

GOAL:

- Develop accelerator quality, high field, hybrid (ReBCO HTS inner + LTS outer) cosine theta magnet

FOR:

- Future Hadron Colliders that need > 16 T

CHALLENGES:

- New technology, complex end geometry, high stresses, large magnetization harmonics

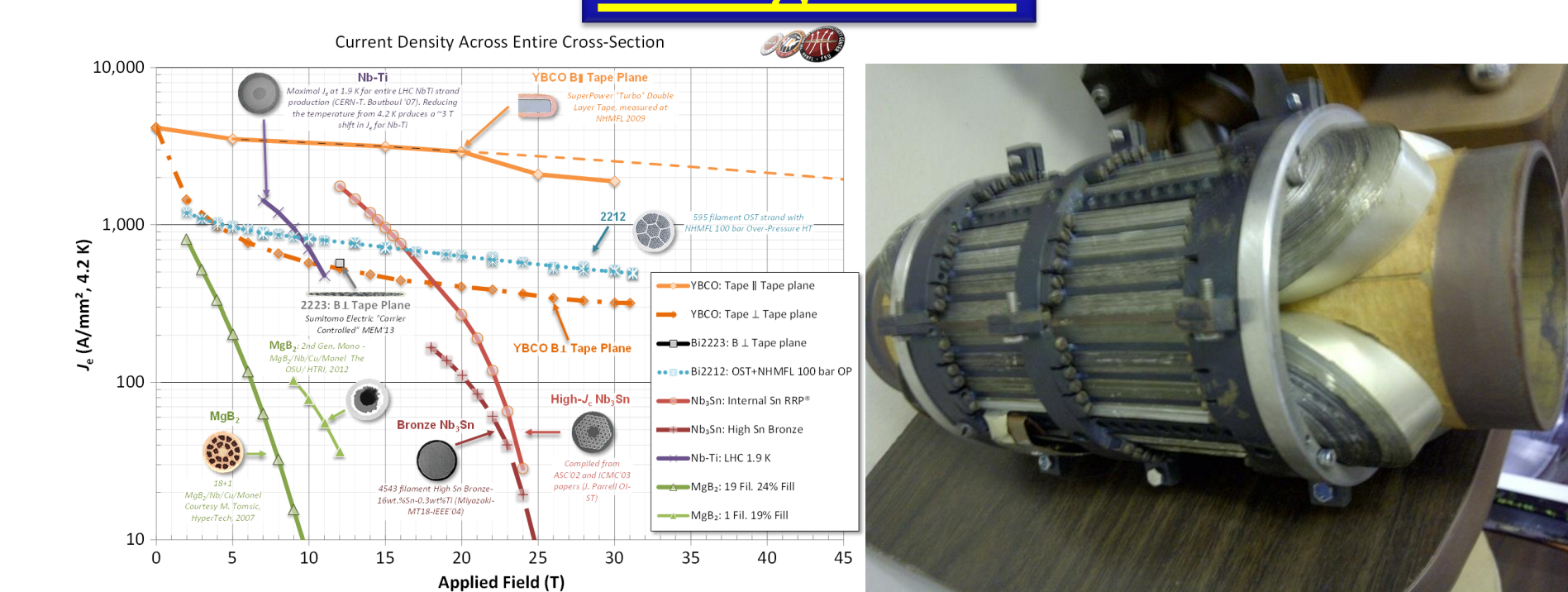
ALTERNATIVES:

- Bi2212 conductor, racetrack coil geometry

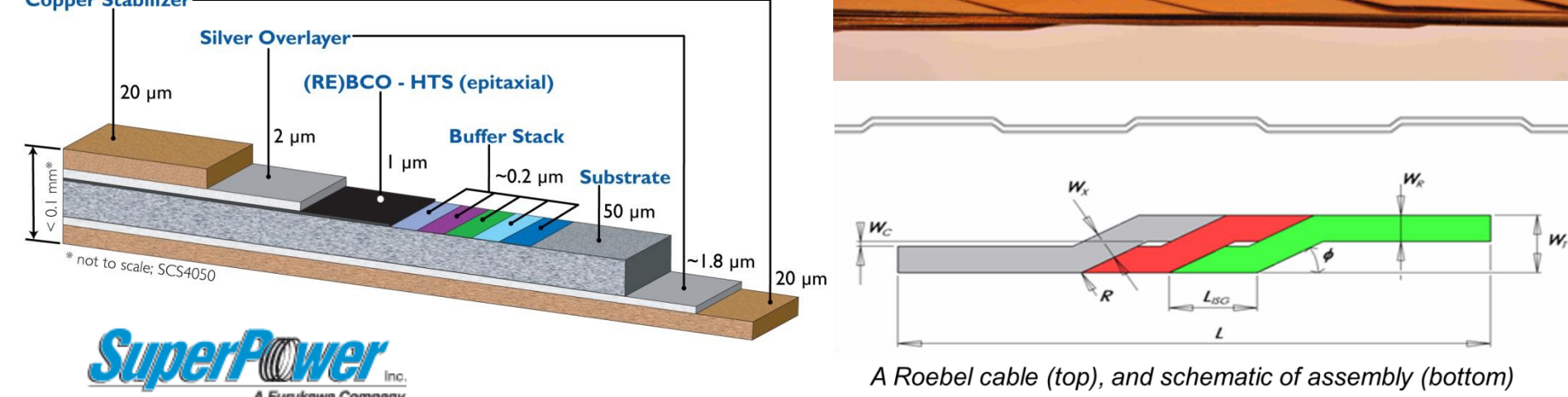
DEMONSTRATIONS:

- Construction and 77 K tests of coil (pole block), use of Kapton CI insulation in HTS coil

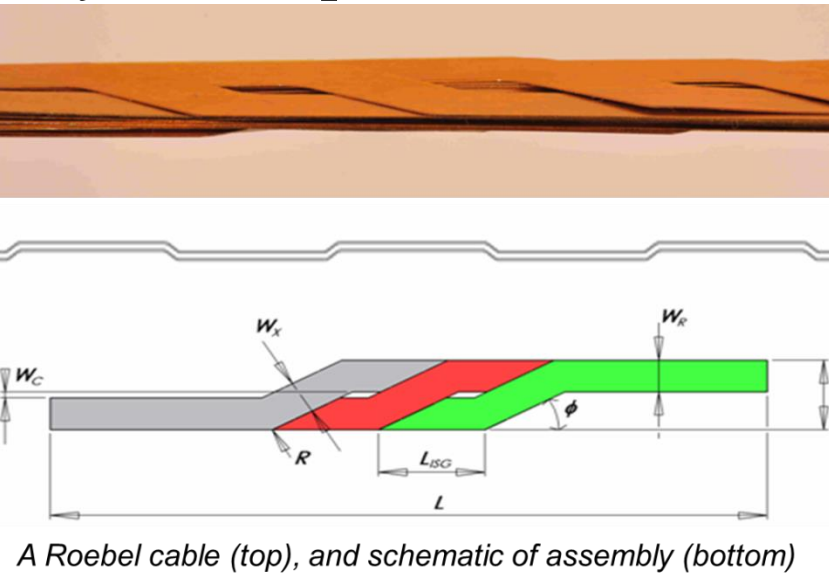
Background



Engineering current density for YBCO tape and Bi-2212 wire compared to other high field superconductors, showing the advantages of YBCO and Bi-2212 at high fields. Data compiled by P. Lee, NHMFL.



Nb₃Sn tape quadrupole made by W. Sampson at BNL



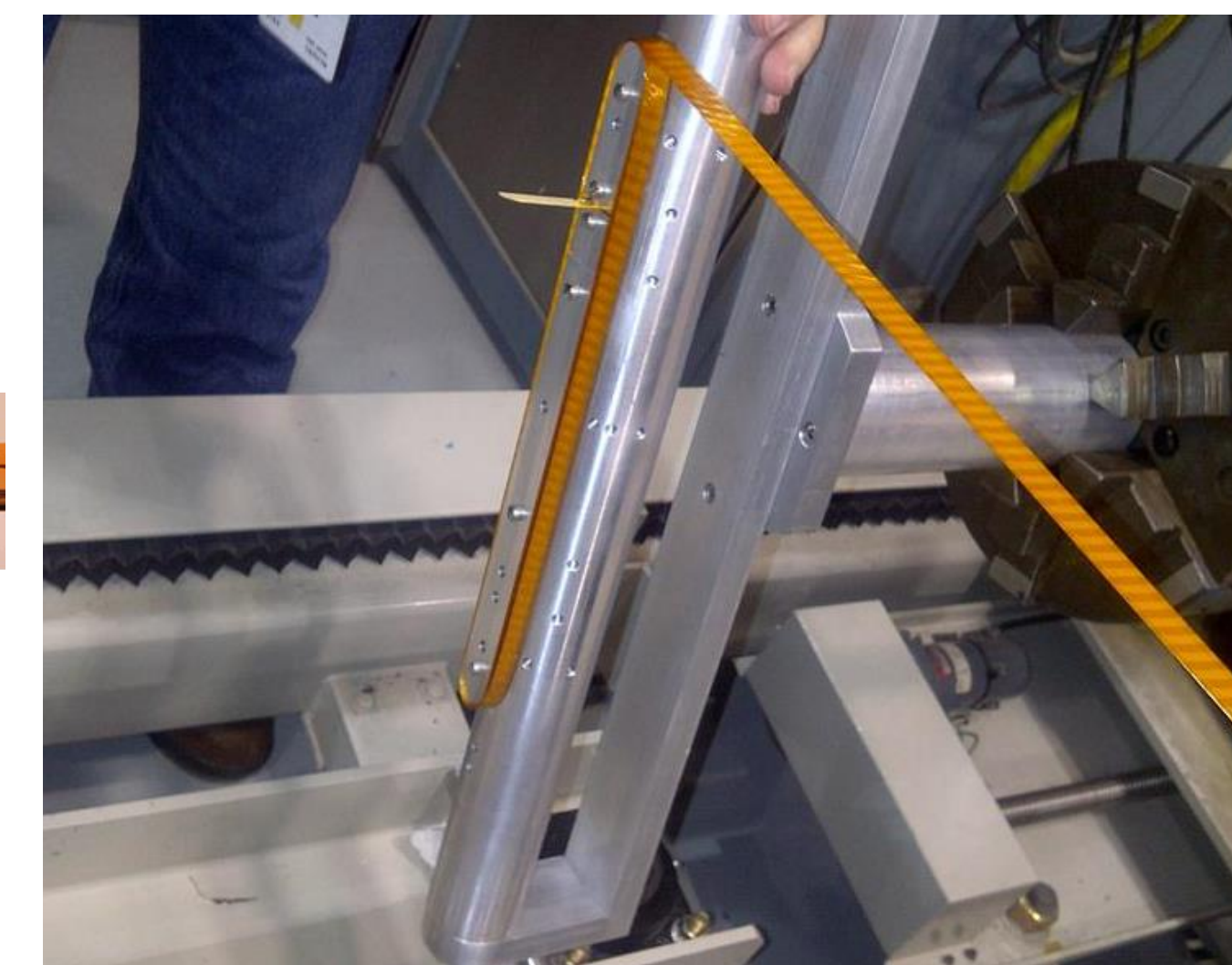
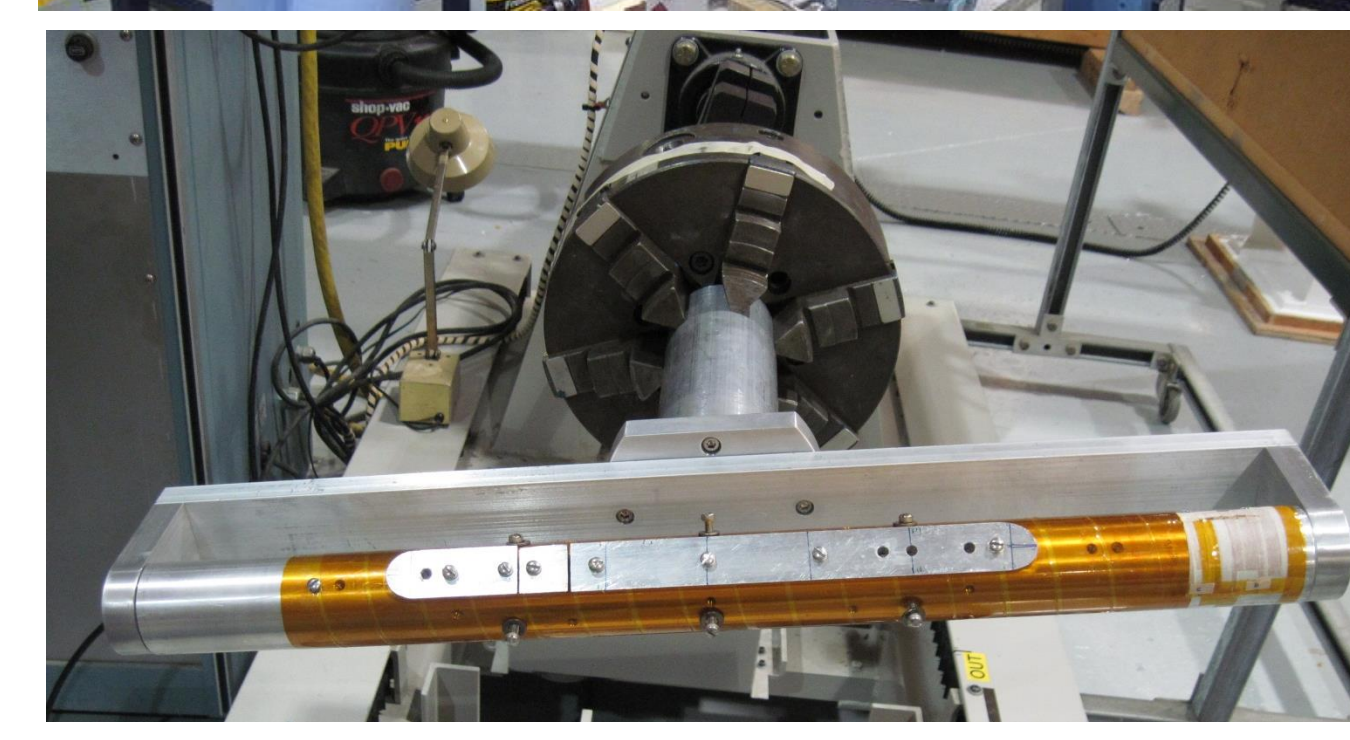
Kapton CI Insulation on ReBCO Tape



BENEFITS:

- No epoxy/adhesive to HTS tape (prone to degradation by epoxy)
- Robust, radiation-resistant, standard insulation in accelerator magnets
- Once cured coil can be handled easily
- Makes good coil (including ends)

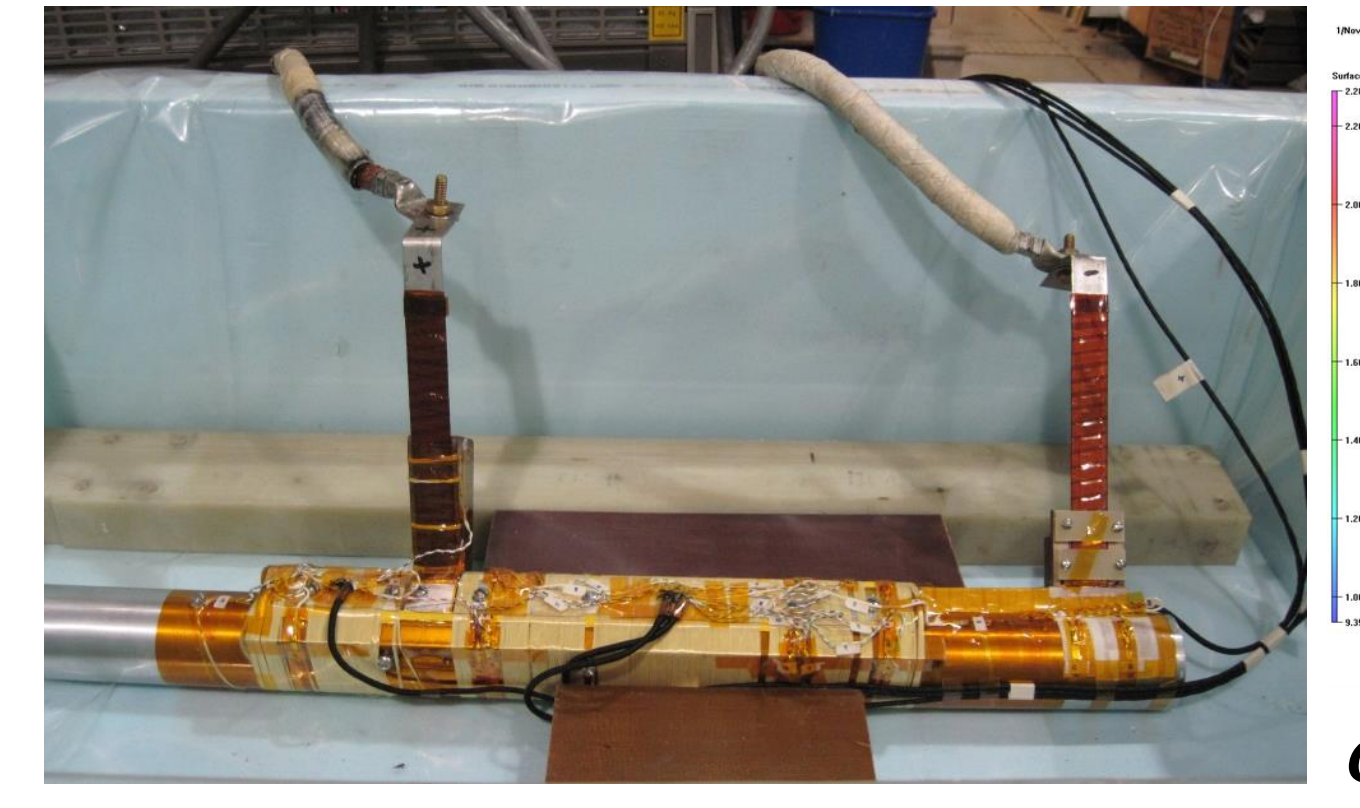
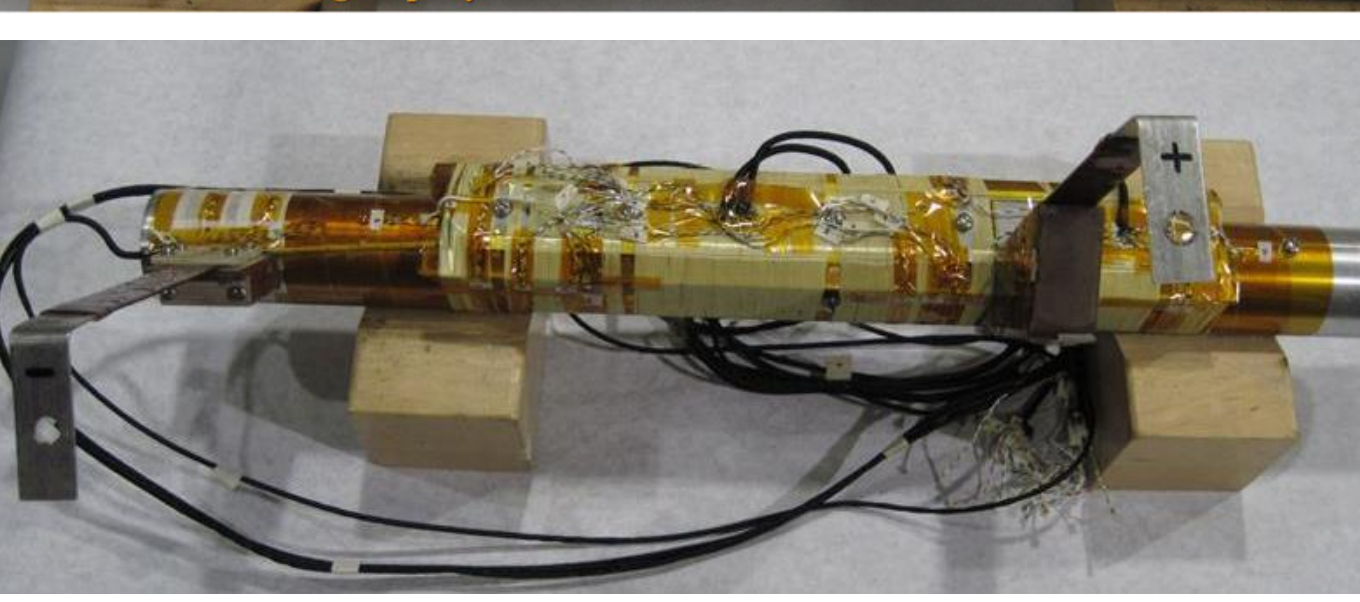
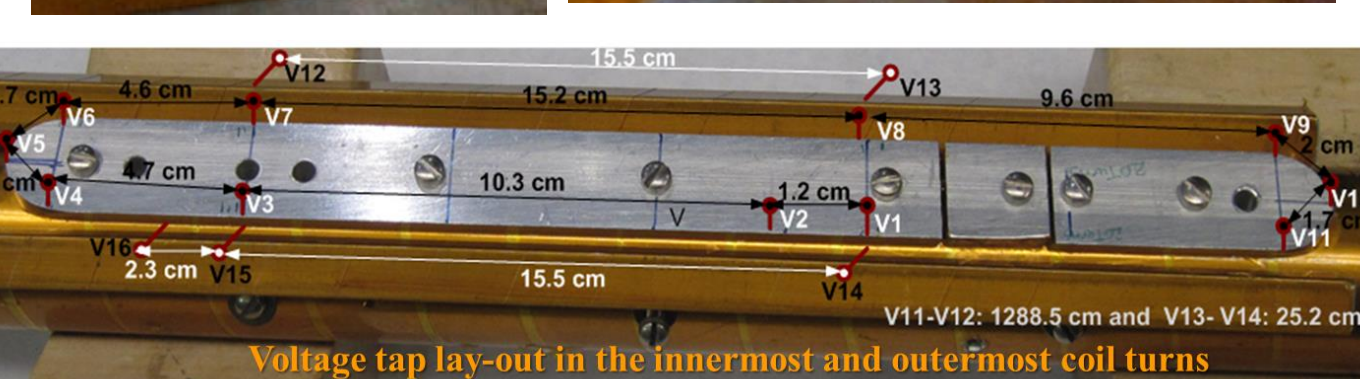
Winding with 12 mm Wide SP Tape



Cured Coil with 12 mm Wide SP Tape

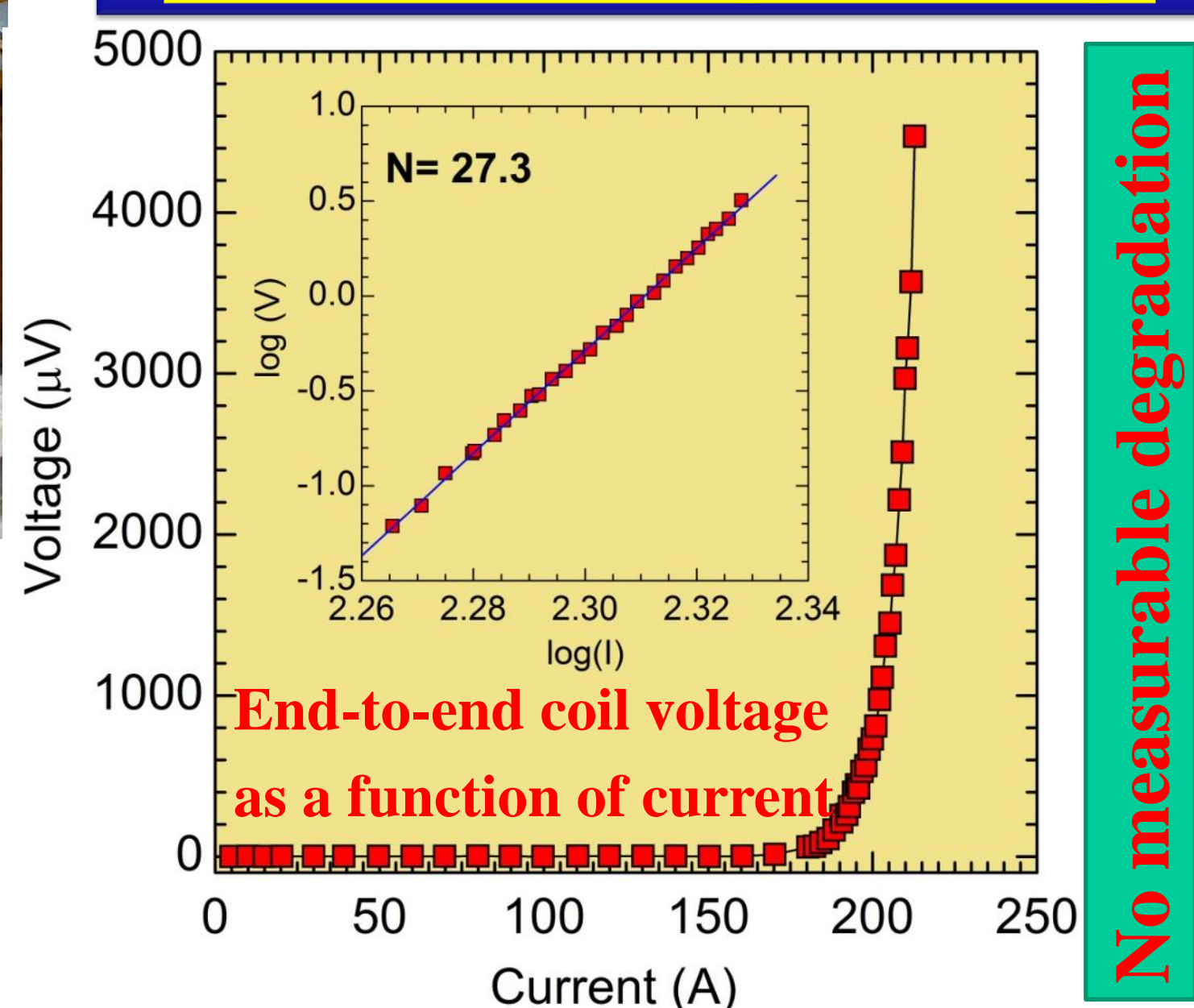


The 20-turn pole winding after fabrication. The 12 mm wide HTS tape conductor with its Kapton CI wrap is visible on the left.

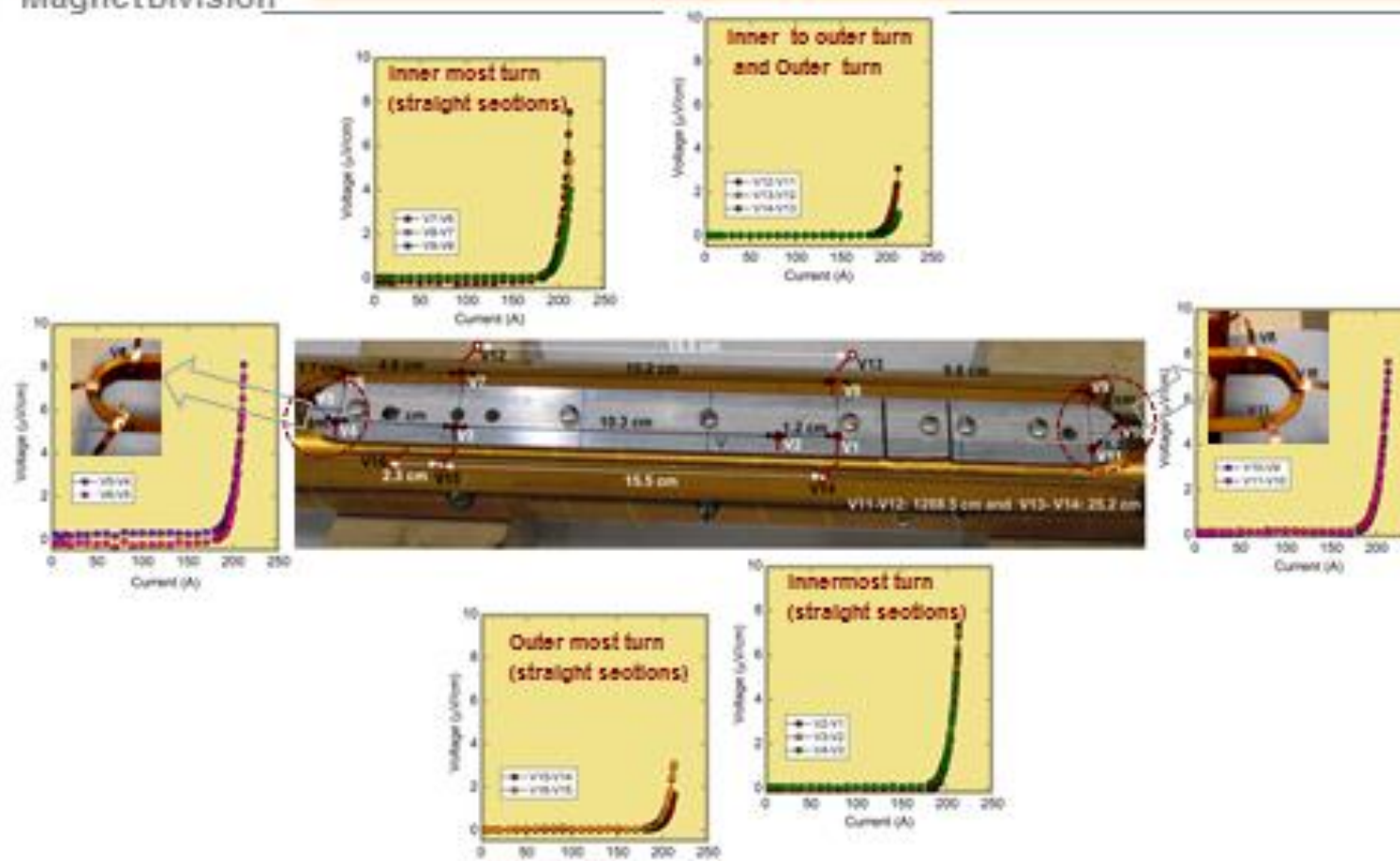


The coil for testing at 77 K in liquid nitrogen.

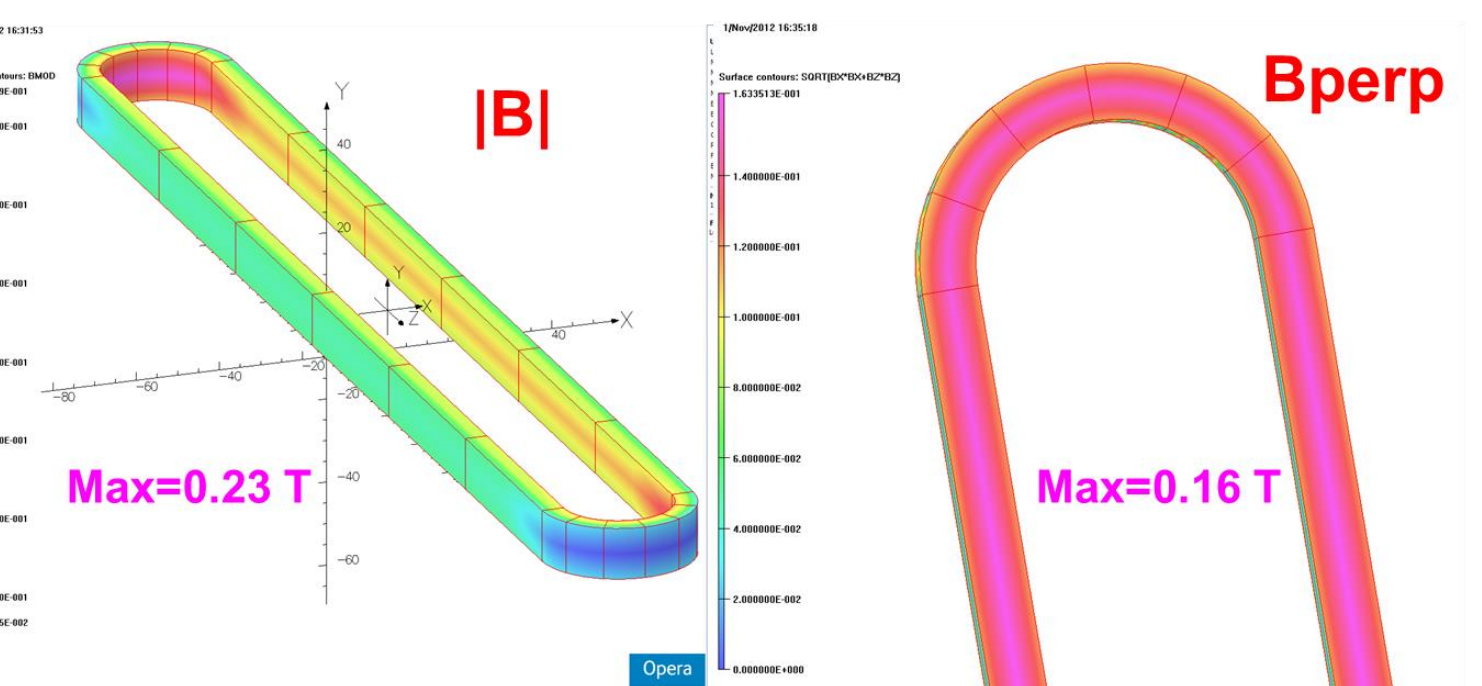
Test Results of cosine theta (pole block) with 12 mm Wide SuperPower Tape



How do the small coil sections behave?

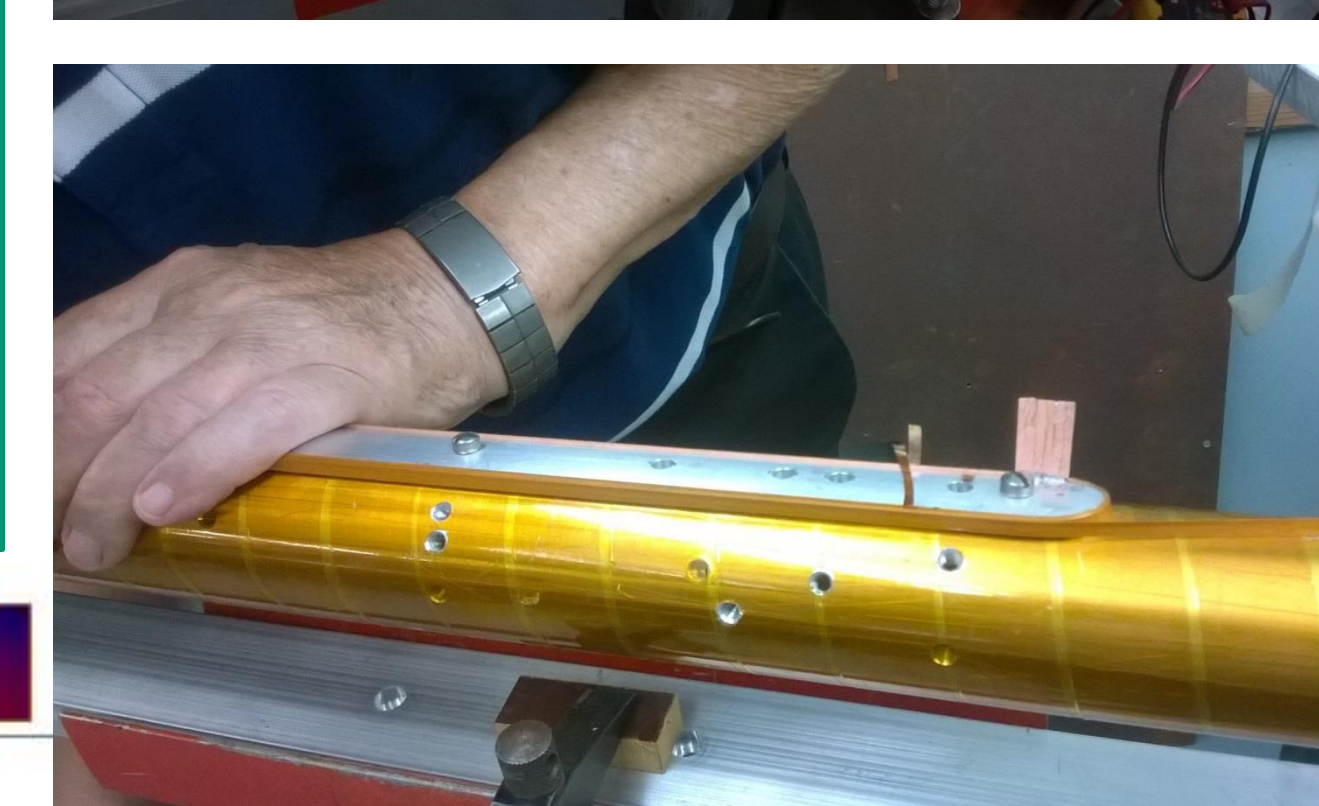
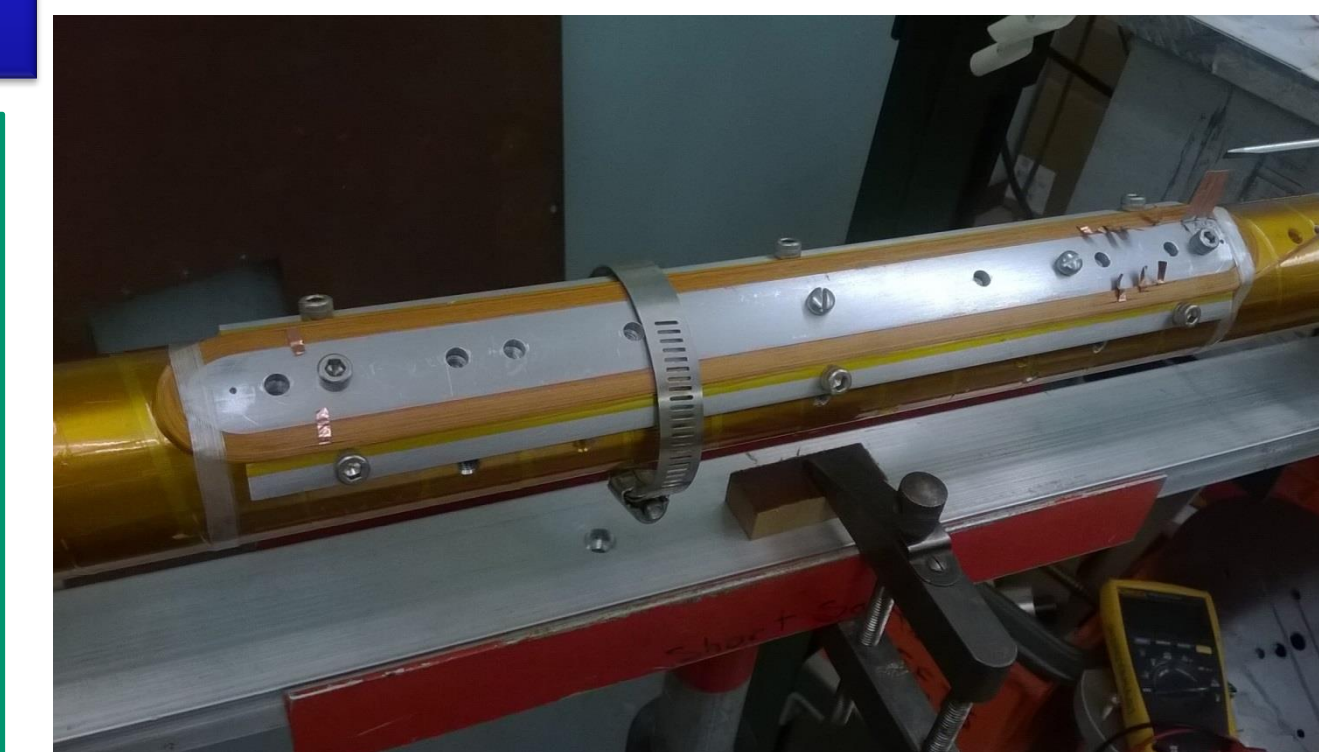


LTHFSW12, Tape, CA, November 6, 2012, J.S. Eubank

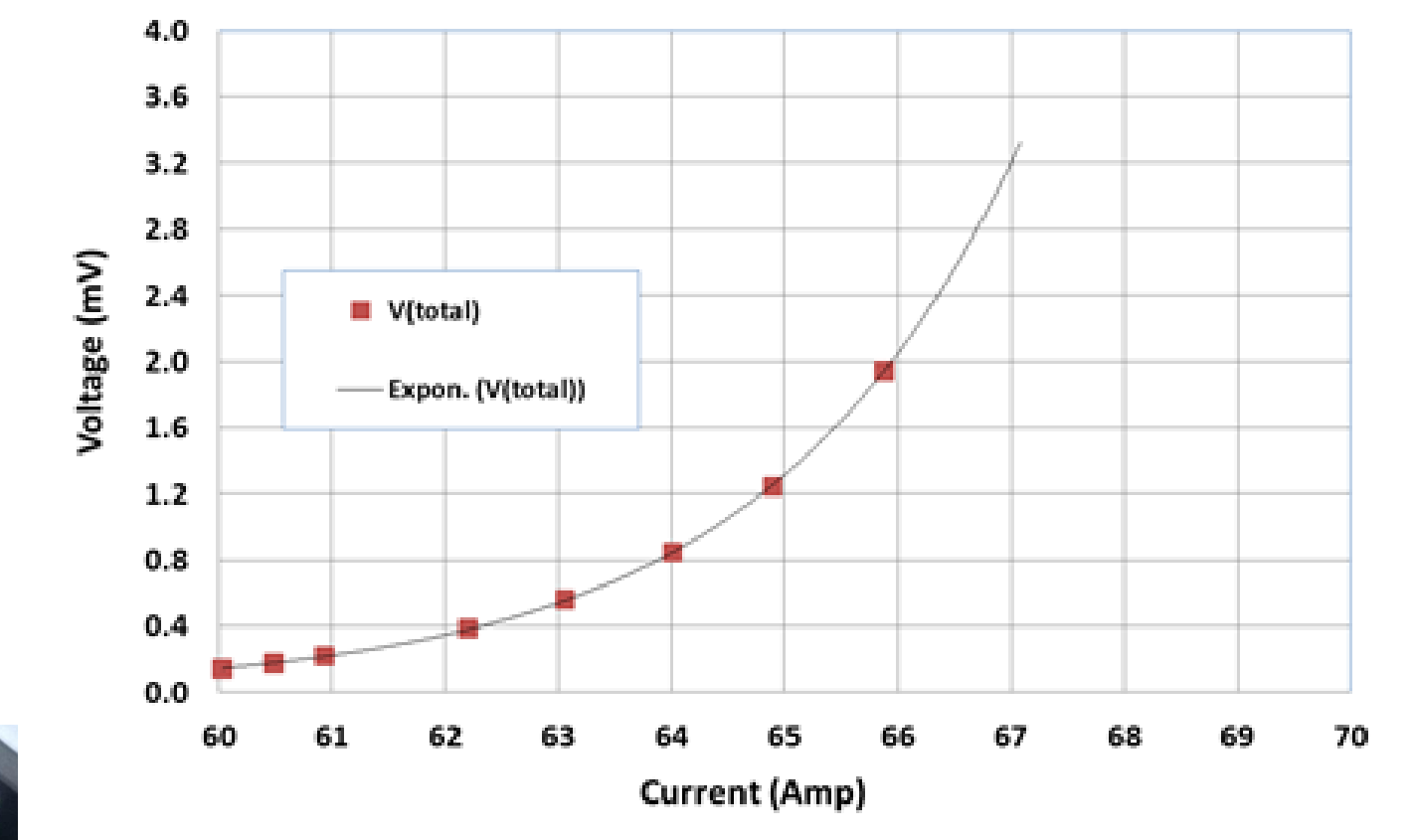
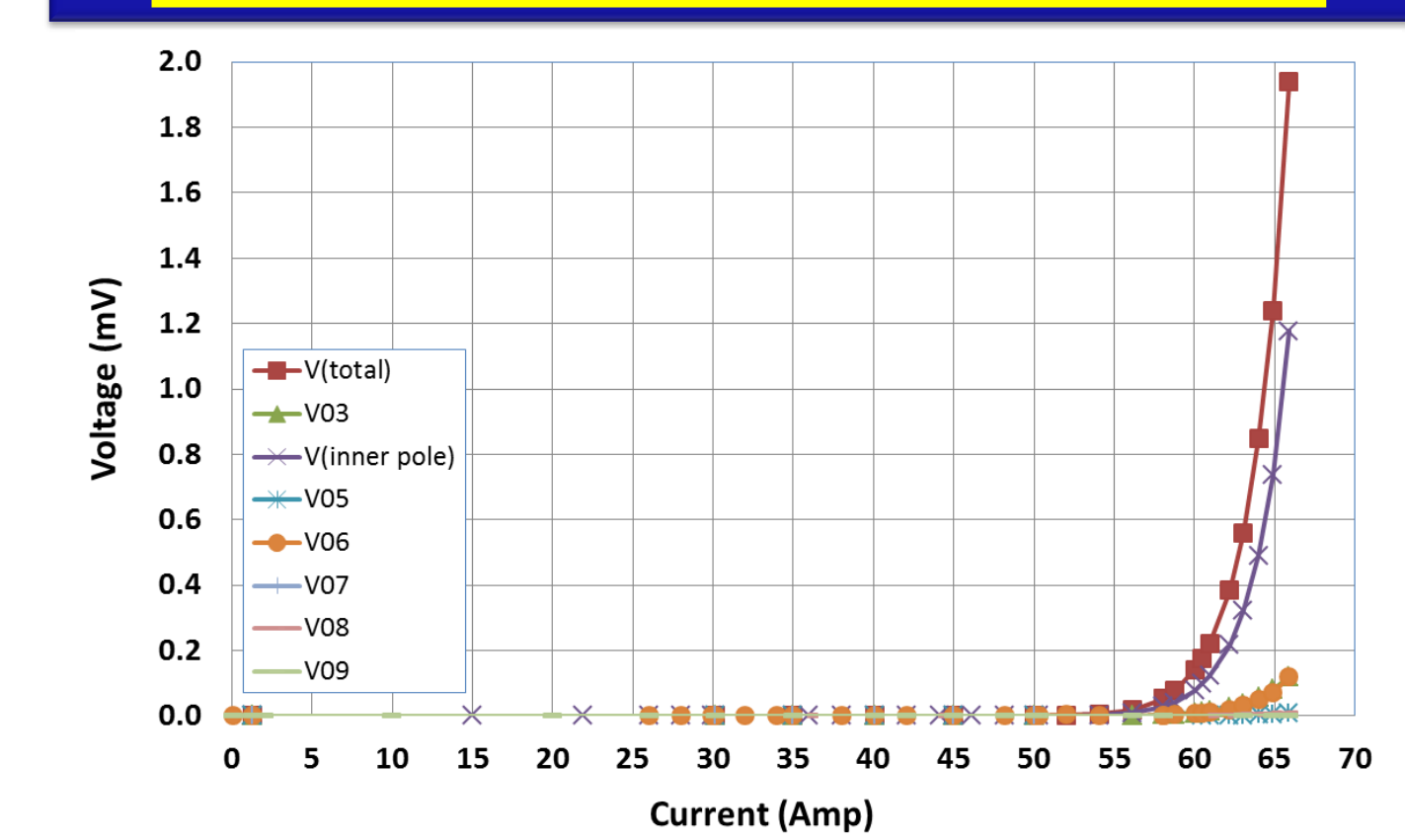


Computed magnitude and field perpendicular component at 200 A, superimposed on the 12 mm wide 20-turn coil

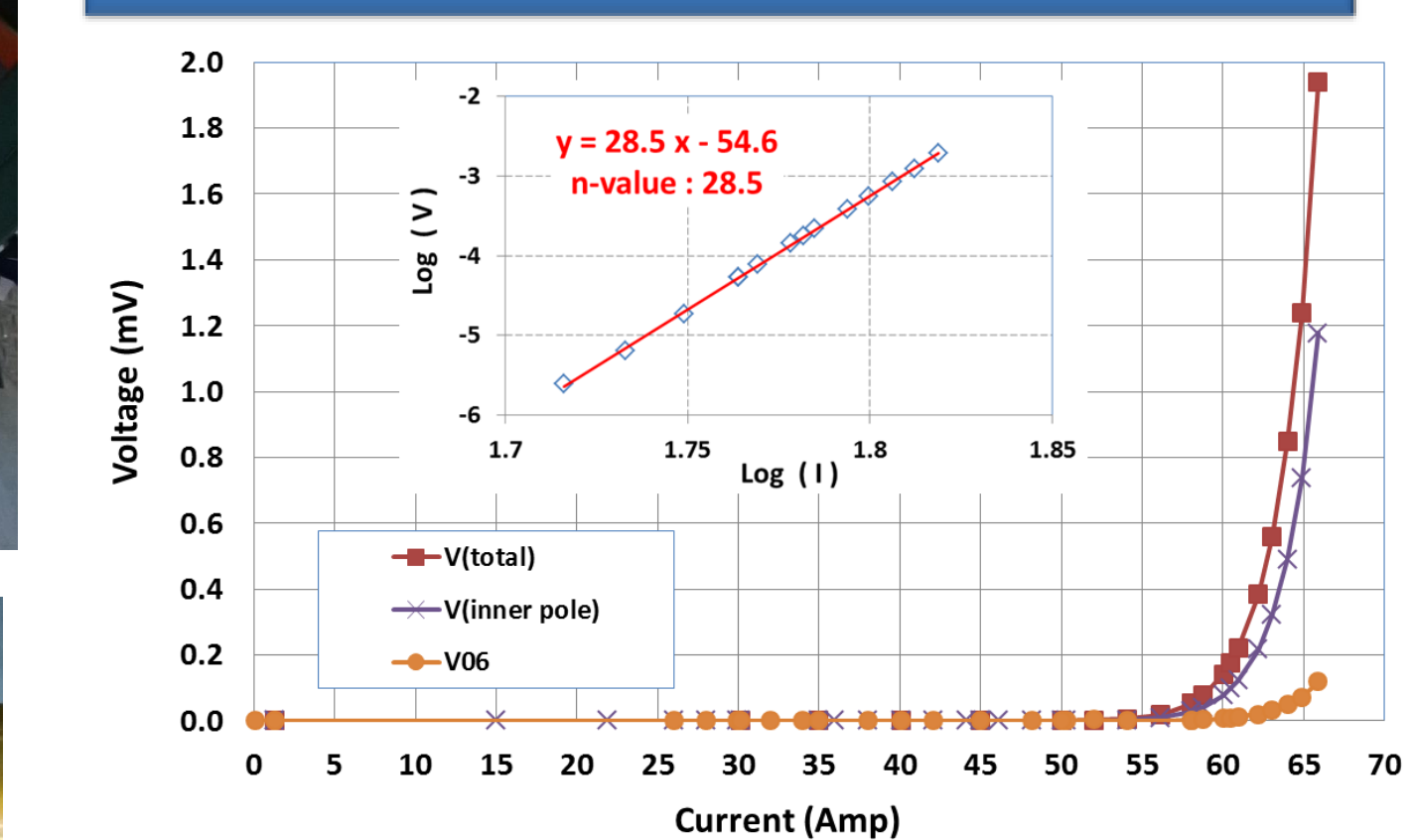
Winding with 4 mm Wide SP Tape



Test Results of cosine theta (pole block) with 4 mm Wide SuperPower Tape



Ic = 60 A for 0.1 μV/cm and 67 A (extrapolation) for 1 μV/cm



Computed magnitude and field perpendicular component at 65 A, superimposed on the 4 mm wide 20-turn coil

Conclusion on Test Results

- Similar peak fields in coils made with ~4 mm tape and in coils made with ~12 mm tape
- Both coils show no significant degradation. In both cases n-value is high.
- Critical current in ~4 mm coil is about 1/3 of critical current in ~12 mm coil

Future Work

- Construction and 4 K test of full cos (θ) coil in next few months
- R&D to develop base technology for accelerator magnets in next few years (includes measuring and finding ways to deal with magnetization)
- Use these magnets in an accelerator in next few decades

SUMMARY

HTS, in hybrid magnets, has the potential to produce very high field (>20 T) magnets. Future work includes modelling and measurements of field harmonics, particularly due to conductor magnetization, and design, construction and test of an accelerator quality high field hybrid dipole magnet.