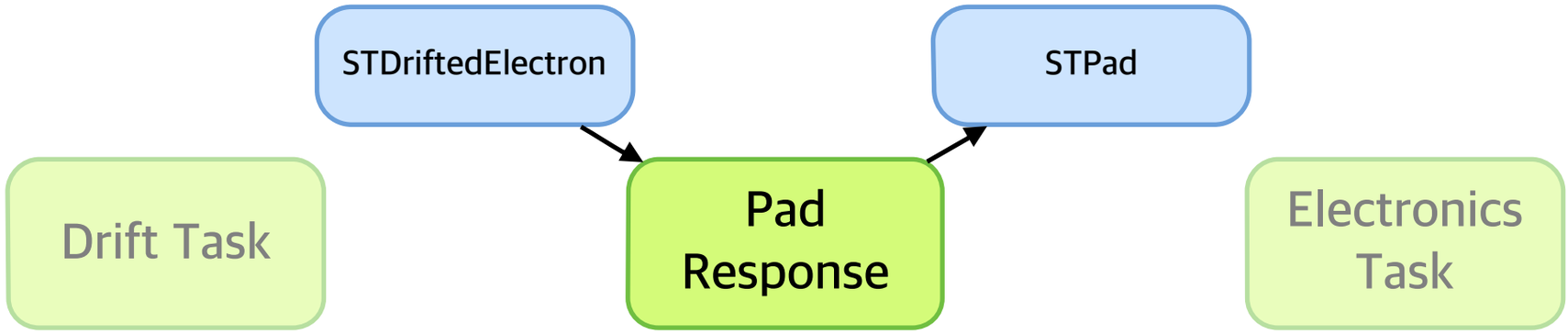
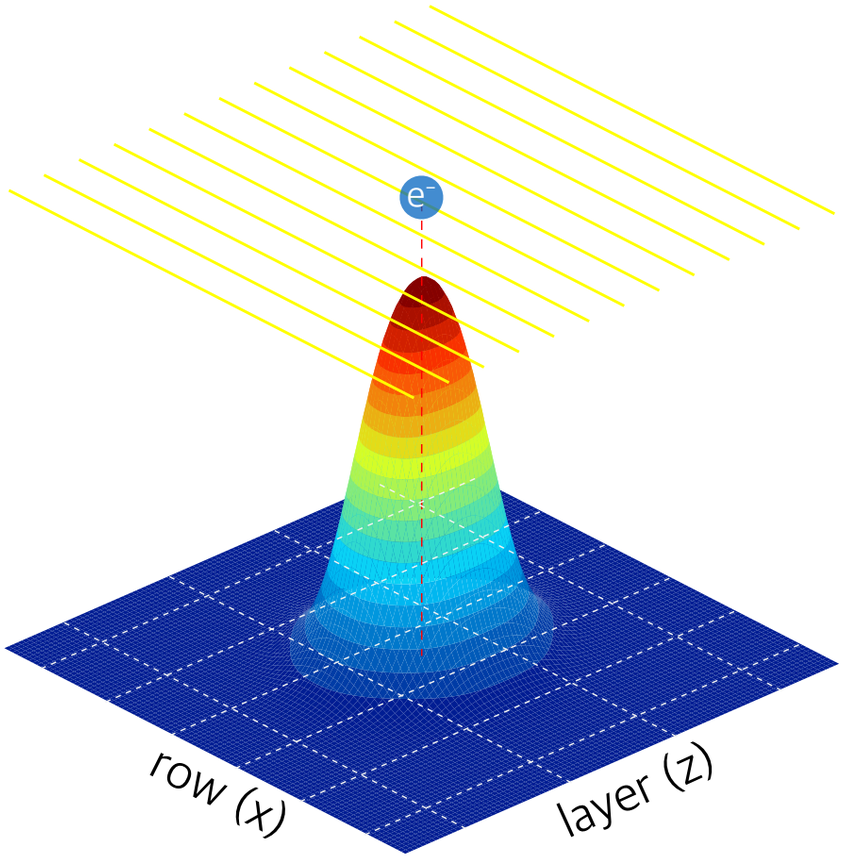


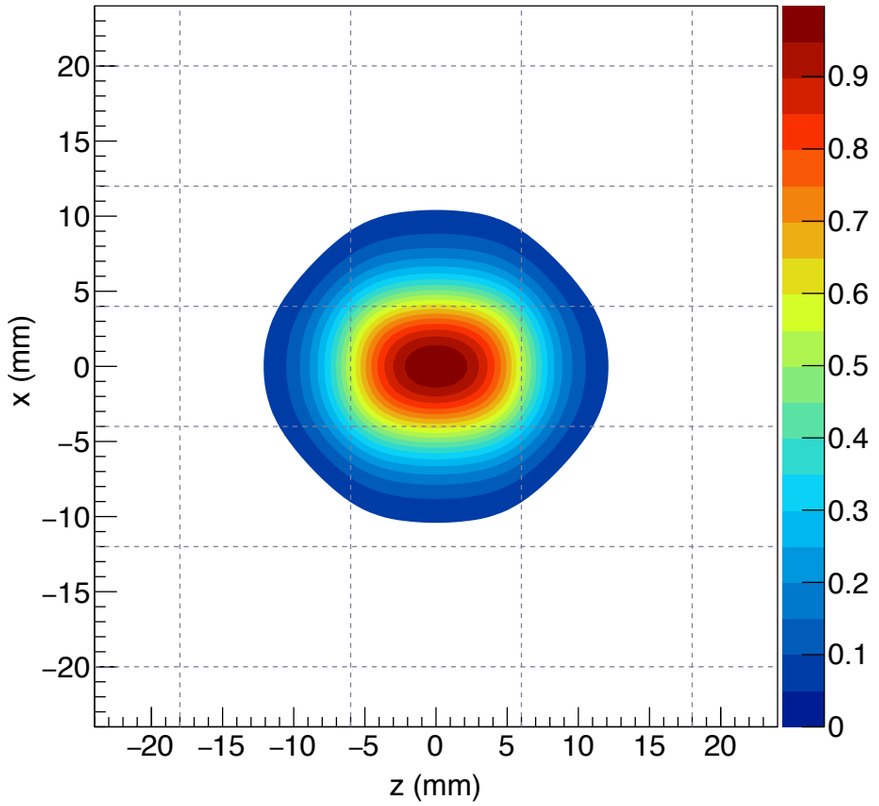
Digitization - Pad Response



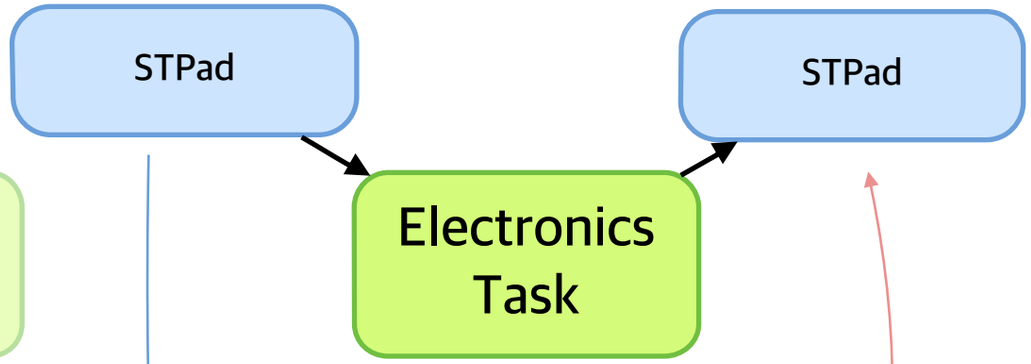
Pad response function describes the induced charge by the avalanche electrons. The function is calculated from the Gatti distribution using geometry of wire plane and pad plane.

$$P(\lambda) = \frac{K_1}{K_2\sqrt{K_3}}\left[\arctan\sqrt{K_3}\tanh\left(K_2\left(\lambda+\frac{w}{2h}\right)\right) - \arctan\sqrt{K_3}\tanh\left(K_2\left(\lambda-\frac{w}{2h}\right)\right)\right]$$



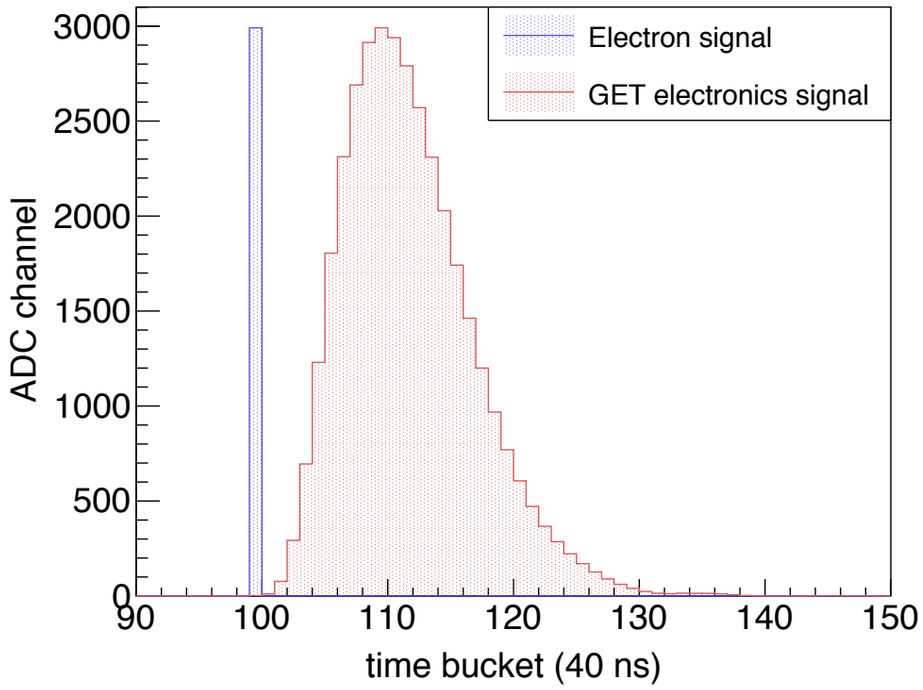


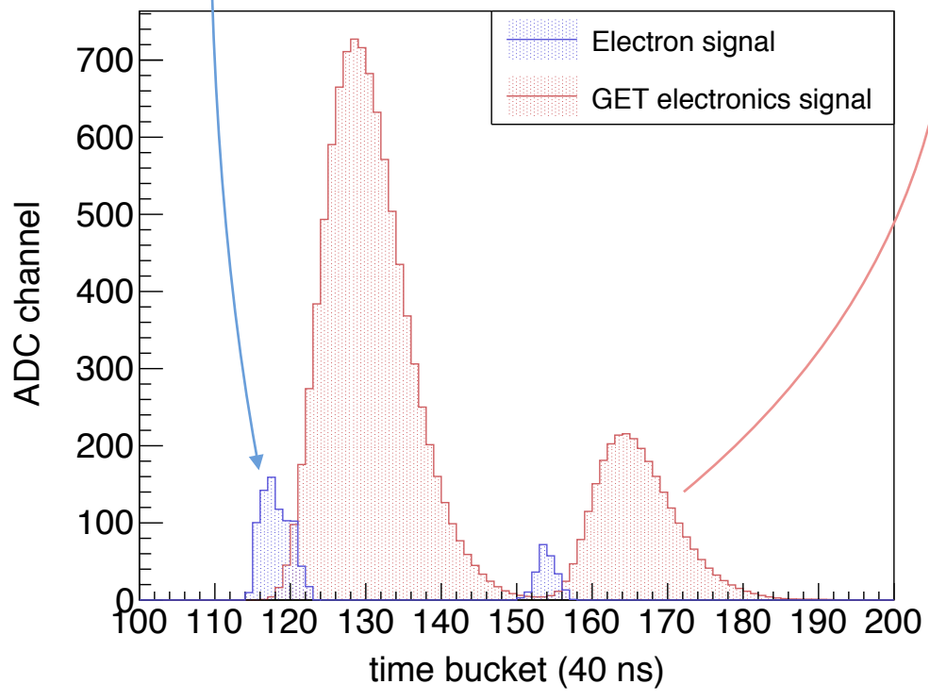
Digitization - Electronics Task



Drift Task

Pad Response





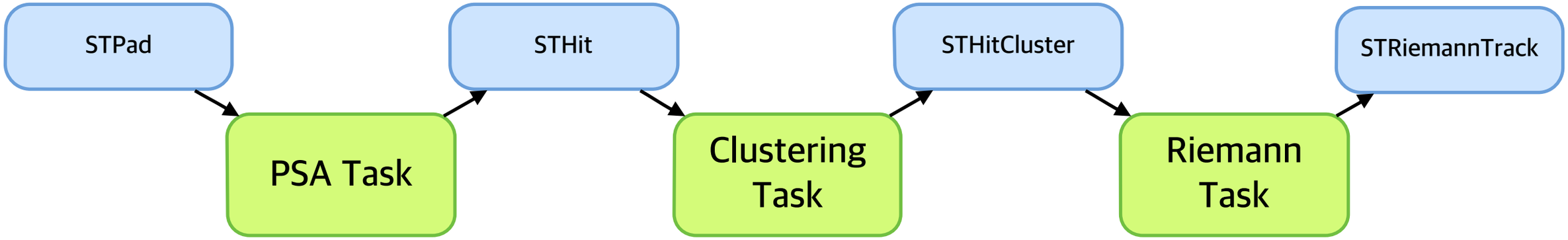
Experiment data

Average pulse shape from GET electronics is obtained from the experimental data(HIMAC test). The height of pulse shape is proportional to input electron charge.

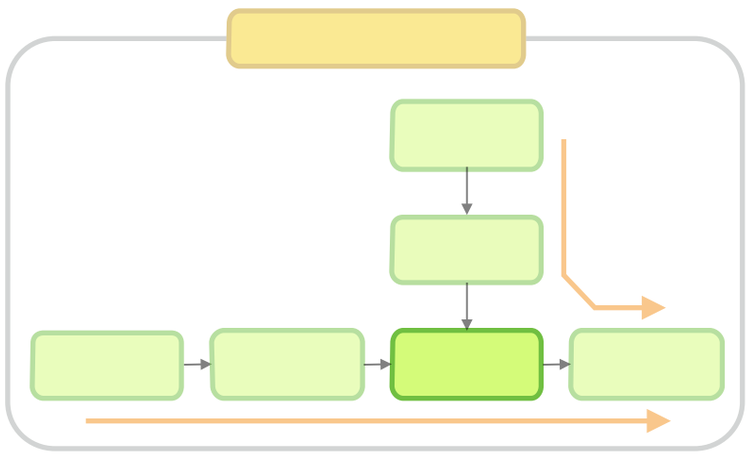
Simulation process

The input electron charge are distributed along the time bucket. The GET electronics signal is the superposition of responses from several bins for each input group.

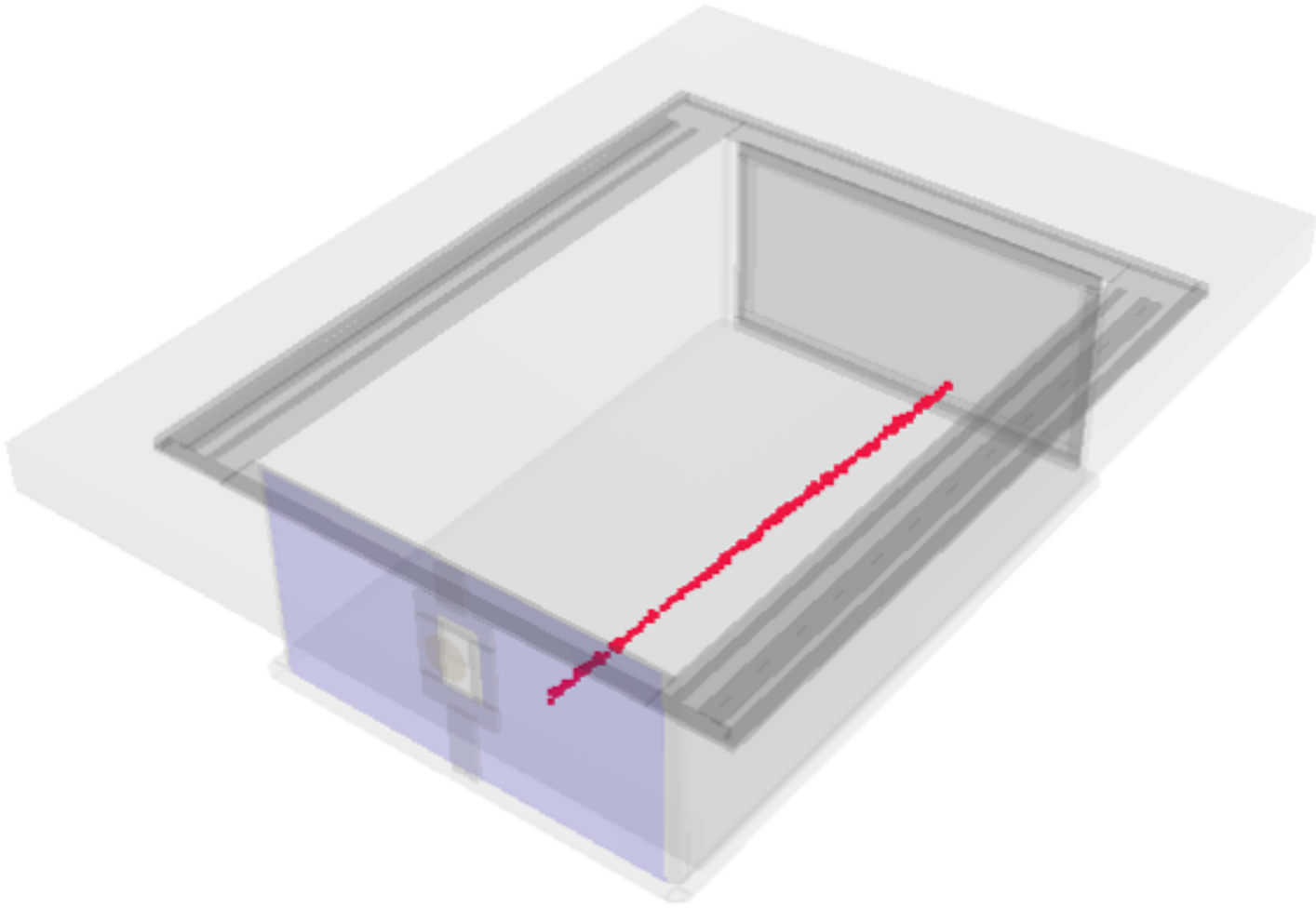
Reconstruction



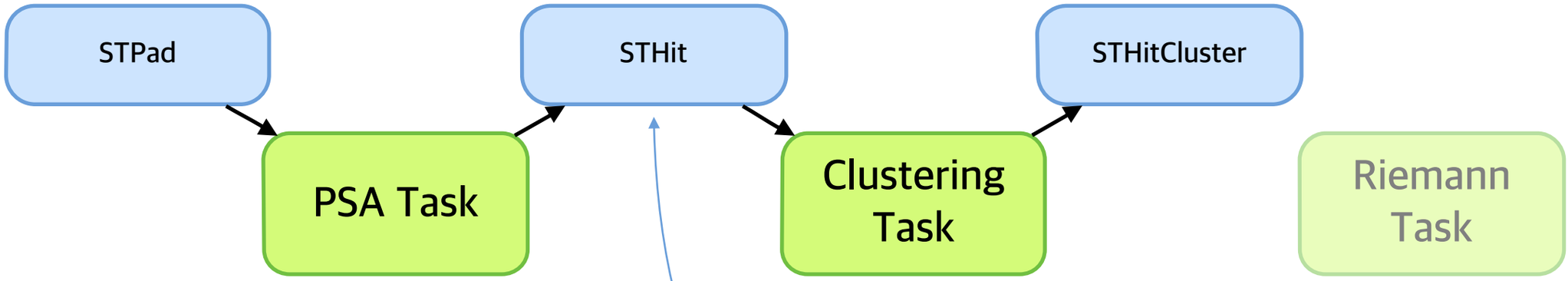
- For particle ID and momentum estimation, we need the reconstruction process.
- The experimental data and the simulation data are produced in the same format so both of them can be used as input to the reconstruction process.
- The reconstruction process converts the pad responses to tracks.

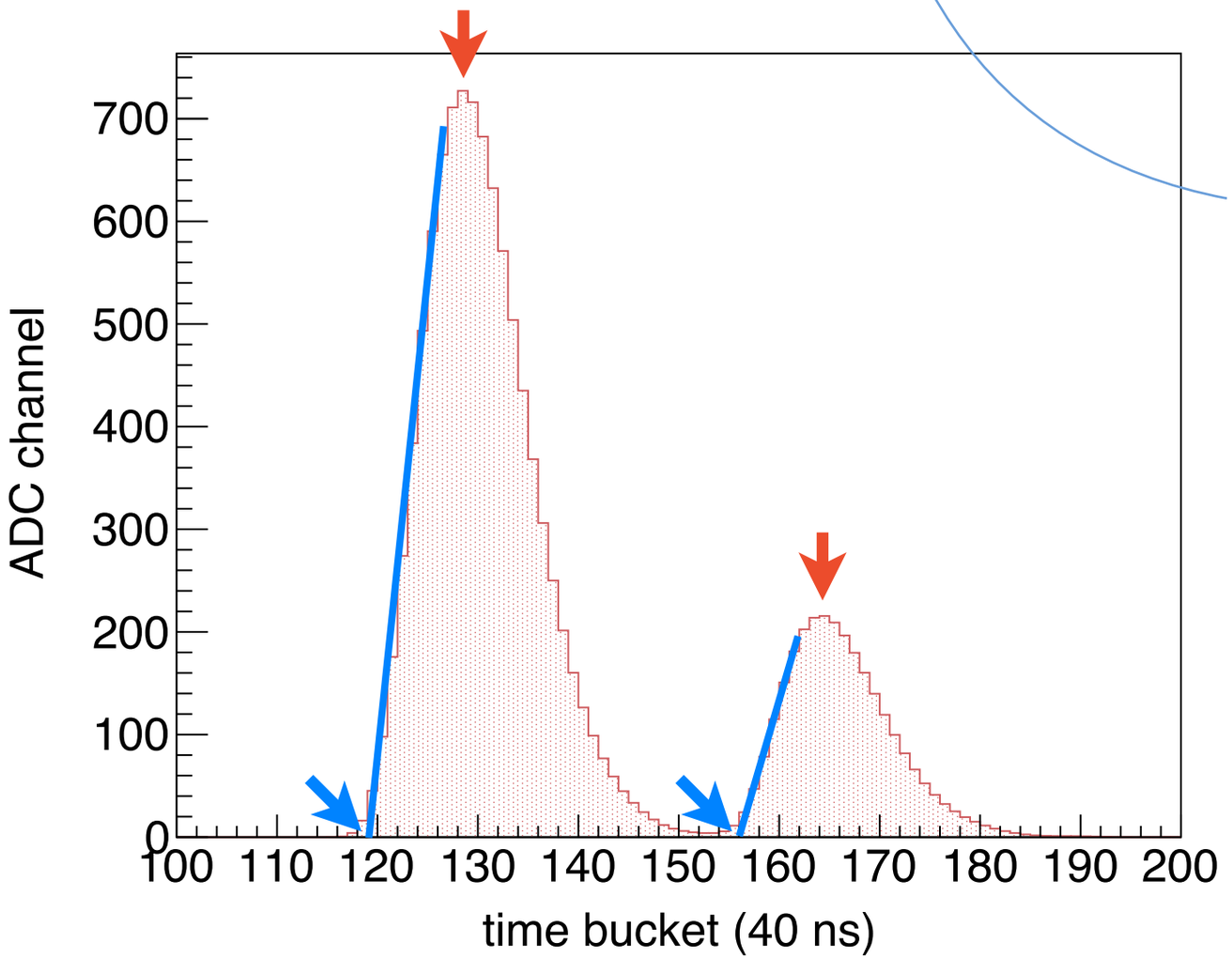


Display of hits from cosmic data



Reconstruction - PSA & Clustering



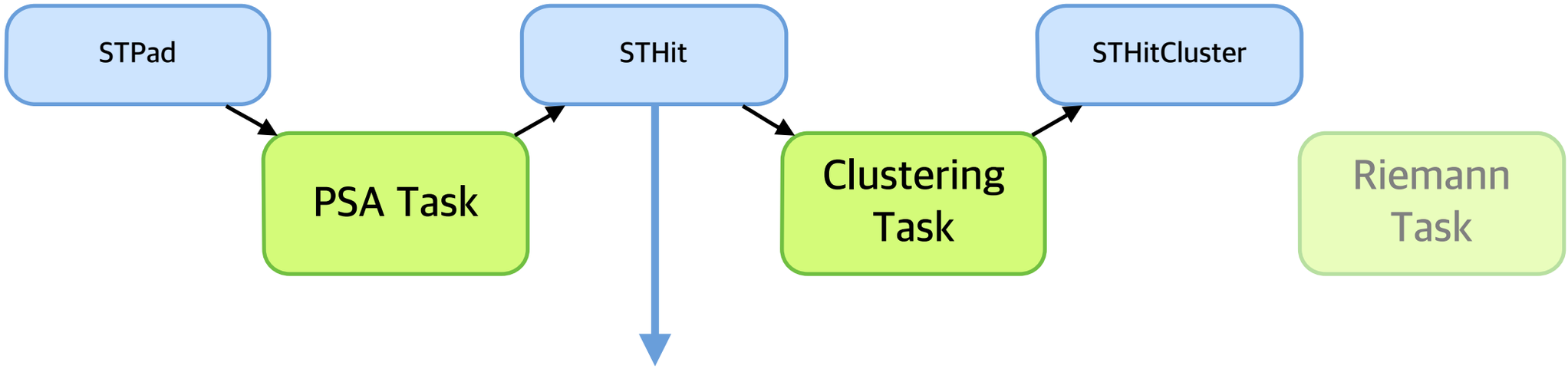


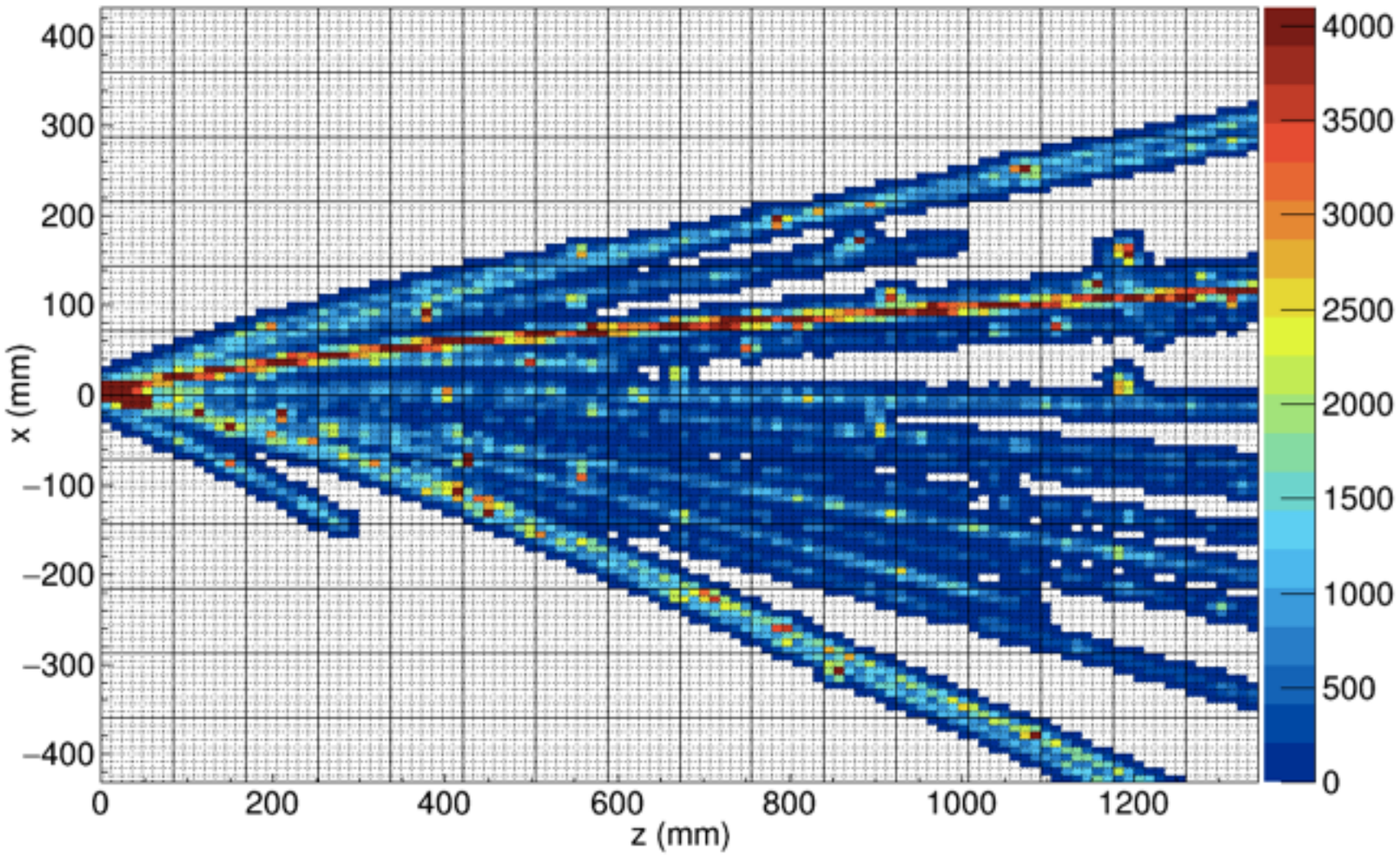
1. Search every peak of pulse using TSpectrum.

2. For all pulses, fit the rising part of pulse with a linear function in range between bins with heights corresponding to 10% and 90% of the peak value. The x intercept of this linear function is defined as a time of hit. Charge of hit is defined by height of the peak.

3. For all pad, find hit with local maximum charge. Collect near pads, calculate center of charge to make cluster (to be done).

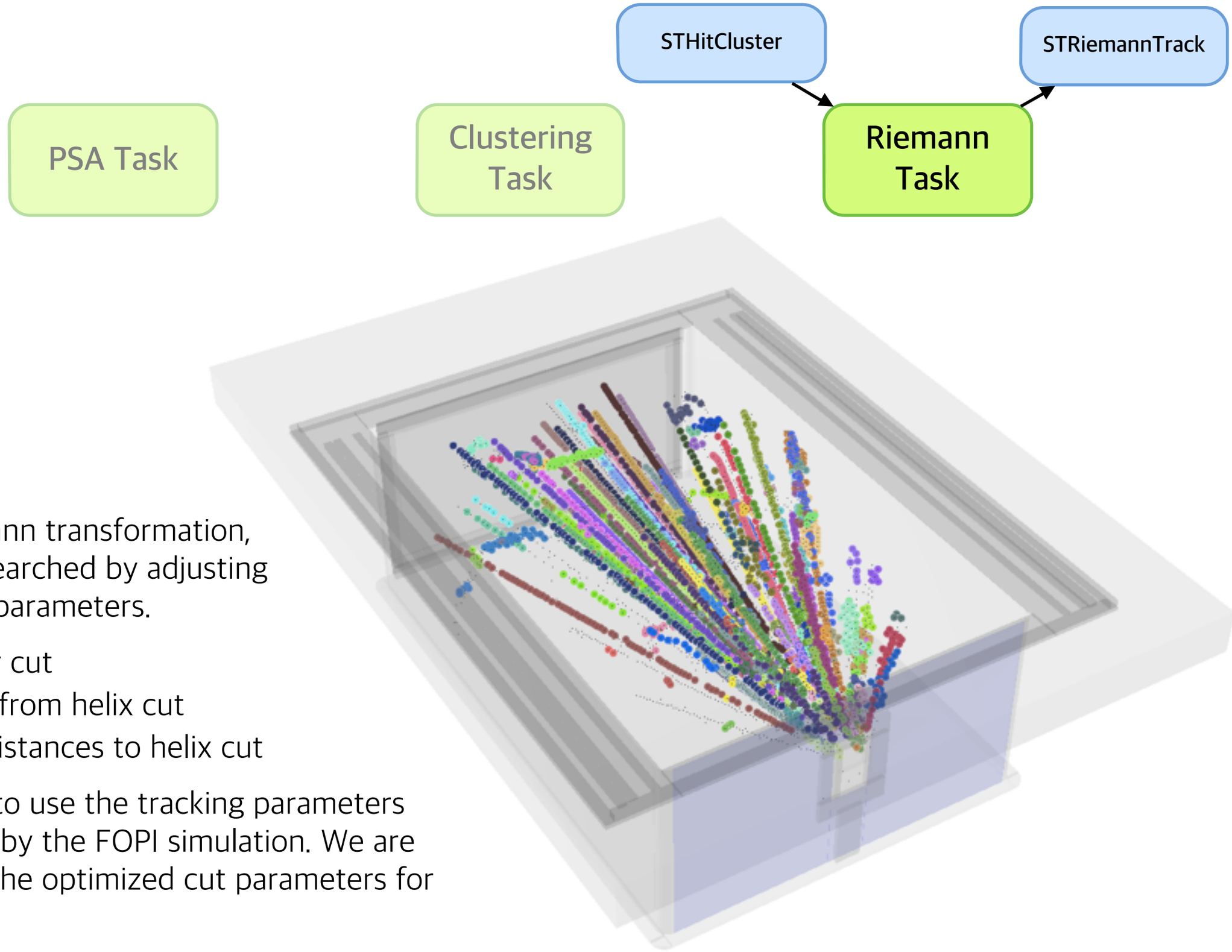
Reconstruction - PSA & Clustering





Projection of hits in pad plane

Reconstruction - Riemann Tracking (preliminary)



- Using Riemann transformation, tracks are searched by adjusting various cut parameters.
  - Proximity cut
  - Distance from helix cut
  - RMS of distances to helix cut
- We started to use the tracking parameters determined by the FOPI simulation. We are looking for the optimized cut parameters for SπRIT-TPC.

Summary

- We are building up the basic software framework called SπRITROOT.
- The results from the simulation and test of GET electronics are important input.
- We are actively developing the reconstruction process.