Far Detector LI Drift Calibrations

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- Introduction
- Long-term Drifts

  Comparison of calibration schemes

  Magnetic field effect
- Next steps?

Introduction

- LI drift runs (1000 pulses with fixed pulse height) taken every 3 hours at FD to monitor PMT drift (temperature, long-term gain changes)
- Mean and rms for each channel stored in massive PULSERDRIFT database table (together with pin diode data in PULSERDRIFTPIN)

  All FD data from August 2003 – mid-September 2005 now in database
- Enables drift corrections to be calculated for each pixel-spot (stripend) separately (PulserDriftCalScheme):

  $$ADC_{cor} = ADC_{uncor} * \frac{ADC(0)}{PIN(0)} * \frac{PIN(t)}{ADC(t)}$$
- Reference values $\frac{ADC(0)}{PIN(0)}$ obtained from slope of fit to PMT v PIN at low ADC

  Currently use temporary values from June 2005 gain curve

  Near-end pmt v high-gain pin for preference

Introduction

- PulserDriftCalScheme not practical because of size of PULSERDRIFT table (45GB in July and growing)
- Nathaniel has devised PmtDriftCalScheme which calculates gain based on mean/(rms**2) and averages over all channels on a pmt
- Aim here to compare PulserDriftCalScheme PIN-based drifts with PmtDriftCalScheme PMT gain-based drifts
  - How do gain-based drifts compare with pin-based ones?
  - Can we use pmt-averages rather than spot-by-spot values? (these could be pin-based or gain-based)
- In the following:

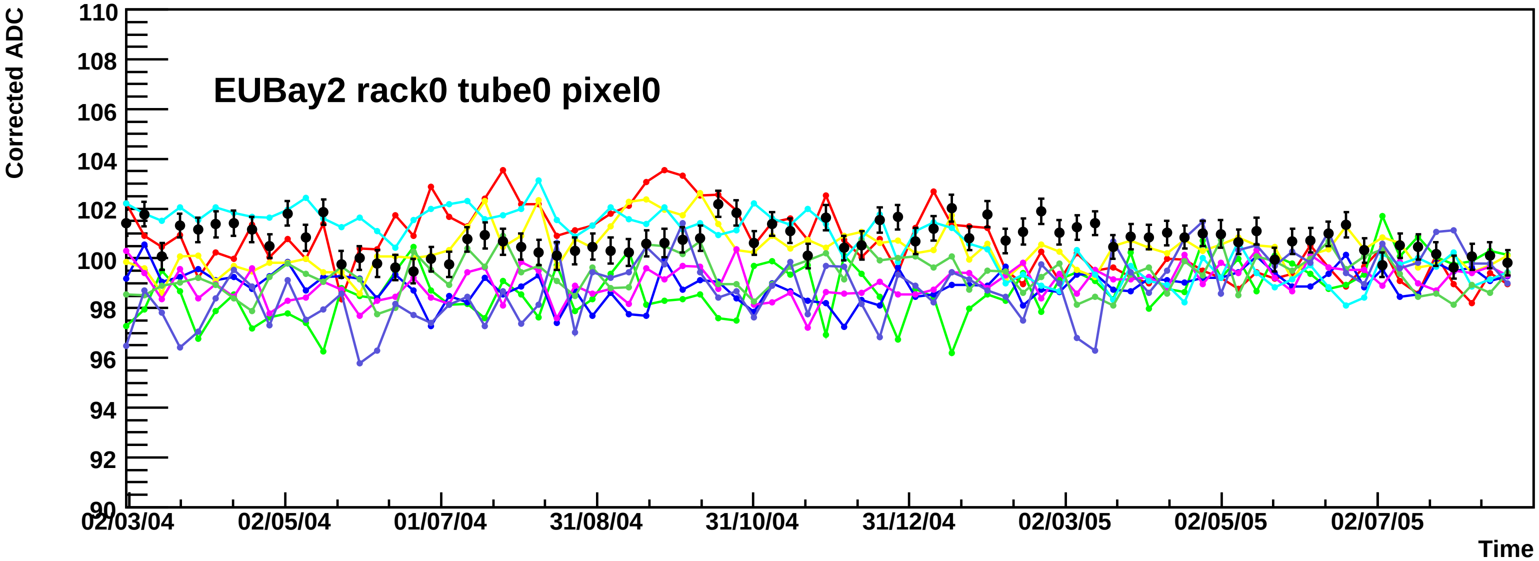
  PIN means PulserDriftCalScheme, using pin diodes for normalisation

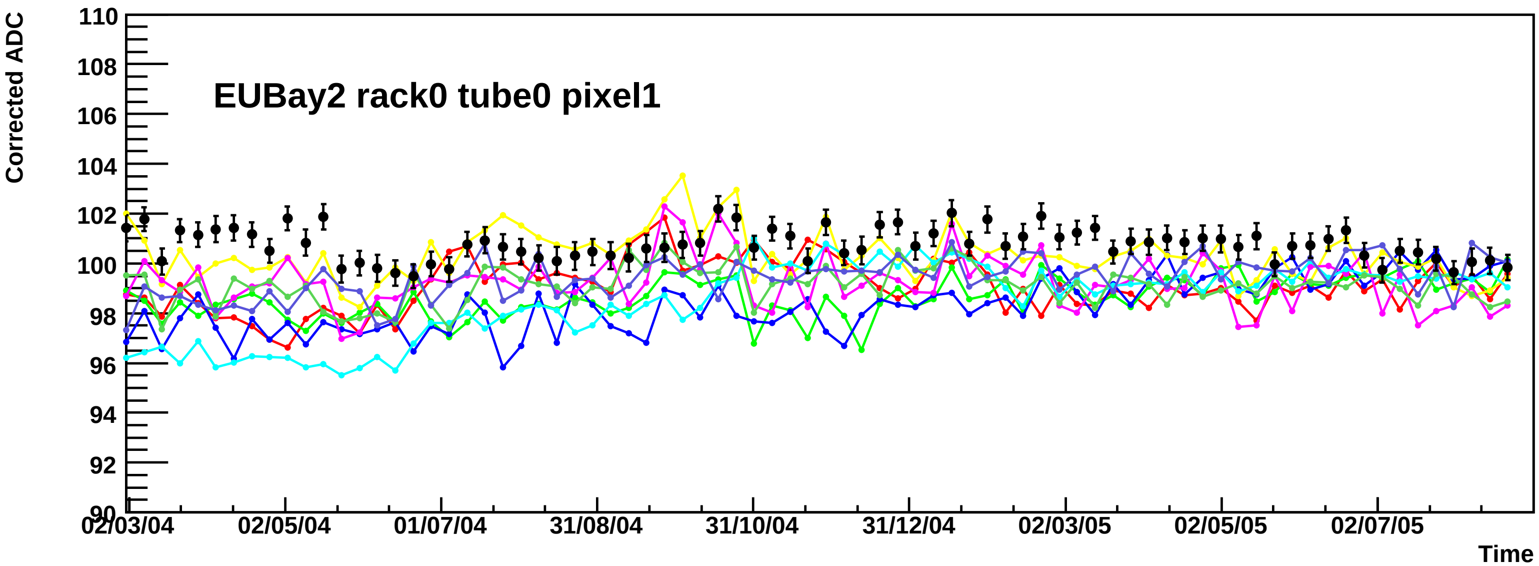
  PMT means PmtDriftCalScheme, pmt averages based on (mean/rms**2)

Long-term Drifts

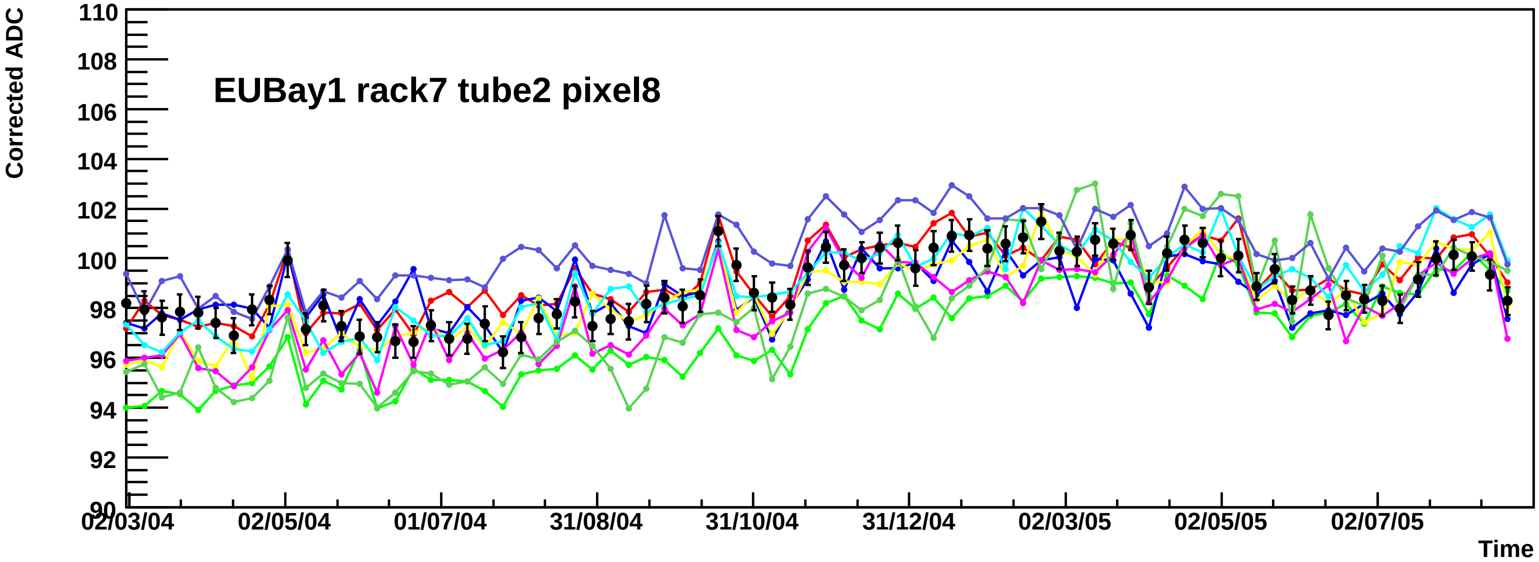
- So far have been looking at long-term drifts
- Plot drift-corrected values for an input ADC of 100
- One point per week for period 1st March 2004 – 1st September 2005 (18 months)
- Here are a few example plots; each plot corresponds to one pixel:
  Black points with error bars = PmtDriftCalScheme
  Coloured lines = PulserDriftCalScheme, each colour is one pixel-spot
- N.B. Overall normalization not necessarily the same, just look at slopes and other features

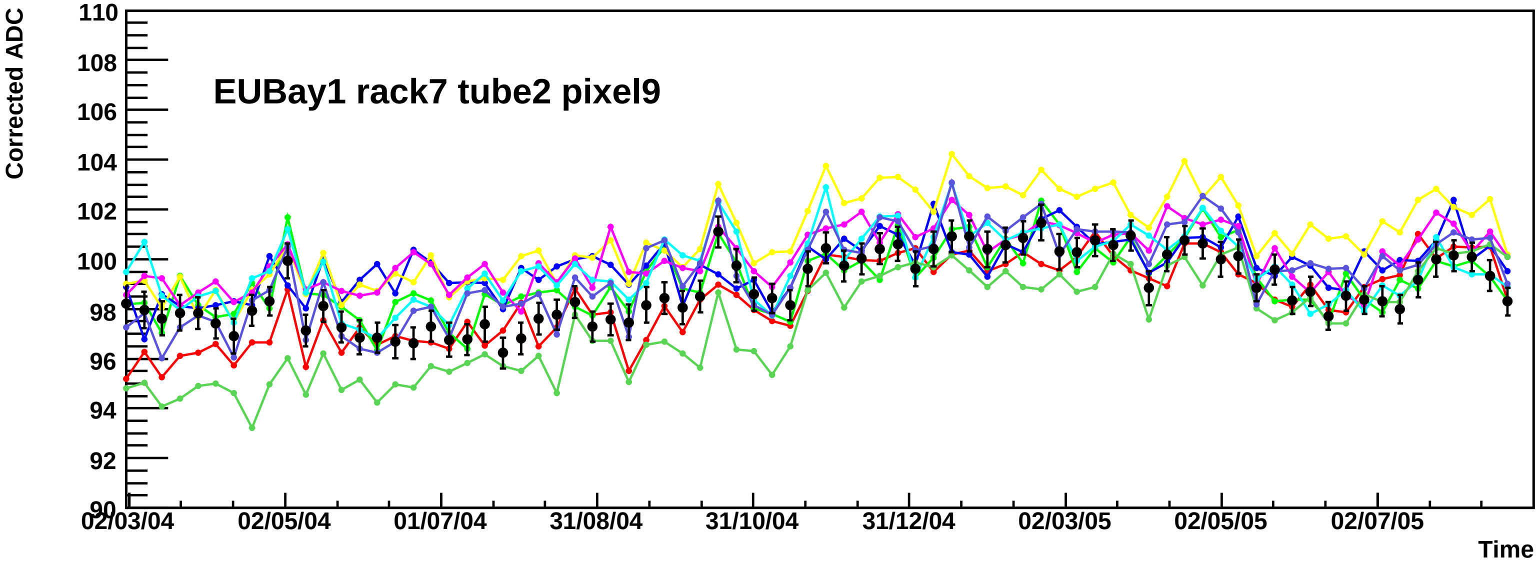
Example 1: black=PMT; colour=PIN, individual spots



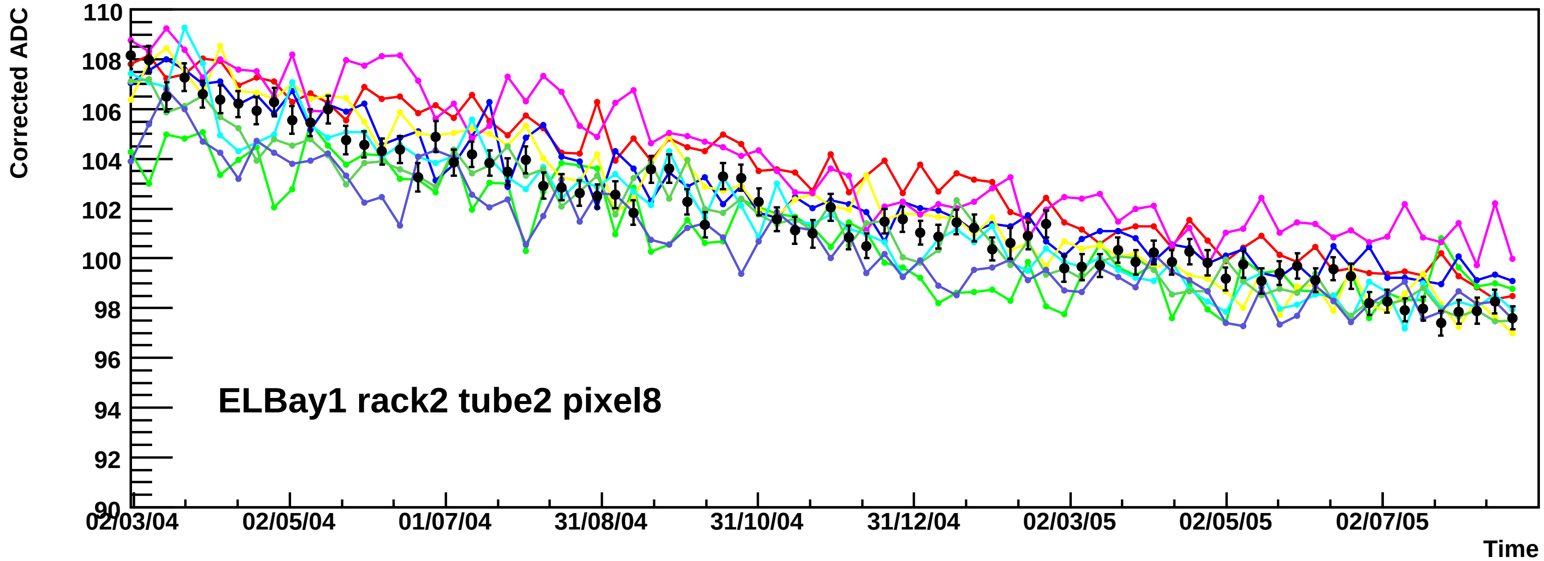


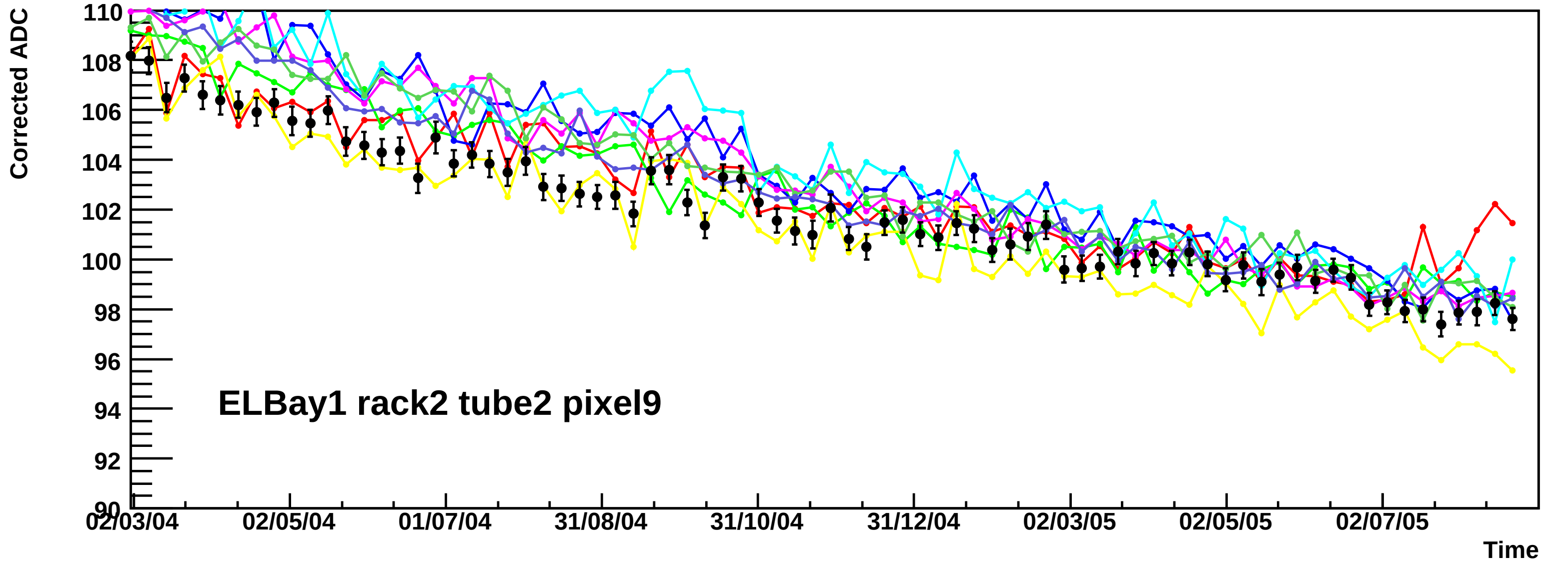
Example 2: black=PMT; colour=PIN, individual spots



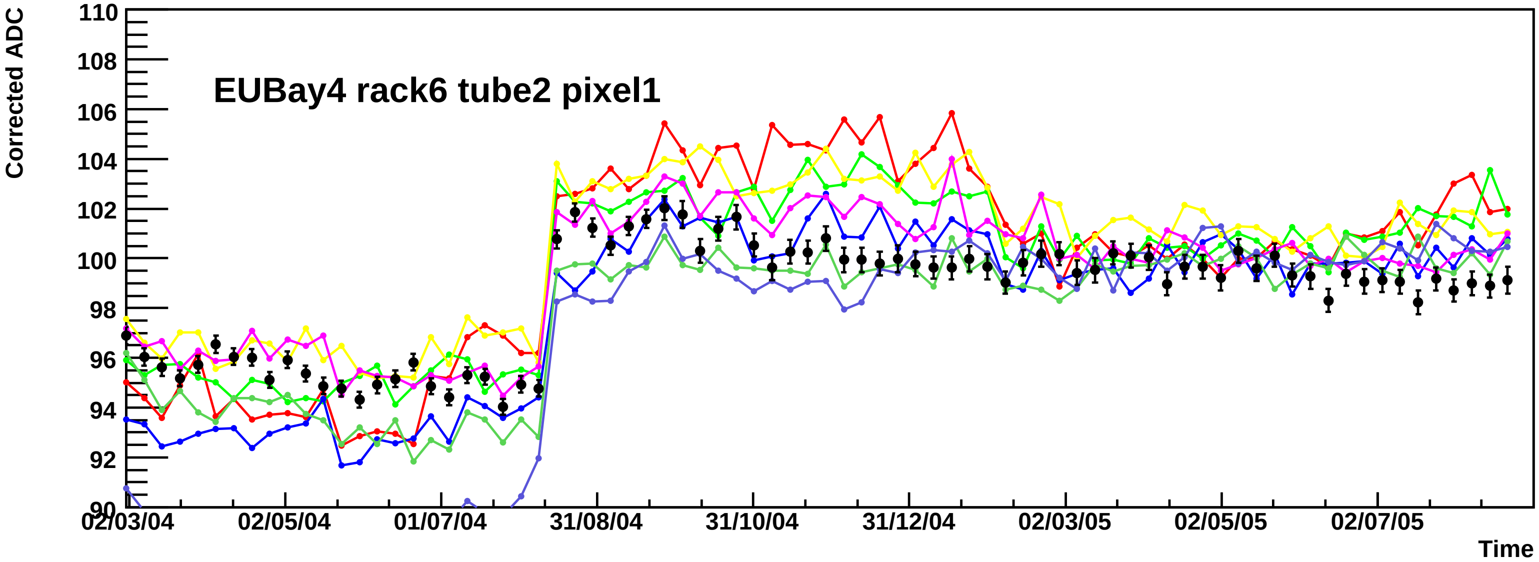


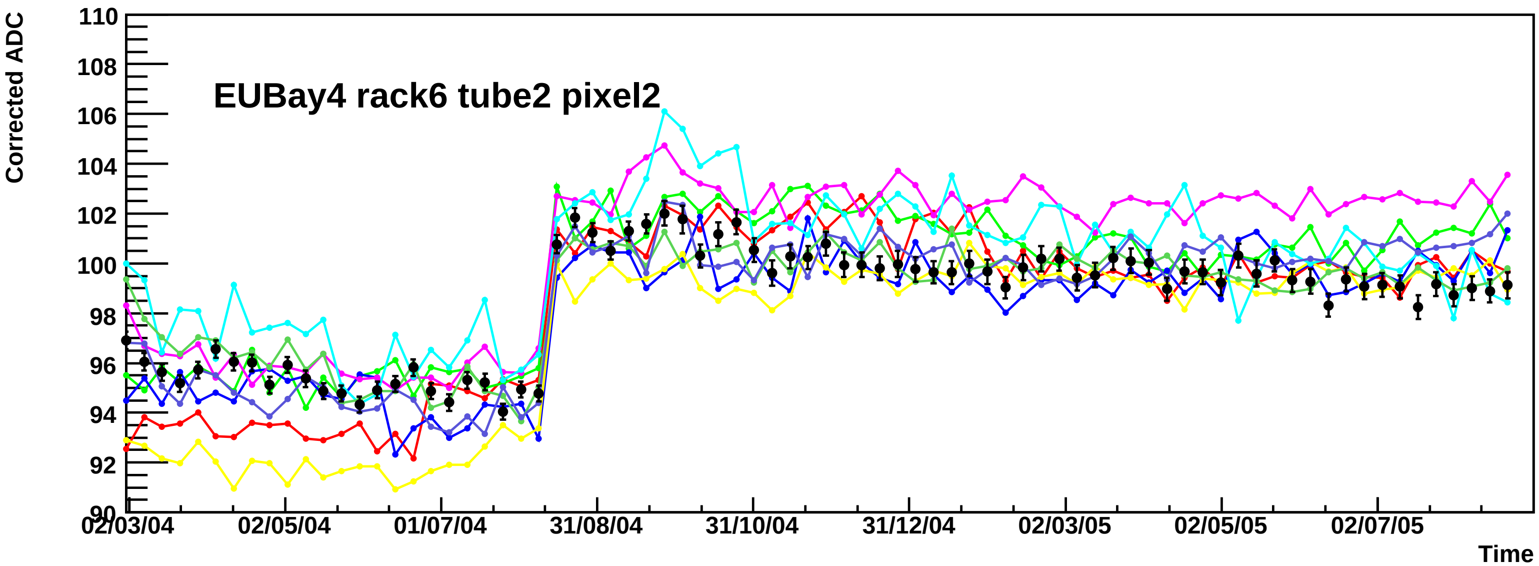
Example 3: black=PMT; colour=PIN, individual spots



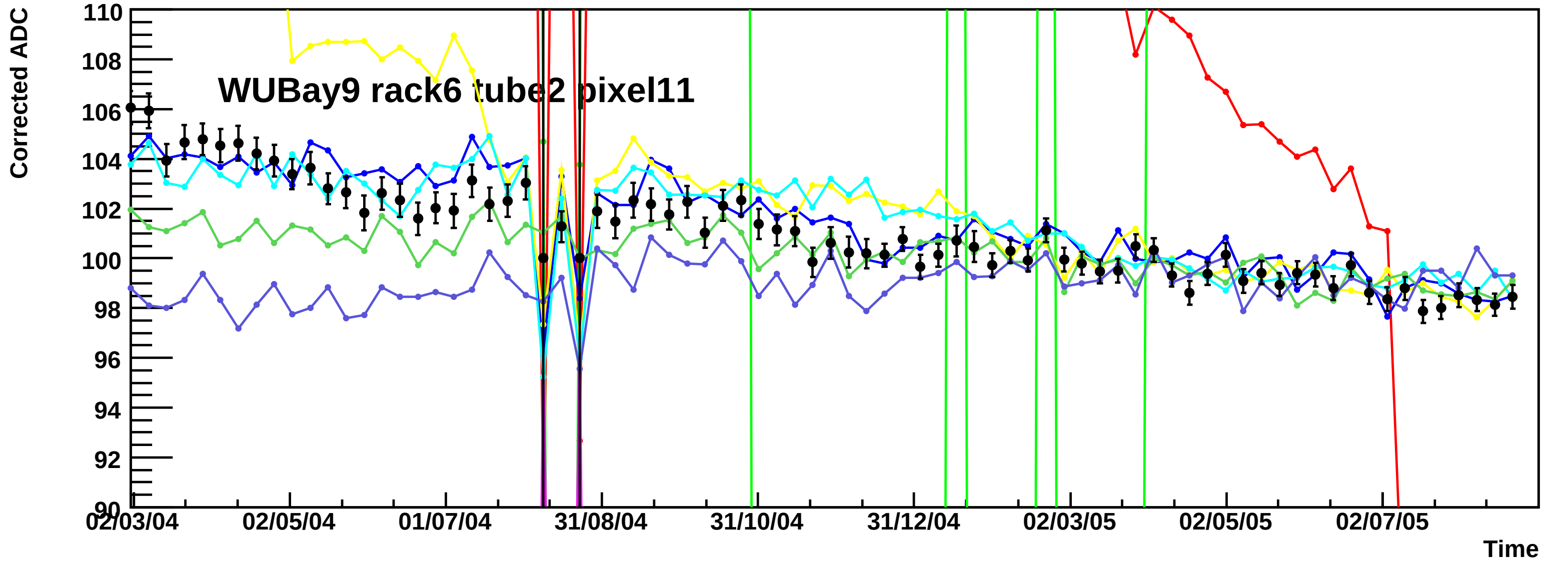


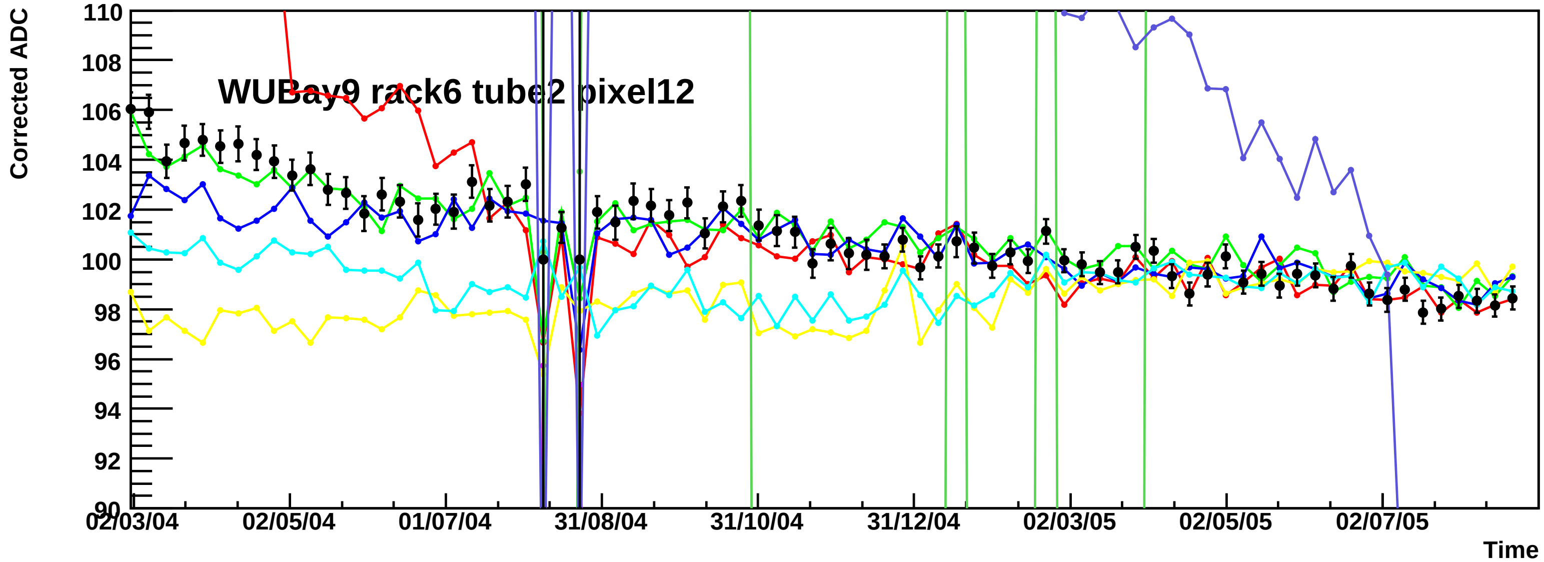
Example 4: black=PMT; colour=PIN, individual spots



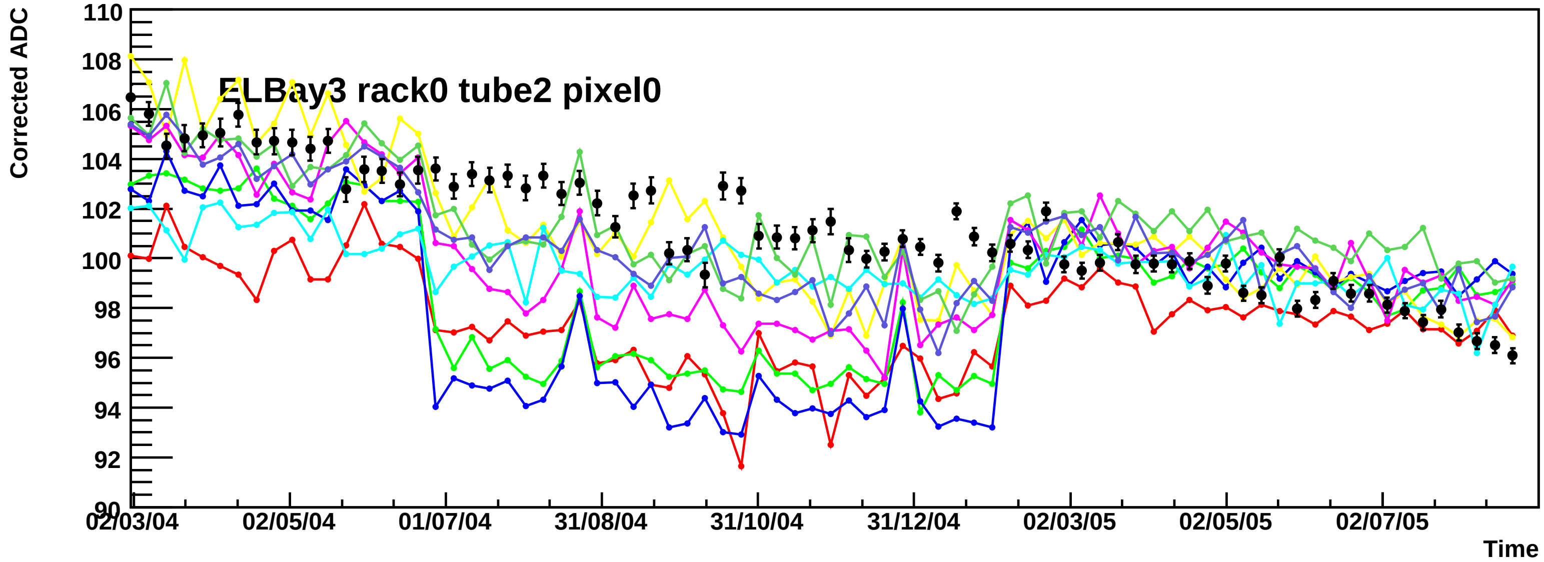


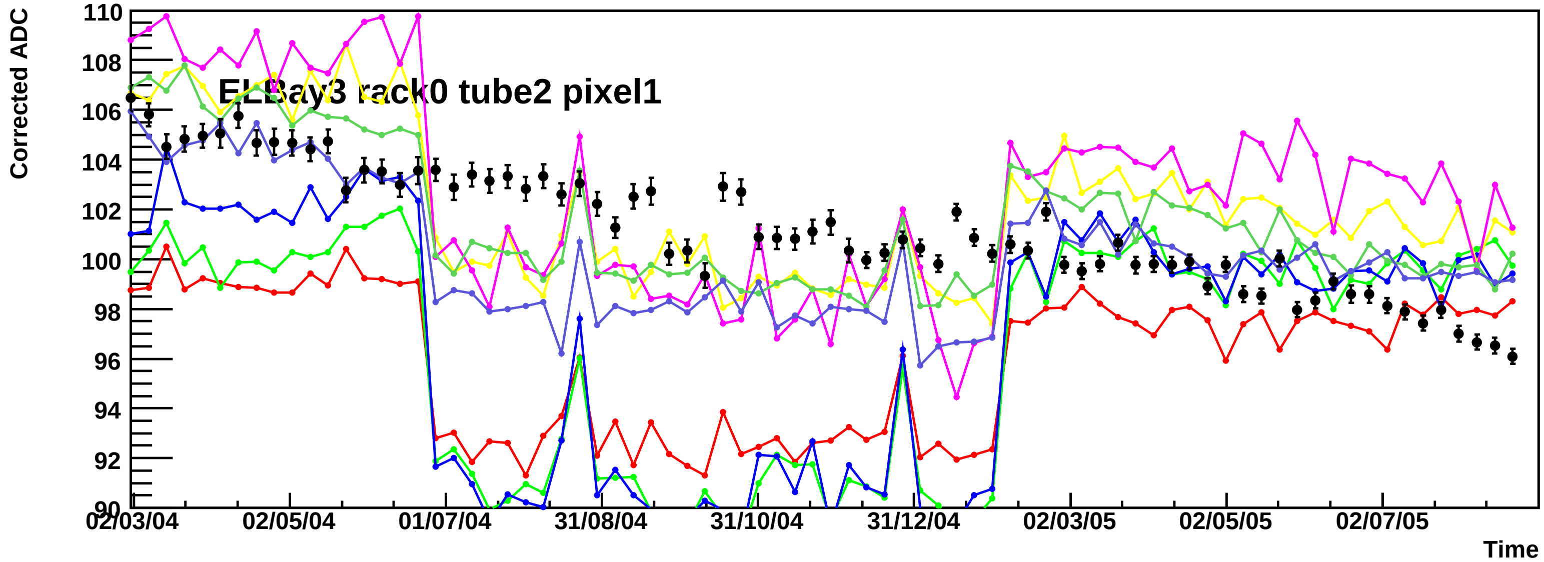
Example 5: black=PMT; colour=PIN, individual spots





Example 6: black=PMT; colour=PIN, individual spots

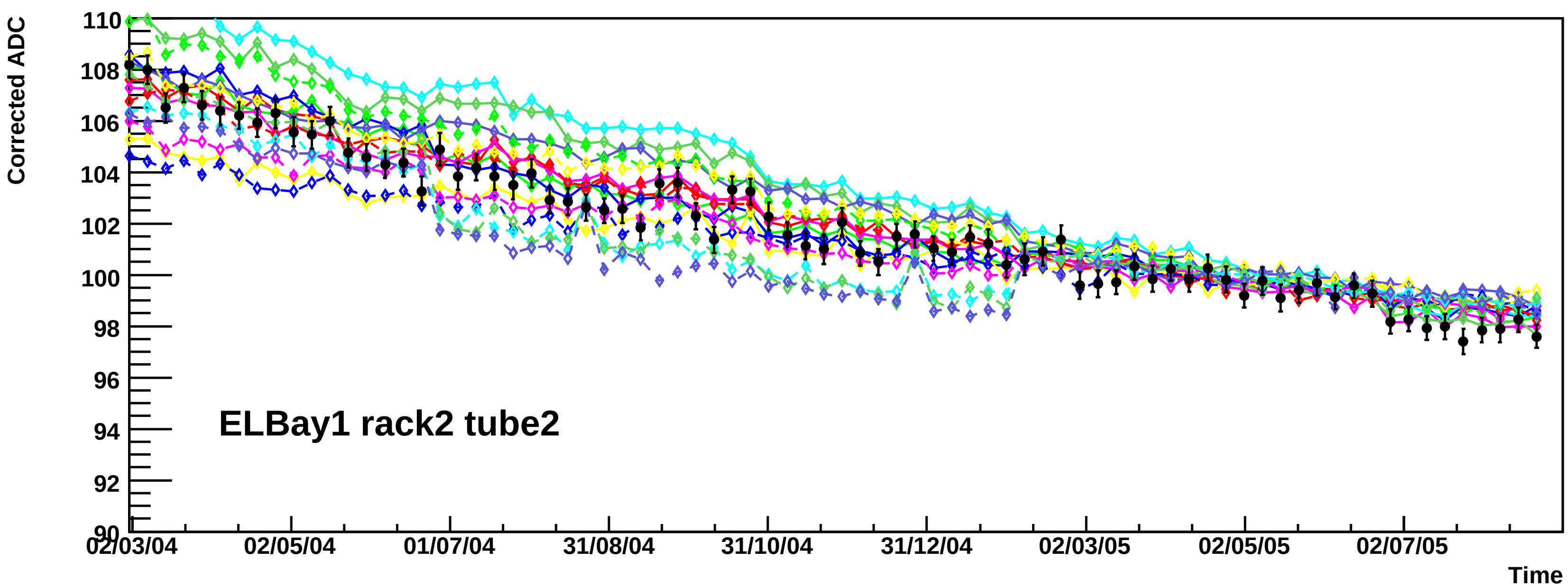




Long-term Drifts

- Generally good correlation between individual spots and between PIN and PMT long-term drifts e.g. examples 1–3
- For better comparison, average PIN mean over all spots on a pixel for the tube in example 3:

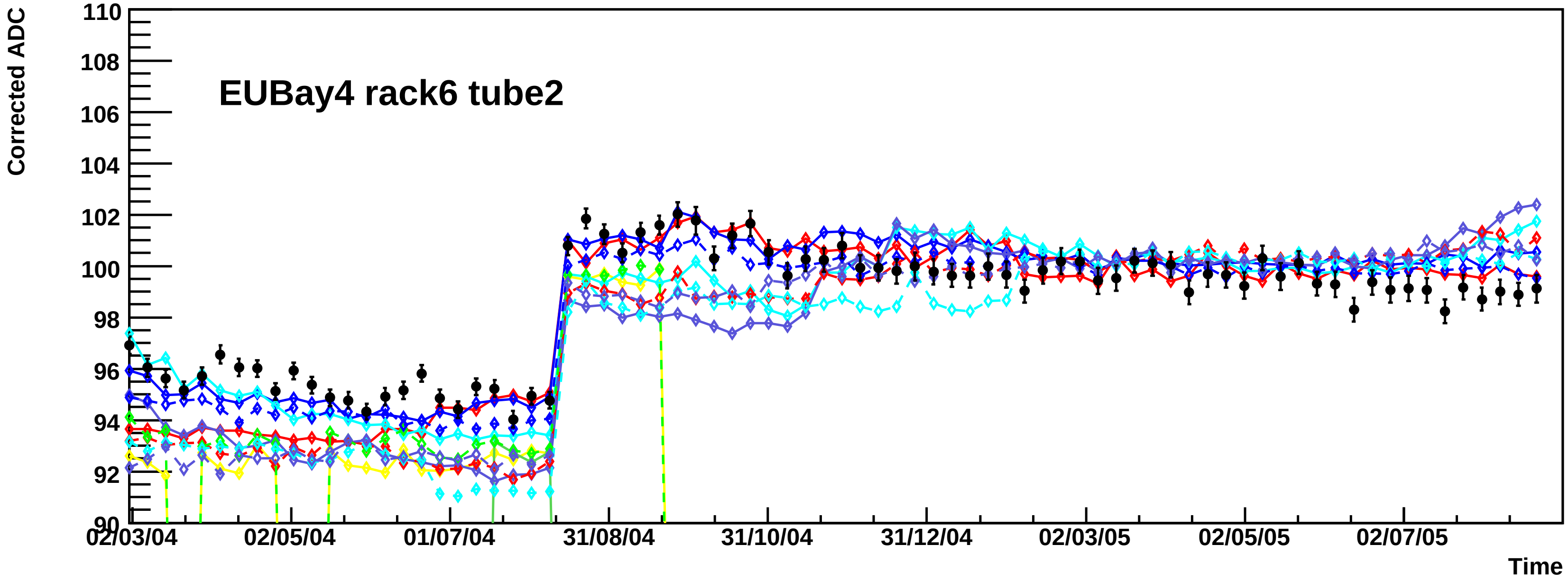
Example 3: black=PMT; colour=PIN, pixel averages



Long-term Drifts

- Can also see effect of hardware changes e.g. example 4
- Jump is seen in all pixels of this pmt, and corresponds to a VFB change

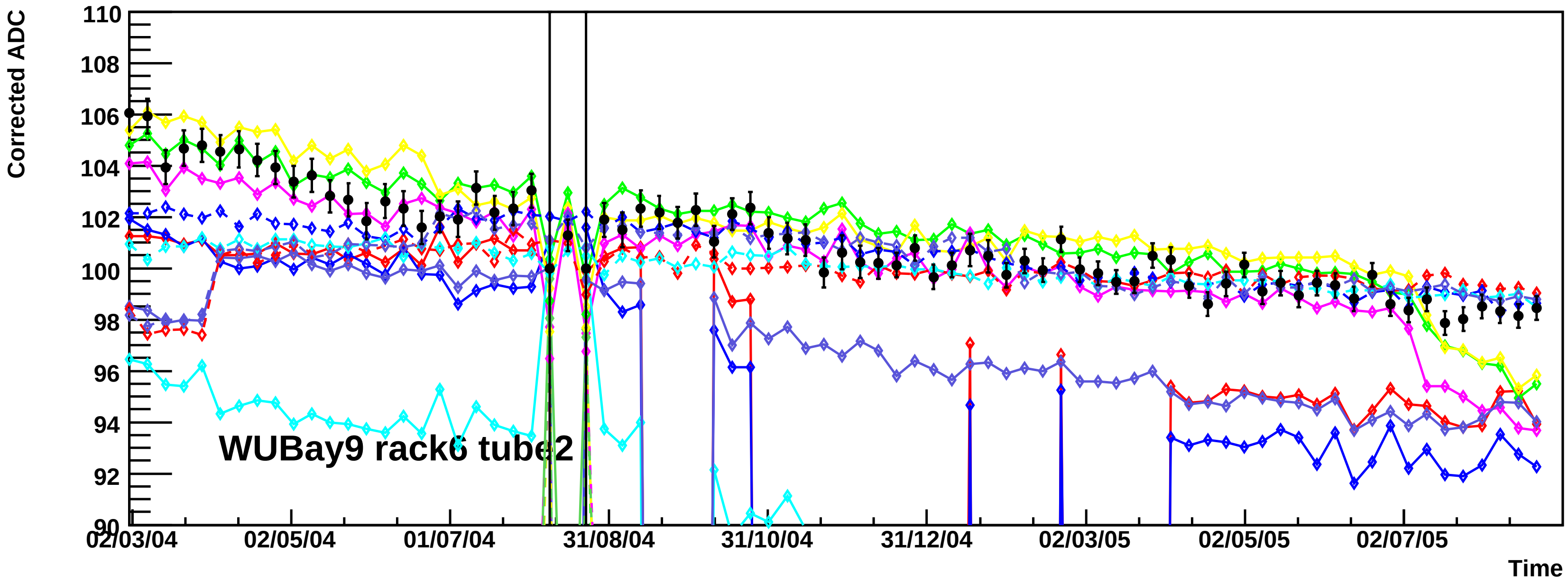
Example 4: black=PMT; colour=PIN, pixel averages



Long-term Drifts

- Some pixels show clear problems with the data for one or more spots e.g. example 5
- Hence pixel-averaged data for these is unreliable

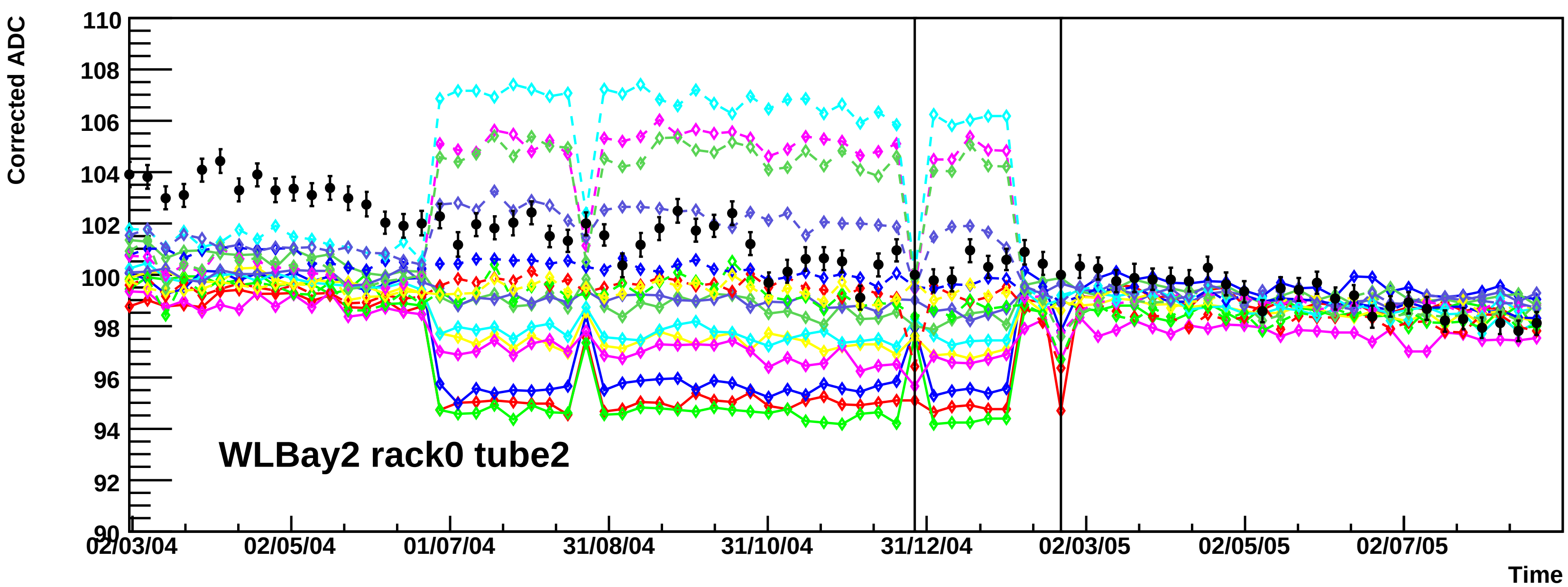
Example 5: black=PMT; colour=PIN, pixel averages



Long-term Drifts

- In several cases see some or all spots on a pixel showing different gain for a period of some months, then returning to original value e.g. example 6
- Another example where most spots on a pixel jump hence pixel-means also jump:

Example 7: black=PMT; colour=PIN, pixel averages



Correlated Jumps

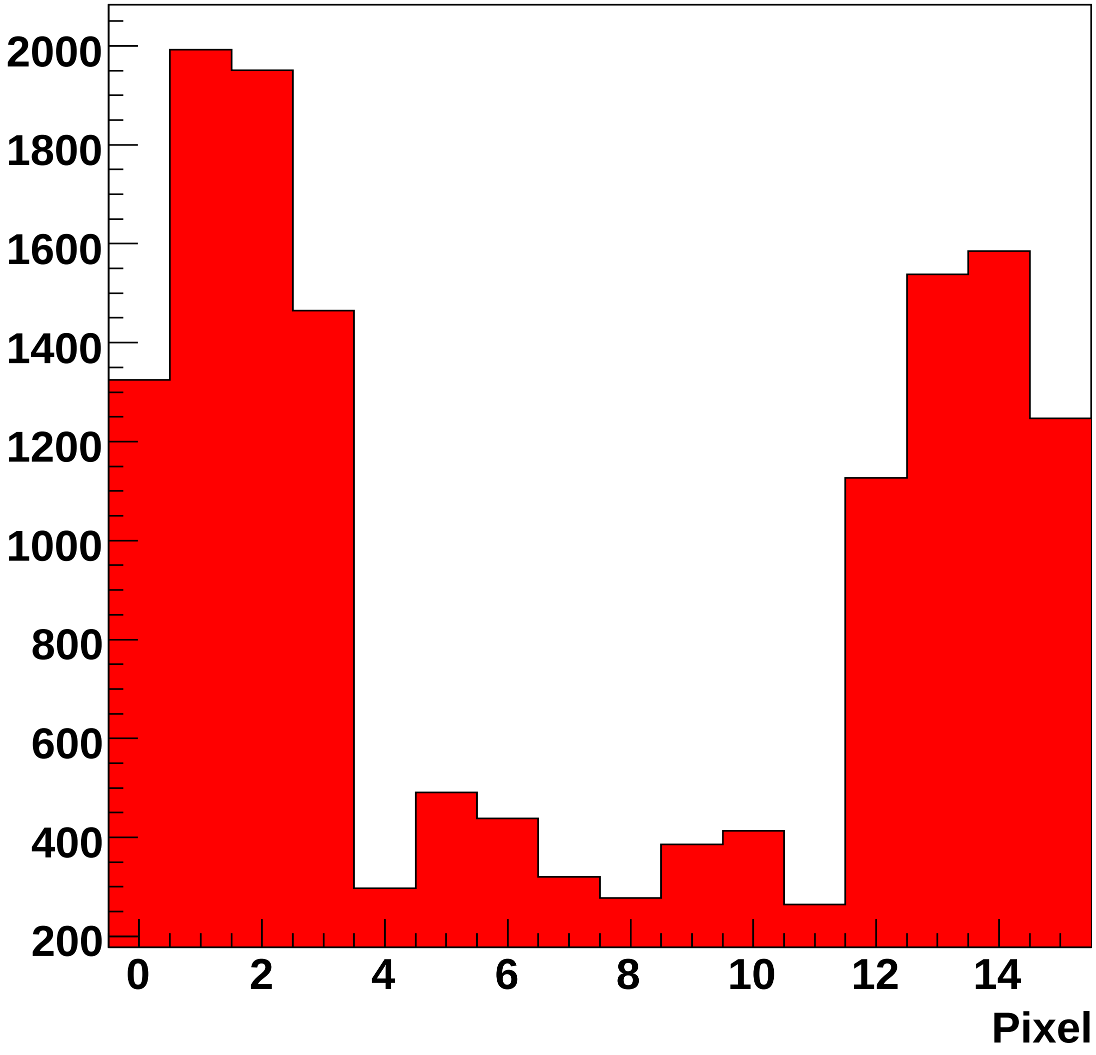
- A significant number of channels show jumps at the same time
- Sometimes just a few spots, often all spots on a pixel
- Can be up or down, often with some pixels up and some down on one pmt
- Not seen in PMT values nor, usually, in pmt-averages of PIN values
- Timing of jumps corresponds to period when FD magnetic field was reversed
- What is causing the gain difference in reversed field?

Magnetic Field Effect - Cause?

- Light is injected directly into the fibre
  Not a scintillator effect
- Jump seen in raw PULSERDRIFT data, not in the pin values
- For a particular stripend, jump seen when light injected at both near and far end, i.e. for two different leds
- No jump in data for the readout at the other end of the strip, for either led
  Not caused by led or pin
  $\Rightarrow$ Probably pmt, or mechanical movement of connectors
- Try to quantify effect: define channels with jumps as those where average gain is $>$2% different (higher or lower) during period 21st June 2004 – 1st February 2005 (reversed field) than both before and after this period

Magnetic Field Effect

Channels with jump



- 8.7% of channels show such a jump
- Around 3/4 occur in the lower MUX boxes
- Some tendency to occur in the middle of each SM
- Pixels 0–3 and 12–15 are more affected than others

Magnetic Field Effect

- Seems clear that this is a PMT effect - tubes not perfectly shielded
- Occurs for about 8.7% of channels, with mean change of $\sim$5%
- We can probably safely ignore this effect:

  Using pmt-based drift corrections will correct on average, but resolution will be degraded

  In any case, field will not be reversed for beam data, and resolution is not critical for atmospheric analysis

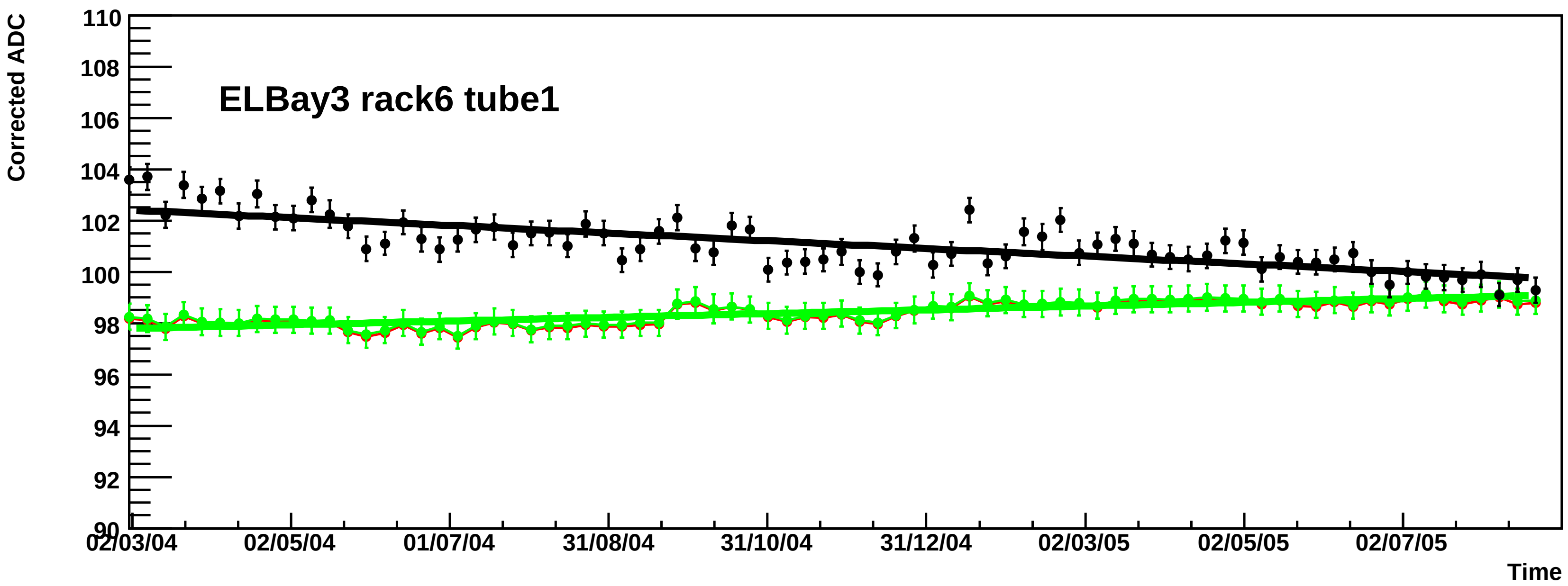
Long-term Drifts

- Main long-term effect seen in plots is a fairly linear decrease with time

  N.B. This means an INCREASE in pmt gain with time

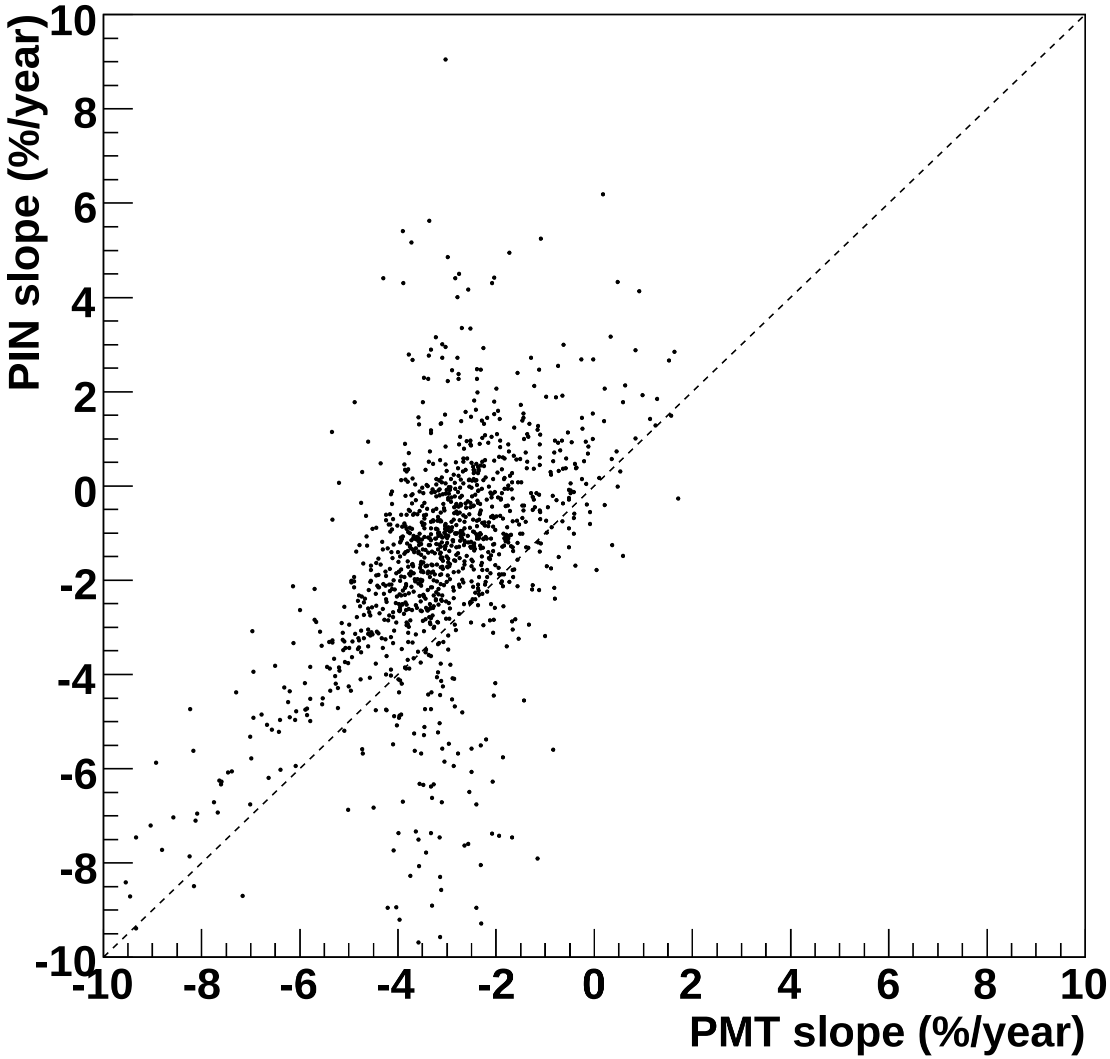
- Compare PMT and PIN drifts by fitting straight line to pmt averages

Black=PMT; green=PIN, pmt-average



Drift Slopes

Drift slope comparison



- Generally good correlation between PIN and PMT slopes, but
- PIN slopes smaller than PMT slopes
- Some tubes show totally different behaviour
- e.g. tubes with large PIN slope and normal PMT slope on plot are all Pulserbox 6 or 9

Summary and Outlook

- First comparisons between PIN-based and PMT-gain-based drift corrections made

  Plots of all channels on

  http://www.hep.phy.cam.ac.uk/ cpw1/plots/index.html

- Some pixels (spots) have different gain in reversed magnetic field

  Seems to be effect of field on pmt

  Not a problem for beam data

- Generally good correlation between PIN and PMT drifts

  But need to quantify this

- Some tubes show completely different behaviour – to be investigated

- Source of differences is probably hardware problems or bad data

  Urgently need to implement some data quality checks