ArgonCube 2x2

Slow control feedthrough

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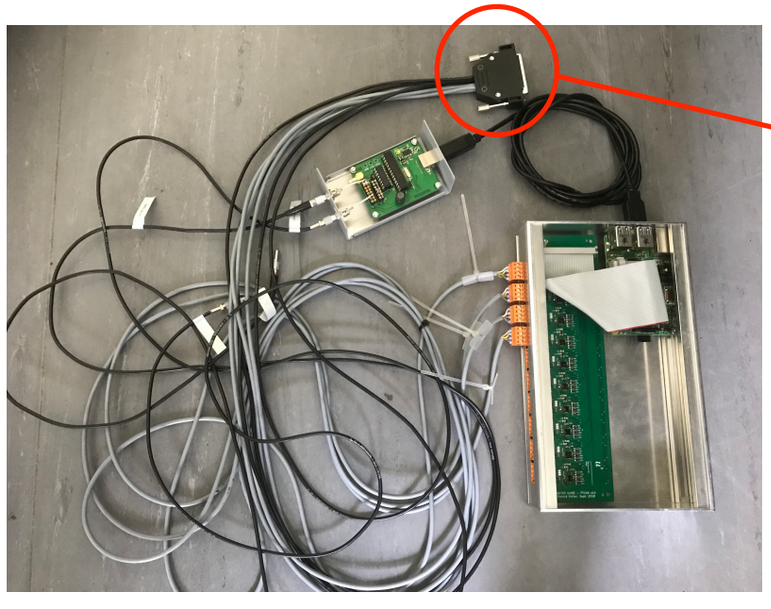
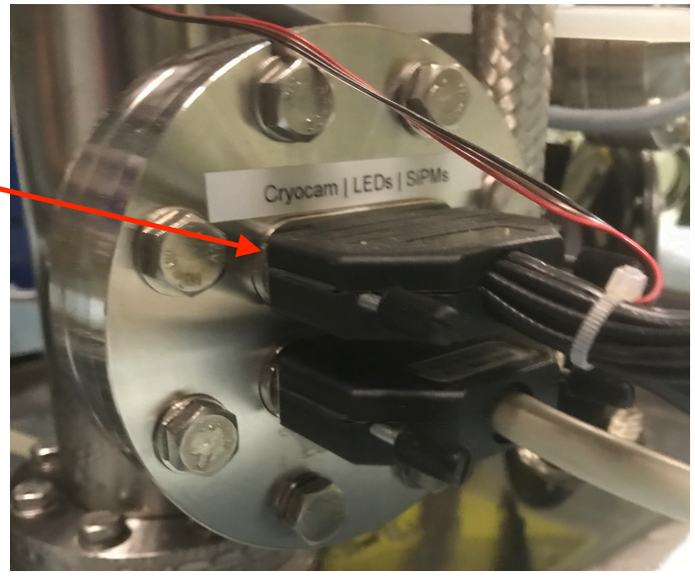
A short recap

Need electrical feedthroughs:

- Several Pt100 inside each module and inside the cryostat (at different levels)
- Cylindrical capacitor level meters inside cryostat and each module
- 12 total cryogenic bistable valves: 8 in cryostat, 1 in each module

Current configuration: level meters and T sensors readout



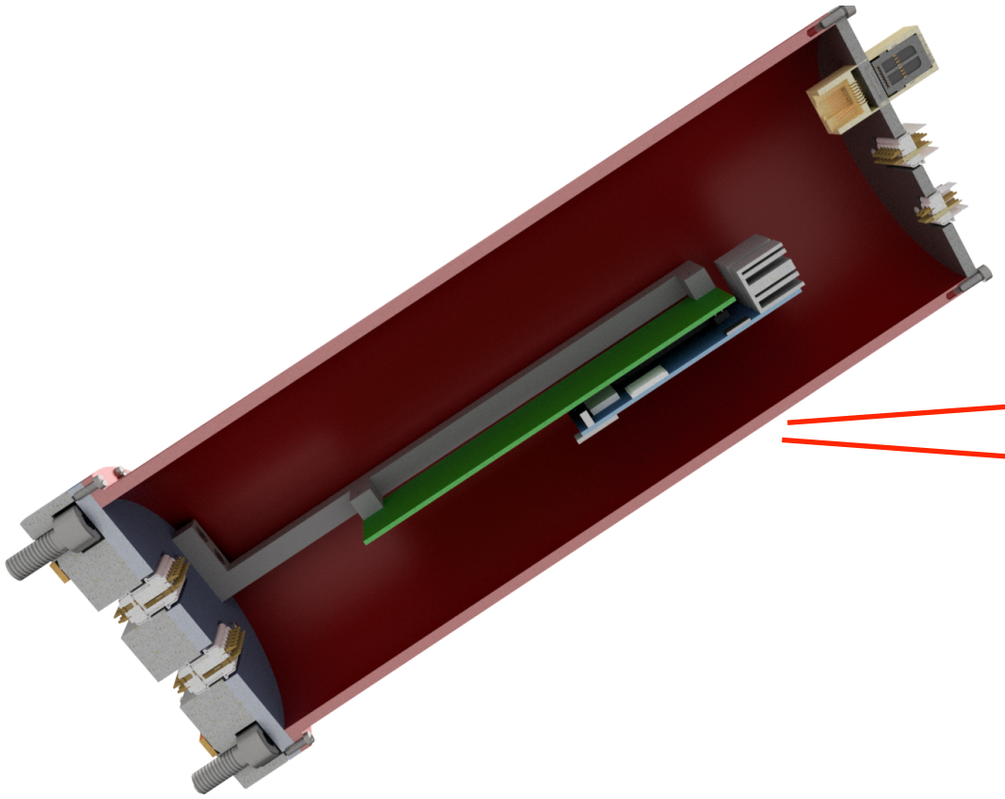


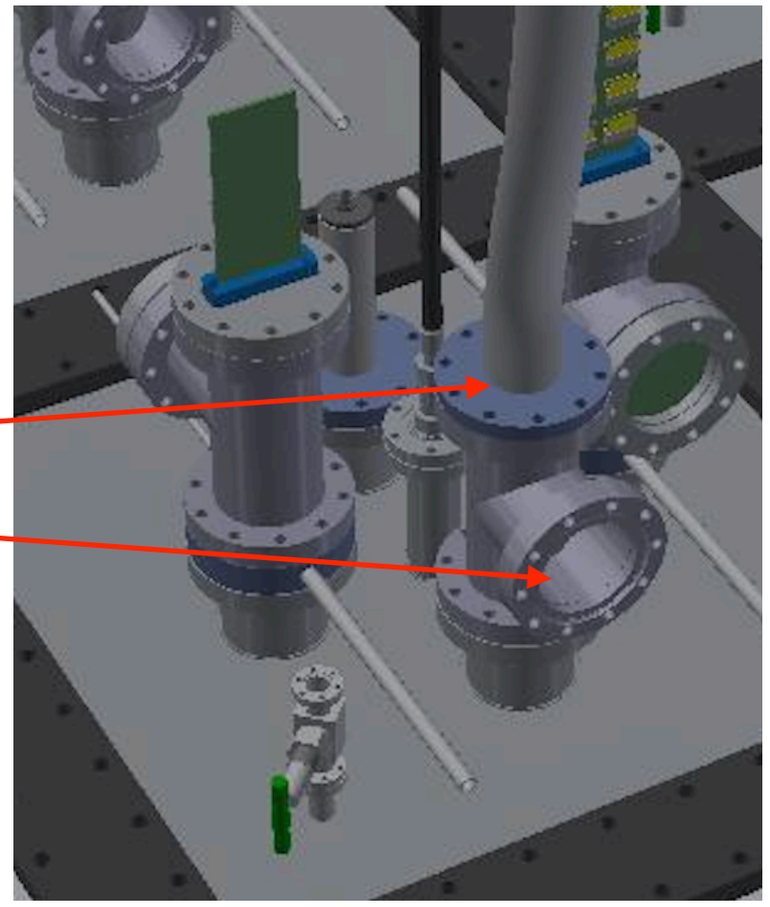
Raspberry Pi based system in star topology grounding:

- RTD readout box
- UTI board grounded on detector ground through GND line of USB interface
- shield of coaxial cables for LM readout connected at the GND of UTI board only to avoid ground loops
- connected with non-shielded ethernet to DAQ server

Too many long cables going to cryostat/module feedthrough: potential pick-up noise (antenna)

Slow control feedthrough: new design

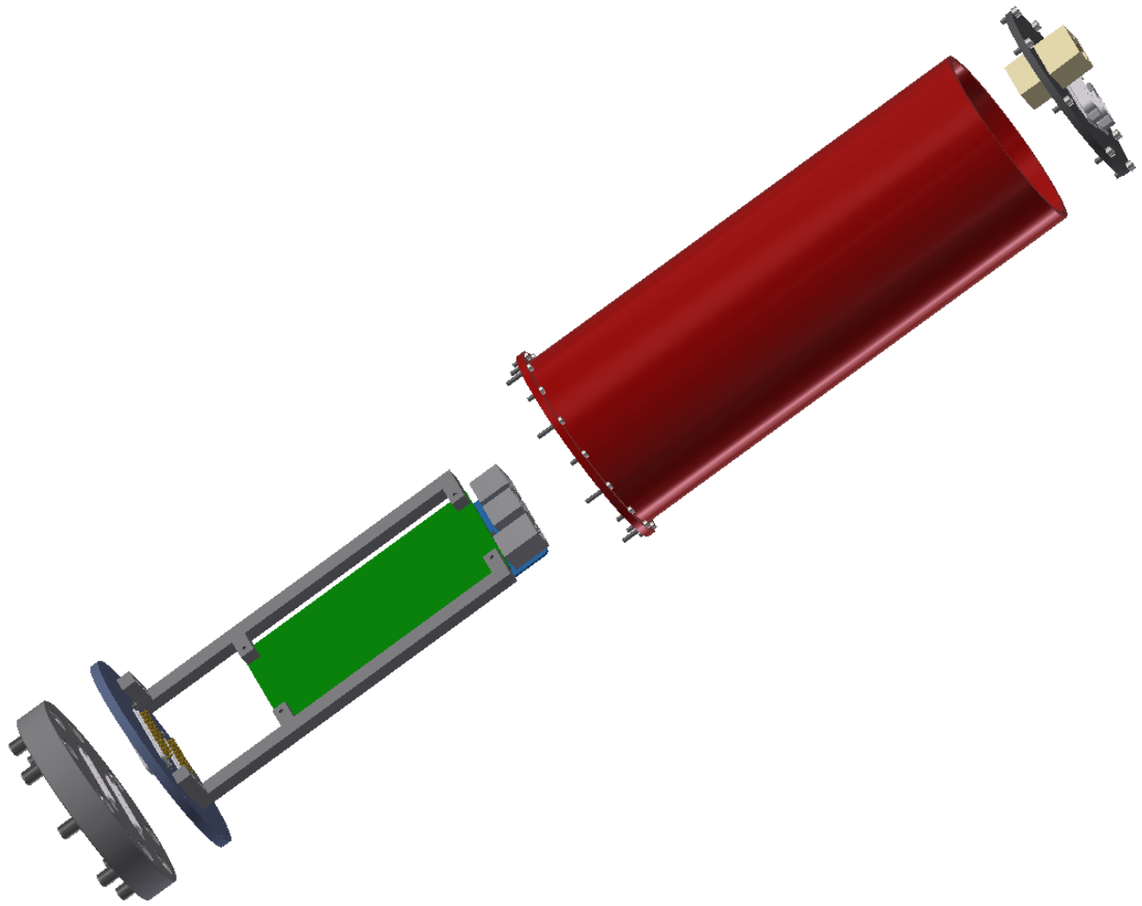




Drawings from Roger Haenni

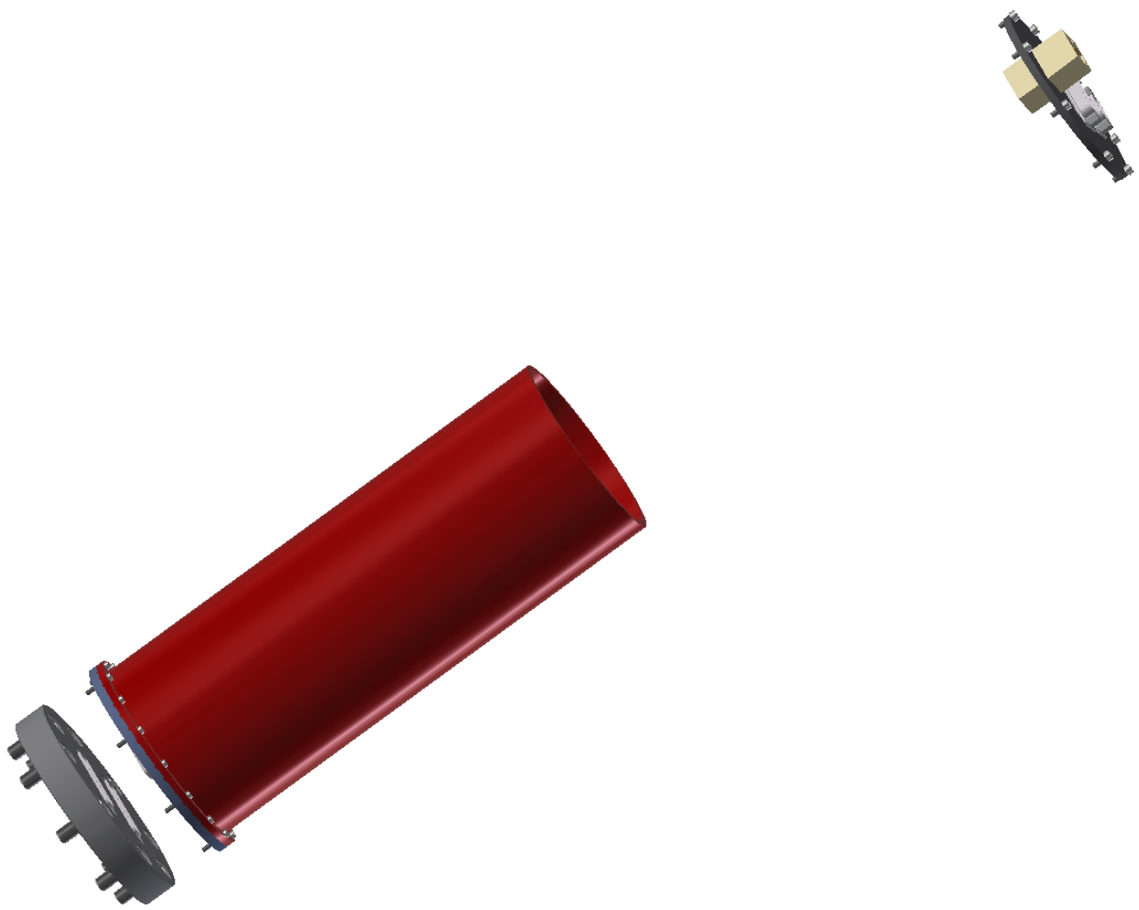
- Getting rid of long external cables
- Readout electronics and Raspberry Pi inside a Faraday cage

Slow control feedthrough: installation



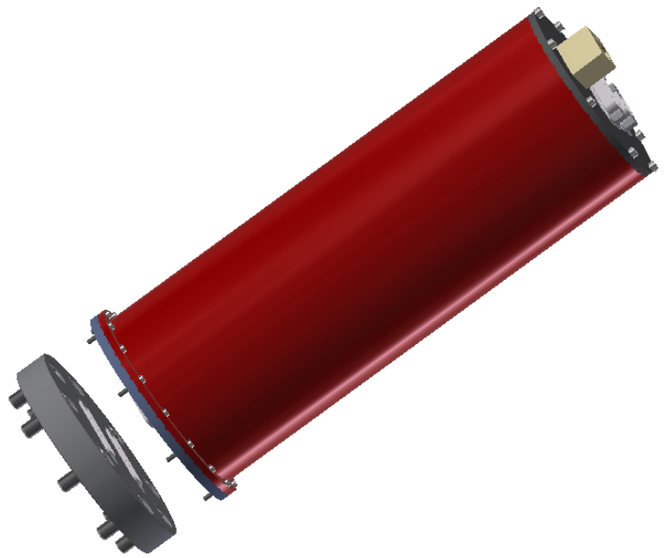
1 - Mount on bottom disk and make FT connections

Slow control feedthrough: installation



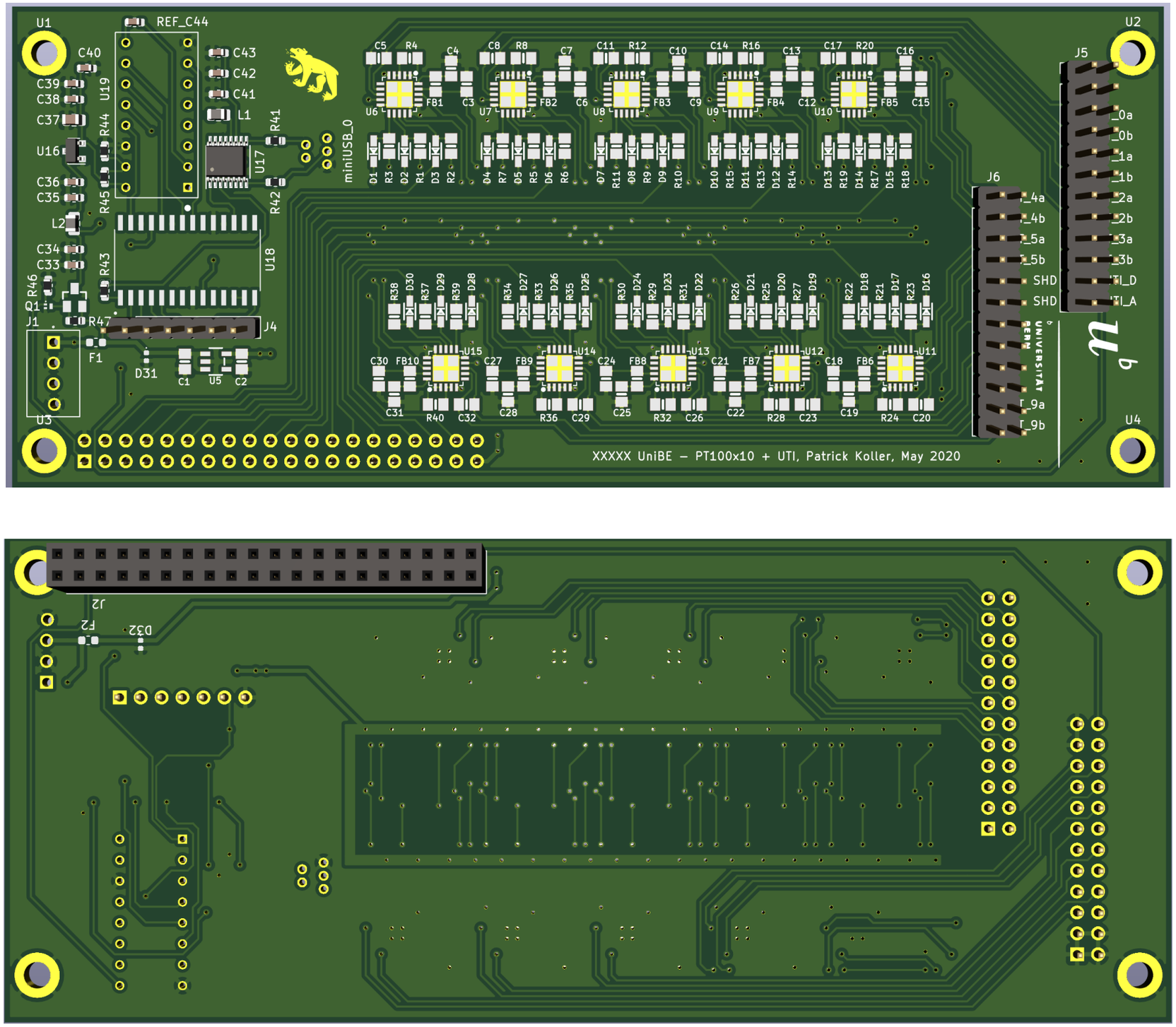
2 - Close the bottom disk and make the connections at the top disk

Slow control feedthrough: installation



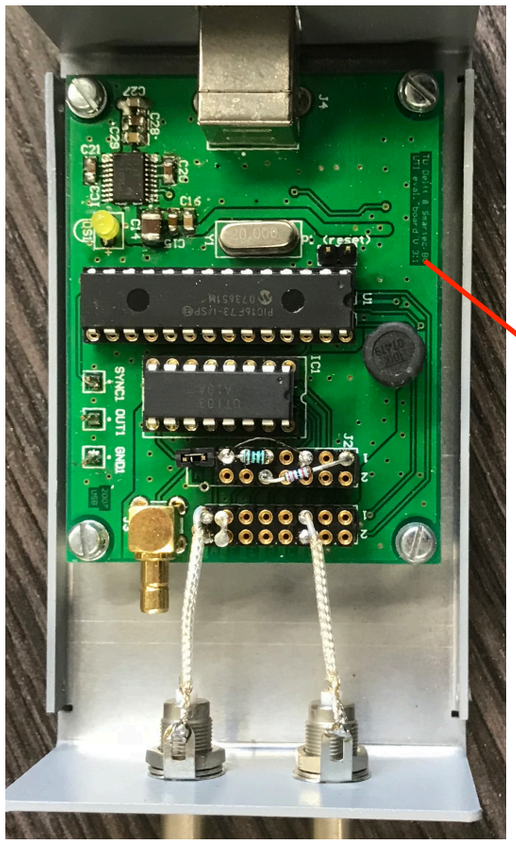
3 - Close the top end-cap and install on flange

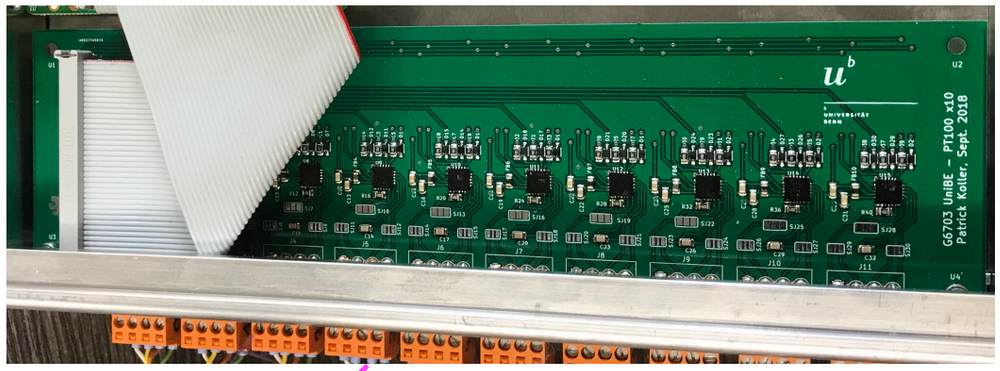
Slow control feedthrough box: custom PCB

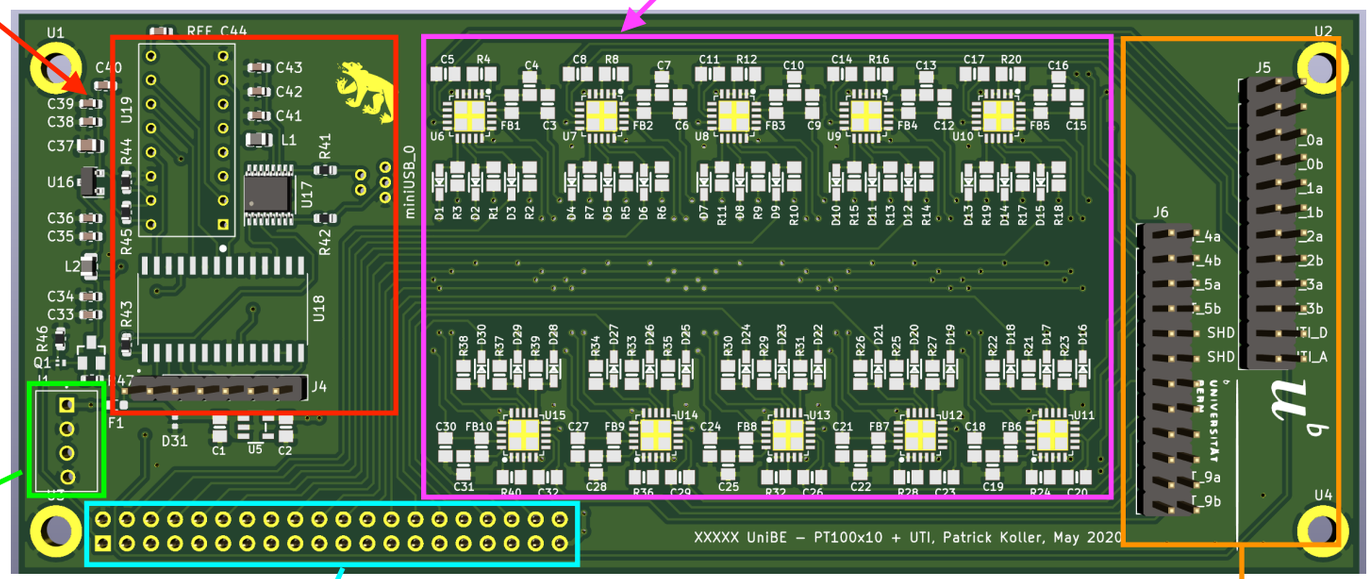


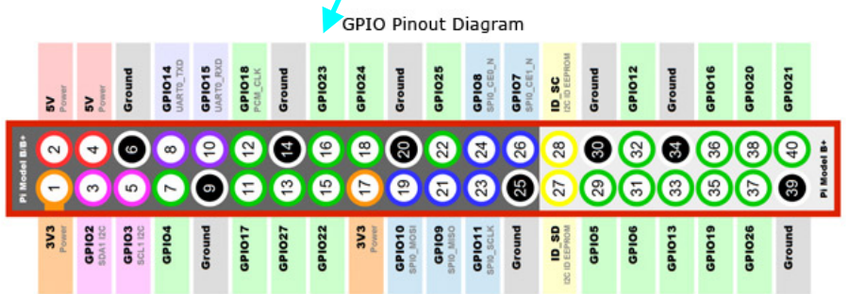
PCB layout from Patrick Koller

Slow control feedthrough box: custom PCB



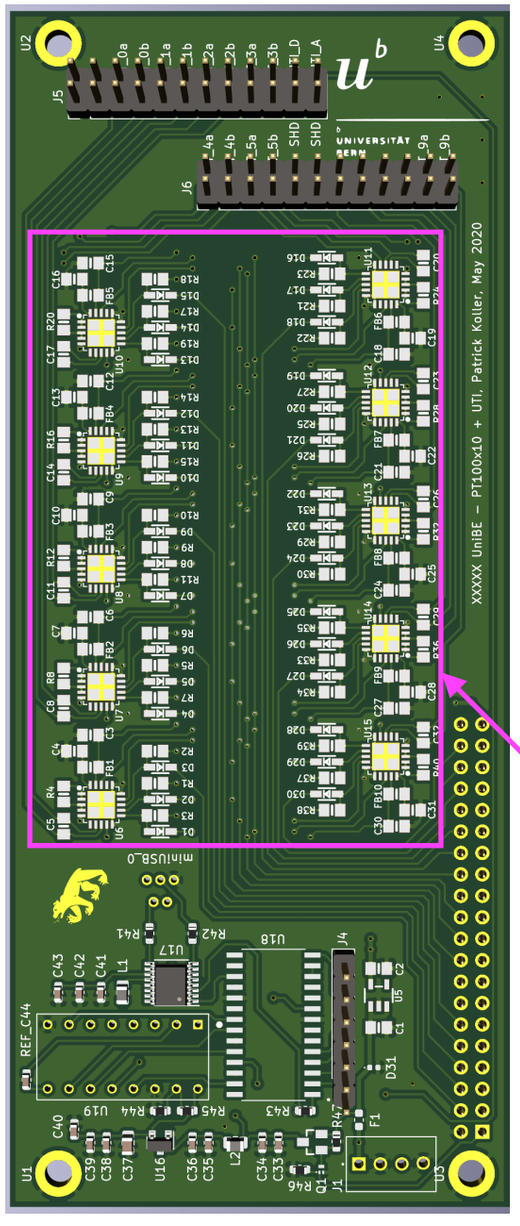


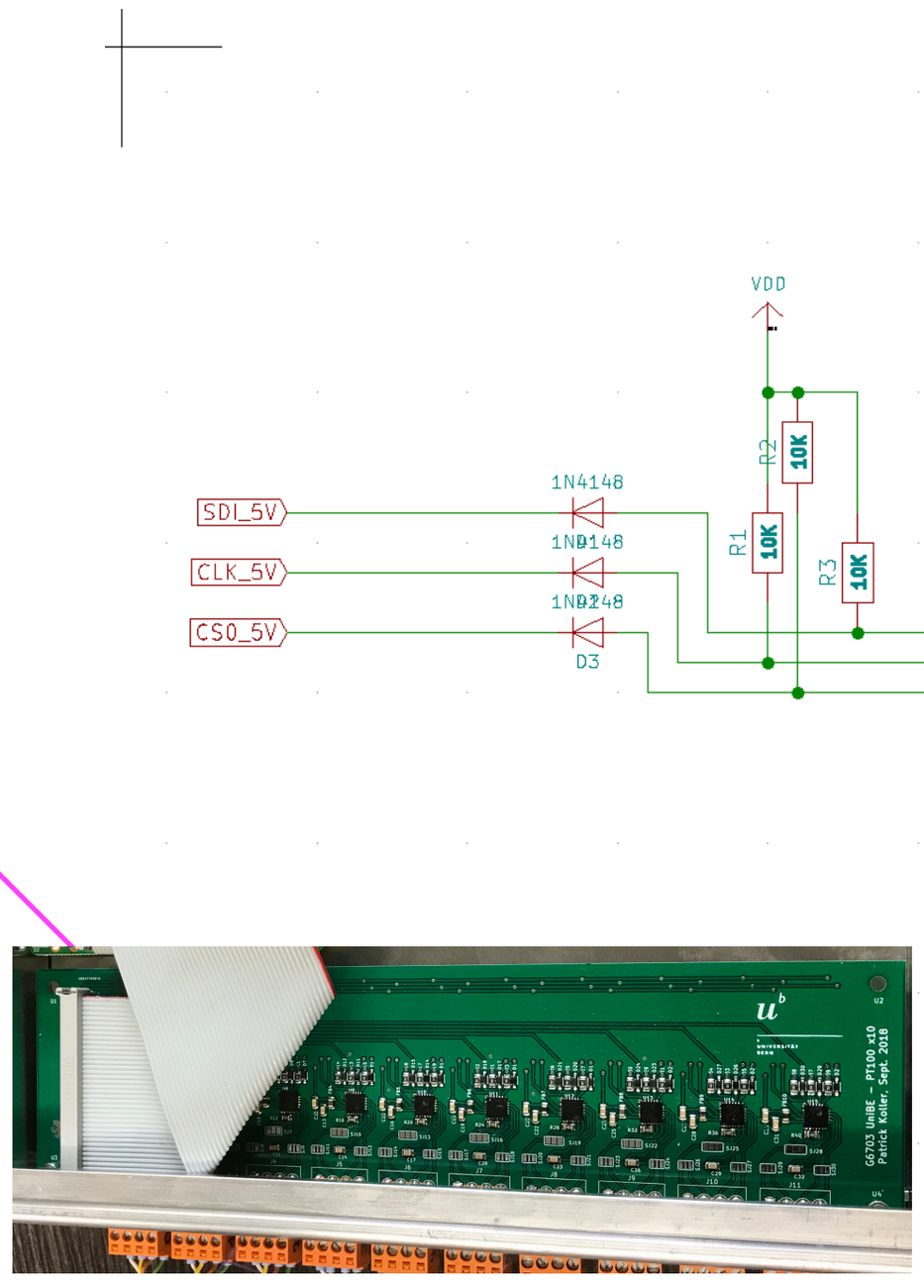




To D-Sub 25 feedthrough (multi-wire flat cable)

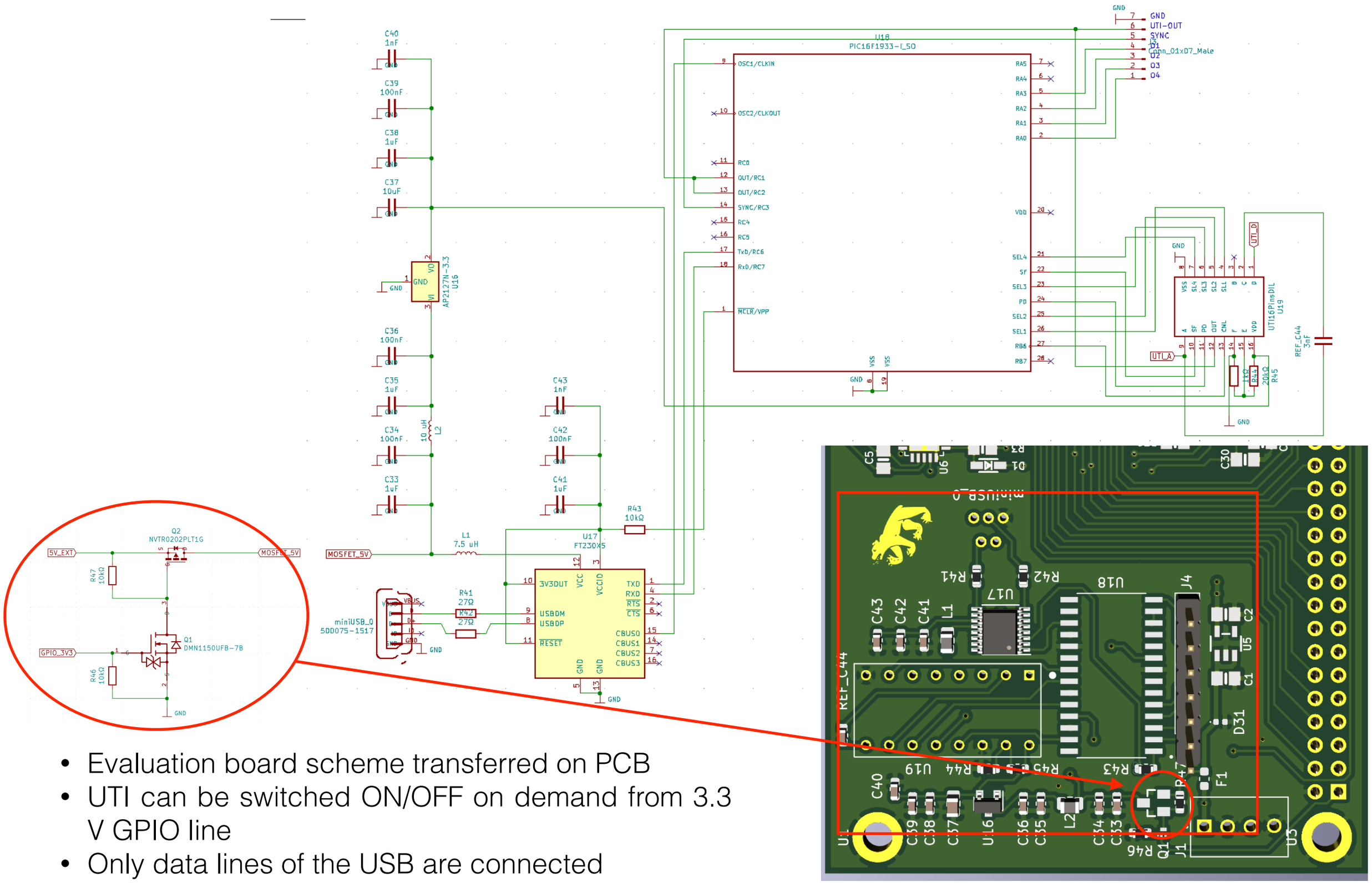
Slow control feedthrough box: Pt100 readout





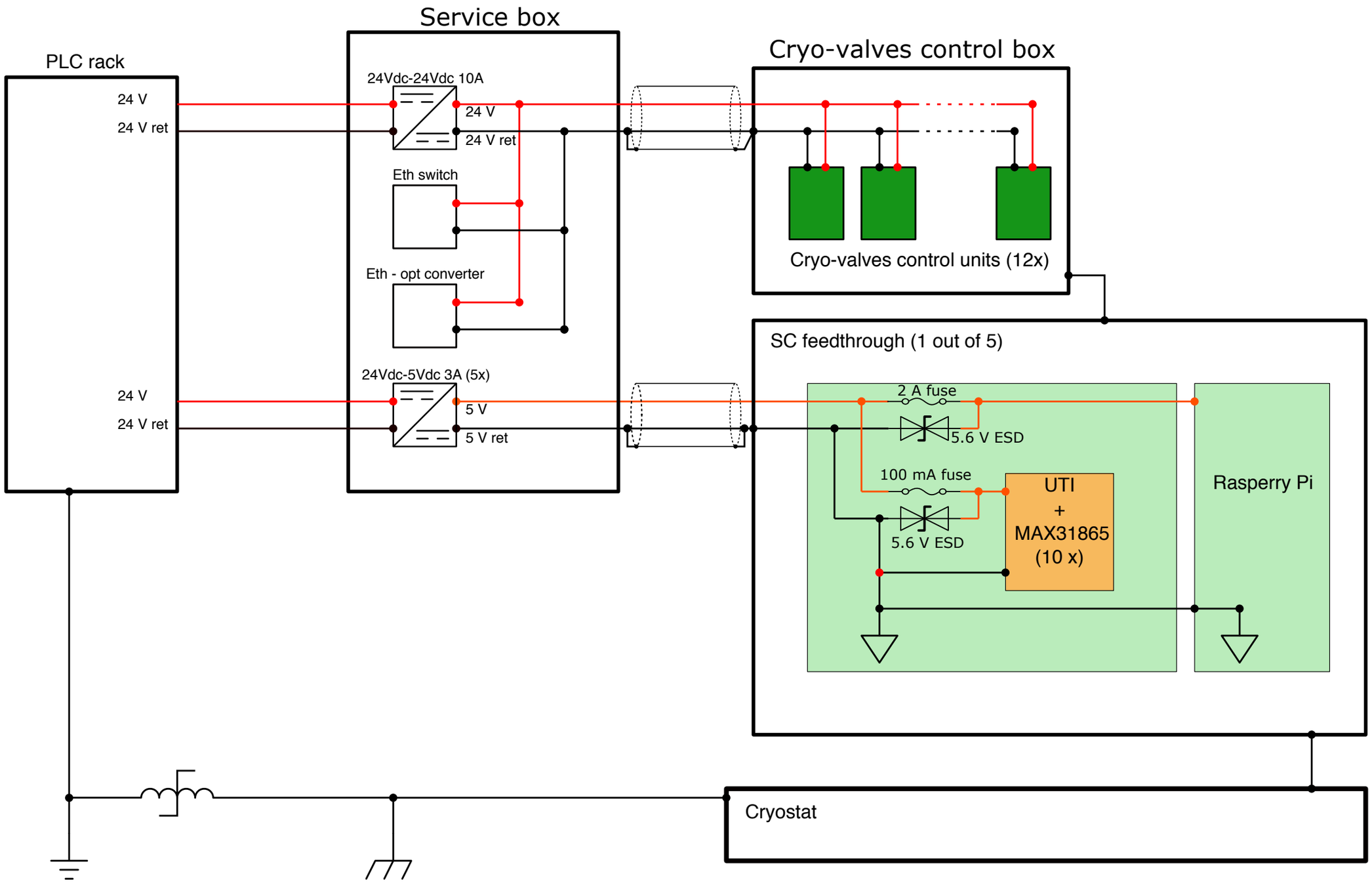
- Based on Adafruit MAX31865 RTD Pt100 amplifier chip
- Pt100 4 points measurement

Slow control feedthrough box: UTI system



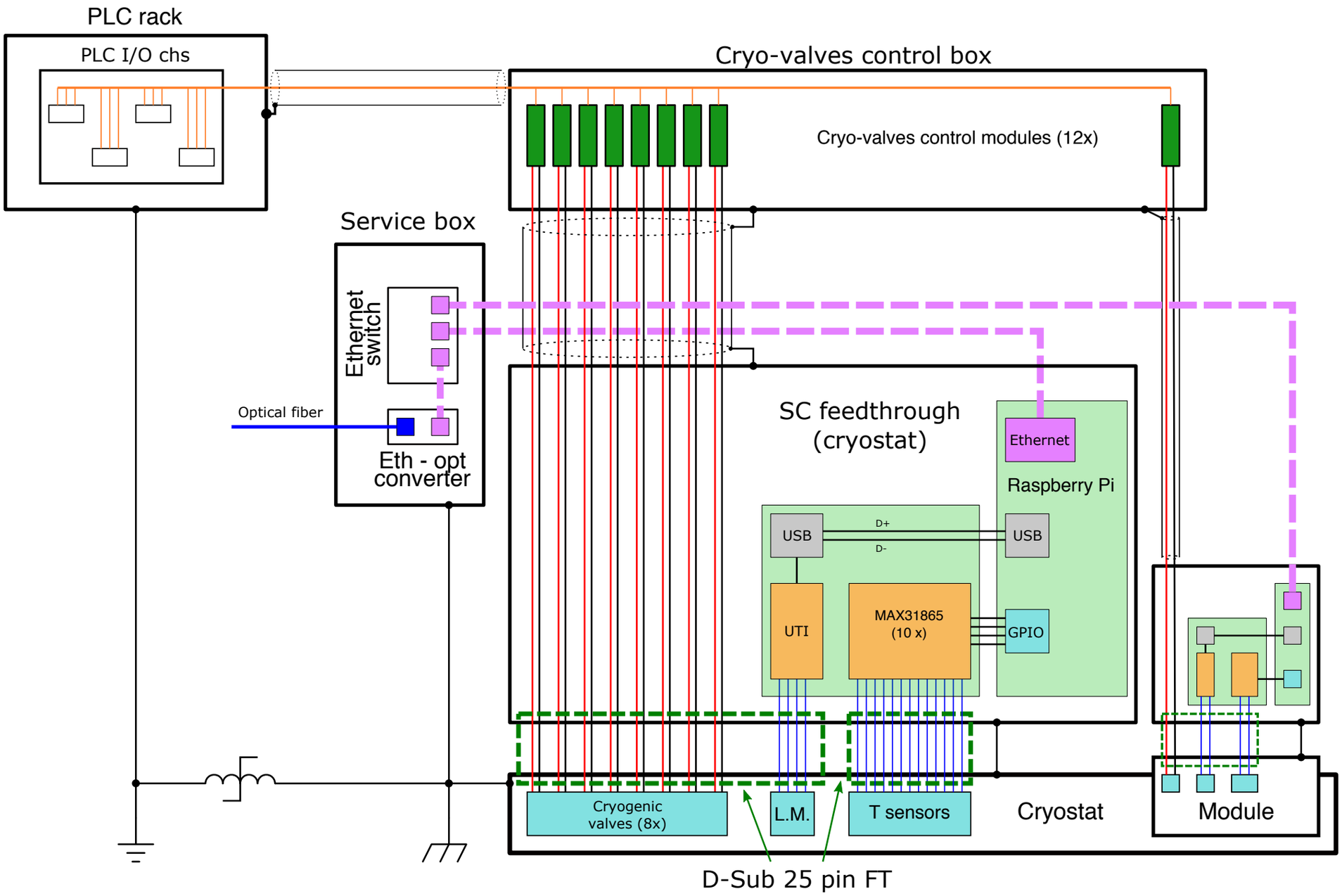
- Evaluation board scheme transferred on PCB
- UTI can be switched ON/OFF on demand from 3.3 V GPIO line
- Only data lines of the USB are connected

Slow control feedthrough box: power distribution



- Trying to keep the star topology for the grounding
- Isolated DC/DC converters
- Independent fusing of the RPi and devices resident on the SC PCB: very different current requirements
- Over voltage protection with ESD at 5.6 V (clamping voltage)

Slow control feedthrough box: system view



Trying to minimise the length of the cabling referred to detector ground
Not everything can be integrated into the feedthrough PCB. External auxiliary boxes still needed:

- Service box: DC-DC converters (isolated), ethernet switch (mixed RJ45, SFP ports)
- Cryo-valves control box: modules for controlling the 12 cryogenic valves

Slow control feedthrough: auxiliary box

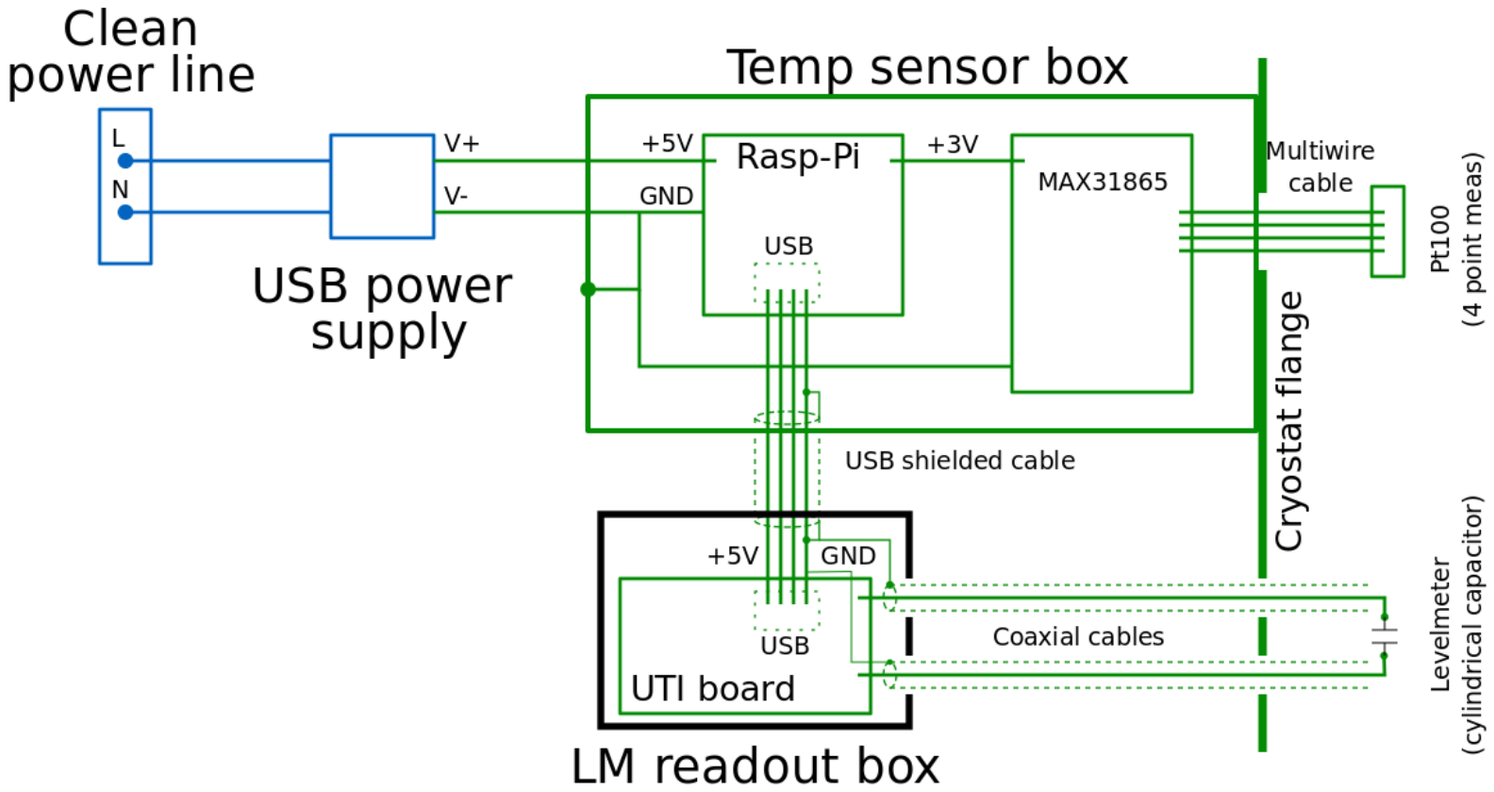
- Box dimensions: L=300 mm; W=261 mm; H=134.5 mm
- The closer to the FTs the better

Slow control feedthrough: power requirements

Device	N. units	Suppy Voltage	Pwr consumption (per unit)	Total pwr consumption	Notes
MW DDR 240B (24Vdc-24Vdc)	1	24 Vdc	312 W (max!)	312 W (max!)	Max output: 10 A @ 24 Vdc
XP DTJ1548S05-D (24Vdc-5Vdc)	5	24 Vdc	18 W (max!)	90 W (max!)	Max output: 3 A @ 5 Vdc
MOXA EDS-2010-ML-2GTXSFP-T (Eth switch)	1	24 Vdc	6 W	6 W	
Valves control units (Arduino nano)	12	24 Vdc	1.2 W (meas)	14.4 W (meas)	Valve controlled by current pulses: I ~ 5 A; t ~10 ms
RaspberryPi 2 B+	5	5 Vdc	1.75 W (9 W max!)	15.8 W (45 W max!)	
UTI (Levelmeter readout)	5	5 Vdc	250 mW (meas)	1.25 W (meas)	
MAX 31865 (Pt100 readout)	< 50	3 Vdc	10.5 mW	< 0.53 W	Not all the 10 units in a PCB will be used!

Backup slides

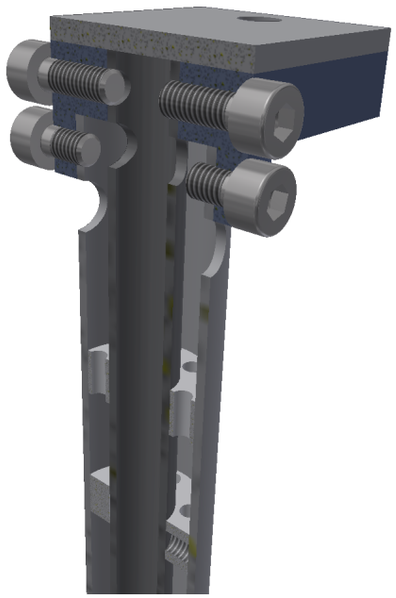
Design proposed at ArgonCube Meeting Dec 2019



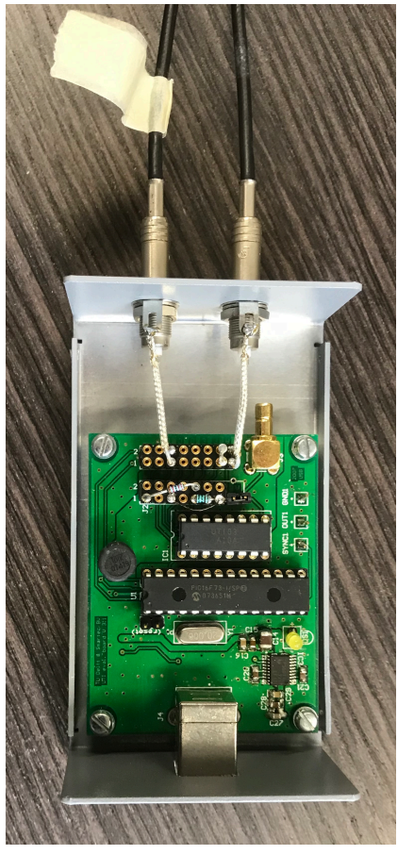
Raspberry Pi based system:

- Temperature box grounded directly on feedthrough flange by mechanical contact (in development)
- UTI board grounded on detector ground through GND line of USB interface
- shield of coaxial cables for LM readout connected at the GND of UTI board only to avoid ground loops
- connected with non-shielded ethernet to DAQ server

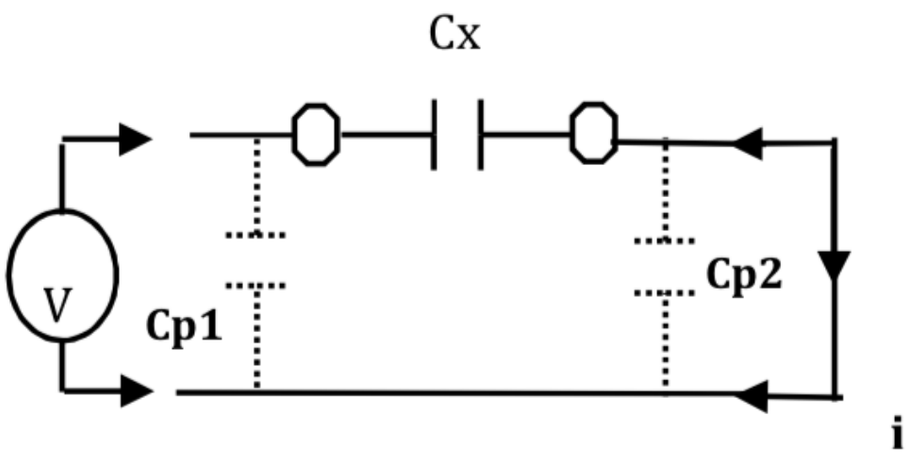
Liquid level monitoring



Design

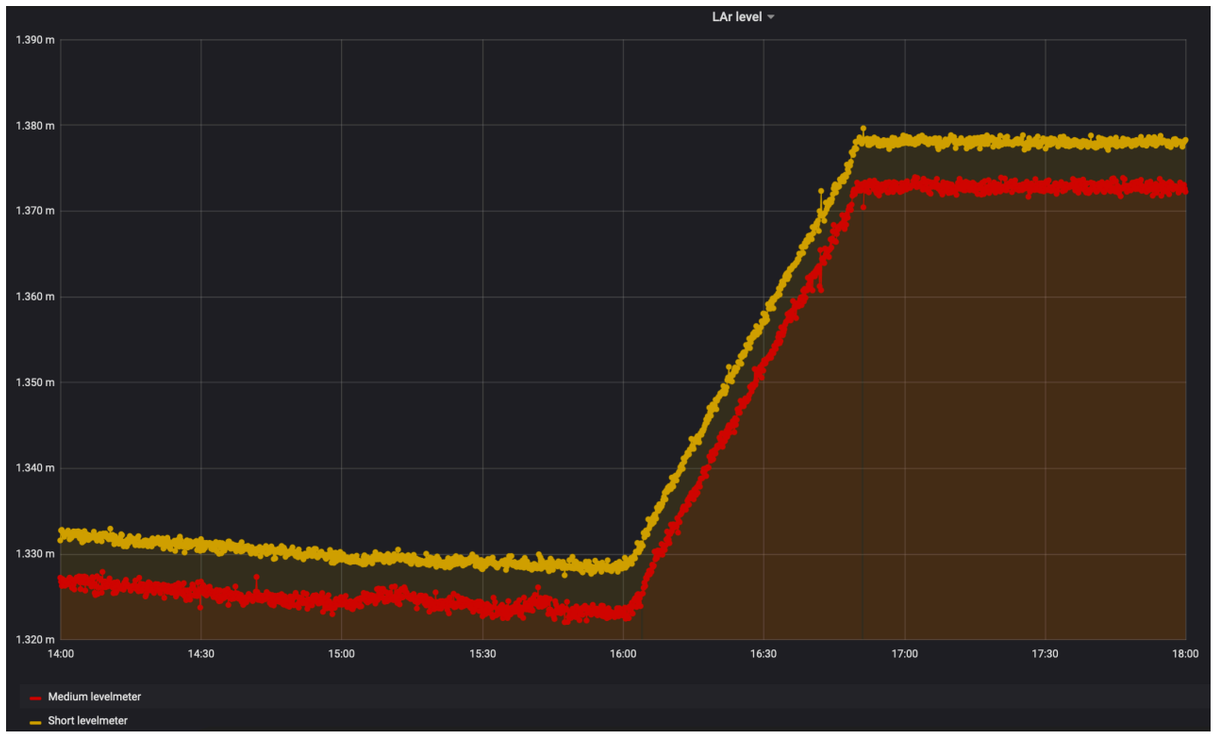


UTI box



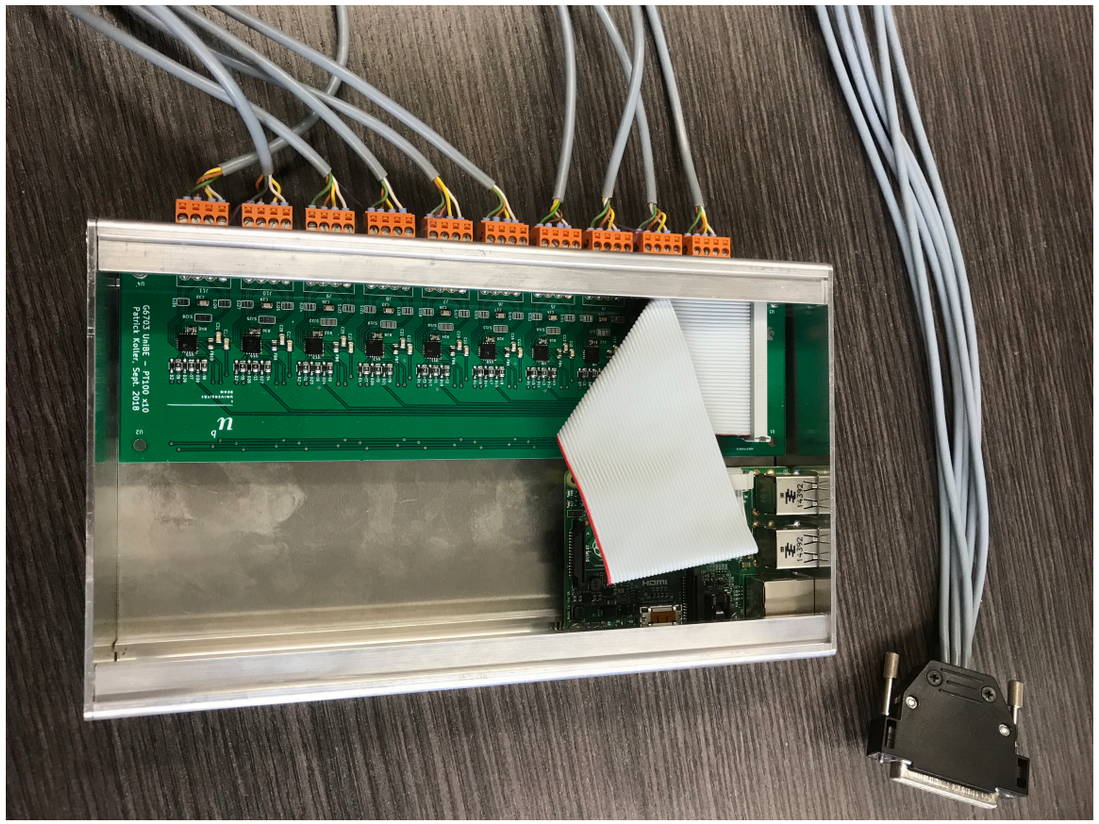
Measurement principle

- Cylindrical capacitors
- Based on UTI for capacitance measurements
- System developed at LHEP (R. Berner)
- Serial interface (through USB) for com and power
- Precision (current setup): ~2 mm
- Current setup: 2 in the module 1 in cryostat

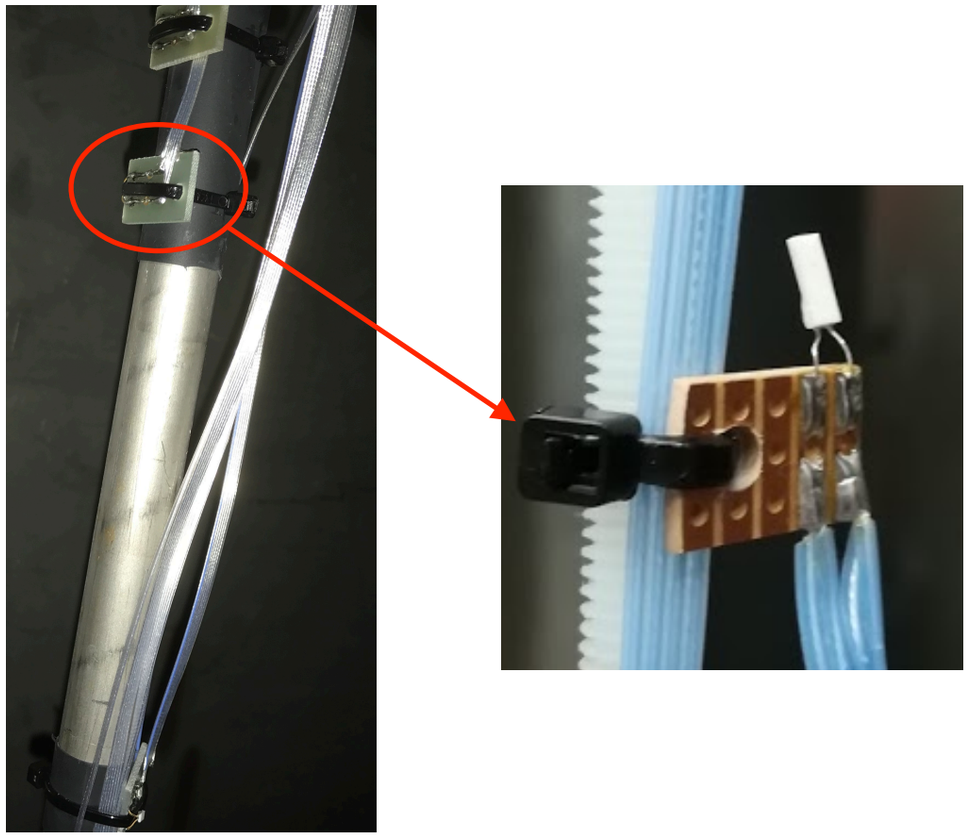


Liquid level in module during LAr refilling

LAr temperature monitoring



T sensors readout box



Pt100 mounted along levelmeter

- Based on MAX31865 RTD to digital converter: 4 point measurements of Pt100
- Board designed and developed at LHEP (P. Koller): up to 10 sensors
- RaspberryPi:
  - interface to MAX31865
  - Communication with DAQ server through ethernet

Bistable cryogenic valves

No mixing between PLC ground (building) and detector ground:

- Valve control (input) through mechanical relays
- Status and fault (outputs): optical decoupling