Partnership Opportunity Document
(POD)

Deployable Electric Field Booms

to be included within the proposed

Vector Electric and Magnetic Field Investigation (VEMFI)

on Goddard's ASTRE Explorer Proposal

NASA/Goddard Space Flight Center

December 8, 2010

1.0 Introduction and Scope

The Vector Electric and Magnetic Field Investigation (VEMFI) instrument team at the NASA/Goddard Space Flight Center (GSFC) is developing a proposal to provide a DC and wave electric field detector and magnetometer on a GSFC-led Explorer proposal named ASTRE. The proposal will be submitted in response to the NASA Explorer Announcement of Opportunity (AO) NNH11ZDA002O. The AO was released on November 1, 2010 with proposals due on February 16, 2011.

This partnership opportunity will establish an agreement between GSFC and Industry to provide for deployable electric field booms that will constitute part of the Goddard VEMFI instrument and, if selected, part of the GSFC VEMFI investigation as part of the Goddard-led Explorer.

For the portion of this partnership that involves the preparation of the first step of this proposal in response to the AO, there shall be no exchange of funds between the partners. NASA funding will be available for subsequent phases, should the ASTRE proposal be selected to proceed to Phase A.

2.0 Mission Overview and Schedule

The GSFC-led Explorer shall explore the Earth's ionosphere using in situ probes mounted on a satellite in low earth orbit with a high inclination. The space environment is similar to that encountered by NASA's Dynamics Exporer-2 and Atmosphere Explorer satellites.

2.1 Schedule:

AO release	11/2010
Proposals due	2/16/2011
NASA Recommendations announced	August 2011
Phase A report due	July, 2012
Site Visits	October or November 2012
Contracts Awarded	February, 2013
Launch	2016 (estimated)
End of Operations	Launch + 24 months

3.0 VEMFI Deployable Electric Field Booms (8-15m) Concept Description.

The proposed electric field instrument will include six booms that shall deploy spherical sensors near their tips that will gather electric field data to study the Earth's ionosphere. The booms must be lightweight, stow into a small volume, deploy upon command, maintain rigidity after deployment, extend a spherical sensor electrically connected to wires fed through the boom element, and undergo minimal thermal distortions while on orbit.

The anticipated geometry of the deployed units with respect to the spacecraft velocity vector is shown in Figure 1. Note that the spacecraft is a three-axis stabilized (non-spinning) satellite. The booms are oriented such that four booms are in the orbit plane and two booms are perpendicular to this plane. Slow rotations about the axis perpendicular to the orbit plane may be performed on an infrequent basis for calibration purposes.

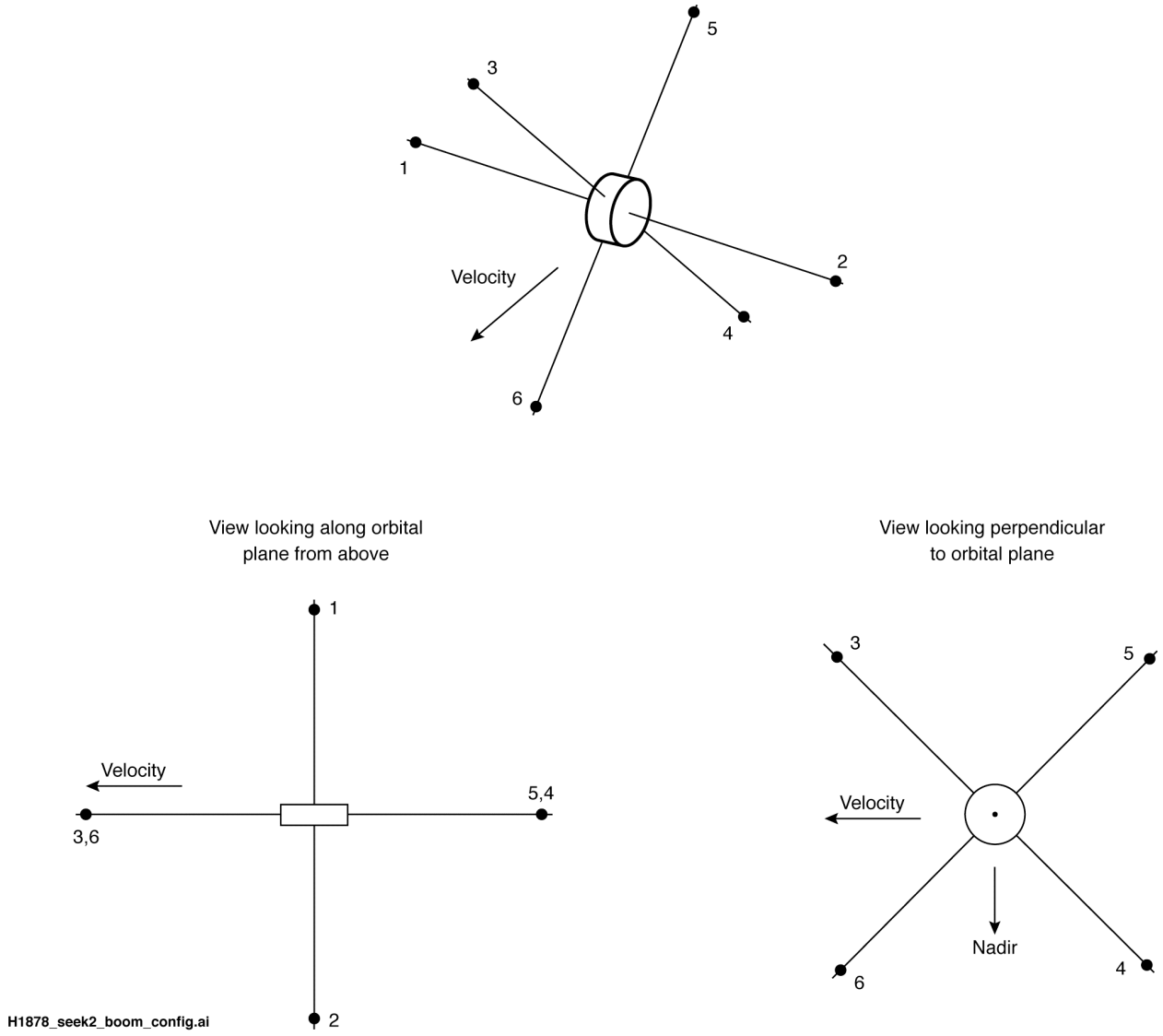

Figure 1

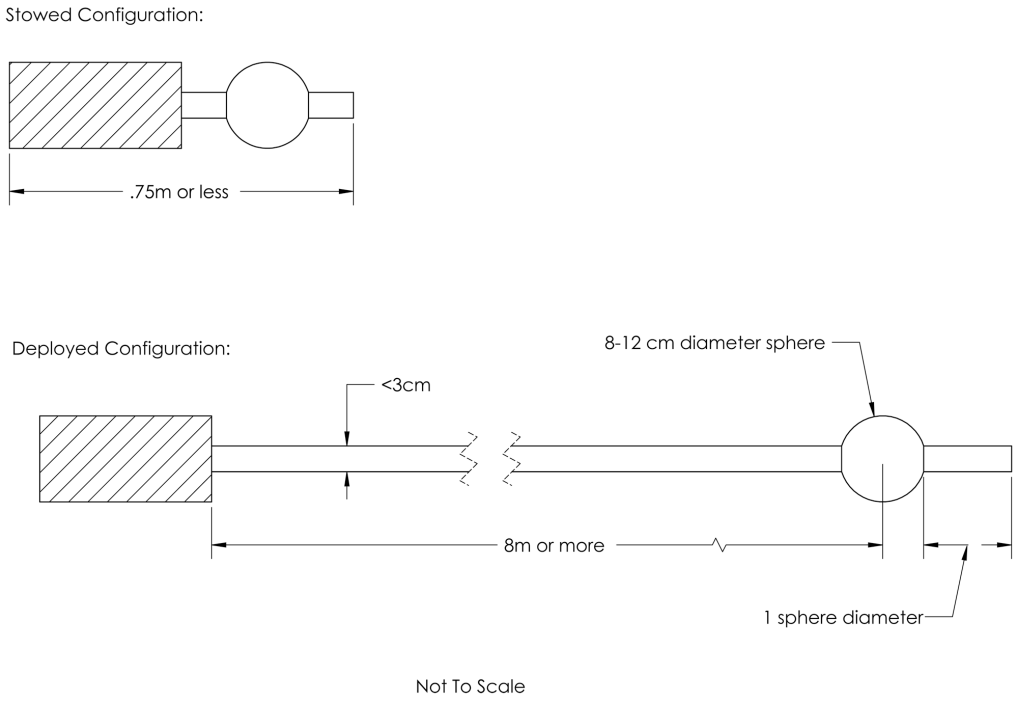

Figure 2

4.0 Boom System Requirements

The boom mechanisms shall meet the following engineering requirements:

1. The deployed boom length shall be at least 8 m with the ability to extend to further lengths (10-15 m) preferred.

2. The booms shall be stowed in a housing whose length along the deploying axis (including the sensor sphere) shall be 0.75 m or less. See Figure 2.

3. The combined mass of the boom and deploying mechanism shall be less than 7 kg.

4. The boom unit shall support a single spherical sensor (8-12 cm diameter) near the tip end. The nominal mass of this sphere and embedded electronics is 0.25 kg.

5. The deployed boom shall support a small wire harness leading to the sensor sphere at the boom tip. The nominal linear density of the wire harness is 0.03 kg/m.

6. The deployed boom tip must be precisely positioned and stable within a full cone angle of 1 degrees with respect to a known reference vector while under the influence of thermal effects consistent with a 83 degree inclination low earth orbit.

7. The stiff boom must be structurally stable after deployment and capable of withstanding all space environmental conditions and perturbations expected in the earth's ionosphere to altitudes as low as 150 km.

8. The boom diameter shall be 3 cm or less. A somewhat larger diameter at the boom element base is permissible provided the average diameter is 3cm or less over the entire length of the boom.

9. The boom unit shall have a short ($\geq$ one sphere diameter) extension or "shadow equalizer" on the outboard side of the sphere away from the satellite (See Figure 2). This may either be a fixed or deployed element.

10. The stowed boom unit shall restrain the spherical sensor and shadow equalizer such that the entire ensemble successfully survives all vibrational and acoustic forces associated with lift off of the most likely available launch vehicles (e.g., Pegasus-XL, Taurus-XL, Falcon 1, 1e, Athena I, II -- per Explorer web site) as well as fairing and door releases. The release mechanism of the sphere and boom shall constitute part of the boom mechanism itself.

11. The exposed boom element (i.e., the outside portion of the boom) must be insulated from the space environment. If the main boom element is conducting (and hence has its outer surface coated with an insulator), then this main boom element must not be electrically connected to the boom deployment mechanism or chassis. It is preferred if a portion of the insulation may be removed to enable the boom element to provide an additional signal input. In such instances, the ability to connect a wire to the boom element shall be provided.

12. The boom unit shall include a means to determine the boom extension length on orbit.

13. Retractability and the ability, upon command, to partially deploy or partially retract to a given deployment length, are preferred features of the boom mechanism.

14. The minimum (fixed base) first mode bending and torsional frequency is 1 Hz.

15. Outgassing of materials shall have a total mass loss (TML) of $< 1\%$ and a collected volatile condensable mass (CVCM) of $< 0.10\%$.

16. The boom unit shall include a means to easily inject test signals to the sphere and boom element (if conducting) during bench and spacecraft integration testing.

5.0 Pre-Selection Support

5.1 Initial Proposal Support

The selected partner is expected to provide support at no cost to the Goddard proposal team to help develop and write the boom-related parts of the VEMFI portion of the ASTRE proposal. This will involve discussions and a possible meeting(s) with the PI and members of the science team and the mission engineering team. The selected partner is further expected to meet with, or correspond with, the proposal team to ensure that sufficient technical details are provided to describe the boom mechanisms and their performance such that they not only pass the proposal technical review but also readily convey to the reader that the booms will function successfully in space, gathering high quality, accurate electric field data. This will include boom-related cost estimation for all mission phases. See schedule in Section 2.1.

5.2 Phase A Support

If the ASTRE proposal and hence, the VEMFI instrument, is selected during the first round of proposal reviews, then a Phase A Concept Study will be carried out. The selected partner will be expected to support this Concept Study as well, providing technical expertise and cost and schedule details regarding the boom development. The selected partner will also be asked to participate in a "site visit" meeting at a TBD location, to help answer questions, etc. Funding will be available to the selected partner to support the Phase A Concept work.

6.0 Development Support

If the ASTRE proposal and hence, the VEMFI instrument, is selected for development and launch, the respondent will be responsible for the design, development, technical analyses, integration, and test of the electric field boom systems. The respondent will be responsible for: specifying the boom system characteristics such that they meet the requirements, providing all aspects of the boom systems (either directly, or through procurement or teaming arrangements) including six per satellite plus one qualification unit, providing technical analyses (thermal and mechanical), providing all necessary pre-delivery testing including thermal and environmental testing of the boom units, supporting the integration of the booms to the satellite and all alignment measurements, and providing any additional testing support as needed.

The period of performance for this phase is expected to last approximately 18-24 months, and start on approximately February 1, 2013.

7.0 Detailed POD Response Instructions

The respondent shall:

1. Demonstrate understanding of the VEMFI boom under consideration:

2. Propose means of addressing technical and system requirements as currently specified.

3. Highlight and resolve if possible particularly critical or challenging areas for the design of the boom, including the performance of the boom in space, impact of thermal environment, straightness characteristics, etc.

4. Provide information on which boom-related design and trade studies will be conducted by the respondent in support of this proposal and explain the basis for ROM cost, mass, power, etc.

5. Identify design and performance characteristics of the proposed boom system. Provide modeling capabilities required to support development and analyses of the boom system. Identify relevant experience from similar efforts by key personnel.

6. Identify fabrication and testing facilities required to support development and test of the boom system.

7. Indicate level of resources to be allocated to the support of this proposal, including relevant skills of key personnel.

8. Provide a Rough Order of Magnitude (ROM) cost estimate and timeline for the scope of the design, fabrication, and testing of the boom system (6 identical units plus one qualification unit required). This includes all analyses, design, fabrication, testing and integration costs.

9. Characterize the risk of cost overruns and provide contingency plans.

10. Identify (if any) pertinent prior missions or mission proposals supported in the areas of boom design, fabrication, and integration and testing.

11. Include basic information on scope of work, including how well the fielded system met customer requirements (cost and technical) and proposed schedules.

8.0 Additional Information

For pre-selection or development support, the respondent may provide any additional information on any other pertinent missions for which his/her establishment, and any partners/vendors proposed, have provided boom systems, and identify the relevant details of similar systems. Also, identify any other ideas and related activities which your organization has been involved with that might have significance to the VEMFI initiative.

9.0 General Instructions for POD Response

Potential respondents are asked to contact the VEMFI team within one week after release of this document. This response shall not be considered binding, but shall serve to help the VEMFI team disseminate all relevant information to potential partners. Questions can be asked during the first week after release of this document. All questions and answers will be sent to those who express a desire to respond, while the source of the questions shall be held confidential. For purposes of this partnership opportunity, the VEMFI contact is Mr. Tim Gehringer, timothy.c.gehringer@nasa.gov.

Responses to the Partnership Opportunity Document shall:

1) Be in a presentation format that shall not exceed 30 pages. The font size for the text shall be no smaller than 12 point.
2) Address all requirements noted in section 7.0 of this document.

Responses shall be treated as proprietary information and controlled as such.

The respondents shall deliver the requested information in a presentation format. Presentation packages must be received by 5:00 p.m. (EST) on January 10, 2011. Please provide 5 copies of the presentation and deliver them to:

Mr. Tim Gehringer
NASA Goddard Space Flight Center
Code 101
Building 8, Room 301C
Greenbelt, MD 20771
timothy.c.gehringer@nasa.gov

All respondents that intend to provide a response to this POD are requested to provide written or electronic notice within one week of the issue date of this POD (see cover). Notice may be by e-mail to Mr. Mr. Tim Gehringer, timothy.c.gehringer@nasa.gov, or in writing to the above address.

10.0 Selection Criteria for Awarding Partnership Opportunity

Selection criteria will be consistent with the need to procure booms that are technically best suited to the experiment as well as to encourage cost effective partnerships between the Government and industry.

Selection Criteria (in order of importance)

1. Boom system characteristics and their ability to meet the technical requirements of the electric field detector.
2. Ability of the booms to pass all technical reviews and to alleviate any technical concerns of the spacecraft engineers.
3. Cost.
4. Delivery schedule.
5. Credibility of cost and schedule estimates including cost and schedule control measures and past performance on previous missions.
6. Past performance of boom systems in space.
7. Experience of team.
8. Design and modeling capabilities to support the effort including technical analyses (mechanical and thermal).
9. Fabrication and testing facilities to support the effort.
10. Contingency plans and descope options (if any) that might be specified in the proposal.

11.0 Acronym List

AO	Announcement of Opportunity
cm	centimeter
EST	Eastern Standard Time
GSFC	Goddard Space Flight Center
km	kilometer
M	Million
m	meter
POC	Point of Contact
POD	Partnership Opportunity Document
ROM	Rough Order of Magnitude
SOW	Statement of Work
TBD	To Be Determined
VEMFI	Vector Electric and Magnetic Field Investigation