FAST

Field Instruments

Known Data Problems and Limitations

Boom Deployments:

The radial spin plane boom carrying probes 3 and 4 failed to deploy, leading to probe 4 being situated right outside of the spacecraft skin, and probe 3 being situated within the spacecraft. Due to this problem, any DQD derived from probe 3 should not be used (V3-V4, for example); in fact, nearly all the Fields Modes do not include any probe 3 dependent DQDs because of this failure. As noted in the Shadowing Effects section below, probe 4's proximity to the spacecraft skin makes it more prone to solar and magnetic shadowing effects, as well as making it susceptible to spacecraft potential variations. Both can be deal with via Notching, as is discussed in the section on Despin routines below. While the effects of shadowing are quite strong at quasi-DC and low-frequencies (10 Hz and below), the higher-frequency response of probe 4 (and potential differences derived therefrom) seems to match probes further from the spacecraft, and can thus be used at those higher frequencies without notching if due care is taken to understand the contamination at lower frequencies.

The axial boom carrying probe 9 was not deployed until orbit TBD, and the axial boom carrying probe 10 has not been deployed as of this date (May 2001). Prior to deployment, each of these two probes was in close proximity to the spacecraft skin, and thus suffered similar shadowing and spacecraft potential problems to those of probe 4. The DC calibration of these probes is not well known on-orbit, due to the lack of availability of spin-periodic signals with which to estimate gains and offsets. Their AC calibrations seems to agree with pre-flight estimates (properly adjusted for the probe separation), and after probe 9 was deployed, allow for 3D AC electric field estimates in modes that support it.

Shadowing Effects:

As described in detail in the Shadowing Effects section below, the potential of a given probe (density or potential) relative to the surrounding plasma depends upon the current carrying populations available at its surface. That availability depends strongly upon the solar illumination of the probe, and the relative orientation of the probe, the ambient magnetic field, and the rest of the spacecraft. These aspect-sensitive effects will occur to one extent or another on all of the spin plane probes of the electric field experiment, with magnetic aspect effects showing up on almost every orbit due to the close alignment of the FAST spin plane and ambient magnetic field, and the most pronounced effects observable on any potential or potential difference derived from the probe 4 measurement (probe 4 is quite near the skin of the spacecraft, and so is easily blocked during large portions of the spin period. Solar aspect effects show up most regularly in the spin plane probes in noon-midnight orbit configurations; most readily in the spin axis probes in the dawn-dusk orbit configurations.

The current-collection capabilities of the density probes also seems to show solar and magnetic aspect sensitivity.

AC versus DC effects:

Contamination of spectral density at low frequencies, but little evidence for gain changes between illuminated and shadowed situations.

Sweeps:

Early in the mission (prior to orbit 5700;), the bias current applied to the potential probes was swept several times (one to three) over the course of a given pass in order to better characterize the current-voltage characteristic of the coupling between the potential and density probes and the surrounding plasma (see the discussion on Biasing Schemes for the motivation behind this). A master list of swept orbits and times is being compiled, but an individual sweep is fairly obvious in the data when one compares the potential differences from swept and unswept probe pairs in SDT or IDL. A sweep will affect the estimation of the despun DC electric field, as well as estimates of the AC electric field up to a few Hz (at most).

Data Gaps:

The different channels can have data gaps at different times, and so care must be taken in comparing or combining data from different channels, such as in the various DESPIN routines. The FA_FIELDS_COMBINE routine is built to detect gaps in different data streams, and either interpolate across or leave the gap alone, doing this to match up two different data channels prior to applying any of the higher-level data reduction programs (any of the DESPIN routines, for example).

Sequential Versus Simultaneous Sampling of Data:

Survey vs burst vs hsbm sampling; does this have any real effect on the data that appears in IDL, or already accounted for via linear interpolation during calibration?

Failure to Detect HG Channel Gain State Setting:

A factor of four gain change has not been properly taken into account in calibration procedures for HG time series and DSP data, as well as SFA, BBF, and HSBM data taken from the two spin plane probe pairs V1-V4 and V5-V8. The source of this failure to detect the gain state setting is under investigation. Until this ambiguity is resolved, the affected channels (V5-V8HG and V1-V4_HG in Survey or Burst mode; V1-V4 and V5-V8 in DSP, SFA, BBF, or HSBM data) should not be used for any quantitative estimates of wave amplitude (including the estimation of wave polarization using multiple antennas), but may be used for qualitative description of wave spectra.

Disparity Between DSP and Time Series Spectral Density Estimates:

Comparison of the spectral density estimates derived from the on-board DSP data dn 16k Burst data shows that there is a discrepancy between those estimates. The DSP estimate of the electric field spectral density (V5-V8, etc.) is roughly a factor of 500 higher than that resulting from the 16k Burst data. The DSP estimate of the magnetic field spectral density (Mag3ac only) is roughly a factor of 3160 lower than that resulting from the 16k Burst data. The source of this discrepancy is not known, but arises from the DSP calibration, rather than the time series (Burst) calibration. The above quoted figures may be used to correct the DSP data for qualitative work, and a package of analysis routines (DSP_AUTOCAL) has been developed to allow for a more detailed analysis of the discrepancy for a given interval of analysis; Contact the FAST Fields Team mailto:jbonnell@ssl.berkeley.edu for further information.

The HSBM “One-Second” Problem:

The HSBM data often appears to be roughly one second early relative to other data streams; ie. if HSBM and 16k Burst data is available from the same antenna at a given time, individual features of the waveforms will appear about one second earlier in the HSBM data than in the Burst data. The cause of this problem is under investigation, and is not known at this time, but is an aspect of the HSBM data, not the Burst data. This problem is intermitent. A rough work-around exists if precise timing of HSBM bursts relative to other events is required. Contact the FAST Fields Team mailto:jbonnell@ssl.berkeley.edu or further information.

Degradation in Performance of Sphere 5:

An intermittent DC offset appeared in all DQDs derived from the sphere 5 potential (V5-V8, for example), starting around January 2000, and continuing through the present. The offset is believed to arise from increased leakage current in the sphere 5 preamp, and may depend upon the ambient plasma density.

Prior to January 2000, a typical DC offset in V5-V8 would be a few mV/m, corresponding to a difference in the floating potentials of spheres 5 and 8 of approximately 0.25 V. The extra offset, when it occurs, it quite obvious in a plot of V5-V8, and is currently around 760 mV/m (corresponding to a difference in floating potential of 30-40 V).

In addition to the increased offset voltage, the leakage current appears to make the sphere potential unstable in some plasma environments, leading to large, non-geophysical fluctuations in the estimated electric fields derived from sphere 5.

Power Supply Problems in On-Board Processing of DC Magnetometer Data

(the `P12S7V' Problem):

An anomaly occured in the power supply for the on-board data processor supporting Survey DC magnetometer data on orbit 8431 (09 October 1998). The power supply voltage fell far enough to degrade the quality of the DC magnetometer data. Something else happened between orbits 9200 and 9937 (19 Dec 1998 to 24 Feb 1999). Something else entirely happened after orbit 9937. Details to come from RJS.

The collection of BackOrbit DC magnetic field data was curtailed at orbit TBD, reducing the accuracy of the in-flight calibration performed by UCLA_MAG_DESPIN (see perturbation magnetic field analysis below). Small-scale perturbations in the magnetic fields can be trusted, but larger-scale offsets (possibly indicative of global modifications to the magnetospheric field) can not; contact the FAST Fields Team mailto:jbonnell@ssl.berkeley.edu for further details.

Effects of Torquer Operations on Magnetometer Data:

Roughly once a day, a magnetic torquing system is used to adjust the orientation of FAST's spin axis so as to insure the best possible alignment between the spin plane and the ambient magnetic field in the northern auroral regions. Torquer operations have two effects on magnetic field measurements. First, the torquers produce a DC offset in the magnetic field measurements while on (several hundred nT), and also slightly change the offsets and gains of the magnetometers themselves after turning off. The DC offset can be seen directly in the magnetometer data, and while compensated for to some extent in UCLA_MAG_DESPIN, means that DC B fields should not be trusted during torquer operations. The changes in instrumental gains and offsets are accounted for in the on-orbit calibration procedures that UCLA_MAG_DESPIN implements. Second, the torque upon the spacecraftleads to nutation with a period of roughly 20 seconds that persists for up to two orbits after the torquer has been turned off. This effect is also obvious in the magnetometer data, as a few tens of nT oscillation in all three components of B. Care must be taken in interpreting the DC and low-frequency magnetic field data while nutation is occuring (ULF pulsation fans, take note!).

AC (Searchcoil) Magnetometer Background Levels:

All three axes of the AC (searchcoil) magnetometer have significant spin-dependent background noise levels. The source of this noise floor is currently under investigation, and can be described by the model accessible here: TBD.

Searchcoil Magnetometer not Properly Calibrated in Survey Mode:

All three axes of the AC (searchcoil) magnetometer are not sampled at high enough rates in Survey mode to allow for proper use of the standard searchcoil calibration procedures. The only exception to this is mag3ac in the fastest FastSurvey sampling rate (2048 samp/s)). The under-sampling of the data distorts the time series and spectral shape of the `calibrated' data through aliasing effects. Magac Survey data should thus be used for only the crudest qualitative estimates of the ELF magnetic spectrum, if at all.