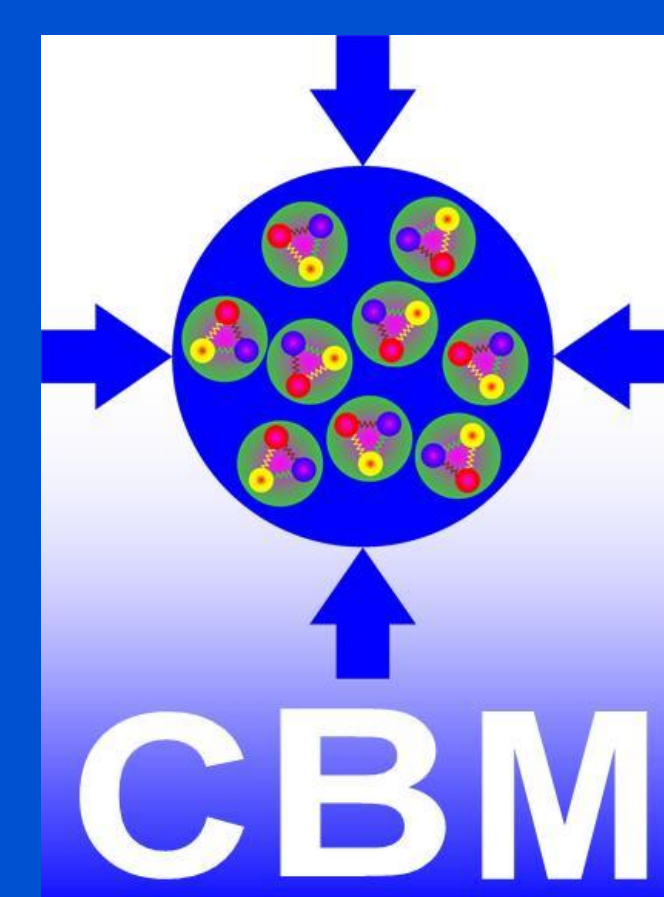


# Development of prototype components for the Silicon Tracking System of the CBM experiment at FAIR

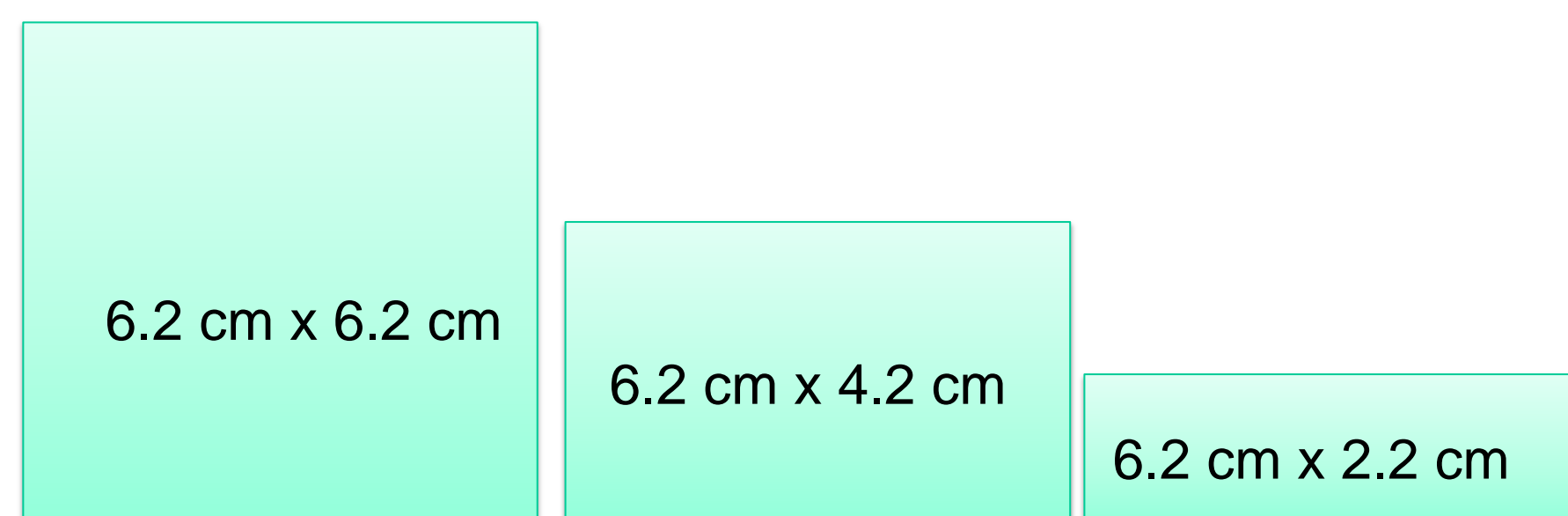
Pradeep Ghosh, for the CBM Collaboration



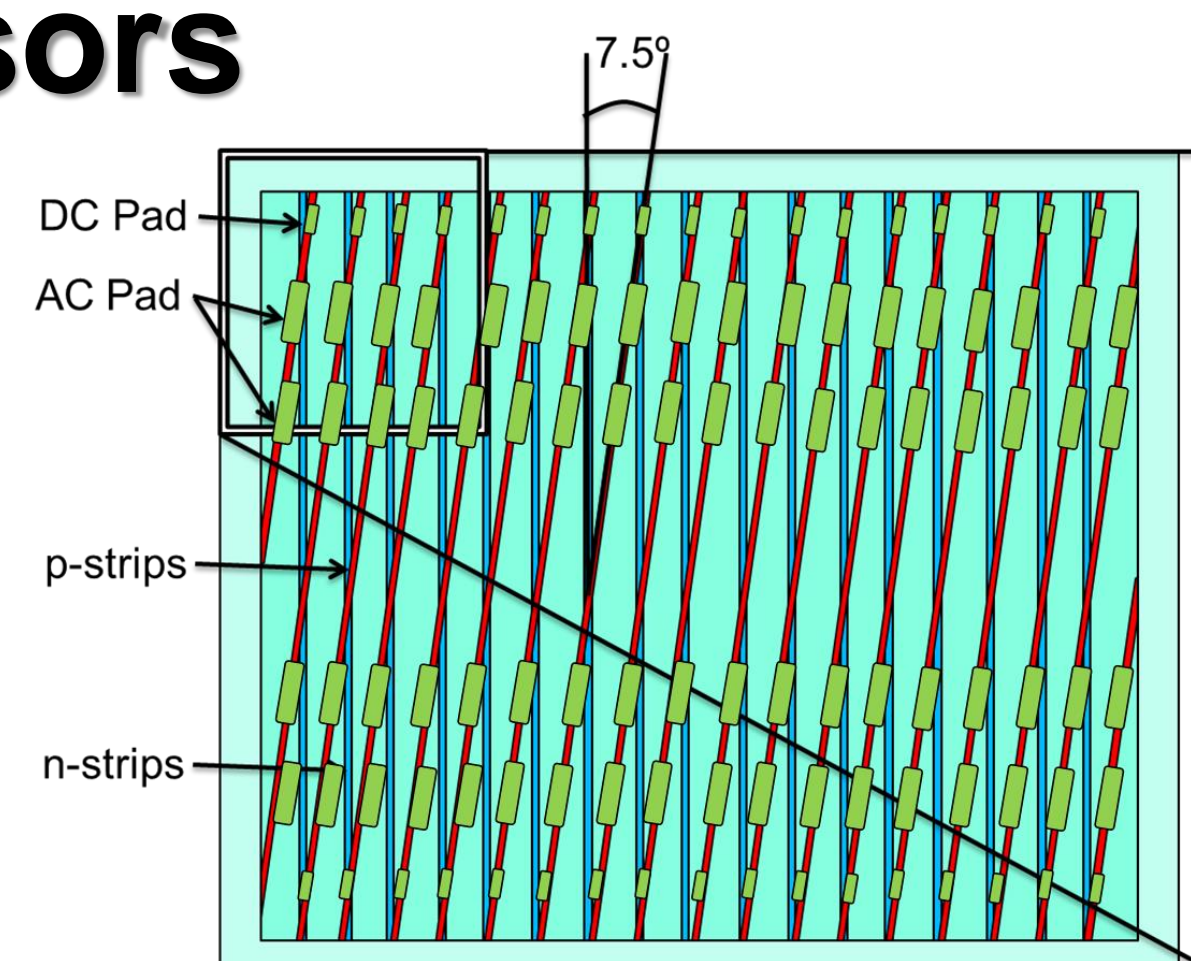
## Features

- Double-sided silicon strip sensors
- p-n-n structure
- Integrated AC coupled read-out
- 285  $\mu\text{m}$  thickness
- 1024 strips/side
- 3 sensor sizes
- 58  $\mu\text{m}$  strip pitch
- 7.5° stereo angle on p-side

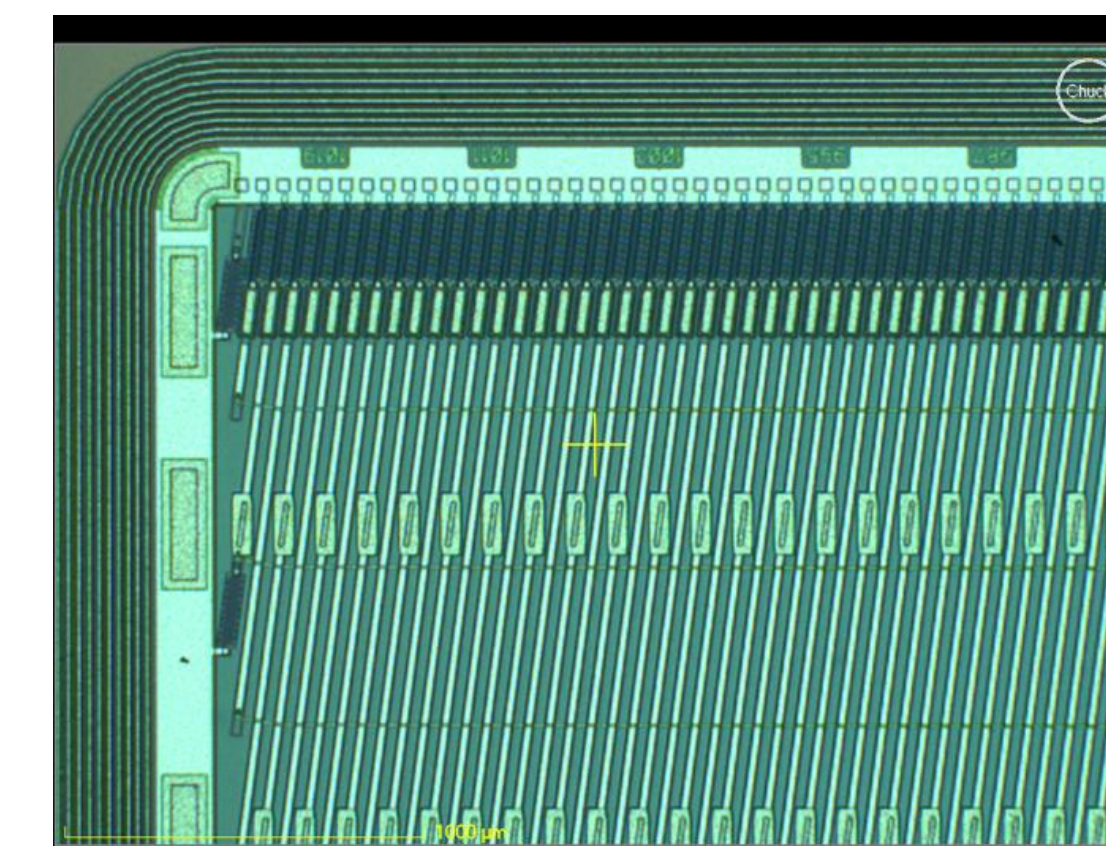
## Micro-strip Sensors



Sensors of 3 sizes is planned, Some sensors will be daisy chained



Schematic: Stereo-angled strips on p-side & orthogonal strips on n-side



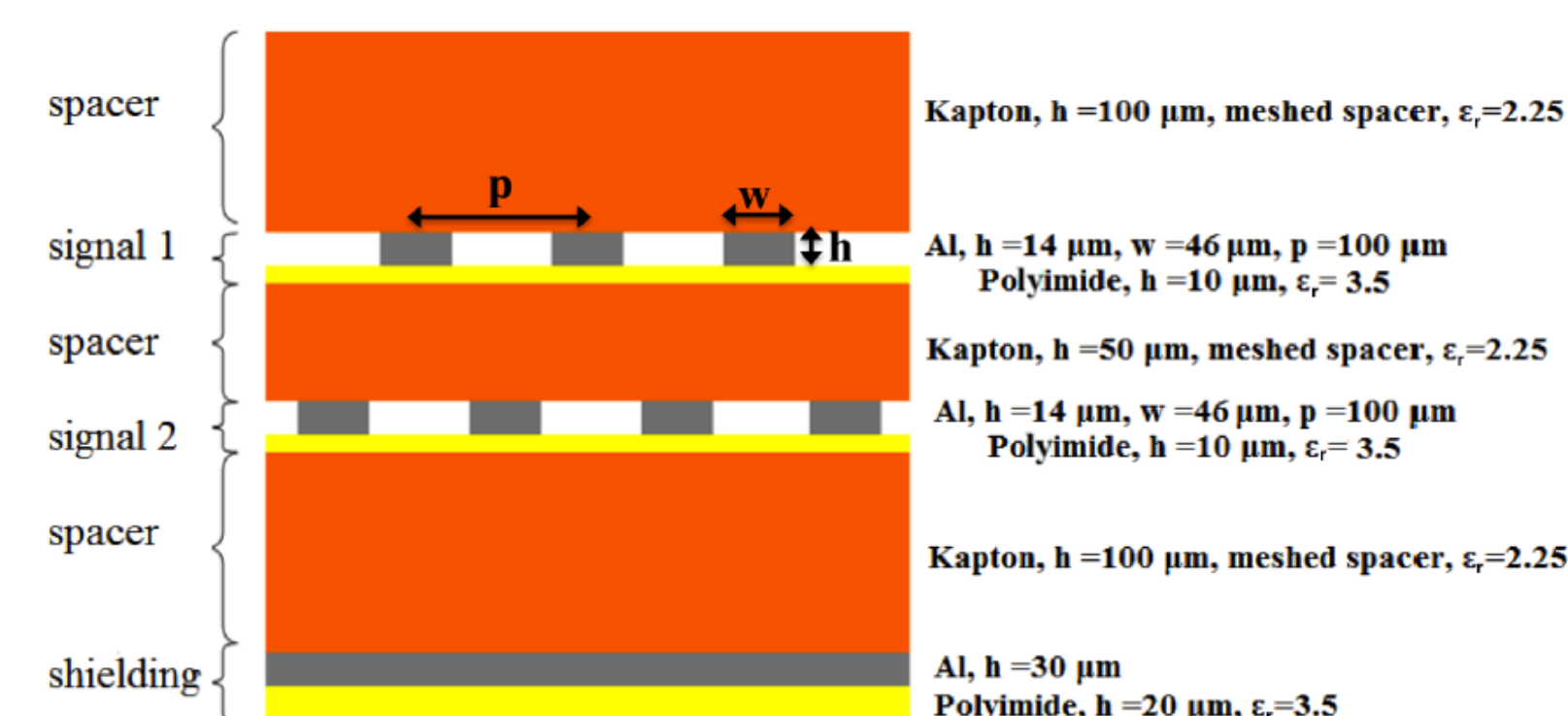
Prototype sensor CBM05

## Two vendors

- CiS Erfurt, Germany
- Hamamatsu Photonics, Japan

## Read-out Cables

2 signal layers + 2 spacer layers + 2 shielding layers  
TAB bonded to the sensors



Schematic for the read-out cable prototype



Low-mass micro cables prototypes 10 cm, 20 cm and 30 cm

## Read-out Electronics

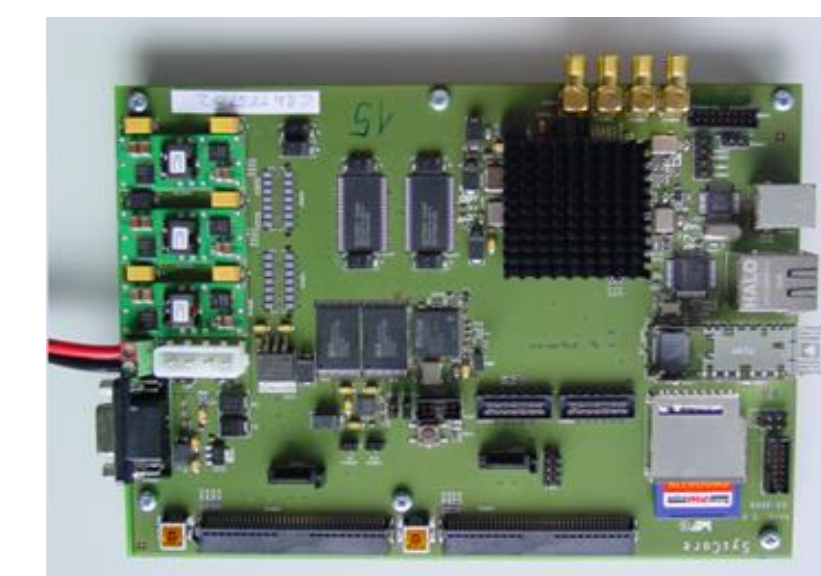


FEB prototype with n-XYTER chip



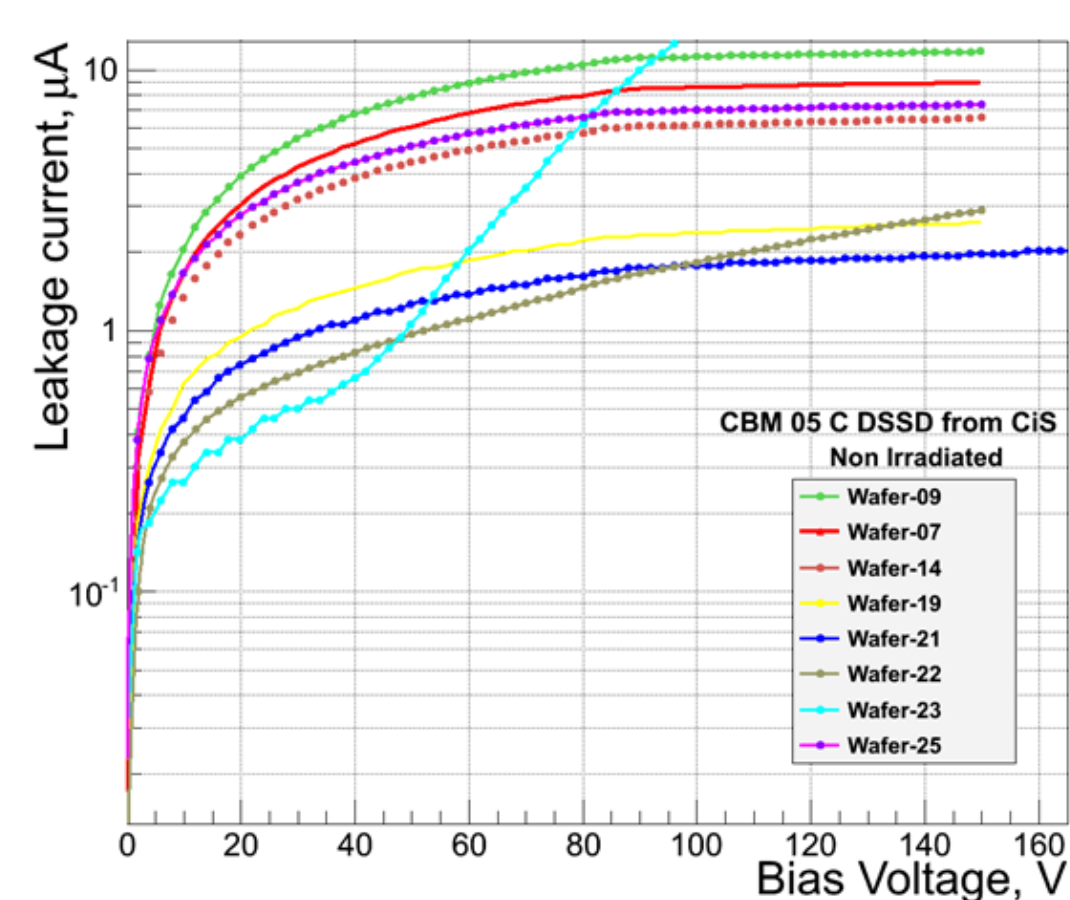
FEB prototype with STS-XYTER chip, 2013

- Front-end board with n-XYTER chip for early stage prototyping
- Self triggered, LSB time resolution 1 ns, fast shaper up to 1ns.
- Front-end board with STS-XYTER chip developed based on STS requirements (final chip)
- Self triggered, time resolution < 5 ns, shaping time 30 ns
- design and development at AGH Krakow
- testing and characterization at GSI

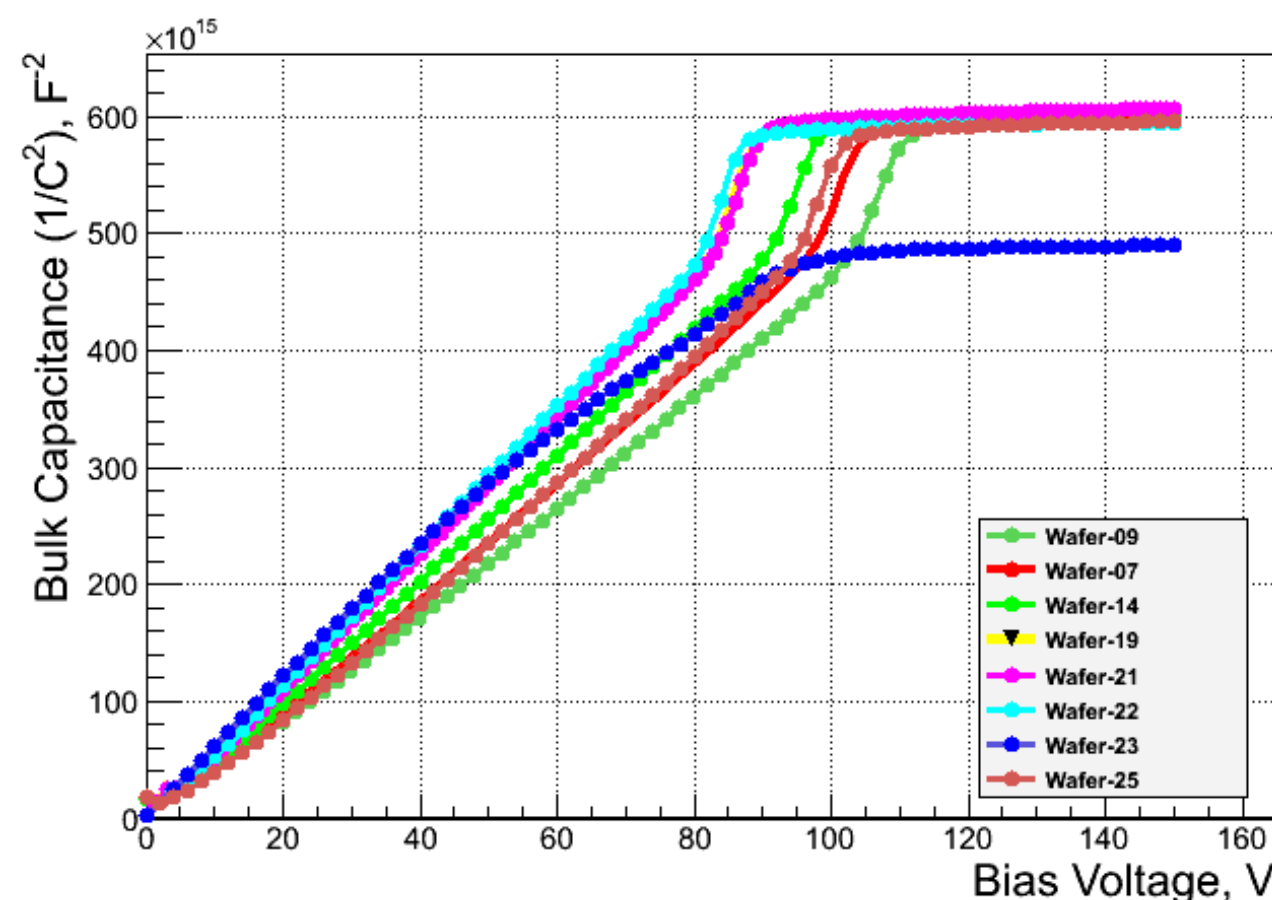


Read-out controller (ROC) for Data Acquisition

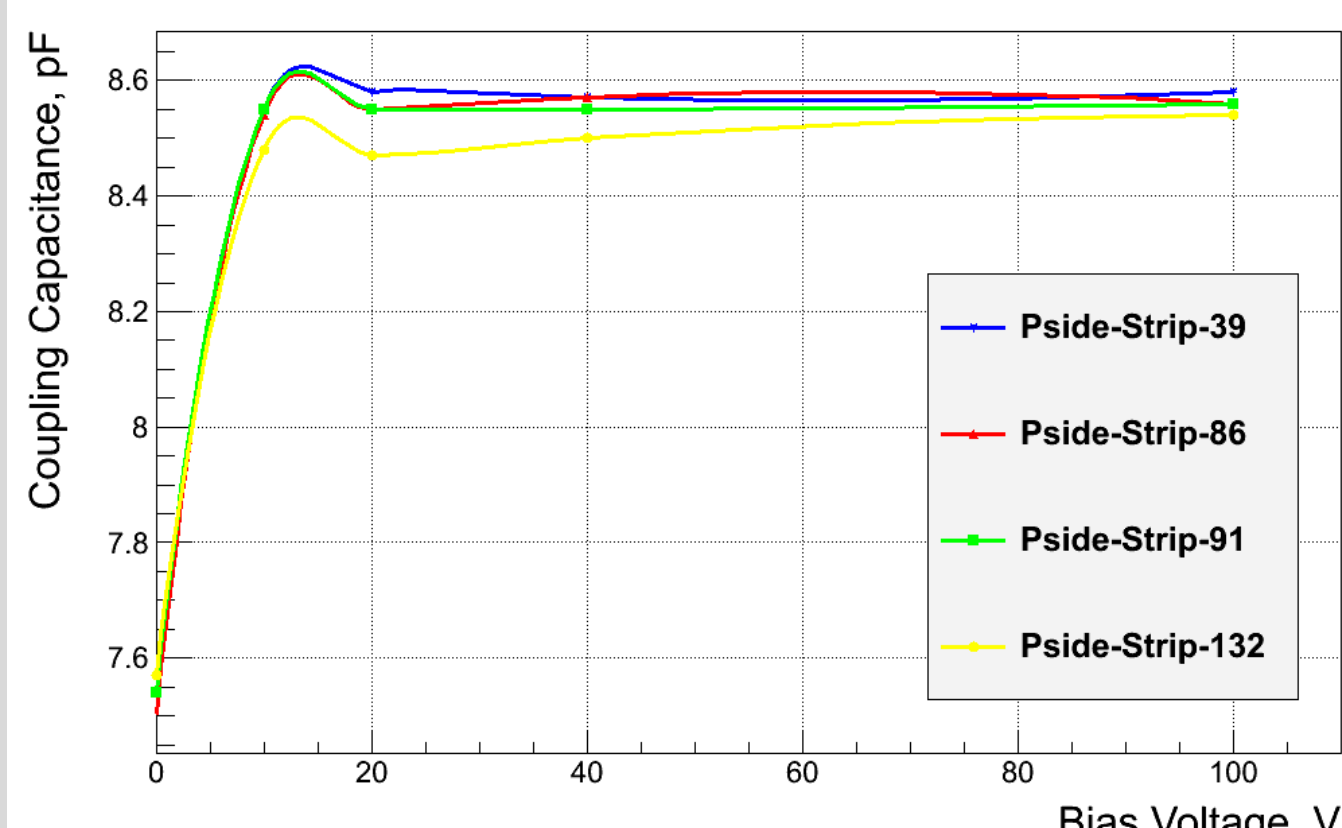
## Characterization and QA



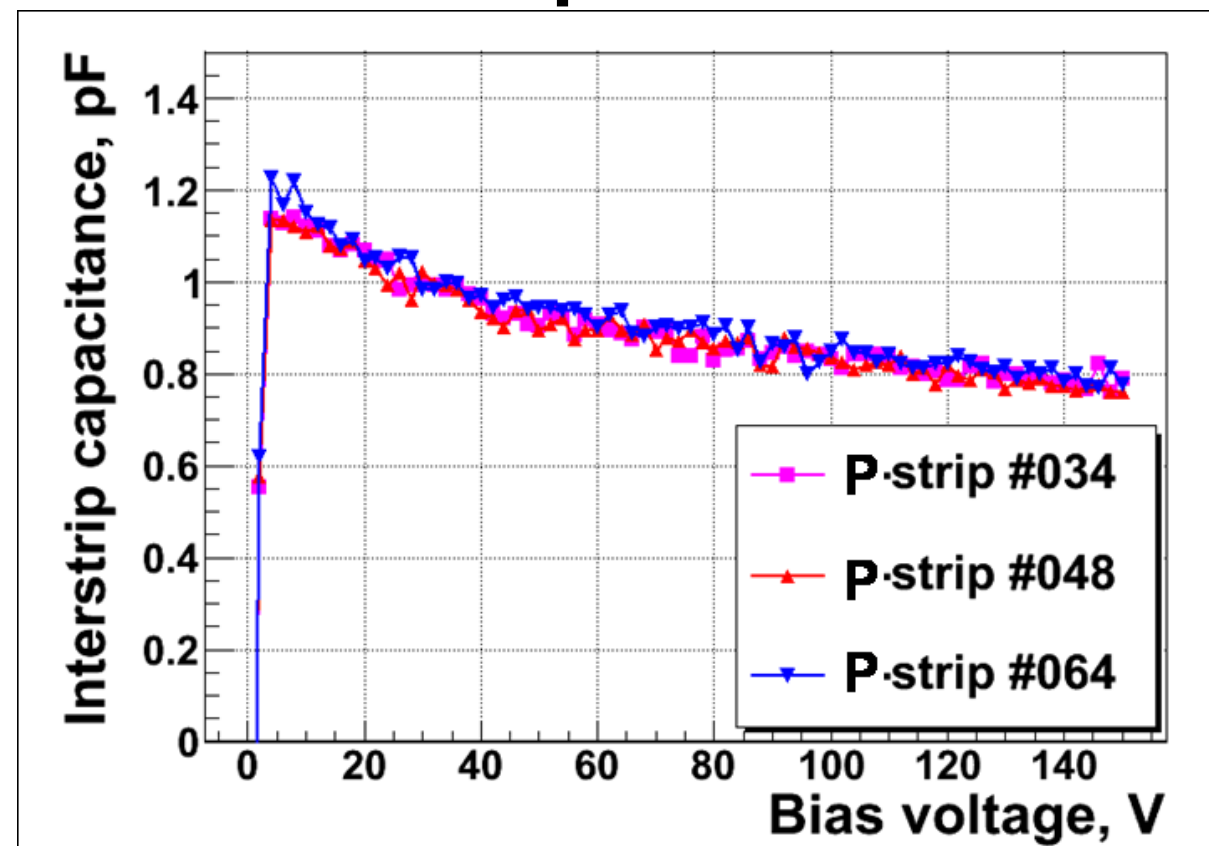
Leakage current



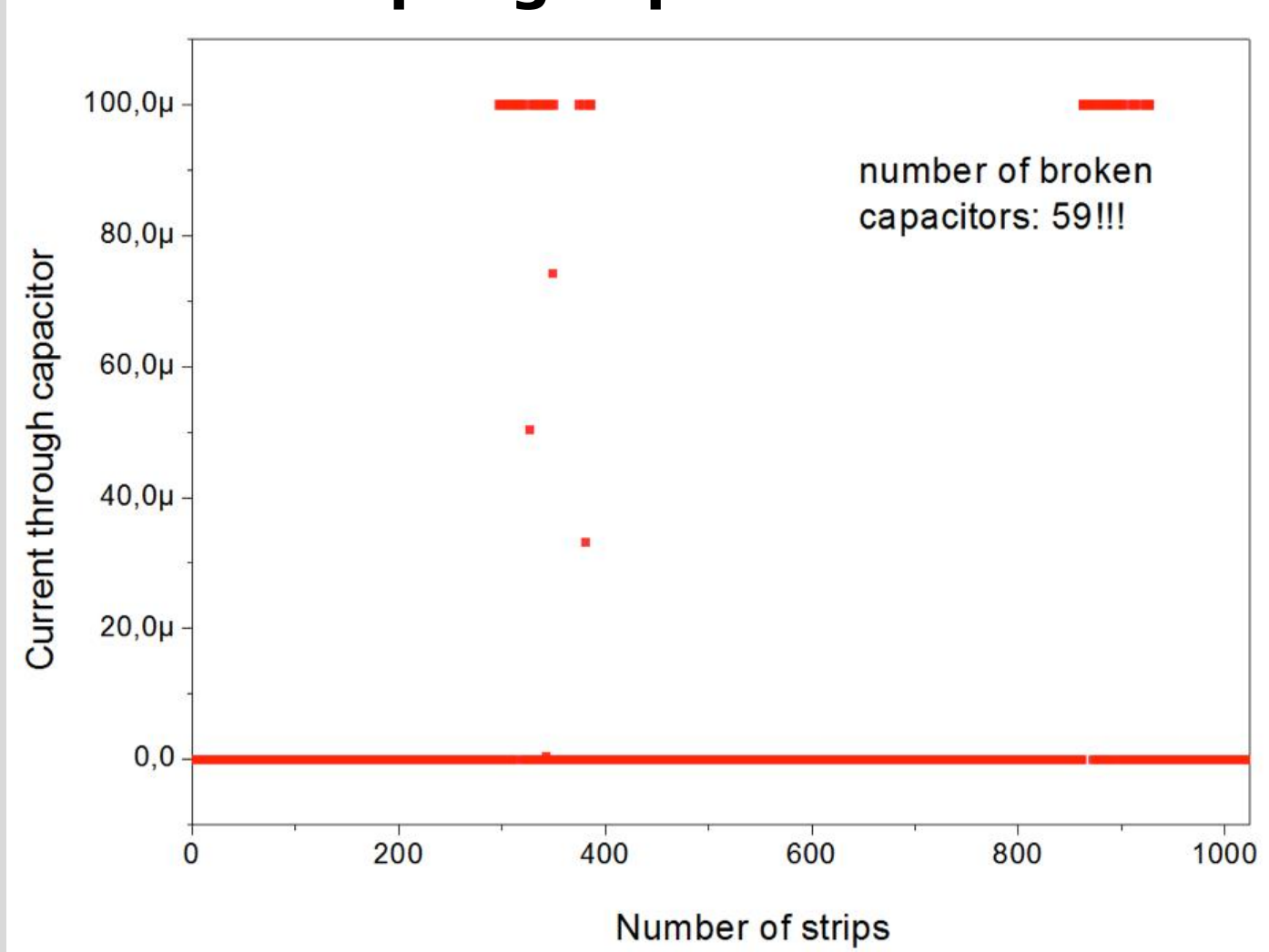
Bulk capacitance



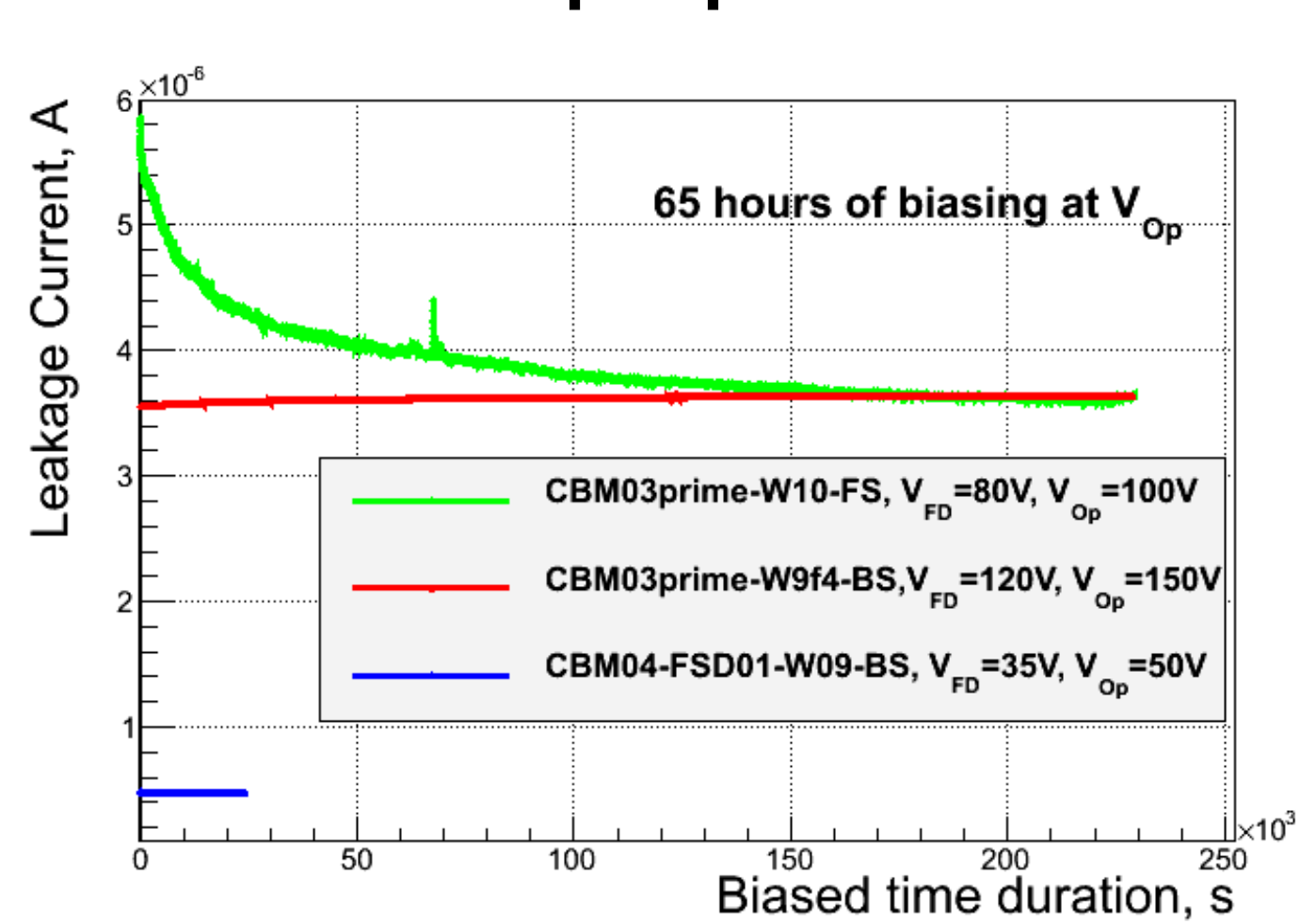
Coupling capacitance



Inter-strip capacitance



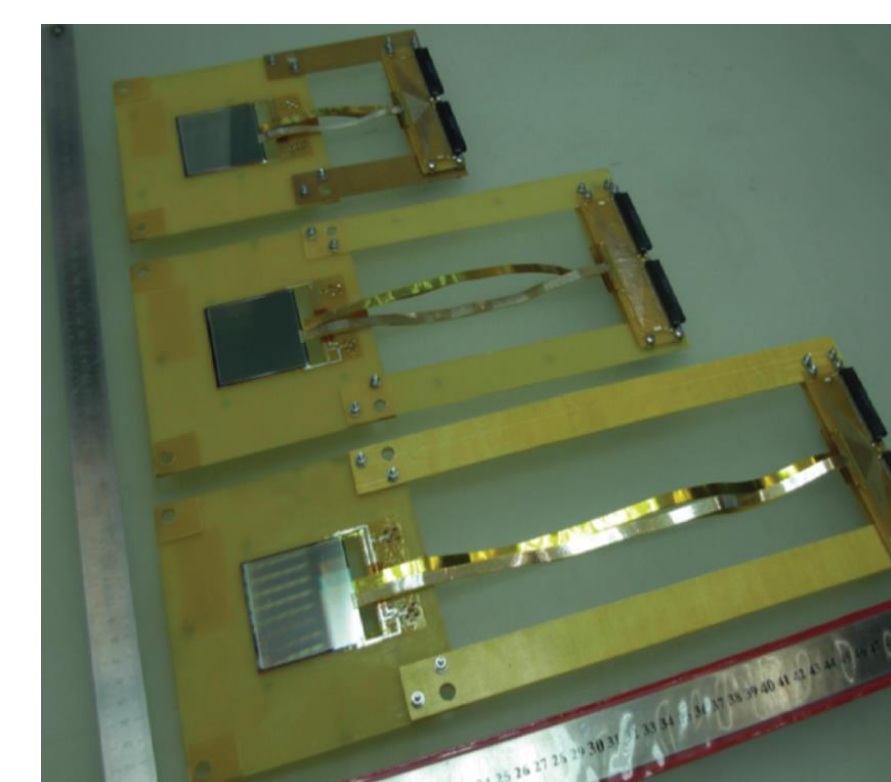
Pinhole test



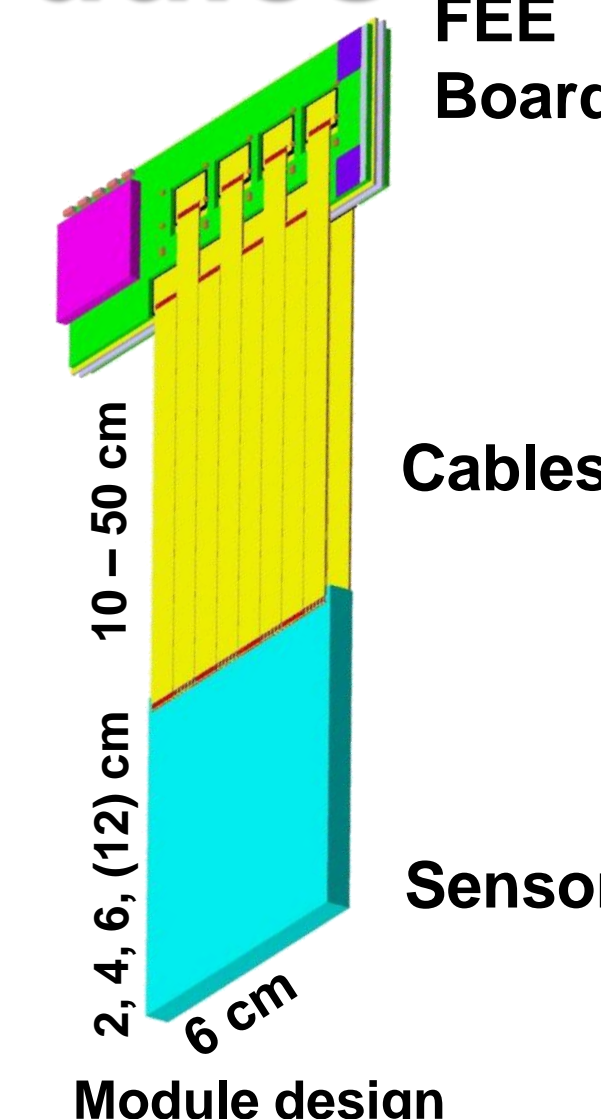
Current Stability

## Detector Modules

- STS will have of 8 detector stations
- 1220 sensors
- 896 modules
- 14.4 k FEE & cables
- Cables of 10 – 50 cm length
- Aperture (2.5° – 25° in phase space)

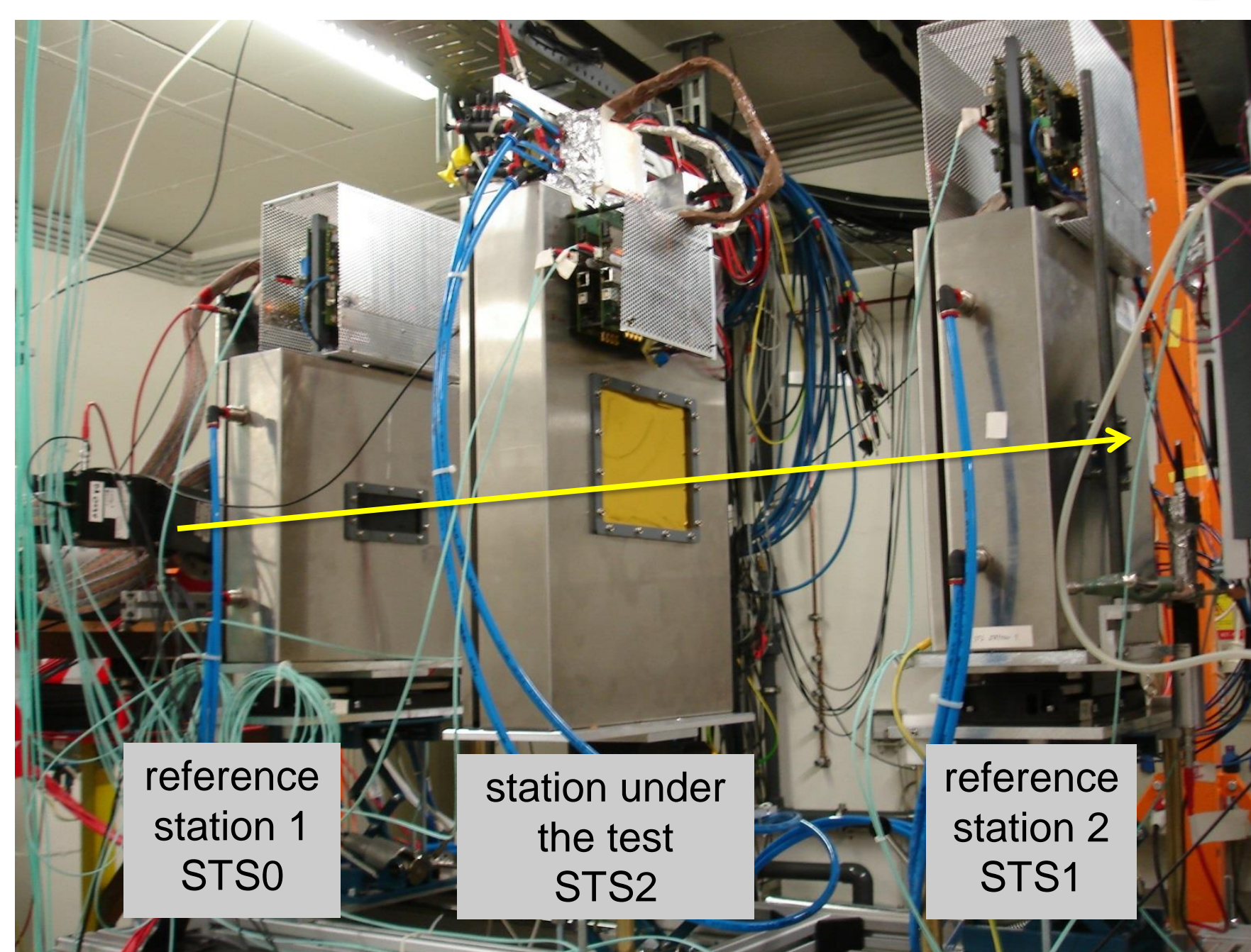


First prototypes with CBM01 sensors, 2009



Module prototype

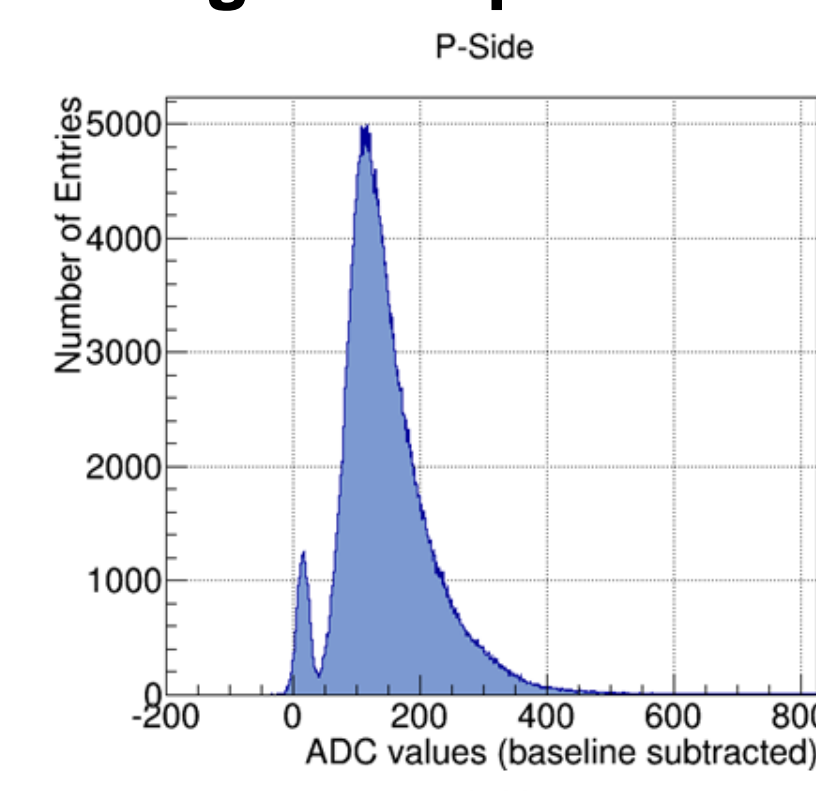
## In-beam Test @ COSY



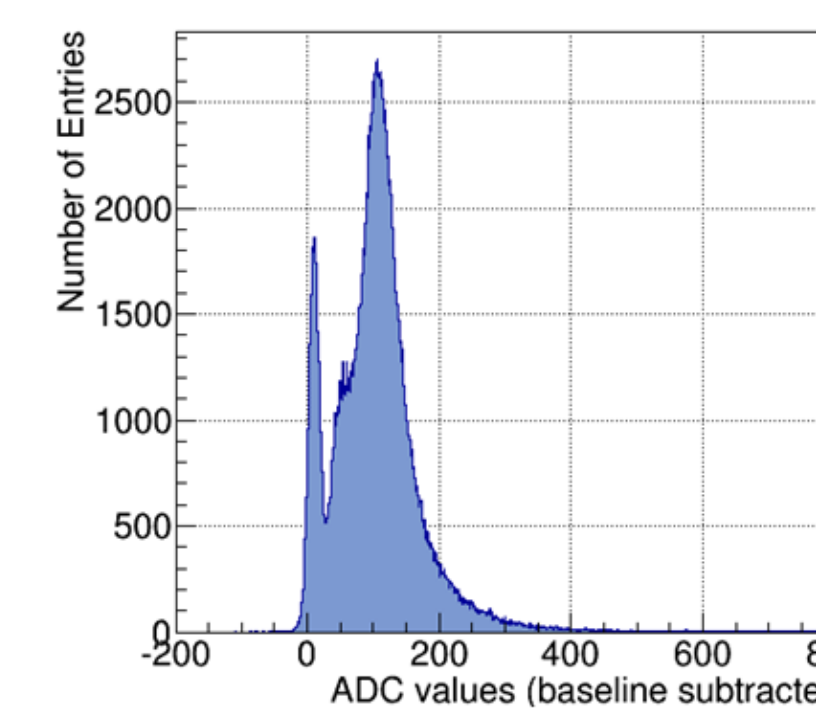
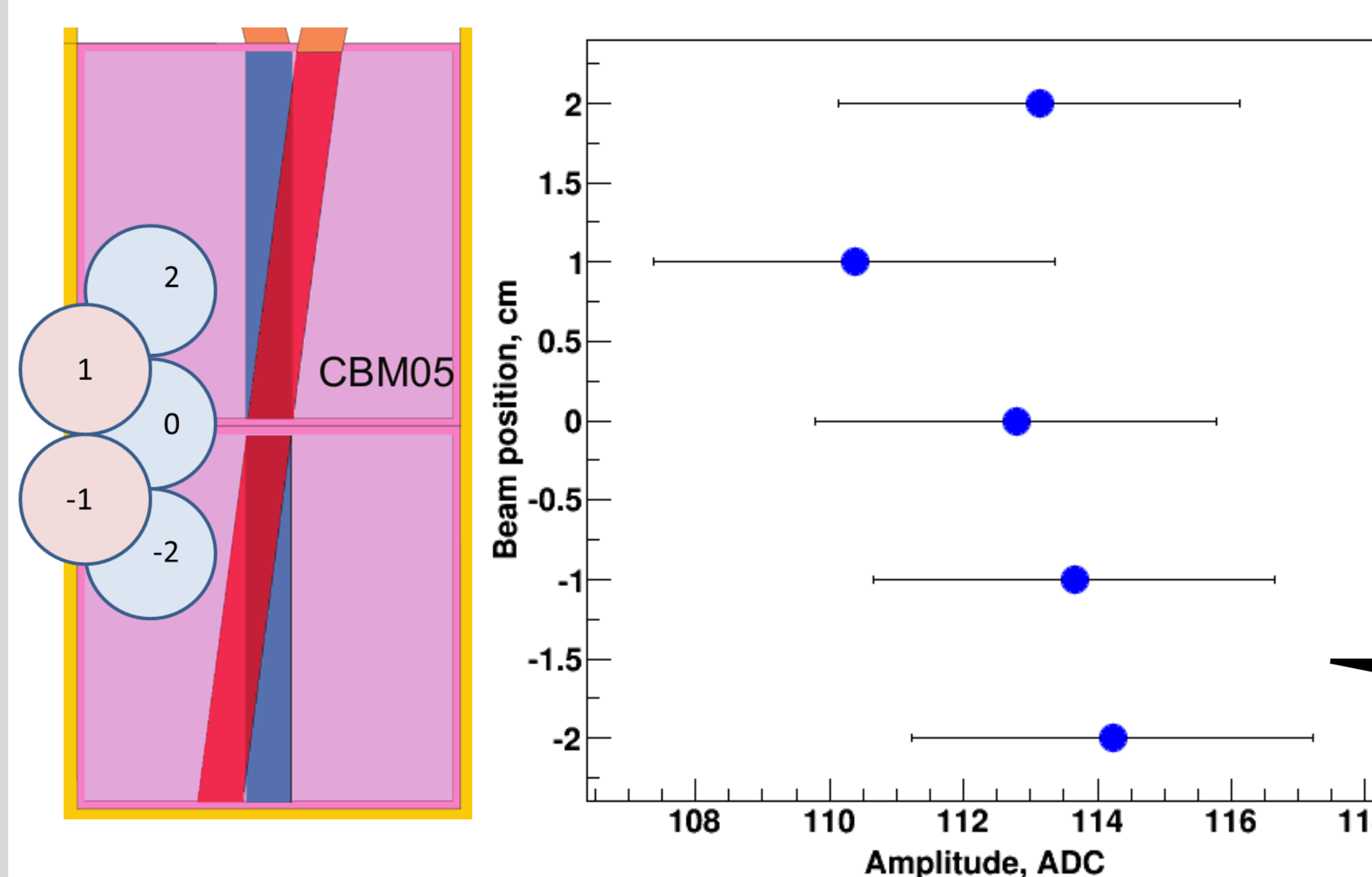
reference station 1 STS0, station under the test STS2, reference station 2 STS1

- proton beam, 2.8 GeV
- self-triggered and externally triggered r/o
- prototype modules under test

### Signal amplitudes



### Study of daisy-chained sensors



Cluster size

## Radiation Tolerance

Exposure of test sensors up to the maximum integrated neutron equivalent fluence expected in the STS:  $1 \times 10^{14} \text{ n}_{\text{eq}} \text{ cm}^{-2}$

Table summarizing the depletion voltage and charge collection efficiency from irradiated prototype sensors

- operation at  $T = -5^\circ\text{C}$
- electrical properties
  - depletion
  - operation
- charge collection efficiency (CCE)

Fluence $\text{n}(\text{eq})/\text{cm}^2$	$V(\text{fd})$ V	$V(\text{bias})$ V	Peak ADC ( $\pm 3$ )		CCE efficiency ( $\pm 4$ )	
			p-side	n-side	p-side	n-side
0,00E+00	80 $\pm$ 2	160 $\pm$ 1	117	102	100	90
1,00E+13	35 $\pm$ 2	130 $\pm$ 1	105	100	90	88
5,00E+13	45 $\pm$ 2	180 $\pm$ 1	95	95	81	84
1,00E+14	110 $\pm$ 2	300 $\pm$ 1	95	81	81	71

