

DArT electronics

Current status

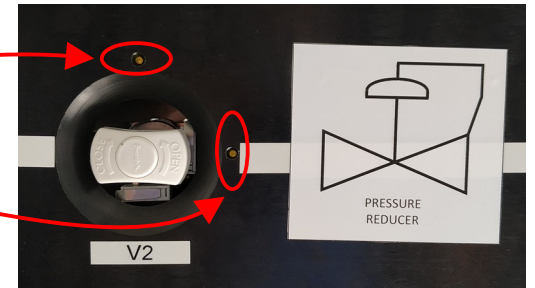
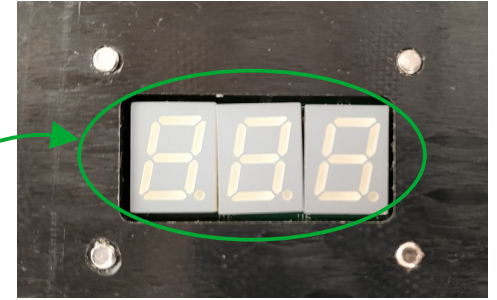
José-Manuel Cela (Ciemat) / April 21th, 2022

Topics

- Control electronics. Functionalities.
- Level and temperature sensors.
- Drivers.
- Control electronics. Pending tasks.
- Slow control support electronics.
- DArT-eyes. Current status.
- Cabling design.
- Cabling issues.
- More pending tasks.

Control electronics. Functionalities

- Internal DArT control measurements:
 - Detect liquid argon **level**.
 - Measure internal **temperature**.
 - During emptying, **heat liquid argon** to reduce vaporization time.
- Main rack front panel:
 - Read gas system manual **valves status** (opened / closed).
 - Show **arbitrary** (3 digits) **messages**.
 - Set valves companion leds states: **on** / **off** / **blinking**.
- Argon recovering condenser:
 - **Measure** liquid nitrogen **temperature** and **level** inside the cryostat.
 - **Keep level** of the liquid nitrogen bath within a programmable range (automatic refilling).
- Gas system parameters:
 - Measure pressures.
 - Measure and control gas flow.

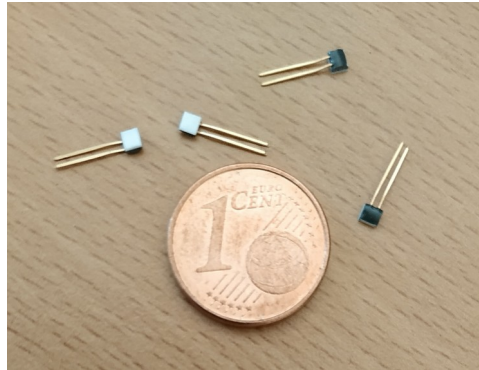


Level and temperature sensors

- Platinum (PT-100) resistors as main sensor for DArT internal measurements. (IST P0K1.202.3FW.B.007)
 - Temperature measurement, level detection or heating: all of them with a single resistor, only changing the current injected on it.
- General control electronics reused from another project.
(“LiquidArLeS” board from “Avolar”: <https://arxiv.org/pdf/2001.05268.pdf>)
 - Multipurpose board.
 - Fast development cycle.

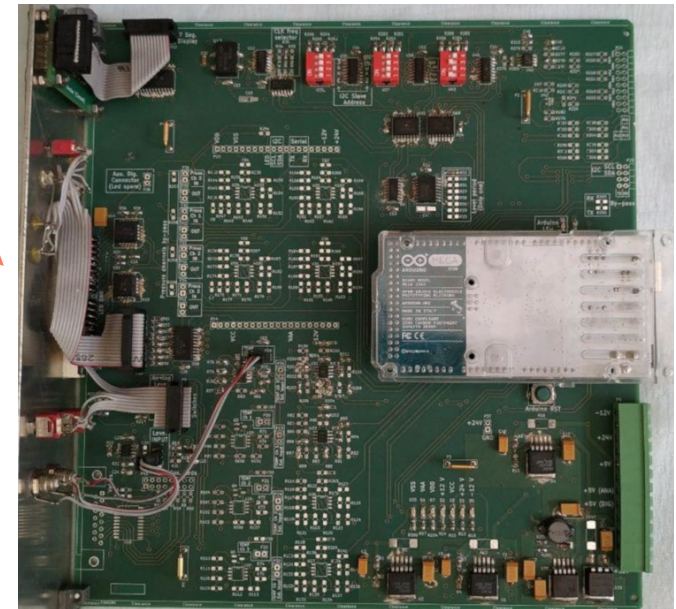
PT-100 advantages

- Low mass.
- Small form factor.
- High temperature range [73 °K, 573 °K].
- Good linear behaviour with temperature, within the design range.



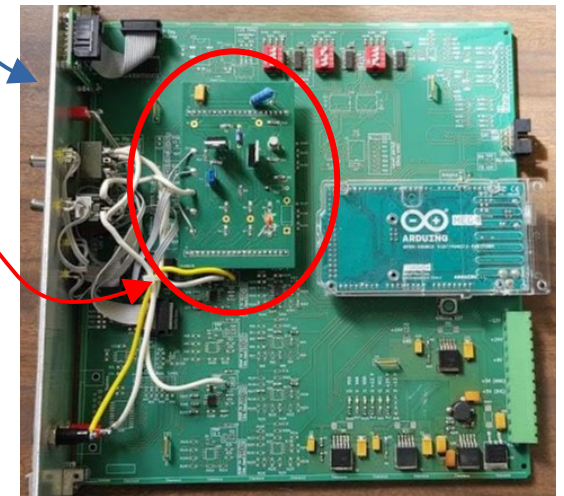
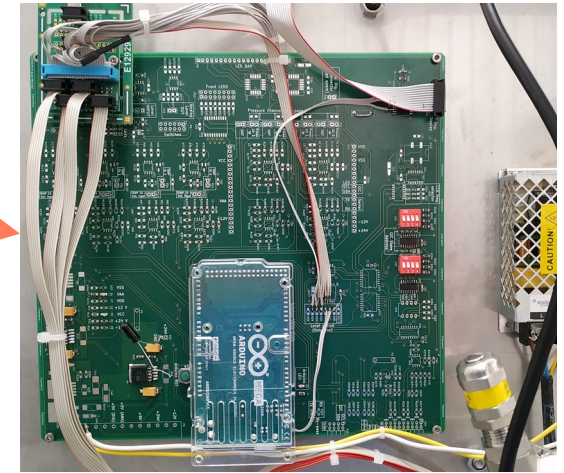
LiquidArLeS board

- 4 temperature measurement channels.
- 4 + 4 generic configurable amplifier channels (pressures / temperatures)
- 1 channel for cryogenic liquid level measurements.
- 7-segments display / leds / led bar for user information on board frontis.
- Control core based on Arduino Mega 2560.
- Extensible by mean of mezzanine boards.
- Eurocard 6-U form factor.



Drivers

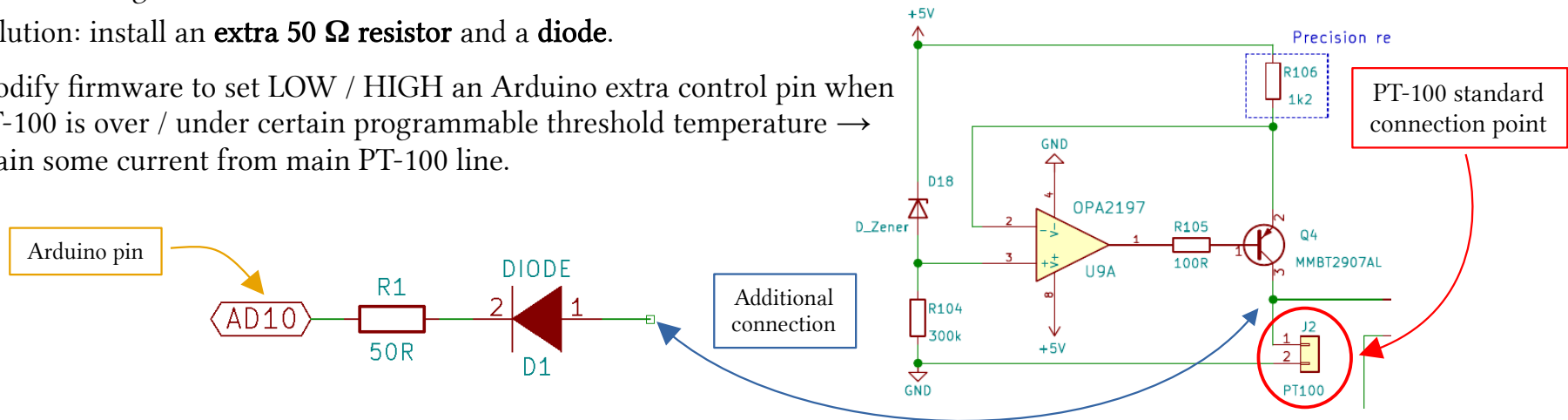
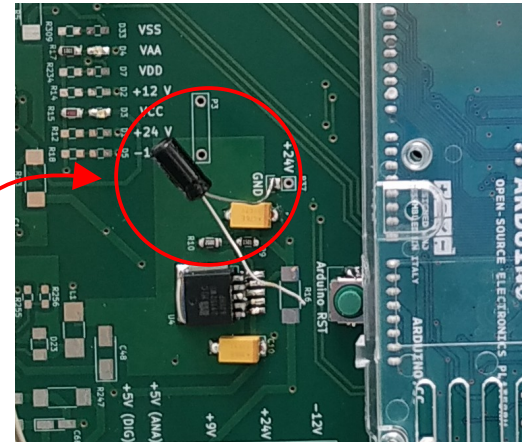
- Developed 1 board for DArT rack front panel control.
- 6 additional boards as PT-100 drivers. (Ciemat technical report #1504: [Electronic driver for DArT platinum resistances](#))
- All of them with an specific “firmware” (Arduino logic) depending on the functionality.



Heater
mezzanine
on RPT
driver board

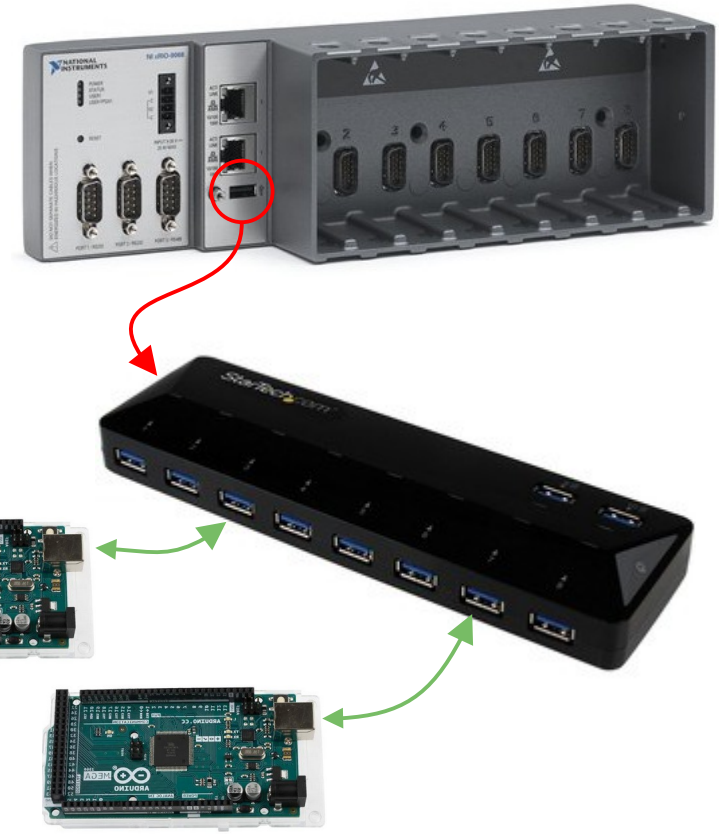
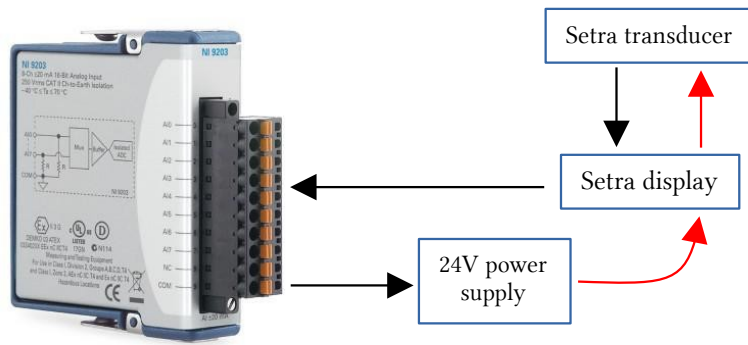
Control electronics. Pending tasks

- **Avoid** Arduino controllers **auto-reset** when an USB connection is opened.
 - Intended behaviour (“by design”) to allow an easy way for controller firmware reprogramming, but it erases any internal board status/information kept by the controller.
 - Solution: add an **external capacitor** to keep RESET line at HIGH level (**10 μF** seems to be enough).
- Modify PT-100 controllers to **avoid dangerous auto-heating**, in level mode, when RPT are under high vacuum.
 - Solution: install an **extra 50 Ω resistor** and a **diode**.
 - Modify firmware to set LOW / HIGH an Arduino extra control pin when PT-100 is over / under certain programmable threshold temperature \rightarrow drain some current from main PT-100 line.



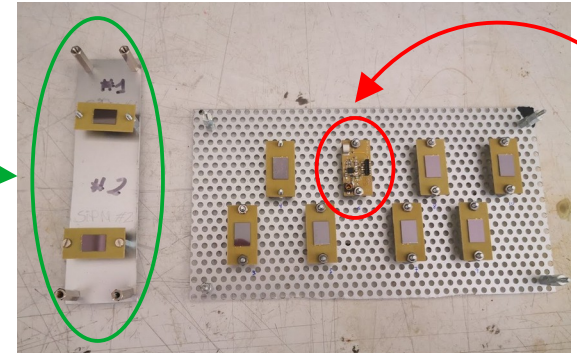
Slow control support electronics

- Installed the **cRIO** “slow” controller and a 10-ports USB hub, in the main control rack.
 - Test basic **communications** between cRIO and different system boards.
 - Verify that cRIO is able to **read front panel** state (valves, leds, ...) and is, also, able to configure any led and user message.
 - Retrieve and check status **information from RPT** driver boards.
- Already installed Setra **pressure sensors**.
 - Test **reading** information from every **sensor**.
 - Verify scaling factors to match information between Setra sensor display and cRIO virtual front panel.
- Installed 2 flow controllers.
- More details in Sara Sullis’ talk.

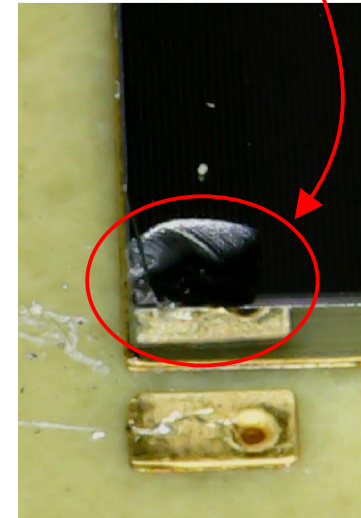


DArT-eyes. Current status

- 10 DArT-eyes were received at Ciemat from LNGS.
 - 2 originally with wire bonding and fully characterized (#1 & #2).
 - 8 without it. Wire bonding done at Ciemat (**single wire**).
 - 1 with severe damages on the silicon after bonding process (#6).
- Characterization under ambient and cryogenic temperatures (#3 to #10): temperature cycling ($300\text{ °K} \leftrightarrow 77\text{ °K}$), I-V curves, determination of the optimal bias voltage ($\sim -31\text{ V}$), dark current measurements, signal measurements with LED pulses.
 - Summarized in Edgar's report:
<https://cernbox.cern.ch/index.php/s/mrJZG2BHzhJHex8> and
presentation: <https://cernbox.cern.ch/index.php/s/HYw5B0AXiiGAVtp>
 - Not all wire bonding resisted temperature cycles. Wires were not long enough to resist contraction at 77 °K .

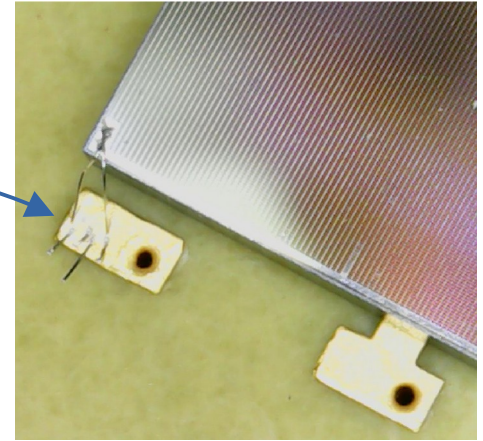


#6

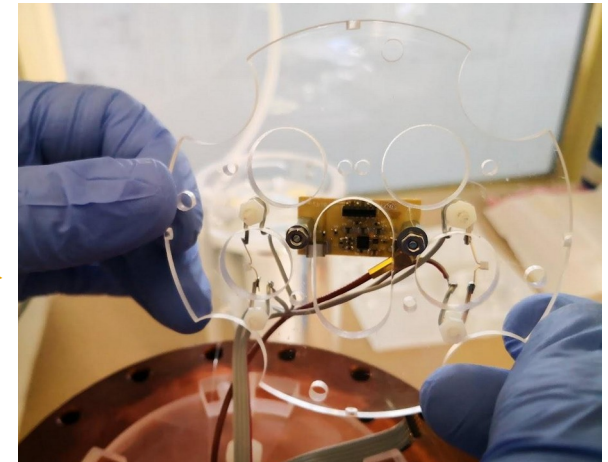


DArT eyes. Current status

- New wire bonding at Universidad de Zaragoza with **double wire**.
 - New temperature cycling → Wire bonding resists.
 - Summarized in Edgar's spreadsheet: [SiPMs for DArT](#).
- Finally, **two** DArT-eyes are **currently installed** inside DArT.

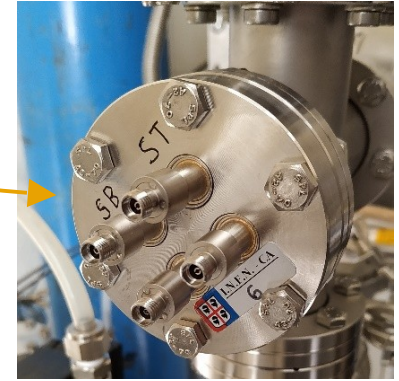


DArT-eyes placed
on bottom and
top caps

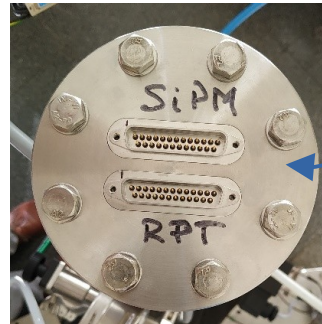
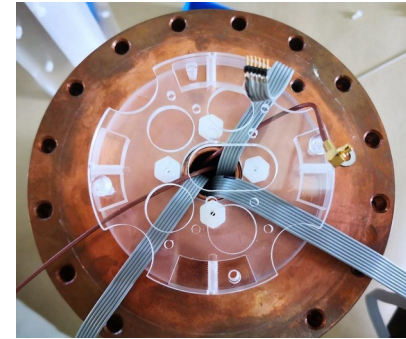
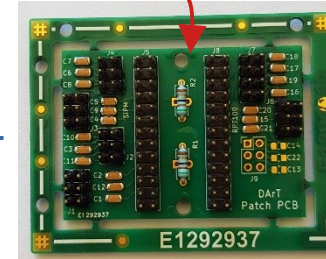


Cabling design

- All cabling have been designed for 4 DArT-eyes.
- DArT main cables:
 - 4 coaxial MMCX cables for SiPM signals → connected to CF40 SMA feedthrough.
 - 4 six-wire flat cables for DArT-eyes OPAMP power supply and SiPM polarization (3 GND, +2.5V, -2.5V, $-V_{\text{bias}}$).
 - 1 eight-wire flat cable for the 4 bottom platinum resistors.
 - 1 four-wire flat cable for the 2 top platinum resistors.
- 4 optical fibers (2 bottom / 2 top) → from methacrylate internal chamber (active volume) to LEDs support structure.



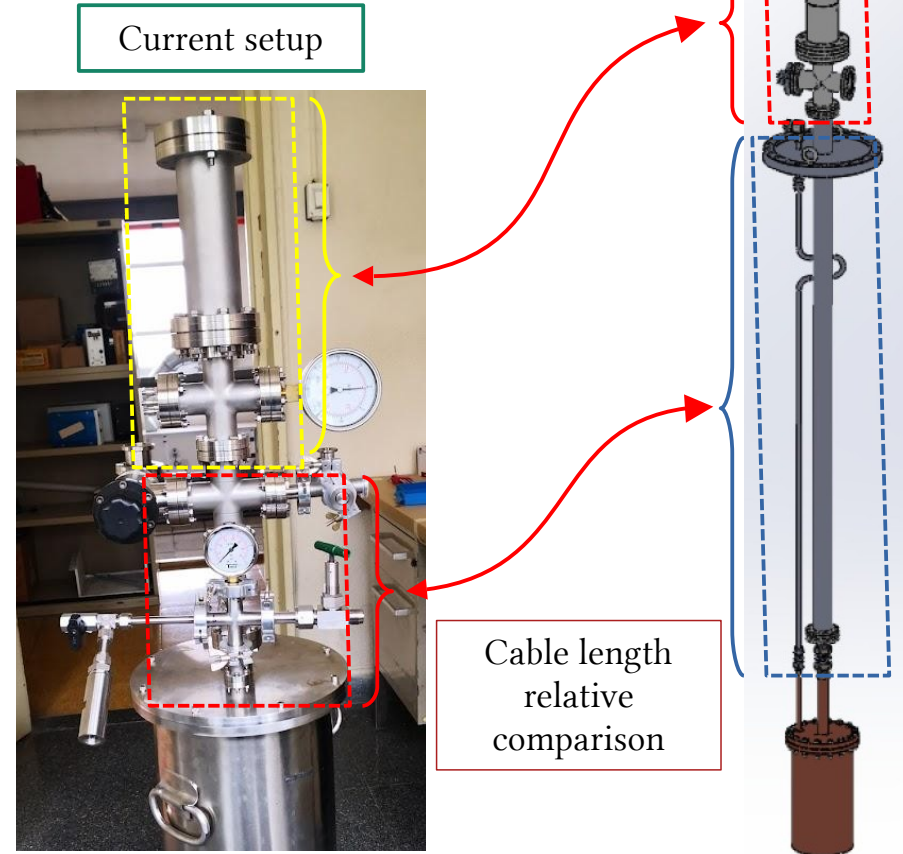
Connected to the
"power patch
PCB"...



... and from
it to the CF65
with 2 DB25

Cabling issues

- PROBLEM !!! Cables are too short for the final setup.
 - Current cables length enough to reach the top CF65 with DB25 connectors.
 - Also optical fibers.
- Needed length 2.5 meters.

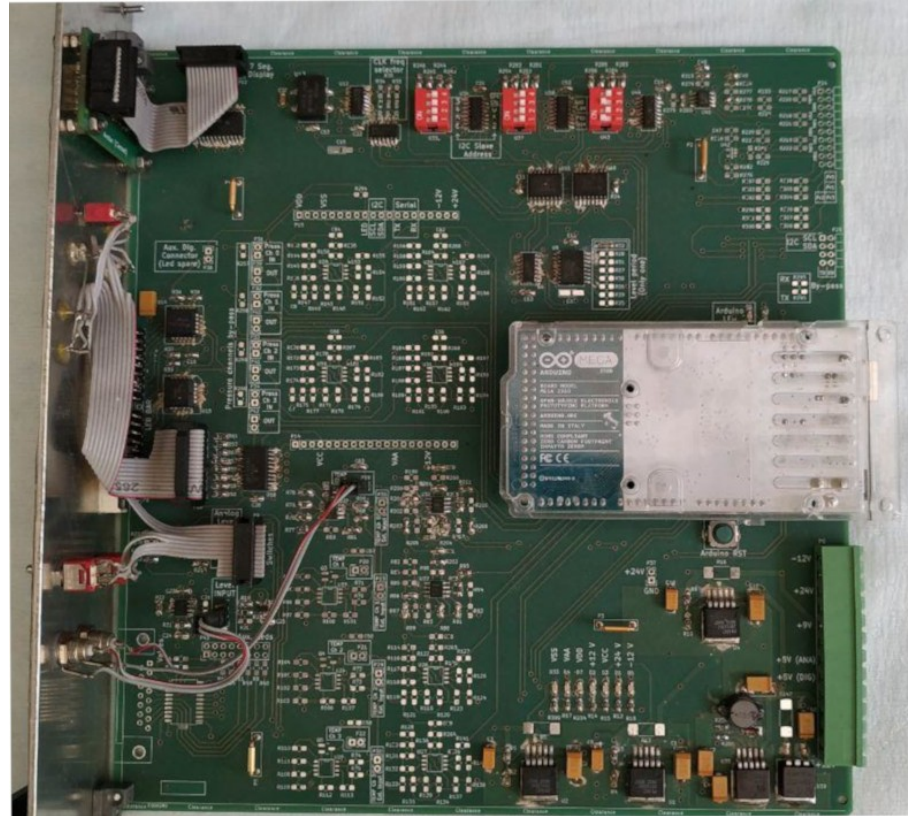
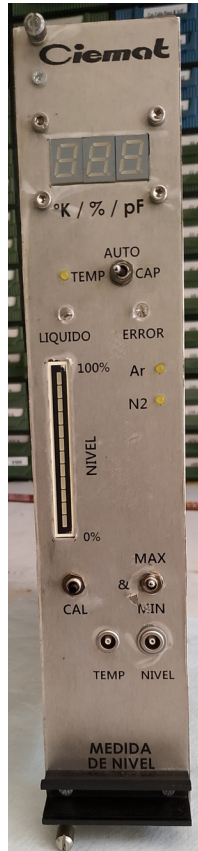


More pending tasks

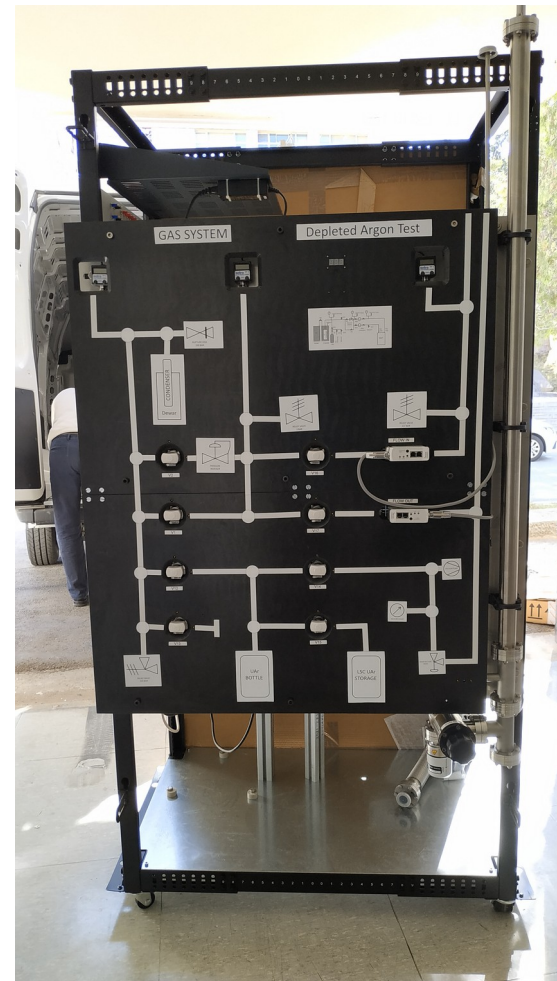
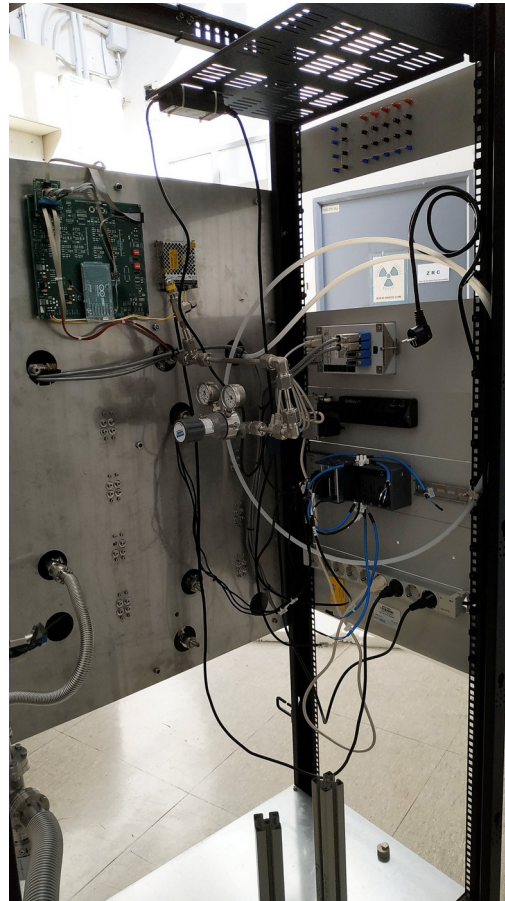
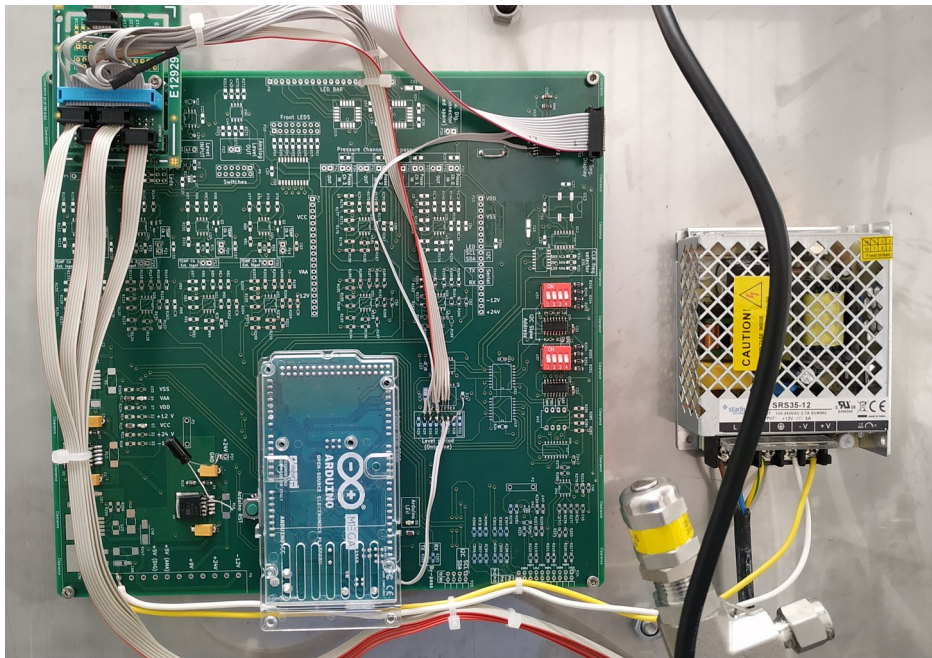
- Before installing DArT inside ArDM:
 - Install 2 additional DArT-eyes (bottom / top) → Maybe new ones manufactured at LNGS ???
 - Add new power and signal (coaxial) cables for the new additional DArT-eyes.
 - Modify both methacrylate caps to hold two DArT-eyes each → currently at Ciemat's general workshop.

Thank you for your attention

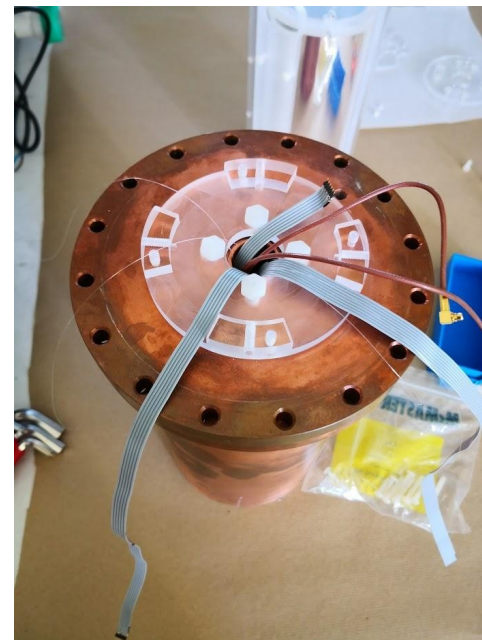
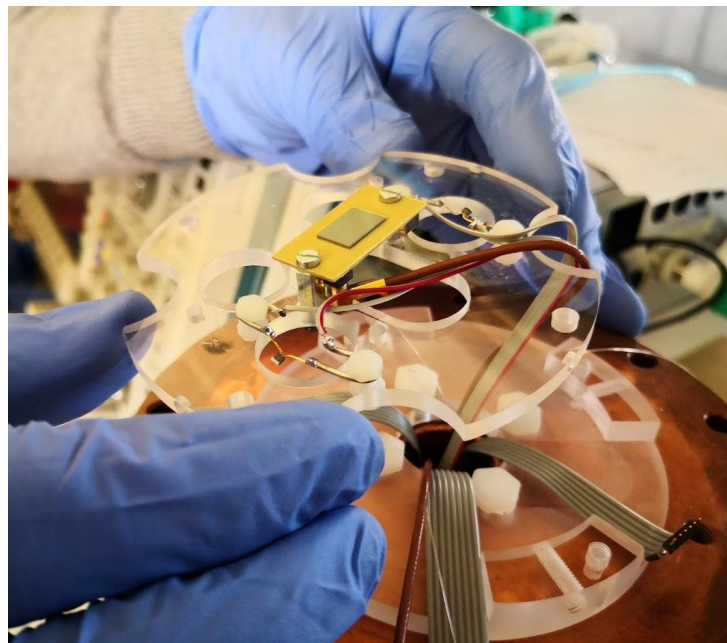
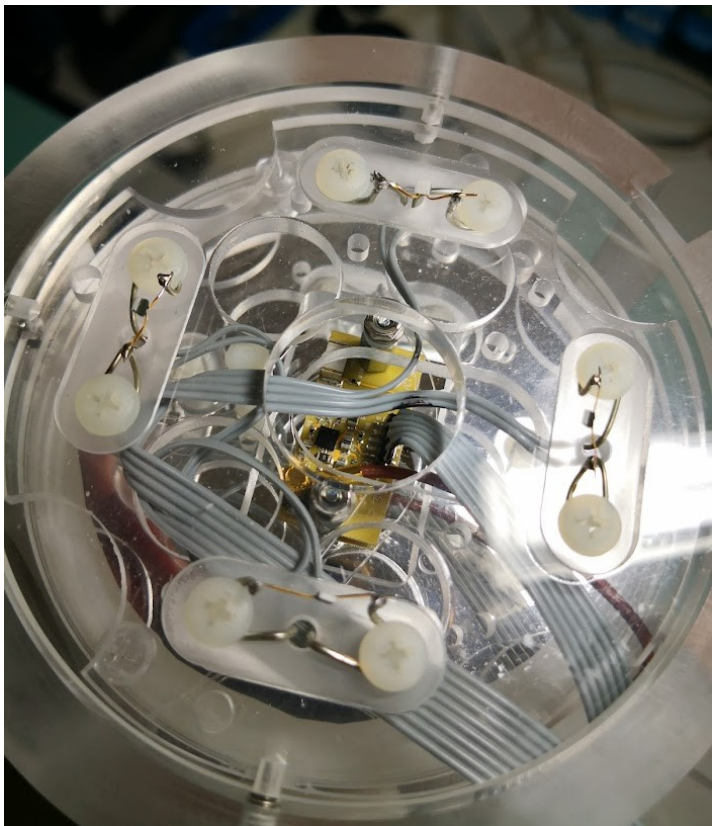
Extra slides. Images (I)



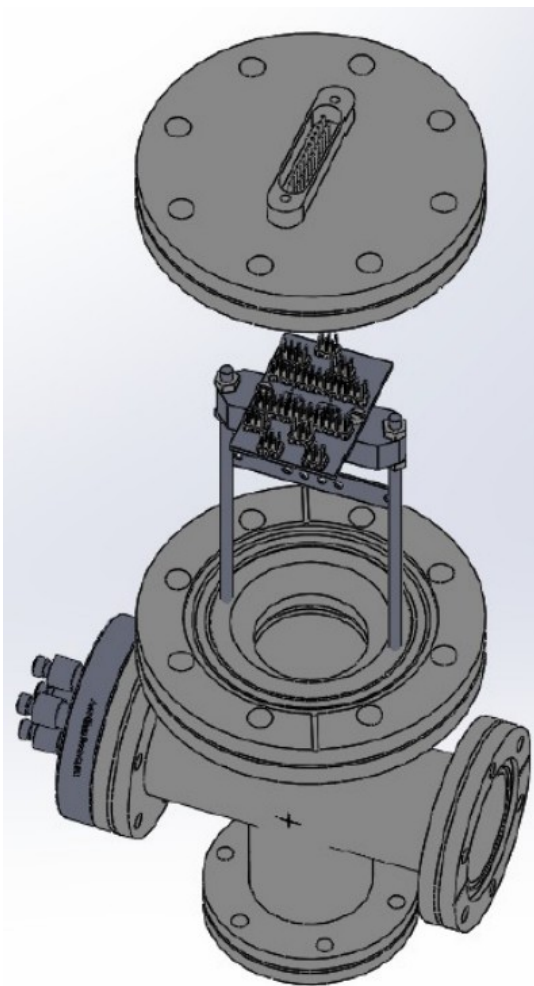
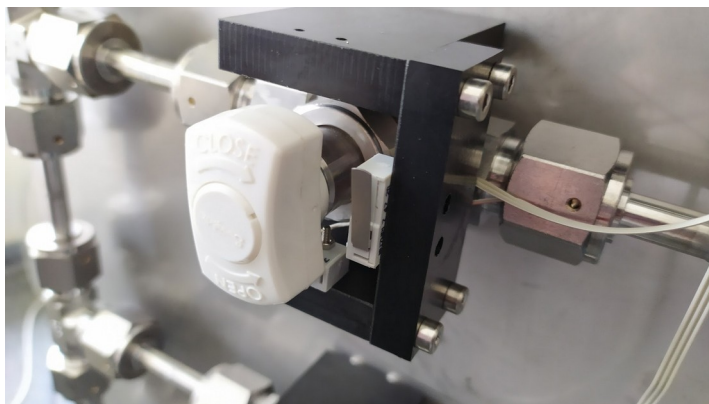
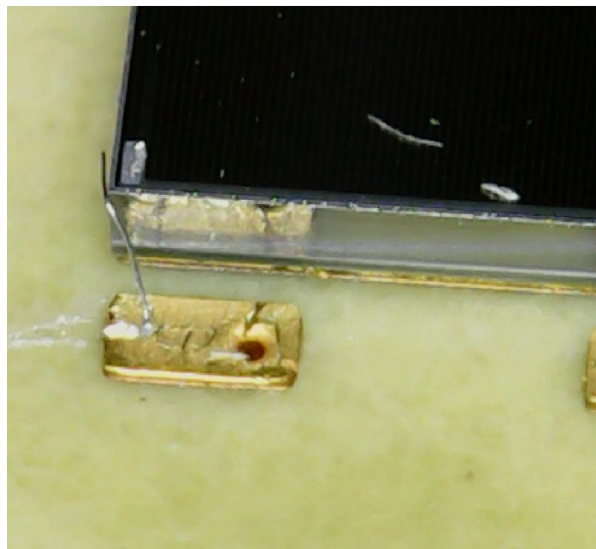
Extra slides. Images (II)



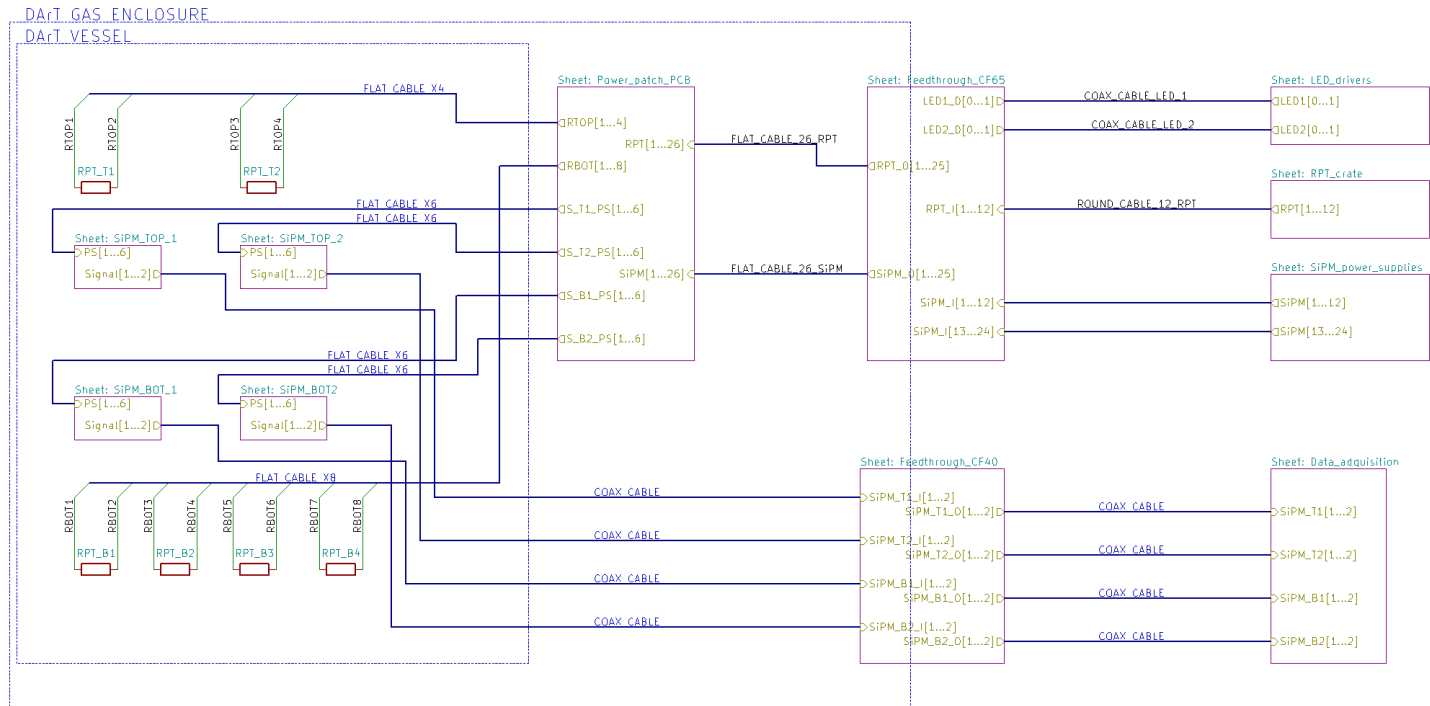
Extra slides. Images (III)



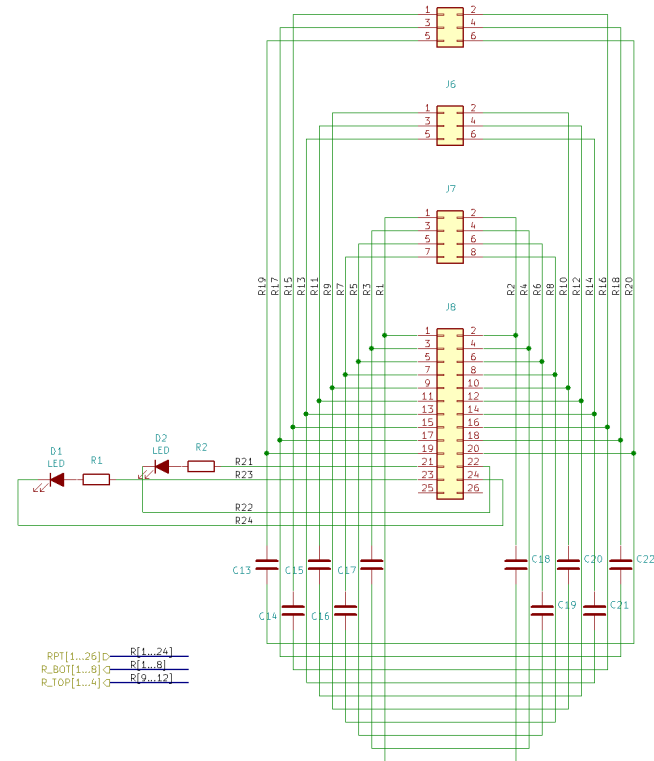
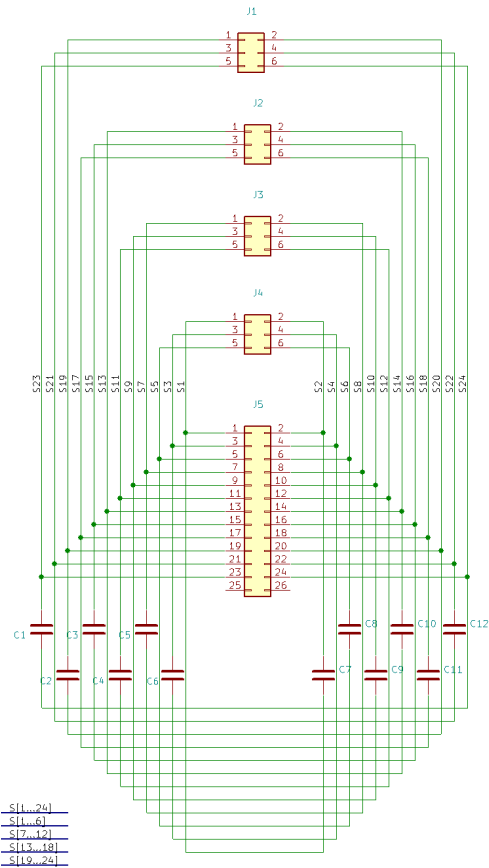
Extra slides. Images (IV)



Extra slides. Electronic schemas (I)



Extra slides. Electronic schemas (II)



DArT PATCH PCB

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