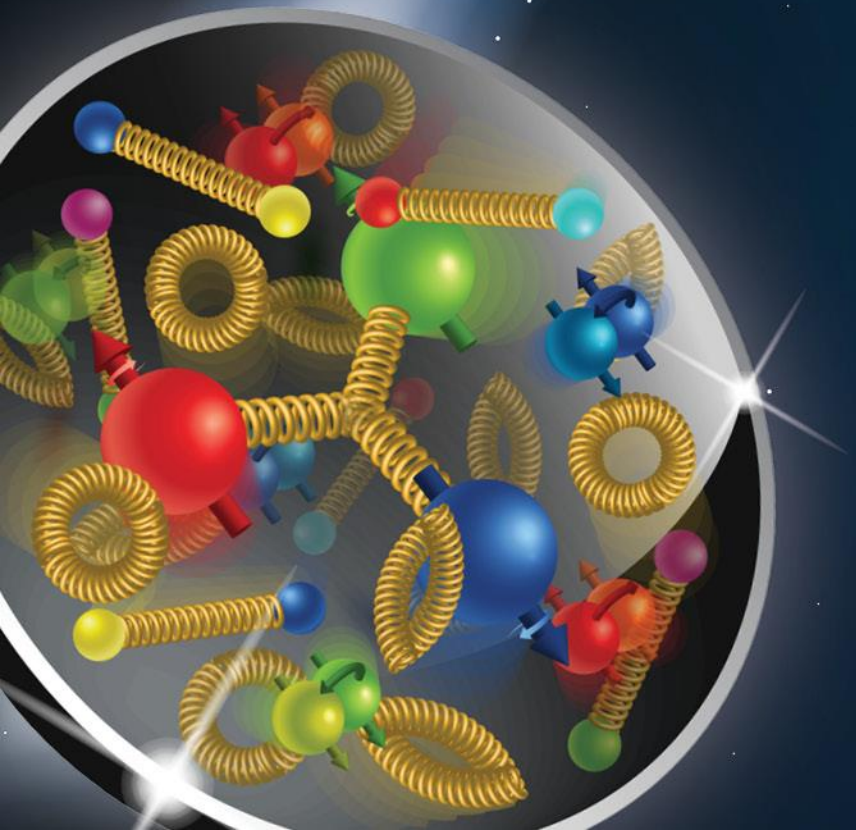
Cryogenic system configurations to cool superconducting radio frequency cavities at 2 K



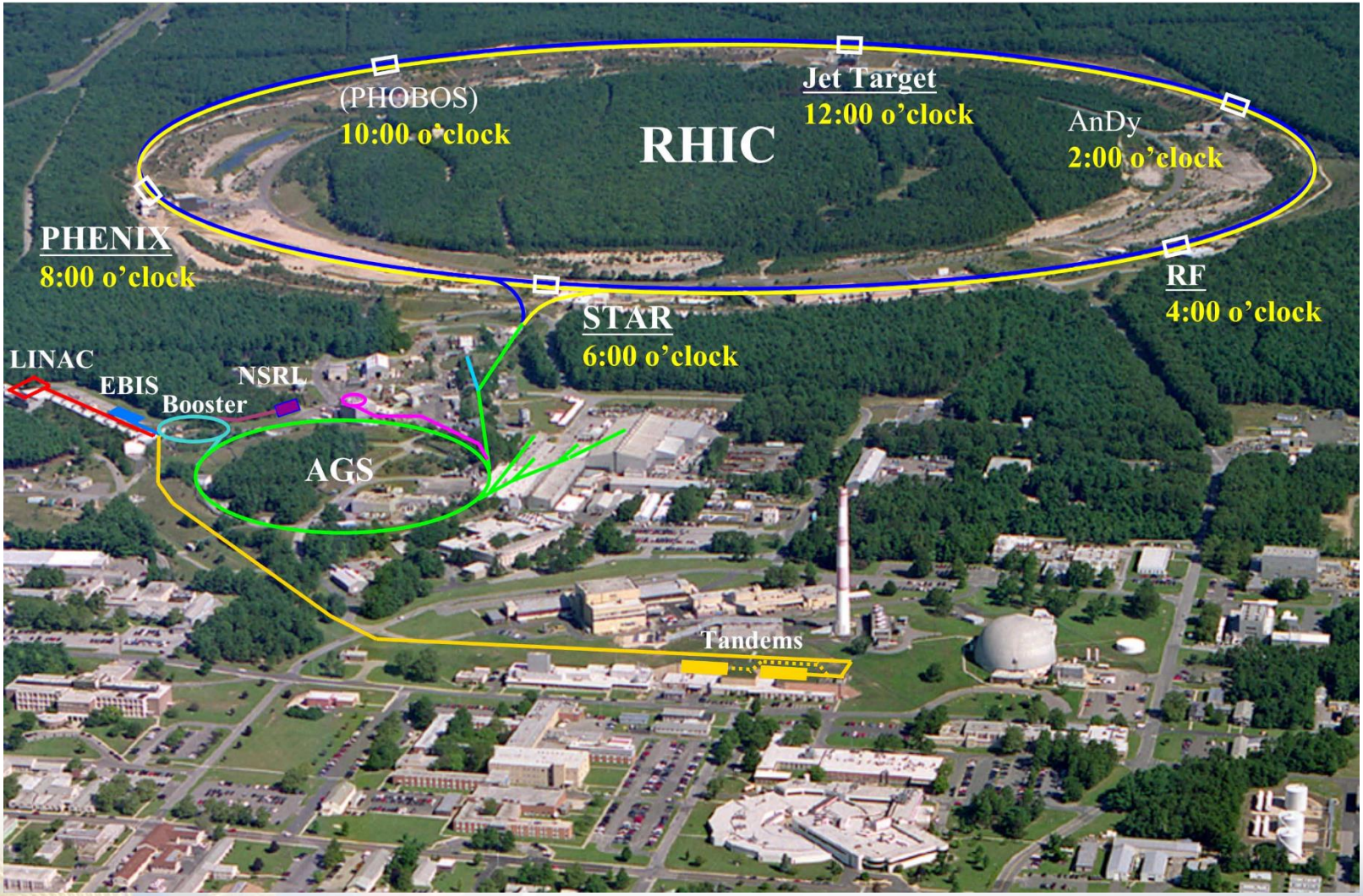
07/22/2019

Dhananjay Ravikumar

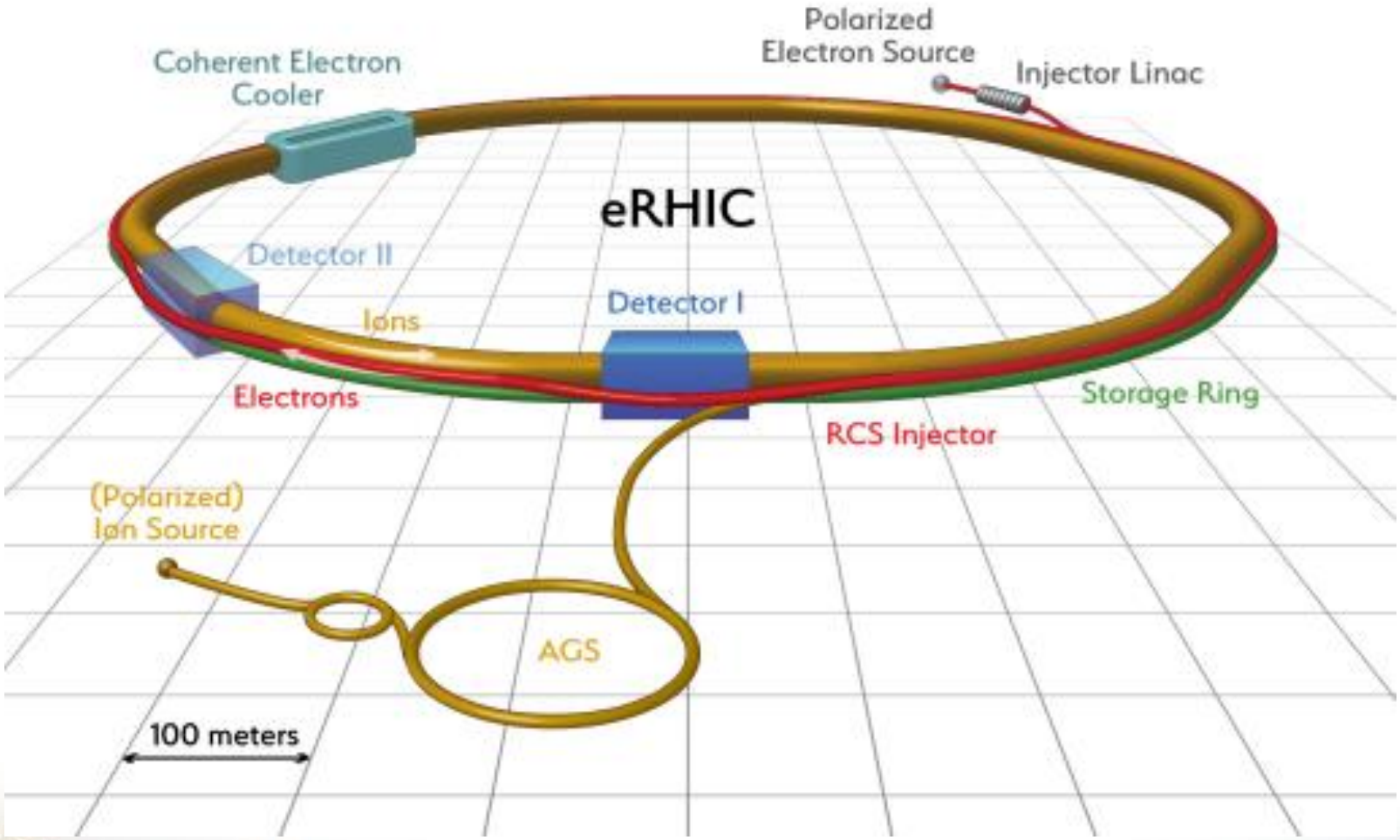
Electron Ion Collider – eRHIC

BROOKHAVEN NATIONAL LABORATORY
U.S. DEPARTMENT OF ENERGY | Office of Science

The Relativistic Heavy Ion Collider (RHIC)



Upgrading the RHIC: eRHIC



Designing a Quiet Helium Source: Problem description

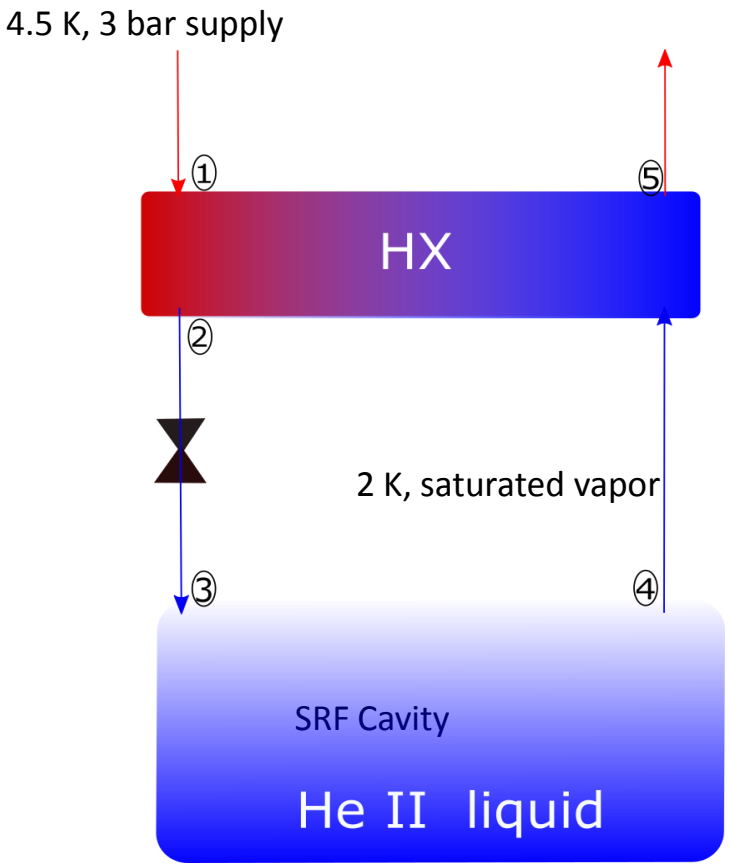
- Microphonics – What is it?
- Sources

Cryogenic contribution

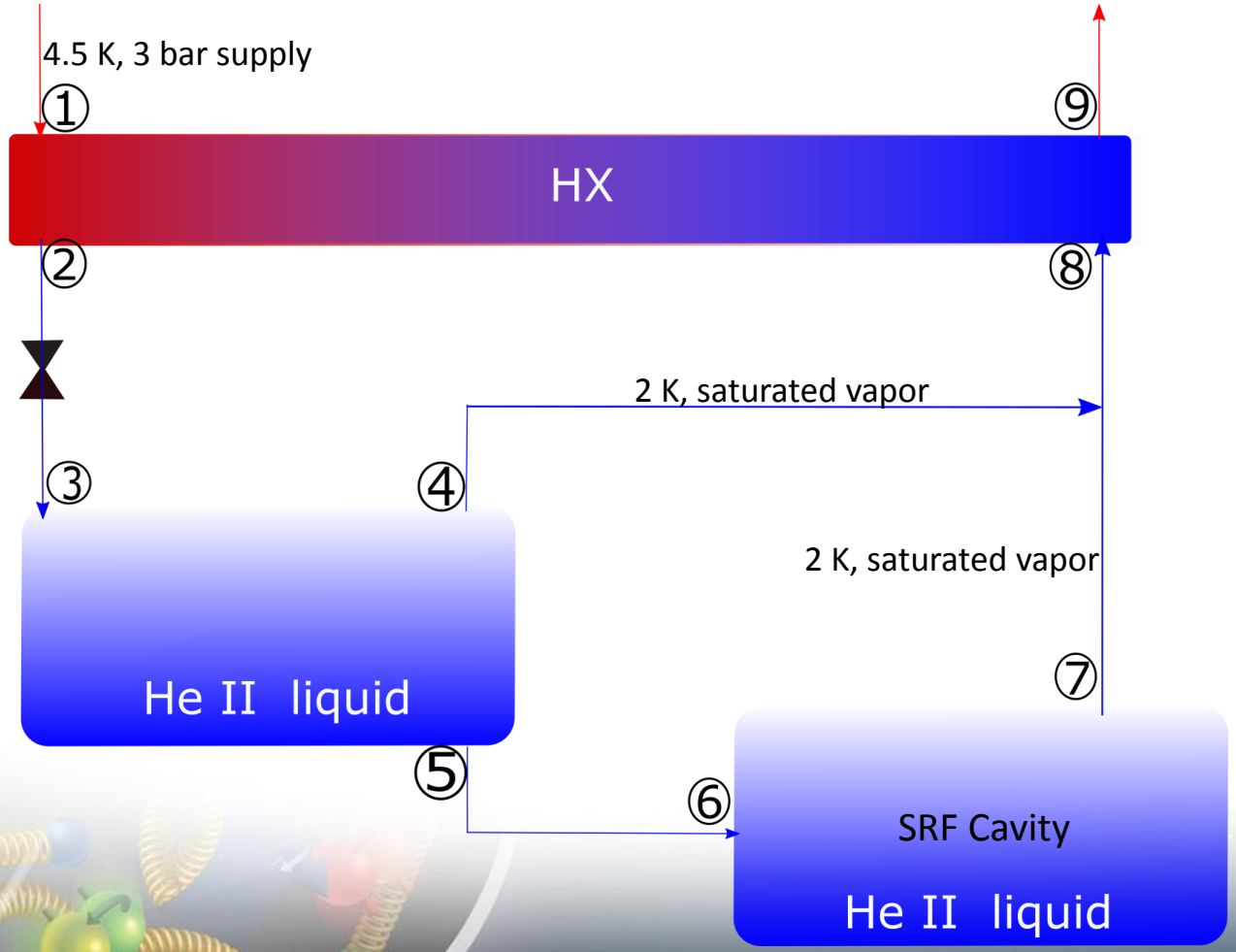
- Around 4K
- Fast (> 1Hz) pr change 0.01 – 0.05 mbar → detuning of ~20 Hz

- At 2 K
- Two phase flow
- Pressure fluctuations

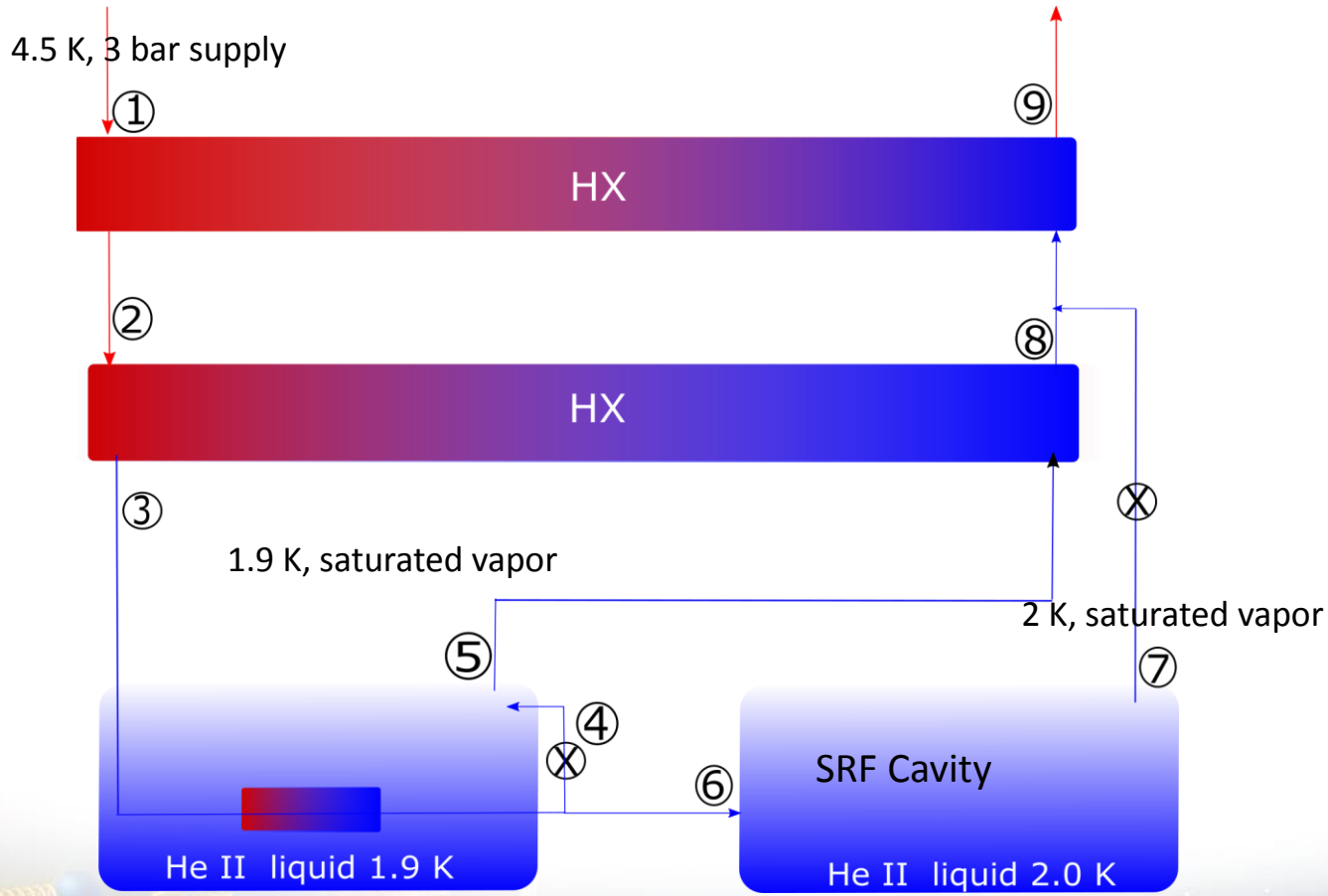
Mitigating flow induced microphonics



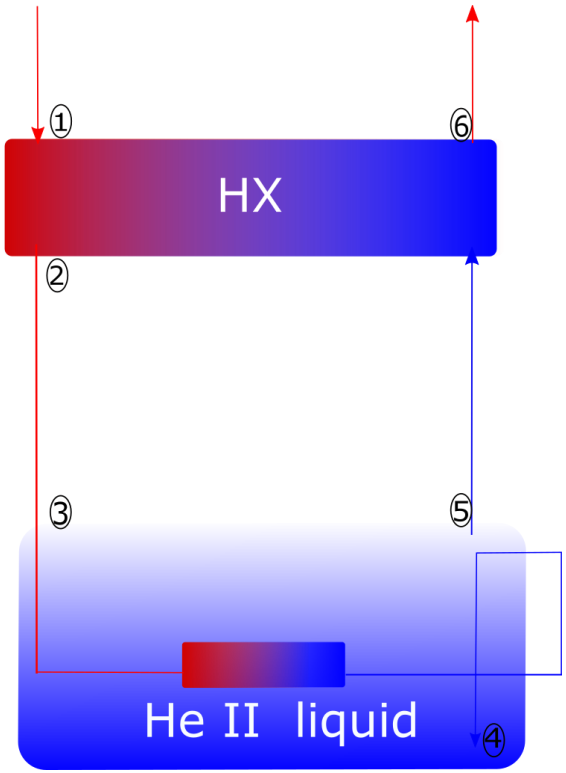
Dual bath single temperature system



Dual bath dual temperature system



Quiet Helium Source (QHS)



- Can completely suppress vapor generation if properly engineered
- Liquid head needs to be calibrated depending on the inlet enthalpy
- Liquid head is very sensitive to inlet enthalpy
- When the supply is at 4.5 K, 3 bar, a head of 5m is required to completely suppress vapor
- Workaround:
  - Throttle the flow upstream of the subcooler,
  - In the right range, J-T effect increases temperature.
  - More heat can be transferred across the subcooler as a result.
  - Other option would be to add a phase separator and supply saturated liquid at 4.5 K at point 1.
- Manuscript submitted to *Cryogenics*

Future work

- Performing feasibility studies on heat exchanger sizes and approach
- Incorporating the QHS design in eRHIC cryomodule designs
- Performing experiments to test the QHS principle.