



IMAPP



technische universität
dortmund

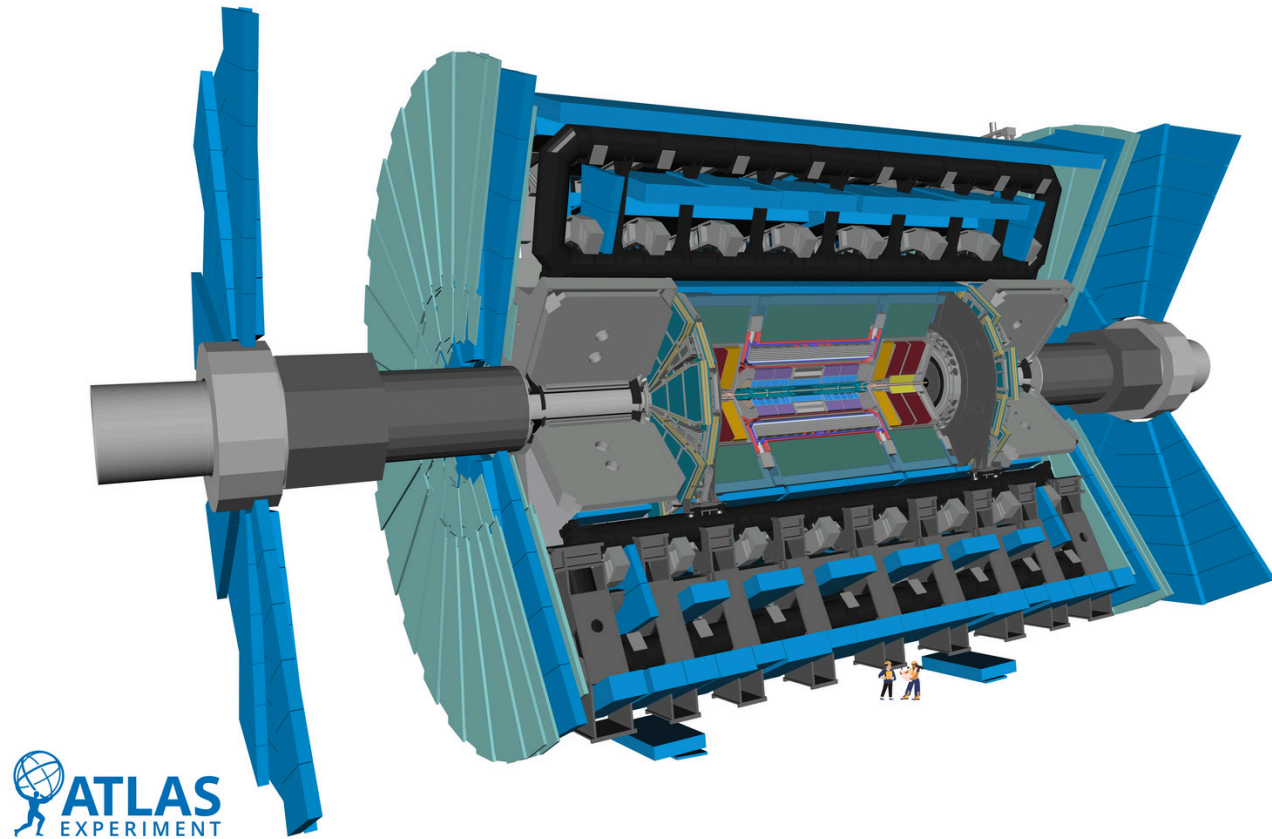
QUALITY CONTROL OF SILICON DETECTORS: FROM ATLAS TO MU3E

S O F I I A B A L E T S K A

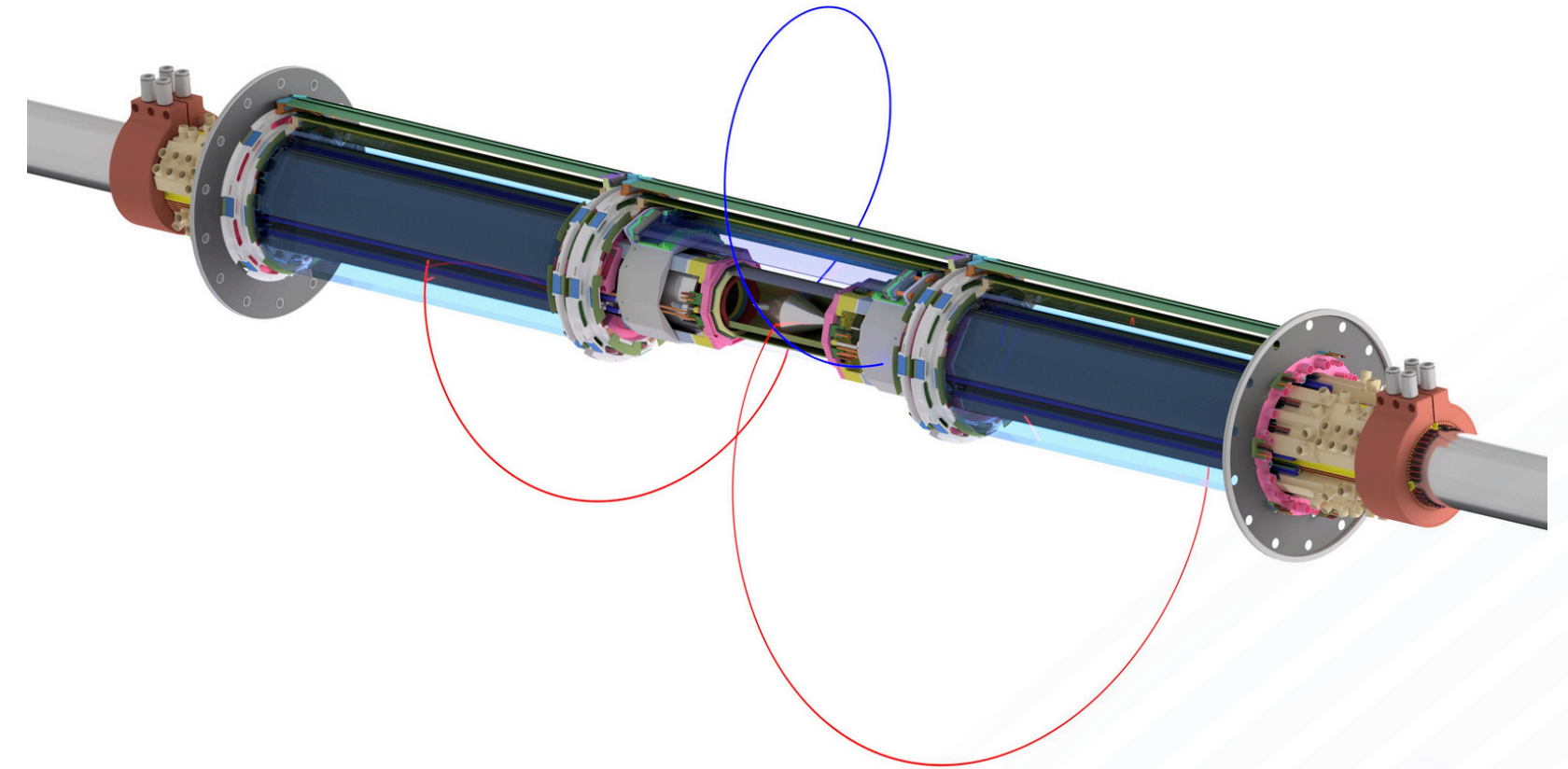
IMAPP Erasmus Mundus Master's Programme
TU Dortmund University

WHY DO WE NEED QUALITY CONTROL?

Silicon detectors are the key tracking systems in both experiments.



ATLAS detector (CERN)
Source: ATLAS Collaboration


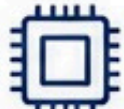




Mu3e detector (PSI)
Source: Mu3e Collaboration

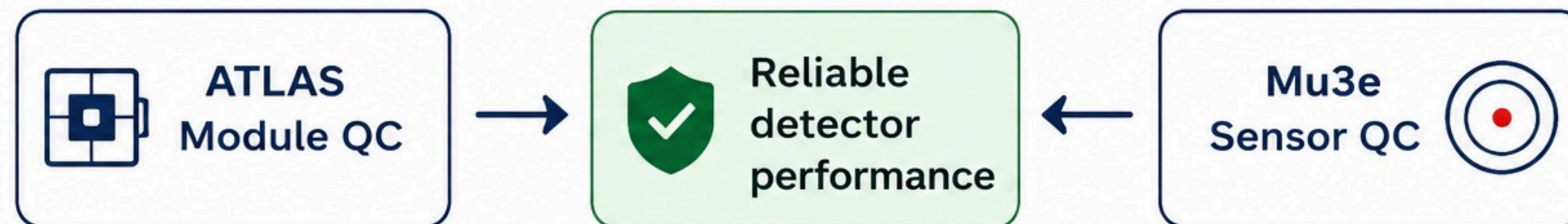
Different experiments, same challenge

- Precise particle tracking
- Reliable detector performance
- Trustworthy physics results

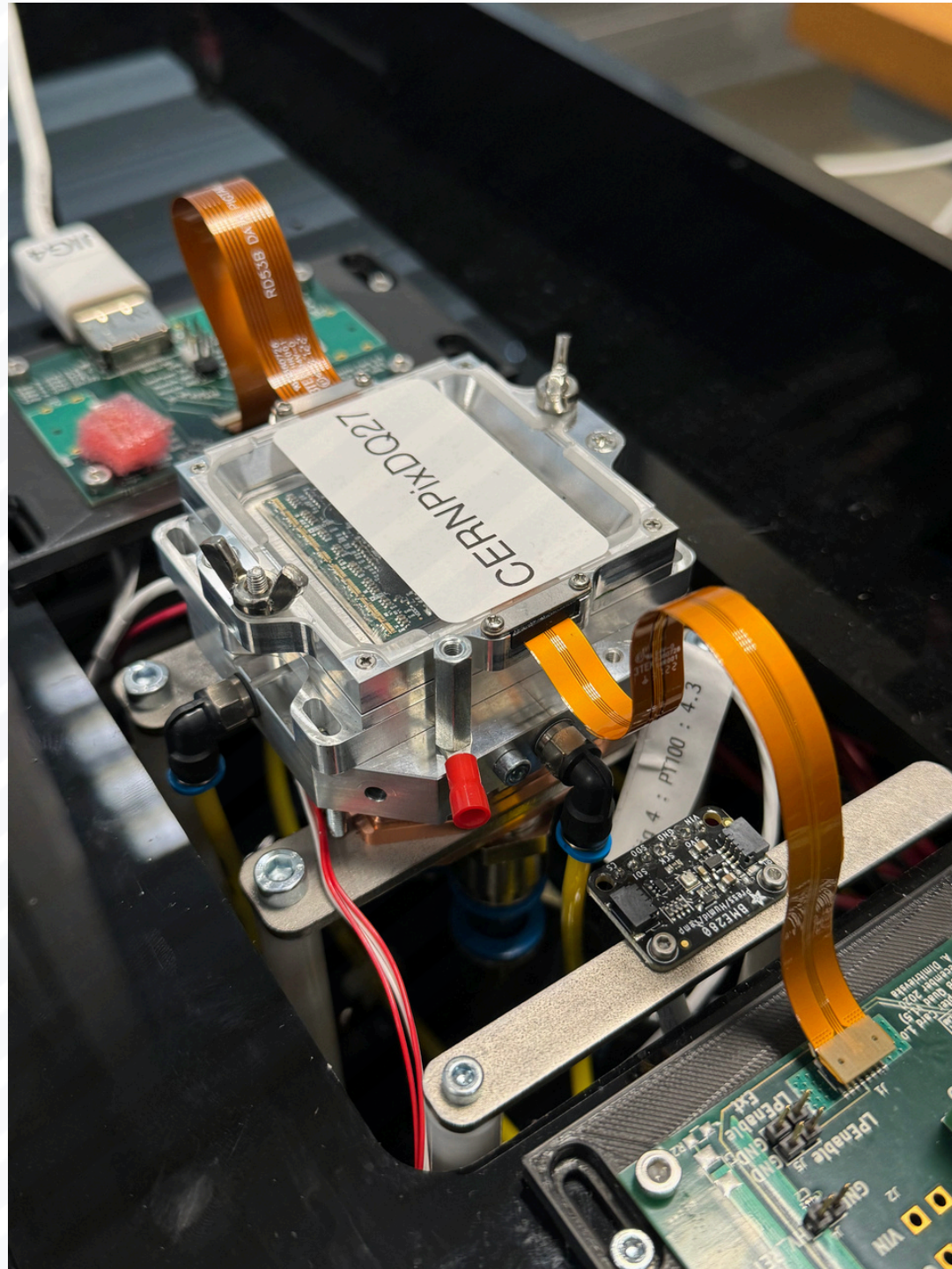
ATLAS VS MU3E

Aspect	ATLAS	Mu3e
 Physics goal	High-energy proton-proton collisions	Search for the rare decay $\mu^+ \rightarrow e^+ e^- e^+$
 Tracking detector	Silicon pixel modules	Monolithic silicon pixel sensors
 Detector scale	Large-scale tracker	Ultra-light tracker
 Quality control	Module qualification	Sensor qualification

Different detector technologies, same goal: reliable physics measurements.



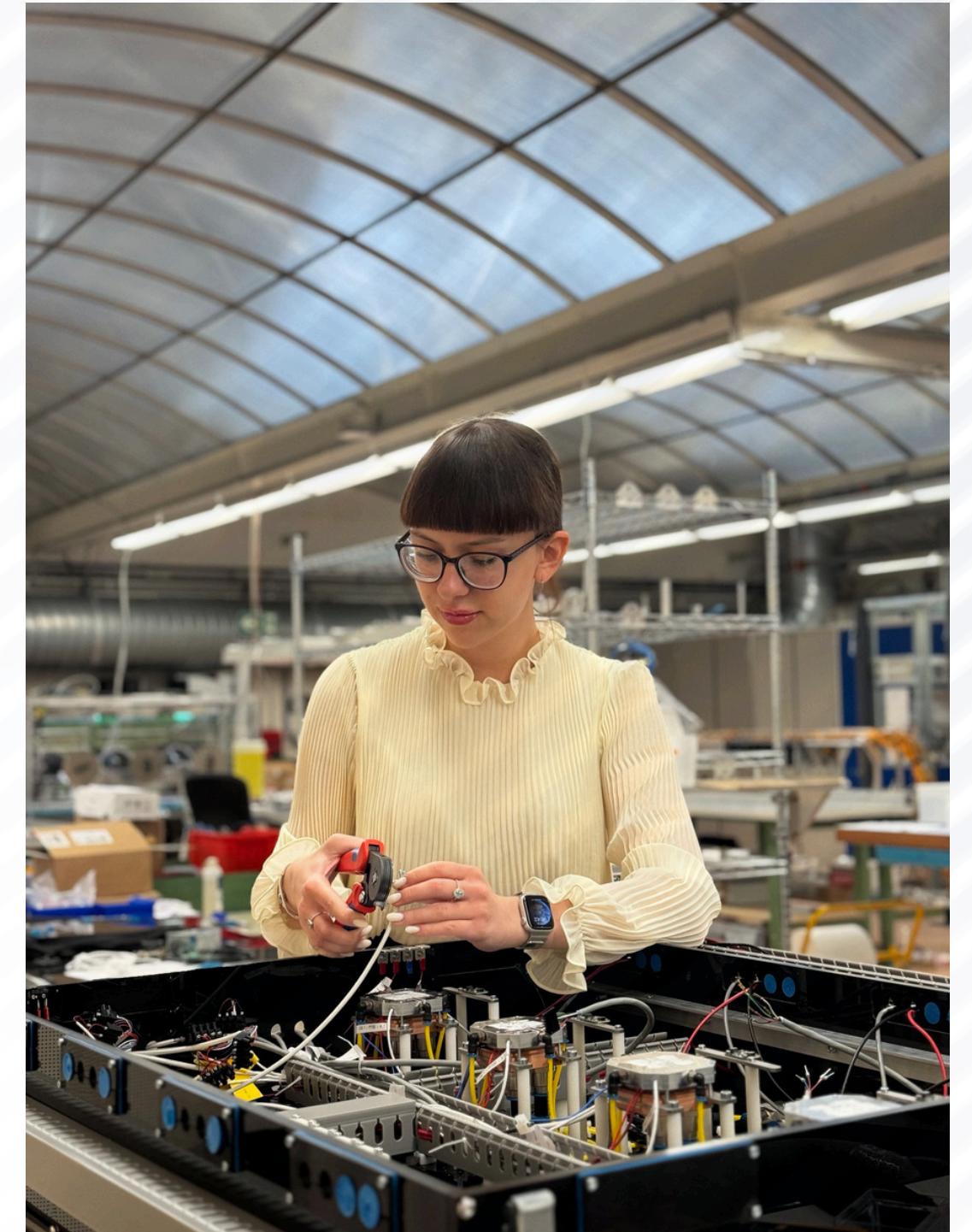
ATLAS INNER TRACKER UPGRADE



ITk quad pixel module
Source: personal photo, CERN

ATLAS ITk Outer Barrel Pixel System

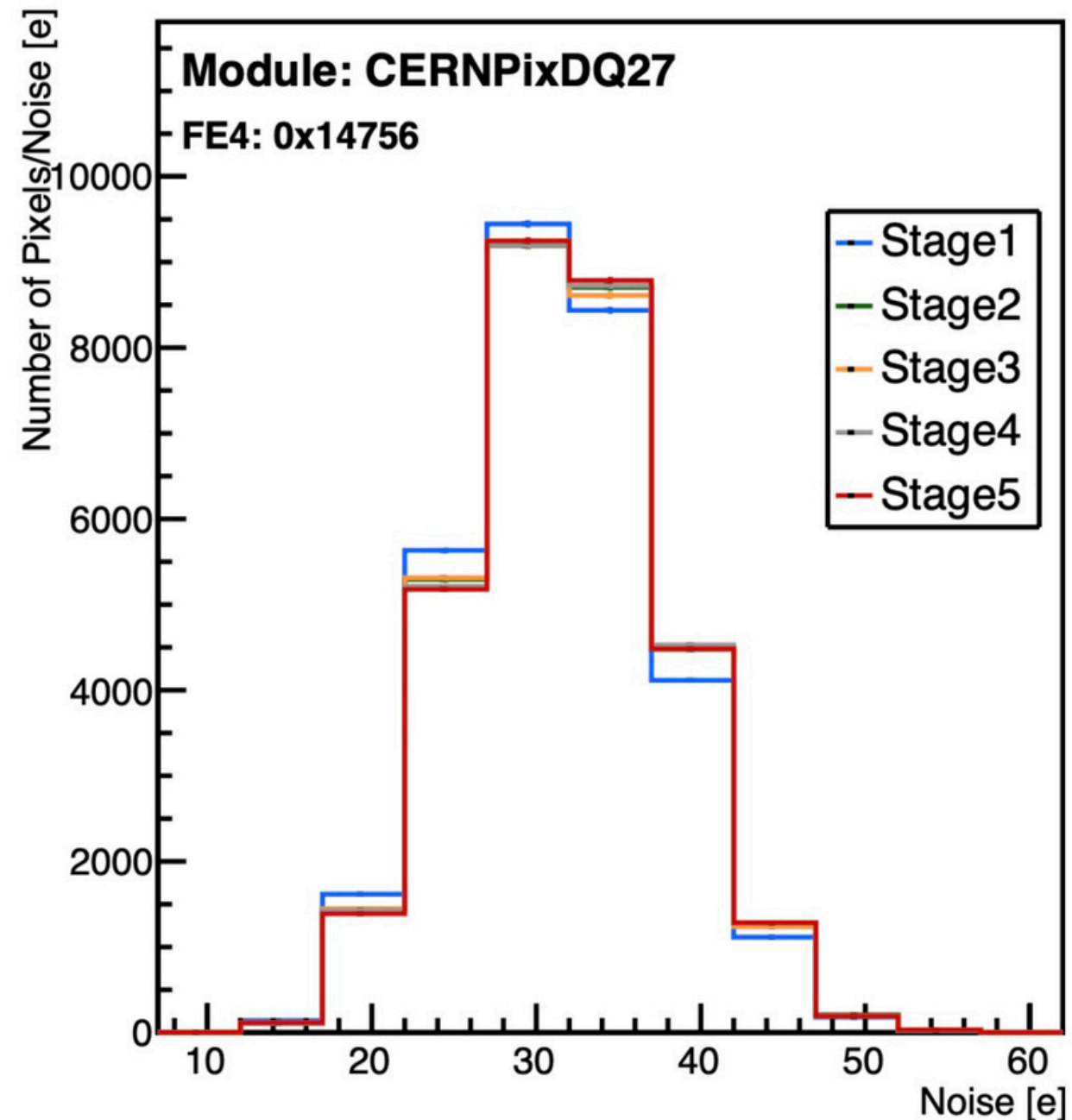
- Quad pixel detector modules
- Performance validation
- Quality control before installation



Quality control setup at CERN
Source: personal photo, CERN

QUALITY CONTROL AT CERN

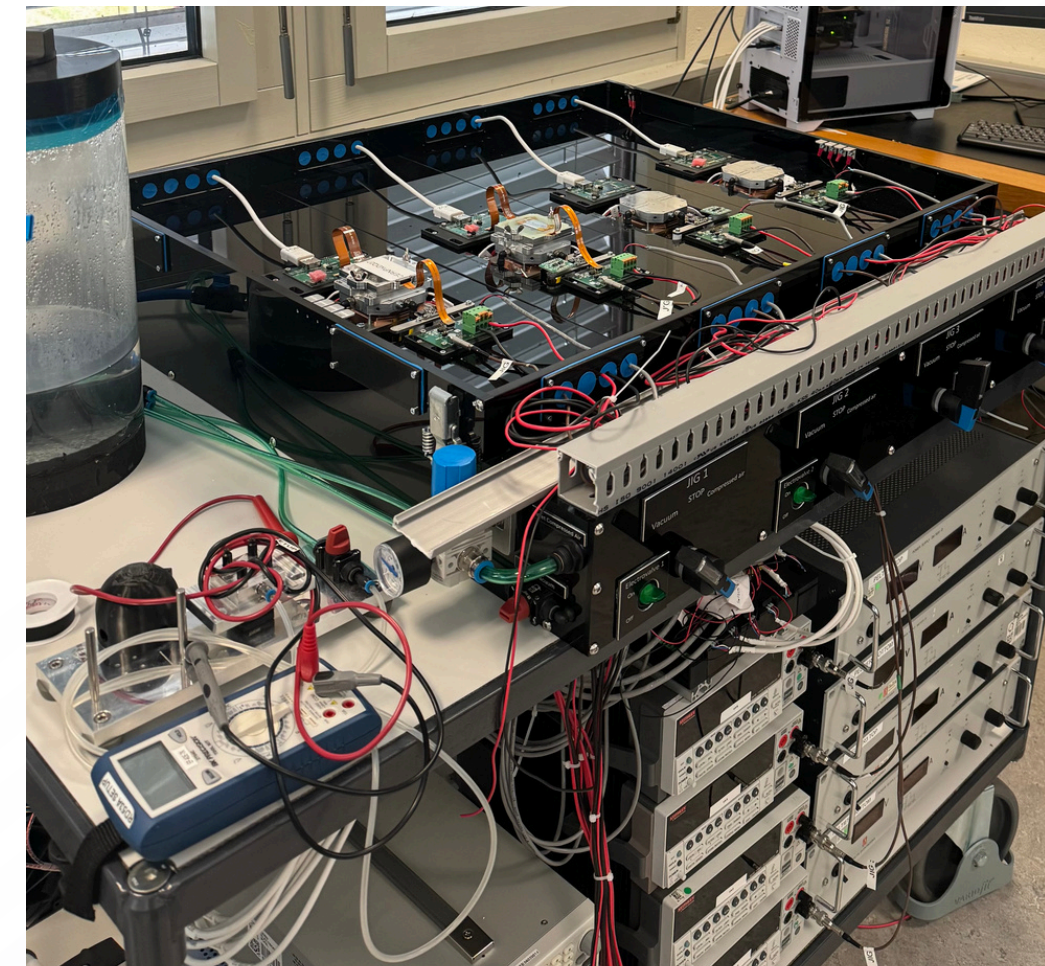
[std FE] NoiseDist-0 (Comparison)



Example noise distribution of one front-end chip
Used for pixel module quality assessment
Source: ATLAS ITk QC, CERN (2024)

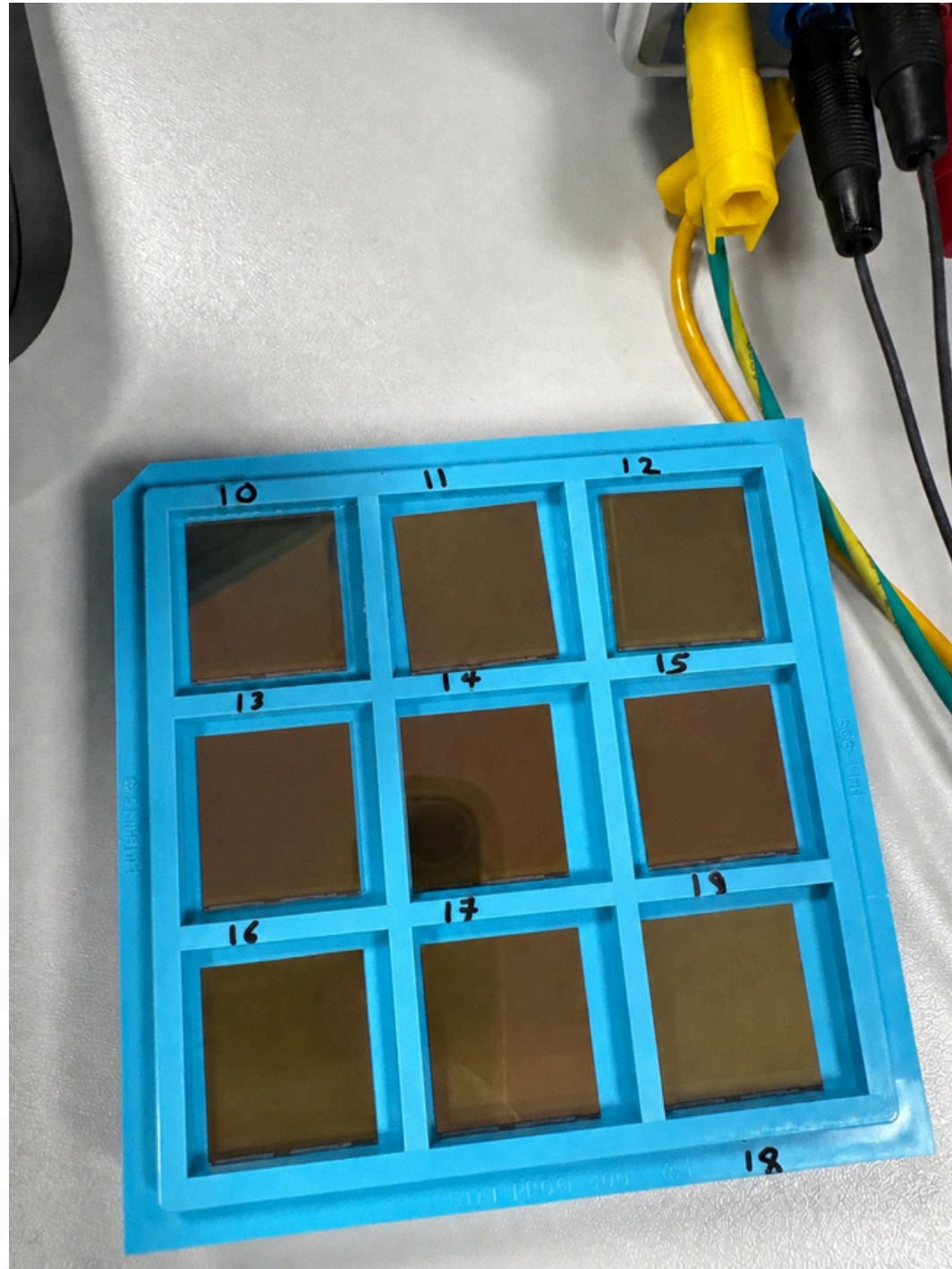
Quality Control Tests

- Digital and analog scans
- **Noise** and threshold measurements
- Operation at low temperature ❄️ (-15 °C)



ATLAS ITk quality control setup
Source: personal photo, CERN

MUPIX11 SENSOR QUALIFICATION



MuPix11 sensors on wafer carrier

Source: personal photo, University of Oxford

Main qualification tests

- IV measurements
- Threshold scans
- Noise measurements

Only sensors that pass all qualification tests are used for detector assembly.



Probe station for sensor testing

Source: personal photo, University of Oxford

EXAMPLES OF SENSOR DEFECTS AND QUALITY ASSESSMENT

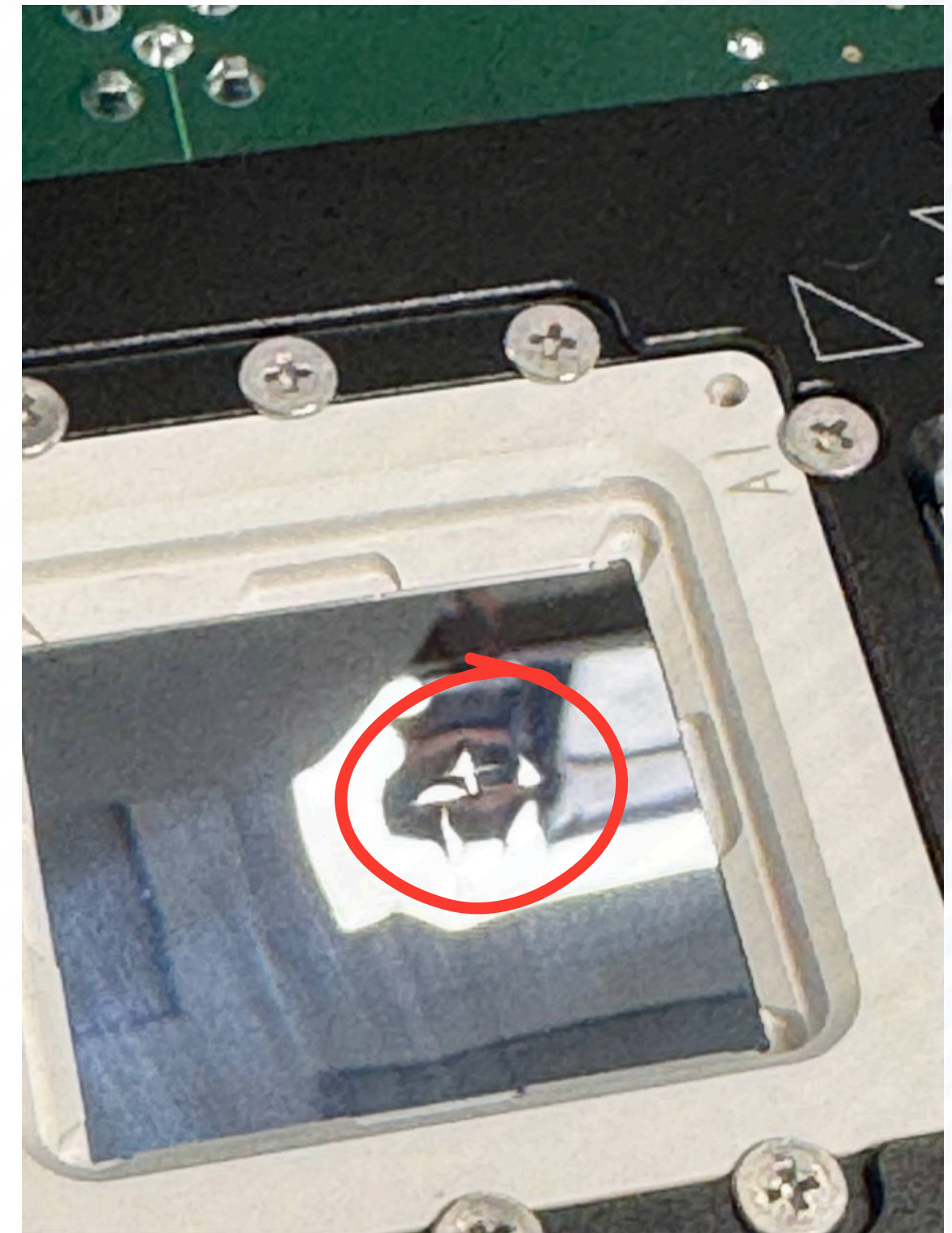
Quality checks include

- Visual inspection
- Electrical tests
- Performance validation

Example defect

Observed during incoming sensor inspection

- Surface scratch detected during visual inspection
- Sensor rejected before detector assembly



Example of sensor damage identified during QC
Source: personal photo, University of Oxford

CONCLUSION

- Quality control is essential for reliable detector operation
- ATLAS and Mu3e apply different QC strategies adapted to their detector technologies
- Quality control ensures that only well-performing detector components are used.
- Early defect identification improves detector performance and reduces production losses

Thank you for your attention!