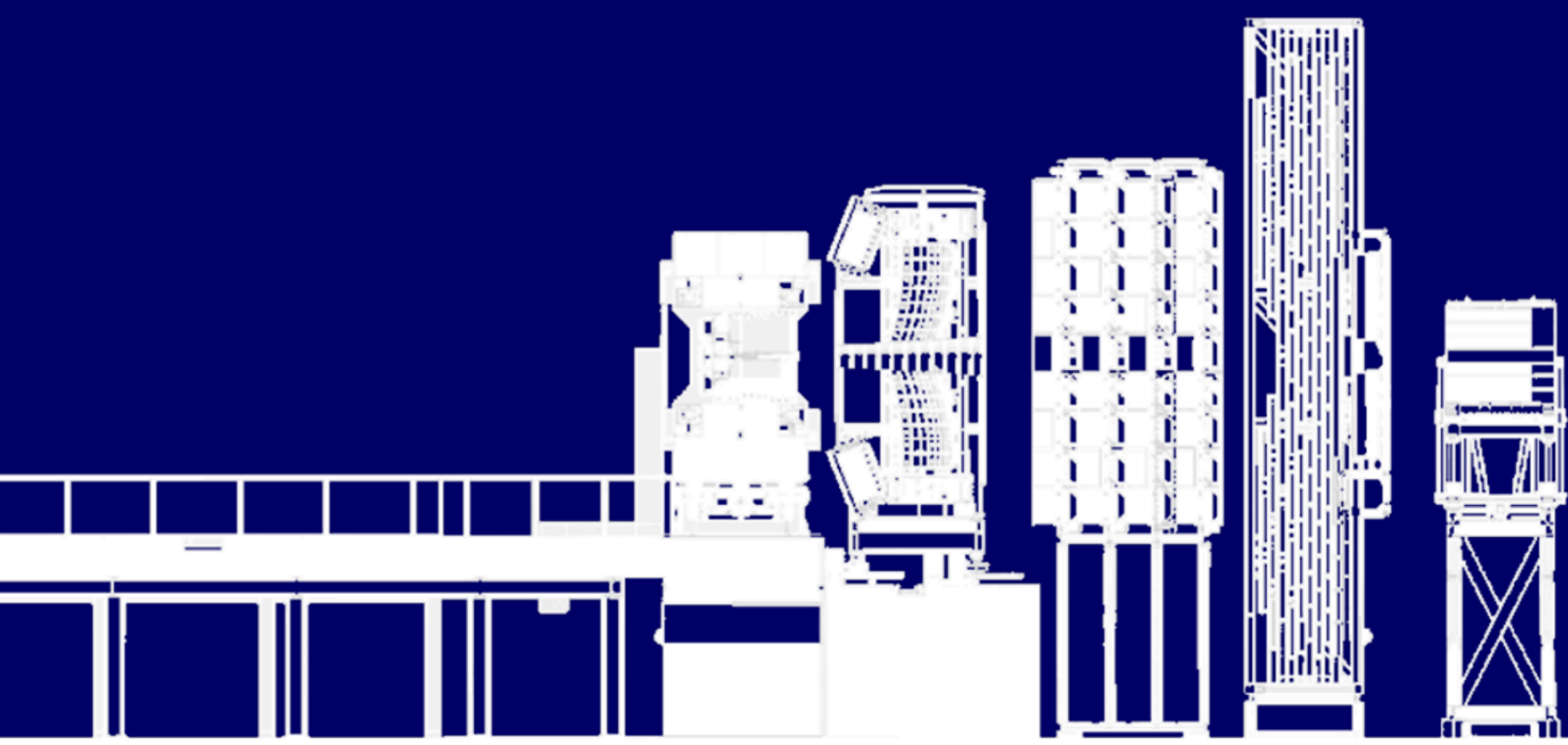




CBM Compressed Baryonic Matter experiment at FAIR



Production and characterization of ladders of the Silicon Tracking System for the CBM experiment

Lady Maryann Collazo Sánchez

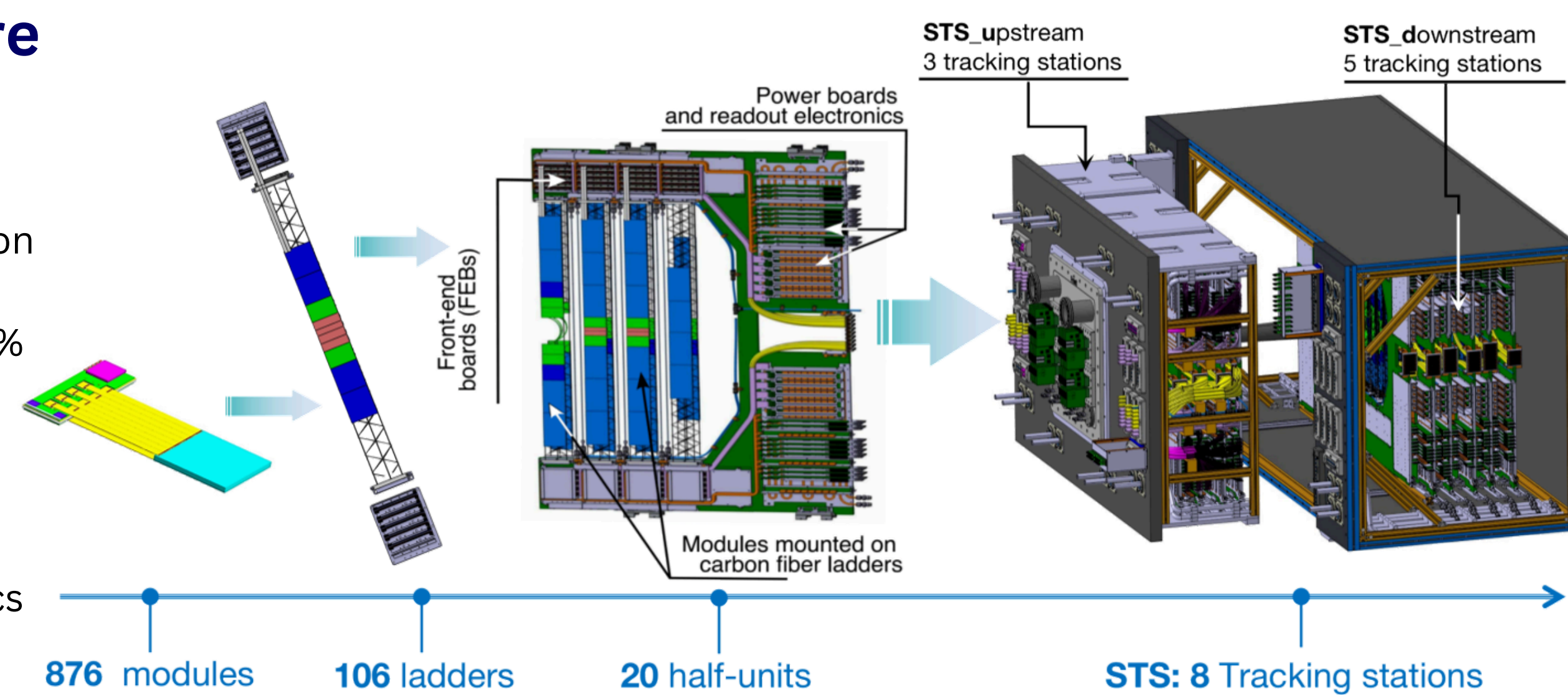
GSI Helmholtzzentrum für Schwerionenforschung GmbH; Goethe University Frankfurt, Germany

STS integration structure

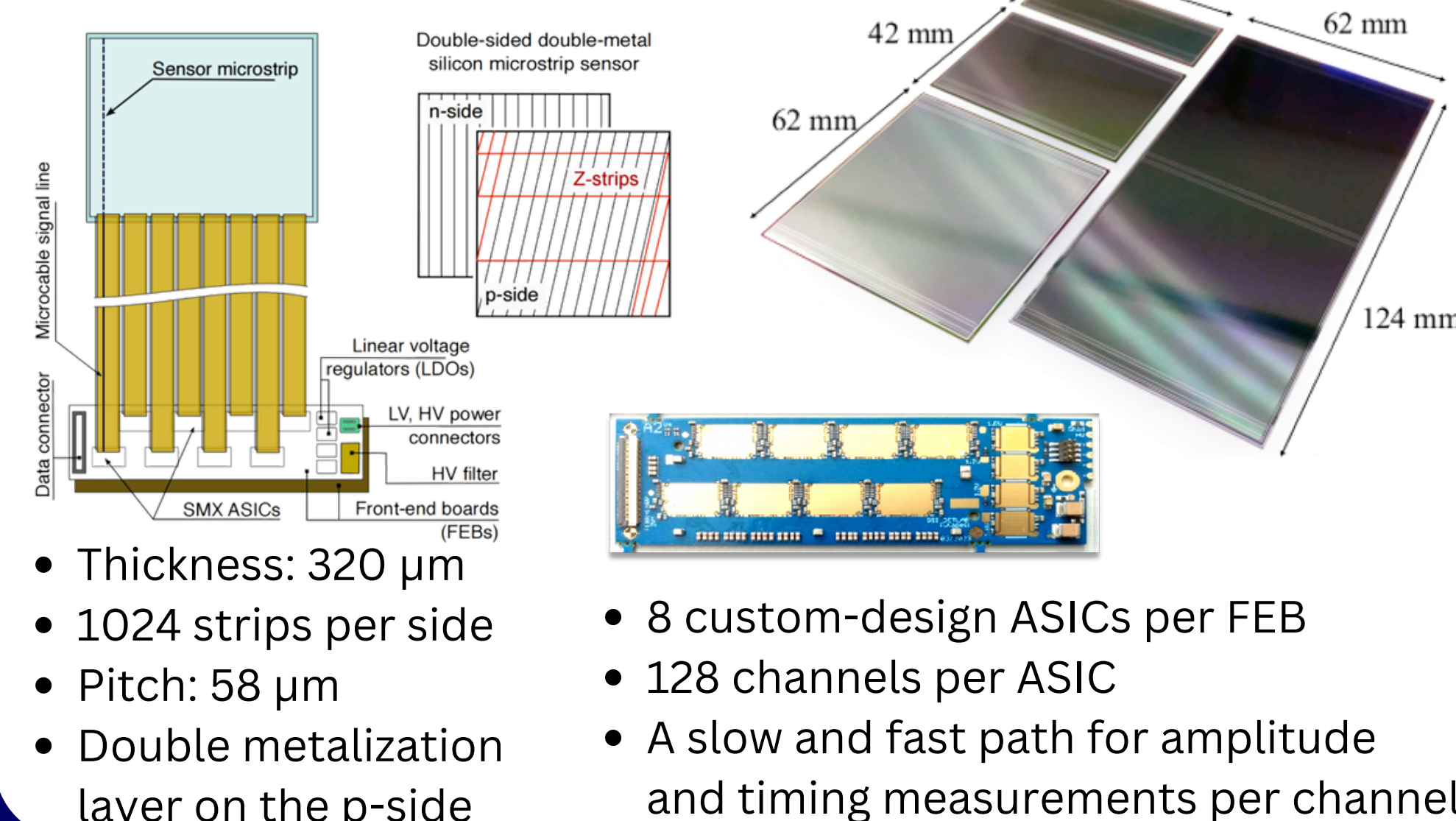
Features of the heavy-ion CBM experiment's Silicon Tracking System:

- Unprecedented beam-target interaction rate ≤ 10 MHz.
- Maintains material budget within 2 – 8% X_0 .
- High granularity, spatial, and timing precision.

Integration approach: Read-out electronics are placed outside sensitive volumes.



STS module

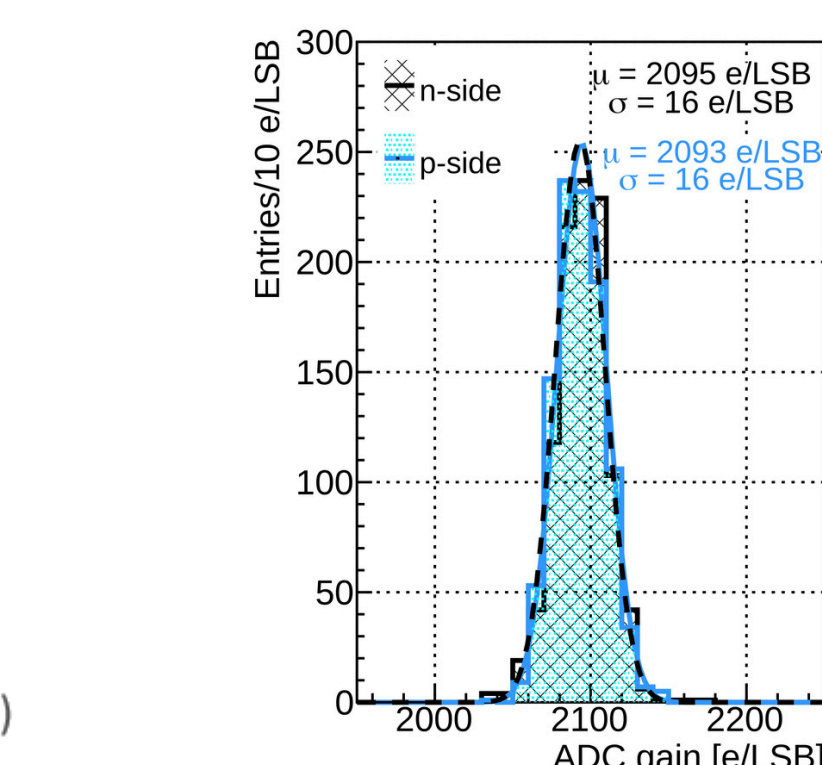
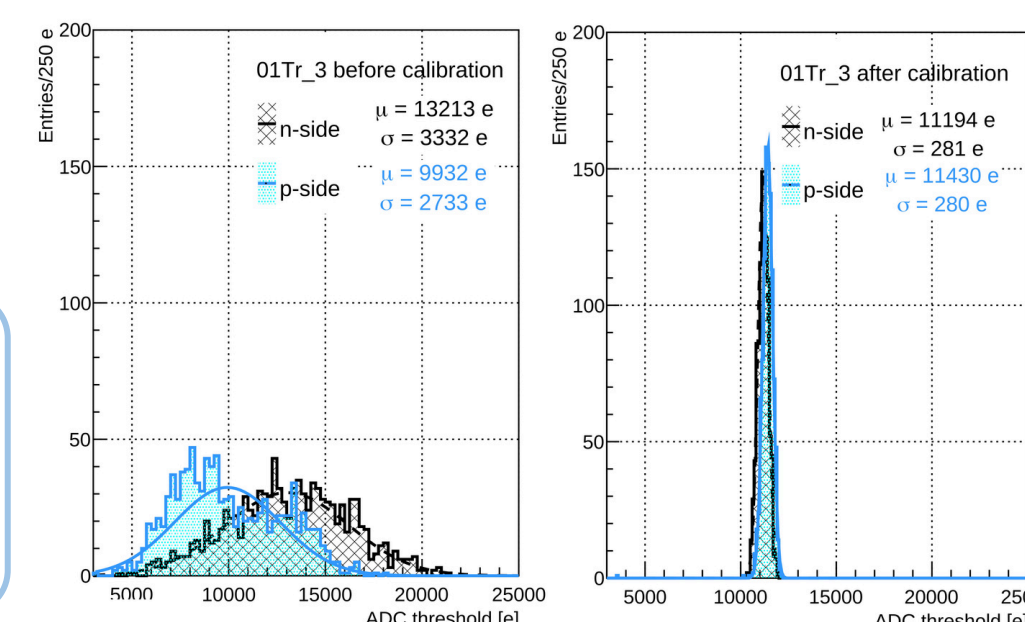
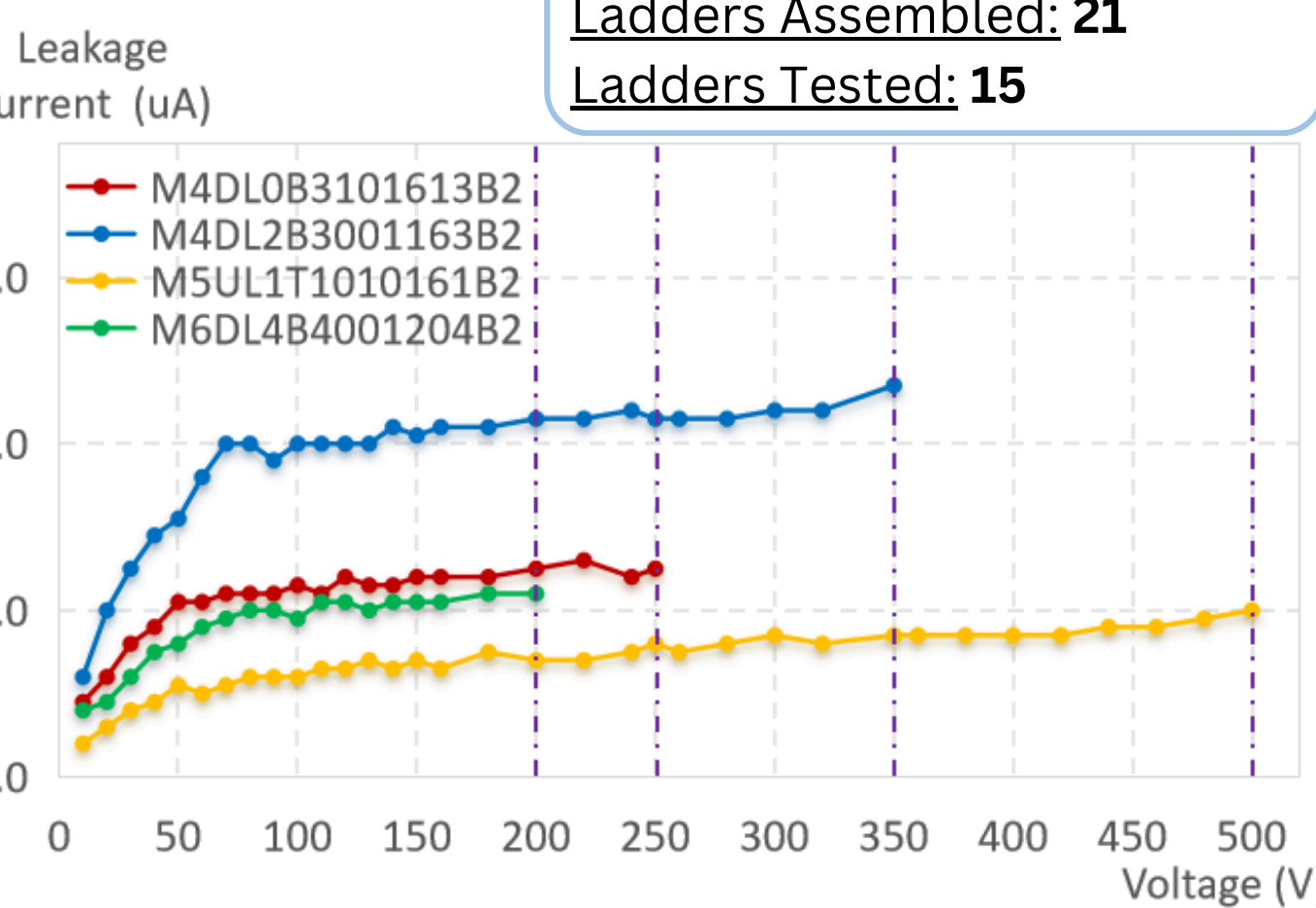


Module testing

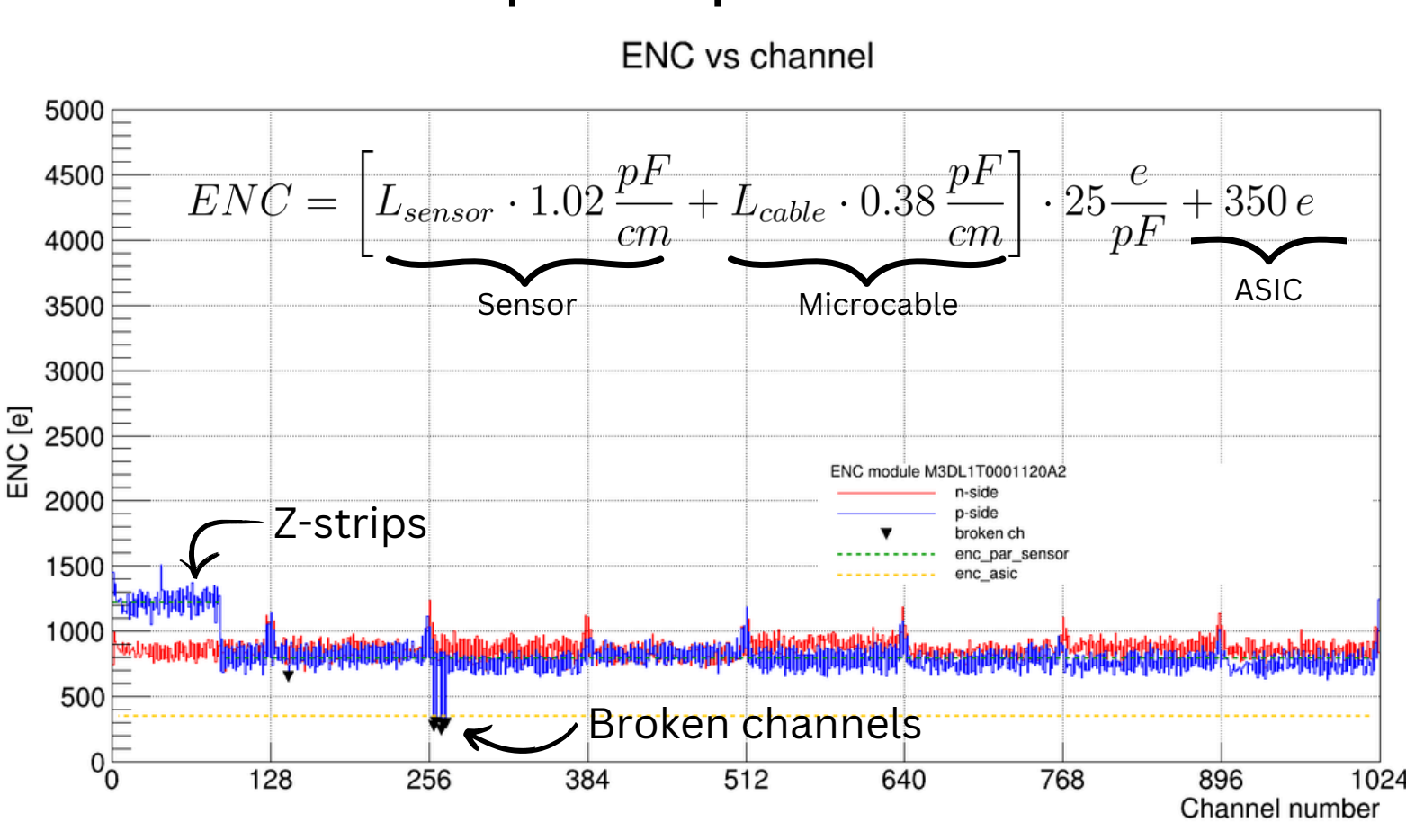
Sensors are biased up to the projected End of Life (E-O-L) conditions

STS in in module series production

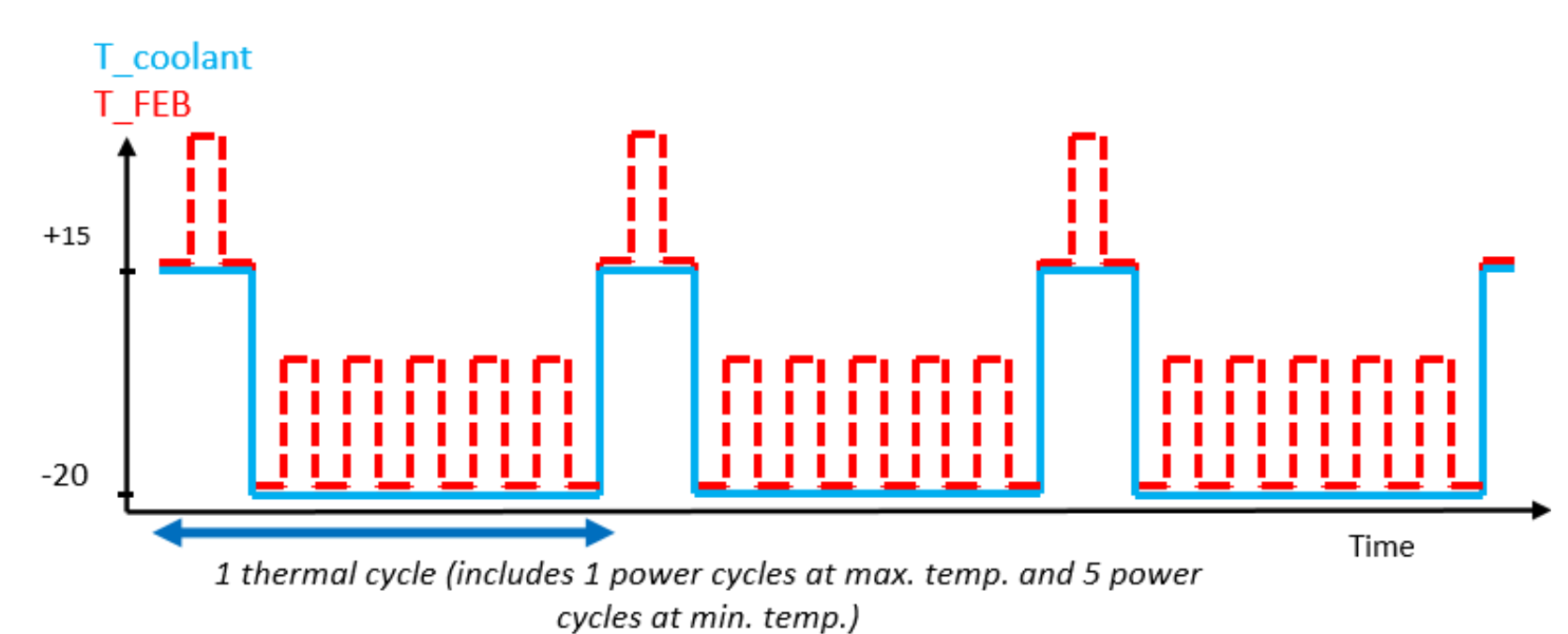
Produced: 690 (78% of total)
Tested: 573 (65% of total)
Ladders Assembled: 21
Ladders Tested: 15



Equivalent Noise Charge (ENC) derived from an S-curves scan in every channel, where the **discriminator response** is evaluated in a **pulse amplitude scan**.



1. FEB Power up, LV monitoring
2. Sensor biasing up to 150 V
3. FEE communication & functionalities check
4. Calibration
5. ENC determination & channel's connectivity check



The temperature ranges: [-20,15] in the LAUDA chiller and [-15, 20] in the BINDER climatic chamber

Thermal cycles: 3 thermal cycles

Power-ups at low temp: 5 per thermal cycle

Power-ups at high temp: 1 per thermal cycle

STS operation temperature: -20°C

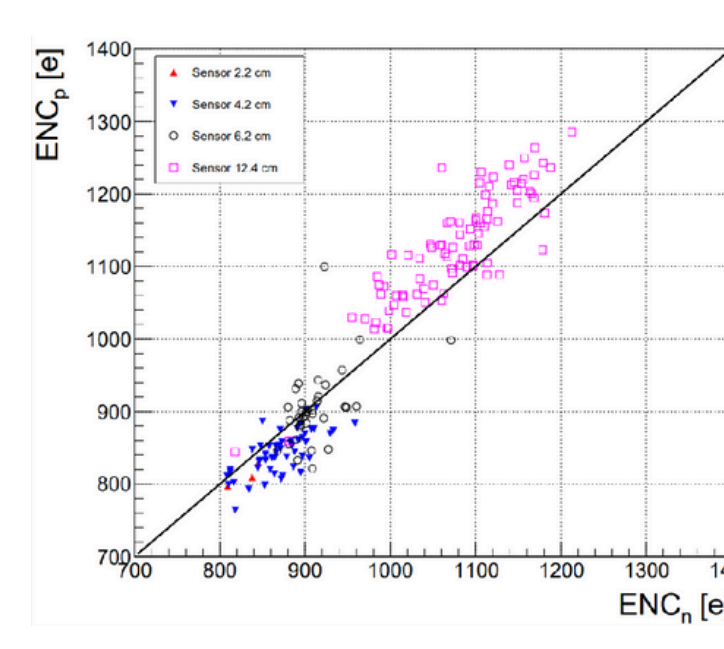
Perform ~ 10% power start-ups to replicate the STS running scenario

IV measurement

Calibration and functional test

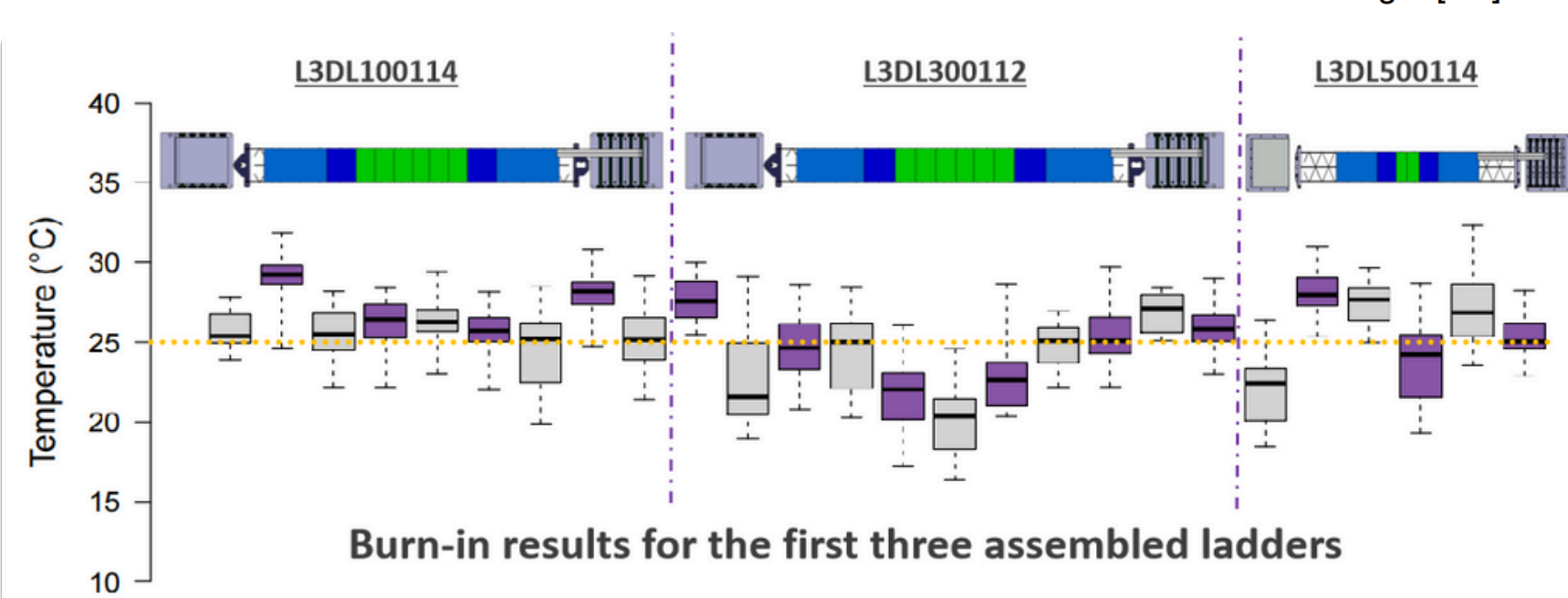
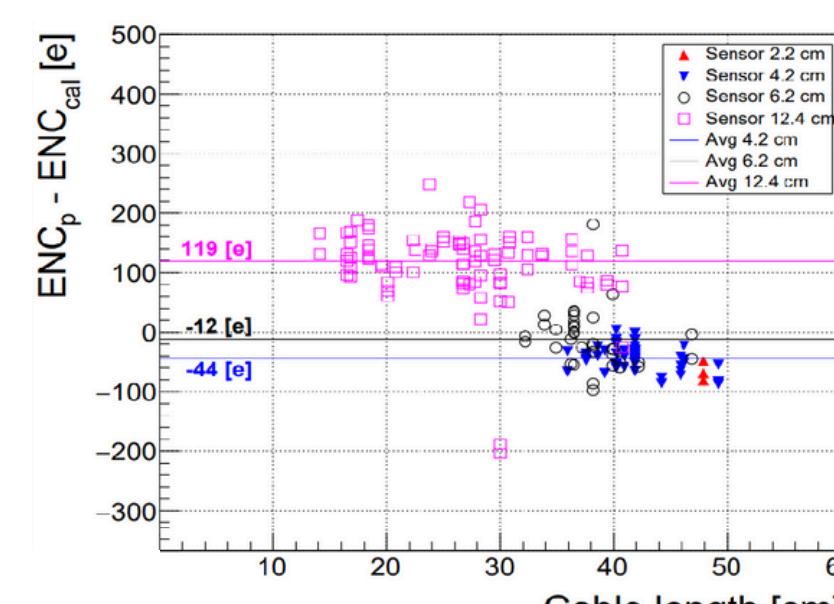
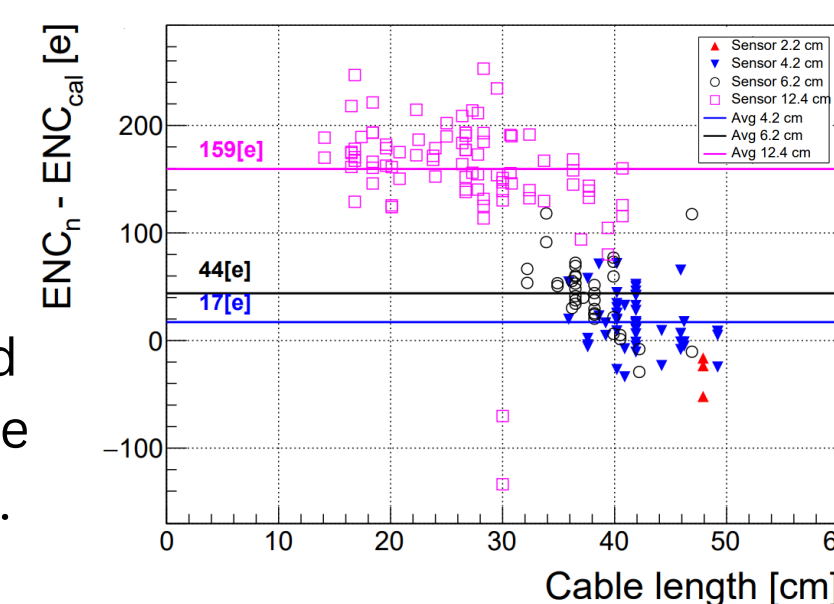
Thermal stress test (BURN-IN)

Statistics of STS modules



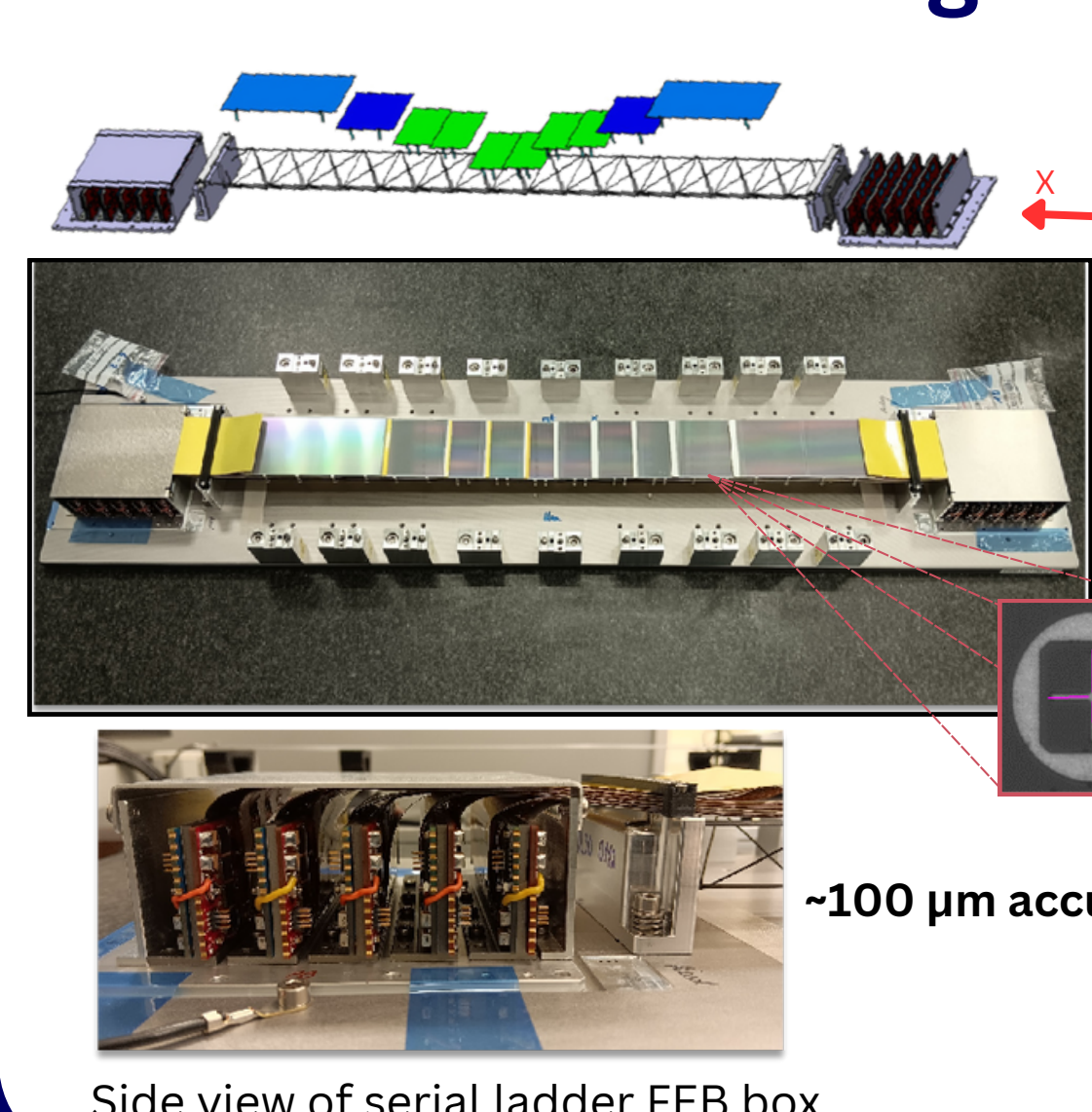
For modules with 12.4 cm sensor size, the noise level on the p-side is higher than on the n-side.

The deviation of the ENC measured from the expected does not depend on the cable length on sensors of 12.4 cm.



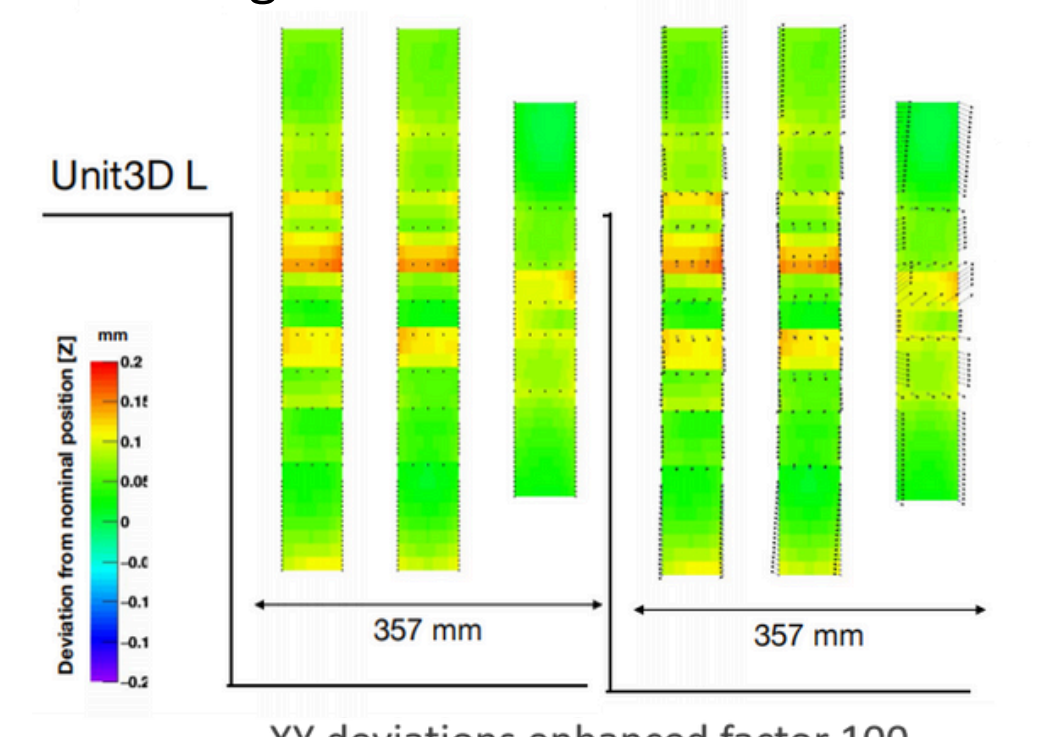
The average temperature difference between each ASIC and the cooling system at -20°C is around 25°C

Ladder Assembling



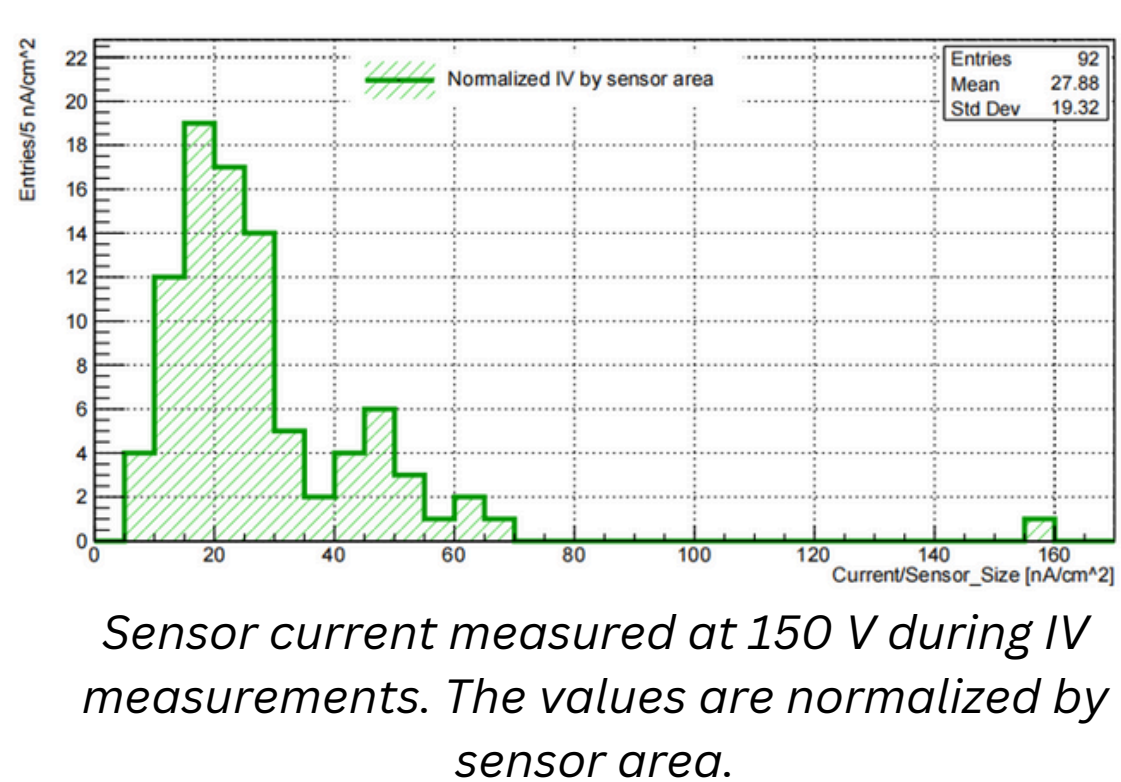
Optical inspection of the sensor surface with precision better than 10 μm

- XY based on pattern recognition
- Z (high) based on focus variation



Ladder Testing

IV measurement with low resolution (0.1uA) HV power supply and LV cables unconnected.

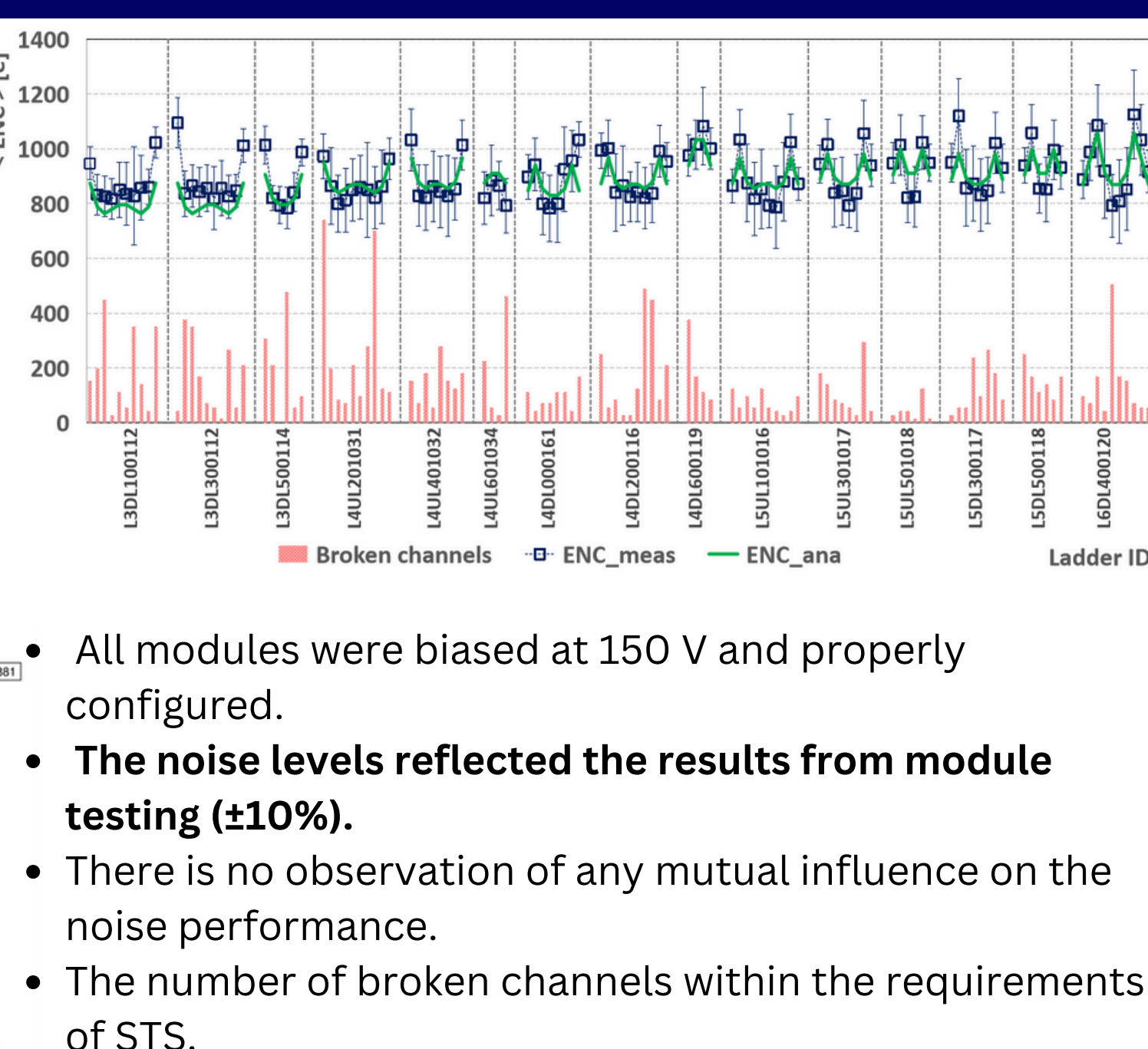
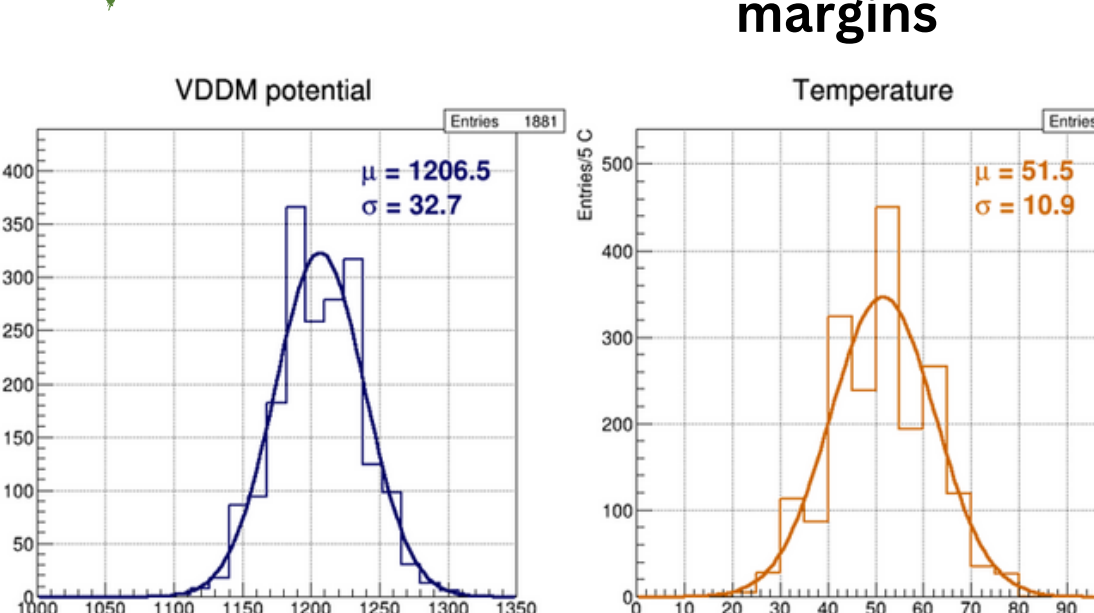


Functional test for all modules on ladders:

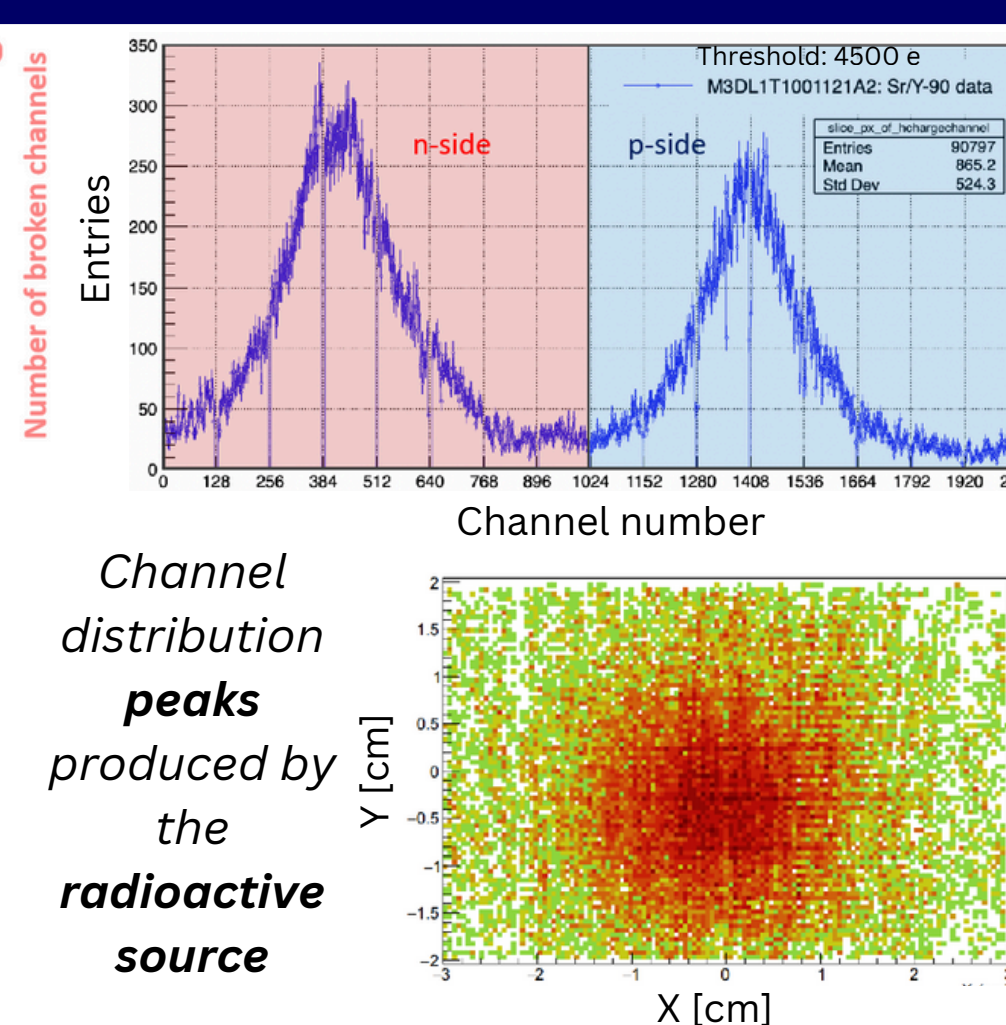
Communication w/ ASICs	1888/1888
Register W/R	✓
LV power current check	2.58 A (1.2 V) / 2.21 A (1.8 V)
Analog front-end issues	4/1888

Nominal VDDM: 1200 mV

Temperature within operational margins



- All modules were biased at 150 V and properly configured.
- The noise levels reflected the results from module testing ($\pm 10\%$).
- There is no observation of any mutual influence on the noise performance.
- The number of broken channels within the requirements of STS.



Data readout from Sr/Y-90 and Am-241

Summary

- All modules were successfully biased to the projected end-of-life (EOL) specifications.
- The average noise behavior is consistent with the sensor size.
- The number of broken channels for each module agrees with our acceptance criterion.
- All the ASICs had survived the thermal stress test.
- ENC levels measured on the ladders $\pm 10\%$ deviation from the individual module testing.

