C.2.4 IMPACT Boom

The IMPACT Boom is used to mount the STE, SWEA, Magnetometer and SWAVES Air Coil (if selected) instruments in a fixed position relative to the spacecraft. The boom also provides the mounting and retaining structures for these instruments during launch. The boom will have a deployable section, with a fixed section mounted on the deployed end, to which the Science complement is attached. The IMPACT Boom consists of the following substructures:

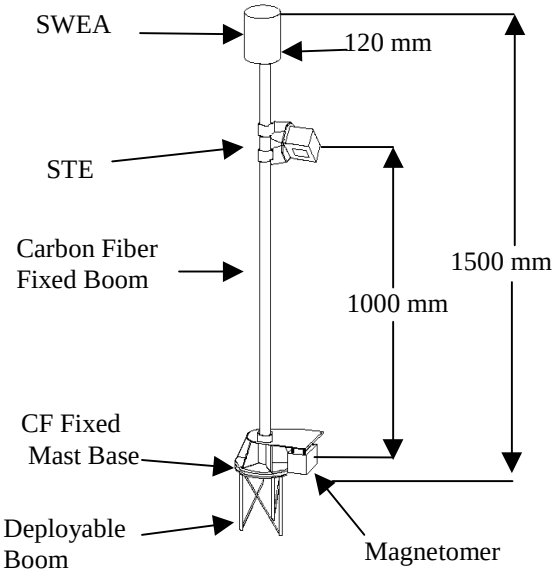

Figure C.2.4 IMPACT Boom

C.2.4.1 Deployable Mast (Astromast) Section

A 4.7 m deployable longeron mast, here referred to as the "astromast," is used to extend the IMPACT fixed boom away from the spacecraft. The astromast is stowed for launch by coiling the longerons into a cylindrical canister. An initiator (e.g.: pyrotechnic, paraffin, or SMA) begins the deployment by releasing the deployment governor lock mechanism (by ground command). The astromast then self-deploys using the stored strain energy (from stowing) to form the familiar triangular space frame. The deployment rate is governed by an axial lanyard attached to a spool that is spin-rate limited by a rotational damper. The astromast will be conductive along its length according to applicable EMC specification.

The astromast will mount to the spacecraft using mounting hardware attached to the canister. The mount provides for clearance of the magnetometer helical path during deployment. The deployment initiator and 'housekeeping' circuit will be through a 15 pin subminiature connector that will connect directly to the spacecraft bus.

The fixed mast mounts to the end plate of the astromast. The proximity of the magnetometer requires that the end plate be non-metallic, so an epoxy-glass reinforced material is used. The astromast will provide attachment points for two cable bundles running parallel and external to the longerons. These bundles will attach via shielded connectors to the spacecraft bus. The fixed mast is retained for launch by a caging mechanism mounted to the lower deck of the spacecraft. This mechanism will release the fixed mast prior to the release of the astromast

The astromast is an off-the-shelf technology, with multiple suppliers and known heritage. The estimated natural frequency is 0.5 Hz, and stiffness is expected to be $>10^7$ kg-m^2.

Procurement of the astromast is 52 weeks ARO. UCB purchasing department will procure these units, and provide project management and engineering.

The deployable mast safety requirements are: retaining by safety bolt during non-deployment testing; personnel safety and static protection for electroexplosive devices (EEDs); controlled environment while assembly is deployed.

For flight acceptance testing, an off-loading mechanical ground support equipment (MGSE) system will be required to simulate a zero gravity deployment. This system will be available for spacecraft level deployment testing, should that be required. The known requirements are: free-standing base, a rail with sliding, low friction trolleys to support the full length of the astromasts, and a rotational attachment fixture to allow unconstrained fixed mast movement.

C.2.4.2 Carbon Fiber (CF) Fixed Mast Section

The fixed mast is a 1.5-m long, 35mm diameter tube, fabricated from a 1.25-mm thick, epoxy pre-impregnated - carbon fiber woven material. The structural rigidity is achieved by using five layers with the fibers aligned in a 0-90 degree direction for the outer, mid and inner layers, while the two remaining 'sandwiched' layers are oriented at 45 degrees. This maximizes the axial and torsional strength while minimizing mass. For fabrication, the material is draped onto a mandrel of the correct form, and then vacuum-bagged and cured in an oven. The magnetometer mount will be incorporated into the base mounting flange as an integral part of the tube, while the SWEA and STE mounts will be post-bonded. Estimated natural frequency is 11 Hz and a stiffness of $\sim 10^9$ kg-m^2 is expected.

The fixed mast mounts onto the moving end of the deployable astromast, using titanium fasteners. The magnetometer mount is located at the base of the fixed mast, being an integral part of the carbon fiber (CF) fabrication. The fixed mast will provide standoffs and cable attachment points for the SWEA / STE harness. The standoff will provide sufficient clearance between the magnetometer and the harness conductors.

The fixed CF mast will be fabricated at the University of California Berkeley Mechanical Engineering Composite Lab, at the same facilities used

for Lunar Prospector magnetometer boom. The obtaining of the pre-preg fabric is a long lead item: 36-45 weeks. All materials will be procured by UCB purchasing department to applicable specifications.

The SWAVES Air Coil (if selected) will be installed in a groove in the base of the fixed mast mounting plate, between the deployable mount and the fixed mount. There can be provision for the SWAVES Air Coil harness giving sufficient clearance for the magnetometer.

C.2.4.3 Magnetometer Mount

The magnetometer mount will be incorporated into the fixed mast base flange, as mentioned in C.2.4.2, utilizing the high strength and low mass of the CF, and requiring no metallic components except titanium fasteners for the actual attachment of the magnetometer housing. The mount is extended slightly to be a sun-shade for the STE. The mount will provide 1 m distance from STE instrument, and the harnesses will be no closer than 125 mm (the titanium mounting hardware and the cable bundle and connector for the magnetometer will be closer). Standoffs and attachment points are provided for the magnetometer harness.

If the SWAVES Air Coil is added, the effects due to the proximity of the coil to the magnetometer should be investigated.

C.2.4.4 SWEA Mount

The SWEA mounts to the extreme end of the IMPACT boom. An inner tube and outer sleeve fabricated of aluminum are chemically post-bonded (high strength epoxy) to the CF tube to fix the base of the interface plate to the CF fixed mast. This provides a strong, reliable joint between instrument and CF tube. Provision for harness attachment is supplied. The SWEA must be in shadow, so the base plate will provide for this during all anticipated on-station orientations. A coating on the base plate may be chosen to help keep the instrument warm, thus requiring that the plate be thermally isolated from the CF tube. The harness from the spacecraft will attach to the SWEA, and the STE 'pigtail' will also be connected to the instrument. Stand-offs and fastening points will be provided for both.

The mounting plate and associated hardware will be fabricated at UCB. The described post-bond method has been used on many spacecraft: Polar, Fast, LP; all fabricated at UCB.

C.2.4.5 STE Mount

The STE mounting requirements include minimal thermal conduction, so the mounting assembly for the instrument will be fabricated from PEEK, a strong, low-thermally-conductive engineering plastic. The mount will be mechanically and chemically bonded to the narrow tube portion of the fixed mast. The positional location for the instrument will be provided by an assembly jig, to ensure correct orientation of the STE FOV. Due to the thermal requirement, the STE must be shielded from direct sun exposure. This is accomplished by including a shade in the magnetometer mount, which minimizes the mass. The harness for STE is routed to SWEA.

C.2.4.6 Harness Mount

Harnessing for the instruments will consist of 2 or 3 bundles of conductors. One bundle is dedicated to the magnetometer, one for the combined SWEA and STE instruments, and (if selected) one for the SWAVES Air Coil. Their construction will meet the EMC and termination requirements for the STEREO project. The harnesses mount to the longerons of the astromast via standoffs, with canister clearance provided during stowed and deployment conditions. These are provided by the astromast vendor.

C.2.4.7 Alternate Mast Technologies

As part of the on-going design process, two alternative possibilities have been identified for the astromast. As the spacecraft design becomes better known, having these options are important to guarantee achievement of the science objectives. An addition to the existing concept is also presented. These possible solutions will be investigated in more detail during early Phase B. Technology to be used will be decided based on overall suitability for the mission, by doing trade studies of: the extra resources required for the IMPACT boom vs. resource savings for the spacecraft; cost, risk and availability of each technology. Final selection will occur by January 2001.

C.2.4.7.1 Deployable Longeron Type Astromast with Intermediary Plate (Triana Style). There are mass and cost benefits related to shortening the overall length of the IMPACT boom assembly. One possibility is having an intermediate plate installed in the deployable astromast. The magnetometer would then mount to this plate, allowing the fixed mast SWEA /STE assembly to be shortened to ~0.75 m, for an overall length of ~1.3 m. The harness for the magnetometer will require more careful design, and the greater mass and expense of the (more) complicated boom design must be considered. This boom type has long flight heritage, and is currently being fabricated for use on the Triana mission.

C.2.4.7.2 Telescoping Deployable Mast. An alternate to the deployable longeron style astromast has been identified: a multi-sectional, concentric, carbon-fiber telescoping mast. Four sections of ~1.2 m length would be used to support the IMPACT instrument suite. The magnetometer would be mounted on the second to final tube end, and the STE/SWEA instruments would be mounted on the final (inner) tube. Harnessing would be routed inside the conductive tube, possibly allowing for a lighter harness assembly. The overall length would be ~1.4 m. The mass estimate

for this assembly is ~0.75% of that of the deployable longeron type. This type of mast has been selected for flight on the ISIS satellite. Cost is believed to be equivalent to that of the 'Triana' type mast, but would require no additional 'fixed' mast. The method of deployment and the deployment requirements are TBD. The caging mechanism is not required for this system.

C.2.4.7.3 Deployable Hinge Element. As an option, a hinge element could be added to the existing deployable/fixed design. To decrease the stowed length, this hinge would be incorporated in the STE mount. There would be an increase in mass near the end of the fixed mast with a slight increase in cost, and the caging mechanism would need to be moved to the bottom deck. The effects of the mass increase on the ACS of the spacecraft need to be analysed. The overall length would be ~1.5m.

C2.4.8 SWAVES Air Coil Mount (if selected)

The Air Coil will mount to the base of the fixed CF mast between it and the astromast. The Air Coil uses a circular loop that is integrated into a groove on the fixed mast. A small preamplifier mount point is provided on the base of the loop, with sufficient clearance for the magnetometer requirements and deployable mast end plate. The harness will be routed along a longeron, using provided standoffs. The mount will be fabricated at UCB, and integrated to the coil at University of Colorado LASP, returning to UCB for integration into the IMPACT Boom.