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Conduction Cooling of a Niobium Superconducting Radio Frequency (SRF) Cavity Using a Cryocooler

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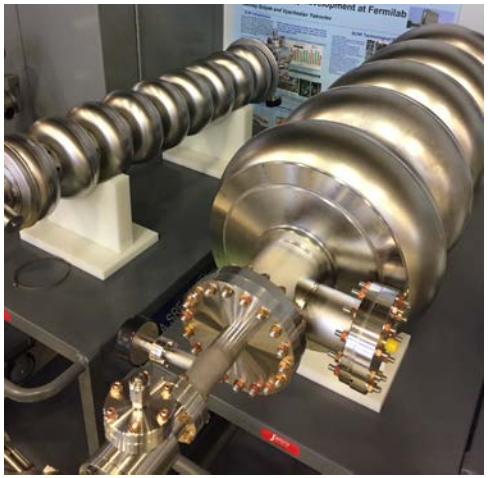
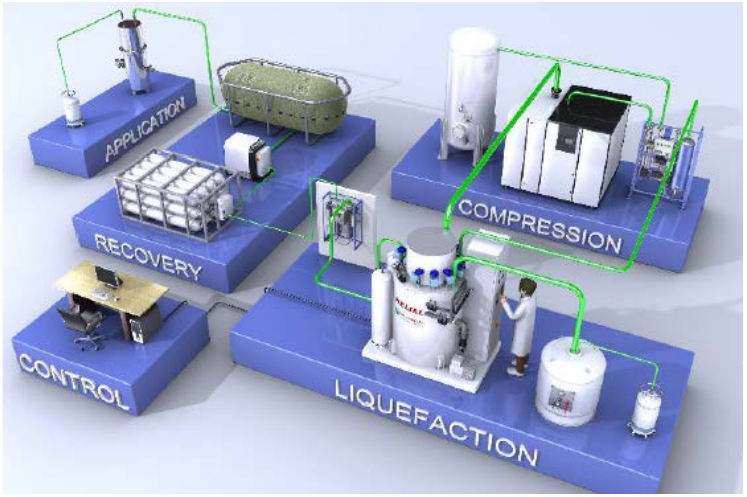
Background on SRF Cavities

- SRF cavities are the primary choice for high-energy research accelerators



- SRF cavities are cooled with liquid helium
  - Involves complex cryogenic plants



[1]

- Industrial accelerators have not yet adopted SRF technology
  - Complexity of operating with liquid helium

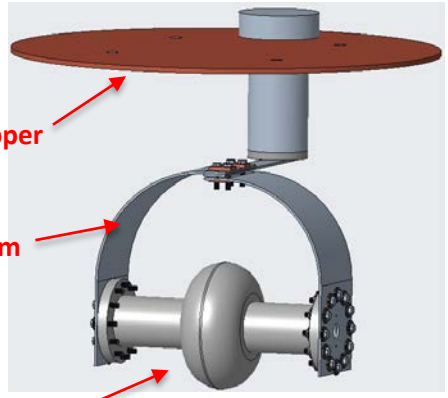
Our approach: cool a Niobium SRF cavity using a cryocooler

- Cryocooler-based cooling offers distinct advantages over liquid helium plants
  - Compact
  - Simple
    - Operation
    - Cryostat construction

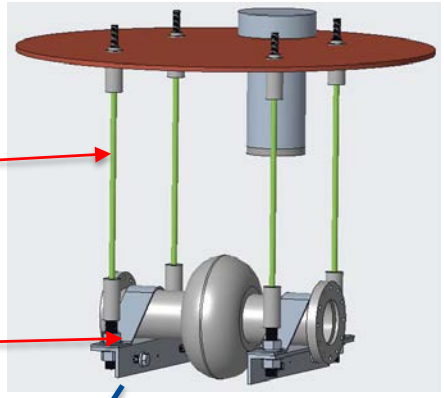
[2]

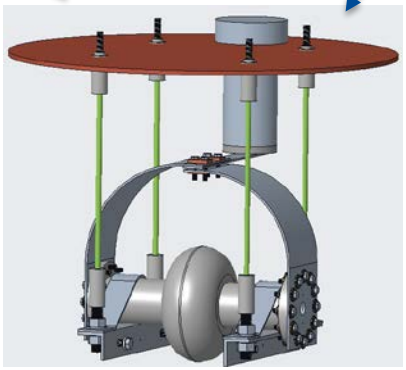
Challenge 1: Design of cooling and support structures

Conduction Path for Heat Flow



Mechanical Support and Thermal Isolation





Integrated

A 1.3 GHz Nb cavity being assembled for conduction cooling

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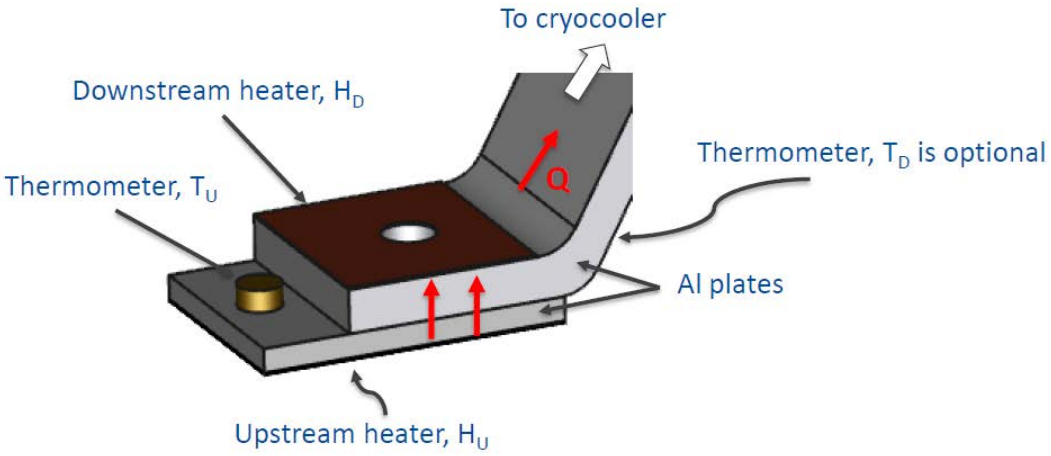
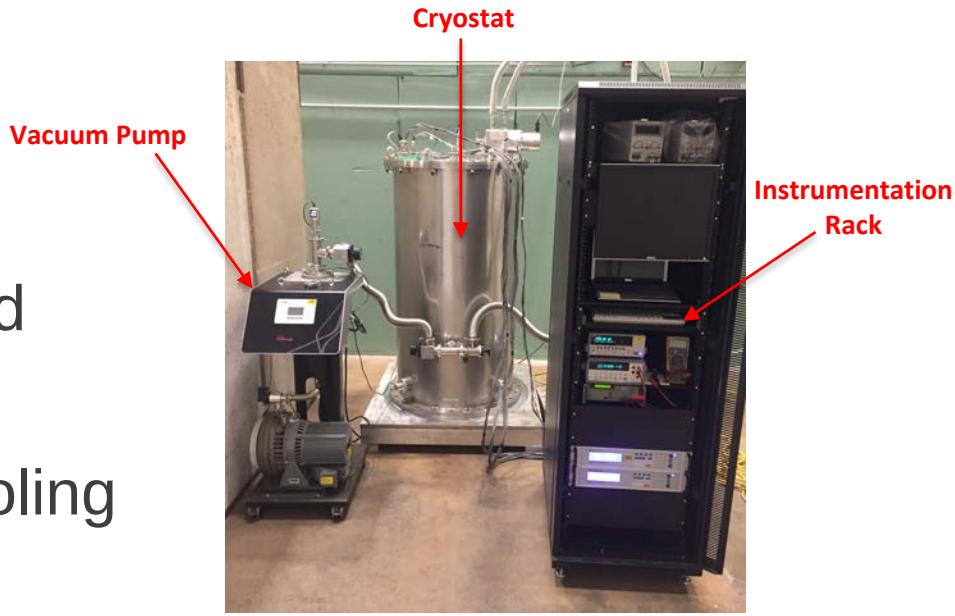
Challenge 2: Optimizing Thermal Connections

- Near 4 K, mechanical joints likely to dominate thermal resistance
- To minimize resistance, we are determining optimal:
  - Interposer
  - Bolting pressure
  - Surface preparation
- Use of two-heater one-thermometer method [3]



Progress and Future Plans

- Conduction cooling being attempted for the first time ever
  - 1.3 GHz niobium cavity
  - Estimating cool-down time



- Apparatus being automated
- Optimize support and cooling structures

References

[1] R. Kephart, et al., “SRF AND COMPACT ACCELERATORS FOR INDUSTRY AND SOCIETY” *Proceedings of SRF2015*, Whistler, BC, Canada, FRBA03

[2] SHI Cryogenics Group, “Cryocooler Product Catalogue”, 9, 16, 2017

[3] R.C. Dhuley, et al., “Thermal conductance characterization of a pressed copper rope strap between 0.13 K and 10 K” Cryogenics 86, 17-21, 2017

Acknowledgements

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