DarkSide-20k

DAQ emulation and Event Data Model

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DS-20k simplified DAQ
From raw waveforms to disk

Time-over-threshold segments (ZLE)

Channel

64 channels {

Channel

Channel

Channel

Channel

Channel

Channel

Channel

Channel

Digitizer

Digitizer

Digitizer

Digitizer

Filtering + Hit Finder

Front-End Processor

Front-End Processor

Network data switch

‣ **Time slice on-disk writing**
‣ **Online pulse finding**
‣ **SN trigger**
‣ **Online reconstruction**

Time Slice Processors

Time Slice Processors

Time Slice Processors
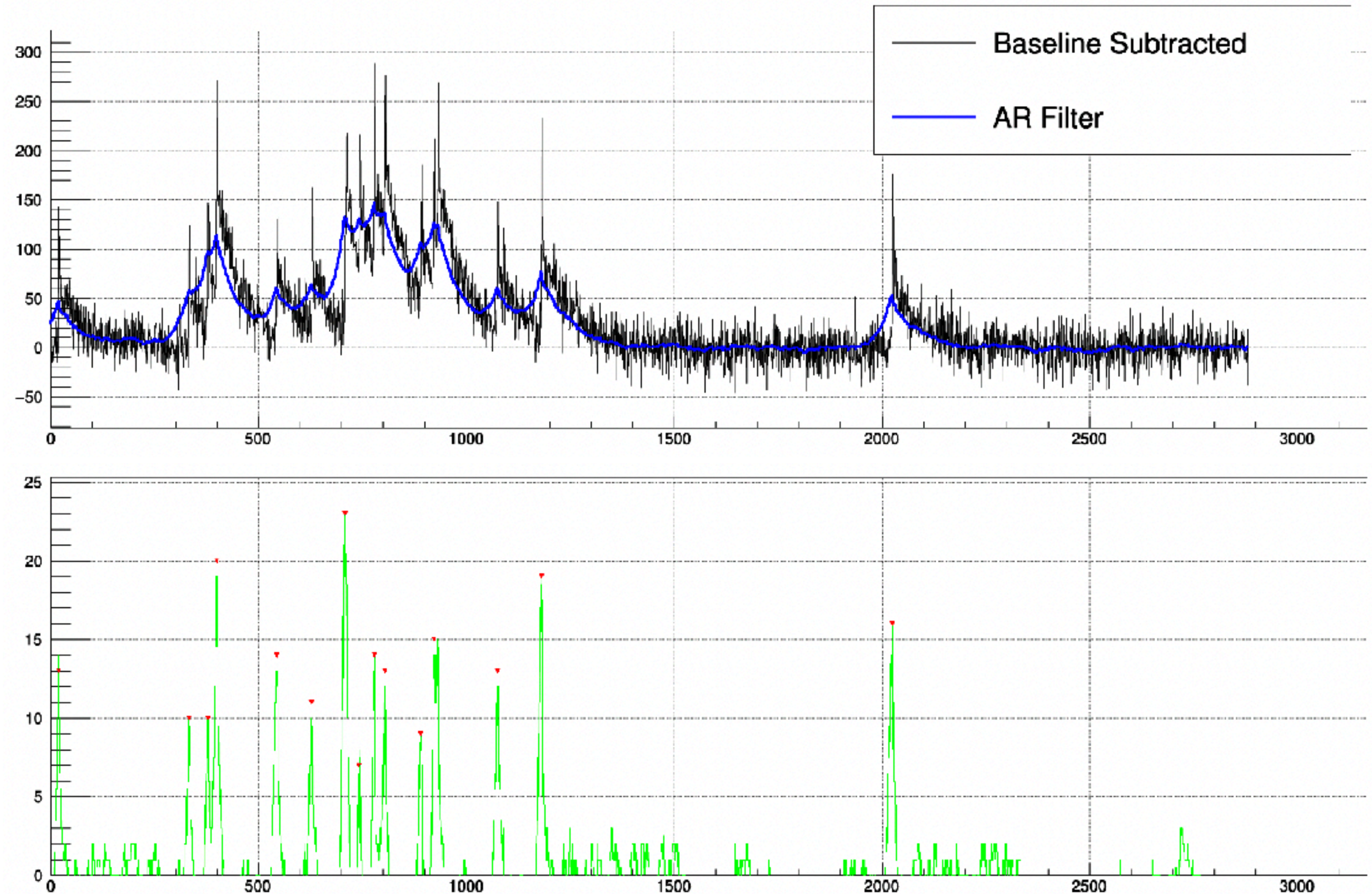
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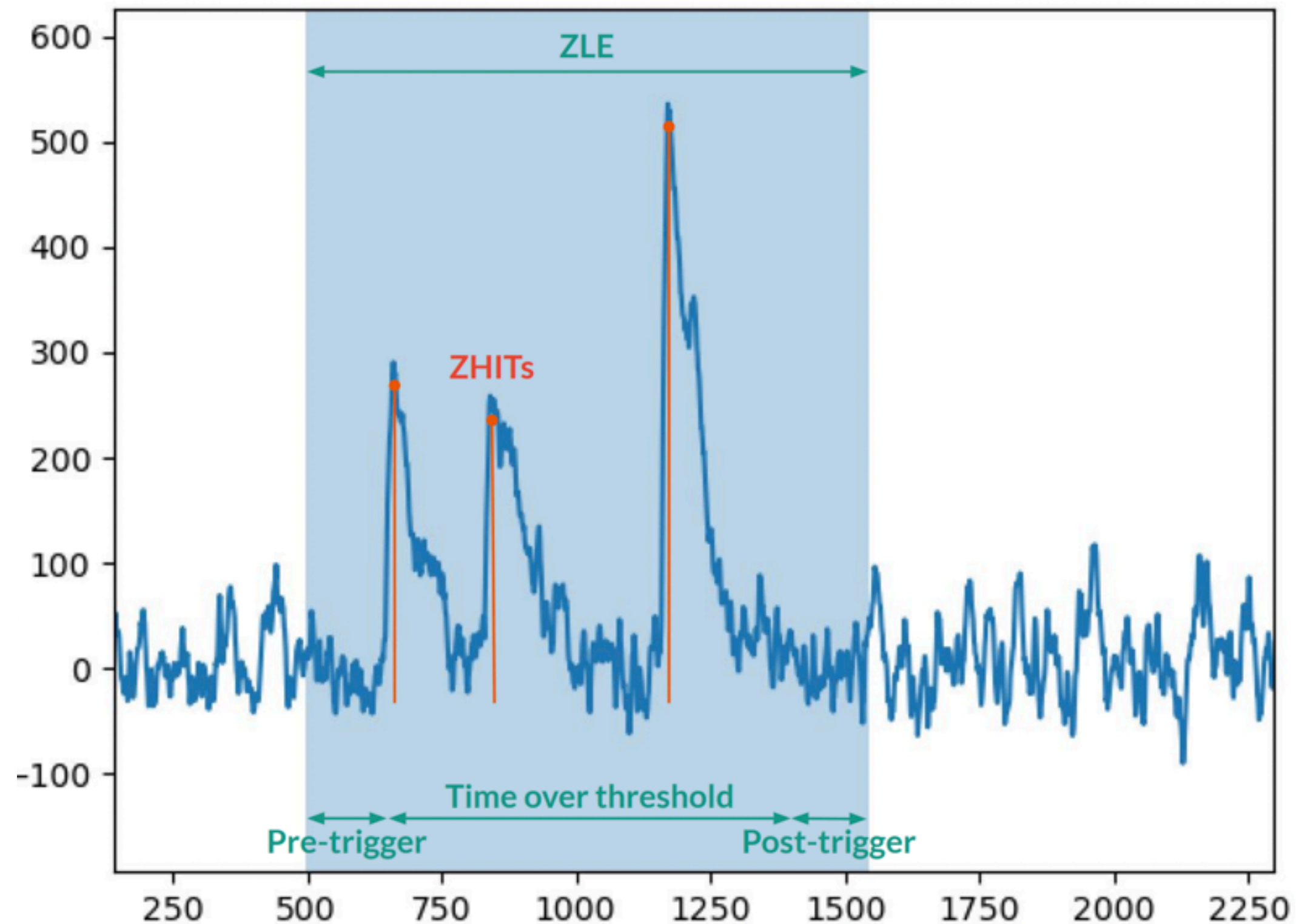# Matched filtering hit finder

Applied online on waveforms segment

▸ **Above threshold waveform** (ZLE) of every channel are transmitted **from the digitizer to the front-end processor** (FEP).

▸ FEP apply **filtering and hit finder online** and transmit to hits and the ZLE informations.

DAQ emulation
ZLES and ZHITs

- ▸ **ZLE**: **Time-over-threshold region** (0.5 PE during at least 18 samples) at the channel level identified by the digitizer.

- ▸ **ZHIT**: Hit found within ZLE.

ZLE information stored
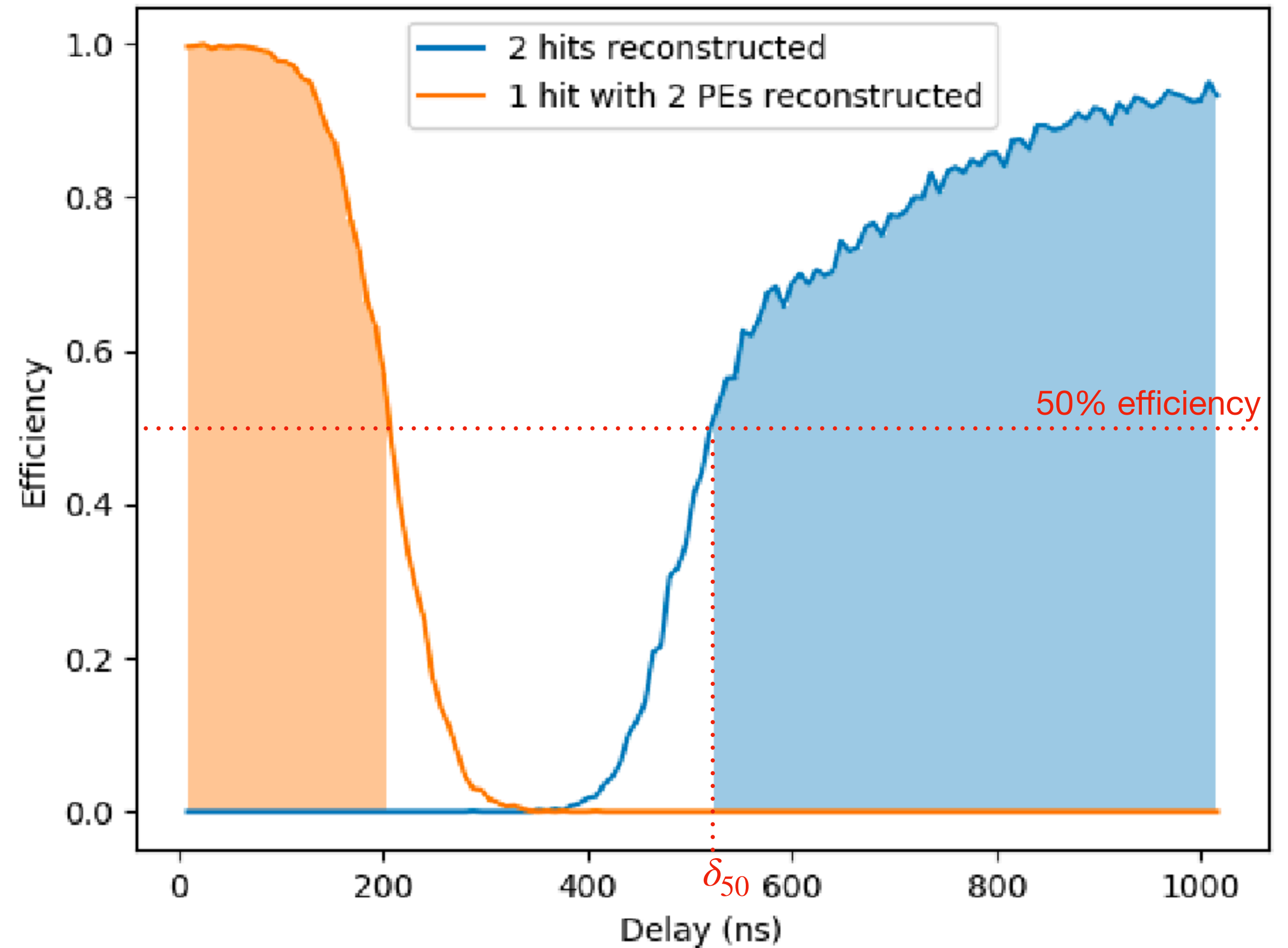Start time
Integral
Length
Number of hits

ZHIT information stored
Sample (wrt ZLE start)
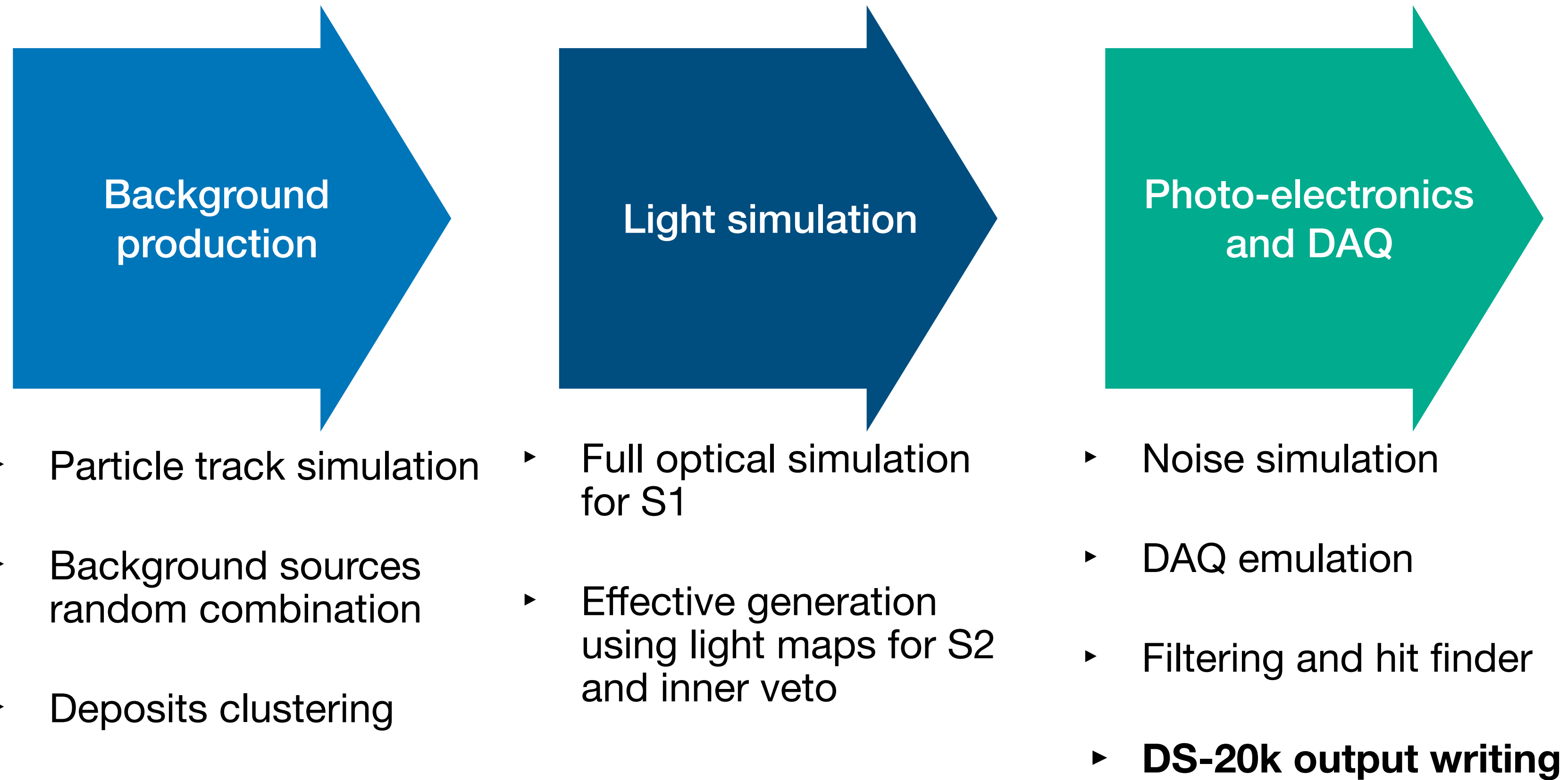Prominence

Hit finder performance
Optimised for low occupancy

Single Hit Efficiency	0.9969 ± 0.0004
Fake Hit Rate (Hz)	<4.6 (90% CL)
δ_{50} (ns)	520

Full simulation chain
Event Data Model validation

Background production → **Light simulation** → **Photo-electronics and DAQ**

- ‣ Particle track simulation
- ‣ Background sources random combination
- ‣ Deposits clustering

- ‣ Full optical simulation for S1
- ‣ Effective generation using light maps for S2 and inner veto

- ‣ Noise simulation
- ‣ DAQ emulation
- ‣ Filtering and hit finder
- ‣ **DS-20k output writing**

Transfer rate
And requirements

Digitizer transfer rate (64 channels) - μ = 40 MB/s

- ► **100 ms rolling mean**
- ► **1 s rolling mean**

μ = 64 MB/s

Dark count rate increased by a factor 10

Data rate in 100 ms slices (μ=23.5 MB/s)

Data rate in 100 ms slices (μ=40.1 MB/s)

Dark count rate increased by a factor 10
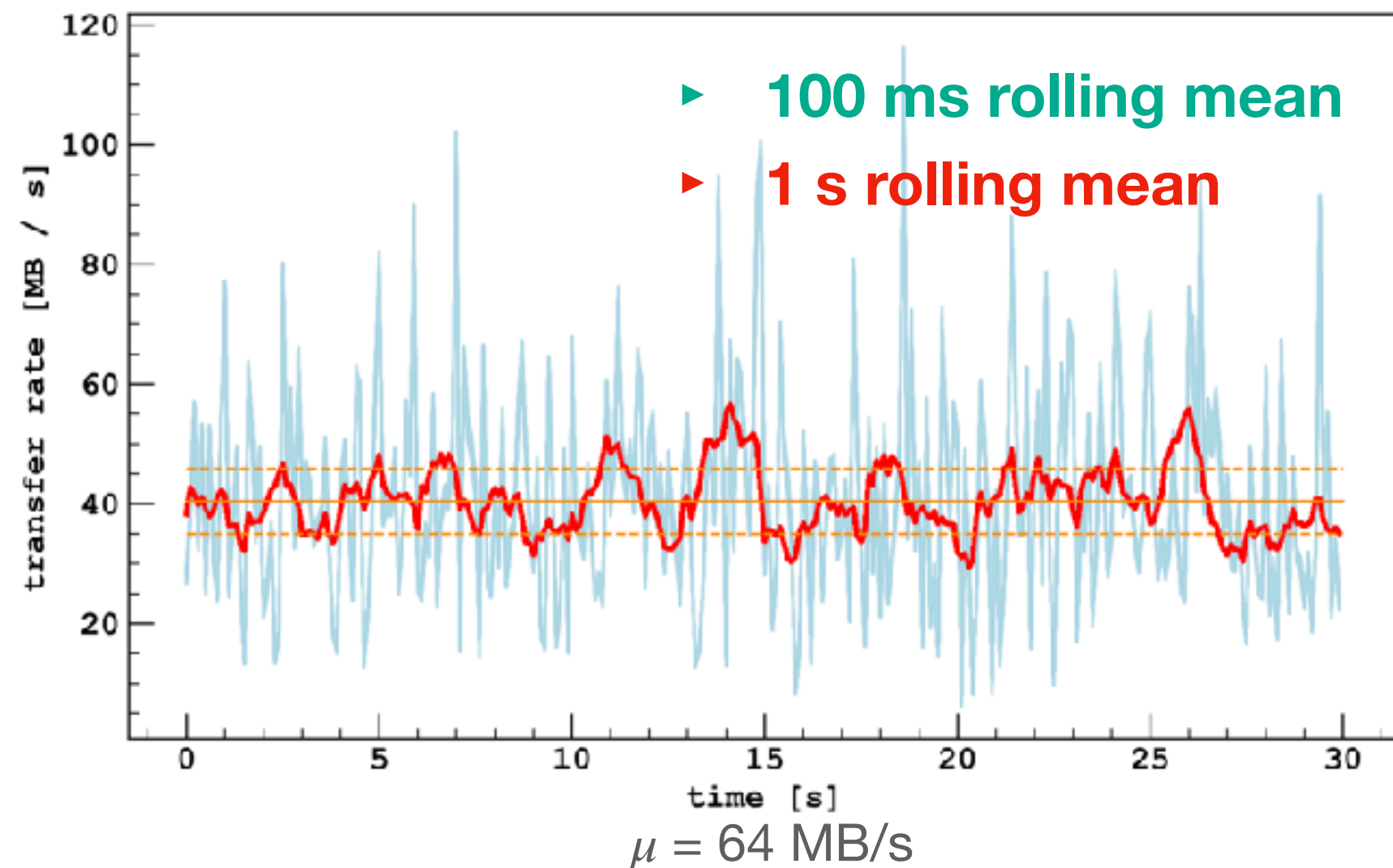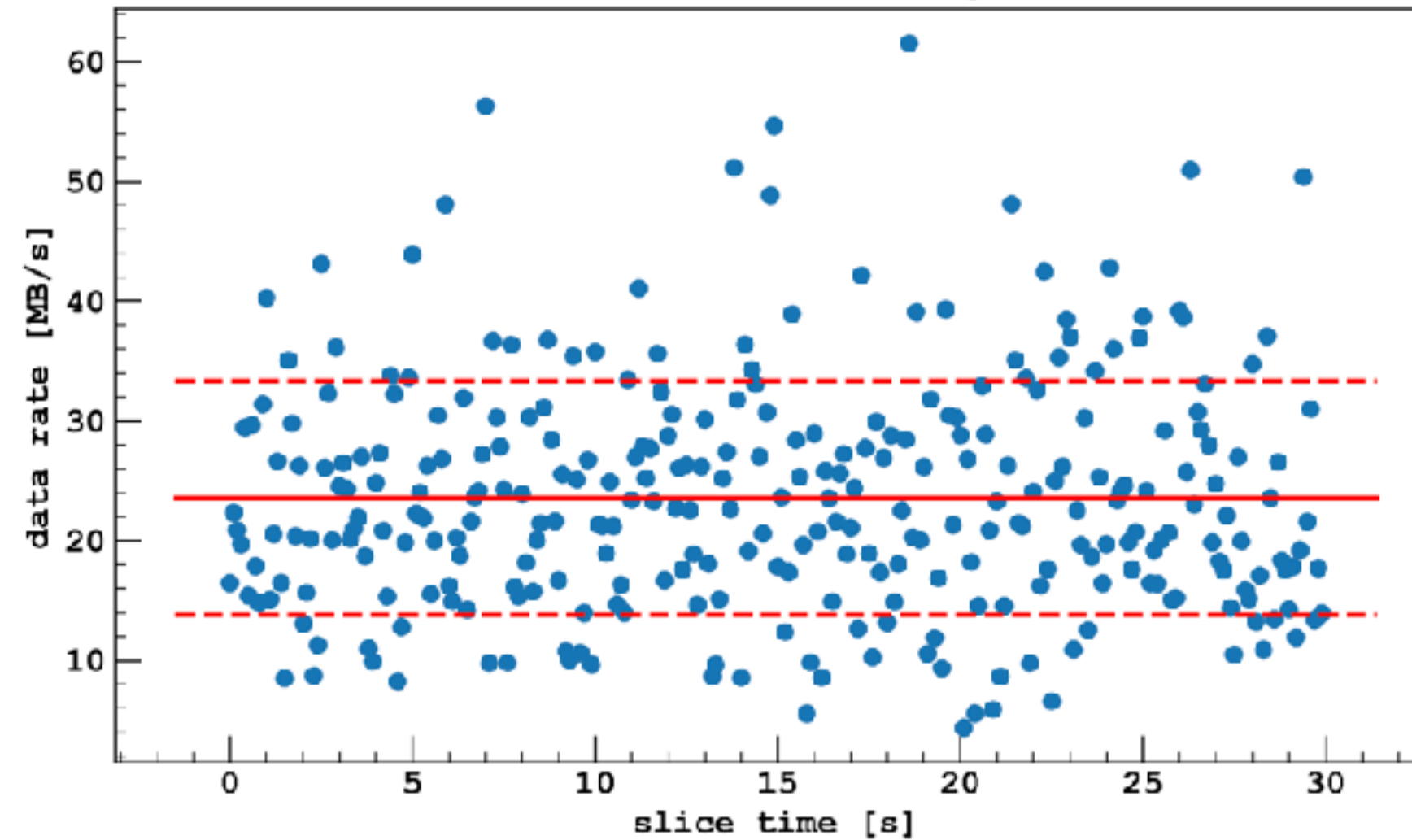
- ► Target transfer rate: **200 MB/s per FEP**

- ► Target on-disk data rate: **60 MB/s on average**

- ► **Compression can further reduce data rate by ~30%**

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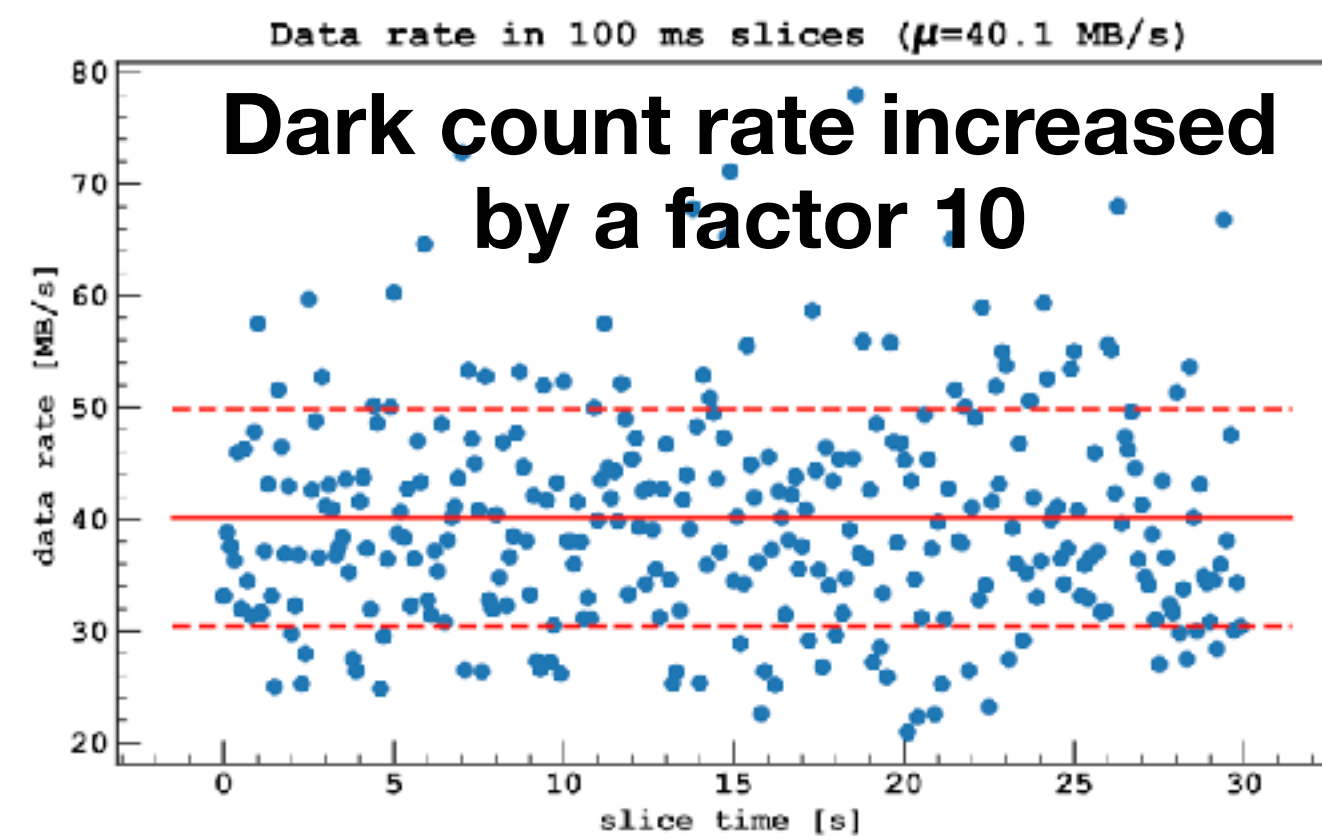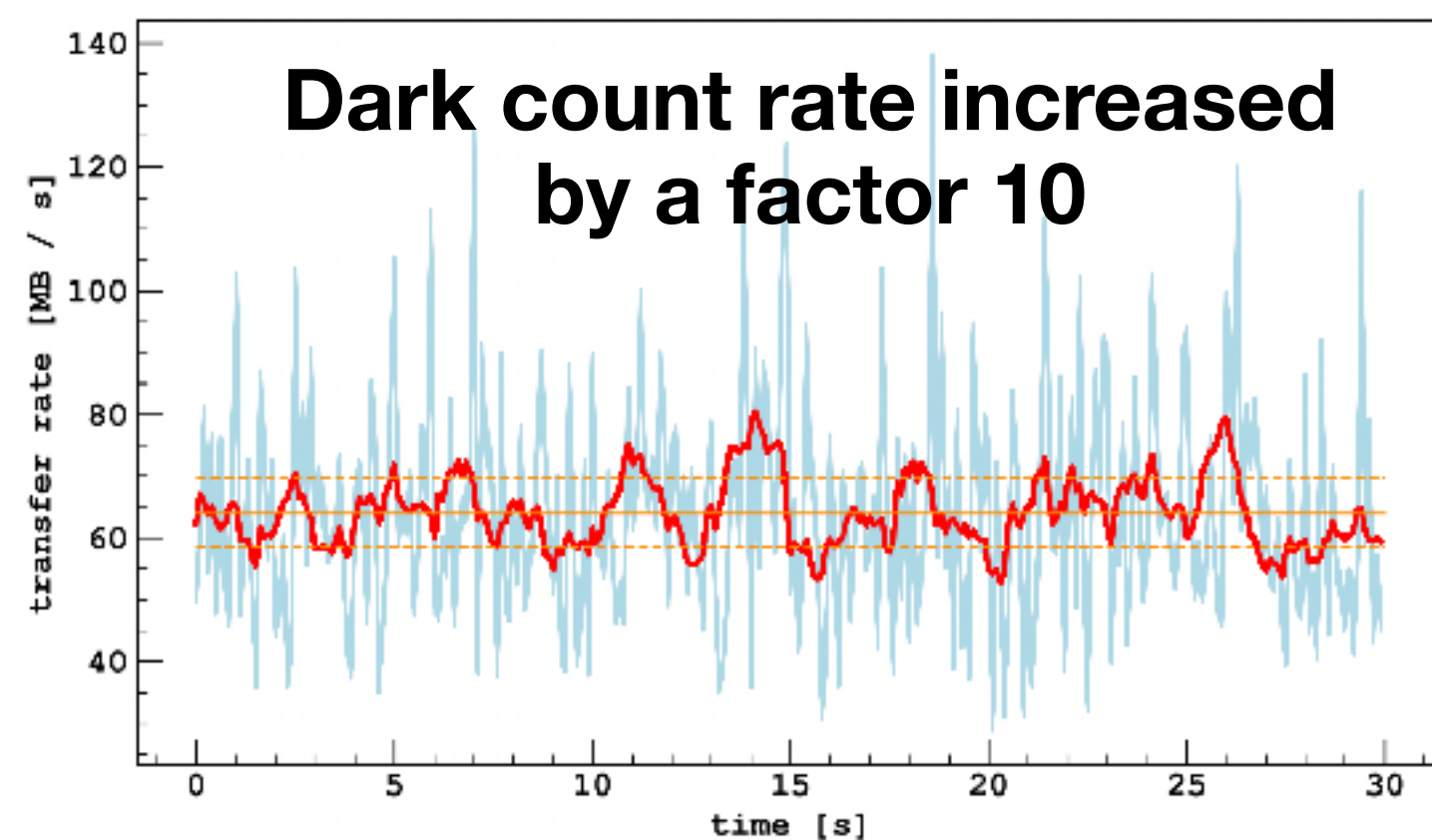
Energy reconstruction
Variable definition

▸ **Number of hits:**
Not affected by resolutions, iCT. Expect to provide best PSD performance.

Linear in low channel occupancy regime. Suffer from saturation at higher occupancy.
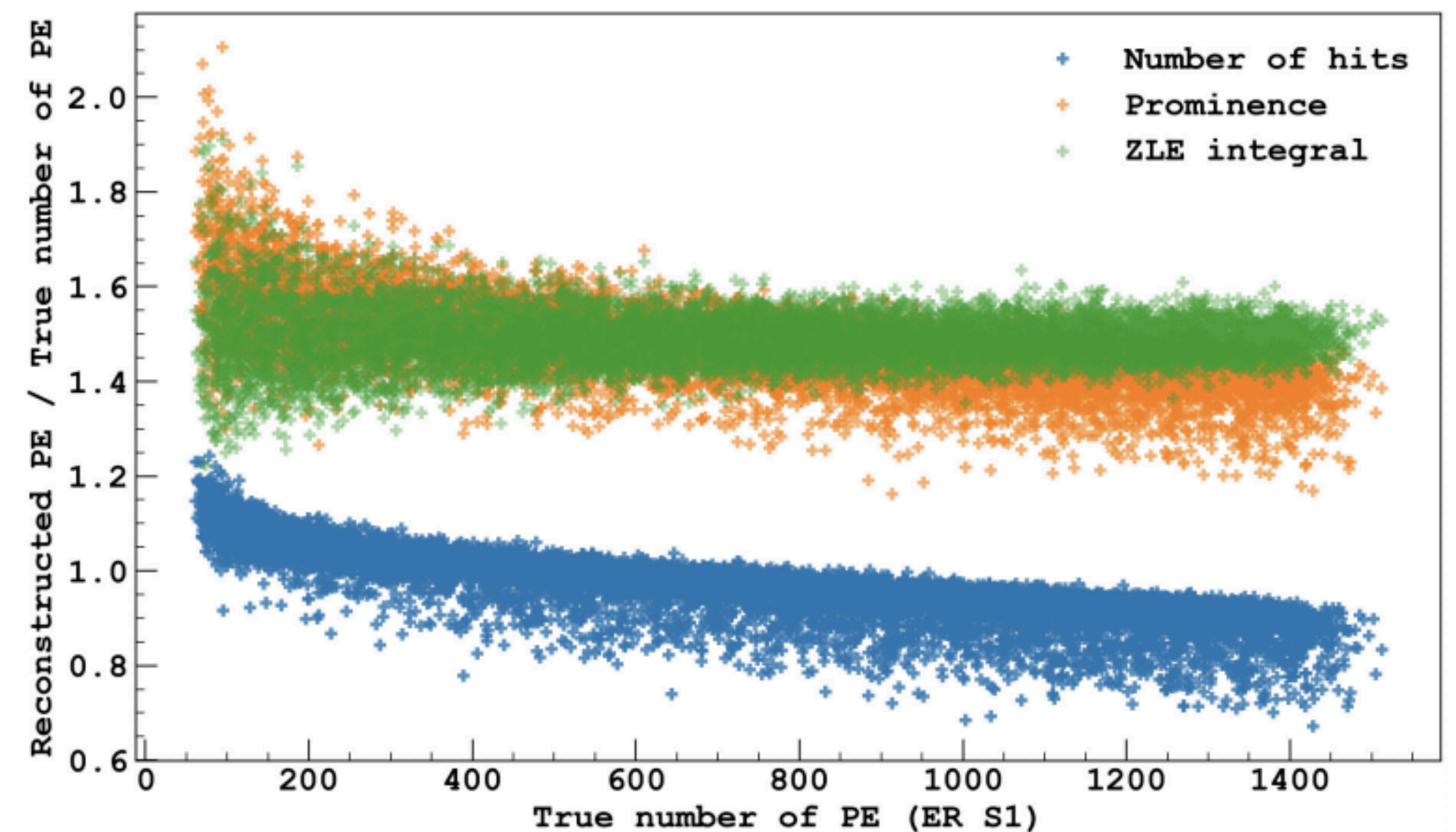
▸ **Number of hits weighted by prominence:**
Partially recovers non-linearity by considering the height of the peak. But still affected by inefficiency of the hit finder.

▸ **Sum of the ZLE charges:**
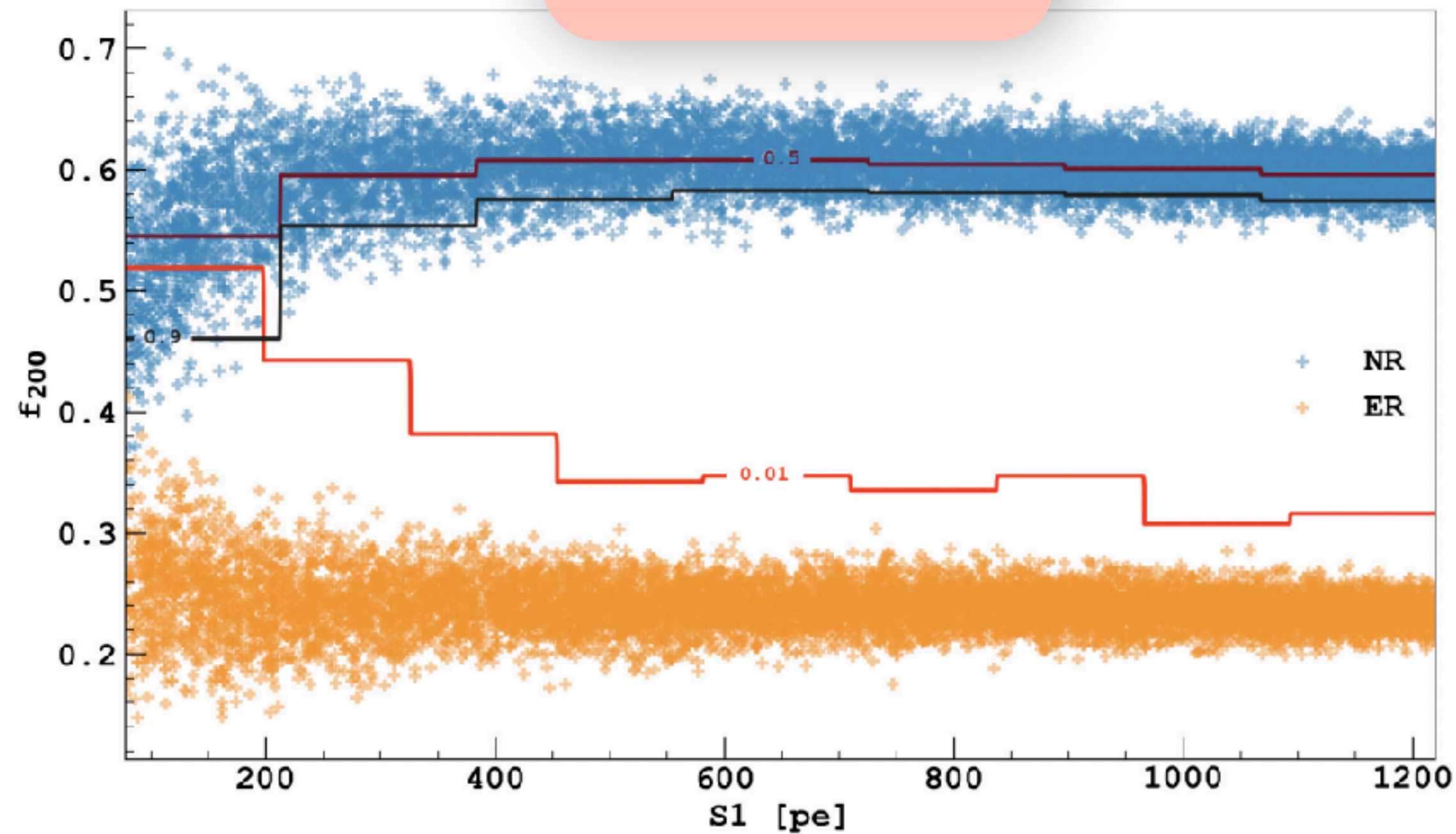Exploit high efficiency and linearity of the charge.

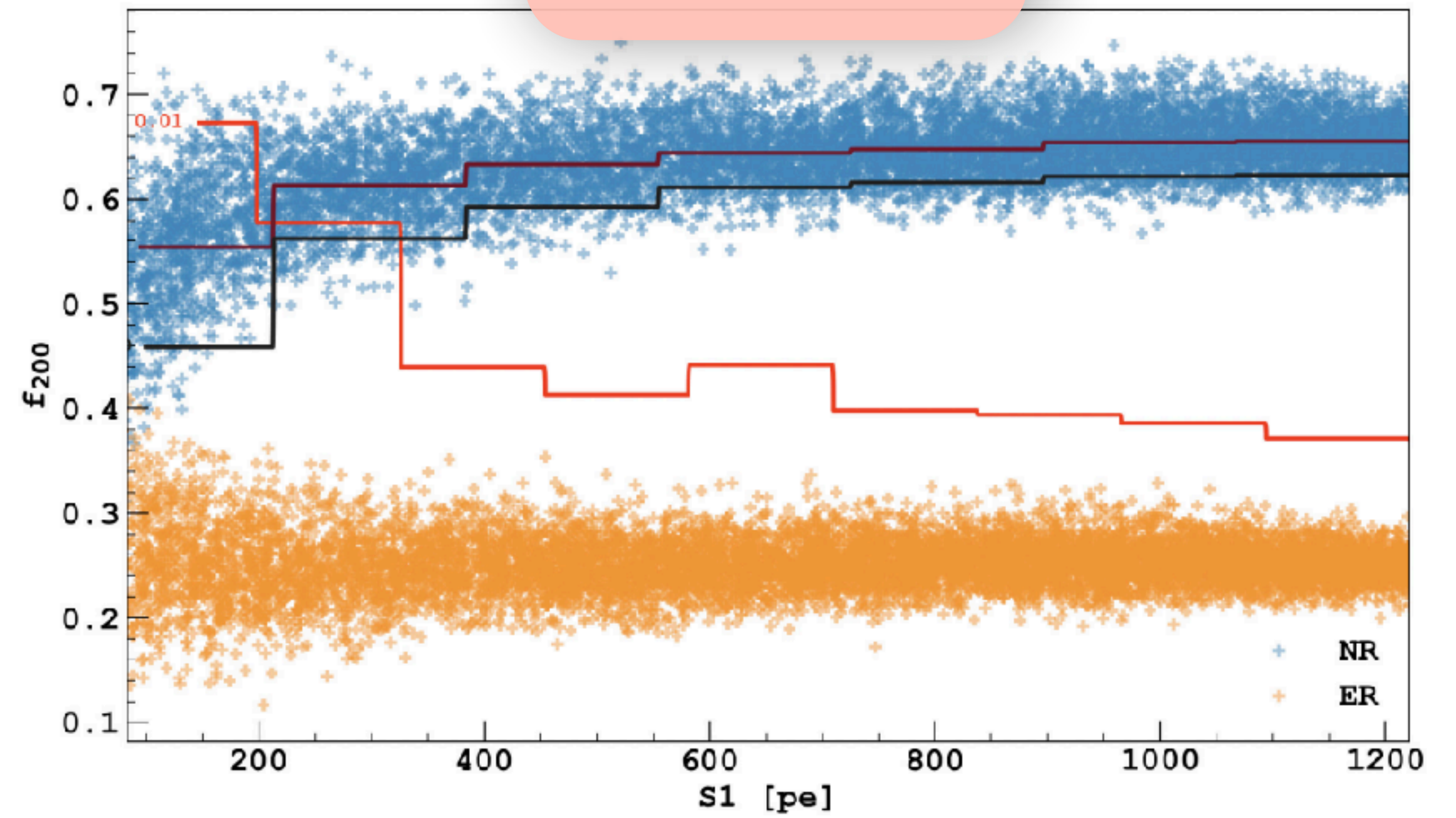Resolution affected by baseline fluctuations and correlated noise.

Pulse Shape Discrimination

Prompt fraction against S1
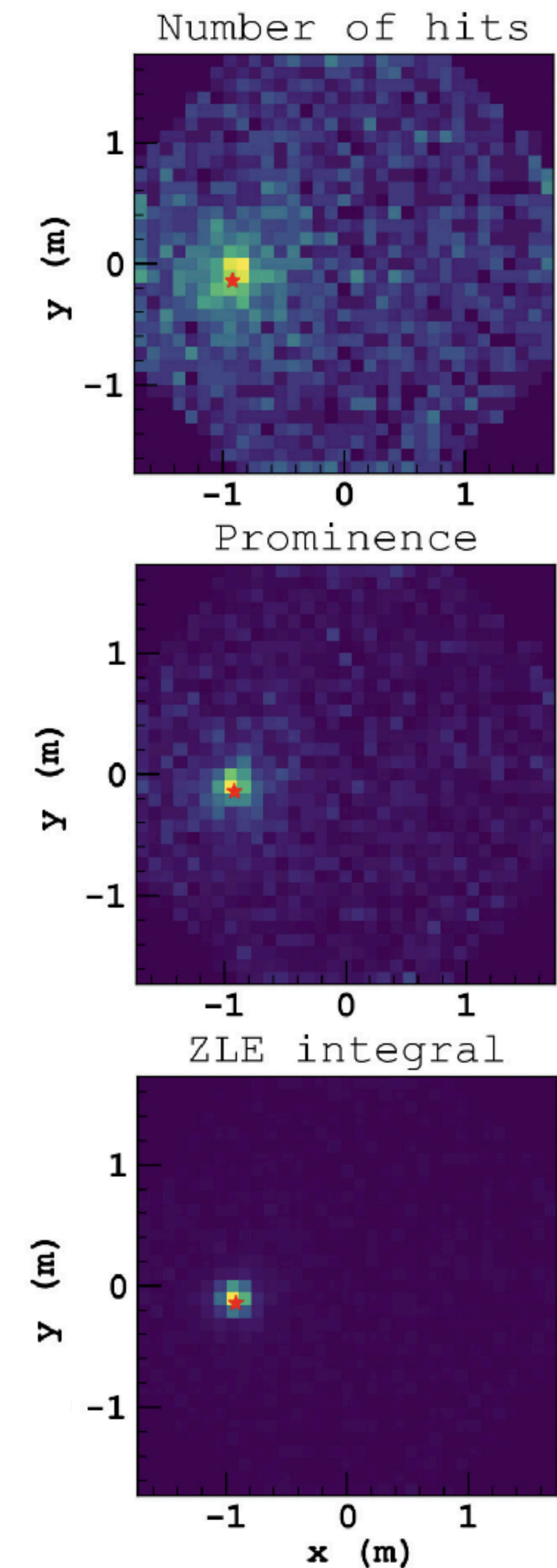

Number of hits

Prominence

‣ The ER contour corresponds to **0.1 event in ROI after full exposure**.

‣ ER/NR separation is better **without prominence weights**.
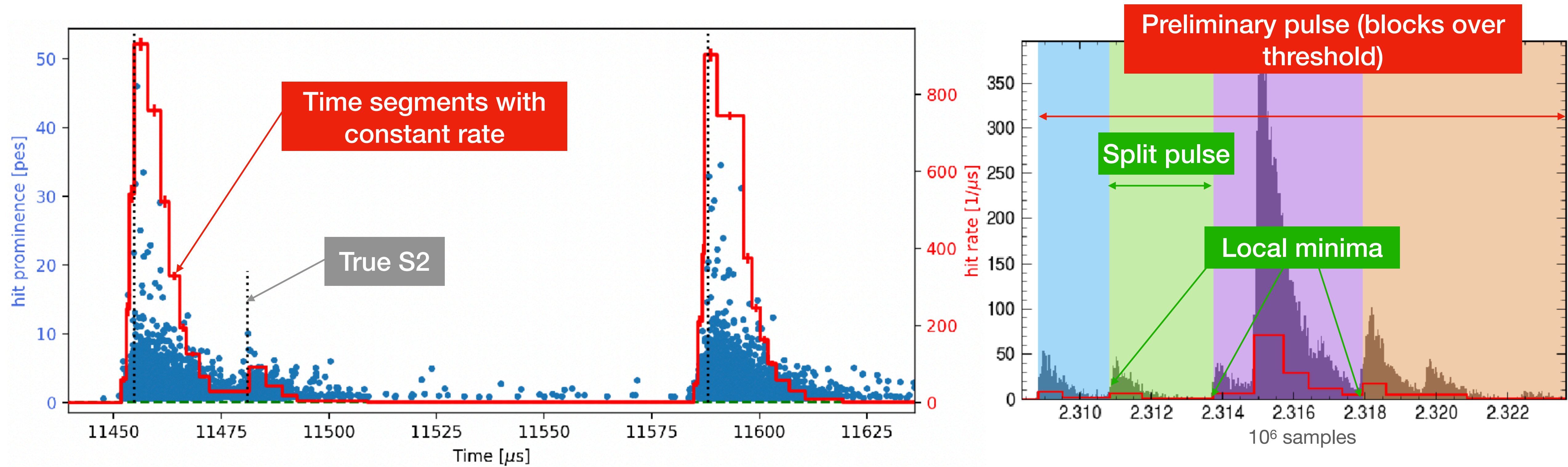
XY reconstruction
Naive algorithm for validation

1. Select the 10 ZLEs with largest charge.

2. Recover their channel position.

3. Compute the charge-weighted average of the positions.

▸ Between **2 cm and 3 cm RMS** along x- or y-axis for ERs within **10 keV and 100 keV.**

▸ In agreement with requirements for **fiducialisation.**

Pulse finder
Bayesian blocks algorithm

Time segments with constant rate

True S2

Preliminary pulse (blocks over threshold)

Split pulse

Local minima

10^6 samples

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Next steps
For reconstruction

‣ Development of a **peak finder** to identify pulses unresolved by bayesian blocks.

‣ **Pulse reconstruction**.

‣ Investigation of **digitizer buffer saturation** and the impact on reconstruction.

‣ Study of accidental WIMP-like events from random coincidence between **S1 only events and unresolved S1+S2**.

Thank you for your attention