AIDA wp 9.5 – Adaptive power supply for SiPM

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Outline of project

Achieving the goal will require:

- Characterization of temperature influence to SiPM gain
  →Define voltage function to obtain constant gain.

- Code implementation
  - Application into CALICE AHCAL, Labview control, for DIF (POWER board) at DESY

- HV module
  - Temp sensor, amplifier, voltage regulation

Timescale

- In WP9 milestone "MS45 – Calibration and power supply" has delivery date January 2014
- Agreed to have at the end of 2013 the proof of principles.

UiB tasks:

- July 2013: Study G(T,V) = const. Is linear or quadratic?

FZU tasks:

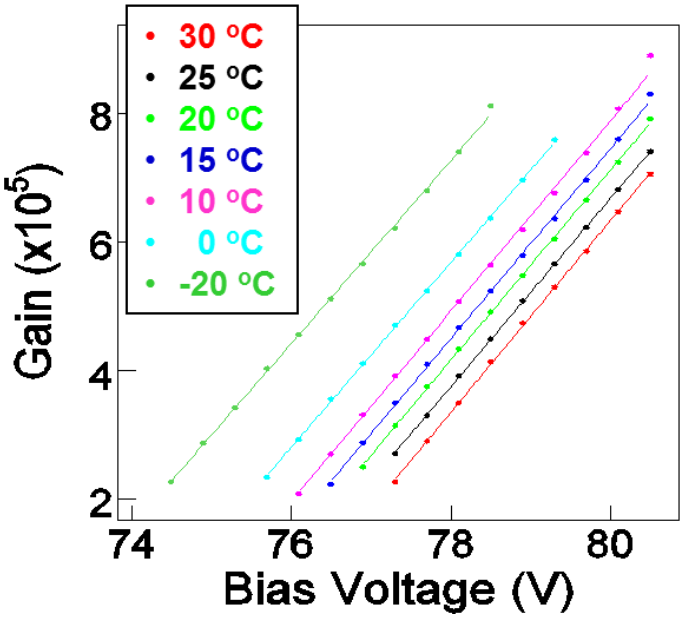
- Summer 2013: Design of analogue control circuit
- Autumn 2013: PCB development and construction
- December 2013: PCB ready and first test (size of ΔV ripples?)

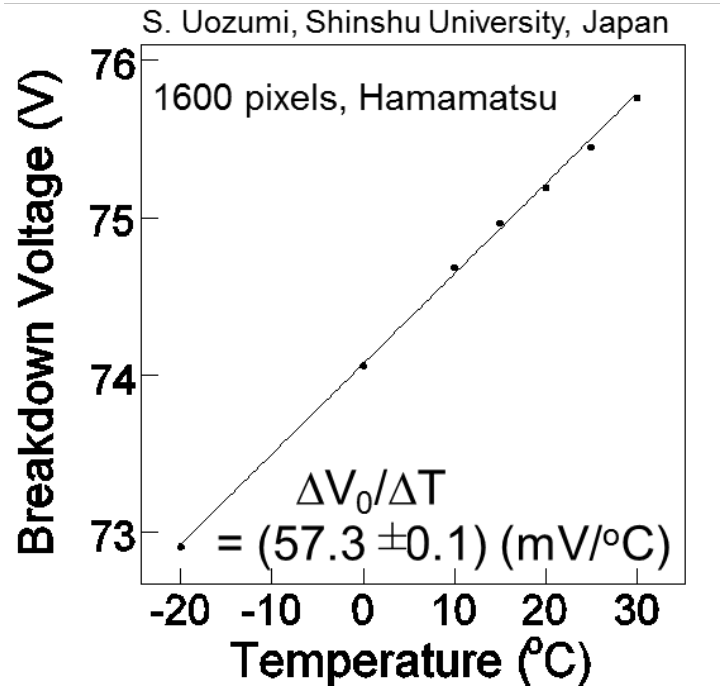
Characterization of temperature dependency

- Choose two different SiPMs:
  - Start with Russian SiPMs and Hamamatsu MPPCs
  - Measure at least 3 pieces of each type
- Temp range of interest defined as 18–28 °C, steps of 1°C
  - Stay close to real conditions & easy to measure
- Temperature controlled box for measurement
  - SiPM run with pulsed LED
  - SiPM gain will be measured by the standard method: fit to the single photon spectra

Tuning voltage for constant gain

- Measure gain as function of temperature and bias voltage. Typically: linear dependence with -3% / 1°C.
- Measurements done earlier (e.g. Satoru) for MPPC →





← linear dependence for breakdown V
- ΔV / ΔT = (57.3 +- 0.1) (mV / °C)
- Similar slope expected for the operating voltage

From these scans, find function G(T, HV) = const

Bergen – Erik @CERN

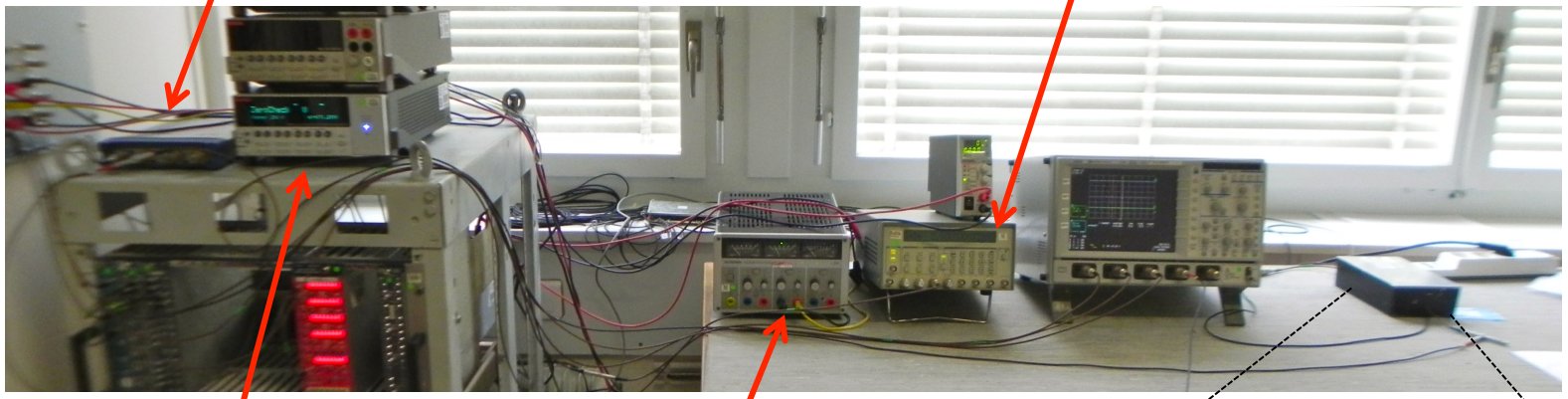
- For blackbox with temperature regulation:
  → environmental control box at CERN
- Have a LED+pulse generator.
  If not adequate, Ivo can provide one of the FZU drivers (QMB1A).

- Experience of CALICE T3B:
  - They seem to reach accuracy of 1% on gain measurement.
  - That is adequate for us.
- Have same pre-amp and digital oscilloscope (picoscope) T3B used.
  - Reproduce their approach for gain measurements.
  - Lars, Chris & Marco from T3B helped with installing their DAQ, and getting it to work.
  - Get setup working in AC-controlled room; once working, go to controlled box.

Setup in CERN LCD SiPM lab

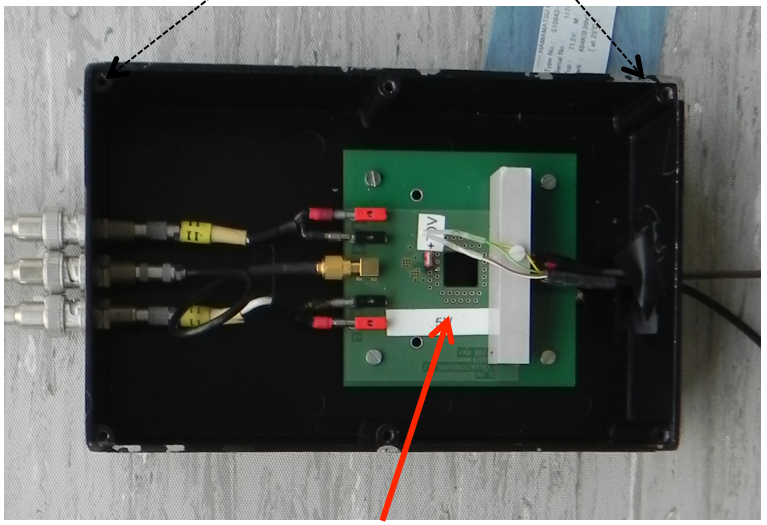
Digital oscilloscope – readout by PC with T3B DAQ

Pulse generator for LED



Keithley 6517B
Bias V source

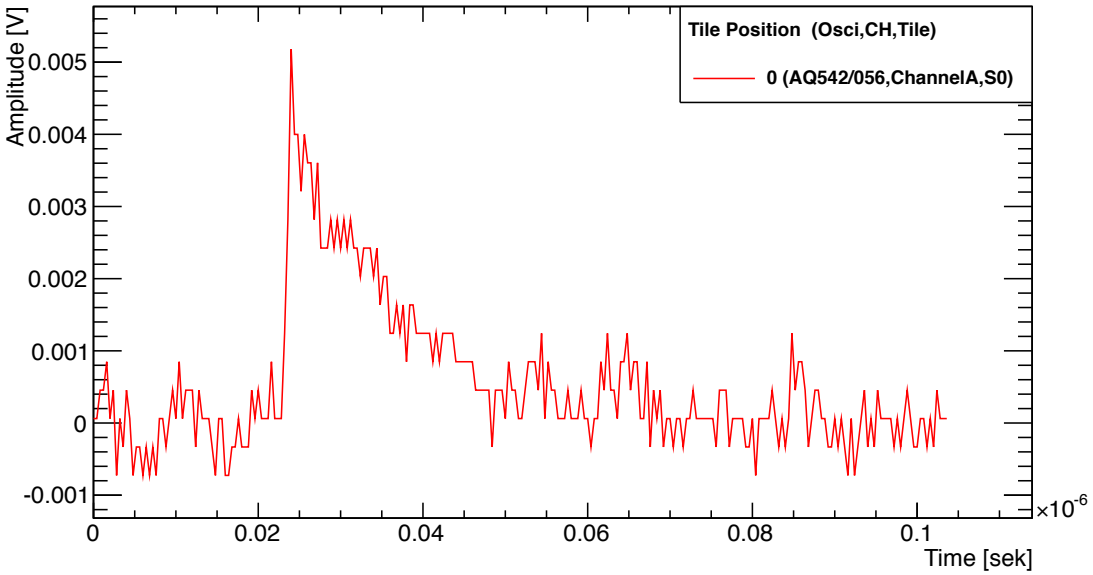
LV source



SiPM + preamp + T-sensor + LED

- Picoscope bought by CERN LCD with WP9.5 money (see other talk)
- Thanks to T3B team @MPI Munich, had a working DAQ within a day

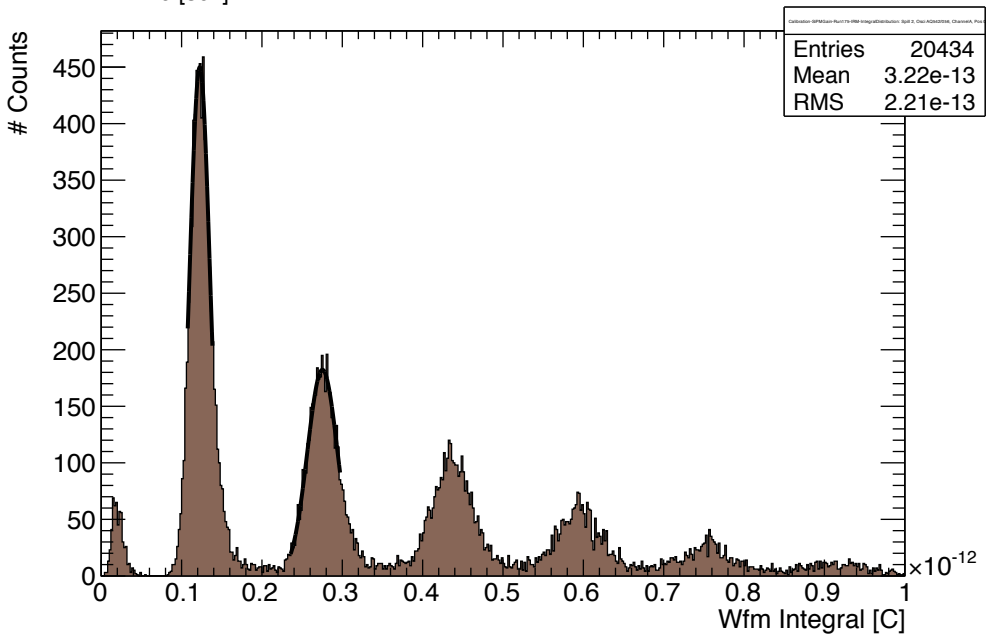
Obtaining photon spectrum



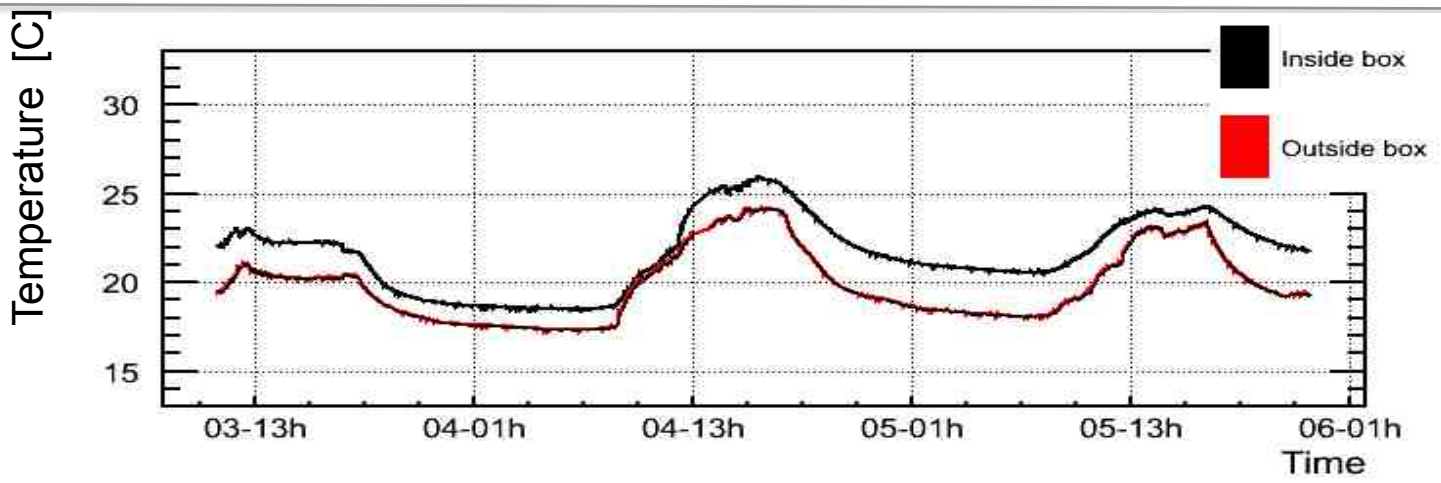
- 8bit ADC
- Sampling / 400ps

- Trigger on 3 mV
- Using T3B DAQ, integrate waveform

- Integrating 20k waveforms →
- Extract gain from 2γ - 1γ peak to ~1% accuracy.



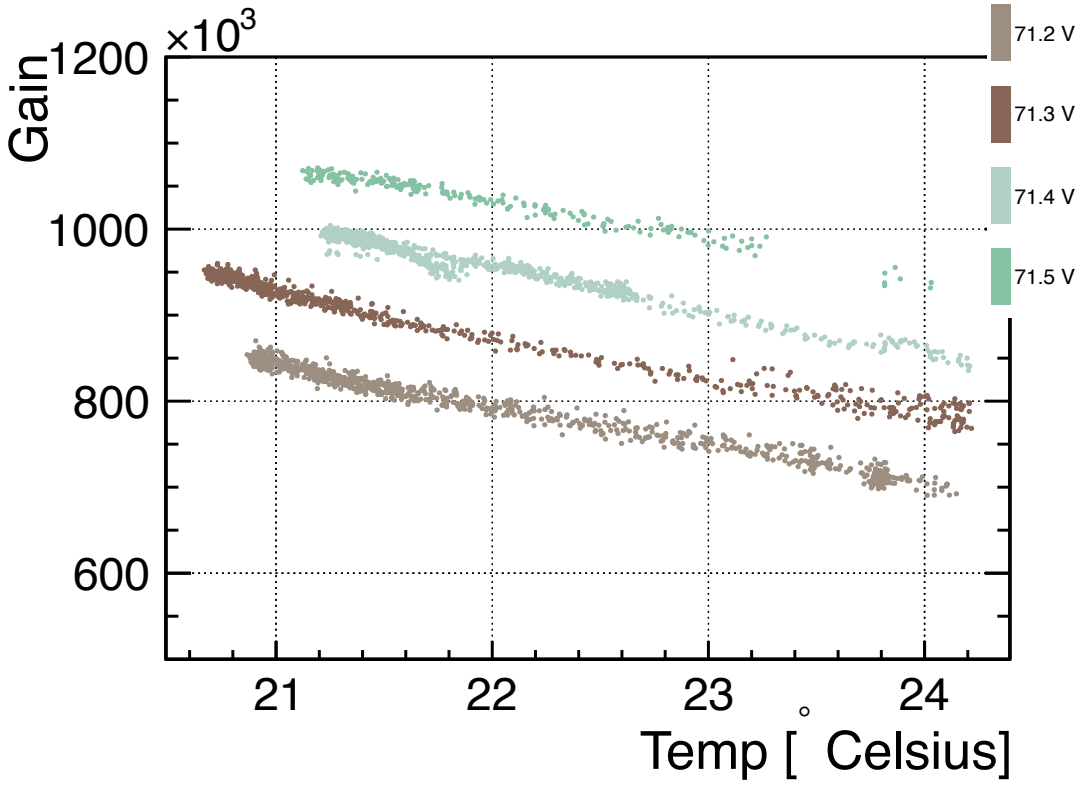
First temperature scans



Using day/night fluctuations:

- First results of G(T,V).
- As expected, linear results. (Temperature changes sometimes too fast)

→ Ready to go to temperature controlled box to take larger scans



Code implementation

- Application into CALICE AHCAL, Labview control, for DIF (POWER board) at DESY
  - C code?
  - Implementation to local Labview control system
  - Analog / software linearisation of used PT1000 temperature sensors
  - Precise measurement of temperature is the key, it improves the loop stability of the compensation

HV hardware module

Development of compensative module

- Some (possible) features:
  - HV from bulk PSU in (max. 100V)
  - Implemented HV ramp-up, ramp-off
  - Module could contain:
    - Temp sensor input, compensation analogue or ADC/DAC, voltage regulator
  - TeREG by +/- 2 V compensation
  - Output voltage can be regulated as:
    - Input HV (regulated by bulk PSU)+ trimming TeREG
    - Internal HV (regulated by module) + trimming TeREG

Summary

- WP 9.5 adaptive power supply project started.
- Temperature dependency characterization is ongoing
  - Had a quick start thanks to help from T3B team @Munich.
  - Setup commissioned → move to temperature controlled box
- Need to decide on the options for the HV module
- Plan is to have proof of principle by end of year.

Backup