Status of the AHCAL engineering prototype

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AHCAL meeting

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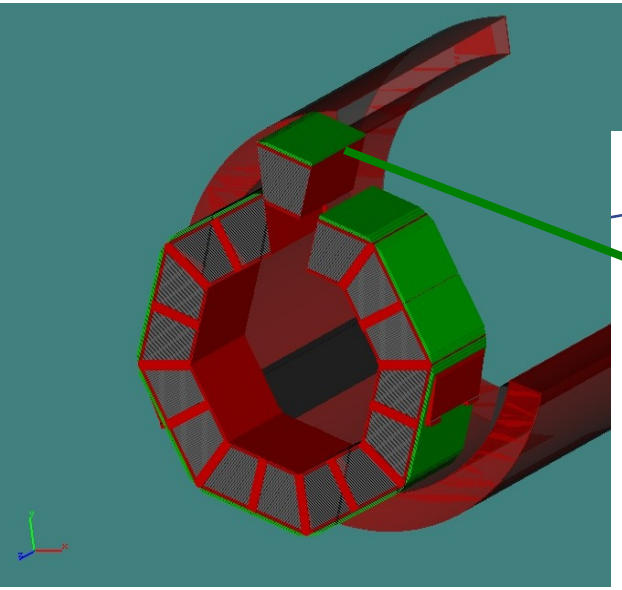
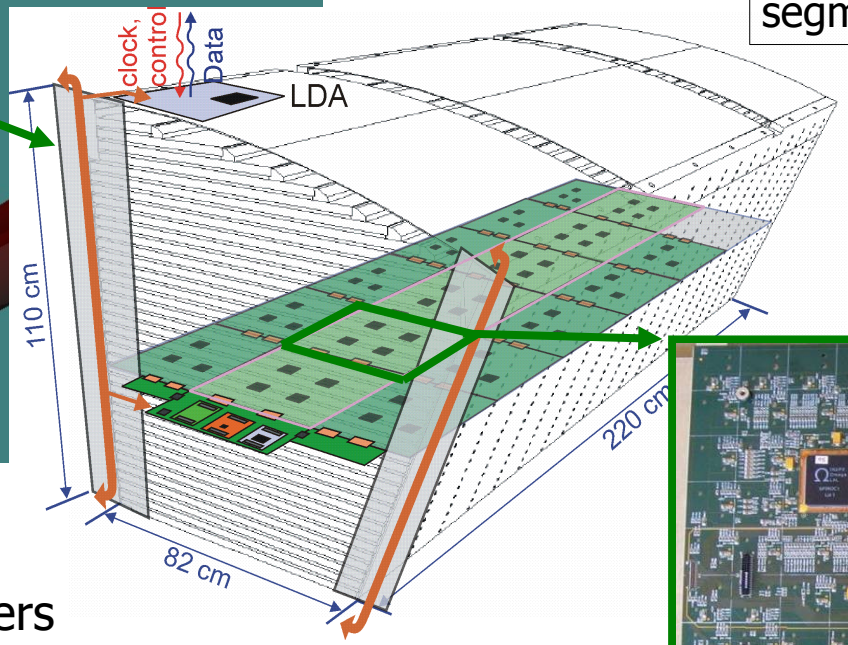
- Status of electronics/DESY activities
  - Next generation electronics status
  - Testbeam and charge injection setups and results
  - LED calibration systems
- Summary and outlook

The engineering AHCAL prototype

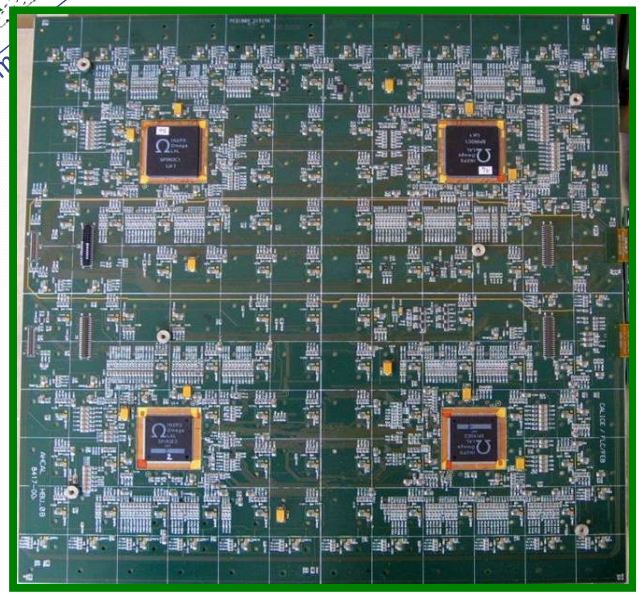
Development of scalable LC detector based on successful experience with physics prototype





Octagonal shape, 16 equivalent wedges, segmented in two along z

PCB with 4 SPIROCs, 144 scintillator tiles, SiPM readout

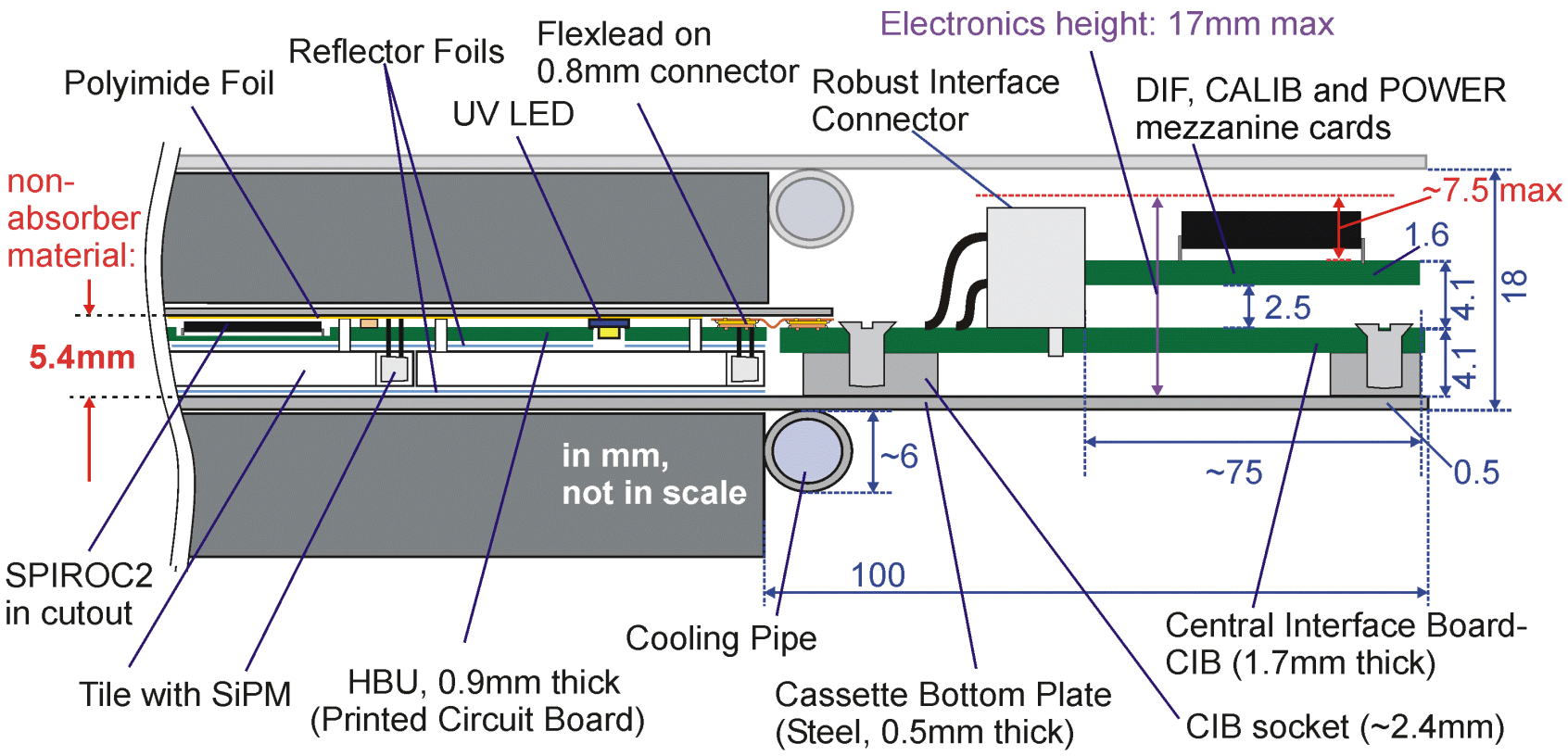


Challenges:

- No spacer between layers
- Minimize dead material between wedges
- Minimize gap between barrel and endcap

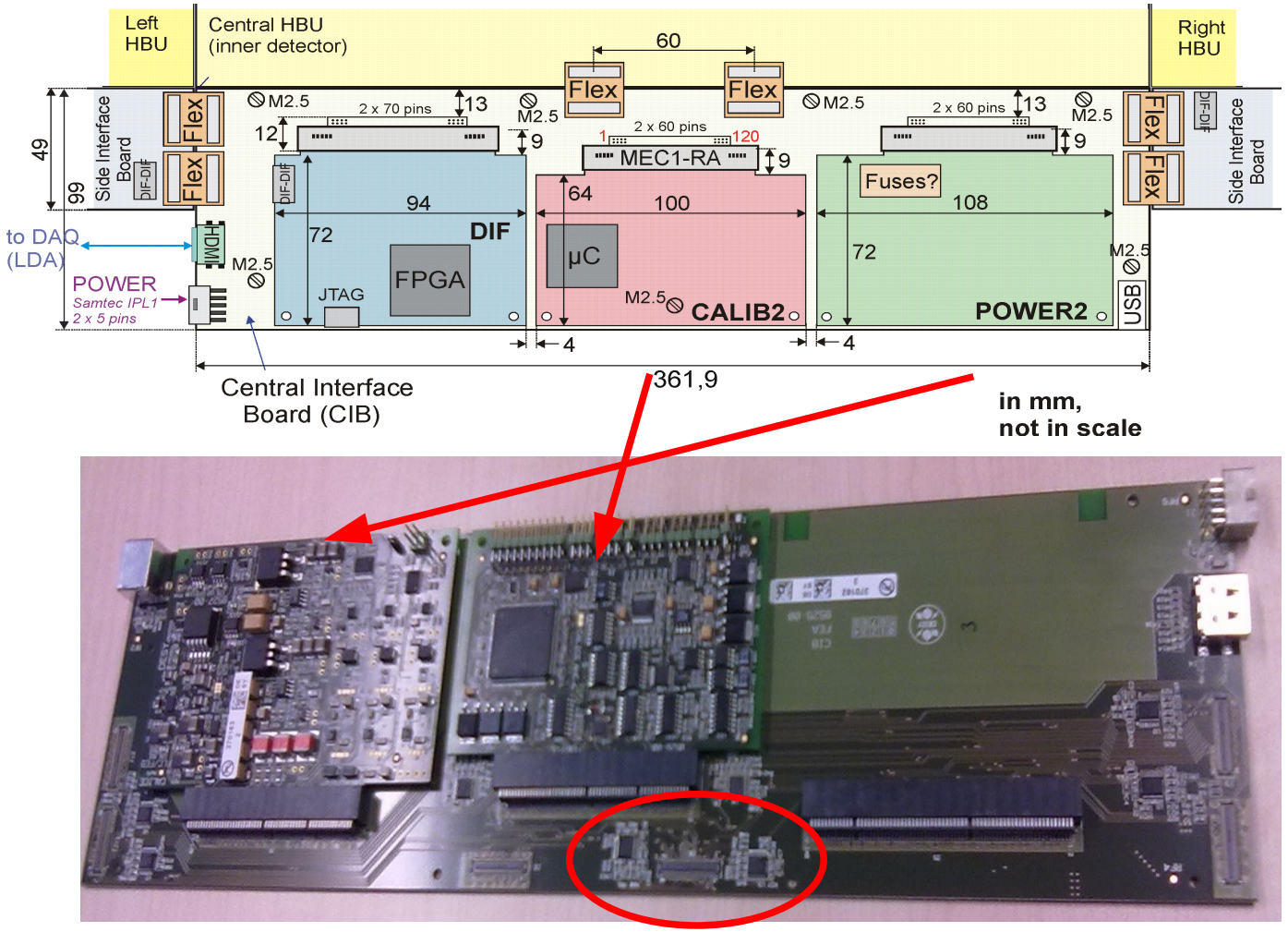
→ Integrated readout electronics

AHCAL layer – cross section



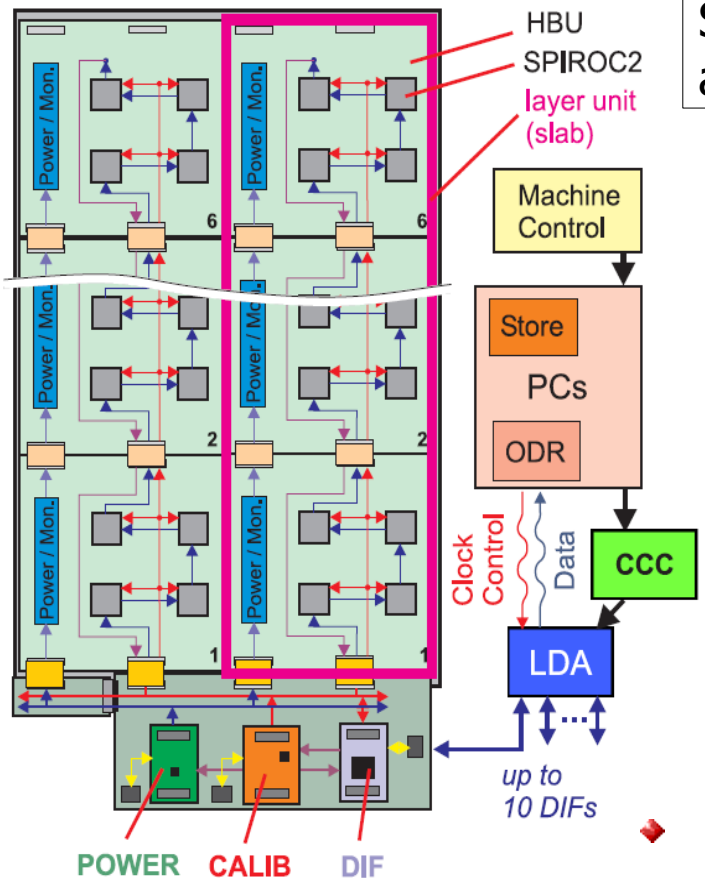
- Redesign and production of subcomponents ongoing or finished (DIF (NIU), CALIB2, POWER2, HBU2 (waiting for parameters of LED system), CIB (last bugfix), Flexleads (SIB not needed yet))
- Compliant with steel and tungsten options

CIB, POWER and CALIB

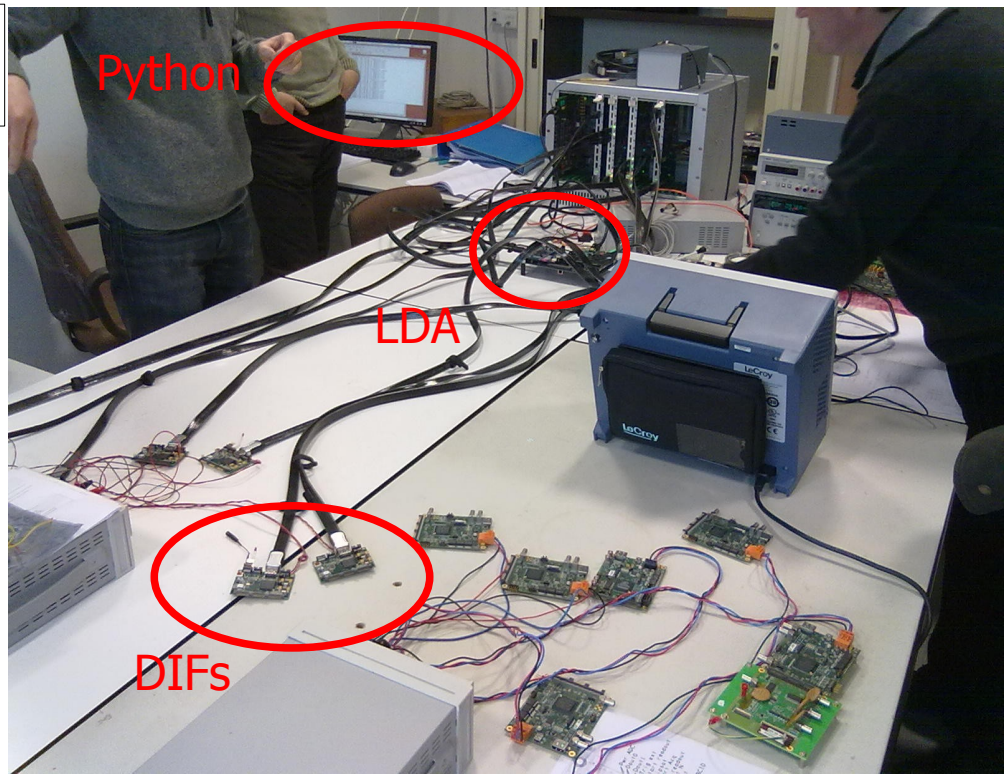


- Redesign of power and control signal connectors (wrong order)
- Still tests of DIF, CALIB and POWER possible

Data acquisition interface



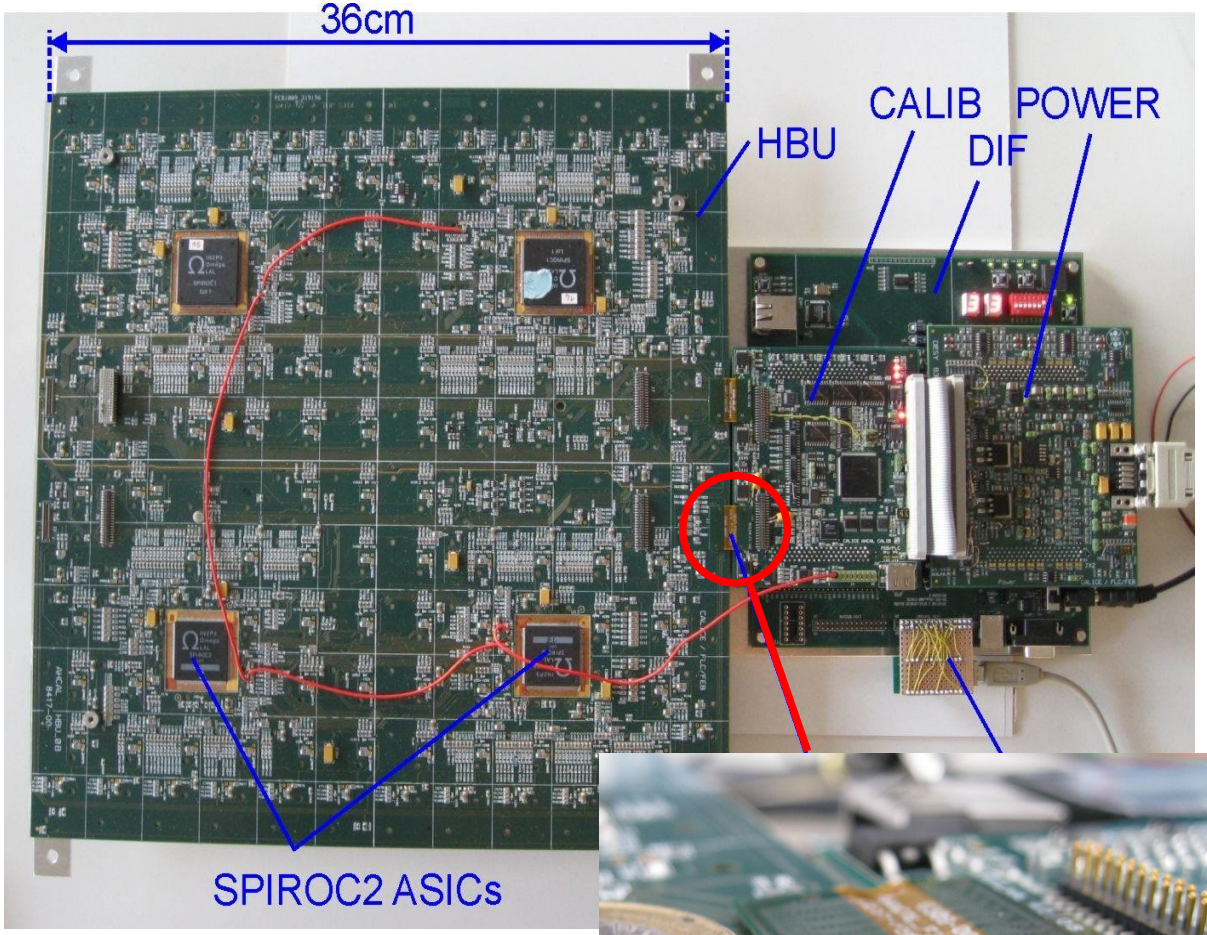
Setup at LLR



- DAQ modules are arriving at DESY
  - 8 LDAs, 2 CCCs, 1 ODR, cables, fibres …
  - Components may still change later...
- LLR developed Python interface that will be used to setup DAQ at DESY

HCAL Base Unit (HBU)

- At DESY 2 setups (HBUs) available
- 1 for charge injection and LED calibration tests
- 1 for testbeam operation with 2GeV electron beam
- Found/fixed many bugs/problems in ASICs, HBU, firmware, Labview, tiles, LEDs ...



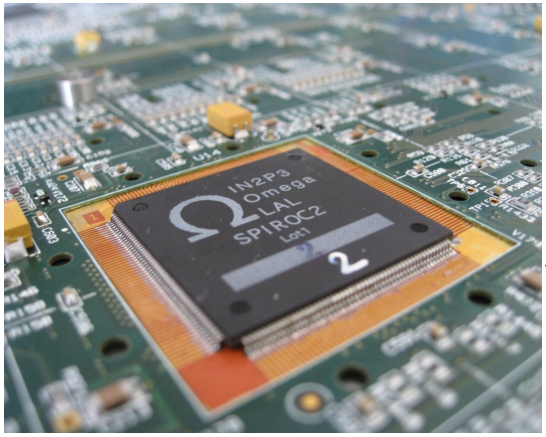
SPIROC2

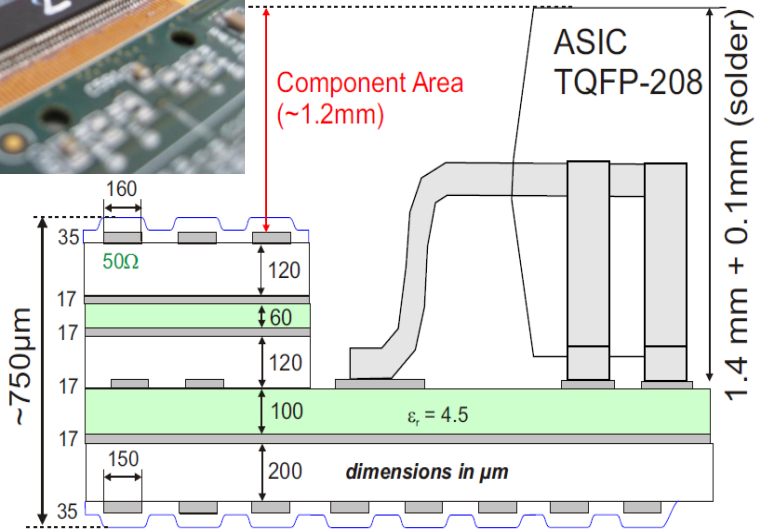
Specific chip for SiPM readout:

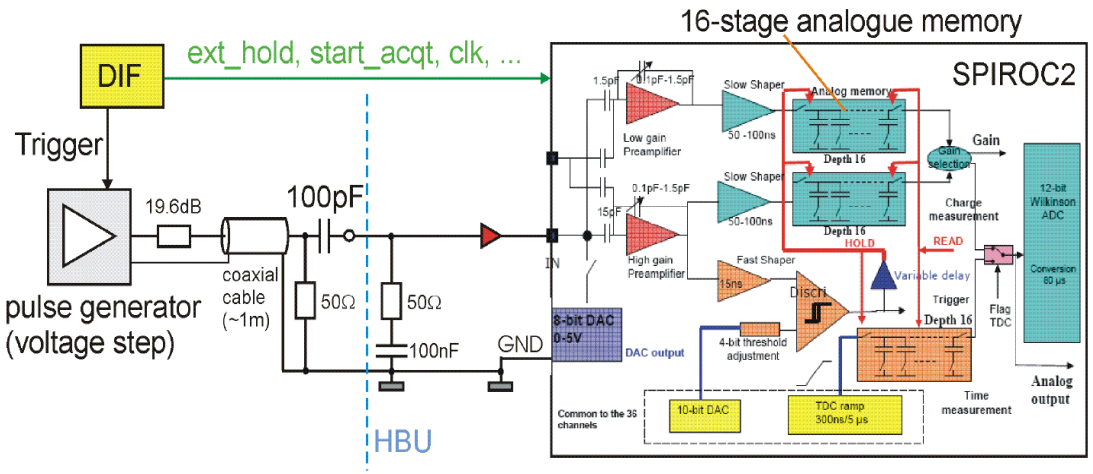
- Input DAC for channel-wise bias adjustment (36 channels)

Designed for ILC operation:

- Power pulsing → 25µW/ch
- Dynamic Range 1-2000pe with dual-gain setup per channel
- Internal ADC
- Autotrigger mode
- Time stamp (~100ps)







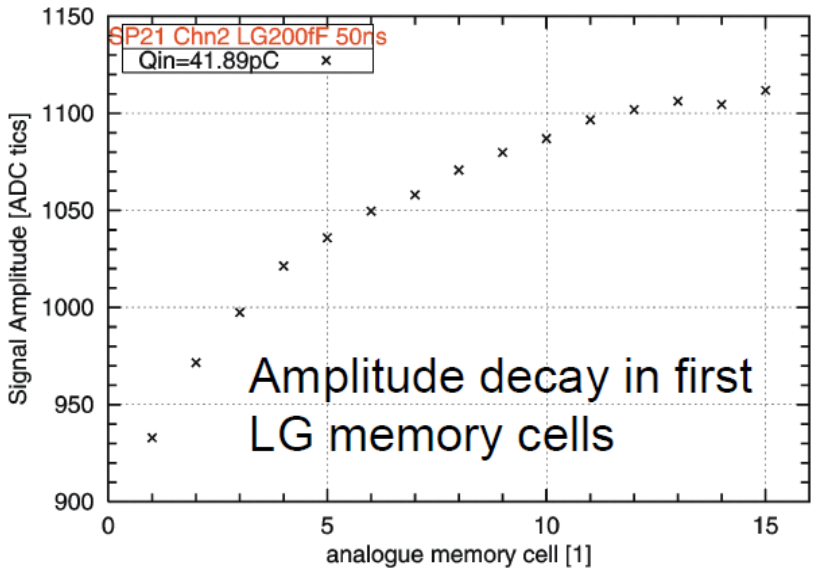
Charge injection setup

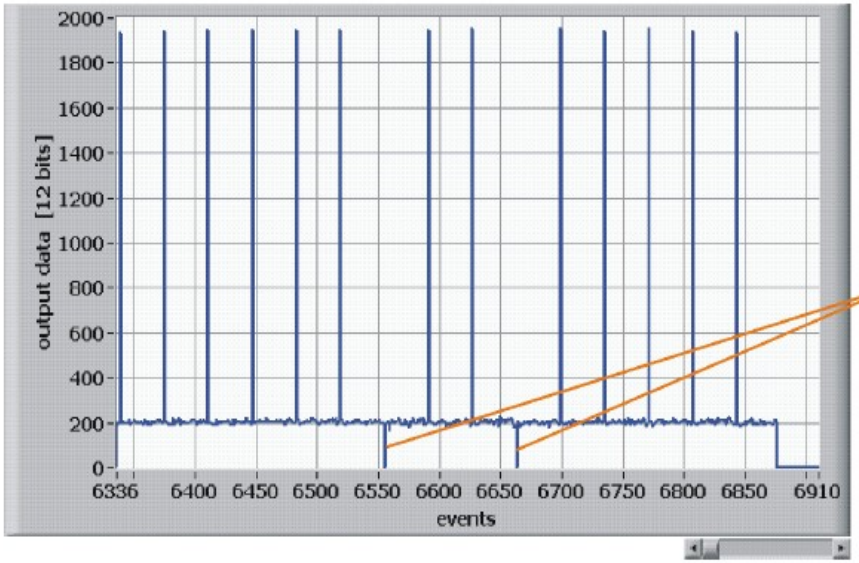
Placement of components in PCB cutouts

→ 300µm/layer

→ 30mm in total!

Open SPIROC2 Issues





Cell dependent gain:

- Depends on pulse shape and injection pattern (time between 2 bursts of 16 events)

  → Too small bias current for dynamic feedback resistor

  → Role of compensation capacitors?

- See Ludovics talk

Zero-events:

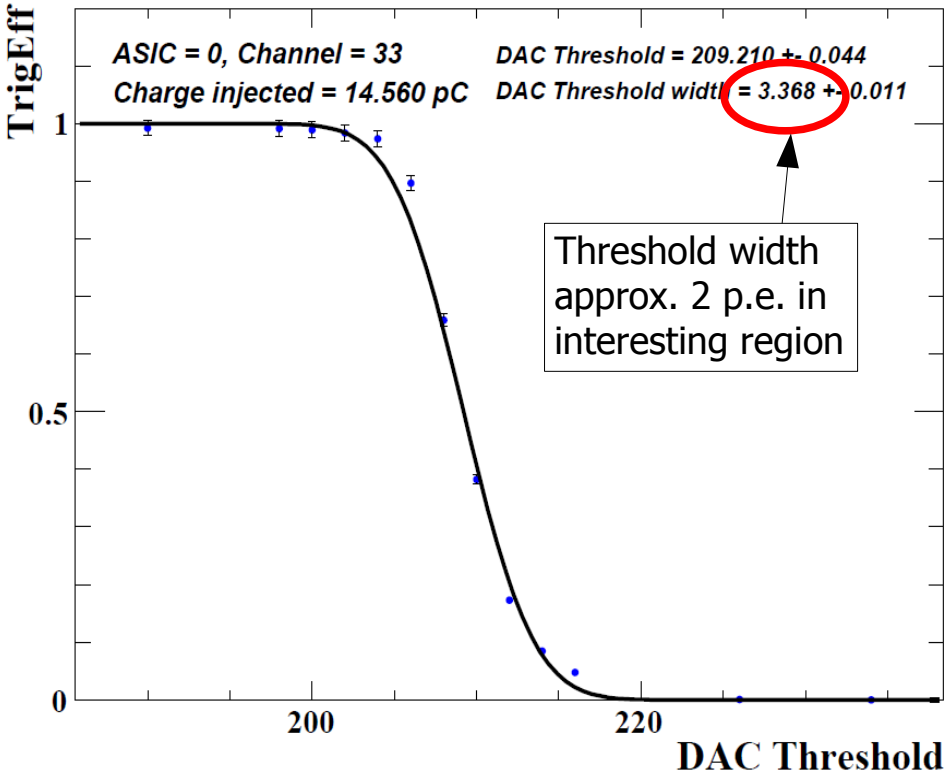
- All channels show randomly events with 'zero' as output
- Not understood so far

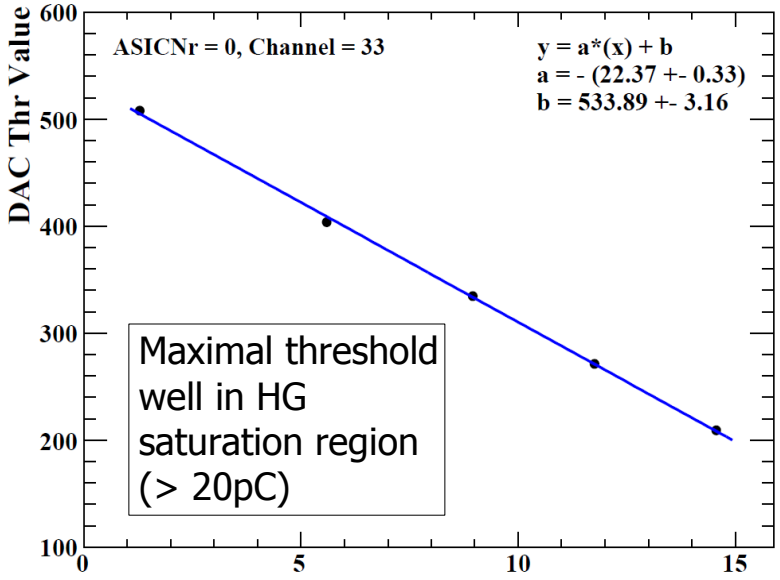
LG linearity:

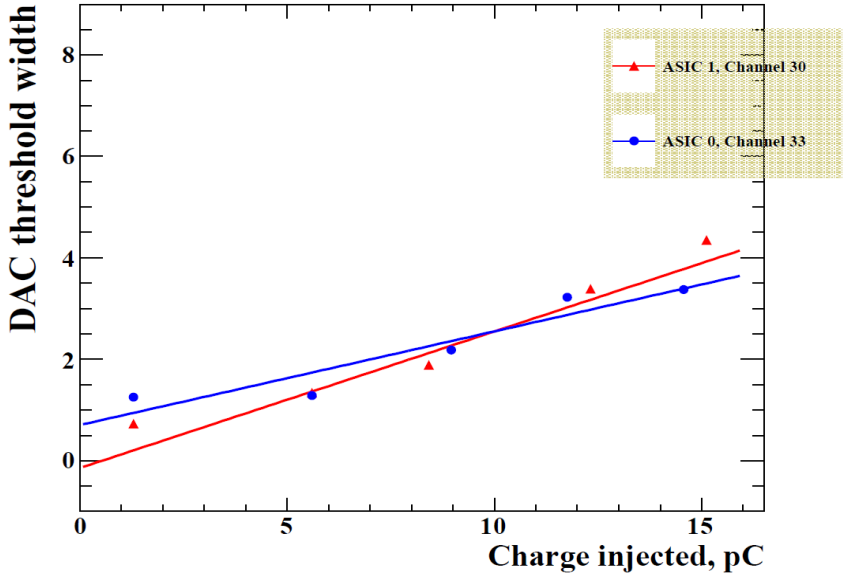
- HG-LG cross talk...

Autogain performance - Thresholds

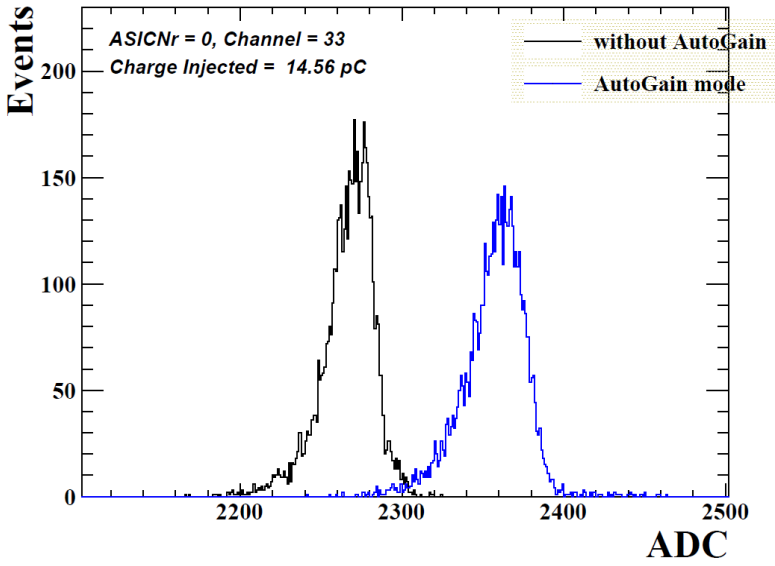
- Autogain: automatically switch between high gain and low gain mode
- Compare signal with predefined (10 bit) DAC threshold
- Similar performance as for autotrigger

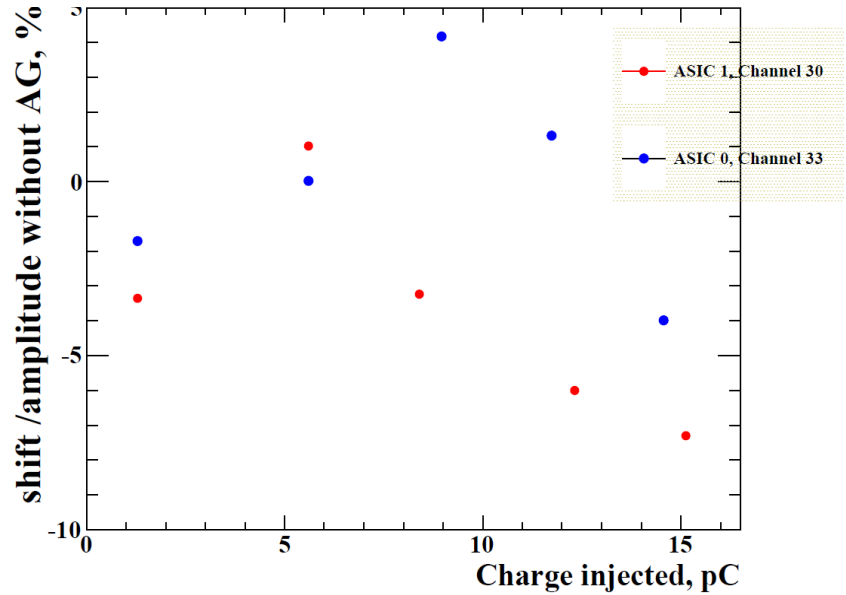




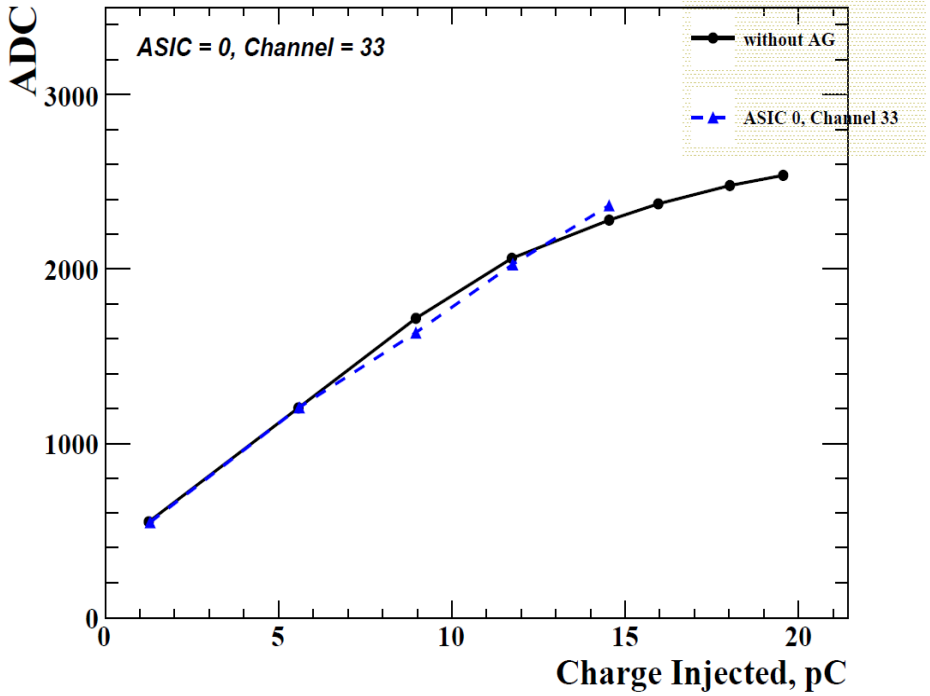


Autogain performance - Linearity



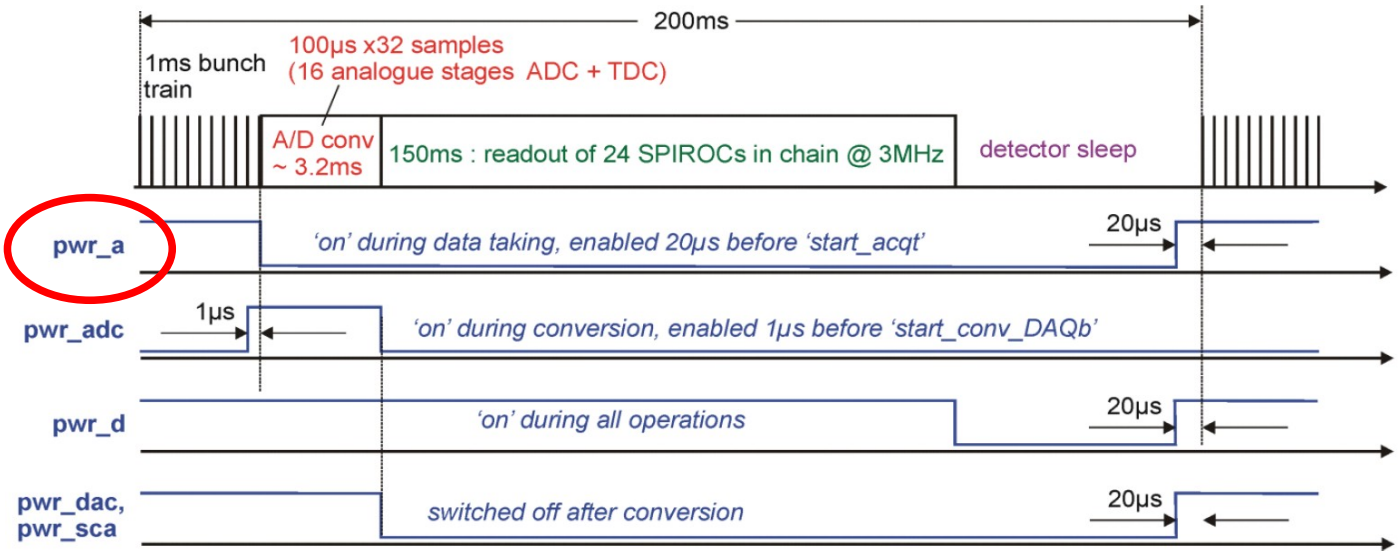


- Observation of amplitude shift in AG mode with respect to normal mode
- Shifts non-linear and different from channel to channel
- Has to be investigated/discussed further...

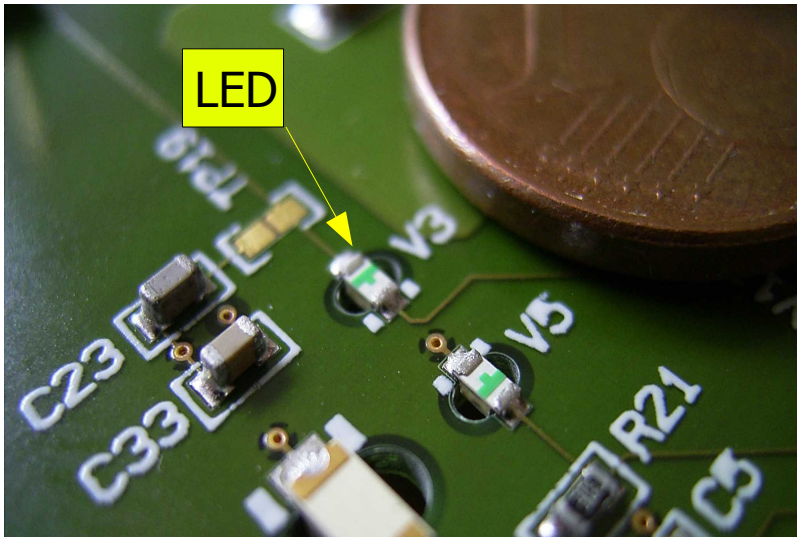


Power pulsing

- Needed to restrict power consumption and needs for cooling
- Bug in SPIROC2:
  - Open-collector outputs (e.g. data output) switched off, if power_on_analog is switched off
  - BUT: power_on_analog most important power pulsing signal, immediately switched off after data taking
  - Bug fixed in SPIROC2b
- Since we have SPIROC2b at DESY, we will use it very soon...



LED calibration system

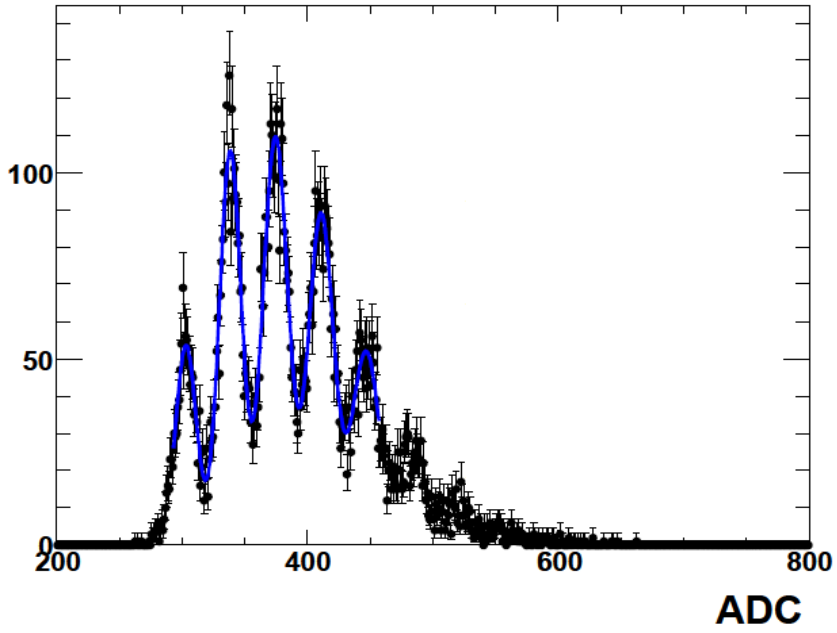


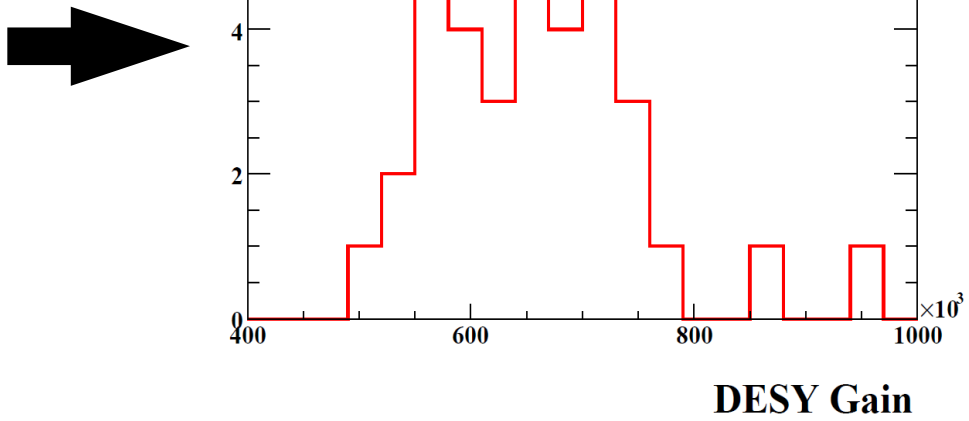
System task:

- SiPM gain calibration via single pixel spectra
- SiPM saturation curves

Wuppertal solution:

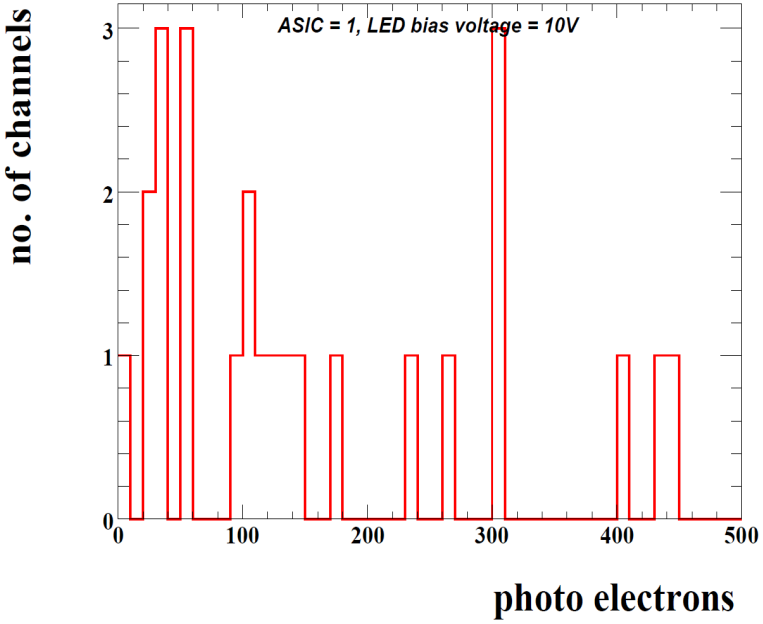
- Light directly coupled into the tile by 1 integrated LED per channel
- See Julians talk

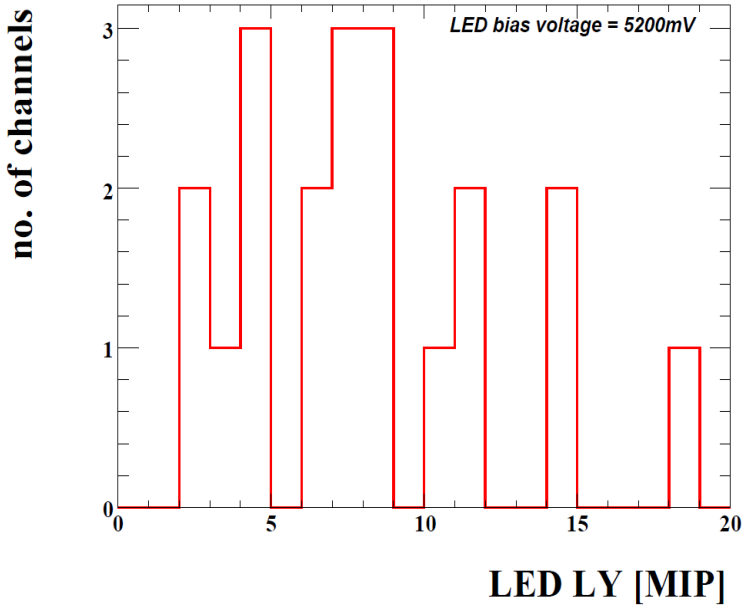




LED calibration system – Open issues

- Tested blue LEDs for possibly higher intensities and cost savings
  → Pulse of blue LEDs too long (~100ns) with current circuit
  → Use UV LEDs (5-10ns)
  → Dependence of pulse shape of UV LEDs on VCALIB?
  → Can the SiPMs be saturated with UV LEDs? (Max VCALIB = 10V)
- How large is the spread in light output of UV LEDs?
  → Need values for compensation capacitors

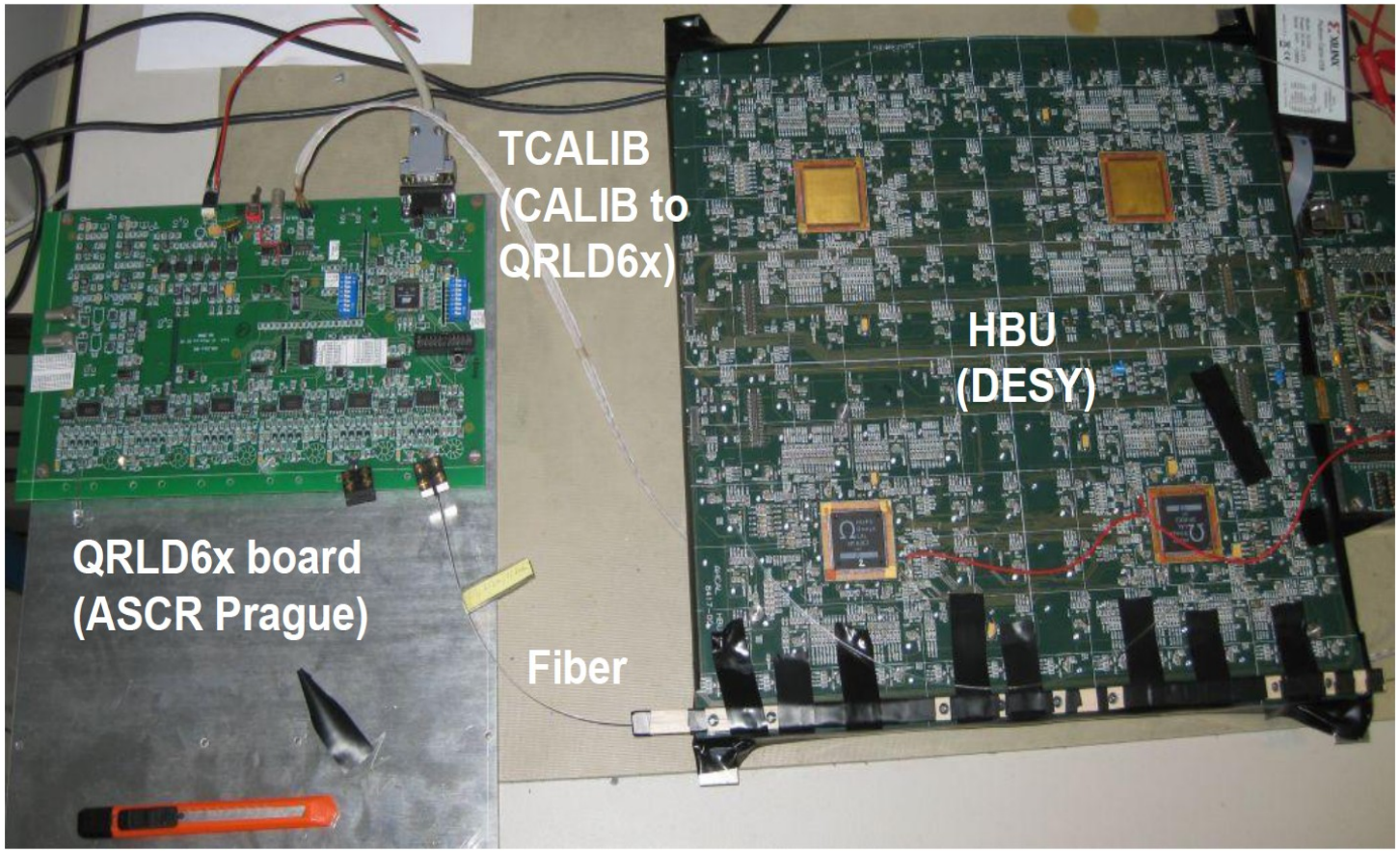




LED calibration system

Second option for LED system (Prague solution):

- Light distributed by notched fibers
- First tests (including lab and testbeam measurements) promising



Summary and outlook

- New technological AHCAL prototype under development
- 2 setups running in Hamburg
  - Successful testbeam operation and MIP calibration
  - Tests of SPIROC2 with charge injection (incl. AT and AG)
- Redesigns ongoing and almost finished
- LED calibration system development ongoing with 2 options
- DAQ modules available now

To do

- Further tests of power pulsing
- Start using SPIROC2b (e.g. channel-wise gain adjustment, TDC)
- DAQ integration and further development
- This year: Integration to full slab (2.2m calorimeter layer)

Autotrigger performance

- Autotrigger: mode of ILC operation
- Compare fast shaped signal with predefined (10 bit) DAC threshold
- Set threshold to minimize noise hits and maximize MIP efficiency