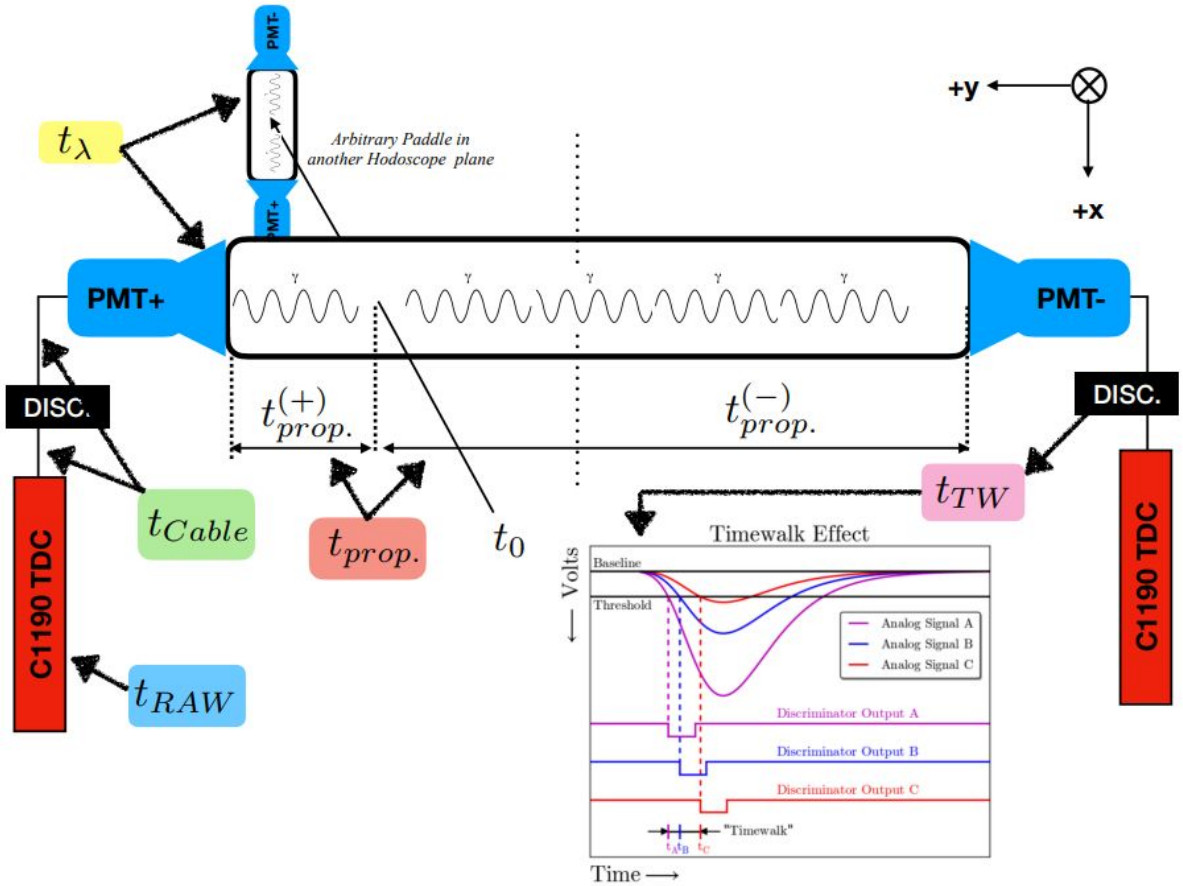
Hodoscope Calibrations

Avnish Singh

THE CATHOLIC UNIVERSITY OF AMERICA

Corrections to Hodoscope

- Timewalk
- Cable time
- Hodoscope planes time difference
- Propagation time



Steps for Hodoscope Calibration

- Hodoscope calibration requires several steps where we need to change (param) file names and/or replay the raw data with the updated param files.
- Replay the raw data with “htofusinginvadc=0” —> timeWalkHistos.C —> timeWalkCalib.C —>

  Rename hhodo_TWcalib_runnumber.param to hhodo_TWcalib_nps23.C —>

  Replay the raw data again —> fitHodoCalib.C —> Rename hhodo_Vpcalib_runnmber.C to hhodo_Vpcalib_nps23.param —> Replay raw data one last time.

- Suggest to use a bash script is ready which combines all these steps and gives us the corresponding param files for every run at the end. Already have a script ready (some modifications for swif2).
- We can then compare/analyse those param files and the final replayed root files, and select the “best ones”.

Time Walk Corrections

- It relates to the the leading edge discrimination of the signal in the time-to-digital converters (TDCs).
- Analog-to-digital converters don't see this problem as they correct for this internally.
- Correlation between TDC-ADC pulse time difference and the ADC pulse amplitude is used to correct for this.
- The fit function currently used for this is:

$$f_{TW}(a) = c_1 + \frac{1}{(\frac{a}{TDC_{Thrs.}})^{c_2}}$$

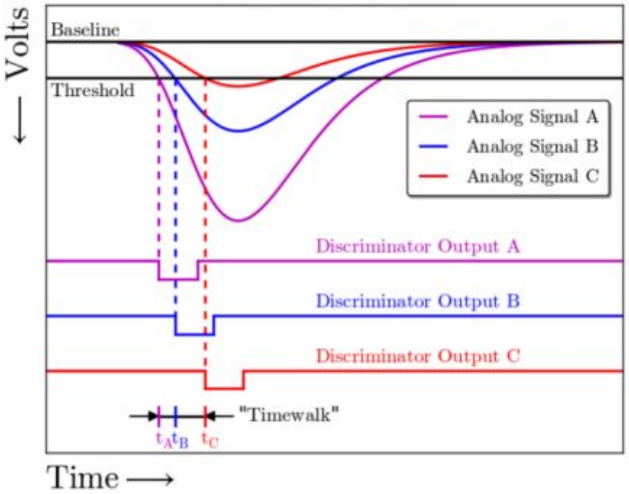


Fig. from Dr. Yero's document

Plots for timewalk parameters

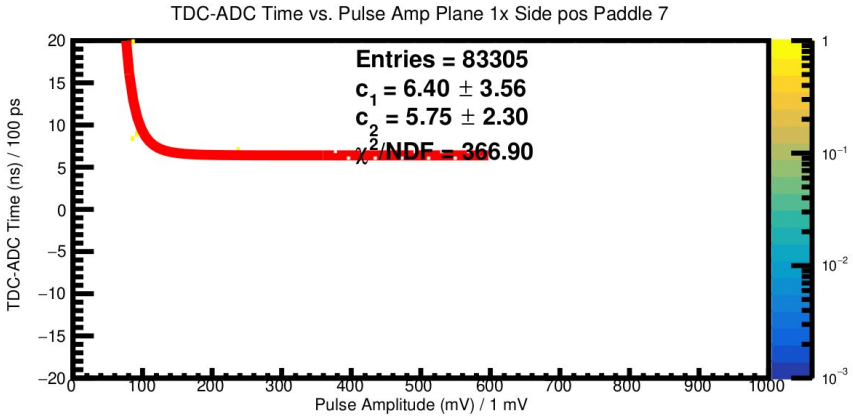


Fig. from time walk calibration;
Run 6810 (ongoing calibration)

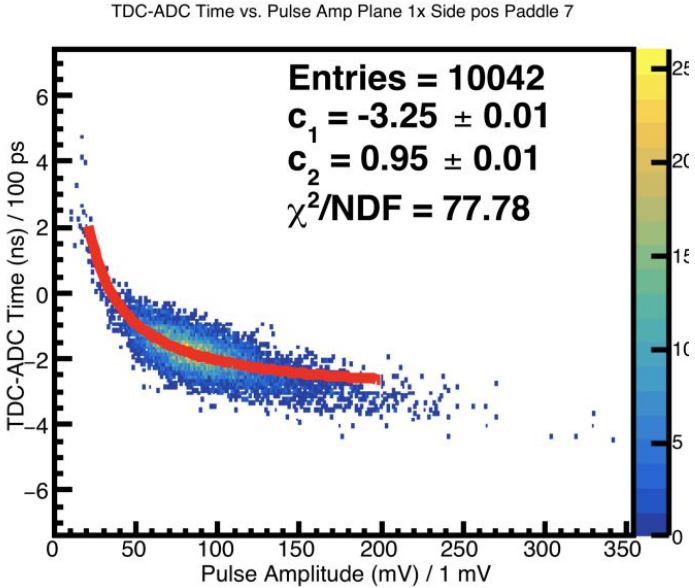
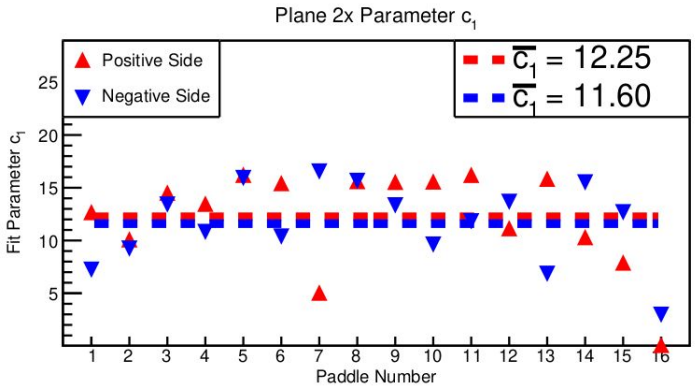
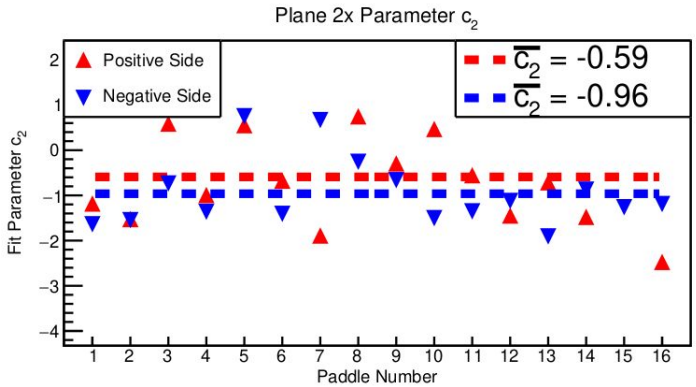


Fig. from time walk calibration;
Dr. Yero's document

Typical timewalk parameter plot





- Most of the calculated c's for different paddles lie close together (or in similar ballpark), however, as can been seen from the left figure, some of these can lie quite far from the others.

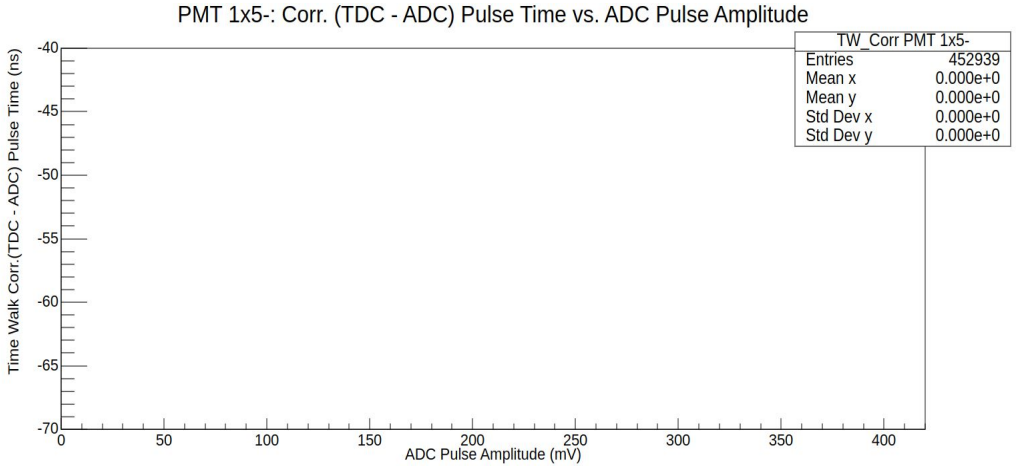
Other corrections summarised

- Cable time: corrections for the time it takes the signal to propagate through the cables.
- Hodoscope planes time difference: essentially perturbations to the recorded signals.
- Propagation time: corrections for the time it takes the signal to propagate through the paddles.

Scenario after fitHodoCalib.C

- Could not fit several paddles.
- A lot of empty plots despite having non-zero entries.
- No (next to zero) entries for getting Vp (vel. of propagation) which is required for getting cable time corrections. (next slide)

```
Initializing 1st Pass of Event Loop:
Initializing 2nd Pass of Event Loop:
1e+02  % Warning in <Fit>: Fit data is empty
 Could not fit plane = 0 paddle = 1
Warning in <Fit>: Fit data is empty
 Could not fit plane = 0 paddle = 9
Warning in <Fit>: Fit data is empty
 Could not fit plane = 0 paddle = 12
Warning in <Fit>: Fit data is empty
 Could not fit plane = 3 paddle = 4
Warning in <Fit>: Fit data is empty
 Could not fit plane = 3 paddle = 7
Warning in <Fit>: Fit data is empty
 Could not fit plane = 3 paddle = 8
FINISHED Getting Vp and Cable Fits . . .
Starting the code to fit Hodo Matrix . . .
 Reach limit of filling matrix
17  %
```



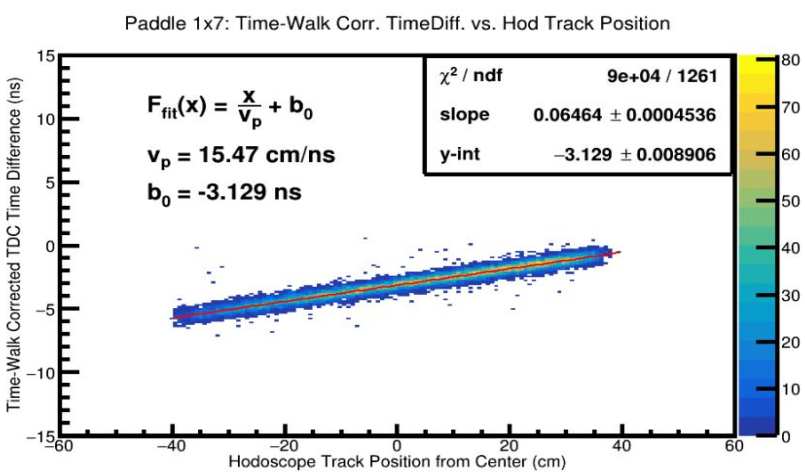
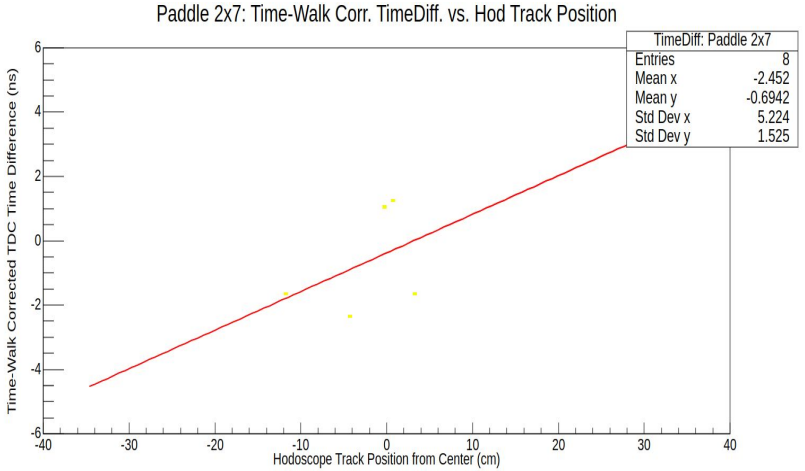


Fig. from Dr. Yero's document.



Plot taken from the ongoing calibration; Run 6810.

- It is observed that most of the plots are empty.

Sources of warnings/errors

- Not sufficient number of events in the replayed file.
  - Checks were done first with 200k events to ensure that there are no errors in the scripts themselves.
  - However, 200k events seem to be too less for hodoscope calibration and the script timeWalkCalib.C gives the error “Time Walk Fit Failed” for several paddles.

```
[singhav@ifarm2402 hms_hodo_calib]$ hcana -l -b -q "timeWalkCalib.C(6810)"

Processing timeWalkCalib.C(6810)...
ERROR: Time Walk Fit Failed!!! Status = 31 For Plane: 1x Side: pos Paddle: 2
ERROR: Time Walk Fit Failed!!! Status = 31 For Plane: 1x Side: pos Paddle: 4
Warning in <Fit>: Fit data is empty
ERROR: Time Walk Fit Failed!!! Status = -1 For Plane: 1x Side: pos Paddle: 7
Warning in <Fit>: Fit data is empty
ERROR: Time Walk Fit Failed!!! Status = -1 For Plane: 1x Side: pos Paddle: 8
Error in <ROOT::Math::Fitter::CalculateMinosErrors>: Minos error calculation failed for all the selected parameters
ERROR: Time Walk Fit Failed!!! Status = 61 For Plane: 1x Side: pos Paddle: 9
Error in <ROOT::Math::Fitter::CalculateMinosErrors>: Minos error calculation failed for all the selected parameters
ERROR: Time Walk Fit Failed!!! Status = 61 For Plane: 1x Side: pos Paddle: 11
Warning in <Fit>: Fit data is empty
ERROR: Time Walk Fit Failed!!! Status = -1 For Plane: 1x Side: pos Paddle: 12
Warning in <Fit>: Fit data is empty
ERROR: Time Walk Fit Failed!!! Status = -1 For Plane: 1x Side: pos Paddle: 14
ERROR: Time Walk Fit Failed!!! Status = 31 For Plane: 1x Side: neg Paddle: 4
Error in <ROOT::Math::Fitter::CalculateMinosErrors>: Minos error calculation failed for all the selected parameters
ERROR: Time Walk Fit Failed!!! Status = 61 For Plane: 1x Side: neg Paddle: 7
Error in <ROOT::Math::Fitter::CalculateMinosErrors>: Minos error calculation failed for all the selected parameters
ERROR: Time Walk Fit Failed!!! Status = 41 For Plane: 1x Side: neg Paddle: 9
Error in <ROOT::Math::Fitter::CalculateMinosErrors>: Minos error calculation failed for all the selected parameters
ERROR: Time Walk Fit Failed!!! Status = 30 For Plane: 1x Side: neg Paddle: 10
Warning in <Fit>: Fit data is empty
ERROR: Time Walk Fit Failed!!! Status = -1 For Plane: 1x Side: neg Paddle: 12
Error in <ROOT::Math::Fitter::CalculateMinosErrors>: Minos error calculation failed for all the selected parameters
ERROR: Time Walk Fit Failed!!! Status = 30 For Plane: 1x Side: neg Paddle: 14
Warning in <TCanvas::Constructor>: Deleting canvas with same name: 1y_pos_twFitCan
Error in <ROOT::Math::Fitter::CalculateMinosErrors>: Minos error calculation failed for all the selected parameters
ERROR: Time Walk Fit Failed!!! Status = 41 For Plane: 1y Side: pos Paddle: 10
Warning in <TCanvas::Constructor>: Deleting canvas with same name: 1y_neg_twFitCan
Error in <ROOT::Math::Fitter::CalculateMinosErrors>: Minos error calculation failed for all the selected parameters
ERROR: Time Walk Fit Failed!!! Status = 40 For Plane: 1y Side: neg Paddle: 10
Error in <Minuit2>: VariableMetricBuilder Initial matrix not pos.def.
Error in <ROOT::Math::Fitter::CalculateMinosErrors>: Minos error calculation failed for all the selected parameters
ERROR: Time Walk Fit Failed!!! Status = 50 For Plane: 2x Side: pos Paddle: 13
Error in <ROOT::Math::Fitter::CalculateMinosErrors>: Minos error calculation failed for all the selected parameters
ERROR: Time Walk Fit Failed!!! Status = 41 For Plane: 2x Side: pos Paddle: 15
ERROR: Time Walk Fit Failed!!! Status = 30 For Plane: 2x Side: neg Paddle: 9
Warning in <TCanvas::Constructor>: Deleting canvas with same name: 2y_pos_twFitCan
Warning in <TCanvas::Constructor>: Deleting canvas with same name: 2y_neg_twFitCan
```

- **Hard-coded cuts** in the scripts can lead to negligence of the relevant region of true events and thus, can cause a bad fit.
- Discussions over this are ongoing with Casey and Carlos Yero.

```
static const Double_t hodoPulseAmpCutLow     = 25.0;   // Units of mV
static const Double_t hodoPulseAmpCutHigh    = 1000.0; // Units of mV
static const Double_t refAdcPulseAmpCutLow    = 50.0;   // Units of mV
static const Double_t refAdcPulseAmpCutHigh   = 60.0;   // Units of mV
static const Double_t refAdcPulseTimeCutLow   = 210.0;  // Units of ns
static const Double_t refAdcPulseTimeCutHigh  = 225.0;  // Units of ns
static const Double_t adcTdcTimeDiffCutLow    = -100.0; // Units of ns
static const Double_t adcTdcTimeDiffCutHigh   = 100.0;  // Units of ns
static const Double_t calEtotCutVal           = 0.100;  // Units of GeV
static const Double_t cerNpeSumCutVal         = 1.5;    // Units of NPE
```

Example of the cuts defined in the scripts. These need a closer examination.

Hodoscope summarised:

- The method/workflow has been tested. Updates for support for newer version of ROOT has been pushed to github.
- However, there are several warnings present at the moment. Cuts also need to be modified.
- Studying to get a better idea on what other parameters could be relevant for quantifying the calibration.
- Updated timing window script and pushed it to git. It should be available to everyone as the pull request is approved.
- The calibration will be executed for the runs specified in runlists as we are able to better figure out the sources of errors/warnings/empty plots.