Laser Monitoring analysis status

2010, April, the 29th
ECAL Days

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On behalf of the LM team

Outline

1. **Introduction:**
   - LASER control and DAQ software status
   - New OMDS LM schema status
   - Analysis status

2. **“Convolution method” and new LASER pulse shape corrections**

3. **New PN linearity corrections**

4. **Histories and stability maps for:**
   - **TP**
   - **IRed LASER**
   - **LED**
   - **Blue LASER**

5. **Conclusions**

LASER control and DAQ software status

Philippe Gras

1. Laser supervisor OK (DAQ interface), latest features:
   - error robustness: auto recovery , reset possible on the fly (during a run), robustness of laser data acquisition wrt LED control problems
   - error report system with online help to solve the problem
   - automatic laser intensity scan for linearity measurements

2. LASER controls stability: **http://indico.cern.ch/conferenceDisplay.py?confId=91986**
   - several expert on-call interventions end of March
   - OK in April. But running stability improvement not fully understood.

3. Sequence duration:
   - 2007's monitoring sequence design document: 28 mn (blue+IR laser)
   - current status: 48.5 mn
     - 11mn extra time from laser region switching (slower than expected)
     - 9mn extra from LED (can be reduced to 8mn)
   - reducing switching time to 2 sec per move would permit to achieve:
     23mn (blue+IR), + 4mn extra time per LED color

4. Acquisition:

   No acquisition during fills, needs to be addressed

New OMDS LM schema status

Gautier, Philippe, Giovanni Organtini

1. New schema defined:

   - 3+3 parameterization (3 times, 3 values) of calibration constants, providing continuity of the constants between IOVs
   - Filling time interval without measurements and keeps track of it
   - Supporting versioning: if needed, data can be reprocessed
   - Full tracking of computation from laser primitives to calibration constants

2. Mini-workshop held in Saclay with Giovanni Organtini on April 15th

   - Very fruitful
   - Agreed on final schema details and on reading/writing code

3. Implementation status

   - Tables in place in a test database and validated
   - Code for writing and reading data under finalization (Giovanni Organtini)
   - Move to new schema is transparent to offline code: change made at O2O level

Analysis status

1. **Processing APD (VPT) LASER amplitudes with both the $\alpha\beta$ method and the "convolution method" in parallel:**

    - $\alpha\beta$ have been calculated on dedicated data
    - APD and VPT Single Pulse Responses (SPR) obtained for each channel on same dedicated data

2. **Refined PN linearity corrections and PN amplitude fitting functions (computed for each PN on dedicated data)**

3. **Dependency of APD(VPT)/PN with LASER pulse changes, formerly corrected with LASER FWHM from MATACQ, now corrected with both LASER pulse and SPR information**

    - known and universal dependency
    - correct APD(VPT)/PN for all LASER behaviour changes (width, tails,...)

APD (VPT) amplitude calculation: convolution method

Marc Déjardin

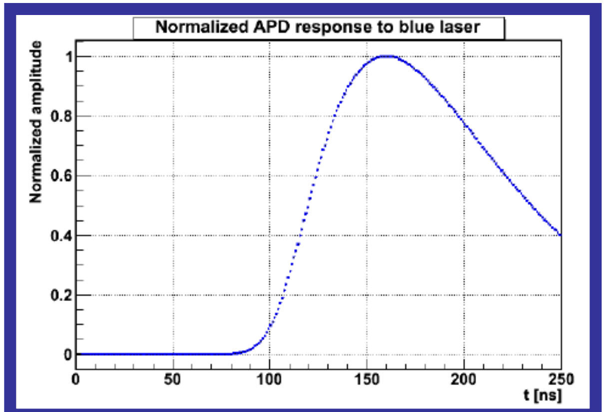
Detector Note-2008/001 (draft)

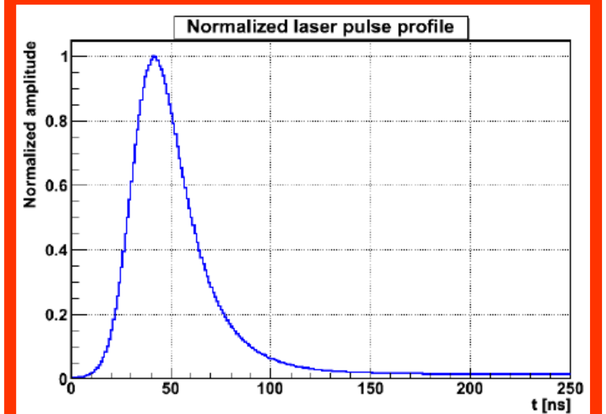
• **Idea:** instead of an analytic function, use the real signal shape by convoluting APD (VPT) SPR with the laser pulse shape from MATACQ

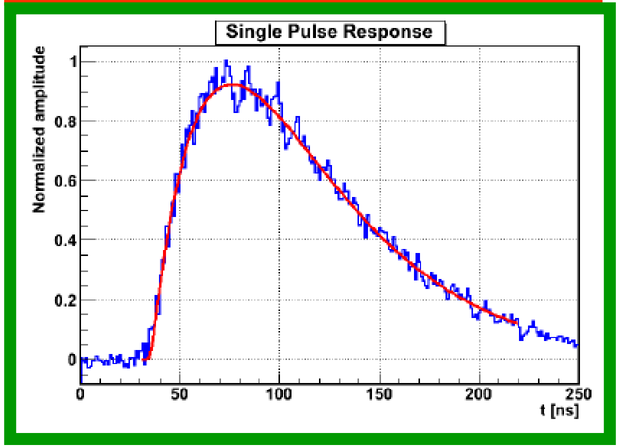
• **Method to get SPR:**

- Get the APD(VPT) response with a fine sampling on dedicated data exploring the full range of phase within the LHC clock (data taken by adding delays in the laser trigger line)
- Get the LASER pulse shape from MATACQ on the same data
- Deconvolute the APD (VPT) SPR using Fourier Transforms

• **In the LM processing:** convolute this stable APD SPR with the laser shapes from MATACQ sequence by sequence to get the APD (VPT) amplitude fitting function







APD (VPT) amplitude calculation: convolution method

Detector Note-2008/001 (draft)

- EE and EB electronics do not have the same responses, thus their SPR have been parameterized by two different functions:

EB APD

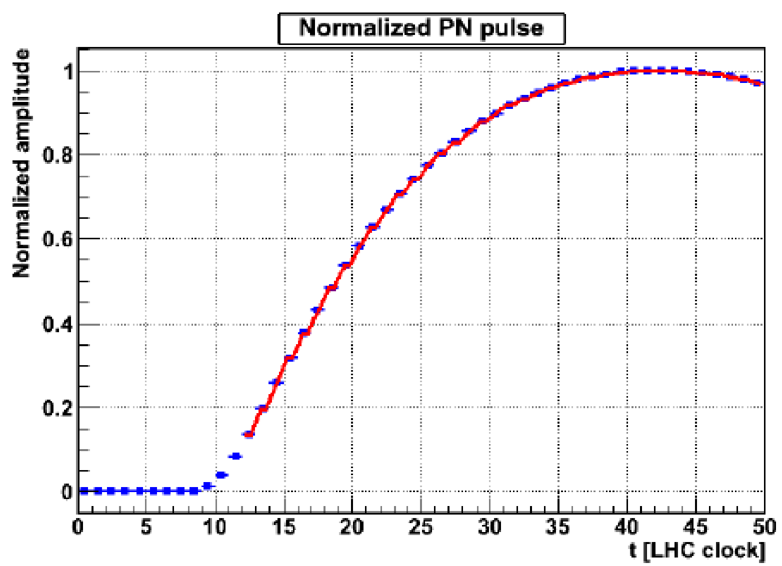
$$h(t) = \frac{t}{\tau} e^{-\frac{t}{\tau}}$$

EE VPT

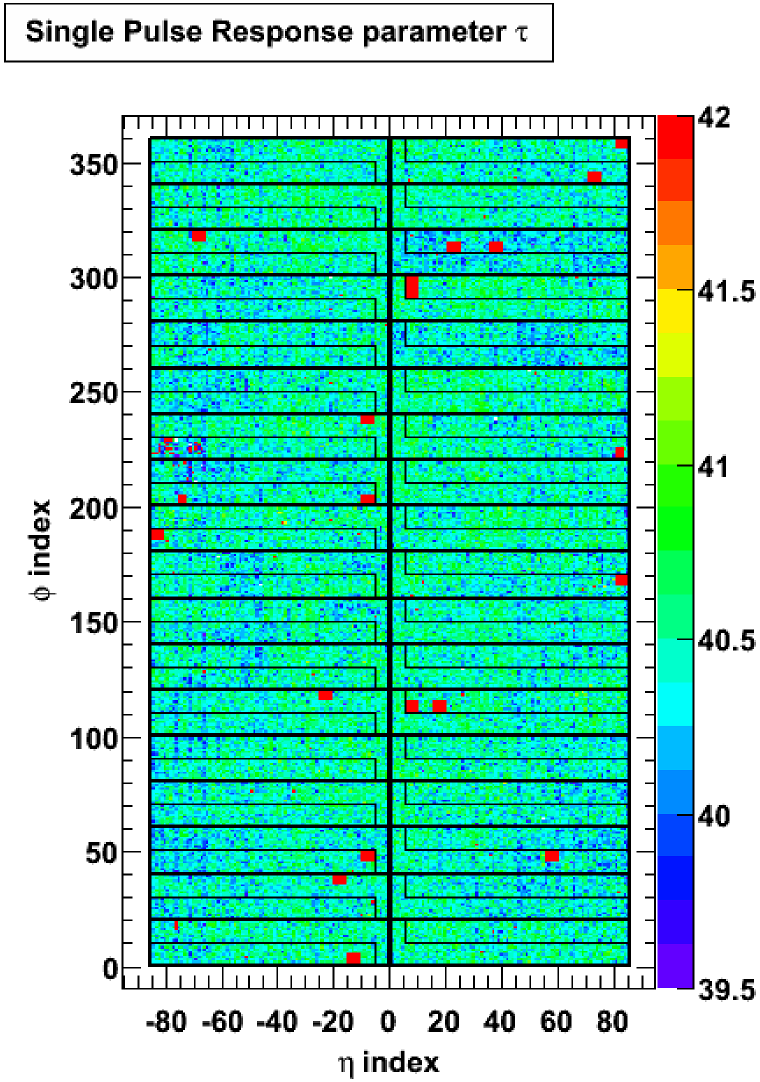
$$h(t) = \frac{t}{\tau_1} e^{-\frac{t}{\tau_1}} * e^{-\frac{t}{\tau_2}}$$

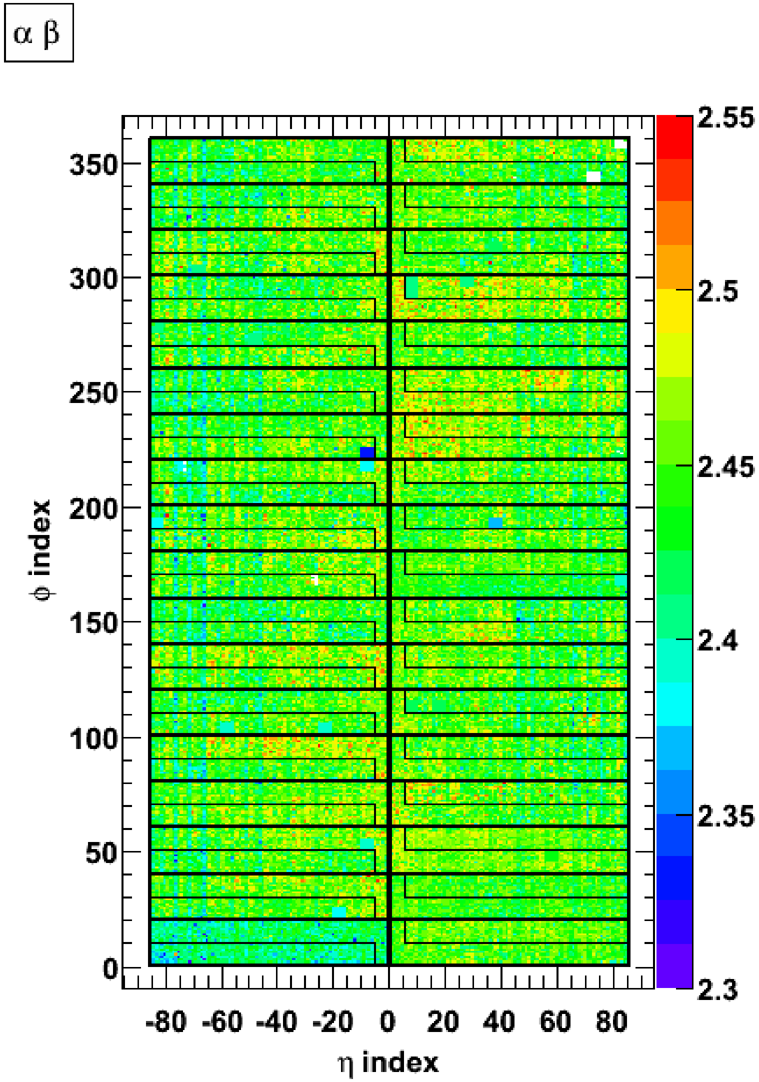
- SPR determination and parameterization has also been done for PN signals:

Example of PN signal and superimposed SPR response convoluted with LASER pulse from the MATACQ



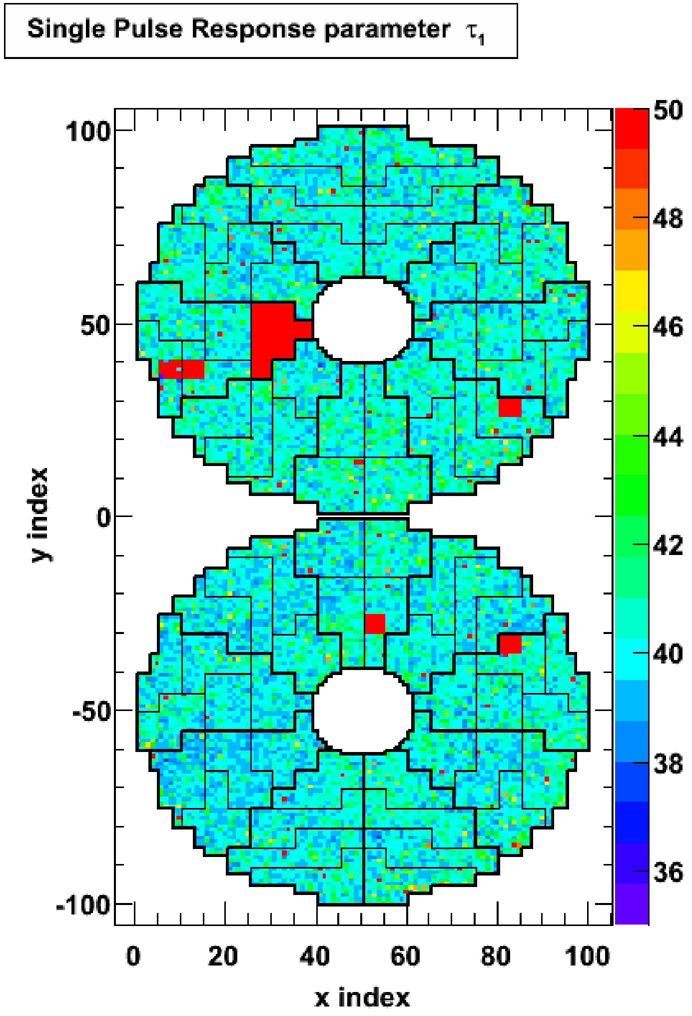
EB: SPR parameter τ and αβ parameters

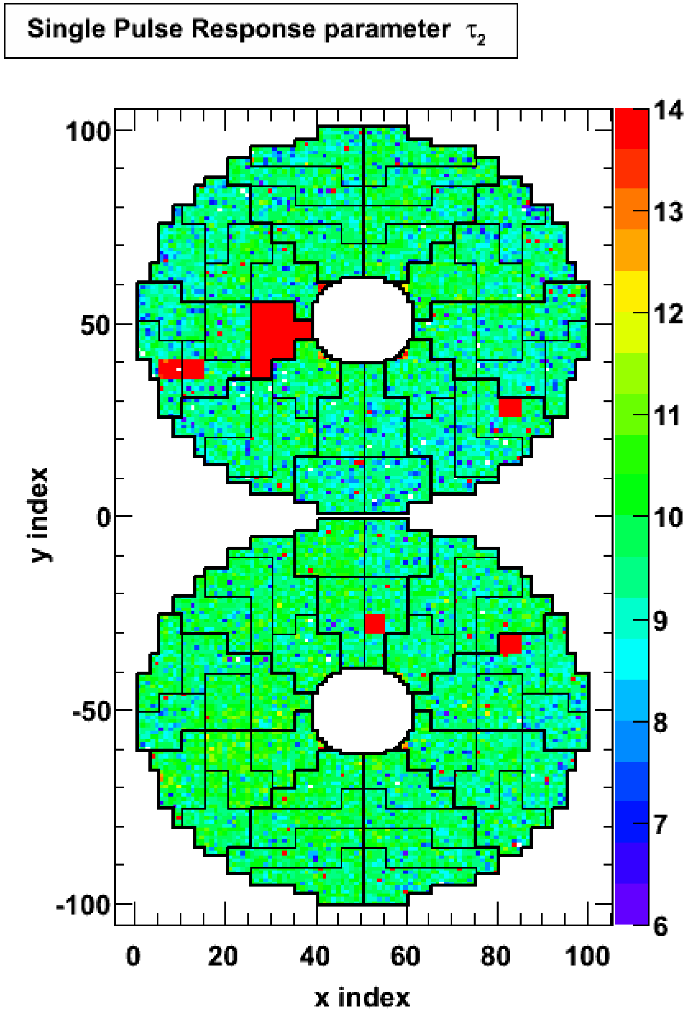




EB has a uniform response

EE: SPR parameters τ_1, τ_2

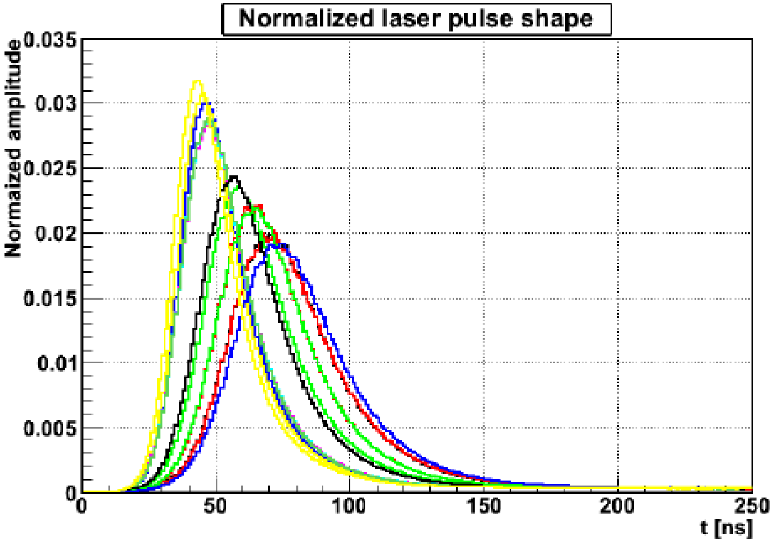




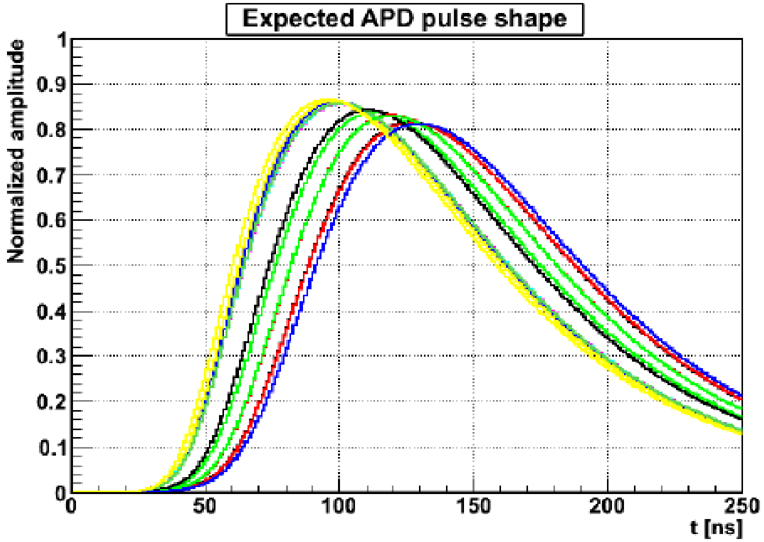
- EE and EB have different electronic responses
- Electronic response more uniform in EB than in EE (not problematic as long as we know the SPR)

APD amplitude calculation: “convolution method”

Knowing SPR allows to know the APD response for a given laser pulse shape:



Laser signals (constant energy)



Corresponding APD shapes

Two effects have to be considered:

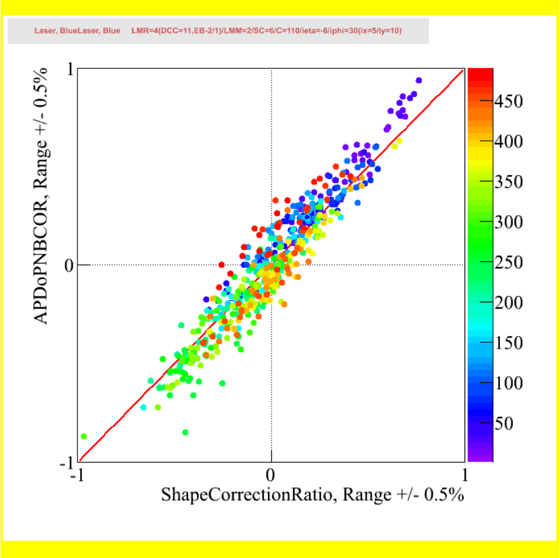
1. APD (VPT) pulse amplitude reconstruction has to take into account those variations to avoid fitting bias with varying laser pulses ⇒ done by the “convolution method”
2. The measured amplitude, even unbiased, is not directly related to the laser energy and depends also on the laser pulse shape

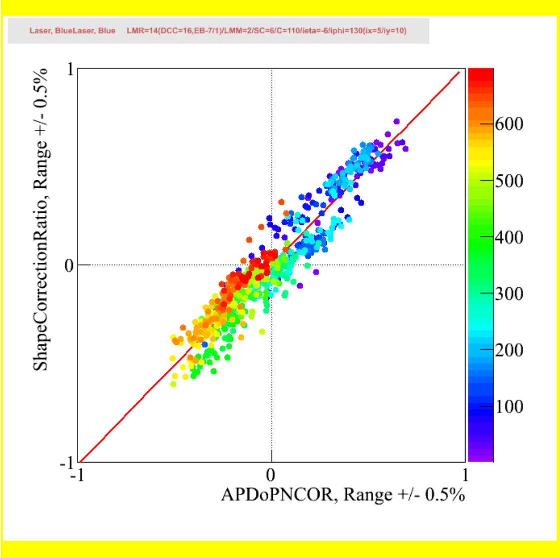
Laser variation correction within convolution method

• LASER width correction formerly computed by removing the correlation between APD/PN and the measured LASER FWHM
• Knowing SPRs and the LASER pulse shape for each sequence allows to compute what would be the ratio APD(VPT)/PN and to correct directly with it:

$$corr = \frac{max(SPR(APD, VPT) * laser)}{max(SPR(PN) * laser)}$$

• known universal correlation
• correct for all LASER variations (width, tails)





• example channels in 2 different SM
• color is the sequence number (time)

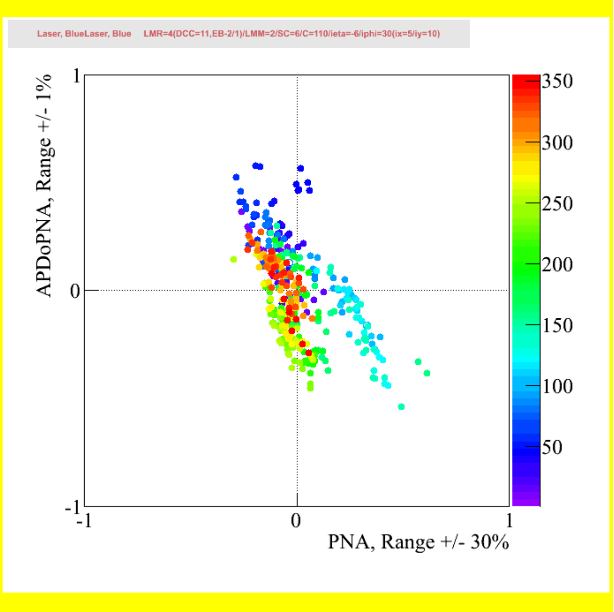
corr Vs APD/PN for 2 periods of 2010 data taking: correlation is 1

PN linearity corrections

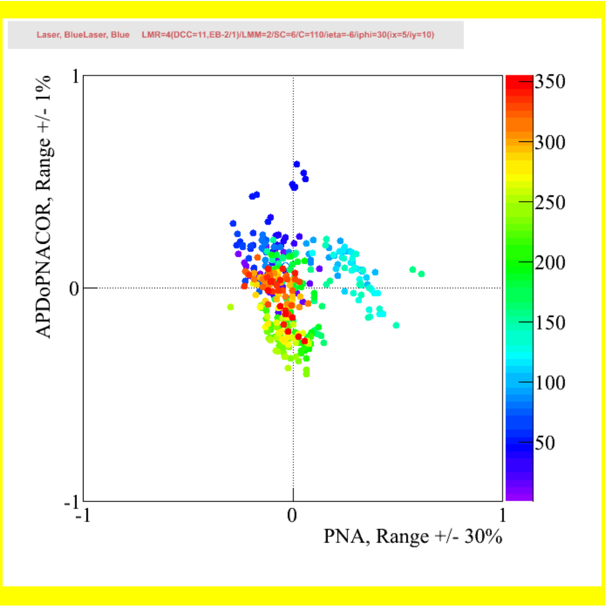
- Formerly, the same PN linearity corrections were applied to all PNs
- They have been refined for each PN
- The processing now includes these new corrections

APD/PN Versus PN

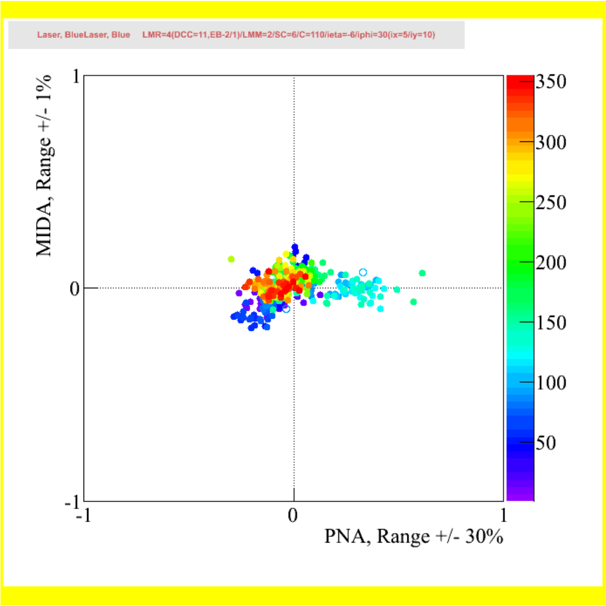
- **example channel**
- **color is the sequence number**



- **NO PN linearity correction**
- **NO LASER width correction**



- **PN linearity correction**
- **NO LASER width correction**



- **PN linearity correction**
- **LASER width correction**

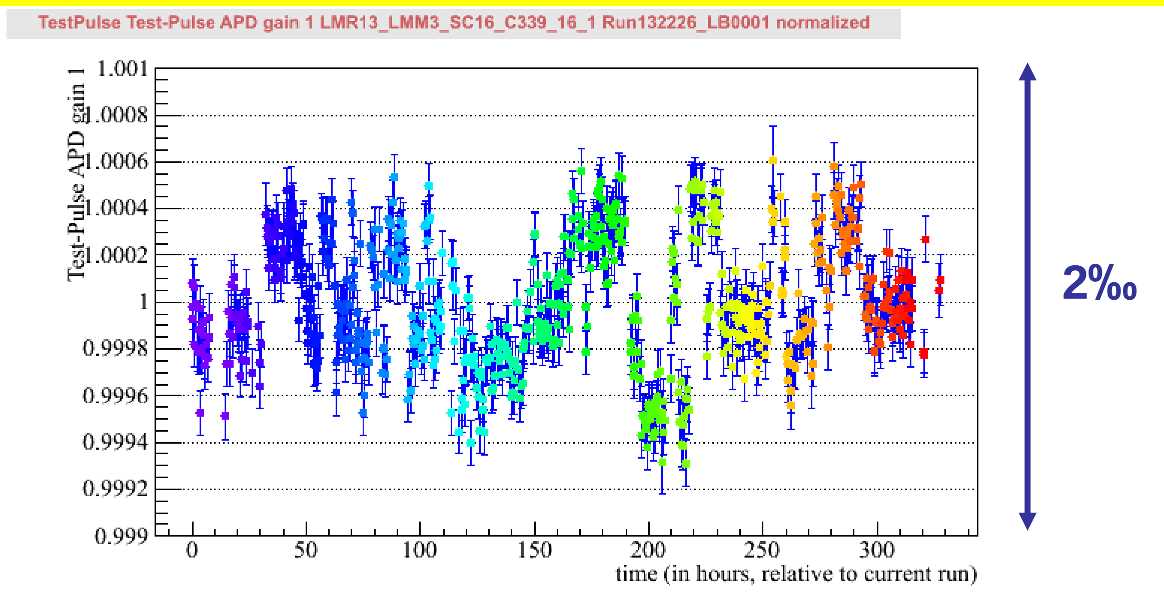
Stability results and histories

- Two periods separated by a LASER change considered in 2010 data:
  - **First period: Runs 130144 →132206**
    - Blue and IRed LASER, Blue and orange LED
    - ~500h, ~500 sequences
  - **Second period: Runs 132226 →132914** (start of LASER ampl scan)
    - Only Blue LASER
    - ~350h, ~750 sequences

- All following results obtained:
  - on the second period, except for IRed LASER and LED (results are comparable for the two periods)
  - with the convolution method + all corrections

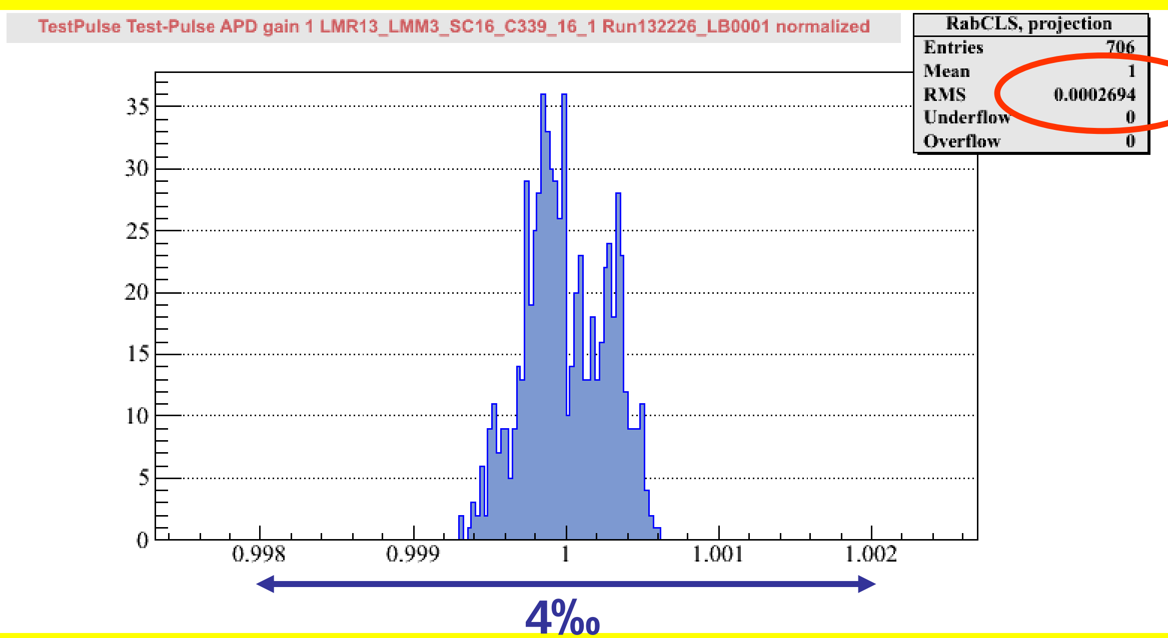
- Loose selection applied to remove pathological sequences:
  - 100 < number of events < 2000
  - 20 < laser FWHM < 45
  - 200 ADC < amplitude < 4000 ADC
  - 3 < signal maximum sample < 8
  - max amplitude r.m.s.: 10%
  - max amplitude m3: 40%
  - max amplitude/PN r.m.s.: 3%
  - max amplitude/PN m3: 40%
  - 0.8(0.7) < laser pulse correction < 0.9(0.95) for barrel (endcap)

TP APD history example



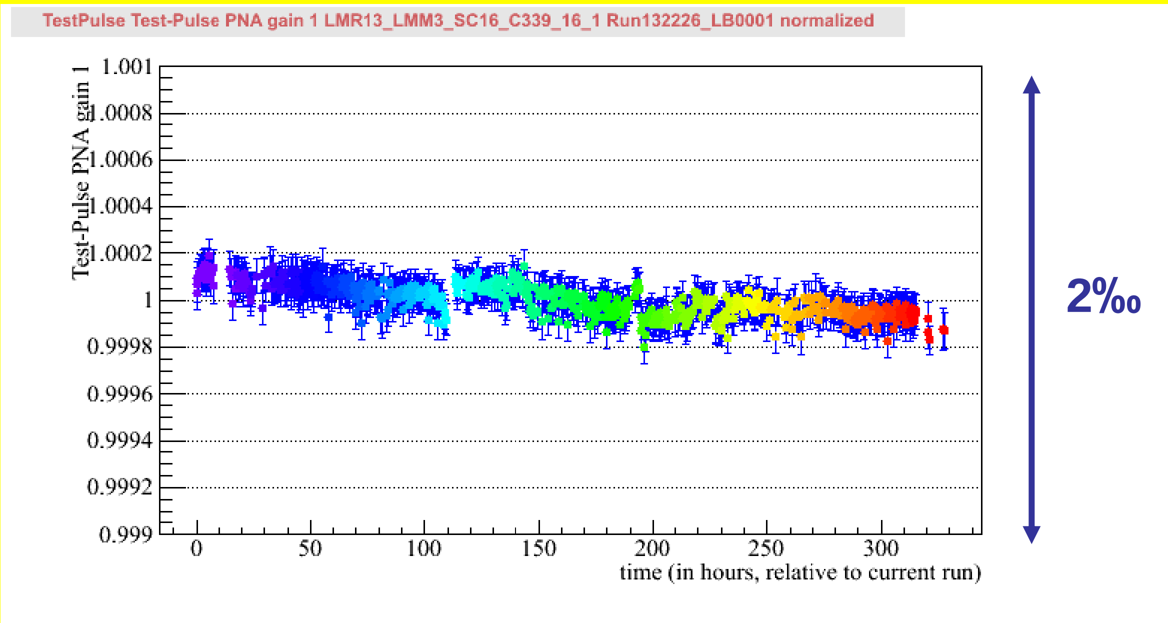
second period

Raw TP APD history



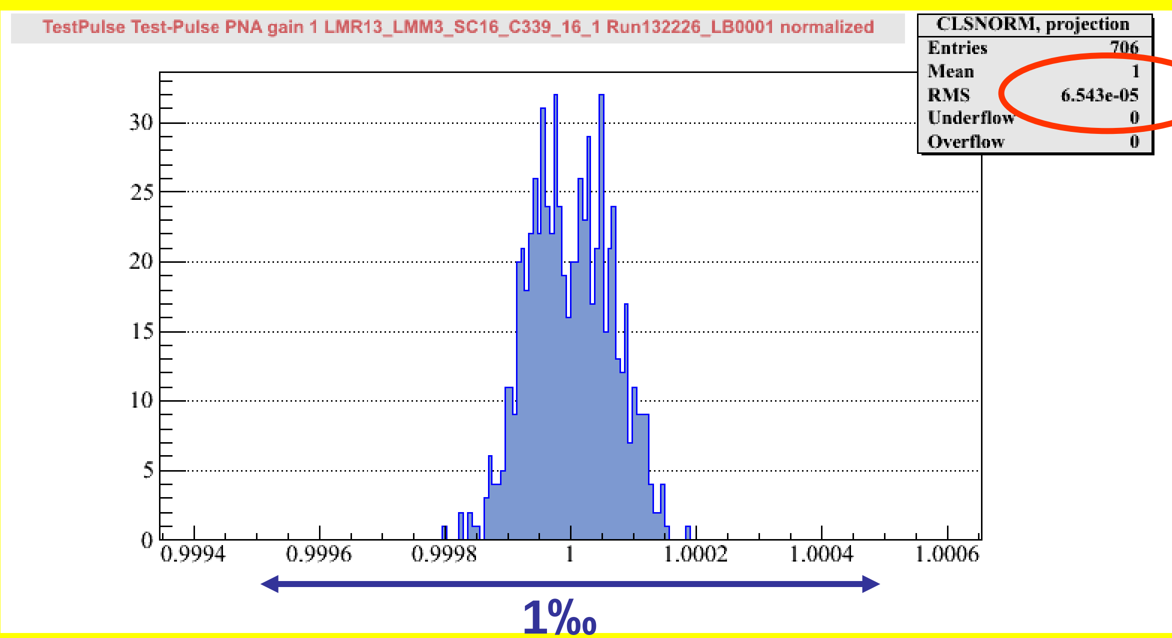
0.3‰

TP PN history example



second period

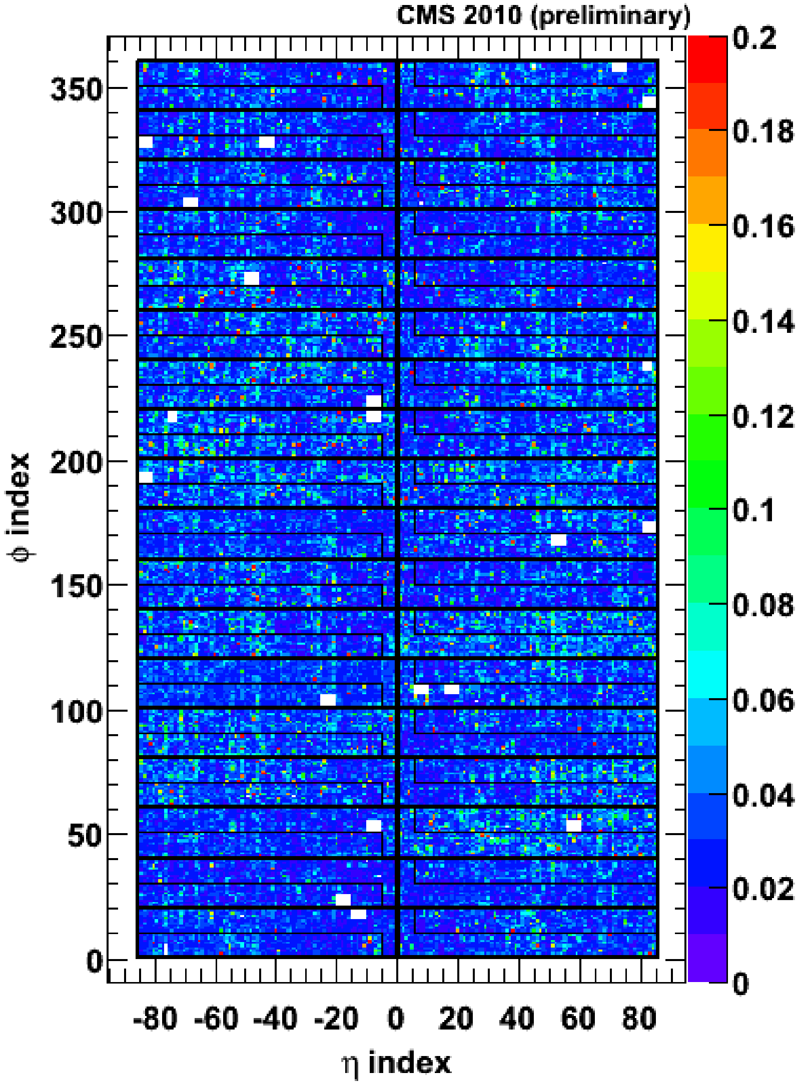
Raw TP PN history



0.06‰

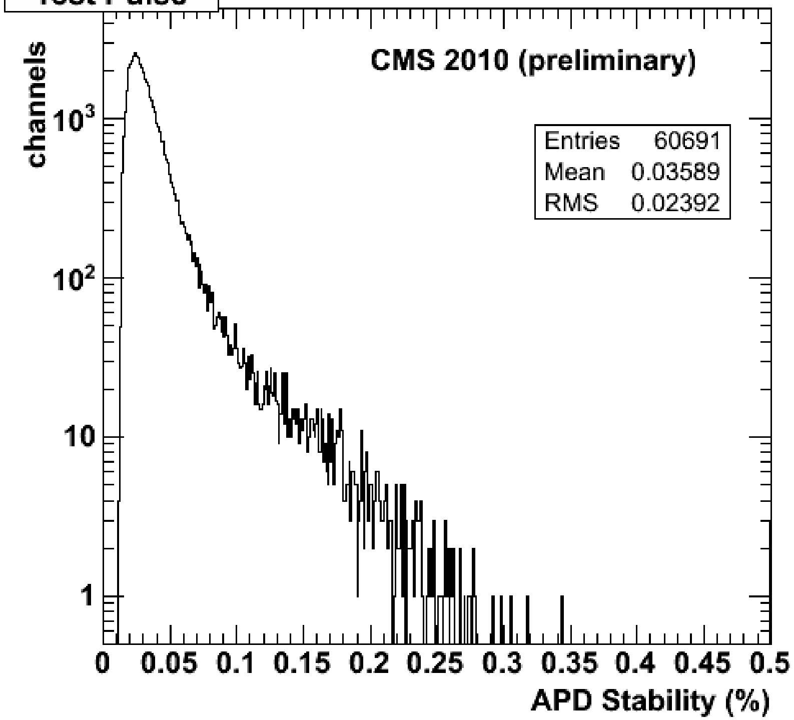
TP APD stability maps: EB

Test Pulse: APD Stability (%)



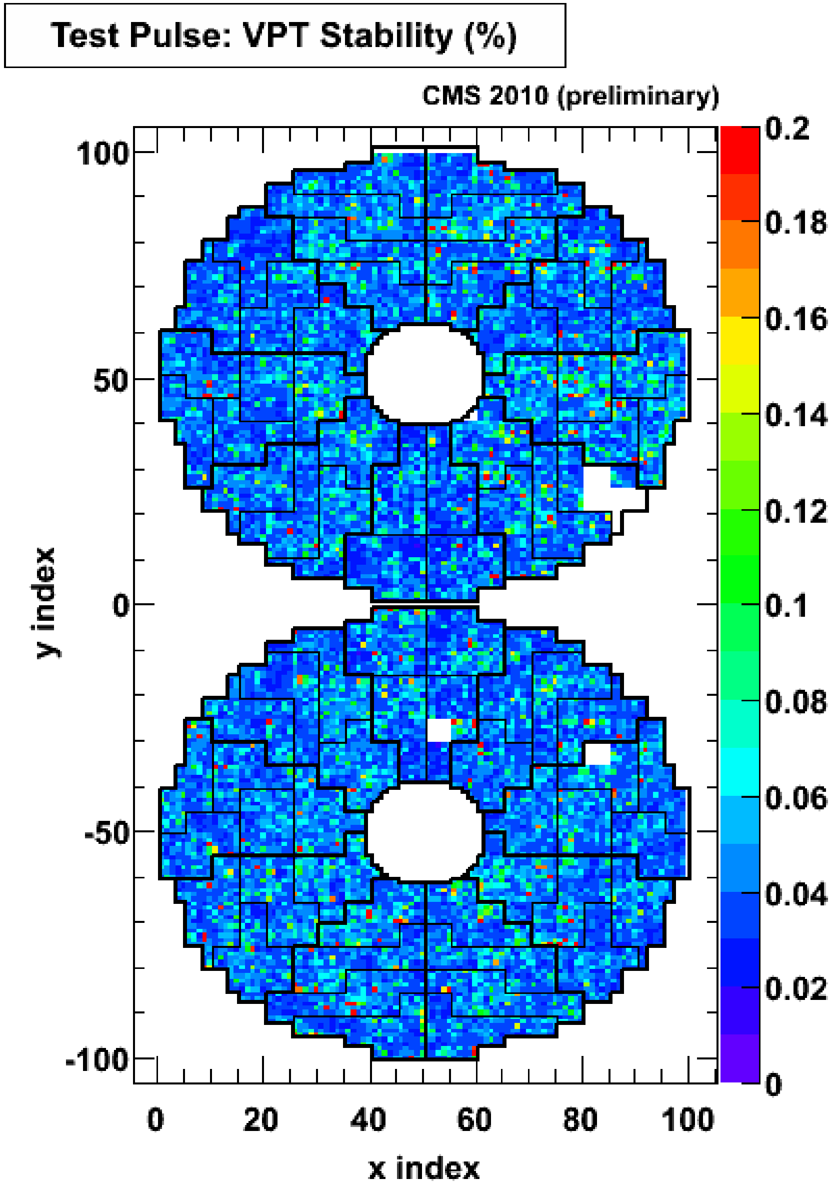
second period

Test Pulse

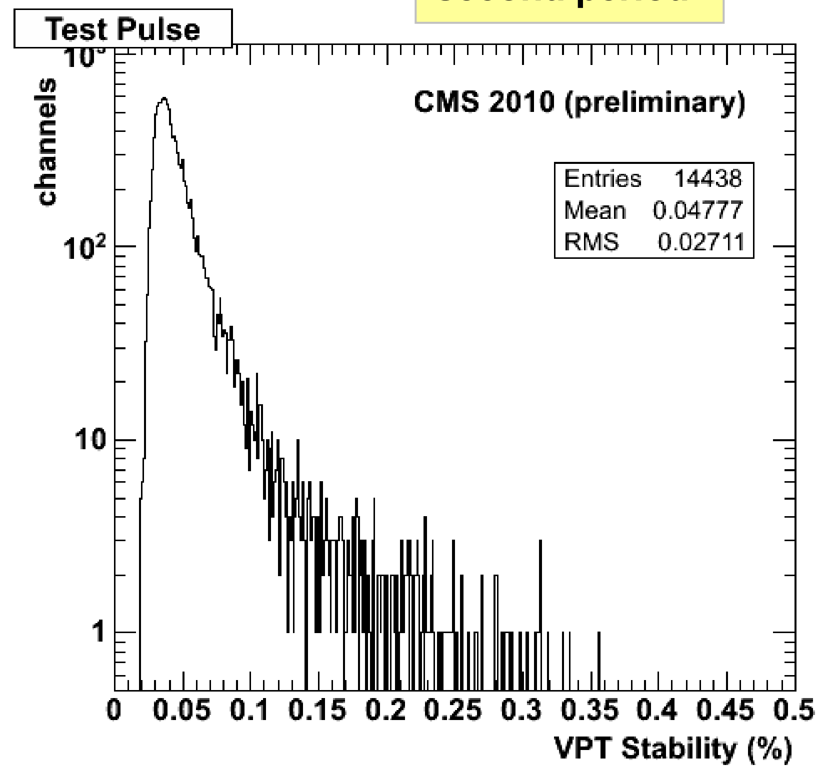


98 % of channels below 1 per mil
99% of channels below 2 per mil

TP VPT stability maps: EE

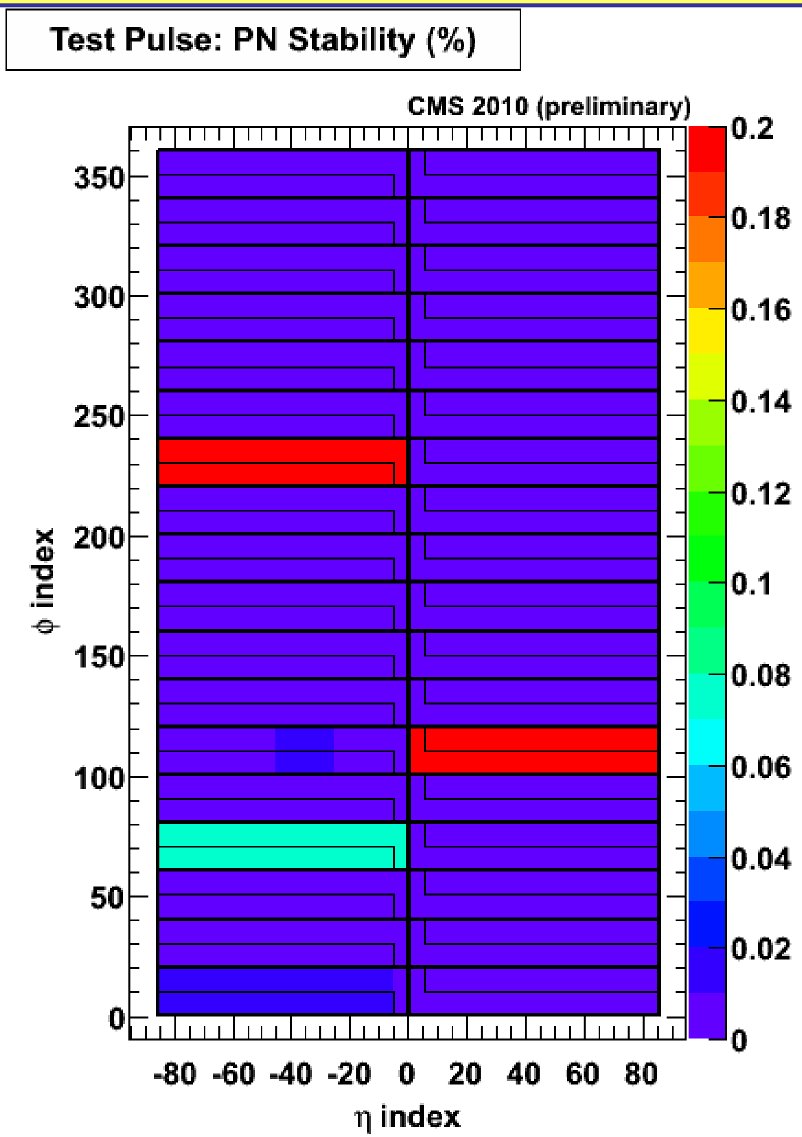


second period

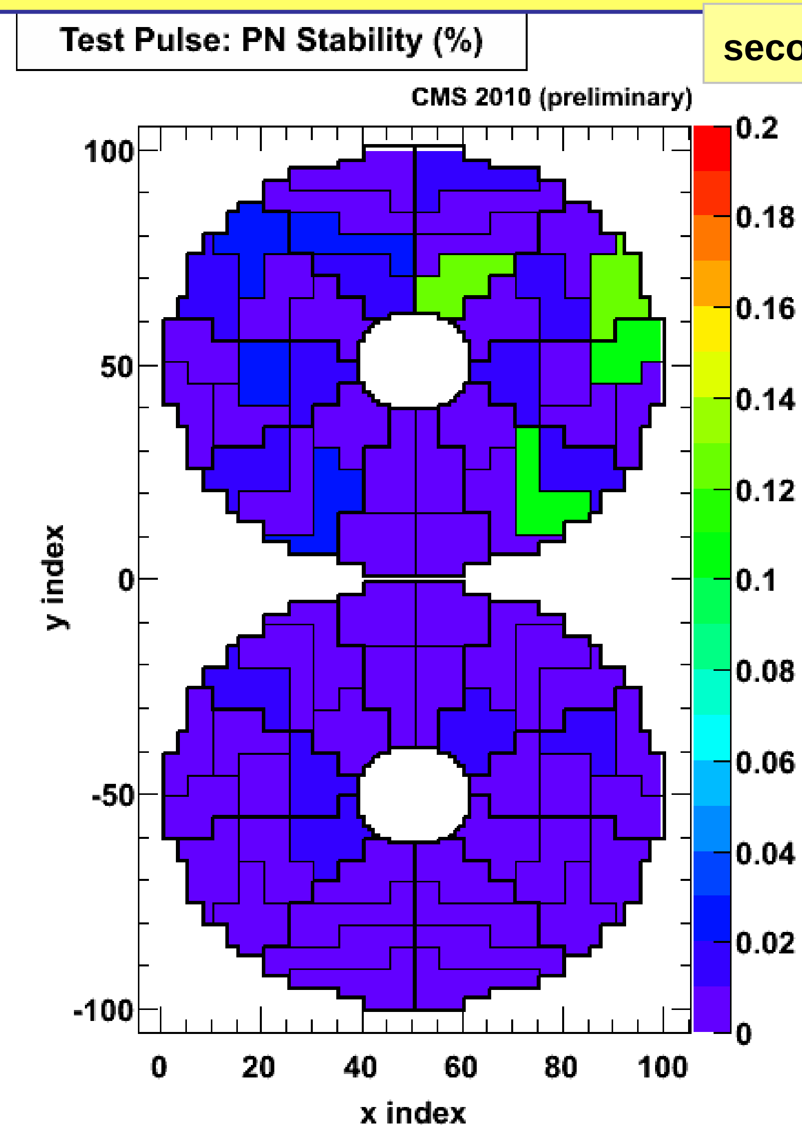


96 % of channels below 1 per mil
99% of channels below 1.7 per mil

TP PN stability maps: EB and EE

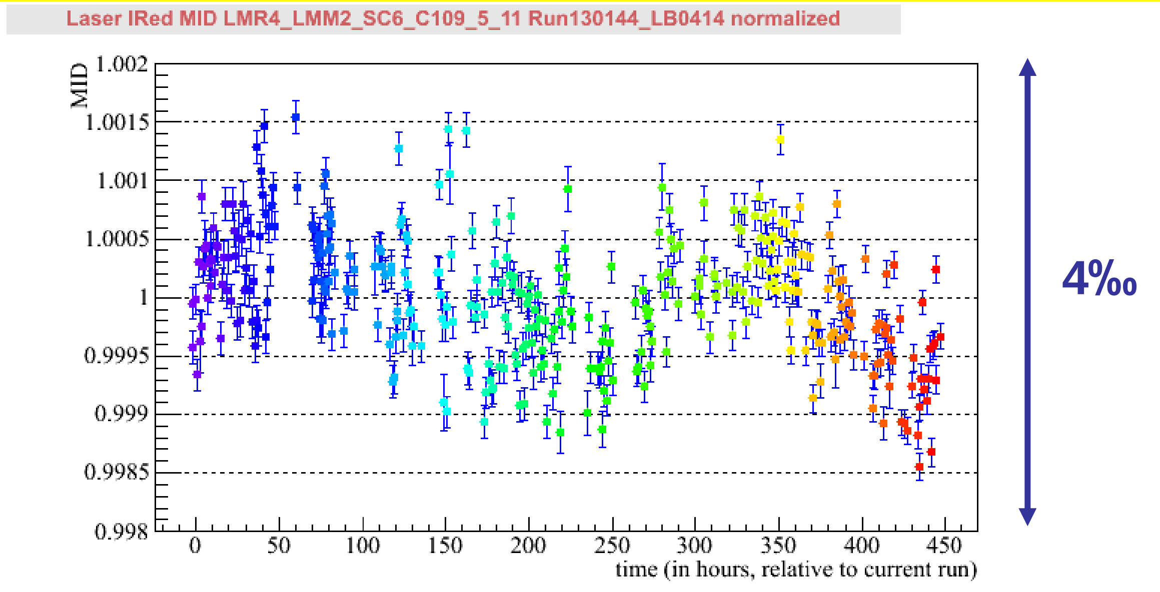


second period



- these bad regions are not seen in LASER data
- not understood, TP feature been investigated

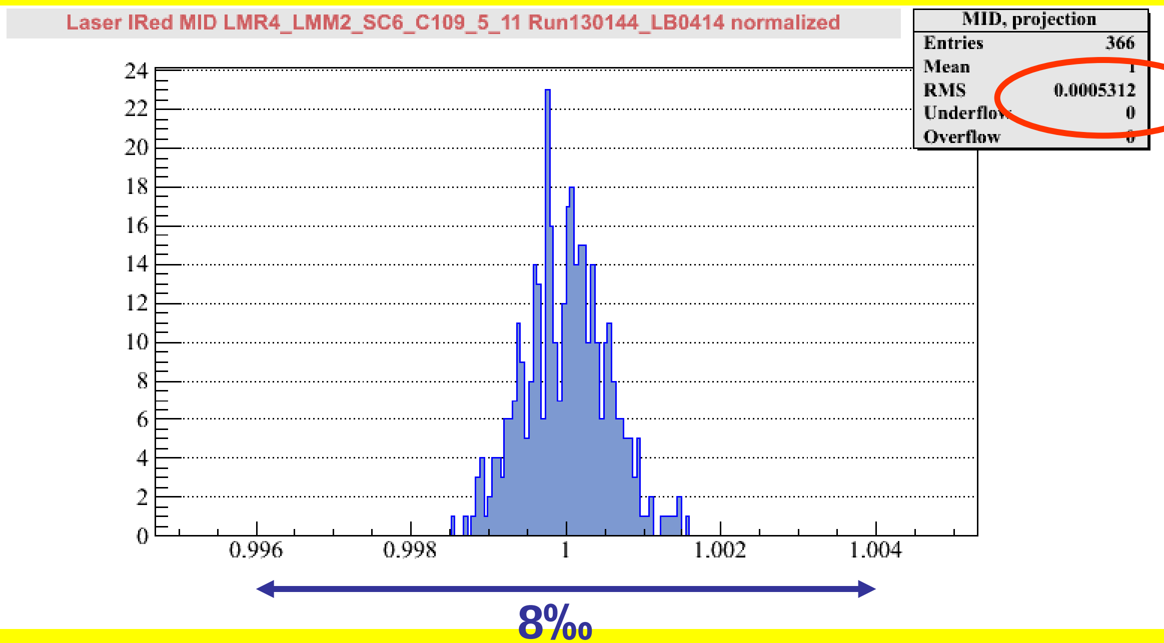
IRed LASER history example



first period

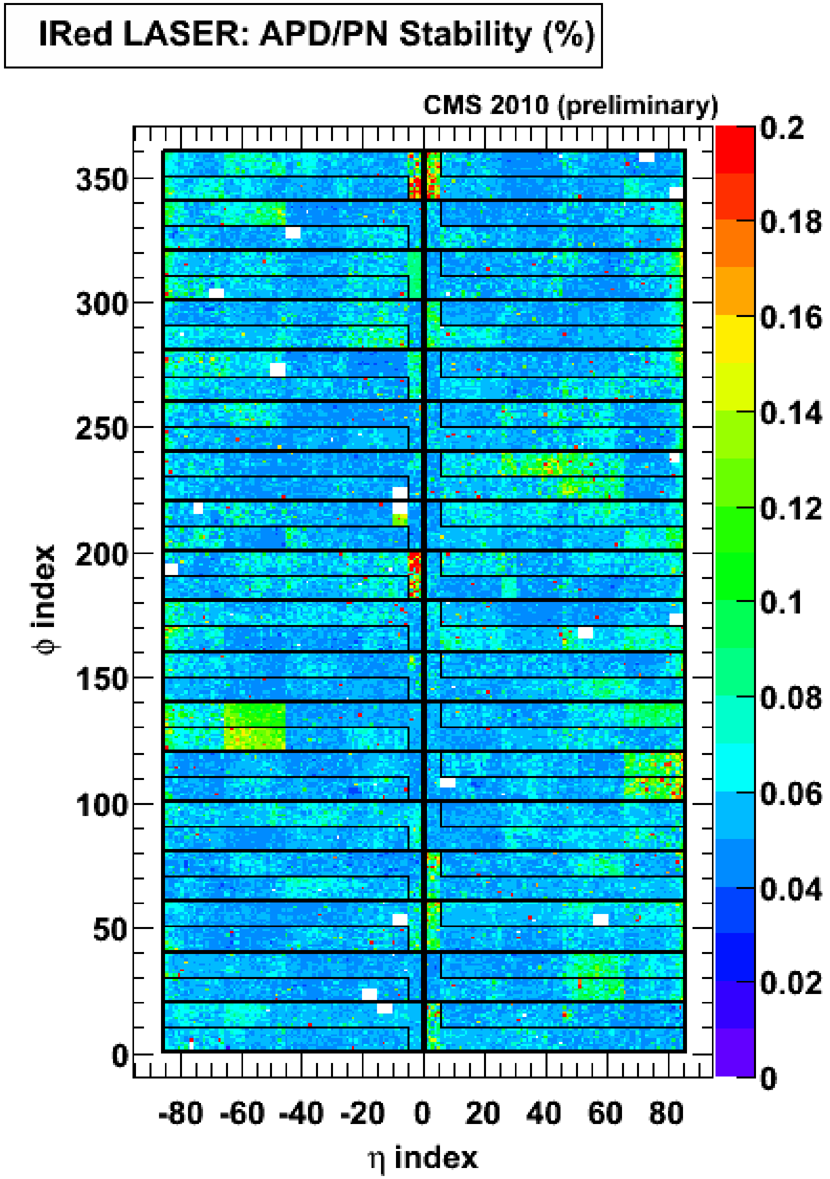
APD/PN history

Including all corrections

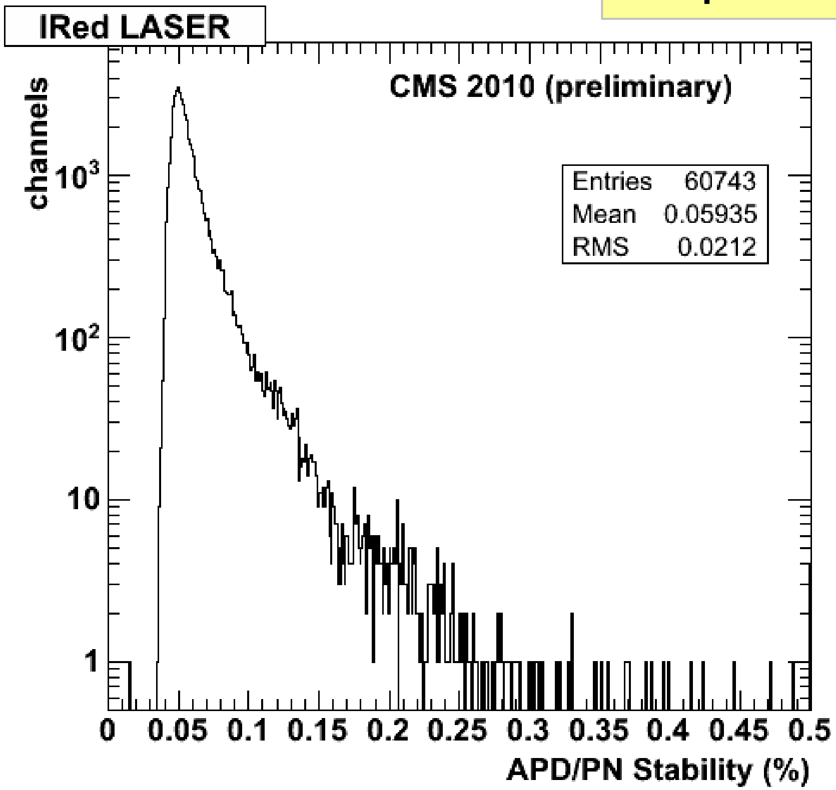


0.5‰

IRed LASER stability maps: EB

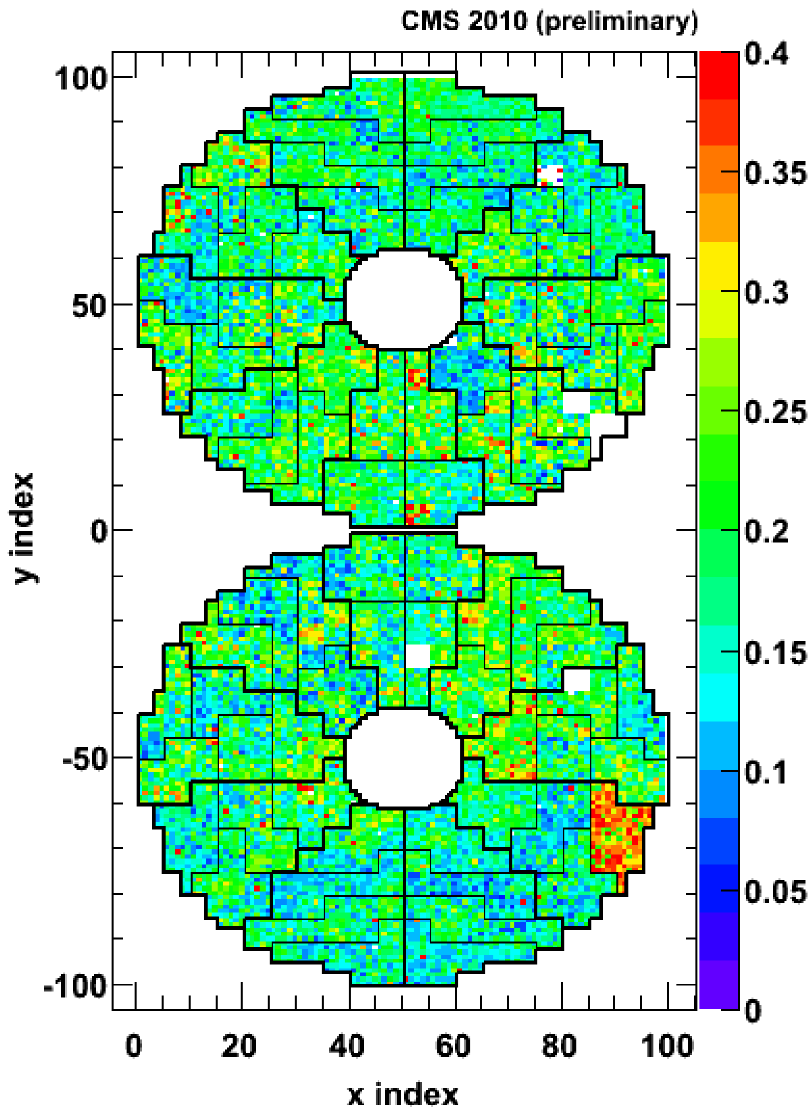


first period

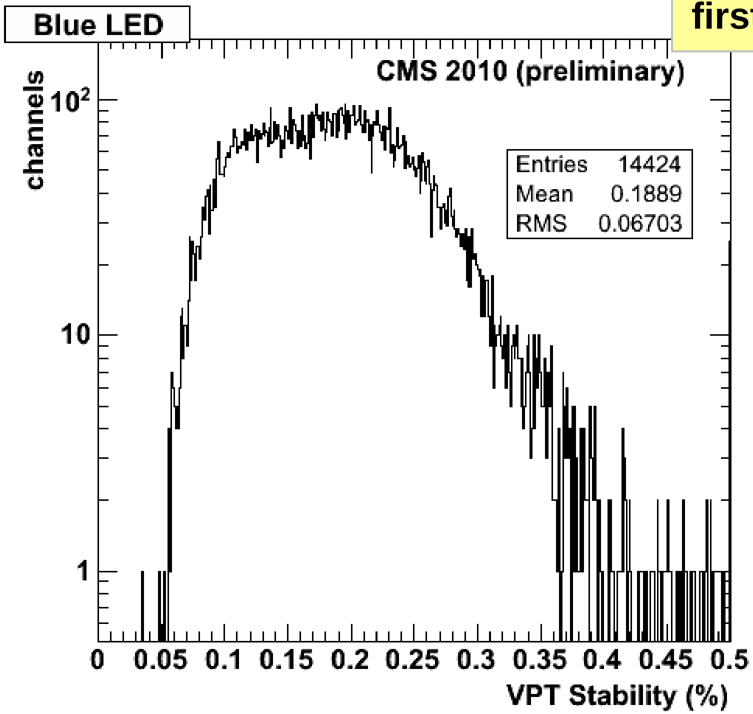


95 % of channels below 1 per mil
99% of channels below: 1.5 per mil

Blue LED stability maps: EE



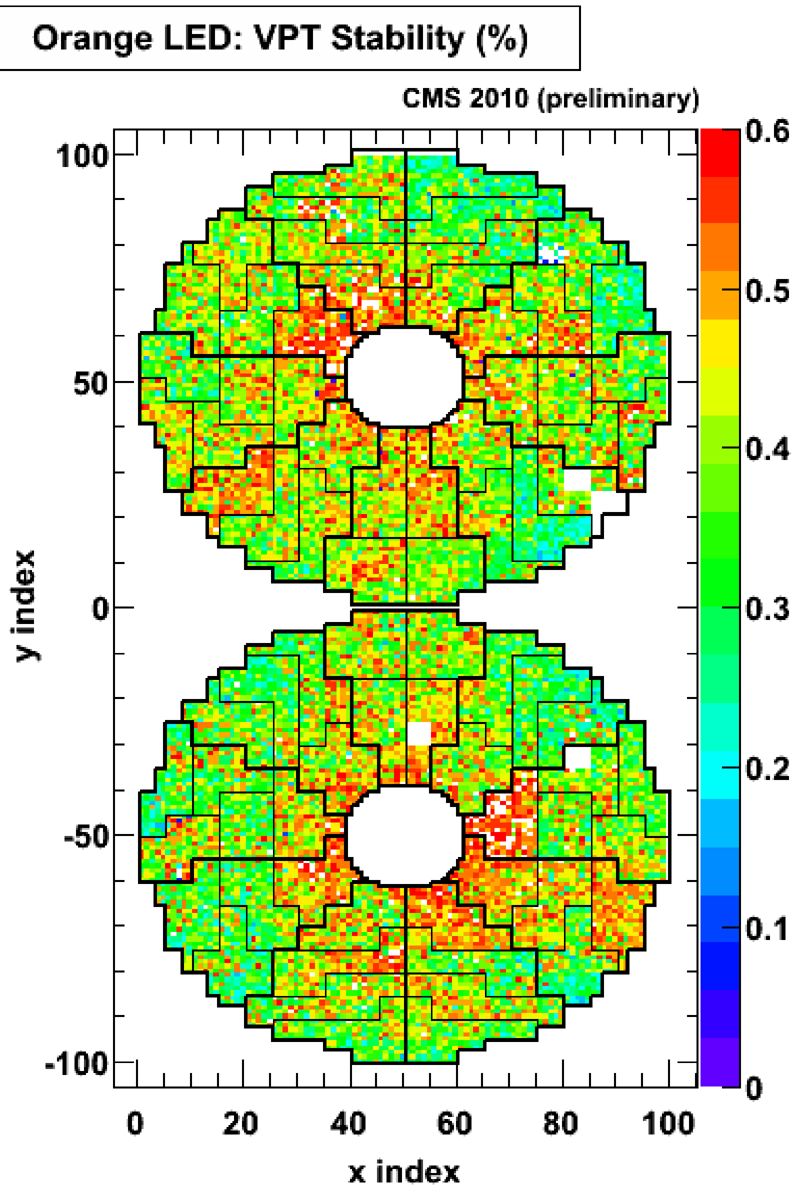
first period



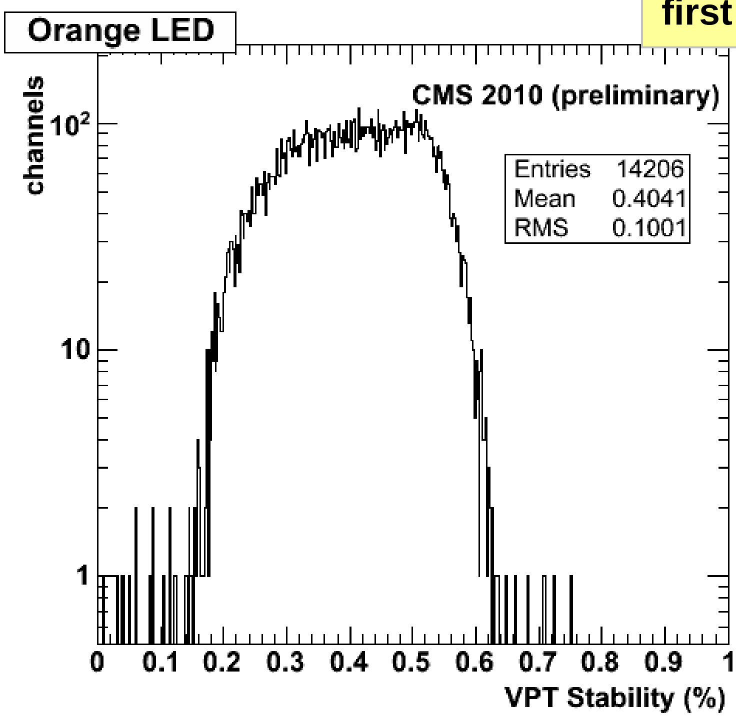
Raw VPT stabilities (not normalized to PN)

- normalizing to PN amplitude is not feasible with the current LED supervisor setting (light from 2 diffusing sphere going to the same PN)
- if we want to use LED data for stability purposes, this setting has to be changed
- blue led amplitude ~ 300 ADC counts

Orange LED stability maps: EE



first period

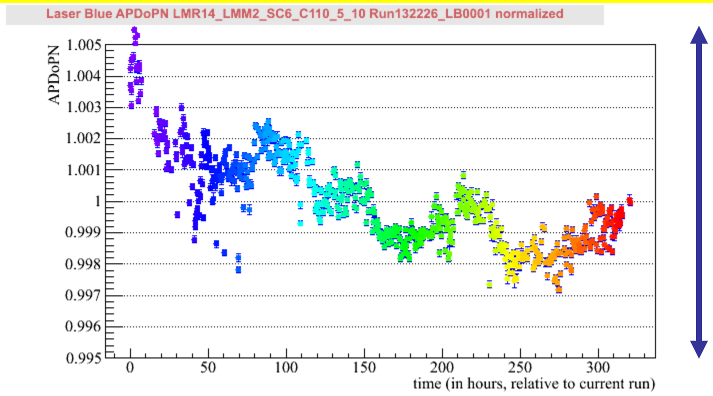


Raw VPT stabilities (not normalized to PN)

- orange led amplitude ~ 20 ADC counts
- this amplitude would have to be increased by a factor 10 at least if we want to use it for stability purposes

Blue LASER history examples

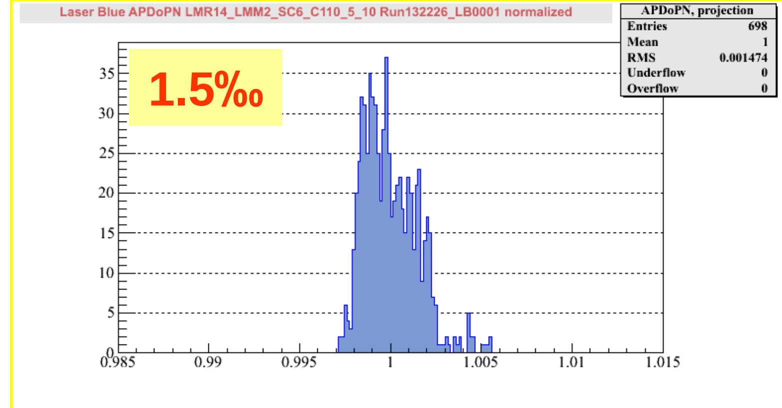
second period

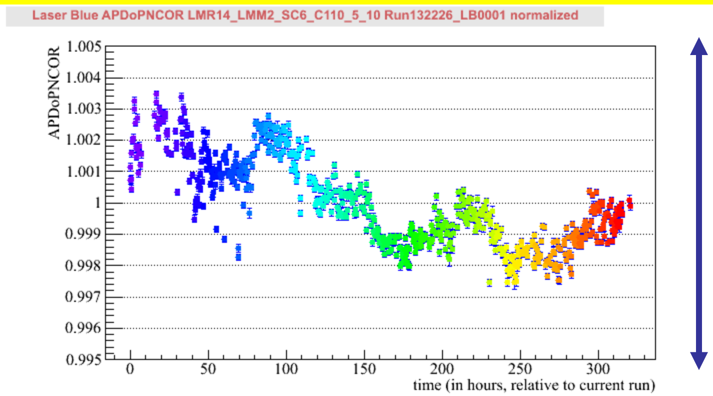


1%

APD/PN

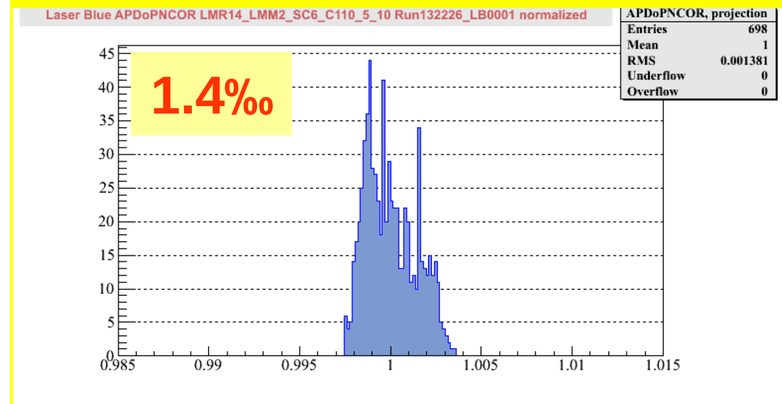
raw

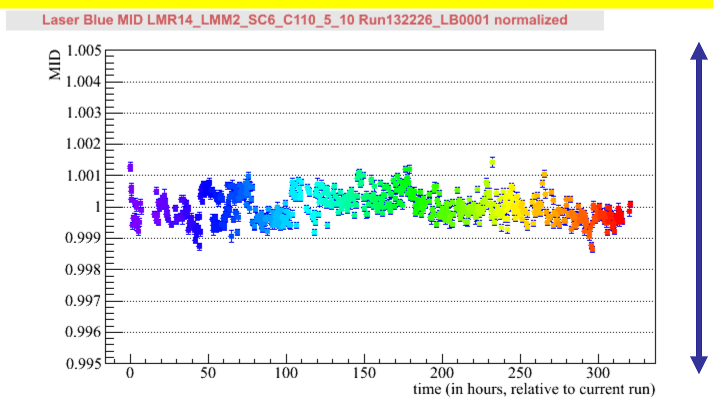




1%

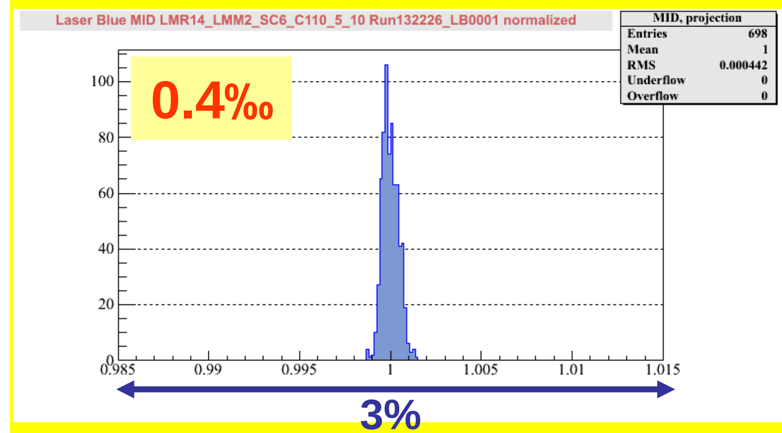
with PN linearity correction





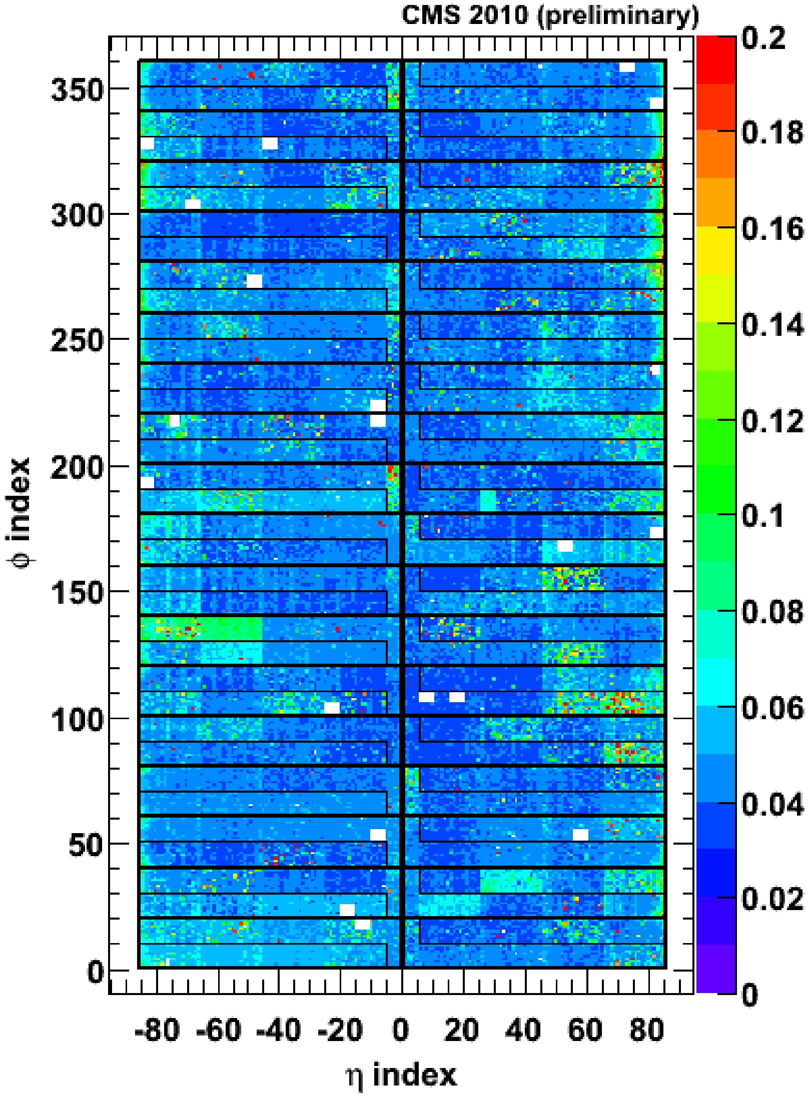
1%

- **PN linearity correction**
- **LASER width correction**

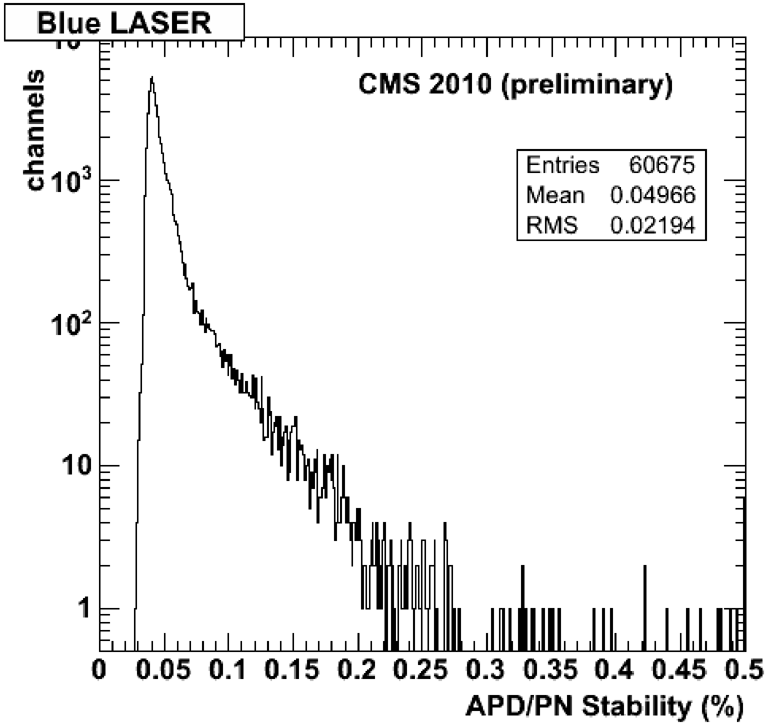


Blue LASER stability maps: EB

Blue LASER: APD/PN Stability (%)

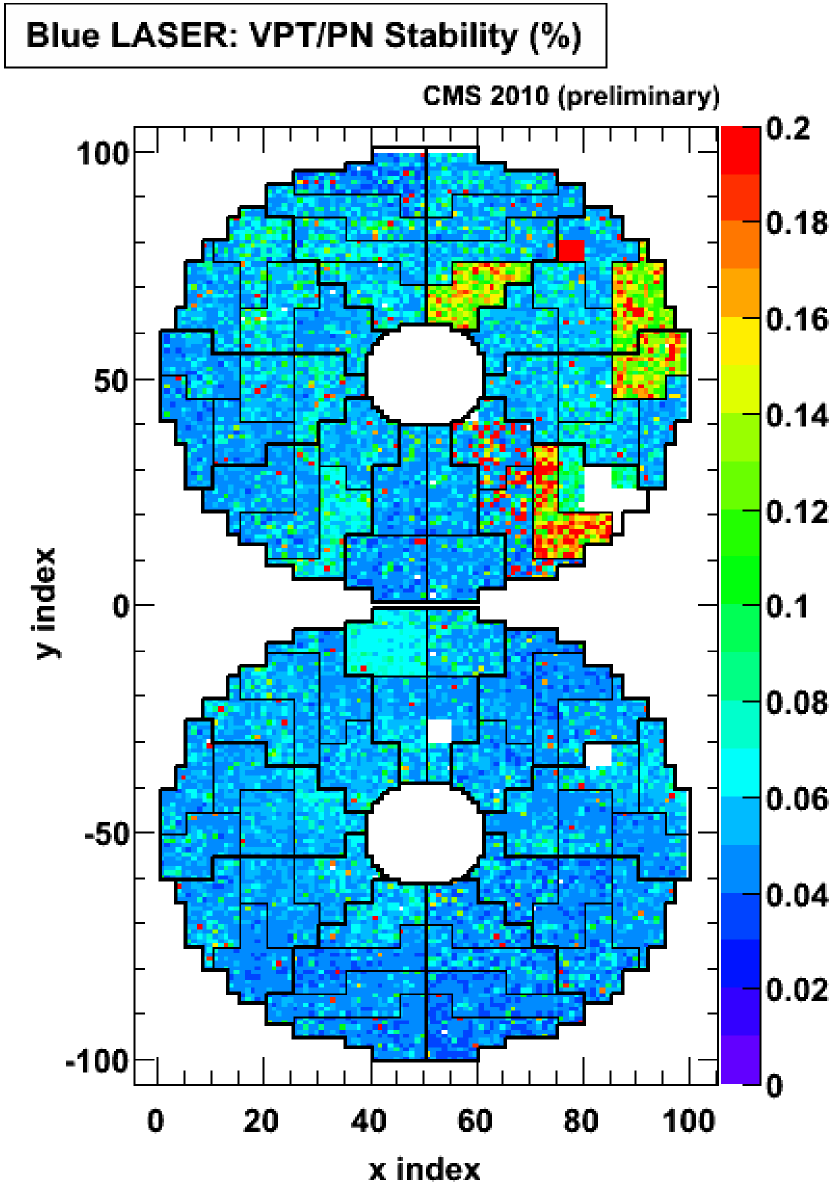


second period

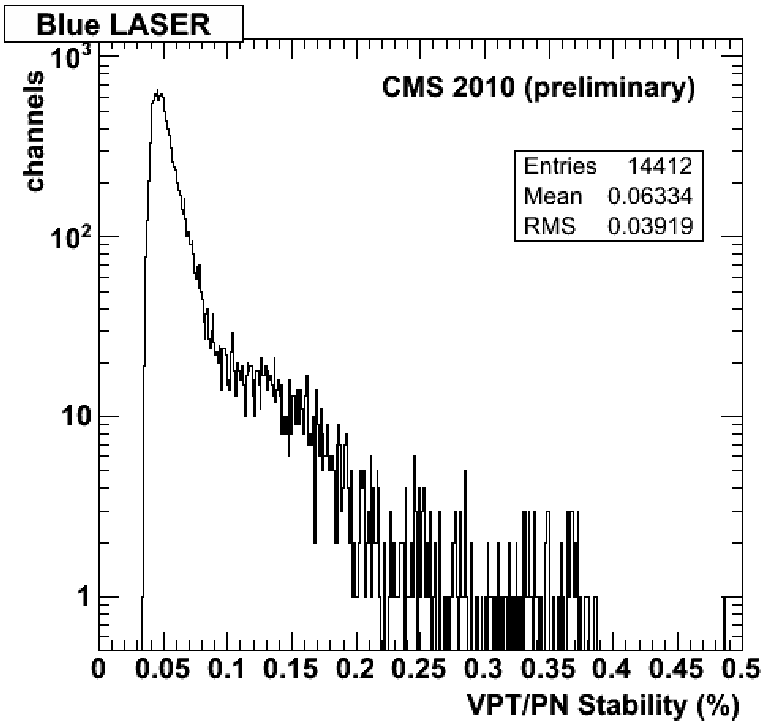


97.5 % of channels below 1 per mil
99% of channels below: 2.4 per mil

Blue LASER stability maps: EE



second period



90.5 % of channels below 1 per mil
99% of channels below: 2.5 per mil

Conclusions

1. DAQ and LASER controls

    - LASER supervisor improved
    - LASER controls stable in April
    - Sequence duration to be improved
    - No acquisition during fills to be addressed

2. OMDS

    - New schema defined
    - Implementation being finalized

3. Analysis

    - Convolution method for APD and PN amplitudes calculation is fully implemented and now the nominal method
    - New PN linearity and LASER pulse shape corrections working very well
    - Very good stabilities achieved both for TP, IRed LASER, Blue LASER

The LASER Monitoring system performs very well and has proven to be very stable during the whole period of first collisions data taking