Ladder Assembly for the Silicon Tracking System of the CBM Experiment at FAIR

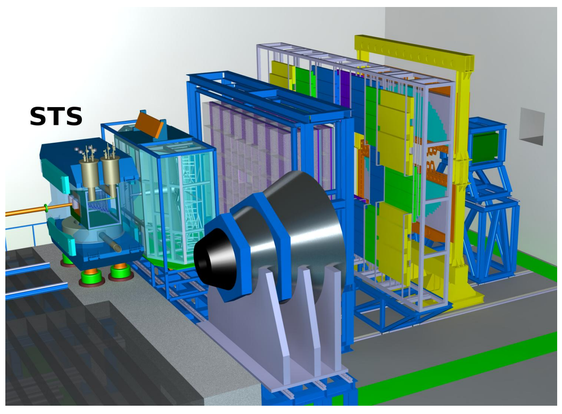
S.Mehta[1,2],* U.Frankenfeld[2], O.Vasylyev[2], and H.R.Schmidt[1,2]

1 Physikalisches Institut- Eberhard Karls Universitat Tübingen, Auf der Morgenstelle, Tübingen, Germany

2 GSI Helmholtzzentrum für Schwerionenforschung GmbH, Planckstrasse 1, Darmstadt, Germany

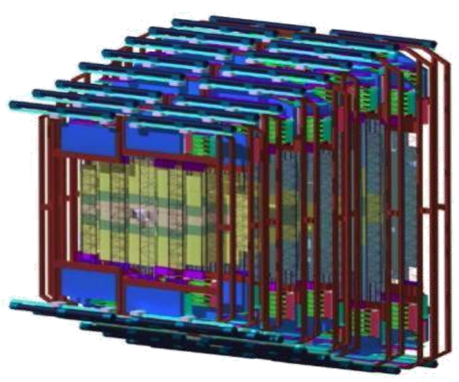
** email: s.mehta@gsi.de*

The STS for the CBM experiment at FAIR

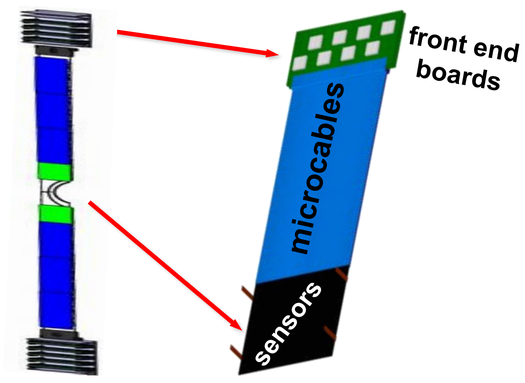


- STS is the core detector of CBM
- Located inside the dipole magnet
- Track reconstruction, momentum measurement

STS with 8 tracking stations

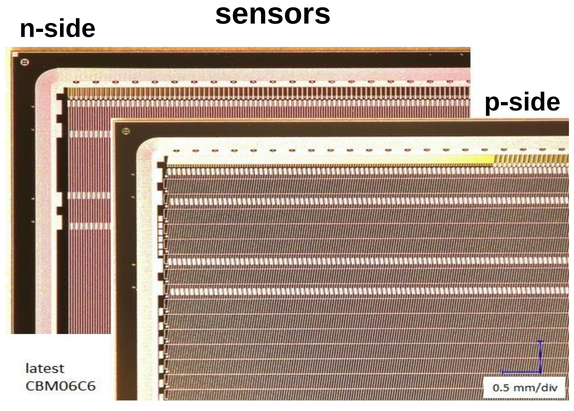


106 ladders **896 modules**



- Consists of 8 tracking stations
- 896 detector modules mounted on 106 Carbon Fiber (CF) ladders
- 8-10 modules on each CF ladder
- Requirement: Precision of sensors in 3D with in the order of100 µm

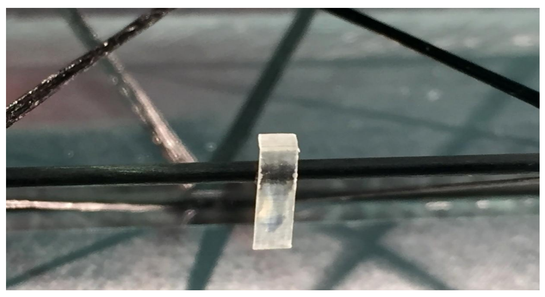
sensors



- Double-sided silicon micro-strip sensors
- 1024 strips on each side
- Stereo angle between front /back strips 7.5º
- 4 sensors size 6.2 x 2.2, 4,2, 6,2, 12.4 cm^2

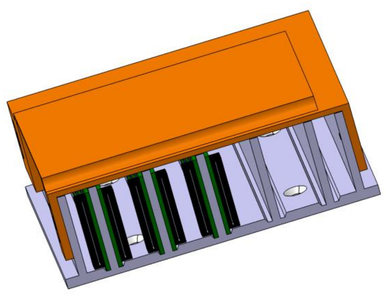
STS ladder components

Carbon Fiber support structures



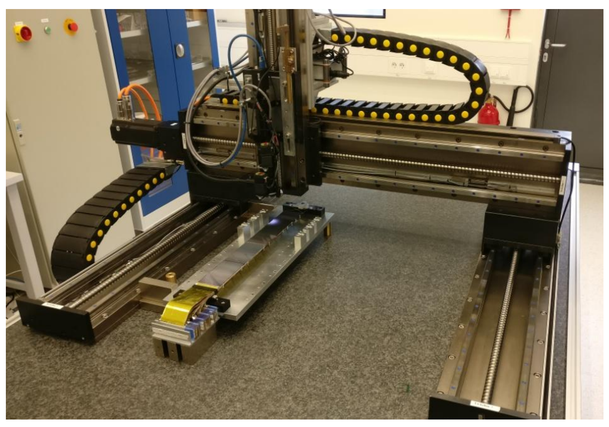
Sensor holding structures, L-legs

Sensor module: sensors, micro cables, FEBs



FEB (Front End Boards)

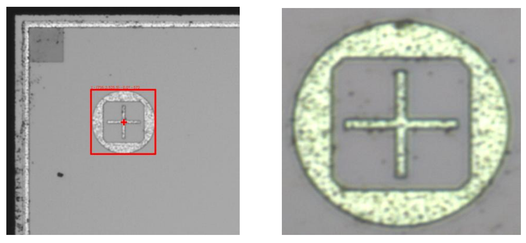
Instrument for optical survey



- Three-axis measurement instrument (1100 x 800 x 170 mm)
- Equipped with camera
- Non-rectangularity of X & Y axis is 17 µm
- Overall precision of table taking long term reproducibility of measurement is ± 10 µm.

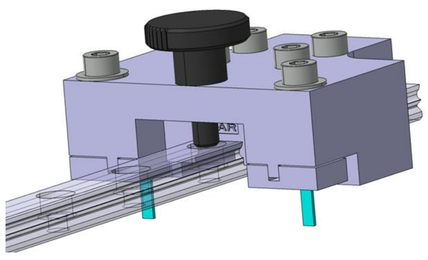
Reference paper: http://arxiv.org/abs/1812.00917

Measurement Technique

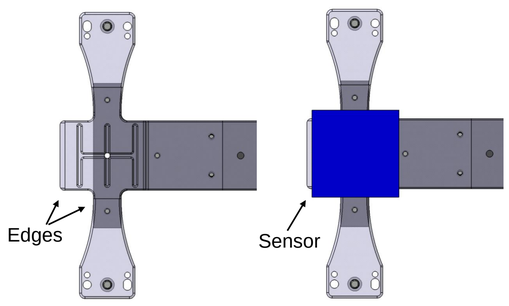


- LABVIEW software from NI is used for the optical survey of the table.
- 3D-position of sensors is determined from alignment marks on sensors surface.
- Measurement of height (in Z direction) is based on auto focusing.
- Measurement of XY surface is based on pattern recognition based on NI vision package.

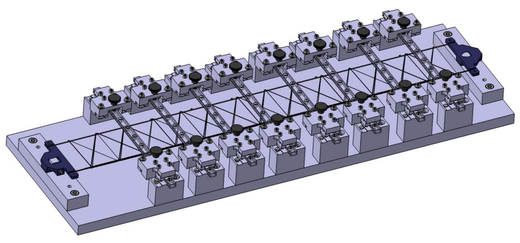
Assembly technique



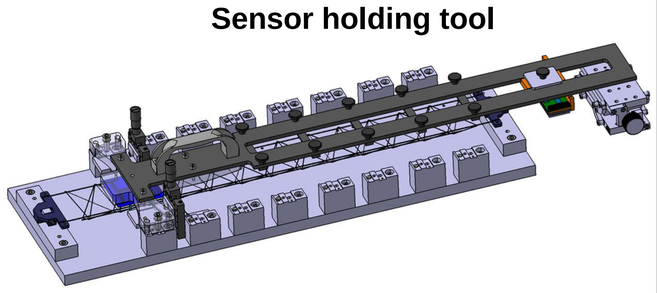
L-leg mounting tool holding l-legs (two l-legs goes in one fixture)



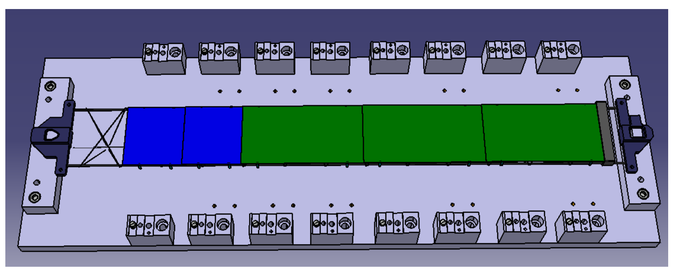
Sensor holding tool



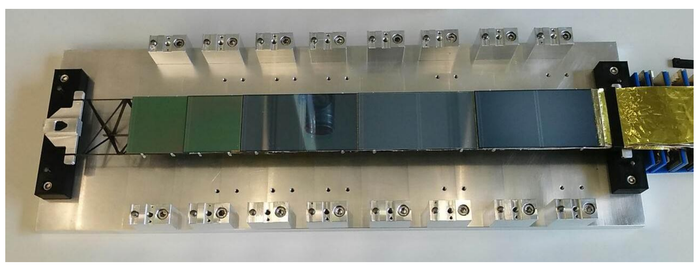
Tool to assemble 5 sensors on a ladder



Assembly of first module using module holder

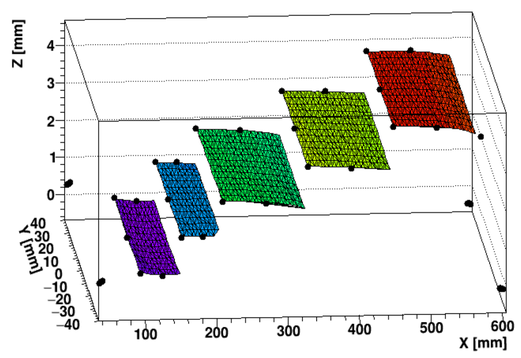


- A tool has been designed to mount the modules on the CF ladders.
- Sensors are positioned in respect to the supporting fixtures on the sensor holder.
- Sensor holder is positioned to the tool with dowel pins.

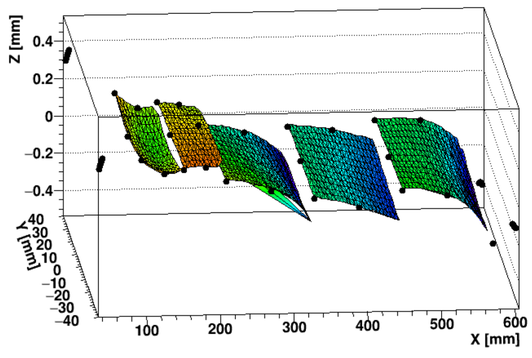


- Ensures the feasibility to mount the modules on the tool.
- Assembly of CF ladder with 5 non-functional modules mounted on it.

Positioning accuracy of sensors on ladder



Measurement of the sensor surface space points. The black dots refer to the alignment marks on the sensor surface.



Nominal module Z position was shifted to zero for all the sensors
ZMax-Min: Surface 417 µm
Marks 483 µm

Conclusion & Outlook

- A setup and procedure is developed to determine the position of objects in 3D with good precision.
- Pattern recognition technique based on NI vision package helps to make an automatic scan of the sensors.
- Mounting tools and jigs can be improved for the better precision.
- Measured sensor position on ladder will be further used as an input for the track based alignment.
- Based on the same concept of ladder assembly, a functional ladder is assembled for the mini-STS which is now under test.