TB22 ANALYSIS

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26 / 09 / 24

OVERVIEW

- Telescope resolution
- Hough Transform (HT) uncertainty
- Calorimetry – prelim

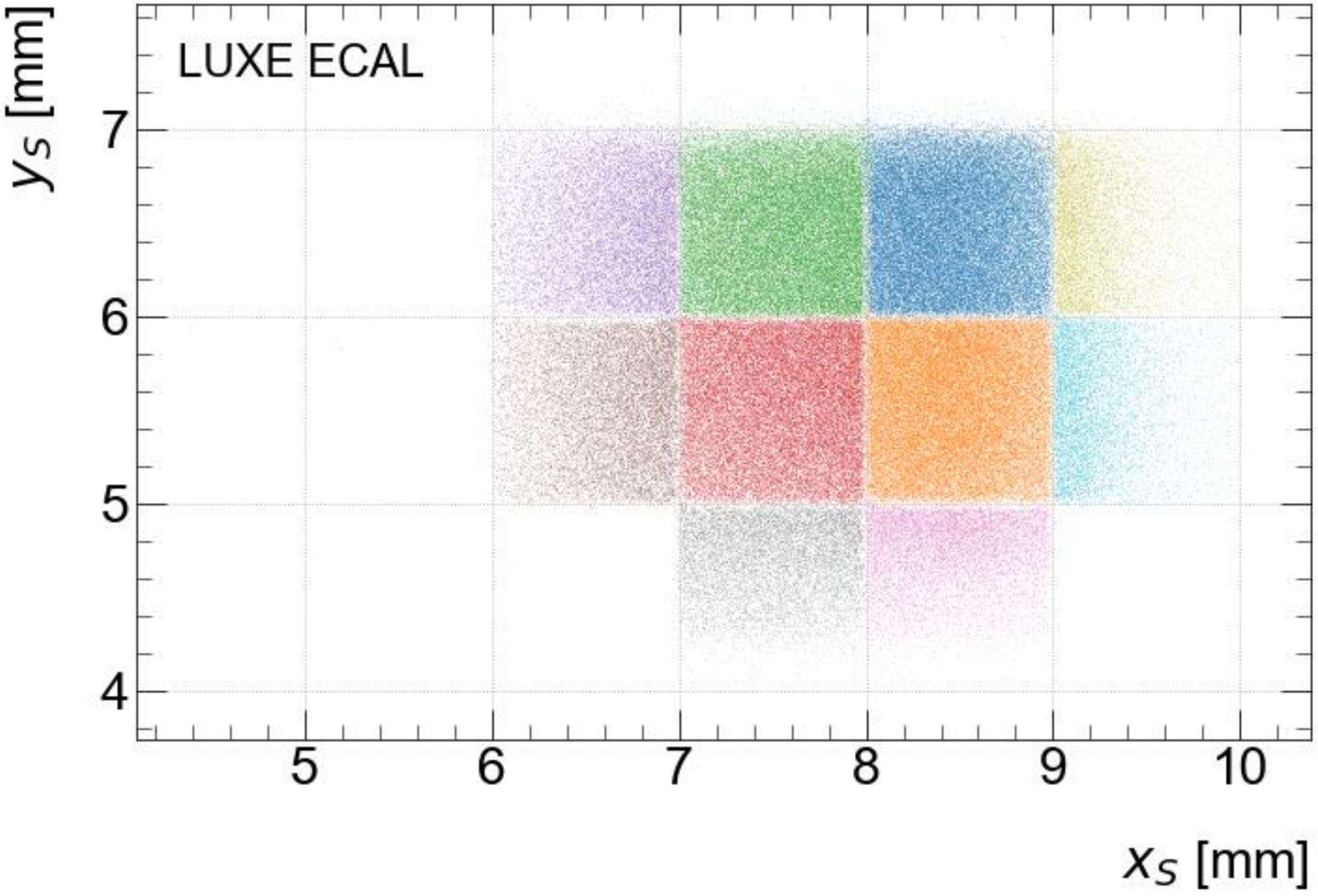
TELESCOPE RESOLUTION

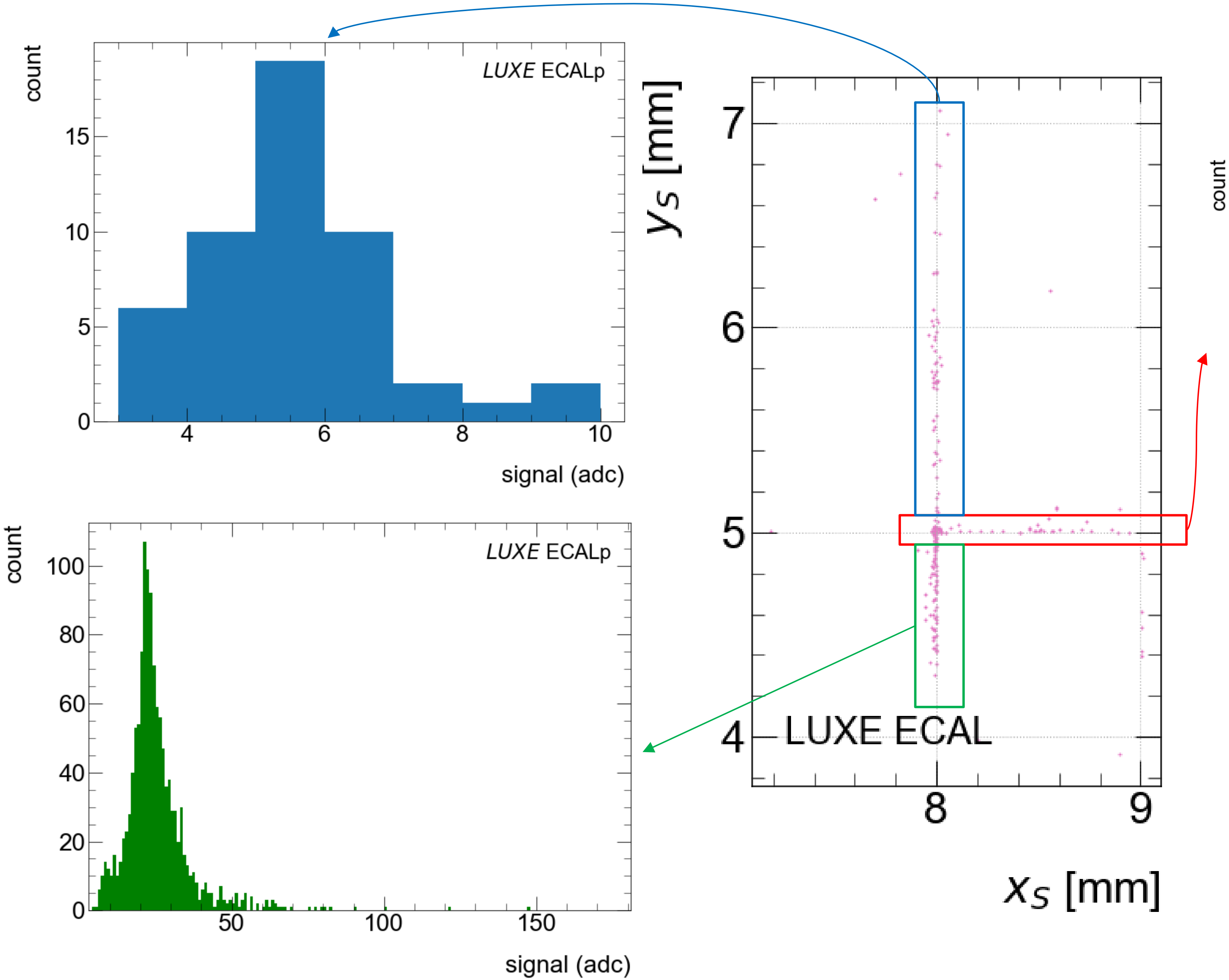
A second attempt

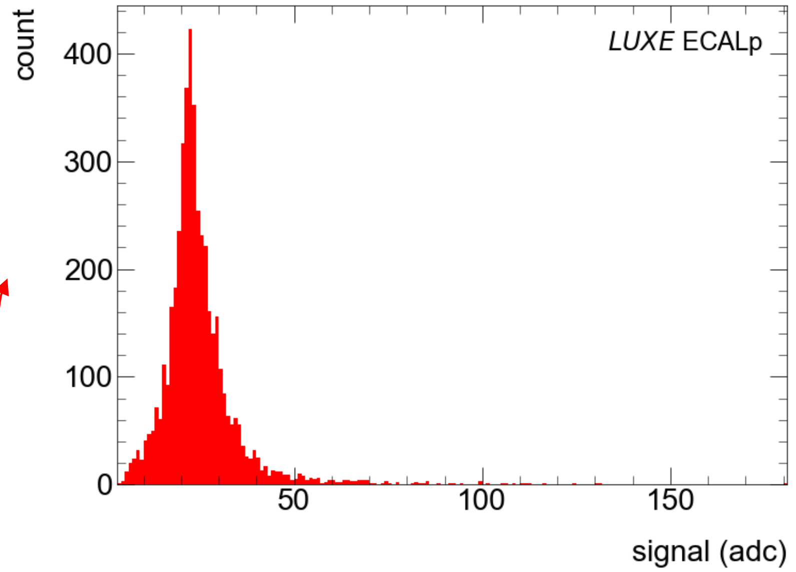
GAAS HITS OUTSIDE PAD RECAP

Events of single track & single pad hit.

Pad-based color assignment.







- Selected events assigned to pad (8, 4) that fell outside the pad area after alignment.
- Plotted the ADC count histograms of each marked area.

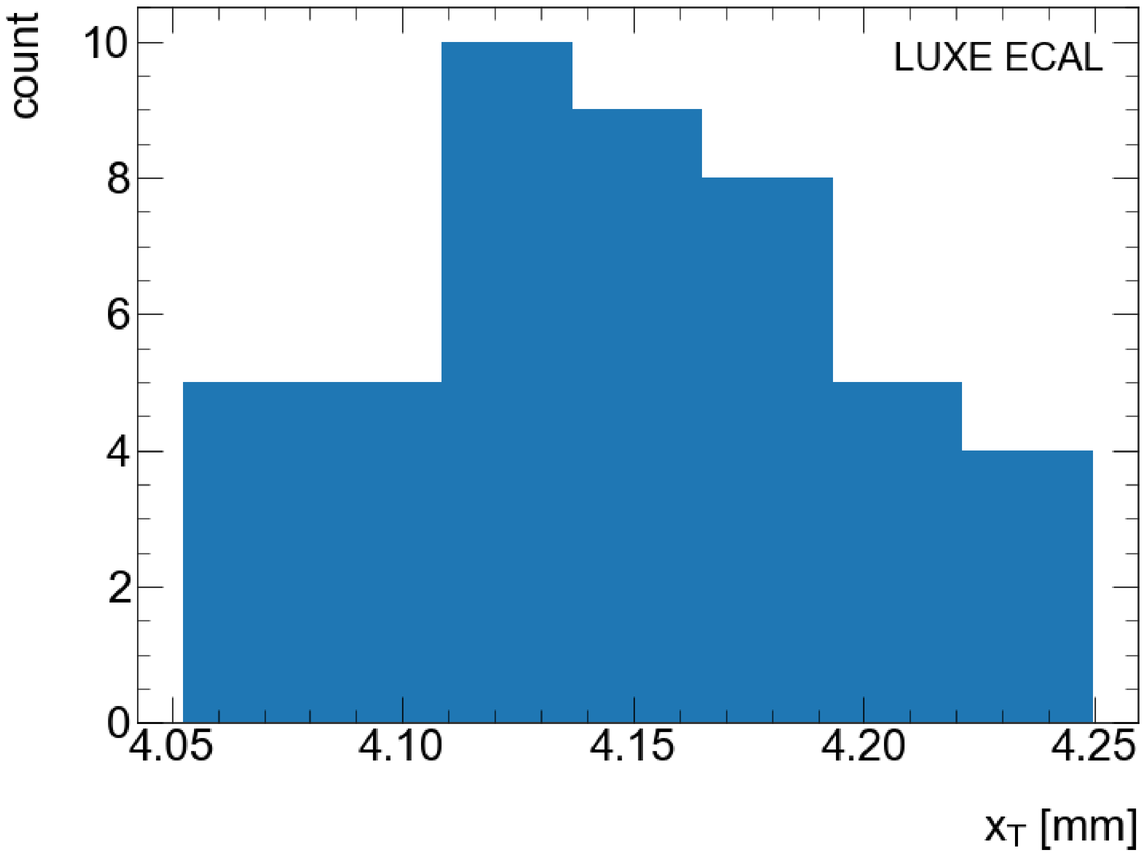
→ ADC count on traces ~5

TELESCOPE RESOLUTION

Idea – use hits on the traces to get the telescope resolution.

- Choose events with (x, y) position **far above** the assigned pad.
- Plot a histogram of their x value given by the telescope.
- The standard deviation is the telescope resolution (neglecting the trace width).

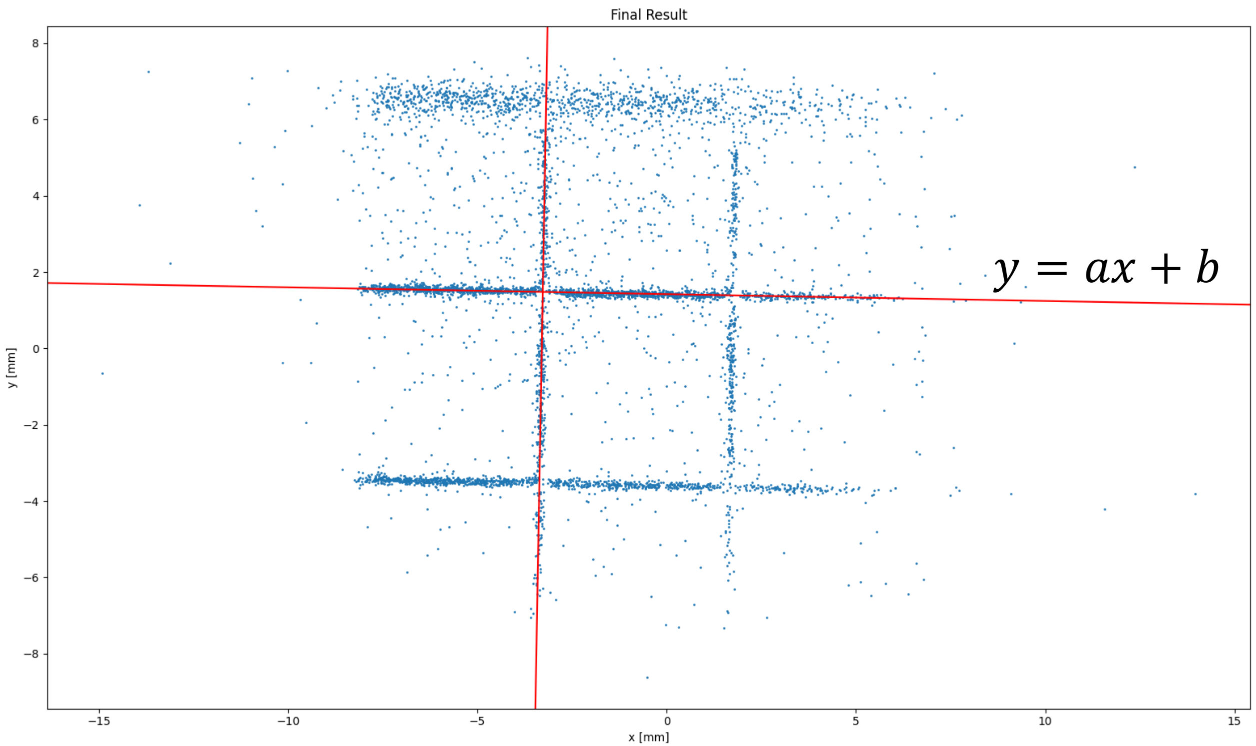
The result is ~50 microns.

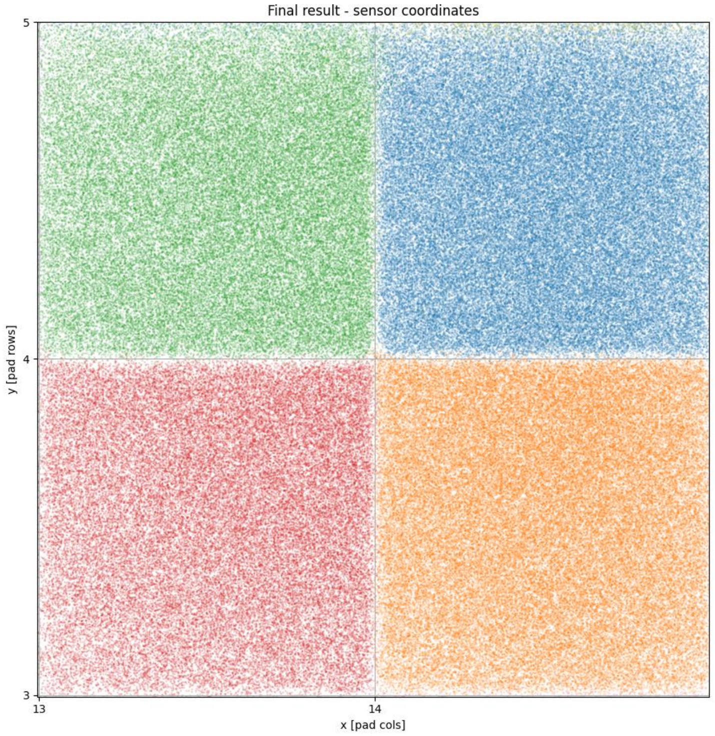


HT UNCERTAINTY

Update & Summary

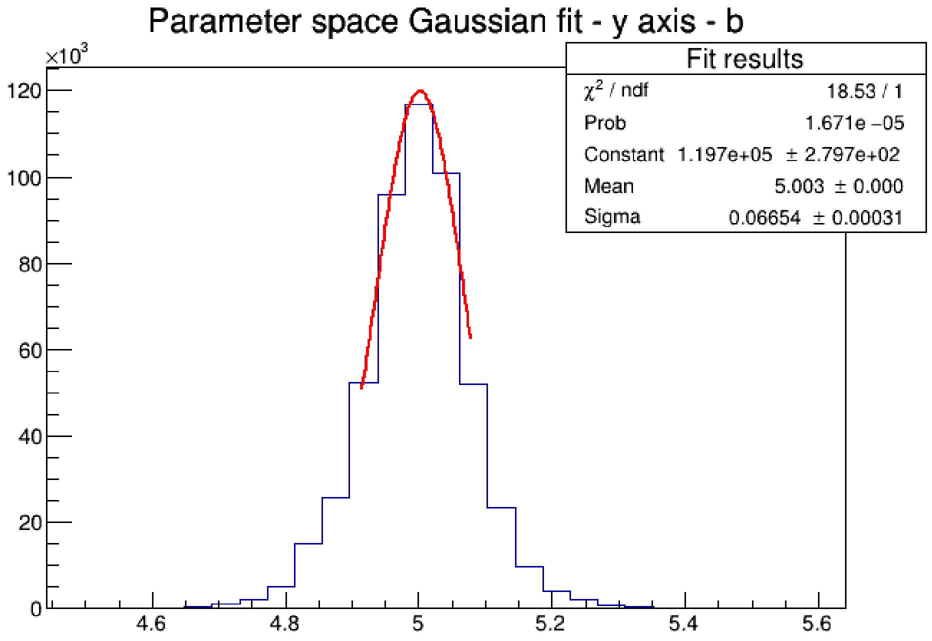
HT – FIND LINE EQUATION



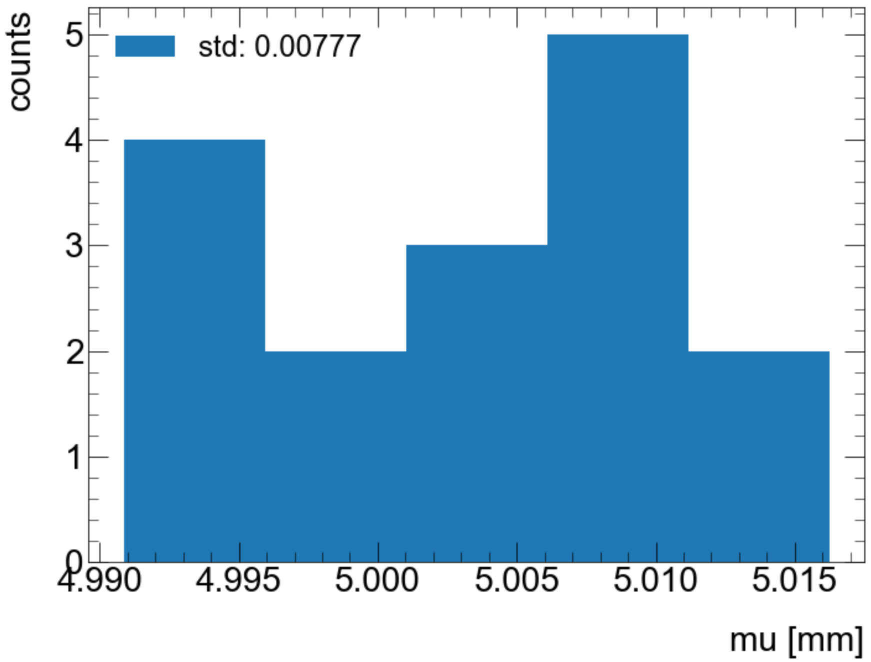


STATISTICAL UNCERTAINTY

Get line parameters distribution
Fit Gaussian → get mpv



Subdivide data to get distribution of mpv
→ std of the mpv distribution is the algorithm's uncertainty



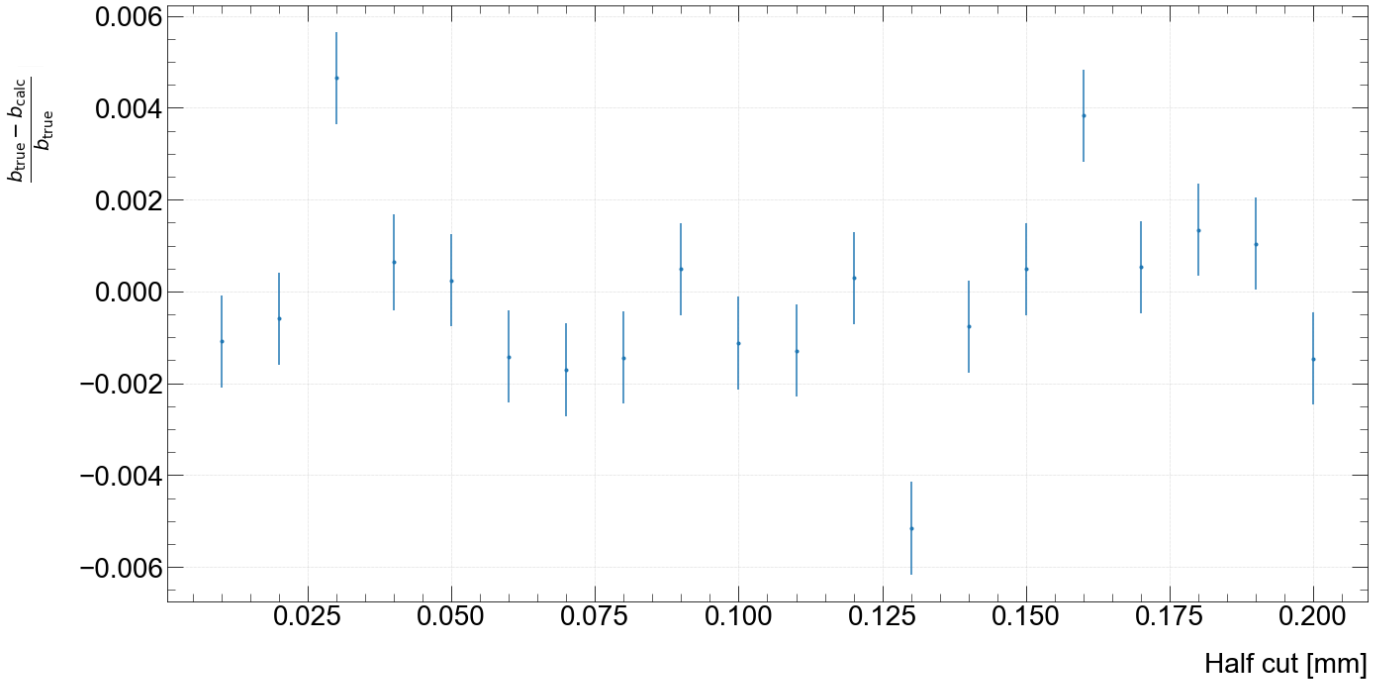
CONTROLLED TEST

- Generated random points from a uniform distribution on a horizontal line.
- Smeared points with σ values of 10, 20, …, 100 microns.
- Ran the alignment algorithm on the smeared dataset and got the uncertainty.

- In addition, checked the effect of changing the parameters of the algorithm, and statistics.

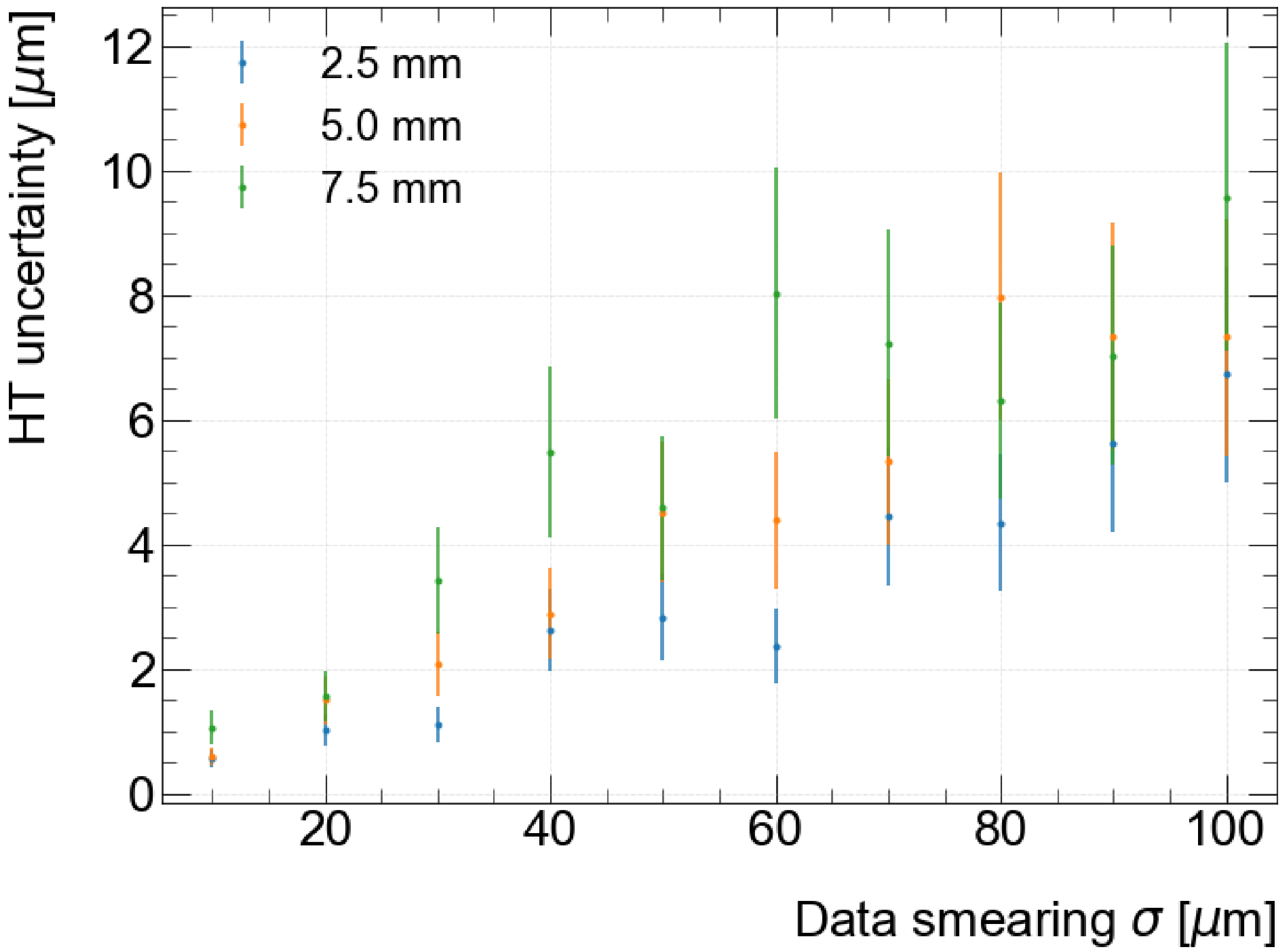
CONTROLLED TEST

Values are nicely distributed around 0



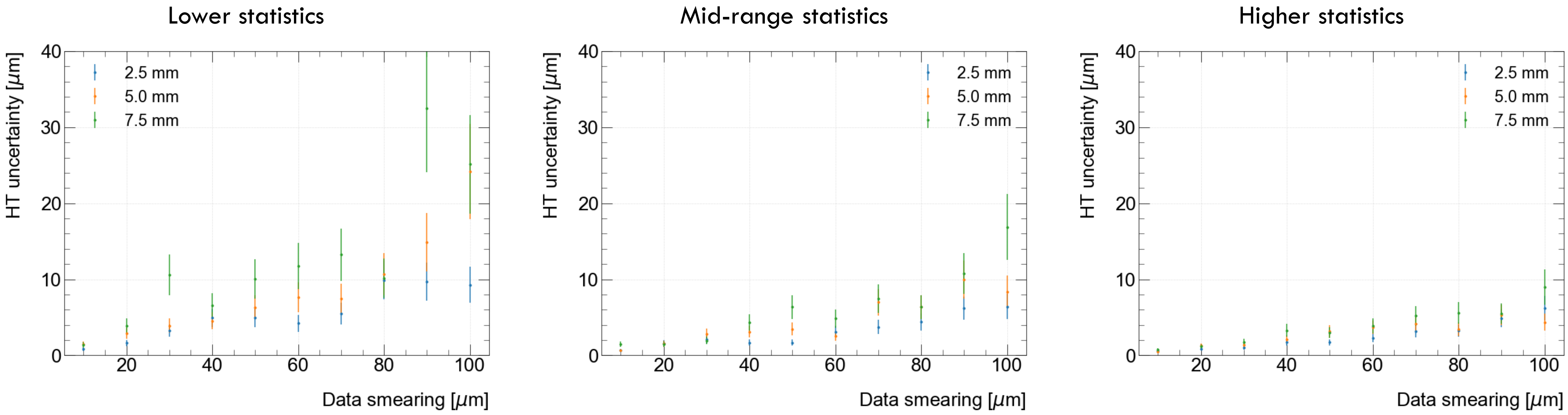
CONTROLLED TEST

The uncertainty for a given smearing σ slightly varies, but it is always at the level of a few microns and hence negligible.



CONTROLLED TEST

Higher statistics give smaller uncertainties, but are still at the order of a few microns



HT UNCERTAINTY – CONCLUSION

- Statistics is the main variable affecting the algorithm's uncertainty
- The algorithm's uncertainty is at the level of a few microns
- The alignment's uncertainty is dominated by the telescope resolution

CALORIMETRY

Preliminary

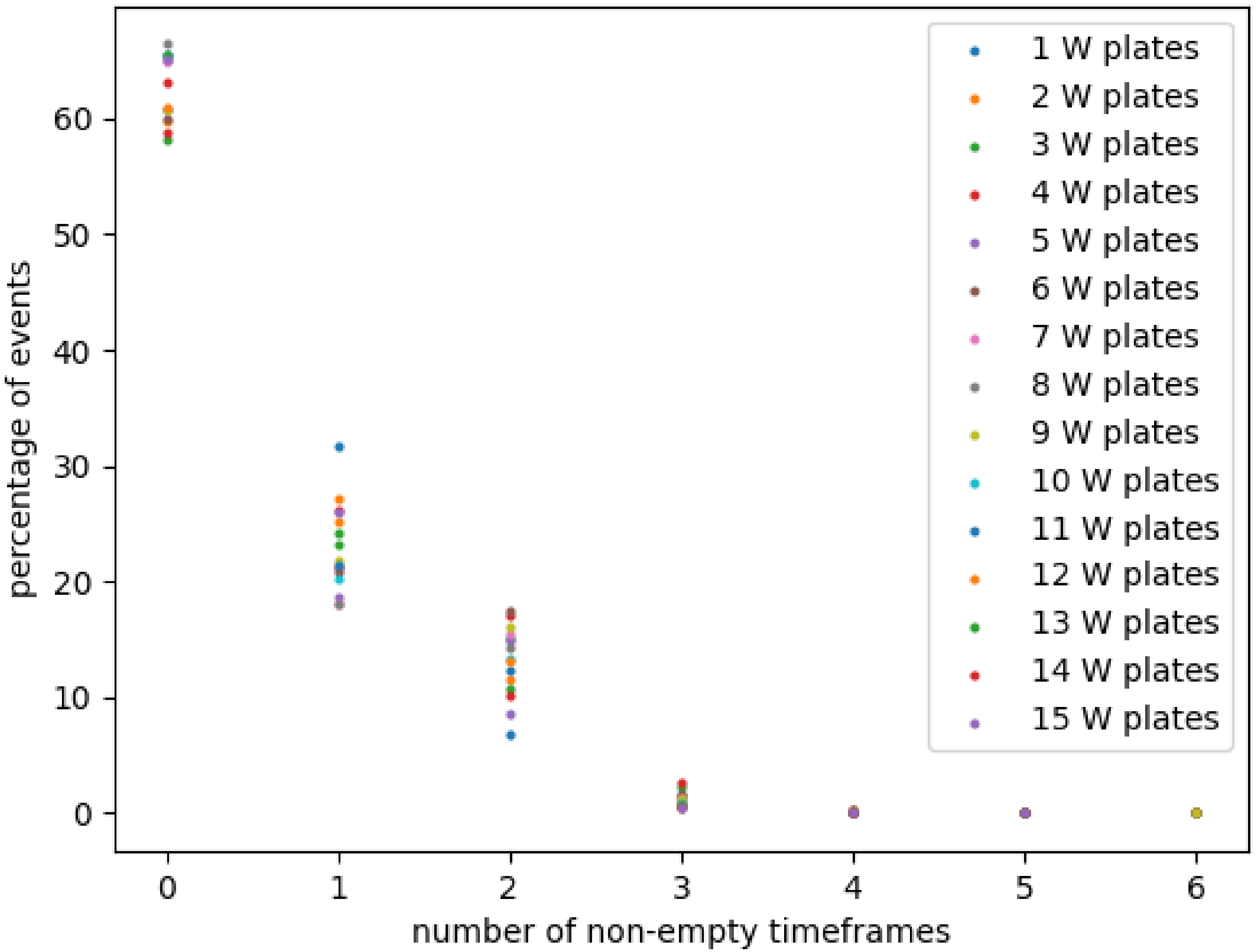
DEBUG DATA ON

Calorimetry files:

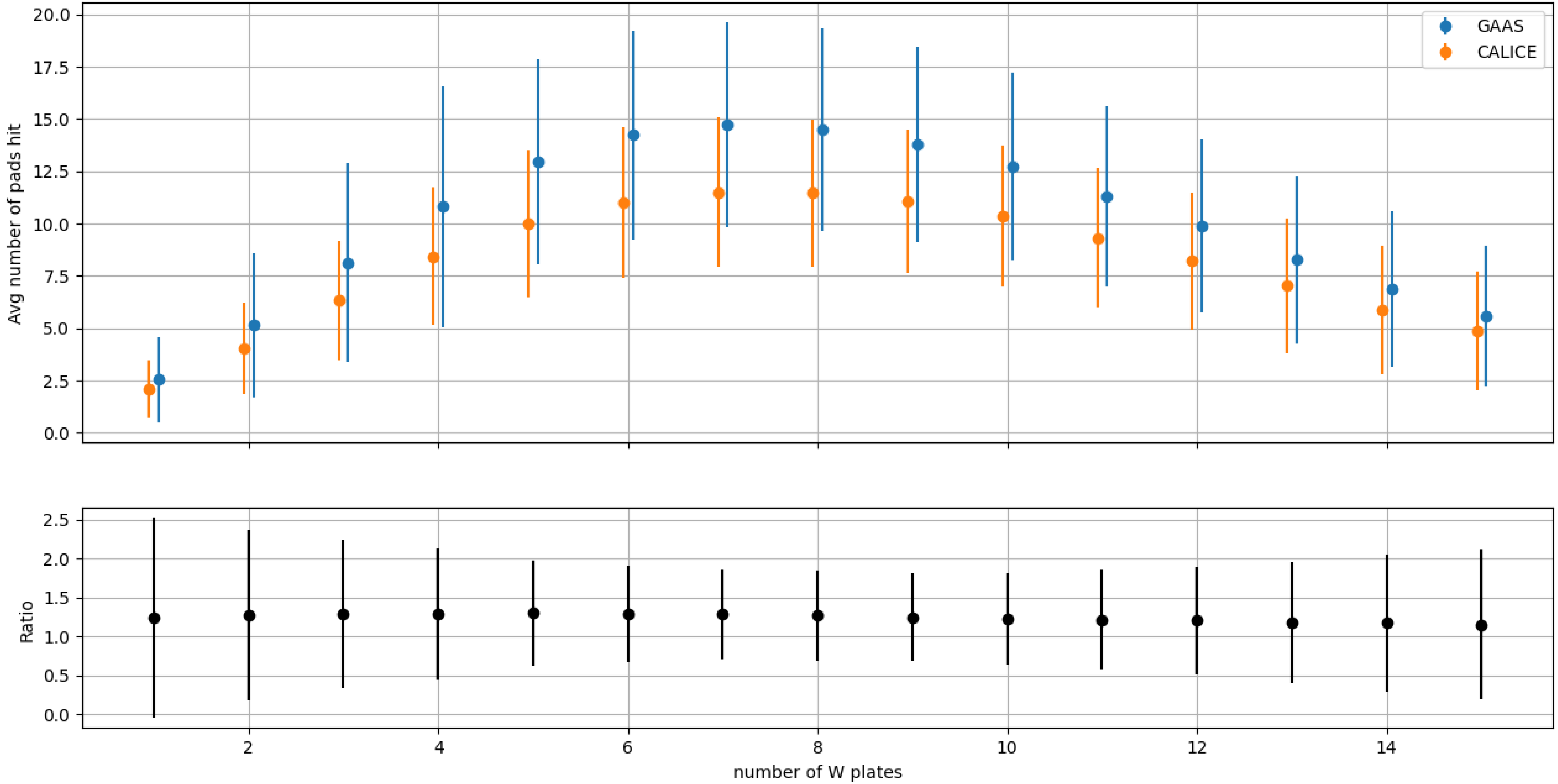
~ ½ million events

~ 300,000 empty events

~ 150,000 events with data



NUMBER OF PADS HIT

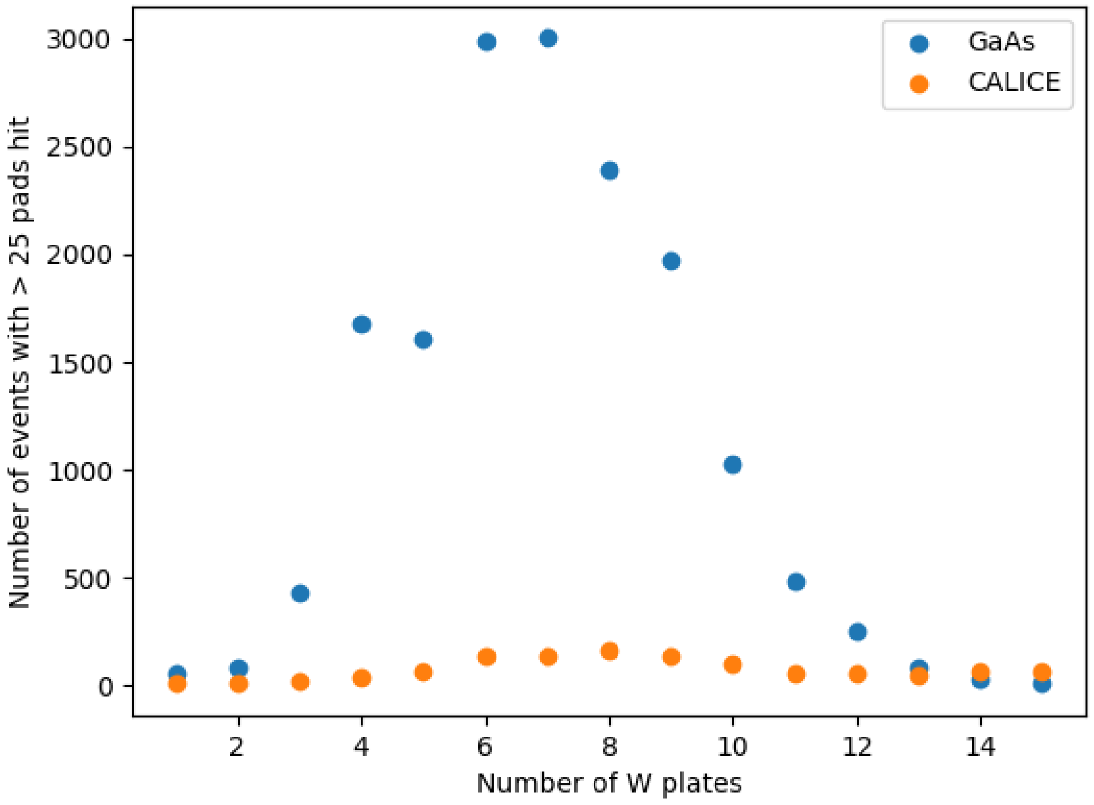


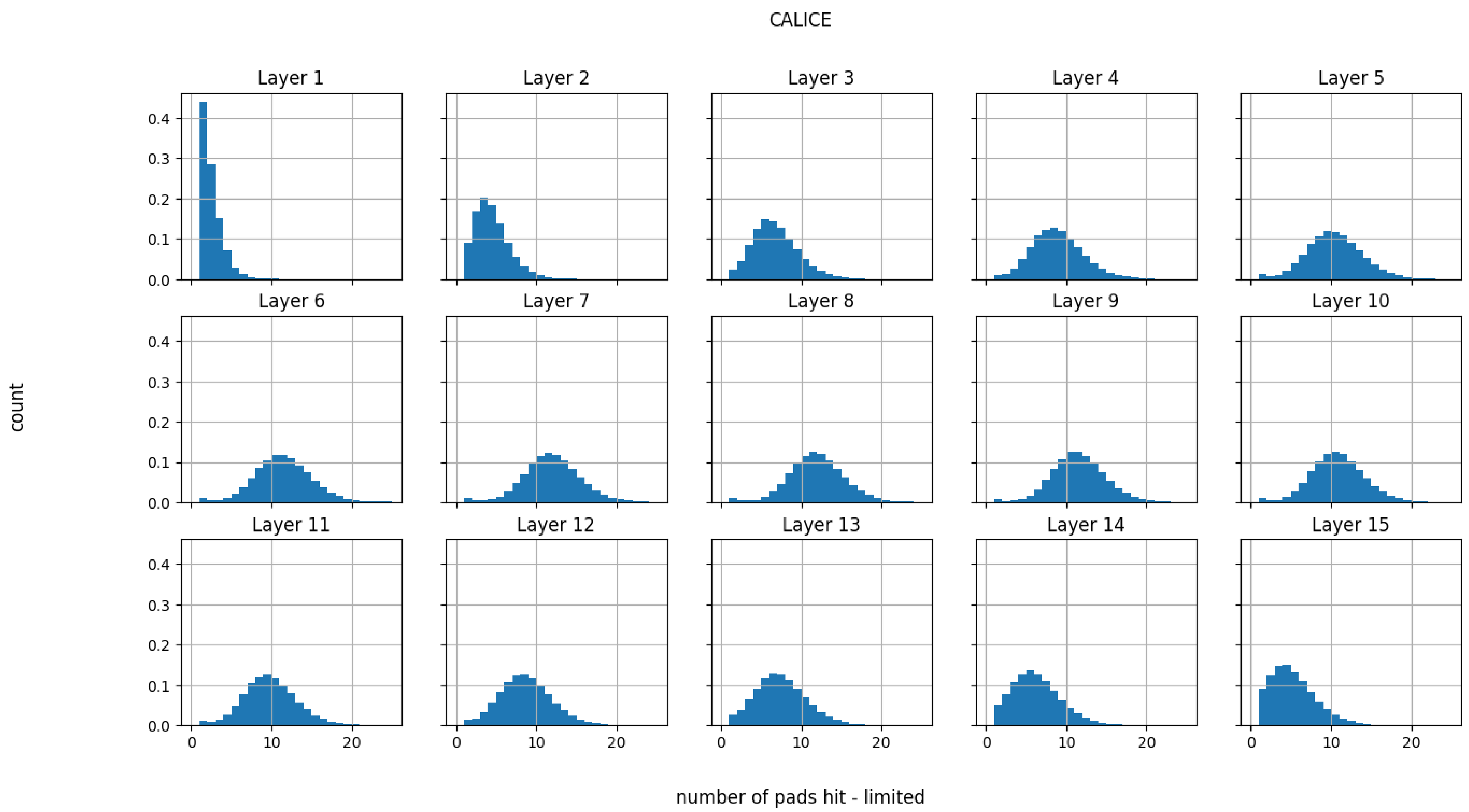
NUMBER OF PADS HIT

Based on a Molière radius of about 9mm, if the particle hit in the center of a pad, we expect to see about 25 pads hit.

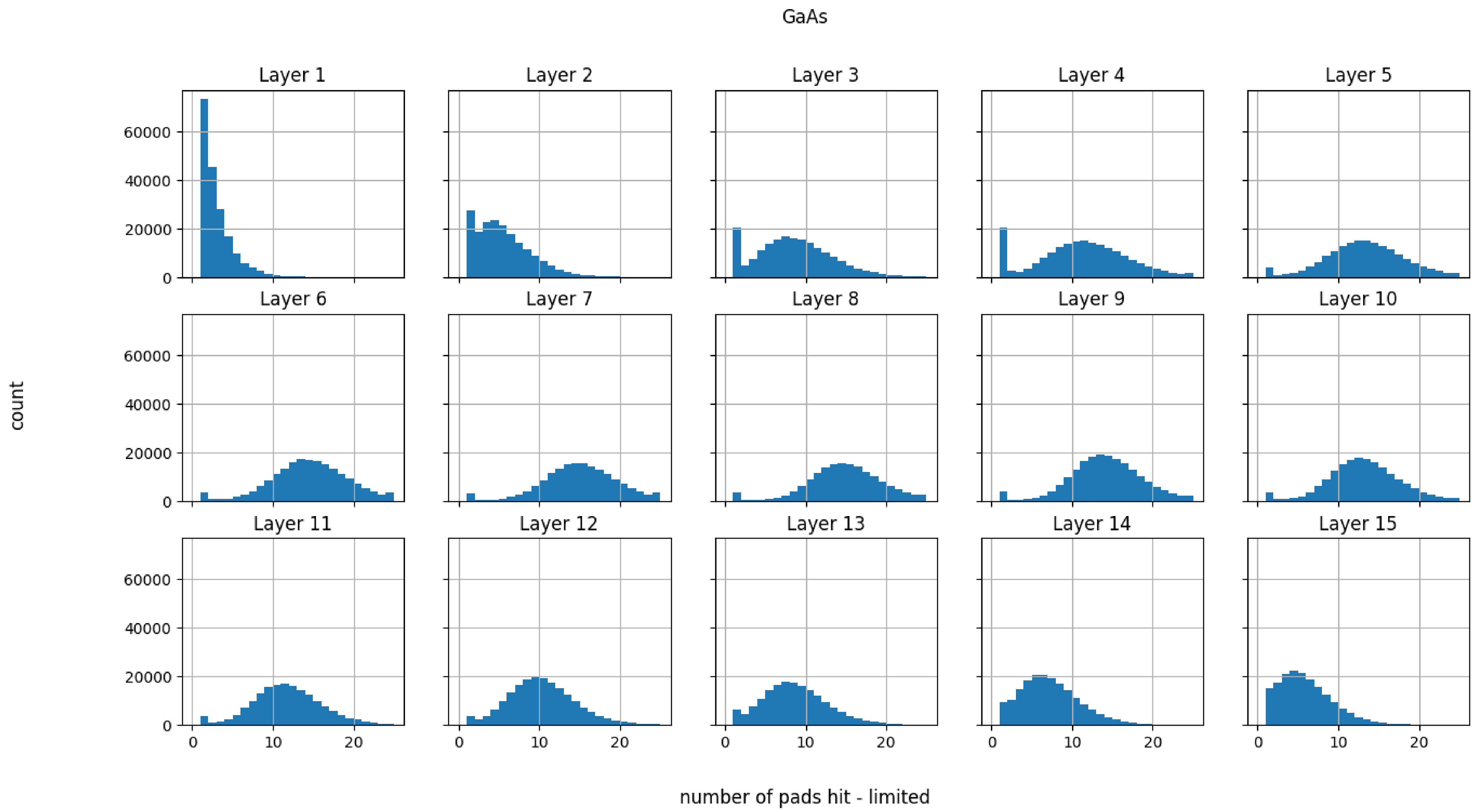
Other hit positions will give a lower number.

Plot to the right shows the number of events with more than 25 pads hit, per layer.





- Events with up to 25 pads
- Full sized plots, layer-by-layer, are available at the end of the presentation



- Events with up to 25 pads
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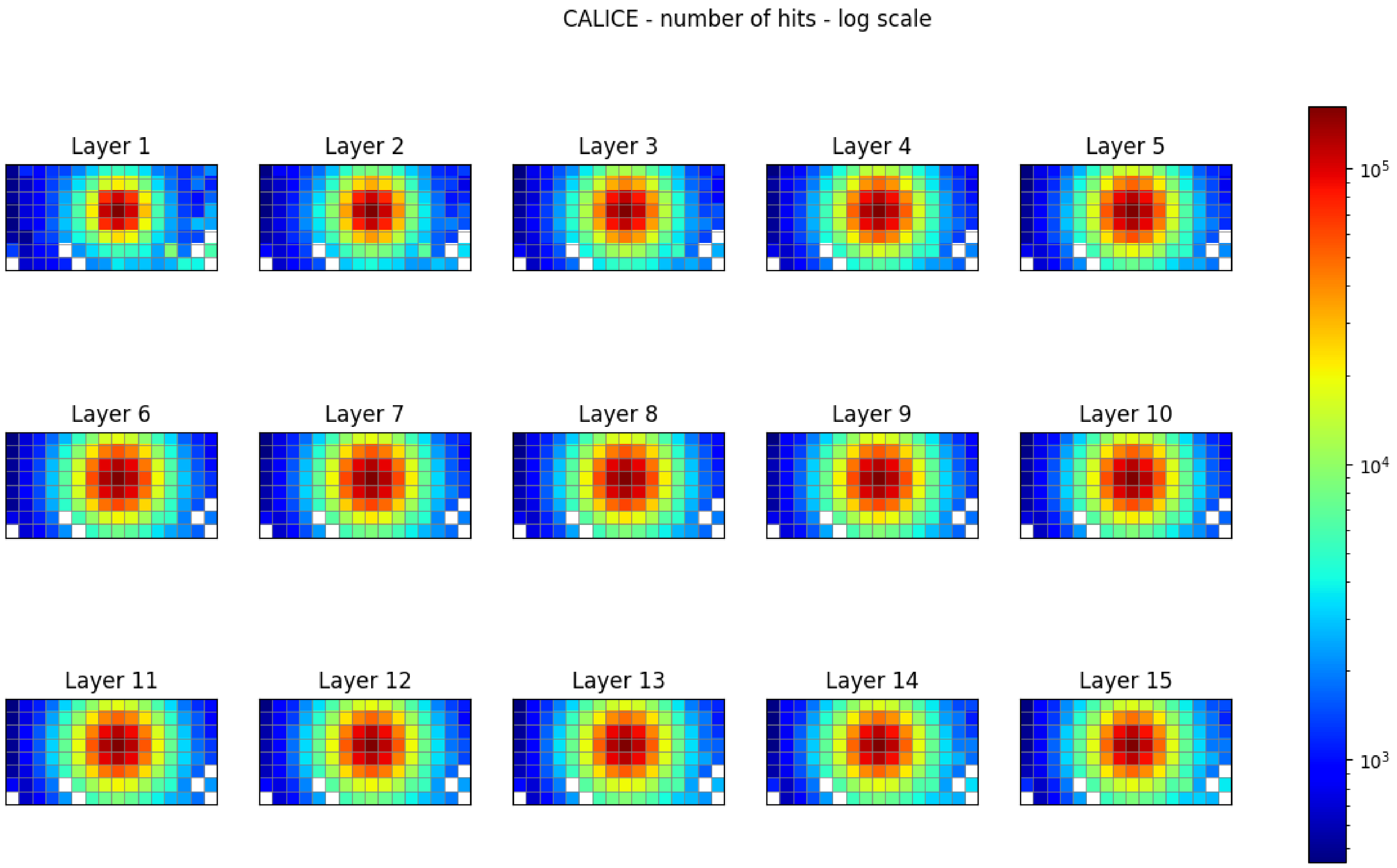
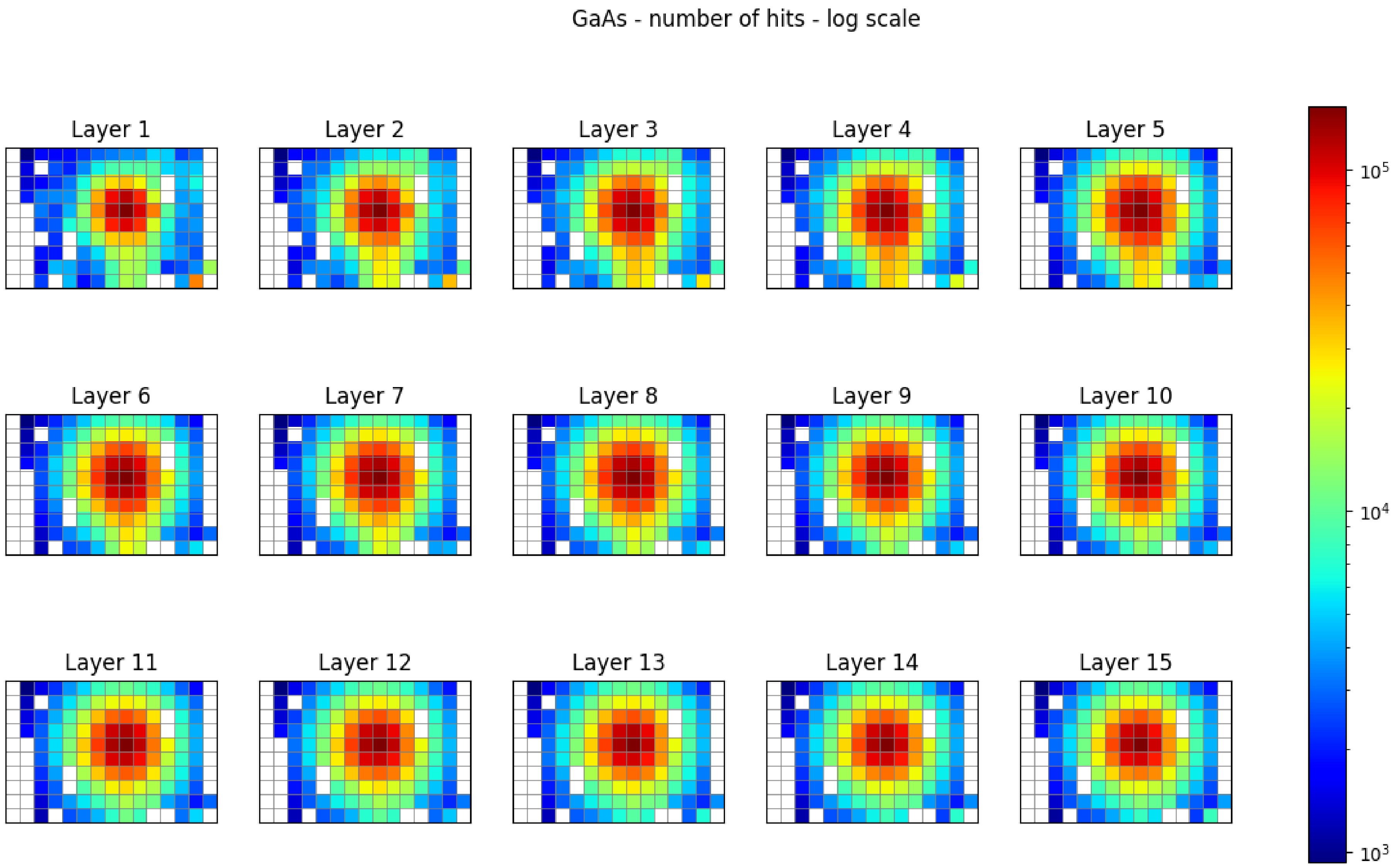


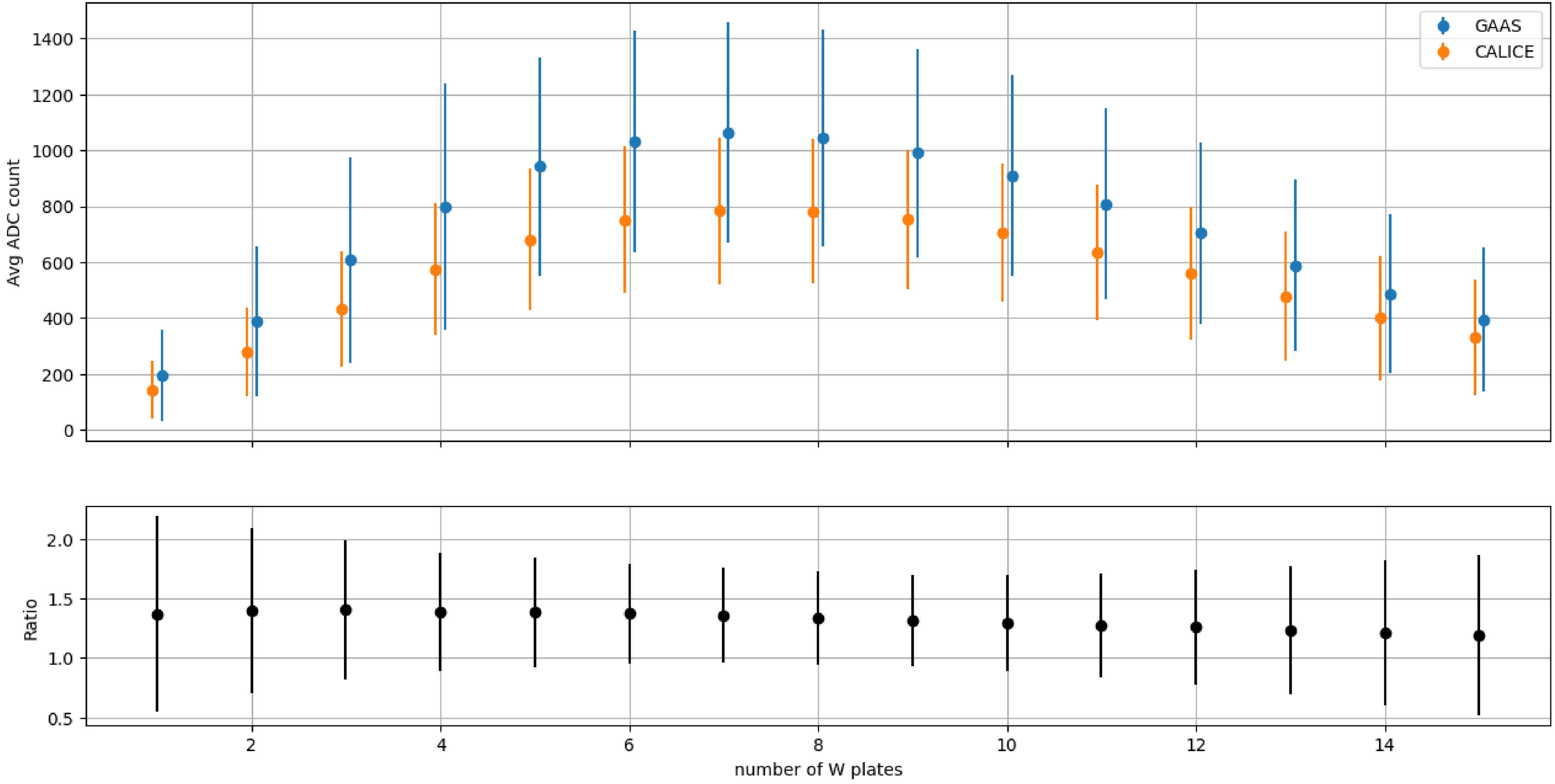
Seems isotropic in the radial direction

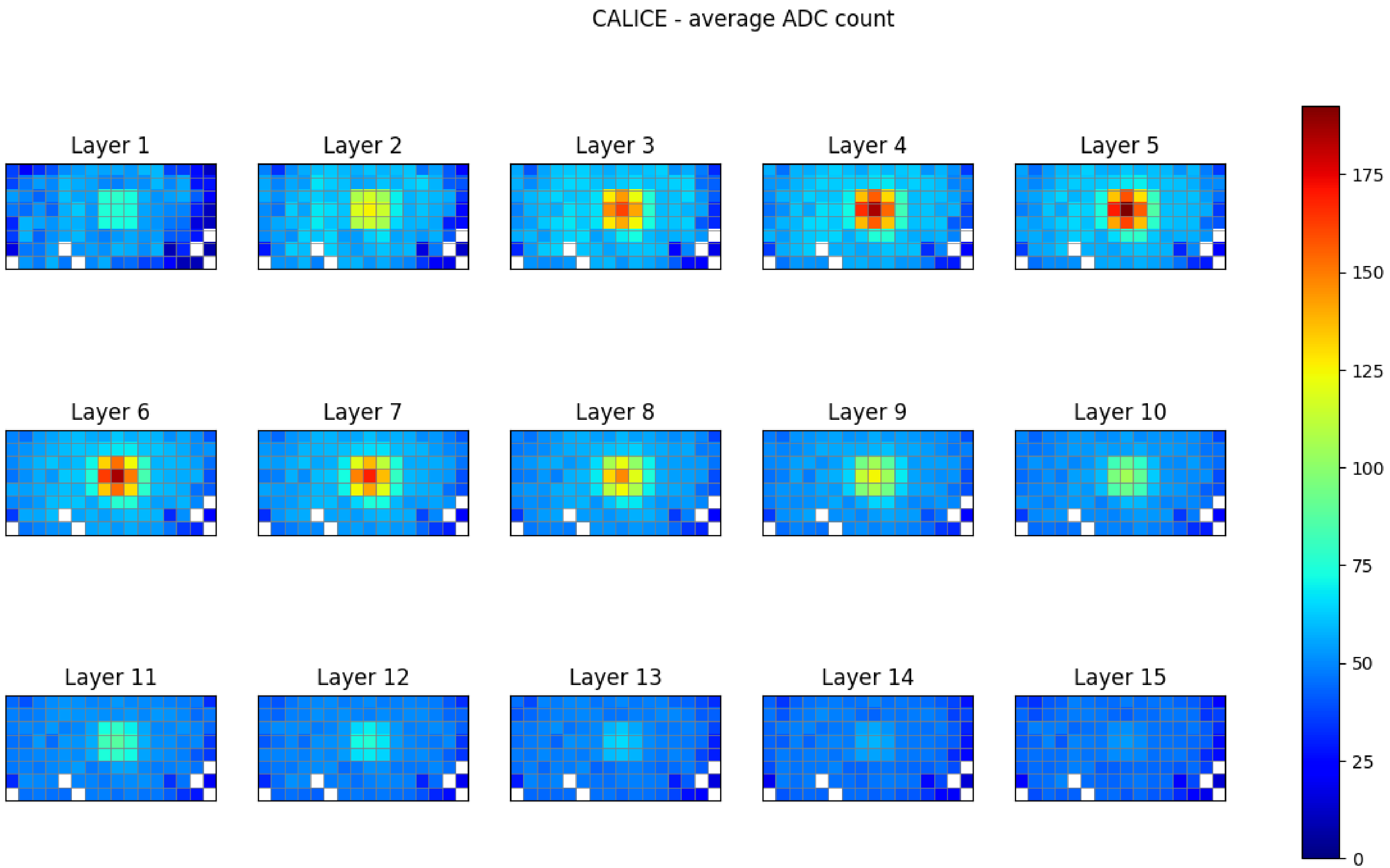


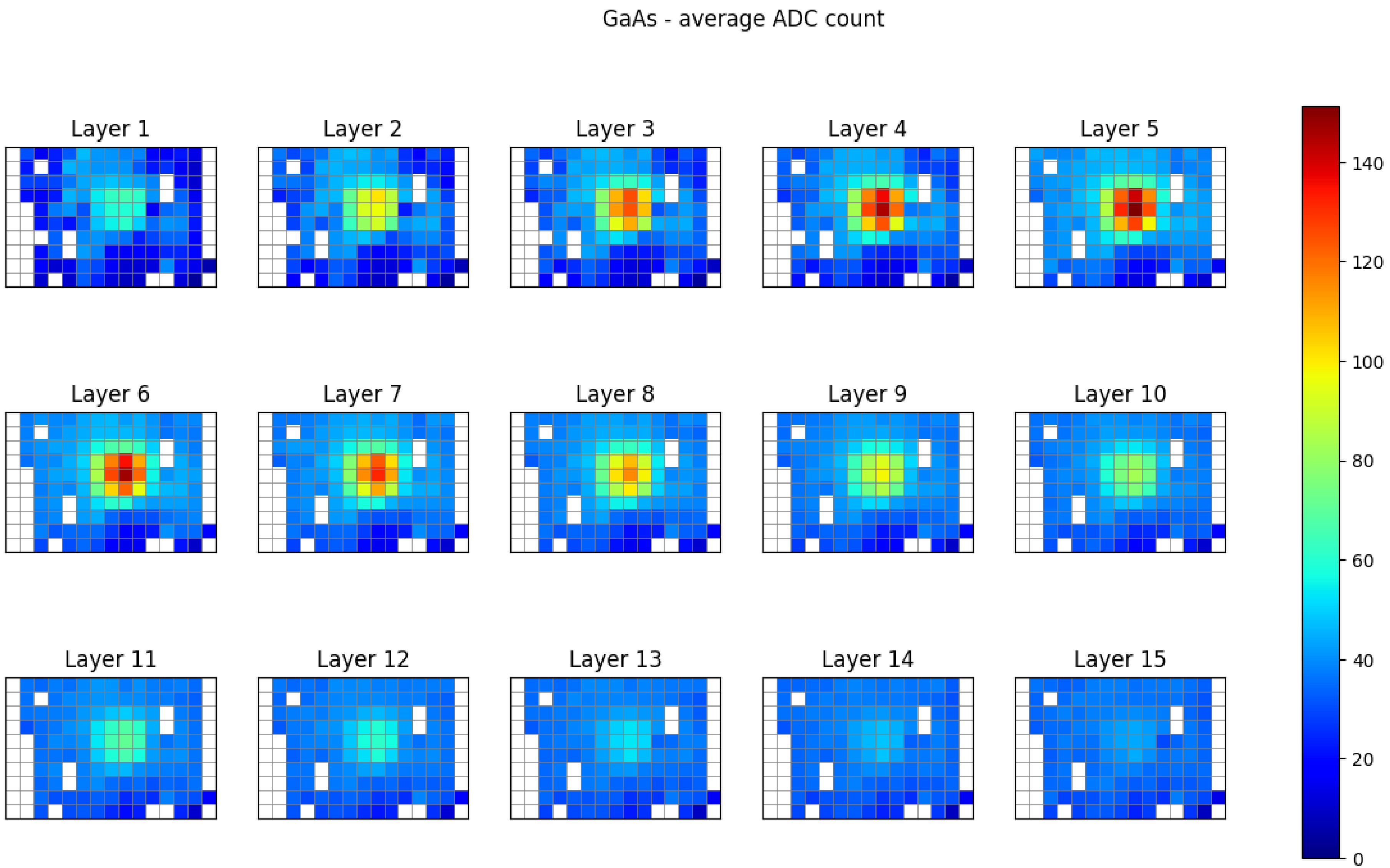
Pads below the beam center are hit more often than those above

→ Traces ?

AVERAGE ADC COUNT




CALICE - average ADC count
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6
Layer 7
Layer 8
Layer 9
Layer 10
Layer 11
Layer 12
Layer 13
Layer 14
Layer 15
175
150
125
100
75
50
25
0



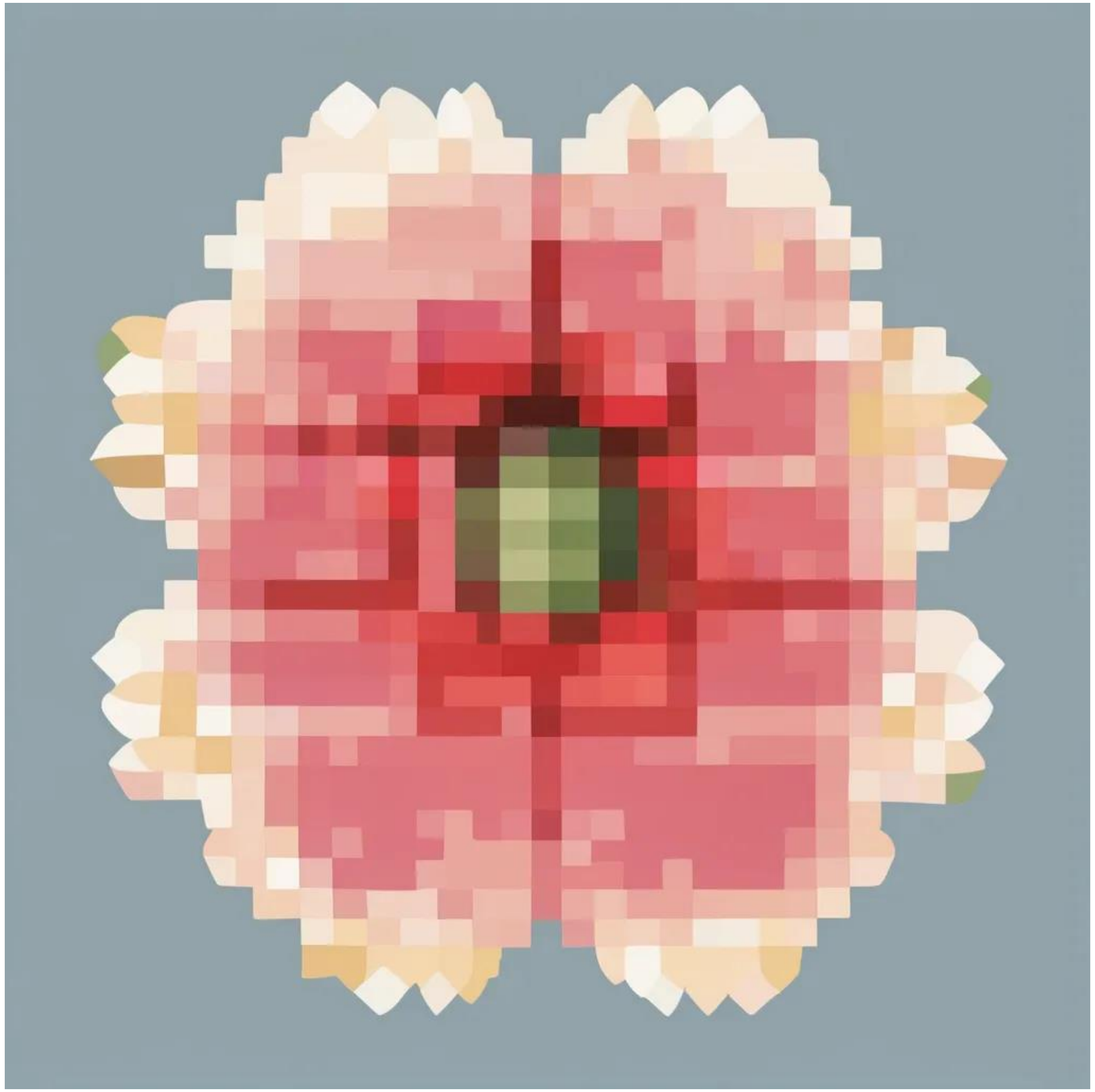
Pads below the beam have a lower average ADC count

→ Traces ?

SUMMARY

- Traces-based telescope resolution calculation – 50 μm
- Alignment precision is dominated by the telescope resolution
- Calorimetry:
  - Traces seem to cause additional pads hit with lower ADC count.
  - Total ADC count in GaAs is on average higher than CALICE – to be further investigated

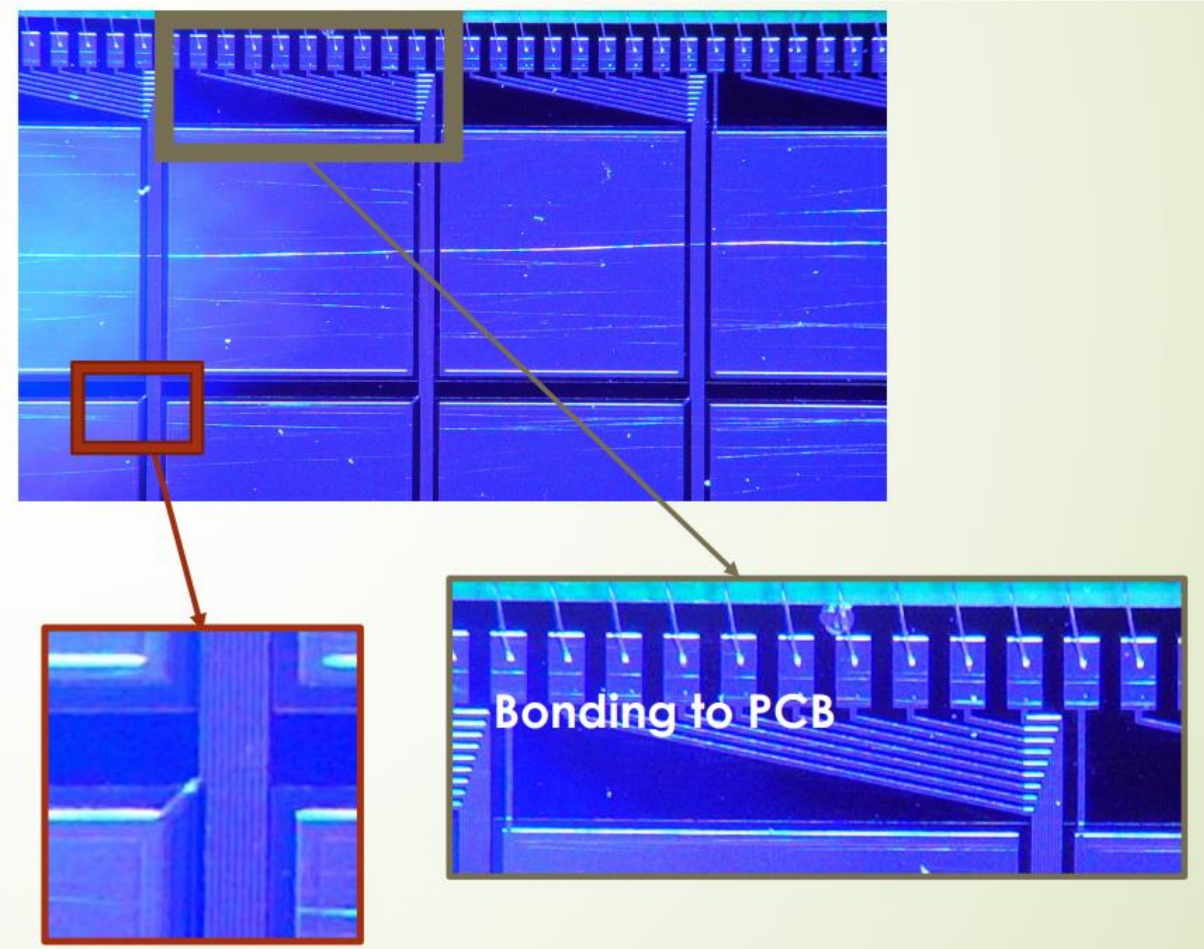
THANK YOU!



A pixelated flower in reference to the previous slides

BACKUP

TRACES BASED EFFECTS

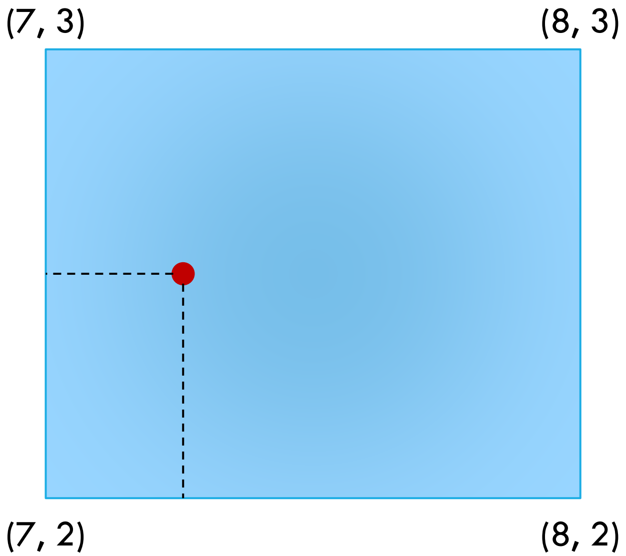


ALIGNMENT GOAL

Translate global position given by the telescope to a local position on the sensor.

Local coordinate system agreed – units of pad length

- e.g. (7.25, 2.5) is located as such pad (7, 2):



ALIGNMENT METHODS

- <u>Max hits in pad</u>

Set a grid and find the position that gives the highest number of hits in the correct pad.

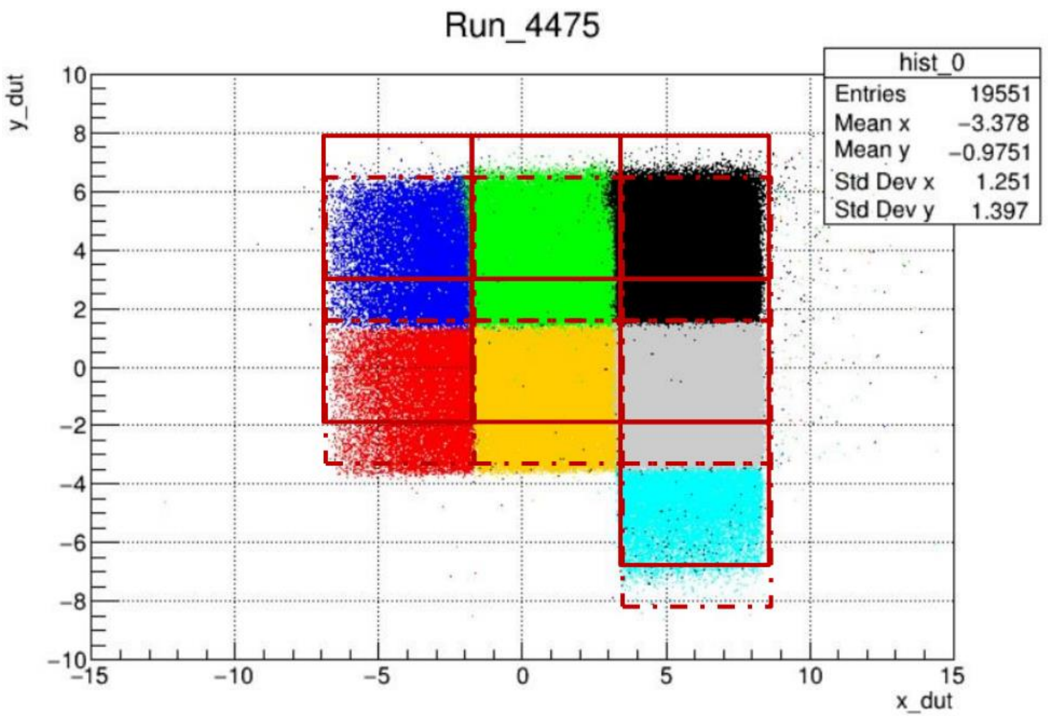
Input data – events of a single electron & a single hit.

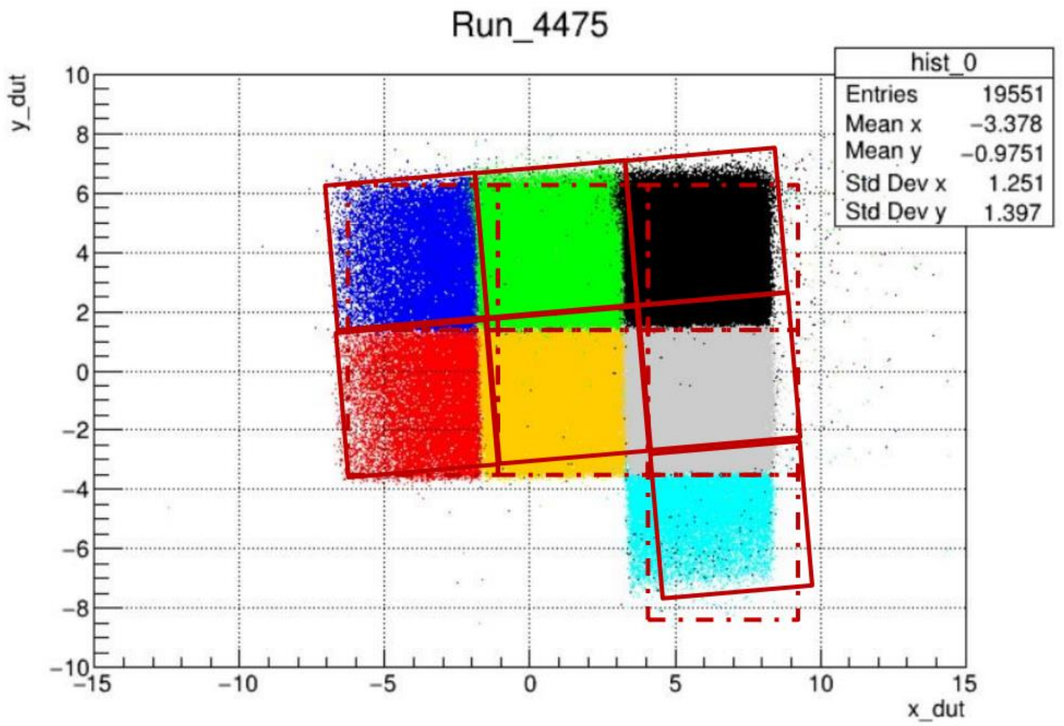
- <u>Hough Transform</u>

Used as a line recognition algorithm to find the edges of the pads.

Input data – single electron events that hit in between pads (to get a good "image" of the edges).

MAX HITS





Figures from the 29/11/23 presentation by Kirill.

HOUGH TRANSFORM

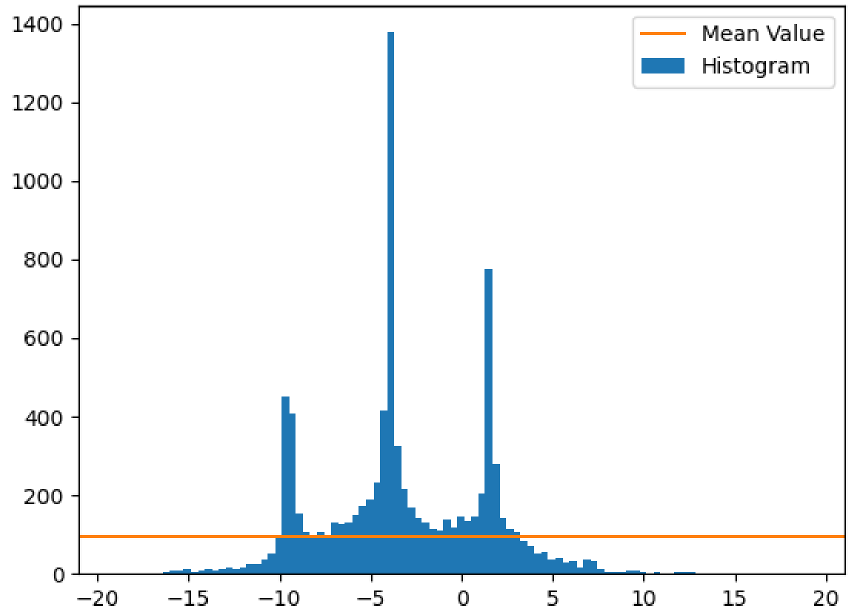
- Shape detecting framework
- Used a slight variation of the original

FIND RELEVANT AREA

The data is noisy, and we are only interested in a single line.

We don't want to consider all points, so we first find an estimation for the edge position.

Revisited – seems to miss some fine-tuning.



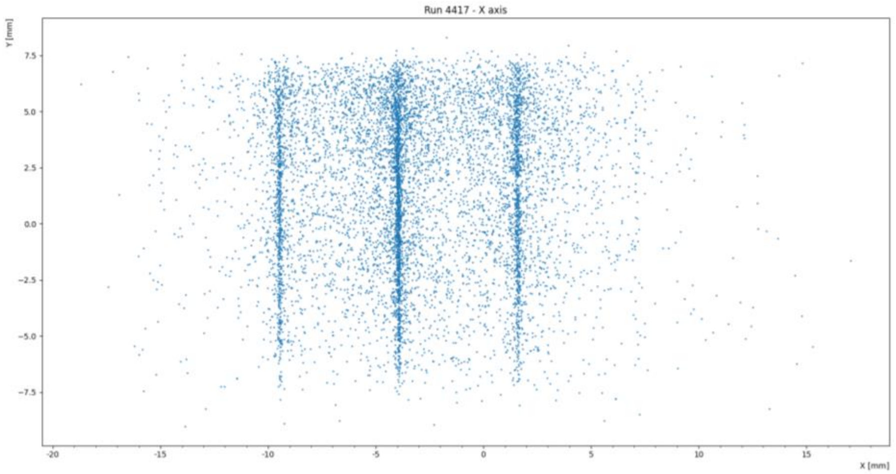


Image and parameter space

variables

$$y = mx + b$$

parameters

variables

$$y - mx = b$$

parameters

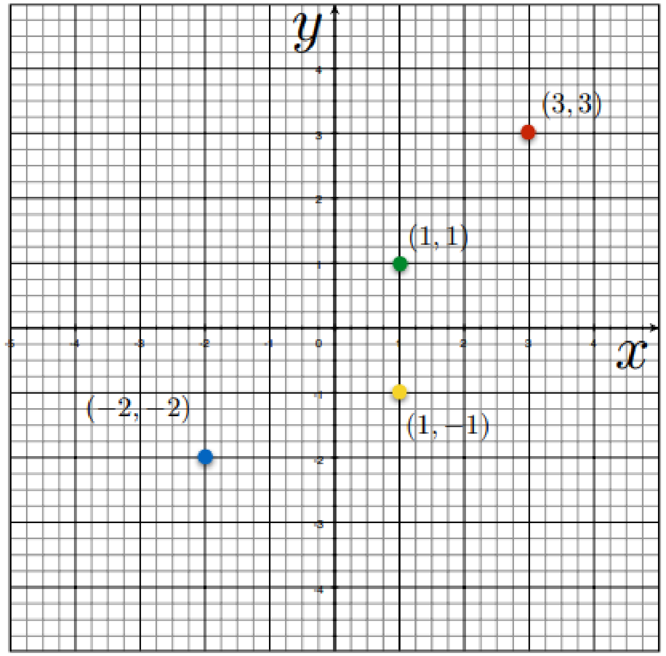
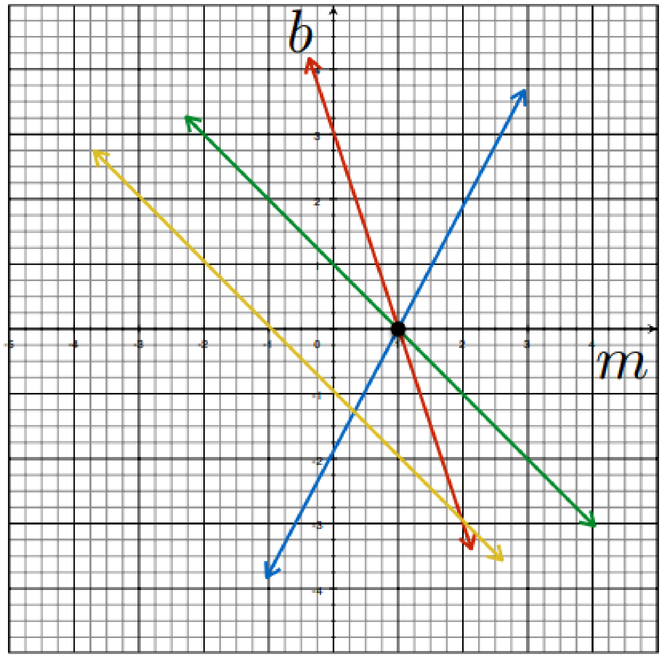


Image space

four points become ?

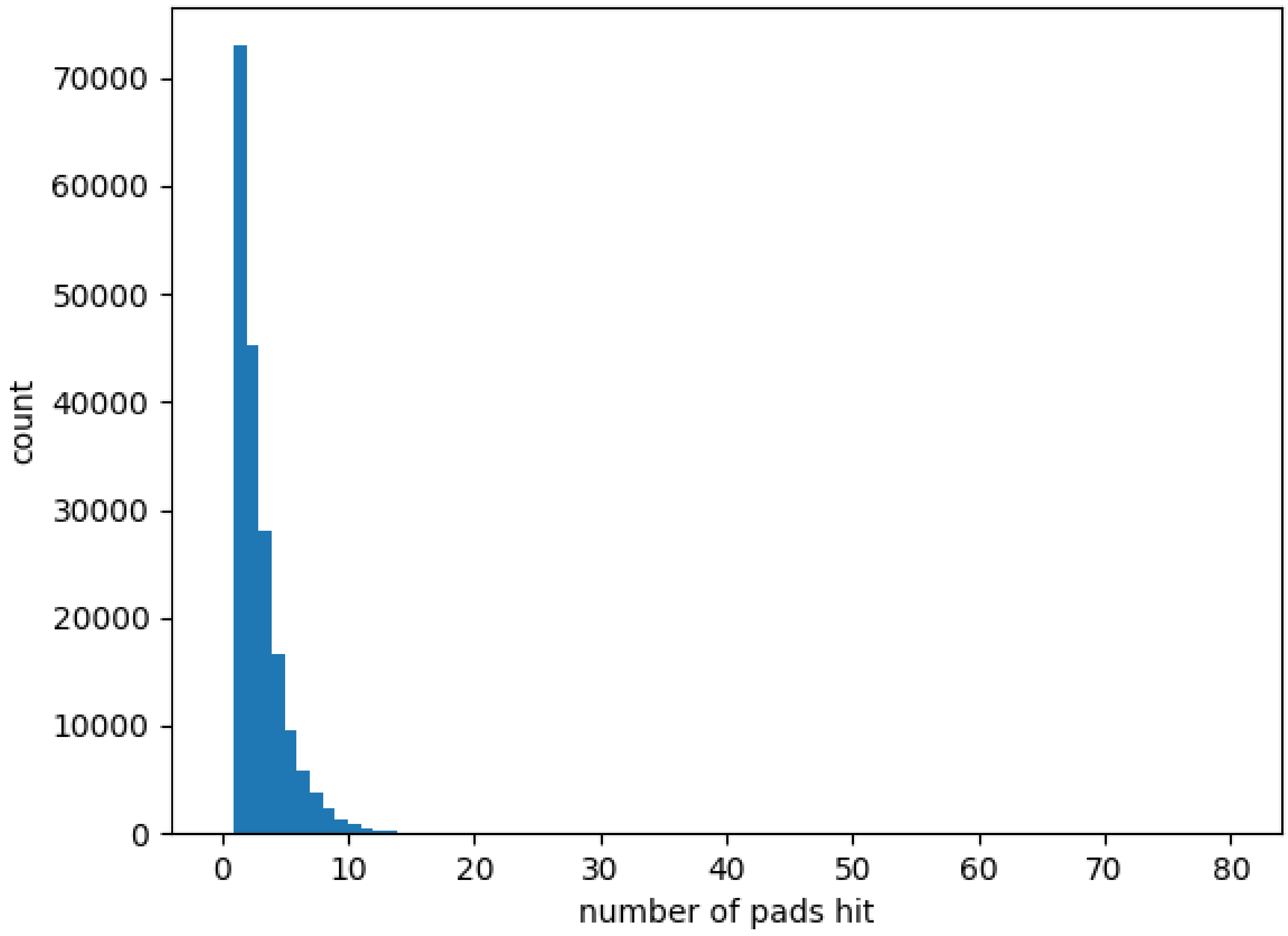


Parameter space

Slide taken from: https://www.cs.cmu.edu/~16385/s17/Slides/5.3_Hough_Transform.pdf

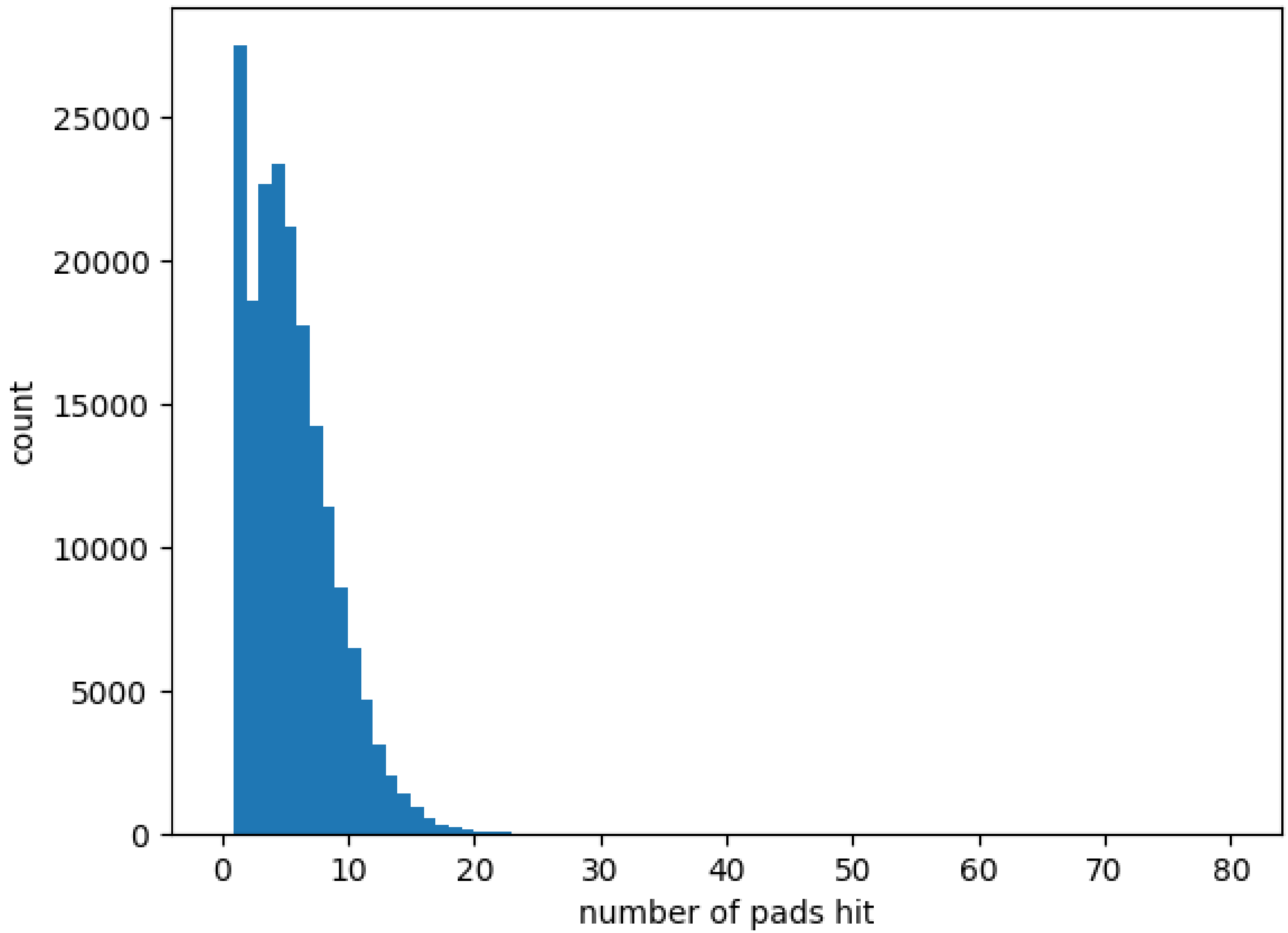
GaAs

Layer 1


70000
60000
50000
40000
30000
20000
10000
0
count
0
10
20
30
40
50
60
70
80
number of pads hit

GaAs

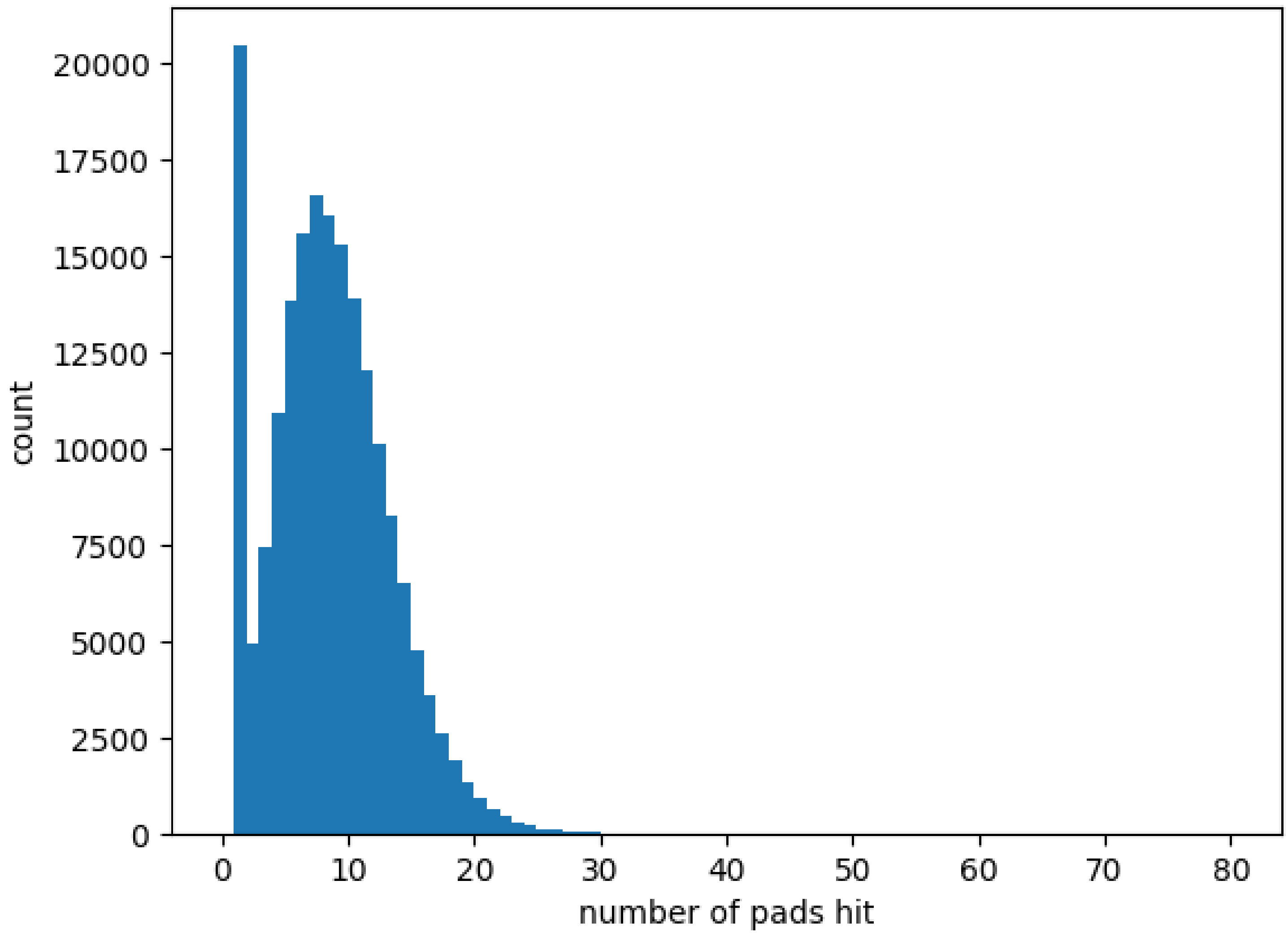
Layer 2



25000
20000
15000
10000
5000
0
count
0
10
20
30
40
50
60
70
80
number of pads hit

GaAs

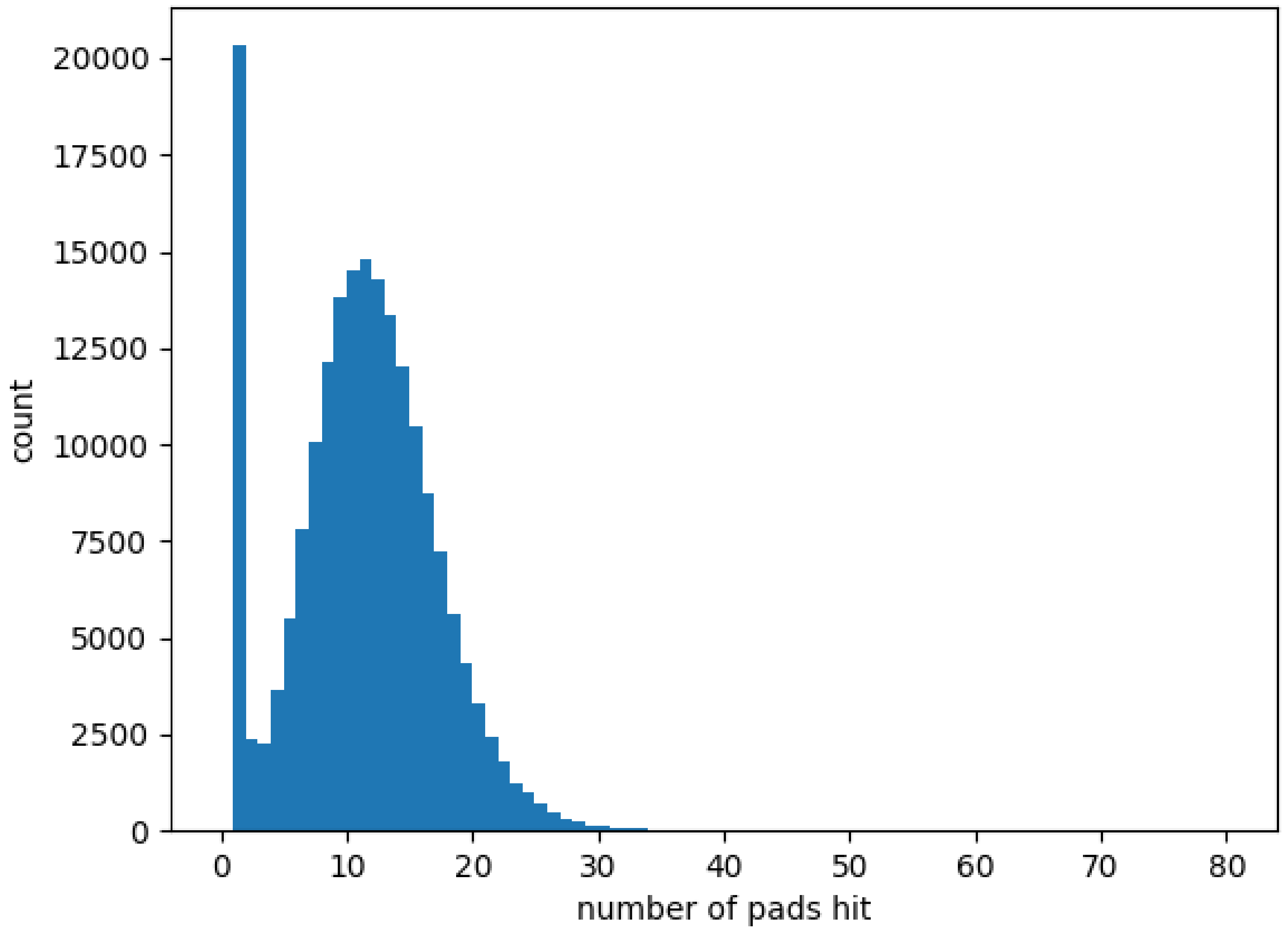
Layer 3



20000
17500
15000
12500
10000
7500
5000
2500
0
count
0
10
20
30
40
50
60
70
80
number of pads hit

GaAs

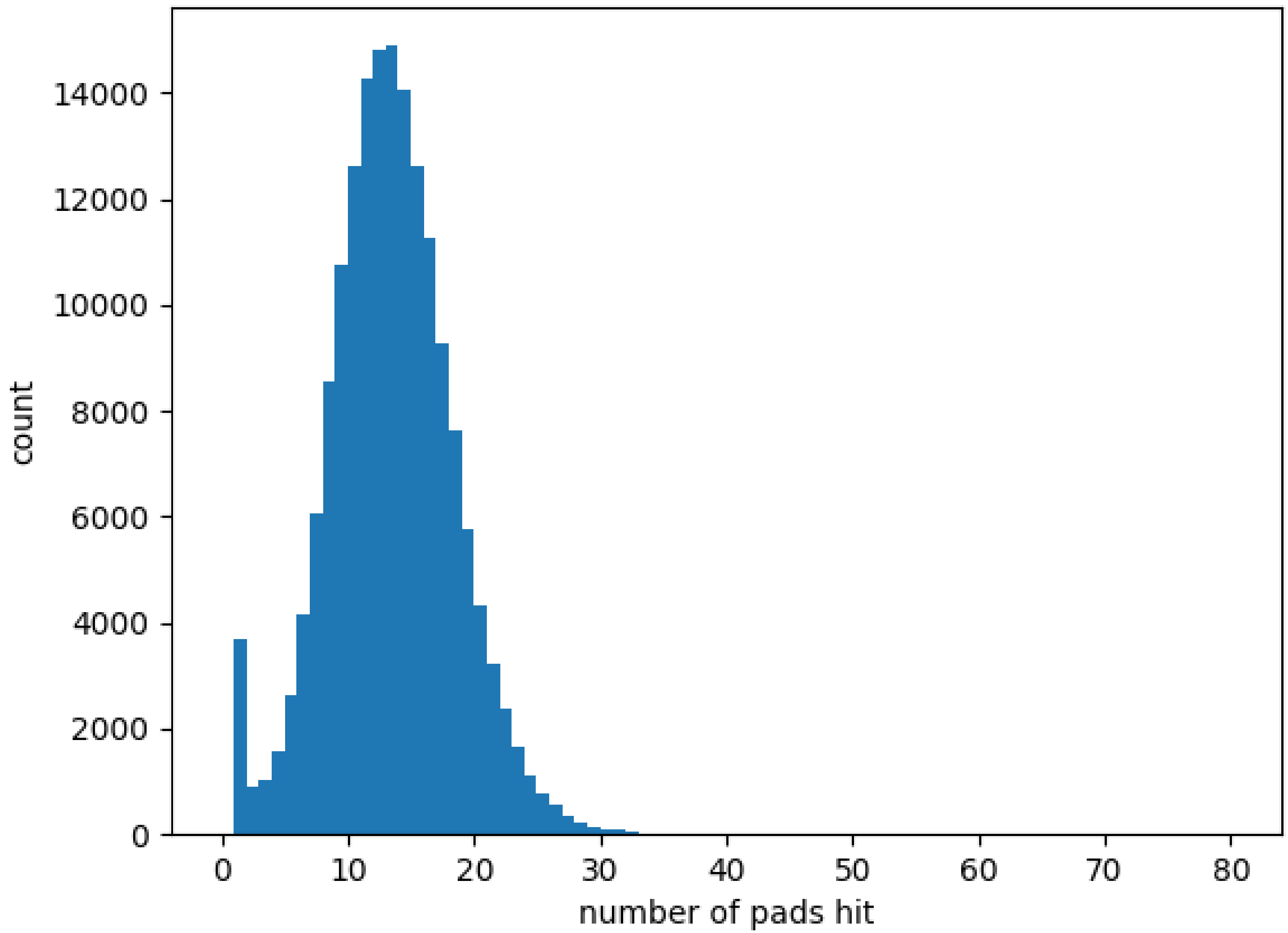
Layer 4



count
20000
17500
15000
12500
10000
7500
5000
2500
0
0
10
20
30
40
50
60
70
80
number of pads hit

GaAs

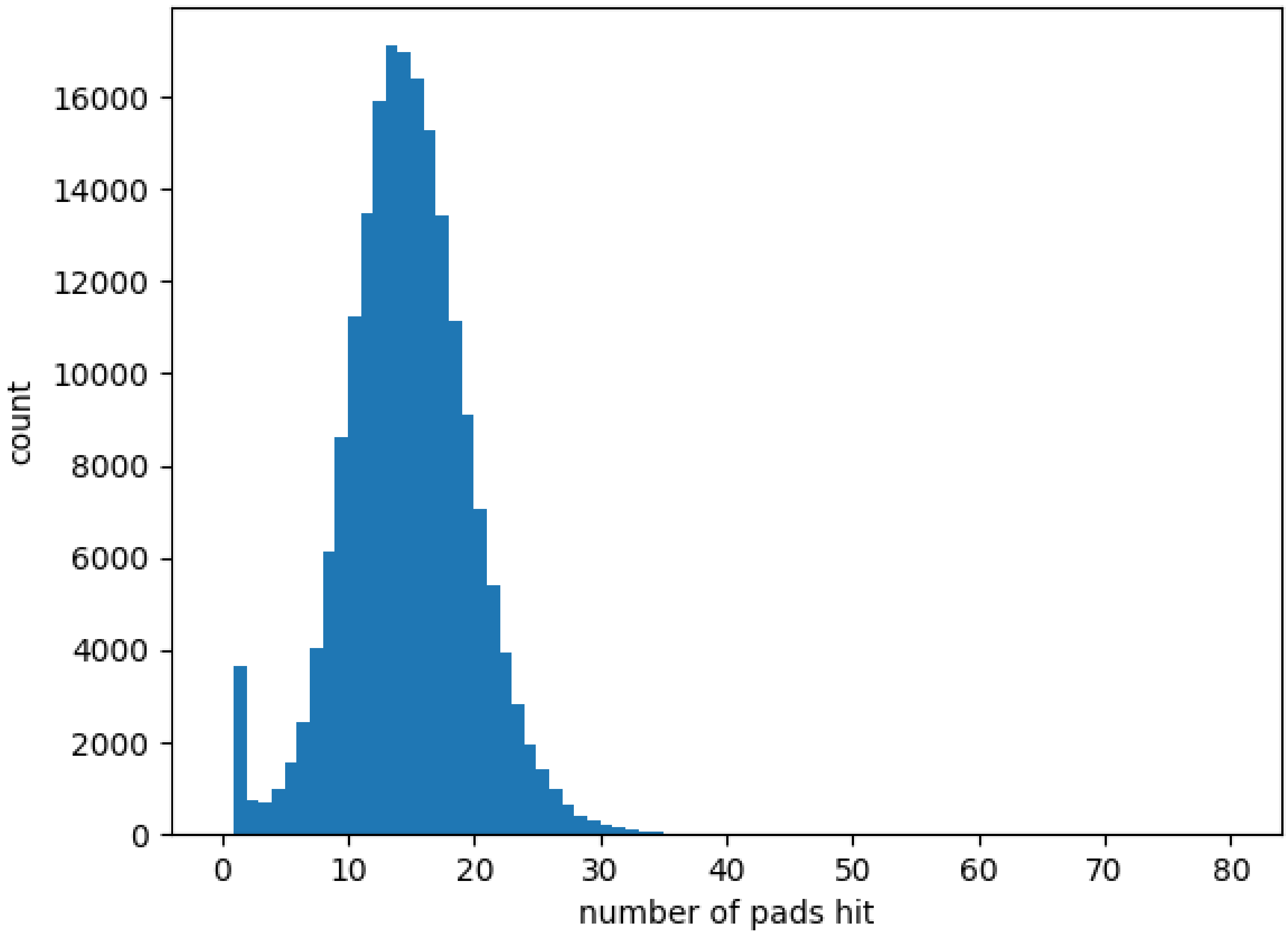
Layer 5



14000
12000
10000
8000
6000
4000
2000
0
count
0
10
20
30
40
50
60
70
80
number of pads hit

GaAs

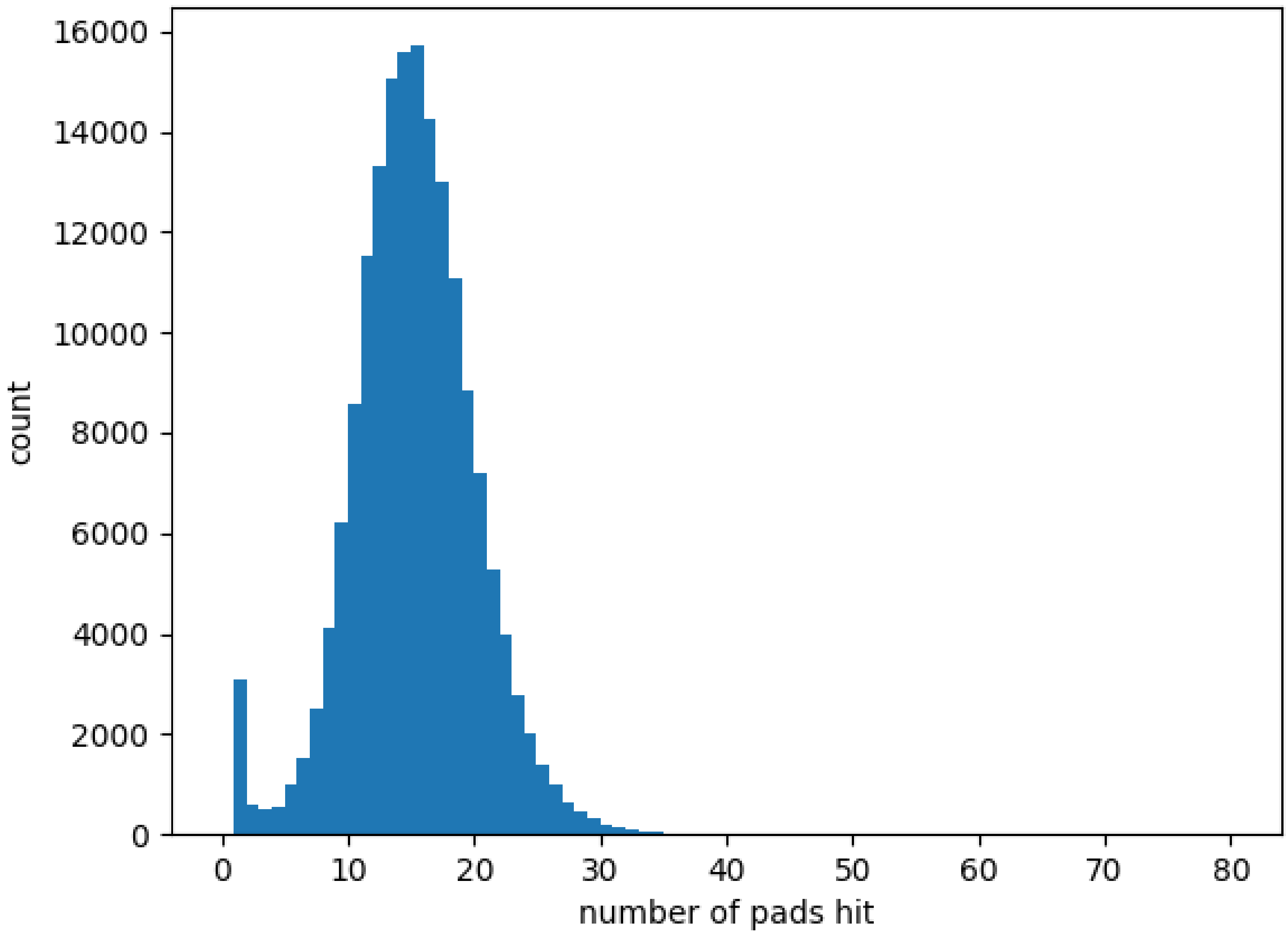
Layer 6



16000
14000
12000
10000
8000
6000
4000
2000
0
count
0
10
20
30
40
50
60
70
80
number of pads hit

GaAs

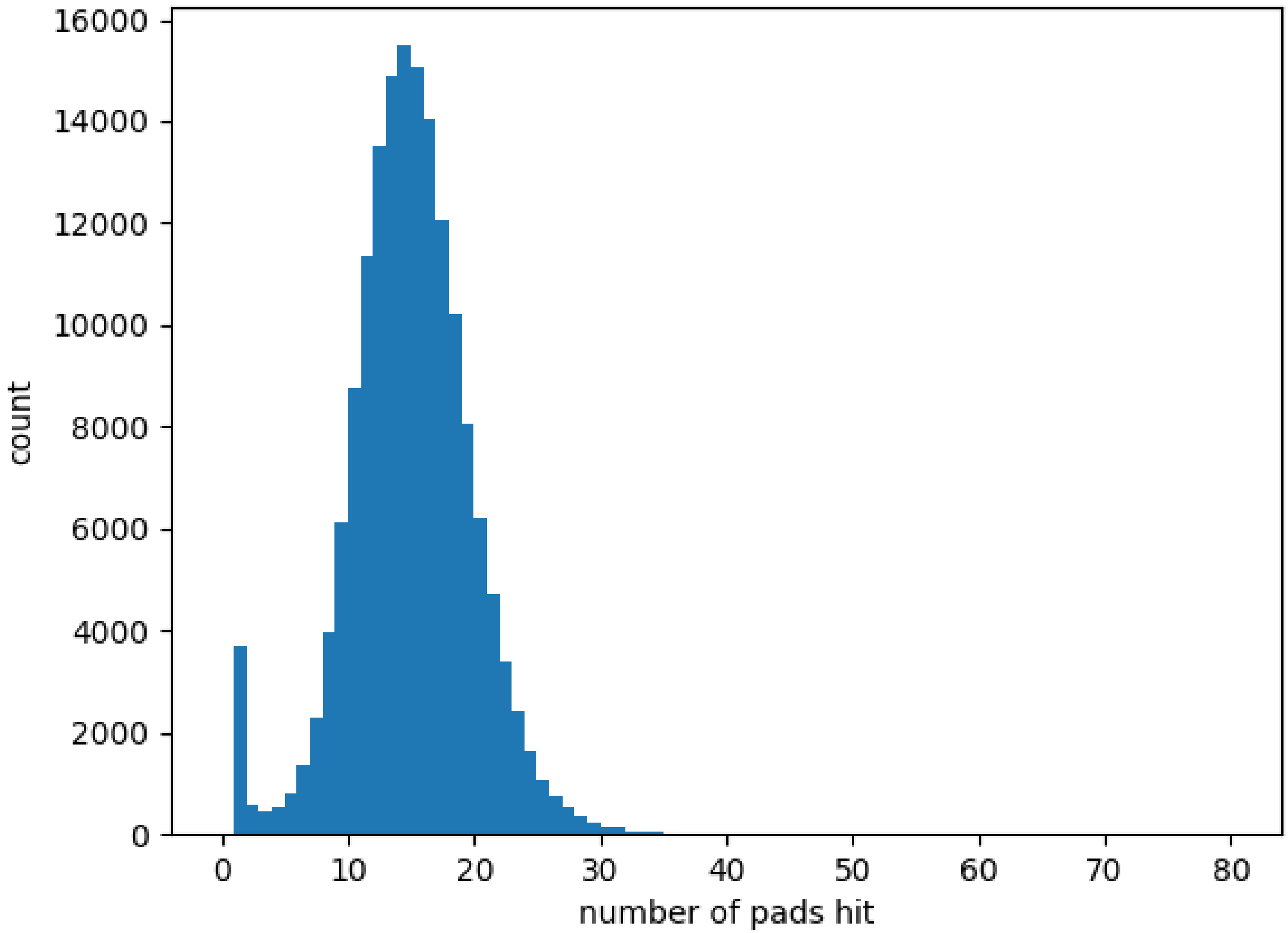
Layer 7



16000
14000
12000
10000
8000
6000
4000
2000
0
count
0
10
20
30
40
50
60
70
80
number of pads hit

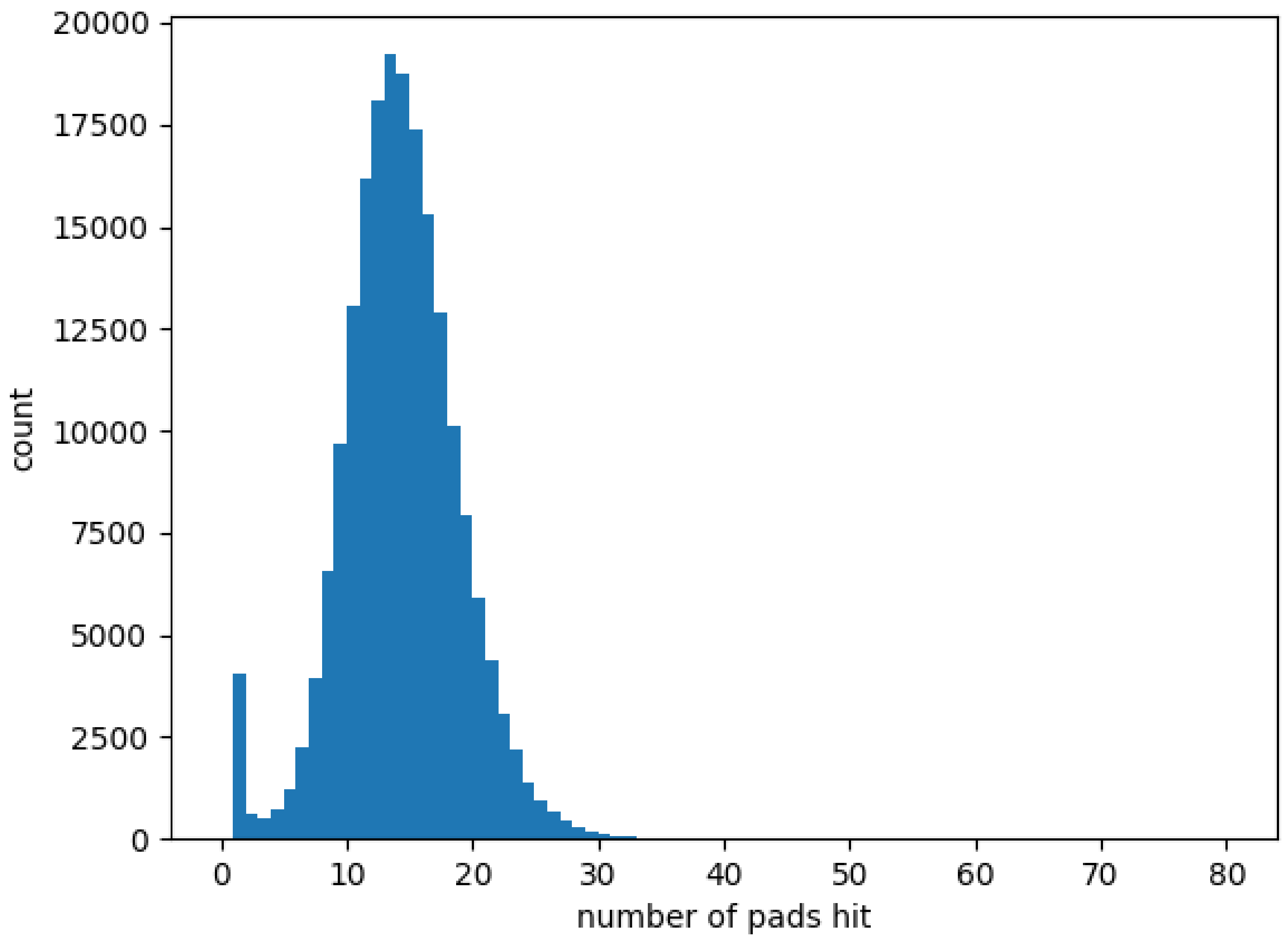
GaAs

Layer 8


16000
14000
12000
10000
8000
6000
4000
2000
0
count
0
10
20
30
40
50
60
70
80
number of pads hit

GaAs

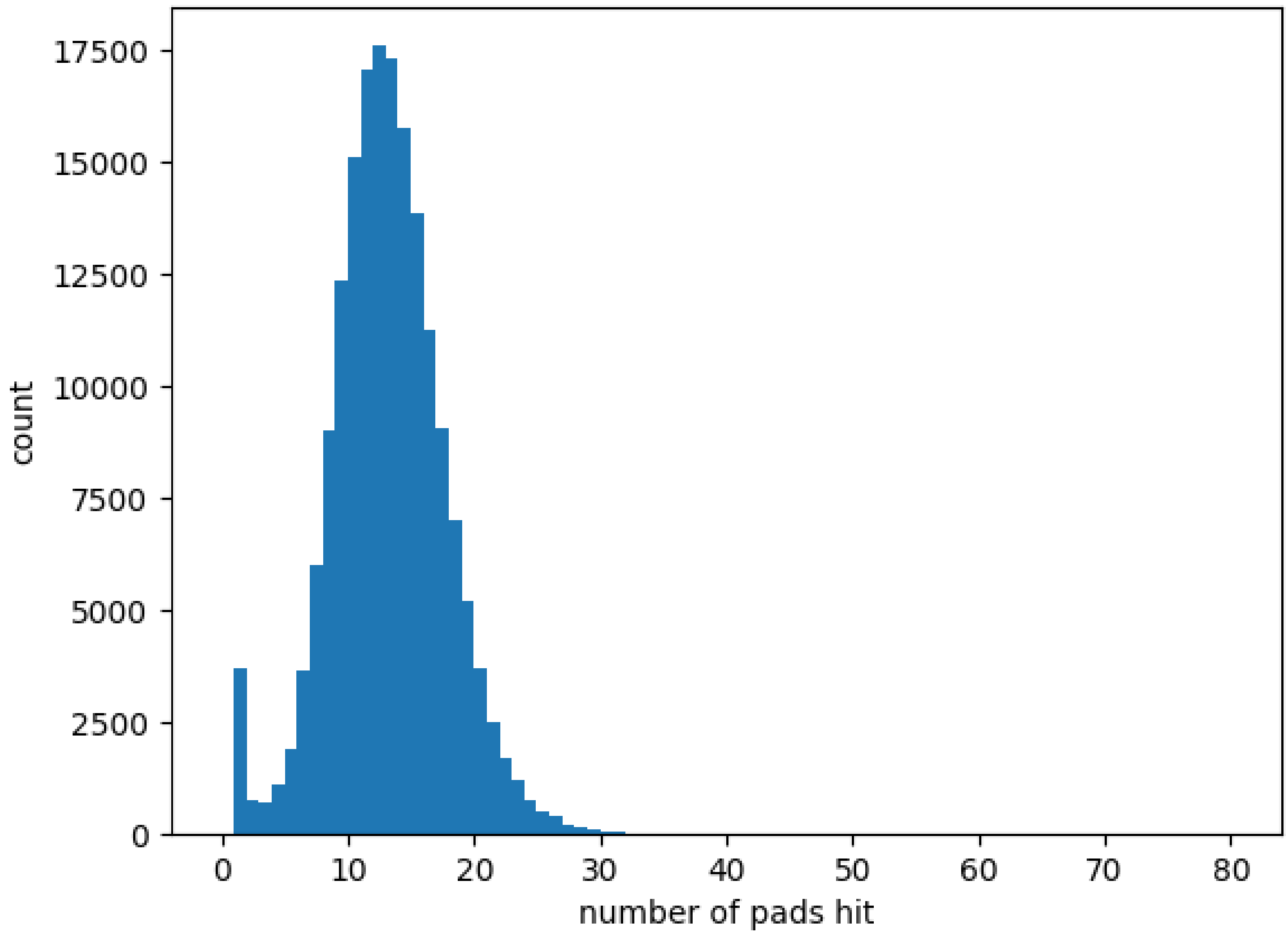
Layer 9



count
20000
17500
15000
12500
10000
7500
5000
2500
0
0
10
20
30
40
50
60
70
80
number of pads hit

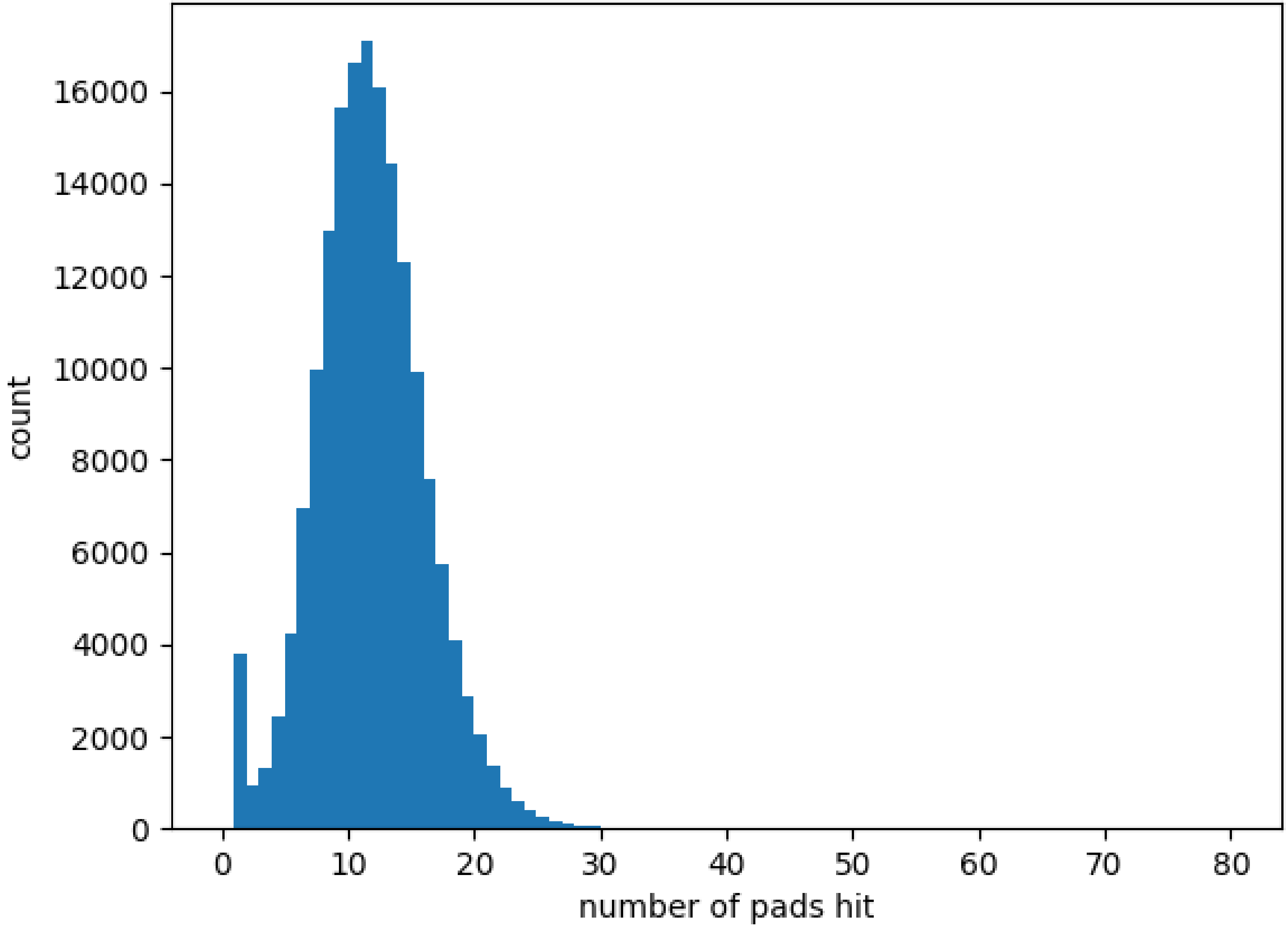
GaAs

Layer 10



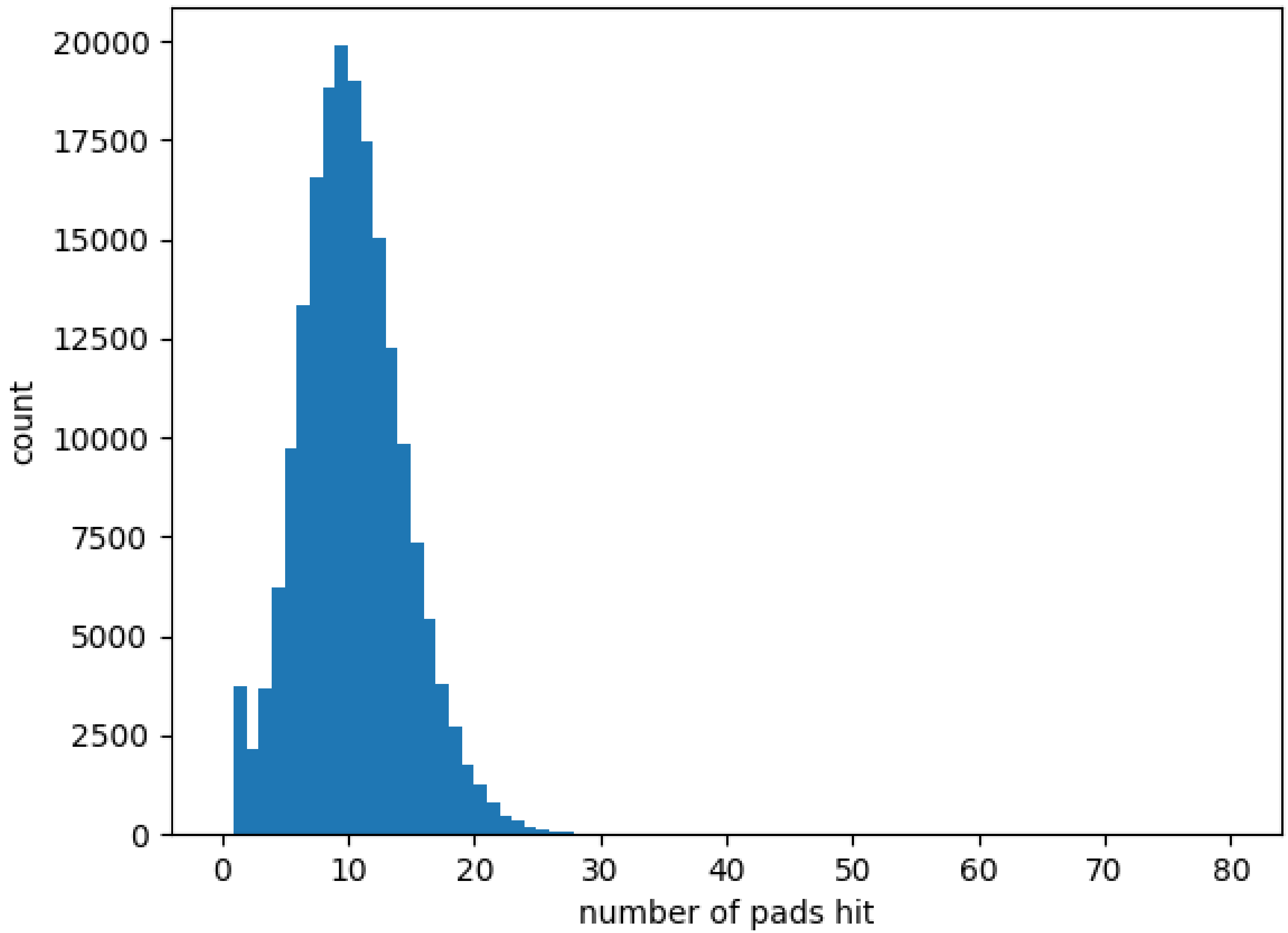
GaAs

Layer 11



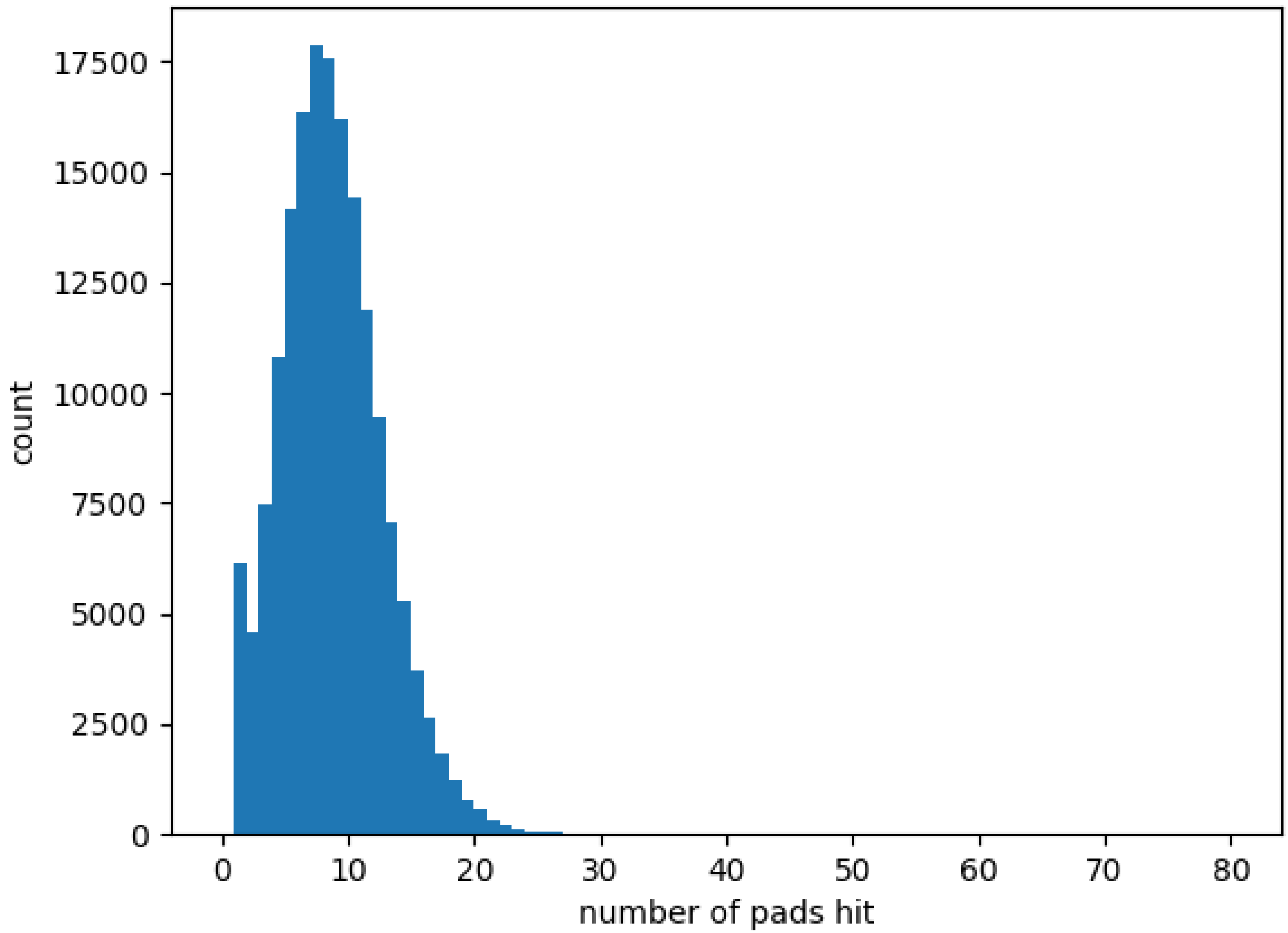
GaAs

Layer 12



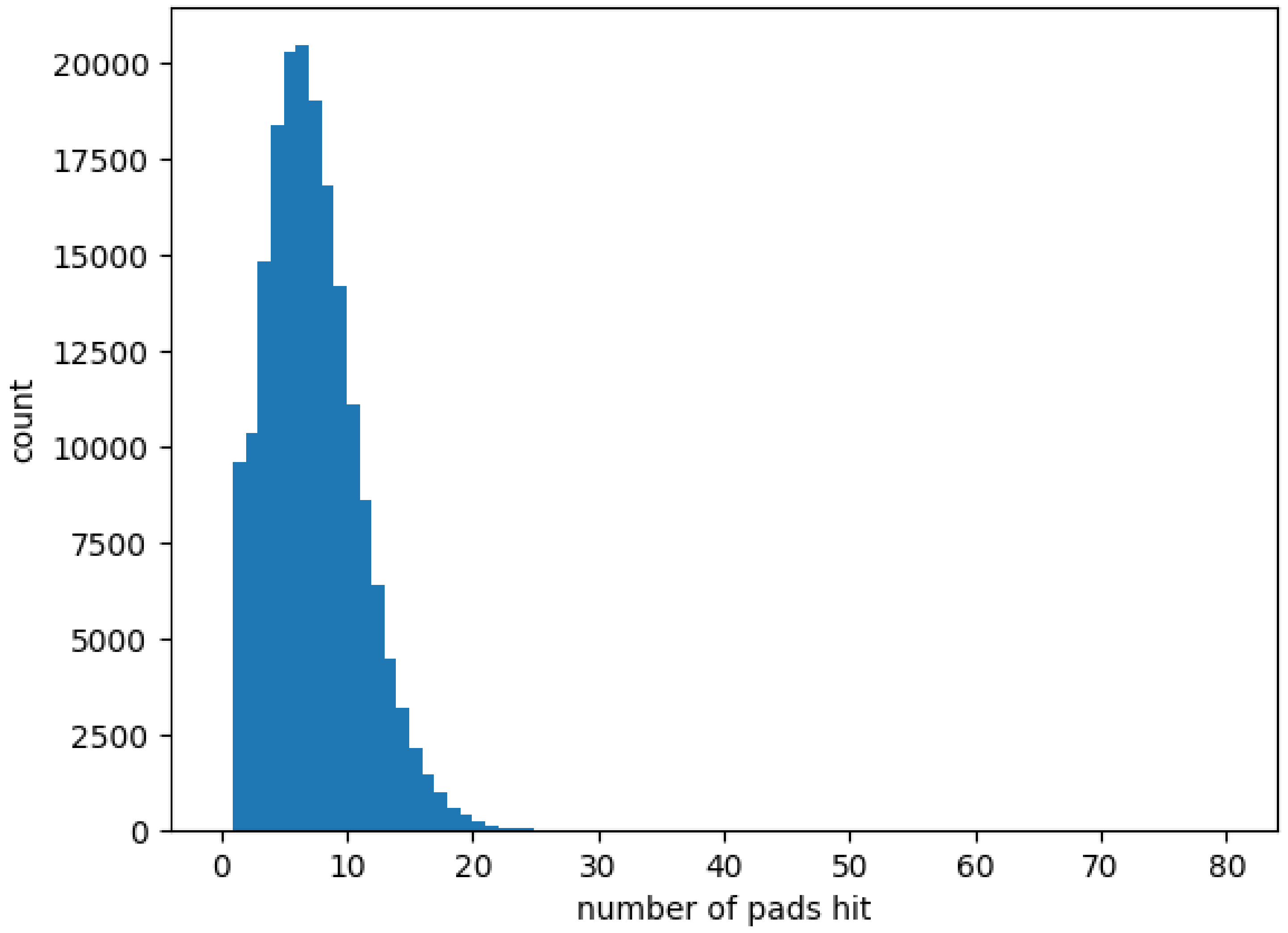
GaAs

Layer 13



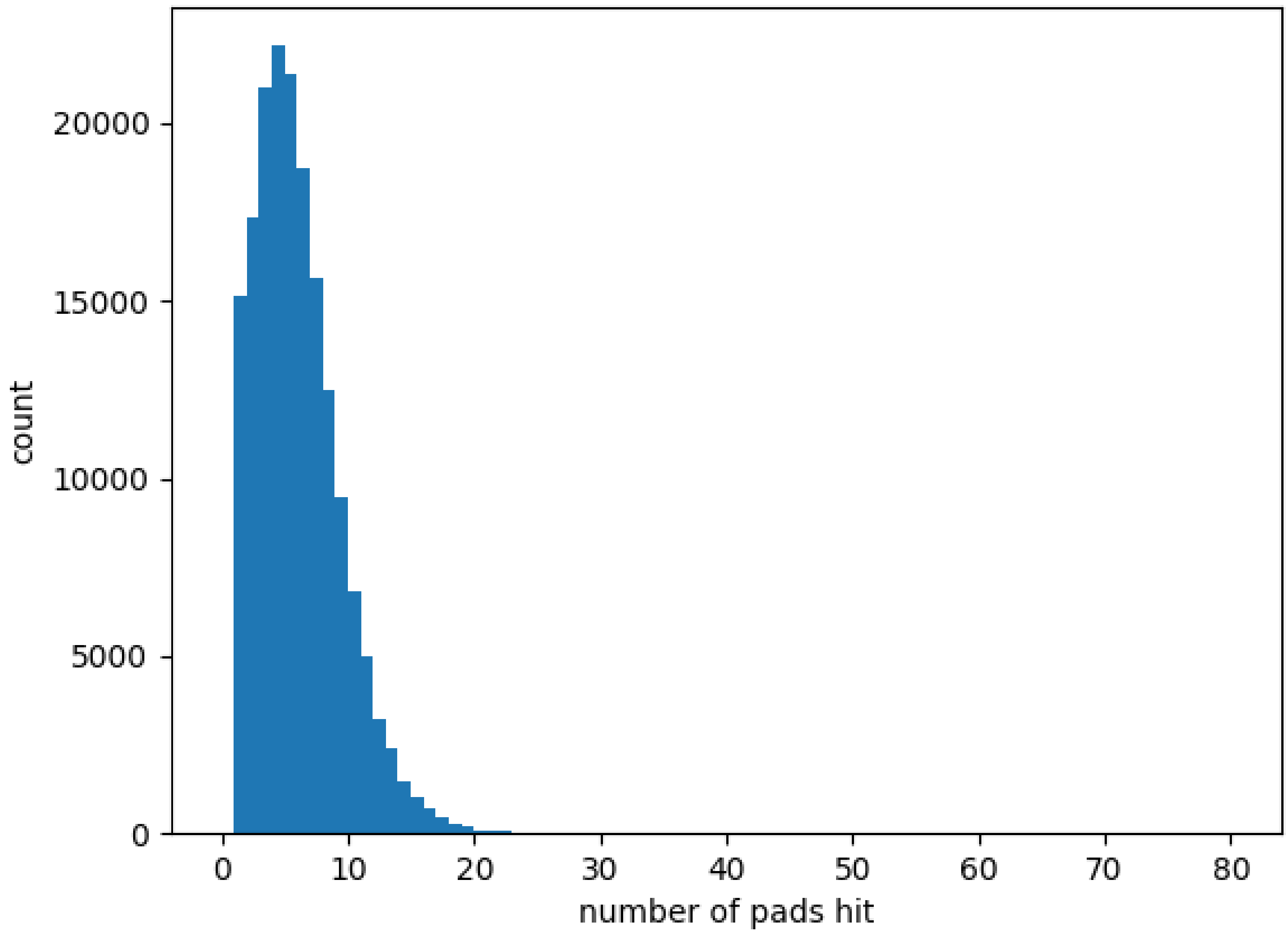
GaAs

Layer 14



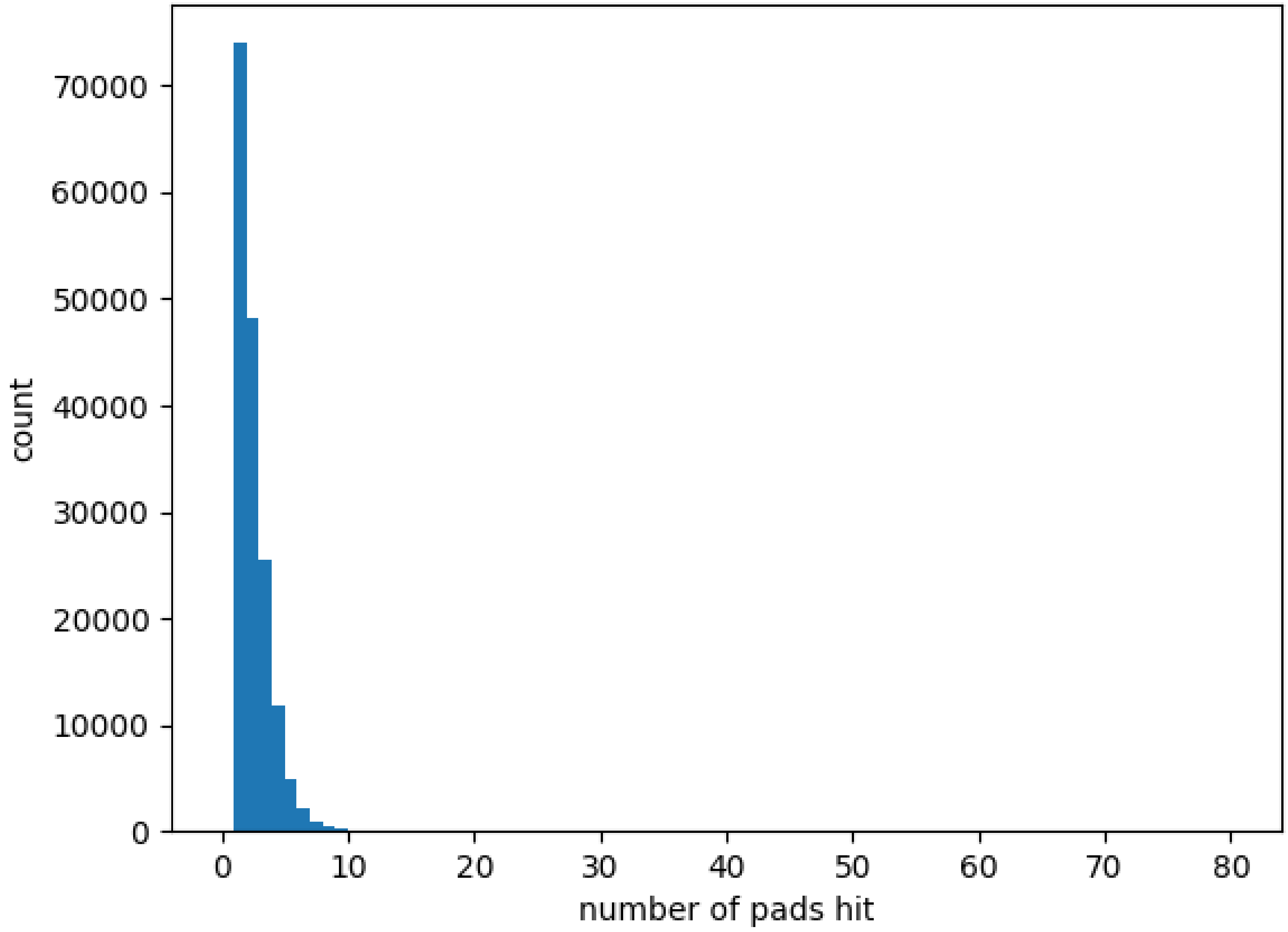
GaAs

Layer 15



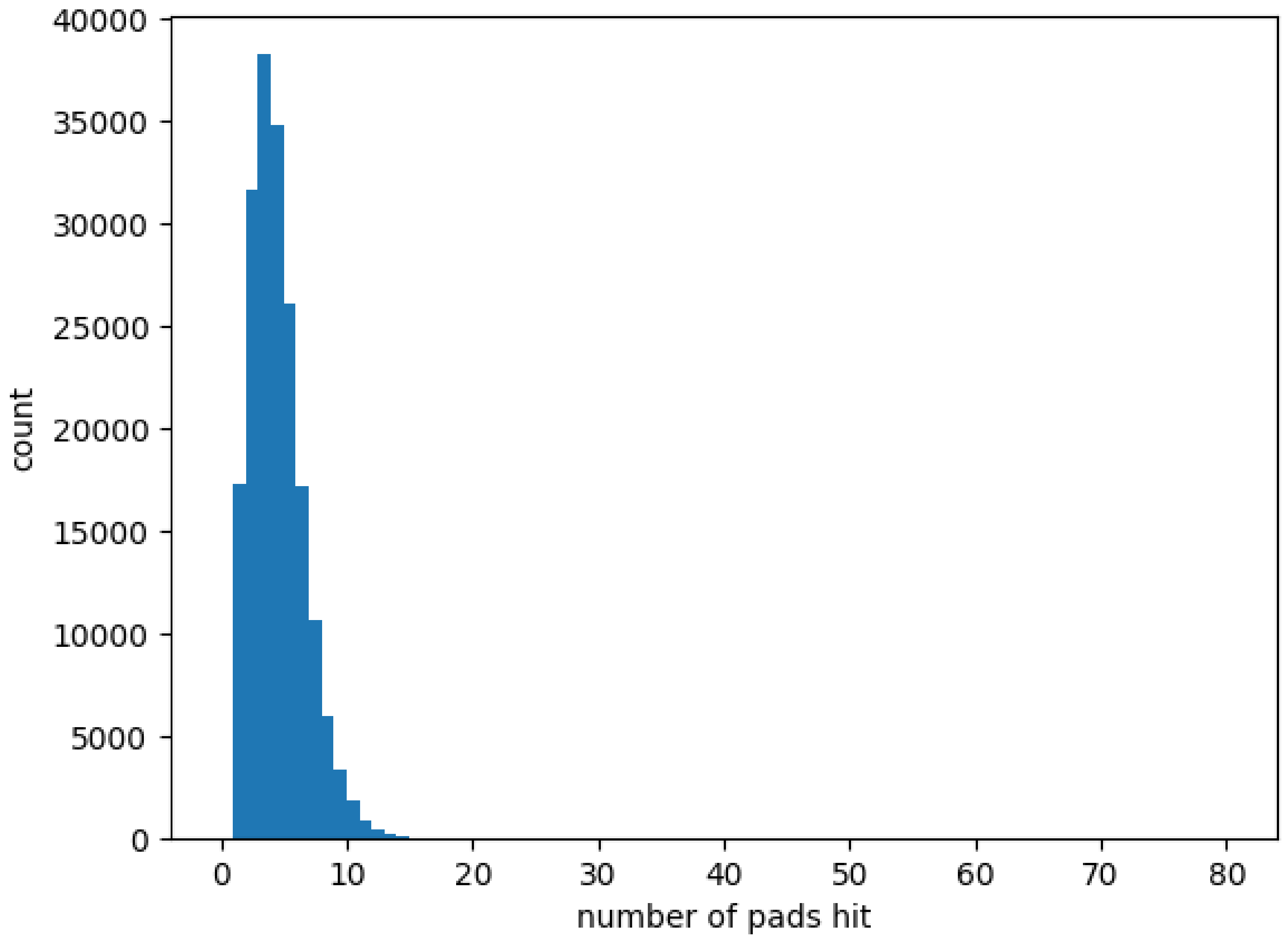
CALICE

Layer 1



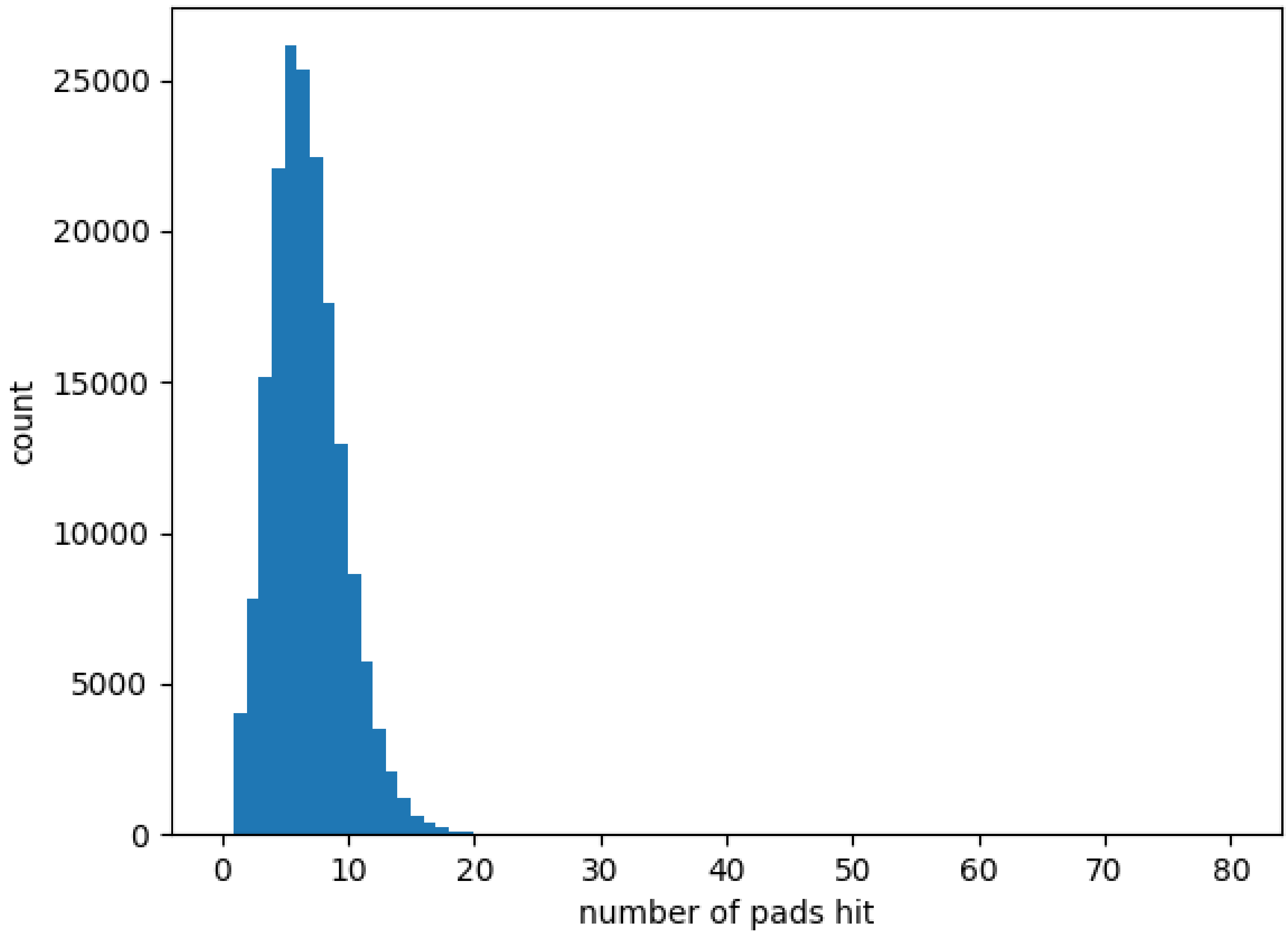
CALICE

Layer 2



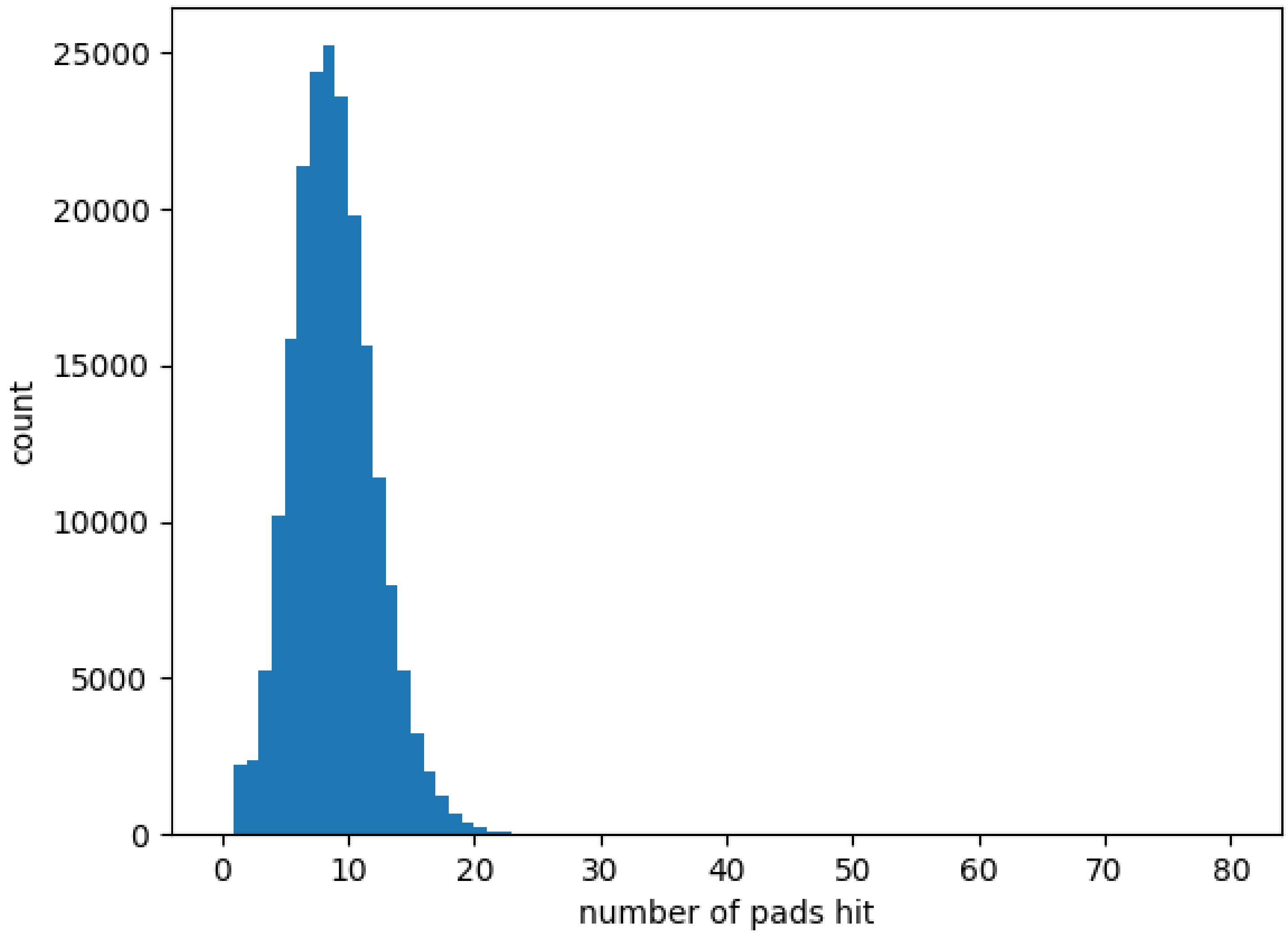
CALICE

Layer 3



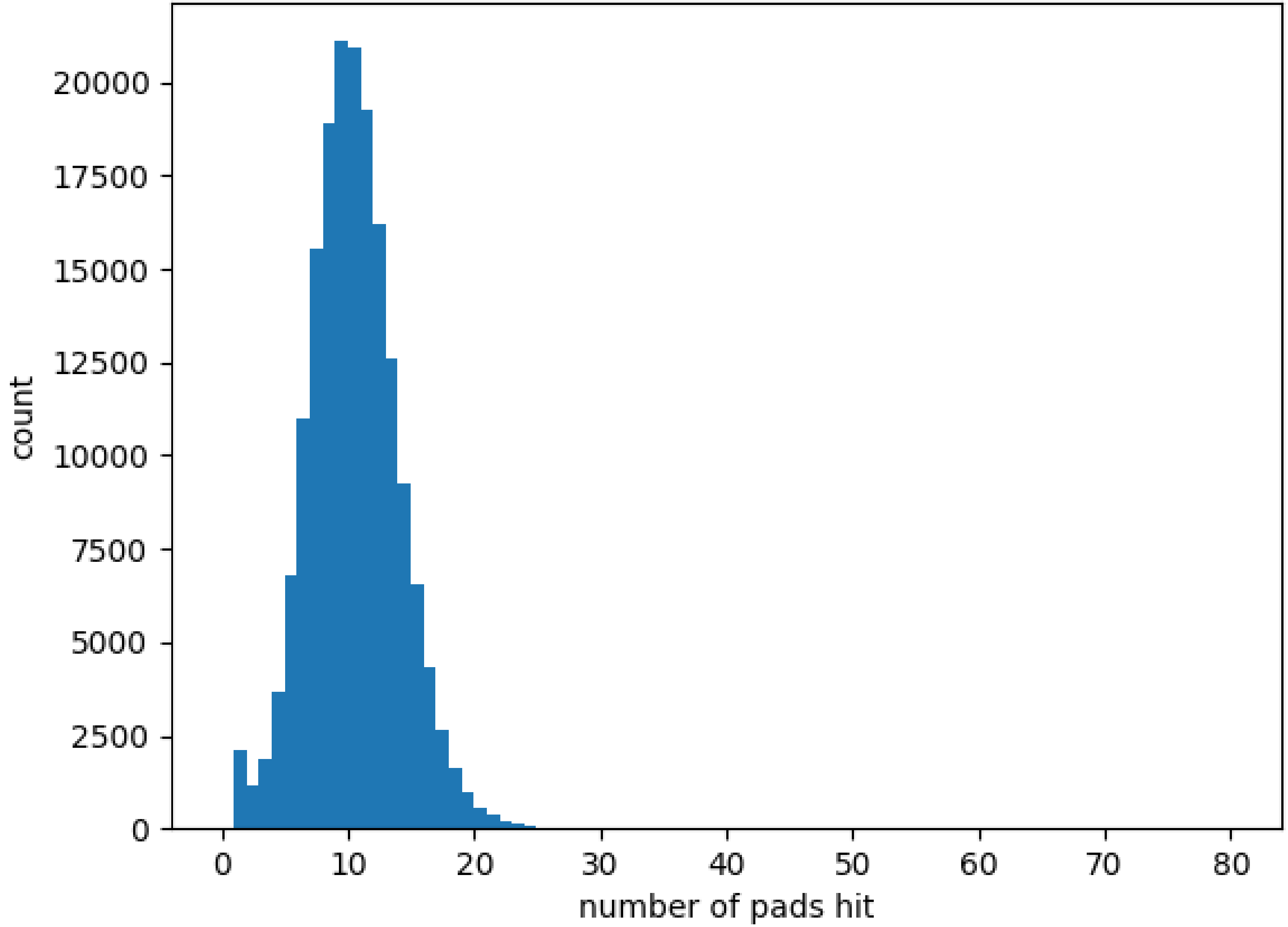
CALICE

Layer 4



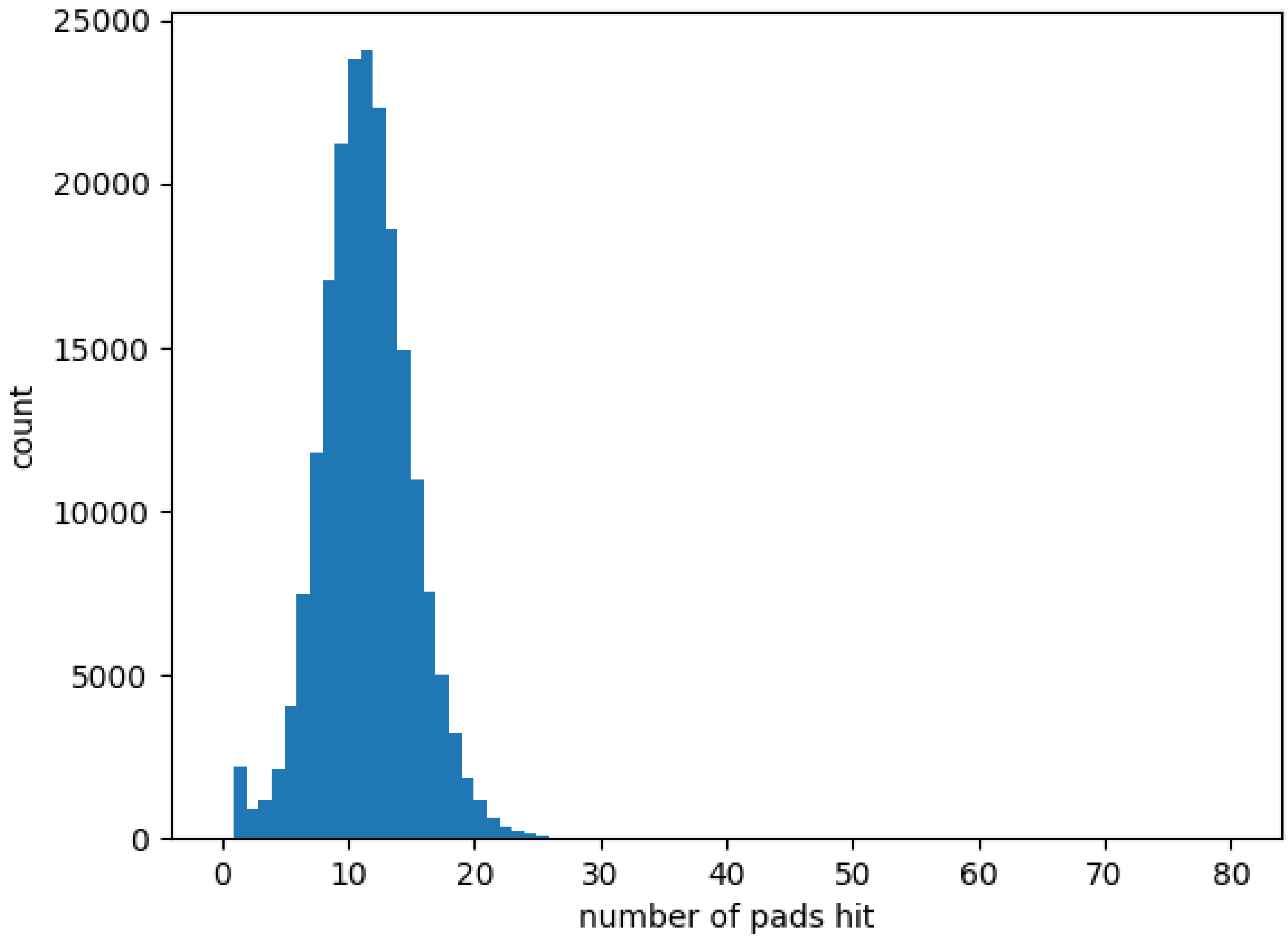
CALICE

Layer 5



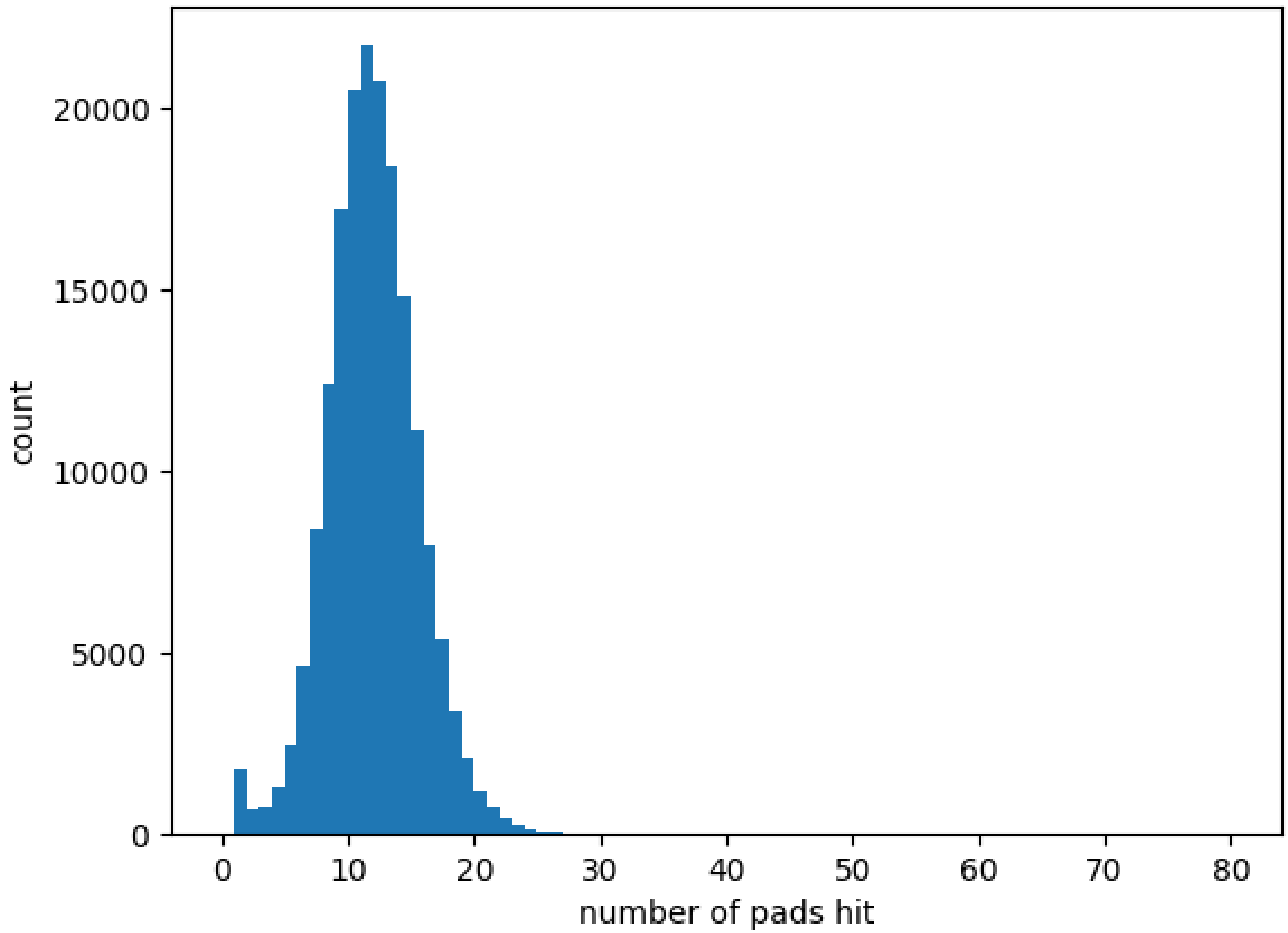
CALICE

Layer 6



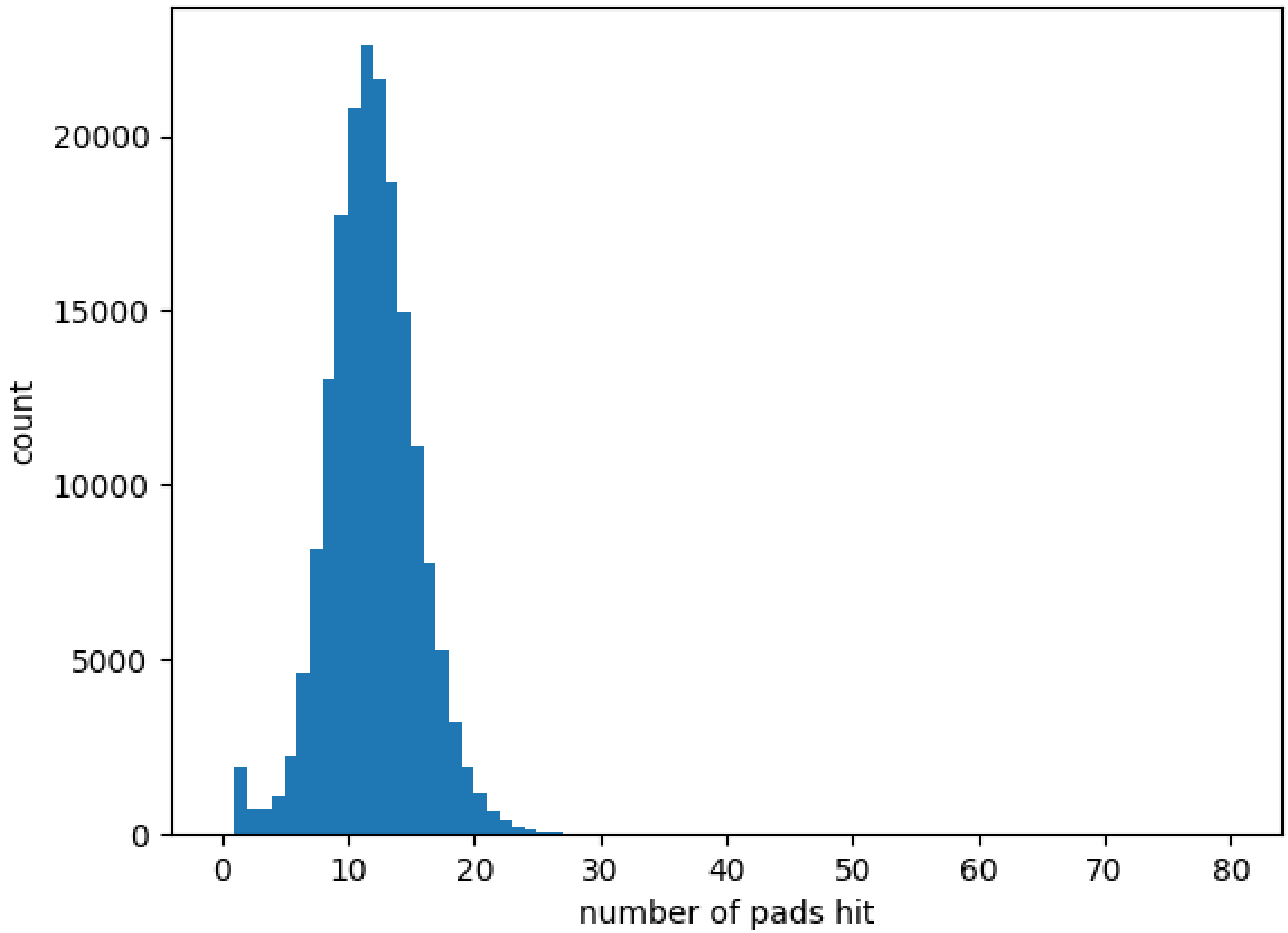
CALICE

Layer 7



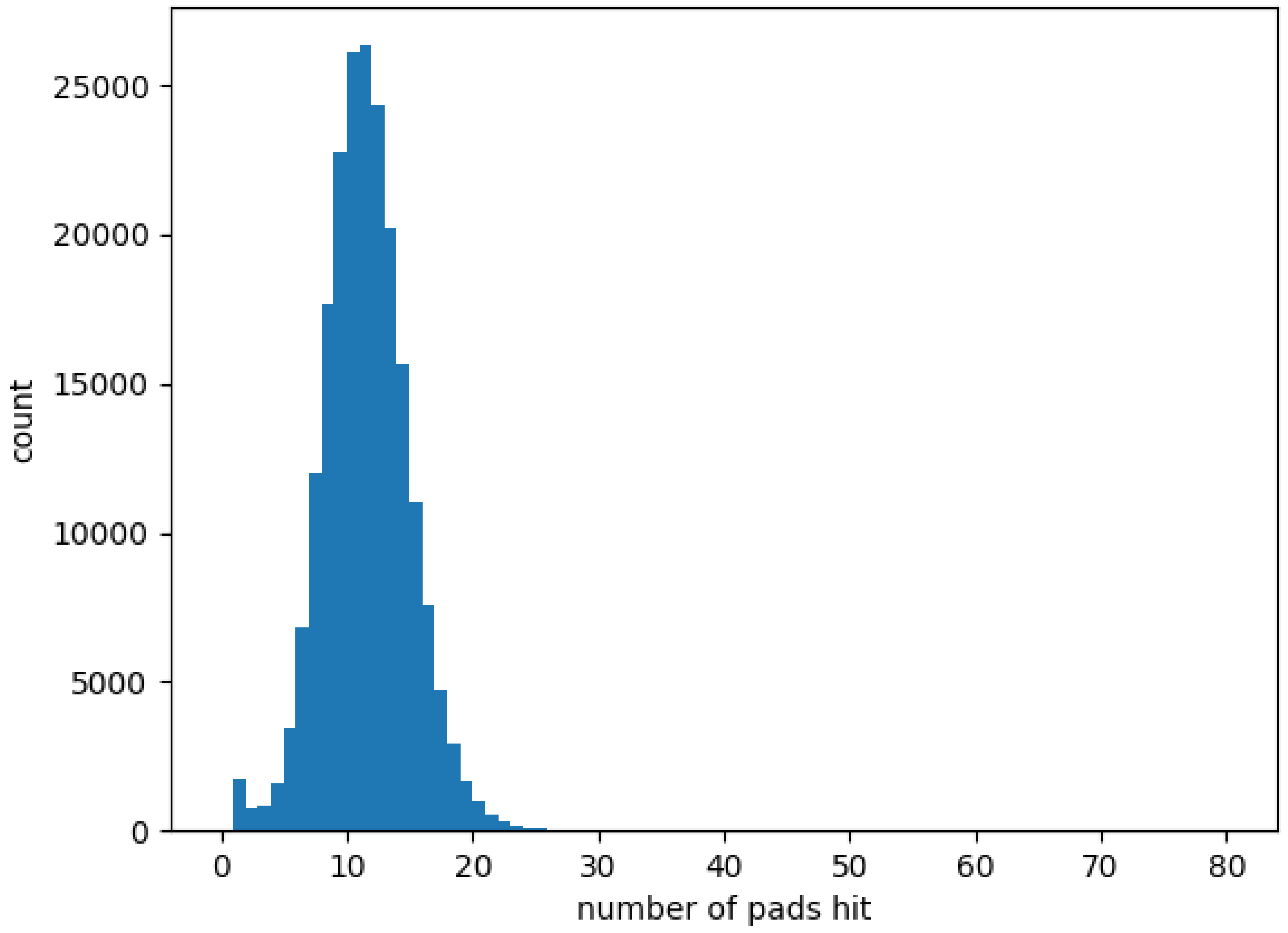
CALICE

Layer 8



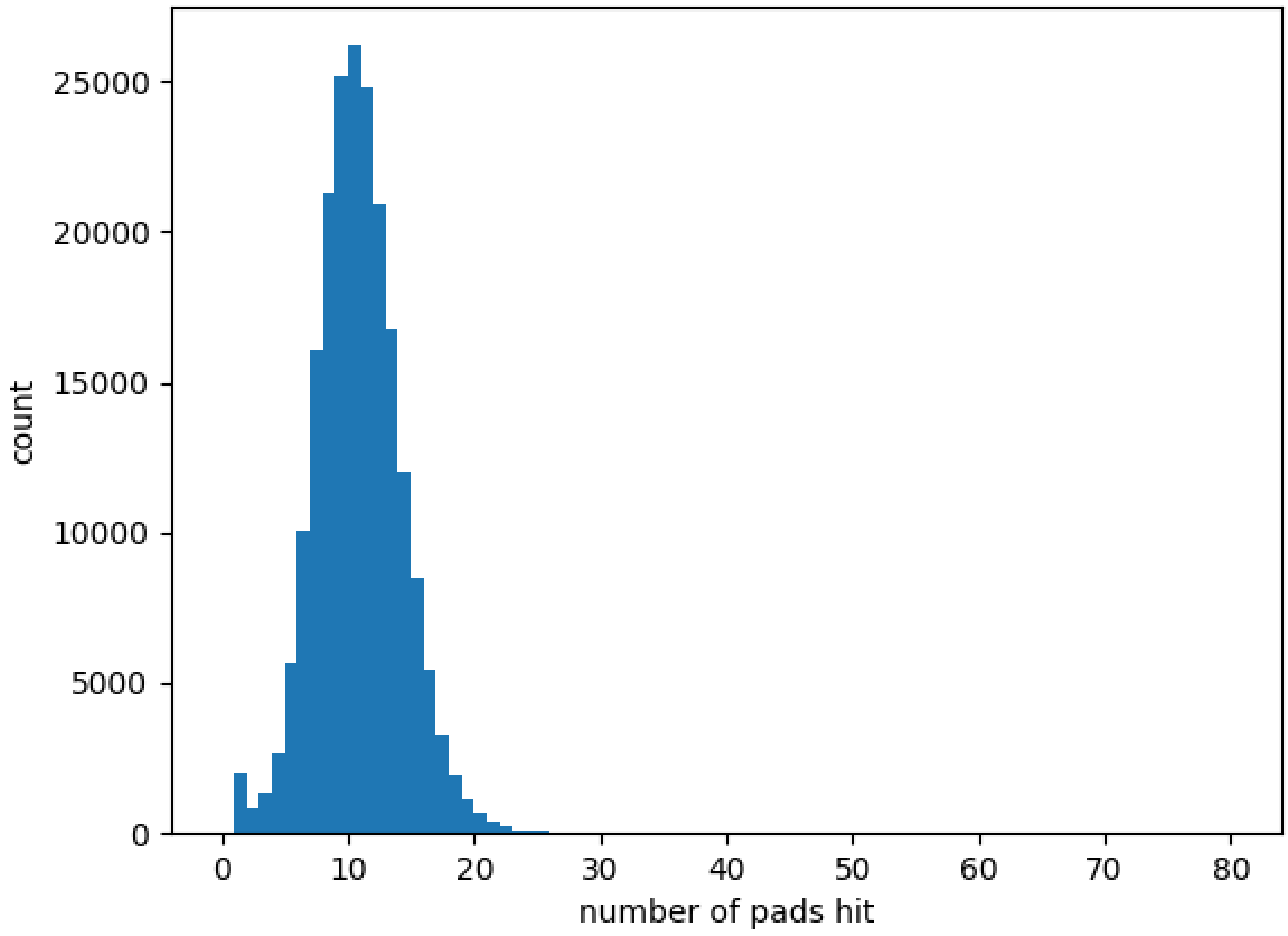
CALICE

Layer 9



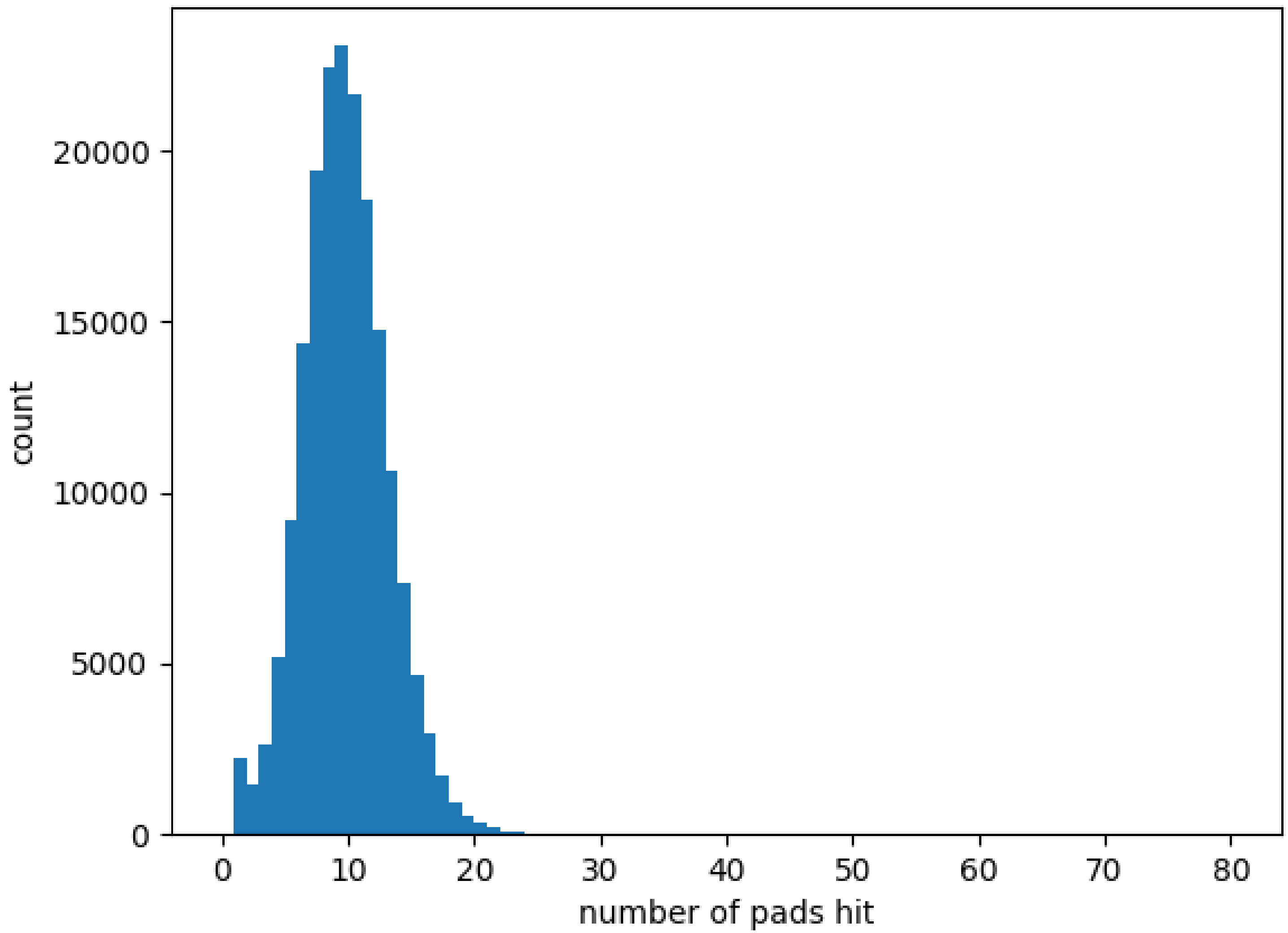
CALICE

Layer 10



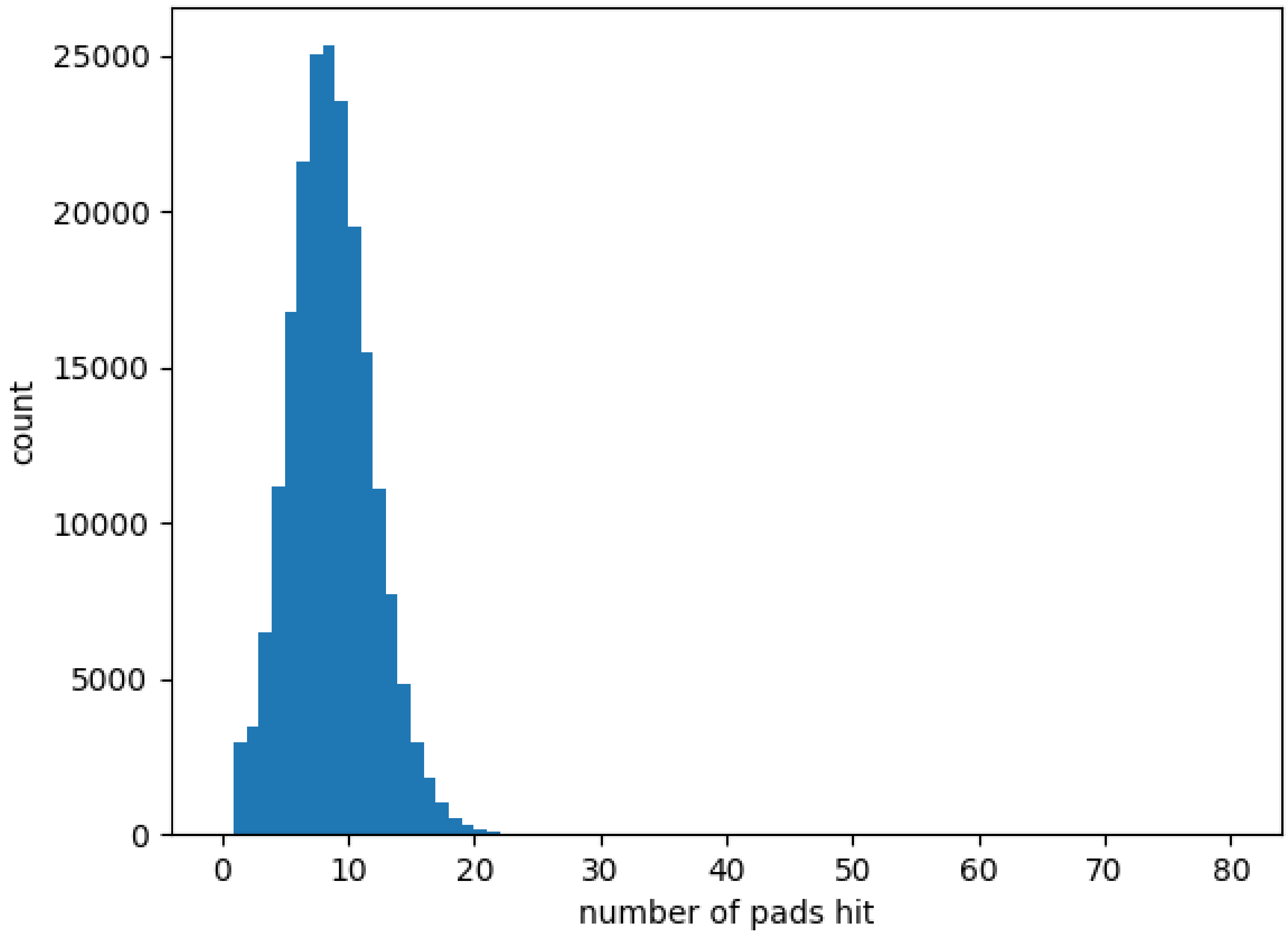
CALICE

Layer 11



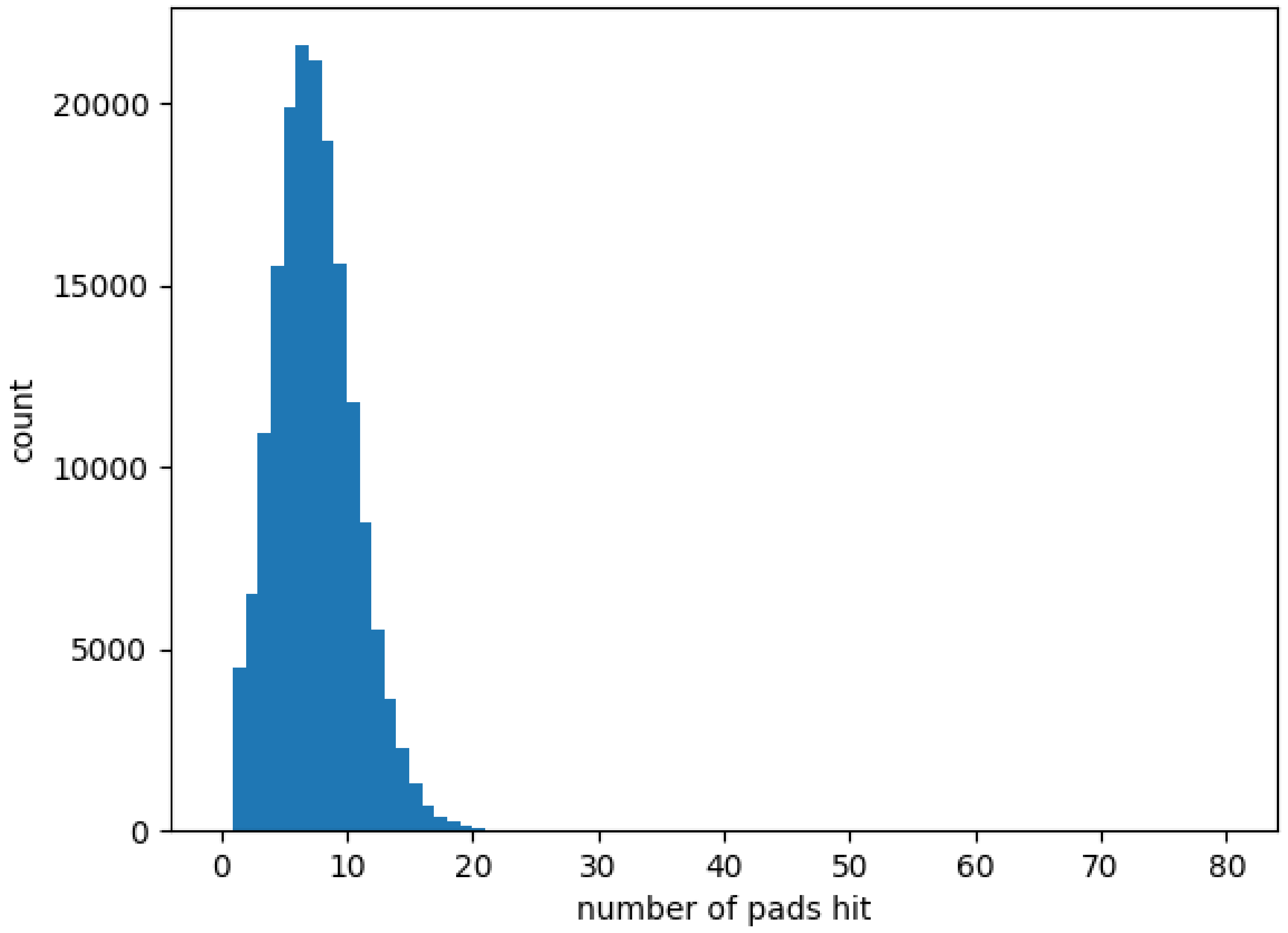
CALICE

Layer 12



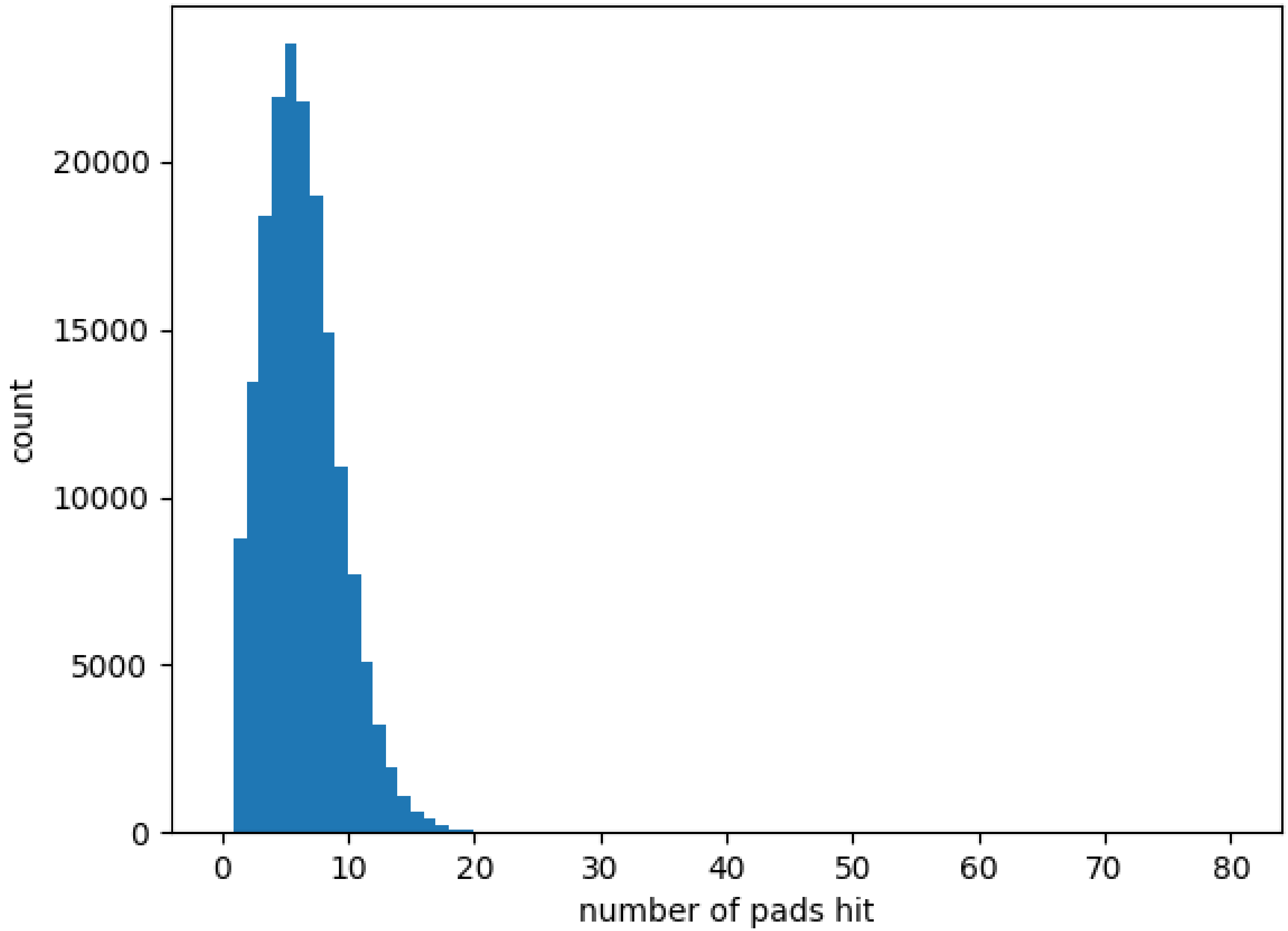
CALICE

Layer 13



CALICE

Layer 14



CALICE

Layer 15