HETDEX
VIRUS Detector System
Statement of Work

January 29, 2010

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Revision Summary

1. Date: 20 January 2009
   Revision: 1
   ECR: NA

2. Date: 25 March 2009
   Revision: 2
   ECR: 0019

3. Date: 17 August 2009
   Revision: 3
   ECR: 0033

4. Date: 29 January 2010
   Revision: 4
   ECR: 0038

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1   Introduction

The Hobby-Eberly Telescope (HET) is an innovative large telescope of 9.2 meter aperture, located in West Texas at the McDonald Observatory. A major upgrade of the HET is in progress that will substantially increase its capabilities. This includes development and deployment of a revolutionary new integral field spectrograph called VIRUS (the Visual Integral-Field Replicable-Unit Spectrograph), in support of the Hobby-Eberly Telescope Dark Energy Experiment (HETDEX). VIRUS consists of up to 192 simple fiber-fed spectrographs, each of which contains a camera that employs a cryogenically cooled 2064 by 2064 pixel Charge Coupled Device (CCD).

As the University of Texas operates HET on behalf of the HET Consortium, and the HETDEX Project procurements will be a University of Texas procurement, for simplicity we shall hereafter refer to the HETDEX Project and the HET Consortium as "the University," and the successful candidate vendor for the VIRUS detector system as "the Contractor."

This Statement of Work (SOW) defines the activities and interactions required to design, fabricate, integrate, test, and deliver a VIRUS detector system for the HET as per the requirements presented in the *VIRUS Detector System Specification* (HX0031) on the agreed-upon schedule. Note that the VIRUS detector system consists of the following elements:
1) Packaged CCDs
2) Vacuum electronics interconnects
3) Bulkhead connector
4) CCD controllers
5) Software interface to the VIRUS Data Acquisition System (VDAS) computer
6) CCD controller hardware interface to the VDAS computer
7) Power supplies for the above items (excluding the VDAS computer)
8) Electrical and fiber optic interconnects
Even though this SOW assumes that the Contractor supplies all eight of these elements, the Contractor may propose to supply a subset of elements 6, 7, and 8 if it results in cost, schedule, and/or other benefits to the University. In the event that the Contractor proposes to deliver a subset of elements 6, 7 and 8 the Contractor's response to this SOW shall be considered compliant provided that the Contractor clearly states in their proposal which elements they are not supplying and why this limited scope of supply is beneficial to the University. Note that the Contractor must supply the design solution to all eight elements. Additionally, they must supply the hardware/software associated with elements 1 through 5 to be considered compliant with this SOW.

To reduce technical risk, this SOW includes developing and delivering two test articles (referred to as TA1 and TA2). These test articles will be used to verify as many aspects of the VIRUS Detector System design as possible before the Contractor starts actual production of the VIRUS Detector System components.

Test Article 1 (TA1) is a pair of nonfunctional detectors (each with integrated vacuum electronics interconnect, bulkhead connector with protective cap, temperature sensor interfaces and heater interfaces) as defined in Sections 2 and 5. It will be used by the University to:

- Verify that the TA1 components meet all mechanical interface requirements
- Verify that the TA1 components meet all heat transfer requirements
- Test CCD/FFLA alignment procedure
- Verify the spider assembly integration procedure
- Verify all measurements that are reported in the Contractor's TA1 Metrology report

Test Article 2 (TA2) is a pair of fully functional CCDs and controllers as defined in Sections 2 and 6. It will be used by the University to verify that the design will meet all software and performance requirements. It will also be used in the laboratory to support VIRUS detector system troubleshooting over the detector system's lifetime.

Project milestones are shown in Table 1 along with some key milestone dates. The intent is to:

- Develop and test TA1 as quickly as possible to facilitate the University's parallel design efforts associated with the vacuum cryostats. Ideally, lessons learned from TA1 testing would be incorporated in the Contractor's design that is presented at Preliminary Design Review (PDR).
- Accept delivery of production Run 1 components no later than 12 months ARO and final delivery of the remaining production runs as quickly as possible thereafter. However, even though the University prefers delivery of Production Run 1 components no later than 12 months ARO, a later delivery will be seriously considered, especially if it results in a lower price and/or less technical risk and/or a significantly better design.

Milestone	Date
Kickoff meeting	2 weeks ARO
TA1 delivery	≤ 3 months ARO
TA1 Test Report completed by the University	≤ 3 months ARO + 2 weeks
PDR meeting	3 months ARO
Specify final location of CCD controllers (see HX0031 requirement 5.18)	Completed before the PDR is conducted
CDR meeting	TBD
TA2 delivery	TBD
TA2 Test Report completed by the University	TA2 delivery + 4 weeks
PRR meeting	
Production run 1 received at University	12 months ARO
Production run 2 received at University	TBD
Production run 3 received at University	TBD
Production run 4 received at University	TBD

Table 1: Suggested project milestones.

The contractor shall supply the CCDs, CCD controllers, and other electronics as summarized in Section 16. As part of this SOW the University will be furnishing the

Contractor with a variety of items. These include the hardware and documentation that are summarized in Section 16.

1.1 Applicable Documents

1) HX0003 − *Acronyms*, Richard Savage
2) HX0031 – *VIRUS Detector System Specification*, Richard Savage
3) HX0033 – *VIRUS Detector System Request for Proposal*, Richard Savage
4) HX0049 – *VIRUS Spider Assembly*

1.2 Glossary of Terms and Acronyms

See HX0003 − *Acronyms*, for a complete list of HETDEX Project abbreviations and acronyms. A partial list relevant to the VIRUS detector system is provided here for the reader's convenience:

ARO	**A**fter **R**eceipt of **O**rder (i.e., the date the contract is executed)
CCD	**C**harge **C**oupled **D**evice
CD	**C**ontractor **D**eliverable
CDR	**C**ritical **D**esign **R**eview
CF	**C**ontractor **F**urnished
COTS	**C**ommercial **O**ff **t**he **S**helf
ESD	**E**lectro**s**tatic **D**ischarge
FAT	**F**actory **A**cceptance **T**est
FATP	**F**actory **A**cceptance **T**est **P**lan
HET	**H**obby-**E**berly **T**elescope
HETDEX	**H**obby-**E**berly **T**elescope **D**ark **E**nergy **E**xperiment
KO	**K**ick**o**ff
MPD	**M**easurement **P**rocedure **D**ocument
MSDS	**M**aterial **S**afety **D**ata **S**heet
MTBF	**M**ean **T**ime **B**etween **F**ailure
MTTR	**M**ean **T**ime **t**o **R**epair
PCB	**P**rinted **C**ircuit **B**oard
PDR	**P**reliminary **D**esign **R**eview
PRR	**P**roduction **R**eadiness **R**eview
RFP	**R**equest **f**or **P**roposal
SOW	**S**tatement of **W**ork
TA	**T**est **A**rticle
TBD	**T**o **b**e **D**etermined
TR	**T**echnical **R**eview
UF	**U**niversity **F**urnished
VDAS	**V**IRUS **D**ata **A**cquisition **S**ystem
VIRUS	**V**isual **I**ntegral-Field **R**eplicable-**U**nit **S**pectrograph

2   Design VIRUS Detector System and Test Articles

2.1   The Contractor shall work closely with the University to design a VIRUS detector system (which includes the CCD package, vacuum electronics interconnect, bulkhead connector, temperature sensor interfaces and heater interfaces, spectrograph enclosure slot address generator readers, CCD controllers, multiplexers [or auxiliary controllers], CCD controller interface to the VDAS computer, power supplies, electrical interconnects, and fiber optic interconnects) that meets or exceeds all of the requirements contained in the HX0031. One primary goal is to design the system so that it is easy to set up and maintain. The reference design provided in HX0031 may provide a starting point for the final design. The Contractor may begin the design process using this design or another design that meets or exceeds all specifications. *The Contractor shall be ultimately responsible for the configuration and performance of the final design.*

2.2   Requirements for the VIRUS detector system mechanical, electrical, and software interfaces are contained in HX0031. Exact details of these interfaces shall be worked out between the Contractor and the University and shall be mutually agreed upon in the course of this SOW's design phase. This includes defining the electrical parameters that must be adjustable via computer control and specifying the lengths of all interconnects.

2.3   TA1 is a pair of nonfunctional detectors (or equivalent mechanical surrogate), each with integrated vacuum electronics interconnect, bulkhead connector with protective cap and temperature sensor interfaces and heater interfaces. The Contractor shall work closely with the University to design TA1. TA1 shall meet all of the HX0031 requirements as necessary for the University to:
- Verify that the TA1 design will meet all mechanical interface requirements
- Verify that the TA1 design will meet all heat transfer requirements
- Test CCD/FFLA alignment procedure
- Verify the spider assembly integration procedure
- Verify all measurements that are reported in the Contractor's TA1 Metrology report

2.4   TA2 is a pair of fully functional CCDs, vacuum electronics interconnects, bulkhead connectors, and controllers. The Contractor shall work closely with the University to design TA2. TA2 shall meet all relevant HX0031 requirements as necessary for the University to verify that the design will meet all software and performance requirements.

2.5   The Contractor shall modify the design to correct the deficiencies discovered during the test article tests conducted by the University (see Sections 5 and 6) and as per the outcome of project meetings (see Section 11).

3 Develop CCD Measurement Procedure

3.1 The Contractor shall develop a procedure for obtaining the measurements required to align the CCD with the Field Flattener Lens Assembly (FFLA). This procedure (referred to as the CCD Measurement Procedure) shall be documented and shall include:
- A description of the required measurements with measurement tolerances
- A description of the Contractor's measurement equipment and calibration procedures
- A description of quality control procedures that shall be followed by the Contractor when making the measurements and creating the Metrology Reports
- An example Metrology Report that will accompany each shipment of CCDs to the University (note that this report shall contain a tabulation of actual CCD measurements as a function of CCD serial number)

3.2 Revision 1 of the CCD Measurement Procedure Document (MPD) shall be delivered to the University for review no later than two weeks after the Kickoff (KO) meeting. The Contractor shall revise the document as per the University's comments. The revised document (Revision 2) shall be submitted to the University no later than two weeks after receiving the University's comments. Note that the procedure defined in Revision 2 shall be the procedure that is verified during TA1 testing at the University (see Section 3).

3.3 Revision 3 of the CCD MPD shall be delivered to the University for review no later than two weeks after TA1 testing is completed at the University (see Section 5). The Contractor shall revise the document as per the University's comments. The revised document (Revision 4) shall be submitted to the University no later than two weeks after receiving the University's comments. Note that the procedure defined in Revision 4 shall be the procedure that is used during production (see Section 8).

3.4 Contractor shall supply all facilities, equipment, and personnel required to obtain the measurements contained in the Metrology Reports that will be delivered as part of the contract.

4 Develop Factory Acceptance Test

4.1   The Contractor shall create a Factory Acceptance Test Plan (FATP) that addresses all requirements in the VIRUS detector system specification and SOW, and shall include the following items:
- Verification matrix
- List of test equipment
- Test equipment specifications
- Description of test setups, procedures, data reduction techniques, and criteria used to determine when a test has been passed
- Recommended testing order
- Section designed to verify design compliance
- Section designed to verify functional performance
- Section designed to verify critical dimensions/tolerances with drawings indicating the dimensions to be verified
- Section to record intermediate calculation and pass/fail check boxes

4.2   The verification matrix shall contain the following items for every requirement of the specification:
- Requirement to be tested
- Verification method
- "Pass" and "Fail" check boxes
- Blank area for recording numeric values
- Blank area for short notes/comments

4.3   The FATP tests shall utilize the following verification methods:
- Review (R) – the design is reviewed and it is obvious to all whether or not the item is in compliance
- Inspection (I) – the completed item is inspected and compliance can be easily observed
- Testing (T) – this entails a technical effort whereby the system is stimulated in a certain fashion and its response is compared to the required response.
- Analysis (A) – compliance of the design to the requirements is proved by mathematical analysis.

All tests and methods shall be approved by the University.

4.4   The FATP shall include tests to measure quantum efficiency as a function of wavelength, dark current, readout noise, and charge transfer efficiency. At a minimum, these tests shall be conducted in a vacuum at the cryogenic temperature selected by the Contractor to meet HX0031 requirement 6.1.

4.5   Revision 1 of the FATP shall be delivered to the University at the Preliminary Design Review (PDR). The Contractor shall revise the document as per the University's comments. The revised document (Revision 2) shall be submitted to

the University at the Critical Design Review (CDR). Note that FATP Revision 2 shall be verified during TA2 testing at the University (see Section 6).

4.6　　After TA2 testing is complete, the Contractor shall modify the FATP as per the University's comments. The revised document (Revision 3) shall be submitted to the University at the Production Readiness Review (PRR). Note that FATP Revision 3 shall be used for the first production run Factory Acceptance Test (FAT) (see Section 8).

4.7　　Note that the tests conducted during the first production run FAT shall be comprehensive. However, the subsequent production run FATs may be less comprehensive if approved by the University.

4.8　　The Contractor shall implement all the University-requested modifications to each FATP revision no later than two weeks after receiving the University's comments.

5　Fabricate and Test TA1

5.1　　The Contractor shall fabricate and inspect TA1, which includes two non-electrically functional CCD packages (each with integrated vacuum electronics interconnect, bulkhead connector with protective cap and temperature sensor interfaces and heater interfaces) required to support a single pair of spectrographs. Note that TA1 does not include the FFLA with integral focal plane mask and support flexures. These will be supplied by the University and mounted to TA1 (by the University) during TA1 testing (see requirement 5.3). Fabrication of TA1 shall not begin until approval has been obtained from the University.

5.2　　The Contractor shall ship TA1 (with Metrology Report) to the University no later than three months ARO.

5.3　　TA1 testing will be conducted by the University. Testing is anticipated to last two weeks. At the end of the test period the University will provide the Contractor with a test report. After receiving the TA1 Test Report, the Contractor shall modify the design to correct all deficiencies revealed by the testing (see requirement 2.5).

6 Fabricate and Test TA2

6.1   The University shall supply the Contractor with the following items so that the Contractor can test their heater control and temperature sensor circuits:
▪ Cold block assemblies with integrated heaters, and temperature sensors
▪ Cryostat temperature sensors
▪ Other spider assembly components as requested by the Contractor
▪ One or more test cryostats as requested by the Contractor

6.2   The Contractor shall fabricate TA2 which consists of the following:
▪ Two functional CCD packages (each with integrated vacuum electronics interconnect, bulkhead connector with protective cap and temperature sensor and heater interfaces) required to support a single pair of spectrographs
▪ All of the other VIRUS detector system components (e.g., spectrograph enclosure slot address generator readers, VDAS computer hardware and software, controllers, multiplexers [or auxiliary controllers], and interconnects) required to facilitate testing of a complete pair of spectrographs with a University-supplied VDAS computer and a University-supplied DC power supply (as per HX0031 requirement 8.1)
Fabrication of TA2 shall not begin until approval has been obtained from the University. Fabrication of long-lead-time items may proceed prior to CDR with the University's approval.

6.3   The University needs several weeks to prepare the TA2 FFLAs that will be used during the University tests (see 6.11). To support this preparation effort, the Contractor shall supply the University with the TA2 Metrology Report in advance so that the FFLAs can be prepared without incurring a project delay.

6.4   The University needs several weeks to purchase the DC power supply (as per HX0031 requirement 8.1) required to support TA2 testing. To support this preparation effort, the Contractor shall supply the University with the power supply specification and ordering information in advance so that it can be procured without incurring a project delay.

6.5   The Contractor shall conduct a FAT as per FATP Revision 2.

6.6   The Contractor shall provide all personnel, test equipment and facilities required to conduct the FAT.

6.7   The Contractor shall allow the University's representatives to witness all FATs.

6.8   During the FAT, the Contractor shall provide the University's representatives training which is sufficient to allow them to test TA2 as per requirement 6.11.

6.9 The Contractor shall deliver to the University the completed original FATP and Production Report (see requirement 12.8) at completion of the FAT.

6.10 After passing the FAT, the Contractor shall ship the TA2 components to the University.

6.11 Additional TA2 testing will be conducted by the University after the University:
- integrates TA2 into the spider assemblies,
- attaches the FFLAs to the spider assemblies, and then
- installs the spider assemblies into a spectrograph pair.

Testing is anticipated to last four weeks. At the end of the test period the University will provide the Contractor with a test report. After receiving the TA2 Test Report, the Contractor shall modify the design to correct all deficiencies revealed by the testing (see requirement 2.5).

6.12 The Contractor shall be available via telephone to support University TA2 testing during normal business hours. However, when TA2 tests are being conducted on the HET the Contractor shall be available via telephone (to support testing) 24 hours a day seven days a week. Note that approximately ten nights of testing with TA2 on the HET are anticipated.

6.13 The University will provide the Contractor with a TA2 Test Schedule to help ensure telephone support is available when needed. Note that the test schedule may be modified at short notice to accommodate the outcome of previous tests and weather conditions at the HET.

7 Conduct Training

7.1 Prior to conducting the first production FAT, the Contractor shall conduct a training class at its facility for up to six University personnel.

7.2 Class duration shall be at least two consecutive 8-hour days and shall not exceed five consecutive eight-hour days.

7.3 All training will be conducted in English.

7.4 The class will cover the following items:
- Safety issues, including safe handling of components
- Overview of the design
- Software interfaces and development environment
- All procedures in the Operations and Maintenance Manual, including procedures used to update software and firmware parameters
- Troubleshooting

7.5 The Contractor shall provide all training materials, including bound hardcopies for each student.

8   Produce VIRUS Detector System and Conduct FATs

8.1   The Contractor shall supply VIRUS detector system components as per the design agreed upon at CDR and the schedule shown in Table 2.

Production Run	Number of Pairs	Delivery (Months ARO)
1	8	12
2	24	TBD
3	43	TBD
4	25	TBD

Table 2: Delivery schedule.

8.2   Fabrication shall not begin until approval has been obtained from the University. Fabrication of long-lead-time items may begin prior to CDR with the University's approval.

8.3   The Contractor shall supply the Metrology Report for each production run no later than two weeks after completing the measurements that are contained in the report. Each CCD shall be measured to verify compliance with HX0031 requirements 4.2 and 4.3, and to provide MDO with the information required to mount the CCDs. Additionally, compliance with HX0031 requirement 4.1 will be based upon batch testing (i.e. all CCDs in each batch do not have to be measured to verify compliance with 4.1). The number of CCDs that will measured to verify compliance with requirement 4.1 shall be mutually agreed upon.

8.4   The Contractor shall allow the University to inspect the VIRUS detector system components as they are being fabricated. Anticipate at least one one-day visit during each production run.

8.5   The Contractor shall conduct a FAT, as stipulated in Section 4 of this document, for each production run.

8.6   The Contractor shall provide all personnel, test equipment and facilities required to conduct all FATs.

8.7   The Contractor shall allow the University's representatives to witness all FATs.

8.8   The Contractor shall deliver to the University the completed original FATP and Production Report at completion of each Production Run FAT.

8.9   After the University receives the VIRUS detector system components, the University shall assemble the spider assemblies with the following University furnished components:
▪ Spider assembly integration procedure

- Cold block assemblies with integrated cold link, heaters, and temperature sensors
- Cryostat temperature sensors
- Spiders
- Temporary bulkhead connector strain reliefs
- Back caps
- All fasteners, adhesives, and other items (e.g., thermally conductive paste and retaining compounds)

The University shall also install the FFLAs after the spider assemblies have been assembled by the University.

9 Packing and Shipping

9.1   The Contractor shall be responsible for the entire process of packing and shipping all VIRUS detector system components to a University-designated site in Texas.

9.2   The Contractor shall be responsible for designing and building appropriate shipping containers for the VIRUS detector system components. The Contractor shall ensure that best practices are used to minimize the possibility of damage to these components during shipping.

9.3   Note that since some of the Contractor's VIRUS detector system components may be shipped to the University in batches, it is permissible to reuse packaging if this is the most cost effective approach. If reusable packing is provided, the Contractor shall allow the University at least 4 weeks to unload the packages and then send them back to the Contractor.

9.4   After the VIRUS detector system components have passed their FAT, the Contractor shall (after receiving University approval) pack them and ship them to a University-designated site via a mutually agreed-upon means. The delivery address will be designated by the University no later than two months prior to projected delivery. Note that Contractor's cost proposal should assume the shipment will be to Austin, Texas.

9.5   Prior to shipping, Contractor shall coordinate the shipping schedule with the University to ensure that qualified personnel are available to receive the shipment.

9.6   Immediately upon arrival, all shipments will be visually inspected by qualified University receiving personnel for shipping/handling damage in the presence of the shipper's representative. Receiving personnel will immediately notify the Contractor (by email and/or telephone) if an item has been damaged. Upon receipt of notification, the Contractor shall take immediate action to remedy all problems.

10 Project Organization and Control

10.1   The Contractor shall produce a revised (from the plan delivered in the proposal response) preliminary project plan at the Kickoff (KO) meeting and, following agreement with the University on the plan, shall update and maintain the project plan throughout the course of the contract. The plan shall identify each project task, how each task sequences and relates to other tasks, and the personnel or other resources required to achieve the task. A Gantt chart or similar combined graphical and text presentation of the project plan is the form preferred by the University.

10.2   Throughout the project, the Contractor shall keep the University informed in writing of any potential schedule delays and shall propose a plan to address and recover the delay. This shall include problems with subcontractors' deliveries as well as problems the Contractor experiences at its own facility.

10.3   The Contractor shall provide progress reports on a monthly basis that detail the activities leading to delivery of the VIRUS detector system. In particular, the reports shall:
  ▪ Contain a summary of work performed
  ▪ Contain a list of action items with status (see requirement 11.12)
  ▪ Describe major activities scheduled for the next reporting period
  ▪ Contain an updated project plan with schedule
  ▪ Flag any areas of concern that could cause schedule delay due to technical problems, material ordering/availability/delivery issues, or any other reasons

10.4   Progress reports shall be in the Contractor's format and submitted via email.

10.5   The first progress report, which shall contain the first detailed baseline Project Schedule, shall be submitted four weeks after receipt of purchase order. The University will review the baseline schedule to ensure that it contains sufficient detail. Vendor shall modify the baseline schedule within one week after receipt of the University's recommendations.

10.6   The Contractor shall maintain strict configuration control on all elements of the project under his control. This shall include revision control of all drawings and documents that are produced in association with this project.

11 Reviews and Meetings

11.1   The Contractor shall conduct a minimum of five meetings. These include the KO, PDR, CDR, PRR, and one Technical Review (TR) meeting.

11.2   All of the meetings shall be conducted at the Contractor's facility.

11.3   The Contractor shall prepare presentation materials and submit them to the University at least one week in advance of each meeting.

11.4   The Contractor shall prepare Meeting Minutes with a brief summary of the items discussed, and a list of action items with the name of the individual responsible for the action item and the anticipated date for closing the action item. Draft Meeting Minutes shall be submitted to the University for review no later than one week after each meeting. The Contractor shall modify the draft Meeting Minutes within one week after receipt of the University's Meeting recommendations.

11.5   The Contractor shall present the following items at the KO meeting:
- Convincing evidence that the Contractor understands the project requirements and technical specifications
- Project Plan with schedule and milestones
- Preliminary designs for the mechanical, electrical, and software interfaces
- Estimate of the CCD operating temperature required to meet the VIRUS detector system performance requirements
- Estimate of the amount of heat generated by the CCD for all modes of operation
- Estimate of the amount of heat conducted through the vacuum electronics interconnect
- Spectrograph enclosure VIRUS detector system heating and cooling requirements (e.g., location of all VIRUS detector system heat generation sources and heat loads)
- Estimate of the Mean Time Between Failure (MTBF) and Mean Time to Repair (MTTR)
- Quality Assurance Plan

11.6   The Contractor shall present the following items at the PDR meeting:
- Convincing evidence that the preliminary design meets all system requirements with acceptable risk
- Conceptual system drawings
- List of long lead time items that must be procured before the CDR meeting
- Refined designs of the mechanical, electrical, and software interfaces
- FATP Revision 1
- CCD operating temperature required to meet the VIRUS detector system performance requirements
- Amount of heat generated by the CCD for all modes of operation
- Amount of heat conducted through the vacuum electronics interconnect
- Refined spectrograph enclosure heating and cooling requirements
- Refined MTBF and MTTR estimates

11.7   After the PDR, the Contractor shall modify the design as per the meeting action items. After receiving approval from the University, the Contractor shall proceed with the final design.

11.8   The Contractor shall present the final design at CDR. This includes:
- Convincing evidence that the VIRUS detector system will meet or exceed all specifications
- Detailed design of the mechanical, electrical, and software interfaces
- Data sheets and other documentation for all commercial off-the-shelf components as considered necessary by the University
- Complete drawing package
- List of spares with estimated lead times and prices (see Section 13)
- FATP Revision 2
- Training class outline

11.9   After CDR, the Contractor shall modify the design as per meeting action items.

11.10   A PRR meeting shall be conducted prior to starting the first production run. The contractor shall present the following items at the PRR meeting:
- Convincing evidence that the VIRUS detector system is ready for production
- All documentation (e.g., drawings and procedures) required to implement the first production run

11.11   The Contractor shall provide information in a timely manner as requested by the University to:
- Respond to the University's inquiries
- Allow for concurrent design of the University-supplied equipment that interfaces to the VIRUS detector system

11.12   The "Action Item" list developed in regular Contractor/University meetings shall be the responsibility of the Contractor to maintain. Each action item shall consist of the item to be resolved, the person responsible for resolving the item, the date the action item was created, the projected date the item is to be resolved, and the current status of the item.

12 Other Documentation and Deliverables

12.1   The Contractor shall provide documentation as stipulated in this section of this document. Note that these requirements also pertain to the following:
- Training materials described in Section 7
- Progress Reports described in Section 10
- Presentation materials, meeting minutes and action item list described in Section 11

12.2   All documentation shall be provided in English.

12.3   As a goal, all documentation shall be provided copyright free with unrestricted use subject to item 12.4.

12.4 As a goal, documentation will not contain proprietary information. All information which is proprietary shall be clearly marked on each page that contains proprietary information.

12.5 All documentation (described in this specification) shall be provided in electronic format (i.e., in their native "editable formats") on one or more CDs.

12.6 Two bound hardcopies of each Production Report shall be provided, and six bound hardcopies of all other documentation shall be provided.

12.7 The Contractor shall submit a single draft electronic copy of all documentation to the University during the first FAT. The Contractor shall complete all University-requested changes to the documentation no later than one month after receipt of the changes. The Contractor shall submit a single final electronic copy of all documentation (which reflects the equipment's as-built configuration) to the University within one week after all University-requested changes have been implemented.

12.8 A Production Report shall be provided for TA2 and each production run that includes the following information:
  ▪ All relevant quality records
  ▪ Machine-readable data sheets (in Microsoft Excel-compatible format) which contain setup information and test results for each item that has a serial number (e.g., tabulated values of CCD quantum efficiency as a function of wavelength for each CCD)
  ▪ Other relevant information which has been mutually agreed upon

12.9 A Design Report shall be provided that includes:
  ▪ Description of the methodology/rationale used to converge upon the final design
  ▪ Description of all design assumptions and boundary conditions
  ▪ Description of detailed analysis and/or modeling and results necessary to verify performance
  ▪ Critical mechanical tolerance analyses and error budgets
  ▪ All finite element models and results
  ▪ MTBF and MTTR estimates
  ▪ All as-built documentation including Bill of Materials, PCB artwork, electrical drawings, and CAD drawings in a format that is compatible with AutoDesk Inventor version 2008 or higher
  ▪ Other relevant information which has been mutually agreed upon

12.10 An Operations and Maintenance Manual shall be provided that includes:
  ▪ System description with illustrations depicting the location and arrangement of all equipment and controls
  ▪ Theory of operation
  ▪ Description of all safety equipment and features
  ▪ Description of all electrical interfaces

- Utility requirements (e.g., electrical power, heating and cooling)
- Description of the software interface, programming features, and software commands
- Description of the tests and test equipment required to ensure that performance requirements are met
- Relevant CAD drawings of individual components with weights and center of mass location
- All drawings required to locate and identify items required for routine maintenance with maintenance specifications on the drawings. Preventative maintenance points shall be clearly identified with reference to specific procedures and steps in the Operation and Maintenance Manual
- Interconnect drawing showing all interconnects and modules
- Electrical schematics required to support troubleshooting down to the PCB component level
- List of consumable hardware with specifications
- Shipping and handling instructions (especially for ESD sensitive components)
- Installation procedures
- Setup procedures
- Operating procedures
- Assembly/disassembly procedures
- Maintenance procedures and schedule to support a lifetime of 20 years
- Procedures for troubleshooting at the field-replaceable-module level
- Procedures for replacing field-replaceable modules
- Procedure for cleaning the CCD light-sensitive surfaces
- Procedure for optimizing the clock and bias signals
- Procedure for generating the timing patterns for all operation modes
- Procedure for updating firmware
- Procedures for verifying performance of safety equipment
- Safety instructions and all Material Safety Data Sheets (MSDS)
- Other relevant information which has been mutually agreed upon

12.11 All VIRUS detector system software and firmware with source code, libraries, and development environments (e.g., compliers) in native electronic format.

12.12 Any non-COTS utility software required to modify the operating characteristics of the readout electronics including clock and bias voltages, timing patterns or others.

12.13 A non-exclusive license to use and or modify all of the Contractor's software for use at the observatory.

12.14 All special tooling and test equipment fully burdened to this project.

13 Spares

13.1   The Contractor shall develop a spare parts list for critical VIRUS detector system components to support a 20-year lifetime. The list shall be based upon the following selection criteria:
▪ Mean time between failures
▪ Lead time
▪ Part obsolescence probability
▪ Shelf life
▪ Likelihood of incurring accidental damage (e.g., ESD experienced during system troubleshooting activities)
▪ Degree to which availability of the spare could facilitate system troubleshooting
▪ Price

13.2   The spare parts lists shall include contact information for the suppliers of all components including supplier name, address and telephone number.

13.3   Spares shall be provided as an option to the University and probably will not be ordered any sooner than CDR.

14 Warranty

14.1   The Contractor shall provide a warranty as stipulated in this section of this document.

14.2   The warranty period shall begin after the last item of the last production run has been received by the University and installed on the telescope.

14.3   The warranty period shall last for one year.

14.4   Prior to the start of the warranty period, and during the warranty period, the Contractor shall provide (at no cost to the University) engineering telephone support during normal business hours.

14.5   The Contractor shall provide onsite support as requested by the University. Support shall be provided on a time and materials basis with travel reimbursement. At a minimum, this support shall be made available to the University throughout the entire warranty period.

14.6   Should a problem arise that could turn out to be a flaw in the design or workmanship of the Contractor's supplied equipment within the warranty period, the Contractor shall take actions agreed to by the University and the Contractor to investigate the condition. The University shall compensate the Contractor on a time and materials basis with travel reimbursement for the investigation phase.

Should the problem be found to be caused by the Contractor, the Contractor shall remediate the problem at no additional cost to the University.

14.7   Contractor's labor rates and travel reimbursement costs shall be as specified in its proposal (i.e., in its response to the University's RFP HX033).

15 University Furnished Hardware

15.1   As part of this SOW the University will furnish the Contractor with a variety of items. These include the hardware and documentation that are summarized in Section 16. Upon receipt of this hardware the Contractor, shall be responsible for replacing/repairing these items at no cost to the University in the event that they are damaged or stolen.

16 Summary of University Furnished Items and Contractor Deliverables

Item	Requirement	Description	
1	Section 3	▪ CCD MPD (revisions 1 through 4)	CD
2	Section 3	▪ All facilities, equipment, and personnel required to obtain the measurements contained in the Metrology Reports	CF
3	Section 4	▪ FATP Revisions 1, 2, 3 ▪ Subsequent FATP revisions as mutually agreed upon	CD
4	Section 5	▪ TA1 and Metrology Report	CD
5	Section 5	▪ Equipment and personnel required to support TA1 testing at the University (e.g. equipment required to measure the alignment between the CCD and FFLA) ▪ TA1 Test Report	UF
6	Section 6	▪ Spider assembly integration procedure ▪ FFLAs with integral focal plane mask and support flexures ▪ Cold block assemblies with integrated cold link, heaters, and temperature sensors ▪ Cryostat temperature sensors ▪ Spiders ▪ Temporary bulkhead connector strain reliefs ▪ Back caps ▪ All fasteners, adhesives, and other items (e.g., thermally-conductive paste and retaining compounds) ▪ Spectrograph enclosure address generators ▪ VDAS computer ▪ DC power supply	UF
7	Section 6	▪ TA2 ▪ Metrology Report ▪ Completed FAT and Production Report	CD
8	Section 6	▪ All personnel, test equipment and facilities required to train University representatives and conduct FAT	CF
9	Section 6	▪ Equipment and personnel required to support TA2 testing at the University ▪ TA2 Test Report	UF
10	Section 6	▪ TA2 Test Schedule	UF
11	Section 7	▪ Training class	CF
12	Section 7	▪ Training materials	CD

Table 3: Summary of deliverables and furnished items. A "CD" in the far right column indicates a Contractor deliverable, a "CF" indicates a Contractor-furnished item, and a "UF" indicates a University-furnished item.

Item	Requirement	Description	
13	Section 8	▪ CCDs with integrated vacuum electronics interconnect, bulkhead connector with protective cap, temperature sensor interfaces and heater interfaces ▪ Spectrograph enclosure slot address generator readers ▪ CCD controllers ▪ Multiplexers (or auxiliary controllers) ▪ CCD controller interface to VDAS computer ▪ Interconnects ▪ Spectrograph enclosure address generators ▪ Metrology Reports ▪ Completed FATs and Production Reports	CD
14	Section 8	▪ Spider assembly integration procedure ▪ FFLAs with integral focal plane mask and support flexures ▪ Cold block assemblies with integrated cold link, heaters, and temperature sensors ▪ Cryostat temperature sensors ▪ Spiders ▪ Temporary bulkhead connector strain reliefs ▪ Back caps ▪ All fasteners, adhesives, and other items (e.g., thermally-conductive paste and retaining compounds) ▪ Power supplies	UF
15	Section 8	▪ All personnel, test equipment and facilities required to conduct FATs	CF
16	Section 9	▪ All shipping containers and special packaging materials required for ESD protection	CD
17	Section 9	▪ All shipping costs, including insurance (this includes shipping and insurance costs associated with returning the reuseable packaging materials described in requirement 9.3)	CF
18	Section 9	▪ All import duties for items shipped to the United States	UF
19	Section 10	▪ Preliminary Project Plan with subsequent revisions ▪ Monthly Progress Reports ▪ Meeting Presentation Materials and Minutes	CD
20	Section 11	▪ Presentation Materials ▪ Meeting Minutes (drafts and final revisions)	CF
21	Section 12	▪ Design Report draft and final revision ▪ Operations and Maintenance Manual draft and final revision ▪ All VIRUS detector system software and firmware with source code, libraries and development environments (e.g., compliers) ▪ All special tooling and test equipment purchased/developed as part of this contract	CD
22	Section 13	▪ Spare parts lists	CD
23	Section 14	▪ Warranty	CF

Table 3 Continued: Summary of deliverables and furnished items. A "CD" in the far right column indicates a Contractor deliverable, a "CF" indicates a Contractor-furnished item, and a "UF" indicates a University-furnished item.