Update on Coincidence Time/Hodoscope Calibration Analysis Software

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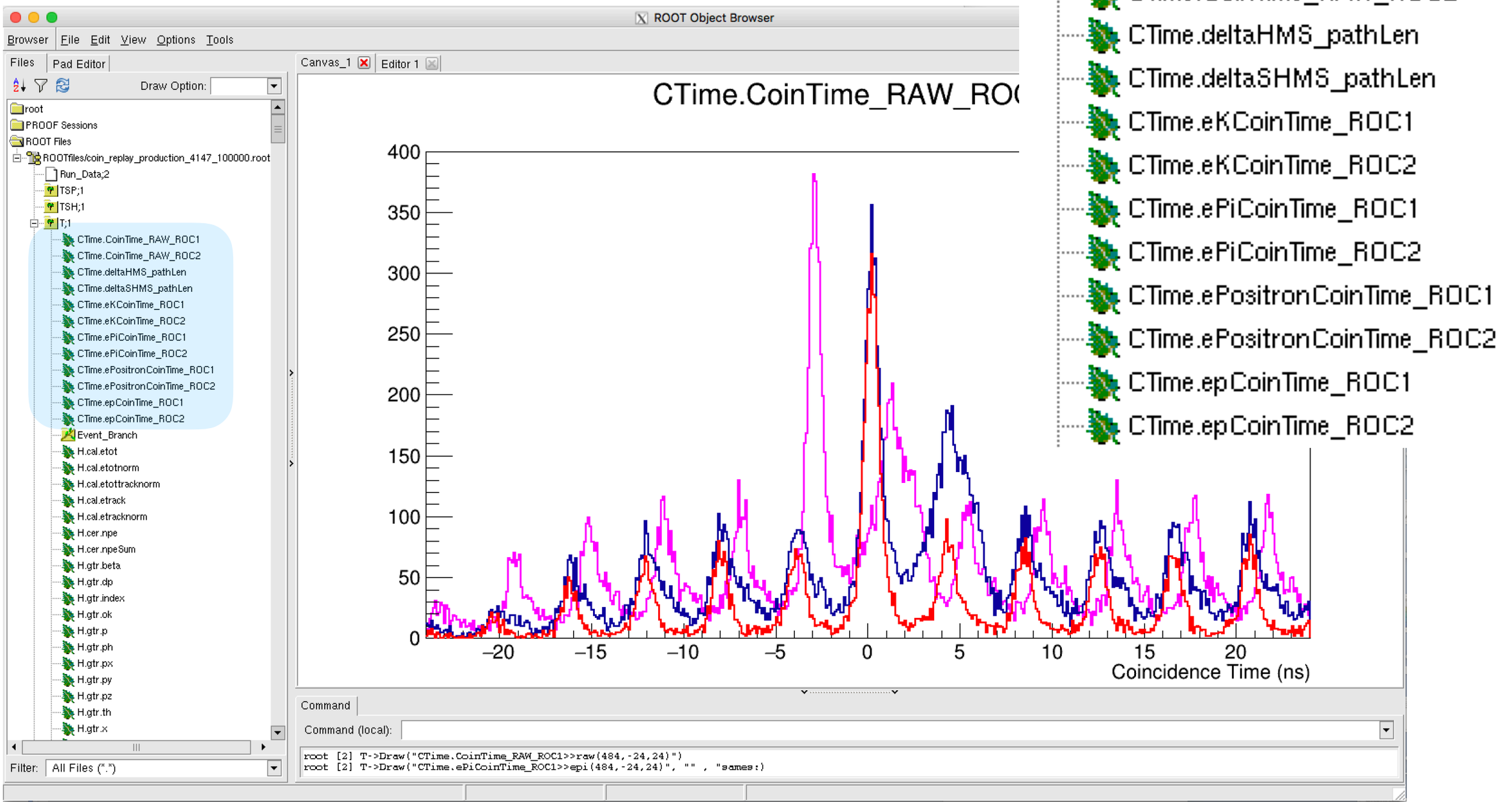
Coincidence Time Physics Module

☑ Created THcCoinTime.cxx/.h physics module in hcana

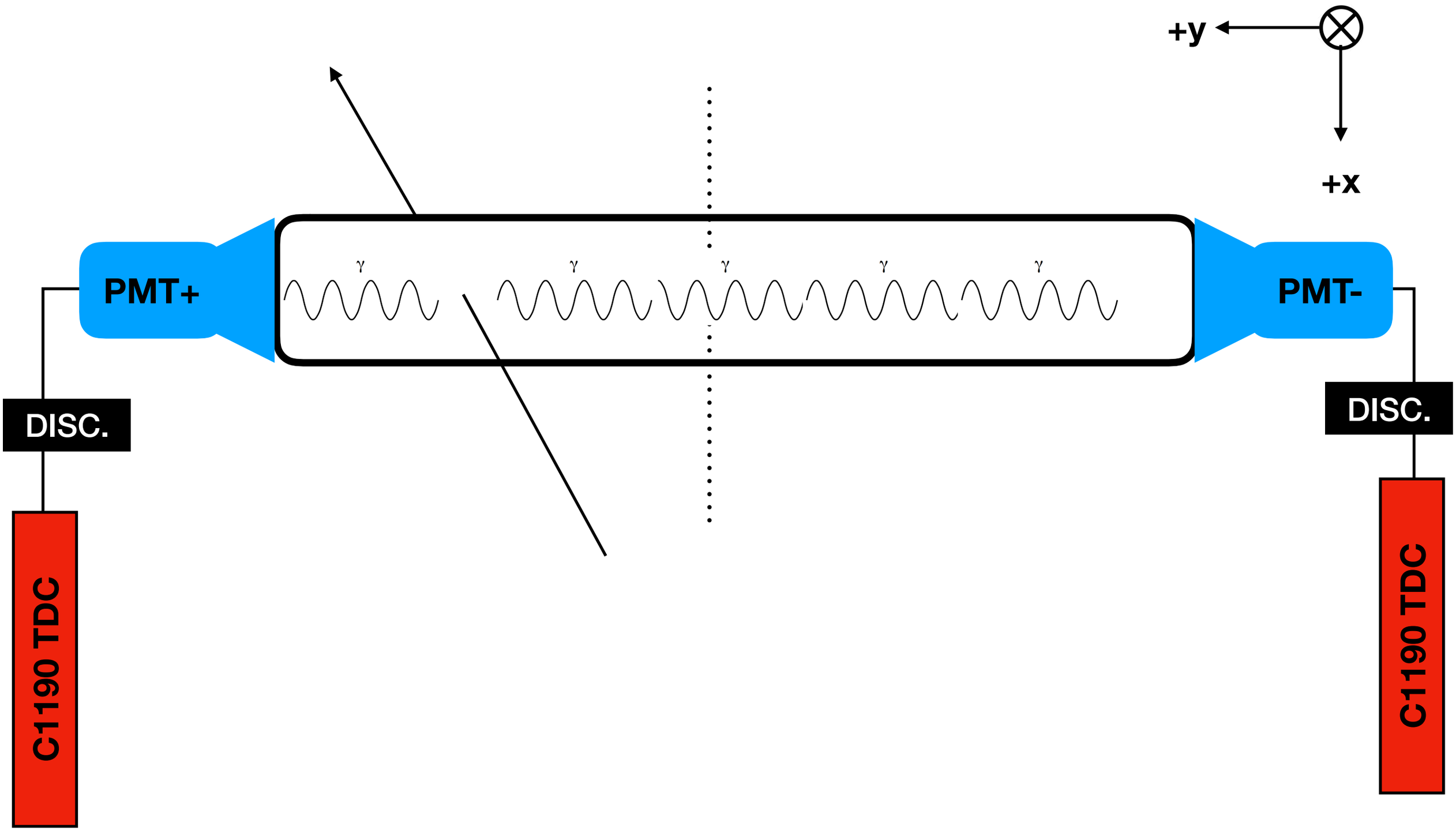
☑ Added PathLength/Offset parameters in hallc_replay

☑ Tested the newly added coincidence time leaf variables with recent SIDIS experimental runs

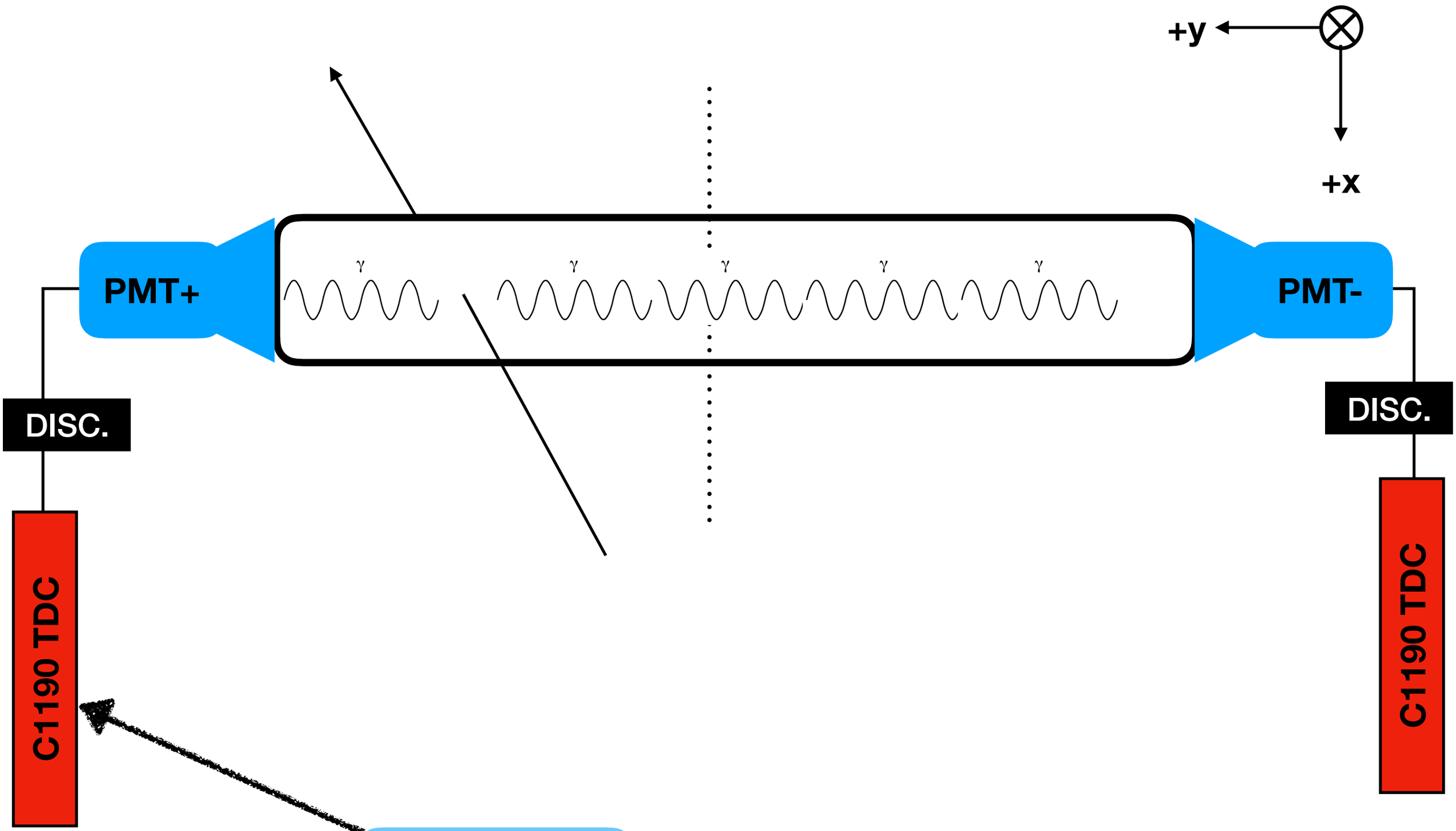
Module Doc. Link



HODOSCOPE CALIBRATION UPDATE

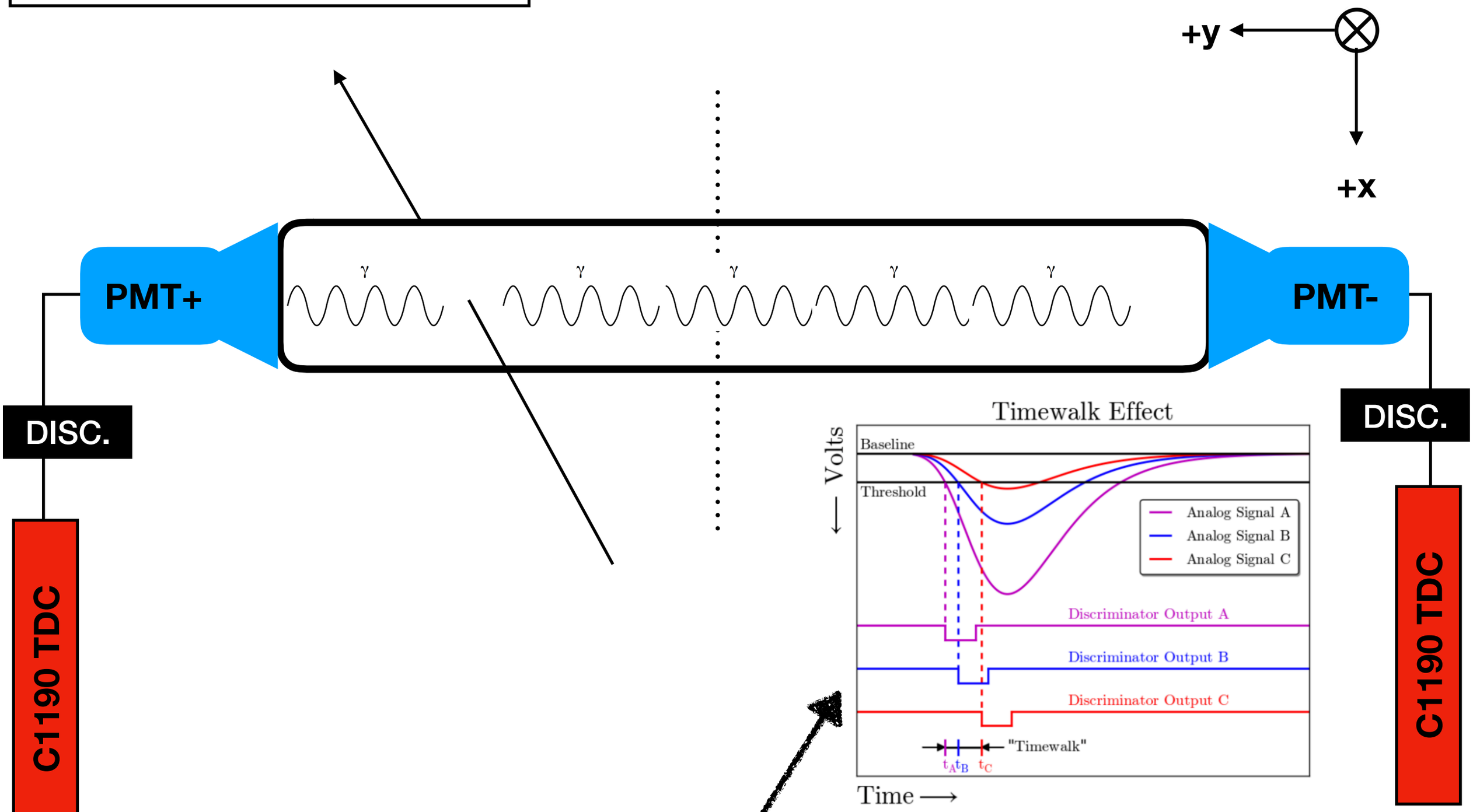


$$t^{(\pm)}_{Corr.} = t^{(\pm)}_{UnCorr.} - t^{(\pm)}_{TW} - t^{(\pm)}_{cable} - t^{(\pm)}_{prop.}$$

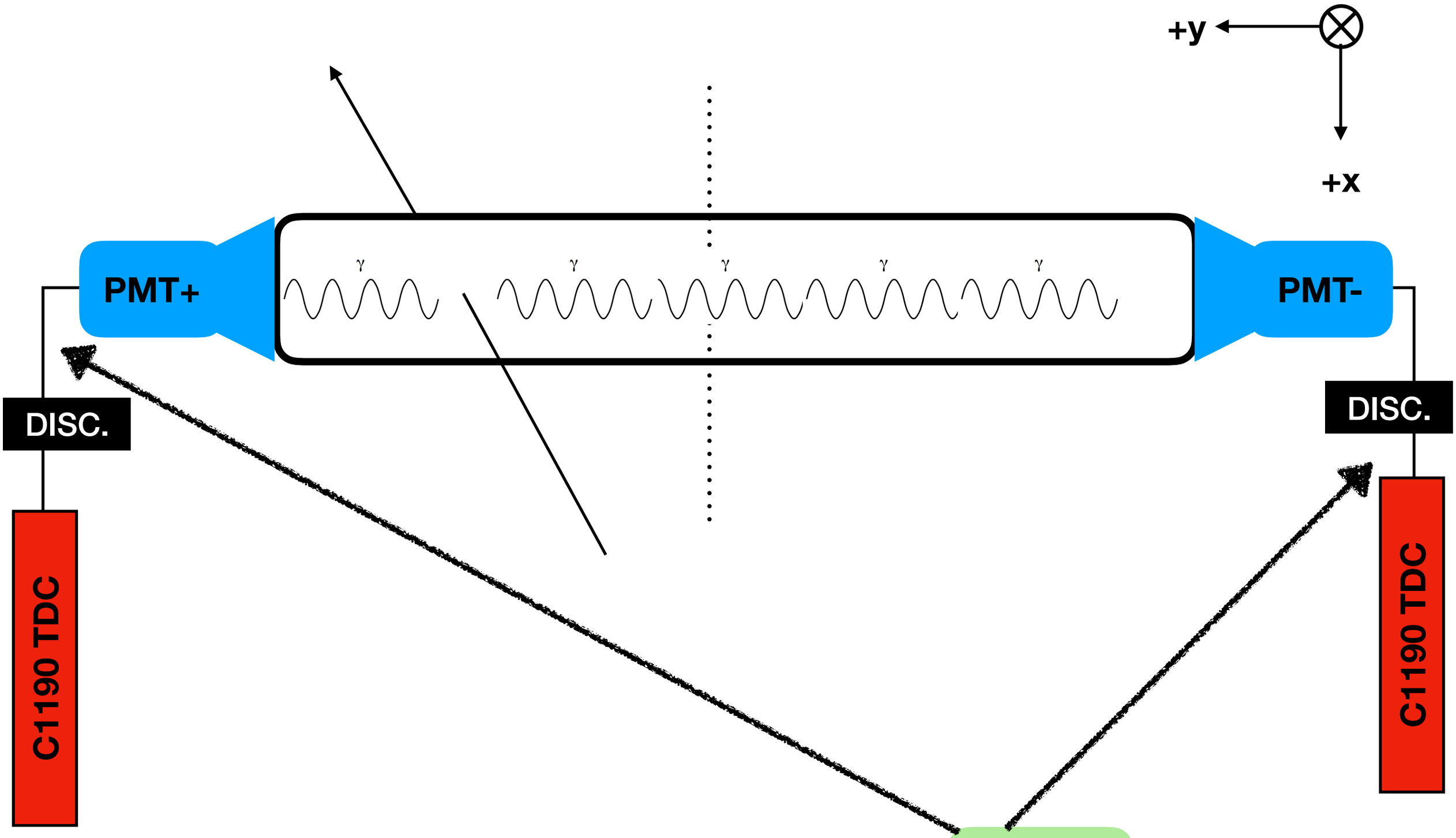


$$t^{(\pm)}_{Corr.} = t^{(\pm)}_{UnCorr.} - t^{(\pm)}_{TW} - t^{(\pm)}_{cable} - t^{(\pm)}_{prop.}$$

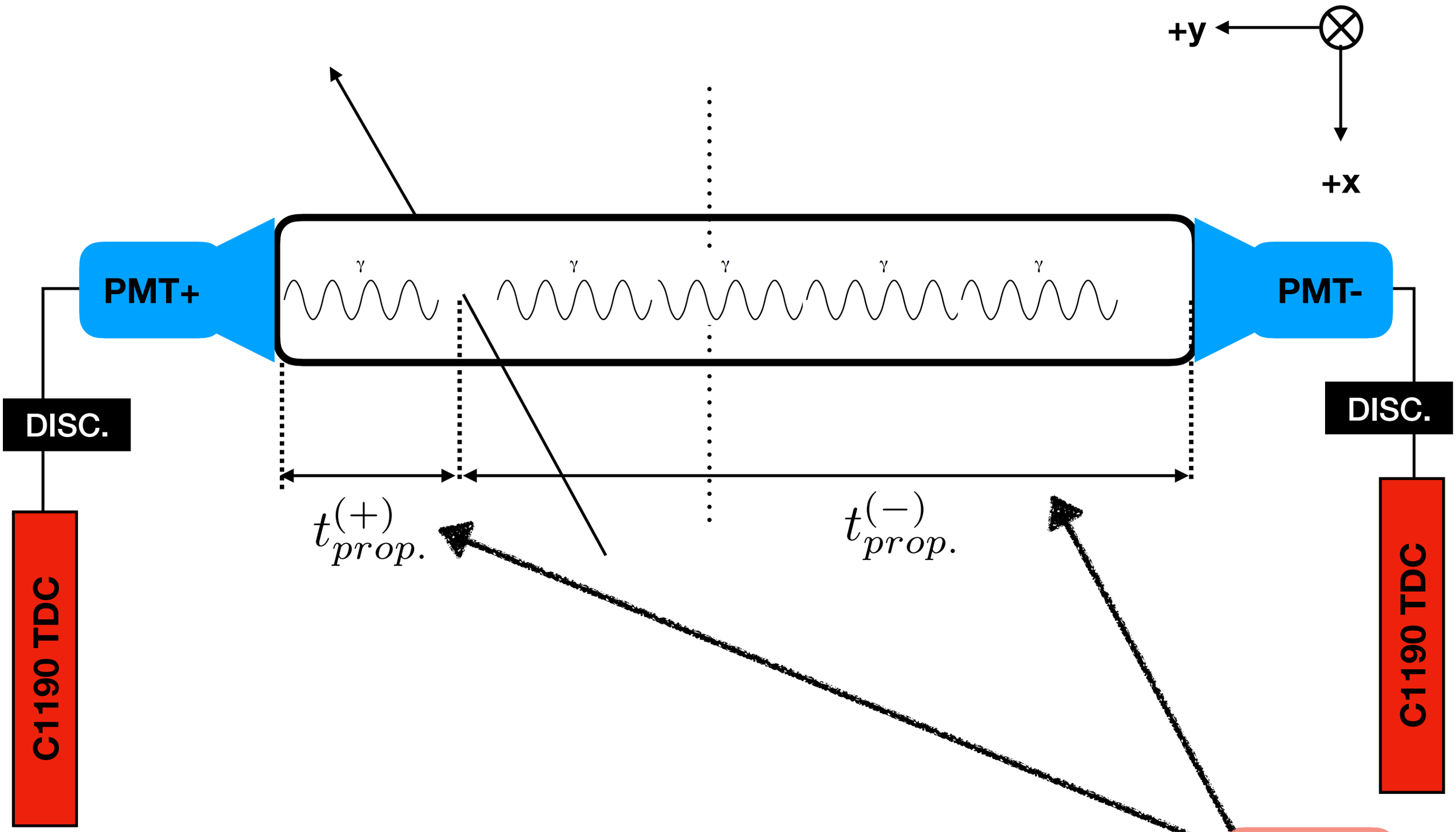
Image Source: E. Pooser



$$t^{(\pm)}_{Corr.} = t^{(\pm)}_{UnCorr.} - t^{(\pm)}_{TW} - t^{(\pm)}_{cable} - t^{(\pm)}_{prop.}$$

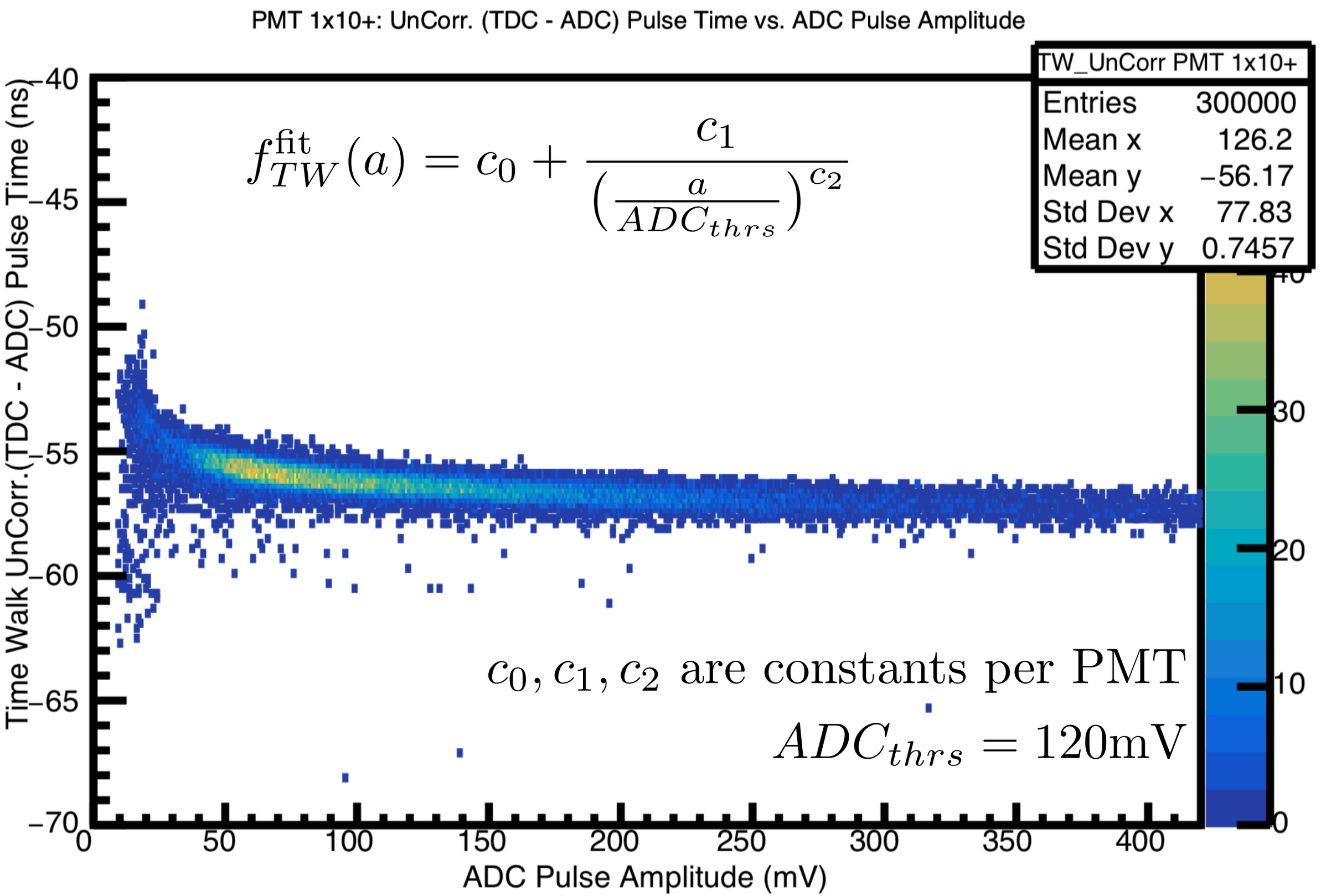


$$t^{(\pm)}_{Corr.} = t^{(\pm)}_{UnCorr.} - t^{(\pm)}_{TW} - t^{(\pm)}_{cable} - t^{(\pm)}_{prop.}$$

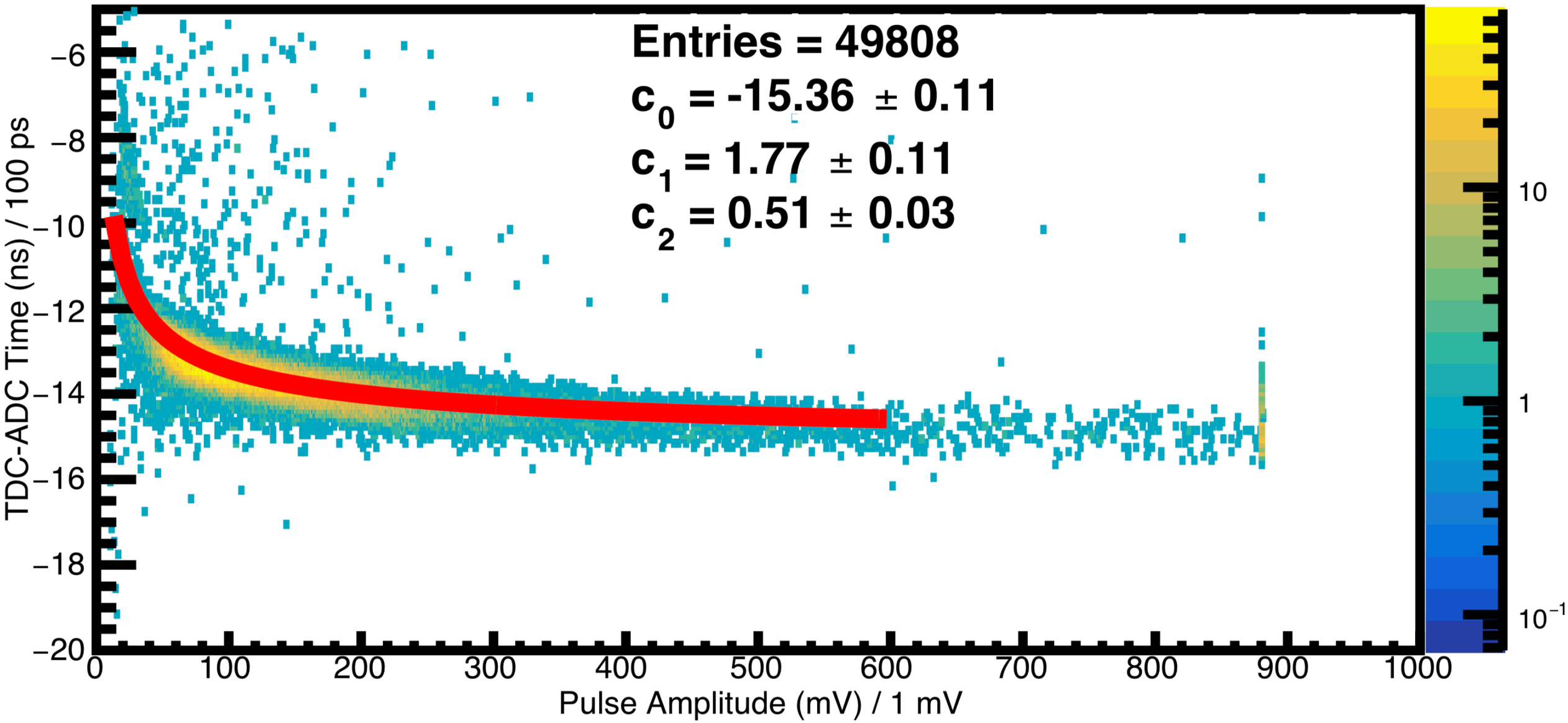


$$t^{(\pm)}_{Corr.} = t^{(\pm)}_{UnCorr.} - t^{(\pm)}_{TW} - t^{(\pm)}_{cable} - t^{(\pm)}_{prop.}$$

Time-Walk Corrections



TDC-ADC Time vs. Pulse Amp Plane 1x Side pos Paddle 10



PMT 1x10+: Corr. (TDC - ADC) Pulse Time vs. ADC Pulse Amplitude

$$f_{TW}^{correction}(a) = \frac{c_1}{\left(\frac{a}{ADC_{thrs}}\right)^{c_2}} - \frac{c_1}{\left(\frac{a_0}{ADC_{thrs}}\right)^{c_2}}$$

a_0 is a reference ADC amplitude: $a_0 = 200$ mV

W_Corr PMT 1x10+	
Entries	300000
Mean x	126.2
Mean y	−56.81
Std Dev x	77.83
Std Dev y	0.535

Time Walk Corr.(TDC - ADC) Pulse Time (ns)

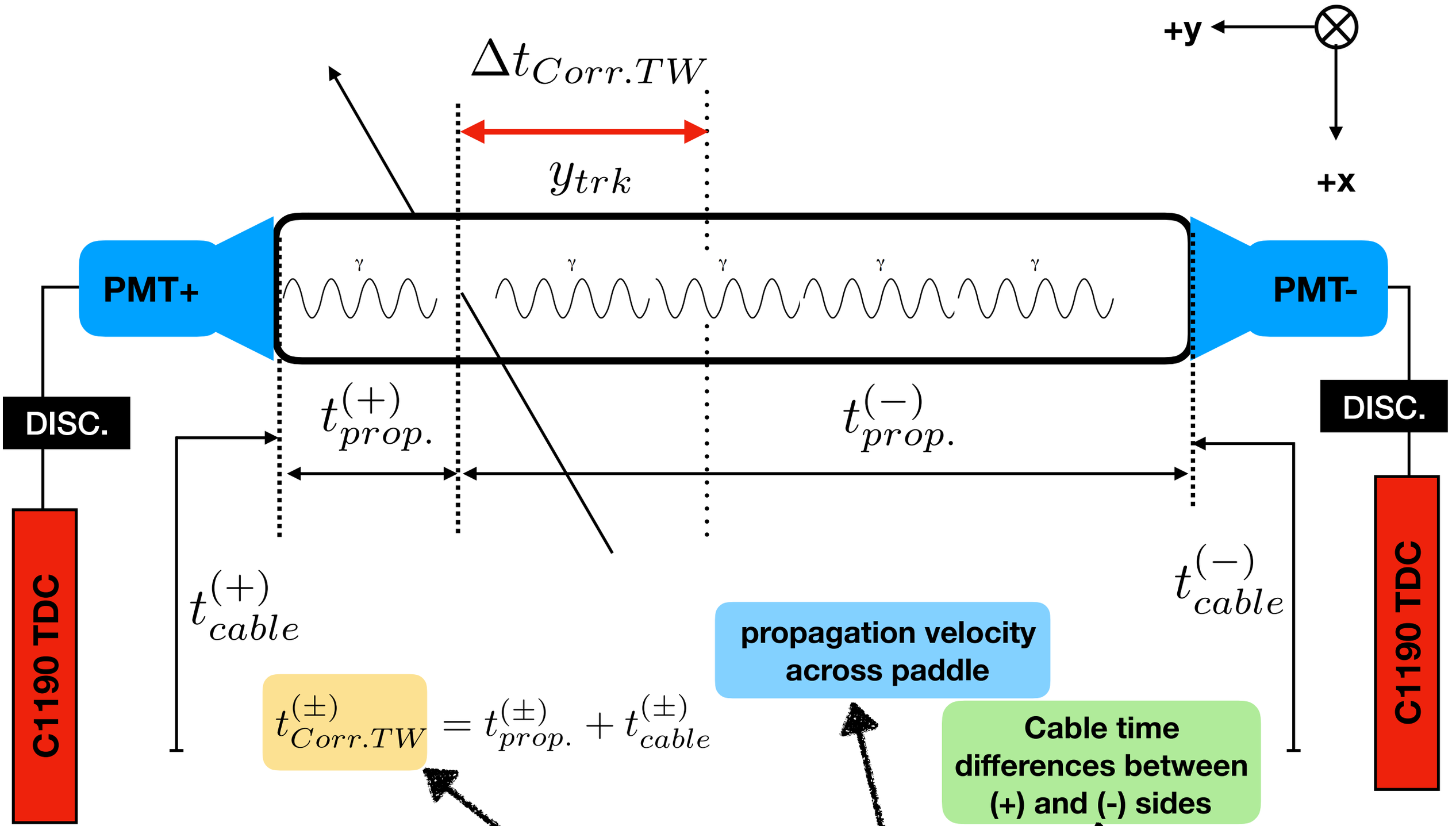
−40
−45
−50
−55
−60
−65
−70

0 50 100 150 200 250 300 350 400

ADC Pulse Amplitude (mV)

30
20
10
0

Propagation Velocity / Cable Length Corrections



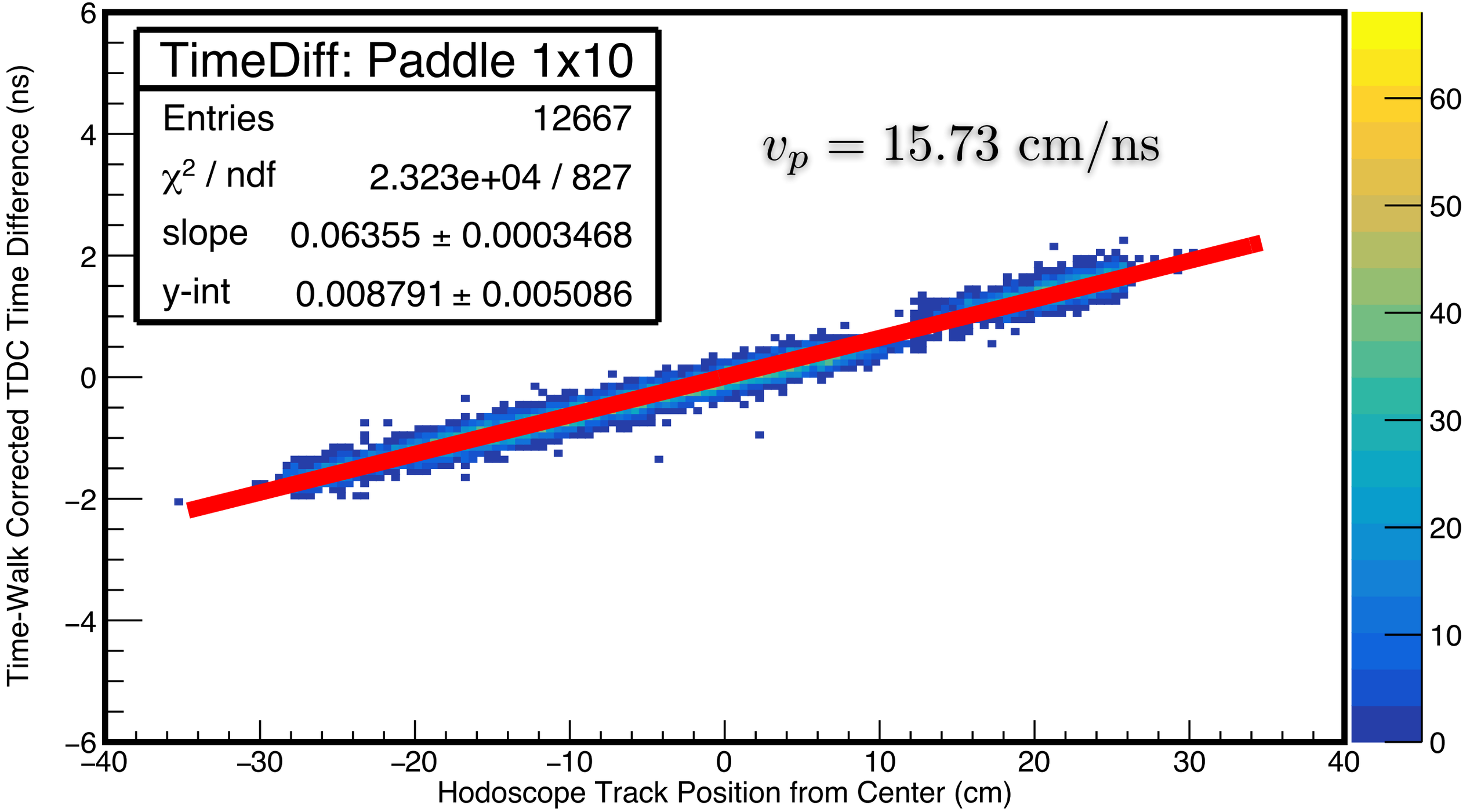
$$t^{(\pm)}_{Corr.TW} = t^{(\pm)}_{prop.} + t^{(\pm)}_{cable}$$

propagation velocity across paddle

Cable time differences between (+) and (-) sides

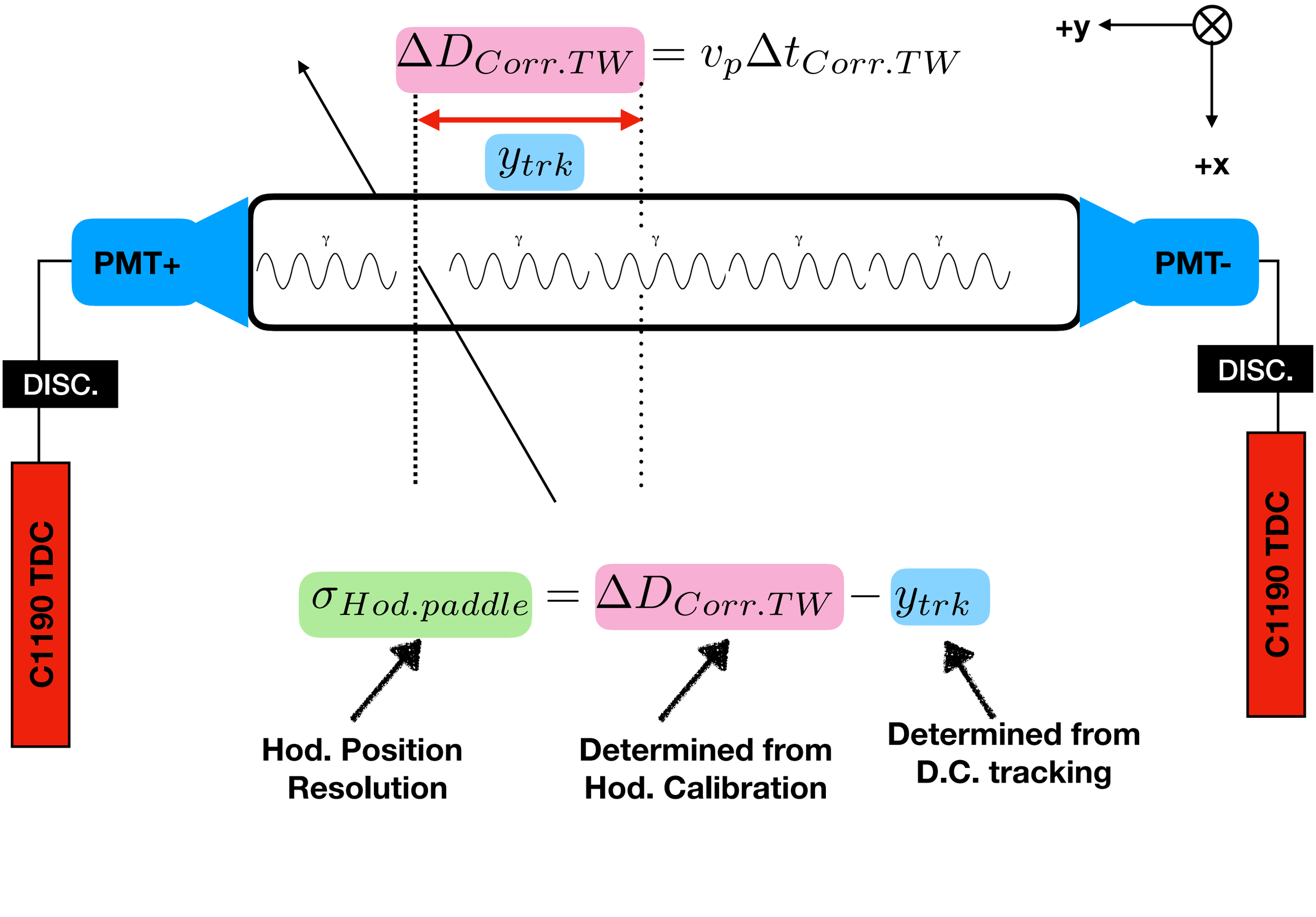
$$\Delta t_{Corr.TW}(y_{trk}) \equiv \frac{1}{2}(t^{(-)}_{Corr.TW} - t^{(+)}_{Corr.TW}) = \frac{1}{v_p} y_{trk} + b_0$$

Propagation Velocity / Cable Length Corrections



Hodoscope Paddle Resolution

$$\Delta D_{Corr.TW} = v_p \Delta t_{Corr.TW}$$



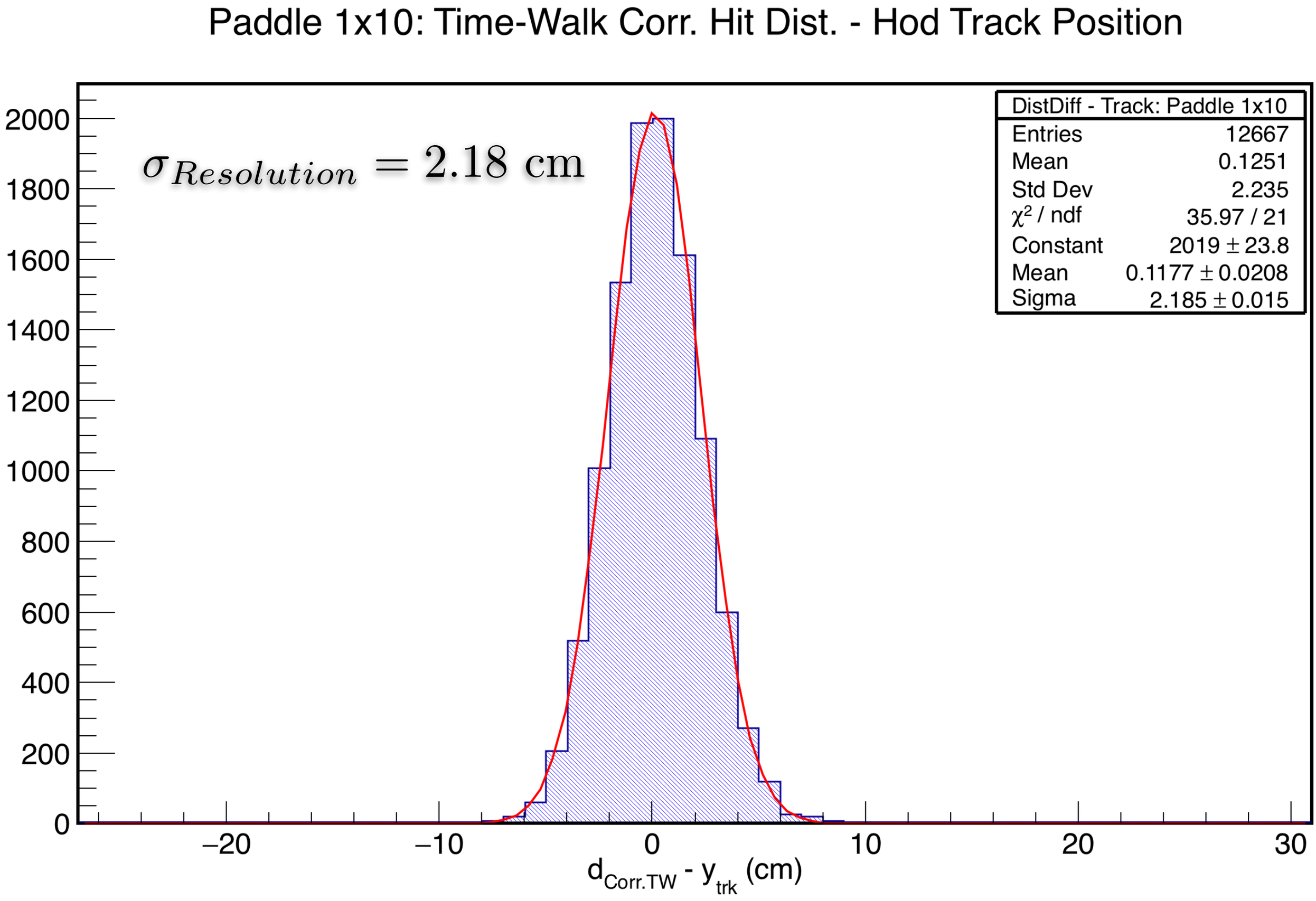
$$\sigma_{Hod.paddle} = \Delta D_{Corr.TW} - y_{trk}$$

Hod. Position Resolution

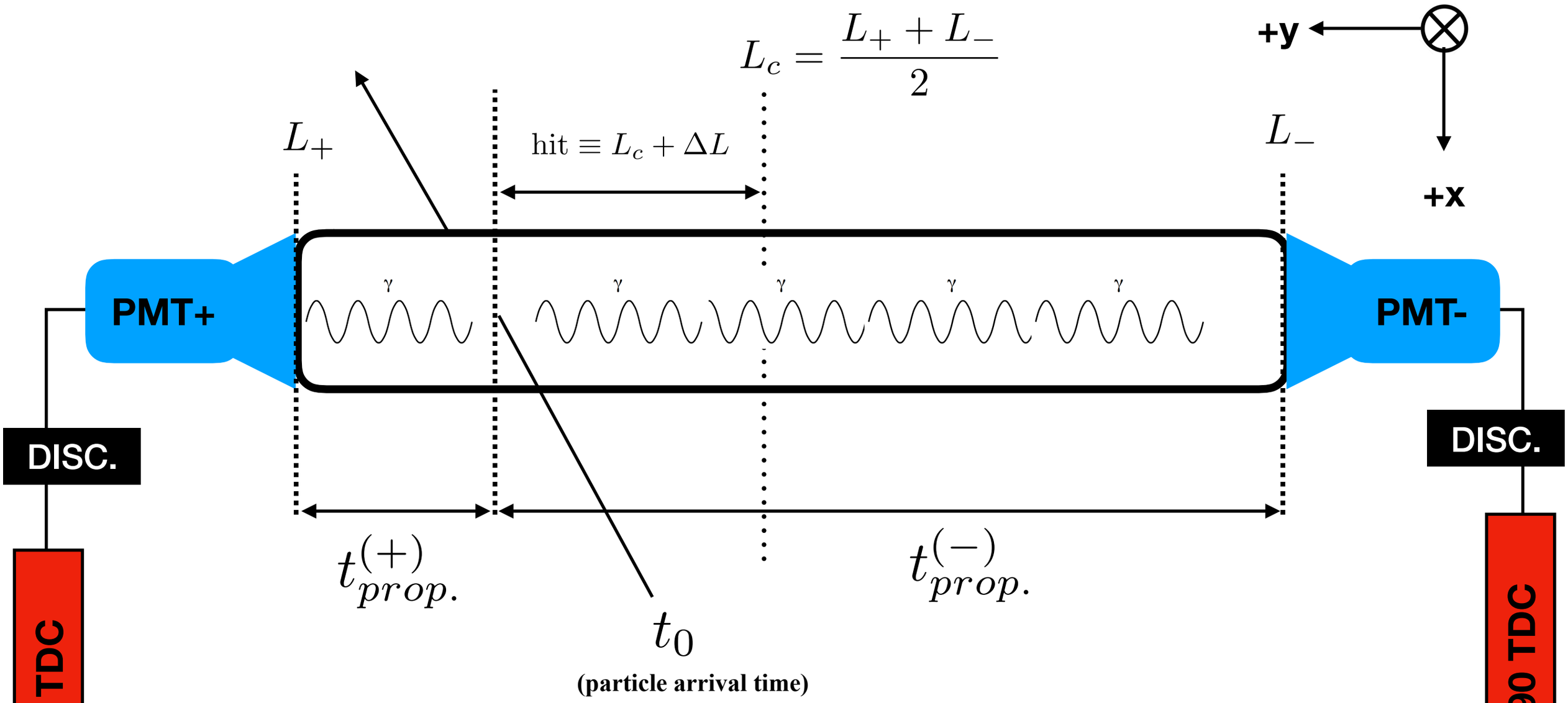
Determined from Hod. Calibration

Determined from D.C. tracking

Hodoscope Paddle Resolution



Propagation Time Corrections



$t^{(\pm)}_{Corr.} = t_0 + t^{(\pm)}_{prop.}$ (time-walk/cable corrected)

$$\Delta L = \frac{1}{2}\left(t^{(-)}_{Corr.} - t^{(+)}_{Corr.}\right) v_p$$

$$= \boxed{\frac{1}{2}\left(t^{(-)}_{prop.} - t^{(+)}_{prop.}\right) v_p}$$

Propagation Time Corrections

$$t^{(+)}_{Corr.} = t^{(+)}_{Corr.} - (L_+ - \text{hit})\frac{1}{v_p}, \text{ where } t^{(+)}_{prop.} \equiv (L_+ - \text{hit})\frac{1}{v_p}$$

$$t^{(-)}_{Corr.} = t^{(-)}_{Corr.} - (\text{hit} - L_-)\frac{1}{v_p}, \text{ where } t^{(-)}_{prop.} \equiv (\text{hit} - L_-)\frac{1}{v_p}$$

The propagation time is subtracted from the time that has already been corrected for time-walk/cable length, to obtain the final corrected time, which is independent of the propagation time. This final time, is the true arrival time of the particle at the paddle, and an average of the two sides must be taken.

$$t_{avgCorr.} = \frac{1}{2}(t^{(+)}_{Corr.} + t^{(-)}_{Corr.}) = \frac{1}{2}(t^{(+)}_{TW_{Corr.}} + t^{(-)}_{TW_{Corr.}})$$

The time-walk corrected time is the corrected time is the right hand side of the top equations. So it turns out that the average final corrected time is the average of the time-walk corrected time, after doing some algebra.