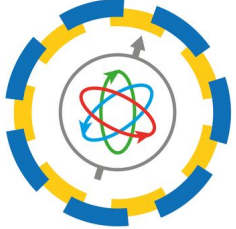


J-PET

Status of detector performance and measurements

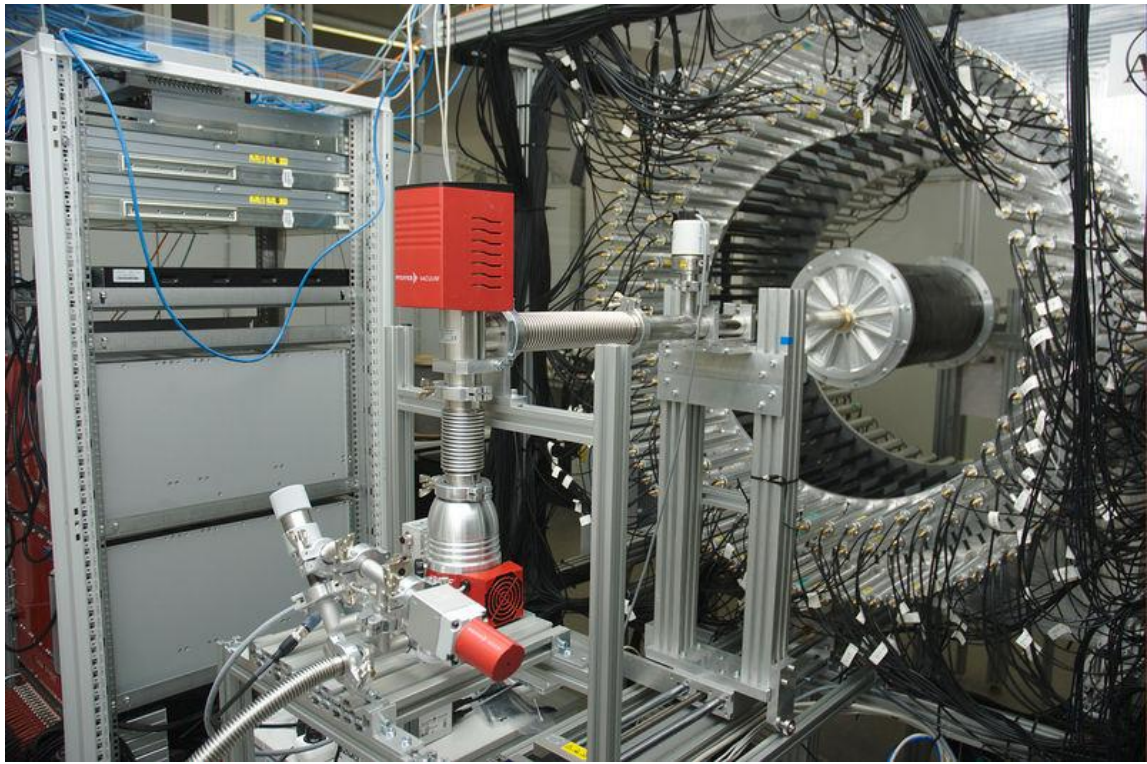
Szymon Niedźwiecki

3rd Symposium on Positron Emission Tomography and 1st Symposium on Boron Neutron Capture Therapy

10th - 15th September 2018

Plan of presentation

1. J-PET prototype
2. Detector performance
3. Measurements done so far
4. Future plans

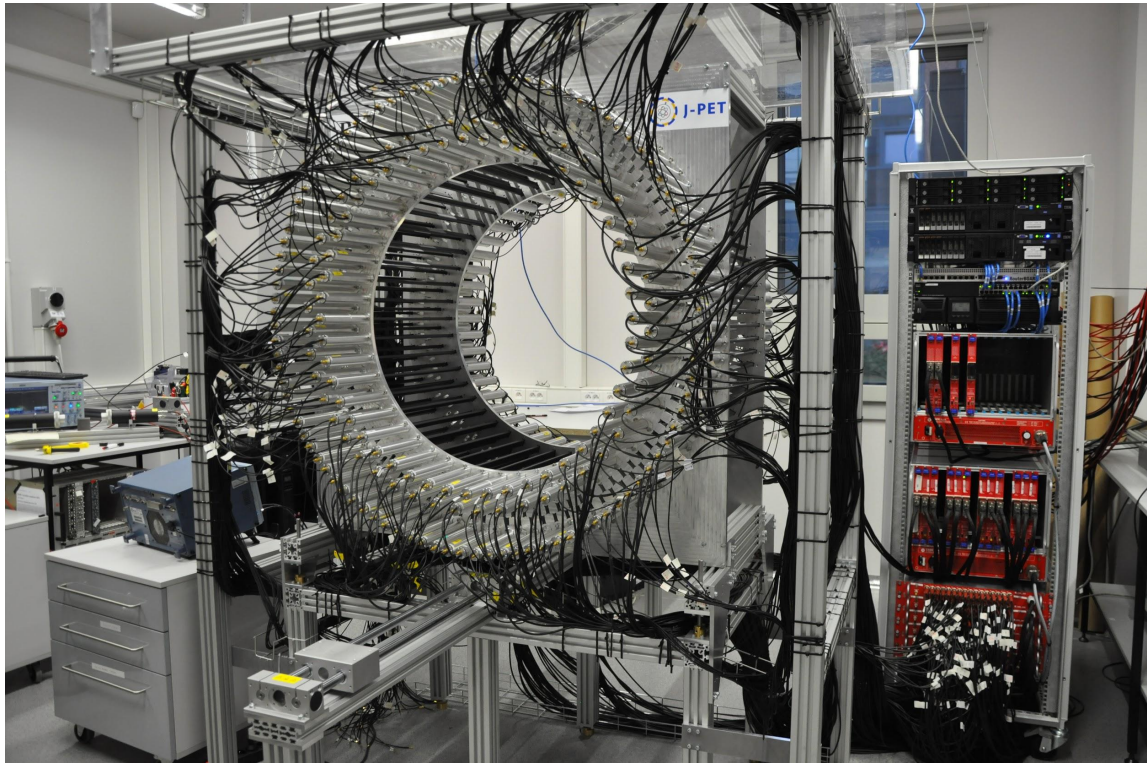


J-PET prototype

192 BC420 scintillators

384 R9800 photomultipliers

1536 channels

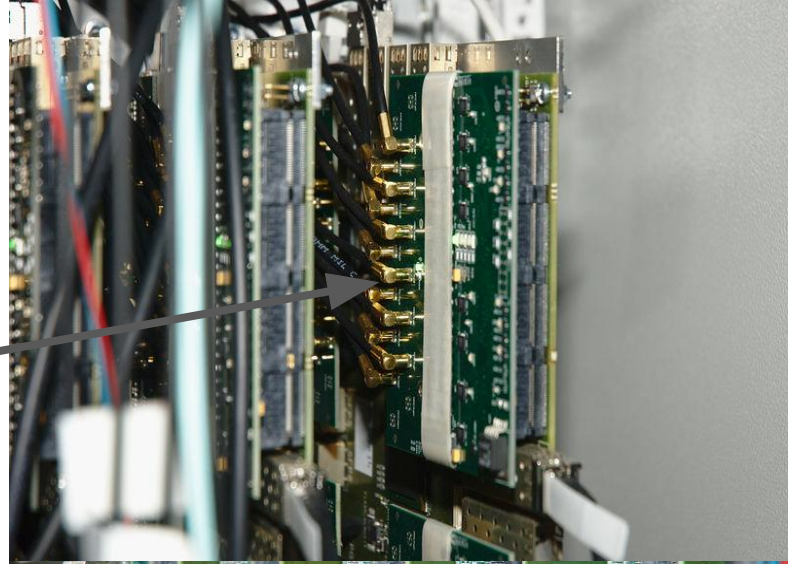


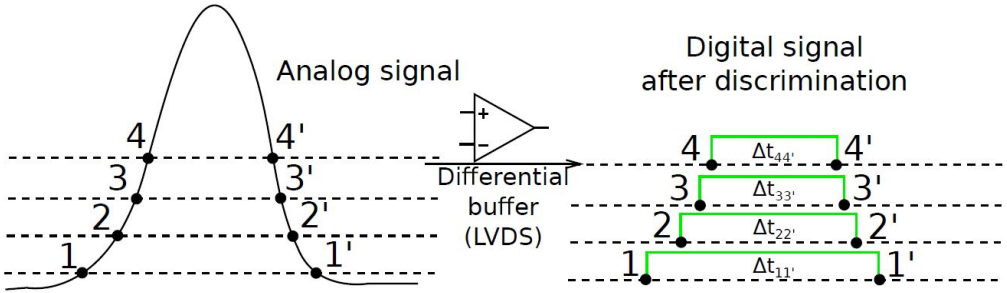
J-PET prototype

PMT signal splitted into 4

Constant threshold discrimination

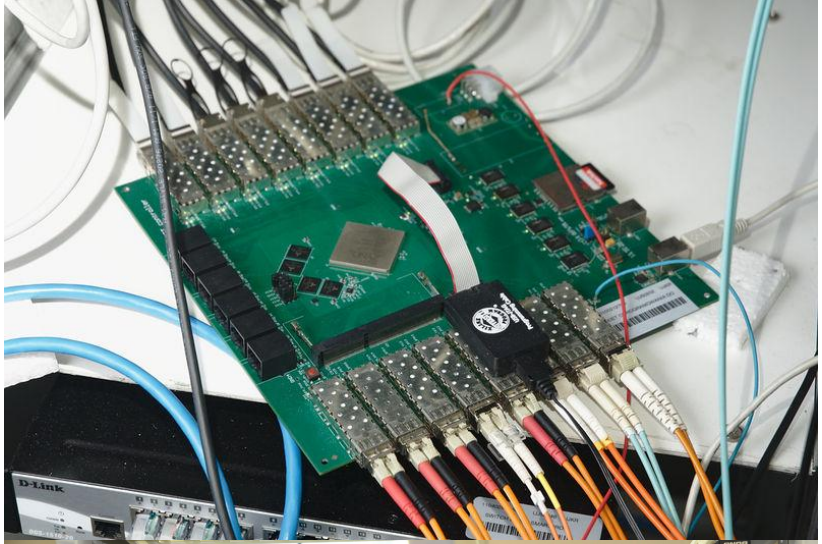
TDC on TRB3 boards



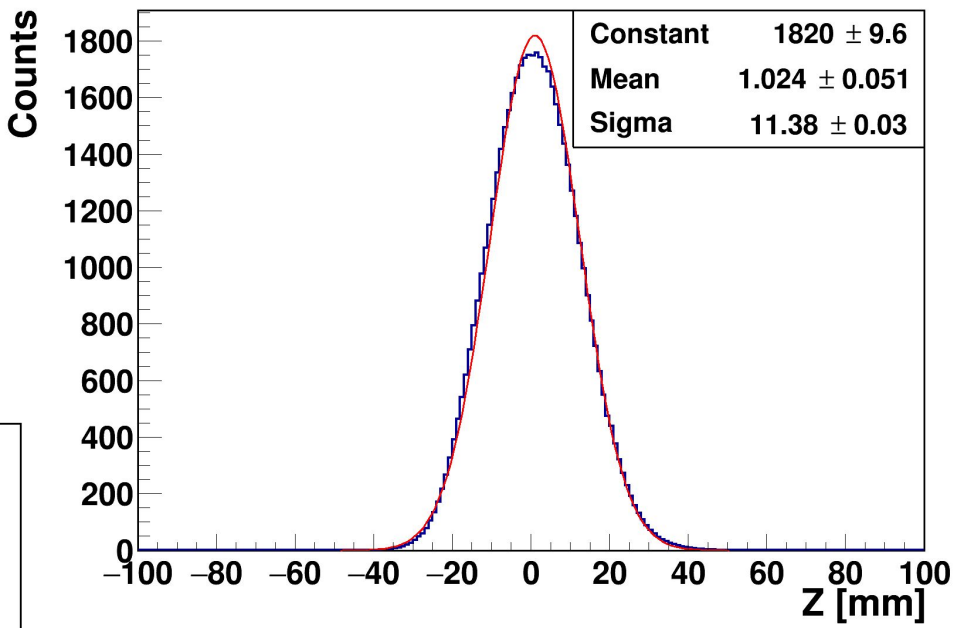


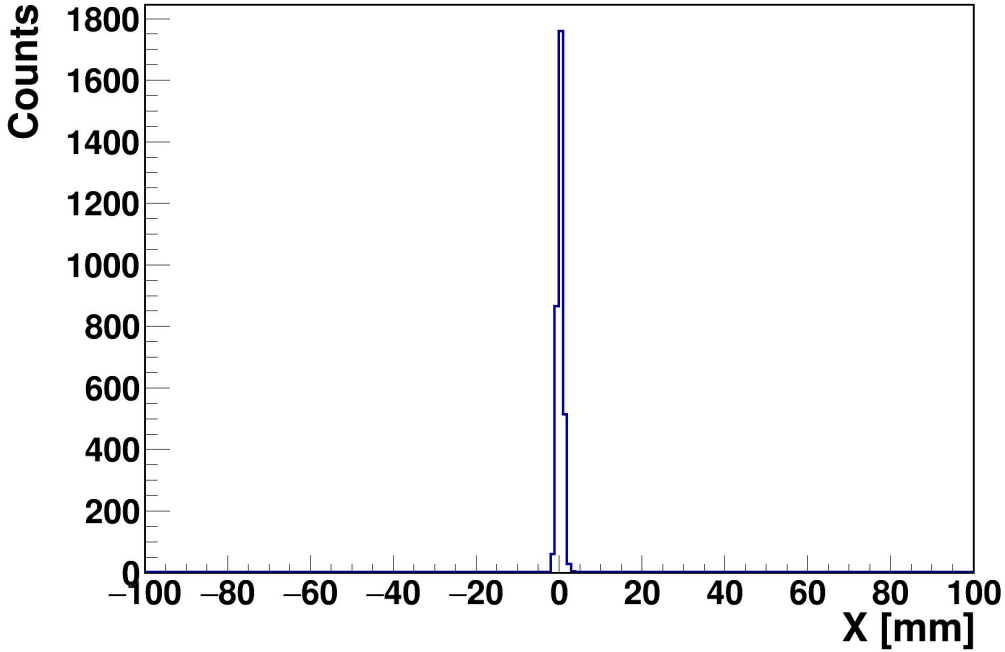
J-PET prototype

Data concentrated on Controller board and sent to servers for compression, analysis, storage etc.



Detector performance: spatial resolution

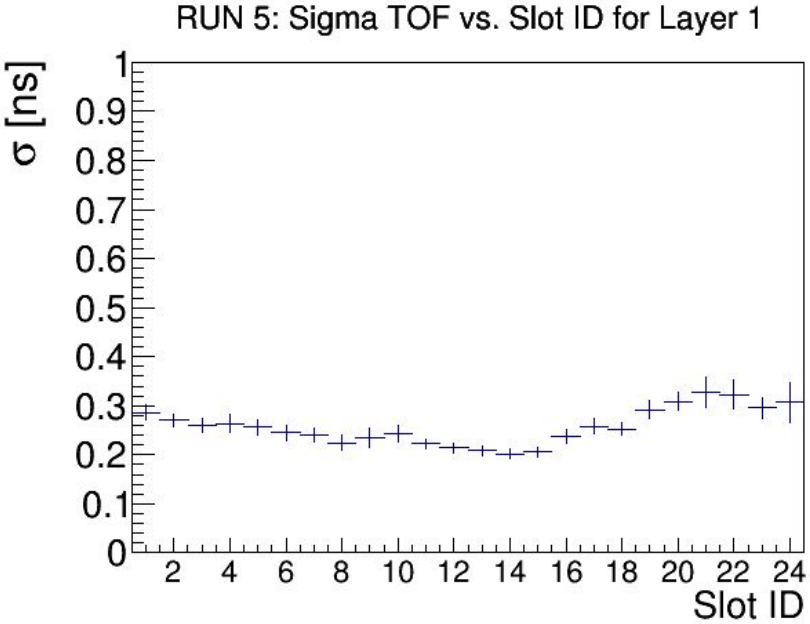


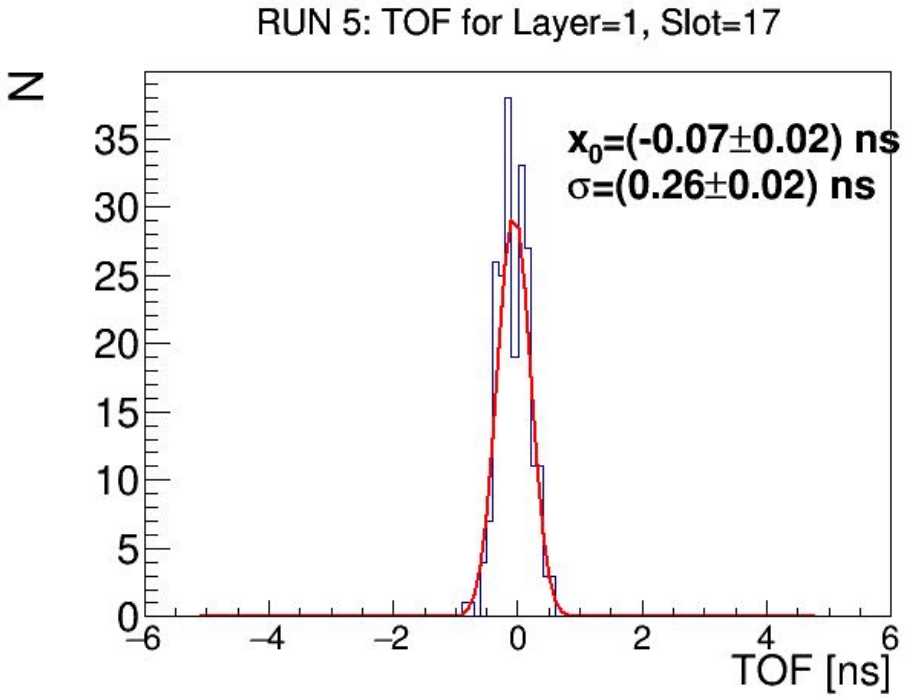


Resolution in XY in the order of source size (2-3 mm)
Resolution in Z ~ 1.2 cm

Preliminary Studies of J-PET Detector Spatial Resolution
Acta Phys. Polon. A 132, no. 5, 1645 (2017)

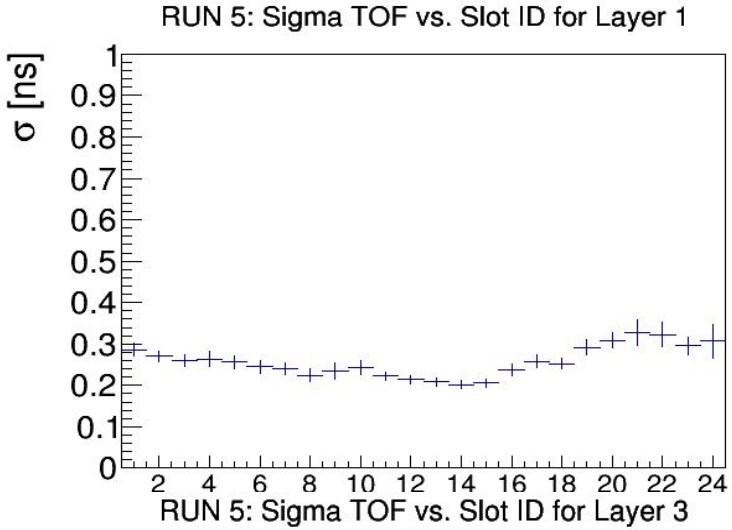
Detector performance: time resolution

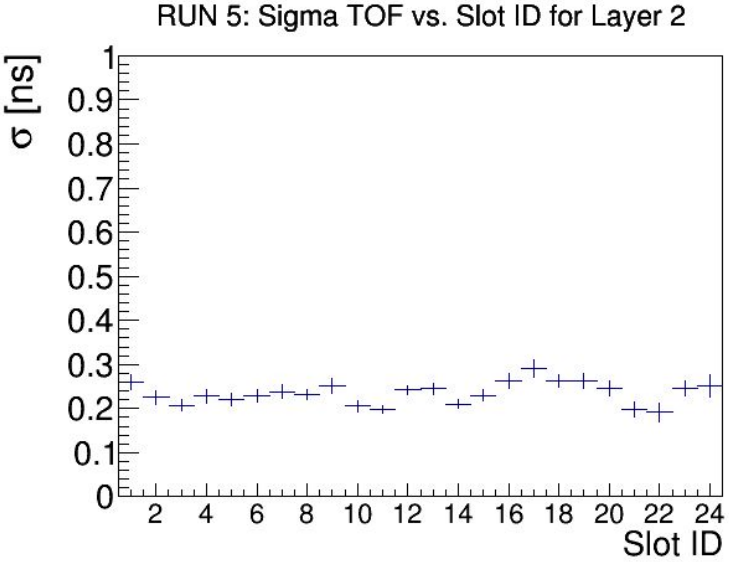




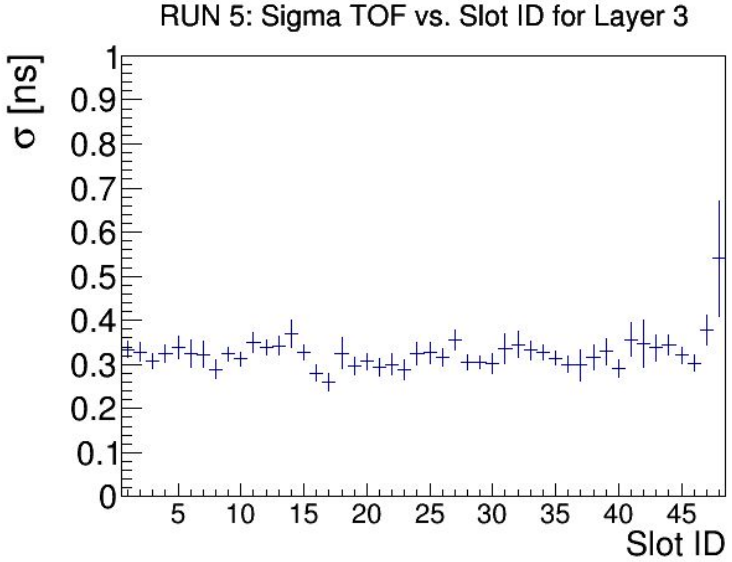
Courtesy of
M. Skurzok

Detector performance: time resolution

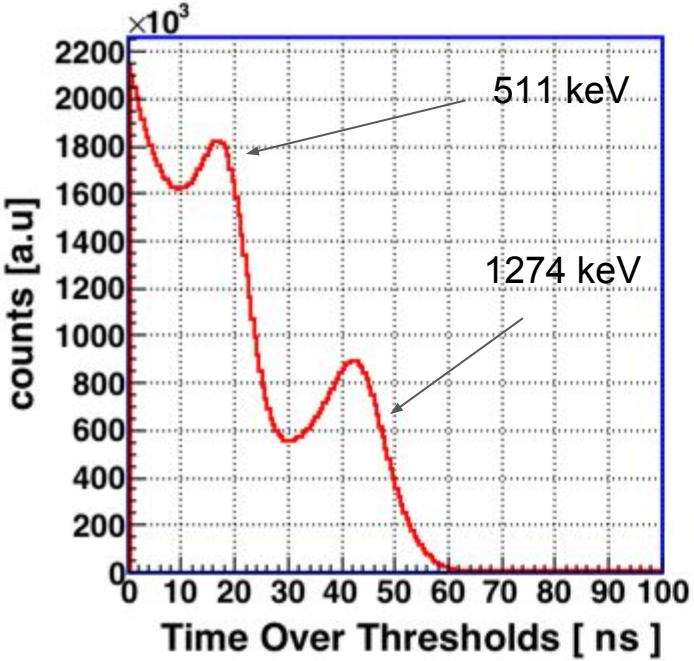




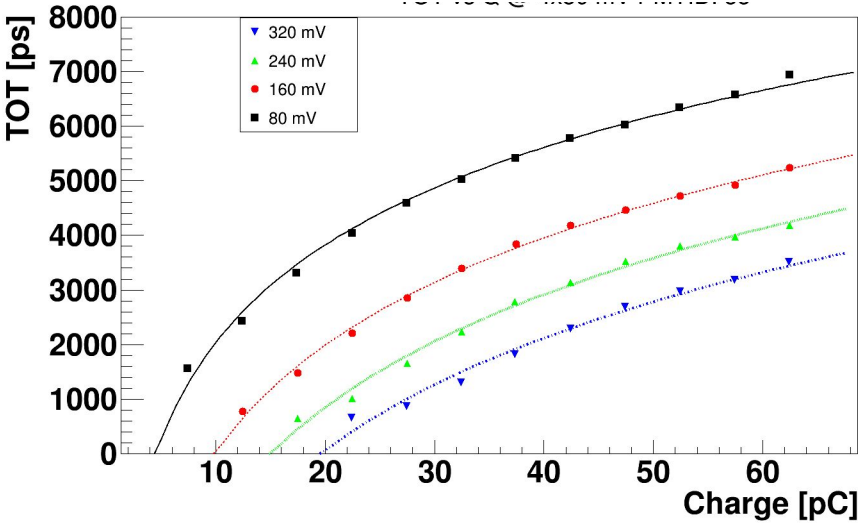
Courtesy of M. Skurzok



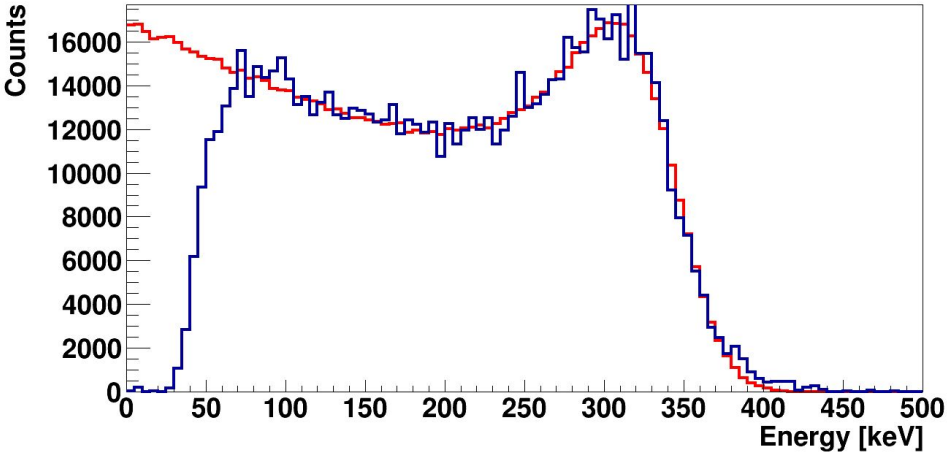
Detector performance: Time Over Threshold

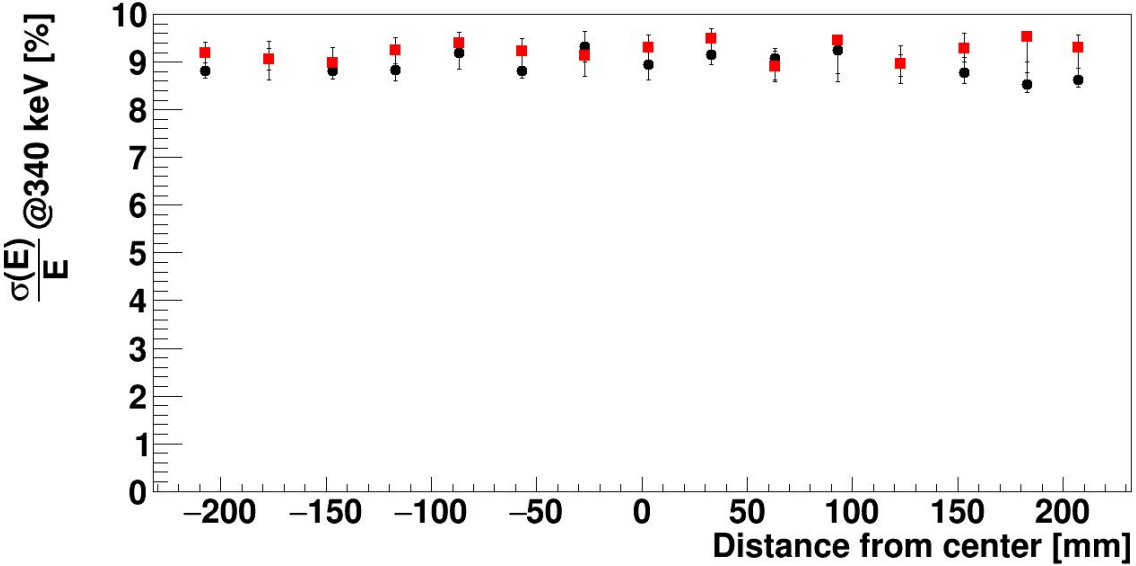


Courtesy of S. Sharma



Detector performance: energy resolution

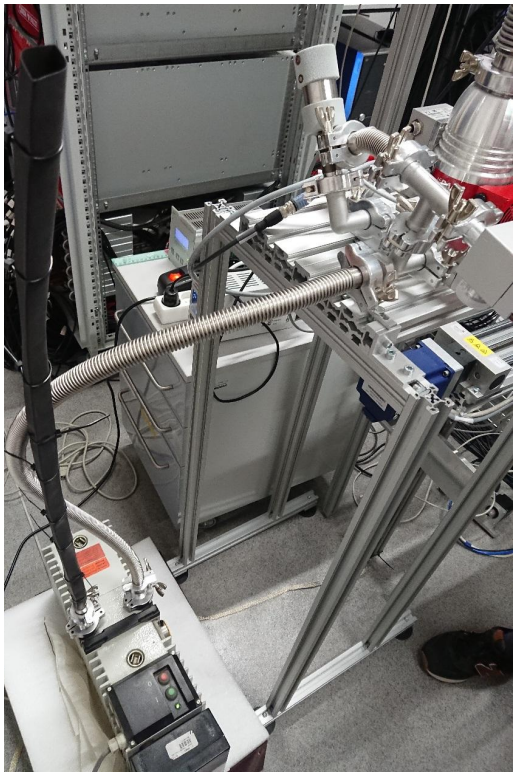




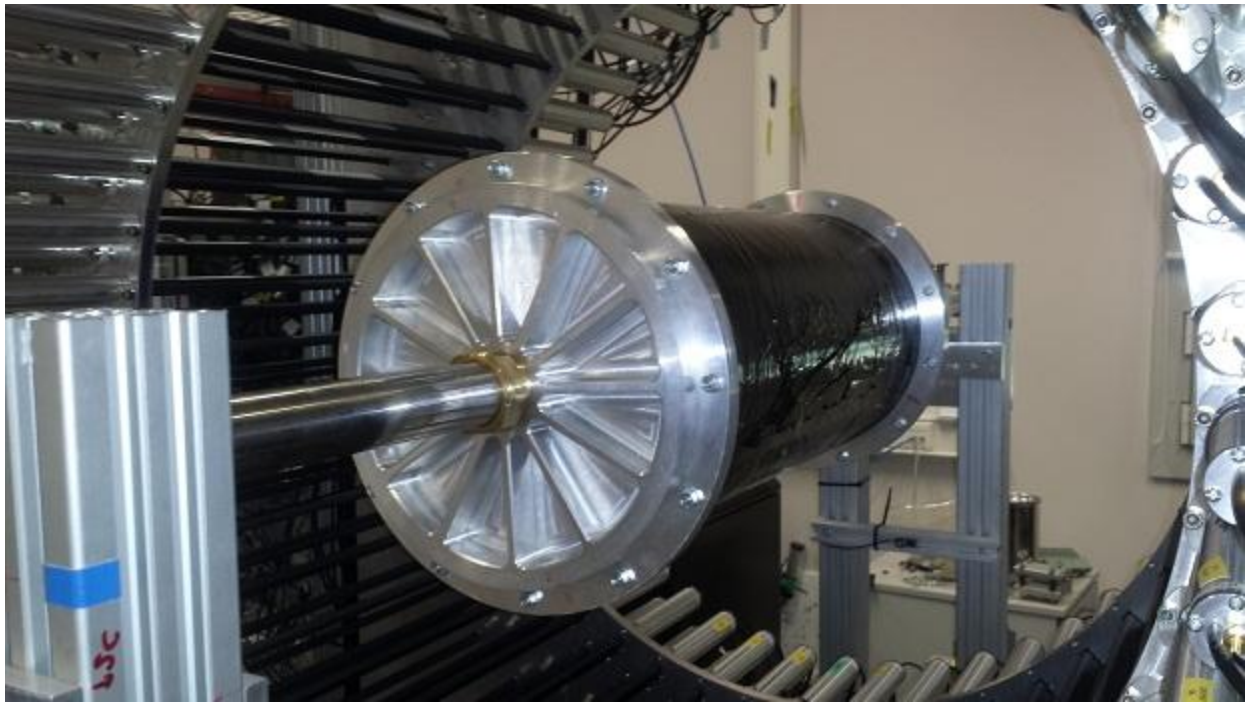
Results from 2 strip studies

Detector performance: pressure

8 Pa => 0.01 Pa => 0.009 Pa



Detector performance: DAQ speed



with ~ 10 MBq source

~100 MB / s of data

~6 GB per minute of raw data

Performed measurements

Calibration

- count rates
- velocity
- time
- cosmics

Physics

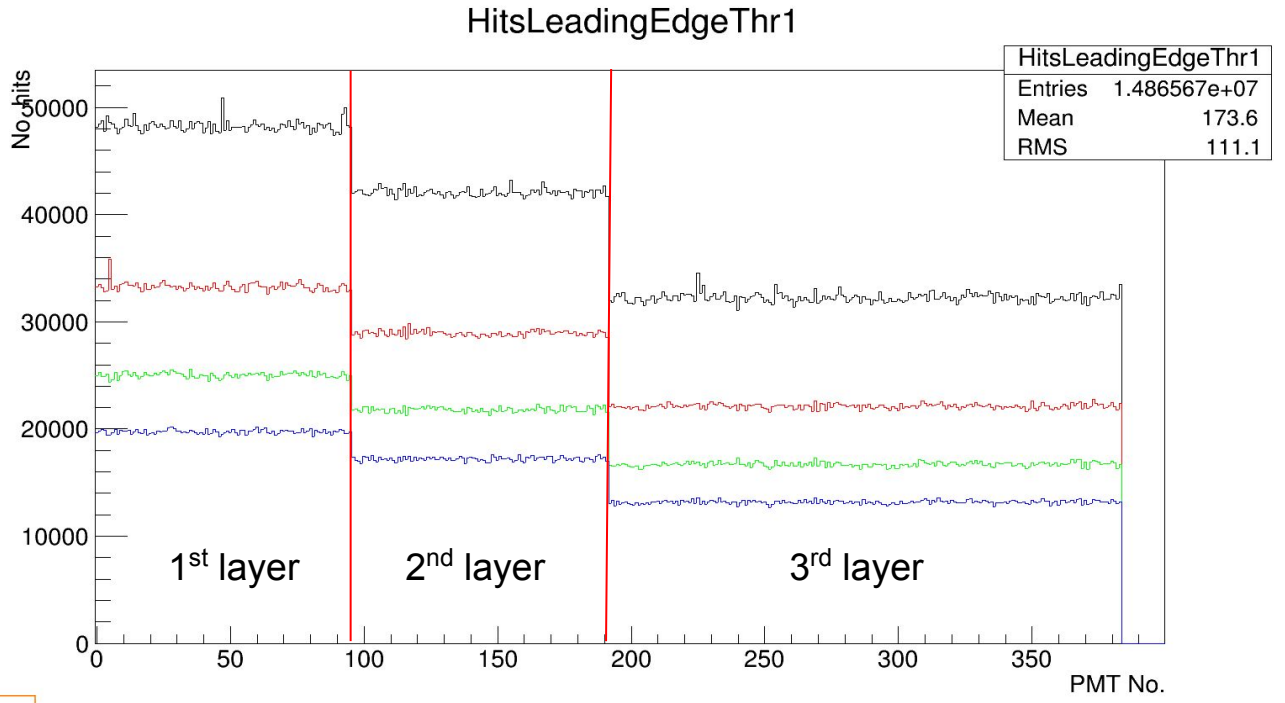
- o-Ps and p-Ps decay
- polarization of photons
- quantum entanglement
- symmetry breaking

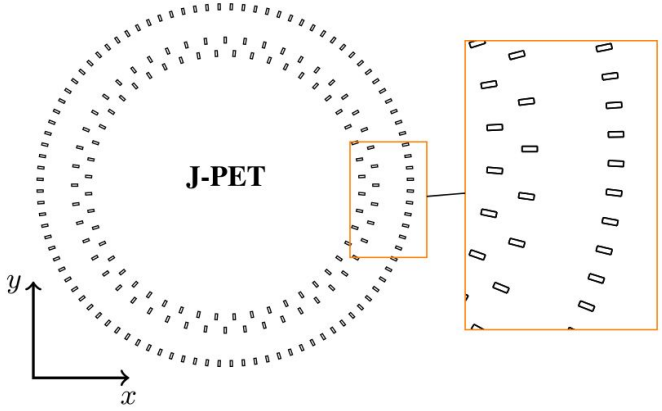
Medical

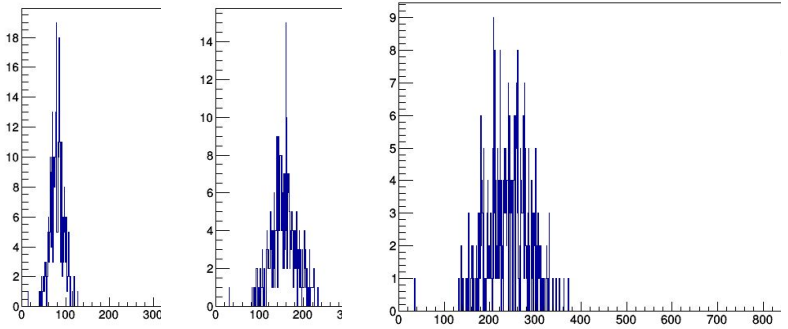
- new diagnostic parameters
- NEMA characteristics

Calibration: count rates

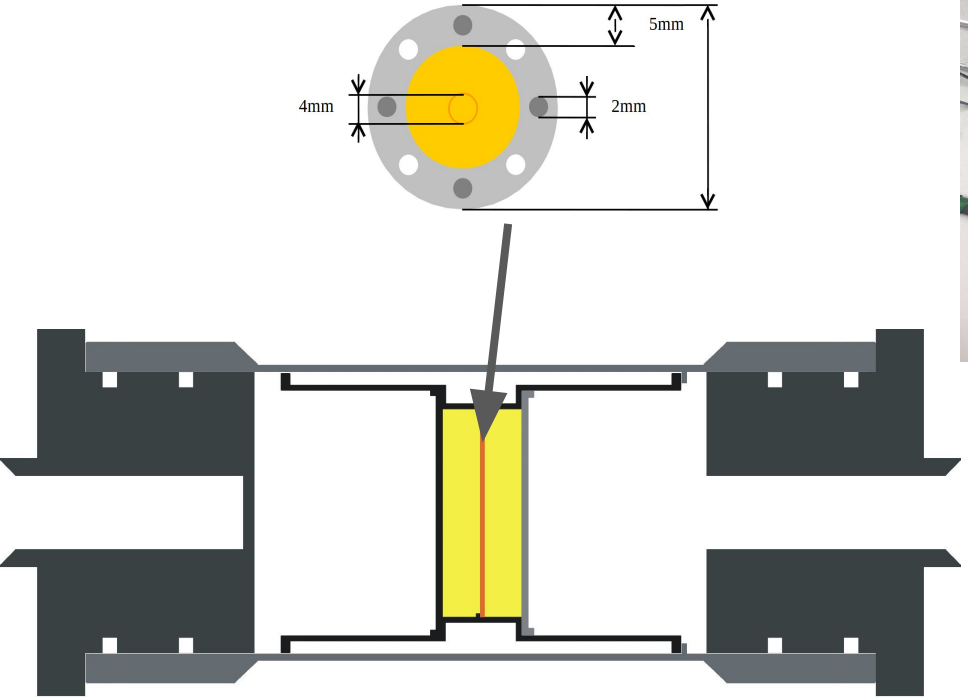
- Source placed at the center of detector
- Interlayer ratios from Geant4 simulations







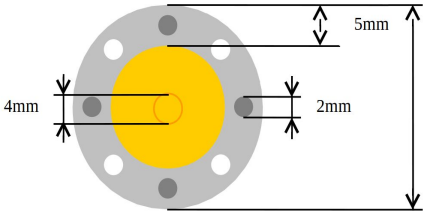
Performed measurements:
Run 1

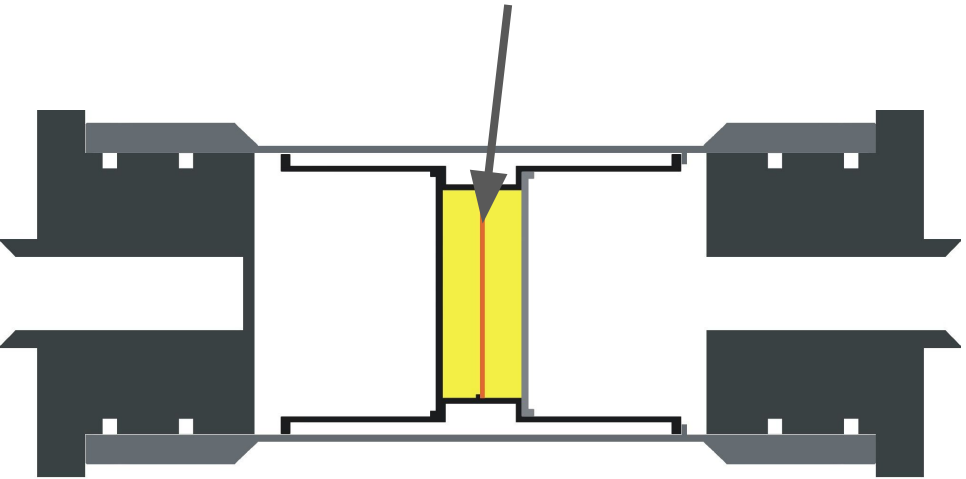


Small chamber with XAD4

yellow colour - XAD4
orange colour - ^{22}Na source

Performed measurements: Run 1



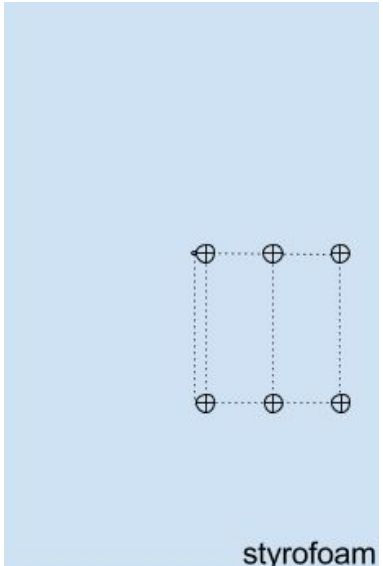


Small chamber with XAD4

yellow colour - XAD4
orange colour - ^{22}Na source

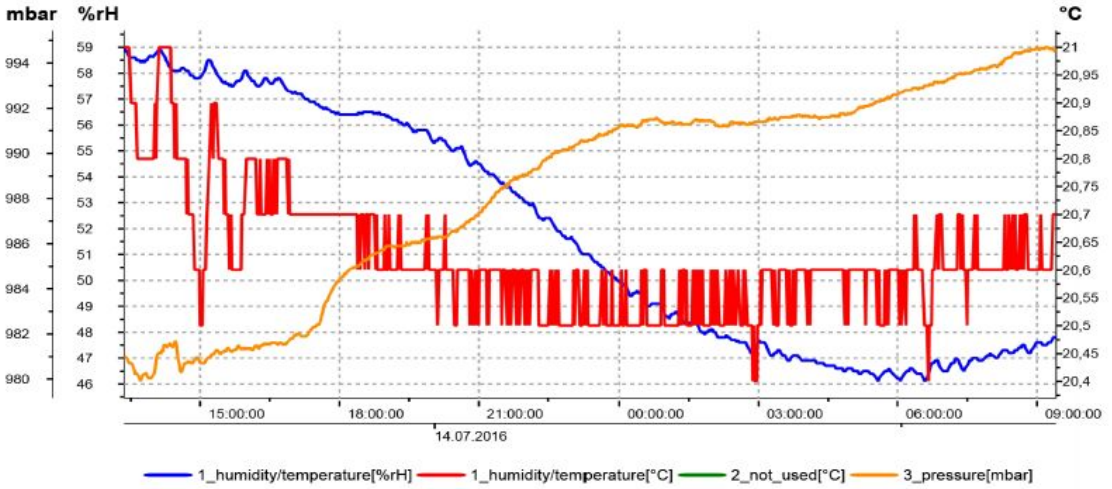
Performed measurements: Run 1

^{22}Na source

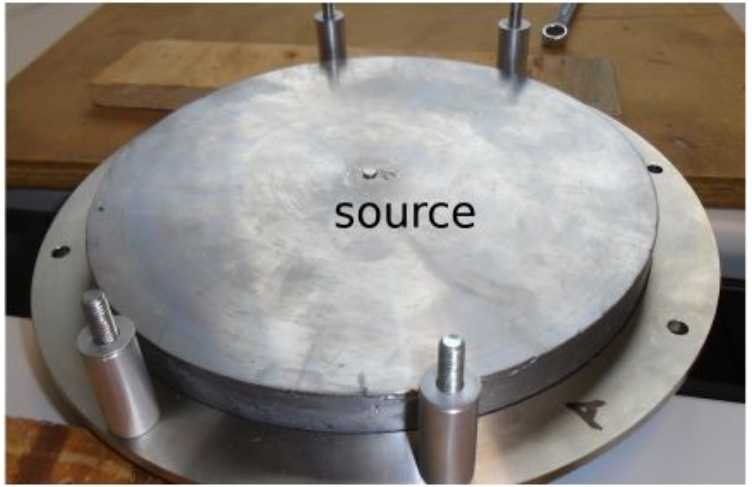


Performed measurements:
Run 1

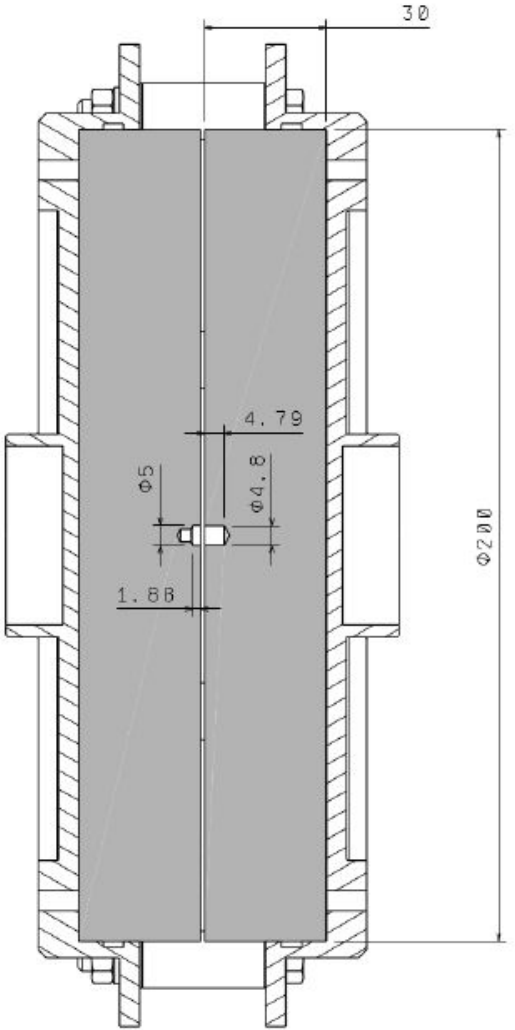
Instrument name: J-PET		2016-07-15 09:38:37			Page 1/1
Start time: 2016-07-14 13:21:46		Minimum	Maximum	Mean value	Limit values
End time: 2016-07-15 09:24:46	1_humidity/temperature [%rH]	46,10	59,00	51,778	0,0/100,0
Measurement channels: 4	1_humidity/temperature [°C]	20,40	21,00	20,620	0,0/70,0
Measured values: 1204	2_not_used [°C]	----	----	----	0,0/0,0
SN 41000813	3_pressure [mbar]	979,90	994,70	988,455	600,0/1100,0
lab					

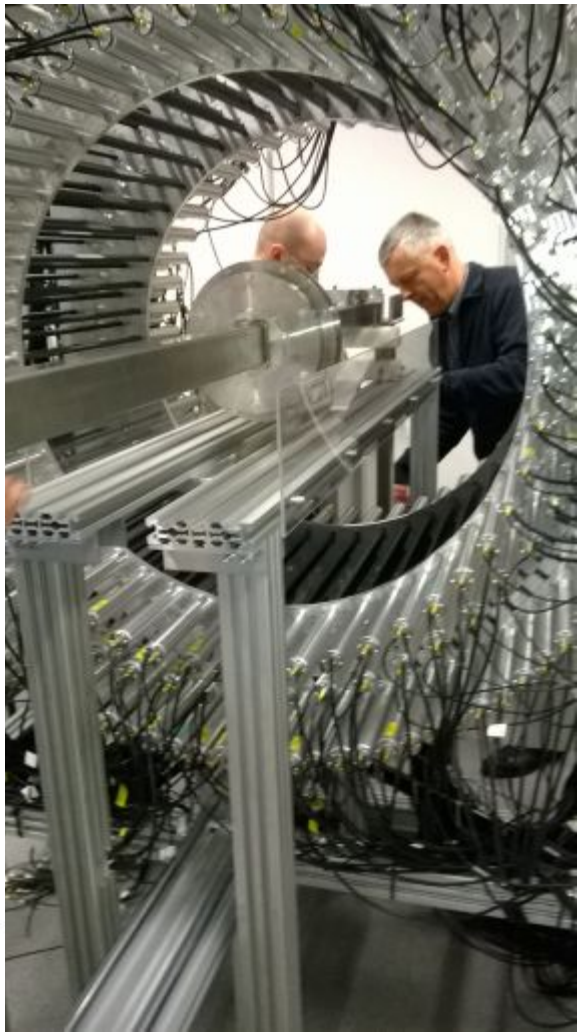


Performed measurements: Run 1

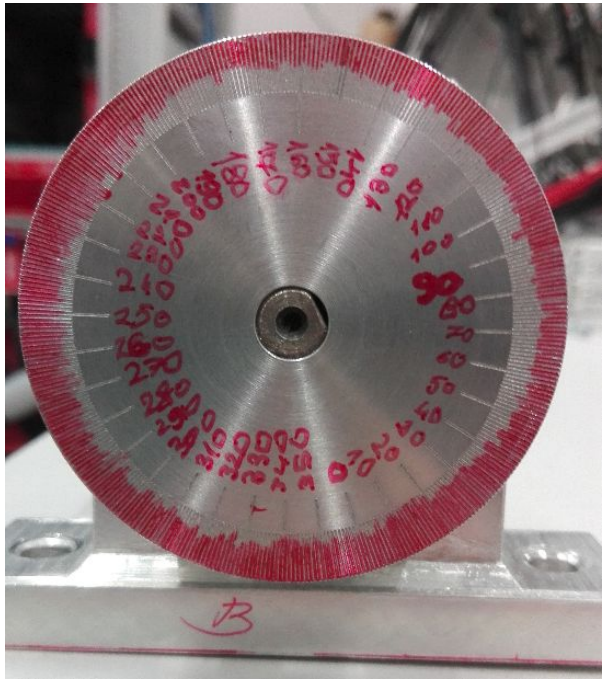


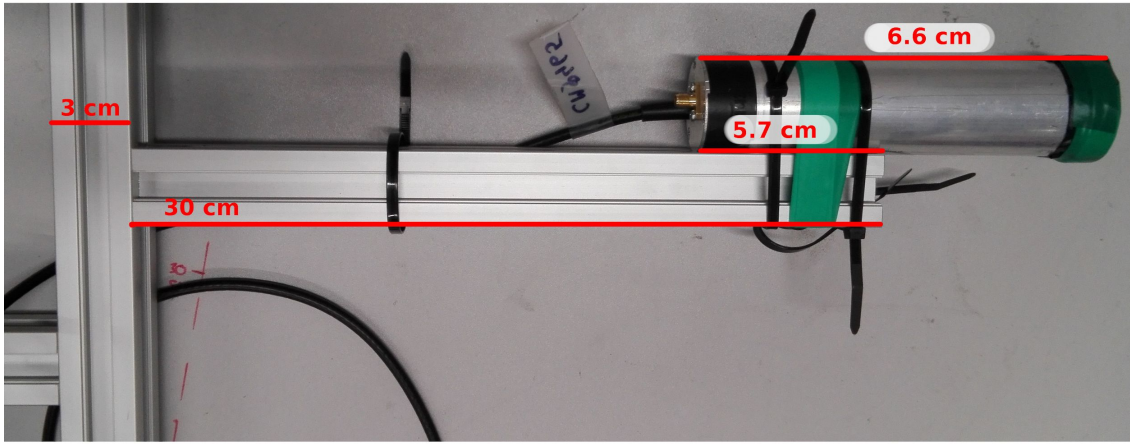
Performed measurements: Run 1





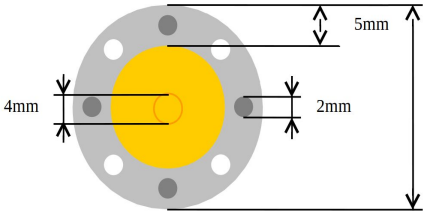
Performed measurements:
Run 1

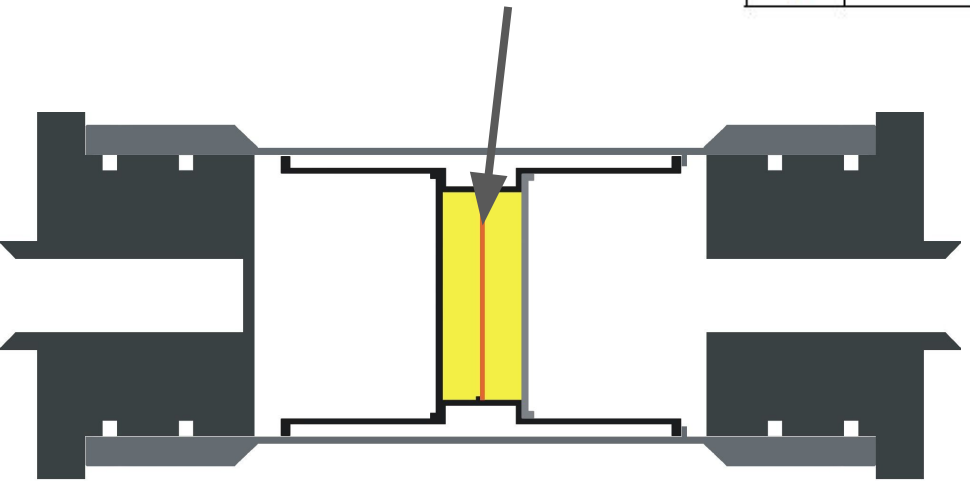




Performed measurements:
Run 2

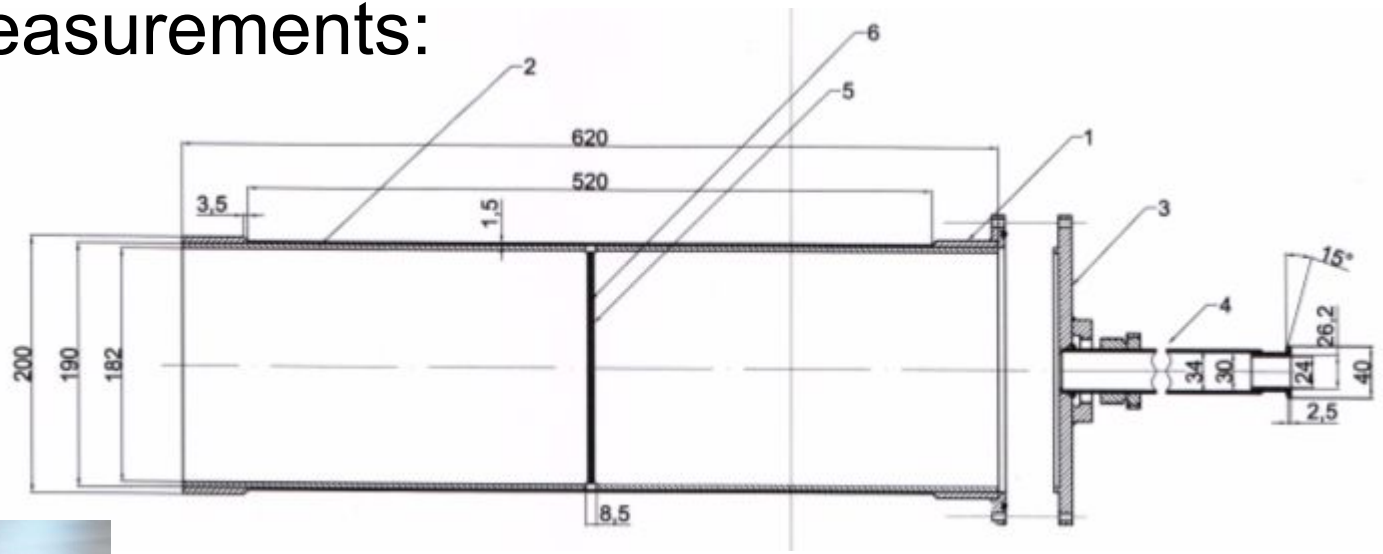
No.	Measurement	start	stop
1	thresholds synchronization	27.09.2016	28.08.2016
2	6 polymer samples	12.10.2016	14.10.2016
3	XAD4 sample	14.10.2016	07.11.2016
4	measurements with reference detector	07.11.2016	11.11.2016
5	mesurements with collimator	10.11.2016	12.11.2016
6	thresholds calibration	15.11.2016	15.11.2016





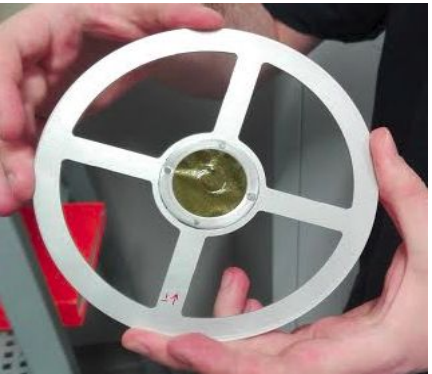
yellow colour - sample
orange colour - ^{22}Na source

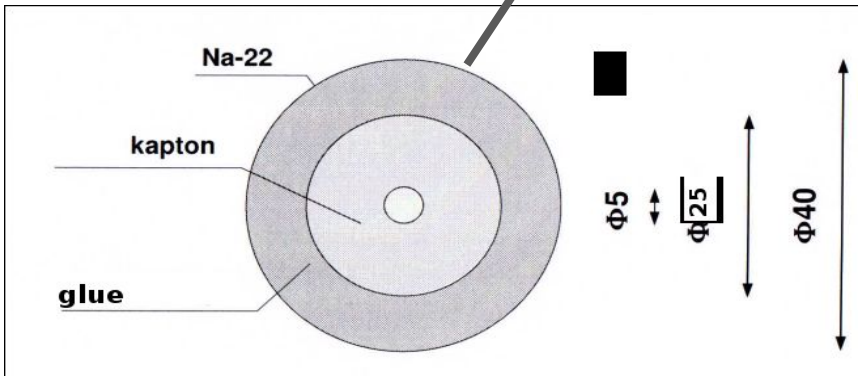
Performed measurements: Run 3

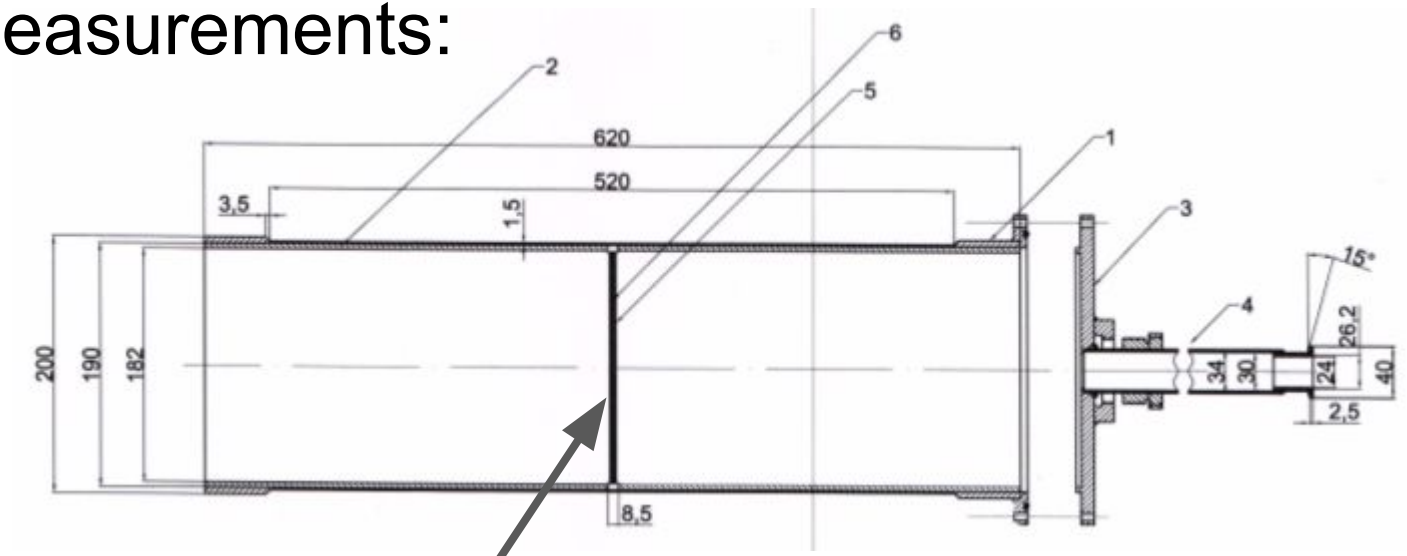


Large chamber

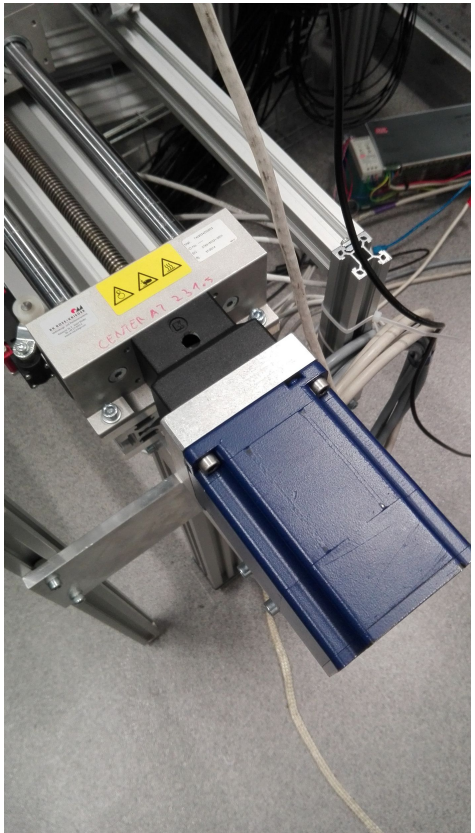
Performed measurements: Run 3





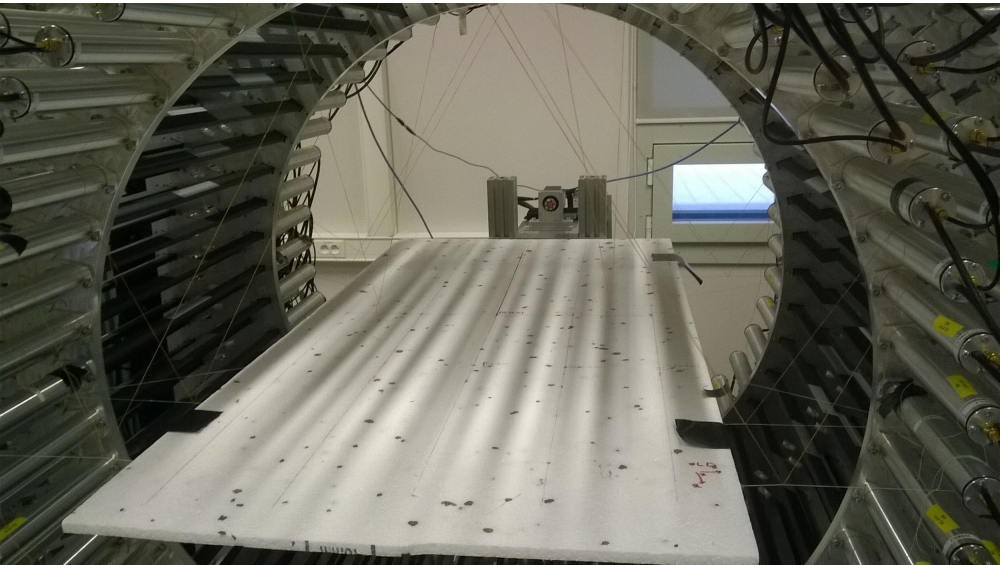


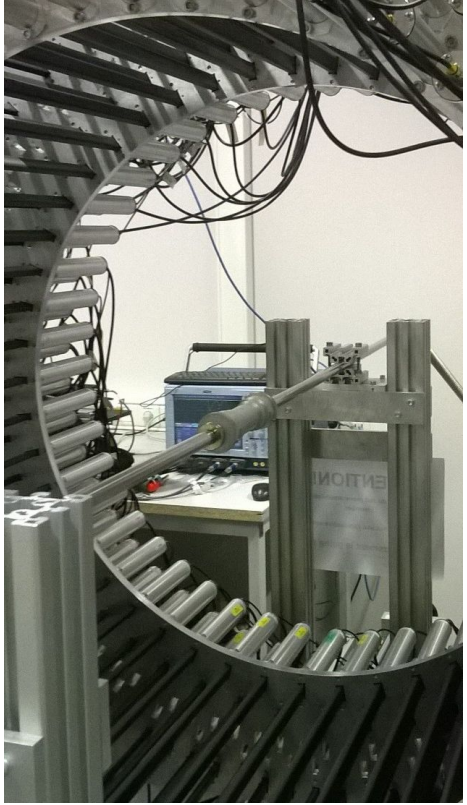
Performed measurements: Run 3



Performed measurements: Run 4

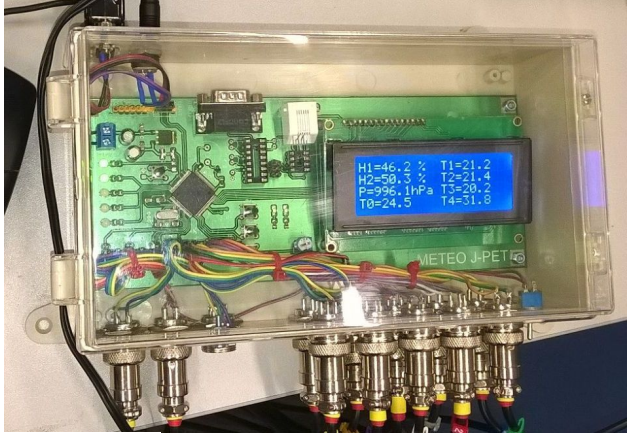
NEMA studies

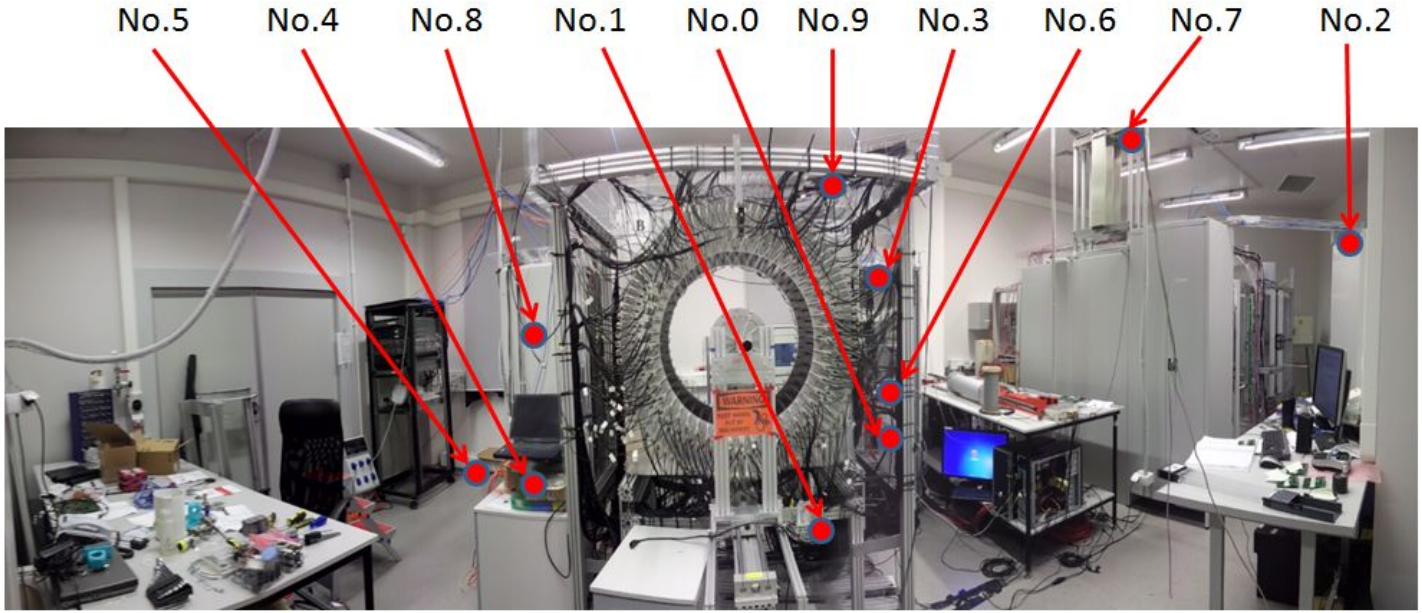




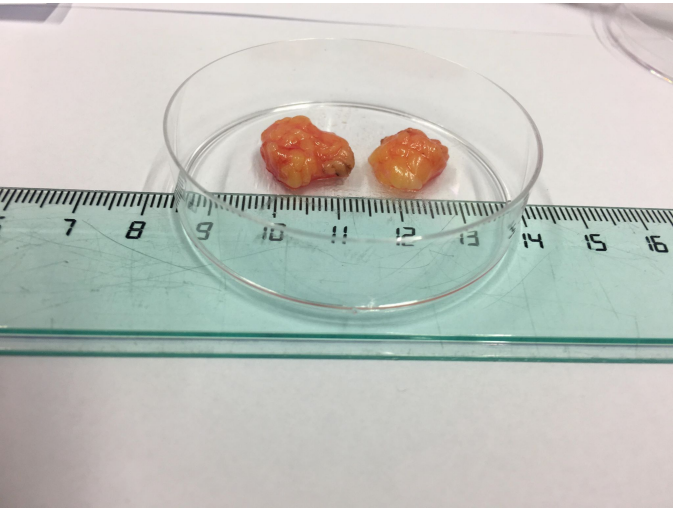
Small chamber with XAD4

Performed measurements:
Run 4





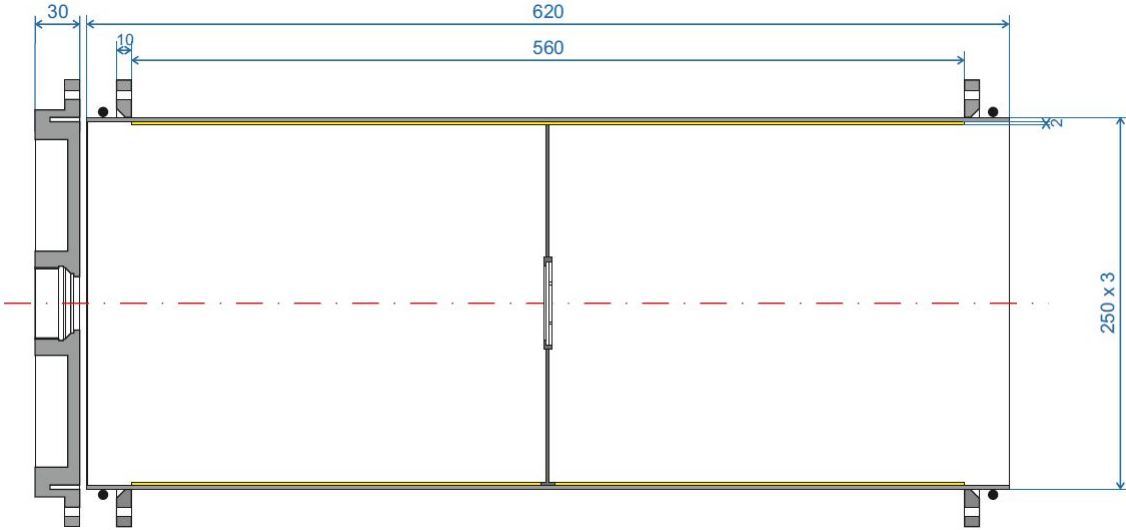
Performed measurements: Run 5



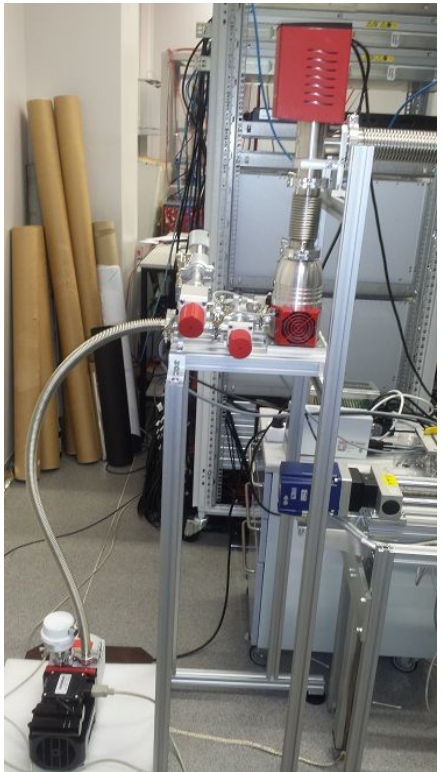
Tumor samples

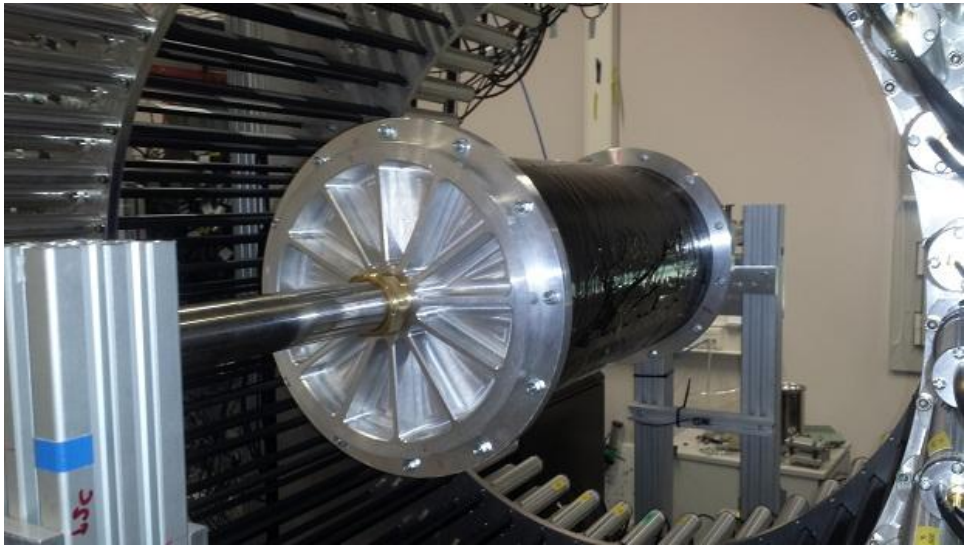
Small chamber with XAD4

Performed measurements:
Run 6



Performed measurements:
Run 6





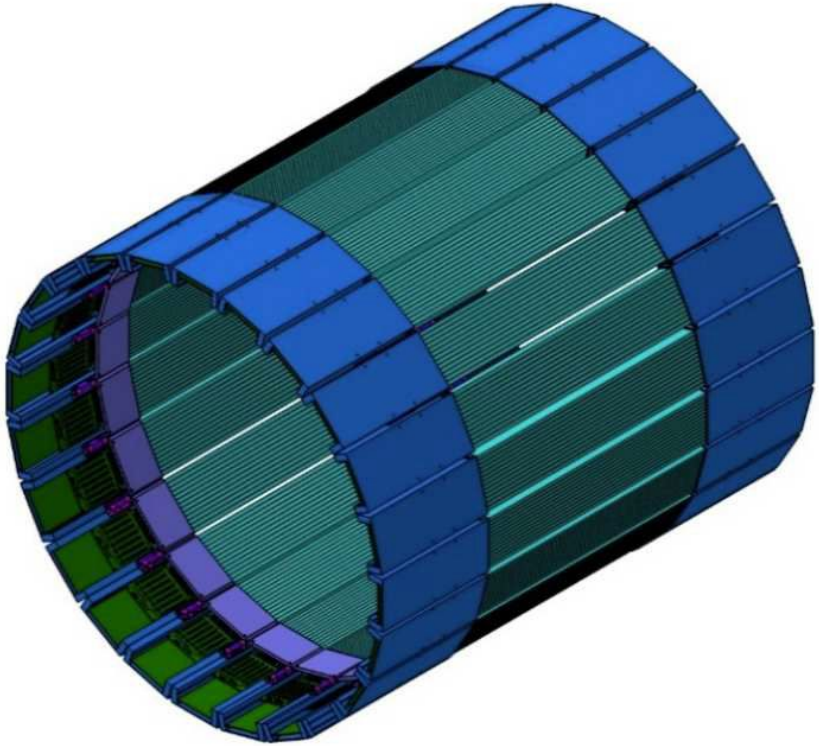
Performed measurements: Runs summary

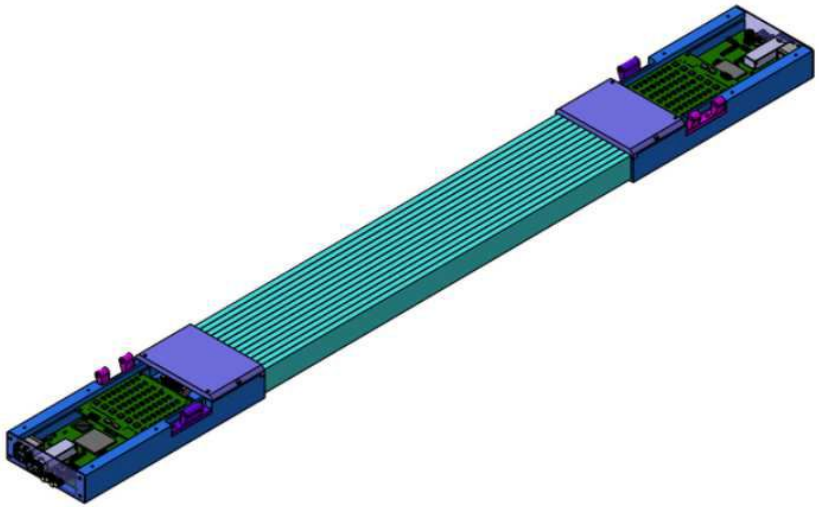
RUN	Time period	Length [days]	Measurements
1	07.2016	8	NEMA and NEMA-like spatial resolution studies, small chamber with XAD with rotary pump
2	09 -11.2016	49	Small chamber, with rotary pump, with different polymer samples: C16, Q1, A22, PIII, F27, B20, XAD4
3	01-04.2017	77	Big annihilation chamber with rotary pump
4	07-10.2017	87	NEMA and NEMA-like spatial resolution studies, small chamber with XAD with rotary pump, cosmic radiation
5	10.2017-01.2018	87	Small chamber with rotary pump, biological samples
6	05.2018 - NOW	128	Big annihilation chamber coated with porous material, with turbo and rotary pumps

Performed measurements: gathered data summary

RUN	Time period	Length [days]	Data gathered [TB]
1	07.2016	8	27
2	09 -11.2016	49	
3	01-04.2017	77	13
4	07-10.2017	87	22
5	10.2017-01.2018	87	328
6	05.2018 - NOW	128	462

Assembly of fourth layer in current prototype and as standalone detector

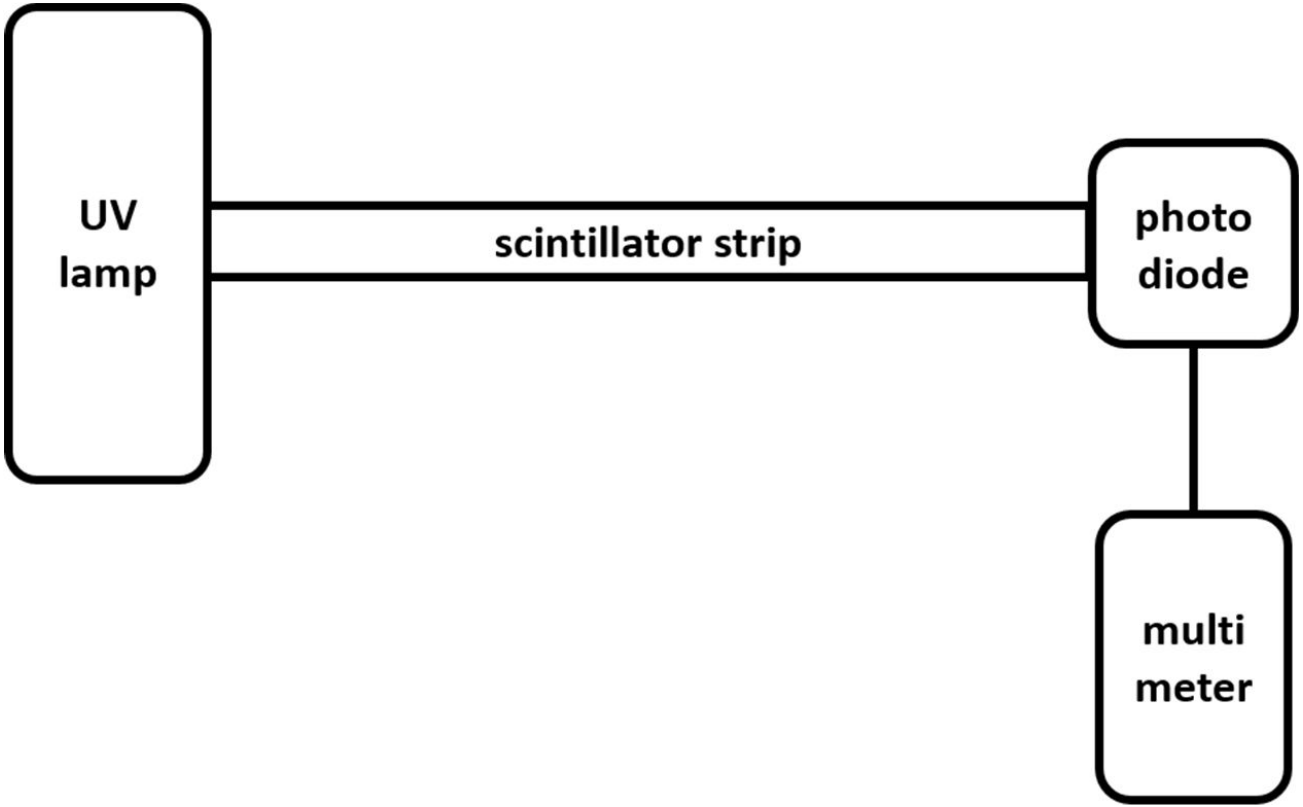




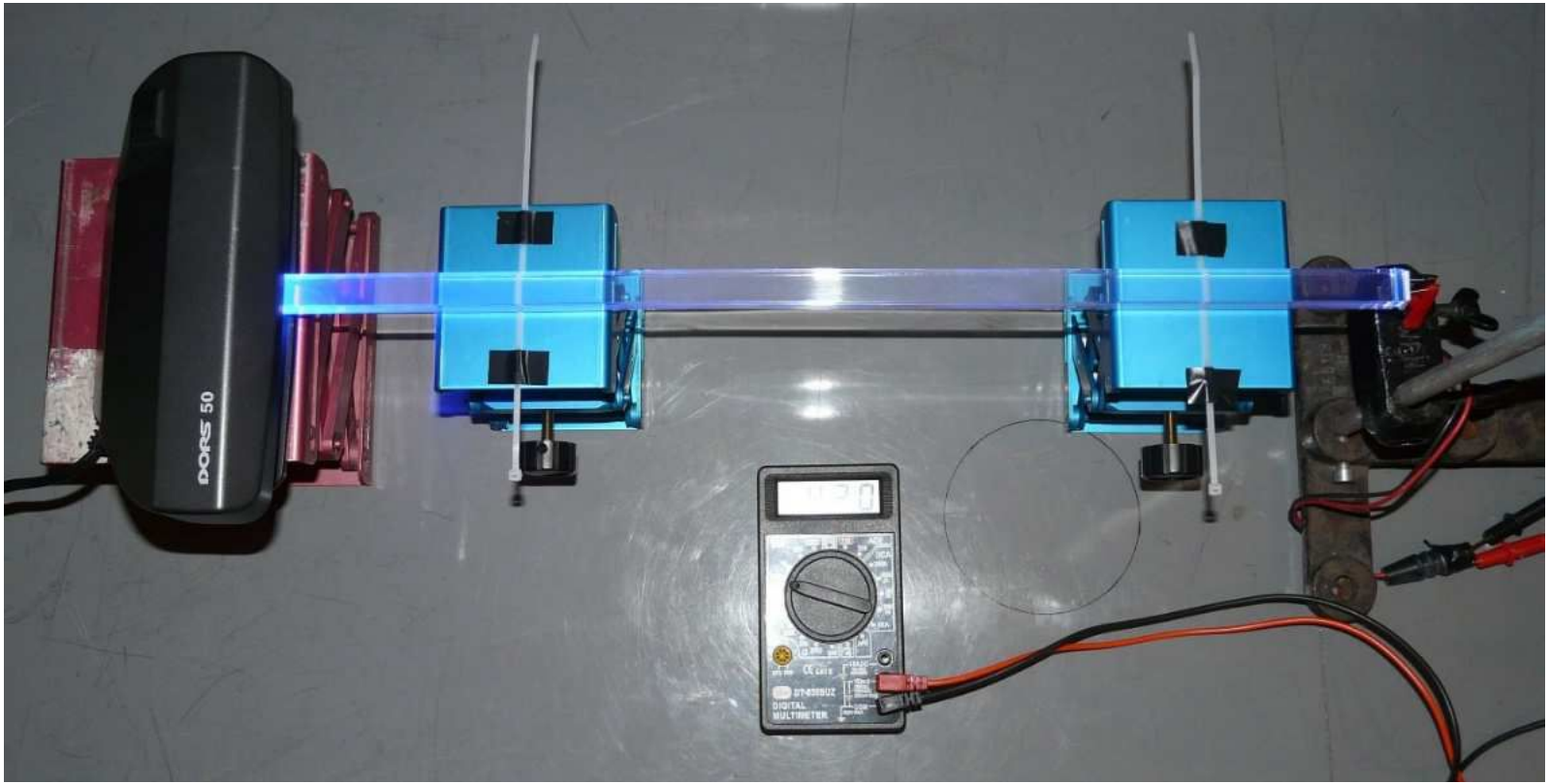
Assembly of fourth layer in current prototype and as standalone detector

- Scintillator tests
- SiPM gluing, wrapping and tests
- Preamps tests
- FTAB tests
- Module assembly

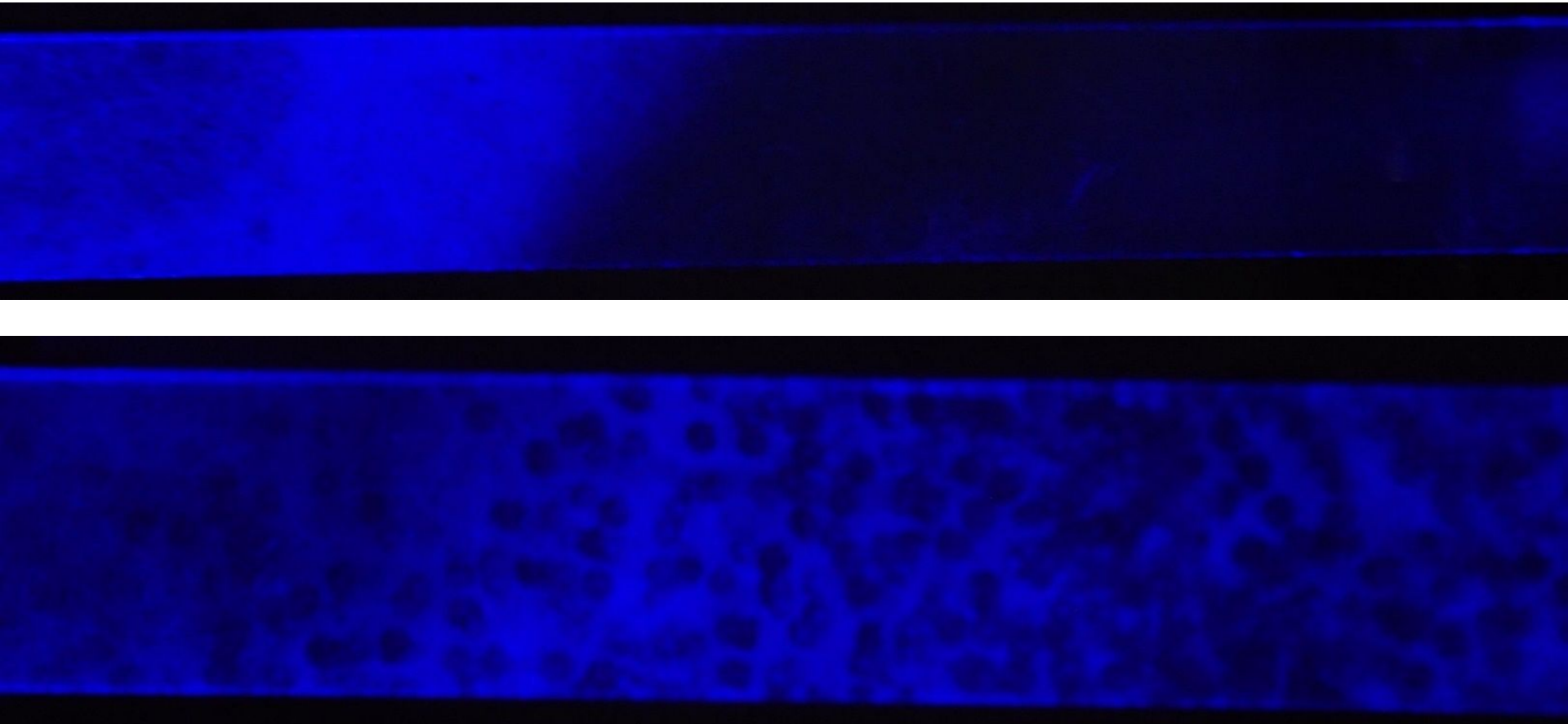
Scintillator tests



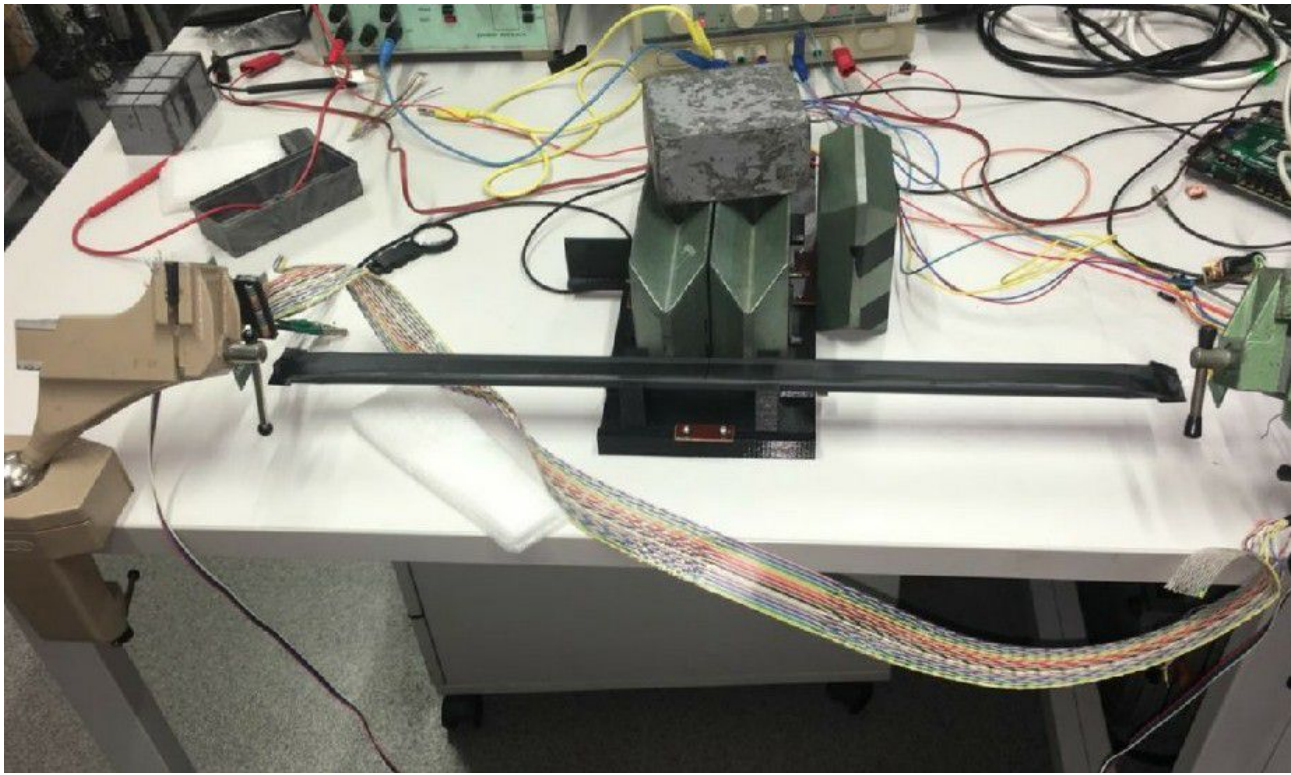
Scintillator tests



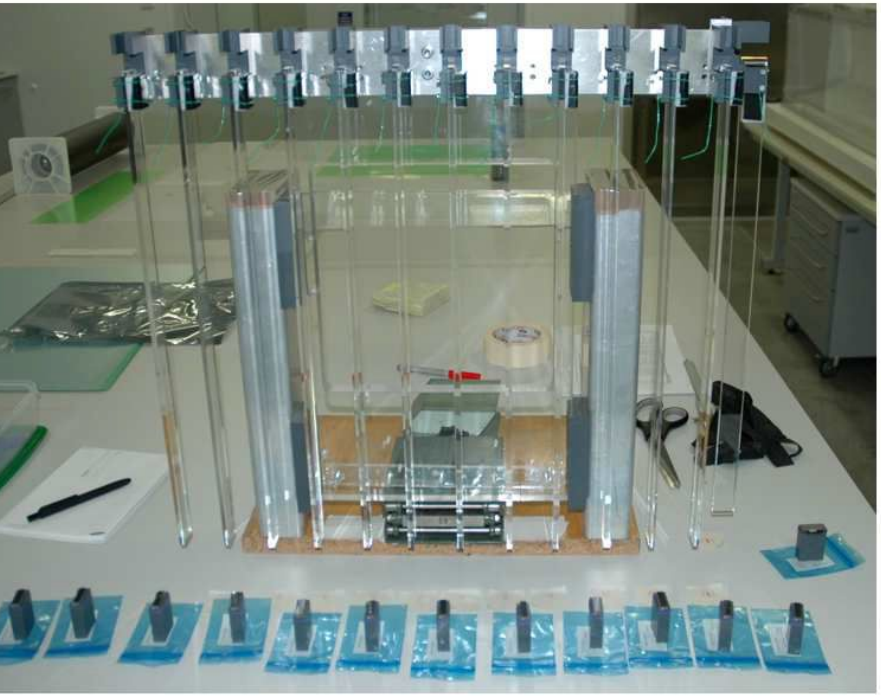
Defects found



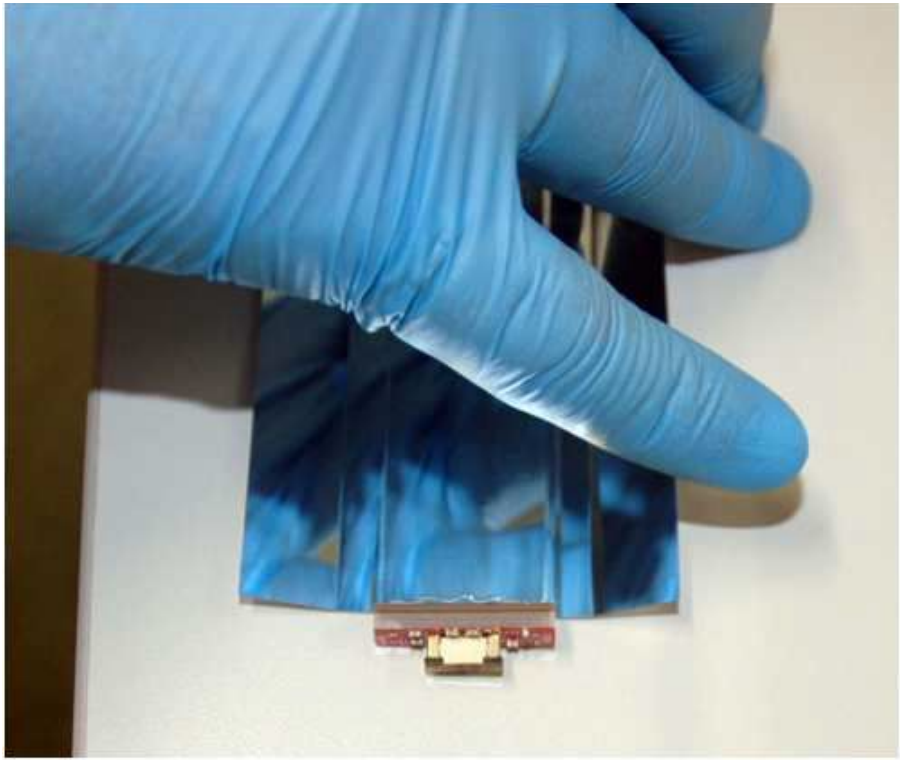
SiPM base tests



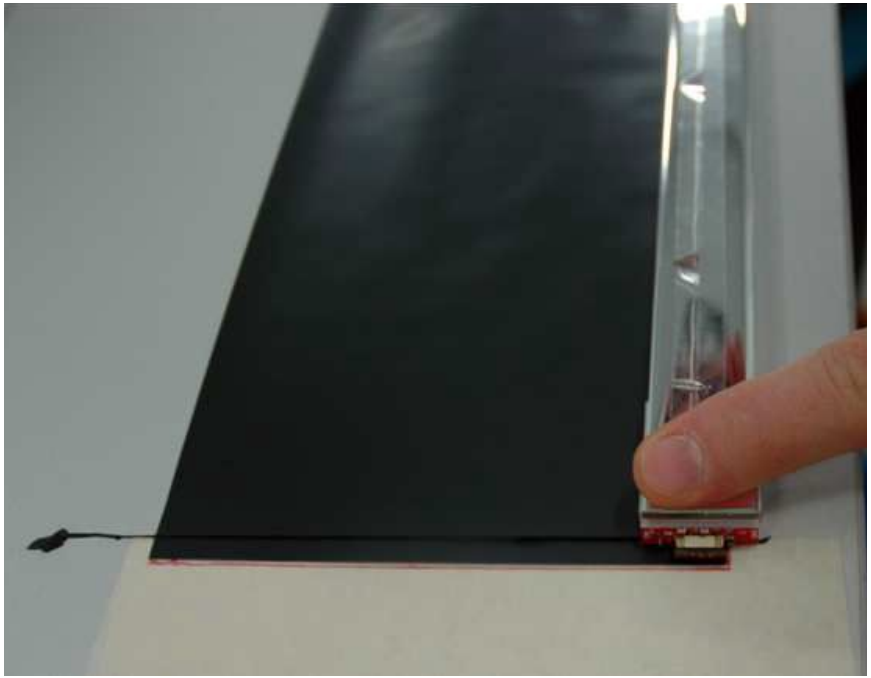
SiPM gluing

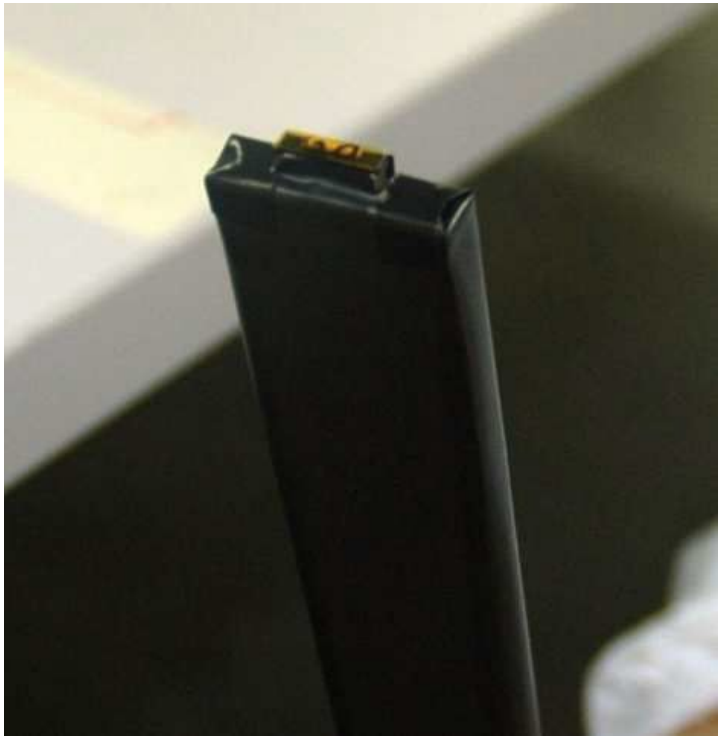


Scintillator wrapping

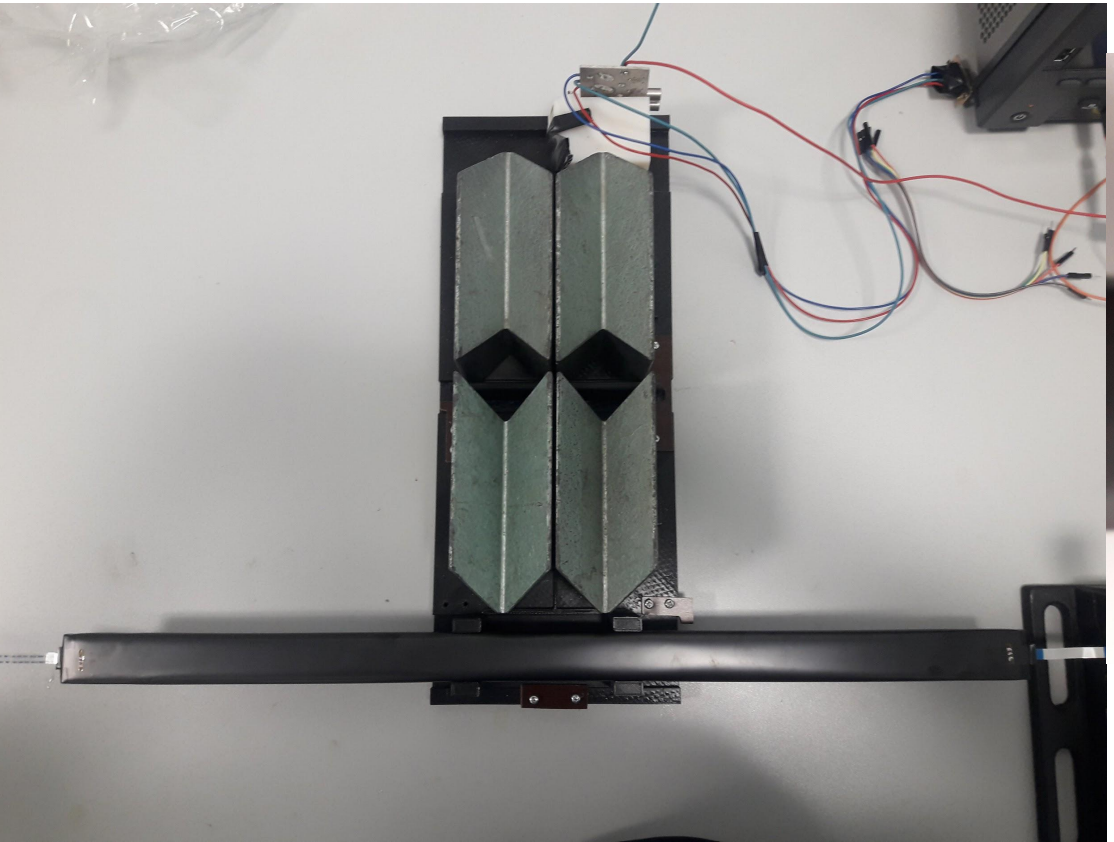


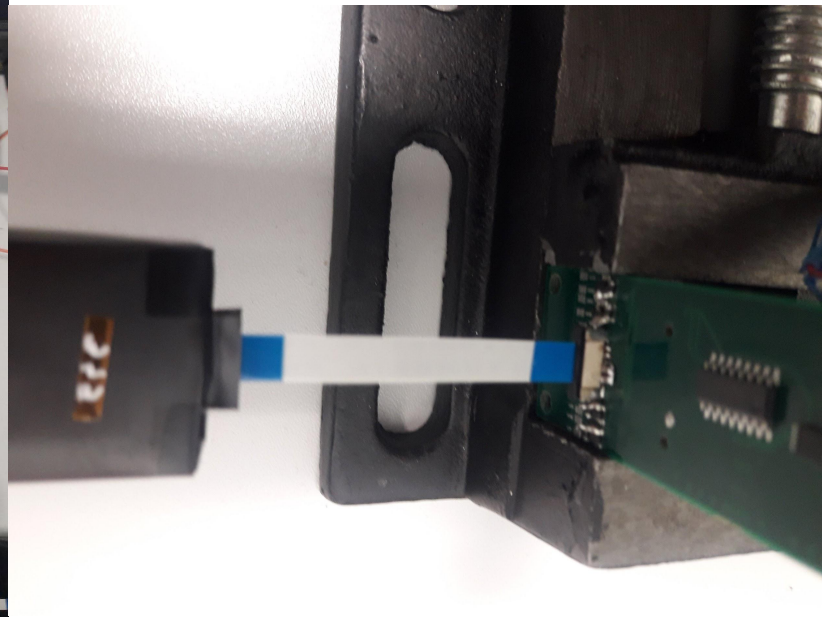
Scintillator wrapping



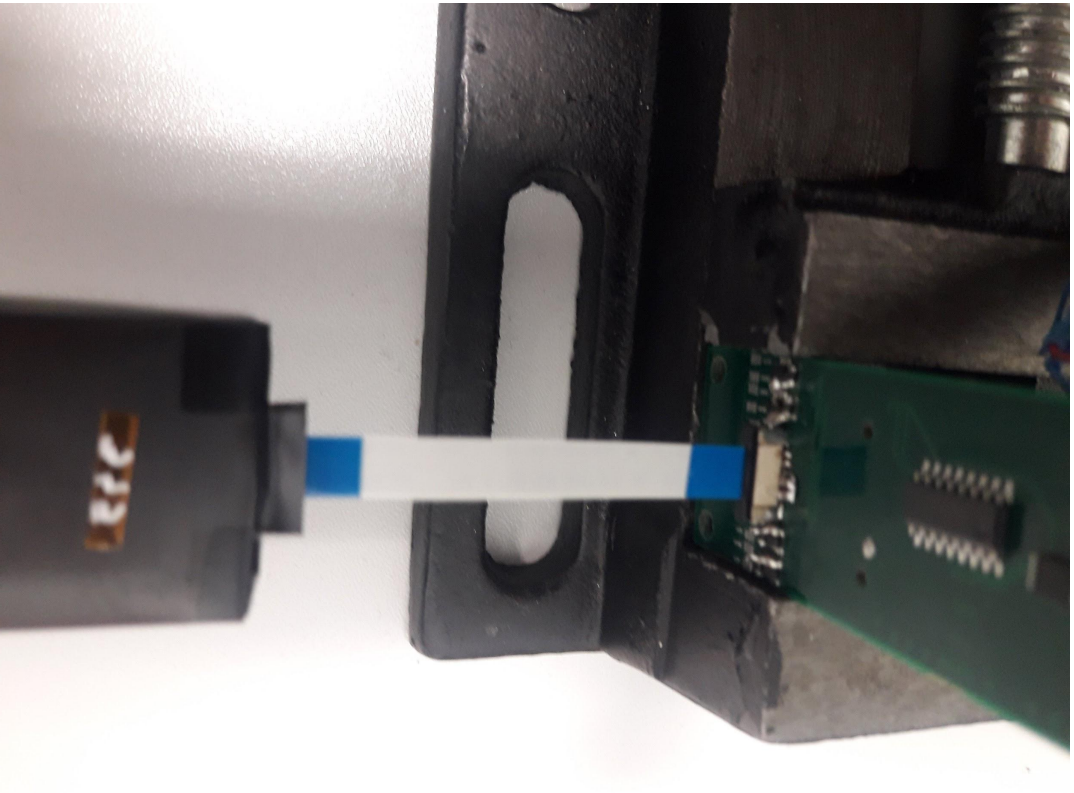


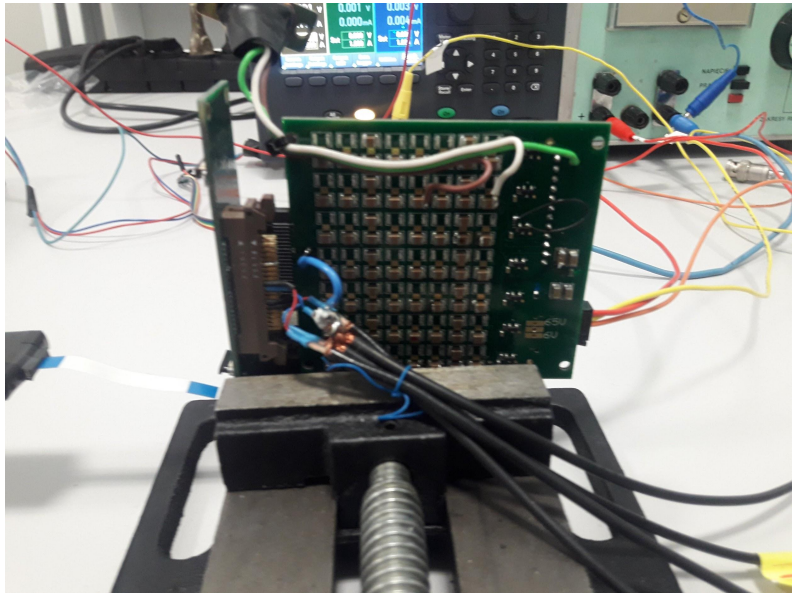
SiPM readout tests



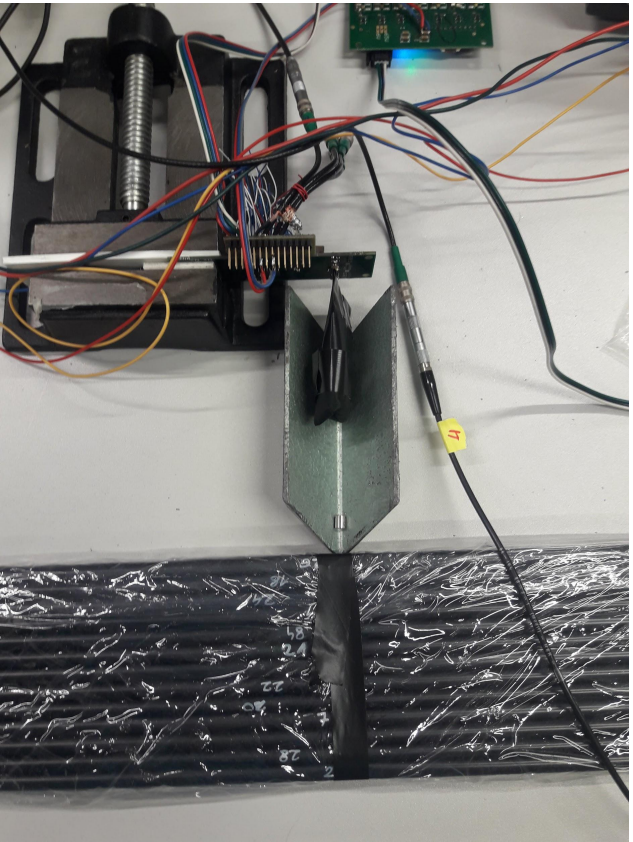


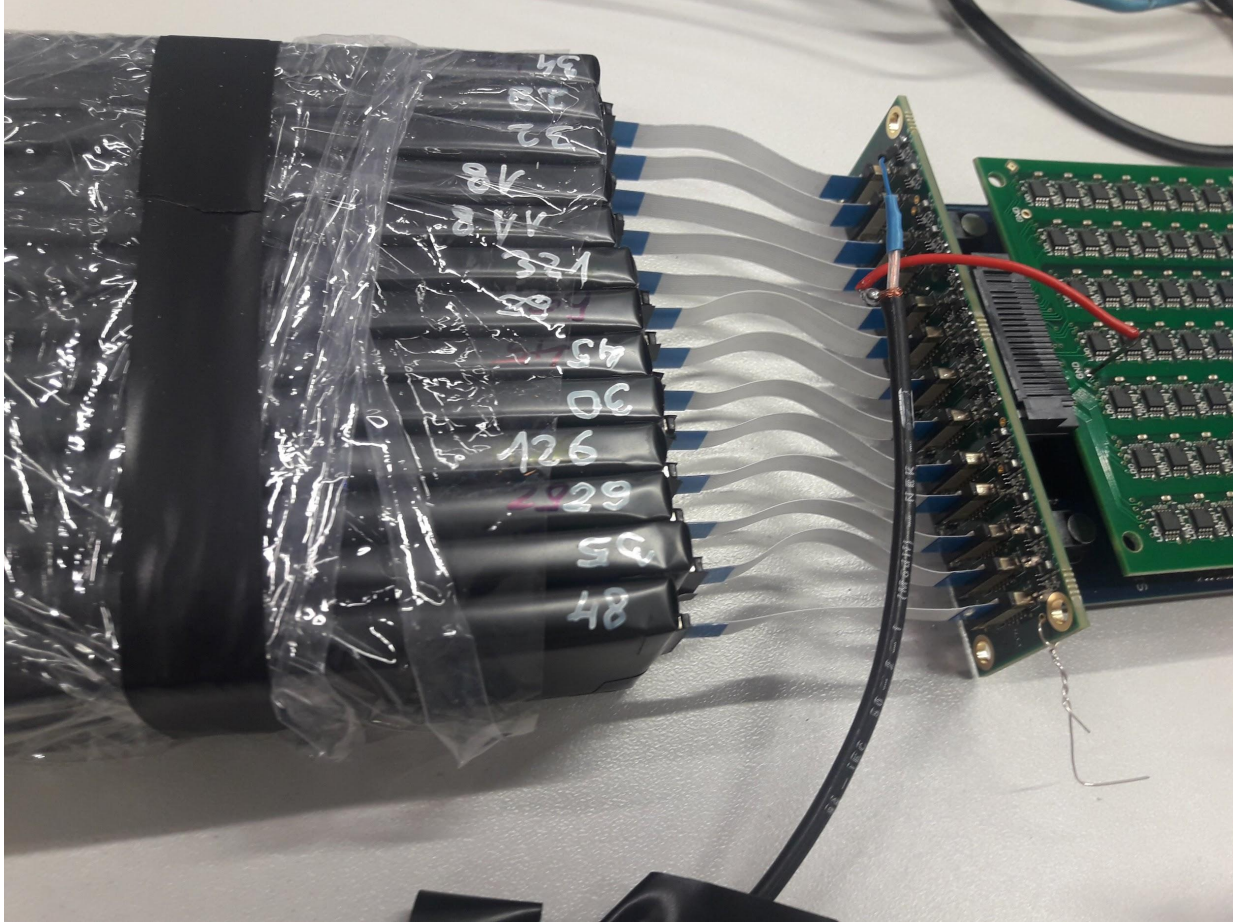
SiPM readout tests



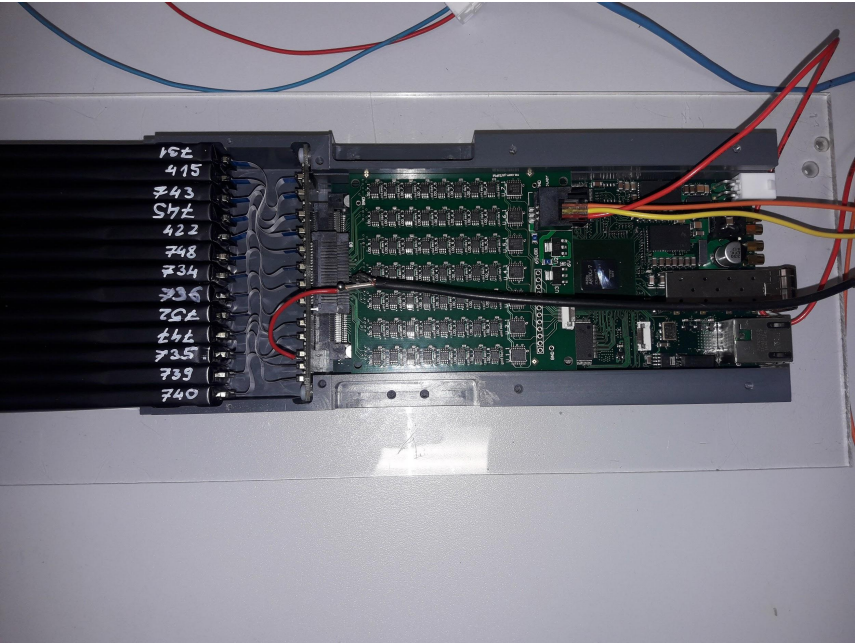


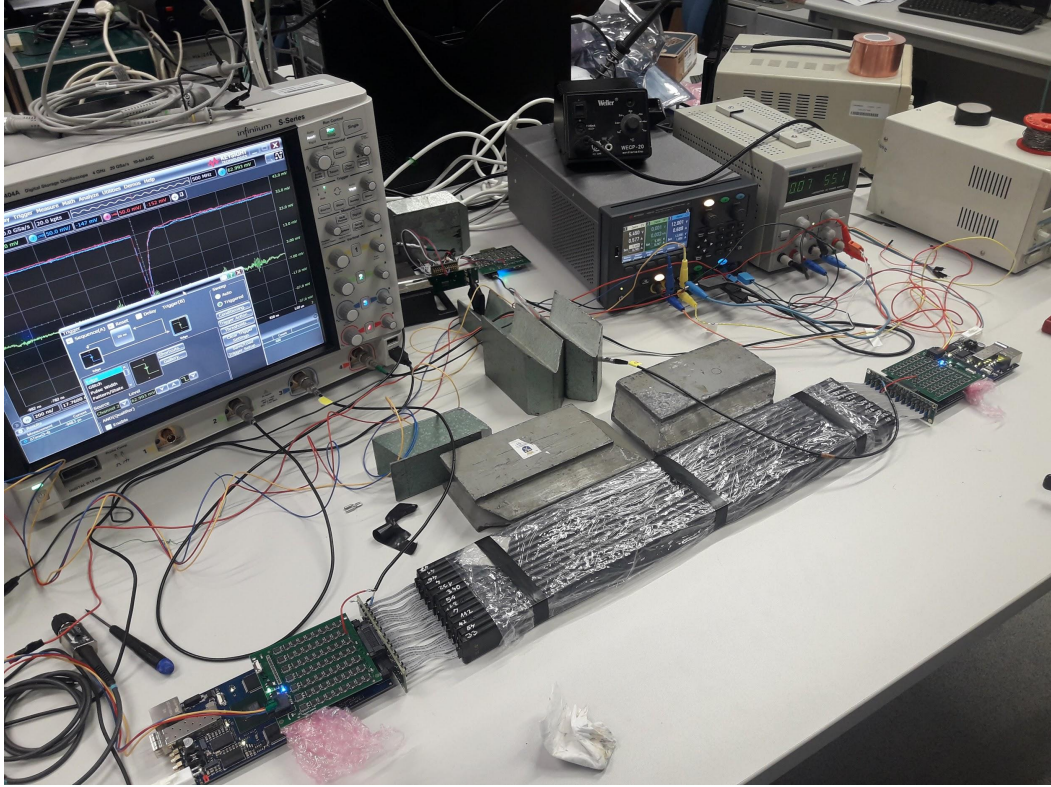
Preamps tests





FTAB tests





Future plans

- fourth layer assembly
- threshold and gain calibration
- Ge^{68} rod measurements
- NEMA phantoms measurements
- additional diagnostic parameters studies
- cosmics as a calibration for detector
- online reconstruction
- ....

Thank you for
Your attention