Study of Static Microchannel Plate Saturation Effects for the Fast Plasma Investigation Dual Electron Spectrometers on NASA's Magnetospheric MultiScale Mission

L.A. Avanov[1, 2], U. Gliese [1, 3], C.J. Pollock[1], T.E. Moore[1], D.J. Chornay[1, 2], A.C. Barrie[1, 4], J.T. Kujawski[1, 5, 6], D.J. Gershman[1, 7], C.J. Tucker[1, 8], A. Mariano[1], D.L. Smith[1, 9], and A.D. Jacques[1]

1. NASA/Goddard Space Flight Center, Greenbelt, MD, United States
2. University of Maryland, College Park, MD, United States.
3. SGT, Inc., Greenbelt, MD, United States.
4. Millennium Engineering and Integration Company, Arlington, VA, United States
5. Siena College, Dept. of Physics and Astronomy, Loudonville, NY, United States.
6. Drexel University, Philadelphia, PA, United States
7. Oak Ridge Associated Universities, Washington, DC, United States.
8. Global Science & Technology, Greenbelt, MD, United States.
9. Orbital Sciences Corporation, Greenbelt, MD, United States.

Imaging detecting systems based on microchannel plates (MCPs) are the most common for low energy plasma measurements for both space borne and ground applications. One of the key parameters of these detection systems is the dynamic range of the MCP's response to the input fluxes of charged particles. For most applications the dynamic range of the linear response should be as wide as possible. This is especially true for the Dual Electron Spectrometers (DESs) of the Fast Plasma Investigation (FPI) on NASA's Magnetospheric MultiScale (MMS) mission because a wide range of input fluxes are expected. To make use of the full available dynamic range, it is important to understand the MCP response behavior beyond the linear regime where the MCPs start to saturate. We have performed extensive studies of this during the characterization and calibration of the DES instruments and have identified several saturation effects of the detection system. The MCP itself exhibits saturation when the channels lack the ability to replenish charge sufficiently rapidly. It is found and will be shown that the ground system can significantly impact the correct measurement of this effect. As the MCP starts to saturate, the resulting pulse height distribution (PHD) changes shape and location (with less pulse height values), which leads to truncation of the PHD by the threshold set on the detection system discriminator. Finally, the detection system pulse amplifier exhibits saturation as the input flux drives pulse rates greater than its linear response speed. All of these effects effectively change the dead time of the overall detection system and as a result can affect the quality and interpretation of the flight data. We present results of detection system saturation effects and their interaction with special emphasis on the MCP related effects.