



Optical fiber calibration system

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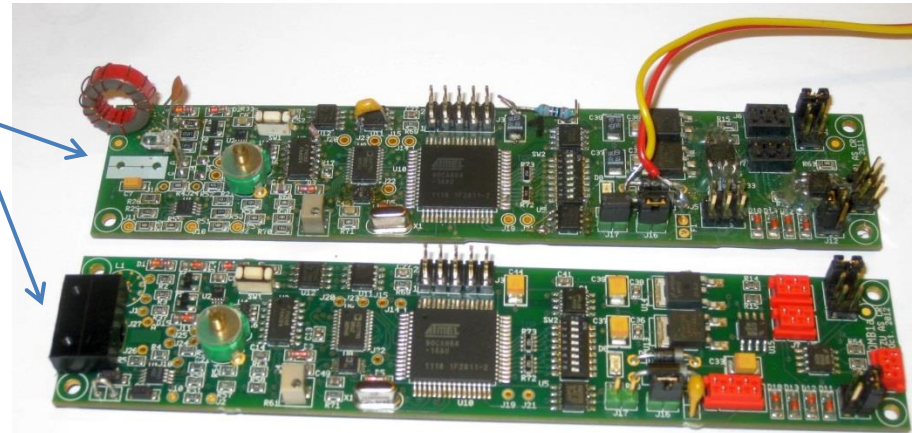
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- QMB1a - the LED driver
- Test setup - 6 HBU at DESY
- Results - HBU data
- Results - notched fibers

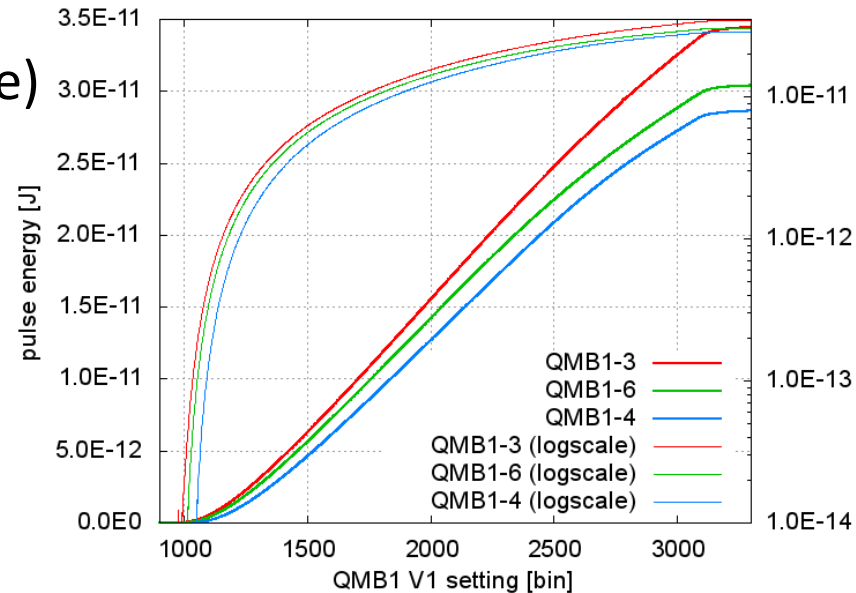
The LED driver – QMB1

- Quasi-resonant LED driver
- Modular system
- Dec 2012: **QMB1a**
 - External coil pads (~30 ns pulse)
 - New connectors, minor changes
 - Boards are working,
 - Performance measurements ongoing
- Main parameters:
 - Smooth pulse shape (half-sinus shape)
 - Variable amplitude (~1A peak)
 - Repetition rate up to 100 kHz
 - Fixed pulse width (2.4–3.5 ns)
 - PCB size 30 × 140 mm²
 - Output power is not linear to the V1 setting
 - UV LEDs has a different threshold

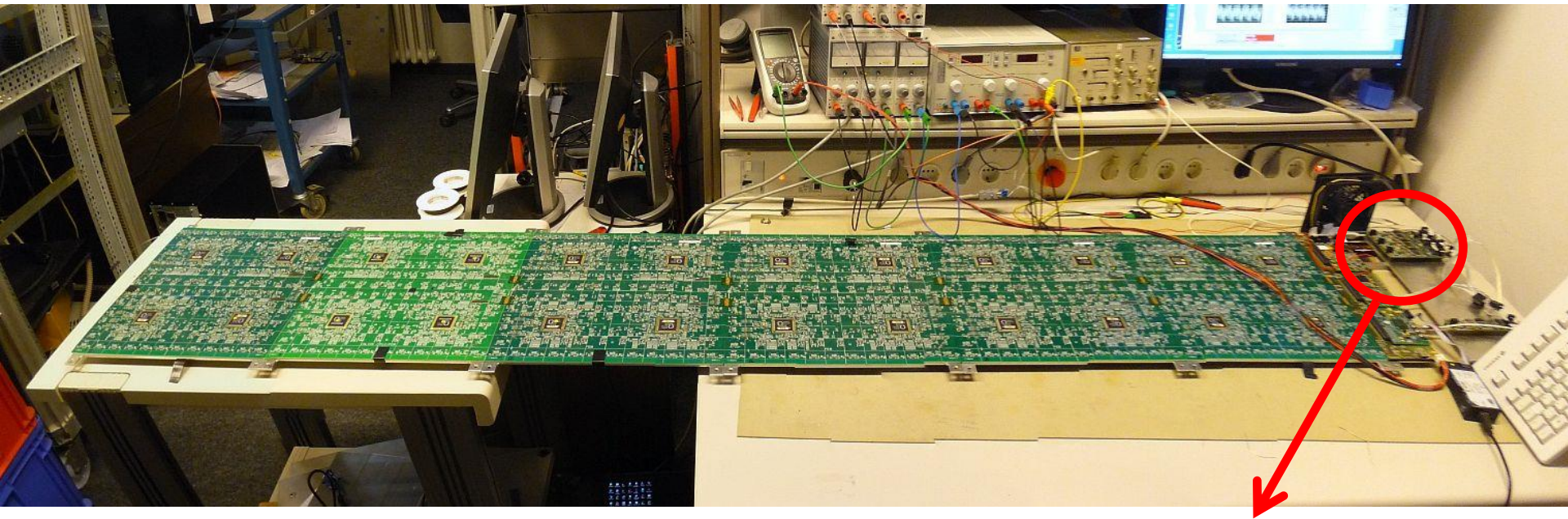
QMB1
QMB1a



Output optical power vs V1 setting,
QMB1, optical fibre 7m in length, 1mm in diameter,



6-HBU setup – DEC 2012

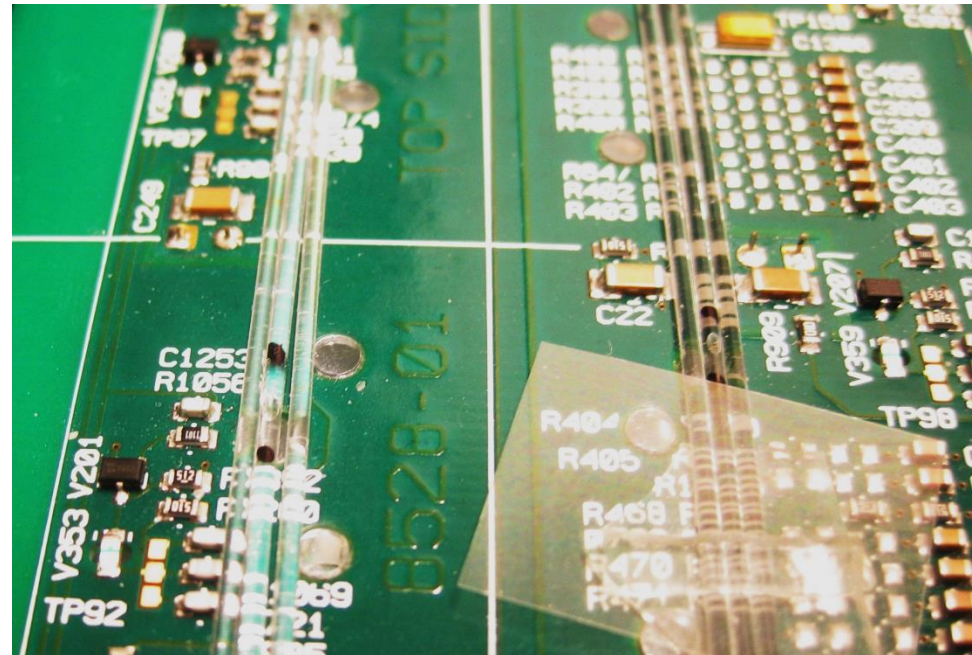
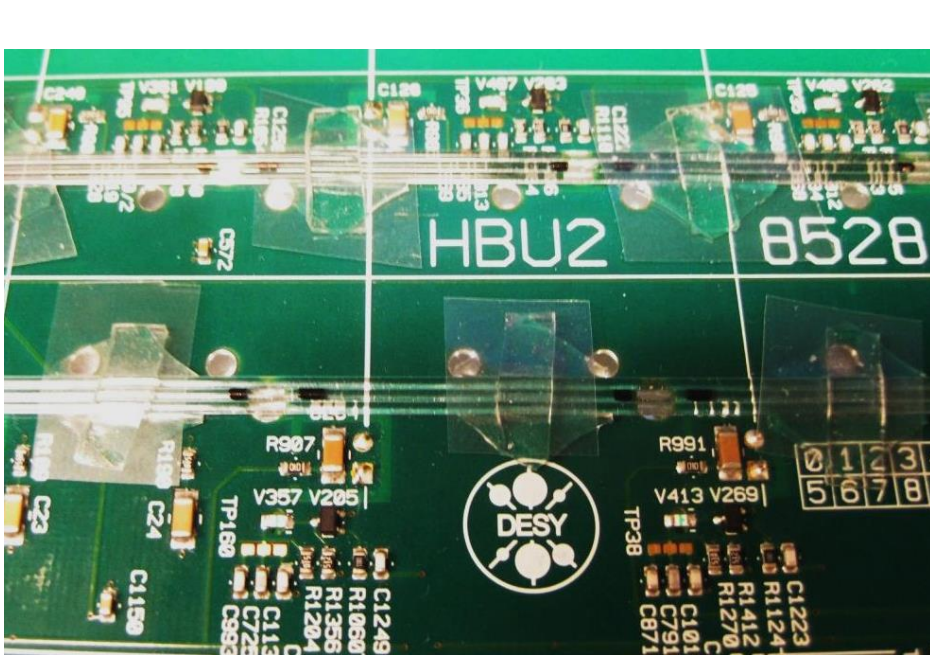


- Full setup with 6 HBU (2.2 m of electronics!)
- Data readout from all HBUs is stable
 - only 5 HBU equipped with tiles
- 3 row of tiles (3×72 tiles) illuminated by notched fibers and QMB1 LED drivers
- 1 row of tiles was illuminated by 1 QMB1 and 3 fibers (each fiber has 24 notches) → fiber triplet bundle (see next slide)
- One QMB1 LED driver per row of 72 tiles



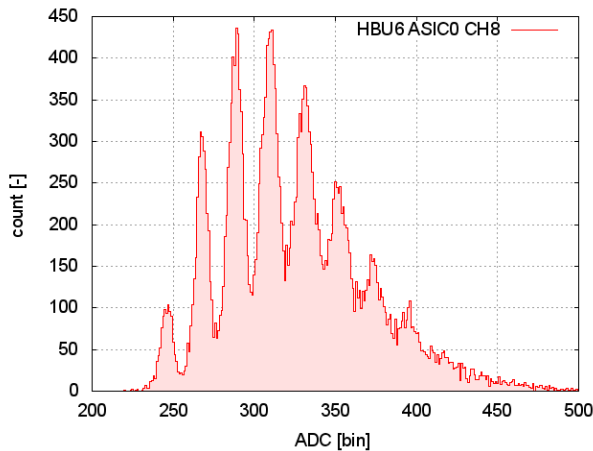
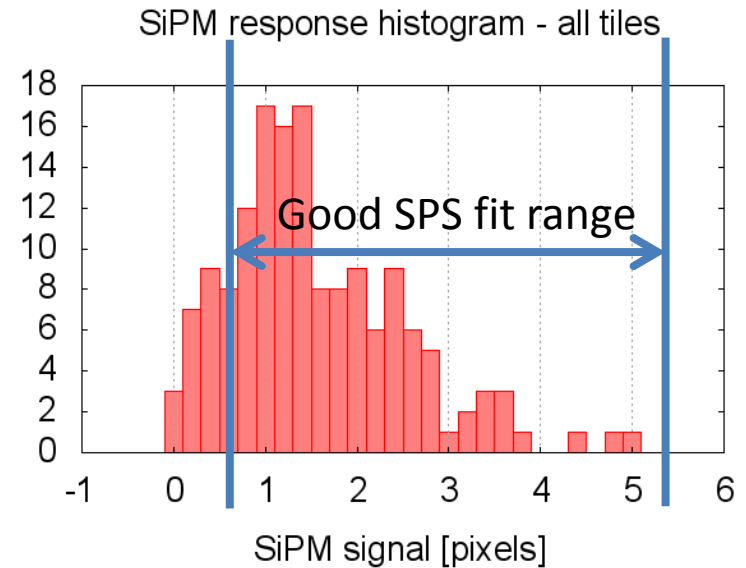
Notched Fiber triplet

- “Glued” manually by a TESA stickers
 - Good for testing
 - Not suitable for the mass production (it took few hours to install and de-install the fibers)
- Why 3 fibers with 24 notches instead of 1 fiber with 72 notches?
 - 24 notches can be produced with better precision
 - The manufacturer has a semi-automatic machine for 24-notched fibers
 - The light output from the 3mm LED couples well into 3 fibers → 3 times more light in total
 - Due to the light profile of the LED
 - Reminder: we have a single 72-notched fiber prototype with spread <25% made by hand



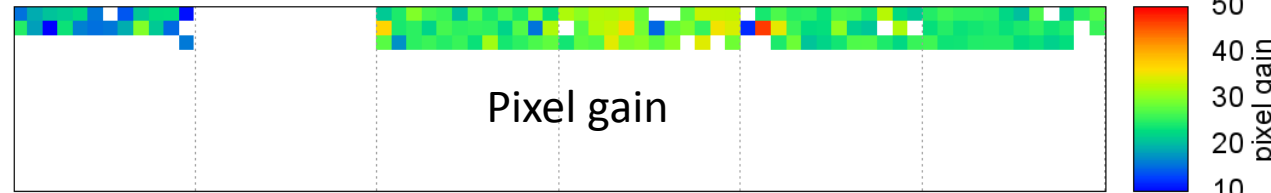
Results

- 153 “good” tiles (90.5% of assembled tiles)
 - “good” means visible SPS (Single Pixel Spectra)
- Gain successfully extracted from SPS, good fit with signal within 0.5–5 pixels range (noise-free channels even larger signal)
- Gain extraction successful for 92% of the *good* tiles **within a single run**
- Some channels need more light (especially tiles without holes in the PCB for the fiber)

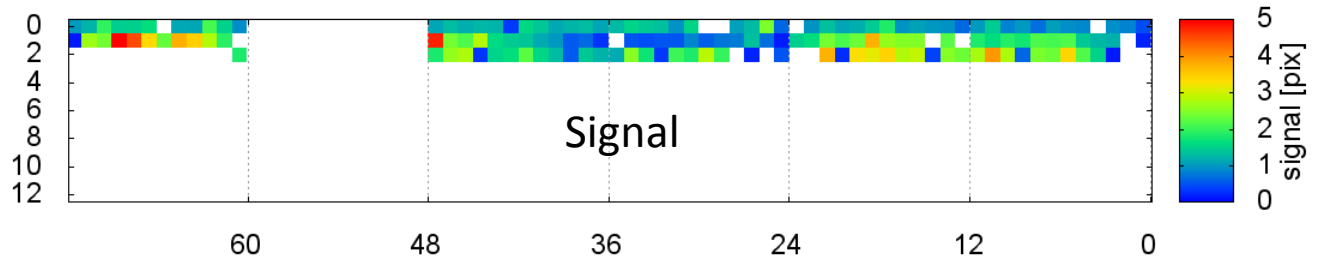


One of the good SPS

Pixel gain in HG mode [bins per pixel]

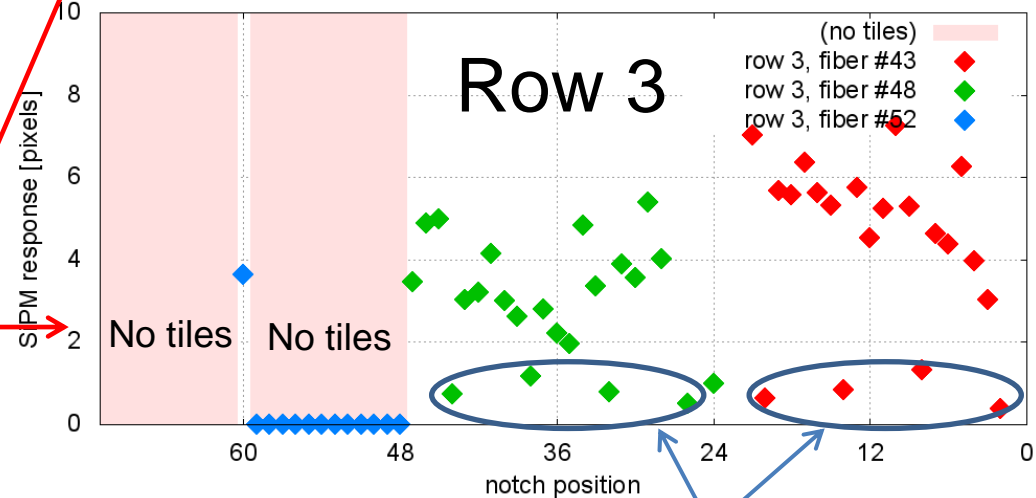
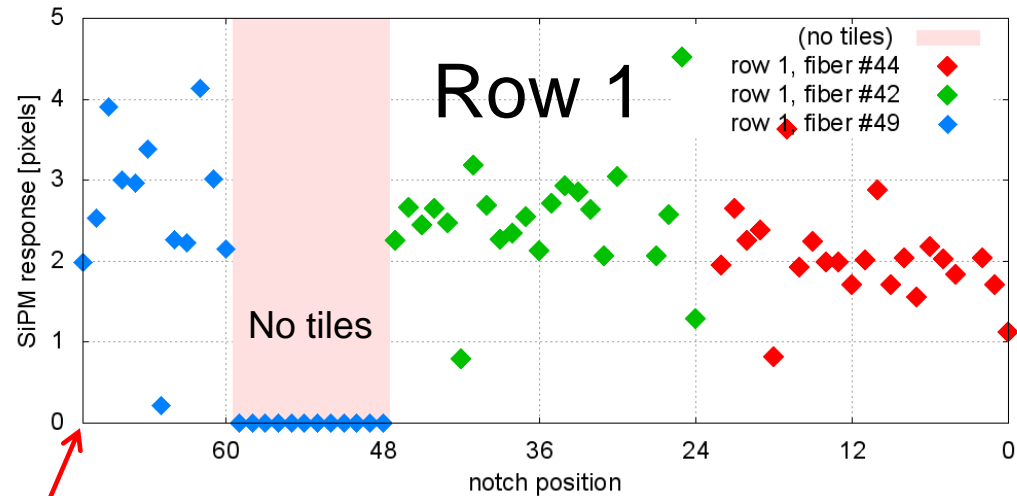
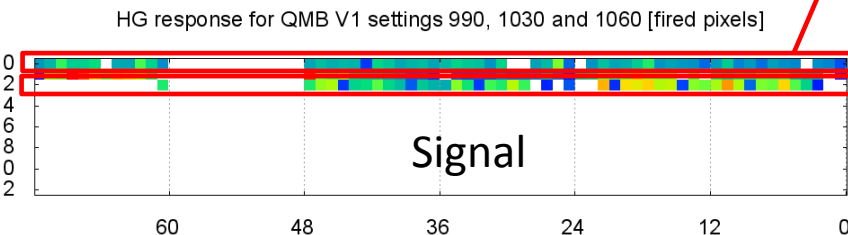


HG response for QMB V1 settings 990, 1030 and 1060 [fired pixels]



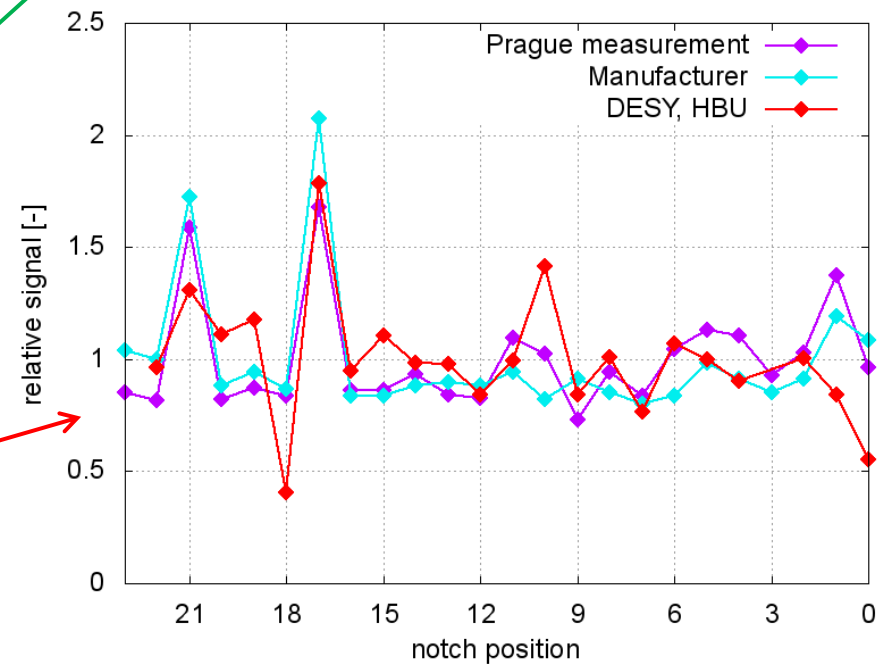
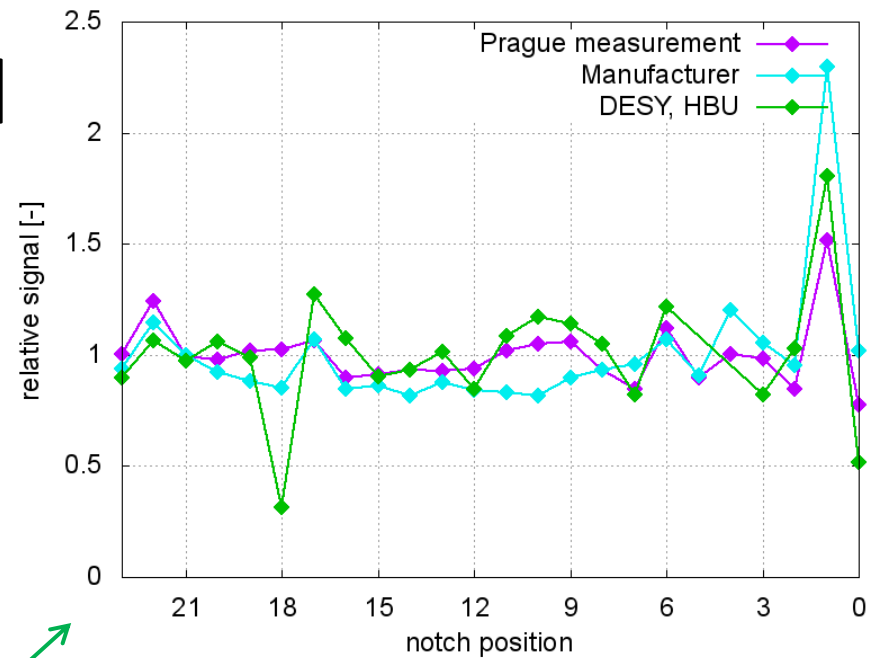
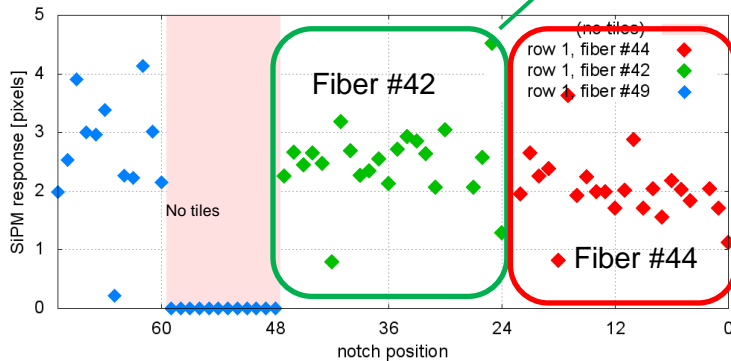
Notched fiber performance

- Spread of light registered by the SiPM is shown
- Testing fibers used, first fiber triplet prototype in our hands
- Fibers have issues with quality (personal changes at the manufacturer)
- Missing holes in the PCB (due to ASIC) clearly seen, but still got some light from reflection



Measurements compared

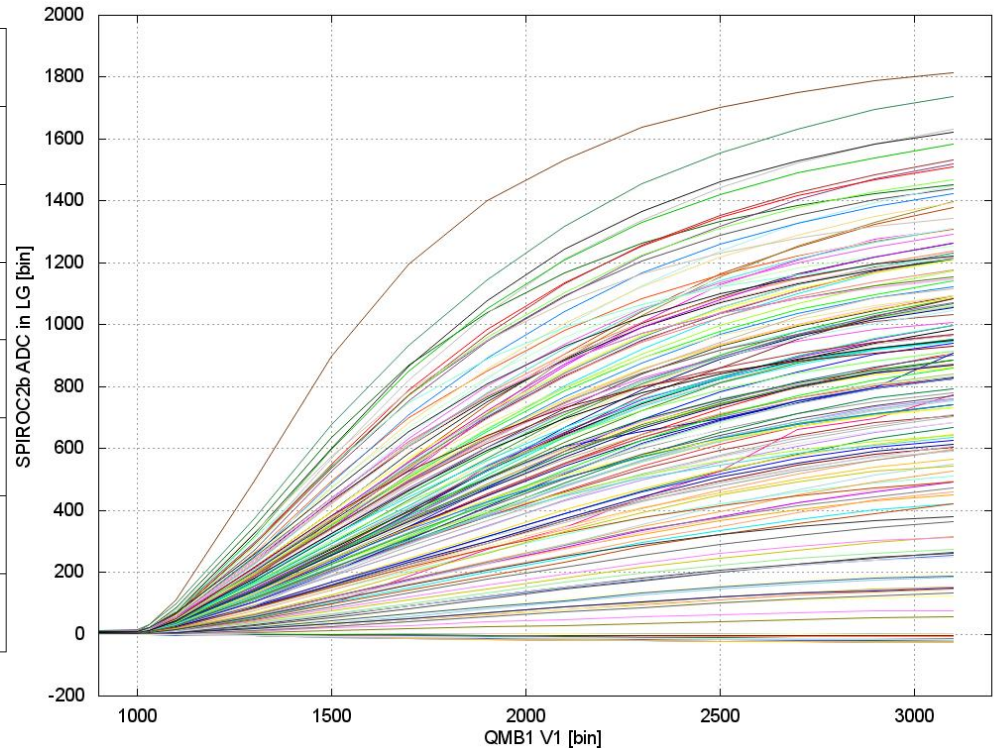
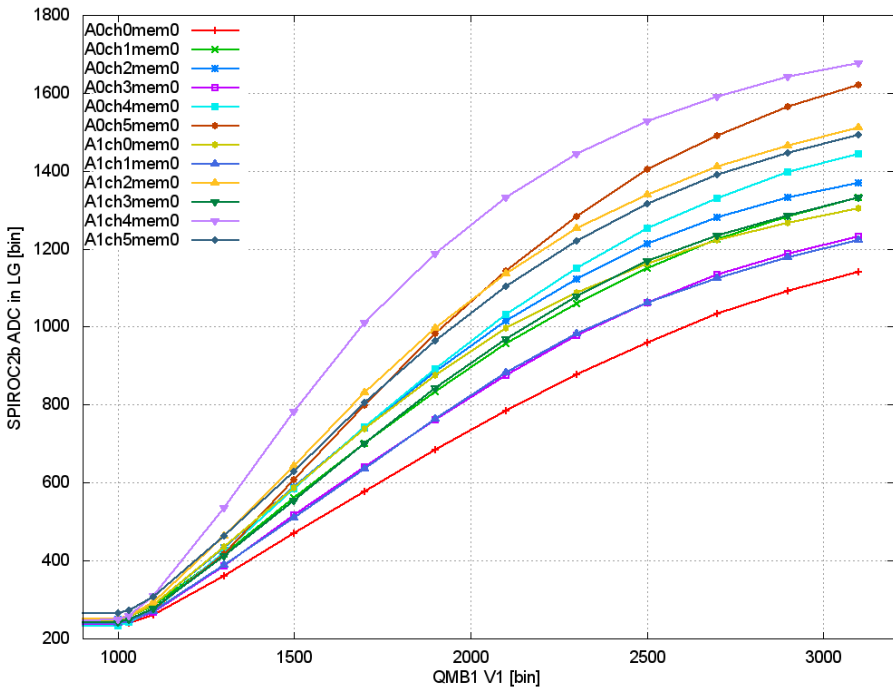
- Fibers were measured:
 - During manufacturing
 - At the institute in the Lab
 - At DESY on HBU
- We finally came to measurements agreement
- Some trouble at starting points points (systematically lower, because fiber is lifted there due to the connector)
- Some points do not match (HBU vs. LAB) for unknown reason
- For the fiber production, notches will have 15% spread limit



Results: Saturation curves

- 1st row, 1st HBU (12 channels)
- RAW Spiroc ADC data

- All 205 channels (including dead and without SPS)
- RAW Spiroc ADC data
- pedestal subtracted

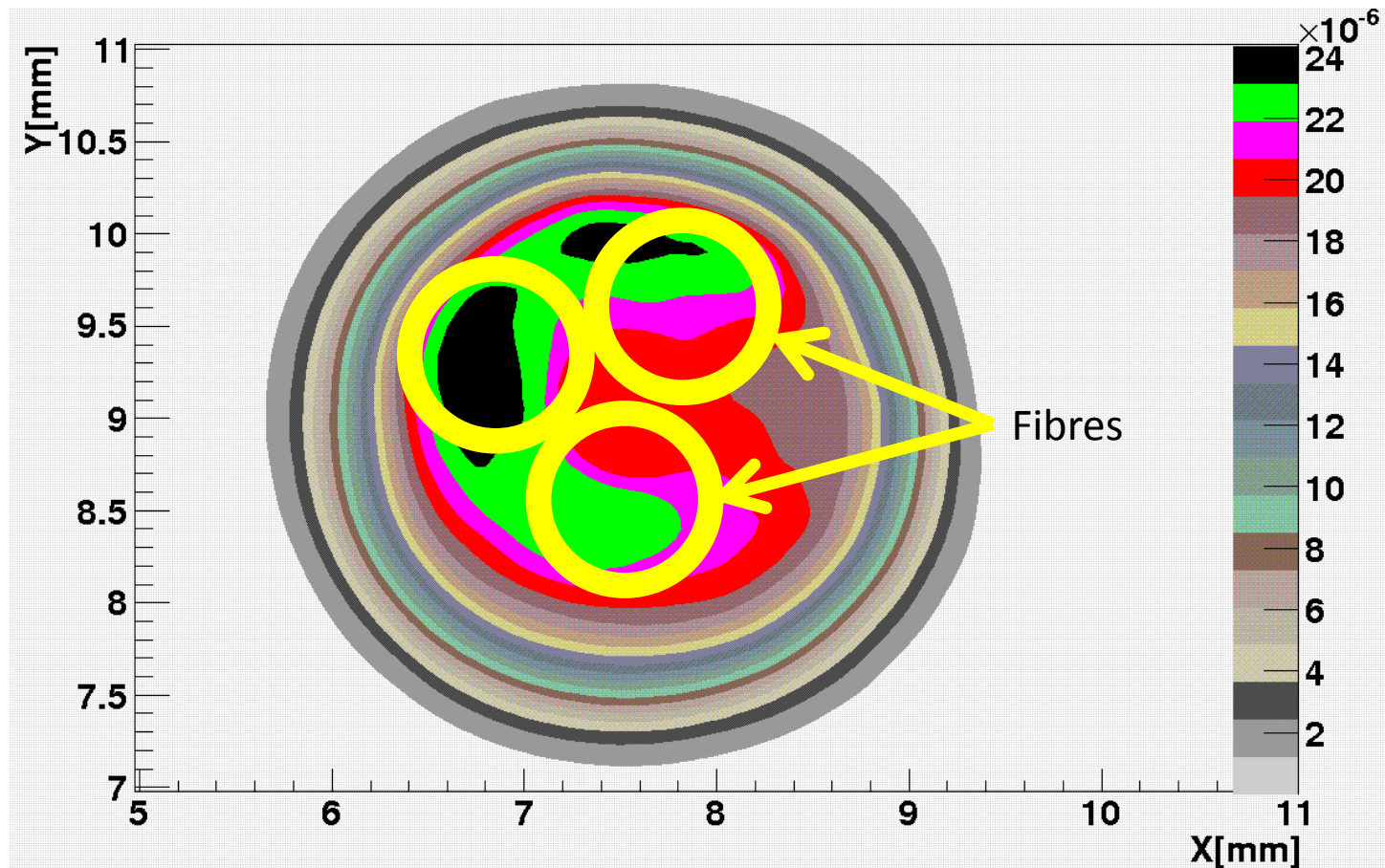


Summary

- We have tested 6 HBU setup
 - Worked smoothly and stable
- First test of full length illumination (72 tiles) by a single LED
- Beautiful Single Pixel Spectra taken
 - Gain was extracted
 - Gain extracted for 92% of tiles in a single run
 - Some channels required more light for gain extraction (no holes in PCB, fiber lifted)
- SiPM saturation seen
- Fiber to HBU attaching tuned
 - Good for tests
 - Not suitable for production – high assemble time
- New version of the LED driver produced (QMB1a)
 - Working, QA ongoing
- Fiber semi-automatic machine is ready
 - we expect fibers, that match the production quality (<15% spread) this year

Backup slides

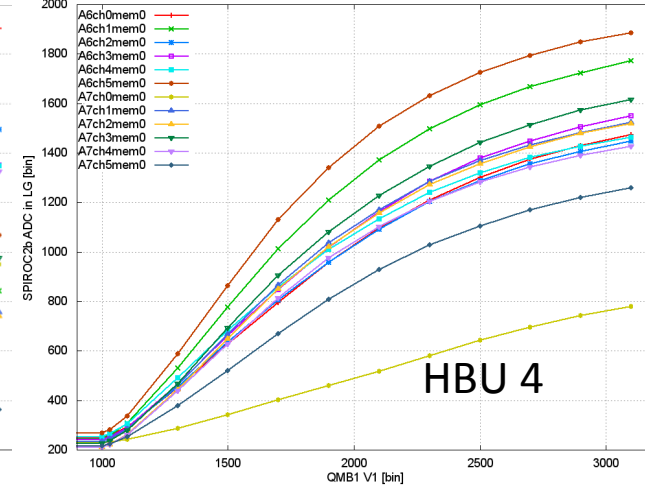
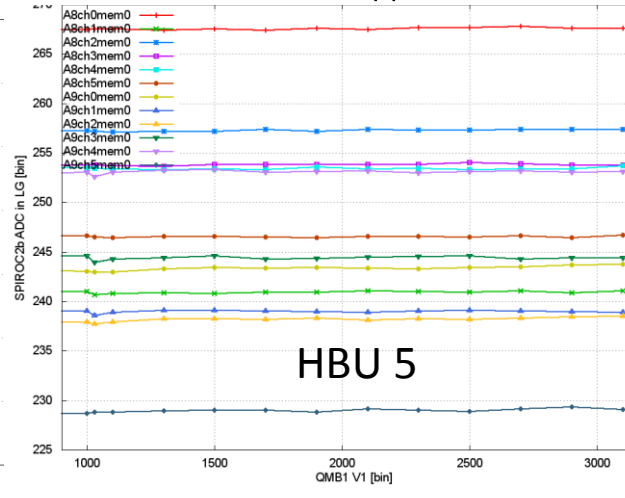
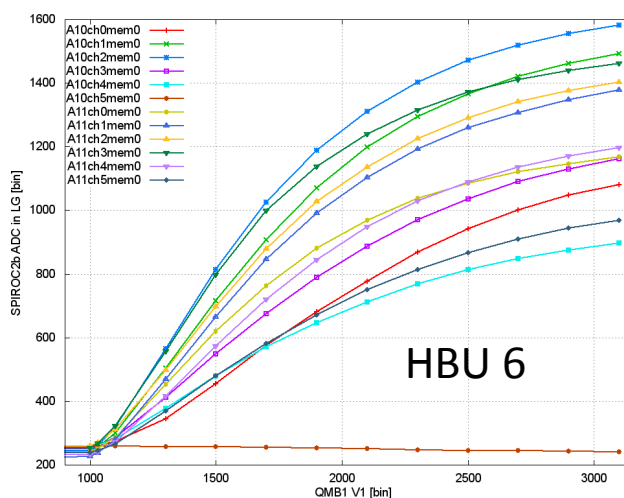
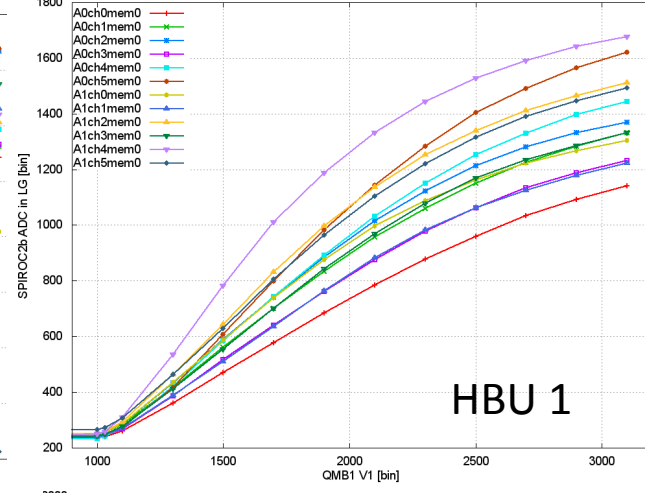
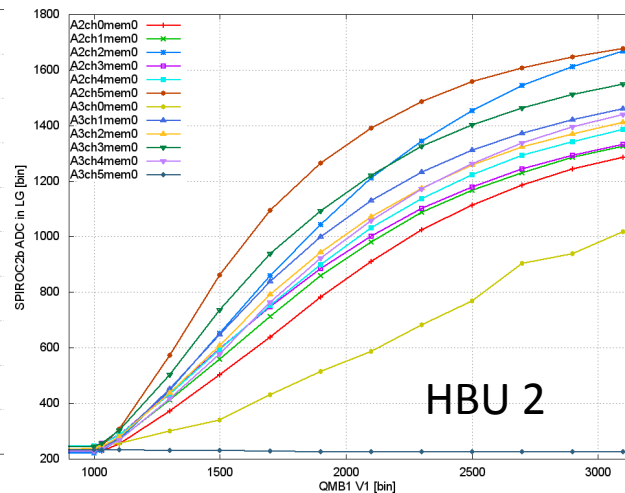
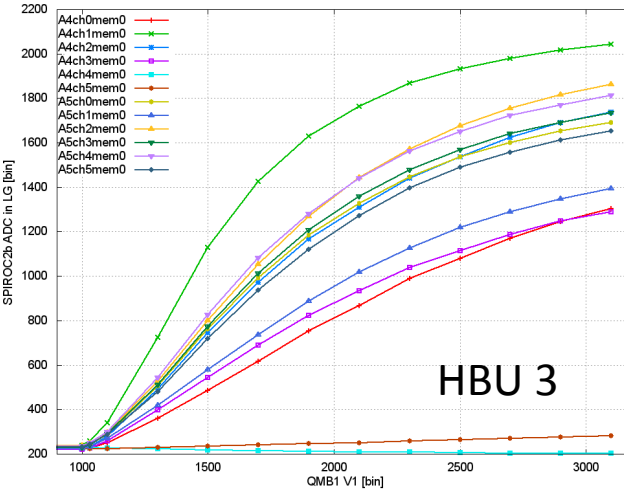
LED light output profile



TESA Kleberpads fiber holder

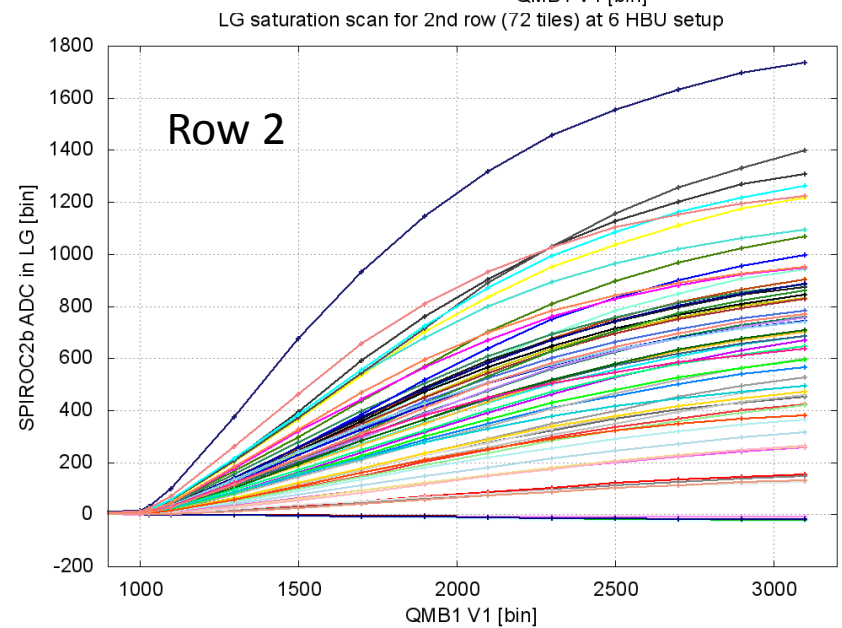
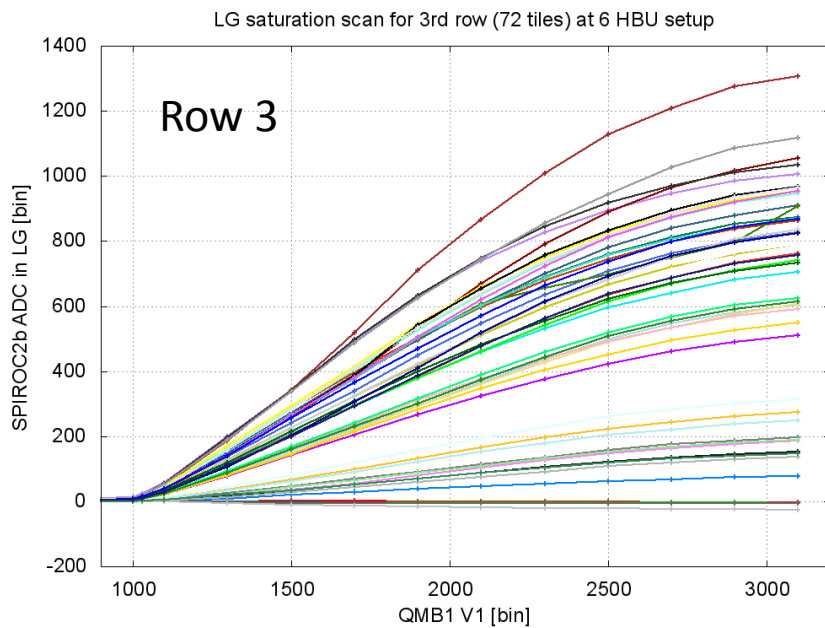
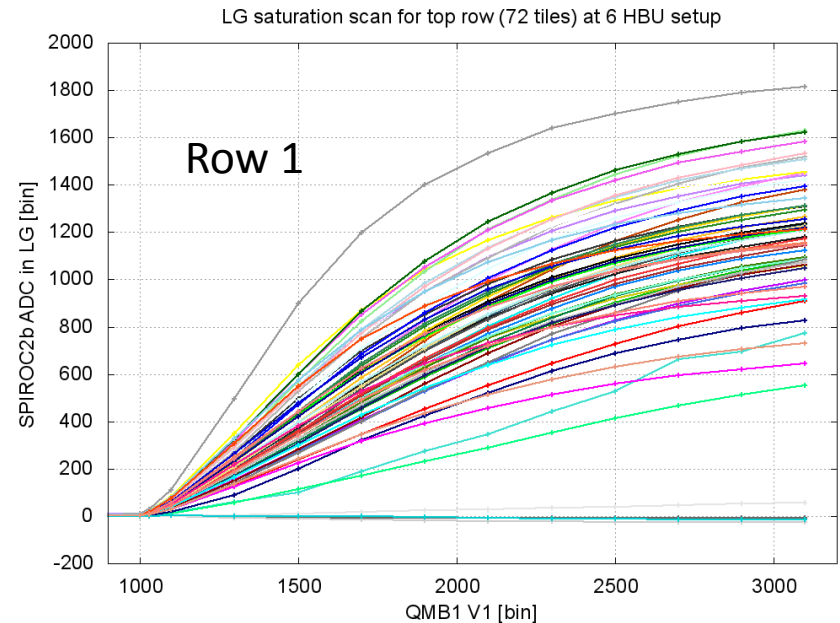


Saturation curves of row1

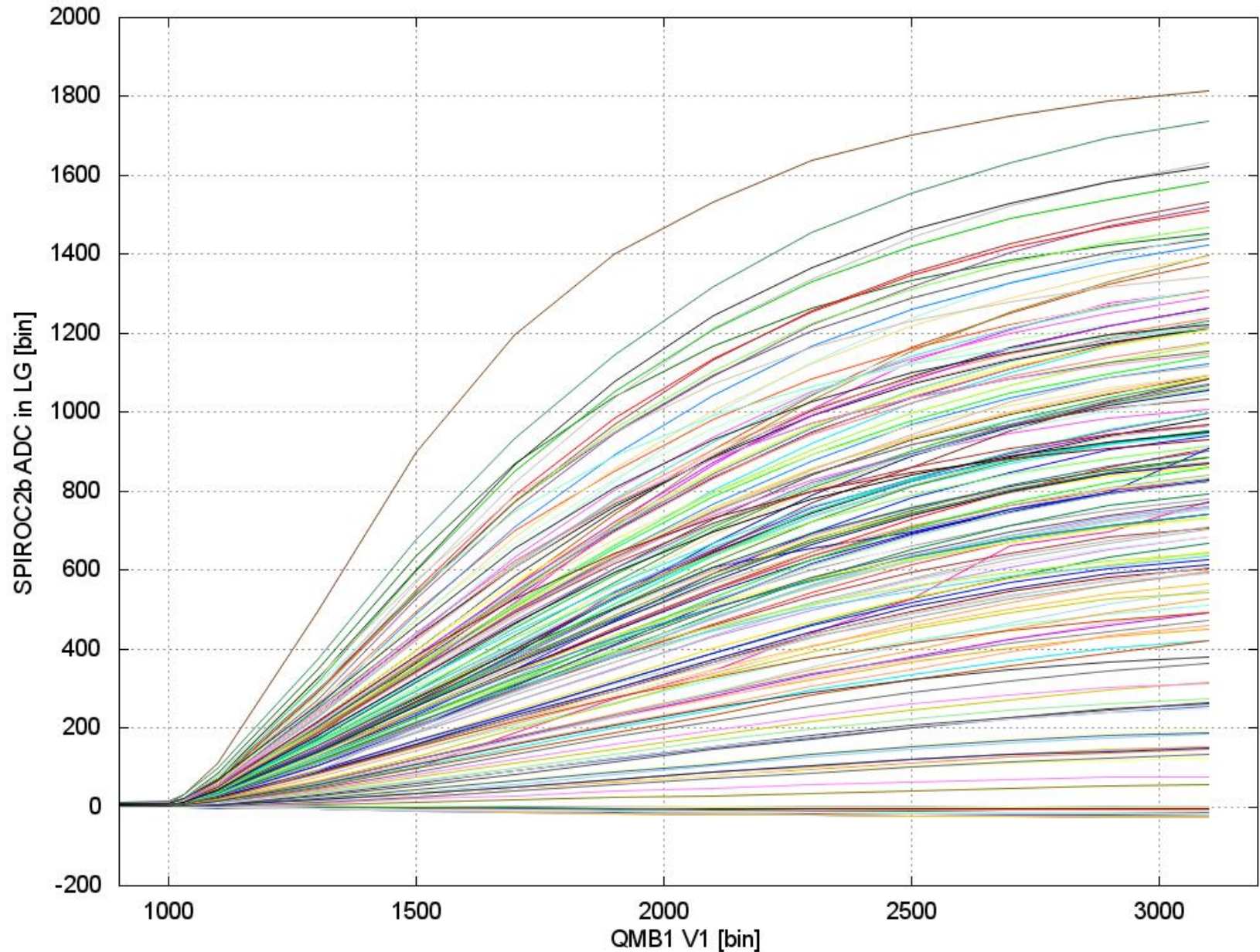


Saturation curves

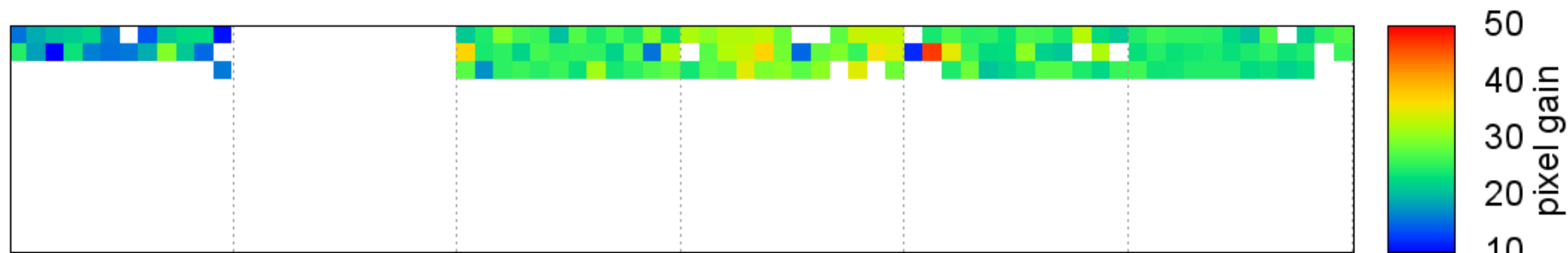
- Each row: 3 fibers



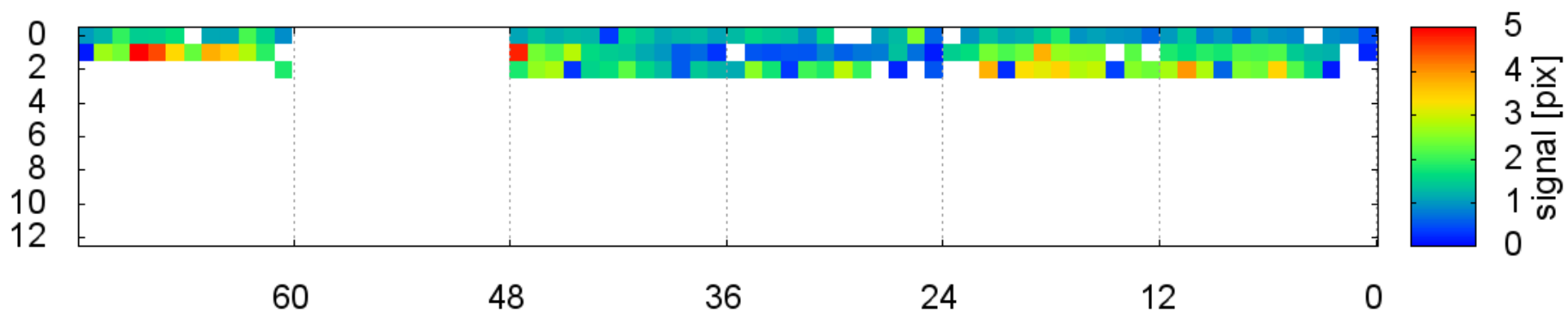
Saturation of all channels



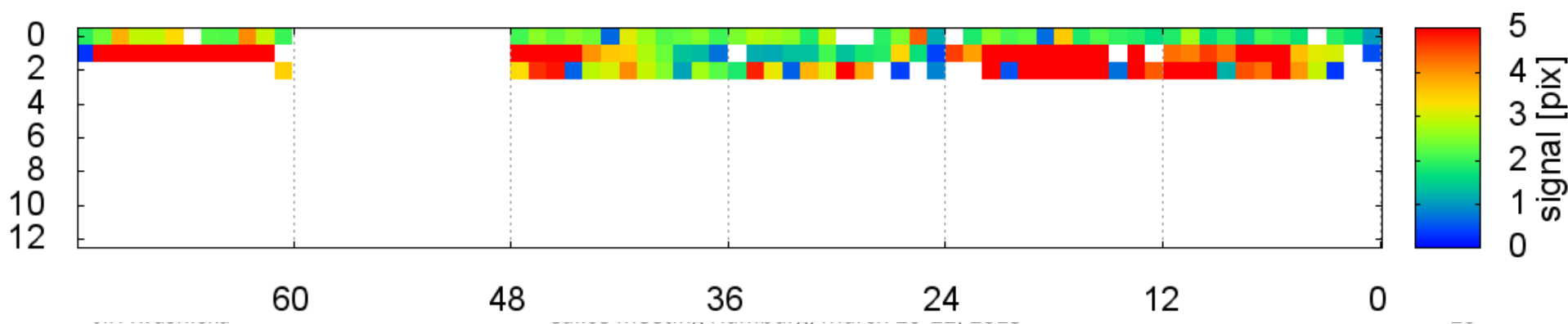
Pixel gain in HG mode [bins per pixel]



HG response for QMB V1 settings 990, 1030 and 1060 [fired pixels]

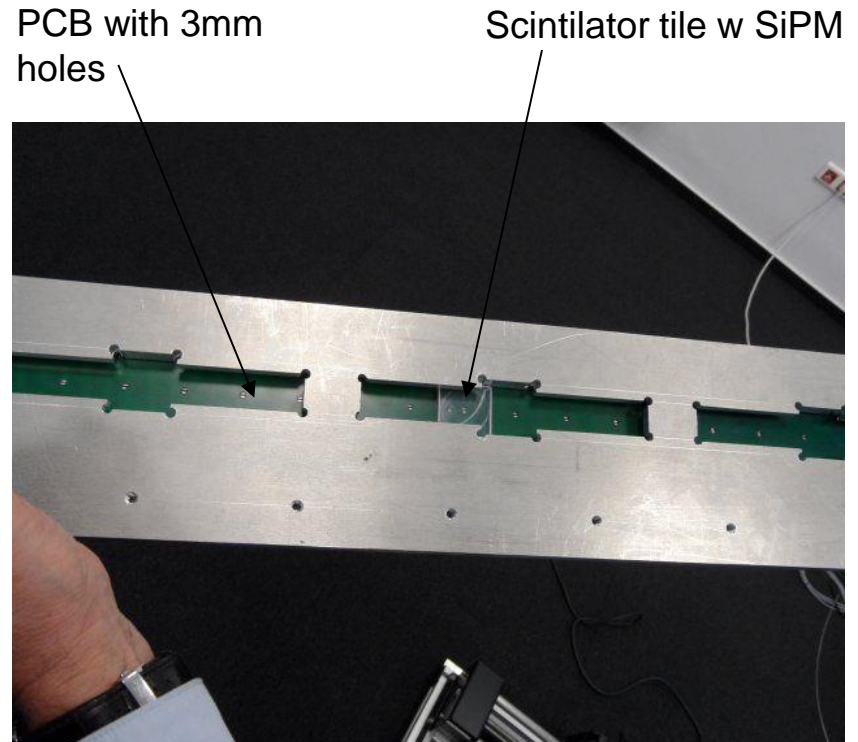
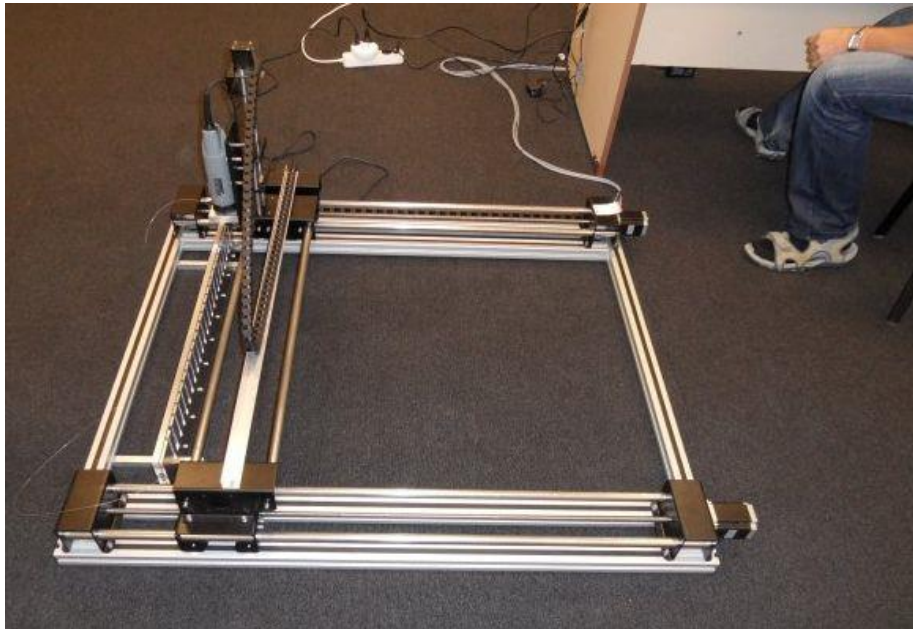


HG response for QMB V1 settings 1000, 1060 and 1080 [fired pixels]



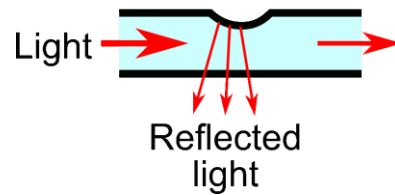
Semi-automatic drilling machine

- Frame with x-y stepper motors
- Drill machine used as milling cutter to groove the notch
- Alu/PCB Template with moving scint tile

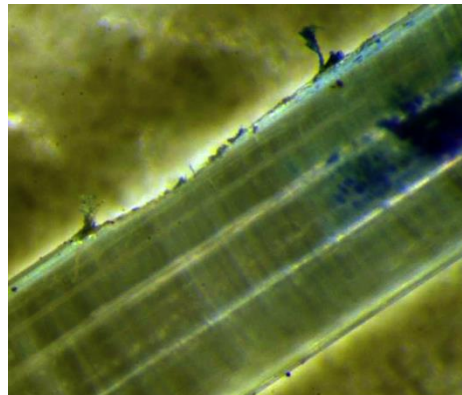


Distribution of light: Notched Fiber

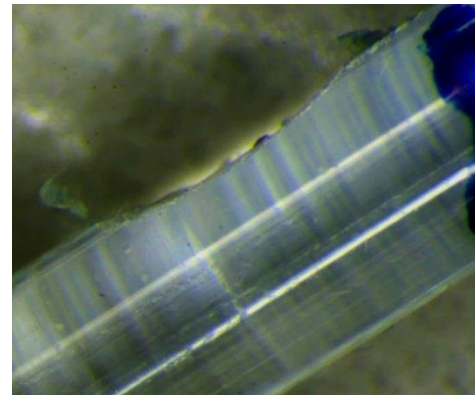
- Light is emitted from the **notches**
- The **notch** is a special scratch to the fiber, which reflects the light to the opposite direction
- The size of the notch varies from the beginning to the end of the fiber to maintain homogeneity of the light, which comes from notches



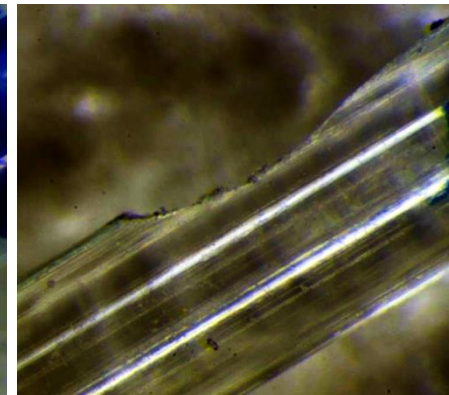
First notch



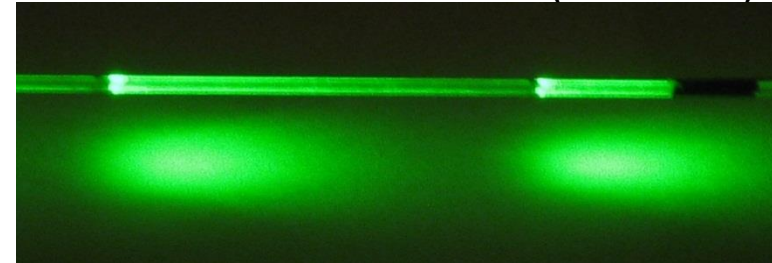
Middle notch



End position notch



Emission from the fiber (side view)



Illuminated by
Green laser

24 notches

