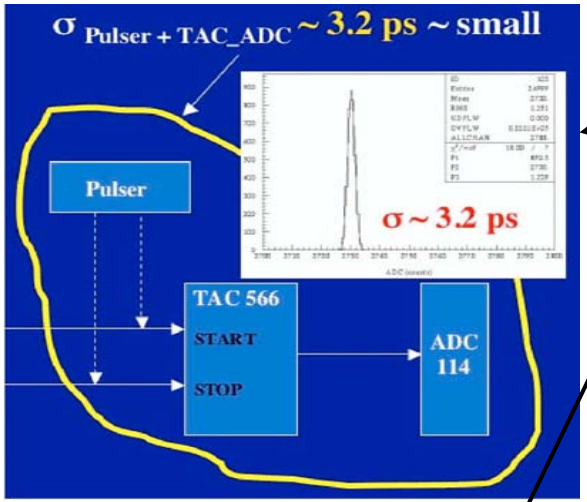
Calibration of time of propagation measurements of Focusing DIRC using a new pulser

Matthieu Bethermin

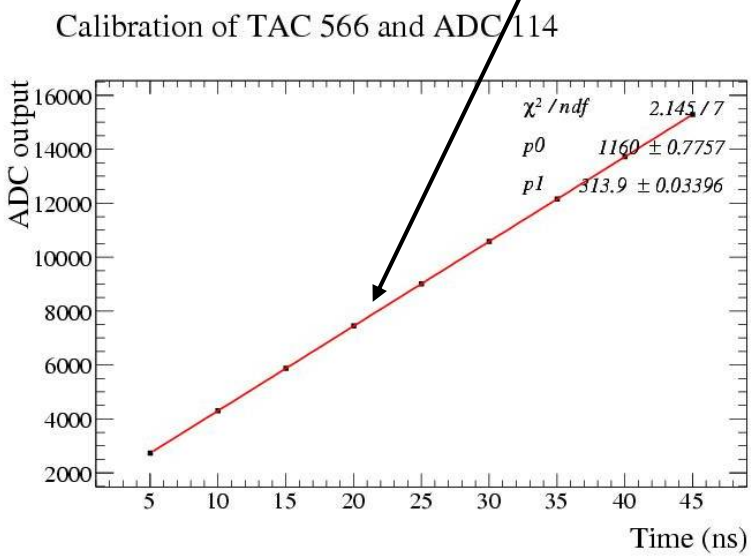
Presentation of the pulser

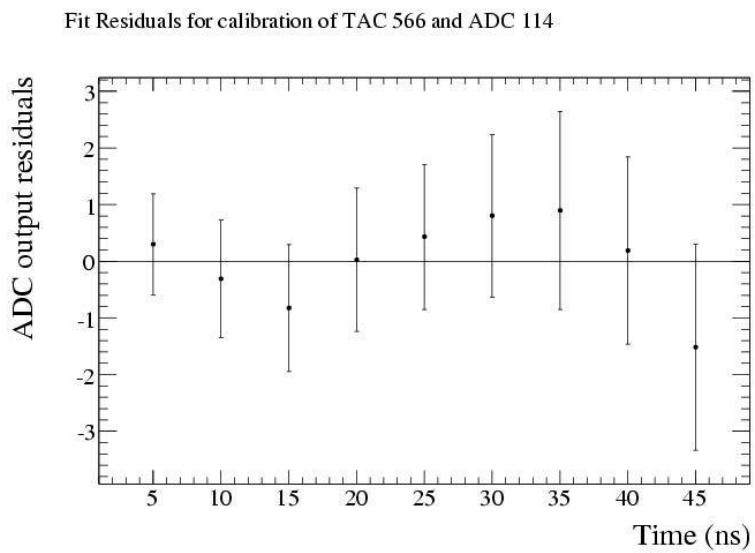
- For this calibration, we use a pulser, which sends a start and a stop signal randomly delayed by a multiple of 5ns between 5ns and 100 ns. The pulser delay of 5 ns known to a few ps - this variation is neglected in this analysis (calibrated by the manufacturer using an ORTEC 9308 TAC system).
- Consequently, if a TDC is connected to this pulser, the histogram of different TDC values will contain up to 20 peaks separated by 5ns.

Test of a linearity of TAC 566 & ADC 114, used in the TOF counter



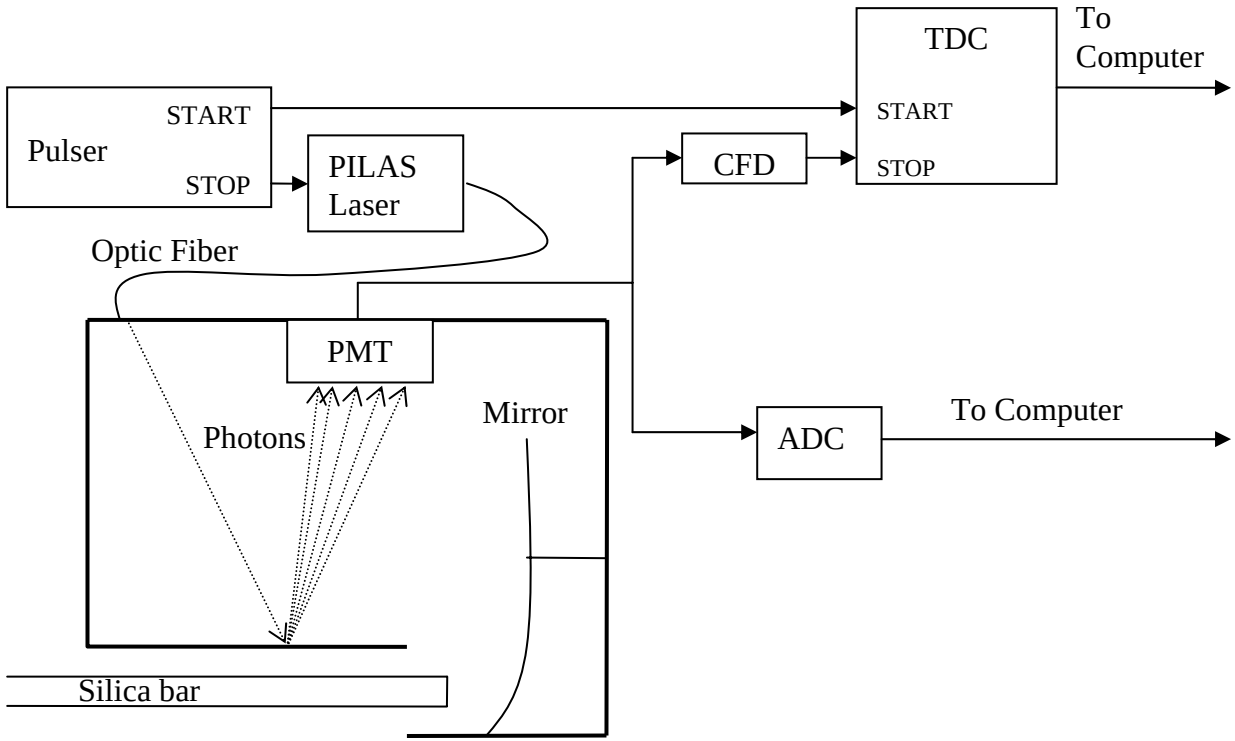
- Verify Jerry's TOF counter lab results
- The time between the peaks is very steady (maximum error of about 3 ps).
- So, the pulser can be use as a time reference of time for the calibration of the prototype.





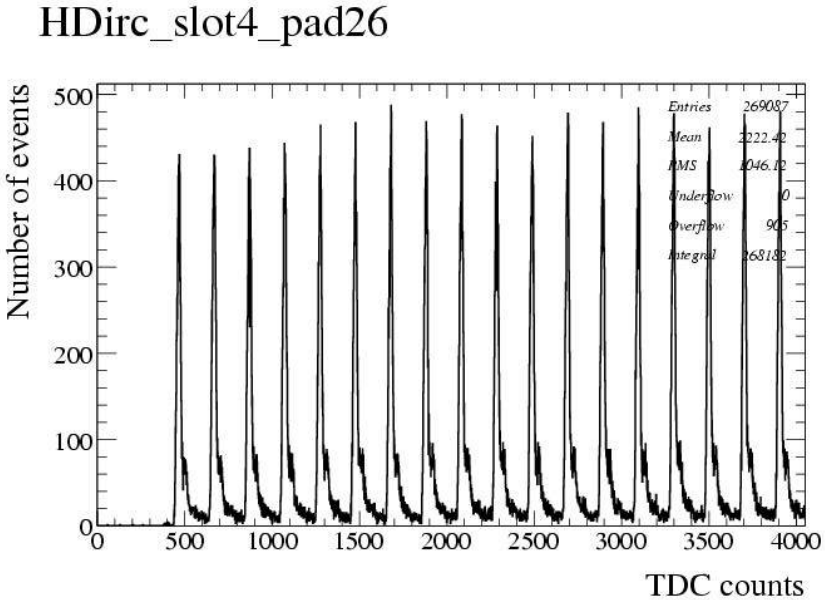
Principle of the PiLas calibration in the Focusing DIRC prototype

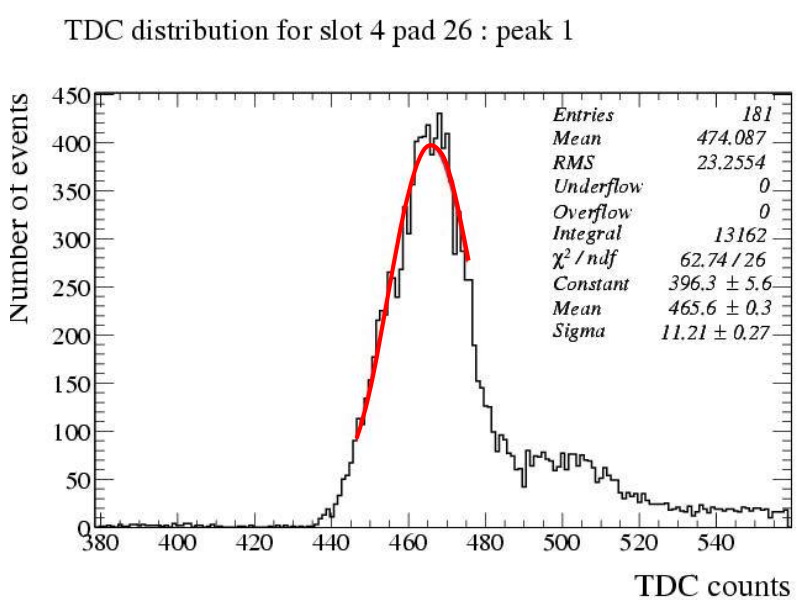
- The start signal of the pulser go directly in the TDC.
- The stop signal of the pulser trigger the PILAS. The photon generated by the PILAS hit the PMT. The electronic of the prototype detects this photon and stop the TDC.
- There is only one channel represented on the picture. In fact, there is about 160 pads connected to 12 16-channel-TDC.



Distribution of TDC values during a pulser calibration

Example: pad 26 of slot 4:

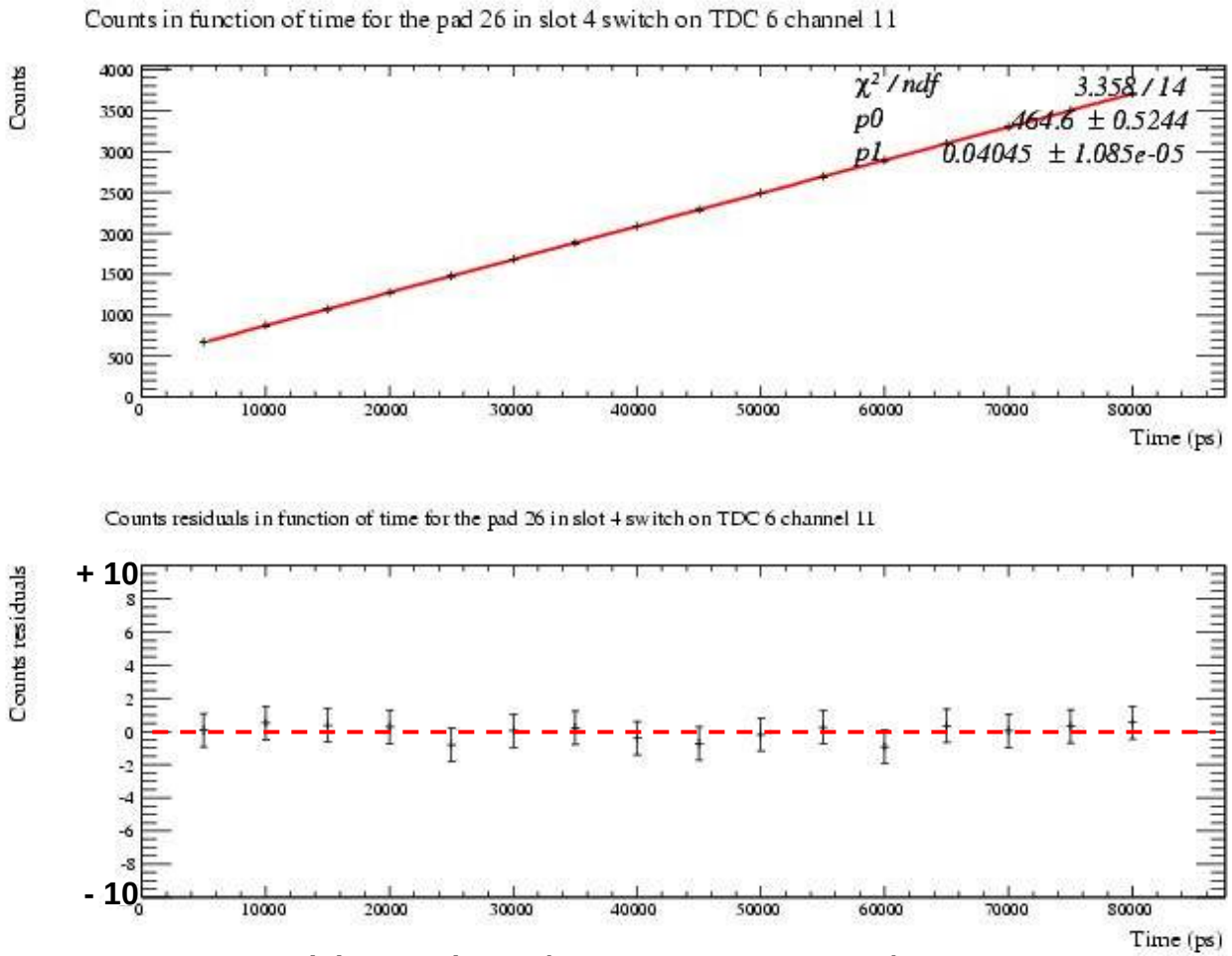




- The distribution of the TDC values for one pad has up to 20 peaks.
- The peak position is determined with gaussian fit in a range of 2 sigma on the left and 1 sigma on the right (the sigma and the center is determined by a prefit). This task is made automatically by a program.
- Each peaks correspond to a delay (5ns, 10ns, 15ns…). So, we have a list of TDC values in function of the time delay.

Determination of ps/counts

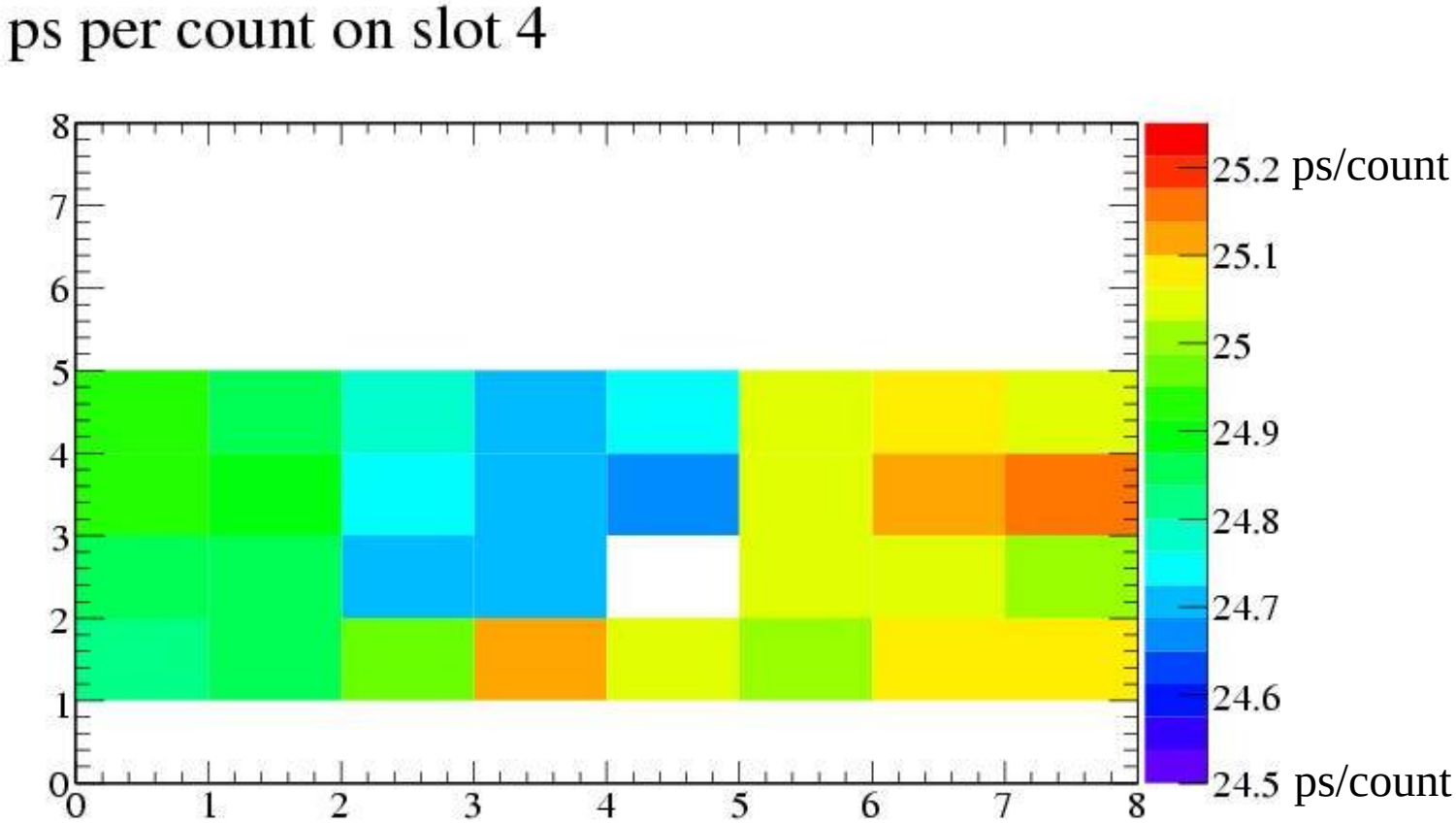
Example: pad 26 of slot 4:



On this pad: ps/count = 24.72 +/- 0.01

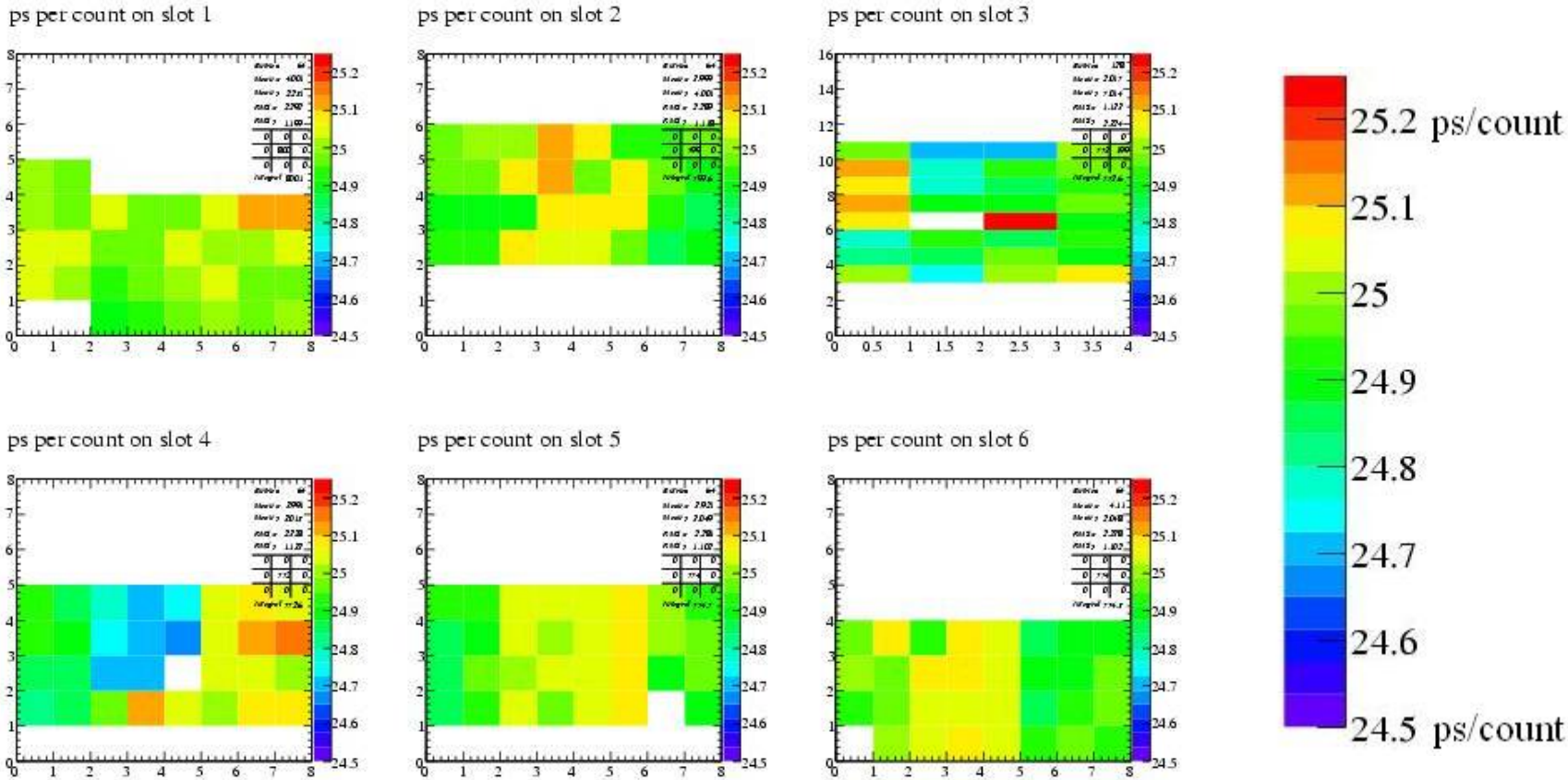
- The delay between two peaks position is exactly 5ns.
- So, it's possible to extract the number of ps per TDC count with a linear fit.
- The low residuals tends to indicates there is no significant variation of ps/count value in function of TDC value.
- So, the pulser calibration have proved that time-TDC counts relation is linear.

ps per count value for the slot 4



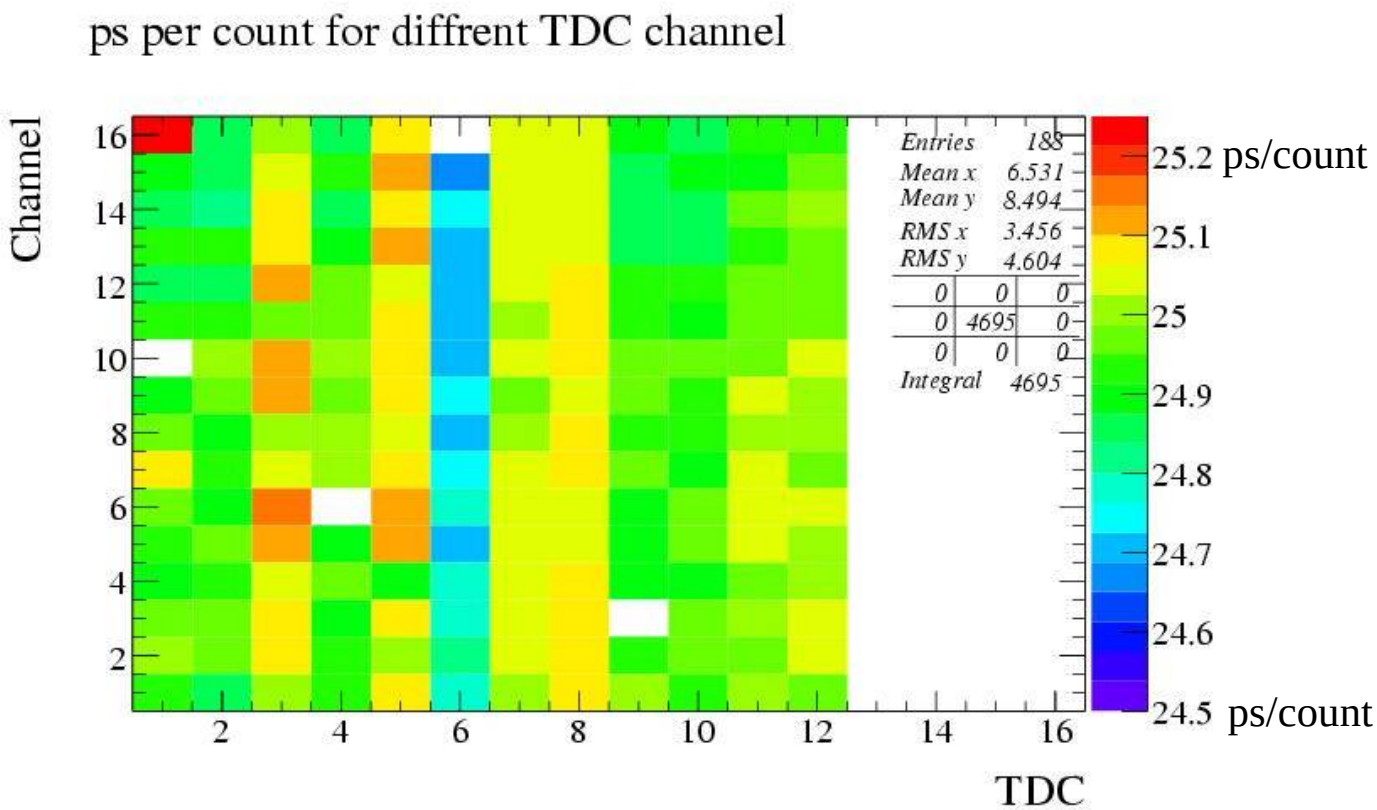
- On the current analysis software, the ps per count value is 25 for all pads.
- In fact, this value is different for each pad (between 24.7 and 25.2 on slot 4).

ps per count for all slots



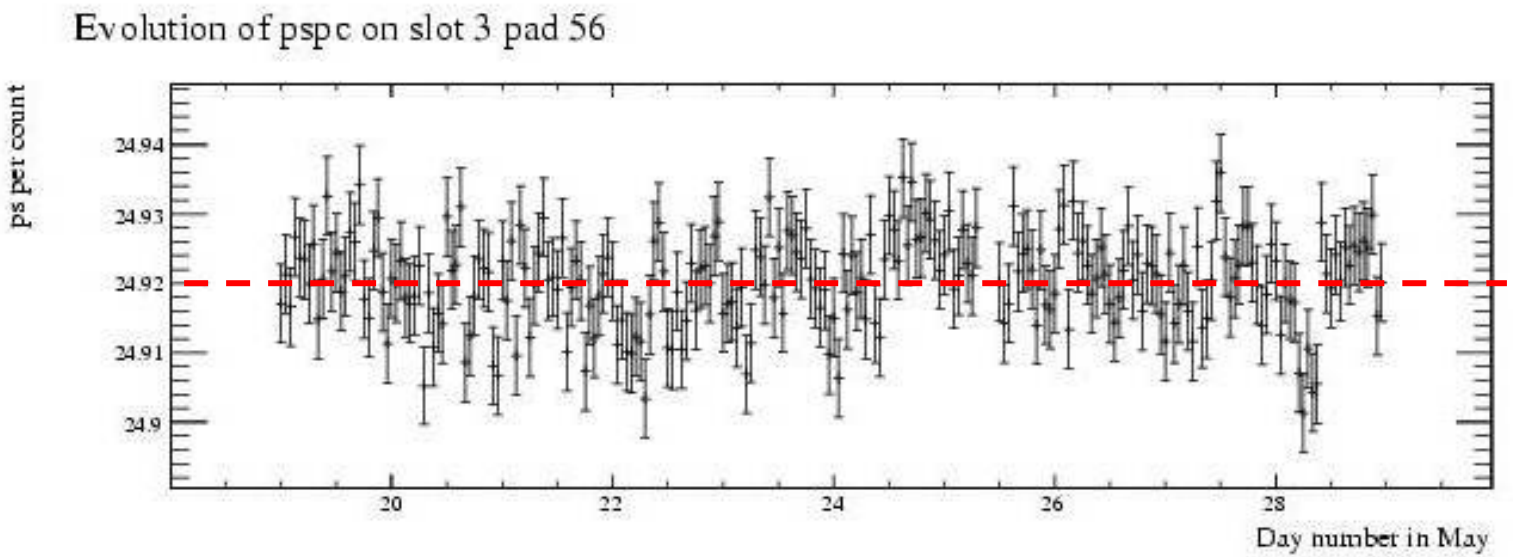
- Some slots have the same ps/count value for all pads (1,2,4,5) and on some slot the difference between pads are very high (3,4). Sometimes, two neighbor pads have a difference of more than 0.5 ps/counts => this type of analysis is very important.

Comparing ps per counts for different TDC.



- This graph reveals that each TDC have a different speed.
- There is fast TDC (yellow) and slow TDC (blue). In each TDC, there are difference between the channels.
- The TDC1 Channel 1 have a very high speed (26.03 ps/counts), but the peaks and the fits looks correct.

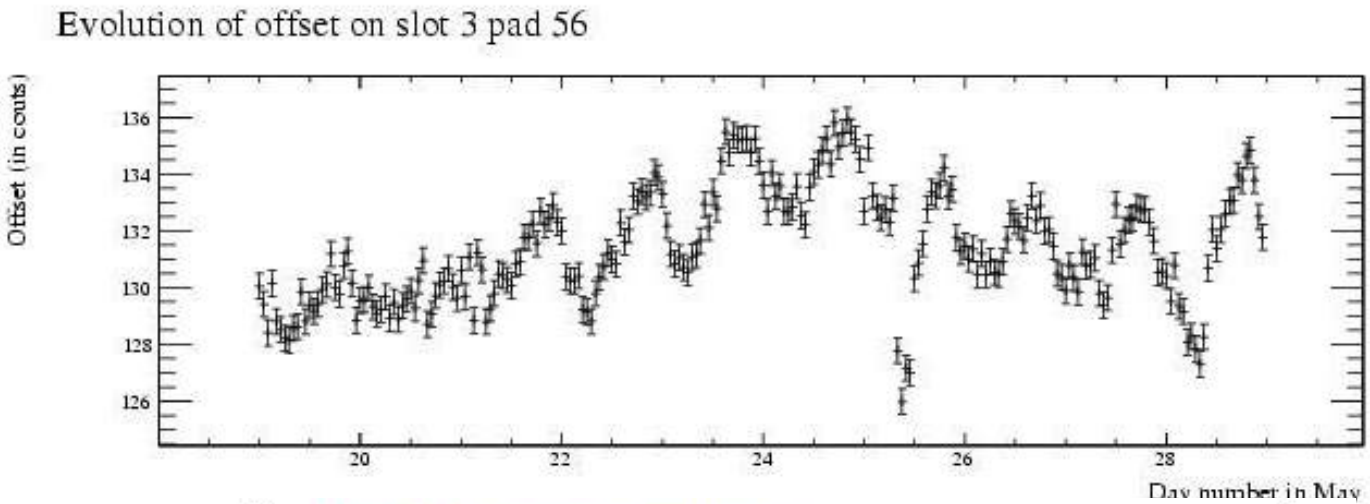
Evolution of ps per counts



- The slope of the fit looks very steady. The maximal fluctuation are 0.01 ps/count. So, it's implied an error of 20 ps after 2000 counts.
- So, it's not useful to calibrate it often.
- A data base of ps/count value was generated for the next beam test.

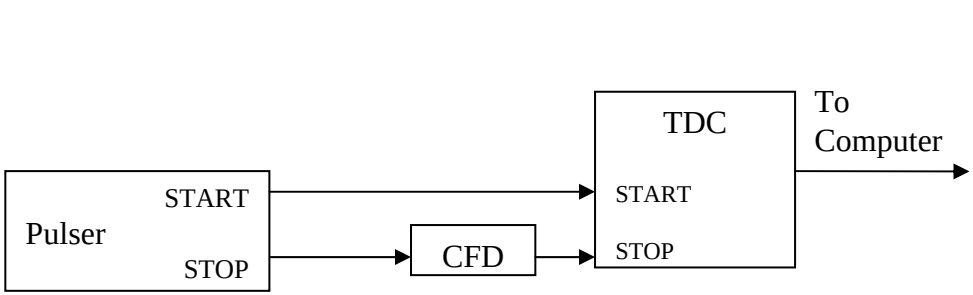
Evolution of offset

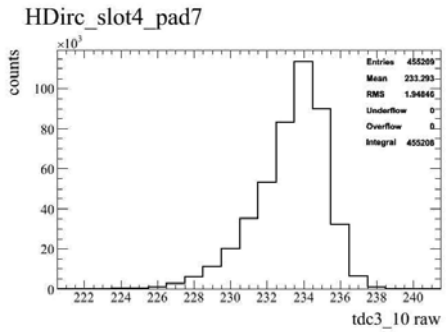
- The offset of the linear fit is not so steady. There is about 10 counts of fluctuations. So, it's implied an error of 250 ps. This offset seems to be correlated with temperature.



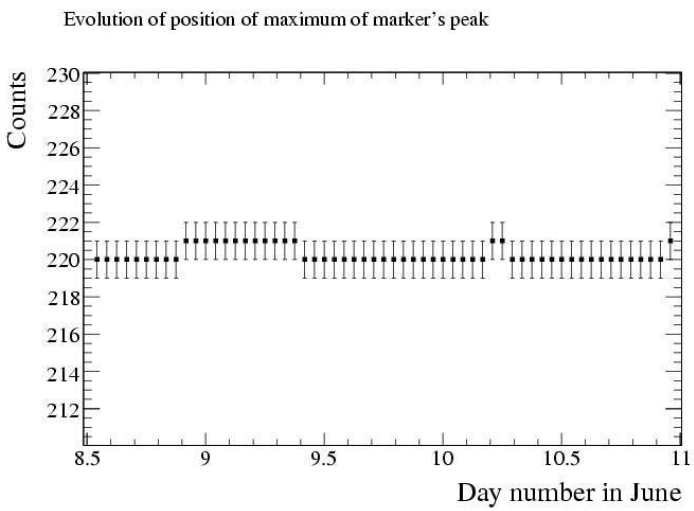
- The previous attempt of calibration using only one peak and delay cable have probably failed because of this drift…
- On the pulser calibration, this drift implies wider peaks, so it's reduce a little the precision of peaks position determination. Nevertheless, the results stay very good, because ps/counts is calculated with peaks coming from the same run (same drift for all peaks).

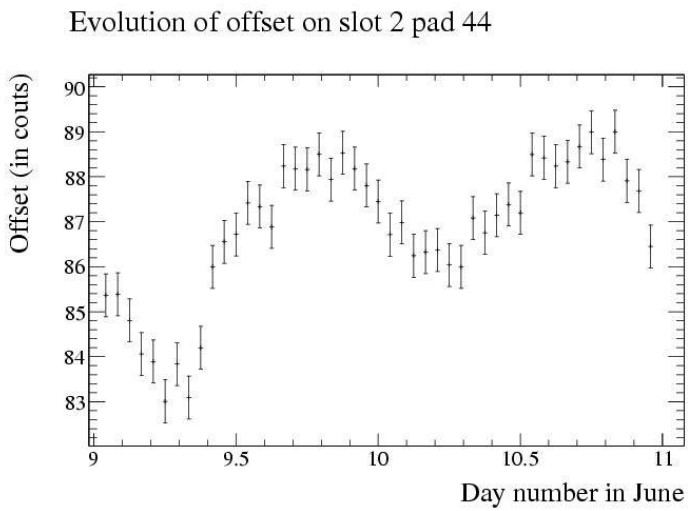
Test of CFD&TDC stability



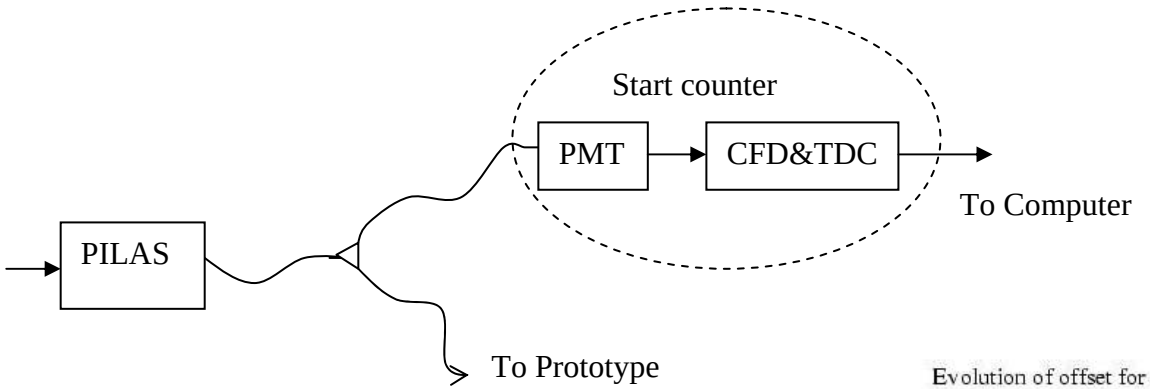


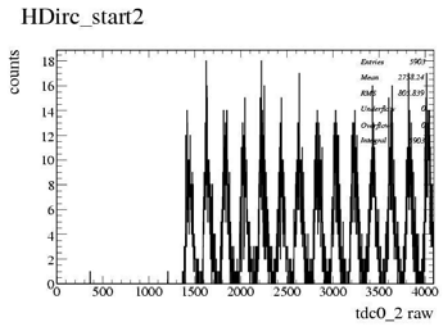
- In order to test the stability of CFD&TDC, the CFD was directly connected to the stop output of the pulser.
- The “marker” position is very steady. So, the offset variation are not due to electronics, which includes “the pulser, CFD and TDC”.



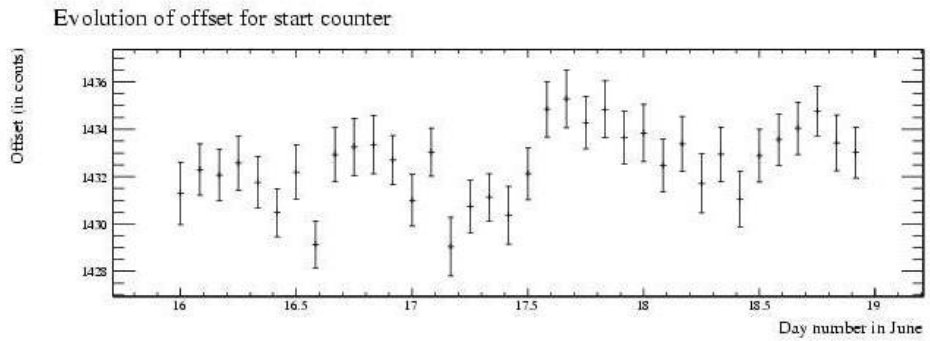


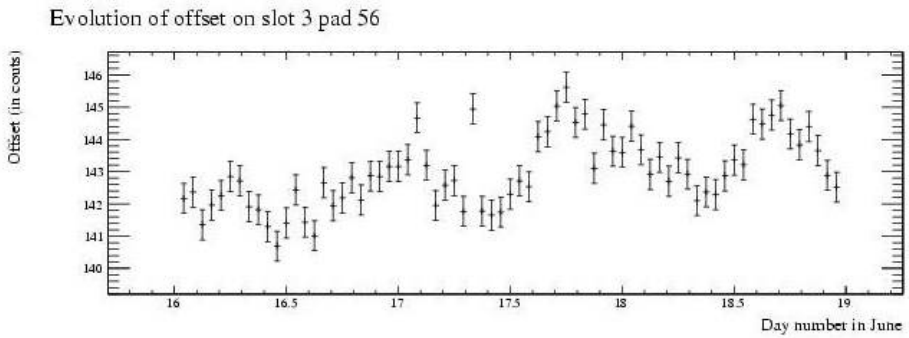
Start counter evolution





- The start counter have the same type of offset variation than the pads.
- So, this offset variation is probably due to the PILAS laser used for the calibration.
- In fact, the PiLas manufacturer confirms that the laser head and the electronics may have to be temperature stabilized.





Conclusion

- With a new pulser calibration, we know with a high precision the coefficient what linnks TDC counts and TOP.
- In the previous beam test, the analysis was done with 25 ps/count for all pads. Now, we have a value between 24.6 and 26 for each pad. It will improve significantly the TOP measurement.
- The stability of this calibration was check during 2 months. The variation are more little than 0.02 ps/counts.
- A delay of the PiLas due to temperature was detected. This delay may explain the problems during the previous attempt of calibration.