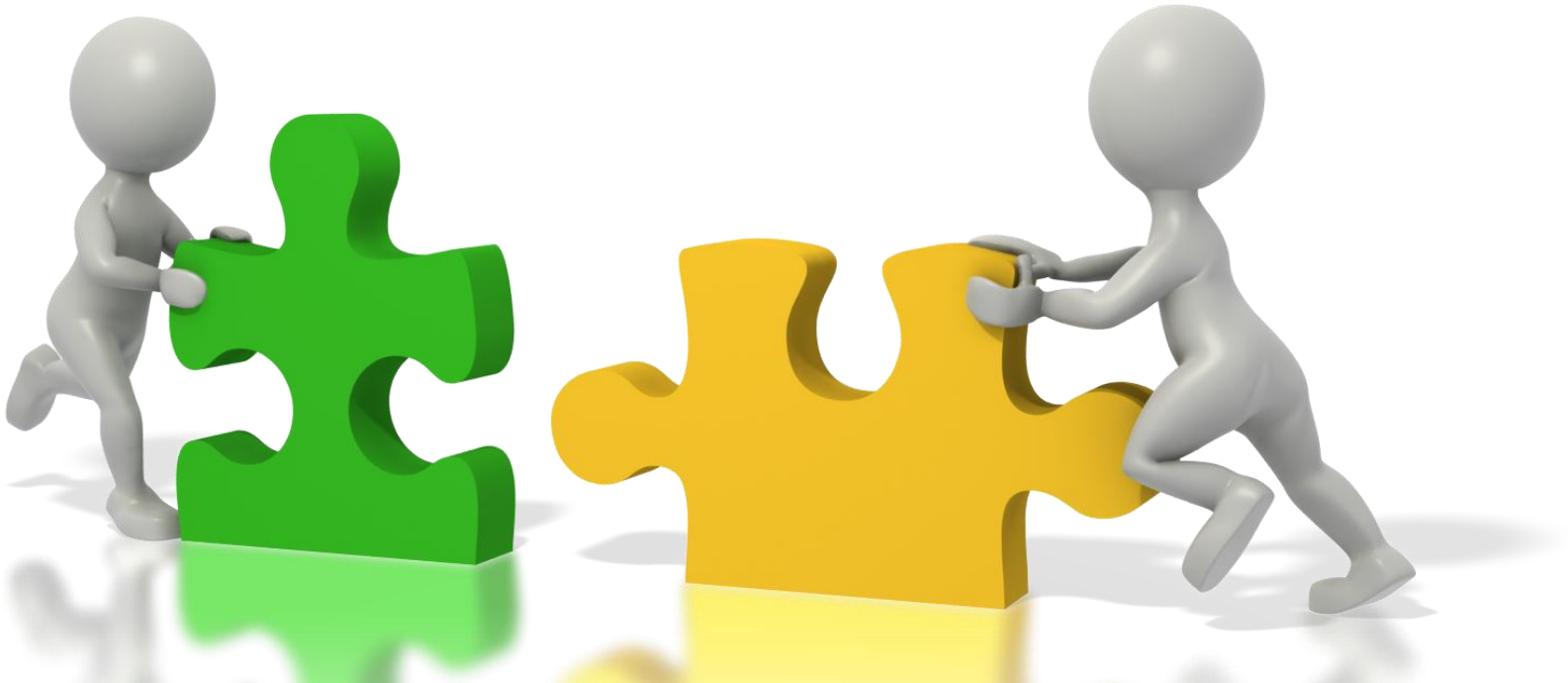
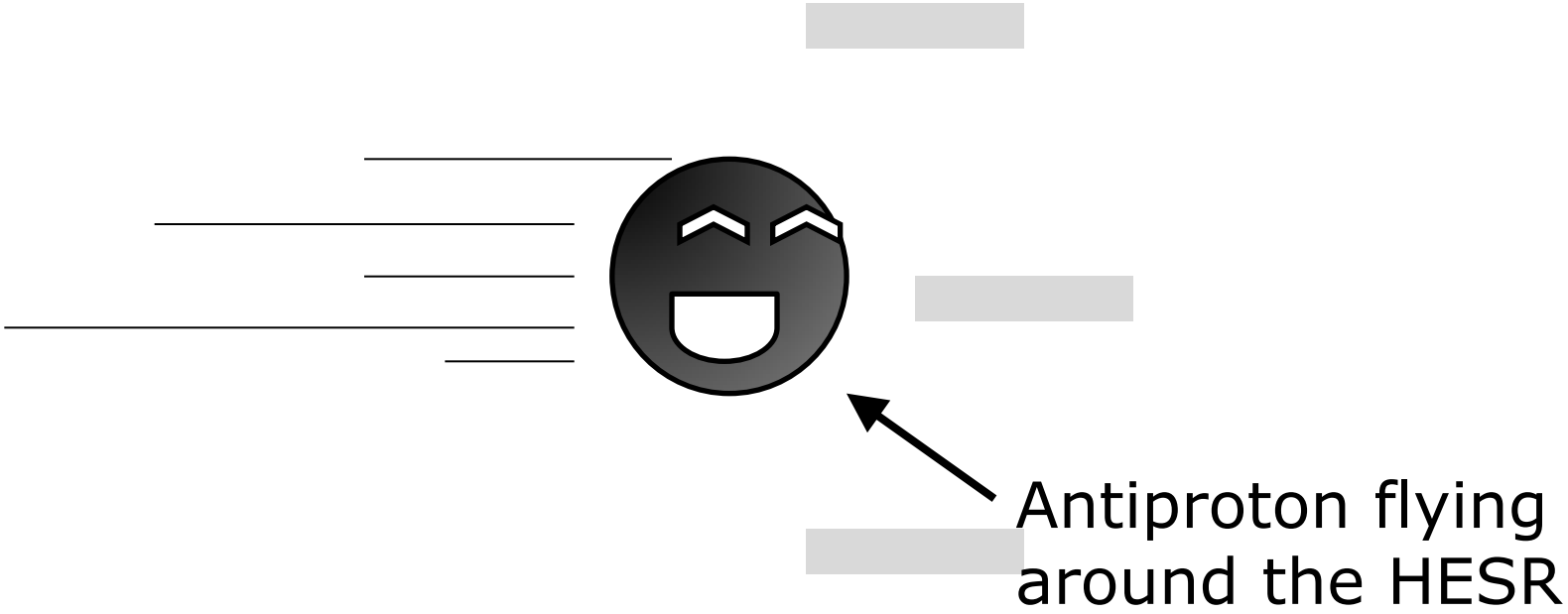
university of groningen
kvi - center for advanced radiation technology

Status update for an online clustering algorithm for the PANDA EMC

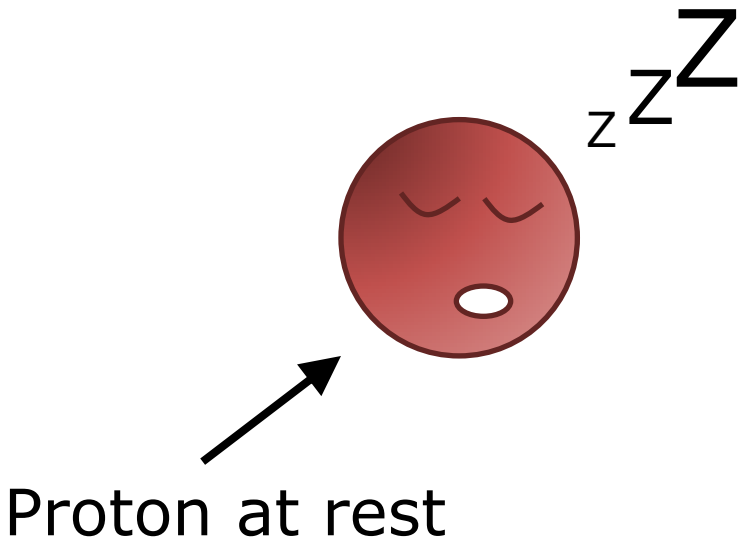
- Phase 1: Testing using simulated data



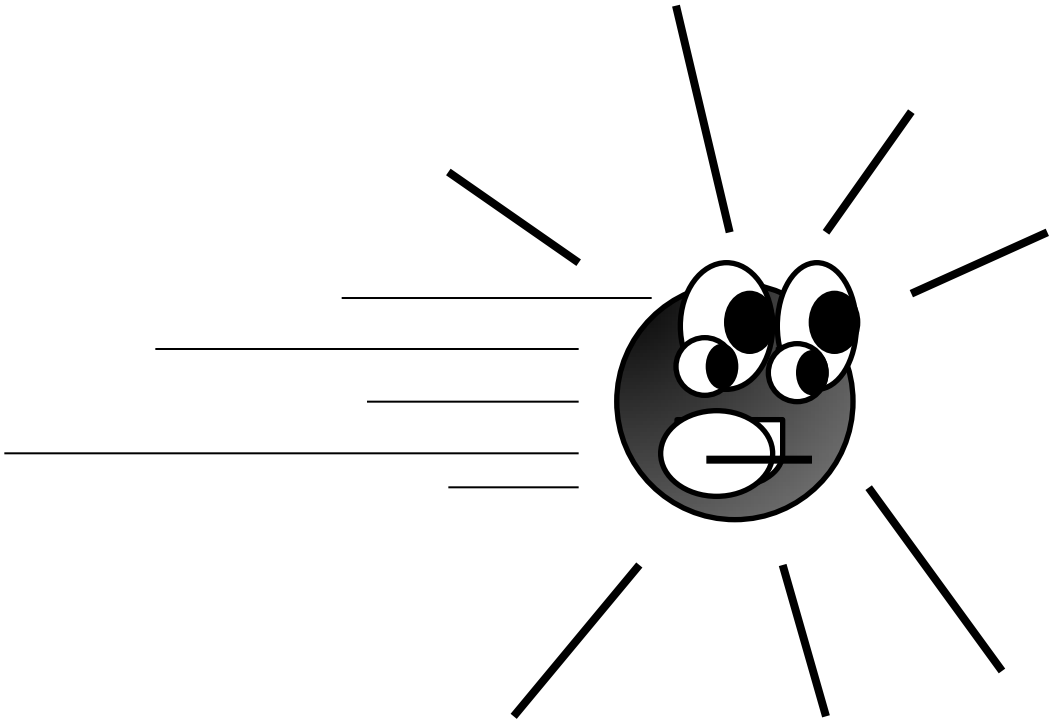
Particle production



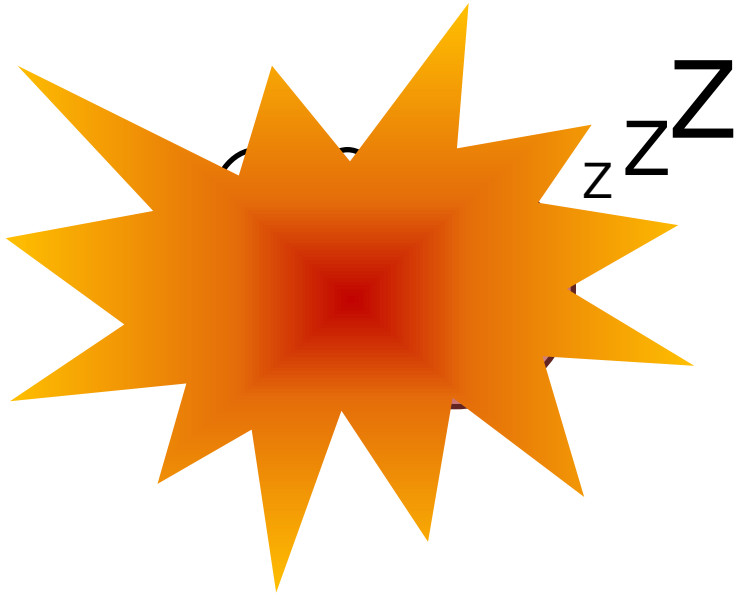
Particle production



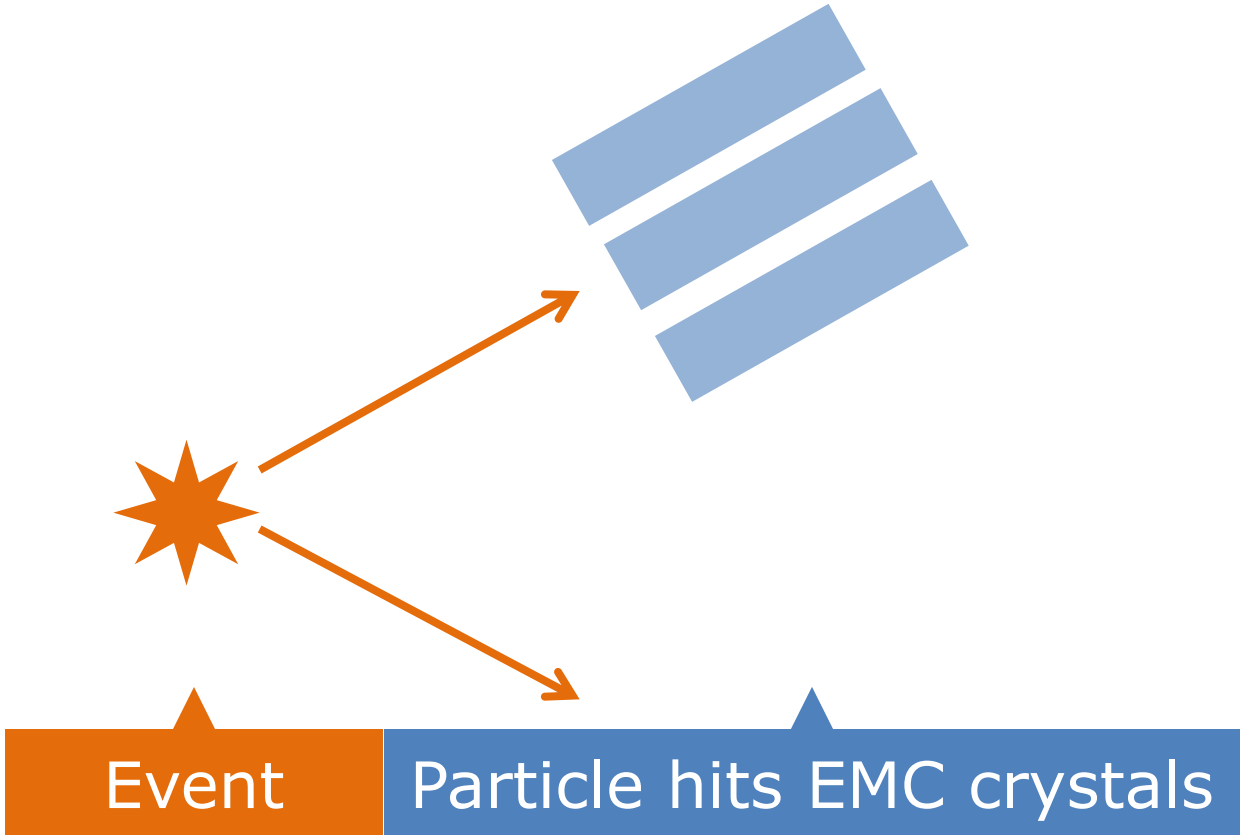
Particle production



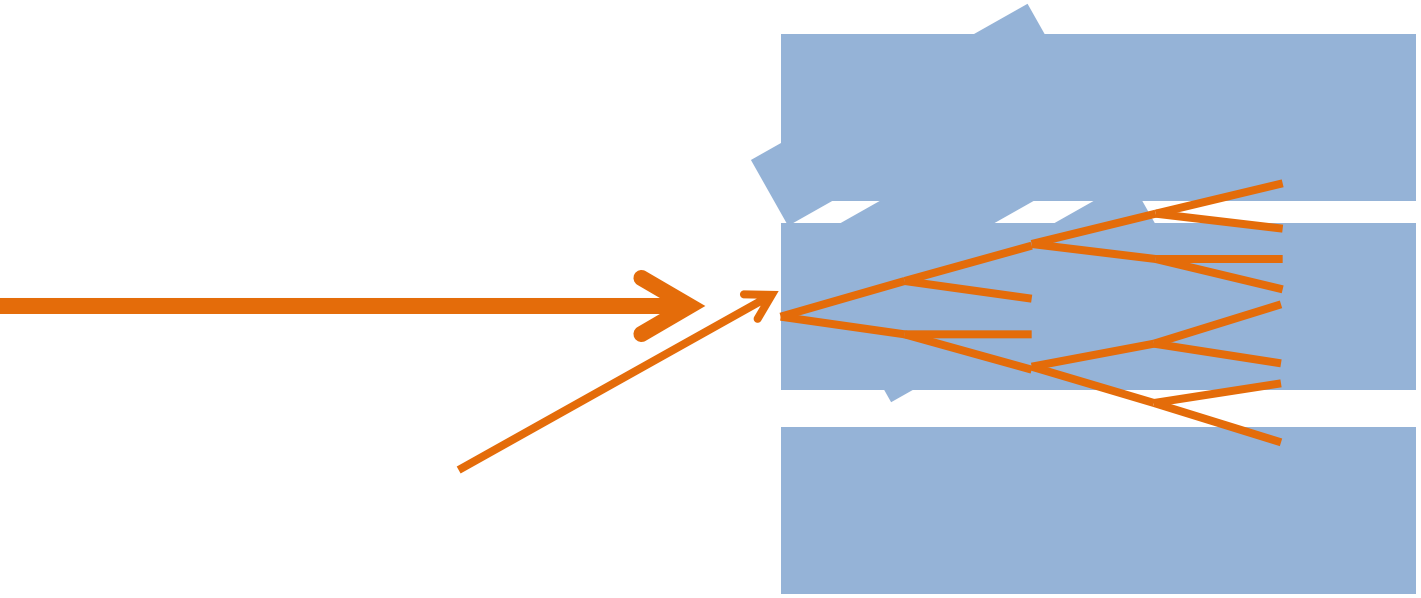
Particle production



Particle production

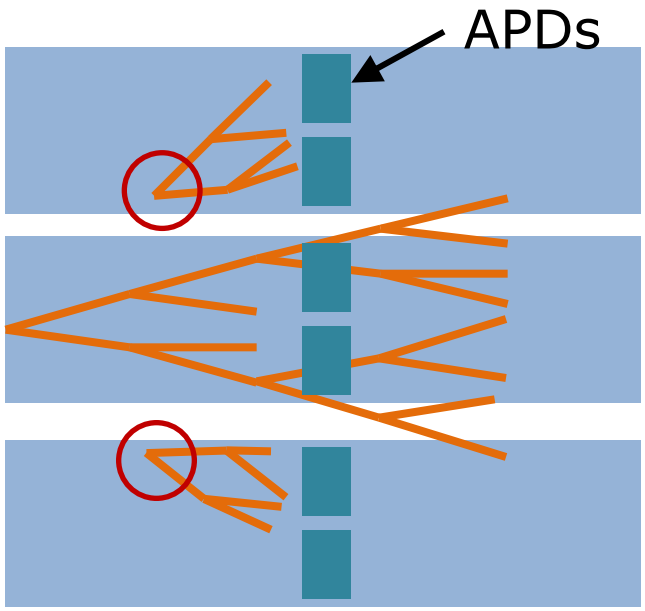


Shower production



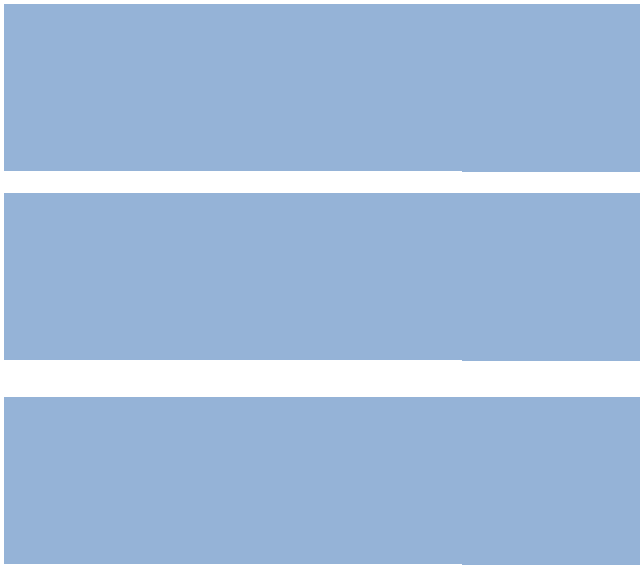
Which spreads out laterally

Shower production



Creating hits in neighbouring crystals as well

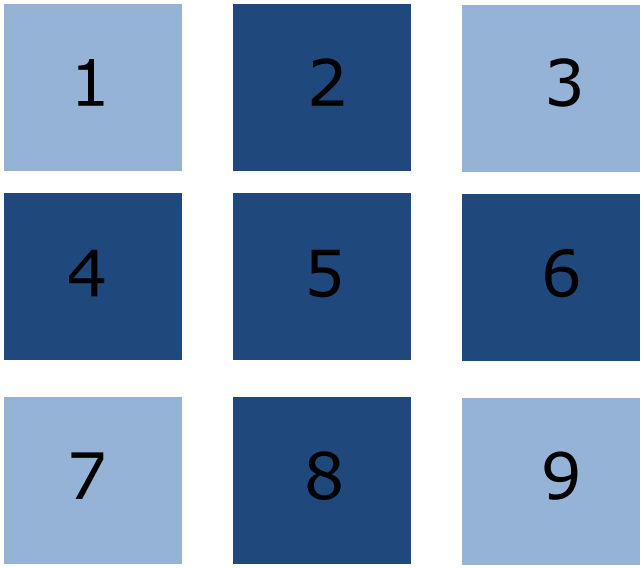
Cluster forming



(Cross-sectional view)

This creates groups of hits in the EMC, defined as CLUSTERS

Cluster finding

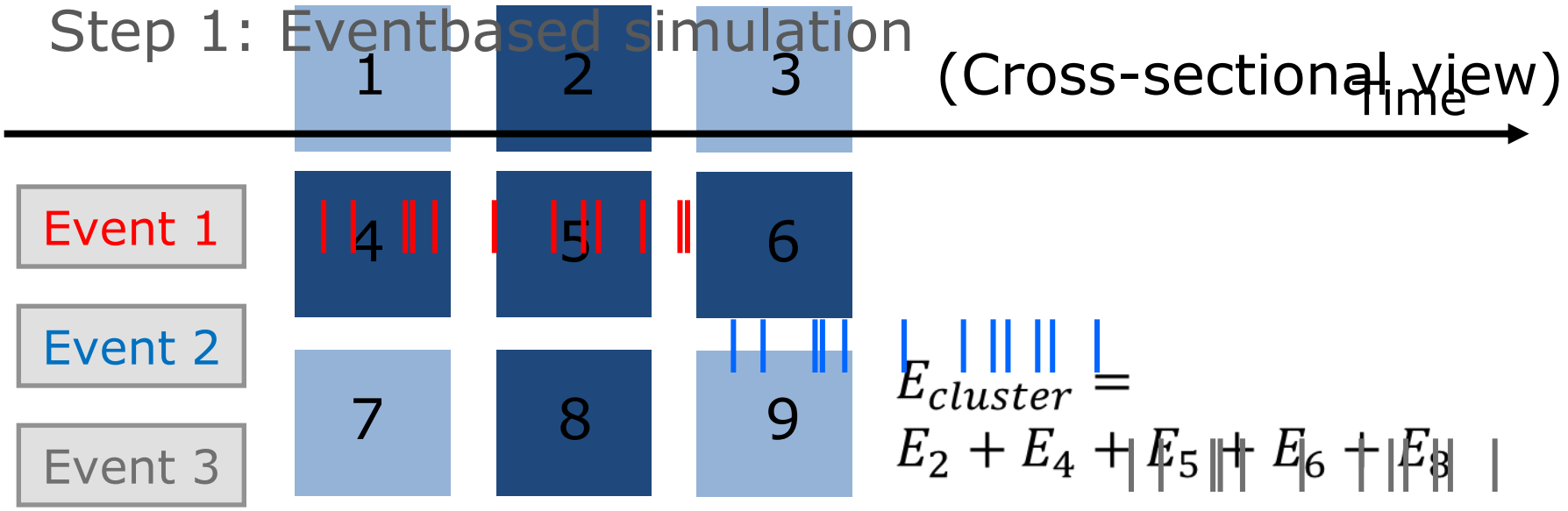


(Cross-sectional view)

$$E_{cluster} = E_2 + E_4 + E_5 + E_6 + E_8$$

Simulation

Step 1: Eventbased simulation

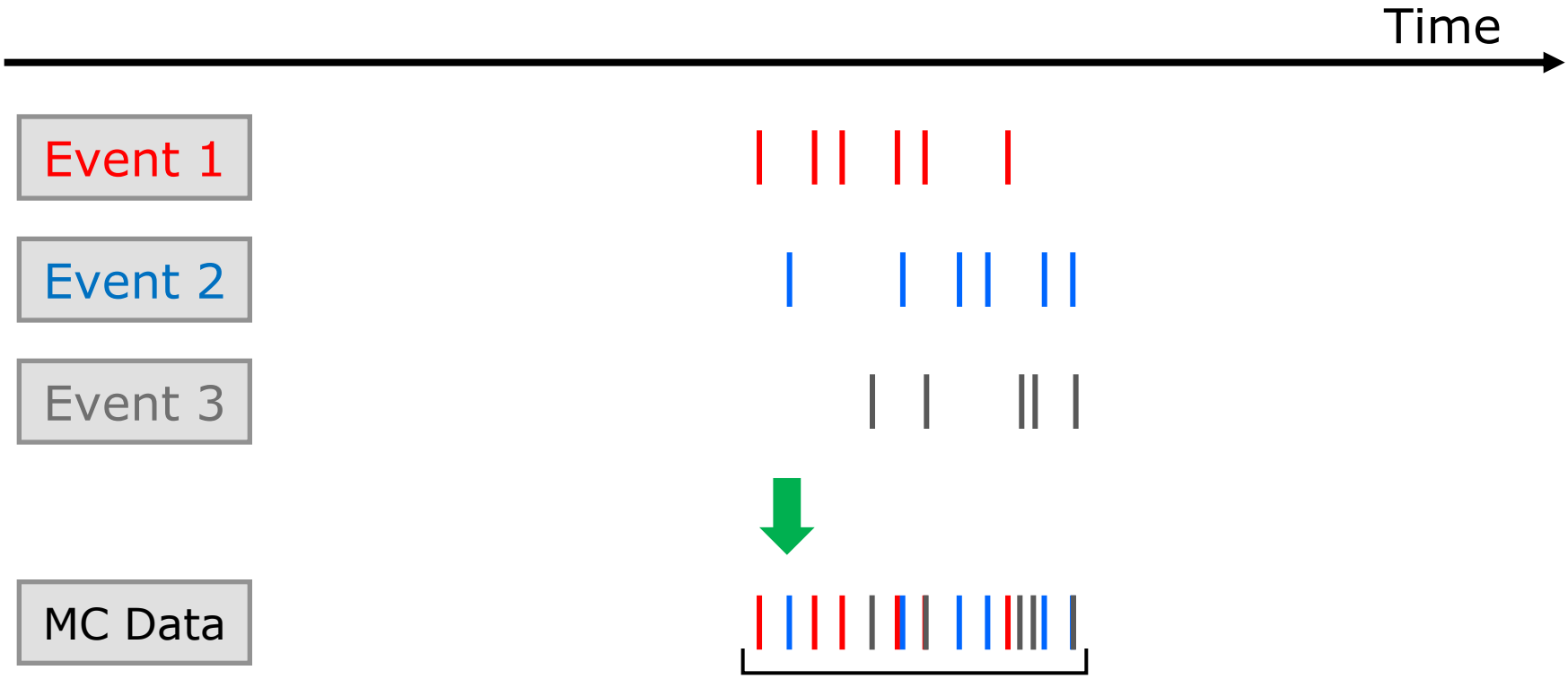


However:

- Annihilation rates up to 20 MHz
- $p\bar{p} \rightarrow$ anything

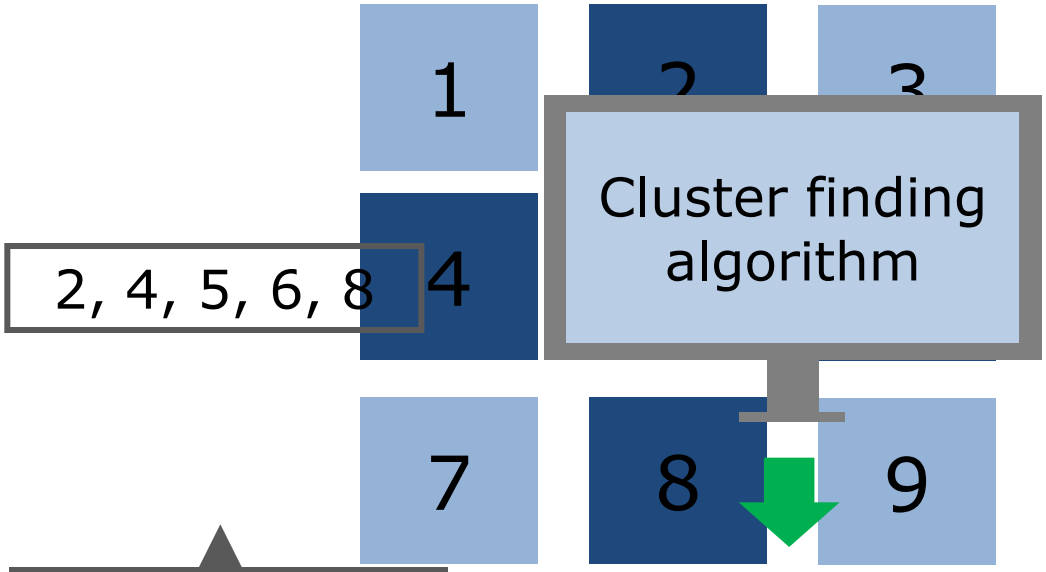
Simulation

Step 2: Timebased simulation



Ref: G.Tambave et al., JINST 7, P11001, 2012

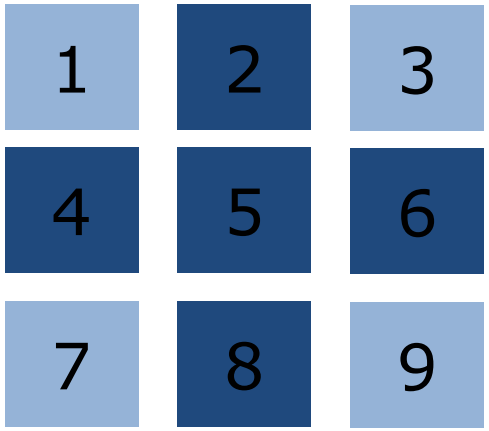
Cluster finding - Algorithm

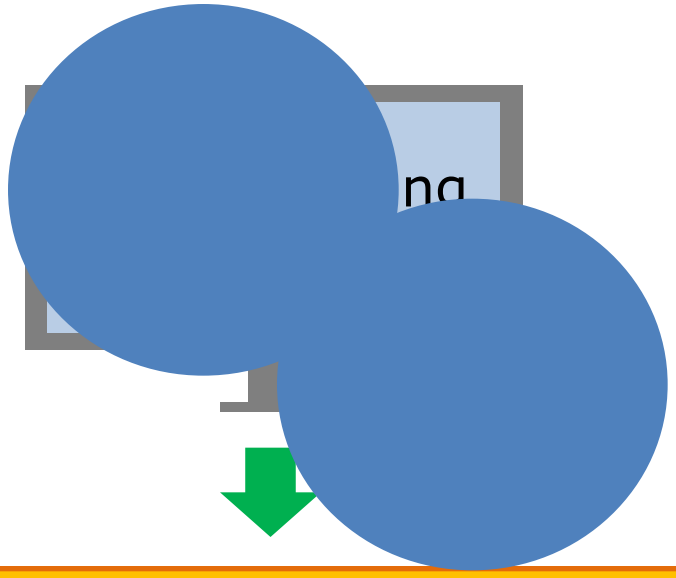


Online, hence:
(Cross-sectional view)
- Consume few resources
- Has to be fast

1. Neighbour finding, first pass
2. Neighbour finding, second pass
3. Merge neighbouring hits into clusters

Cluster finding – "Bump splitting"





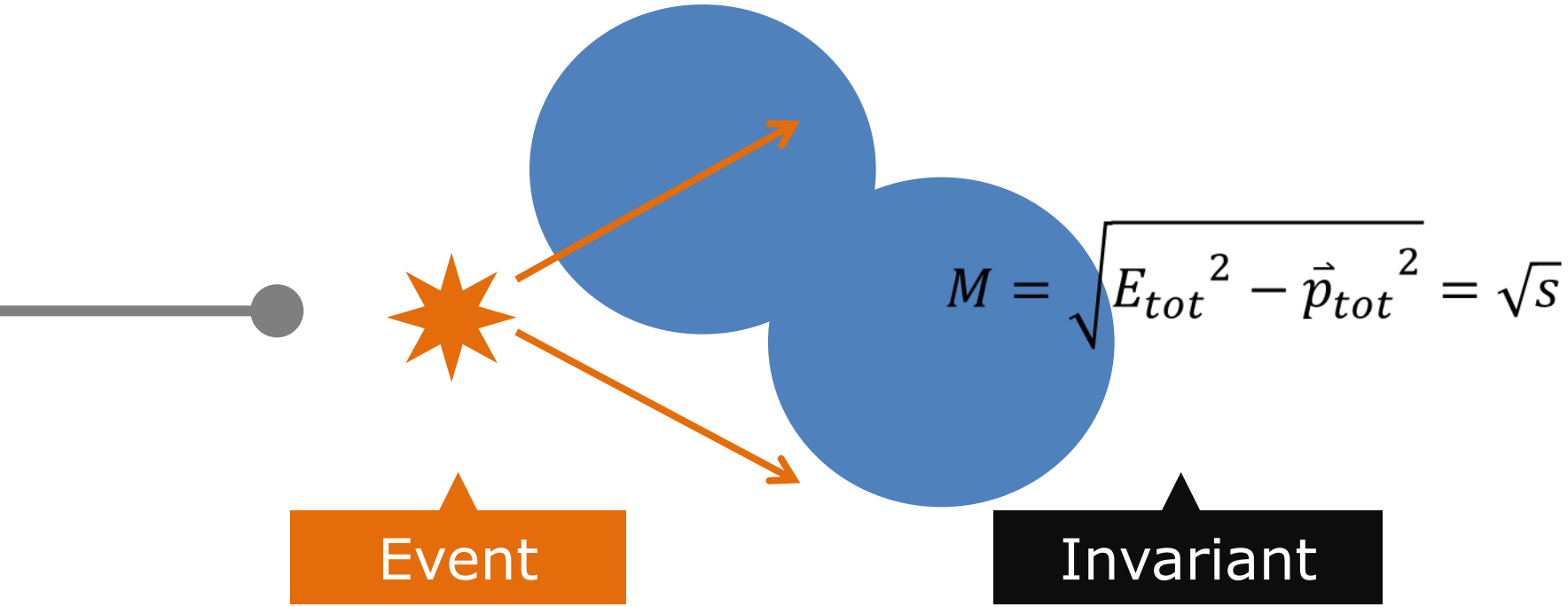
1 Neighbour finding, first pass

2 Neighb

3 Merge neighbouring hits into clusters

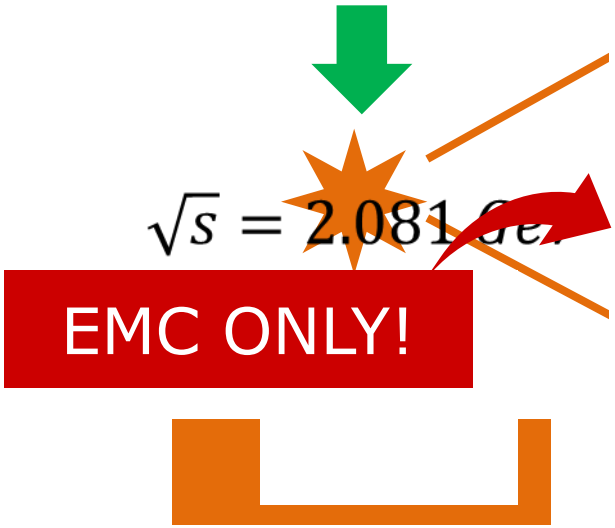
Effect of such overlapping clusters not yet investigated

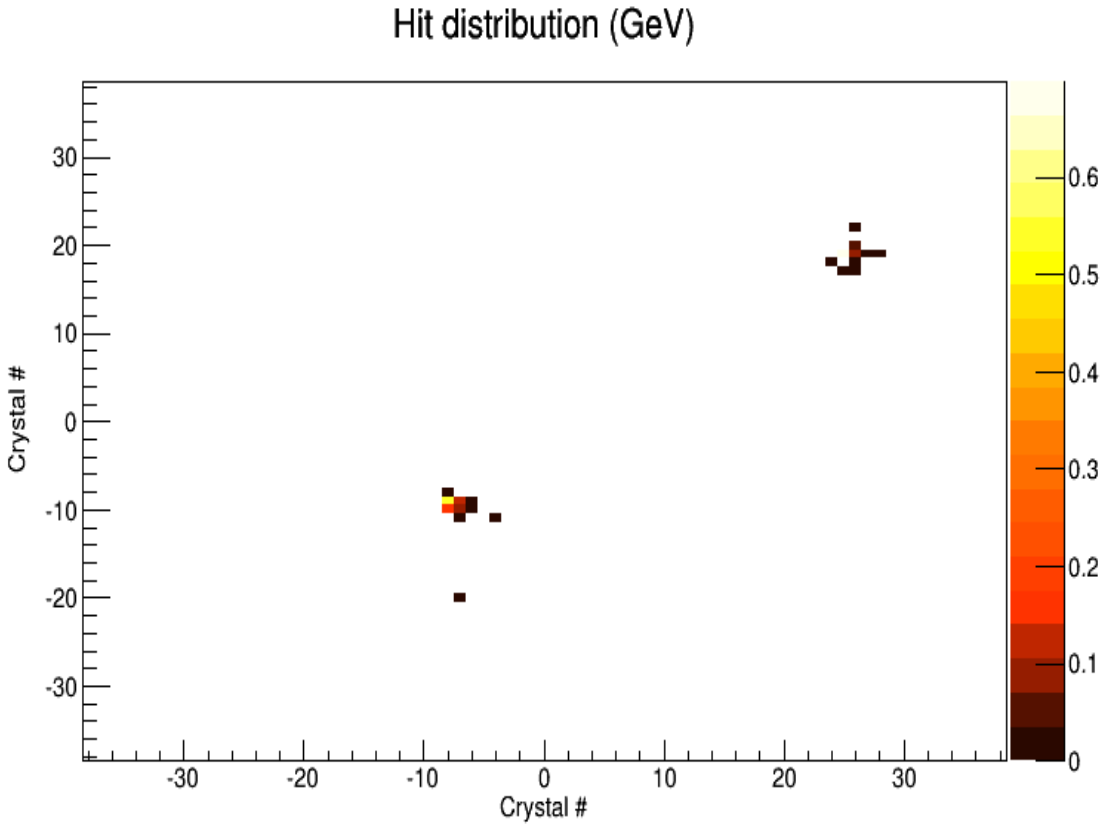
Cluster finding – Reconstruction



Cluster finding – Test channel

$$p\bar{p} \rightarrow \gamma\gamma, \qquad with\ \vec{p}_{\bar{p}} = 1\ GeV/c$$



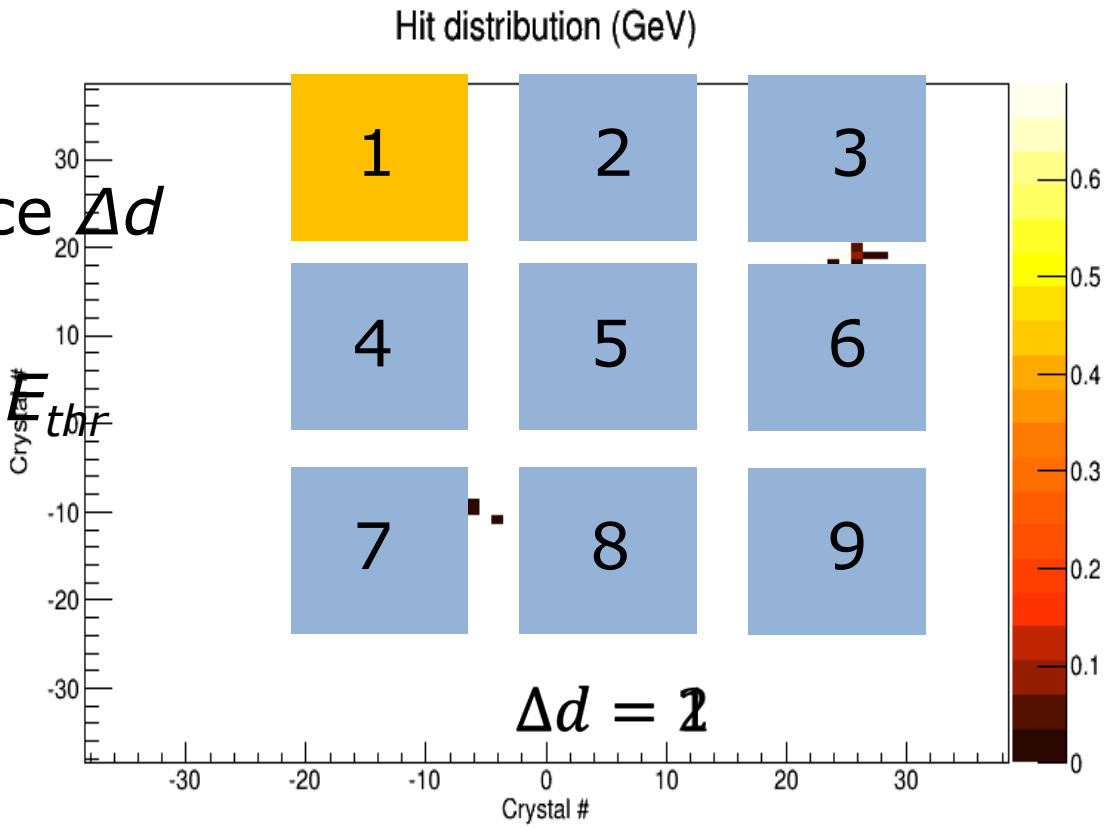


Cluster finding – Test channel

$$p\bar{p} \rightarrow \gamma\gamma, \qquad with\ \vec{p}_{\bar{p}} = 1\ GeV/c \qquad \sqrt{s} = 2.081\ GeV$$

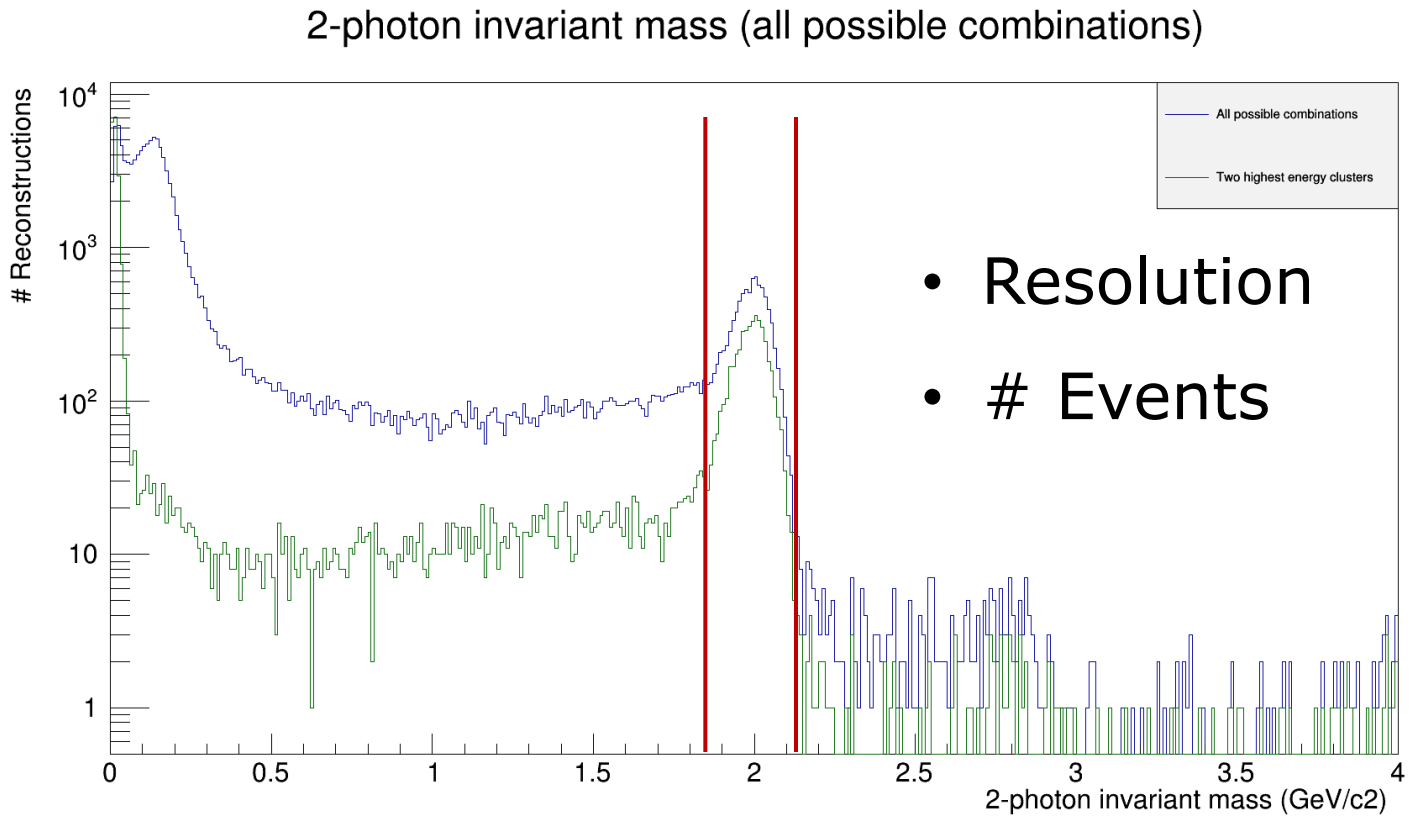
Parameters:

- Neighbour distance Δd
- Energy threshold E_{thr}
- Time gap Δt



Test channel – Reconstruction

$$p\bar{p} \rightarrow \gamma\gamma, \qquad with\ \vec{p}_{\bar{p}} = 1\ GeV/c \qquad \sqrt{s} = 2.081\ GeV$$

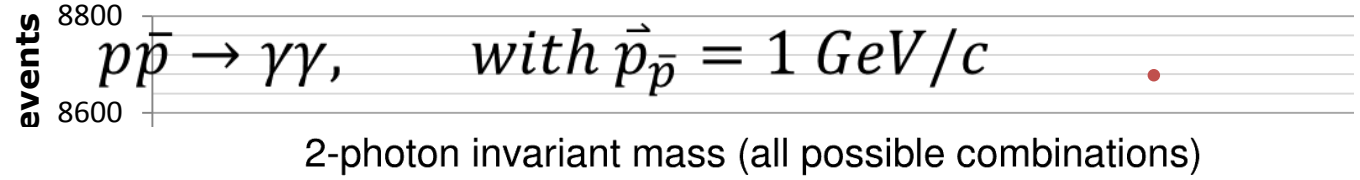


- Resolution
- # Events

Timebased @20 MHz
6
9

Test channel – Reconstruction

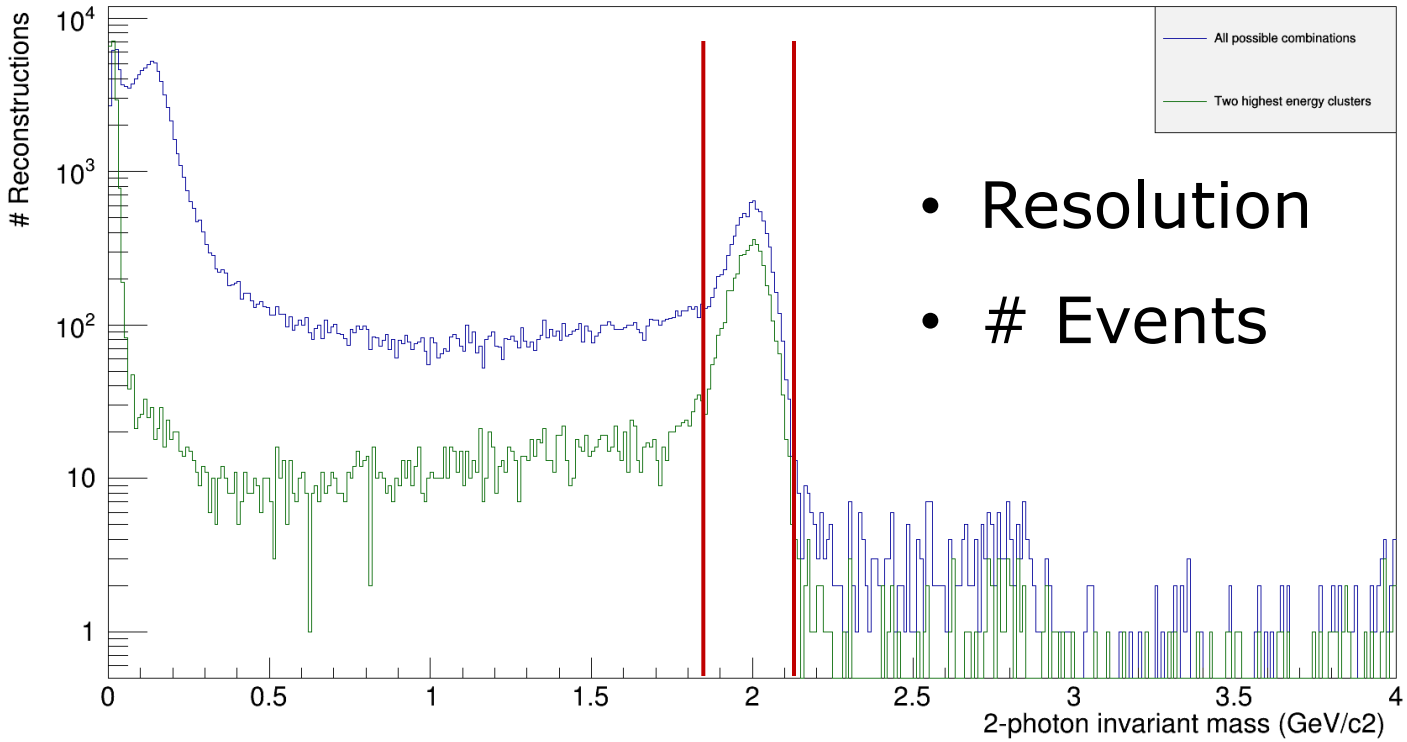
- All 2-photon-cluster combinations



- Default (1, 1, 5)
- $\sqrt{s} = 2.081\ GeV$
- Δd = 2
- Δd = 3
- E_{thr} = 5 MeV

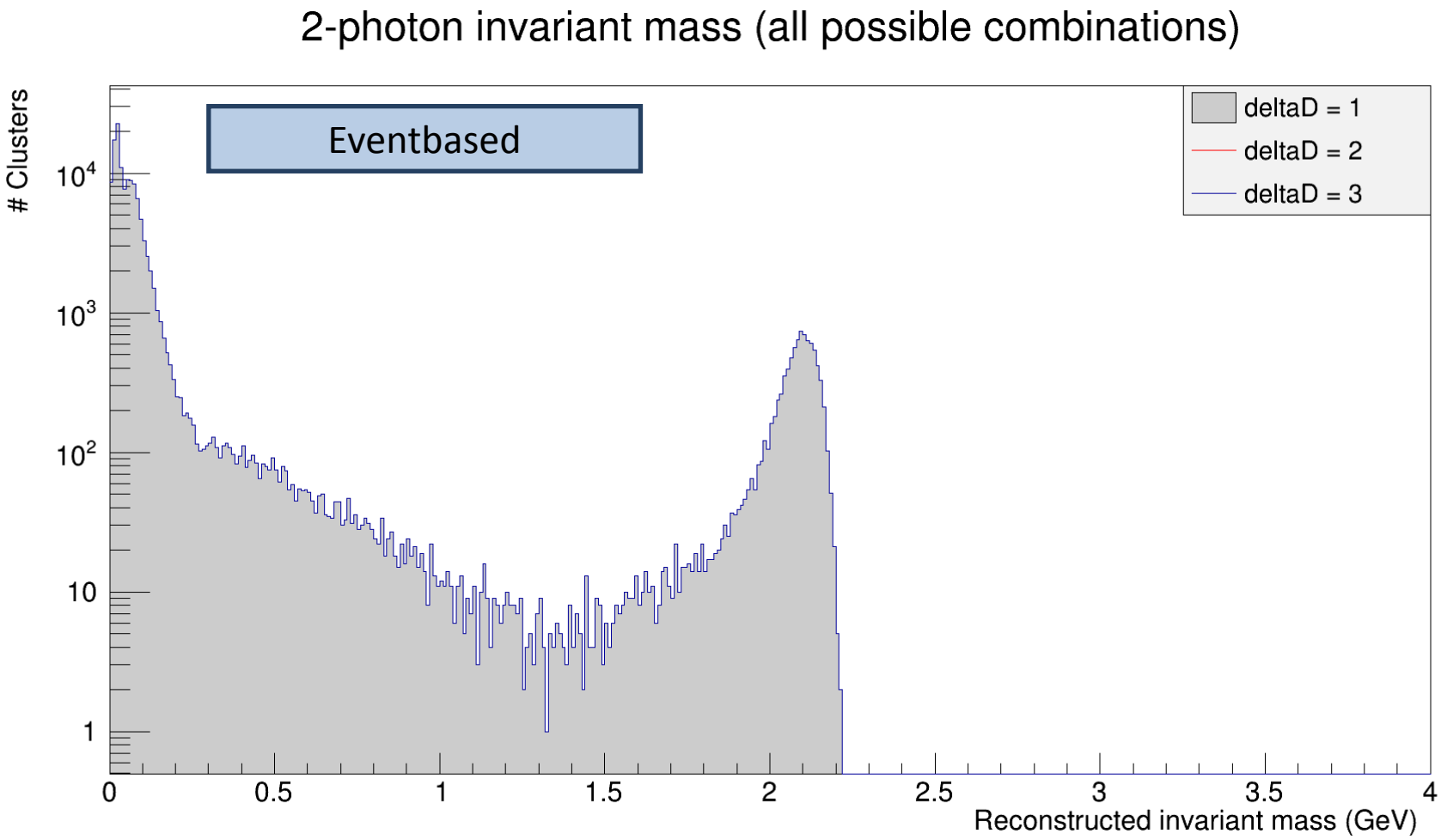
Timebased @20 MHz

- Δt = 15 ns
- Δt = 20 ns

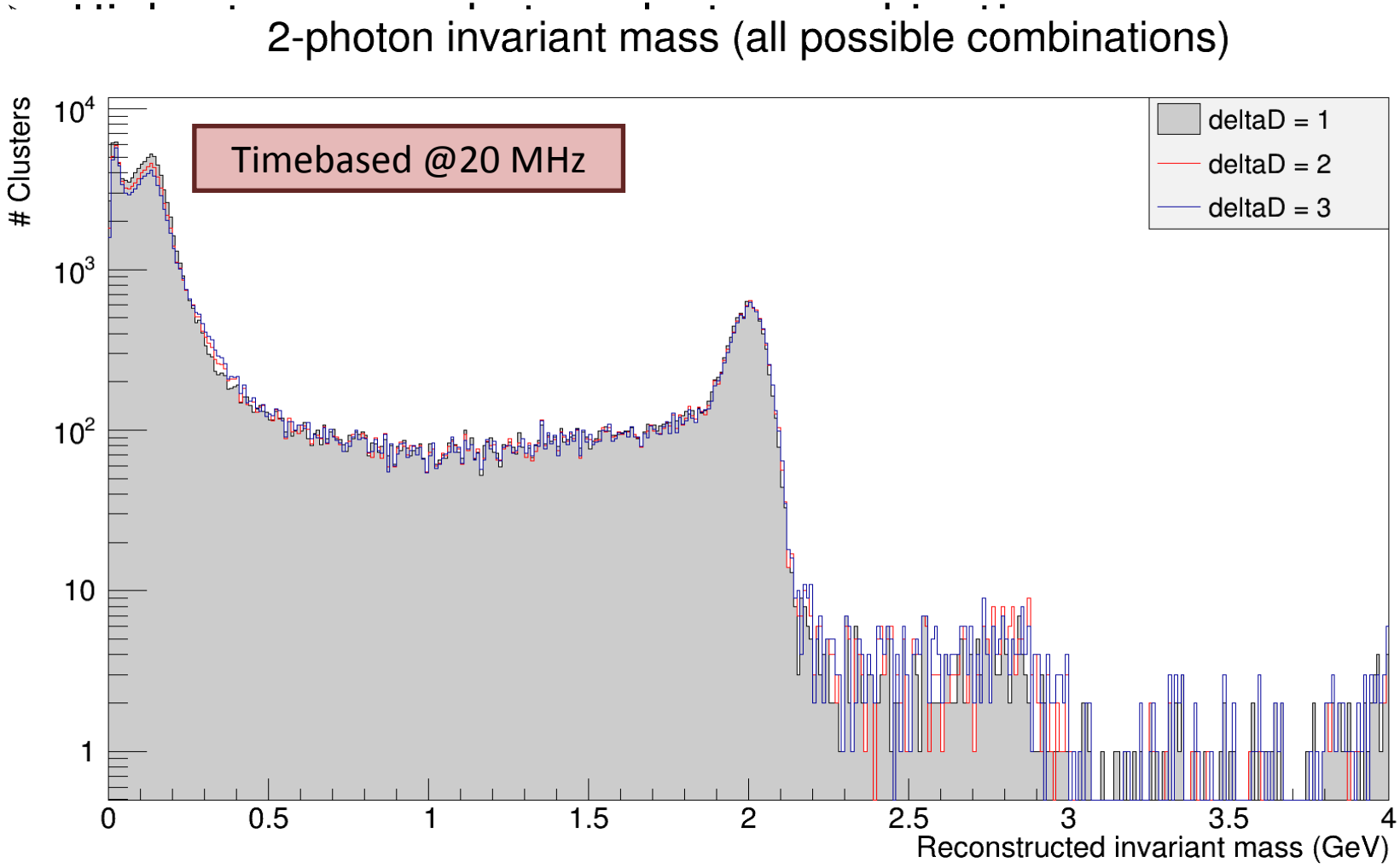


- Resolution
- # Events

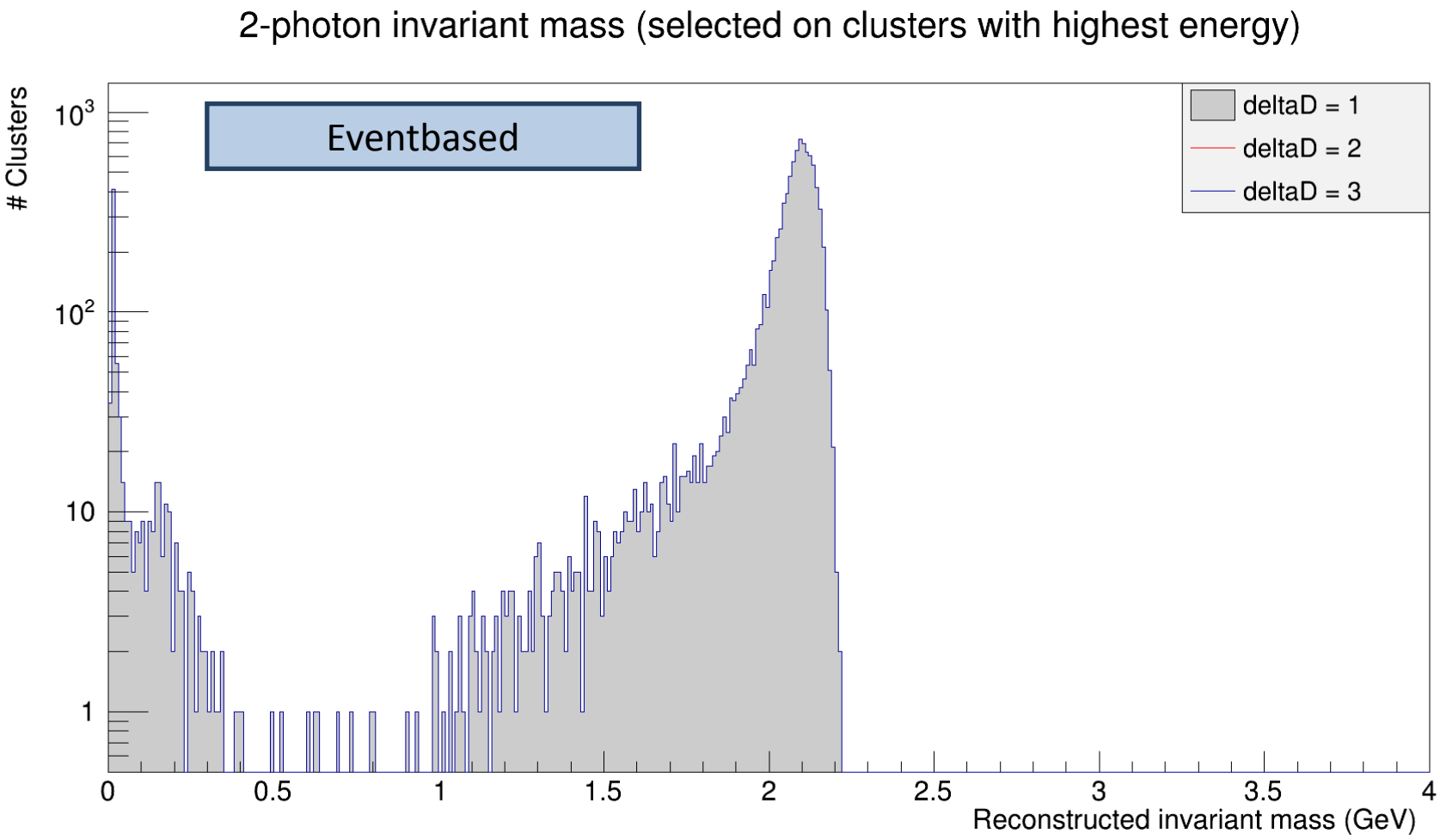
Test channel – Reconstruction



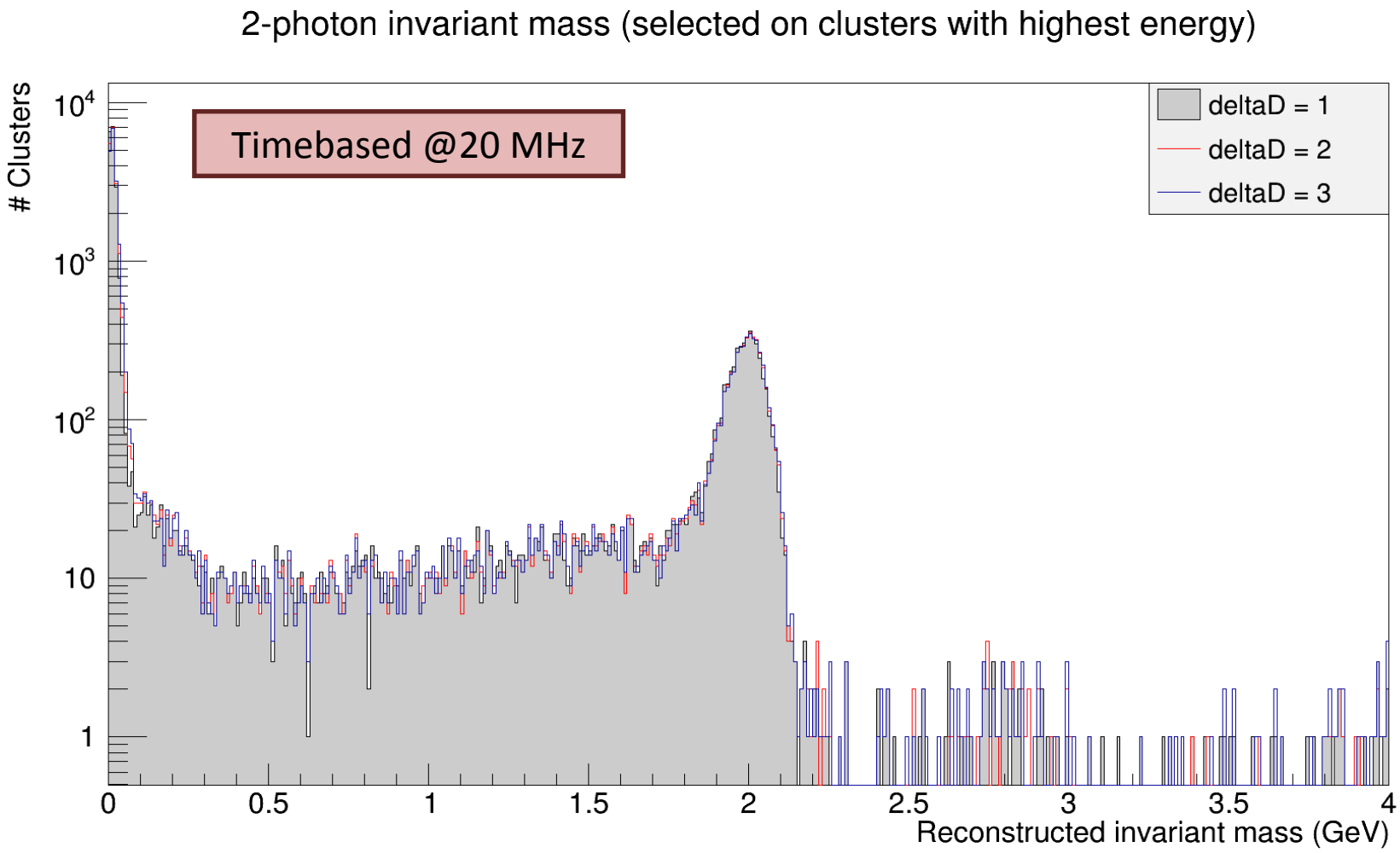
Test channel – Reconstruction



Test channel – Reconstruction



Test channel – Reconstruction



Summary

- Eventbased reconstruction only yields ~70% efficiency
- Timebased simulation run at a low rate is compatible with eventbased, as expected
- At high rate (timebased), there are 2 cases:
  1. Combining only the highest energy clusters; better resolution, lower yield (~40%)
  2. Making all 2-cluster combinations; slightly worse resolution, much higher yield (~80%)

Discussion/Questions/Suggestions

- Improvements are underway