

# Tracker Readout

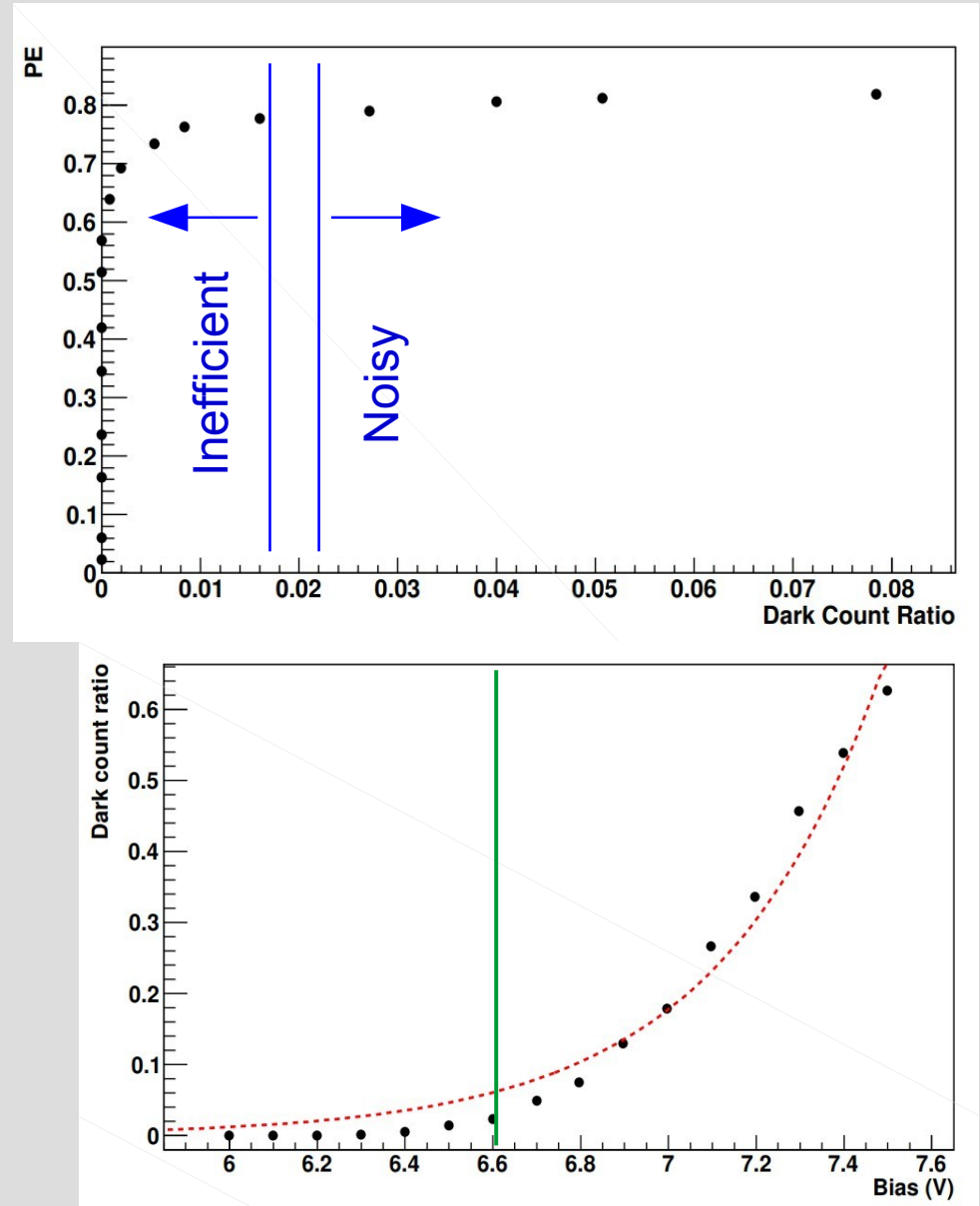
- Tracker systems have been stable since last cm.
  - No major changes to Hardware or DAQ code since last cm.
- Just prior to shifts starting in February cryostat 3 had a minor shudder and was taken offline,
  - Cryostat 3 warmed up, and was then cooled down.
  - Suspect a small amount of water entered the cryostat and resulted in the disconnection of some VLPC channels (50+),
  - To recover the problem a waveguide was successfully was moved from a bad (50 dead ch) module to a better module (8 bad ch), this was done quickly and efficiently thanks to the whole tracker team!
- Ongoing work in the tracker lab to assemble spare front end boards and buffer boards.
  - 4 validated good boards.
  - Need to calibrate temperature/bias for spare boards.

# Tracker Controls

- Control system has also been stable since the last cm.
  - No major changes.
  - Now using “Pro” version.
- Pierrick is adding state machine to tracker controls:
  - Will add alarm handler to monitor alarm on hardware problems
  - More sophisticated control of archiver

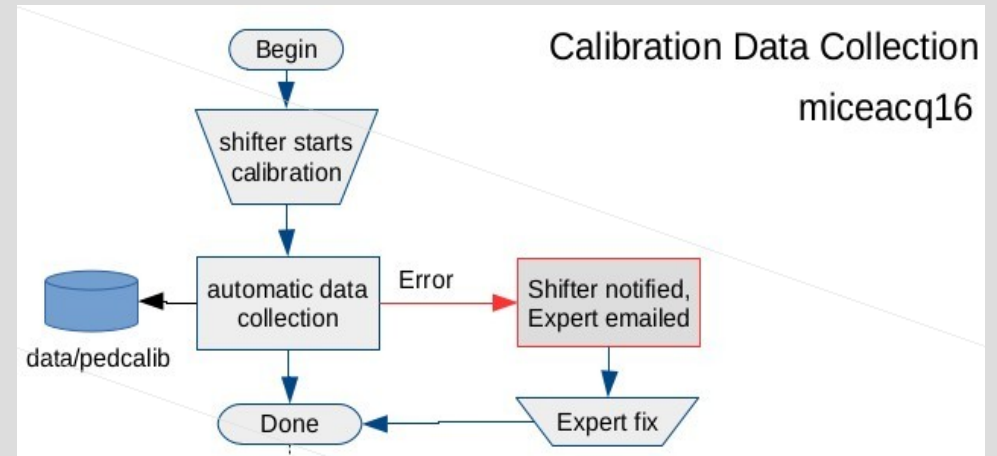
# Tracker: Bias Calibration

- Optimum Bias is a balance between dark counts (noise) and quantum efficiency.
- Top plot gives light yield as a function of noise. Quantum efficiency flattens off, however noise grows exponentially.
- Ideal region is  $\sim 0.02 = 2\%$  probability of a generating a hit over the first photo-electron charge within a 180ns gate. 220kHz singles rate.
- Optimum bias is performed by scanning a range of bias voltages. The optimum is then selected where the dark count ratio is closest to 0.02.
- A common bias is shared between groups of 64 channels.
- The optimum biases are **checked** by eye once.
- Plots from D. Adey Thesis. For more information read it!



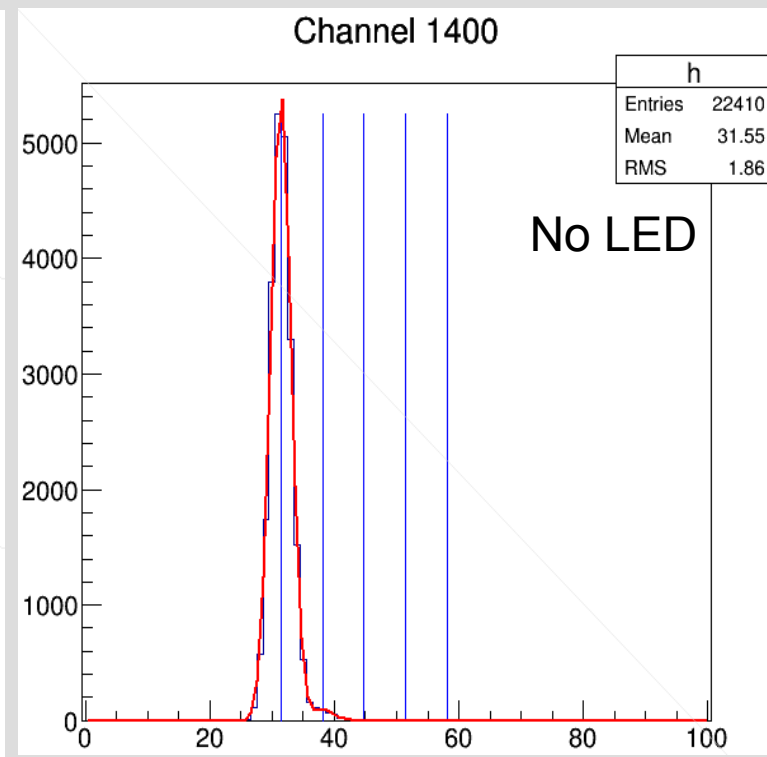
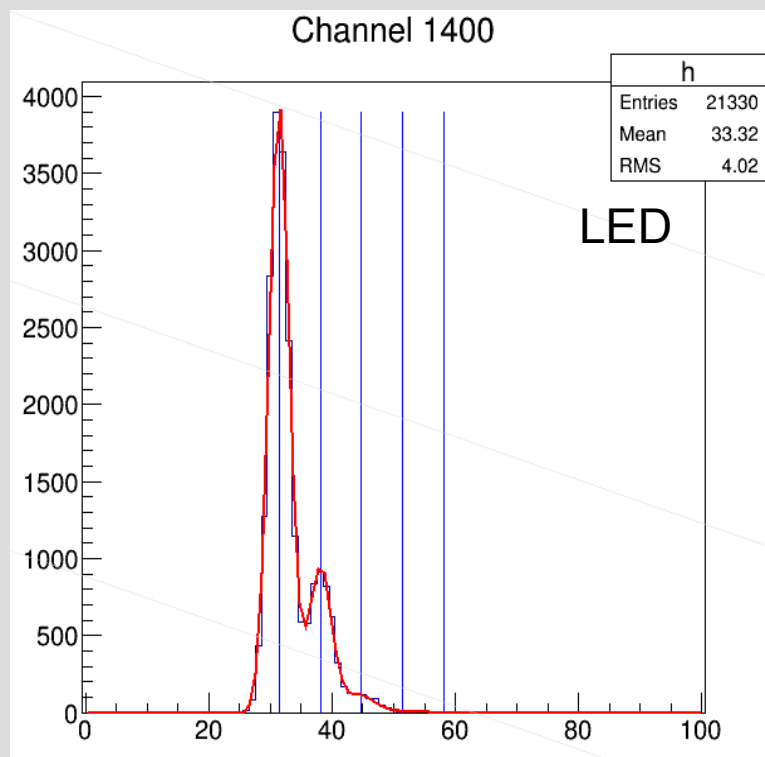
# Tracker: ADC Calibration: Data Collection

- For the tracker reconstruction to work properly a calibration file is required which converts from the ADC values to a meaningful 'npe' value.
- Data for this is collected by the "RunPedCalib.py" script, which is run by the shifters at the start of each shift.
- The calibration dataset contains two runs, one with the internal light injection system enabled, and one with this disabled.
- All tracker calibration data is stored on a RAID1 disk, nightly backed up to micenet backups and finally uploaded to the grid once a week.
- Each calibration data set requires 2.6MB of disk space.



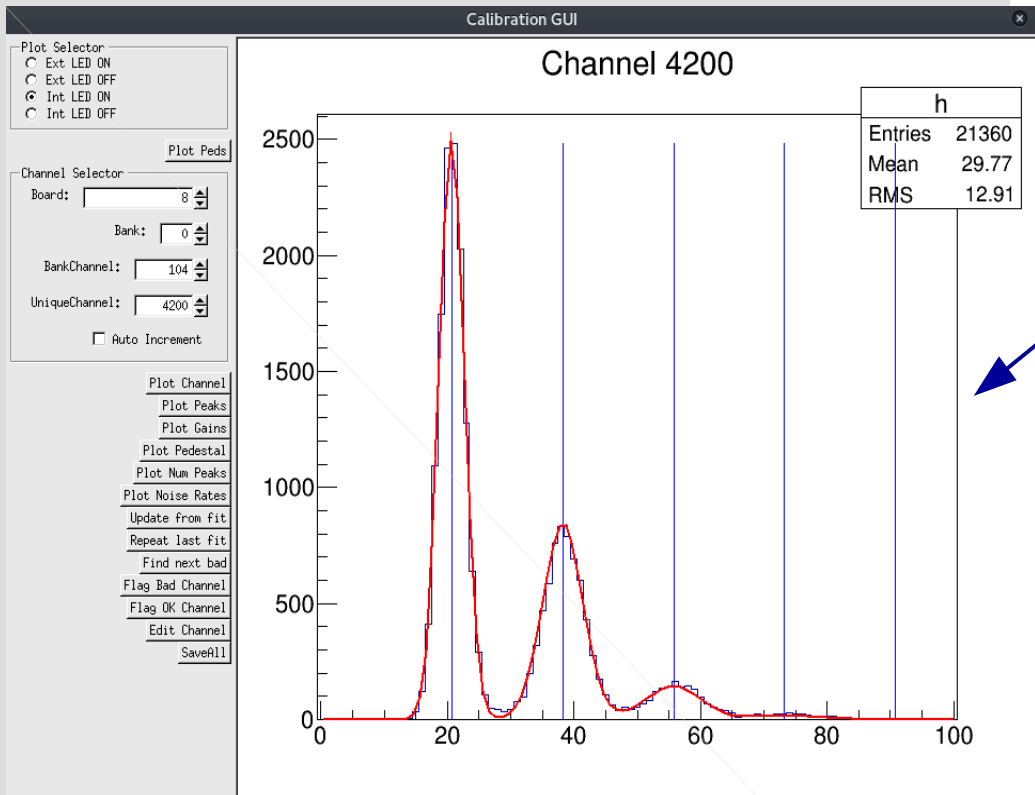
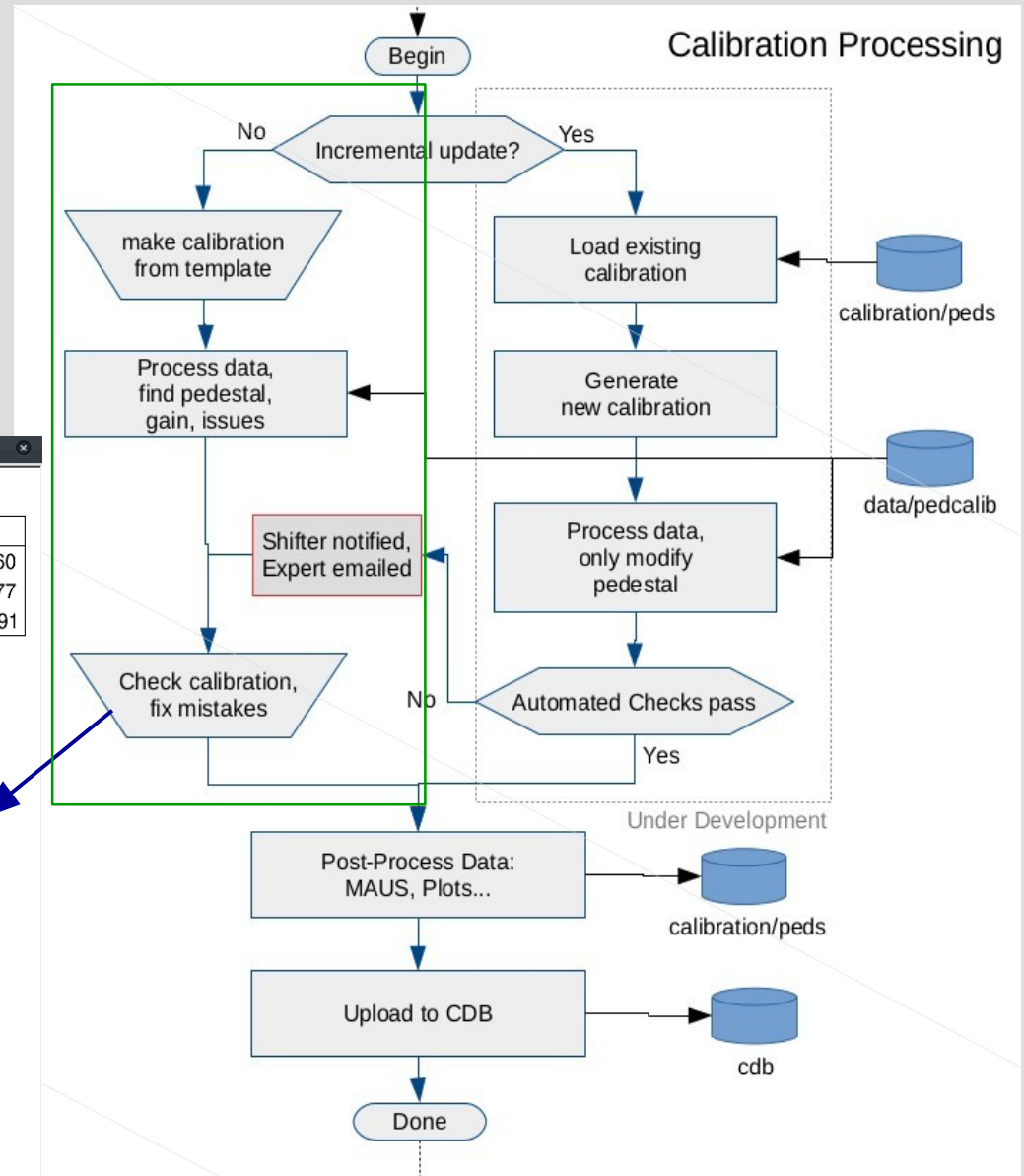
# Tracker: ADC Calibration: The Fit

- At the heart of the calibration is the fit. A combined poisson-gaussian function is used which accurately describes the ADC distribution.
- The fit is conducted simultaneously (one minimisation) on LED and no LED histograms, sharing common parameters.
- This strategy was empirically found to produce the best reliability and results, at the expense of cpu time..
- The  $\chi^2/\text{ndf}$  values of each fit are checked, and if they exceed a threshold the channel is flagged for human investigation.



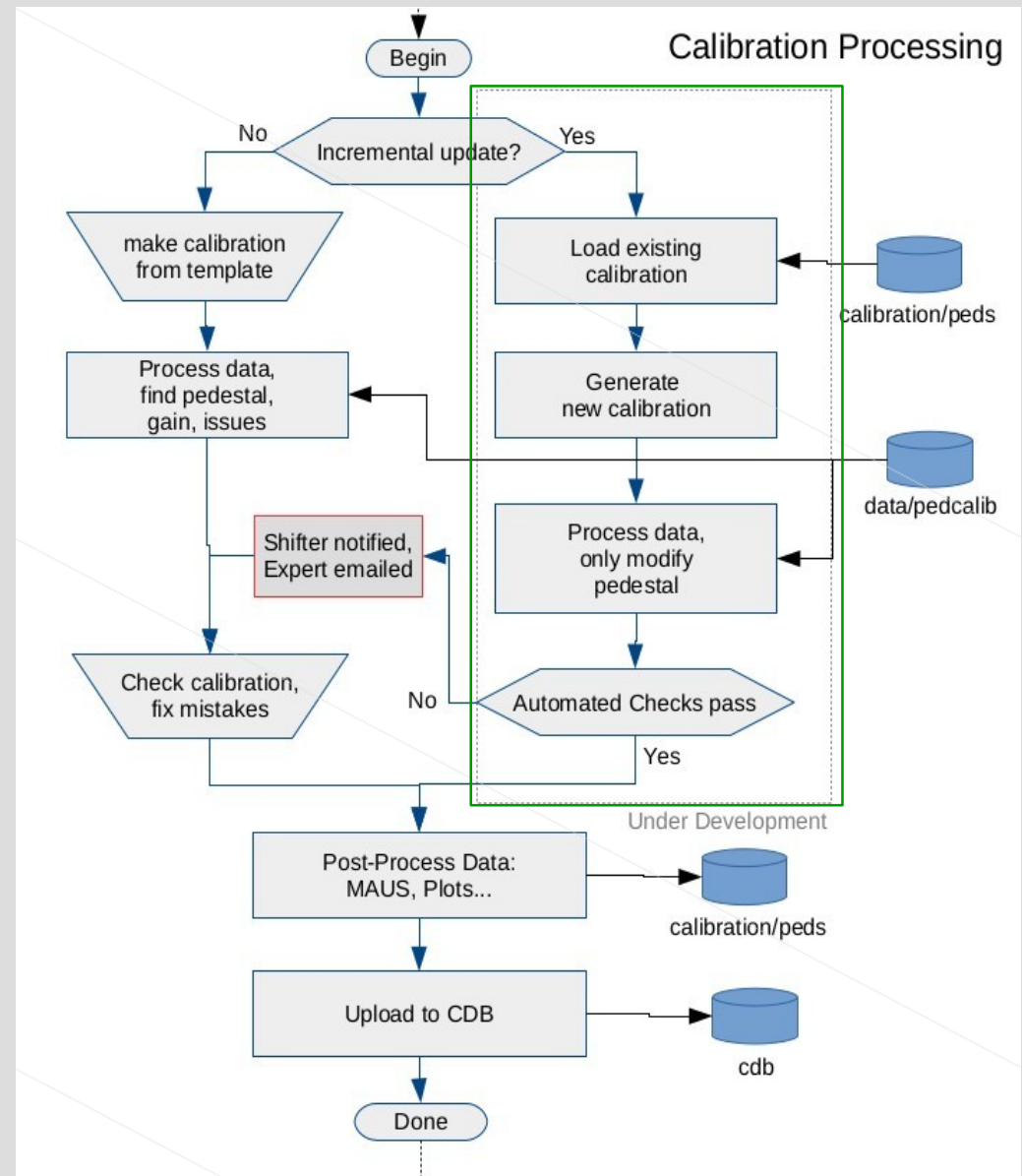
# Tracker: ADC Calibration: The Workflow

- The Calibration process follows the workflow:
- The “Manual” process has a human check stage.
  - Can be time consuming.
  - Not good for daily updates!

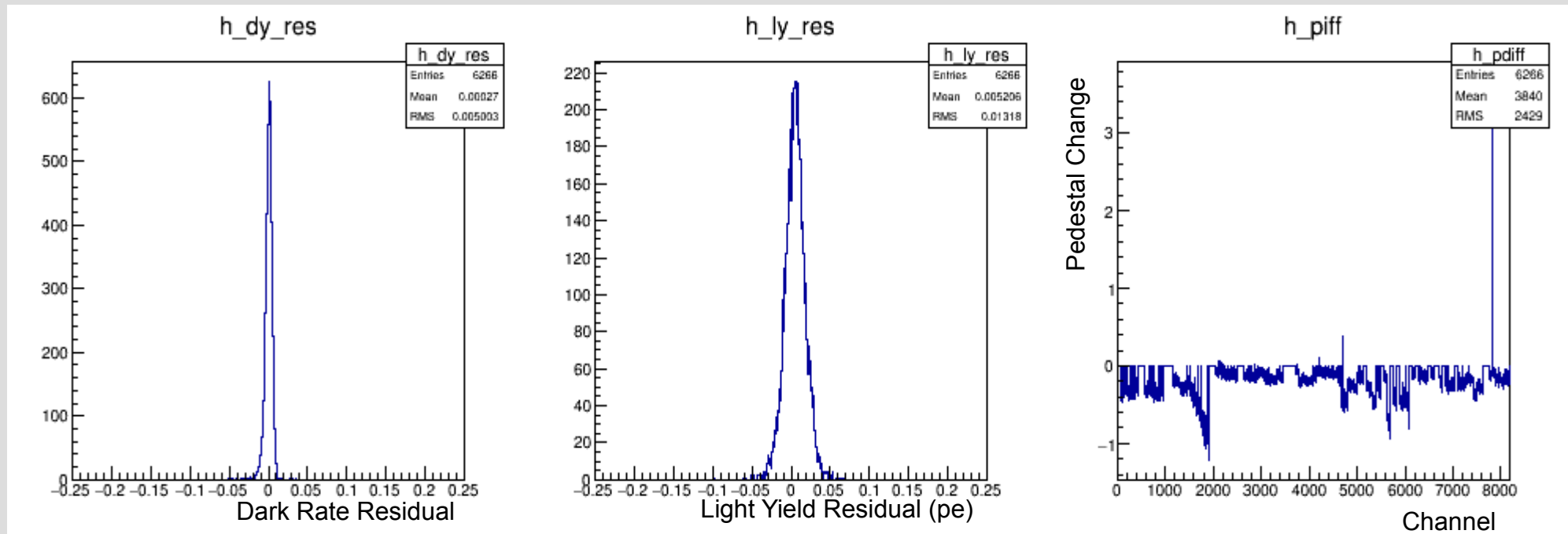


# Tracker: ADC Calibration: The Workflow

- Addition of an “Automatic” calibration update.
- This only provides an incremental update to the location of the pedestal
- The VLPC gain is very stable, which we have checked in MICE.
- Process uses an existing calibration as a starting point and only updates the pedestal location.
- Checks are finally performed on the light yield and noise rates.
- Plan is to integrate this as part of the data collection script, to alert the control room before taking data that the tracker is not comparable to a “good” reference state.
- Online running still under development.



# Tracker: ADC Calibration: Auto Checks



- Plot the residual dark rate, and light yield between this and a previous calibration. If these change then the detector state is not 'stable'.
- Summary of all tracker calibrations since Sept 2015 available at:
  - <http://heplnv152.pp.rl.ac.uk/tracker/summary.xhtml>



# Tracker Calibration

- Improvements made to calibration process to facilitate regular calibration updates:
  - Master calibration performed at beginning of ISIS cycle
  - Daily updates to calibration account for small shifts and are verified against “master” performance.
  - Calibration information can be found at: <http://heplnv152.pp.rl.ac.uk/tracker/summary.xhtml>.
- Aim to automate the “per shift” calibration updates
  - And launch from a button!