Fast Plasma Investigation for MMS: Simulation of the Burst Triggering System

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Abstract

The Magnetospheric Multiscale (MMS) mission will study small-scale reconnection structures and their rapid motions from closely spaced platforms using instruments capable of high angular, energy, and time resolution measurements. To meet these requirements, the Fast Plasma Instrument (FPI) consists of eight (8) identical half top-hat electron sensors and eight (8) identical ion sensors and an Instrument Data Processing Unit (IDPU). The sensors (electron or ion) are grouped into pairs whose 6° x 180° fields-of-view (FOV) are set 90° apart. Each sensor is equipped with electrostatic aperture steering to allow the sensor to scan a 45° x 180° fan about the its nominal viewing (0° deflection) direction. Each pair of sensors, known as the Dual Electron Spectrometer (DES) and the Dual Ion Spectrometer (DIS), occupies a quadrant on the MMS spacecraft and the combination of the eight electron/ion sensors, employing aperture steering, *image* the full-sky every 30-ms (electrons) and 150-ms (ions), respectively.

To probe the diffusion regions of reconnection, the highest temporal/spatial resolution mode of FPI results in the DES complement of a given spacecraft generating 6.5-Mb•s^{-1} of electron data while the DIS generates 1.1-Mb•s^{-1} of ion data yielding an FPI total data rate of 6.6-Mb•s^{-1}. The FPI electron/ion data is collected by the IDPU then transmitted to the Central Data Instrument Processor (CIDP) on the spacecraft for science interest ranking. Only data sequences that contain the greatest amount of temporal/spatial structure will be intelligently down-linked by the spacecraft. This requires a data ranking process known as the *burst trigger system*. The burst trigger system uses pseudo physical quantities to approximate the local plasma environments. As each pseudo quantity will have a different value, a set of two scaling factors is employed for each pseudo term. These pseudo quantities are then combined at the instrument, spacecraft, and observatory level leading to a final ranking of data based on expected scientific interest.

Here, we present simulations of the fixed point burst trigger system for the FPI. A variety of data sets based on previous mission data as well as analytical formulations are tested. Comparisons of floating point calculations versus the fixed point hardware simulation are shown. Analysis of the potential sources of error from overflows, quantization, etc. are examined and mitigation methods are presented. Finally a series of calibration curves are presented, showing the expected error in pseudo quantities based solely on the scale parameters chosen and the expected data range.

We conclude with a presentation of the current base-lined FPI burst trigger approach.