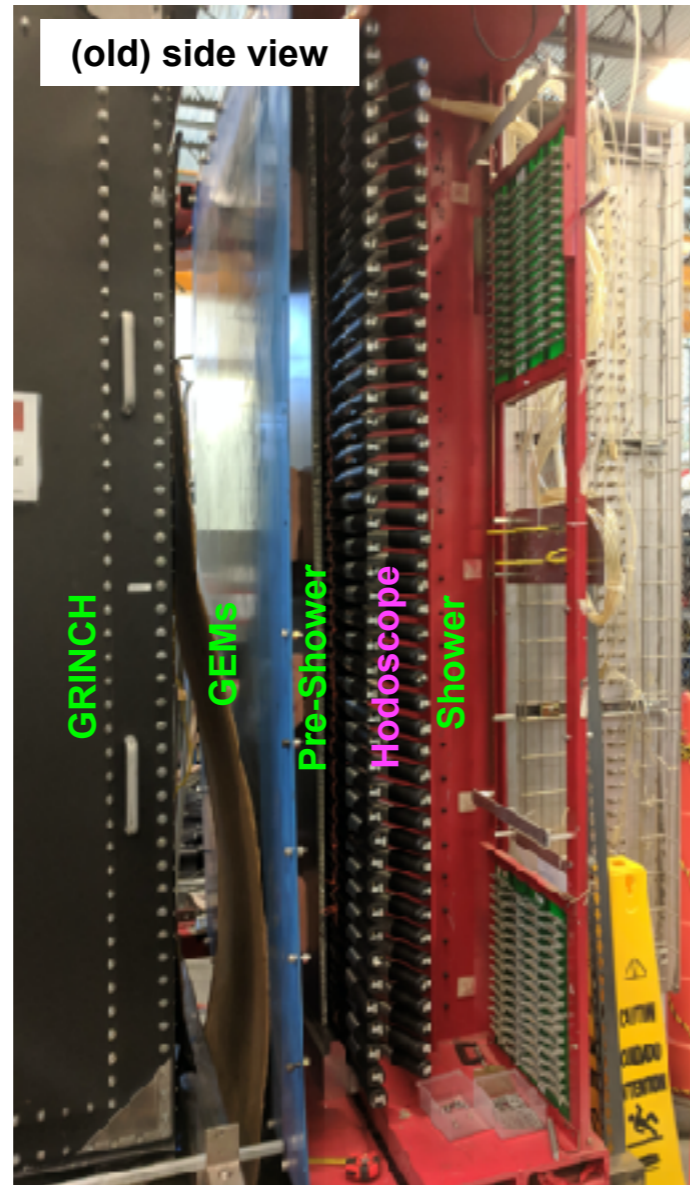
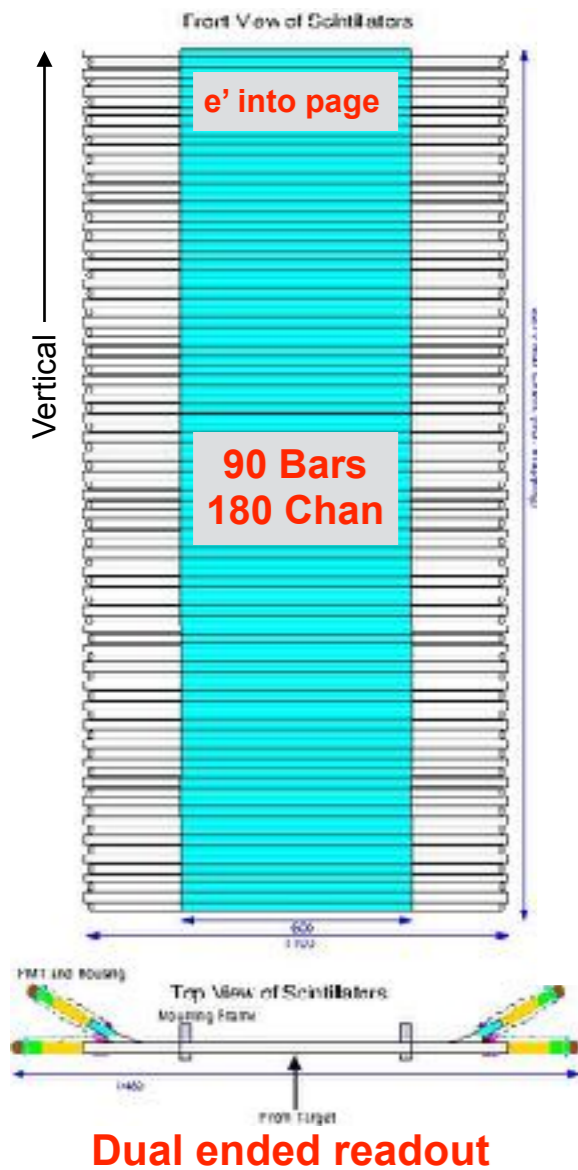


Hodoscope Software Update

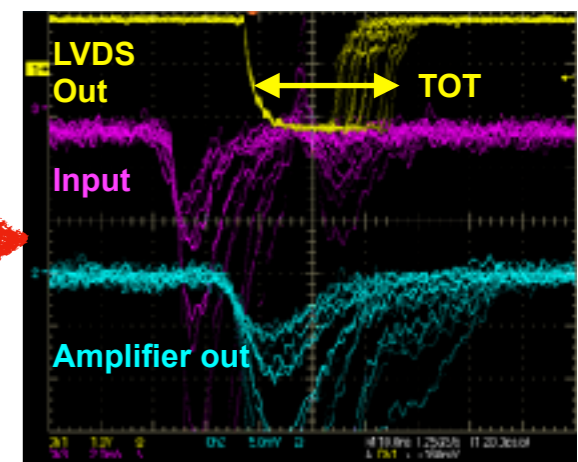
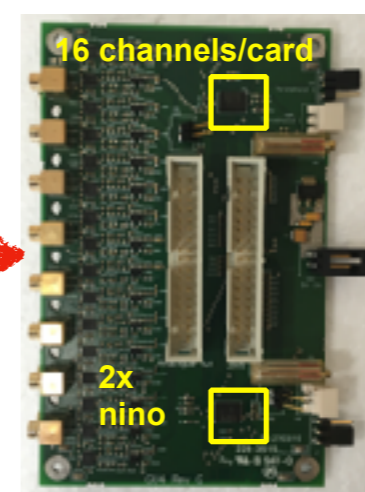
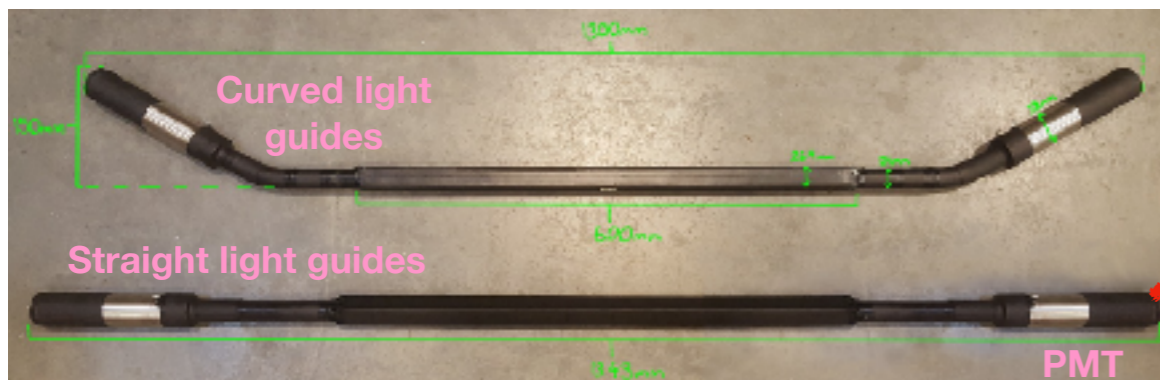
SBS Weekly Meeting 28/06/21

R. Montgomery on behalf of several hodoscope colleagues

Hodoscope Reminder



- Subsystem of BigBite
- Positioned between PS and SH
- Vertical stack of 90 (89 currently) bars
- Each scintillator bar (600mm x 25mm x 25mm) readout by 2x single channel PMTs, one at each end
- Time difference between bar PMTs of give rough hit position information along bar length (expected time difference resolution from original prototype tests ~300ps, or ~6cm)
- Bar position in stack gives rough vertical position (bar height 25mm)
- Production data: PMT signals -> amplifier & discriminator (NINO) cards -> multi-hit TDCs
- Time over threshold (TOT) gives coarse pulse height information
- Calibration data: ADC to calibrate TOT and set NINO thresholds



Planned/Typical Data Plots

Initial plans for hodoscope only data:

(ie not considering correlations with other detectors on this slide, although will be useful and should start to think about routines soon)

During general shift checking

- For each of 180 channels:
 - Leading edge (LE) TDC spectra (TDC reference time corrected and NINO discriminator walk corrected)
 - TOT distributions
 - TOT against LE time distributions
- For each of 90 bars:
 - Mean time distributions
 - Time difference distributions
 - Reconstructed hit position in TH local coordinates (y vertical bar, x from time difference)

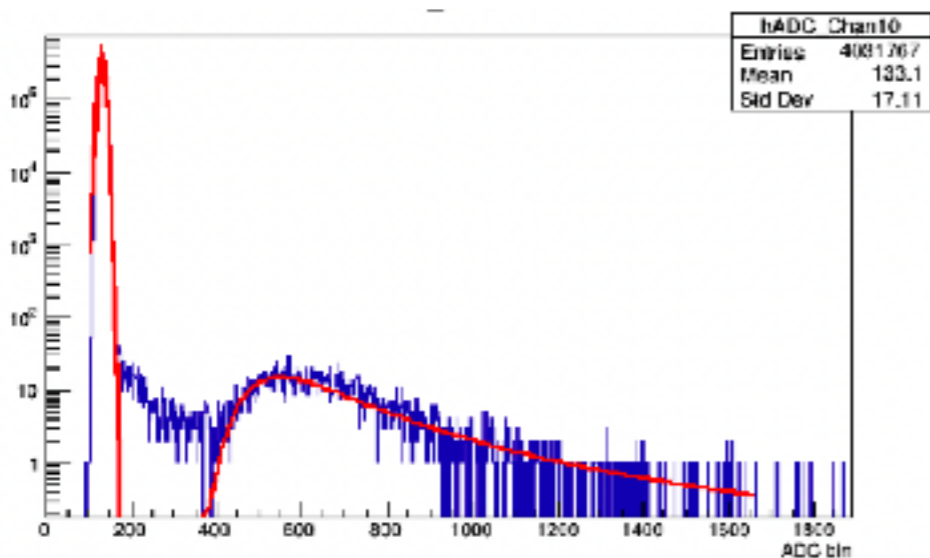
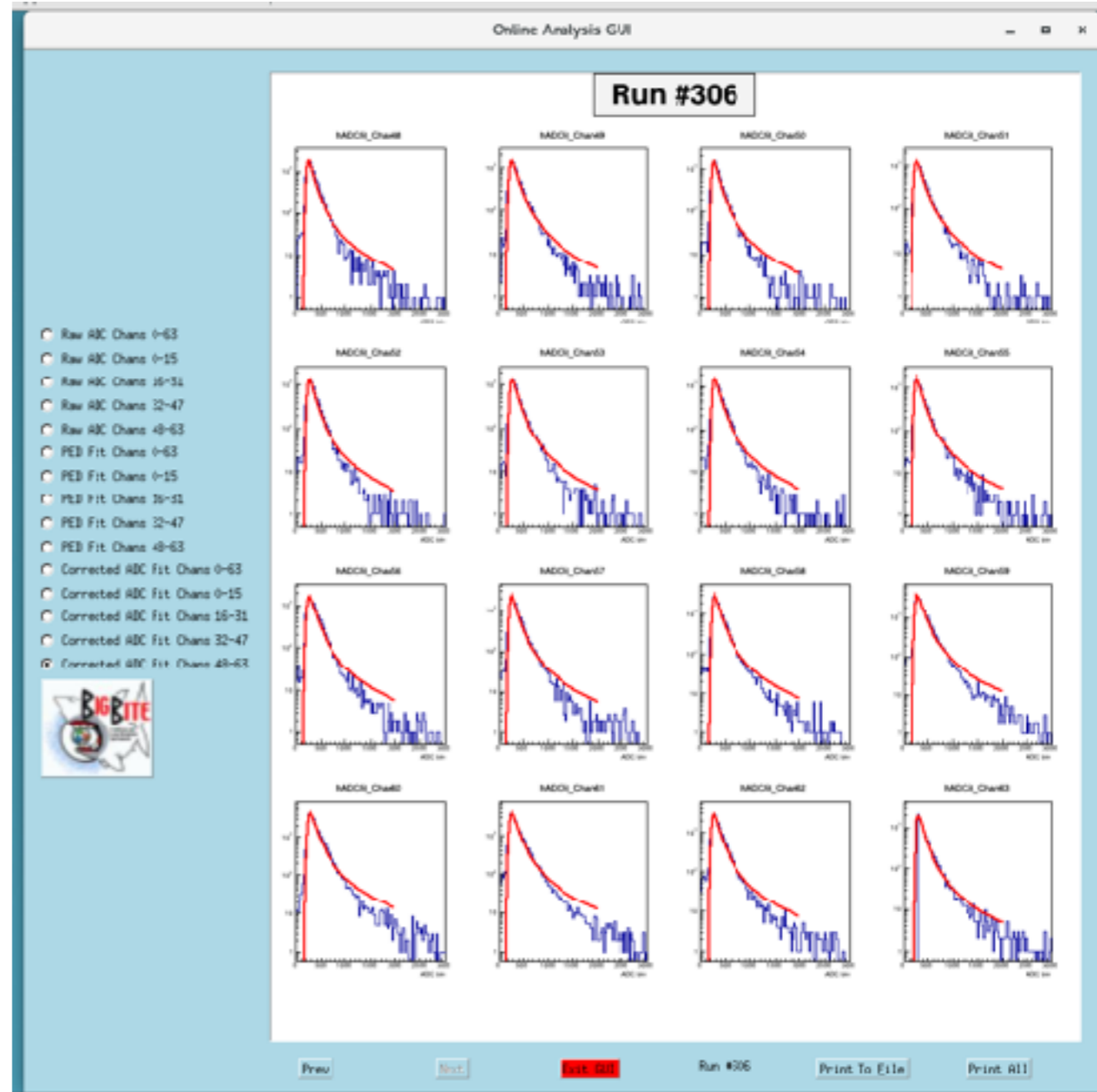
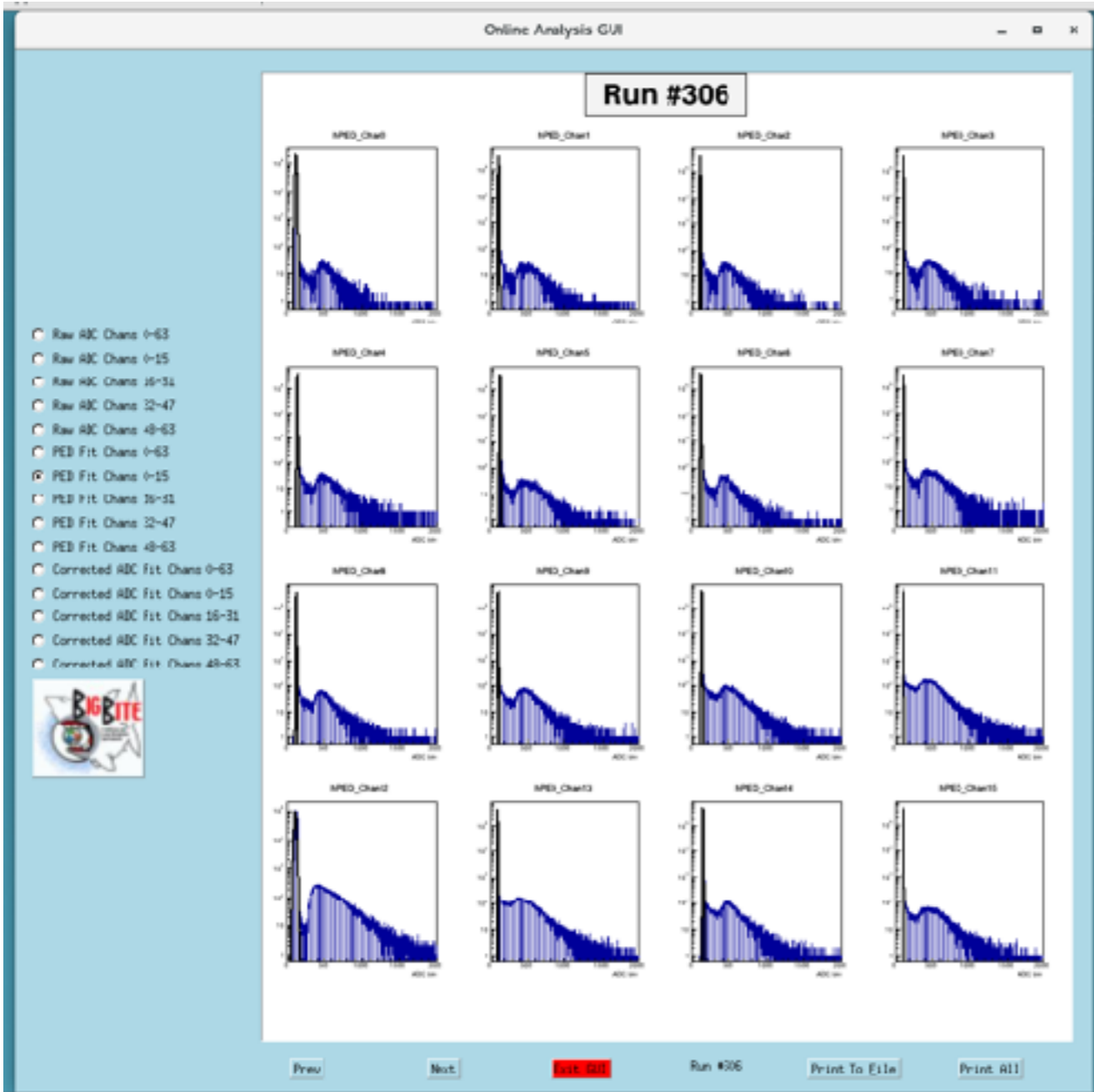
Additional ADC-related plots for initial calibration/commissioning runs

- For each of 180 channels from cosmic data (collected by cycling through sub-sets of 64 channels at a time):
 - ADC pedestal distributions
 - Pedestal corrected ADC distributions
 - TOT against ADC distributions
- For initial beam test, low current would be good to check calibrations are consistent for a subset of 64 channels before removing ADC from production data

Existing Chain for Hodoscope Data Analysis During Cosmic Running

- Raw data (**evio** file)
 - 2x v1190 TDCs
 - all 180 channels, ie 90 bars at a time
 - 2x v792 QDCs
 - 64 channels at a time, ie 32 bars - for calibration of NINO only
- **SBS offline** with modified base SBSTimingHodoscope class
 - Records and writes out all raw hits (ie all ADC and multiple TDC hits/event)
 - Working on updating SBS offline class (more later)
- Stand alone **ROOT macros** for analysing/histogramming data, e.g.:
 - Plot ADC spectra (raw or pedestal corrected)
 - Gaussian fits to ADC pedestals and writing of fit results to text file
 - Landau fits to pedestal corrected ADC spectra and writing of fit results to text file
 - Plot reference corrected TDC related spectra (LE, TOT, LE vs TOT, TOT vs ADC)
 - Working on time walk correction (more later)
 - Output distributions saved in ROOT file
- Classic **Hall A online display GUI**
 - Reads in ROOT file output from analysis macros
 - Can select plot in configuration text file, highly configurable, different config files for eg ADC displays or TDC displays or combined (can also compare with “golden” plots)
 - Can click through several plots at a time in GUI

Example Plots from Existing Hodoscope Chain - ADC

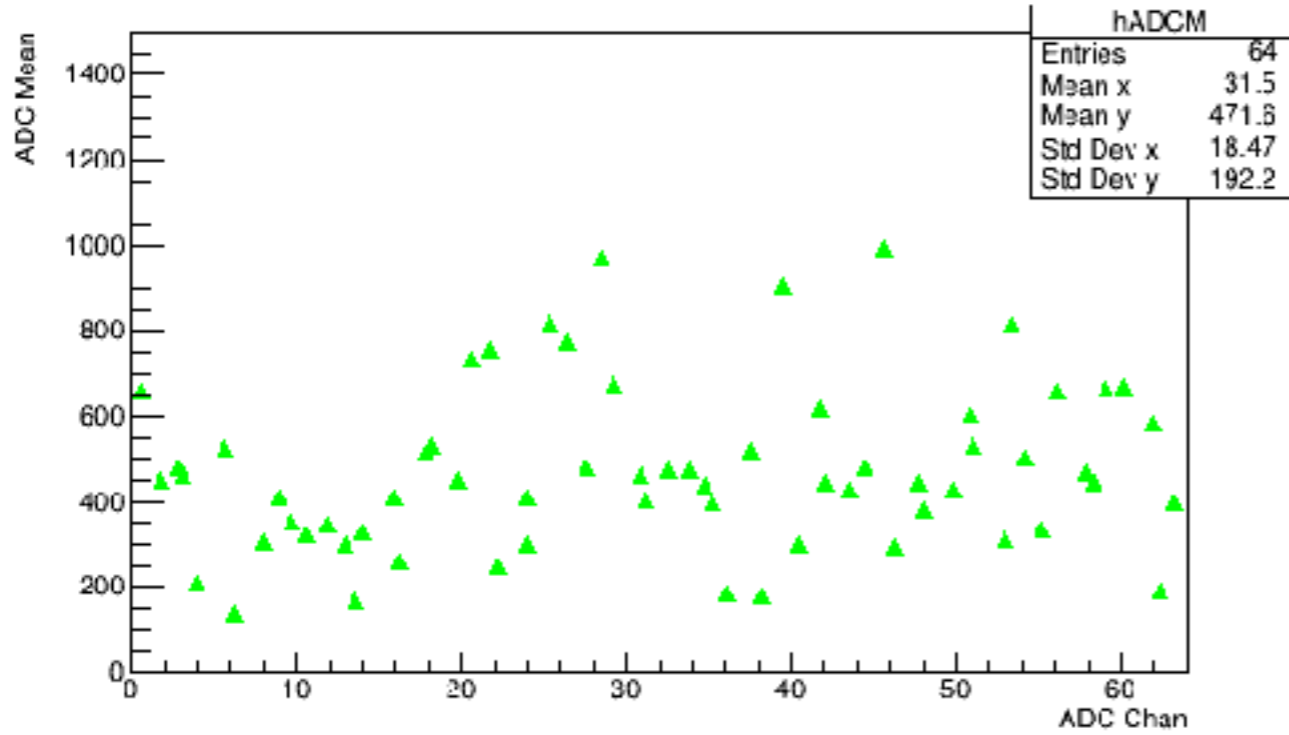


- Above: example ADC displays currently in menu
 - Raw ADCs for all channels or subsets of channels (for zooming)
 - Pedestal fits (Gaussian)
 - Landau fits to pedestal corrected ADCs (again all channels of subsets of channels)
 - Also have macro which writes out pedestal and Landau fit results to text files (left example for one channel)

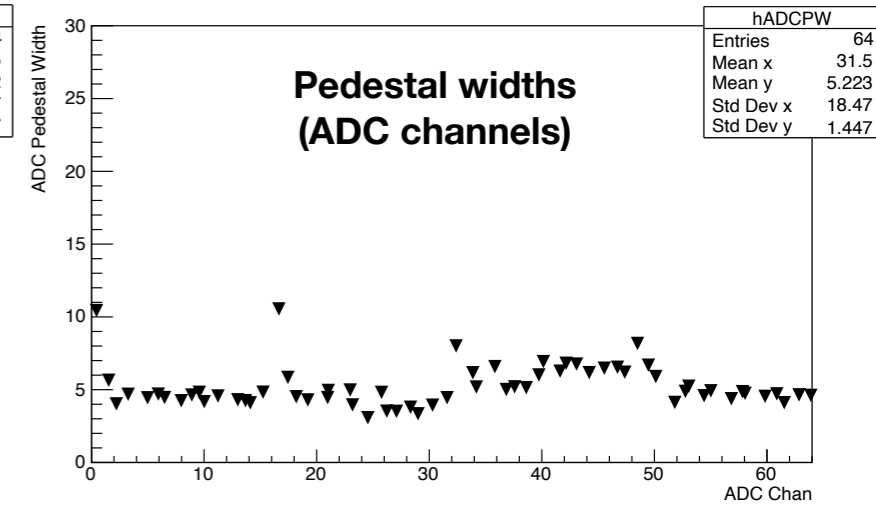
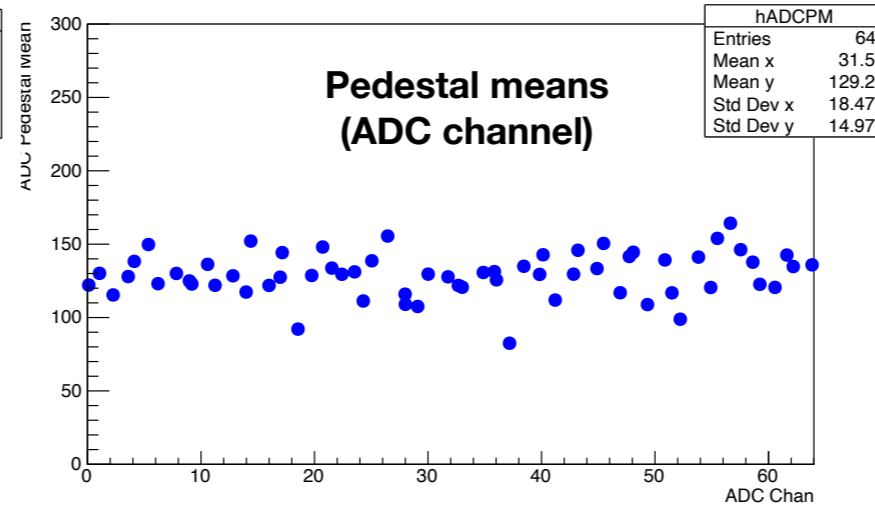
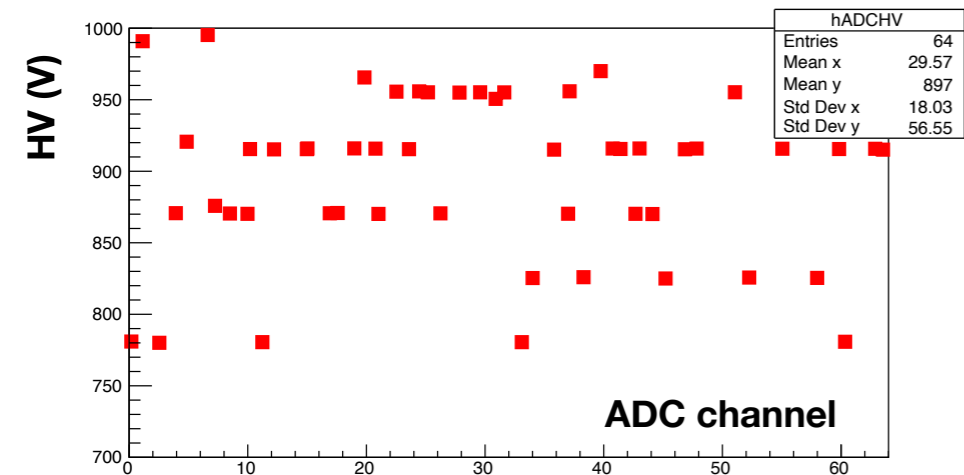
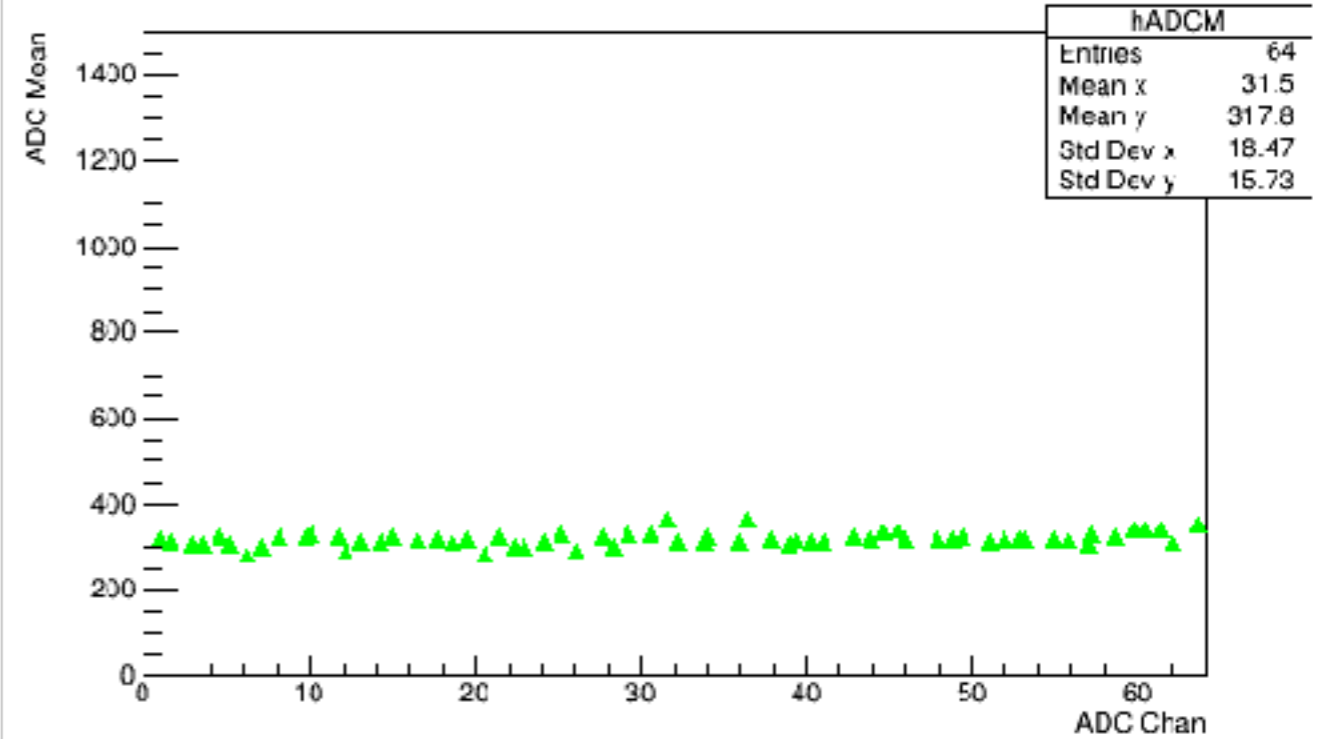
ADC data used for PMT gain matching, pedestal monitoring

- Previously reported on by R. Marinaro
- PMTs were gain matched during TEDf cosmic data collection and NINO thresholds were checked

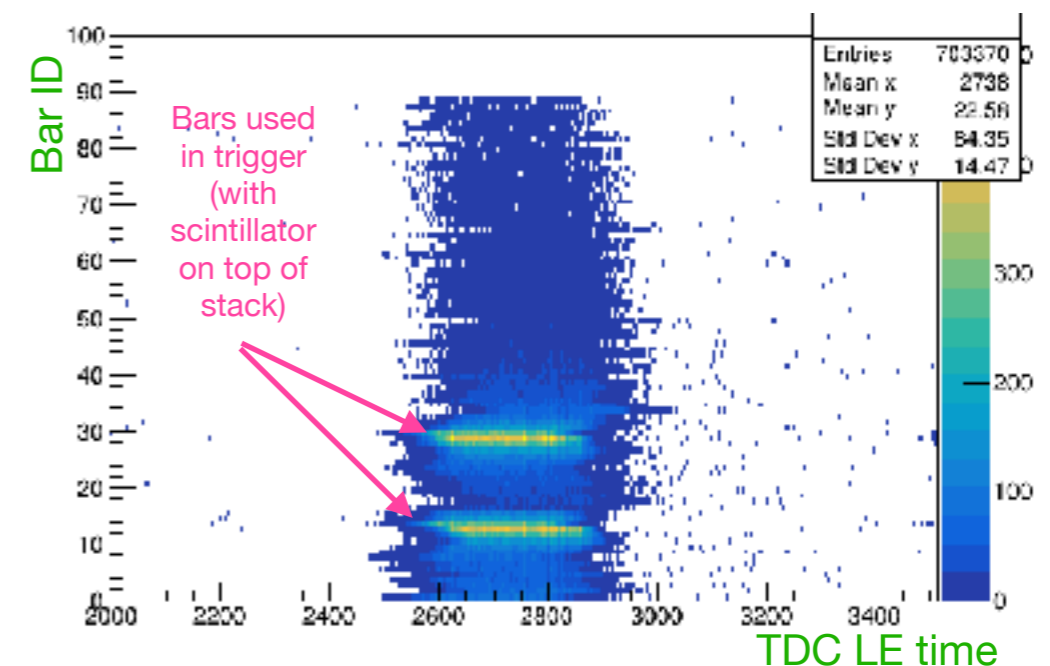
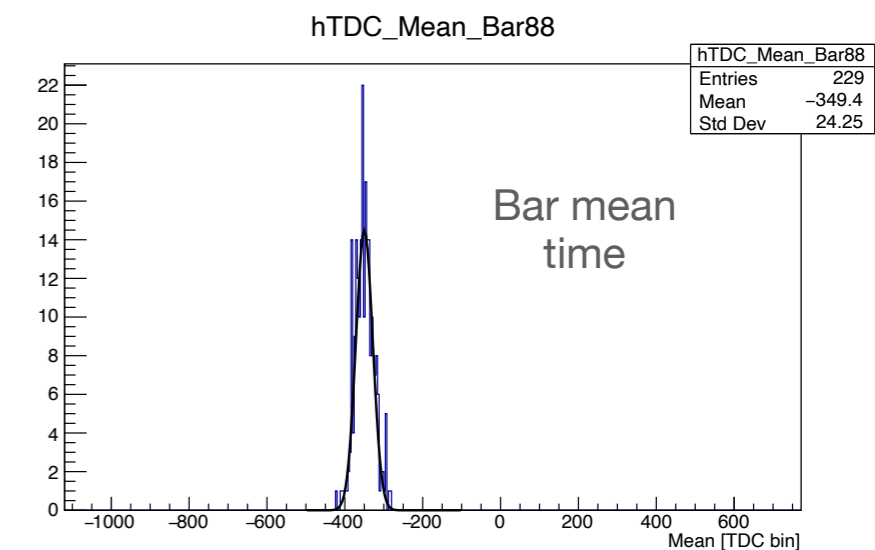
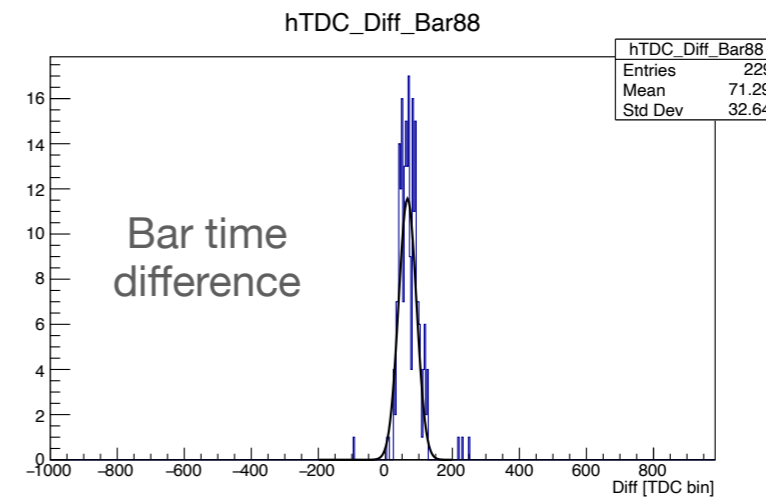
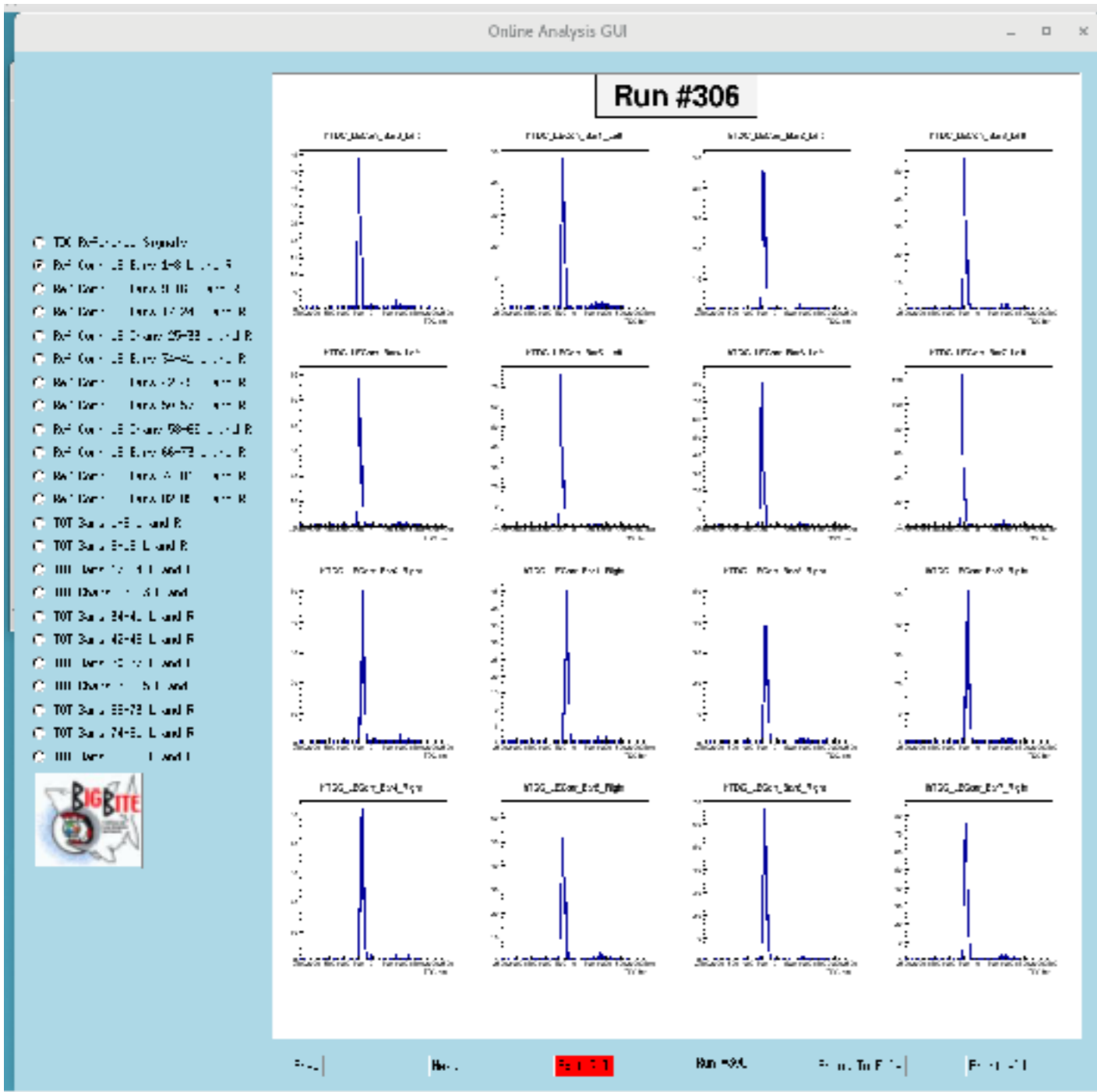
ADC Chan vs. ADC Mean



ADC Chan vs. ADC Mean



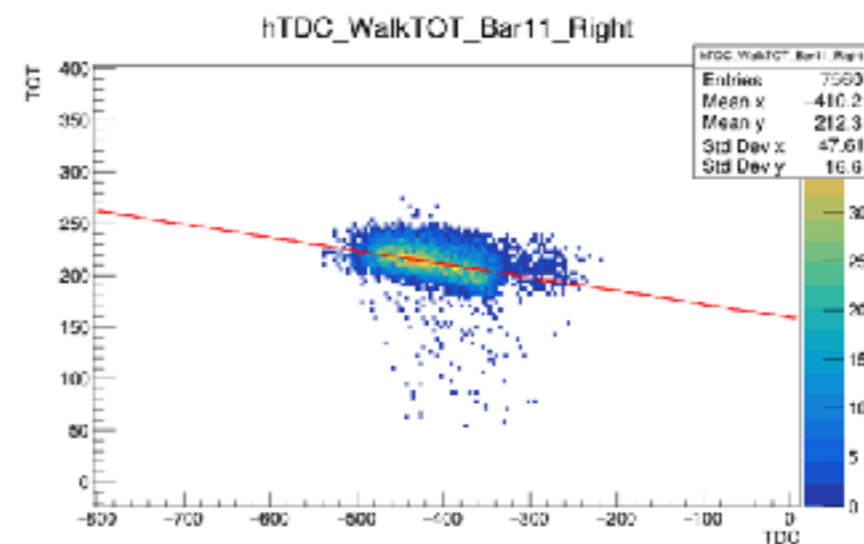
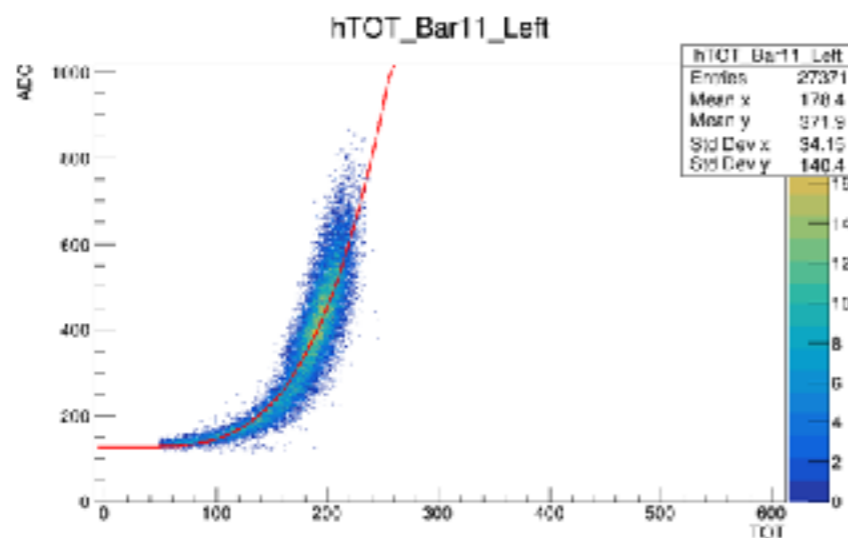
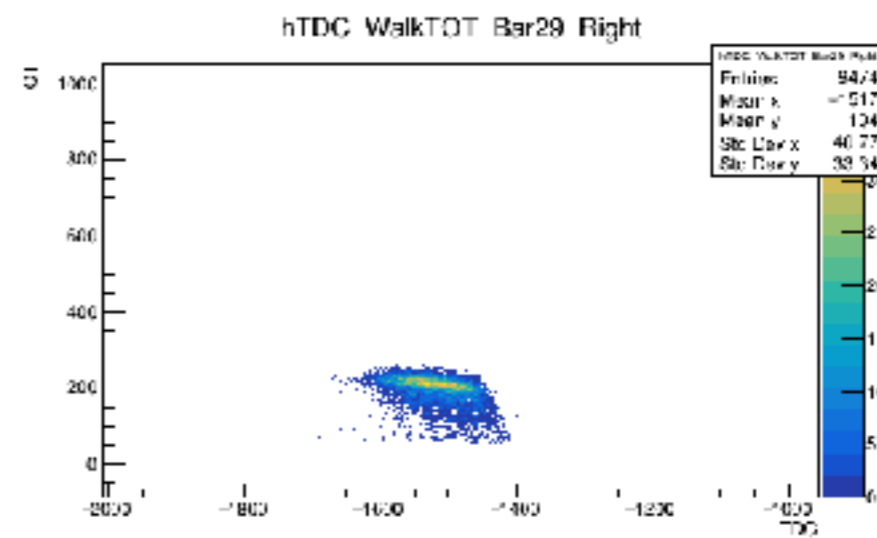
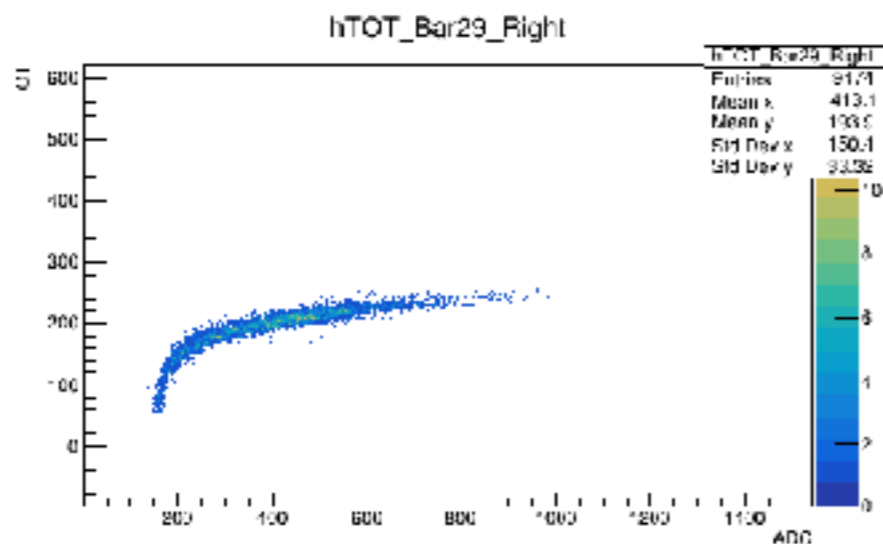
Example Plots from Existing Hodoscope Chain - TDC



- Example TDC displays currently in menu
 - Reference signals
 - Reference corrected LE times
 - TOT distributions
 - Also have bar mean times and time differences
- Currently we are working on implementing TOT calibration and NINO time walk calibration algorithms
 - Need this to get measured time resolution

Example “event display”, bar ID versus hit time (R. Marinaro)

Current Activities - TDC Routines



Example fits from R. Marinaro. Work on-going

- Working on TDC algorithms/methods
 - Calibration of TOT using ADC (not needed for time walk correction, but could give energy loss in bar during production data)
 - Calibration of TOT versus LE time (to allow for time walk correction). Expect linear correlation in first instance, or 2nd order polynomial if we have enough resolution
- Trigger in cosmics relatively low rate and cosmics of all directions hit positions along entire lengths of bars
 - Timing somewhat smeared and statistics low if implementing cuts to clean up TDC distributions
 - Need to study these cuts/data selection more in our calibrations
- Have also collected data at different NINO thresholds to check consistency of calibrations with threshold
 - need to check results quantitatively (initial look showed calibrations consistent)

Summary

- Most of the code to plot raw distributions needed during running already exists
 - Could serve to be simplified
- Currently working on developing a more advanced class in SBS offline, based on SBSGenericDetector
 - This class should include finding “good hits” (method for this, without ADC info should be decided/ studied)
- Once SBS offline class is updated should simplify analysis macros/root scripts
 - Eg expect bar mean time, time diff etc could be available directly in SBS offline output
- In parallel working on time walk correction and TOT calibration fitting and algorithms
 - This should be priority study in Hall cosmic data taking
 - Could be good to get access to fast scintillator, and in particular if it was of small cross section to move across bars in steps to check time difference vs position reconstruction with a more efficient trigger