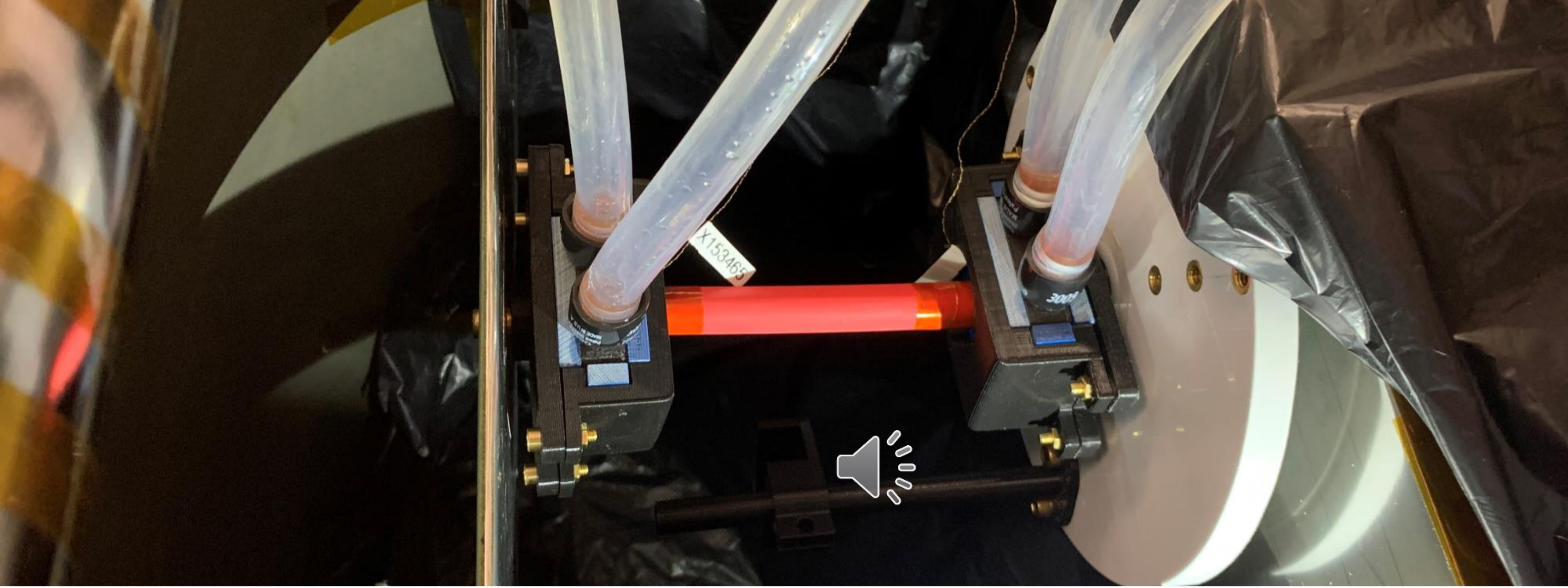

Virtual Research Presentation Conference

Characterization and Mitigation of Thermostatic Magnetic Interference for On-board Magnetometers

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Program: Innovative Spontaneous Concepts

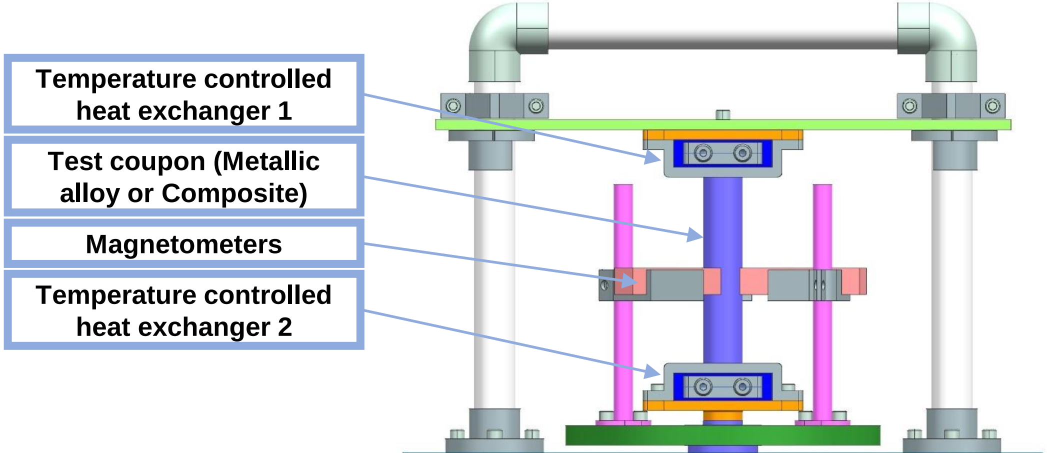
Assigned Presentation #RPC-212

Jet Propulsion Laboratory
California Institute of Technology

Tutorial Introduction

Abstract: To date, there does not exist adequate understanding of the thermostatic magnetic effect induced by temperature gradient in metal alloys. Magnetic noise induced by temperature gradient in magnetometer interfaces jeopardize the success of a mission. In this study, an experimental setup was designed and fabricated to characterize the magnetic disturbances caused by a temperature gradient in selected metal alloys and composites. A magnetically isolated chamber with ±50pT accuracy and TwinLeaf VMR Magnetoresistive Vector Magnetometer with ±1nT measurement sensitivity are used to provide accurate magnetically clean measurements. A steady state uniform temperature gradient was imposed in the test coupons, and an induced magnetic field was measured in the axial and angular directions.

Characterized data will directly impact the design of next-generation planetary magnetometers for demanding, high radiation environments and will provide unique insights that lead to specific guidelines to alleviate magnetic interference independent of material selection.



Thermostatic Magnetic Test Setup Design

Problem Description

a) **Context (Why this problem and why now):** State of the art planetary magnetometers are becoming ever more sensitive to magnetic fields. Previous magnetometers, used on Pioneer, Voyager, and Mariner were only sensitive to up to 100s pT/√Hz field fluctuations. Newer instruments, used on Cassini, SWARM, ICEMAG, and Psyche are able to achieve higher sensitivity in the order of 10s of pT/√Hz. At this high sensitivity, though, very small temperature variation can rapidly dominate measurements. In a conductive material, a static temperature gradient will produce an electric current, which then induces nanoTesla (nT) order magnetic fields. This creates errors up to two orders of magnitude higher than the sensitivity of the instrument.

b) **SOA (Comparison or advancement over current state-of-the-art):** To date, there does not exist adequate understanding of the thermostatic magnetic effect induced by temperature gradient in metal alloys. Tests setup designed and assembled under this task is the first test setup creating a stable temperature gradient across the sample.

c) **Relevance to NASA and JPL (Impact on current or future programs):** Characterized data will directly impact the design of next-generation planetary magnetometers for demanding, high radiation environments and will provide unique insights that lead to specific guidelines to alleviate magnetic interference independent of material selection.

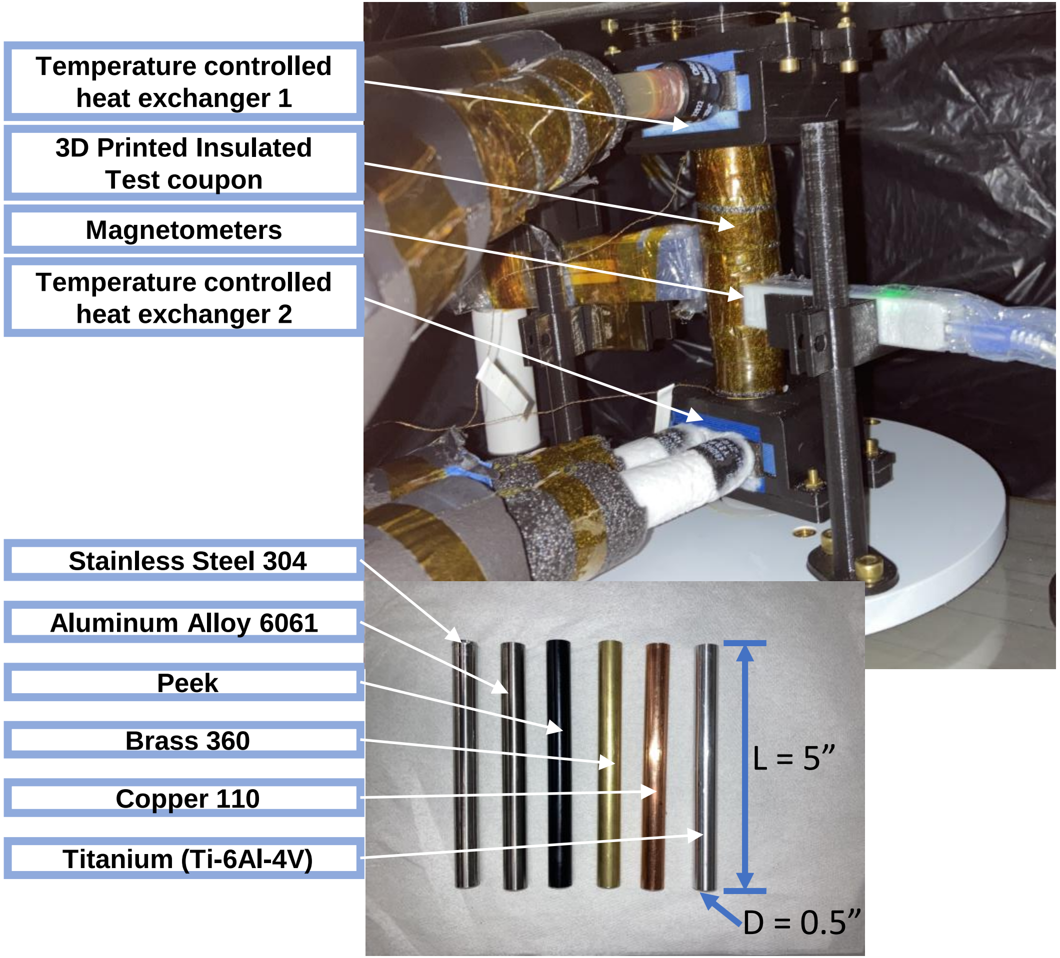
Methodology

a) Formulation, theory or experiment description

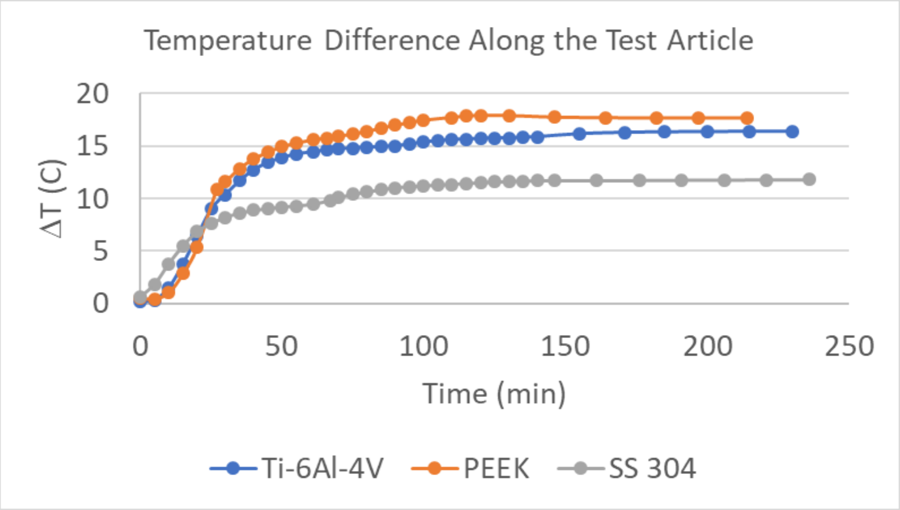
- Design and test setup implementation with a magnetically clean chamber.
- Fabricate 3D printed rods (Ti, Al, Cu alloys, silicon carbide, and carbon loaded PEEK in circular, and elliptical cross-sections).
- Samples will be subjected to temperature differentials while are thermally insulated to impose a uniform temperature gradient.

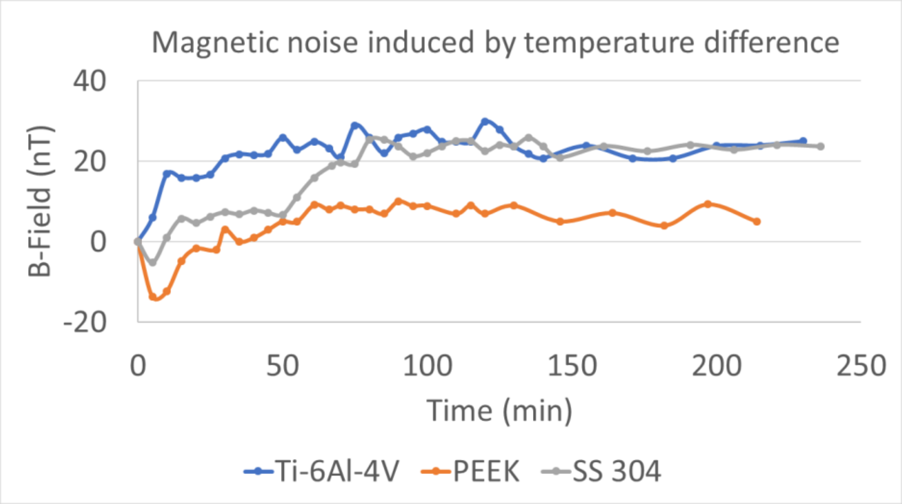
b) Innovation, advancement

- Provide the first test setup creating a stable temperature gradient across the sample for thermo-magnetic induced noise measurement.
- Provide specific guidelines to reduce magnetic interference due to thermostatic in magnetometers by one to two orders of magnitude.



Results





Temperature Difference across the samples kept in the same order of magnitude.

Steady state criteria 0.1°C/hr to 0.3°C/hr

Magnetic Field magnitude increases as the temperature difference across the sample increases. Peek shows the lowest magnetic noise induced by temperature difference.

*Magnetic field was measured with an offset of 1.2 inches for the outer diameter of the sample

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