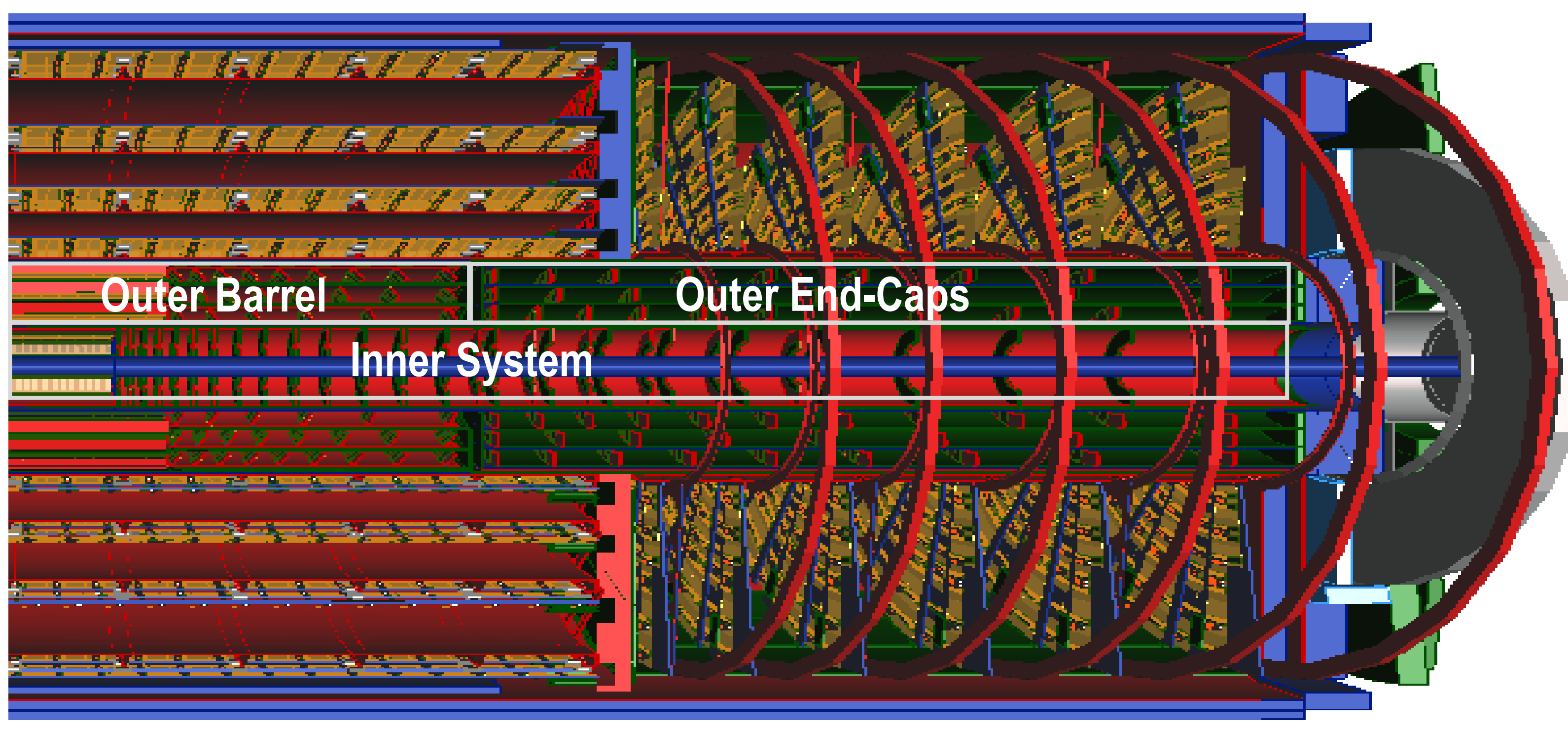


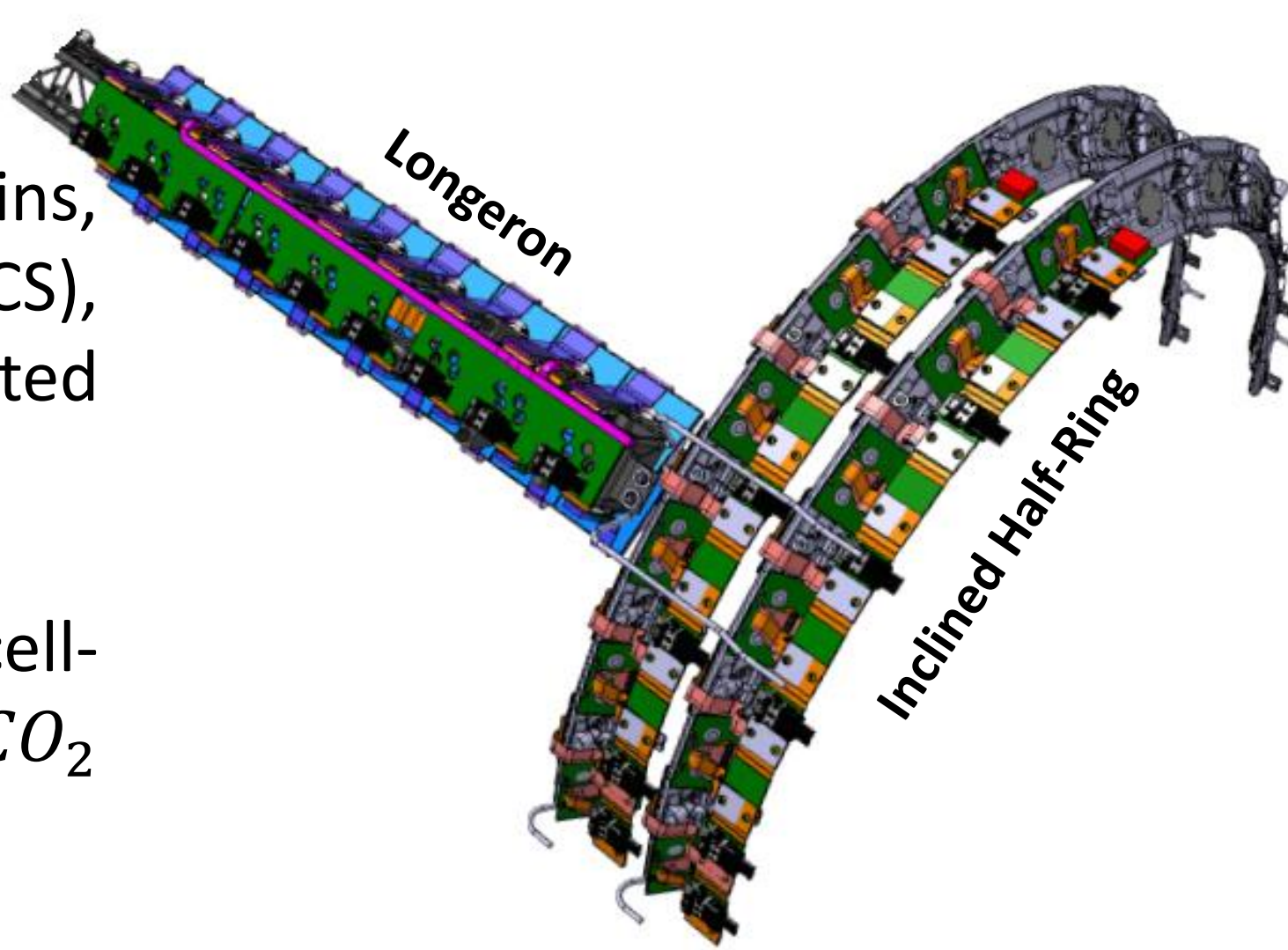
Construction and Evaluation Of the ATLAS ITk Pixel Modules For the Outer Barrel Demonstrator Project



How to prototype the Outer Barrel (OB) ITk?

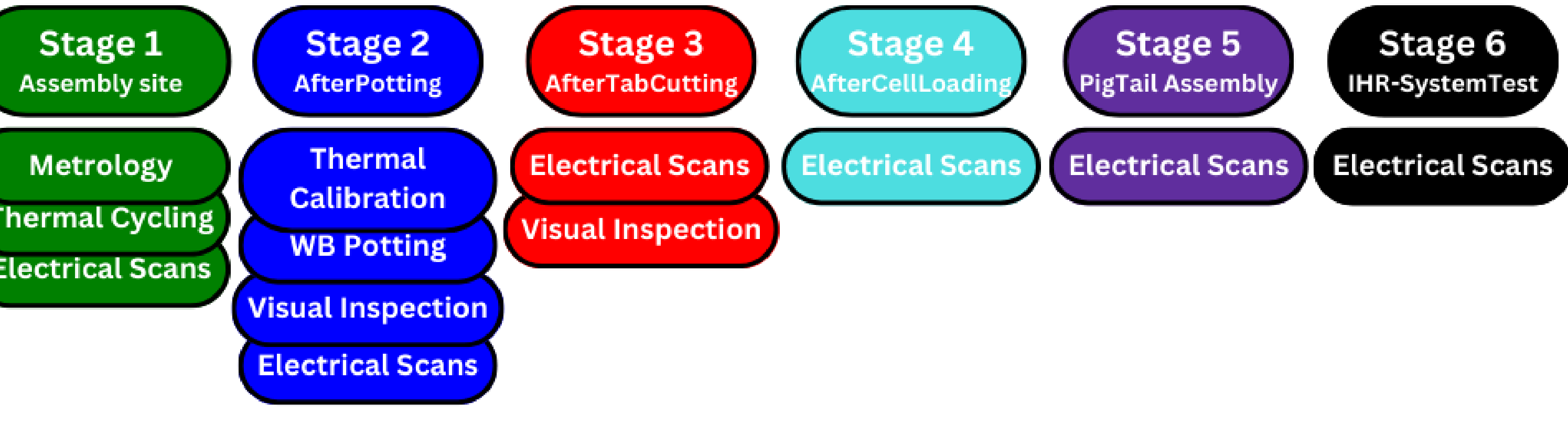
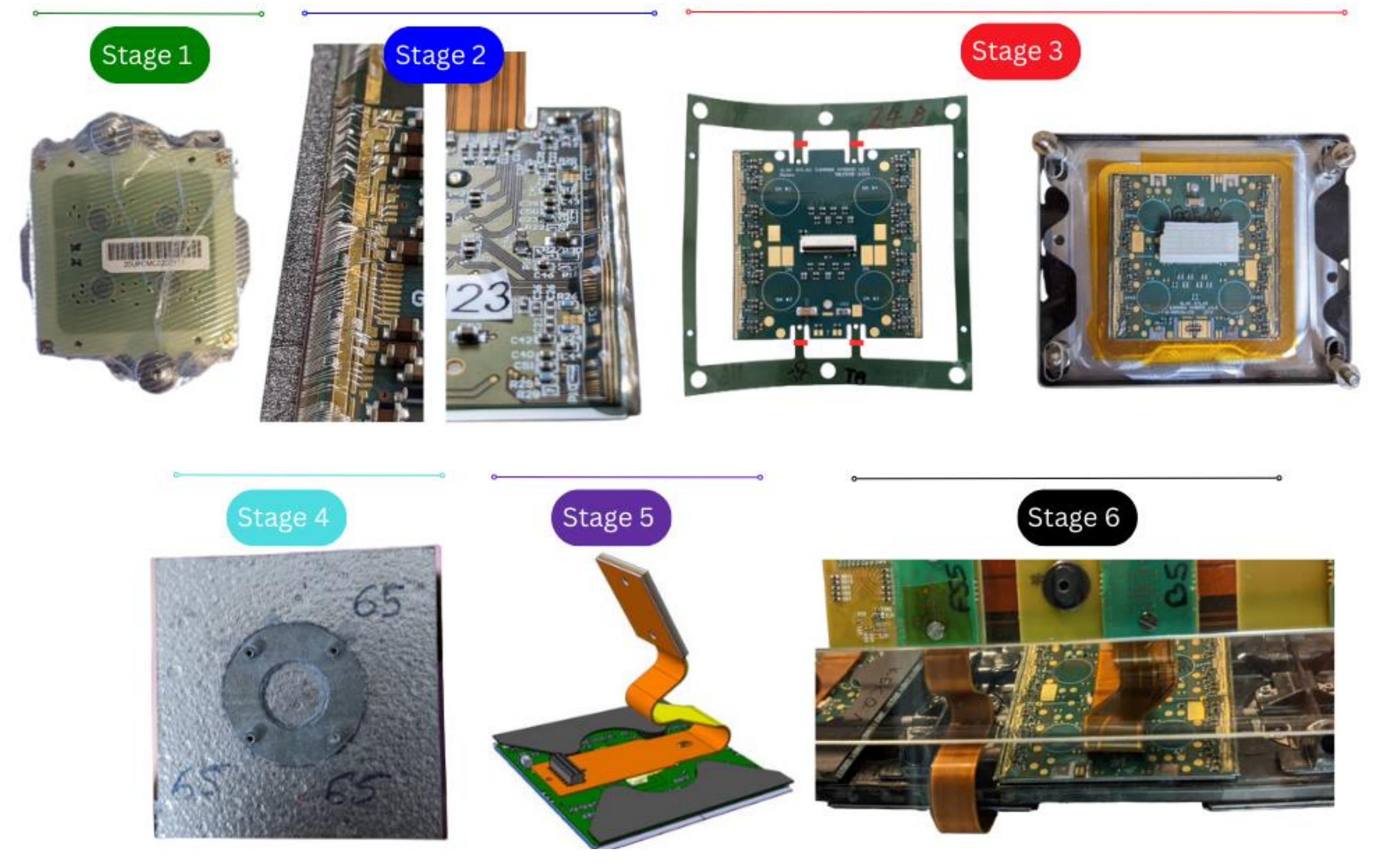
Proof of concept for the OB ITk:

- ✓ The DAQ, CO₂ cooling, novel SP chains, distributed control systems (DCS), construction, and other system-related aspects.
- ✓ Validation of the local loaded support, cell-loading methods, and reliability of CO₂ cooling.
- ✓ Produced 32 quad pixel modules with **RD53A electronics** and study the module performance in different production stages.

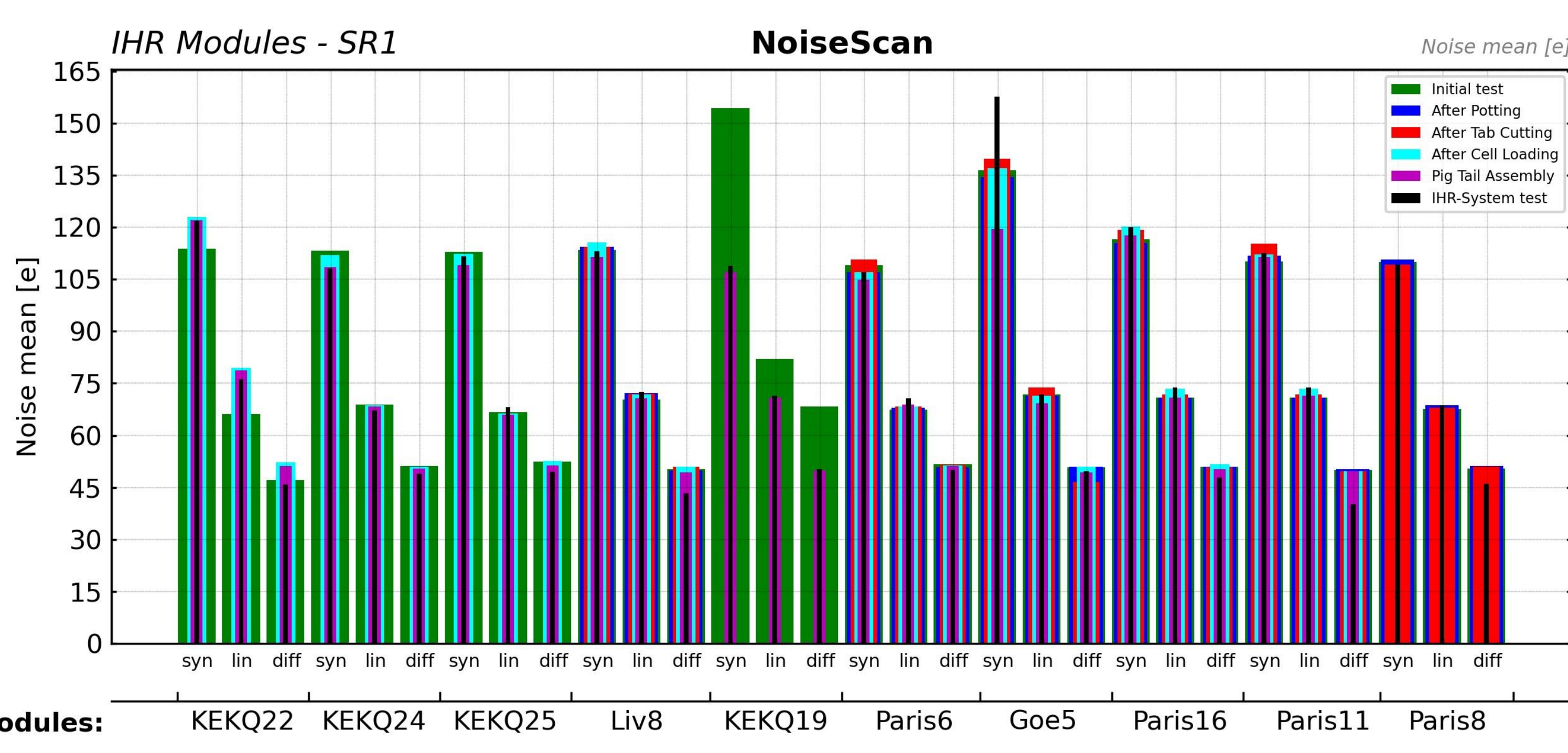


- x2 Longeron: 1 SP chain with 6/12 modules.
- x1 Inclined Half-Ring: 1 SP chain with 11 modules.

What about the pixel production flow and QA?



What were the testing outcomes?



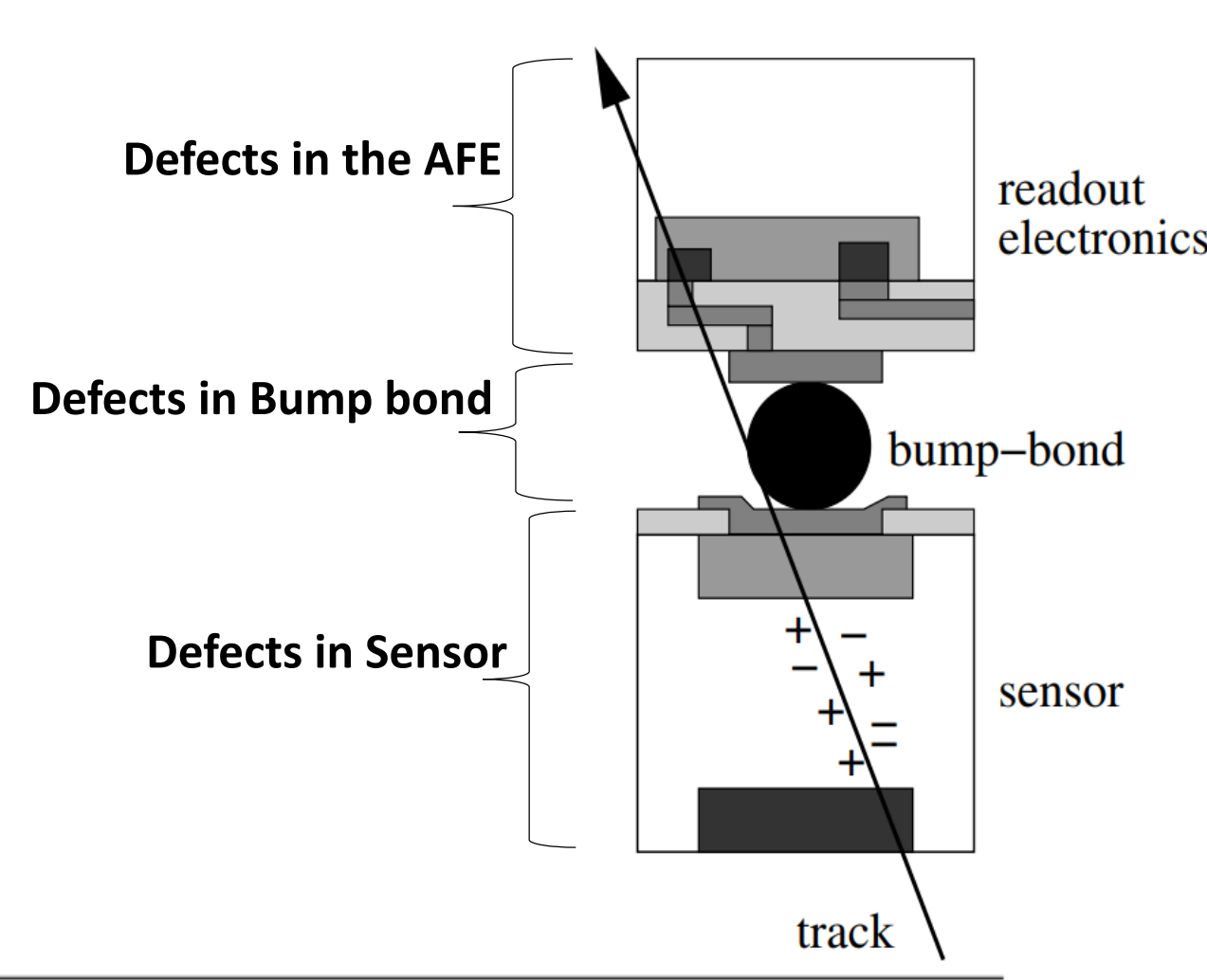
Results demonstrated a consistent modules performance across different production stages for all relevant electrical scans.

Complexities of large tracking systems

- The OB ITk will house a considerable amount of **4472** quad pixel modules.
- **Problem:** A broad spectrum of performance inconsistencies emerges among these modules. Compounded by potential degradation during production: Determining whether such modules should be incorporated becomes a critical challenge.
- **Solution:** Through a novel QC assessment tool, the production yield of the OB demonstrator quad pixel modules is implemented by combining electrical scans to detect the defect origin and classify the pixel defect category.

What pixel defects we expect and how to classify them?

- Failure classification is exclusive, which means that **only one category of pixel defects** would be assigned per pixel.
- A novel QC tool designed for the RD53A quad pixel modules reveals the defect origin, classify the failure, and categorize them for 32 modules (114 chips).



Failure ID	Scan Type	Criteria Conditions
Digital Dead	Digital	Occupancy = 0
Digital Bad	Digital	Occupancy > 98 or 102 < Occupancy
Analog Dead	Analog	Occupancy = 0
Analog Bad	Analog	Occupancy > 98 or 102 < Occupancy
Merged Bump	Crosstalk and Analog	Analog bad and Threshold Occupancy < 10% of the total injections and Threshold Occupancy ≠ 0
Tuning Failed	Threshold	Threshold Occupancy = 0 (S-curve Failed)
Tuning Bad	Threshold	Pixel Threshold - Threshold mean > 5 σ
Noisy Pixel	Noise	Pixel Noise - Noise mean > 3 σ
Open Bump	X-ray and Crosstalk	X-ray Occupancy = 0 and Crosstalk Threshold Occupancy = 0

QC assesment: What we have observed?

- QC tool uses the stacking methodology to identify any trends of defects for 114 chips.
- Certain locations in the Diff AFE poses high number of defects.

