

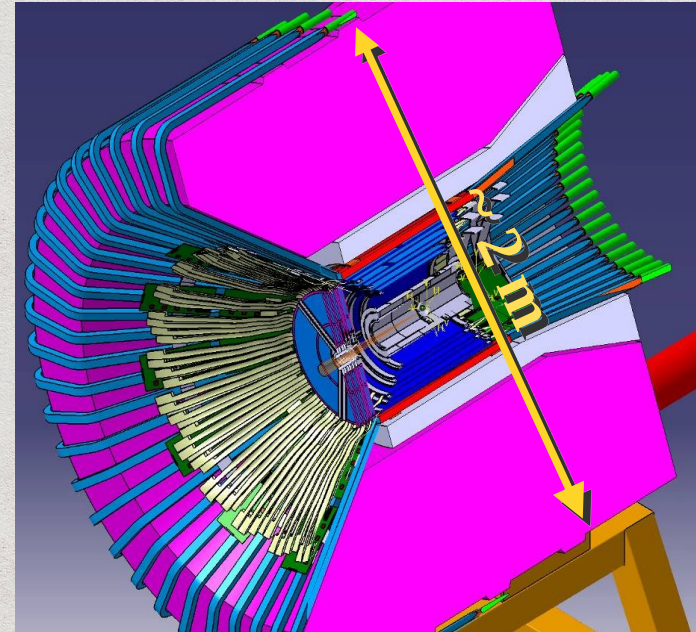
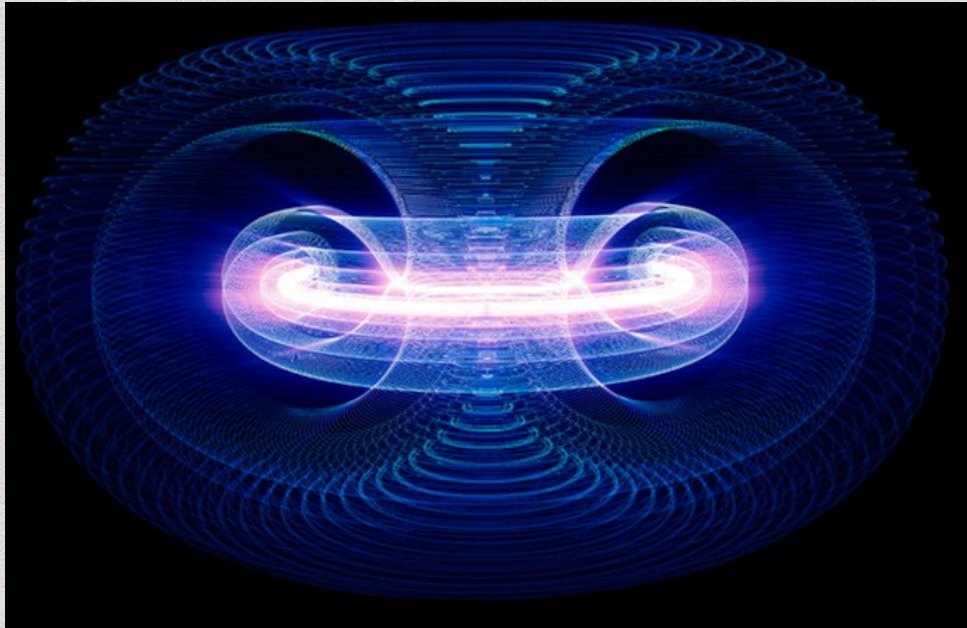
Bulk MgB₂ superconductor
for Nuclear Physics experiments

Luca Barion – INFN Ferrara

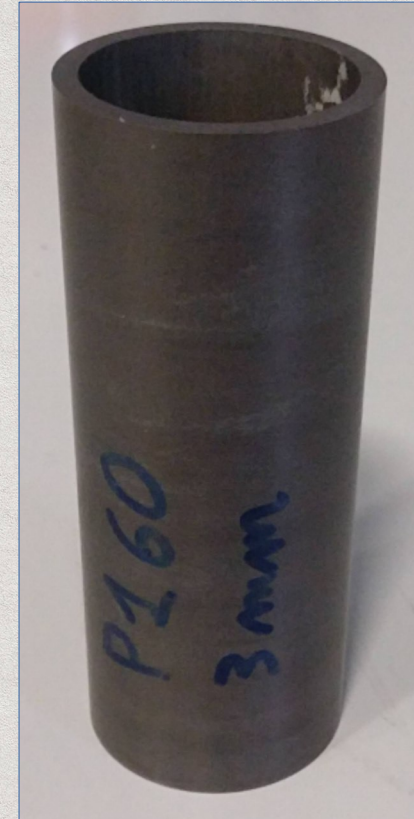
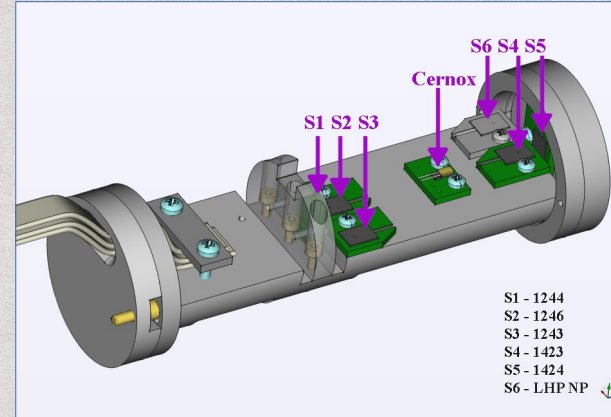
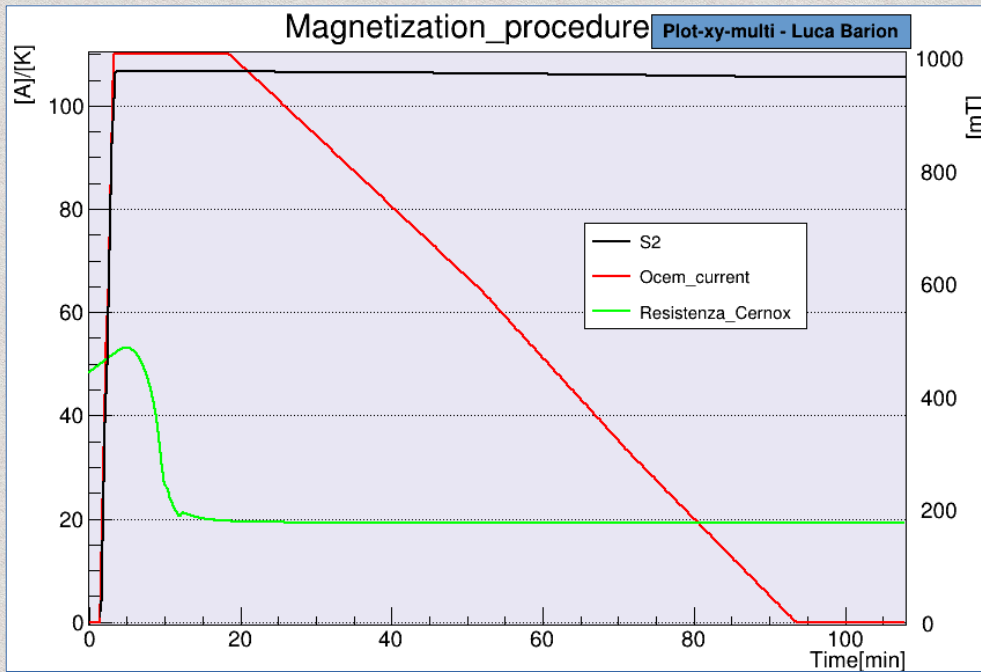
Applications

For use instead of traditional SC magnets:

- Nuclear fusion
(magnetic confinement, eg. Tokamak reactor; polarized fuel)
- Nuclear physics experiments
(polarized targets, eg. CLAS12 central detector)



Why / How



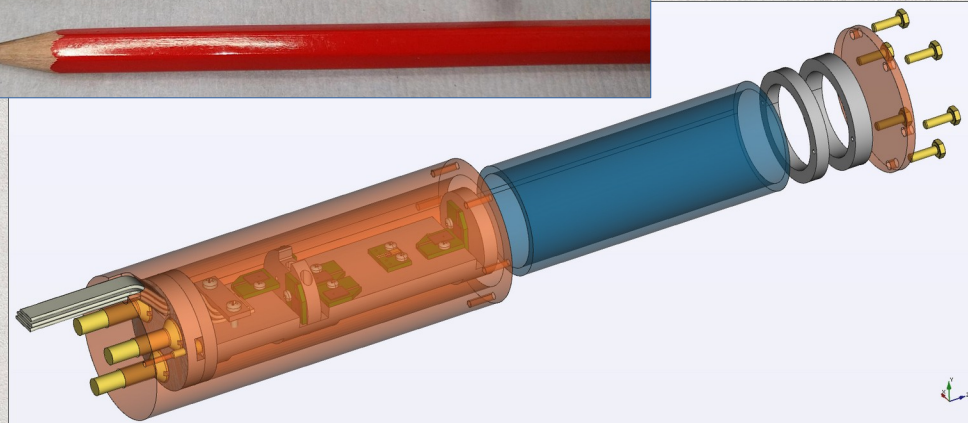
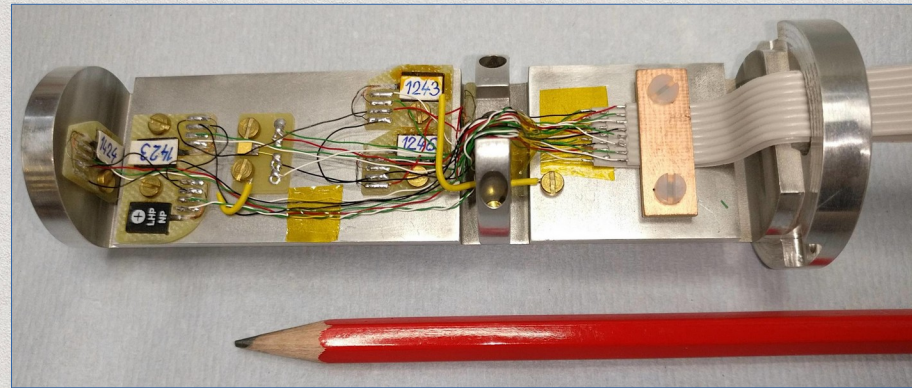
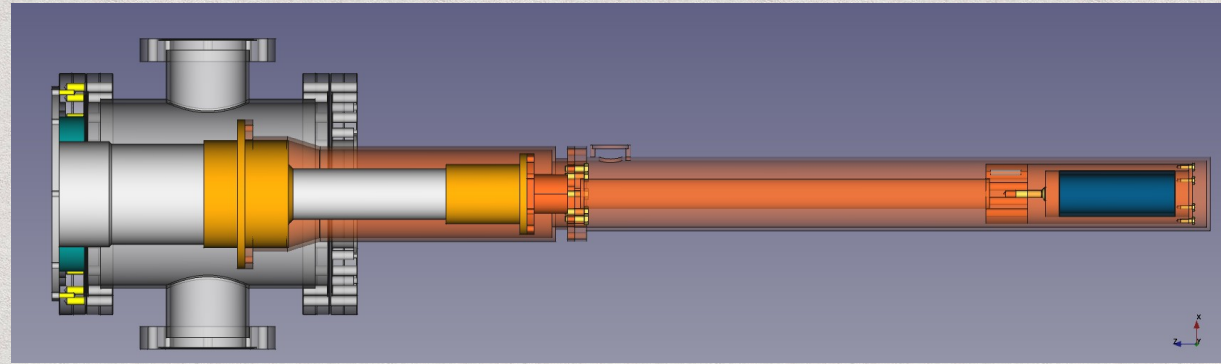
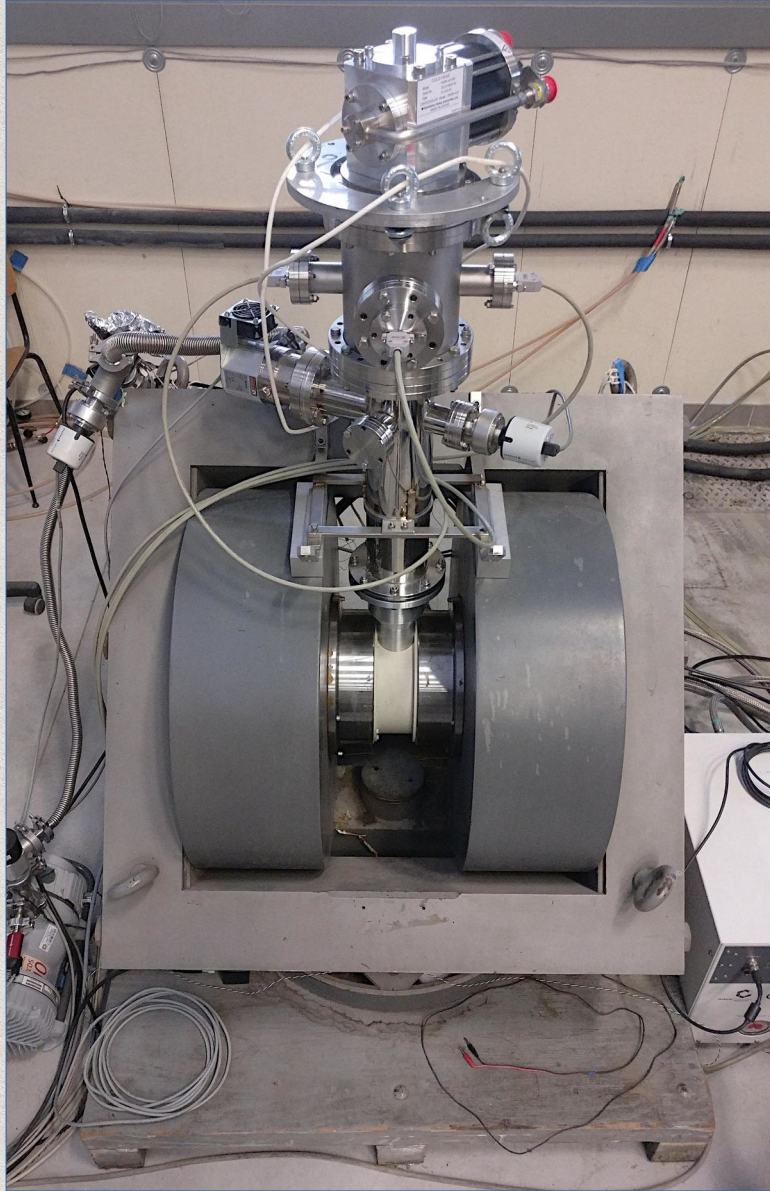
MgB₂

- compact
- almost arbitrary shape
- no current-leads
- no external power (excl cooling?)
- high magnetic field (tested 1T)
- both magnet and shield

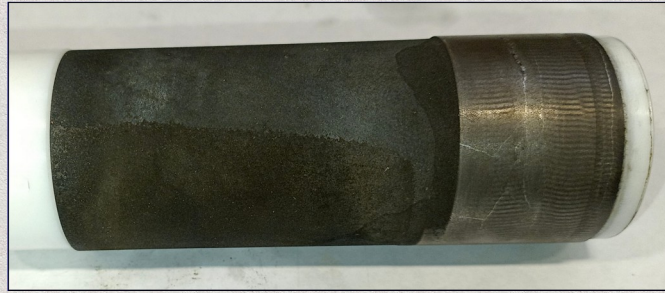
Conventional SC magnet

- current-leads (heat load, space)
- conventional shape
- continuous external power needed
- only magnet *

Experimental setup

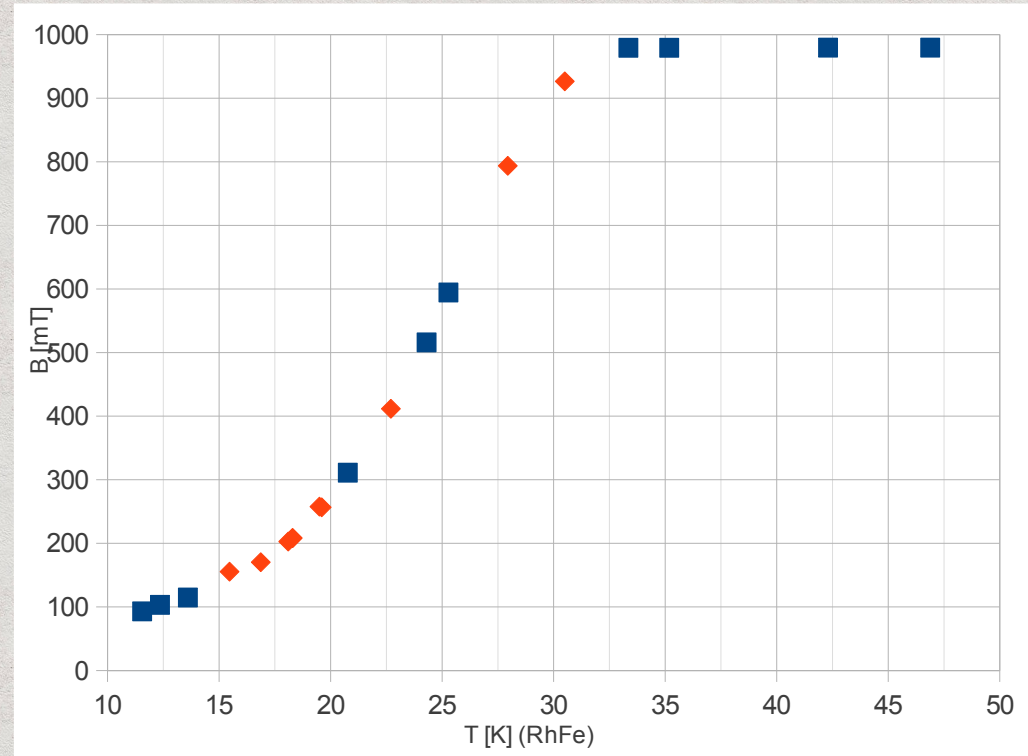
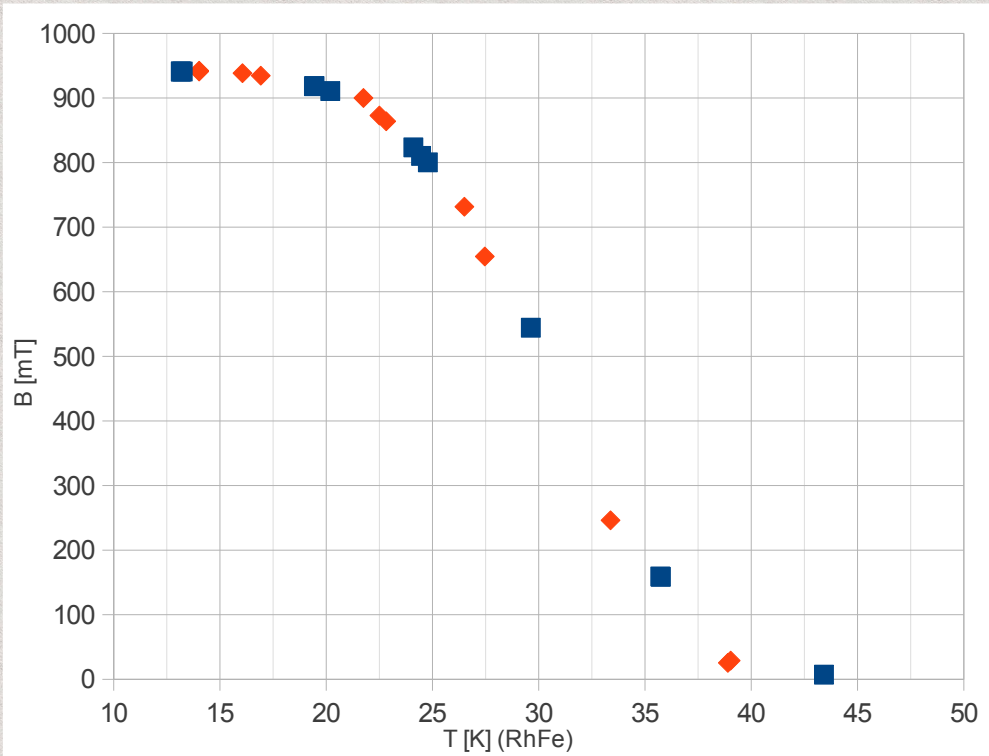


Measurements on first sample



Magnetization

Shielding



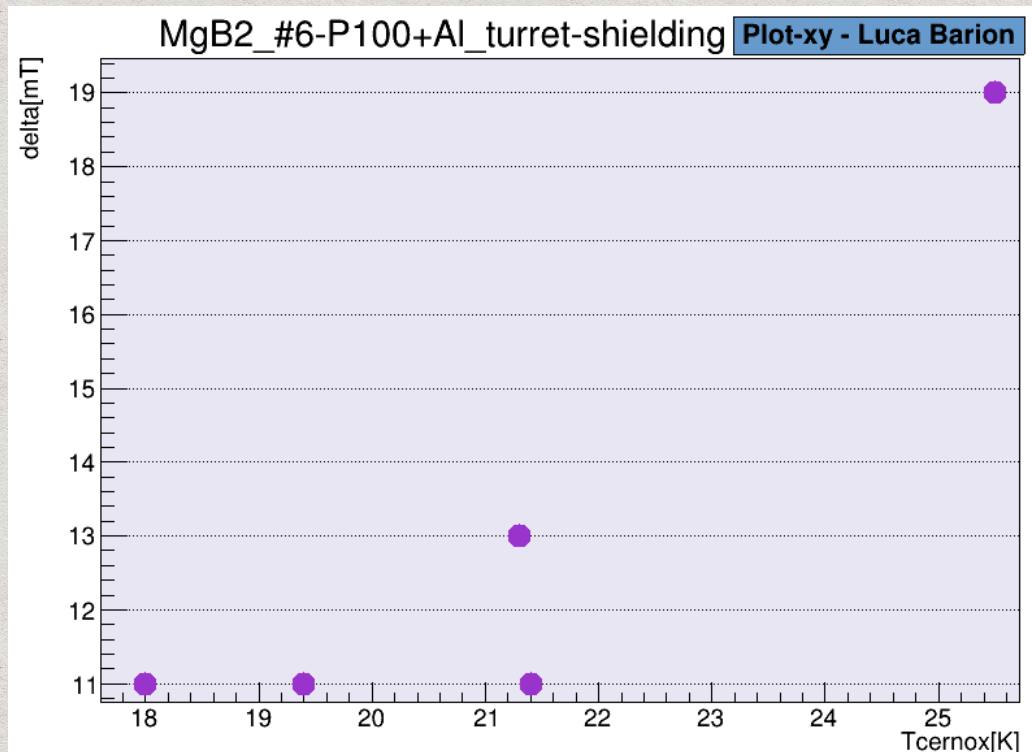
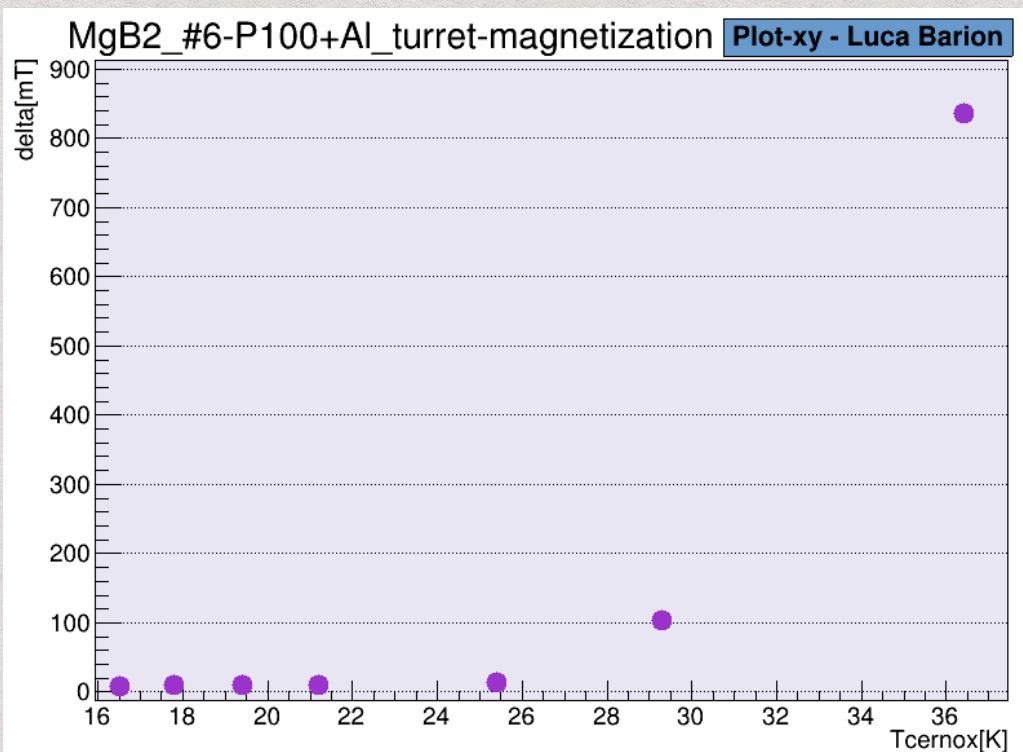
Results on sample #6 P100

(from new set)



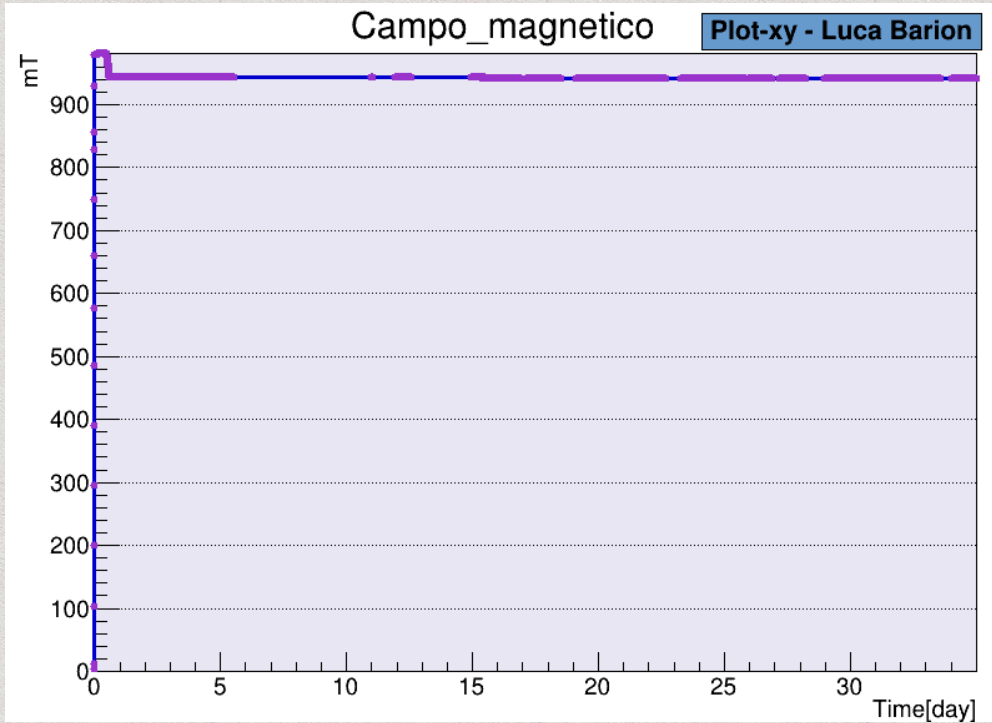
Best magnetization: 964 → 955 mT (**99%**)
[@ 16.5 K]

Best shielding: 5 → 16 (965) mT (**1%**)
[@ 18.0, 19.4, 21.4 K]

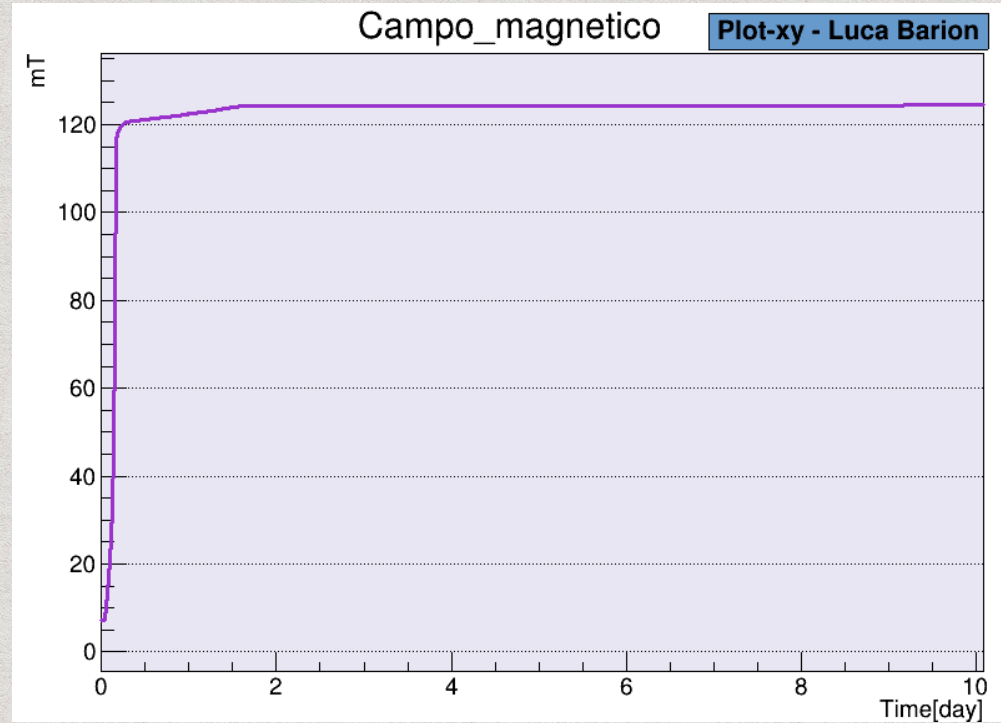


Long term performance

Magnetization, 2015-12-18



Shielding, 2019-04-22



Conclusions / outlook

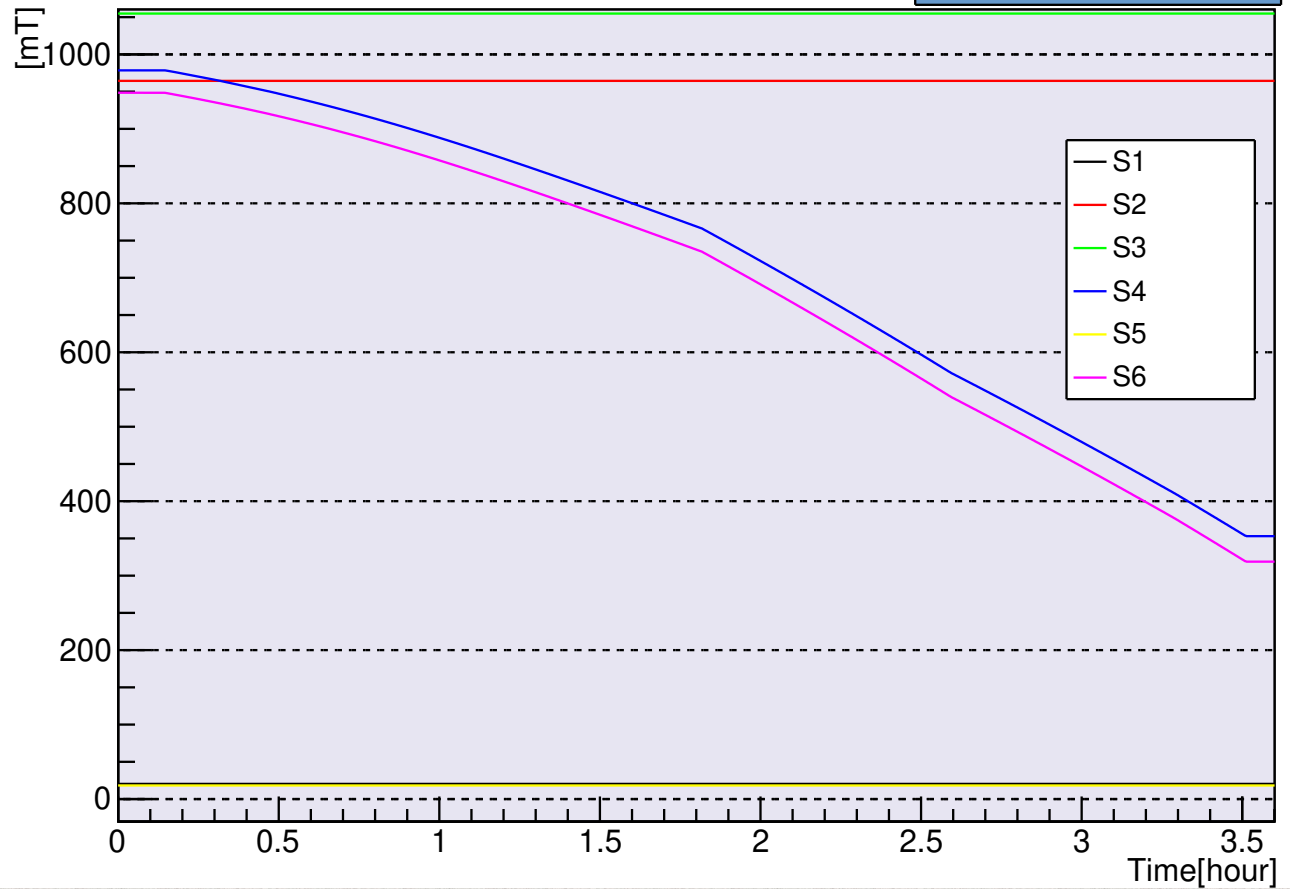
- MgB2 bulk superconductor is working
 - holding up to 99% initial ~ 1 T field
 - shielding up to 99% external ~ 1 T field
- Continue testing different geometries/granulometry
- Test higher field
- Analyze field homogeneity (5 more probes already acquired)
- Test solenoidal field

Backup slides

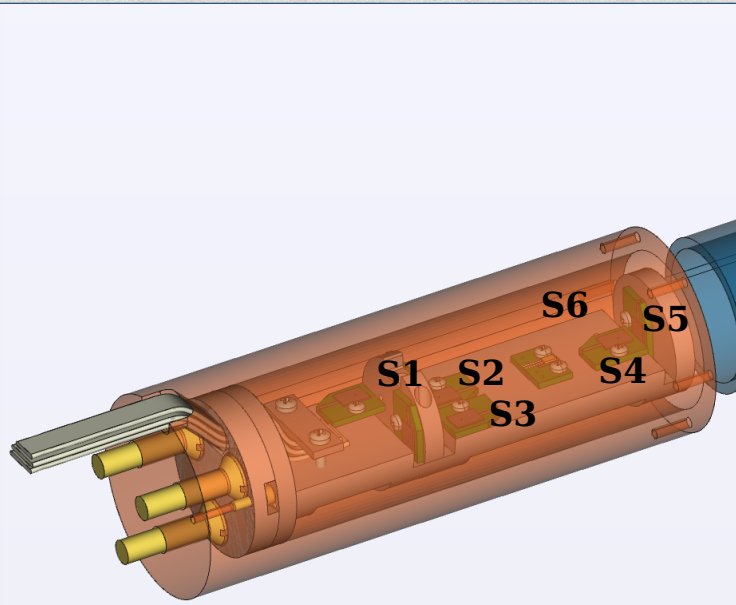
Other probes

Magnetic_field

Plot-xy-multi - Luca Barion



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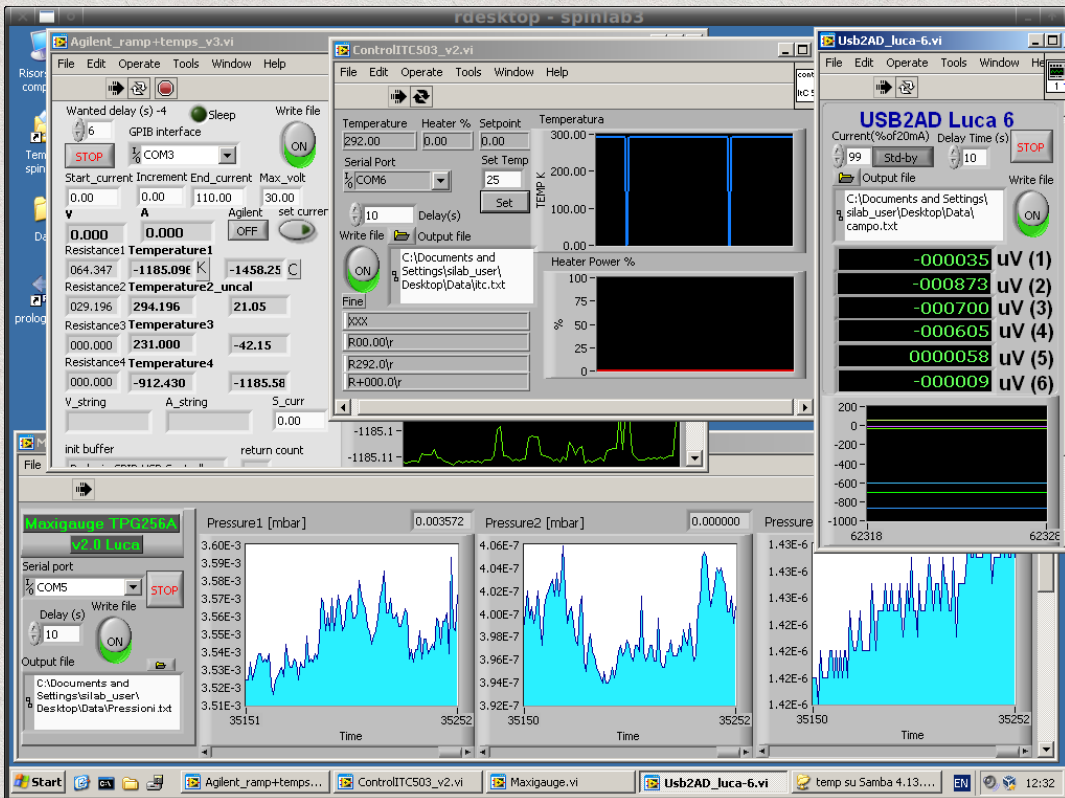
DAQ hardware



Available samples

#	Grana	Din	Dout	Spessore
#1	P?	33	38.5	2.75
#2	P?	35	38.5	1.75
#3	P?	35.4	38.0	1.3
#4	P160	32.5	38.5	3.0
#5	P160	30.6	38.5	3.95
#6	P100	32.5	38.5	3.0
#7	P40	32.5	38.5	3.0
#8	P160	32.5	38.5	3.0

DAQ (virtualized Labview + bash scripts / custom C progs)



```
lab@spinlab3: ~  
File Modifica Visualizza Cerca Terminale Aiuto  
1707737770 => T1=026.68 RH1=033.33  
1707737780 => T1=026.70 RH1=033.33  
1707737790 => T1=026.71 RH1=033.26  
1707737800 => T1=026.70 RH1=033.26  
1707737810 => T1=026.70 RH1=033.26  
1707737820 => T1=026.70 RH1=033.26  
1707737830 => T1=026.67 RH1=033.26  
1707737840 => T1=026.66 RH1=033.26  
1707737850 => T1=026.69 RH1=033.29  
1707737860 => T1=026.73 RH1=033.29  
1707737870 => T1=026.74 RH1=033.23  
1707737880 => T1=026.77 RH1=033.19  
1707737890 => T1=026.78 RH1=033.19  
1707737900 => T1=026.80 RH1=033.12  
1707737910 => T1=026.83 RH1=033.12  
1707737920 => T1=026.87 RH1=033.06  
1707737930 => T1=026.89 RH1=033.06  
1707737940 => T1=026.91 RH1=032.99  
1707737950 => T1=026.92 RH1=032.92  
1707737960 => T1=026.93 RH1=032.92  
1707737970 => T1=026.94 RH1=032.89  
1707737980 => T1=026.93 RH1=032.86  
0&$* bash
```

```
lab@spinlab3: ~  
File Modifica Visualizza Cerca Terminale Aiuto  
12:36:11 75.000 17.100  
12:36:21 75.000 17.102  
12:36:31 75.000 17.105  
12:36:41 75.000 17.107  
12:36:51 75.000 17.109  
12:37:01 75.000 17.111  
12:37:11 75.000 17.113  
12:37:21 75.000 17.115  
12:37:31 75.000 17.117  
12:37:41 75.000 17.119  
12:37:51 75.000 17.121  
12:38:01 75.000 17.123  
12:38:11 75.000 17.125  
12:38:21 75.000 17.127  
12:38:31 75.000 17.129  
12:38:41 75.000 17.132  
12:38:51 75.000 17.134  
12:39:01 75.000 17.136  
12:39:11 75.000 17.138  
12:39:21 75.000 17.140
```

```
lab@spinlab3: ~/data/slow_log  
File Modifica Visualizza Cerca Terminale Aiuto  
1707737782 Water 0022.5 0028.4 0023.4 0022.5  
1707737792 Water 0022.6 0028.5 0023.5 0022.5  
1707737802 Water 0022.6 0028.6 0023.5 0022.5  
1707737812 Water 0022.7 0028.6 0023.5 0022.6  
1707737822 Water 0022.6 0028.6 0023.5 0022.6  
1707737832 Water 0022.7 0028.6 0023.5 0022.6  
1707737842 Water 0022.7 0028.6 0023.5 0022.6  
1707737852 Water 0022.7 0028.6 0023.6 0022.6  
1707737862 Water 0022.8 0028.7 0023.7 0022.6  
1707737872 Water 0022.8 0028.8 0023.6 0022.7  
1707737882 Water 0022.9 0028.8 0023.7 0022.8  
1707737892 Water 0022.9 0028.9 0023.7 0022.8  
1707737902 Water 0022.9 0028.9 0023.7 0022.8  
1707737912 Water 0023.0 0028.9 0023.8 0022.9  
1707737922 Water 0023.0 0029.0 0023.8 0022.9  
1707737932 Water 0023.1 0029.0 0023.8 0023.0  
1707737942 Water 0023.0 0029.0 0023.8 0023.0  
1707737952 Water 0023.1 0029.1 0023.8 0023.0  
1707737962 Water 0023.1 0029.1 0023.8 0023.0  
1707737972 Water 0023.1 0029.1 0023.8 0023.1  
1707737982 Water 0023.2 0029.2 0023.9 0023.1  
1707737992 Water 0023.2 0029.2 0023.9 0023.1  
0&$* bash
```