

# Recent studies on the new EUNET module

News from the Testbeam

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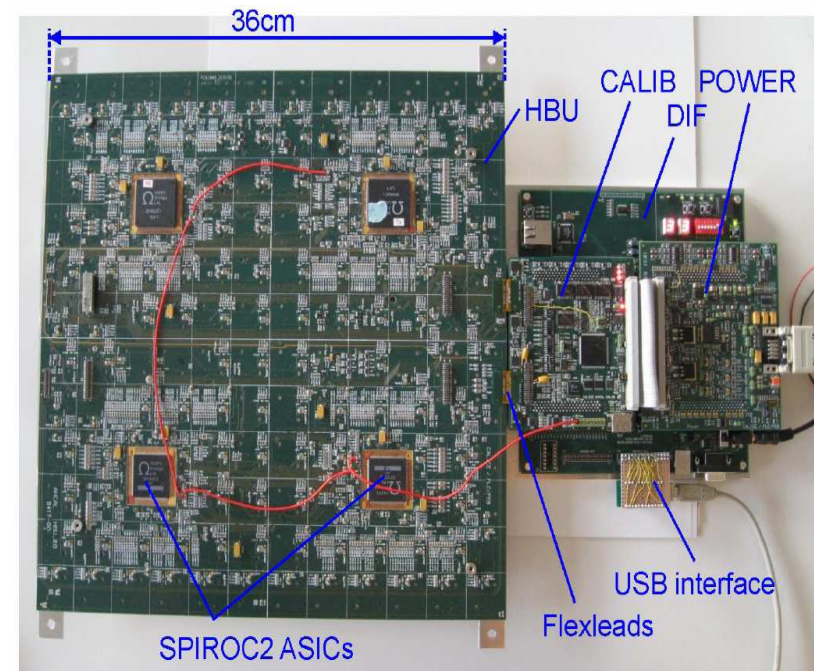
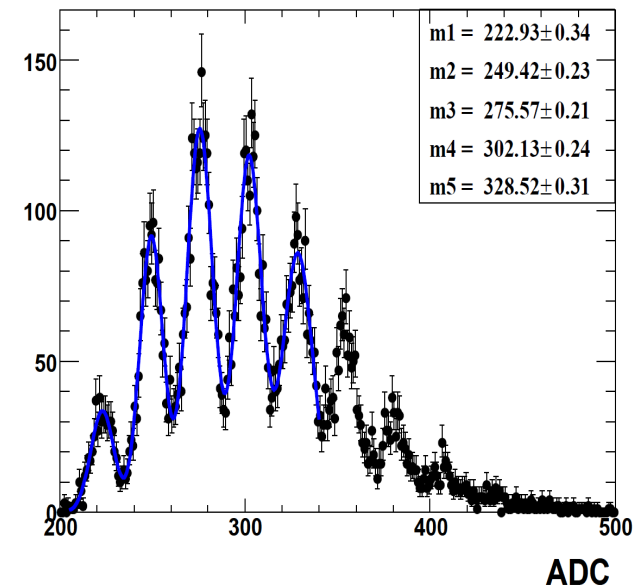


# Outline

- Reminder
- Characterization of the LED system
- Pedestal shift investigation
- MIP calibration
- Summary
- Todo next

# Short reminder

- Mounted with two 1st & 2nd generation SPIROC
  - Each with 36 Tiles+SiPM
- Each Tile has a UV-led for relative gain calibration
- Single Photon Spectra (SPS) show gain as peak to peak distance
  - Produced by **small** led pulses



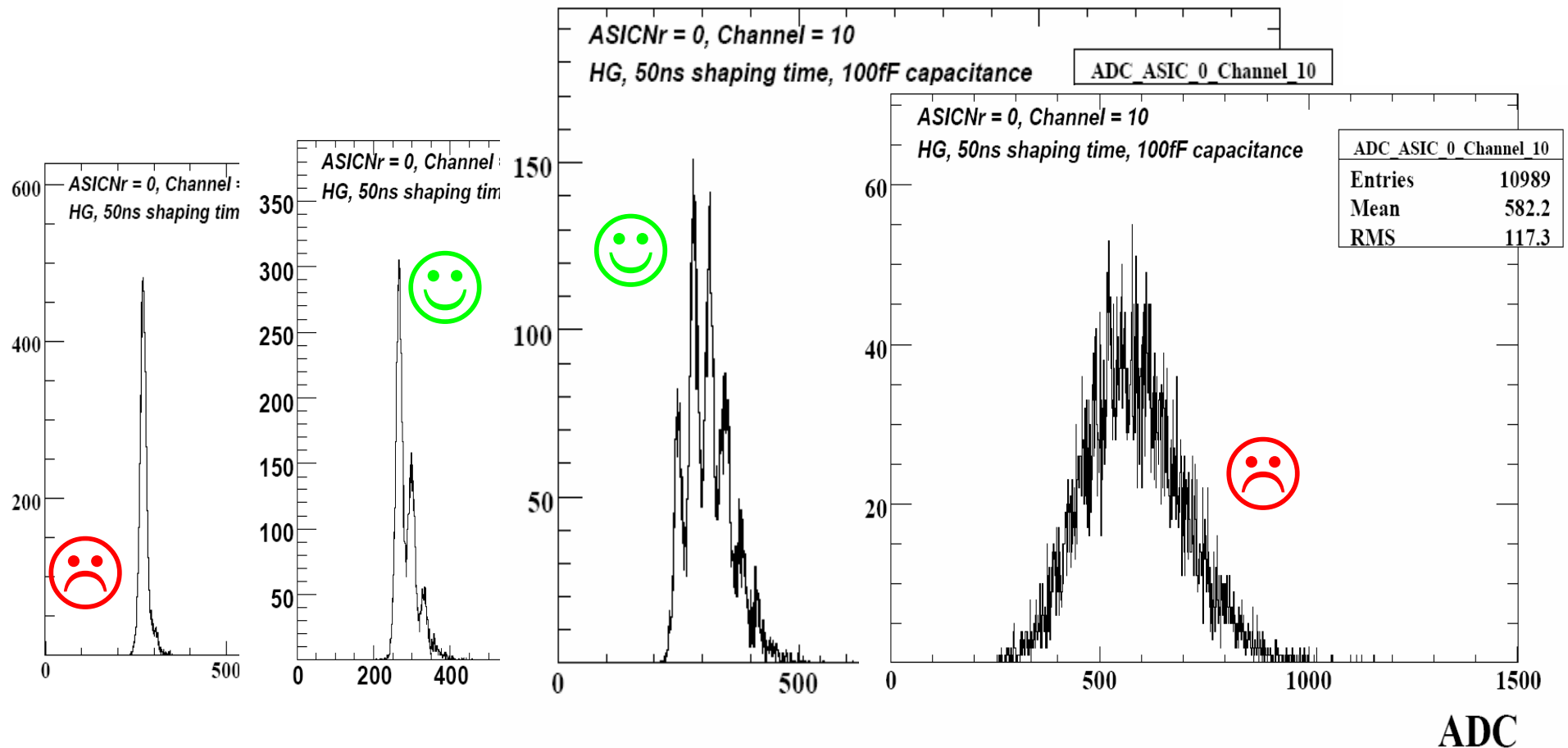


# Characterization of the LED system

- The LED system has two major tasks:
  - Tool for SPS creation (in high gain) → SiPM gain calibration
  - Tool for Saturation (in low gain) → determine the effective number of SiPM Pixels
- Testing the SPS creation
  - Map operational tiles and validate SiPM gain from SPS-fit
  - Determine the number of LED voltage settings for safe SPS production (# voltage settings = # LED runs)
- Test of the LED's dynamic range, SiPM saturation possible?
  - To be done: Error in low gain mode, work in progress

# Ideal SPS behavior

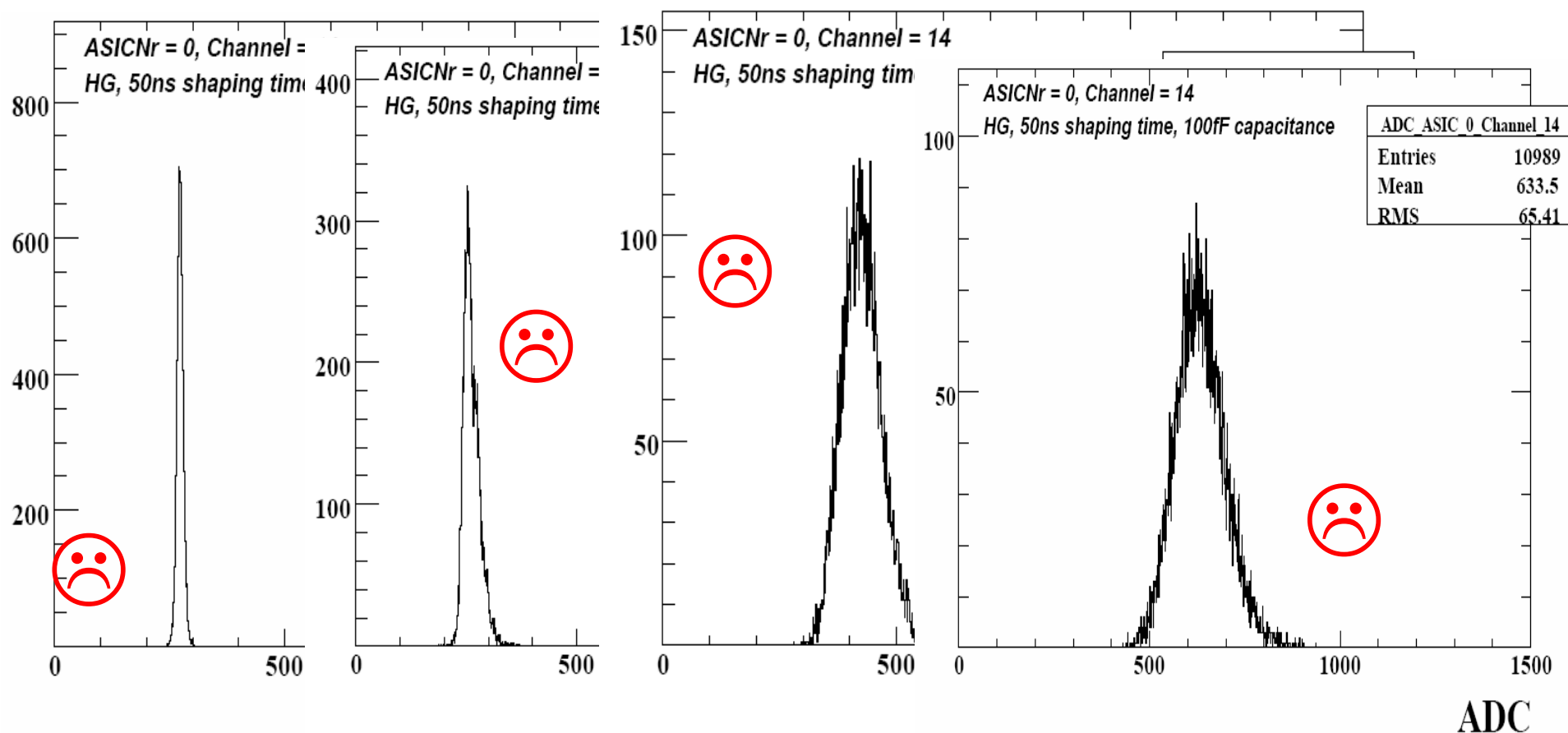
Development of the SPS for the same tile(channel) for different given LED voltages: left to right: 4650mV, 4850mV, 5050mV, 5500mV



# Other SPS behavior: smeared spectra

Development of the SPS for the same channel for different given LED voltages: left to right: 4650mV, 4850mV, 5050mV, 5500mV

- Possible reason: strange LED behavior, puls structure not stable?



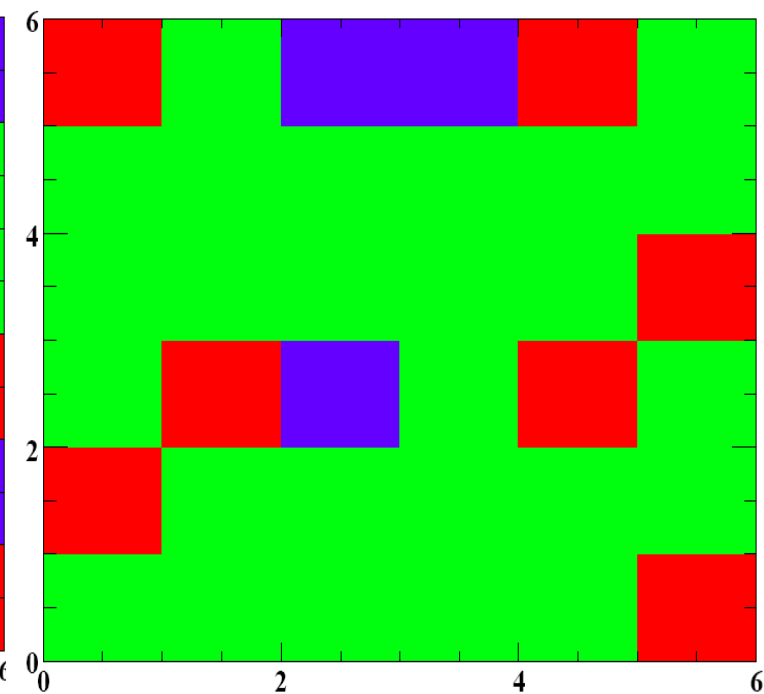
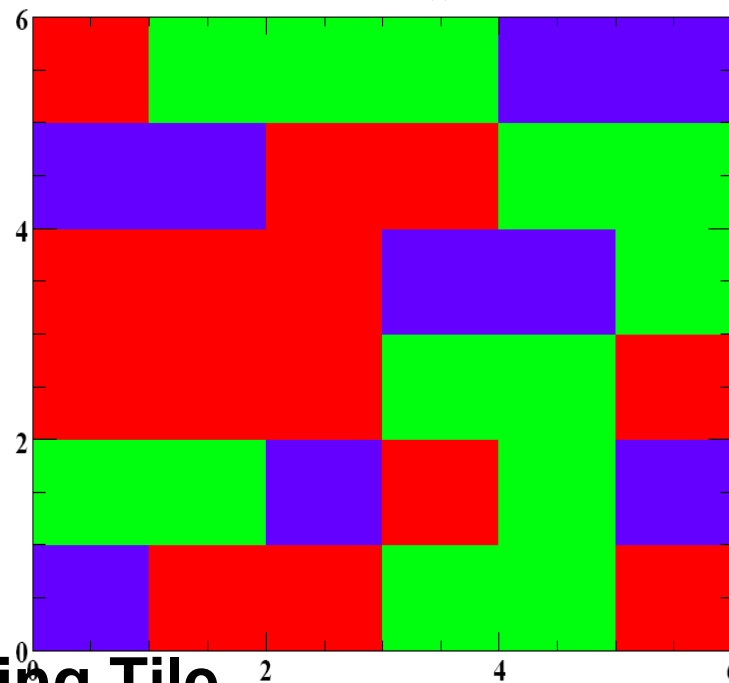
# Map of the tiles

- 5 different LED voltage settings are needed to produce SPS in all channels
- Many channels are „smeared“ → no SPS

**Legend:**  
green =  
operational

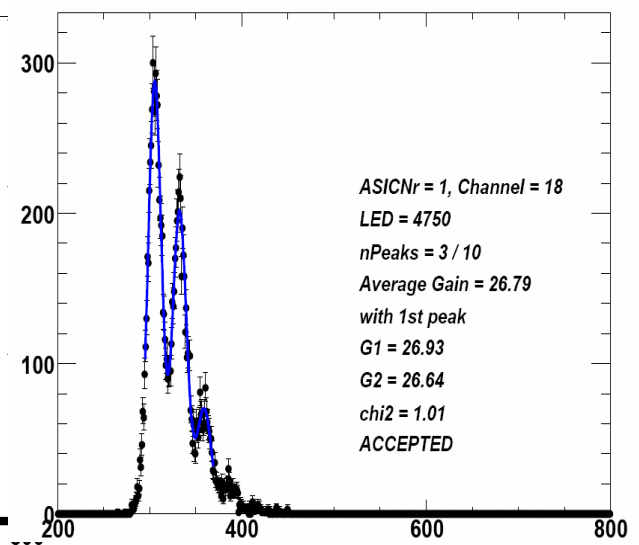
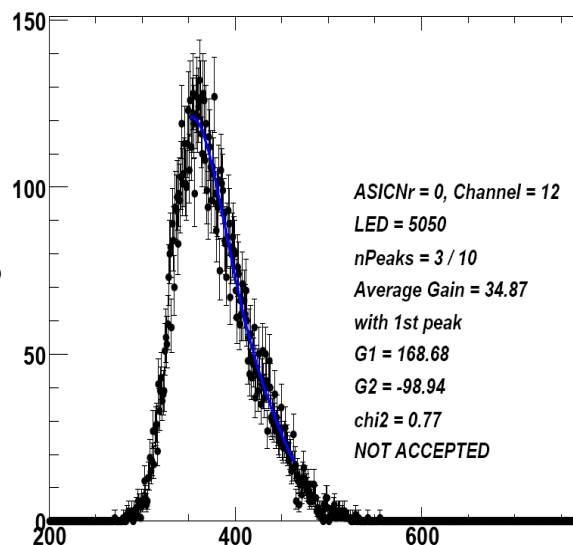
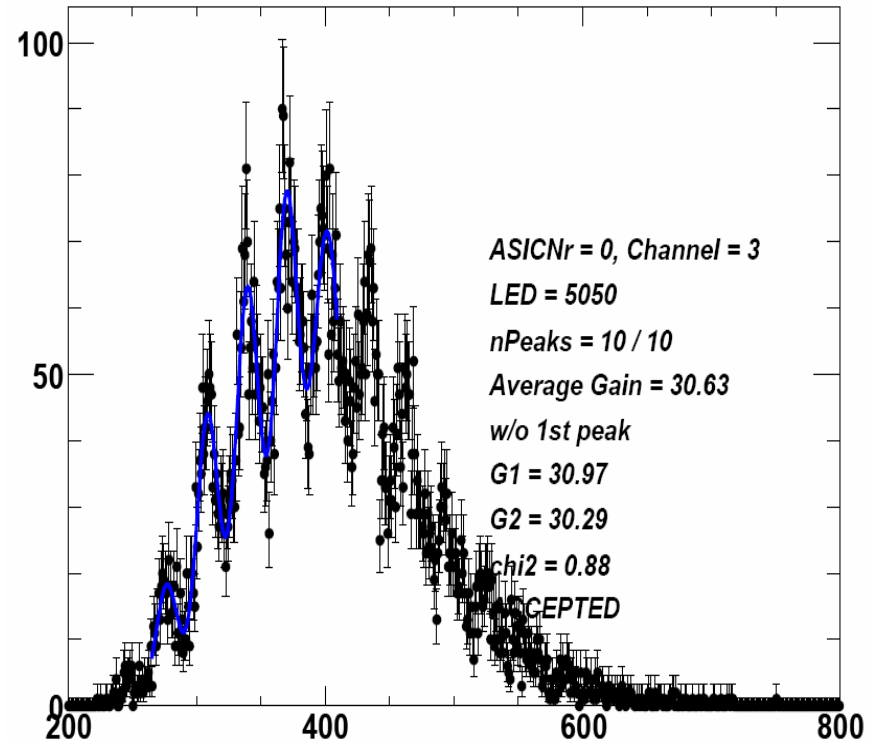
red =  
smeared

blue = missing Tile  
(or broken SiPM or LED)



# Gain extraction

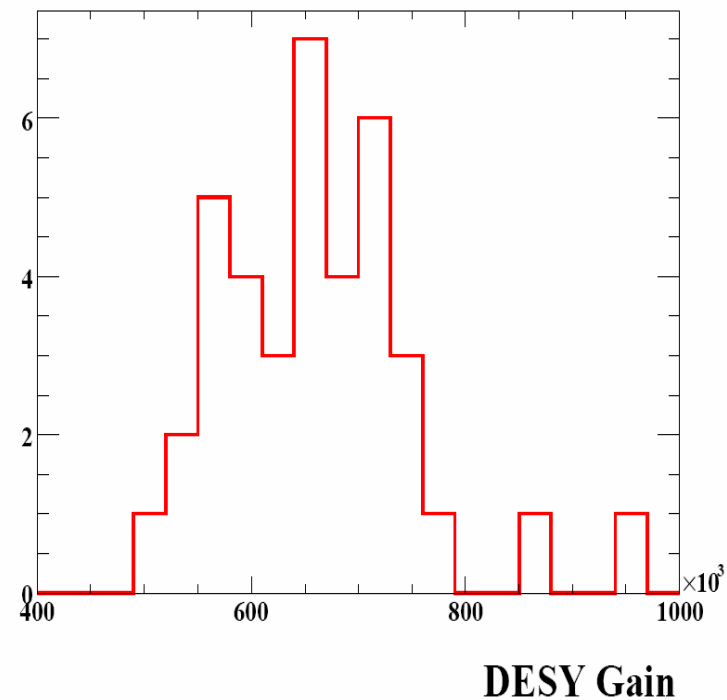
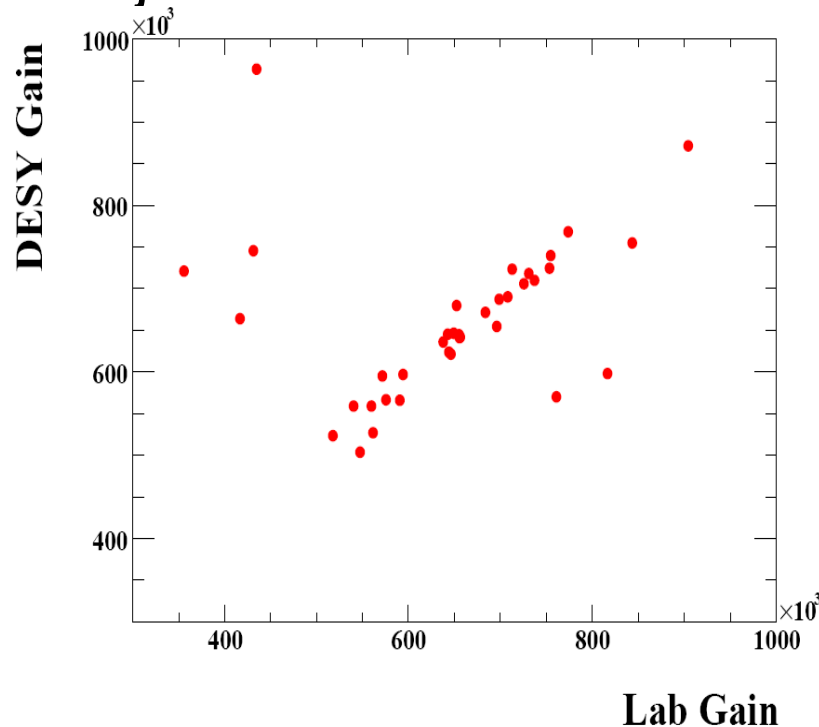
- Gain is extracted as the peak distance
- Fit function is a sum over up to 5 Gaussians
- Can be used to determine the number of LED voltage settings automatically





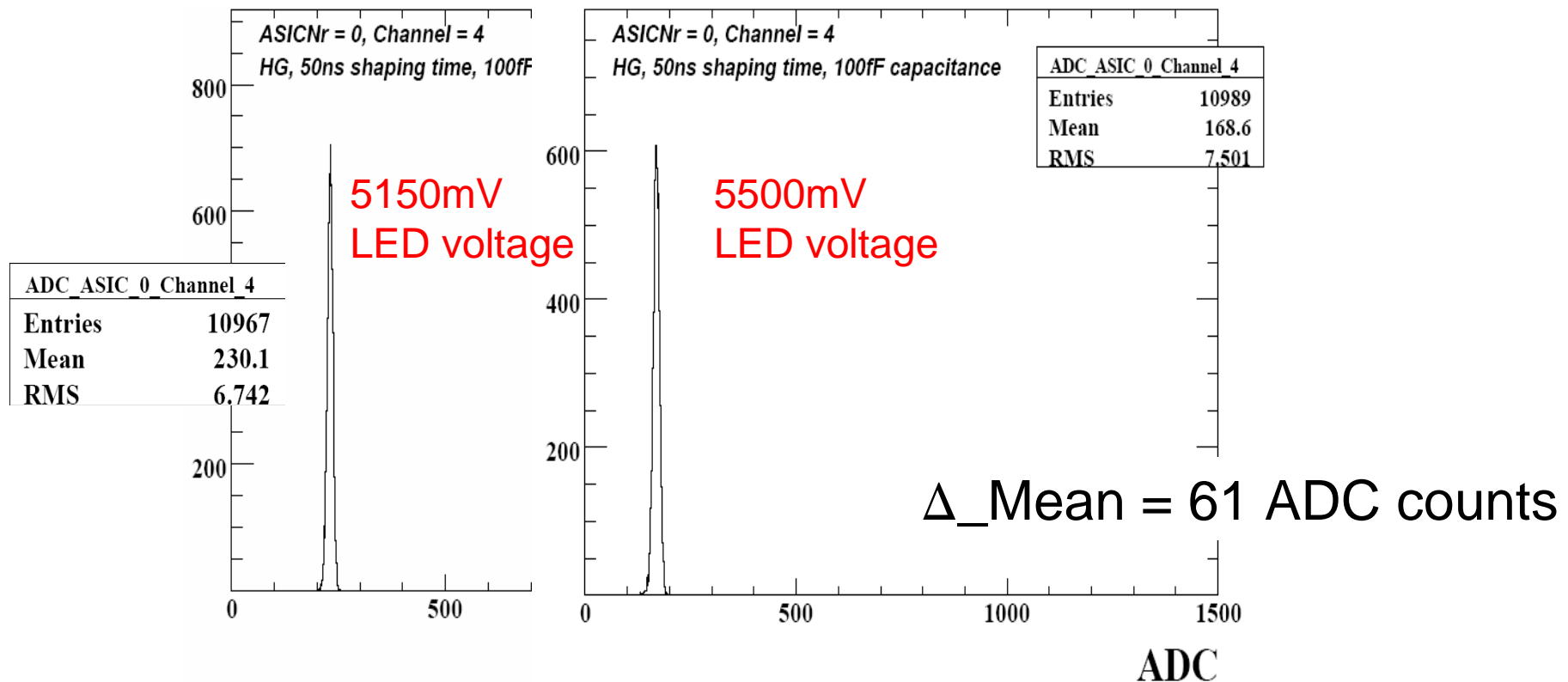
# Testbeam gain vs. lab gain and quantity

- Same readout (SPIROC2)
- Minor differences due to temperature differences (summer/winter)
  - ~2% gain per 1°C
- Major aberrations to be understood...



# Pedestal shift

- Phenomenon is known from the last prototype
- One explanation was: LED Pulse induced electrical noise



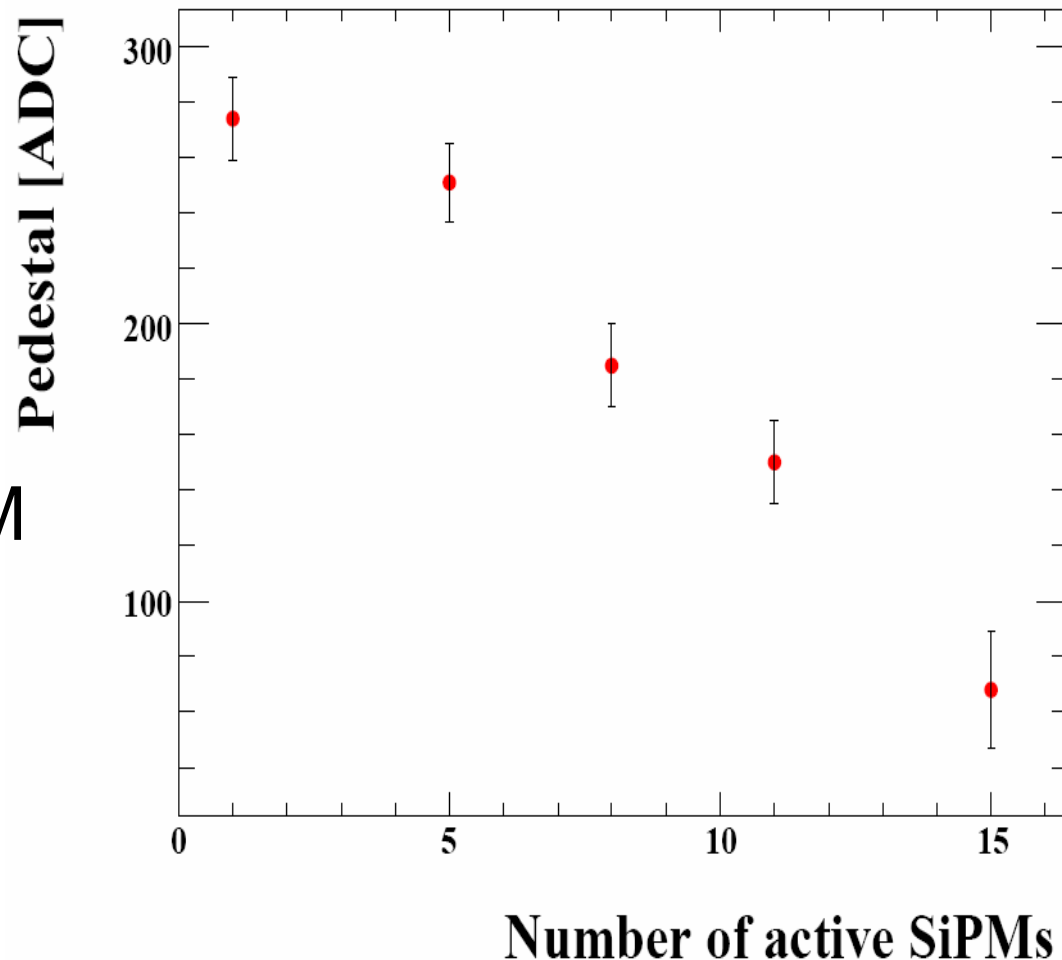


# Pedestal shift investigation

- The shift vanishes, if most SiPM voltages are switched below breakdown voltage
  - Setup still pulses all LEDs, strong hint that the LED has no direct effect
- Charge injection (into the SPIROC) shows same result → proof that LED is not causing the shift
- First try: Run measurements with different numbers of powered SiPMs

# Pedestal shift dependency of number of active channels

- LED voltage:  
5500mV
- SPIROC2\_2  
□ Channel24
- 25+ active SiPM  
accumulate at the  
ADC lower limit





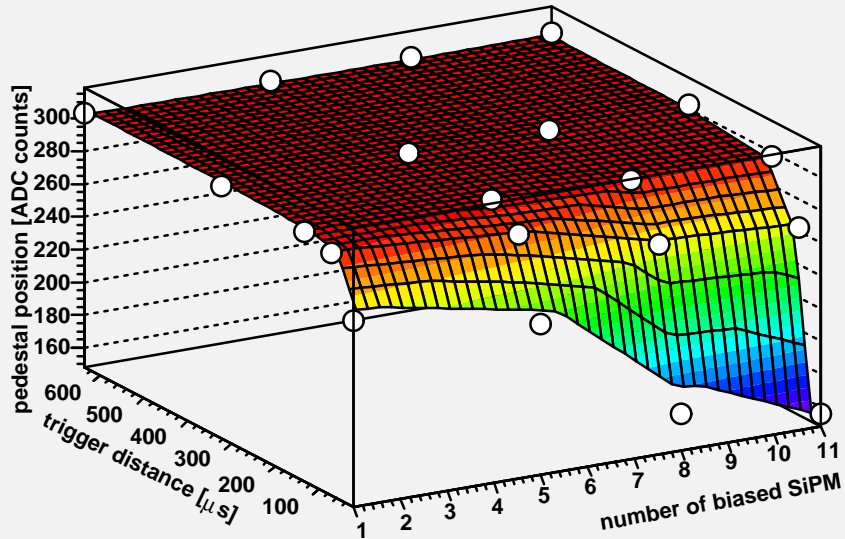
## Possible reason

- All shifts were measured in *internal trigger* mode (LED and charge injection)
- # channels and the LED-voltage indicate a overall signal amplitude dependency
- The electronic groups suggest an amplifier issue, related to the fast internal trigger rate

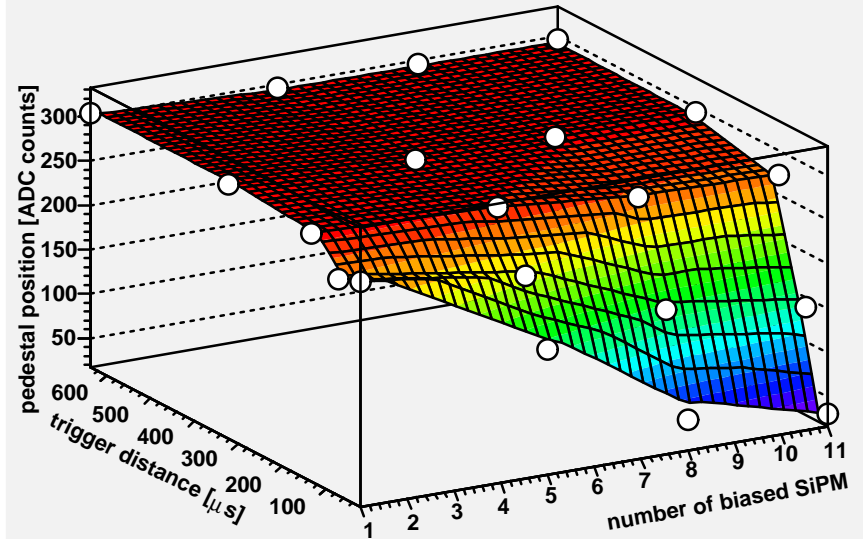
(Trigger distance  $\sim 21\mu\text{s} \neq 200\text{ms}$  ILC repetition rate)

# Trigger rate dependency

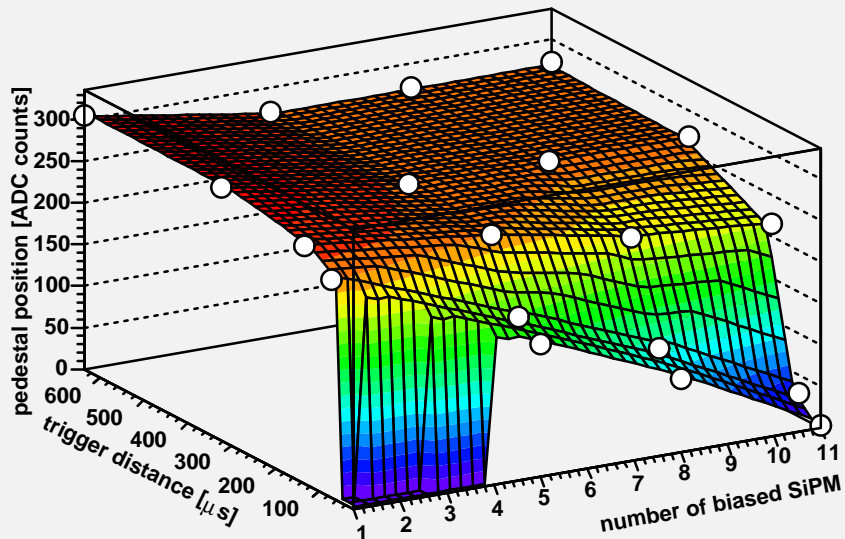
Pedestal position at 5500mV



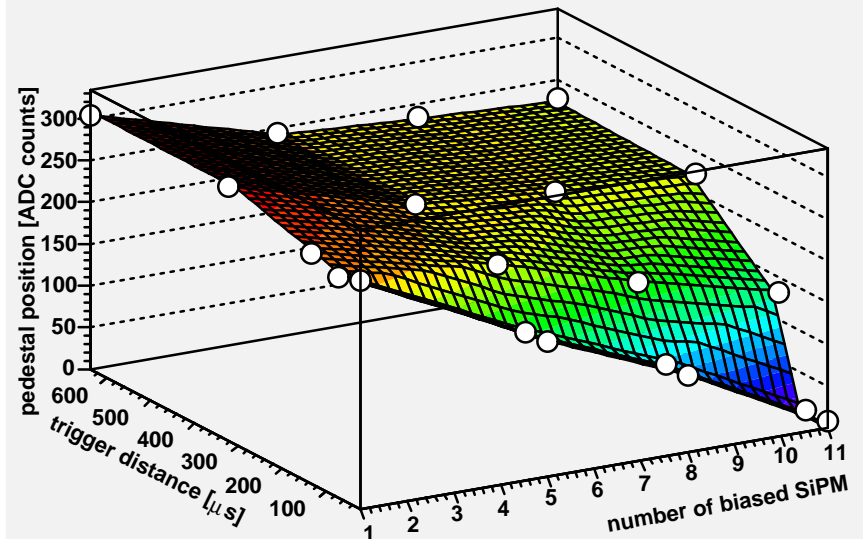
Pedestal position at 6500mV



Pedestal position at 7500mV



Pedestal position at 8500mV





# Problem seems solved...

... but not understood in detail. Current chip simulation does not show the effect.

- Should not affect MIP measurements or other physics runs

→ To be studied

# MIP measurements

- MIP at the Testbeam is a 2GeV electron
- Module is moved on a positioning table
- First step: measure MIP spectra for all operational tiles
- Extract lightyield and gain from the MIP spectra

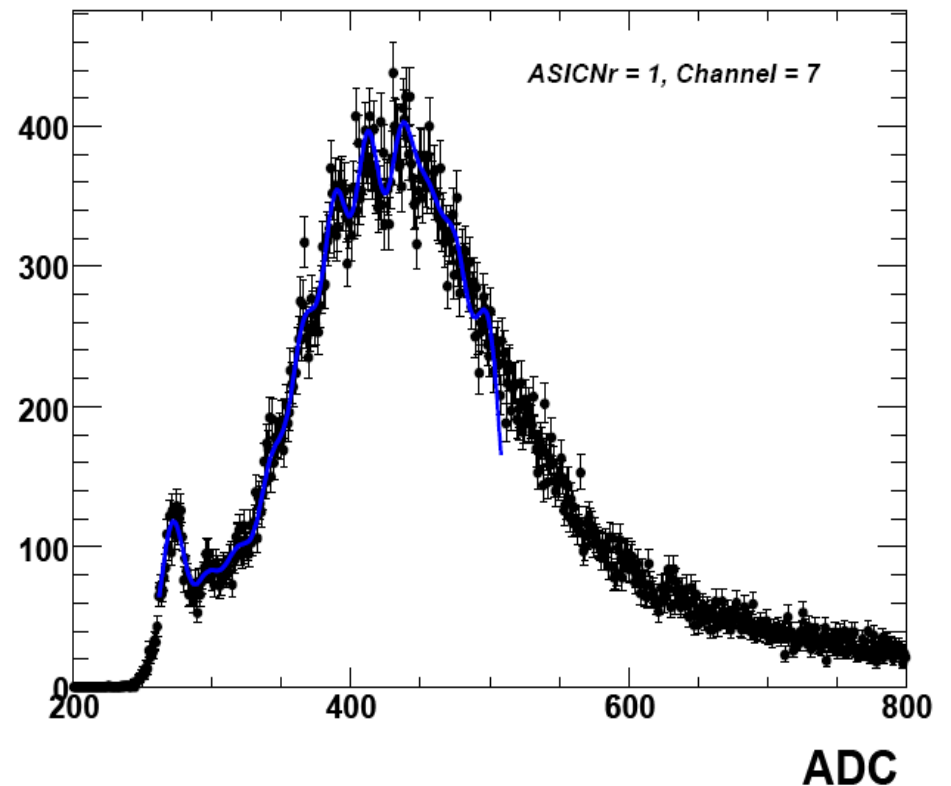
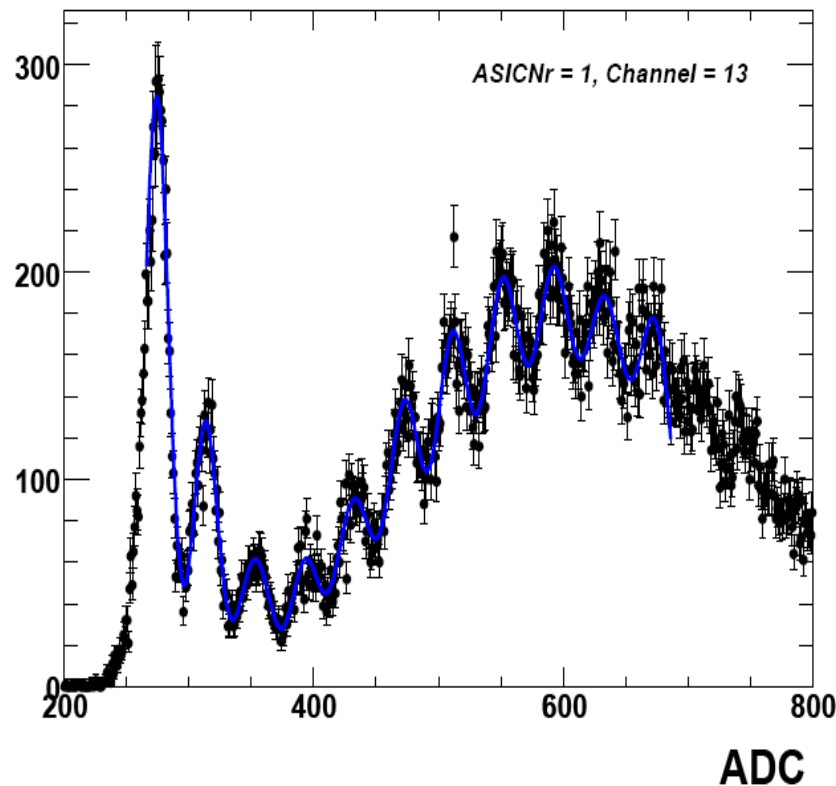


First person impression of a MIP (non relativistic) before hitting the module



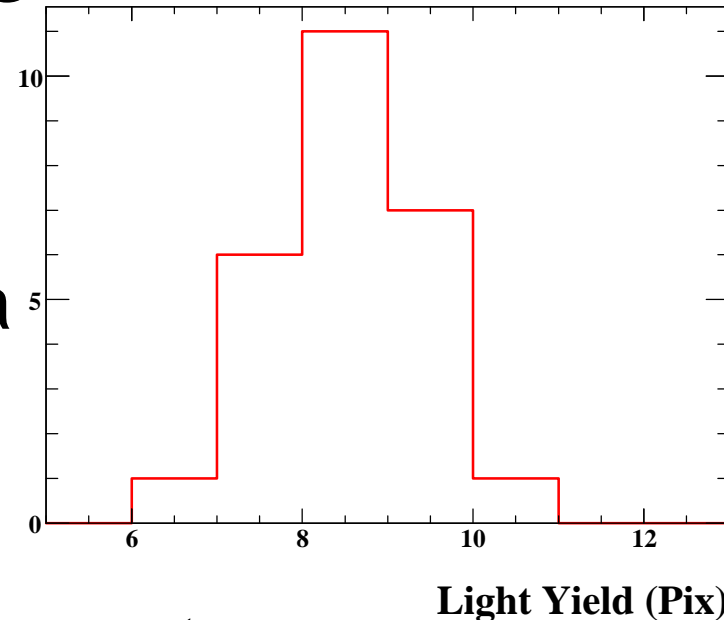
# MIP spectra

- Good MIP signals show as well the SPS structure, again many channels are smeared
- Fit and gain extraction works likewise



# First pure MIP results

- A first glimpse: Lightyield taken from the MIP spectra as biggest amplitude
  - So far only for 1 SPIROC



- For a true lightyield measurement:
  - the Landau distribution must be taken into account
  - The mean of smeared MIP spectra can be determined in number of pixels due to LED SPS



# Summary

- Concerning the LED measurements
  - All operational tiles are mapped
    - But there are smeared channels
  - Automated gain extraction works
    - Can be used to minimize # voltage settings
- Pedestalshift
  - Shift is caused by huge signal in many channels
  - Can be compensated by adjusting the trigger distance
- MIP measurements
  - First lightyield estimation
  - Not all LED SPS show a good MIP spectrum



## Next steps

- Understand the smeared channels, are there correlations to high darkrate channels? Or noisy channels? Or is it LED related? Try other Types
- Test the dynamic range of the LED system for saturation
- Find the reason of the pedestal shift
- Continue MIP analysis, combine with gain from LED measurements
- Include 2nd SPIROC for MIP measurements