Tileboards for CMS HGCAL.

Tileboard_Proto1 Status

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HELMHOLTZ GEMEINSCHAFT

Calorimeter for ILC

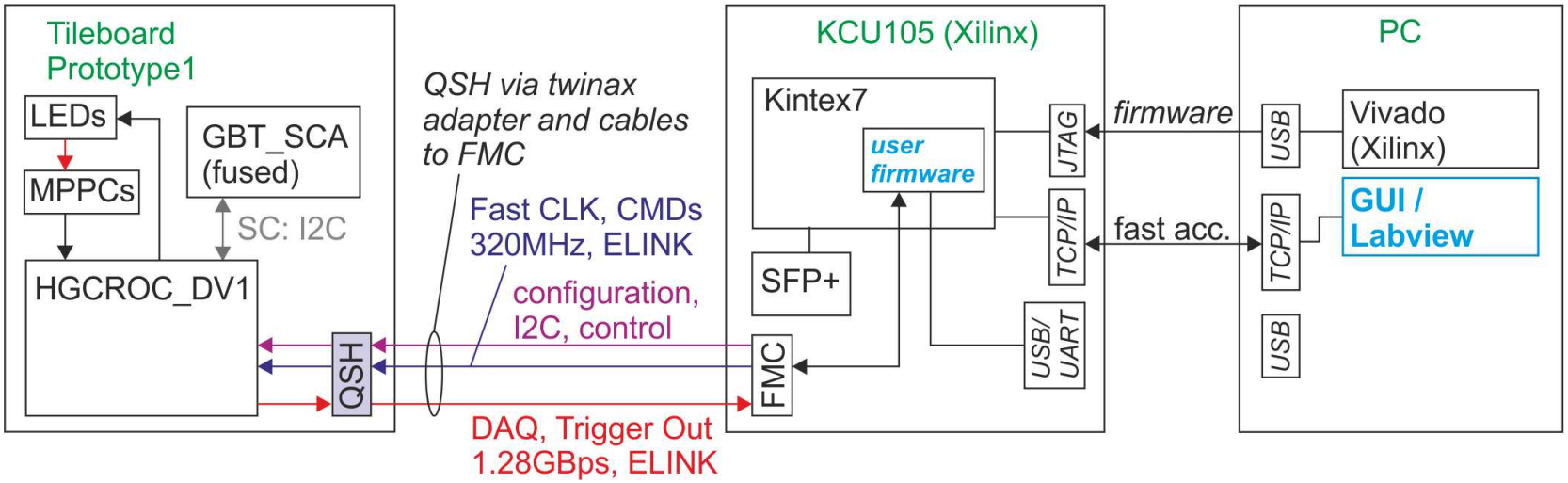
CMS

DESY

A scintillator tileboard detector for CMS HGCAL

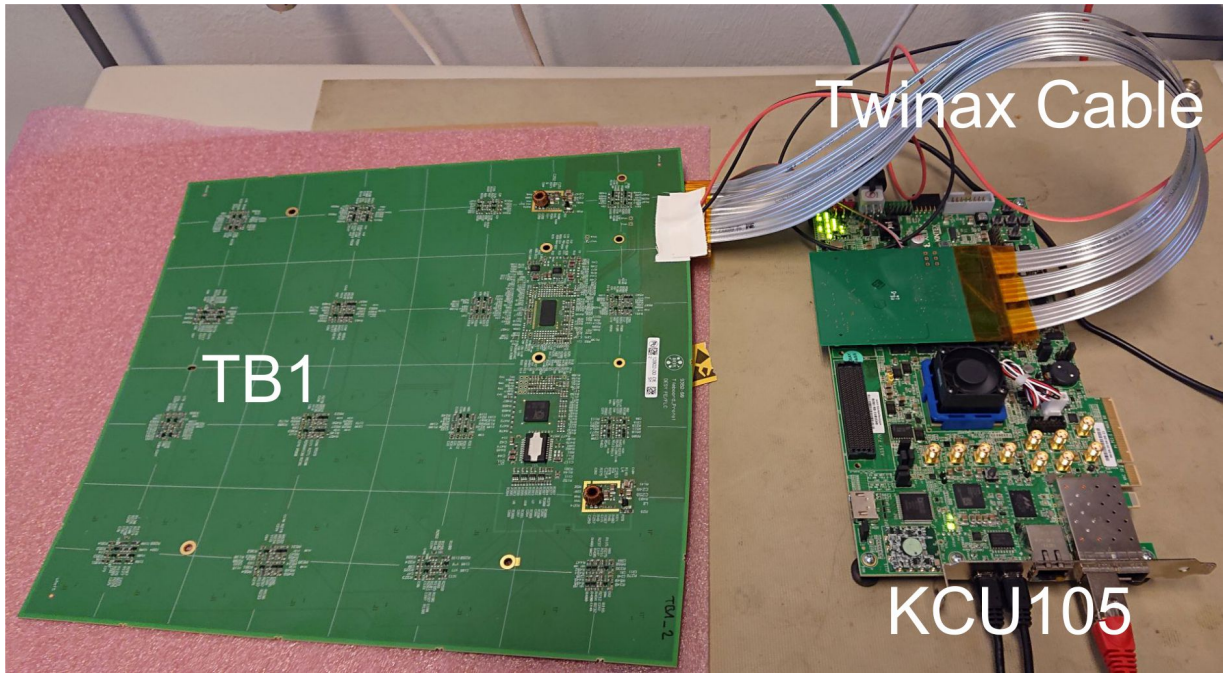
- The HBU technology is foreseen for the front-end boards of the Phase II CMS HGCAL detector (outer endcaps).
- We can profit a lot from CALICE experience
  - MPPC readout and powering.
  - Sensitive analogue electronics, large PCBs.
  - LED system for calibration and monitoring.
  - Tiles and Wrapping.
- But there are also new challenges:
  - High radiation environment, no standard components.
  - DAQ: continuous data-taking.
  - Operation at -30°C.

First Tileboard (TB1) and DAQ setup @DESY



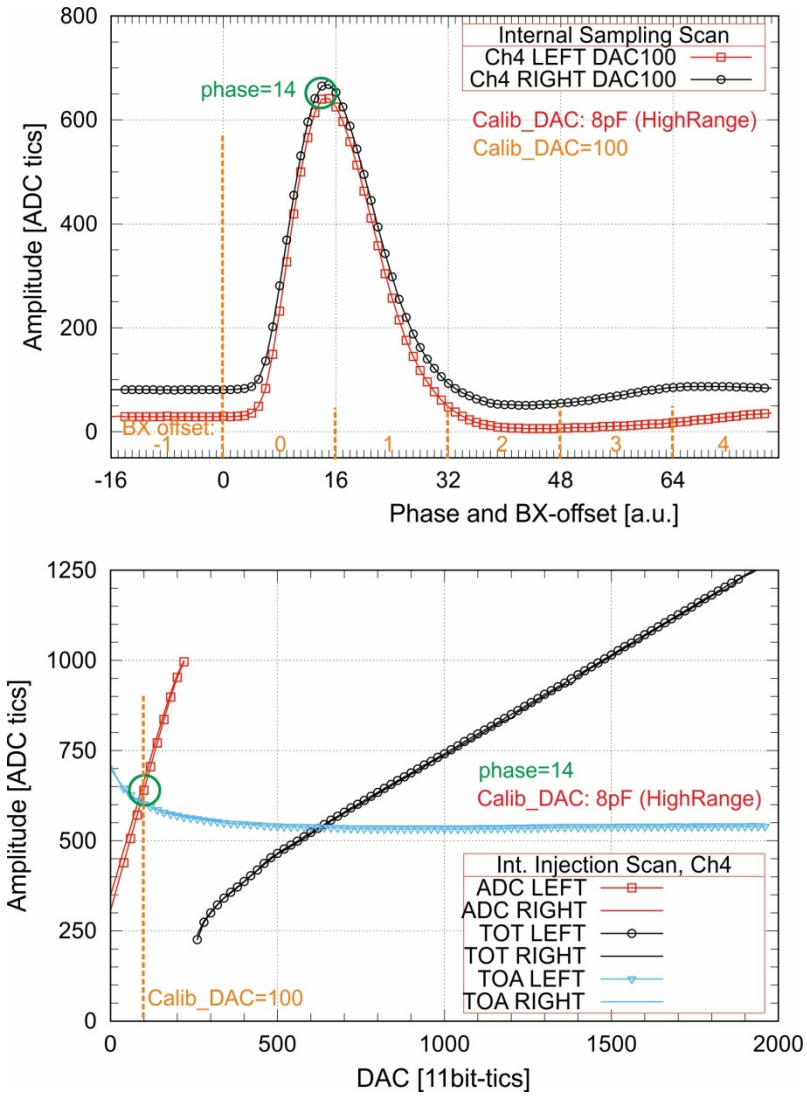
- First step: Use DAQ hard-, firm- and software for TB1 commissioning as developed at Omega and LLR.
  - Known-good DAQ setup for commissioning of new board.
  - Easy comparison of results with Omega/LLR.
- GBT_SCA for slow-control disabled in this first step. Direct I2C link to KCU105.
- Quick and easy exchange of TB1 with HGCROC testboard (Omega) for verification in case of problems on TB1. Very useful!

Tileboard_Proto1 (TB1) and KCU105 DAQ



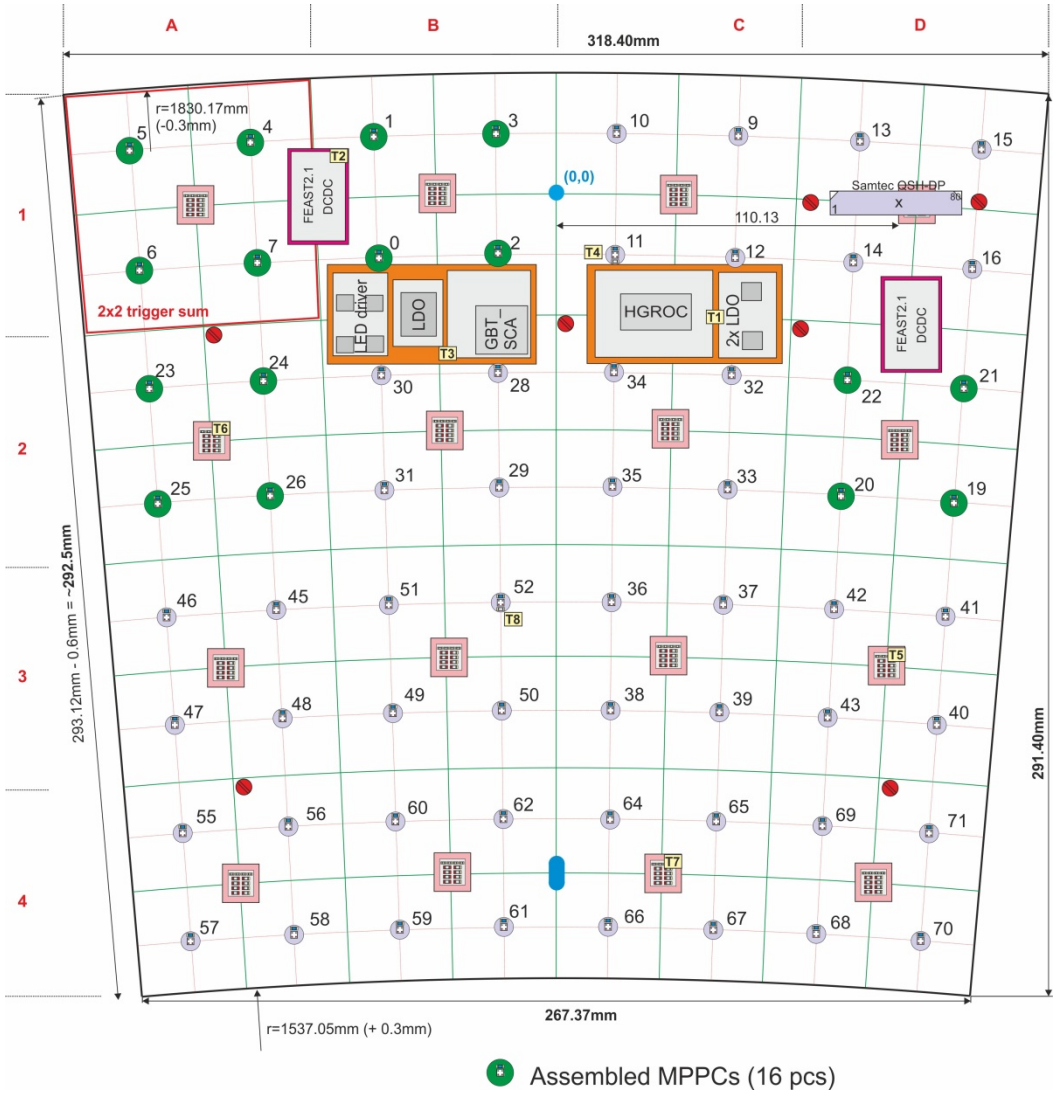
- 3 assembled and 3 unassembled TB1s available at DESY. Components for the 3 unassembled boards are there as well.
- 2 TB1s are commissioned in parallel:
  - compare results in case of problems,
  - have one board ready for shipment.

TB1 – Internal Sampling- and Injection-Scan



- First step: Check if HGCROCv2 ASIC is operational on TB1.
- Using internal calibration DAC for charge injection.
- Same results for both halfs of chip (LEFT and RIGHT).
- No special noise observed using FEAST DCDC converters on board.
- Results are ok for ADC, TOT and TOA!

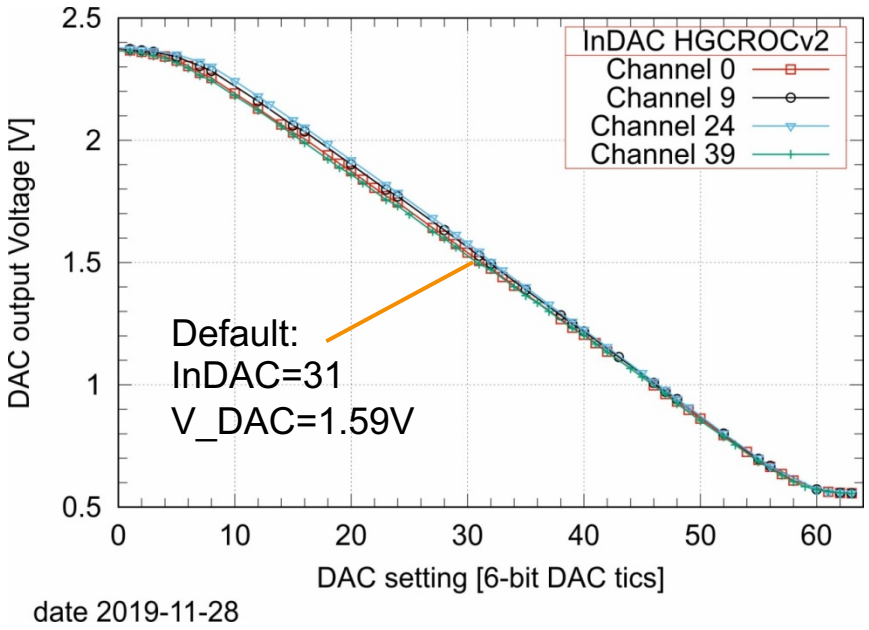
TB1 – 16 assembled MPPCs



- Next step: Check with MPPCs and LED system.
- 16 MPPCs of type S14160-1315PS are assembled on first three TB1s. See green dots for their locations.
- 2x2 trigger-sum placement.
- All MPPCs in one HGCROC2 half.

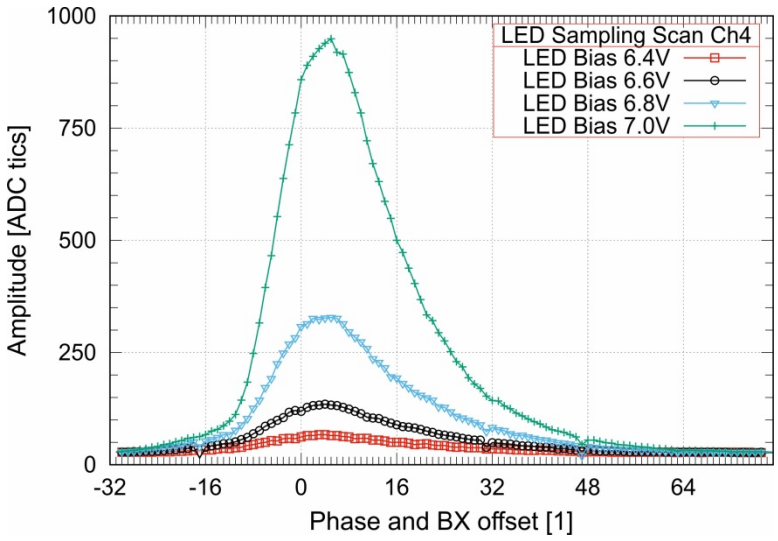
Top View
(connector side)

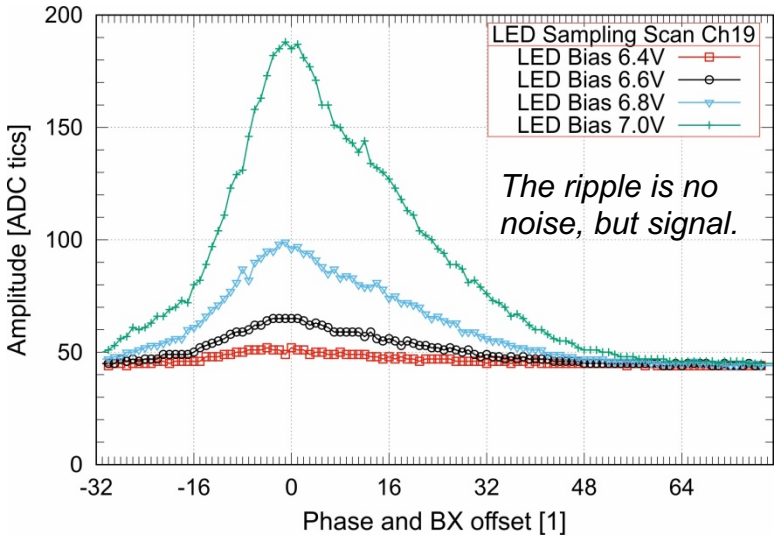
TB1 – MPPC BV adjustment



- No regulators in setup!
- MPPC-BV is defined by external power supply (Vout).
- MPPC-BV = Vout - V_DAC
- MPPC-BV=41.99V => Vout=43.6V, not precise on a 10mV level.

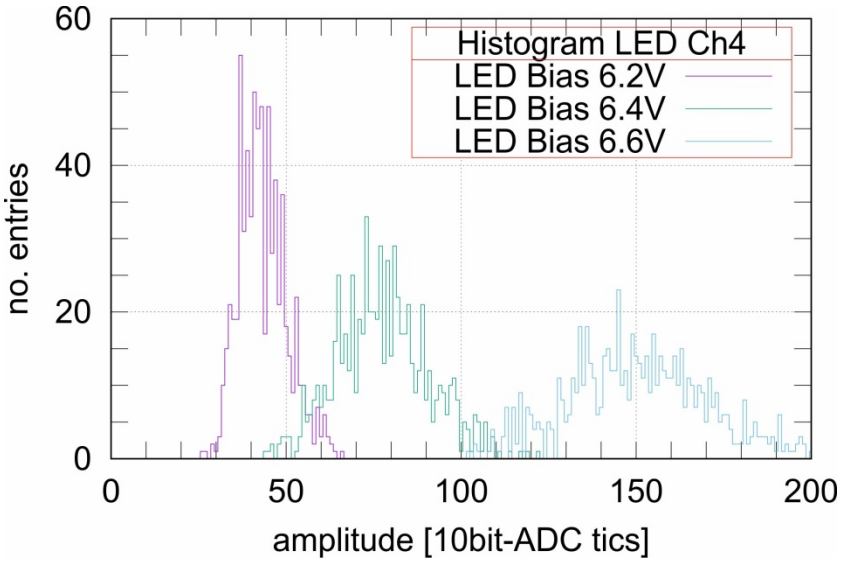
TB1 – LED and MPPC sampling scan





- Using TB1 MPPCs and LED system, 'real signals' to HGCROC's inputs!
- Amplitude can be adjusted by LED_BIAS – OK!
- Wider pulse widths than with internal injection. Optical pulse or HGCROC parameter adjustment? To be discussed with Omega.
- Channel-to-channel variation in amplitude and position – as known from CALICE HBUs and ASICs. Still ok!
- Latest news: Broad pulse might be from coupling of LED_trigger between HGCROCv2 and LED system. Tests ongoing!

TB1 – LED and MPPC: Histogram



Very new results!
Tests ongoing!

- Using TB1 MPPCs and LED system.
- Amplitude can be adjusted by LED_BIAS – OK!
- KCU105 DAQ can only take 700points in one run.
- No single-pixel spectrum (SPS) achieved so far. Christophe:”Setup not optimized for SPS, gain is rather low.”
- Gain settings to be discussed with Omega. HGCROC has 4 main gain parameters: Preamp’s Cf, Cd, Rf and gain of current-conveyor.

Conclusion

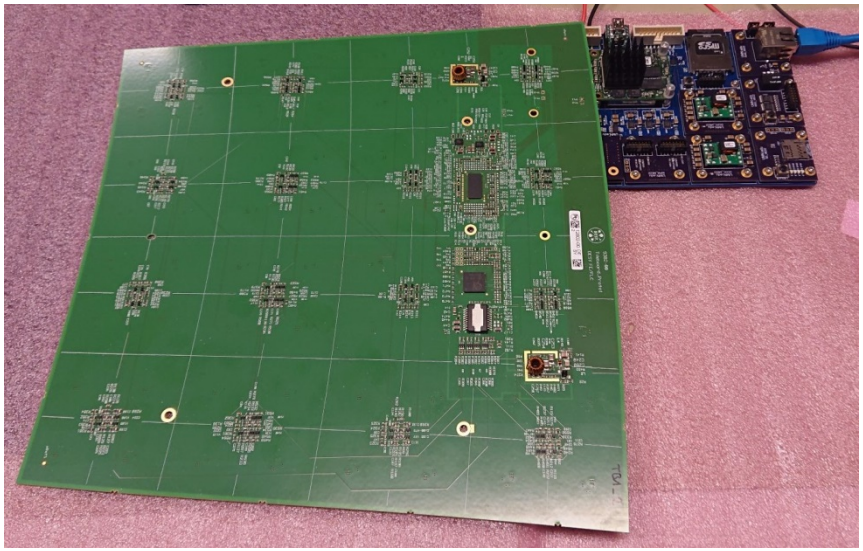
- TB1 is still in commissioning. LED system an HGCROC parameter adjustment not completed.
- GBT_SCA not tested.
- No systematic tests so far, concentrated on bringing functional blocks to life.
- No show-stoppers on TB1 – both tested TB1s ok.
- DAQ: Stable operation for >2 hours without losing synchronization with KCU105. Sometimes hickup during power-up.
- Toolchain for data taking and analyzation has been set up (KCU105 DAQ).

Backup

Backup slides

Tileboard_Prototype1 (TB1) Status

- Michael Krohn (UMN) at DESY for 2 weeks.
- First connection of TB1 to tileboard tester from UMN. Challenges:
  - Some unknowns: Untested TB1 and HGCROC on TB1. TB-tester has not been used with real HGCROC before.
  - Twinax-adapters/cables not available. Adapter from UMN required for connection
  - Using adapter TB1 collides with power mezzanine of TB-tester. Mezzanine has to be removed, power cables soldered.
  - Some minor configuration errors on TB1 discovered during discussions with Damien, e.g. polarity of ResB_I2C and Sel_CK_ext, termination of PLL output.
  - “Bad reflections” on FastClock and FastCommands turned out after 1 day to be from a broken oscilloscope.



TB1 connected to tileboard-tester (UMN)

Tileboard_Prototype1 (TB1) Status

- By sending FastCLK and FastCommands TB-tester can align to DAQ outputs of TB1 and capture data after trigger event.
- Trigger outputs of TB1 send data (seen on scope), but are not recorded from TB-tester. Probably minor problem in software.
- GBT_SCA to TB-tester checked with scope: Data In/Out and Clock look ok.
- I2C configuration of HGCROC on TB1 not tested so far.
- Signal quality on fast lines look ok (1GHz scope). To be re-checked with faster scope, but big problems would be visible with 1GHz scope already.

- No big issues discovered so far on TB1.
- Many things need to be tested. Basic commissioning and characterization with KCU105 DAQ (LLR, Omega) using twinax adapters for interconnection.

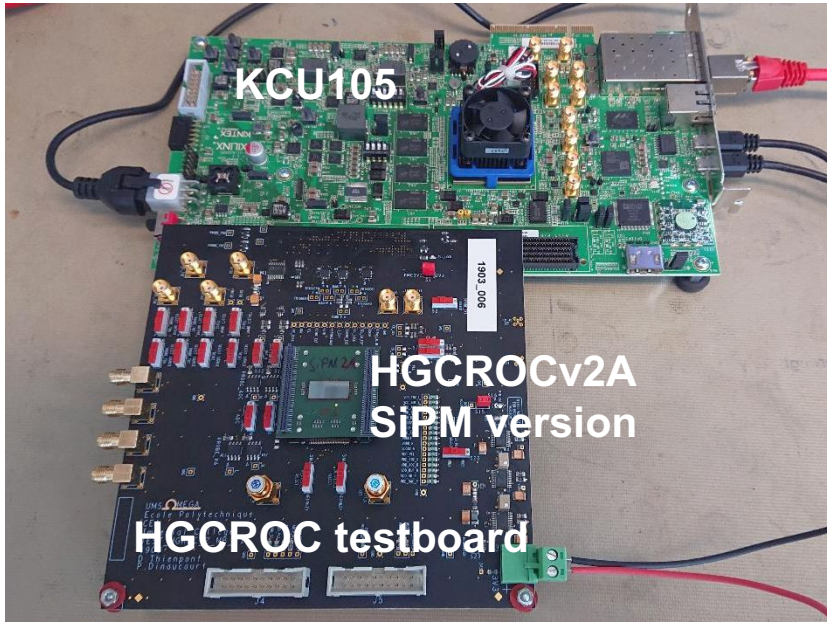
Twinax adapters (TA), twinax-cables - Status

- 2 TAs required for TB1-KCU105 connection:
  - Samtec QTH connector on TB1-side
  - FMC (LPC) connector on KCU105 side
- TAs completed (UMN).
- Twinax cable for realized TAs with 5 differential pairs obsolete (3M SL8801/11-10DA5-00).
- Replacement by 4-pair cable type (SL8801/12). Use existing TAs by cutting the new cable lengthwise (U Florida). Afterwards, TAs with cables come to DESY. Soon: Redesign of TA adapters.
- In discussion in scintillator group: Do we need more space (cable widths) in the cassette and re-align connector positions? Preliminary: No change in concept required.

Twinax adapter, FMC side (UMN)

KCU105-DAQ at DESY - Status

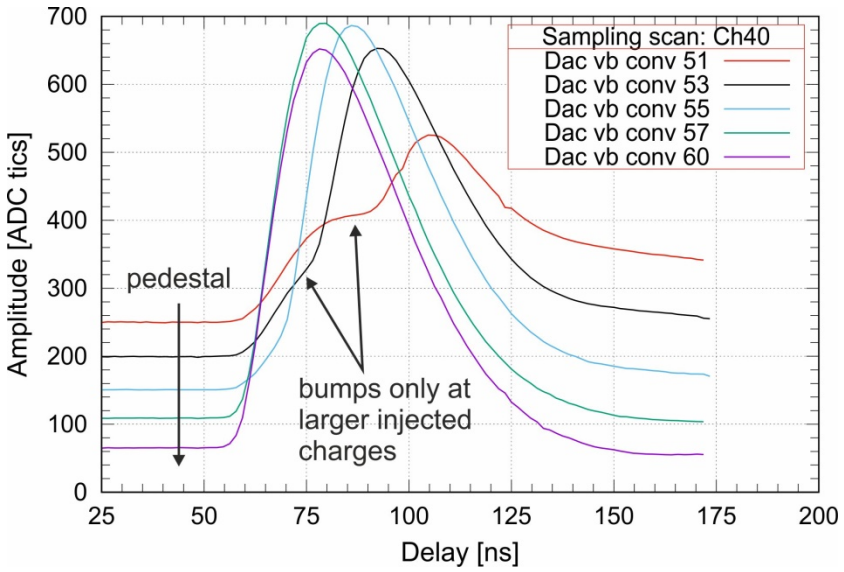
- Omega testboard with HGCROCv2 (SiPM version) arrived at DESY.
- CentOS7 PC with local copy of KCU105 DAQ in operation.
- New configuration file for the SiPM HGCROC version in place – works.
- Important preparation for TB1 commissioning:
  - Understand DAQ scripts
  - Understand HGCROCv2 operation
  - Finally: compare results

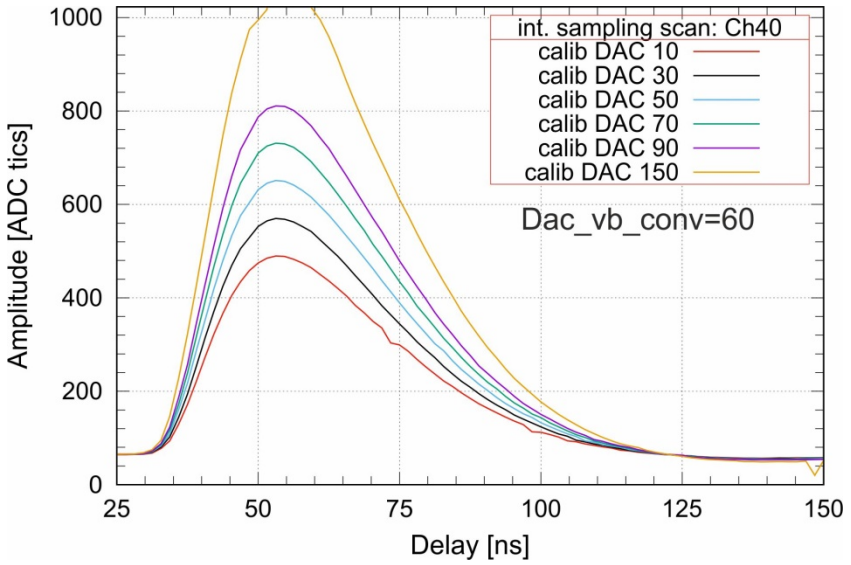


DAQ setup with HGCROC testboard (Omega, LLR) at DESY

Special thanks to Artur (LLR), Damien (OMEGA) and Pieter (ICL) for their help!

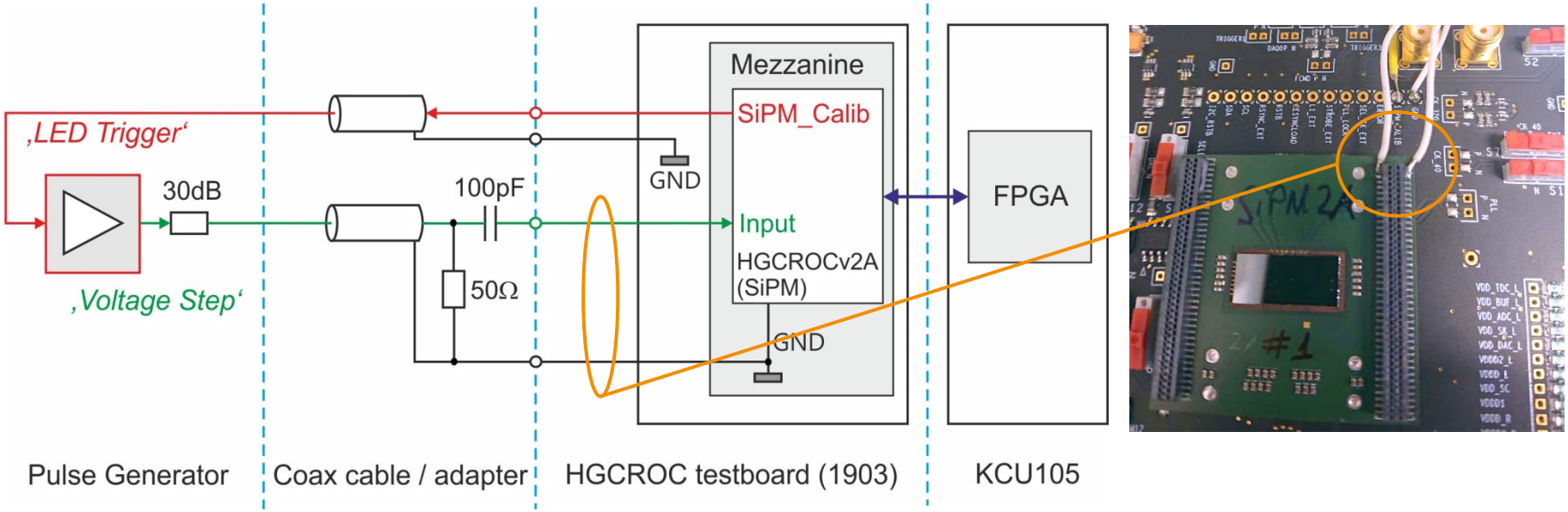
HGCROCv2A (SiPM) – Dac_vb_conv (internal inject.)





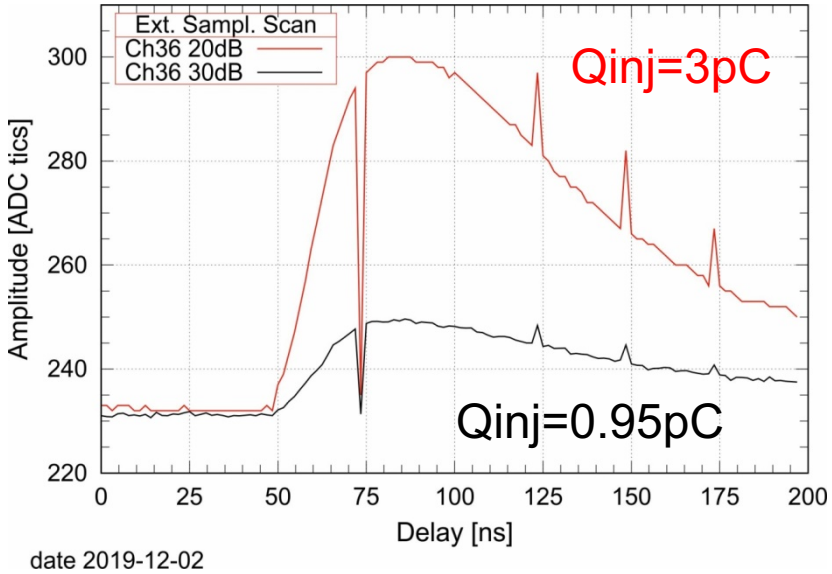
- Increasing Dac_vb_conv leads to shorter shaping times and better stability against bumps.
- Question (right plot): Probably calib-DAC=0 will not provide pedestal level. This is for 8pF injection capacitor (HighRange).

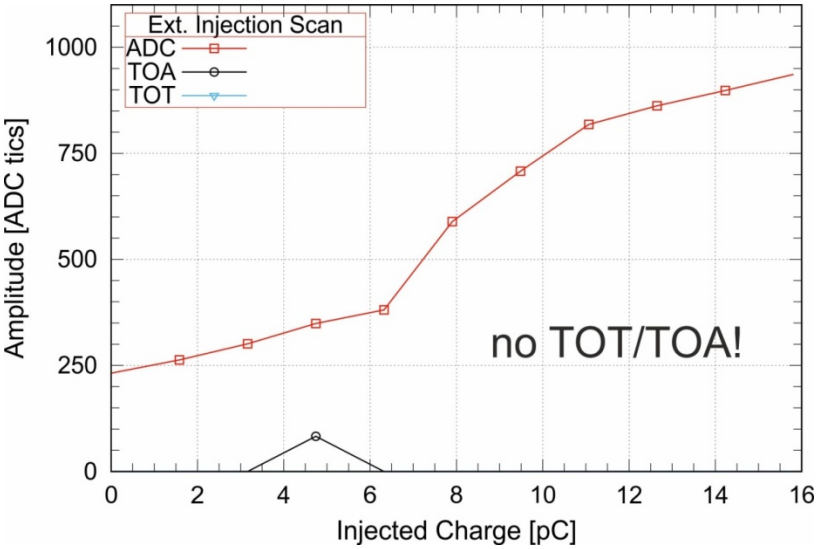
HGCROCv2A (SiPM) – External Charge Injection



- Real, external signal injected to HGCROCv2 input. Internal Calib-DAC off.
- Use SiPM_CALIB signal (later: LED system trigger) to synchronize pulse generator. Delay (pulse generator specific): 30 clock periods (“calib_offset”).
- Important test: Can we operate LED system with KCU105-DAQ?
- Disadvantage: One channel at a time.

HGCROCv2A (SiPM) – External Charge Injection





- Default (old state) configuration for HGCROC – to be optimized (e.g. shaped pulse width and ADC characteristic)!
- No TOT/TOA in external injection visible (wrong BX?).
- KCU105 DAQ can be used for LED system in current state. All delays can be adjusted.