Brief considerations about forward/backward muons with time of flight (TOF)

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Outline

- Comparison with Mariaelena's results
  - Golden Track Selected Data with 4 stations from (Runs: #915-18 and #929) BLU detector used to produced here
  - Boards selection criteria
  - raw TDC difference
  - measured TOF distributions for both views with and without the ϕ-cut
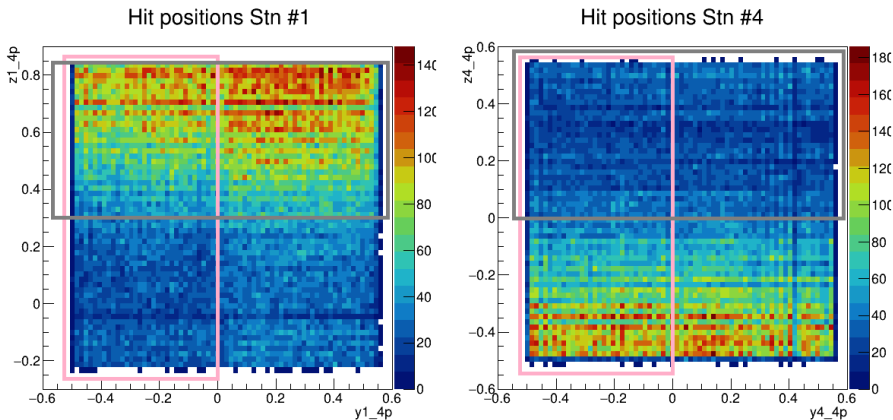- Some considerations

Figure: Y and Z hits positions in Station 1 and Station 4

- Boards in the X-views (i.e., #1, #13) were selected a logical "AND" of gray boxes
- Similarly, a logical "AND" of pink boxes was used to select Y boards (i.e., #2, #14)
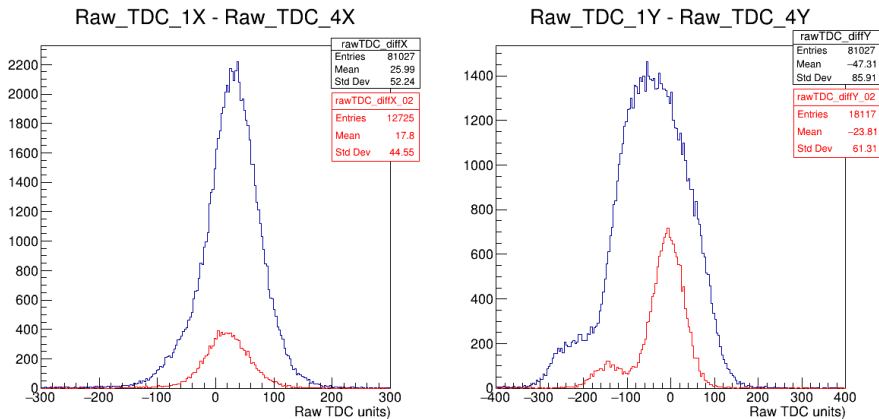
Raw TDC Difference in the selected regions

Figure: Blue histgrams represent overall raw TDC difference while red ones represent those after making the boards selection

$\rightarrow$ We were puzzled by the "shoulders" that appear in the Y view (never in the X view), and that Mariaelena did not see with her selection

measured TOF calculations for X and Y views

$$TOF_{mes} = \frac{(T_i - T_i^0)}{E_i} - \frac{(T_j - T_j^0)}{E_j} \tag{1}$$

$\rightarrow$ Using Texp parameters for relevant X-boards

$$TOFX_{mes} = \frac{(T_1 - 538.0)}{7.25} - \frac{(T_4 - 597.0)}{7.91} \tag{2}$$

$\rightarrow$ Using Texp parameters for relevant Y-boards

$$TOFY_{mes} = \frac{(T_1 - 494.7)}{6.73} - \frac{(T_4 - 566.5)}{7.05} \tag{3}$$

$\rightarrow$ Minimization function used:

$$\sum_i [\Delta T_i(p)]^2, \text{where,}$$
$$\Delta T_i(p) = \frac{T_1}{E_1} - \frac{T_4}{E_4} - p - \Delta T_{exp} \tag{4}$$

Minimization results comparison of the free-parameter, p

	This work	Mariaelena's prior work
p (X-view)	-3.97	-3.59
p (Y-view)	3.73	5.39

Table: Free parameters obtained from prior and this work

$\rightarrow$ Since the result for Y-view seemed off, we examined the selection criteria used for both studies more closely.

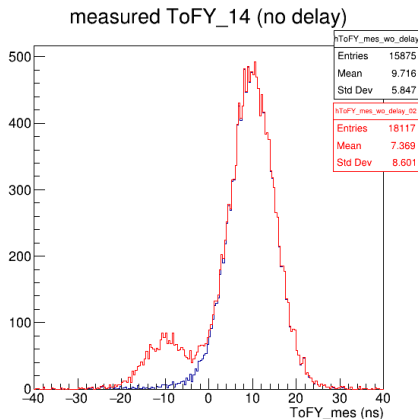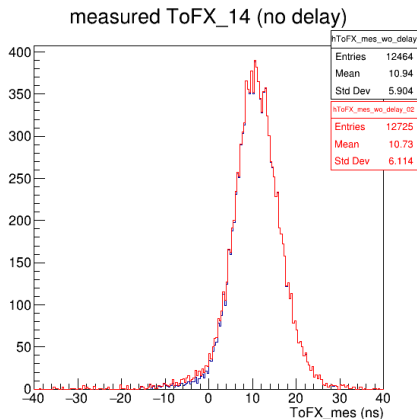# measured TOF distributions for X and Y views

Figure: measured TOF (without delay) for both views after relevant boards selection with and without the ϕ-cut: $(90 < \phi < 270)$

$\rightarrow$ Then we realized that our selection was not really the same: we were missing a $90 < \phi < 270$ cut that she applies for the purpose of this study!

Some considerations

- Currently, in the reconstruction software, the "raw" elevation angle θ is used to classify the muon as forward or backward: if $\theta < 0$, $\theta \rightarrow -\theta$ and $\phi \rightarrow \phi + 180$

- However, a negative raw value of θ can also happen for a forward muon that scattered in the ground before reaching the detector; in that case, we would consider more appropriate to keep $\theta < 0$

- once TOF calibration will be considered final and validated, it should be possible to replace the previous criterion with a TOF criterion, i.e.:

    - if $TOF \geq 0$, θ and ϕ stay as they are (i.e., allowing $\theta < 0$)

    - else, $\theta \rightarrow -\theta$ and $\phi \rightarrow \phi + 180$

- We believe that this new definition will be more intuitive and less confusing

- In addition, we currently only have access to reconstructed θ, ϕ; it would be interesting also to have a look at raw θ, ϕ distributions in future studies

- Any comments, feedback, and suggestions are most welcome.

Thank you for your attention