HIGH SPEED AND ACCURATE PRESSURE MEASUREMENT WITH A MEMS PIRANI PRESSURE GAUGE FROM 100 TO 0.1 MTORR IN SUPPORT OF MOMA-MS. A. E. Southard[1], Tomoko Adachi[2], Gary Brown[3], Zach Gonnsen[3], Christopher Johnson[3], Ricardo Arevalo[3]. [1]University Space Research Association (Adrian.e.southard@nasa.gov), [2]Catholic university, [3] Nasa Goddard Space Flight Center

Introduction: Mass spectrometers typically operate at low pressures to prevent damage to sensitive detectors and filaments that operate at high voltage. Thus, analysis of the organic content of planetary environments with thicker atmospheres (pressures > 0.1 torr) require stages of pressure reduction accomplished through the use of large vacuum pumps and/or restrictors to limit vacuum conductance. Alternatively, a valve with higher vacuum conductance inlet can be pulsed open. This is especially useful when ions have a limited lifetime and should be trapped and analzed as soon as possible after they are formed. This requires an accurate pressure gauge with a fast response time.

Recent improvements in the sensitivity of a MEMS pirani sensor have extended the operational range of these gauges into the µTorr regime [1]. These gauges are very small (size of a transistor can) and use only 300-600 µWatts making them ideal candidates for small, hand-held mass spectrometers and/or instrumentation for planetary exploration .However, the response time of the gauge is limited by its heat capacity since pressure measurements drift until the gauge has reached thermal equilibrium with its surroundings. We demonstrate an approach to improve response time of such a gauge and demonstrate its readiness for use in the MOMA ion trap mass spectrometer, a key scientific instrument on the 2018 ExoMars rover.

MOMA mass spectrometer:
The MOMA mass spectrometer[2] is part of the suite of instruments on the 2018 ExoMars rover lead by the ESA. Its goal is to search for the existence of past of present life on Mars. The ExoMars rover will be the first rover to house a drill that is 2 meters in length for extracting specimens of Martial soil at depth.The MOMA mass spectrometer utilizes an ion trap and mass analysis scheme that utilizes high RF and DC voltages to perform mass analysis of organics extracted by the drill or on the surface; therefore, it must operate at pressures low enough to prevent arcing which could damage the dynode and electron multiplier used in the spectrometer and prevent unnecessary wear on a filament used to perform electron ionization with the spectrometer. The MOMA mass spectrometer will be the first to employ laser desorption ionization (LDI) on the Martian surface. This process, in brief, begins when a laser ionizes Martian regolith on the surface or from a drilled sample. Immediately after, a valve briefly opens to allow Martian atmosphere and entrained ions into the vacuum chamber. Before the MOMA mass spectrometer can analyze the ions formed, the pressure must be reduced from about 0.1 torr to under 5E-4 torr. The MOMA mass spectrometer also has a mode of operation that uses a gas chromatograph in conjunction with the ion trap. In this mode, pressures must not exceed 1E-3 torr within the mass spectrometer.

Methods: Commercial micro Pirani gauges provided by Heimann (k type) have been calibrated for the MOMA instrument to accurately and precisely predict pressure over the range of 0.2 torr to 1E-4 torr, over a spectrum of temperatures (-20 to 80 °C). The gauge is calibrated in CO_2 gas (Martian atmosphere is 96% CO_2) and He gas (used during pyrolysis/gas chromatography mass spectrometry). A prototype control circuit has been used to dynamically (Figure 1) and statically test calibrated gauges under a variety of environmental conditions to mimic flight-like operations. The gauge has already been qualified for space flight through vibration, shock and noise susceptibility tests and lifetime tests are underway to trend drift in calibration parameters of the gauge.

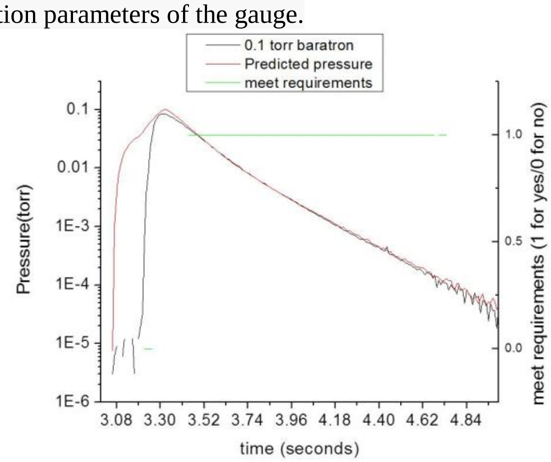

Figure 1 The predicted pressure (red) matches the pressure reading of a reference gauge (black) and meets flight requirements throughout the designated range (green).

References:
[1] Volklein, F. (2013) *J. Vac. Sci. Technol. A 31*, 061604 [2] Brinckerhoff, W.B.; *et al.* (2013) *Aerospace Conference, 2013 IEEE* , vol., no., pp.1-8