

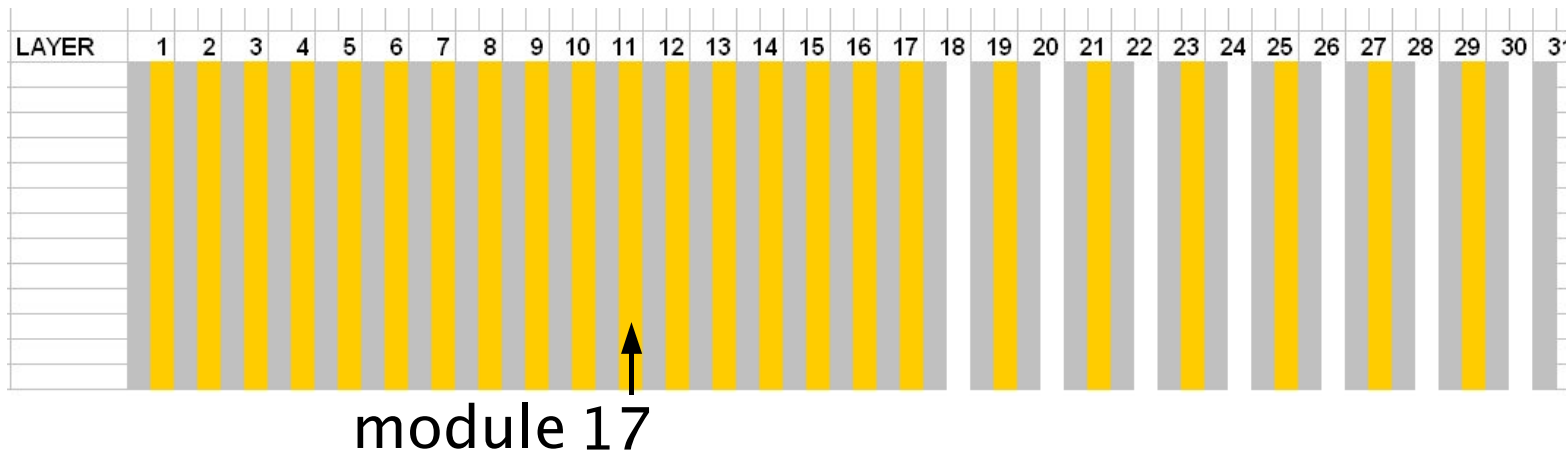
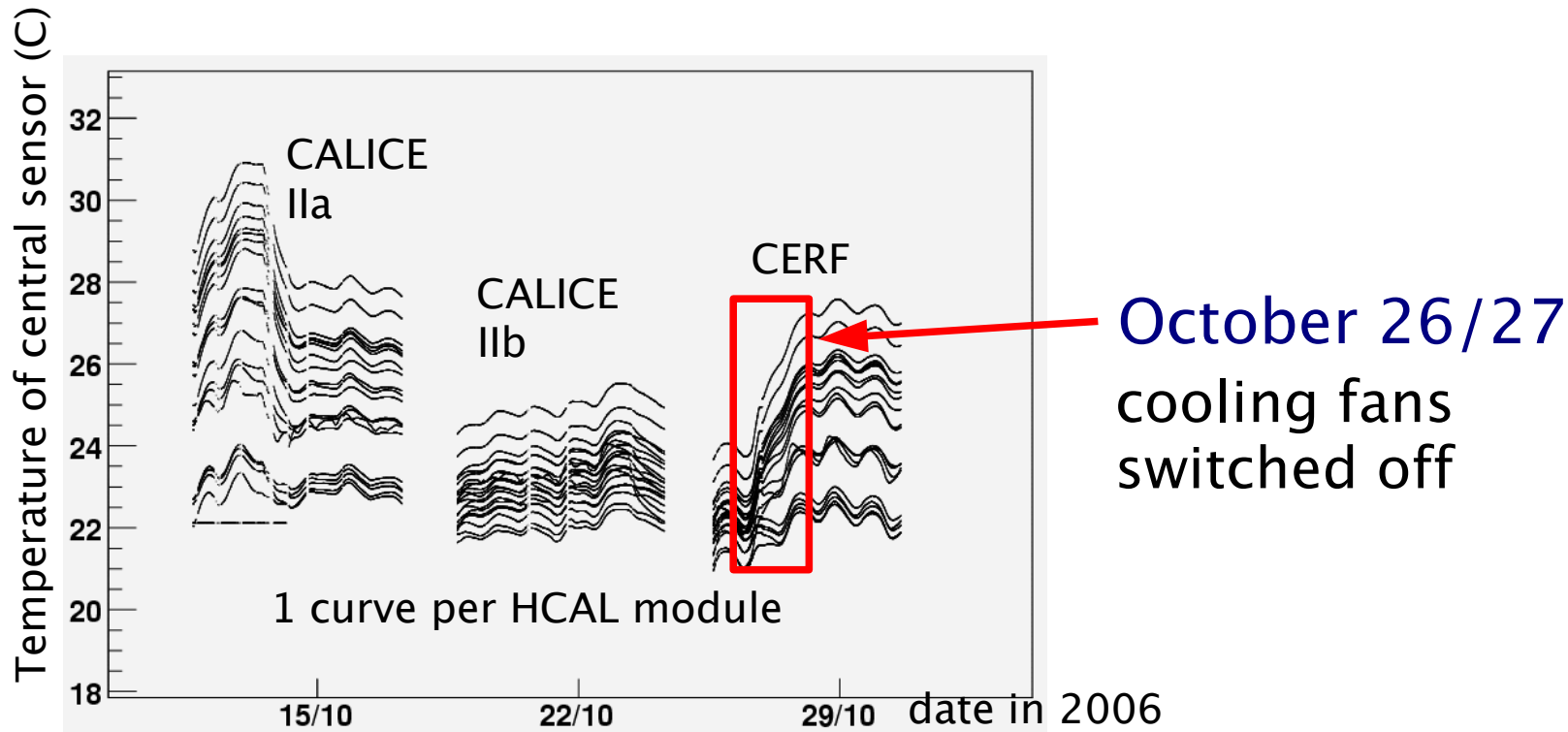
# Scintillator HCAL Stability

Sebastian Schätzel

18 April 2007

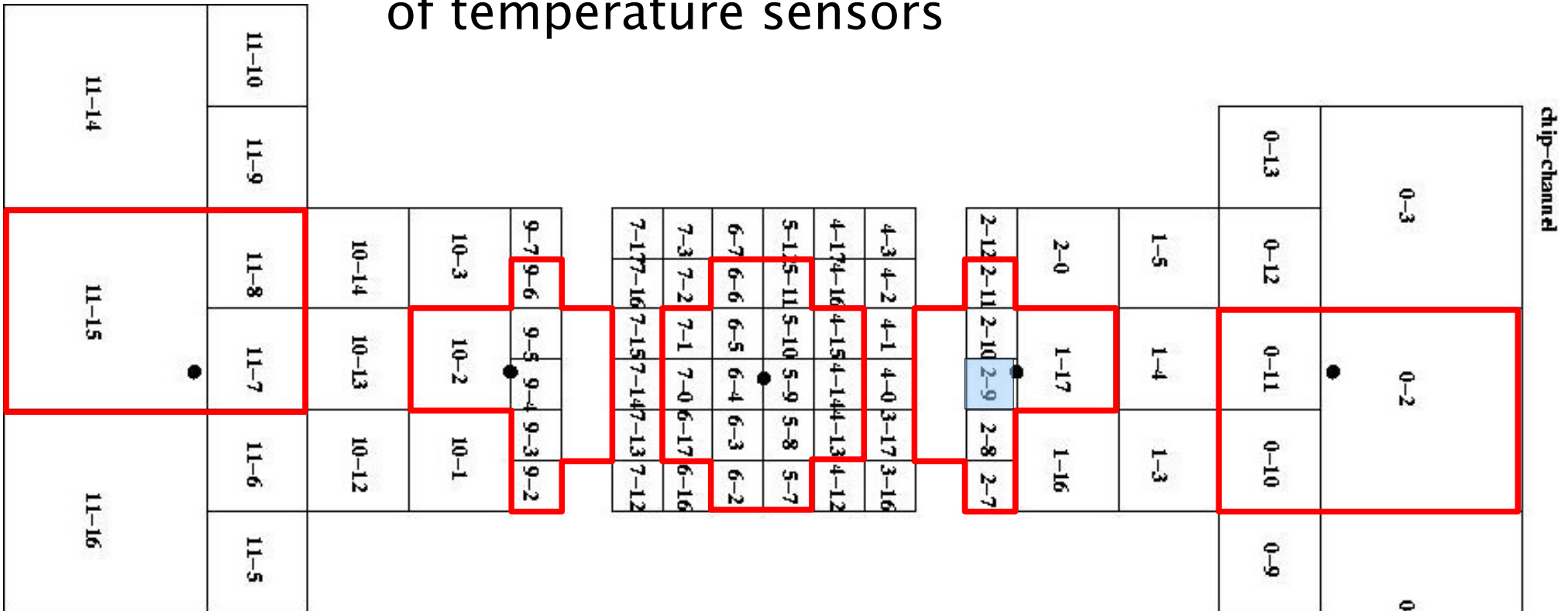
- I. SiPM temperature dependence
- II. short calibration procedure review

# Data with increased temperature variation



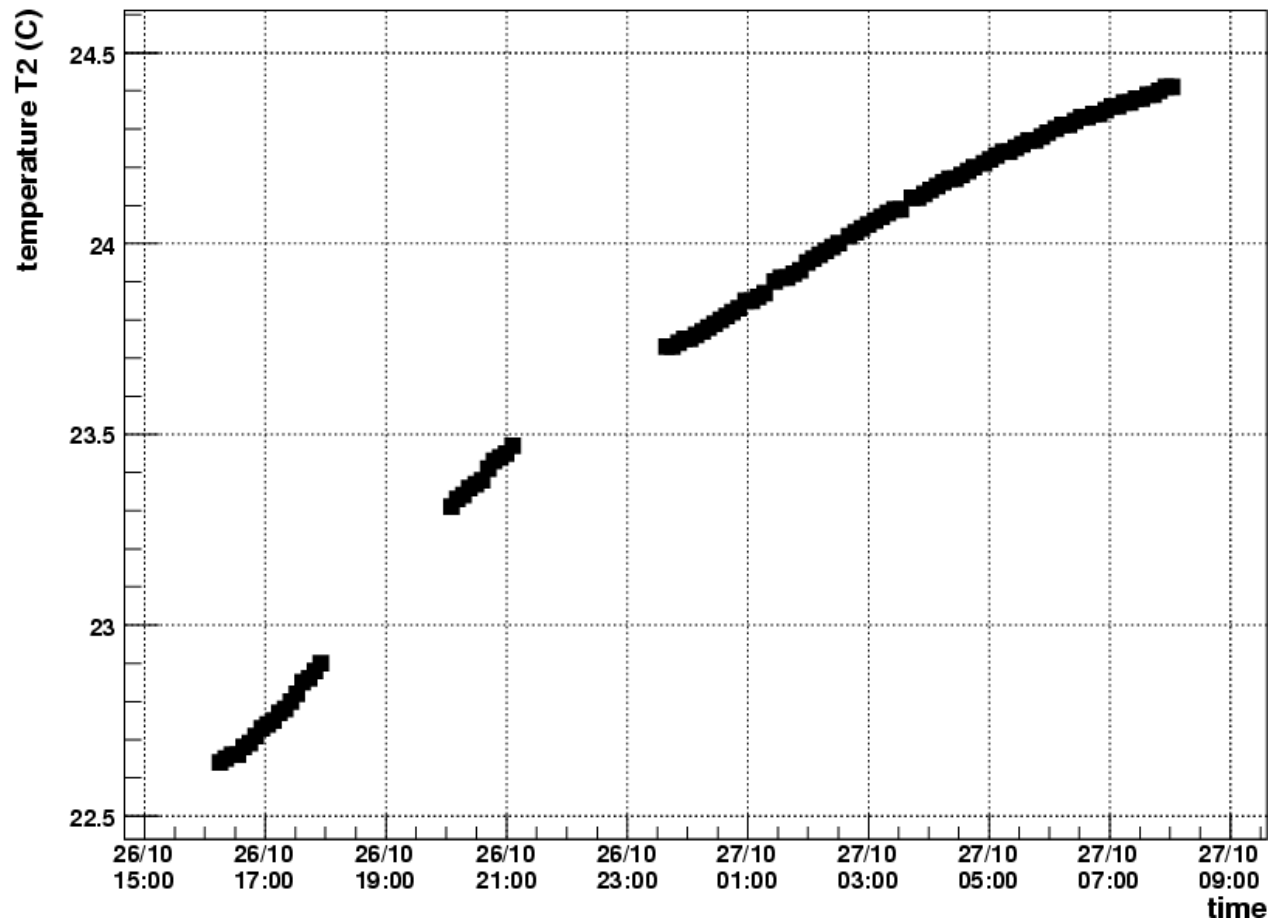
# Temperature Sensors

studied 40 SiPMs in vicinity (ca. 6 cm radius) of temperature sensors



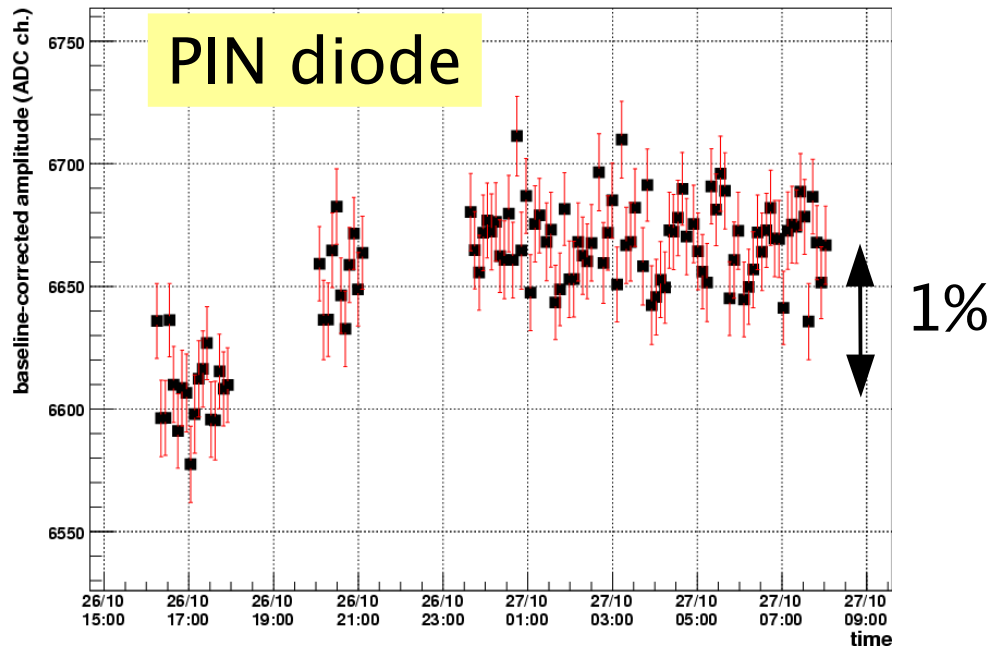
# Temperature T2 in Module 17

Oct 26/27, Module 17



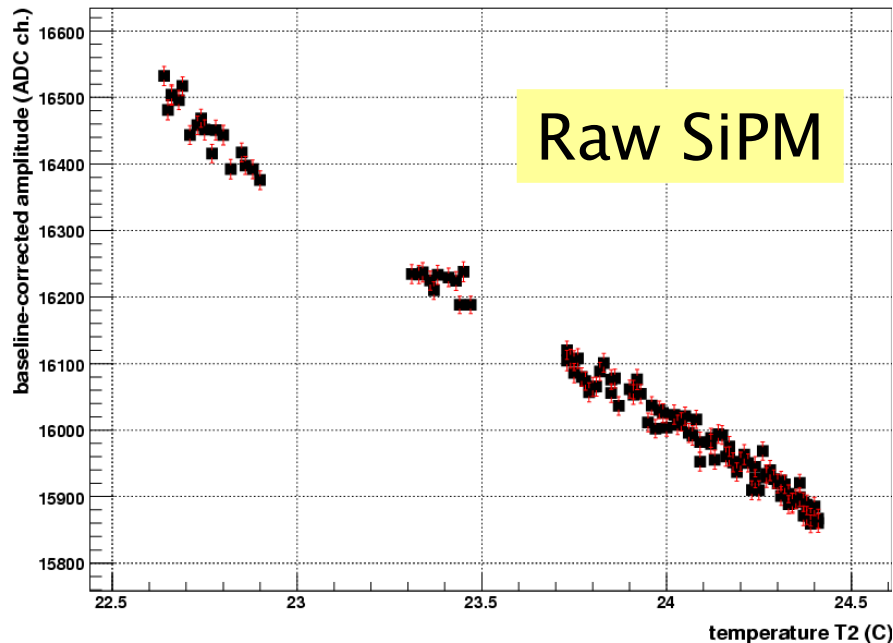
monotonic increase  
of temperature  
by 1.7K

MIP calibration runs 300804, 300806  
300815-300820



# LED Fluctuations

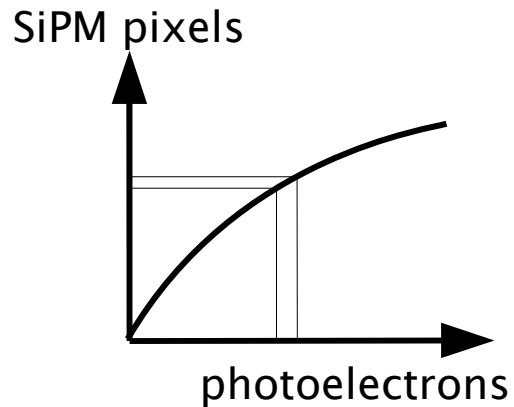
corrected for all channels using PIN diode signal



high LED intensity  
→ 16000 ADC ch. in SiPM

→ **Saturation effect:**  
1% change in PIN diode  
≠ 1% change in SiPM

# Saturation correction



assume simple formula (no XT):

$$px = \frac{pe}{1 + \epsilon pe} \quad \epsilon = 0.0007(2)$$

$$\frac{\Delta px}{px} = \frac{\Delta pe}{pe} (1 - \epsilon px)$$

change in SiPM

change in  
PIN diode

SiPM amplitude in px



gain and intercalibration required

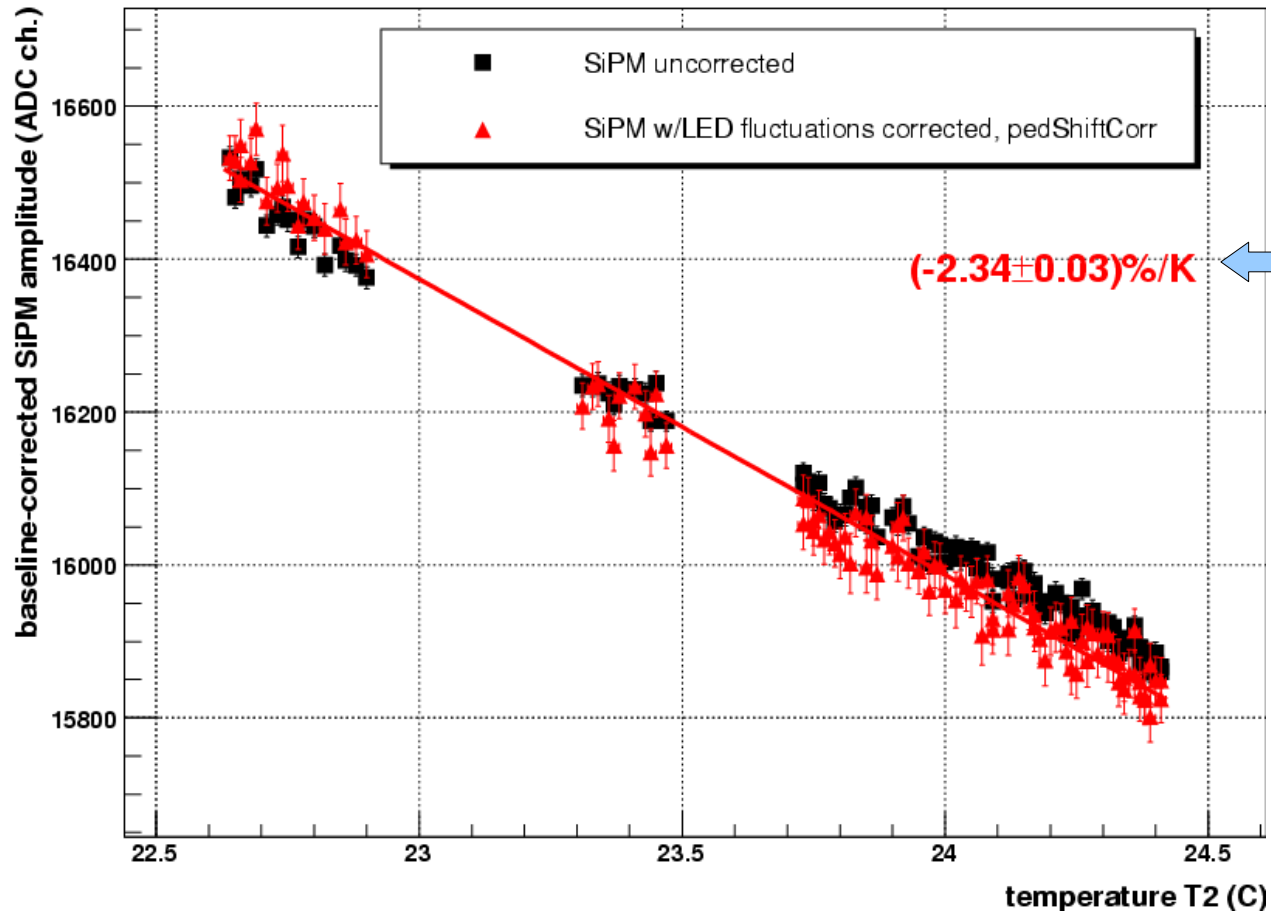
# Gain & Intercalibration (IC)

- IC taken from runs 300805/6  
uncritical, does not depend on T
- gain: using run 300797 (Oct 26, 13h37) with  
temperature correction  $1/G \, dG/dT = -2\%/K$
- all gains and ICs are available from a special ROOT file created by  
Sebastian Schmidt. They are not yet in the database.  
I have filled the values into a local database for testing,  
and they will go into the official DB soon.

NOTE: presently the official database does not hold  
temperature-dependent gain values!

# SiPM temperature dependence

Oct 26/27, LED Monitoring, Module 17, Chip 2 Channel 9

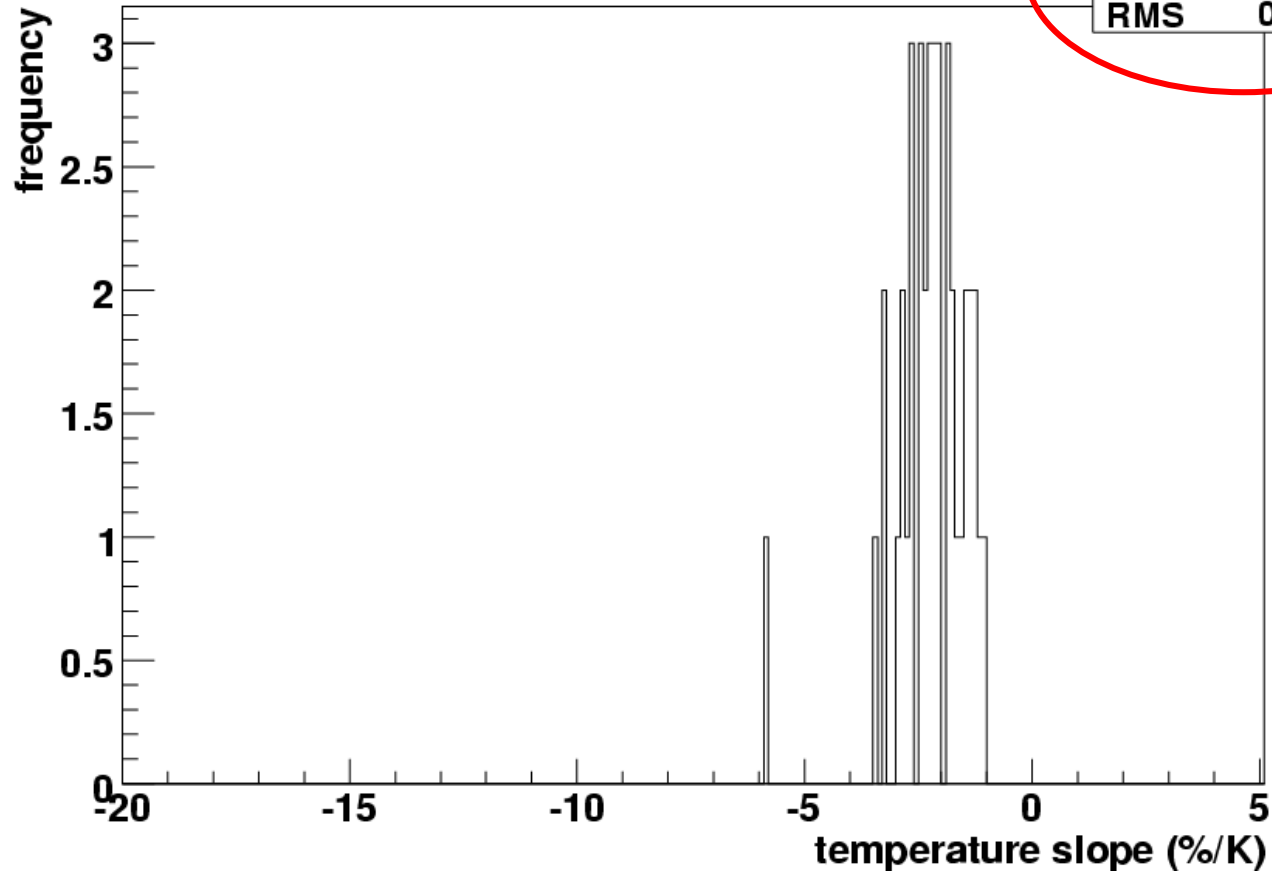


value from MEPhI:  
-3.7%/K (mean of  
several SiPMs?)



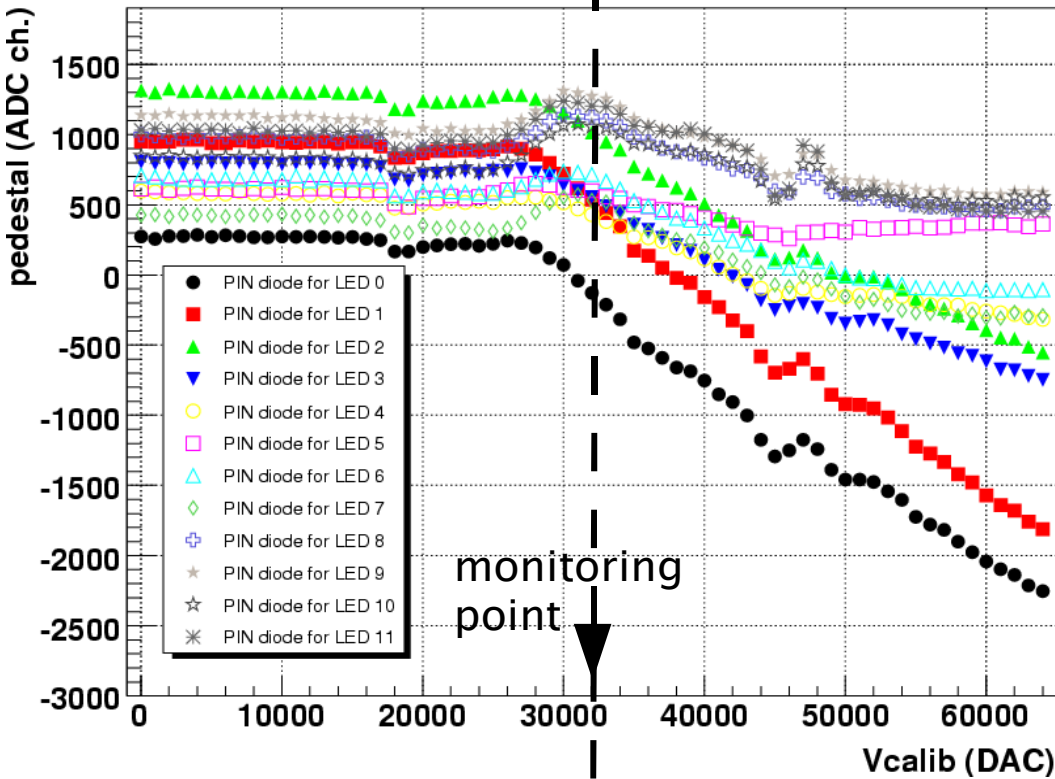
# Temperature-dependence for 40 SiPMs

Oct 26/27, Module 17, SiPM amplitude temperature dependence, pedShiftCorr

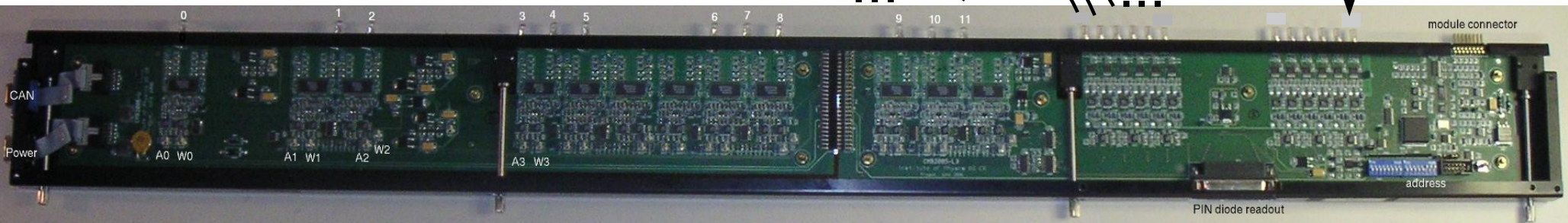
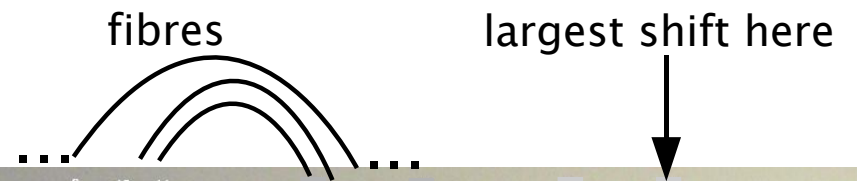


# Caveat: PIN Diode Pedestal Shift

Pedestals of PIN diodes - Run 400010

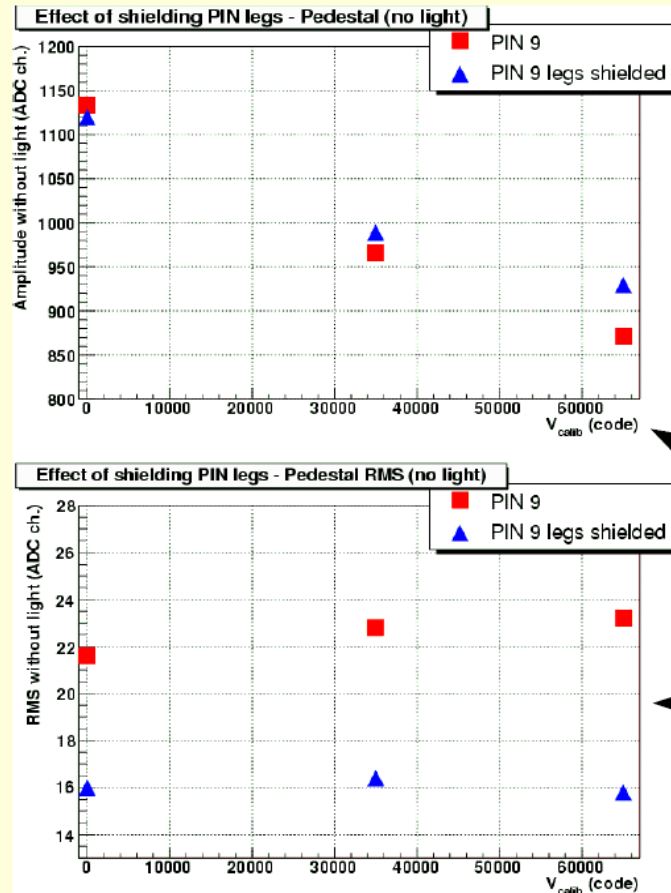


- CMB 30 on Module 24 (DESY Testbeam)
- electrical pulse to LED
- LED light blocked



# PIN pickup noise

without CMB housing!



- LED9 light blocked with paper
- scope connected
- compare pedestal dependence on  $V_{calib}$  for unshielded and shielded PIN legs (foil wrapped around legs)

shielded PIN has reduced pedestal shift

shielded PIN has significantly smaller RMS: ~16 vs. ~22 ch.

shielding improves PIN signal

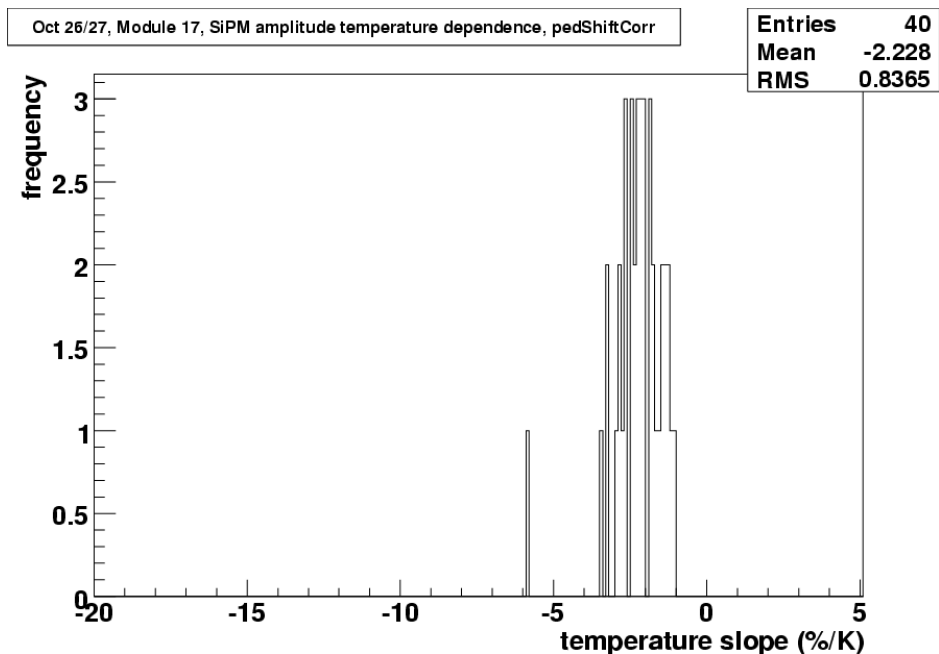
20 April 2006

S Schätzel

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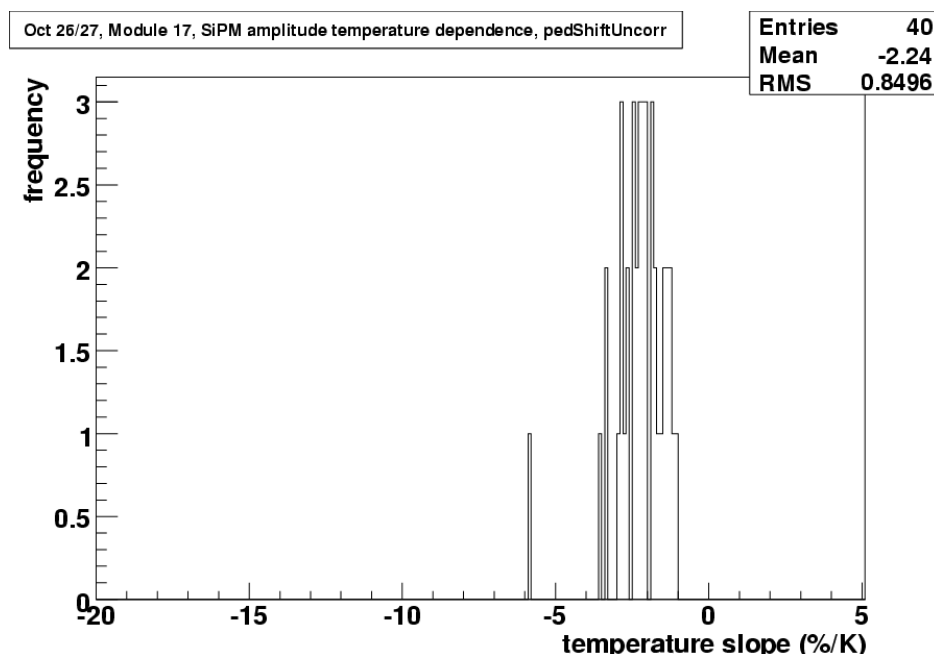
- pedestal shift is a known problem
- there was no time for modifications for CERN2006 beam test
- modifications for CERN2007 under study (Ivo Polak)

# PIN diode pedestal shift uncorrected



# corrected

(assuming CMB30 pedestal shift;  
module 17 has CMB25 with the same  
V\_calib scale)



no significant difference

This is why a high intensity monitoring point was chosen.  
(pedestal shift can be neglected)

# Open Questions

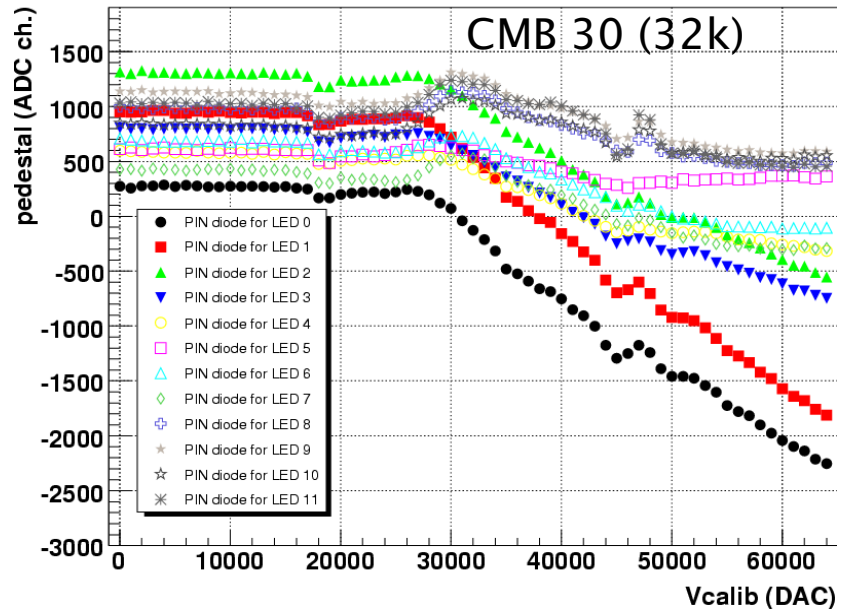
## 1. Correction of CERN2006 data:

16 CMBs have monitoring point at 46000 (different  $V_{calib}$  scale)

for them, the picture  hopefully looks different!

shift must be checked using CALICE DAQ; possible with Prague setup? otherwise have to do it at DESY

Pedestals of PIN diodes - Run 400010



## 2. Remove pickup noise for CERN2007

- Ivo brought modified CMB to DESY (PIN diode legs shielded)
- We will test improvement and modify as many CMBs as time permits

## 3. Pedestal shift screws up saturation curve big time!

correction in principle possible but expect large uncertainties at high  $V_{calib}$ ; but shift is stable

# Outlook: Application in physics analysis

$$A(T) = A(T_0) + (T - T_0) \left. \frac{dA}{dT} \right|_{T_0} = A(T_0) \left( 1 + \Delta T \frac{1}{A(T_0)} \left. \frac{dA}{dT} \right|_{T_0} \right)$$

(e.g. MIP)

$$\equiv A(T_0) C(T)$$

## Different possibilities:

1. Temperature:  $C(T) \approx 1 - x\% \Delta T/K$  ← this talk

2. LED1: (Gain)  $C(T) \approx 1 + 2 \frac{G(T) - G(T_0)}{G(T_0)}$  ←  $\frac{1}{A} \frac{dA}{dT} \approx y \frac{1}{G} \frac{dG}{dT}$

3. LED2: (monitoring)  $C(T) = \frac{A_{\text{LED}}(T)}{A_{\text{LED}}(T_0)} f\left(\frac{\text{PIN}(T_0)}{\text{PIN}(T)}\right)$  ← this talk

saturation correction

Next step: apply all methods to T-dependent MIP calibration

# Part II

Are we happy with the calibration procedure or do we have to change it for the CERN2007 beam test?

- **calibration runs**
  - ahcGain: scan 10 V\_calib values with 12k events each  
**✗ optimise → next slides**
  - Intercalibration: ahcPmLedVcalibScan **✓ ok**
  - taken every few hours when beam was gone or after beam runs **✓ ok**
- **LED monitoring data** taken interleaved with beam data:  
pedestal-LED-beam:
  - might lower the monitoring intensity depending on success of PIN diode shielding
- **temperature** recorded every 10min **✓ ok**

# Calibration constants

- Gain

- calibration efficiency in stable temperature running periods:
  - August 2006: for 94% of all channels
  - October 2006: 97% (period IIb)
- efficiency per calibration run is only approx. 60% (?)
  - unclear how channels are recovered in other runs (60%→9x%); needs to be investigated
  - SiPM pedestal moving with V\_calib (→Beni 6 Oct 2006)
    - channels rejected if shift too large
  - optimise LED intensity and statistics in ahcGain runs

- Intercalibration

- >98% (close to 100% when corrected for dead channels!)



# why channels are not fitable

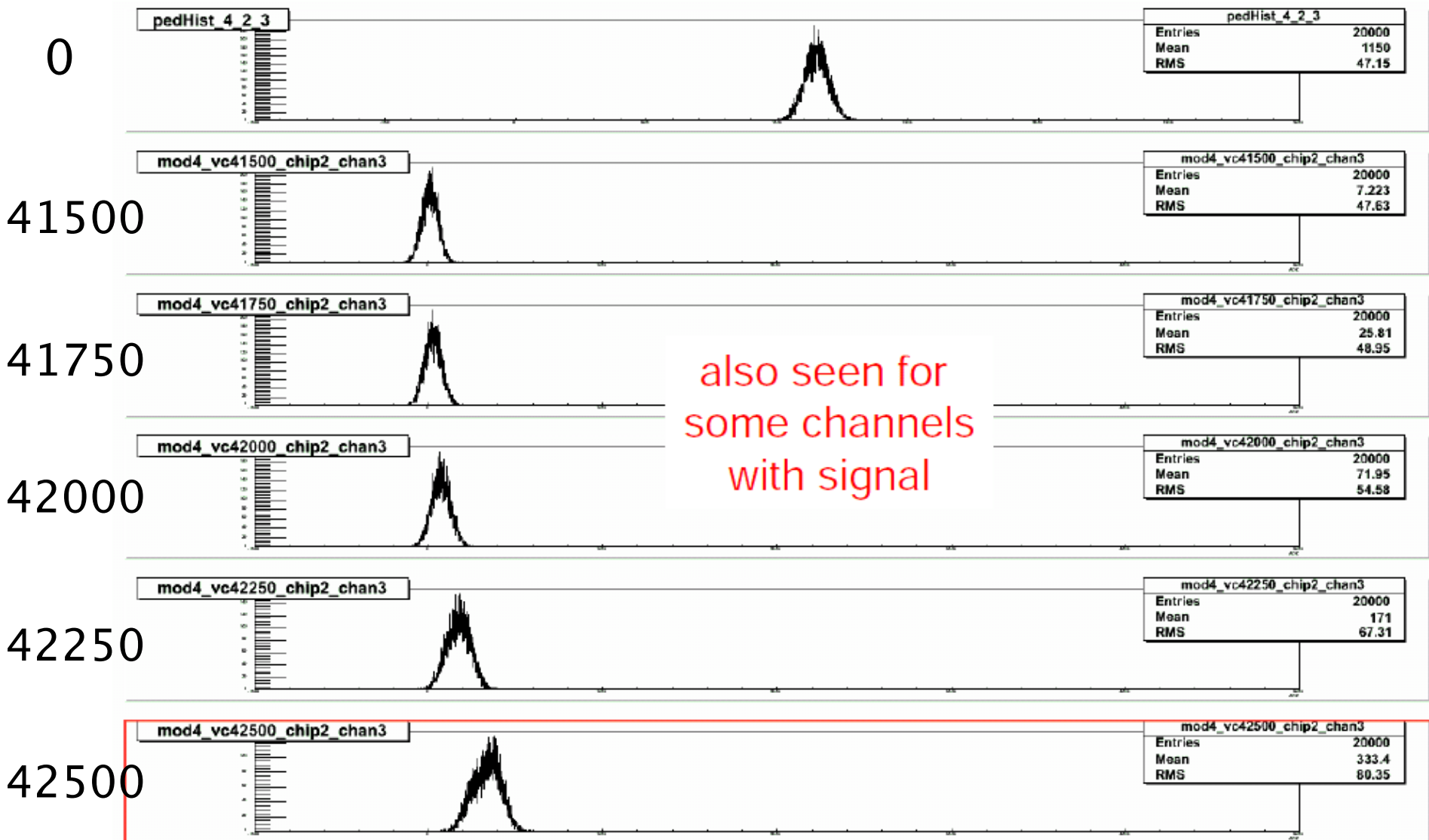
## first view

August 2006  
(94% efficiency)

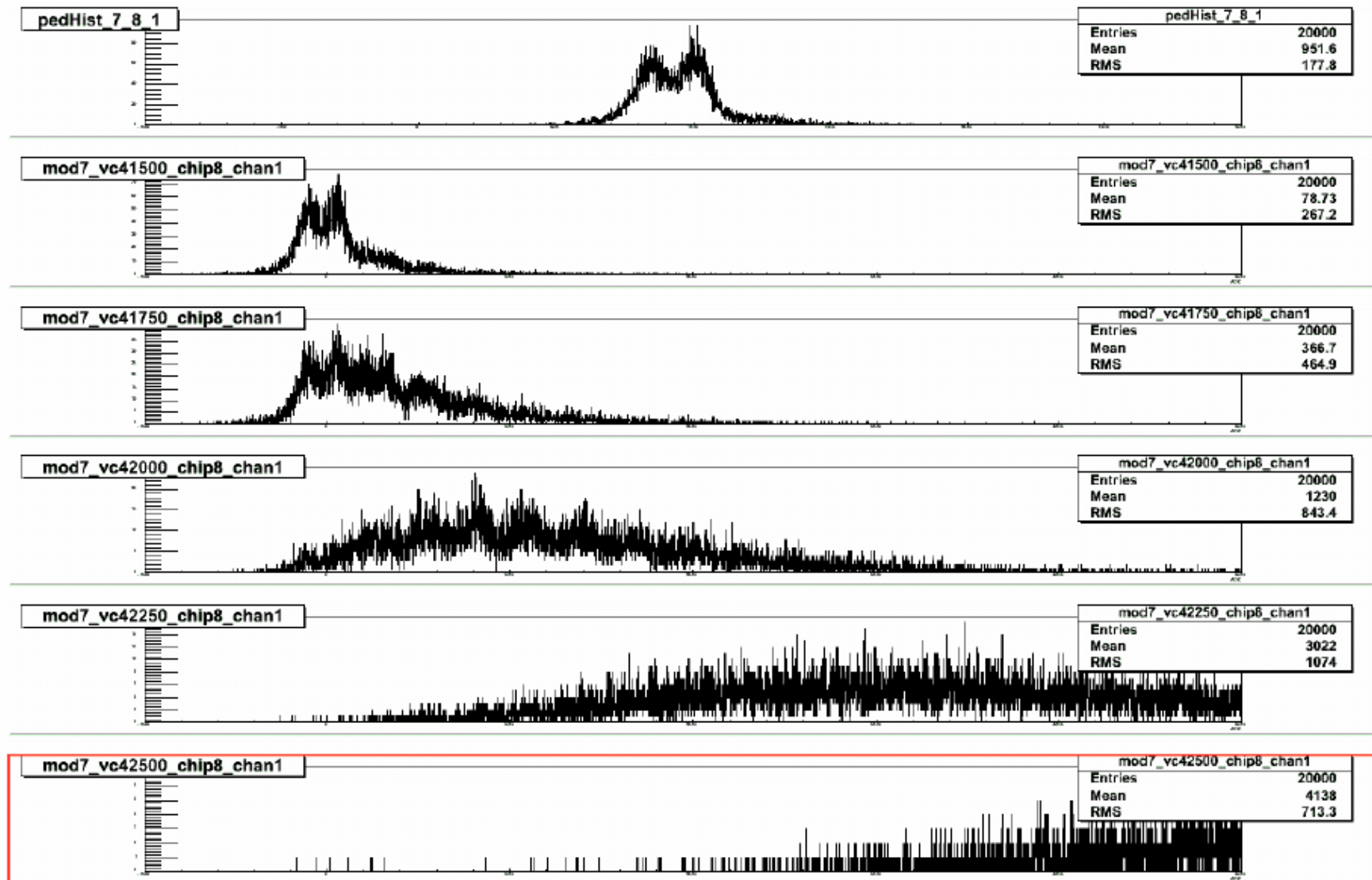
		% of bad	% of all	occurance per module
dead	54			
long discharge	13	6%	0,4%	2 to 3
bad pedestal	55	27%	1,7%	12 to 18
double signal	15	7%	0,5%	1 or 13
light intensity	39	19%	1,2%	too low: 1 to 12 / too high: 23
other reasons	84	41%	2,6%	
sum (no dead)	206		6%	
total channels	3186			

# moving pedestal

Vcalib

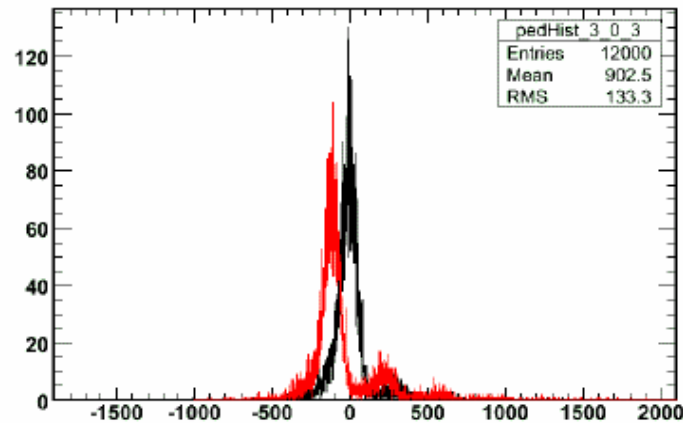


# strange pedestal

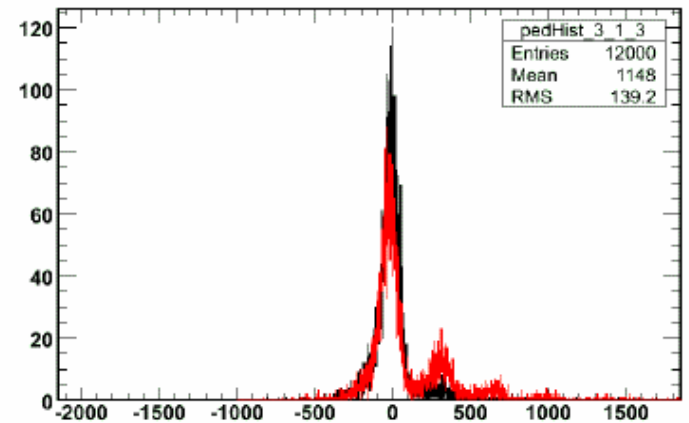


# deeper look

pedHist\_3\_0\_3

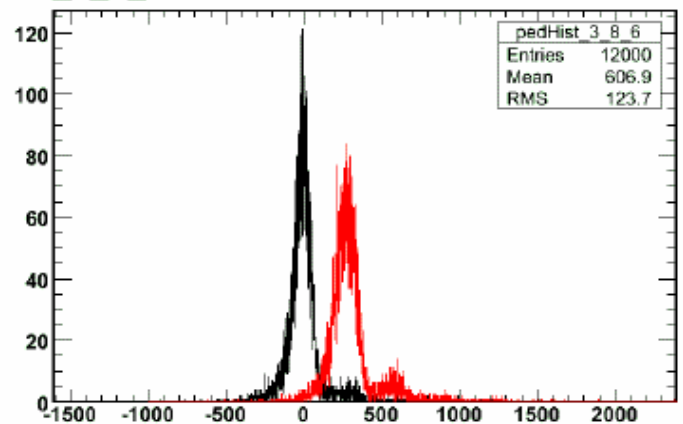


pedHist\_3\_1\_3

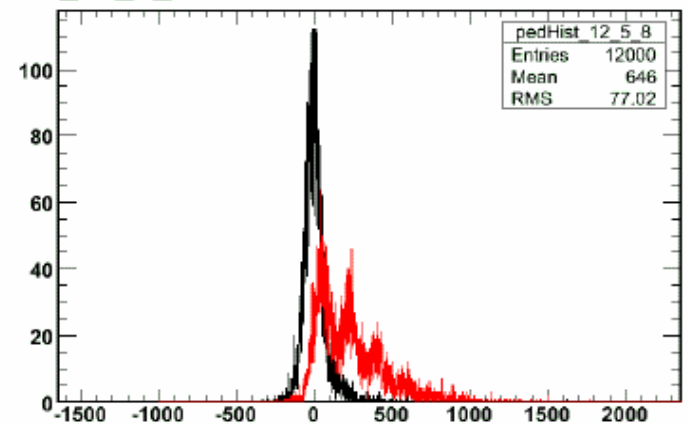


pedestal  
low vcalib

pedHist\_3\_8\_6



pedHist\_12\_5\_8



# Summary

- SiPM temperature dependence studied using LED system  
–  $-(2.2 \pm 0.8_{\text{RMS}})\%/K$  vs.  $-3.7\%/K$  at MEPhI
- LED fluctuations corrected using PIN diode
  - PIN diode pedestal influenced by electrical pickup depending on  $V_{\text{calib}}$  → further studies needed
- PIN diode pedestal shift impact on saturation curve to be studied
- MIP calibration dependence on temperature and application of T-correction is ongoing
- optimisation of calibration data for CERN2007:
  - remove SiPM pedestal shift ( $V_{\text{calib}}$  dependent)
  - optimise  $V_{\text{calib}}$  values and statistics in gain runs
  - lower LED monitoring point if PIN diode shielding successful