

## Modifications of Fridge 4, 2020-2021

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# Moving pumps and N<sub>2</sub> traps

Pumps and traps rearranged in a more compact way.



Roots pump moved up, rotary pump placed below it

All N<sub>2</sub> traps are connected with flexible tubes

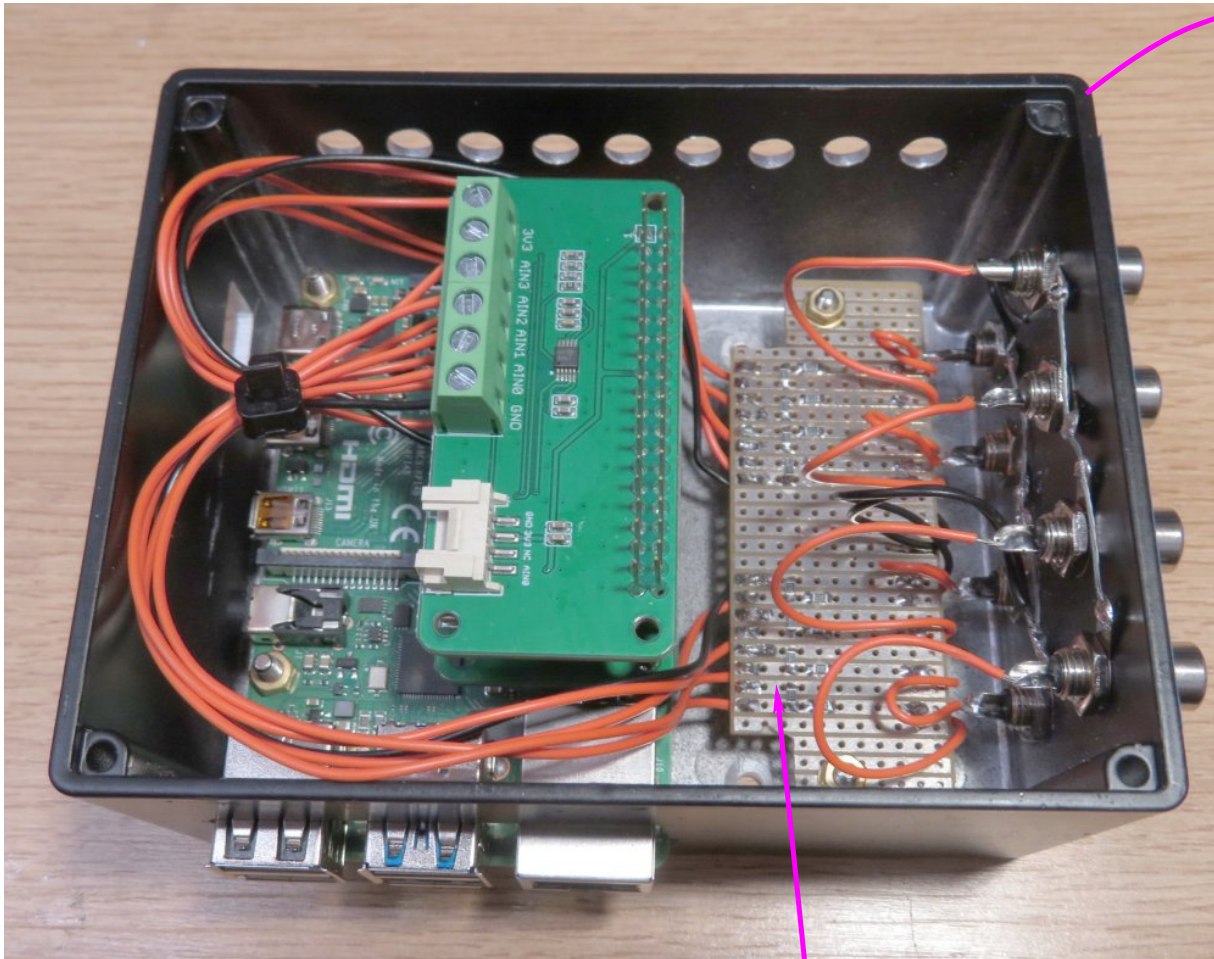
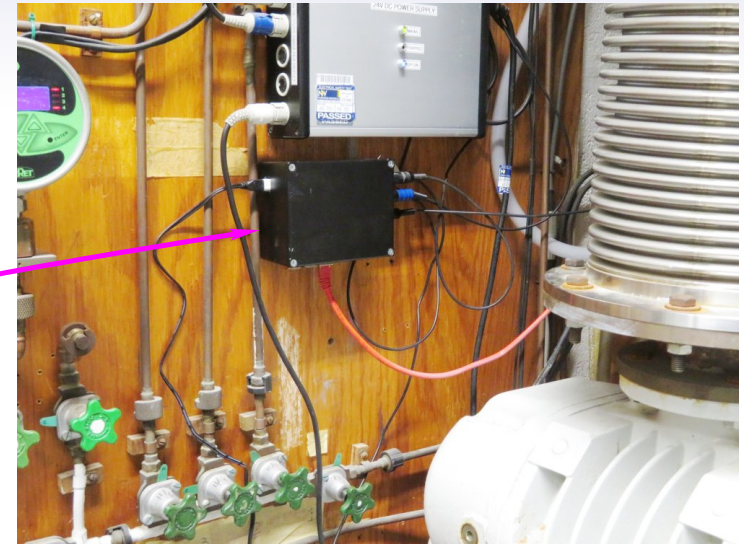
1K pot pump moved closer to the wall



gas purifier added

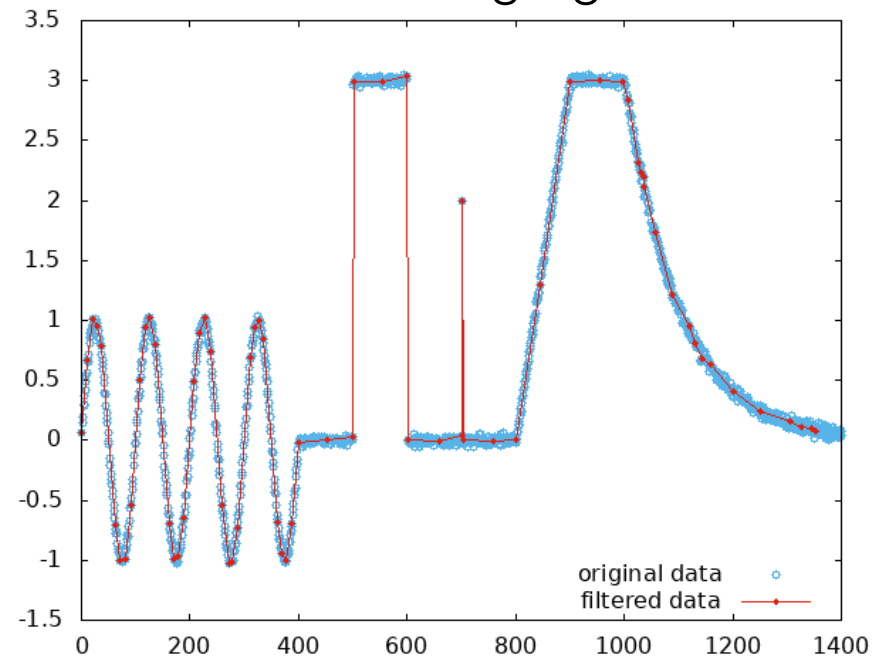
**Old:** Windows computer with NI ADC card.

**New:** Raspberry Pi 4 computer with two ADS1115 cards (8 channels).



1:3 voltage dividers

new data filtering algorithm:



# Lines for thermometers and heaters

**Old:** Oxford resistance bridge with 3-wire connection. No computer interface.

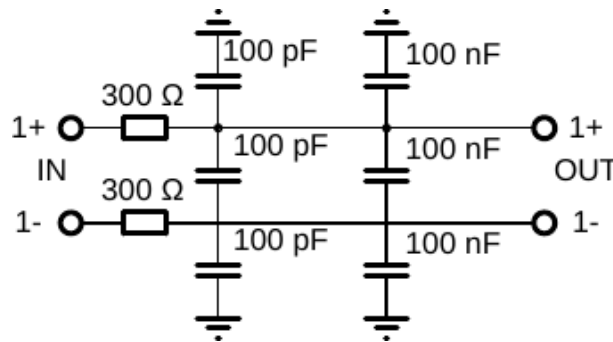
**New:** Lakeshore 370AC, 16 channels.

New wiring for cryostat thermometers and heaters.

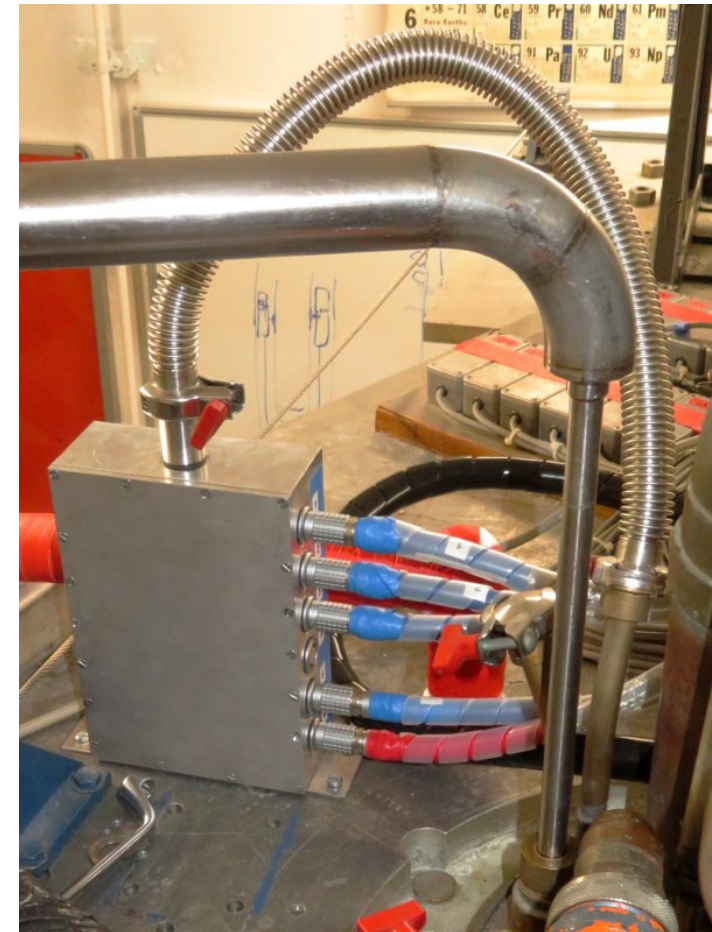
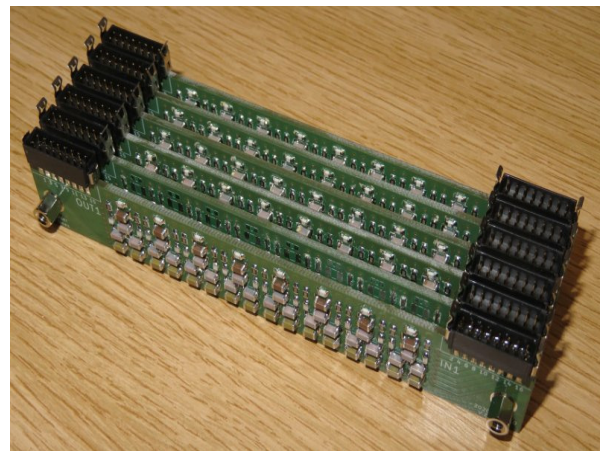
48 CuNi twisted pairs: 20 4-wire channels for thermometers, 8 heaters.



RC-filter box for 48 pairs



Suitable for R up to 10kΩ



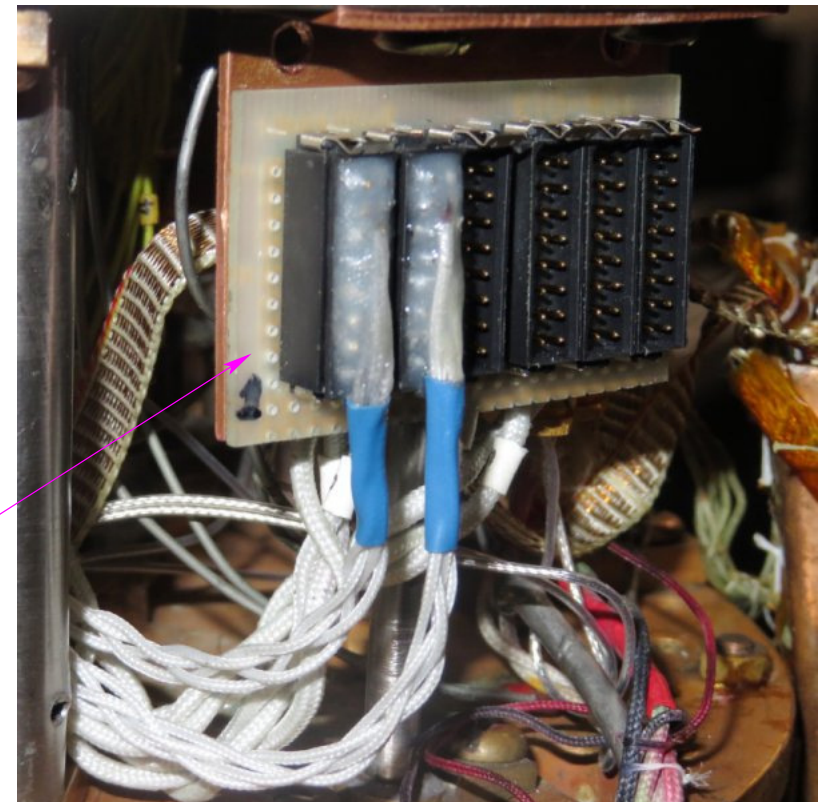
## Lines for thermometers and heaters



Harwin Datamate connectors  
M80-85016, M80-85316.  
2 mm pitch,  
rated for 500 mating cycles.

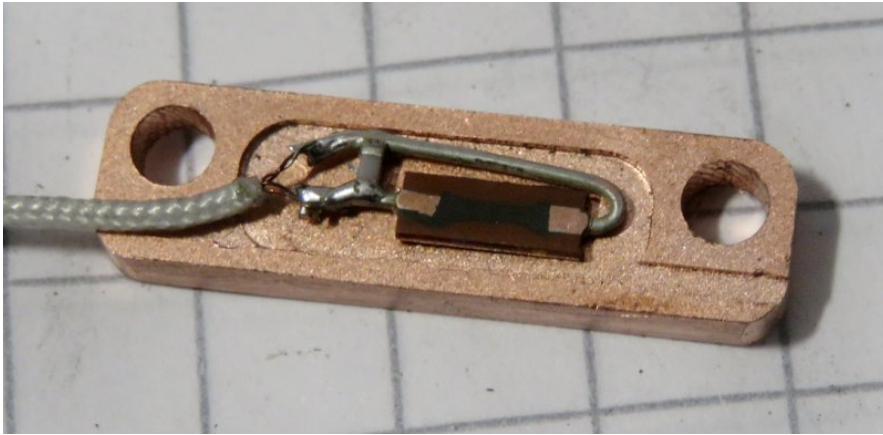
Feedthrough outside  
the vacuum can

Inside the vacuum can



# Calibrated thermometers

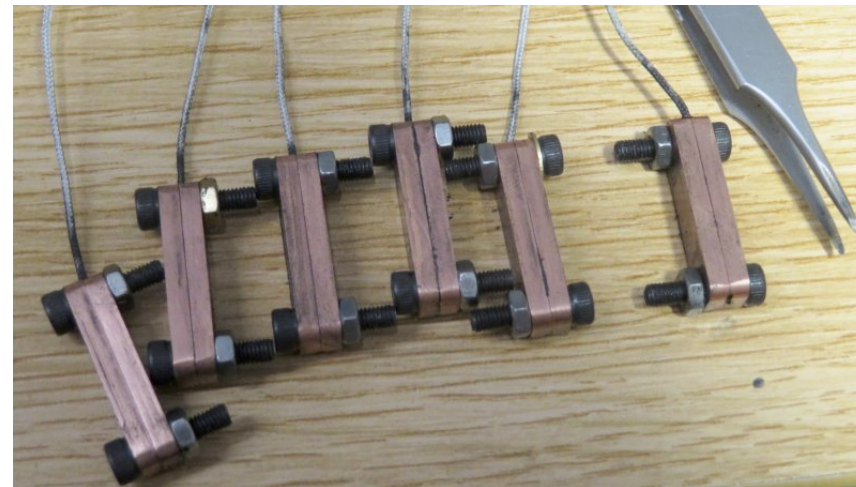
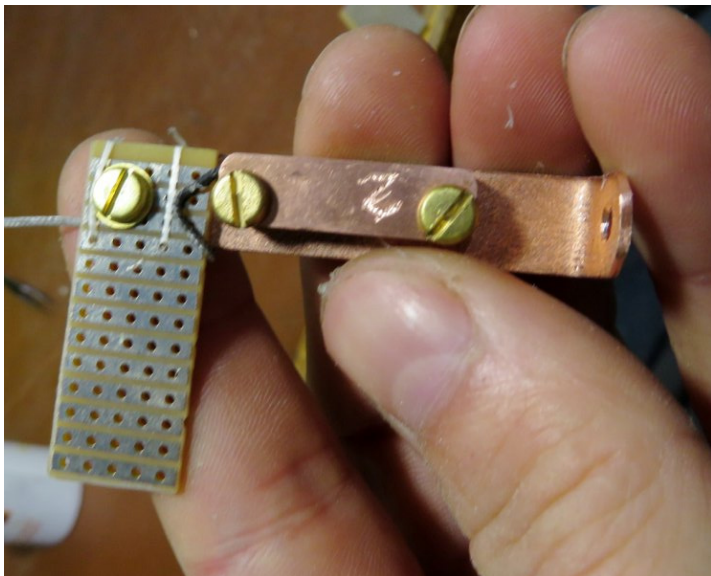
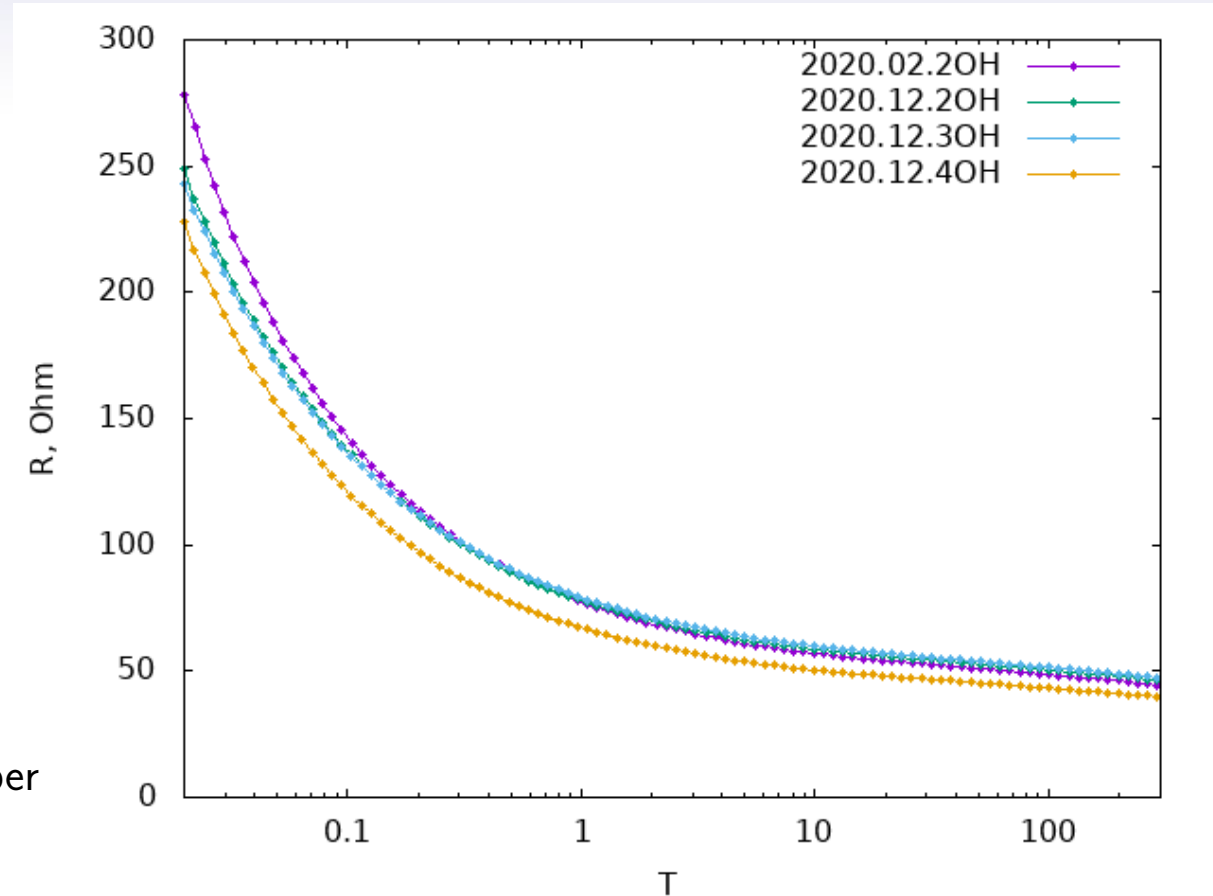
Old: no calibrated thermometers

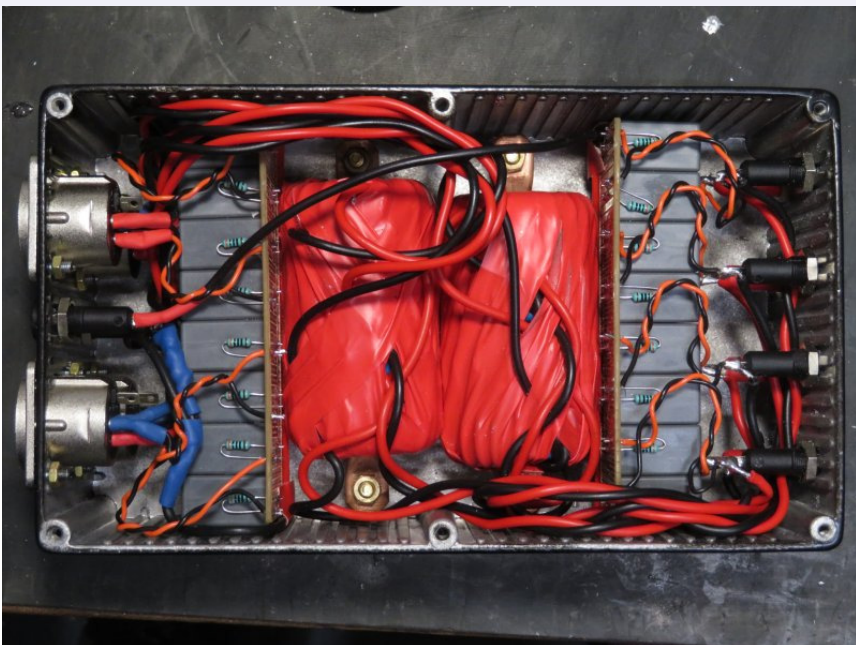


Ohmite carbon resistors, glued in copper enclosure.

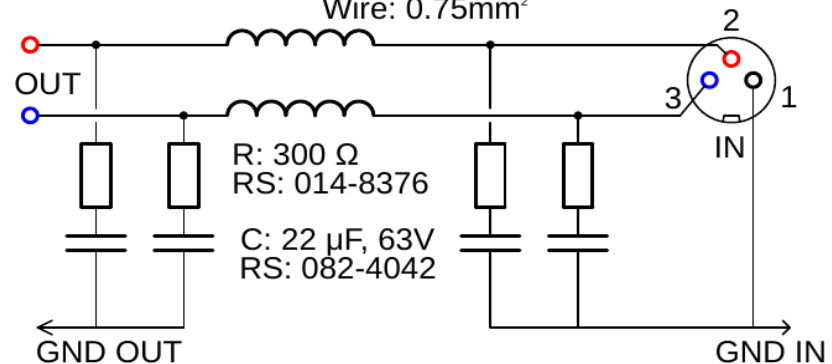
Calibrated in Triton cryostat down to 20 mK

Installed to 1K pot, still, 20 mK plate, mixing chamber



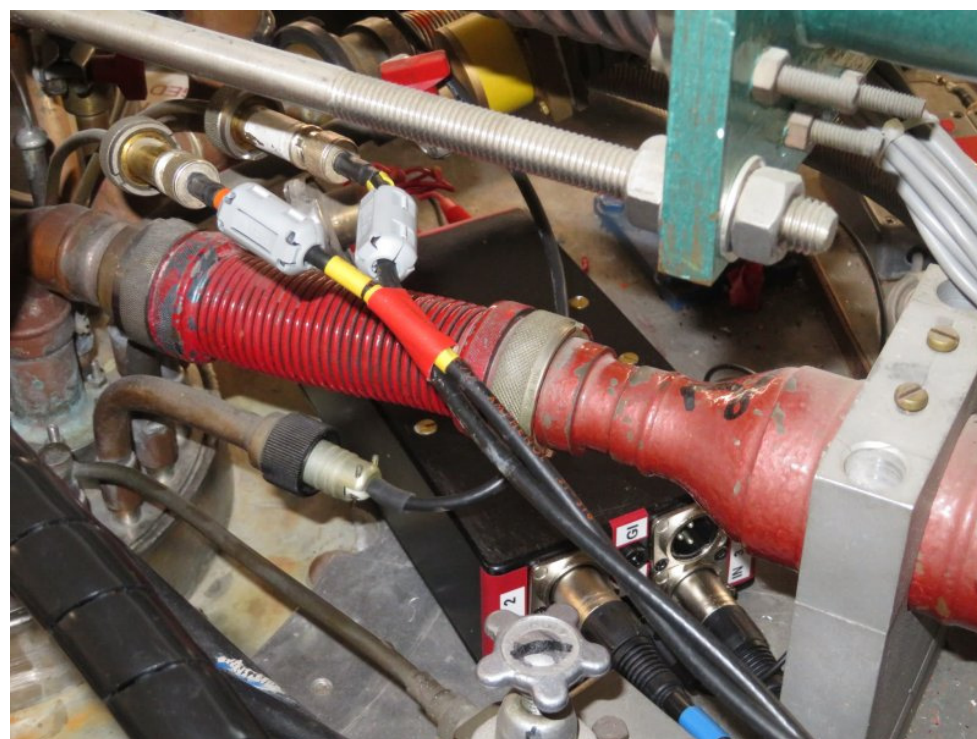


Banana connectors:  
 RS: 433-3332 L: ??  
 RS: 433-3326 Ferrite: RS:212-0875  
 Wire: 0.75mm<sup>2</sup> XLR connectors  
 RS: 046-4729  
 RS: 045-8024

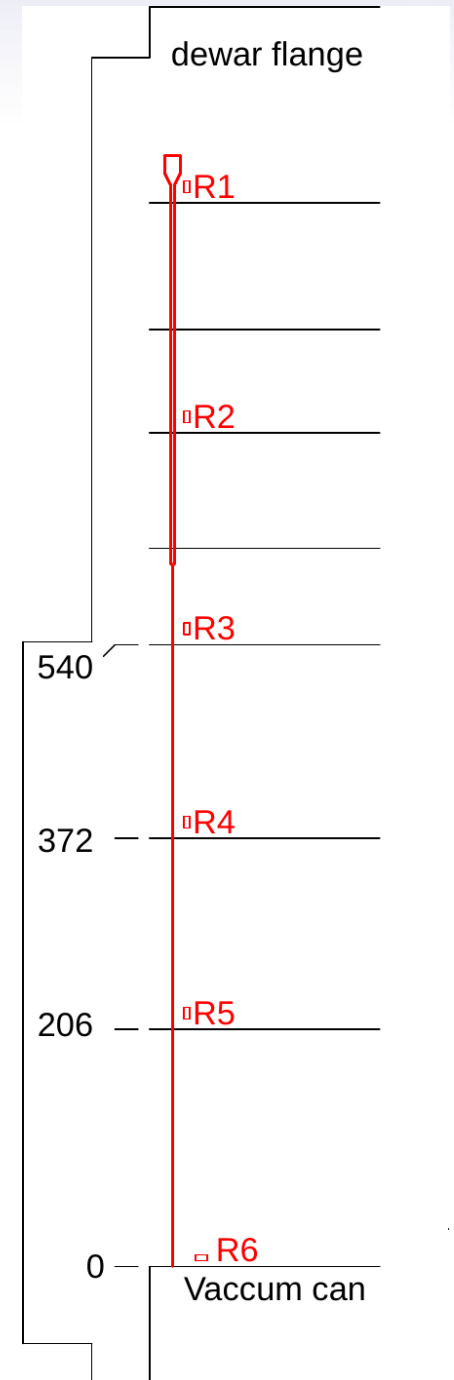
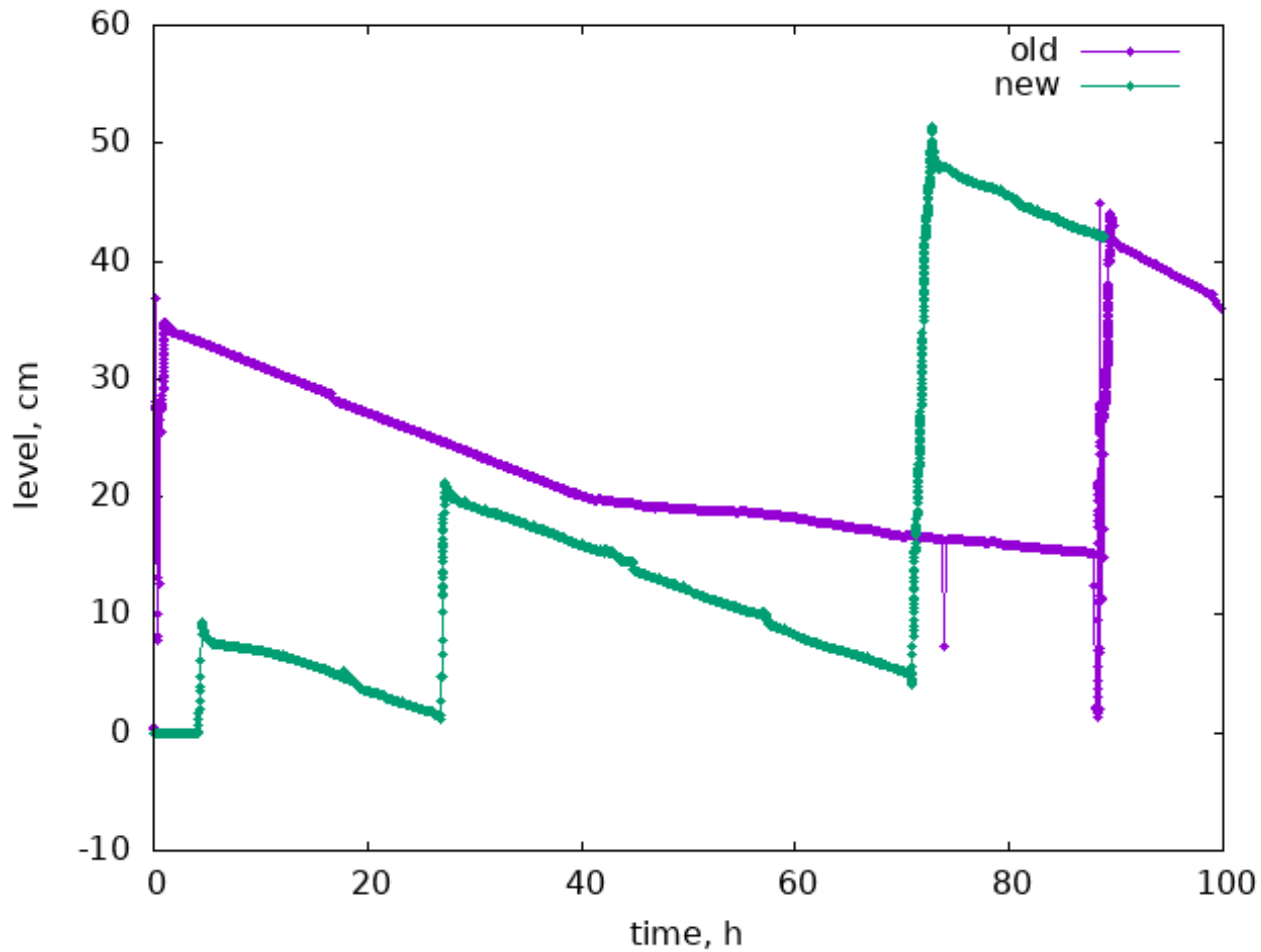


Magnet filter (4 channels)  
 V.Zavjalov, 23.03.2021

14A max

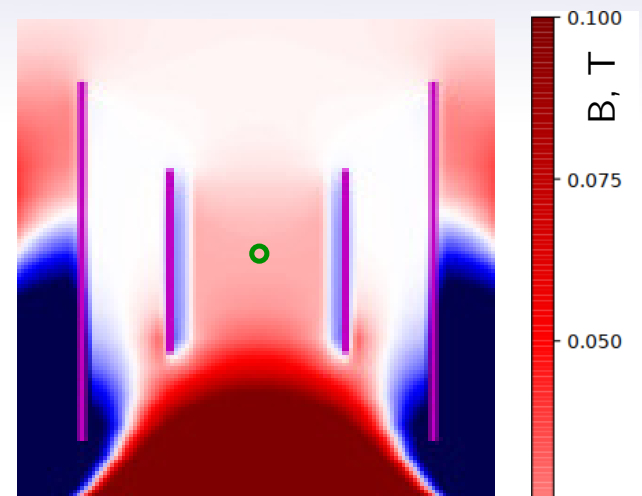
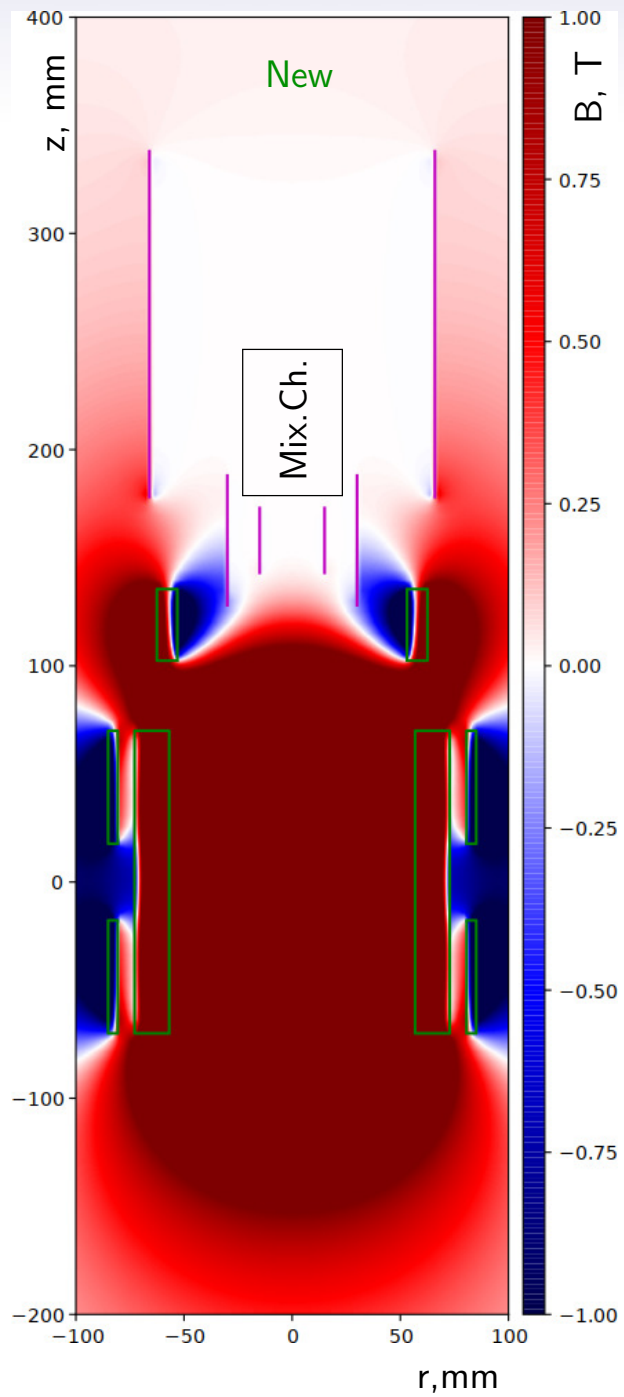
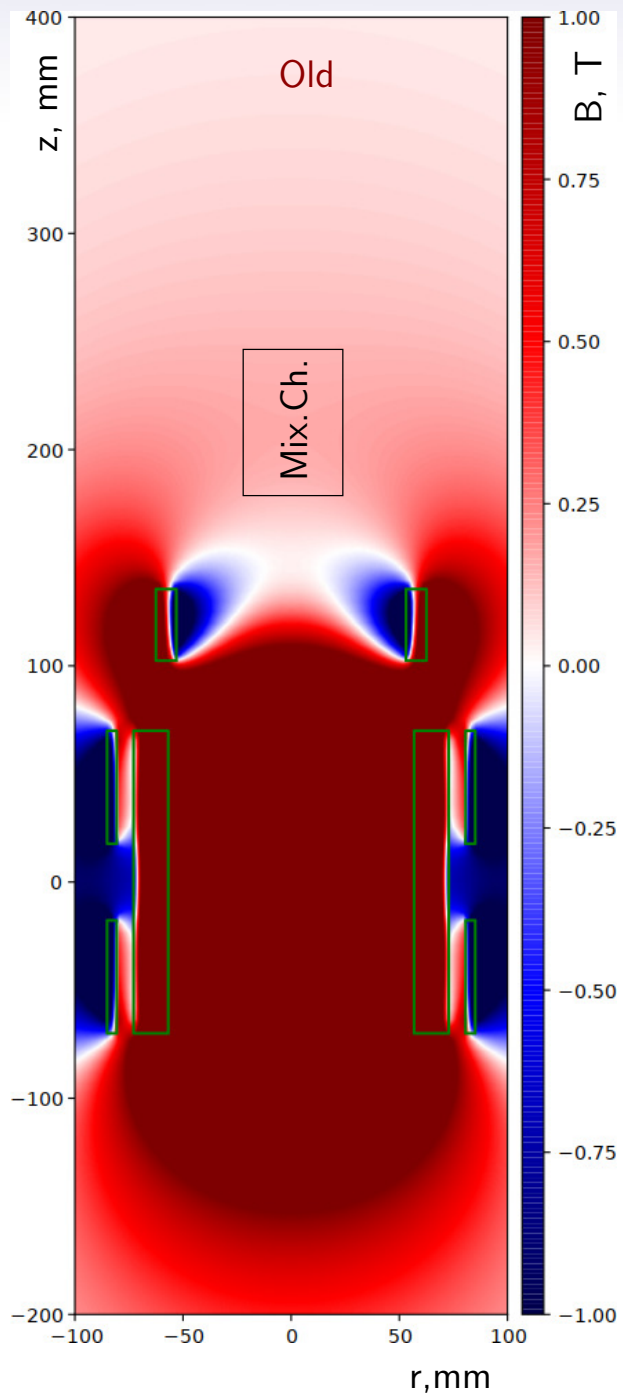


**Old:** Oxform HLM. Did not work at low levels and during transfers.  
**New:** Cryogenic level meter.

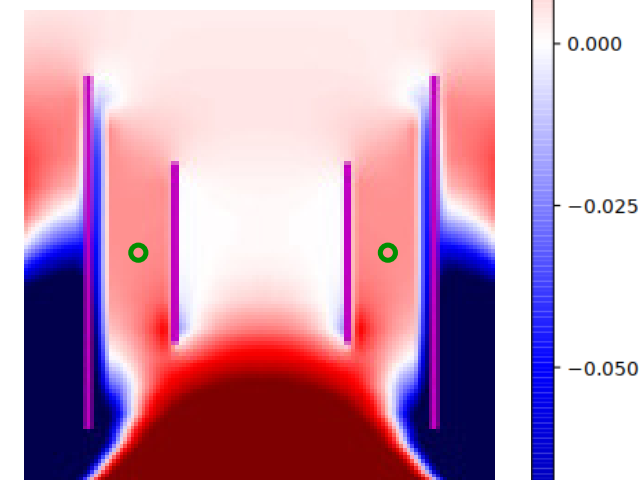




# Niobium shields



Heat switch magnet



NMR thermometer magnet

**Old construction:**

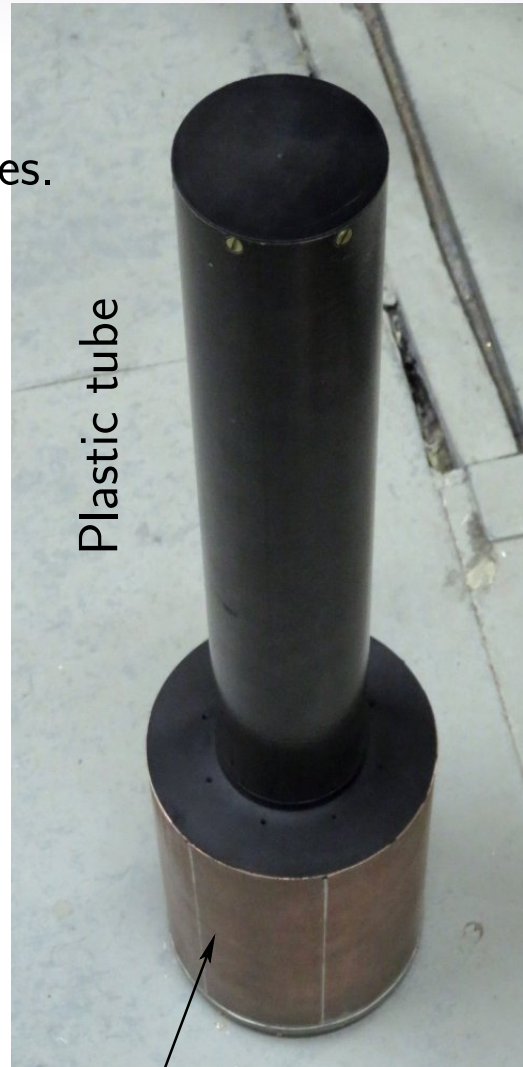
Stainless still tube 2.5" x 0.01" with copper stripes.

For magnetic field sweep rate 1 mT/s calculation gives:

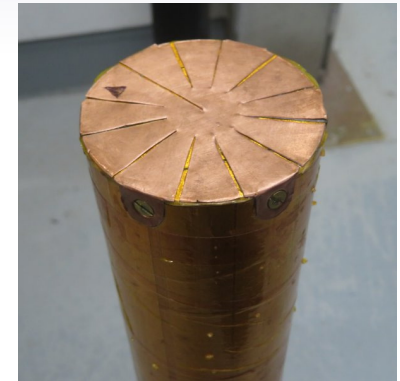
- heating:  $2 \mu\text{W}$
- temperature at the bottom end: 47 mK

**New construction:**

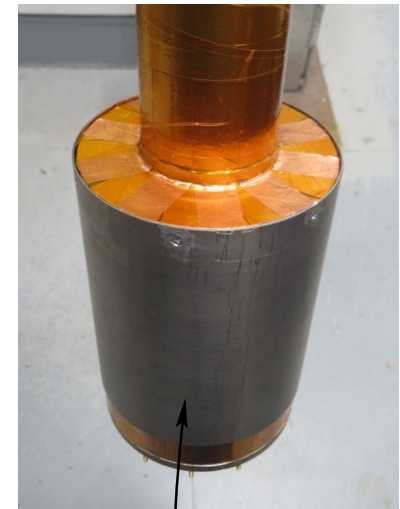
Fiberglass tube with GRP flanges covered with stripes of copper foil. No electrical contact around the tube.



Plastic tube



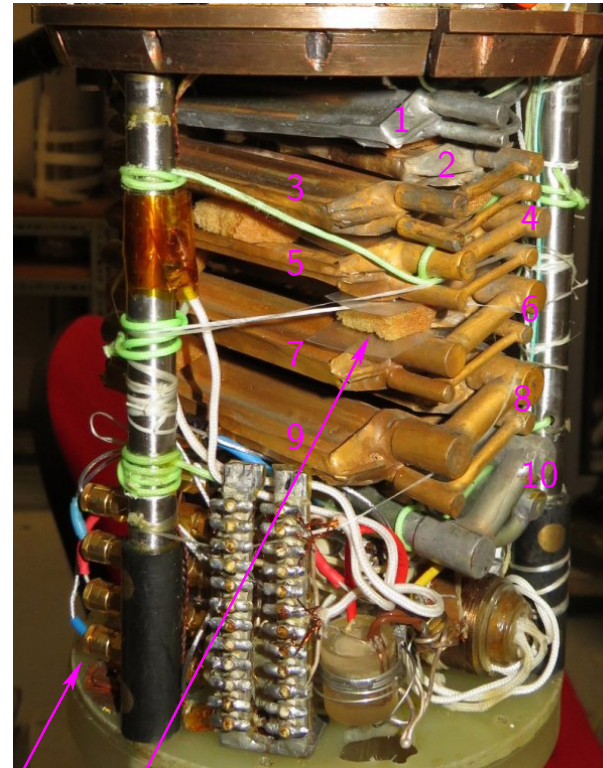
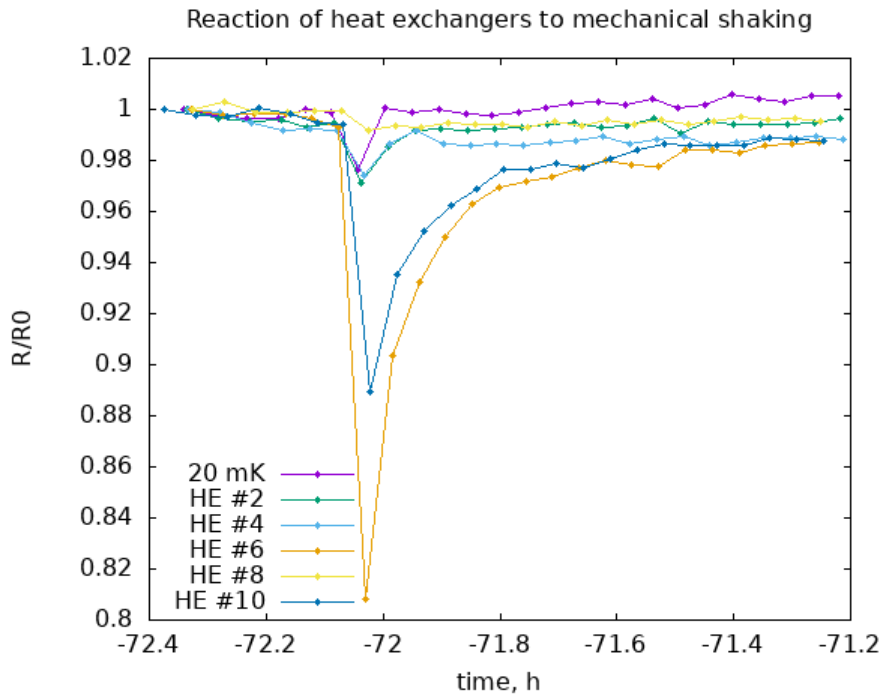
bottom of the shield: kapton-separated copper



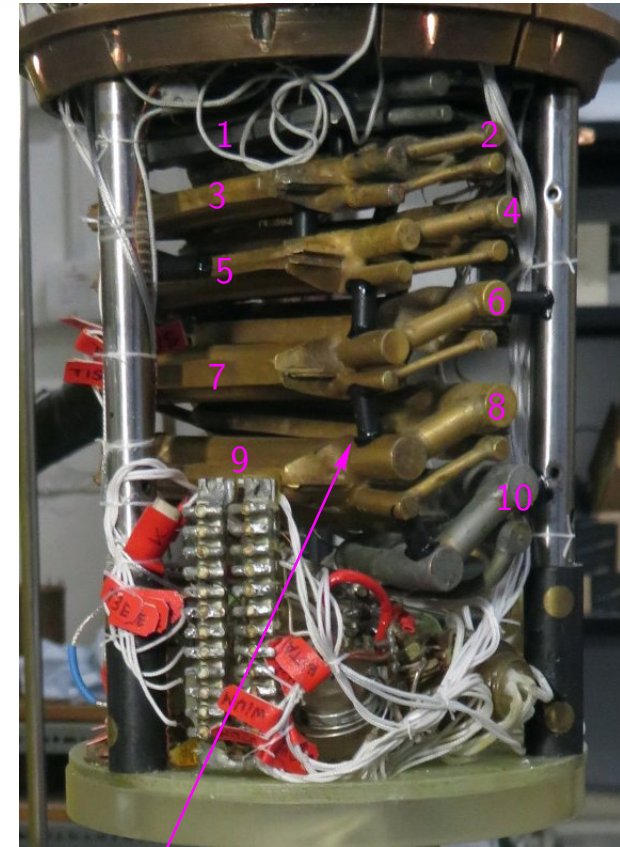
Nb shield

Upper part left unchanged: st.st. tube covered with copper

# Heat exchangers



**Old:**  
Heat exchangers fixed with threads and foam spacers.  
SMA connectors - removed



**New:**  
Heat exchangers separated with pieces of plastic tube

Shaking of heat exchangers can result in heating. Temperature measurements show that HE 6 and 10 were heating more than others.

