

REQUEST FOR PROPOSAL: MIL: Magnetic field Investigation of Luna

I. OPPORTUNITY DESCRIPTION

The National Space Grant Consortia have joined together to create new opportunities for students to design, build, test, and operate significant missions to locations beyond Earth orbit. Launch of these missions will be constrained by upcoming launch opportunities with larger missions. One such student space mission is currently in the design phase: Magnetic field Investigation of Mars by Interacting Consortia (MIMIC). While MIMIC is relatively far along in the design phase, the plans for a second mission, to the Moon, are still in development.

One possible Lunar mission would be to obtain Lunar magnetic field data¹ suitable for determining mining² or other opportunities for Lunar settlement. Of course, any mission planning team should be open to other complementary mission goals, so students on the design team should attempt to determine other science goals for the spacecraft.

II. PROJECT OBJECTIVE

The objective of this project is to produce a complete system design and mission analysis for a mid-sized spacecraft to conduct a magnetic field investigation of the Moon. The spacecraft would ultimately be designed, built, tested, and operated by university students distributed across the United States. Launch of the spacecraft would almost certainly be from Wallops Flight Facility on a Taurus launch vehicle. Note that an important element of the project is to determine what magnetic field data for the Moon already exist and to de-

termine what is required to improve on the existing data.

III. REQUIREMENTS AND CONSTRAINTS

The fundamental requirement is to develop a detailed design of a spacecraft to conduct a magnetic field investigation of the Moon.

- The spacecraft mass and volume shall be appropriate for a Taurus launch from Wallops Flight Facility to the Moon.
- The spacecraft shall incorporate a magnetometer of sufficient quality to add to the existing body of magnetic field data for the Moon.
- The spacecraft shall have adequate computational and communications systems so that data can be communicated to scientists on Earth. Note that relay satellites may be possible, but should not be assumed without justification.
- The spacecraft shall have adequate orbit and attitude determination sensors such that post-analysis of the magnetic field measurements are of sufficient accuracy to add to the existing body of magnetic field data.
- The spacecraft shall have adequate orbit and attitude control such that communication of all data and telemetry can be accomplished within a reasonable time.
- The spacecraft shall not use any systems or materials which are incompatible with student fabrication and testing.
- The spacecraft shall have additional capabilities as deemed appropriate and feasible by the student design team.

V. DATA REQUIREMENTS

The proposal should

- a) describe in detail the spacecraft and the system architecture;
- b) describe using engineering drawings all structural components and interfaces;
- c) include a mass budget providing the masses of all subsystems and components, with design margins as appropriate;
- d) explain from first principles how the design was chosen;
- e) describe the Earth-to-Moon trajectory and the lunar orbit;
- f) describe all orbit and attitude determination and control hardware and algorithms;
- g) define all mechanisms to be used, and give the basis for the belief that the chosen mechanisms will work;
- h) describe how the spacecraft will be built;
- i) describe the power requirements and the power system design, including load, solar arrays, batteries, and any required power electronics;
- j) describe how mission operations will be conducted;
- k) describe the command and data handling system, including telemetry and data storage requirements;
- l) list the metrics that will be used to establish that the mission was successful;
- m) include performance predictions;

- n) describe the end-of-life disposal procedures; and
- o) include cost estimates for production, deployment, and operations.

VI. REFERENCES

1. C. T. Russell, P. J. Coleman, Jr., B. K. Fleming, L. Hilburn, G. Ioannidis, B. R. Lichtenstein, and G. Schubert, "The Fine-Scale Lunar Magnetic Field," *Proceedings of the 6th Lunar Science Conference*, 1975, pp. 2955-2969 (available at: <http://www-ssc.igpp.ucla.edu/personnel/russell/papers/Lunar/>)
2. John S. Lewis, *Mining the Sky*, Addison-Wesley, Reading, Massachusetts, 1996
3. K. Daugherty *et al*, *ARTEMIS: The Academic Research Team for the Establishment of a lunar Magnetic field Investigation System*, AOE 4065 Spacecraft Design Report, Aerospace and Ocean Engineering, Virginia Tech, Blacksburg, Virginia, May 6, 2005