The development of persistent joints for MgB_2-based conductors

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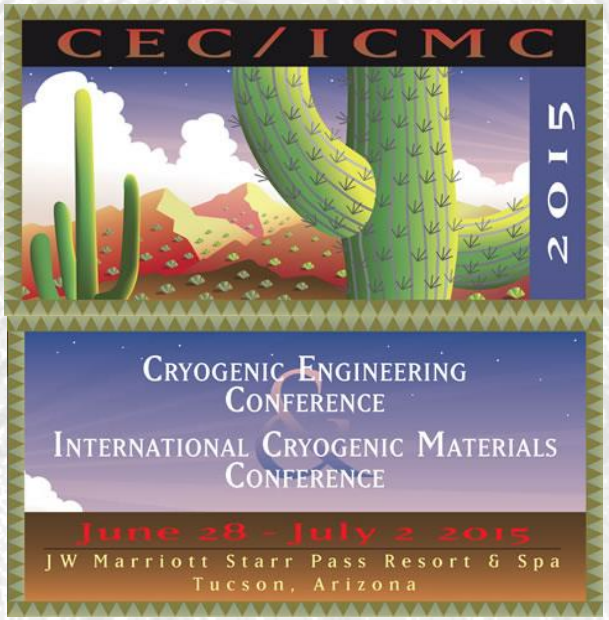


Funded by an NIH bridge grant, and also an NIH NIH, National Institute of Biomedical Imaging and Bioengineering grant, under R01EB018363.

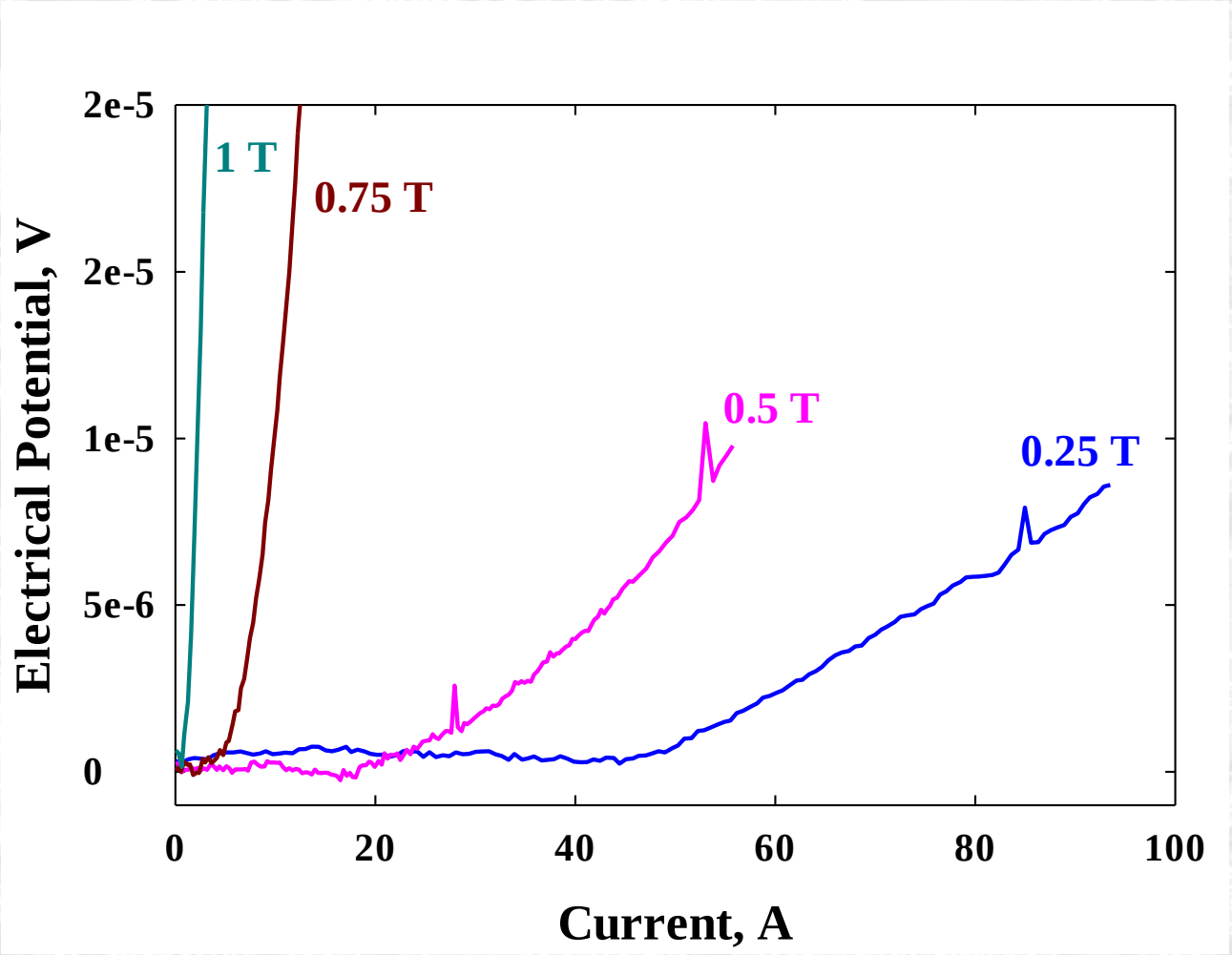
Outline

- Joint development – Hyper Tech is developing both superconducting solder type MgB_2 persistent joints and MgB_2-MgB_2 persistent joints
- OSU is developing the test process and performing the test of the MgB_2 persistent joints
- First, direct *I-V* measurements are used which can probe down to *R* value of 10^{-10} ohms
- Results for the direct *I-V* probe are discussed
- Second, a decay rig is described, cable of measuring R in the 10^{-12} or less regime
- Initial results with decay rig are described, including a test NbTi joint and a first decay MgB_2 joint

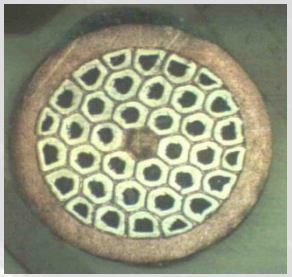
Note: Reacted wire joints

- In many cases, previous work has been on joints where the wire and the joint are co-reacted.
- Our focus here is on the application-ready reacted wire joints.
- We are also focusing on multifilamentary wires of the kind relevant to the application (including stabilization)
- This is important for our MRI demonstration project (image guided system) as well as enabling commercial MRI applications

MgB_2-MgB_2 joint (example results)



Development of Persistent Joints



Two styles of joints

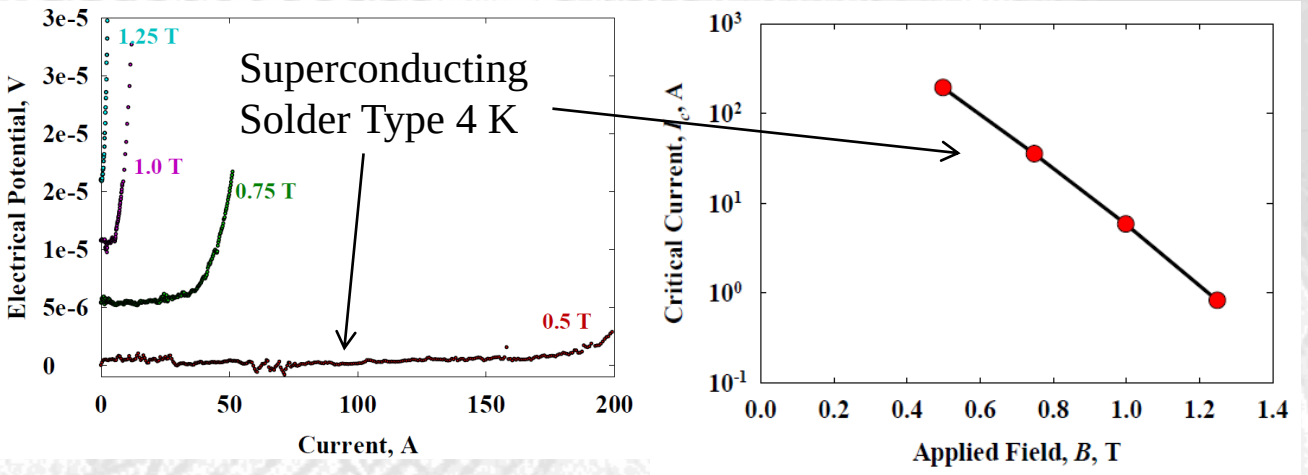
1. Superconducting solder type
2. Direct MgB_2-MgB_2

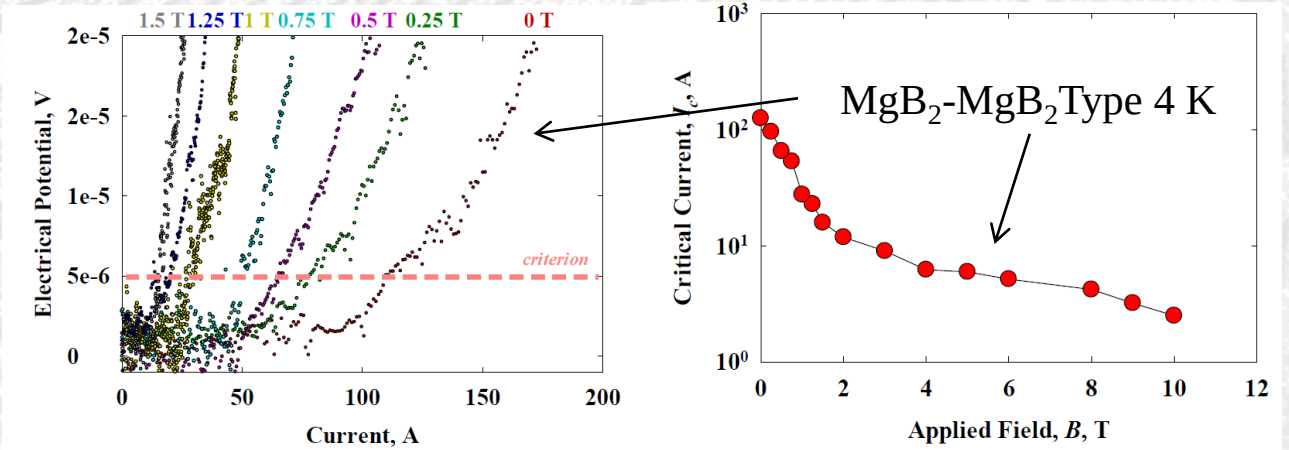
In both cases, used already reacted wire

Preliminary testing to date using direct *I-V*, $R < 10^{-10}\ \Omega$

Decay Testing rig and samples in preparation for increased *R* sensitivity and decay test

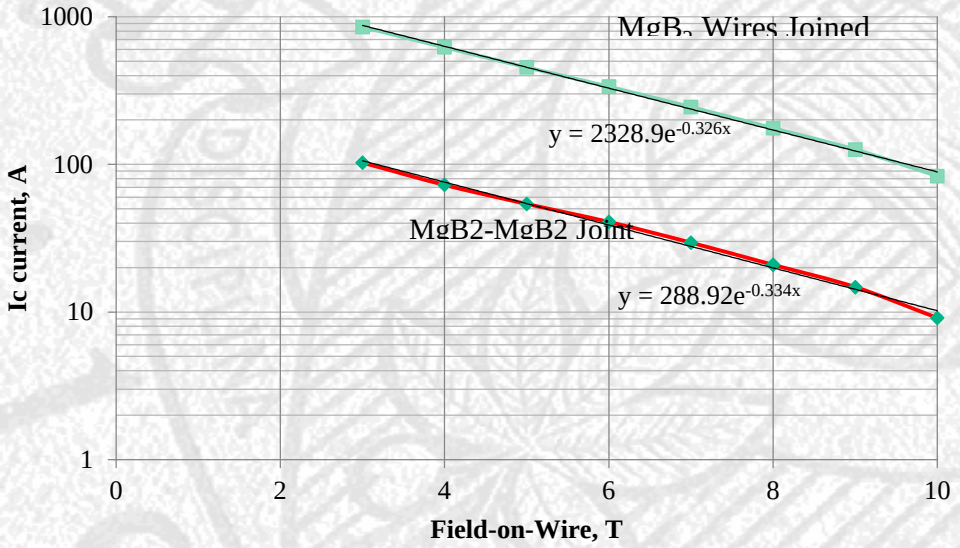
Working now to improve performance and measure to high sensitivity



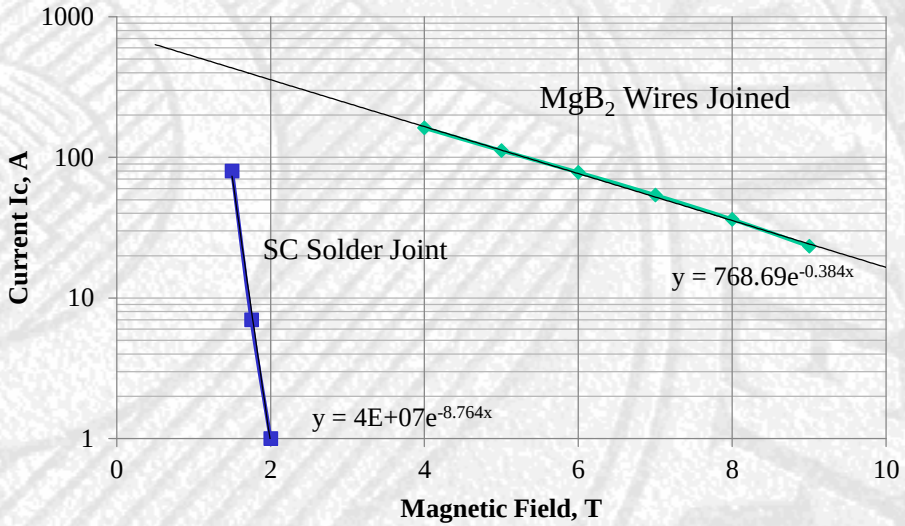


Persistent Joints Between Reacted MgB_2 Wires

Ic of Persistent Joint vs Ic in MgB_2 Wire



Ic in Persistent Joint vs Ic in MgB_2 Wire

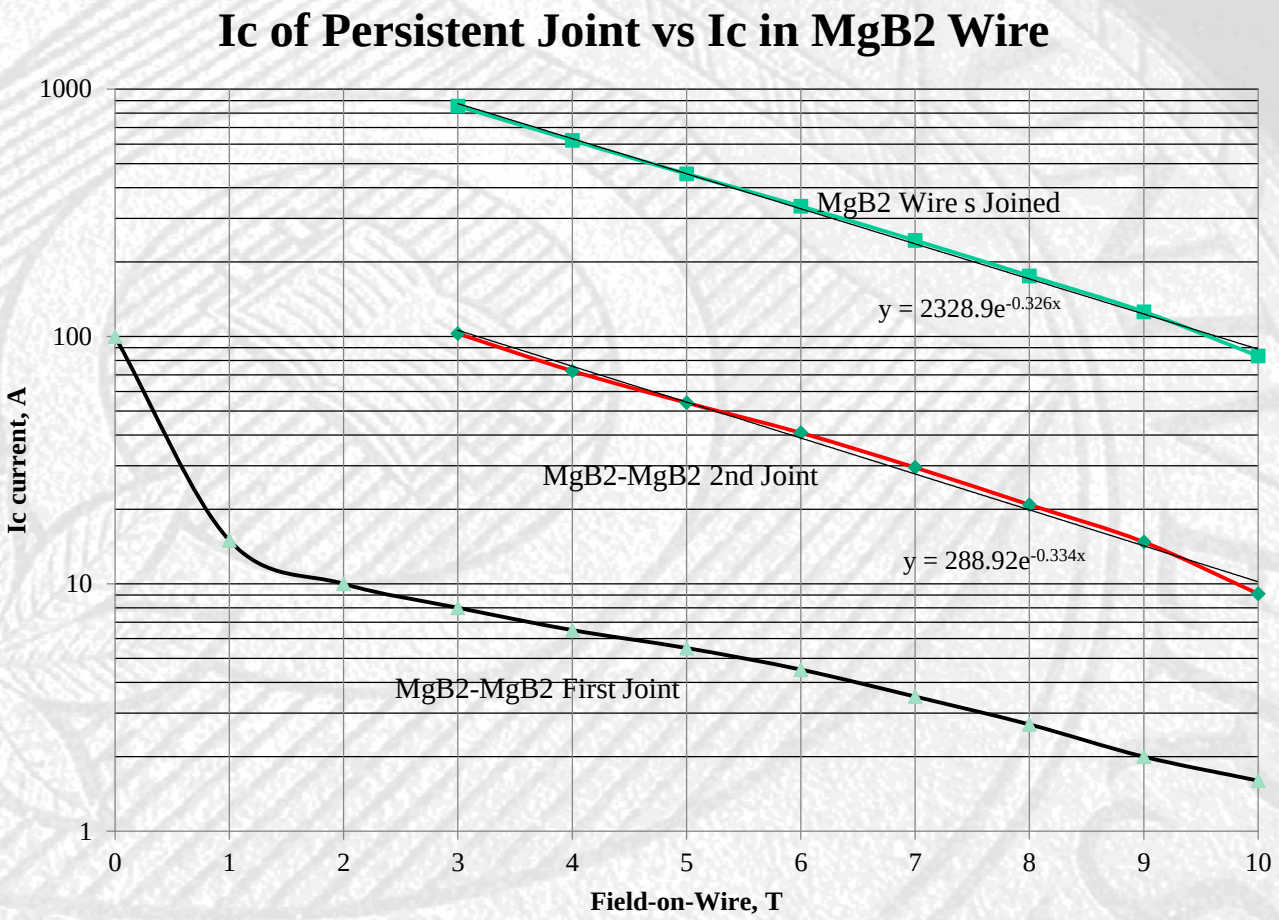


MgB_2 to MgB_2 Joint Using Mg+2B

MgB_2 to MgB_2 Joint Using SC Solder

Persistent joints between reacted MgB_2-MgB_2 wires

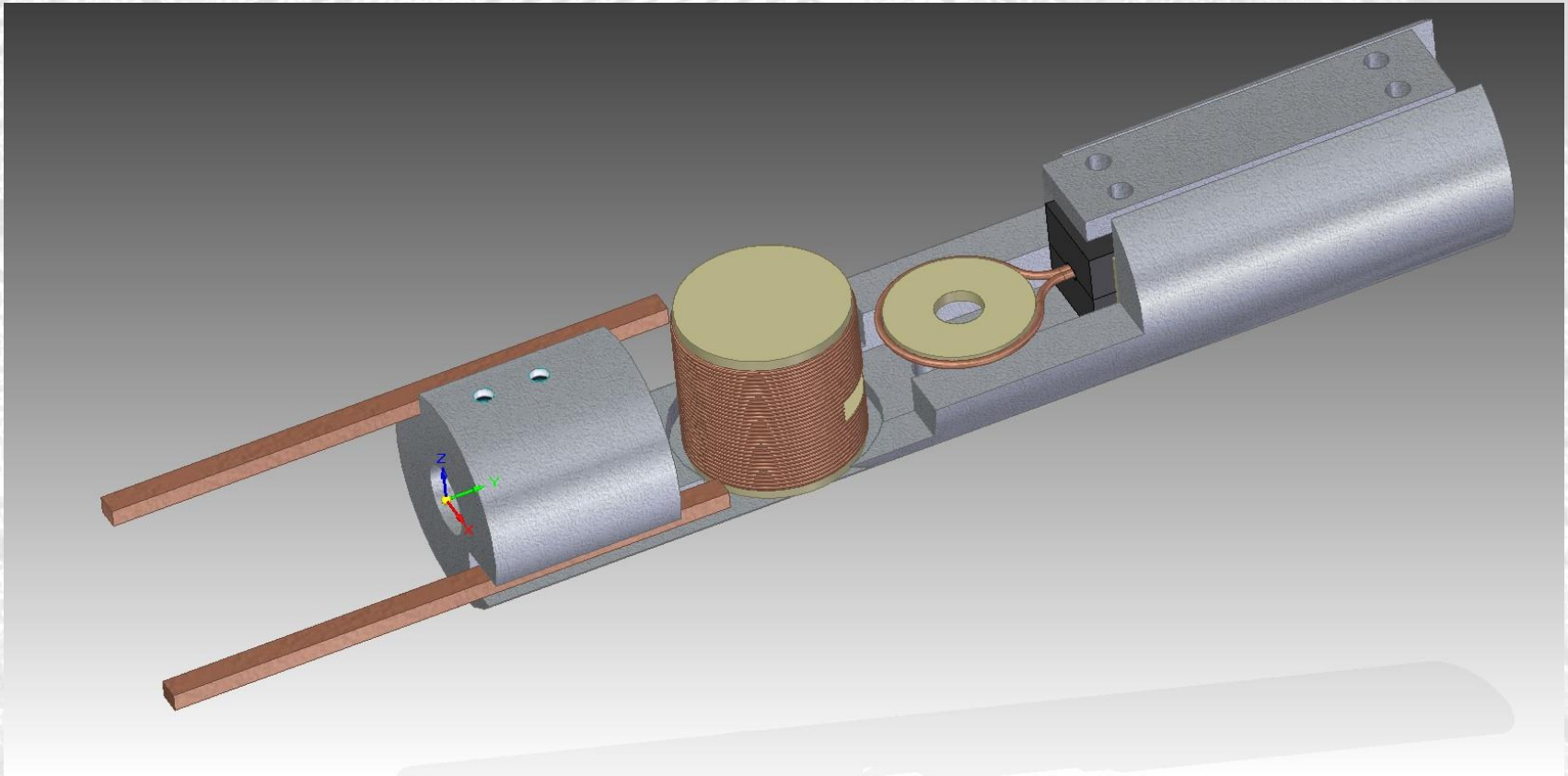
MgB_2 to MgB_2 Joint
Using Mg+2B



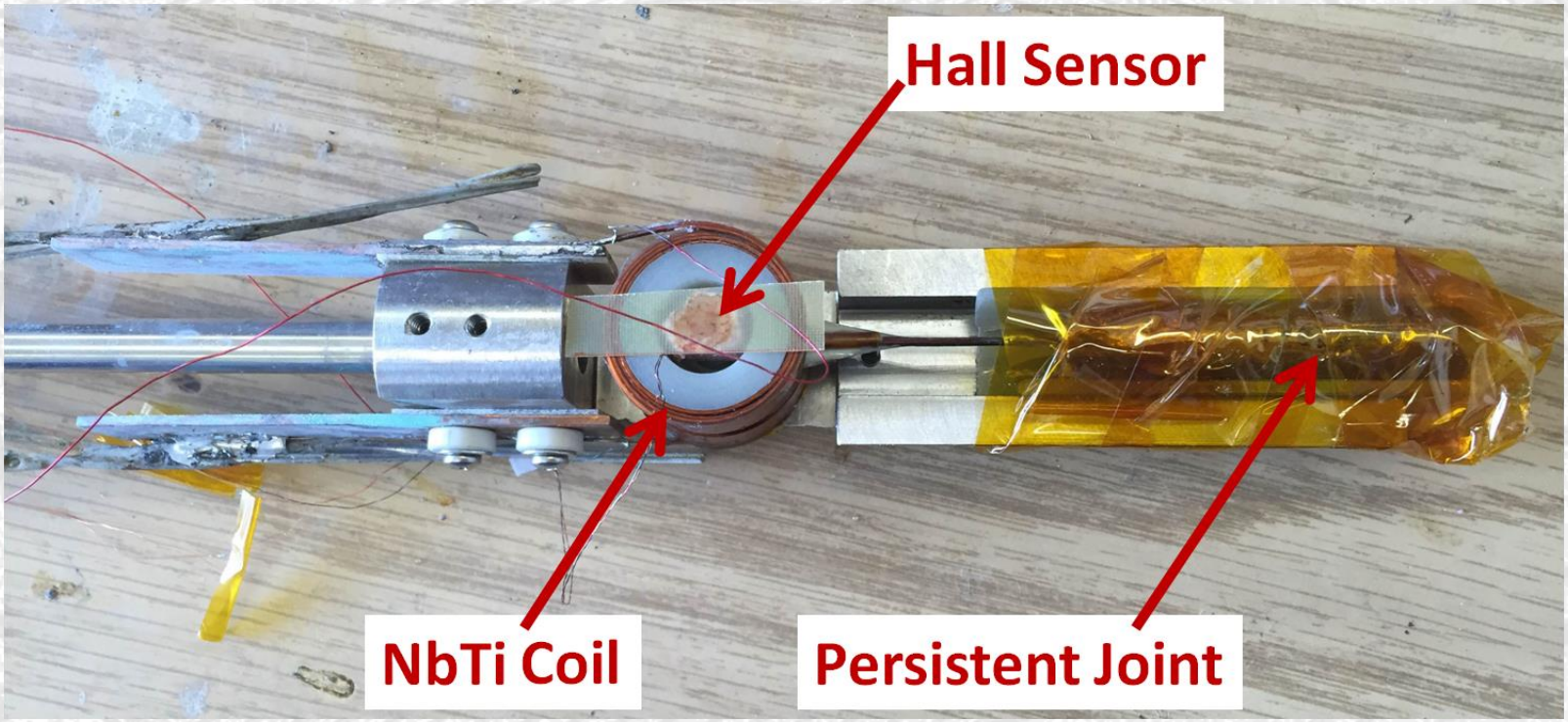
Moving from screening test to decay test

- While further improvement in critical current of joints is still in process, it is important to measure *R* at values below 10^{-10} ohm
- Thus, a decay rig was needed, as well as some initial testing and verification

New test arrangement for decay measurements – machine drawing



Test rig for decay measurements – with test NbTi joint mounted



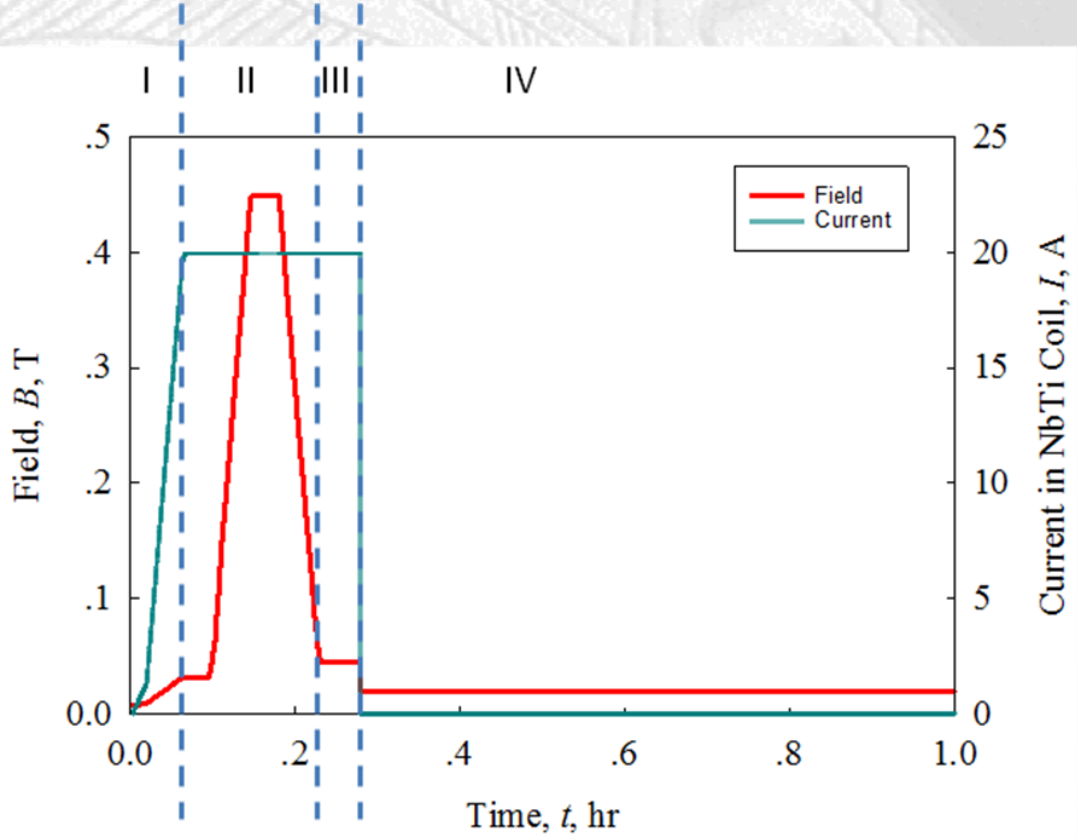
Overview NbTi test Persistent joint result

- Blue curve at right shows current change in the NbTi coil.
- Red curve indicates the field reading by the Hall sensor.

Protocol:

I. Use NbTi coil to generate B_{coil} (I = 20 A)
II. Increase the B_{ext} to 3 T (pushes joint > SC)
III. Drop B_{ext} to 0.
IV. Turn off NbTi coil rapidly.

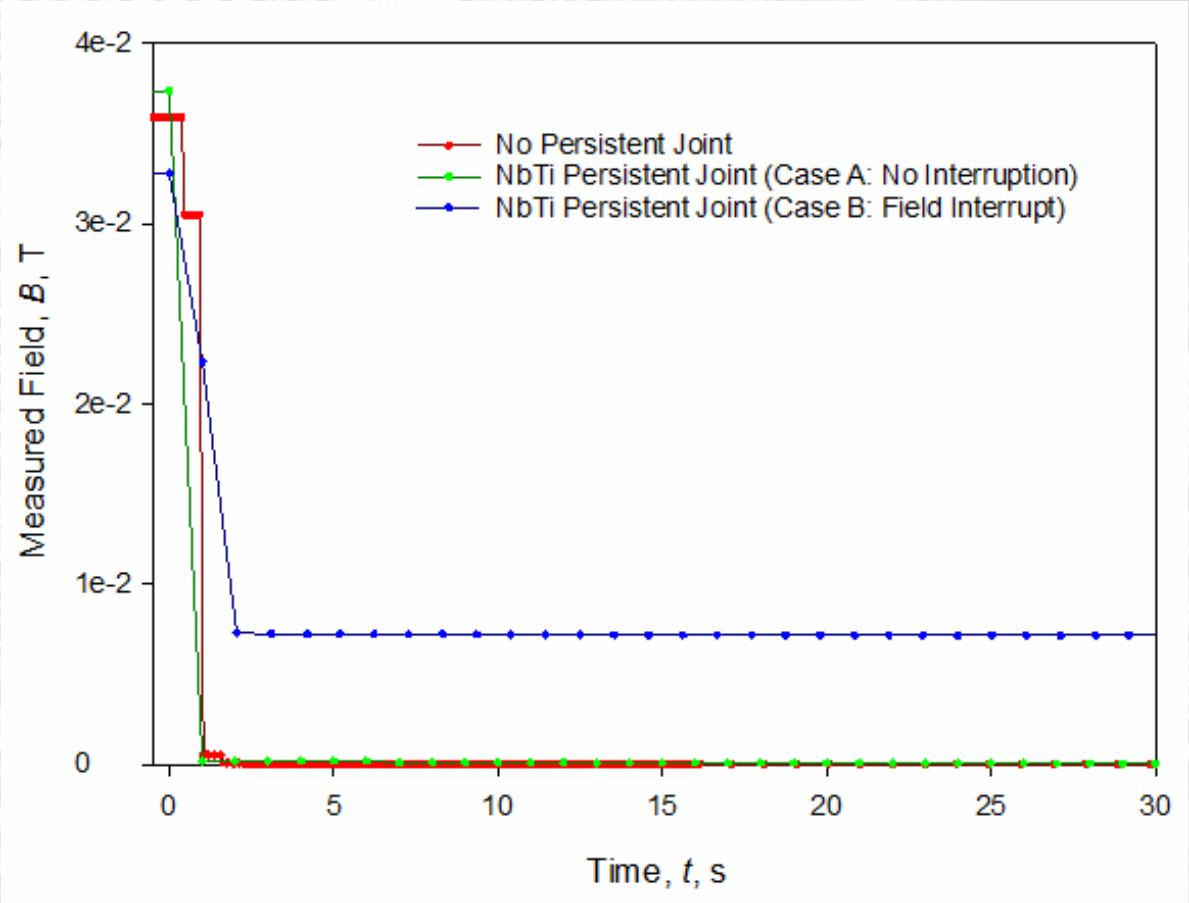
Note: Only the field in step IV indicates the field generated by the test (here NbTi) joint.



Expansion of decay region NbTi test joint

Results for a NbTi persistent joint (at the time of stage III, IV in overview result).

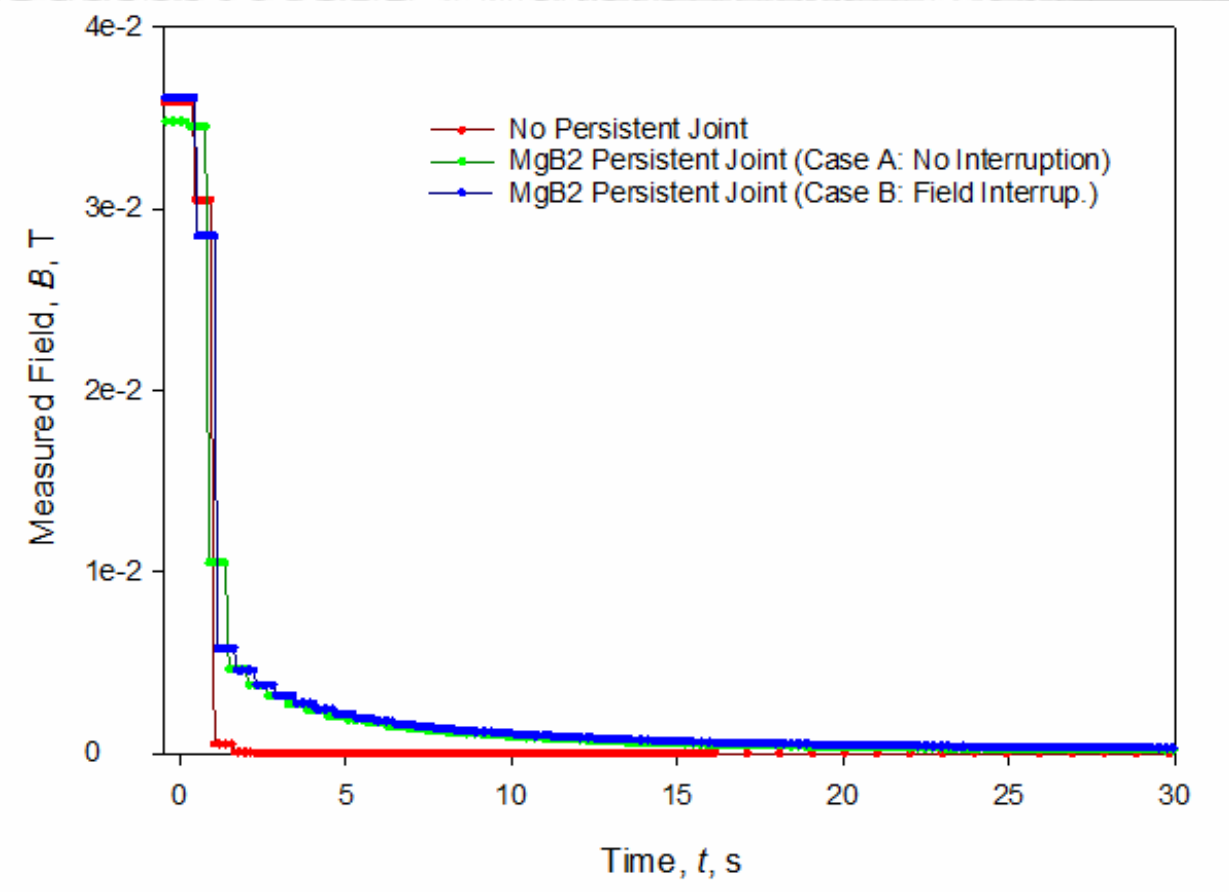
Superconducting solder type.



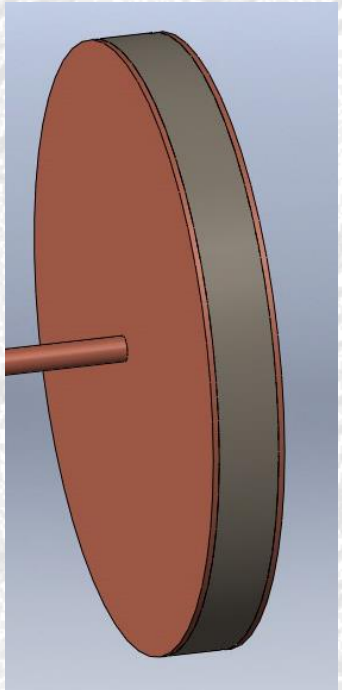
Test of first persistent decay MgB_2 sample

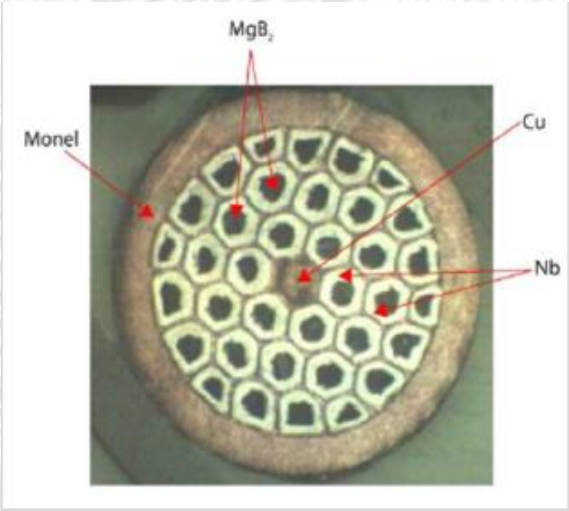
Results for a MgB_2 persistent joint (at the time of step III → IV along the lines of NbTi overview figure).

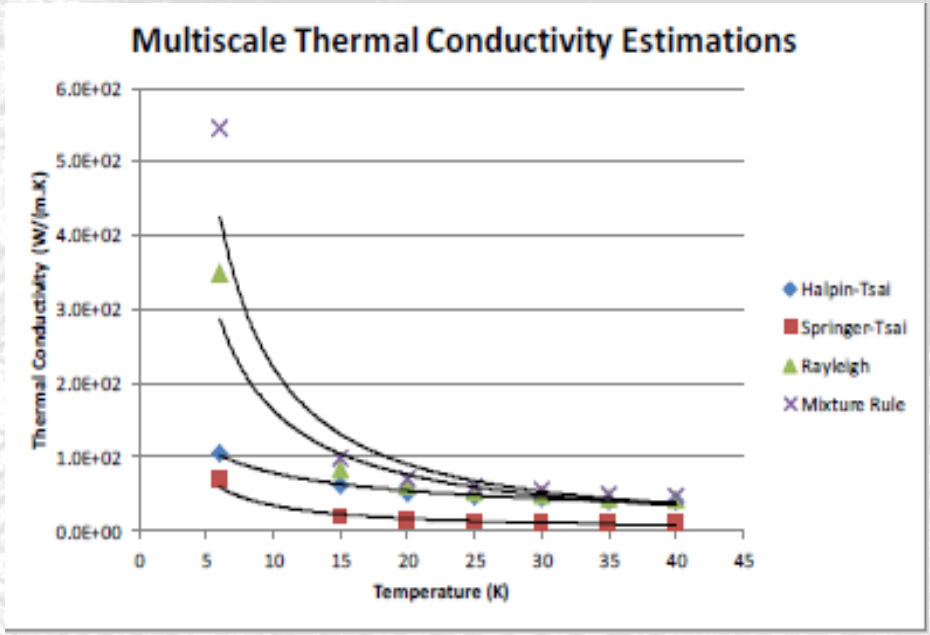
Superconducting solder type.

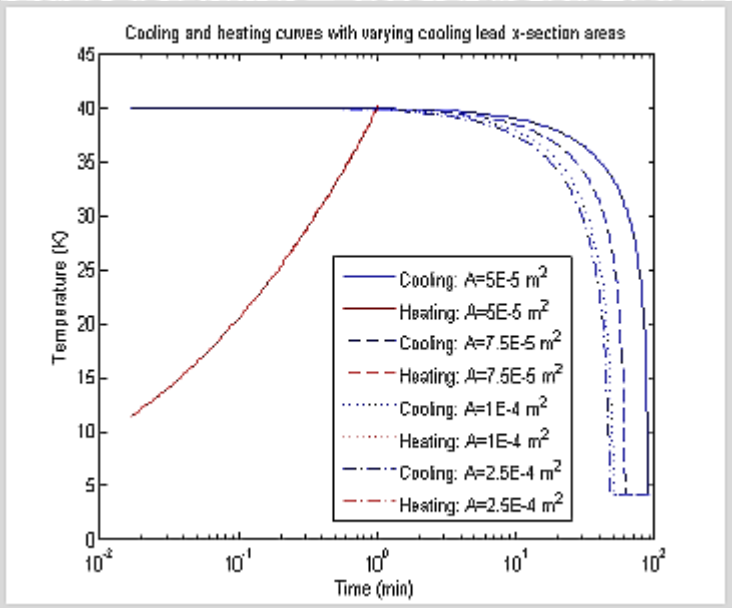


Persistent Switch thermal modelling









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Conclusions

- Hyper Tech is developing persistent joints using MgB_2 of two kinds: (i) superconducting solder type, and (ii) MgB_2-MgB_2 type
- Initial screening results show good results $R < 10^{-10}$ ohm, indicate that it is time to move to decay measurements
- The design of a new PJ decay rig is shown
- Initial tests with NbTi and MgB_2 joints are shown, and the results where described
- HTR-OSU is moving at an accelerated pace to useful MgB_2 PJ, and are planning their test in a larger device
- Testing and development is in full swing, moving now to larger coudncutor joints for image guided system