NEWS Meeting – September 25, 2017

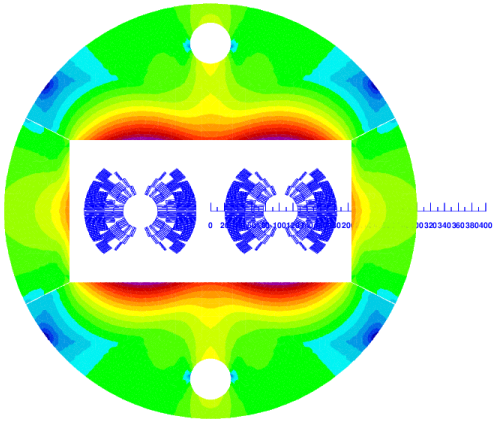
NEWS Work Package 7

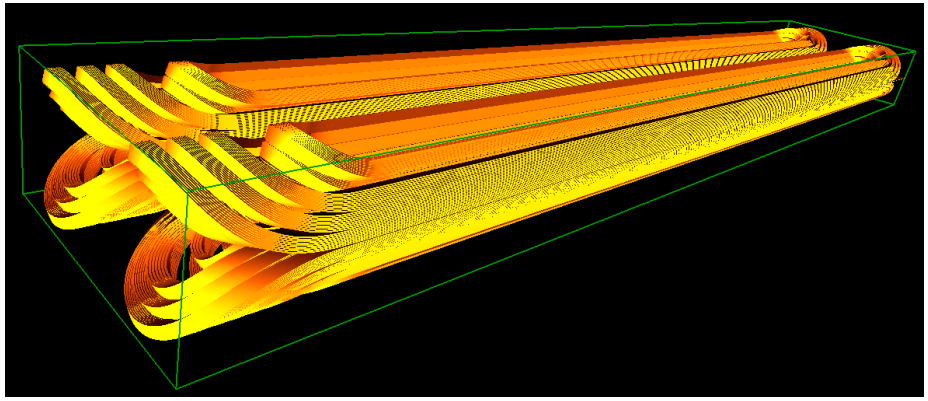
Advanced Superconducting Technologies for Particle Accelerators

Emanuela Barzi, Fermilab

FNAL-INFN 16 T Accelerator Dipole

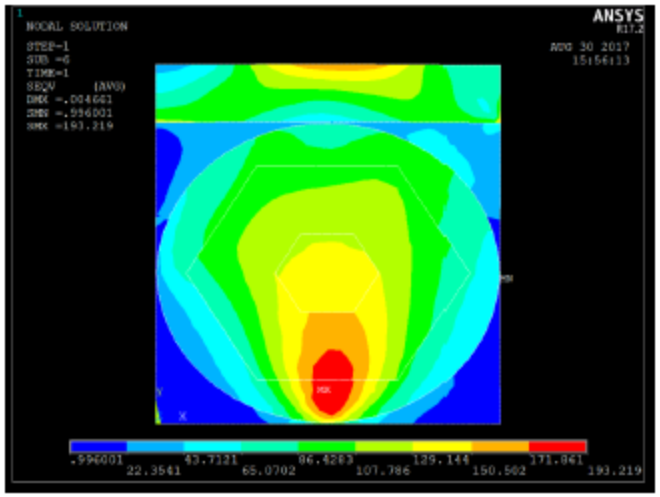
- **The challenge for the INFN-FNAL collaboration is pushing the design limit of these magnets to their superconducting potential (or Short Sample limit, SSL). For a 16 T Nb_3Sn dipole, the design limit needs to be at least 17 T. ➔ The team will need to investigate creative strain management options.**
- **However, first one has to solve the problem of why Nb_3Sn accelerator magnets typically reach at best 90% of SSL. This means that the conductor is only carrying 70% of its critical current I_c.**





Necessary Step is

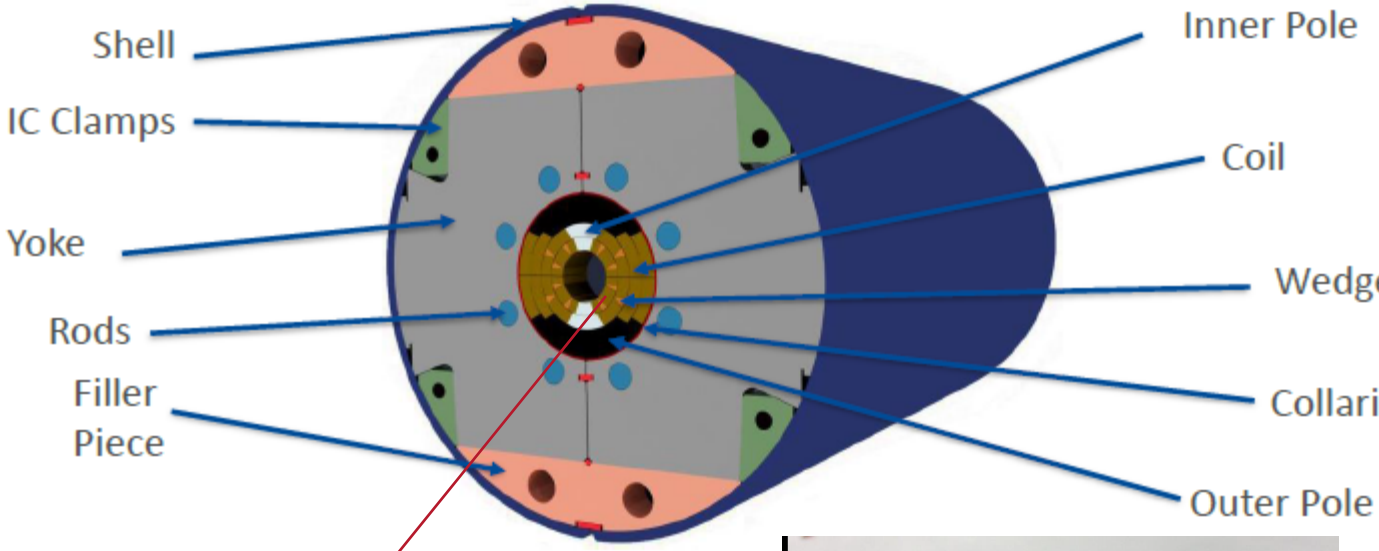
Understand how stresses and strains are distributed inside the superconductor



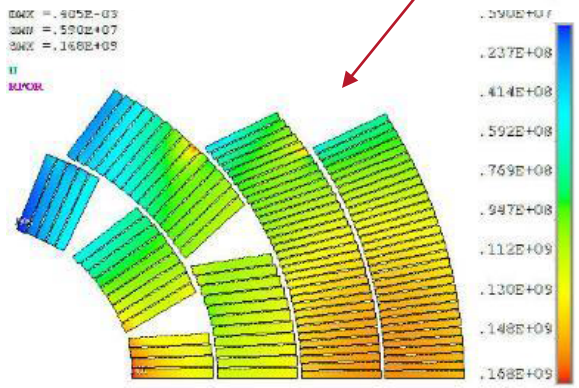
In order to…

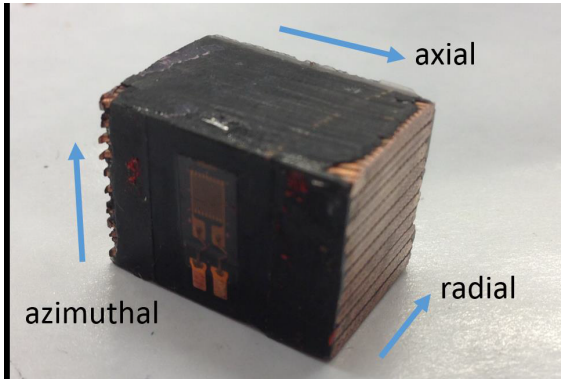
Apply strain and stress management techniques

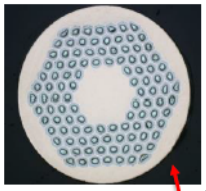
Sub-Modeling at 300K

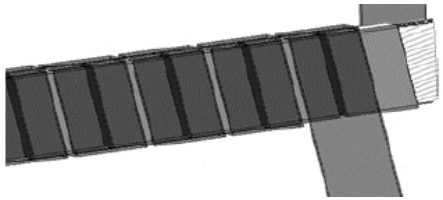


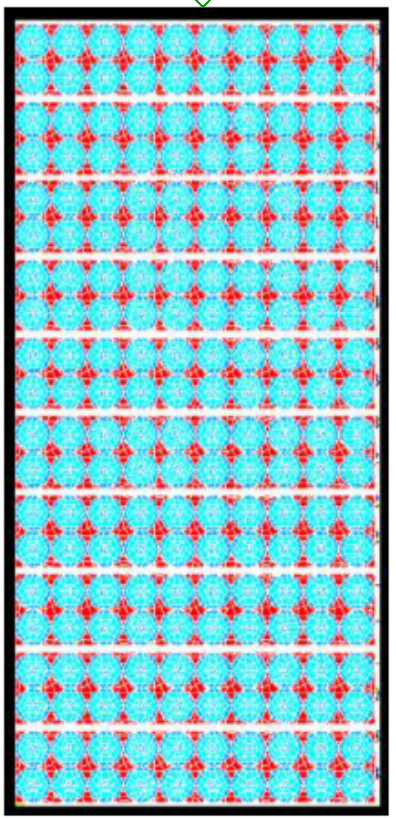
STATIC LOAD IN ELASTO-PLASTIC REGIME



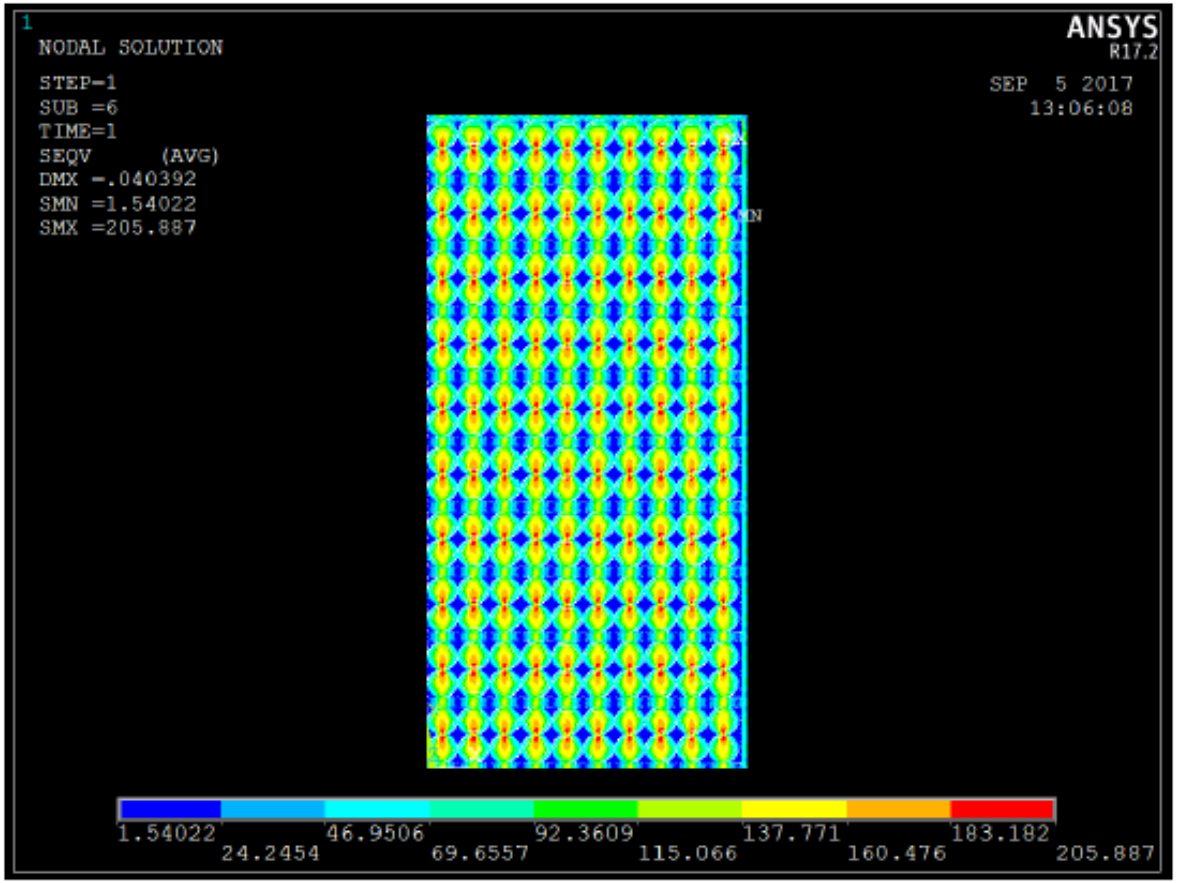








Nb_3Sn Thin Films on Nb –New Results (1)



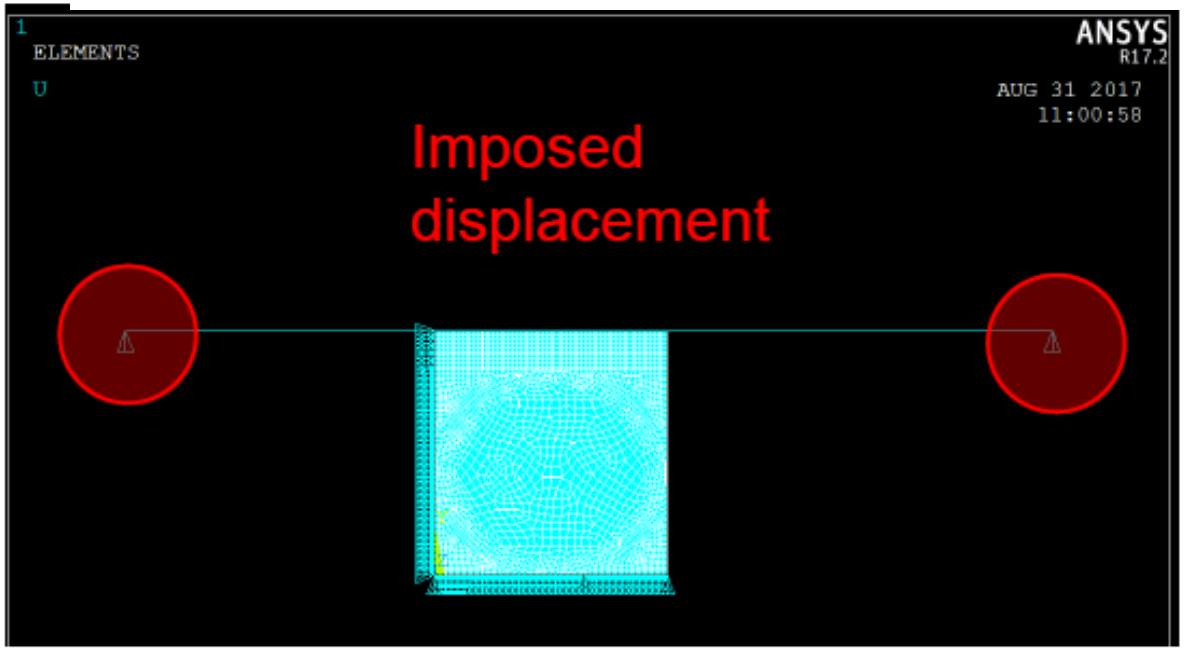
- Static loading (80MPa)
- Max internal stress ~180 MPa

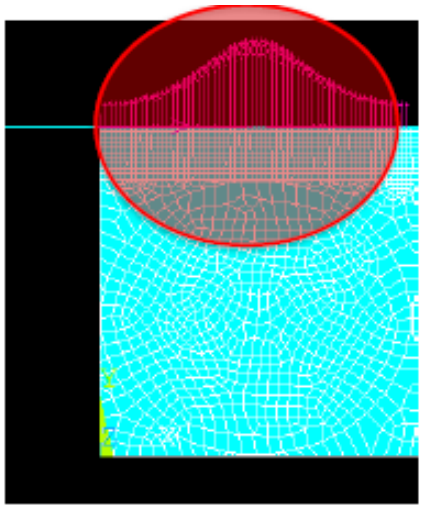
The maximum obtained T_c was 17.68 K and the B_{c20} ranged between 22.5 T and 23.8 T

Next Steps

- Mechanical characterization of the composite material strands ($Cu+Nb_3Sn$) + epoxy + insulation in the simplest assumption of anisotropic material, i.e. Orthotropic transversally isotropic

E_{xy} υ_{xy} E_z G_{zx} υ_{zx}

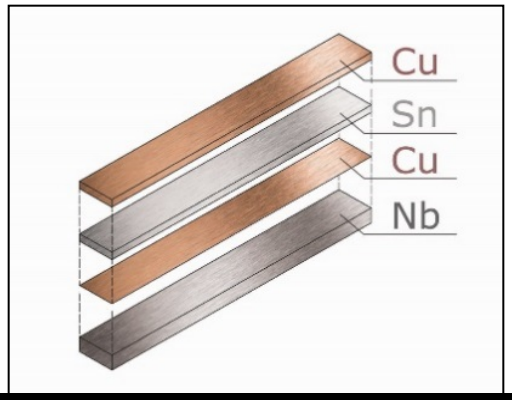


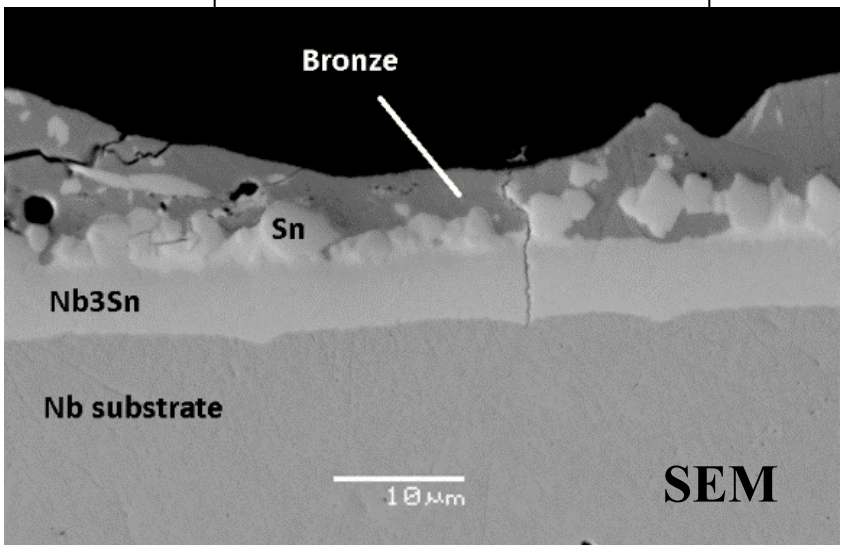


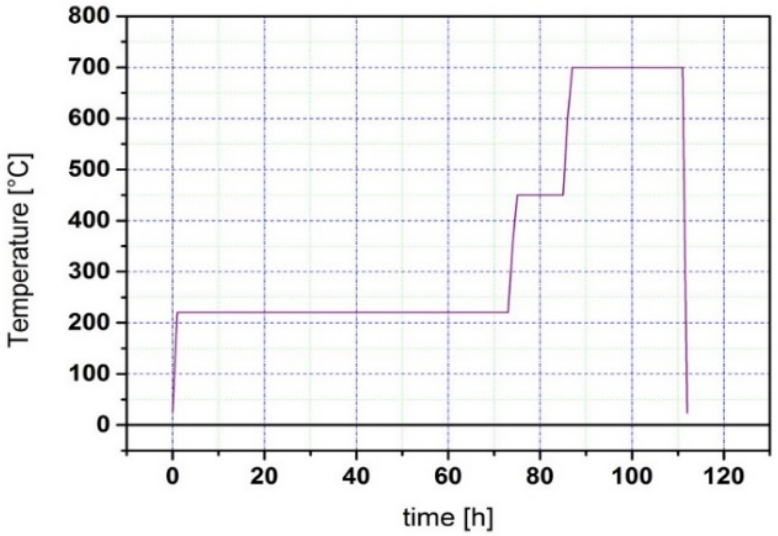
Nb_3Sn Thin Films on Nb

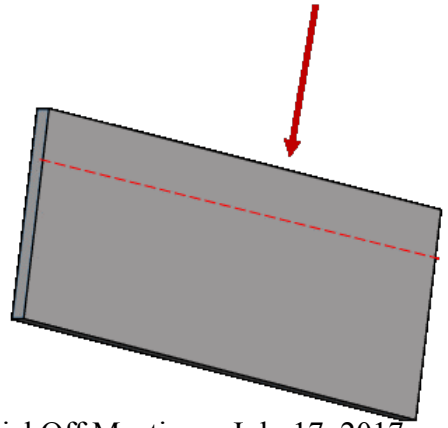
*** An electro-chemical deposition technique to produce Nb_3Sn coatings was developed in the last few years by FNAL and the Politecnico di Milano.**

*** The Nb_3Sn phase is obtained by electrodeposition of Sn layers and Cu intermediate layers onto Nb substrates, followed by high temperature diffusion in inert atmosphere. In 2014, Nb_3Sn superconducting samples between 5.7 and 8.0 μm in thickness were produced with a maximum obtained T_c of 17.68 K and B_{c20} ranging between 22.5 T and 23.8 T.**



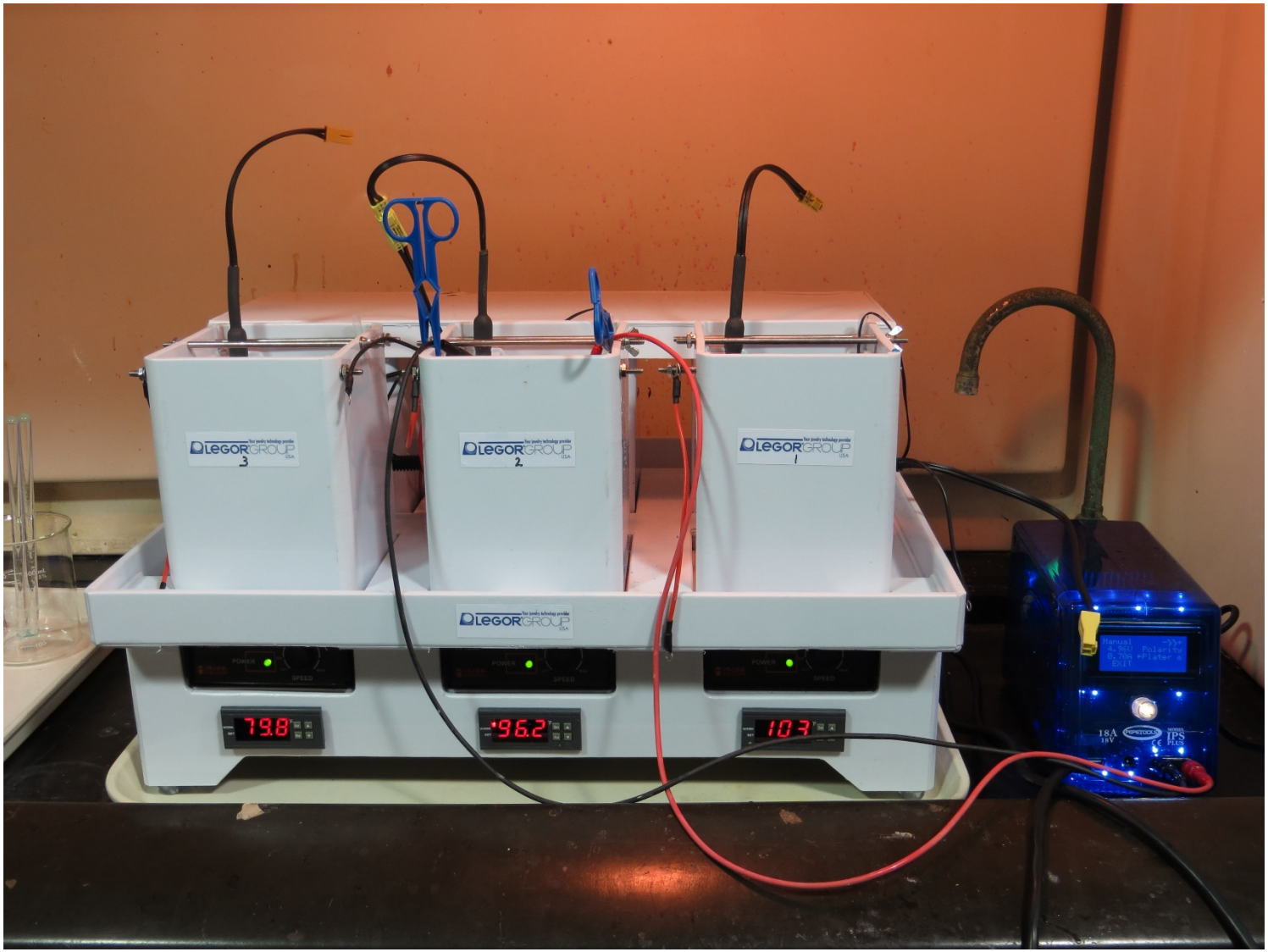




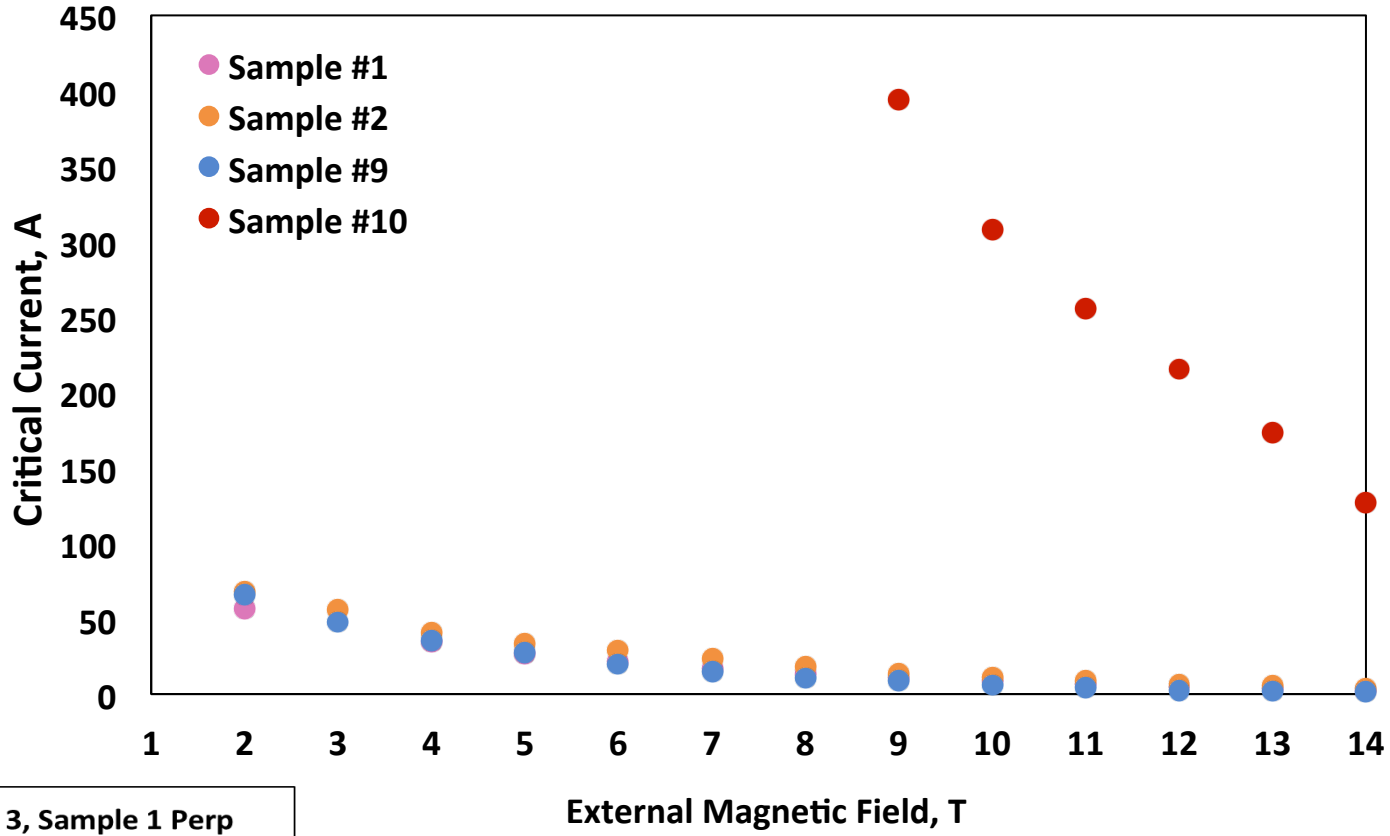


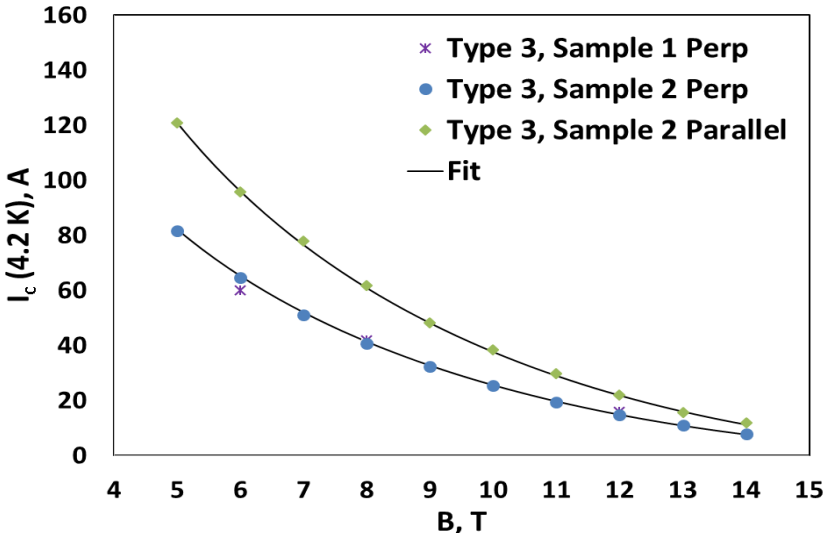
"Synthesis of Superconducting Nb_3Sn Coatings on Nb Substrates", E. Barzi, M. Bestetti, F. Reginato, D. Turrioni and S. Franz, Supercond. Sci. Technol. 29 015009.

New FNAL Setup for Electro-chemical Deposition

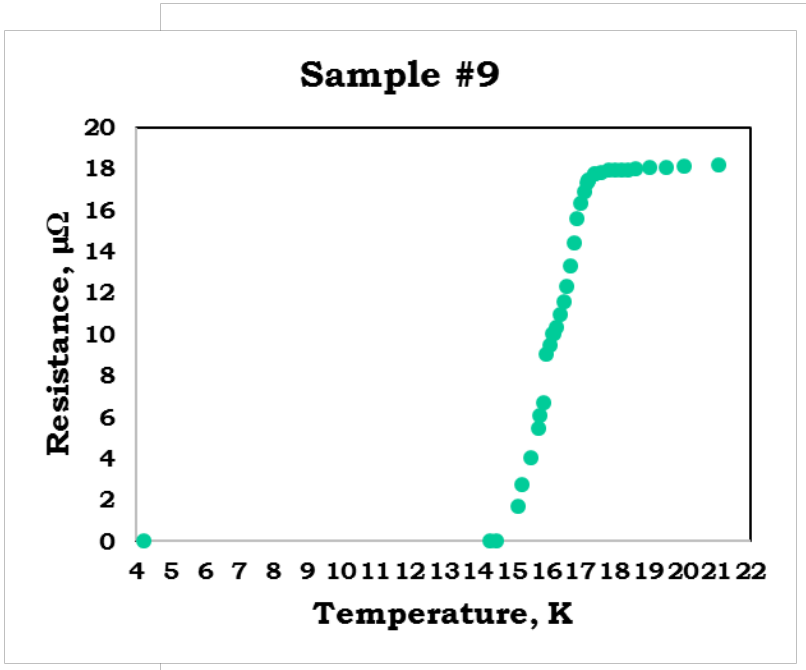


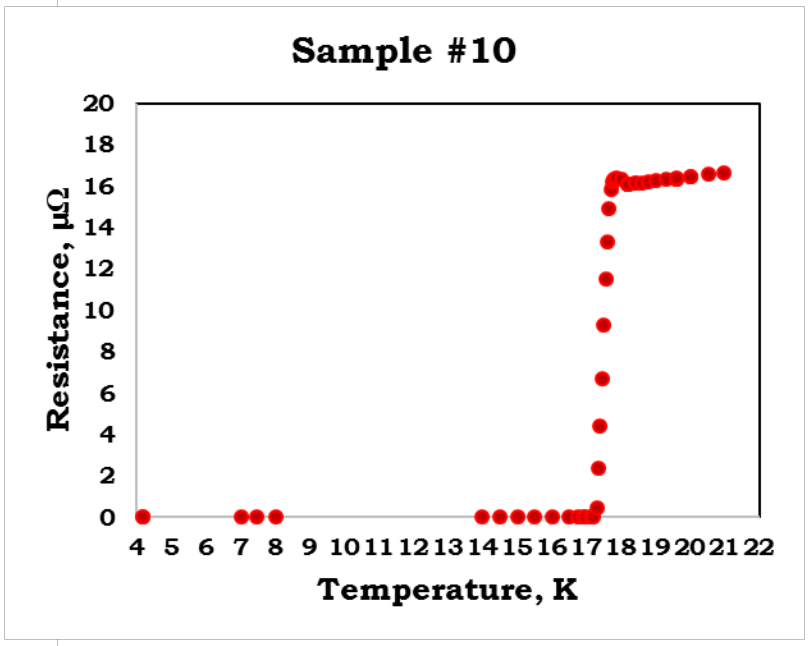
Nb_3Sn Thin Films on Nb –New Results (1)





Tc


Sample #9
Resistance, μΩ
0
2
4
6
8
10
12
14
16
18
20
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Temperature, K


Sample #10
Resistance, μΩ
0
2
4
6
8
10
12
14
16
18
20
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Temperature, K

First Goal for Superconducting Nb_3Sn Films was

Reproduce the original recipe.
Achieve:

- **the best uniformity of the deposit across the surface**
- **the best purity**
- **improve the adhesion of the film**
- **eliminate Nb oxides at the interface**

Next Steps

SEM analyses