

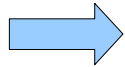
SiPM HCAL Stability

Sebastian Schätzel (DESY)

14 February 2006

1. AHCAL signal is temperature-dependent

$$1/A \, dA/dT \approx -4\%/K$$



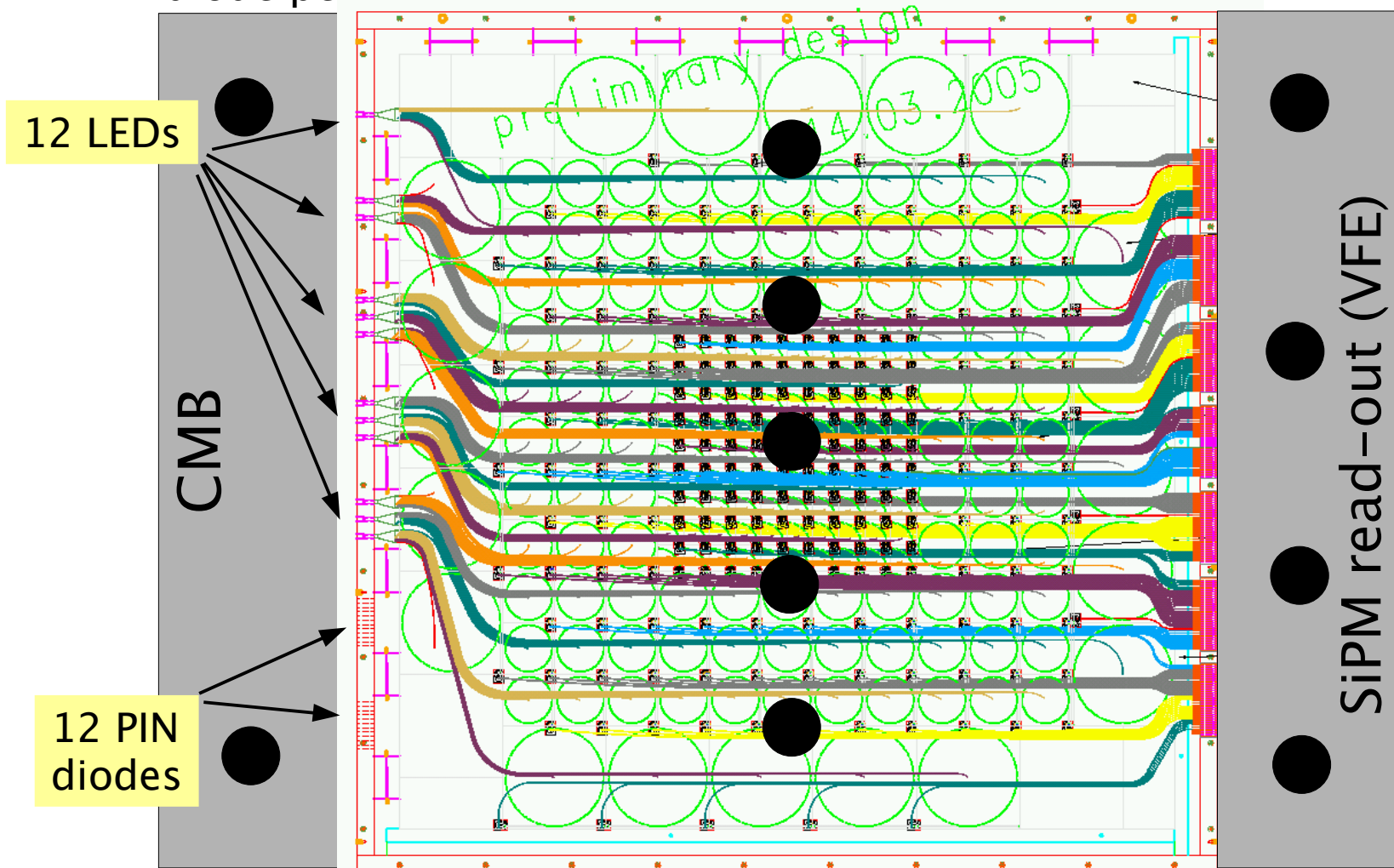
need stable temperature
or offline correction

This talk: outline possible corrections
(no physics results yet)

2. Test long-term SiPM stability

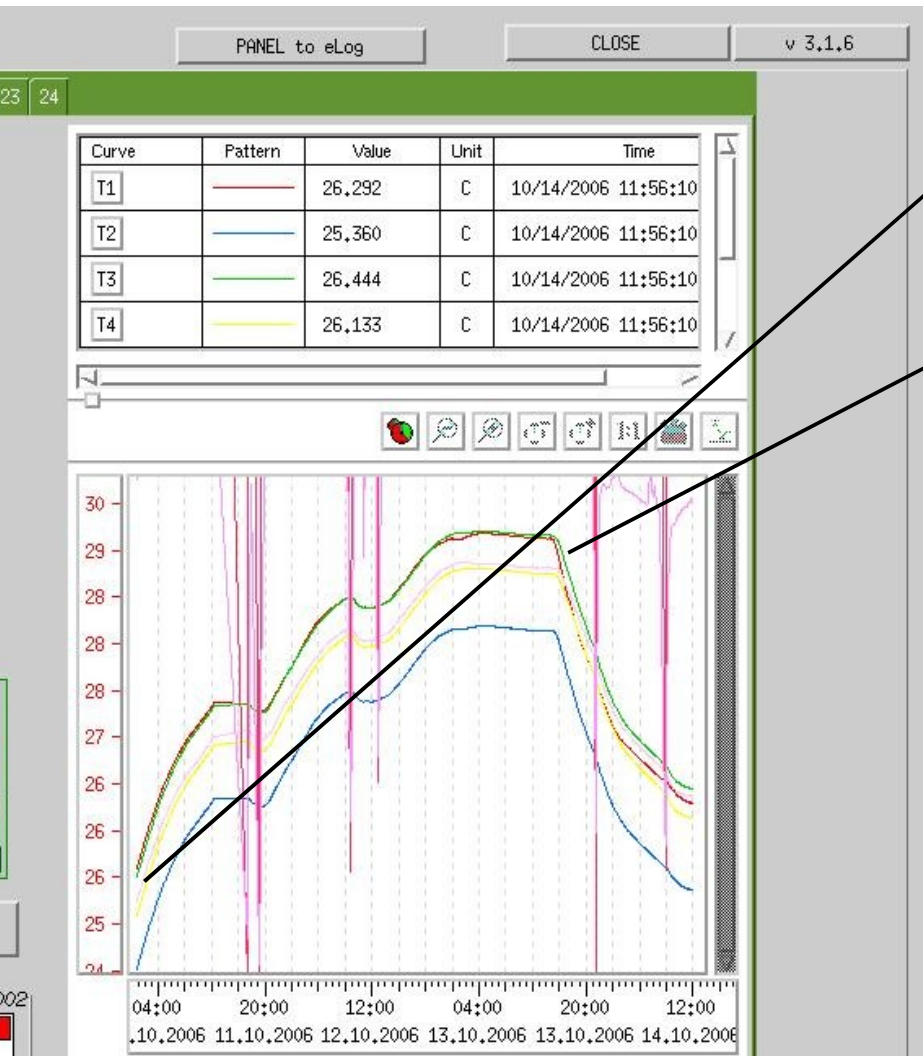
The Tools: LEDs and Temperature Sensors

1 LED per 18 SiPMs
1 PIN diode per LED



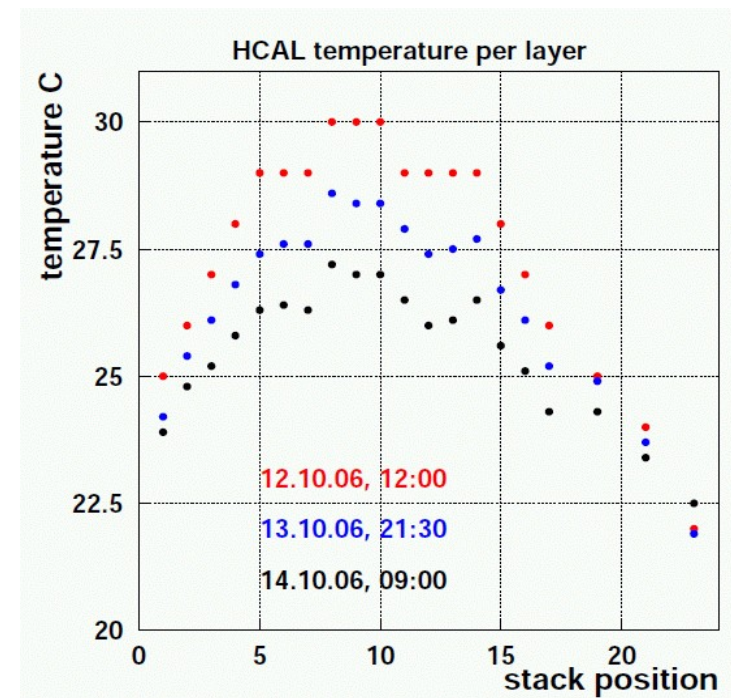
● = Temperature sensor
(read by slow control and central DAQ)

Observed temperature variation at CERN



heat-up: HCAL switched on
(~2 days, ~4K)

cool-down: 4 air fans installed
(2 under VFE, 2 under CMBs)



Correcting temperature dependence

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

(e.g. MIP)

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

Different possibilities:

1. Temperature: $C(T) \approx 1 - 4\% \Delta T / K$

2. LED1:
(Gain)

$$C(T) \approx 1 + 2 \frac{G(T) - G(T_0)}{G(T_0)} \quad \leftarrow \quad \frac{1}{A} \frac{dA}{dT} \approx 2 \frac{1}{G} \frac{dG}{dT}$$

3. LED2:
(monitoring)

$$C(T) = \frac{A_{\text{LED}}(T)}{A_{\text{LED}}(T_0)} \underbrace{f\left(\frac{\text{PIN}(T_0)}{\text{PIN}(T)}\right)}_{\text{saturation correction}}$$

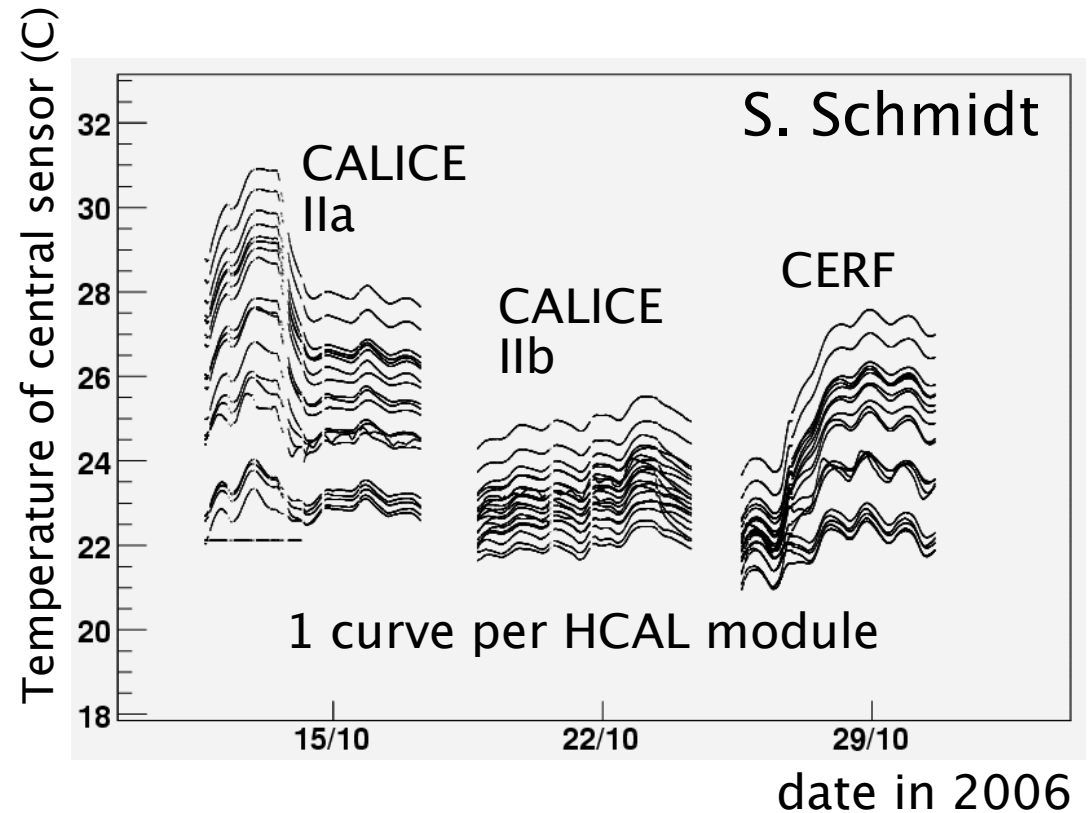
Software Tools

- using CALICE software, Marlin processors
- **Temperature**
 - from database (conditions data)
 - example processors exist (R. Pöschl, S. Schmidt)
- **LED runs**
 - **gain fitter** (B. Lutz)
 - all gain runs are processed, gain data are available
 - **monitoring run processor** (S. Schätzel)
 - inclusion of PIN diode correction is ongoing
- **MIP calibration**
 - the benchmark signal
 - processor by N. D'Ascenzo

Data taking periods

2 periods with increased temperature variation:

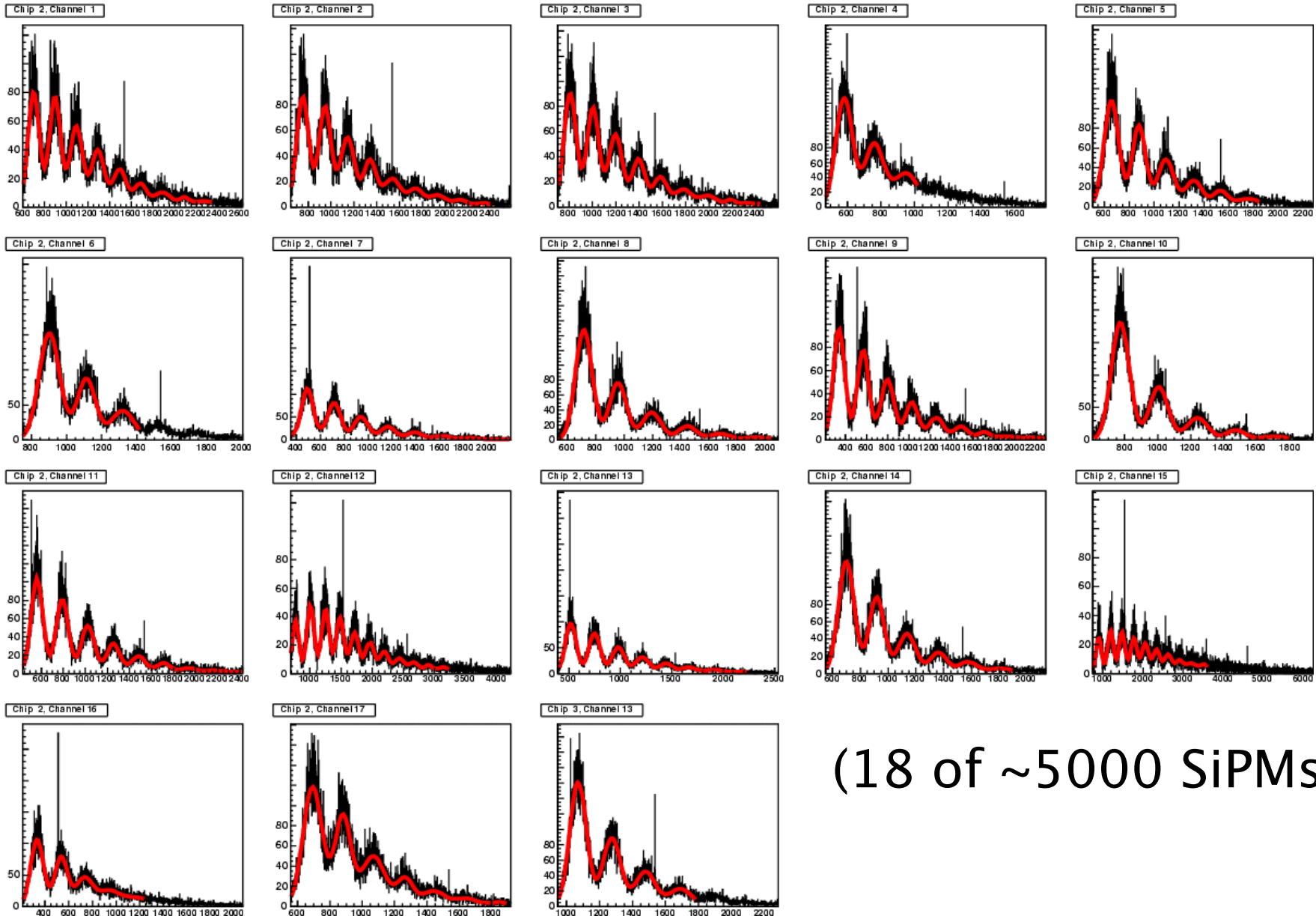
- initial heating/cooling
- +Additional data during parasitic CERF running:
 - cooling fans removed
 - plenty of muon and gain calibration runs



➔ exercise & benchmark tools here
before application to physics data

Example for Gain Fitter

Run 201353 - LED 2 - SER013, Slot 12, FE3 - Entries vs. ADC channels

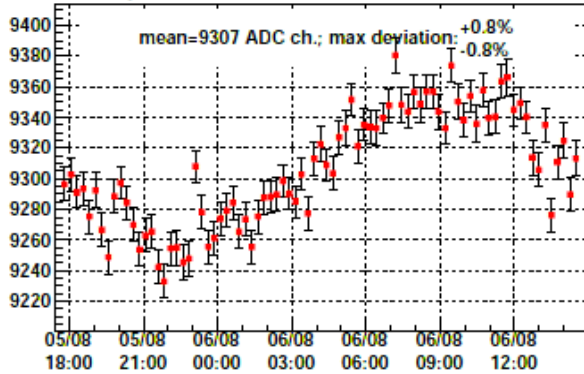


(18 of ~5000 SiPMs)

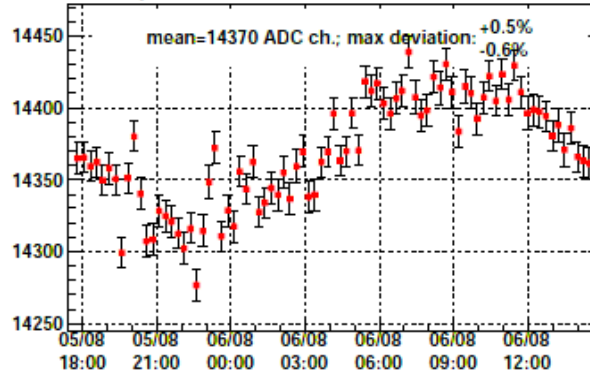
Example for LED Monitoring

Run 320409, Module 10, LED events, pedestal-subtracted mean amplitude (ADC ch.) vs. time (UTC)

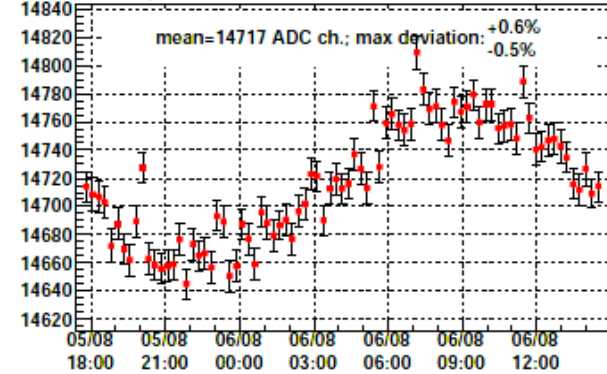
SiPM chip 1 chan 11 (LED 3)



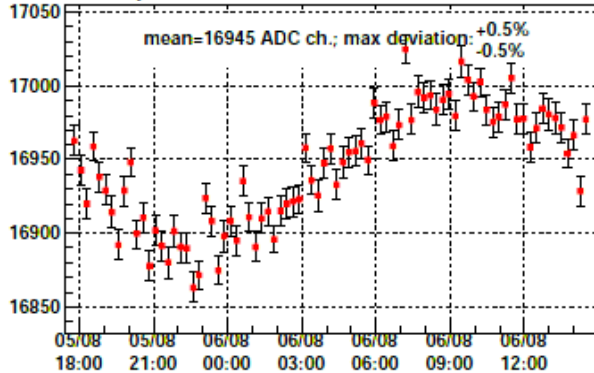
SiPM chip 3 chan 0 (LED 3)



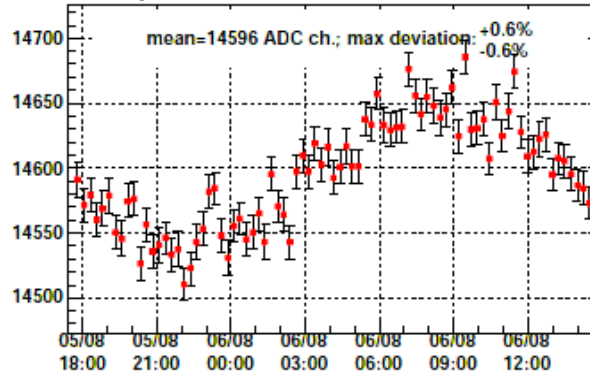
SiPM chip 3 chan 1 (LED 3)



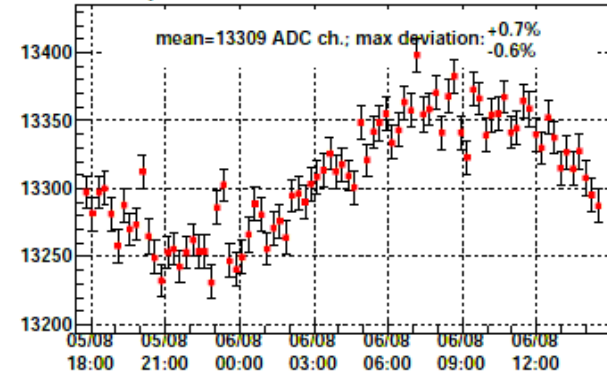
SiPM chip 3 chan 2 (LED 3)



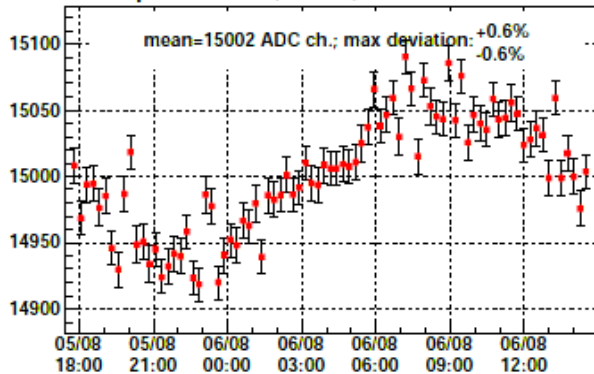
SiPM chip 3 chan 3 (LED 3)



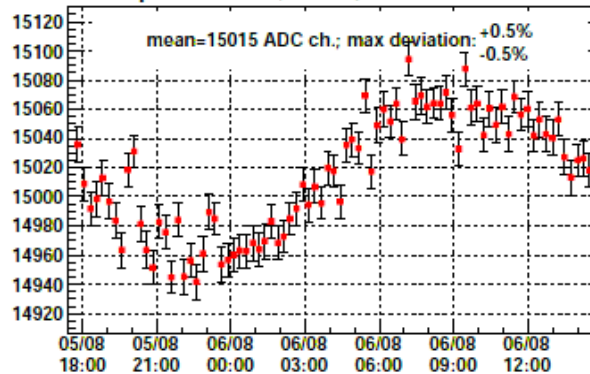
SiPM chip 3 chan 4 (LED 3)



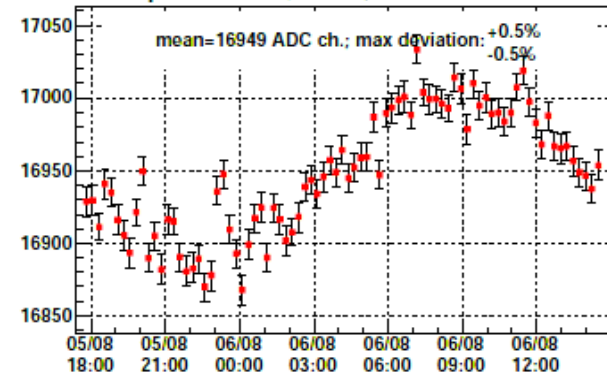
SiPM chip 3 chan 5 (LED 3)



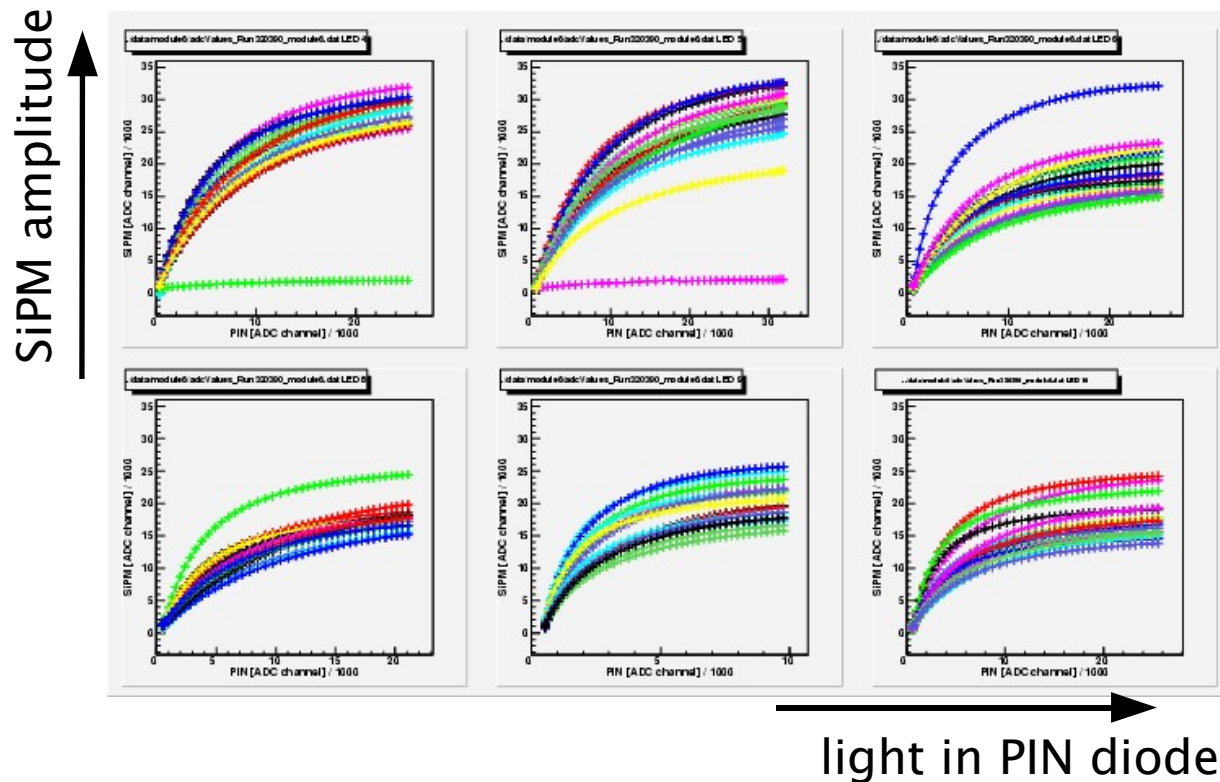
SiPM chip 3 chan 6 (LED 3)



SiPM chip 3 chan 7 (LED 3)



SiPM Saturation curve stability



- special LED runs with varying light intensity (every ~3h)
- analysis started by Nanda Wattimena, now taken over by Trygve Buanes (Bergen)
- close collaboration with Vasiliy Morgunov
- see talk by Gerald Eigen

Conclusions

- AHCAL requires stable temperature or offline correction
- Calibration system offers different correction methods
- Software tools are in place
- The fun is about to start!

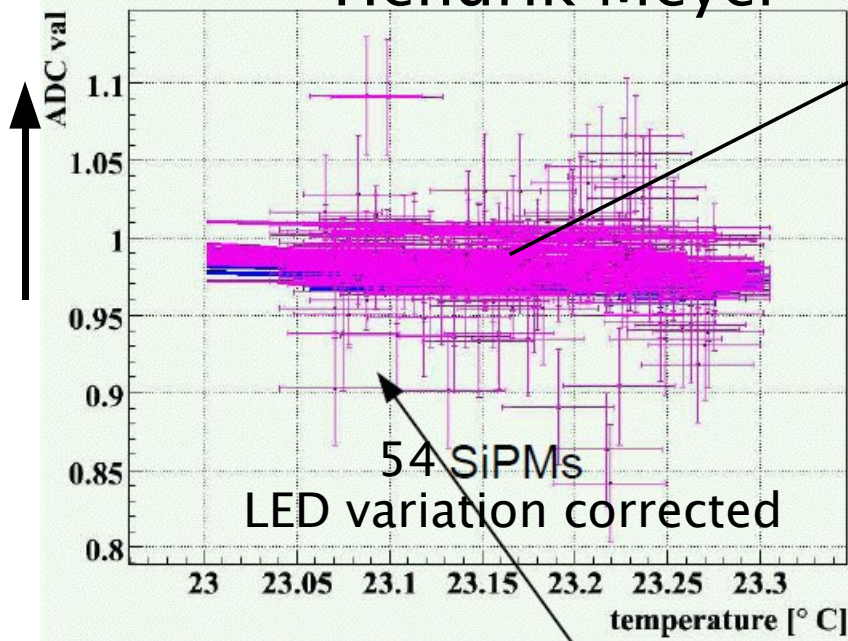
Backup Slides

Experience with monitoring during cosmics run

- prototype of LED system was used in a 2 weeks cosmics run last winter
- small temperature variation → little signal variation
- low MIP statistics (cosmic muons)

normalised SiPM
response to LED

Hendrik Meyer



$$\frac{1}{A} \frac{dA}{dT} = -3.7(2)\%/K$$

full glory of monitoring
system to be unveiled
with CERN data!

CERN monitoring data

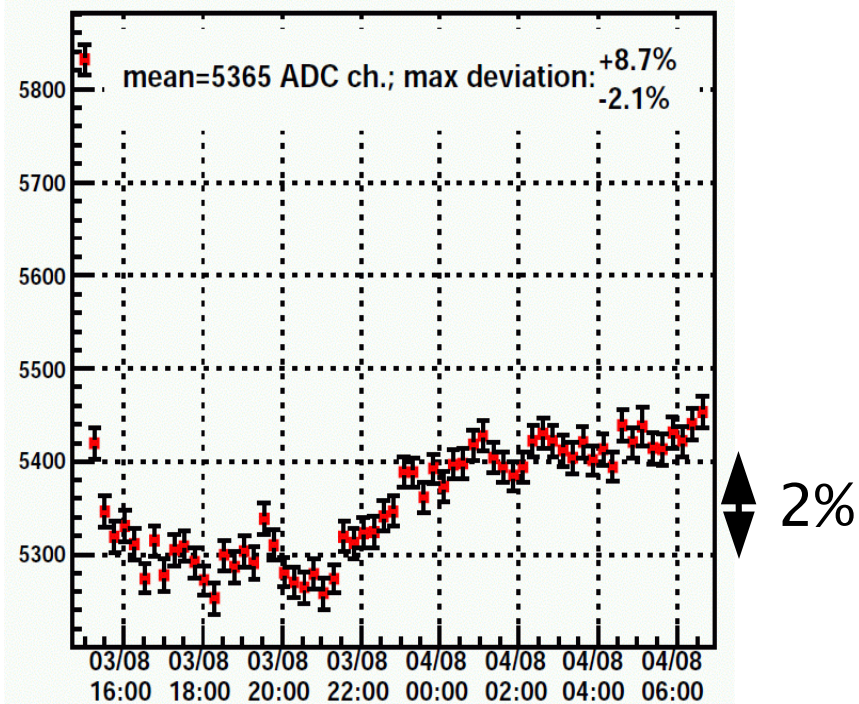
- HCAL calibration runs
 - ahcGain
 - ahcPmLedVcalibScan
 - taken every few hours when beam was gone (no regular “schedule” for these runs)
- fixed intensity LED monitoring data taken interleaved with beam data (pedestal – LED – beam cycle)
- temperature from sensors continuously recorded with data and written to HCAL database

First LED/PIN stability check

- only first look at beginning of CERN data taking
- SiPM response to LED stable within 3%
- PIN photo-diodes indicate light intensity change where SiPMs are stable, careful checks needed

Run 320404, Module 10, LED events, pedestal-subtracted mean amplitude (ADC ch.) vs. time (UTC)

PIN diode connected to LED 7



SiPM chip 6 chan 17 (LED 7)

