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Readout of a prototype CBM-STS silicon sensor module with STS-XYTERv2 ASIC

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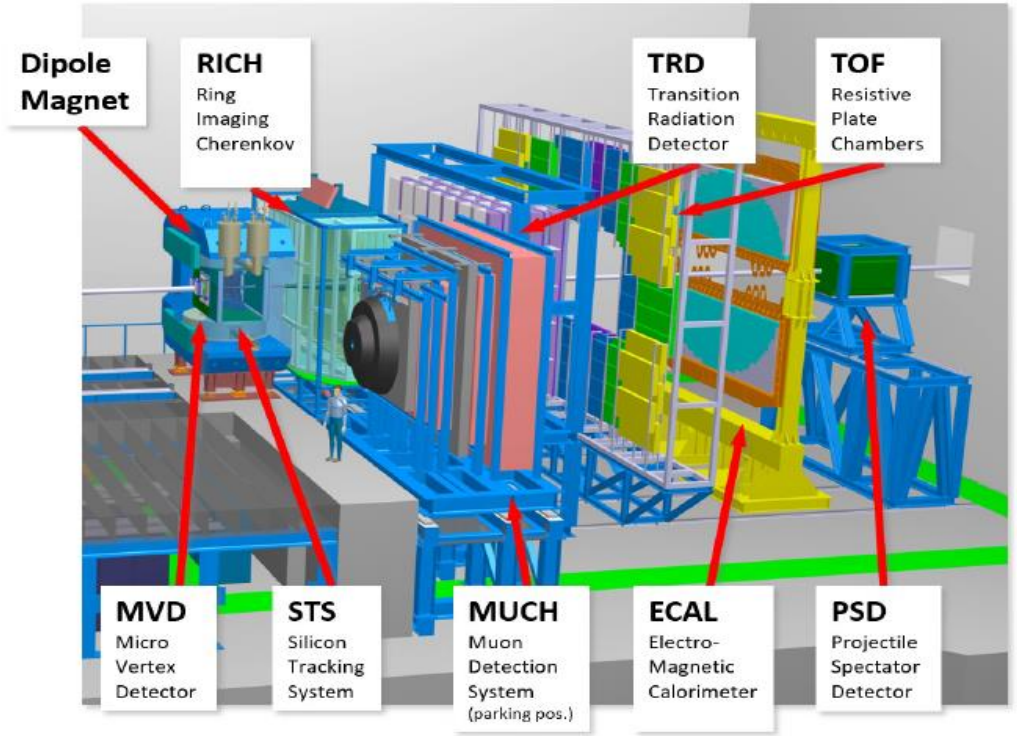
Introduction

The **C**ompressed **B**aryonic **M**atter experiment at FAIR



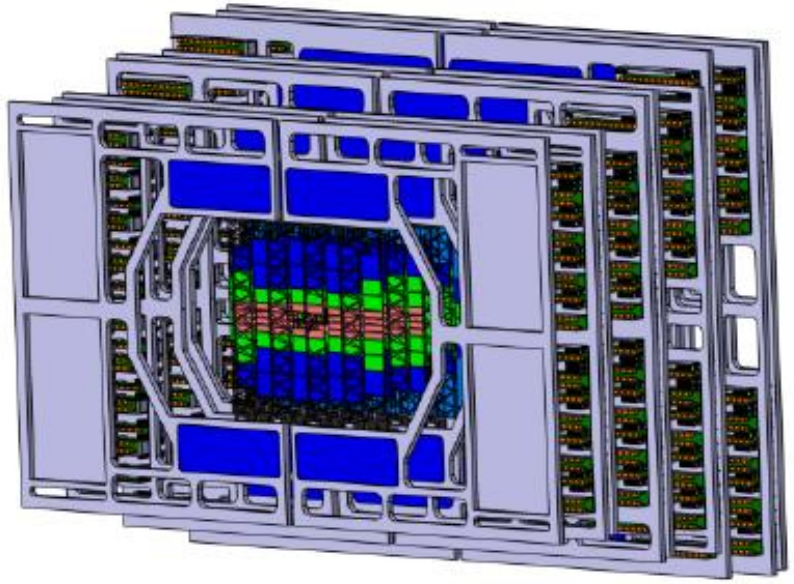
Goals:

- To explore the QCD phase diagram in the region of very high baryon densities
- Search for the phase transition between hadronic and quark-gluon matter, the QCD critical endpoint
- High precision measurement of rare probes

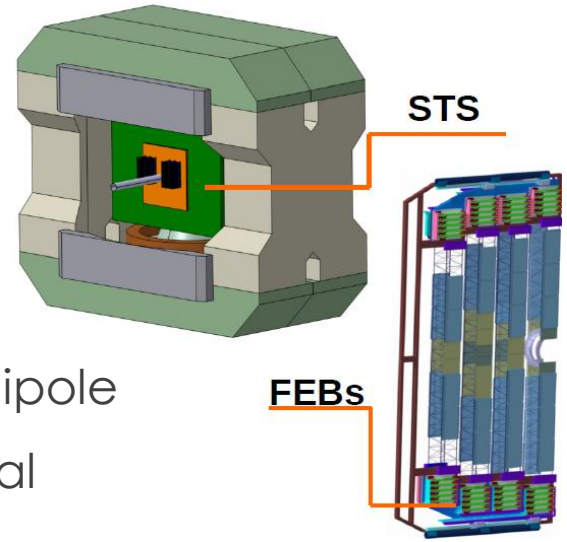
- Very high collision rate (up to 10 MHz)
- Self-triggered read-out electronics
- 4D event reconstruction and fast selection algorithms
- High granularity and radiation tolerant detectors & frontend electronics

Introduction

The **S**ilicon **T**racking **S**ystem of CBM



- 8 tracking stations
- ~900 double sided Si strip sensors (2 x 1024 strips)
- Self-triggered electronics
- $\delta p / p \approx 1.8\%$
- 58 µm strip pitch



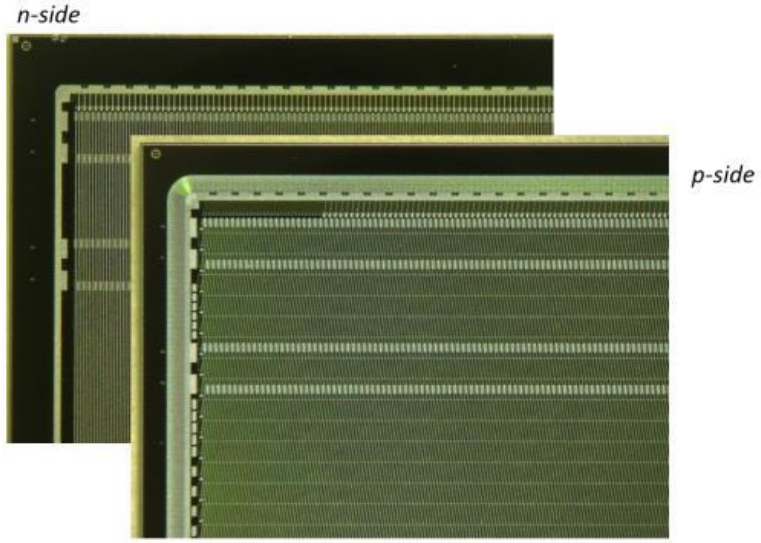
- ~4.2 m^3 volume contained inside a superconducting magnetic dipole
- Readout electronics mounted on top and bottom of the individual detectors ladders
- Efficient cooling needed (approx. 40 kW dissipated heat)

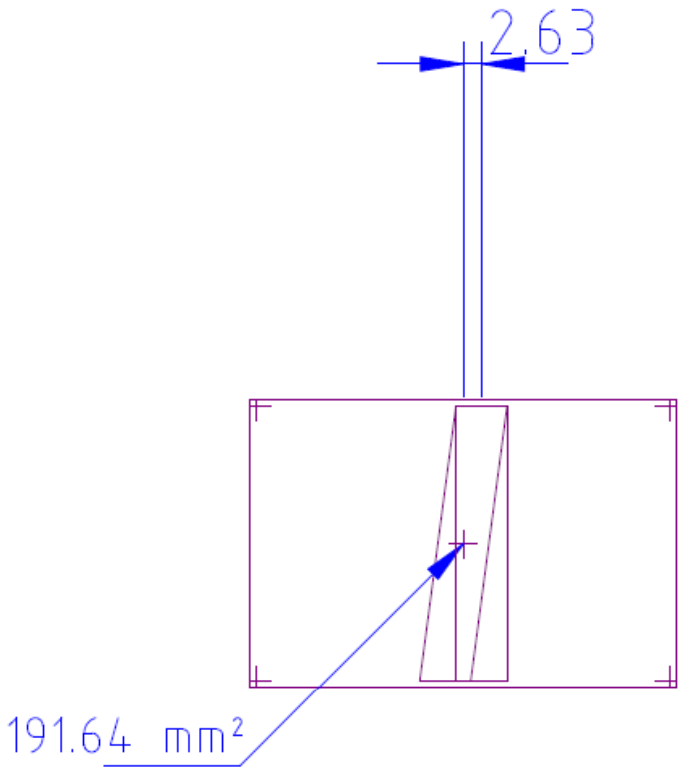
Motivation

First time that a system close to a fully assembled STS module will be tested allowing:

- To investigate sensor performance and system noise
- To study the performance of the STS XYTER v2.0 fronted ASIC
- To determine detection efficiency
- To test the data acquisition system

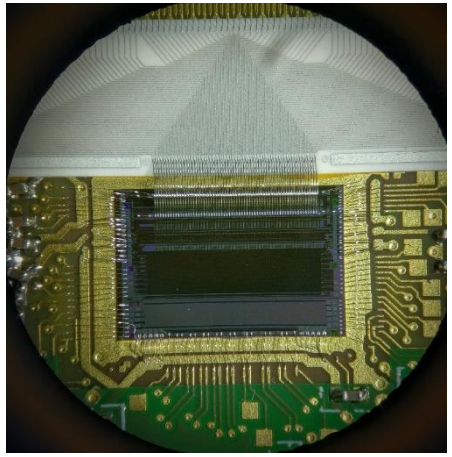
Sensors used

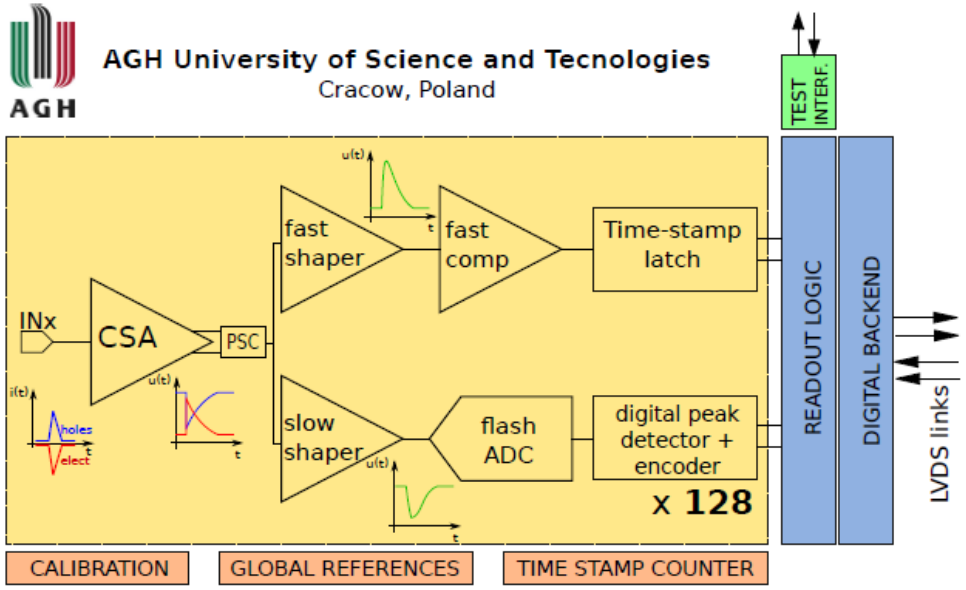




- Doubles sided silicon micro-strip sensors
- Strip structure of the sensors:
  - n-side straight strips
  - p-side 7.5° to the edge
- 128 strips connected per side
- Trapezoidal shape of the overlapping region
- 192 mm^2 of the sensitive area

STS XYTER v2.0 ASIC





Features:

- Low power, self-triggering ASIC
- 128 channels + 2 test channels
- Time resolution ~ 5 ns
- Provides digitized hits with:
  - 5 bit Energy Resolution.
  - 14 bit Time stamp.
- Linearity range up to 15 fC
- Radiation hard layout

Modules Preparation

Before module assembling:

- Sensors were selected and tested before tab-bonding:

  Leakage current

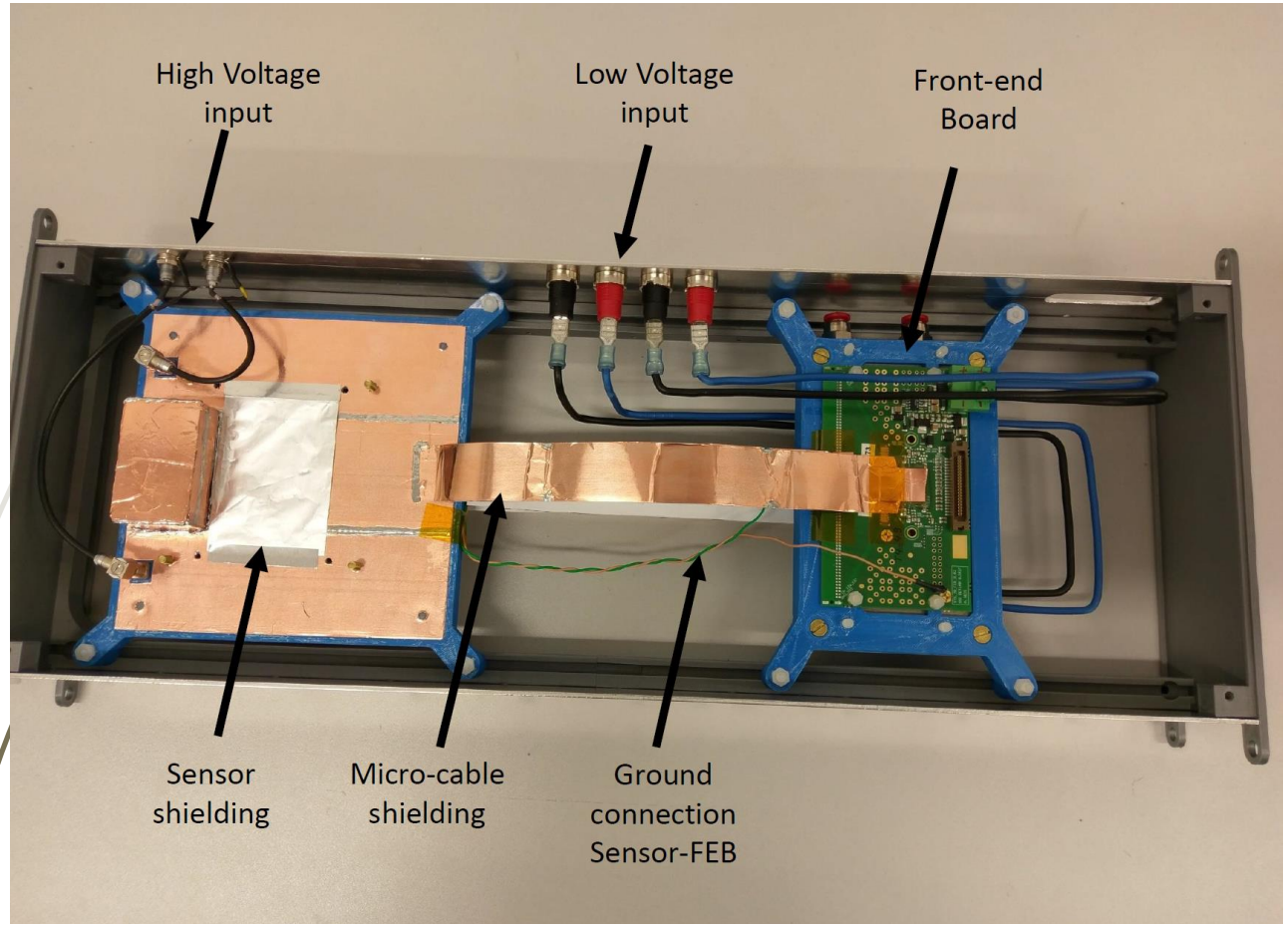
  Pin-holes
- ASICs tested and calibrated
- Mechanical support produced using 3D printing technology

After module assembling:

- Typically 2-3 channels per side with bad connection from strips to ASIC (out of 128 connected)

  Leakage current is not affected

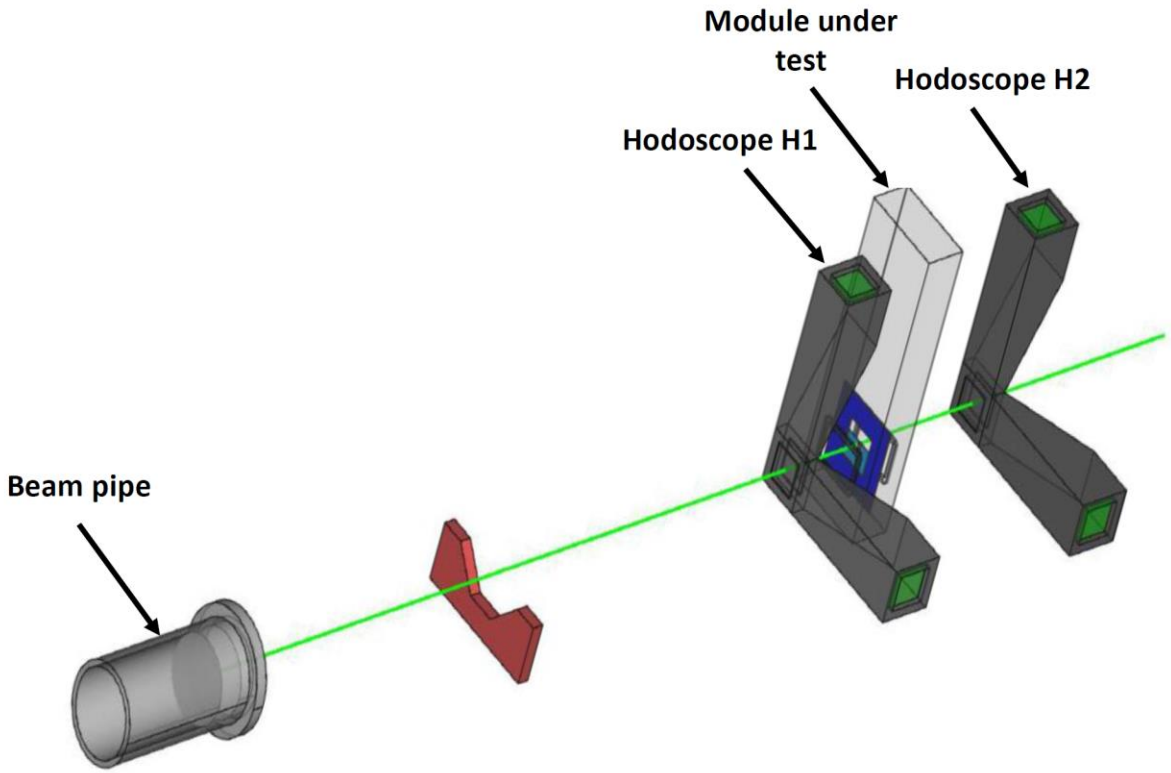
Modules Preparation



- Features:
- STS-XYTER v2.0 ASIC
- 42×62 mm^2 sensors (CiS)
- 128 channels per side read out
- Stack of 25 cm aluminium-polyamid micro-cables

- Designed to study hit detection efficiency and noise performance
- Hand-made shielding and grounding

Test beam setup



COSY, Research Center Julich

- Proton beam 1.7 GeV/c
- Reference detectors:

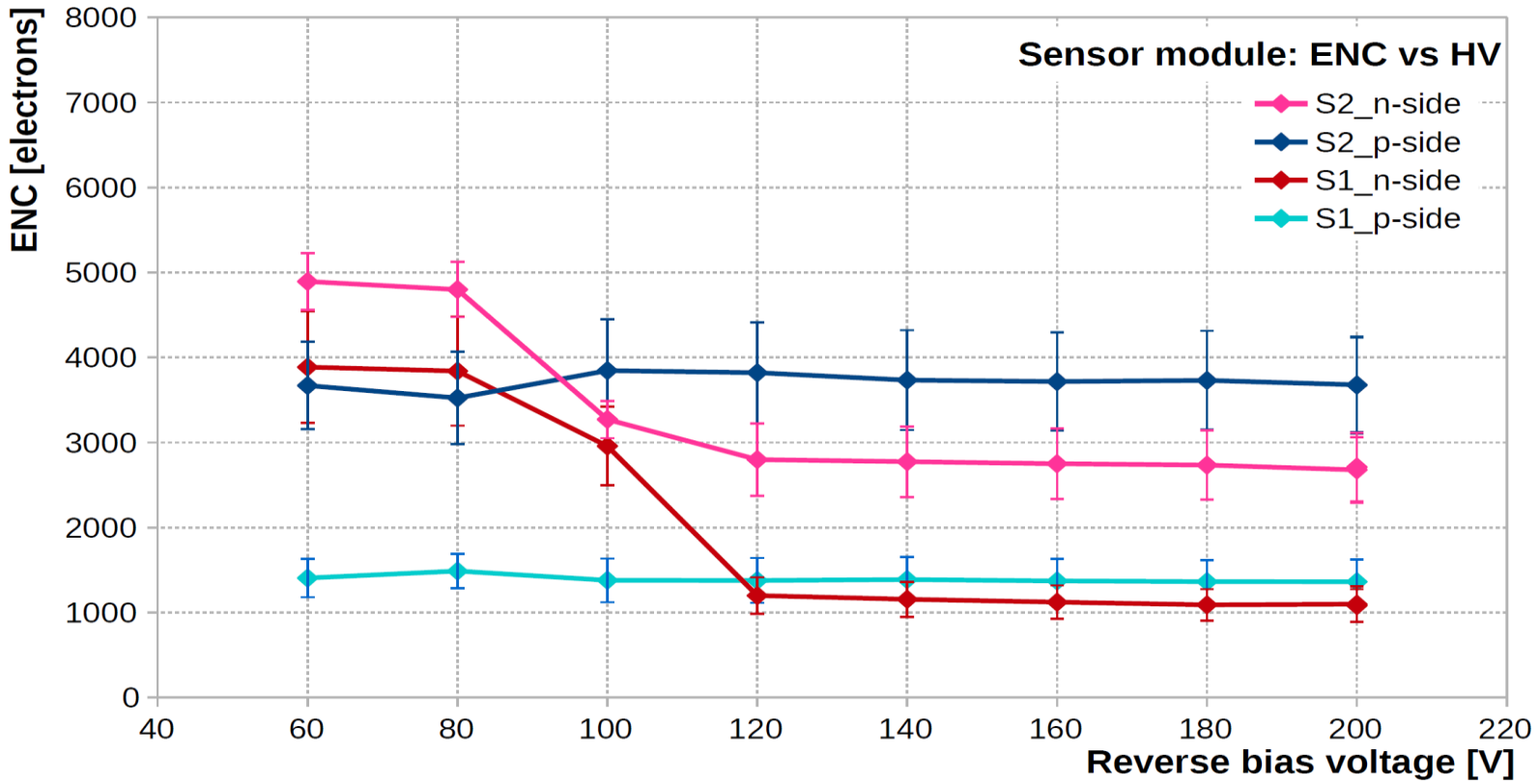
  Fiber hodoscopes
- Read-out:

  µTCA crate with AFCK + DAQ chain

  low and high voltage supplies

- Beam spot diameter ~1 cm (100% in hodoscopes, 30-40 % in each sensor)
- X/Y resolution in hodoscopes 290 µm
- X resolution in sensor 17 µm, Y resolution 17 µm / tan 7.5^{o} = 130 µm

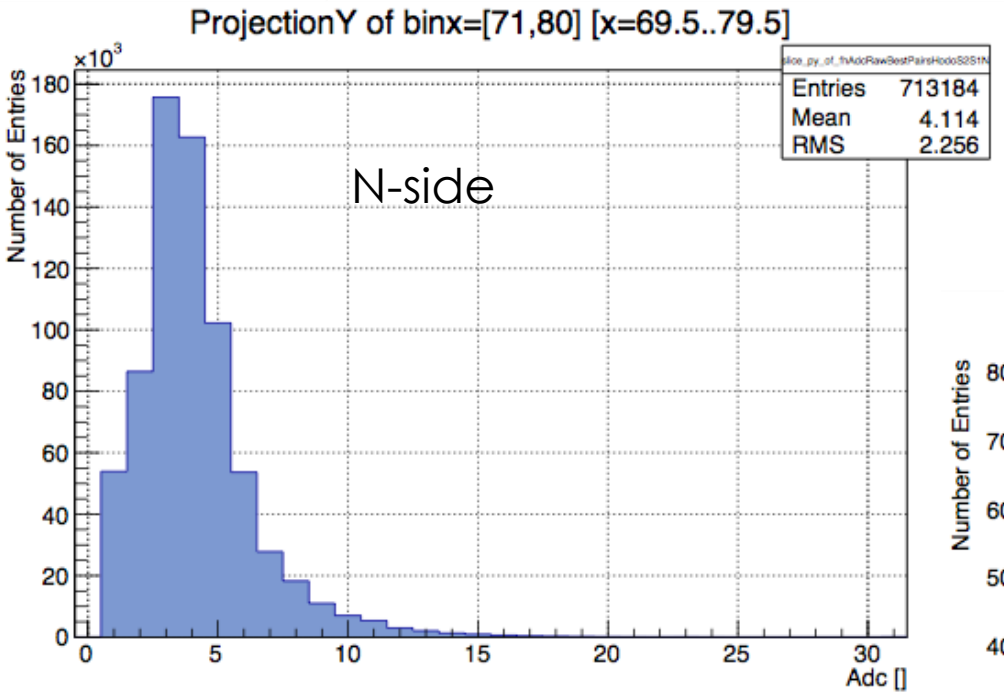
Noise performance

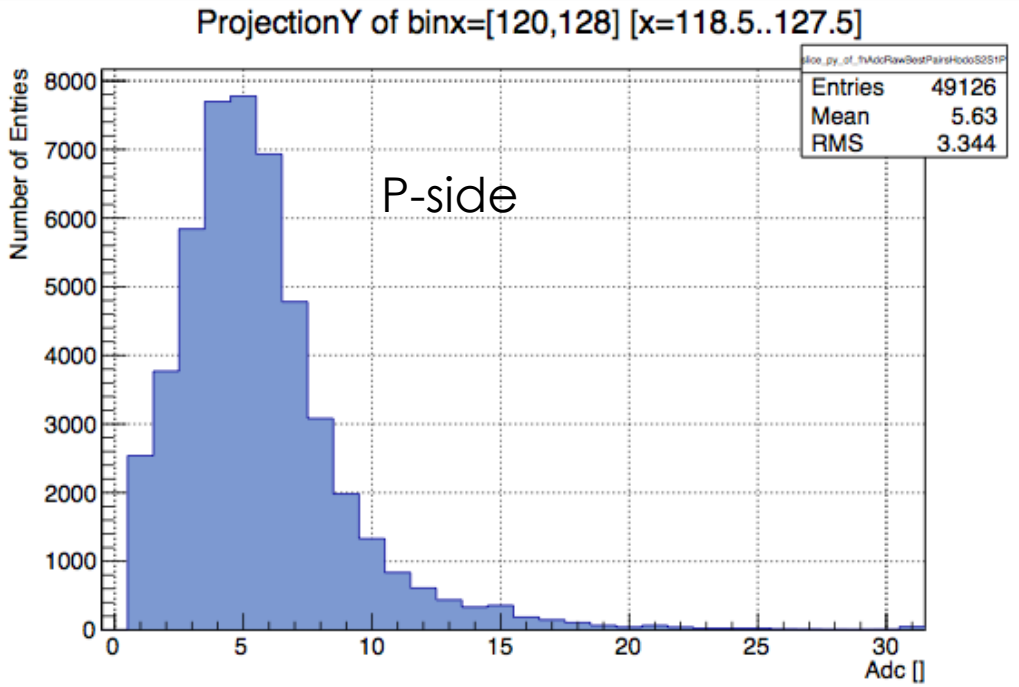


- Noise from 31 ADC discriminators of each channel were measured
- Effect of bias voltage visible in n-side
- Operational voltage above 120V

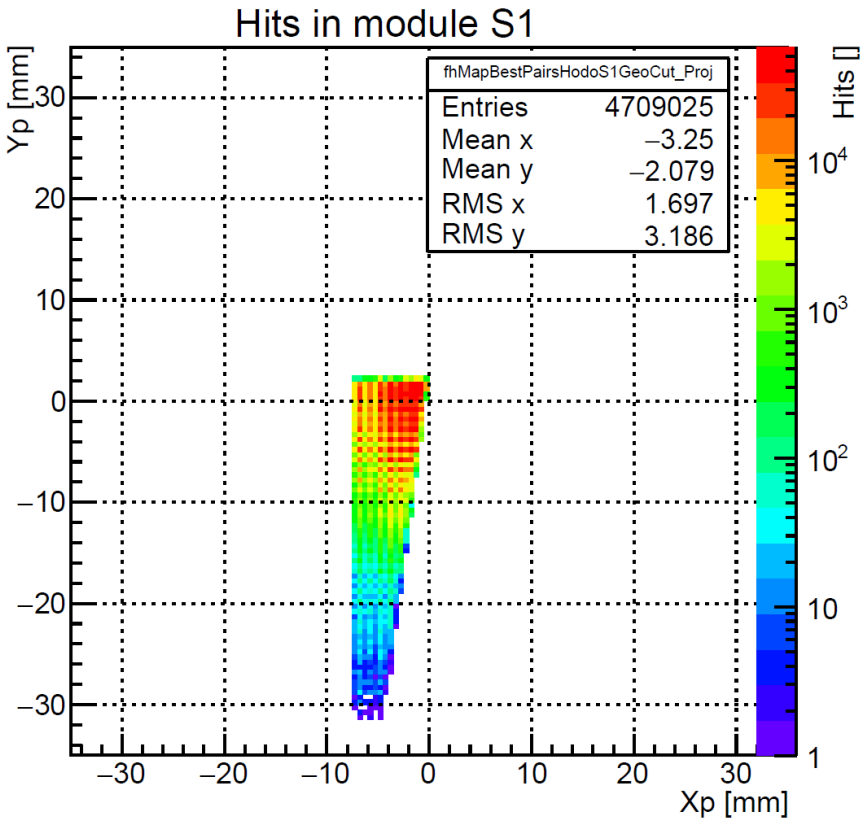
Signal ADC

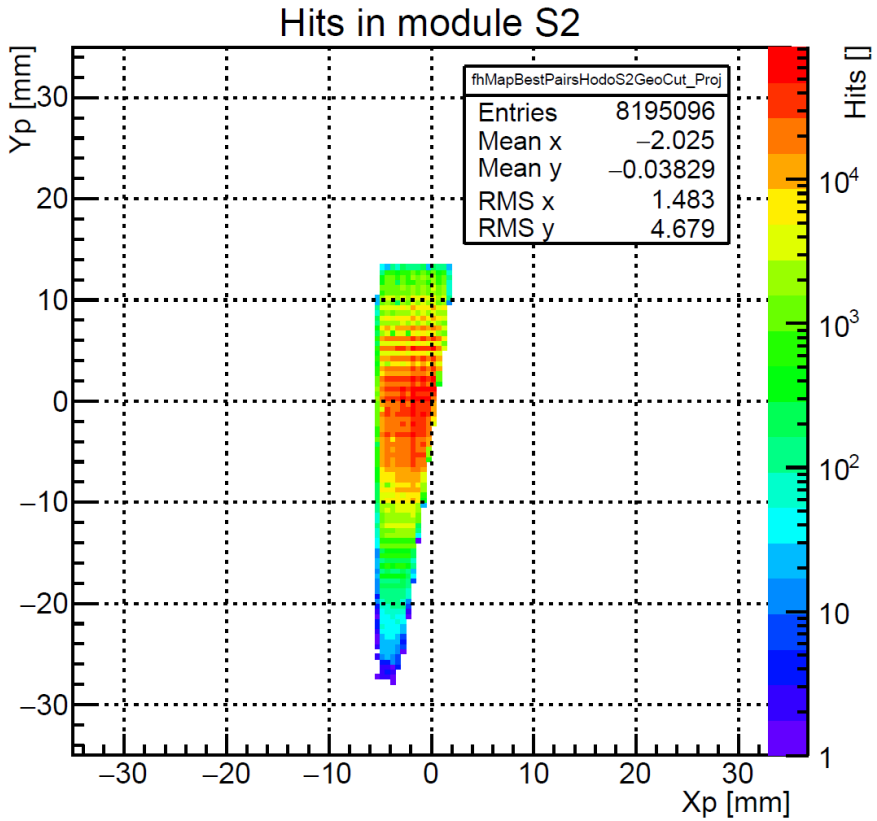
- Amplitude distribution of individual strips
- Significant offset ~1.12 fC
- Signal amplitude mean value is given in ADC units





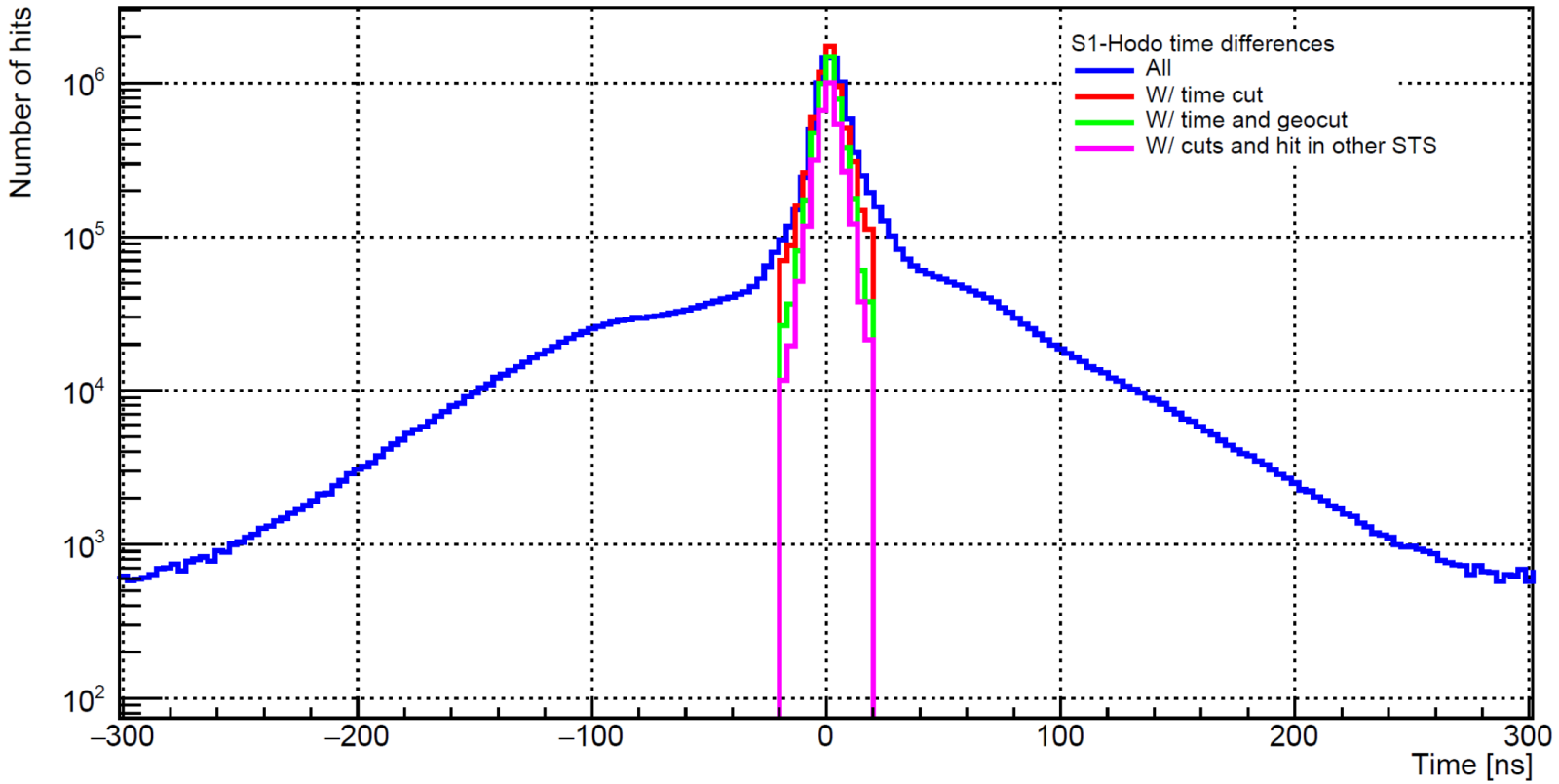
Hits map





- Temporal coincidence between each module and hodoscopes
- The structure results from overlapping area of p and n side strips
- Trapezoidal area ~ 192 mm^2

Time correlation



- Correlation peak at 0 ns
- Time difference sensors hits and hodoscopes within same time micro-slice was calculated
- Peak structure based on different selection criteria (mainly geometrical cuts)

Summary

- Preliminary results from fully assembled STS module have been shown.
- First time in-beam operation of detector modules with close to final components.
- Signal and noise contributions have been analyzed.
- Timing and amplitude information from bias voltage, signal threshold and beam incidence to be analyzed.

Thanks for your attention