

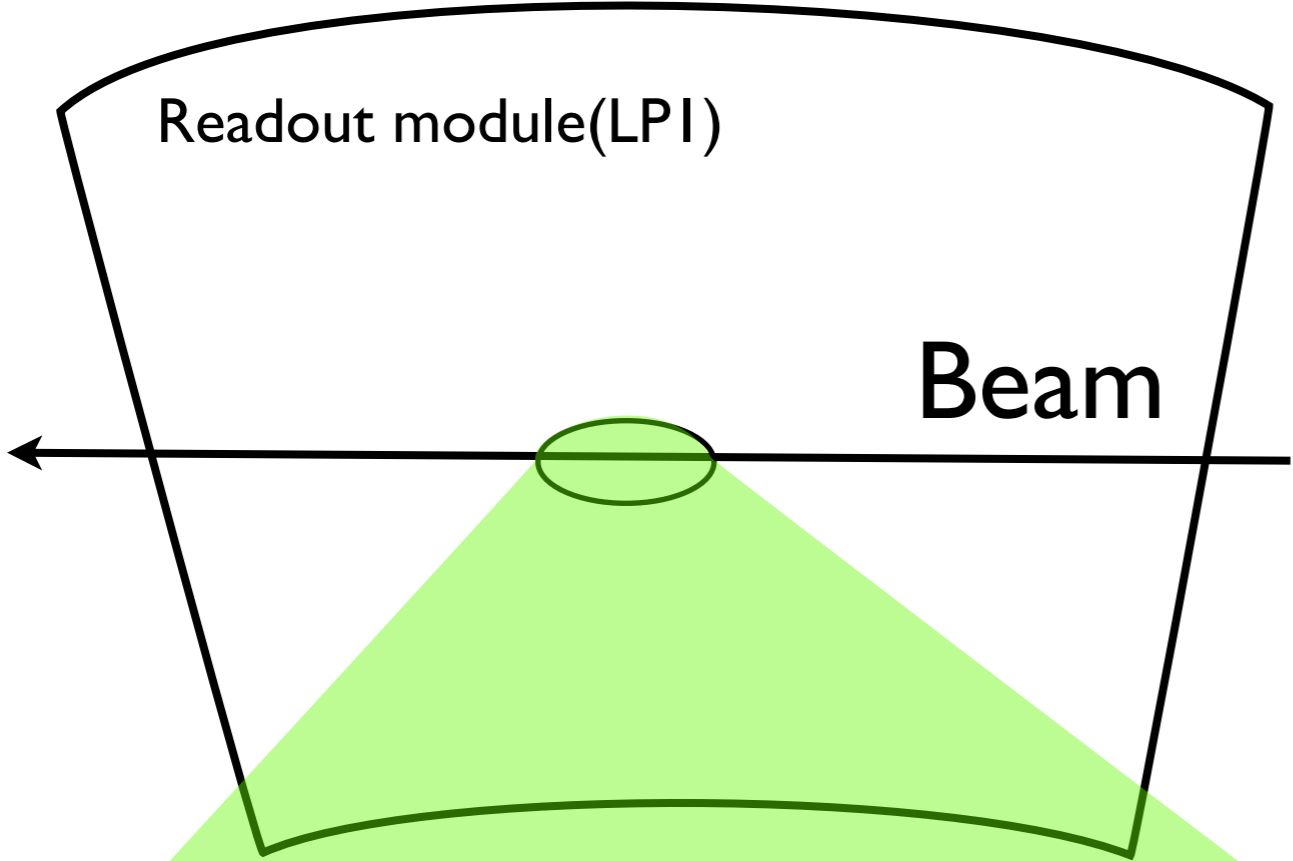
- **Study on the energy loss calculation model**
(Measurement of the mean free path with LPI beam test data)

**Previous report summary
and
Status Memo**

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31 Dec. 2009

Rough idea to measure the mean free path

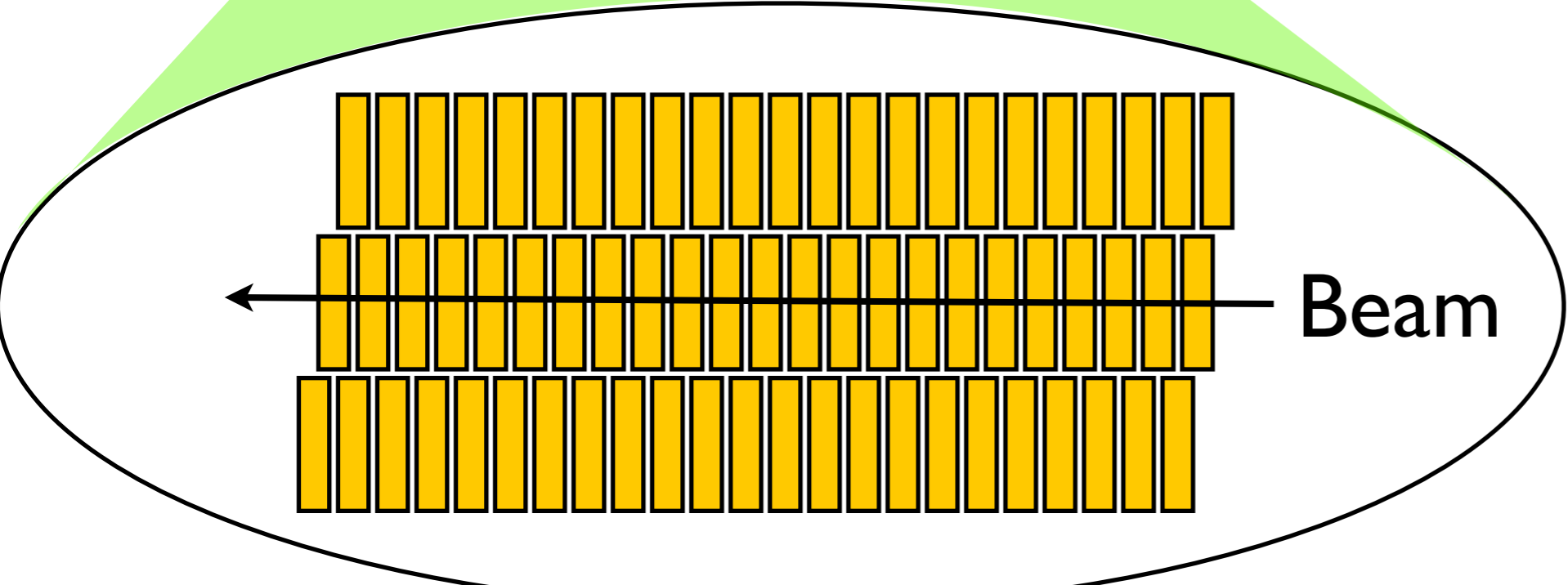


1. Define “missing hit-pad” :
The pad which should have hit signal but has no signal (see next page)

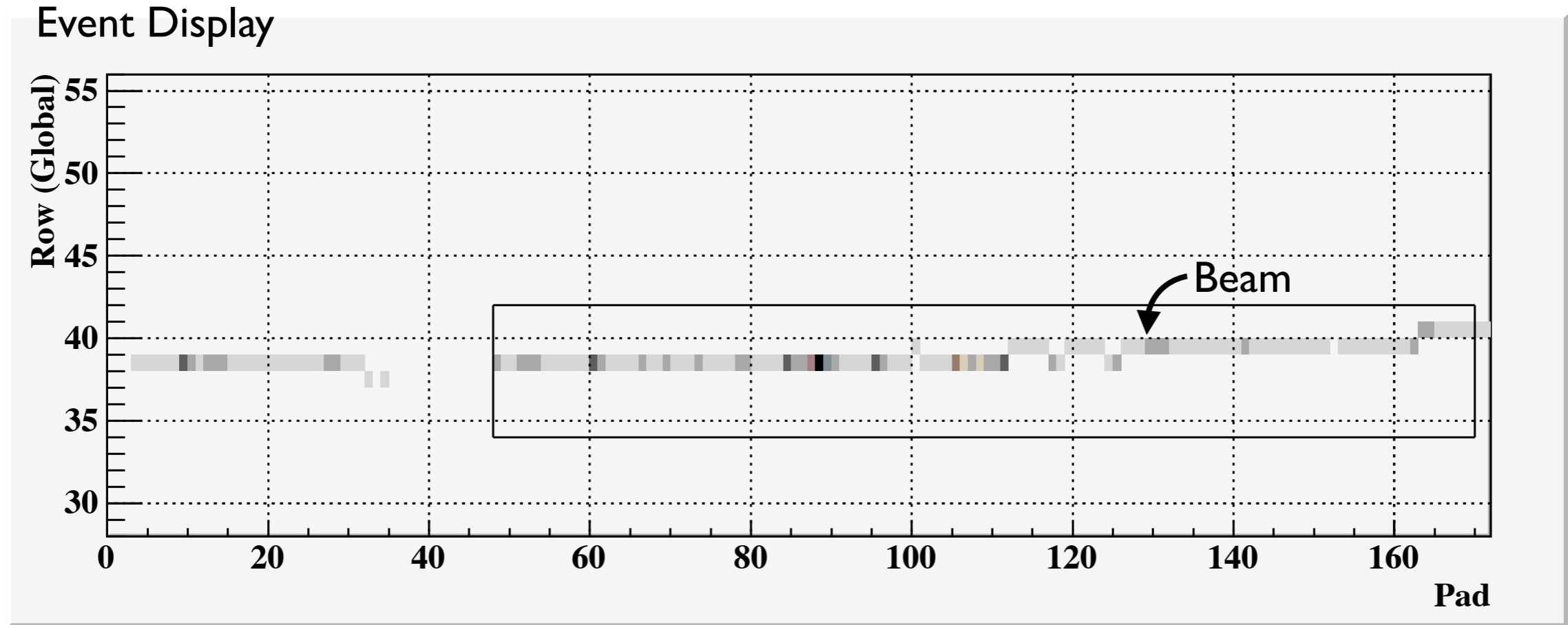
2. Find missing hit-pads in certain regions
(= population)

3. Calculate the probability that missing hit-pads exist.

(The probability should be something to be related to MFP.)

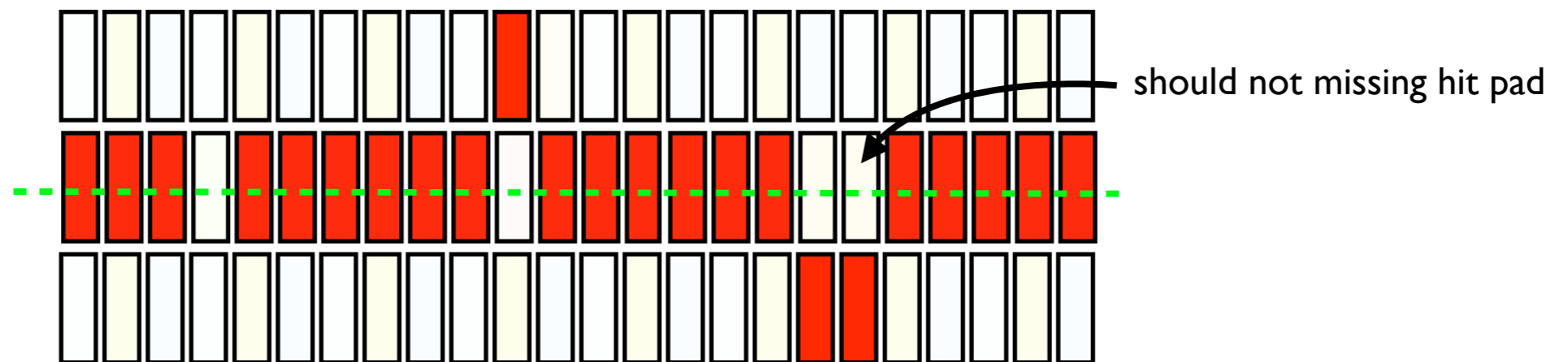


• How to define “missing hit-pad” - I



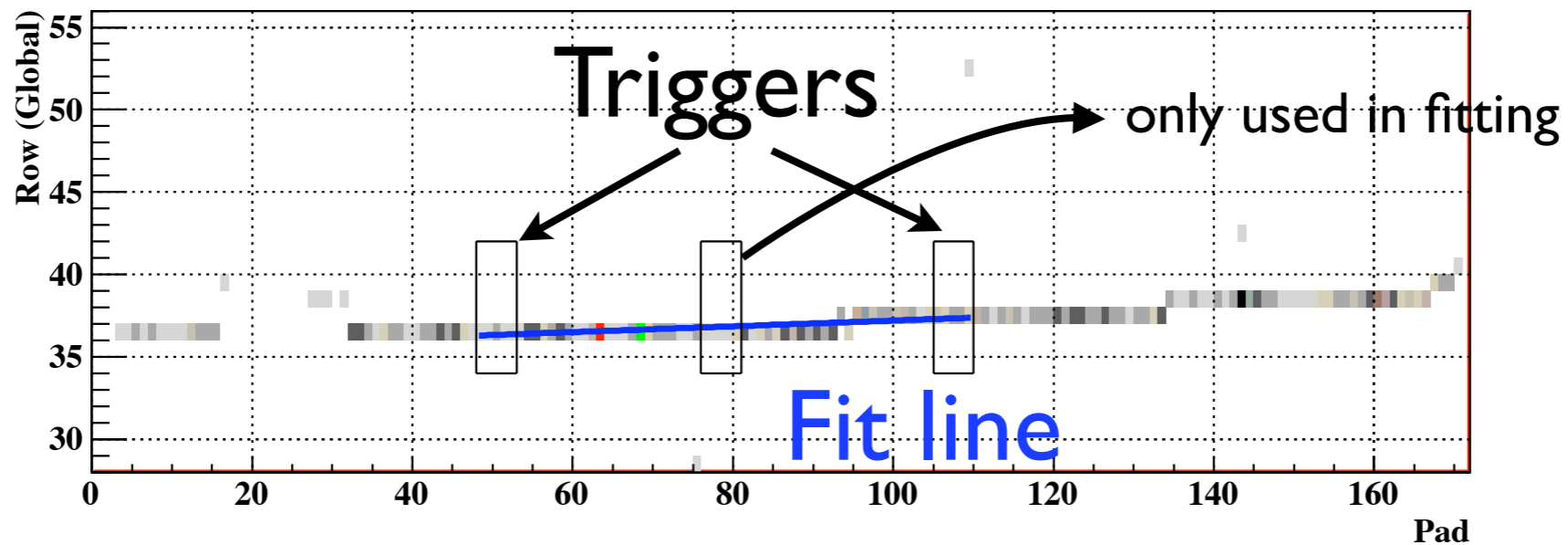
※ Point in this plot corresponds to center position of hit cluster in each row.

If we get following result, we can imagine that the beam go through like green dotted line.



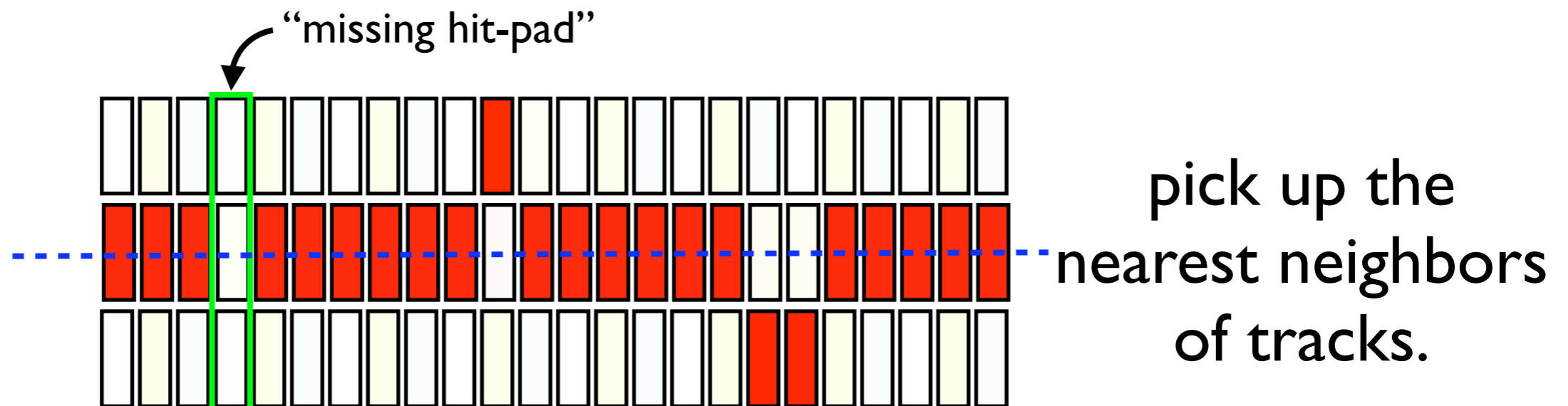
In LPI data(real data), we can find some hits which seem to be displaced.
But these should not be missing hit pads.

• How to define “missing hit-pad” - 2



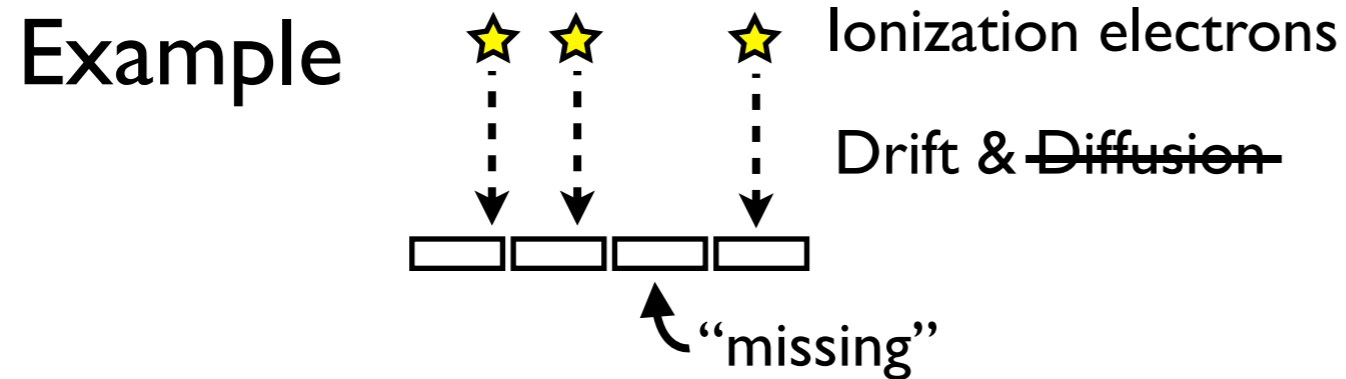
Trigger : Require that # of hits are more than 3 in 5 pads(=trigger region).
Fit line : Fit hit points of triggers and central box which is between 2 triggers.

After the fitting, hit candidates are searched around the fitted line.



Relation between “missing hit-pad” and λ (mean free path)

As a first step, I have cut away diffusion effect ...



Probability that there is no hit on a pad

$$P(0) = e^{-W/\lambda} \quad W: \text{pad pitch} = 1200[\mu\text{m}]$$

Probability that there is hit on a pad

$$P(1) = 1 - e^{-W/\lambda}$$

Probability that there are N “missing hit pads” in M pads

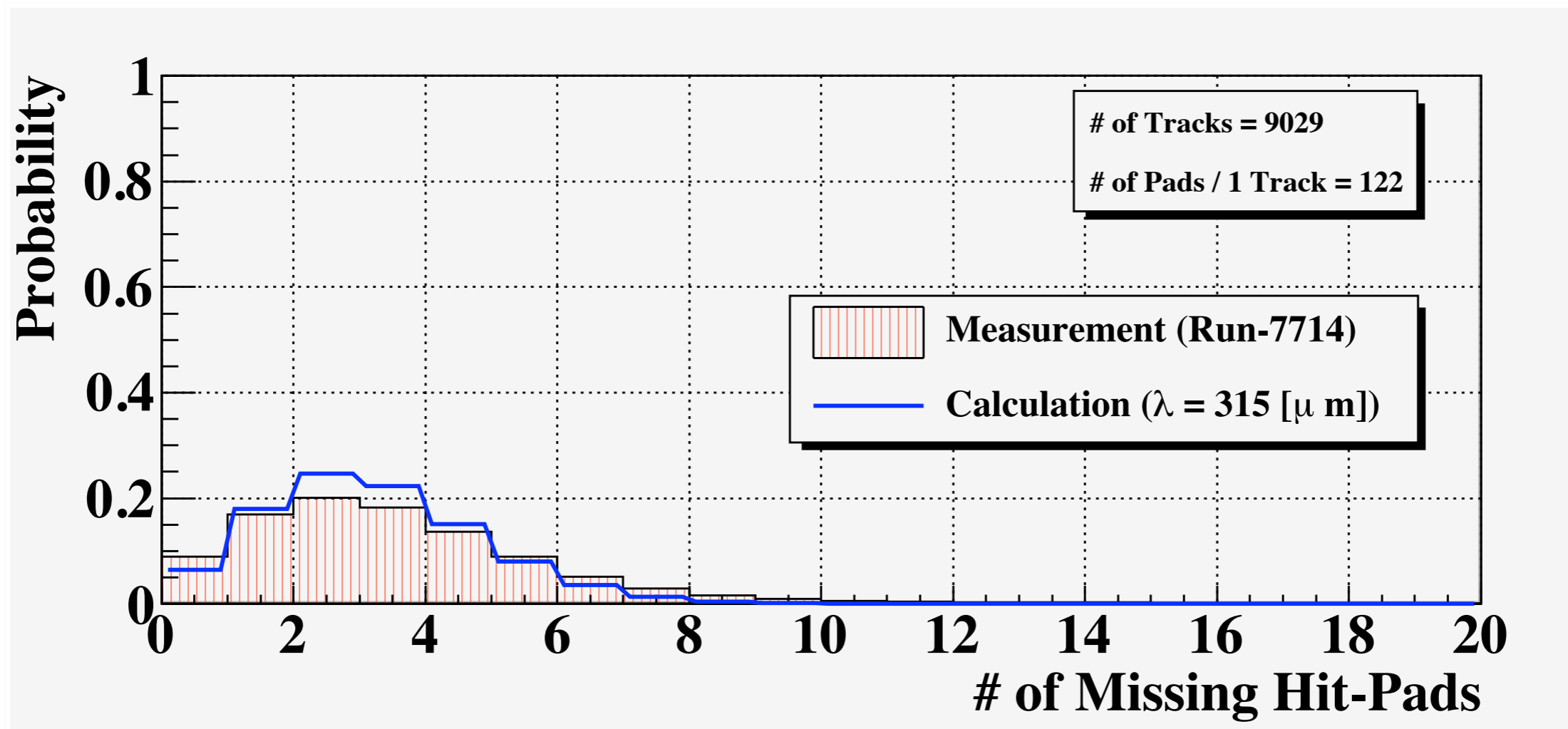
$$P_M(N) = {}_M C_N P(0)^N P(1)^{M-N}$$

First Result

Fitting result $\lambda = 317 \pm 12$

Comparison between
measured data and calculation ($\lambda=315[\mu\text{m}]$)

For MIP in Ar gas
28 [I/cm]
→ $\lambda \sim 360 [\mu\text{m}]$

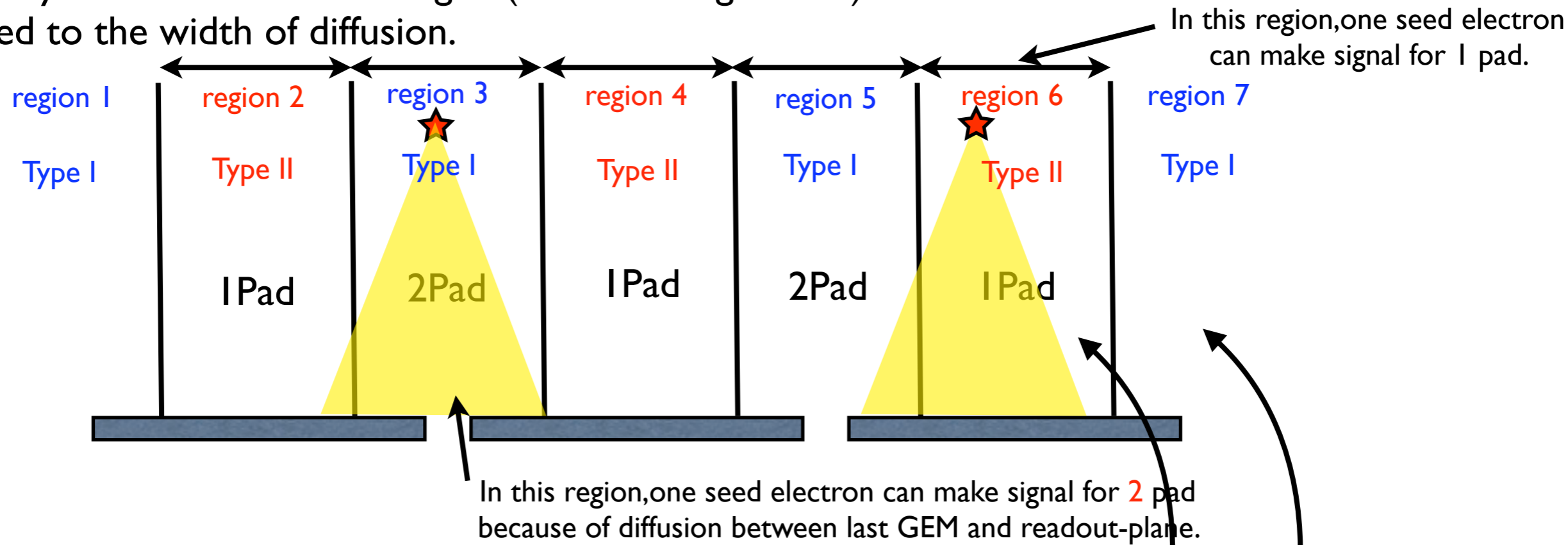


→ Next step is to include diffusion effect.

Simple Example

Consider only 3 pads ...

We can introduce new 'virtual' divisions, which are divided into 2 types, instead of pad width. One is that only 1 pad gets signal by one electron in the region, and the other is that 2 pads get signal by one electron in the region(see following sketch). The width of this divisions should be related to the width of diffusion.



If we get pad signal (0 1 1), the possibility are ...

pad1 pad2 pad3

(where seed electron should be ...)

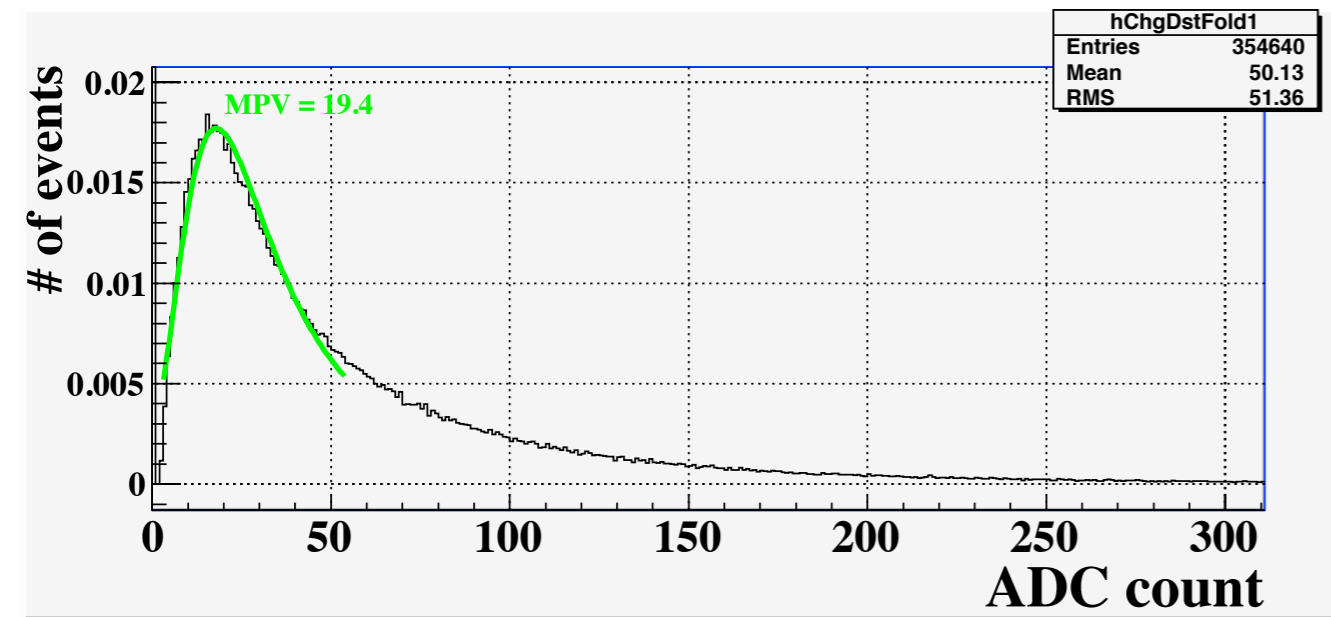
	region 1	region 2	region 3	region 4	region 5	region 6	region 7
possibility 1	0	0	0	1	1	1	0, 1
possibility 2	0	0	0	0	1	0	0, 1
possibility 3	0	0	0	1	0	1	0, 1
possibility 4	0	0	0	1	1	0	0, 1
possibility 5	0	0	0	0	1	1	0, 1

This virtual divisions make it possible to do simple calculation.

Estimation for the size of the virtual division

For the calculation, we need to define appropriate divisions.

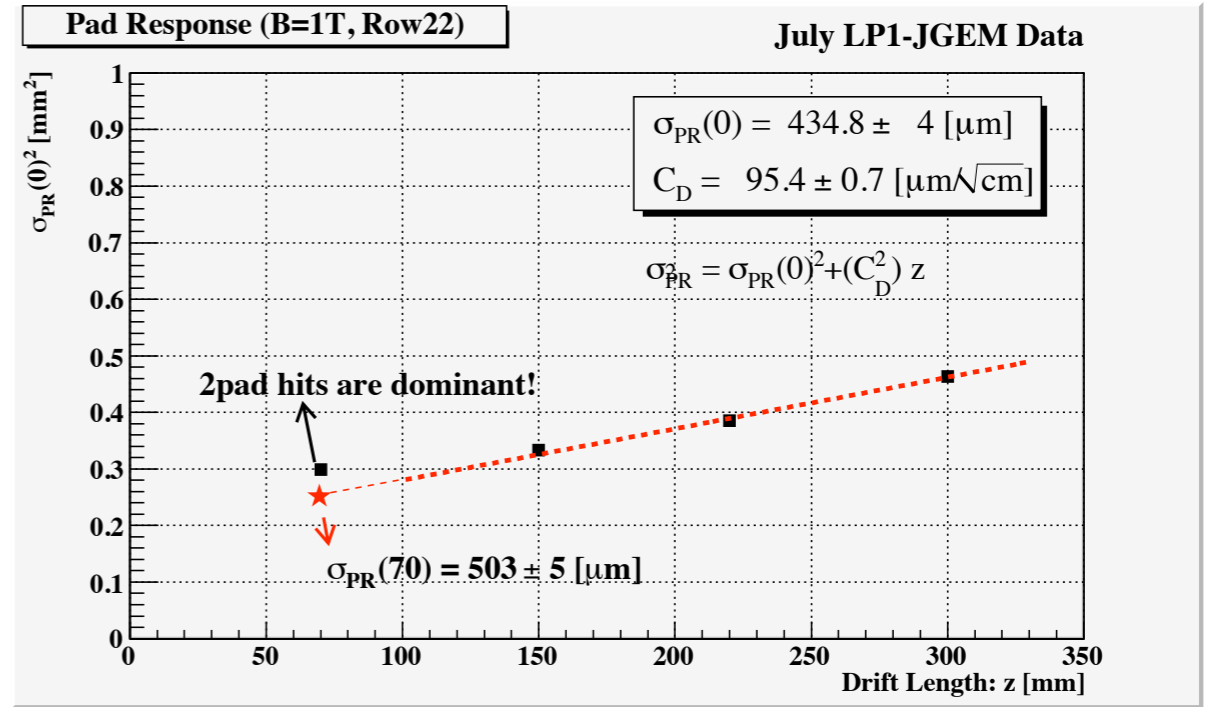
charge sum (Pad # 53 ~ 105)



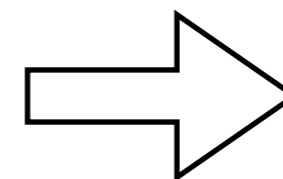
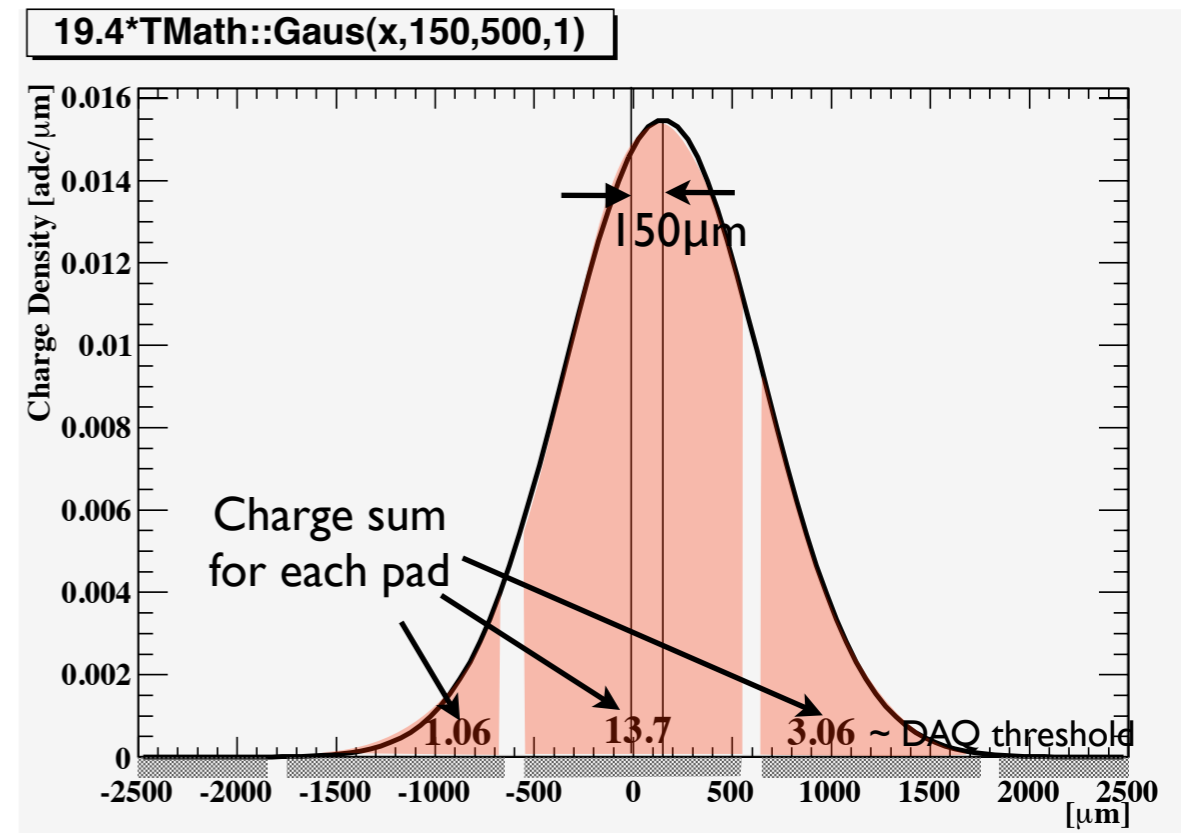
charge sum = 19.4

Typical charge distribution

Width of normalized charge distribution

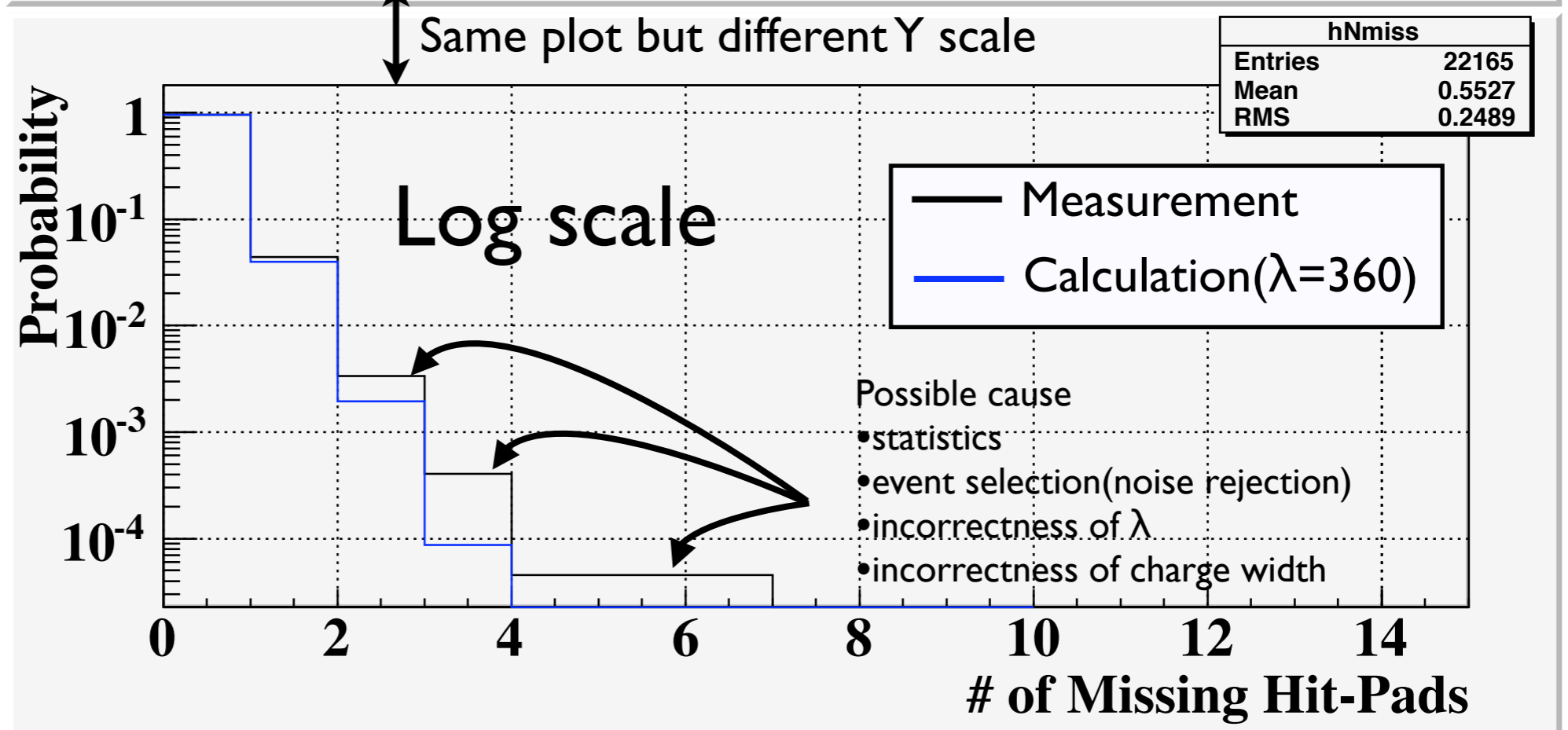
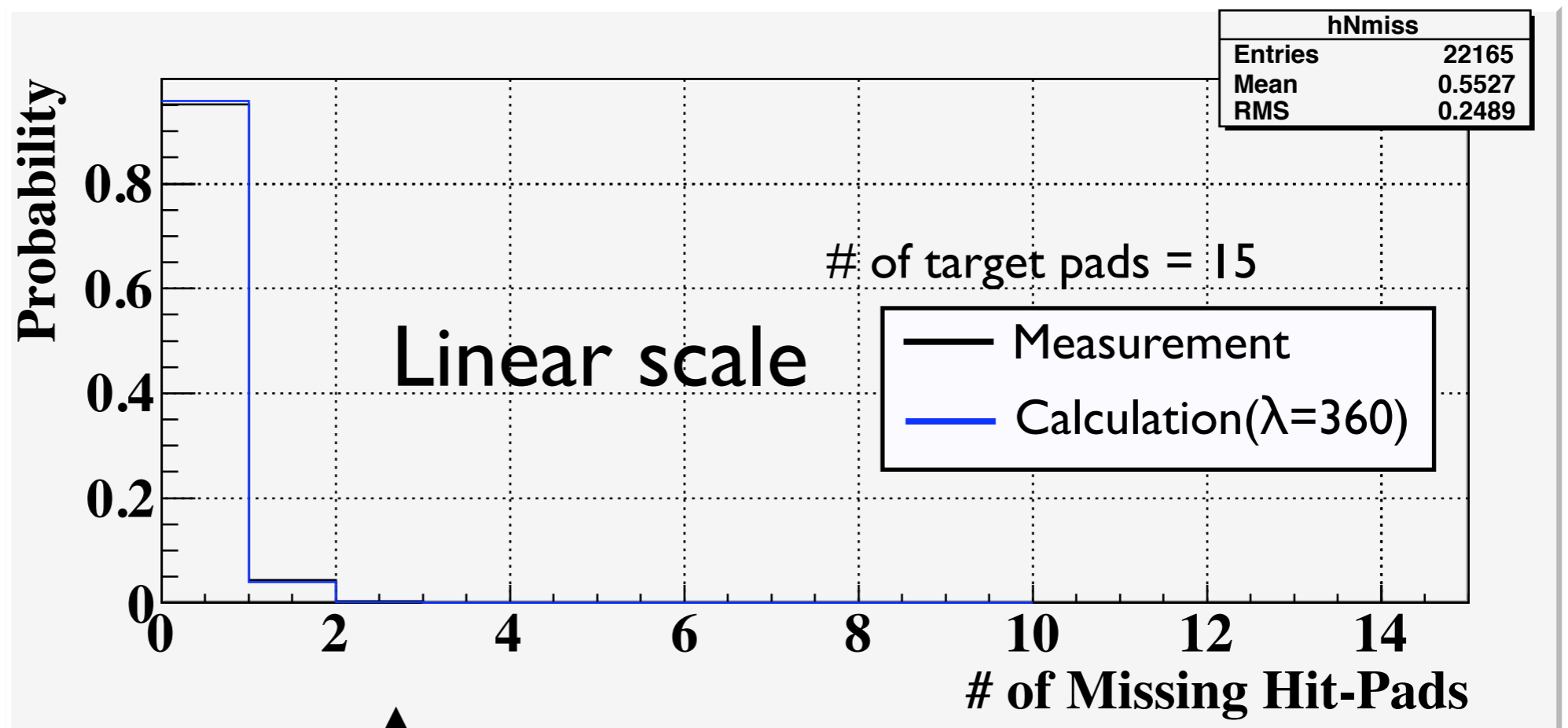


$\sigma = 50[\mu\text{m}]$

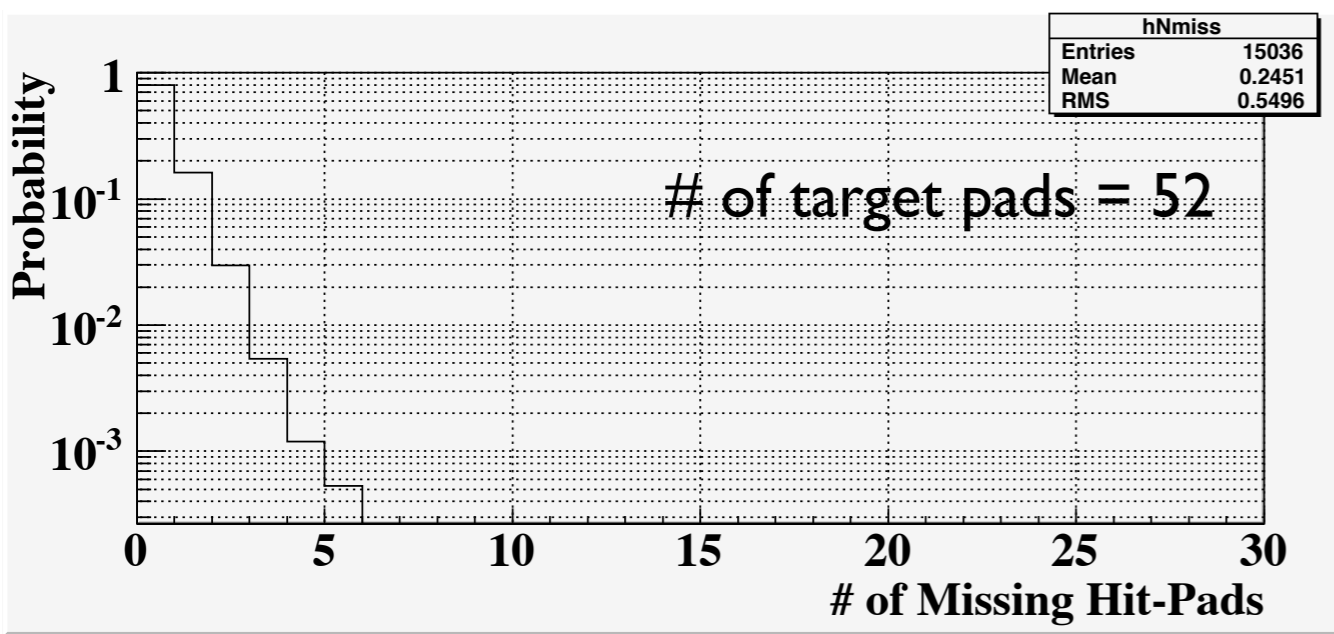


1 pad region : $\sim 300\mu\text{m}$
2 pad region : $\sim 900\mu\text{m}$

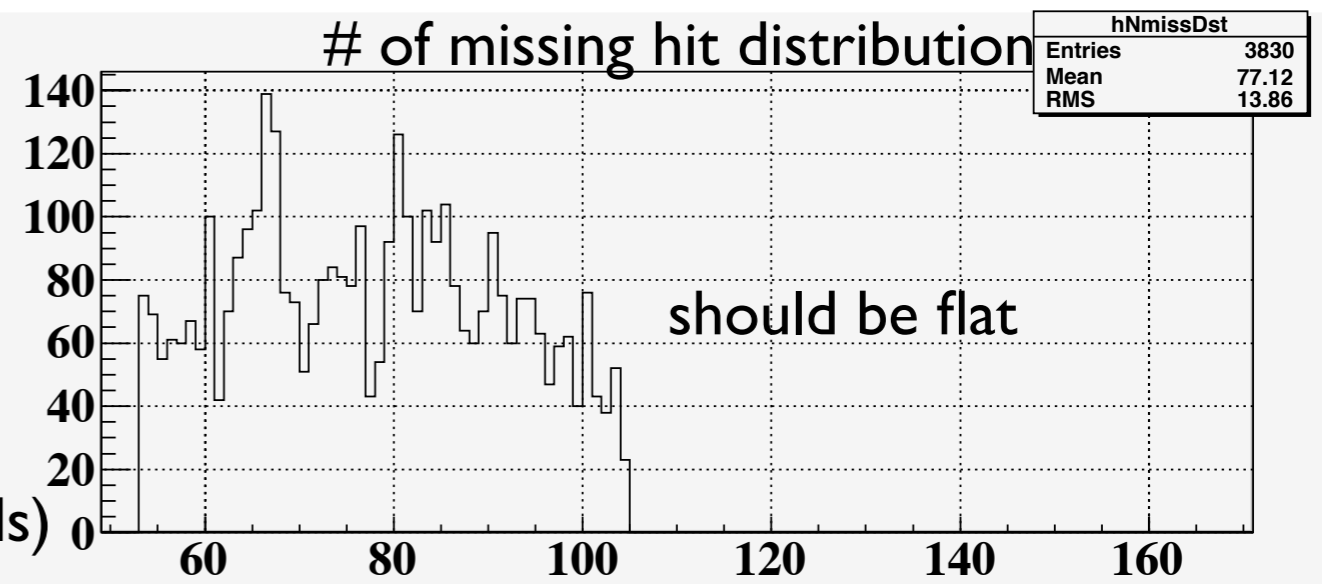
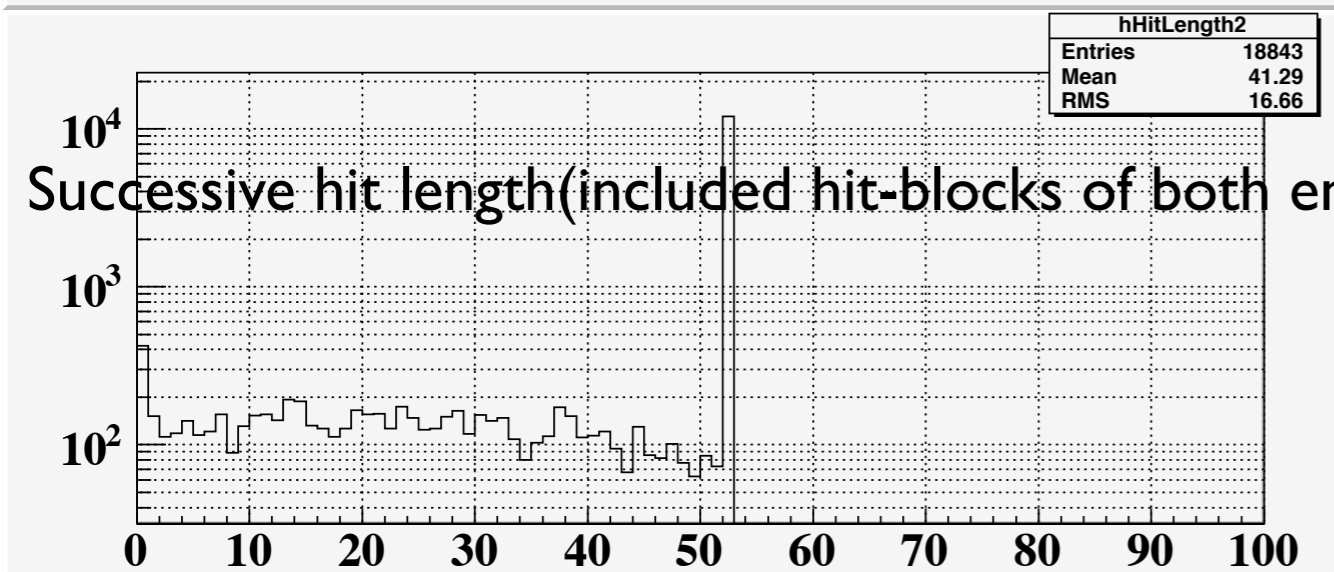
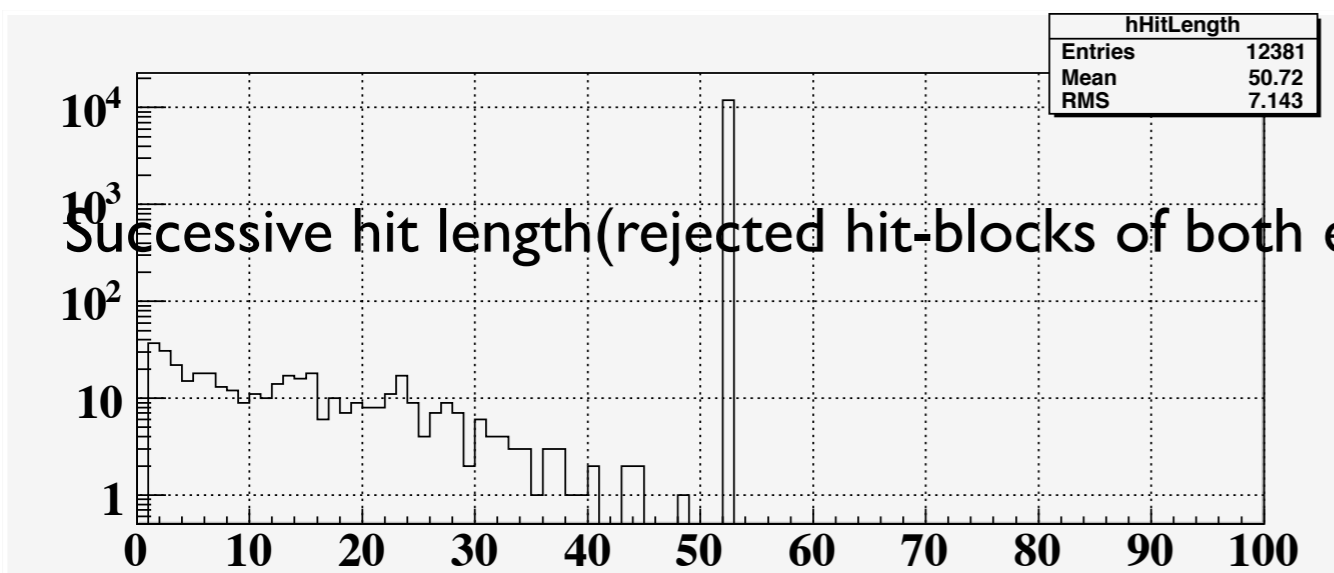
Comparison between measurement data and calculation



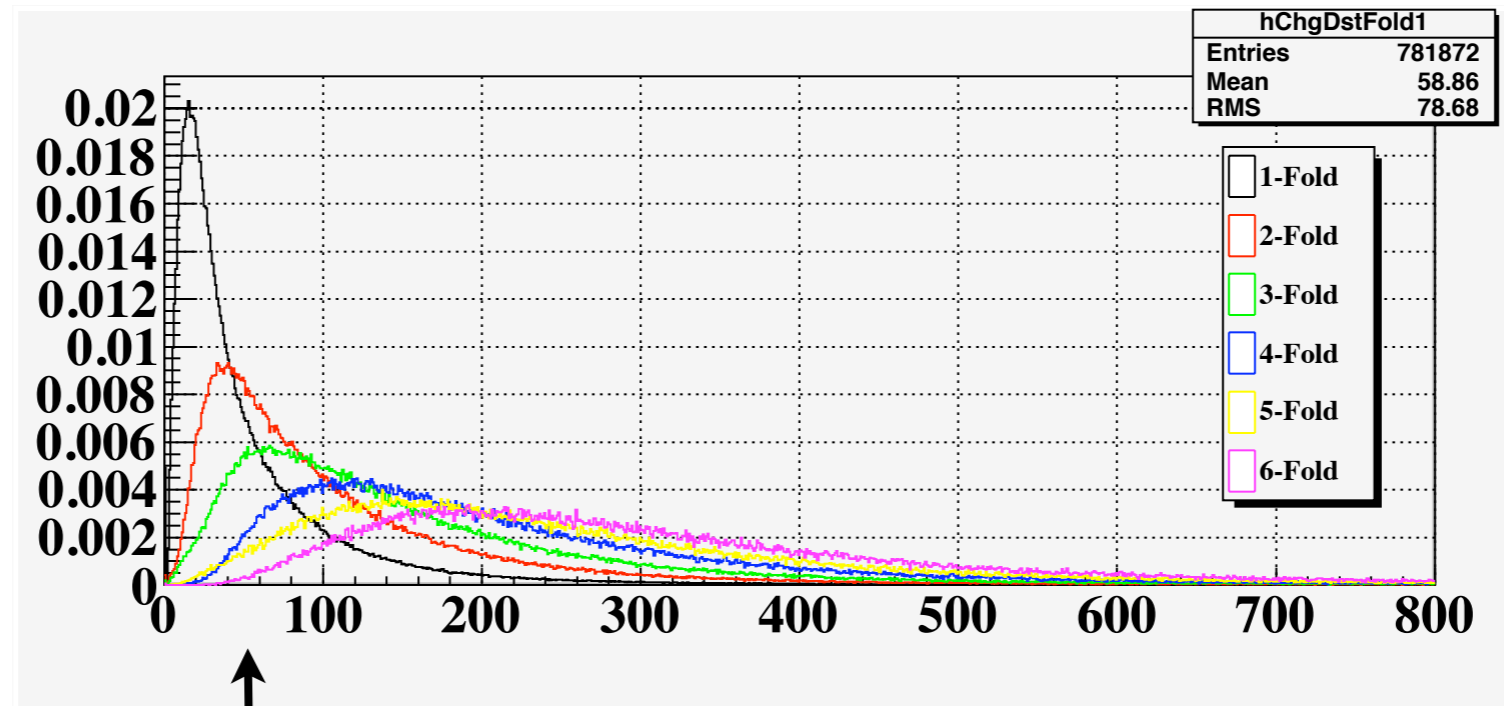
→ Even this simple calculation seems to be good.



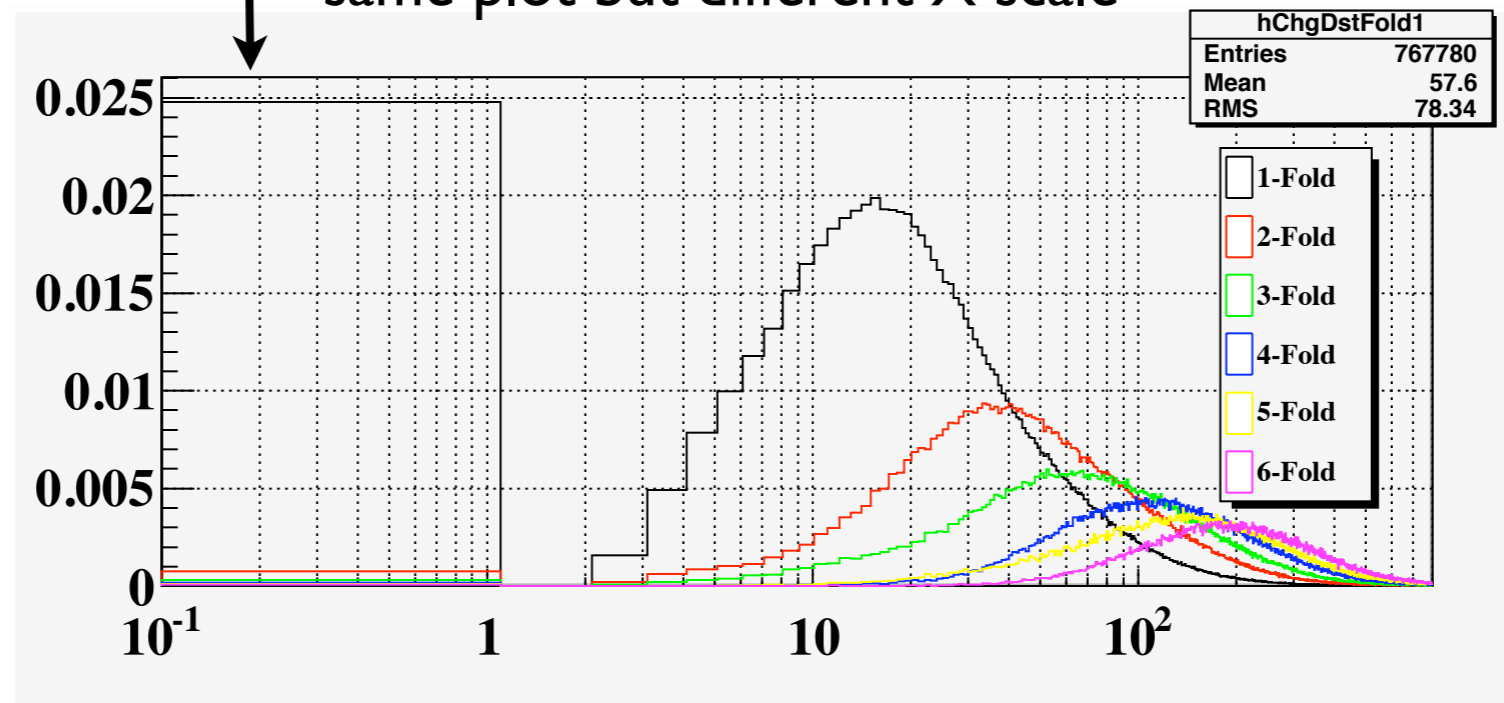
Event selection has been improved.
(no too much missing)



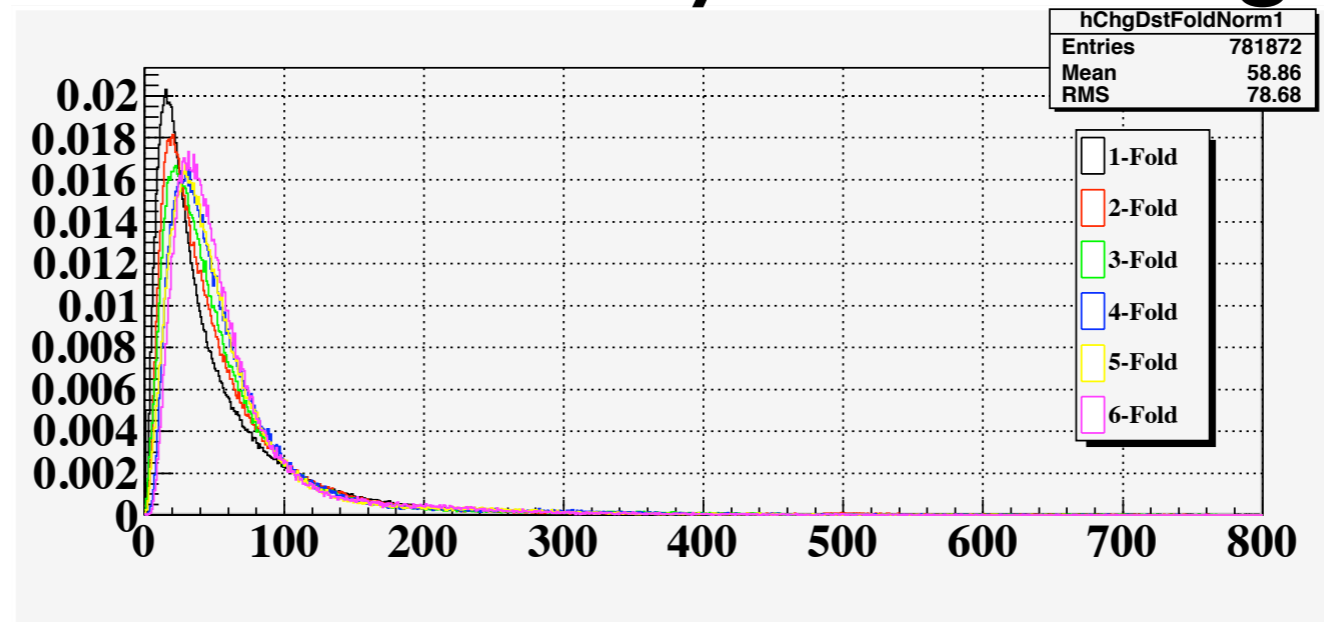
Charge distribution



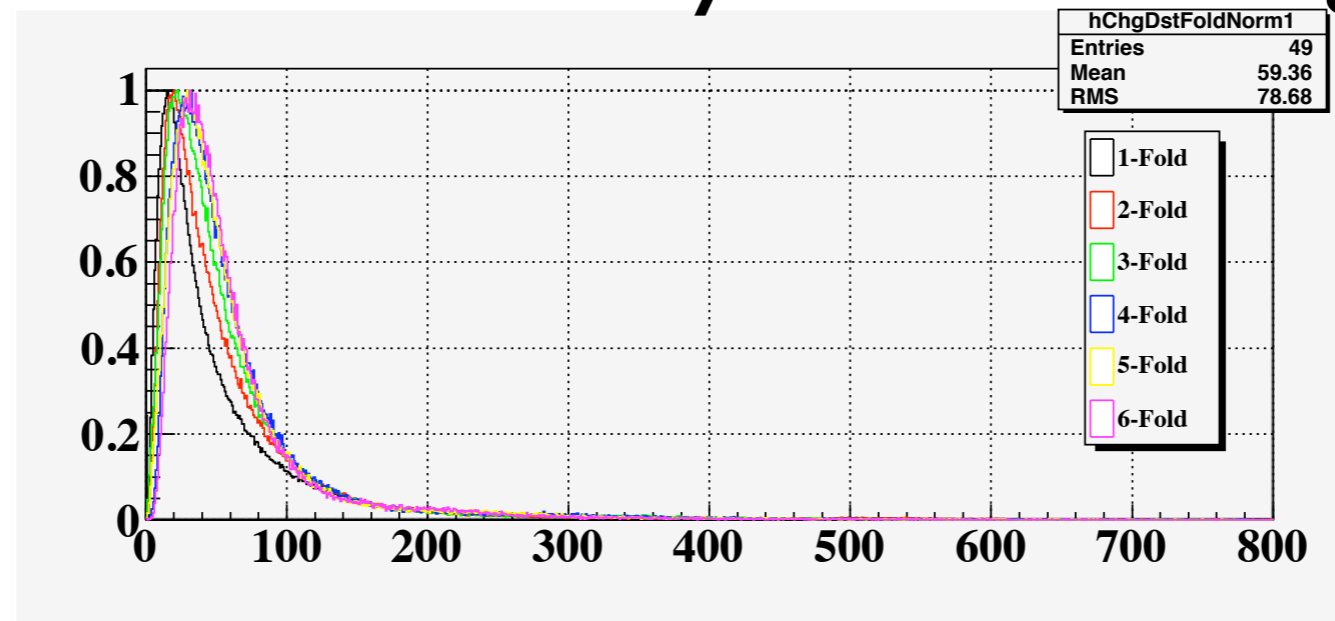
same plot but different X scale



Normalized by # of folding



Normalized by maximum height



Summary

LPI geometry(1mm readout pads) seems to make it possible to study energy loss calculation included detector effect.

Event selection has been improved.(31 Dec. 2009)
Essential plots are ready.

Next step is to understand the results and start preparing for a small paper on this issue.