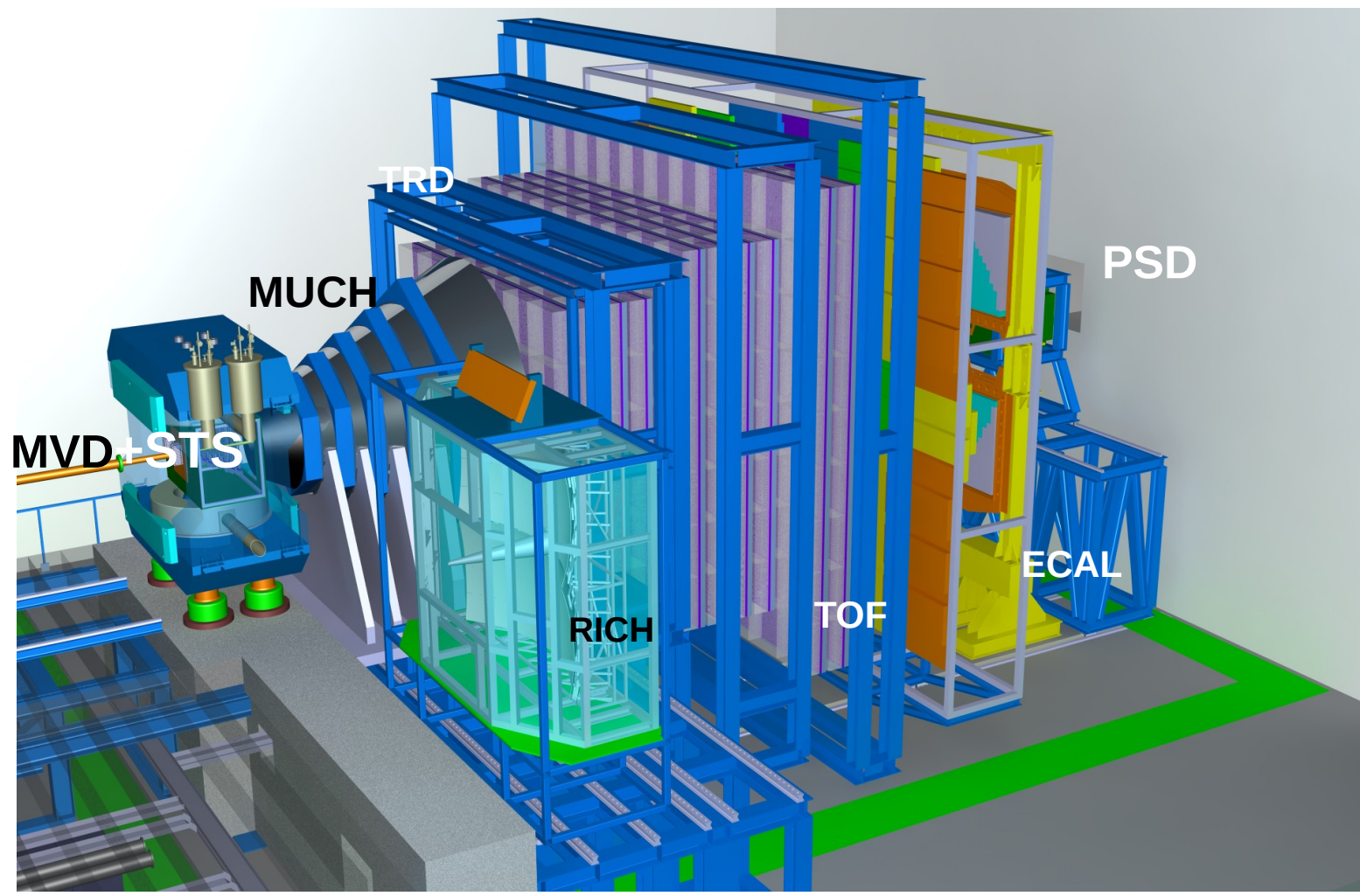


# Charge collection studies of silicon microstrip sensors for the CBM Silicon Tracking System.

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## The Compressed Barionic Matter experiment (CBM) at FAIR



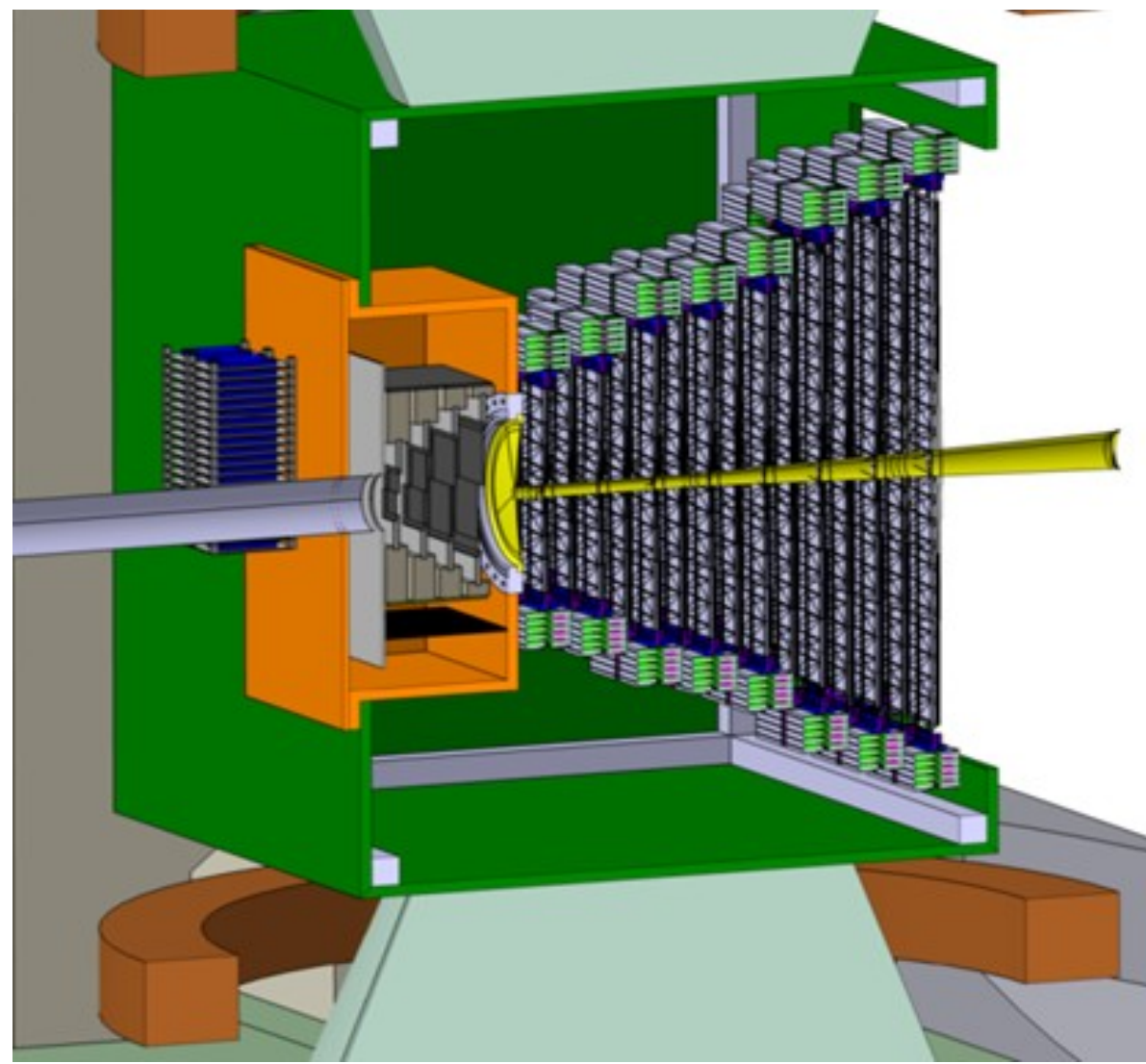
### Goal

- To study the QCD phase diagram at high net baryon densities and moderate temperatures.
- SIS100 collision energies  $2 \div 11$  AGeV

### Physics observables

- Differential cross-sections
- Rare diagnostic probes: strange mesons, light vector mesons ( $\rho$ ,  $\omega$ ,  $\phi$ )

## Silicon Tracking System (STS)

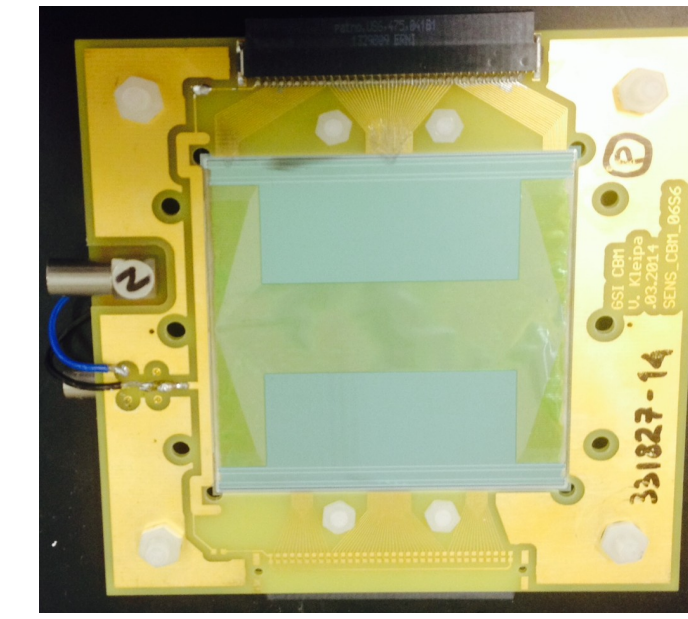


- 8 tracking stations
- double-sided silicon microstrip sensors
- sensor sizes 6x2, 6x4, 6x6, 6x12 cm<sup>2</sup>
- stereo angle front-back sides 7.5°
- momentum resolution ( $\Delta p/p \sim 1\%$ )
- 25  $\mu$ m hit spatial resolution
- material budget  $\sim 1\%$  X<sub>0</sub> per station
- radiation tolerance up to  $1 \times 10^{14}$  1MeV n<sub>eq</sub> cm<sup>-2</sup>
- S/N > 10 for the hit reconstruction efficiency  $\sim 98\%$

## Aim of the studies



Prototype of sensor with Double Metalization layer (DM)



Prototype of sensor with Microcable (SMwC)

- Test radiation tolerance up to  $2 \times 10^{14}$  n<sub>eq</sub> cm<sup>-2</sup>
- Choose the appropriate technology for the routing line
- Compare sensors from two vendors

## Sensors under test

- p-n-n structure sensors
- sensor sizes 6x6 and 6x4 cm<sup>2</sup>
- 1024 strips per side (58  $\mu$ m pitch)

- n side – 0° strips, p side – stereo angle 7.5°
- neutron irradiation to  $2 \times 10^{14}$  n<sub>eq</sub> cm<sup>-2</sup>

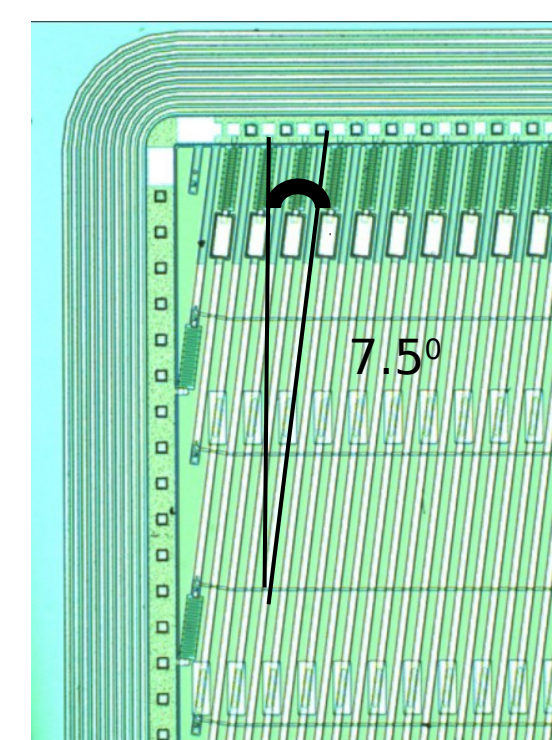
### Interconnection schemes

#### I. Double metalization (DM)

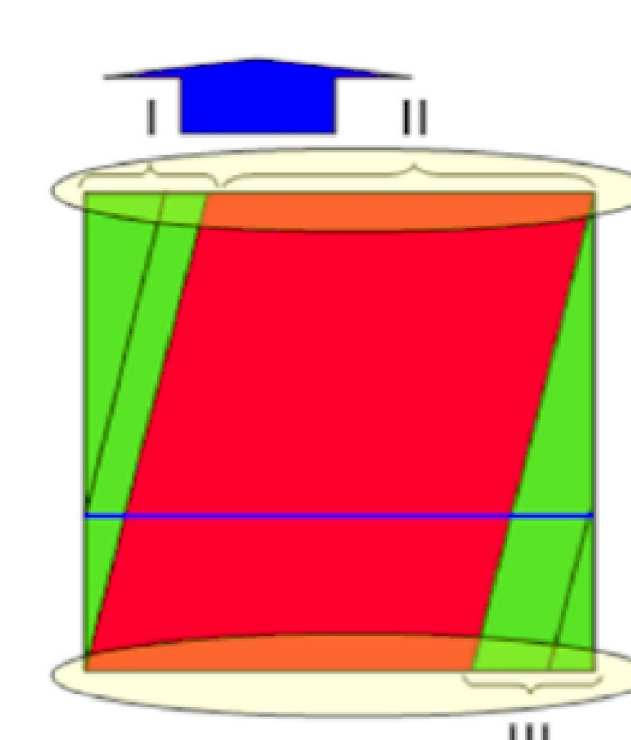
each strip is connected to its partner on the opposite end with a second metal layer

#### II. Interstrip cables on the top of the sensor (SMwC)

routing lines are made by the microcables on the top of the sensor

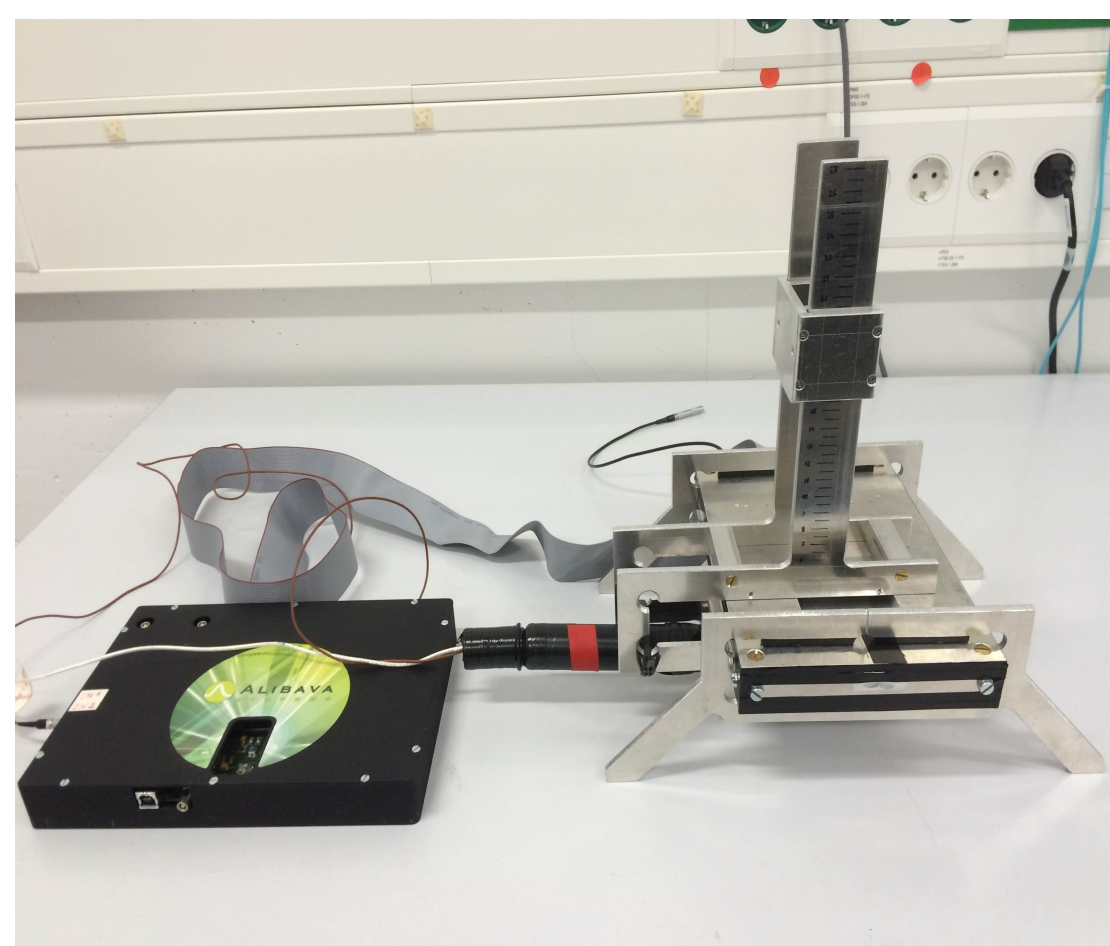


Microscopic view the sensor edge (DM)



Schematic view

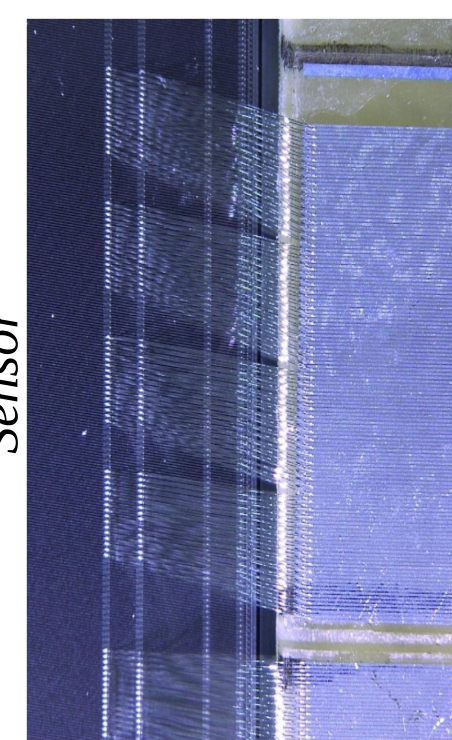
## Experimental set-up



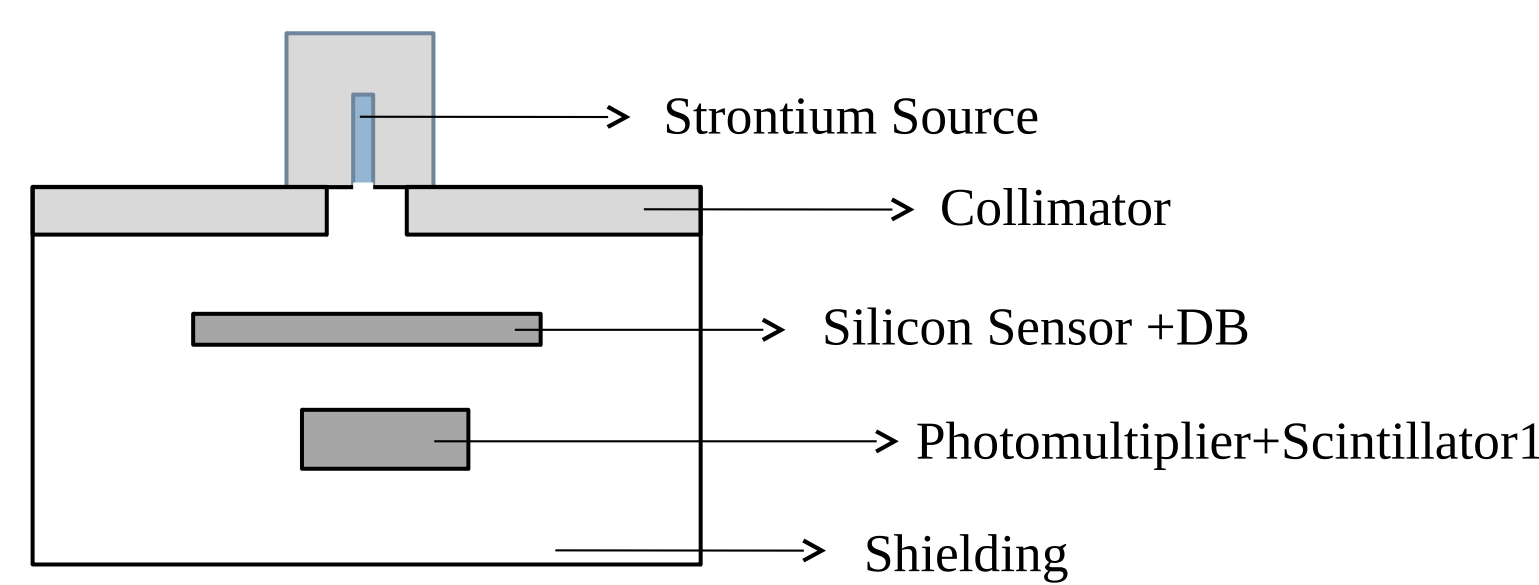
Set-up in the STS lab



DUT connected to the r/o electronics



Beetle chip



- Measurements made in light-tight box
- Sensors tested for electrical test and charge collection with <sup>90</sup>Sr ( $\beta$ -source)

Sensors with different type of interconnection scheme were selected:

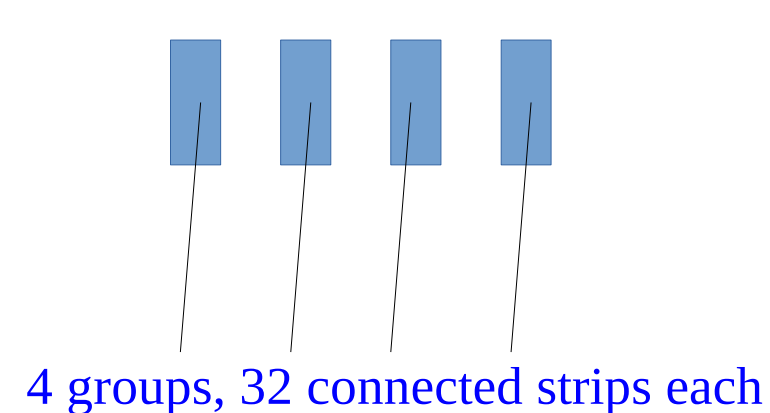
CBM0-	Size, cm x cm	Thickness, $\mu$ m	Connection type	V <sub>td</sub> , V
6H6-W29	6x6	327	SM	70
6H6-W28	6x6	331	SMwC	75

ALIBAVA read-out system:

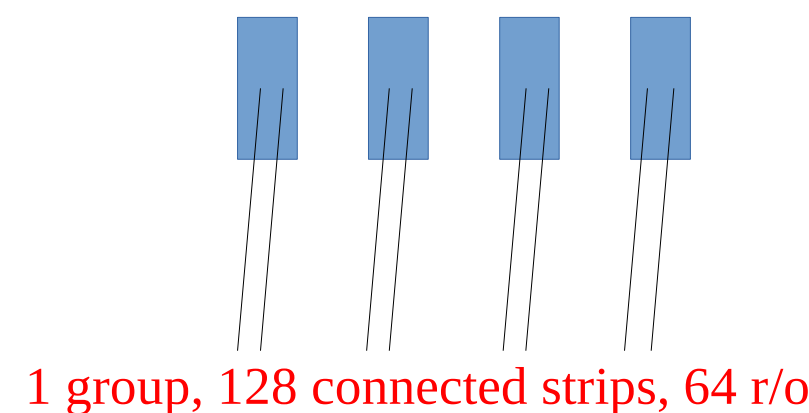
- 128 r/o channels
- ALIBAVA r/o system comprises Mother Board and Daughter Board (2 Beetle-128 chips) 256 r/o channels
- Temperature monitoring

## Sensor with different read-out bonding patterns

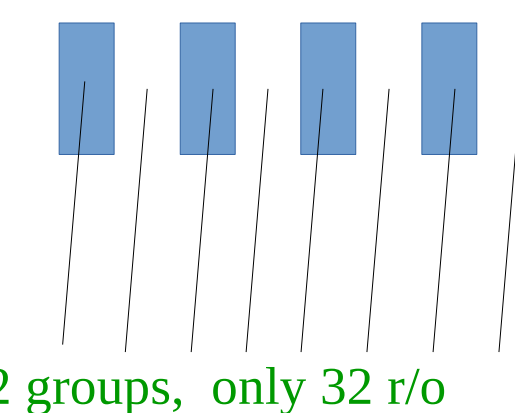
### 1. Every strip from sensor corresponds to strip from r/o electronics



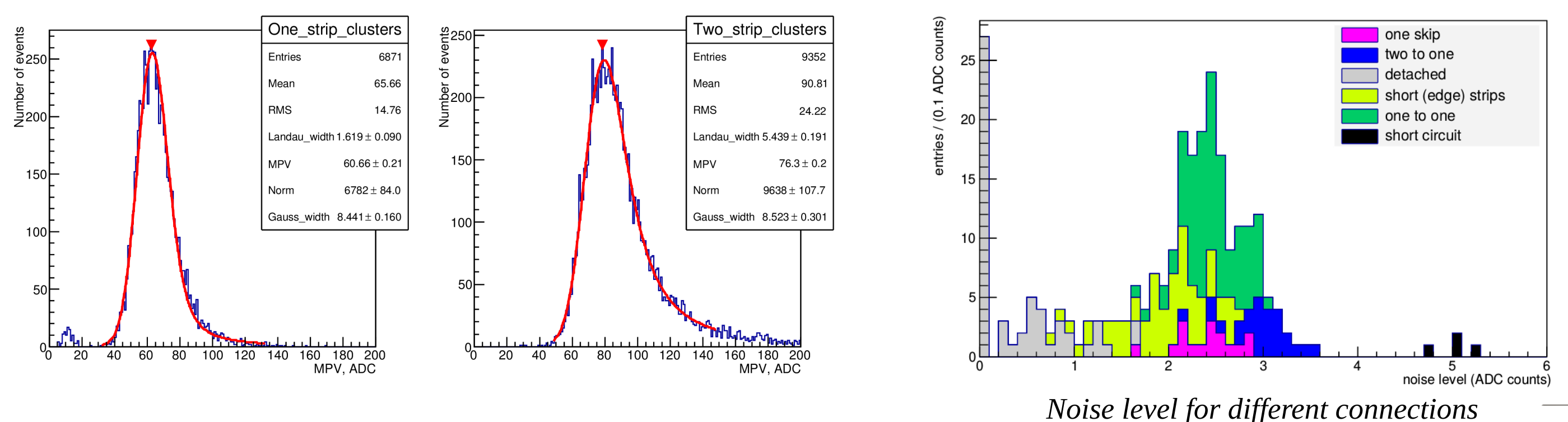
### 2. Two strips from sensor connected to one read-out



### 3. Every second sensor's strip is r/o



- To find out how different r/o connection may influence on collected charge, three schemes were tested: the same sensor, only long strips, all 256 r/o channels were used.
- Measurements were done in the same conditions under temperature monitoring.



Noise level for different connections

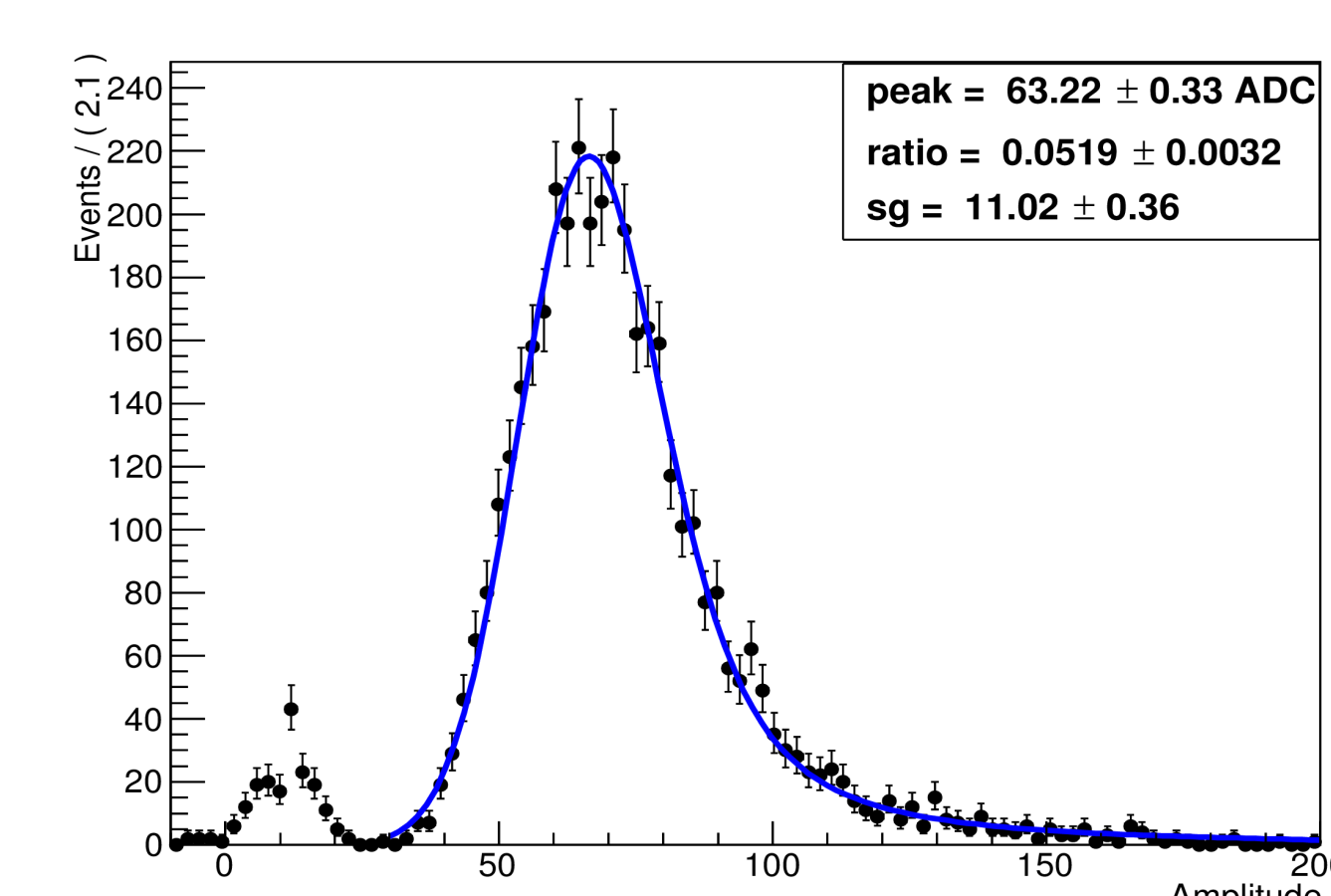
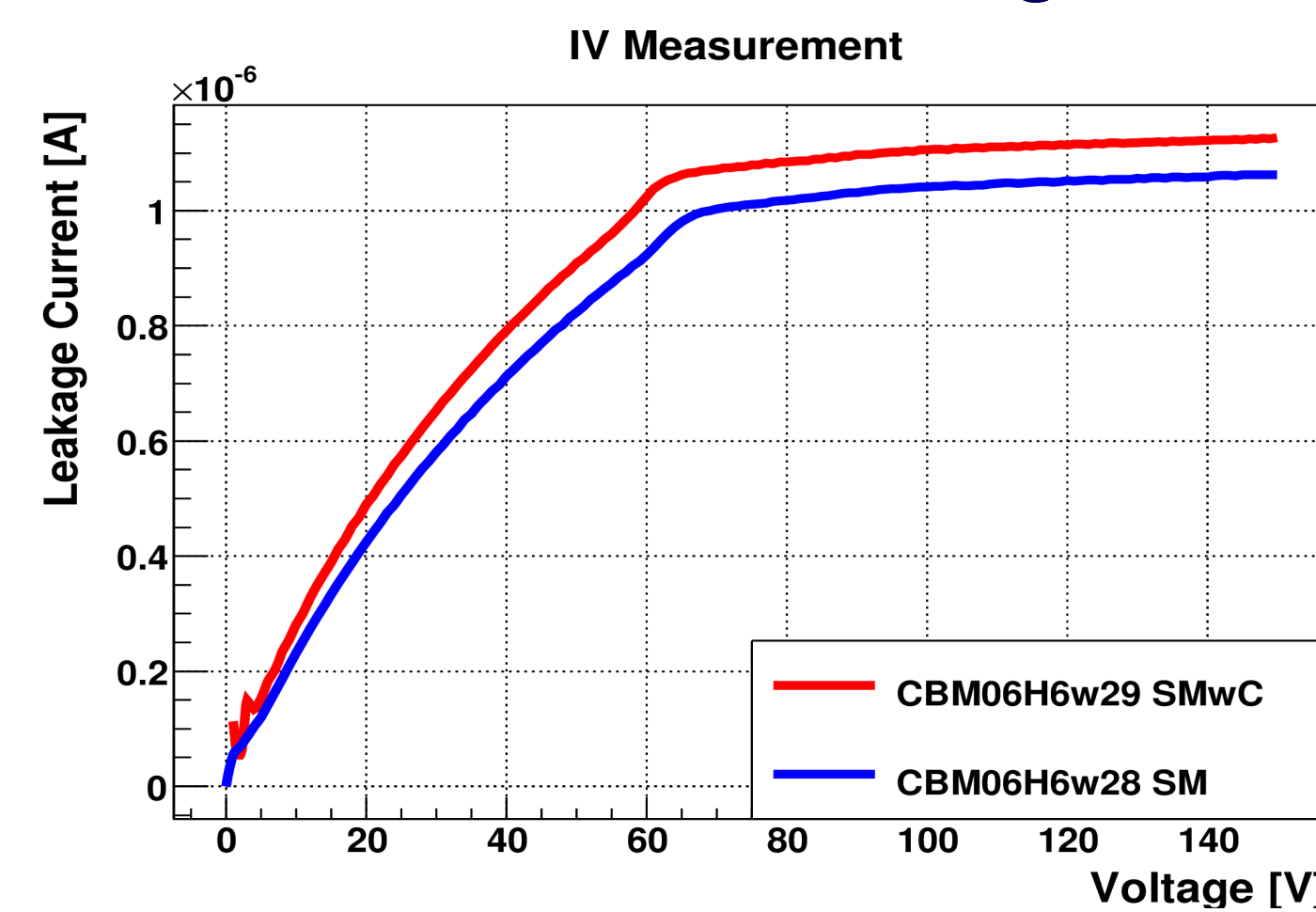
- Only events  $>3\sigma$  were selected, edge strips removed from analysis
- Noise is differs in range of 10 %
- Absence of distinctions in charge collection and S/N will allow to use less r/o channels  $\rightarrow$  less electronics

Charge collection in terms of ADC for different cluster configuration (connection scheme #2 with r/o only every second channel)

### Preliminary results:

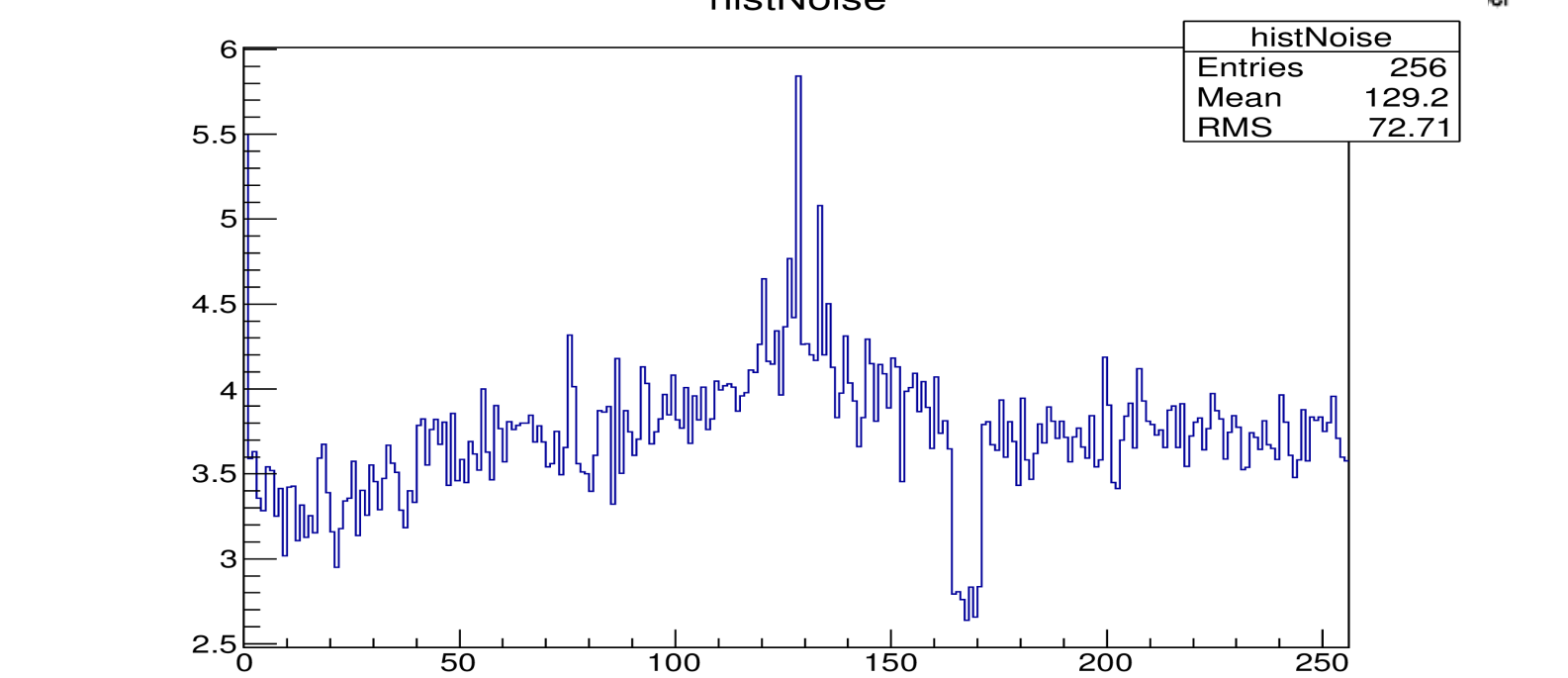
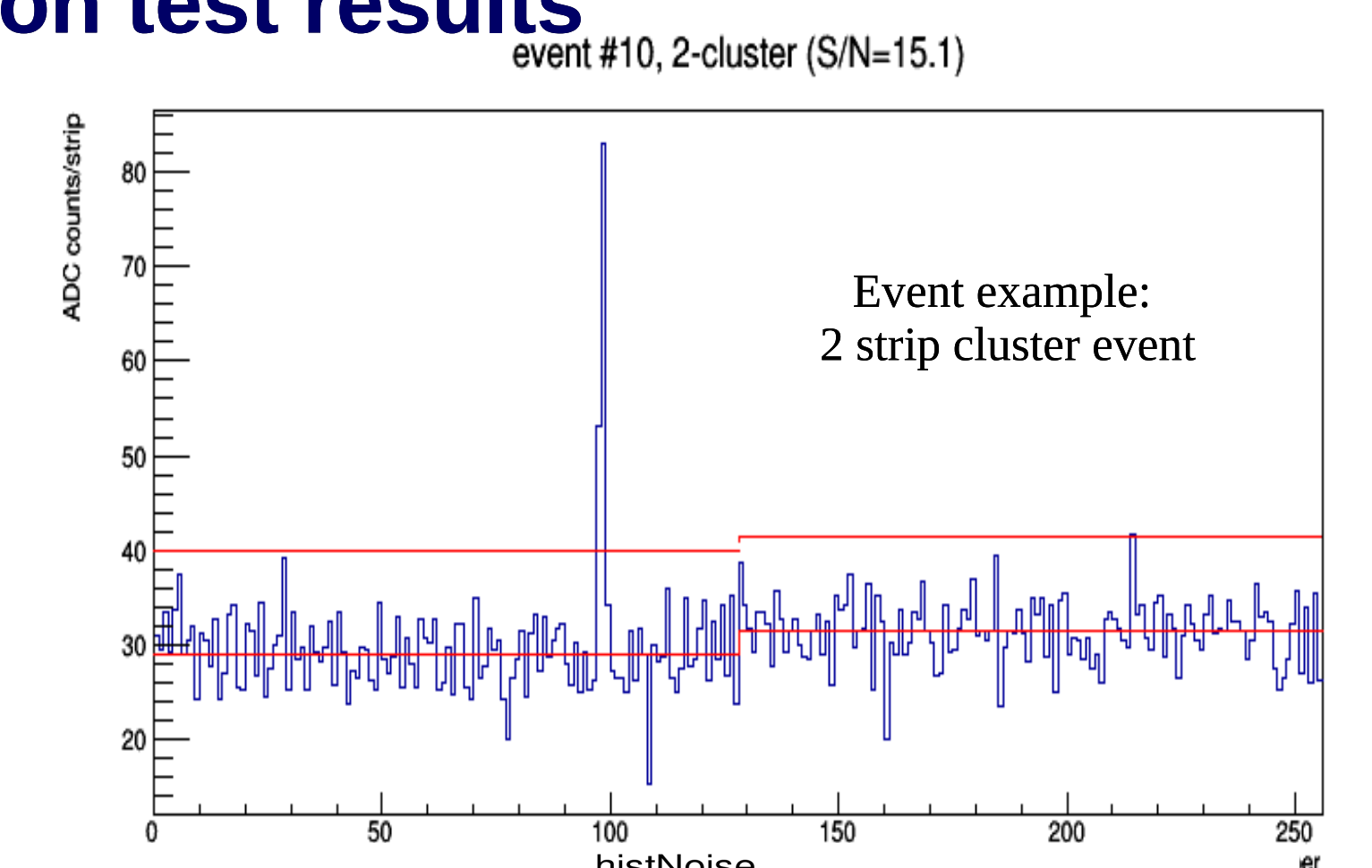
	Noise $\pm$ Err, ADC	MPV 1_strip $\pm$ Err, ADC	MPV 2_strip $\pm$ Err, ADC	MPV $\Sigma$ $\pm$ Err, ADC
1 $\leftrightarrow$ 1	2.57 $\pm$ 0.05	59.76 $\pm$ 0.38	73.81 $\pm$ 0.45	70.25 $\pm$ 0.77
2 $\rightarrow$ 1	3.05 $\pm$ 0.05	60.45 $\pm$ 0.03	76.0 $\pm$ 0.22	67.0 $\pm$ 0.36
1 omit	2.28 $\pm$ 0.04	60.2 $\pm$ 0.48	57.88 $\pm$ 1.47	60.49 $\pm$ 1.33

## Charge collection test results



Signal from Sr<sup>90</sup> fitted Landau-Gauss convolution

- Two sensors with different connections were tested: S/N for both  $\geq 15$
- Similar charge collection at 150 V:  
SMwC 77.8  $\pm$  0.2 ADC,  
SM 76.3  $\pm$  0.2 ADC



## Further studies

- Characterize more sensors from different vendors and two types of routing lines
- Characterize sensors after irradiation
- Compare measurements with nXYTER r/o system