FAST

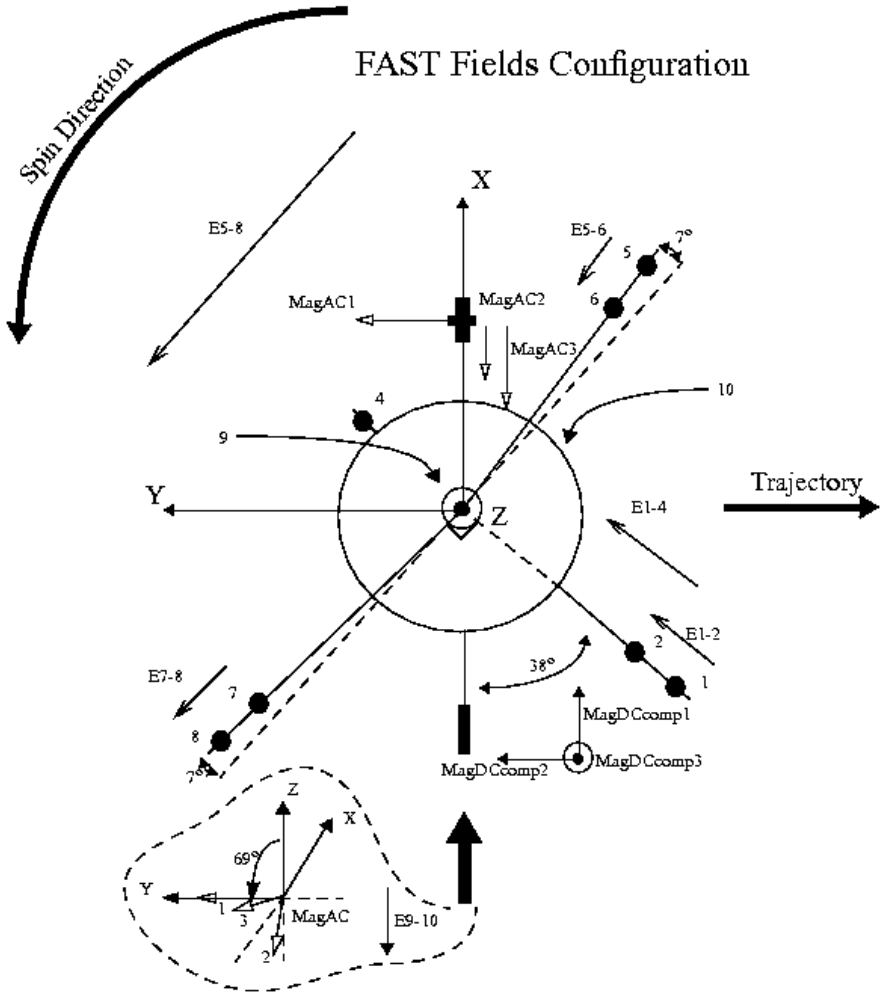
Description of the Experiments

Field Instruments

Introduction

The FAST Fields Experiment consists of many sensors with lots of flexibility in what data is gathered, at what rates, and what sorts of on-board processing is applied before telemetering the data to ground. Thus things get complicated, and users need to learn a bit before getting comfortable with the data and using it and the analysis routines proficiently.

The on-orbit configuration of the FAST fields sensors is shown in the figure below. Each of the electric and magnetic field sensors is situated on a boom in order to get the sensor well away from the spacecraft body. The electric and magnetic field sensors are described below, followed by the various data products available from the sensors, and an example of a fields mode sheet.



Electric Field and Plasma Density (Current) Sensors

The electric field sensors on FAST consist of four radial wire booms in the spin plane, each carrying a double probe at its end, along with two rigid axial booms, each carrying a single probe. The outboard probes of all the spin plane booms were designed to operate as potential (electric field) probes only, while the inboard probes can be operated as density probes as well. Both (?) of the axial probes can be operated in either potential or current mode. The biasing scheme (current bias for potential probes, and voltage bias for current probes) is set by the mode of the fields instrument, and the parameters of the given biasing scheme are described in detail on the individual Fields Mode Sheets <http://sprg.ssl.berkeley.edu/fast/scienceops/modes/fmodes.htm>. As noted in the Pitfalls section, one of the radial booms failed to deploy, leaving the spin plane measurements with only three well-separated antennas. Only one of the axial booms has been deployed to date (probe 9).

Magnetic Field Sensors

The magnetic field sensors consist of a three-axis fluxgate magnetometer (the DC magnetometer) and a three-axis searchcoil magnetometer (the AC magnetometer). For details of the magnetometer sensors see Elphic et al., [Space Science Reviews, 2001] (Magnetic Field Instruments for the FAST Auroral Snapshot Explorer <http://sprg.ssl.berkeley.edu/fast/scienceprod/papers/elphic/00_07_11_FAST_mags_MS.pdf>).

Data Products

A variety of different data products are available from the fields experiment. All of the different data products are described in detail in the Fields Experiment Article; the real workhorse data products are the time series data, along with spectral estimates, and these will be described in some detail below.

Time Series

Time series data comes in two flavors: survey and burst. Survey data comes in two speeds: slow and fast. The exact meaning of the two depends upon the Fields Mode, but typically Fast Survey data is sampled at sixteen times the rate of Slow Survey (up to 2048 samples/s for Fast Survey). DC magnetometer data also comes in in Back Orbit rate as well (8 samples/s), up until the P12S7V anomaly; see the Pitfalls <#prob> section below. The FAST satellite enters the auroral zone in Slow Survey, and then depending upon trigger events arising due to cues from various fields and particles measurements, it will shift back and forth between Fast and Slow Survey mode throughout a given pass. Note that both the fields and particle (ESA and TEAMS) experiments switch between fast and slow survey together. In addition to Survey rate data, the fields experiment will also enter Burst mode during a given pass in response to fields and particle cues. Depending upon the Mode, data from selected channels will be acquired at either 8192, 32768, or both samples/sec to produce the 4k and 16k Burst data streams. Note that both the fields and particle experiments enter into burst mode together, and that Burst mode data is gathered concurrently with Survey mode data; ie. both rates of data are available during the Burst intervals. Data will also be gathered from a very select set of channels at rates of up to 2 Msamples/s to produce the high-speed burst memory (HSBM) data stream, subject to a similar, but distinct set of fields and particle cues.

Spectral Estimates

Spectral estimates in several frequency bands are made on-board, either from the time series data using a digital signal processor (DSP), or using an analog swept-frequency analyzer (SFA). The DSP is also used to analyze the data from a 16-kHz-wide band around a given frequency using the plasma wave tracker (PWT). The estimated local electron cyclotron frequency is typically used as the center frequency, although other selections are possible. The DSP can also produce estimates of cross-spectral coherence and phase shift. The details of the operation of each of these data products (averaging intervals, sweep rates, tracking frequency, etc.) can be found on the Mode Sheets as well in the Fields Experiment Article.

Other Data Products

Several other data products are created on-board, but do not currently enjoy wide use or a well-developed user interface in IDL. These data products include the Low-Frequency Filter (LFF), Broadband Filter (BBF and HFQ), and Wave-Particle Correlators (WPC). See the Fields Experiment Article for the details on these data products, and contact one of the Fields experiment team for aid and discussion before using these data products.

Fields Mode Sheets

All that one needs to know about what particular data products are available at a given time from the fields experiment can be determined using the Fields Mode Sheets <http://sprg.ssl.berkeley.edu/fast/scienceops/modes/fmodes.htm>. One can determine the Fields Mode for a given timespan or orbit in several ways:

- Use the Search http://sprg.ssl.berkeley.edu/fast/scienceops/Database_modes.html or Listing http://sprg.ssl.berkeley.edu/fast/update/model_list.txt utilities available on the FAST Website.
- Examine the value of a Fields Mode Data Quantity with a SDT session.
- Use the FA_FIELDS_MODE call from within IDL (see the IDL Utility Routines <#util> section below).

A typical Fields Mode sheet is shown in the PDF-format document below:

Fields Mode Sheet for Mode 19 http://sprg.ssl.berkeley.edu/fast/scienceops/modes/mode019.pdf

Now for some unfortunate, but necessary jargon and acronyms. The data from FAST is organized into bundles of channels known as APIDs. Each APID consists of several different fields quantities, or a particular type of particle data, or spacecraft ephemeris/housekeeping data. Each quantity is identifed by its Data Quantity Descriptor or Identifier (DQD or DQI, both acronyms are used interchangably throughout the FAST SDT/IDL documentation and software package).

A Fields Mode sheet consists of several sections that describe the channels (DQDs) available in a given instrument mode, the APID that those channels appear in, and the rates at which the data from those channels are acquired. The most important sections to look at are Sections A, B, C, and D, covering the Sphere Configuration, Slow and

Fast Survey data channels and Burst mode data channels respectively.

Section A can be found near the top of the first page of the mode sheet, and is a simple listing of which probes are in current mode. Here, one can see that probes XXX and YYY are in current mode for Fields Mode 19.

Sections B and C are also found on the first page of the mode sheet, and detail what DQDs are available in Slow and Fast Survey modes (first column of each section), as well as the sampling rates of those channels (second column of each section). Here, for example, one can see that the estimated electric field from probes 5 and 8 (V5-V8_S) is available at 256 and 2048 samples/s in Fields Mode 19 for Slow and Fast Survey.

Section D can be found on the second page of the mode sheet, and details what DQDs are available in Burst mode, as well as the sampling rates of those channels (the first and second columns of the section, respectively). The DQDs and sampling rates available via the HSBM processor are also detialed in Section D. Here, for example, one can see that XXX is available at 8192 samples/s and YYY is available at 32768 samples/s in Burst mode, while AAA, BBB, and CCC are available at 2 Msamples/s via the HSBM in Fields Mode 19.