

Technology and Integrated Discipline Engineering Services (TIDES)

All deliverables and requirements must follow the guidelines in NNG15CR65C with no exceptions

Task Order Statement of Work (SOW)

Date: 18 August 2020

Task Name: MMS FPI Integrated Research and Technology Engineering Services

Task No./Mod: 23/10

Task Monitor (TM): Barbara Giles

Contract number: NNG15CR65C

Contract SOW Reference:

FUNCTION 3-IMPLEMENTATION PHASE SERVICES-MULTI-DISCIPLINARY

FUNCTIONS: 3E. Laboratory and Test Instrumentation Services; 4C. Software Systems Technology Services; 3F. Post-Launch Operations Support;

FUNCTION 5- SUPPORT SERVICES - 5A. Computer Support Technology Services

Task Mod Summary:

Mod 0: establishes task for support of FPI Ground System Lead (subtask 1) and FPI Operations Lead (subtask 2)

Mod 1: adds engineering support for FPI anomaly resolution (subtask 3)

Mod 2: adds engineering support for data analysis and software support (subtask 4)

Mod 3: extends period of performance and increases level of support for subtask 4.

Mod 4: increases level of support for subtask 4

Mod 5: administrative mod

Mod 6: extends period of performance

Mod 7: extends period of performance

Mod 8: extends period of performance

Mod 9: expands scope to support Gateway/EEA, as per the red-lined changes below.

Mod 10: extends period of performance of subtasks 1-3 through 14 April 2021; subtask 4 does not need to be extended beyond 14 October 2020.

I. Scope:

a. Background

Magnetospheric Multiscale (MMS) is a Solar Terrestrial Probes mission comprising four identically instrumented spacecraft that use Earth's magnetosphere as a laboratory to study the microphysics of three fundamental plasma processes: Magnetic reconnection, energetic particle acceleration, and turbulence. These processes occur in all astrophysical plasma systems but can be studied in situ only in our local solar system and most efficiently only in Earth's magnetosphere, where reconnection controls the dynamics of the geospace environment and plays a critical role in the process known as "space weather".

The Fast Plasma Investigation (FPI) is one of the instrument suites onboard MMS; the suite consists of 64 particle spectrometers and 4 IDPUs. FPI is operated and managed by the Code 673 Geospace Physics Laboratory out of Building 21 on the Goddard campus. The FPI team has need for experienced engineers to research

and develop advanced software systems for FPI performance, ground support and ground support equipment, data reduction and analysis, and preventative maintenance on the hardware and software. The work also includes the development and upgrading of the MMS FPI development laboratories in support of long-term goals for Heliophysics Science Division hardware development.

The Lunar Gateway is an in-development space station to be deployed in lunar orbit as part of NASA's Artemis program. The first module of the Gateway is the Power and Propulsion Element (PPE). This module will contain a suite of science instrumentation. The Electron Electrostatic Analyzer (EEA) is one of the science instruments aboard the PPE. EEA is an electron spectrometer that will measure electron fluxes in the solar wind, magnetosphere, and near-lunar Environments. EEA development is managed by the Code 673 Geospace Physics Laboratory out of Building 21 on the Goddard campus.

II. Sub-Task 1: MMS FPI Ground Systems Support (up to 1 WYE):

a. Required skills/Knowledge:

- Knowledge of NASA software systems development requirements and best practices;
- Advanced programming skills in IDL, C, Python, Perl, multiple shell scripting languages; ability to operate within a variety of OS including Linux, Windows, Mac; proficiency with common software development applications such as SVN, LabView, MatLab; some proficiency with the GSFC Common Data Format (CDF).
- Advanced skill and experience with state of the art science satellite ground systems, engineering and science data systems, and data distribution and archive methodologies.
- Detailed knowledge of the MMS FPI data products, their requirements and status; detailed knowledge of both the FPI and the MMS SDC data processing systems, protocols, and limitations; and the FPI operations macros and tables and their update/build/validation processes.
- Ability to communicate both professionally and effectively -- at the leadership level both orally and in writing -- with the full MMS FPI and Gateway/EEA teams and the broad cadre of mission support personnel at the MMS payload PI institution (SWRI), and the MMS Science Data Center (LASP).

b. Period of Performance:

The period during which the work for this subtask shall be performed is from task award thru **14 April 2021**.

c. Specific Tasks:

The following are to be executed as assigned by MMS/FPI and Gateway/EEA leadership:

- The contractor shall provide software systems technology services for the MMS FPI and Gateway EEA ground system including acting as a primary

interface to the science data center, development of plans and procedures, and assuring reliable data acquisition, processing, validation, distribution, analysis support, and archiving;

- Oversee the development of, and advise on, advanced data processing architectures including the automation of existing processes and the further deployment of distributed processing and archival processes across multiple institutions; and
- Enable advanced data reductions, displays, and architectures to perform statistical and thematic trends analysis on MMS FPI and Gateway EEA performance and/or scientific phenomenon, proposing new methodologies to improve data quality and utility; and
- Provide the computer support enabling the conceptualization, design, development, integration, test, sustaining engineering, maintenance and utilization of ETU, laboratory, and test equipment necessary for MMS FPI anomaly and/or Gateway EEA issue resolution.

d. Deliverables/Schedules/Milestones:

- The deliverable for this subtask is a monthly progress report.
- Schedules are determined by the MMS payload operations, MMS data delivery, and Gateway EEA development schedules
- Attend meetings as required by the Team

e. ODC (Travel and Procurement):

May include occasional travel, which can include limited foreign travel. For the CY2020 performance year, the expectation is for two trips of 2 days each to the MMS SOC at LASP in Boulder, Co.

III. Sub-Task 2: MMS FPI Instrument Support (up to 1.5 WYE):

a. Required skills/Knowledge:

- Broad knowledge of NASA research and technology and space flight project management requirements and best practices;
- Programming skills in IDL, Python, or other data analysis packages of choice; proficiency using Windows *and* Mac OS; some proficiency with utilizing data in the GSFC Common Data Format (CDF).
- Detailed knowledge of the design specifics, operational procedures, and anomaly resolution processes for the FPI DES, DIS, and IDPU; detailed knowledge of DES/DIS calibration challenges and procedures, detailed knowledge of the FPI flight operation systems, protocols, schedules, requirements and limitations; and the principles and history of the FPI operation macros and tables and their update/build/validation procedures.
- Ability to develop lab processes and procedures as required to support instrument anomaly resolution and instrument assembly, modification, or repair; ability to manage and maintain ETUs, tools, and laboratory test equipment for the FPI flight hardware and for potential future hardware builds.
- Ability to communicate both professionally and effectively -- at the leadership level both orally and in writing -- with the full MMS FPI and Gateway/EEA

teams and the broad cadre of MMS mission support personnel at the GSFC MOC, the payload PI institution (SWRI), and the MMS Science Operations Center (LASP).

b. Period of Performance:

The period during which the work for this subtask shall be performed is from task award thru **14 April 2021**.

c. Specific Tasks:

The following are to be executed as assigned by MMS/FPI and Gateway/EEA leadership:

- The contractor shall provide technical support to the MMS FPI payload and its support equipment including acting as an interface to the payload operations center, development of plans and procedures, assuring payload health and safety;
- Provide technology support for the further development of MMS FPI embedded software systems to improve reliability, efficiency, and accuracy of end-to-end mission architecture and functionality;
- Provide engineering support and data reductions to perform statistical and thematic trends analysis on MMS FPI performance, proposing new methodologies to improve and/or maintain data quality; and
- Provide technical support for the conceptualization, design, development, integration, test, sustaining engineering, maintenance and utilization of ETU, maintenance and utilization of the SPIF laboratory, and utilization of SPIF laboratory test equipment necessary for MMS FPI anomaly resolution and/or future hardware builds for flight.
- Monitor health and safety of FPI flight hardware, review command sequences, incoming telemetry streams, and available housekeeping and engineering data
- Employ advanced algorithms to detect outliers in ground and flight test data, increase ability to detect early onset of anomalies
- Develop and deploy calibration and data correction processes for science data.
- Develop and maintain a laboratory testing infrastructure for Gateway/EEA, including automation of lab hardware and fixturing, tracking of lab use, monitoring safety, experimental and user requirements and setup, storage and dissemination of data, and organization of lab related tasks
- Develop a ground test and calibration plan for Gateway/EEA, and assist with implementation, data handling and storage, and acceptance criteria
- Inform the design, assembly, test, and integration of Gateway/EEA hardware with lessons learned from previous missions

d. Deliverables/Schedules/Milestones:

- The deliverable for this subtask is a monthly progress report.

- Schedules are determined by the MMS payload operations and Gateway EEA development schedules
 - Attend meetings as required by the Team
- e. ODC (Travel and Procurement):
 May include occasional travel. For the performance year, the expectation is for eleven trips of 3 days each between Portland ME and Washington DC.

II. Sub-Task 3: MMS FPI Instrument Anomaly Support:

- f. Required skills/Knowledge:
- Detailed knowledge of the design specifics, operational procedures, and anomaly resolution processes for the FPI DES, DIS, and IDPU; detailed knowledge of DES/DIS calibration, challenges and procedures; detailed knowledge of the FPI flight operation systems, protocols, schedules, requirements and limitations; and the principles and history of the FPI operation macros and tables and their update/build/validation procedures.
- a. Period of Performance:
- The period during which the work for this subtask shall be performed is from task award thru **14 April 2021**.
- b. Specific Tasks:
- The contractor will provide on-call instrument systems mission operations, anomaly, and advanced analytical and performance support for the FPI DES, DIS, and IDPU flight hardware. This includes support to the payload and its support equipment.
 - The expectation is that no more than 5% of the specialist's time will be required each WY, distributed unevenly and as requested.
- c. Deliverables/Schedules/Milestones:
- The deliverable for this subtask is a monthly progress report.
 - Schedules are determined by the MMS payload operations schedules
 - Attend meetings as required by the Team
- d. ODC (Travel and Procurement):
- May include travel; no travel is anticipated or budgeted for CY2020.

II. Sub Task 4: MMS FPI Data Analysis and Software Support (up to 0.33 WYE):

- ~~f. Required skills/Knowledge:~~
- ~~• Knowledge of NASA software systems development requirements and best practices; Adherence to the FPI Software Development Process.~~
 - ~~• Advanced programming skills in IDL, Python, and multiple shell scripting languages; ability to operate within a variety of OS including Linux, Windows, Mac; proficiency with common software development applications such as SVN and Trac; some proficiency with the GSFC Common Data Format (CDF).~~

- ~~Ability to communicate both professionally and effectively with the MMS FPI operations team.~~

~~g. Period of Performance:~~

~~The period during which the work for this subtask shall be performed is from present thru 14 October 2020.~~

~~h. Specific Tasks:~~

- ~~The contractor shall complete work in progress on the FPI Operations Dashboard software and other FPI operations and science software architectures as specified by the FPI Ground Systems Lead.~~
- ~~Provide FPI calibrations support and lead data product validation efforts.~~
- ~~Facilitate the development and operations of novelty detection by mining the FPI science and engineering data repository.~~
- ~~Provide input to the FPI Operations Team on integration and operations of software modules completed to date.~~

~~a. Deliverables/Schedules/Milestones:~~

- ~~Attend tagup meetings as directed by TM or designee~~
- ~~Additional data analysis or development tasks as designated by the TM or designee, to be captured via email record~~

~~b. ODC (Travel and Procurement):~~

~~May include occasional travel. For the CY2020 performance period, the expectation is for one trip for one person for ~5 days to a domestic technical conference in San Antonio, TX.~~

IV. Government Furnished Facilities, Equipment, Software and Other Resources:

The Government will provide account and passwords to government-furnished workstations where existing versions of various relevant software packages shall be maintained. It shall be the contractor's responsibility to complete any GSFC required security-related training courses.

The contractor shall provide Systems Administration service and support equipment required for both onsite & offsite contractor functions.

V. Facilities:

All work will be performed on site at GSFC.