

Collaborators:

M. Battistoni, D. Burk, C. Chapman, K. Ewald, L. Elementi, M. Foley, H. Hahn,  
 D. Hicks, F. McConologue, T. Reid - FNAL  
 D. Seidman, J. Sebastian – Northwestern  
 J. Norem - ANL  
 T. Grimm, A. Aizaz, H. Jiang, T.R. Bieler - MSU  
 D. Larbalestier, A. Gurevich, P. Lee, T. Polyanskii, A. Squitieri - UW Madison ASC



SRF Materials Lab

## Eddy Current Scanner

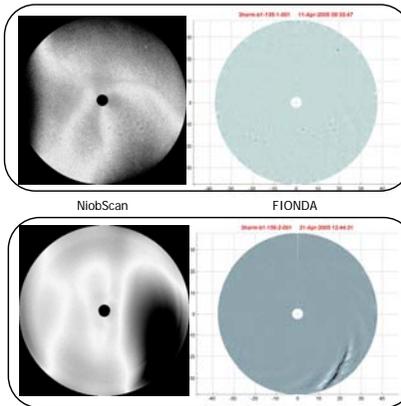


Scanning disks is part of the QC process during SRF cavities production:  
 - 100  $\mu$ m Ta defects can be detected  
 - Over 200 disks scanned  
 - ~30% rejection rate

Eddy Current Scanner – on loan from SNS -



DESY Calibration Disk



NiobScan

FIONDA

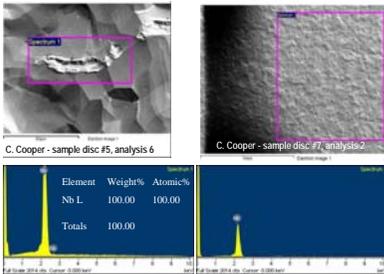


FIONDA (Filtering Images of Niobium Disks Application)

Is a software implementing an algorithm that, applied to the data resulting from an eddy current scan, allows to eliminate the masking effect due to the disk thickness variation.

The result of each scan is stored in form of picture, for easy evaluation, and in form of binary data file. Starting from the data file one can generate a matrix and manipulate single rows and columns with FIR filters. This process allows for eliminating the unwanted features and enhancing possible defects.

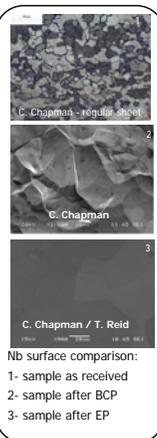
## ElectroPolishing - Surface Analysis



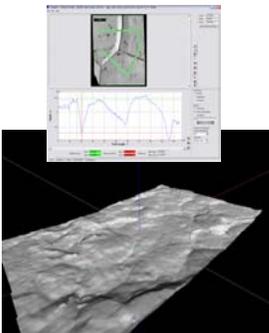
SEM is used to characterize the surface topology of Nb, both as received and during the fabrication process.

Displayed on the right are 3 samples: the top one as received, the center one after BCP and the bottom one after EP revealing the different effect of the treatments on the Nb surface.

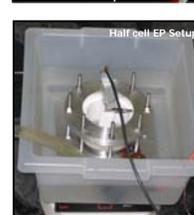
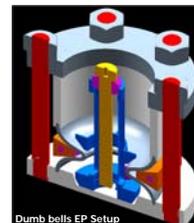
EDX is used, as shown above, to characterize the possible contamination of the material after heat treatment due to the furnace environment.



Nb surface comparison:  
 1- sample as received  
 2- sample after BCP  
 3- sample after EP



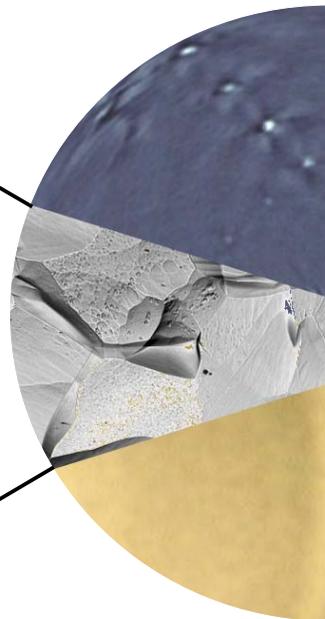
Software based 3D reconstruction and profilometry are used to quantitatively characterize the effect of BCP, EP, and Heat treatments on the surface topography of Nb. Two SEM images of the same area, obtained at different angles, are used for the 3D reconstruction.



A program EP on small samples with the goal of understanding the effect of different parameters on the process results is ongoing.

Half cells and dumbbells are electro polished using a simple vertical setup on the bench.

Additional studies must be performed to extend the concept of vertical setup to multi cells cavities.



## RRR – Thermal Conductivity – Kapitza Conductance

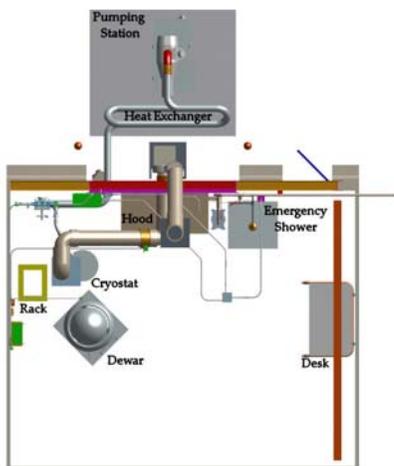


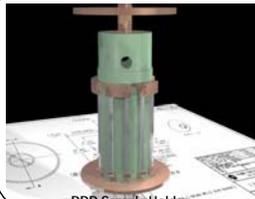
3D Model of the SRF Materials Lab

The infrastructure to perform R&D on SRF materials is in the design-construction stage.

The Eddy Current Scanning is already performed in the SRF materials lab in IB3. The RRR measurement test station will be placed in the same area. In future, thermal conductivity and Kapitza conductance will be measured as well.

The test station is equipped with a powerful pumping station allowing operating the 100 liters Helium Dewar in the 1.5 K range .





**RRR Sample Holder**

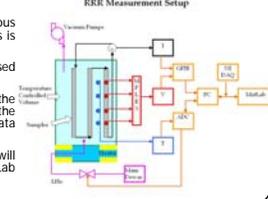
**RRR Measurements**

A setup for the simultaneous measurement of 10 Nb samples is being designed.

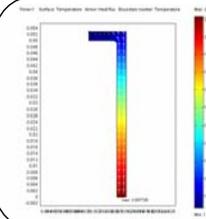
On the left is shown the proposed sample holder.

On the right is shown the experimental setup, including the cryogenic circuit and the data acquisition schematic.

The DAO code and interface will be designed in MatLab environment.



**RRR Measurement Setup**



**Thermal Conductivity and Kapitza conductance**

The design of the optimal sample shape allowing the measurement of thermal conductivity and Kapitza conductance on the same material used for SRF cavities is ongoing.

The scheme of the setup is shown on the right: the C-shaped Nb sample is placed between a G10 block and the Helium interface, while a G10 steak is used as a support. Three thermometers on the side are used to measure thermal conductivity while a thermometer in the helium bath together with one at the interface Nb/He are used to measure Kapitza.

On the left is shown the temperature distribution along the cross-section of an alternative cylindrical shaped sample with a Nb disk on top, at the bottom it is placed a heater while the top disk is in contact with helium.

