Study of Thermal Interface Material for the Front-End Electronics Cooling of the CBM Silicon Tracking System

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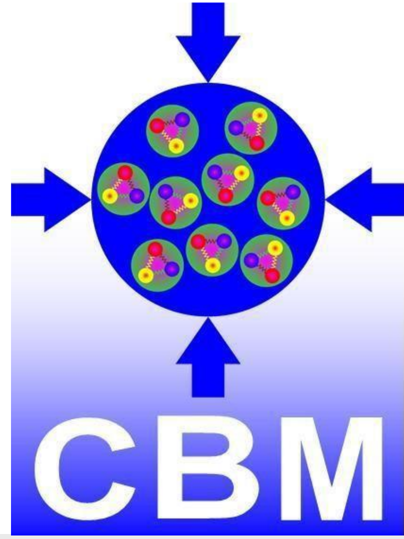
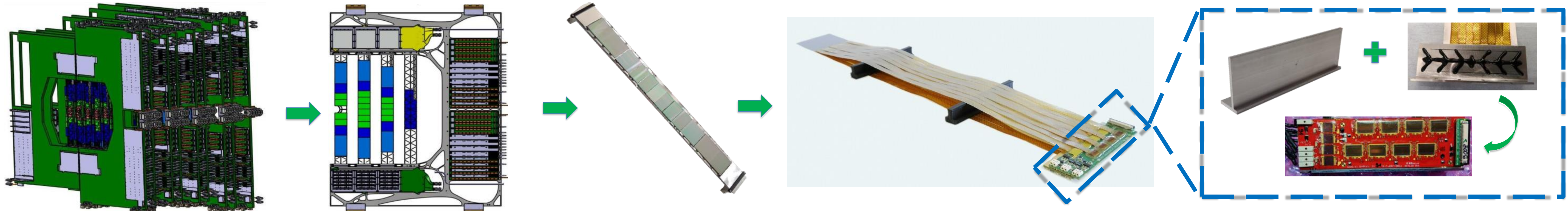


Introduction: Thermal Interface for Front End Electronics of the **S**ilicon **T**racking **S**ystem



Silicon Tracking System : key detector of CBM experiment

- ✓8 Tracking Stations inside 1 Tm dipole magnet
- ✓876 detector modules integrated on 106 CF ladders
- ✓Low material budget: 0.3% – 2% X_0/station
- ✓Radiation tolerance: ≤ 10^{14} n_{eq} cm^{-2}
- ✓Self-triggering Front End Electronics
- ✓Power dissipation ~ 40 kW in ~ 2m^3

Requirements for **T**hermal **I**nterface **M**aterial

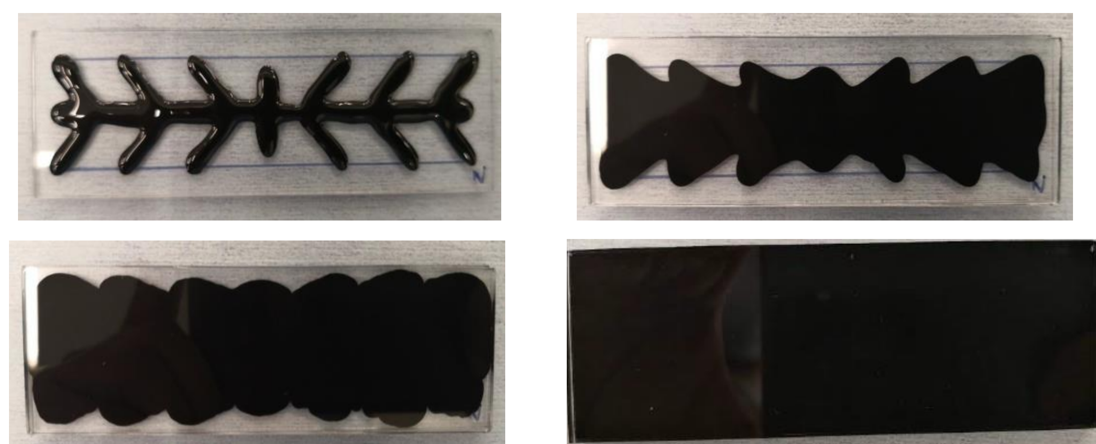
- ✓Permanent glue joint < 150 µm thickness
- ✓Good Thermal Conductivity (> 1 W/m.K)
- ✓High Dielectric strength (> 5 kV/mm)
- ✓Radiation Hard (up to 1 MRad)
- ✓Able to compensate for **C**oefficient of **T**hermal **E**xpansion (CTE) mismatch

❖ To neutralise the heat from Front-End-Electronics, it is imperative to optimize the Thermal Interface Material

❖ **STYCAST 2850 FT with 23 LV catalyst** was chosen as the thermal Interface between the Front-End-Boards and cooling shelves

Gluing technique: Pattern optimization and assembly procedure

Optimisation of glue pattern



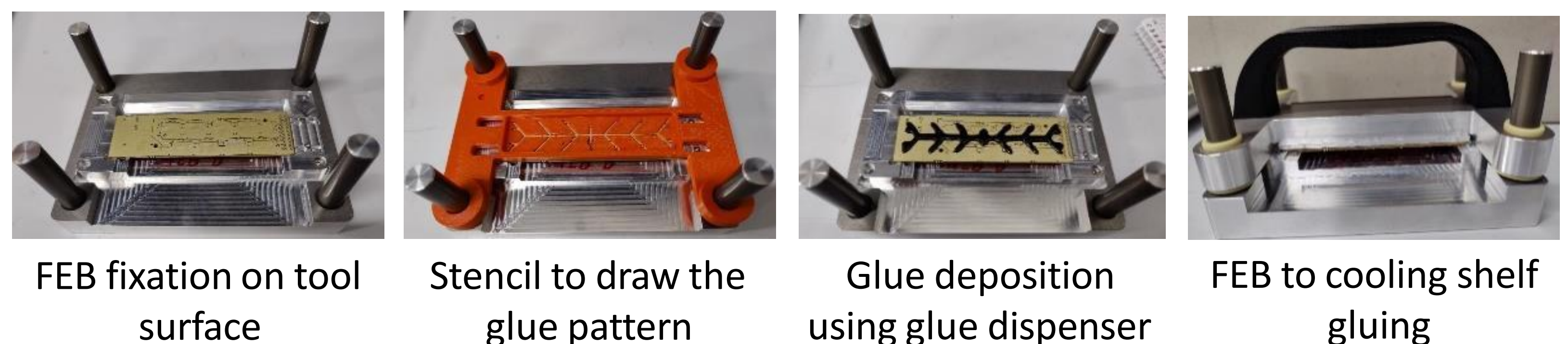
Customised glue pattern using glass sheets

Challenges:

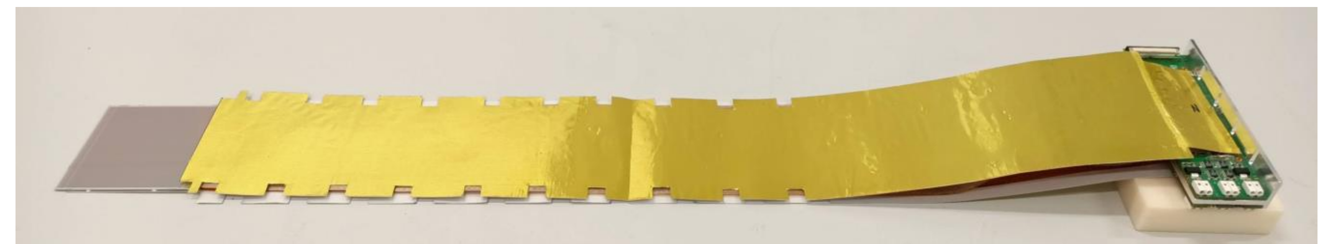
- ✓Required thickness of 150 µm
- ✓Full surface coverage of FEB (10 cm x 3 cm)
- ✓Capillary dispersion of glue since no external force can be applied because of electronics
- ✓No squeeze out of glue because of micro cables

References: 1. Conductive-Adhesive-Dispensing, Nepcon West, February 1999, Anaheim CA
2. The squeezing process of complex epoxy patterns in the die-attaching of large IC-chip, IEEE Xplore, 9858140 (2006)

Procedure for gluing FEBs to cooling shelf



FEB fixation on tool surface | Stencil to draw the glue pattern | Glue deposition using glue dispenser | FEB to cooling shelf gluing



STS module glued to cooling shelf using STYCAST with the help of tool

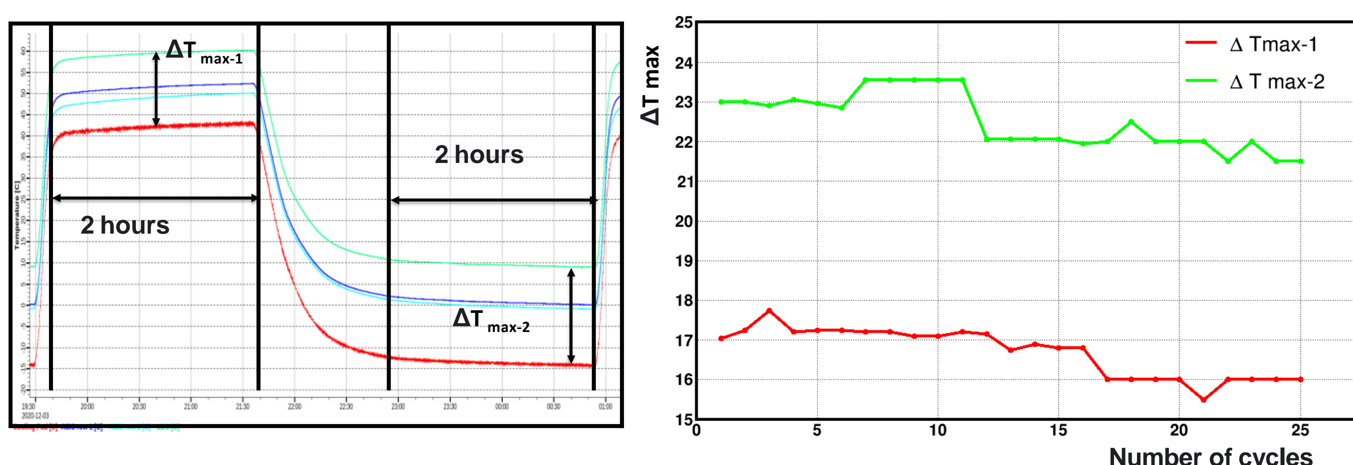
Summary:

- ✓Tool has been prepared to meet the gluing requirements
- ✓Glue pattern is prepared using Ultra TM 2800 EFD Nordson glue dispenser
- ✓Minor oozing of glue ensures surface coverage
- ✓Module was tested under 500 V (between FEB ground and cooling shelf)

Successful demonstration of the concept with Stycast was performed with a functional module using the gluing tool

Thermal stability tests

Thermal stability of the glue was tested to ensure that they can tolerate CTE mismatch b/w back plane of FEBs (Copper) and cooling shelves (Aluminium) at nominal power dissipation



Observation:

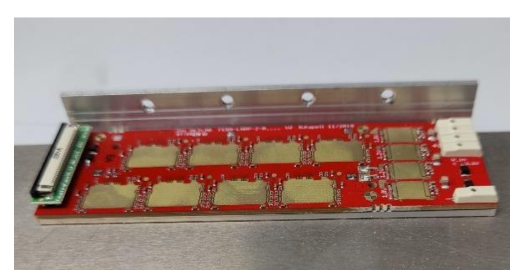
❖ 25 Temperature cycles performed between +20 and -40 °C

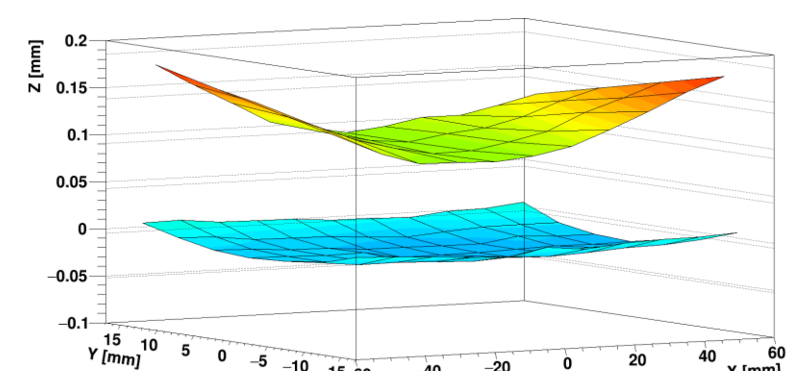
❖ 2 hours at extreme temperature for each cycle

❖ **No deterioration in glue joints observed**

Remaining challenges and outlook

Optical inspection of surface of FEBs and cooling shelves in free orientation





Challenges

- ✓ Optical inspection of FEB and shelves shows deviation of ~ 100-150 µm
- ✓ Surface unevenness >100 µm could lead to an undesired electrical contact between them

Outlook: Further optimisation of assembly procedure with newer version of FEBs with additional electrical isolation layer (~10µm thick)

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