CMS ECAL Laser Source Performance in the 2003 Beam Test at H4

Adi Bornheim
CALTECH

WACH04
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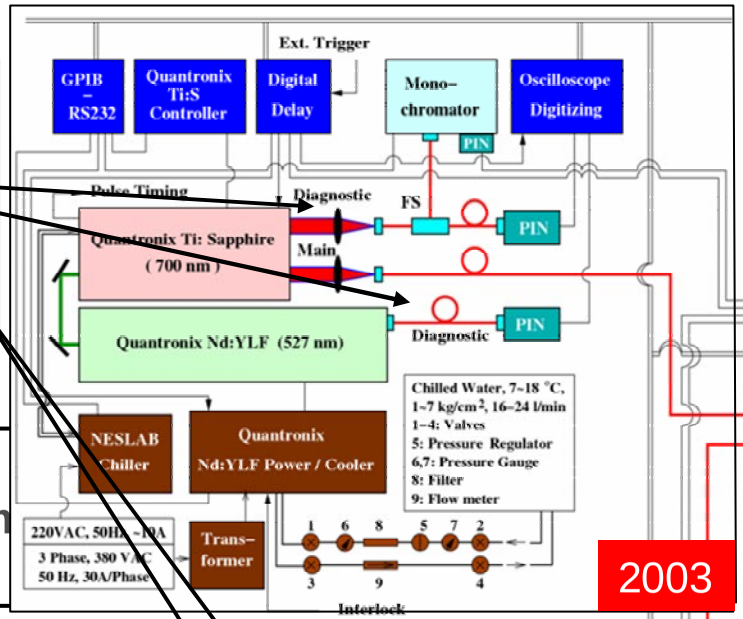
Laser source layout at H4

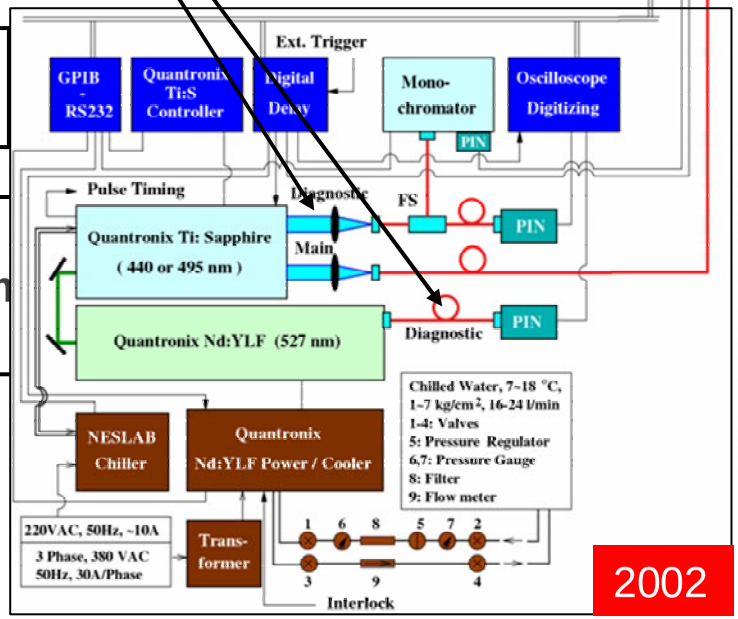
Monitor :
energy, pulse width, timing of pump laser and main laser

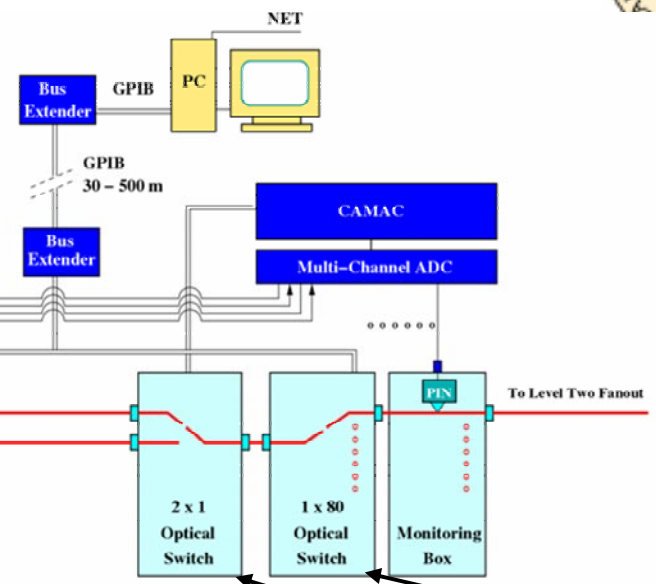
RED Laser:
Provides **700 nm** and **800 nm**

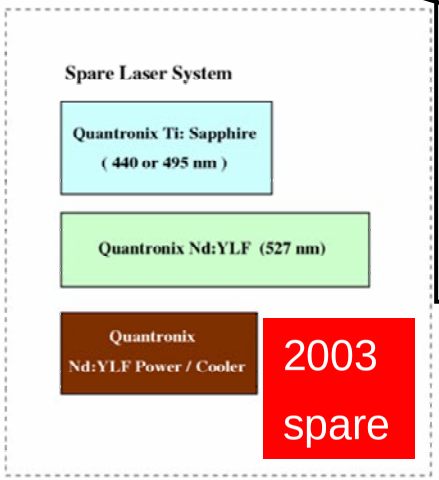
Switching 700↔800 or 440↔495 is done inside the laser ('slow', > 1 min)

BLUE Laser:
Provides **440 nm** and **495 nm**







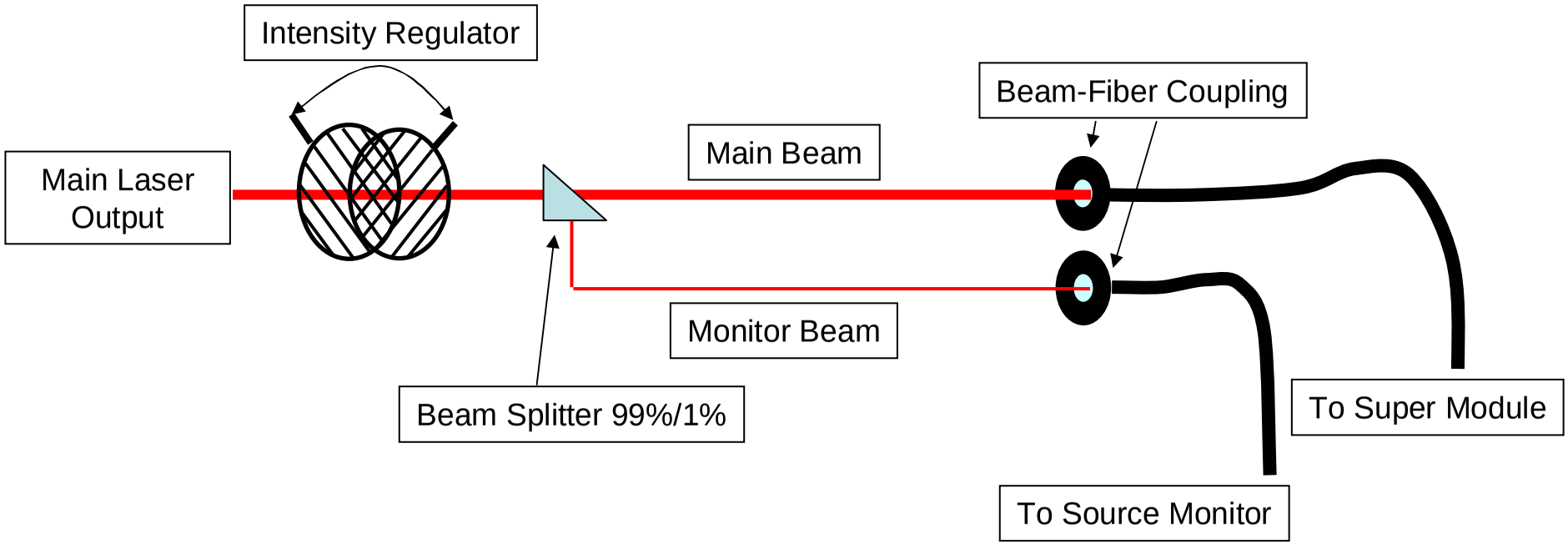


2x1 and 1x80 switch :
2x1 selects red or blue laser,
1x80 switch selects SM

Switching from 'red' to 'blue' is 'fast', < 30 sec

Caltech June 13, 2002

Few Details on the Source Monitor



Few Notes :
Laser max pulse rate is 100 Hz, Laser source monitor DAQ runs at 1Hz
Laser Source Monitor integrates the laser pulse signal from a diode with a digital scope
Laser source monitor is meant to help to adjust and monitor laser performance
Intensity regulator is not a high precision (sub %) device, at very low intensity settings
The intensity measurement of the source monitor is (can be) calibrated with a photometer

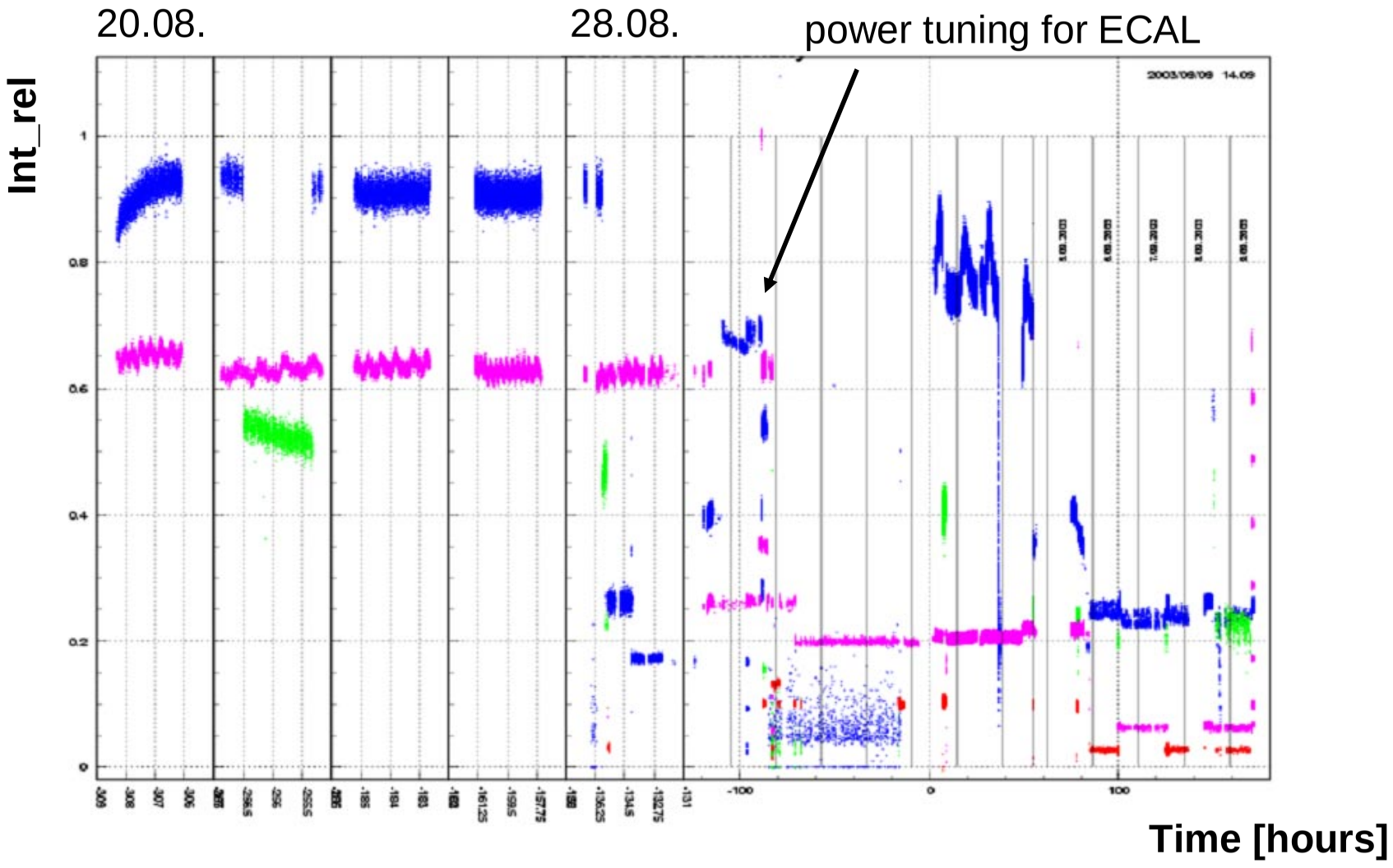
Source Monitor

Pulse Energy : 1.0/0.6 mJ at 440nm/495nm, spec. was < 10 % RMS
traditionally one quotes a long term (many hours) and a short term (consecutive pulses) stability.
Later in this talk I will add very long term (month).

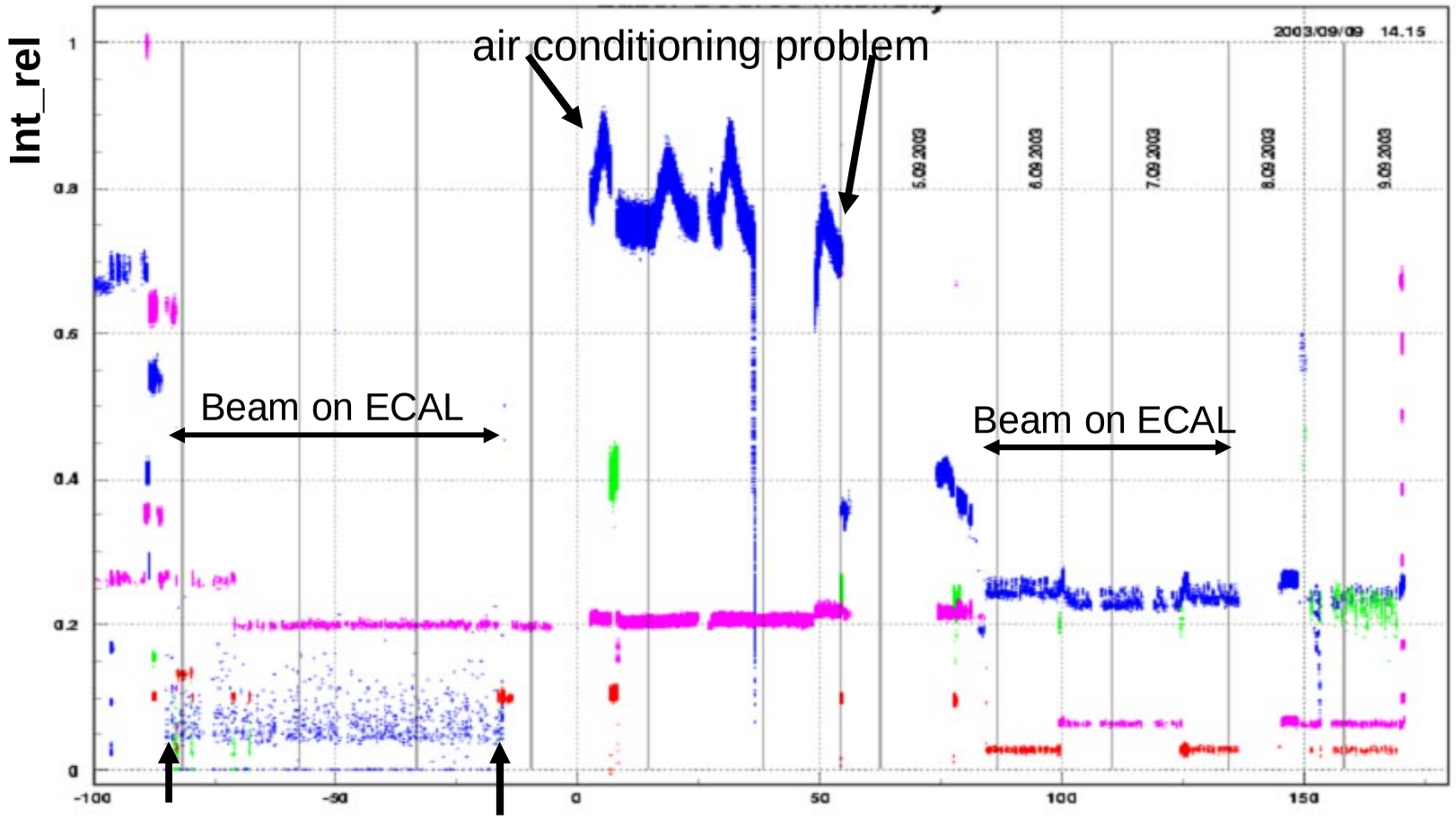
Pulse Width : spec. was < 40 ns, but 2002 revealed that for FPPA much shorter would be much better. For MGPA less of an issue (?).

Pulse Jitter : Pulse timing, again long/short term, typically <4 ns / < 2 ns

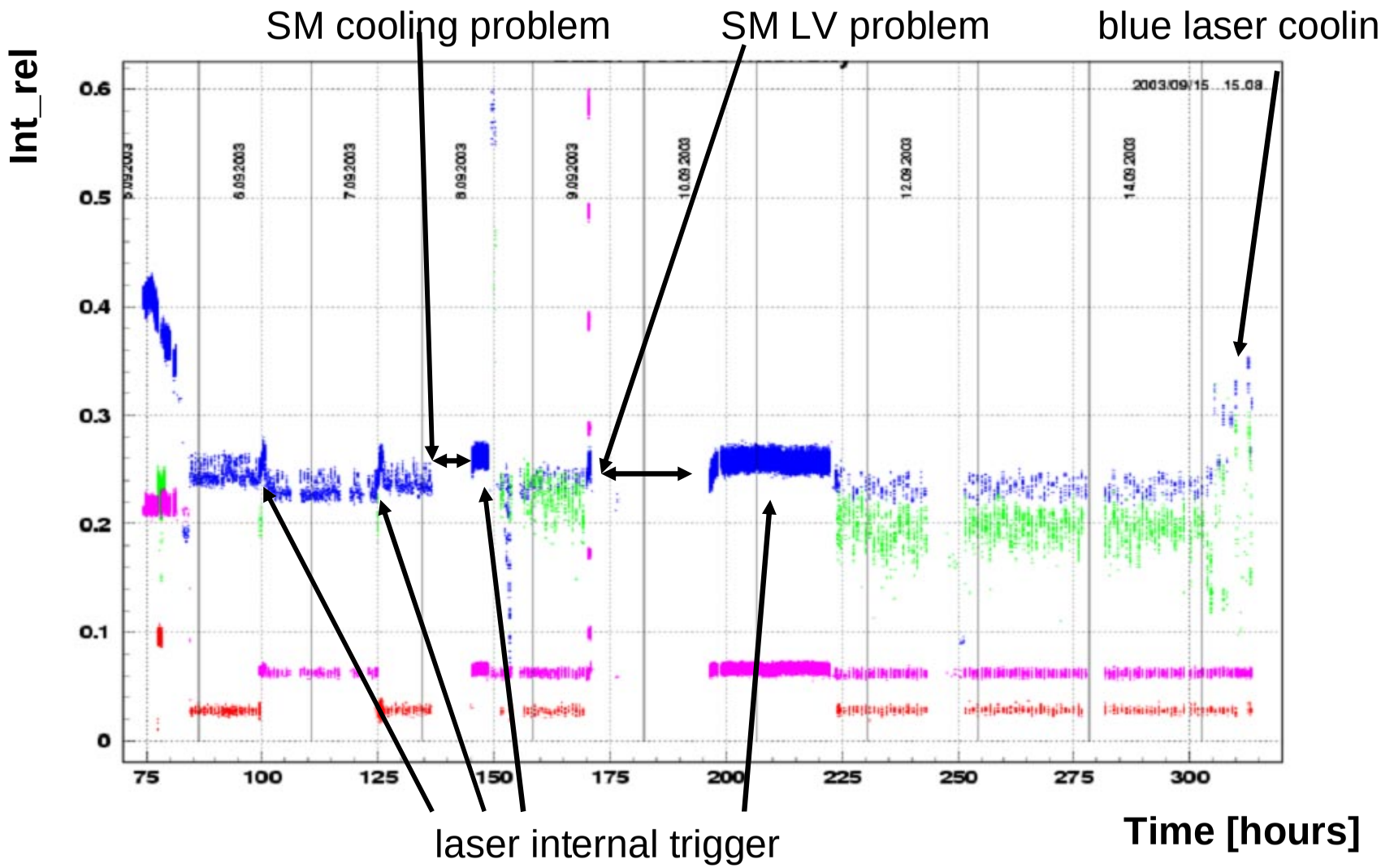
Laser Power History - Setup Period



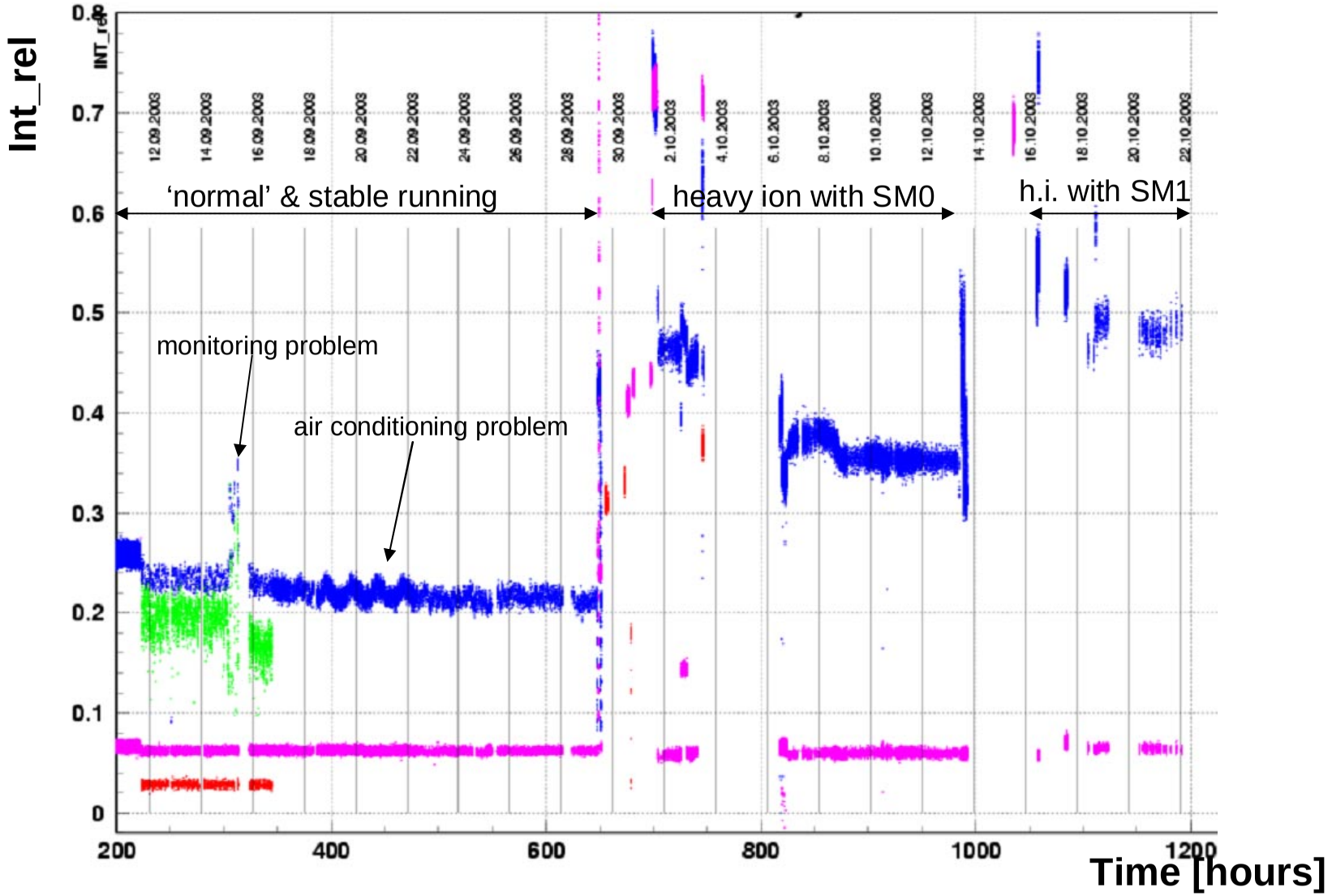
Laser Intensity at H4 for all wavelength



Power History (cont.)

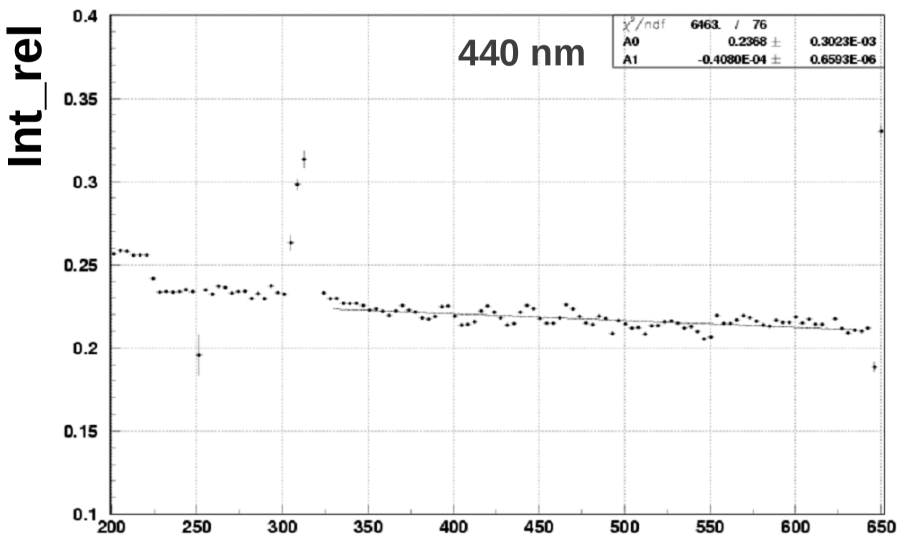


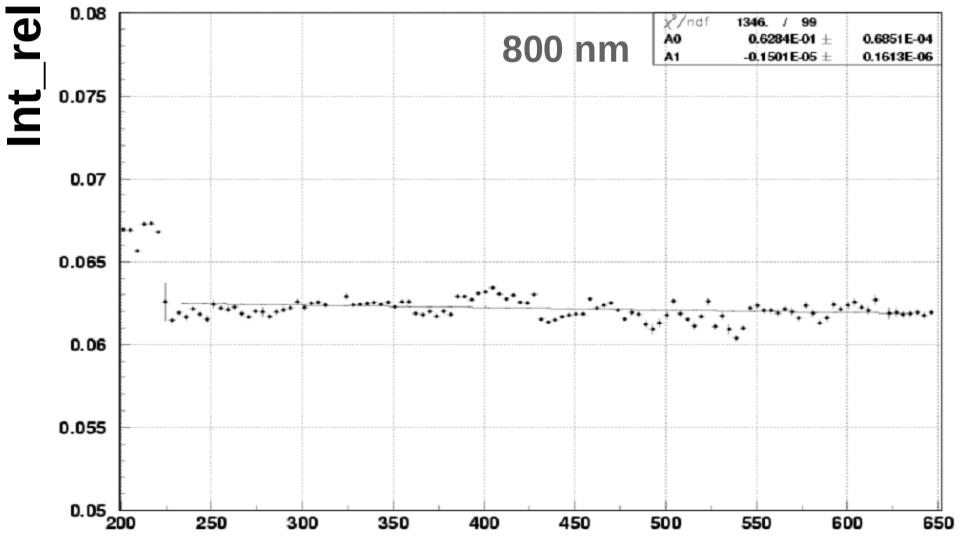
Pulse Energy History (cont.)



Long Term Pulse Energy Degradation

Pump lamp for pump laser degrades over time → Pulse energy degradation for constant pump current





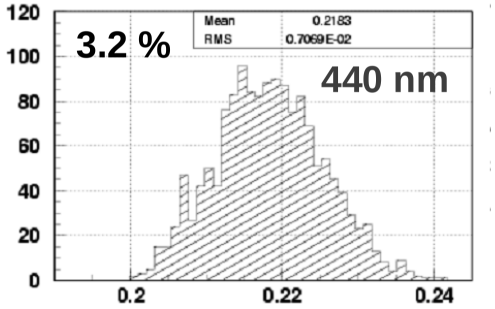
For blue laser (runs at higher pump current) :
Mean degradation : 0.41%/day - 12.4%/month

For red laser :
Mean degradation : 0.057%/day - 1.72%/month

This can be compensated by increasing the pump current and replacing the pump lamp.
The pump current adjustment can be automated with a feedback system.
It was decided to not touch the lasers during the period shown above to ensure stable running.

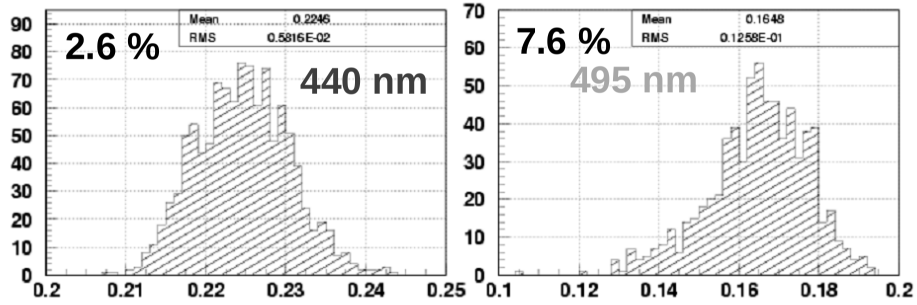
Pulse Energy Stability

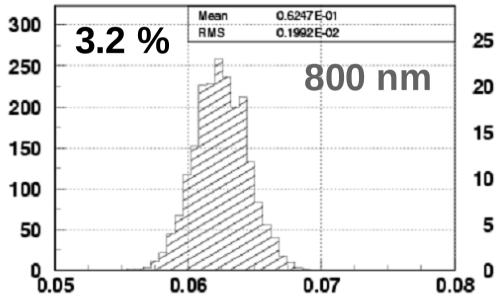
t_{ref} : 400 - 425 h

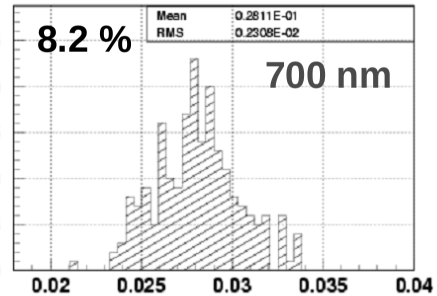


Stability over 25 h

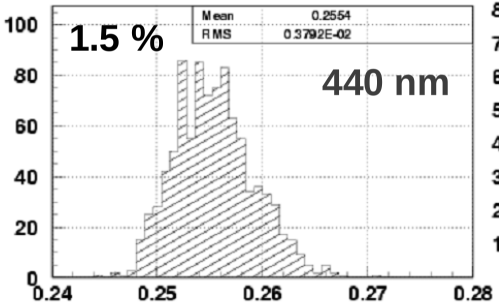
t_{ref} : 330 - 335 h

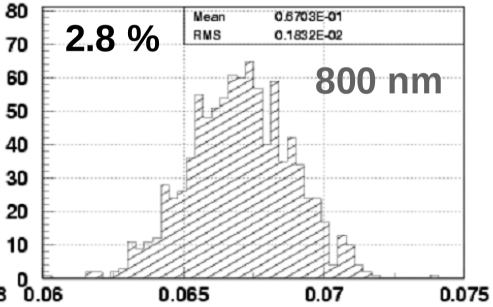






t_{ref} : 200 - 200.5 h

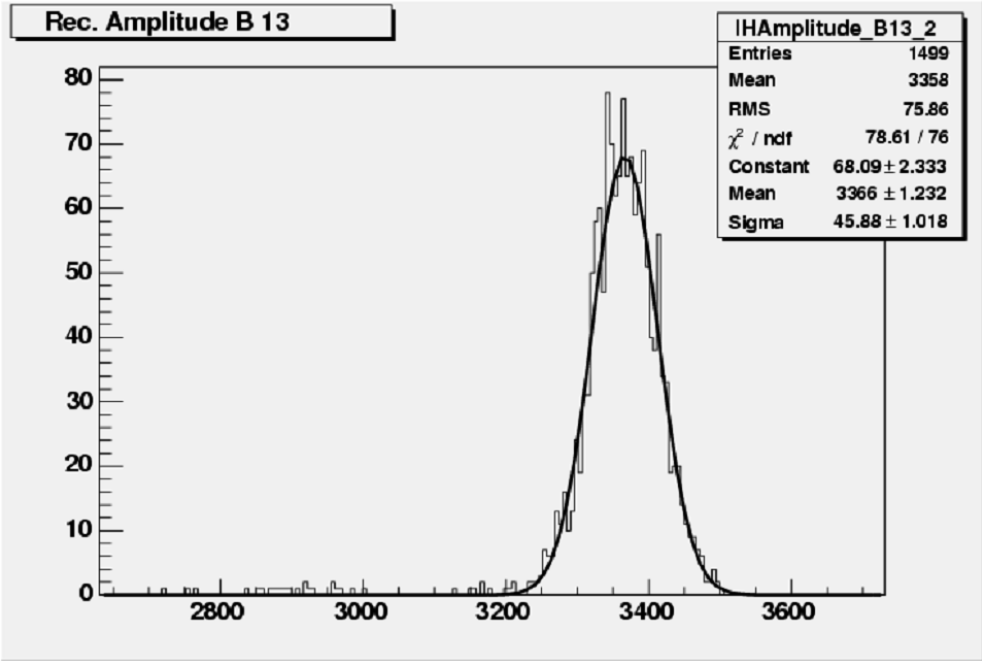




Stability over 30 min

Comparison : Source Monitor - ECAL

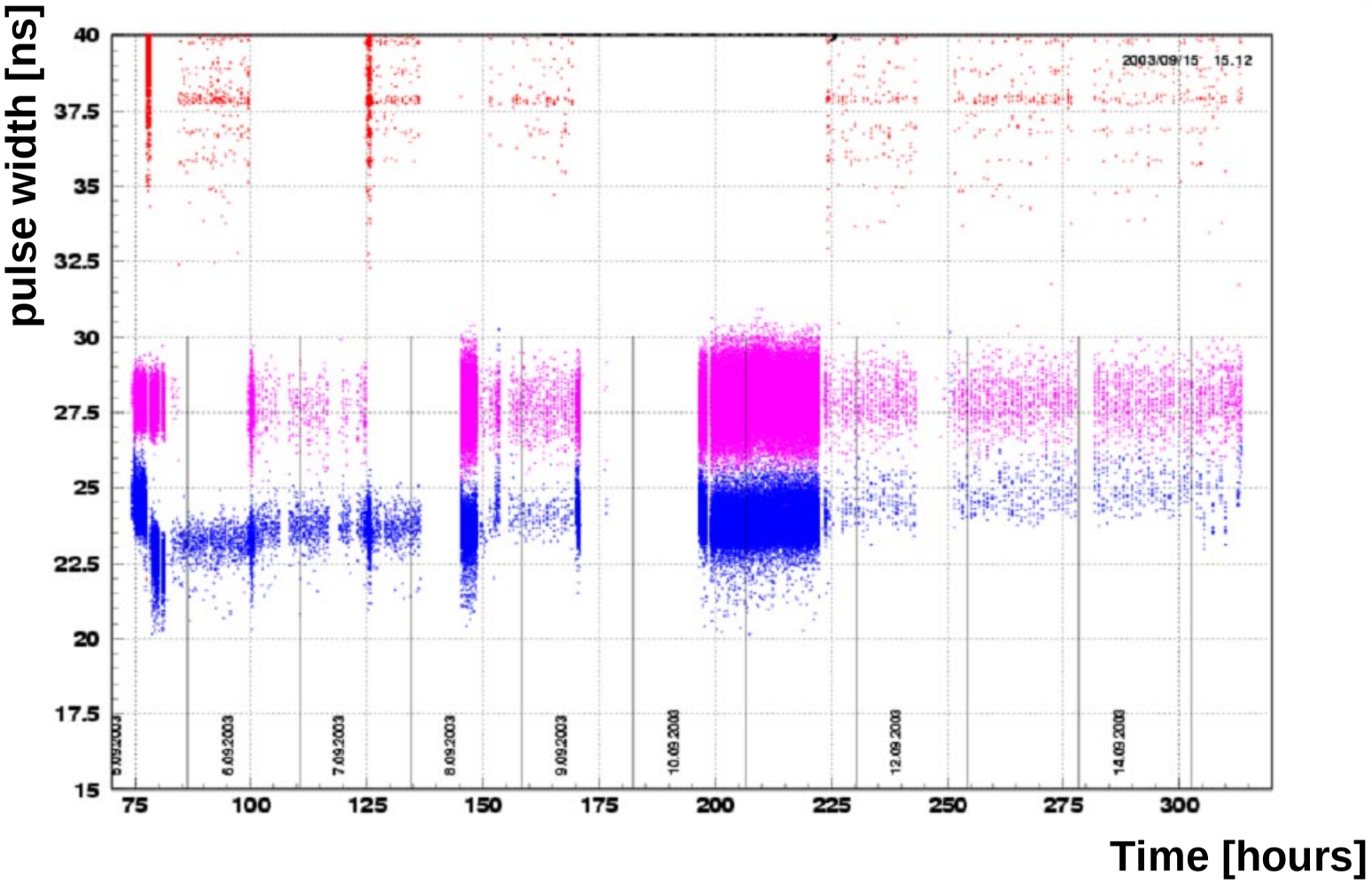
Short term pulse energy is compatible with ‘resolution’ of laser runs as seen by the ECAL :



σ =1.36 %

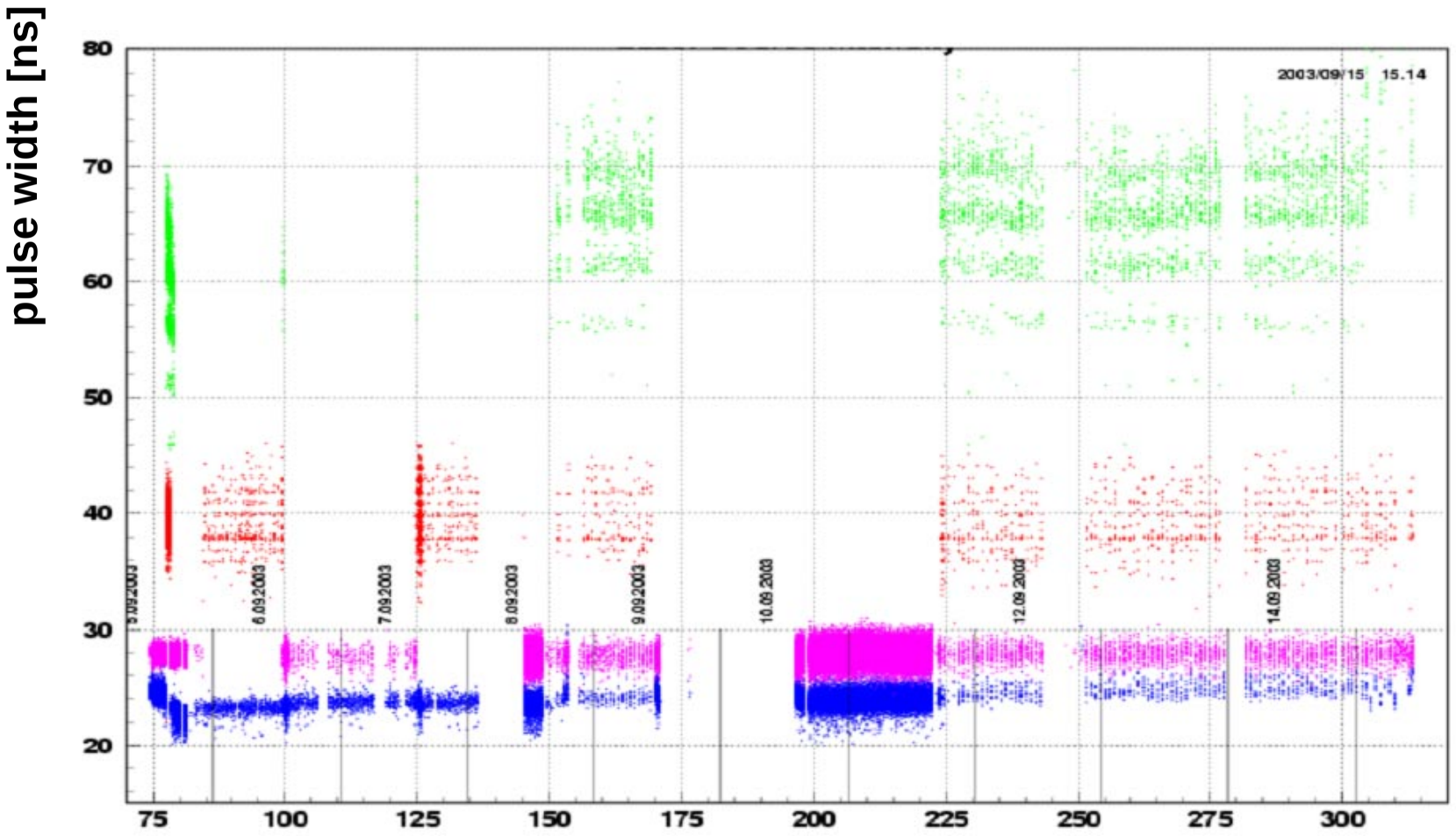
Laser Run 64984, single crystal, 17.09.2003

440nm/800 nm pulse width

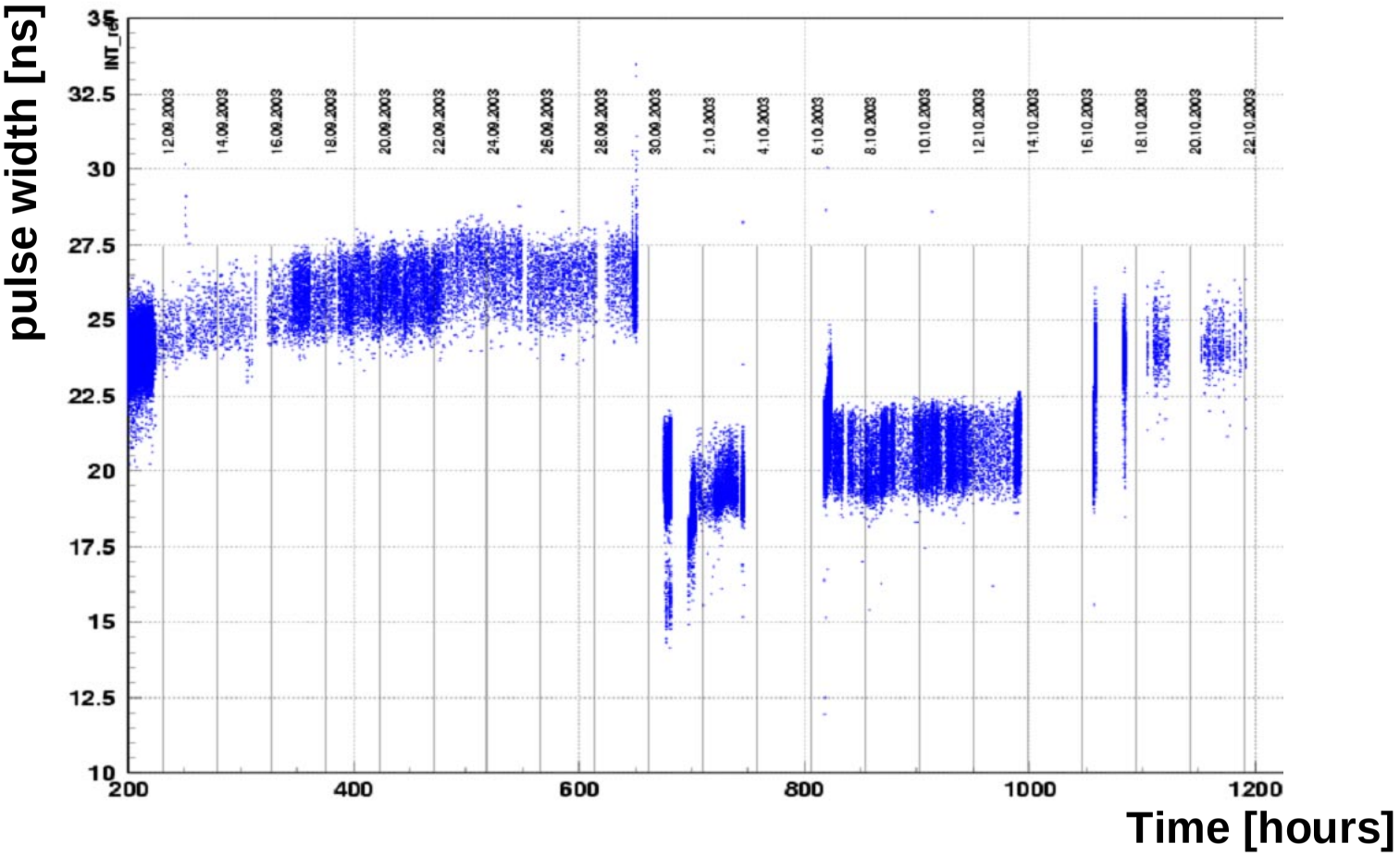


Pulse width is anti-correlated to the pulse energy !

All pulse width



Pulse Width 440nm - Long Term

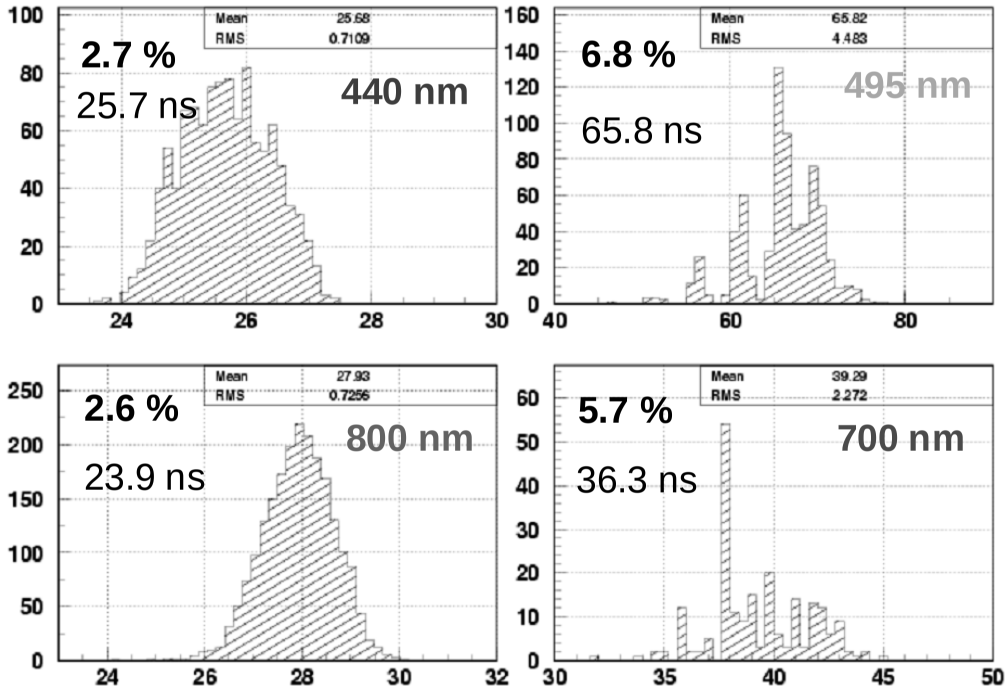


Pulse width degrades in the same way as the pulse energy. With new lamp down to 20 ns !

Pulse Width Stability

t_{ref} : 330 - 335 h

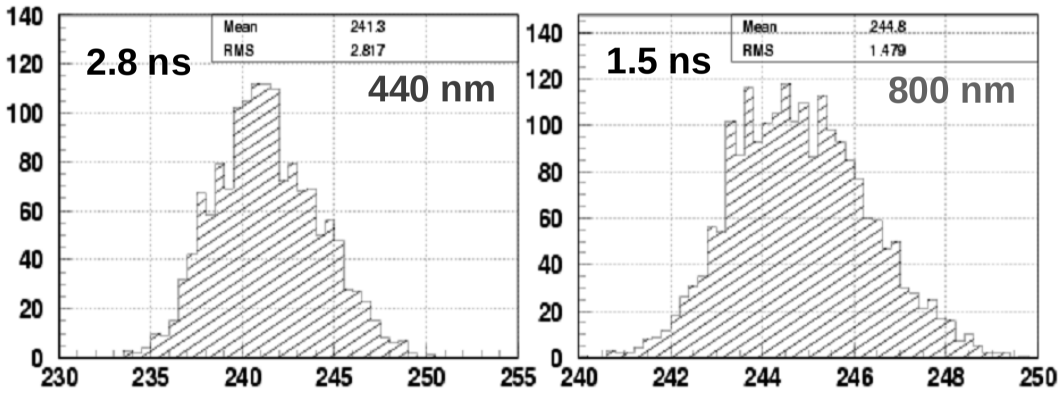
Stability over 25 h



pulse width [ns]

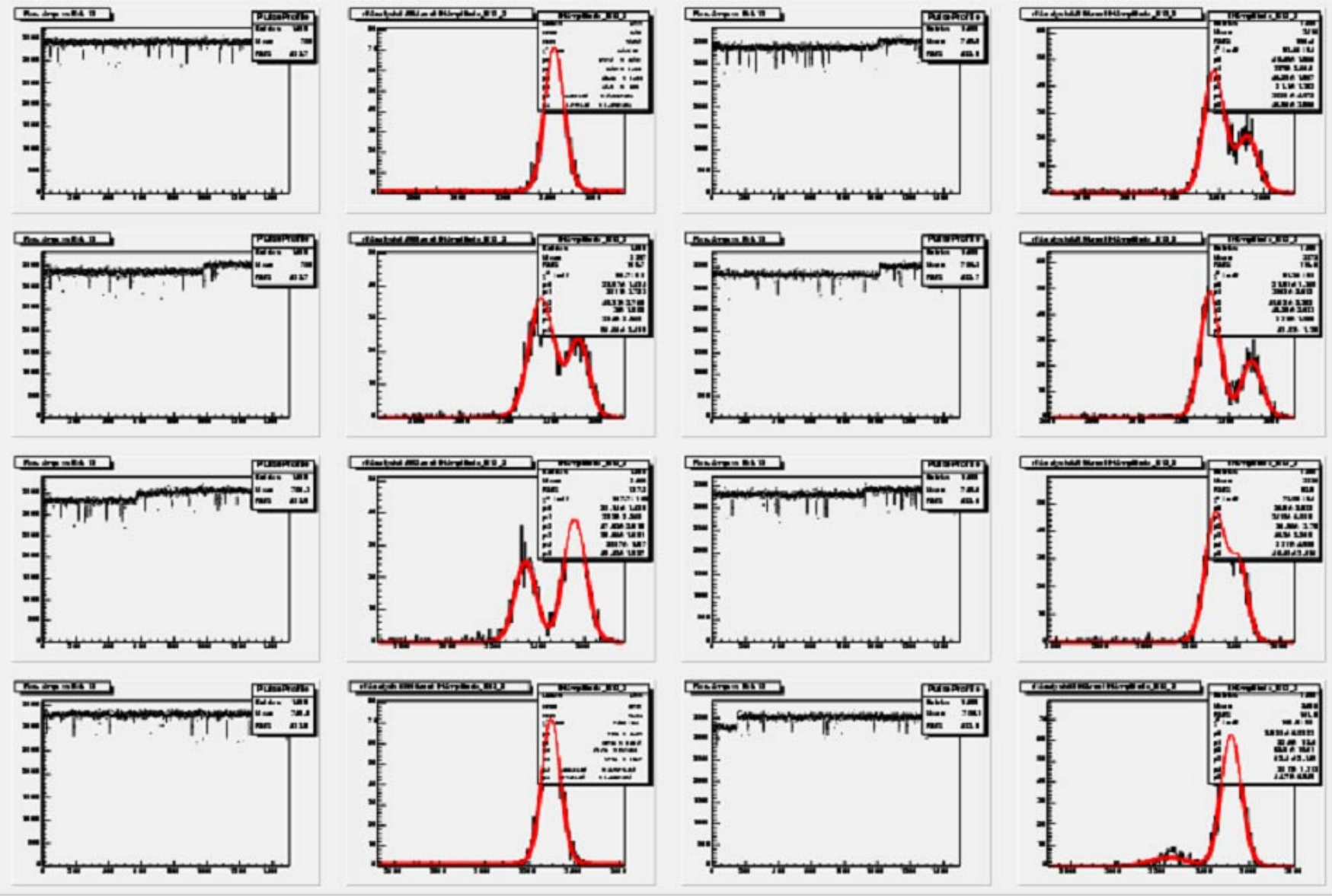
The requirements on pulse width and pulse width stability depend somewhat on the electronics used.
If needed one could force down the pulse width (see eg. previous slide).

Pulse Timing Jitter



Pulse timing jitter is anti-correlated to the pulse energy jitter !

Instabilities in Laser Runs as seen by ECAL



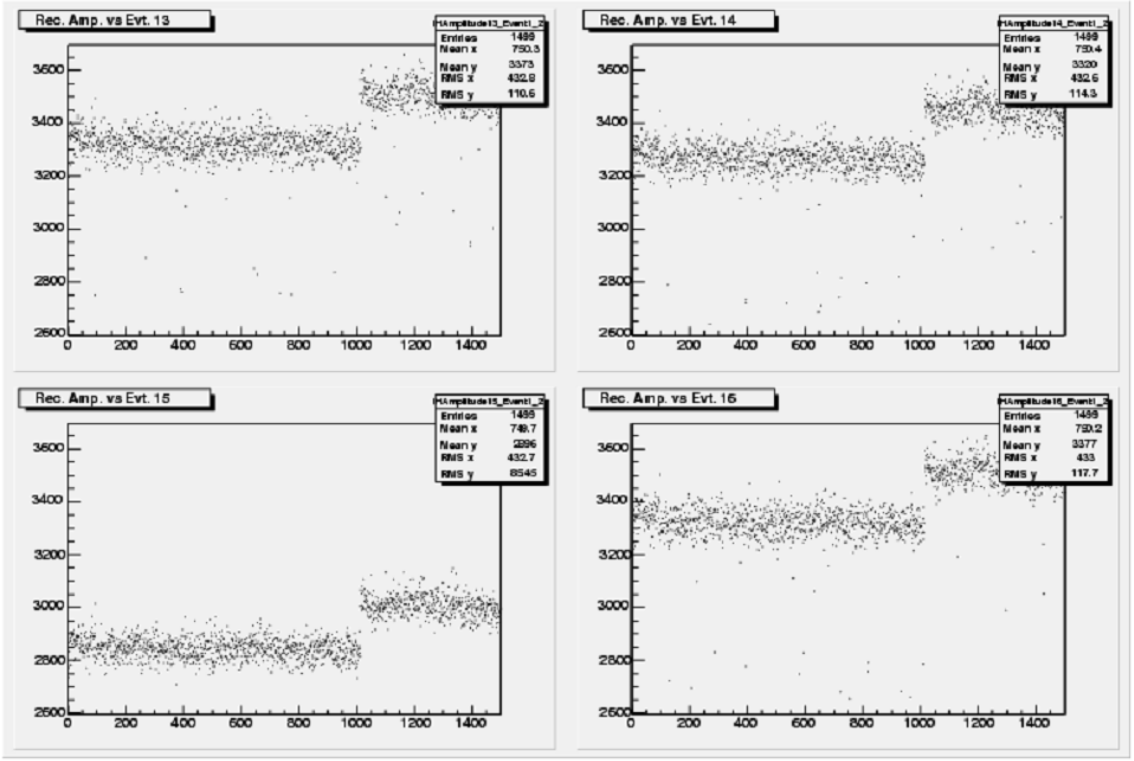
? Laser Run Jumps in ECAL ?

Some Features of the jumps :

- Most runs show these jumps.
- They are always in all crystals.
- The size of the jumps varies, it can be up to 10%.
- It seems to happen at random times during the run.
- It seems to be only in FPPA data.
- The jumps are always upwards.

→Patter and size makes it unlikely that this is an actual laser intensity fluctuation.

?? Any ideas ??



This hinders studies on long term stability - Maybe by selecting ‘good’ laser runs this can be overcome.

Summary

- Laser performance in 2003 beam test was very good.
- Well within design specs. As good as in Caltech after setup.
- Laser performance critically depends on a stable environment – air conditioning, water cooling, cooling water quality. H4 barracks are barely good enough.
- Stability could be improved if needed.
- Performance varies a lot between different wavelength which should be considered in the analysis.

- Detailed studies on systematic effects in laser runs and on the long term stability of the ECAL are under way.