Automated assembly of large double-sided microstrip detectors for the CBM Silicon Tracking System at FAIR

Patrick Pfistner, for the CBM collaboration

- CBM will be one of the major scientific pillars of the future FAIR facility
- Investigation of QCD phase diagram at highest baryon densities

**Silicon Tracking System (STS)**
- One of the core detectors of CBM located inside the dipole magnet [1]
- Track reconstruction and momentum determination of charged particles
- Track multiplicity ≤ 700 per central Au+Au collision in aperture 2.5° < θ < 25°
- Momentum resolution ∆p/p < 2% for 5 TeV
- Lifetime fluence up to 1 x 10^{15}n_{eq} in innermost region

**STS conception**
- Eight tracking stations 0.3 m to 1 m downstream of the target
- 896 detector modules arranged in 106 ladders of 23 variations
- Readout electronics located in the periphery
- Module structure is rather complex

**Automated bonder machine developed at KIT**

- Complementing the established Al TAB bonding interconnection technology based on an aluminum microcable, a novel high-density interconnection technology based on a gold stud
- Chip process and a copper microcable has been developed at KIT [3].
- To fully exploit its automation capabilities, an in-house bonder machine has been developed in parallel.

**Cable bonder characteristics**
- Four stepper motors in x, y, z, φ with sub-micron step resolution to achieve alignment accuracy < 6 µm
- Dual-camera system including calibration mechanism for precise alignment of microcable and sensor
- Specialized mechanics for the handling of STS module components
- Valve island for automated pneumatic control
- Heatable bondhead and sensor plate with automated temperature control
- Pressurized air cooling

**Test setup**
- 6.2 x 6.2 cm² double-sided sensor biased at ±150 V
- One copper microcable for n-side and p-side
- Two Front-End Boards type C (FEB-C), each hosting one STS-XYTER readout ASIC
- Readout via AFCK board hosting Kintex7 FPGA controlled by IPbus
- Full noise analysis performed inside aluminum shielding box with the help of STS-XYTERs internal test pulsing capability

**Noise analysis: preliminary results**
- ENC analysis is essential for the QA of detector modules during R&D as well as production
- Identification of possible bad connections on sensor or ASIC side
- Comparison between interconnection technologies
- Influence of different cable and sensor sizes
- Optimization of shielding and grounding

- **Expected ENC**
  \[ 460 \text{e}^- (ASIC) + \left( 0.44 \text{pF/cm} \times 20 \text{cm (cable)} + 1.52 \text{pF/cm} \times 6.02 \text{cm (sensor)} \right) \times 27.4 \frac{\text{e}^-}{\text{pF}} = 952 \text{e}^- \]

- **Measured ENC for connected channels**
  - P-side: 1000 ± 80 e^-
  - N-side: 1100 ± 80 e^-

- Preliminary results are comparable to aluminum TAB bonding technology.

References:

KIT – The Research University in the Helmholtz Association

www.kit.edu