Contribution ID: **663** Type: **Contributed Oral Presentation**

C3Or1A-03: Quench spot detection for SRF cavities via flow visualization in superfluid helium-4

Wednesday 24 July 2019 11:30 (15 minutes)

Superconducting ratio-frequency (SRF) cavities, cooled by superfluid helium-4 (He II), are key components in modern particle accelerators. Quenches in SRF cavities caused by Joule heating from local surface defects can severely limit the maximum achievable accelerating field. Existing methods for quench spot detection include temperature mapping and second-sound triangulation. These methods are useful, but all have known limitations. Here we describe a new method for surface quench spot detection by visualizing the heat transfer in He II via tracking He_2^* molecular tracer lines. A proof-of-concept experiment has been conducted, in which a miniature heater mounted on a plate was pulsed on at various heat fluxes and pulse durations to simulate a surface quench spot. A He_2^* tracer line created nearby the heater deforms due to the counterflow heat transfer in He II. By analysing the tracer-line deformation, we can well reproduce the heater location within a few hundred microns, which clearly demonstrates the feasibility of this visualization-based non-contacting quench spot detection technology. Our analysis also reveals that the heat content transported in He II is only a small fraction of the total input heat energy. The remaining heat energy is essentially consumed in the formation of a cavitation zone surrounding the heater. The size of this cavitation zone is estimated based on the knowledge obtained about the transported heat. This information has allowed us to propose a new explanation for the decades-long puzzle observed in previous second-sound triangulation experiments regarding heat transfer at speeds higher than literature values. The excellent quantitative agreement between our predicted excess second-sound velocity and those measured in triangulation experiments provides a strong support of our model.
Acknowledgements: S.B. and W.G. acknowledge support from U.S. Department of Energy under Grant No. DE-FG02-96ER40952. The experiment was conducted at the National High Magnetic Field Laboratory, which is supported by National Science Foundation Cooperative Agreement No. DMR-1644779 and the State of Florida.

Author: Dr BAO, Shiran (National High Magnetic Field Laboratory)

Co-author: Dr GUO, Wei (Florida State University, National High Magnetic Field Laboratory)

Presenter: Dr BAO, Shiran (National High Magnetic Field Laboratory)

Session Classification: C3Or1A - Superfluid Helium