Cubism - Braque’s Bottle and Fishes, Paris c.1910-12

Instrumentation and control for ND modules

DEEP UNDERGROUND NEUTRINO EXPERIMENT

ArgonCube Engineering call
October 23rd 2020
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LAr monitor and control

LAr supply to each TPC has to be sufficient to provide cooling and purify the volume.

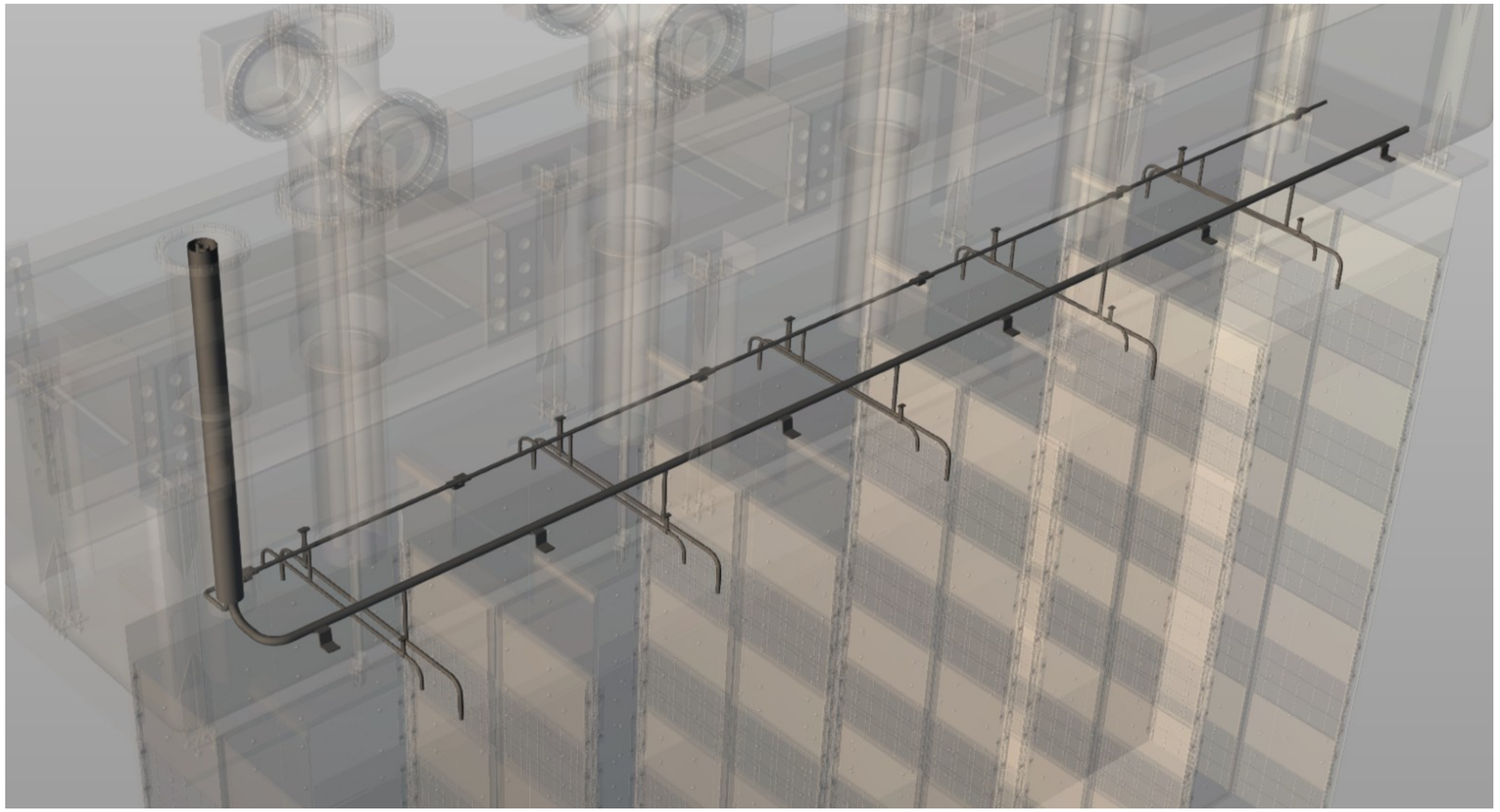
Minimum requirements

Cooling 0.0005 kg/s/module

Purity 0.0097 kg/s/module

0.0485 kg/s/row → 0.3395 kg/s/total (LBNF target 0.8 kg/s)

LAr is supplied via a single inlet line and then distributed evenly to the modules.



LAr monitor and control

LAr mass flow has to be measured at inlet, preferably in warm (no additional feedthroughs).

Question: is LBNF or consortium providing flow meter?

If consortium, then we should identify the component soon.

Coriolis flowmetres for LNG meet specification. Endress+Hauser Proline Promass F 300 Coriolis flowmeter looks like a good option.

LAr flow in the module

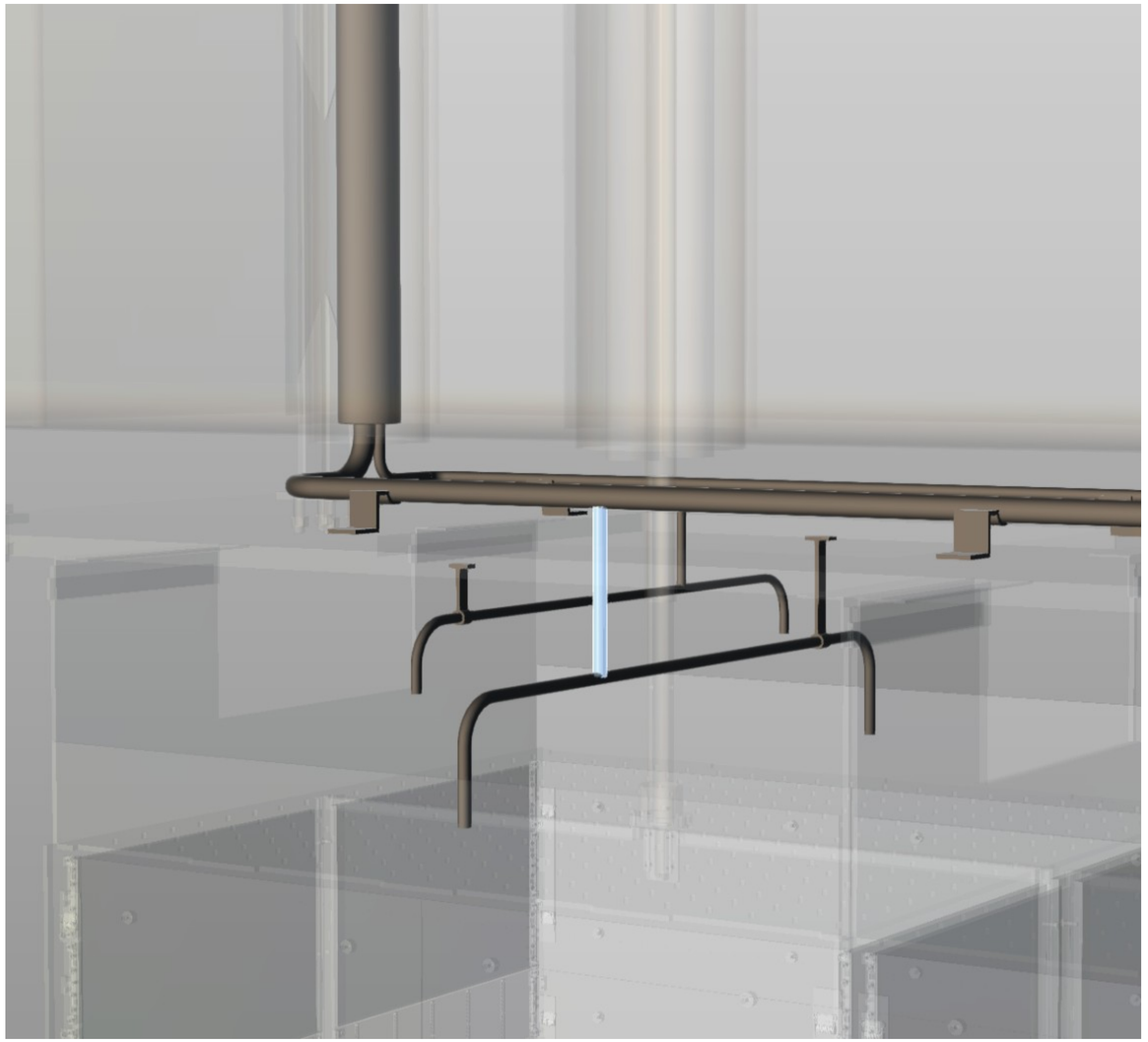
LAr has to throttled at each outlet, to ensure the same mass flow to each TPC.

The throttle should be placed in the line above each module.

The throttle aperture should be determined through simulation/calculation.

Can be as simple as a plate/pipe with a preset bore. Or, adjustable needle/ball valve (disfavoured for calibration).

Diffusers will also. be needed, restriction could be applied there



Module instrumentation

PT100s and lots of them!

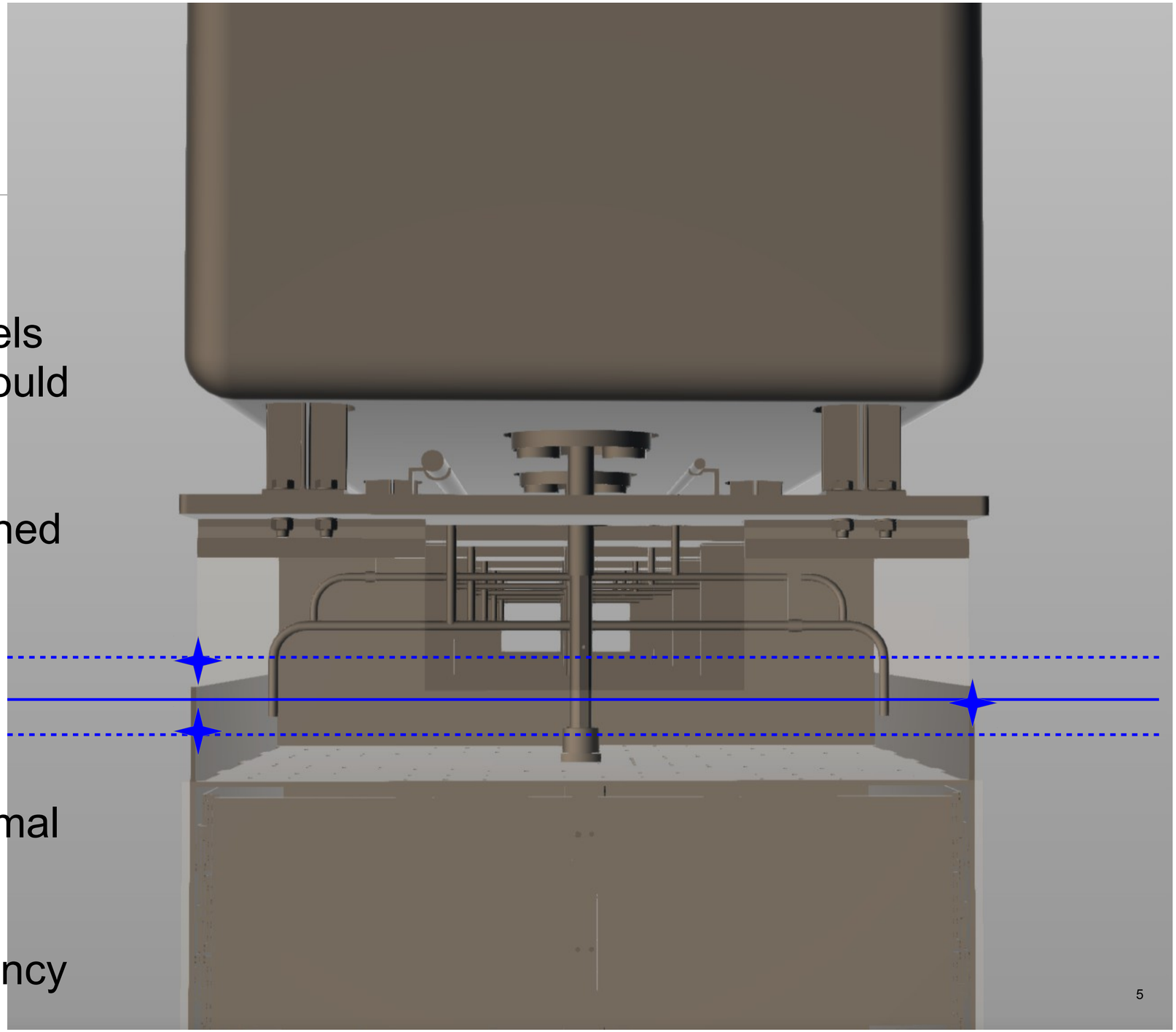
Above the module we define 3 levels of interest where temp sensors should be mounted

1 – optimal LAr level (determined by simulation)

2 – safe lower limit
(set by HV feedthrough)

3 – in the gas, just above optimal level

Sensors on both sides for redundancy



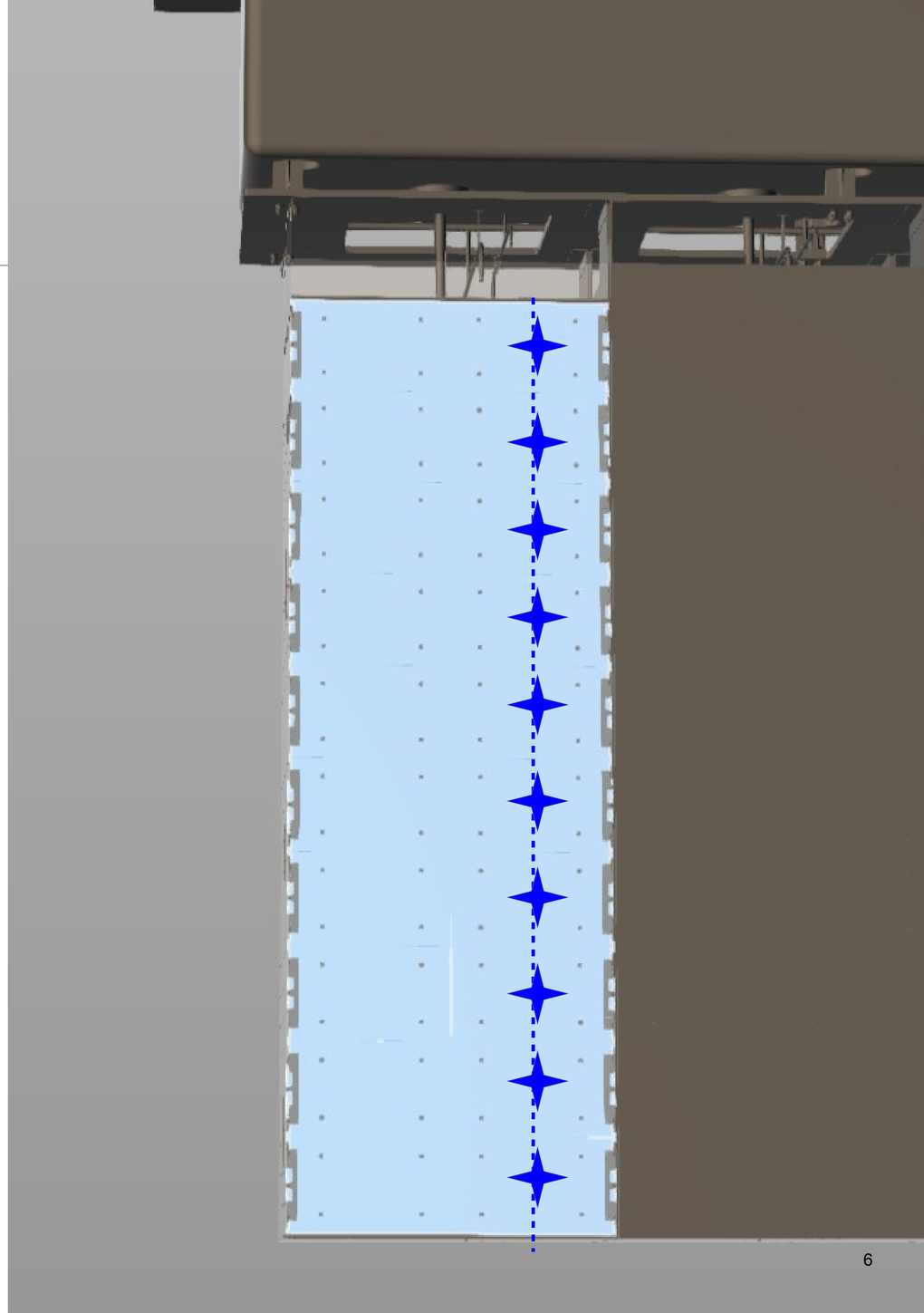
Module instrumentation

In addition to the sensors above the TPC, we will mount sensors running vertically in the volume next to the ASICs.

During normal operation - monitors selected ASICs and flow.

During filling/draining – monitor liquid level provide feed back for temp gradient control.

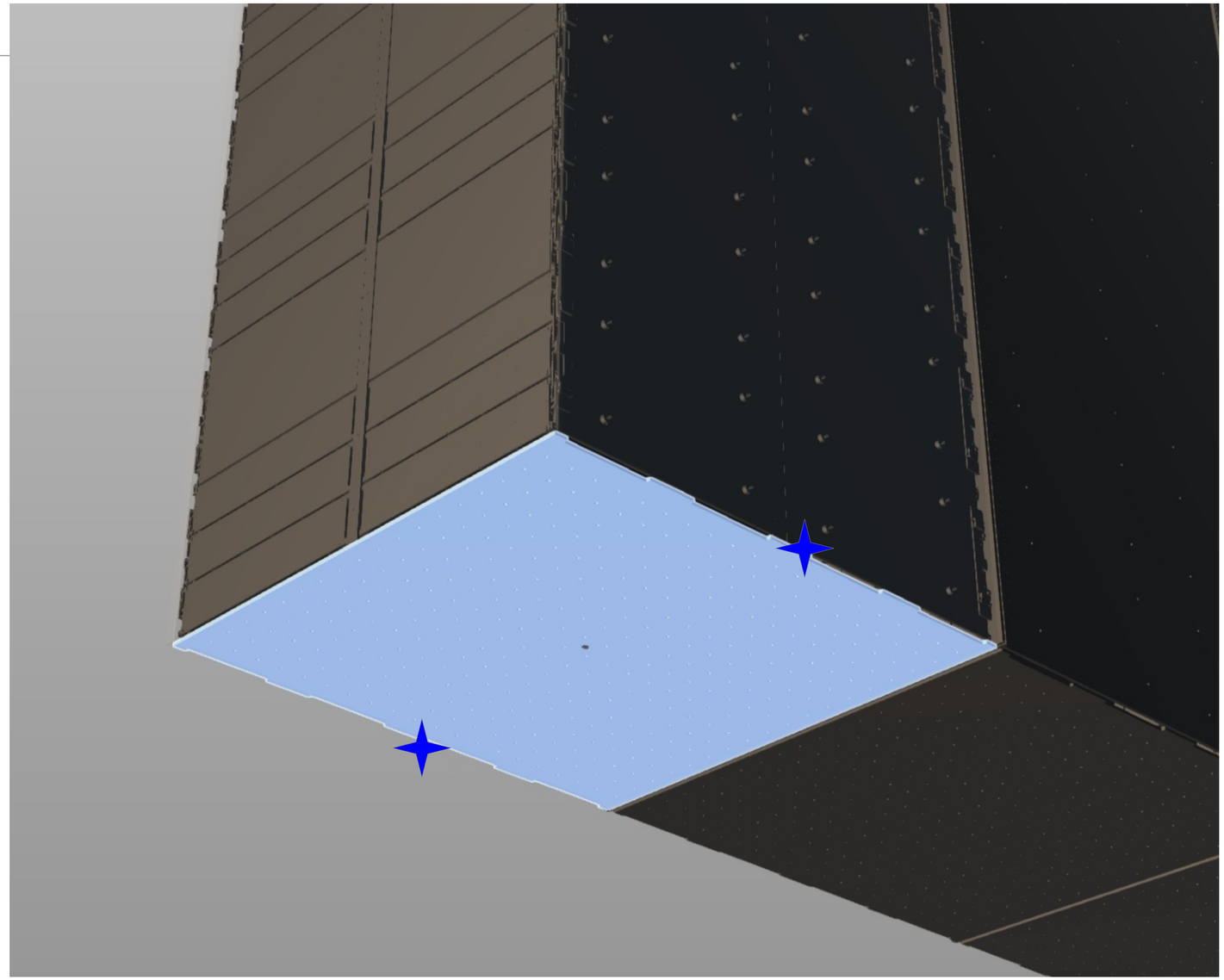
10 sensors per anode plane, 1 for every 2 pixel tiles. At both anodes for redundancy



Module instrumentation

Also 2 sensors at the base of each TPC.

These are important when filling, and useful for monitor heat input.

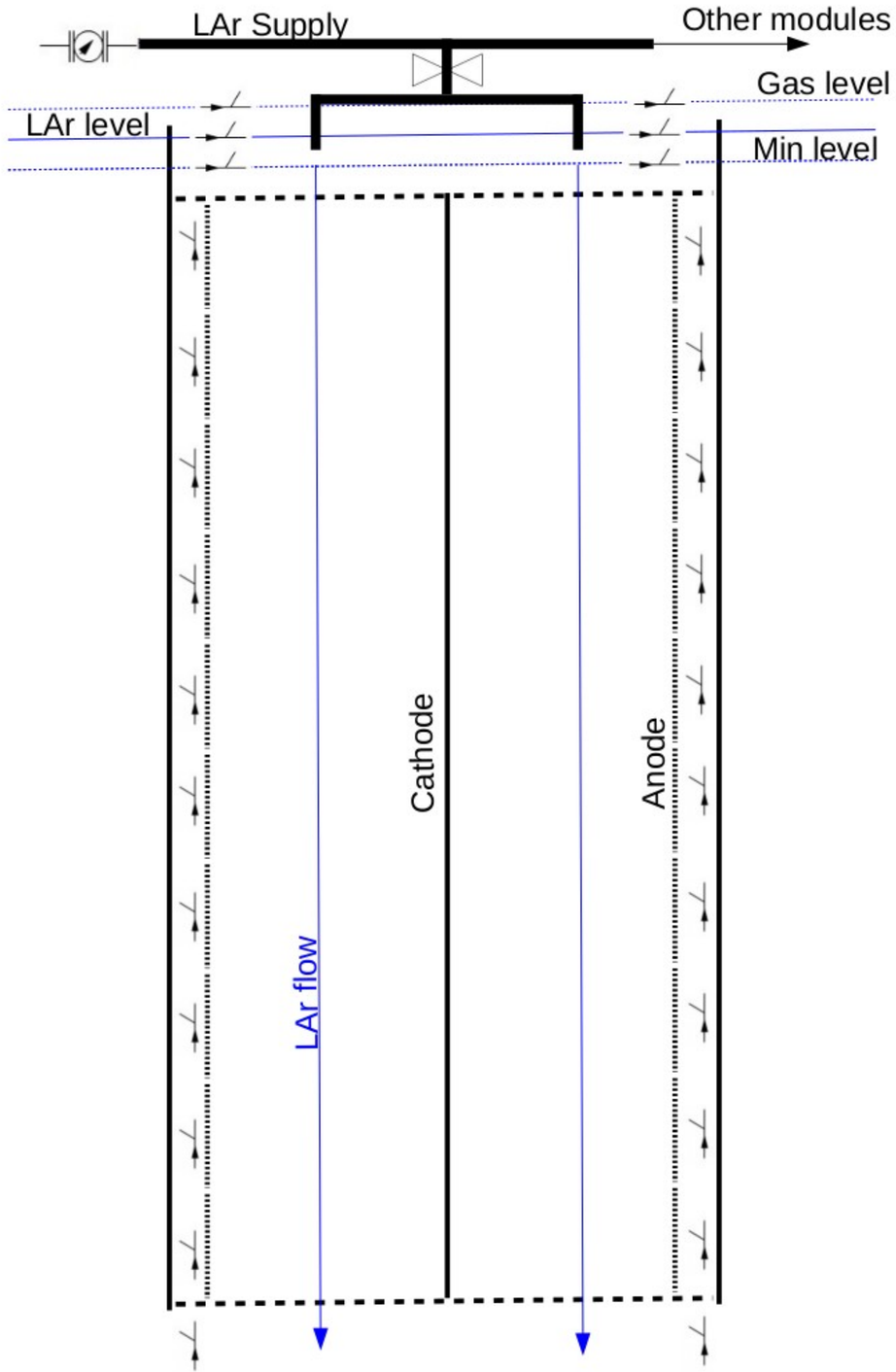


Module instrumentation & control

28 PT100 sensors in total: 6 above the TPC, 20 along the anode, and 2 at the base of the TPC.

Flow control valve at the inlet to each module.

Flow meter at the inlet to each row.

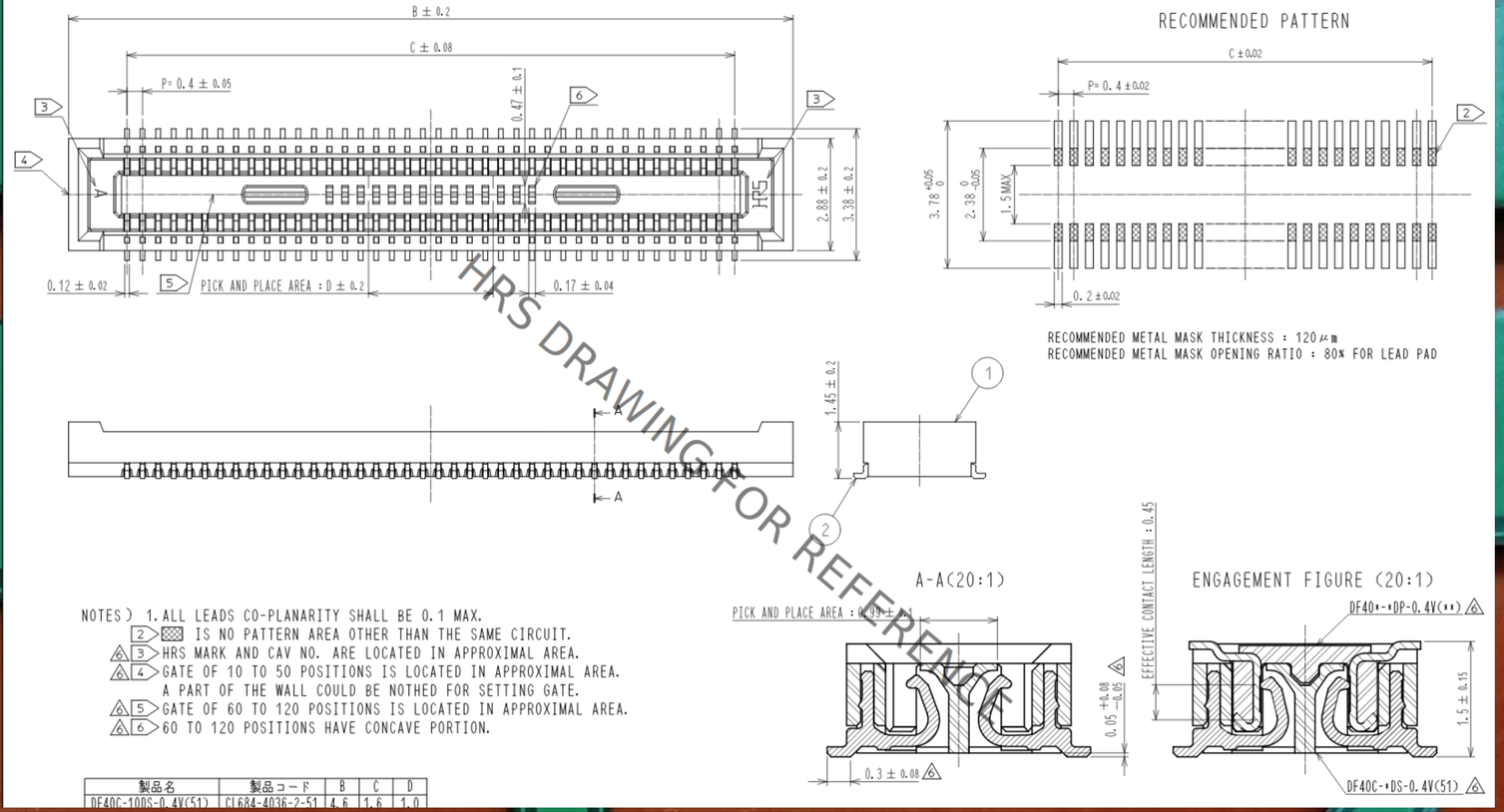


Module instrumentation

Sections of flex would be used to route the PT100s, with PCB-reinforced sections at each sensor.

The sections can be robustly joined with Hirose connectors (as in the ATLAS ITk).

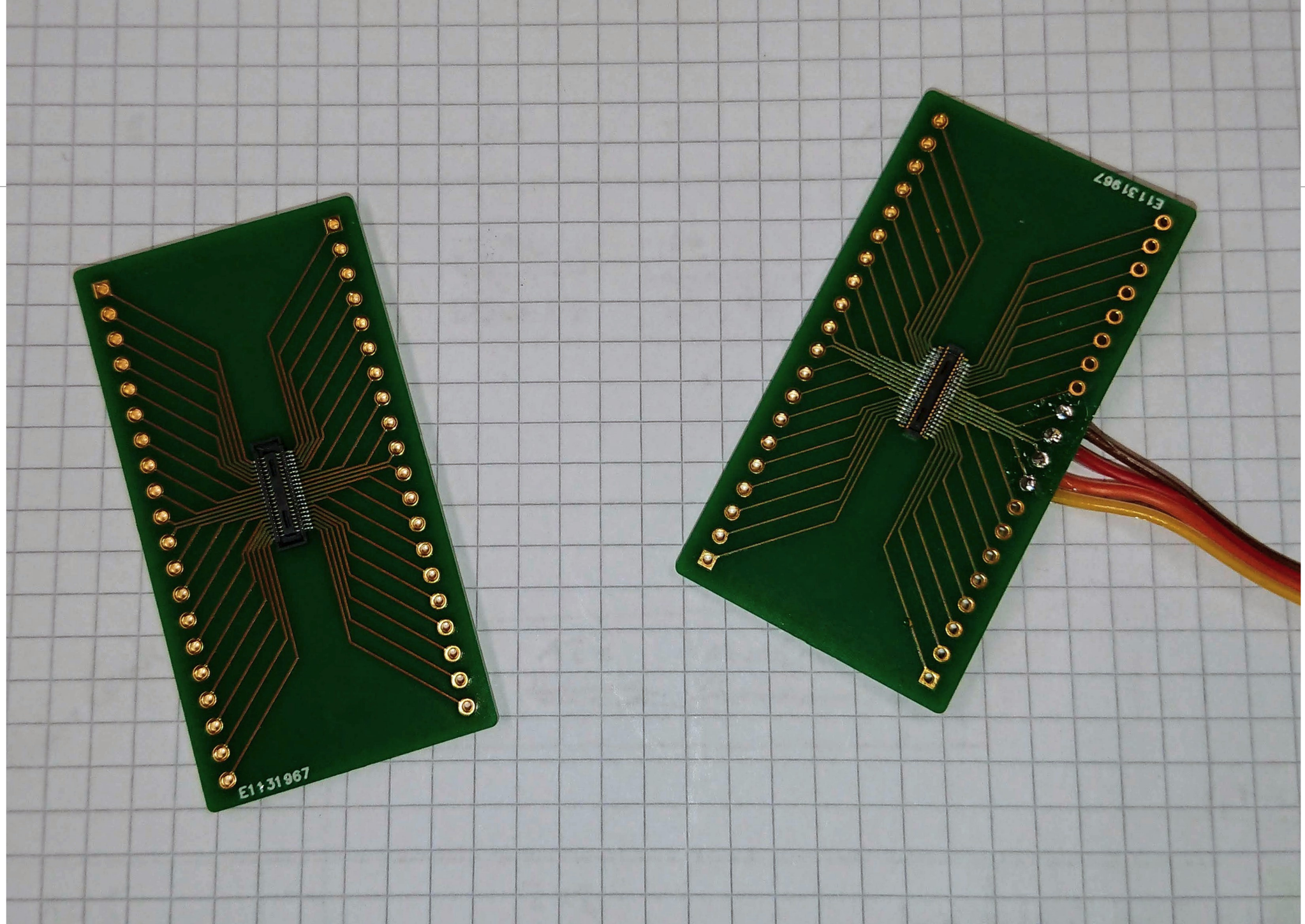
These connector have been shown to be suitable for cryogenic use: tested at 120 V in LN2, with shock cooling and cold disconnect/reconnect.



HRS DRAWING FOR REFERENCE

NOTES) 1. ALL LEADS CO-PLANARITY SHALL BE 0.1 MAX.
2 IS NO PATTERN AREA OTHER THAN THE SAME CIRCUIT.
3 HRS MARK AND CAV NO. ARE LOCATED IN APPROXIMAL AREA.
4 GATE OF 10 TO 50 POSITIONS IS LOCATED IN APPROXIMAL AREA.
A PART OF THE WALL COULD BE NOTHED FOR SETTING GATE.
5 GATE OF 60 TO 120 POSITIONS IS LOCATED IN APPROXIMAL AREA.
6 60 TO 120 POSITIONS HAVE CONCAVE PORTION.

製品名	製品コード	B	C	D
DF40C-100S-0.4V(51)	CL684-4036-2-51	4.6	1.6	1.0


E131967
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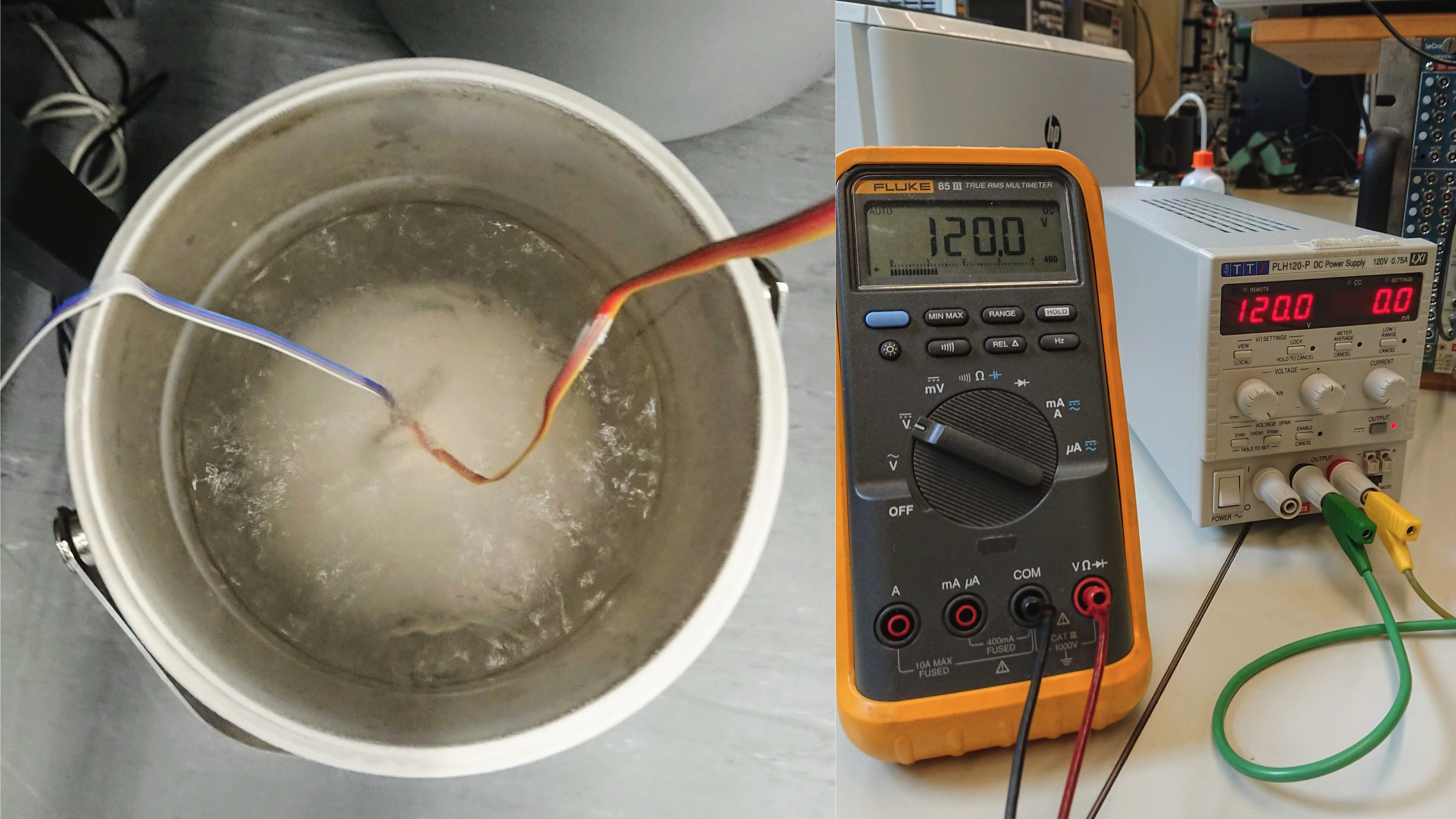
FLUKE 85 III TRUE RMS MULTIMETER
AUTO
120.0
V
MIN MAX
RANGE
HOLD
REL Δ
Hz
mV
mA
A
V
μA
OFF
A
mA μA
COM
V Ω
10A MAX
FUSED
400mA
FUSED
CAT III
1000V
TTi PLH120-P DC Power Supply 120V 0.75A LXI
REMOTE
CC
SETTINGS
120.0
V
0.0
mA
V/I SETTINGS
VIEW
(LOCAL)
LOCK
HOLD TO CANCEL
METER AVERAGE
CANCEL
LOW I RANGE
CANCEL
VOLTAGE
CURRENT
Vmin
VOLTAGE SPAN
Vmin (VIEW) Vmax
HOLD TO SET
ENABLE
CANCEL
OUTPUT
OUTPUT
REMOTE
POWER