Advanced Propulsion Physics Lab: Eagleworks Investigations

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Abstract

Eagleworks Laboratory is an advanced propulsions physics laboratory with two primary investigations currently underway. The first is a Quantum Vacuum Plasma Thruster (QVPT or Q-thrusters), an advanced electric propulsion technology in the development and demonstration phase. The second investigation is in Warp Field Interferometry (WFI). This is an investigation of Dr. Harold "Sonny" White's theoretical physics models for warp field equations using optical experiments in the Electro Optical laboratory (EOL) at Johnson Space Center. These investigations are pursuing technology necessary to enable human exploration of the solar system and beyond.
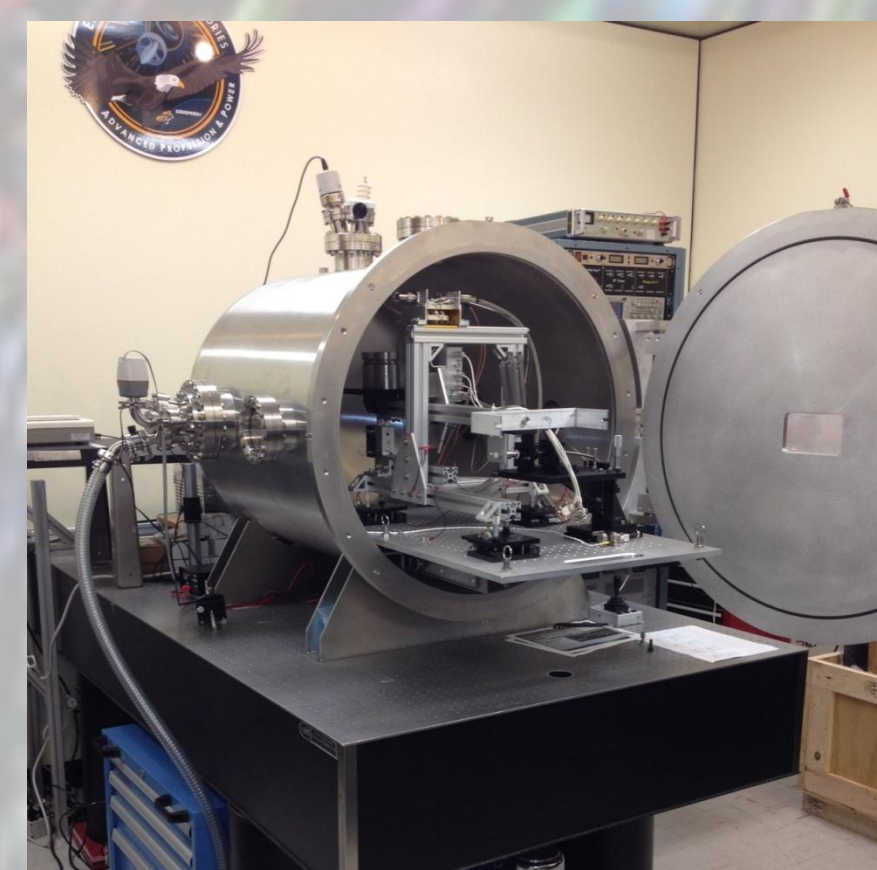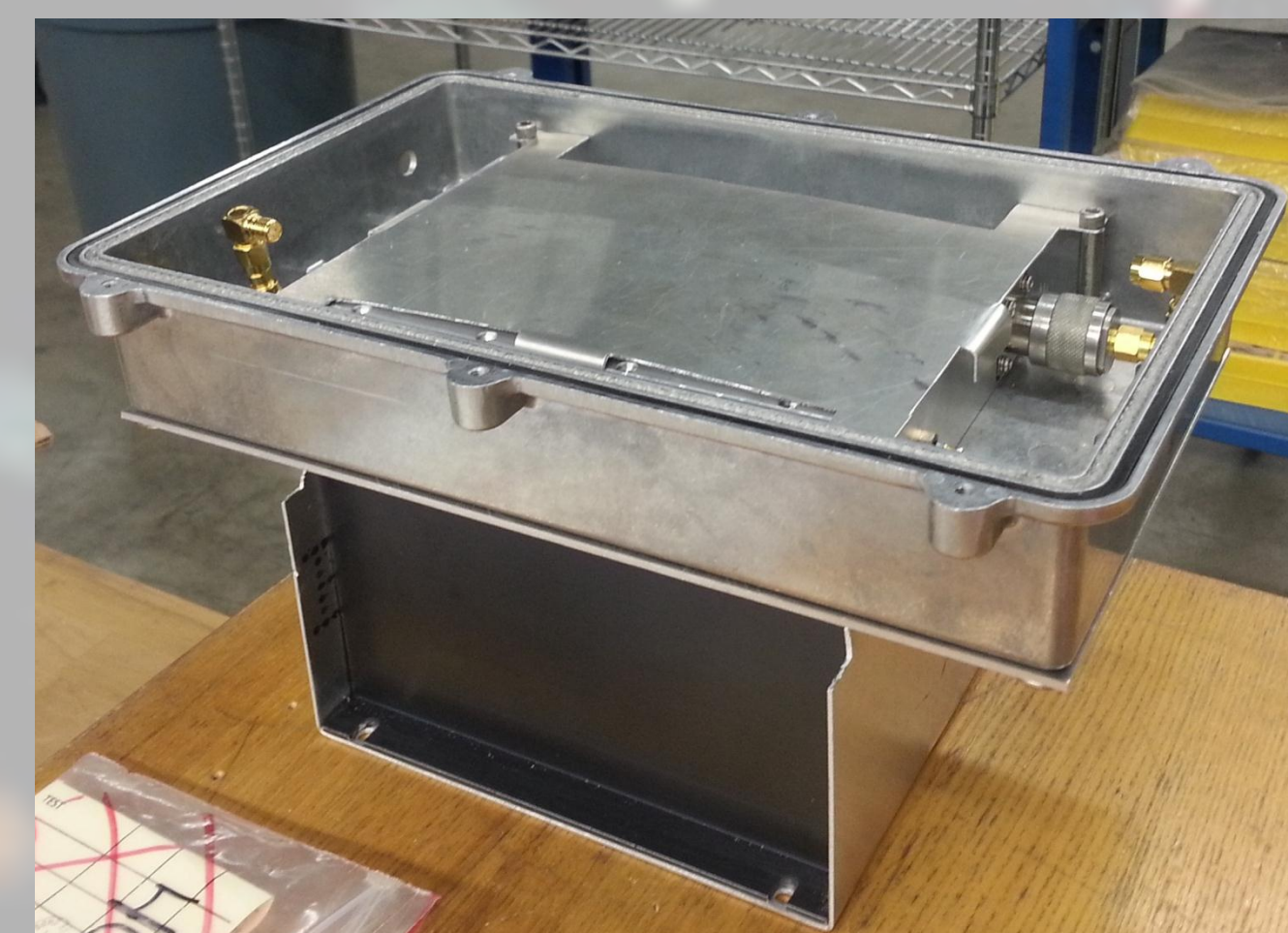
QVPT Background

The Quantum Vacuum Plasma Thruster (Q-thruster) takes advantage of the sea of virtual particles in the quantum vacuum (lowest state of the electrodynamic field) by exposing the virtual plasma to a crossed E and B field. This induces a plasma drift of the entire plasma in the E x B direction (orthogonal to applied fields) which can be used for thrust. While a normal plasma thruster requires some form of propellant, a Q-thruster uses quantum vacuum fluctuations for the fuel source and has no need to carry a consumable propellant onboard. Eagleworks uses a torsion pendulum in a vacuum chamber to measure ultra-low thrust levels from Q-thruster test articles.

WFI Background

The Warp Field Interferometry (WFI) aims to explore Dr. White's theoretical models on a fundamental physics basis. Based on the canonical form of the Alcubierre metric, it may be possible to engineer spacetime. This could be achieved by generating a small spherical region of optical distortion that would change the path length for a transiting photon. The small warping of space is to be demonstrated via a lab experiment that uses a capacitor ring of positive energy density normal to a He-Ne laser beam pathway. The original experimental test setup aimed to measure this warping by applying a He-Ne laser through this portion of space to a detector camera on the opposing end. If the experiment is able to successfully perturb spacetime in this region, an optical interference fringe pattern will be detected.
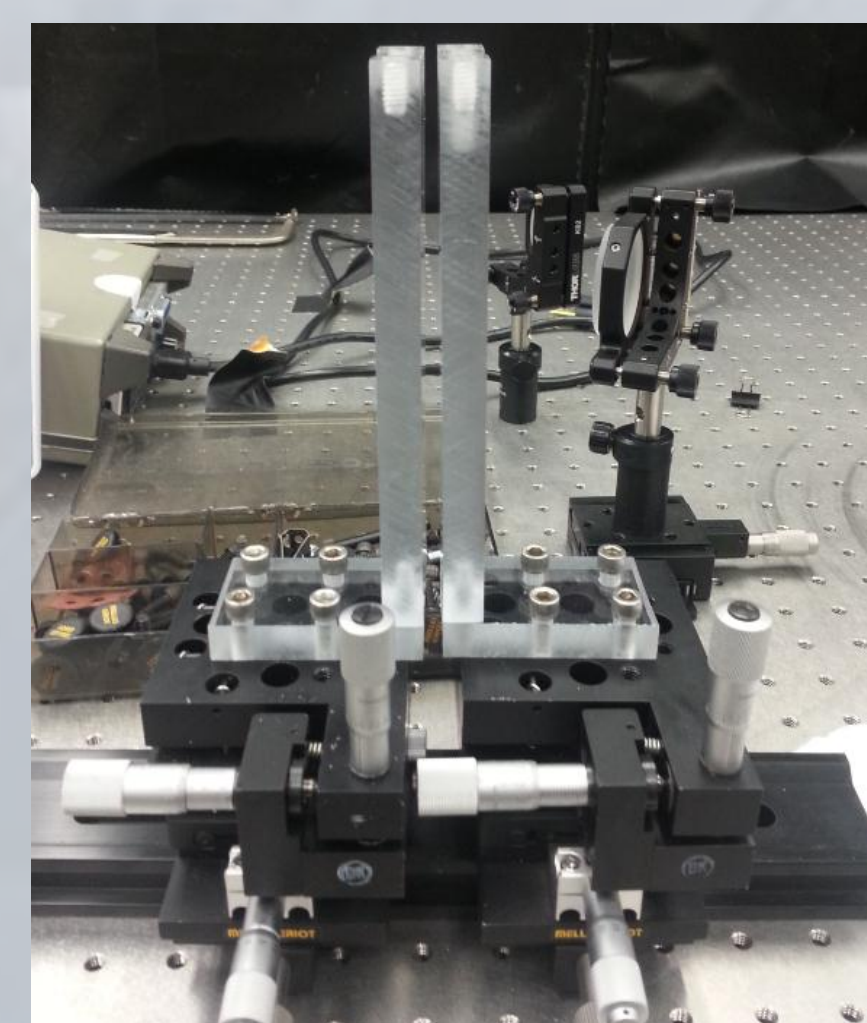
Primary Projects

Quantum Vacuum Plasma Thruster Project:
Amplifier Heat Sink Containment for Vacuum Application

- Q-thruster test articles are going to be tested in a vacuum to reduce possibility of air currents polluting the thrust signal during testing, but electrolytic capacitors in signal amplifier are not vacuum compatible
- Amplifier expected to heat up drastically during power on cycles; needs to be cooled by a heat sink
- Aluminum container was modified to hold an amplifier and maintain pressure of 14.7 psi. Clamping systems hold the amplifier down for efficient heat transfer and to prevent sliding of the amplifier during transport or from exterior movement of the container
- Heat sink was fitted with a tri-fold aluminum piece to contain a phase-change material such as paraffin wax
- As amplifier heats up, energy is transferred conductively through container to the heat sink fins. The heat sinks fins transfer heat to the phase-change material so it converts from solid to liquid phase, then cools and re-solidifies during the off-duty period of the cycle.


Ultra-low thrust torsion pendulum and vacuum chamber in Eagleworks Lab

Warp Field Interferometry Project:
Open-air etalon mirror mounting with solenoid and WFI Enclosure

- New WFI experiment uses 5mm diameter open-air etalon mirrors to reflect light beam between two surfaces for longer path without potential piezoelectric interference frequencies from previous experimental configuration
- Magnetic field generated by test article could be affected by metals, so non-ferrous mounting required
- Polycarbonate mounting rods with cylindrical mirror fittings were machined, mounted on 6-axis degree of freedom (DOF) optical surfaces
- New optical enclosure required to prevent air currents resulting in vibrations that could affect beam detection
- 80/20 aluminum frame with doors designed and built for easy of access for future test configurations
- Dark matte on inside surface of panels allows for diffusion of light and thus minimum reflection of scattered light near testing platform

Polycarbonate mounts and platforms for minor adjustments in alignment
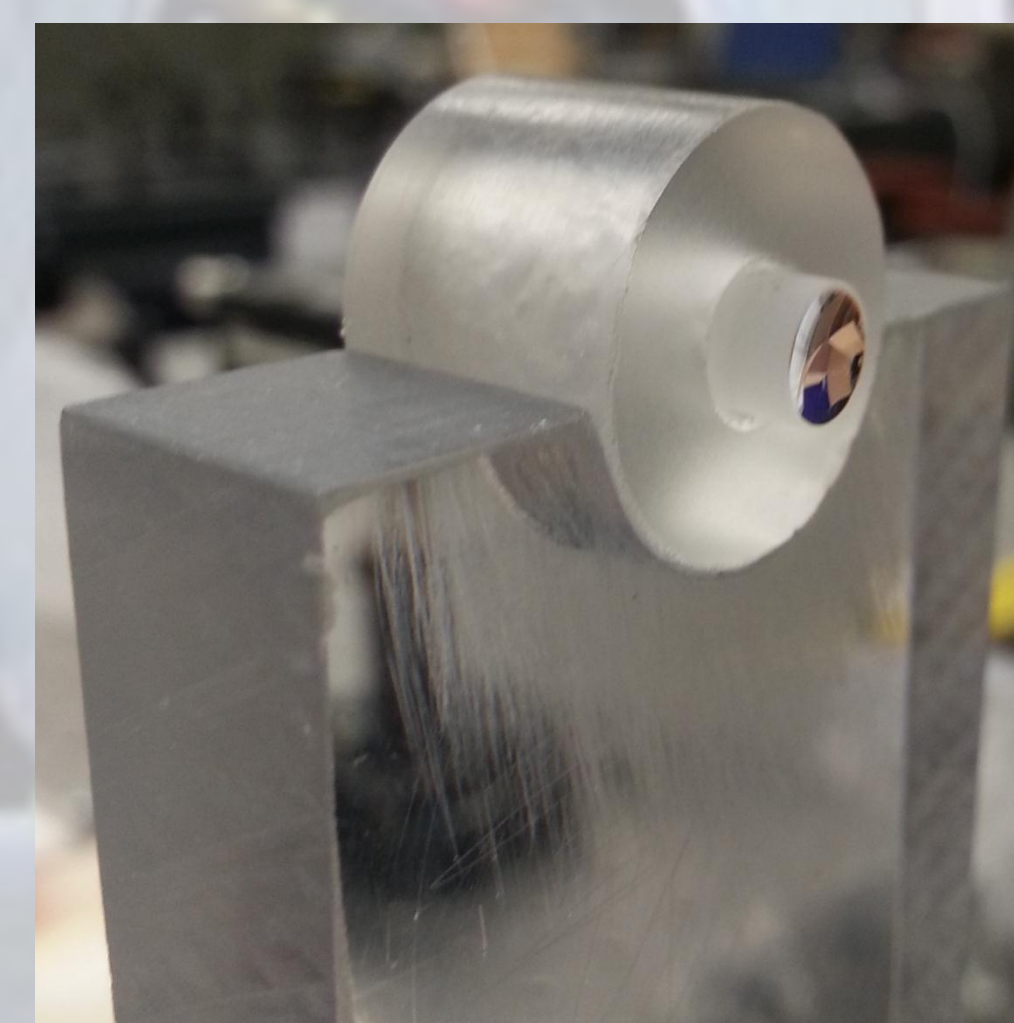
Open-air etalon mirror, 5mm diameter on polycarbonate mounting

Warp Field Interferometry enclosure under construction

Secondary Projects

Copernicus

- Copernicus is a mission architecture design tool used for trajectory analysis for a potential mission to Mars using QVPT engines compared to conventional chemical or ion engines systems
- Copernicus takes the user's input state variables and spacecraft conditions between two points called nodes to create segments
- Multiple segments create a trajectory as Copernicus uses a solver to optimize the solution to a minimum number of days for a mission to Mars and back

Future Work

Quantum Vacuum Plasma Thruster

- Seal heat sink container with epoxy, implement pressure transducer, test in vacuum chamber for effectiveness

Warp Field Interferometry

- Build a solenoid to induce the needed magnetic field to perturb the space that the laser travels through
- Complete tests on open-air etalon mirror configuration with solenoid between mirrors, then with the solenoid encasing both mirrors
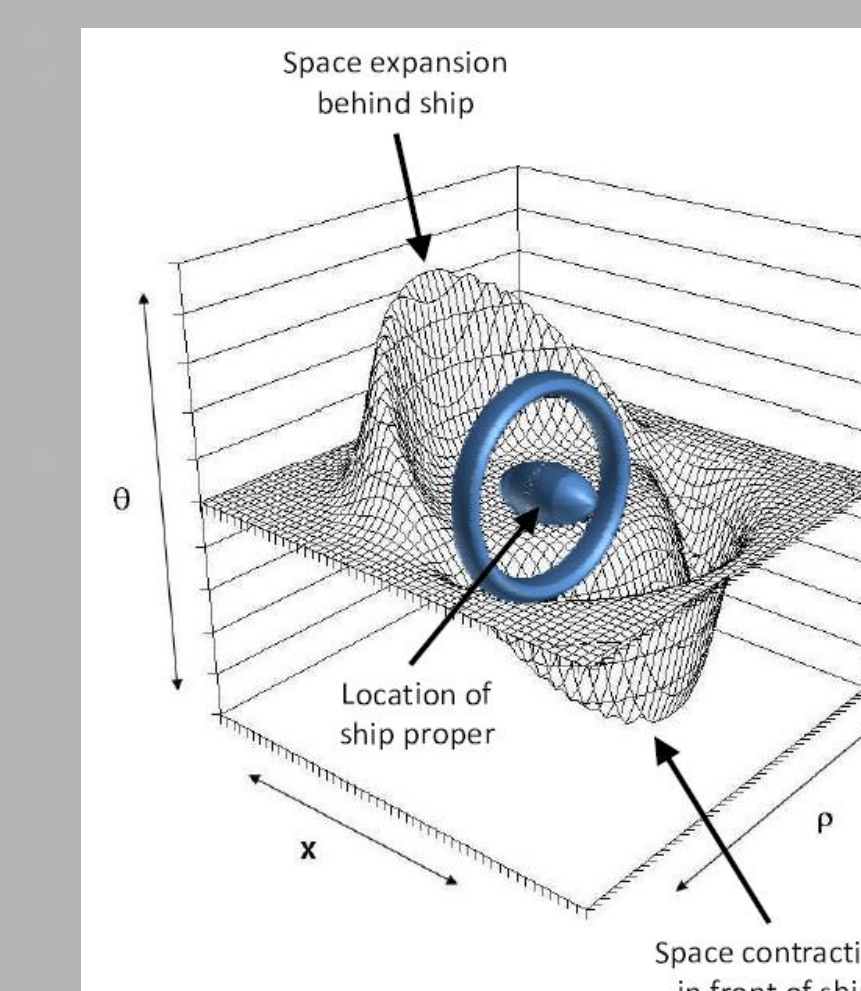
Inflation of space in the Alcubierre Metric

Acknowledgements