

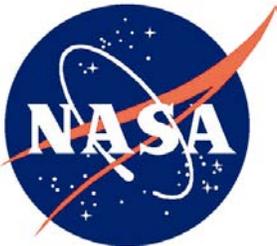
Wide Field Infrared Survey Telescope (WFIRST)

Study Office

Code 448

**Wide Field Instrument (WFI) Industry Concept Study
Statement of Work (SOW)**

December 14, 2015



**National Aeronautics and
Space Administration**

**Goddard Space Flight Center
Greenbelt, Maryland**

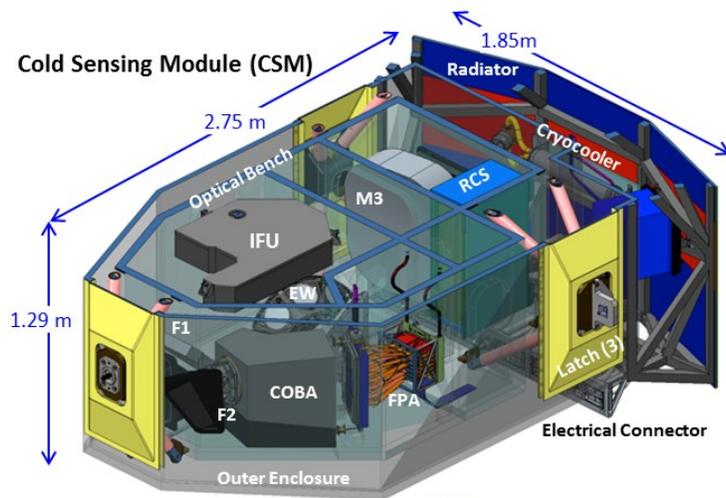
TABLE OF CONTENTS

	<u>Page</u>
1.0 INTRODUCTION.....	1
2.0 REFERENCE DOCUMENTS.....	2
3.0 STUDY ASSUMPTIONS.....	2
4.0 WORK TO BE PERFORMED	4
4.1 STUDY CONTENT.....	4
4.1.1 WOMA Physical Description.....	4
4.1.2 WOMA Design Description.....	5
4.1.3 Engineering Study Tasks.....	5
4.1.4 Cost and Schedule.....	5
4.1.5 Integration and Test.....	6
5.0 DELIVERABLES AND REPORTING	6
5.1 STUDY DELIVERABLES	6
5.2 STUDY REPORTING.....	7

1.0 Introduction

This Statement of Work specifies what is to be performed by the contractor in support of the WFIRST Wide Field Instrument (WFI) Concept Study. This study activity is intended to determine feasible WFI implementation approaches for the preliminary WFIRST science requirements, assess the critical thermal, optical, mechanical and interfaces that drive the WFIRST WFI design, and address the development and verification approach of the WFI. The study will also assess the critical cost, schedule, technical performance and risk drivers and develop cost and schedule estimates for the design, build and test of the WFI.

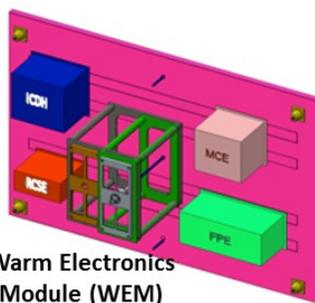
As shown in Figure 1 and more fully described in the reference documents, the WFI consists of a cold instrument module and a warm electronics module. The Wide Field Channel (WFC) is one of two optical channels in the WFI; the other is an Integral Field Unit (IFU) with a much smaller field of view. The entire WFI, except for the two Focal Plane Assemblies (FPAs) in the WFC (WFC FPA and AG FPA) and their associated electronics, and the IFU (henceforth referred to as the WFI Opto-Mechanical Assembly, or WOMA) would be built, aligned, and tested by the flight contractor and delivered to GSFC. This study should assume a flight hardware phase (under separate procurement) that would result in delivery of the WOMA as a flight deliverable. WOMA and WFI integration and test would be conducted at the contractor facility, or at the Goddard Space Flight Center (GSFC), or at a combination of the two facilities. The instrument level calibration would be conducted by GSFC with support by the flight contractor. The development of a concept for integration and test phase that makes optimal use of the contractor and GSFC personnel and facilities, while minimizing cost, schedule, and risk is a major objective of this concept study.



Cold Sensing Module in Instrument Carrier (IC)

- Wide Field Channel
 - F1 & F2 (fold) and M3 (optically powered) mirrors
 - Element Wheel (EW) (6 filters, grism, blank)
 - Focal Plane Assembly (FPA)
 - Cold Optics Baffle Assembly (COBA)
 - Auxiliary Guider (AG)
- IFU Channel
- WFI-level subsystems
 - Relative Calibration System (RCS)
 - Optical Bench (OB)
 - Outer Enclosure (OE) w/serviceable latches and electrical connector
 - Radiator
 - Cryocooler with driving electronics

WFI Opto-Mechanical Assembly (WOMA) designates the contractor deliverable sub-assembly of the WFI consisting of the entire instrument except the FPA, AG, IFU, ICDH, FPE, and IMH



Warm Electronics Module (WEM)

Warm Electronics Module in Spacecraft

- Instrument Command and Data Handling (ICDH)
- Focal Plane Electronics (FPE)
- Mechanism Control Electronics (MCE)
- Relative Calibration System Electronics (RCSE)

Inter-Module Harness (IMH) in Instrument Carrier

- Connects the WEM to the CSM through the IC
- Not serviceable
- Connections on CSM and WEM harnesses which mate to the IMH are serviceable

Figure 1. Cut-away drawing of the MCR concept for the WFIRST WFI instrument. In the Government/Industry partnering scenario to be explored in this concept study, the Government would retain responsibility for the design, fabrication, and test of the FPA, AG, IFU, ICDH, FPE, and IMH (highlighted in red). The Industry partner would have responsibility for the design, fabrication, and test of the remainder of WFI instrument; designated the WFI Opto-Mechanical Assembly (WOMA) and would support the integration and test of the Government sub-assemblies to complete the WFI.

2.0 Reference Documents

Documents relating to this study are available, either at the provided links or by request via NASA file transfer protocol

WFIRST March 2015 joint report by study office and science definition team

http://wfirst.gsfc.nasa.gov/science/sdt_public/WFIRST-AFTA_SDT_Report_150310_Final.pdf

{provided on request}

WFIRST Mission Concept Review presentations

{provided on request}

DRAFT WFIRST Study Mission Assurance Requirements

GEVS-STD-7000

General Environmental Verification Standard (GEVS)

<http://msc-docsrv.gsfc.nasa.gov/cmdata/170/STD/GEVS-STD-7000.pdf>

3.0 Study Assumptions

During the course of the study, the contractor shall assume:

- a. The WFIRST Observatory will be deployed into a Sun-Earth L2 Lagrange point orbit.
- b. The WFIRST Observatory will be designed to be serviced in-flight by a yet to be defined robotic servicing vehicle.
- c. The WFIRST Observatory will be launched on a heavy lift launch vehicle acquired by NASA.
- d. The Wide Field Instrument (WFI) will consist of an on-orbit replaceable Cold Sensor Module (CSM) mounted in the observatory Instrument Carrier and an on-orbit replaceable Warm Electronics Module (WEM) located in the spacecraft.
- e. The spacecraft will provide all electrical and electronic harnesses and connectors between the WFI CSM and the WEM.
- f. GSFC will design, build, test, and qualify the WFI focal plane assemblies (WFC FPA, AG FPA, and IFU FPA) and the electronics that control, read, and process guide star data from the WFI FPAs (FPE and ICDH).
- g. Guide star tracking information will be read from the WFI electronics by the spacecraft for incorporation into the observatory Guidance, Navigation, and Control (GN&C) solution.
- h. GSFC will design, build, test, and qualify the IFU and the electronics that control, read, and process data from the IFU.
- i. The contractor shall design, build, test, and qualify the remainder of the WFI, designated the WFI Opto-Mechanical Assembly (WOMA).
- j. GSFC will furnish the optical prescription for the WOMA.
- k. The contractor shall be responsible for verifying the performance of and flight qualification of the WOMA prior to integration of the WFI focal plane assemblies (FPAs) and the IFU.
- l. The contractor shall integrate the GSFC provided FPAs, IFU, and electronics with GSFC support.
- m. The contractor shall be responsible for verifying the performance of and flight qualification of the integrated WFI prior to delivery to GSFC.
- n. GSFC will perform WFI science calibration.
- o. WOMA-level and WFI-level integration and test flow will use the optimal combination of contractor and GSFC facilities, as determined by the WFIRST project, to minimize the risk, cost, and schedule.
- p. Contractor WOMA personnel shall support the WFI calibration and payload and spacecraft integration activities at GSFC.
- q. The contractor shall deliver an Optical Verification Unit (OVU) simulator of the WFI that will be used for early optical verification at the telescope contractor's facility.
- r. The contractor shall deliver a WOMA electrical simulator to support spacecraft development. The WOMA electrical simulator shall simulate all commandable components (e.g. mechanisms and relays), sensors (e.g. temperature) and loads (e.g. heaters) included in the contractor's deliverable.

- s. GSFC will deliver to the contractor a mechanical alignment fixture to be used by the contractor during integration of the WFI mounting latches.
- t. Notional schedule for planning purposes:
 - 1. Concept Study will be 4 months duration, with an award date goal of 3/27/2016.
 - 2. Formulation Study (under separate procurement) will be 8 months duration, with an award date goal of 10/15/2016.
 - 3. Flight hardware phase (under separate procurement) award date of 12/1/2017.
 - 4. WFC FPA, AG FPA, IFU, and electronics ready to integrate into WOMA by 1/21/21.
 - 5. WFI pre-ship (to payload I&T) review date of 3/25/2022 (schedule must include 30 days instrument level calibration).
 - 6. Planned launch NET August 2024.
 - 7. Planned mission life of 6.25 years.
- u. The Draft WFIRST MAR and GEVS are provided for the purpose of supporting the development of the baseline cost and schedule.

4.0 Work to be performed

The contractor shall perform a study that results in at least one feasible WFI Opto-Mechanical Assembly (WOMA) concept using the assumptions above, the WFIRST-AFTA 2015 Report, and the WFIRST December 2015 Mission Concept Review (MCR) presentations. Additional concepts that push the boundaries of the above assumptions, including Government/contractor work split and limited optical prescription changes, to minimize cost, schedule, and risk will be considered. The MCR optical prescription and instrument mechanical design will be provided at the beginning of the study (as Study Office proprietary data and under ITAR control) to allow the selected vendors to package the instrument optical trains.

4.1 Study Content

At a minimum the contractor shall address and provide information on the following to a degree of accuracy that is commensurate with a conceptual design:

4.1.1 WOMA Physical Description

SC01 Provide figures of the on-orbit configuration showing physical layout of the primary components.

SC02 Provide a detailed master equipment list for the proposed concept.

4.1.2 WOMA Design Description

SC03 Provide detailed descriptions of the mechanical structure, thermal control, optical design and any mechanisms used, including an assessment of the heritage and performance history of the mission critical components.

SC04 Provide a summary of the mass properties and electrical resources for the WOMA.

4.1.3 Engineering Study Tasks

SC05 Provide results of trade studies performed in the development of the proposed concept to show that the proposed concept balances technical risk and cost while meeting the general design requirements, as stated in the WFI MCR presentation.

SC06 Substantiate error budgets for all relevant portions of the WOMA, including mechanical, optical and thermal.

SC07 Assess the external interfaces to the spacecraft and instrument and provide a recommended set of interface designs. Identify any aspects of the instrument and spacecraft that must accommodate the proposed concept, using the WFI MCR presentation as a starting point.

SC08 Assess the internal interfaces between the WOMA and the GSFC provided FPAs and IFU and comment on the set of interface designs. Identify any aspects of the instrument that must accommodate the proposed concept, using the WFI MCR presentation as a starting point.

SC09 Substantiate the verifiability of the WOMA design.

SC10 Describe any technology development required to meet the proposed concept and schedule, and provide an assessment of the current technology readiness levels for the WOMA components.

SC11 At the completion of the study, participants are encouraged to identify areas for further investigation to advance the objectives of the WFI design for WFIRST.

SC12 Provide a development plan for optical components (mirrors, filters, and grism) specifically addressing relevant experience, design capabilities, any planned sub-contracts, and available test facilities.

SC13 Provide a recommended development program of design and test that uses a combination of Engineering Development Units, Engineering Test Units, and/or proto-flight units in a manner that optimizes the cost, schedule, and risk level to the WFIRST project. Include a recommended sparing program.

SC14 Provide a recommended verification plan for the WOMA that provides maximum assurance of successful integration with the GSFC provided components of the WFI, integration of the WFI into the observatory, and observatory level GN&C performance. Include recommendations for any GFE that would be required during this verification program.

SC15 Provide recommendations to accelerate schedule, including opportunities for pre-Phase B investments.

4.1.4 Cost and Schedule

SC16 Provide the cost and schedule for developing and testing the proposed concept, including details of the design, fabrication and test phases.

SC17 Identify any long lead items and provide a schedule for procurement of those items.

SC18 Identify all Government Furnished Equipment required and include the need dates in the schedule.

4.1.5 Integration and Test

SC19 Describe the WOMA and WFI integration and test flow, including the optical test flow at temperature, as well as an instrument integration and test flow, that is technically and cost credible.

SC20 Include any recommendations to reduce cost, schedule and technical risks.

SC21 Propose an integration and test flow that minimizes risk, cost, and schedule using contractor and/or GSFC facilities.

SC22 Describe all of the major assembly and test facilities and ground support equipment (GSE) required to build and test the instrument, including optical test equipment, and associated logistics such as shipment of hardware between facilities.

5.0 Deliverables and Reporting

Deliverables under the study effort include a study report as described in the following sections.

5.1 Study Deliverables

The contractor shall provide study reports at the mid-point and end of the study detailing the results of the design and analysis work. The major topics for the reports are:

Mid-term Report:

- Status
- Findings of discrepancies or gaps in the Government furnished concept
- Findings on the proposed Government/contractor work split
- Preliminary WOMA implementation approach
- Initial assessment of WOMA interfaces
- Initial assessment of required Government Furnished Equipment

Final Report:

- Overview
- Concept Development, including:
 1. WOMA design concept
 2. Performance capabilities
 3. Systems block diagram
 4. Top-level implementation schedule
- Engineering Study Tasks
- Conclusions and recommendations
- ROM Price (ROM Price estimates shall be in Real Year (RY) dollars and shall be submitted separately from the final presentation package in electronic format only to the CO).

The Contractor may address additional information in the study report at their discretion, including any additional Contractor suggestions, concerns or issues noted during the study period.

5.2 Study Reporting

The contractor shall support:

1. A study kick-off meeting at the Contractor facility within 30 days of contract award.
2. Teleconferences every two weeks during the study period with the project team. These 1 hour teleconferences will allow the Contractor to ask questions of clarification and to request additional information. Any Government clarifications, corrections, or additional information provided during the study period of performance will be provided to all study participants.
3. A presentation meeting of the mid-term report at the Contractor facility.
4. A presentation meeting of the final report at the GSFC.