

Data Volume Reduction for the Cherenkov Telescope Array

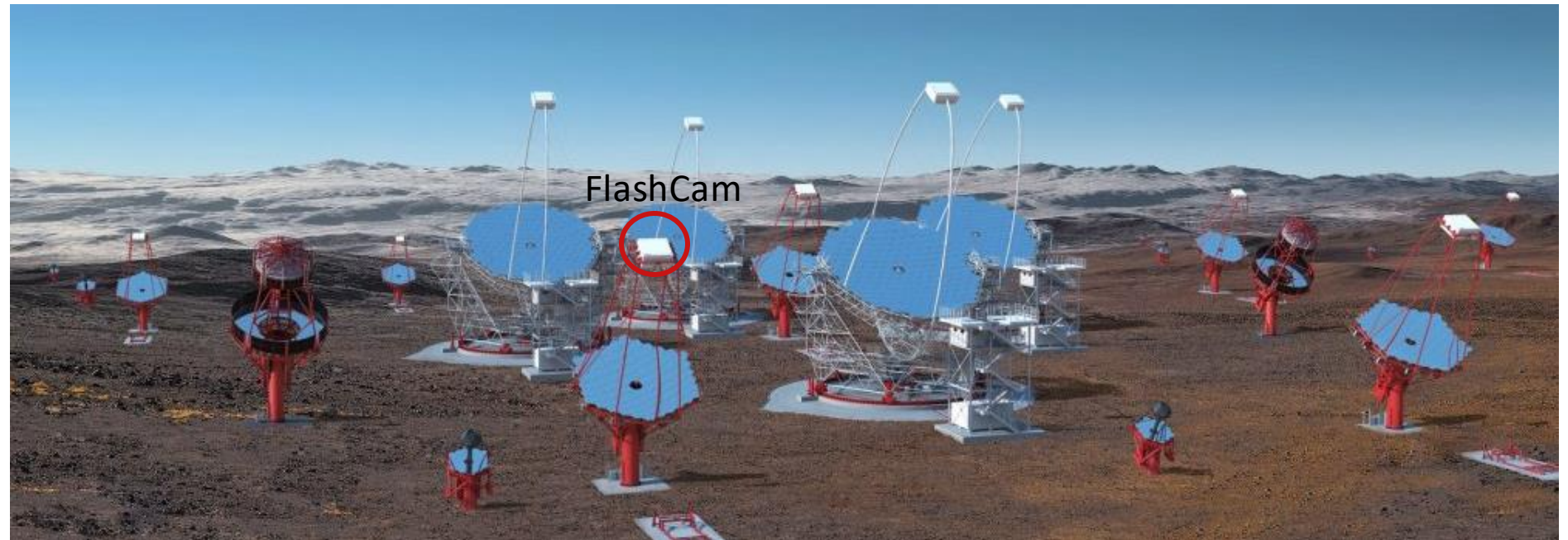
Clara Escañuela Nieves

Max Planck Institute for Nuclear Physics, Heidelberg

October 2023

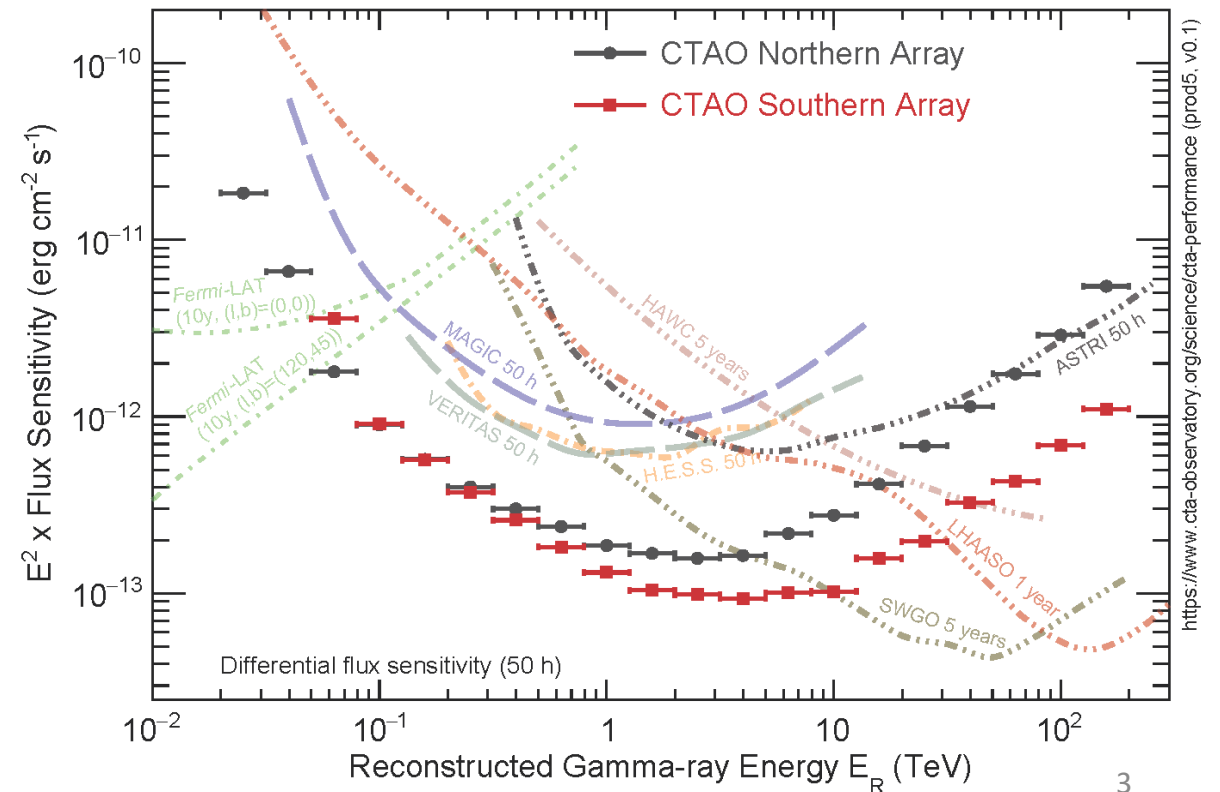
The Cherenkov Telescope Array

- Two sites: Southern and Northern (full sky)
- Three telescopes: LST, MST, SST (wider energy coverage)

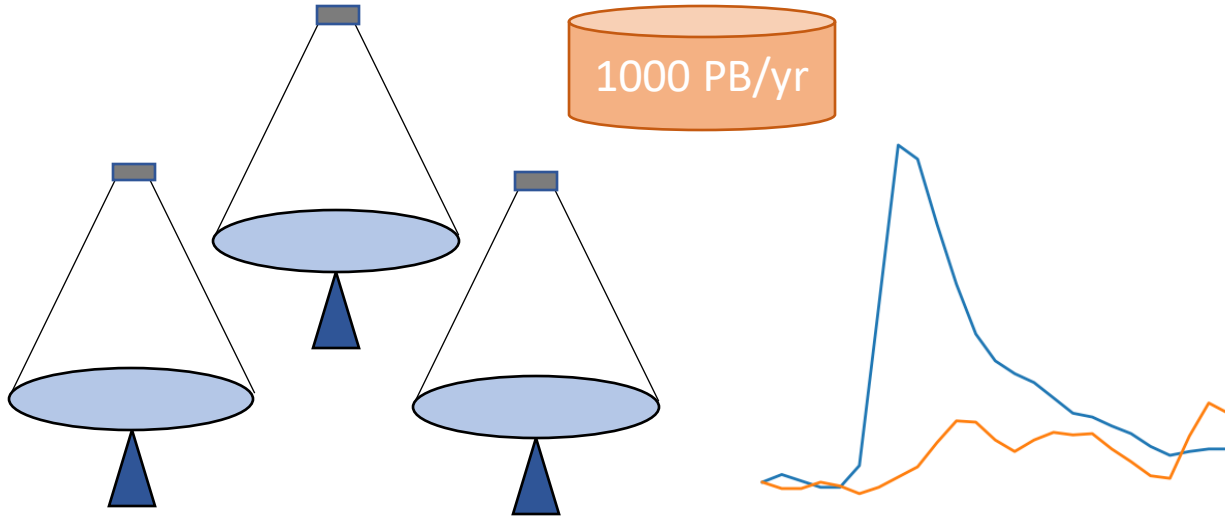


The Cherenkov Telescope Array

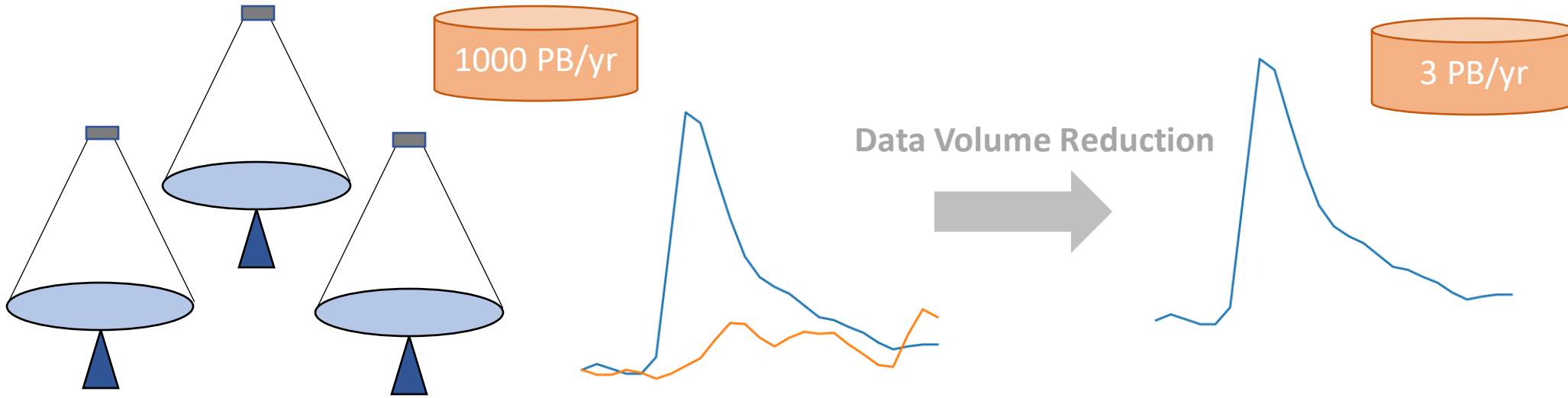
- Two sites: Southern and Northern (full sky)
- Three telescopes: LST, MST, SST (wider energy coverage)
- 10 times better sensitivity



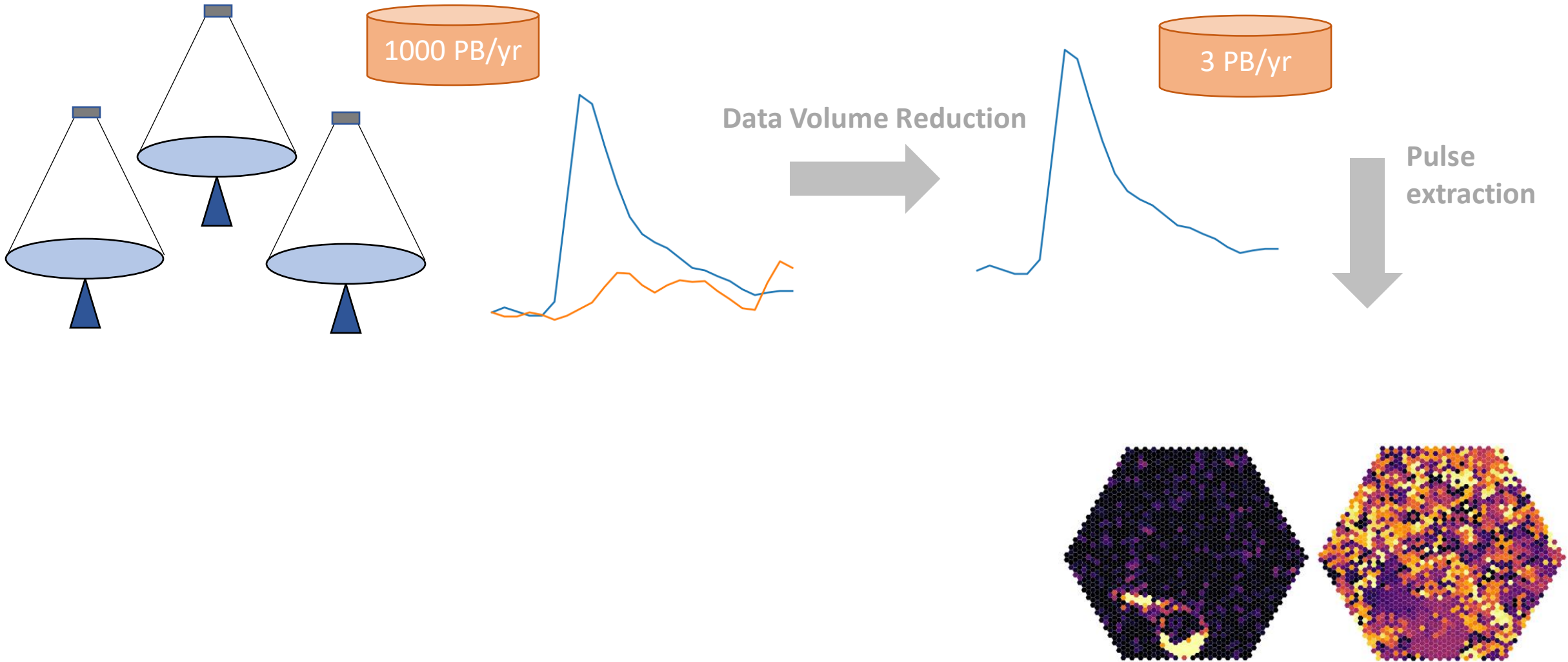
CTA Data Chain



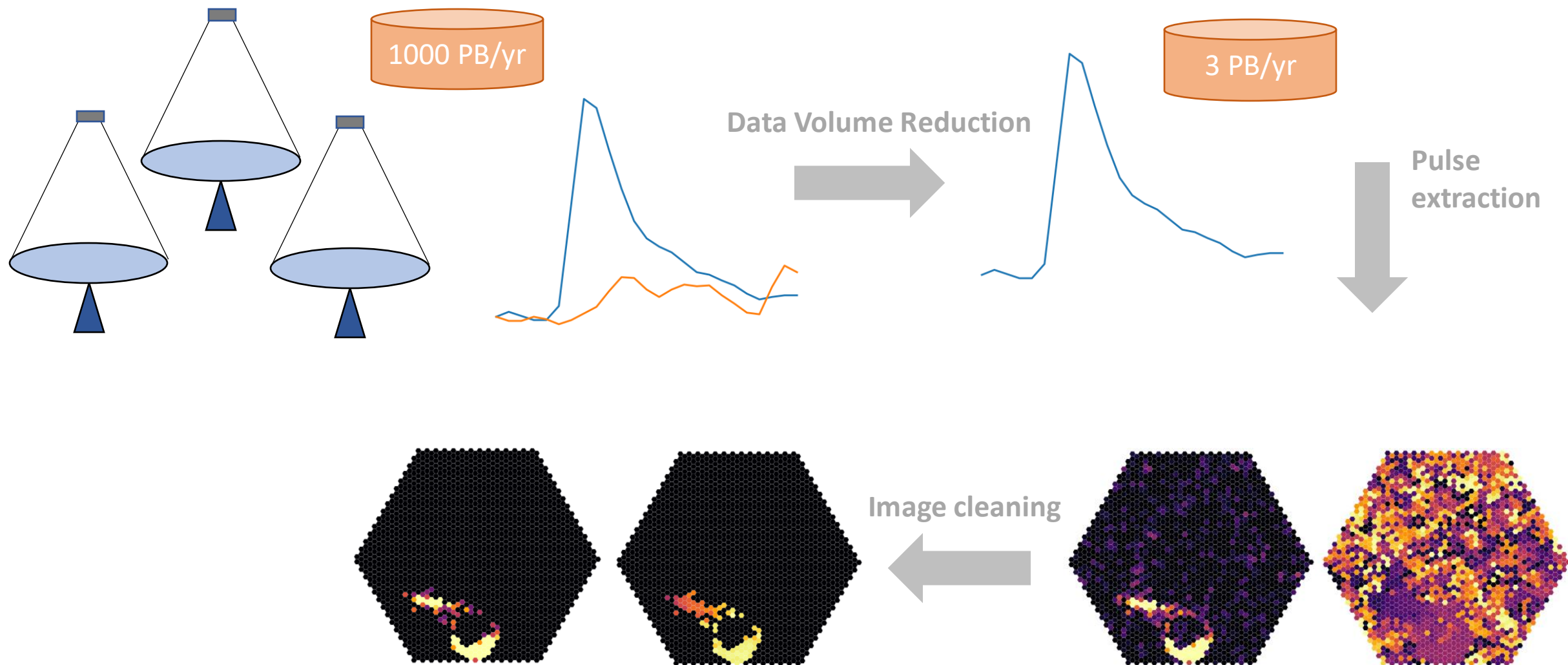
CTA Data Chain



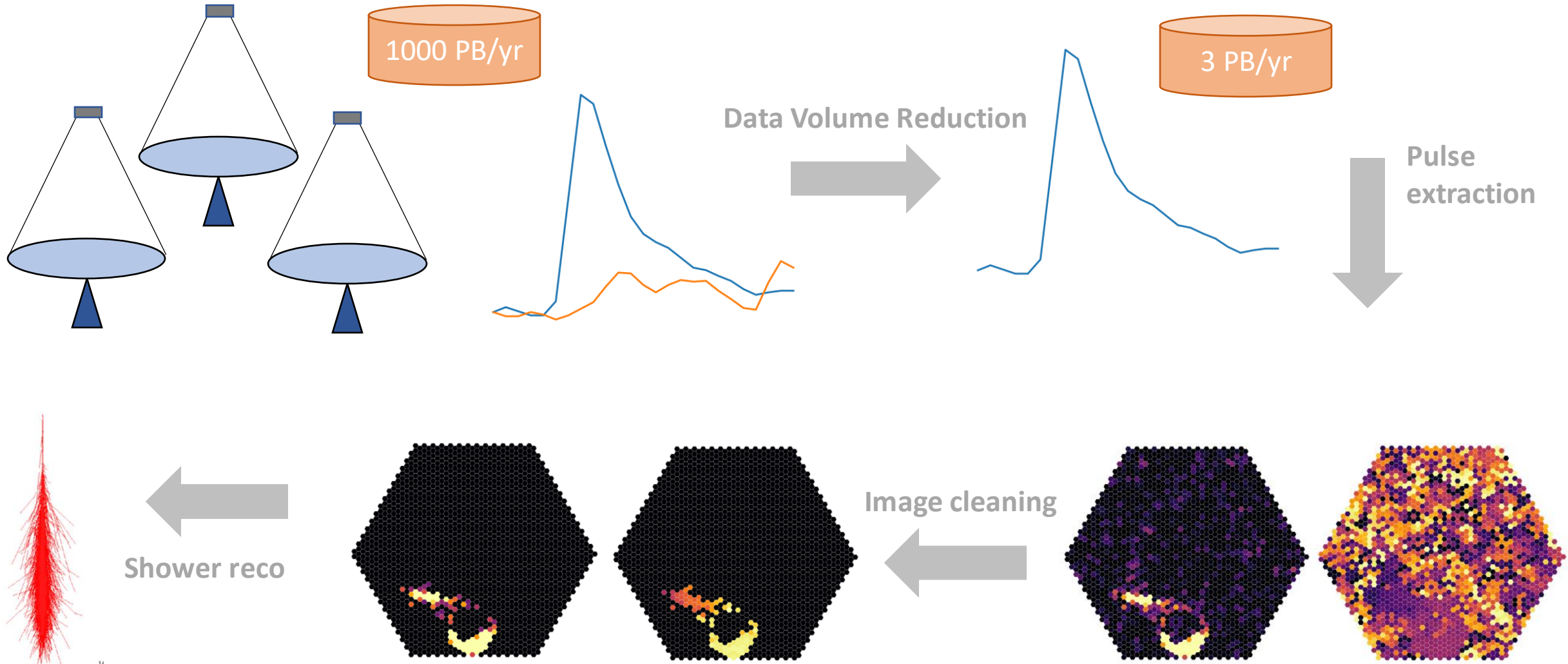
CTA Data Chain



CTA Data Chain



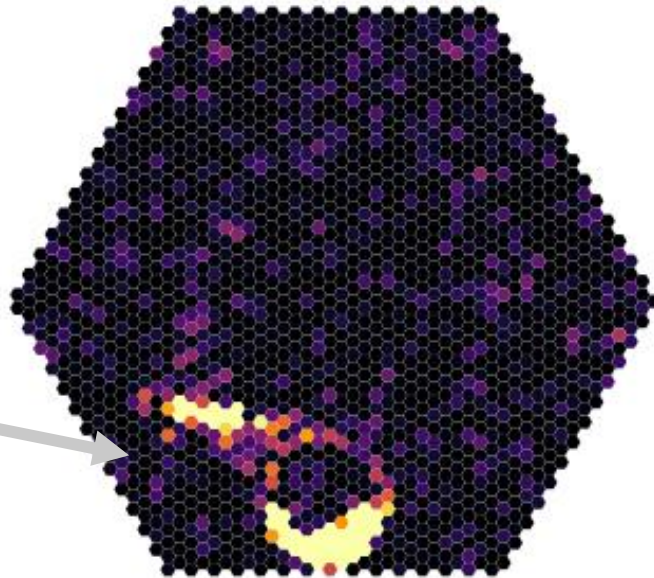
CTA Data Chain



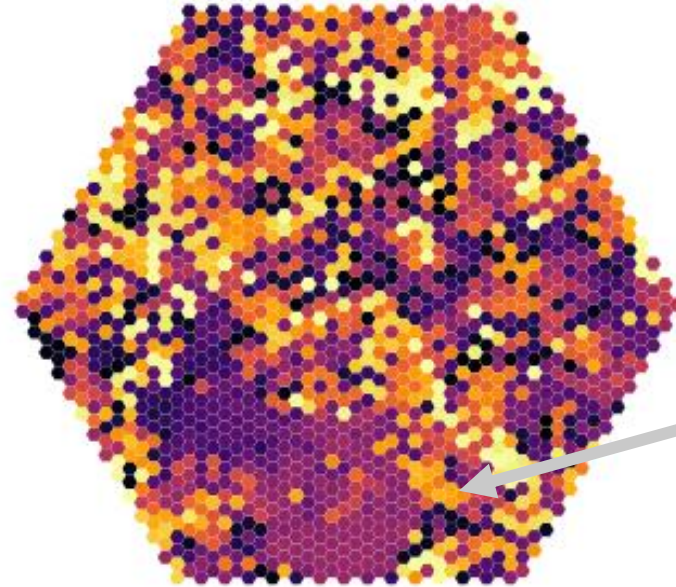
Time clustering

- Algorithms do not exploit time information
- Charge and time distributions give hints on the location of the signal
- DVR: Good in detecting signal, fast, large DVR factors

High significant
pixels

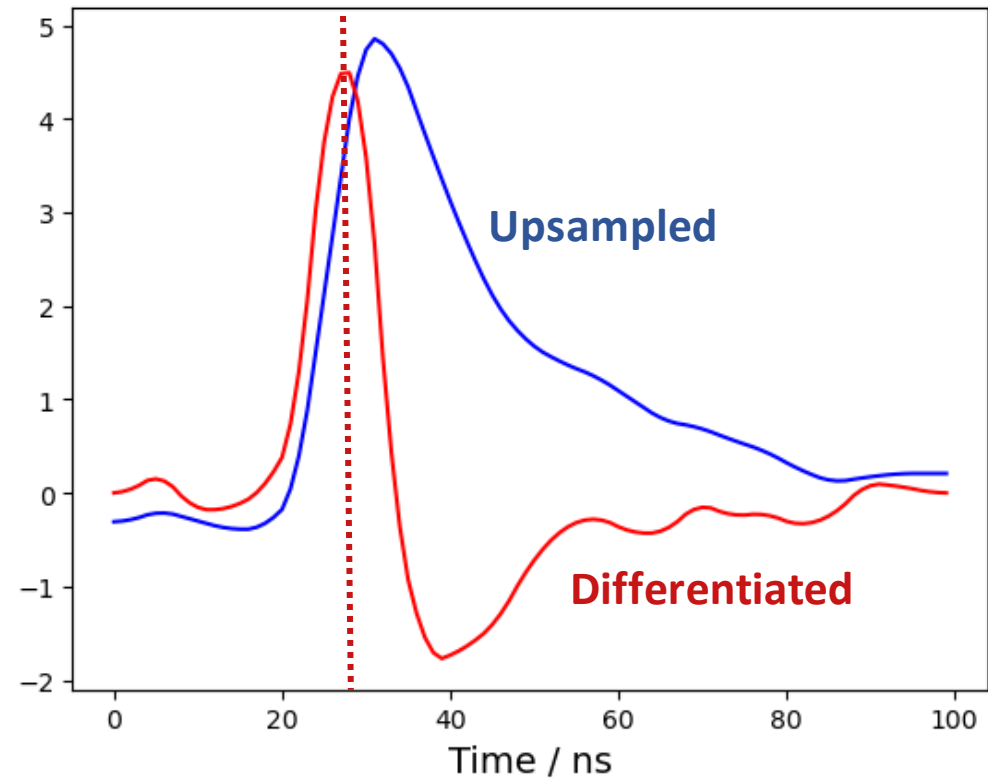
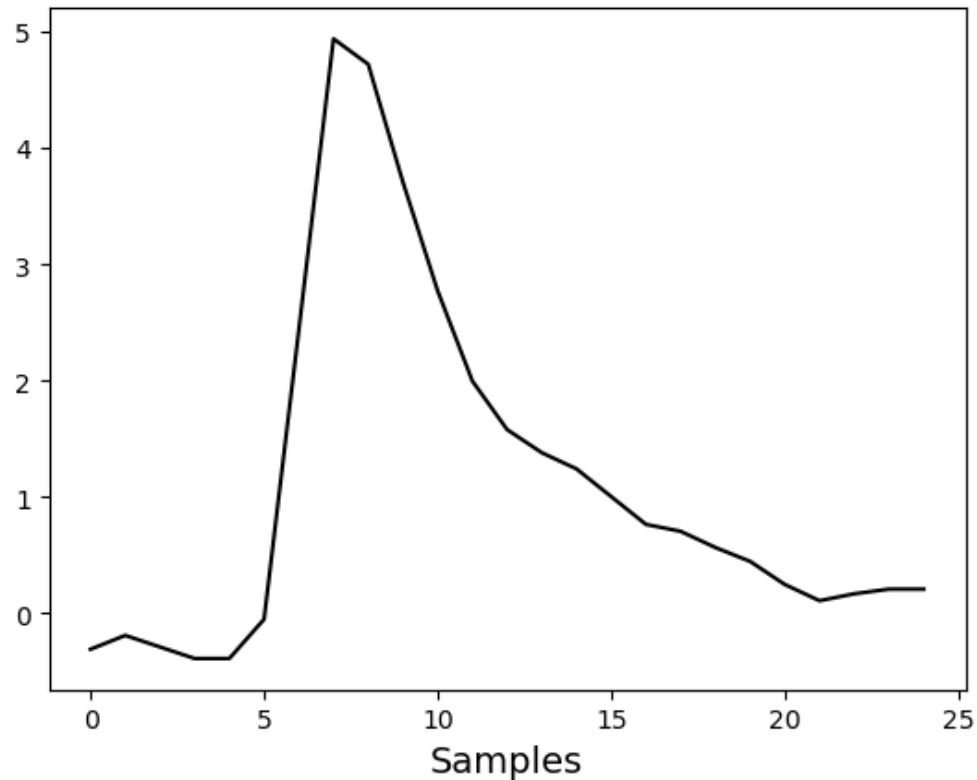


Similar arrival
times



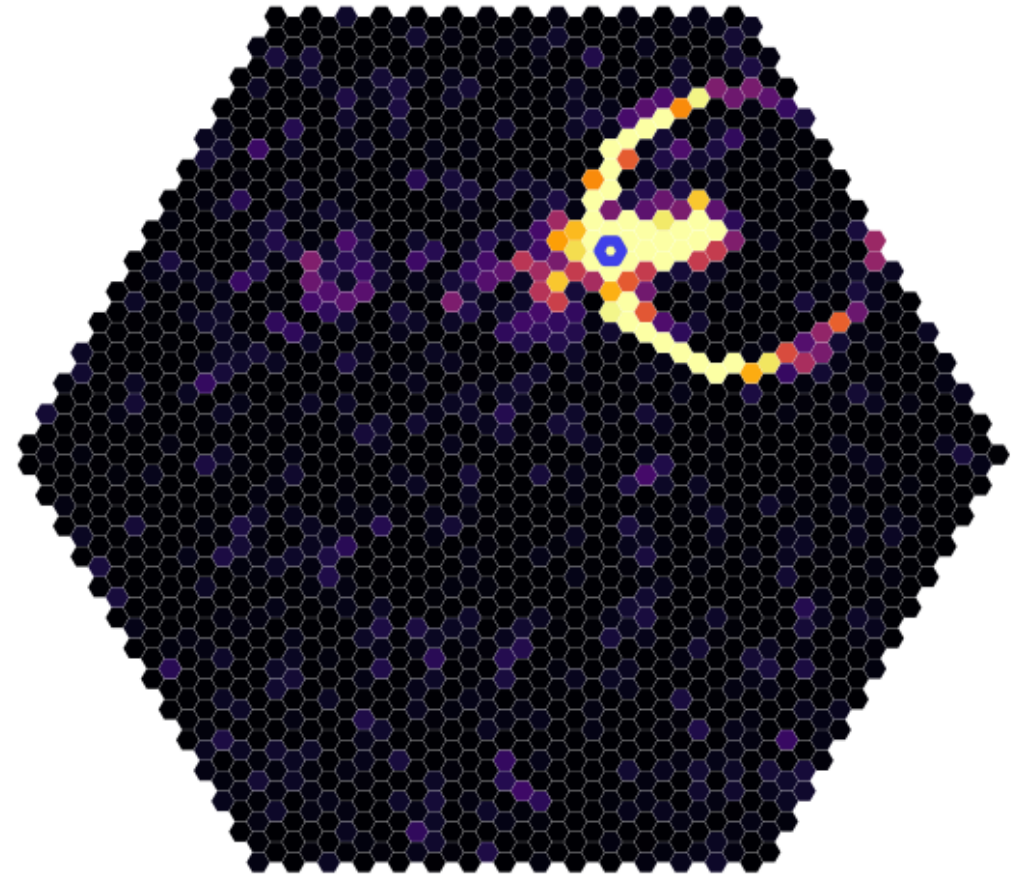
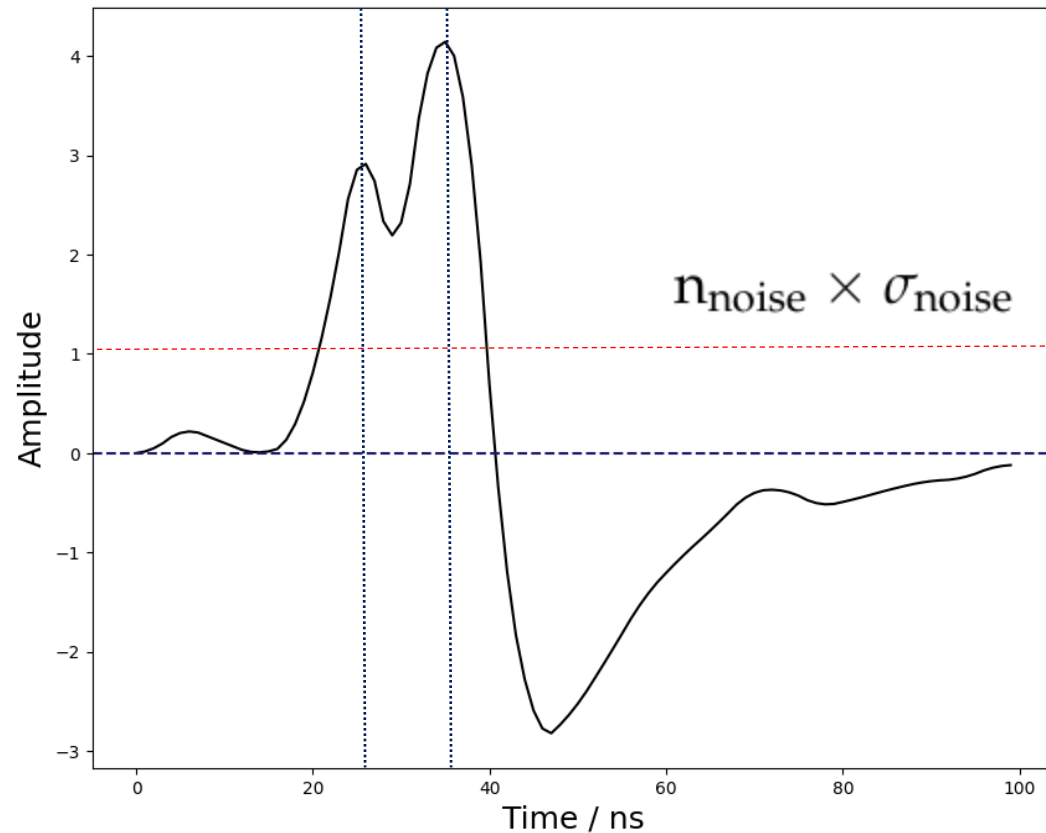
Time extraction

Our electronics introduce a long exponential tail to the pulses. Sampling rates of 250 MHz



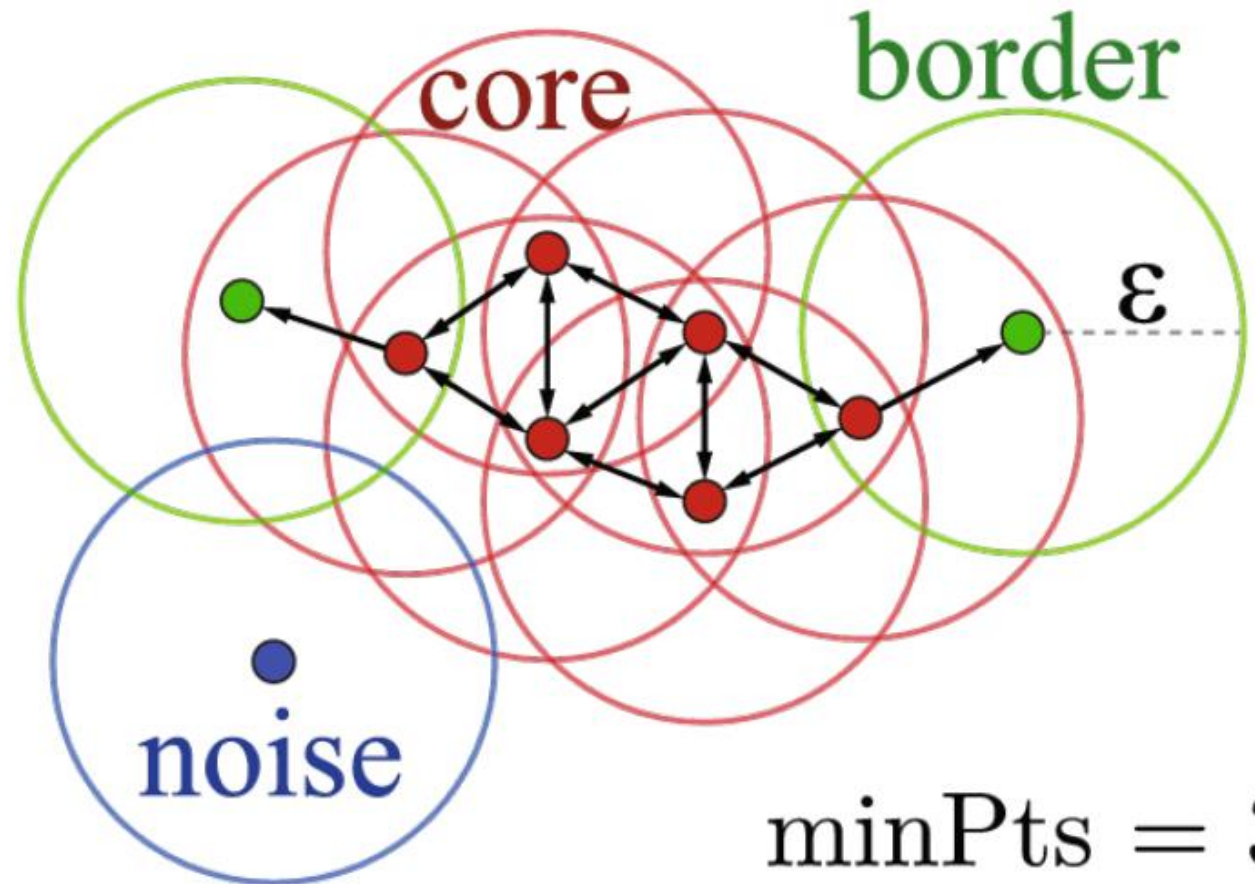
Multi-time finder

- **Input:** Times and pixel positions



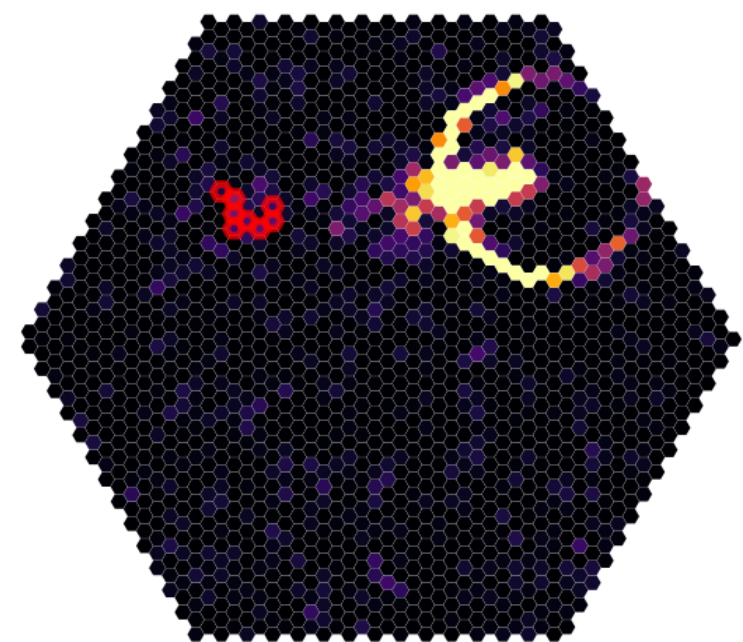
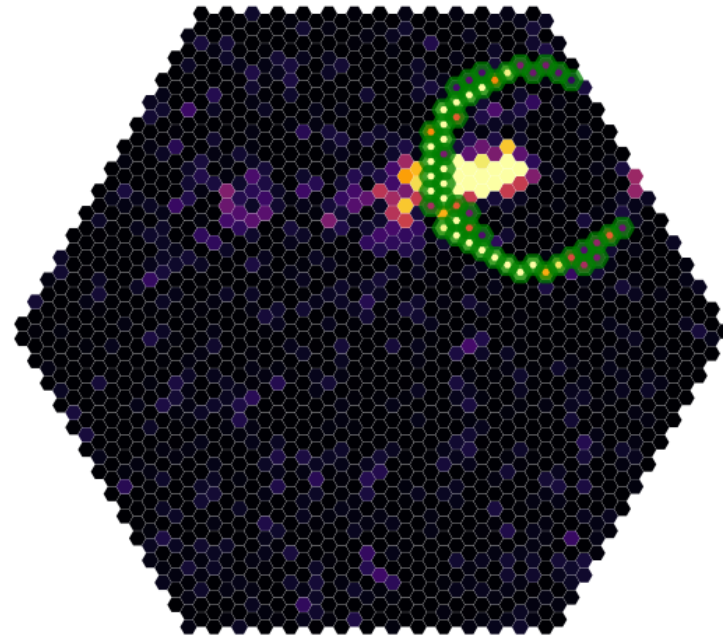
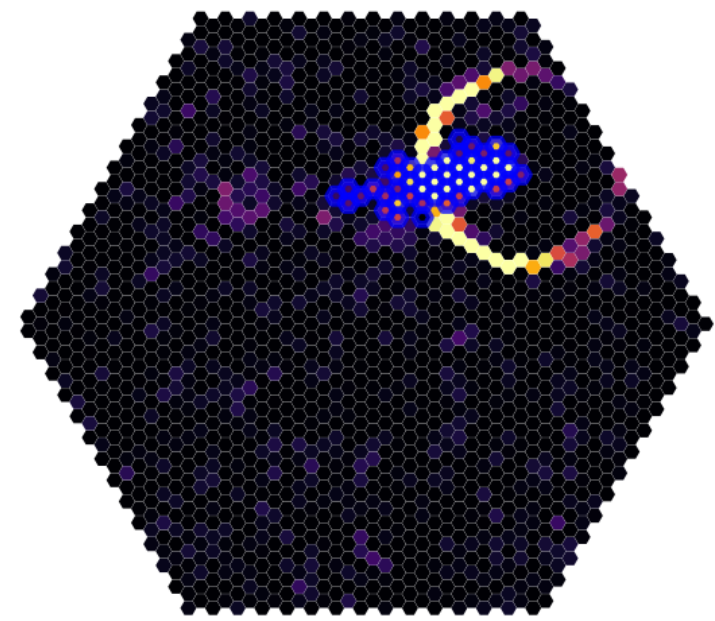
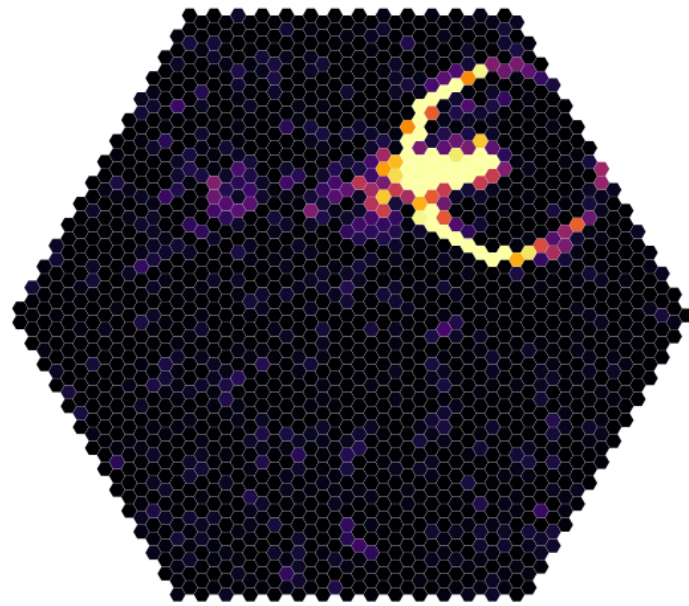
Clustering: DBSCAN

- **Core points:** at least minPts within epsilon
 - **Border points:** within epsilon of a core point
 - **Noise**
-
- Do not need to specify the number of clusters
 - Not all points belong to a cluster: Noise.



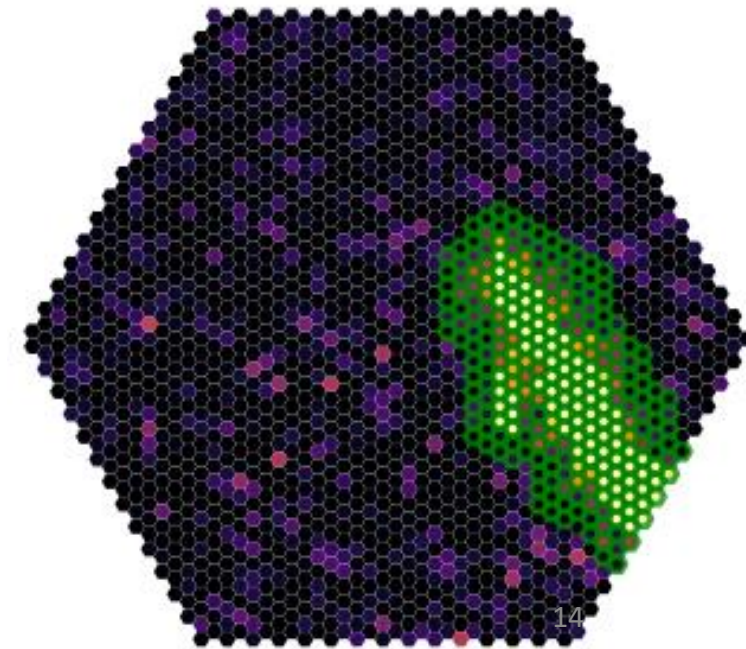
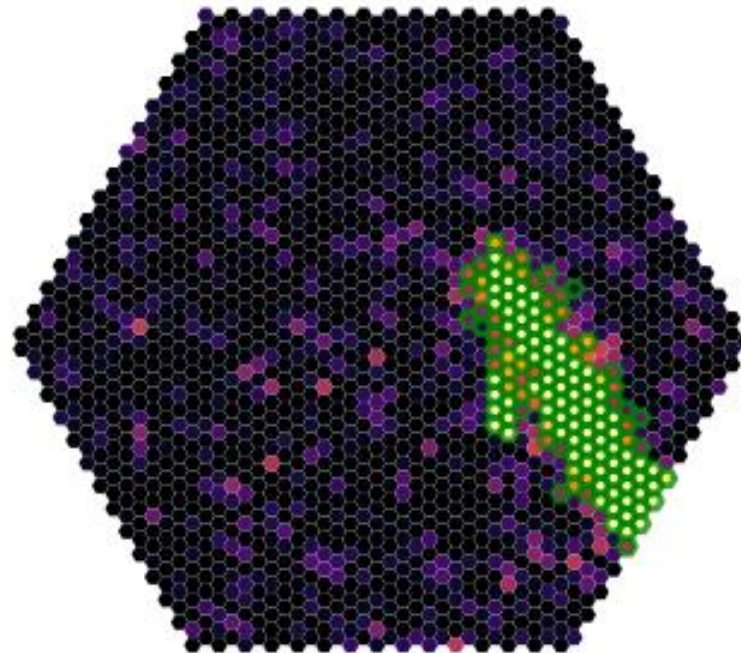
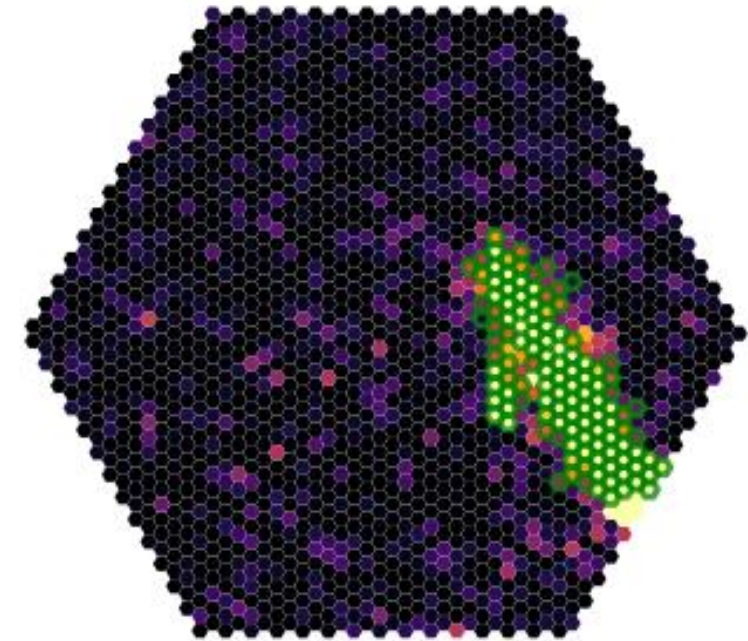
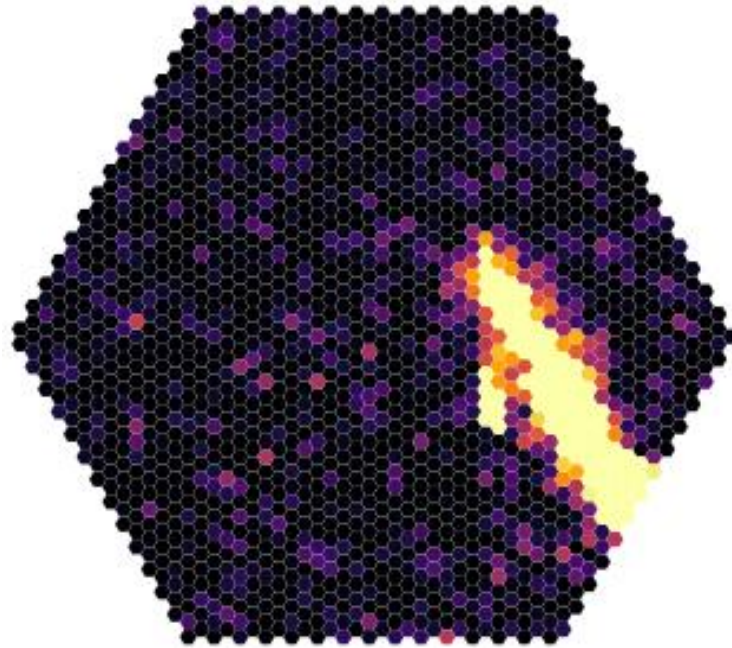
Free parameters:
minPts, epsilon

Cluster IDs



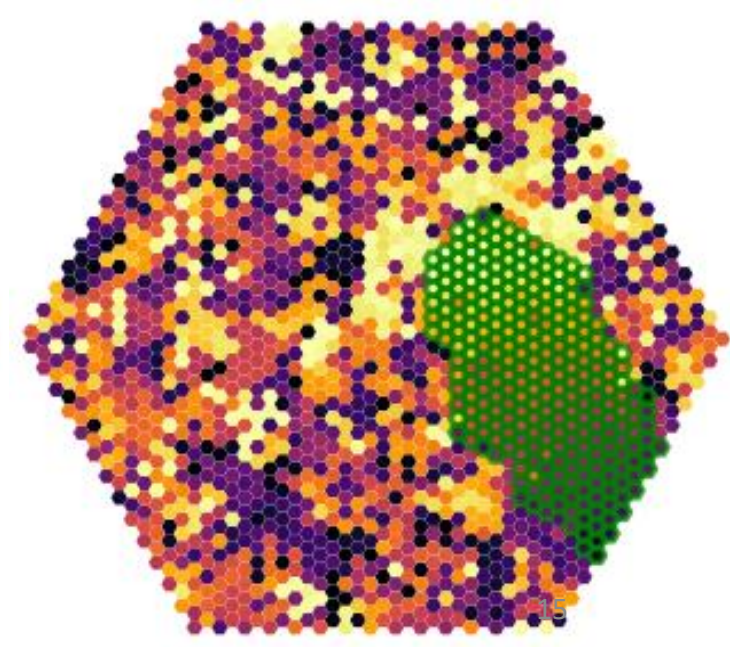
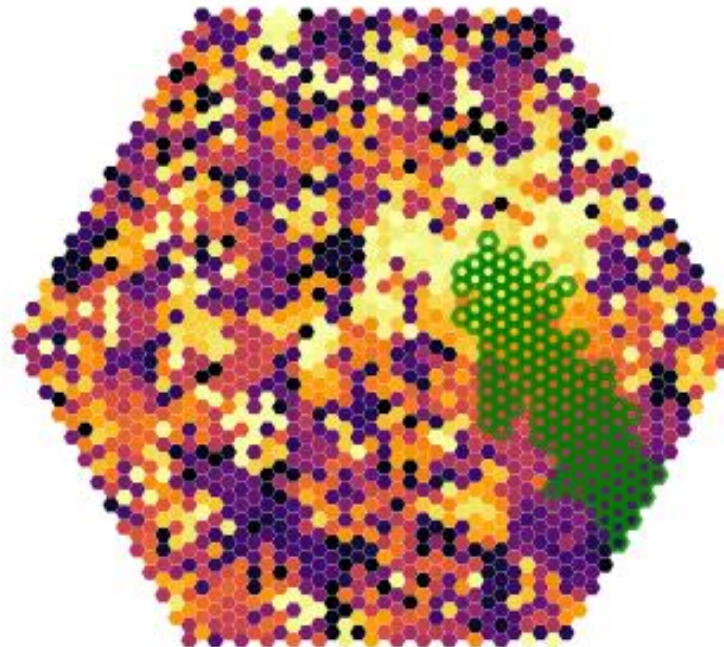
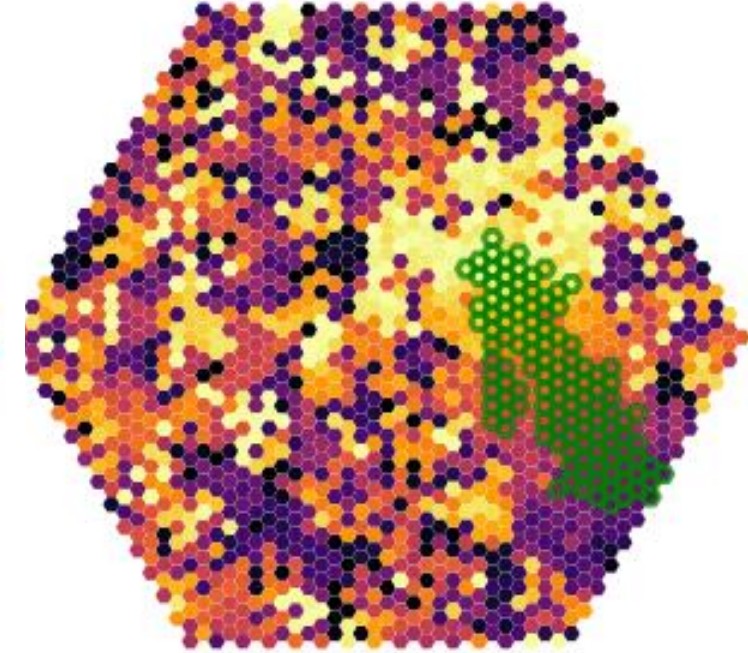
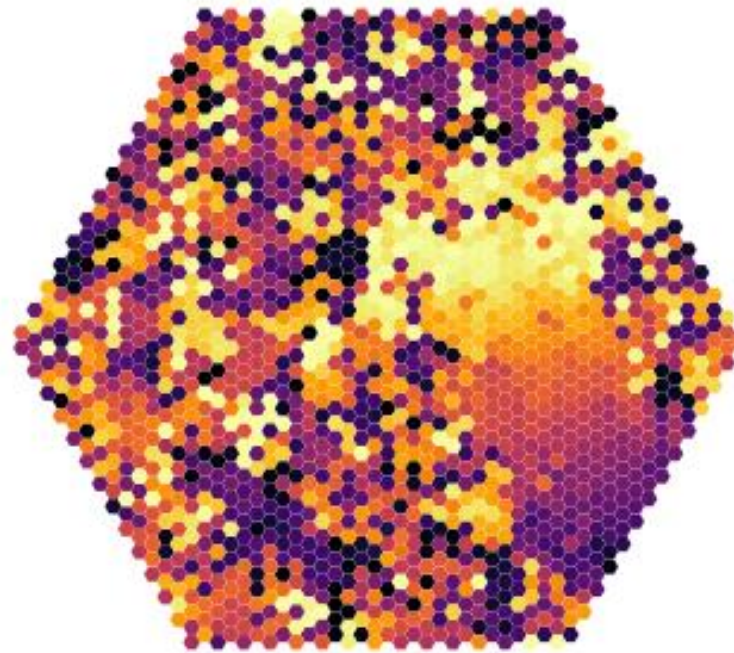
High SNR pixels

- SNR is only used, so far, in the initial cut
- Iteratively add high significant pixels
- Add two rows of pixels around cleaned image



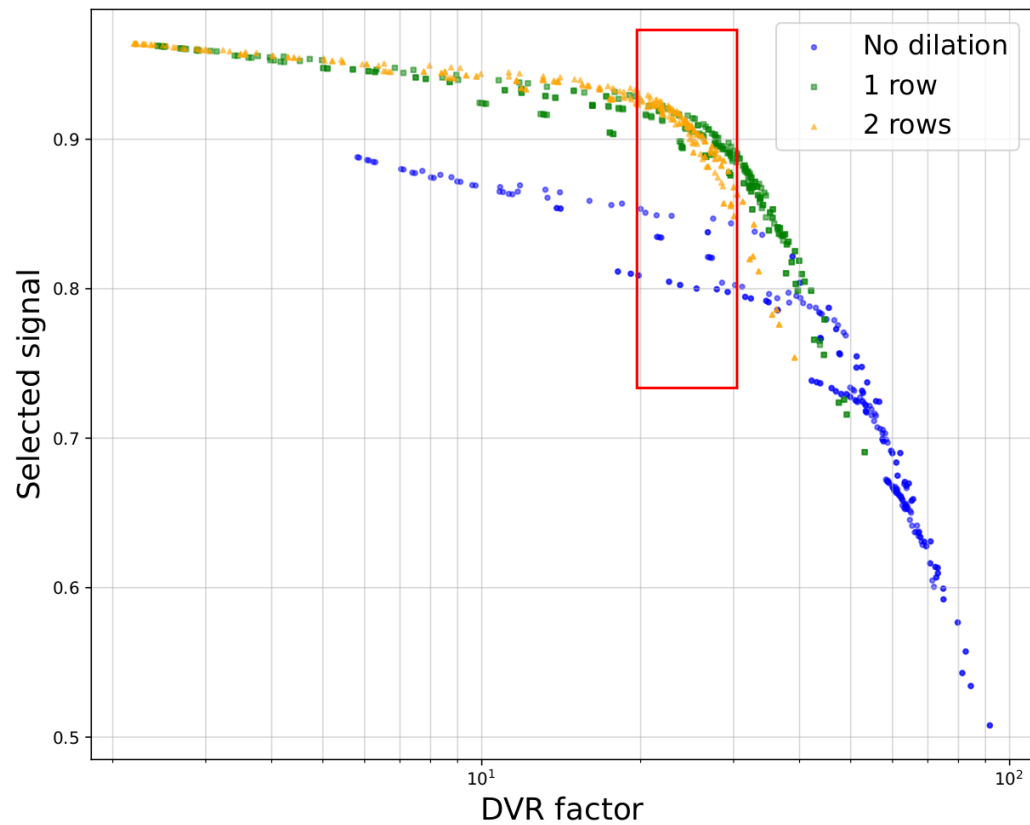
High SNR pixels

- SNR is only used, so far, in the initial cut
- Iteratively add high significant pixels
- Add two rows of pixels around cleaned image

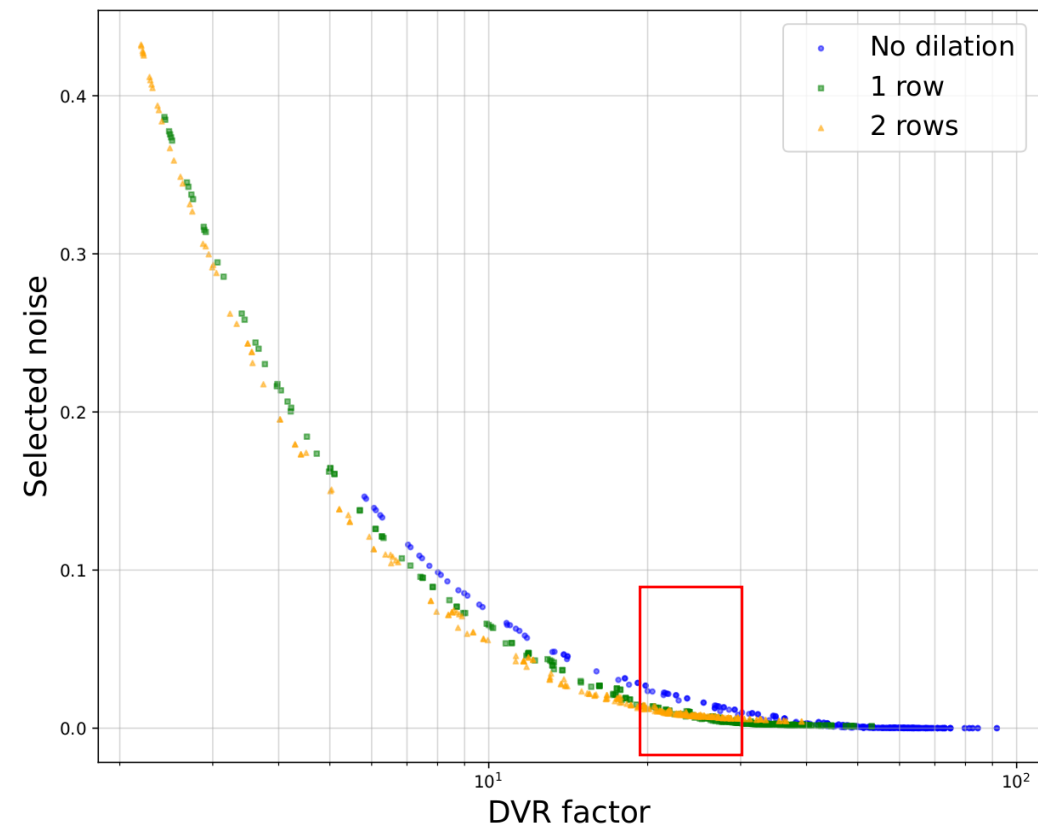


DVR factor

Fraction of signal pixels selected



Fraction of noise pixels selected



Conclusions

- DVR is crucial for the good functioning of the CTA observatory.
- The clustering algorithm fulfills the storage requirements, tested for MSTs in the South.
- More tests with other telescopes will be performed.
- The algorithm is nearly independent on the calibration parameters.
- Clusters are better identified with this algorithm, which could be exploited for gh separation.