Realistic hit reconstruction in SPD Range System

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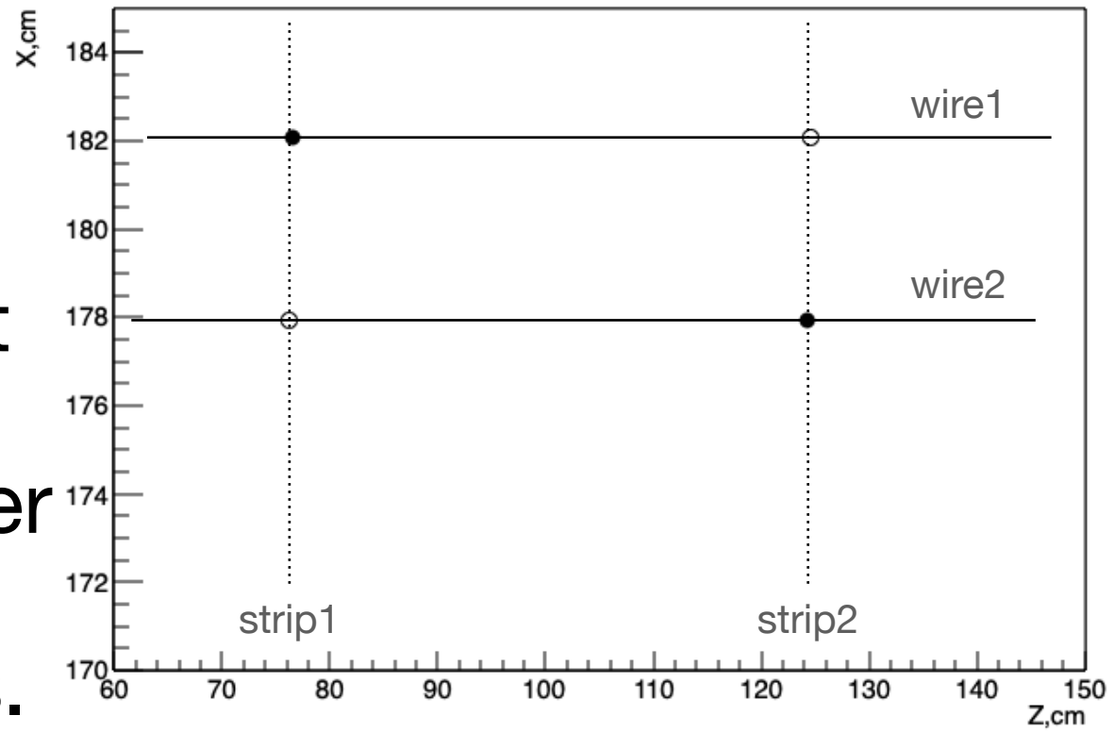
The problem

- Currently, working with SPDRoot one obtains SpdRsMCHits.

- Hit:
  Edep > 1 keV
  Step length > 1 cm

- In reality, for each event we will get signals from wires and strips. If several tracks give hits in a RS layer we should take into account all combinations of wires/strip signals.



A possible solution

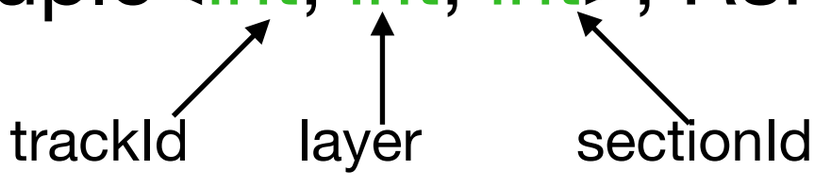
- A new RsMCHit determination with a flag saying is it a true hit or not;
- Any structure (e.g. C++ map) containing real and combinatorial hits.
- Such map could be given to user for analysis or be used for neural network training.

The solution was recently committed into SPDroot git

RsRecHit structure

- The RsRecHit class contains:
  Hit position (TVector3);
  Hit position uncertainty (TVector3);
  is_hit (boolean flag, is it a true hit or not);
  Layer number;
  RS section number (0, 1 - EC, 2-8 - Barrel);

- All the hits are written into
  std::map <std::tuple<int, int, int>, RsRecHit> hit_map;



How it works

- SpdRsMCRealHitProducer

- Fills the hit_map with true hits:
  — reads points from RsTB and RsEC
  — point is accepted
  — hit position:
  Barrel: (x, y) from center of wire, z from center of strip
  EndCaps: (y, z) from center of wire, x from center of strip
  —fills the map with a key (trackId, ilayer, isubs)

- At the end of task fills the hit_map with combinatorial hits: (for each layer of each RS subsystem)

Working time

Reconstruction of event with 40 muons:

- Current reconstruction: 6.2s
- Reconstruction with realistic RsHits: 7.34s

Reconstruction time depends on the number of muon and pion tracks in an event. For realistic MC event the main contribution goes from track fitting procedure.

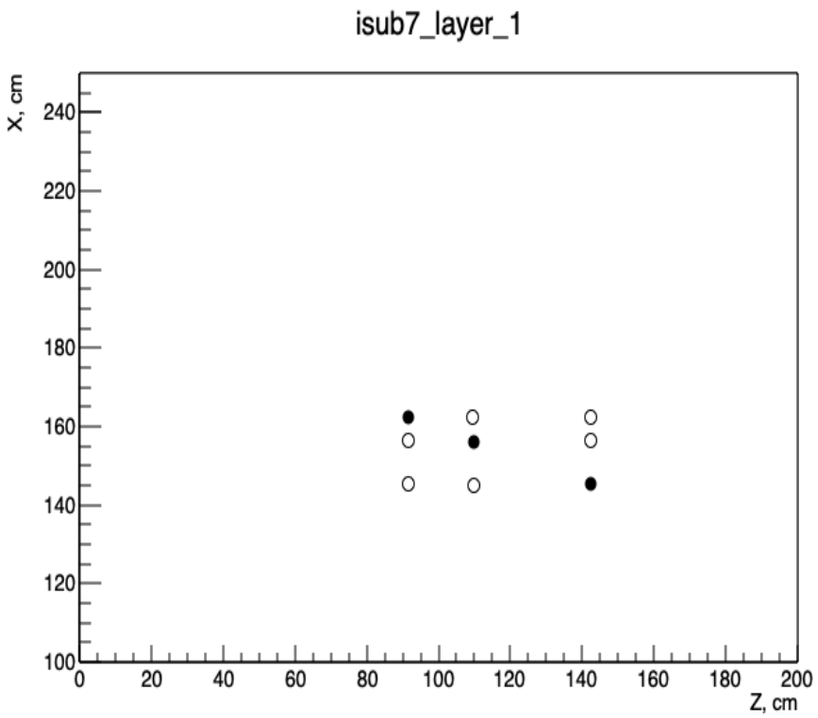
How to run

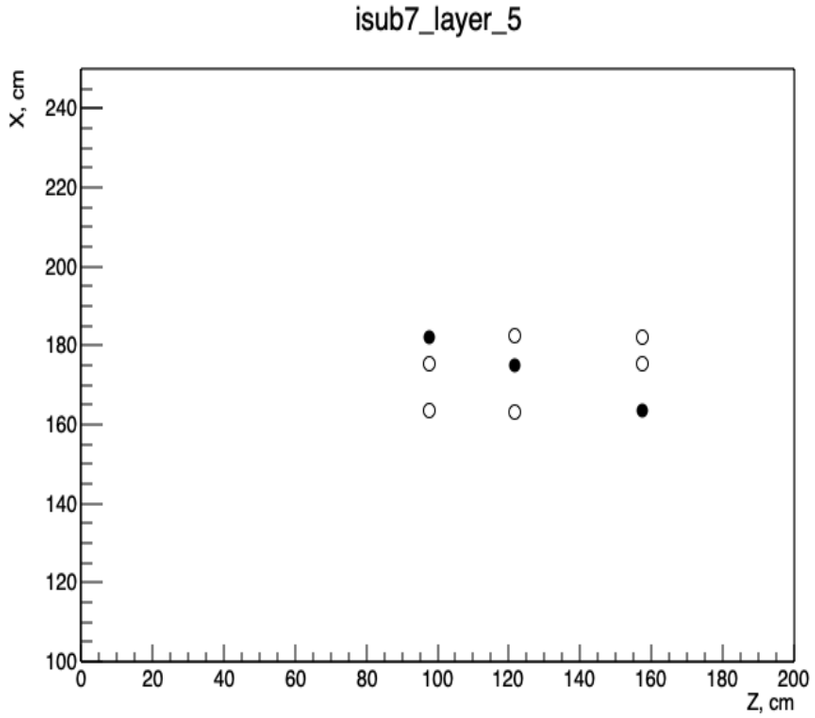
- The code is available at SpdRoot/realistic_hits_rs branch.
- In your reconstruction script (macro/examples/<project>/reco.C)

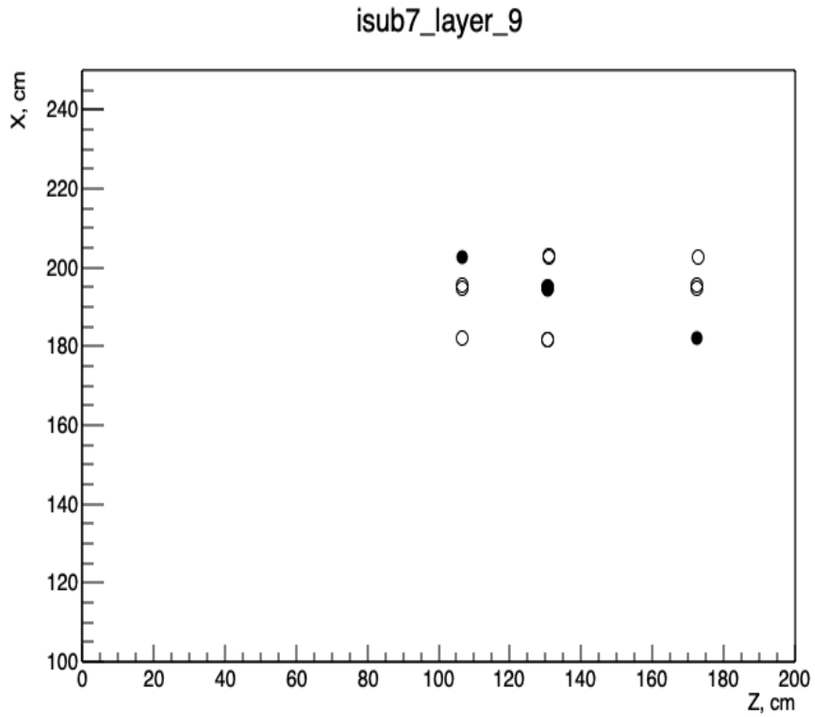
```
// SpdRsMCHitProducer* rs_hits_producer = new SpdRsMCHitProducer();

SpdRsMCRealHitProducer* rs_hits_producer = new SpdRsMCRealHitProducer();
// rs_hits_producer->MakeStripHits(true);

 //rs_hits_producer->SaveHits(false);  // default: true

rs_hits_producer->SetVerboseLevel(1);

Run->AddTask(rs_hits_producer);
```

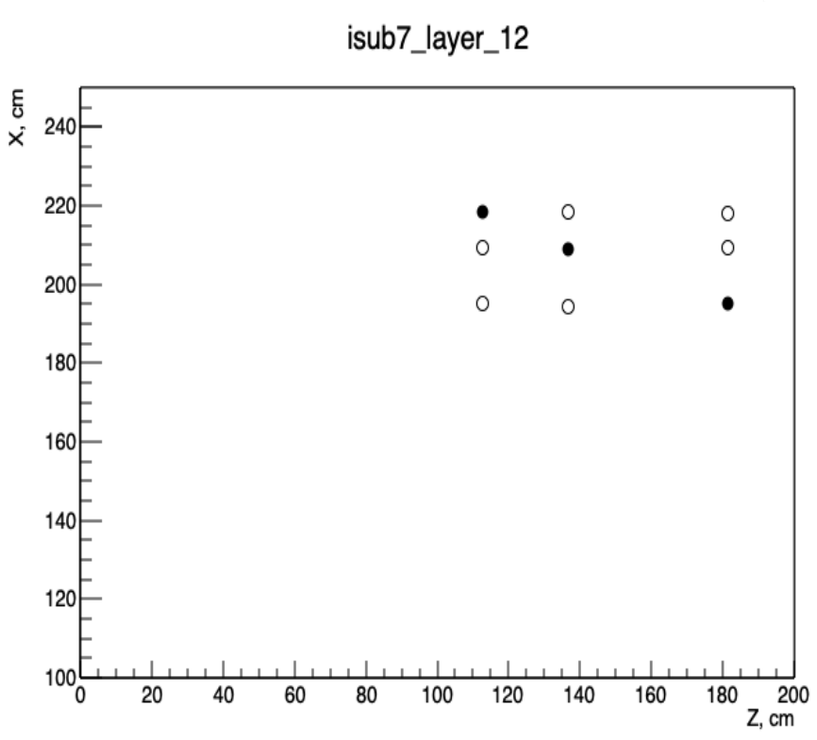
- After reconstruction the rs_hits_producer object will contain a map with real and combinatorial RsRecHits.
- I had an access to the hit map through SpdRsMCRealHitProducer::Finish() method, but in principle, it could be written into a file or be given to user.

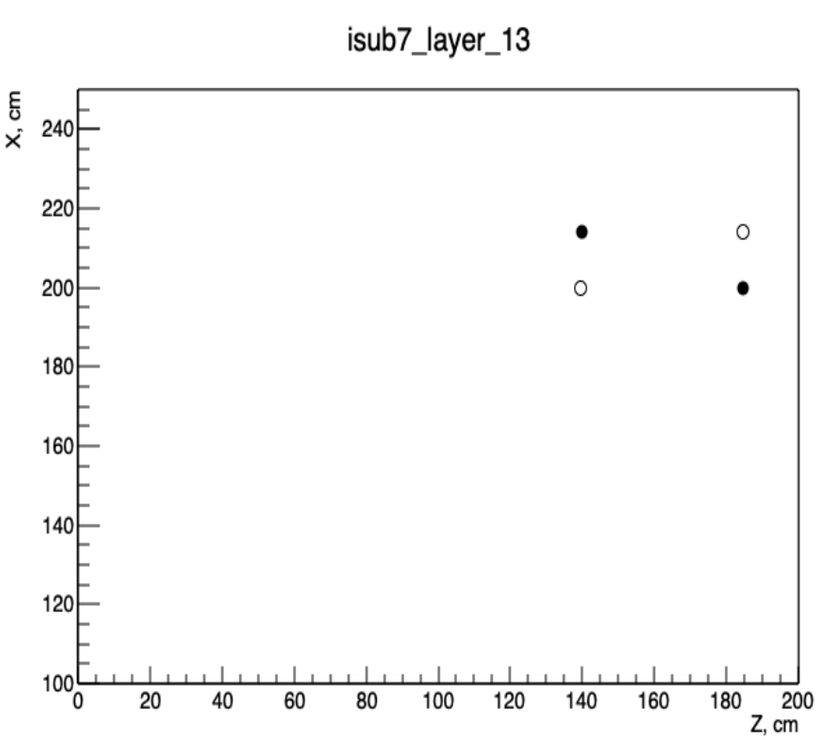
Example for 3 muon event

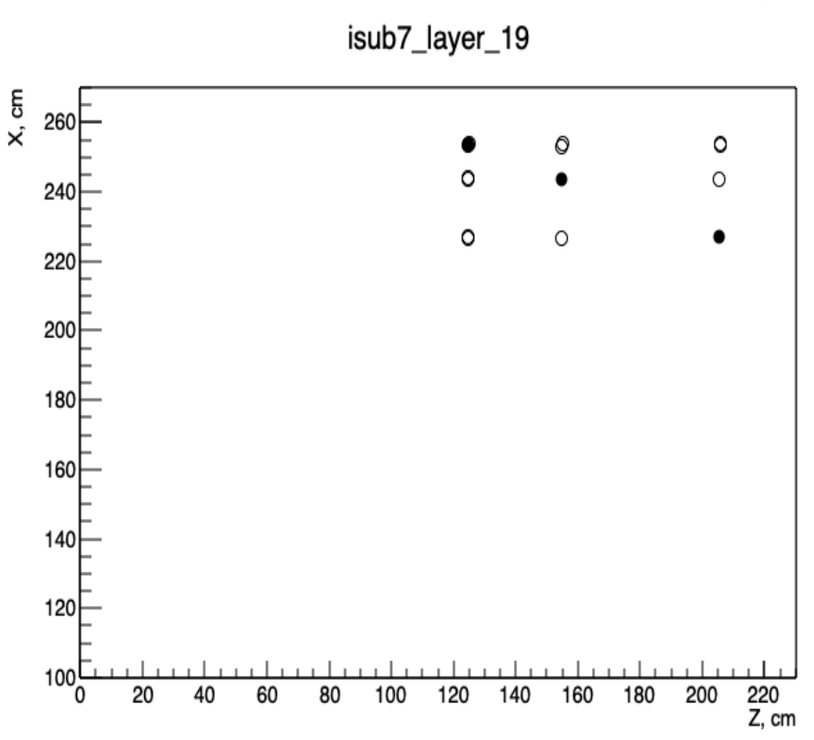






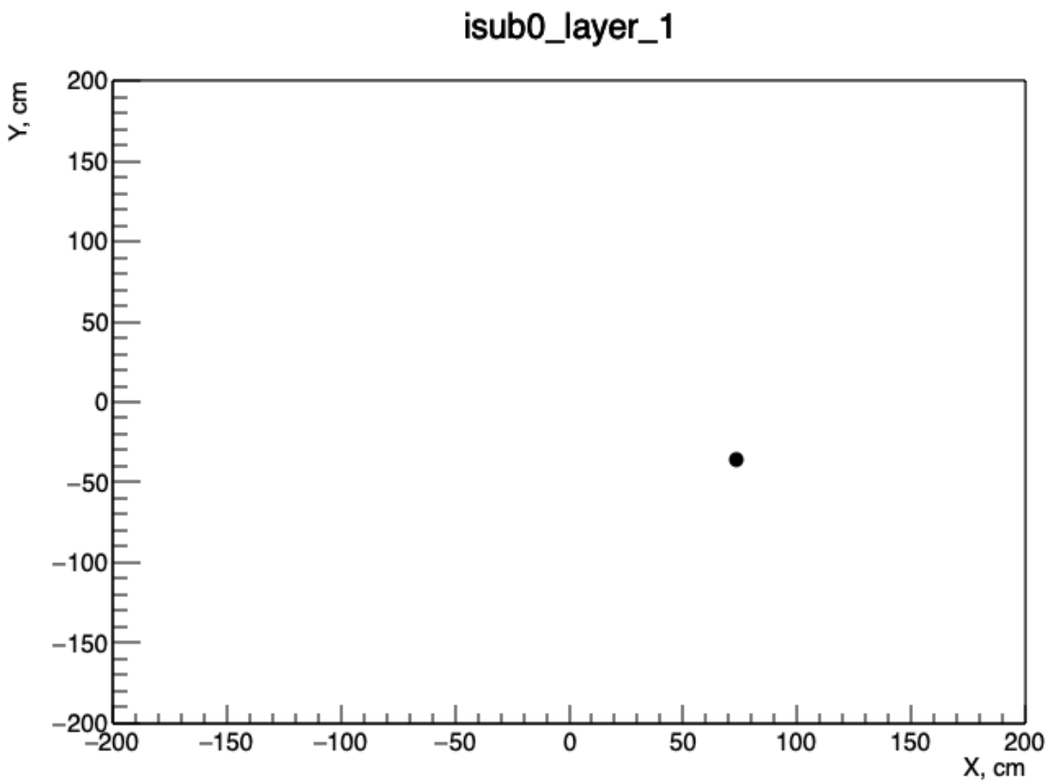


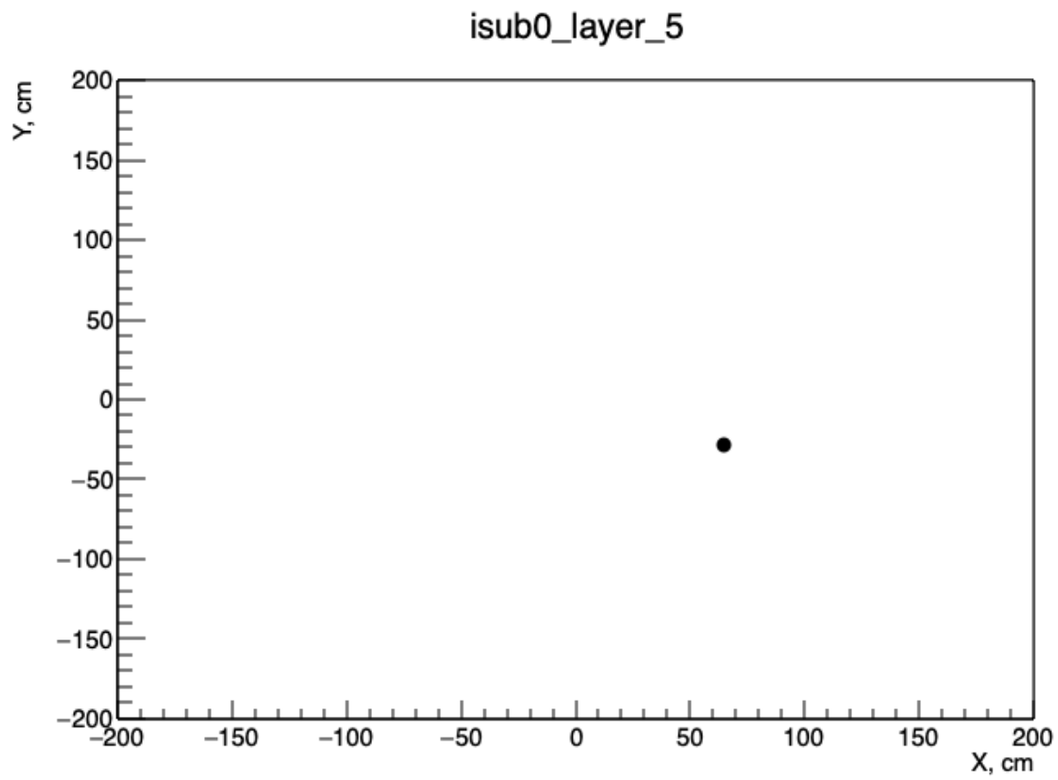


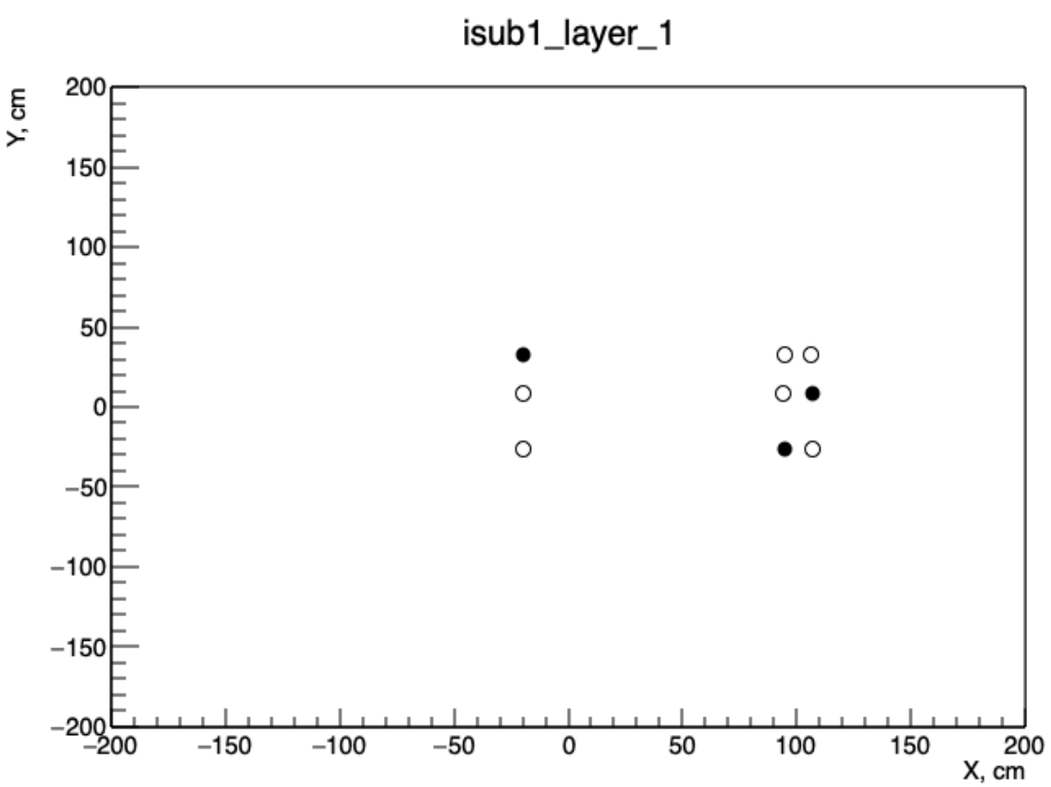


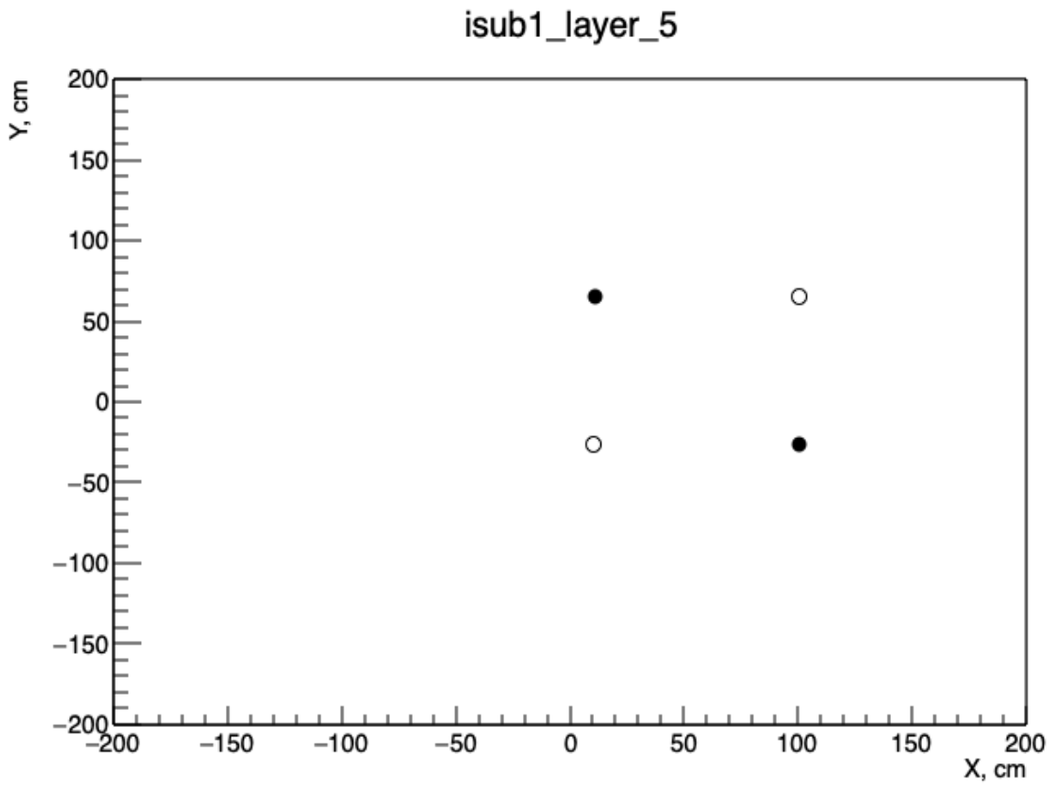
Example for typical J/ψ event

Hits in RsEC









Summary

- Reconstruction of realistic hits (MC hits and combinatorial hits) in SPD Moun System is done as a reconstruction task.
- All the hits are stored in a map that could be given to user or to neural network for training.

Thank you for attention.