Temperature and pressure data acquisition (DAQ) system for the AUGER-MEITNER RADIOISOTOPE MICROSCOPE (AARM)

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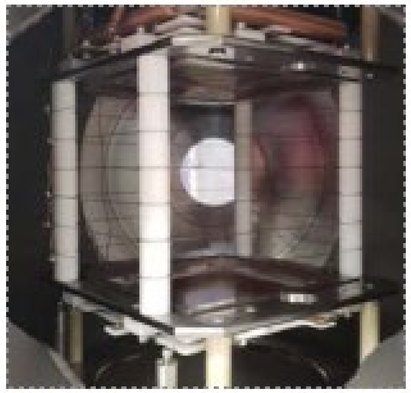
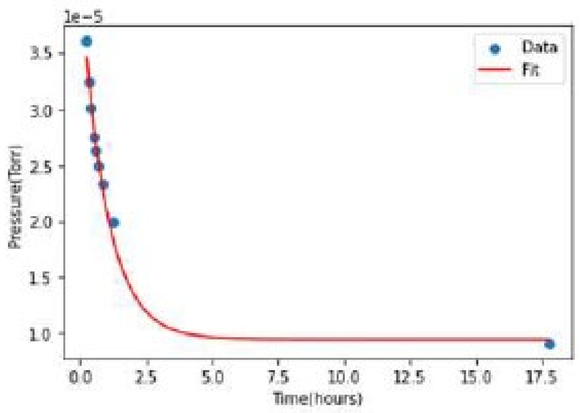
INTRODUCTION AND MOTIVATION

- The AARM is designed to create an environment where we can analyze and collect data on radioisotope Auger-Meitner emitters. The AARM encompasses many critical systems that allow it to function effectively, and the system I was tasked with building and testing was the cryogenic cooling system and vacuum system.
- The purpose of the temperature and pressure data acquisition system is to characterize and verify the environment necessary for the effective delivery of radioisotopes to the microscope (Which can be seen below). This environment includes temperatures as low as 4 Kelvin and pressures as low as 5.00e^-6 torrs.
- The AARM is expected to provide benchmark data for cancer dosimetry models relying on Auger-Meitner emitters and help inform searches for medical isotope candidates.



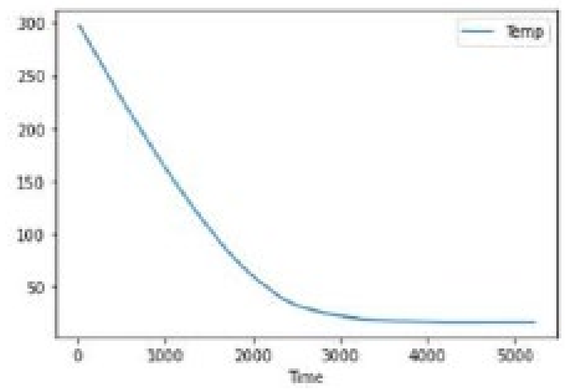
PRELIMINARY RESULTS

Pressure Sensor Results



Time (hours)

Temperature Sensor Results



Time (seconds)

CONCLUSIONS

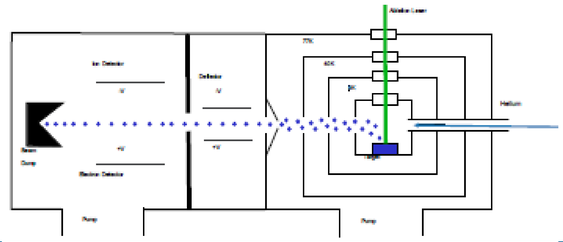
- Upon completing the assembly and rigorous testing of the various components comprising the cryogenic system, a comprehensive analysis was conducted employing the DAQ (Data Acquisition) sensor system in tandem with the ion gauge. This meticulous assessment enabled us to monitor the system's performance and effectively diagnose encountered issues, including copper internal stage oxidation, improper sensor placement, and instances of melting, among others.

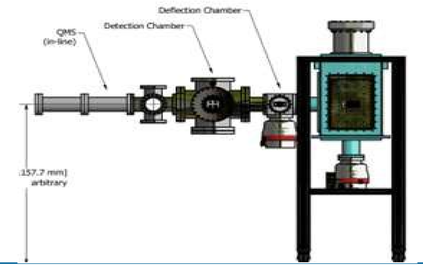
FUTURE PLANS

- Throughout the summer, I contributed to laying the project's foundation by actively participating in developing the cryogenic system. Once successfully completed, this system will facilitate the seamless transportation of radioisotopes to the microscope, enabling precise and comprehensive analysis. The project's completion holds immense potential for revolutionizing cancer treatment.

EXPERIMENTAL METHODS

- Ion Gauge Sensor: The Ion Gauge Sensor provides incremental pressure readings for astrometric pressure measurements within a vacuum environment.
- Temperature Sensors: Specifically engineered to operate under freezing temperatures, these sensors are designed to detect temperatures as low as 4 Kelvin.
- Cryogenic Pump: The Cryogenic Pump generates cold air and contains helium, enabling a cryogenic environment.
- Cold Head: The Cold Head effectively extracts heat from the vacuum chamber, facilitating the introduction of cold air generated by the Cryogenic Pump.
- Stages of Boxes: The vacuum chamber consists of multiple stage components in boxes. The outer box is constructed from steel and maintains room temperature conditions, while the intermediate aluminum box achieves temperatures as low as 50 K. The innermost copper box reaches an impressively low temperature of 4 Kelvin.
- Vacuum Pump: Utilizing a spinning blade mechanism, the Vacuum Pump efficiently removes air from the vacuum system, creating the necessary low-pressure environment.





EXPERIMENTAL DEVICE METHOD PHOTOS

REFERENCES AND ACKNOWLEDGEMENTS

- This work is supported in part by the Horizon-broadening Isotope Production Pipeline Opportunities (HIPPO) program, under Grant DE-SC0022550 from the Department of Energy's Isotope R&D and Production Program.
- The Buffer Gas Beam: An Intense, Cold, and Slow Source for Atoms and Molecules it Nicholas R. Hutzler*, Hsin-I Lu*, and John M. Doyle*