Muon Scintillator Time Calibration Study 3

2019.11.29

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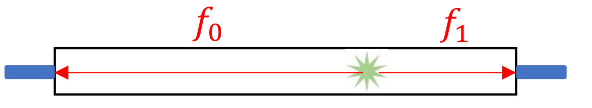
Time Calibration Study – Summary

- Last time I observed

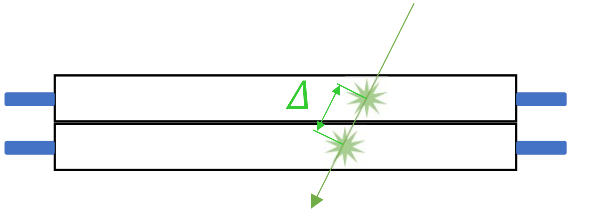
i) $f_1 - f_0$: Distribution of signal flight time difference to both sides in a scintillator.

It had no dependency on its direction.



ii) Δ : Event occurring time difference between two adjoining scintillators.

Muon velocity was measured as $v = (0.978 \pm 0.608)\ c$.

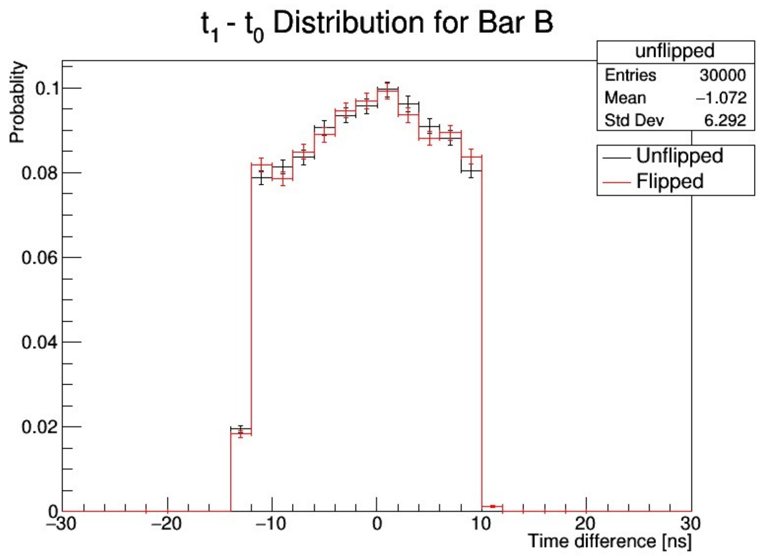


Time Calibration Study – Problem

- Last time I observed
  i) $f_1 - f_0$ Distribution showed asymmetric behavior.

  ii) v_μ had too large error.

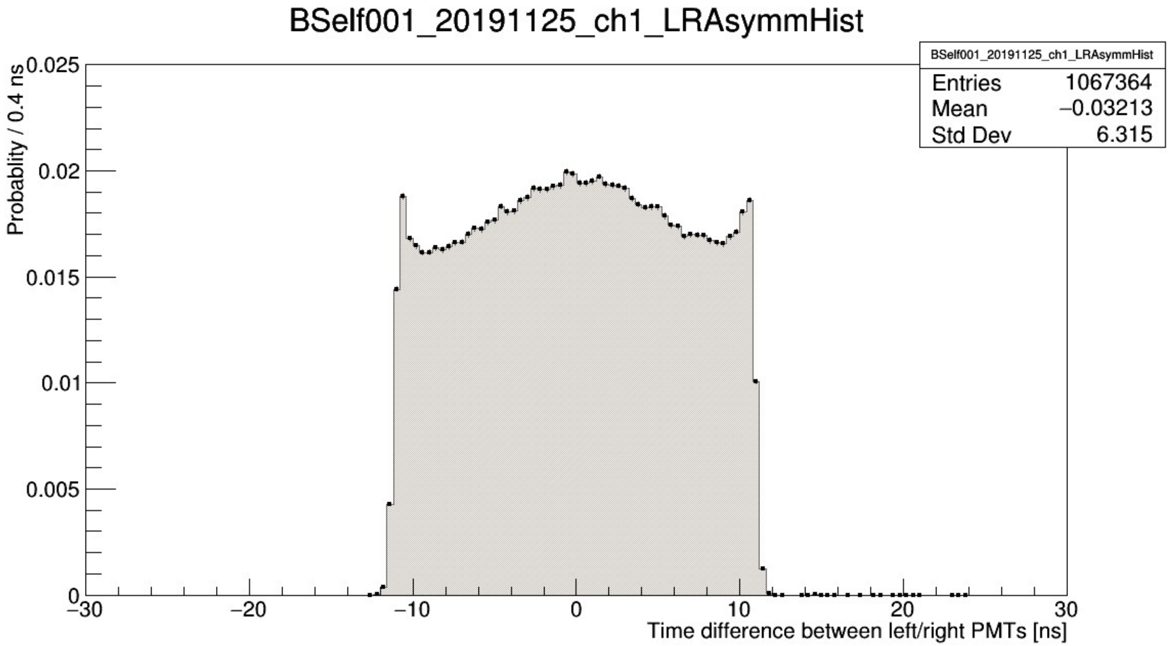
$$v_\mu = (0.978 \pm 0.608)\ c.$$



$f_1 - f_0$ Distribution Asymmetricity

- With more data (~1M), the asymmetricity vanished.
- However, it was not flat at all. There are inclines at both ends.

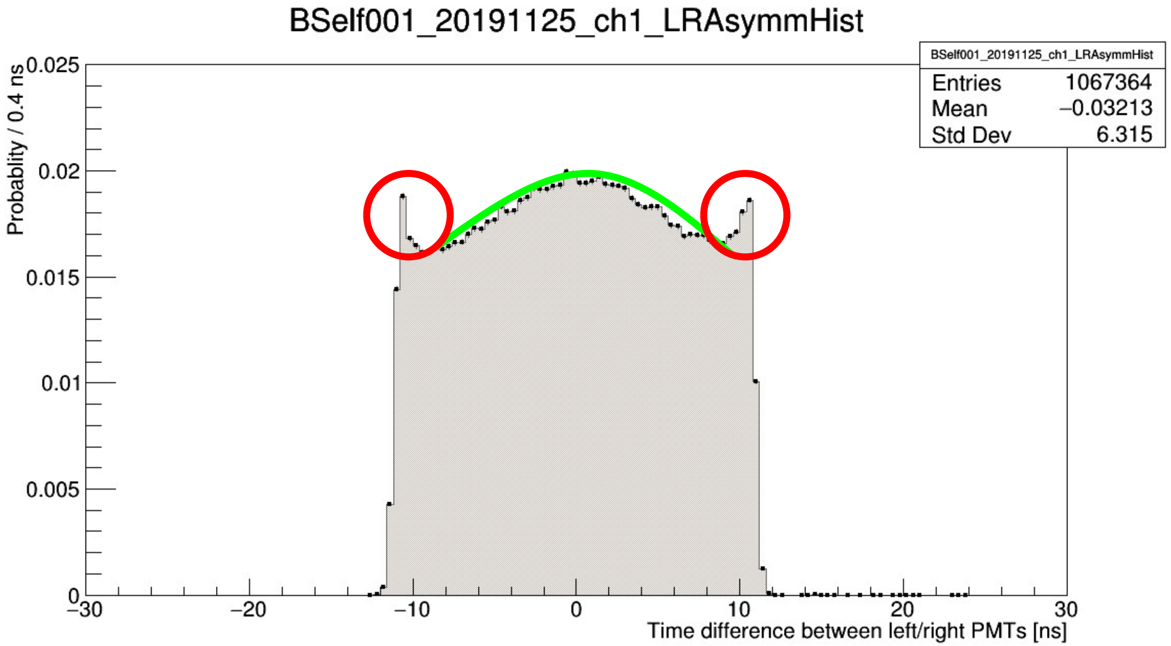
  - Plastic B bar only.
  - No coincidence trigger.
  - Port number 4
  - Data number: 1,067,364
  - THR: 200 ADC
  - 2019.11.25 night ~ 11.26 morning



$f_1 - f_0$ Distribution Asymmetricity

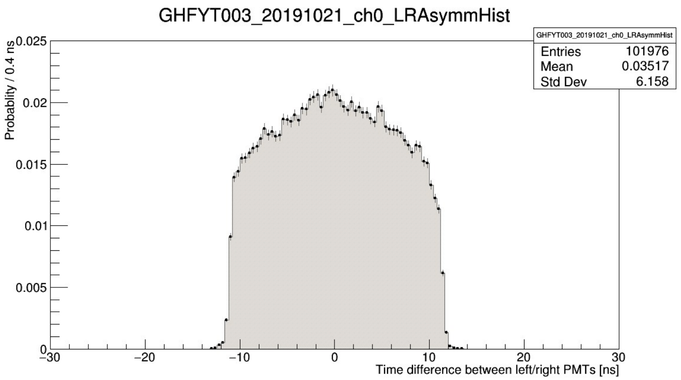
- With more data (~1M), the asymmetricity vanished.
- However, it was not flat at all. There are small hills at both ends.

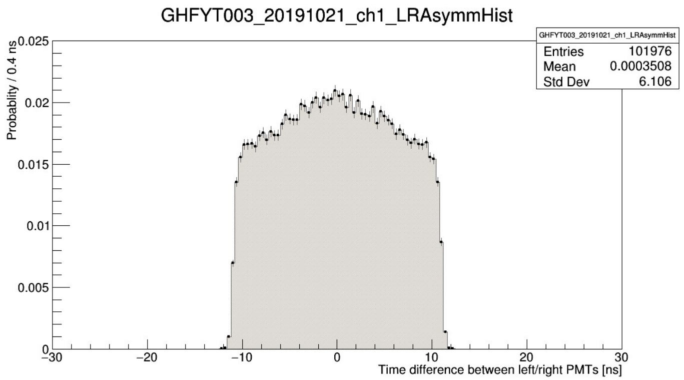
  - Plastic B bar only.
  - No coincidence trigger.
  - Port number 4
  - Data number: 1,067,364
  - THR: 200 ADC
  - 2019.11.25 night ~ 11.26 morning

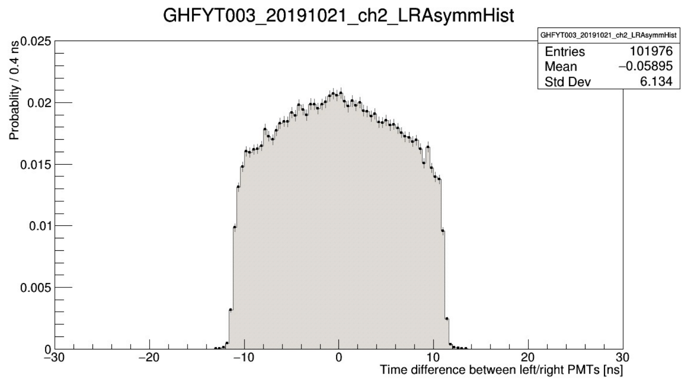


$f_1 - f_0$ Distribution

- Other data (with coincidence condition) also showed un-flat behavior.

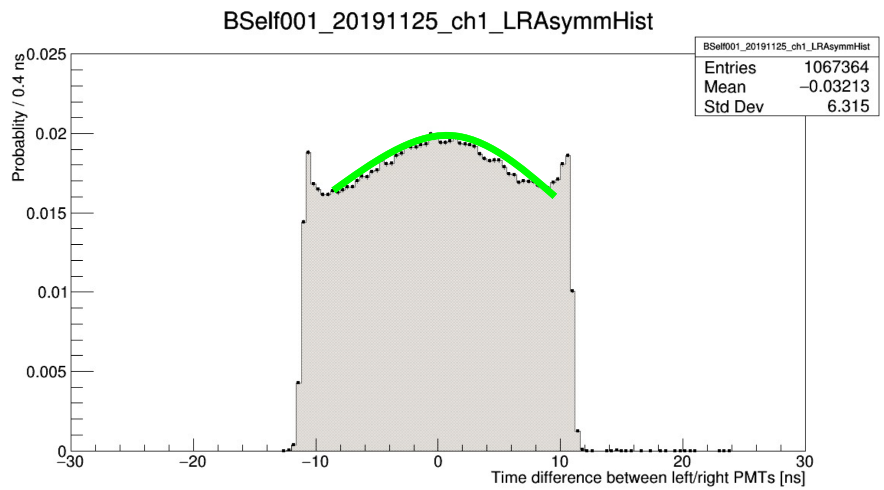


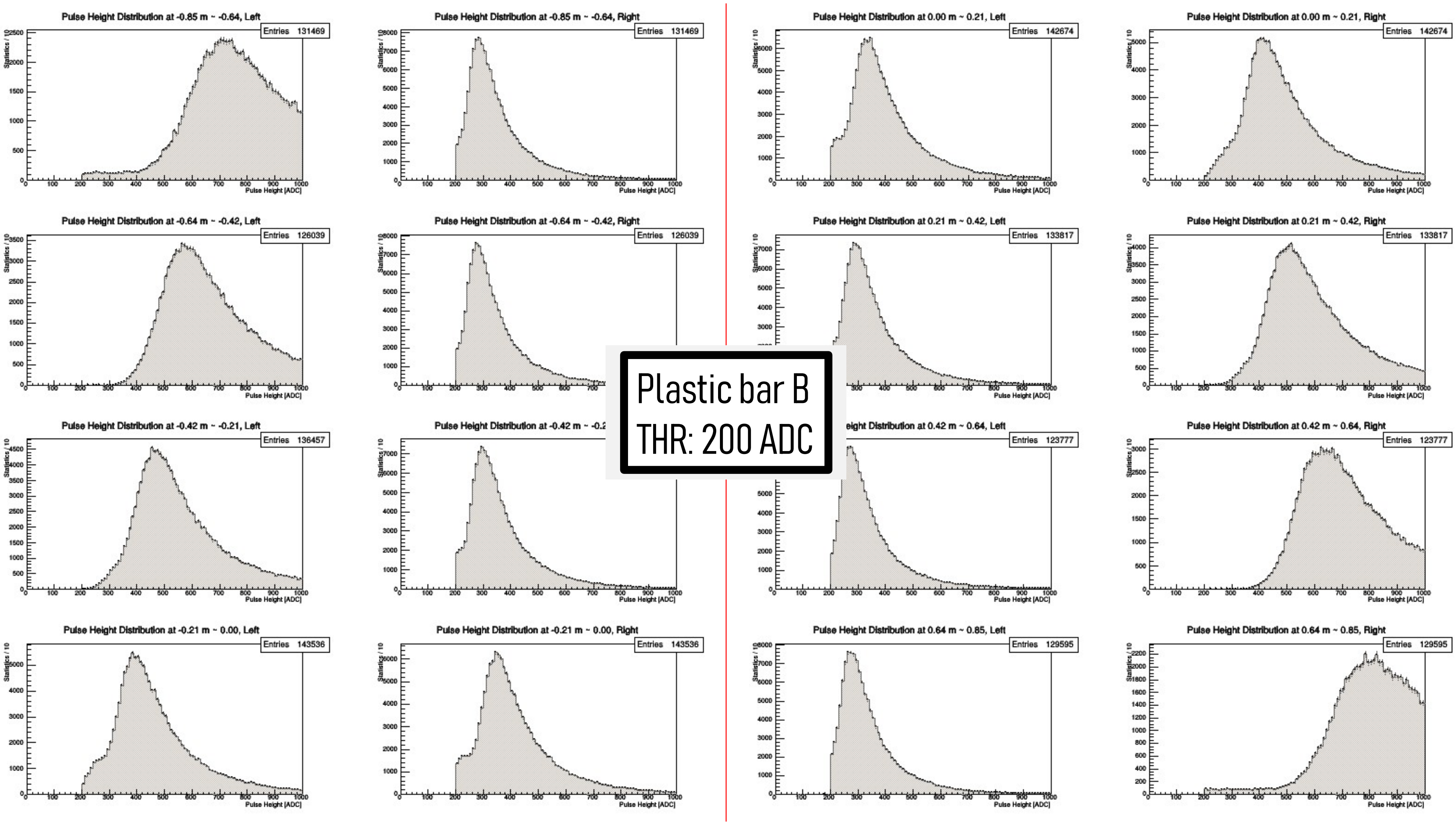




$f_1 - f_0$ Distribution – Unflatness

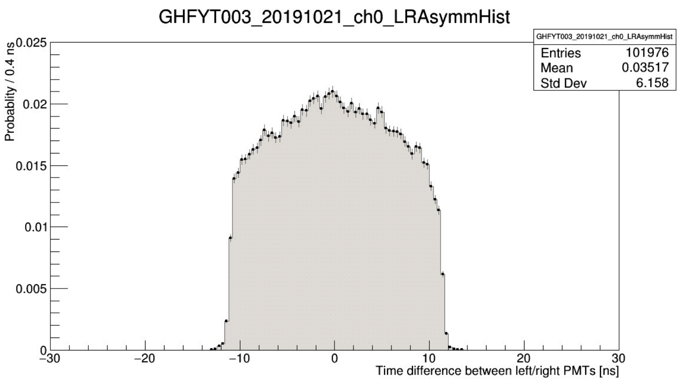
- For B bar, the shape in $f_1 - f_0$ distribution seems due to its threshold and attenuation of the signal intensity.
- If a muon hits near on PMT, then its signal to the other side PMT is attenuated, so some of the events are being missed.

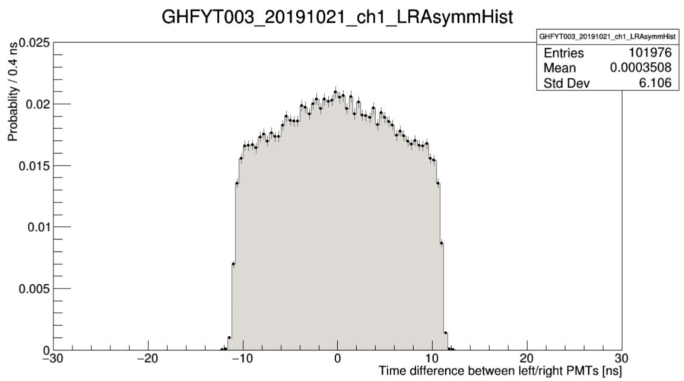


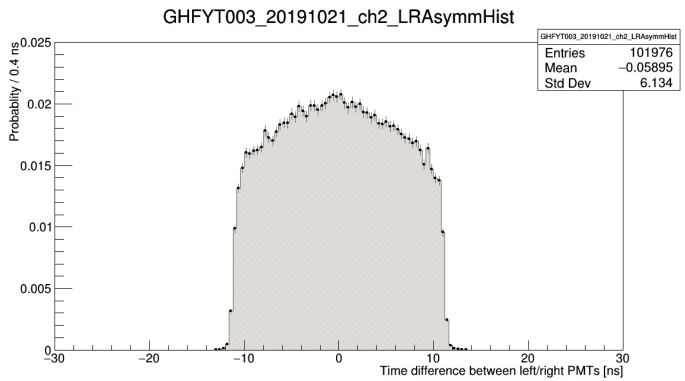

Pulse Height Distribution at -0.85 m ~ -0.64, Left
Entries 131469
Pulse Height Distribution at -0.85 m ~ -0.64, Right
Entries 131469
Pulse Height Distribution at 0.00 m ~ 0.21, Left
Entries 142674
Pulse Height Distribution at 0.00 m ~ 0.21, Right
Entries 142674
Pulse Height Distribution at -0.64 m ~ -0.42, Left
Entries 126039
Pulse Height Distribution at -0.64 m ~ -0.42, Right
Entries 126039
Pulse Height Distribution at 0.21 m ~ 0.42, Left
Entries 133817
Pulse Height Distribution at 0.21 m ~ 0.42, Right
Entries 133817
Pulse Height Distribution at -0.42 m ~ -0.21, Left
Entries 136457
Pulse Height Distribution at -0.42 m ~ -0.2
eight Distribution at 0.42 m ~ 0.64, Left
Entries 123777
Pulse Height Distribution at 0.42 m ~ 0.64, Right
Entries 123777
Pulse Height Distribution at -0.21 m ~ 0.00, Left
Entries 143536
Pulse Height Distribution at -0.21 m ~ 0.00, Right
Entries 143536
Pulse Height Distribution at 0.64 m ~ 0.85, Left
Entries 129595
Pulse Height Distribution at 0.64 m ~ 0.85, Right
Entries 129595
Statistics / 10
Pulse Height [ADC]
Plastic bar B
THR: 200 ADC

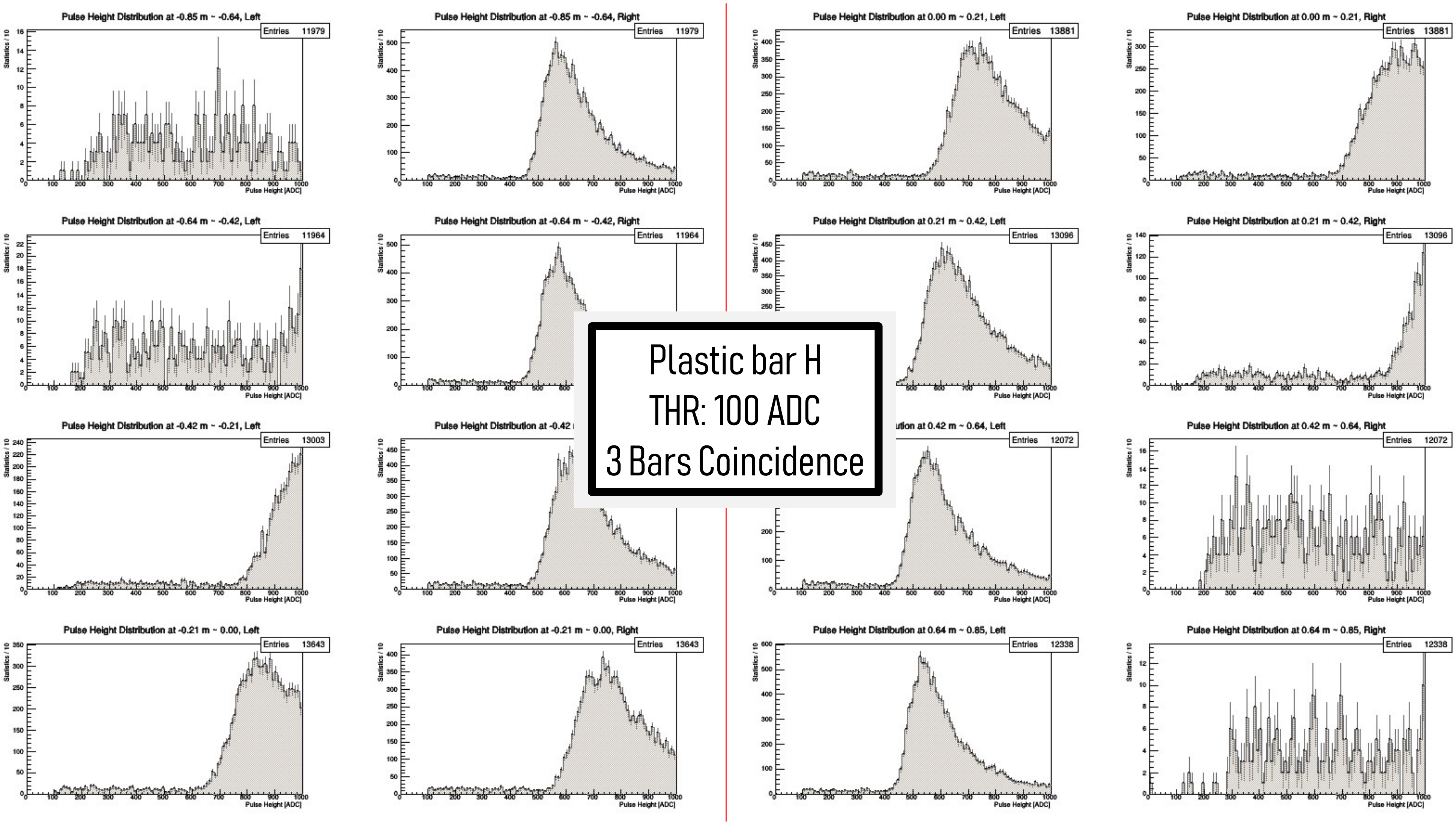
$f_1 - f_0$ Distribution – Unflatness

- But it is not for 3 bars data.
- The threshold for this experiment is not enough to explain its shape.





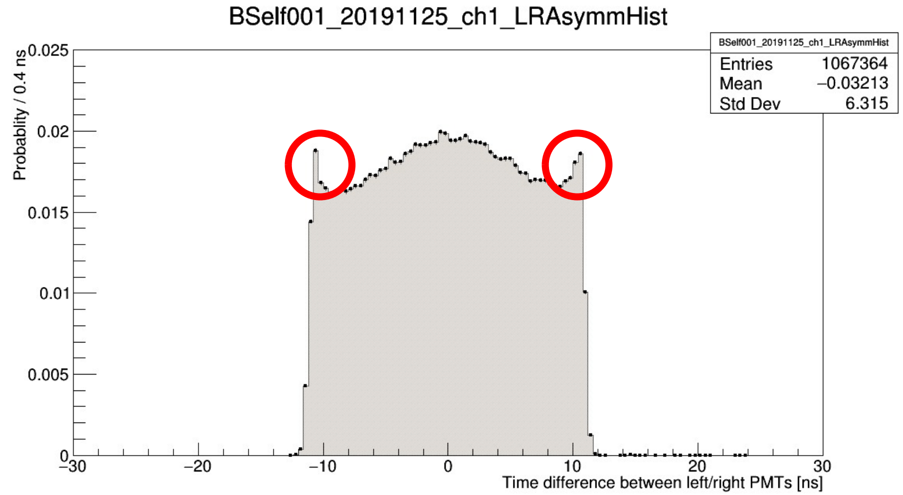


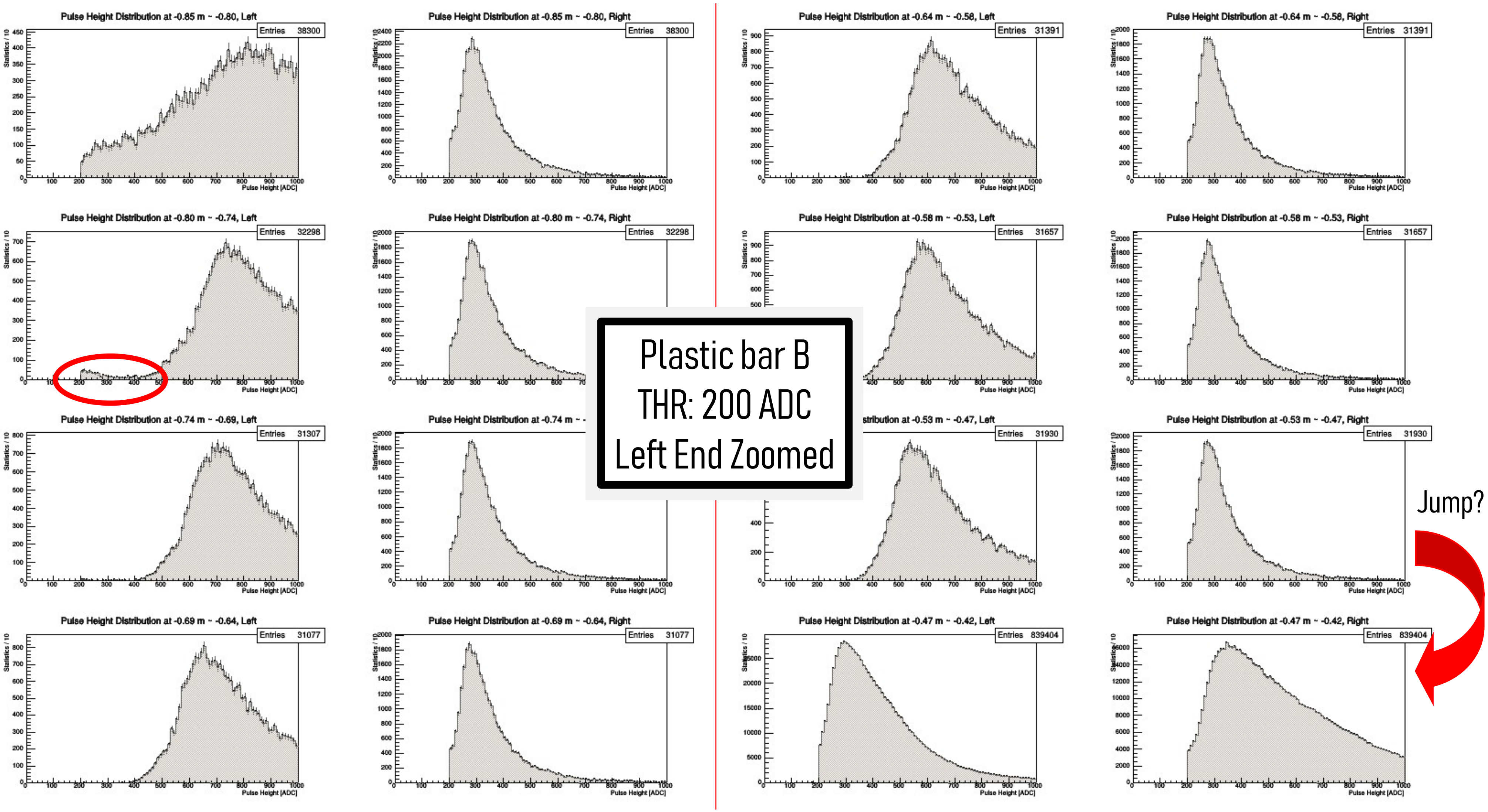


Plastic bar H
THR: 100 ADC
3 Bars Coincidence

$f_1 - f_0$ Distribution – Small Hills

- There was one more mystery – small hills.
- The reflection of signal on the edge of plastic is suspected, but not clear.





Plastic bar B
THR: 200 ADC
Left End Zoomed

Jump?

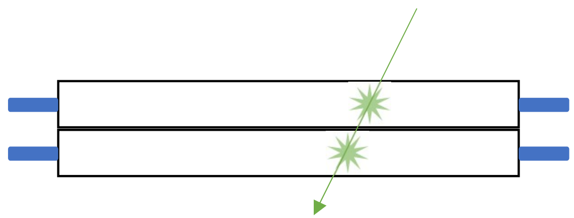
$f_1 - f_0$ Distribution – Conclusion

- Threshold 200 ADC for single plastic bar would be too high.

- But, the reasone for $f_1 - f_0$ distribution shape is not clear.

ν_μ Measurement

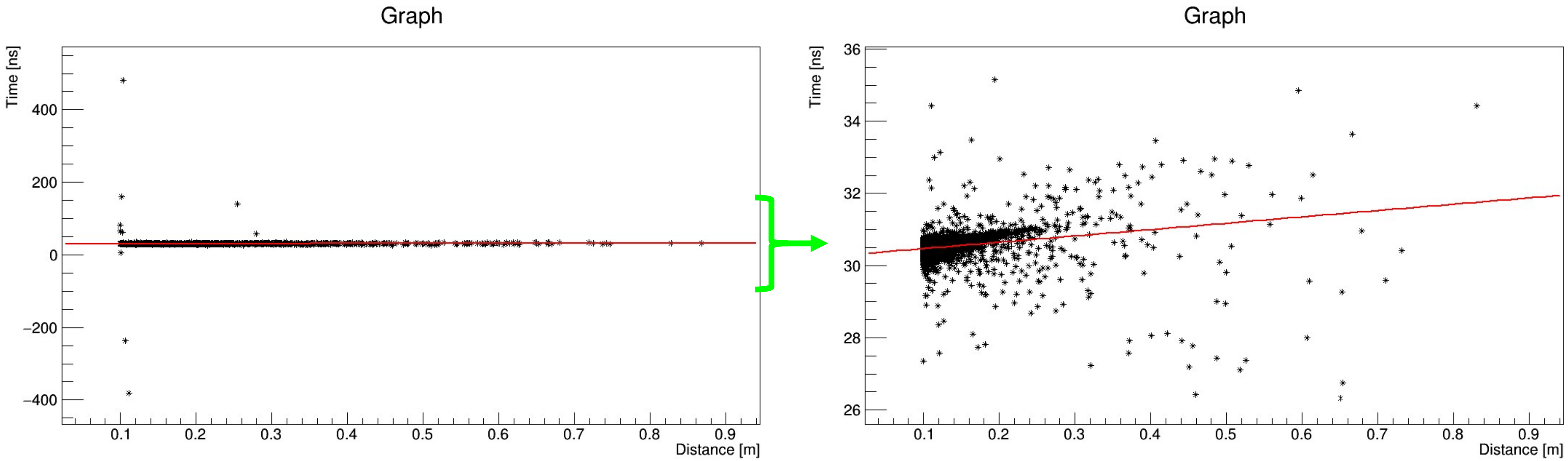
- Tried to plot the time delay vs distance graph directly.
- Distance was assumed as $s = \sqrt{(0.1\mathrm{m})^2 + \Delta x^2}$. The thickness of the plastic was ignored.



Time Delay vs Distance Plot

- The result was awful. Plot is so noisy.
- Line was fitted as below. It means $\beta_\mu = (1.898 \pm 0.369)$c.

$$t[\mathrm{ns}] = (1.757 \pm 0.425)[\mathrm{ns/m}]s + (30.293 \pm 0.052)[\mathrm{ns}]$$



Time Delay vs Distance Plot

- Event cut is inevitable!