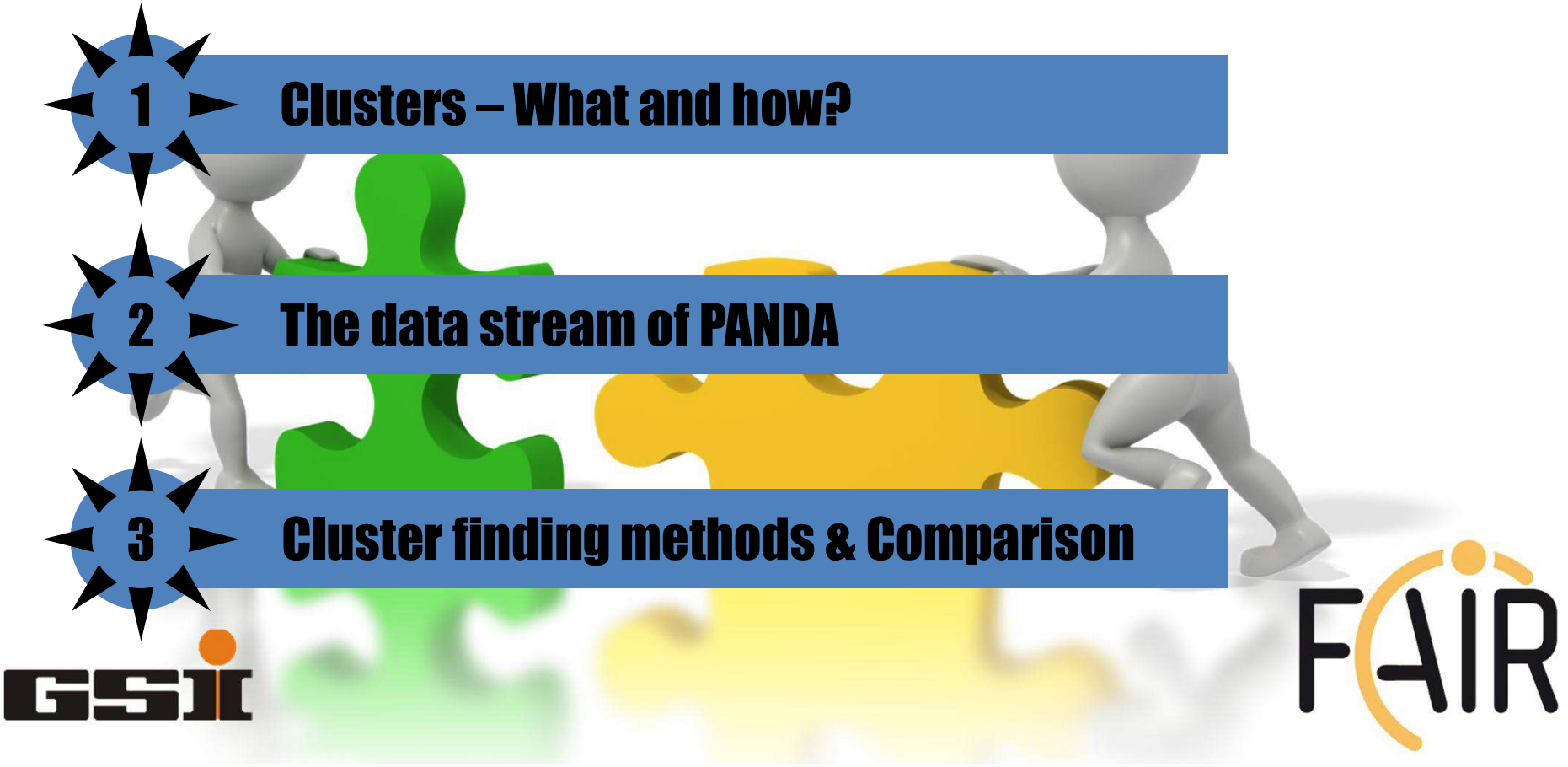
university of groningen / kvi - center for advanced radiation technology

panda

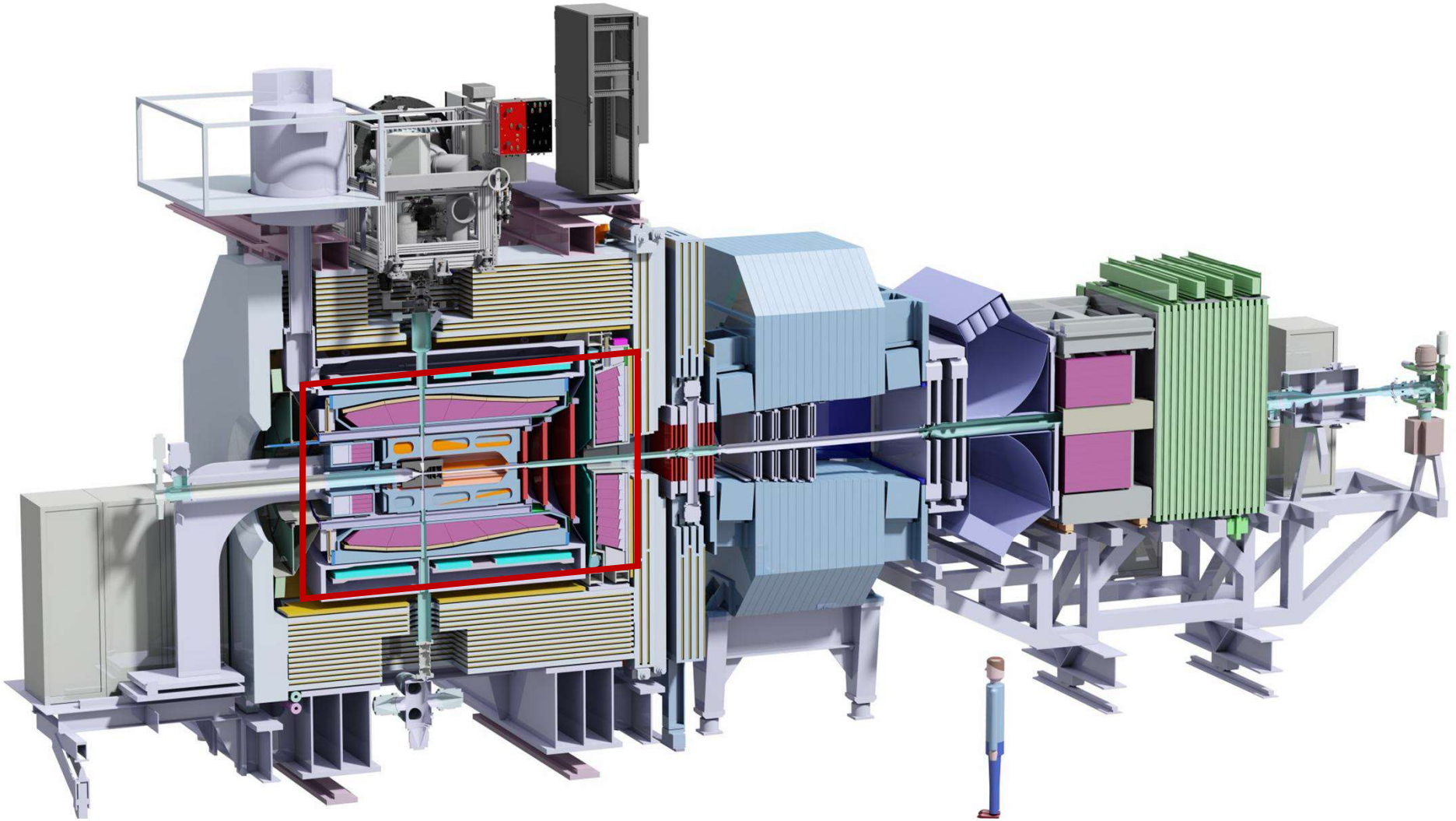
Disentangling PANDA's Timebased Data Stream



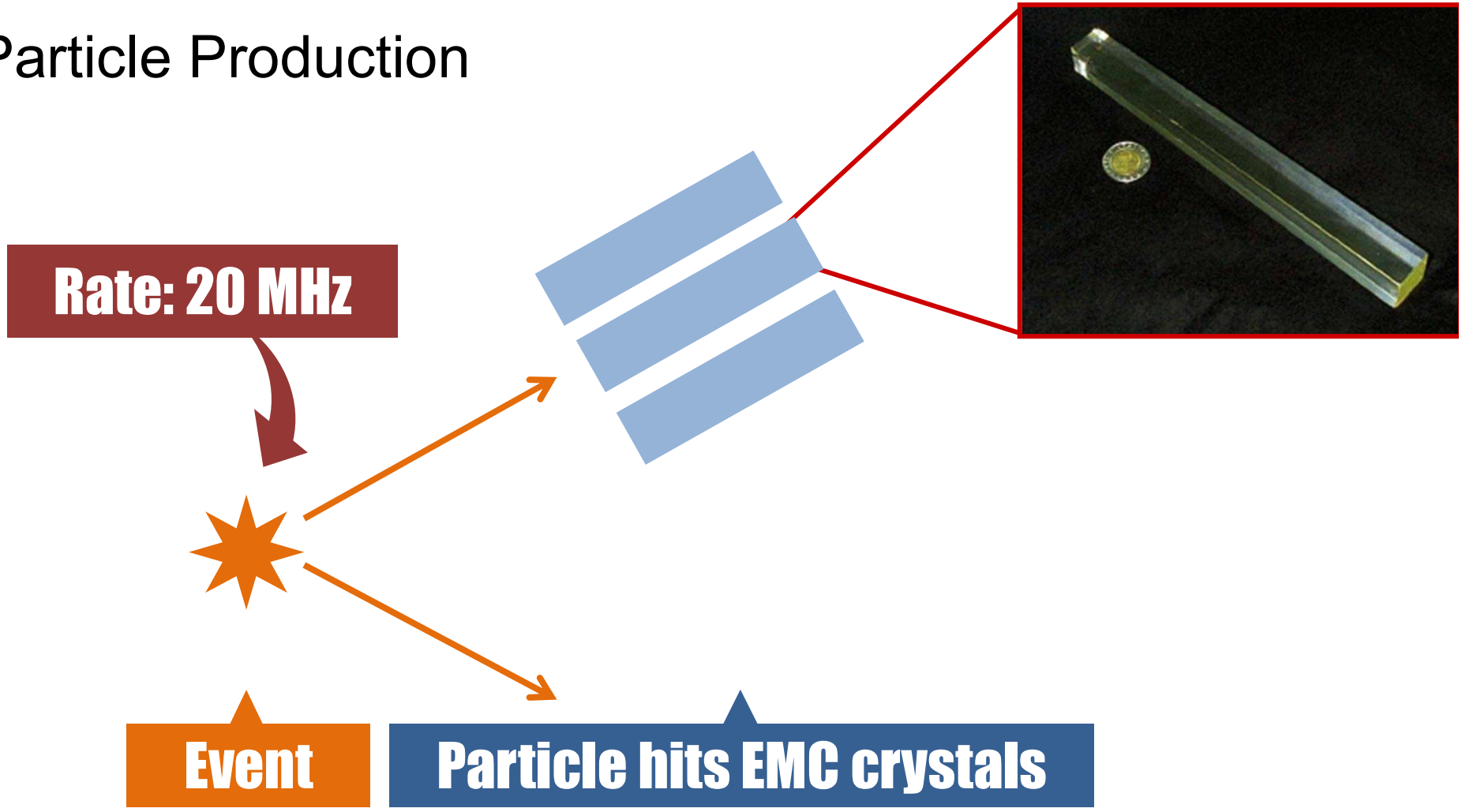
GSI

FAIR

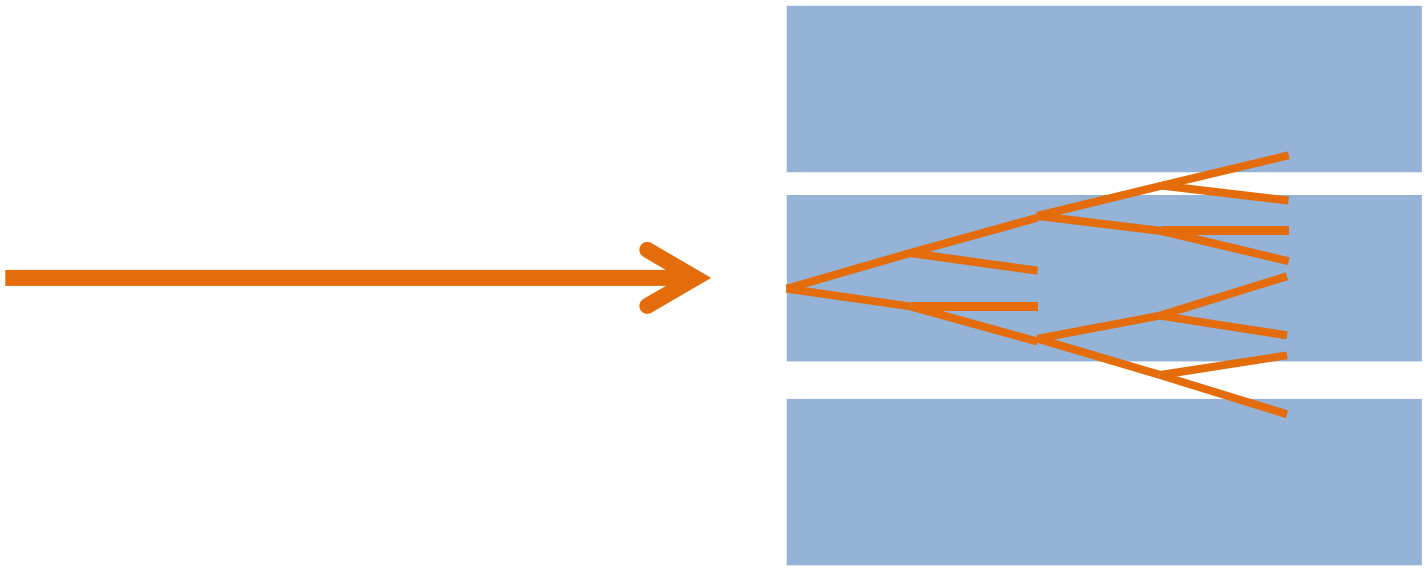
PANDA Experiment



Particle Production

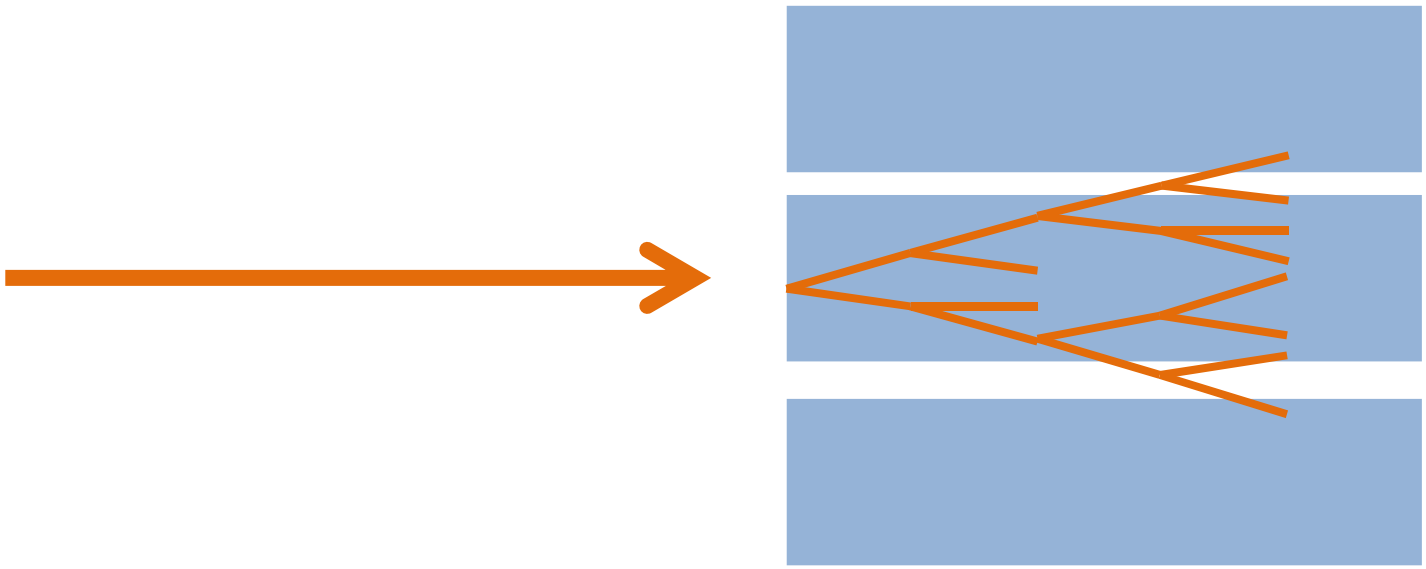


Shower Production



And creates a particle SHOWER

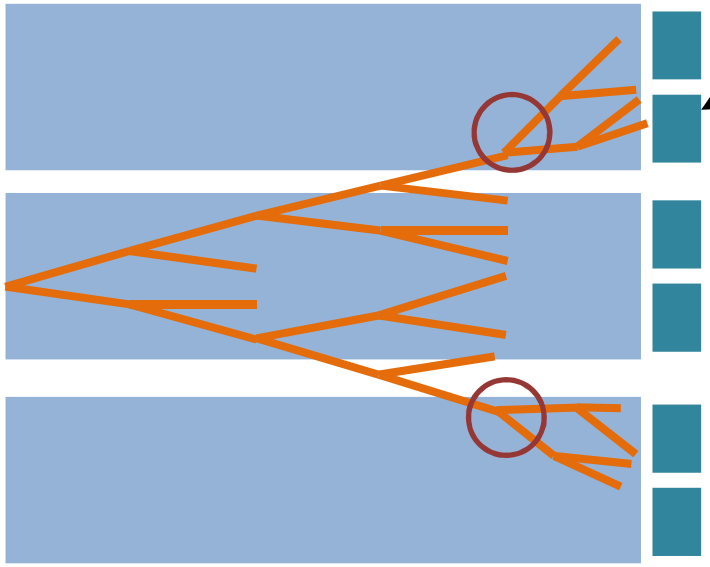
Shower Production

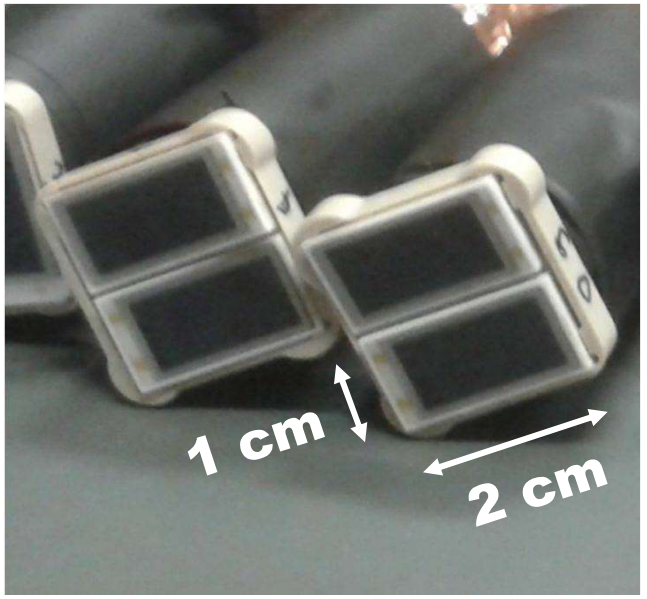


Which spreads out laterally

Shower Production

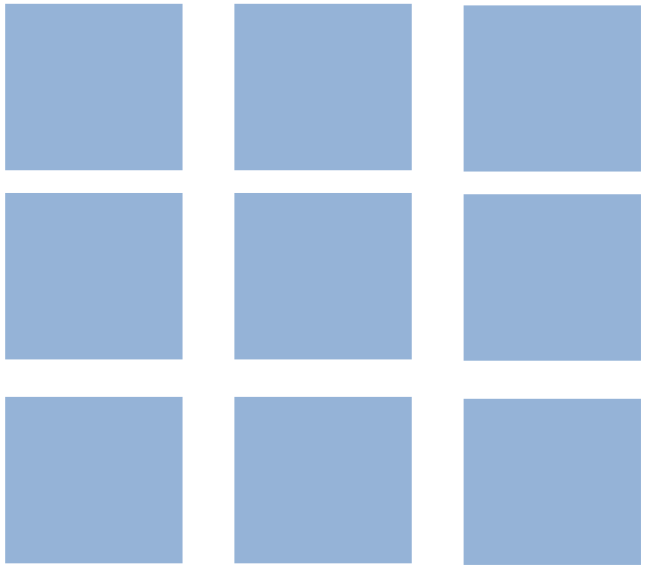
? Hit ≡ Crystal with $E > E_{thr}$





Creating hits in neighbouring crystals as well

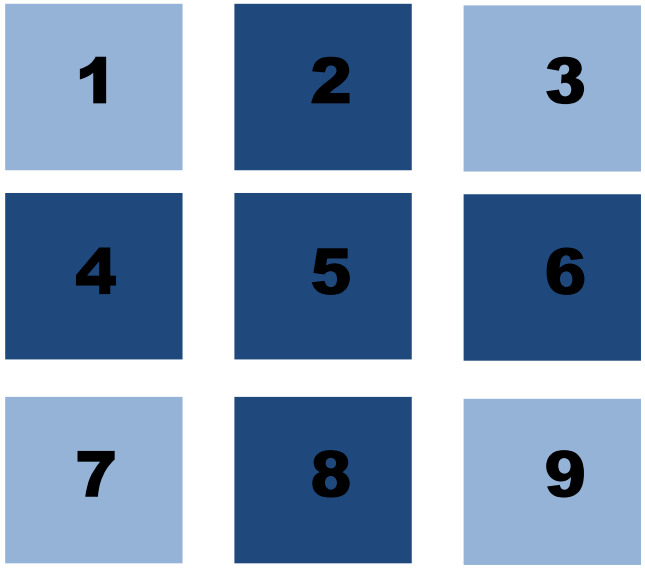
Cluster Forming



(Cross-sectional view)

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

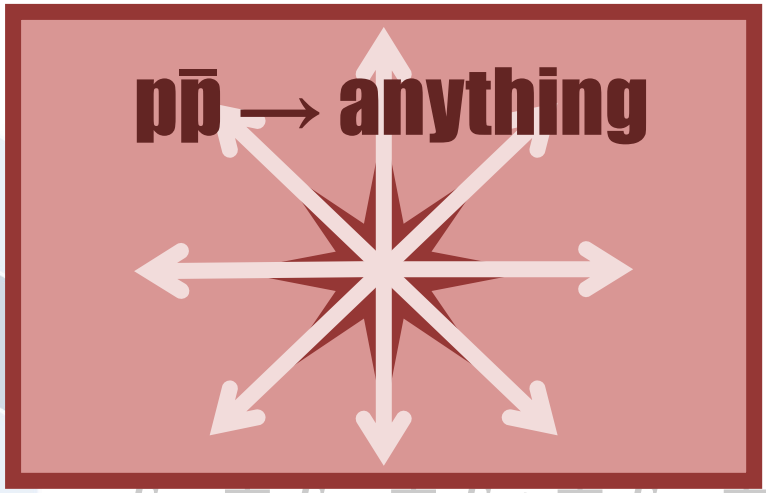
Cluster Finding



(Cross-sectional view)

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

Cluster Finding

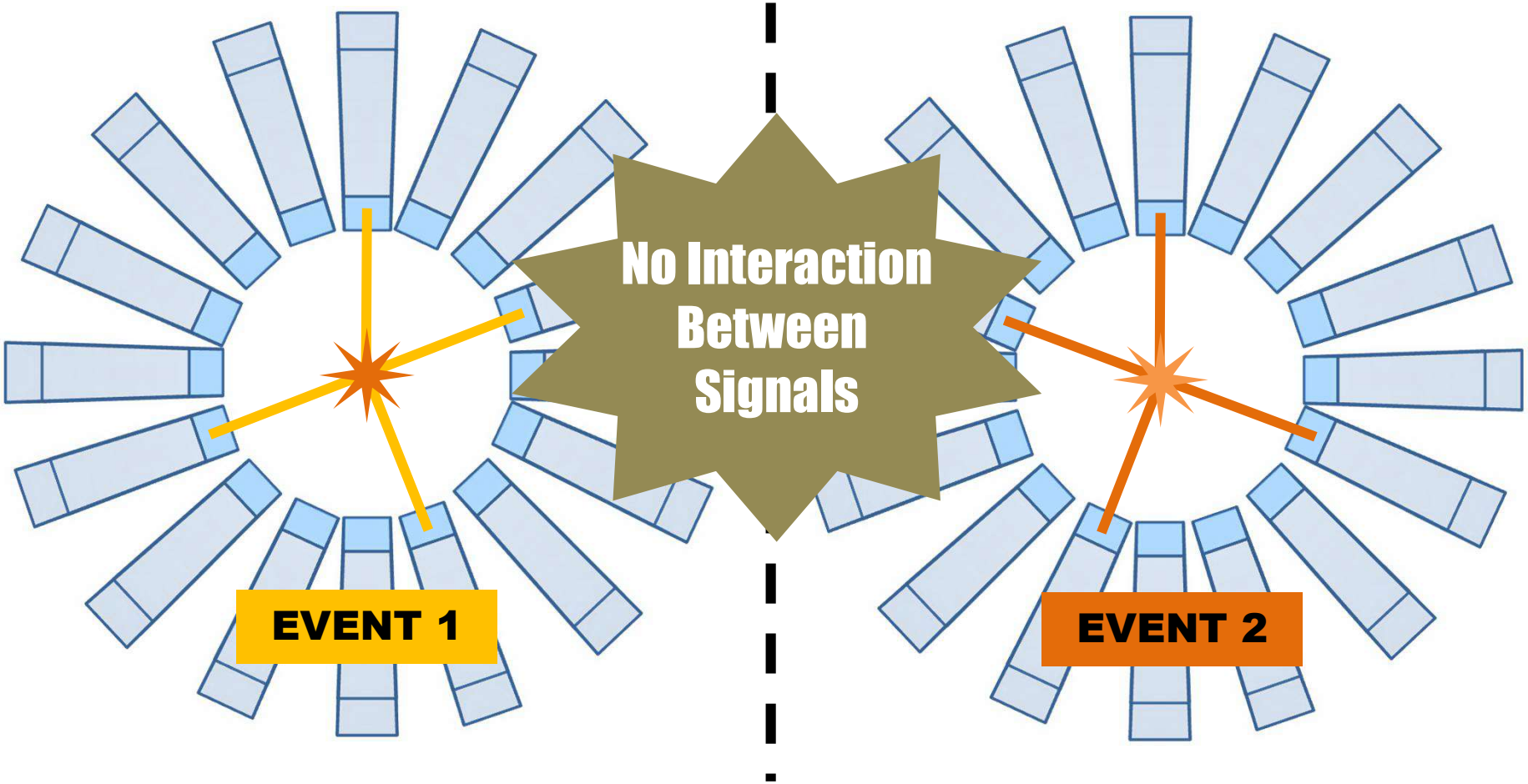


γ, e^-, e^+

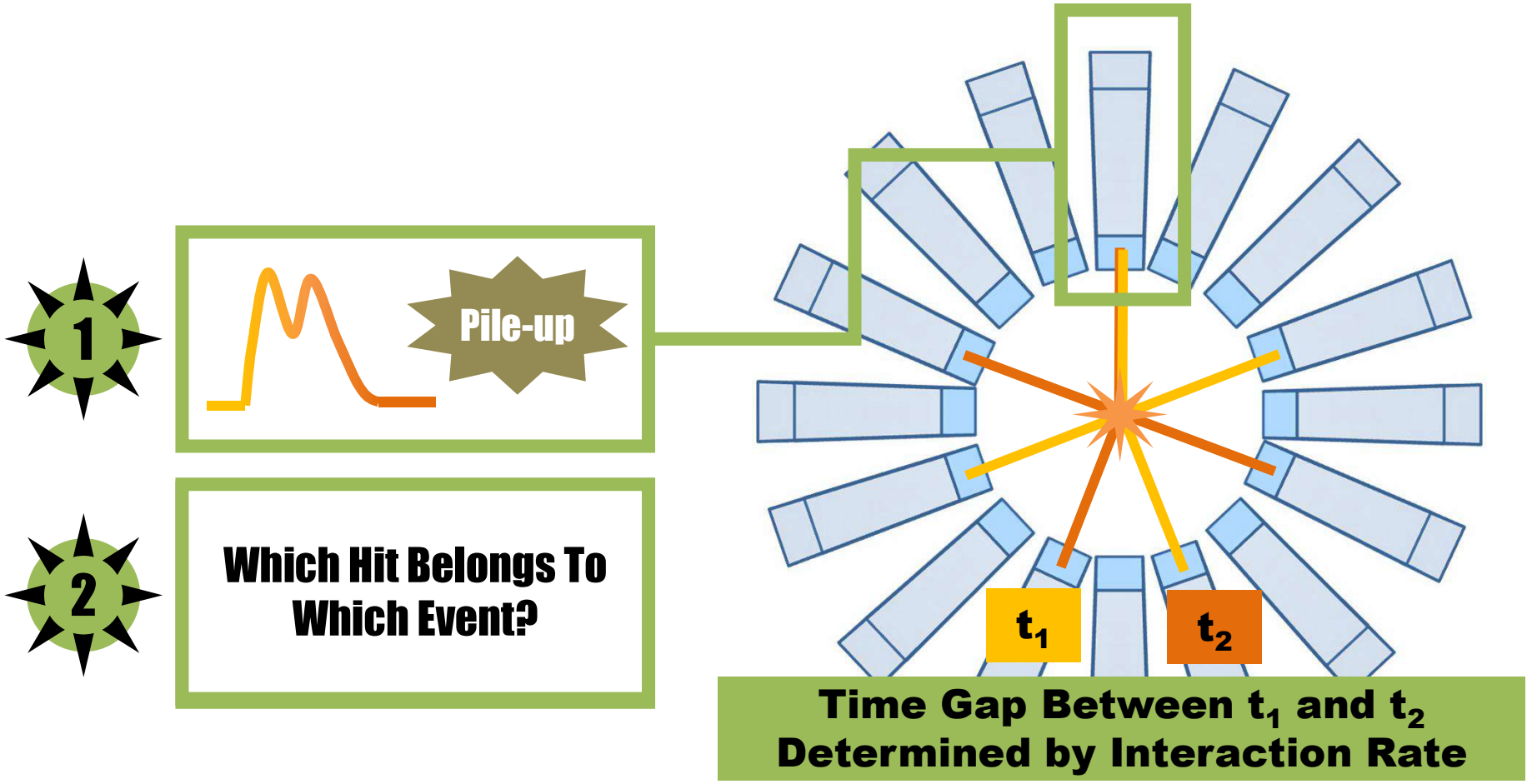
$E_2 + E_4 + E_5 + E_6 + E_8$

And that is that. Or is it?

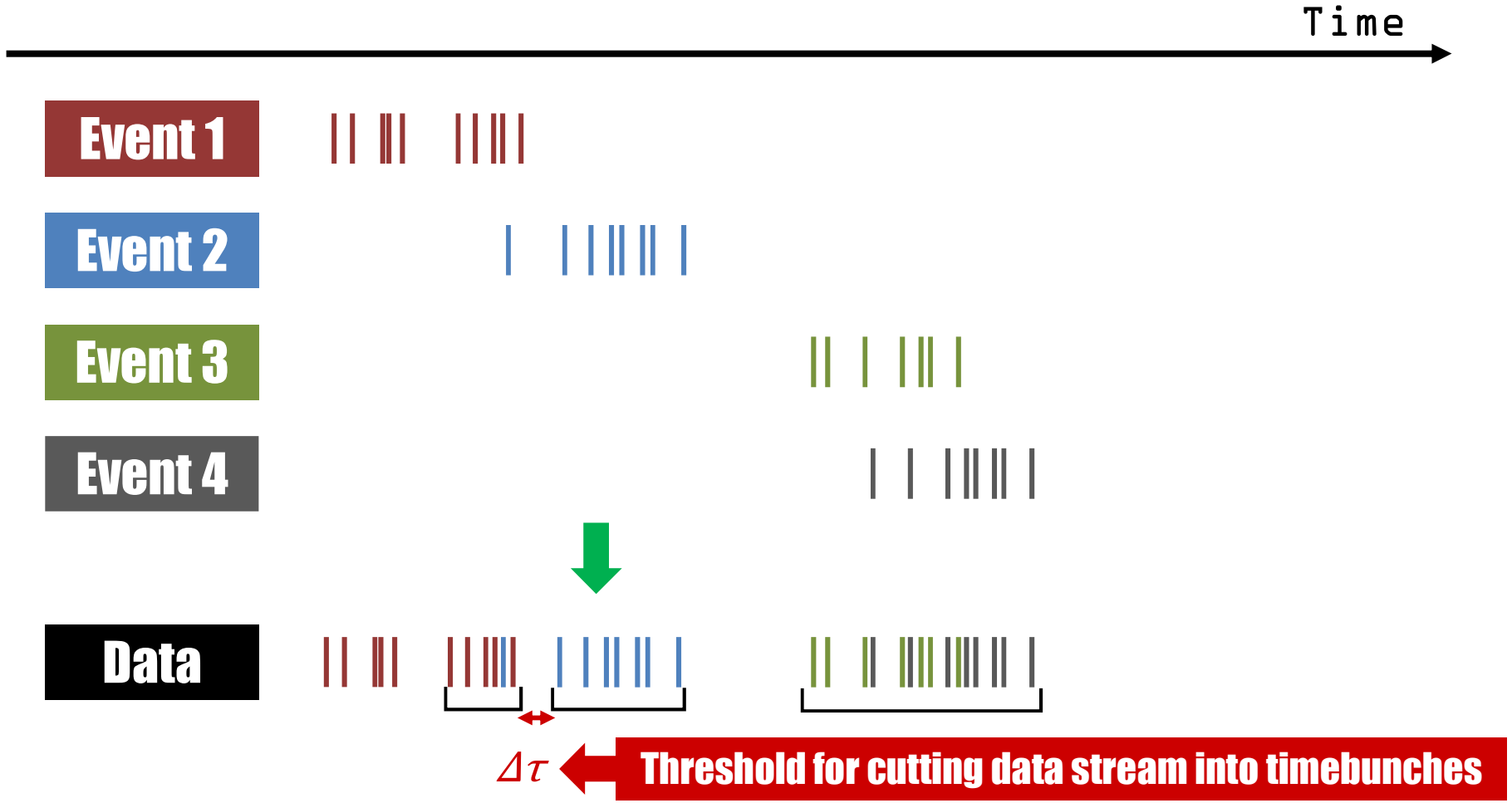
Structure of the Data Stream



Structure of the Data Stream

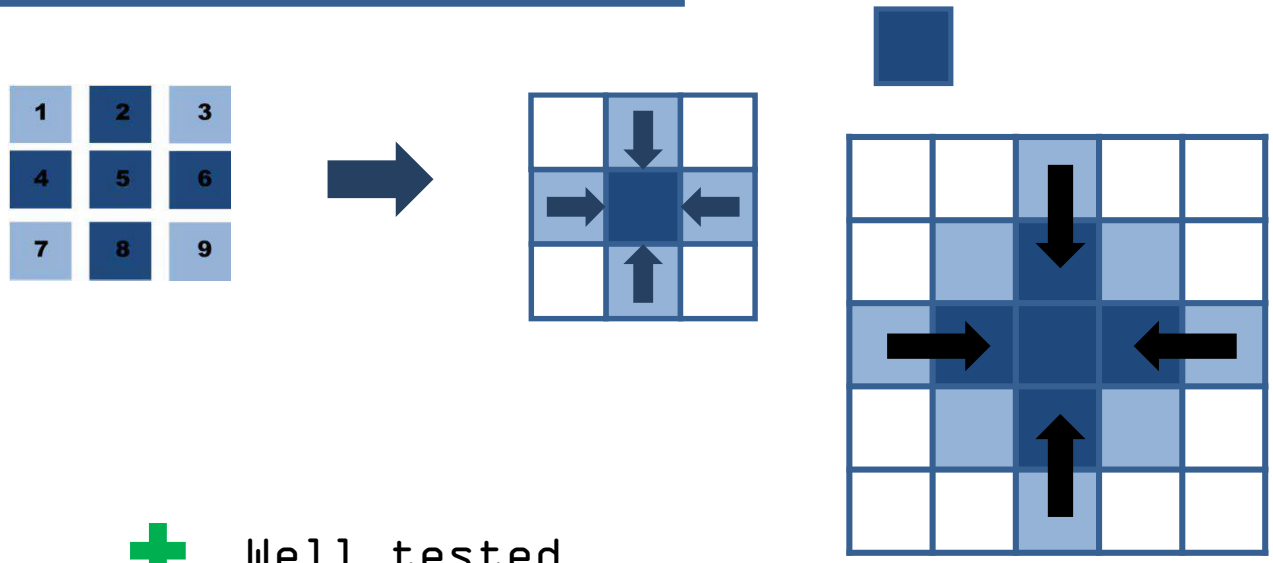


Structure of the Data Stream



Cluster Finding - Methods

"Standard"



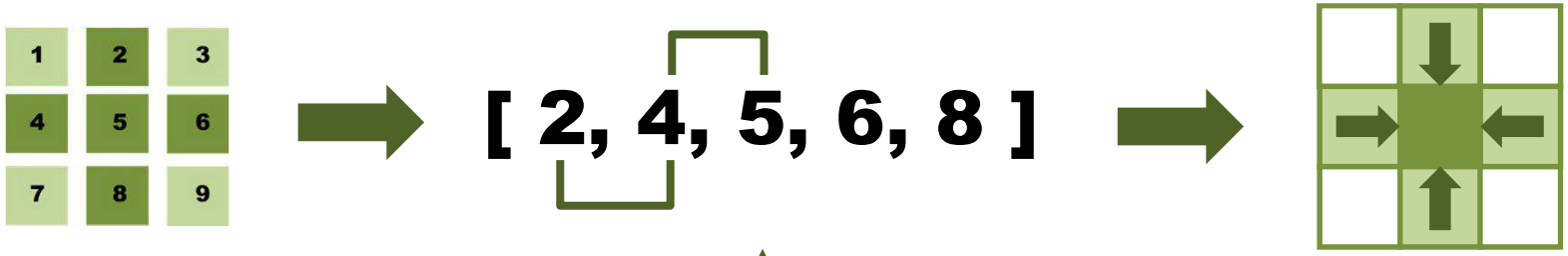
\+ Well tested

\- Slow

\- Fails if e.g. 2 comes first, and then 8

Cluster Finding - Methods

Online

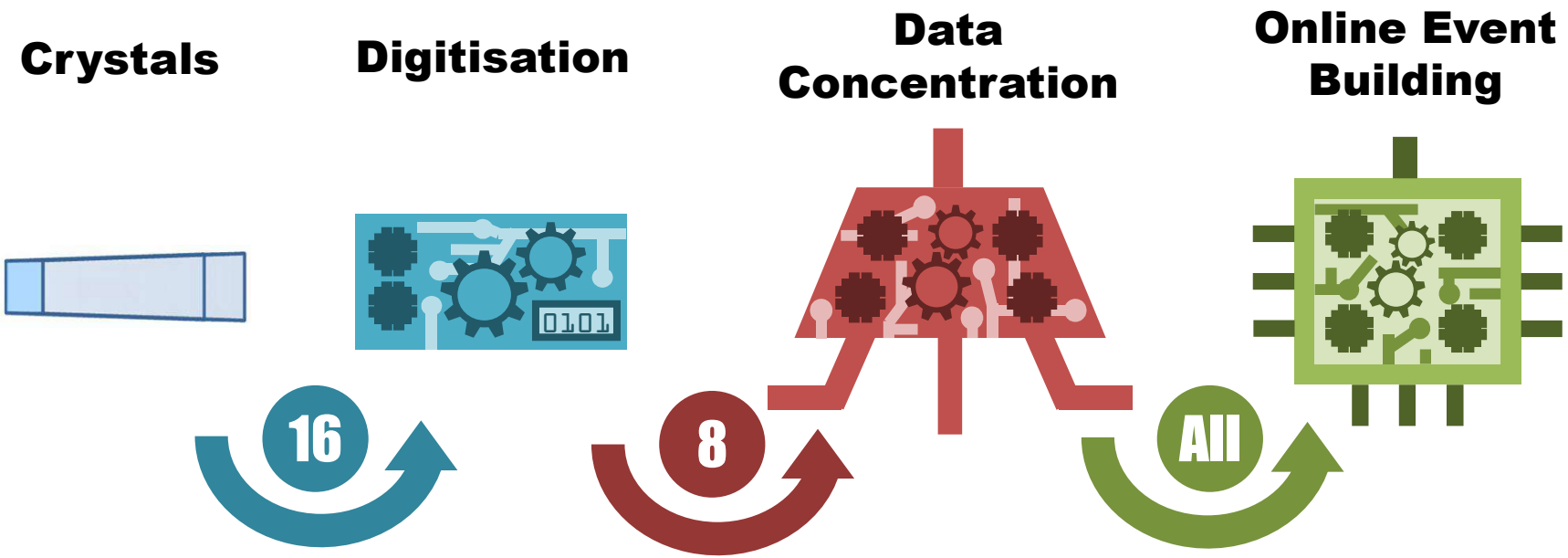


\+ Fast

\- Many iterations

Cluster Finding - Methods

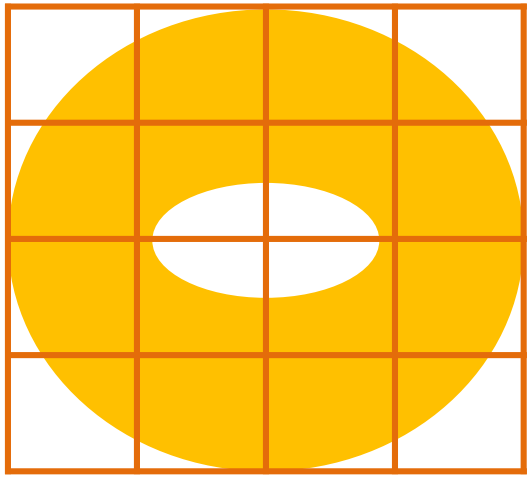
Distributed ▶ **Setting the Stage**



Impression of the Readout Chain of the Detector

Cluster Finding - Methods

Distributed ▶ **What is it?**



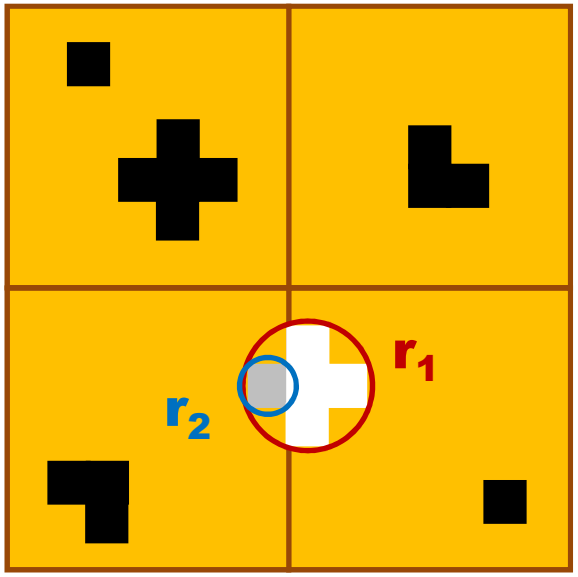
Each Data Concentrator reads out ~128 Crystals

Possible to look for clusters at this level

Example: Forward Endcap (Impression)

Cluster Finding - Methods

Distributed ▶ **How?**



Example: Clusters in 4 Data Concentrators

1. **Look for clusters using the Online algorithm in each DC**
2. **Might not be a "real" cluster >> First specify 3D location (x,y,t) and radius**
3. **At the next level, merge preclusters if** $(x_2 - x_1) < (r_2 + r_1)$

Cluster Finding - Methods

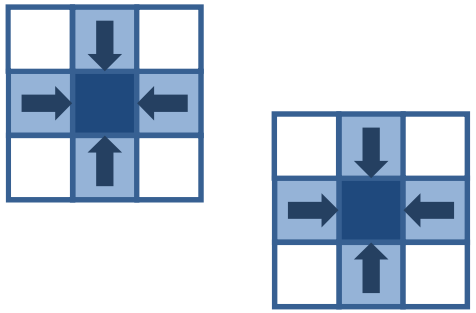
Distributed ▶ **Pros and Cons**

- \+ Each DC has a small sample of the dataset → Fast
- \+ The next stage can use preclusters instead of hits → Fast
- − Some additional operations
- − If preclusters have very elliptical shapes, the radius will be greatly overestimated

Cluster Finding – Methods (Summary)

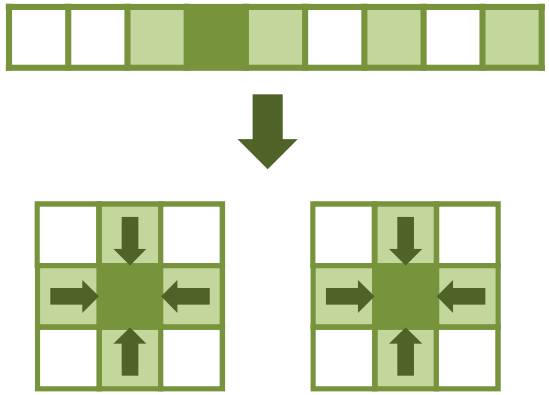
"Standard"

- Treats each new hit as a cluster, and adds neighbouring hits to it



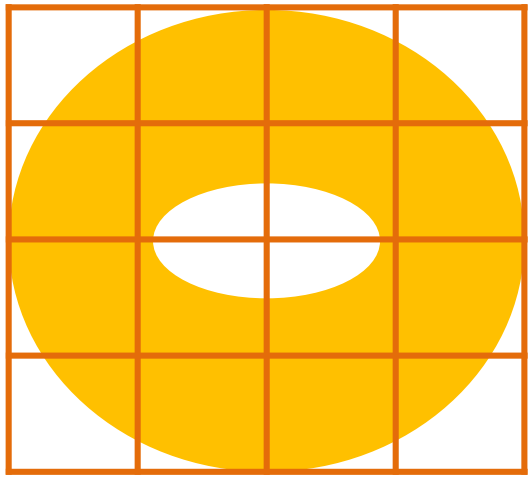
Online

- Builds neighbour relations for all hits in the current input stream
- Uses that info to merge hits into clusters



Distributed

- Same as Online, but first map hits onto Data Concentrators (closer to real readout)



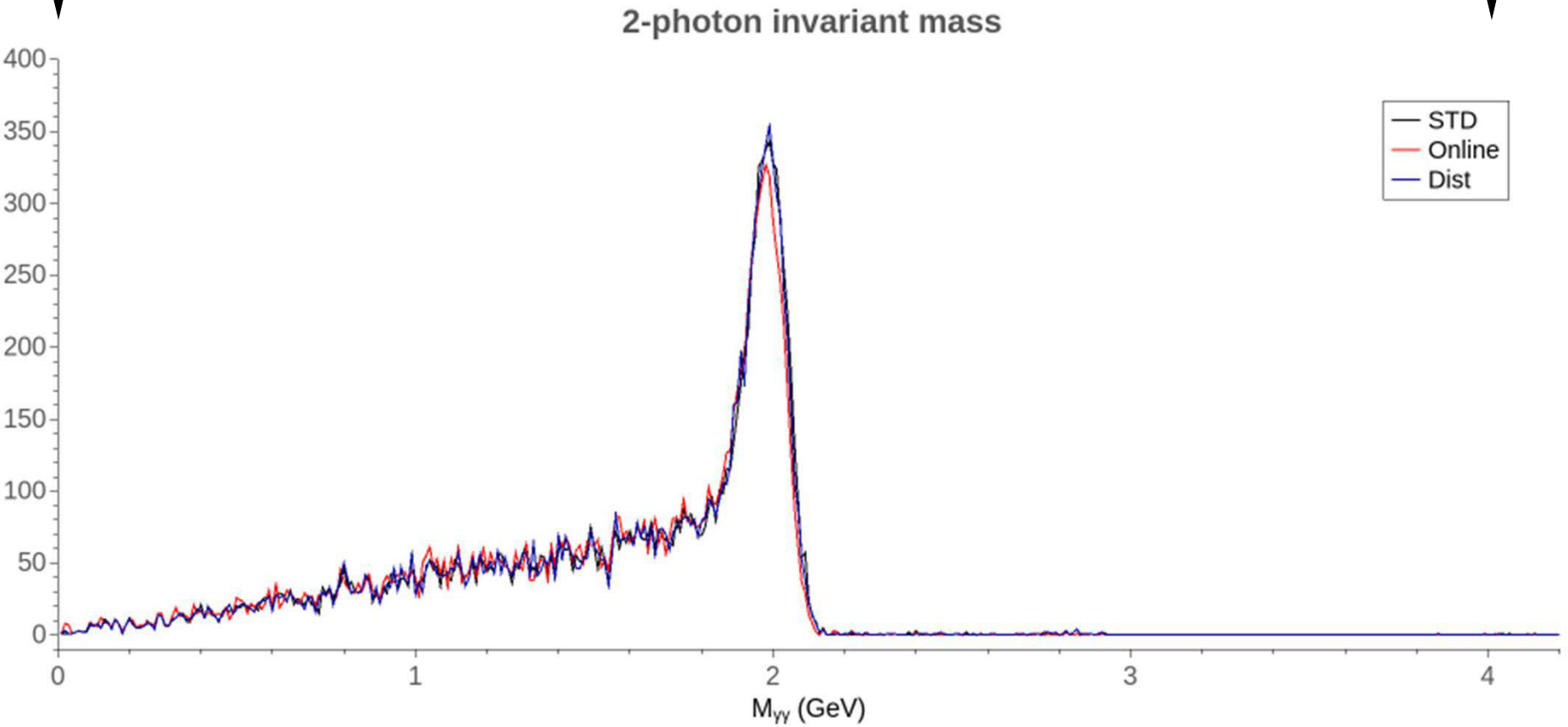
Comparing Methods (Preliminary)

Example channel: $5000 \times p\bar{p} \rightarrow \gamma\gamma,\ \vec{p}(\bar{p}) = 1\ GeV/c$

TEST - PART 1:
Ability to
reconstruct events

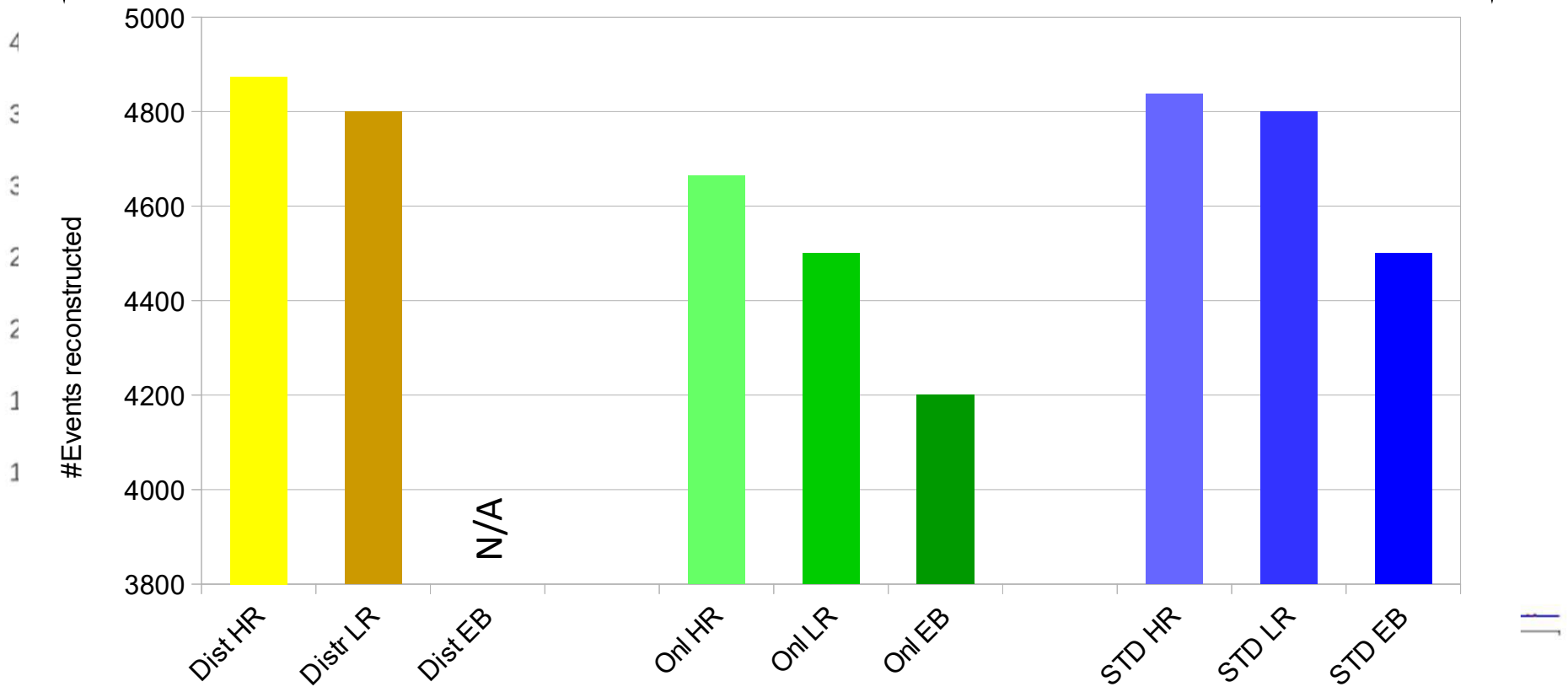
Comparing Methods (Preliminary)

Example channel: $5000 \times p\bar{p} \rightarrow \gamma\gamma,\ \vec{p}(\bar{p}) = 1\ GeV/c$



Comparing Methods (Preliminary)

Example channel: $5000 \times p\bar{p} \rightarrow \gamma\gamma,\ \vec{p}(\bar{p}) = 1\ GeV/c$



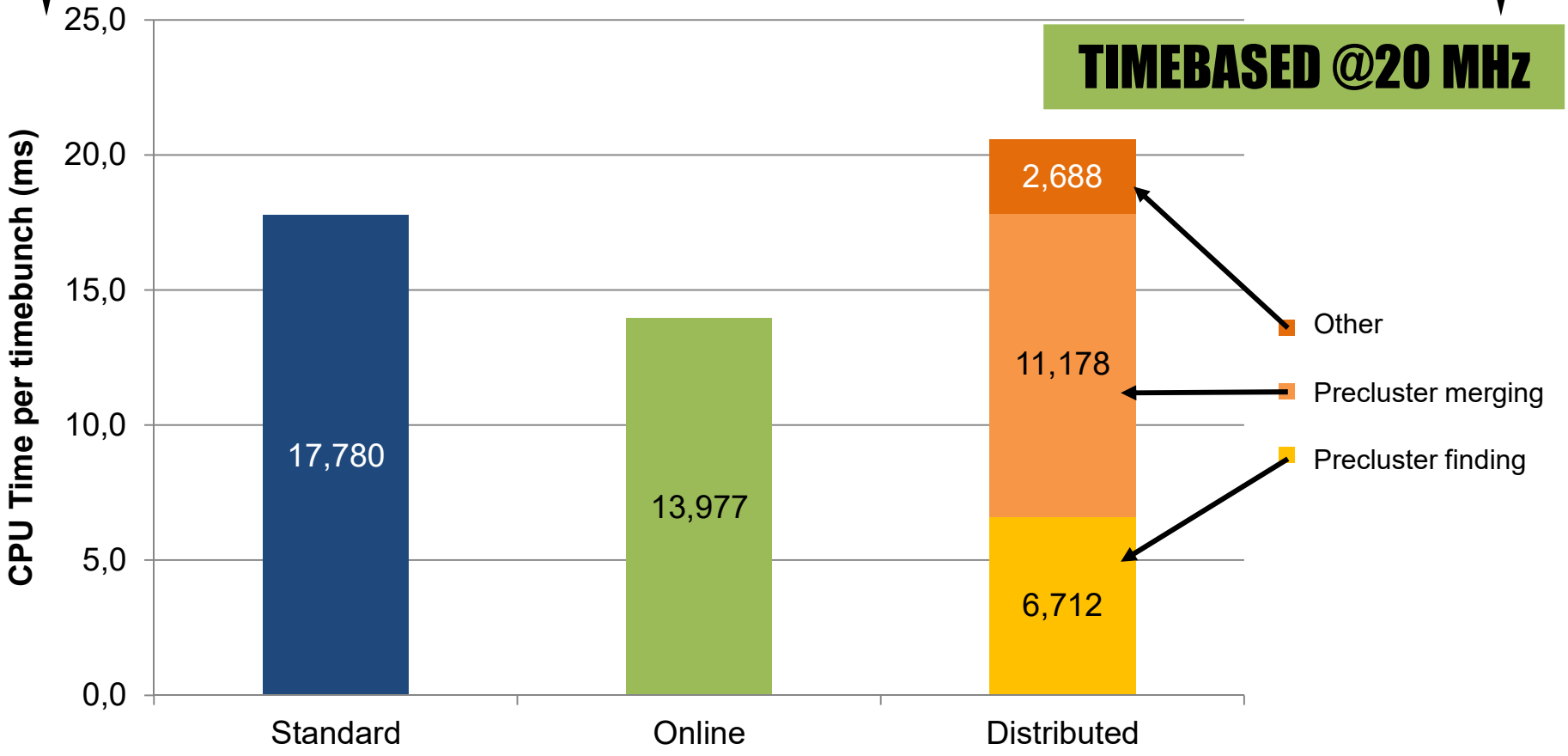
Comparing Methods (Preliminary)

Example channel: $5000 \times p\bar{p} \rightarrow \gamma\gamma,\ \vec{p}(\bar{p}) = 1\ GeV/c$

TEST - PART 2:
Time needed to reconstruct events

Comparing Methods (Preliminary)

Example channel: $5000 \times p\bar{p} \rightarrow \gamma\gamma,\ \vec{p}(\bar{p}) = 1\ GeV/c$



Conclusion

- Different methods for cluster finding are being developed/evaluated.
- All methods yield a similar number of events.
- Online Cluster Finding is the fastest.
- Processing time for all methods is comparable, but the two steps (precluster forming and merging) in distributed cluster finding are separately considerably faster.

Outlook

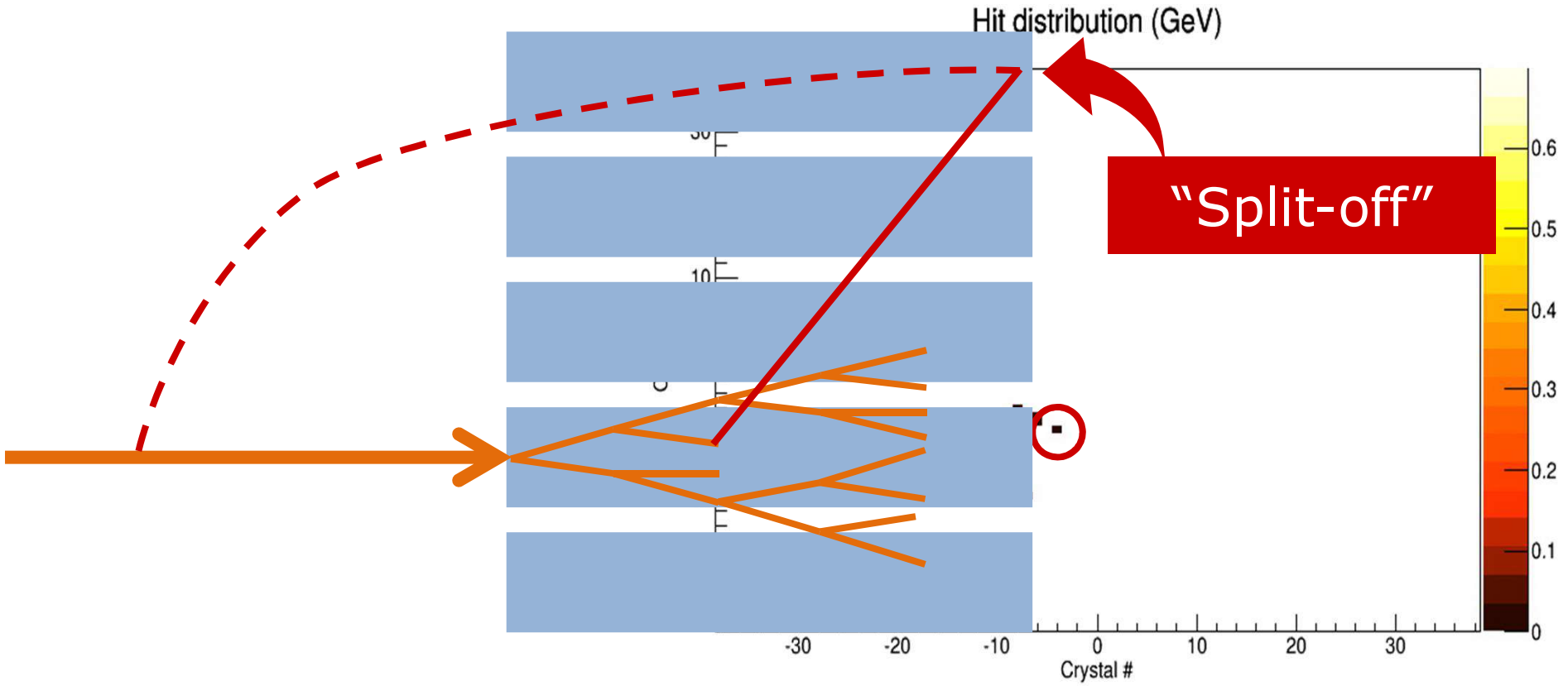
- Optimize algorithms
- Expand to more complicated channel, e.g. $h_c \rightarrow 7\gamma$
- Include background
- Investigate effect of bump splitting

- IMPORTANT SIDENOTE: Speed comparison done on CPU, may (probably will) differ on FPGA

Thank you for your attention. Here's a cluster of pandas.

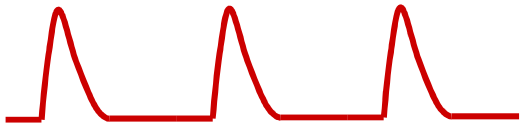
Backup: Split-offs

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

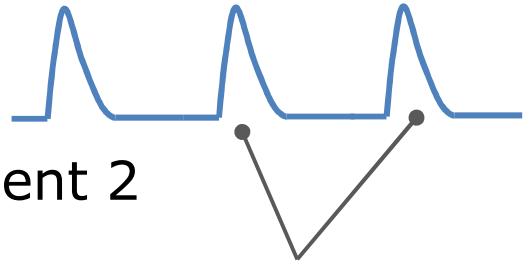


Backup: Simulation details

Step 1: Event Generation



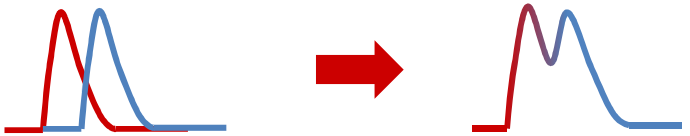
Event 1



Event 2

⋮

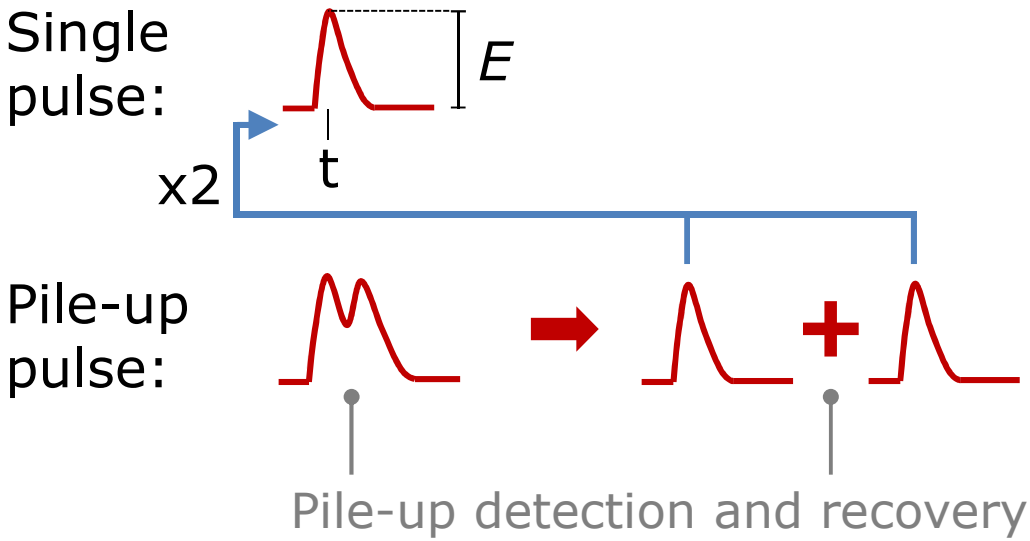
Step 2: Signal Interaction



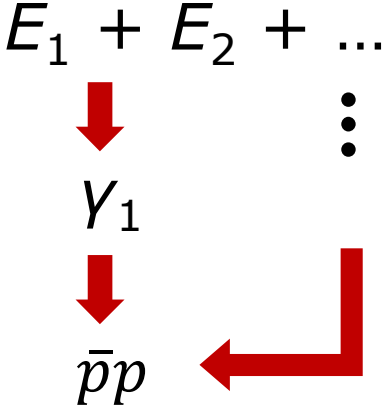
- Occurs when particles enter the same detector element within its response time.
- Poisson Distributed.

Backup: Simulation details

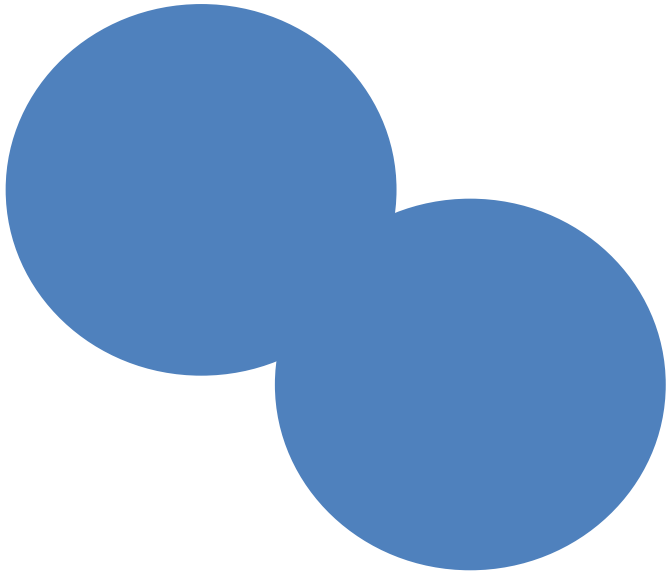
Step 3: Feature Extraction



Step 4: Advanced event prebuilding and event reconstruction



Backup: “Bump splitting”



Effect of such overlapping clusters not yet investigated