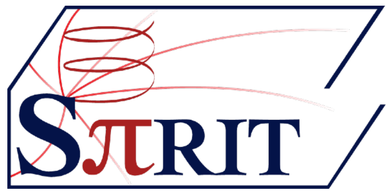
Event Reconstruction with SπRIT-TPC

Jung Woo Lee



Experiment Motivation

$$E(\rho,\delta) = E(\rho,0) + E_{sym}(\rho)\cdot\delta^2 + \mathcal{O}\left(\delta^4\right)$$

$$E_{sym}(\rho) \approx E(\rho,1) - E(\rho,0)$$

$$\delta = (\rho_n - \rho_p)/\rho$$

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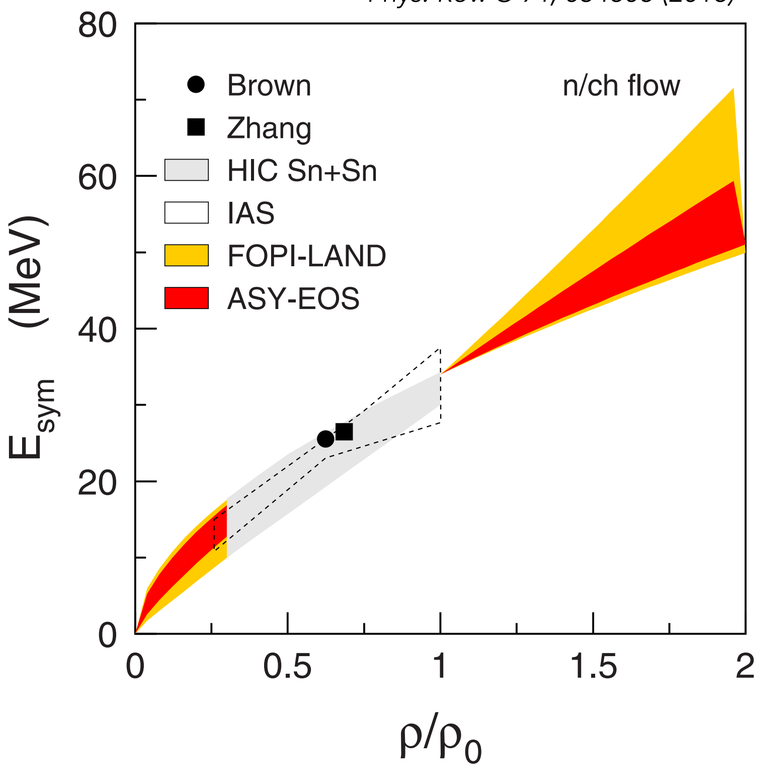
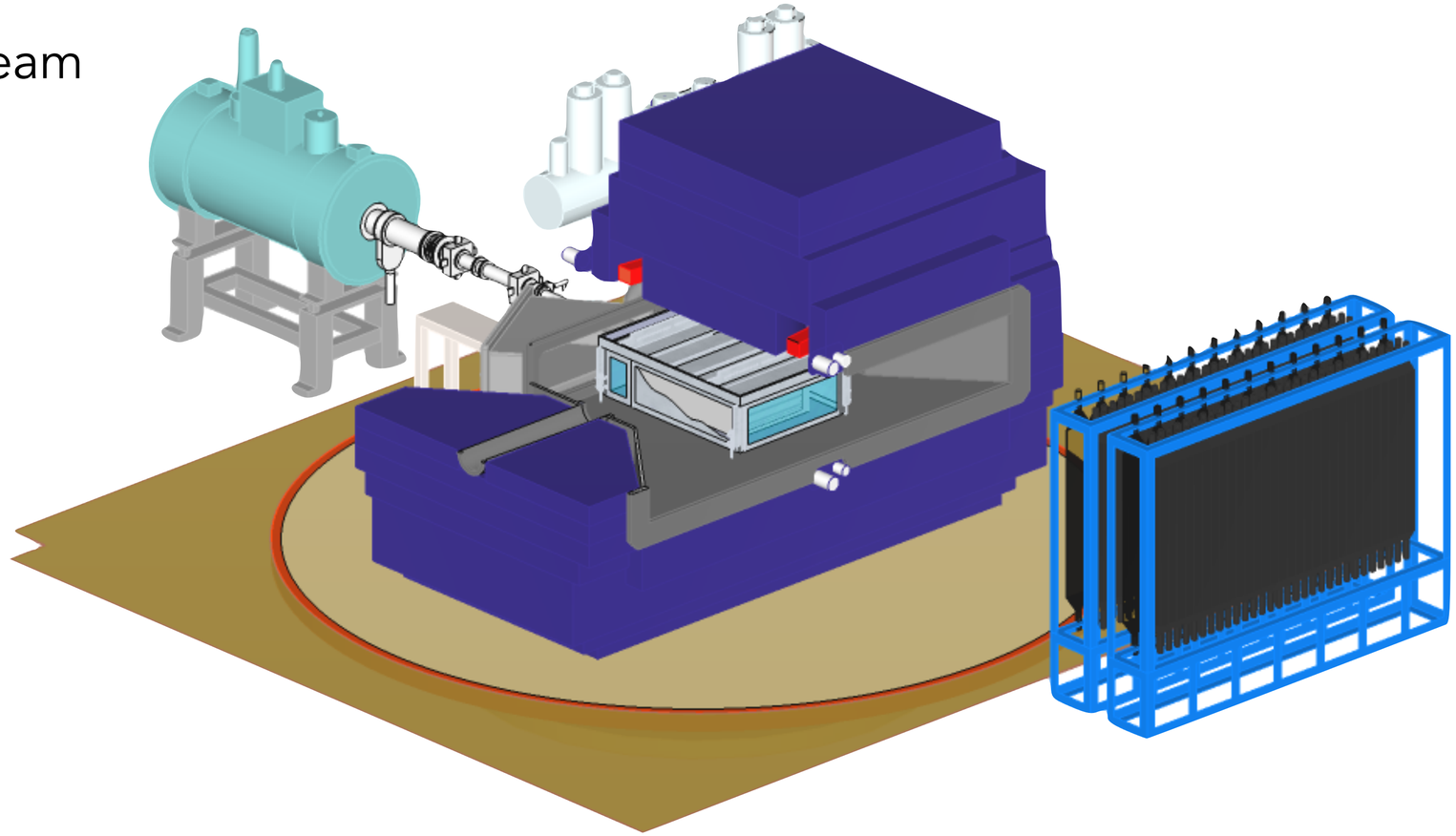


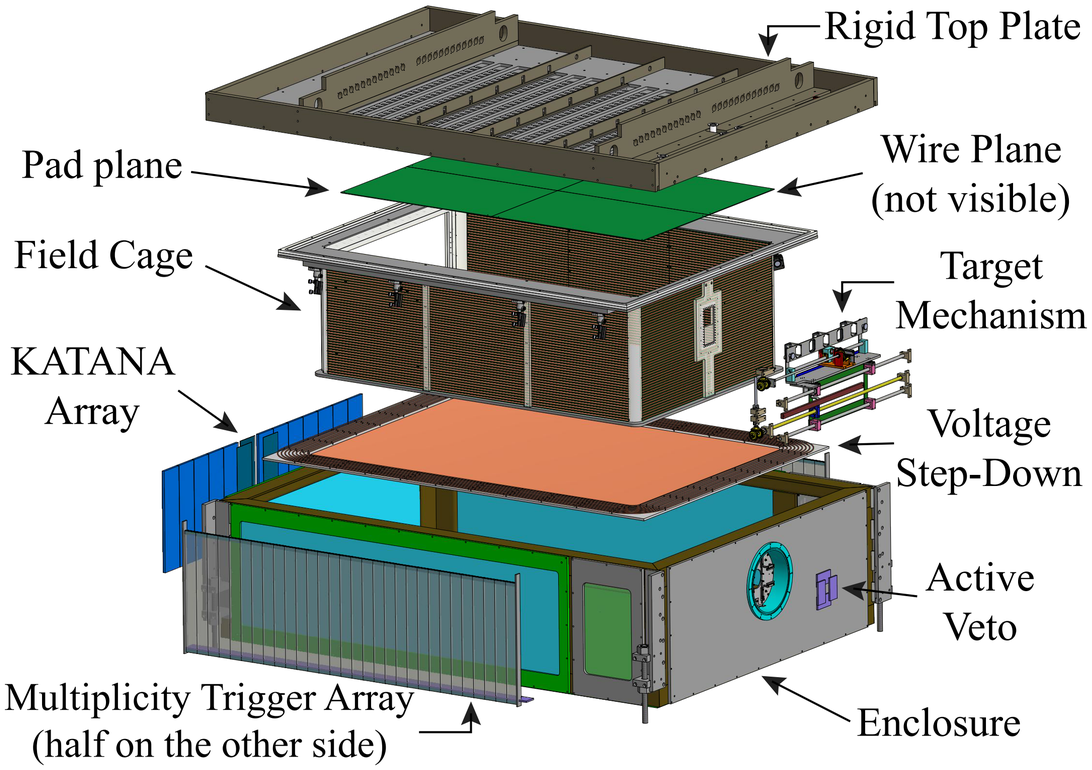
- The liquid drop model predicted bulk properties of nuclear matter.
- The symmetry energy determines the properties of neutron rich/poor system.
- Symmetry energy depends on pressure, temperature, isospin asymmetry etc.

Experiment Overview

- Experiment was performed at RIBF, RIKEN, Japan.
- SAMURAI magnet producing magnetic field; 0.5 T.
- NeuLAND was placed downstream for neutron measurement.
- Beam energy 270 MeV/u
- Collision systems:
  - 132Sn + 124Sn
  - 124Sn + 112Sn
  - 108Sn + 124Sn
  - 108Sn + 112Sn



SπRIT Time Projection Chamber (TPC)



- Effective gas dimension; (864,1344,530) mm
- P10 gas (Ar 90 % + CH_4 10 %) with electric field; 124.73 V/cm.
- Pad plane containing 108×112 rectangular pads (8×12 mm)
- KATANA Array and Kyoto Array were used for multiplicity trigger Array.

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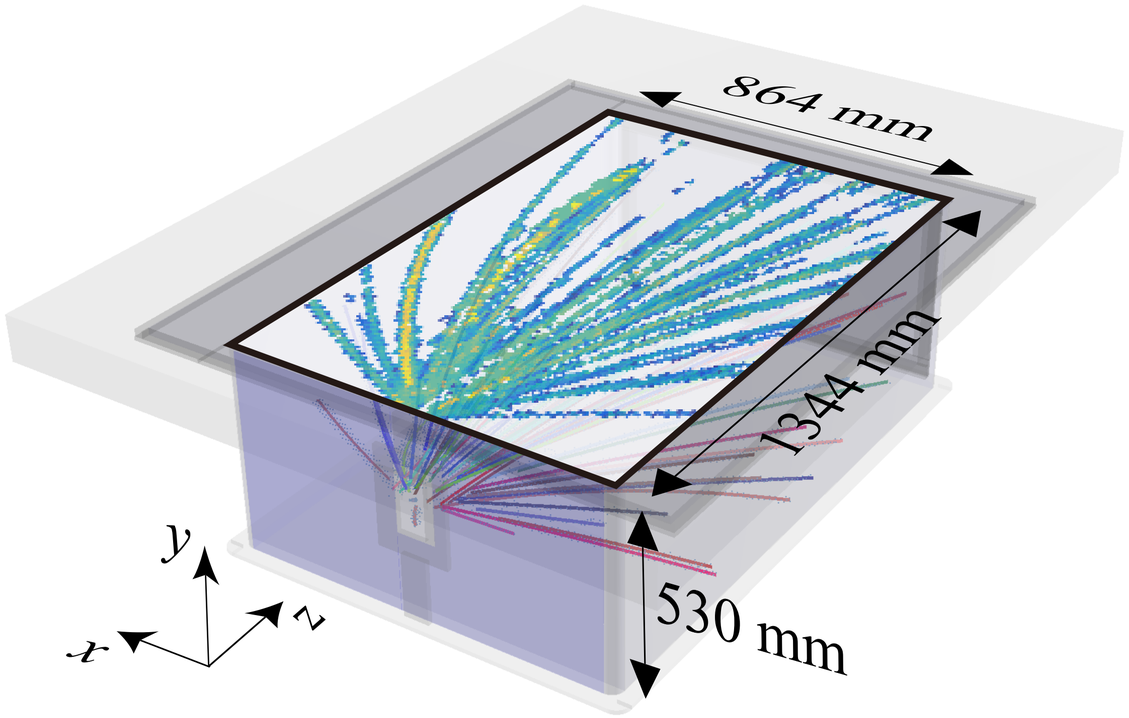

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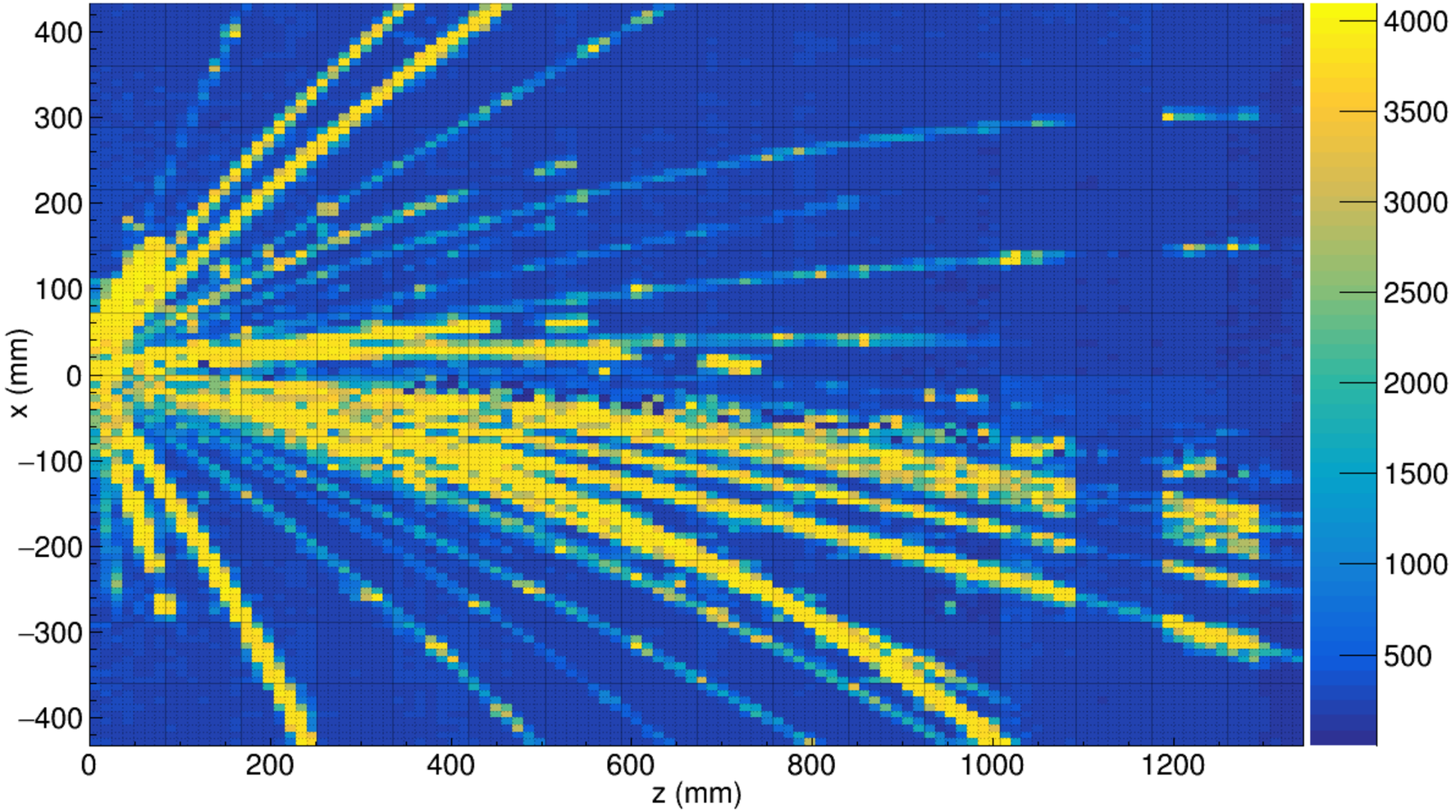
Software Overview and Challenge

- The SπRITROOT software is built on top of FairROOT framework which is developed for 1) simulation and 2) event reconstruction.
- Simulation part uses Geant4 for Monte Carlo process and digitization is developed which mimics the electronics ouput.

- **Event reconstruction contains:**
  - Pulse analysis
  - Track finding
  - Hit-cluster finding
  - Track and vertex reconstruction
  - Particle identification

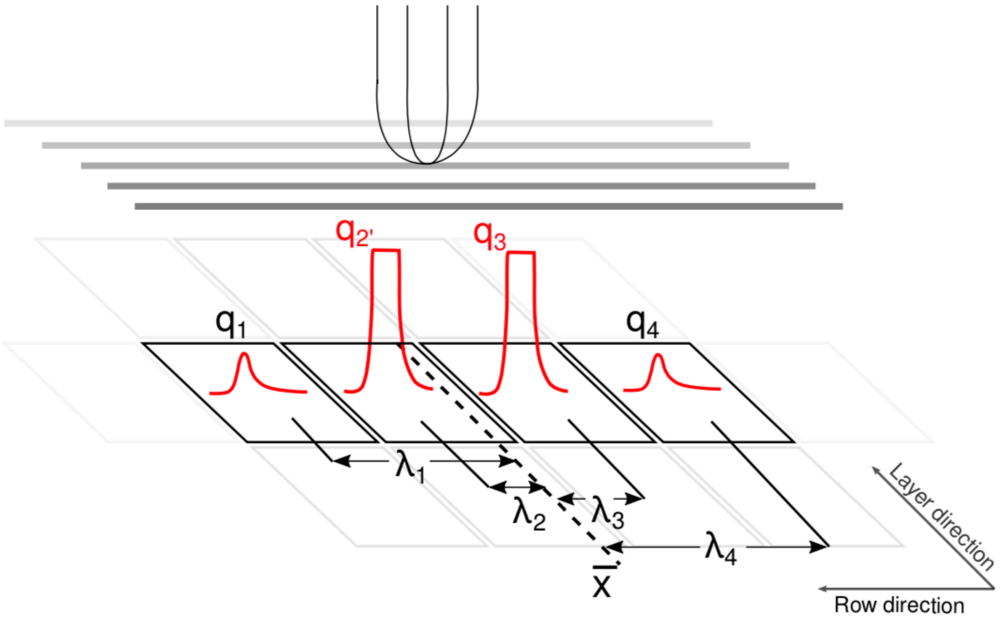
- **Challenges:**
  - Covering primary vertex region with large track density.
  - Target and projectile fragments saturates pads and kill electronics.
  - Extending dynamic range.
  - Rectangular TPC.

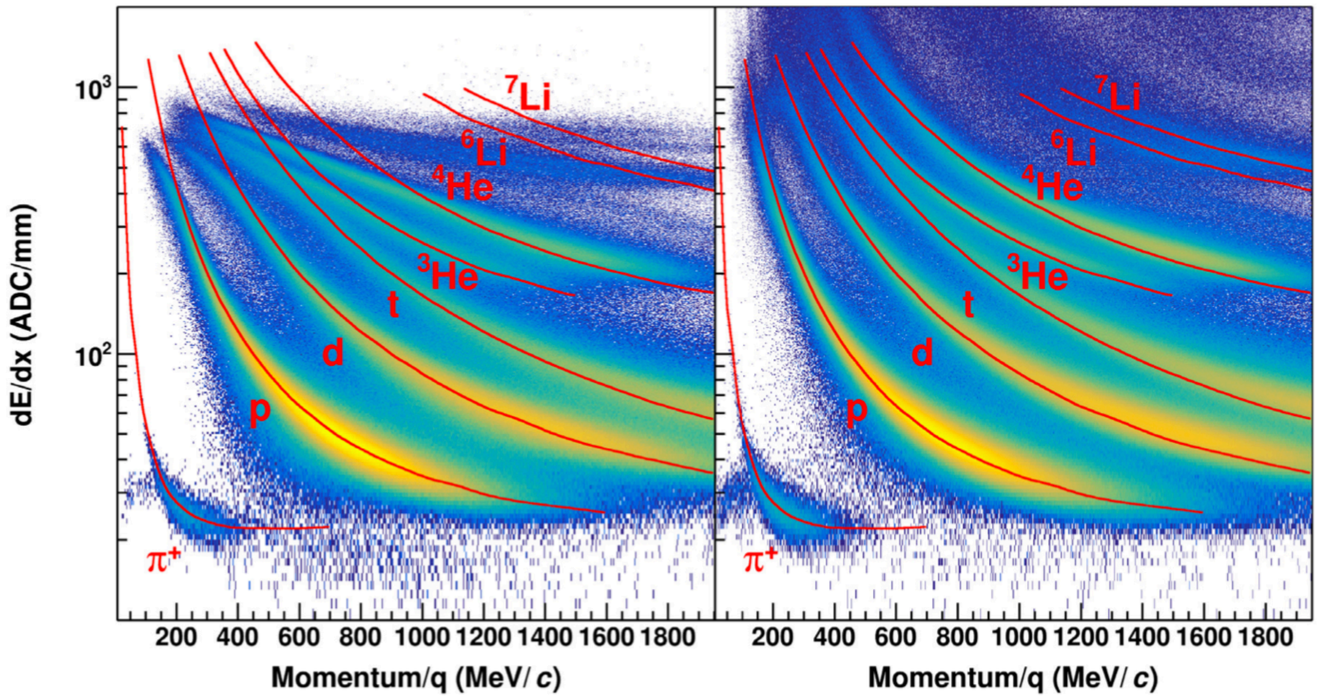
Software Overview and Challenge



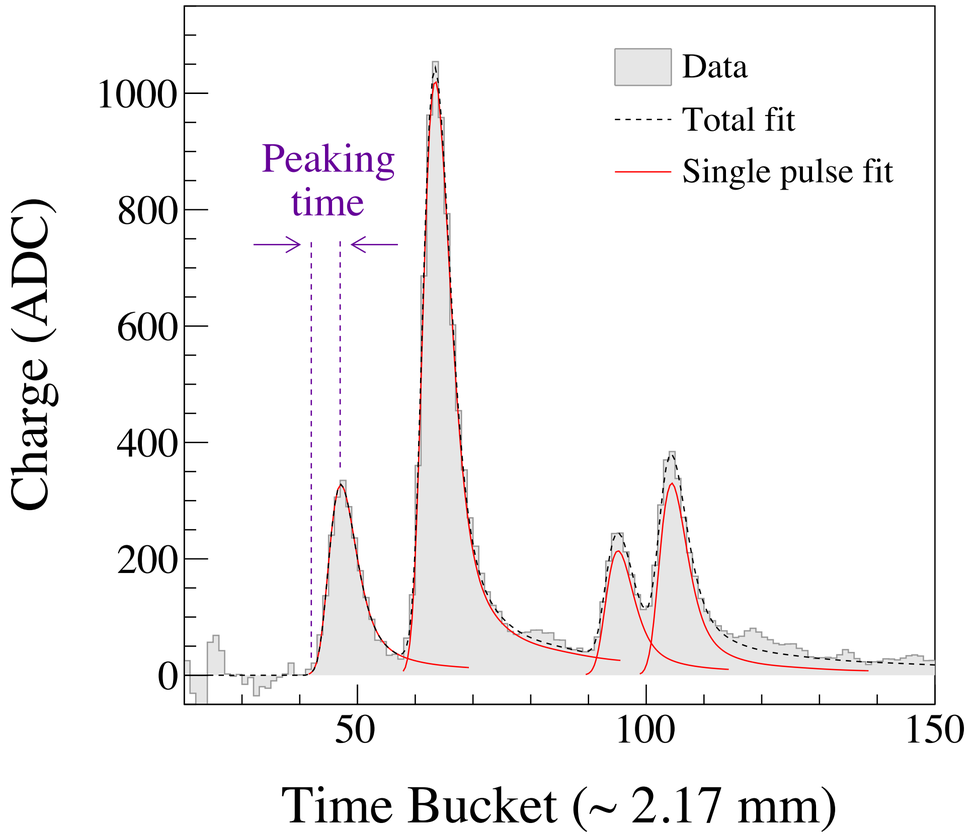
Extending dynamic range

- Upper limit of dynamic range (shown as pad saturation) is extended by pad response function analysis.



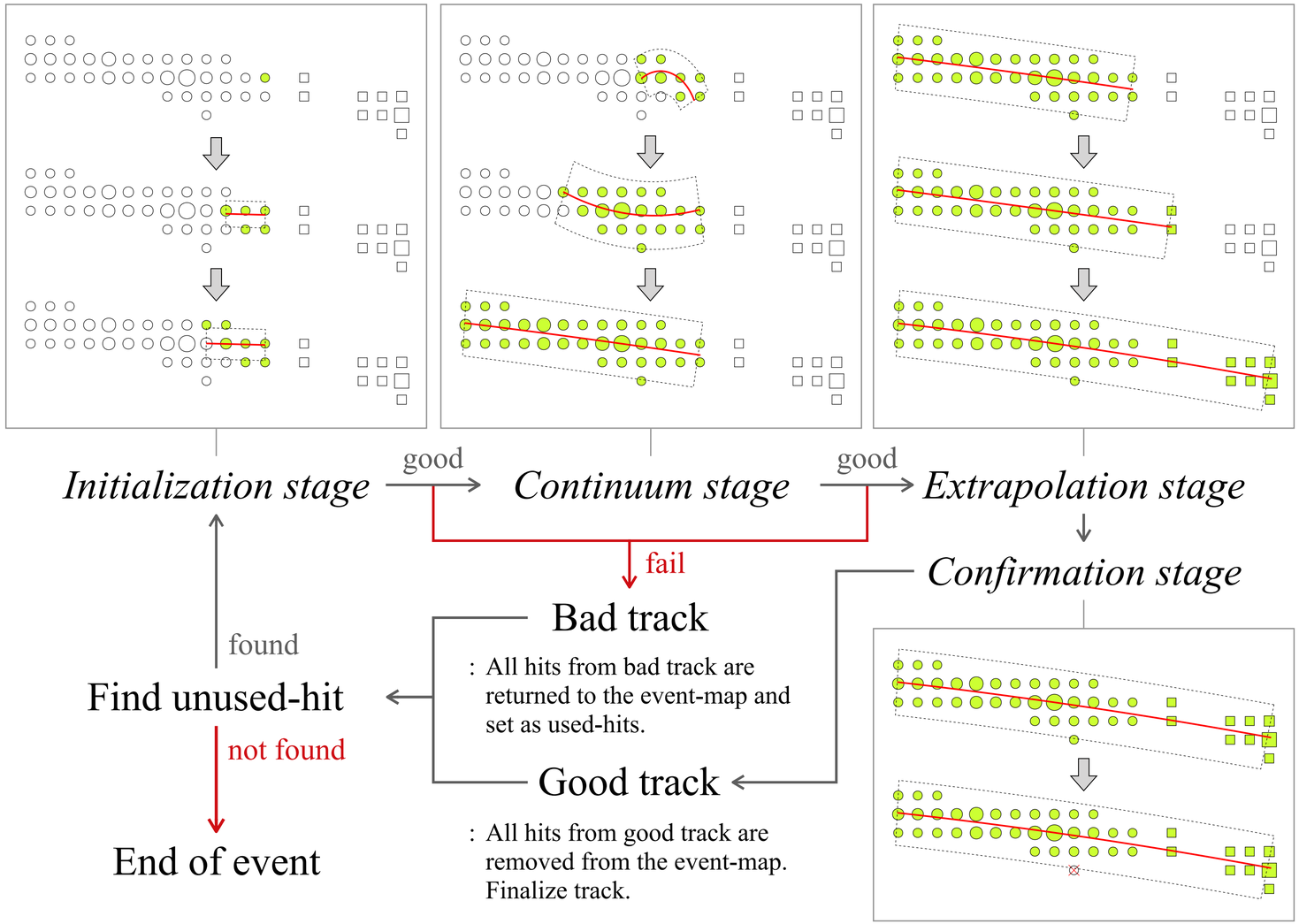


Pulse Analysis

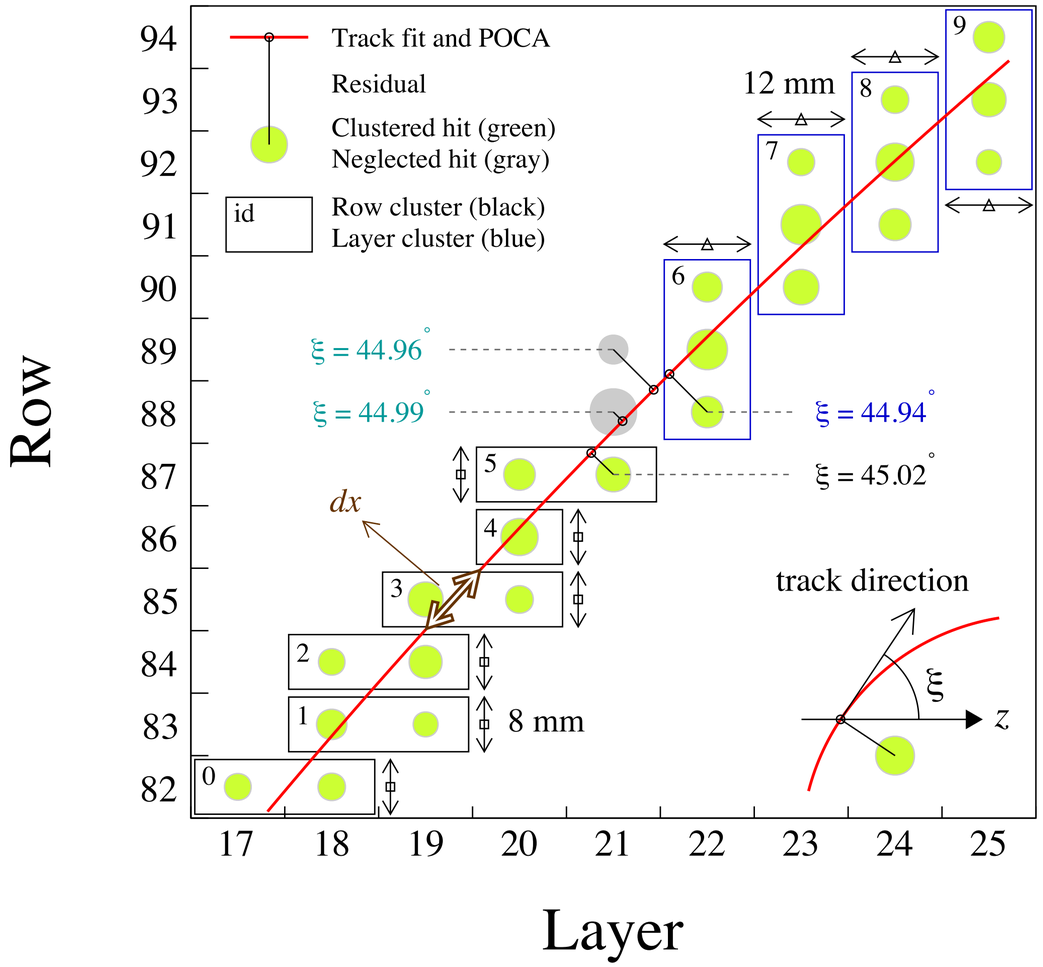


- Pulse Analysis was performed finding overlapping pulses in TPC pads.
- The method use the multi-pulse fitting using reference extracted from the pulse data.
- One hit finding efficiency = 95 ± 1 % and two hit separation efficiency(right figure) is measured.

Track finding



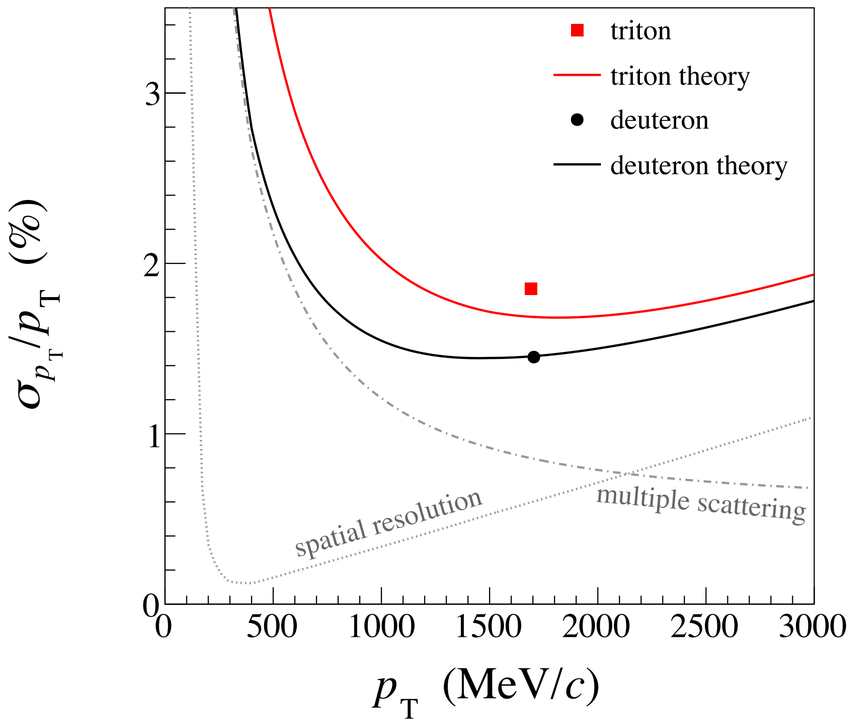
Hit-Cluster Finding

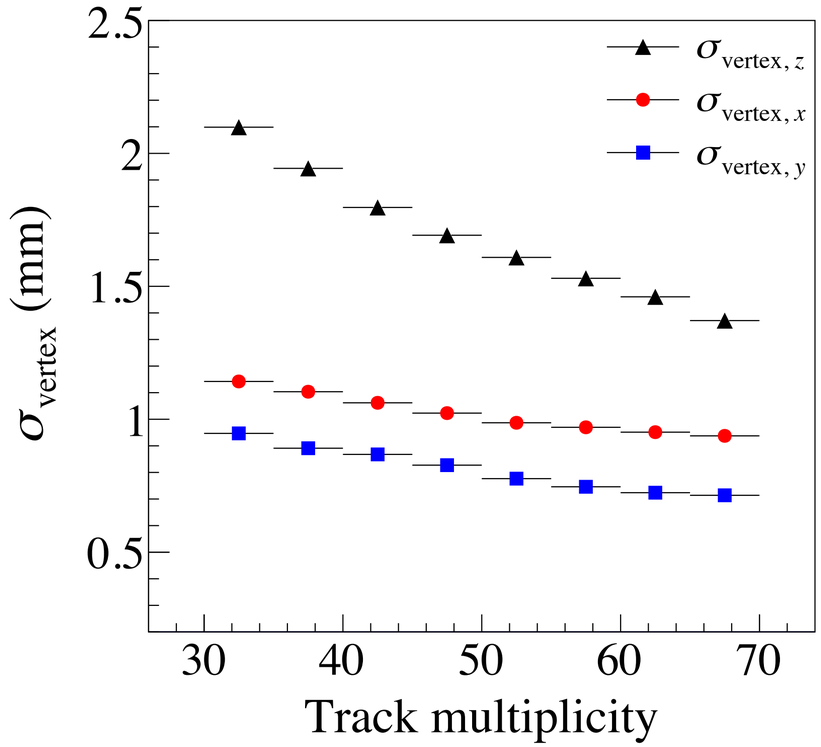


- Hit-Clusters are created by adding hits of same layer (or same row) depending on the track angle.
- Track direction and hit residual angle decides the type of cluster.
- Hit-clusters are points used for measurement points in track reconstruction and points for <dE/dx>.

Track and Vertex Reconstruction

- Track reconstruction: GENFIT considering field map, measurement error and material effect.
- Vertex reconstuction: RAVE, Adaptive Vertex Fitter (AVF) an iterative weighted Kalman filter finding one vertex.





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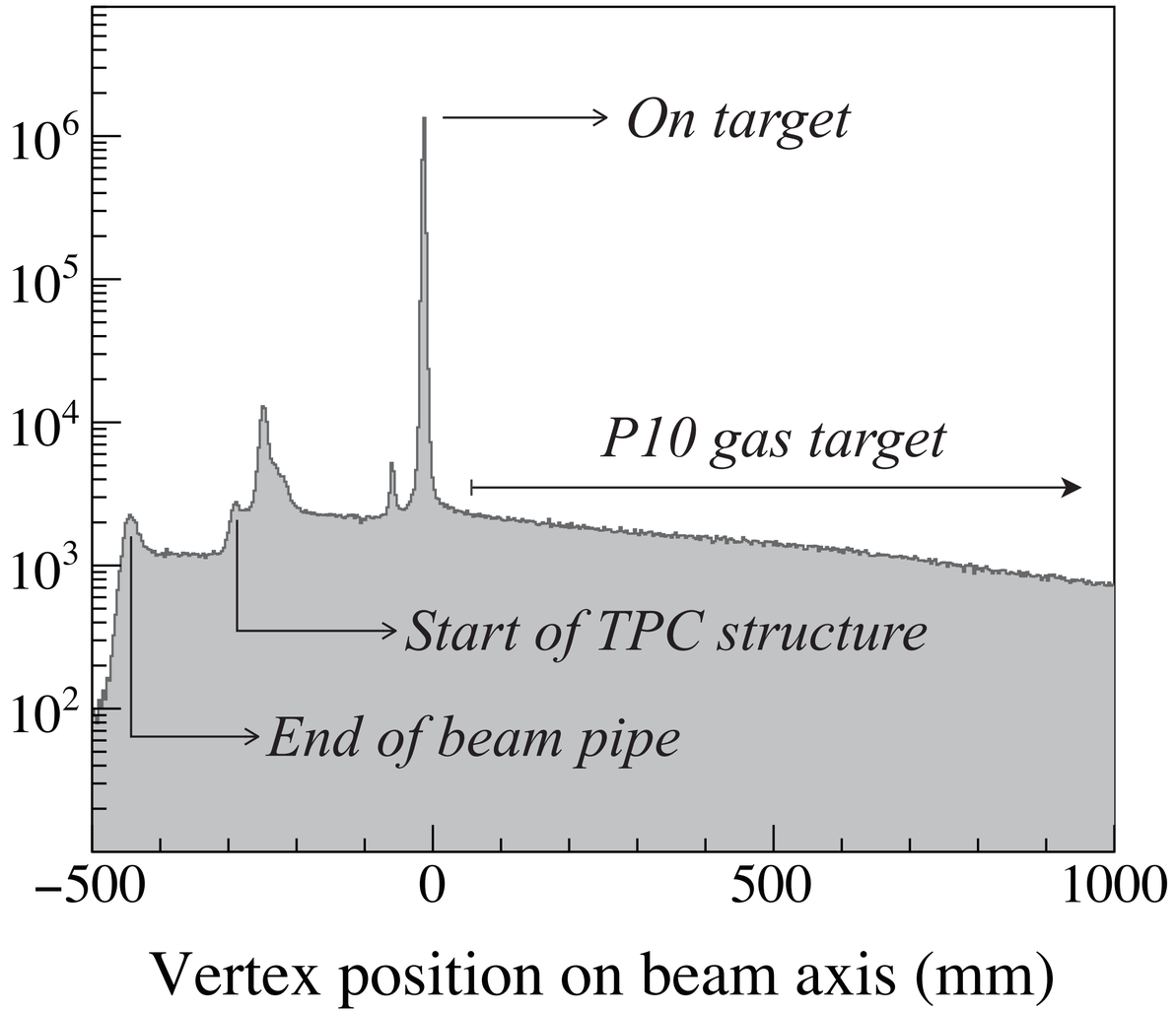

Particle Identification

- For particle identification, rigidity (p/Z) vs <dE/dx> spectrum is used.
- Momentum and charge is identified from GENFIT.
- <dE/dx> is truncated mean of (dE/dx) points from hit-clusters of corresponding track.

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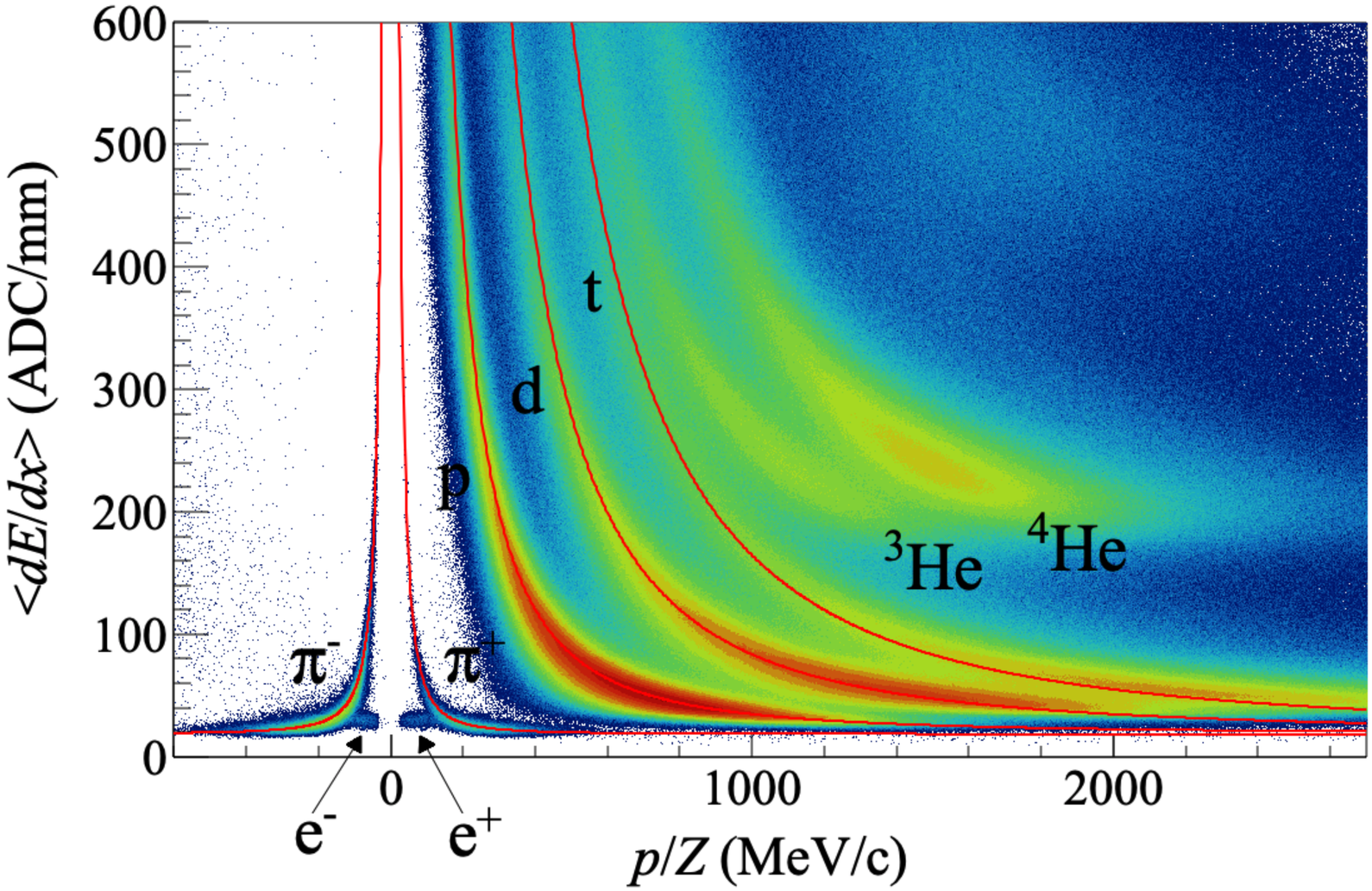

Summary

- For study of symmetry energy, SπRIT-TPC experiment measured heavy-ion collision with neutron rich/poor systems.
- The software framework SπRITROOT is developed to reconstruct experiment data which is also capable of simulation and analysis.
- Physics observables for nuclear symmetry energy is being studied.