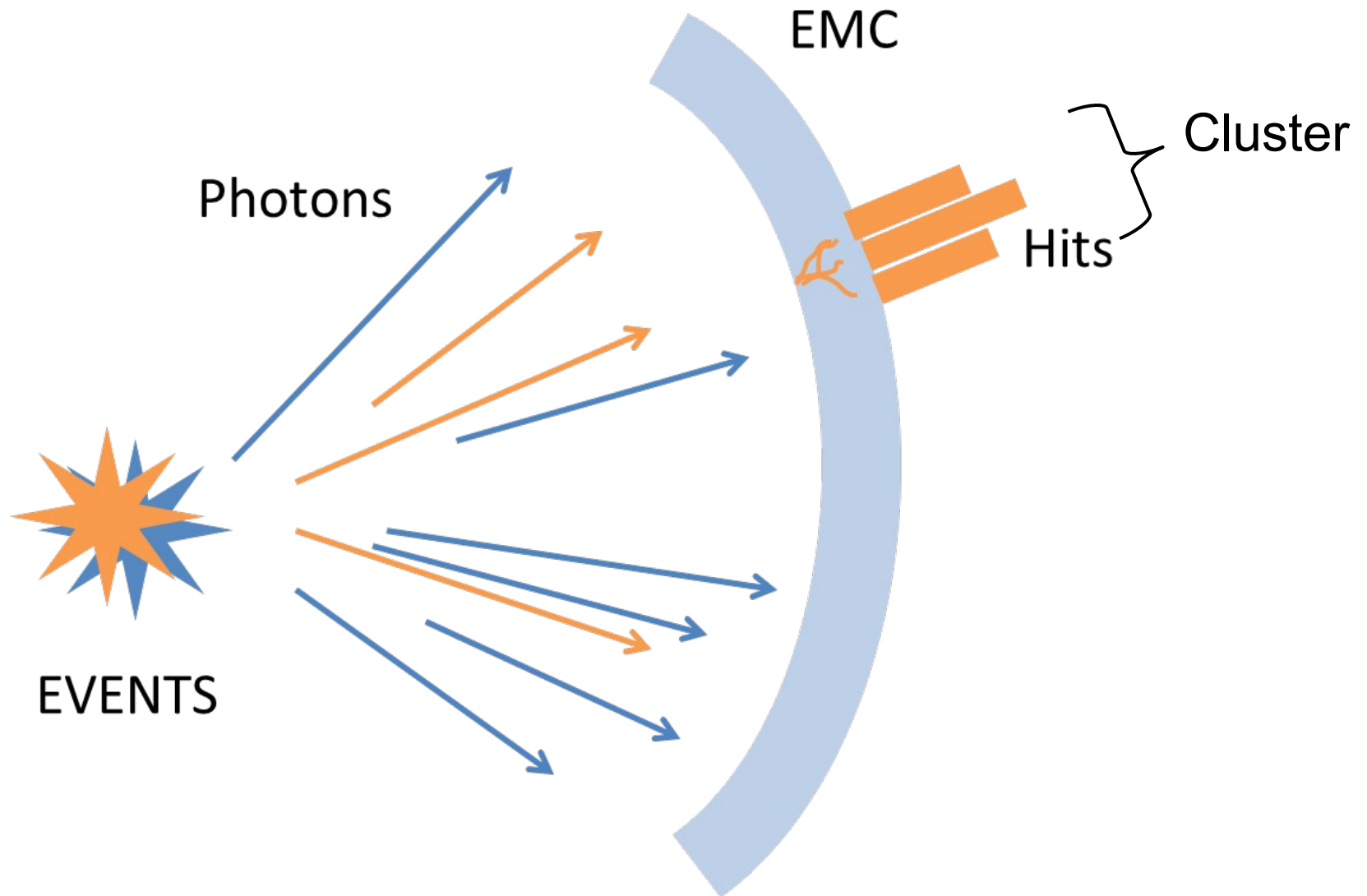




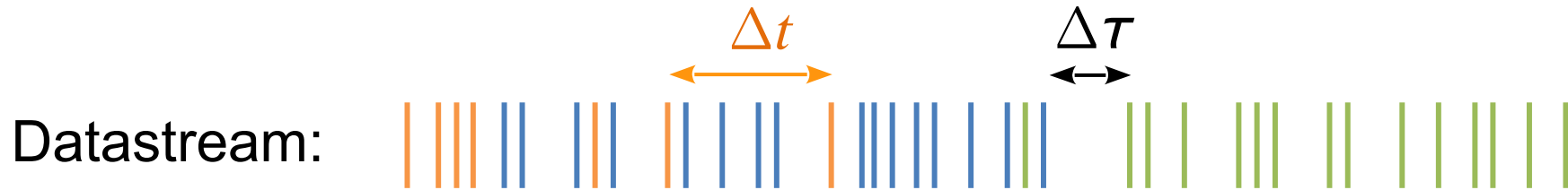
The Latest Developments on the Online Cluster Finding Algorithms



Hit Creation



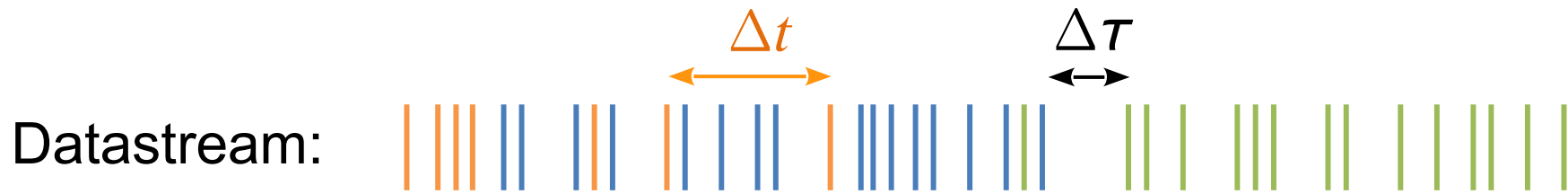
Topology of the Data Stream



Two time-scales: $\Delta \tau$, defined by time difference between **consecutive** hits

Δt , the time difference between **any pair** of hits

Topology of the Data Stream



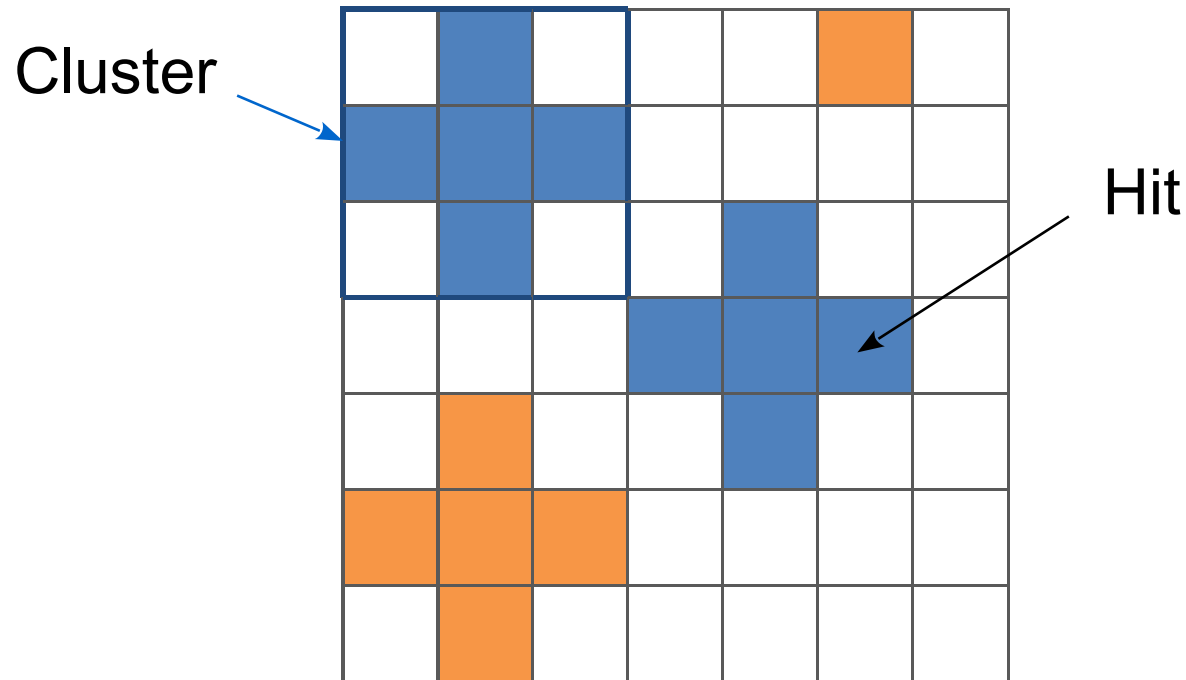
because $t(E)$, timestamps
 can be spread out
 drastically

Hit belonging to the same cluster



4D position needed to
 disentangle hits

Scenarios



Spatially fully
 separated clusters

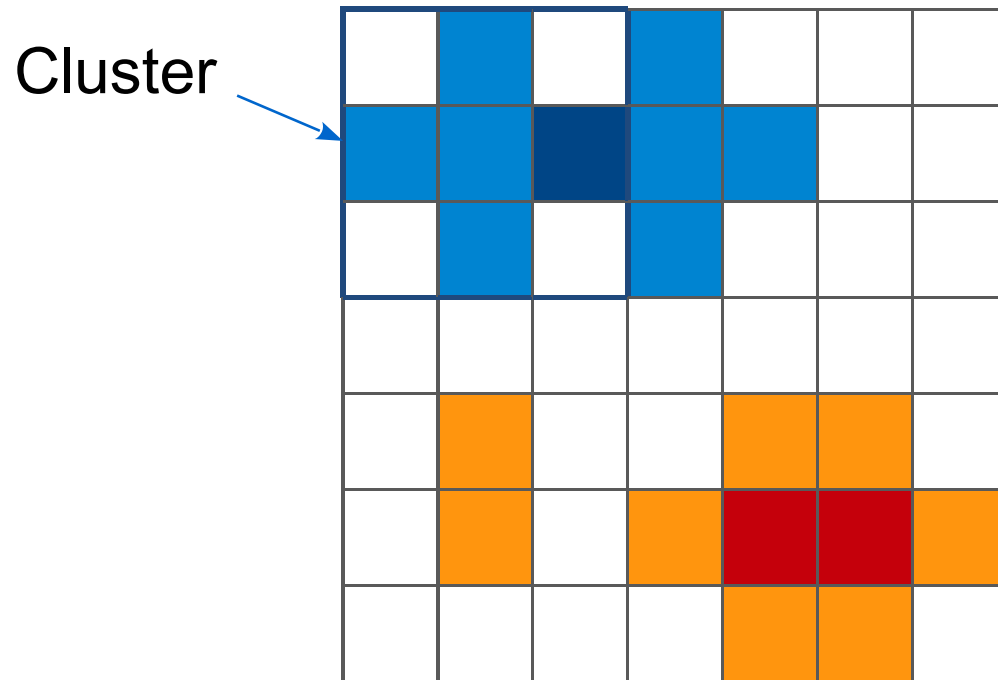


No gain
 when using
 Δt



Make Δt large to
 make sure no hits
 are excluded

Scenarios



Spatially
 overlapping clusters

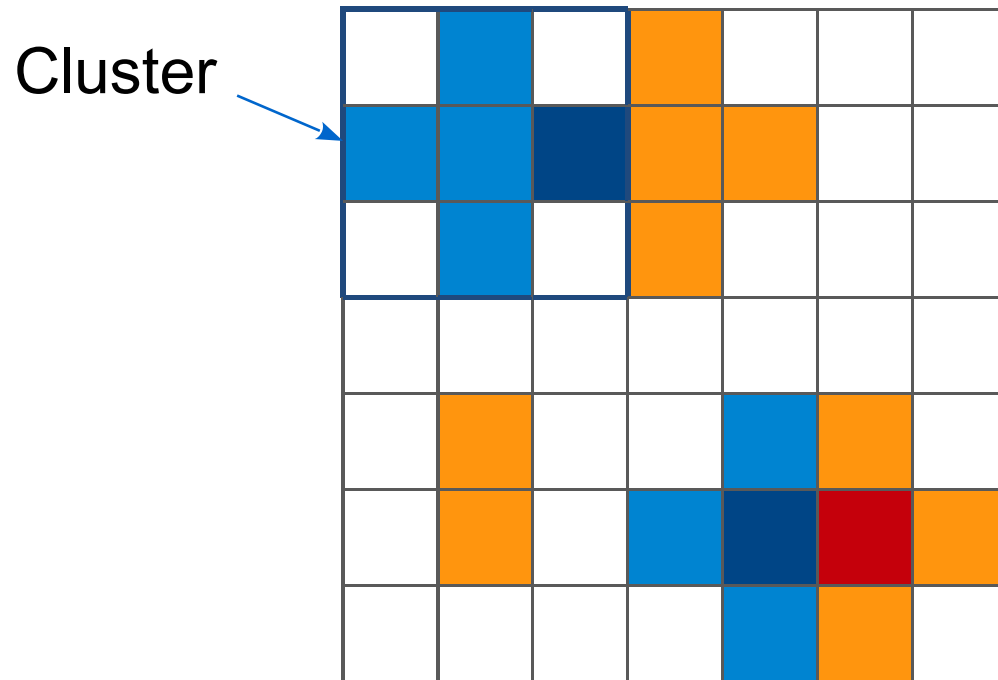


Use Δt to
 separate



May not help
 within events

Scenarios



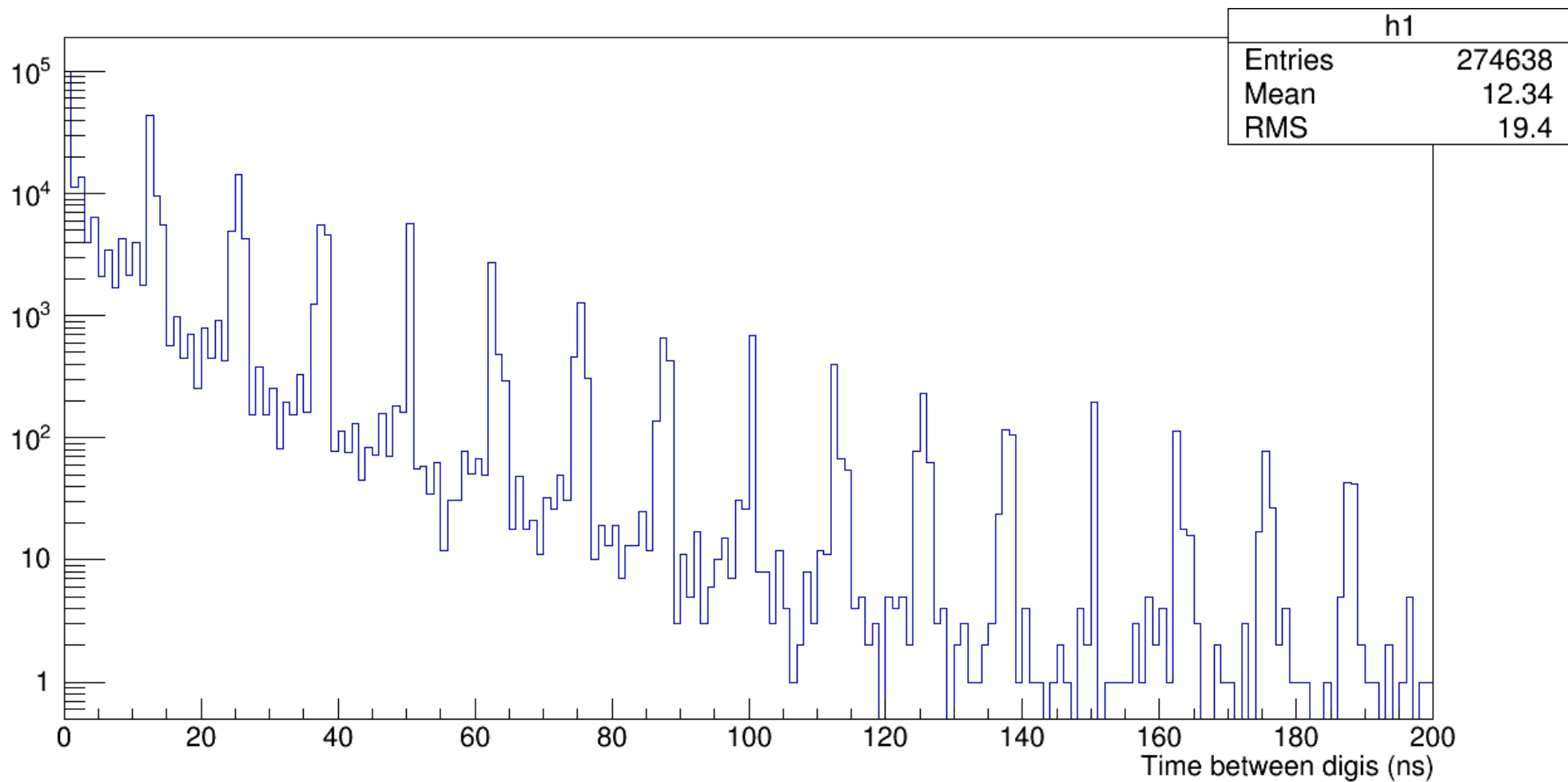
Spatially
 overlapping clusters



Use Δt to
 separate

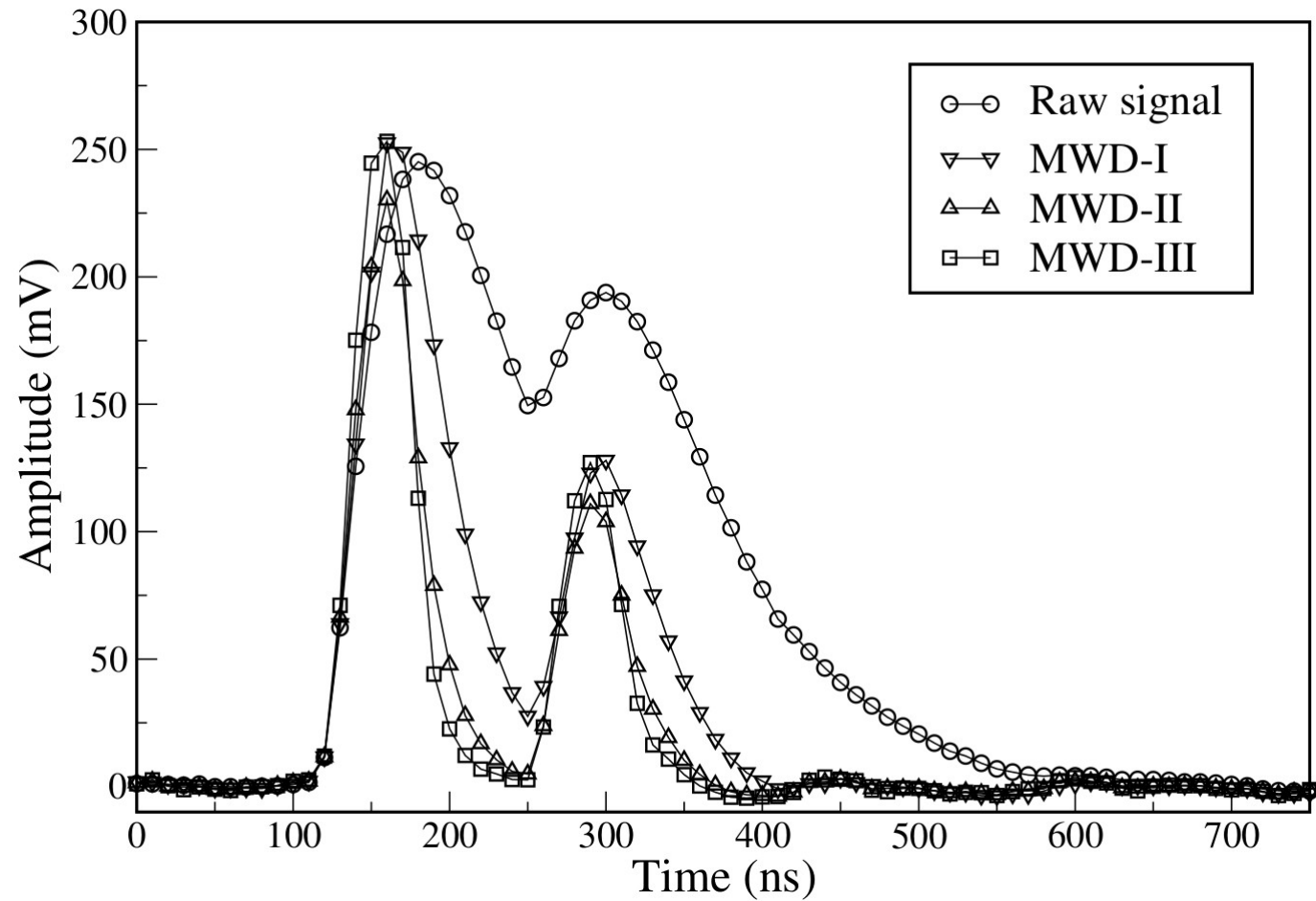
Time is Important!

However, there are problems:



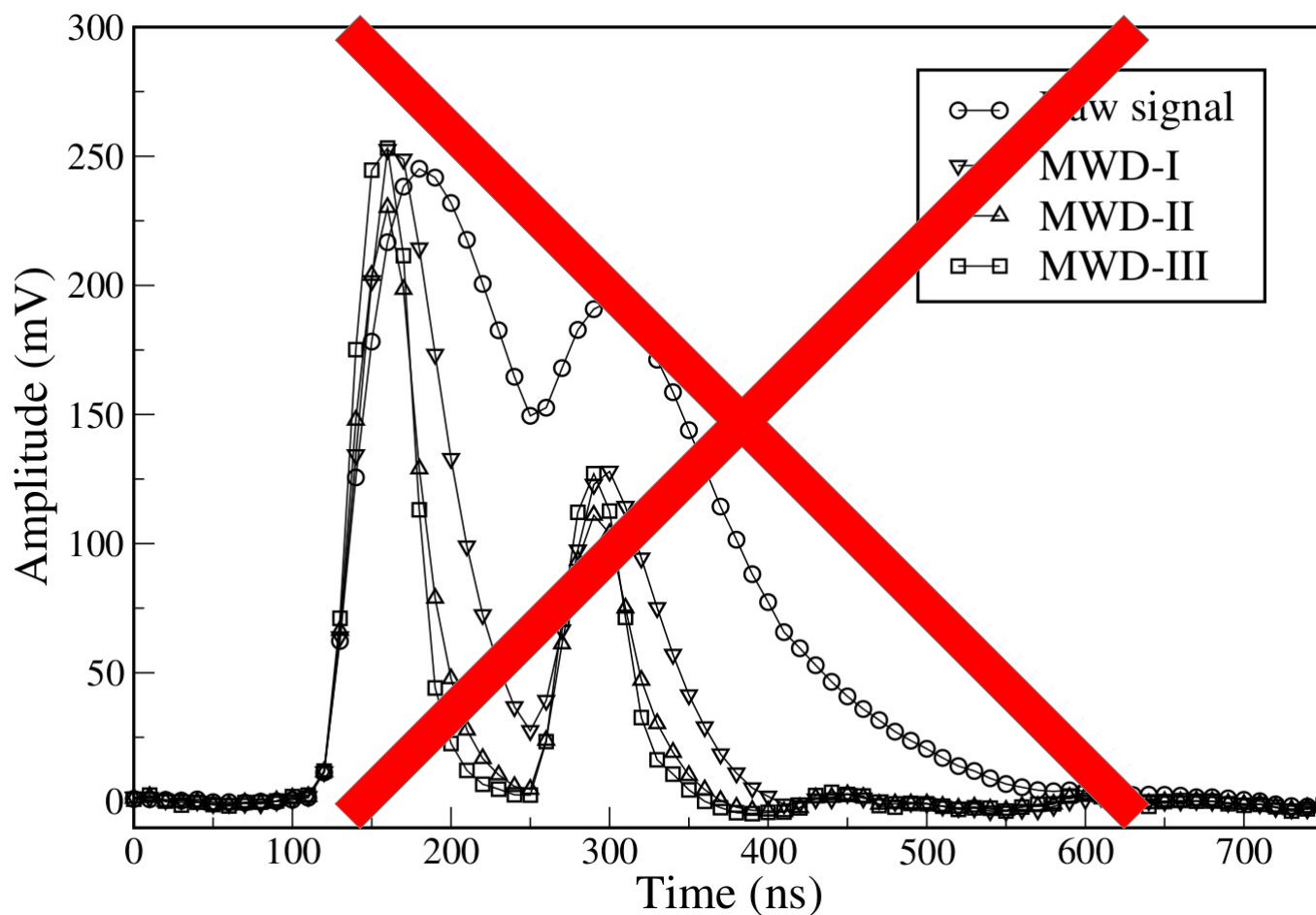
Time is Important!

The evil-doer:



Time is Important!

The evil-doer:



The prize to pay: **No more pile-up recovery**

Time is Important!

The prize to pay: **No more pile-up recovery**



Possible solution: Shorten length of waveforms



HOWEVER

Severely compromises reconstruction efficiency!

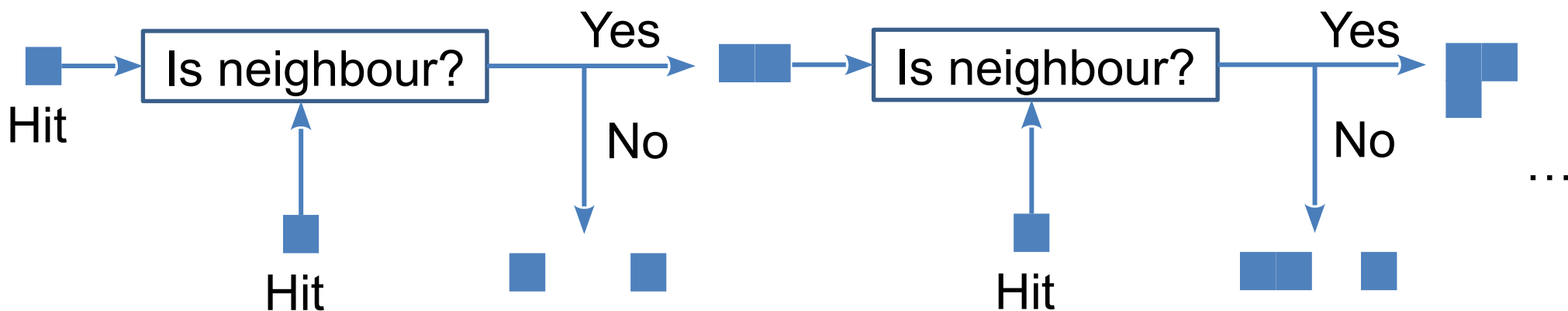


WHY?

Unknown... Some
 bug in the tasks?

'Default' Cluster Finding (PndEmcMakeCluster)

Datastream:

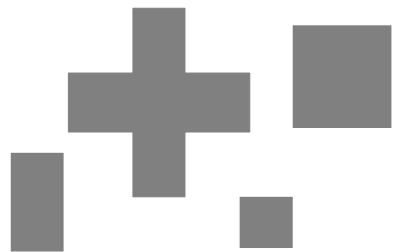


'Default' Cluster Finding (PndEmcMakeCluster)

Datastream:



Grow clusters from "seeds"



Clusters

Issues:

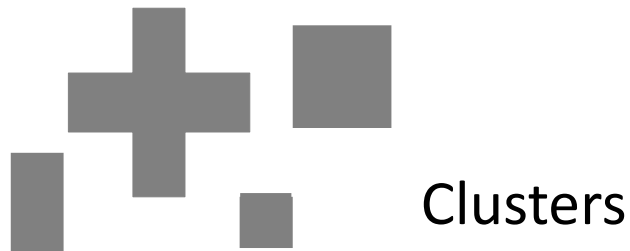
- For each new hit, check if neighbour to cluster \equiv check if neighbour to member hits
- Large number of loops \rightarrow clock cycles on a computing chip \rightarrow latency

'Default' Cluster Finding (PndEmcMakeCluster)

Datastream:



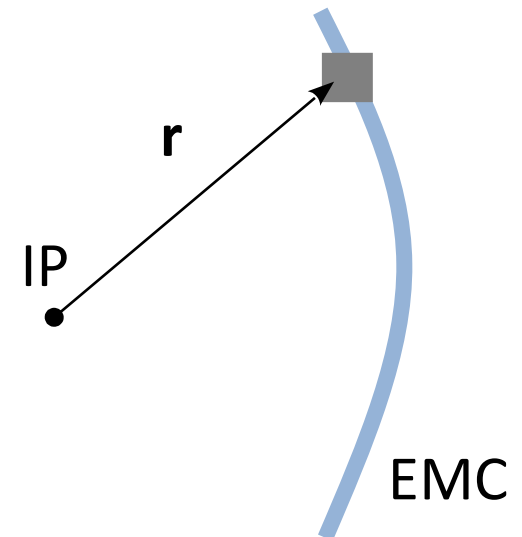
Grow clusters from "seeds"



Get 4-Momenta:

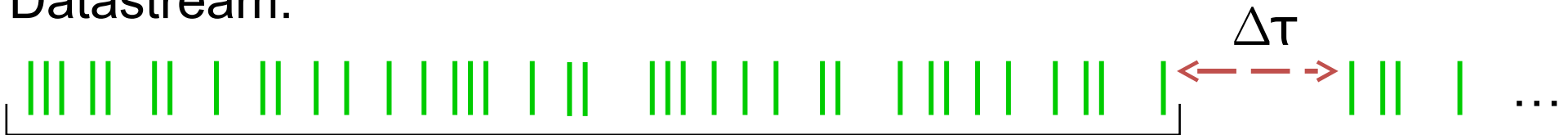
$$E = \sum E_{hit}$$

$$p_i = \frac{E \times i}{|\mathbf{r}|}, i = \{x, y, z\}$$



Online Cluster Finding (PndEmcMakeClusterOnline)

Datastream:



Build hit neighbour relations, make clusters



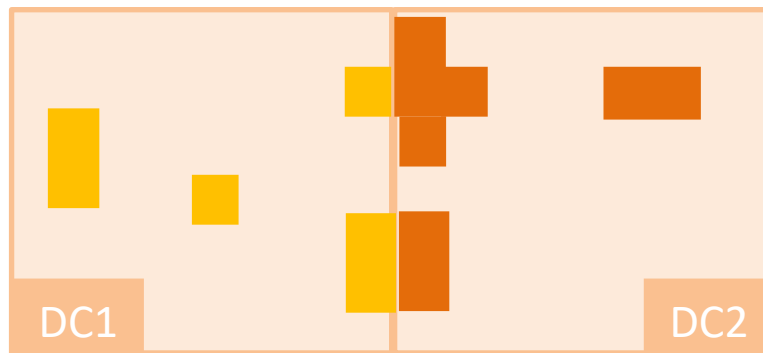
Clusters

Distributed Cluster Finding (PndEmcDistributedClustering)

Datastream:



Assign to virtual Data Concentrators, build hit neighbour relations, make preclusters



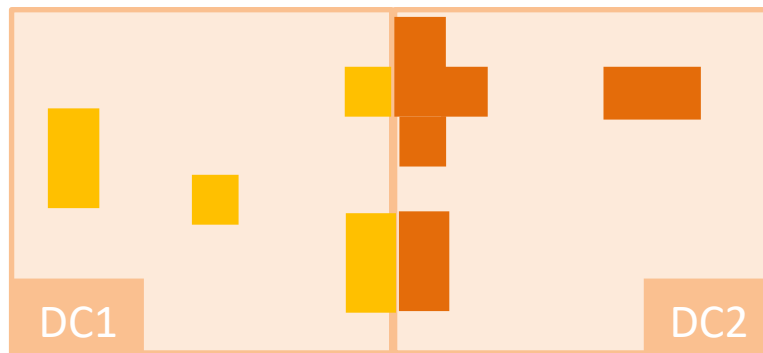
Preclusters

Distributed Cluster Finding (PndEmcDistributedClustering)

Datastream:



Assign to virtual Data Concentrators, build hit neighbour relations, make preclusters



Preclusters



Build precluster neighbour relations, make clusters



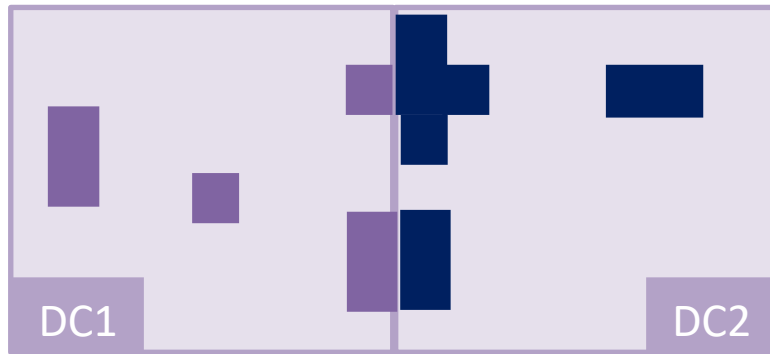
Clusters

2-Step Cluster Finding (PndEmcMakePreclusters)

Datastream:



Assign to DCs, build hit neighbour relations,
make preclusters



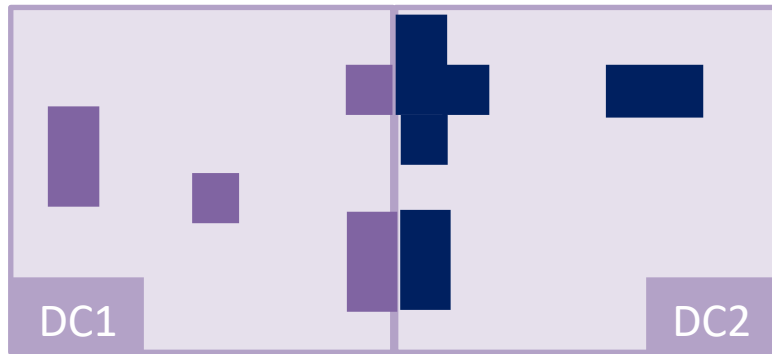
Preclusters

2-Step Cluster Finding (PndEmcMakePreclusters)

Datastream:



Assign to DCs, build hit neighbour relations,
make preclusters



Preclusters

Repeat for all timebunches,
build precluster datastream



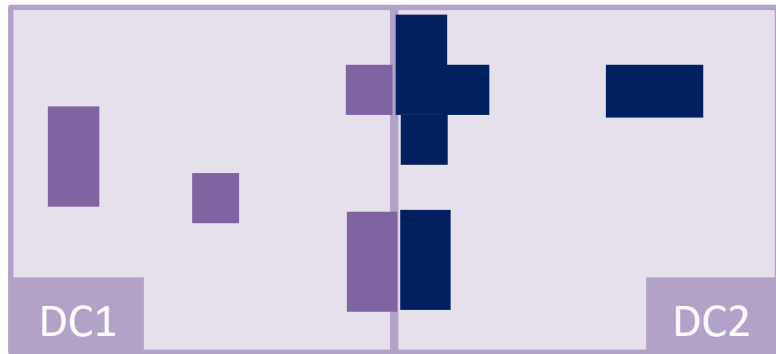
Precluster
datastream

2-Step Cluster Finding (PndEmcMergePreclusters)

Datastream:



Assign to DCs, build hit neighbour relations,
 make preclusters



Preclusters

Repeat for all timebunches,
 build precluster datastream



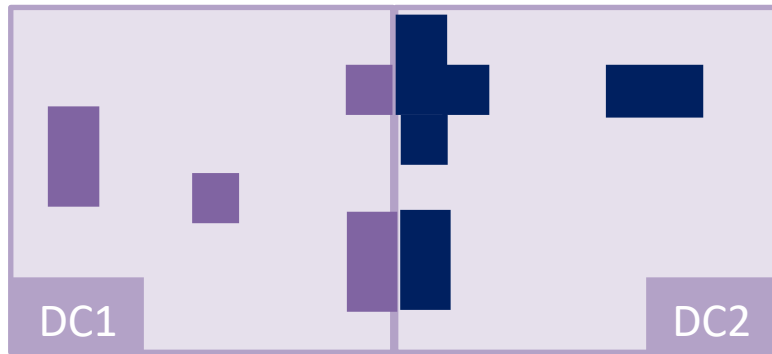
Precluster
 datastream

2-Step Cluster Finding (PndEmcMergePreclusters)

Datastream:



Assign to DCs, build hit neighbour relations,
 make preclusters



Preclusters

Repeat for all timebunches,
 build precluster datastream



Build precluster
 neighbour relations,
 make clusters

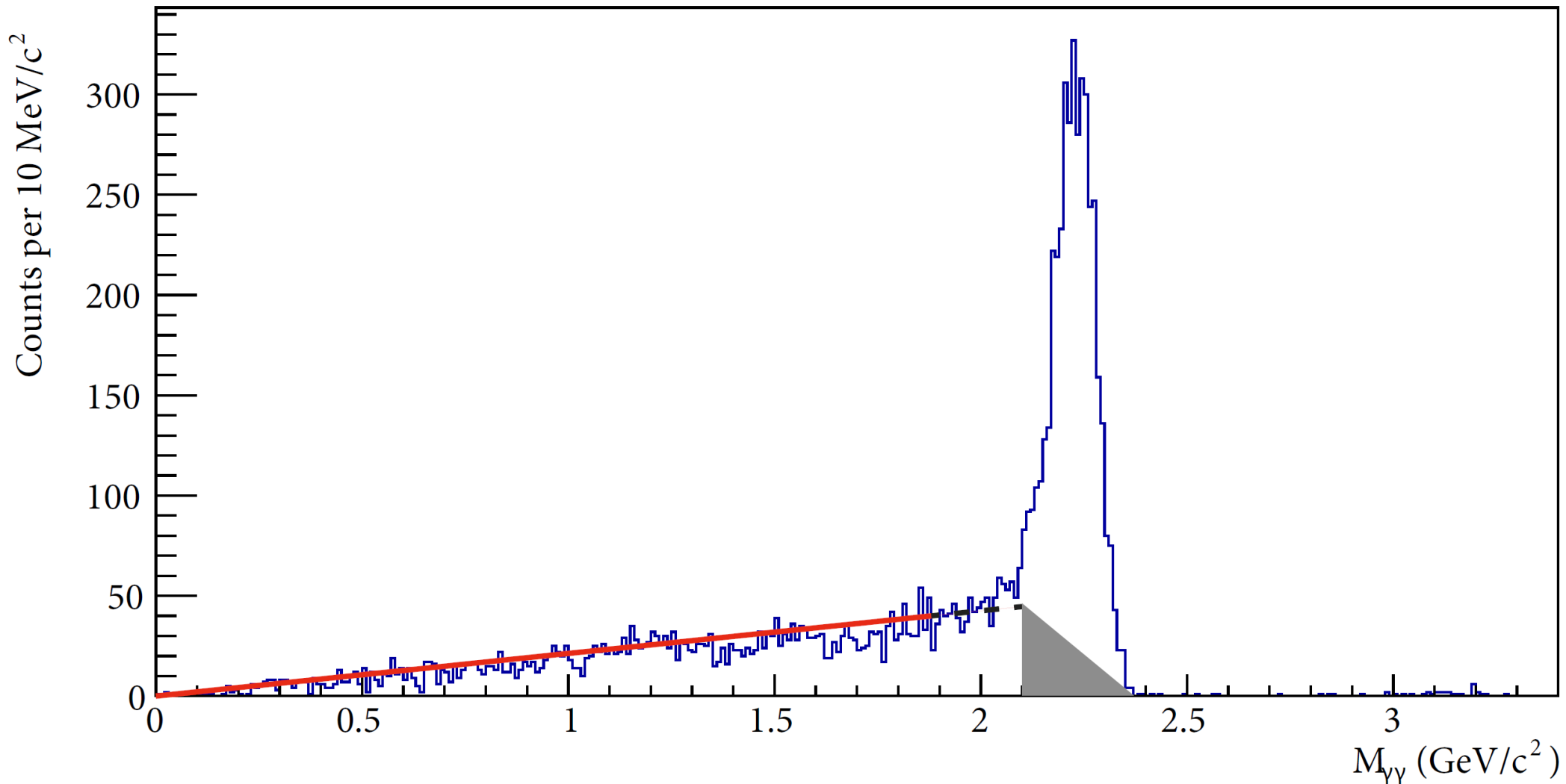
Precluster
 datastream



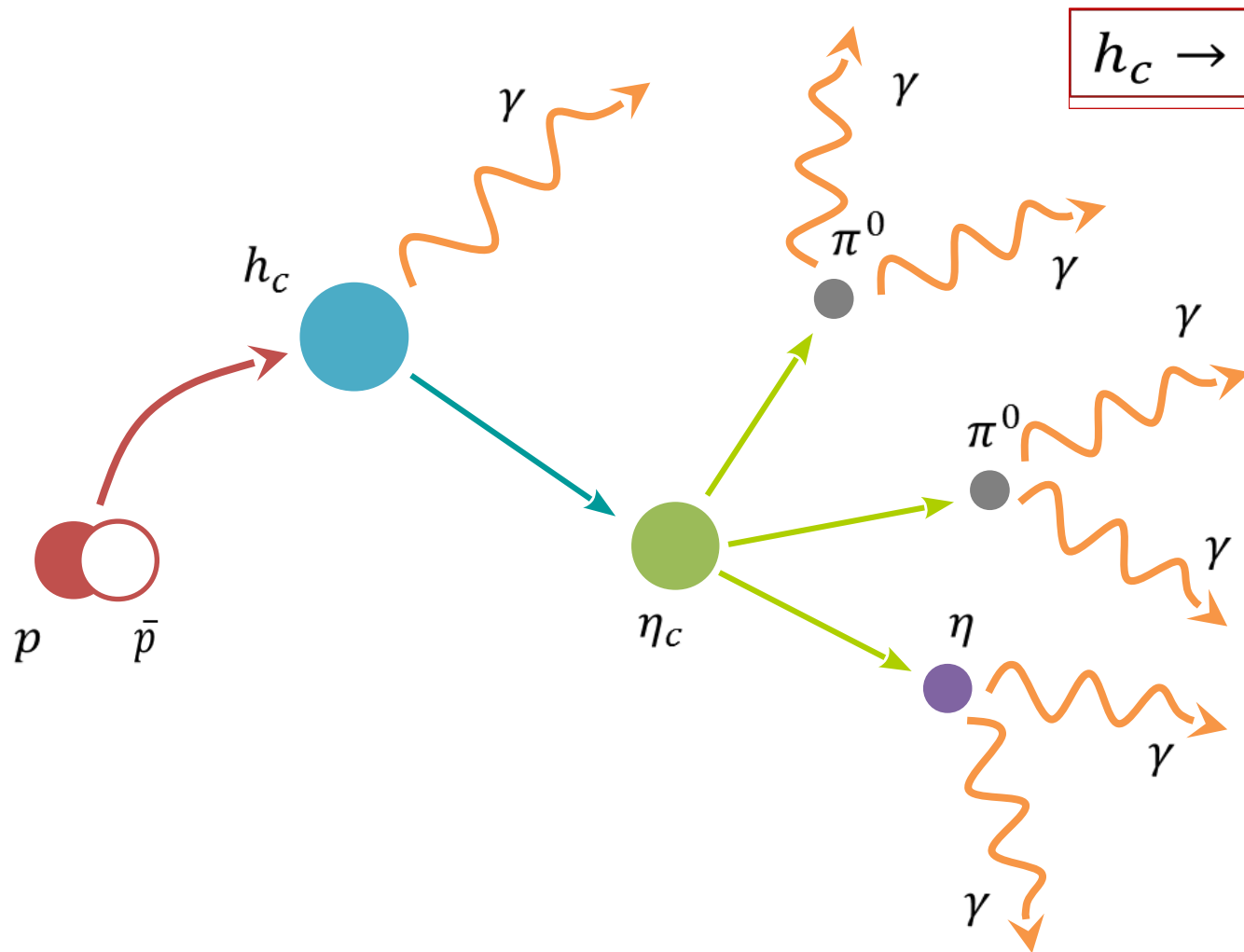
Clusters

Testing the Algorithms

$$M_{\gamma\gamma} = \sqrt{(E_1 + E_2)^2 - (|\mathbf{p}_1| + |\mathbf{p}_2|)^2}$$

 $p\bar{p} \rightarrow \gamma\gamma$ 

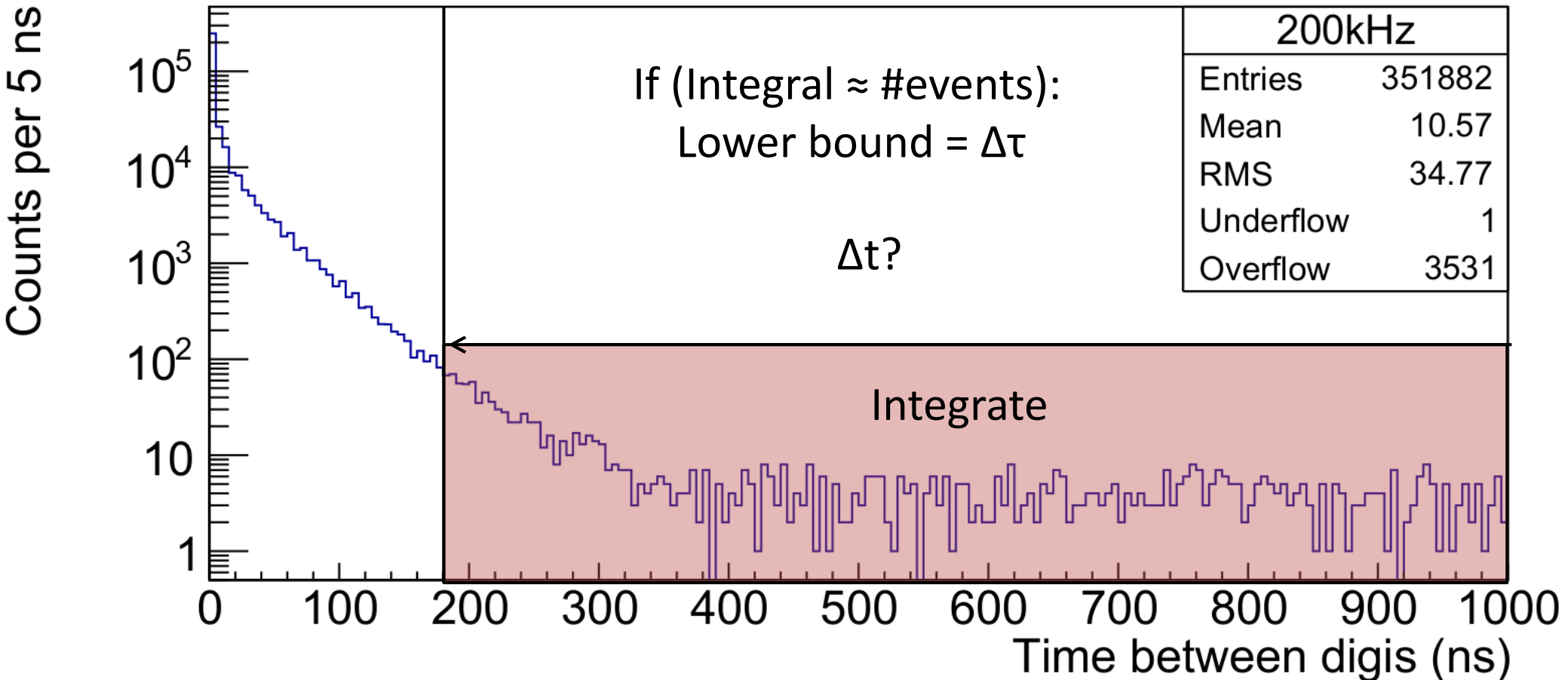
A More Challenging Channel



$$h_c \rightarrow \gamma \eta_c \rightarrow \gamma \pi^0 \pi^0 \eta \rightarrow 7\gamma$$

Finding Optima for $\Delta\tau$ and Δt

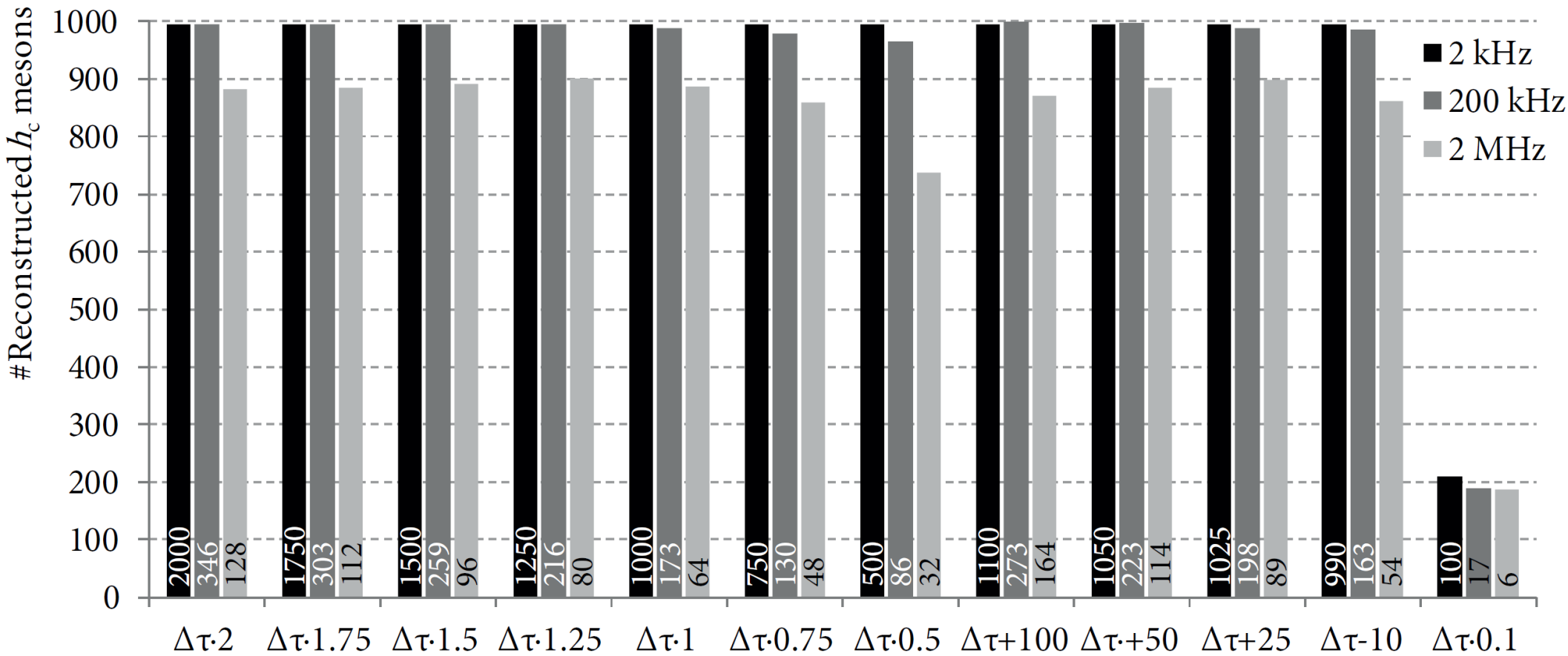
Low rates <2 MHz





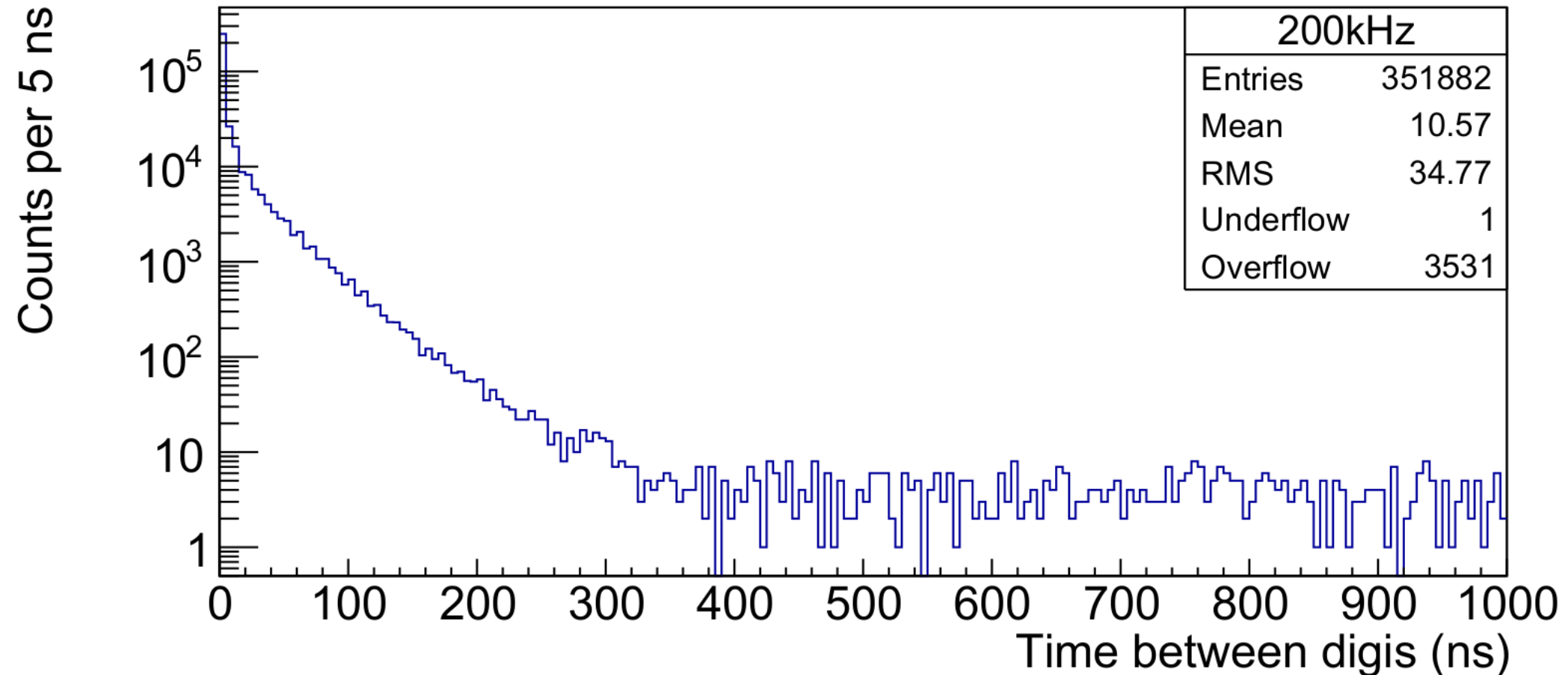
Finding Optima for $\Delta\tau$ and Δt

Low rates <2 MHz



Finding Optima for $\Delta\tau$ and Δt

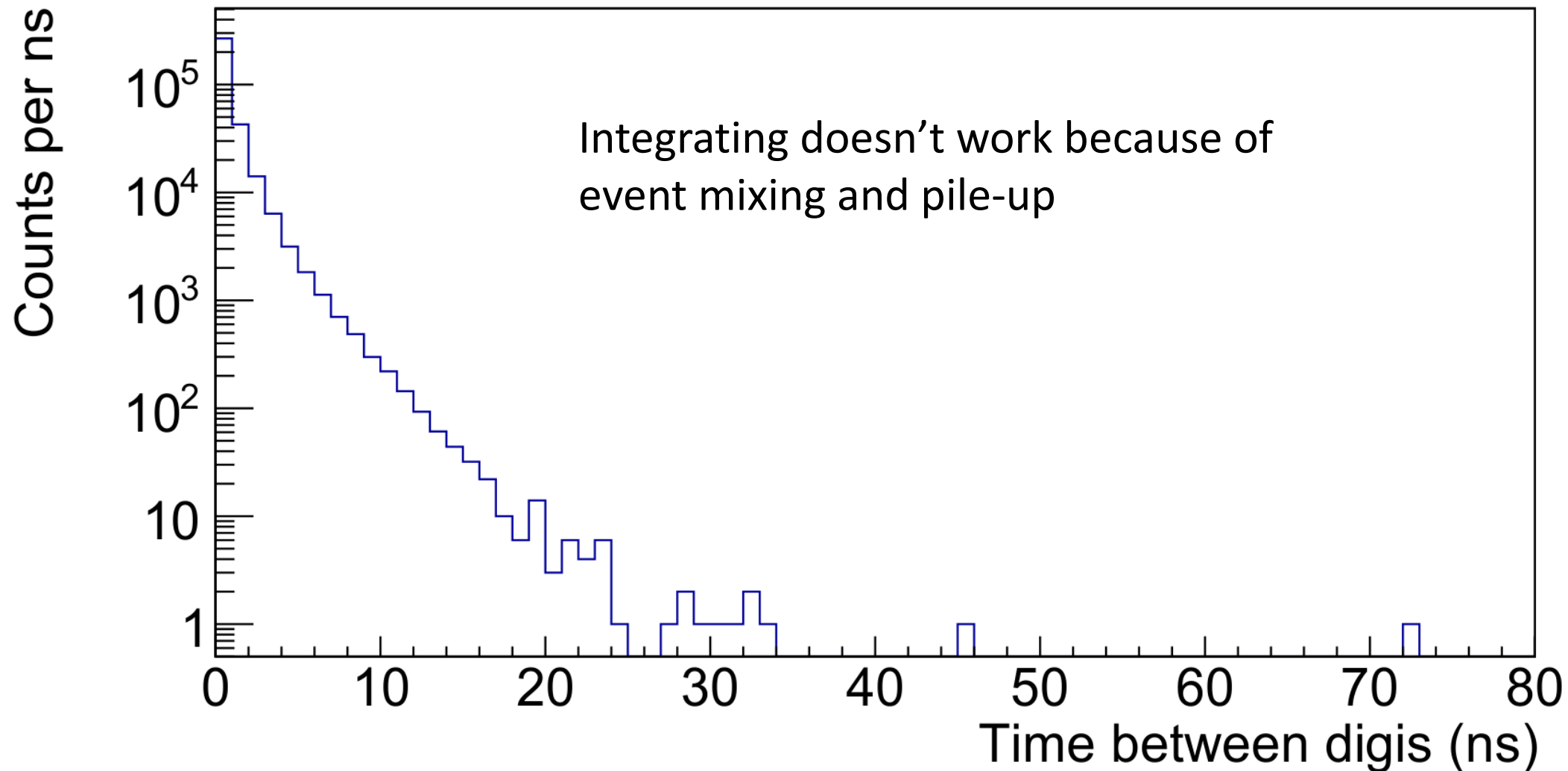
High rate: 20 MHz

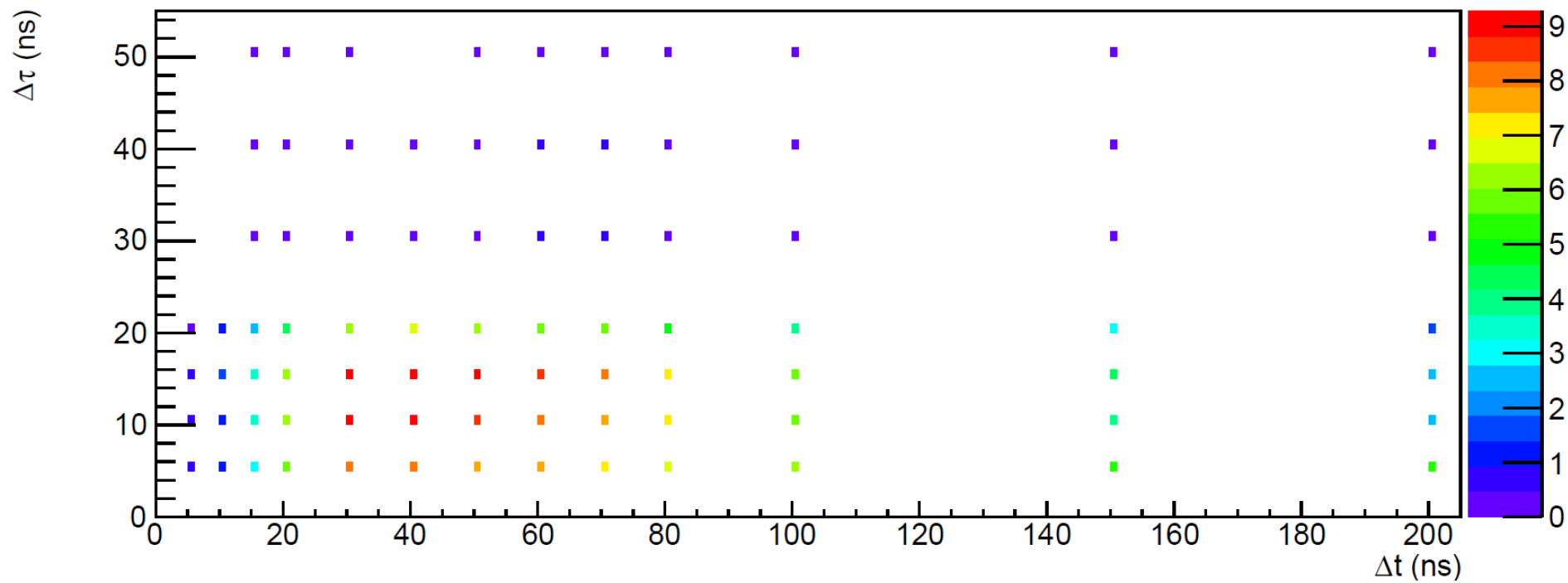
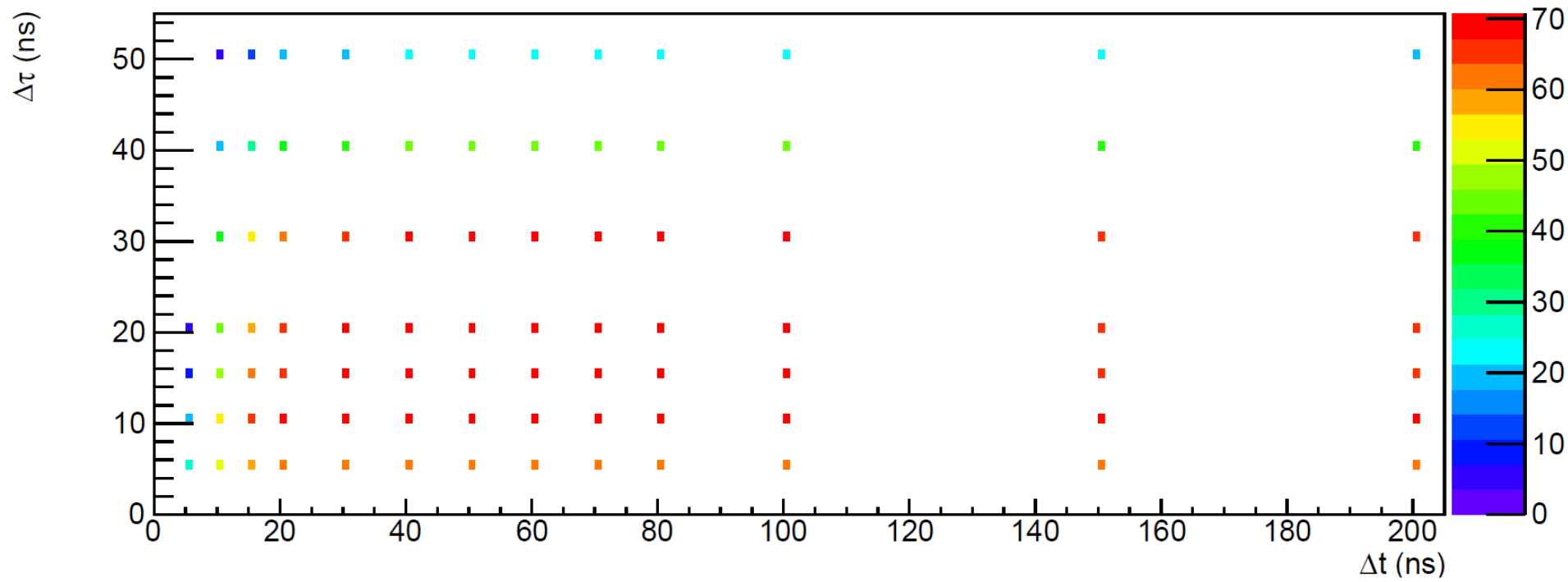




Finding Optima for $\Delta\tau$ and Δt

High rate: 20 MHz



$h_c \rightarrow \dots \rightarrow 7\gamma$  $p\bar{p} \rightarrow \gamma\gamma$ 



Conclusions for $\Delta\tau$ and Δt

$\Delta\tau$ can be determined from time-difference spectra

Δt should be larger than $\Delta\tau$, but not too much larger, + 25 ns

Exception: high rate, but Δt is still $\Delta\tau + 25$ ns