Single Plastic Edge Hill

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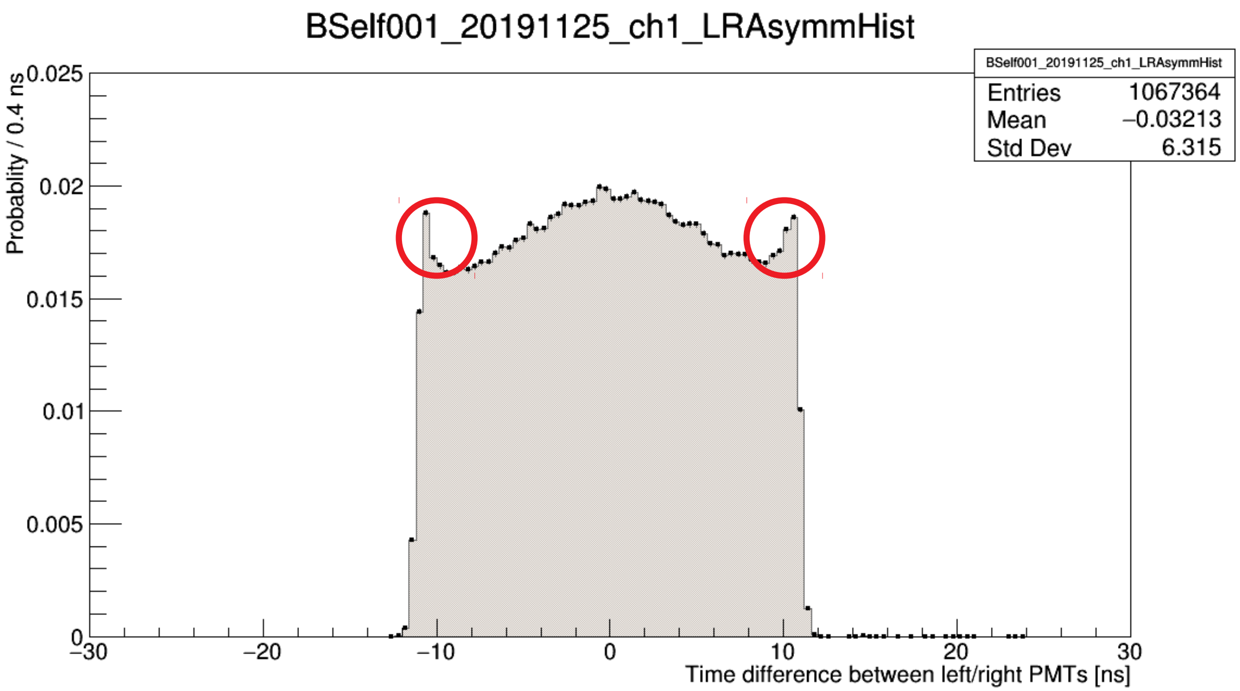
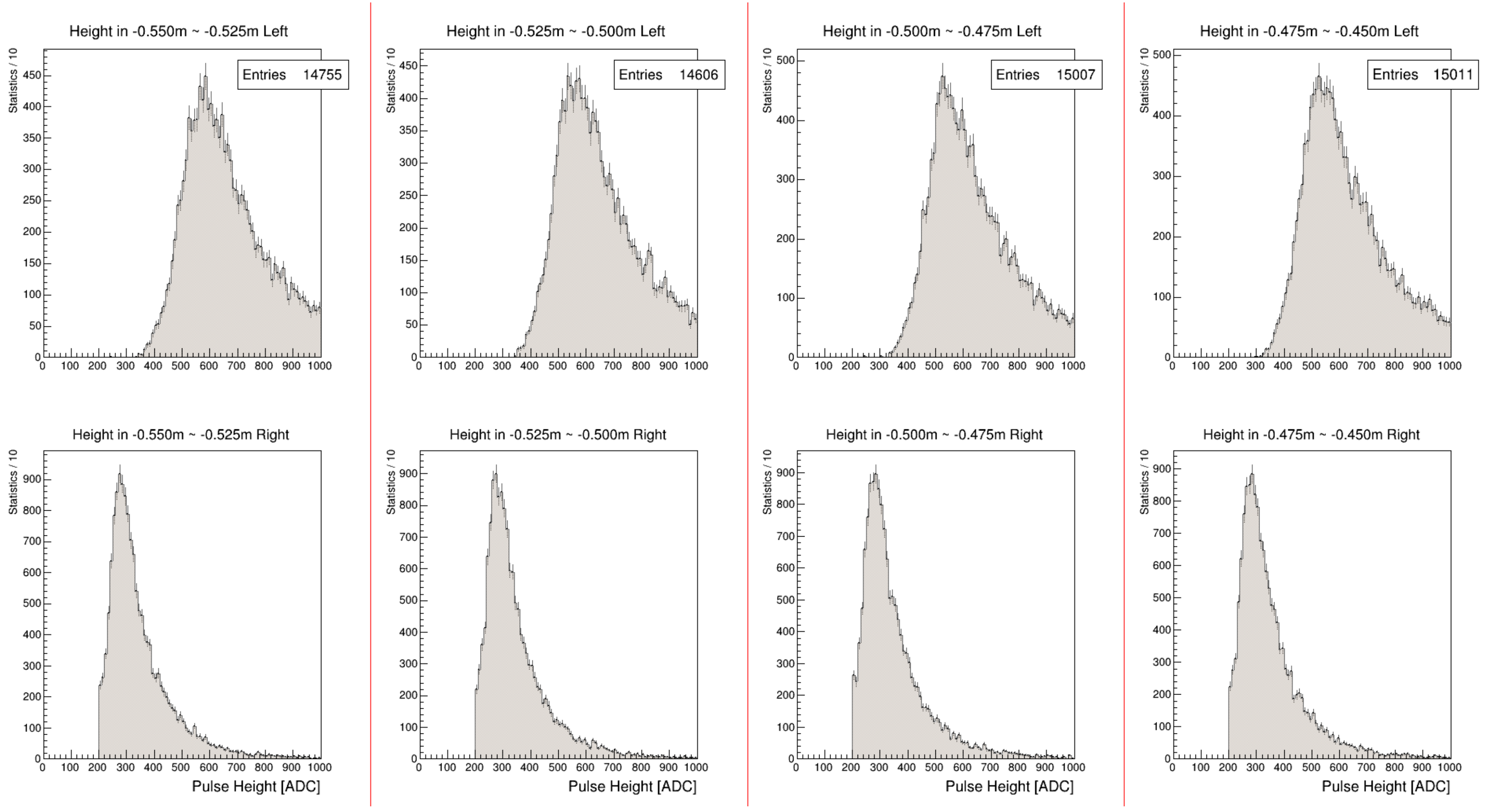
Introduction

- When we detect muon using single plastic scintillator lying down, with pulse height threshold 200, hills appear at each edge.



Introduction

- From a close look at the pulse height, we could find ‘something’ arises near the PMT.



Introduction

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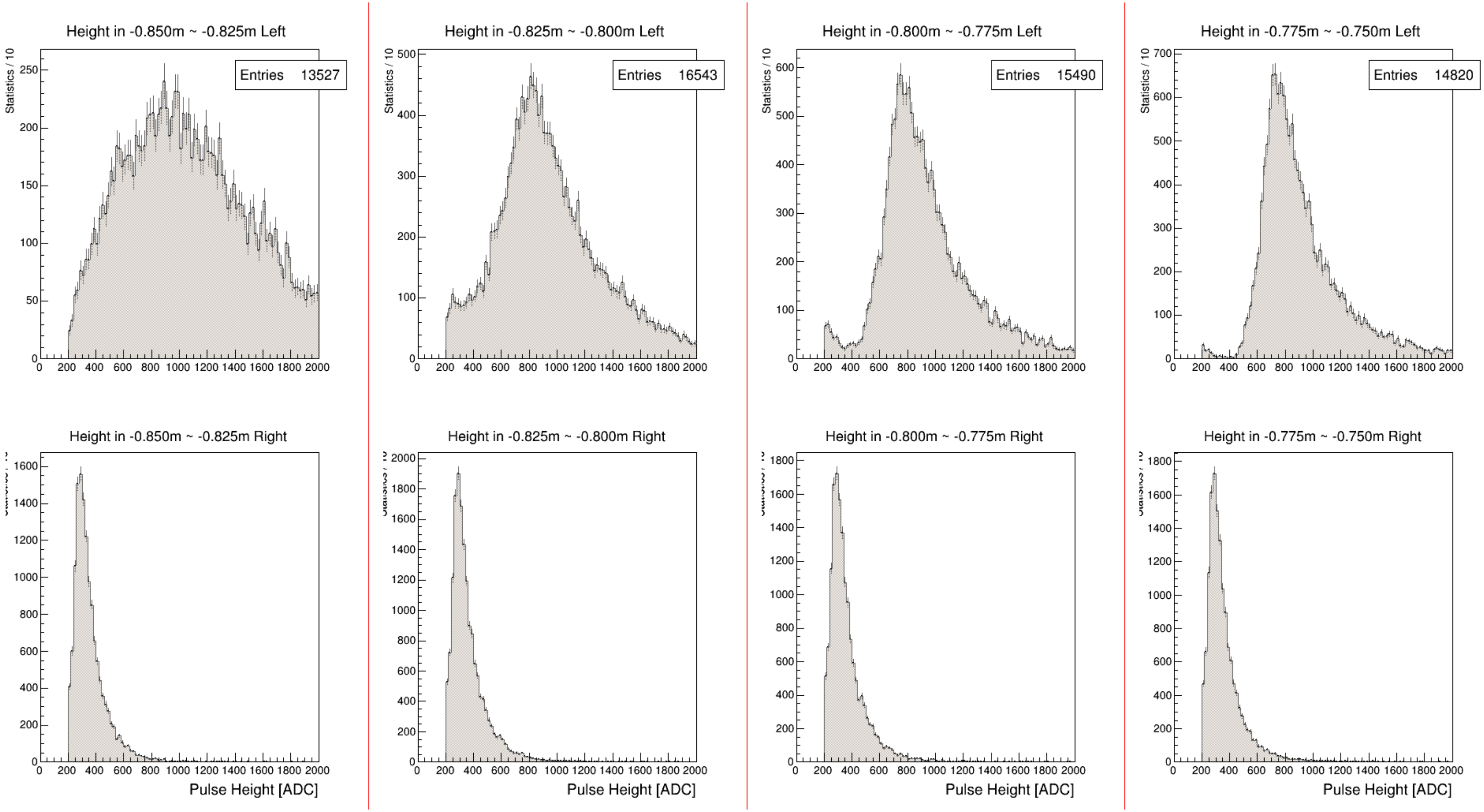


Introduction

- What is the ‘something’?
  - Cherenkov Radiation from PMT lens?
  - Other Particle?

Cherenkov Radiation

- Cherenkov radiation arises when a charged particle in a material medium moves faster than the speed of light in that same medium.
- Energy emitted per unit path length is

$$\frac{-dE}{dx} = z^2 \frac{\alpha\hbar}{c} \int \omega \, d\omega \left(1 - \frac{1}{\beta^2 n^2(\omega)}\right) < 4 z^2 \alpha \hbar \pi^2 c \frac{\int d\lambda}{\lambda^3}$$

  - z=1 for muon, α is the fine structure constant, n is the refraction index.
  - Leo, ‘Techniques for Nuclear and Particle Physics Experiments’, 2nd ed., Springer-verlag, pp. 35-37.

Cherenkov Radiation

Type No. (A)	Assembly Dia. (mm)	PMT Dia. mm (inch)	Built-in PMT (Type No. for referring)	Curve Code (B)	Wavelength (nm)
H7195	ϕ60.0	51 (2)	R329	400K	300 to 650

- Integrating over 300 nm to 650 nm yeilds

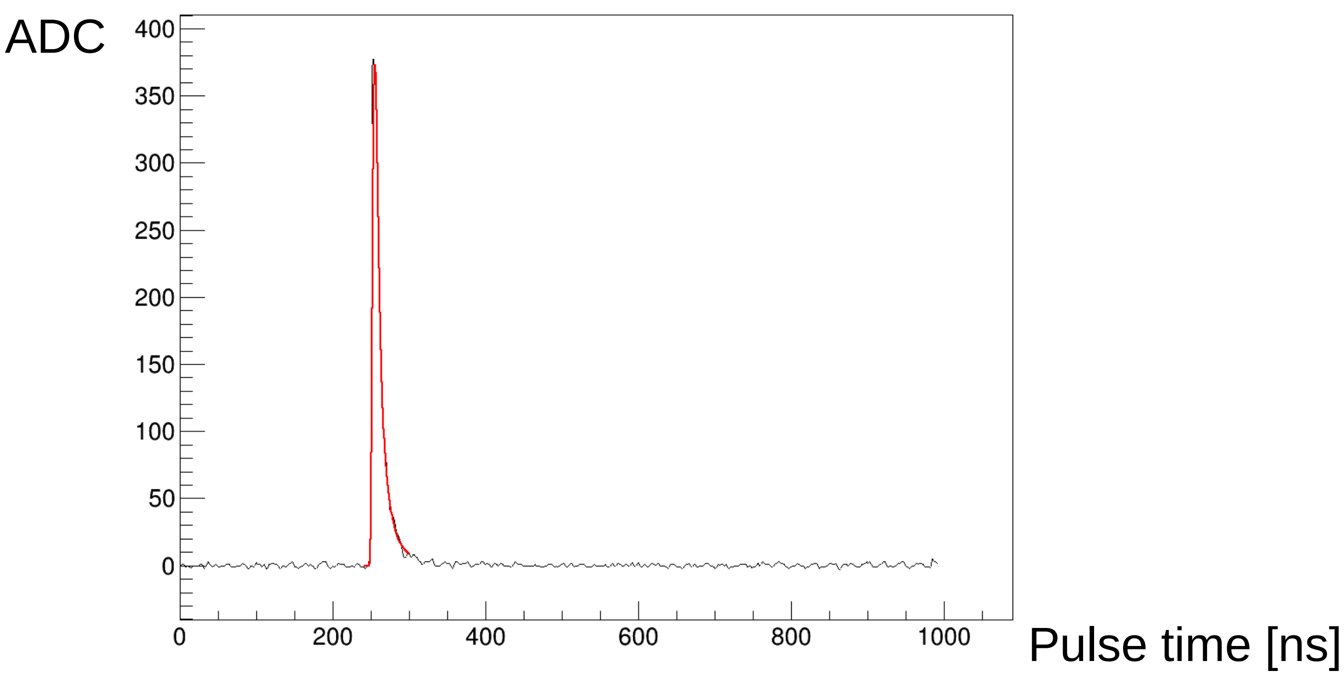
$$\frac{-dE}{dx} < 2\alpha\hbar\pi^2 c\left[\frac{1}{\lambda^2}\right]_{\lambda_2}^{\lambda_1} = 0.025 \text{ MeV / cm}$$

- Relatively negligible!
  - *-dE/dx* for Polyvinyltoluene is ~ 2 MeV/cm.

Pulse Shape

- For more information, I observed the pulse shape.
- Pulse at center is clear landau form.

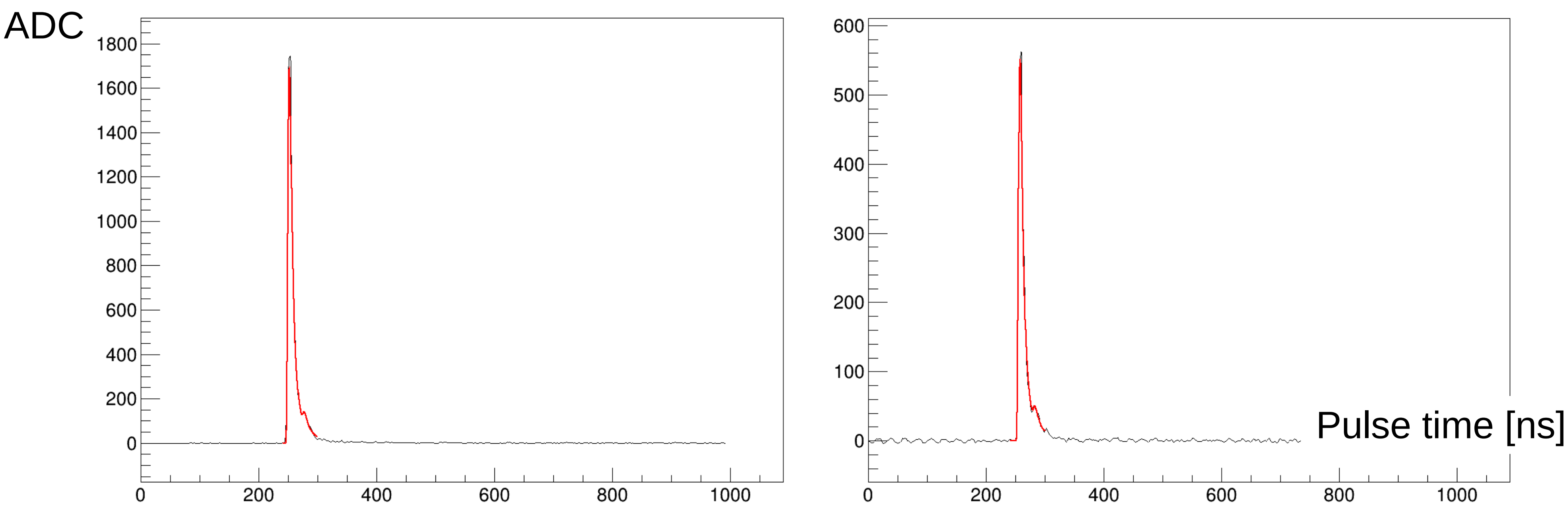
Pulse at center (-0.05 m ~ 0.05 m), Left PMT



Pulse Shape

- Pulse near PMT shows two landau peaks!

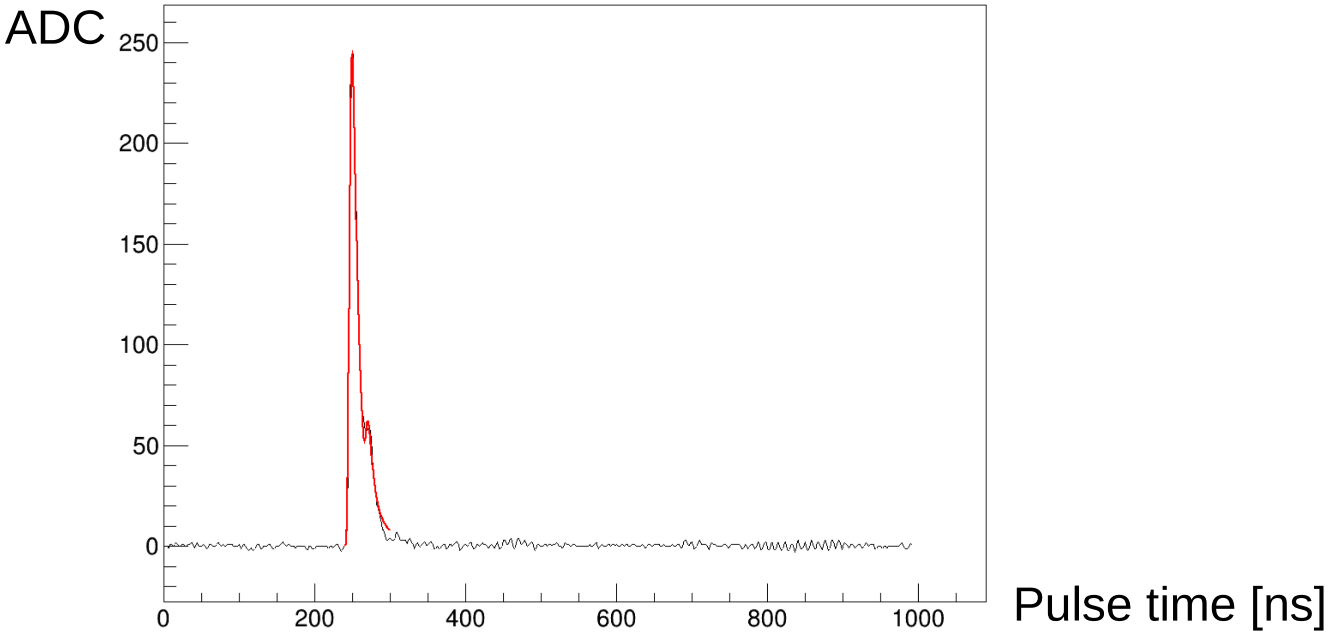
Pulse at center (-0.85 m ~ -0.80 m), Left PMT



Pulse Shape

- Pulse near PMT shows two landau peaks!
- New problem arises!

Pulse at center (-0.85 m ~ -0.80 m), Left PMT

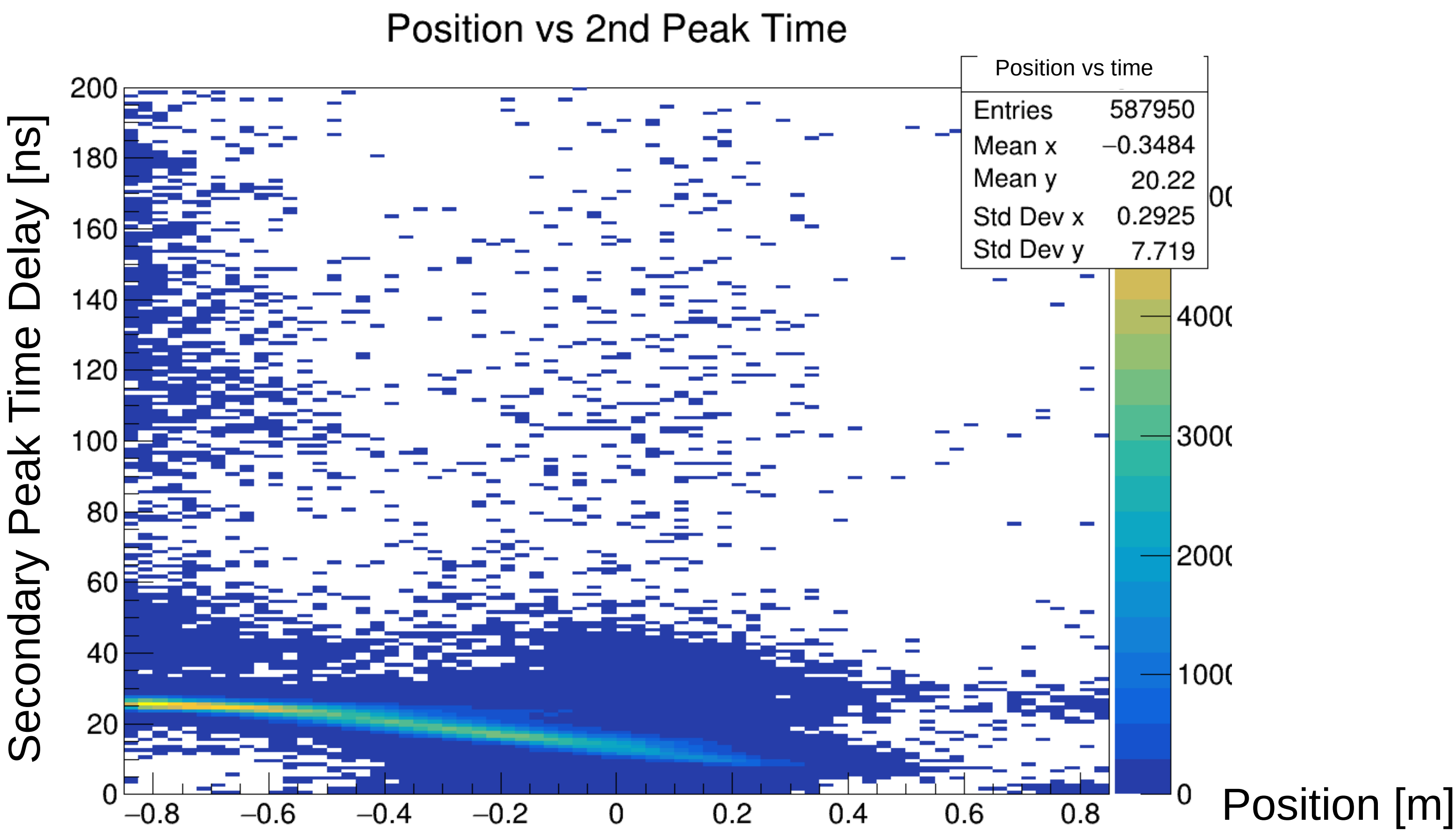


Secondary Peak Problem

- Three properties were observed.
  - Secondary peak appears about 25 ns after the main peak.
  - Secondary peak height is about 50 ~ 100 ADC, without correlation (at least with non-linear correlation) with the main peak height.
  - Secondary peak appears also at the center, but it becomes clearer near the PMT.

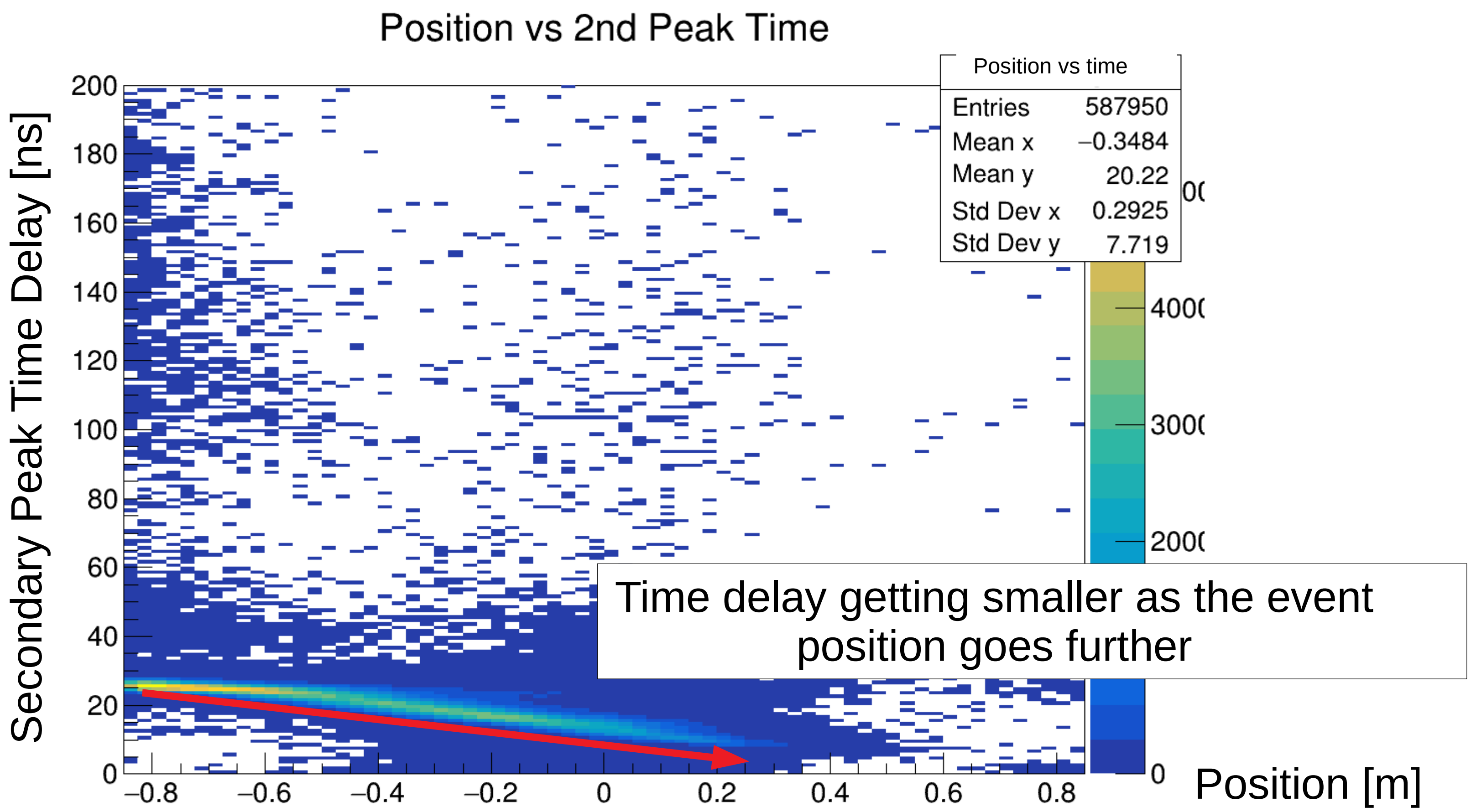
Secondary Peak Property

- Time



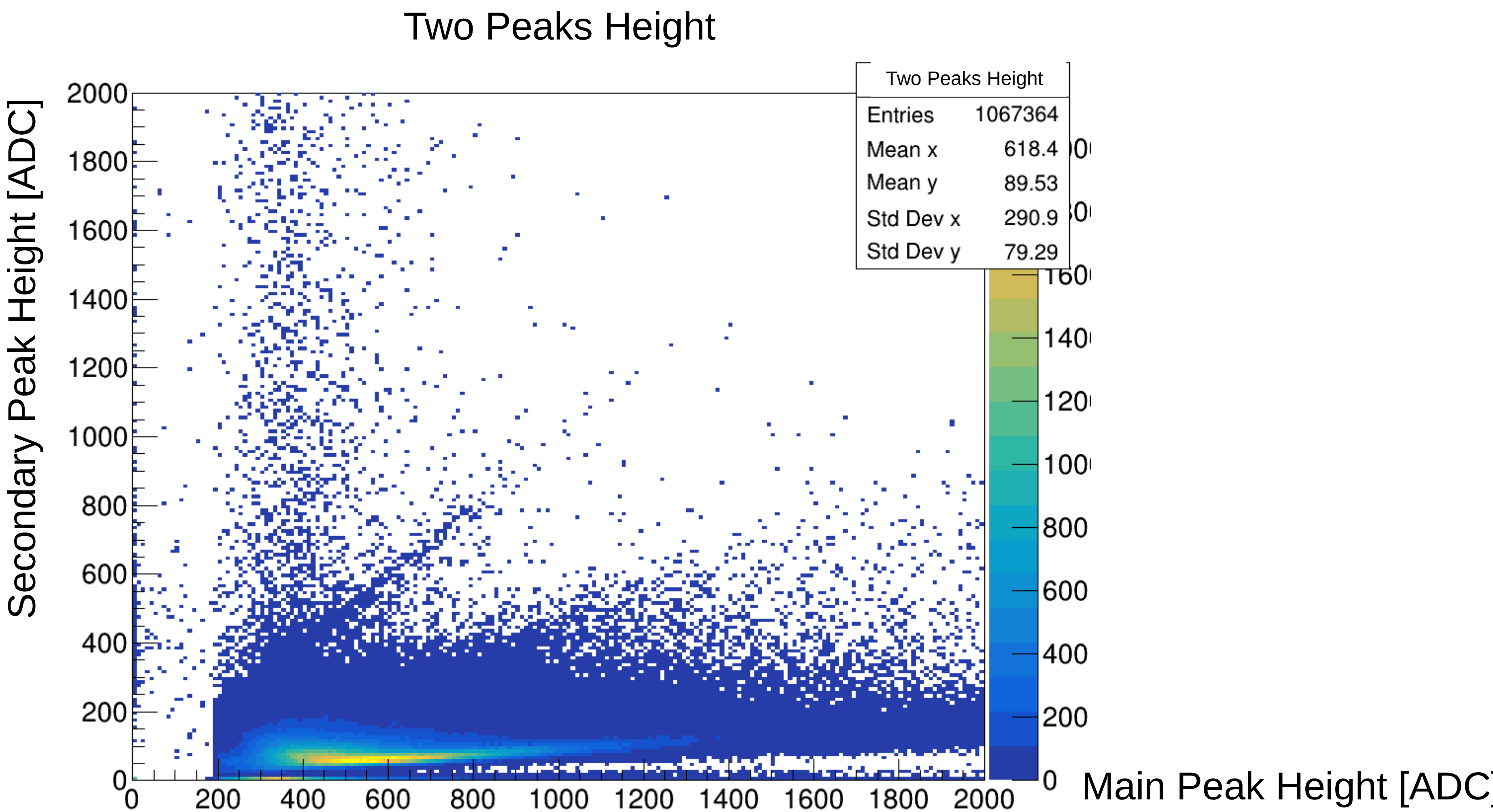
Secondary Peak Property

- Time



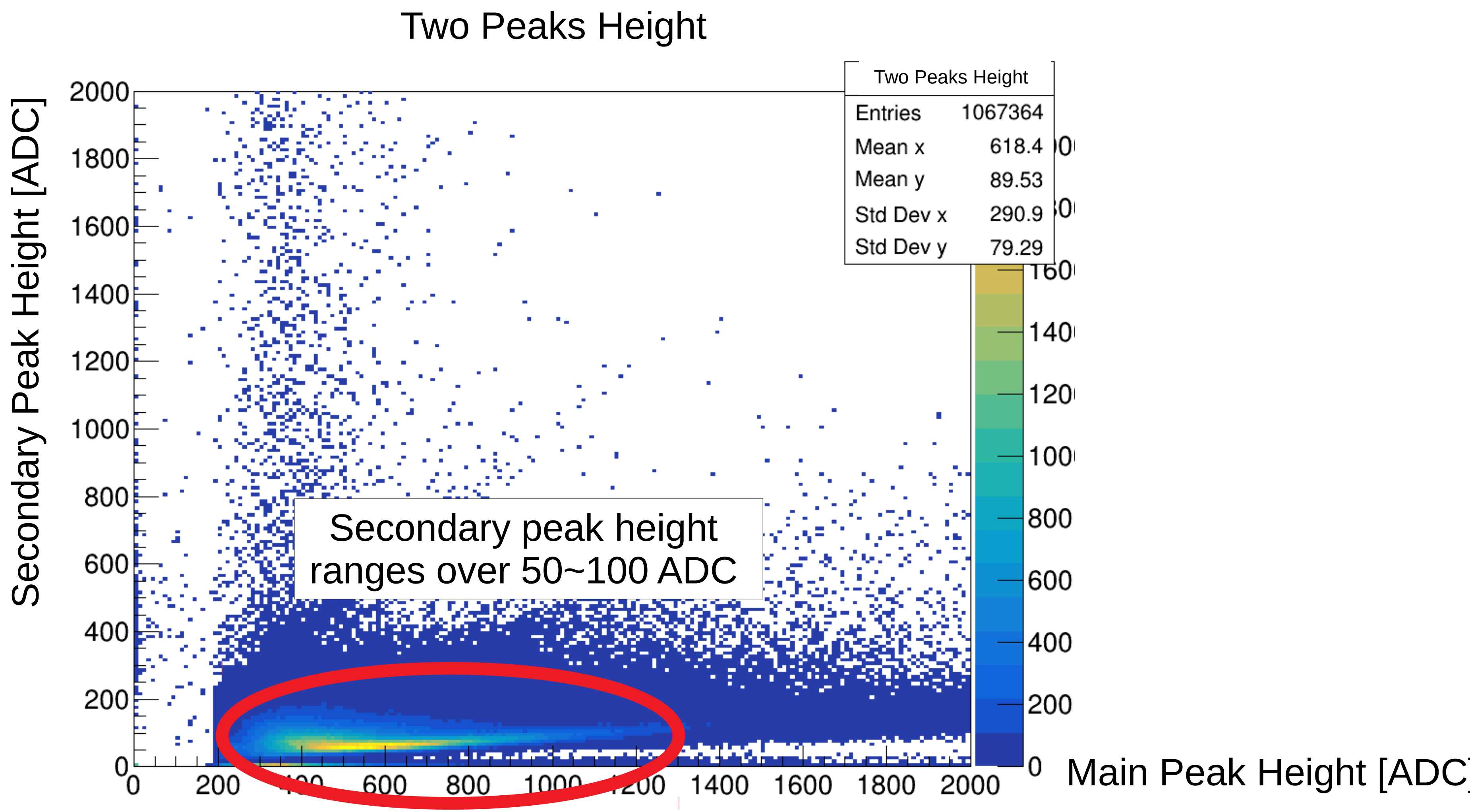
Secondary Peak Property

- Height



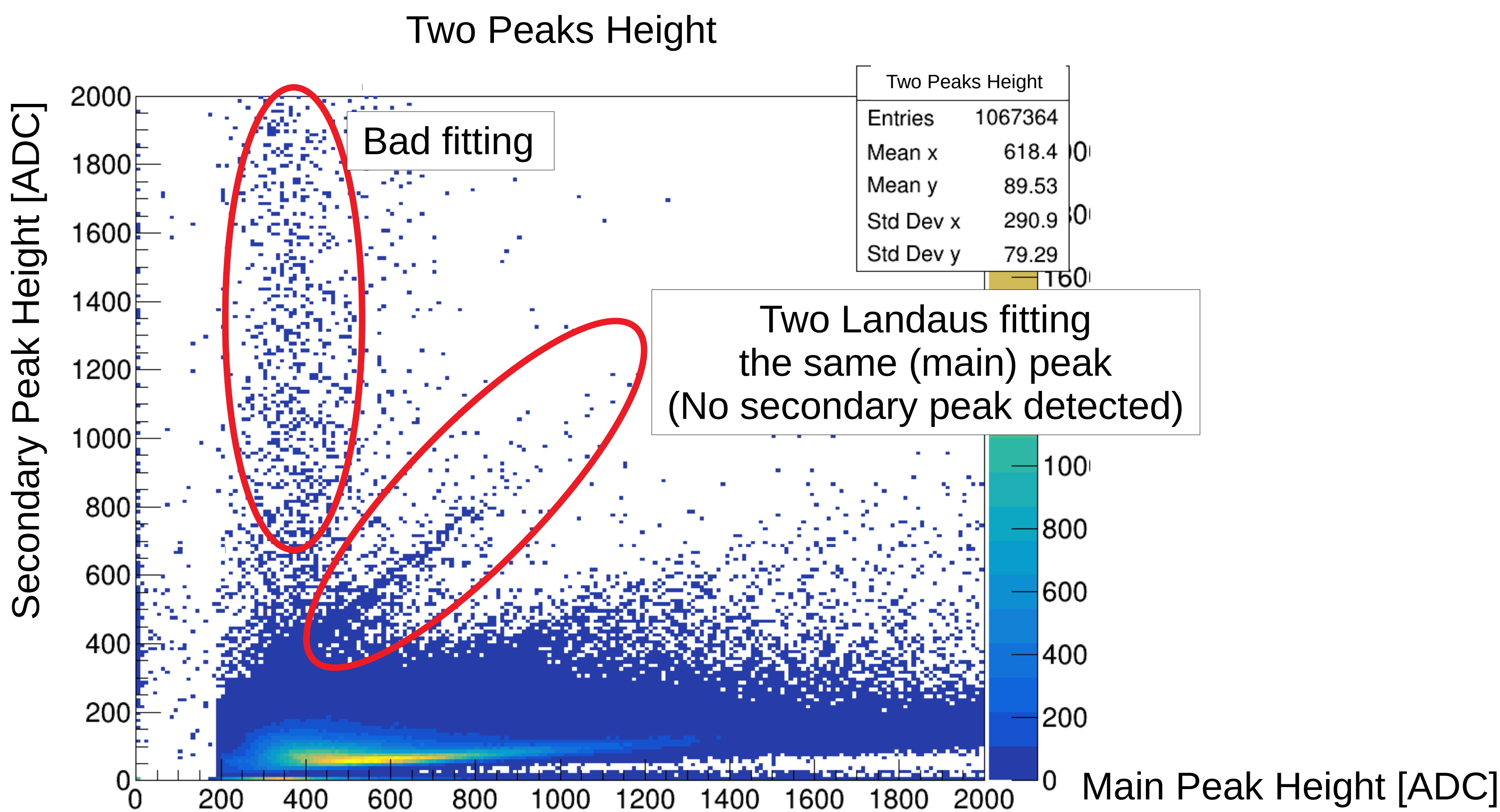
Secondary Peak Property

- Height



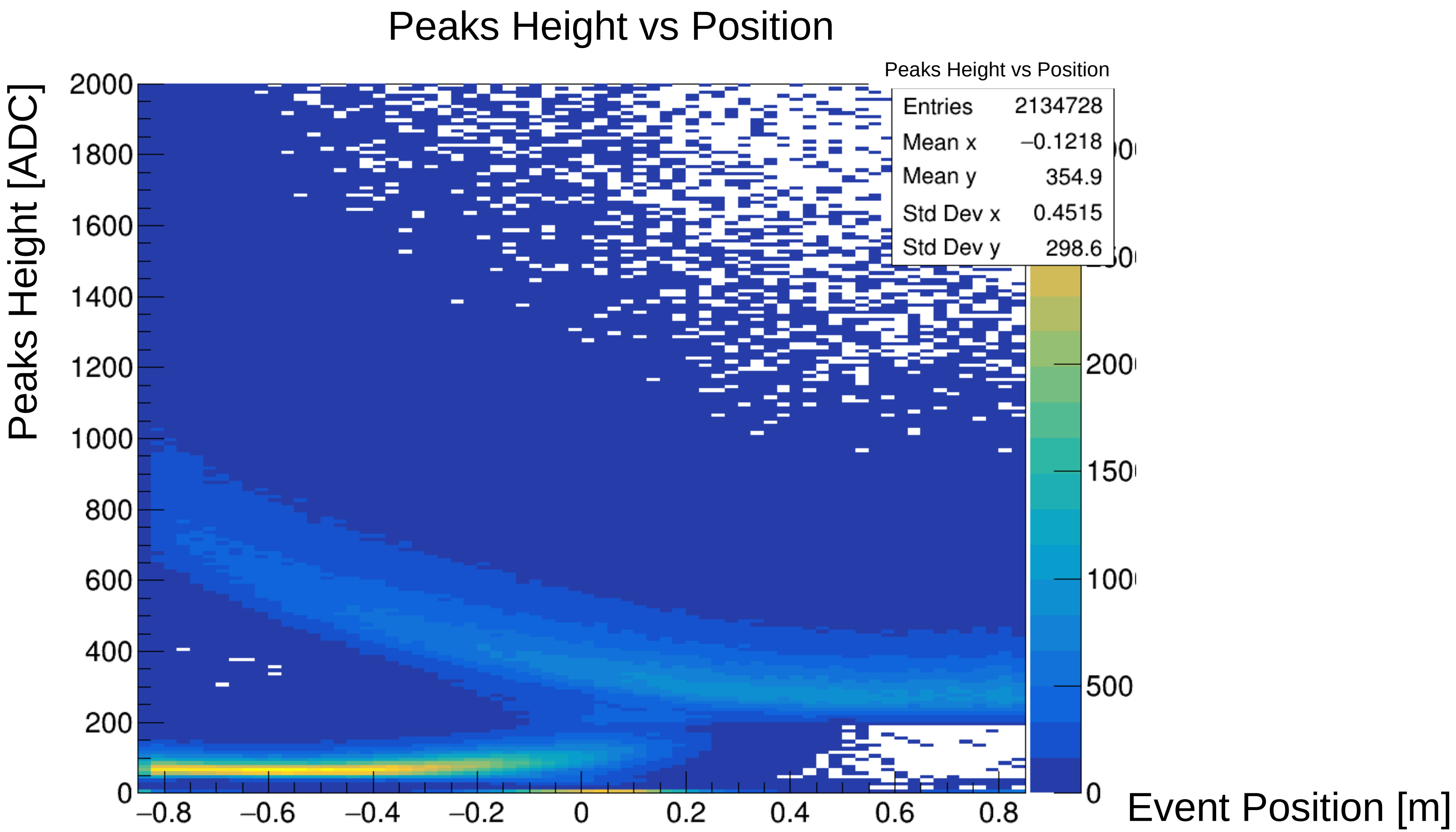
Secondary Peak Property

- Height



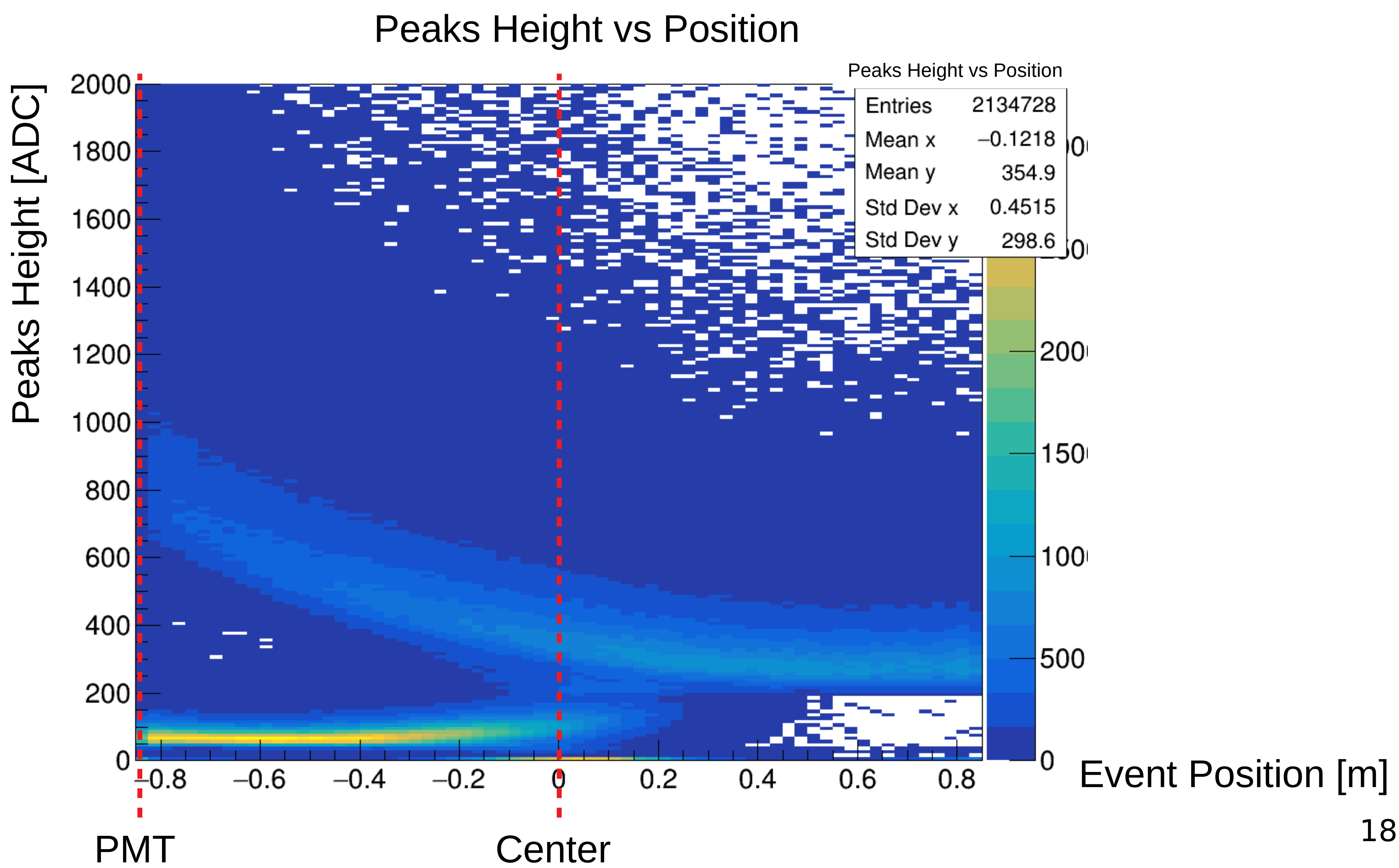
Secondary Peak Property

- Position



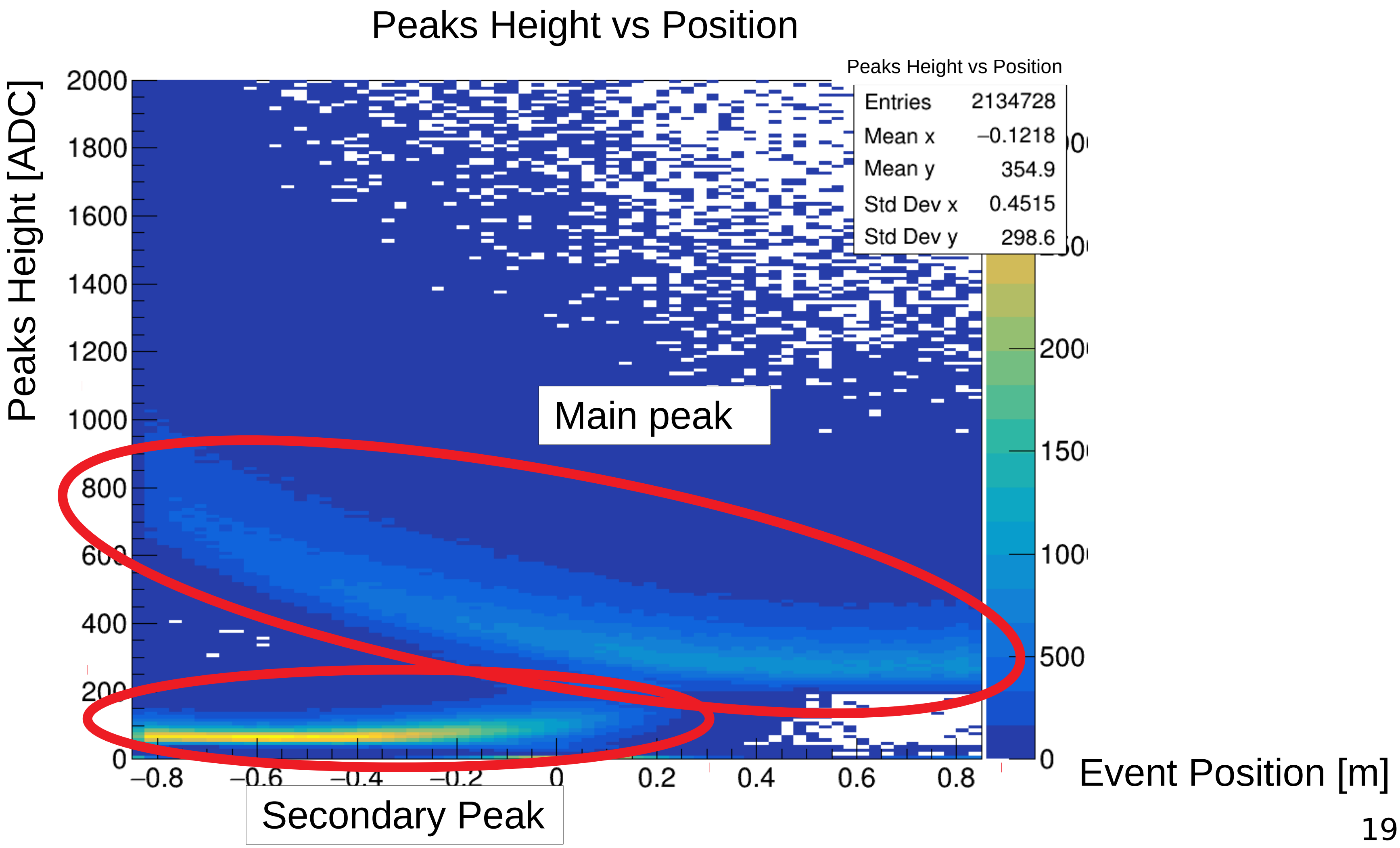
Secondary Peak Property

- Position



Secondary Peak Property

- Position



Secondary Peak Candidate

- Delayed reaction of detecting material?
  - Most reaction amplitude should be proportional to the energy loss of the particle, thus it should be proportional to the main peak height.
  - Still have no clear idea / detail about this kind of reaction.

Secondary Peak Candidate

- New particle detected?
  - Except the central part, almost every events have the secondary peak.
  - This may not be the solution.

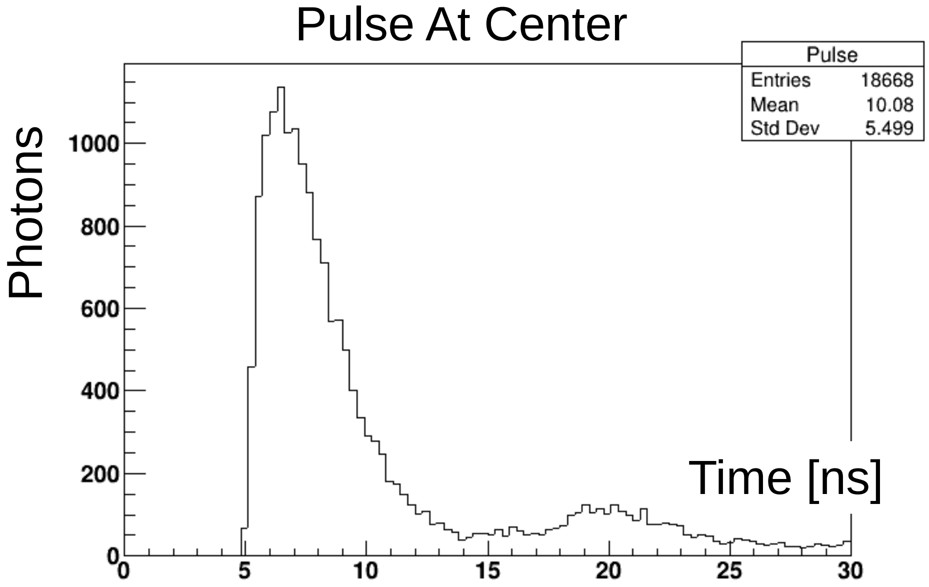
Hobin’s Simulation

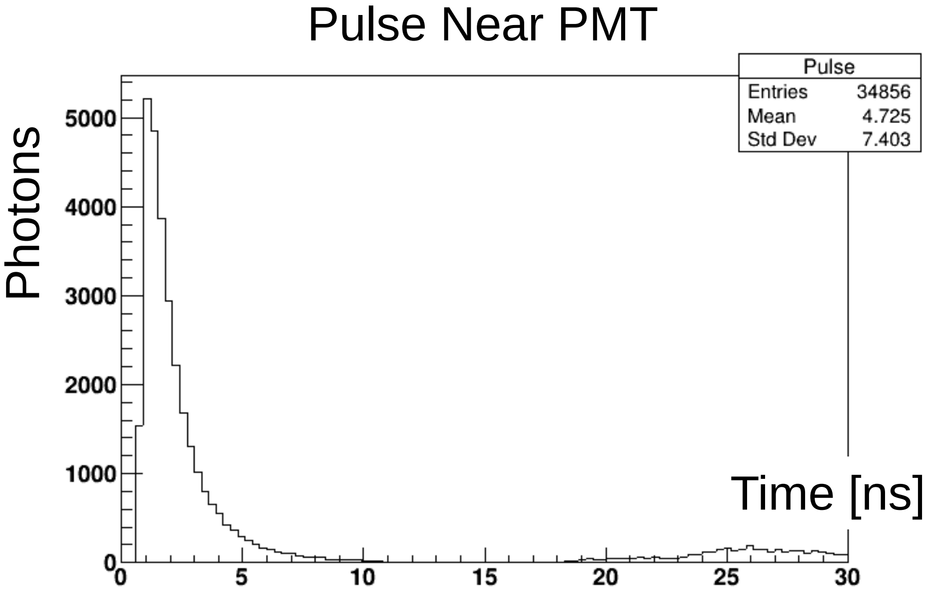
- Hobin gave me a simulation data.
- With 2 kinds of event,
  - 1) Events at center
  - 2) Events near PMT

  counted the number of photons entering PMT.
- It gave the solution!

Hobin's Simulation

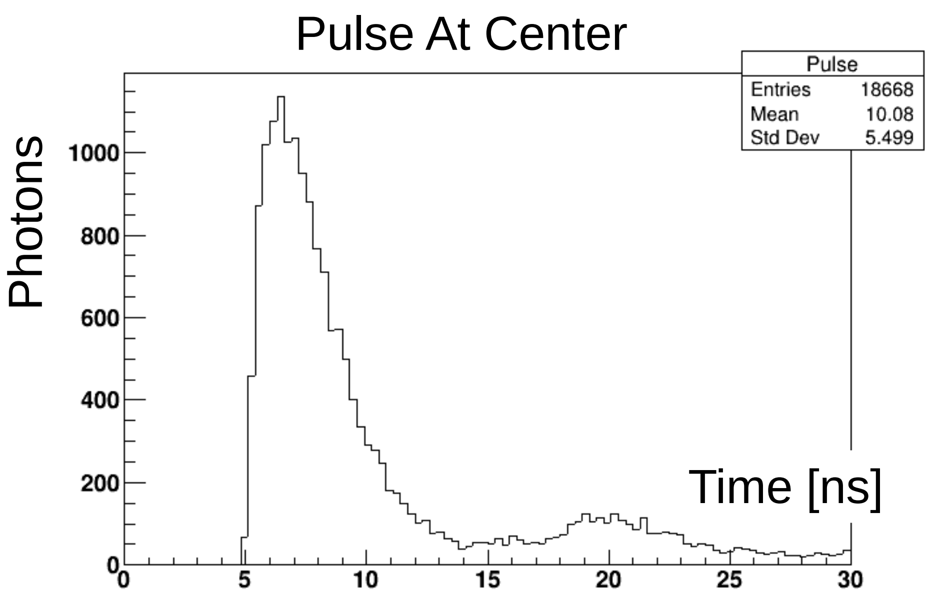
- There are second peaks.
  - Maybe they are from the reflection.
- Events at center have faster second peak.
- Events near PMT have second peak much later.

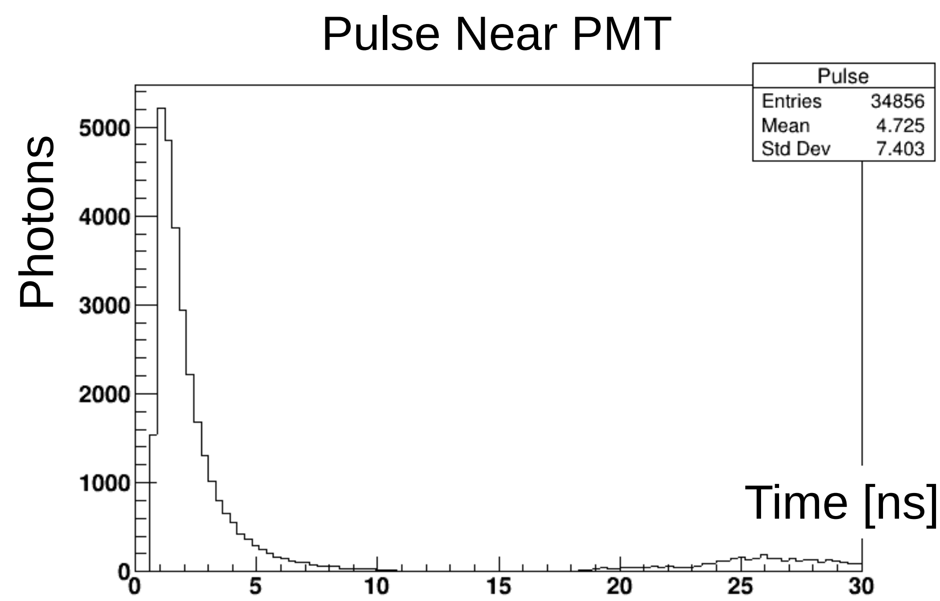




Hobin's Simulation

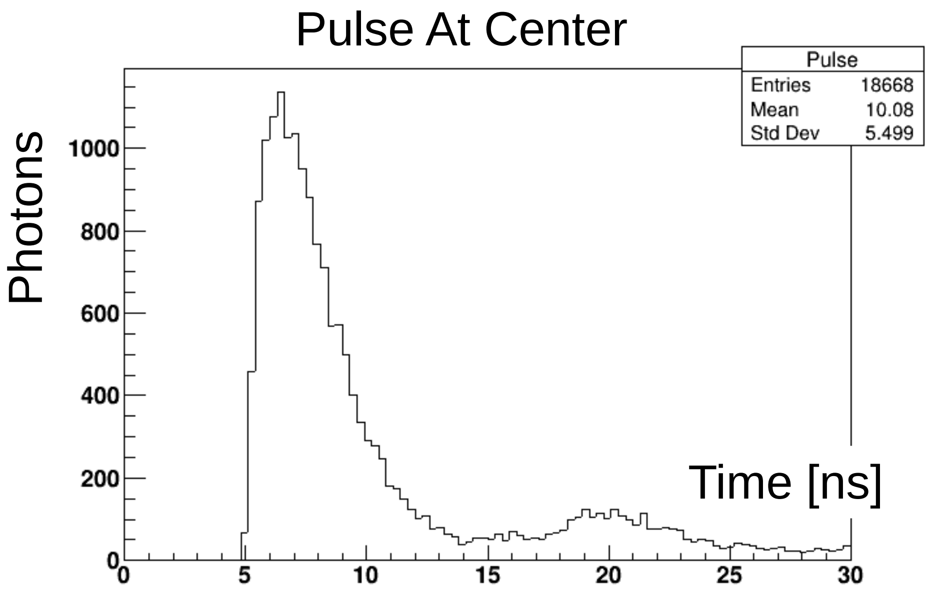
- The secondary peak of central events would be buried by PMT response.
  - This is why we could not see the secondary peak in the events at center.

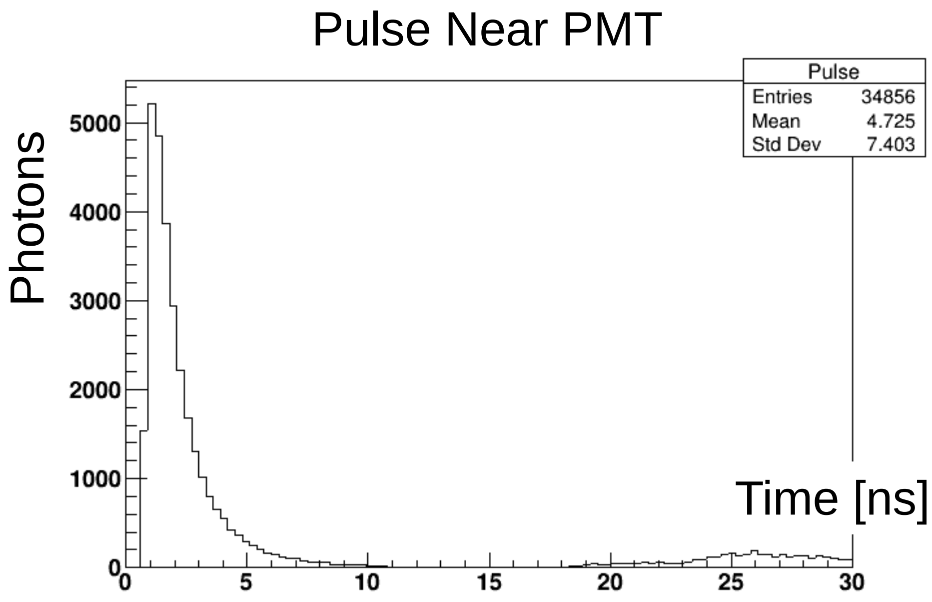




Hobin's Simulation

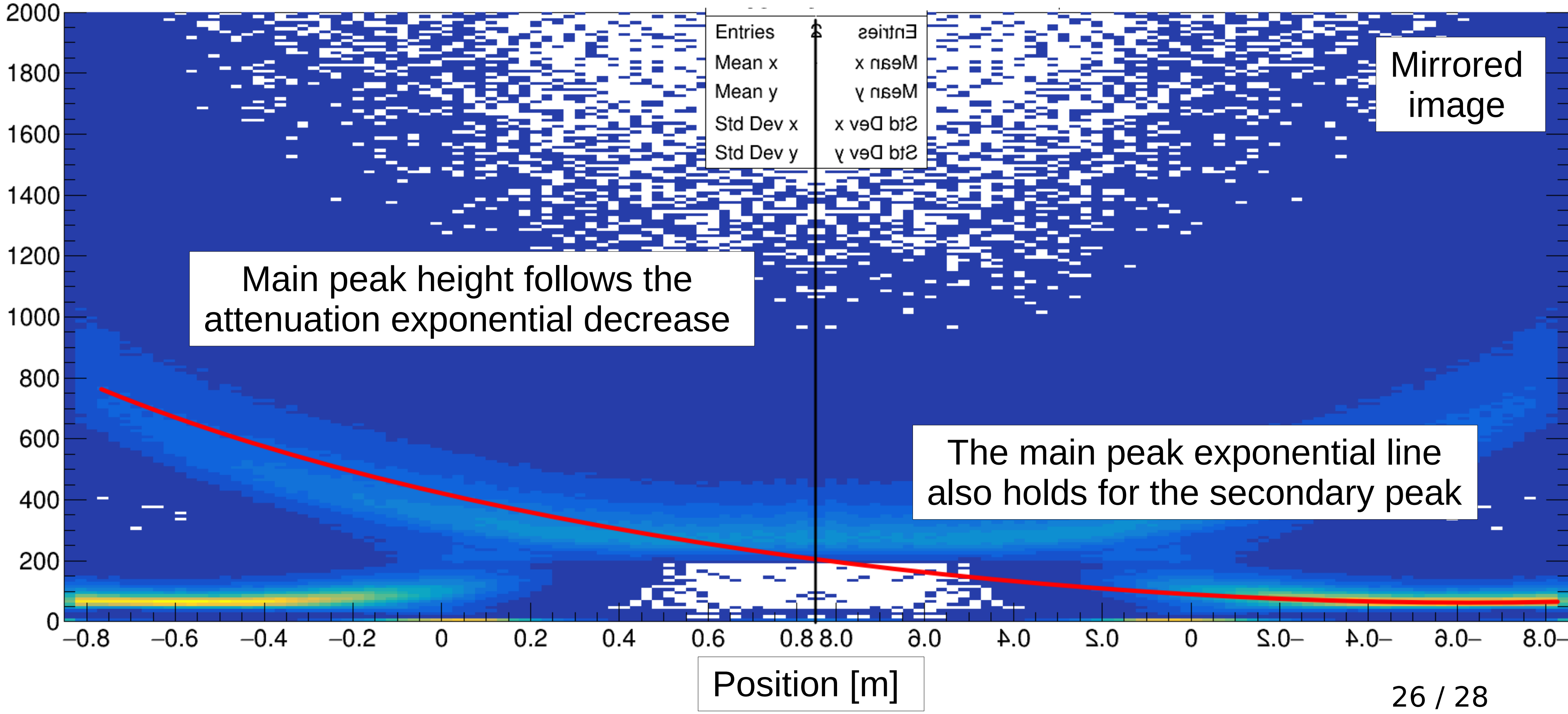
- Secondary peak near PMT has smaller height
  - Due to attenuation. Reflected ray travels further path.
  - Would the secondary peak height follows the attenuation pattern?





Hobin's Simulation

- Secondary peak follows the attenuation pattern!
  - Not qualitatively verified. It seems so.

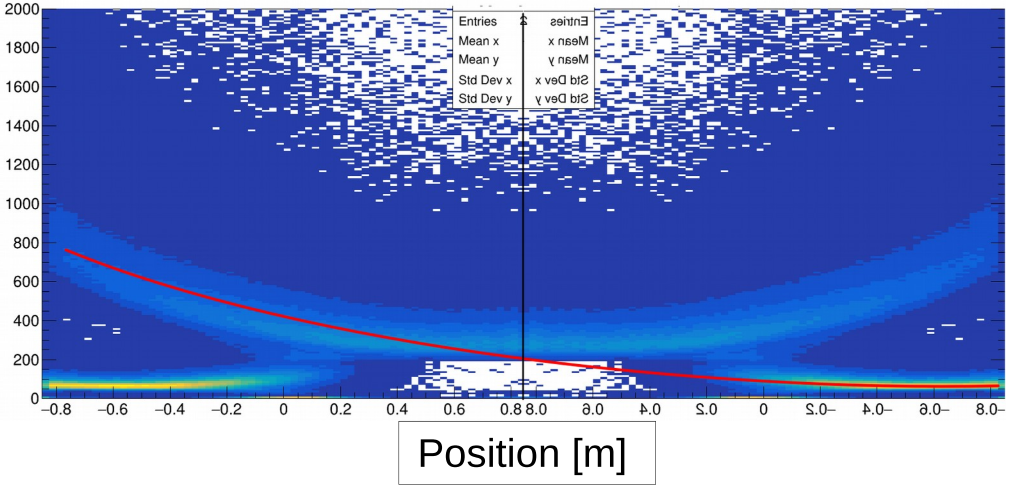


Secondary Peak, So What?

- Will secondary peak give a hint about the edge hill problem?
  - Maybe no.
  - Second peak is too small to be counted as an individual event.

Summary

- The secondary peak is from the reflected signal!



- The edge hill problem is not solved yet...