Contribution ID: **1107** Type: **Contributed Oral Presentation**

M2Or4C-02: Models of the Thermal Conductivity of Superconducting Nb

Tuesday, 23 July 2019 17:45 (15 minutes)

Particle accelerators rely on large values of the thermal conductivity of superconducting Nb for best operation. Manufacturing processes for accelerator cavities can alter the thermal conductivity of Nb by varying its purity, dislocation density, and other material parameters. Optimizing the material parameters for enhanced thermal conductivity may adversely affect other desirable properties, such as material strength. Having models to predict the thermal response of niobium based on values of the material parameters that may be changed during manufacturing can greatly enhance the design of the manufacturing process.

Here, three models of the thermal conductivity for superconducting Nb are compared. The first is a modification of an often used parameterization that is based on BCS theory. An additional term is added to account explicitly for the role of dislocation density on thermal conductivity, especially at temperatures colder than the phonon peak. This model typically relies on measurement of the thermal conductivity and is best suited for characterizing the influence of different scattering mechanisms on the thermal conductivity. The second model is the integrated closed form solution of the Boltzmann transport equation using the relaxation time approximation. The results here include the phonon dispersion relation for Nb, which is not included in the original relation. The third model is a Monte Carlo solution of the Boltzmann transport equation, also using the relaxation time approximation. Using Monte Carlo methods to solve the Boltzmann transport equation reduces the assumptions required, such as the material isotropy. It also allows separate treatment of each of the scattering mechanisms. Each of the model results agrees well with measurements of annealed and deformed Nb, albeit with different degrees of prior information.

Acknowledgement: This research is supported by the U.S. Department of Energy, Office of High Energy Physics, through Grant No. DE-FG02-13ER41974.

Primary authors: Mr XU, Peng (Mechanical Engineering, Michigan State University); Prof. BIELER, Thomas R. (Chemical Engineering and Material Science, Michigan State University); Prof. WRIGHT, Neil (Mechanical Engineering, Michigan State University)

Presenter: Prof. WRIGHT, Neil (Mechanical Engineering, Michigan State University)

Session Classification: M2Or4C - Focus Series C: Superconducting RF Cavity Materials II