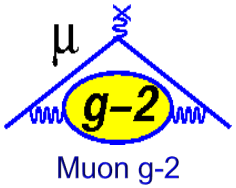
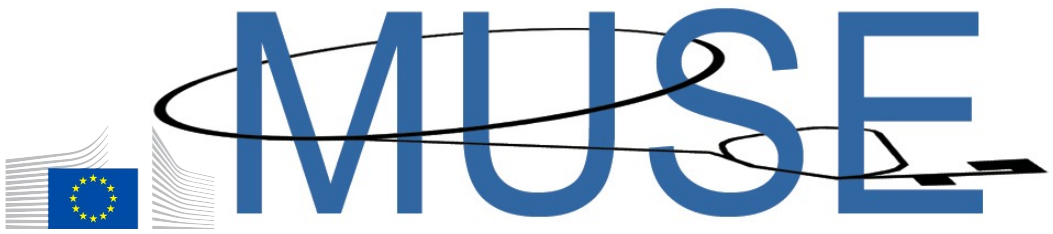




H2020-MSCA-RISE-2015 – Grant Agreement N° 690835

Analysis of Source and Local Monitor Signals.

Muse Collaboration Meeting, October 23, 2018

Nandita Raha, INFN Pisa

Laser System - Basics

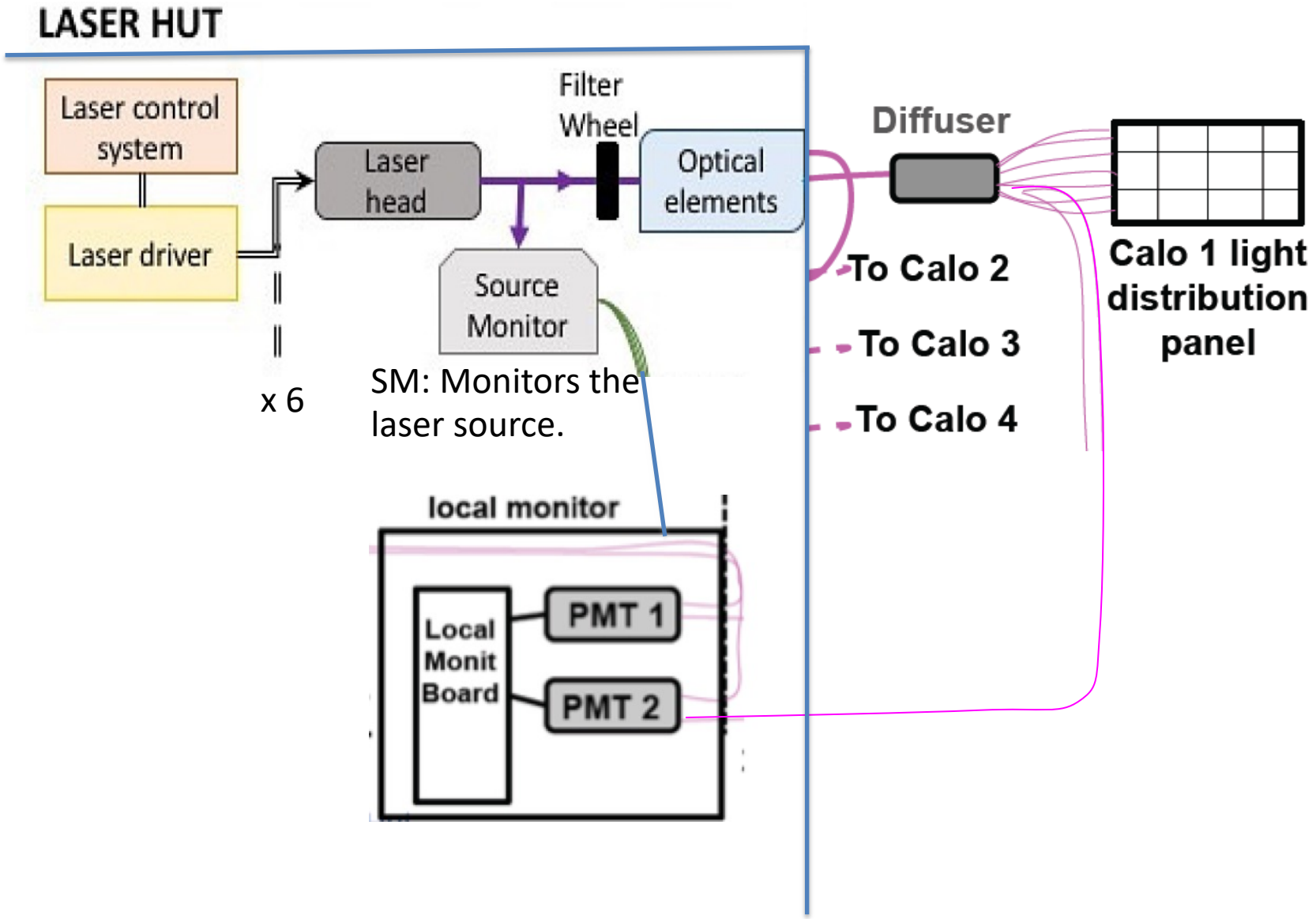
Laser system - used for **calibration** and **monitoring.**

- **Source Monitors** (SM) are used to monitor and correct the **laser intensity** variations. Have **2 PIN diodes** (PiD) and a **PMT.**

  Simultaneous digitization with two independent systems: **Waveform digitizers** (WFDs) similar to those used for the calorimeters and **custom (Naples) electronics**.

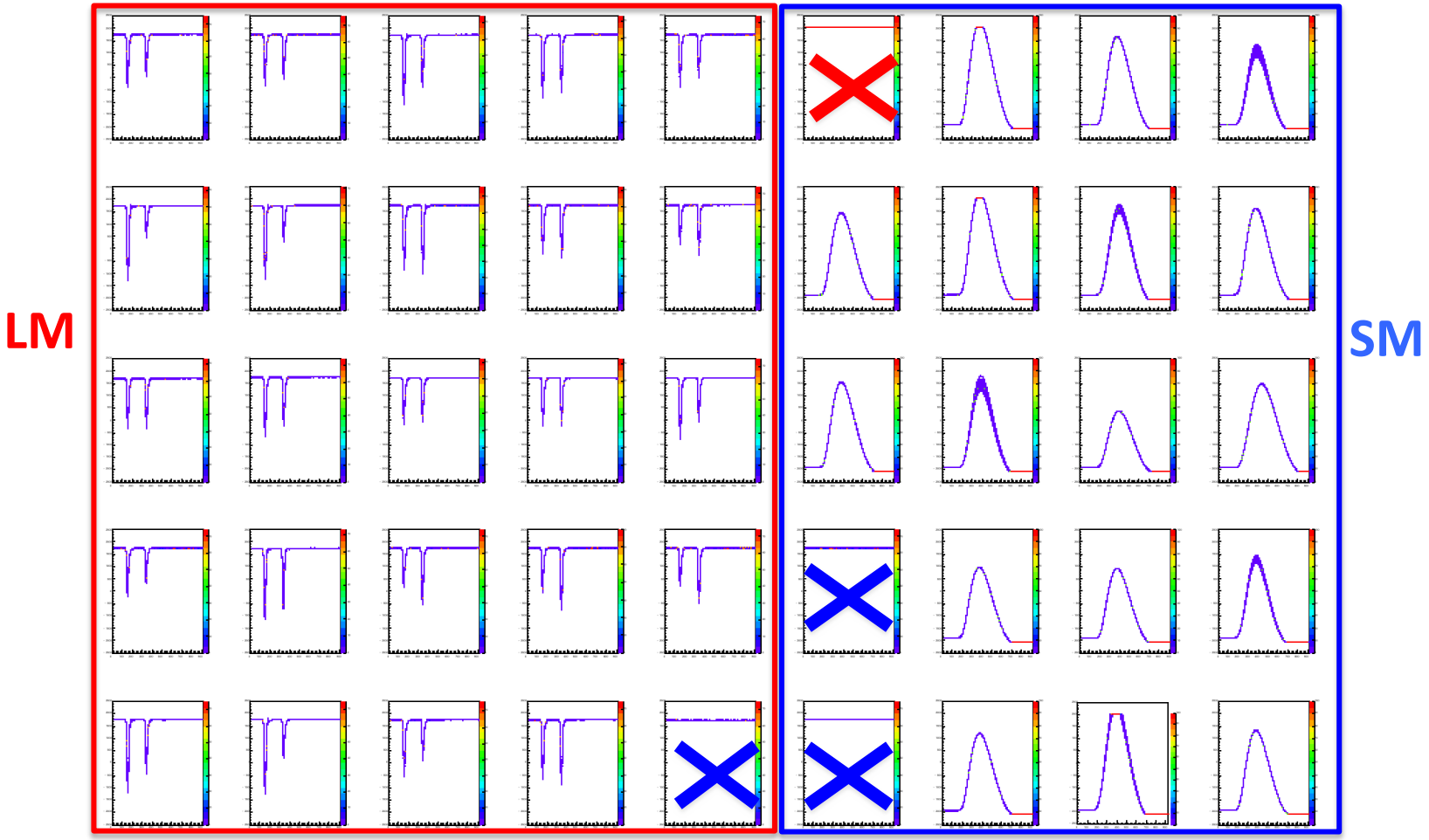
- **Local Monitors** (LM) check and correct the stability of the **light distribution** chain. The same light pulse is split into two separate paths: one is measured locally from the SM, while the other goes to the calorimeter and then returns to the laser hut. The two signals are measured by the **same PM**T and clearly separated in time.

Laser System - Basics



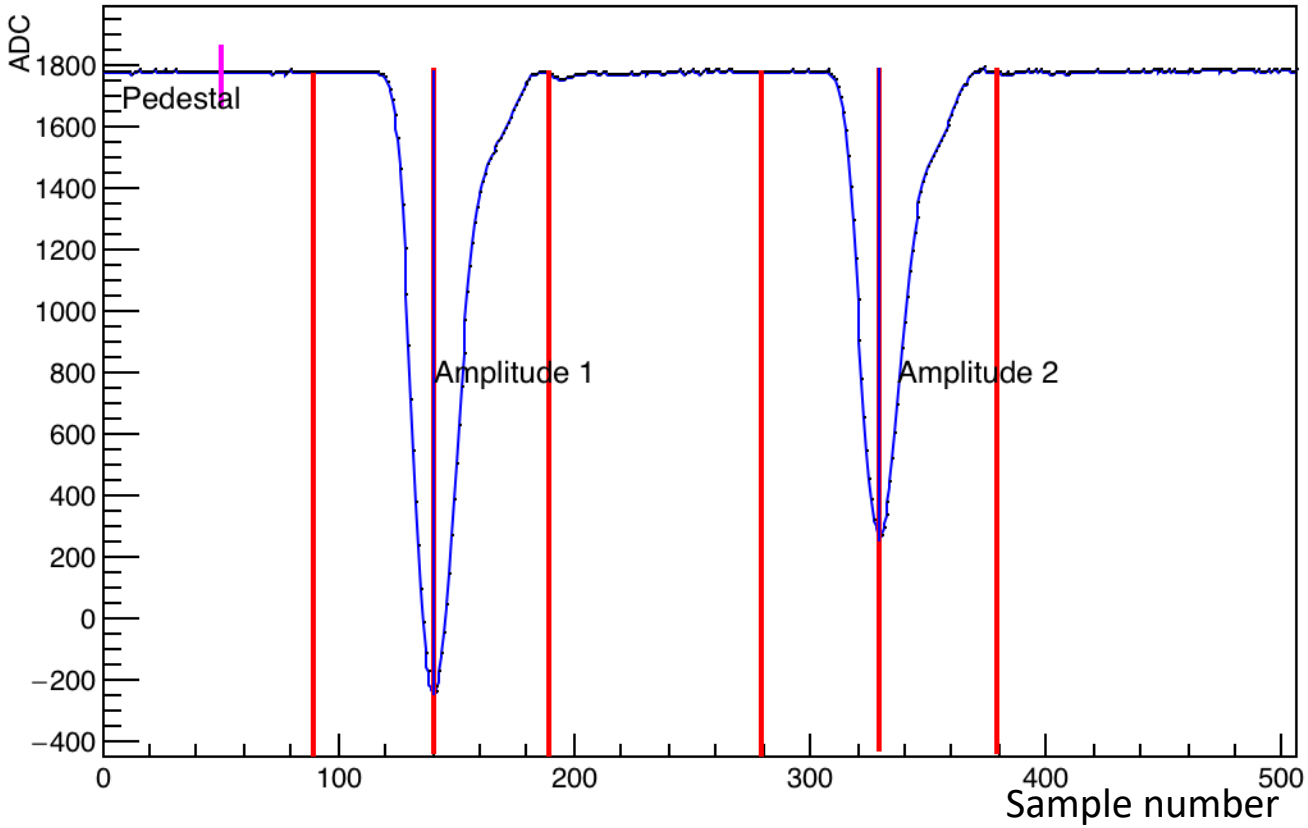
Laser Monitoring System

Map of the laser monitoring system from reconstruction. The red block shows the 17 SMs (SM6 PMT not working shown by red cross and channel 15, 20 and 19 are not connected shown by blue crosses) and the rest show the 24 LMs.



Parameter definitions

- Pedestal: Average first 50 samples
- Amplitude: Pedestal subtracted peak sample
- Area window: ± 50 samples from peak.



Note: Same definitions for Source Monitors too.

Offline Studies

Studies of SMs with WFDs and comparison with custom (Naples) electronics:

- Signal amplitude
- Stability of SMs.

LM studies:

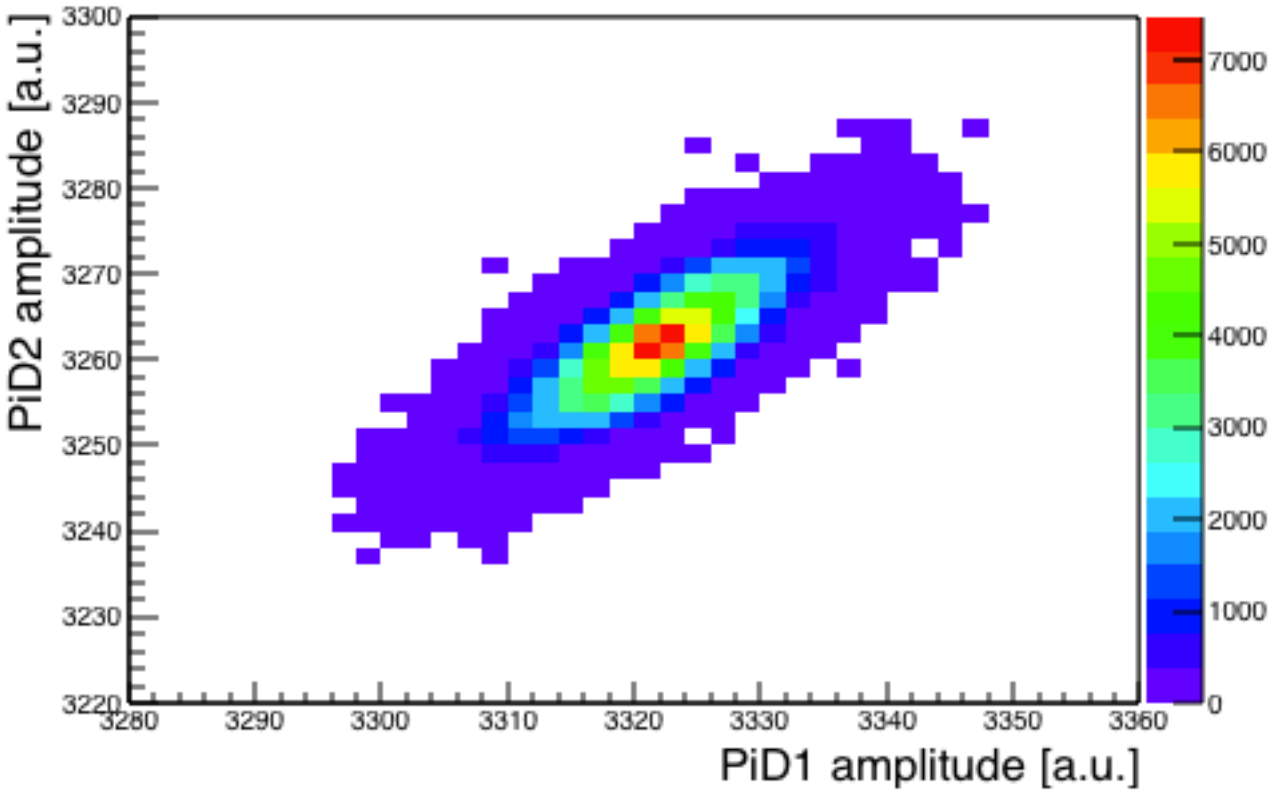
- Signal amplitude
- Stability of light chain (amplitude ratio of the 2 LM pulses)
- PMT Pedestal
- Time interval between the two LM pulses

Time Evolution Studies
Runs 1791 to 1869 (1st to 4th July)

Source Monitors

SM from WFDs

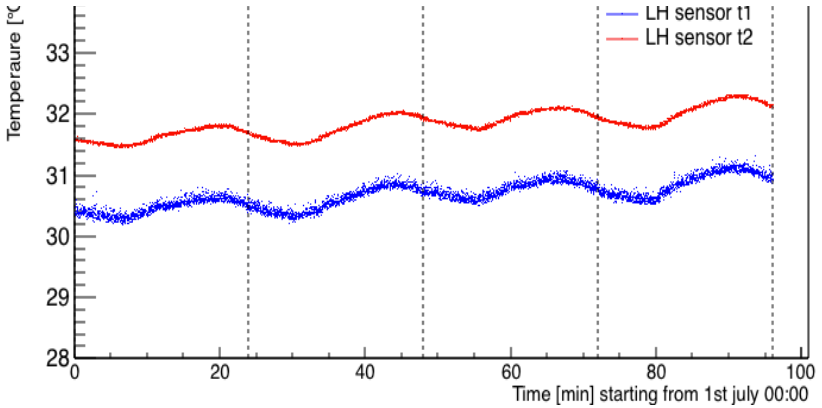
Scatter plot between amplitudes of PiD1 and PiD2 shows a strong correlation, for SM4 which, follow the laser light fluctuations.

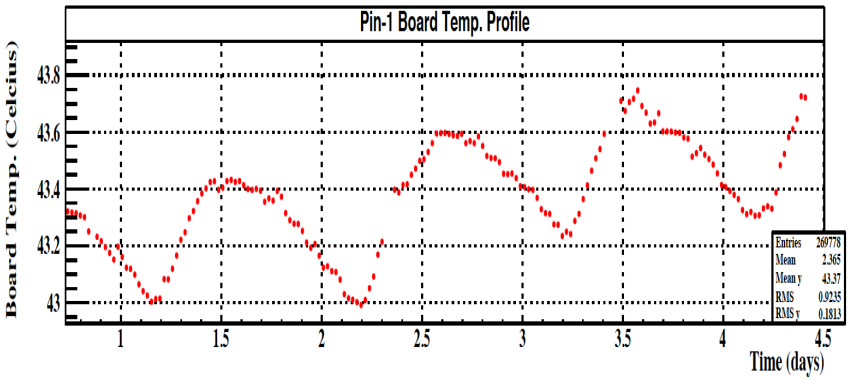


Temperature Dependence

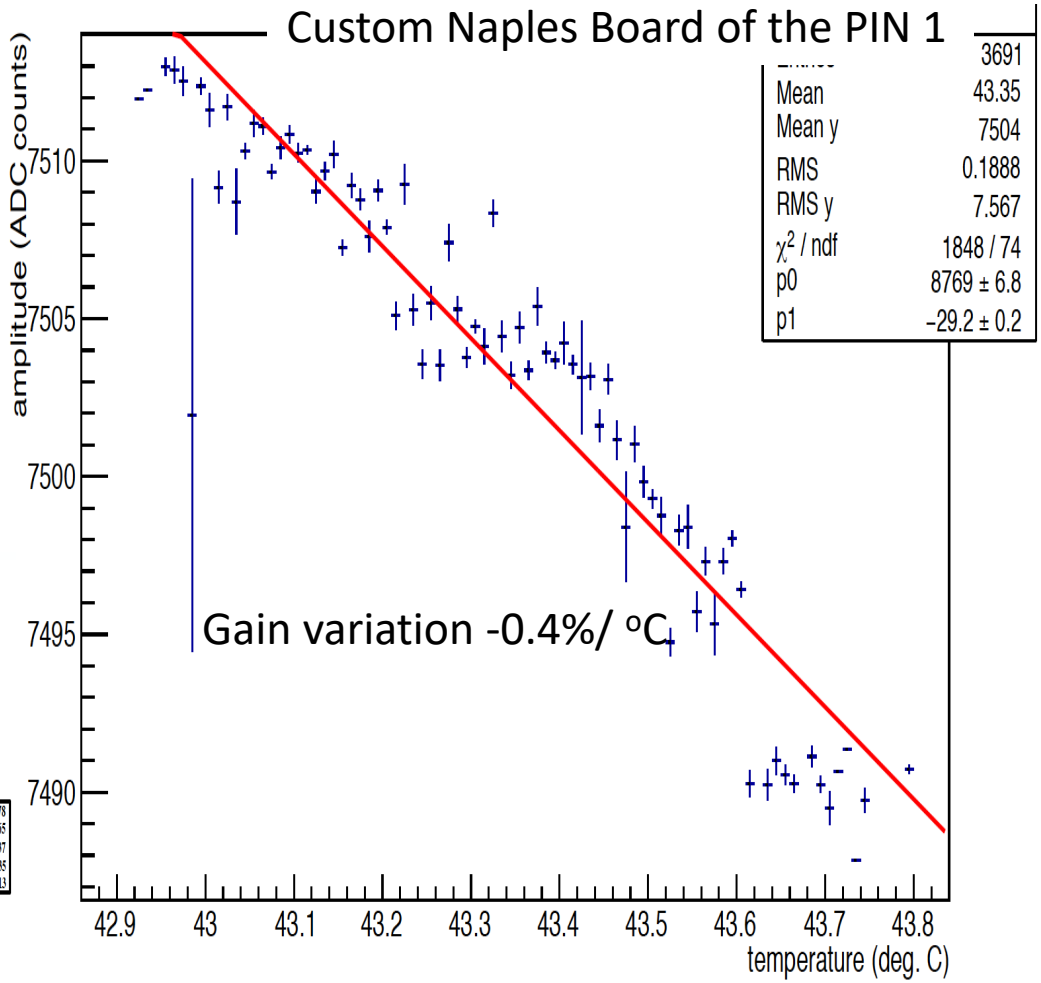
The amplitudes depends both on the ambient temperature (of the laser hut) and on the PiD read-out boards. The board temperature(43 °C) is higher than the room temperature, but its variation follows the trend of the room temperature.

Laser hut room temperature – read by Slow control



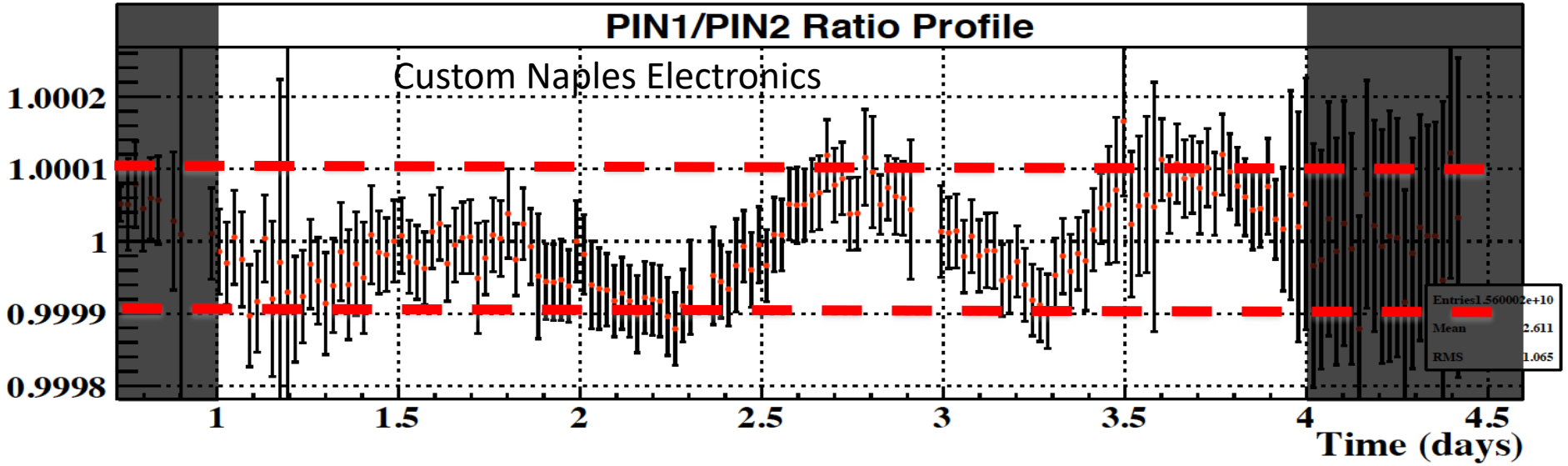


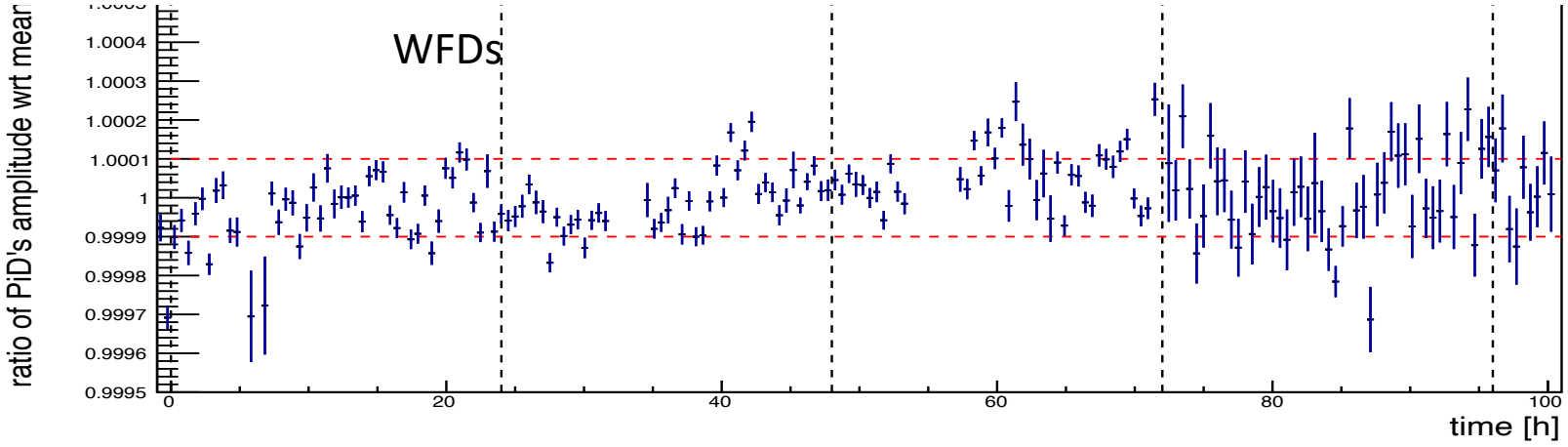
Custom Naples Board of the PIN 1



Source Monitor 4

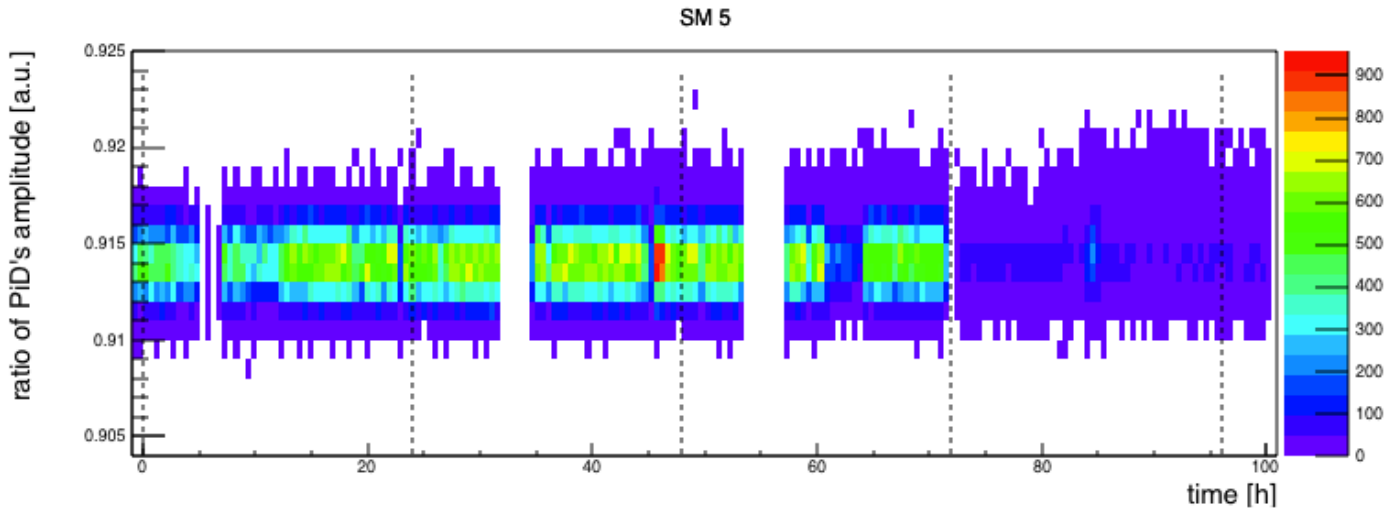
The ratio of amplitudes of PiD1 to PiD2 is a measure of the relative stability of the front end and readout electronics. Compared with two independent systems i.e. WFD's and custom Naples electronics. Lines correspond to an ~10^{-4}.

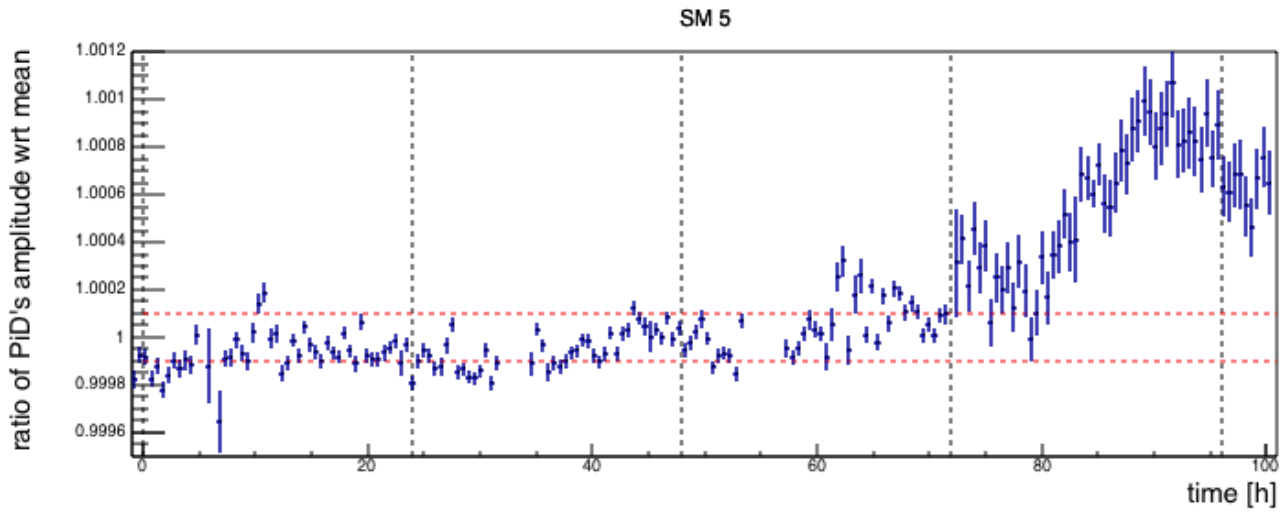




Source Monitor 5

The relative stability is not very good here. Need to investigate the reason for the drifts here. We can't compare with the custom Naples electronics as SM1, SM5 and SM6 could not be read by their boards.





Summary of SM

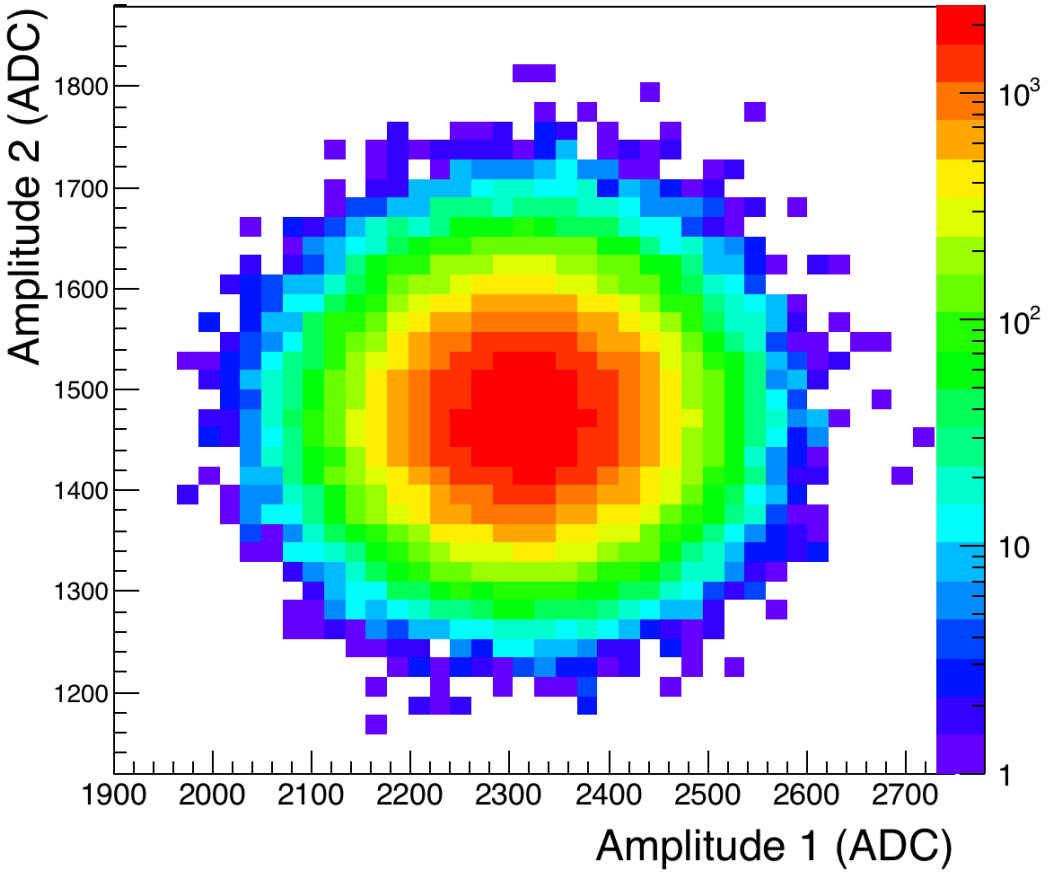
- Aim to achieve a stability of ~ 10^{-4} (stability is measured by the amplitude ratio of PiD1:PiD2).
- Check this stability with two independent systems i.e. WFDs and custom Naples electronics .
- We see local drift for certain PiDs which we are investigating.

Time Evolution Studies
Runs 1791 to 1869 (1st to 4th July)

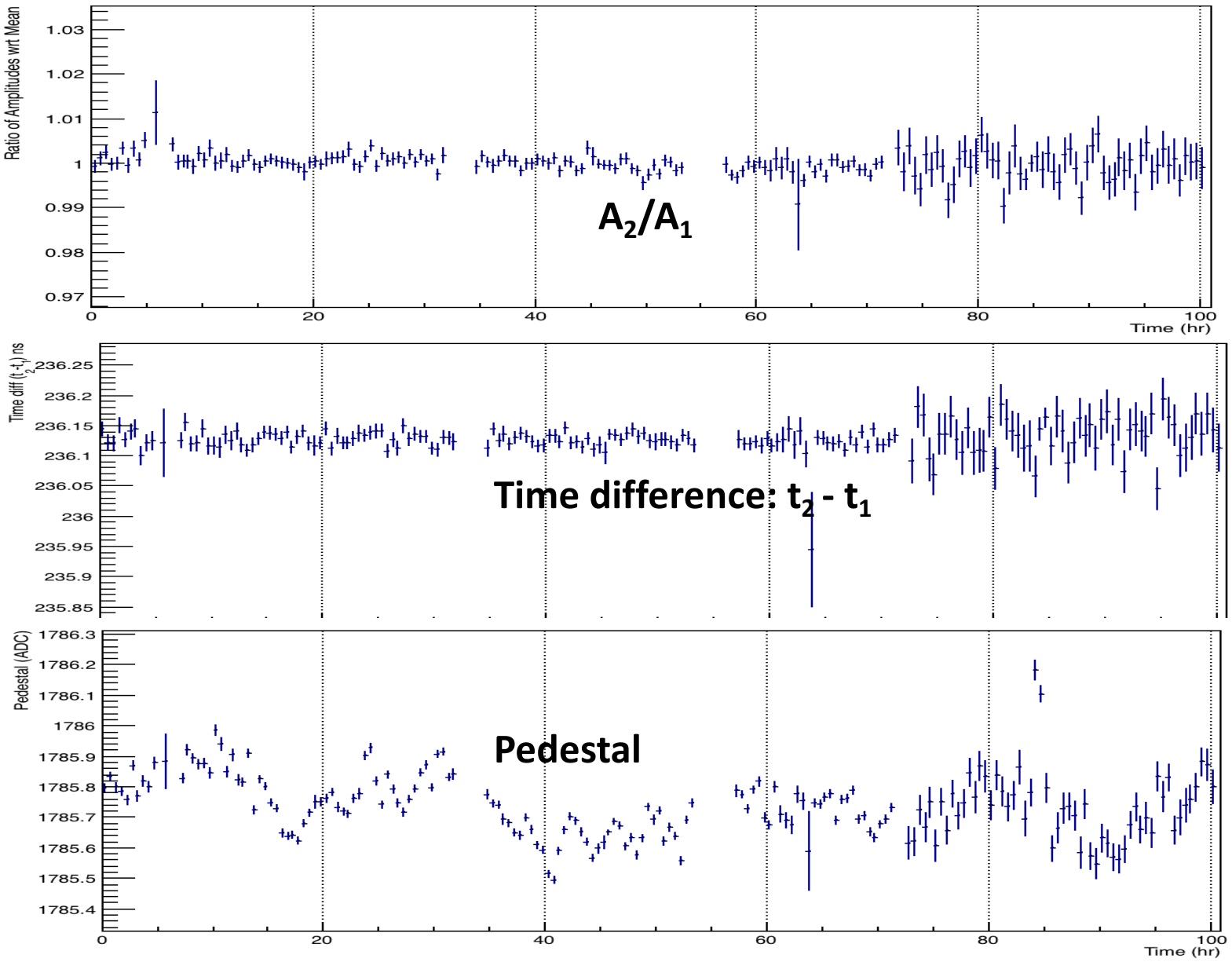
Local Monitors

LM Amplitudes

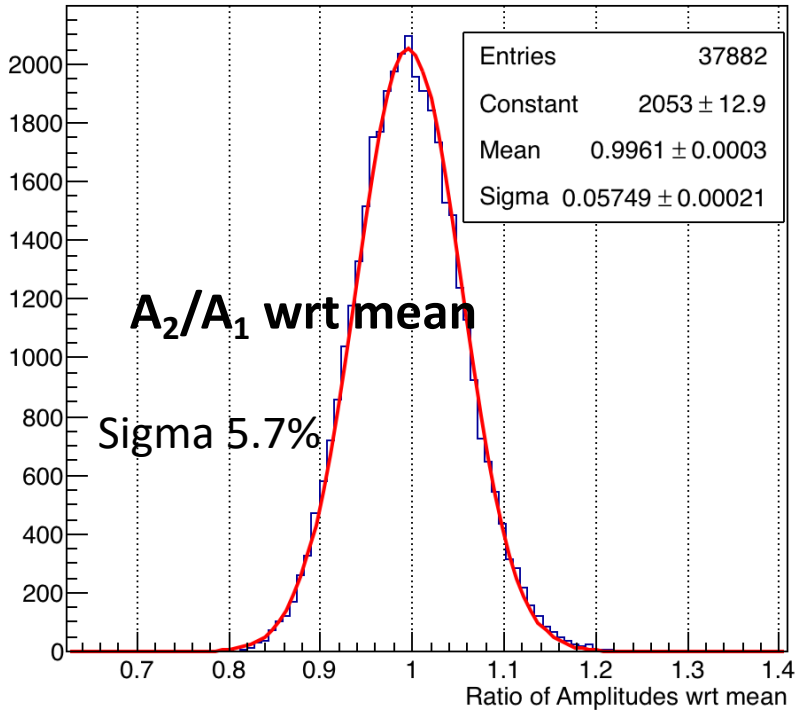
Scatter plot between amplitude 1 and amplitude 2 – almost no correlation for a particular channel – selected this for investigation. PMT fluctuations are larger than laser fluctuation.

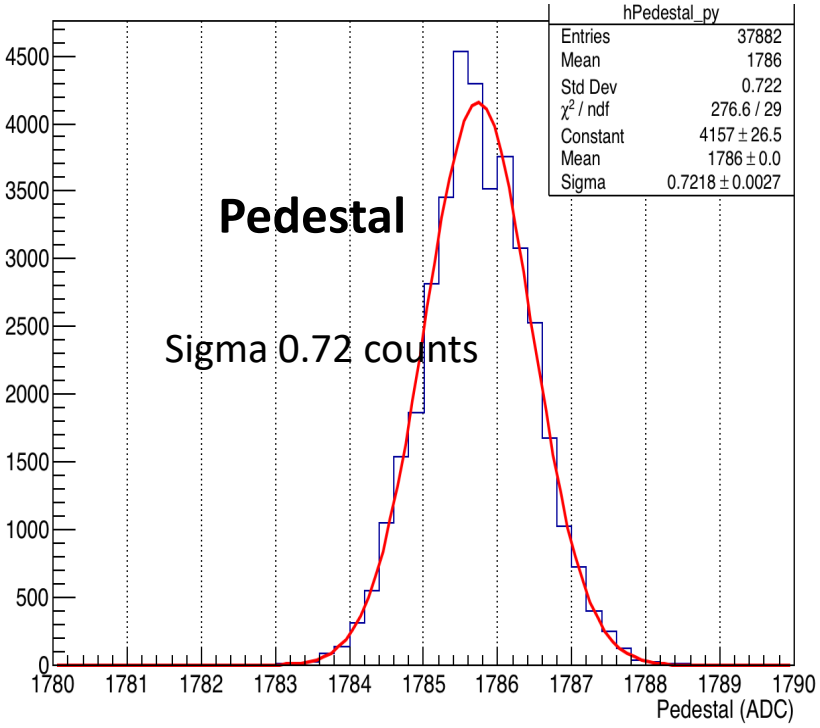


Stability checks – One channel



Stability Checks for a Channel



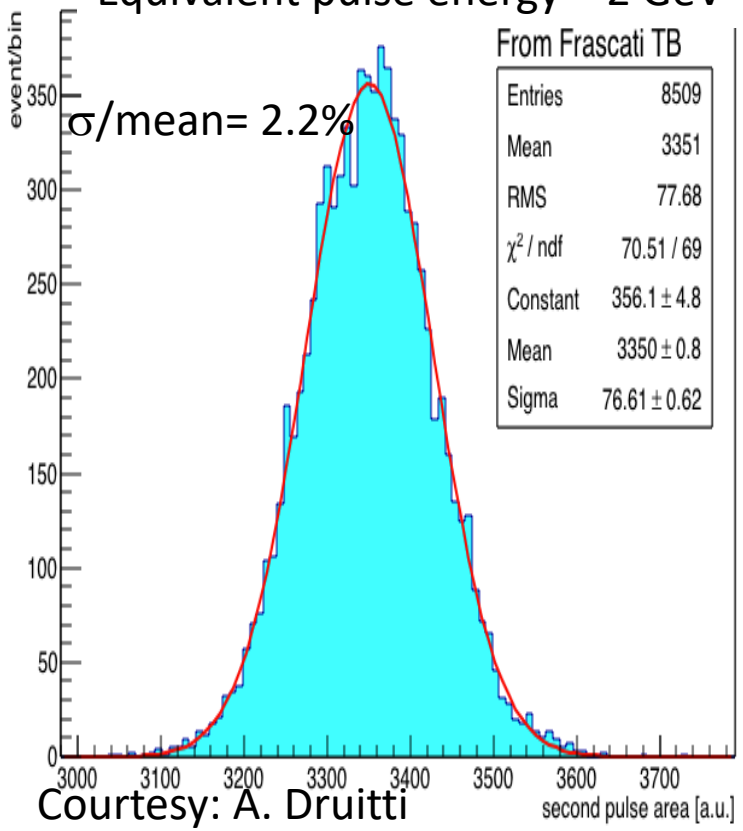


Perform this on all channels and study the variation of sigma (spread) to check stability of pedestal and amplitudes of both pulses. We also investigated the time difference t_2-t_1 for all channel (did not show it since we have just three time bins).

Area Studies

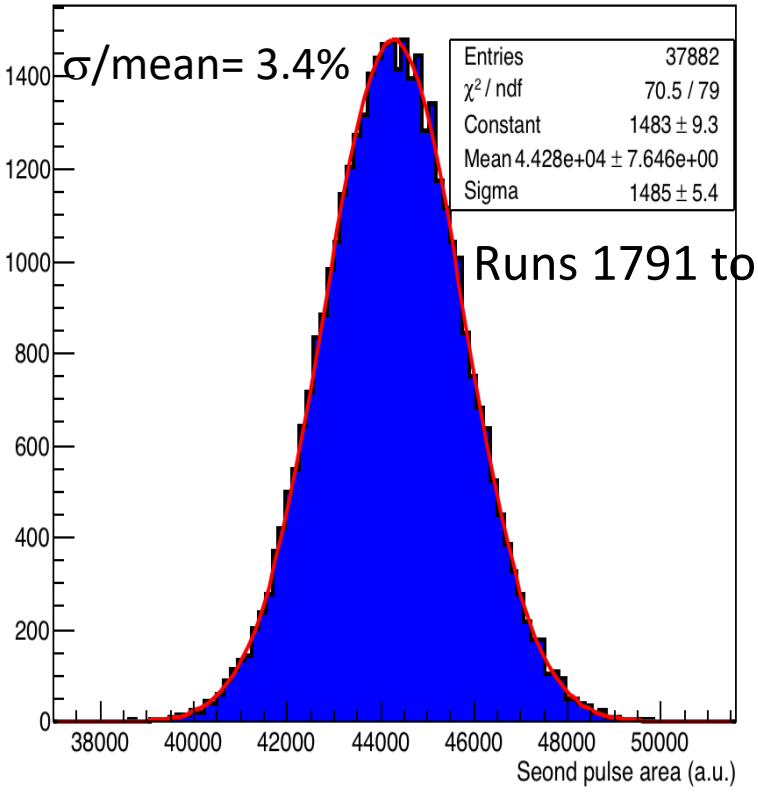
Fitted area distribution of all waveforms of each channel with a Gaussian and plotted the mean values and the reduced χ^2 . 8^{th} local monitor channel and second pulse area (right plot). Same for Frascati test beam (left). A broader spread un this run is due to smaller number of photo electron arriving at the calorimeter. The main effect corresponds to a factor of $\sqrt{2}$ on the σ (as observed).

Equivalent pulse energy ~ 2 GeV



Courtesy: A. Druitti

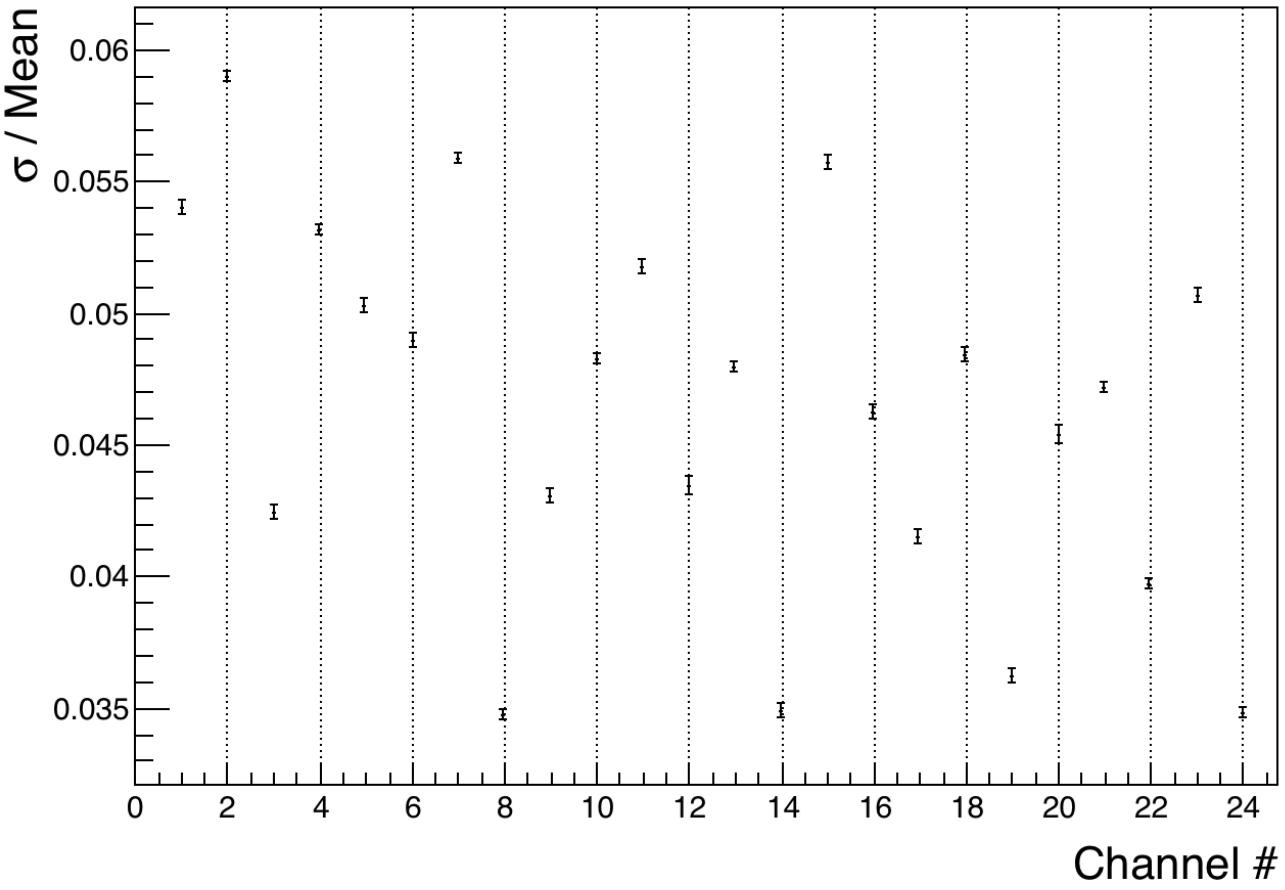
Equivalent pulse energy ~ 1 GeV



Runs 1791 to 1869

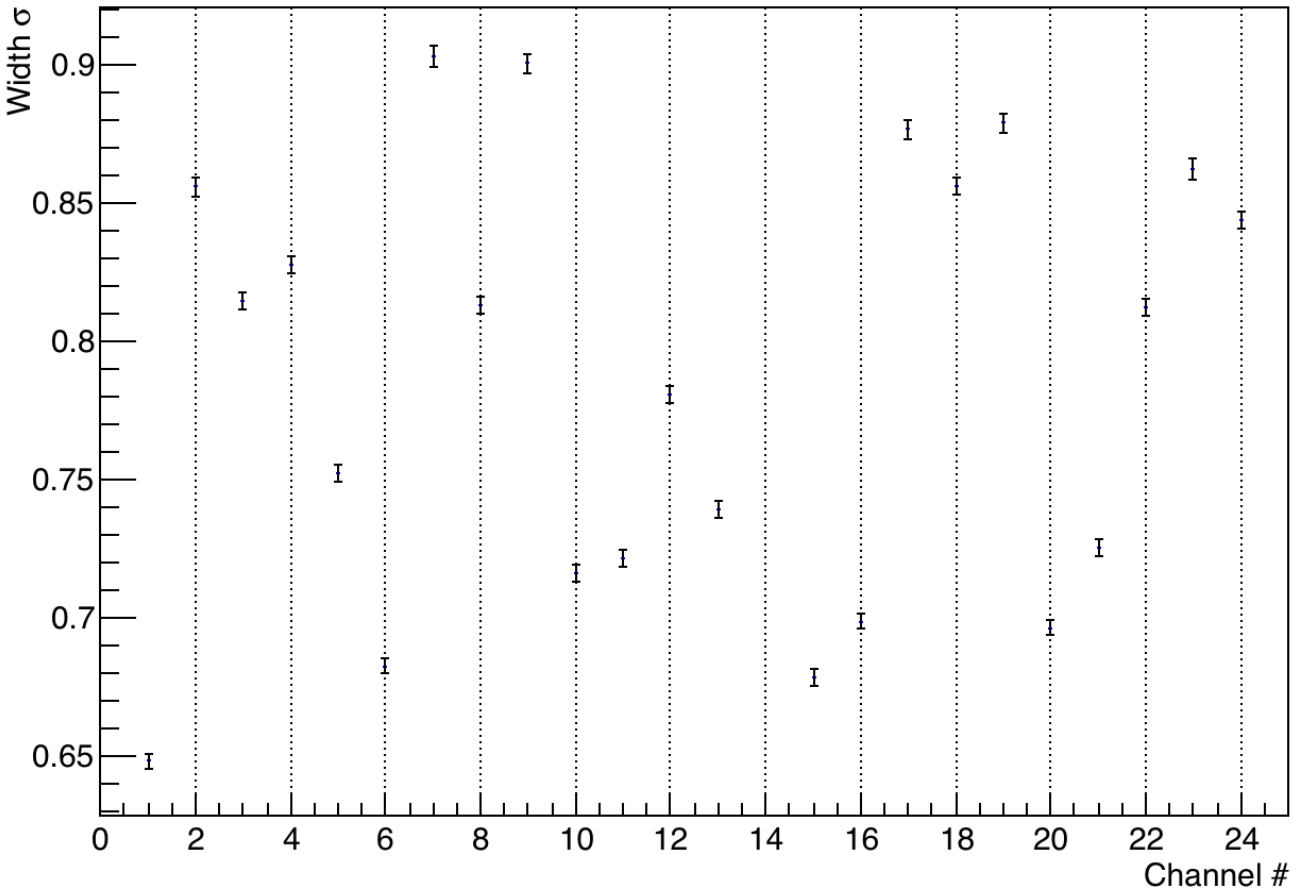
Area A_2 Width Vs. channels

Shows the sigma/mean (width) for all channel.



Pedestal Width Vs. channels

Shows the sigma (width) for all channel.



Summary of LM

Ratio σ/mean of area of second pulse varies from 3.4 to 5.9%, higher than the Frascati test beam (~2.5-3%) . A beam of laser light equivalent of 1 GeV compared to Frascati beam (of ~2 GeV), introduces a reduction by a factor of $\sqrt{2}$ in the width (i.e. ratio σ/mean) which depends on the number of photoelectrons (PE) arriving on the calorimeters .

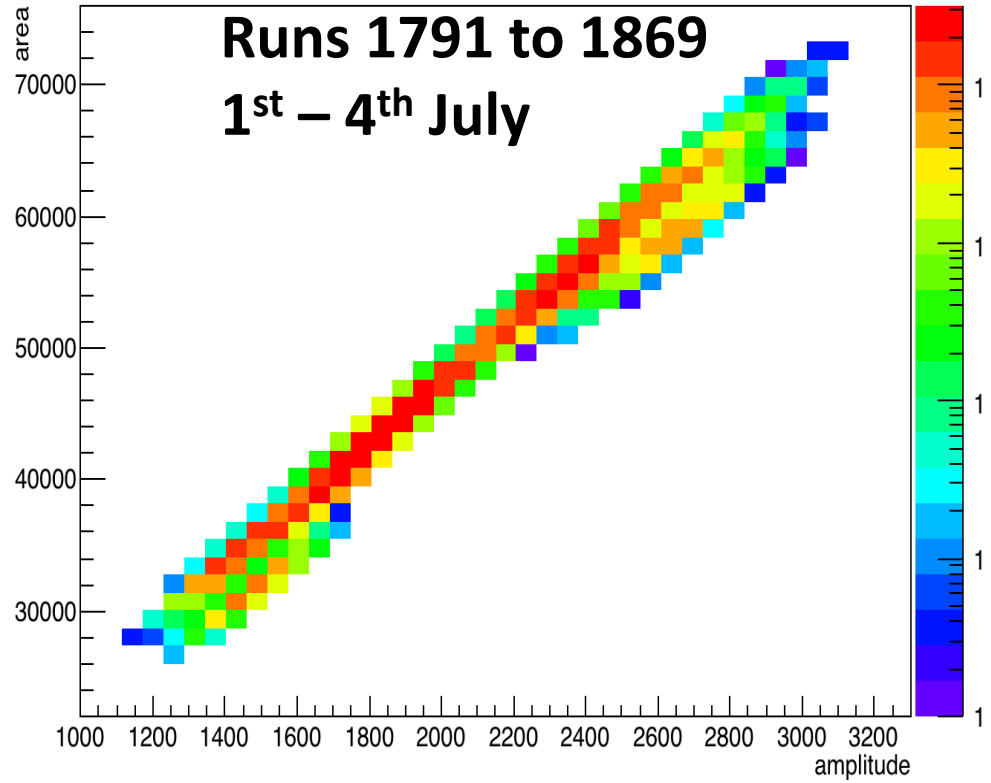
Conclusion

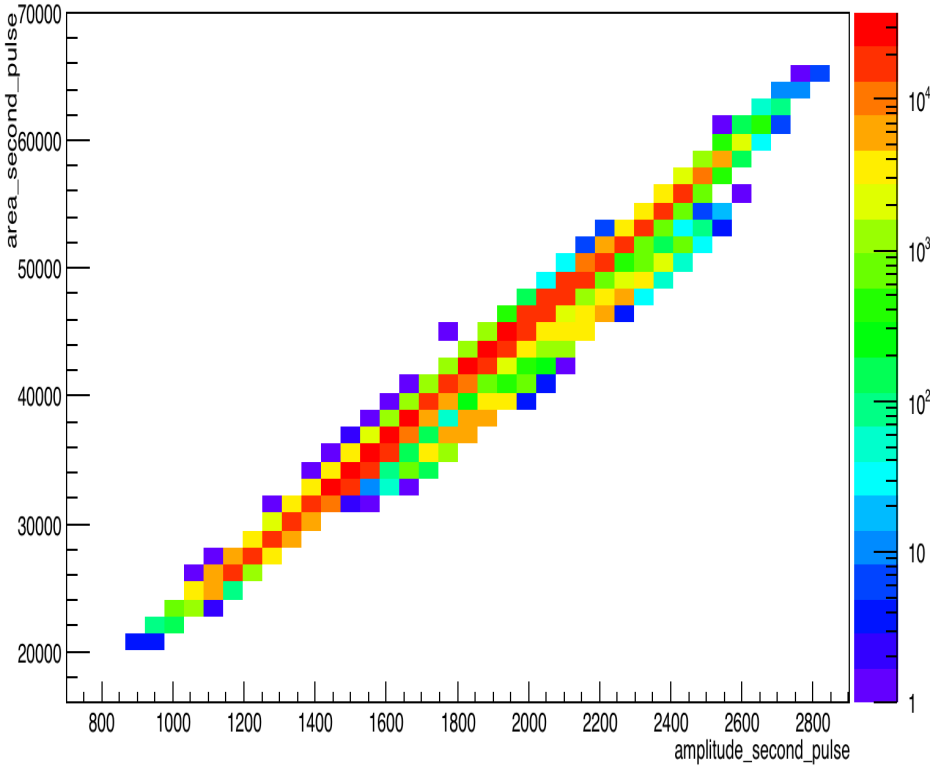
- The stability of the SMs measured by amplitude ratio of PiD1:PiD2 is generally good (of the ~10^{-4}), but some noise and temperature dependence have been observed, which we need to understand.
- LM don't see too much fluctuations. Optimization of light will stabilize and improve their behaviour.
- Redefining the parameters of the pulse (like pedestals, amplitudes, areas etc.) using a template fit or any other sophisticated fits might help in achieving a better stability of both the SMs and LMs.

Backup Slides

LM: Amplitude Vs. Area

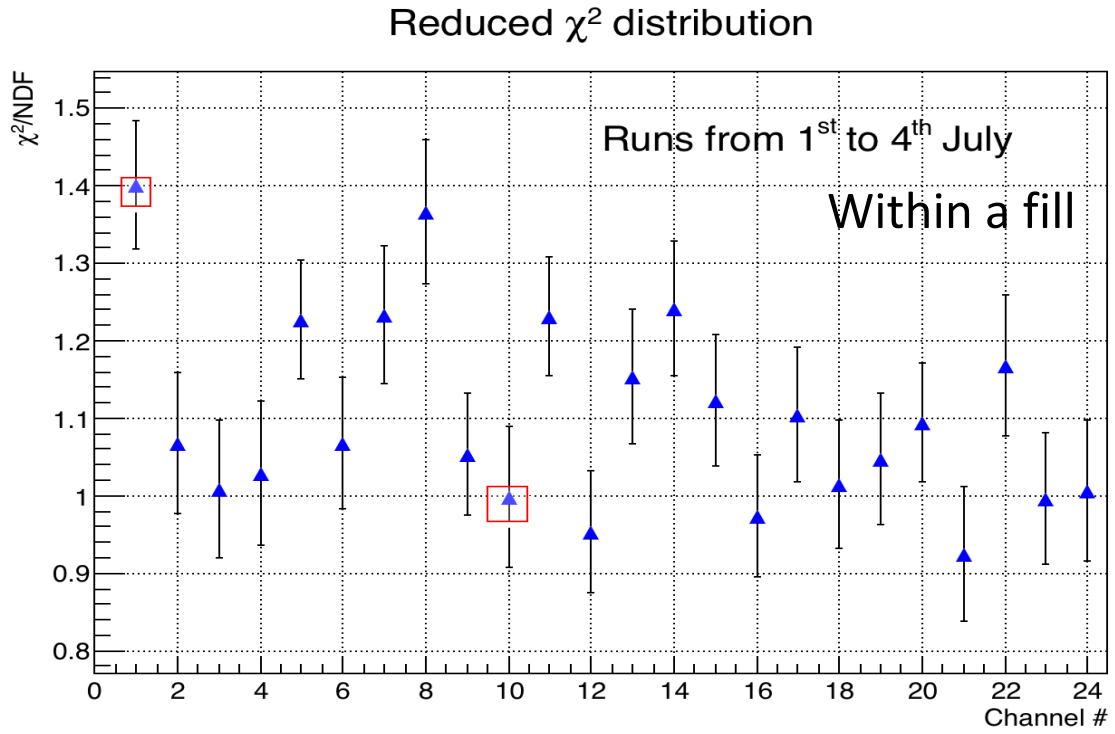
The amplitude and area are proportional as shown 1st pulse (left) and 2nd pulse(right) for channel 1.





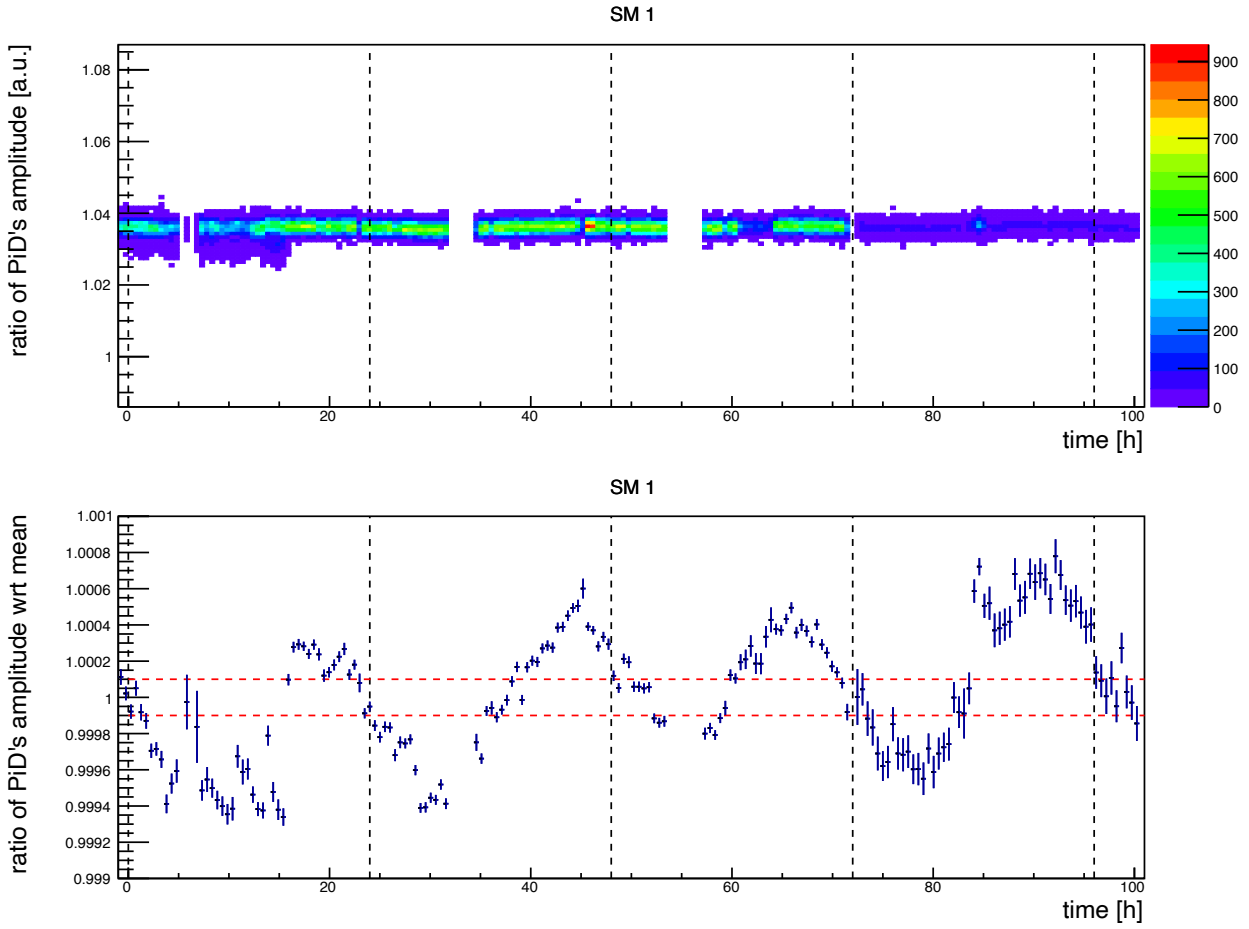
Amplitude Studies – First pulse

The Gaussian distribution of amplitudes for each channel is fitted and the reduced χ^2 distribution is plotted to chose a suitable channel.



Error is 1/[2*sqrt(NDF)]. Selected channel 10 (calorimeter 15) with least reduced χ^2 for time evolution studies.

SM1 from WFD's



The plot of ratio of pin diodes amplitudes only for source monitor 1 is shown here. All other monitors have similar behaviour

SM2 from WFD's