



Institute of Electrical Engineering SAS

Eugen SEILER, Rastislav RIES

# SC characterization at IEE Bratislava

# IEE OVERVIEW

## Sample Batches since the last meeting (Sept.):

*prepared at Siegen Uni:*

- HiPIMS Nb films on Cu – 4.9.2020 series
  6.10.2020 series *meas. in progress…*

*prepared at STFC:*

- HiPIMS Nb on Cu – 22.7.2020 series
- $V_3Si$, HiPIMS Nb, NbTiN, var. substrates (Cu,Sapp,Ta, vitr.C) – 18.9.2020 series
  *not measured yet…*

**Unexpected Outage** – PPMS down 15.10.-12.11.
ARIES measurements resumed 30.11.

**Article** on Laser treated Nb samples (*R. Ries*)

Significant changes (more material characterisation), submitted to Applied Surface Science (27.11.)

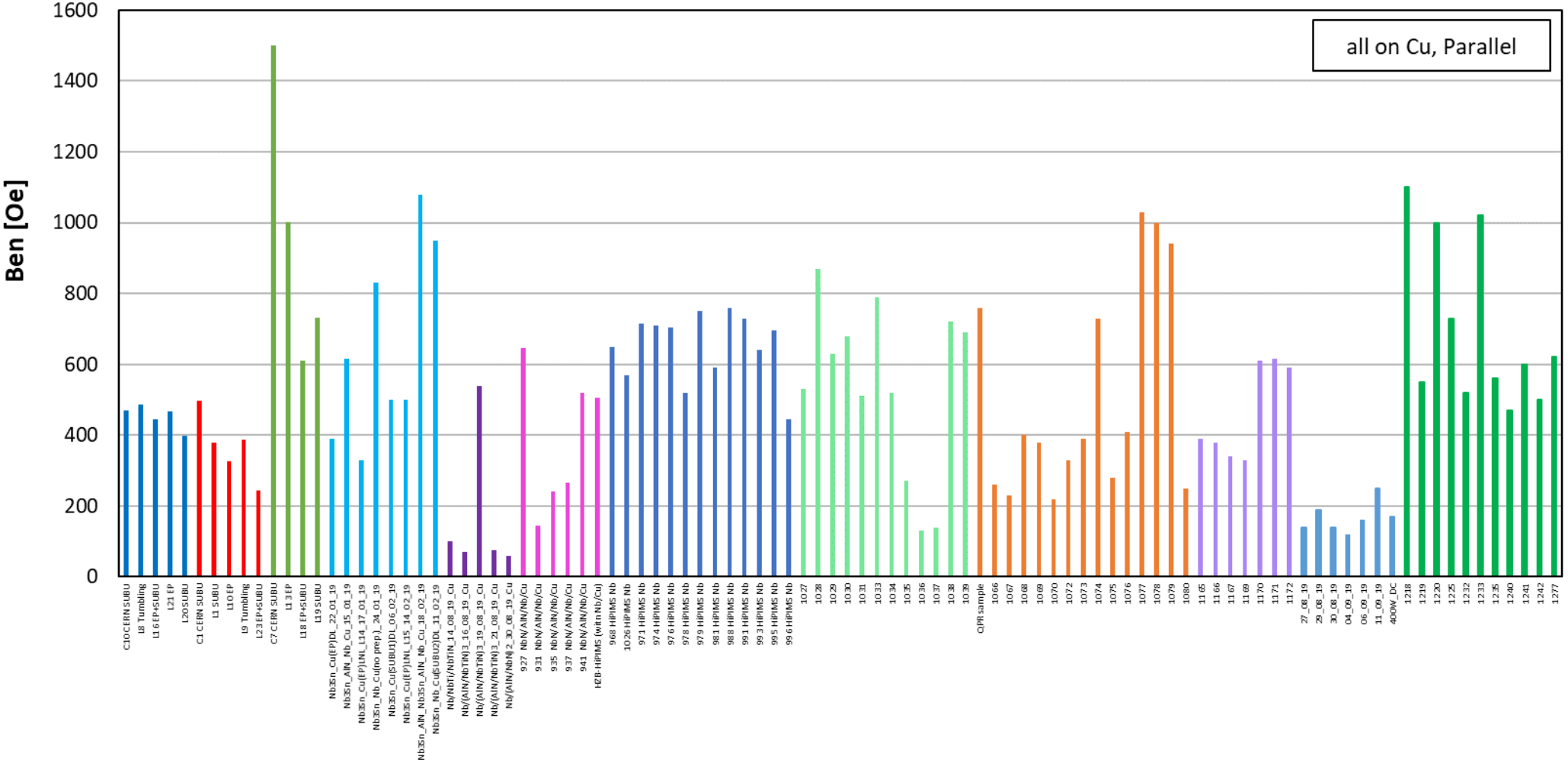
**COVID-19 related restrictions at IEE –** mild so far…

# Table-summary

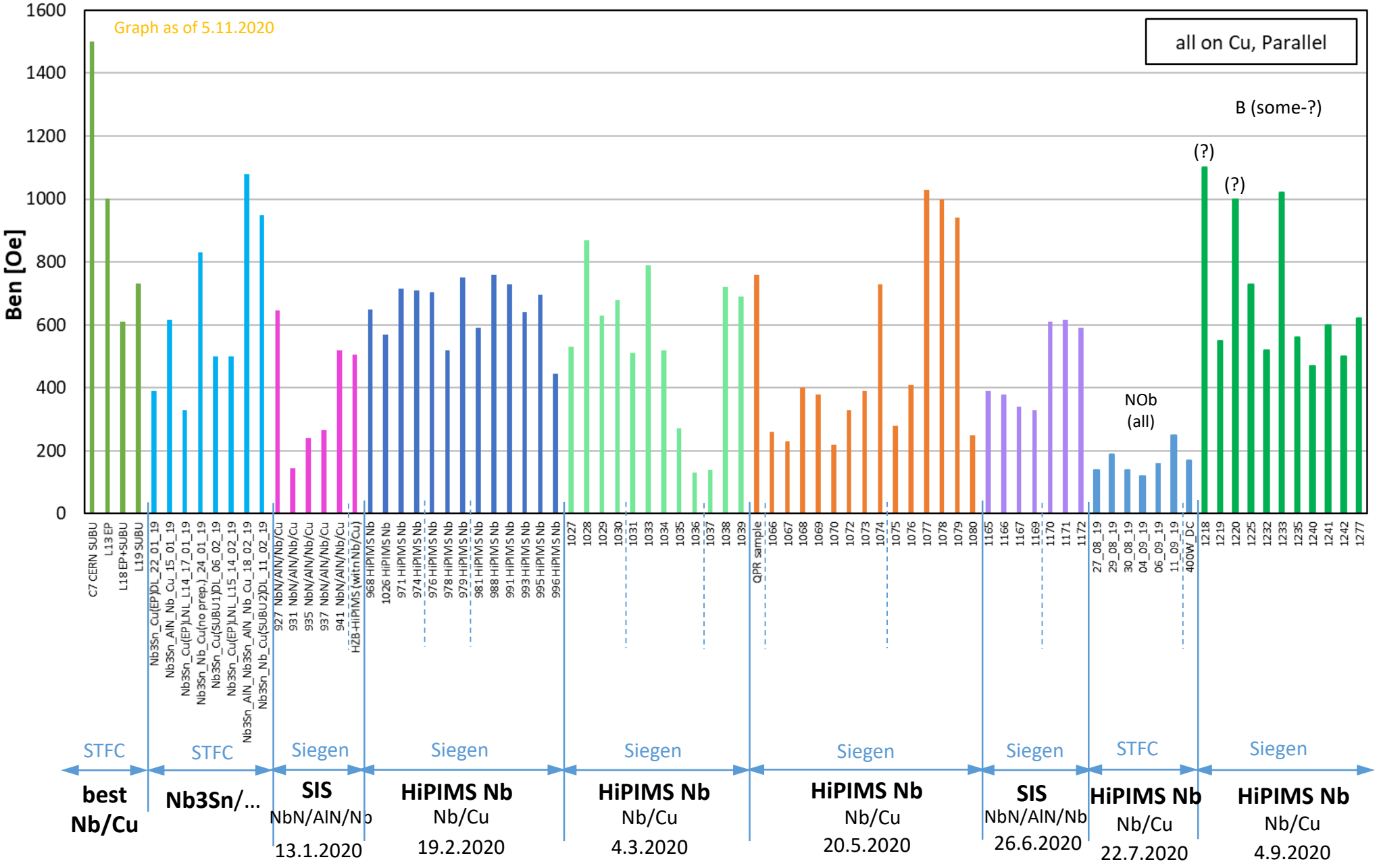
| | sample: | Ben [Oe] perp. | Ben [Oe] Parallel | Tc [K] VSM | |
|---|---|---|---|---|---|
| **HiPIMS Nb (on Cu)** | 27_08_19 | | 140 | 9.5 | |
| | 29_08_19 | | 190 | 9.55 | |
| STFC Daresbury | 30_08_19 | | 140 | 9.55 | |
| 22.7.2020 series | 04_09_19 | | 120 | 9.6 | |
| Reza Valizadeh | 06_09_19 | | 160 | 9.55 | |
| | 11_09_19 | | 220 - 370 | 9.5 | |
| | 400W_DC | | 170 | 9.55 | |
| **HiPIMS Nb (on Cu)** | 1218 | | 1100 | 9.35 | |
| | 1219 | | 550 | 9.4 | Rer |
| | 1220 | | 1000 | 9.45 | |
| | 1225 | | 730 | 9.35 | |
| Uni Siegen | 1232 | | 520 | 9.5 | |
| 4.9.2020 series | 1233 | | 1020 | 9.4 | |
| Stewart Leith | 1235 | | 560 | 9.4 | |
| | 1240 | | 470 | 9.5 | |
| | 1241 | | 600 | 9.45 | |
| | 1242 | | 500 | 9.6 | |
| | 1277 | | 620 | 9.25 | Rer |
| **HiPIMS NbN (on Cu)** | 1284 | | 80 | 14.6 | |
| | 1285 | | 130 | 16.5 | |
| | 1287 | | 275 | 15.5 | |
| | 1288 | | 250 | 15.5 | |
| | 1291 | | 80 | 10 | |
| | 1295 | | 90 | ~ 13 | |
| | 1296 | | 280 | 14.6 | |
| | 1325 | | 140 | 14.6 | |
| Uni Siegen | 1327 | | 220 | 13.5 | |
| 6.10.2020 series | 1341 | | | | |
| Stewart Leith | 1359 | | | | |
| | 1377 | | | | |
| | 1379 | | | | |
| | 1381 | | | | |
| | 1404 | | | | |
| | 1441 | | | | |
| | 1445 | | | | |
| | 1448 | | | | |
| | 1455 | | | | |

| | sample: | Ben [Oe] perp. | Ben [Oe] Parallel | Tc [K] VSM |
|---|---|---|---|---|
| **HiPIMS Nb** | NbTiN_19_02_20_Cu | | | |
| **NbTiN** | NbTiN_19_02_20_VG | | | |
| **V3Si** | NbTiN_19_02_20_Ta | | | |
| | Nb_14_07_20_Cu | | | |
| Substrates: | Nb_14_07_20_Ta | | | |
| **Cu** | Nb_16_07_20_Cu | | | |
| **Sapphire** | Nb_16_07_20_Ta | | | |
| **Tantal** | Nb_22_07_20_Cu | | | |
| **VG** - Vitreous graphite | Nb_22_07_20_Ta | | | |
| | V3Si_24_07_20_Cu | | | |
| | V3Si_24_07_20_Ta | | | |
| STFC Daresbury | V3Si_28_07_20_Cu | | | |
| 18.9.2020 series | V3Si_28_07_20_VG | | | |
| Reza Valizadeh | V3Si_28_07_20_Ta | | | |
| | Nb_31_07_20_Cu | | | |
| | Nb_31_07_20_Sapp | | | |
| | Nb_31_07_20_Ta | | | |
| | Nb_01_08_20_Cu | | | |
| | Nb_01_08_20_Sapp | | | |
| | Nb_01_08_20_Ta | | | |
| | Nb_06_08_20_Cu | | | |
| | Nb_06_08_20_Sapp | | | |
| | Nb_06_08_20_Ta | | | |
| **HiPIMS NbN** | 1467 | | | |
| **HiPIMS ML: Nb/NbN** | 1468 | | | |
| Substrate: | 1472 | | | |
| **Cu** | 1475 | | | |
| | 1477 | | | |
| Uni Siegen | 1496_ML | | | |
| 3.11.2020 series | 1497_ML | | | |
| Stewart Leith | 1498_ML | | | |

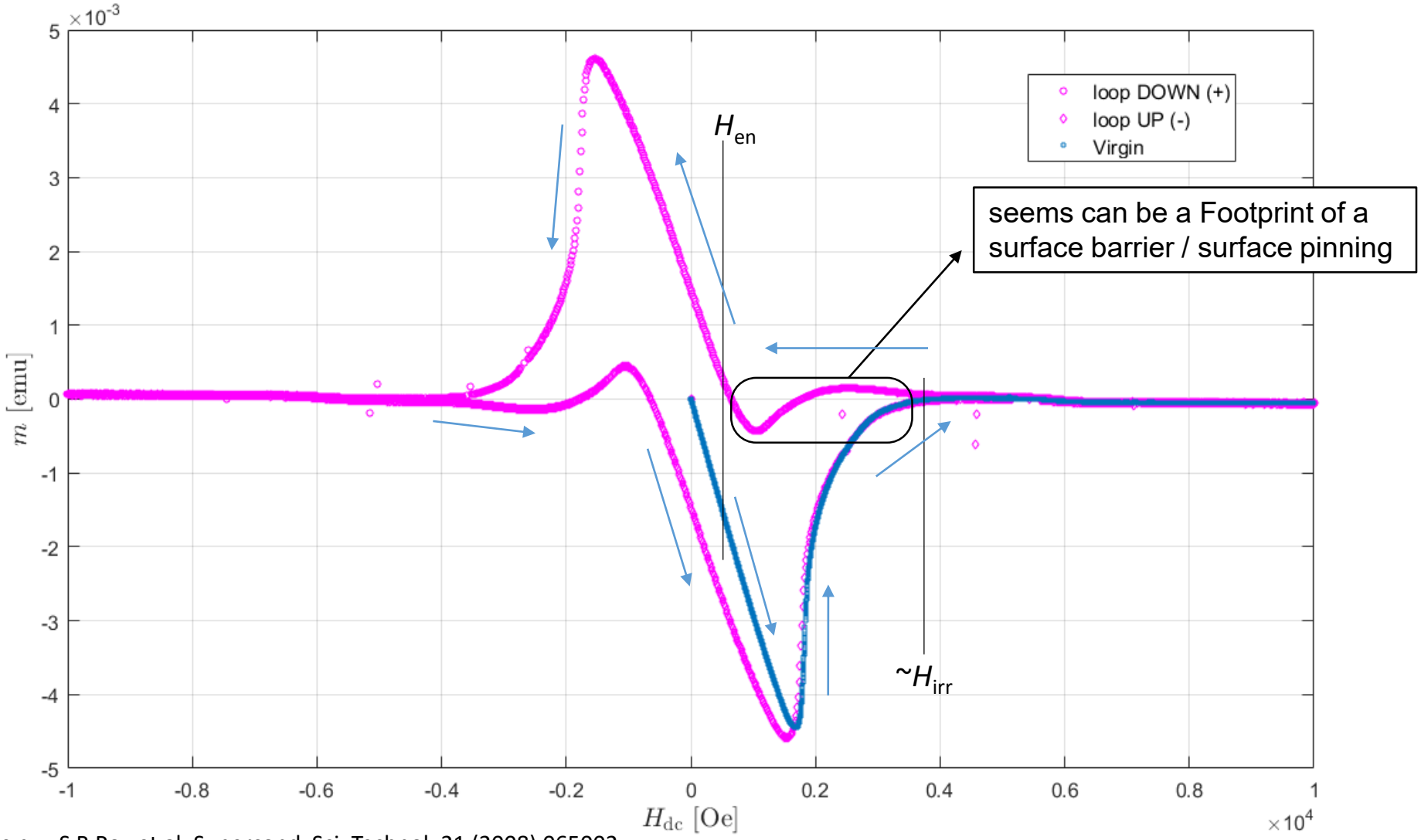
# Selected films on Cu substrates:



# Narrow-Selected films on Cu substrates:

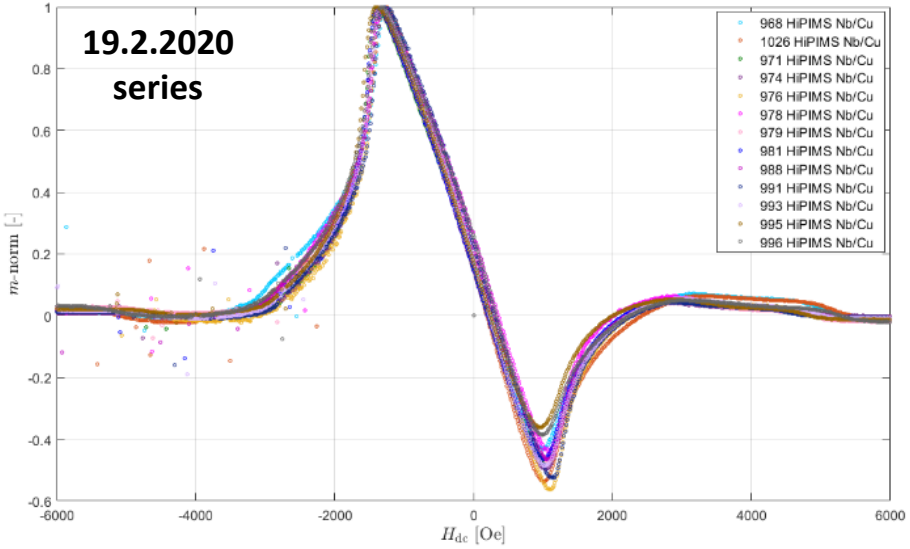


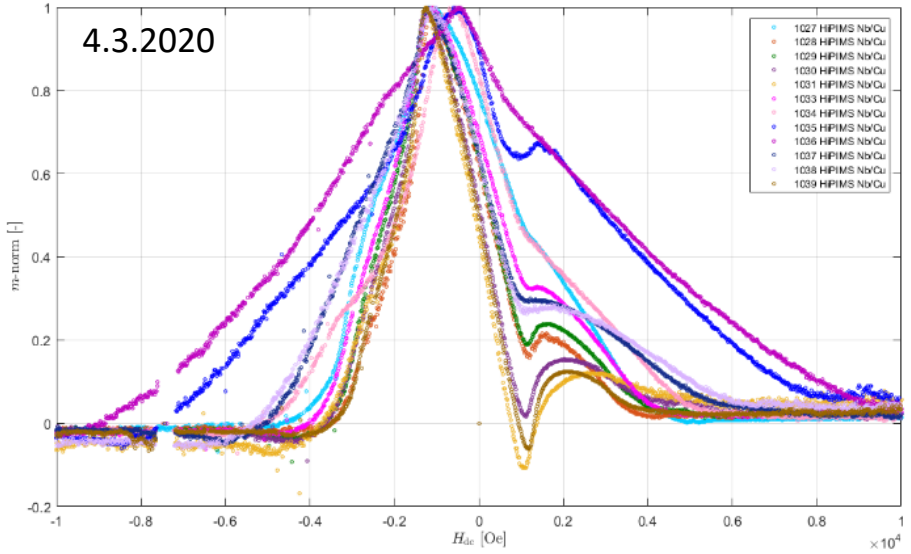
# Shape of magnetization loop

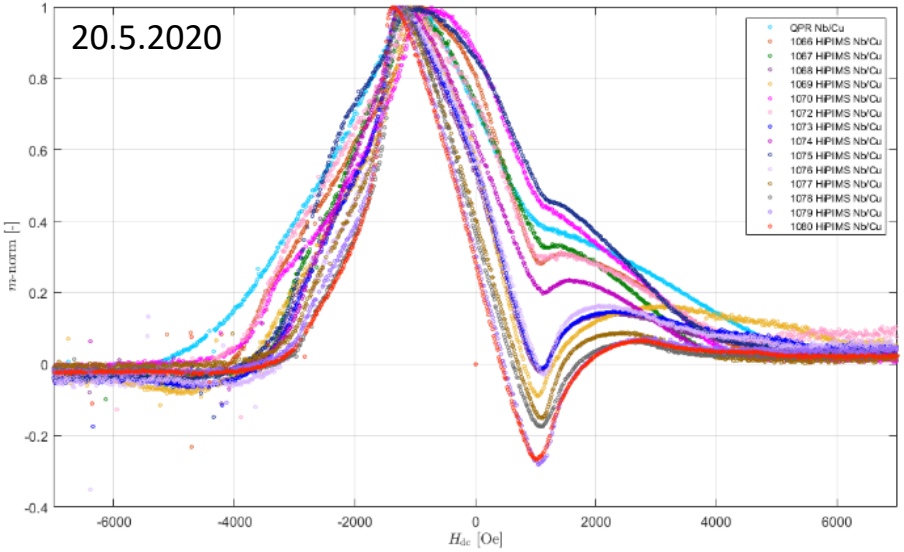


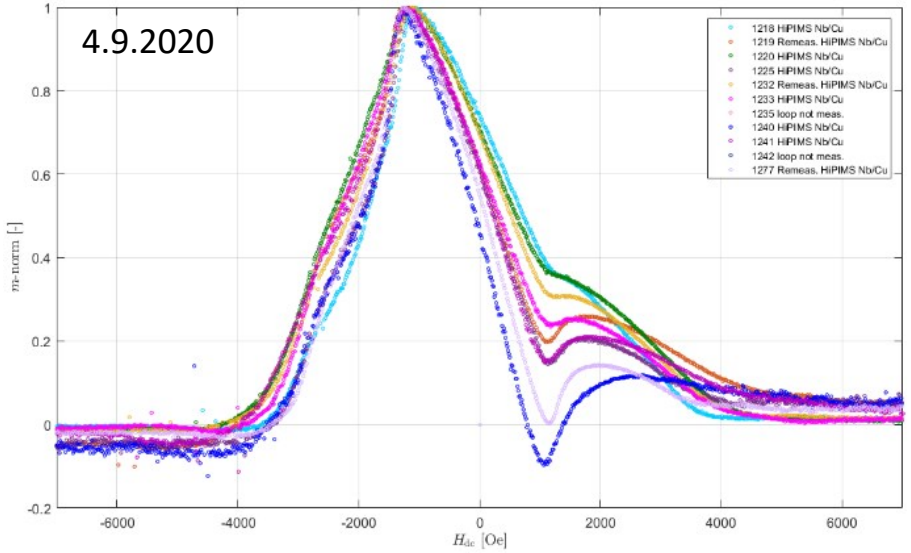

see e.g.: S B Roy et al, Supercond. Sci. Technol. 21 (2008) 065002
E H Brandt, Physica C 332 (2000) 99–107
A S Dhavale et al, Supercond. Sci. Technol. 25 (2012) 065014

# **HiPIMS Nb**/Cu of Siegen Uni




Is there any significant difference in **'Surface quality'** of 19.2.2020 vs. 4.3.2020,20.5.2020,4.9.2020 ?

**FURTHER**

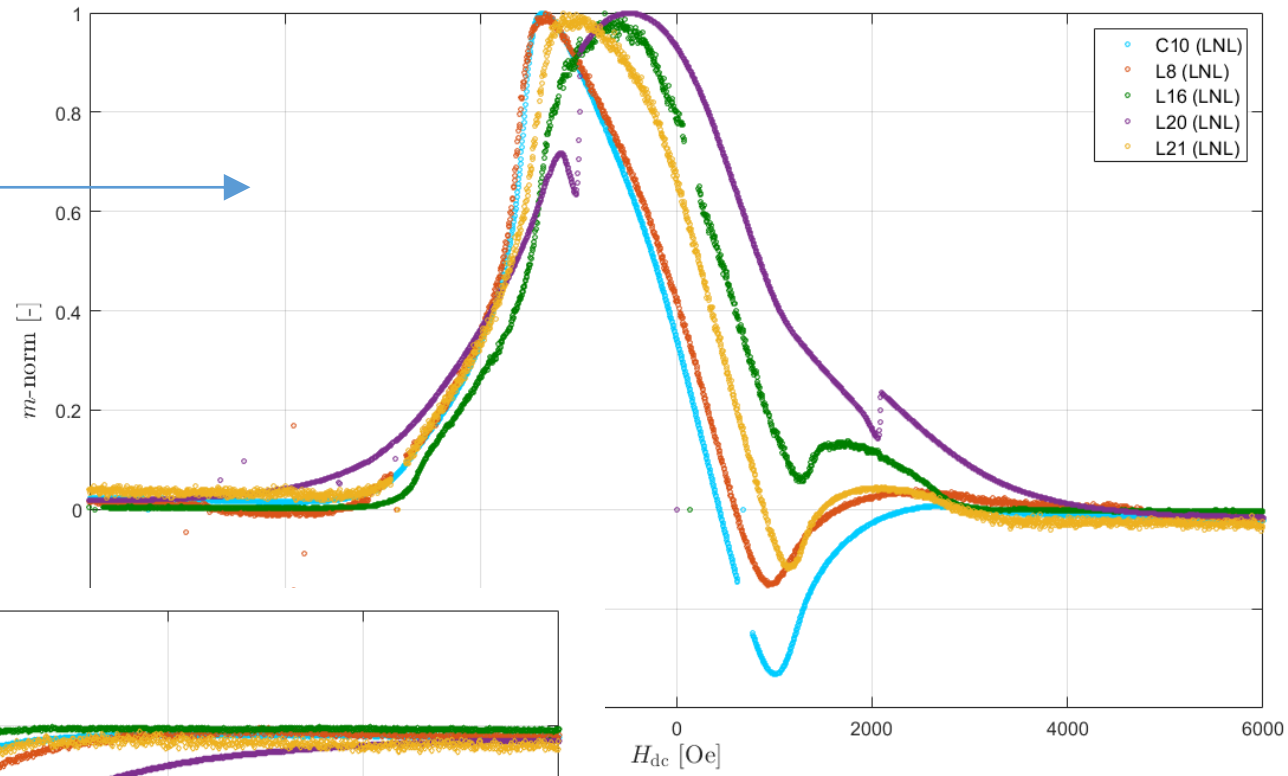
**–**

**Comparisons of mag. loops**

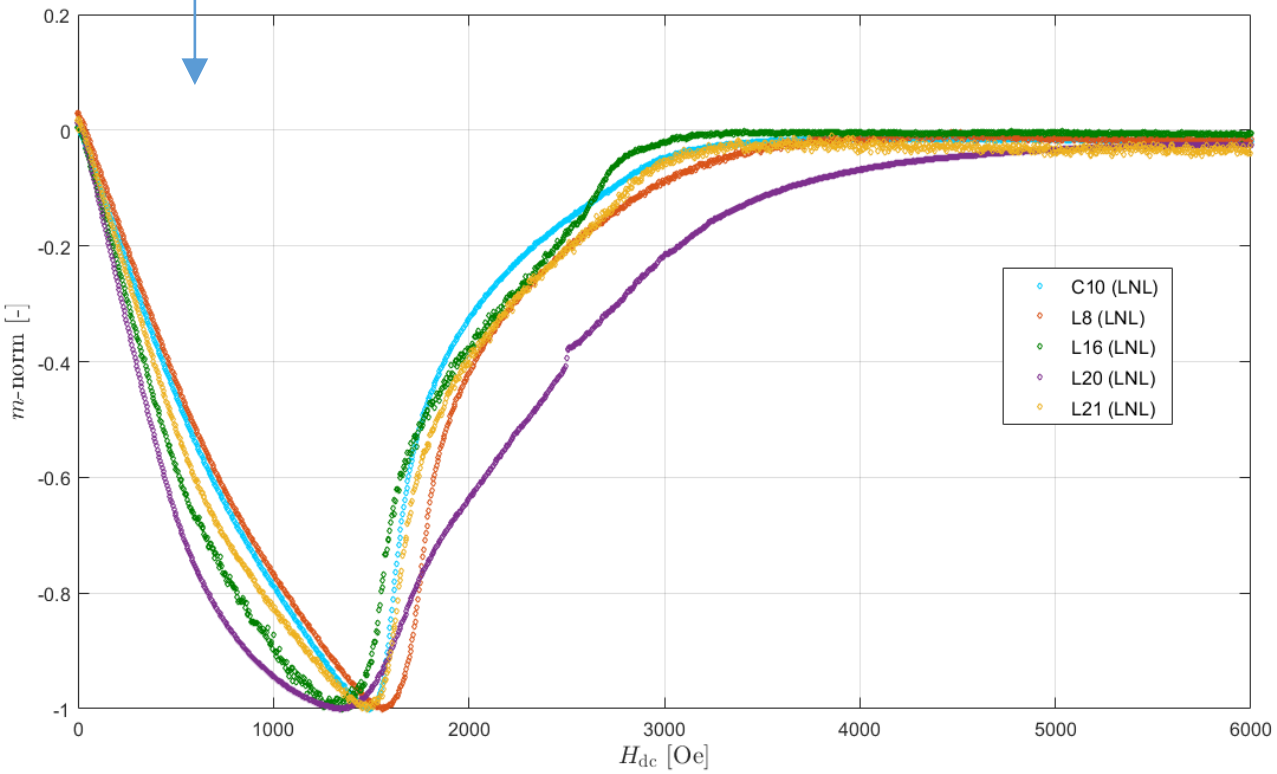
All series on Cu substrates

# Nb/Cu INFN

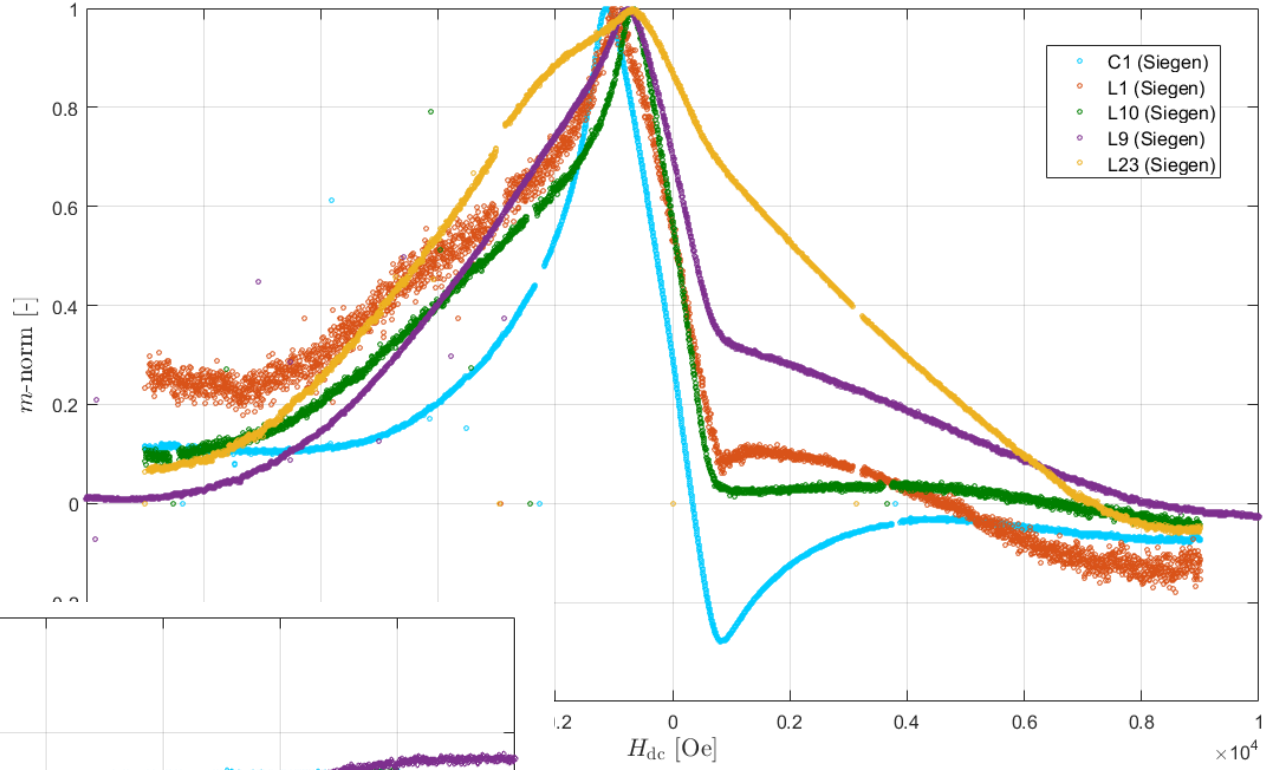
Loop – upper branch,
normalized to Max

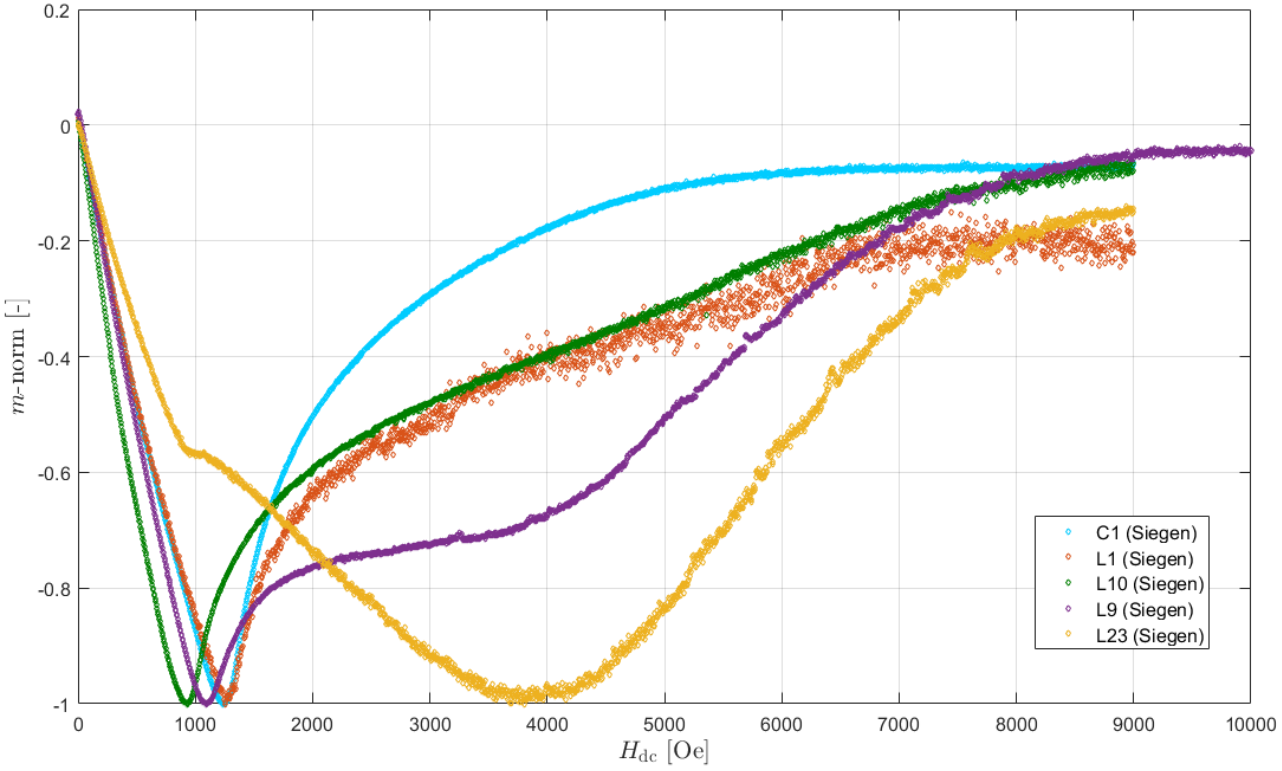



Virgin curve,
normalized to |Max|

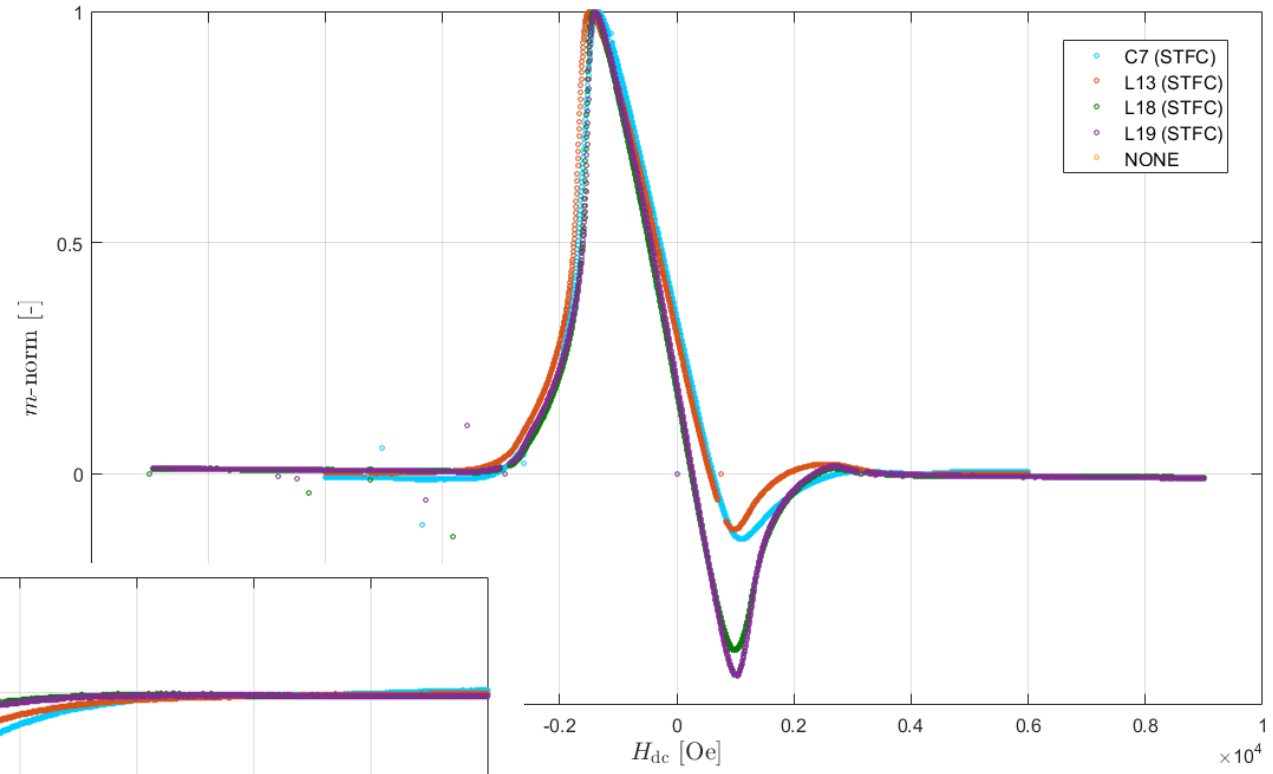


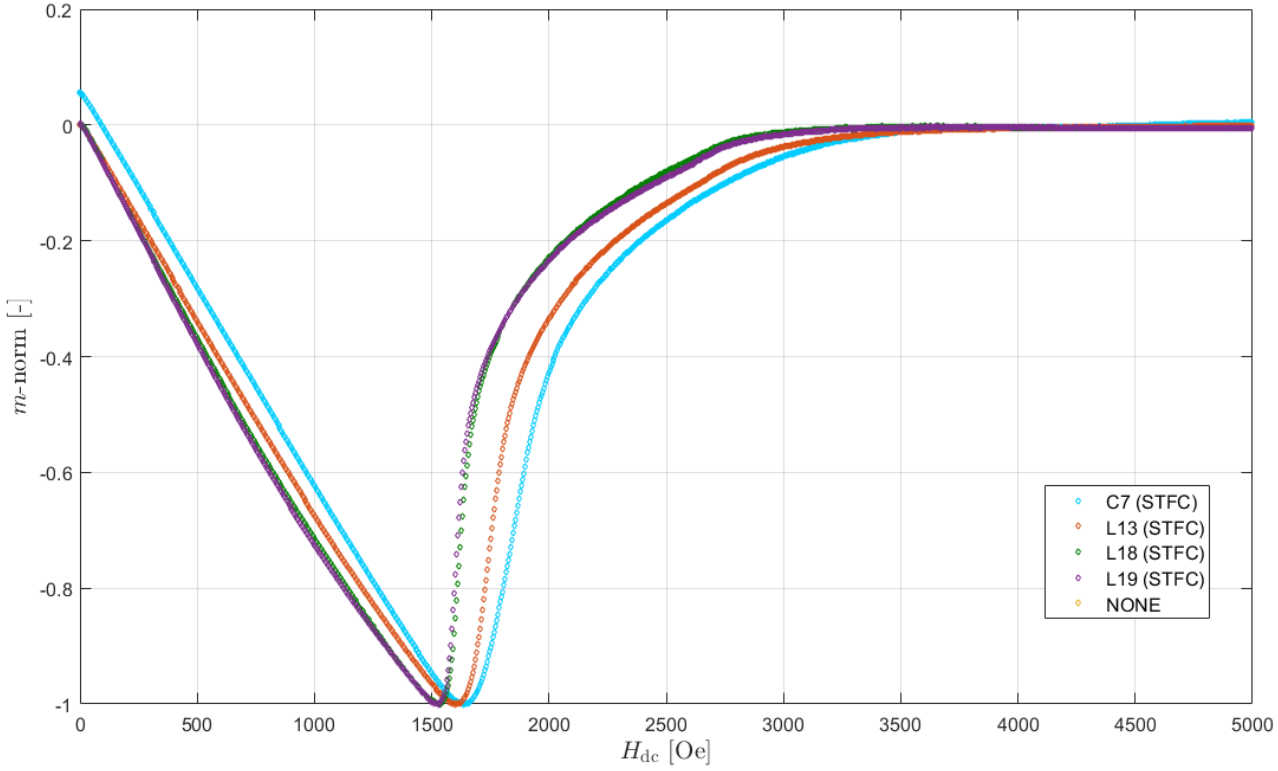
# Nb/Cu Siegen Uni



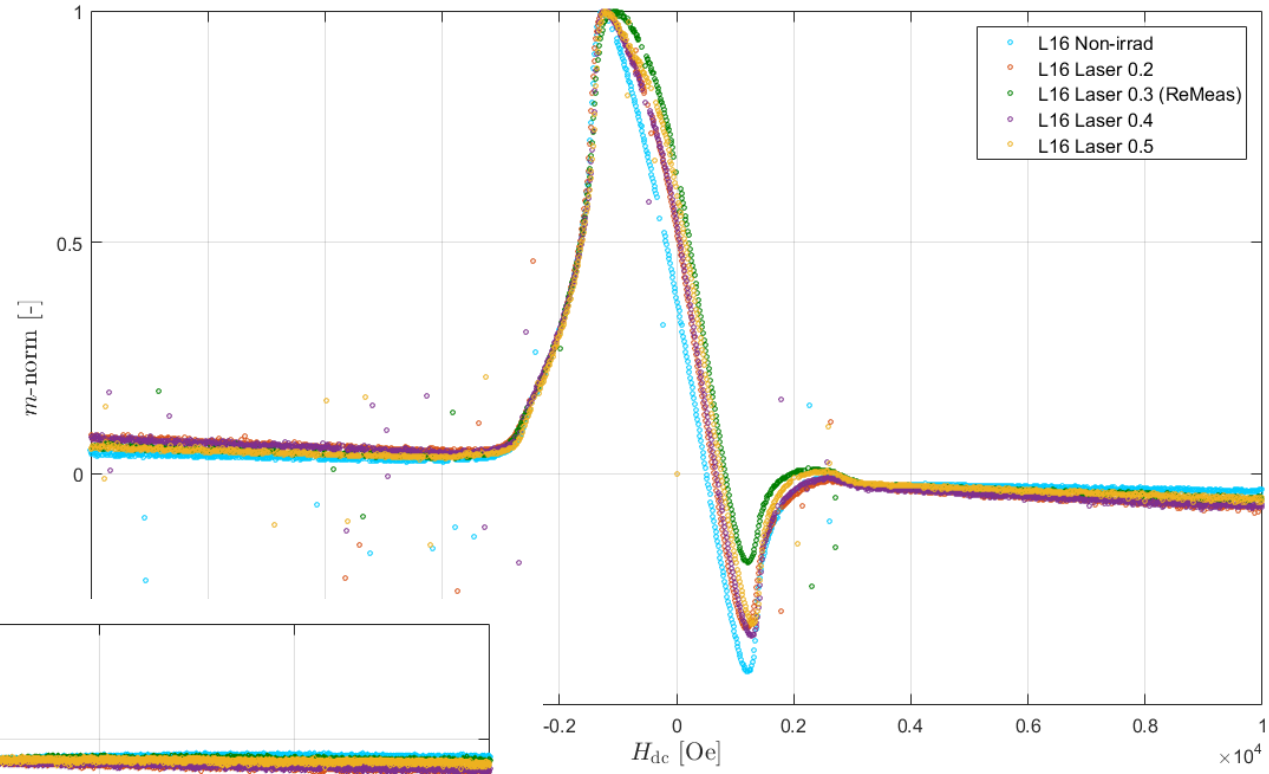



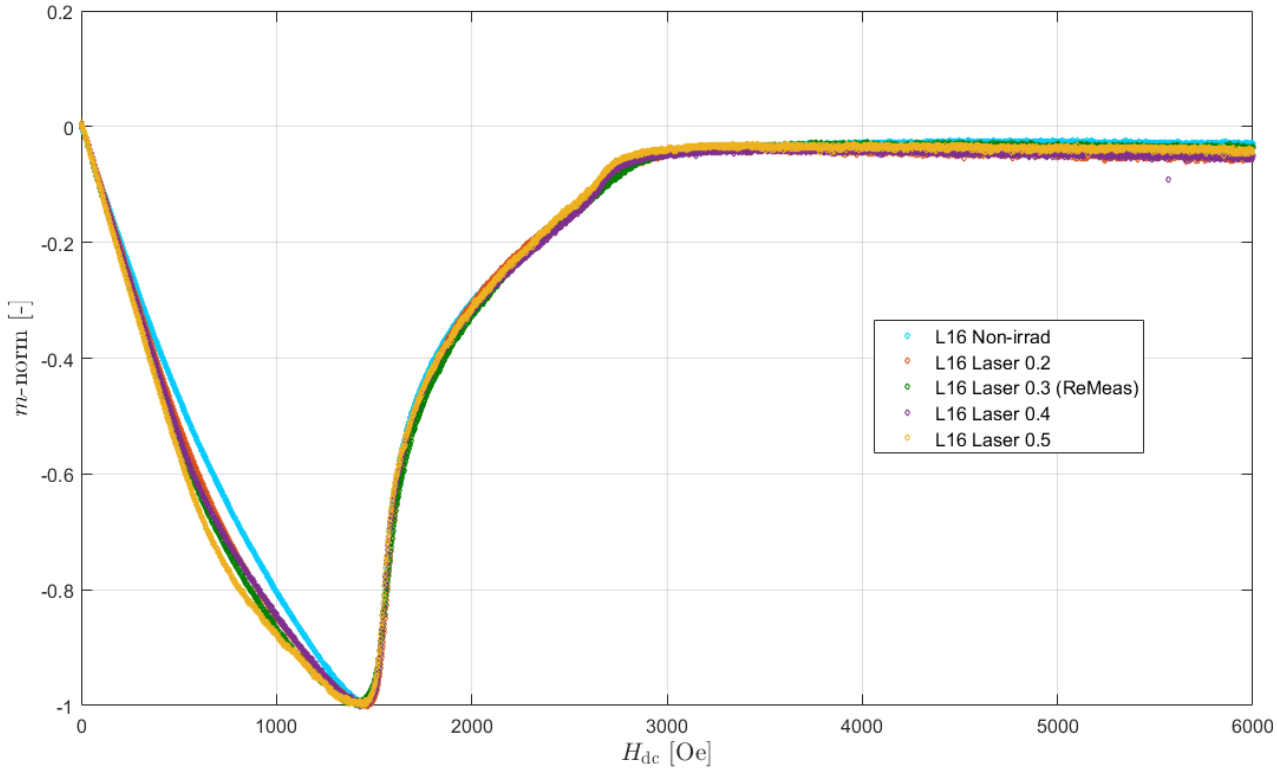
# Nb/Cu STFC


C7 (STFC)
L13 (STFC)
L18 (STFC)
L19 (STFC)
NONE
m-norm [-]
$H_{dc}$ [Oe]
×10^4

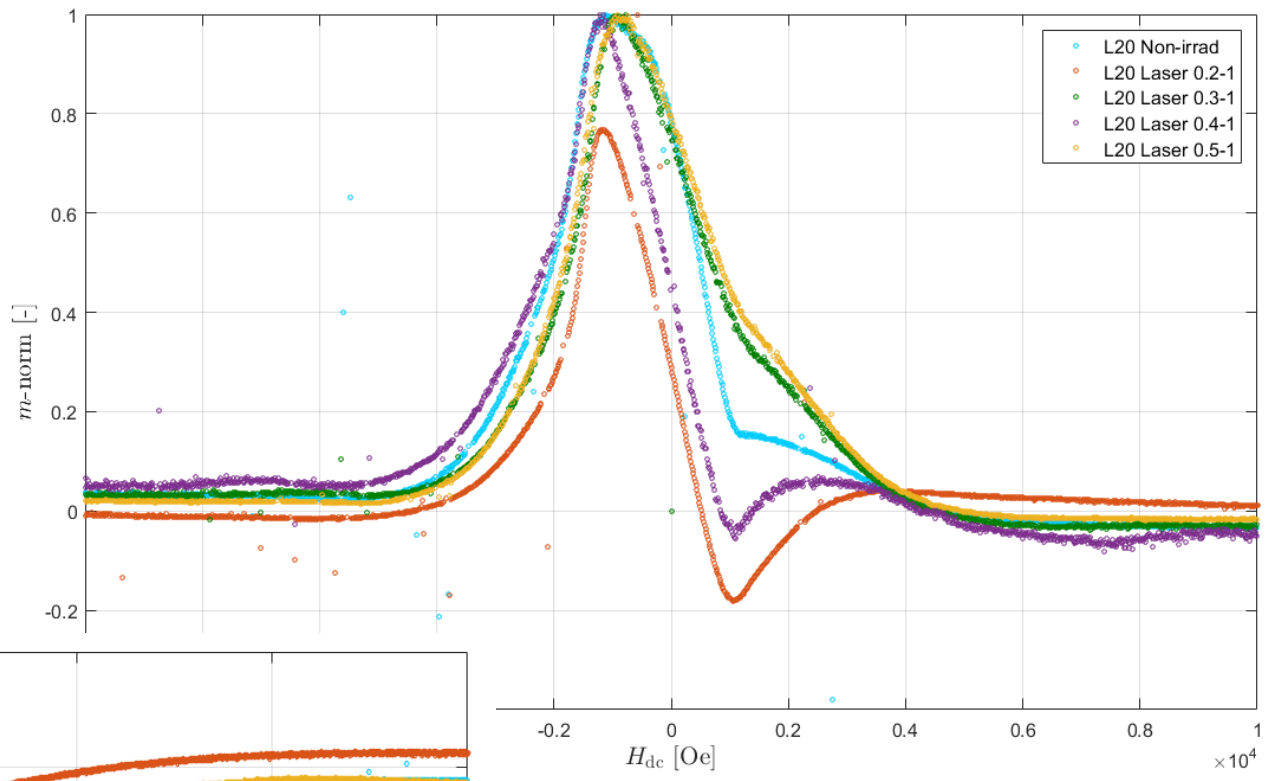

C7 (STFC)
L13 (STFC)
L18 (STFC)
L19 (STFC)
NONE
m-norm [-]
$H_{dc}$ [Oe]

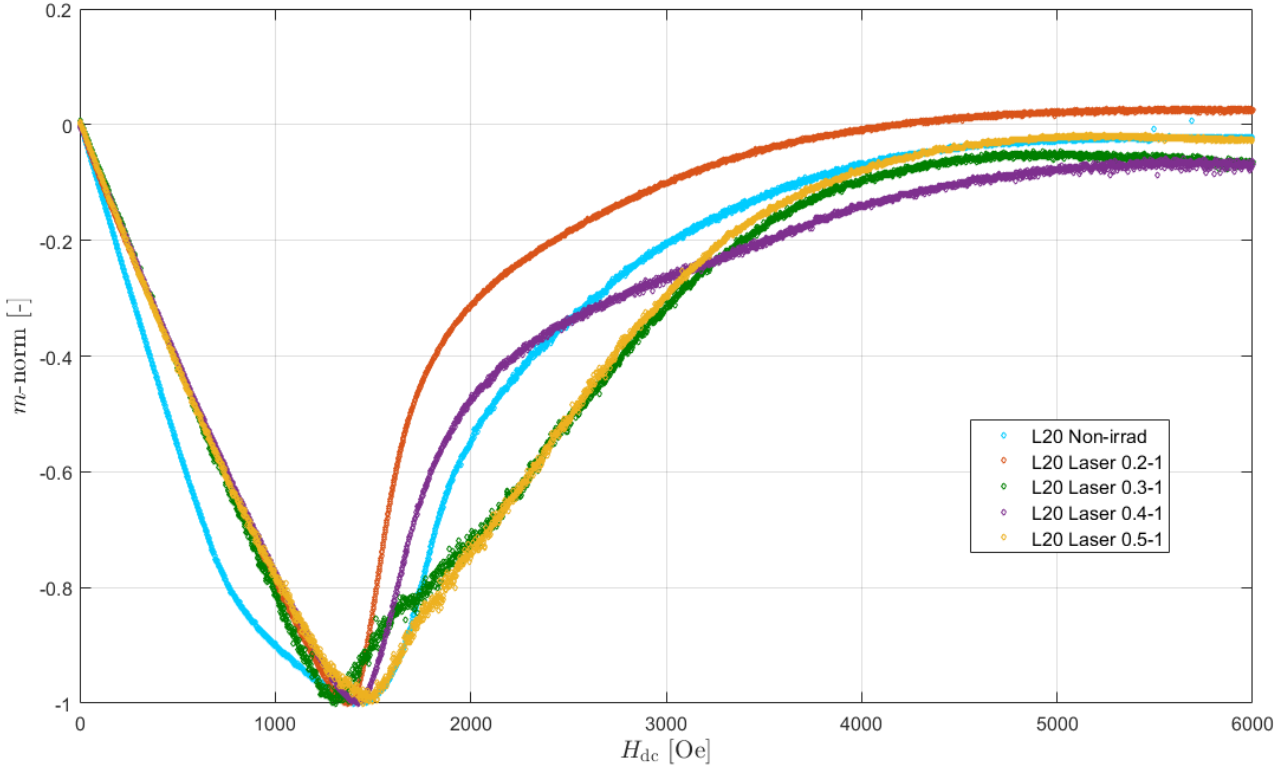
**L16 Laser** (Nb/Cu)



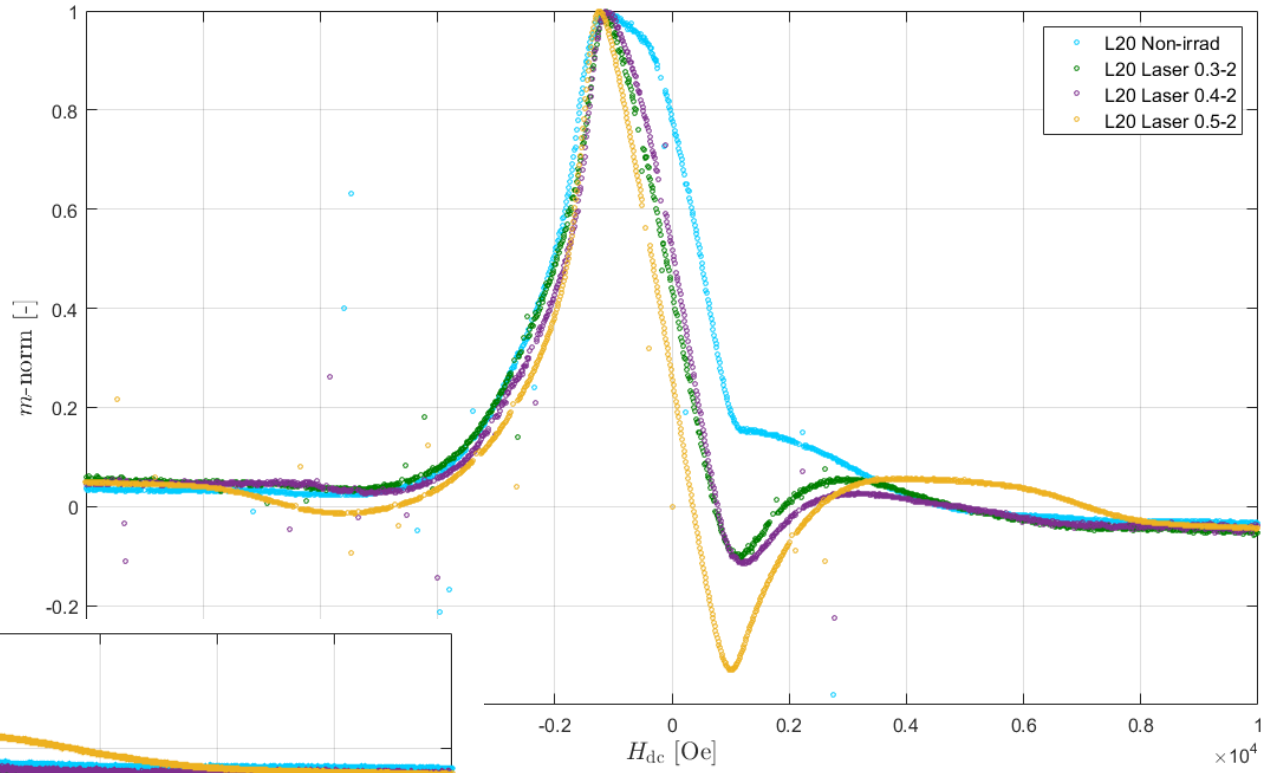



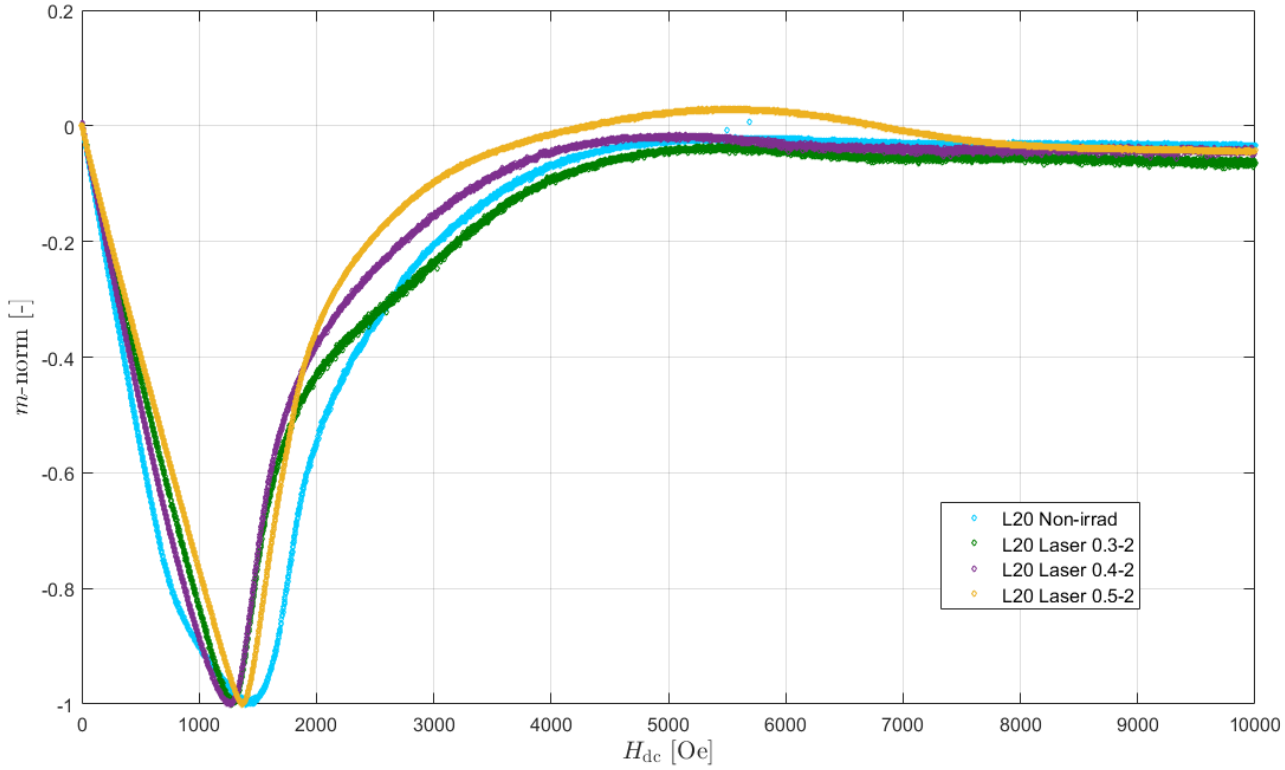
**L20-1 Laser** (Nb/Cu)



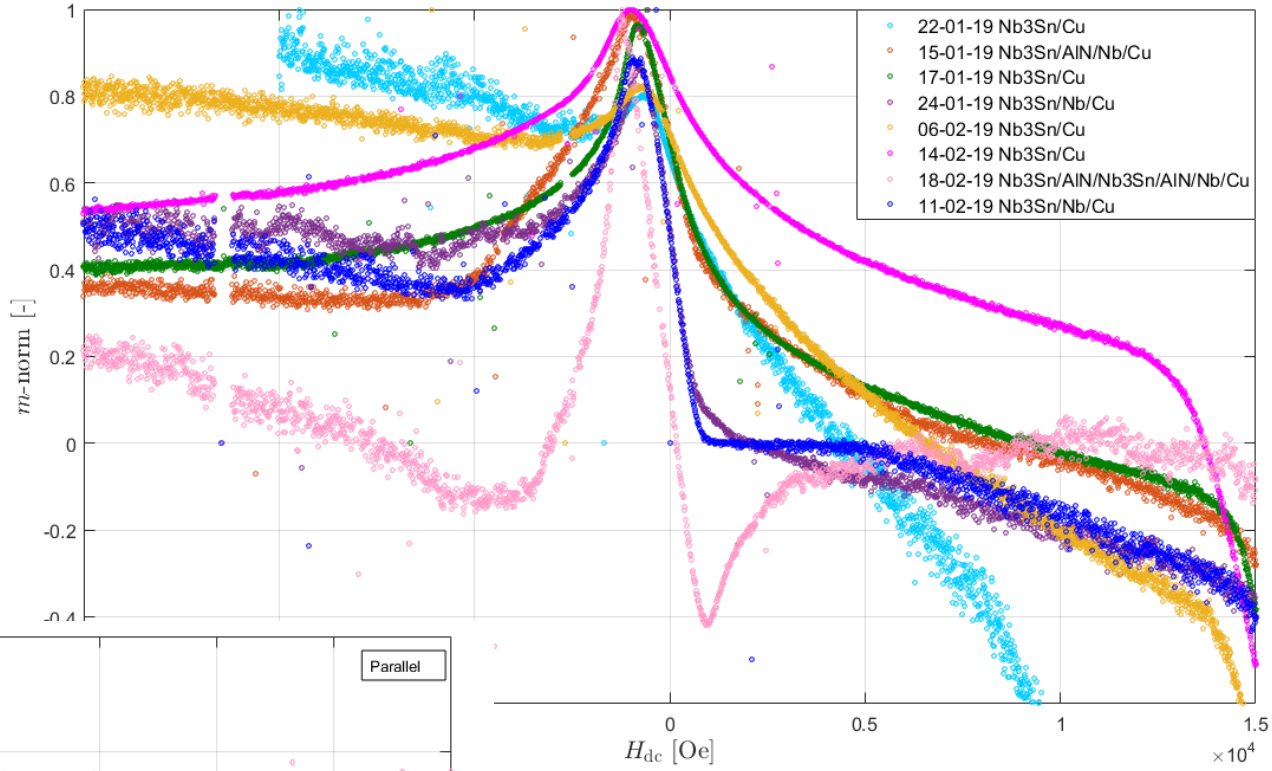



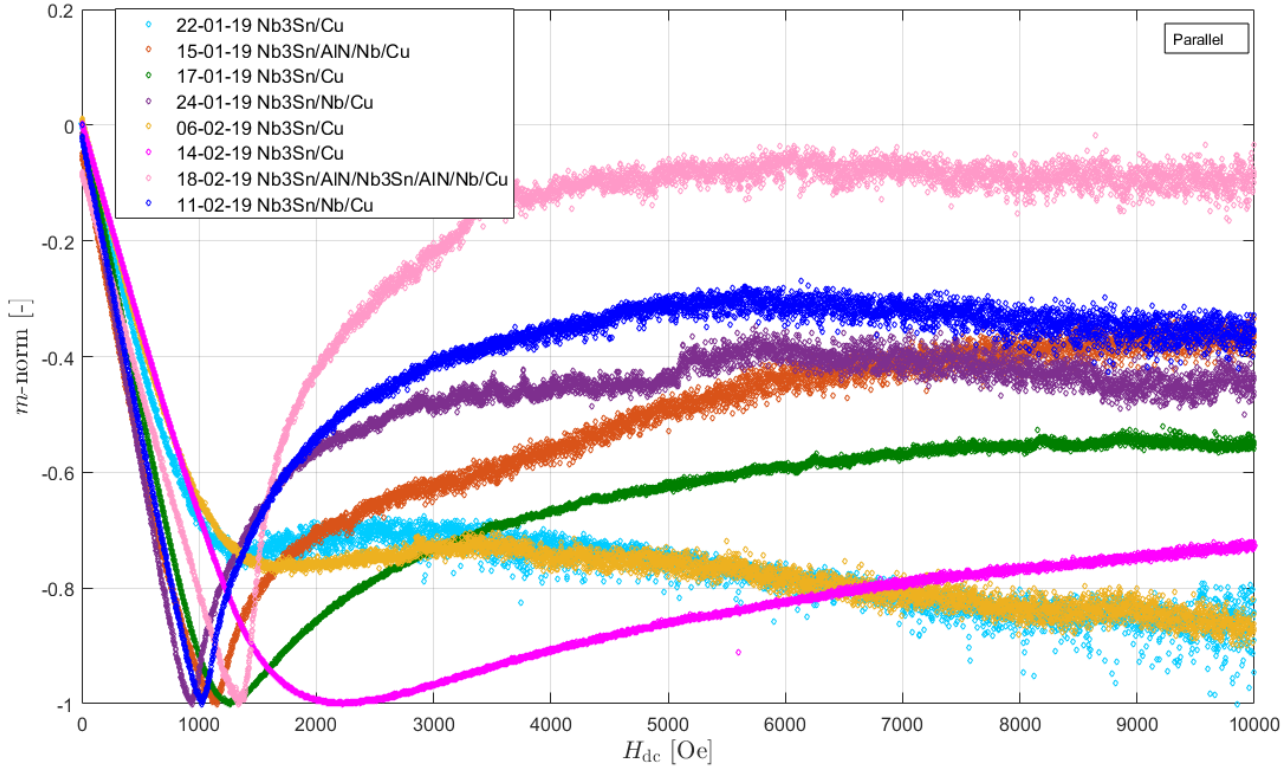
**L20-2 Laser** (Nb/Cu)



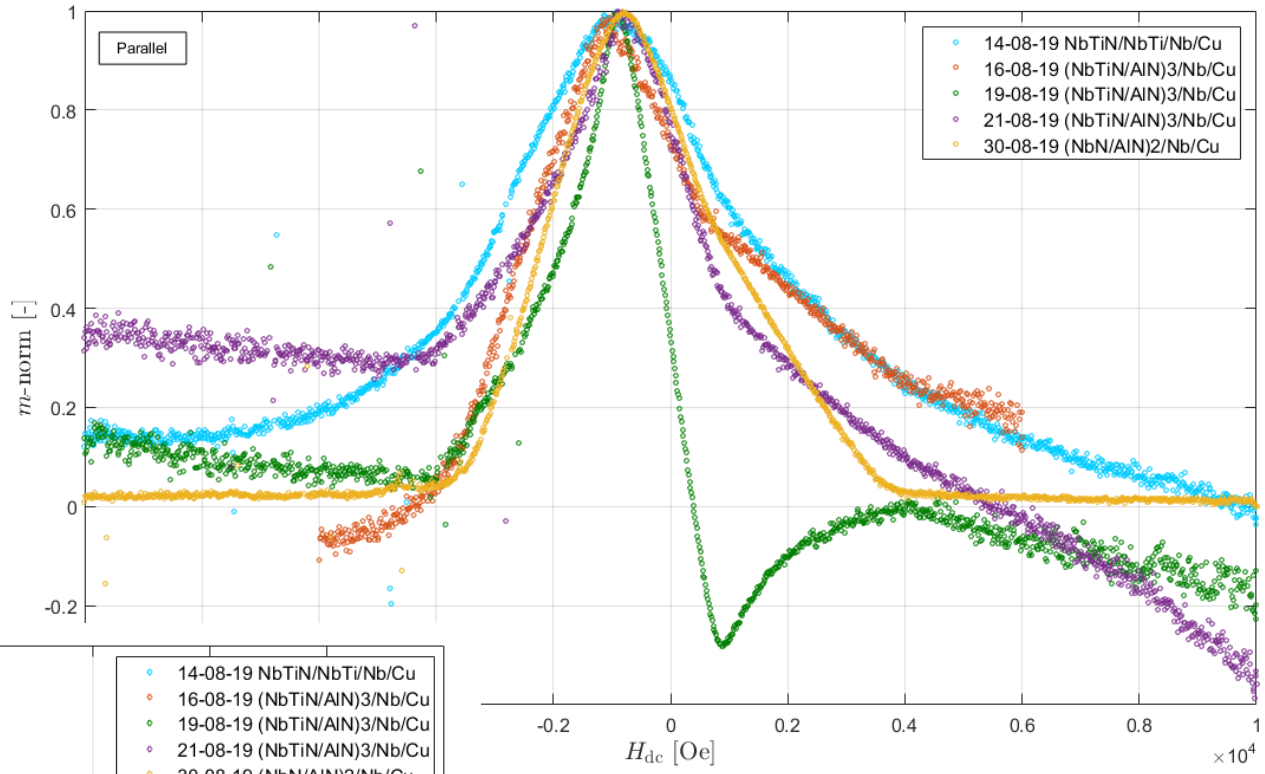
# **Nb3Sn/…/Cu** STFC

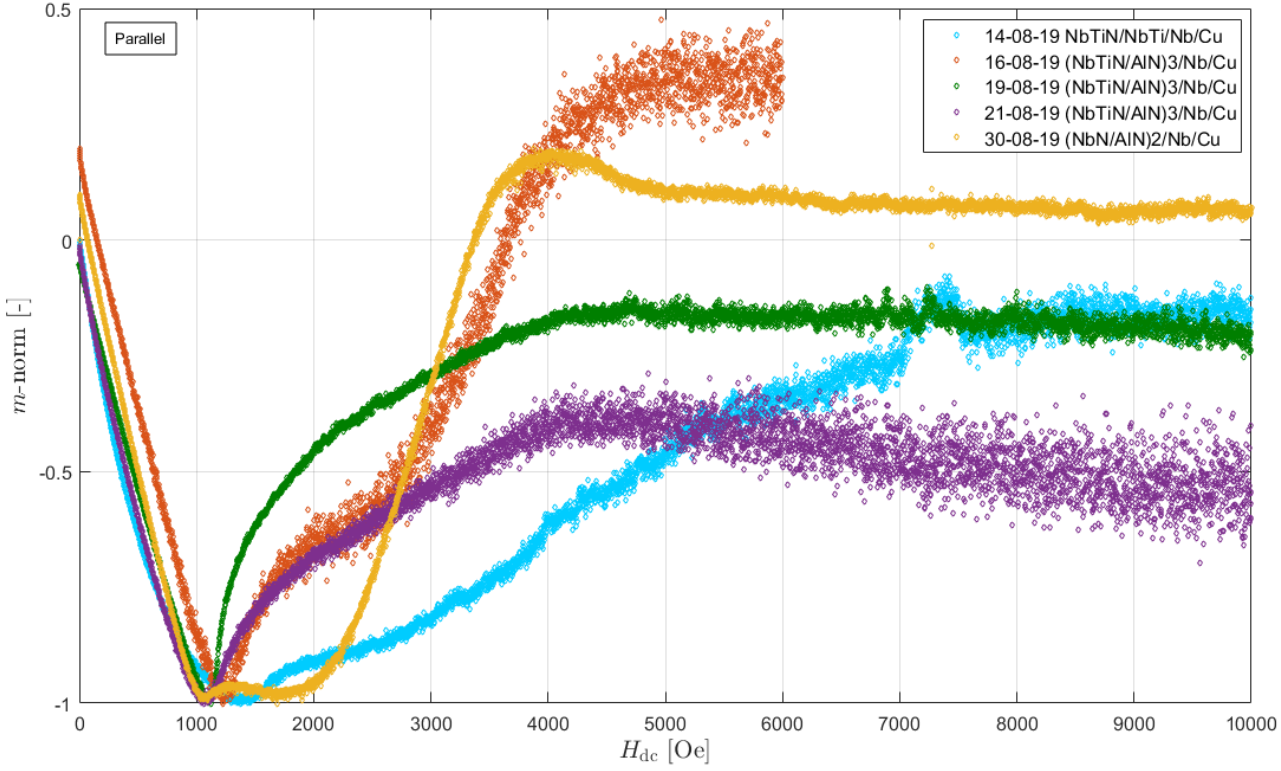


## **Multilayers** STFC

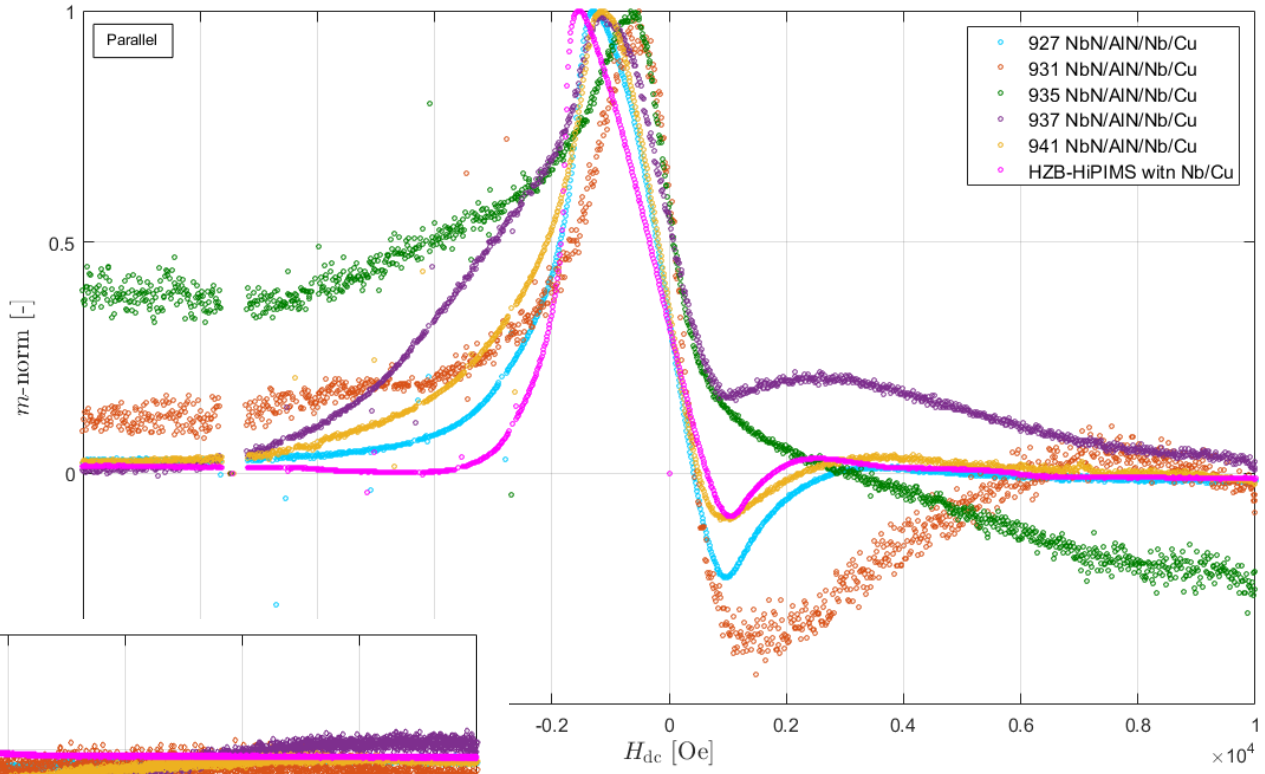
NbTiN (NbN) / AlN / Nb / Cu

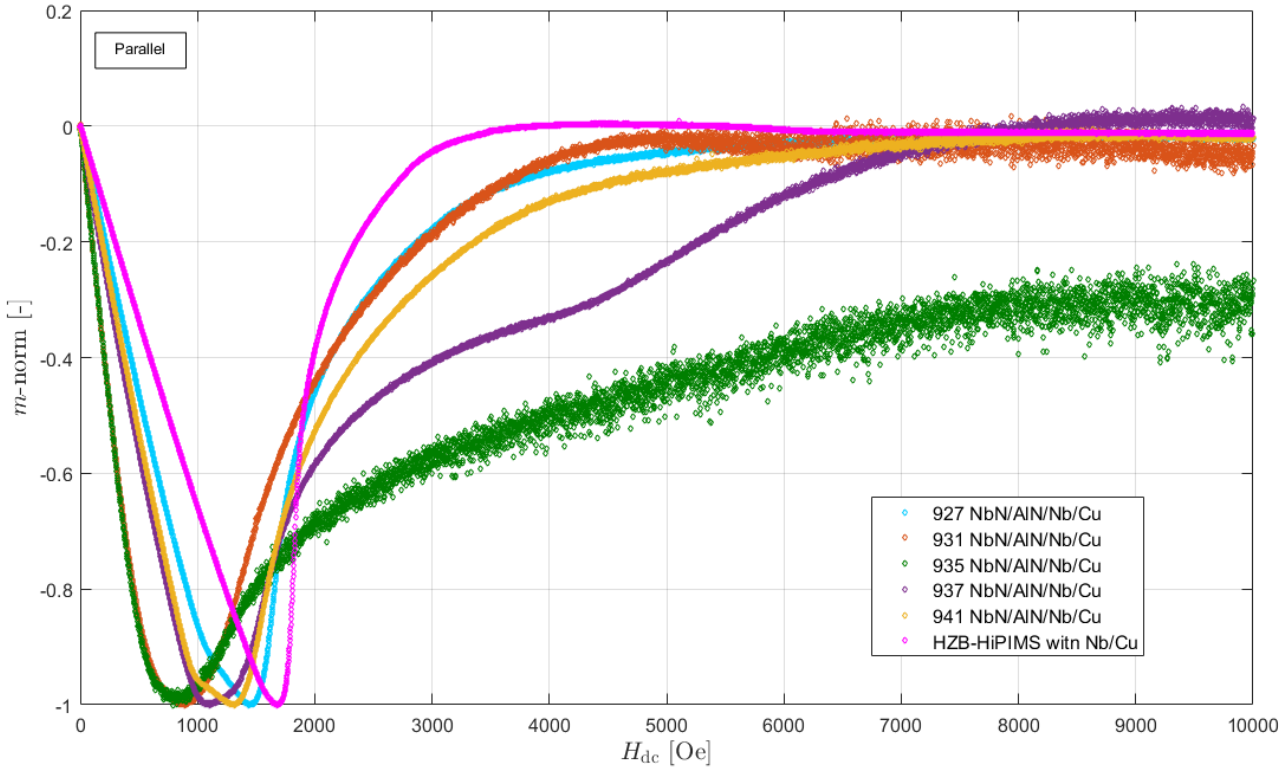


**SIS** Siegen Uni

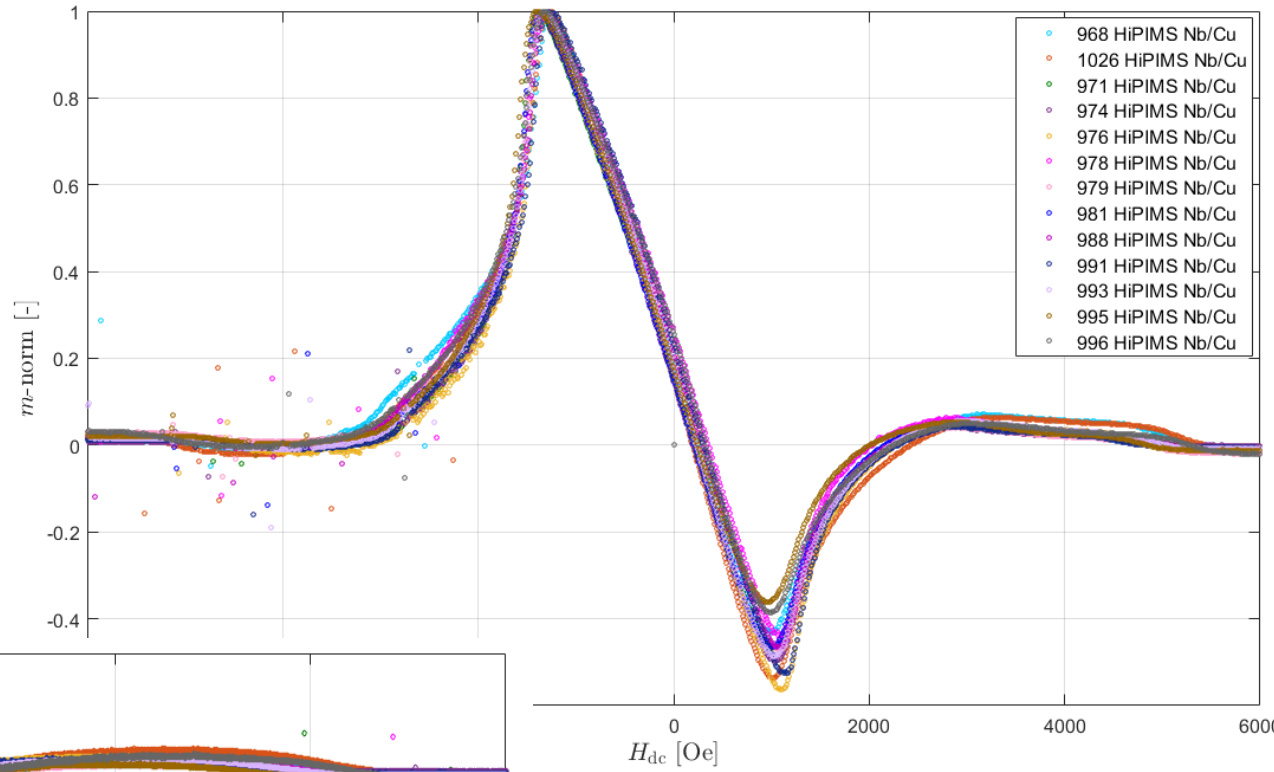
NbN / AlN / Nb / Cu

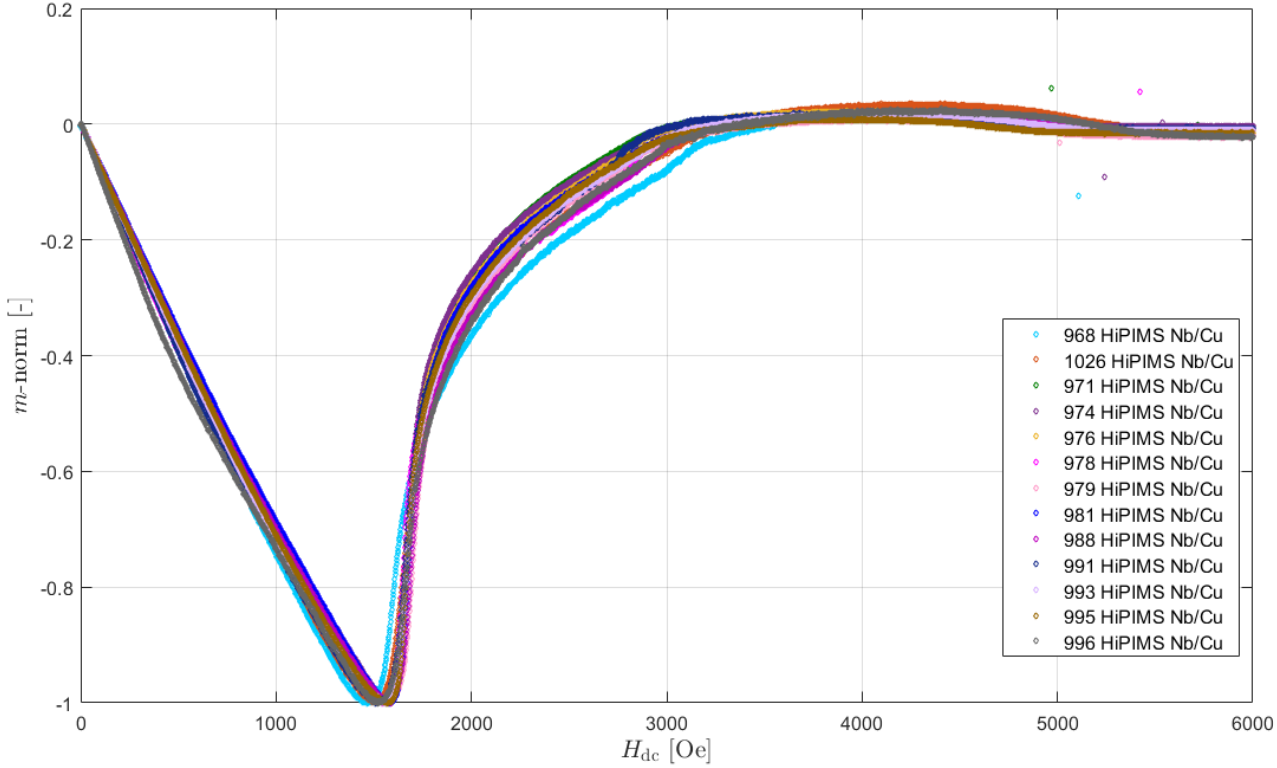


**HiPIMS Nb** 19.2.2020 series
Siegen Uni

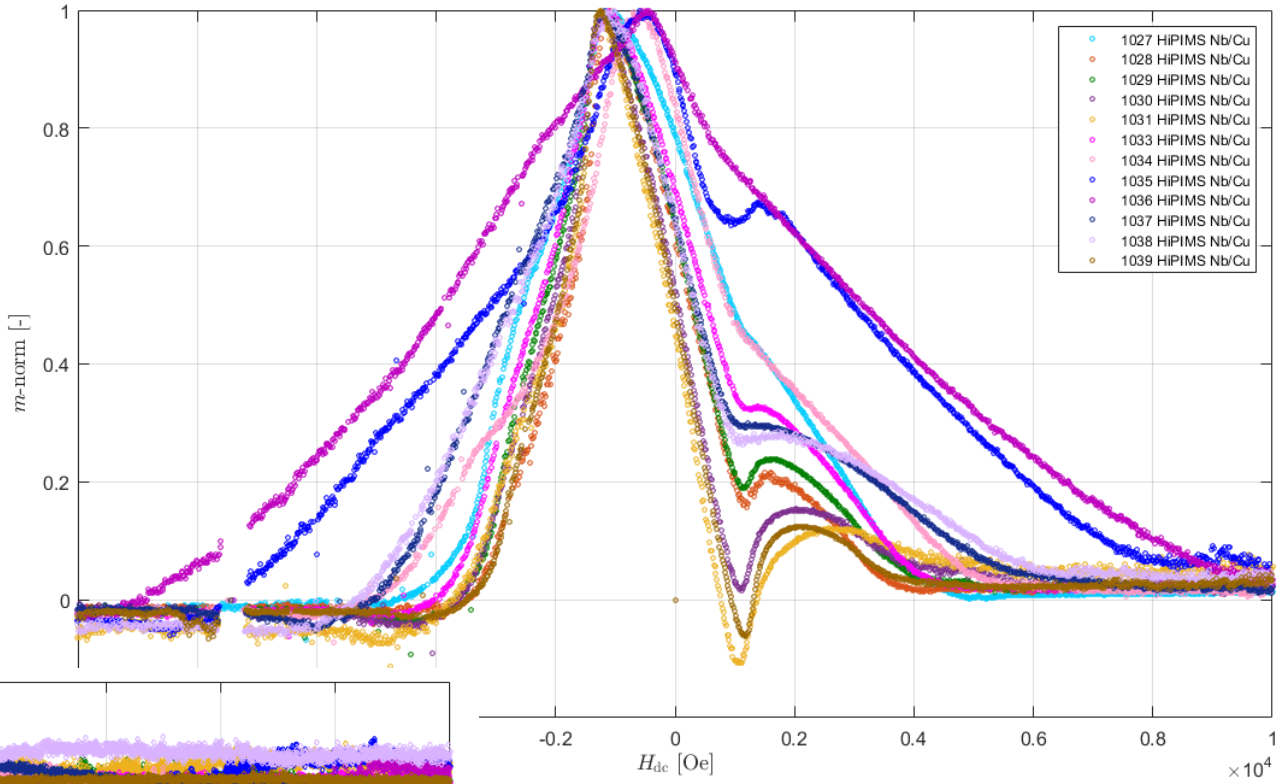
Nb / Cu

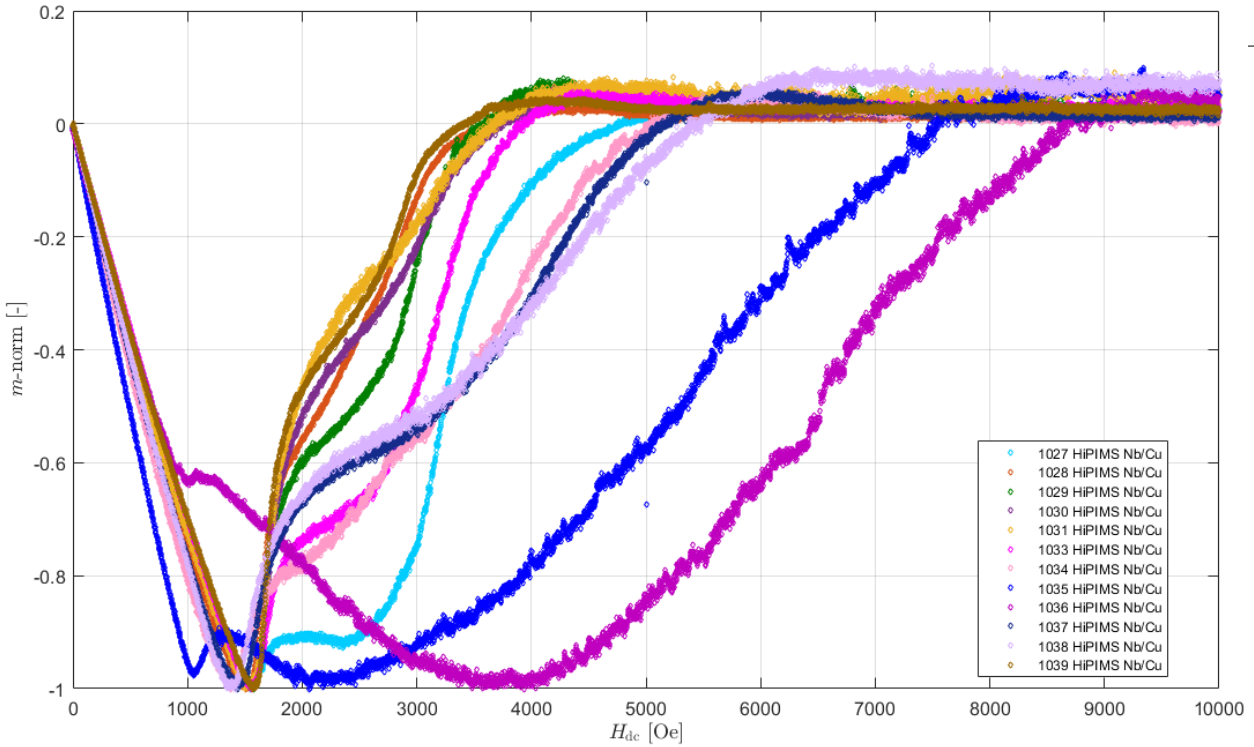


**HiPIMS Nb** 4.3.2020 series
Siegen Uni

Nb / Cu

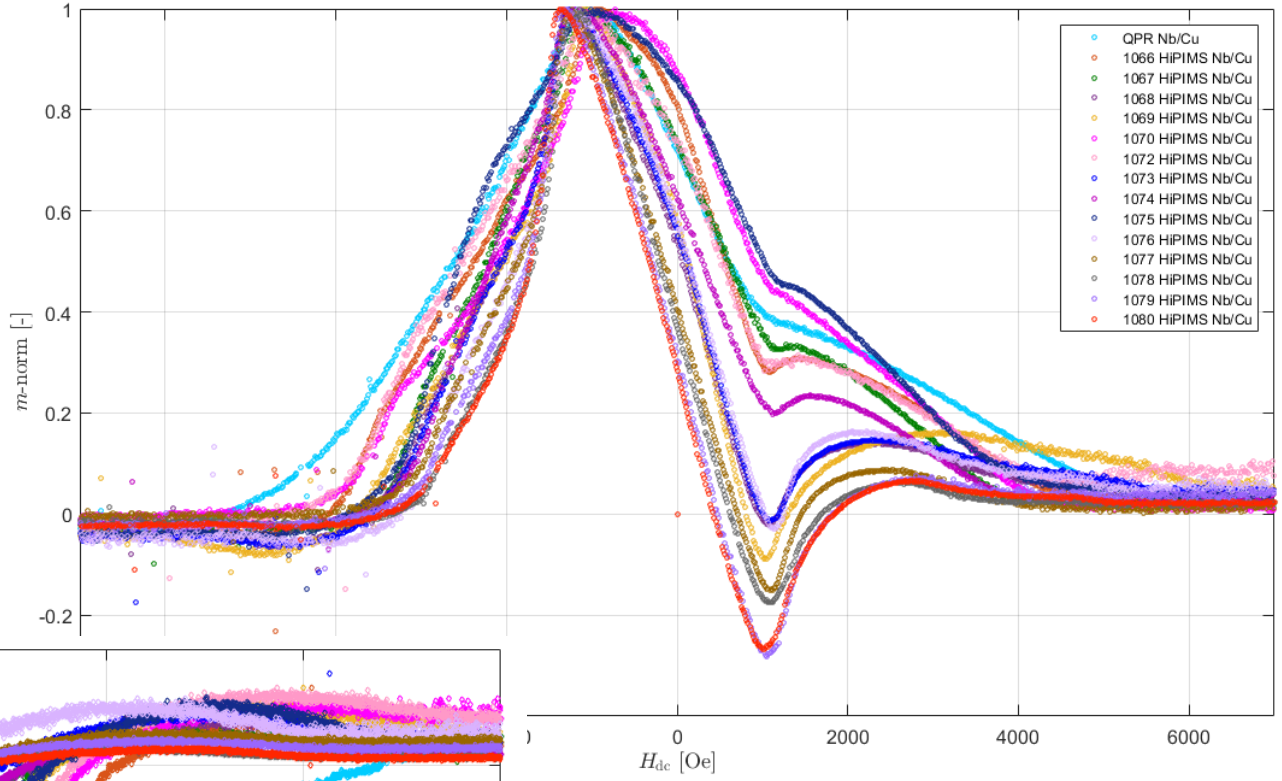


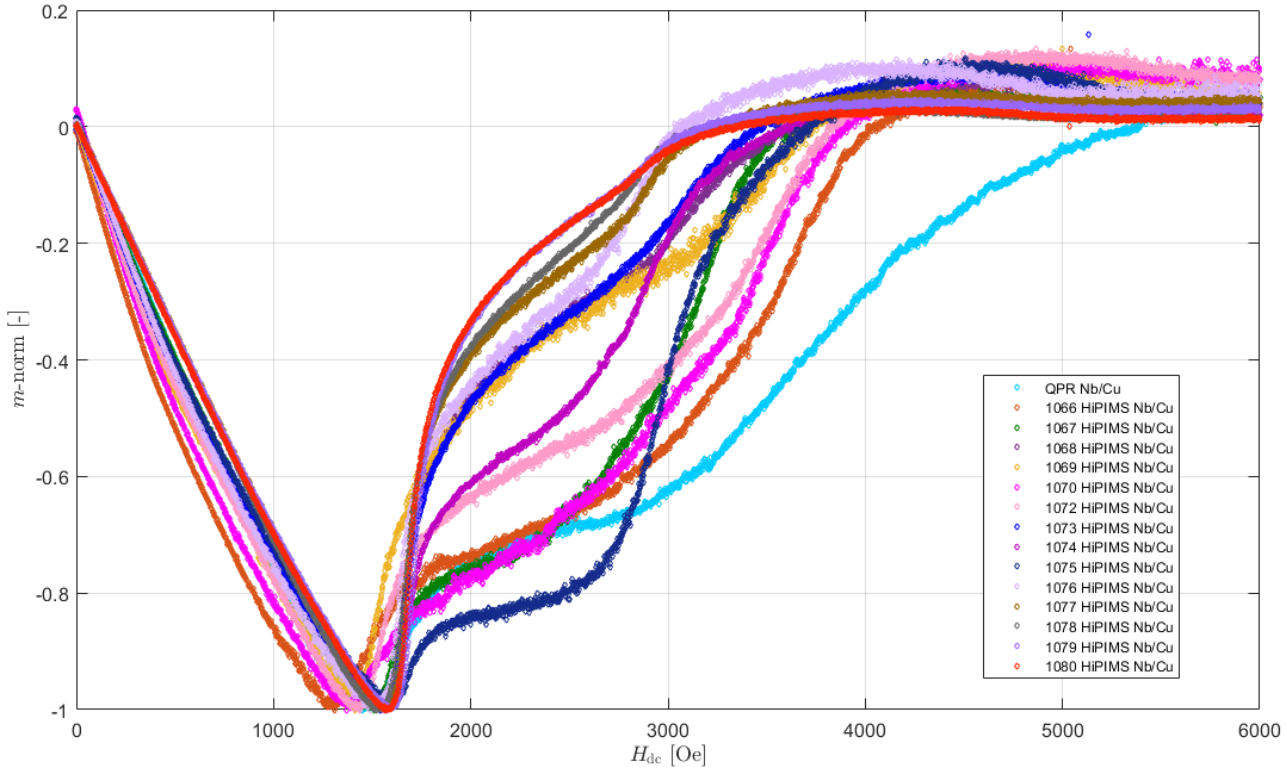



**HiPIMS Nb** 20.5.2020 series

Siegen Uni

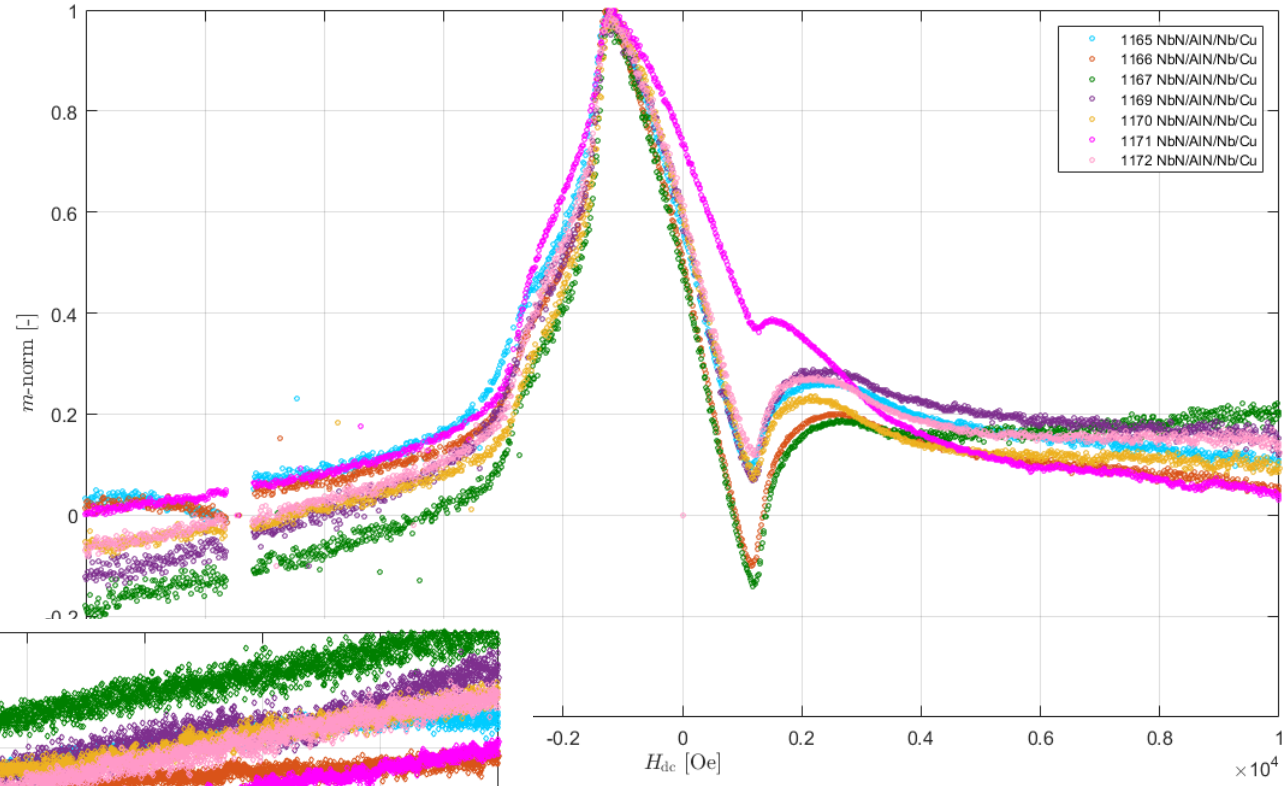
Nb / Cu

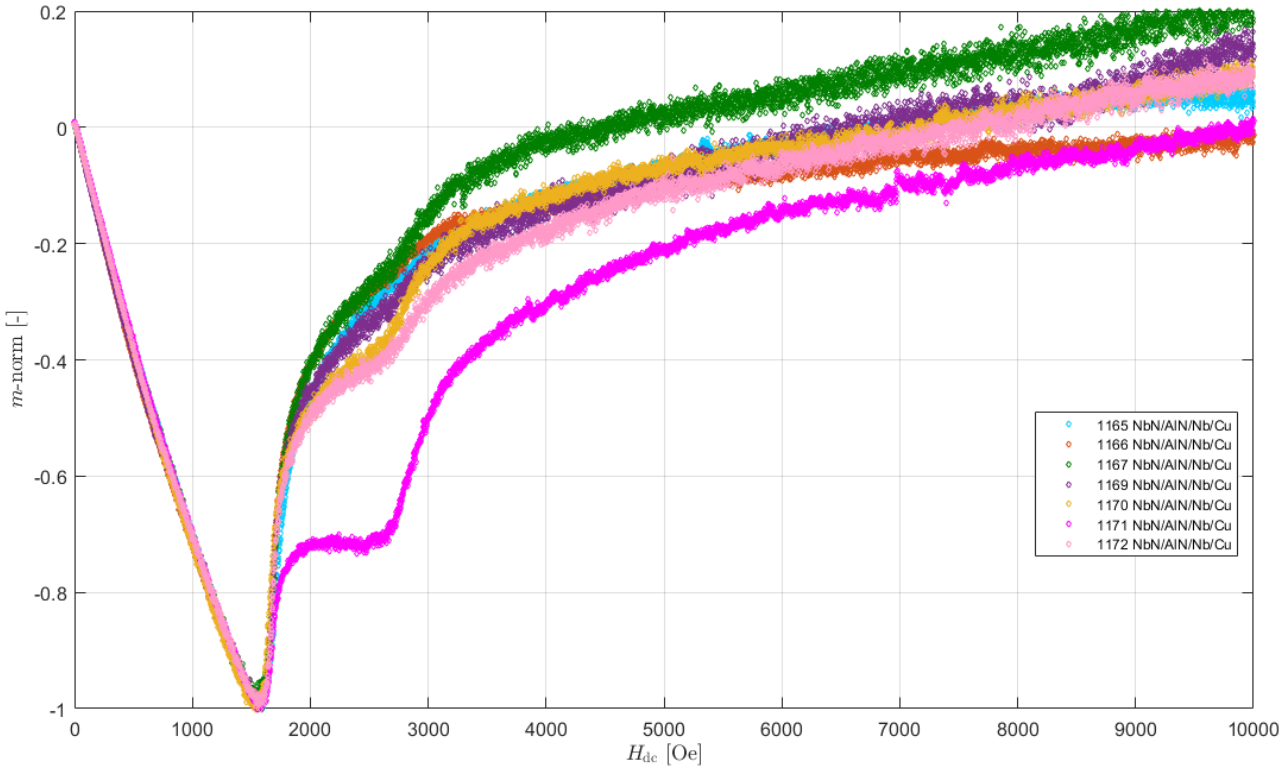


**SIS** 26.6.2020 series
Siegen Uni

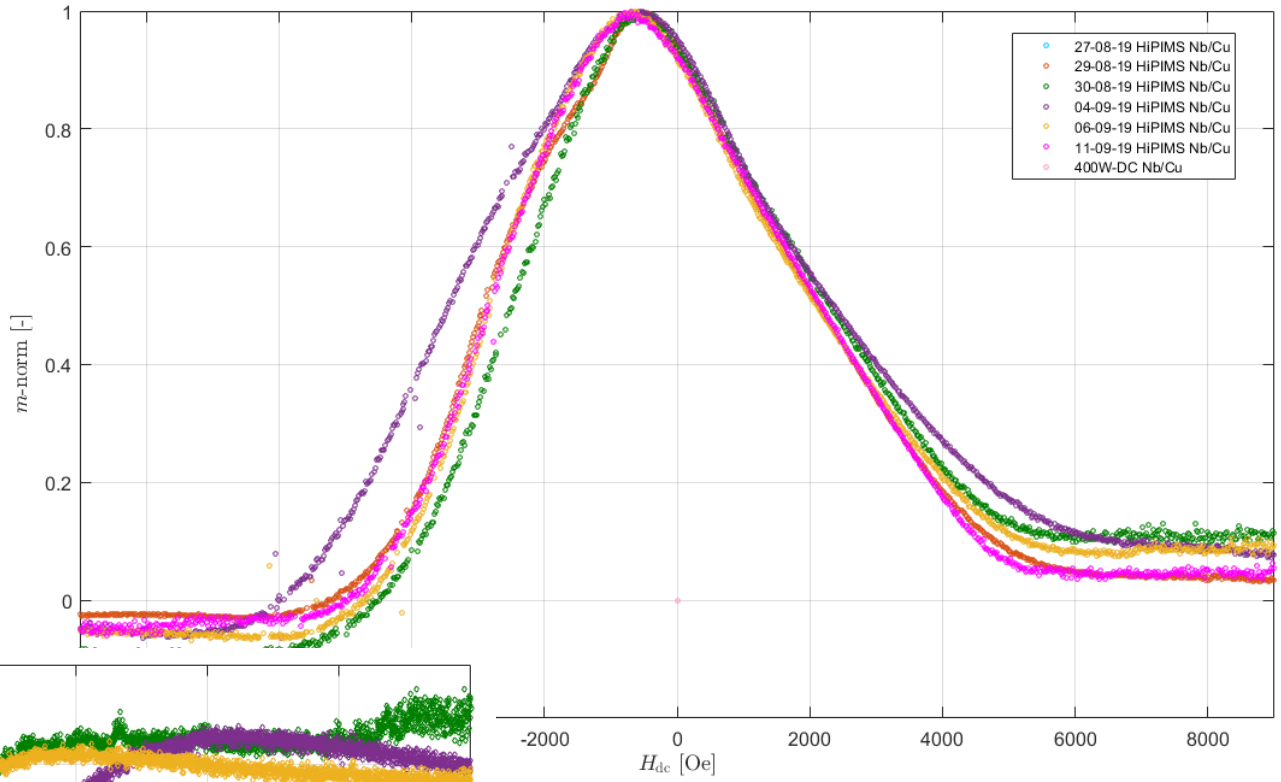
NbN / AlN / Nb / Cu

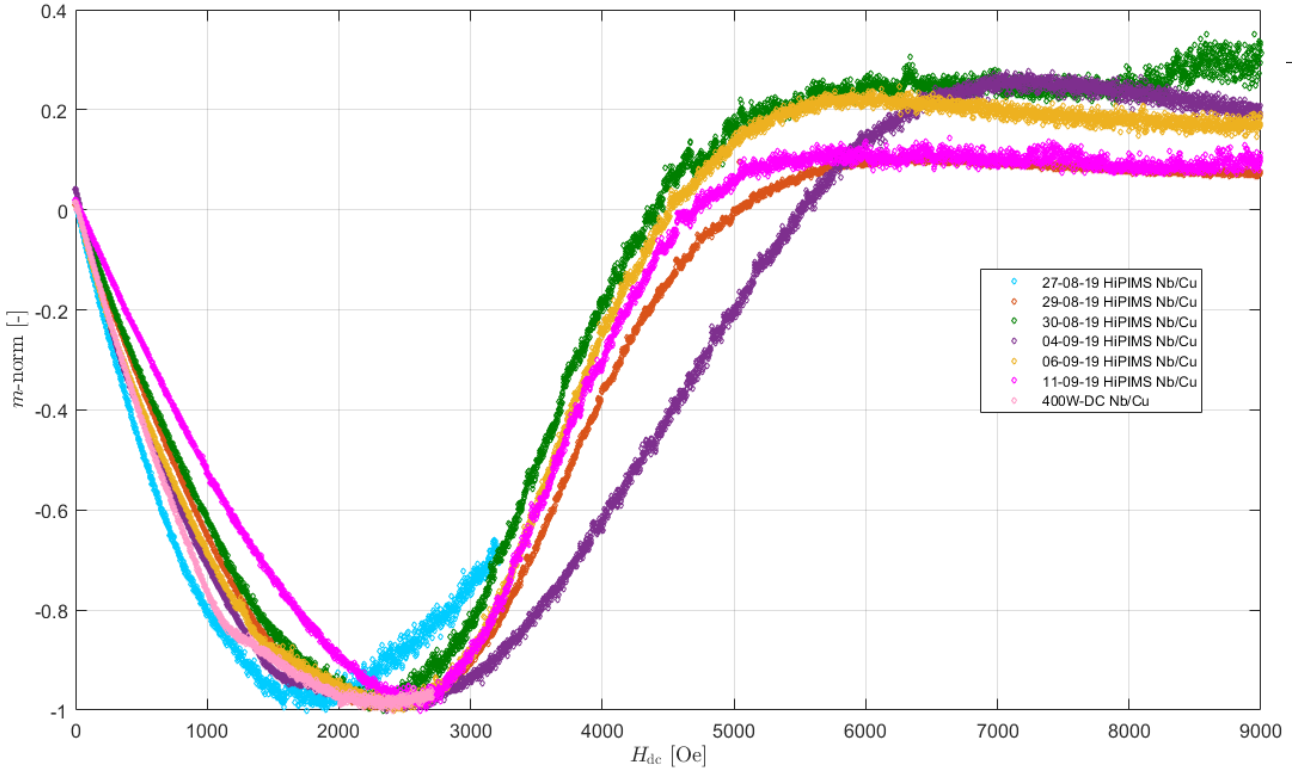


**HiPIMS Nb** 22.7.2020 series
STFC

Nb / Cu



**HiPIMS Nb** 4.9.2020 series

Siegen Uni

Nb / Cu