Strofio: A Status Update J. L. Schroeder[1,2], S. Livi[2,1], F. Allegrini[2,1], [1]The University of Texas at San Antonio, 1 UTSA Circle, San Antonio, TX 78254 (jared.schroeder@contractor.swri.org), [2]Southwest Research Institute, 6220 Culebra Rd, San Antonio, TX 78238

Introduction: The exosphere of Mercury is a tenuous and volatile environment that holds crucial information about the planet's surface. We study this environment for two main reasons: 1) The constituents within this envelope of gas originate from the surface via processes such as photon-stimulated desorption, thermal evaporation, ion sputtering, and meteoroid impacts [1,2,3]. Thus, a fundamental understanding of this region also gives us insight into the surface composition itself. 2) The change in chemical composition over time provides us with information on how the planet evolved and will continue to evolve. To study the chemical composition of Mercury's exosphere, we will send the instrument Strofio as a payload of the BepiColombo mission.

Instrumentation: Strofio is a neutral mass spectrometer that utilizes a time-of-flight (TOF) technique to determine the mass-per-charge (m/q) of neutral species. The design is simple (Fig. 1): Neutral particles enter the instrument through one of two inlets before they are ionized via electron impact. Each source is equipped with a velocity filter to ensure the particles have an exospheric origin. The product ions are then guided by dozens of individually programmed electrodes toward the detector. A rotating electric field determines the TOF of each particle before they collide with a microchannel plate (MCP). Strofio is a member of the Search for Exospheric Refilling and Emitted Natural Abundances (SERENA) instrument suite equipped on the Mercury Planetary Orbiter (MPO). MPO will make orbital insertion in December 2025 where it will remain for a one-year mission duration.

Problem: Immediately following launch, one of the system's electrodes (D5) suffered an anomaly that disrupted communications between the commanded value and the value reported in telemetry. This particular electrode is responsible for steering the particles into the MCP. While this does not affect system resolution or sensitivity, it has significant implications for the TOF of each particle. In order to ascertain the voltage of D5, laboratory testing is required

Tests: Flight tests are limited due to the preservation of spacecraft power. Therefore we must test the flight model through the use of an engineering model (EM) in the laboratory. This method can be cumbersome and time-consuming so we've developed a simulation to assist us when applicable.

Flight tests are usually conducted in the form of voltage scans. We start with the best configuration from initial optimization and scan one or more electrodes to visualize the response of the detector. The test is repeated on the EM with a predetermined value of D5. The goal is to obtain a direct comparison between the response of the engineering and flight model. If a one-for-one comparison can be made then we know the voltage of D5.

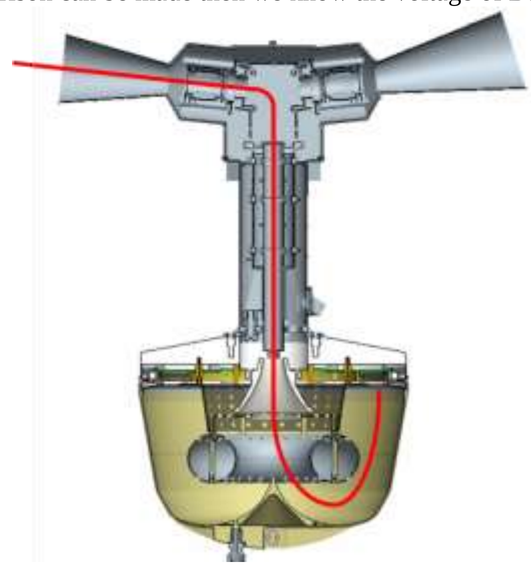

Figure 1: A cross-sectional model of the Strofio instrument. The particle's trajectory is represented by the red line.

Additional Remarks: There are two modes in which the instrument operates: thermal and beam. Thermal mode refers to the configuration that targets outgassing species. These particles originate in the spacecraft reference frame and can be modeled strictly by their thermal velocity components. On the other hand, the beam configuration accepts particles with equal but opposite velocities to the spacecraft. MPO is expected to fly a 400 x 1500 km orbit with an average speed of 3km/s. In beam mode, particles that do not meet the velocity threshold will be rejected via the internal velocity filter.

The flight model does not have access to open space while BepiColombo is in transit because Strofio is installed between MPO and the Mercury Magnetospheric Orbiter (MMO). Once the spacecraft arrives at Mercury, these orbiters will separate and our unit will be exposed. As a result, the data we receive at this time is mostly a result of spacecraft outgassing and can be modeled under the thermal mode.

Conclusion: Laboratory tests with the engineering model confirm mission requirements are satisfied regardless of the electrode state with the caveat being a reduced first-order mass range. However, second-order manipulation can extend the mass range to pre-anomaly standards. We will present the latest advances we have made in optimizing the instrument in its current state.

References: [1] Wurz P. et al. (2010) *Planet. Space Sci. 58*, 1599–1616. [2] Killen R. M. et al. (2010) *Icarus 209(1)*, 75. [3] Berezhnoy A. (2018) *Icarus 300*, 210-222.