



Stability of Calibration Data

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Outline

- Motivation
- Method
- Data Overview in a Single TDC channel
 - ✓ Throughout a day
 - ✓ Over months
- Comparison between TDC channels
 - ✓ Same TDC from same slot
 - ✓ Different TDC, same slot
 - ✓ Same TDC, different slots
- Summary and conclusion

Motivation

Focusing DIRC R&D has to measure arrival time of Cherenkov photons to $\sim 100\text{-}200\text{ps}$ accuracy.

Need precise and stable calibration of all TDCs for beam test analysis.

Data analysis has shown timing drifts, possible due to temperature variations, at the time scale of hours.

Are all detectors/TDCs are affected by those drifts in the same way?

Can a single detector yield a drift correction for all channels?

Use calibration PiLas data in this study. Look at long-term variations of subset of channels on all beam and prototype detectors.

Basic Setup

PiLas laser

Pilas pico-second laser;
single photon mode: $\lambda=635\text{nm}$;
pulse jitter FWHM < 35ps

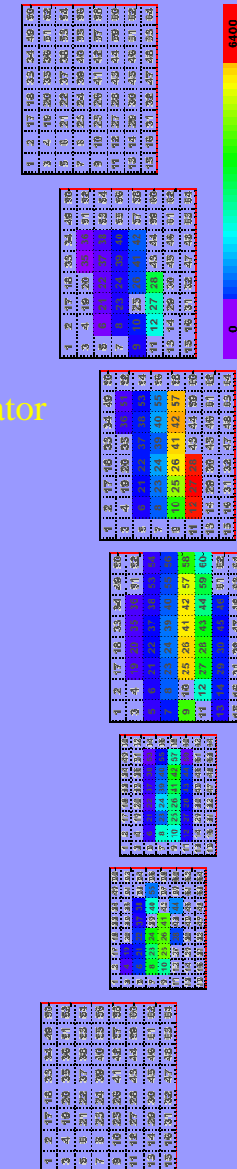
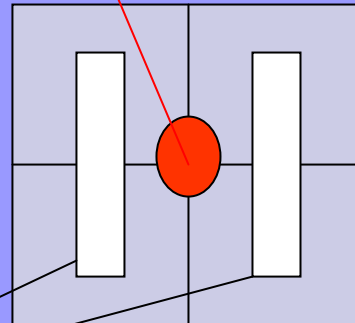
Prototype

Constant-fraction discriminator
Phillips TDC 25ps/count

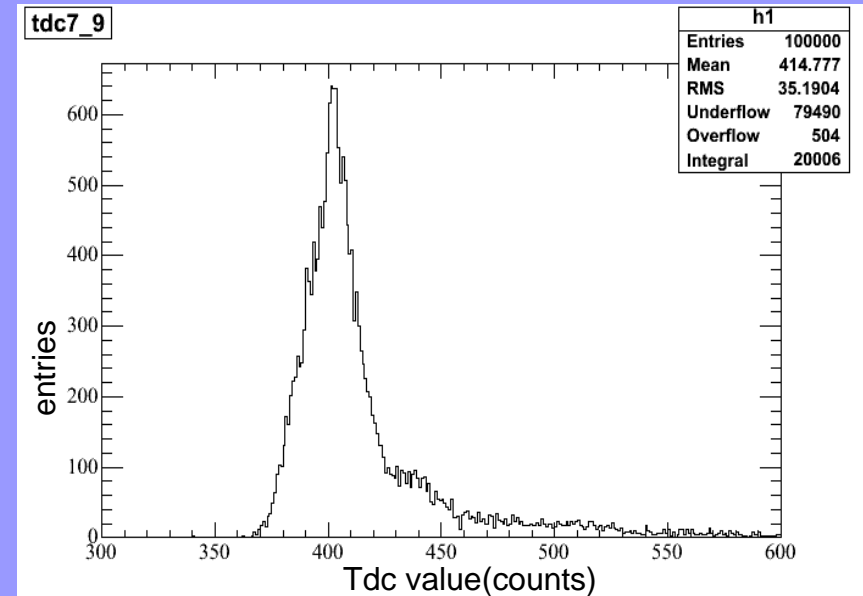
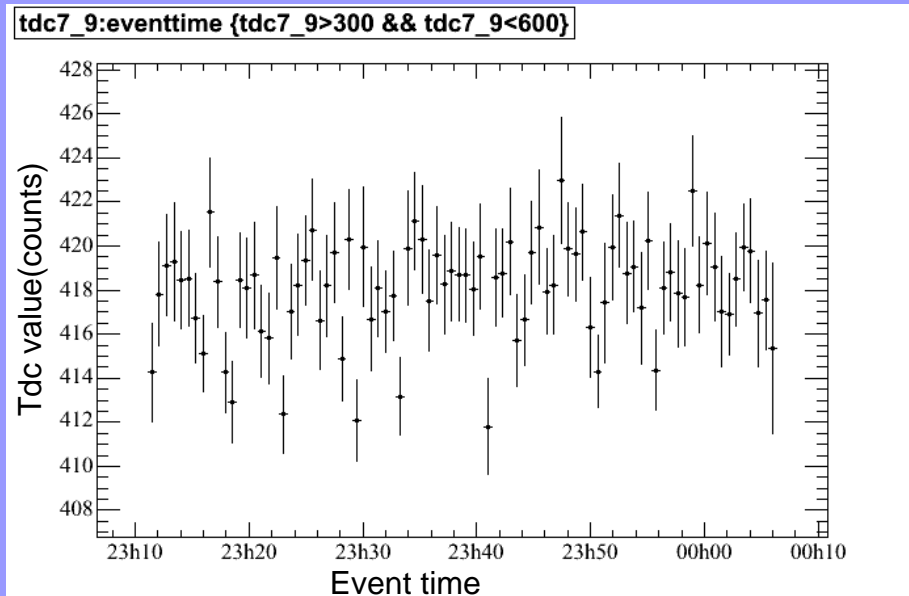
Leading edge discriminator
Phillips TDC 25ps/count

Quartz bars

Start Counter1

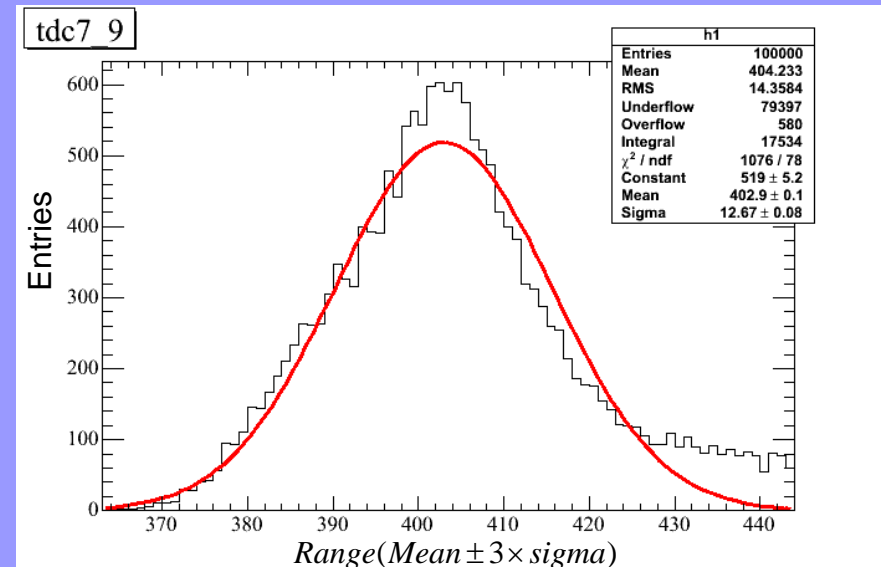
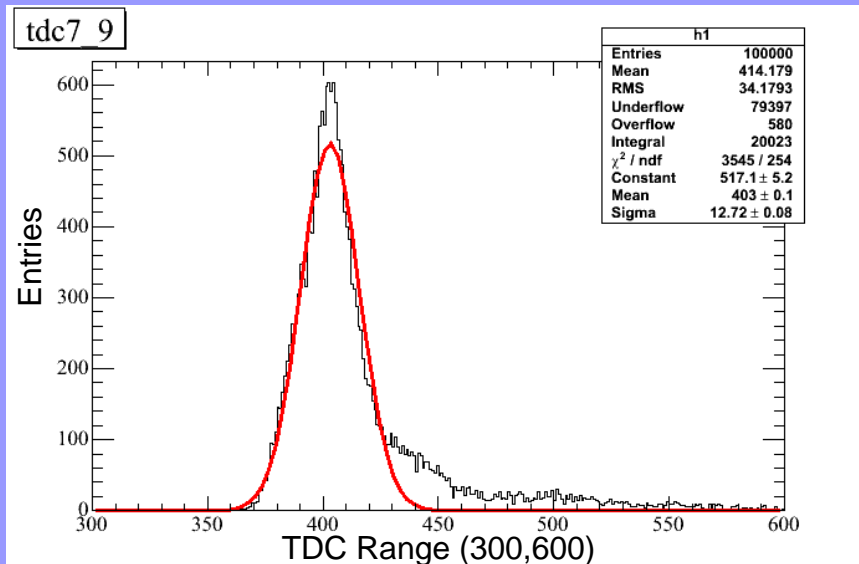


Data in one testrun file, tdc7_9 (slot4 pad24)



Method

TDC values for tdc7_9 in a single calibration run, Fit with Gaussian in different Range. Compare the results from histogram and fit method.



$$\Delta \text{Mean}(\text{hist}) \sim 10$$

$$\Delta \text{Mean}(\text{fit}) \sim 0.1$$

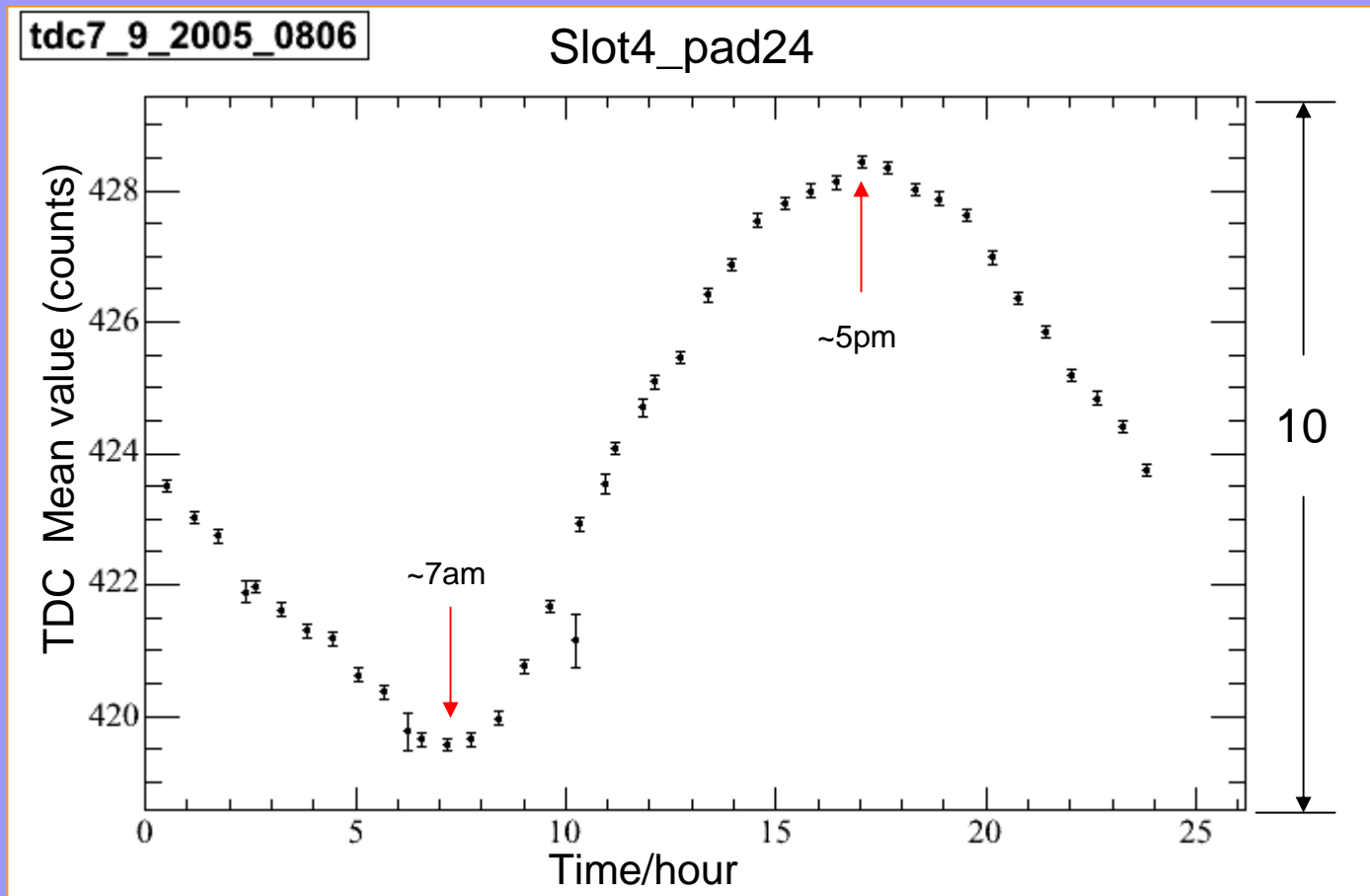
Simply take fit results: Mean(fit)

$$\text{Error} = \frac{\text{sigma}}{\sqrt{\text{integral}}}$$

Filename: "testrun_20050806_0032_100000.root"

Get date and time.

single day: slot 4, pad 24 on August 6, 2005 (tdc7_9)

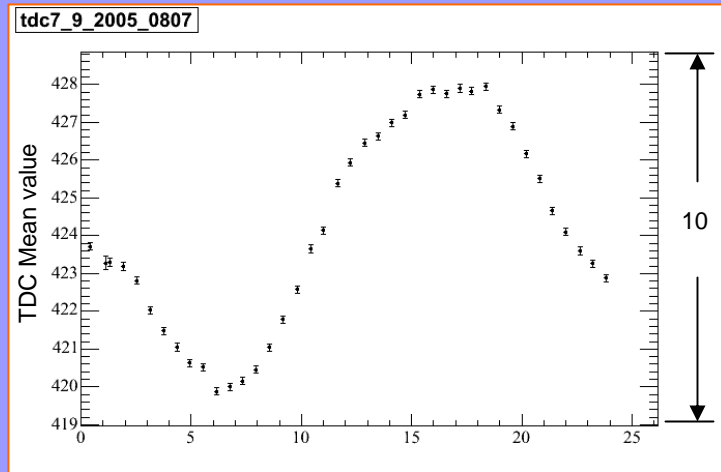


Min to max variation about 8 counts = 200ps.

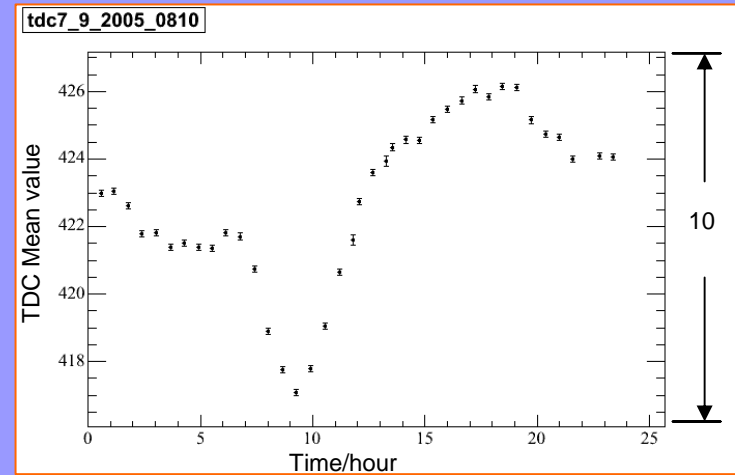
Consistent with day/night temperature variation in End Station A

Some other days, slot 4, pad 24 (tdc7_9)

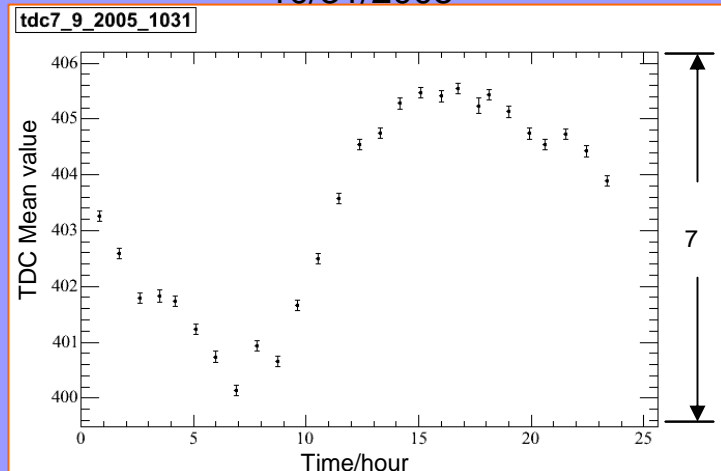
08/07/2005



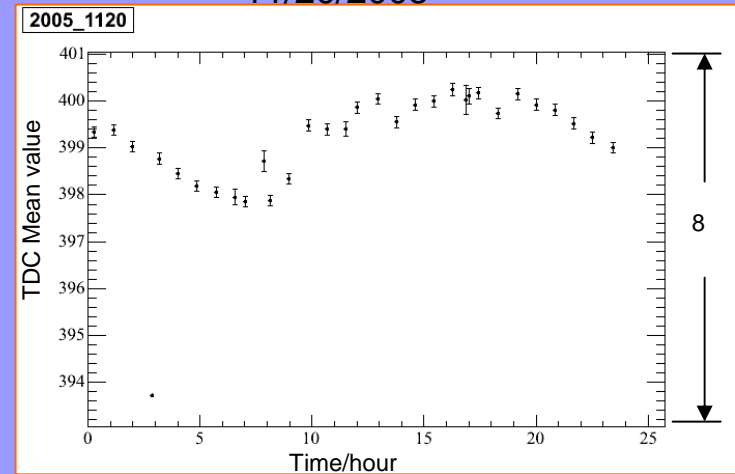
08/10/2005



10/31/2005



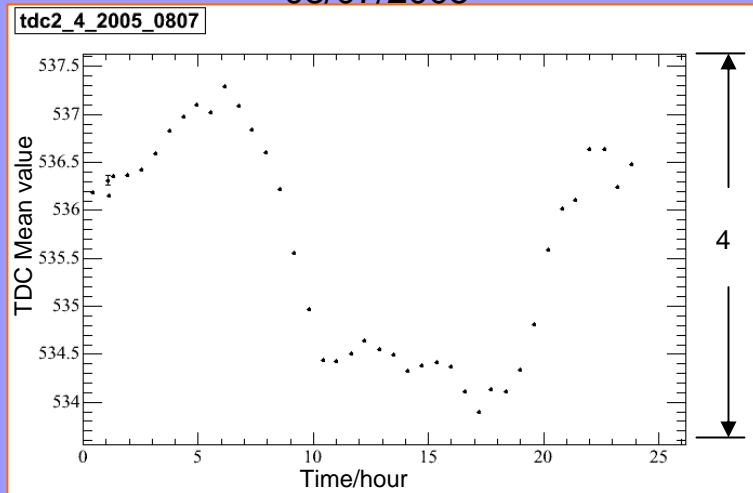
11/20/2005



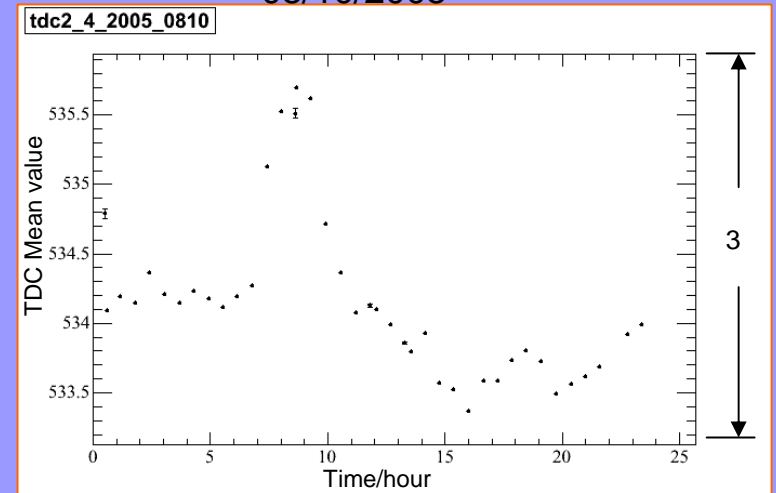
Corresponding days, Marker, slot2, pad 38 (tdc2_4)

Phase reversed, small amplitude

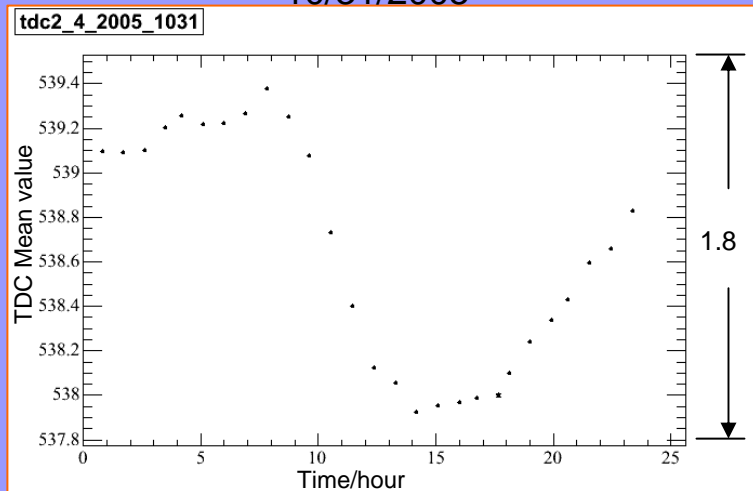
08/07/2005



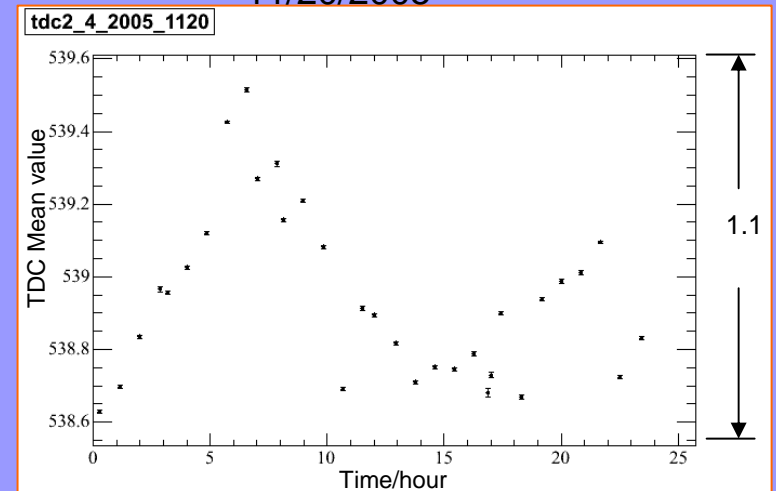
08/10/2005



10/31/2005

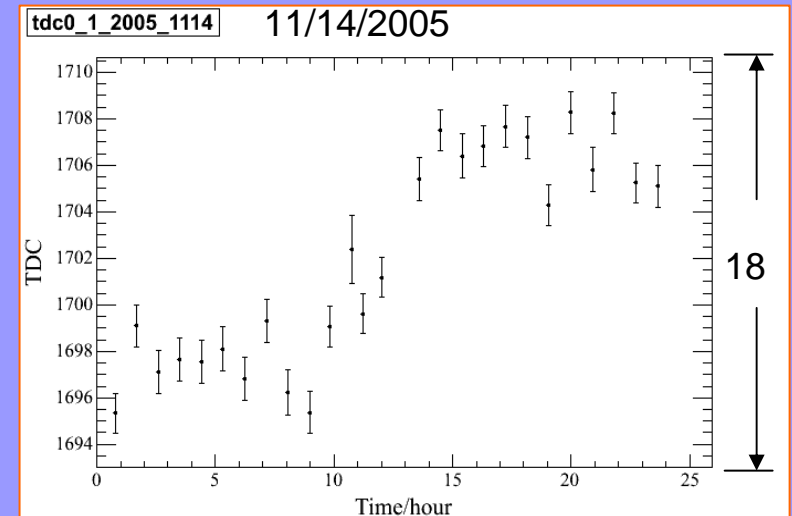
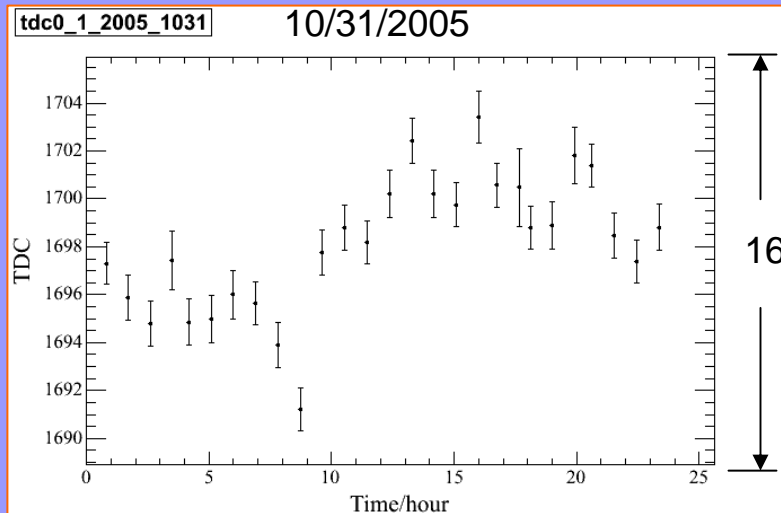
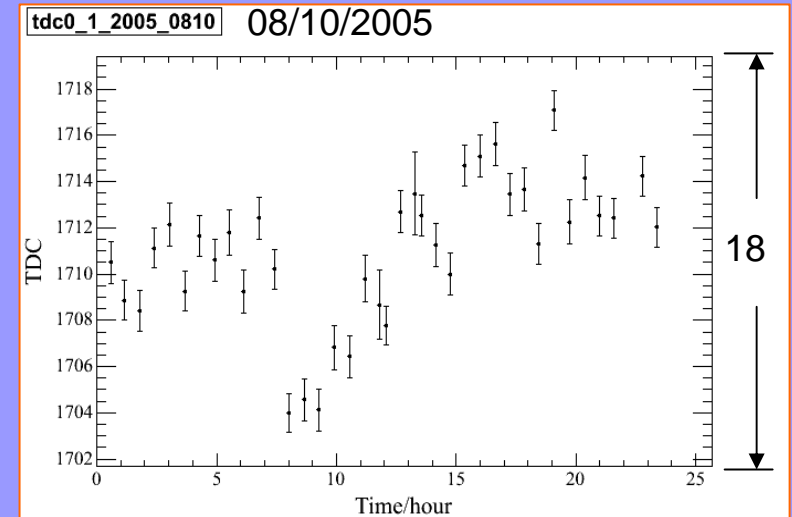
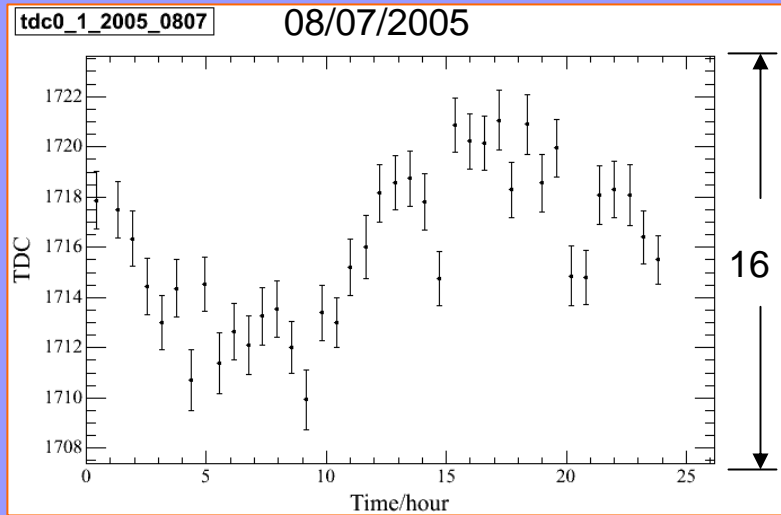


11/20/2005



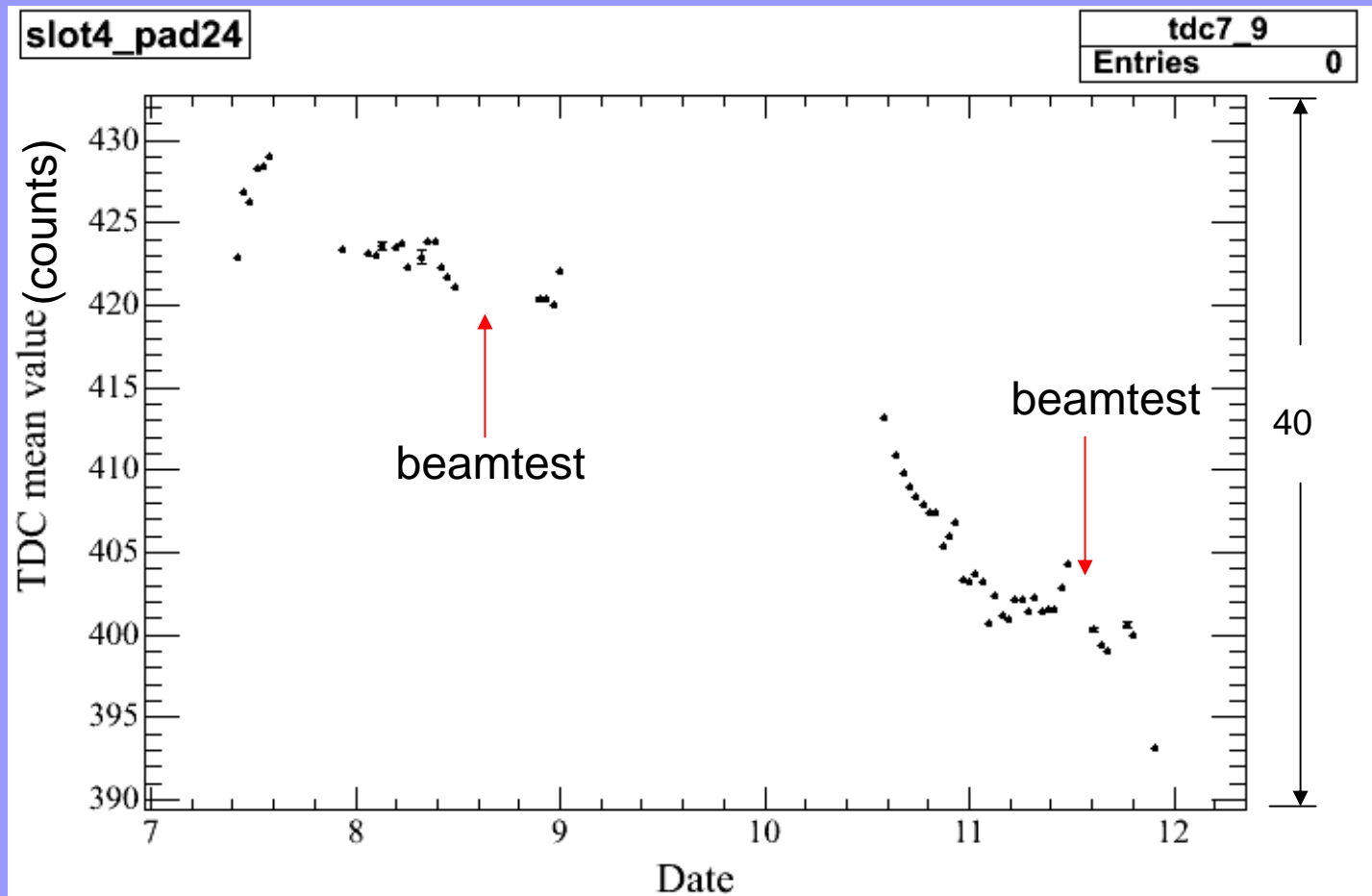
Start counter1, pad 0_1 (tdc0_1), larger error

Larger sigma(~ 3 times of prototype), fewer entries($\sim 1/10$ of prototype)



Data over months: July-November.slot4,pad24(tdc7_9)

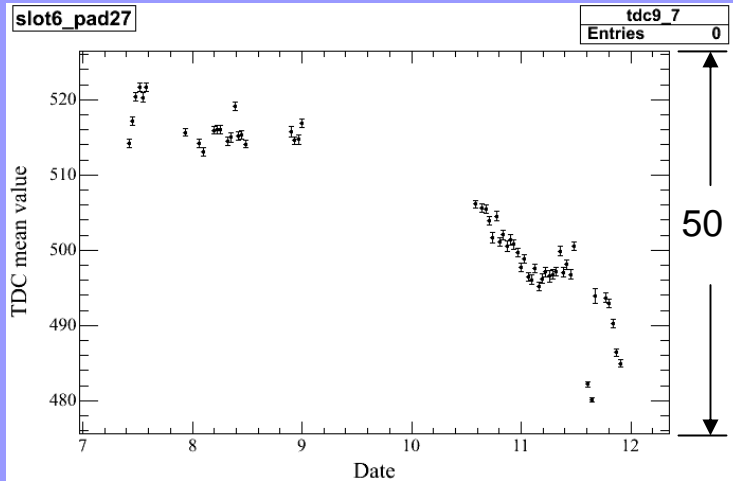
Select the run at midnight each day: testrun_2005????_00*.root



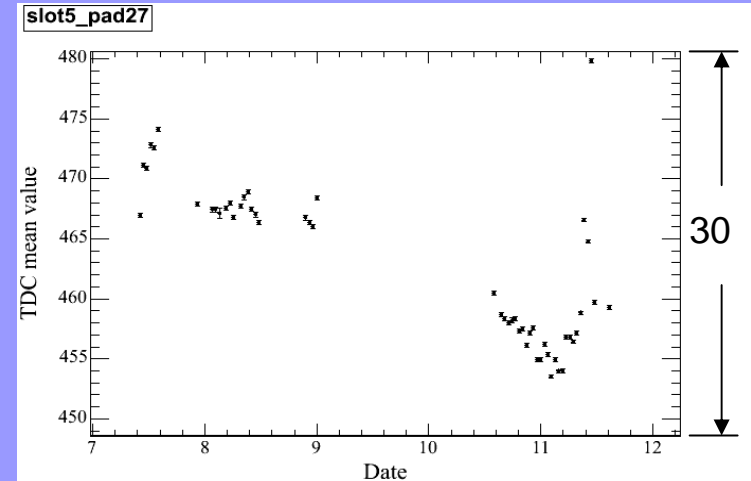
Quite stable in July and August, but turns down fast after mid October

Some other channels, they act differently, the marker is most stable

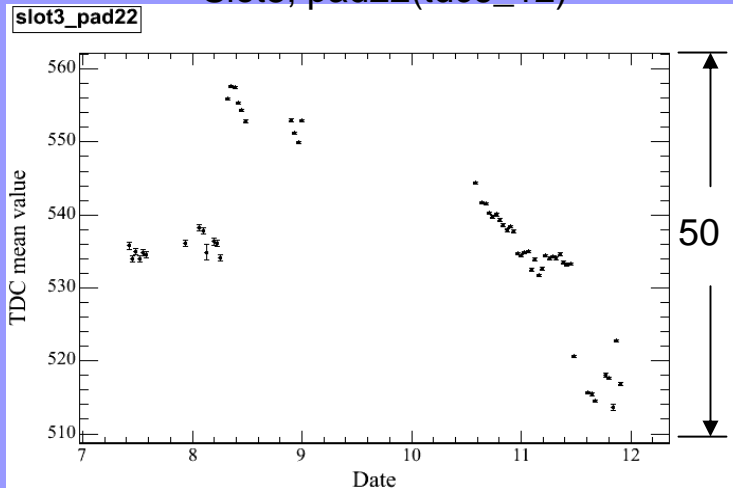
Slot6, pad27(tdc9_7)



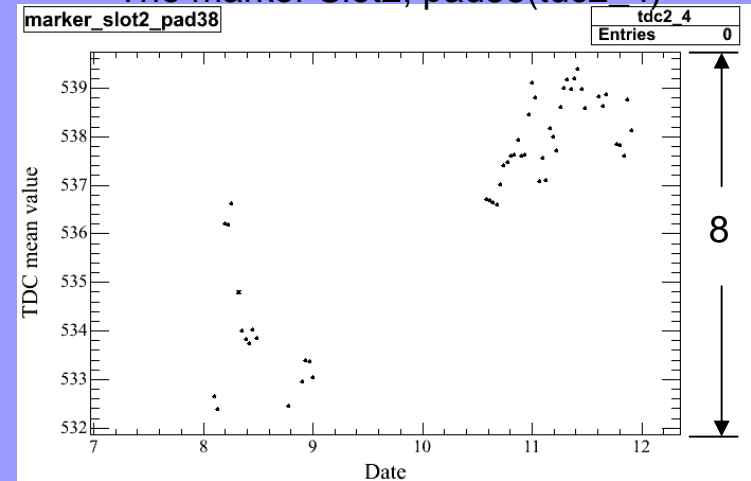
Slot5, pad27(tdc8_7)



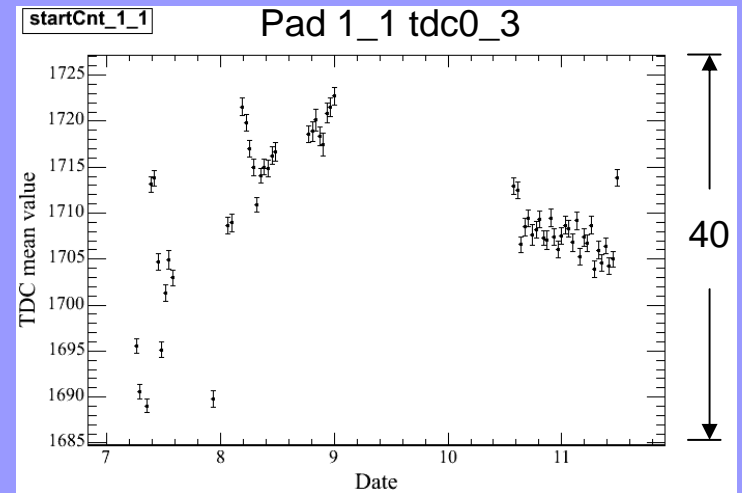
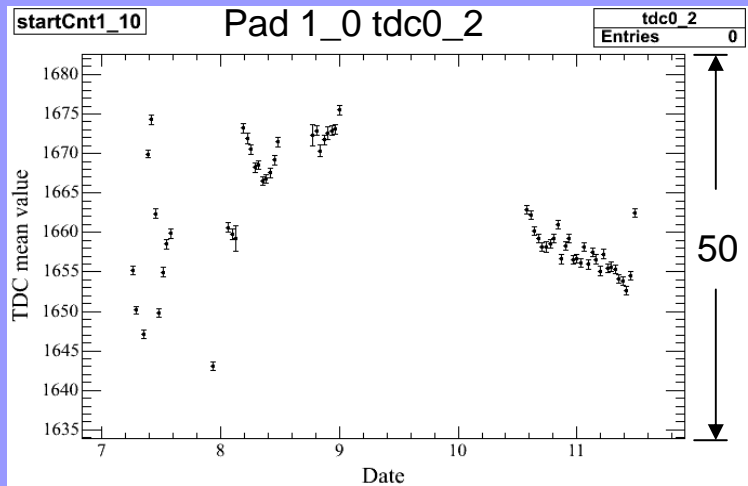
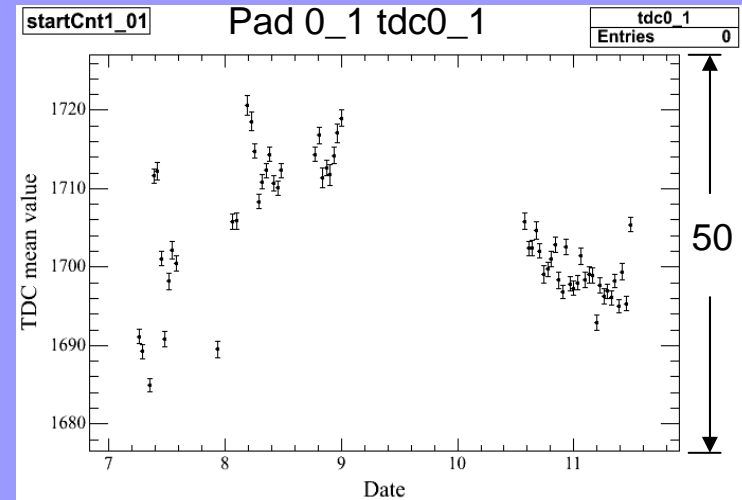
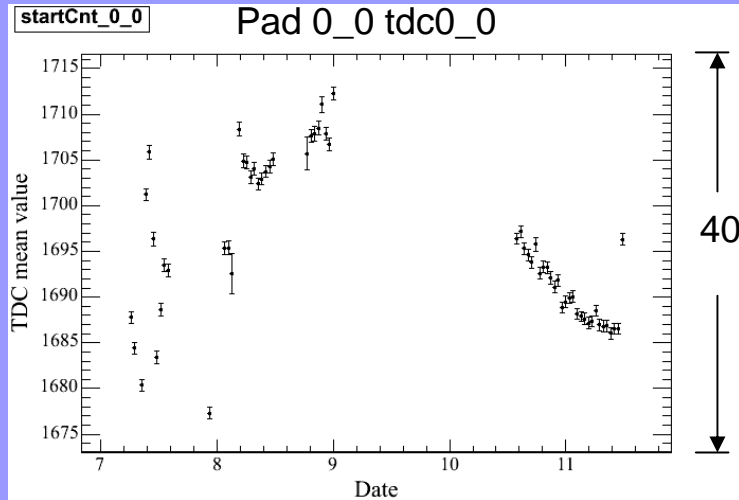
Slot3, pad22(tdc6_12)



The marker Slot2, pad38(tdc2_4)

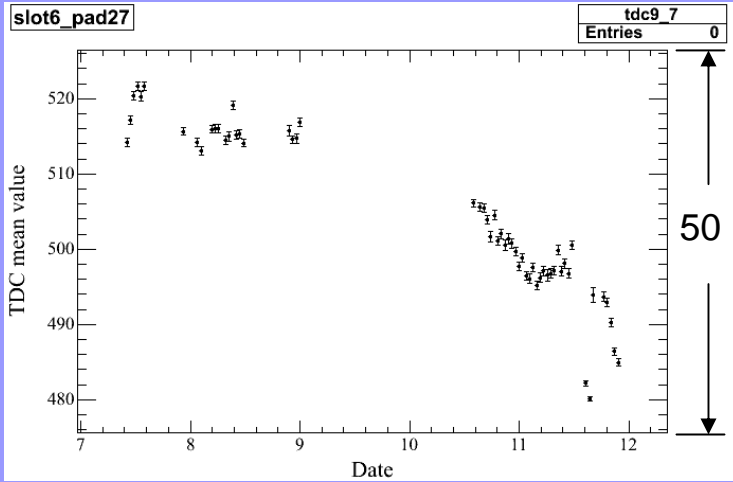


startcounter1, stopped after the beamtest in November

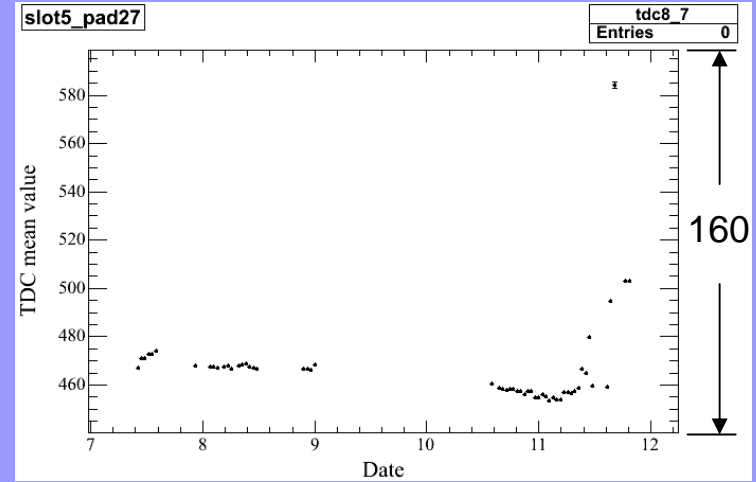


Some big jumps are discovered

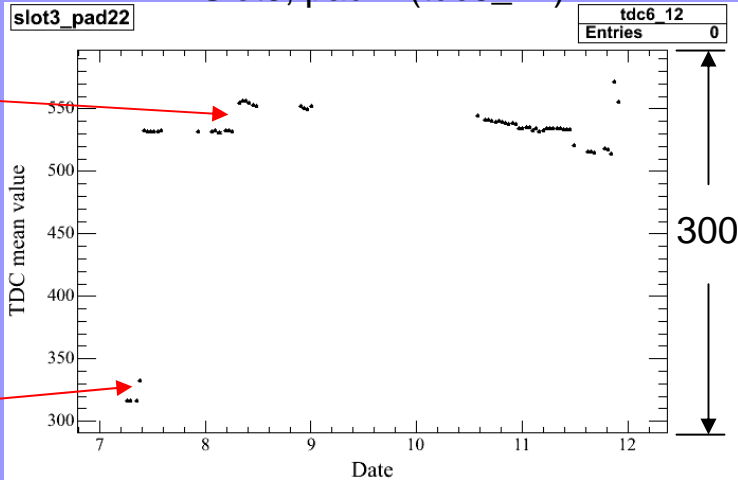
Slot6, pad27(tdc9_7)



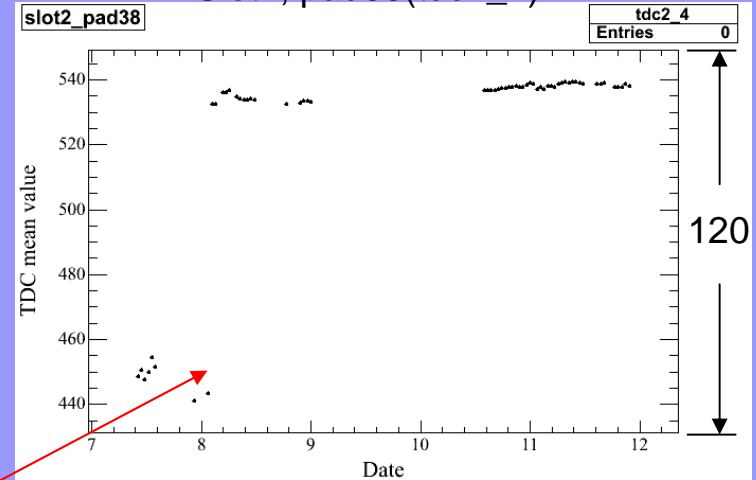
Slot5, pad27(tdc8_7)



Slot3, pad22(tdc6_12)



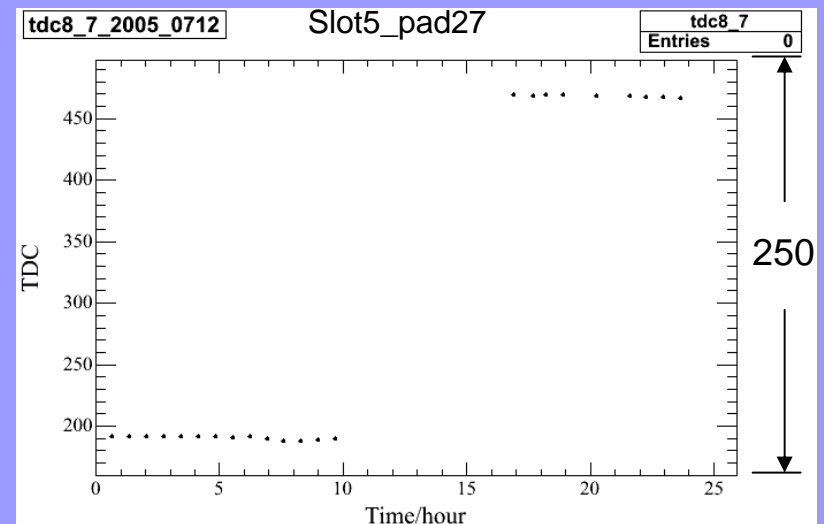
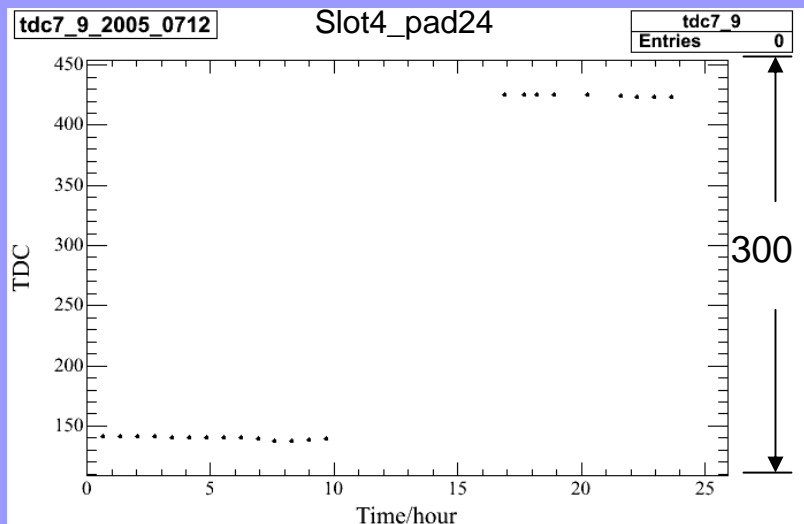
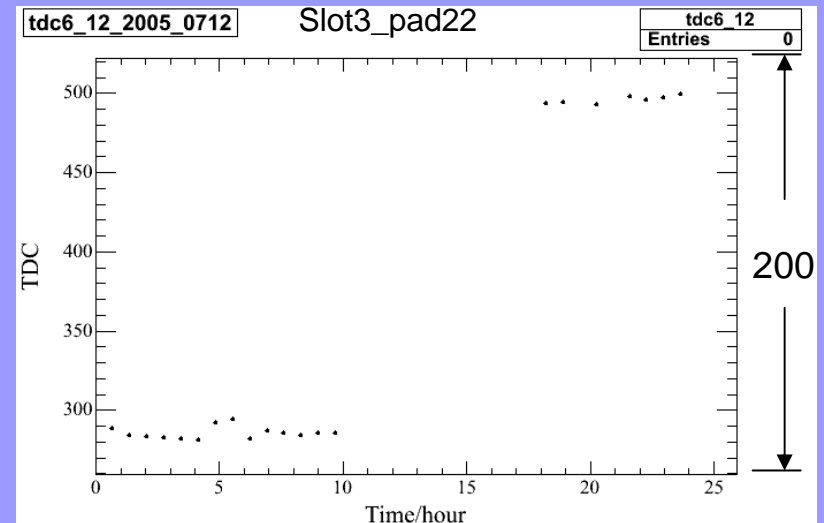
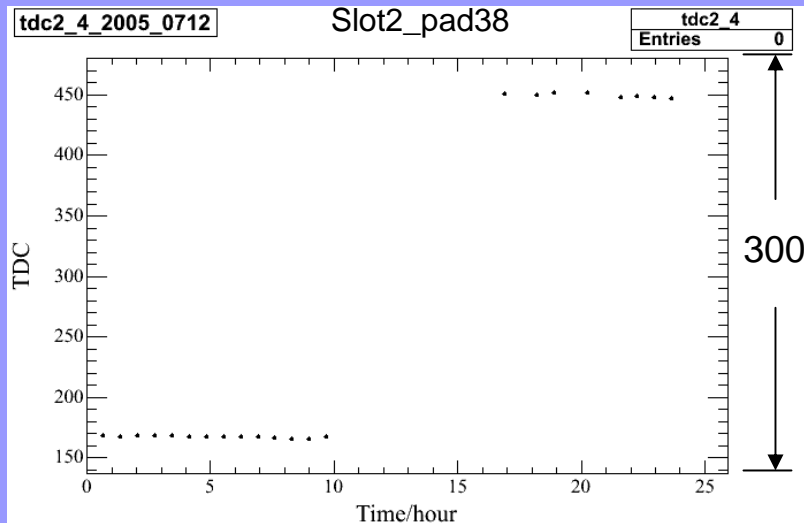
Slot2, pad38(tdc2_4)



what happened at these jumps?

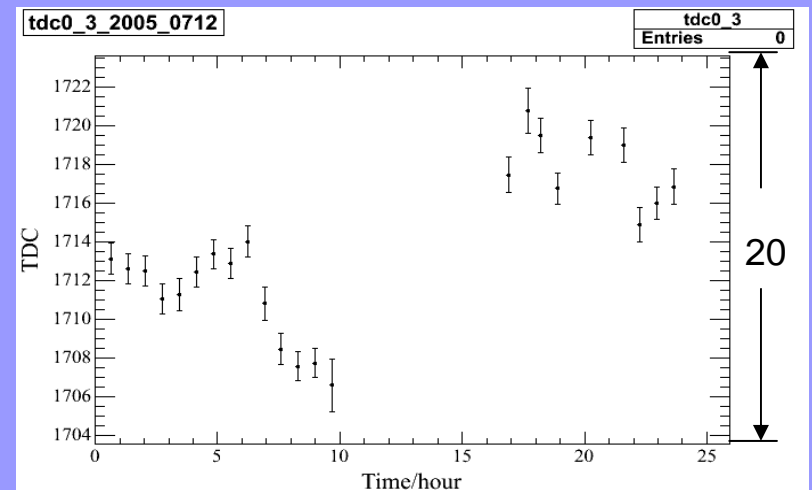
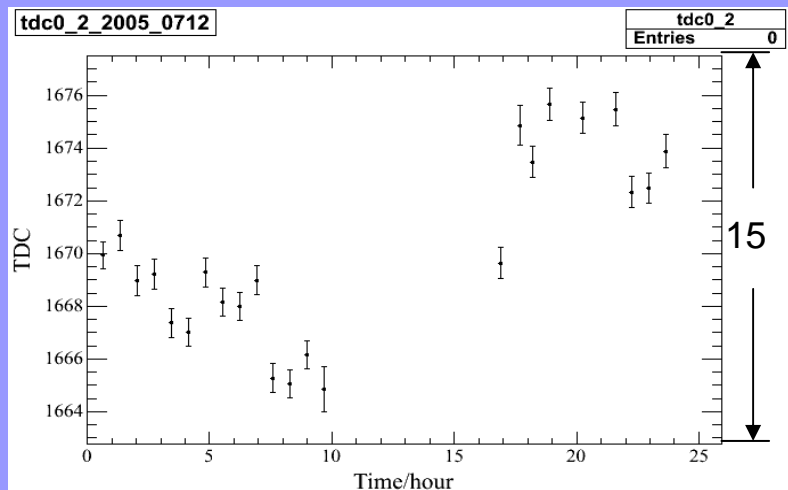
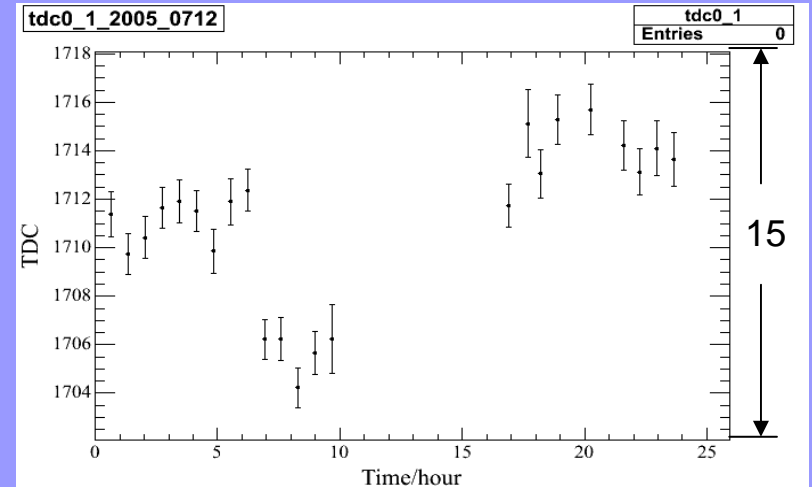
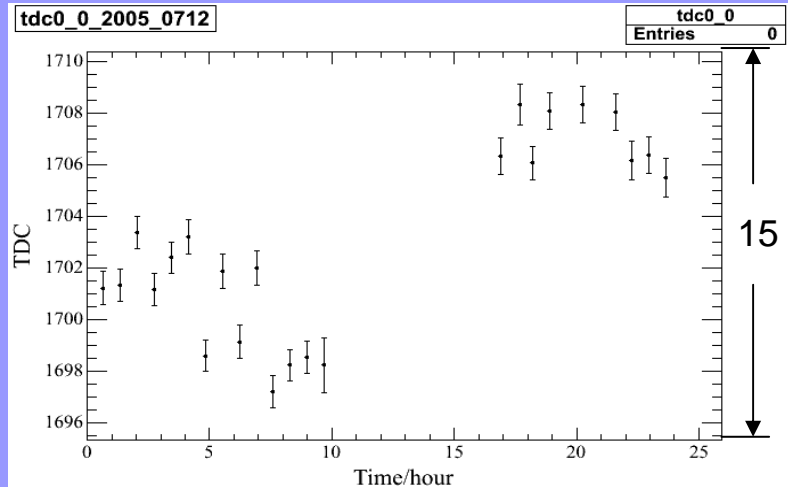
08/02

Check the data on 2005/07/12, jumps occur at all slots



Elogbook: 2005-07-12 18:23:50 INFO juhe Debugging of the prototype electronics and the monitoring software during runs: testrun_20050712_1653_1000000.dat testrun_20050712_1655_1000000.dat testrun_20050712_1742_1000000.dat. 2005-07-12 18:26:29 INFO jjv Restart the system with Josef and Jose.

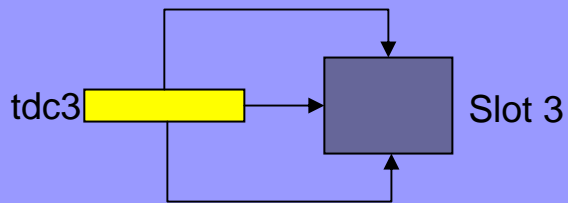
Check the data on 2005/07/12, Start Counter 1 no obvious jumps



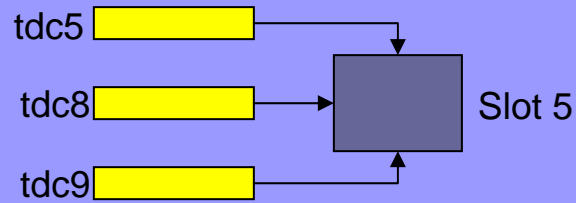
Reasons that caused the jumps can be found in testbeam elogbook.

We 've seen the different behaviors, now I'd like to check out if there are common behaviors among certain channels, if so, then the question is: are they slot dependent or TDC dependent or else?

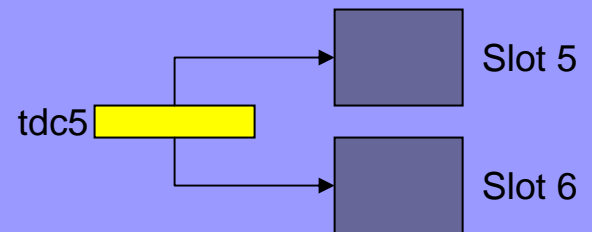
Same tdc in one slot



Different tdc, same slot



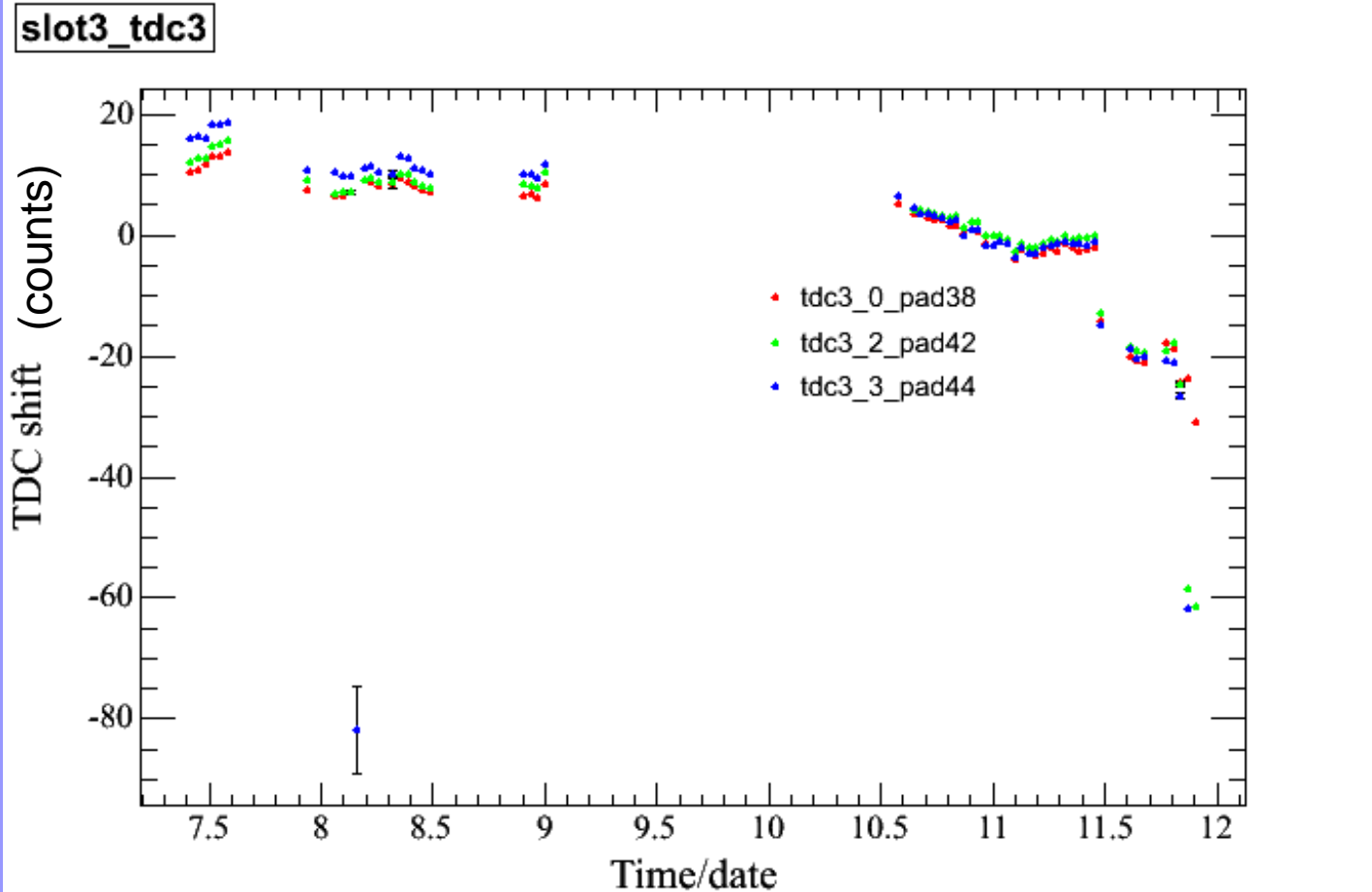
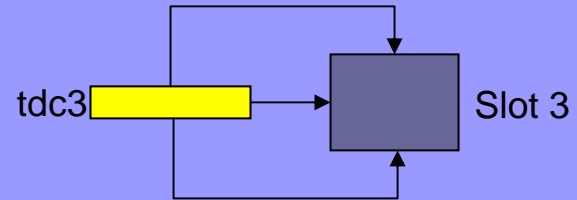
Same tdc in different slots



In order to compare, do the adjustment:

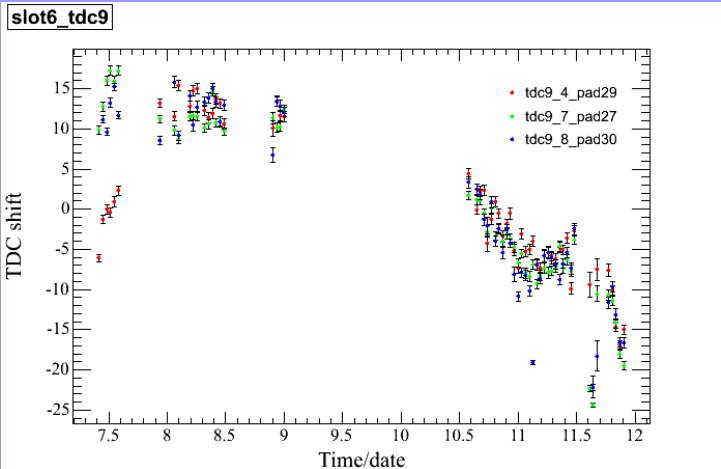
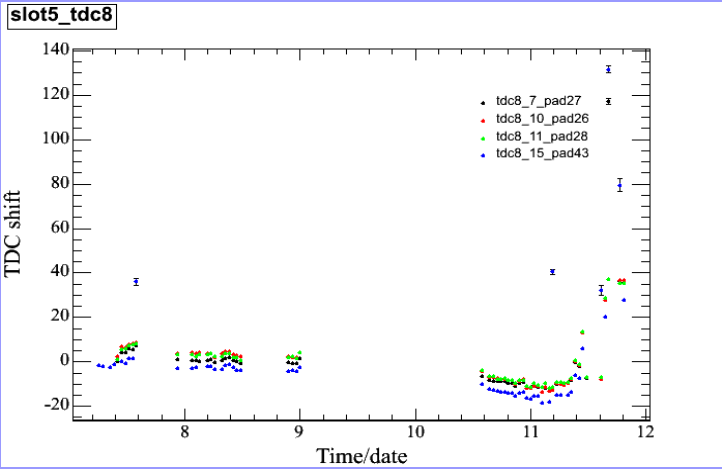
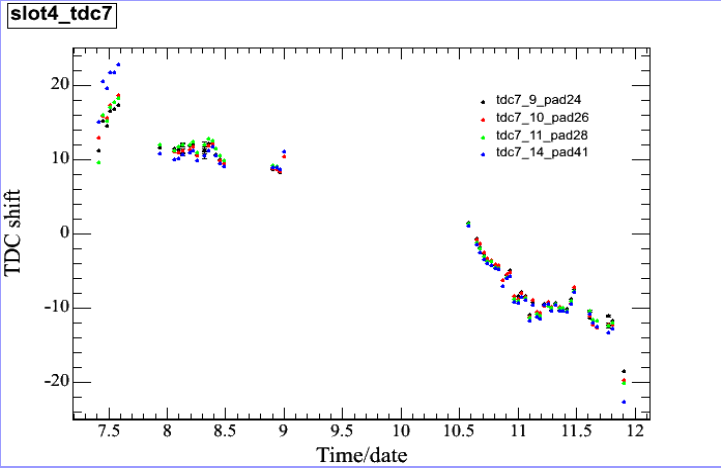
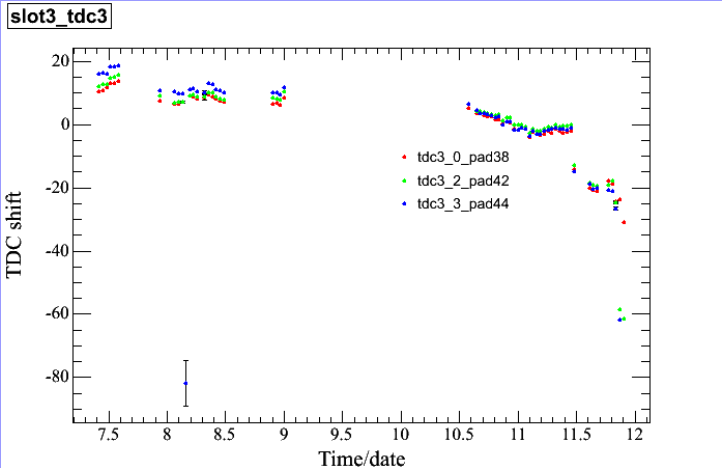
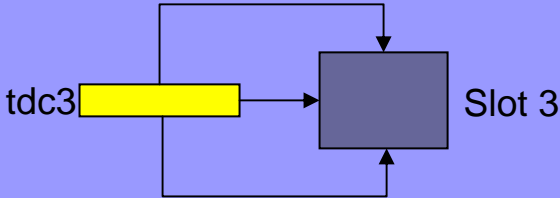
Instead of tdc mean value, take the tdc shift : $\text{tdc mean} - \text{average of tdc mean}$

tdc3 in slot3



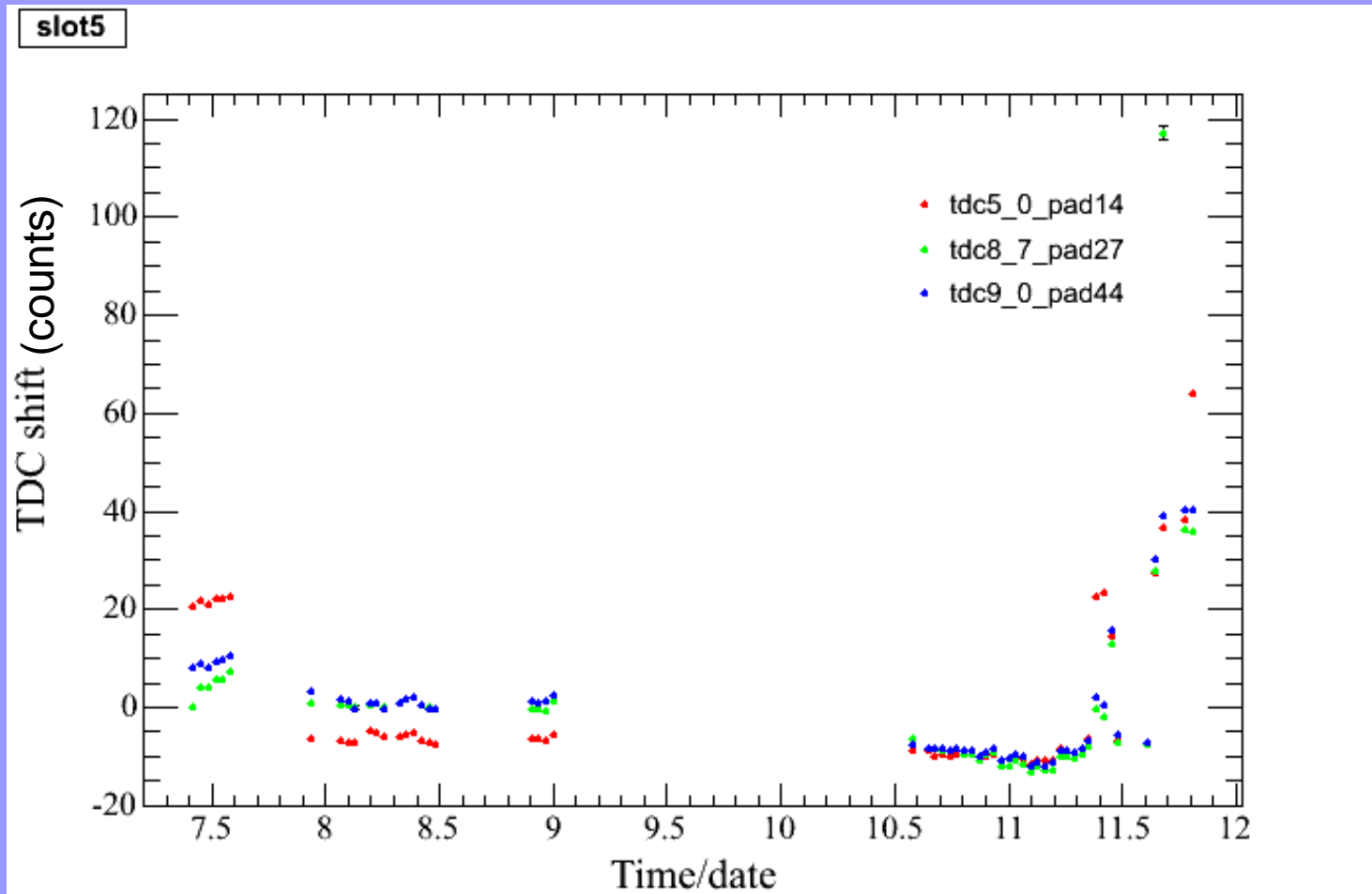
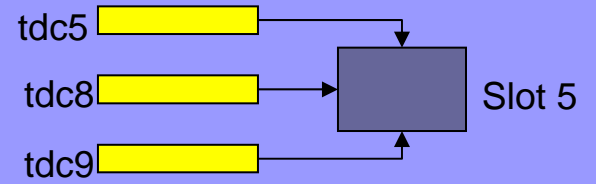
Act quite the same

Some other slots



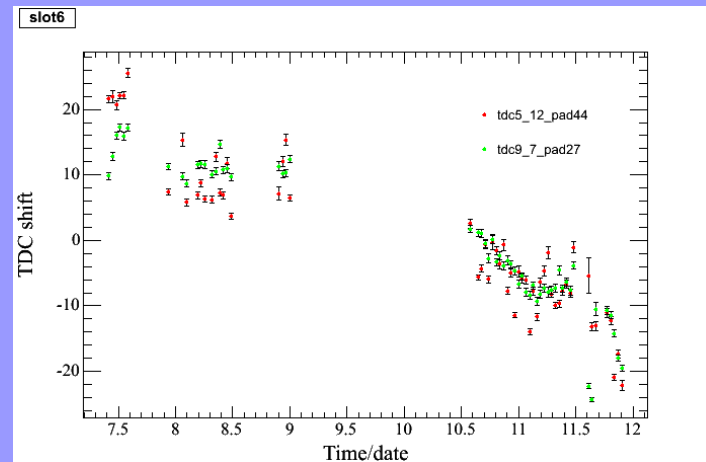
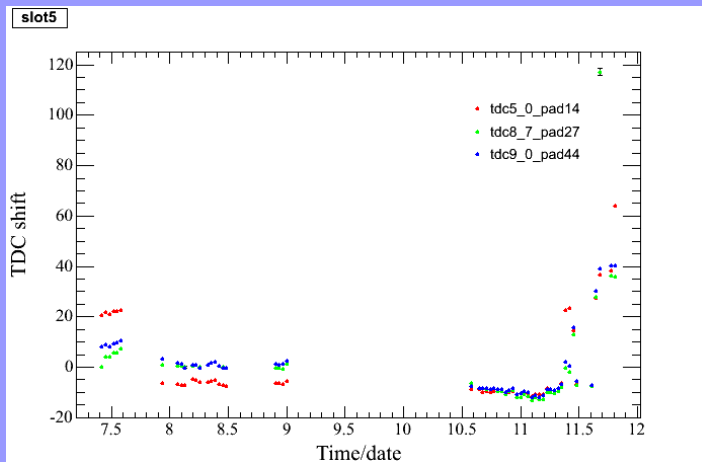
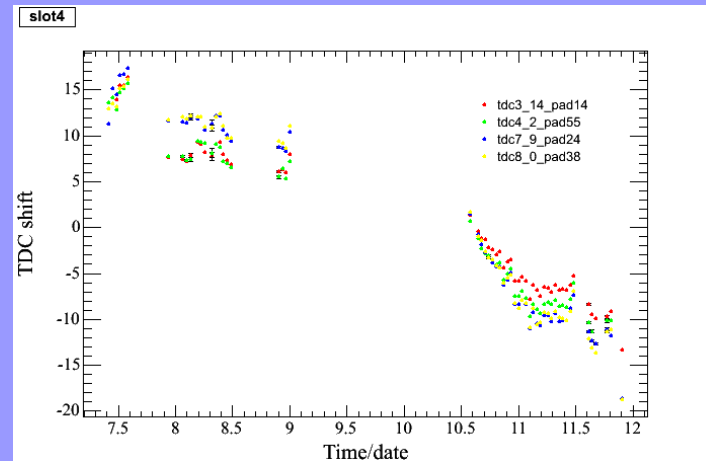
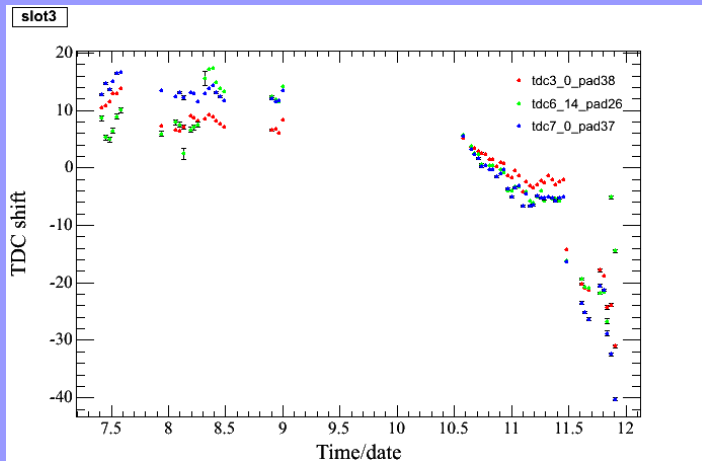
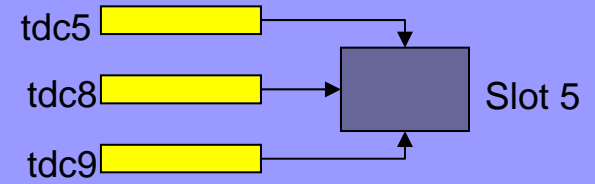
variation < 10

tdc5,tdc8 and tdc9 in slot5



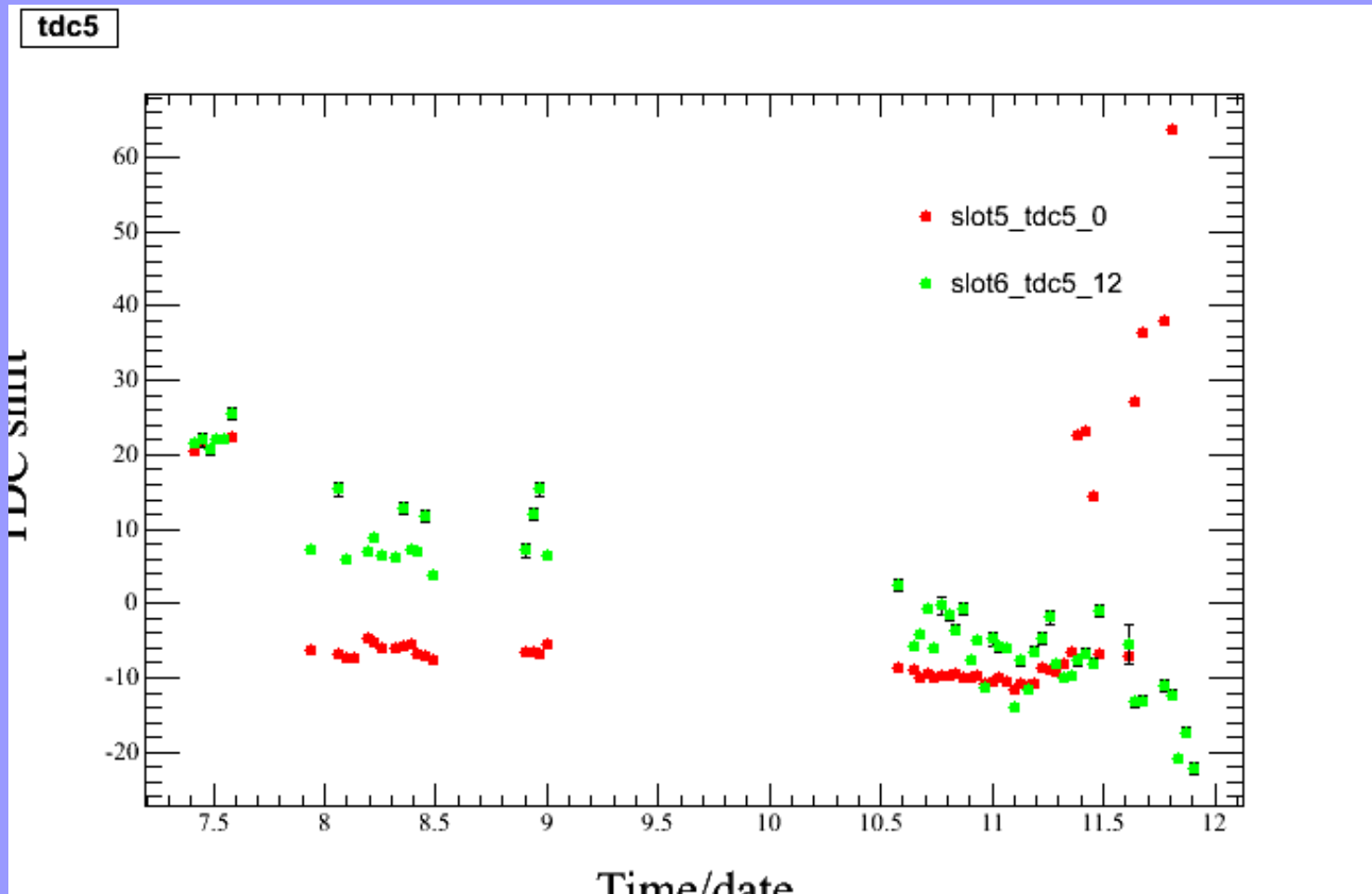
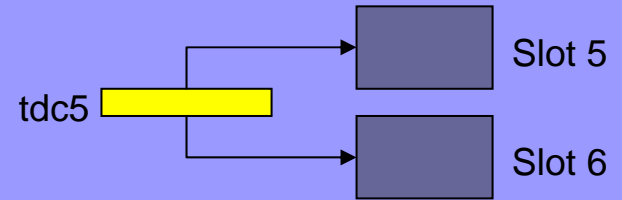
Have similar shapes

Some other Slots



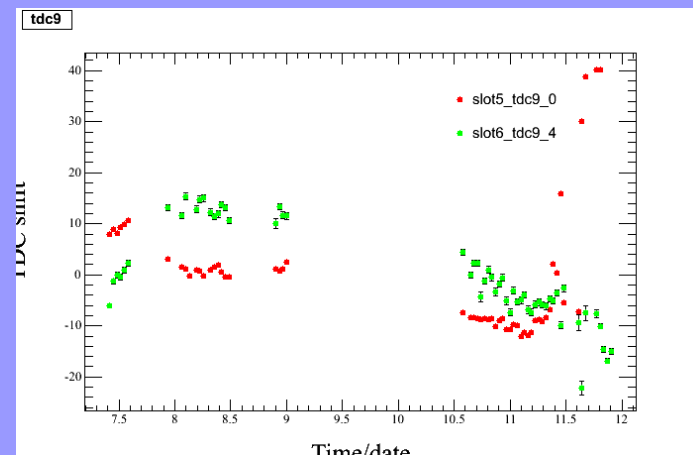
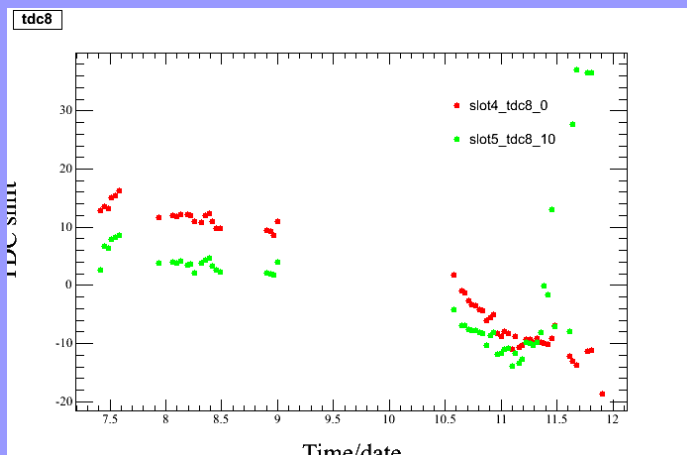
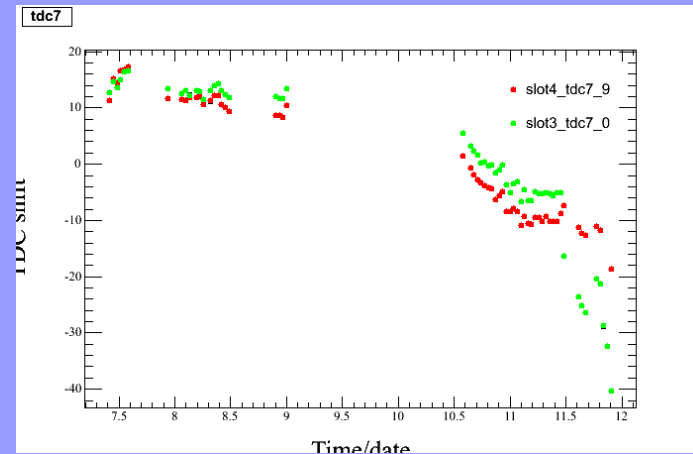
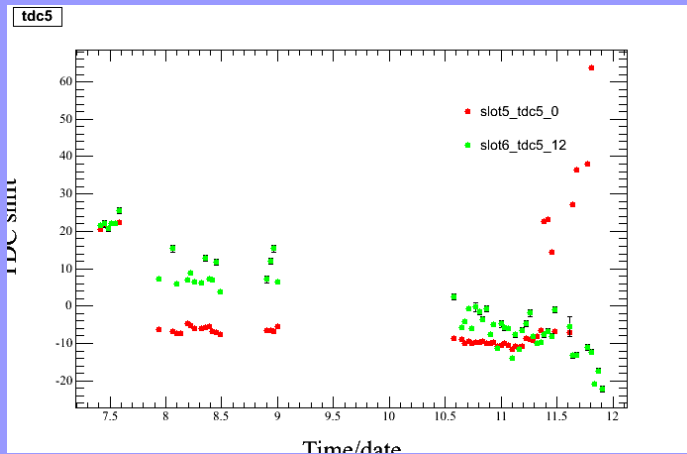
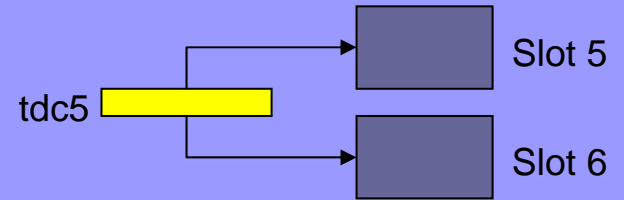
variation < 20

tdc5 in slot5 and slot6



Big difference between slots

Same TDC in different Slots



Large differences between slots

Conclusion

- Generally, TDC mean values vary periodically ($T=1$ day, 200ps shift), probably due to temperature variation.
- TDC mean values are quite stable in a week time scale, but not so over months.
- TDC channels inside each slot tend to behave similarly.
- TDC channels act differently between different slots. So they are much more slot dependent.
- Start counters are not well correlated to prototype slots at first glance. Further study needed.
- To do: study the time stability and corrections to prototype pads in the *beam test data*.