Optical fiber calibration system

Ivo Polák & Jiří Kvasnička

Prague, Institute of Physics ASCR

polaki@fzu.cz

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

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
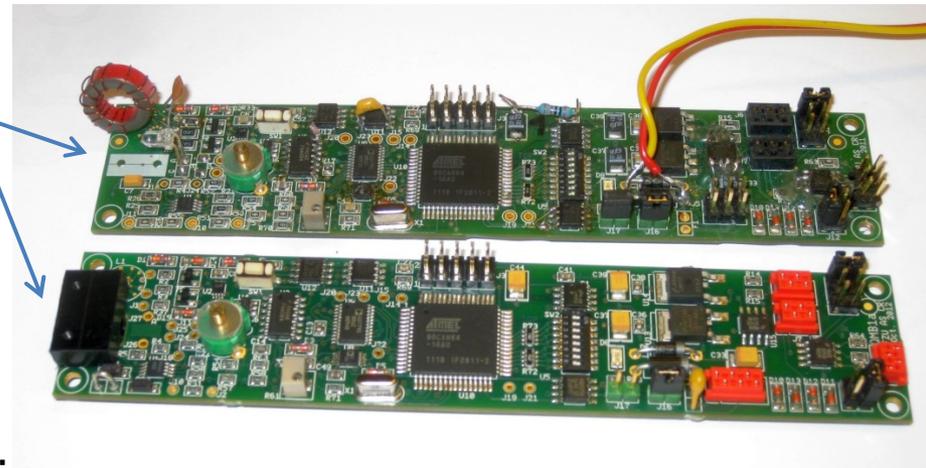
QMB1

QMB1a

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

QMB1-3
QMB1-6
QMB1-4
QMB1-3 (logscale)
QMB1-6 (logscale)
QMB1-4 (logscale)
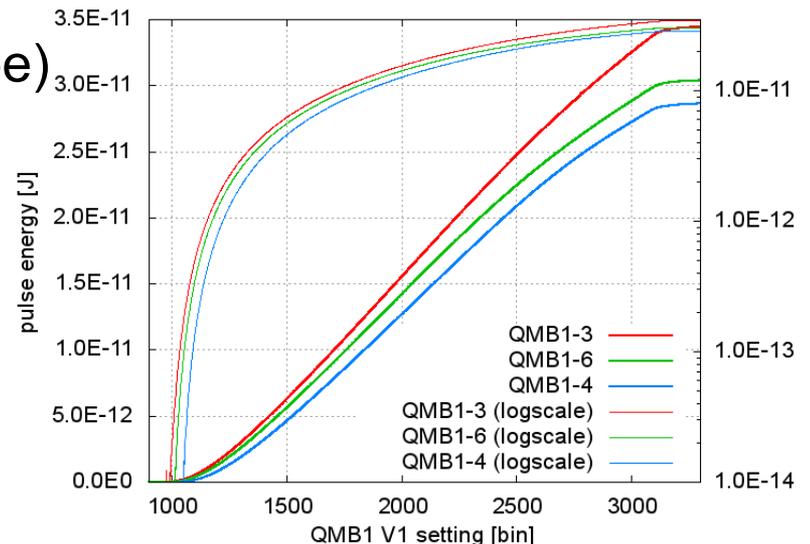
6-HBU setup – DEC 2012
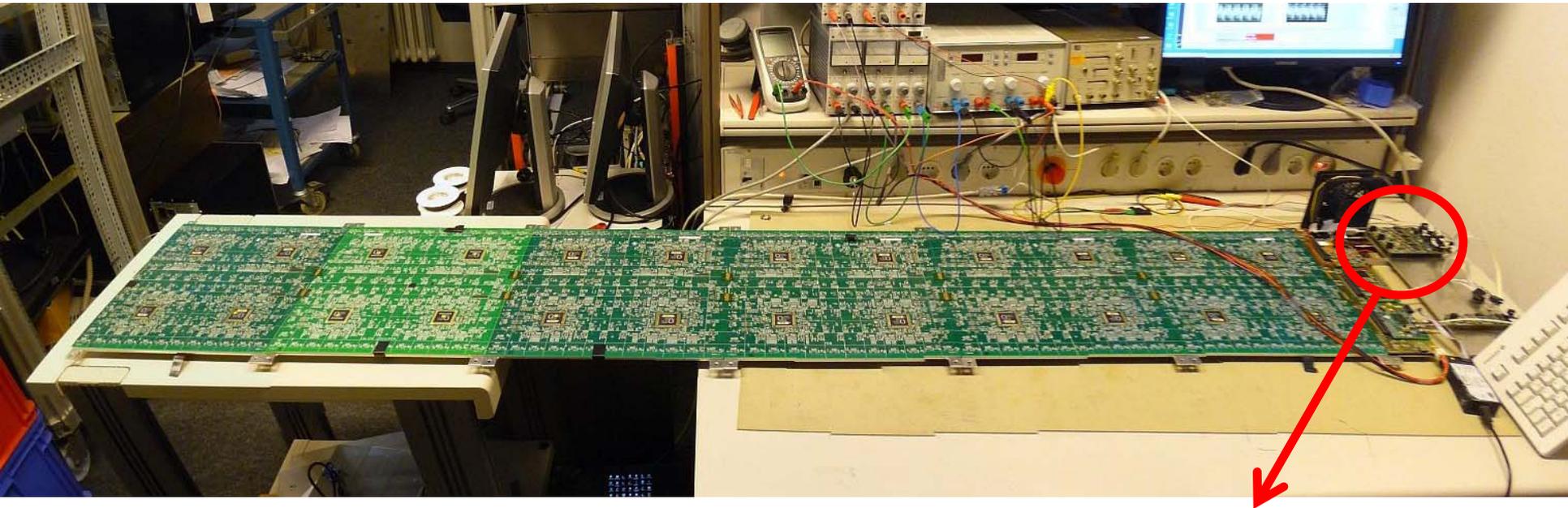
- Full setup with 6 HBU (2.2 m of electronics!)
- Data readout from all HBUs is stable
  - only 5 HBU equipped with tiles
- 3 row of tiles (3×72 tiles) illuminated by notched fibers and QMB1 LED drivers
- 1 row of tiles was illuminated by 1 QMB1 and 3 fibers (each fiber has 24 notches) → fiber triplet bundle (see next slide)
- One QMB1 LED driver per row of 72 tiles

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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
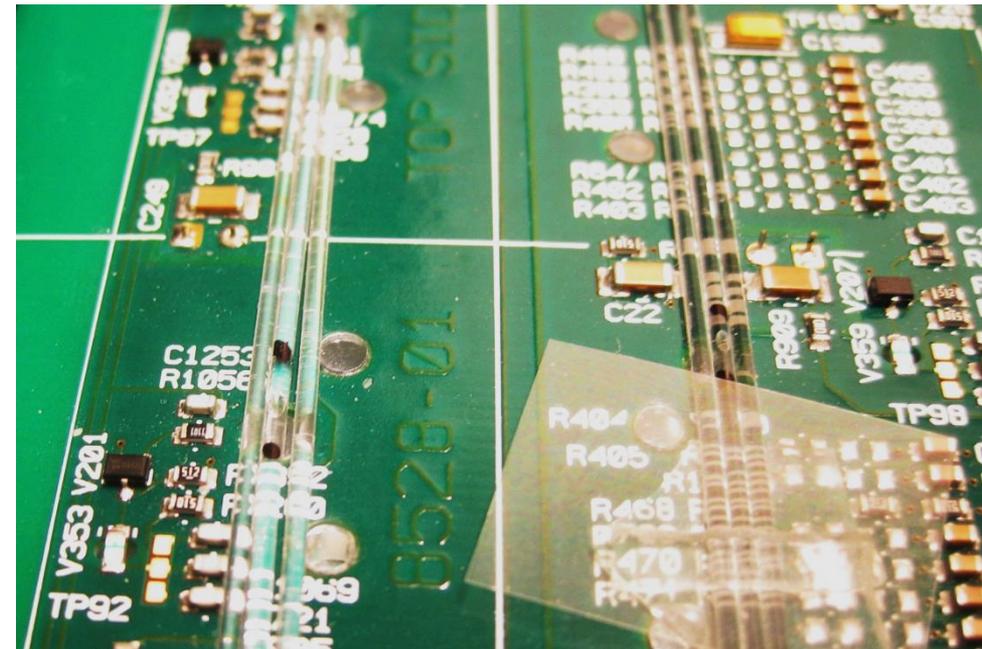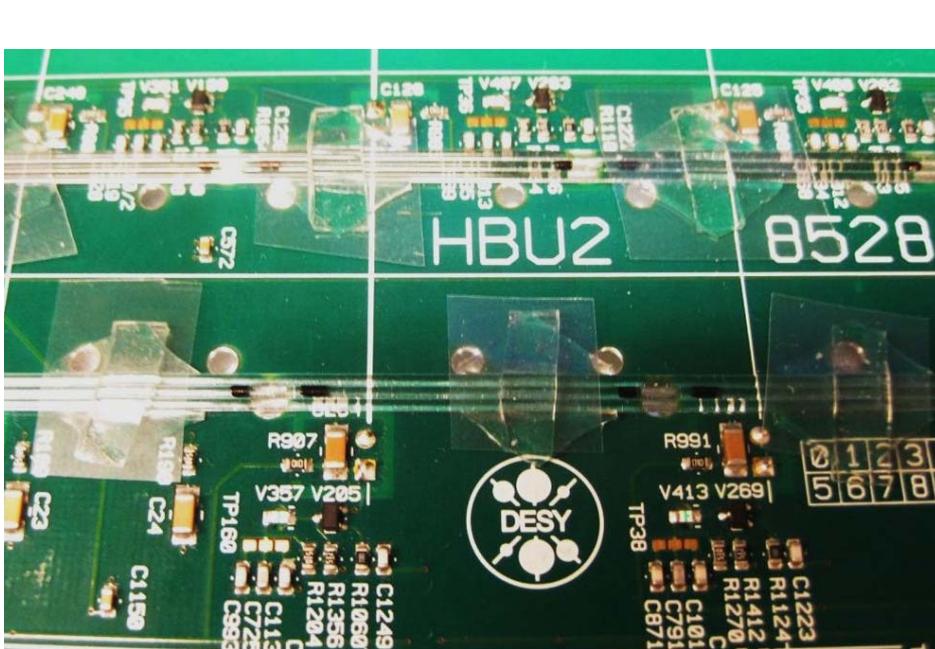
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Results

- 153 "good" tiles (90.5% of assembled tiles)
  - "good" means visible SPS (**S**ingle **P**ixel **S**pectra)
- 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)
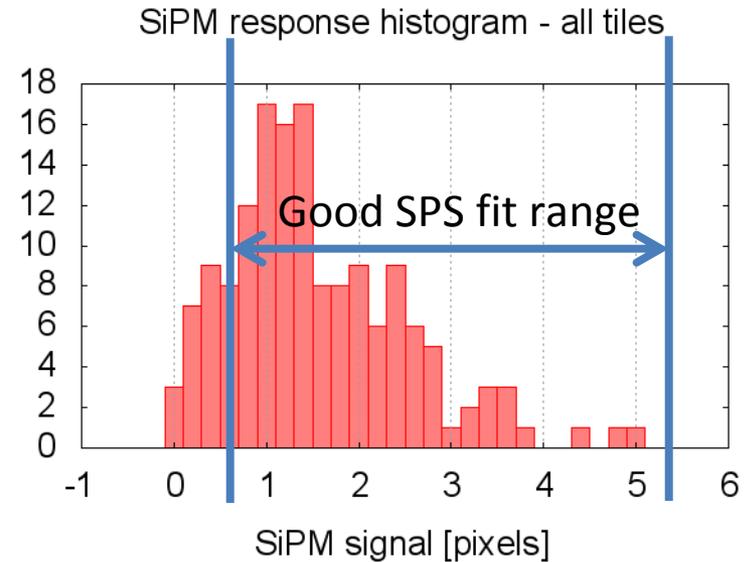
SiPM response histogram - all tiles

Good SPS fit range
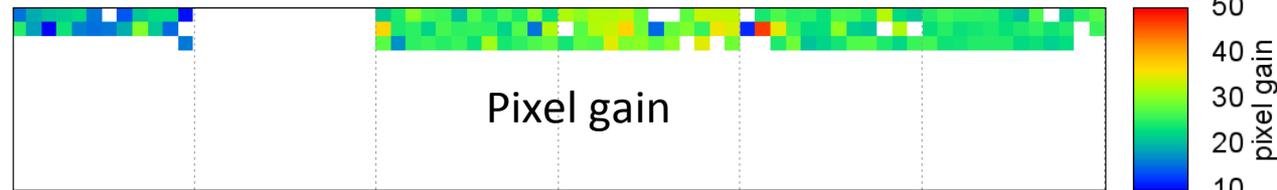
SiPM signal [pixels]

One of the good SPS

Pixel gain in HG mode [bins per pixel]

Pixel gain

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

Signal

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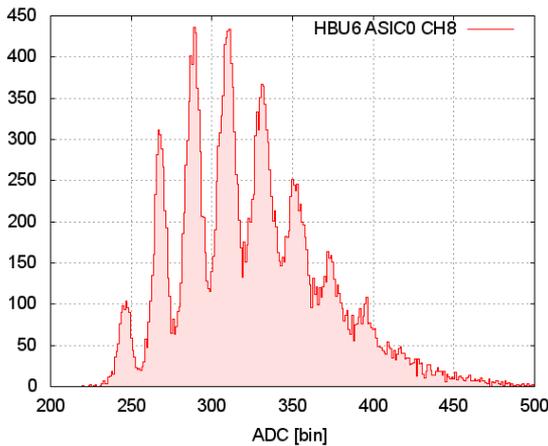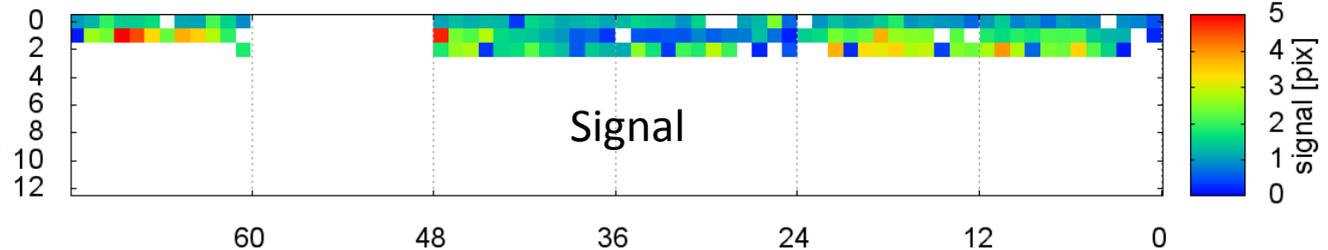
Notched fiber performance

- 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

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

Signal

Row 1

Row 3

No tiles

No holes in PCB
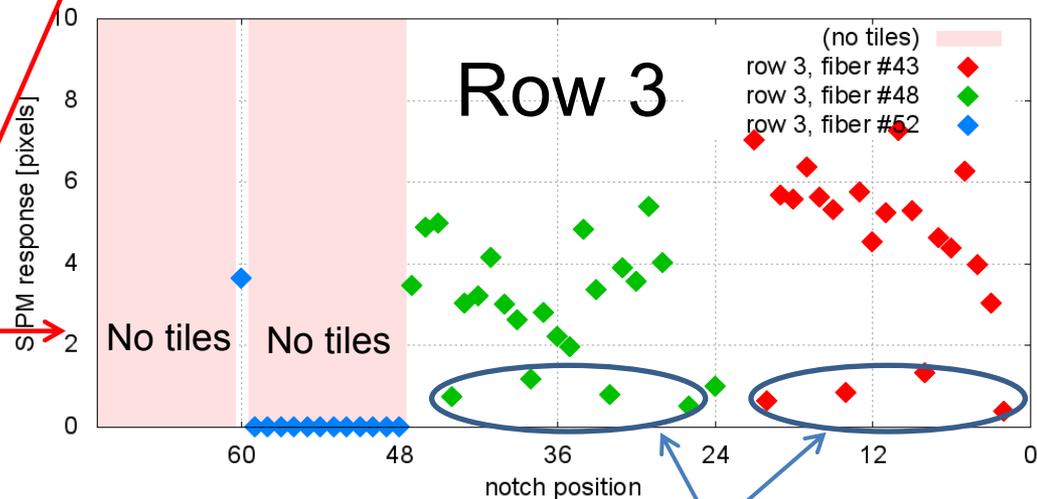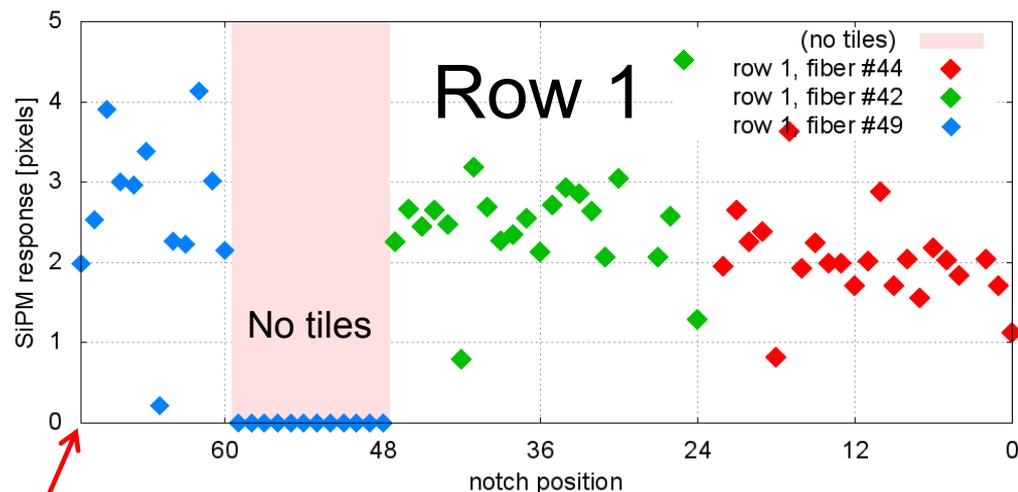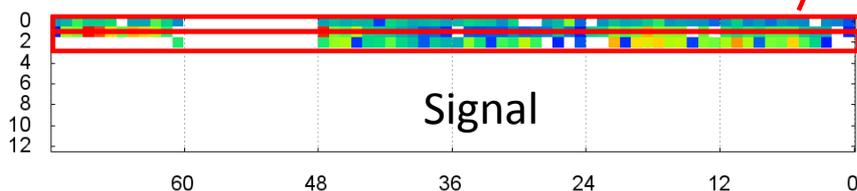
Measurements compared

- 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 (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
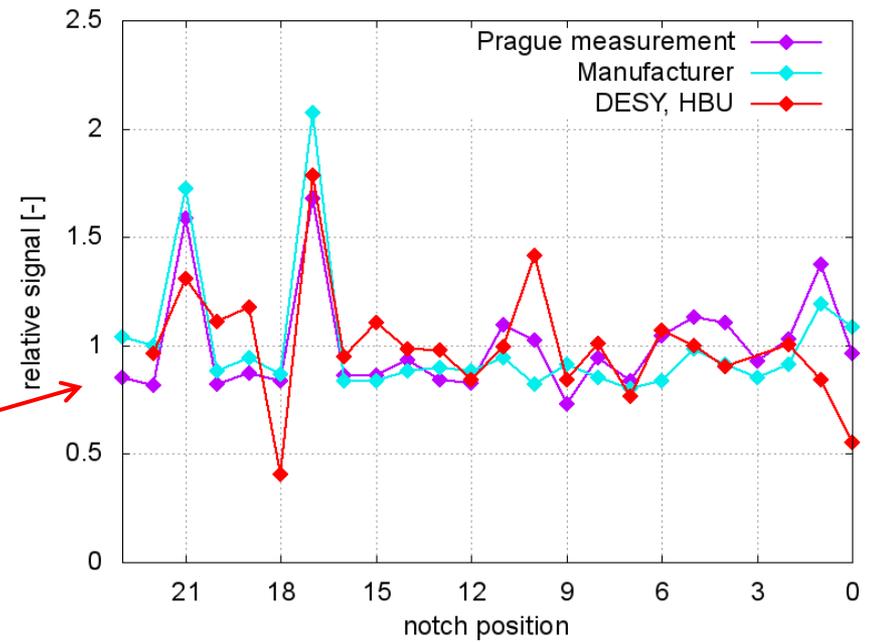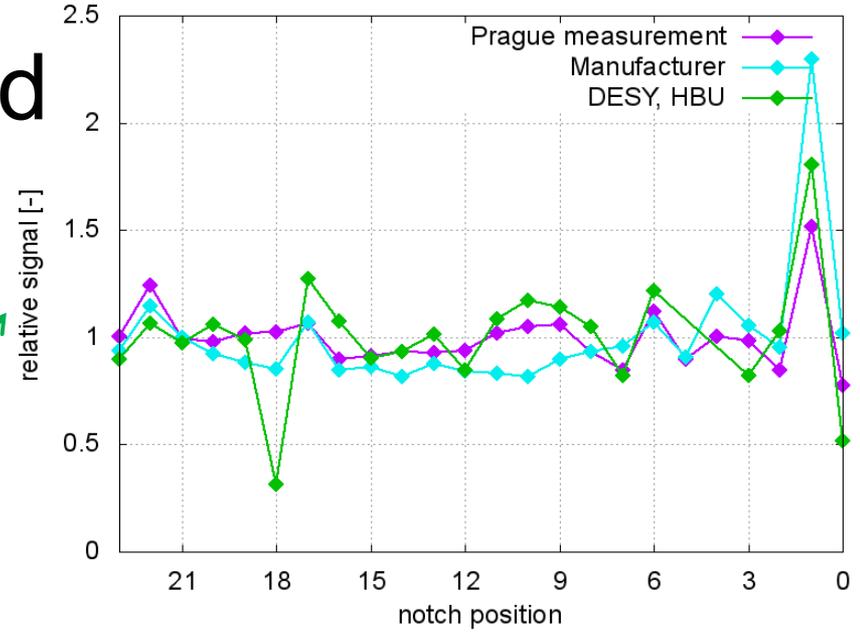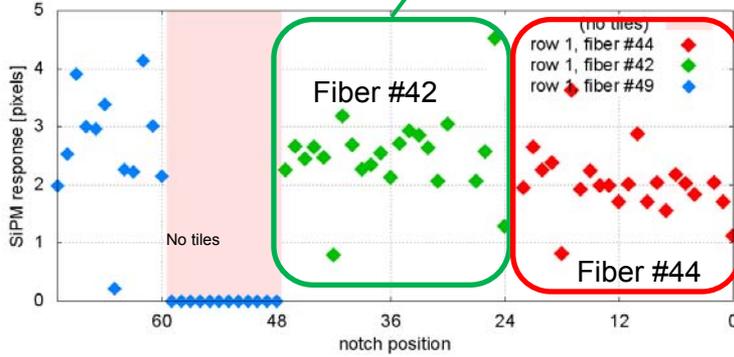
Results: Saturation curves

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

- All 205 channels (including dead and without SPS
- **RAW** Spiroc ADC **data**
- pedestal subtracted
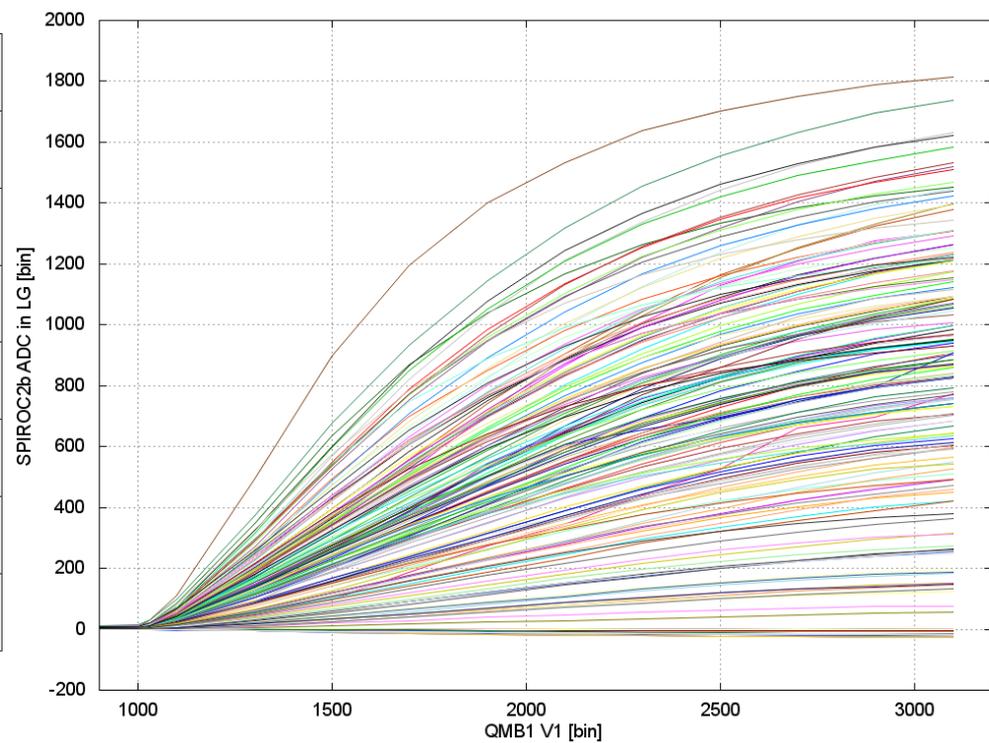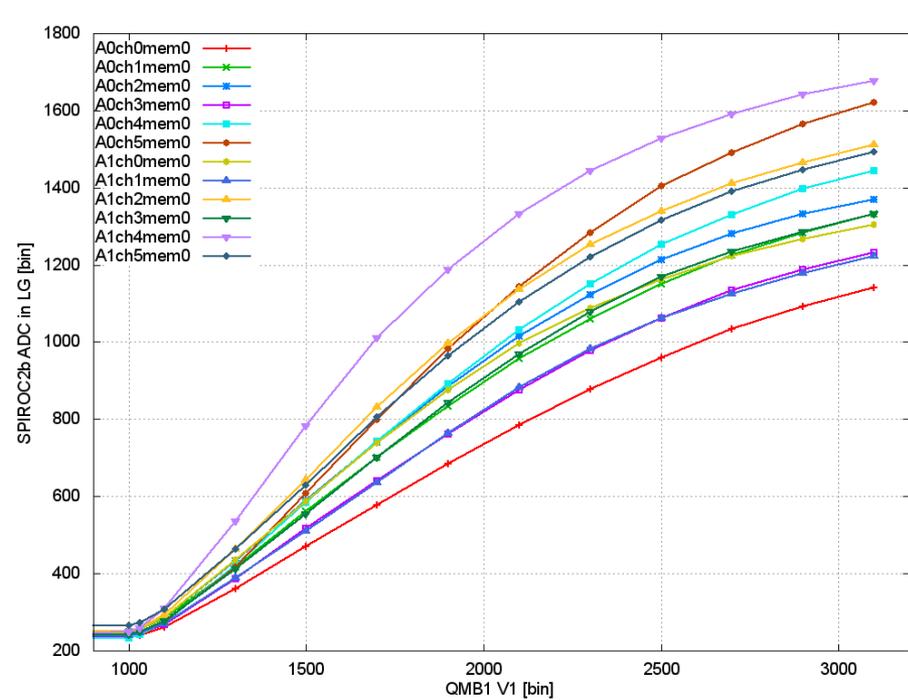
3mm UV-LED light output profile
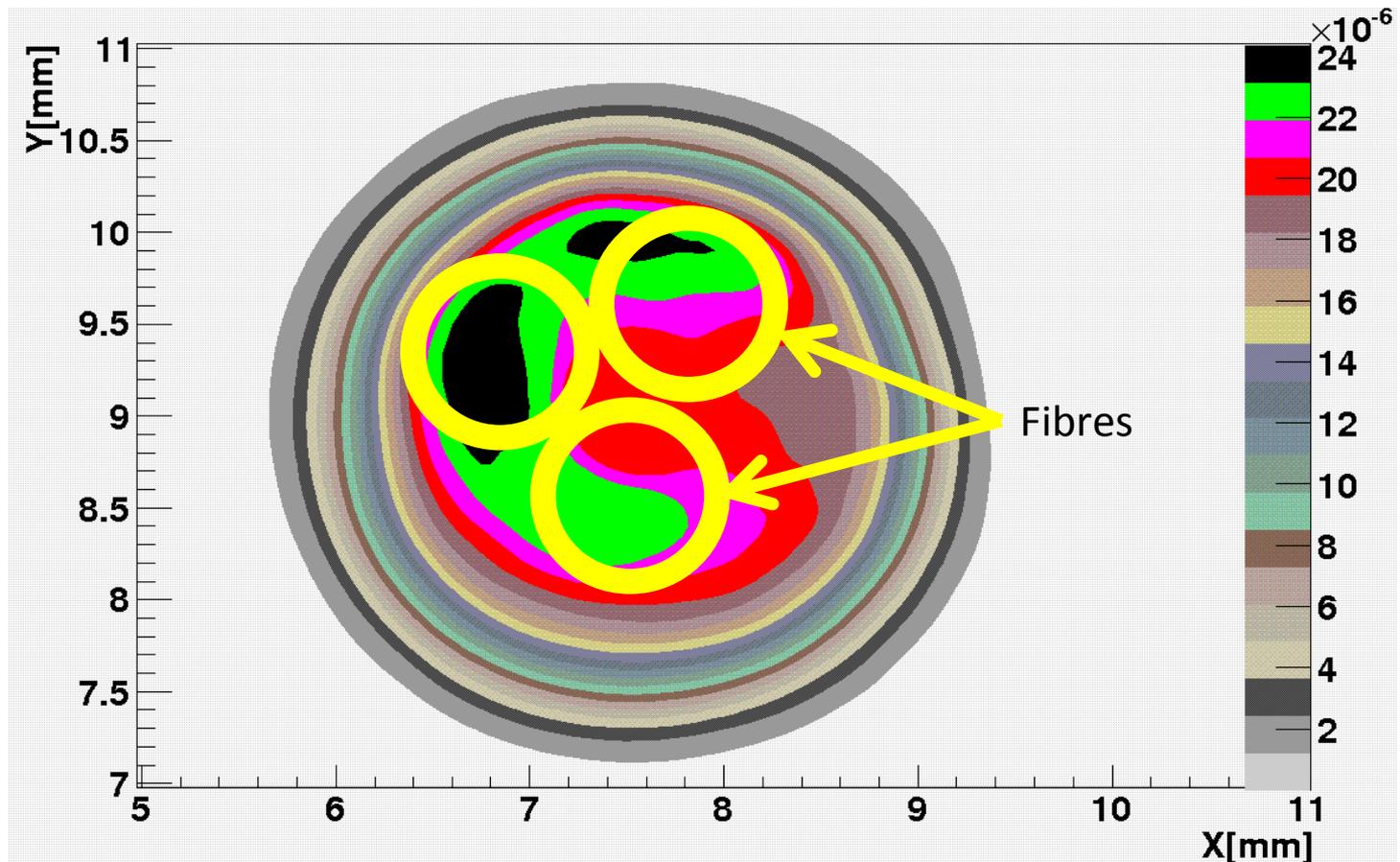
10mm BLU-LEDs distribution of VA, and capacitance

10mm UV-LED spread of Capacitance at VR

Capacitance test shows 3 different LED batches in one plastic bag?

LED #7 is not much different in VA and PWR…
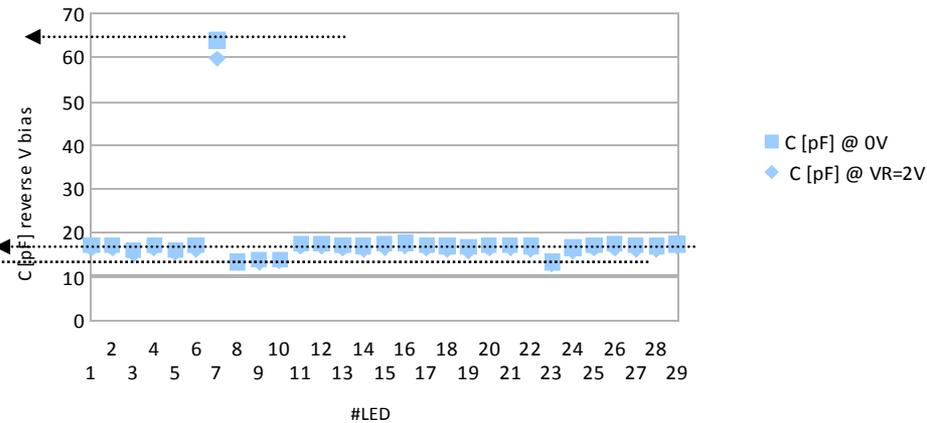
10mm UV-LED spread of VA characteristics
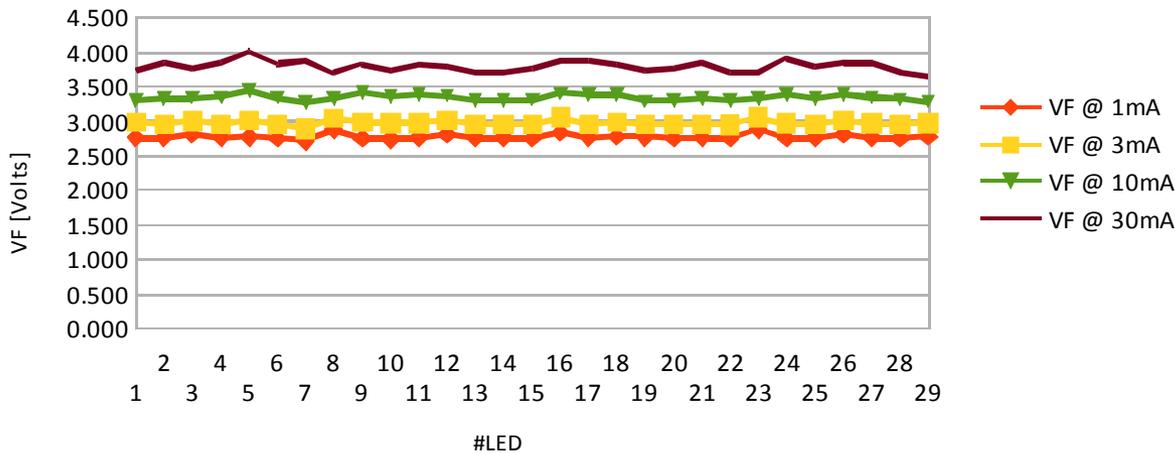
• 29 LEDs measured, primarily for Compass experiment, but results shows value of spread of LED, useful in CALICE

• VA characteristics in 4 points, measured at DC

• Used DMM Fluke 179 with max value on voltage, to suppress self-heating effect of LED

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Distribution of optical Power vs. DC current for a batch of 470nm (blue) LEDs

Good spread of LED power abt. 10%

Visible systematic decay of optical power, probably due to test method influence…

10mm UV-LED spread of Light intensity characteristics, mW
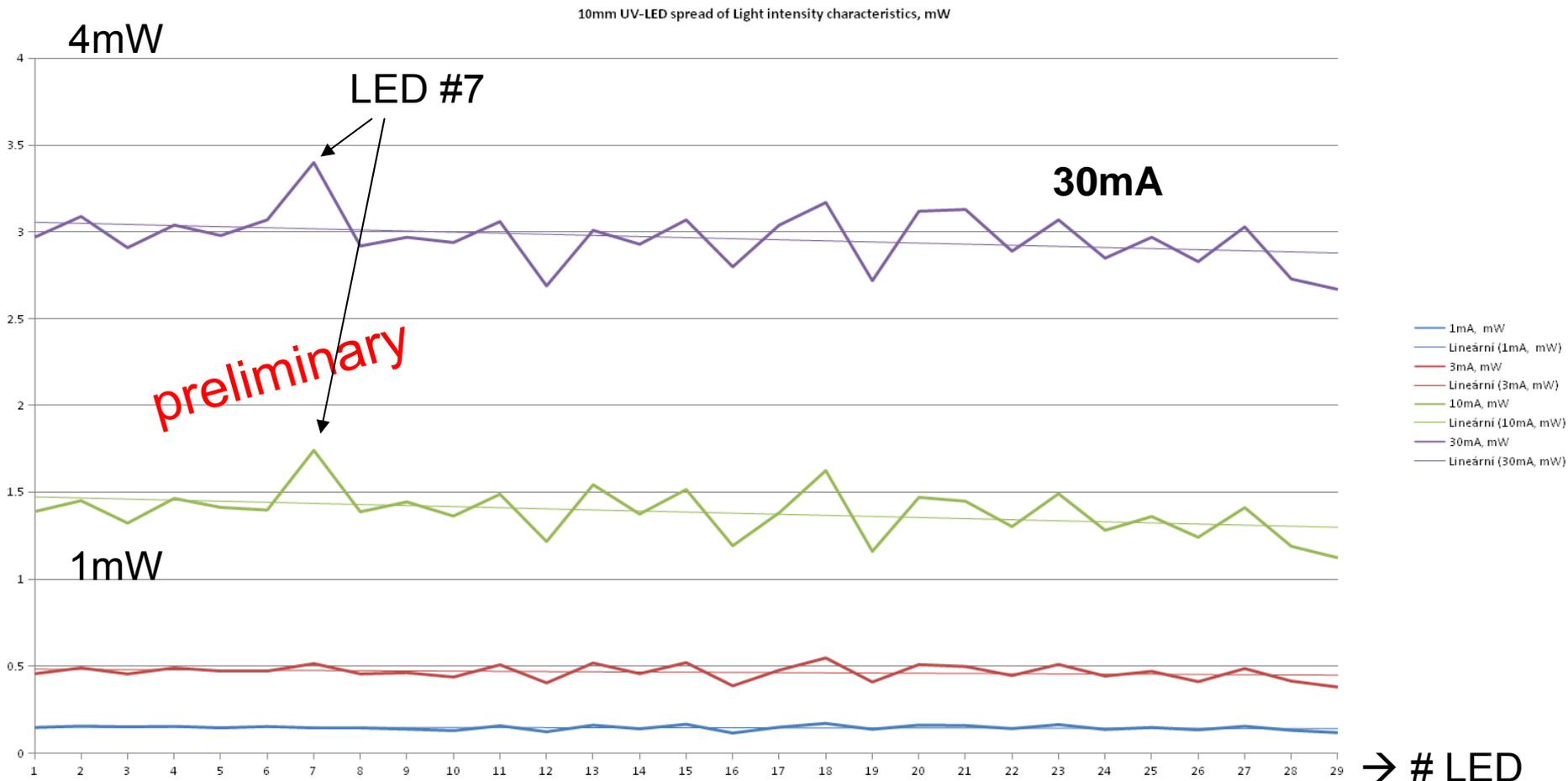
Summary

- 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 mass 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
- LEDs to be checked in some parameters
  - More test to be completed, ongoing process

Backup slides

TESA Kleberpads fiber holder

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Saturation curves of row1
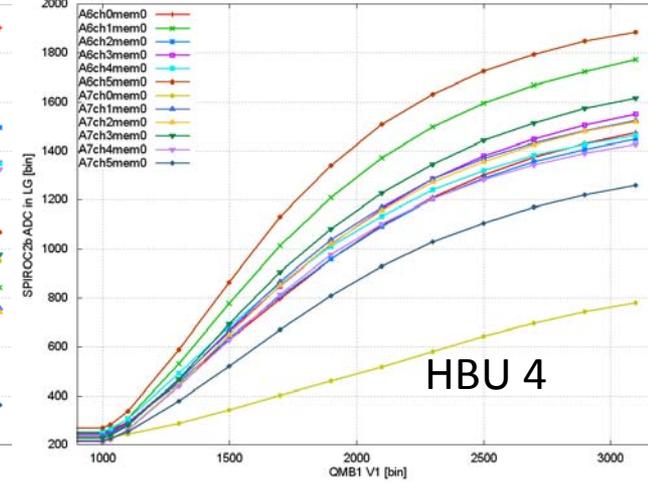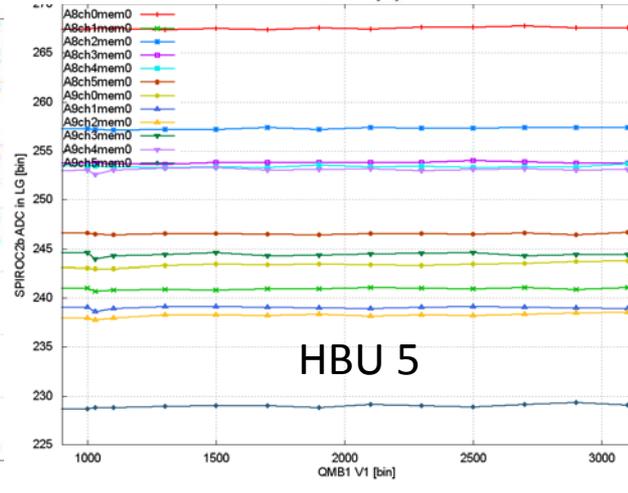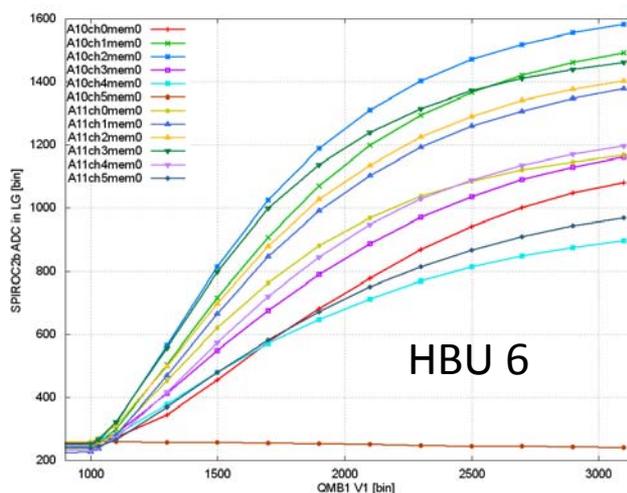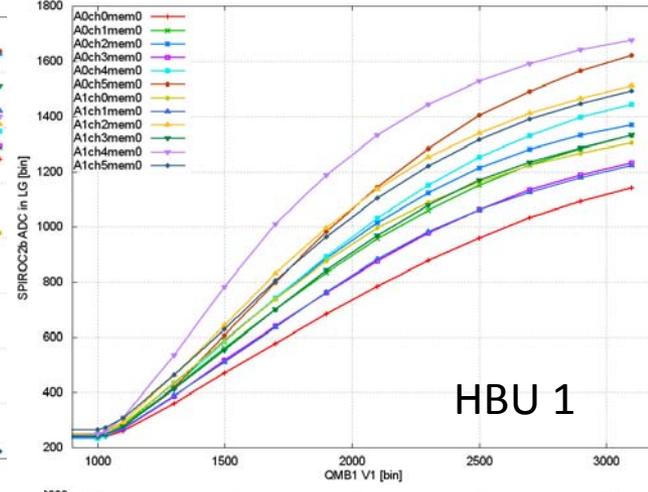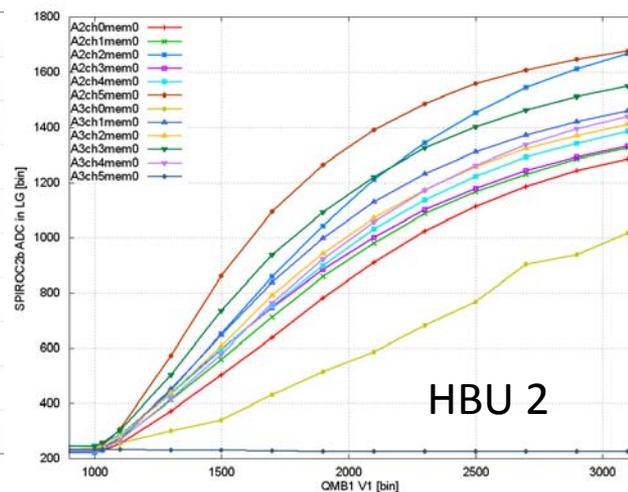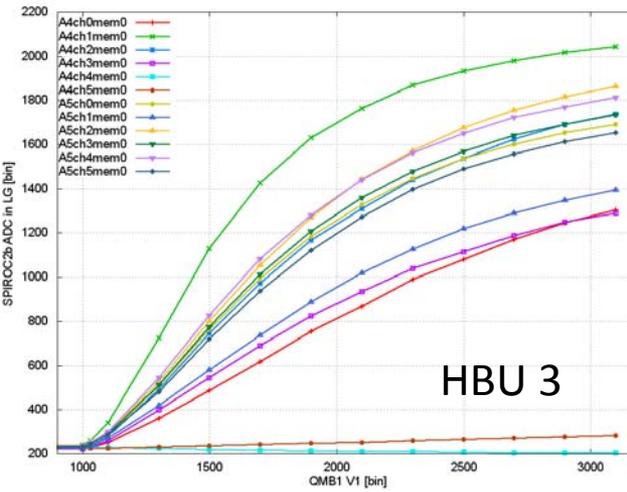
Saturation curves

- Each row: 3 fibers

LG saturation scan for top row (72 tiles) at 6 HBU setup

Row 1

LG saturation scan for 3rd row (72 tiles) at 6 HBU setup

Row 3

LG saturation scan for 2nd row (72 tiles) at 6 HBU setup

Row 2
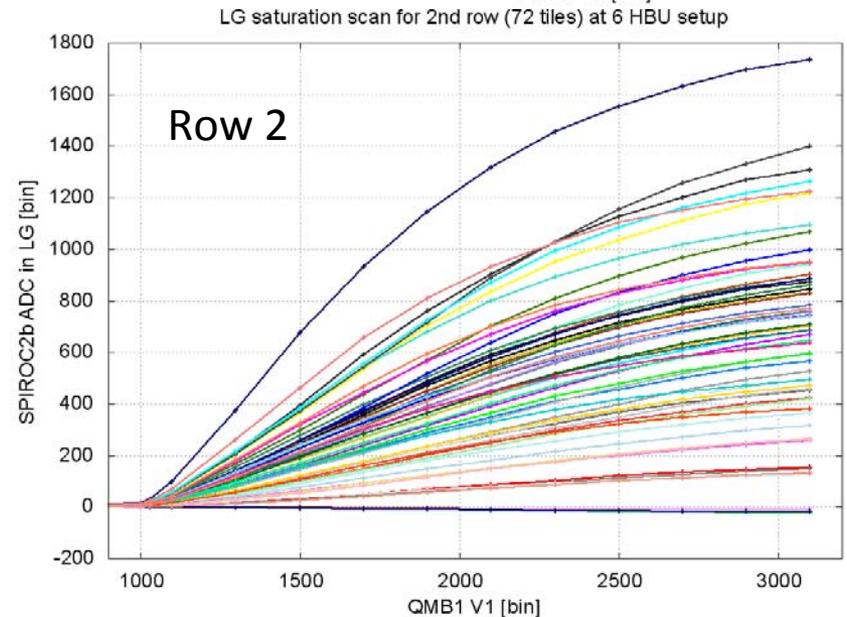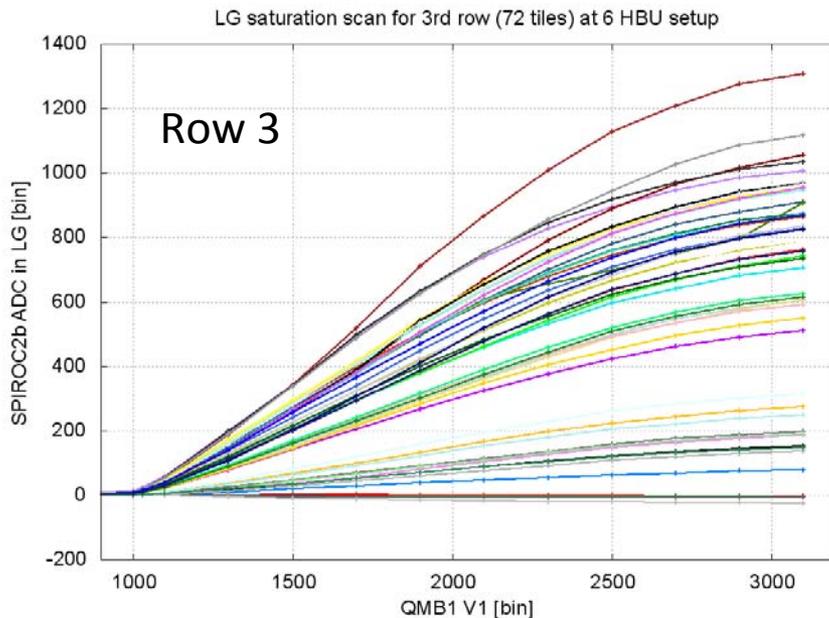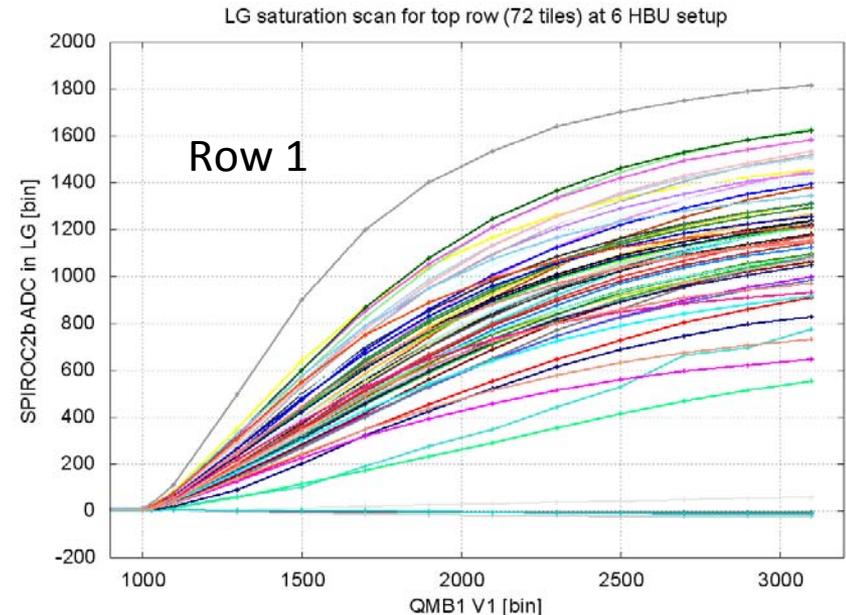
Saturation of all channels
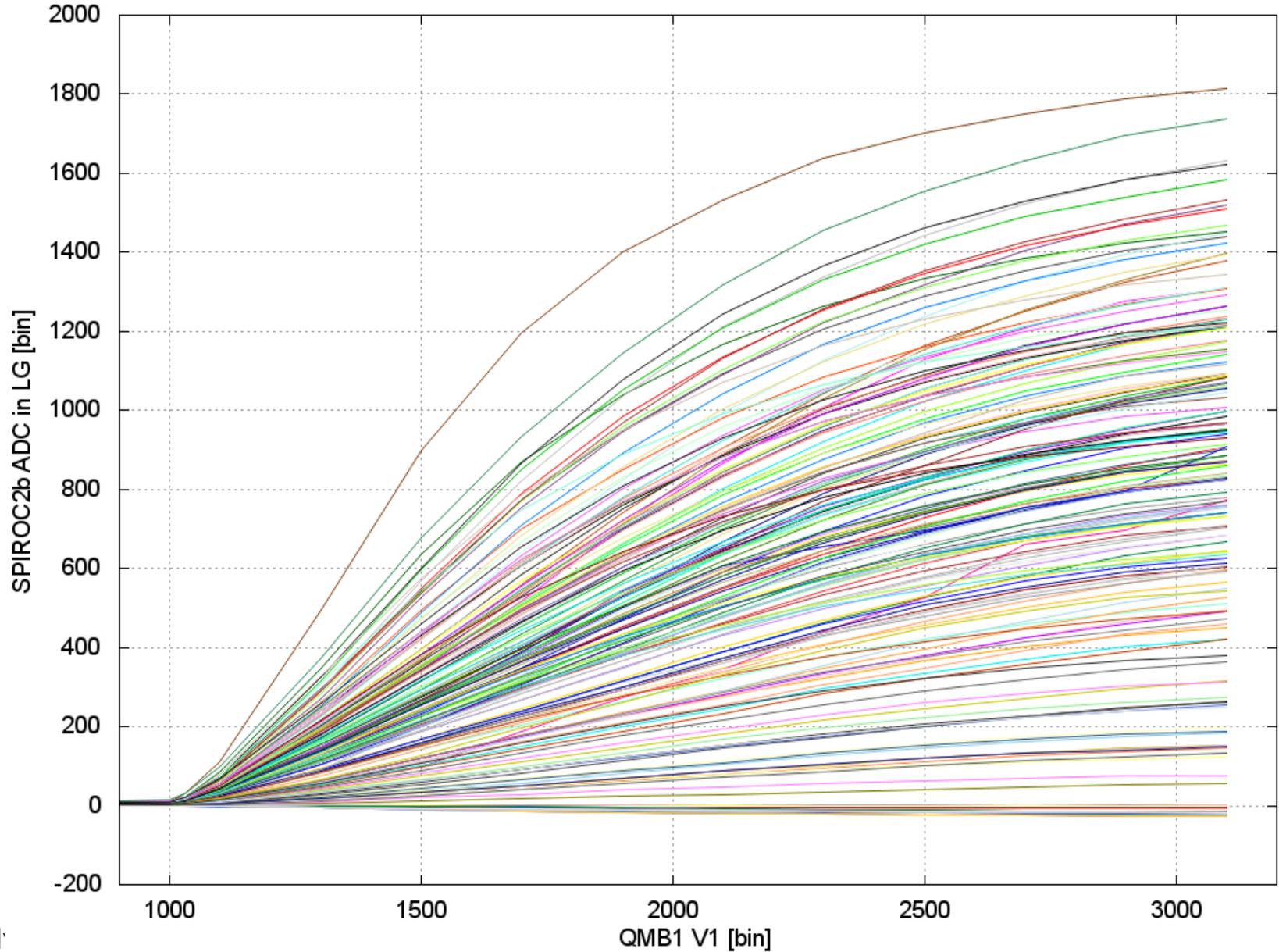
Pixel gain in HG mode [bins per pixel]
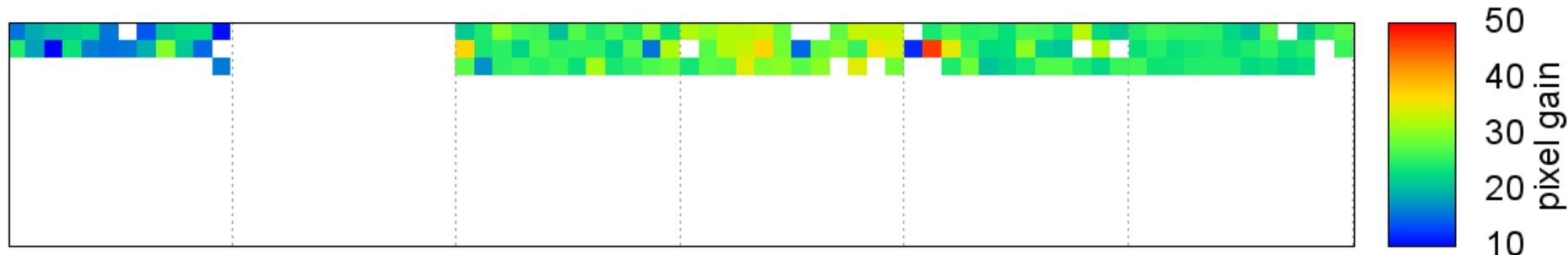
HG response for QMB V1 settings 990, 1030 and 1060 [fired pixels]
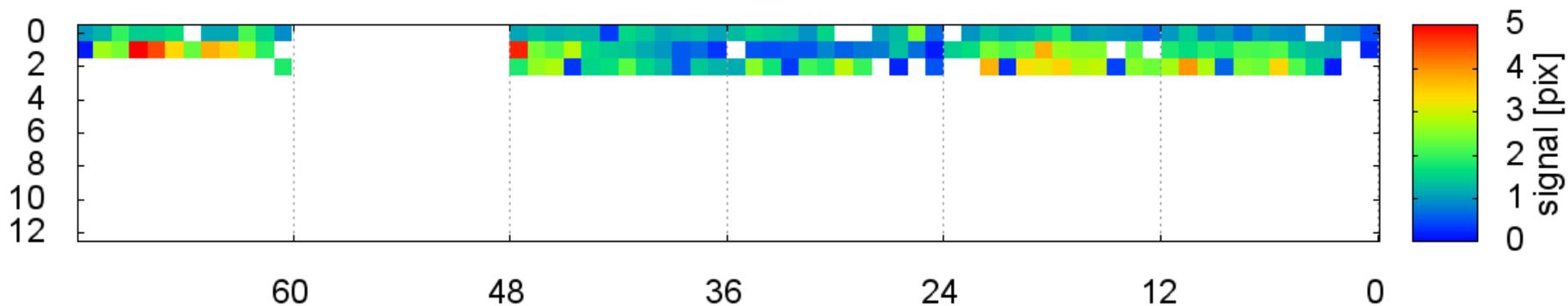
HG response for QMB V1 settings 1000, 1060 and 1080 [fired pixels]
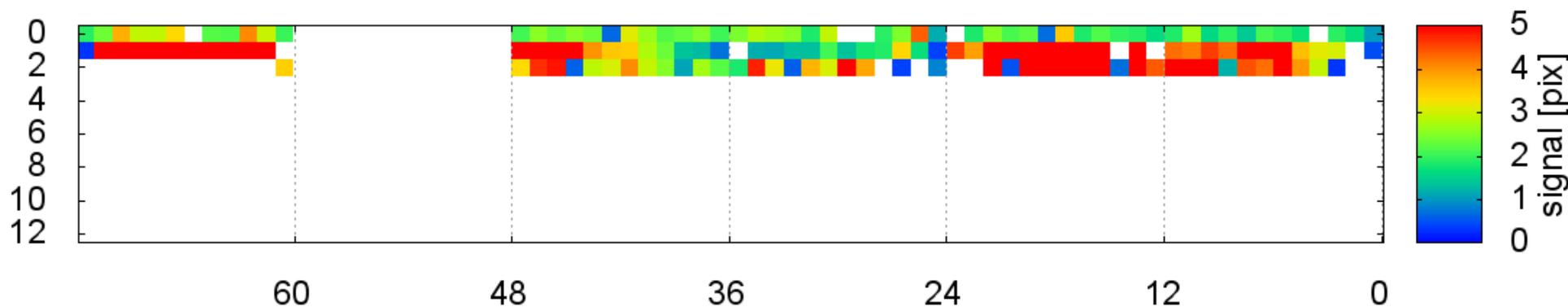
Semi-automatic drilling machine

- Frame with x-y stepper motors
- Drill machine used as milling cutter to groove the notch

- Alu/PCB Template with moving scint tile

PCB with 3mm holes

Scintilator tile w SiPM
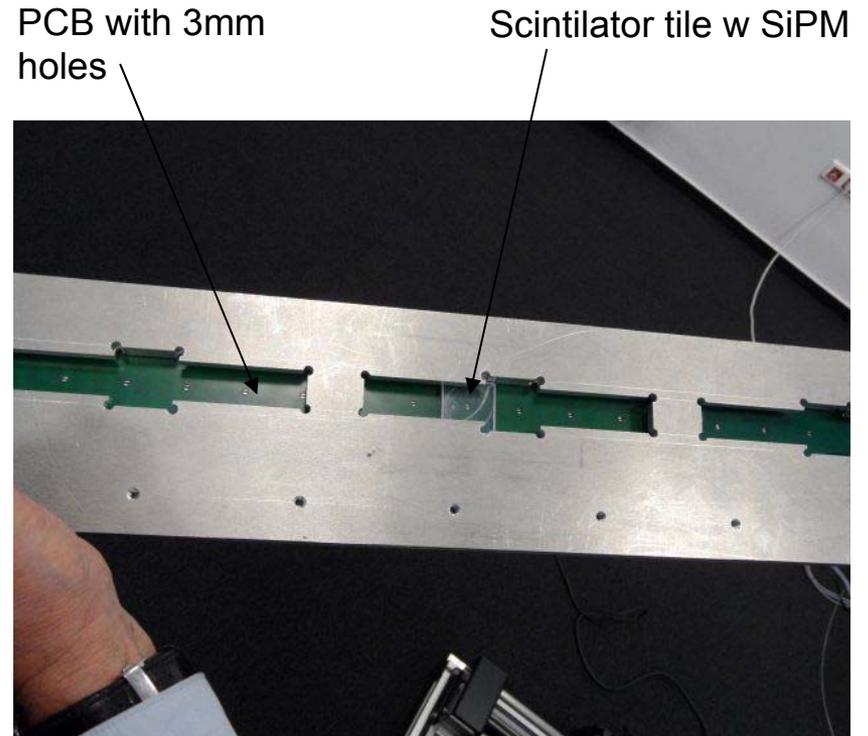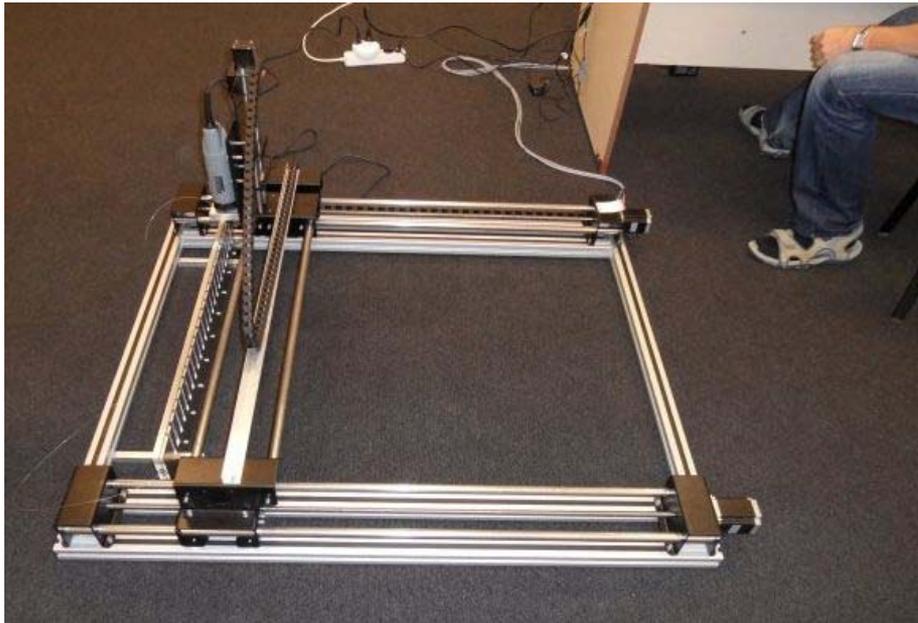
Distribution of light: Notched Fiber

Iluminated by Green laser

24 notches

- 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

Light → Reflected light

Emission from the fiber (side view)
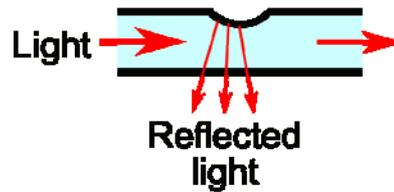
First notch
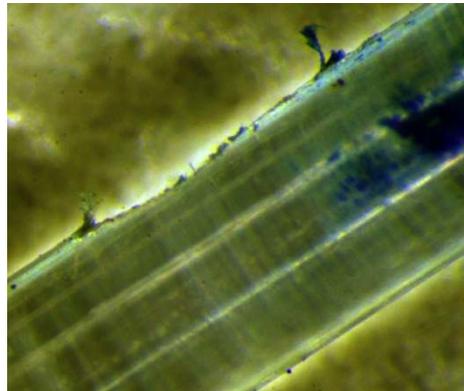
Middle notch

End position notch