

SRF Materials and Processing R&D

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other participants (at Fnal):

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D. Hicks, O. Lira, F. McConologue**

Universities:

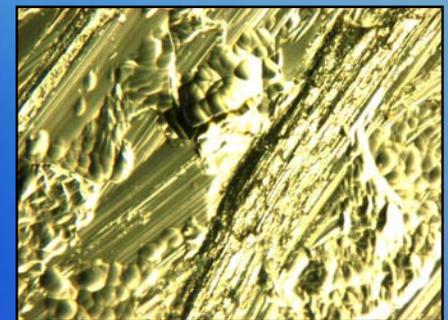
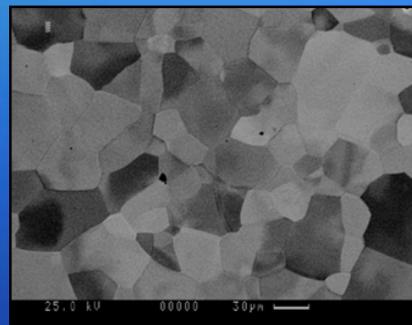
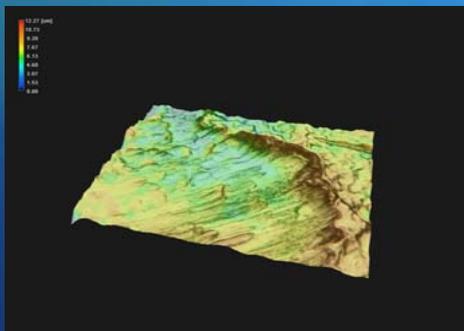
**Applied Superconductivity Center / U. of
Wisconsin**

Michigan State University

Northwestern University

Content

- Mission**
- Main Activities**
- Achievements**
- Summary**



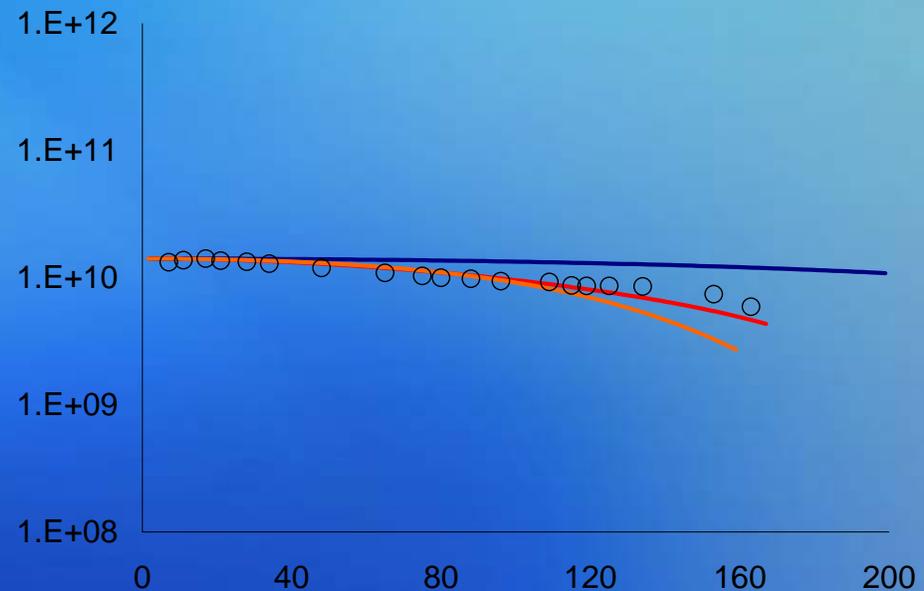
Mission Statement

- ❑ Support ILC and other SRF projects with materials expertise and testing
- ❑ Develop an intellectual understanding that relates SRF cavity performance to materials characteristics measurable in the lab.

Goals include:

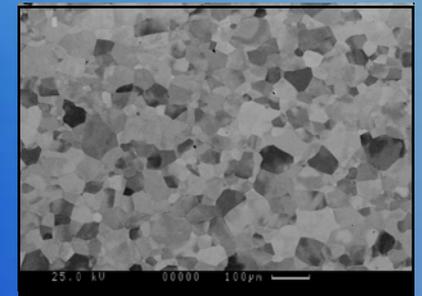
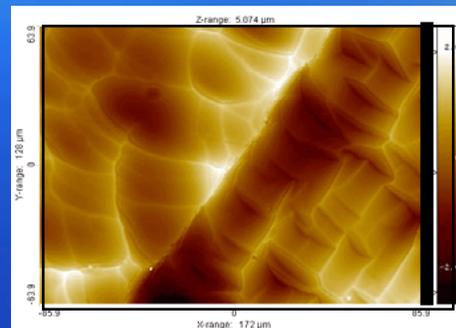
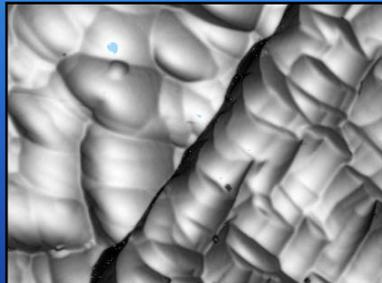
a) reliable & predictable cavity performance

b) significant cost reduction



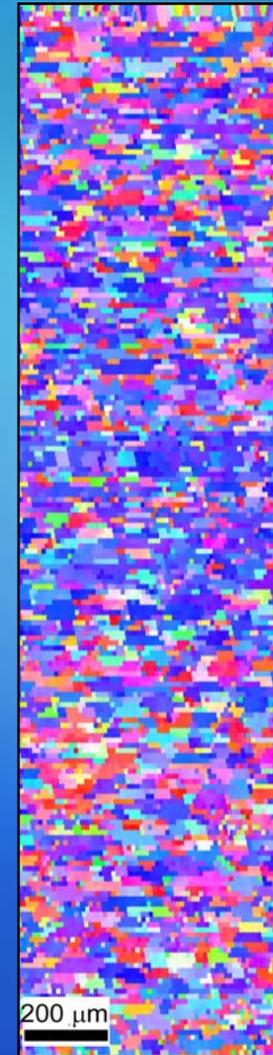
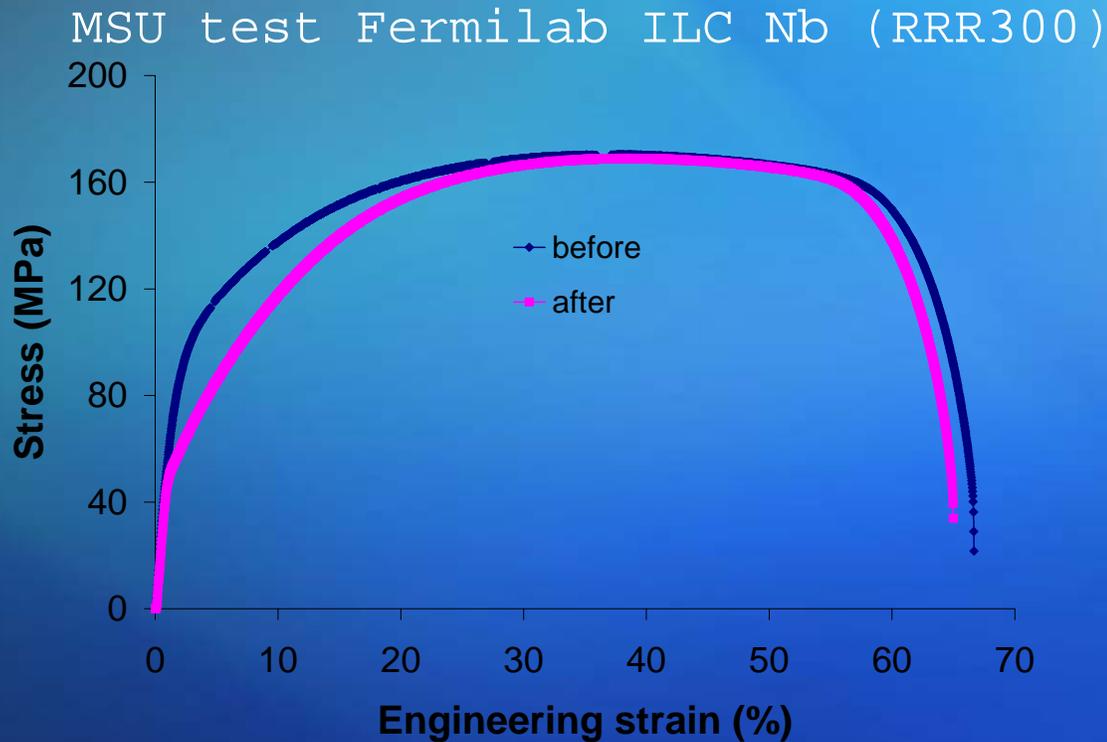
Activities

- Develop Material Specifications
- Characterize as Received Material (QC)
- Dialogue with Vendors – “grow” new vendors
- Materials R&D (including academia)
- Processing R&D (including academia) **new**
- Develop Test Infrastructure at Fermilab
- Support / Troubleshoot Cavity Fabrication
- Attract New Expertise to the Field

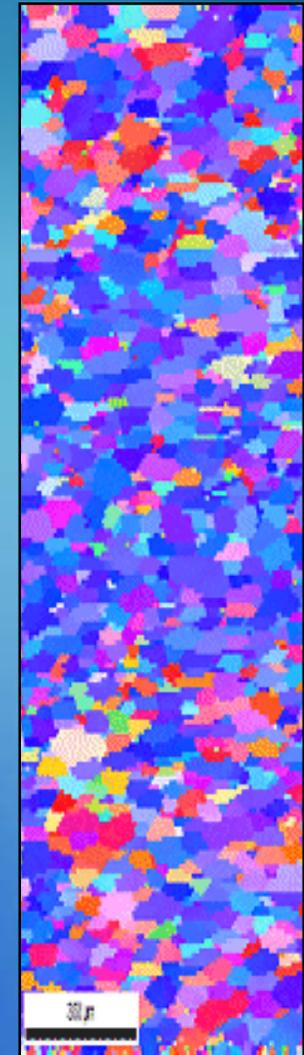


Material Specifications

Recent Forming Problems: Improved Microstructure through Heat Treatment



before HT

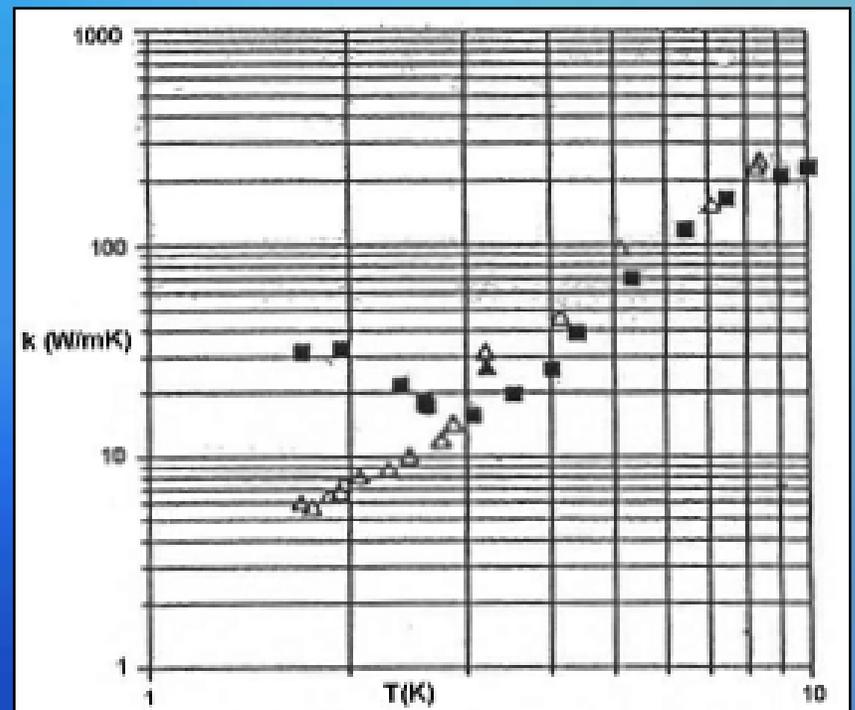
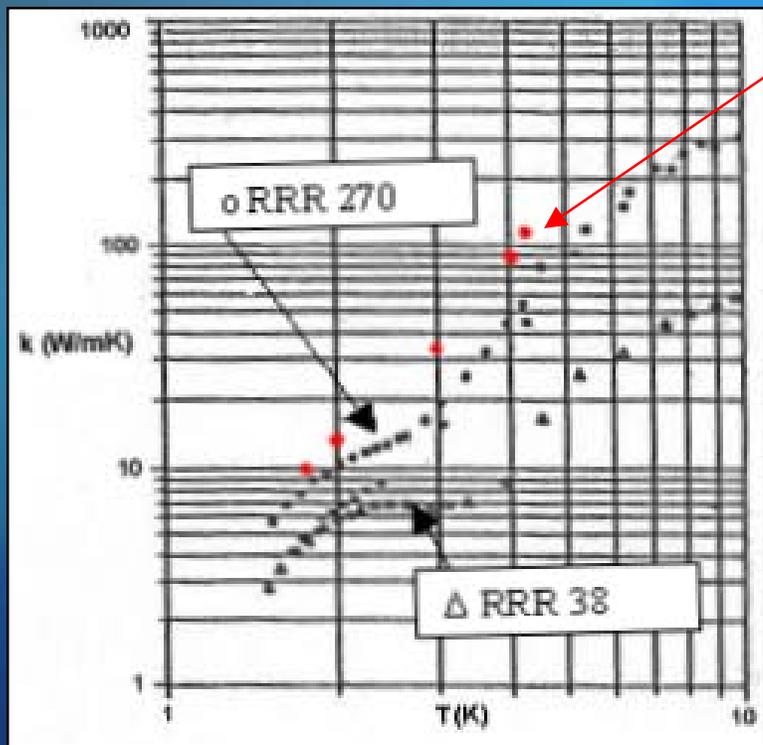


after HT

Material Characterization

Microstructure affects not only forming characteristics but also other parameters: e.g. thermal conductivity

MSU test Fermilab ILC Nb (RRR300)



Eddy Current Scanning

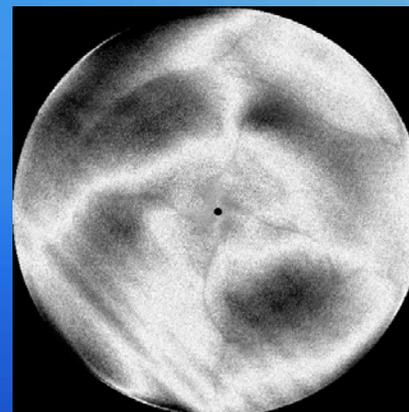
- ❑ **> 500 sheets scanned at FNAL**
- ❑ **Most of the “signals” found thus far benign**
- ❑ **nevertheless an important step**
- ❑ **develop higher resolution device**
- ❑ **stay vigilant!**



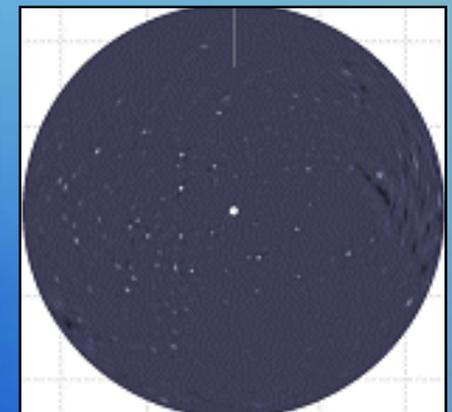
SNS scanner



SNS scanner



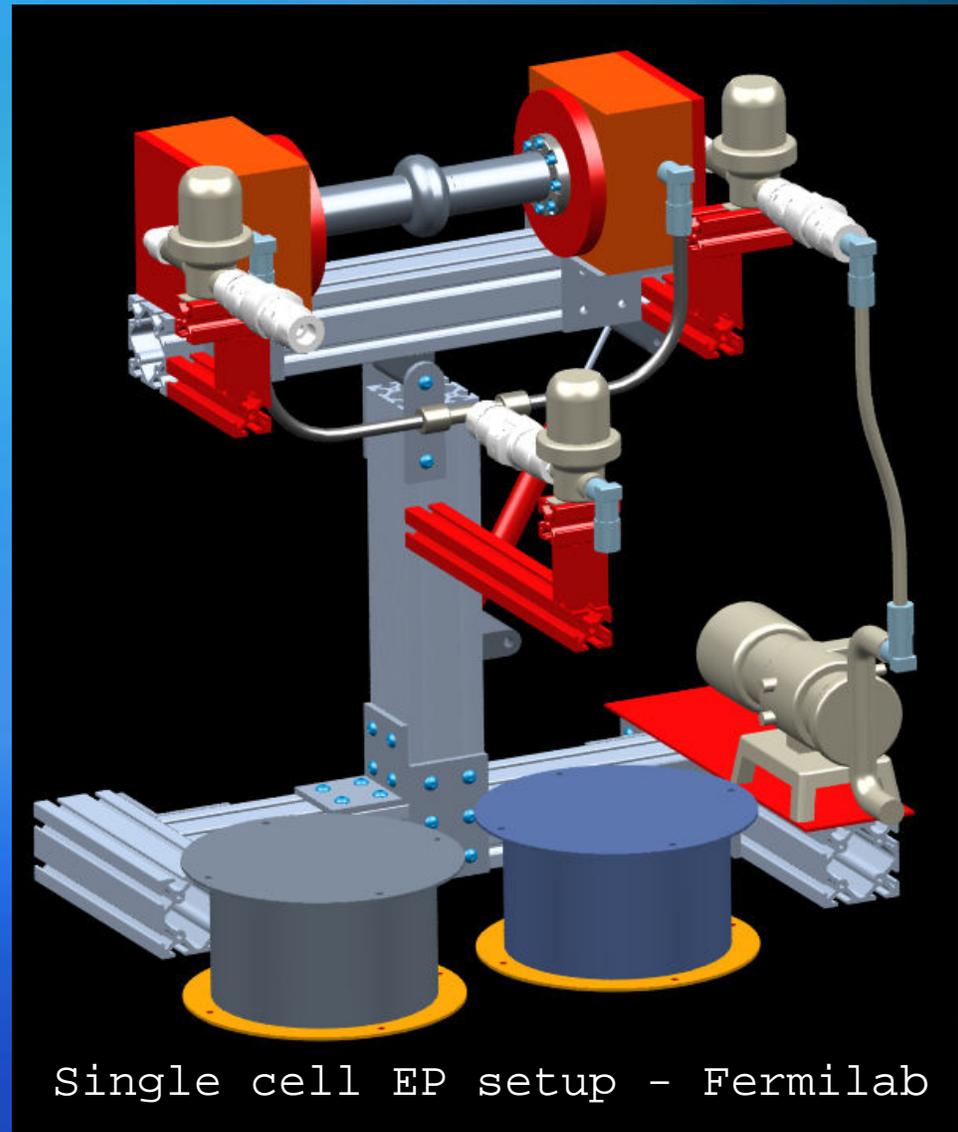
scan example



scan example

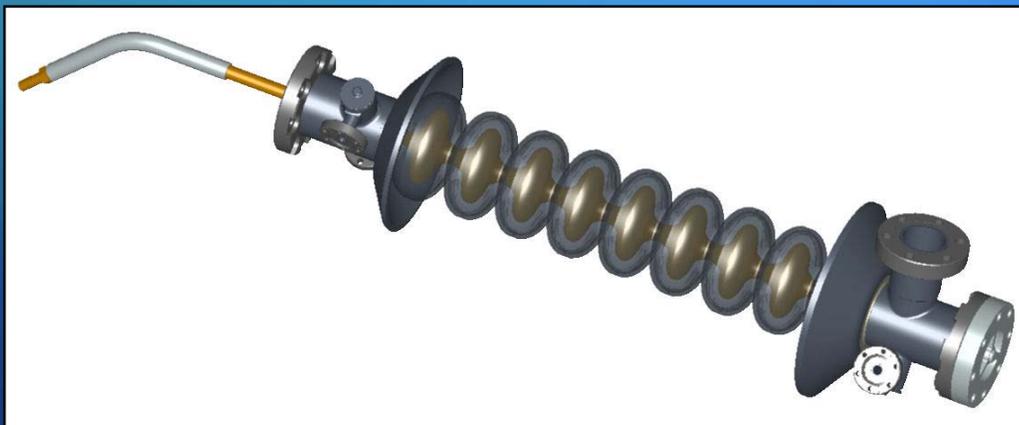
Chemistry R&D

- ❑ Strong program in Electro-Polishing R&D at Fermilab's MDTL: C. Boffo, C. Antoine, C. Cooper
- ❑ Collaborations with JLab & Universities
- ❑ Understanding factors underlying spread in cavity performance following EP



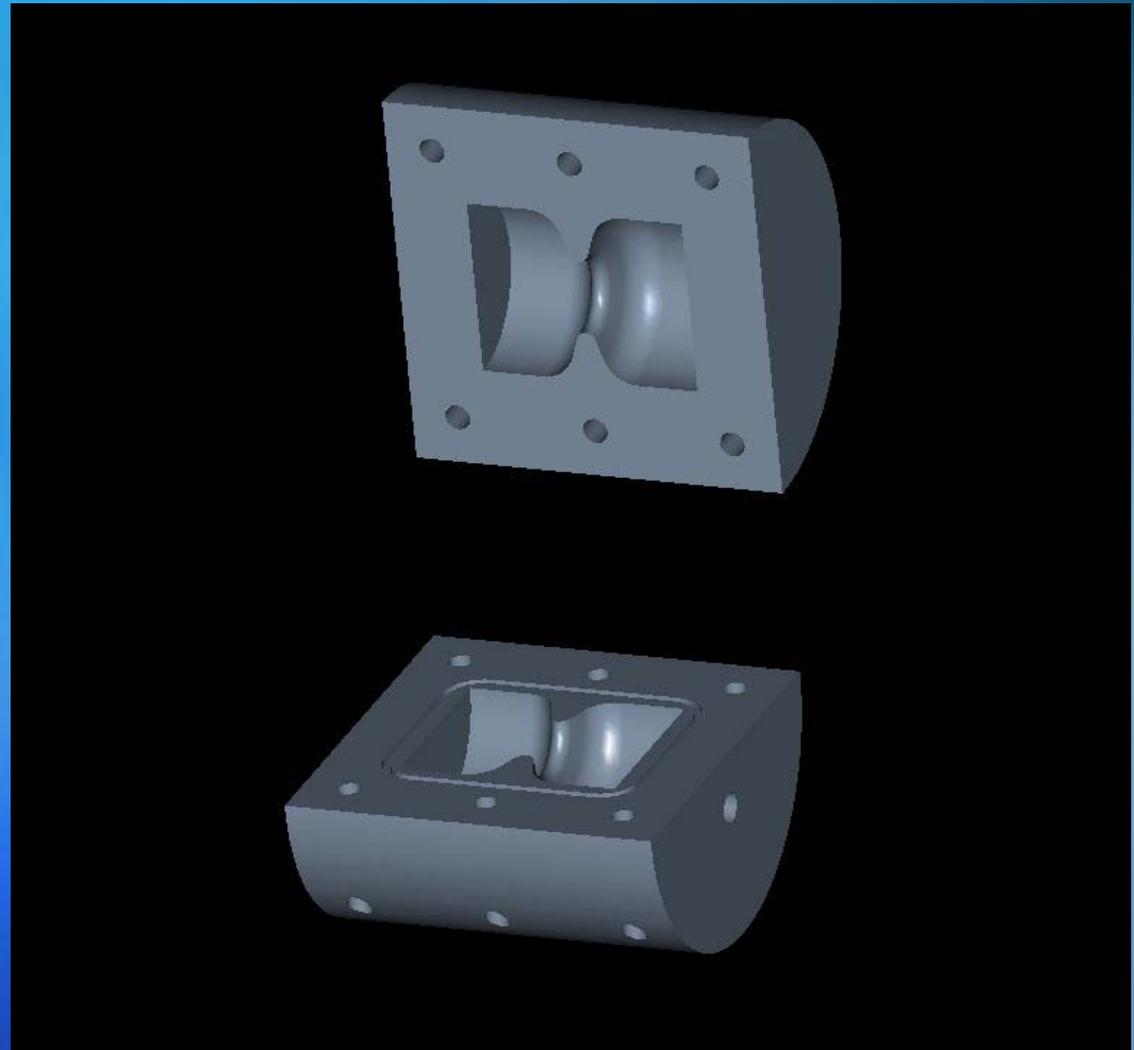
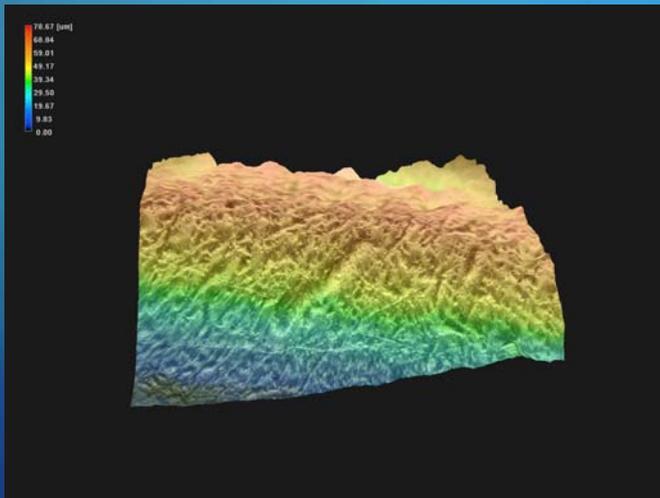
Chemistry R&D

- ❑ BCP optimization program
- ❑ Flow simulations
- ❑ Thermal simulations
- ❑ Reduce Iris to Equator etch-rate variations with bladders



Chemistry R&D

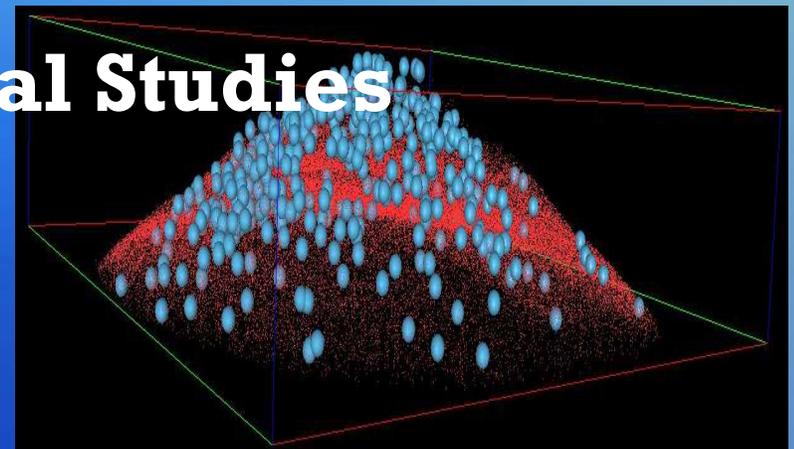
- ❑ **Tumbling R&D**
- ❑ **Design of a small sample setup**
- ❑ **First trials with local industry**



Materials R&D – University Collab.

Fermilab plays a leading role in organizing SRF university activities – a regional pole was established with regular meetings

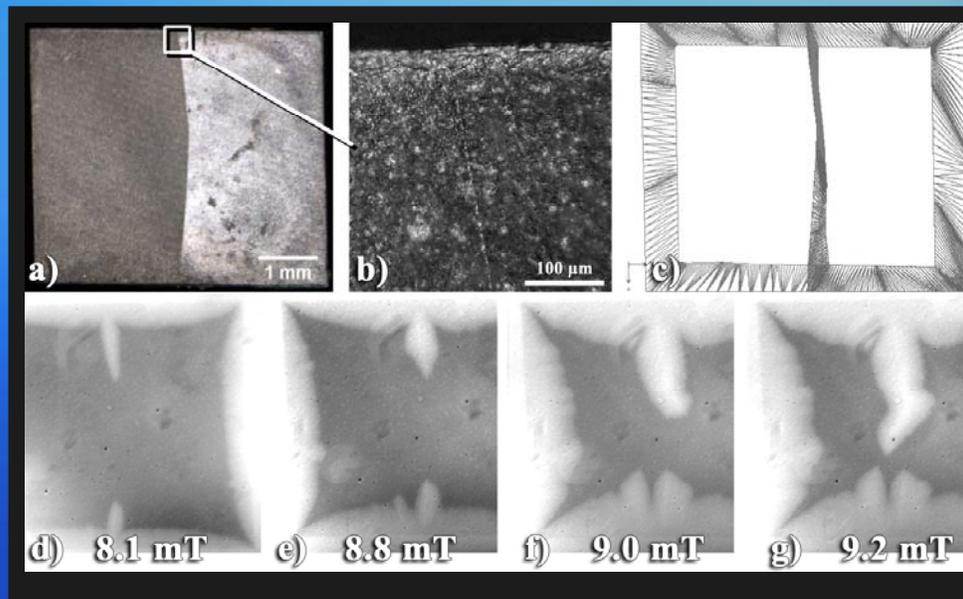
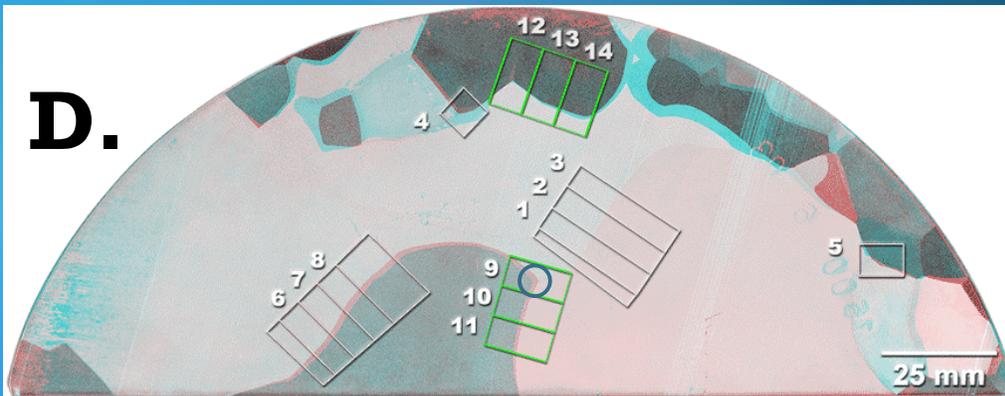
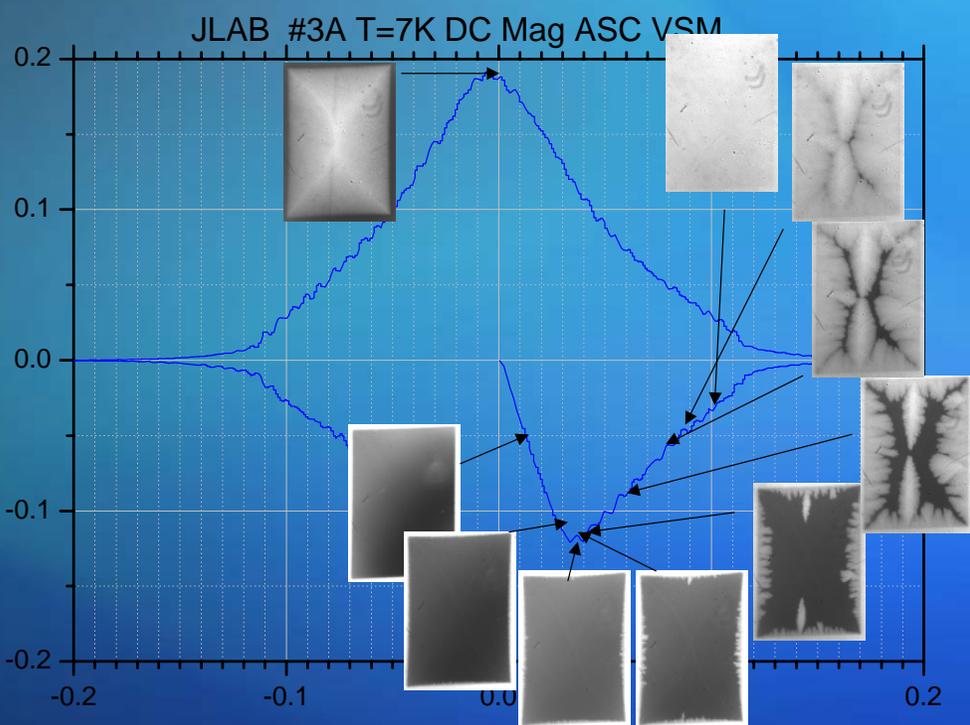
- ❑ Applied Superconductivity Center
Magnetic and Transport Studies, Theory**
- ❑ Michigan State University
Thermal and Mechanical Studies
TIG Welding**
- ❑ Northwestern University
Nano-chemistry**





Magnetic investigation of Nb

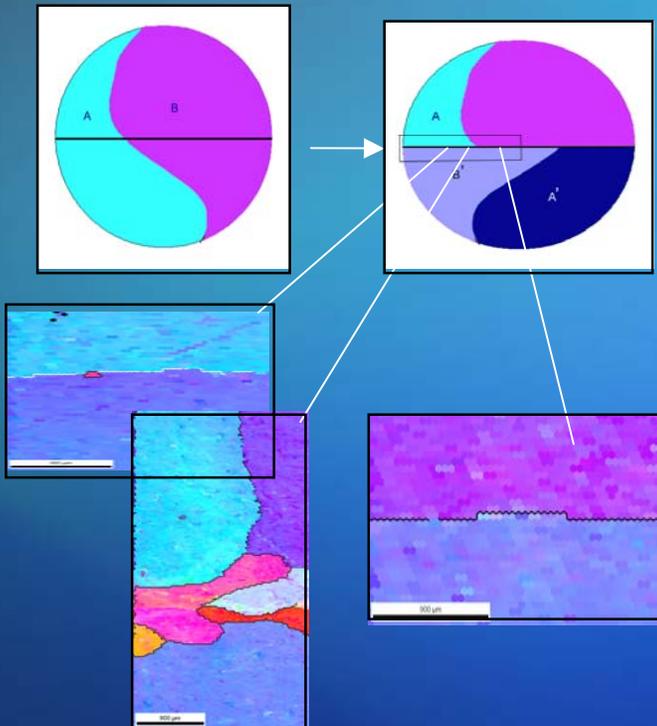
P. Lee, A. Gurevich, A. Polyanskii, A. Squitieri, D. Larbalestier – ASC/UW



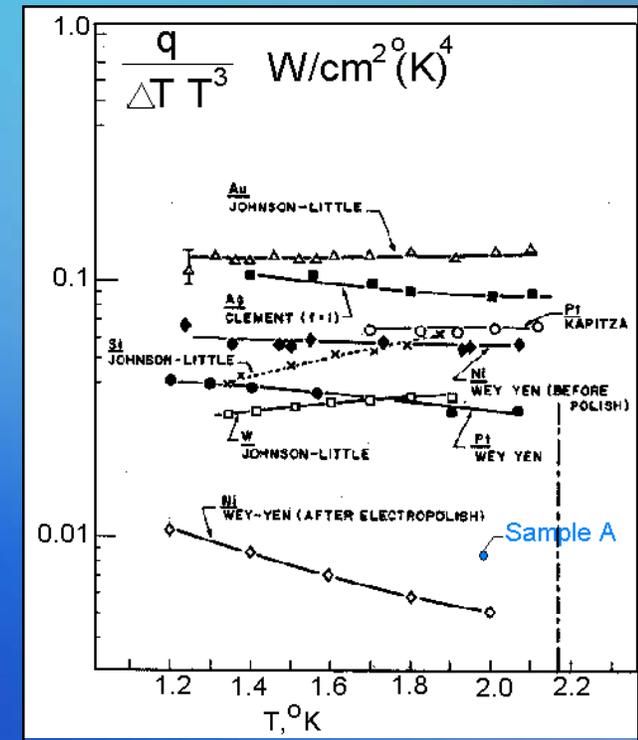
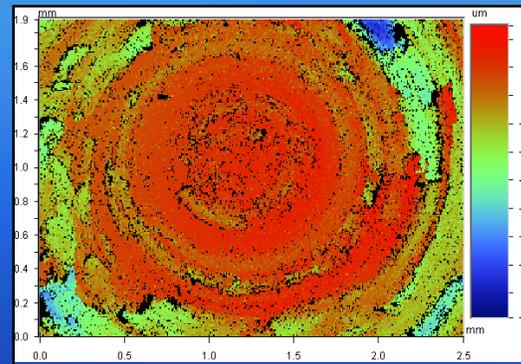
Nb Thermal & Mechanical Propert.

A. Aizas, D. Baars, T. Bieler, T. Grimm, H. Jiang
Michigan State University

Re-crystallization of large grain Nb welds:



Potential for a factor 10 improvement in Kapitza conductance!



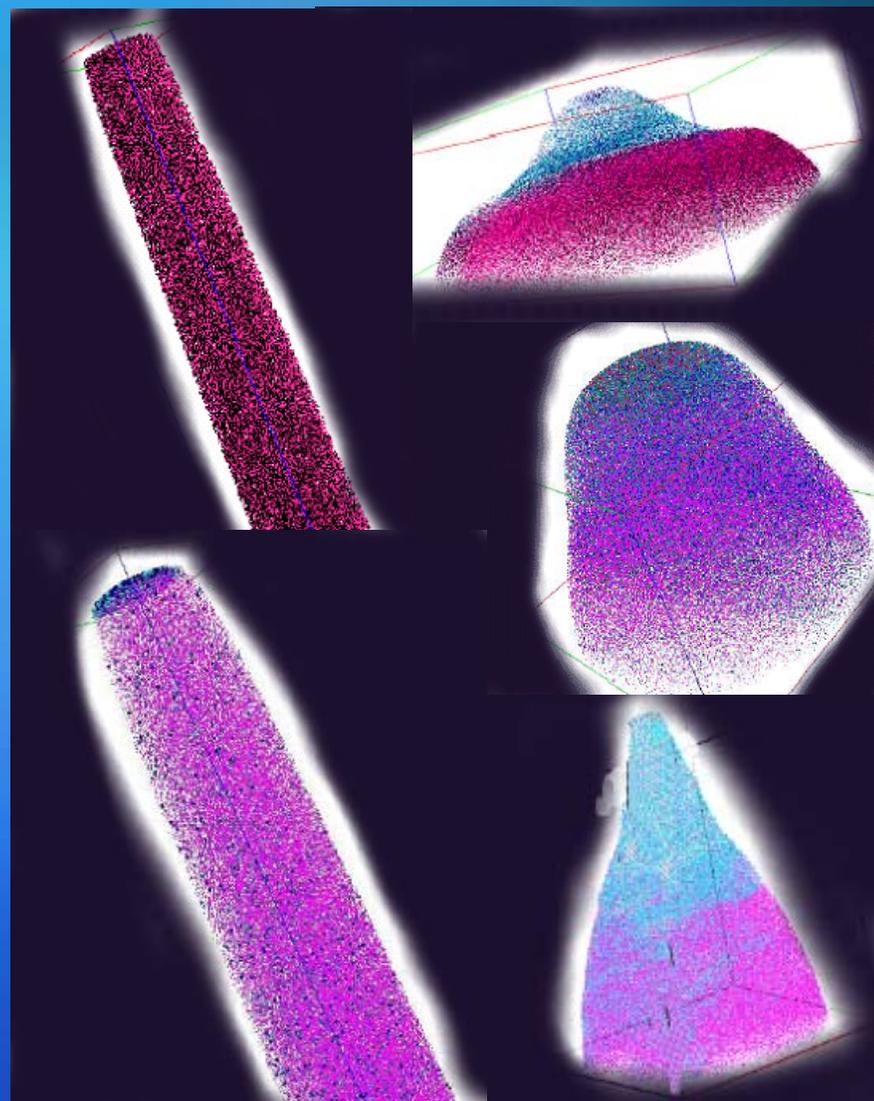
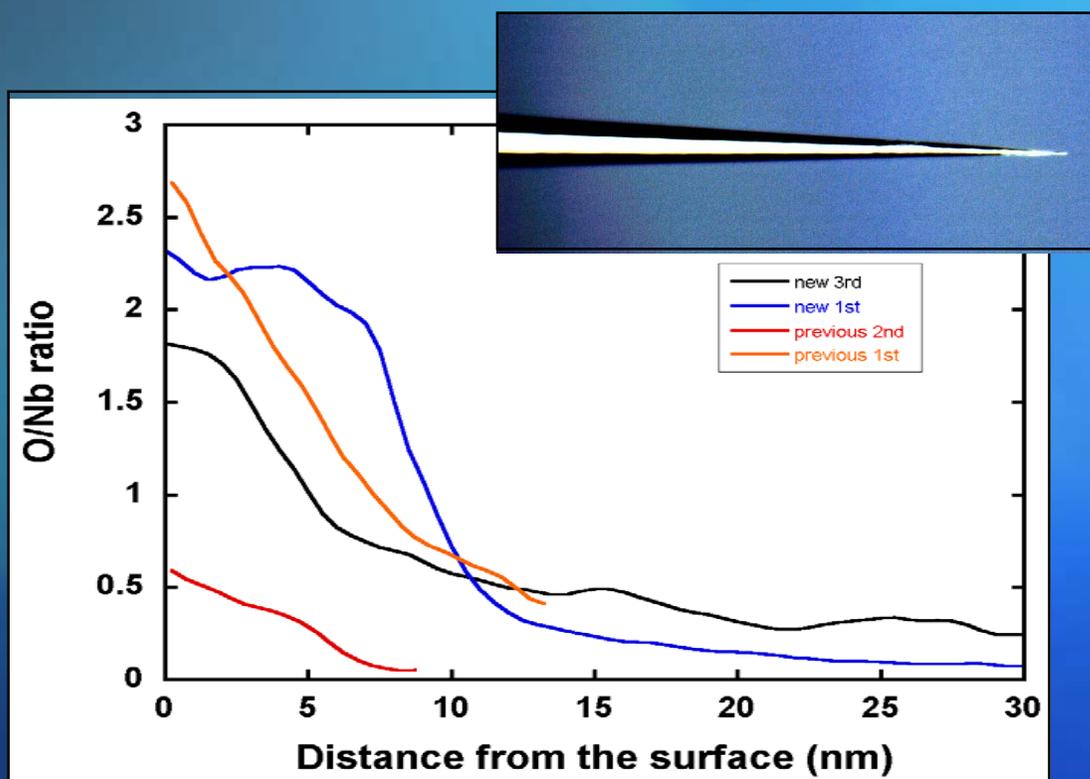
High purity TIG Welding of Nb

S. Bricker, T. Grimm, D. Pendell –
Michigan State University



Nb Nanochemistry w. 3DAP

D. Seidman, K. Yoon
Northwestern University



Achievements I

❑ **Testing Infrastructure : Eddy current scanner, RRR test station, chemistry benches, SEM, mechanical testing, clean rooms**

❑ **Material Testing: actively involved in material purchasing, reception, QC, experimental data on all major material properties, dialogue with niobium vendors**



Achievements II

- ❑ **UW discovery of inhomogeneities in superconducting properties in high purity Nb for SRF - vortex penetration**
- ❑ **Advances in SRF theory – “Hot Spot Model”, Non-Linear BCS Resistance, Thin Film Concept to increase quench field (A. Gurevich – ASC/UW)**
- ❑ **Nb nano-chemistry at unprecedented resolution – promising big results very soon!**
- ❑ **First results in TIG Welding**

Summary

- ❑ Fermilab now has a competitive materials and processing R&D program**
- ❑ Soon EP R&D will become very strong – key players assembled, R&D facilities in assembly stage, strong connections built (e.g. to JLab)**
- ❑ Secret weapon - University groups: Wisconsin, Michigan Northwestern,...**