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

ISIS Structural

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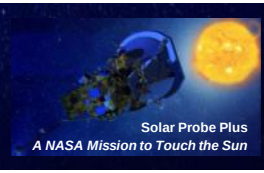
Outline

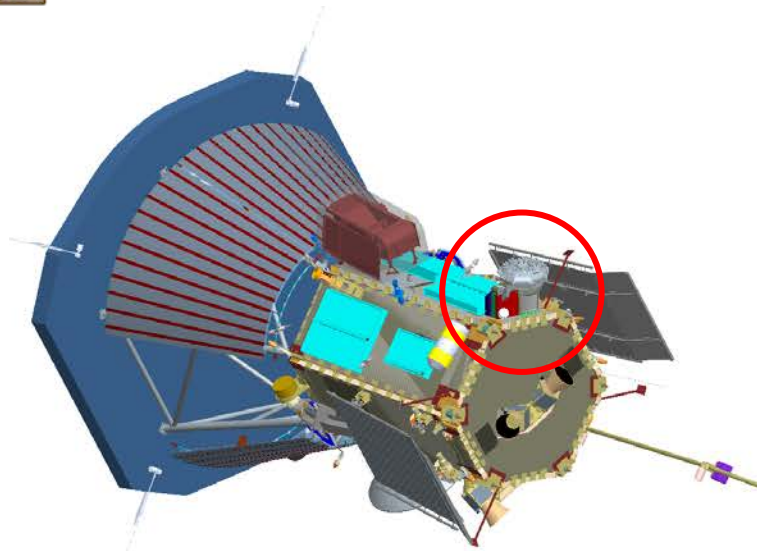
- Summary of mechanical design/structural requirements
- Description of the ISIS overall mechanical configuration
- Description of the finite element models (FEMs) and load cases used to demonstrate structural integrity of applicable components
- Information on structural design margins as well as plans for strength verification
- Description of plans for fabrication of mechanical/structural items

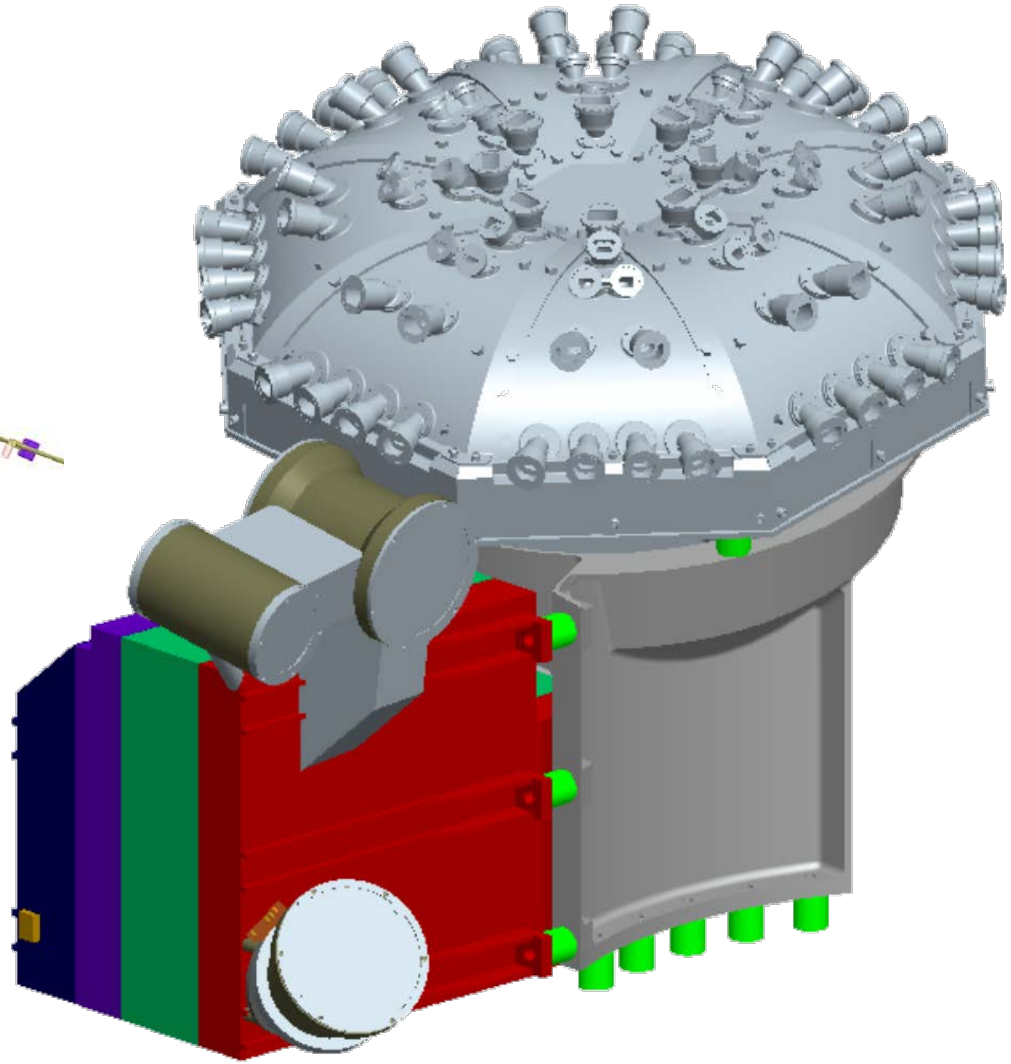
Mechanical Design Requirements



- ISIS bracket must hold EPI-Hi & EPI-Lo in position on the SPP deck
- ISIS bracket must be capable of independently removing EPI-Hi & EPI-Lo, in either order
- ISIS bracket must survive all environments for deck mounted components
  - Minimum resonant frequency >80 Hz
  - Random vibration
  - Sine vibration
  - Shock
- All ISIS suite testing shall be performed on the bracket, with instruments or instrument analogs as appropriate

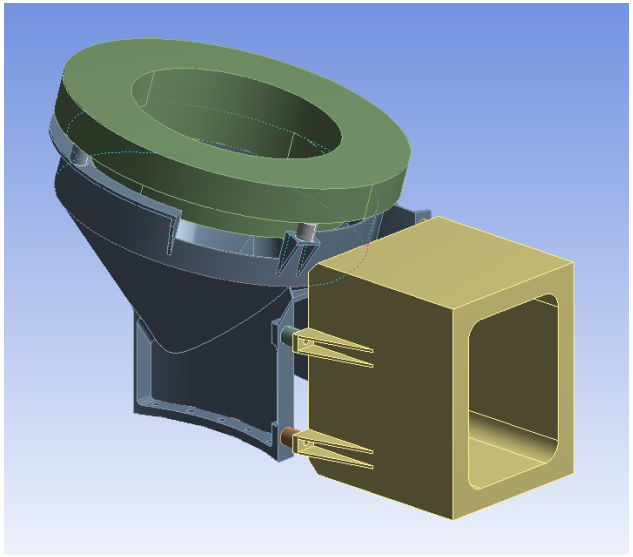
Mechanical Design Overview

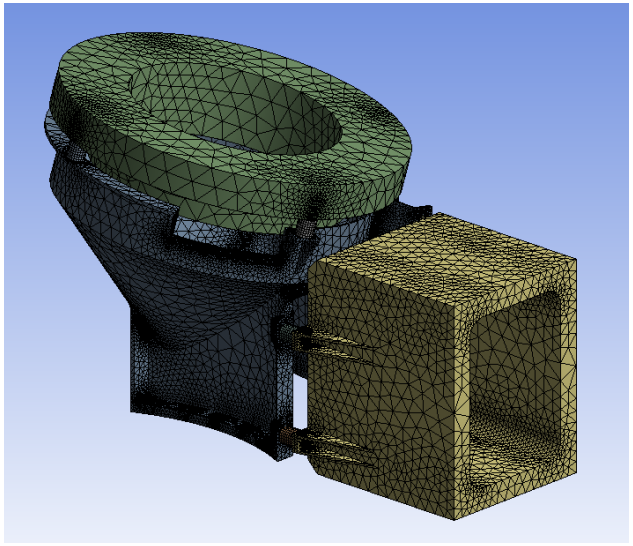




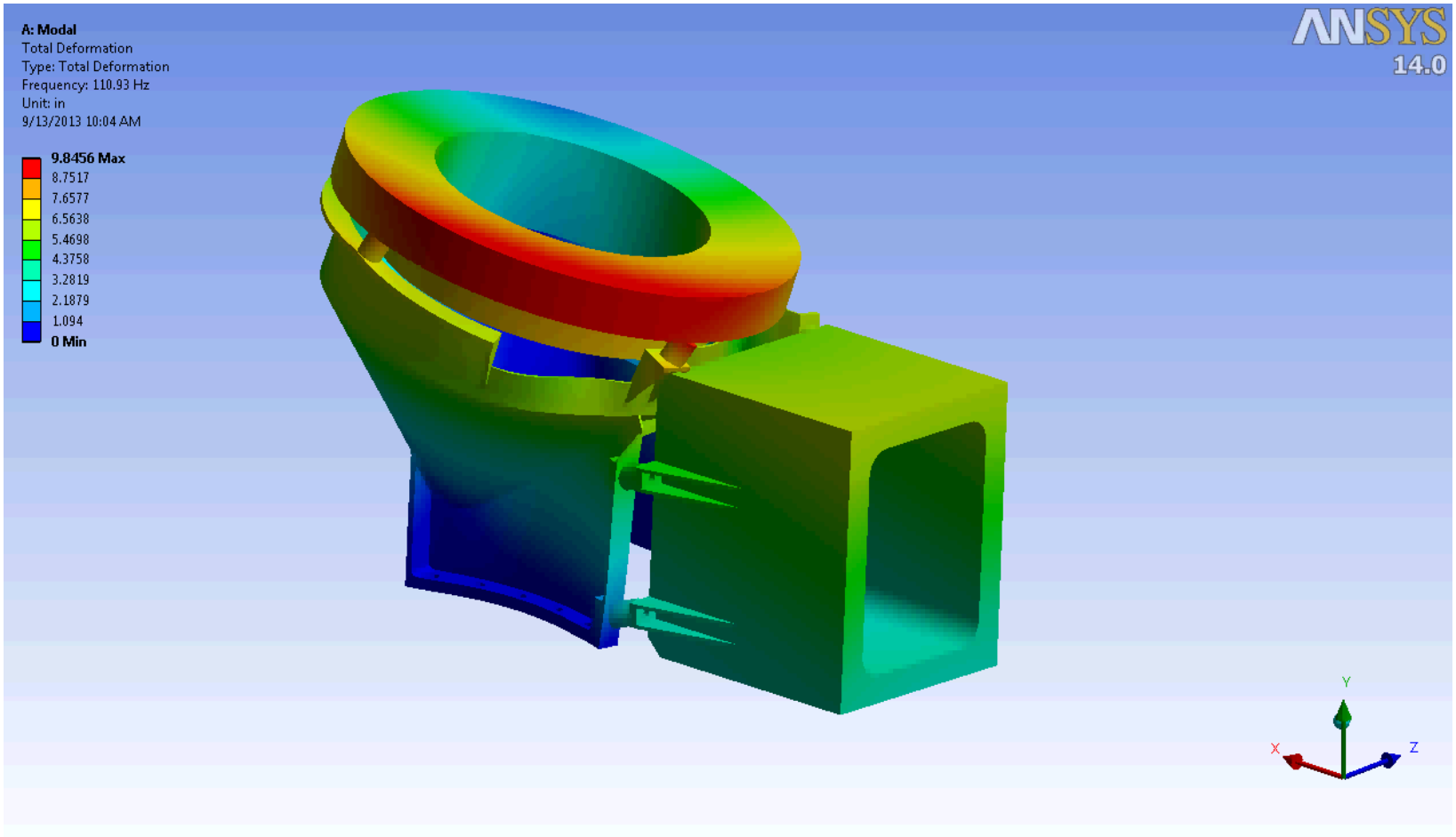
FEM - Setup

- Model includes bracket, EPI-Hi & EPI-Lo mass models (at max allocation) and thermal isolators
  - Bracket & mass models assigned Aluminum 6061-T6 material properties
  - Thermal isolators assigned G10 material properties
- Mass models represent accurate mass & CG properties
  - Test results will be easy to compare to model
  - Mass models are stiff enough to not introduce modes
- Edge to surface connections for all mounting interfaces
- Fixed supports on all 10 bracket mounting holes





FEM - Modal Results



FEM - Structural Setup

- PSD G acceleration applied uni-axially, all 3 major axes
  - 2 direction lateral to panel, 1 direction normal to panel
- PSD input from EDTRD
  - Section 4.4.3, Tables 4-8 & 4-9

Frequency (Hz)	Qualification (G^2/Hz)	Protoflight (G^2/Hz)	Acceptance (G^2/Hz)
20	0.01	0.01	0.01
60	1.25	1.25	0.63
200	1.25	1.25	0.63
350	0.04	0.04	0.04
500	0.04	0.04	0.04
2000	0.01	0.01	0.01
Overall Grms	16.4	16.4	12.6
Duration (mins)	2	1	1

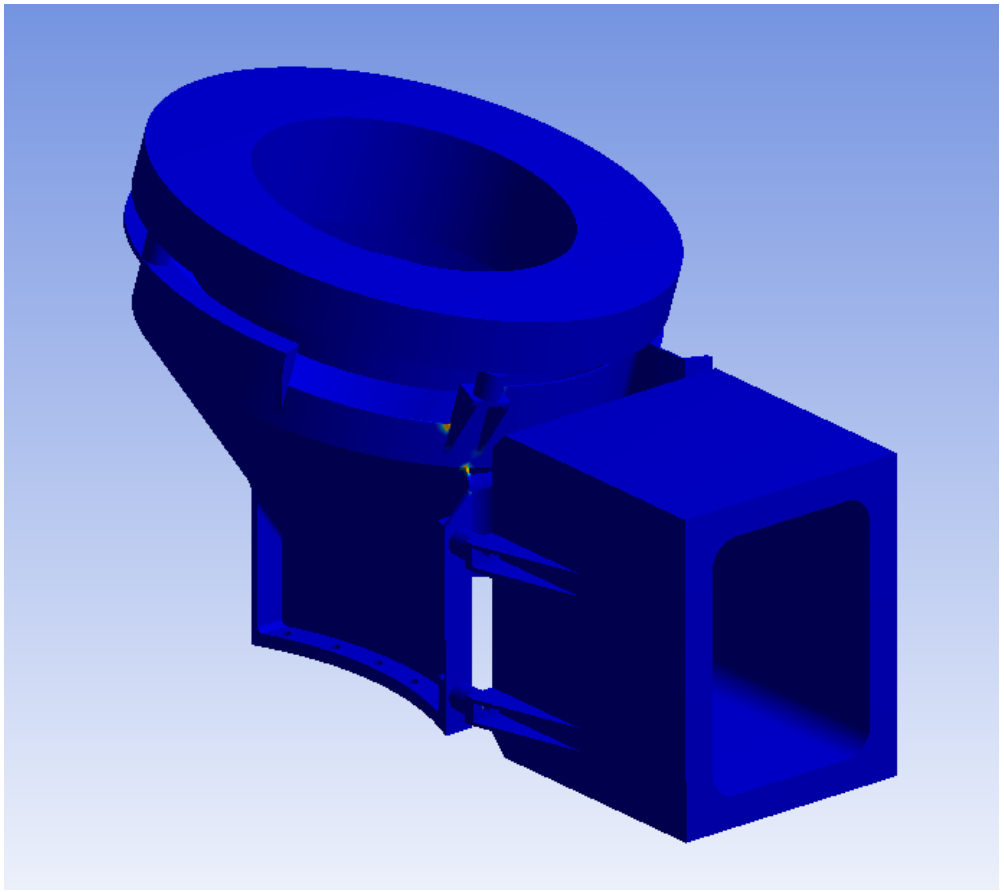
Table 4-8: Side Panels Mounted Components Normal to Panel

Frequency (Hz)	Qualification (G^2/Hz)	Protoflight (G^2/Hz)	Acceptance (G^2/Hz)
20	0.01	0.01	0.01
35	0.04	0.04	0.04
500	0.04	0.04	0.04
2000	0.01	0.01	0.01
Overall Grms	6.8	6.8	6.8
Duration (mins)	2	1	1

Table 4-9: Side Panels Mounted Components Lateral to Panel

FEM - Structural Results (Preliminary)

- Still running stress cases
  - Refining model to mitigate high stress concentrations
- Need to perform bolt analysis for bracket mounting bolts



Structural Design Margins

- Structural results must meet Safety Factors per EDTRD
  - Section 4.4.2.2, Table 4-5 for Metallic Structures (Tested)
    - Ultimate: 1.40 (Aluminum 6061-T6 F_{TU} = 42 ksi*)
    - Yield: 1.25 (Aluminum 6061-T6 F_{TY} = 35 ksi*)
- Margin of Safety must always be positive
  - MS = Allowable/(FS x Applied) – 1.0
  - Maximum Allowable Ultimate Stress = 30 ksi
  - Maximum Allowable Yield Stress = 28 ksi
- ISIS bracket will be exposed to random vibration with mass models attached for verification prior to EPI-Hi & EPI-Lo testing

*Per MIL-HDBK-5J

Bracket Fabrication

- The ISIS bracket can be machined using conventional machining processes
  - Monolithic design, will be machined from a single Aluminum block
  - All operations can be performed on conventional machines (i.e. lathe, mill, etc.)
- Thermal isolators & mass models will also be fabricated to be used during structural testing
- Bracket height increase due to TPS shift can easily be accommodated as needed