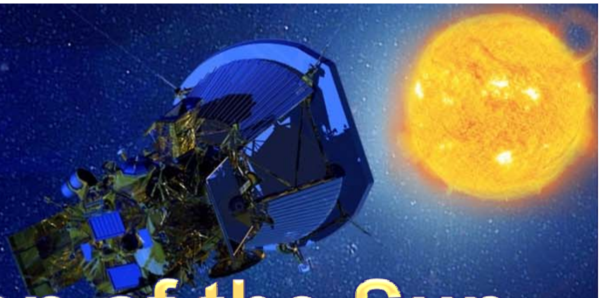
Solar Probe Plus

A NASA Mission to Touch the Sun



Integrated Science Investigation of the Sun Energetic Particles

Preliminary Design Review

05 – 06 NOV 2013

EPI-Hi Mechanical

Sandy Shuman

EPI-Hi Mechanical (GSFC)

EPI-Hi Outline

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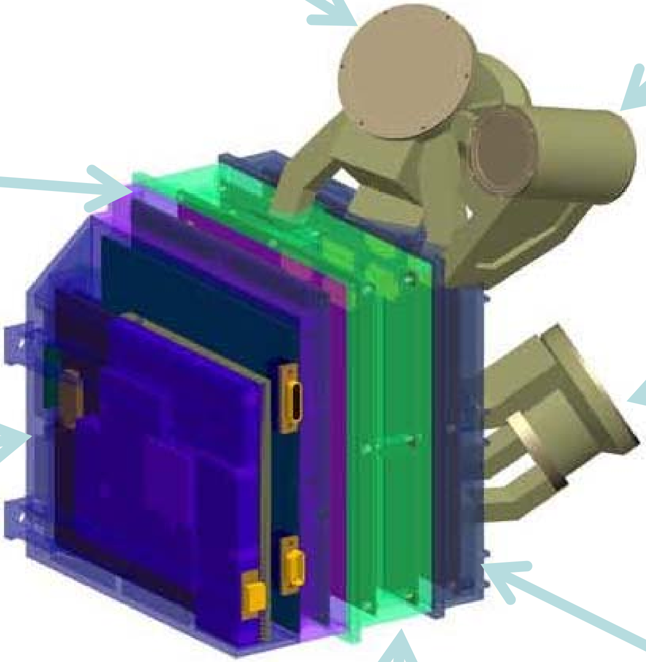
- Overview of Instrument Configuration
- Location on Spacecraft
- Fields of View
- Mass Allocation
- Mechanical Design
- Assembly process
- Summary of Peer Review results

EPI-Hi Component Configuration



LET1
Low **E**nergy **T**elescope **1**

HET
High **E**nergy **T**elescope

DPU/Bias

LET2
Low **e**nergy **T**elescope **2**

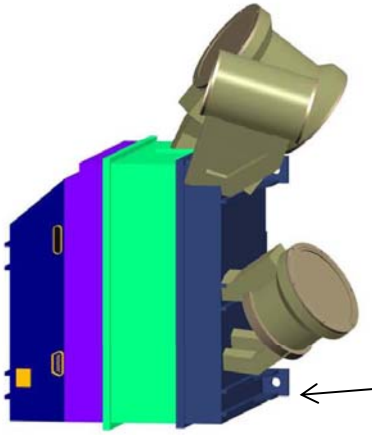
LVPS

LET2 Electronics

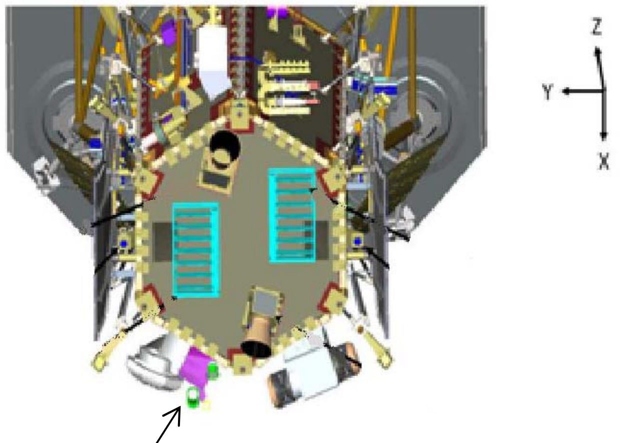
LET & HET Electronics

EPI-Hi Instrument

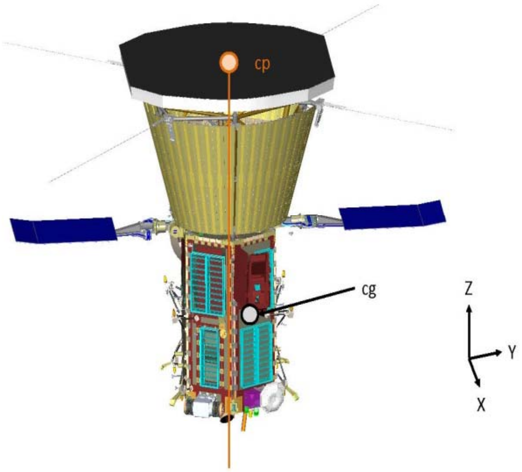
- Location of instrument on spacecraft
  - Located on +X side (RAM side).
  - Lower right mounting bolt on instrument located at: X= 46.16
    Y= 23.39
    Z= 6.13

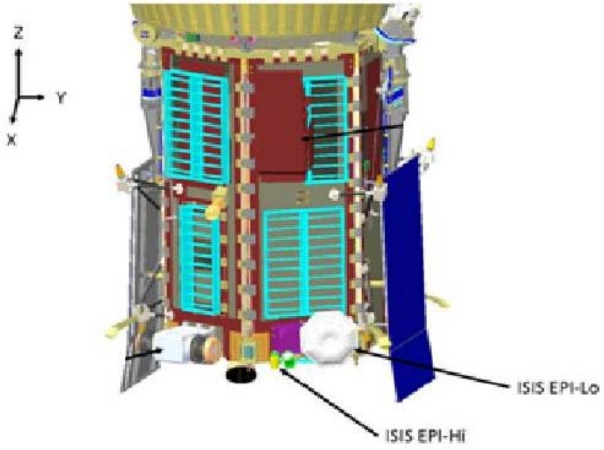


S/C MOUNTING LOCATION REFERENCE



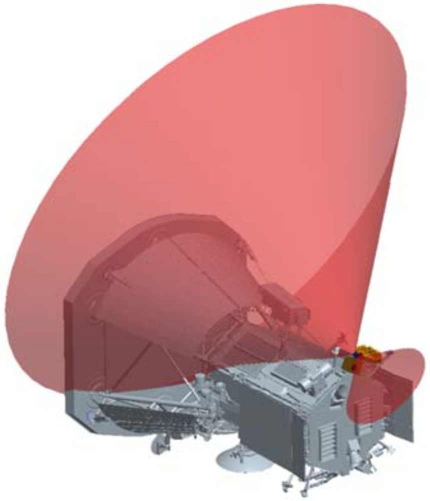
ISIS-EPI-HI





RAM SIDE

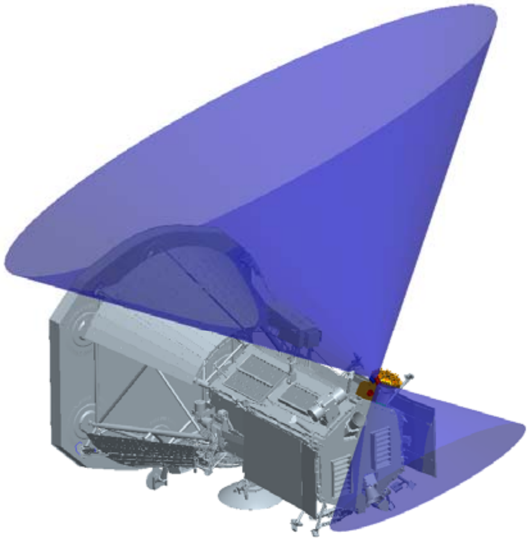
EPI-Hi Instrument FOVs

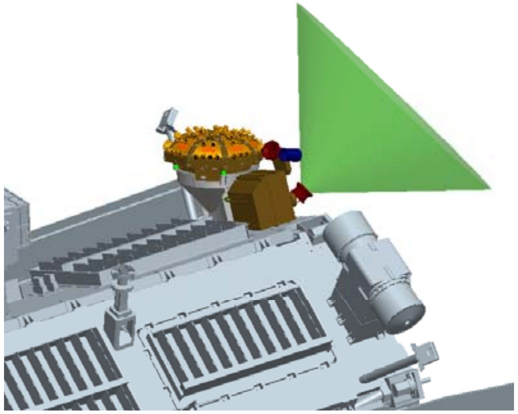


- HET conical 90° FOV
  - Double–ended.
  - 20° above S/C-Sun line

- LET1 conical 90° FOV
  - Double–ended
  - 45° above the S/C-Sun line

- LET2 conical 90° FOV
  - Single–ended
  - Orthagonal to LET1 telescope (135° from S/C-Sun line





EPI-Hi Mass Allocations

Subsystem	Mass [g]
LET1 telescope LET1 board	225 258
LET2 telescope LET2 board	145 233
HET telescope HET board	120 250
DPU board Bias Supply & RF shields LVPS & RF shields	197 225 + 130 160 + 100
Elec. box, hardware & shielding Telescope brackets Thermal hardware MLI blankets	925 + 250 +100 160 50 100
Total	3,628

EPI-Hi Enclosure Requirements

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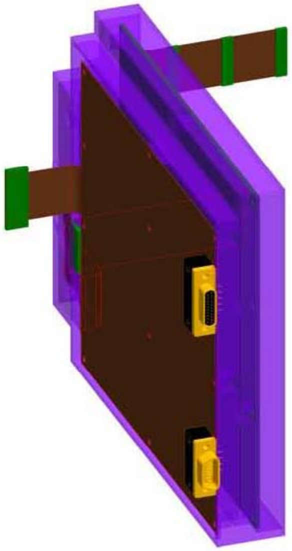
- Work within tight mass constraints
- Design to meet S/C launch environment requirements for Vibration, Acoustics and Thermal conditions
- Design for radiation dose shielding environment
- Package boards maintaining adequate parts clearance board-to-board
- Provide adequate RF and/or ground shielding board-to-board and through the enclosure
- Provide thermal isolation between electronics box and bracket, as well as between telescopes and electronics box

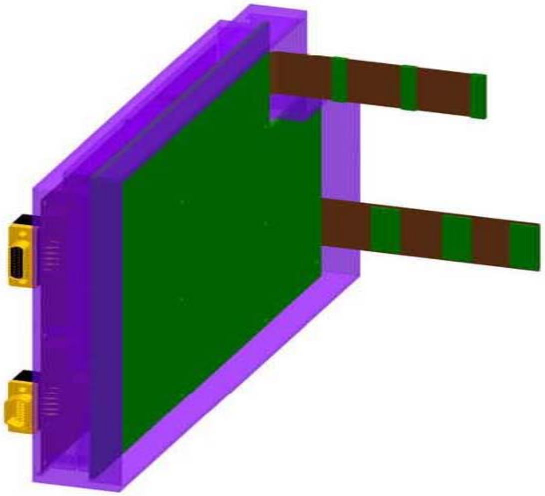
EPI-Hi Electronics Enclosure (1/4)

- Electronics box is made up of 4 major components, the LVPS Assembly, the DPU/HV Bias Assembly, the HET/LET1 Electronics Assembly, and the LET2 Electronics Assembly
- Each Electronics Assembly is mounted in a perimeter style frame
- All “frames” when assembled together will provide a continuous RF shield for internal electronics
- Wall thickness will be minimum 1,0 mm (~40 mils) for radiation dose shielding
- Internal shielding between critical components will create separate shielded areas as necessary for proper electronics function
- Board interconnect is achieved using rigid/flex boards with built-in cables terminating to individual nanonics/microstrip connectors on mating boards
- Connections to the S/C will be via standard Micro-D connectors

EPI-Hi Electronics Enclosure (2/4)

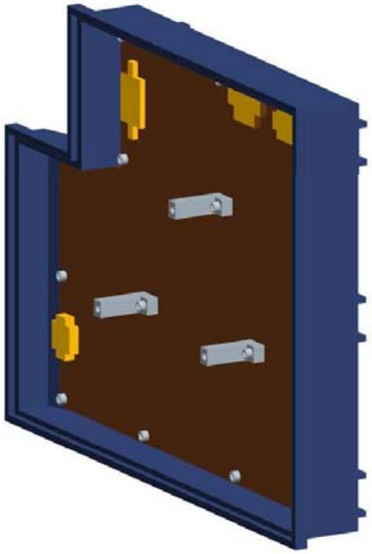


- DPU Board (mounted in one side of frame)
  - Flex connection to telescope boards
  - Flex connection to LVPS
  - S/C connectors (PCB mount)
  - PCBs mounted to machined in posts in chassis

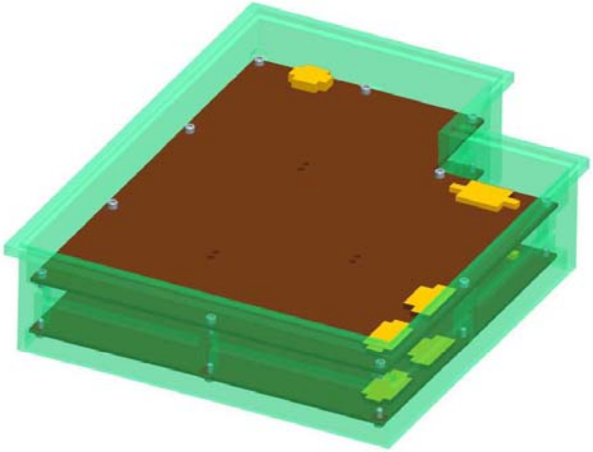


- Bias Supply Board (mounted in one side of frame)
  - Flex connection to 3 detector boards
  - Flex connection to DPU board
  - R/F shielding
  - PCBs mounted to machined in posts in chassis.

EPI-Hi Electronics Enclosure (3/4)

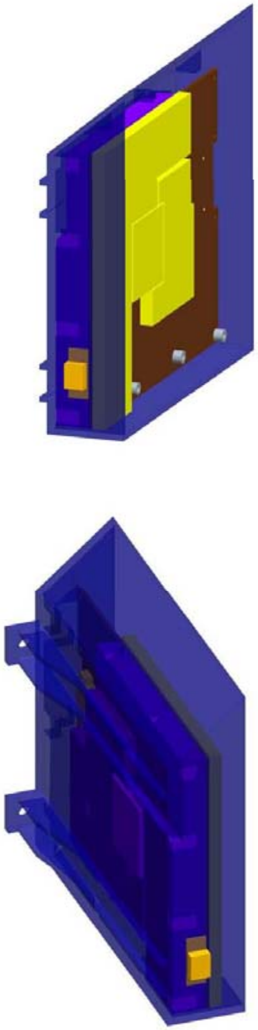


- LET2 Telescope Electronics Assembly
  - Receives flex connection from Bias Board
  - Receives flex connection from DPU Board
  - Receives 2 flex connections from telescope
  - Housing provides feet for Instrument to bracket mounting



- HET & LET1 Electronics Assembly (each board)
  - Flex connection from Bias Board
  - Flex connection from DPU Board
  - 2 flex connections from telescope
  - PCBs mounted to machined in posts in chassis

EPI-Hi Electronics Enclosure (4/4)



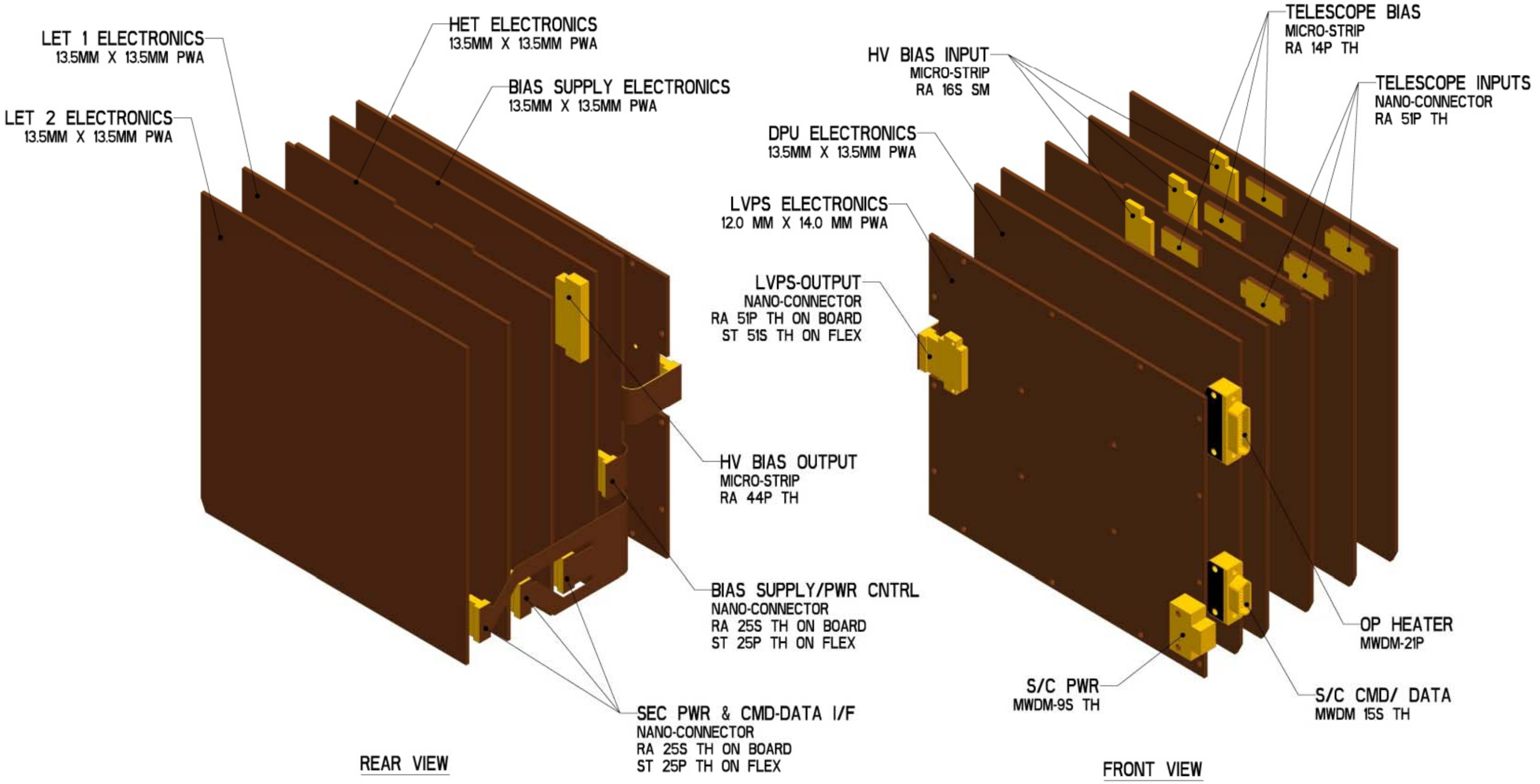
Low Voltage Power Supply

- Receives flex connection from DPU Board
- S/C connectors (PCB mount)
- Individually shielded primary/secondary circuits top and bottom
- Housing is tapered to avoid HET telescope FOV
- Housing provides feet for instrument to bracket mounting
- PCBs mounted to machined in posts in chassis

*LVPS Board provided by APL

*Chassis and shields designed/provided by GSFC

EPI-Hi Interconnect



EPI-Hi Thermal Isolation

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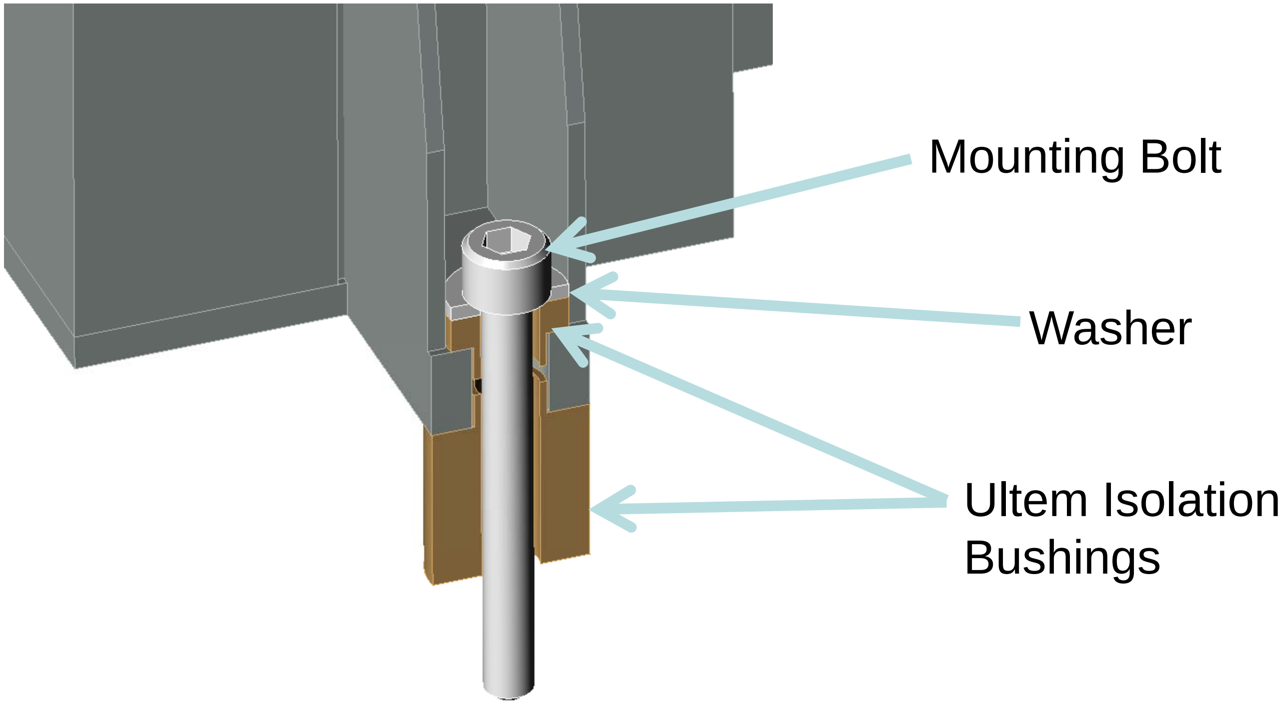
Typical Mounting Foot Showing Thermal Isolation



EPI-Hi Mount Design Requirements

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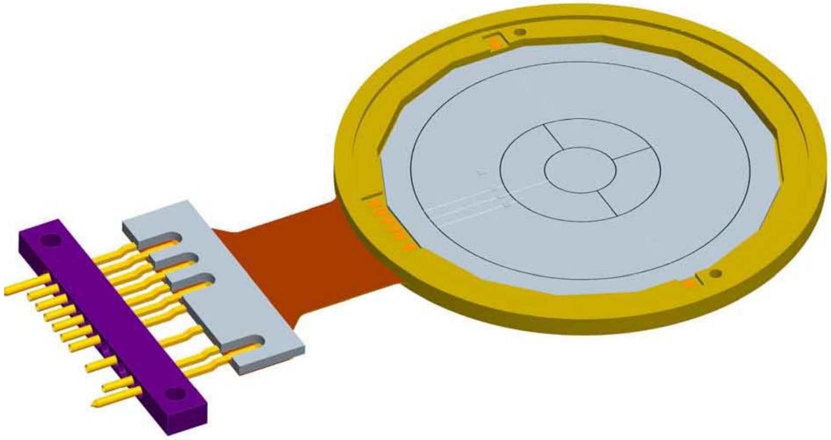
Detector Mounts

- Able to transmit signals from silicon detectors, via wire bond connections to output connector
- Allows the stacking of detectors maintaining 0,5 mm spacing surface-to-surface between thickest detectors (1,0 mm)
- Allows any detector to be stacked face-up or face-down with any other detector
- Allows for the protection of wire bonds from being crushed on either side when placed on flat surface during storage and/or test
- Provides electrical breakdown protection next to detector, when stacked, of up to 200 V differential between crown of HV wire bonds to conductive surface of opposing detector.

EPI-Hi Detector Mount (1/2)



- Recessed detector shelf for silicon detector installation
- Micro-strip connector output
- Flex stiffener to rigidize the area where connector is mounted
- Alignment achieved with alignment pins and concentric stacking shelves on mount and connector
- Tolerancing for mounts will be tightly constrained, but within current CNC machining capabilities
- Detector alignment will be verified through measurement and testing on assembled flight detectors

EPI-Hi Detector Mount (2/2)

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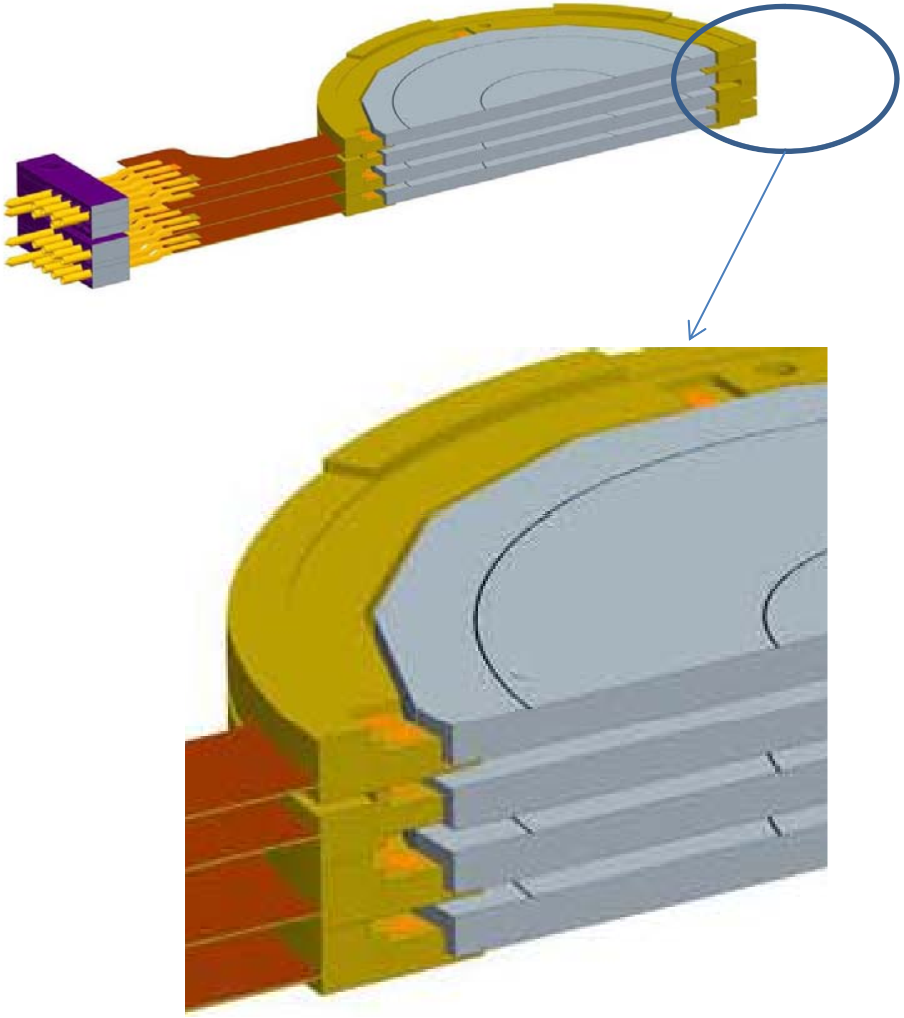

- Mount design allows stacking of detectors face-to-face, face-to-back and back-to-back while maintaining same spacing
- Mounts are spaced 1,5 mm apart when stacked allowing for 0,5 mm separation between thickest detectors
- Detector voltage ranges from ~2 V up to ~200 V.
- Mounts provide adequate spacing/protection for wire bond clearance

EPI-Hi Telescope Design (1/2)

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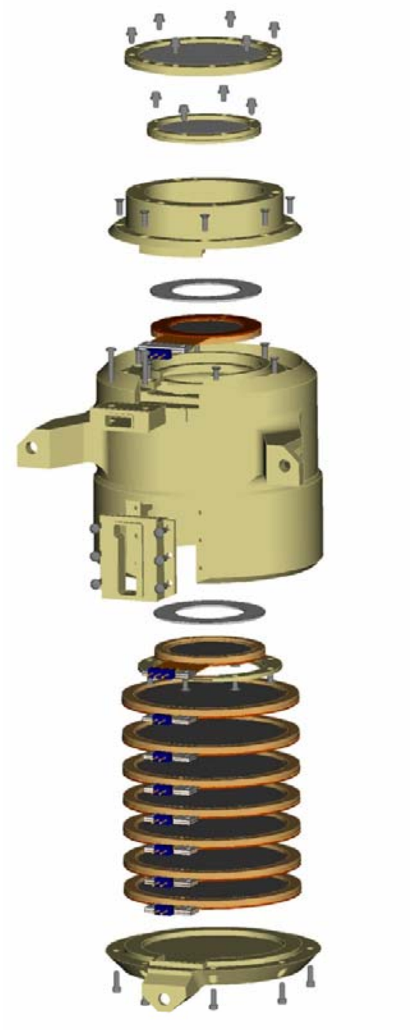
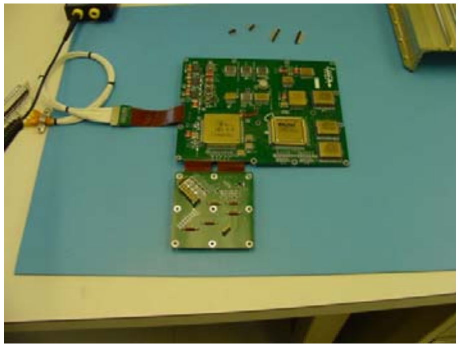
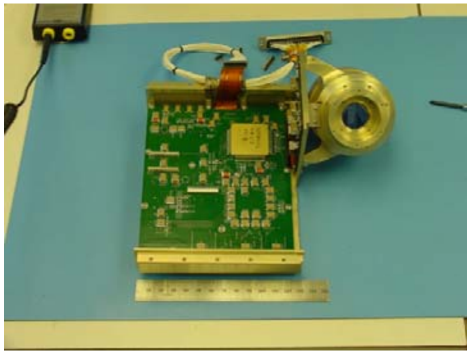
- 3 telescopes comprised of silicon wafer detectors
- Provides ~6,0 mm of aluminum shielding to block unwanted particles from entering through the housing body
- Will have multiple foils for micro-meteorite/light protection
- Mounted directly to the top of the enclosure, allowing the flex interconnect cable to be routed internally to provide proper RF shielding
- Will be thermally isolated from the electronics enclosure
- Will all have red-tag covers over all aperture openings

EPI-Hi Telescope Design (2/2)



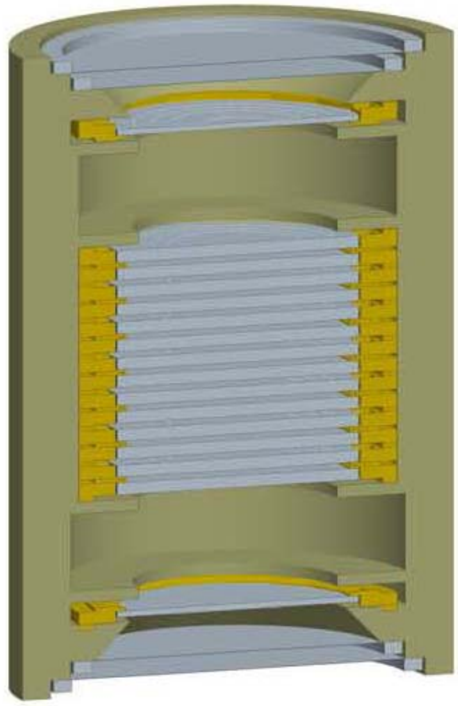




- Heritage design
- Uses alignment pins to stack detectors in telescope body
- Mounting bracket designed into telescope body
- Output signal cable will be completely enclosed in assembly, providing proper shielding

Pictures shown are of STEREO\HET telescope

EPI-Hi High Energy Telescope



- 2- ~127 µm (5 mil) Foils for micro-meteorite /light protection on each end
- Comprised of 16 silicon wafer detectors mounted in flex-rigid mounts
- The front two detectors at each end are spaced apart in order to set a 90° FOV angle

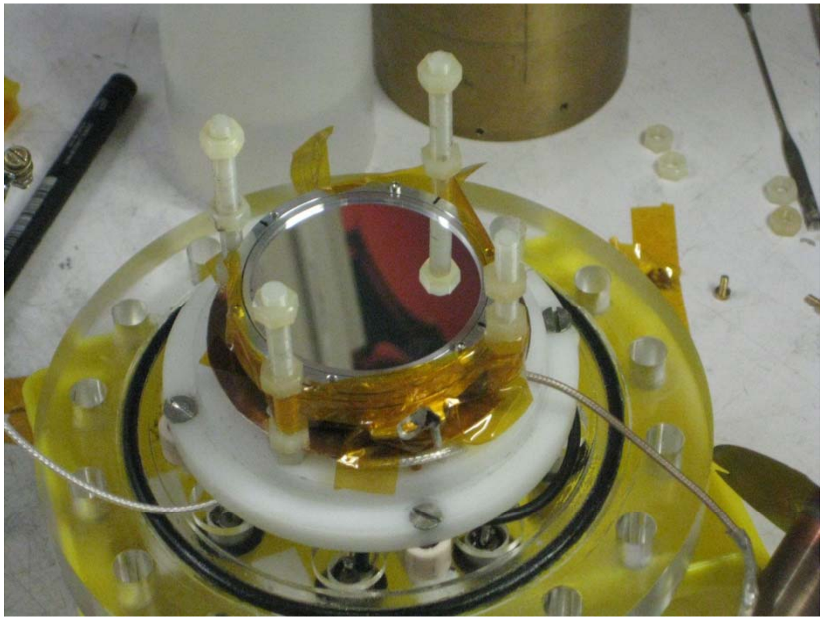
EPI-Hi Low Energy Telescopes

(LET1 shown)

- LET1
  - Double-ended FOV
  - 3 foils for micro-meteorite/light protection on each end
    - Outer foil to be 2 µm polyimide.
    - Inner 2 foils to be 1 µm polyimide.
  - Comprised of 10 silicon wafer detectors mounted in flex-rigid mounts
  - The front 3 detectors at each end are spaced apart in order to set a 90° FOV angle
- LET2
  - Single-ended FOV
  - Comprised of one half of an LET1 telescope

EPI-Hi LET Foils (1/2)

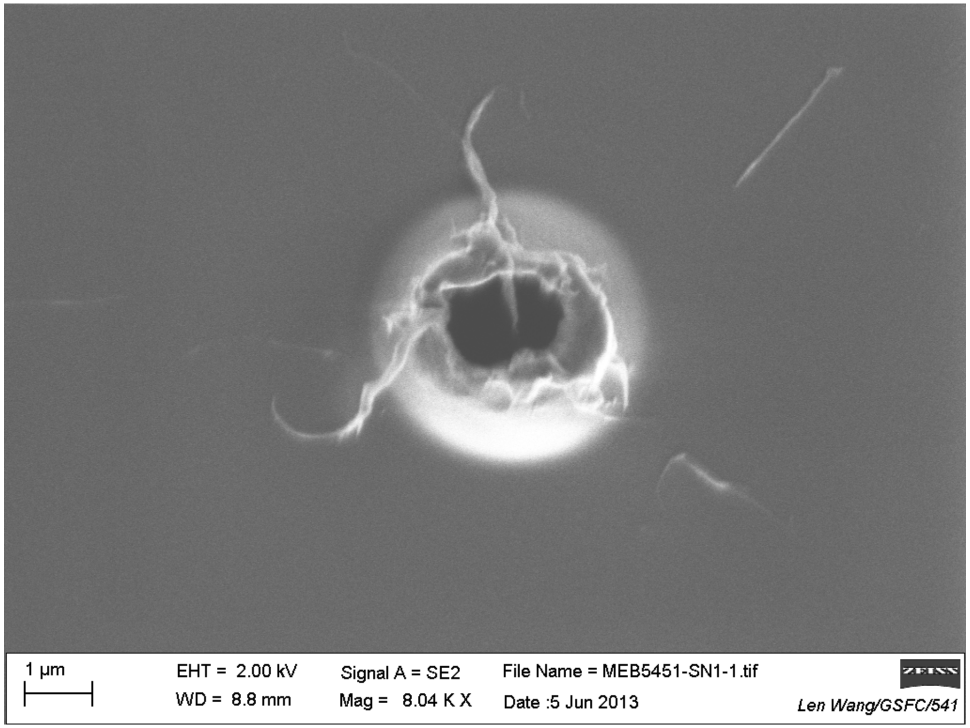
- All foils will be aluminized polyimide manufactured by the Luxel corporation
- Full sized prototype foils (1, 2, and 4 micron) have been manufactured by Luxel during Phase B
- Prototype foils have been thoroughly tested, including a high-velocity dust test at the Heidelberg dust accelerator



Stack of three Luxel foils (1 micron, 2 micron and 4 micron) in dust accelerator set up.

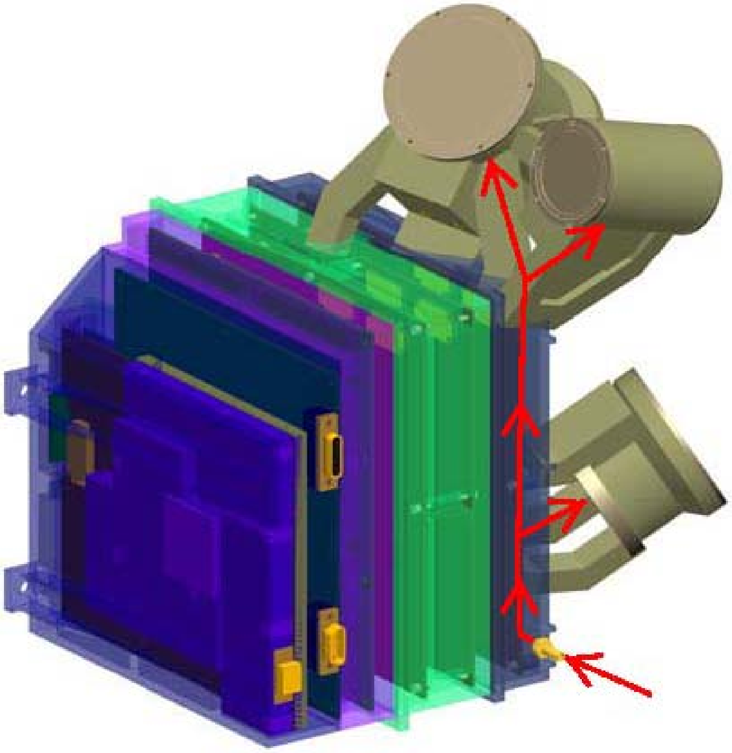
EPI-Hi LET Foils (2/2)

- Dust test shows that holes do not propagate
- Melted polyimide actually appears to strengthen the edge of the hole
- Thermal requirements met with aluminization on the inside surface only



Atomic Force Microscope image of dust impact in 1 micron thick polyimide. Image is from back (exit) side.

EPI-Hi Telescope Purge



- Purge will be established to the individual telescopes with a single purge fitting on the outside of the instrument
- Purge will be distributed internally through a manifold that will send the purge gas into the center volume of each telescope

EPI-Hi Telescope Venting

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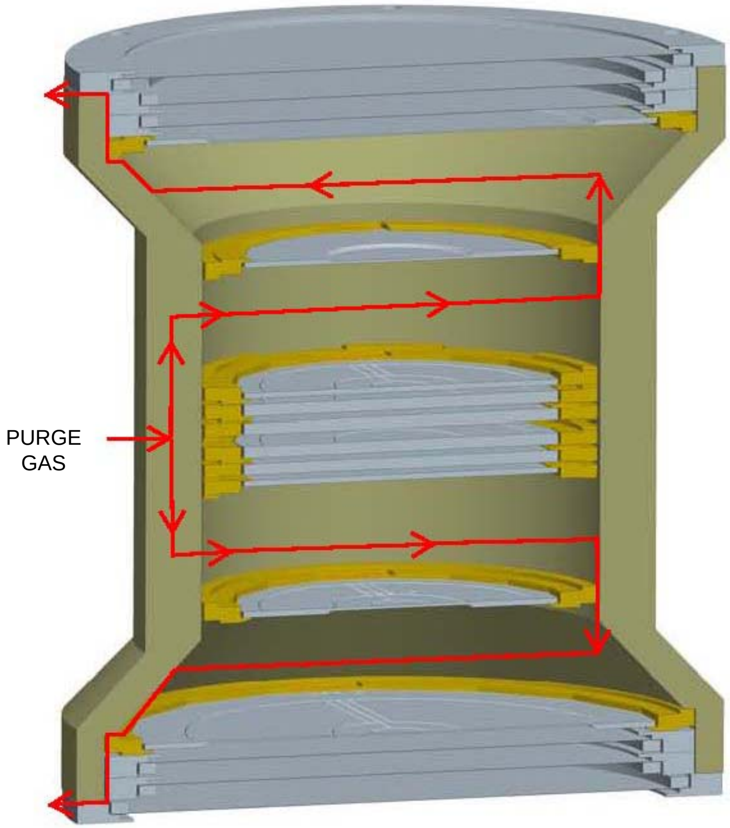

- Heritage venting strategy used on several prior missions
- Purge gas enters thru housing into open center volumes
- Gas then flows outwards thru vent slots in housing shelves, detector mounts and foil rings
- Gas exits each end of the telescope thru vent slots below outer foil

EPI-Hi Assembly Flow (1/3)

Electronics Assembly Flow

- Assembled board will be put into its corresponding frame
- Electronics boards will be tested independently
- Boards will then be interconnected and fanned out like a book for troubleshooting and further testing
- Purge hoses and fittings will be installed
- External RF shields will be added before assembly is closed up
- Frames will then be bolted together, and the last remaining board cabling is installed/connected through access panels in frames
- Access panel covers installed.
- Test, Test, Test…

EPI-Hi Assembly Flow (2/3)

Telescope Assembly Flow

- Processed Silicon wafers placed in mounts and tested
- Detector selections made and mount thicknesses recorded
- Detectors stacked in telescope w/ proper shims, covers and spacers
- Polyimide Foils installed in collimators
- Collimators/covers installed onto telescope
- Red Tag/Protective covers installed
- Telescope tested w/ electronics and radioactive sources
- Stored for integration to box

EPI-Hi Assembly Flow (3/3)

Telescope to Electronics Box Assembly

- Mating cable assembled over detector pins and secured in place
- Closeout cover installed over cable
- Telescope positioned over electronics, and cable fed through corresponding frame
- Cables connected at electronics end through access panels in frames
- Access covers installed
- Test, Test, Test…
- Telescopes mapped by source testing/accelerator calibrations

EPI-Hi Peer Review Results

- Peer Review conducted earlier this month
- No Actions received as of yet
- Issues noted:
    - Thin detectors and implications of environments
        - These will be considered and appropriate testing will be performed
    - PCB/wall-mounted connectors
        - Appropriate measures will be taken to minimize stresses during installation
    - Whether “bolt slip” during instrument/telescope mounting will be sufficient enough to keep telescope FOVs within spec
        - This will be analyzed and verified