Karlsruhe Institute of Technology

High-density interconnection technologies for the CBM Silicon Tracking System

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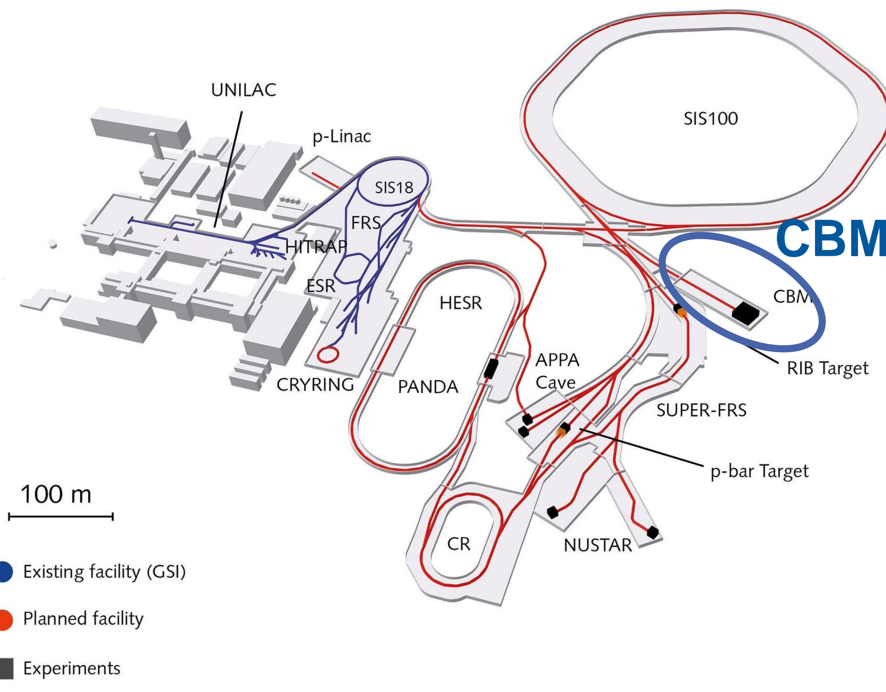
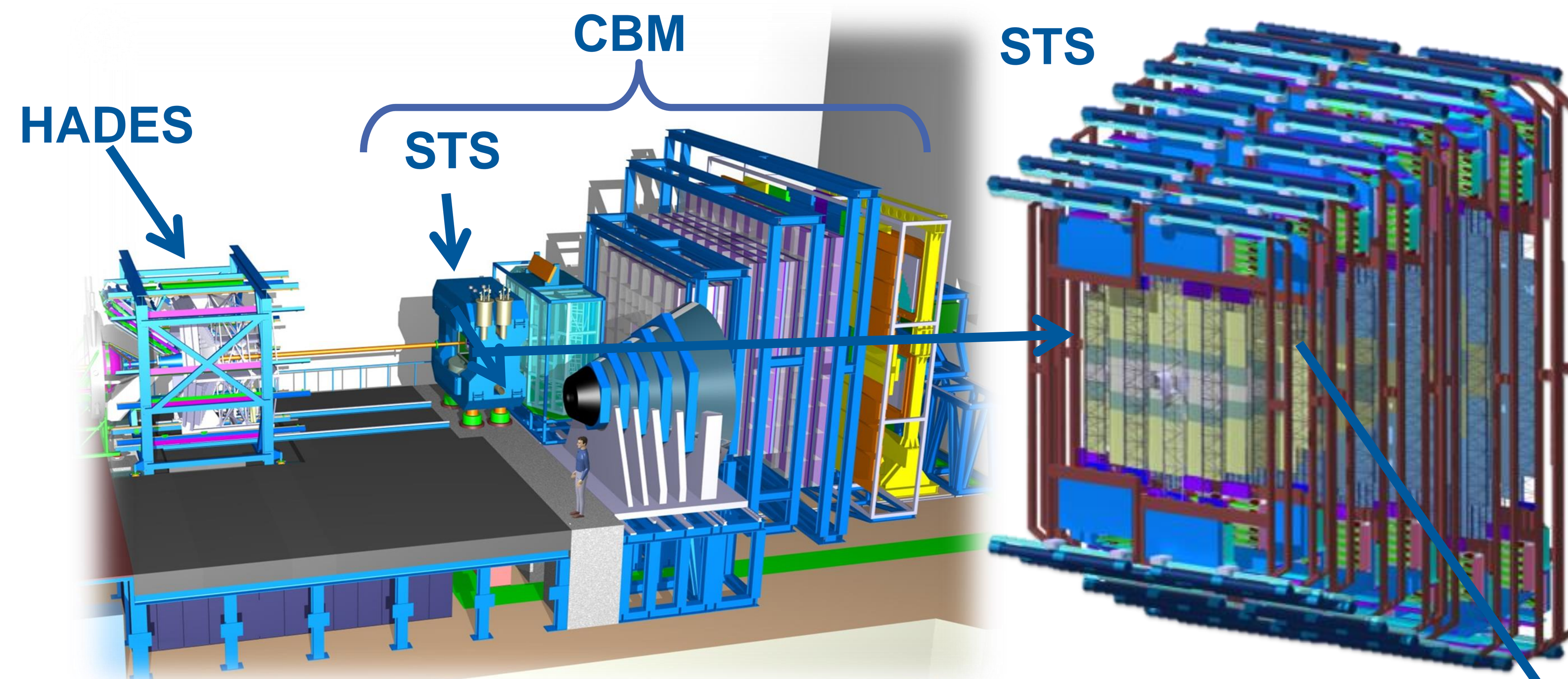
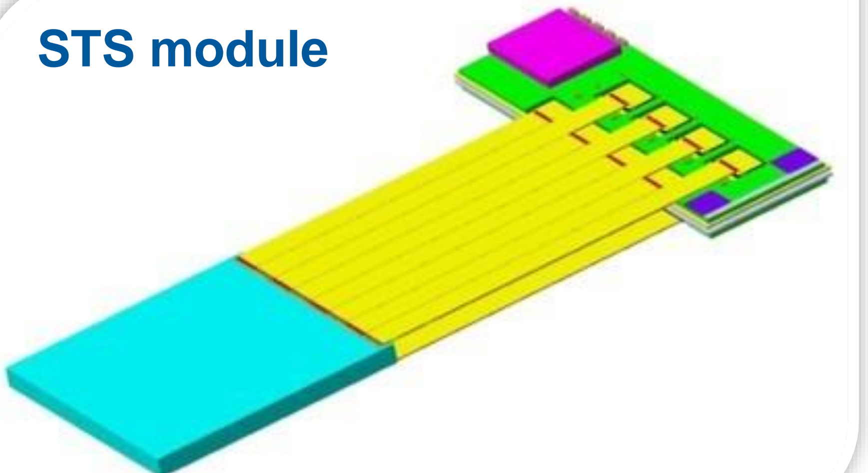
CBM at FAIR, GSI





- STS: 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 leading to complex module assembly

- STS detector module:
  - 1 x double-sided microstrip sensor
  - 16 x STSXYTER ASICs
  - 2 x FEB-8 readout-boards
  - 16 or 32 x low mass microcables



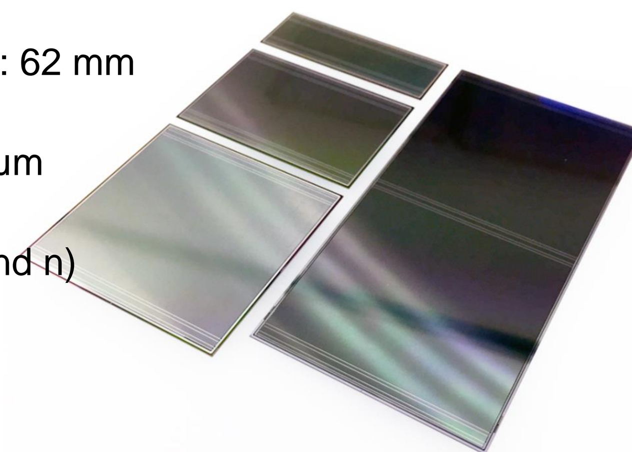
- CBM is one of the major scientific pillars of future FAIR facility
- Investigation of QCD phase diagram at highest baryon densities

Silicon Tracking System (STS)

- One of the core detectors of CBM located inside the dipole magnet
- Track reconstruction and momentum determination of charged particles
- Track mult. up to 700 per central Au+Au collision in aperture $2.5° < \theta < 25°$
- Momentum resolution Δp/p ~ 1%
- Lifetime fluence up to $1 \times 10^{14} n_{eq}$ in innermost region

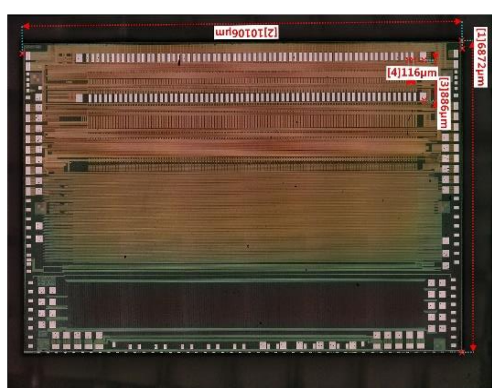
Module components

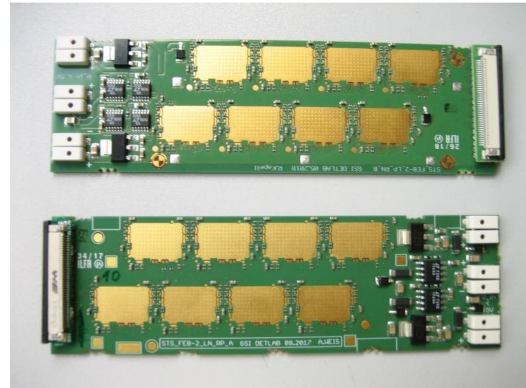
- Four main sensor sizes: 62 mm x 22, 42, 62, 124 mm.
- Sensor thickness: 300 µm
- Strip pitch: 58 µm
- 2 x 1024 channels (p and n)



- Low-mass microcables with a length up to 50 cm for innermost modules

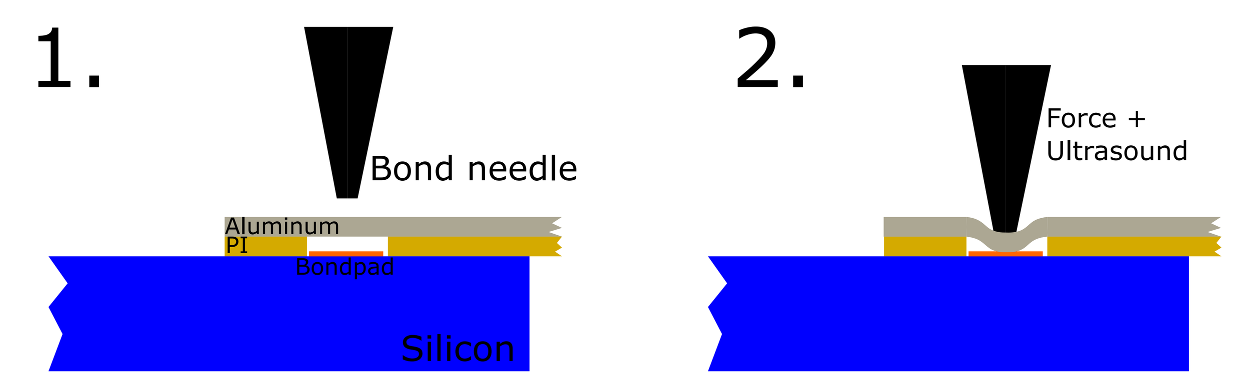
- STS/MUCH-XYTER ASIC
- FEB-8 for p and n-side

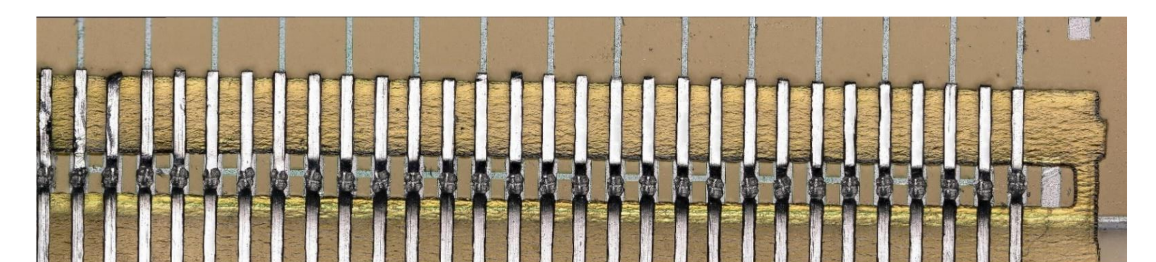




Established interconnection technology: TAB bonding

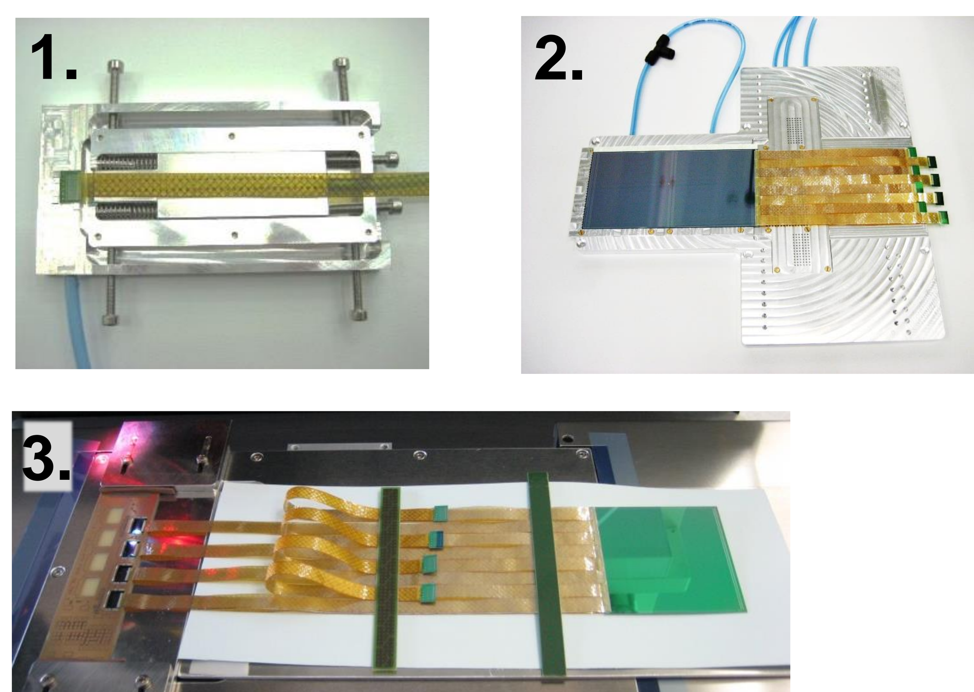
- Aluminum to aluminum TAB bonding
- Aluminum microcable
  - Single layer, 64 channels
  - 14 µm aluminum on 10 µm polyimide carrier
  - Capacity: 0.5 pF/cm
- Material budget: $X/X_0 \sim 0.03$ %
- Reliable, well-established, used in mSTS for mCBM
- Manual and time-consuming process
- Initial questions regarding sufficient yield for production

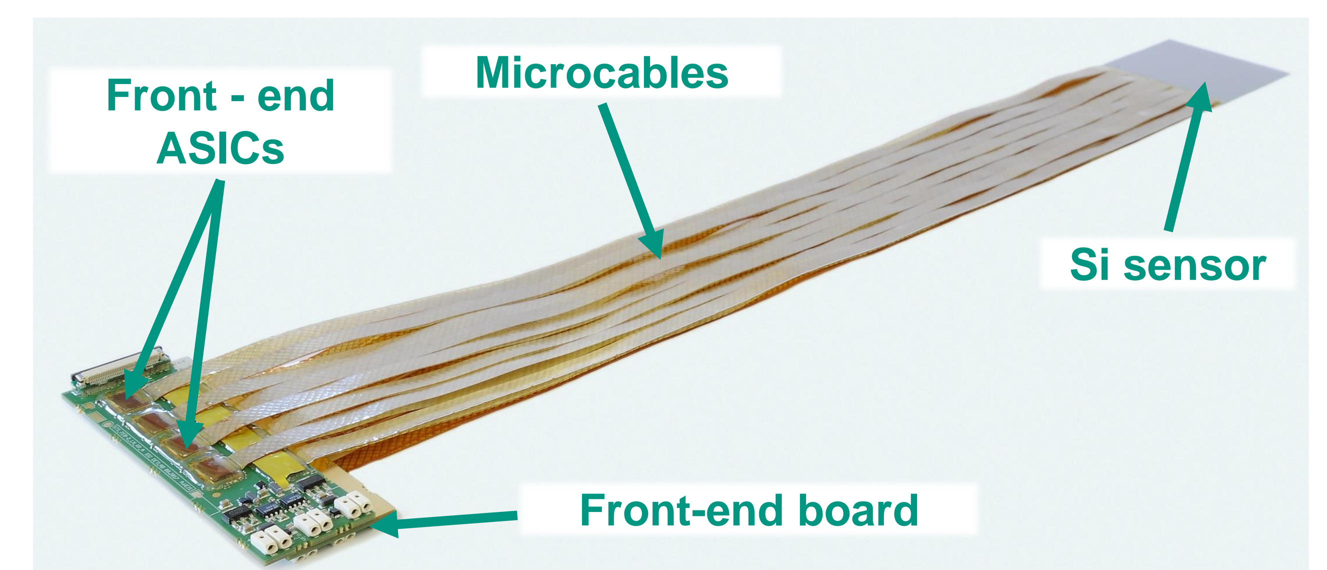




TAB bonded interconnections between microcable and ASIC.

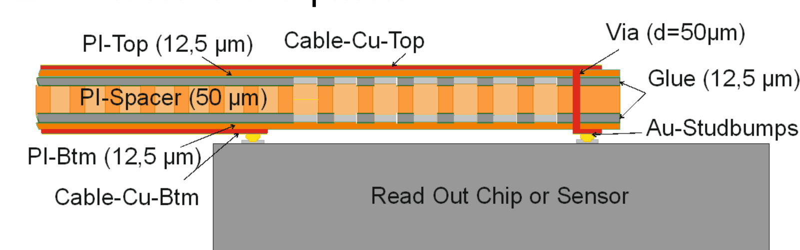
Module assembly workflow



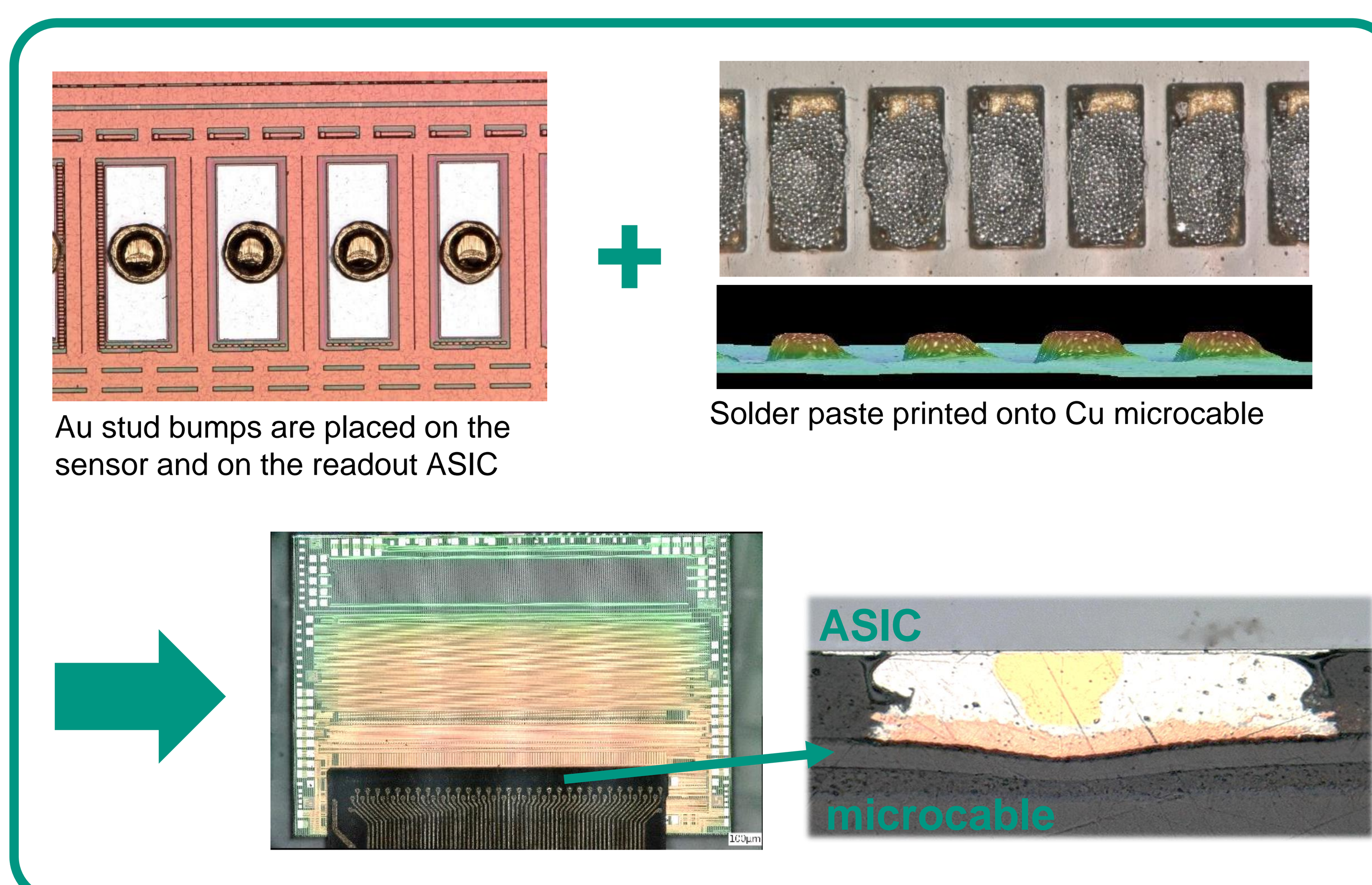


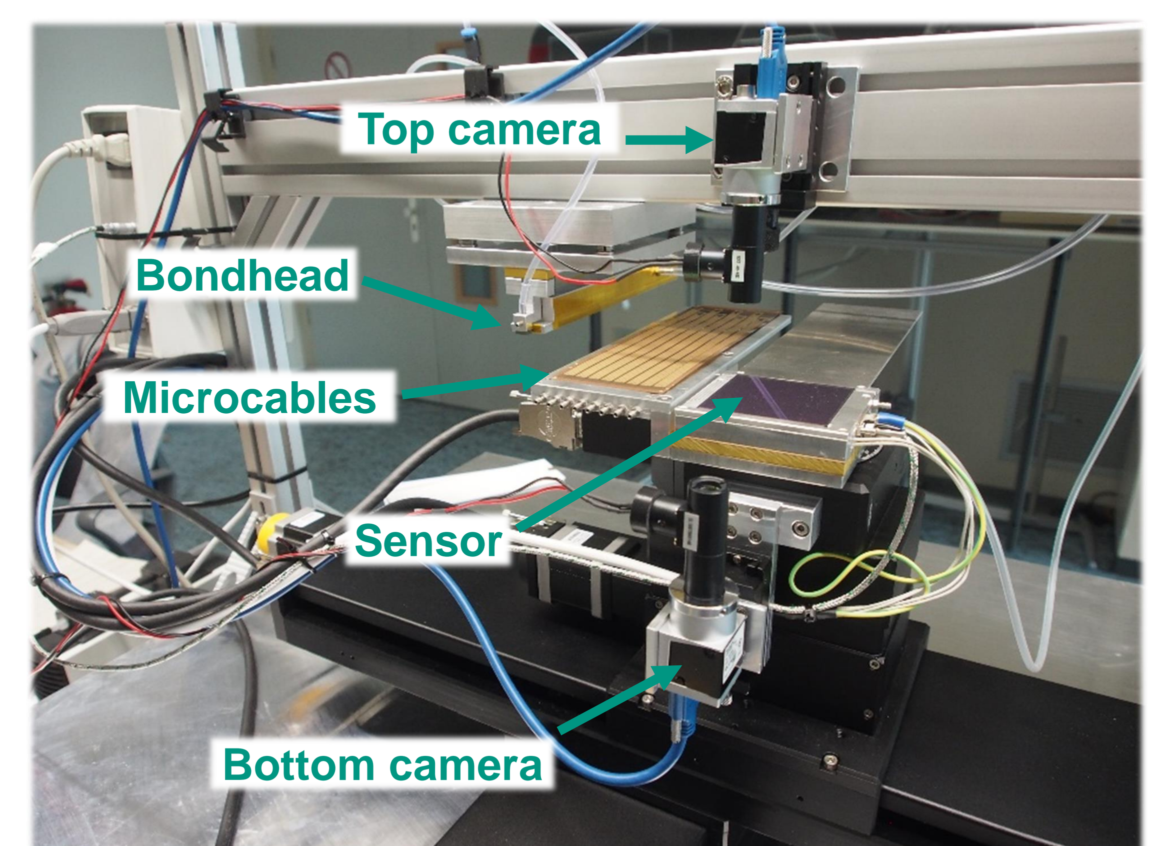
Alternative novel high-density interconnection technology: Gold stud bumping – solder paste printing

- Gold stud bumping on die + fine-grained solder paste printing on microcable
- Copper microcable
  - Two signal layers, 128 channels
  - 8 µm copper on 12.5µm polyimide carrier
  - Capacity: 0.44 pF/cm
- Material budget: $X/X_0 \sim 0.05$ %
- High yields expected, allows for more sophisticated design
- Higher degree of automation achievable
- Under development



Double-layered copper microcable designed at KIT





Dedicated bonder machine developed for CBM STS at KIT