

Field penetration experiment

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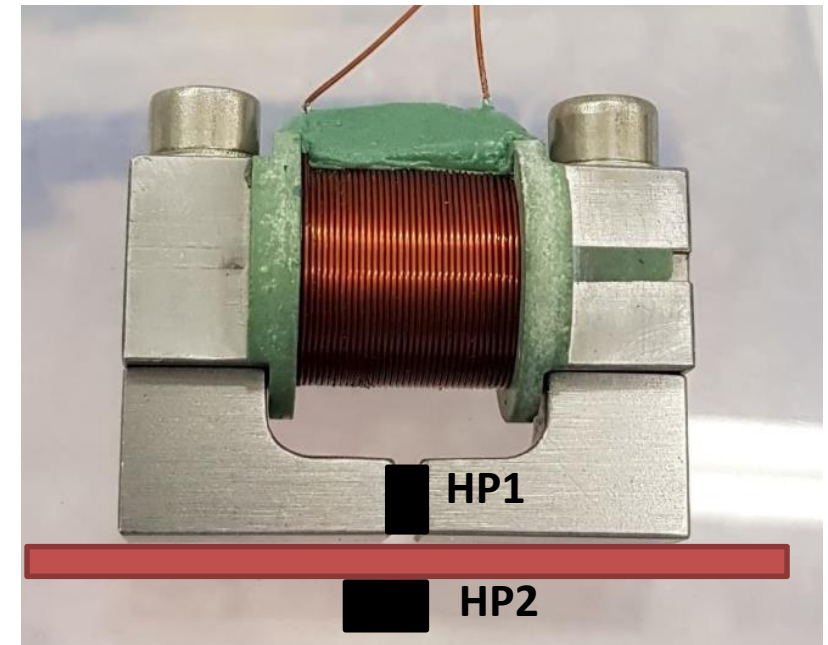
Field penetration concept

- DC magnetic field parallel to the surface
- Field local to the sample surface
 - Avoid edge effect.
 - Allow possibility if sample scanning.
- Magnetic field applied from one side of the sample to the opposing side, similar to an SRF cavity
 - Advantage over VSM/SQUID – Reduced edge effects
- Compatible with small flat samples (easy to deposit)

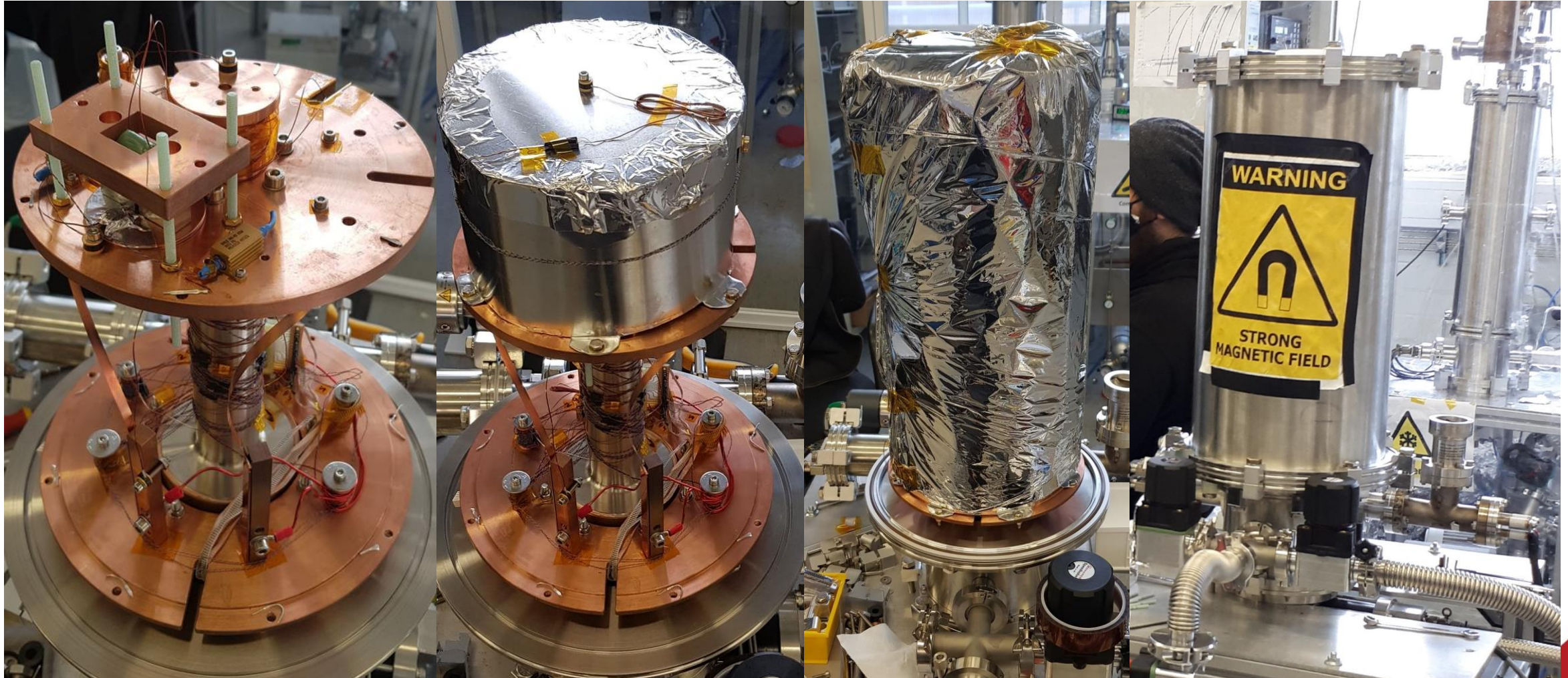
Engineering Concept:

- Simple facility with fast turn around of samples
- Cryogen free – Health and safety concerns, cost of LHe, no problem with LHe supply.
- Run at a range of temperatures

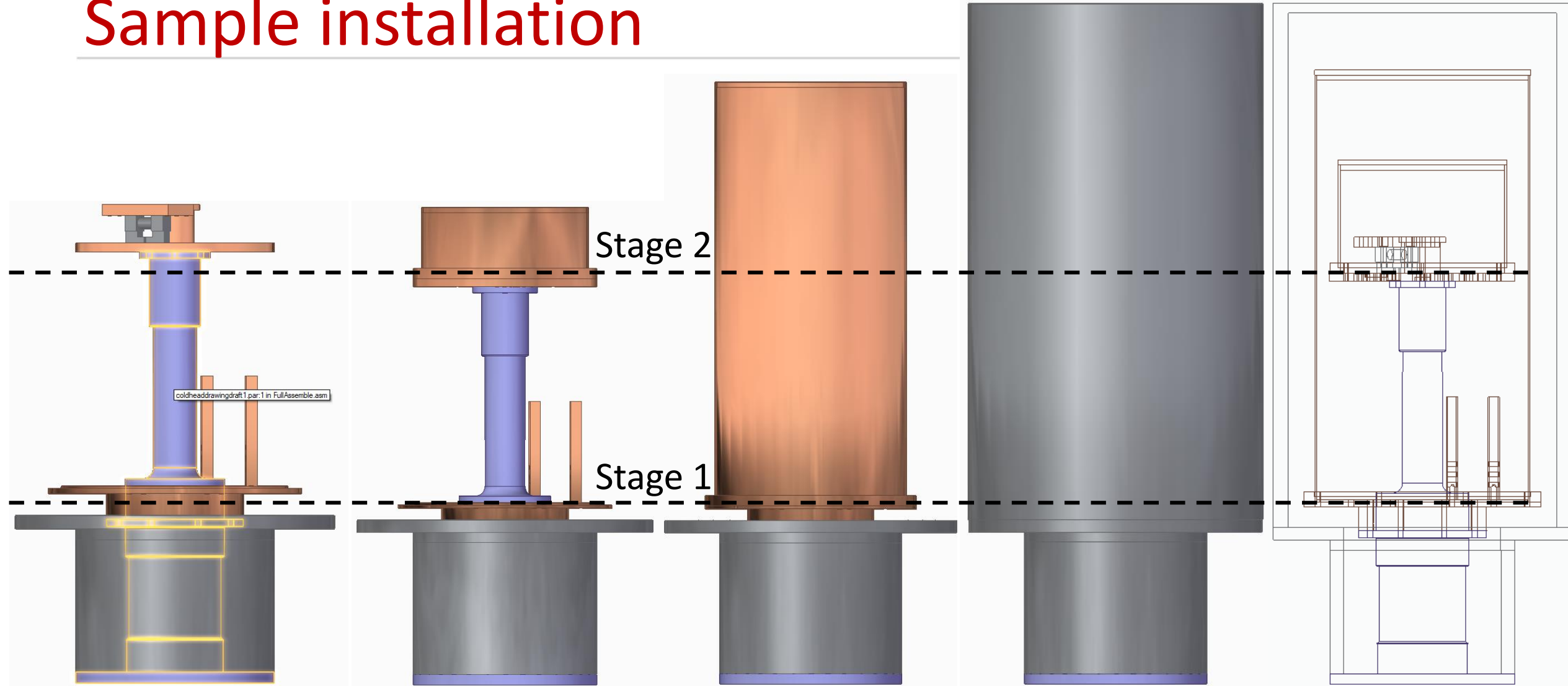
Sample



New facility

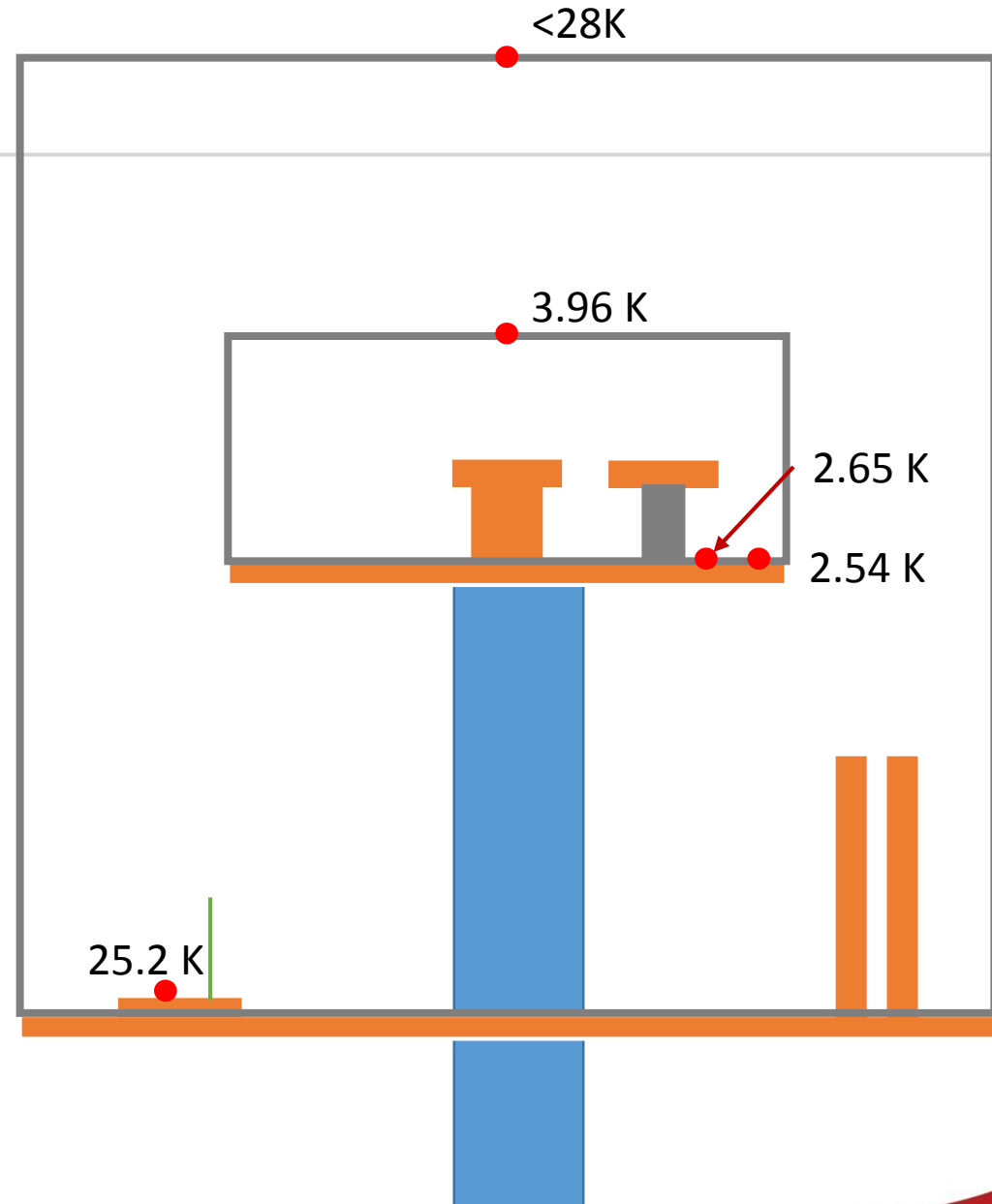


Sample installation

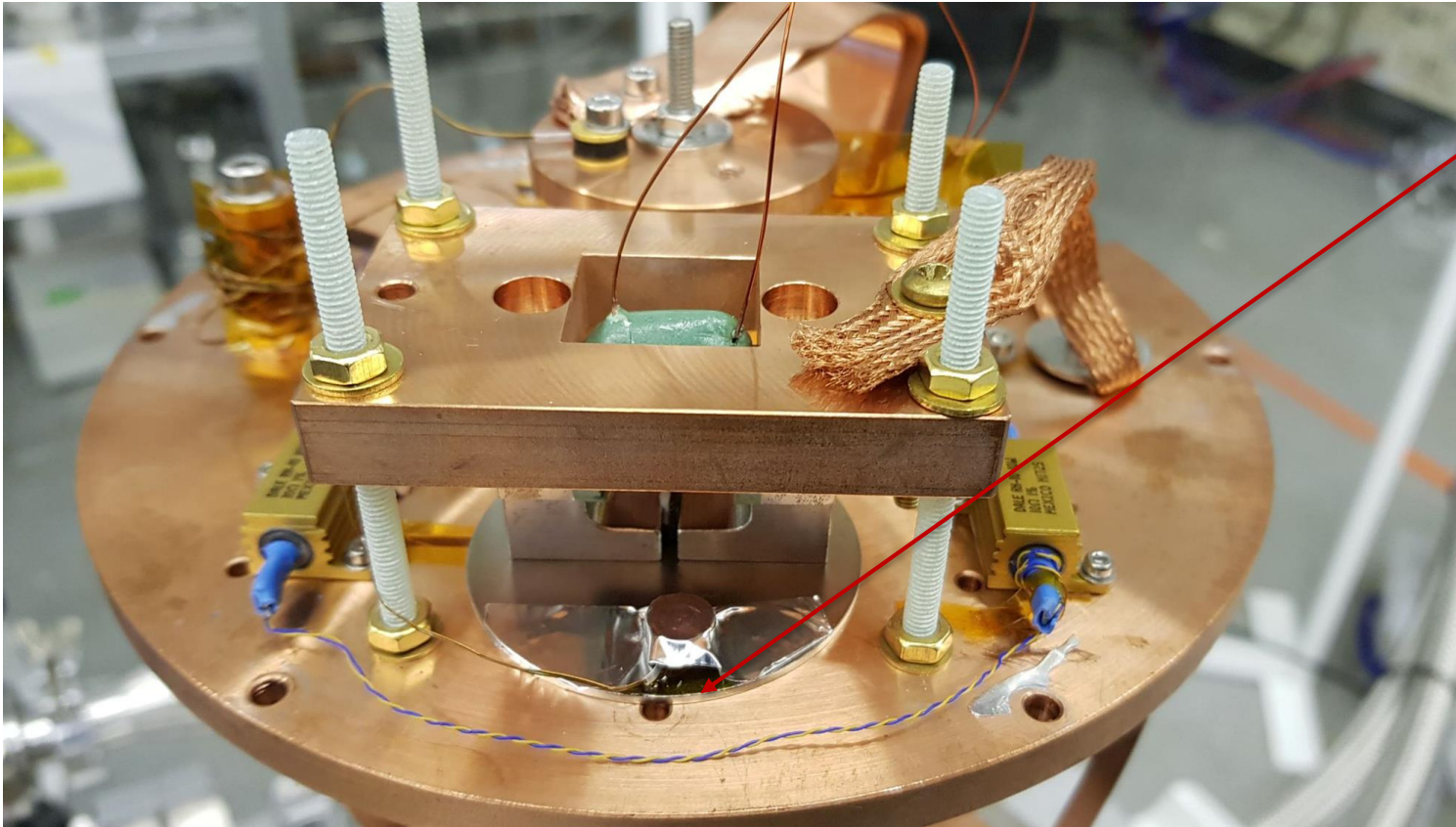


System minimum temperature

- The minimum temperature the sample will reach is approximately 2.6 K.
- The minimum temperatures are reproducible.

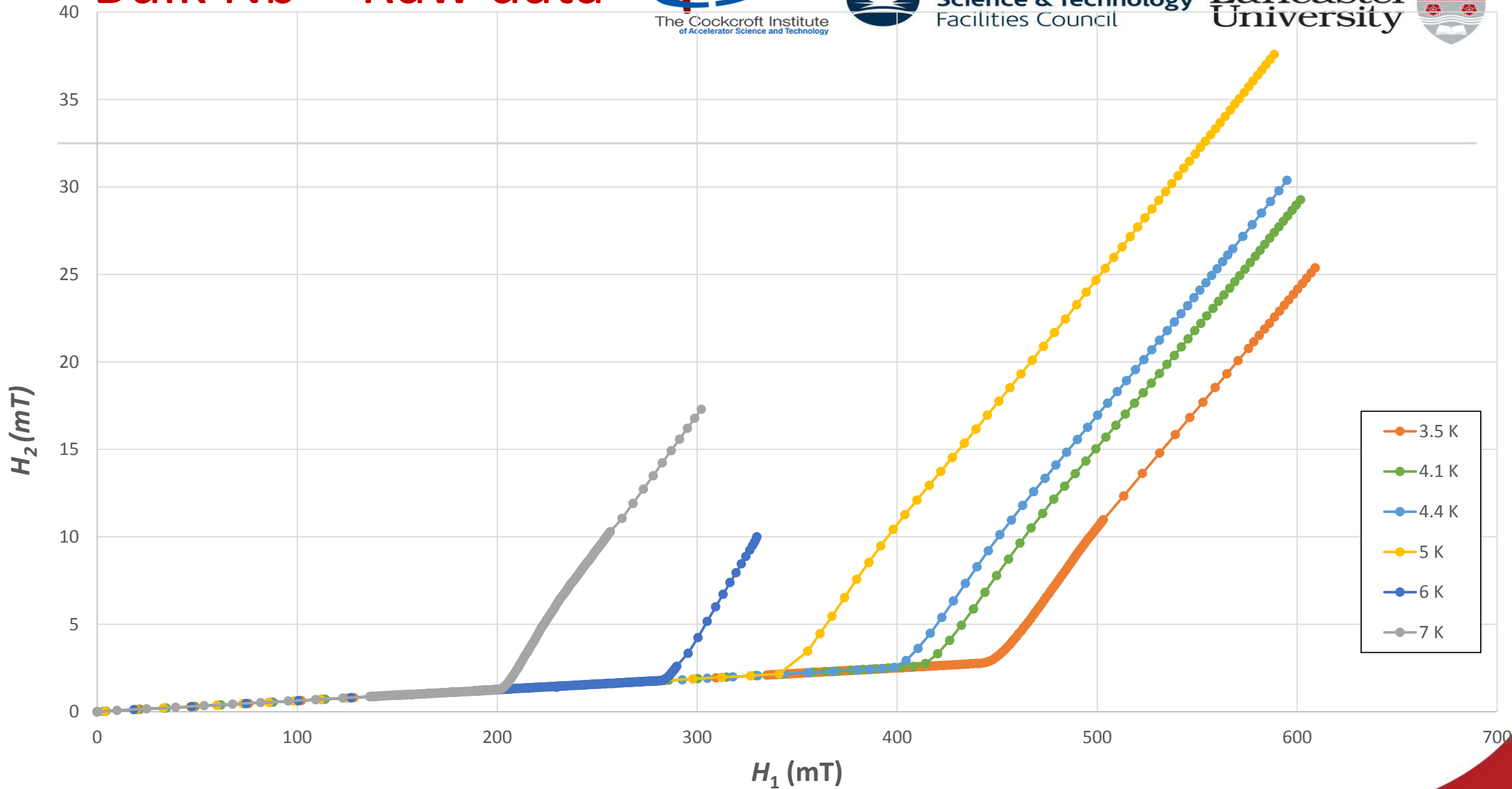


Trial run – Bulk Nb, 1.28mm thick, Niowave, RRR 400



- There is usually a thermometer **here**.
- Due to the size of the sample it had to move to the back of the plate, and another thermometer was stuck onto the sample using both GE varnish and Al tape.

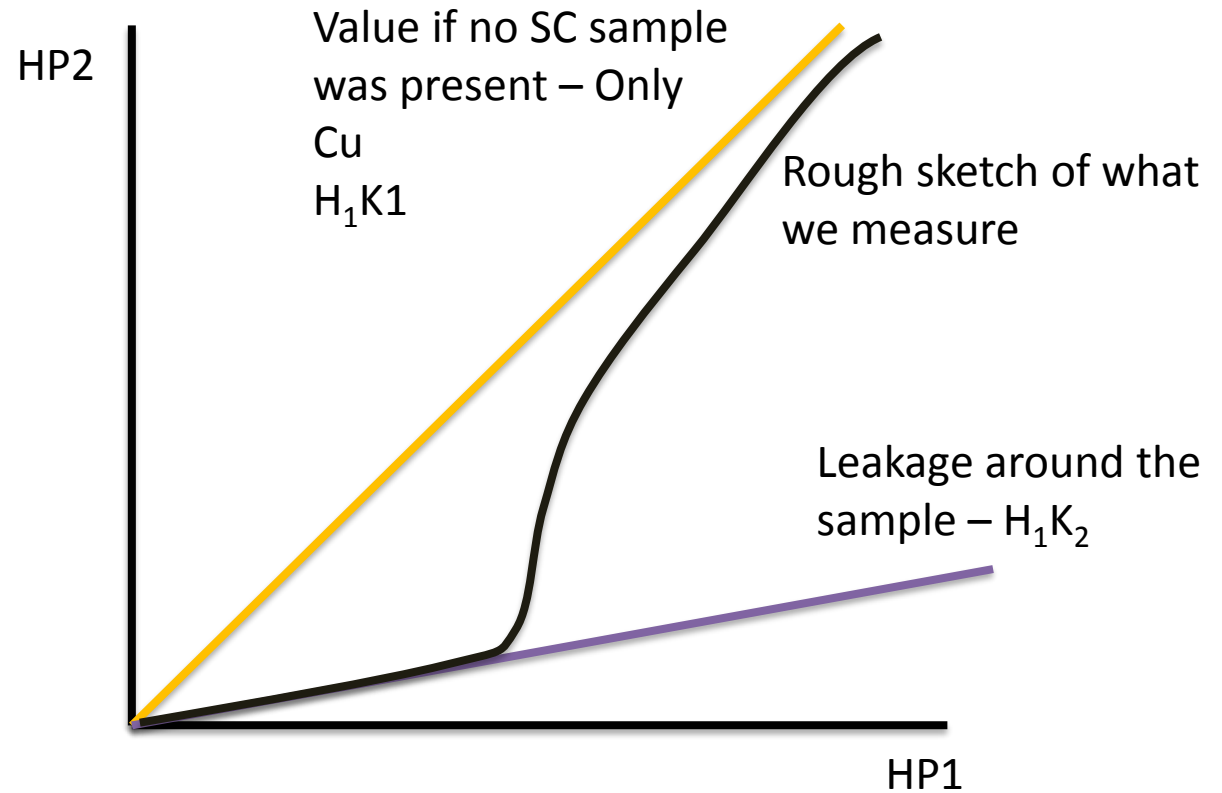
Bulk Nb – Raw data



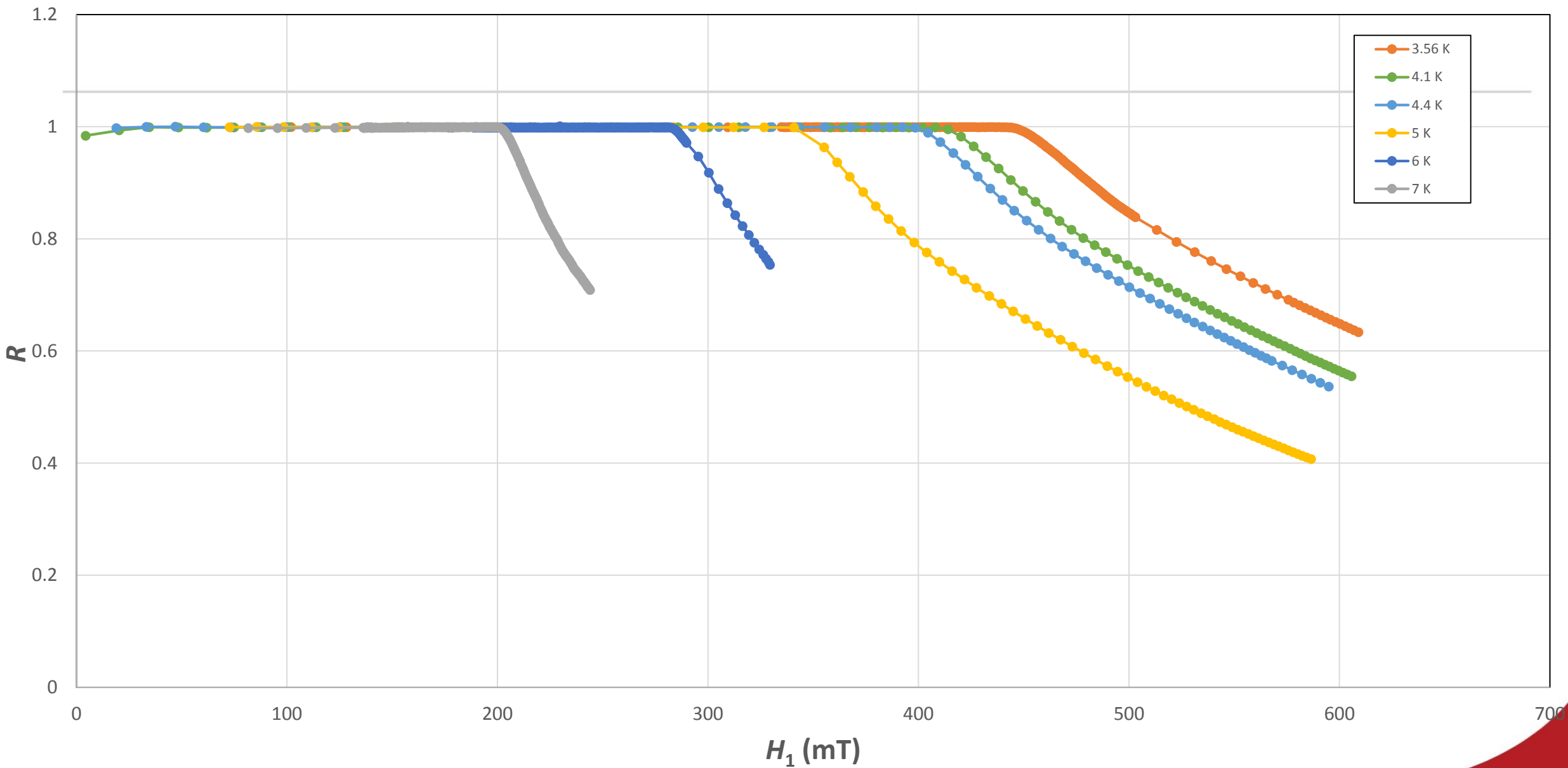
Normalisation

$$R = 1 + \frac{K_2}{K_1} - \frac{H_2}{K_1 H_1}$$

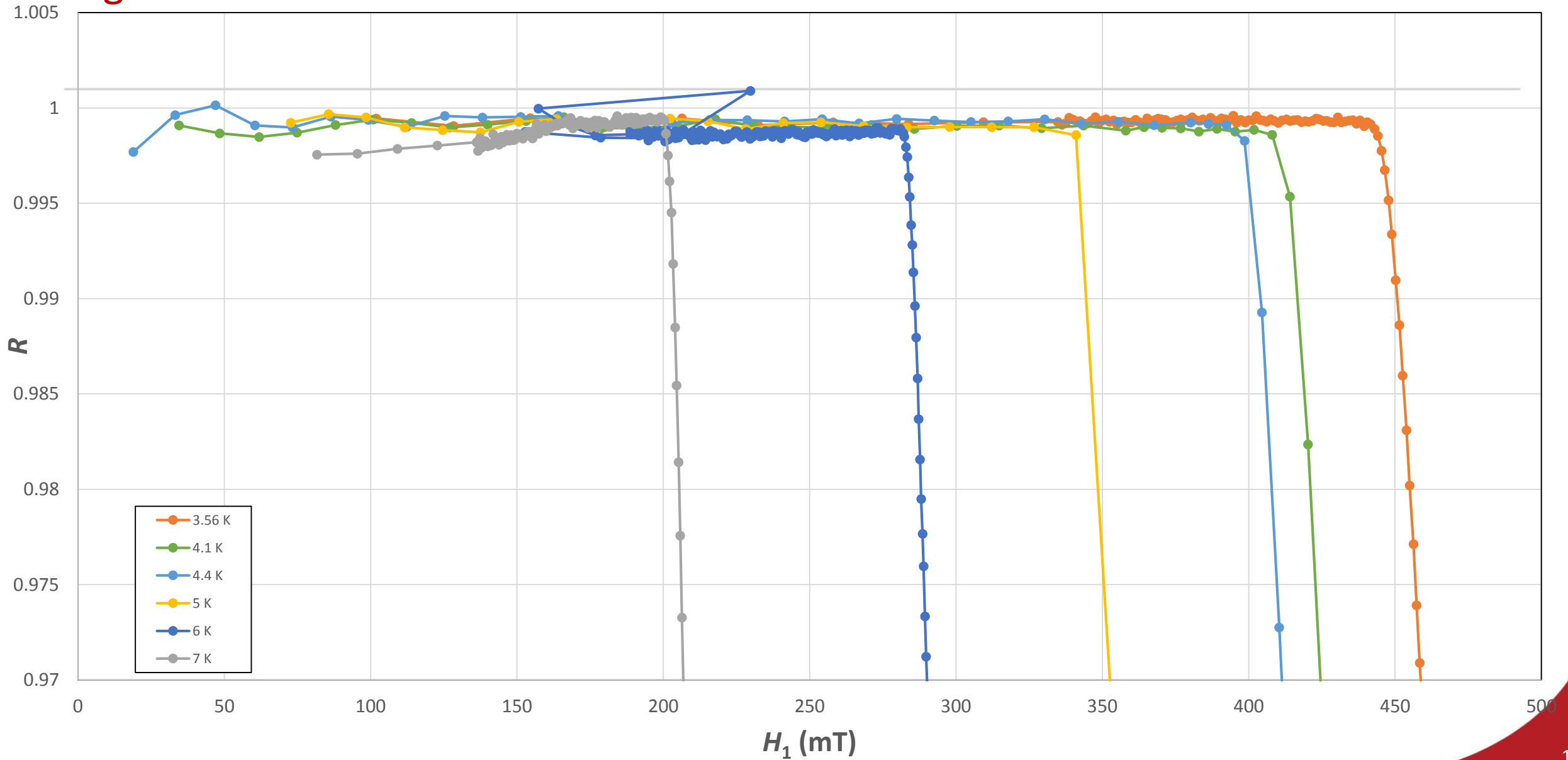
This gives a ratio in the superconducting state, when $R \leq 0.99 = H_{fp}$



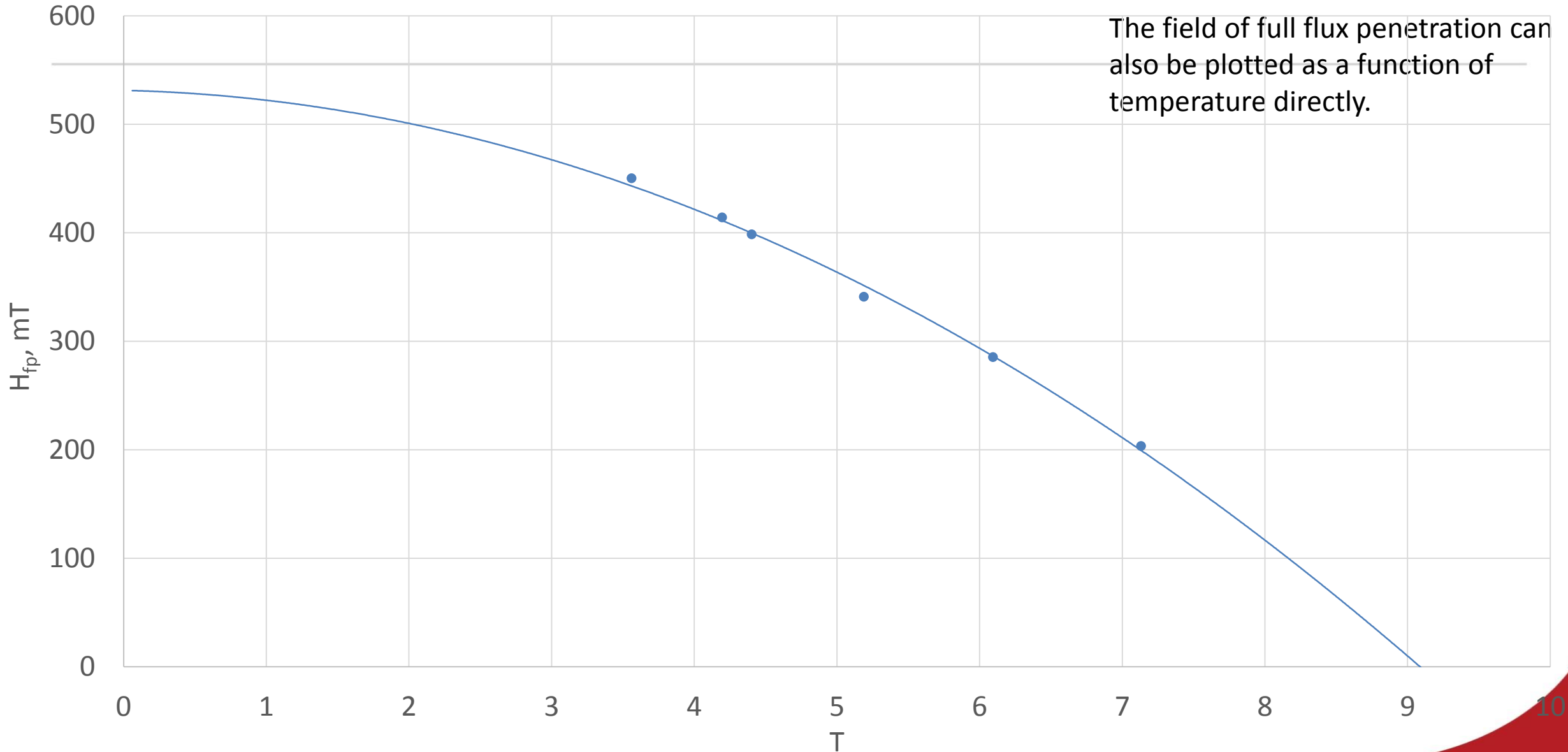
Bulk Nb – Normalised data



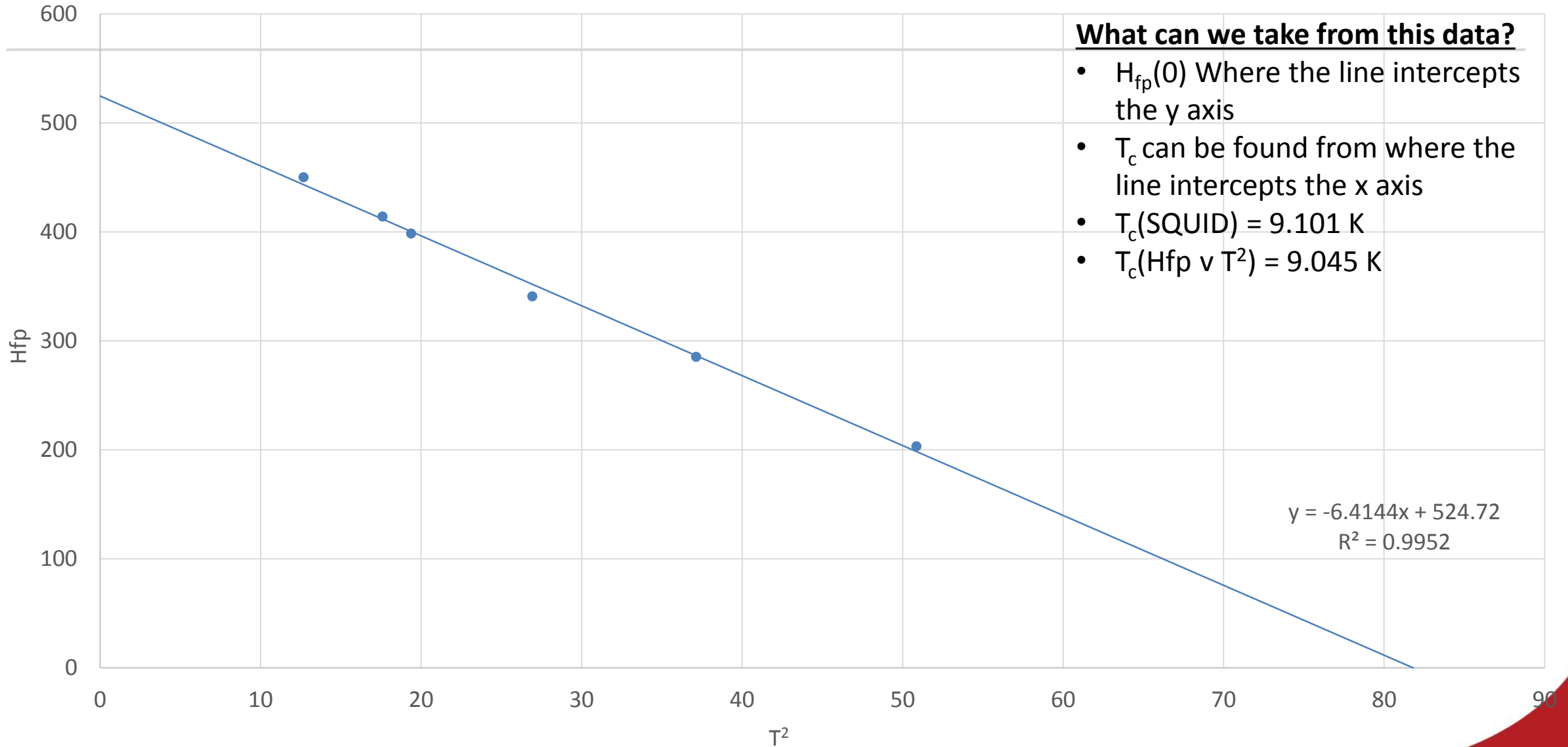
Bulk Nb – Normalised data - Magnified



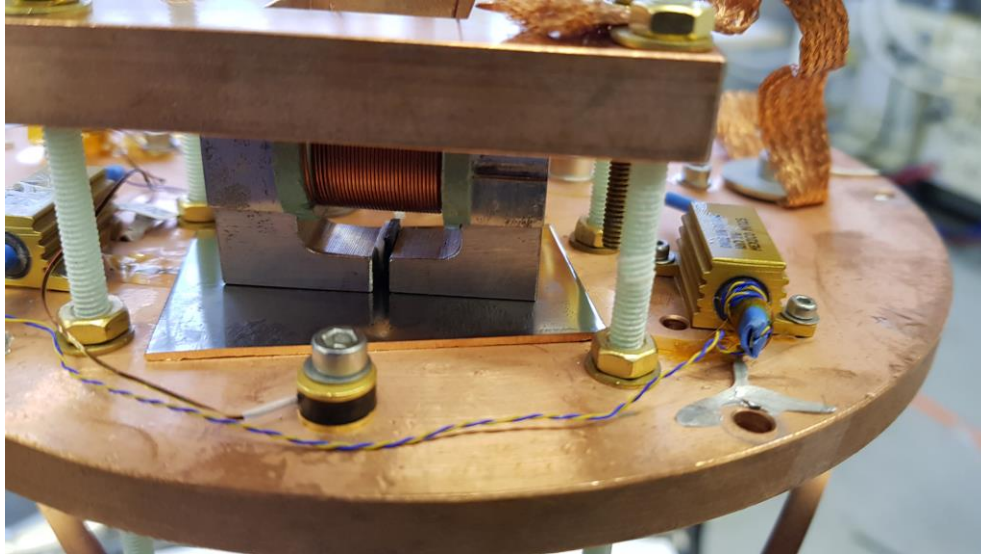
Bulk Nb – H_{fp} vs T



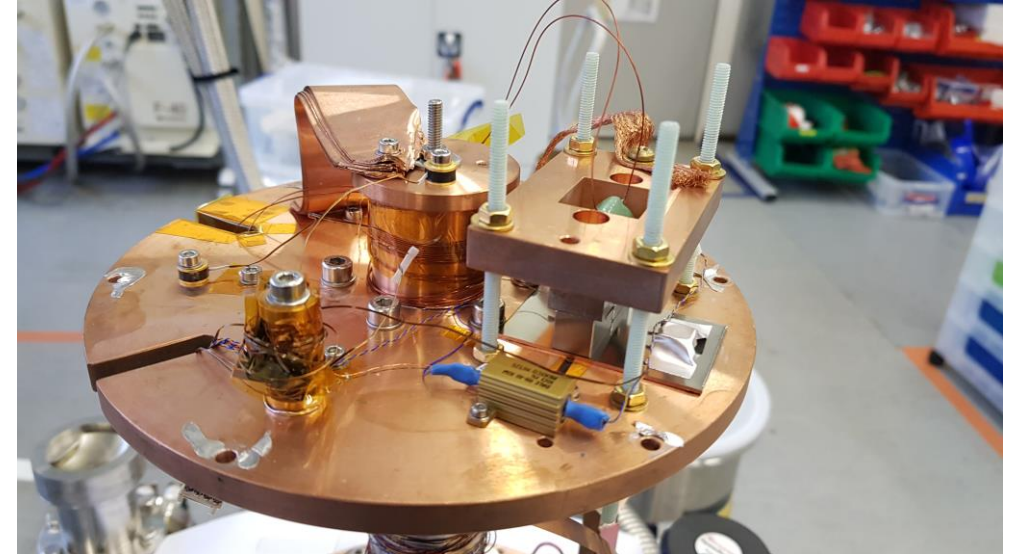
Bulk Nb – H_{fp} vs T^2



Sample C1 - 3 μ m Nb on Cu, Deposited by Siegen, CERN SUBU



- The sample could not be perfectly in line with the magnet due to the space taken up by the bolts.
- Initially there was no thermometer attached.
- This position produced the lowest amount of leakage

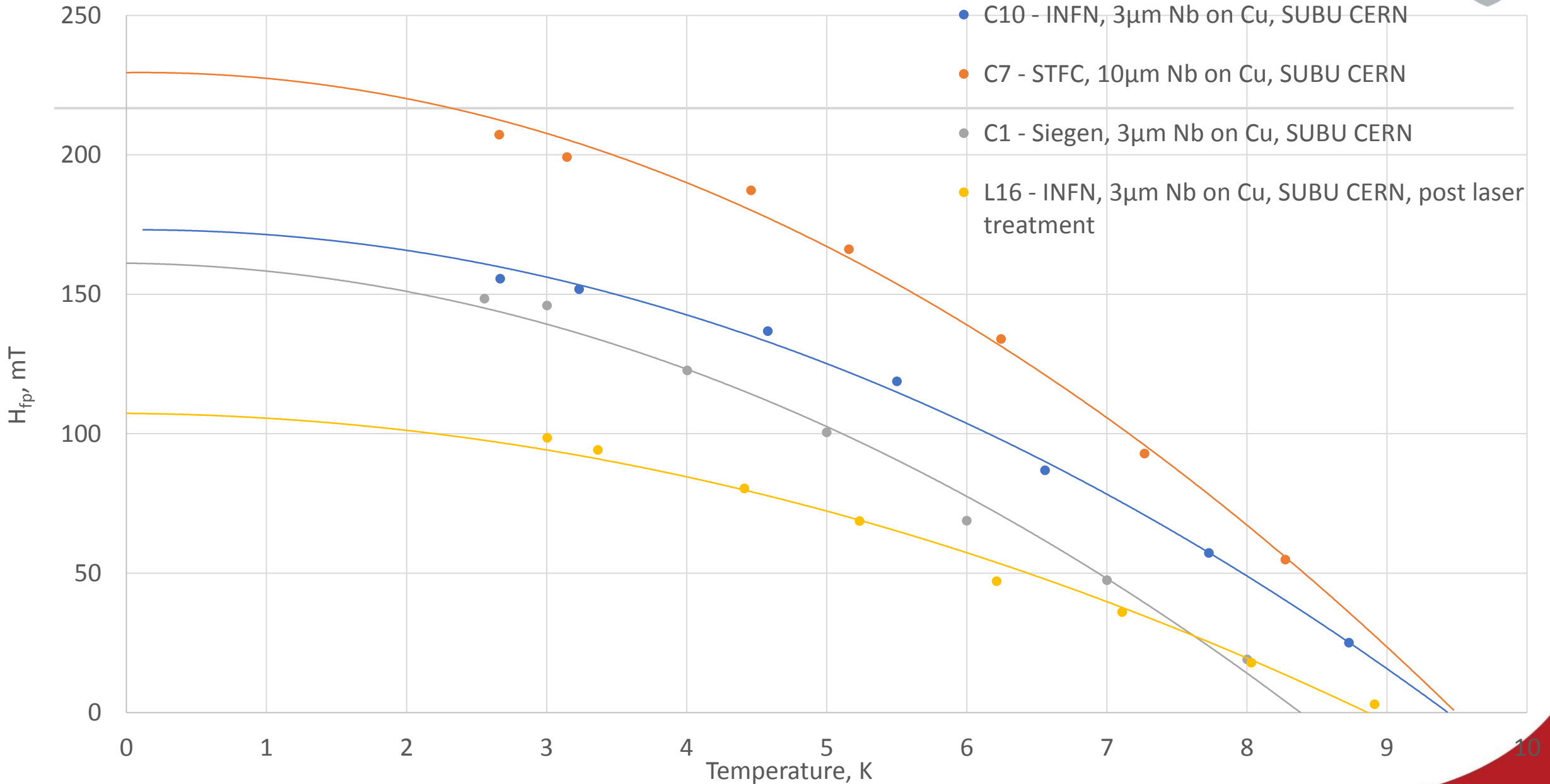


- Thermometer on the edge of the plate had to move, so another was **taped** onto the sample.
- This position produced the more leakage than the position in the image on the left.

Table

Bratislava VSM (4.22 K)													Laser RTU			STFC Field penetration	
Code	Origin	Sample		Treatment	B_{Perp} [mT]	B_{\parallel} [mT]	T_c [K]	B_{Perp} [mT]	B_{\parallel} [mT]	T_c [K]	$H_{\text{fp}}(0)$ [mT]	$H_{\text{fp}}(4.5\text{K})$ [mT]					
		Material	Thickness														
C7	STFC	Nb	10 μm	SUBU CERN	24.1	150.1				9.533	229.47	187.25					
L13	STFC	Nb	3 μm	EP	22	100.3											
L18	STFC	Nb	3 μm	EP + SUBU	17.7	61											
L19	STFC	Nb	3 μm	SUBU	17.3	73.2											
C1	Siegen	Nb	3 μm	SUBU CERN	15.5	49.6				8.512	172.35	130.43					
L1	Siegen	Nb	3 μm	SUBU INFN	14.5	38											
L9	Siegen	Nb	3 μm	Tumbling	16	38.6											
L10	Siegen	Nb	3 μm	EP	15.5	32.7											
L23	Siegen	Nb	3 μm	EP + SUBU	15	24.5											
C10	INFN	Nb	3 μm	SUBU5 CERN	12			17	50.2	9.455	173.1	136.78					
L8	INFN	Nb	3 μm	Tumbling	18			19.1	42.5								
L16	INFN	Nb	3 μm	EP + SUBU5	14			15.5	47.2	8.835	107.29	80.341					
L20	INFN	Nb	3 μm	SUBU5 INFN	20			23.7	45								
L21	INFN	Nb	3 μm	EP	18			18.8	45.2								

Comparison graphs



Conclusion

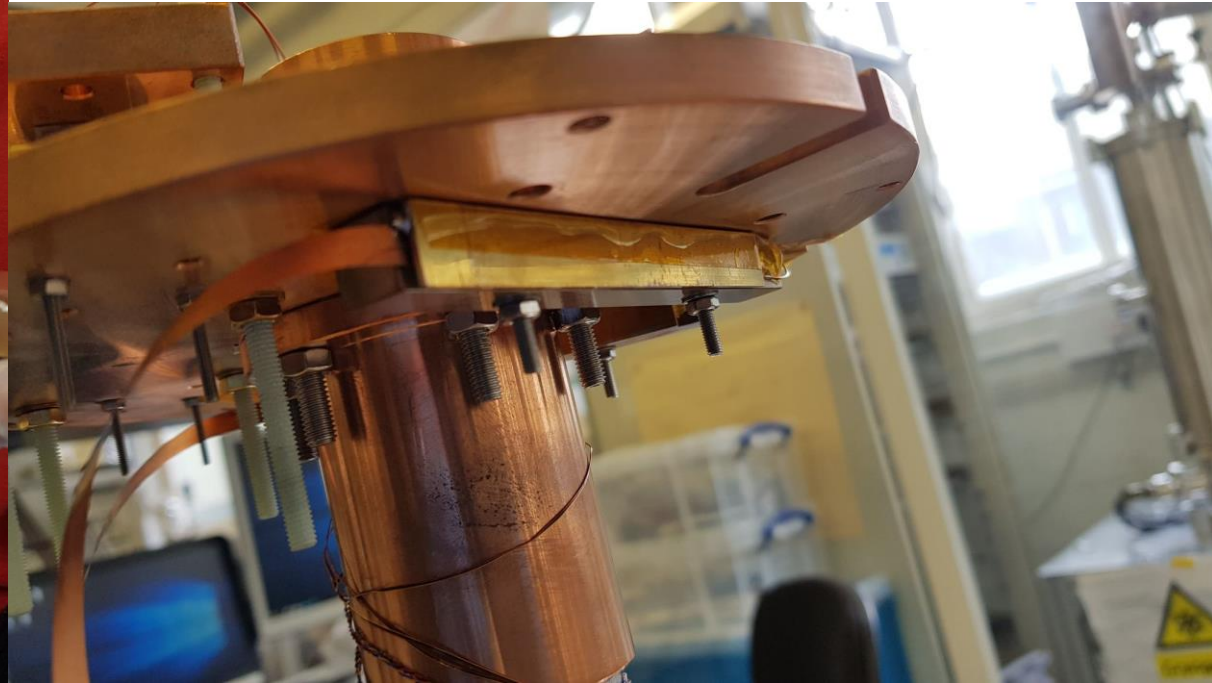
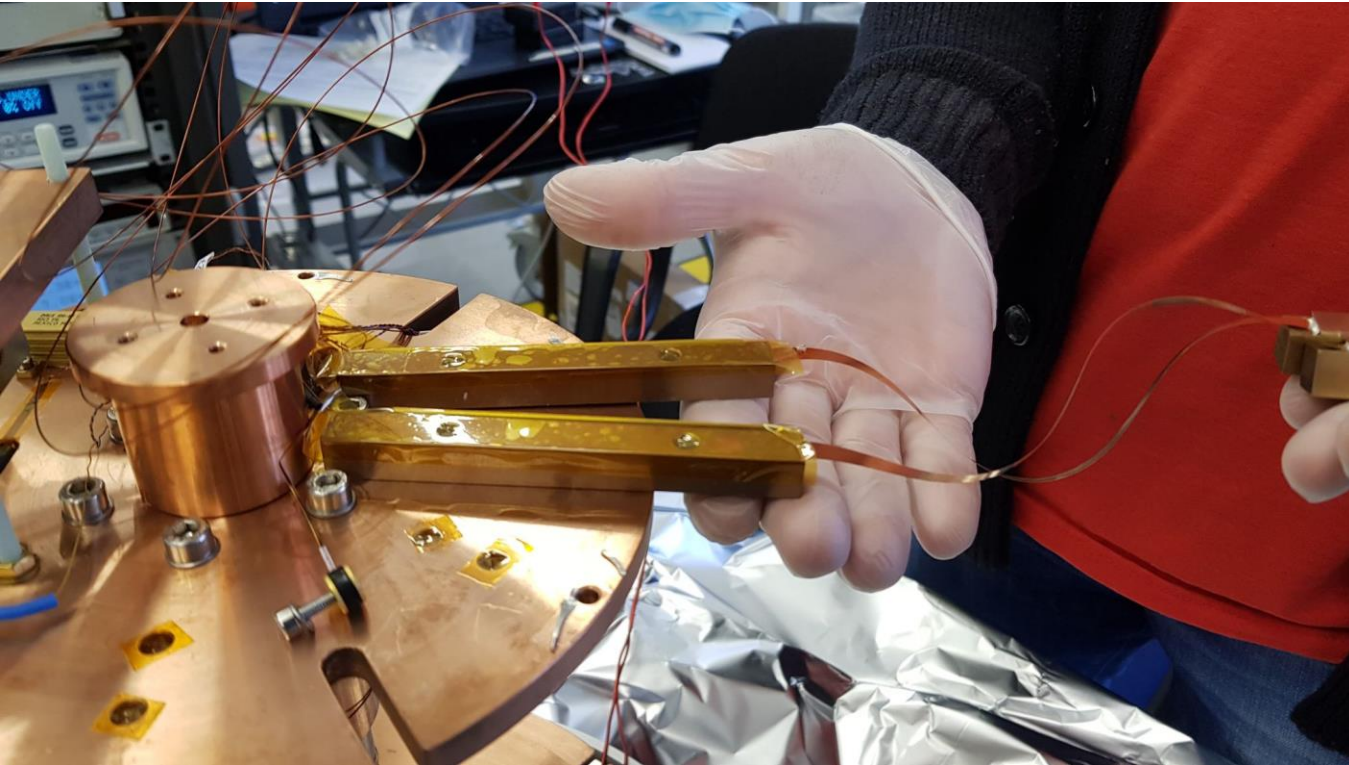
- Penetration method works
- Can compare between various samples for **full** penetration magnetic field as a function of temperature in the range between 2.5 – 9 K
- Facility built and operated as expected.
- We can measure 1 sample a day, with 1 day to install a new sample (3 samples a week)
- More data is needed to speculate about the capability of the system.
- Looking at methods to improve the system

Sample size:

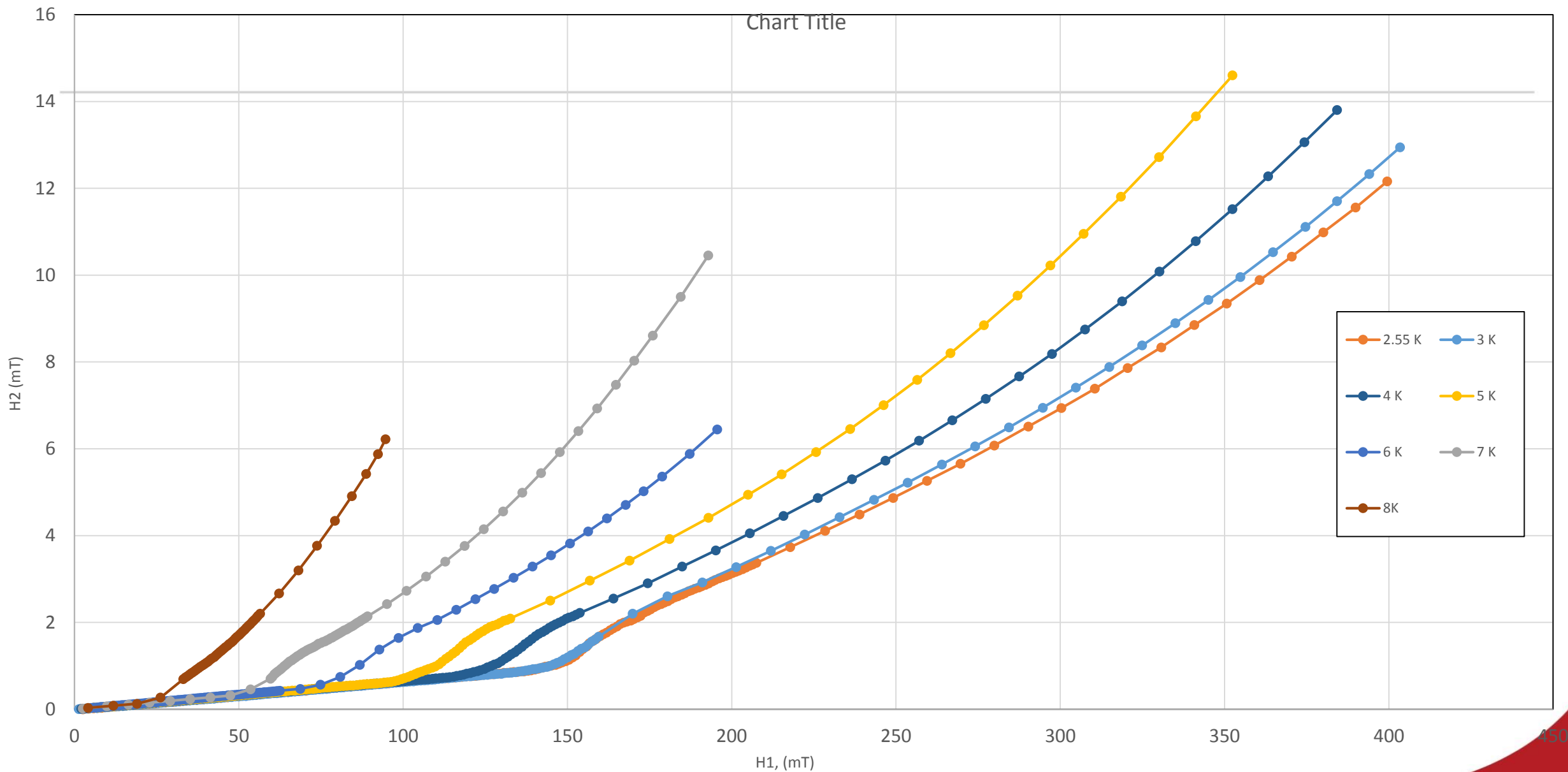
- Smallest size tested is 35×35 mm²
- Maximum size is diameter 50 mm
- Curved samples (eg – Cavity cut outs) can be a future possibility.

Samples welcome!

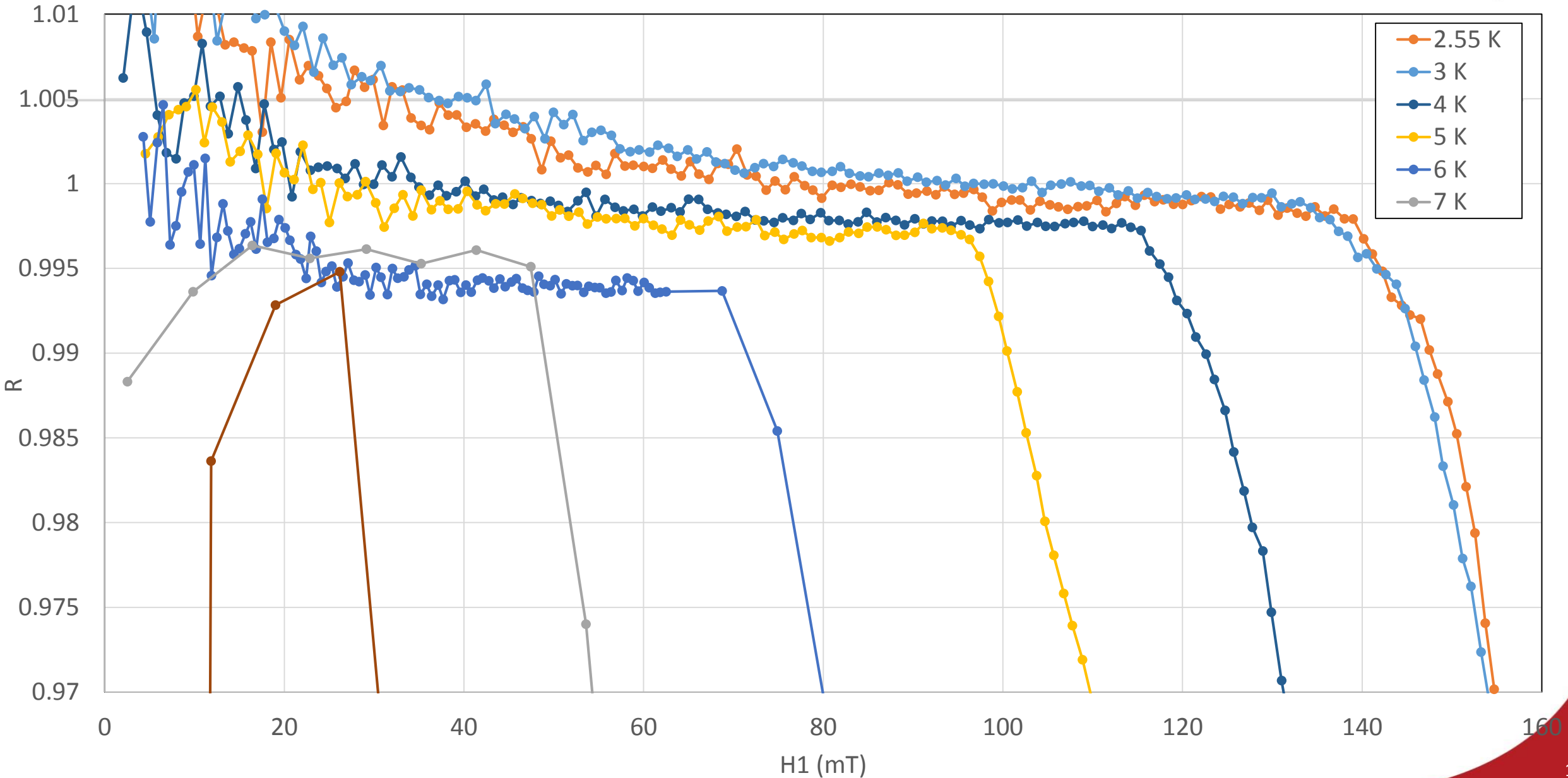
Thanks for listening



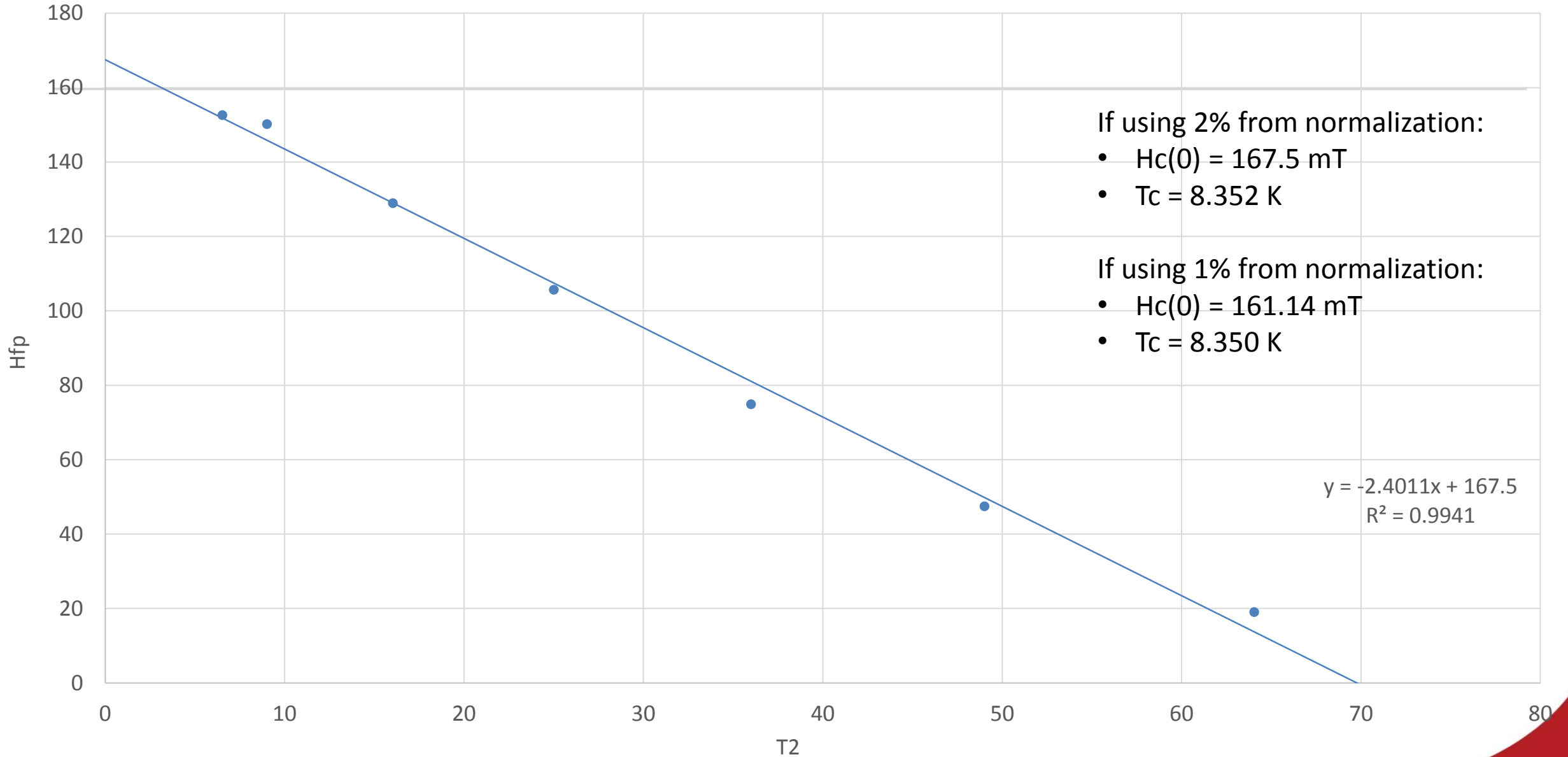
C1



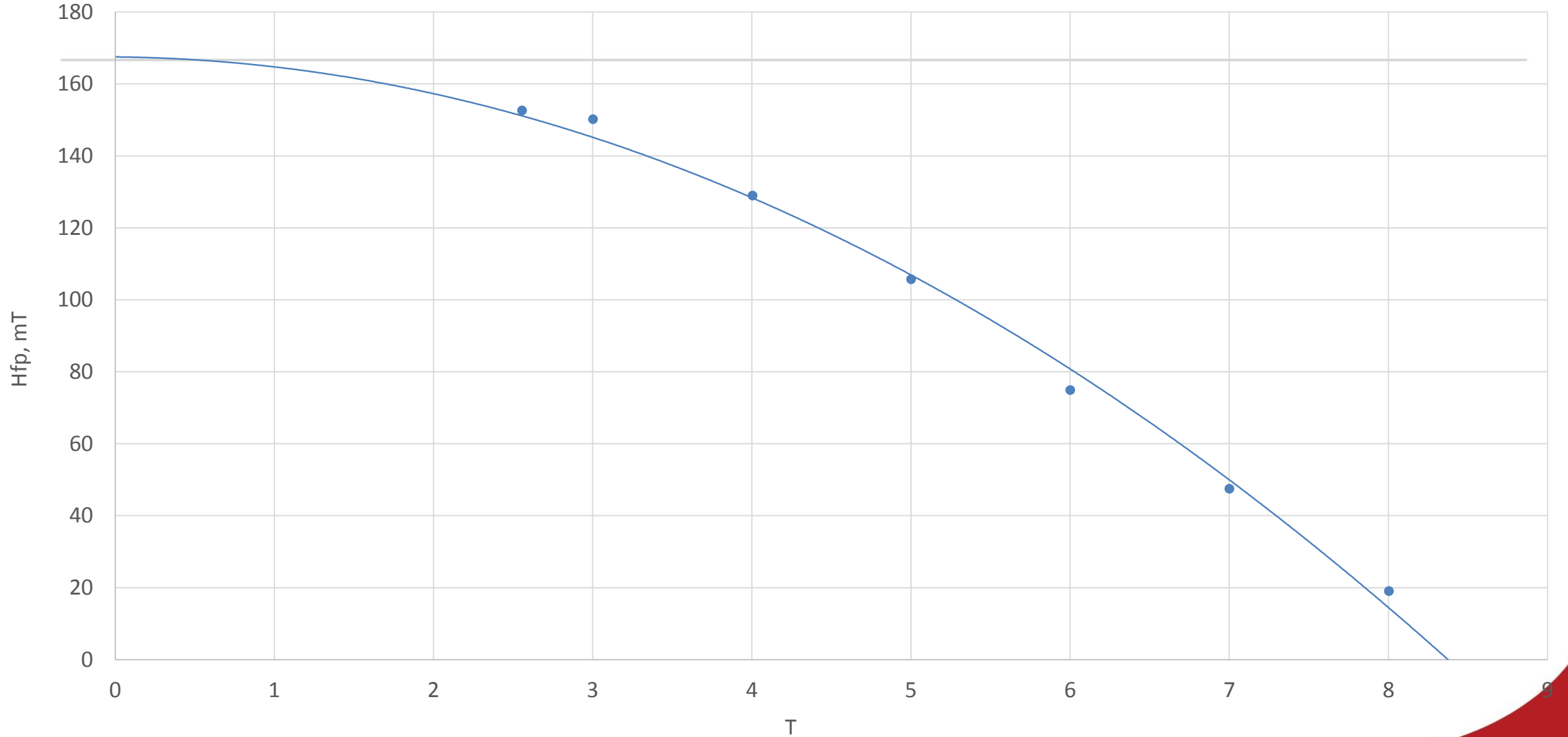
C1



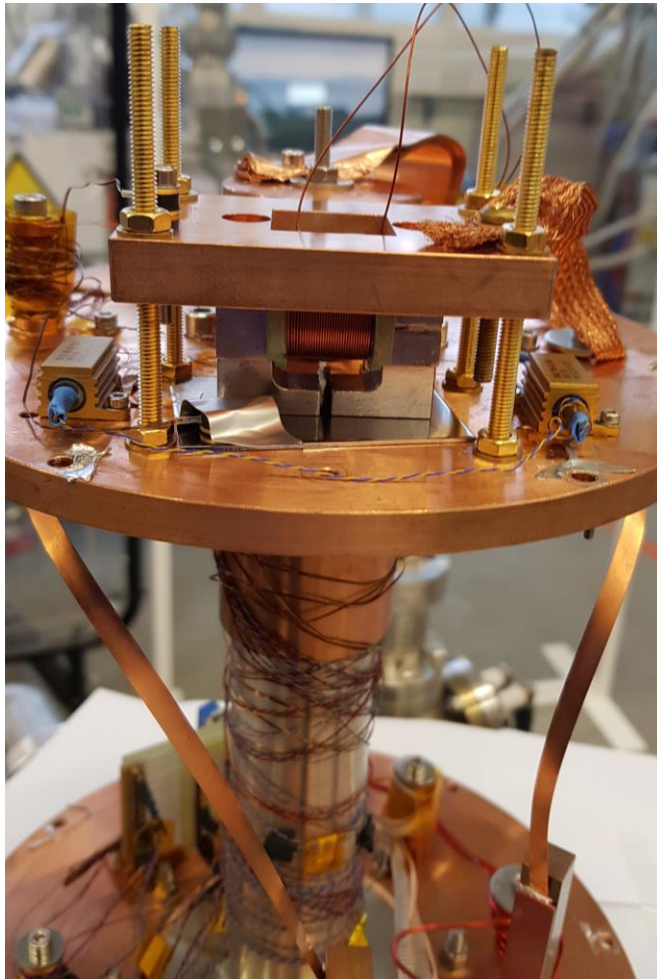
C1



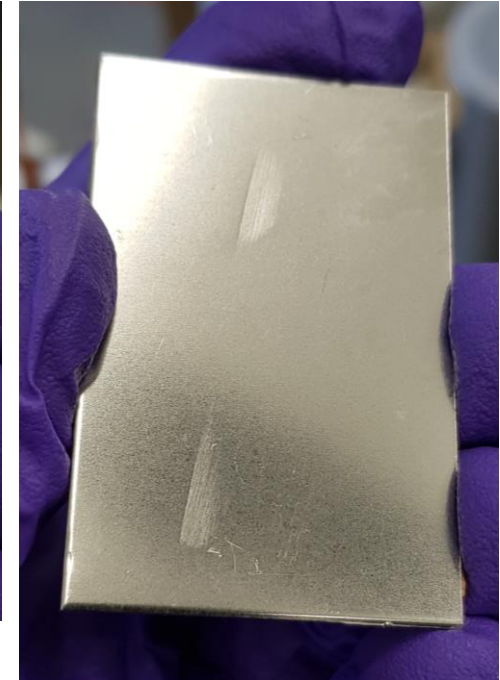
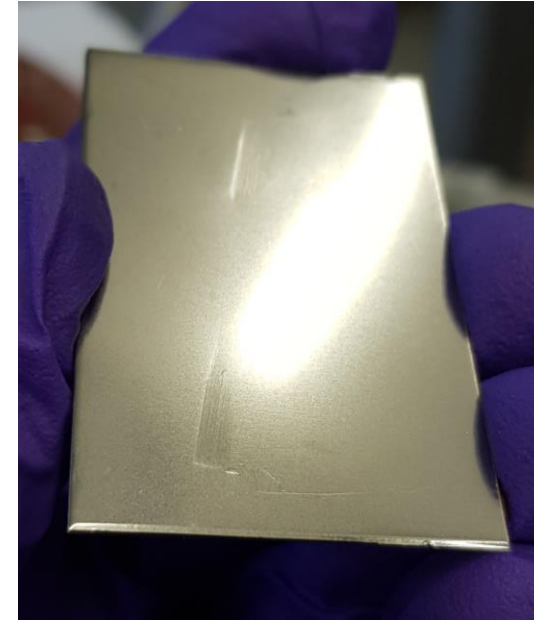
C1

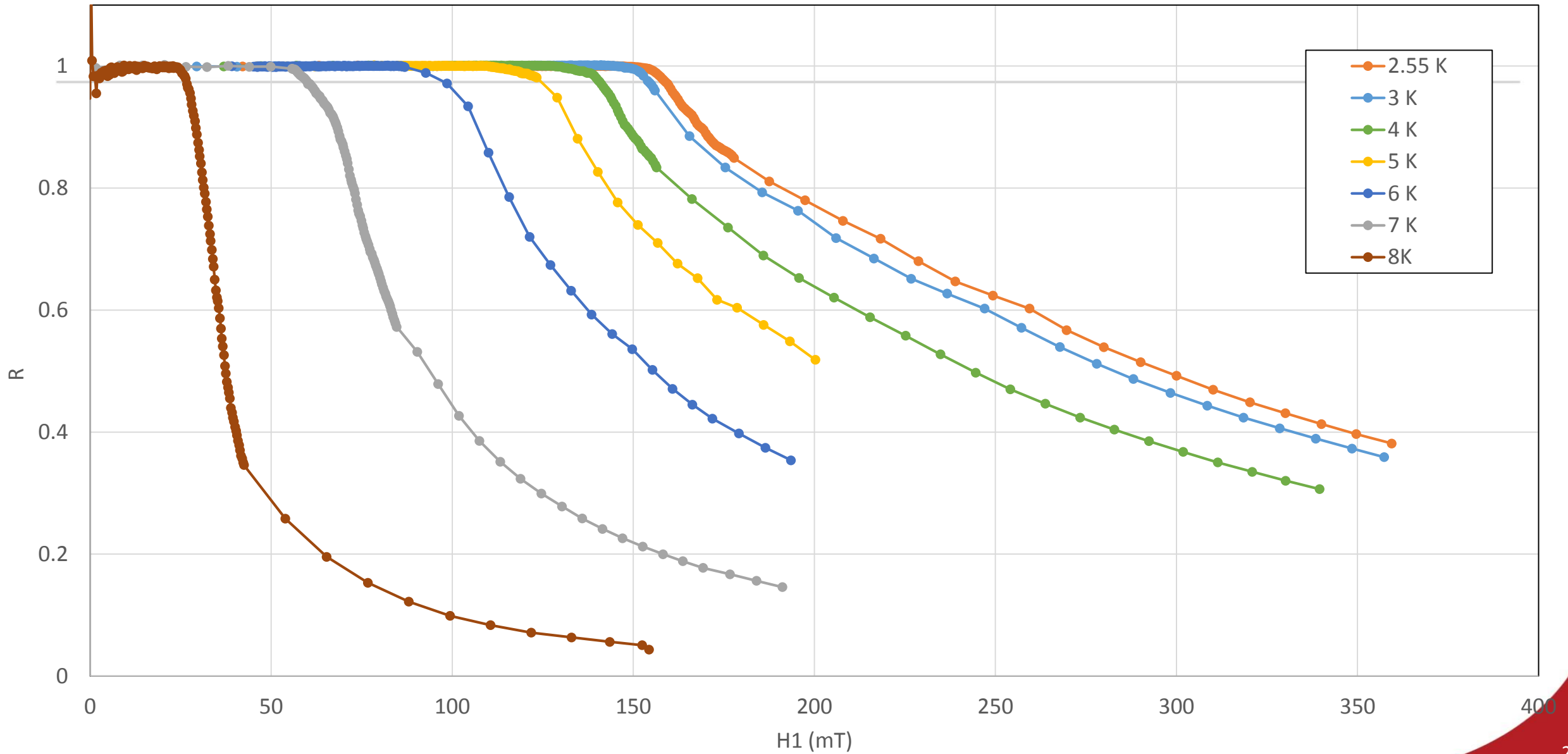


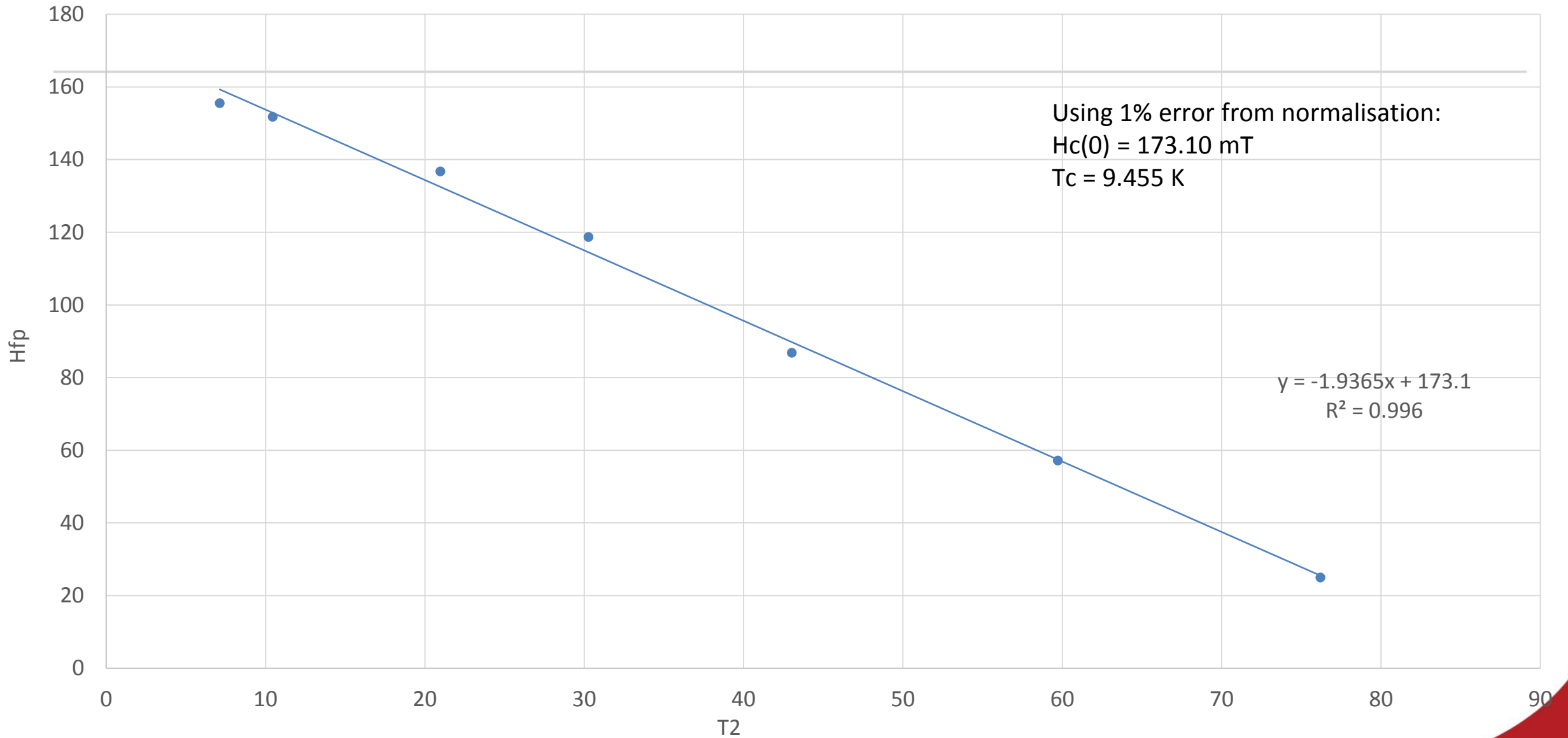
Sample C10 - 3 μ m Nb on Cu, Deposited by LNL, CERN SUBU



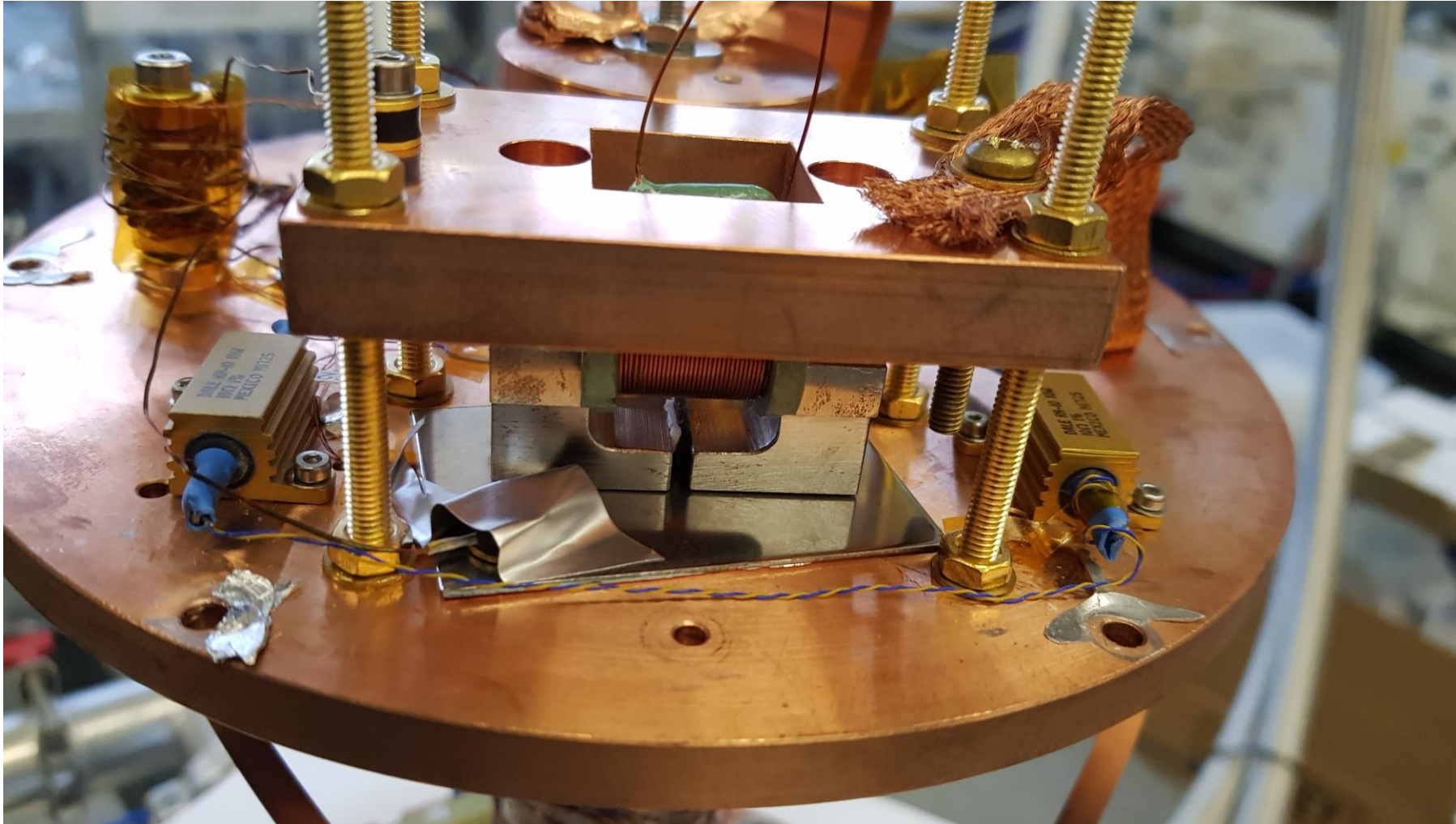
- Thermometer attached using Al tape
- Some noticeable damage on the surface once the test was complete.
- Geometry was the same as C1, therefore the flux leakage is the same.







Sample C7 - 10 μ m Nb on Cu, Deposited by STFC, CERN SUBU



- Thermometer taped onto the sample again.
- Damage occurred again with bolting the magnet down.

