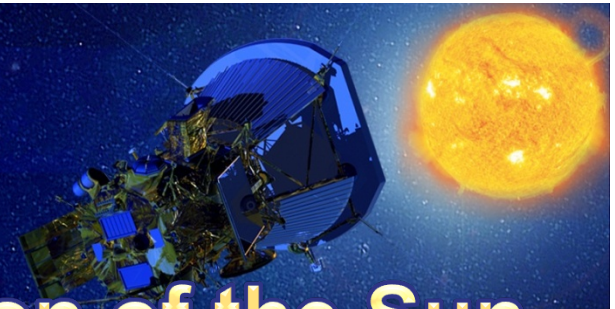
Solar Probe Plus

A NASA Mission to Touch the Sun



Integrated Science Investigation of the Sun
Energetic Particles

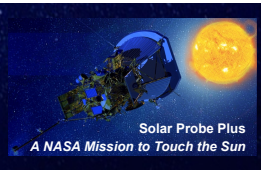
Preliminary Design Review

05 – 06 NOV 2013

EPI-Hi Mechanical

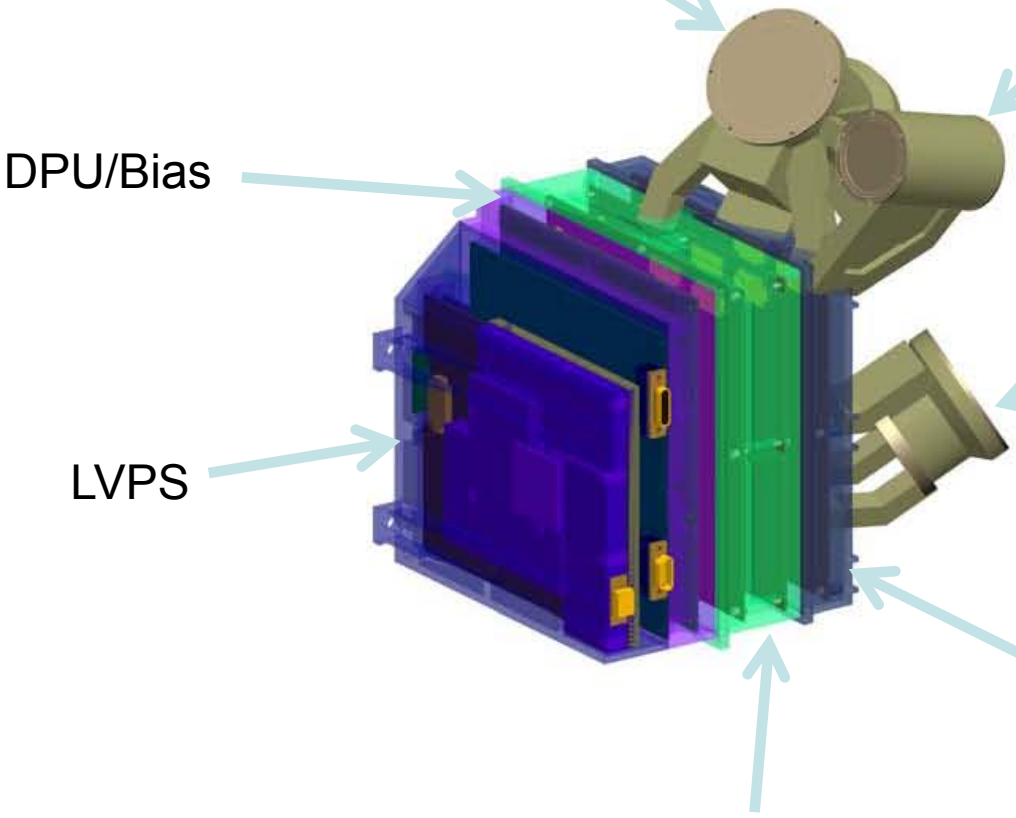
Sandy Shuman

EPI-Hi Outline



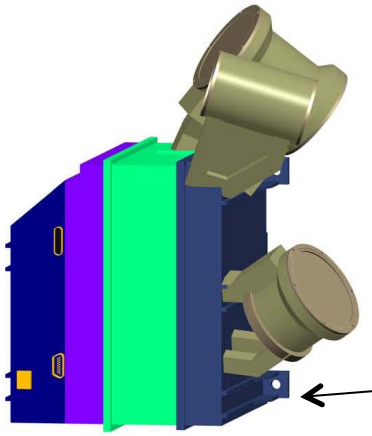
- Overview of Instrument Configuration
- Location on Spacecraft
- Telescope FOV's
- Mass Allocation
- Detailed description of the instrument mechanical design
  - Electronics configuration
  - Detector holders
  - Telescope housings
  - Cable routing within Electronics housing
- Assembly process
  - Electronics
  - Telescopes
  - Telescope to Electronics
- Summary of Peer Review results

EPI-Hi Component Configuration

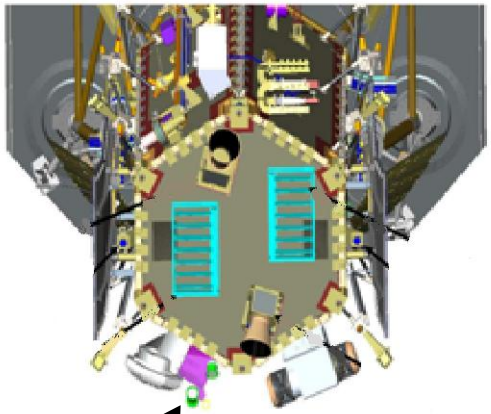


EPI-Hi Instrument

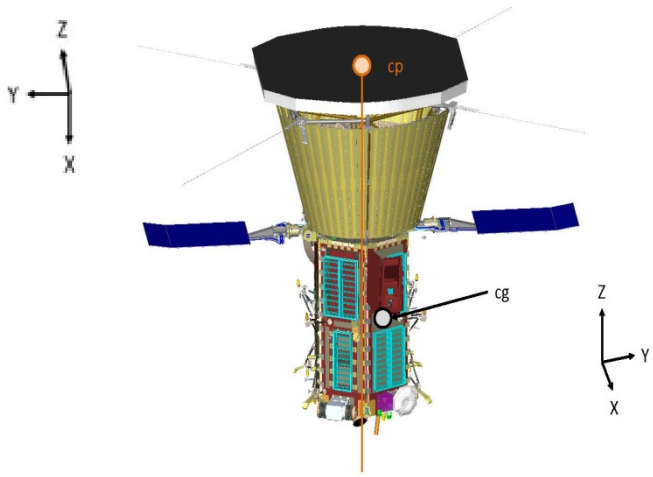
- Location of instrument on spacecraft
  - Located on +X side (RAM side).
  - Lower right mounting bolt on instrument located at: X= 46.16
    Y= 23.39
    Z= 6.13

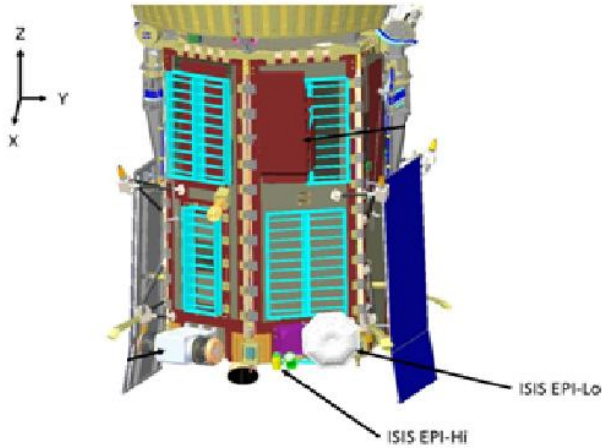


S/C MOUNTING LOCATION REFERENCE



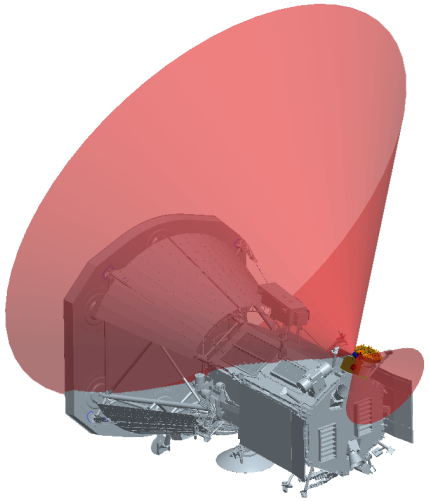
ISIS-EPI-HI



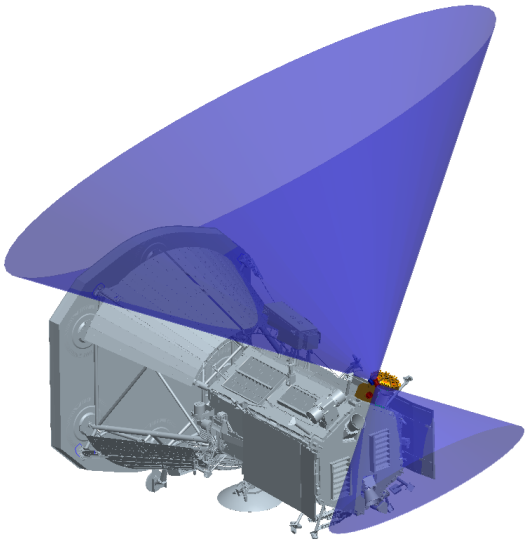


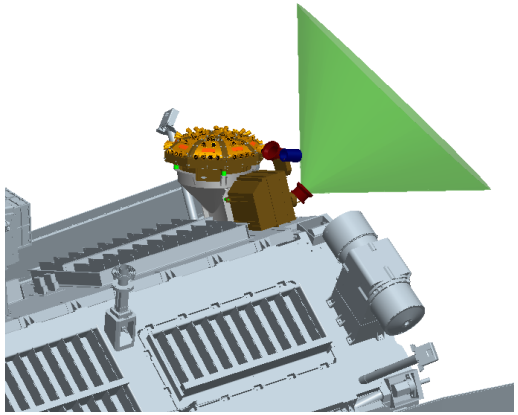
RAM SIDE

EPI-Hi Instrument FOV's



- HET conical 90 Degree FOV
  - Double–ended.
  - 20 degrees above the S/C-Sun line.
- LET1 conical 90 Degree FOV
  - Double–ended.
  - 45 degrees above the S/C-Sun line.
- LET2 conical 90 Degree FOV
  - Single–ended.
  - Orthagonal to LET1 Telescope (135 degrees from S/C-Sun line.

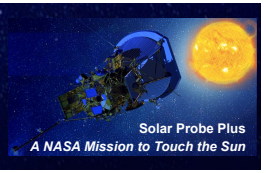




EPI-Hi Mass Allocations

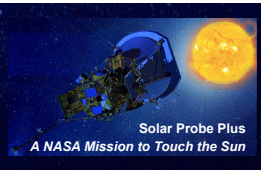
Subsystem	Mass [g]
LET1 telescope LET1 board	225 258
LET2 telescope LET2 board	145 233
HET telescope HET board	120 250
DPU board Bias Supply & RF shields LVPS & RF shields	197 225 + 130 160 + 100
Elec. box, hardware & shielding Telescope brackets Thermal hardware MLI blankets	925 + 250 +100 160 50 100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

EPI-Hi Enclosure Requirements



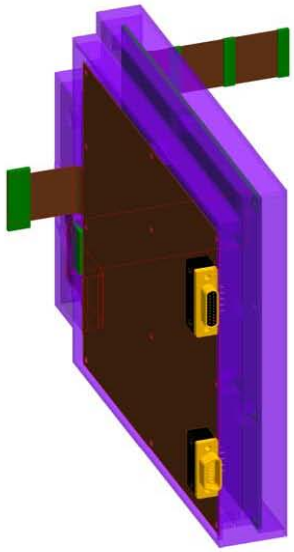
- Work within tight mass constraints.
- Design to meet S/C launch environment requirements for Vibration, Acoustics and Thermal conditions.
- Design for radiation dose shielding environment.
- Package boards maintaining adequate parts clearance board to board.
- Provide adequate RF and/or ground shielding 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

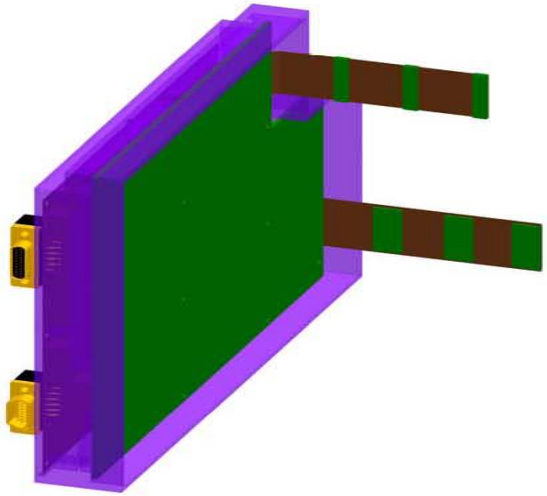


- Electronics box is made up of 4 major components, the LVPS Assembly, the DPU/HV Bias Assembly, the HET/LET1 Electronics Assembly and the LET2 Electronics Assembly.
- Each Electronics Assembly is mounted in a perimeter style frame.
- All “frames” when assembled together will provide a continuous RF shield for internal electronics.
- Wall thickness will be minimum 1,0mm (~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 w/ 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

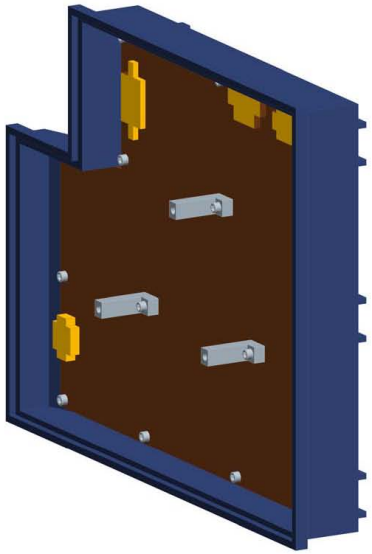


- DPU Board (mounted in one side of frame)
  - Flex connection to Telescope Boards.
  - Flex connection to LVPS.
  - S/C connectors (PCB mount).
  - PCB's mounted to machined in posts in chassis.

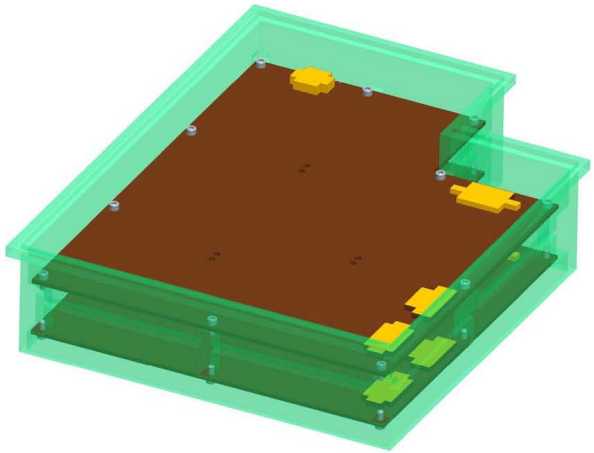


- Bias Supply Board (mounted in one side of frame)
  - Flex connection to 3 Detector Boards.
  - Flex connection to DPU Board.
  - R/F shielding.
  - PCB's mounted to machined in posts in chassis.

EPI-Hi Electronics Enclosure

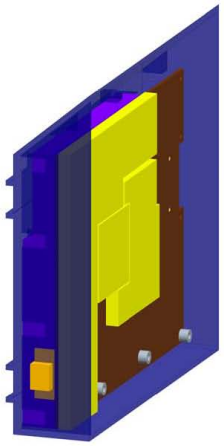


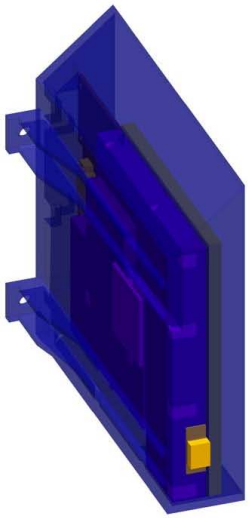
- LET2 Telescope Electronics Assembly
  - Receives flex connection from Bias Board
  - Receives flex connection from DPU Board
  - Receives 2 flex connections from Telescope
  - Housing provides feet for Instrument to bracket mounting.



- HET & LET1 Electronics Assembly (each board)
  - Flex connection from Bias Board
  - Flex connection from DPU Board
  - 2 Flex connections from Telescope
  - PCB's mounted to machined in posts in chassis

EPI-Hi Electronics Enclosure

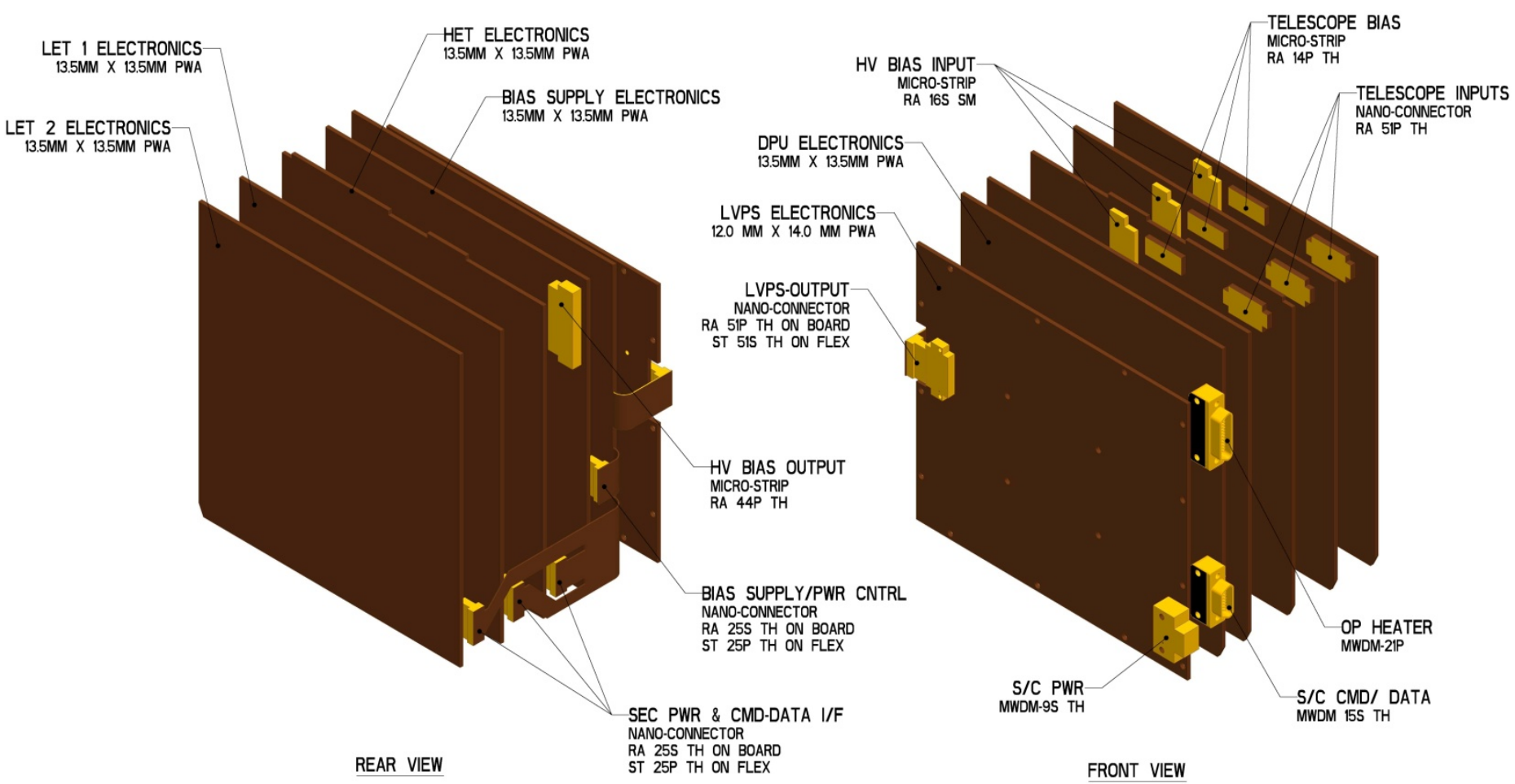




- Low Voltage Power Supply
  - Receives flex connection from DPU Board
  - S/C connectors (PCB mount).
  - Individually shielded primary/secondary circuits top and bottom.
  - Housing is tapered to avoid HET Telescope FOV.
  - Housing provides feet for Instrument to bracket mounting.
  - PCB's mounted to machined in posts in chassis.

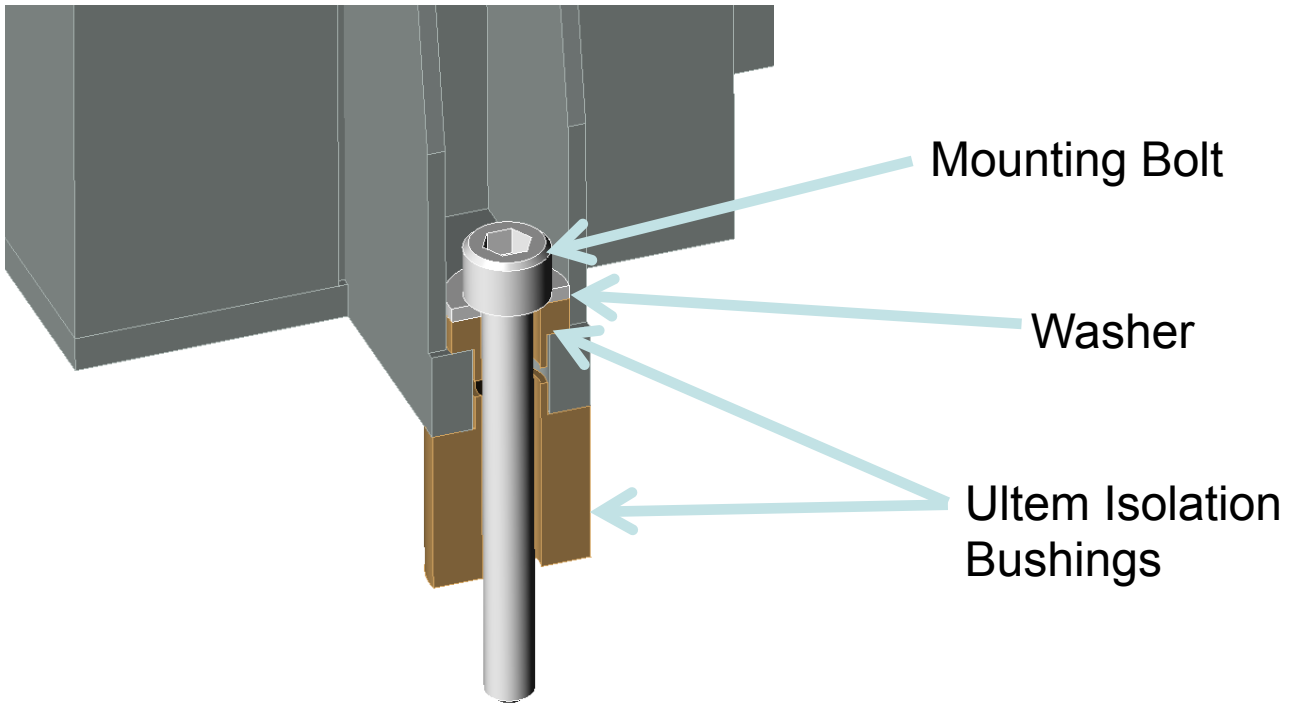
*LVPS Board provided by APL
*Chassis and shields designed/provided by GSFC

EPI-Hi Interconnect



EPI-Hi Thermal Isolation

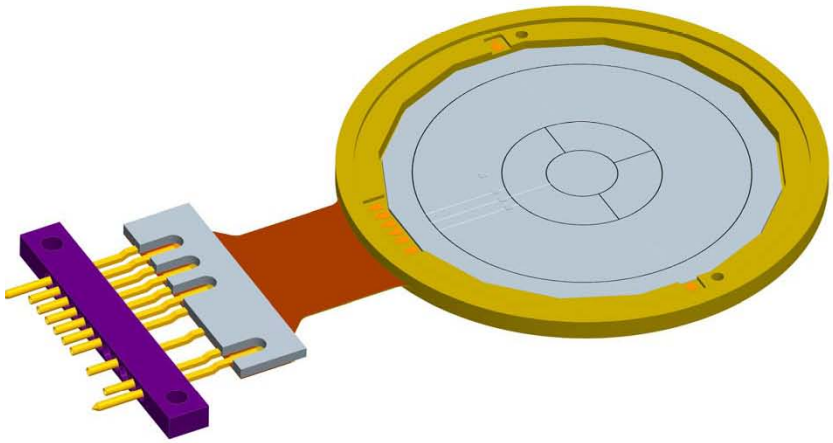
Typical Mounting Foot Showing Thermal Isolation



EPI-Hi Mount Design Requirements

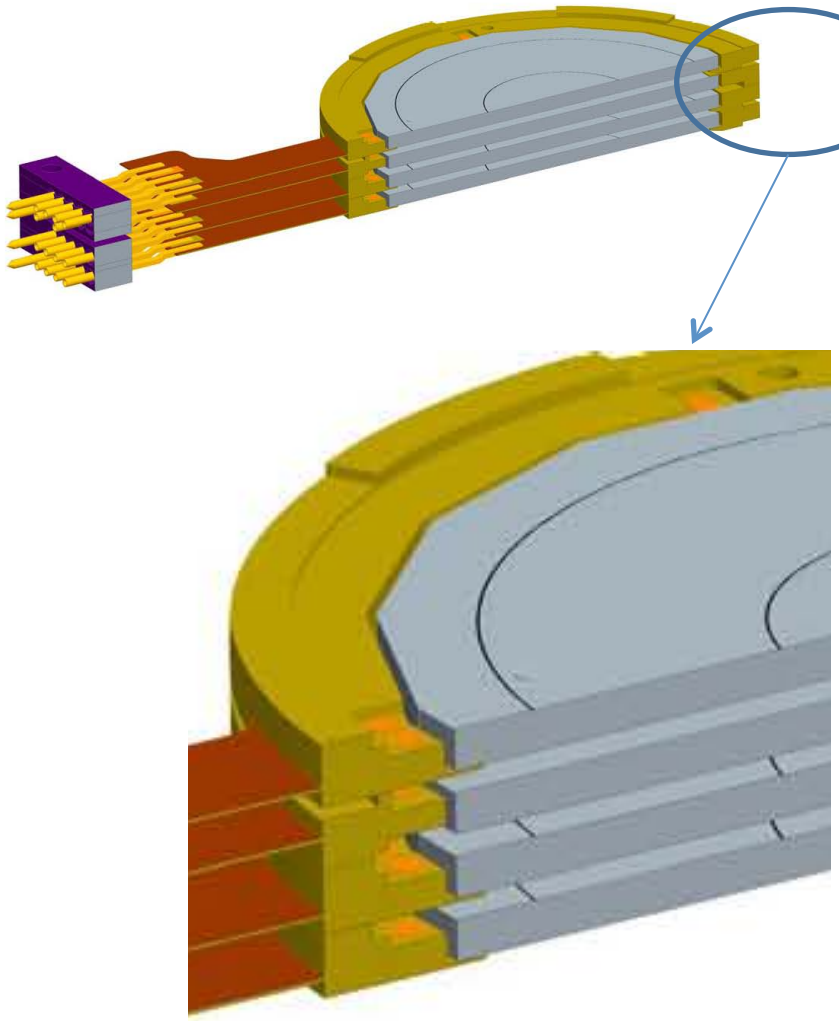
- Detector Mounts
  - Able to transmit signals from silicon detectors, via wire bond connections to output connector.
  - Allows the stacking of detectors maintaining 0,5mm spacing surface to surface between thickest detectors (1,0mm) .
  - Allows any detector to be stacked face up or face down with 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 to next detector, when stacked, of up to 200V differential between crown of HV wirebonds to conductive surface of opposing detector.

EPI-Hi Detector Mount



- 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

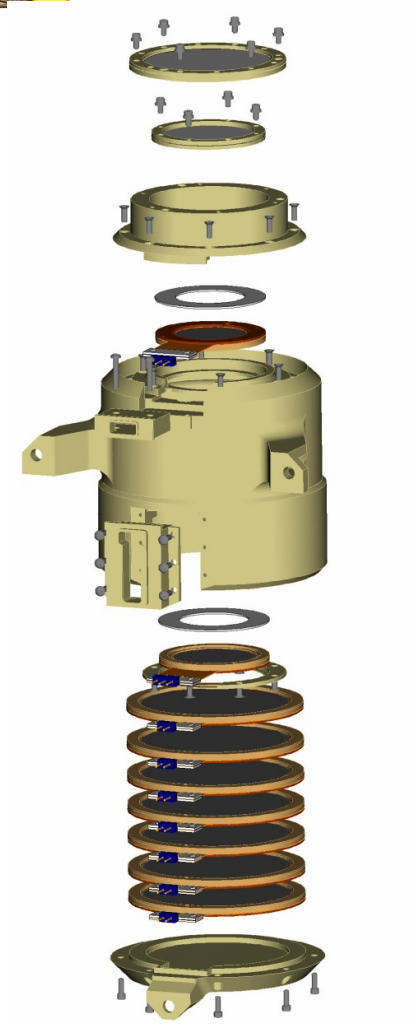


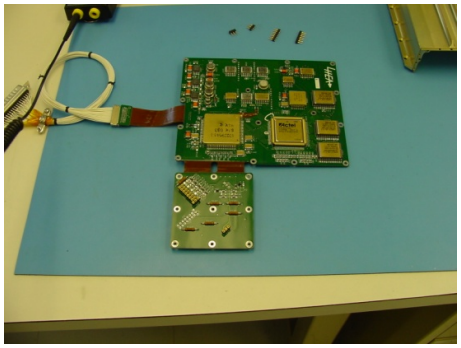
- Mount design allows stacking of detectors face to face, face to back and back to back while maintaining same spacing.
- Mounts are spaced 1,5mm apart when stacked allowing for 0,5mm separation between thickest detectors.
- Detector Voltage ranges from ~2V up to ~200V.
- Mounts provide adequate spacing/protection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

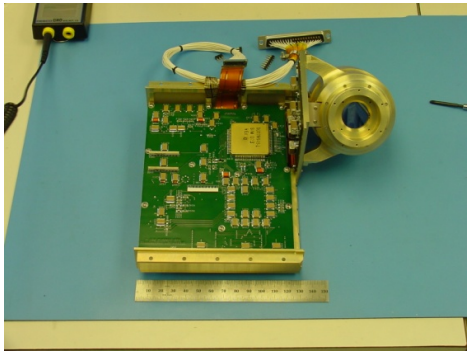
EPI-Hi Telescope Design

- 3 Telescope comprised of silicon wafer detectors.
- Provides ~6,0mm 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



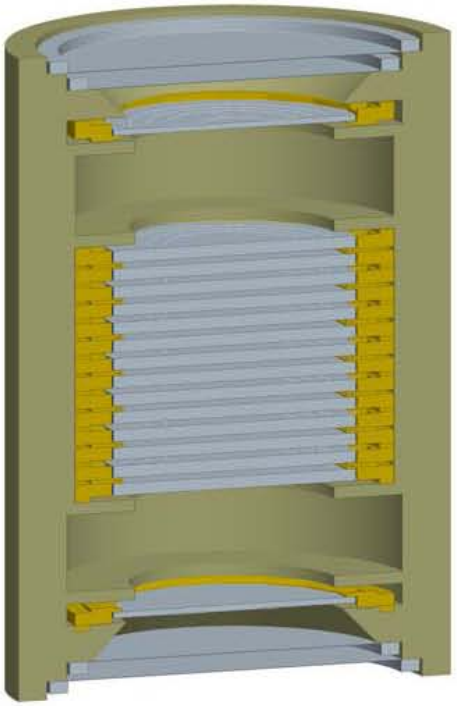




- Heritage design.
- Uses alignment pins to stack detectors in telescope body.
- Mounting bracket designed into telescope body.
- Output signal cable will be completely enclosed in assembly providing proper shielding.

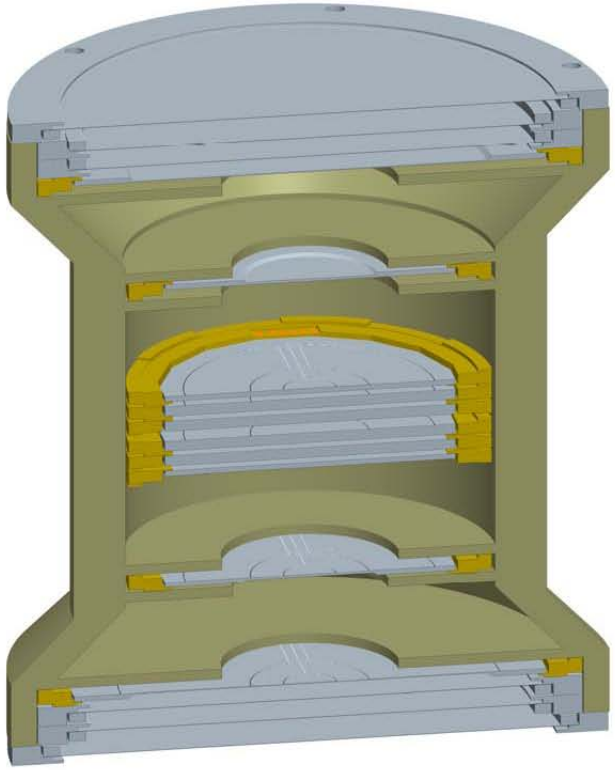
- Pictures shown are of STEREO\HET Telescope

EPI-Hi High Energy Telescope



- 2- ~127um (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 degree FOV angle.

EPI-Hi Low Energy Telescopes

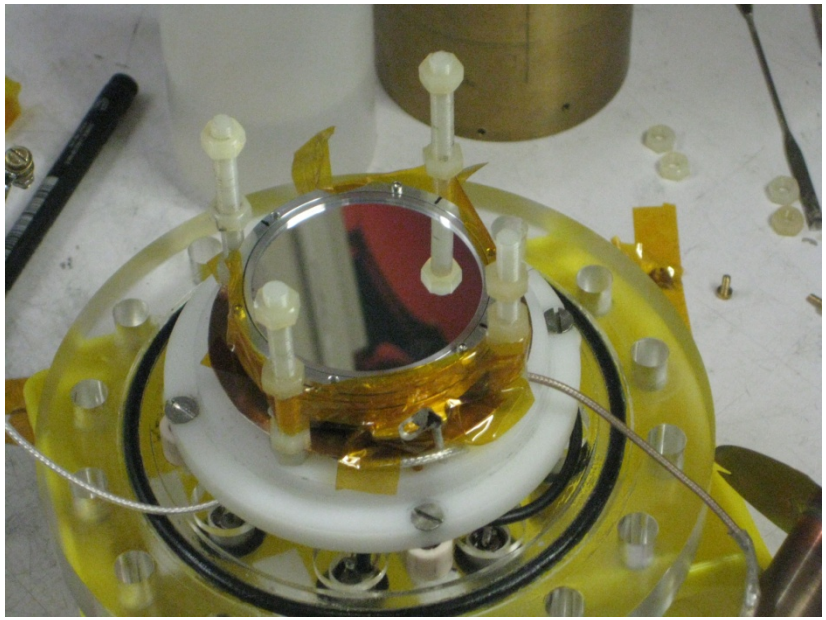


(LET1 shown)

- LET1
  - Double Ended FOV.
  - 3 Foils for micro-meteorite/light protection on each end.
    - Outer foil to be 2um polyimide.
    - Inner 2 foils to be 1um 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 degree FOV angle.
- LET2
  - Single-ended FOV.
  - Comprised of one half of a LET1 Telescope.

EPI-Hi LET Foils

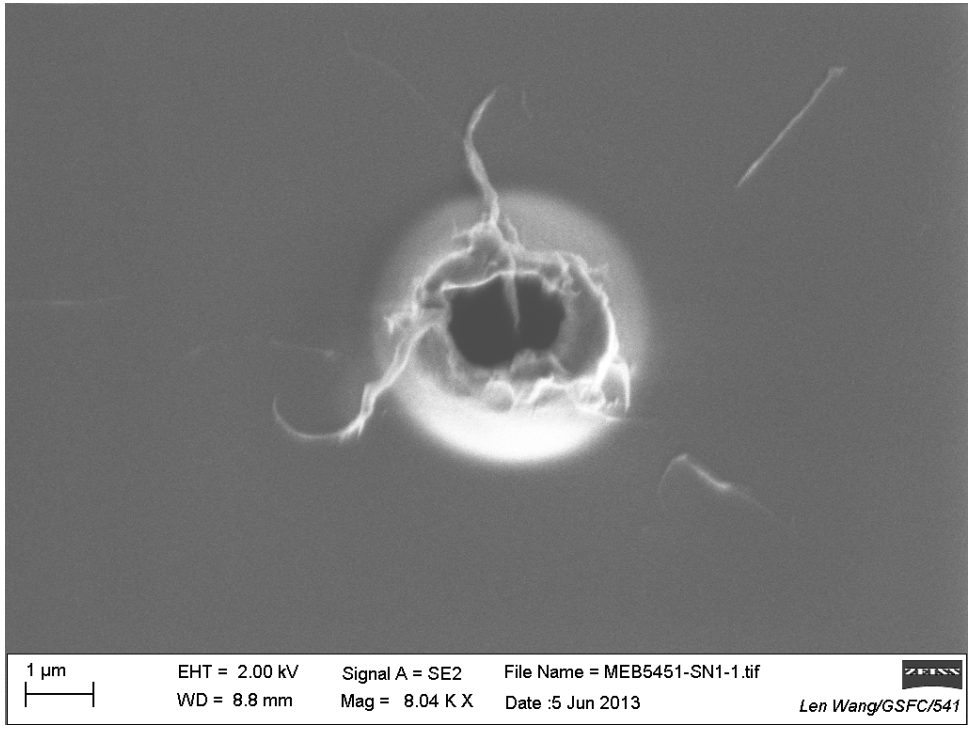
- All foils will be aluminized polyimide manufactured by the Luxel corporation.
- Full sized prototype foils (1, 2, and 4 micron) have been manufactured by Luxel during Phase B.
- Prototype foils have been thoroughly tested, including a high-velocity dust test at the Heidelberg dust accelerator



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

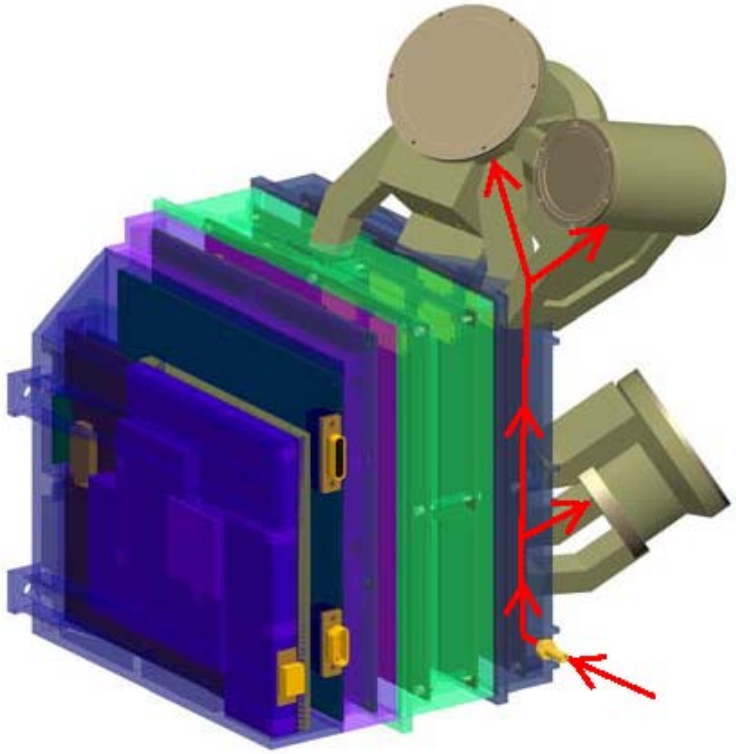
EPI-Hi LET Foils

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



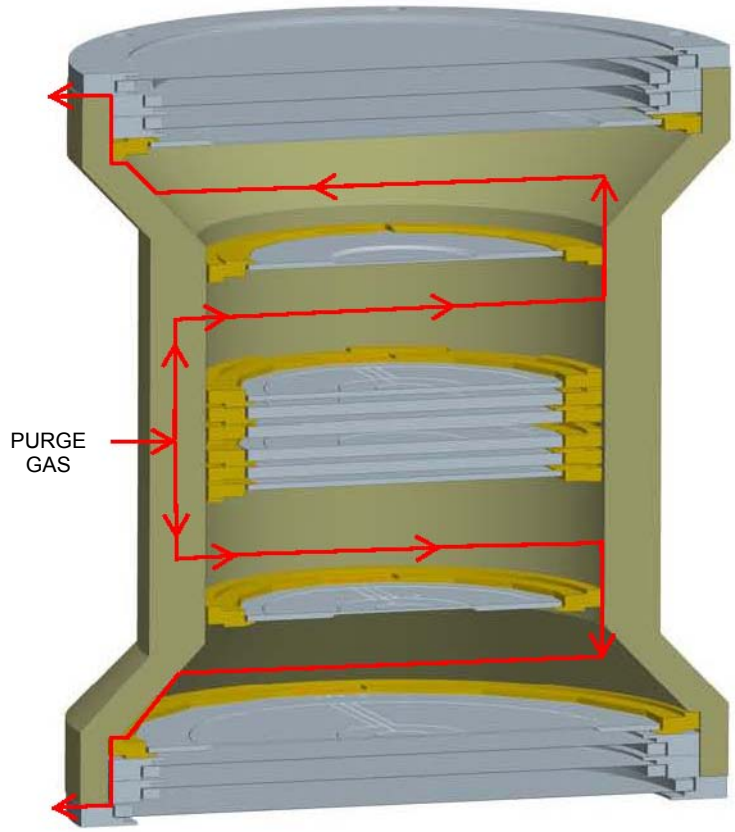
Atomic Force Microscope image of dust impact in 1 micron thick polyimide. Image is from back (exit) side.

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

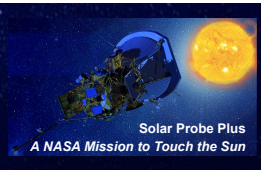


- Heritage venting strategy that was used on several prior missions.
- Purge gas enters thru housing into open center volumes.
- Gas then flows outwards thru vent slots in housing shelves, detector mounts and foil rings.
- Gas exits each end of the telescope thru vent slots below outer foil.

EPI-Hi Assembly Flow

- **Electronics Assembly Flow**
  - Assembled board will be put into it's corresponding frame.
  - Electronics boards will be tested independently.
  - Boards then 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 then bolted together and last remaining board cabling is installed/ connected through access panels in frames.
  - Access panel covers installed.
  - Test, Test, Test…

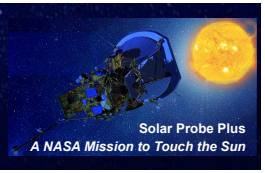
EPI-Hi Assembly Flow



- **Telescope Assembly Flow**

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

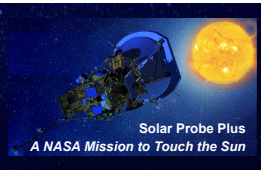
EPI-Hi Assembly Flow



- **<u>Telescope to Electronics Box Assembly</u>**

- Mating cable is 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 thru access panels in frames.
- Access covers installed.
- Test, Test, Test…
- Telescopes mapped by source testing/accelerator calibrations.

EPI-Hi Peer Review Results



- Peer Review was conducted earlier this month, summary has been received, but no Actions received as of yet.
  - Concern was shown for thin detectors and the implications of environments thereon…these will be considered and appropriate testing will be done.
  - Concern was shown over PCB/wall mounted connectors. Appropriate measures will be taken to minimze stresses during installation.
  - Concern was raised about whether “bolt slip” during instrument/ telescope mounting will be sufficient enough to keep Telescope FOV’s within spec. This will be analized and verified.