# Supporting Information for "Electron crescent distributions as a manifestation of diamagnetic drift in an electron scale current sheet"

A.C. Rager[1,2], J.C. Dorelli[2], D.J. Gershman[2], V. Uritsky[1,2], L.A. Avanov[2,3], R.B. Torbert[4,5], J.L. Burch[5], R.E. Ergun[6], J. Egedal[7], C. Schiff[2], J.R. Shuster[2,3], B.L. Giles[2], W.R. Paterson[2], C.J. Pollock[8], R.J. Strangeway[9], C.T. Russell[9], B. Lavraud[10], V.N Coffey[11], Y. Saito[12]

**Contents of this file**

1. Description of Technique
2. Figure S1

**Description of Technique**

Figure S1 illustrates our technique for reconstructing 7.5 (37.5) ms electron (ion) moments from the FPI skymaps. To cover $4\,\pi$ steradians in look direction at each energy step, FPI electrostatically deflects to one of four look directions for each 32-step energy sweep [*Pollock et al.*, 2016]. Since the four deflection states (labeled 0-3 in Figure S1(a)) are visited in the same temporal sequence by each analyzer, it is possible to extract a uniformly sampled three-dimensional phase space density every 7.5 (37.5) ms, albeit at reduced (by a factor of four) azimuthal sampling resolution of 45 degrees.

Figure S1(b) summarizes the algorithm. Each raw counts skymap is organized into a 32x16x32 array in which the first dimension represents the 32 energy steps (identical for all analyzers), the second dimension represents the 16 top hat analyzer entrance aperture zenith angles (identical for all analyzers), and the third dimension represents the $8x4$ analyzer/deflection combinations. Figure S1(c) shows this organization and delineates by color the eight analyzers represented in each raw counts skymap.

The geometry of an FPI electrostatic analyzer is such that the look direction is defined by the surface of a cone. The orientation of this cone is defined by the original undeflected look direction and the azimuthal degree of deflection, meaning that both the zenith and azimuthal look direction angles are coupled to the deflection state of the analyzer. Accounting for this geometry is commonly referred to as the 'polar explosion' correction, due to its pronounced effect near the poles.

Figure S1(a) is a simplified illustration of the deflection states for the equatorial zenith angles. Here it is possible to select a single deflection states data by retaining only every fourth element of the azimuthal dimension. This illustration does not represent the layout of deflection state look directions at the poles, which is complicated by the 'polar explosion' effect.

The FPI ground processing software transforms the raw counts data onto a uniform spherical-polar grid to construct the 32x16x32 phase space density arrays, Figure S1(d). Here the first dimension again represents energy, the second dimension represents zenith look direction angle, and the third dimension represents azimuthal look direction angle. Thus, one cannot recover a single deflection state by simply extracting every fourth element from the azimuthal dimension of the phase space density skymaps (though this may be an acceptable approximation away from the poles); one should instead extract every fourth element from the analyzer/deflection dimension of the raw counts array.

After extracting a single deflection state from the raw counts array, we compute the 32x16x8 phase space density array using the same procedures (transformation to a regular spherical-polar grid, multiplication by geometric factor, application of relative gain correction factors, etc.) used to construct the full 32x16x32 phase space density array. We reconstruct the full 32x16x32 phase space density array by applying cubic spline interpolation in the azimuthal dimension for each energy and zenith angle. Finally, the reconstructed 32x16x32 array is passed to the FPI moments calculation code. The process is repeated for the four deflection states and the data are then organized by order of deflection state to create a single 7.5 ms (37.5 ms) moments data product.

## References

Pollock, C., et al. (2016), Fast plasma investigation for magnetospheric multiscale, *Space Science Reviews*, *199*(1), 331–406, doi:10.1007/s11214-016-0245-4.

Corresponding author: A.C. Rager, amy.c.rager@nasa.gov

[1]Catholic University of America, Washington DC, USA
[2]NASA Goddard Space Flight Center, Greenbelt, MD, USA
[3]University of Maryland, College Park, MD, USA
[4]University of New Hampshire, Durham, NH, USA
[5]Southwest Research Institute, San Antonio, TX, USA
[6]University of Colorado Boulder, Boulder, CO, USA
[7]University of Wisconsin, Madison, WI, USA
[8]Denali Scientific, Healy, AK
[9]University of California, Los Angeles, CA, USA
[10]Research Institute in Astrophysics and Planetology, Toulouse, France
[11]NASA Marshall Space Flight Center, Huntsville AL, USA
[12]Institute for Space and Astronautical Science, Sagamihara, Japan


0094-8276/17/$5.00

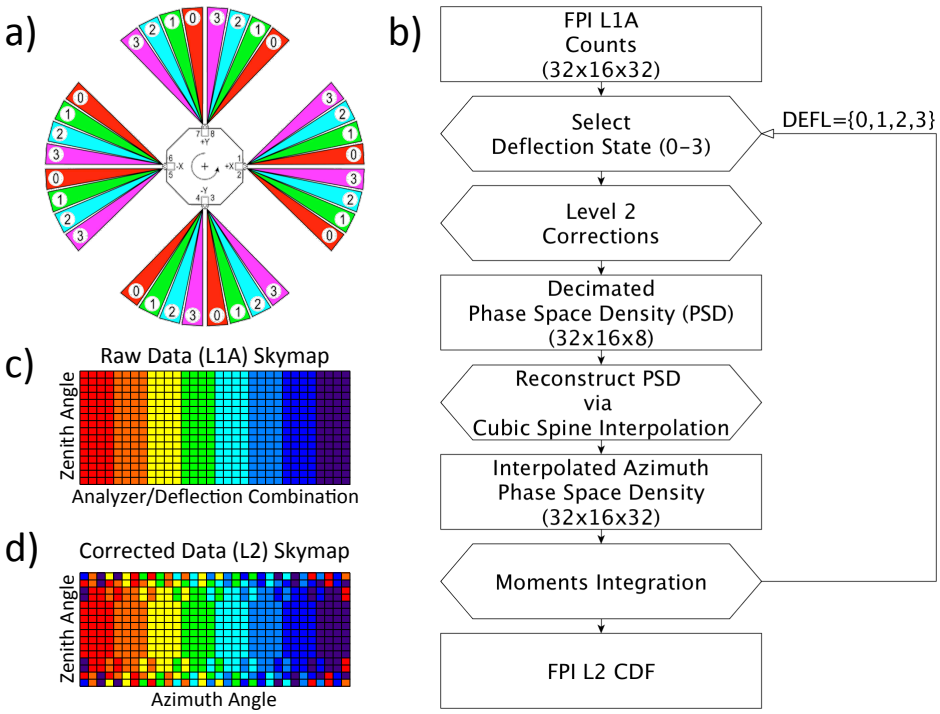


**Figure S1.** (a) From *Pollock et al.* [2016], the 32 total azimuthally deflected fields of view as seen from above the observatory deck. This simplified illustration is only true for the spacecraft equatorial zenith angles. The eight fields of view measured simultaneously are considered a single deflection state, designated by a number (eg. '0-3') . (b) A flowchart of the method for creating 7.5 ms (37.5 ms) distribution and moment CDFs, see description in text. (c)-(d) Skymap placement of counts for the raw and corrected data, respectively. Individual colors represent a common analyzer and serve to show the 'explosion' of counts resulting from the deflection state dependence of azimuthal and zenith look direction angles.