Advanced Automatic Gain Control Algorithms for use in the MOMA Mass Spectrometer

R. M. Danell[1], A. Grubisic[2], F. H. W. van Amerom[3], V. T. Pinnick[2], T. Nolan[4], S. S. Larson[4], E. I. Lyness[4], R. D. Arevalo, Jr.[4], S. A. Getty[4], W. B. Brinckerhoff[4], P. R. Mahaffy[4]

[1]Danell Consulting, Inc, Winterville, NC; [2]Center for Research and Exploration in Space Science and Technology (CRESST), University of Maryland, Baltimore County, MD; [3]Mini-Mass Consulting, Hyattsville, MD; [4]NASA Goddard Space Flight Center, Greenbelt, MD

The Mars Organic Molecule Analyzer (MOMA) is an instrument based around a linear ion trap (LIT) mass spectrometer configured with two complementary ion sources - electron ionization (EI) and laser desorption ionization (LDI). The complete instrument is a joint development between NASA and teams in Germany and France and is a key component of the 2018 ExoMars rover. One of the main goals of this mission is the search for molecular “signs of life”. MOMA’s mass analysis of volatile and non-volatile species will play a key role in achieving this goal. However, automated control of ion trap loading is necessary to obtain optimal mass spectral performance when analyzing what are essentially unknown samples. If there are too few ions, the signal-to-noise ratio (and detection limit) will suffer. If there are too many ions, space charge conditions can cause peak broadening and/or mass shifts. Most ion traps are operated with some form of automatic gain control (AGC), but the GC and LDI modes of MOMA each require specialized algorithms to achieve the desired performance. For the GC mode of operation, the goal of tracking a narrow peak has required the application of proportional-integral-derivative (PID) control theory and the use of three orthogonal parameters within the EI source to control the ion flux into the trap. This combination can produce an effective dynamic range of six orders of magnitude while tracking GC peaks with base-widths on the order of one second. For the LDI mode of operation, both the laser pulse energy and the number of laser shots per burst need to be optimized in order to manage the highly variable interactions of the laser photons with heterogeneous geological samples. Details of these AGC algorithms along with performance results on Mars analog samples will be presented.