

Assembly and QA/QC of the readout electronics for the DarkSide-20k veto photodetector modules



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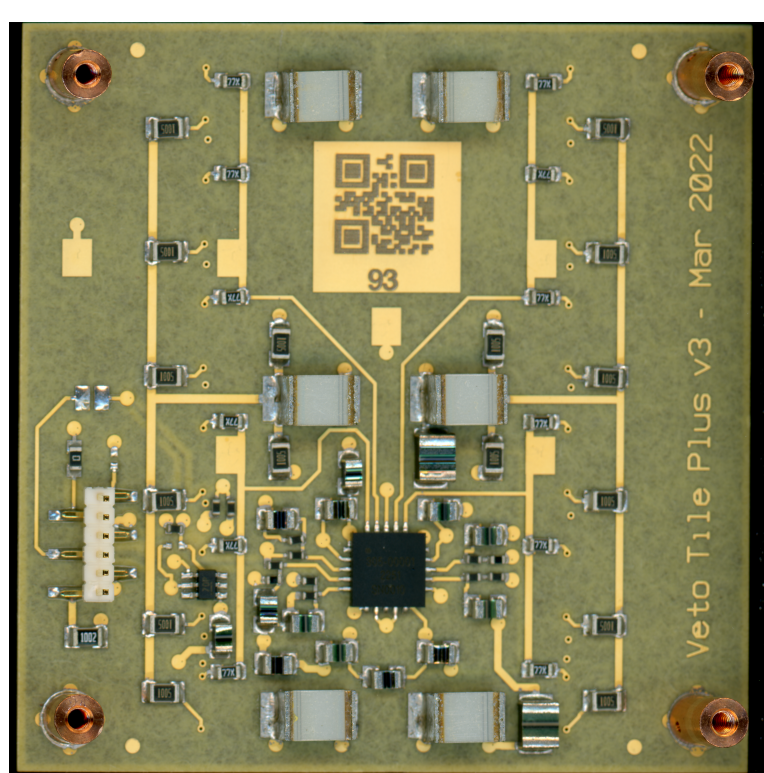
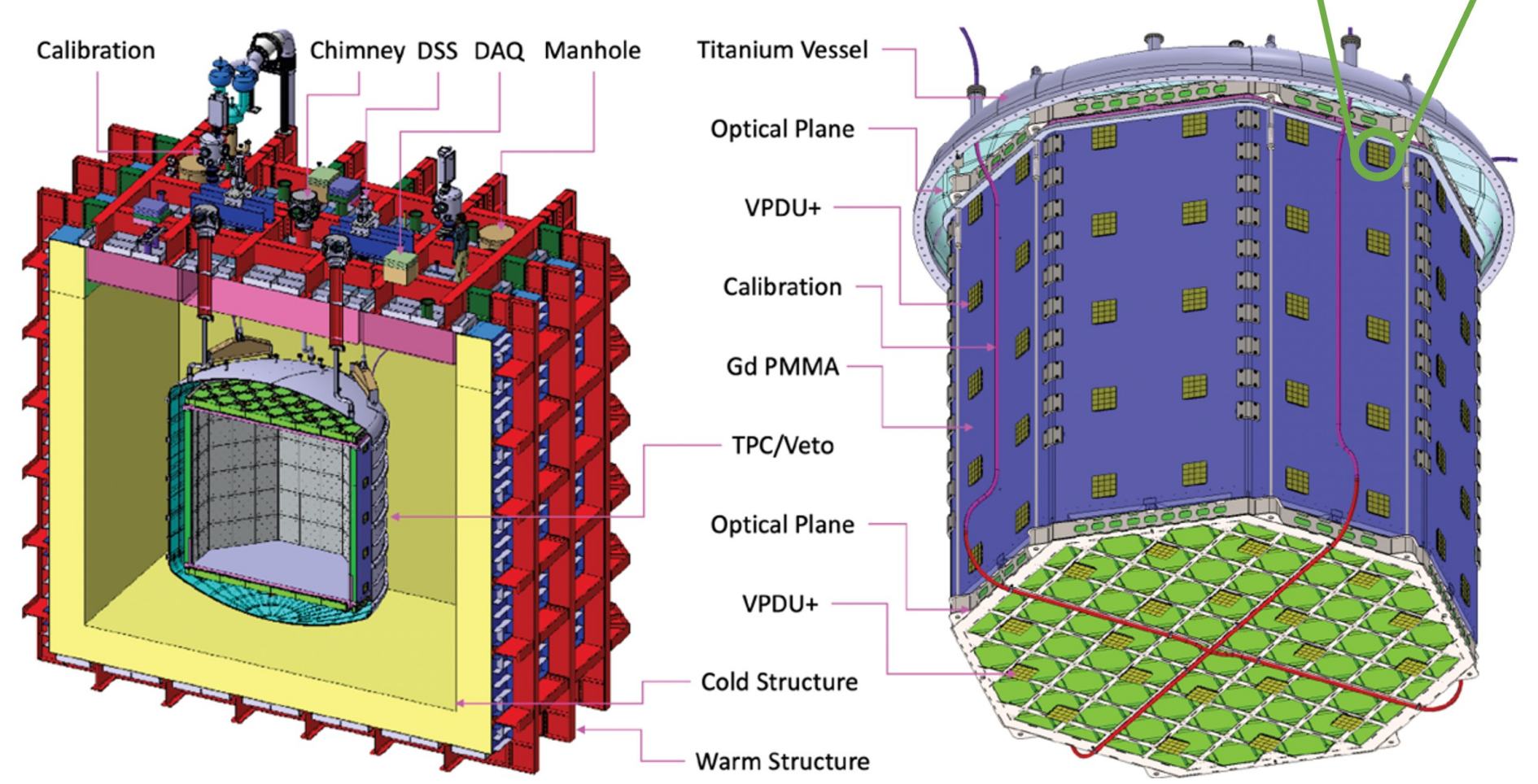
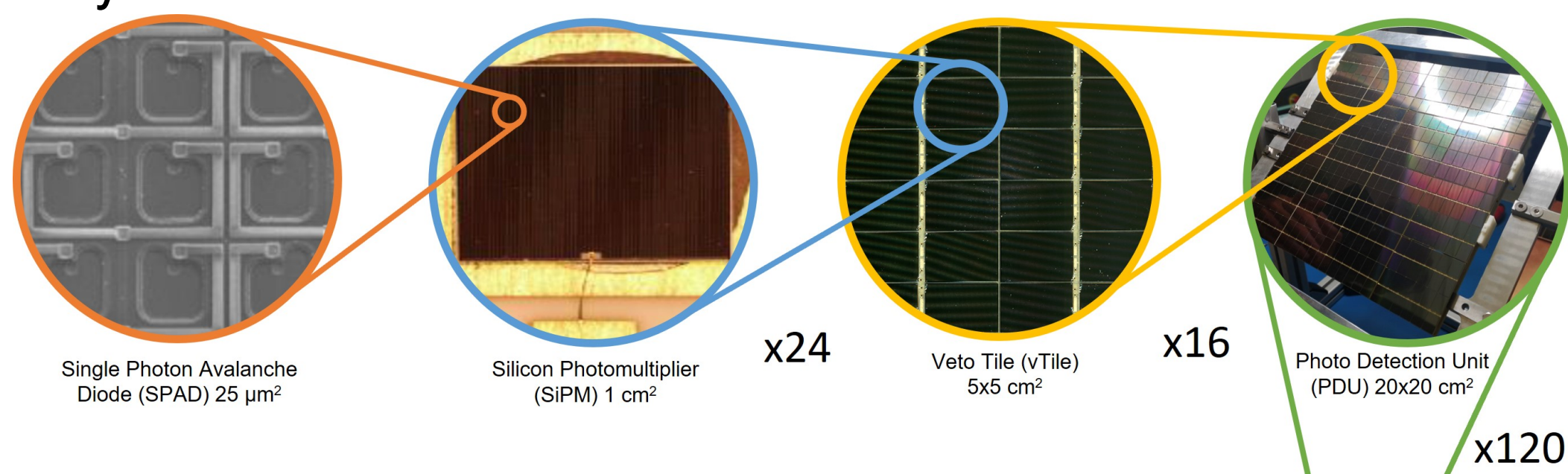
The DarkSide-20k experiment

The Global Argon Dark Matter Collaboration's contribution to the search to uncover the nature of particle dark matter is the DarkSide-20k experiment [1]. Designed to detect interactions of WIMP with a Liquid Argon (LAr) target, DarkSide-20k will probe WIMP-nucleon interactions in the promising mass range of 1 GeV - 10 TeV. DarkSide-20k is formed of a central LAr Time Projection Chamber (TPC) filled with 51 t (20 t fiducial) of purified underground argon [2] surrounded by an inner active (neutron) veto and outer active (muon) veto. The experiment is currently under construction in LNGS with operations expected to start in late 2026.

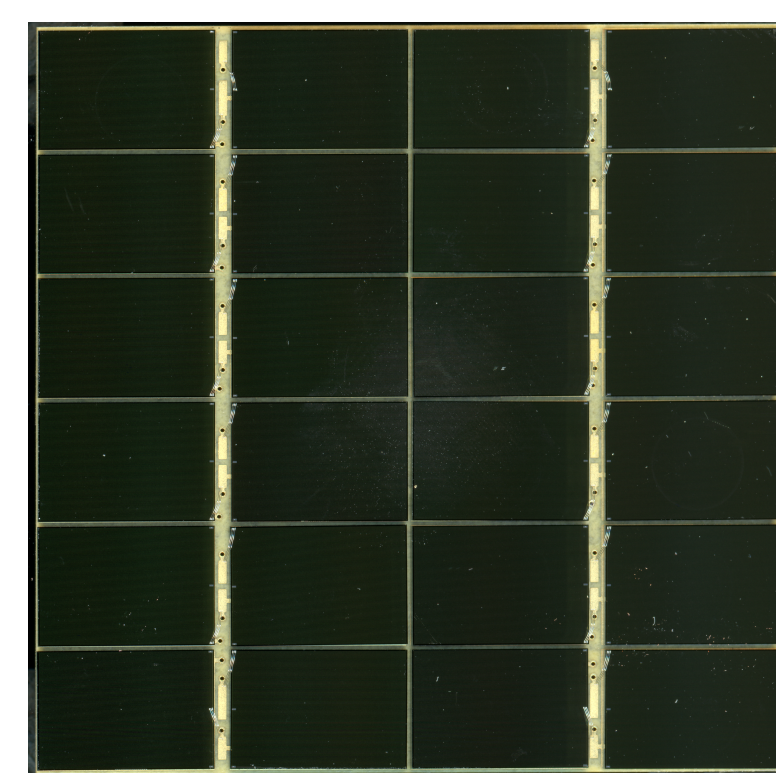
[1] Aalseth, C.E., Acerbi, F., Agnes, P. et al. DarkSide-20k: A 20 tonne two-phase LAr TPC for direct dark matter detection at LNGS. Eur. Phys. J. Plus 133, 131 (2018), [2] Vicente Pesudo and the DarkSide-20k Collaboration 2021 J. Phys.: Conf. Ser. 2156 012043

Photo Detectors

- TPC and veto detectors are instrumented with novel cryogenic Silicon photomultipliers (SiPMs) soldered onto a readout PCB, known as a veto Tile (vTile).
- PCBs are assembled onto a motherboard with summing and filtering circuits which supply the SiPMs with power and funnel response signals to the DAQ.
- The UK collaboration institutes are responsible for producing these for the veto systems with production already well under-way.

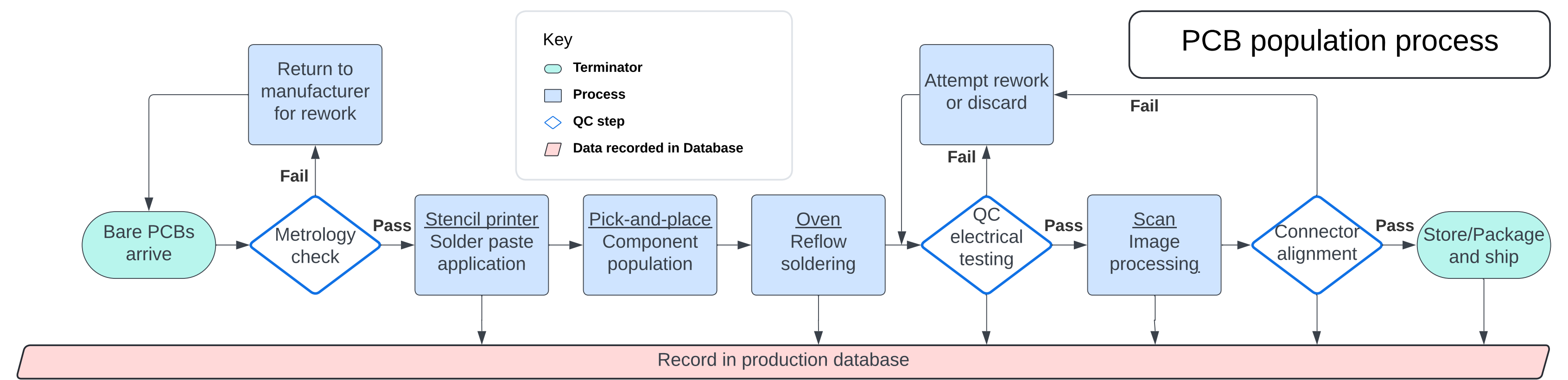


vTile backside assembled at the University of Birmingham. Visible is the custom ASIC amplifier (black centre) and etched QR code.



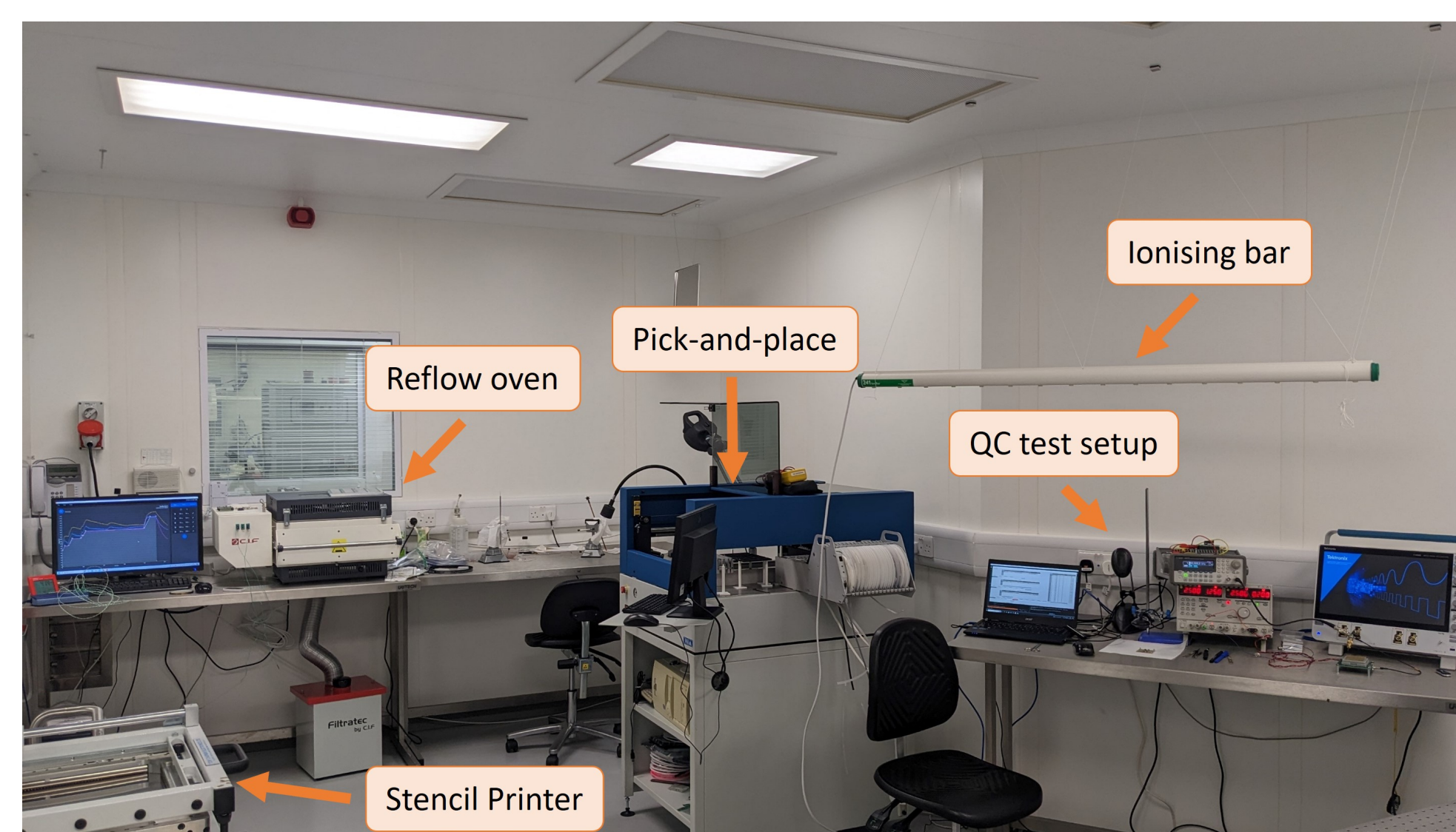
vTile front side. SiPMs are die attached and wirebonded at RAL & the University of Liverpool.

PCB Assembly Facility

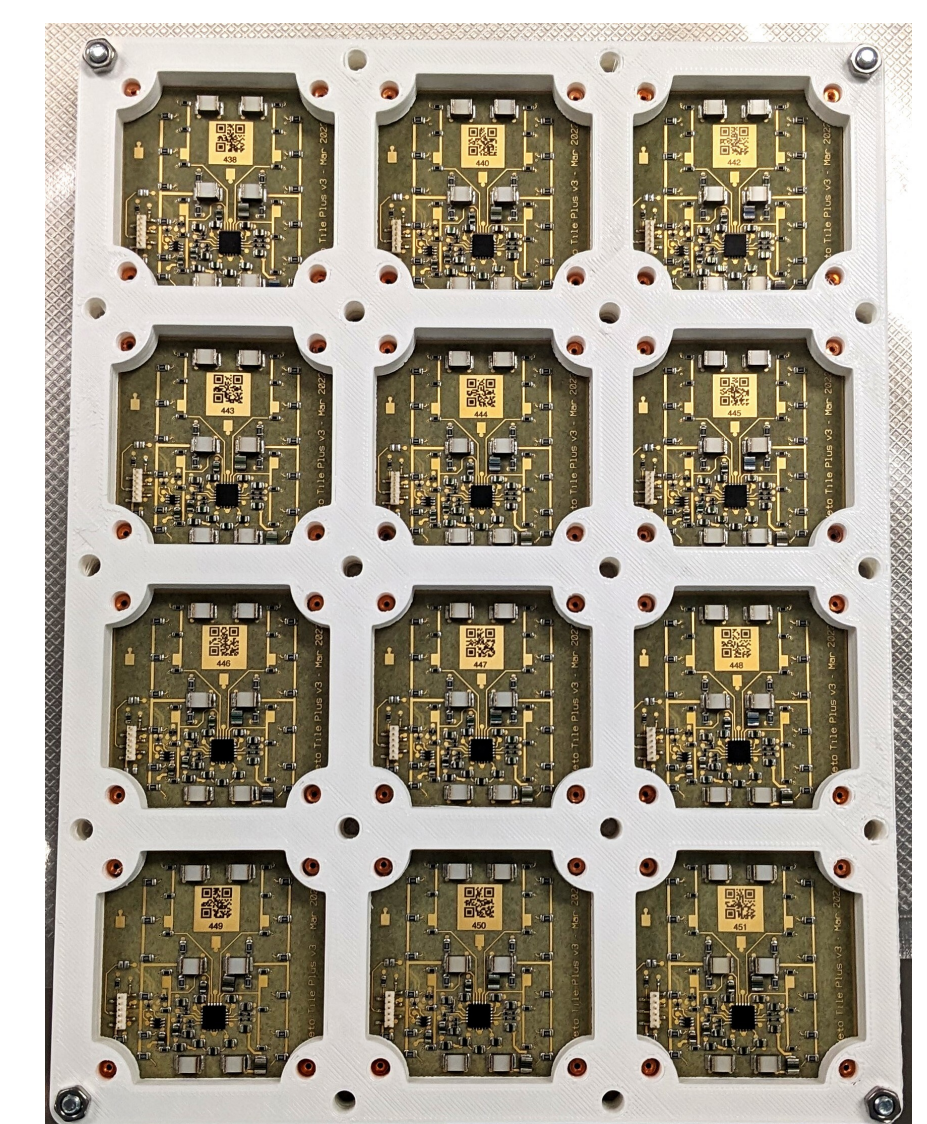


Industry standard PCB assembly facility in an ISO6 cleanroom at the University of Birmingham with radiopurity a major consideration:

- Ion bars above work surfaces reduce dust plate out and static discharges.
- Temperature, humidity and particle count monitoring.
- Periodic surface dust counting.
- Radon tested at $<5 \text{ Bq/m}^3$.
- All components radio-assayed with results below limits set using detailed simulations.
- Assembled PCBs stored under nitrogen in dry cabinets.
- PCBs shipped using an inner vacuumed ESD bag and nitrogen flushed outer dry bag.

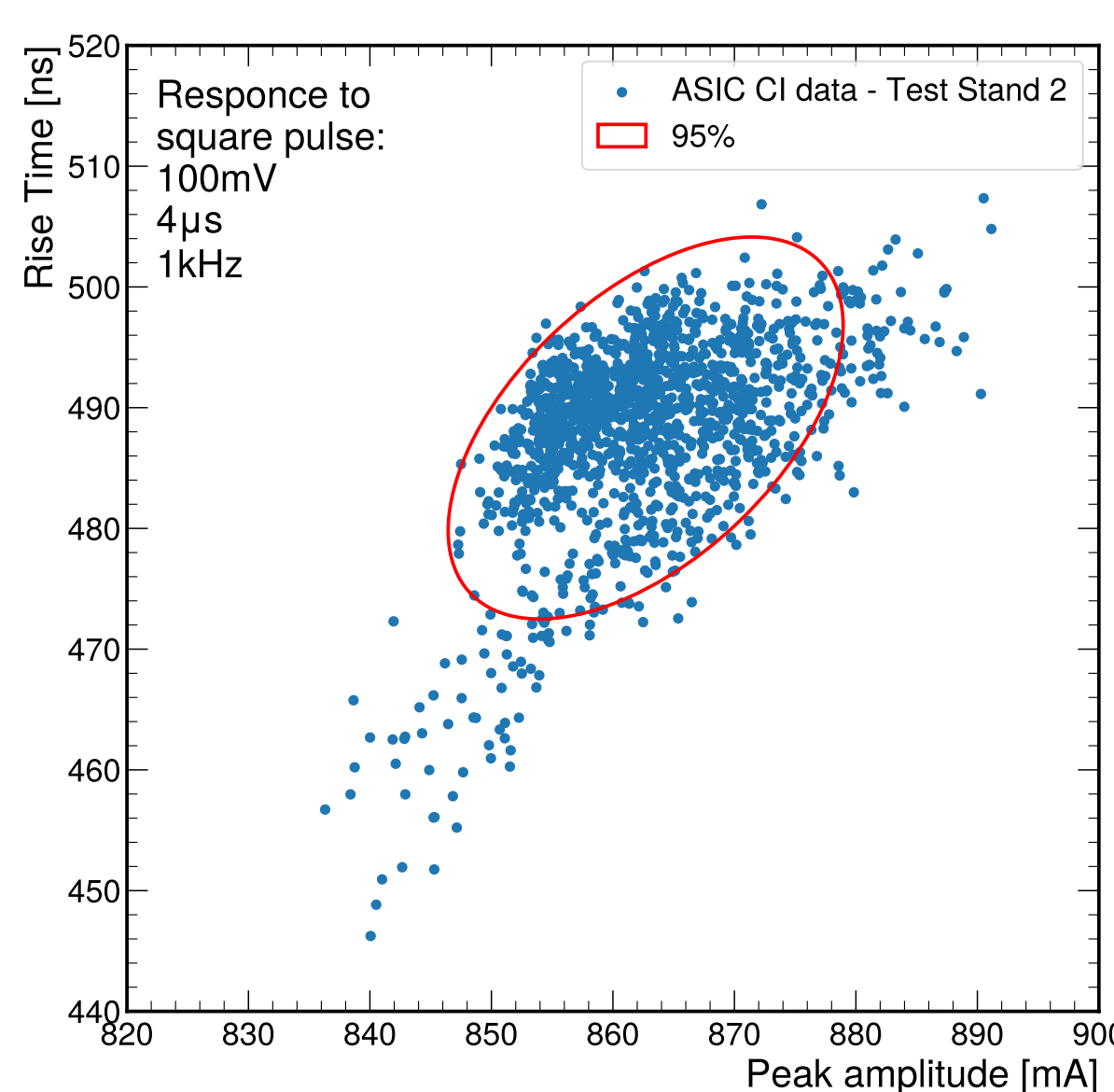


PCB cleanroom assembly facility.



Assembled PCBs in a 3D printed shipping fixture.

Quality Control (QC)



ASIC

- Packaged ASIC chips are tested before being soldered to a PCB.
- Response to a 100 mV, 4 μs, 1 kHz square pulse - emulating a photoelectron detection.
- Quality threshold is 95% of the resulting parameter distribution.

Assembled PCB

Every PCB goes through strict quality controls:

- Current Draw: $33 \pm 2 \text{ mA}$.
- Nominal response to a injected square pulse.
- Front and back of every PCB scanned with a high resolution scanner - image processing script checks accuracy in the positioning of pin headers.
- Results from each production and testing step documented in a dedicated production database.

