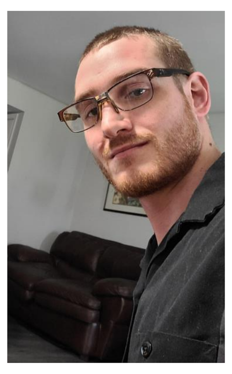
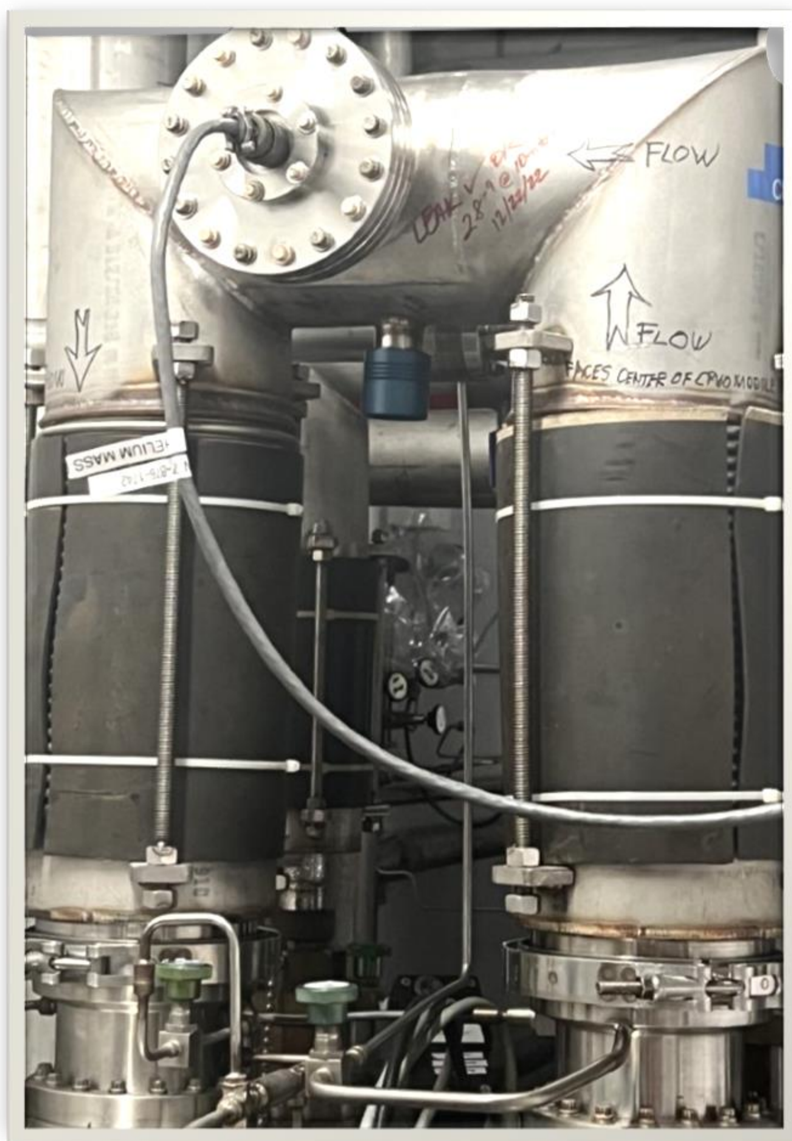


Dakota Christian

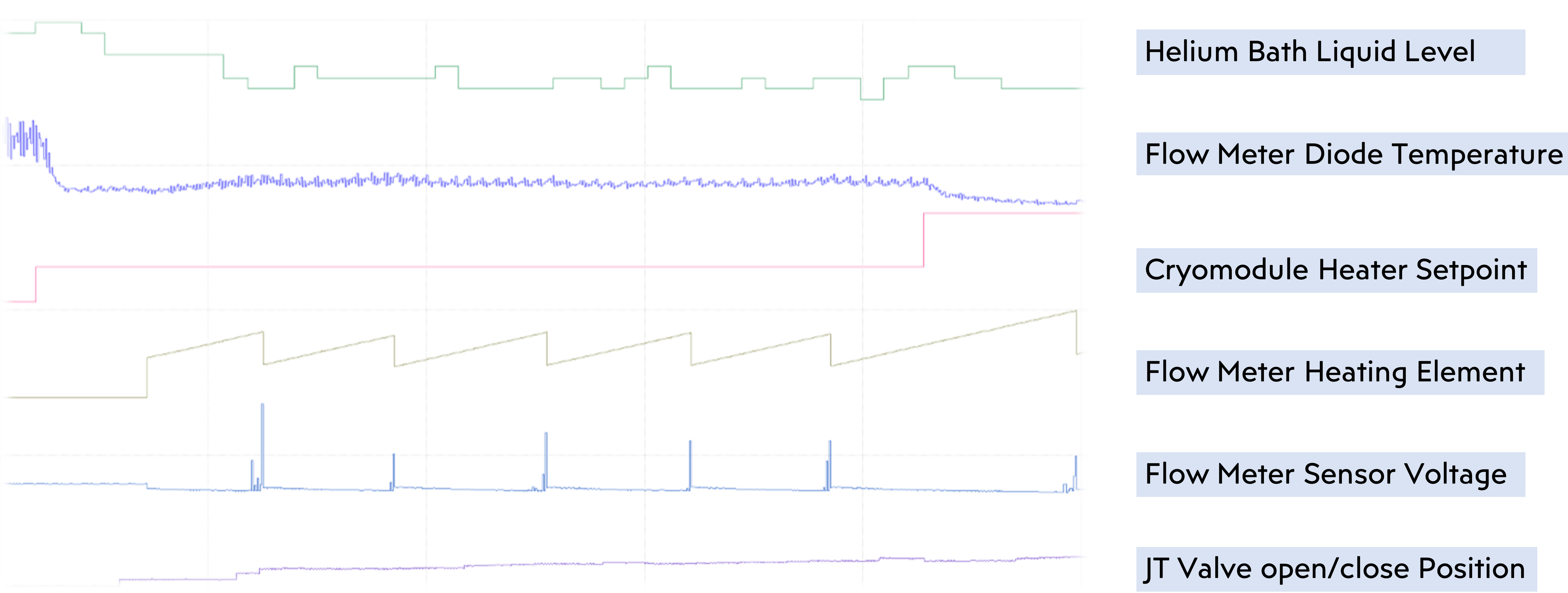
Helium Mass Flow Monitor

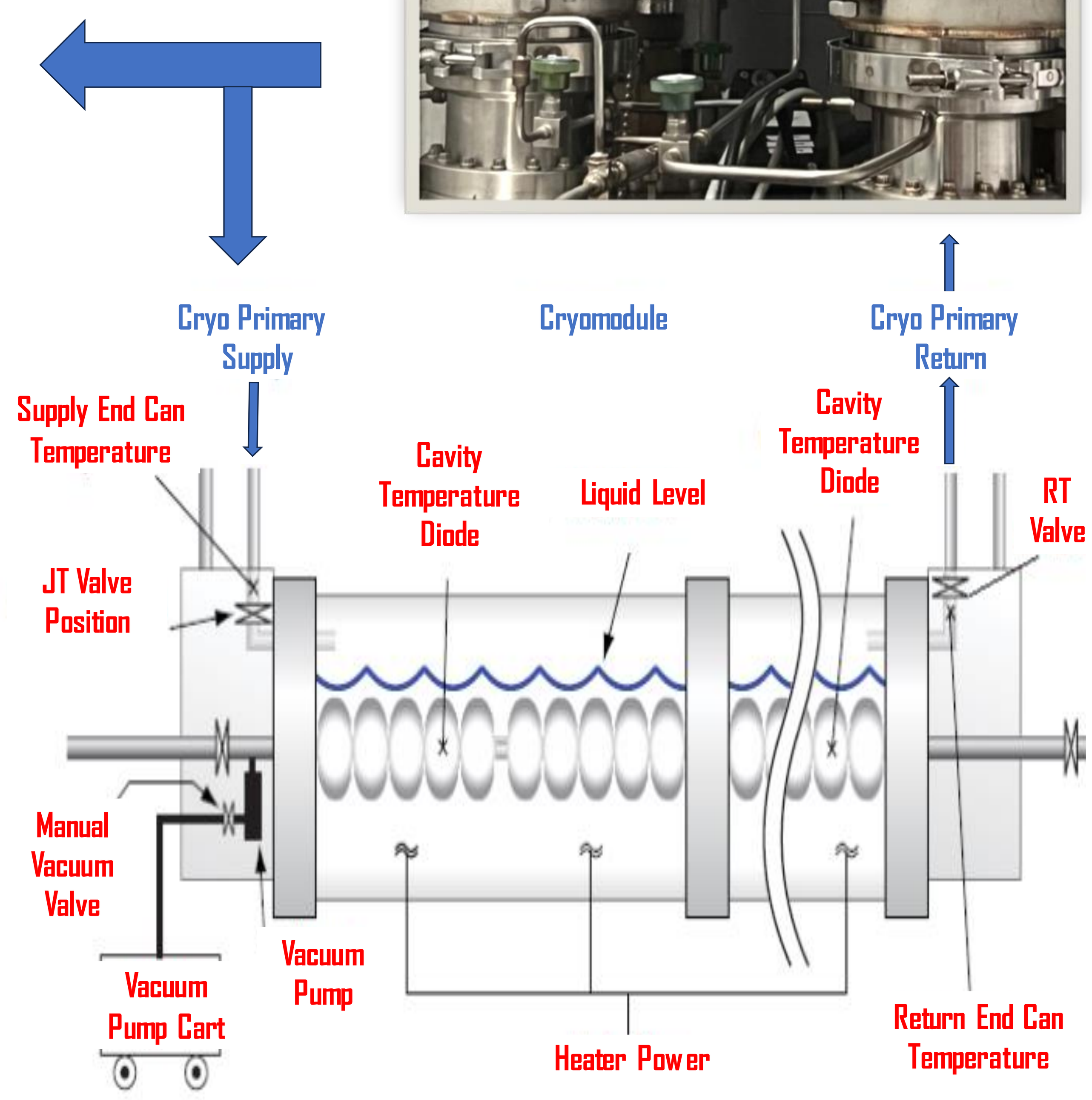
Introduction



The SBIR funded Helium Mass Flow Monitor System, developed by Jefferson Lab (CEBAF) and Hyperboloid LLC, is designed to provide real-time measurements of cavity health (Q0) within a Superconducting Radio Frequency Cryomodule. The device uses a component made of superconducting material that is cooled by a 2 K super-fluid helium bath. By varying the current of the heater our superconducting material will become non-superconducting (quench). It is at the point of superconducting to non-superconducting which correlates to the Helium Mass Flow of the system (power dissipated in the cryomodule). The Linux-based control system is an integral part of this device, providing the necessary control and data processing capabilities. The interface monitors sensor voltage, heater current, and diode temperature. From the interface, measurements are carried out in a semi-auto fashion. In unison, the flow meter and interface provide the ability to monitor the static & dynamic heat load of the CEBAF cryomodules. It will also give the ability to do rapid Q0 measurements without the need for a tunnel access.

Cryomodule Heater Calibration





Electrical Heaters + Radio Frequency (RF) + Static Environmental = Total Heat

Determining Quality Factor (Qo) of the Cavity

The quality factor (Qo) of the cavity is a critical parameter used to assess its performance and efficiency. It is defined as the ratio of the energy stored in the cavity to the energy dissipated per cycle. The energy dissipated primarily occurs due to heat losses. By knowing the RF cavity's power output and understanding the RF power input to the cavity, the Qo can be calculated using the formula

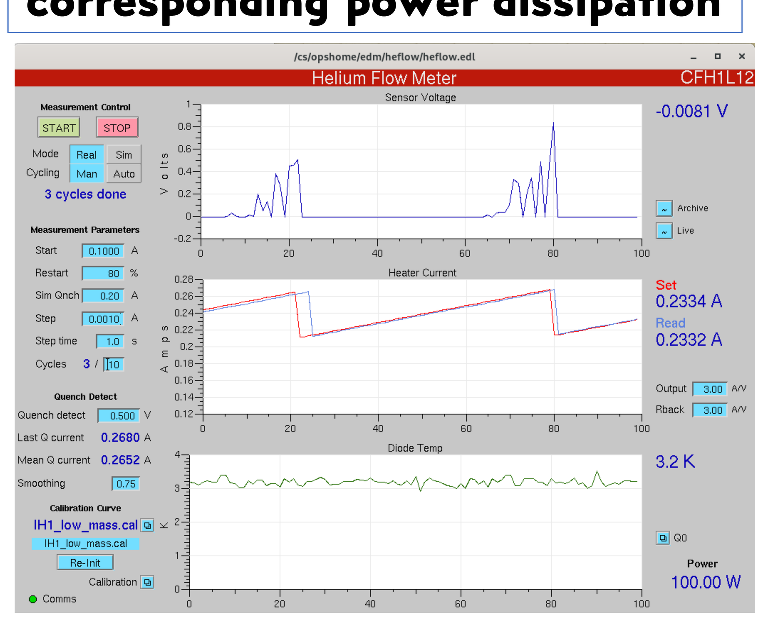
$$Qo = \frac{\text{RF Power Input}}{\text{RF Power Output} - \text{Heat Losses}}$$

Scan Me

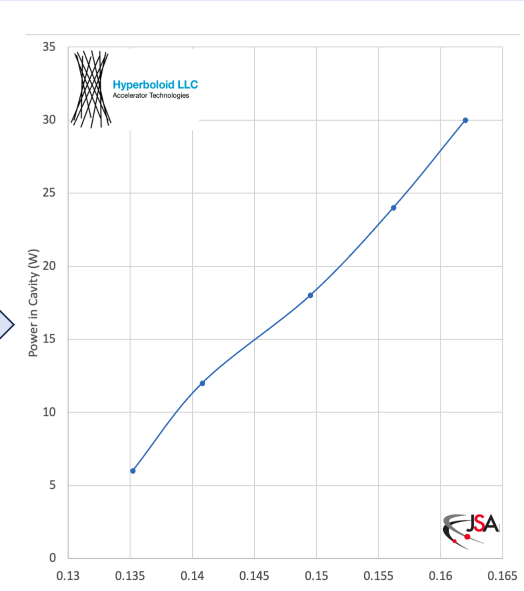
Electric heaters are used in the cryomodule to balance the heat rejection capacity and prevent liquid overfilling

Radio Frequency (RF) heat measurements are made specifically when the RF cavity is operational. By carefully measuring the temperature rise caused by the cavity's RF heat input, its power output can be determined

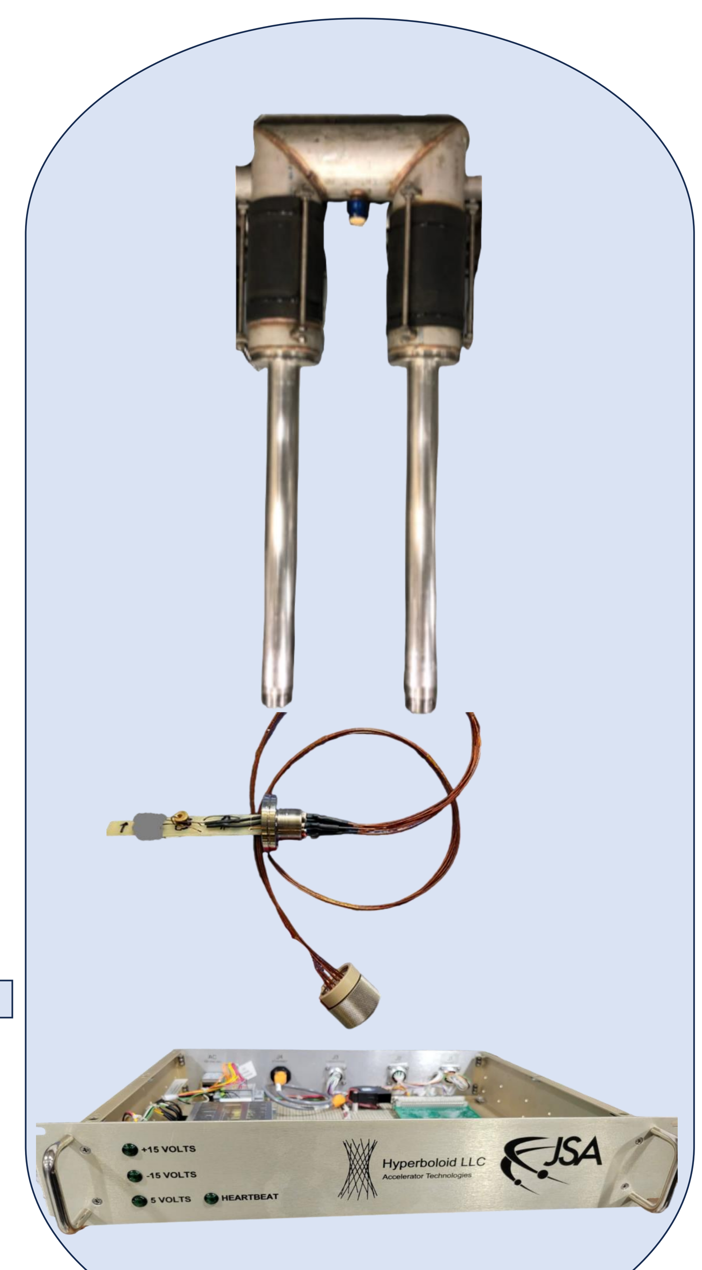
Flow Meter Screen allows users to take an averaged trip current (quench) and find the corresponding power dissipation



Calibration Curves can be generated for the entire cryomodule or for individual cryomodule cavities



Calibration Screen allows users to generate a Calibration Curve for use of finding power dissipated



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