

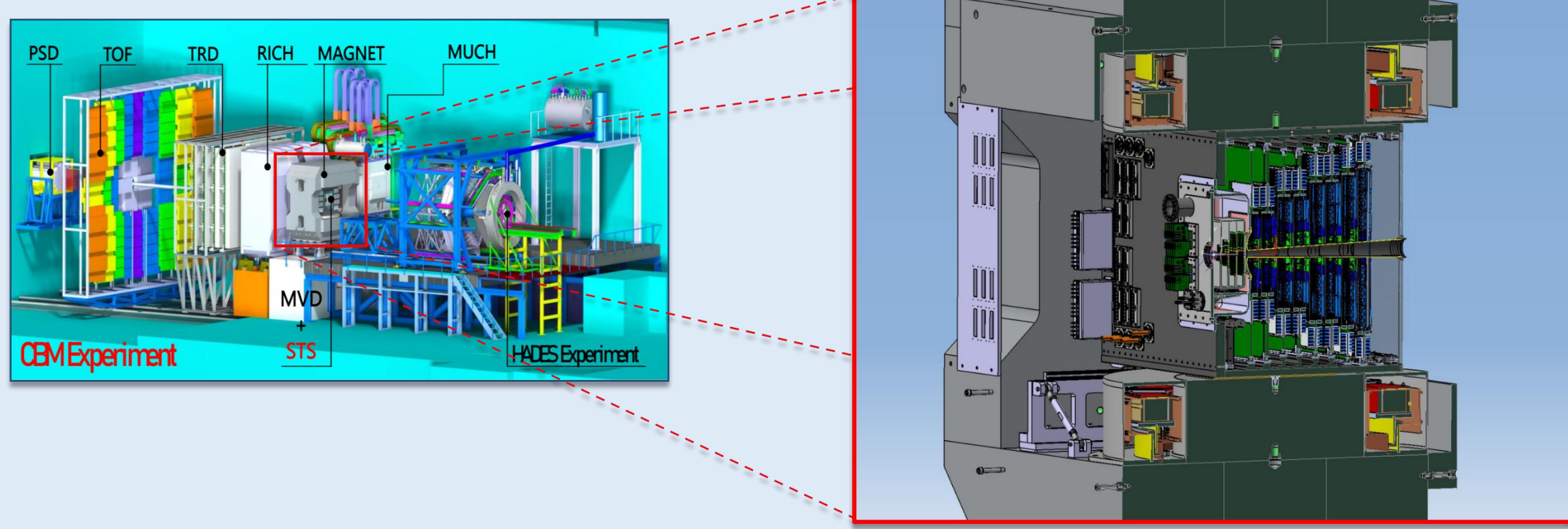
Temperature calibration and thermal stress tests of the Front-End Electronics of the CBM Silicon Tracking System

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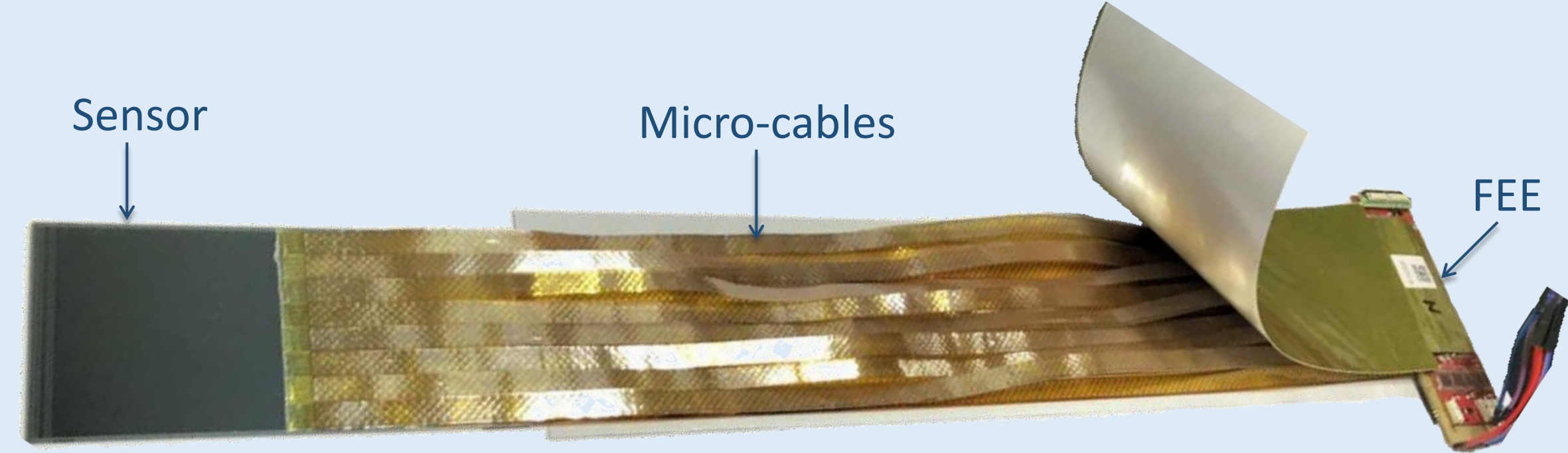
Introduction

CBM - STS



- Features of the heavy-ion CBM experiment's Silicon Tracking System:
 - unprecedented beam-target interaction rate ≤ 10 MHz.
 - maintains material budget within 2 – 8% X_0 .
 - sufficient granularity, spatial, and timing precision.
 - Number of DSDM micro-strip modules: 876.
 - STS operation temperature: -20 °C.
 - Novel integration approach: read-out electronics placed outside sensitive volume.

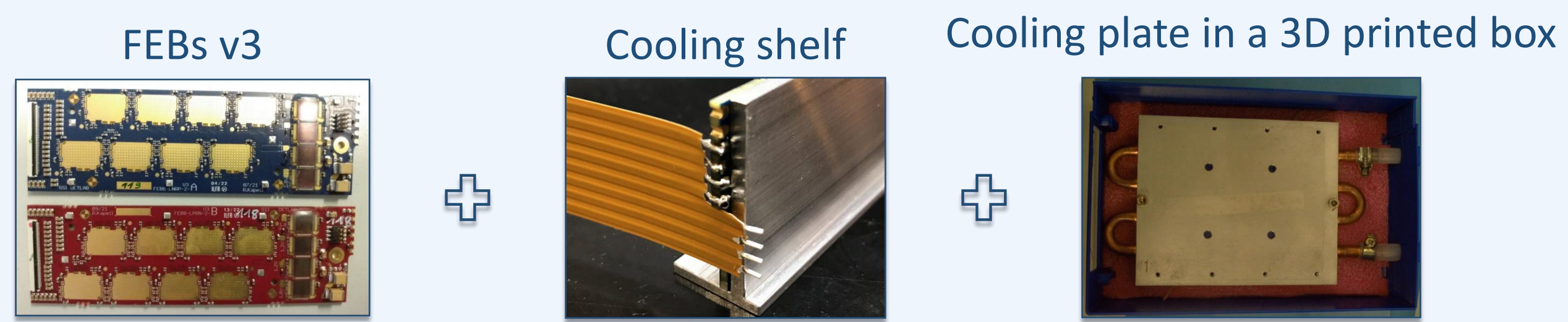
MODULE



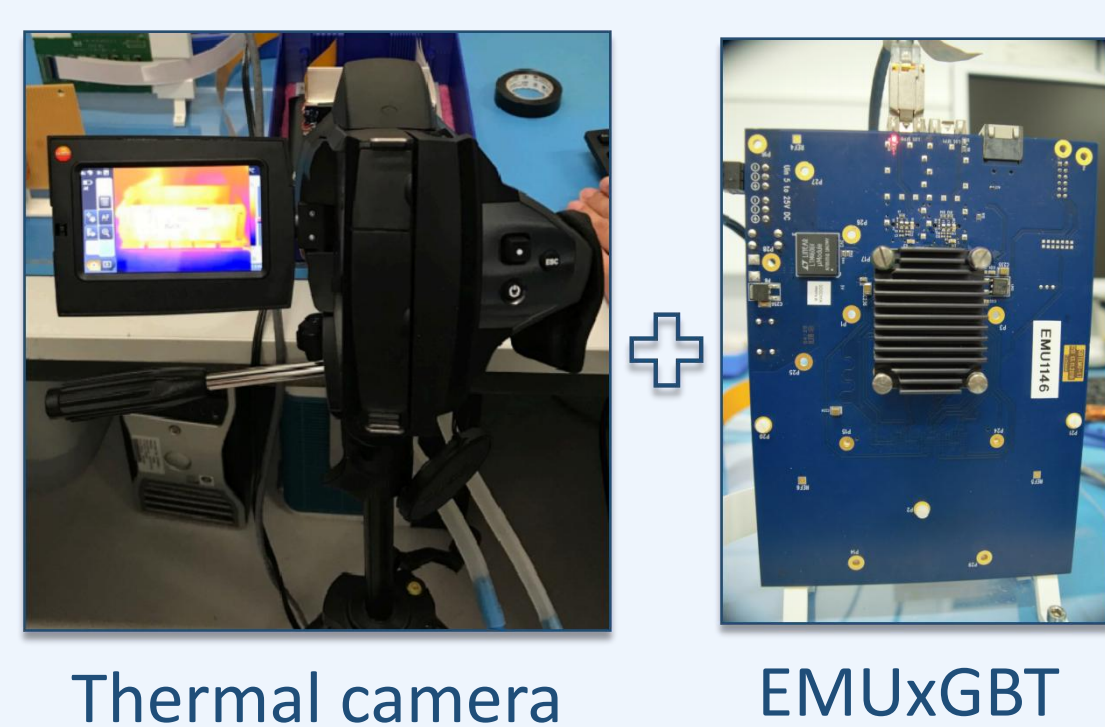
- After module assembly, a 2.7mm thick aluminum cooling shelf is glued (STYCAST) between FEBs.
- Glob top used on ASICs and LDOs: DYMAX 9001.
- Front-End Electronics (FEE): heat producer (≈ 15 W).
- Reliable cooling and thermal interfaces are needed.
- The temperature should be monitored during detector operation.

Calibrating the internal thermometer of ASICs

Measurements of the Temperature



- Low Voltage input is set at STS operational values.
- Registers of ASICs are set to nominal values.
- The temperature on the cooling plate is changed in steps of 2 °C from 10 °C to 30 °C.
- At each step, it measures the external temperature of the ASIC and its internal temperature.
- These two temperatures have a linear dependence.

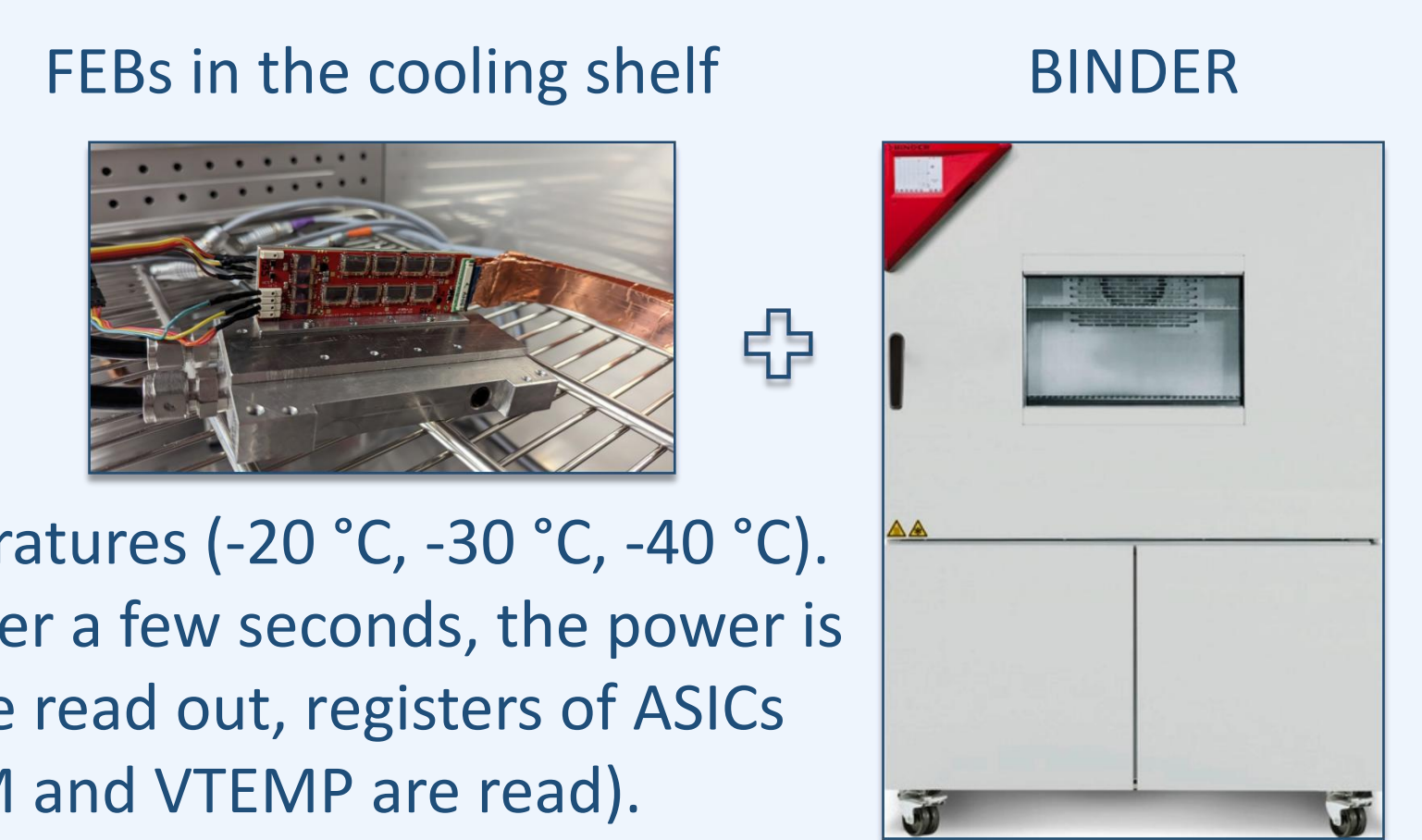


Front End Board thermal stress test

Testing Setup and Procedure

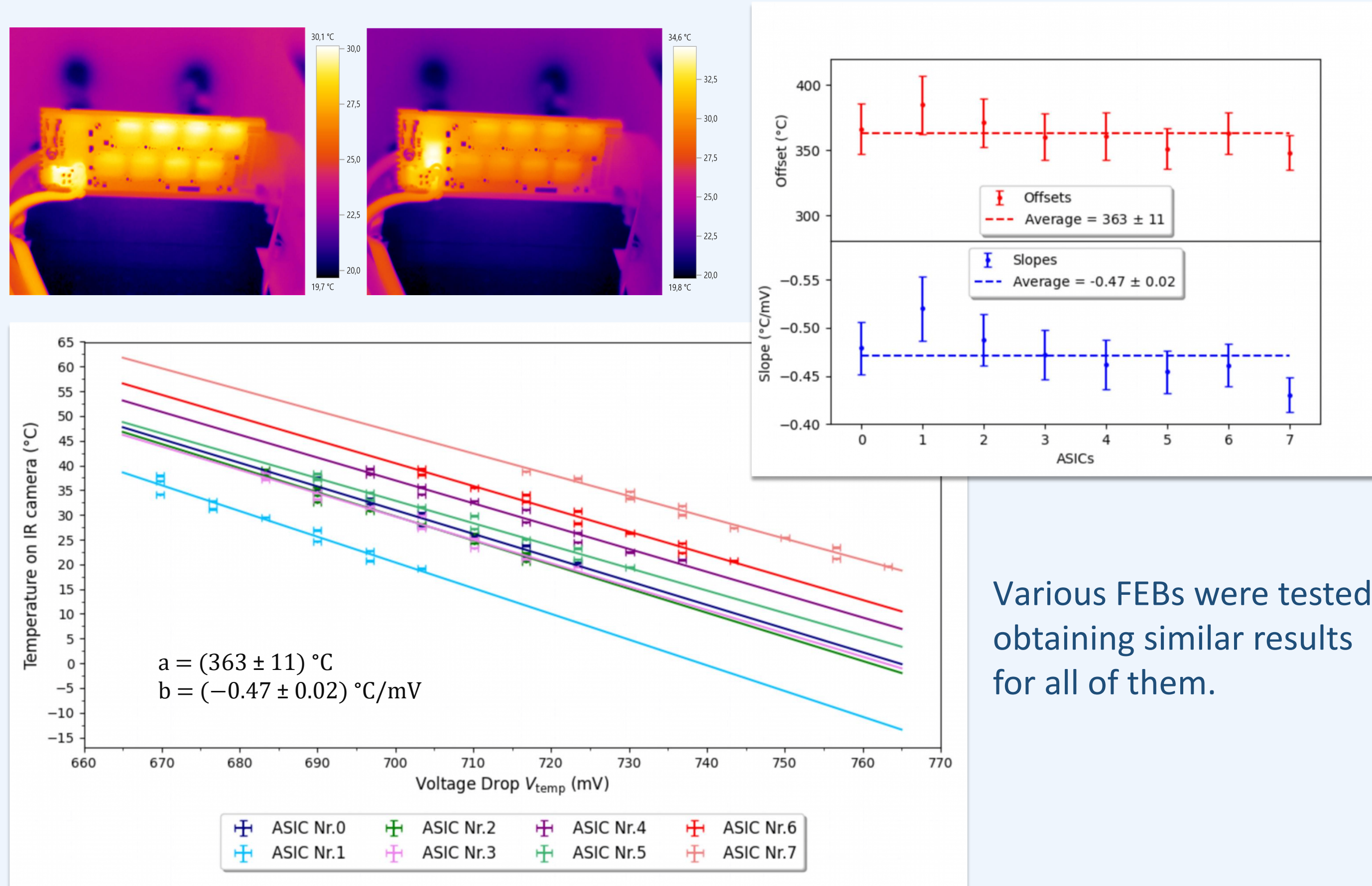
To test the sensitivity of FEB to thermally induced mechanical stress:

- Passive/Active temperature cycling
- **Cold start-up:** power cycles at low temperature.

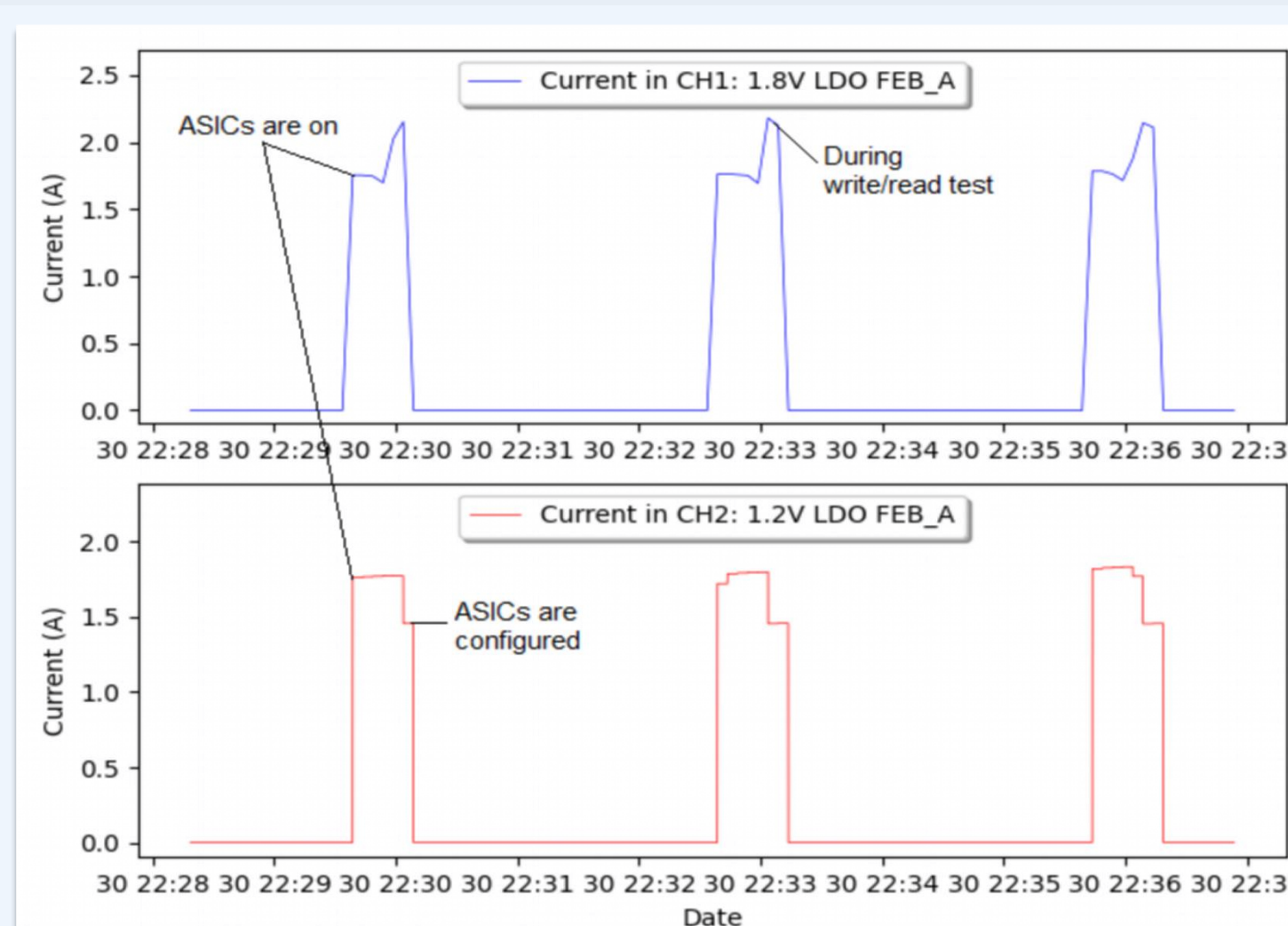


- Set the cooling system at low temperatures (-20 °C, -30 °C, -40 °C).
- The power supply is shut off, and after a few seconds, the power is resupplied (currents and voltages are read out, registers of ASICs are set to nominal values, and VDDM and VTEMP are read).
- Power switches off, and FEBs cool down within half a minute.
- This process was repeated more than 1100 cycles for same sets.

Calibration results

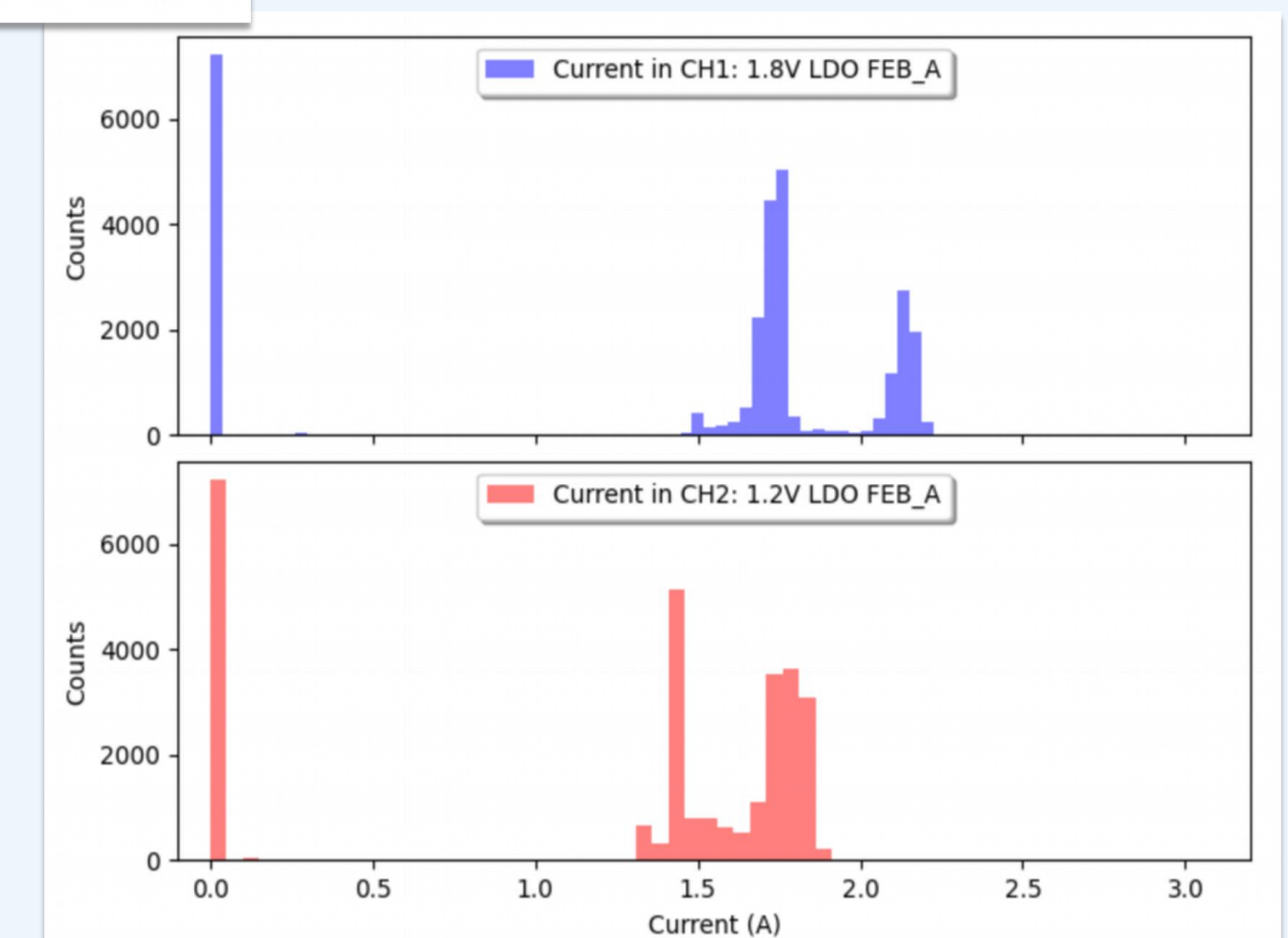


Observables during cycling



- For most of the FEBs, the power consumption behaved normally.
- Deviation for power consumption indicates malfunctioning.
- Observation of other measured parameters helps investigating the source of the failure.

- More than 50 passive cycles were done in previous measurements.
- More than 100 active cycles without failures.
- We expect our electronics to stand frequent power cycles during the detector operation.



Conclusions + Next Steps

- Calibration parameters have been used in lab setups (Thermal cycling and Module operation testing of the E16 experiment) and will be used in the final STS.
- FEBs failures occurred during thermal stress procedures, most of them due to malfunctioning FEB powering.
- **Glob top protection of the LDO voltage regulator wire bonds is suspected of causing problems.**
- As next steps: a conclusive set of tests with the newest available material will be performed:
 - FEB8-v2 and v3 with the newest front end chip SMX2.2.
 - 4 FEBs to be tested simultaneously.
 - Using the first of series production components for further testing campaigns.
- Cold start-up cycling to be performed:
 - With coolant at -20 °C (updated operation temperature).

