



# Darkside-20k





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- Technical staff: Liam Boynton, Paul Sinclair, Dan Hollywood

Big thanks to Alan and Adam for a lot of the technical work shown in these slides



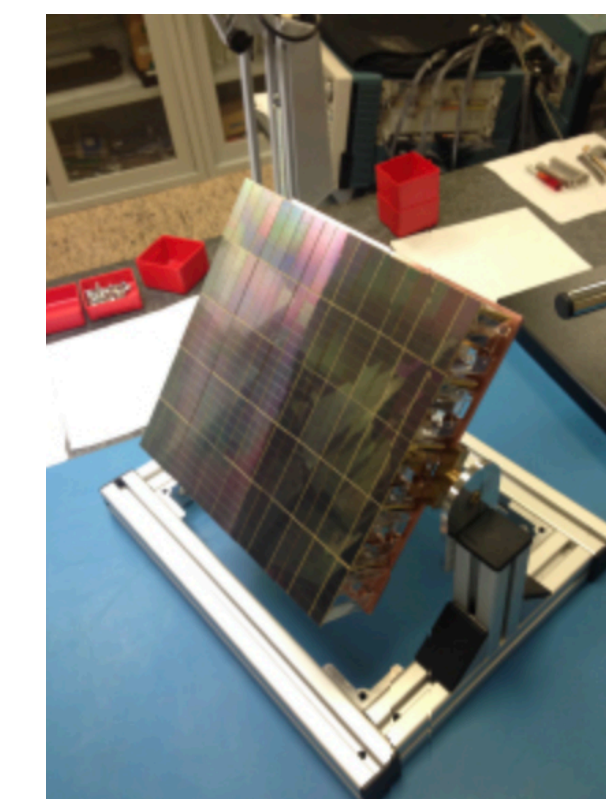
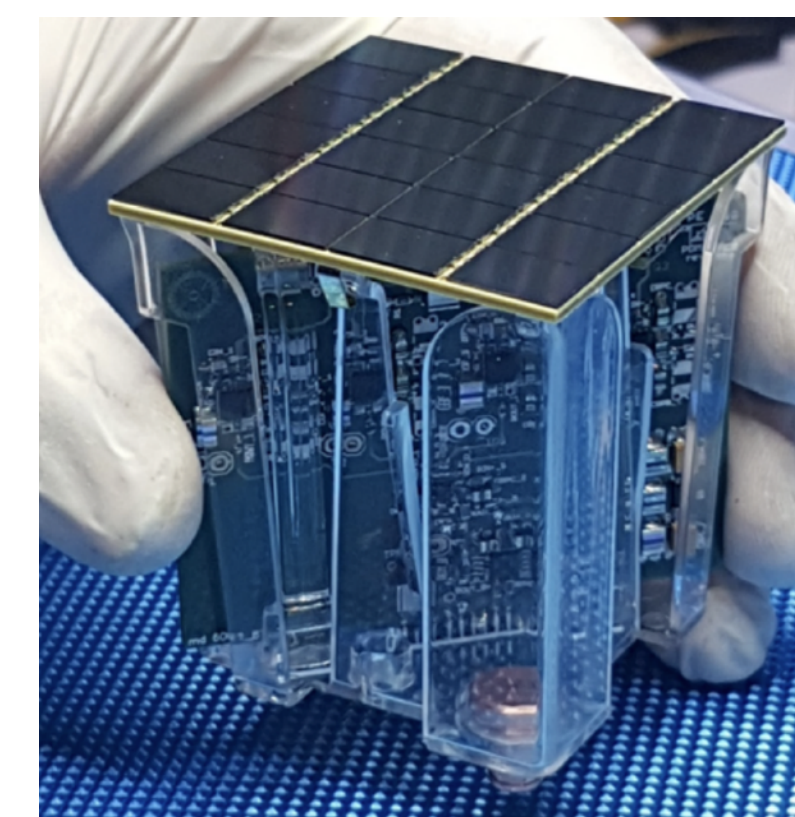
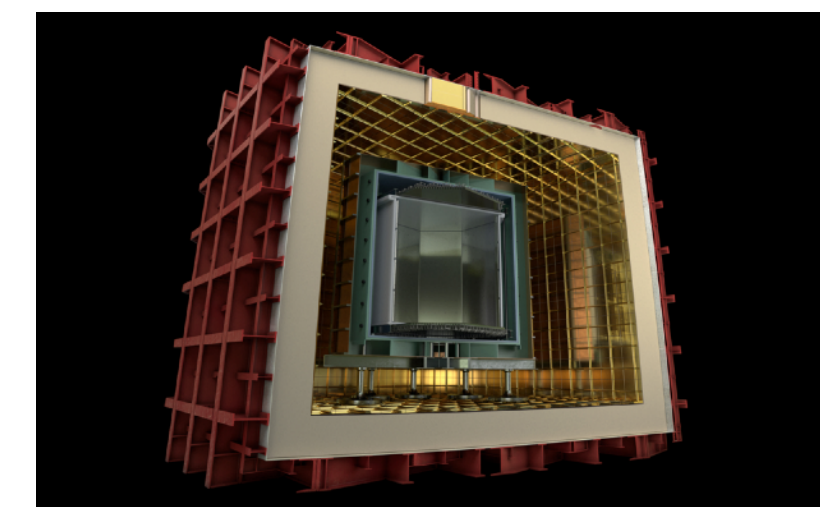
*Purpose:* The purpose of the DarkSide-UK project is to leverage the UK's world-leading silicon detector integration capability to grow UK leadership in large silicon photo-multiplier (SiPM) array detectors for low-background physics.

*Scope:* The DarkSide-UK project scope is the construction, testing and delivery of the photon detector modules (PDMs) to instrument the DarkSide-20k outer veto detector.

*Context:* The DarkSide-UK project is the UK contribution within the Global Argon Dark Matter Collaboration (GADMC) to the construction of the DarkSide-20k experiment.

*Objectives:*

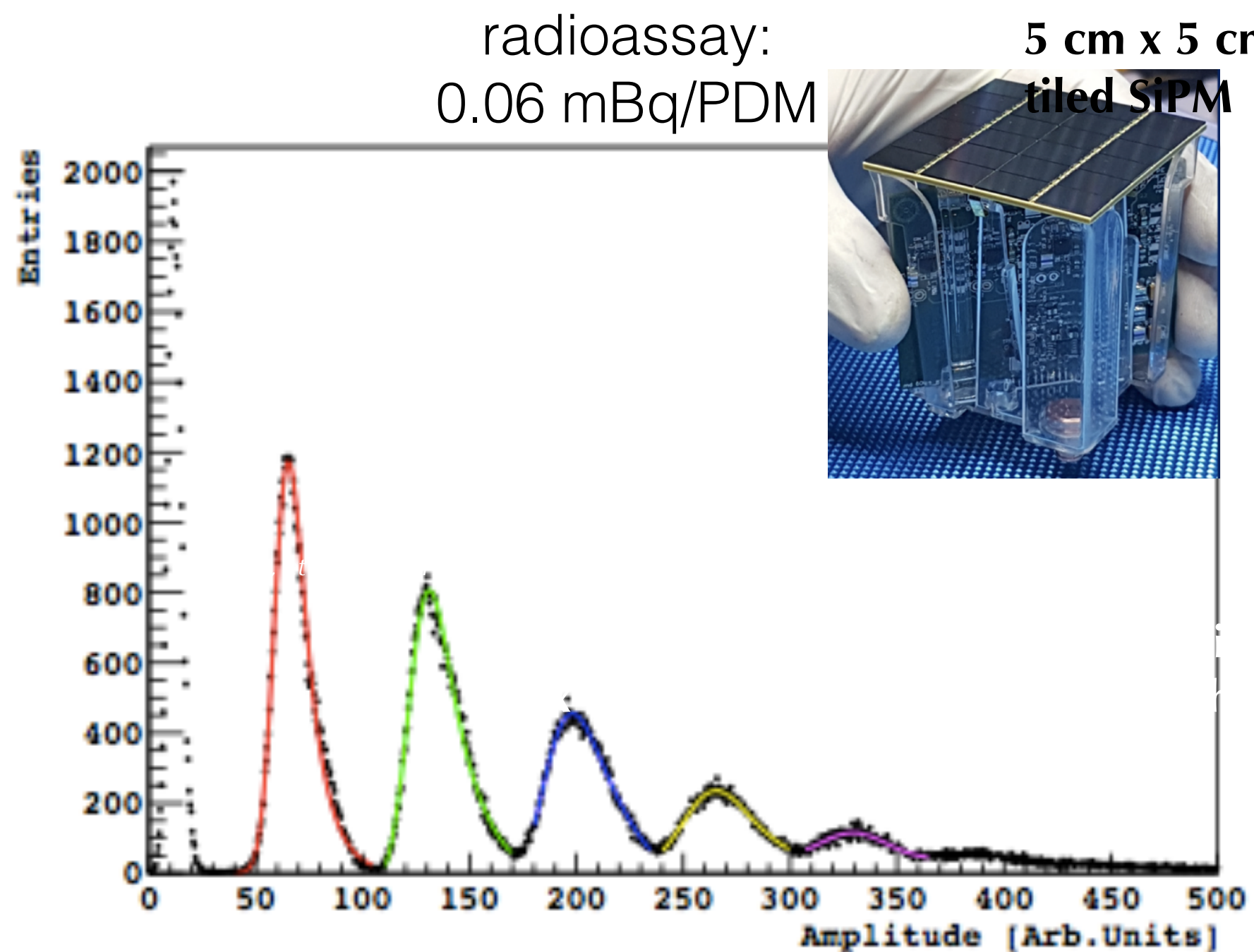
- **Work Package 1: to learn to assemble and ultimately deliver 2400 veto photon detector modules (vPDMs).**
- Work Package 3: to lower the radioactivity of the veto photon detector module with respect to the design implemented to read out the central TPC.
- **Work Package 5: to develop characterization facilities, and grow expertise, in testing SiPM array detectors to qualify the 2400 veto photon detector modules (vPDMs) produced in WP1 at both room temperature and liquid argon temperature.**



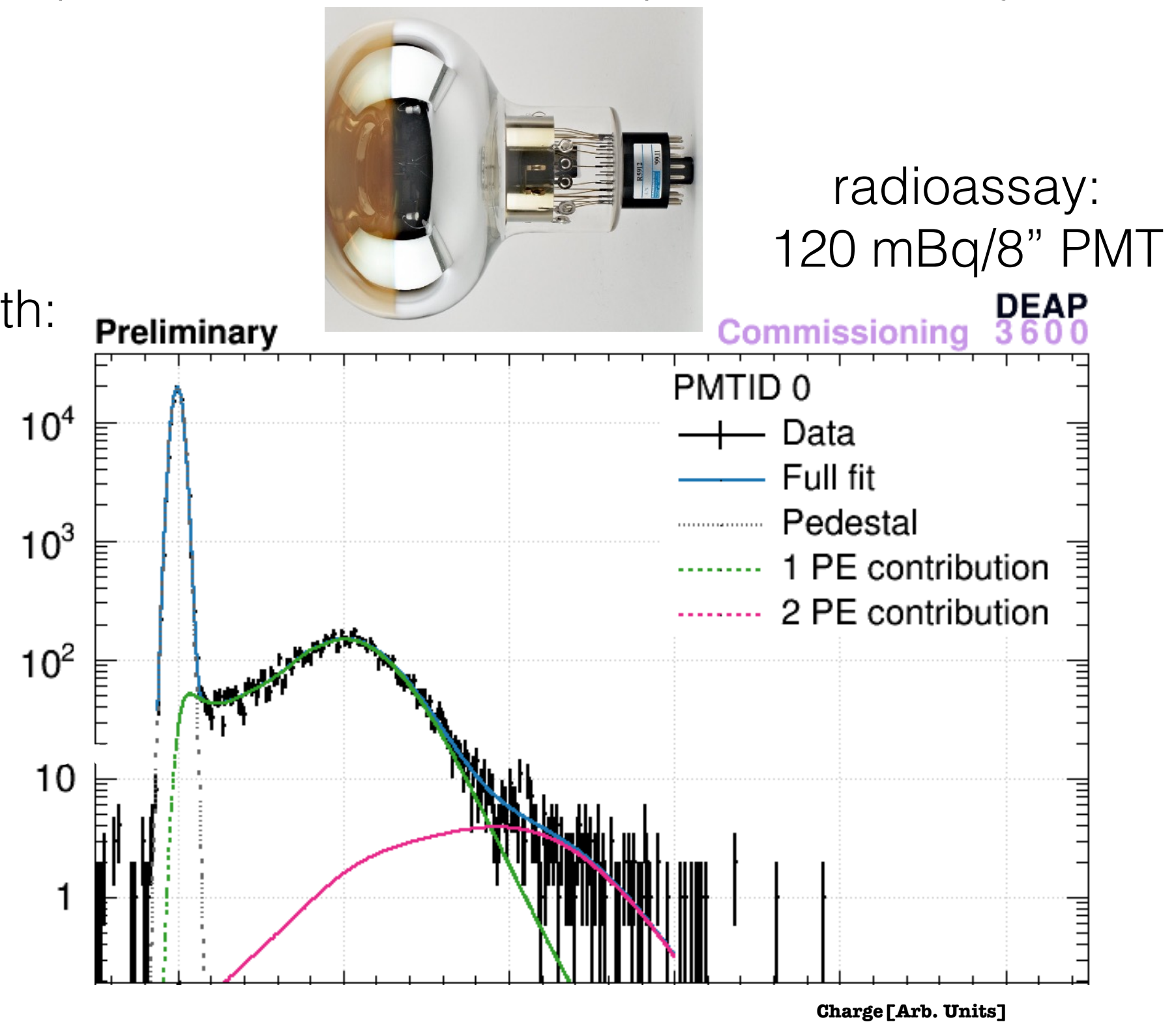


# Darkside-20k - SiPM Photon Detector Module (PDM)

- main challenge: rejecting background interactions from radioactivity, at  $\sim$ keV energies and below...
- Low noise, high efficiency, tiled + summed cryogenic Si sensors developed collaborating with FBK in a dedicated 6+ year 20M+ GBP programme, building on LHC CMOS R&D
- SiPMs have less material per unit sensor area, (nearly) all-Si sensor is possible, better resolution, quantum efficiency & coverage



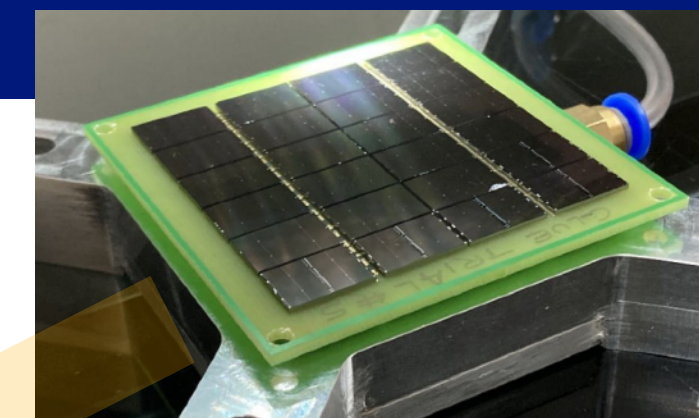
compared with:



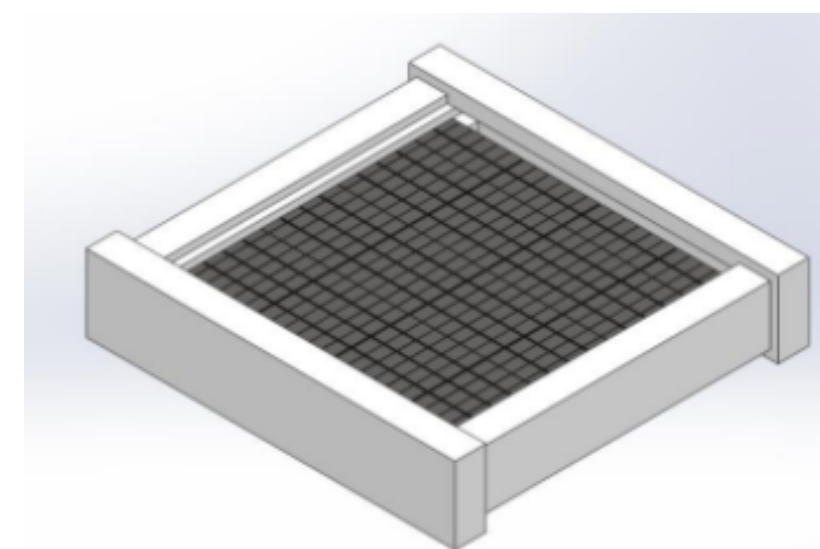


# UK veto tile production flow

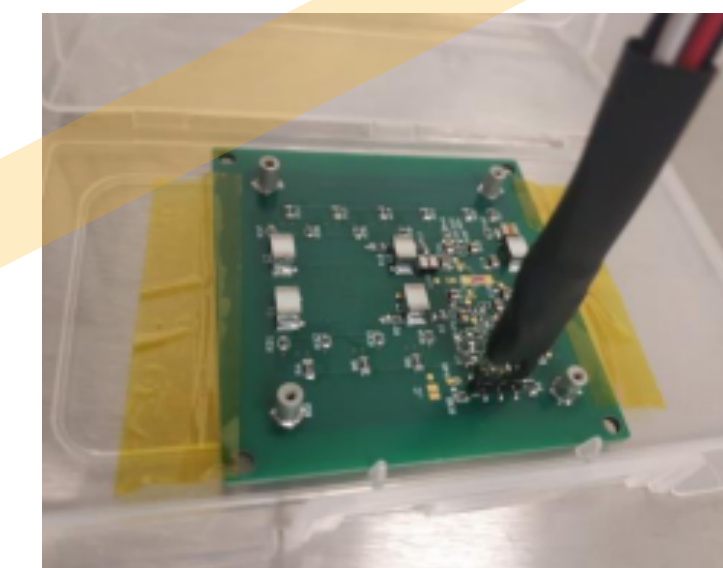
- Production
  - Qualification
  - Radio-assay
  - Assembly
  - Testing
  - Installation
- ... led by UK institutions



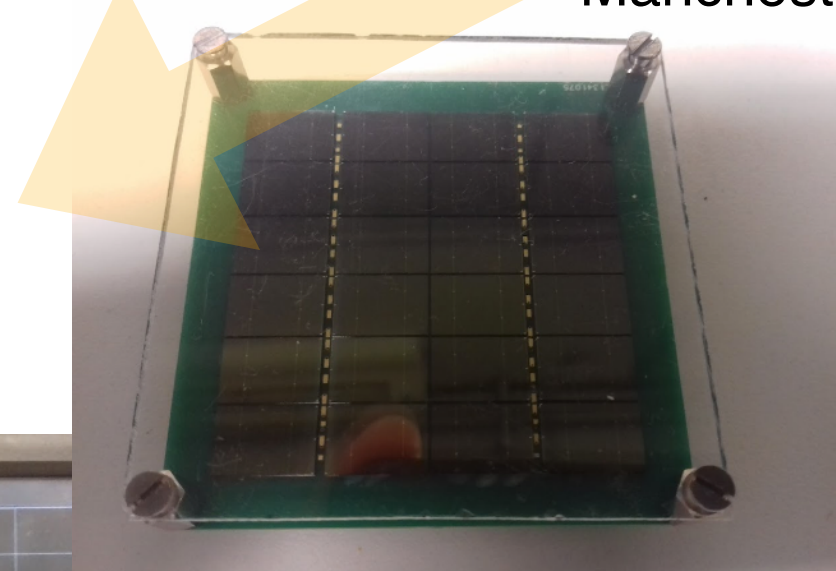
STFC Interconnect +Liverpool



Manchester

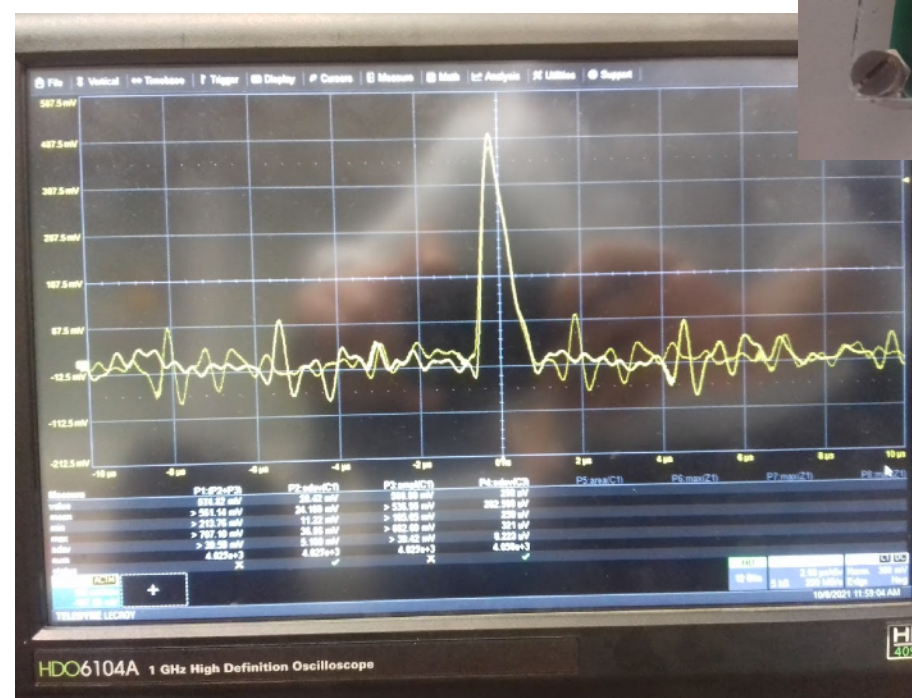


Birmingham

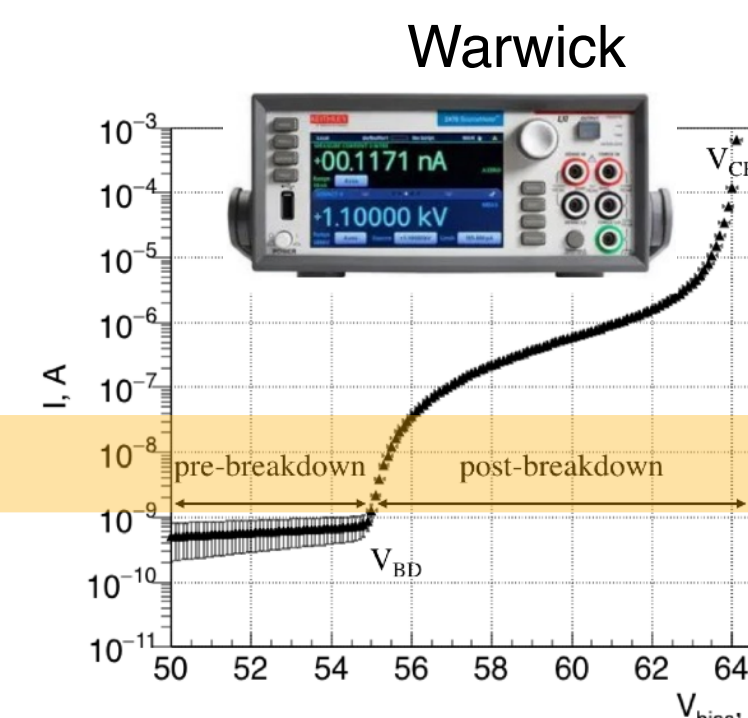
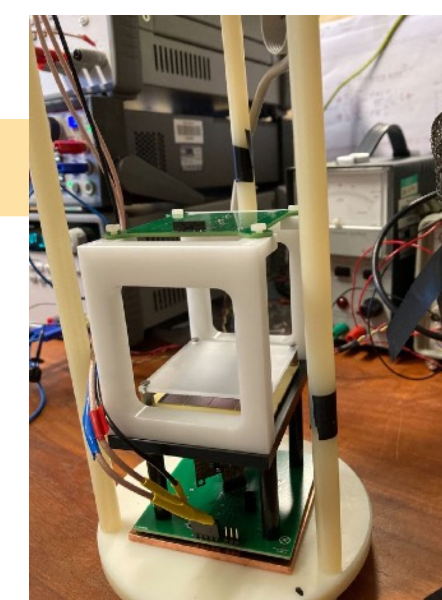


INFN Genova+Torino +Lancs+RHUL

ICL

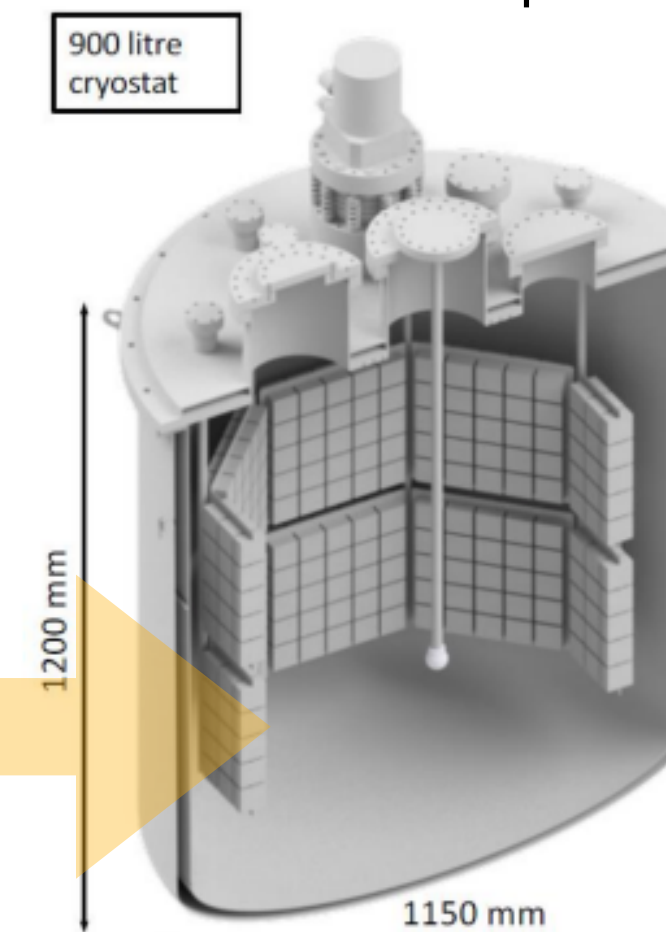


RHUL



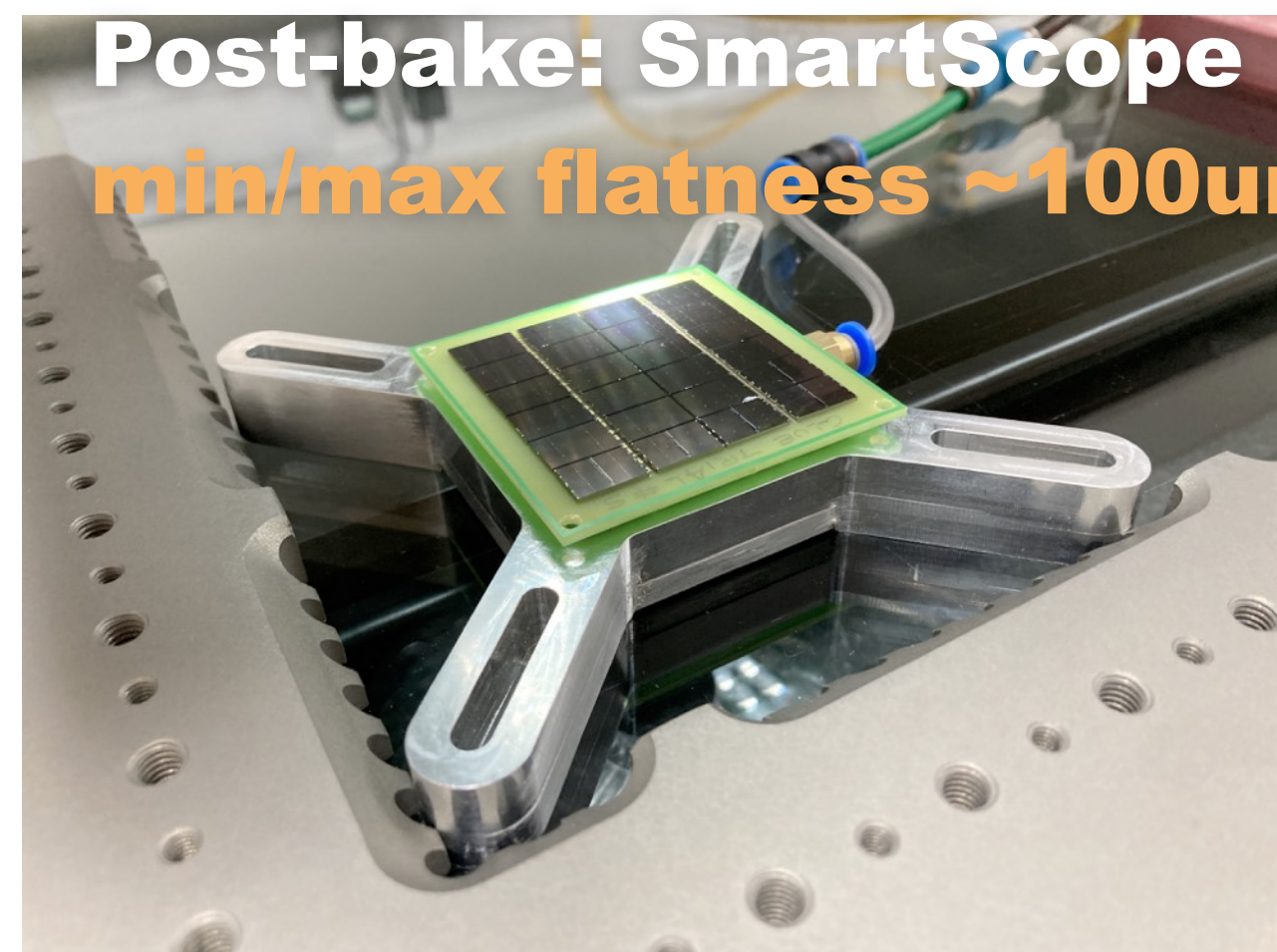
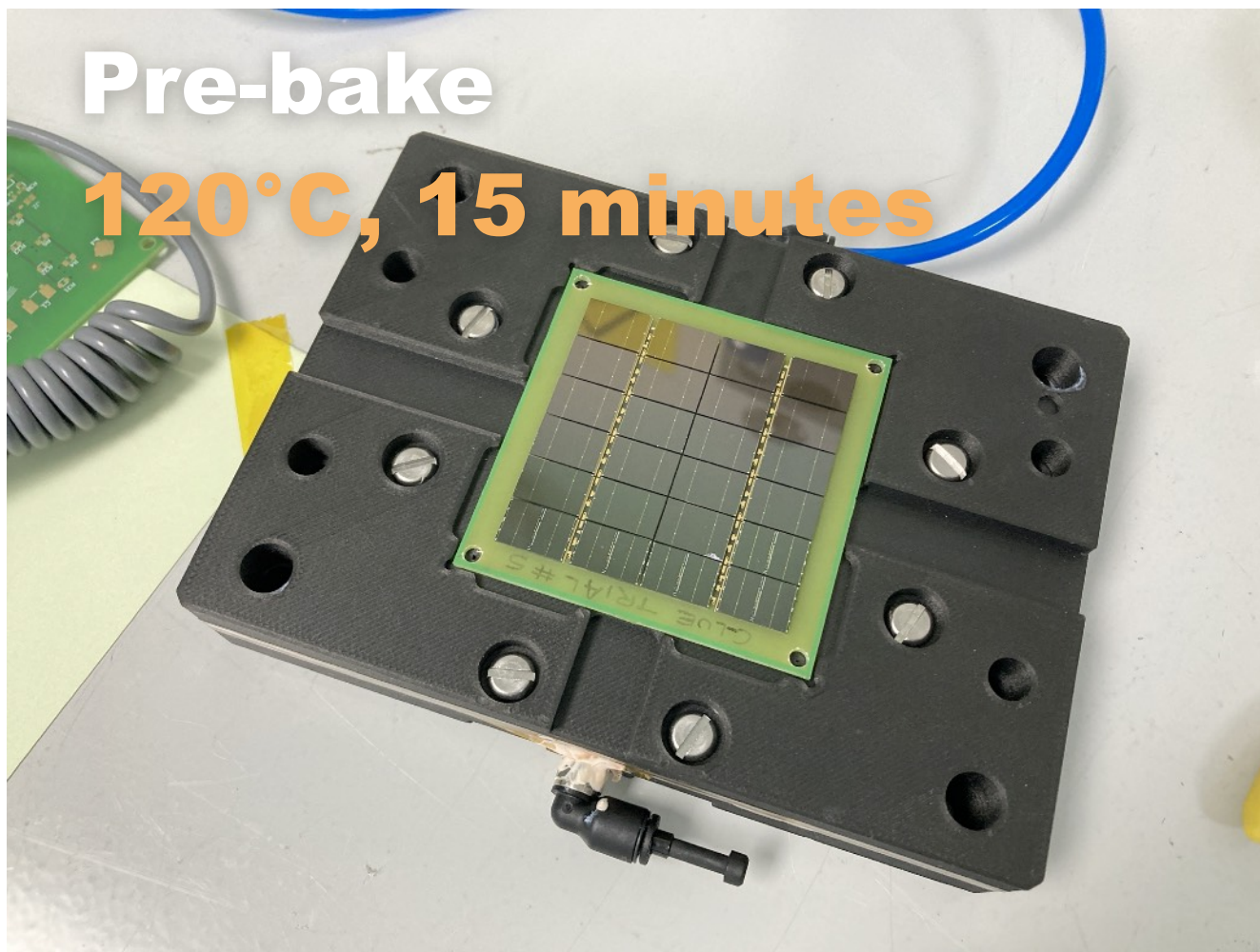
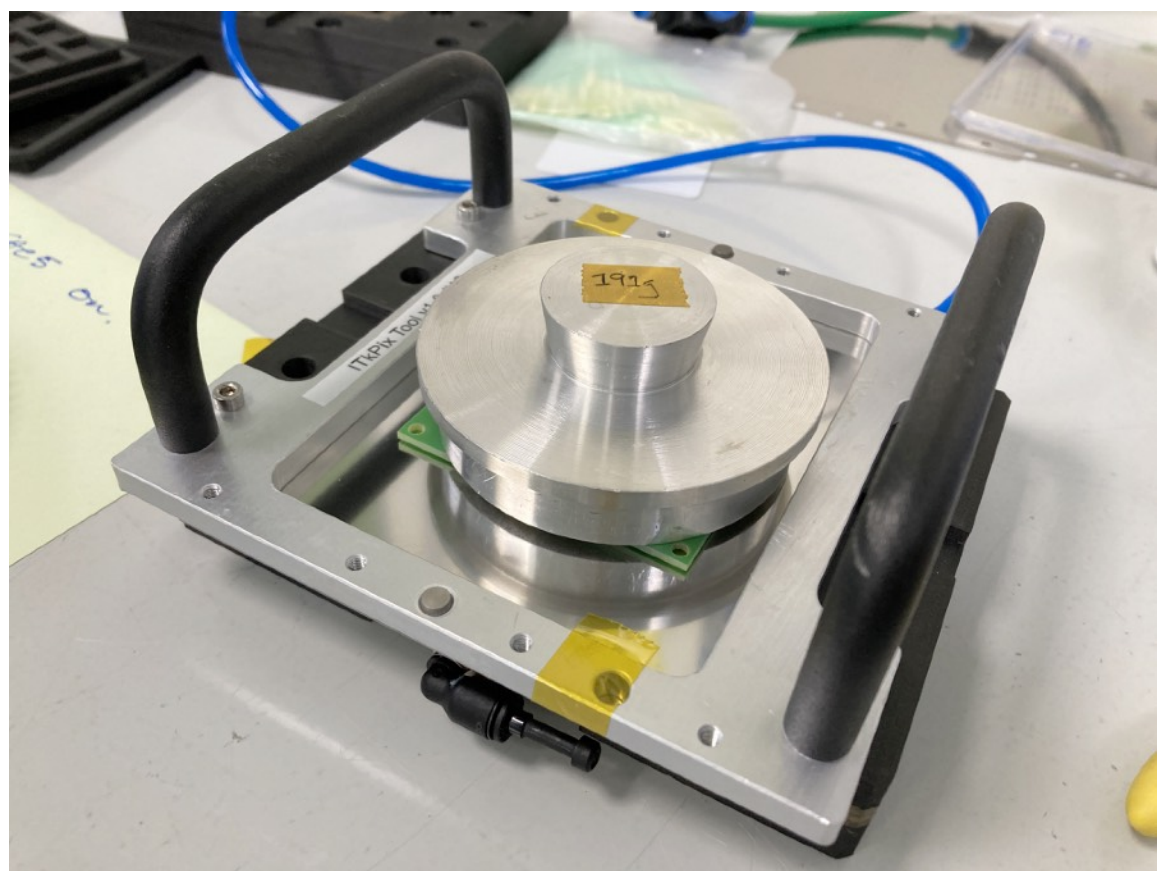
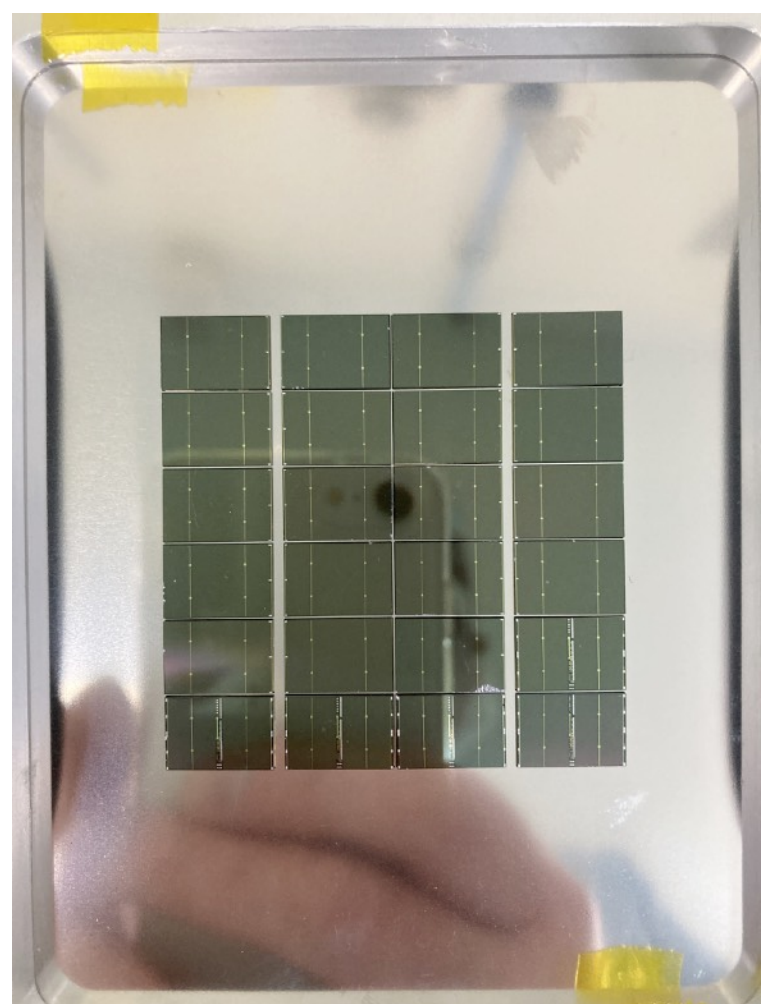
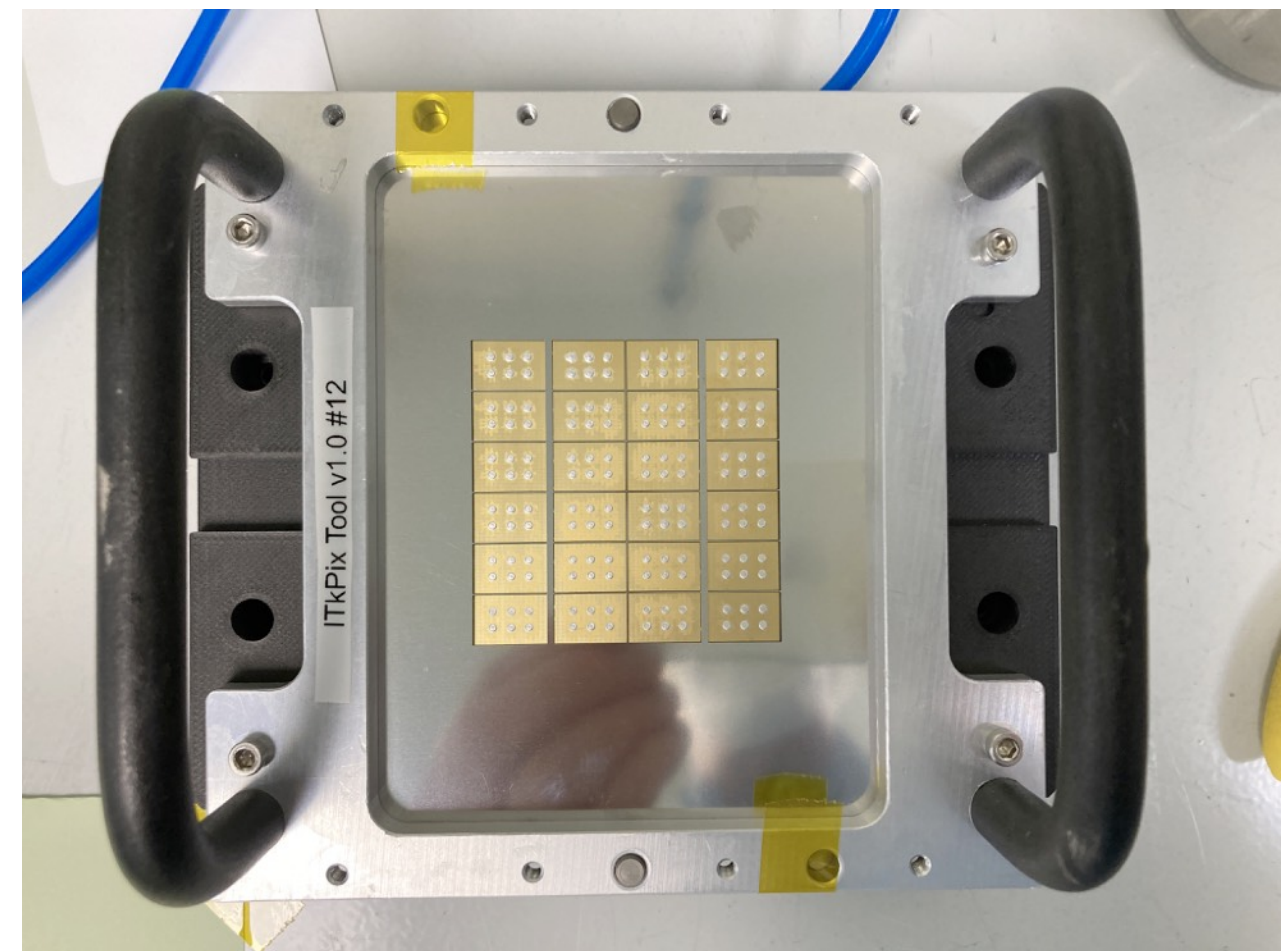
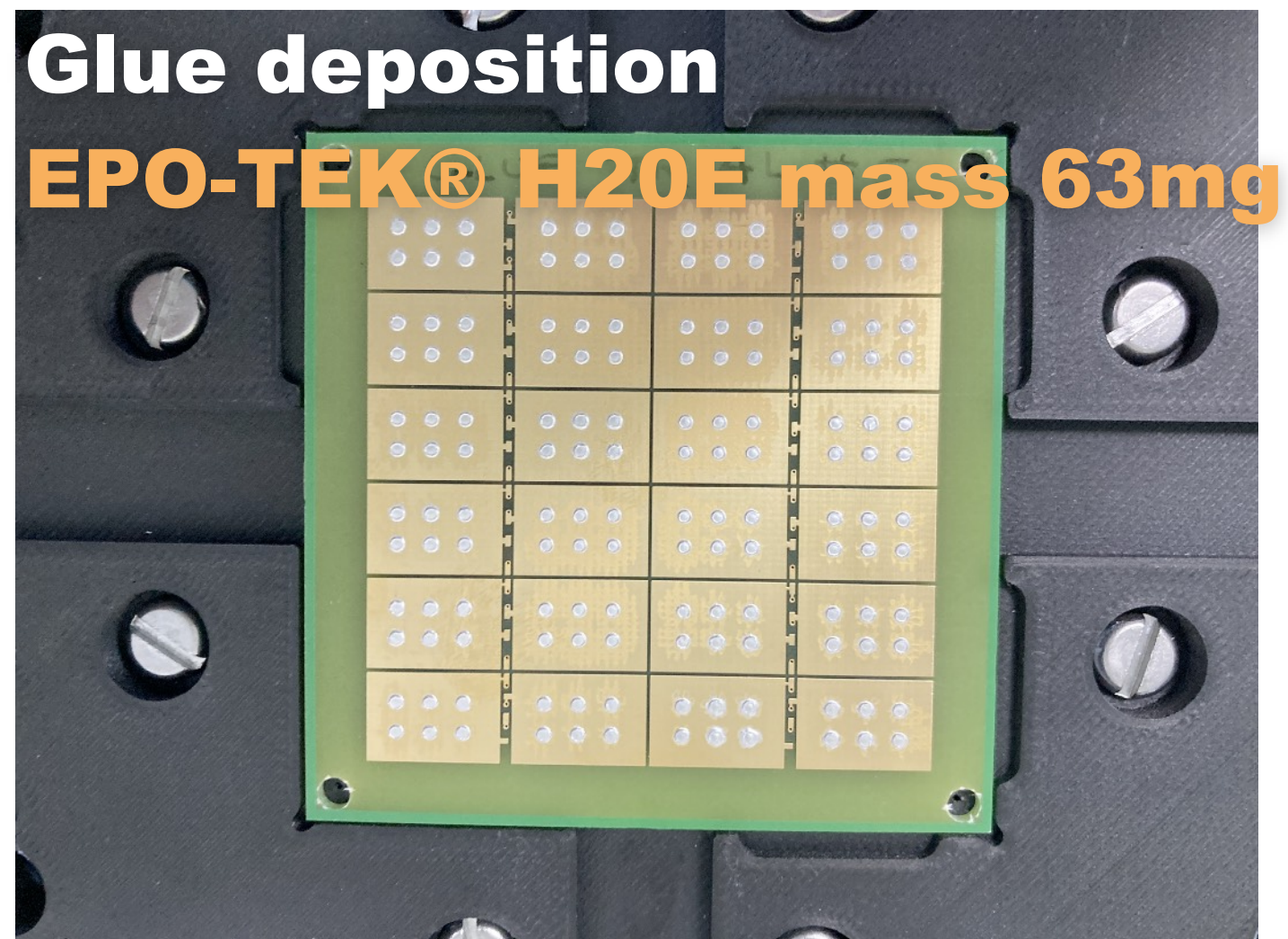
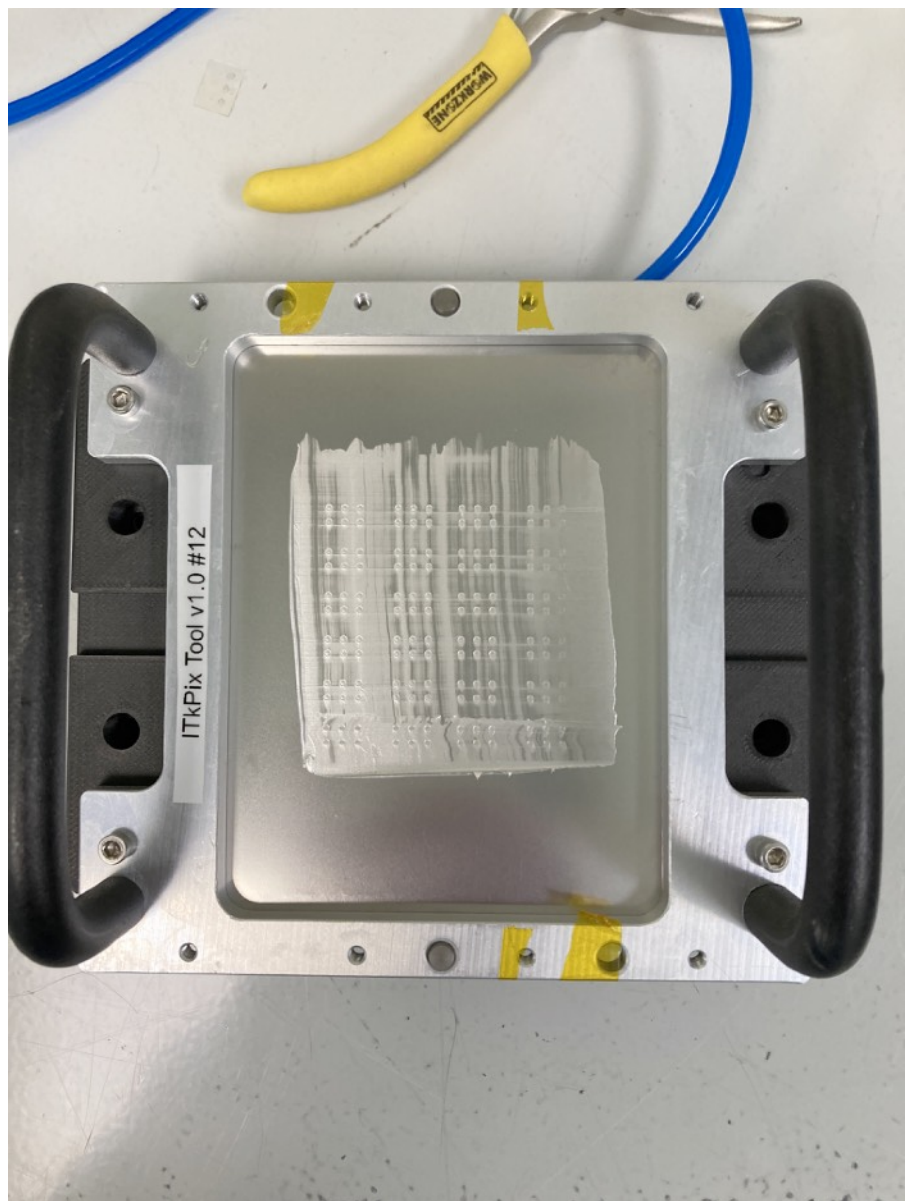
(SW) +RHUL+Lancaster+Edinburgh

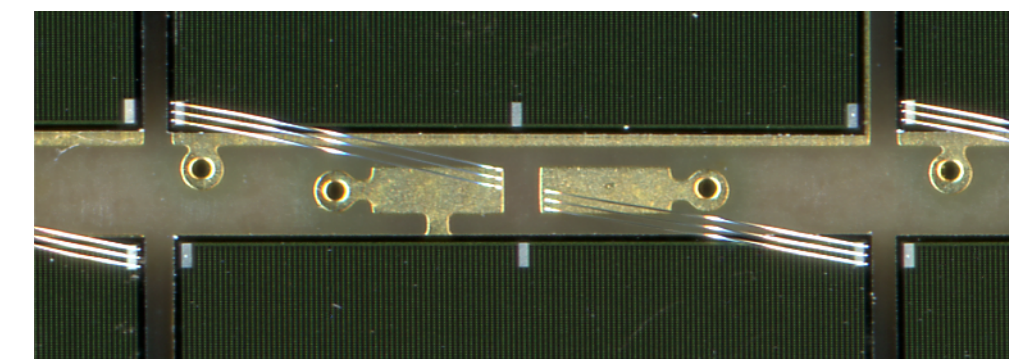
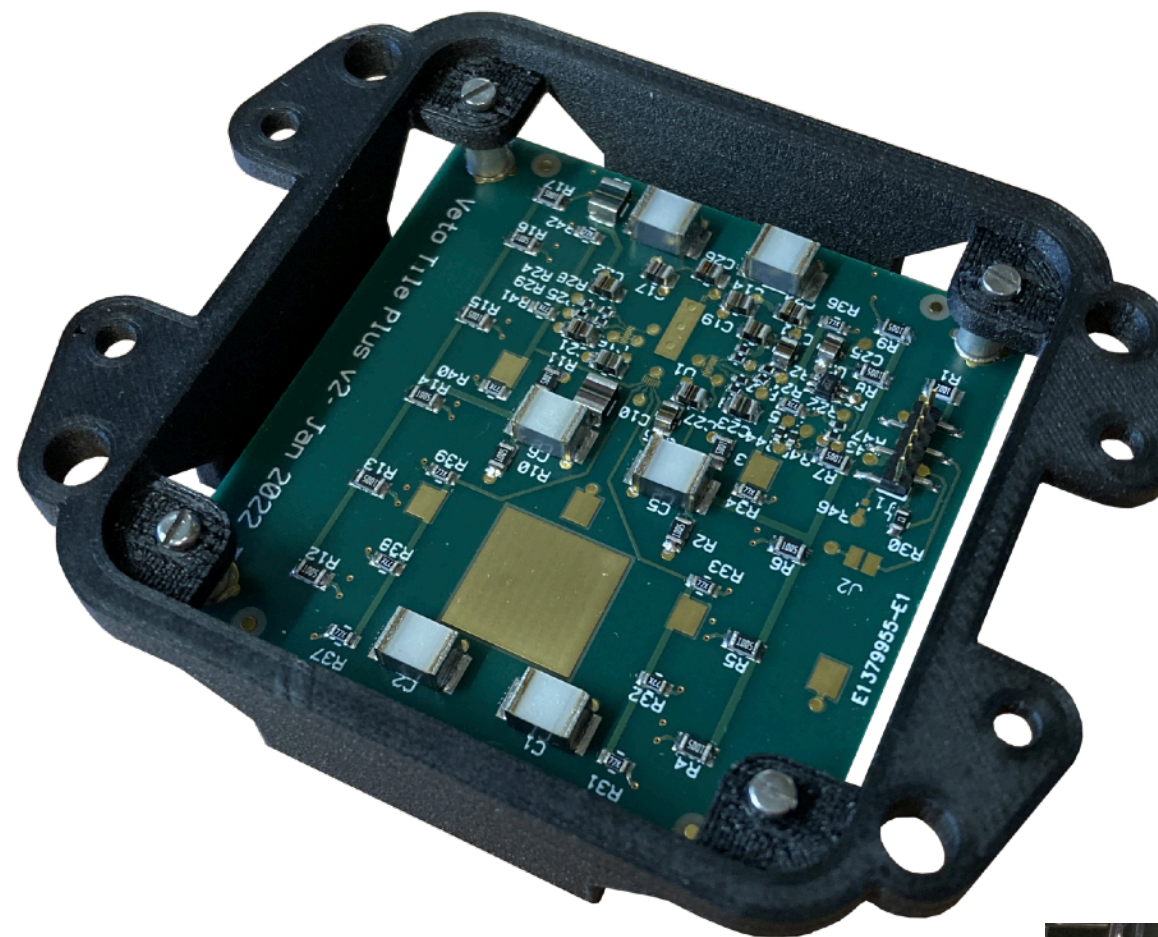
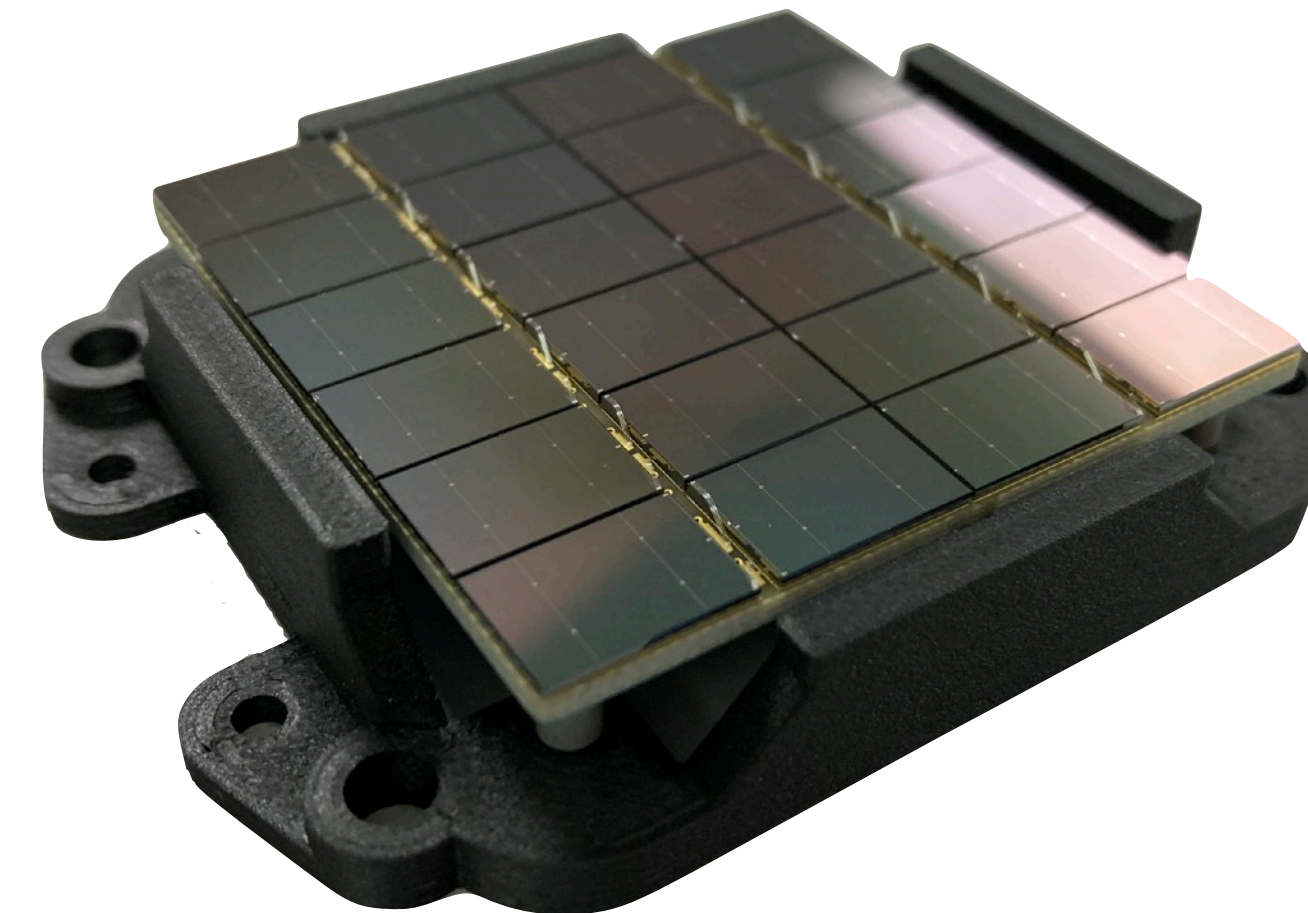
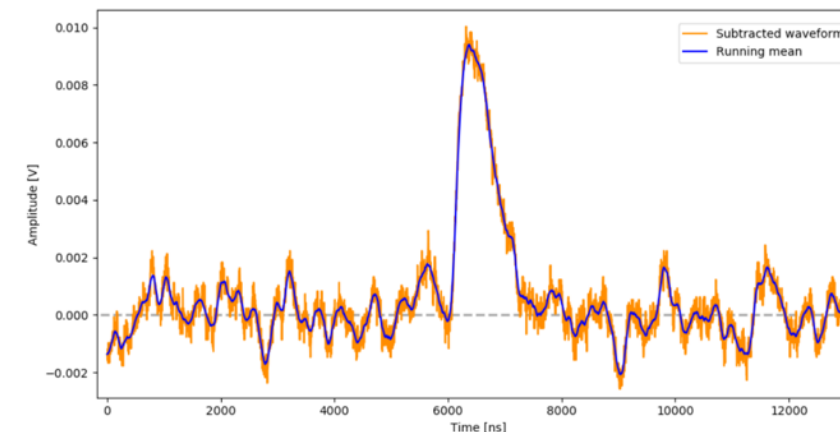
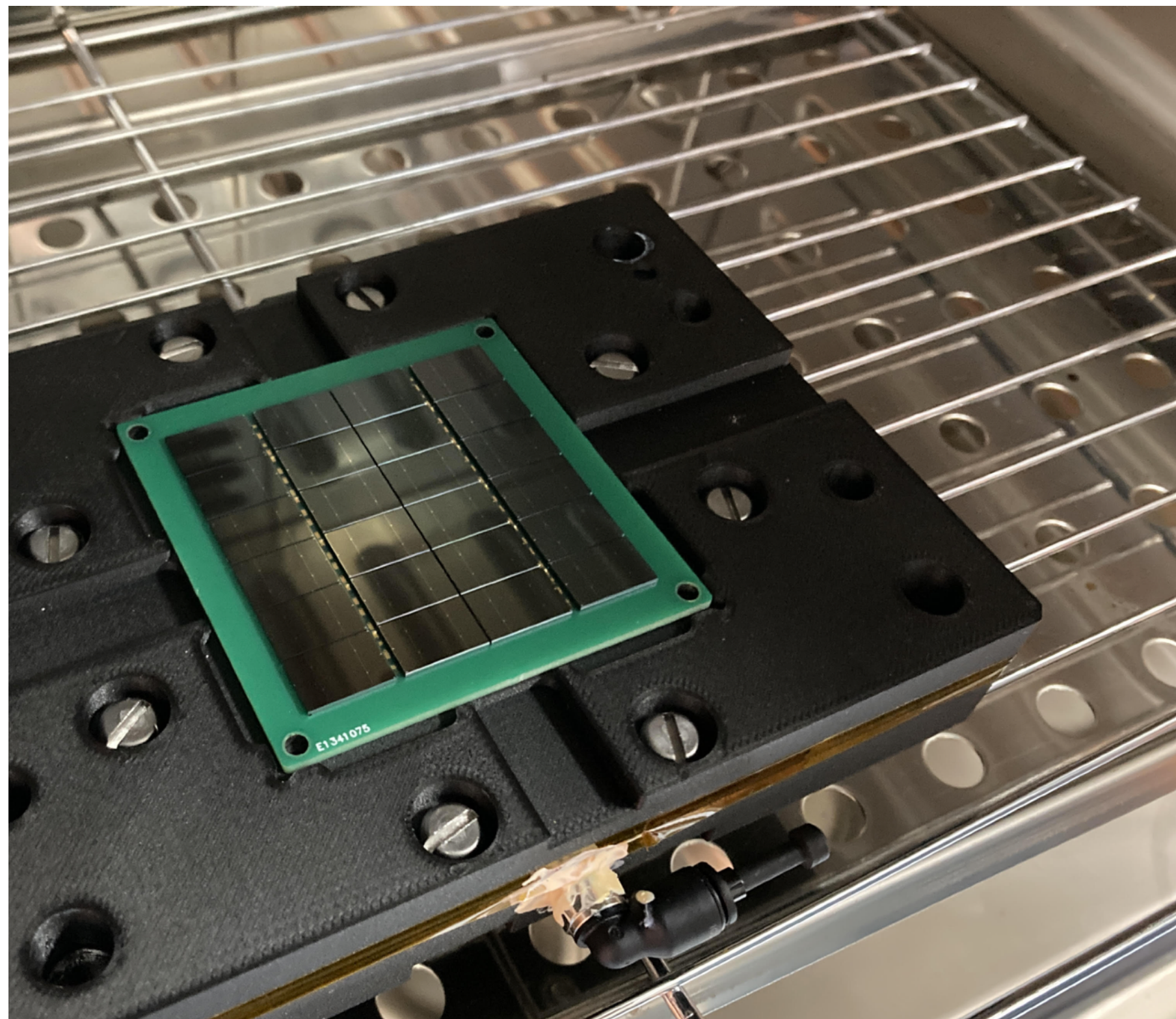
Liverpool



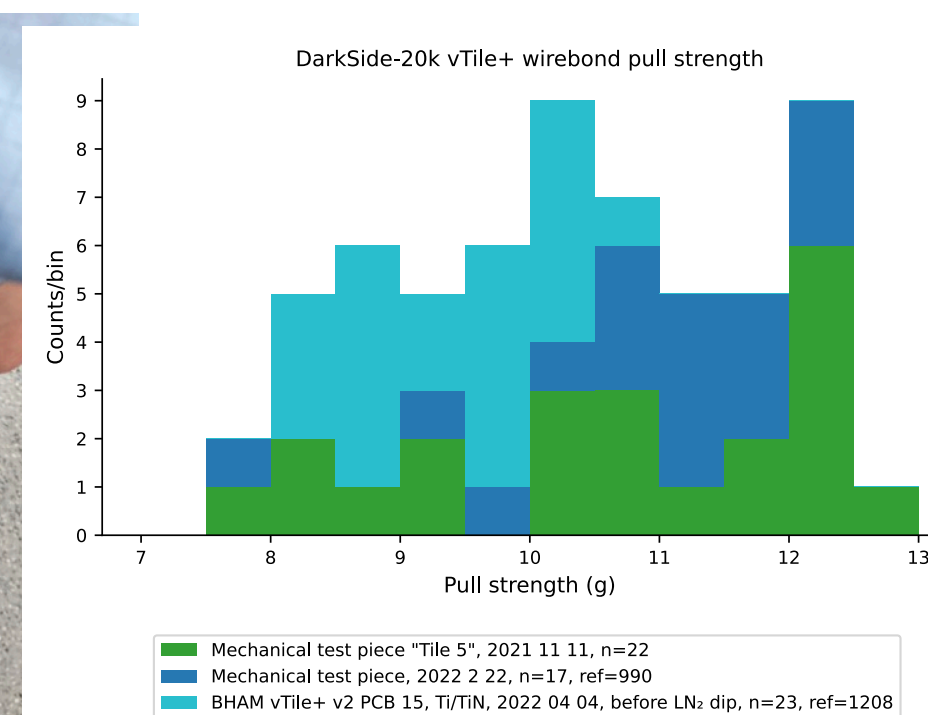


# LSDC vtile+ production flow



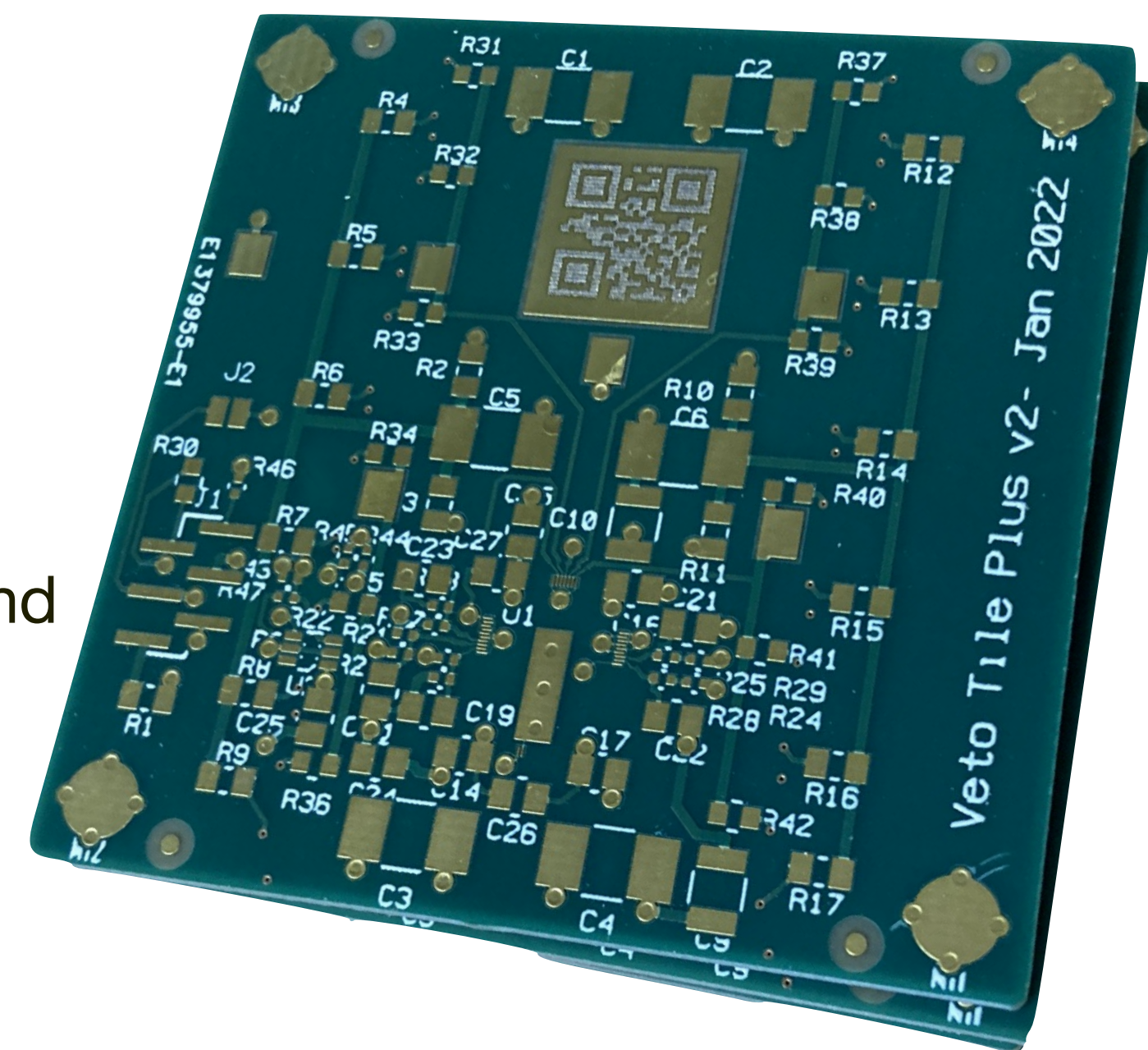
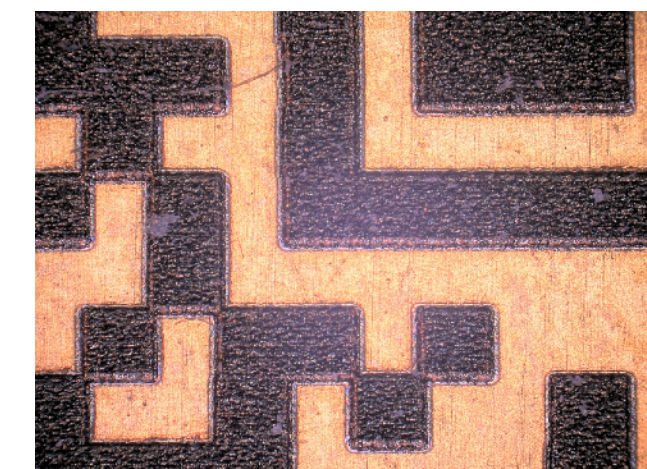


- 3d printed tooling for assembly of veto tiles, curing and wirebonding
- 3d printed bracket for visual inspection, handling and probing of edgeless v2 veto tiles
- Thermal shock tests in LN2 to test mechanical integrity before cryogenic testing
- Tiles manufactured in the LSDC are now tested in RHUL and LGNS

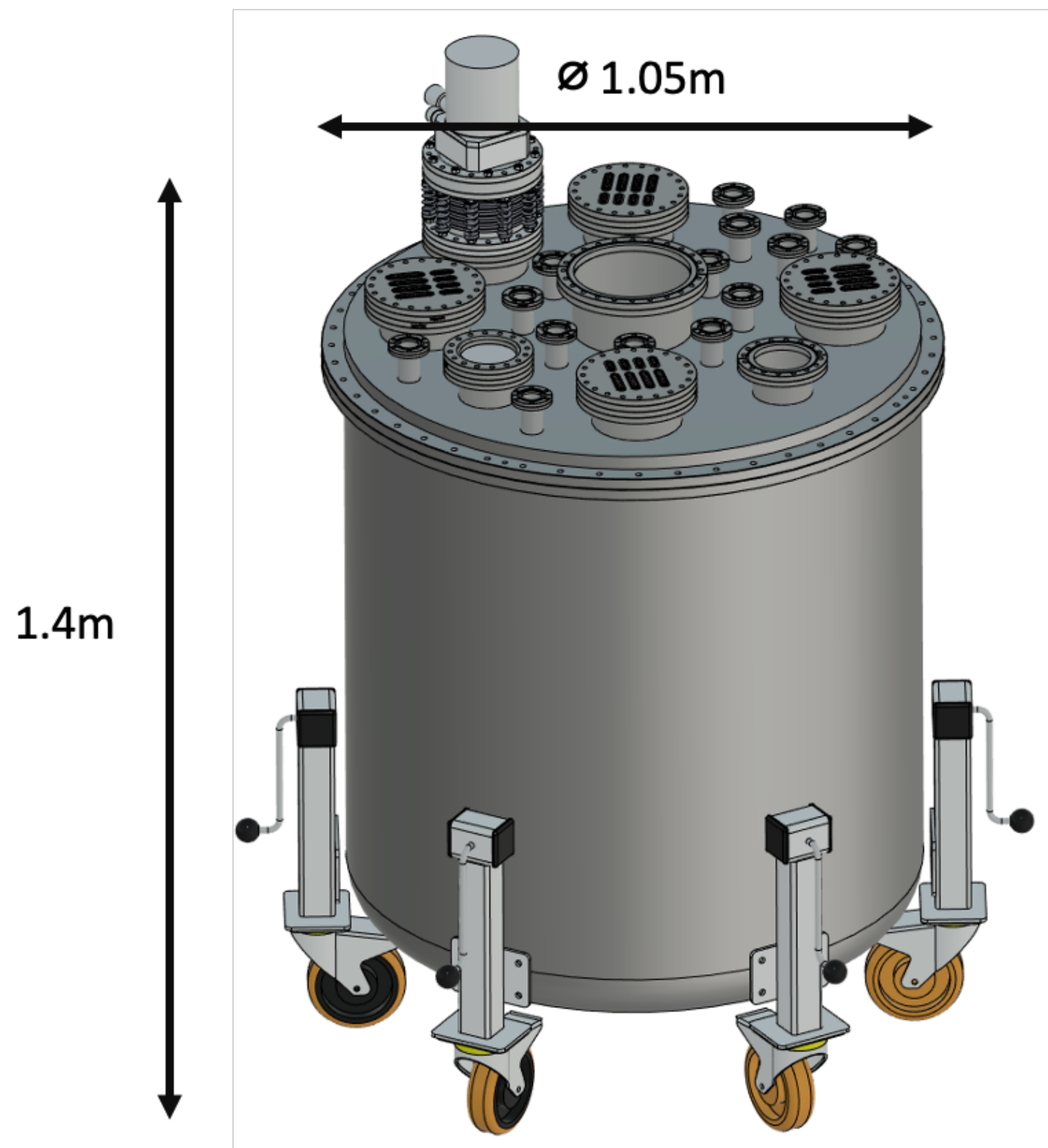




- QR-codes etched using laser engraving in the workshop
- Read-back successfully with a webcam and allows entry and identification in production database
- ElectroX EMS200 laser etcher
  - Around 60s etch time
  - Initial test:
    - Logo block, 90% power, 40kHz
- Automated scripts developed in python by Alan Taylor
  - [qrencode \[2\]](#):
    - creates discrete QR code images
  - [ImageMagick \[3\]](#):
    - creates a correctly size background image
    - performs the tiling operation (offsets from background centre)
  - Result: a composite image with correctly set DPI
    - No further processing required with the EMS200 [4] software







## PHAEDRA - PHoton detection module Assembly cryogEnic DaRkside Apparatus

### Key requirements:

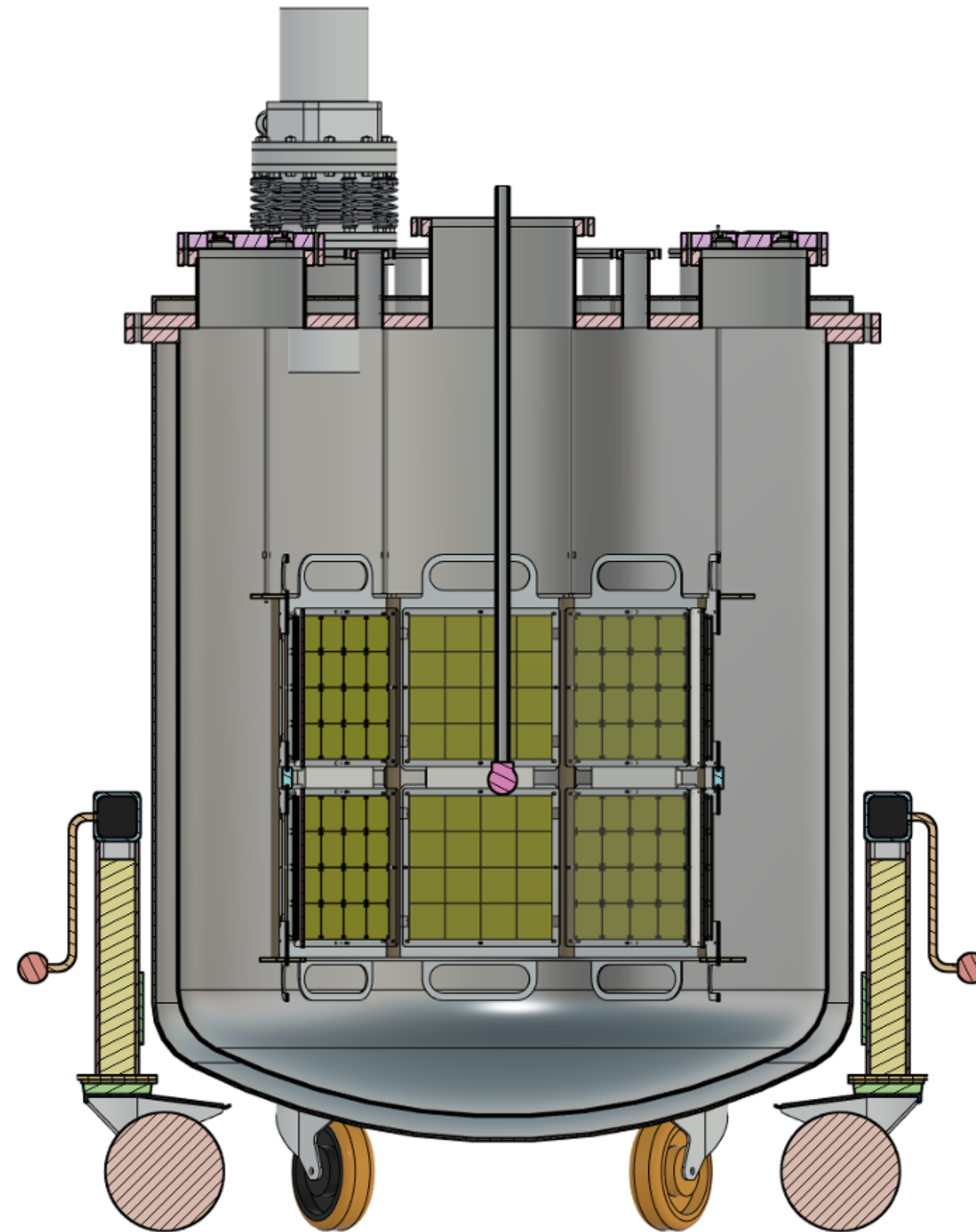
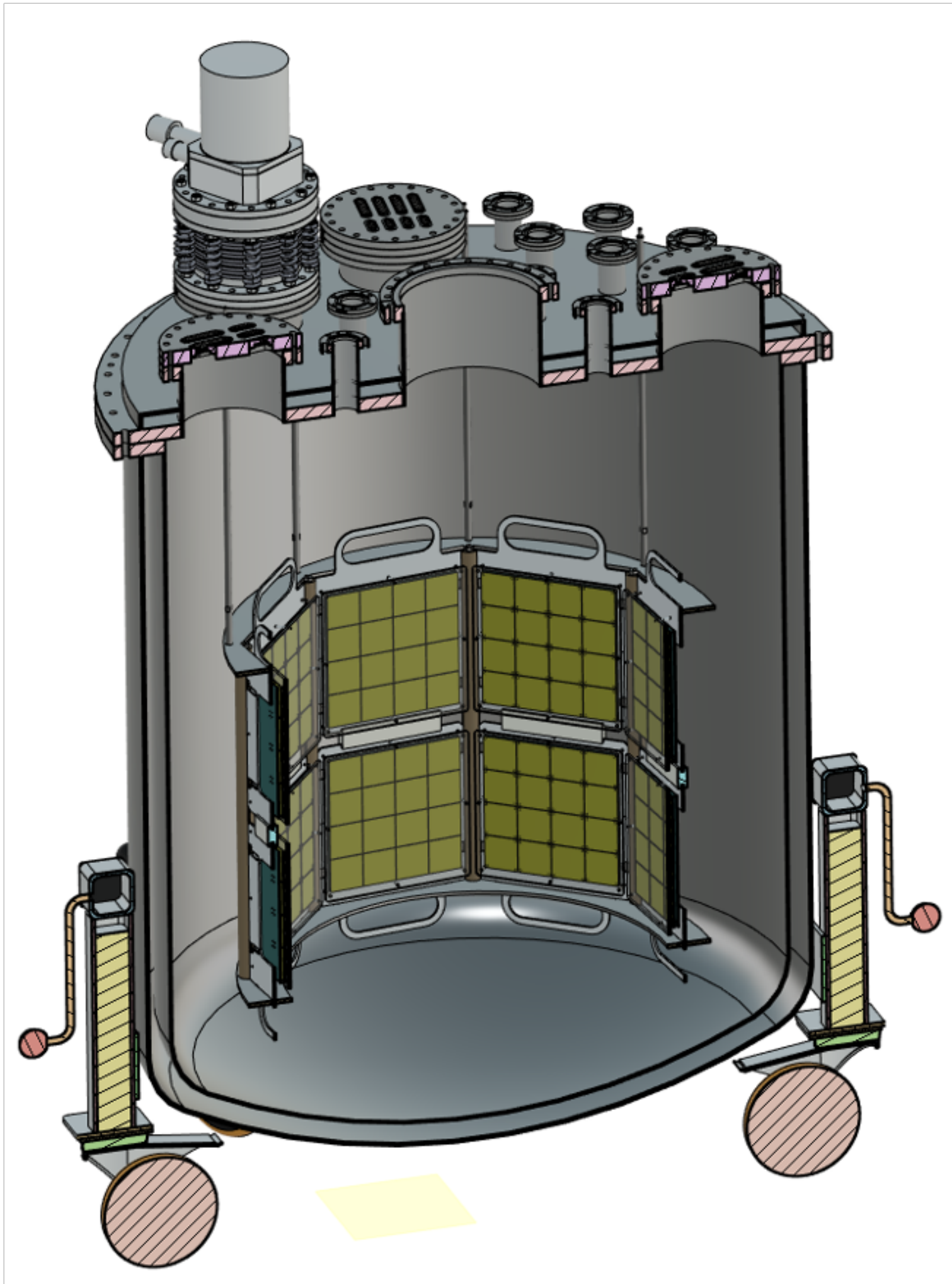
- Testing of PDU assemblies in Liquid Nitrogen (IV Curves, Noise spectrum, Response)
- Integration of optical calibration system to test PDU response

### Cryostat design summary:

- Vacuum jacketed
- O-ring sealed top flange for ease of open/closing.
- Low height to allow open/closing with overhead crane.
- Four differential readout flanges on DN160CF, supporting to up 16 motherboards per cooldown.
- Central DN200CF port for optical calibration system.

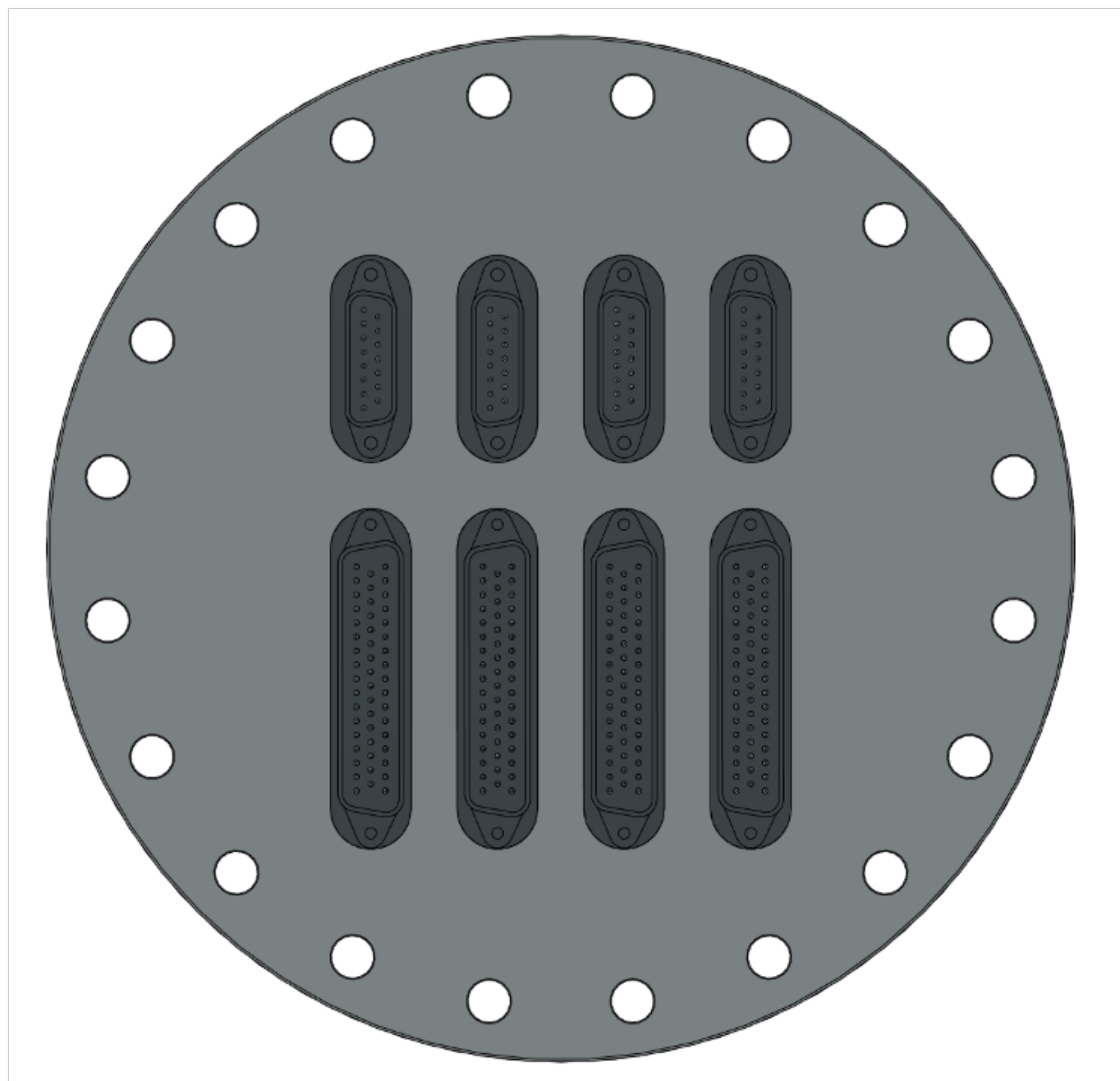


# Liverpool cryogenic testing



Two octagonal rows, each with eight PDU carriers.

Optical diffuser / calibration system installed at center of PDU ring



Differential readout flange with  
1x D50 and 1x D15 per PDU carrier (65 pins total)

Cost quoted at £3000 per flange.

Contains more pins than necessary but might be a good idea  
for separating power/signal connectors.

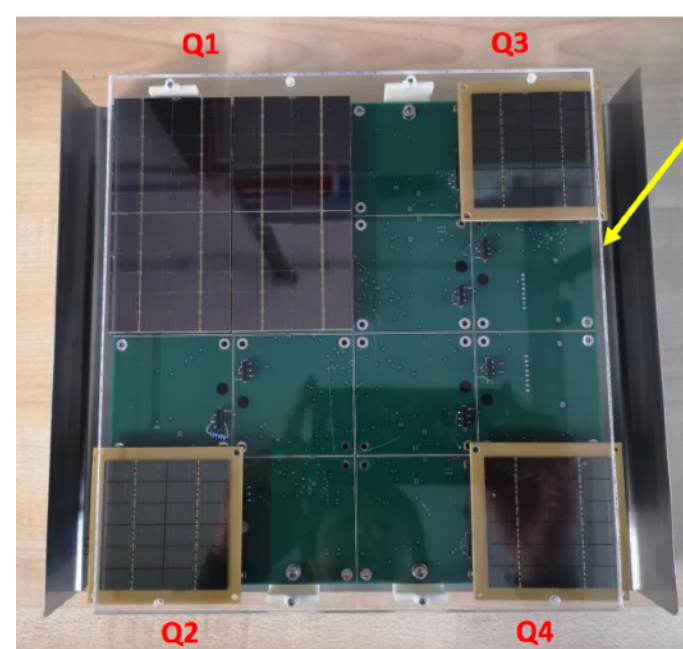
Need to work on finalising pinout and define cable  
terminations.

Find suitable supplier to purchase premade custom cables?  
Buy crimp tool to have capability to build cables inhouse?



- Liverpool has successfully completed the R&D needed to assemble working SiPM tiles (vtile+ ) for the darkside-20k veto
- Design of the cryogenic test stand at Liverpool is complete and procurement of parts is underway
- Exercising of production flow within the UK is ongoing and optimisations are being implemented
- On track for vtile+ production beginning in July this year

PDU populated with UK veto tiles under test in Napoli



Come and join the Darkside!