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Luna

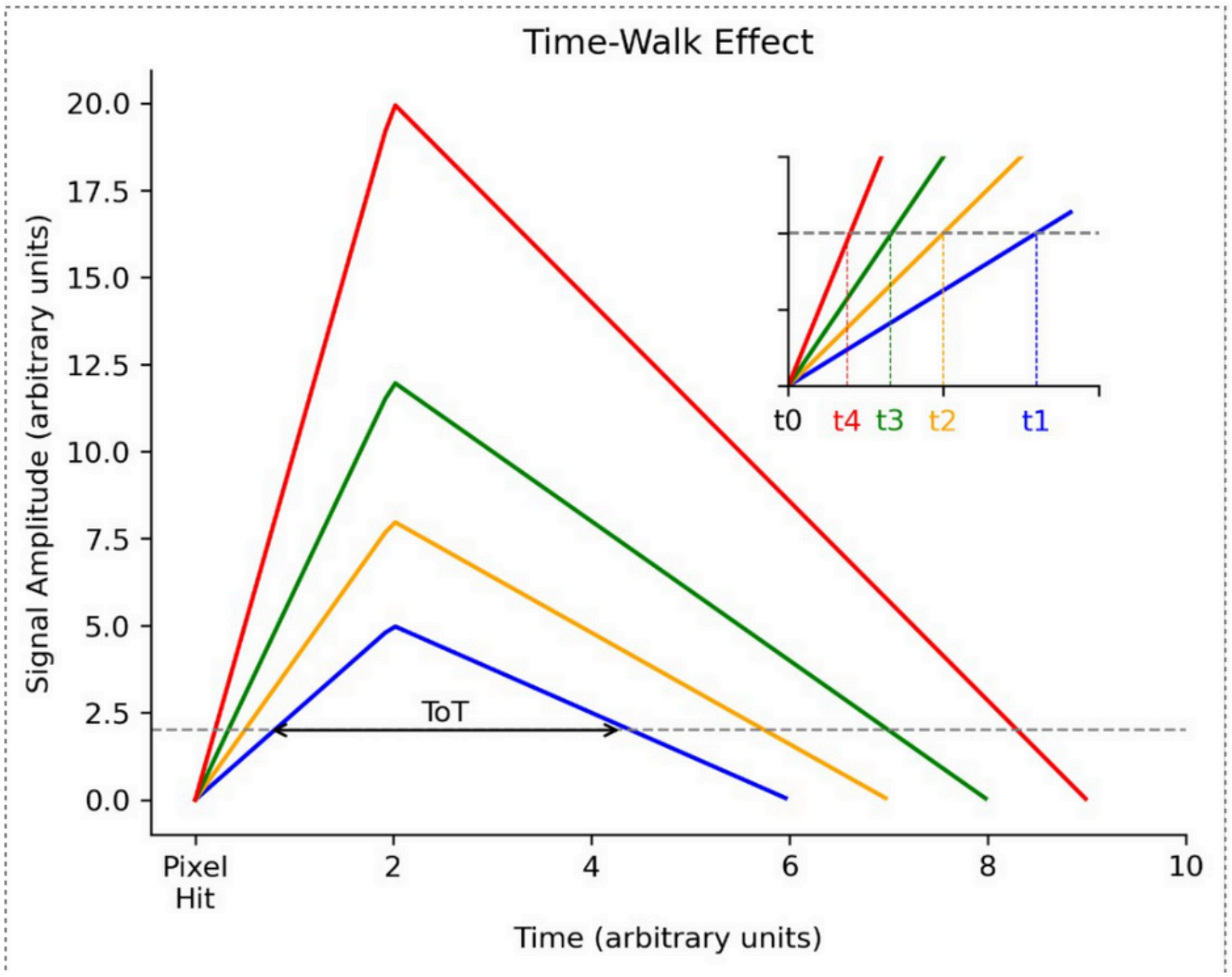
the Timepix Processing Suite

Timewalk correction

The problem:

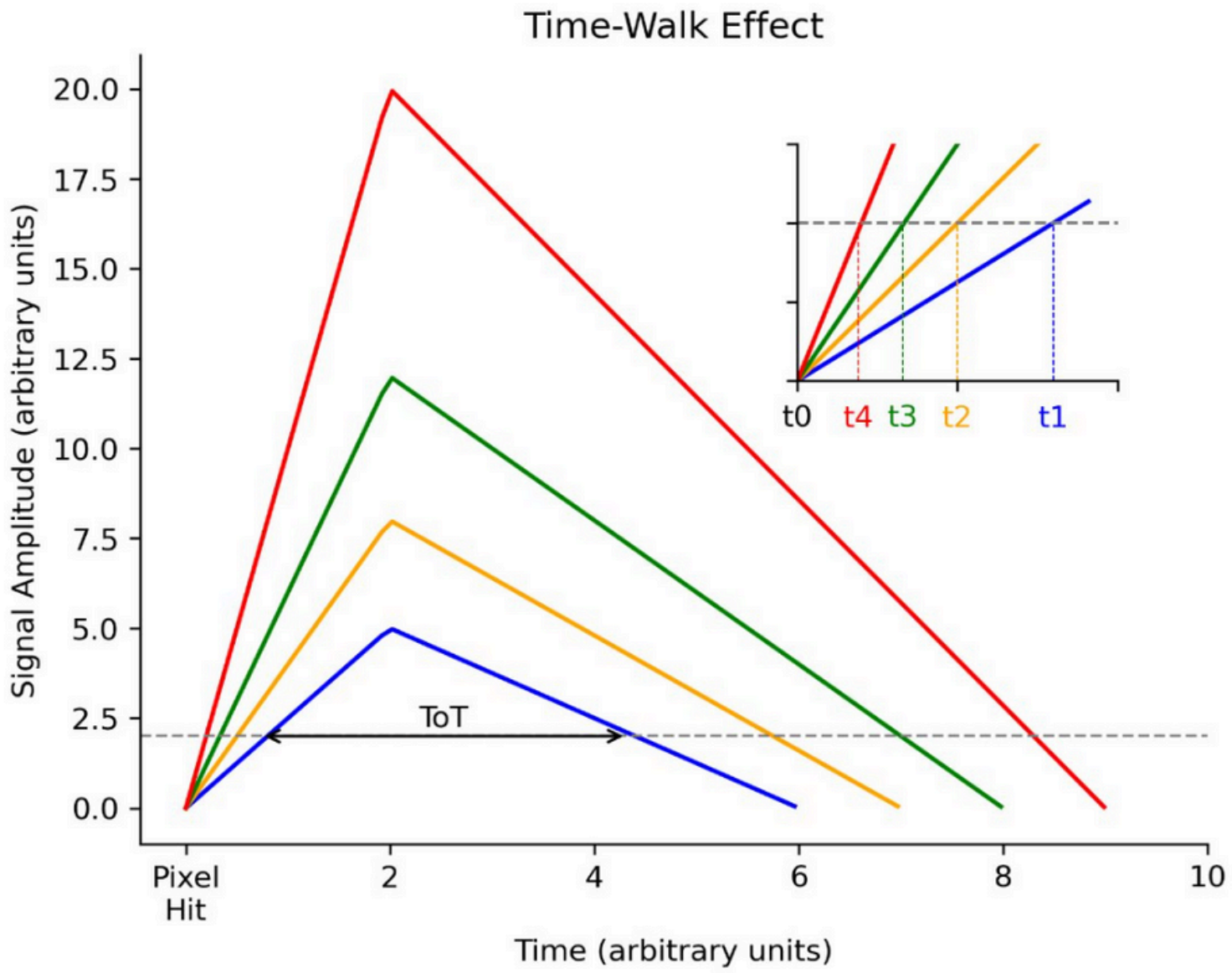
Hits with **larger** energies cross the "activation" threshold **sooner.**

Hits with **smaller** energies cross the "activation" threshold **later**.



The Exact Solution:

If we knew the **t0** we could use simple math to subtract the delay caused by the timewalk effect from a Pixel hits ToA



dt1 = t1 - t0
dt2 = t2 - t0
dt3 = t3 - t0
dt4 = t4 - t0

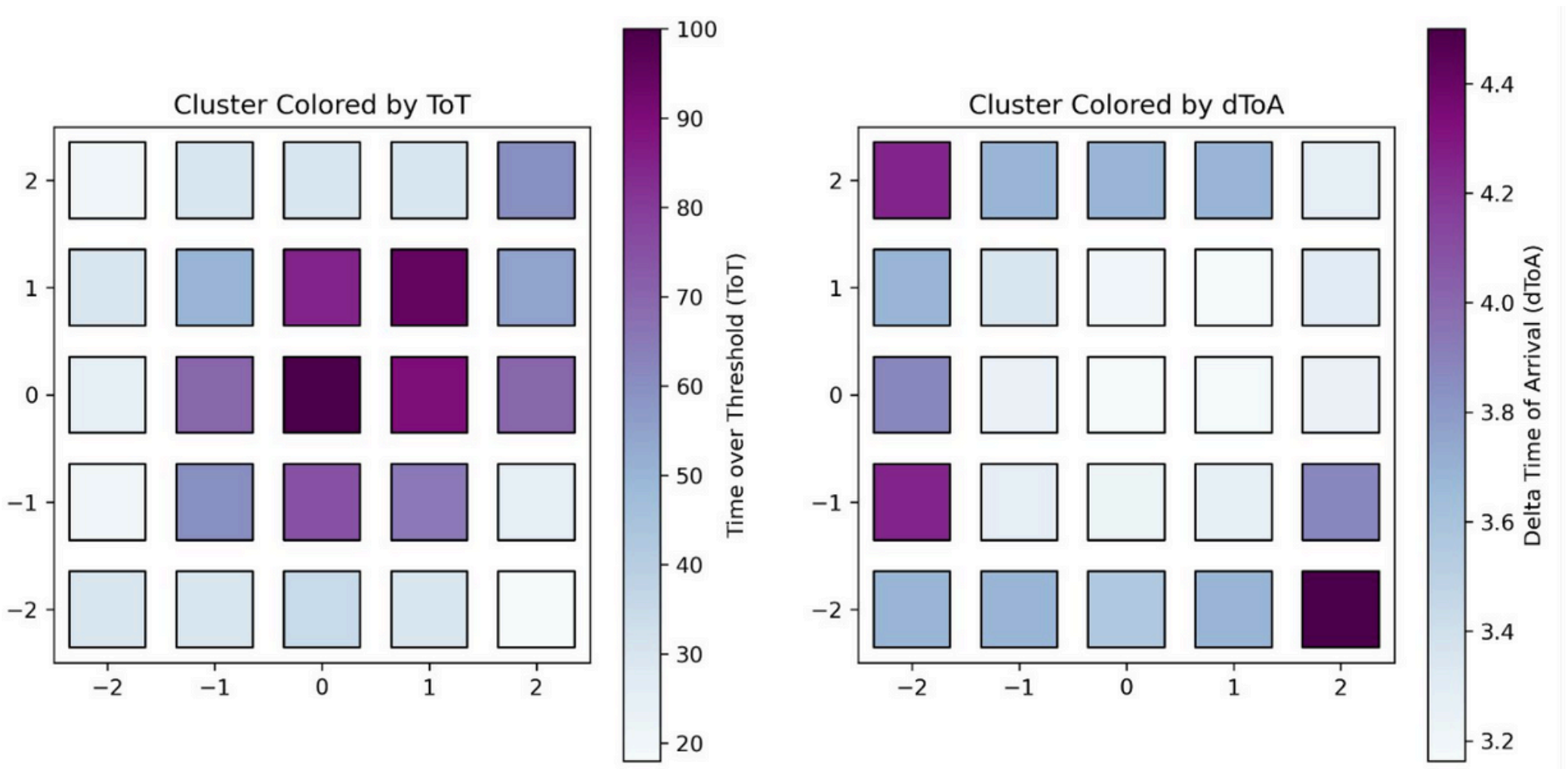
Corrected ToA = ToA - dt

NB: We can get t0 with test pulses which bypass the discriminator. But this is involved

The Statistical Solution:

The pixel with the largest ToT in a cluster is named "cToT". Then, the ToA of the cToT pixel (cToA) is used as an estimator of **"T0"**

dt1 = t1 - cToA
dt2 = t2 - cToA
dt3 = t3 - cToA
dt4 = t4 - cToA



Now we can analyse our collection of dToA values. We want to know:

On average, what is the value of dToA for each combination of cToT and ToT?

Remember that ToT values are discrete.

They increment in values of 25ns and are stored in 10 bits. That is only $2^{10} = 1024$ possibilities

So, there are 1024 possible cToT possibilities

And each pixel within a cluster (with value cToT) can take on 1024 potential ToT values.

The aim of this timewalk correction method is to group our data into these bins (a 2D histogram) and compute the average.

The matrix of average dToA values grouped by cToT and ToT is called the Timewalk Matrix.

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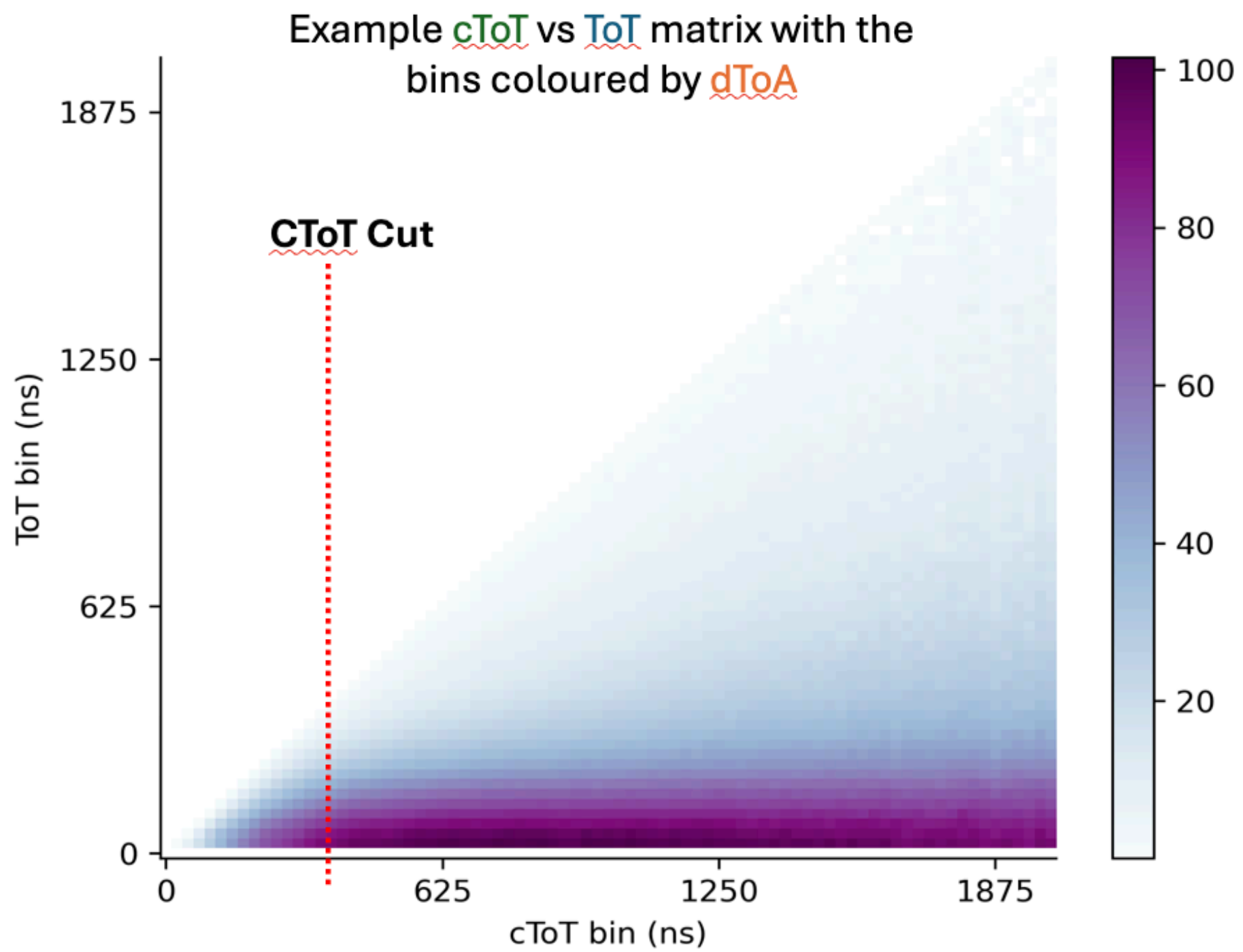
The timewalk matrix:



Why the diagonal?

cToT has the largest ToT in a cluster by definition

Timewalk correction: Constructing a lookup table

Clusters with a cToT larger than a threshold do not display significantly more timewalk effects.

Now that we have the timewalk **matrix** we can use it to construct the timewalk **lookup table (LUT)**

When ToT values get very large the difference in how long it takes to cross the discriminator threshold (dToA) decreases.

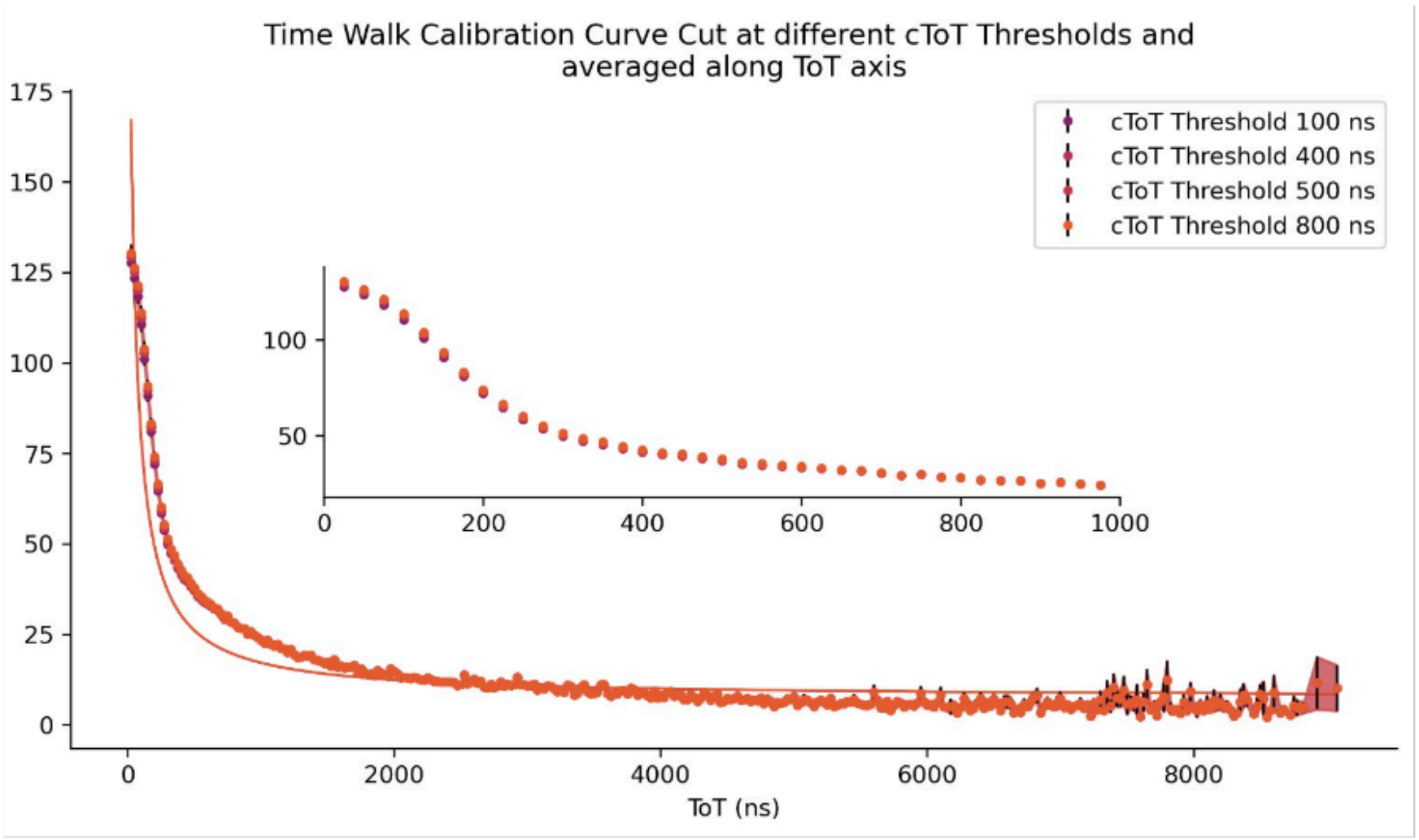
Therefore, we assume that cToT values beyond an empirically defined threshold have a time walk correction factor of 0.

The timewalk matrix is used to find an appropriate cToT cut

cToT cut discards dToA data in lower than this threshold

The LUT is an average of the averages per ToT bin in the time walk matrix over the cToT cut.

Timewalk correction: Constructing a lookup table



Once we have the **LUT**, we feed it values of ToT to get dToA values out.

Timewalk Corrected ToA = ToA - f(ToT)
Timewalk Corrected ToA = ToA – statistical dToA

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