Tests of the fiber-based calibration system

CALICE collaboration meeting
Cambridge, UK 2012/9/18

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- ❑ **QMB1 LED driver and notched fiber system**
- ❑ **Single photon spectra & gain performance**
- ❑ **Amplitude scan and saturation achievement**

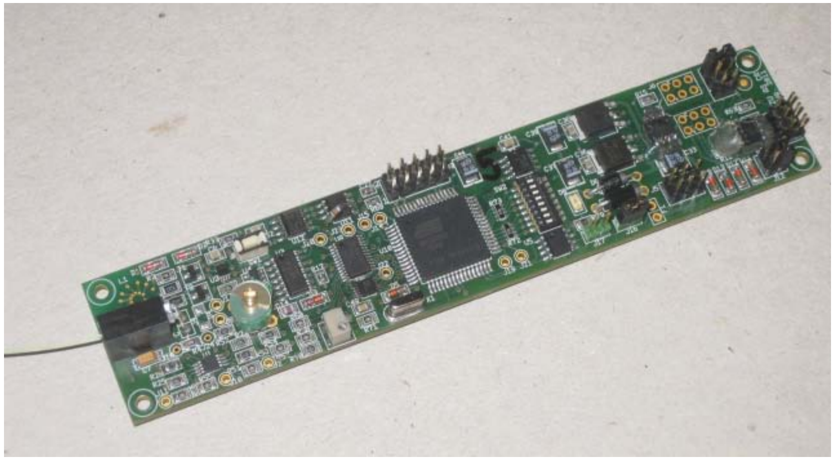
Institute of Physics AS CR

Calorimeter for ILC

QMB1

More info on QMB can be found:

http://www-hep2.fzu.cz/calice/files/20110915-Polak_I.CALICE_Heidelberg.pdf



Single power 15V, 65mA

- **Quasi resonant Main Board**
  - **Modular system, 1 LED per board**
  - **Operation mode:**
    - **DAQ + CAN bus control**
    - **stand-alone mode**
  - **LVDS Trigger distribution system**
  - **Variable amplitude, zero to maximum (~1Amp) smooth**
  - **Pulse width fixed to ~ 3.5ns (UV or blue LED)**
  - **Voltages and temperature monitoring**
  - **Size of PCB: width 30mm, depth 140mm**

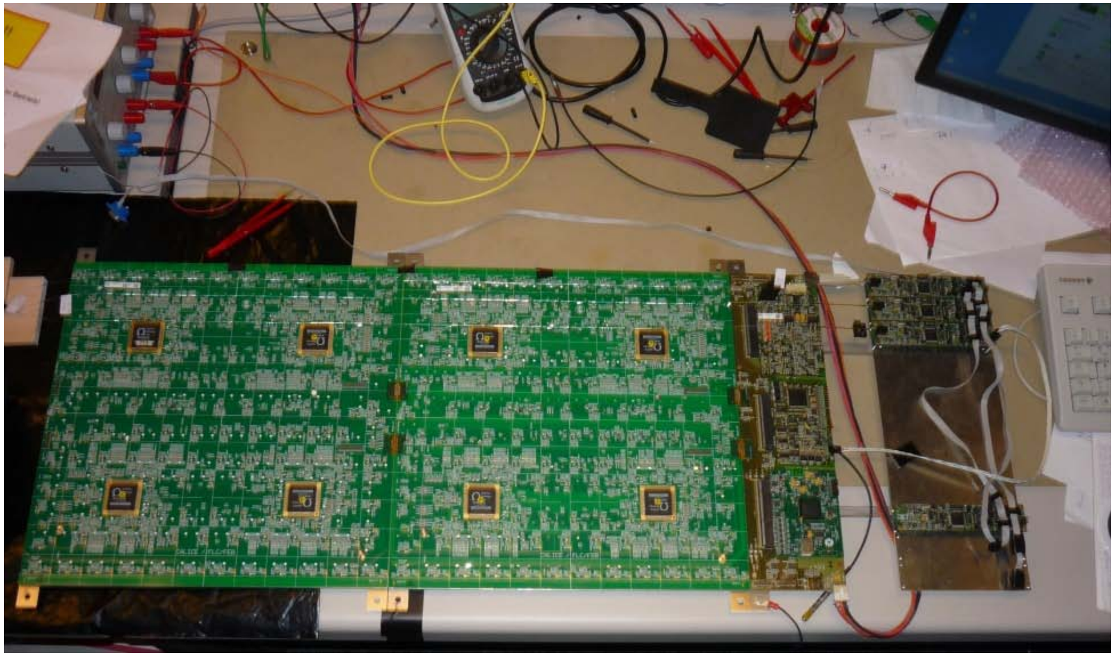
2^{nd} Test @ DESY (May 2012)

- 2 times HBU2, in one row, each had
  - two active SPIRoc2b ASICs,
  - equipped with 3 rows of scintillators & SiPMs
- Different tiles & SiPMs on each HBU2 ('Old' and 'New' HBU)
- Tests at DESY 2012, May 21 & 27

- Low & High Gain running

- Analysis mainly done by Jiří Kvasnička
- Single photon electron spectra
- Fast Fourier Transform of p.e. spectra to get the peak distance
- Linearity & Amplitude scan
- Thanks to Mathias Reinecke for effort to set up the 2^{nd} HBU2

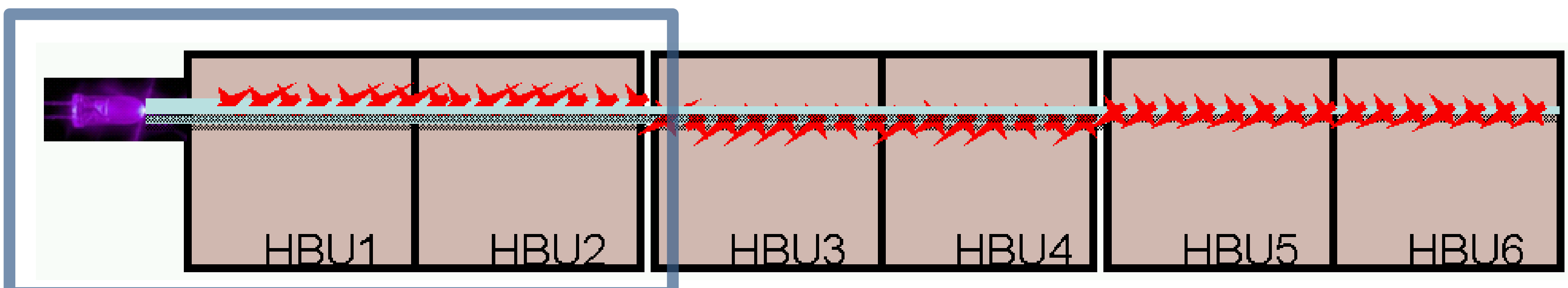
Test setup with 2 HBUs



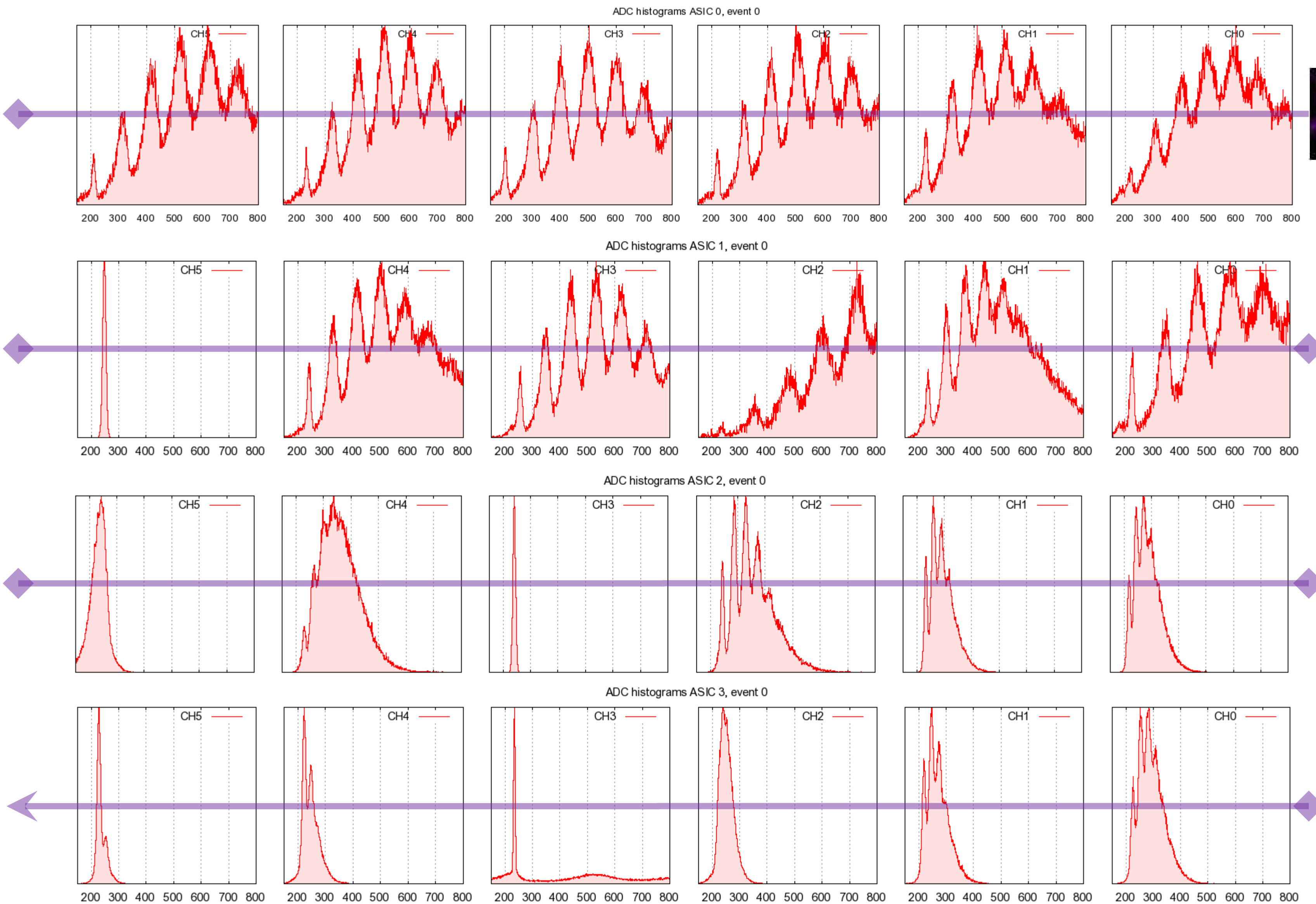
- 3 QMB1 drivers
- 3 UV LEDs
- 3 notched fibers
- Each 24 shining points
- 72 active channels in total
- 4 active Spiroc2b ASICs in r/o (#129,130,131,132)
- @ 2 HBU2s

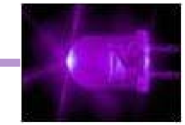
approx 1/3 of final idea:

- 3 notched fiber per 1 LED
- Each fiber for 24 tiles



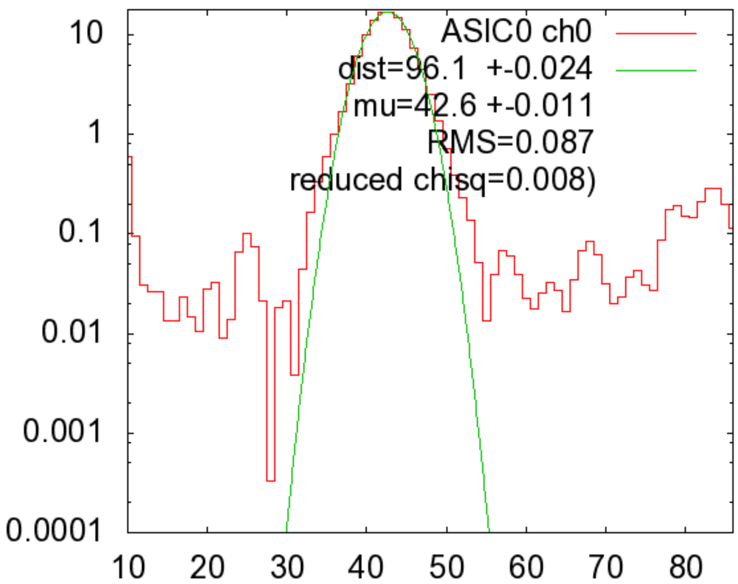
High Gain p.e. spectra

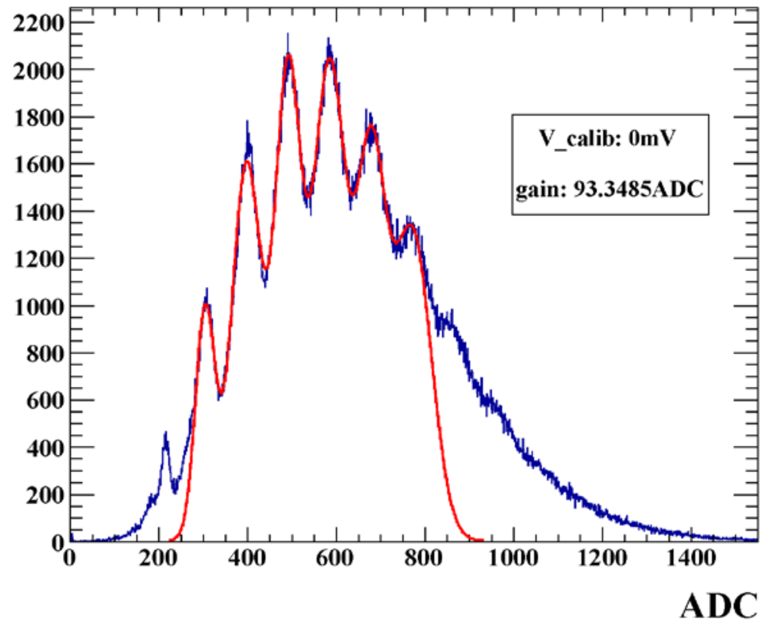




SPS: FFT vs MultiGauss

Thanks to Oskar Hartbrich

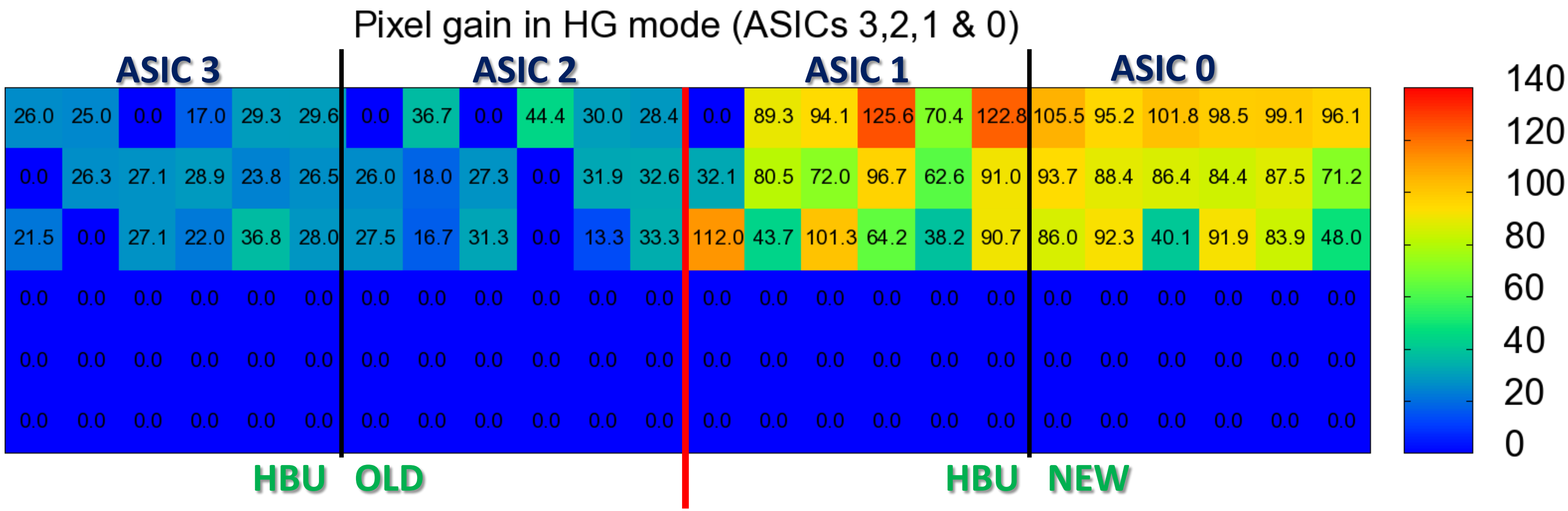




- Single peak distance measurement
  - Performing FFT & Gaussian fit to spectrum

- MultiGuass fit is more accurate (2x lower fit errors)
- FFT overshoots gain distribution mean by 1-3%
- Advantage: powerful with very low statistic

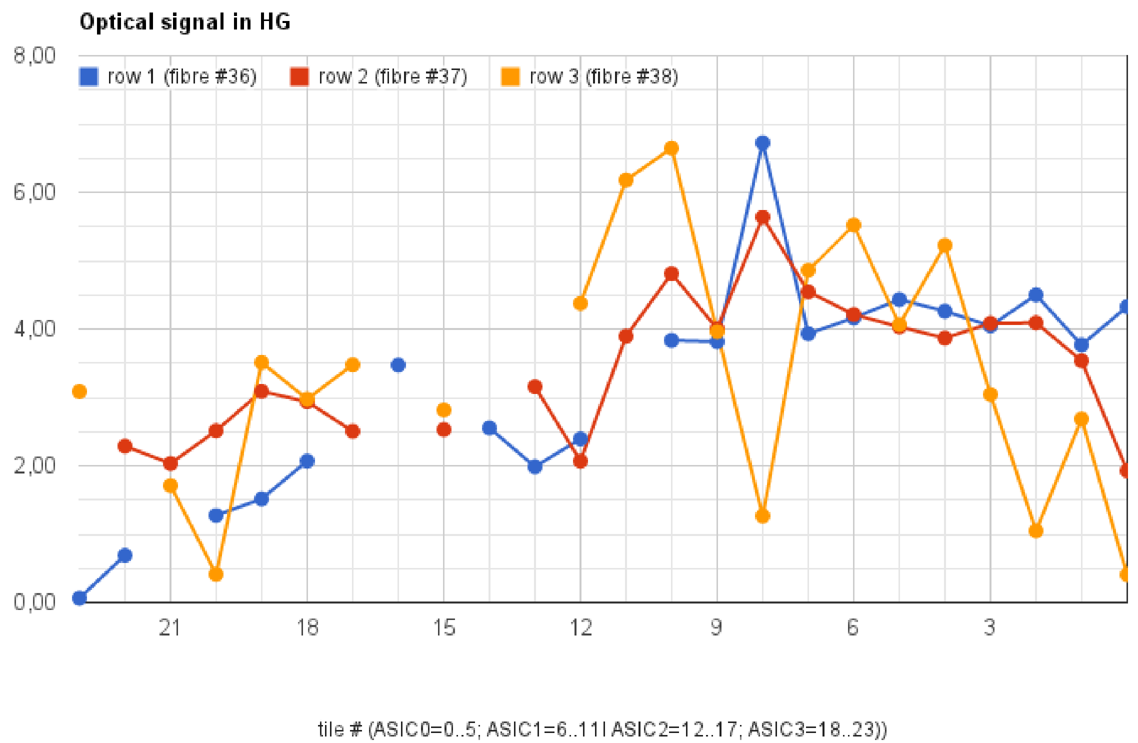
Pixel Gain in HG mode



- **Pedestal shift occurred, probably issue of SpiRoc2b ASIC chips, new ASICs should cure this problem**
- **Some pathological cases (no holes, impossible fixing, no tile) for few channels**
- **Differences of 'old' and 'new' tile-sipm batches are visible**
  - **ITEP: LY of tile & SiPM 15 vs. 12 pix./MIP**
  - **Gain 2.0 vs. 1.5 M, U_{bias} 43V vs. 47V (not good working point, delay setup)**
  - **Physical number of pixels should be same**
- **In average ~3 times higher pixel gain, assuming same light intensity from notches**

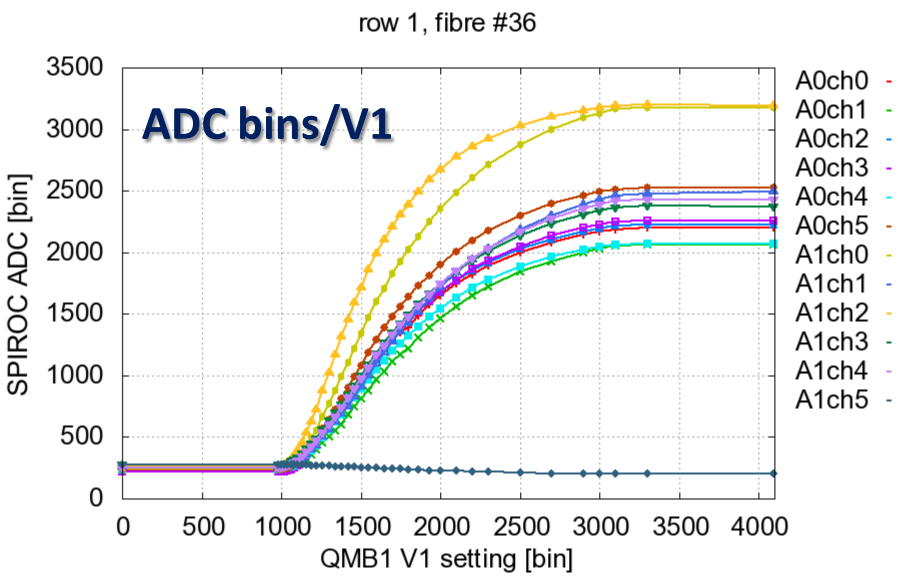
Optical performance (HG)

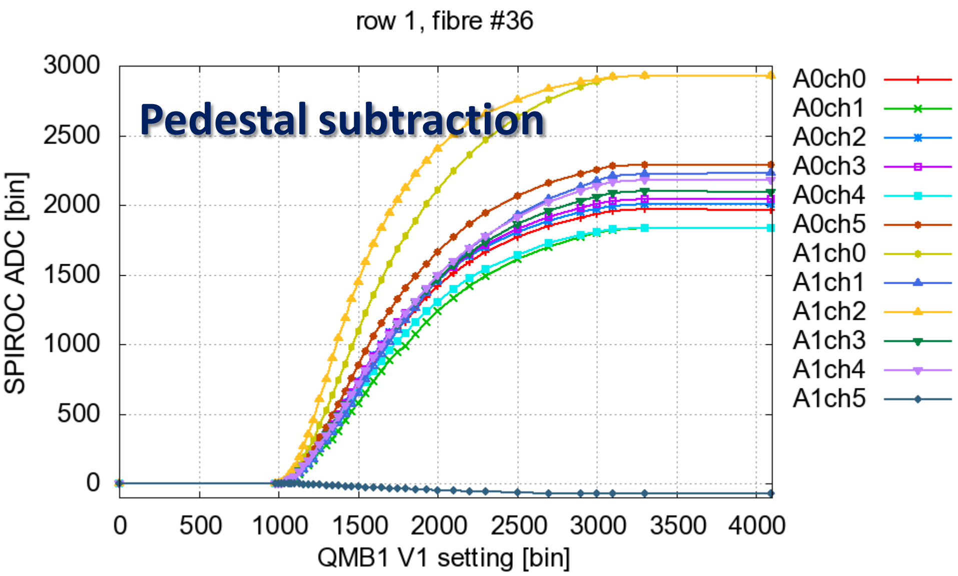
- row/fiber #1
- row/fiber #2
- row/fiber #3

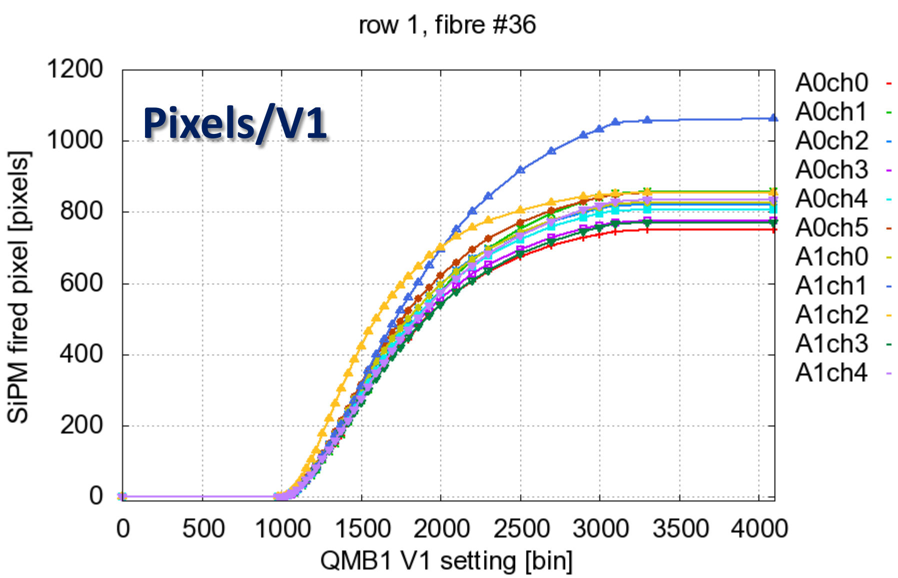


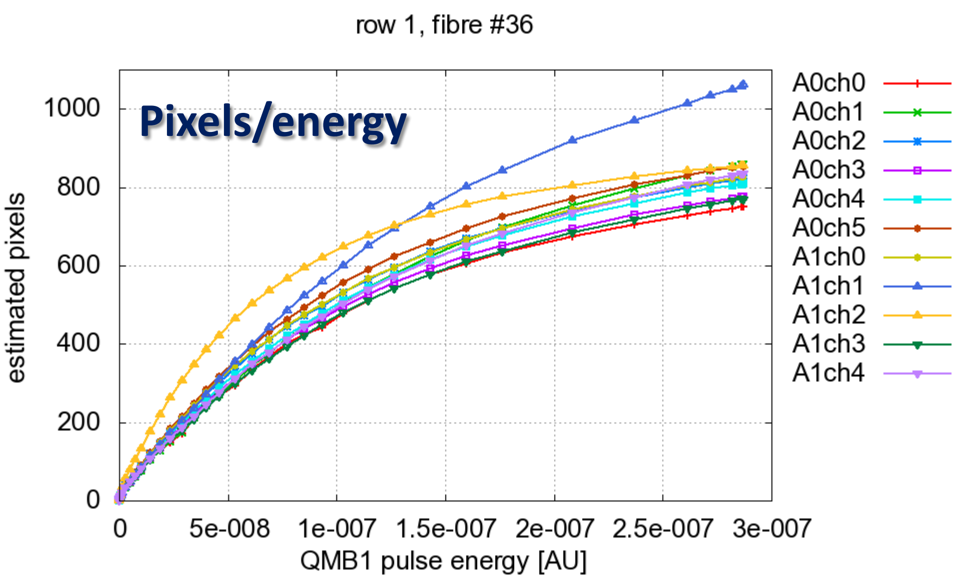
- Same light intensity input, study homogeneity of light coming from notches
- 2 times higher response for 'new' HBU2 in units of pixels
- 1st fiber the best, (omitting point#8) light inhomogeneity within 18%, average variation 6%, even better after correction LG/HG modes
- 2nd fiber still ok, 3rd problematic due to fiber routing & fixing

Saturation curves: procedure

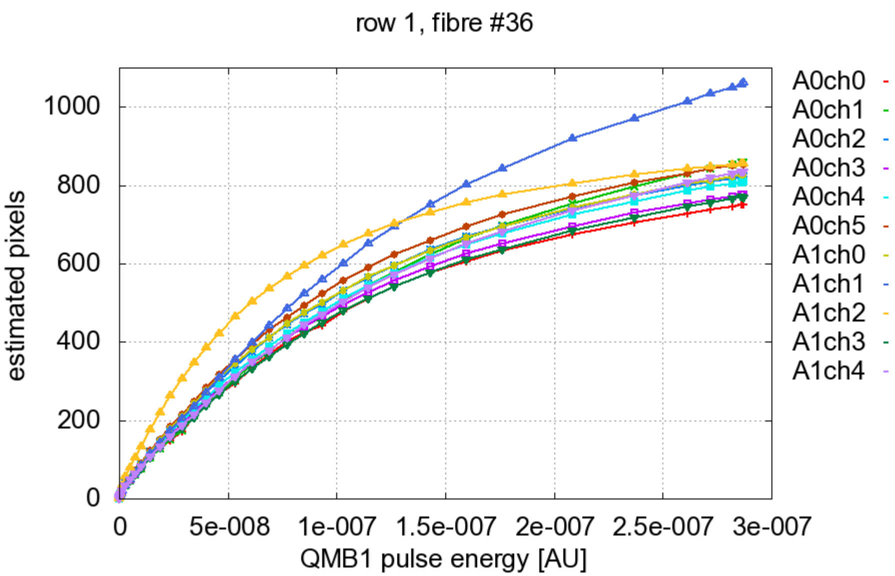


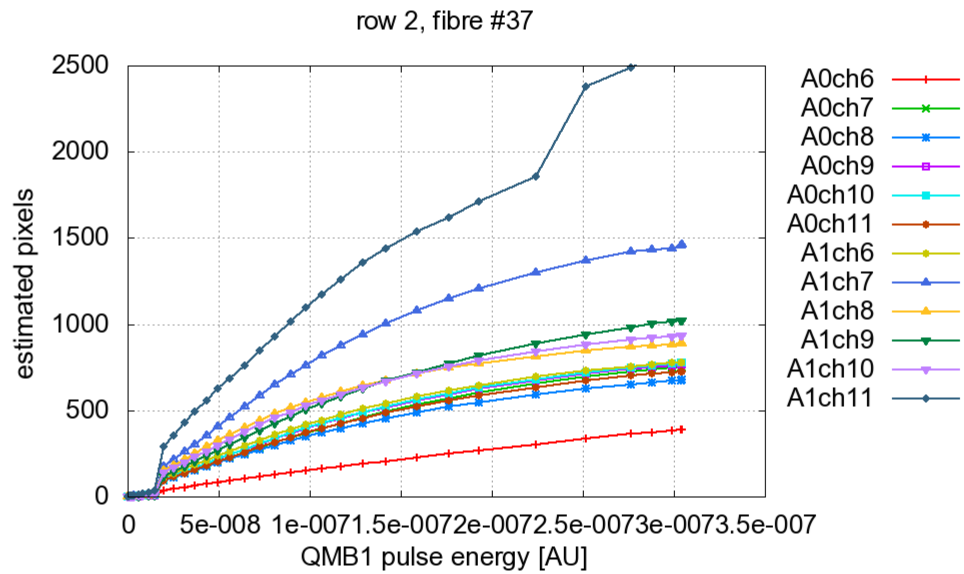


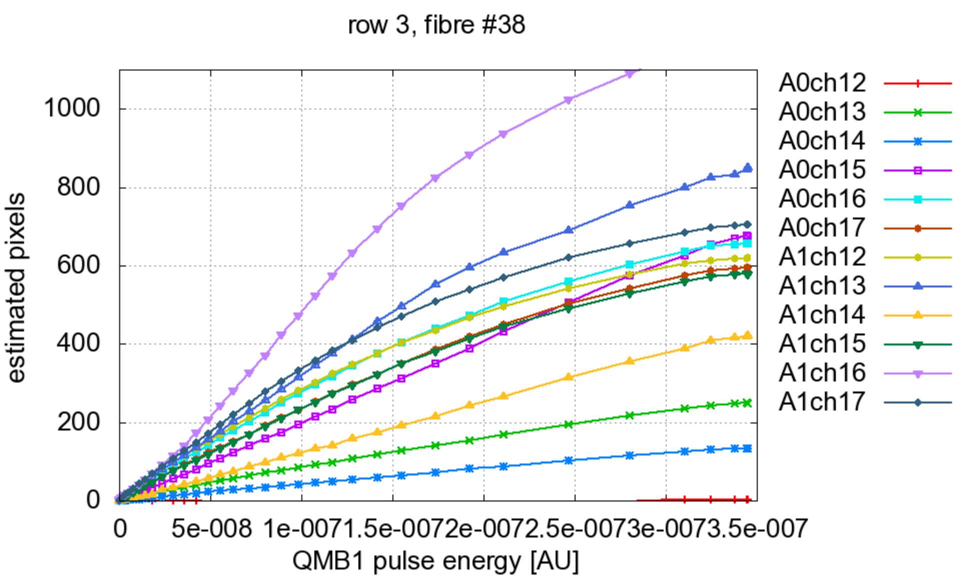




Saturation curves: All rows

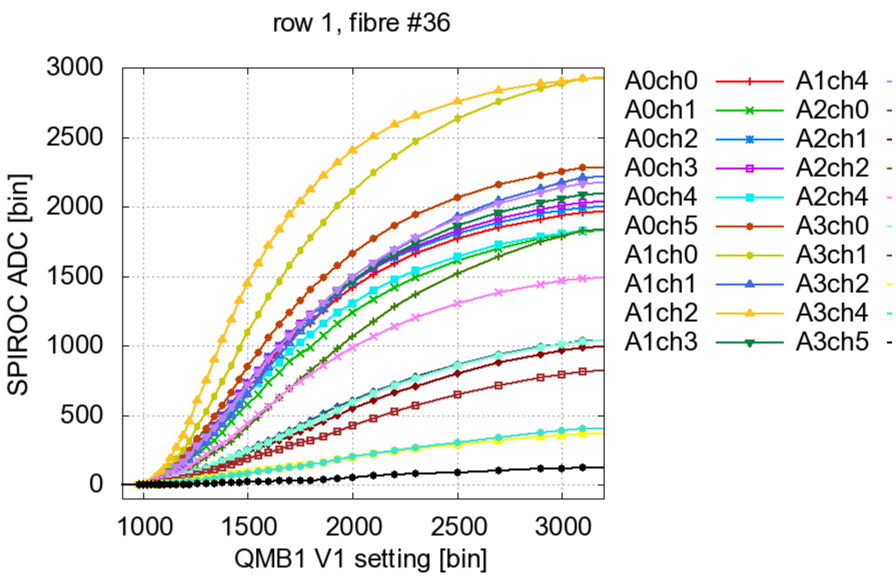


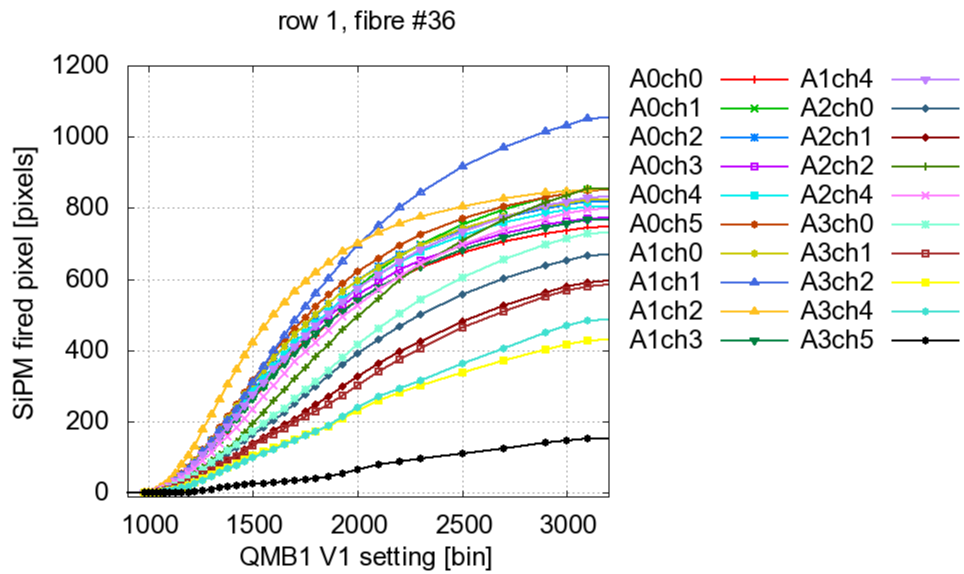


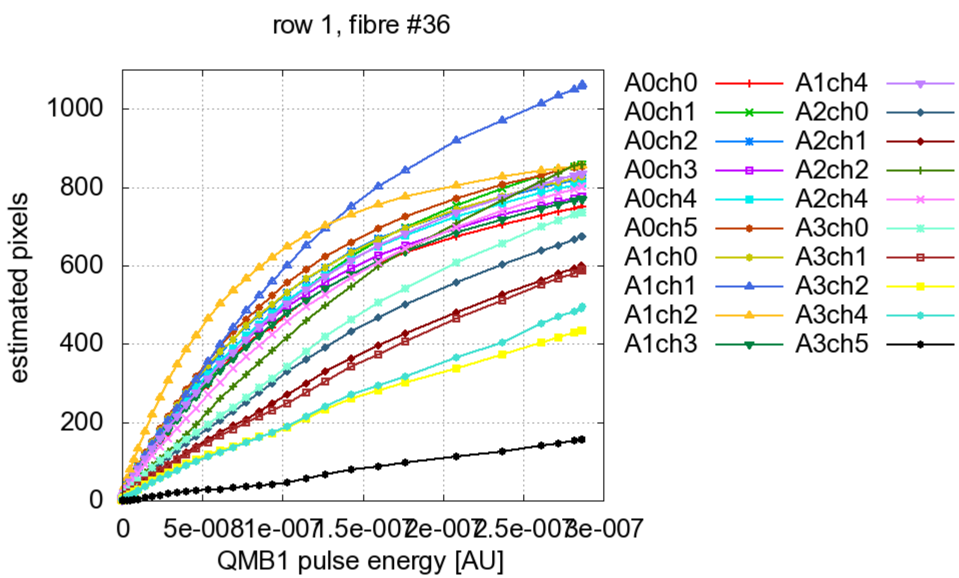


- **Response variation for fibers**
- **1st (outermost) best**
- **2nd some problem with resetting of card slow control**
- **3rd problems with fiber routing, misalignment of fiber notch and holes in HBU PCB**

Saturation curves: All HBUs







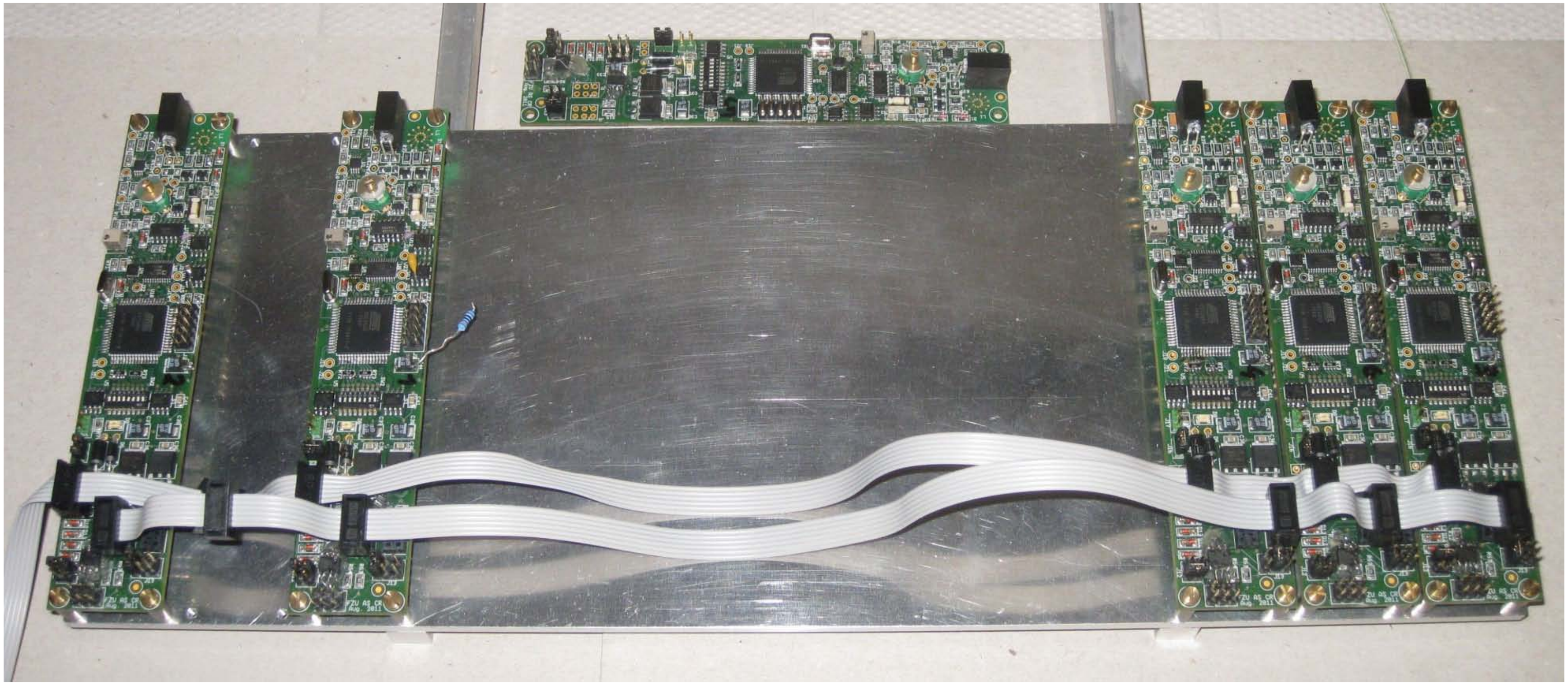
- **scaling factor HG/LG ~40**
- **OLD HBU: asics A2 and A3**
- **Performance of 'OLD' HBU card much worse, no saturation reached**

Conclusion

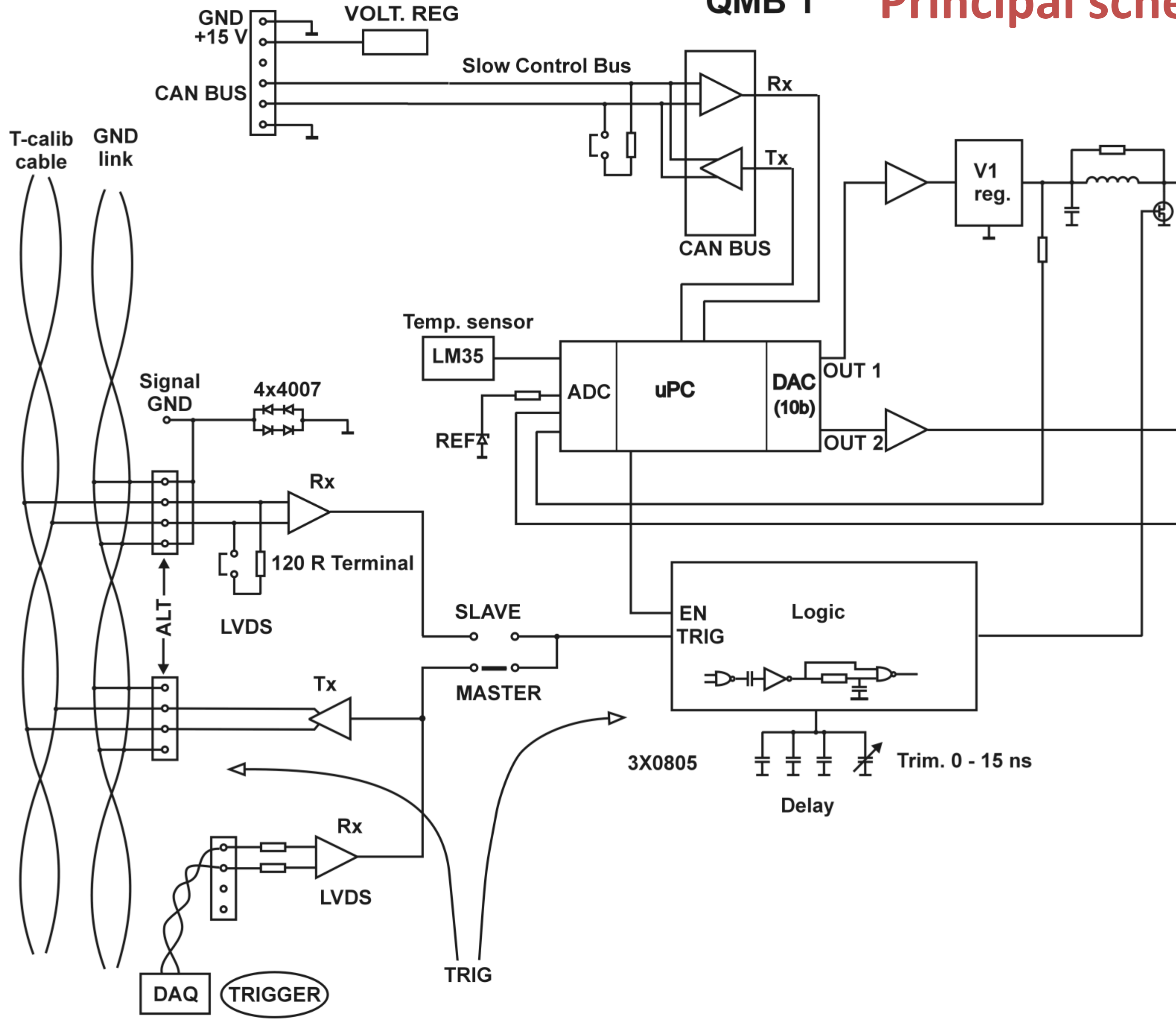
- Fiber-based calibration system tested in May at DESY
  - 3 QMB1 with 3 LED & 24-notch fibers routed on PCB
- Two HBUs connected in one row provided
  - Unfortunately not the same performance of tile – SiPM setup
- Common characteristics measured: HG, LG, amplitude scan
- FFT is successfully applied on p.e. spectra to extract SiPM gain
- Wide range of light intensities provided
- Proper fiber routing allowed to achieve saturation limits
- QMB1 is in full operational stage
- Homogeneity of 24-notch fibers looks reasonable
- Upgrade of QMB1(v2.0) is foreseen in end of 2012

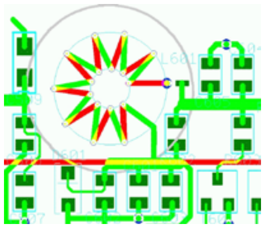
BackUp

Frame with 5 (and 1 spare) QMB1



QMB 1 Principal schema



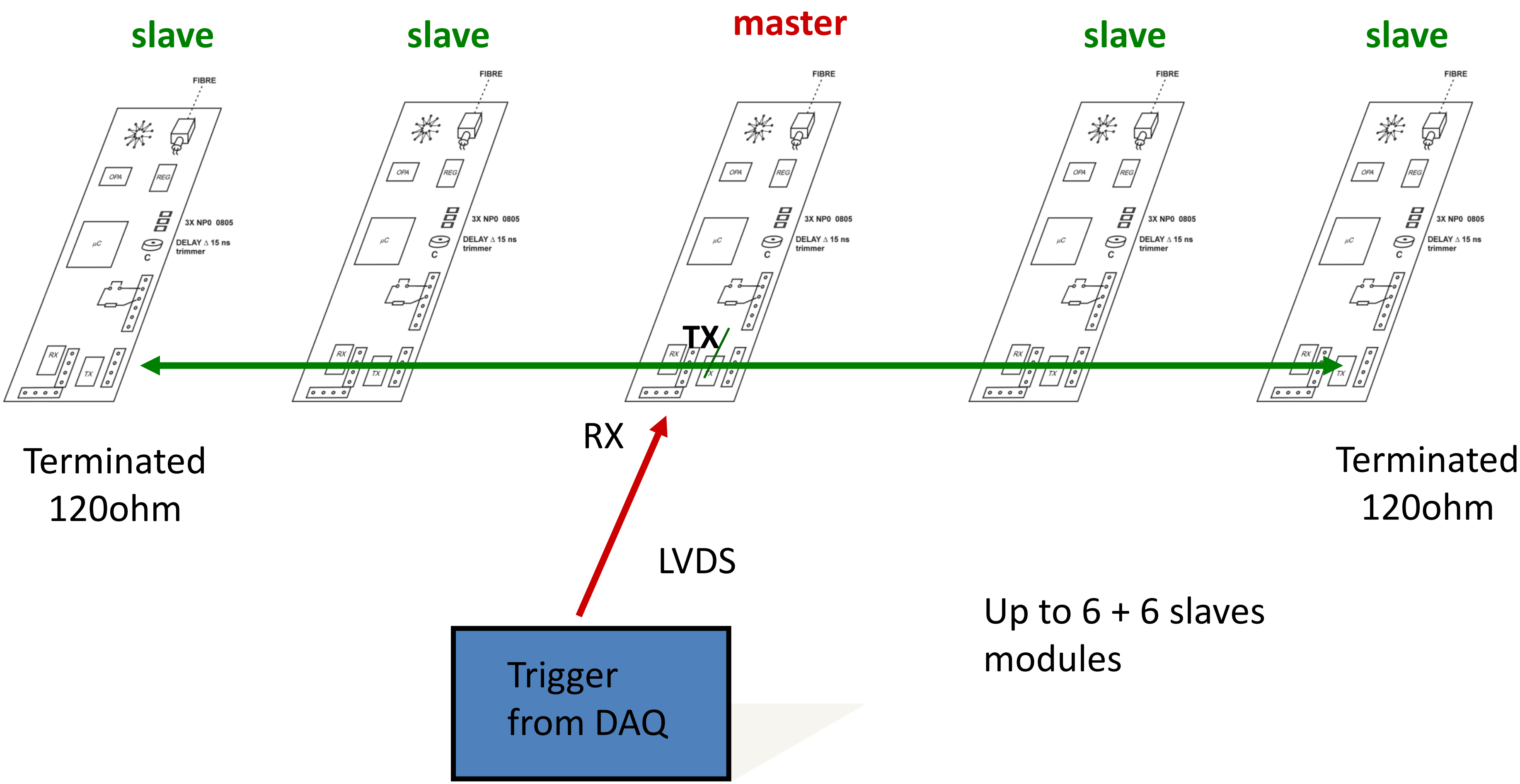


Larger inductor than the older QMB6

Ivo Polák

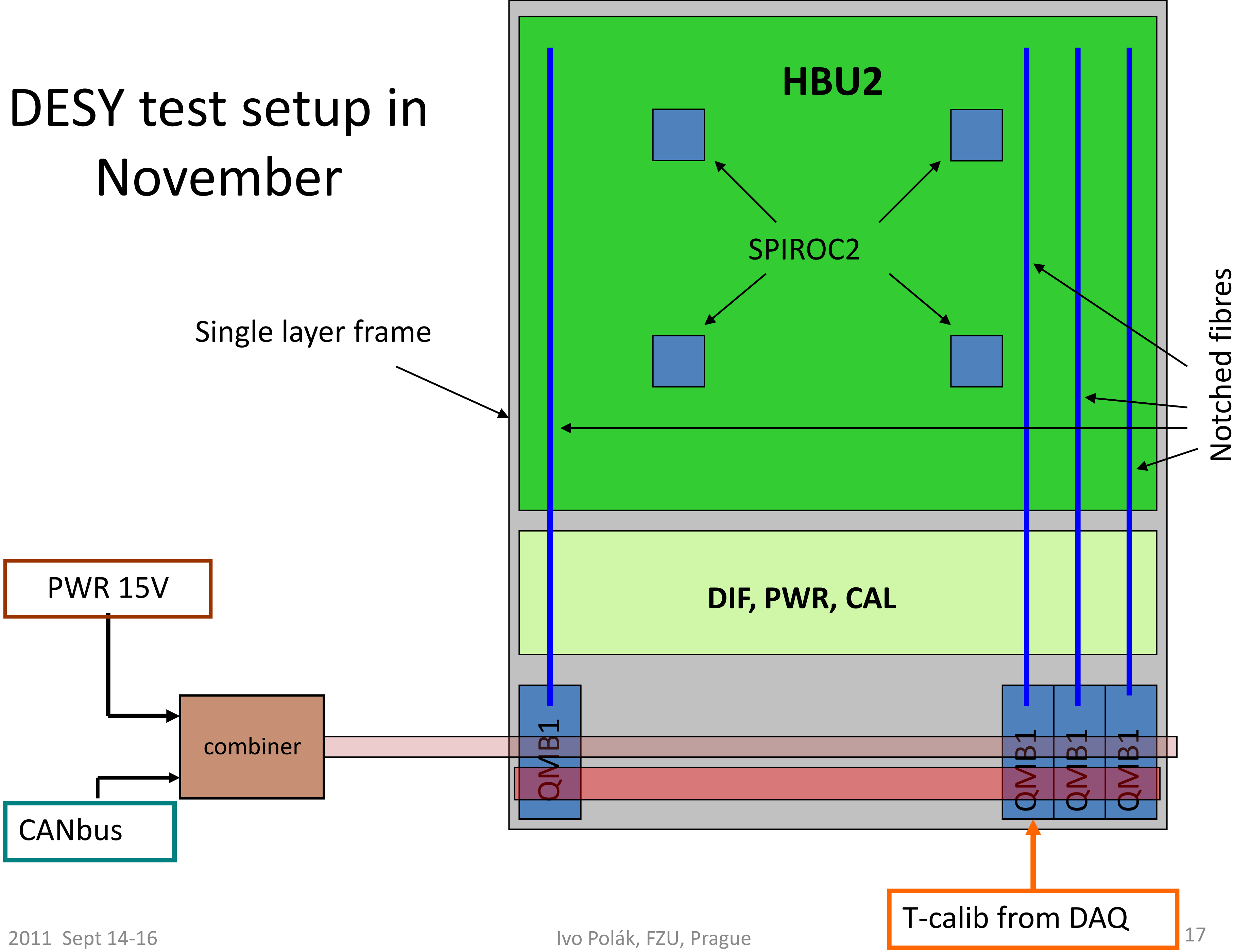
May 2011

TRIGGER (T-calib) LVDS distribution to QMB1



Up to 6 + 6 slaves modules

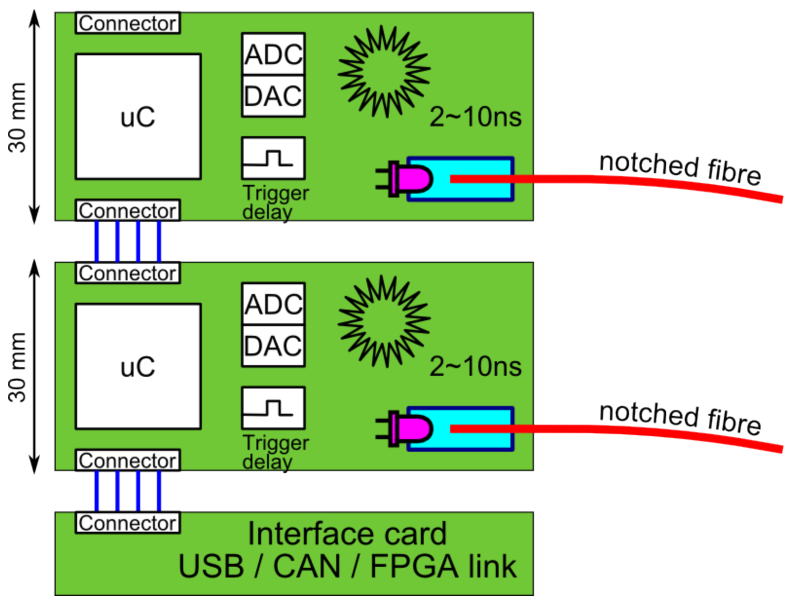
DESY test setup in November

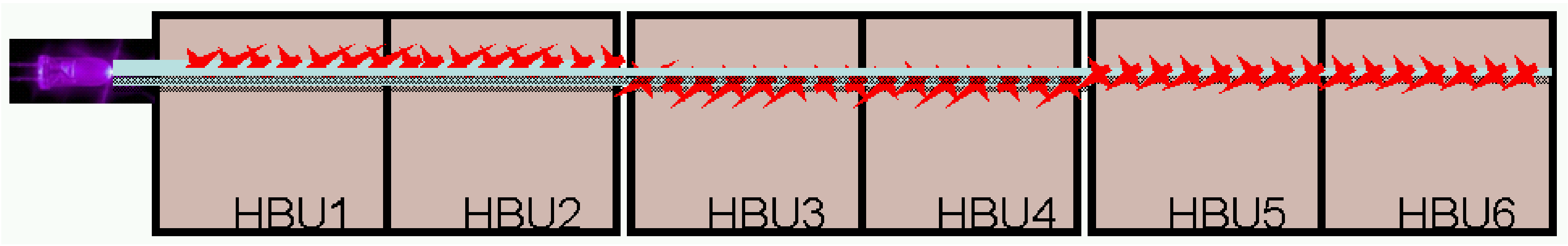


work at 2011

- **QMB1 (1-chanel LED driver)**:
  - Done
    - Topology, PCB design
    - Communicating bus (CAN)
    - CPU (Atmel AVR)
    - Trigger distribution (LVDS)
    - Trigger delay canbe tuned by C trimmer (~10ns)
    - 4 mounting holes for screw M2.5
    - Fibre(LED) position set to center of PCB
  - PCB in production + assembly
  - To be done Debugging in October/beginning of Nov
- Set of **notched fibers, semiautomat machine under development**
  - Set: 3*fibre with 24 notches, creating a line of 72 notches.
  - 3 sets will be delivered in November

2010 Idea





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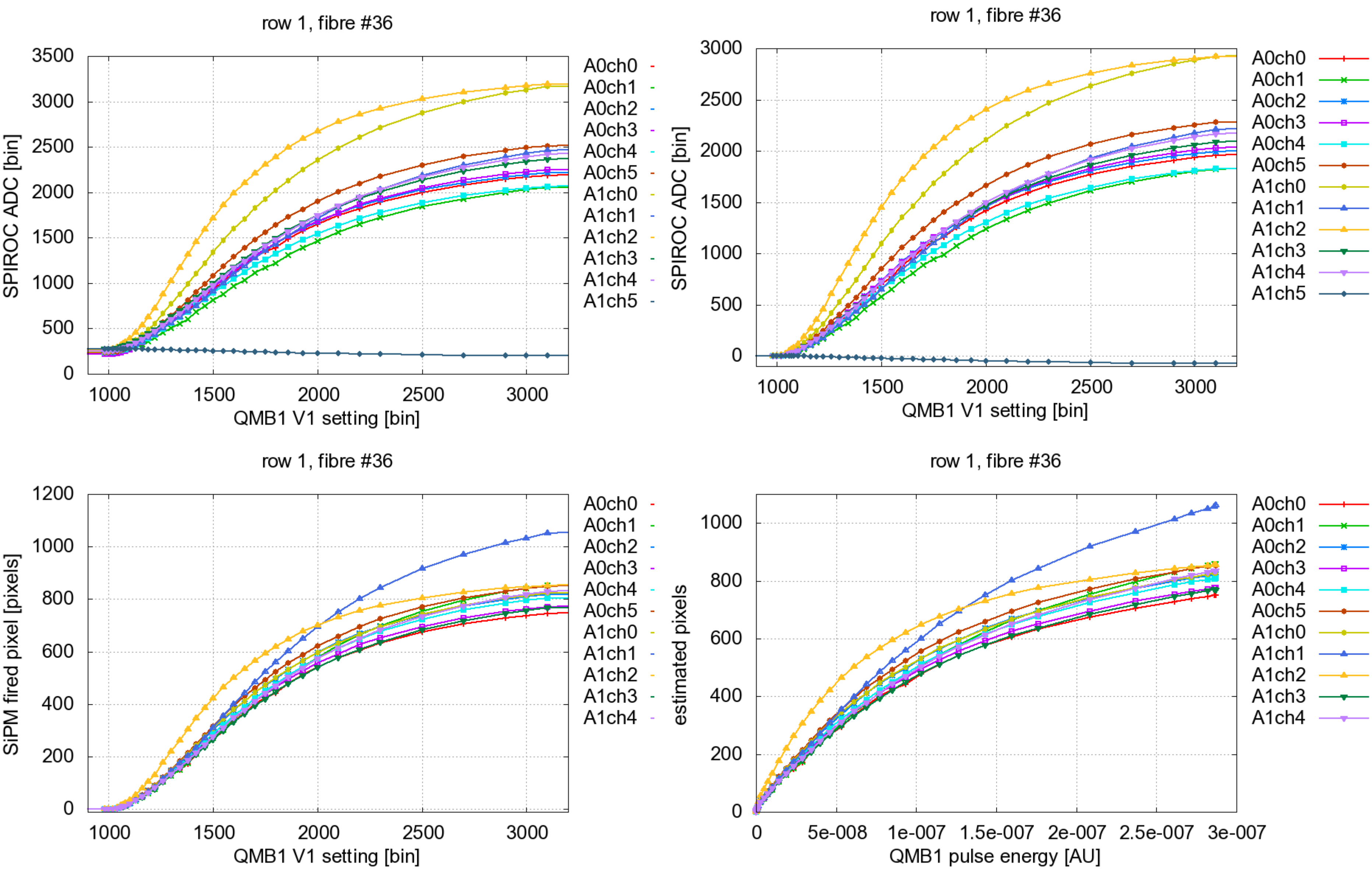
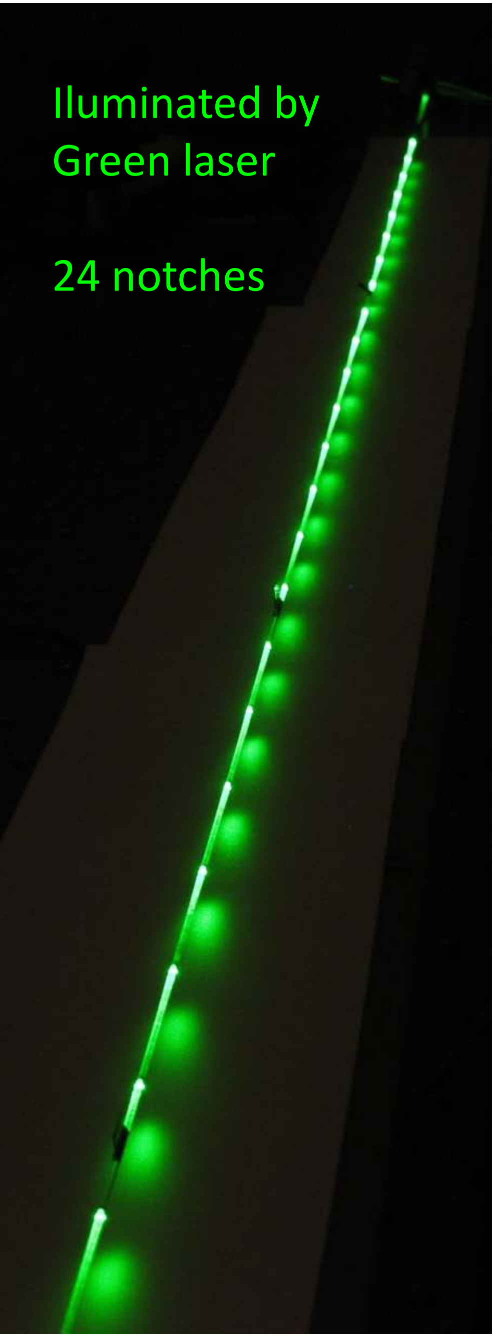
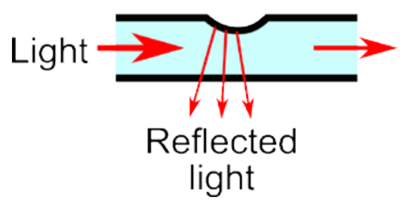


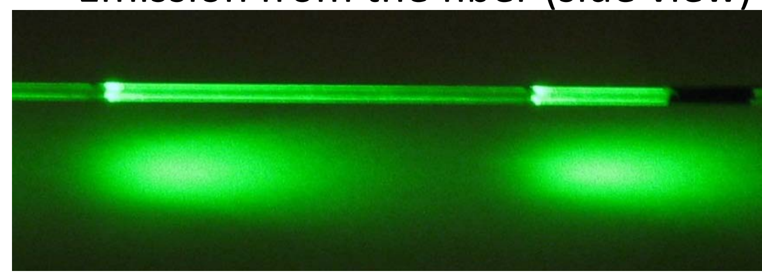


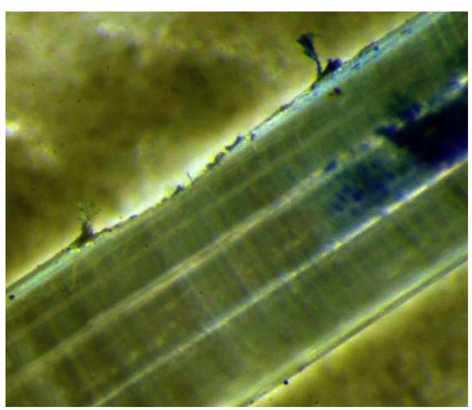
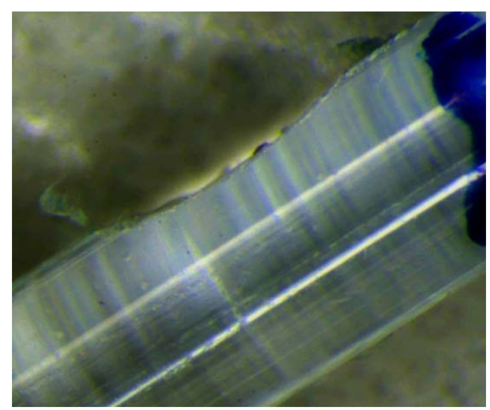
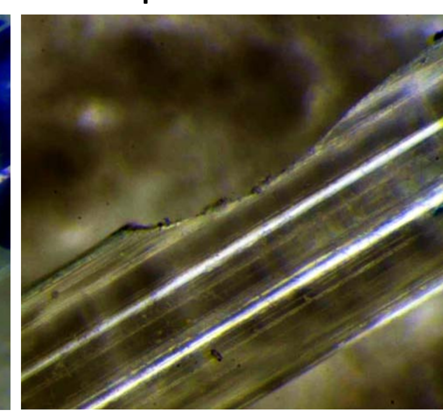
Distribution of light: Notched Fiber

- Light is emitted from the **notches**
- The **notch** is a special scratch to the fiber, which reflects the light to the opposite direction
- The size of the notch varies from the beginning to the end of the fiber to maintain homogeneity of the light, which comes from notches



Emission from the fiber (side view)



First notch	Middle notch	End position notch
		

Notched fibres
Semi-automatic tool

Now in operational debugging & sw development stage

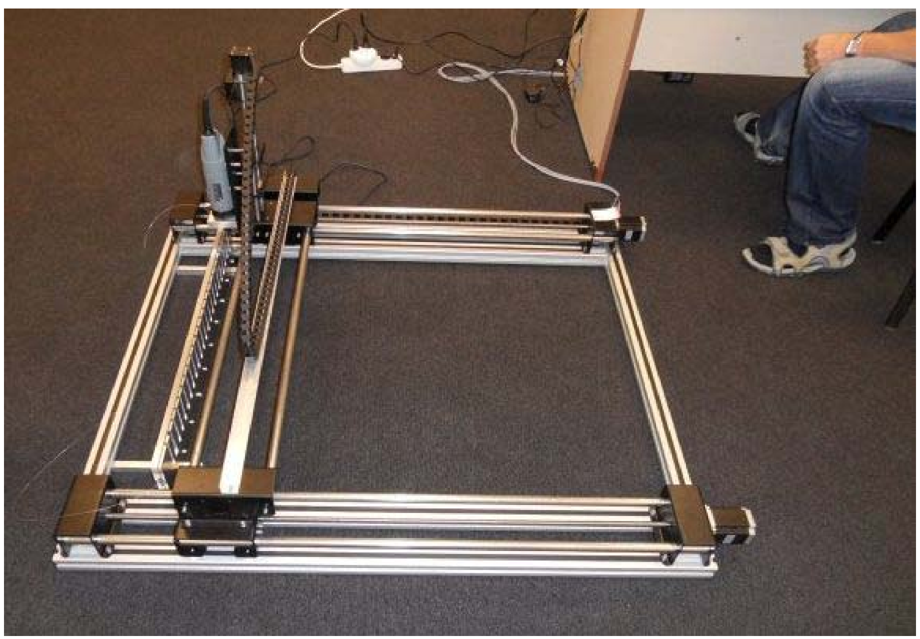
Frame with x-y stepper motors

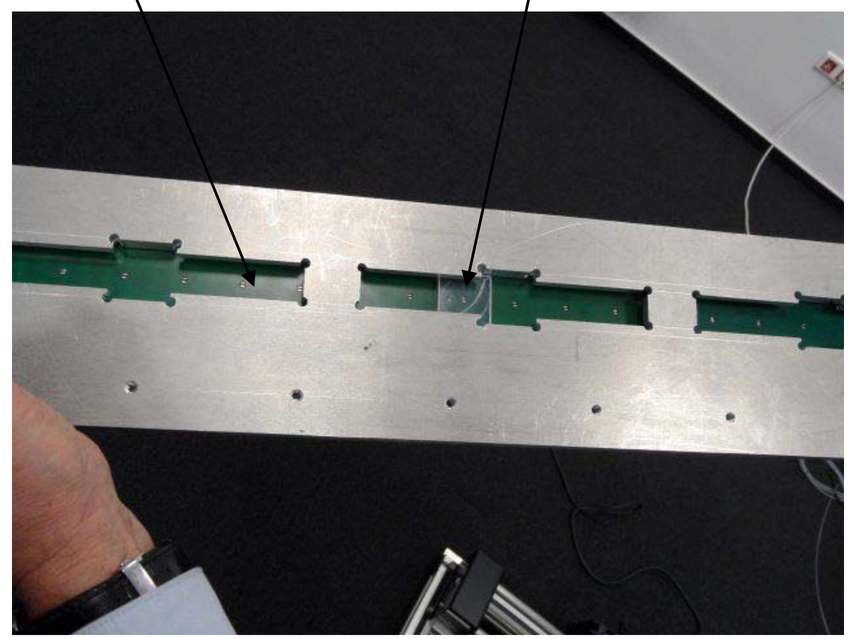
Drill machine used as milling cutter to groove the notch

Alu/PCB Template with moving scint tile

PCB with 3mm holes

Scintilator tile w SiPM





QMB1 linearity, amplitude scan

Standard LED pulses 3ns,

PWR measured by optical power meter ThorLabs PM100D

Differential Nonlinearity