Magnetic Fields and an Operating SRF Cavity

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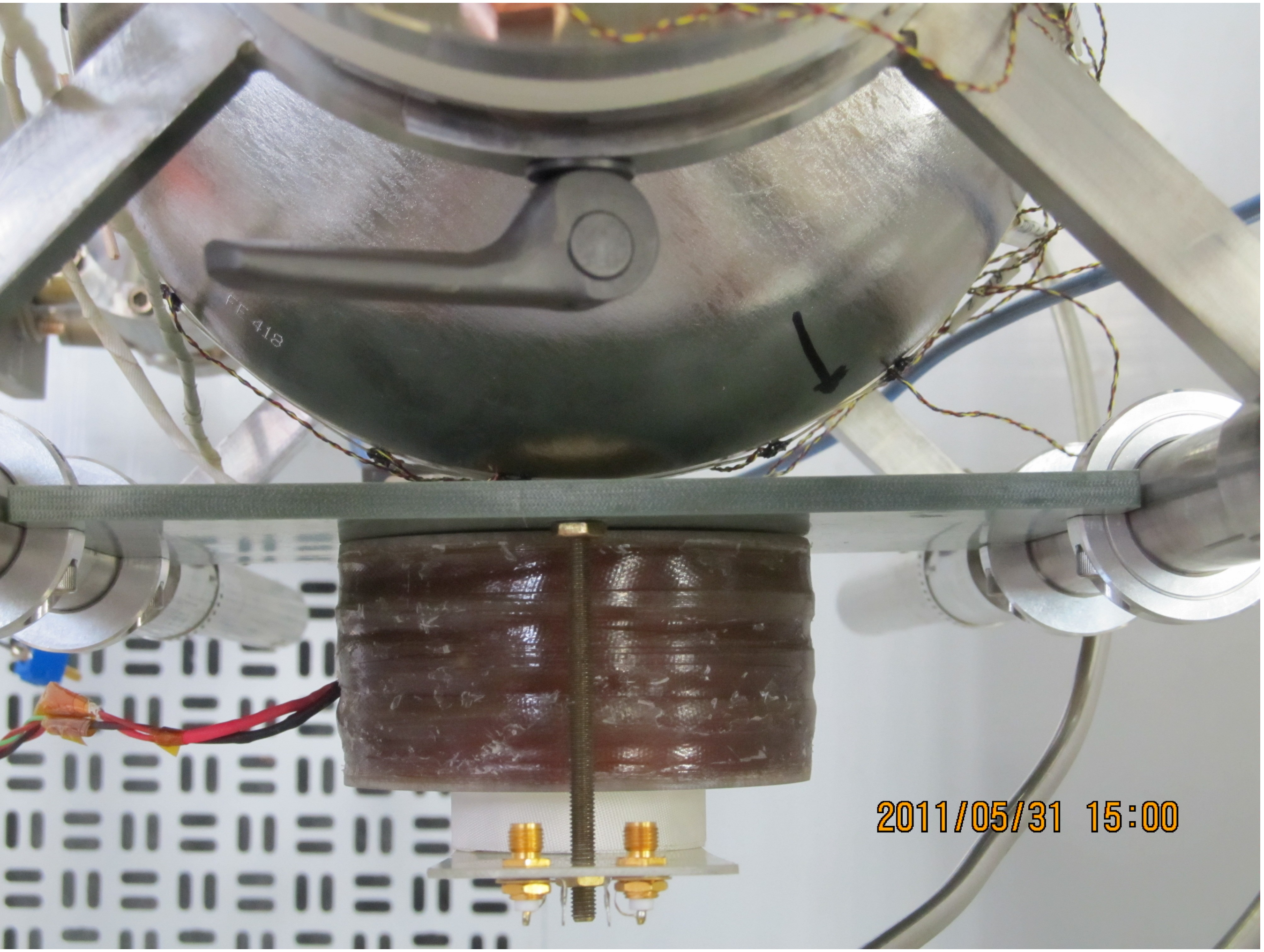
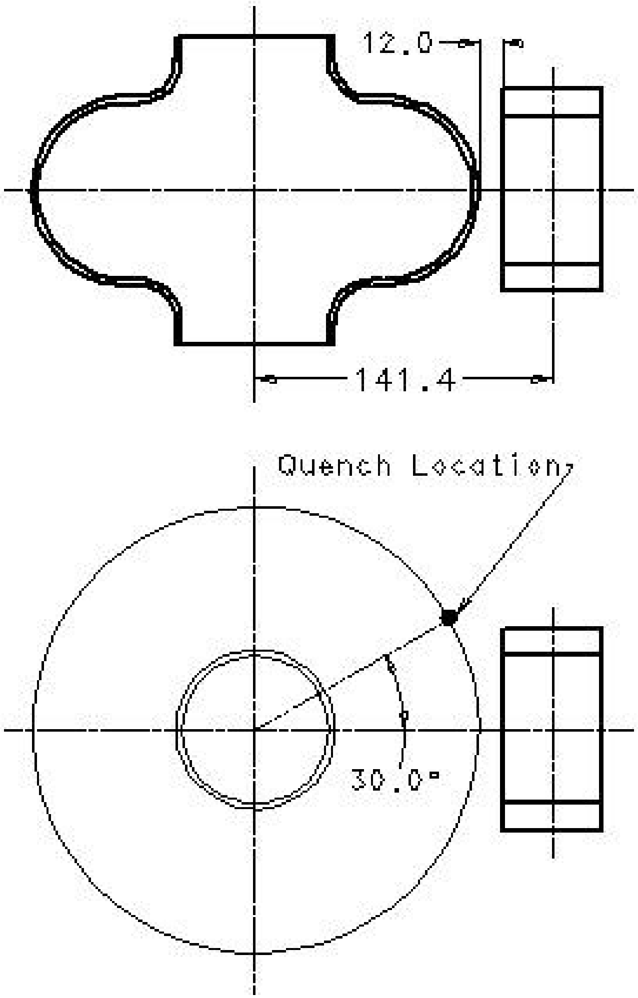
Abstract

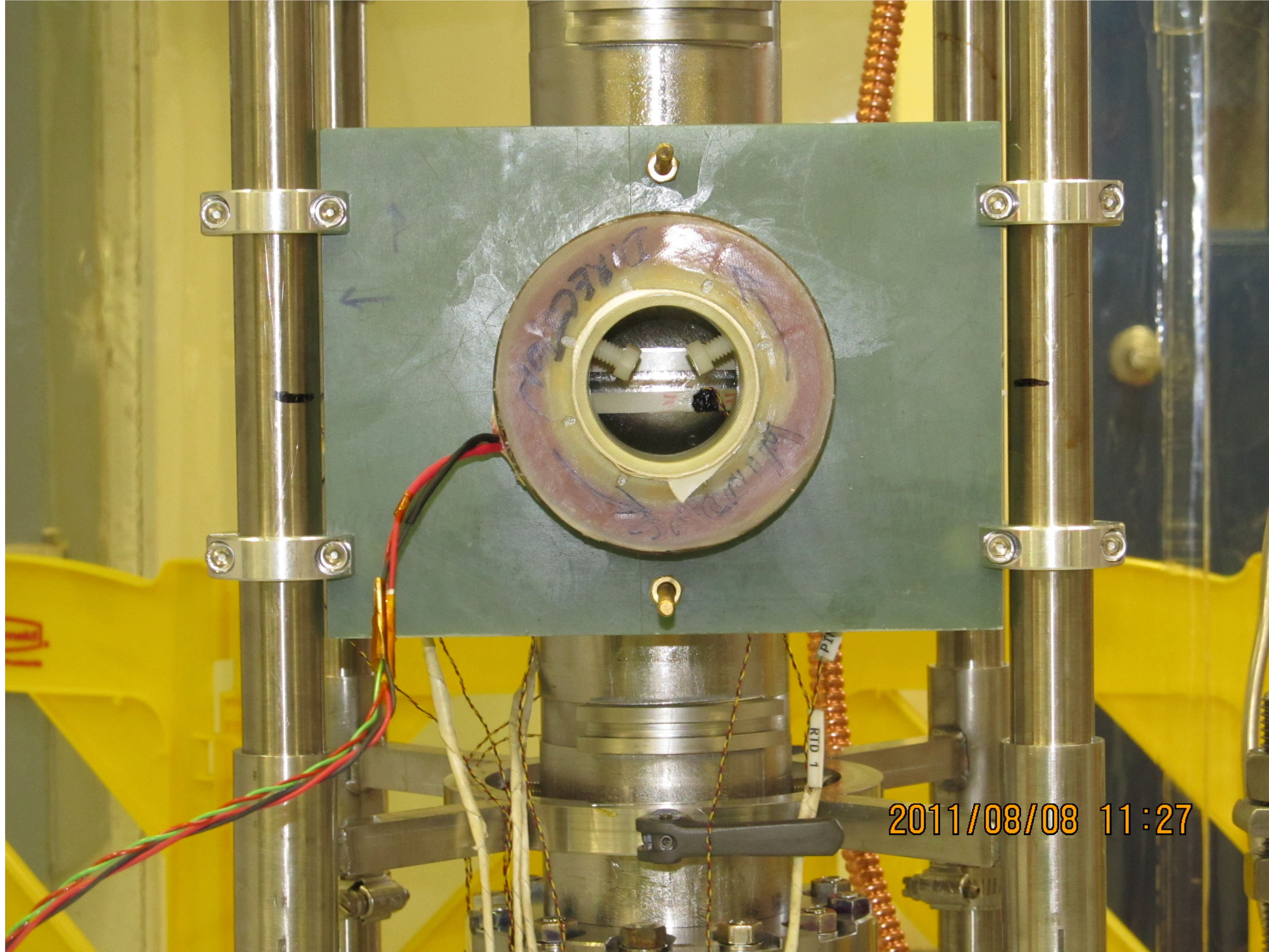
When an SRF cavity is undergoing transition to superconducting state in an external magnetic field it traps some of the flux which results in an increase of surface resistance. This effect was extensively studied, is well understood by now and results in stringent requirements for an ambient magnetic field on the surface of an SRF cavity. The situation is quite different when magnetic field applied to a cavity already in superconducting state. During a normal operation the bulk of superconducting Nb should protects RF surface of the cavity from the fields on the outside. So we expect that the requirements on external magnetic field applied to an operating cavity could be significantly relaxed. One possible failure mode is when the cavity quench while the external field is applied. The magnetic field would penetrate through a normal zone formed during the quench and can get trapped during the subsequent cooling. We studied effects of external magnetic field applied to an operating SRF cavity and report the results.

Setup: 1-cell cavity and magnet





150 Gauss/Amp at the quench location


RTD 1
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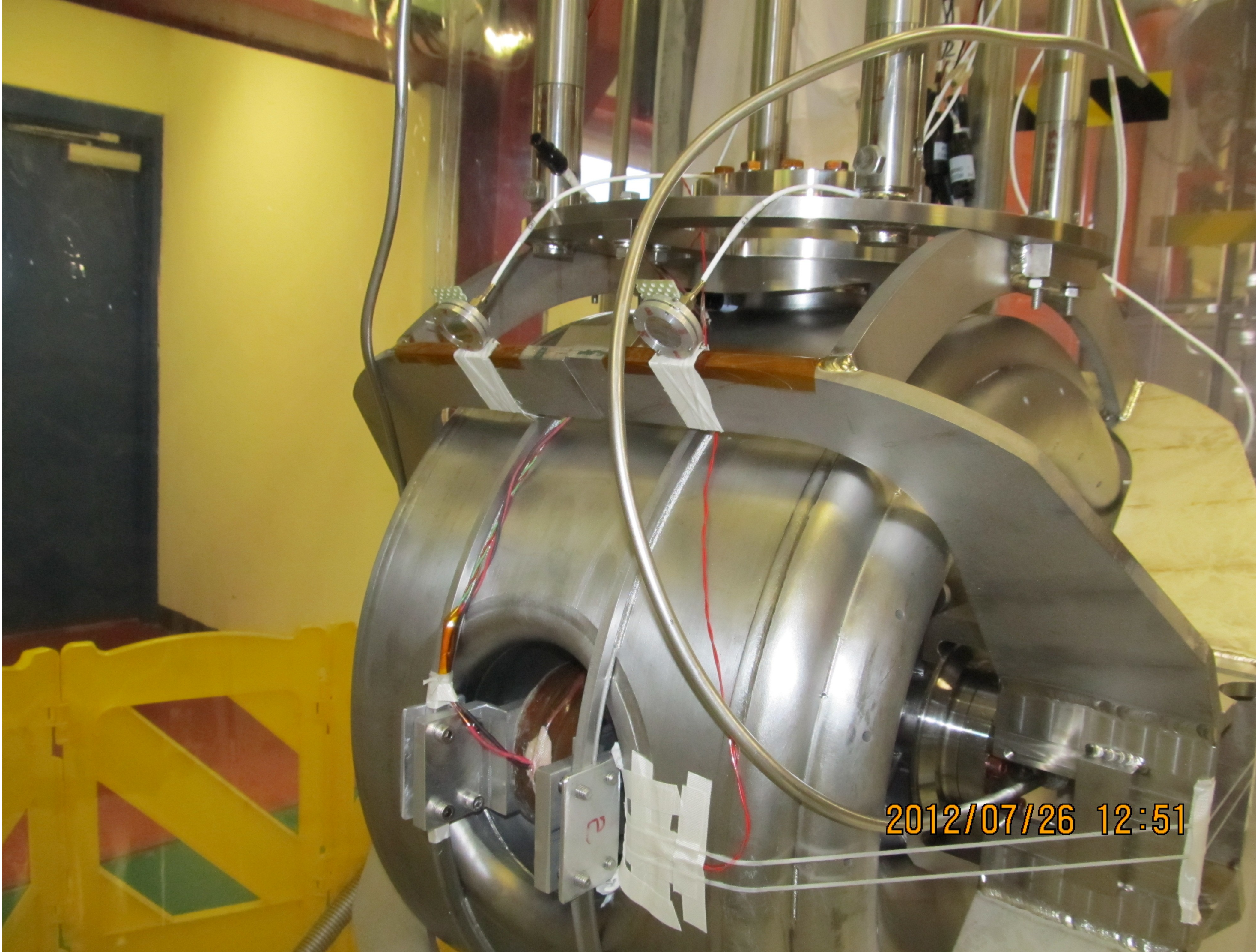
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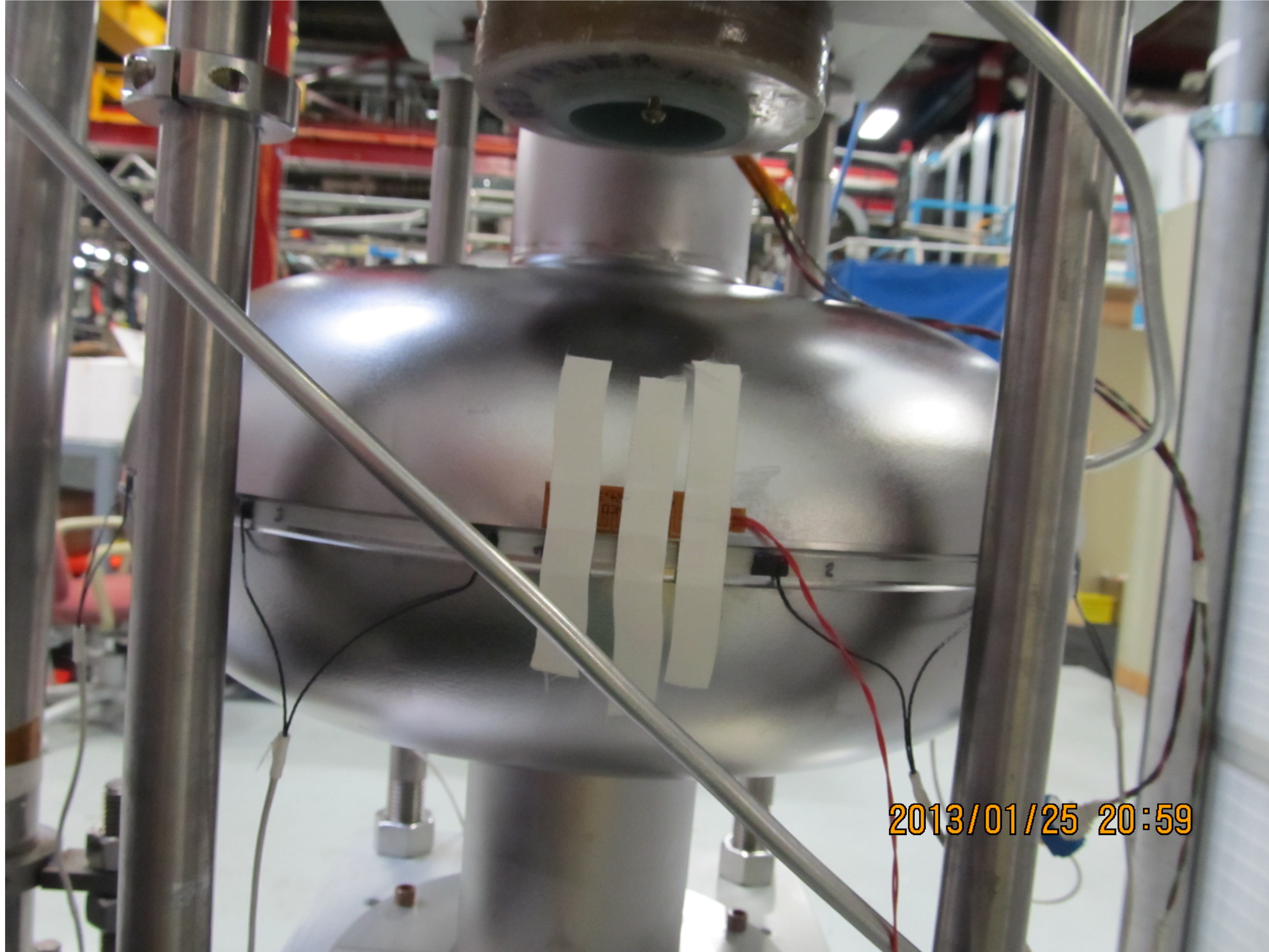
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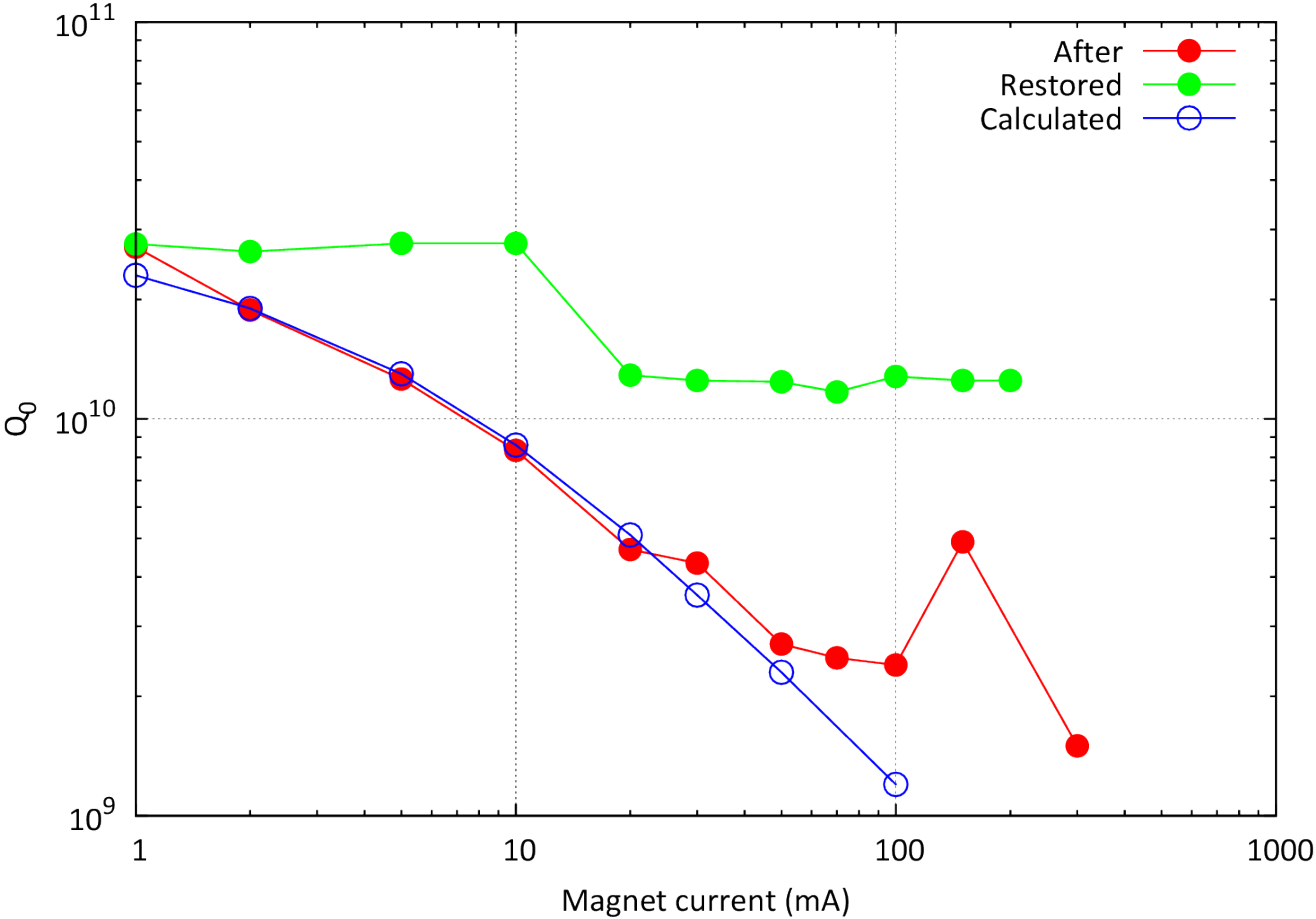
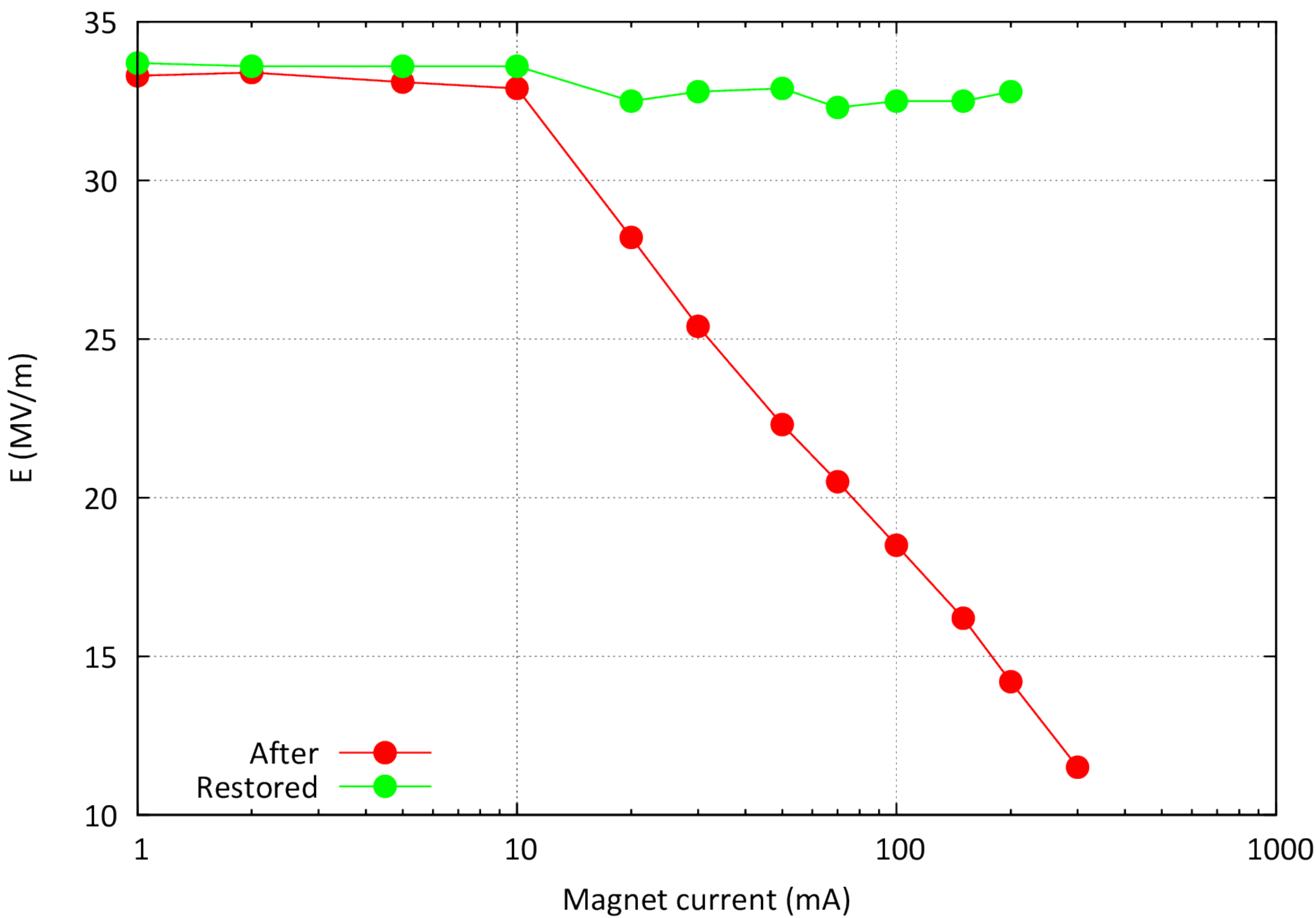
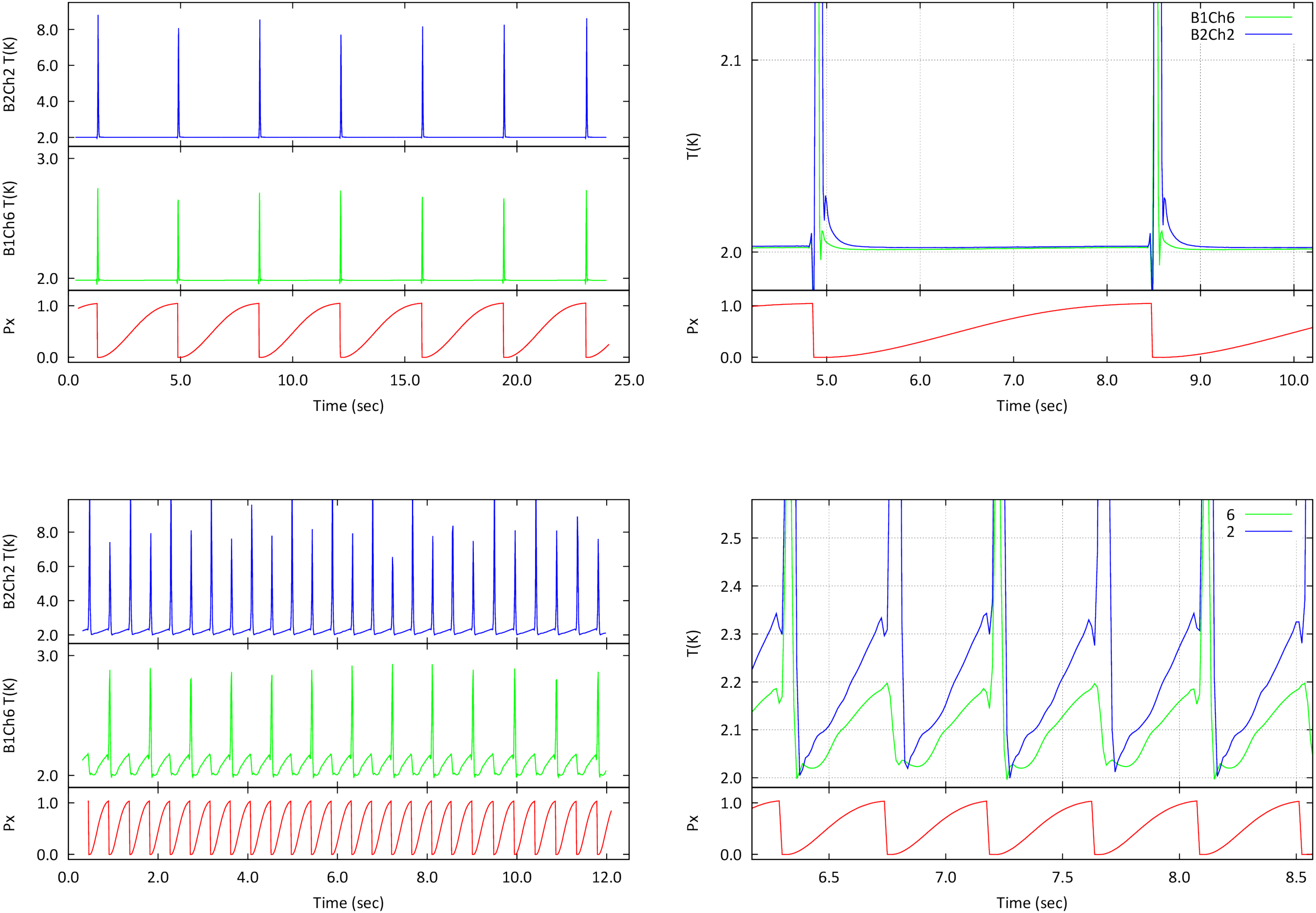


After
Restored
Calculated
10^{11}
10^{10}
10^{9}
Q_0
1
10
100
1000
Magnet current (mA)



35
30
25
20
15
10
1
10
100
1000
E (MV/m)
Magnet current (mA)
After
Restored


B2Ch2 T(K)
B1Ch6 T(K)
Px
Time (sec)
T(K)
B1Ch6
B2Ch2
6
2
8.0
6.0
4.0
2.0
3.0
1.0
0.0
5.0
10.0
15.0
20.0
25.0
2.1
7.0
9.0
12.0
2.5
2.4
2.3
2.2
6.5
7.5
8.5

Conclusion

It appears that an SRF cavity, once in SC state, can tolerate much higher magnetic field than it is usually assumed.
If the cavity quenches and traps some magnetic flux, its performance degrades as expected. Yet, it is possible to (almost completely) recover the original performance (in terms of E and Q) by letting the cavity quench when the external field is turned off.