Laser Pulse Width on SM10

Test Beam Meeting, CMS Week

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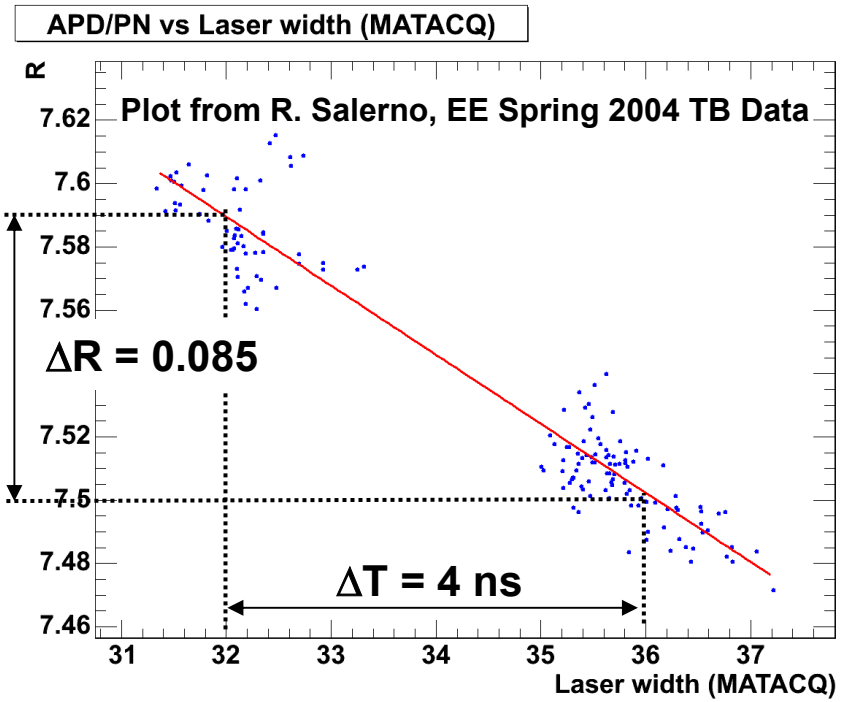
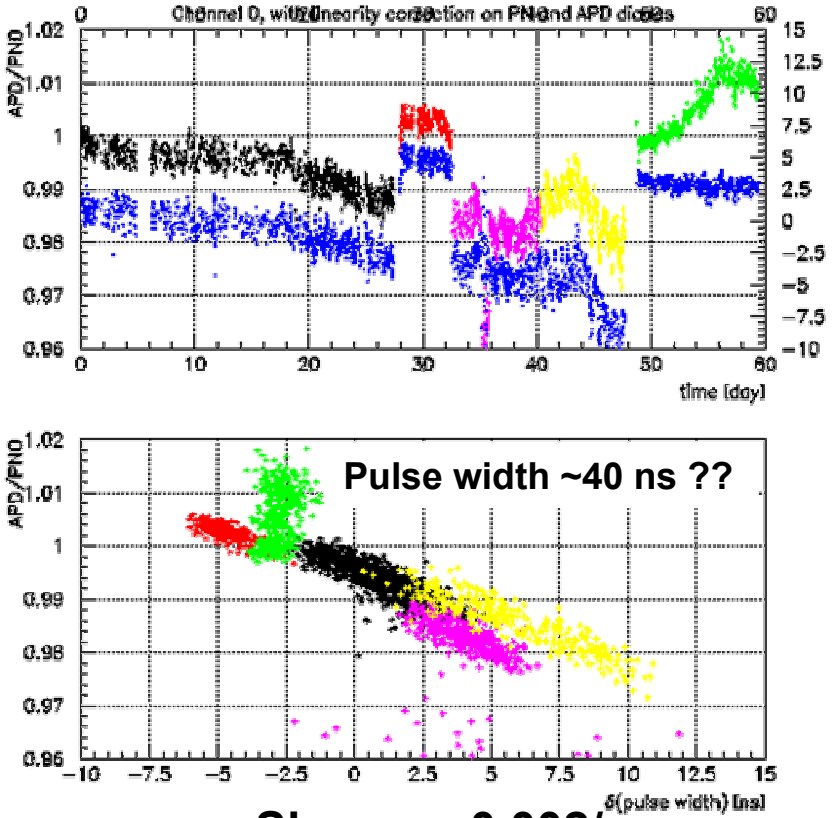
Pulse Width Dependency in Data – 2002/2004



Normalize R to 1 ⇒ Slope : ~ 0.003/ns

Pulse reconstruction method ?

Marc, WACH2002, Paris, 2002 Data



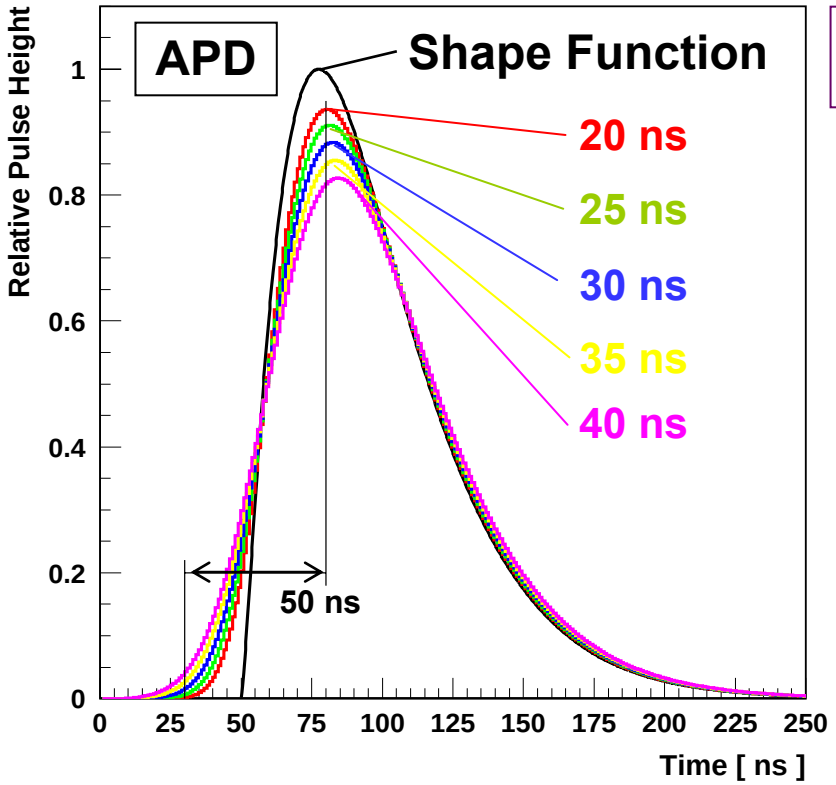
Slope : ~ 0.002/ns

But : Pulse width determination different - From pulse rise time.

Note : Here very different setups are compared (electronics, width measurement, etc.).

Convoluting Pulse Shapes - APD

The sampled pulse is a convolution of the electronic shape and the laser pulse shape. We then estimate the energy from the pulse height.



$$f(t) = \left(\frac{t - (T_{\max} - T_{peak})}{T_{peak}}\right)^{\alpha} \exp\left(-\alpha \times \left(\frac{t - T_{\max}}{T_{peak}}\right)\right)$$

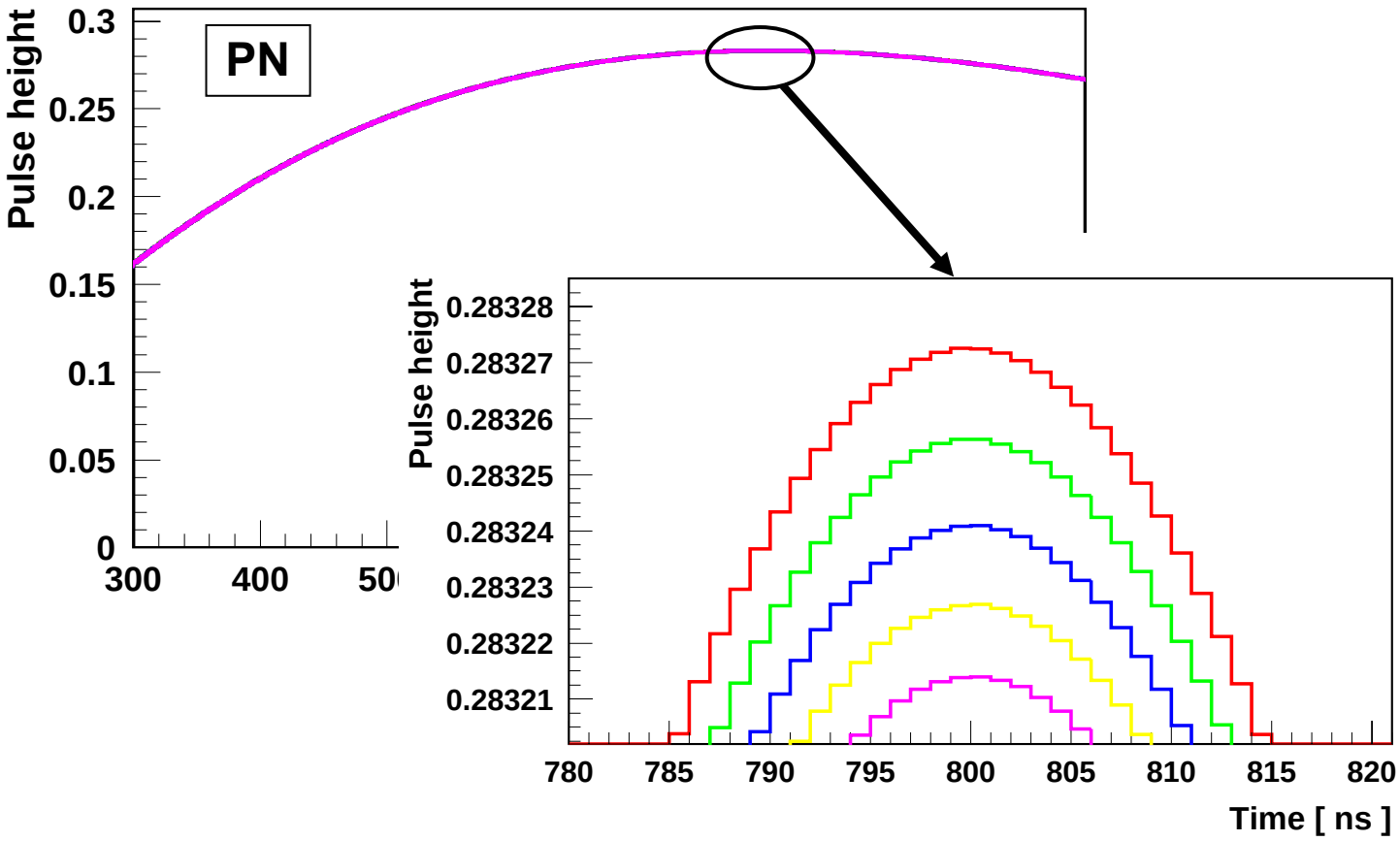
Laser shape (Gauss with FWHM 20 ns, .. , 40 ns) convoluted with shape function.

Parameters for shape function adjusted so that convoluted shape parameters match values from laser data as measured as from Renauld's talk on 16.03.2005.

Note :
FWHM of the 'measured laser shape' seems not to be a good measure of the true width.
The rise time is a good measure.

Effect strongly depends on the rise time !
Sizeable effect on the pulse height for APD.

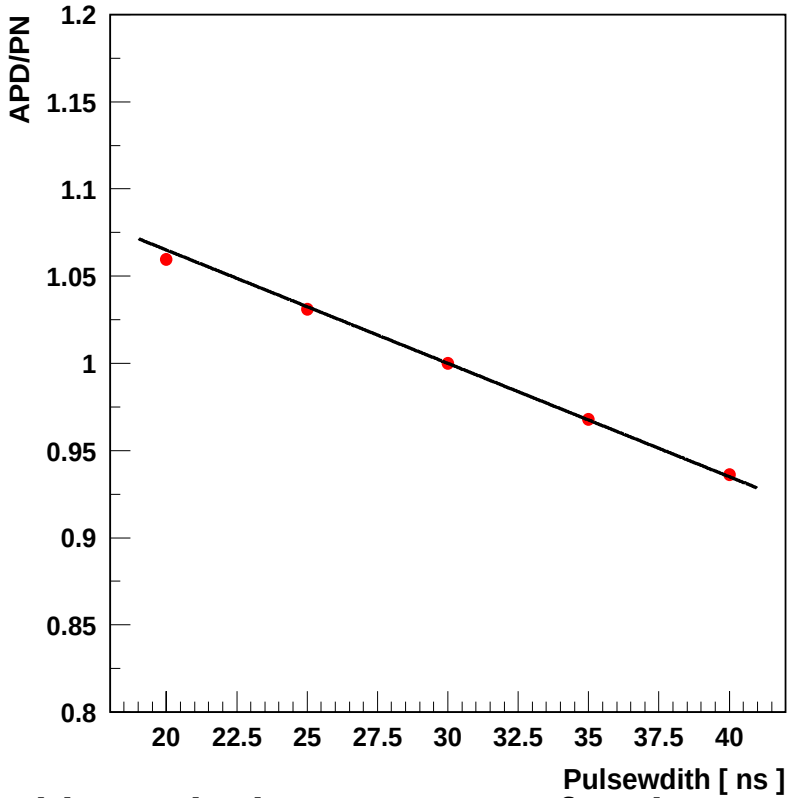
Convoluting Pulse Shapes - PN



Because of the shaping time of the PNs the effect of the convolution is very small.

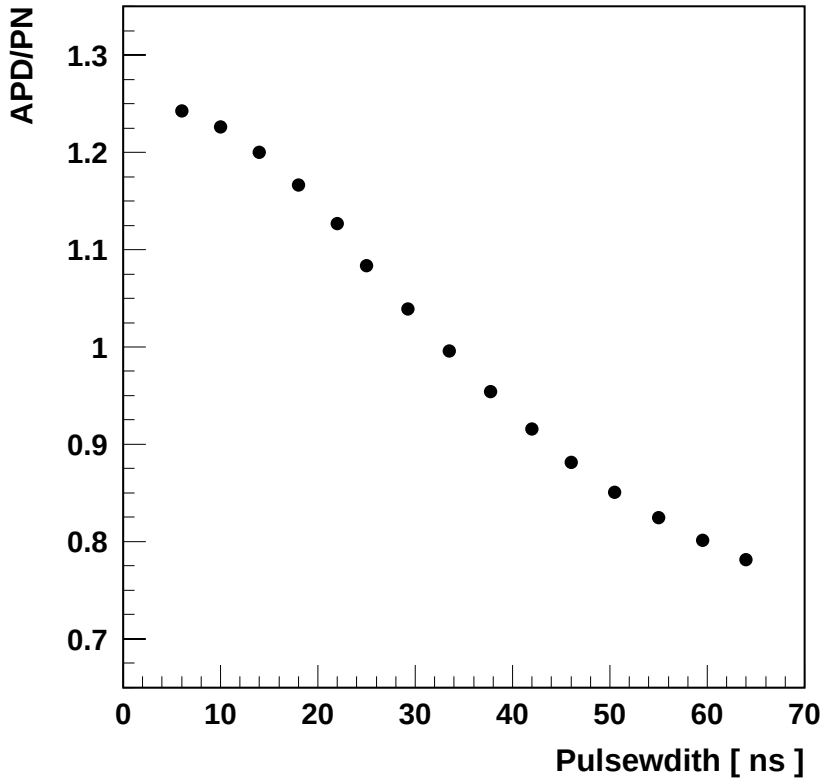
Pulse Shape Convolution (con't)

APD/PN Ratio from previous pages



- **Effect (slope) with this particular parameters for electronic shape is of the order of 0.006/ns.**
- **But this number is strongly (within a factor 2 or more) dependent on the rise time if the electronic shape function.**

Pulse Width Dependency vs Pulse Width



- The pulse width dependency gets weaker for narrower and wider pulses.
- It appears to be maximal for ~30 ns wide pulses.
- Within the range accessible by the laser system no significant variation of the dependency.

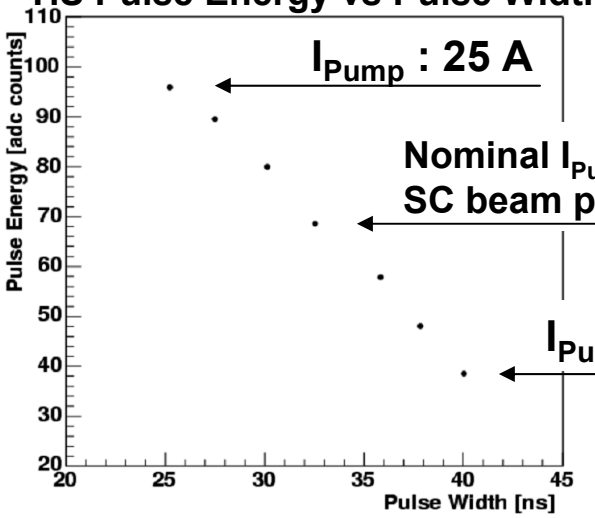
  Thus - within this range mean pulse width does not matter.

  Eases the requirements on the absolute scale of our pulse width measurement.

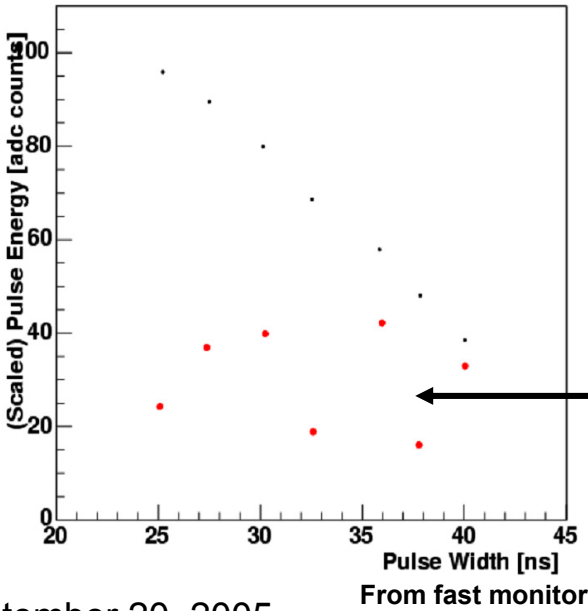
Pulse Width Scan – Spring 2004

Compare : Adi's talk on 06.10.2004

TiS Pulse Energy vs Pulse Width



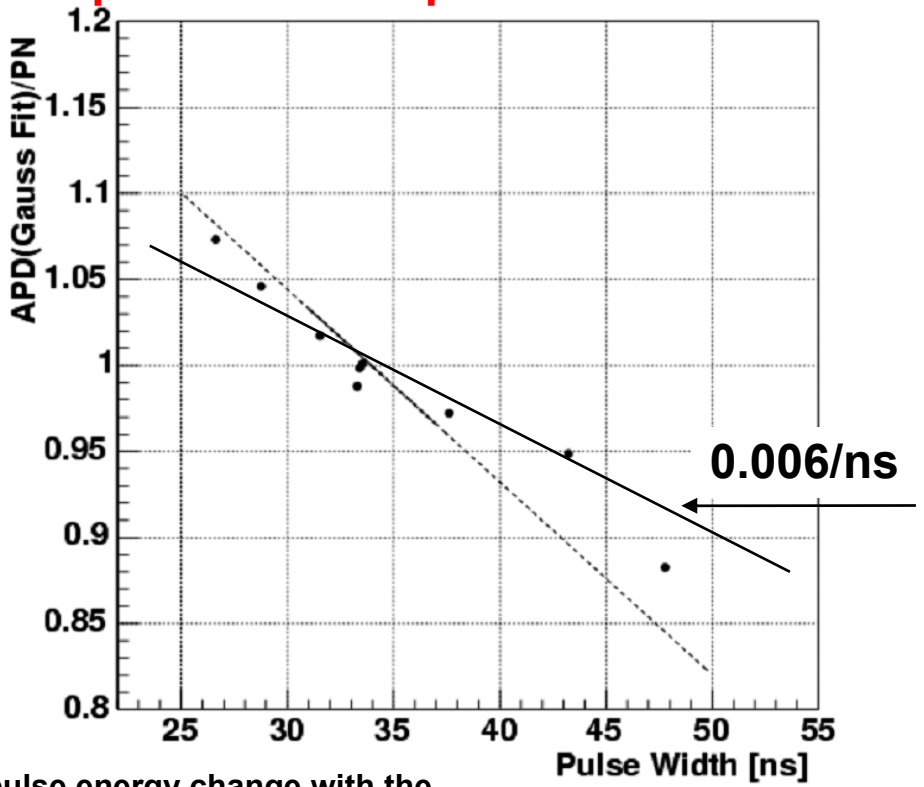
From fast monitor



From fast monitor

Attempt to compensate pulse energy change with the intensity regulator 'online' to isolate pulse width effect. Since pulse height non-linearity is much smaller this is not necessary.

APD/PN pulse width dependence 2004 PW Scan

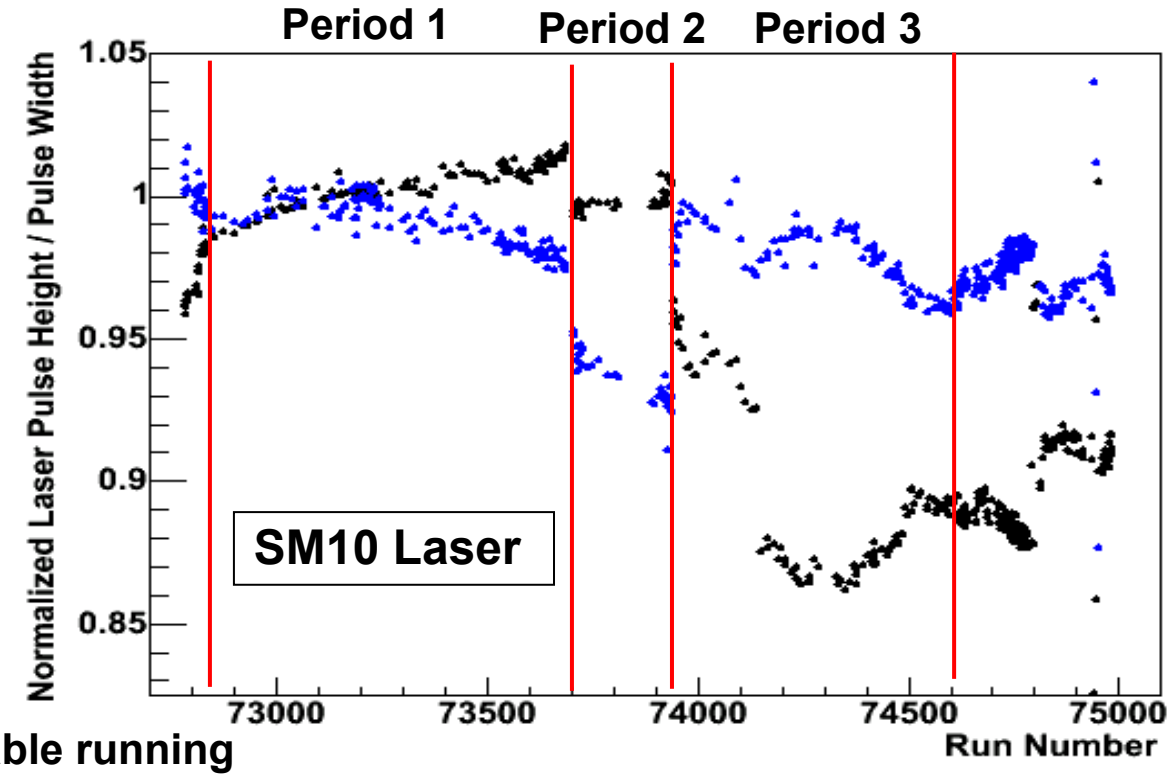


From MATACQ

SM5 pulse width scan taken 09.2005. to be analysed.

Laser Pulse Width Correction - 2004

Please recall Patrice's presentation at test beam meeting on 18.05.2005 : Intercalibration of periods based on electrons.



Pulse Height 440 nm

Pulse Width

Period 1 : Stable running

Period 2 : H4 DAQ trouble (timing ?)

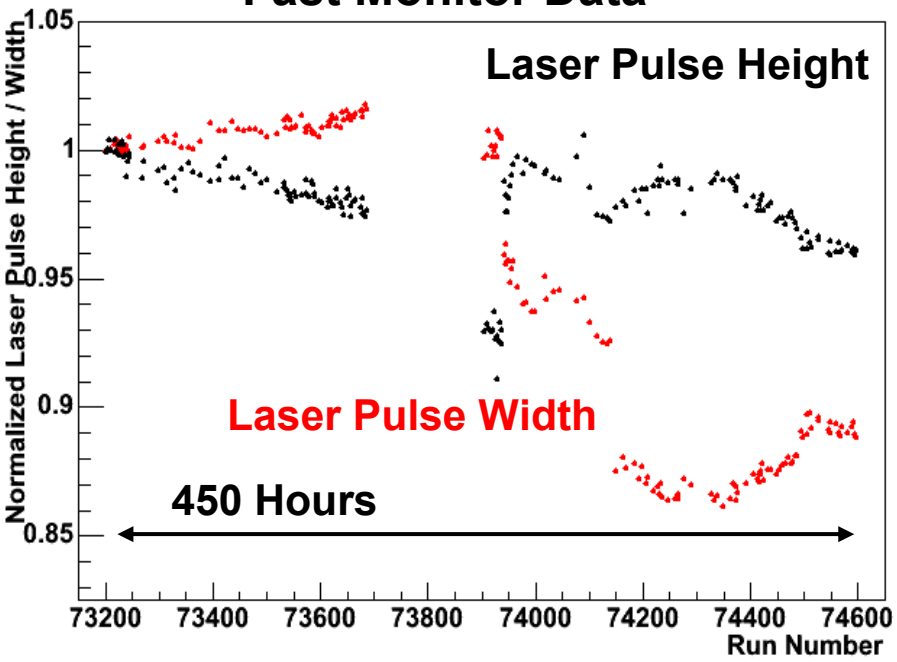
Note : The laser problems in this period have nothing to do with the H4 DAQ trouble.

Period 3 : Running

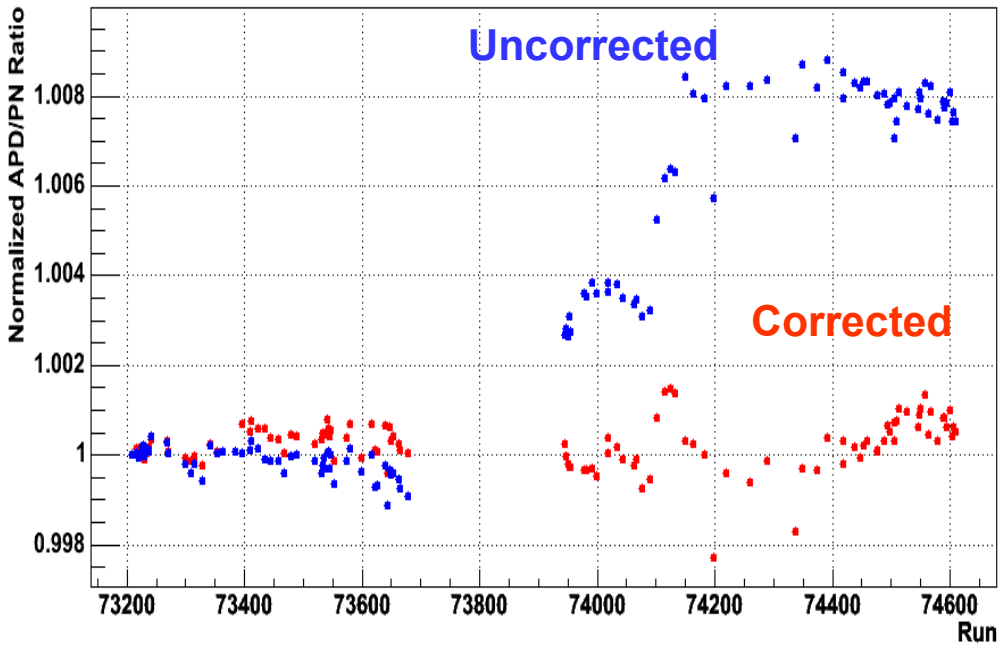
After period 3 : Temperature step, HV scan, laser scans, token ring broken …

Pulse Width Correction on SM10 - 2004

Fast Monitor Data



ECAL APD/PN, Single Channel Monitoring History



Data analysed :

Part of Period 1 (not all the data was re-reprocessed to fix PN data) and Period 3. Period 2 is problematic - and thus not used.

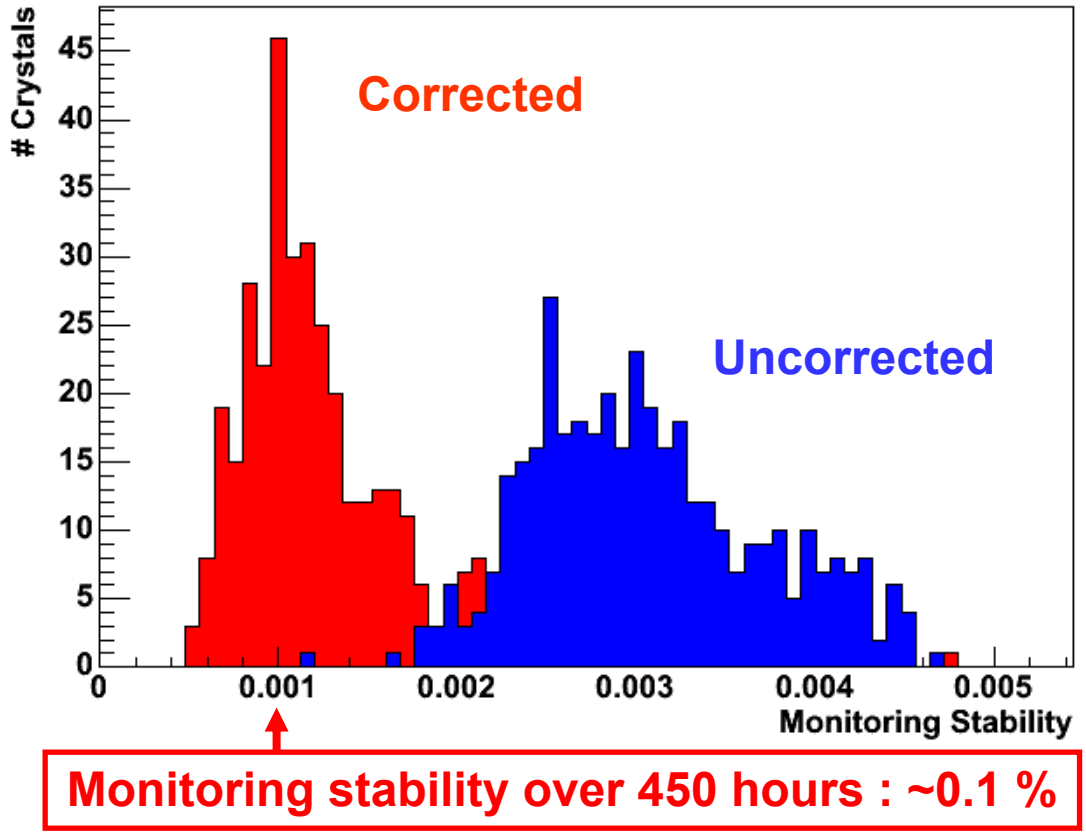
Pulse width correction :

$$APD/PN\_cor = APD/PN + c \cdot PW\_Laser$$

Pulse Width Correction Performance

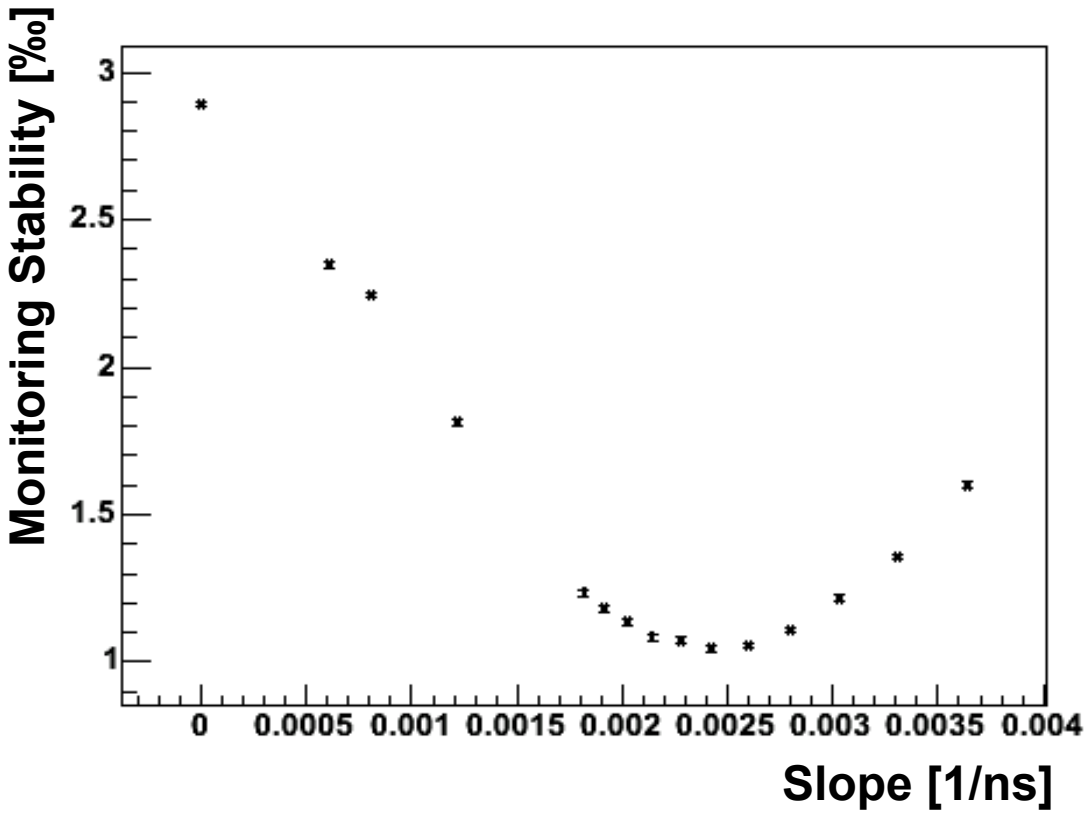
Judge performance (monitoring stability) by projecting values onto Y-Axis for each channel (actually 400 for the plot shown) and determine the RMS.

Period 1 and Period 3 combined.



Monitoring Stability vs Pulse Width Correction

With a linear correction we can vary the slope to study the sensitivity :



From SM10 data it appears that we don't have to know the slope with great precision.

Summary & Outlook

- The pulse width dependence of the APD/PN observed in data can be reproduced from based on the properties of the pulses alone.
- It appears that a laser width stability on the level of <1 ns is needed to achieve the desired monitoring stability.
- Monitoring of the laser pulse width is mandatory.
- The requirements on the precision of the pulse width measurement are not very high.

- Analyse SM5 pulse width scan data as soon as rrf-files are available.
- Perform further scans on SM5 and on further SM as they become available. Presumably the effect is not channel-to-channel dependent.