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SiPM coupled advanced scintillation detectors

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Overview

„Proof of Concept“ detector: Beam Monitor
Crossed Fibre Layers

First Configuration : Square Organic Fibres
electron beam dimensions / electron veto in photon beam

Second Configuration : Round Inorganic Fibres
photon beam dimensions

Segmented trigger detector for cosmic particles:
dimensions of front surface of one PANDA crystal

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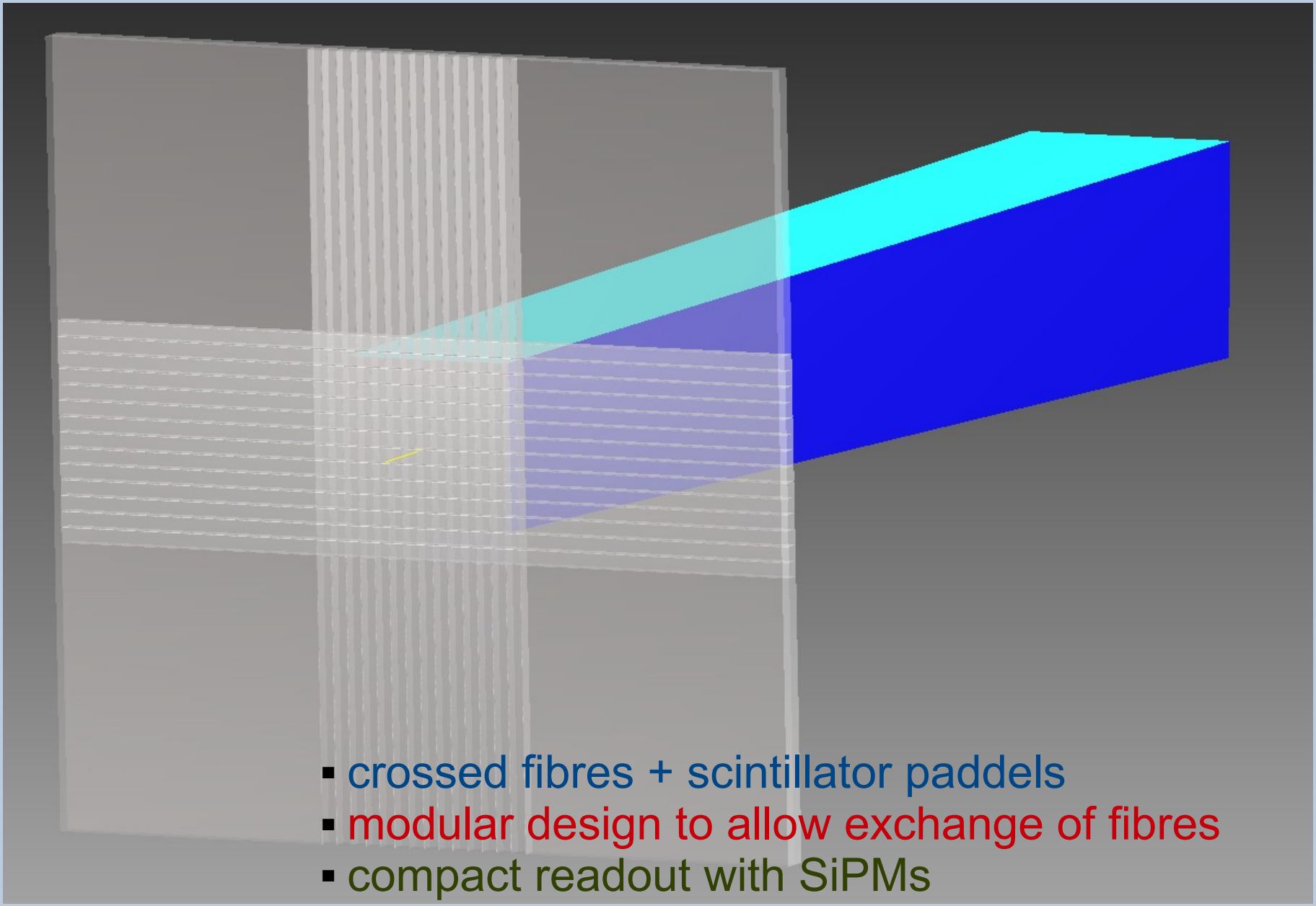
Scintillating fibre detector

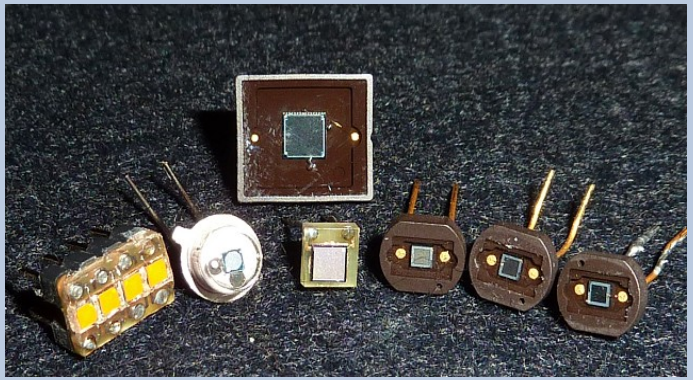


- crossed fibres + scintillator paddels
- modular design to allow exchange of fibres
- compact readout with SiPMs

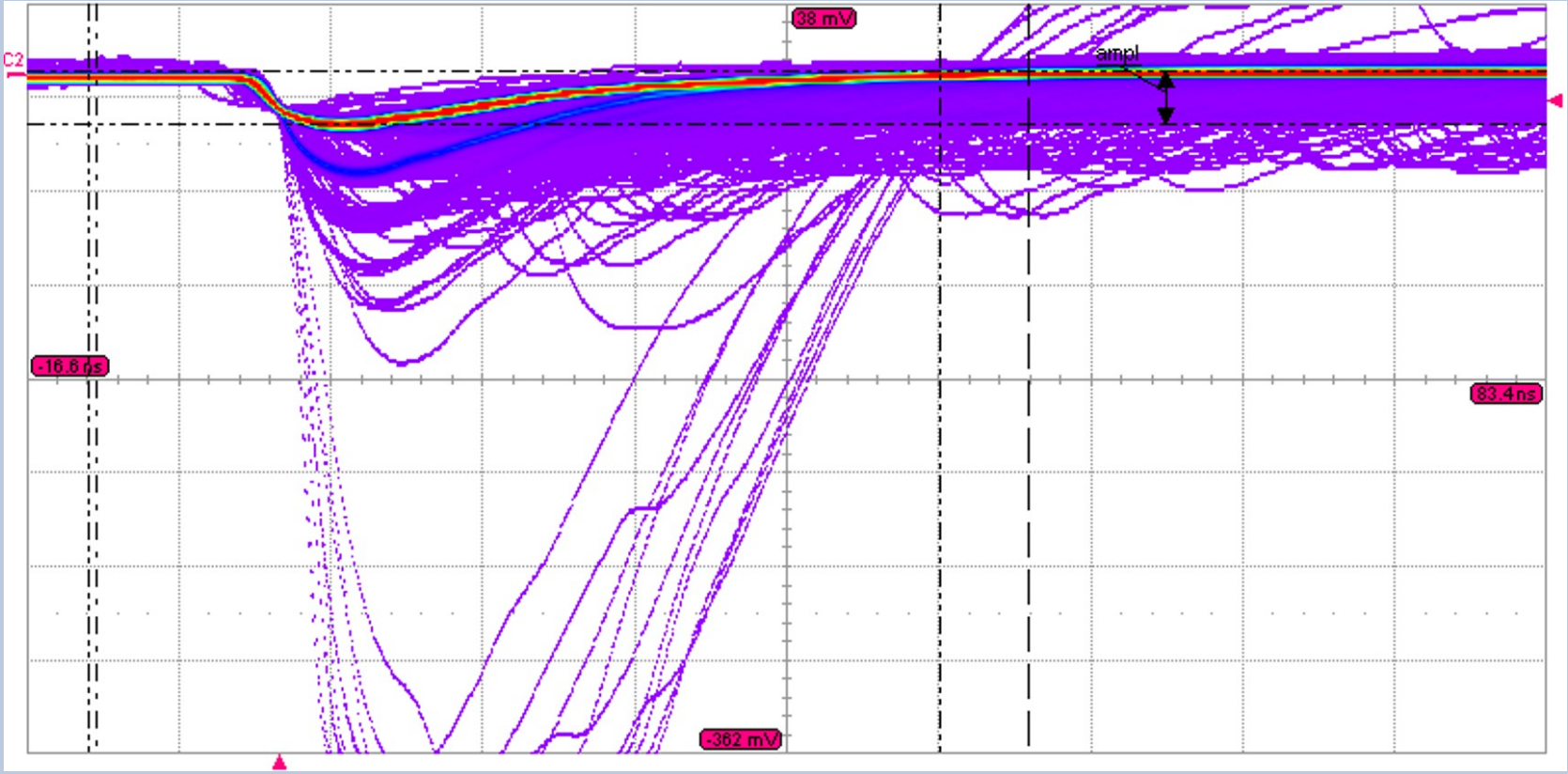
Scintillating fibre detector

Hamamatsu MPPC C50 (400 Pixel) @ Bicron BCF10

performance at lab temperature:



- Signal > 10 Pixel (~22 / MIP)
- Noise <10 Hz at 6,5 Pixel
- Gain <10% up to 1 MHz



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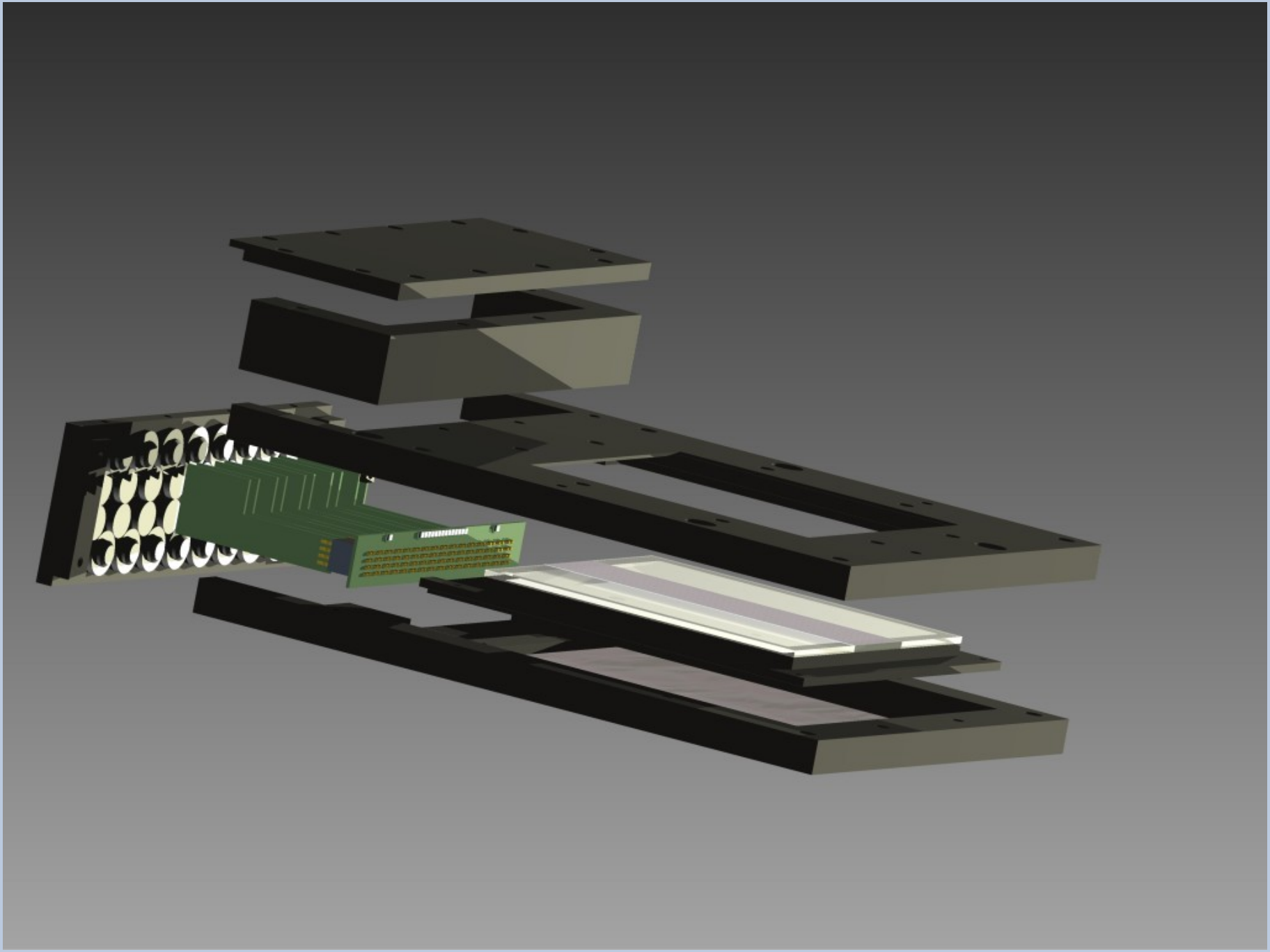
Detector Design



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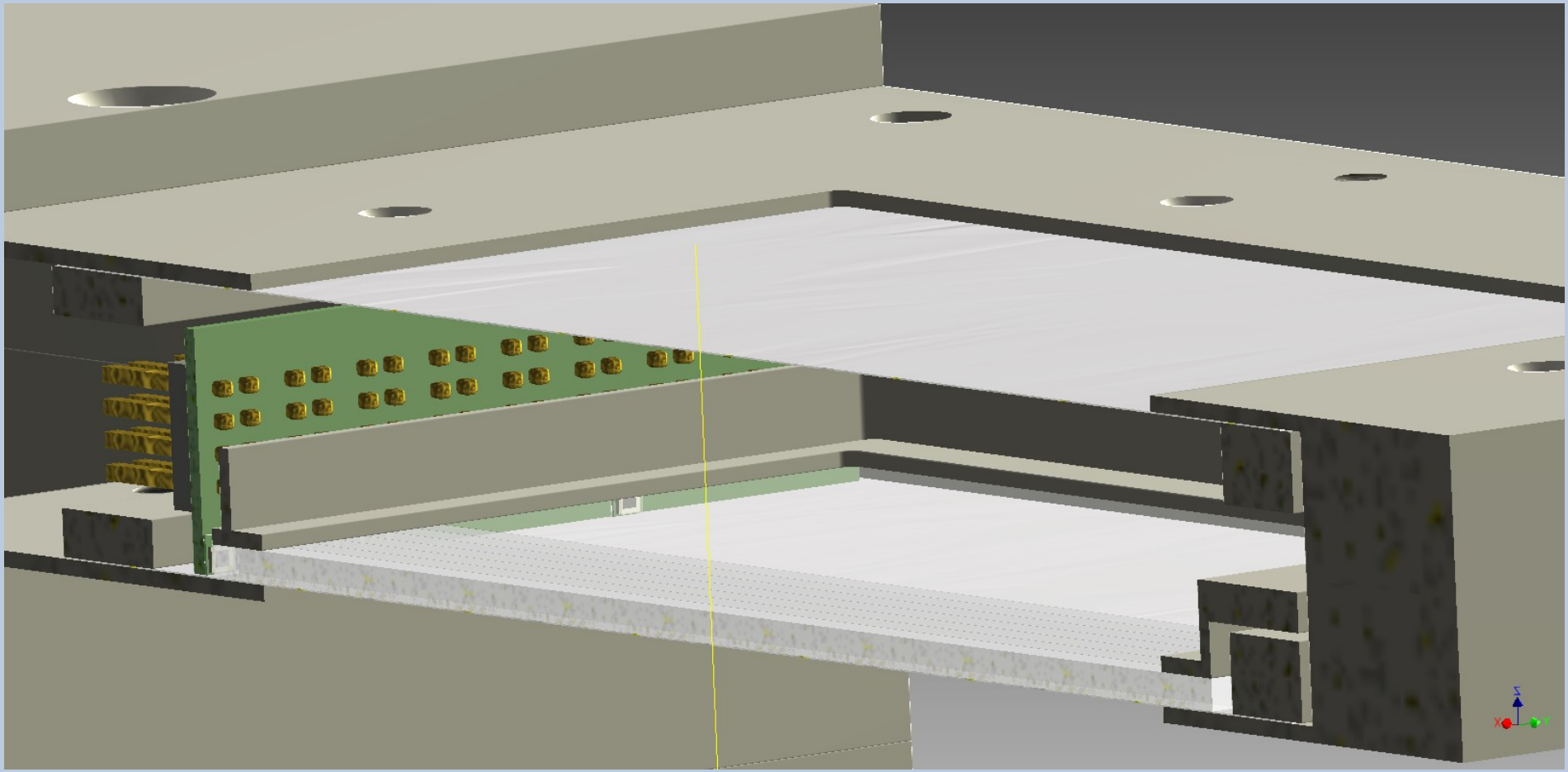
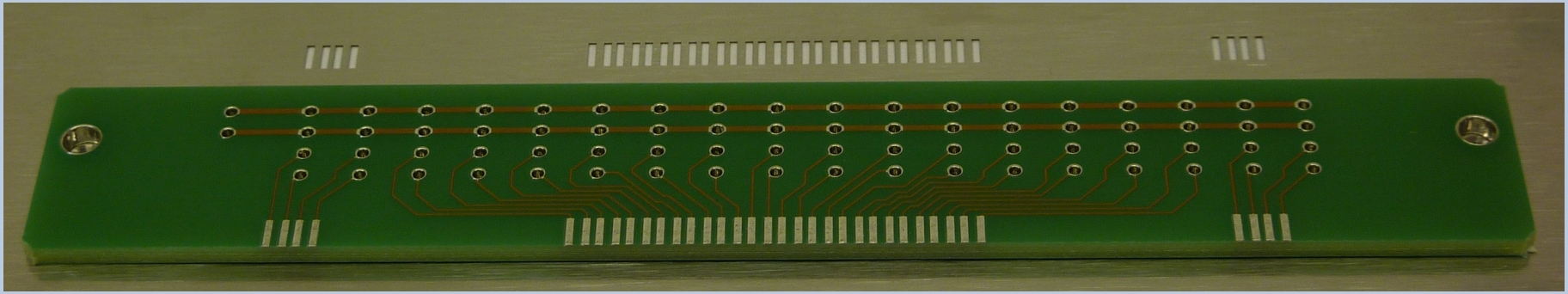
Detector Design

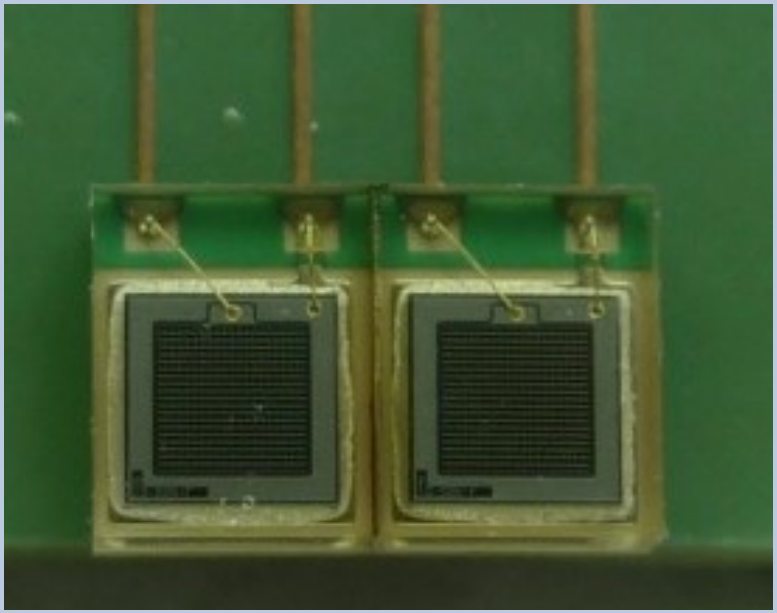
- compact & robust
- light- and EM-shielded
- 2 mm distance between two modules

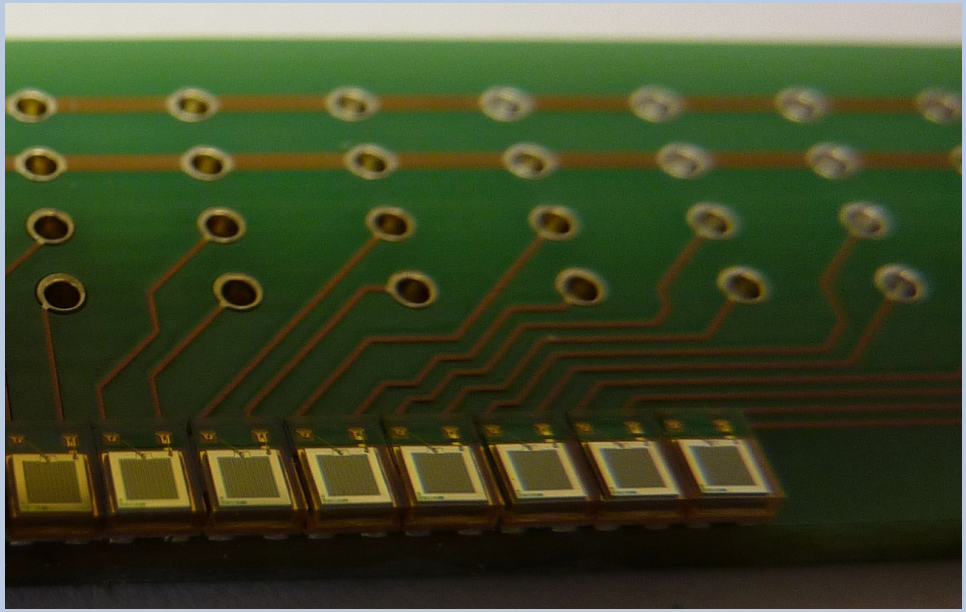


SiPM Board

- common ground connection close to all sensors
- distribution of PreAMP LV
- reflow soldered SiPMs with 2 mm pitch







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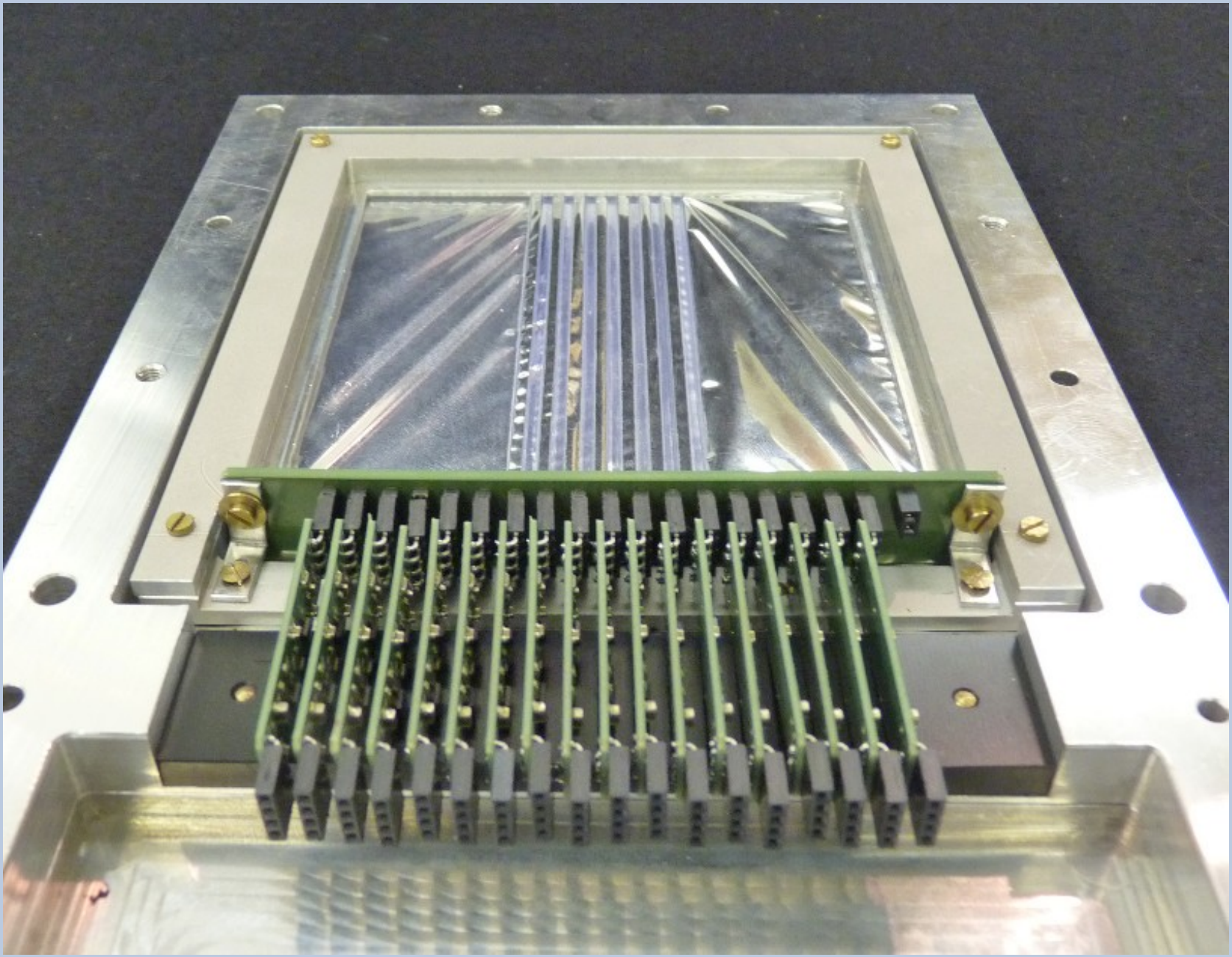
Sensors / PreAMPs



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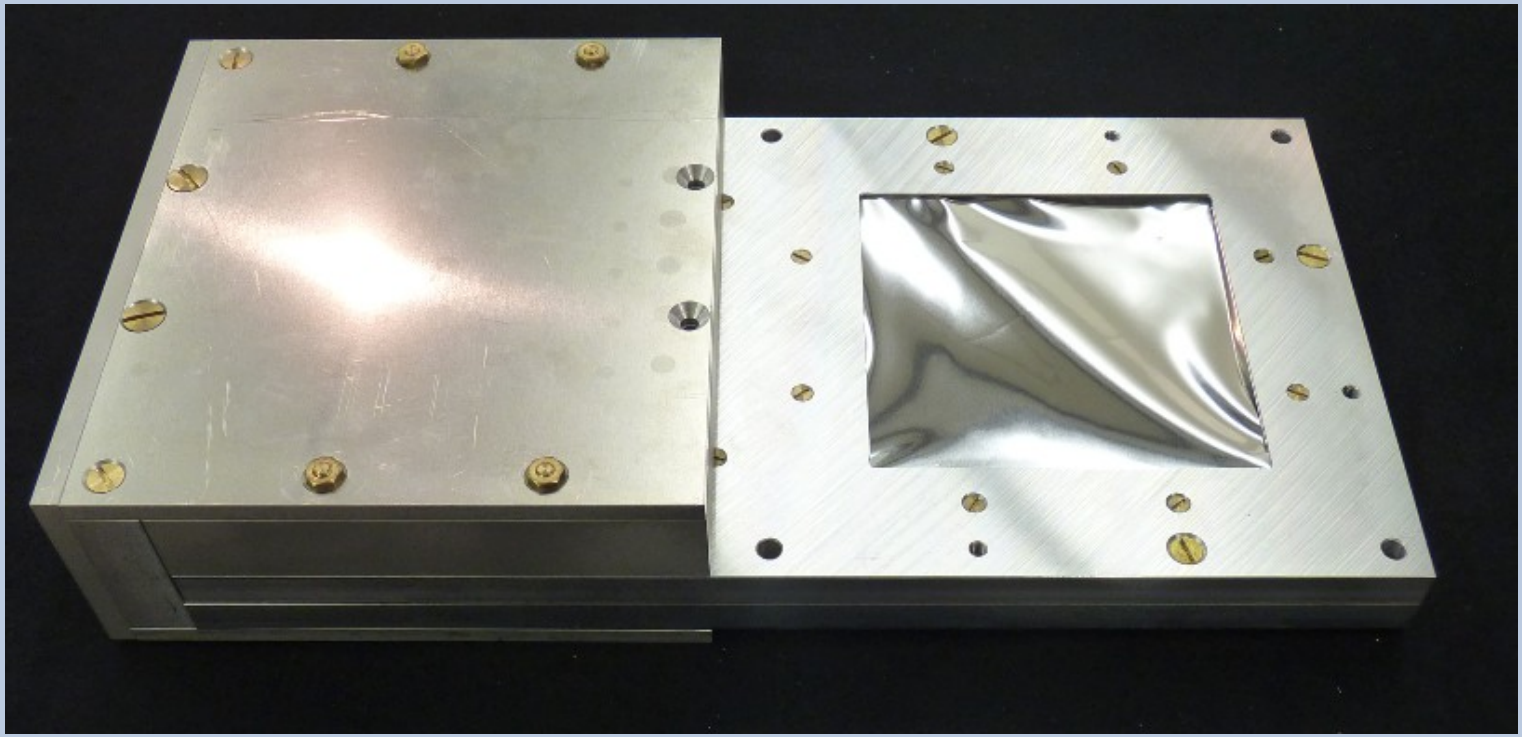
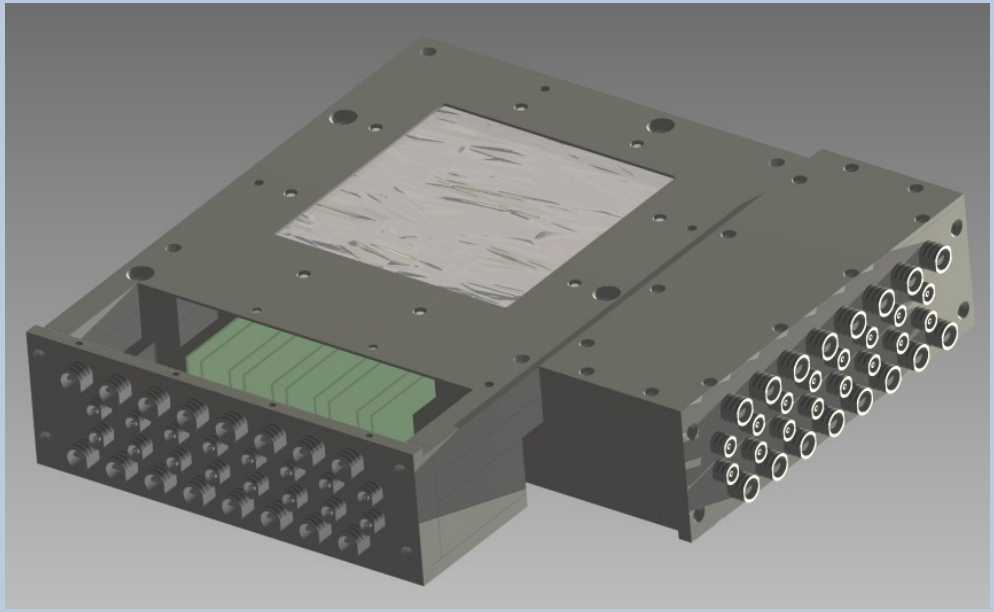
First Detector Module





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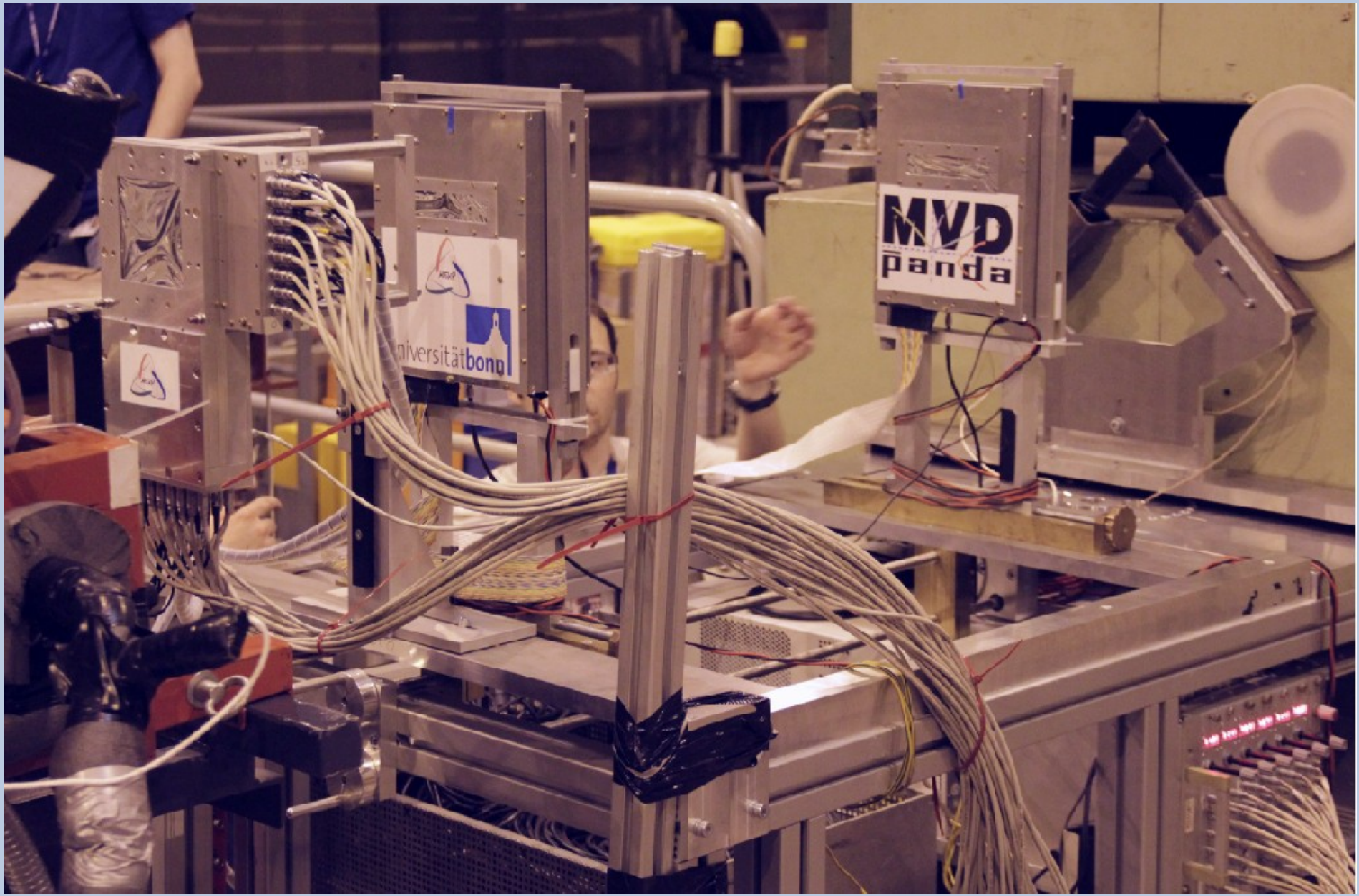
Performance at CERN 2011/2012



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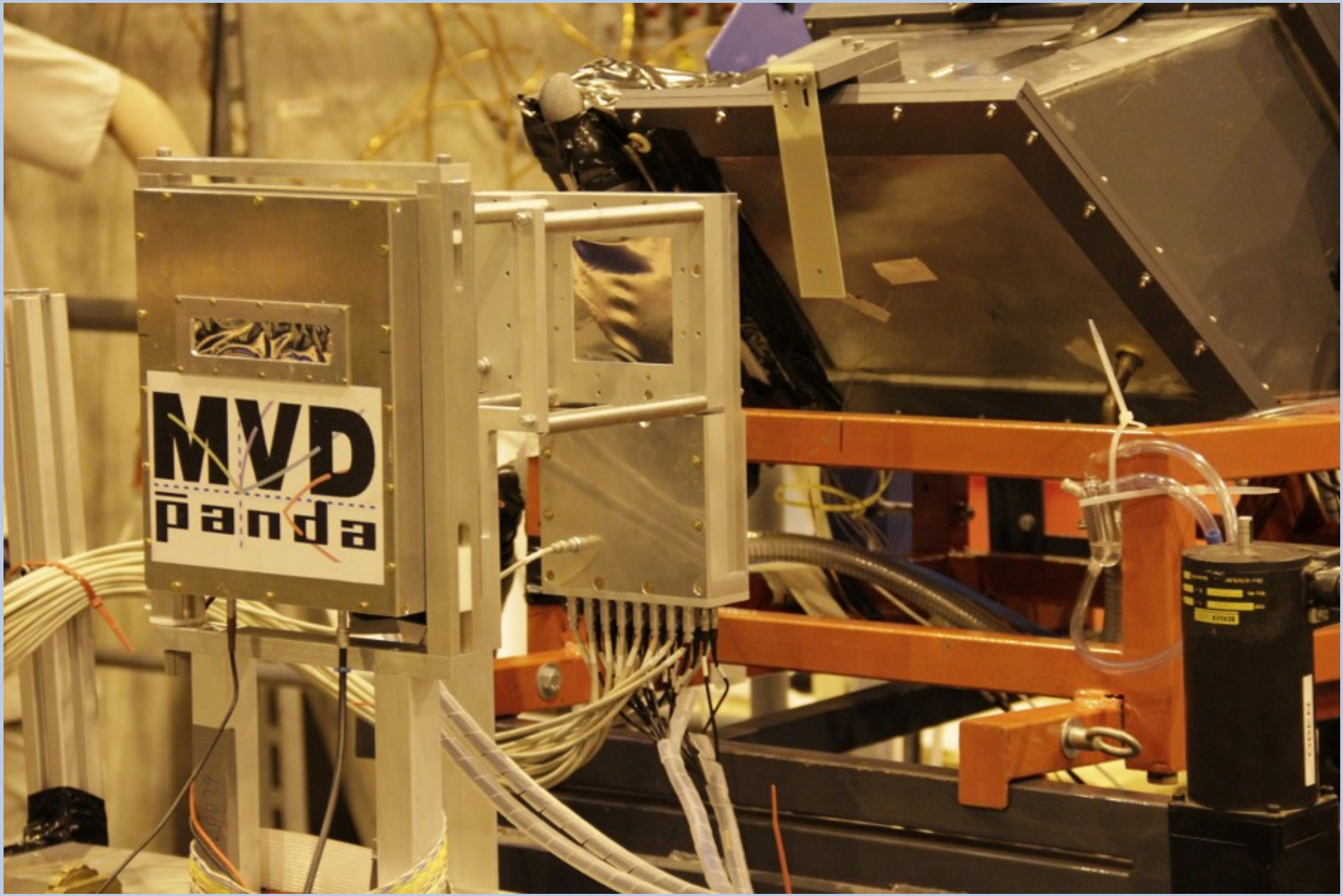
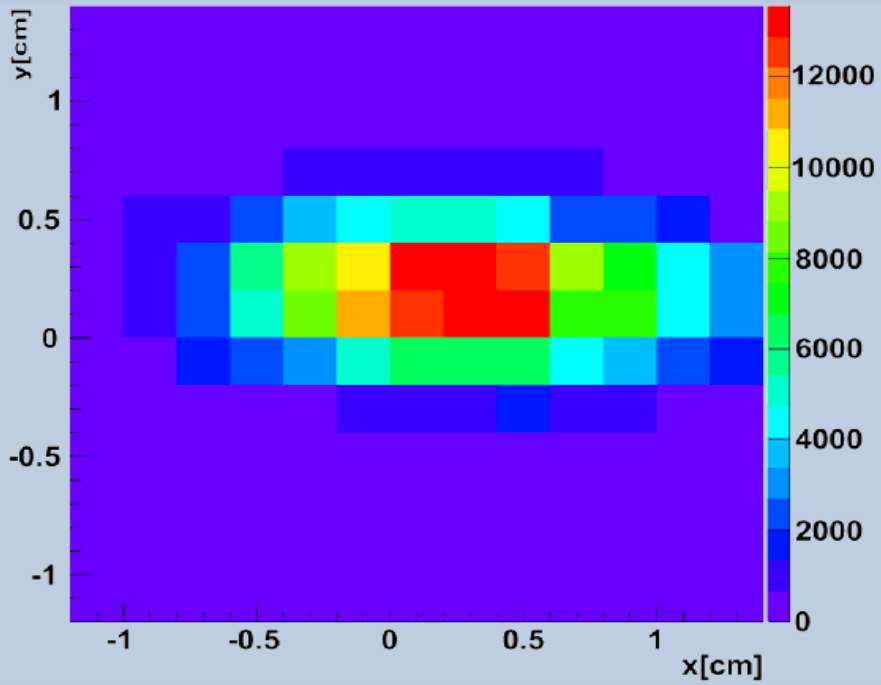
Performance at CERN

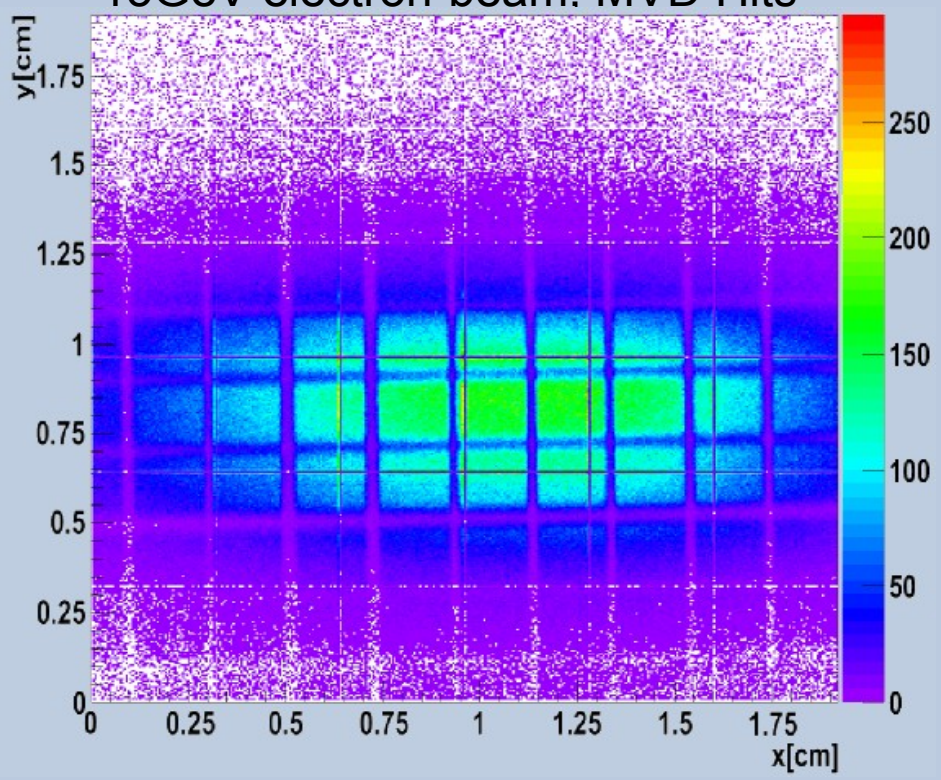


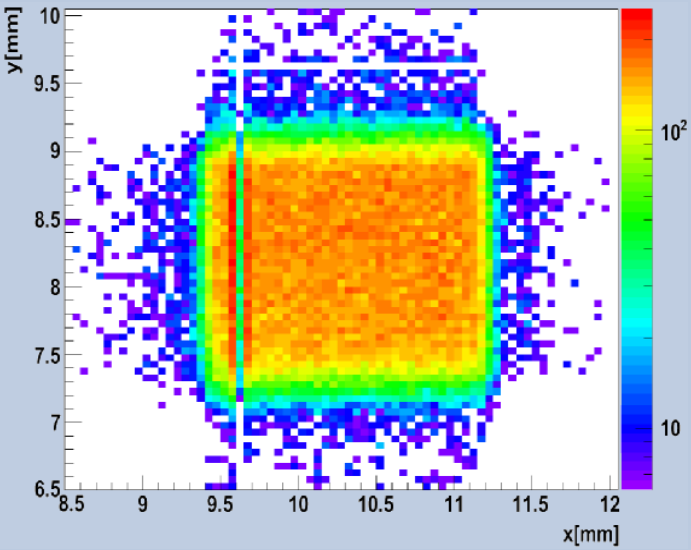
Performance at CERN 2011/2012

15GeV electron-beam, fibre trigger



15GeV electron-beam. MVD Hits





- good performance
- simple and easy to use, robust detector
- used 10 days without any failure

Hits on MVD silicon strip detector cut on two crossing central trigger fibres

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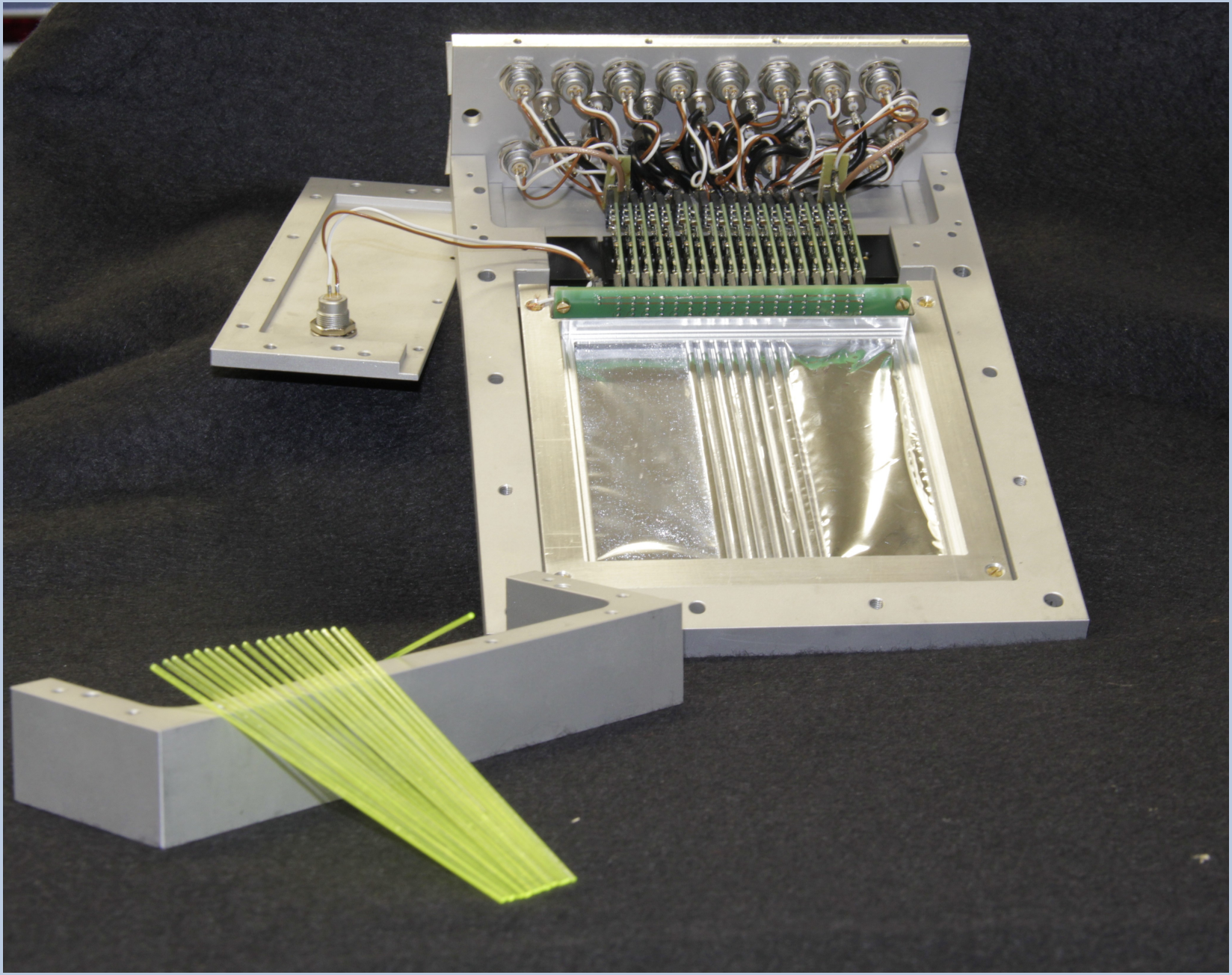
1 mm Round LuAG Fibres, 10 cm Long



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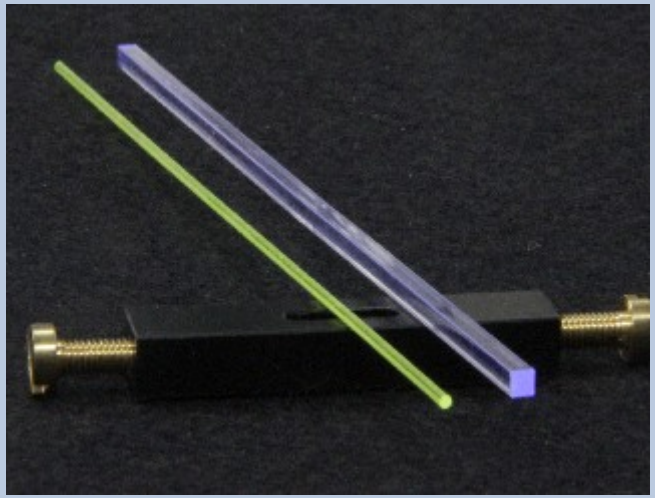
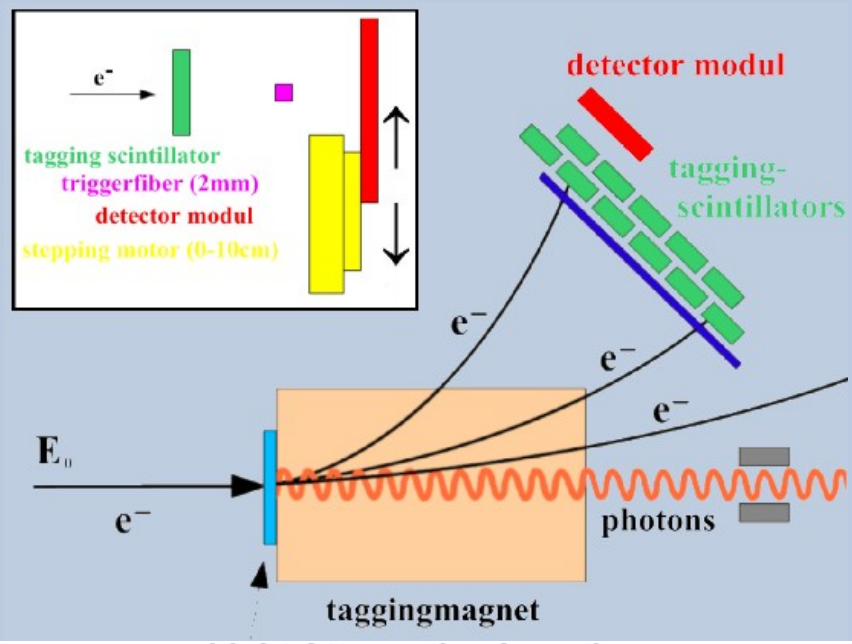
Fibres

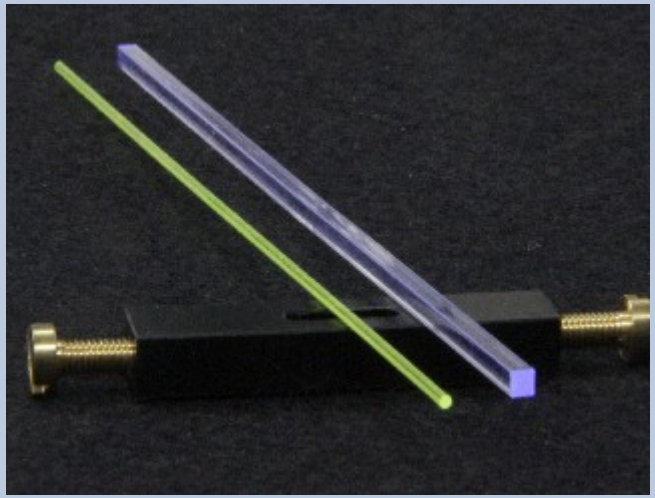


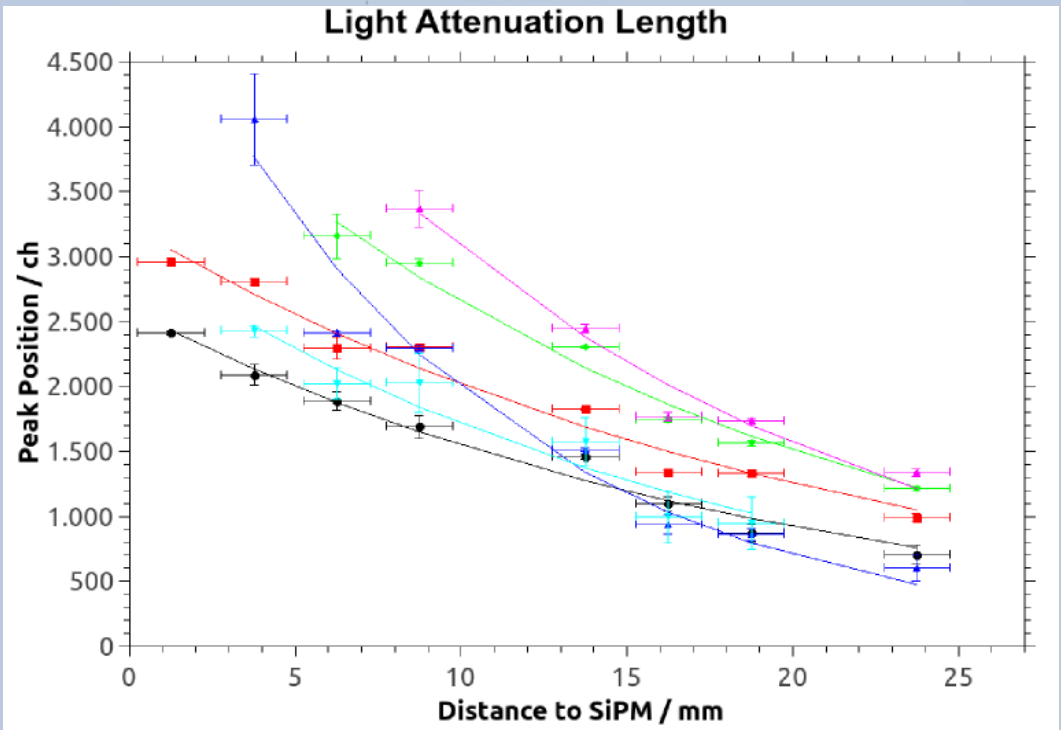
- 20 LuAG:Ce tested
- 1mm diameter
- 10 cm length
- great interest in investigation of their characteristics

- attenuation length tested in Bonn @ELSA Accelerator

Fibres



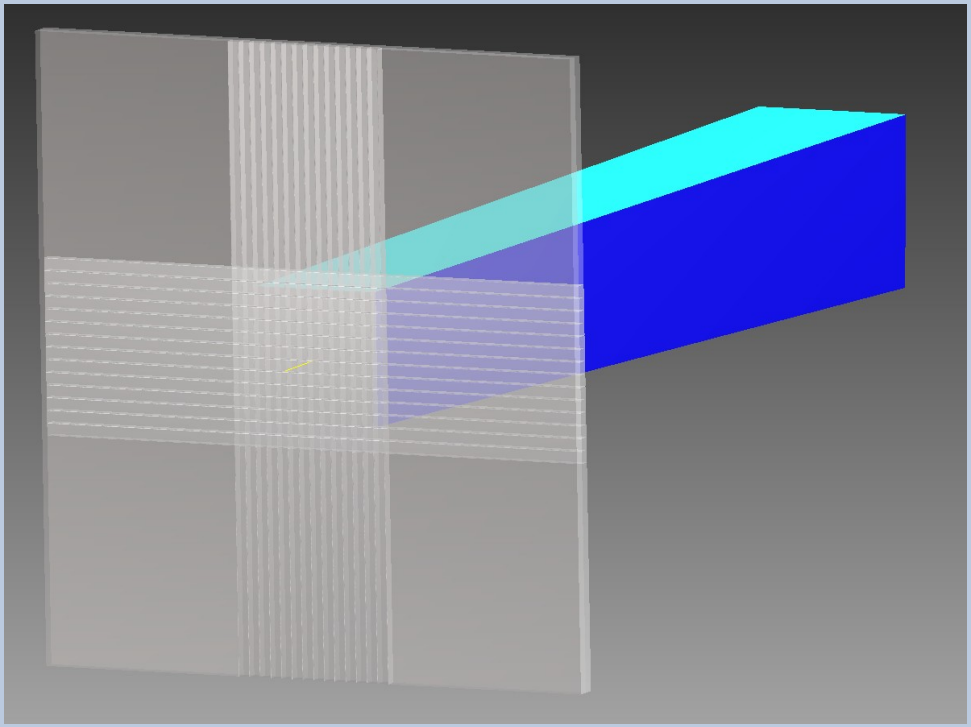


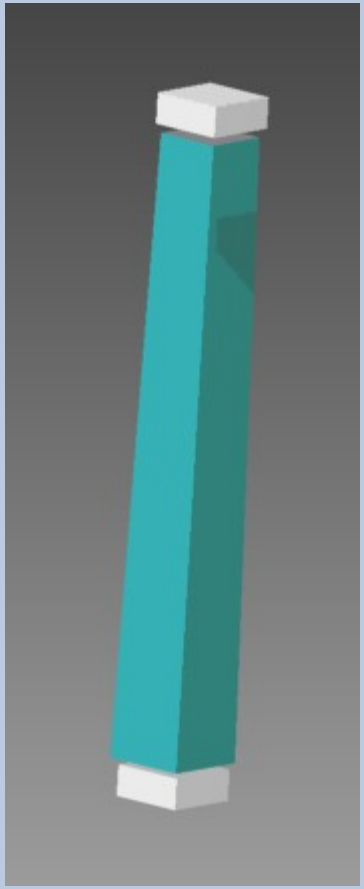


- fibres exposed to high-energy electrons
- fibres can be moved with vertically stepping motor into the electron beam
- distance to SiPM 0-10cm

- average light attenuation length (15,9±0,6)mm

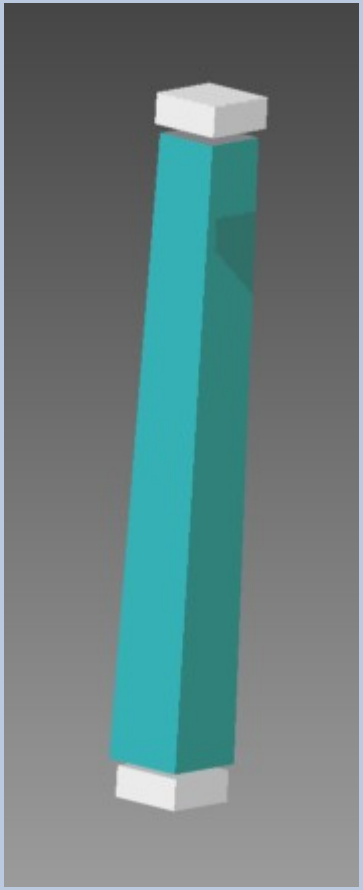
Segmented trigger detector

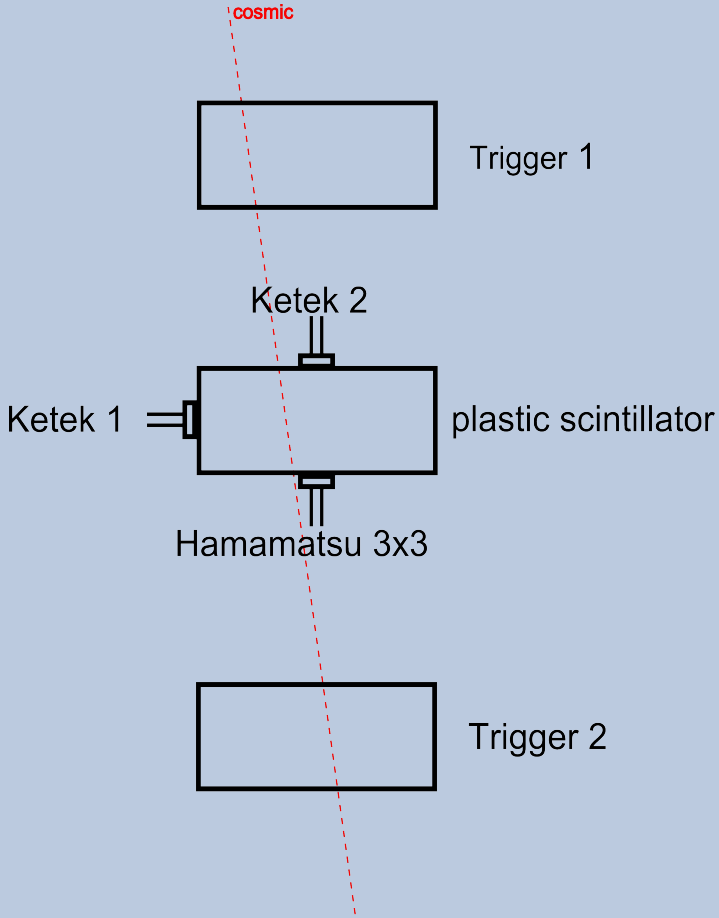




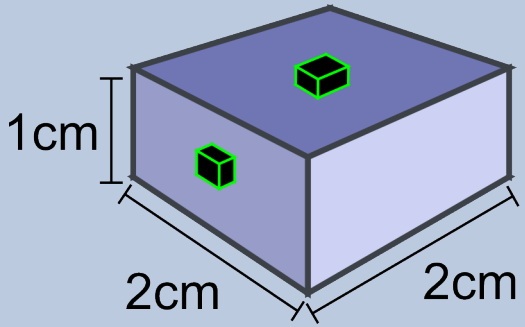
- Trigger detector for cosmic calibration of the Forwardendcap Calorimeter of PANDA-EMC
- segmented design to trigger each crystal
- compact readout, whole setup will be in climate chamber

Test setup



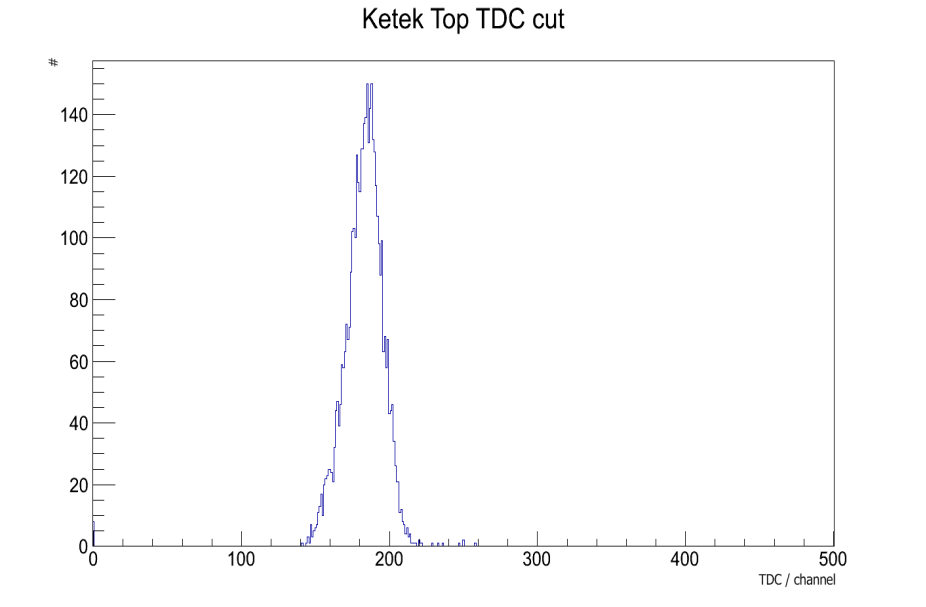


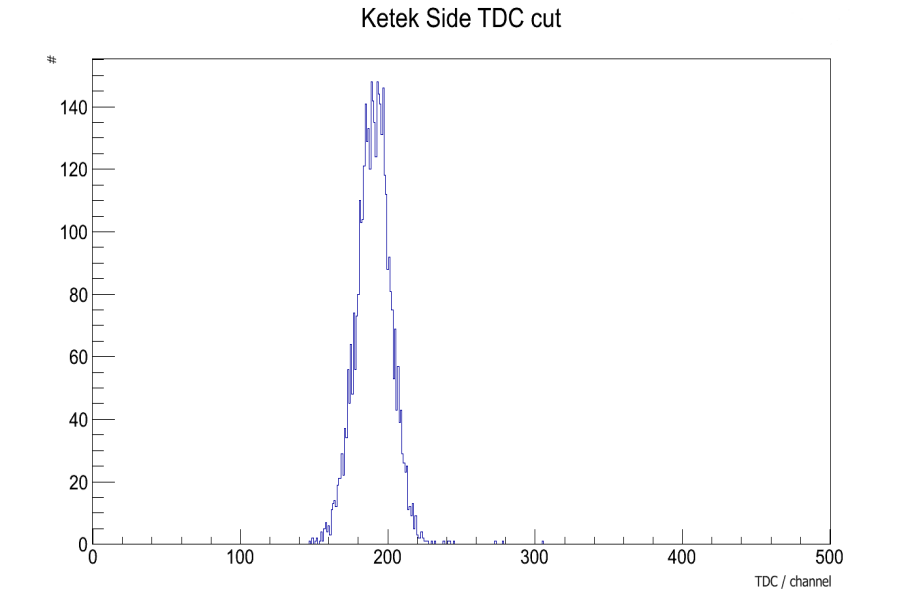
plastic scintillator:
EJ-200

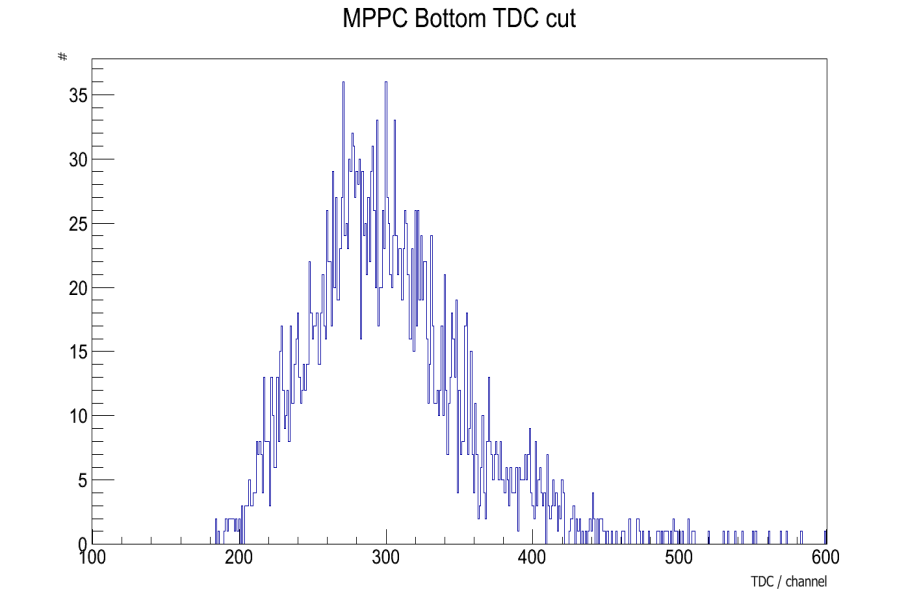


- Trigger by 2 scitillators with PM readout
- Test different:
  - SiPMs
  - SiPM positions
  - coating

some results







Test with Mylar coating

SiPM	efficiency	timeresolution
Ketek Top	98,1%	568ps
Ketek Side	98,2%	584ps
MPPC 3x3 Bot	75%	2210ps

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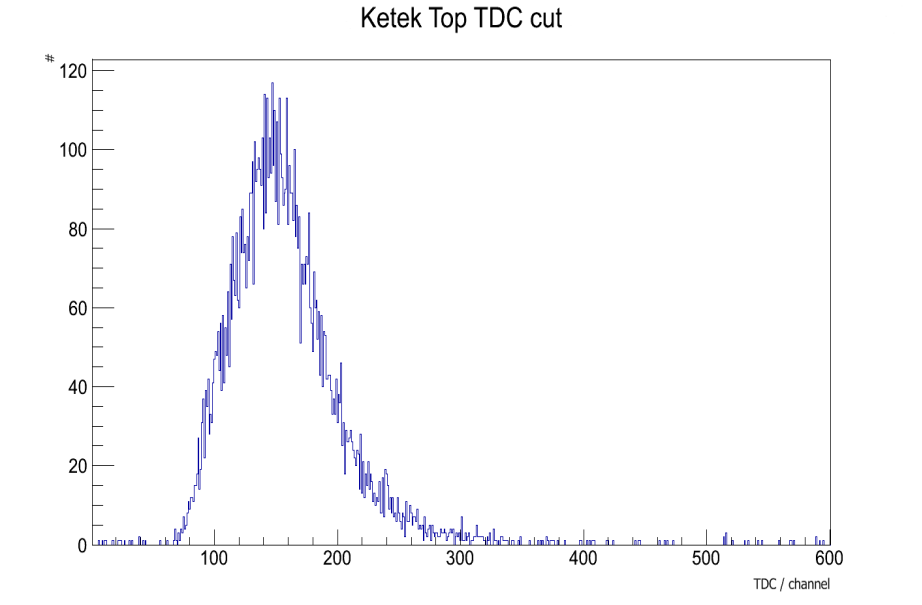
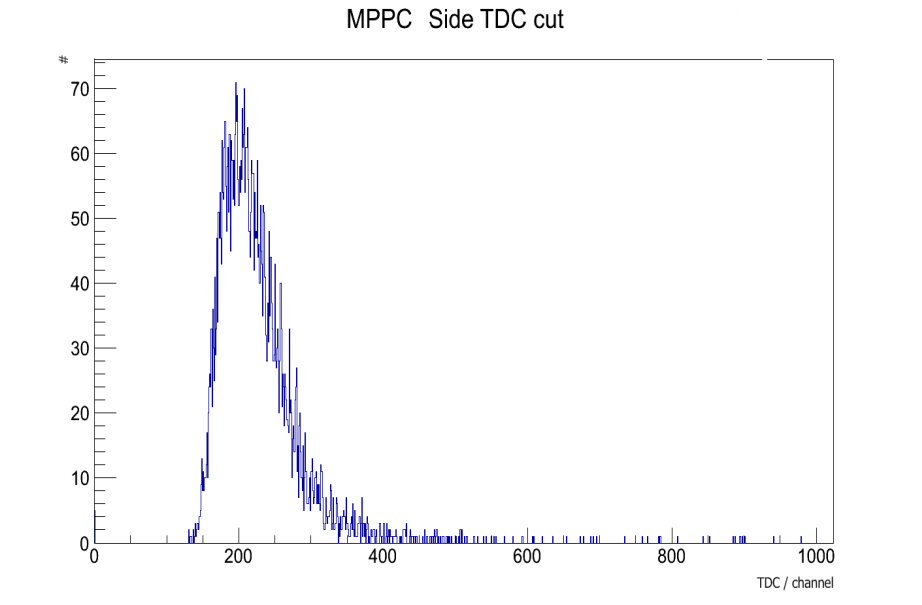
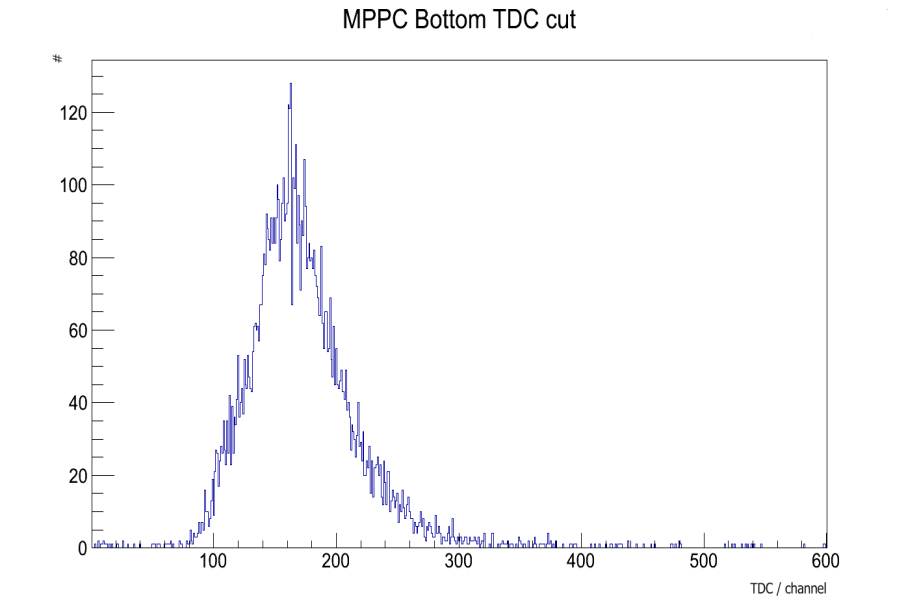
some results



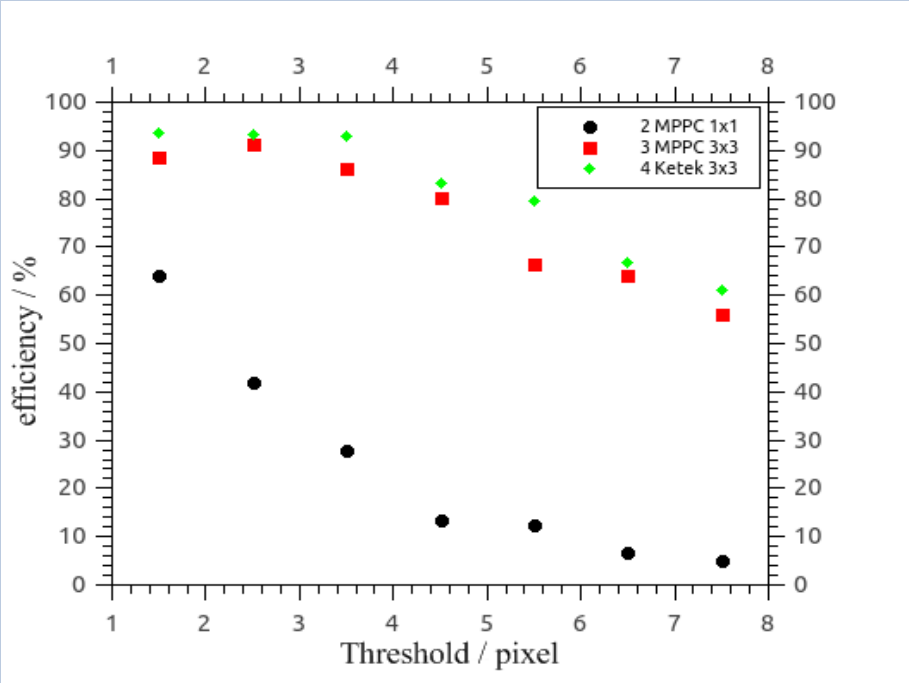


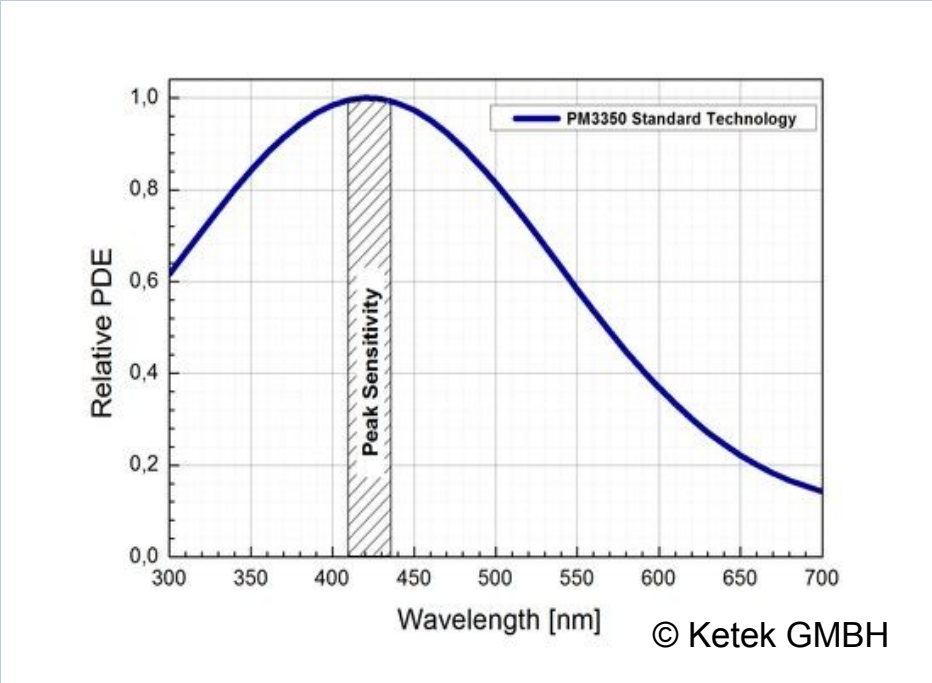


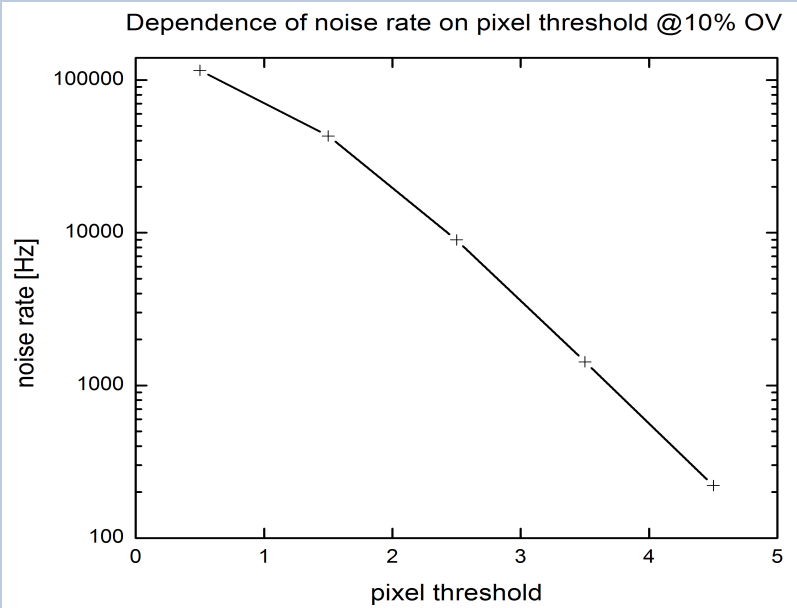
Test without coating

SiPM	efficiency	timeresolution
Ketek Top	94,0%	1,7ns
MPPC 1x1 S	62,3%	1,6ns
MPPC 3x3 Bot	88,2%	1,6ns

some results

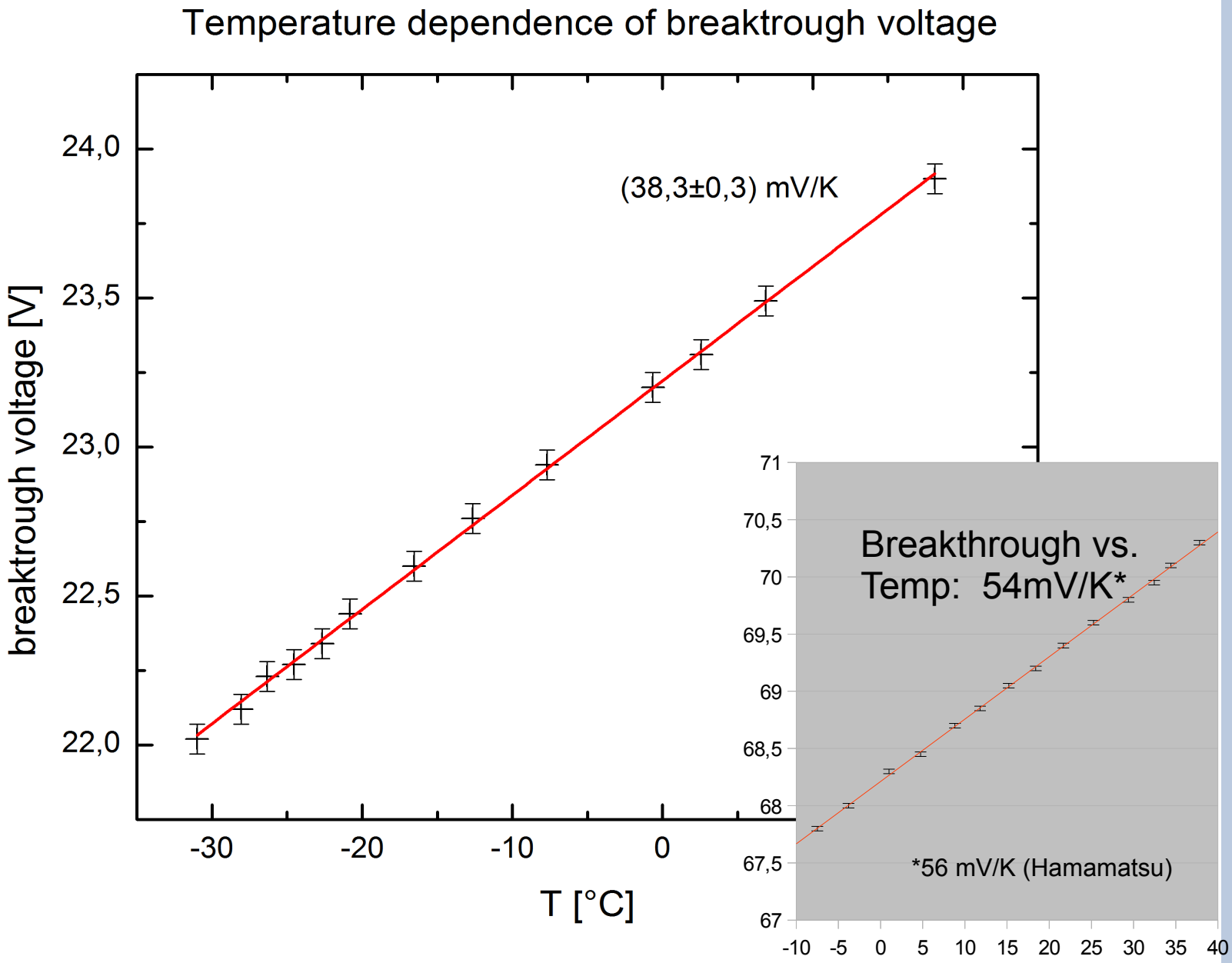






- Ketek SiPM provides:
  - good PDE for blue light
  - good timeresolution
  - best signal to noise ratio

breaktrough voltage Ketek



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Roadmap

Detector tests:
more tests with different coating

Detector development:
mechanical design, shielding, differential outputs, …

END

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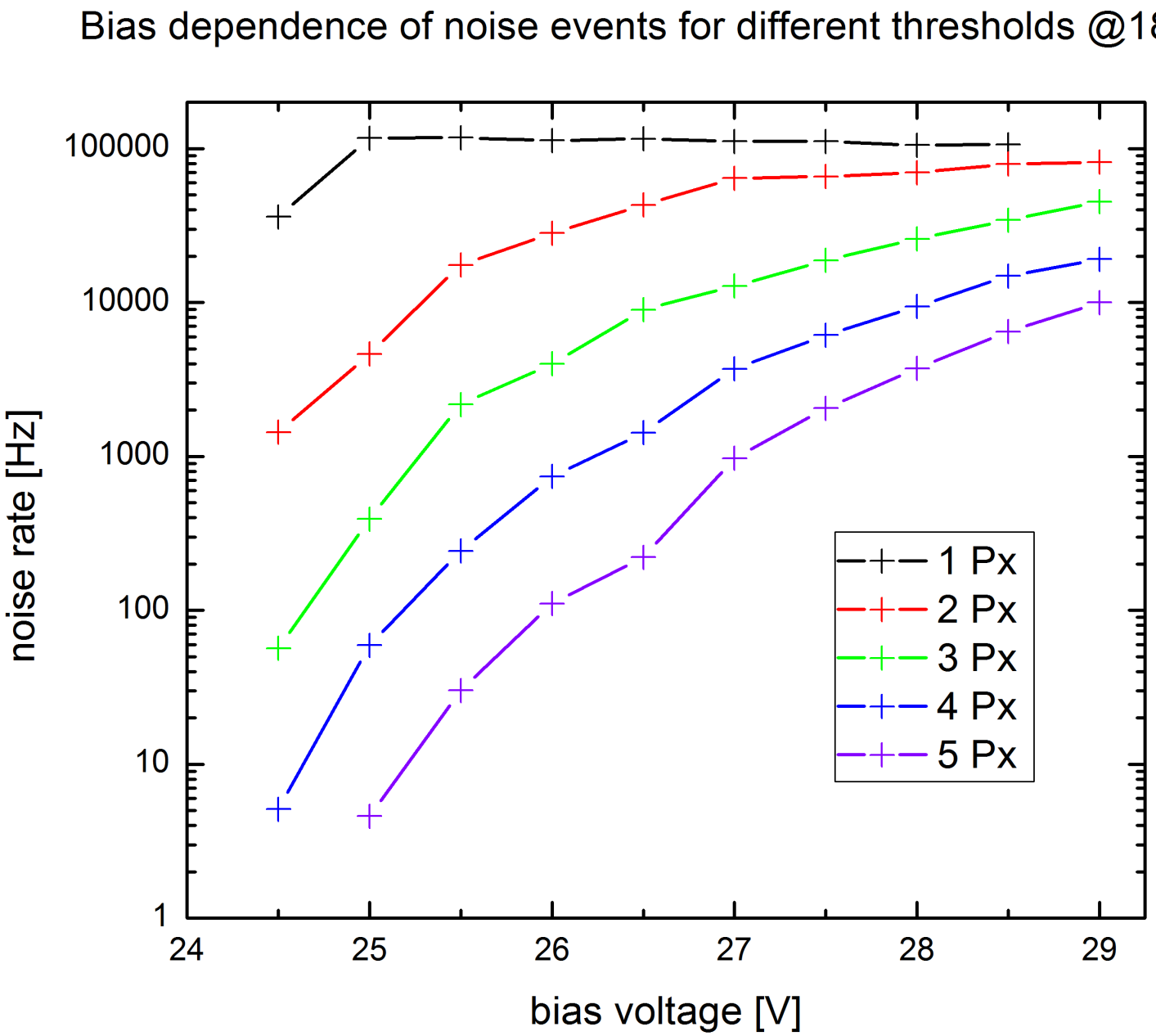
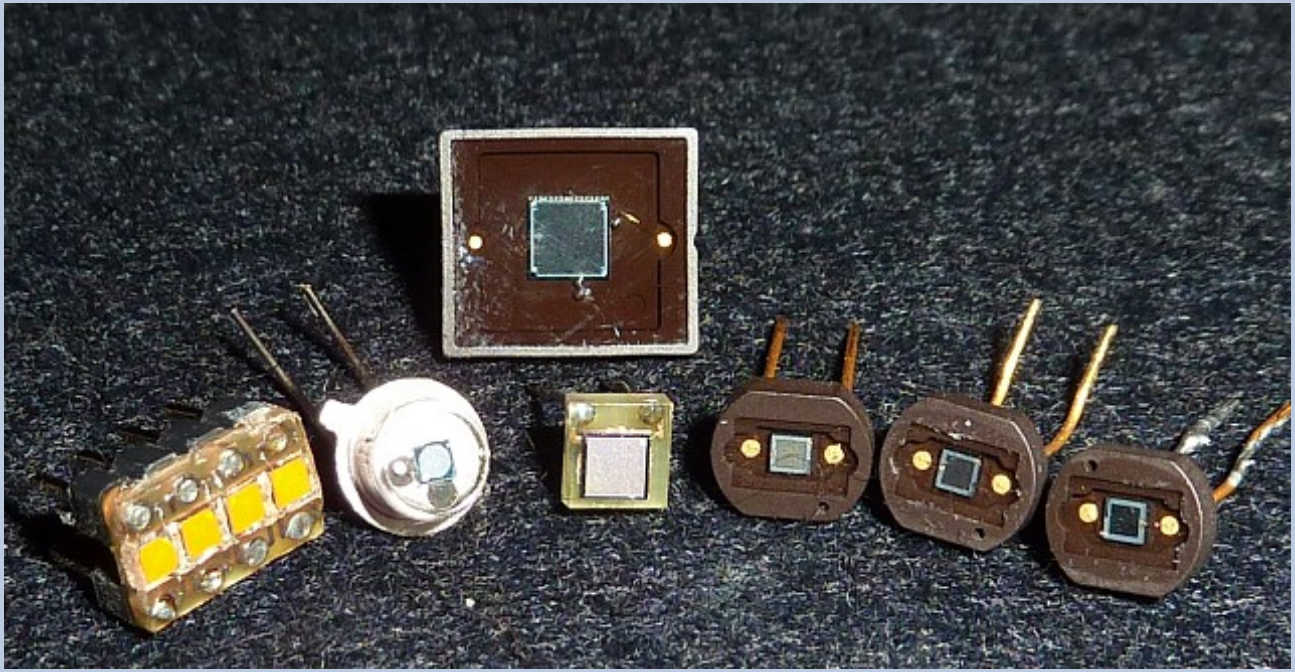
some more results



Selection of SiPM



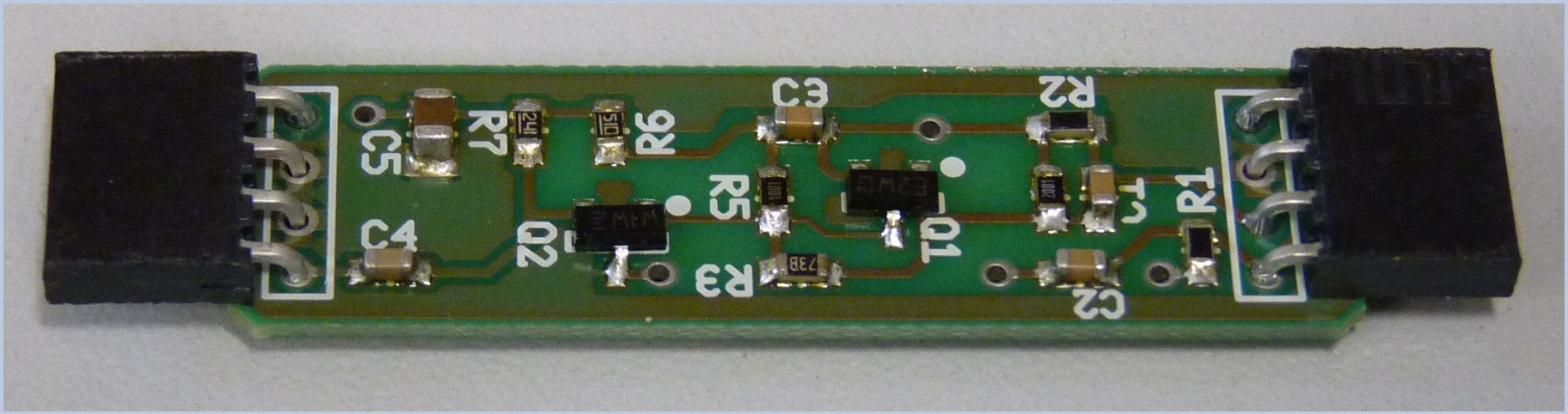
SiPM	Photonique			Hamamatsu S10362-11-			SensL
	0701BG	0611B4MM	Array	25C	50C	100C	MIcro3035
Operating Voltage	31 V	36 V	20 V	70 V	70 V	70 V	28 V
active Area	1 mm^2	4,4 mm^2	1 mm^2	1 mm^2	1 mm^2	1 mm^2	8,1 mm^2
Pixels	556	1700	556	1600	400	100	3640
Fill Faktor	$\geq$ 70 %	$\geq$ 70 %	$\geq$ 70 %	30,8 %	61,5 %	78,5 %	-
Gain	$4 \cdot 10^5$	$0,6 \cdot 10^5$	$4 \cdot 10^5$	$2,75 \cdot 10^5$	$7,5 \cdot 10^5$	$2,4 \cdot 10^6$	$1 \cdot 10^6$
PDE	40 %	25 %	$\geq$ 10 %	25 %	50 %	65 %	20 %
λ bei max. PDE	560 nm	440 nm	560 nm	440 nm	440 nm	440 nm	490 nm
Darkrate	1,6 MHz	2,9 MHz	1,5 MHz	600 kHz	800 kHz	1000 kHz	10 MHz
Rise Time	$\leq$ 0,7 ns	$\leq$ 0,7 ns	$\leq$ 5 ns	$\leq$ 0,3 ns	$\leq$ 0,3 ns	$\leq$ 0,3 ns	$\leq$ 5 ns

plus some more, i.e.

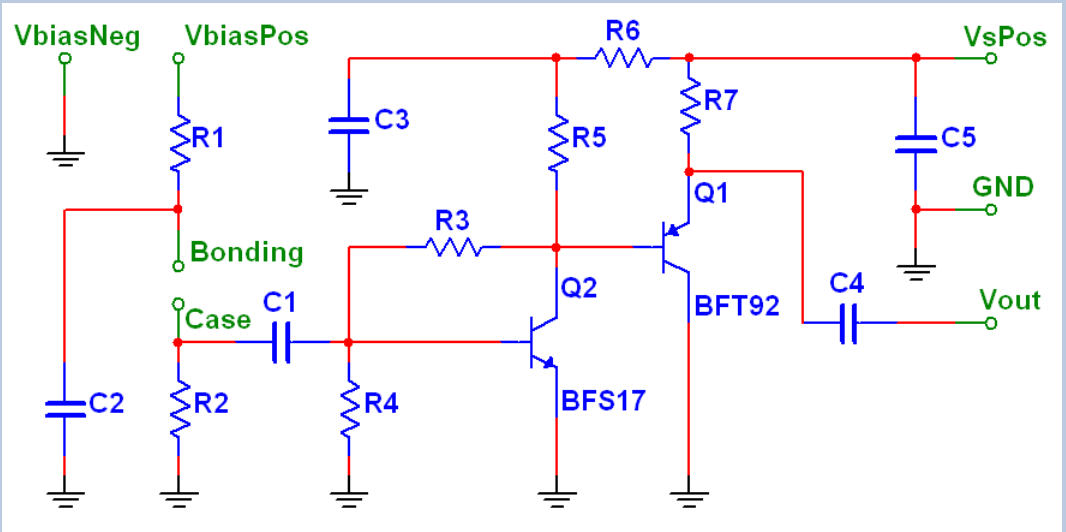
Photonique
- 2.2 x 2.2 red enhanced,

- some older MEPhI/Pulsar Prototypes

PreAMP



- individual, interchangable PreAMPs
- 10V supply via SiPM board
- individual bias supply
- ~ 50x gain output



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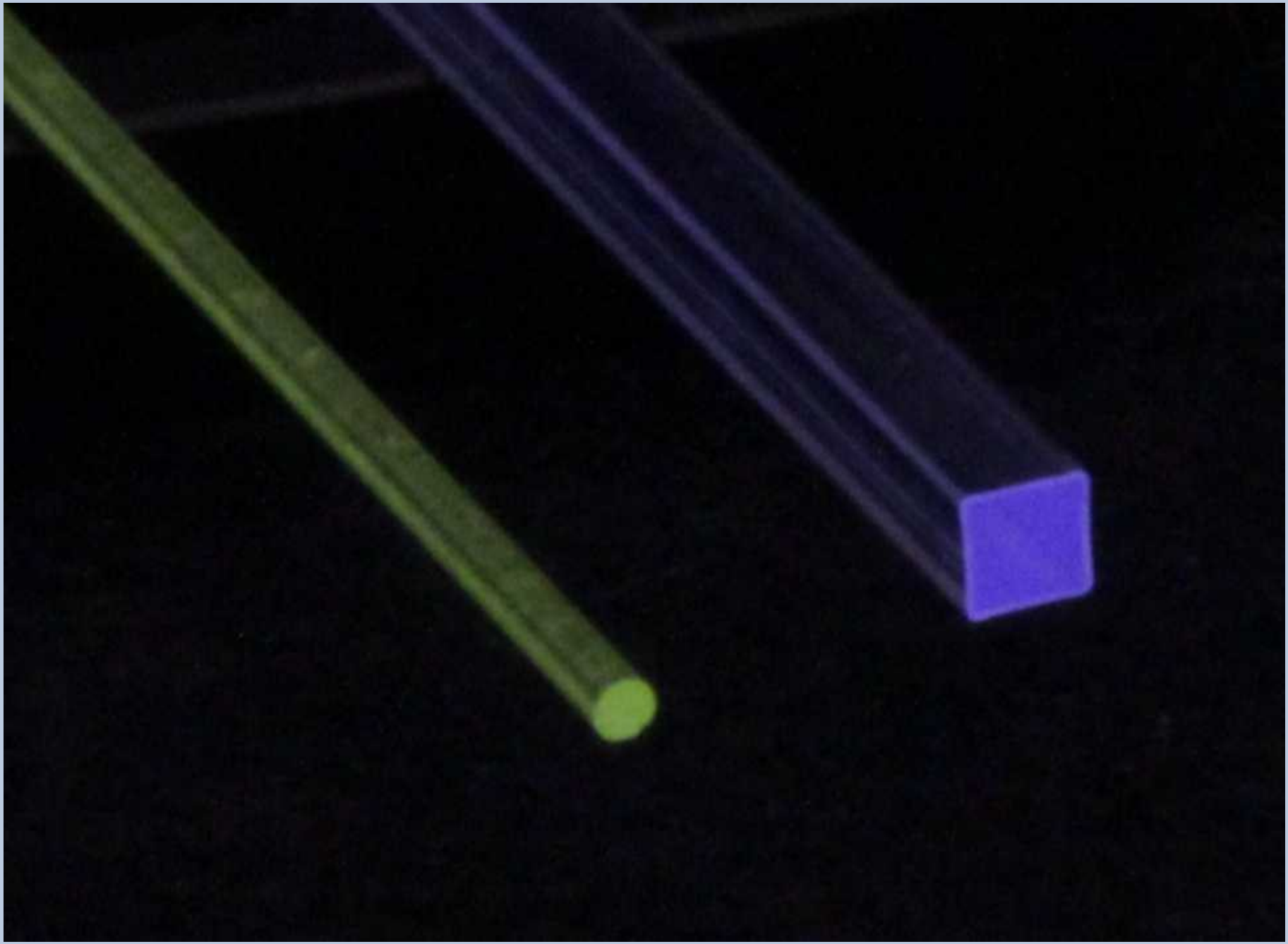
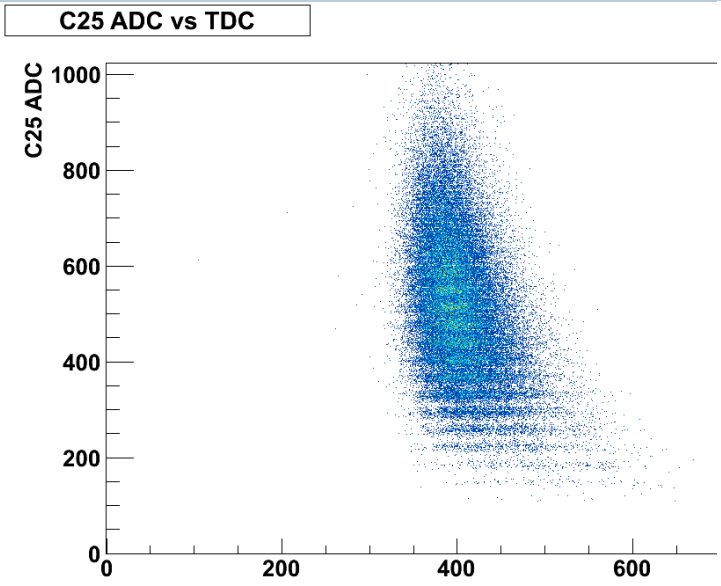
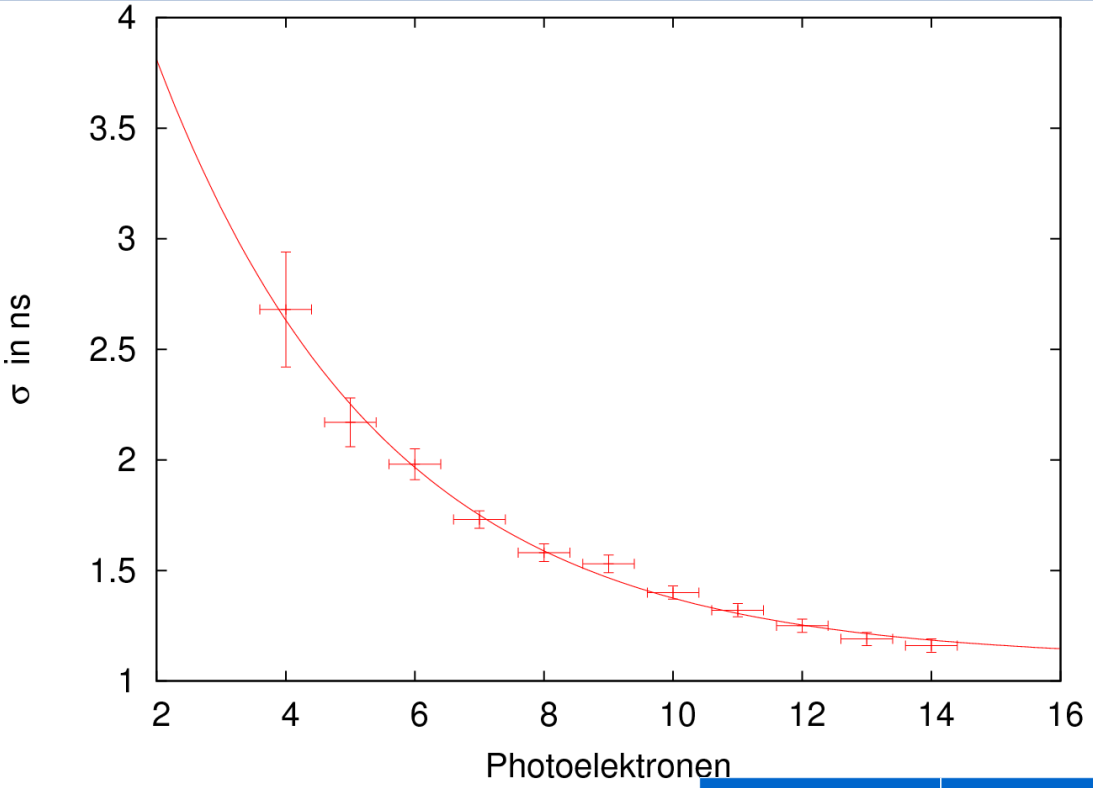
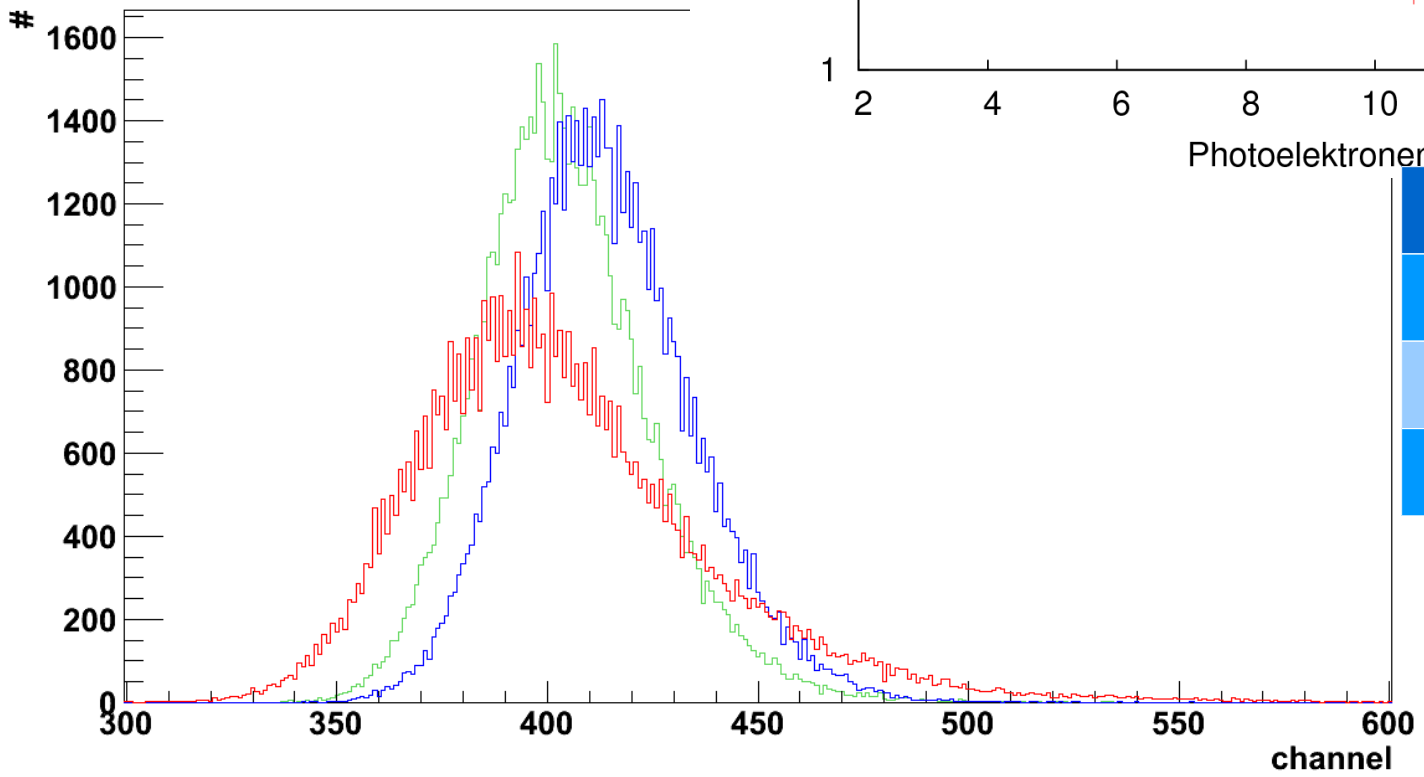
Fibre Closeup



Time Resolution







Model	Sigma
100 C	0,90 ns
50 C	0,94 ns
25 C	1,28 ns

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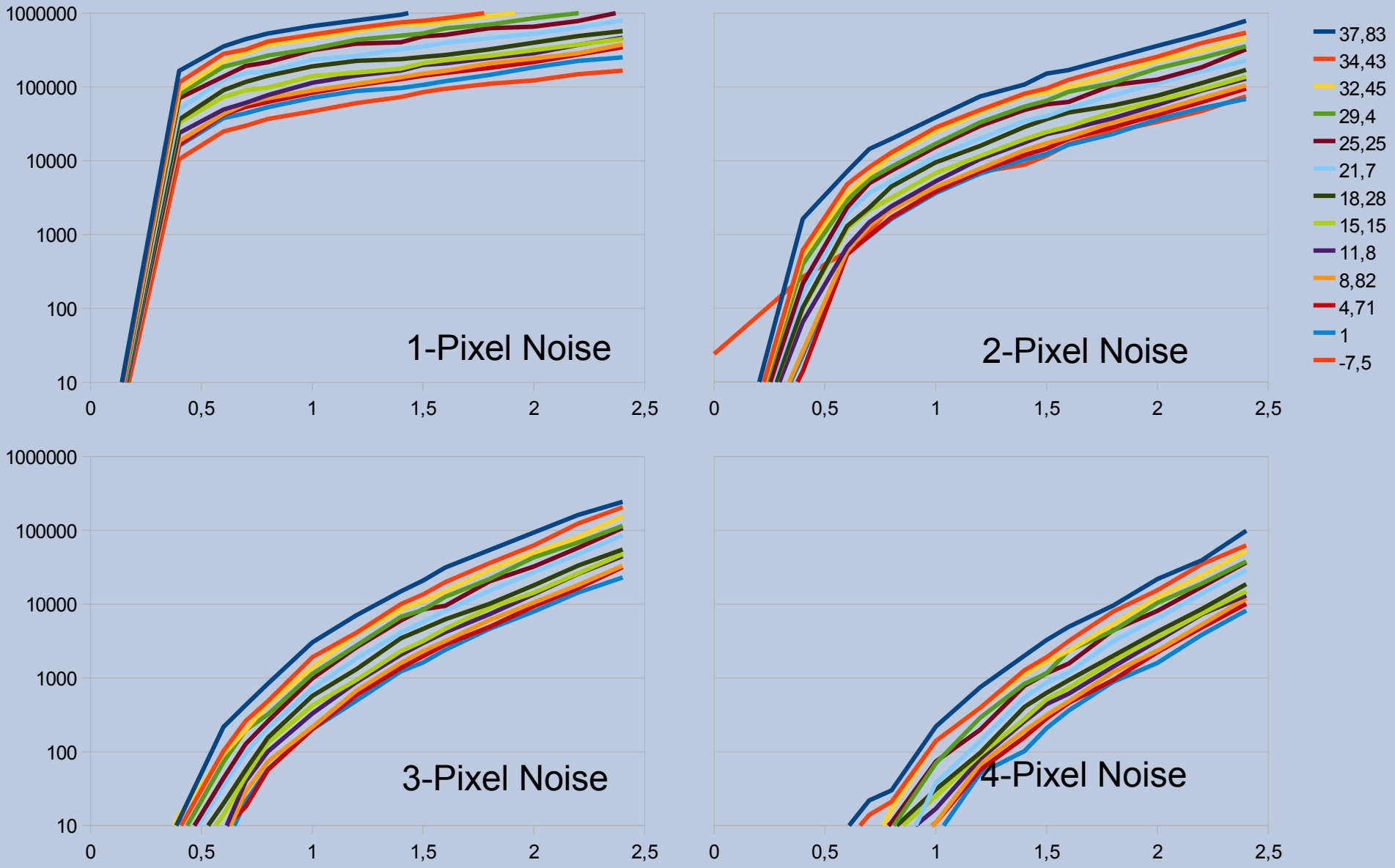
SiPM- Noise vs. OV

~ 1 Order of Magn. / 40 K (dep. on OV)



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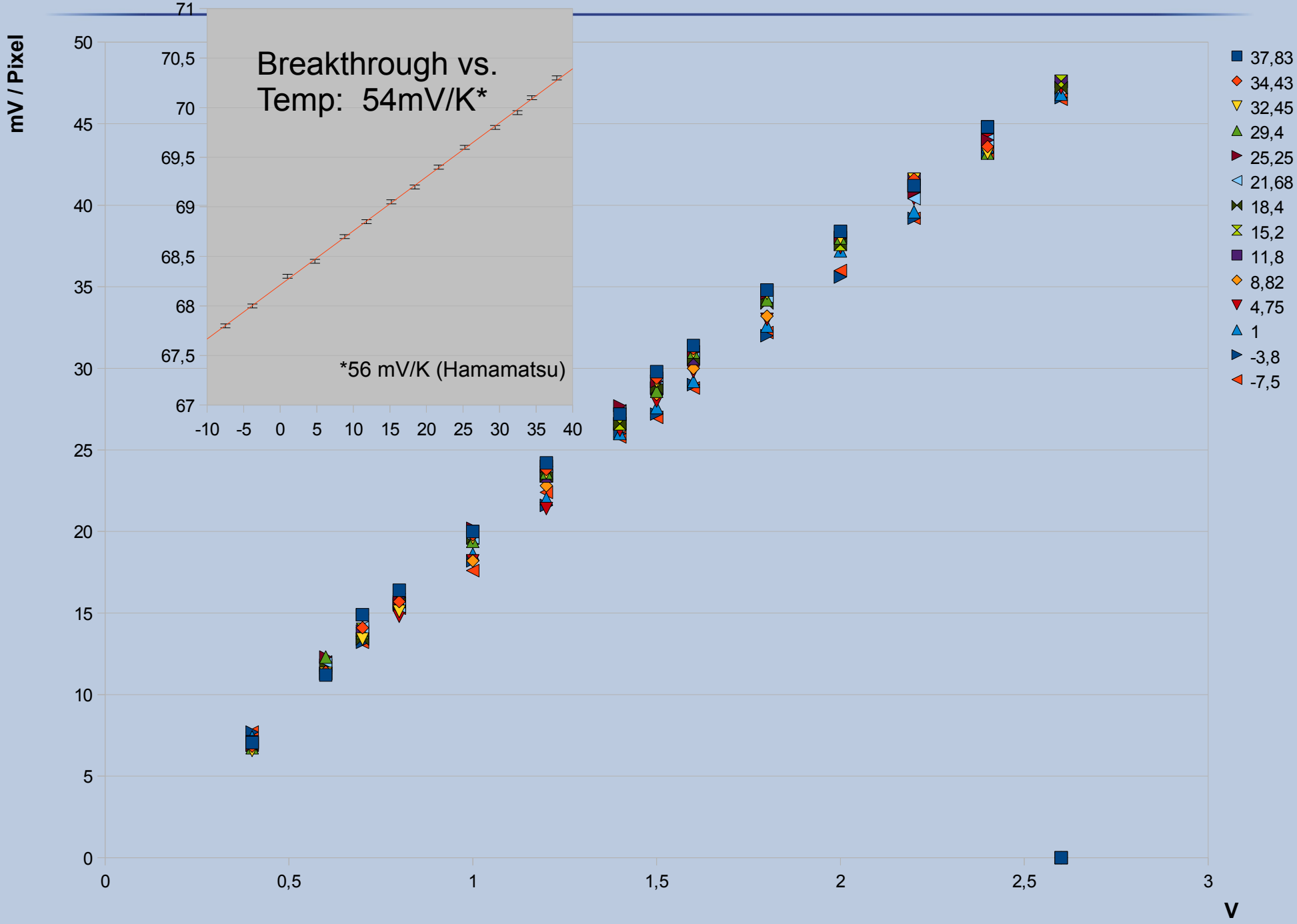
Gain vs. OV : ~18,5 mV / (V · Pixel)