Module and ladder assembly techniques for the Silicon Tracking System (STS) of the CBM experiment at FAIR

Shaifali Mehta, for the CBM collaboration

Eberhard Karls Universität Tübingen, Tübingen, Germany

CBM

Compressed Baryonic Matter experiment at FAIR

STS for the CBM Experiment

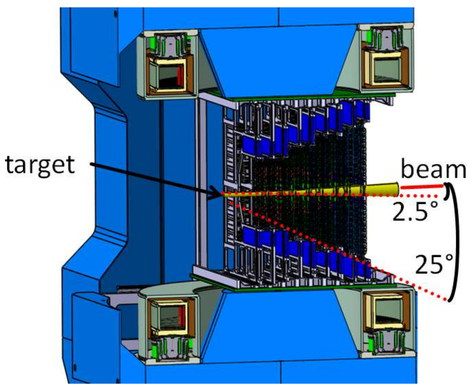


Fig: STS inside the dipole magnet

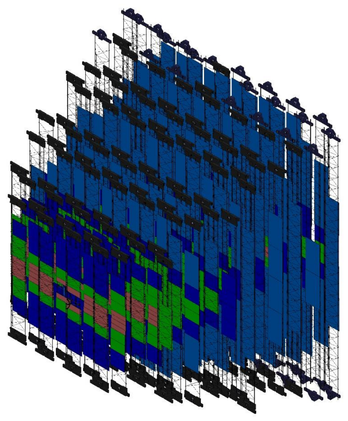
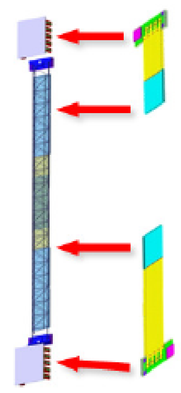


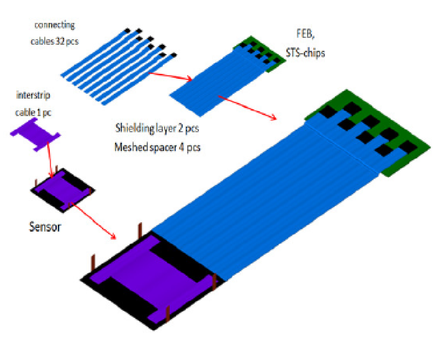
Fig: STS with sensors mounted on carbon fibre ladder

- Core detector of the CBM experiment
- Located inside dipole magnet
- Track reconstruction efficiency, ε ≥ 98%
- Momentum resolution, Δp/p ≈ 1.5%
- Hit spatial resolution ~ 25 µm
- Material Budget ~ 1.5% X_0 per layer
- Self triggering front end electronics

Ladder and detector modules

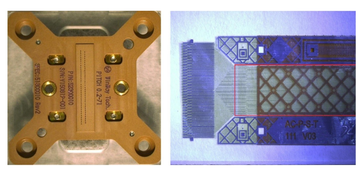


- 8 tracking stations
- 106 Carbon fiber ladders
- 896 detector modules
- 8-10 modules on each ladder
- Front end electronics at both ends of the ladder
- Goal: Positioning of sensors in 3D within order of 100 µm

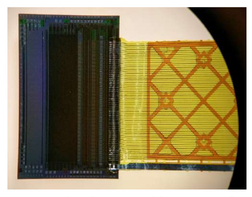


- Double-sided silicon
- micro-strip sensors
- Stereo angle 7.5°
- 58 µm pitch
- 1024 strips on each side
- Strip length: 2/4/6/12 cm
- Strip width: 6 cm

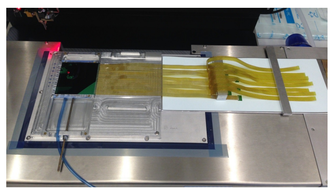
Module assembly



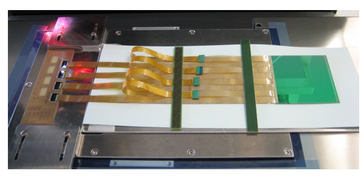
Connectivity test with pogo-pin set-up

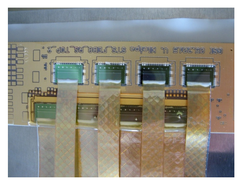


Tab bonding of microcables to ASIC



Tab bonding of micro-cables to Si sensors

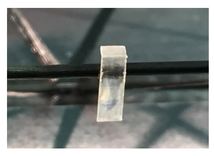




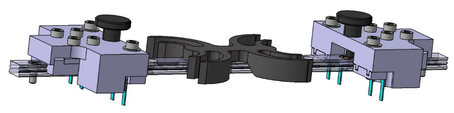
Die and wire-bonding of ASICs to the first row of FEB-8 , after quality measurement procedure is repeated for second row

STS-module consists of a double-sided silicon microstrip sensor connected via microcables to two front-end-electronics PCB´s

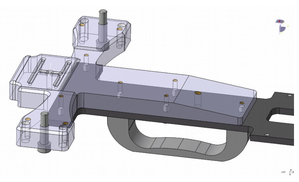
Ladder Assembly



L-legs, made of Glass fibres

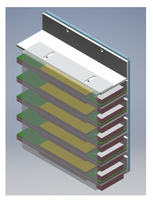


L-leg mounting tool holding l-legs (four l-legs goes in one fixture)

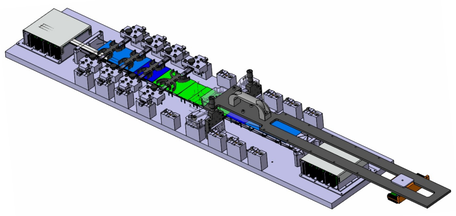


Sensor holding tool

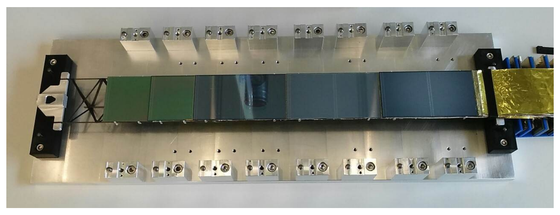
Ladders, Carbon Fibre (CF) support structures



FEBs (Front End Boards) in cooling box



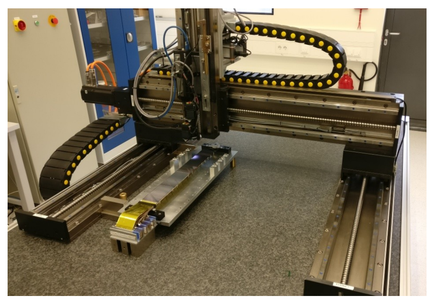
Full size tool to assemble modules on a ladder

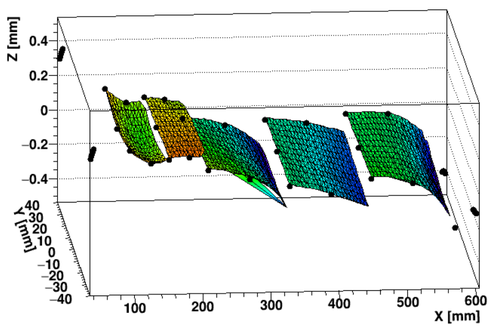


- Assembly of CF ladder with 5 non-functional modules using similar tools
- Ensures the feasibility to mount the modules on the tool
- Technique was used to assemble the ladders for m-STS

Optical survey & measurement Technique

- Three-axis measurement instrument (1100 x 800 x 170 mm)
- Equipped with camera & motorized optics
- Overall precision of table taking long term reproducibility of measurement is ± 10 µm
- Goal is to make sure that the sensors position do not deviate from nominal positions by more than 100 µm





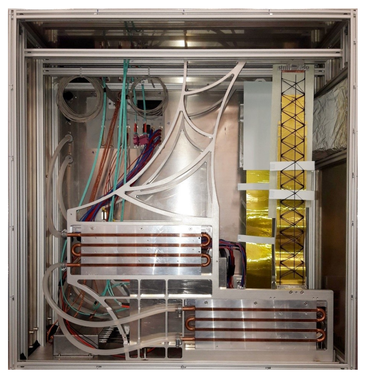
- 3D-position of sensors is determined from alignment marks on surface
- The black dots refer to the alignment marks on the sensors
- Measurement of XY surface is based on pattern recognition technique
- Measurement of height (in Z direction) is based on focusing technique
- Nominal module Z position was shifted to zero for all the sensors

Z Max-Min: Surface 417 µm
Marks 483 µm

Conclusion and outlook

- The technique used to assemble the ladder is promising
- Based on the same assembly concept, further ladders will be assembled
- Mounting tools with better precision are in progress for the bulk production
- Measured sensor position will be further used as an input for the track based alignment

Ladder holding two 6 x 6 cm^2 modules covered by shielding



mSTS

- Full sized half ladders and modules were assembled for the first time
- ASIC configuration was stable
- Integrating prototype detector's modules into a common, free-streaming DAQ
- 13 sensor modules mounted on 5 ladders will be grouped on 2 tracking stations

FAIR
EBERHARD KARLS UNIVERSITÄT TÜBINGEN
MATHEMATISCH-NATURWISSENSCHAFTLICHE FAKULTÄT
Physikalisches Institut
HGS-HIRe for FAIR
Helmholtz Graduate School for Hadron and Ion Research
GSI