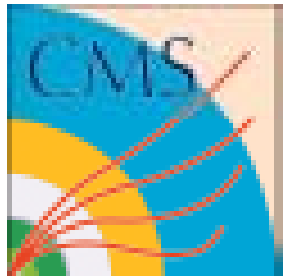


Overview Laser Monitoring on TB 2006

ETBW07, Rome

Adi Bornheim

California Institute of Technology

March 28, 2007

Outline

- Monitoring Data from Test Beam 2006
- Online Data Processing
- Monitoring Stability
- Outlook for CMS

- News on Irradiation Studies (Toyoko)

Laser Data for 2006 Test Beam

➢H4 :

About 1600 laser runs haven been taken on the test beam modules at H4.

This corresponds to ~12 hours of data taking at CMS.

All laser runs have been processed quasi-online by a CMSSW job and a set of ROOT scripts, mostly for making plots.

➢H2 :

About 600 laser runs have been taken on H2.

This corresponds to another ~4 hours of data taking at CMS.

Laser runs have been reprocessed for most runs and processed quasi-online for the π^0 running.

➢Cosmic :

Many laser runs have been taken, but mostly not studied in detail for transparency changes.

Most of the pulse width scans have been taken on the Cosmic stand.

Quasi Online Laser Data Processing at H4

- Each individual laser run data is written to a separate file by the DAQ.
- The online laser processing runs a CMSSW job on this file to fit the pulse shape, reconstruct the amplitude for APDs and PNs with a fit method and stores all values in a ROOT tree and a set of histograms.
- A separate ROOT script extract mean values for the relevant quantities like APD, PN and APD/PN ratios. Mean extraction is mainly done by fitting gauss functions.
- Yet another ROOT script generates plots and produces a web page.
- The task is controlled by scripts from the H4 DQM crew.
- The output of this stage are uncorrected (”raw”) APD/PN ratios.

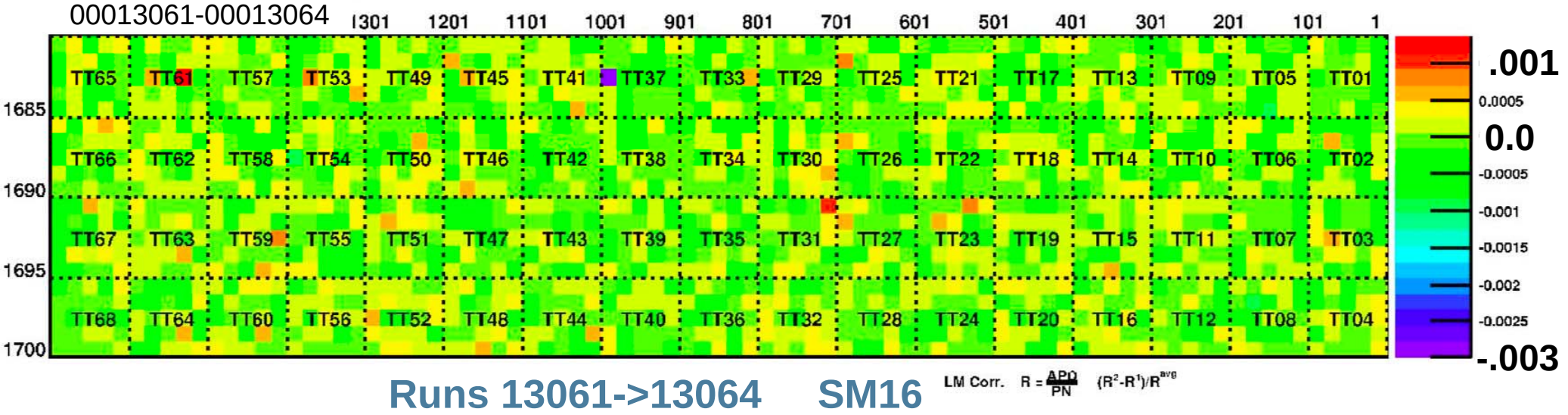
Details : See Chris Rogans talk on 08/31/06

This schema will now be used as a starting point for the implementation of the laser farm for CMS.

Quasi-Online Monitoring Plots

Comparison plots between consecutive runs for the APD/PN and APD values are used to monitor short term stability and inter-run changes

For example, this plot shows the relative difference in the APD/PN values, for each channel, between two consecutive runs. Almost all channels are stable to within .5 per mille



Runs 13061->13064 SM16

These plots have a certain appeal – but proved to be not very powerful in the TB.

We have to think about a good way to visualize 80000 xtals.

Master Analysis at H4

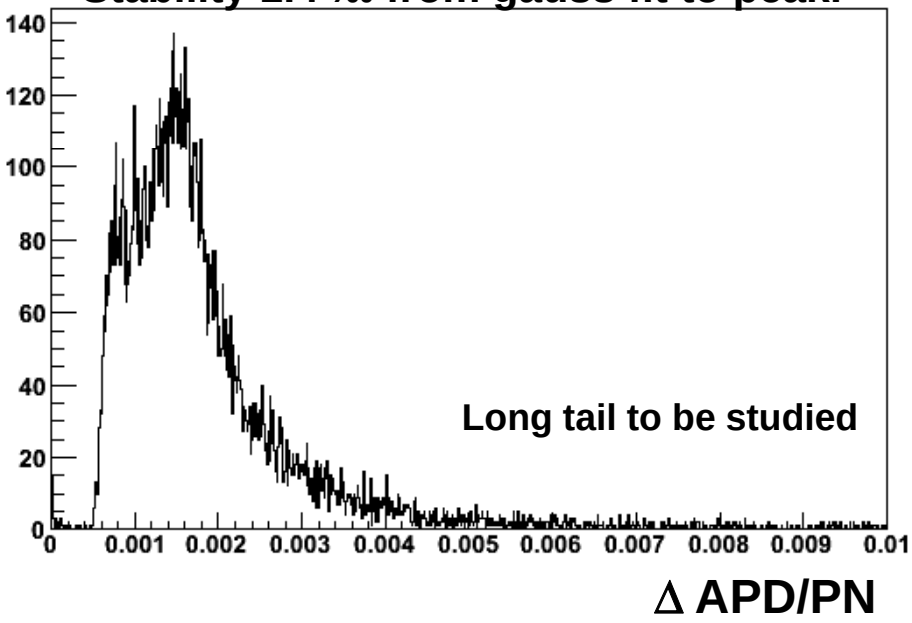
- **Once a certain number of laser runs has been analysed as described before, a higher level analysis is being performed.**
- **The output of the first stage is read in and history plots, mean values for run ranges etc. are generated.**
- **Additional information is retrieved from external sources : Temperatures, Pulse Width information, DAQ into, etc.**
- **At this stage corrections can be derived or applied.**
- **The output of this stage is stored in a ROOT file.**
- **With our current understanding of the systematics : The output of this stage has optimal stability (<0.1%) for some modules and acceptable stability ~0.2% for all modules.** **Note SQRT((0.6%)^2+(0.2%)^2) = 0.63 !**

The transfer to the online data base has been tested using a standalone script. Which tasks writes which information into the online data base has to be optimized.

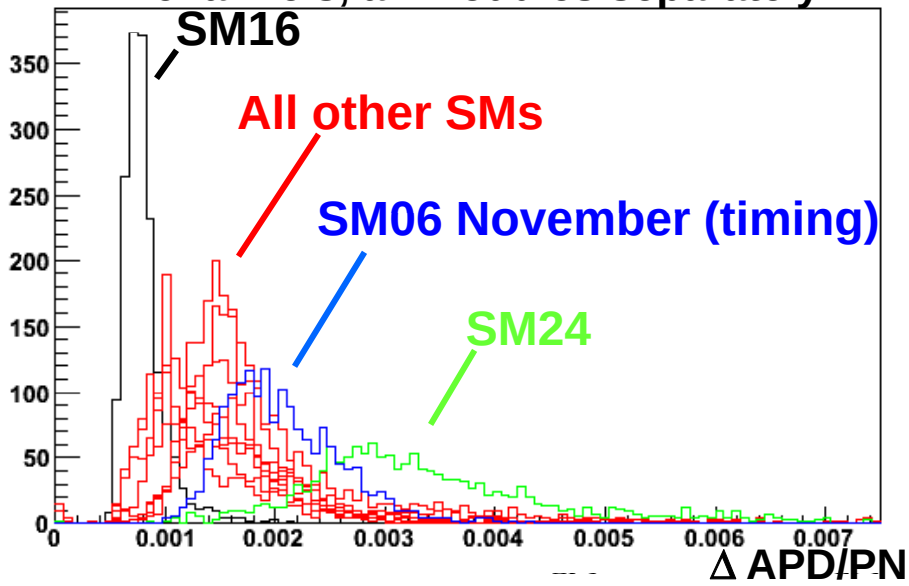
Raw Monitoring Stability at H4

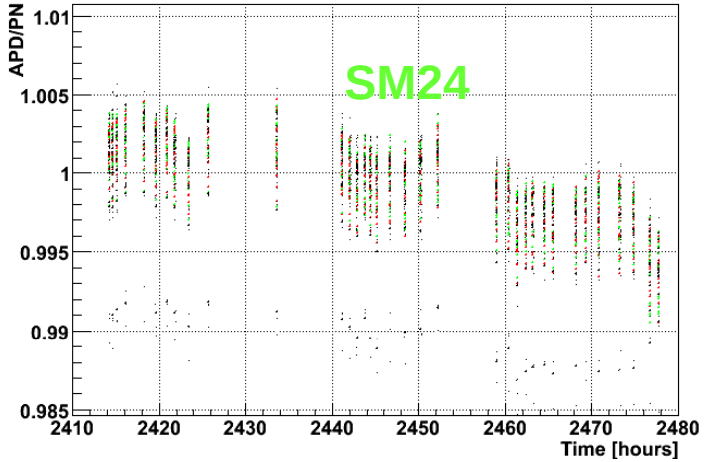
Stability : Get APD/PN ratios for each channel, each SM. Normalize average APD/PN to 1 for each SM. Fit gauss to normalized APD/PN for each channel on each module. The sigma of these fits is the stability.

All channels, all modules :
Stability 1.4 ‰ from gauss fit to peak.



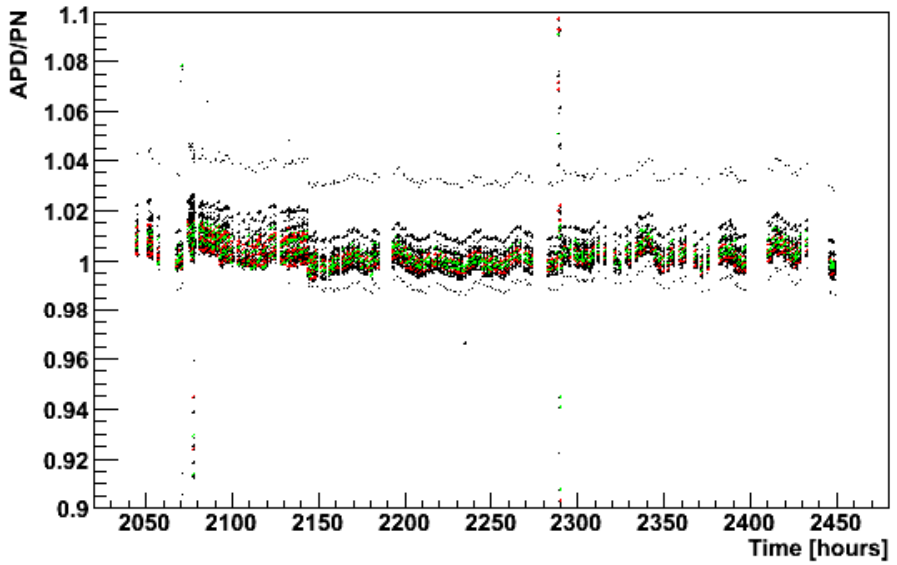
All channels, all modules separately:





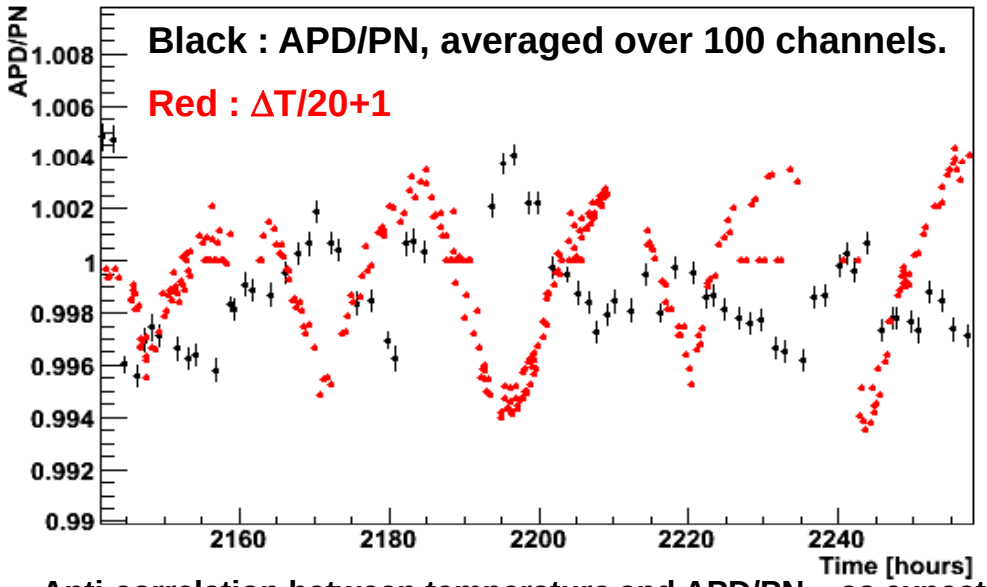
Overall stability good, even at this basic level without any further corrections.

Raw Monitoring Stability at H2



APD/PN vs. Time, 100 Channels (1040 – 1140, center Module 3).

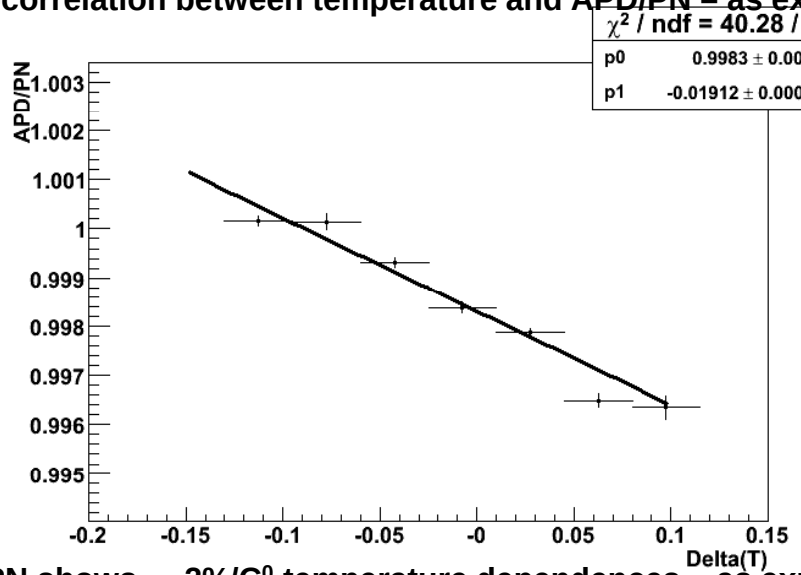
Hardware intervention around t=2150 h, stability reasonable.



Anti-correlation between temperature and APD/PN – as expected.

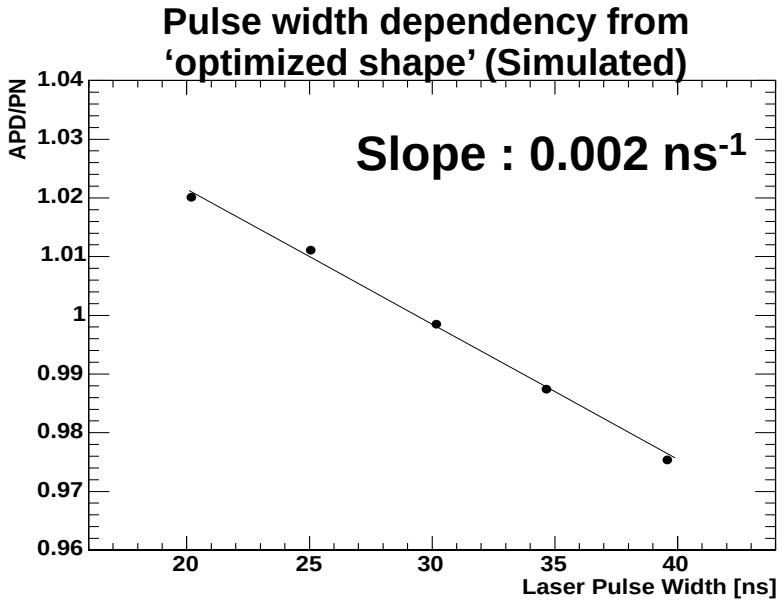
Temperature correction based on thermistors !

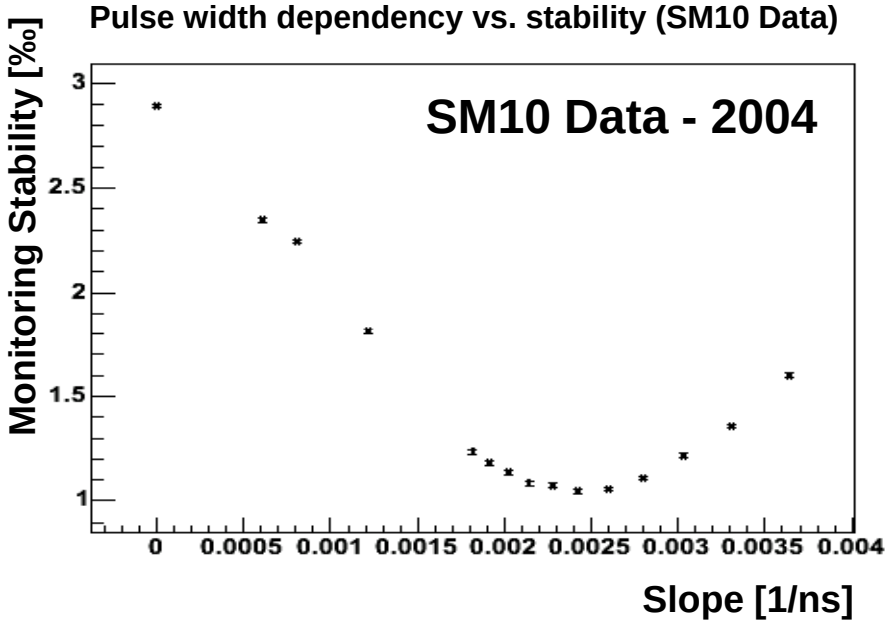
No significant transparency changes (~ 1%) have been observed. Given the limited precision of the H2 inter-calibration no detailed investigation was carried out.

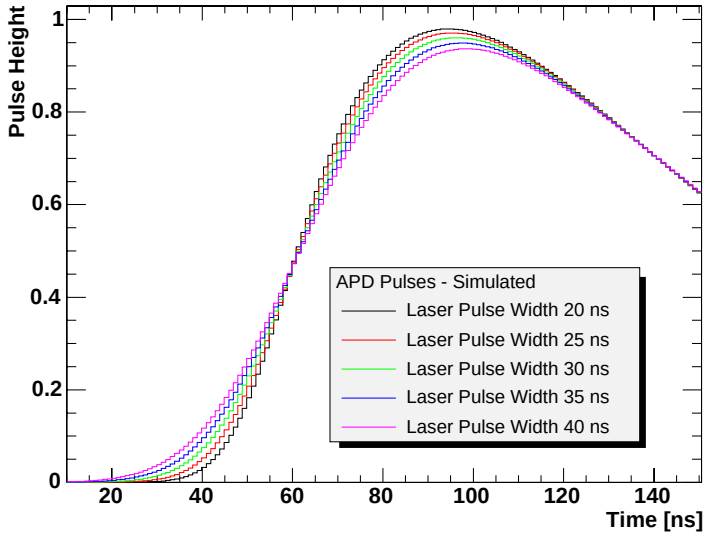


➢APD/PN shows ~ -2%/C^0 temperature dependences – as expected.

Corrections to the raw monitoring results







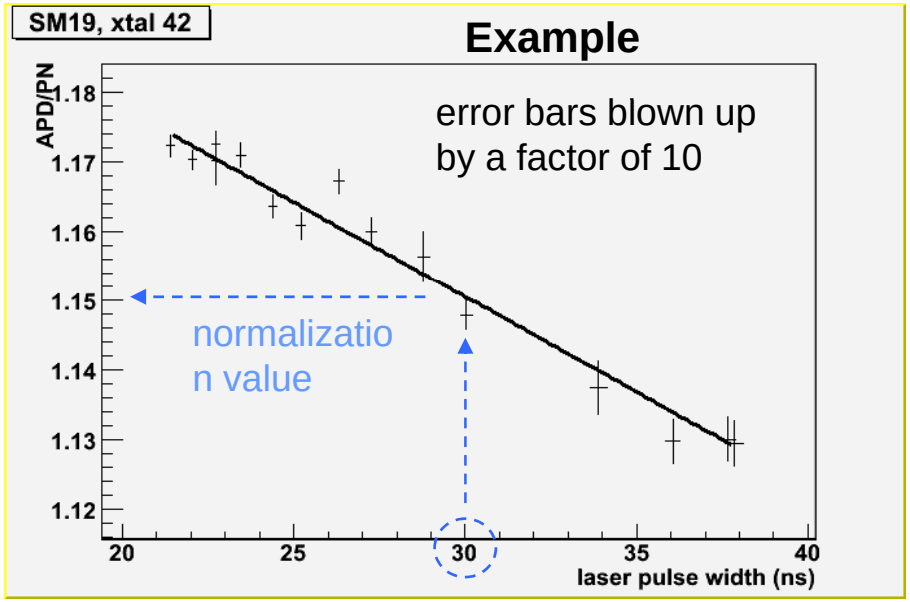
The variation of the laser pulse width causes a systematic effect in the reconstructed amplitude :

"Pulse-Width Non-Linearity"

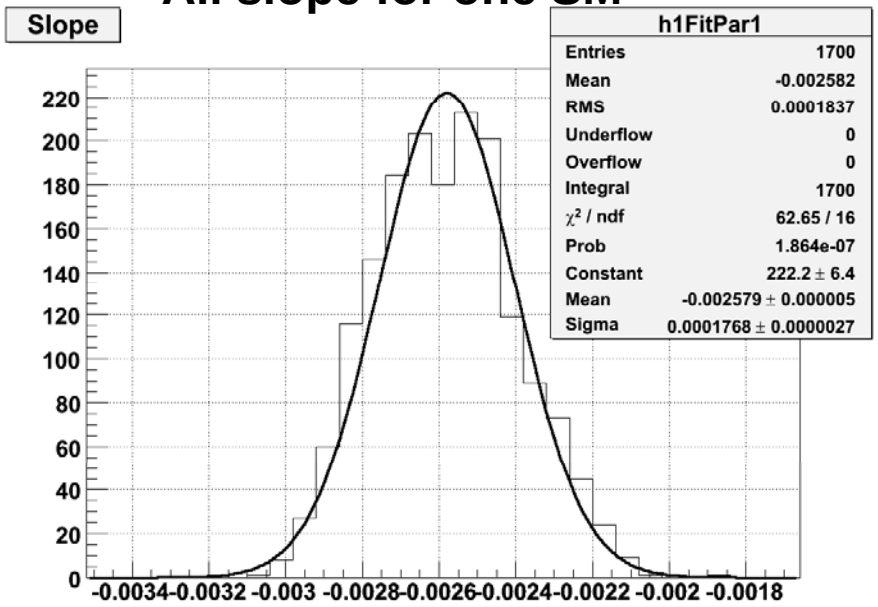
Details : See talks Sep. & Nov. 2005.

Pulse Width Measurement

Jan Veverka



All slope for one SM



- Linear fit of the APD/PN-width dependence for each channel of each SM
- Normalize APD/PN by the fit value at width = 30 ns
- Distributions and crystal maps for the slope, intercept, chi2, etc. of the linear fits for the *normalized* APD/PN values

Sigma / |Mean| = 6.9(1)%

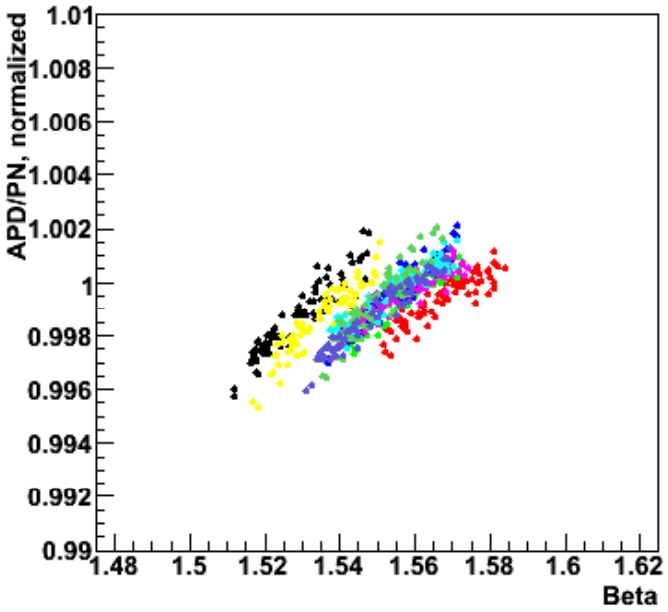
A total of 6 SMs have been measured.

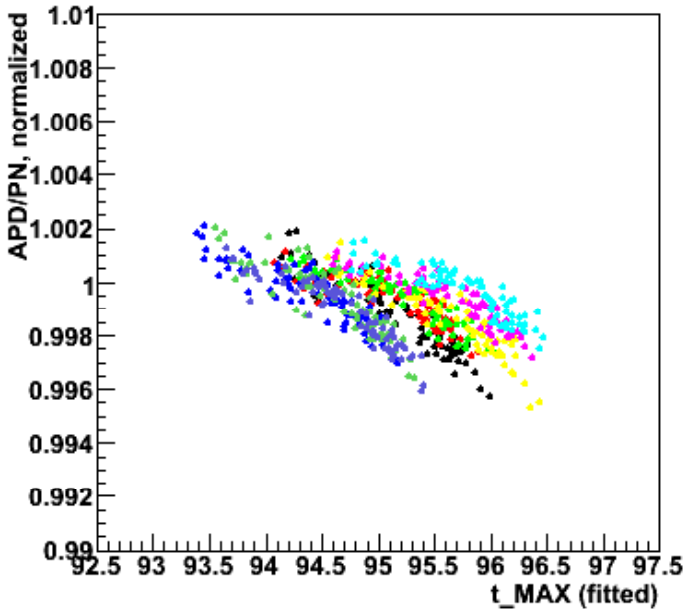
See Jan's talk on 22.03.2007

Pulse Width Non-Linearity has little channel to channel variation !

APD/PN vs Pulse Shape Parameter Beta SM22(1)

- The APD amplitude is reconstructed with a pulse shape fit. It also reconstructs the peak time.
- The shape function is described by two parameters, alpha and beta.
- The pulse shape parameters are determined by a fit to a set of 600 events (= one laser run).
- Alpha and Beta are strongly anti-correlated. Alpha and the peak time might be correlated.

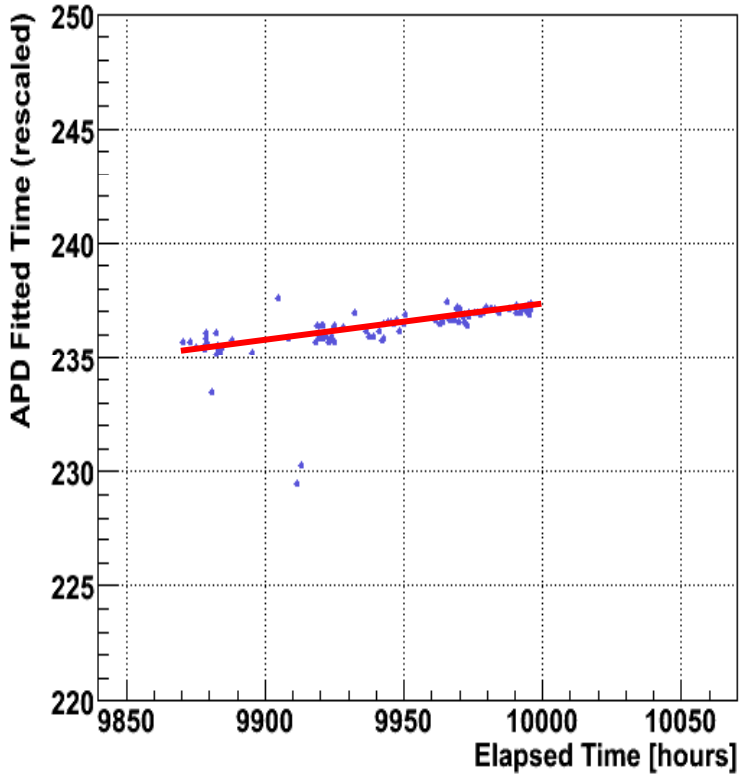




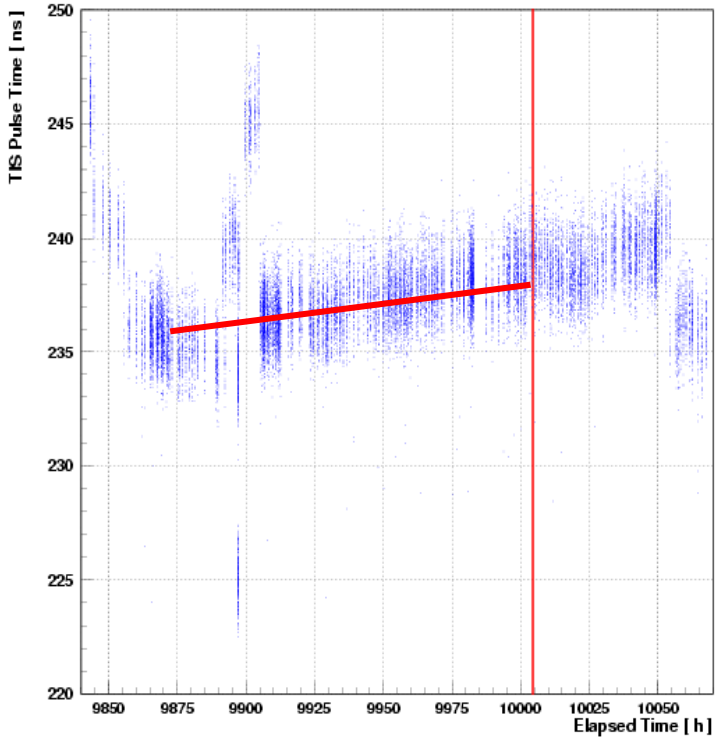
- There is a (anti)-correlation between the APD and the PN versus Beta (peak time).
- Due to the well known difference in the pulse shapes for APD and PN, this results in an APD/PN ratio dependency on the pulse shape and/or the peak timing.

APD Fitted Timing vs Laser Timing

APD Fitted Timing, offsets adjusted



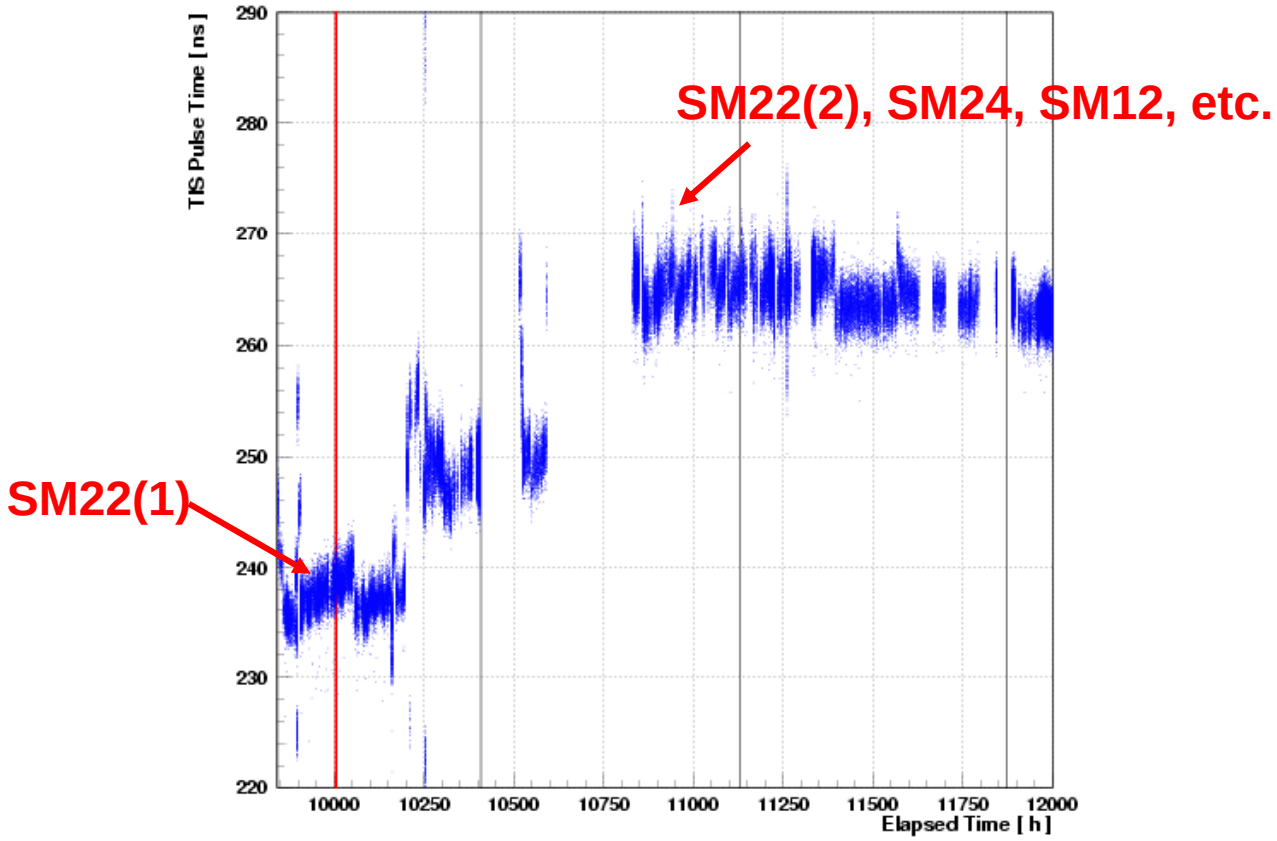
Laser Slow Monitor Timing



It appears that the timing drift extracted from the APD pulses is in fair agreement with the timing drift seen by the slow laser monitor.

Laser Timing Long Term Stability

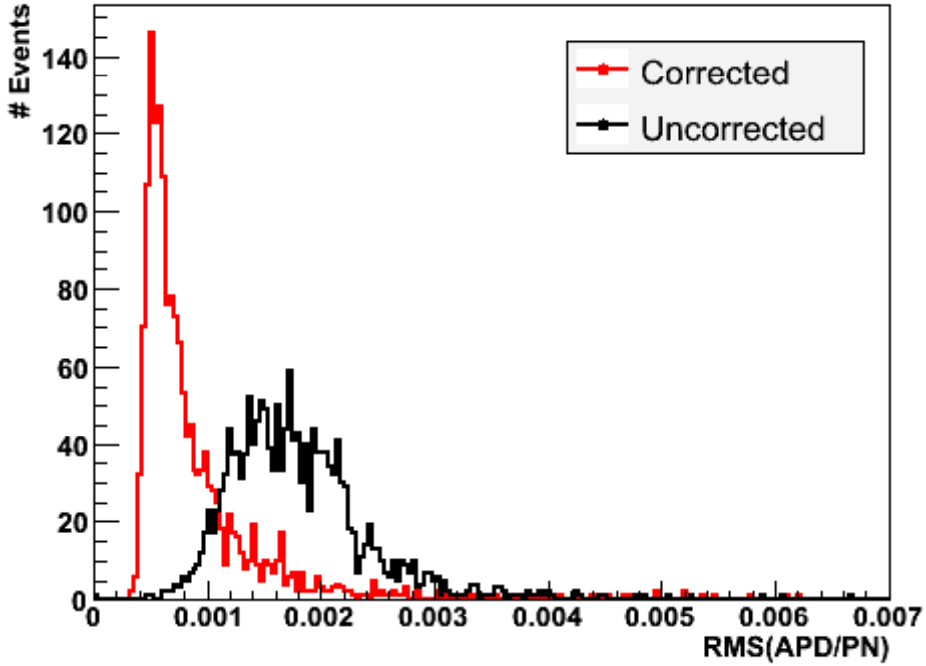
Laser Feedback has been improved during the year.



The feedback can currently stabilize the mean pulse timing to ~2 ns.

Timing & Pulse Shape corrections SM22(1)

Correct APD/PN ratios with a simple linear function of Beta :



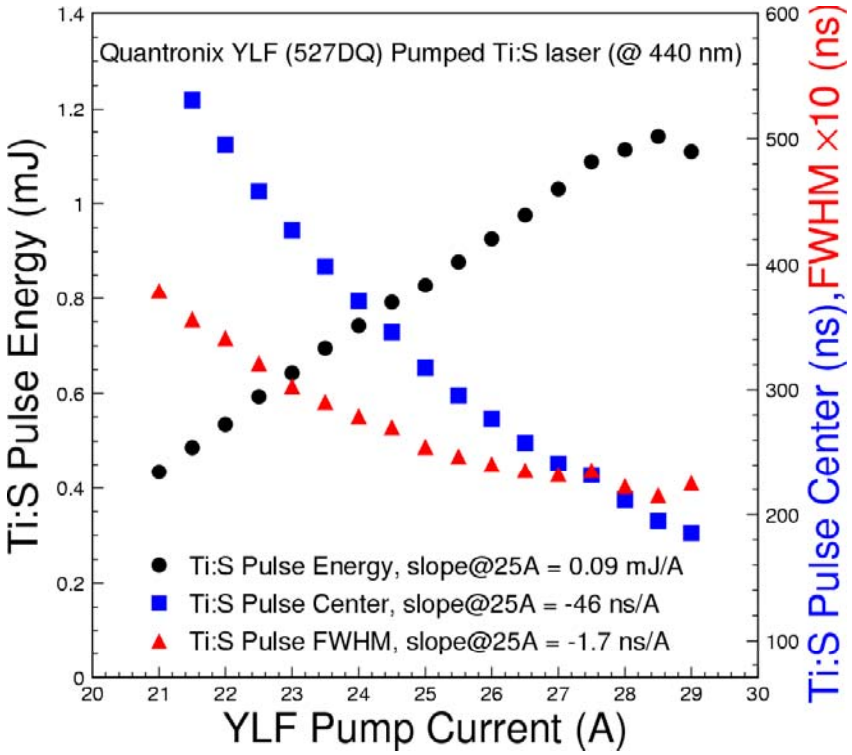
Mean before and after correction : 0.180 % 0.088 %

Peak before and after correction : ~0.170 % ~0.05 %

The correction restores the stability almost to design performance.

Note : Since Beta is very well correlated to the peak timing, a peak timing correction yields very similar results.

Pulse Width/Amplitude/Timing vs Pump Current



At 25 A : -1.7 ns/A width / -46 ns/A timing

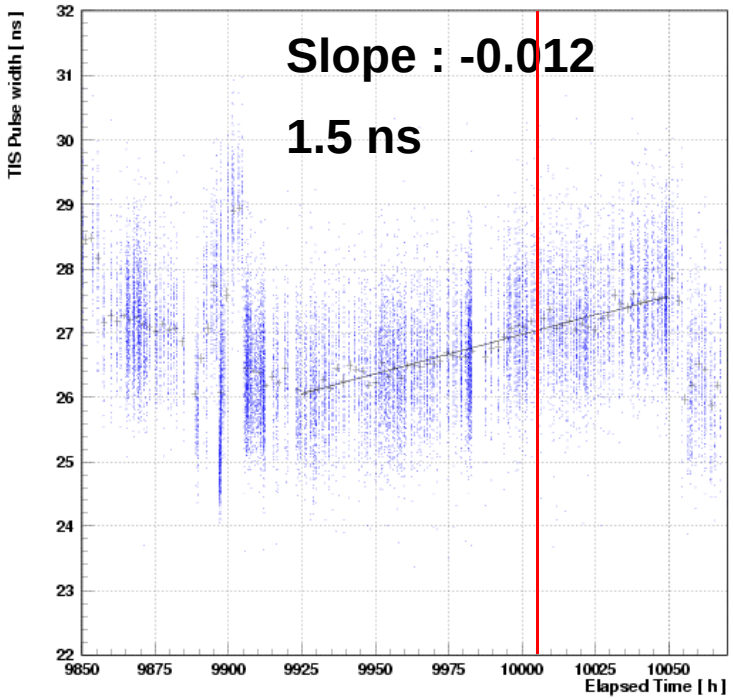
At 22 A : ~ -4 ns/A width / -62.5 ns/A timing

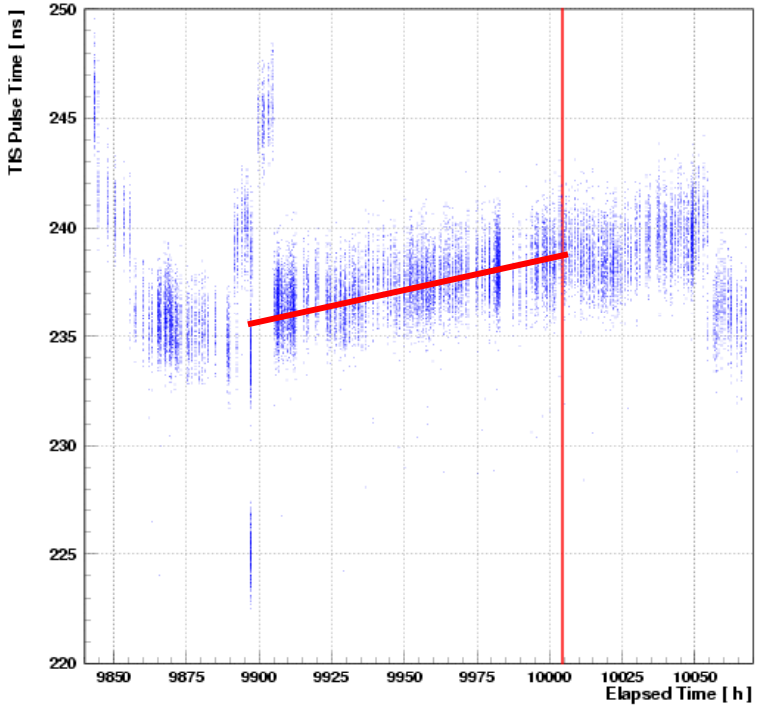
The timing changes ’10 times as fast’ as the width – in units of ns.

The ageing should follow the same curves with respect to each other, otherwise the feedback does not work.

PulseWidth and PulseTiming vs Time (SM22)

Slow Monitor Data



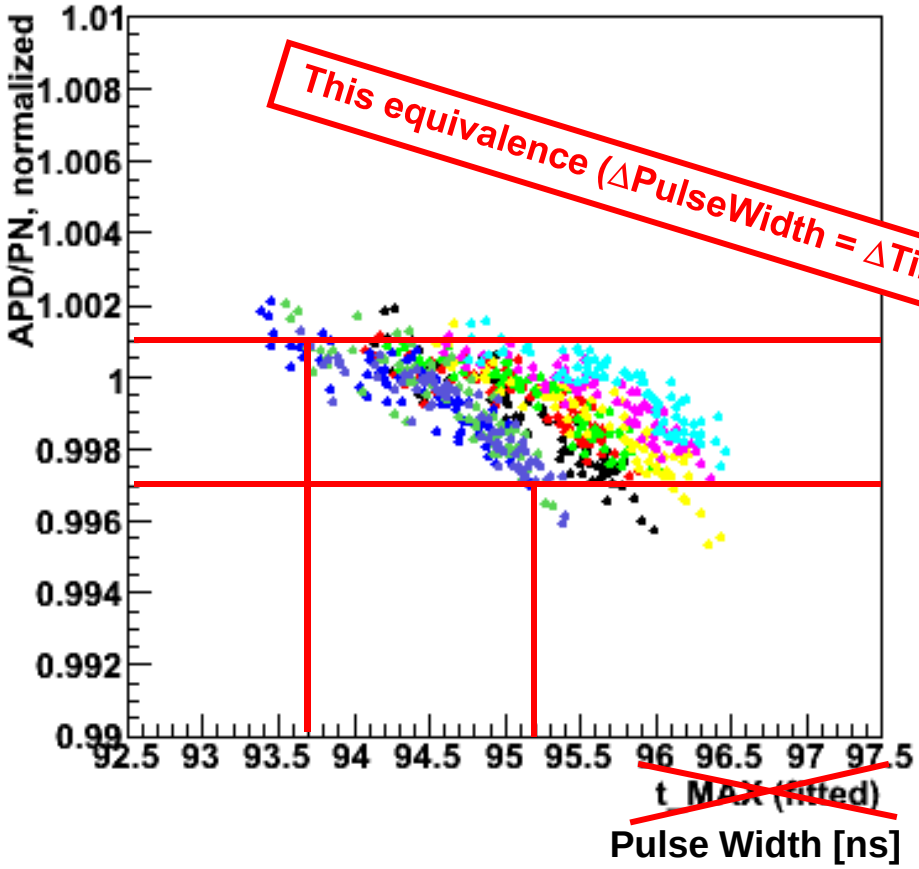


Shown is the drift of the pulse width (left) and the pulse timing (right) for the period corresponding to SM22 on the TB.

While the timing drifts by about 2 ns between 9900 h and 10000 h the width drifts about 1.5 ns. That is clearly in contradiction to the behavior on the previous slide.

This equivalence (ΔPulseWidth = ΔTimingShift) is probably accidental !

Pulse Width Non-Linearity !



This equivalence (ΔPulseWidth = ΔTimingShift) should be accidental !

The observed systematic effect might just be the well known pulse width systematic !

Not all SMs exhibit such a clean behavior. Need to study them in detail !

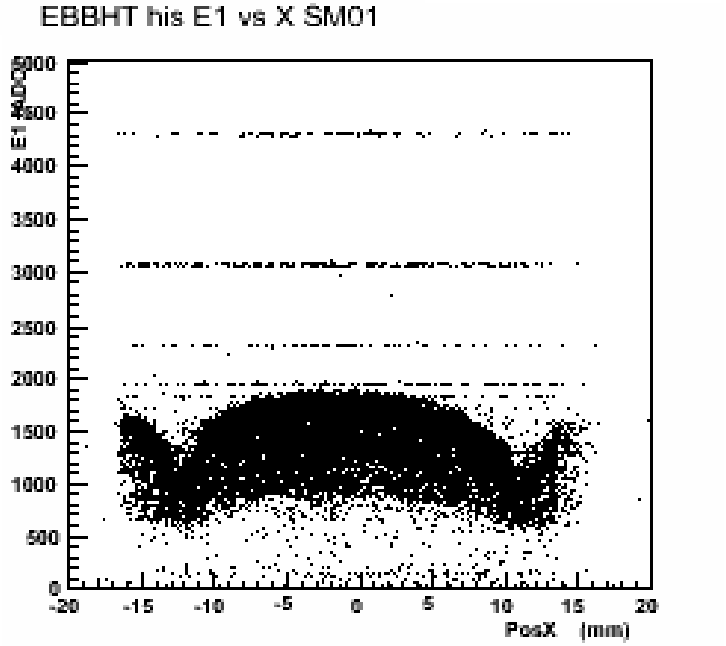
See monitoring talk on 15.02.2007

The pulse width non-linearity is the dominating sytematic effect in the monitoring stability !

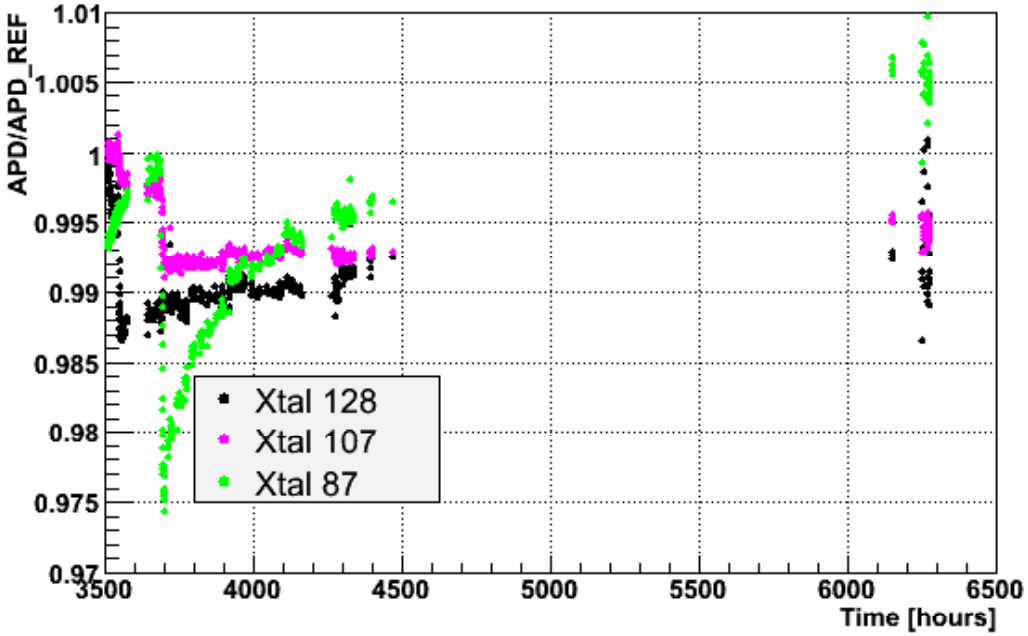
Few Remarks on Master Analysis

- To what extent will we be investigating such systematic details on CMS data ?
- In CMS, there will be a natural structure of the data, namely one CMS run (~12 hours).
- Possibly the Master Analysis will process the monitoring data per CMS run.
- However, the systematic effects observed here are on the timescale of several days.
- Any correction which is channel dependent will be very analysis intense.

Fun with Irradiation and Recovery



Beam profile from SM06 irradiation run



Interesting crystal recovery on xtal 87

→ See Toyoko's talk

Summary

- **The large amount of data taken in 2006 and the semi-automated processing provides valuable lessons for CMS.**
- **A simple monitoring analysis can achieve a reasonable monitoring stability.**
- **Quality checks, efficiency and outlayers have to be studied !**