FAST

Electrostatic Analyzer (ESA)

Known Data Problems and Limitations

For a published discussion, please see: McFadden et al., Ion and Electron Characteristics in Auroral Density Cavities Associated with Ion Beams: No Evidence for Cold Ionospheric Plasma, http://sprg.ssl.berkeley.edu/fast/scienceprod/papers/mcfadden/g98den3d.html JGR, p.14671, 1999.

Sunlight Contamination

Sunlight background counts are observed in all sensors when the spacecraft is near a noon-midnight orbit. Rates the order of ~100/s-anode are observed in the worst look directions.

Scattered Electrons

Scattered electrons can produce a low level of background counts in the all the sensors. These are most noticeable in the electron sensors as pitch-angle wings on narrow field aligned beams, or as background counts above and below an intense mono-energetic peak. The background is greater at energies near the incident electron energy. In the IES sensor, the incident electrons must have >2 keV energy to reach the front of the negatively biased MCP detector to be observed.

Spacecraft Photo-Electrons and Secondary Electrons

Spacecraft produced photo and secondary electrons are observed in the EES and SES sensors at 90 degrees pitch angle at energies up to ~100 eV. Photo-electrons dominate accept in darkness. Secondary electrons produced in the electron sensor aperture can also generate a low energy background.

Missing Field-Aligned Beams

On occasion, the onboard IES and EES deflector settings may be wrong so the sensors can miss narrow field aligned beams. This is especially true in the southern hemisphere, where the magnetic field is sometimes beyond the deflection range. The SES sensors have no deflectors so these sensors will miss field-aligned beams when the magnetic field direction is out of the sensor field of view (+/- 5 degrees).

ExB Effects on Ion Beams

S/C motion through the plasma normally affects only low energy oxygen conics. However, within electrostatic shocks a significant effect on ion beams is observed. The ion spectrometer FOV is nominally aligned along the magnetic field using deflectors. Although most ion beams are observed since the beam widths are large (10-30 degrees), beam intensities may be reduced and moment calculations may be in error when ExB is large.
Noise counts

On occasion there are noise counts at the highest energy steps of the sensor probably due to weak high voltage discharges. If the MCPs get blasted with a high count rate, for example during spacecraft charging at low altitudes, false counts will appear on following energy samples. This background rate decays over several tens of milliseconds and is normally noticed at the highest energy steps of the following sweep.

Spacecraft Charging.

Negative spacecraft charging from a few volts to several tens of volts is common and is obvious in the low energy ion spectra. Current moment calculations do not account for the spacecraft potential.

Incorrect Pitch Angle Due to Magnetic Field Phase Errors

When the magnetometer is off, the magnetic field phase (magphase) in the ESA packet data header is incorrect. This often happens during low latitude (ILAT less than 60 deg) data collection beginning around June 2000. The magphase is used to sort the ESA measurements by pitch angle, thus the pitch angles calculated by the software are incorrect when magphase is wrong. This problem can be easily identified in the data by incorrect pitch angles for the loss cone. An initial correction has been implemented for sdt. By setting the environment variable with the command "setenv FAST_COMPUTE_MAG_PHASE 1", sdt will be forced to calculate "magphase" on the ground based upon a magnetic field model and the sun pulse timing. This fix should work whenever the spacecraft is in sunlight. This fix will also work when the spacecraft is in darkness provided that the onboard "sun-nadir" table is accurate. The sun-nadir table allows FAST to calculate a pseudo-sun pulse based upon horizon sensor data. Early in the mission, FAST had some problems with the sun-nadir table updates. Thus the use of ground calculated magphase may occasionally fail. For pre-June 2000 data we suggest using the onboard magphase by setting "setenv FAST_COMPUTE_MAG_PHASE 0". Software will eventually be updated to allow the user to toggle between these choices without exiting the sdt program. Finally, the ground computed magphase will also be incorrect for those few orbits where the attitude data has not been calculated. A warning message should be implemented in the near future to warn the user of this problem. The onboard magphase and computed magphase can be plotted in sdt by selecting from the menu: "Add Plot -> FAST -> Esa_survey -> EsaSrvSpinMagAndMagPhase" then adding the appropriate choice.