Solar Probe Plus

A NASA Mission to Touch the Sun

Integrated Science Investigation of the Sun Energetic Particles

Preliminary Design Review

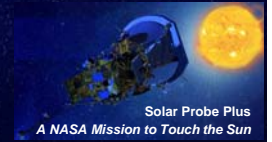## 05 – 06 NOV 2013

Flight Operations

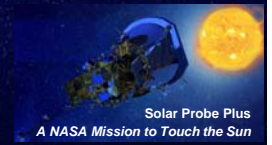Eric Christian

ISIS Deputy PI (GSFC)

Outline

- Initial commissioning
- Nominal operations
- Instrument command loads
- Instrument autonomy requirements
- Flight operations staffing
- Off-nominal operations
- Summary

Initial Commissioning

- EPI-Hi turns on first (EPI-Lo needs two week out-gassing period)
- ISIS Statistics Gathering and Threshold Scans
  - Analysis parameters will be tuned with pre-flight calibrations, but it is likely that some fine-tuning will be required
  - After initial instrument turn on and checkout it is important that the ISIS instruments gather as much data as possible (especially raw event data)
  - Threshold scans will be required to determine optimal threshold values
  - EPI-Lo does not need to be on continuously
- ISIS EPI-Lo and EPI-Hi Table Loads and/or Software Updates
  - Table updates expected (adjustment of flux box bins) 3 weeks into statistic gathering period
  - Software updates might be needed
  - Based on STEREO experience, EPI-HI will require ~10 opportunities (on separate days) to send commands in the first two months
  - Necessary to obtain/analyze at least a few hours of new data in between command opportunities to test whether the commands worked
  - Therefore, need to collect data between commanding opportunities

Nominal Operations

EPI-Hi and EPI-Lo operate the same whenever powered-on except for the volume/content of the data sent to the S/C inside/outside 0.25 AU

- **Spacecraft- Sun Distance R<0.25 AU (Normal Science Mode)**
  - Full nominal power
  - High data collection rate
  - Burst data (EPI-Lo)
- **Spacecraft- Sun Distance: 0.25 AU < R (Low-rate Science Mode)**
  - Full power whenever possible
  - Reduced data collection rate (fits within ISIS telemetry allocation)
  - Commanding window should be scheduled late in the series of telemetry passes, although it may not be used every orbit
 - Minimize power cycling the HV supplies

Instrument Command Loads

- ## Commanding of EPI-Hi and EPI-Lo
  - "Flat-Sat" at UNH used to test command loads
    - Development of Flat-Sat will be Phase D work
    - Constraint Checking Modules
  - Standard Commanding performed via GSEOS at UNH SOC
  - Commissioning and Contingency response, commanding may optionally be done by EPI-Hi and EPI-Lo via GSEOS directly through MOC

- ## Planning for instrument operations
  - Planning software
    - Automated routines and templates for initial planning
    - Interactions with ISIS SOC interfaces for finalization of planning
  - Develop rough plans three orbits ahead
    - Test command load
  - Develop definitive plans one orbit ahead
   - Final testing
    - Upload
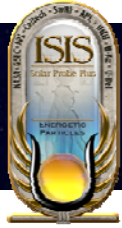
Autonomy

- Instrument Autonomy requirements considerably more than in initial SPP proposal and more than EPI-Hi has experienced in previous missions

- Main additional requirement is the ability to record the instrument state and return to that state autonomously after instrument power cycling, due to either s/c telemetry time periods or anomalous safing of instrument

- ISIS will implement operational mode changes via instrument autonomy logic supplemented by a macro capability

Flight Operations Staffing

- FLEXIBLE
  - variability of telemetry and commanding requires flexible staffing

- Priorities (in order)
  - Analysis of health and safety housekeeping
  - Analysis of snapshot science data to determine interesting time periods (relayed to other SPP instruments) and science optimization
 - Full analysis of science data and generation of data products
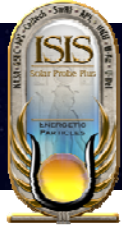
Off-nominal Operations

- Plan to avoid them

- Small amounts of critical housekeeping will give team a heads-up
- Instruments designed to dump diagnostic data when possible
- "Deep bench" of scientists and engineers with many years of experience to draw from

- ISIS will work with the SPP operations team to do what is necessary to prudently diagnose issues and bring instruments back to nominal operations
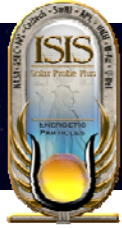
Summary

- ISIS Instrument operation modes designed to reduce complexity
- Autonomous instrument operations simplify SPP spacecraft operations
- ISIS team will develop all of the processes necessary to verify commanding and provide safe and efficient instrument operations