

# 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

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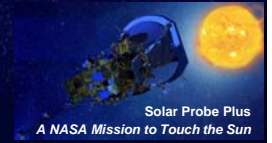
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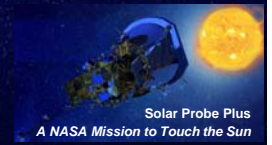
# Outline



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



# Initial Commissioning



- **ISIS EPI-Lo and EPI-Hi Statistics Gathering and Threshold Scans**
  - After initial checkout it is important that ISIS instrument gather as much data as possible (especially raw event data)
  - Allows instruments to populate composition tracks so that TOF vs E flux boxes (EPI-Lo) and De vs Eprime boxes (EPI-Hi) can be adjusted before perihelion
  - Threshold scans to determine optimal threshold values
  - 6 weeks need for these activities
  - 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 as needed
- **Based on STEREO experience EPI-HI will require 10-20 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 mode (EPI-Lo)
- **Spacecraft- Sun Distance:  $0.25 \text{ AU} < R$  (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
- **Expecting some tool to plan and coordinate operations**





# Instrument Command Loads



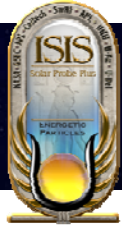
- Commanding of EPI-Hi and EPI-Lo
  - “Flat-Sat” at UNH used to test command loads
    - Development of Flat-Sat will be Phase D work
    - Constraint Checking Modules
  - Standard Commanding performed via GSEOS at UNH SOC
  - Commissioning and Contingency response, commanding may optionally be done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



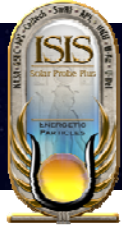
- Instrument Autonomy requirements considerably more than in initial SPP proposal and more than EPI-Hi has experienced in previous missions
- Main additional requirement is the ability to record the instrument state and return to that state autonomously after instrument power cycling, due to either s/c 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 quicklook science data to determine interesting time periods and science optimization
  - Full analysis of science data and generation of data products

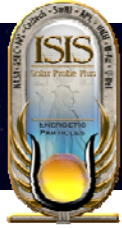


# Off-nominal Operations



- 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 has plans to develop all of the processes necessary to verify commanding and provide safe and efficient instrument operations