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DOCUMENT IDENTIFICATION:

PROJECT:	**SOUTHERN AFRICAN LARGE TELESCOPE ROBERT STOBIE SPECTROGRAPH NEAR INFRARED INSTRUMENT**
DOCUMENT TITLE:	**PROJECT MANAGEMENT PLAN**
DOCUMENT #:	**SALT-3501BP0001**
FILENAME:	**SALT-3501BP0001.090508.doc**
REVISION:	**090508**
KEYWORDS:	**SALT, NIR, RSS, PMP, QUALITY, WBS, BUDGET, SCHEDULE**

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REVISION HISTORY:

Rev	ECN	Description	Date	Approval
-	NA	Original Document		

Table of Contents

Acronym List

AGN .... Active galactic nucleus
CDR .... Critical Design Review
Co-I .... Co-Investigator
ECN .... Engineering Change Notice
Fe I .... Iron I (1.64 µm)
H II .... Ionized atomic hydrogen
He I .... Helium I (1.0830 µm)
ISM .... Interstellar Medium
IV&T .... Integration, Verification, and Test
NIR .... Near Infrared
PDR .... Preliminary Design Review
PI .... Principal Investigator
PM .... Project Manager
PS .... Project Scientist
QAS .... Quality Assurance and Safety Manager
RPN .... Risk Priority Number
RSS .... Robert Stobie Spectrograph
SAL .... Space Astronomy Lab
SALT .... Southern African Large Telescope
SE .... System Engineer
SSEC .... Space Science and Engineering Center
TRR .... Test Readiness Review
UW .... University of Wisconsin
WARF .... Wisconsin Alumni Research Foundation
WBS .... Work Breakdown Structure

Reference Document List

SSEC Document Control Procedure, 1008-0002
SSEC Change Control Procedure, 1008-0004
SSEC Training Procedure, 1008-0005
SSEC Test Equipment Calibration Procedure, 1008-0006
SSEC Project Life Cycle Process, 1008-0007
SSEC Complaint Handling Procedure, 1008-0012
SSEC Project Safety Procedure, 1008-0014
SSEC Quality Records Procedure, 1008-0017
SSEC Software Development Procedure, 1008-0021
SSEC Project Management Plan, 1008-0024
Instrument Budget Reserve Expenditure, Acceptance and Valuation, SALT3000BD0002
Allowable Costs in the Valuation of Scientific Instruments, SALT30000BD0005

1. PROJECT IDENTIFICATION

1.1. Project Name

The Near Infrared (NIR) Spectrograph is a complement instrument to the Visible Spectrograph (Vis) on the Southern African Large Telescope (SALT). Together, they form the Robert Stobie Spectrograph (RSS) and may be referenced as the RSS-Vis and RSS-NIR.

1.2. Funding Agency

The initial instrument support was provided by SALT Foundation and Dr. Andrew Sheinis' laboratory funds. Funds have been secured through two funding sources. The Wisconsin Alumni Research Foundation has agreed to provide $3.3 million towards the instrument development and the National Science Foundation has awarded Dr. Sheinis $1.996 million. The SALT Board has also agreed to provide support for the instrument, but the level of support has not been finalized. For planning purposes, it has been assumed that SALT will provide $1.08 million.

1.3. Principal Investigator

The Principal Investigator is Dr. Andrew Sheinis of the UW Astronomy Department.

1.4. Project Scope & Objectives

The scope of this project is to define, specify, design, develop, integrate and test a near infrared spectrograph for the SALT facility. Once successfully assembled and tested at UW, the instrument will be packed, shipped, and commissioned at the SALT facility.

The objective of the RSS-NIR instrument is to provide a low to medium resolution spectrograph with broadband imaging, spectropolarimetric, and Fabry-Perot imaging capabilities. The RSS-NIR combines with Vis to extend the spectral coverage from 3200 Å to 1.7 µm.

This plan describes the management of the project from PDR through commissioning the instrument at the SALT facility. This is a three and a half year period starting in July 2008 through December 2011 with an additional month of commissioning contingency in January 2012. Project years are defined as July through June.

1.5. Project Science Goals

1. Simultaneous Fabry-Perot near infrared and visible spectroscopy to:
   - detect some of the earliest galaxies to form in the universe ($z = 7\text{-}8$);
   - study dynamic evolution, core collapse, and central black holes in Galactic globular clusters;
   - improve existing studies of the Tully-Fisher relation, cluster galaxy formation and evolution, and the role of hierarchical merging in galaxy formation; and
   - study Galactic high velocity clouds, extragalactic HII regions, and Galactic ISM properties.
2. High throughput, medium resolution near infrared spectroscopy to:

- study star forming regions and superstar clusters in the Small Magellanic Cloud to provide new data on low-metallicty star formation processes,
- observe near infrared excess in the spectra of brown dwarfs to determine whether the excess is due to circumstellar disks of planet-forming material,
- observe and confirm H-alpha emissions from brown dwarfs in the southern hemisphere,
- penetrate the dusty inner galaxy environment to study the ISM in HeI and FeI of the inner galaxy, and
- study QSO absorption lines of Lyman-α systems and Lyman break galaxies at higher z and increased efficiency.

3. Near infrared Spectropolarimetry to:
   - improve the separation of interstellar polarization from intrinsic polarization across the large band pass of 3200 Å to 1.7 μm,
   - increase the number of observable polarized spectropolarimetric targets in the Milky Way,
   - allow studies of much younger and more massive pre-Main Sequence stars,
   - provide the first studies of embedded AGN, and
   - open up the study of asymmetries of ejecta of elements not easily seen in the visible, such as Mg and FeII.

1.6. Project Description

The University of Wisconsin together with Rutgers University and the South African Astronomical Observatory developed the RSS-Vis instrument. It specializes in very high throughput low- and medium- resolution spectroscopy, high time resolution spectroscopy, and spectropolarimetry from 3200 to 9000 Å. It was designed with the intention of having a near infrared instrument operating simultaneously with it. This project adds the complementary near infrared instrument to the SALT facility.

The PI, Dr. Sheinis, is a UW faculty member. His science team consists of fellow members of the Department of Astronomy and the Space Astronomy Lab (SAL). It includes Marsha Wolf, Project Scientist, Co-Investigators Matthew Bershady, Kenneth Nordseick, Amy Barger, and Theodore Williams of Rutgers University. The PM, Quality Assurance and Safety Manager (QAS), and System Engineer are from the UW–Space Science and Engineering Center (SSEC). The engineering support for the project is from the SAL and SSEC. As required, outside vendors are used to augment the UW engineering resources.

2. RESOURCES

2.1. Organization and Key Staff

The RSS-NIR instrument is managed and developed by the Department of Astronomy, SAL, and SSEC located at the University of Wisconsin. Other universities may provide support and in-kind contributions toward the instrument, but no formal agreements have been put in place at this time.

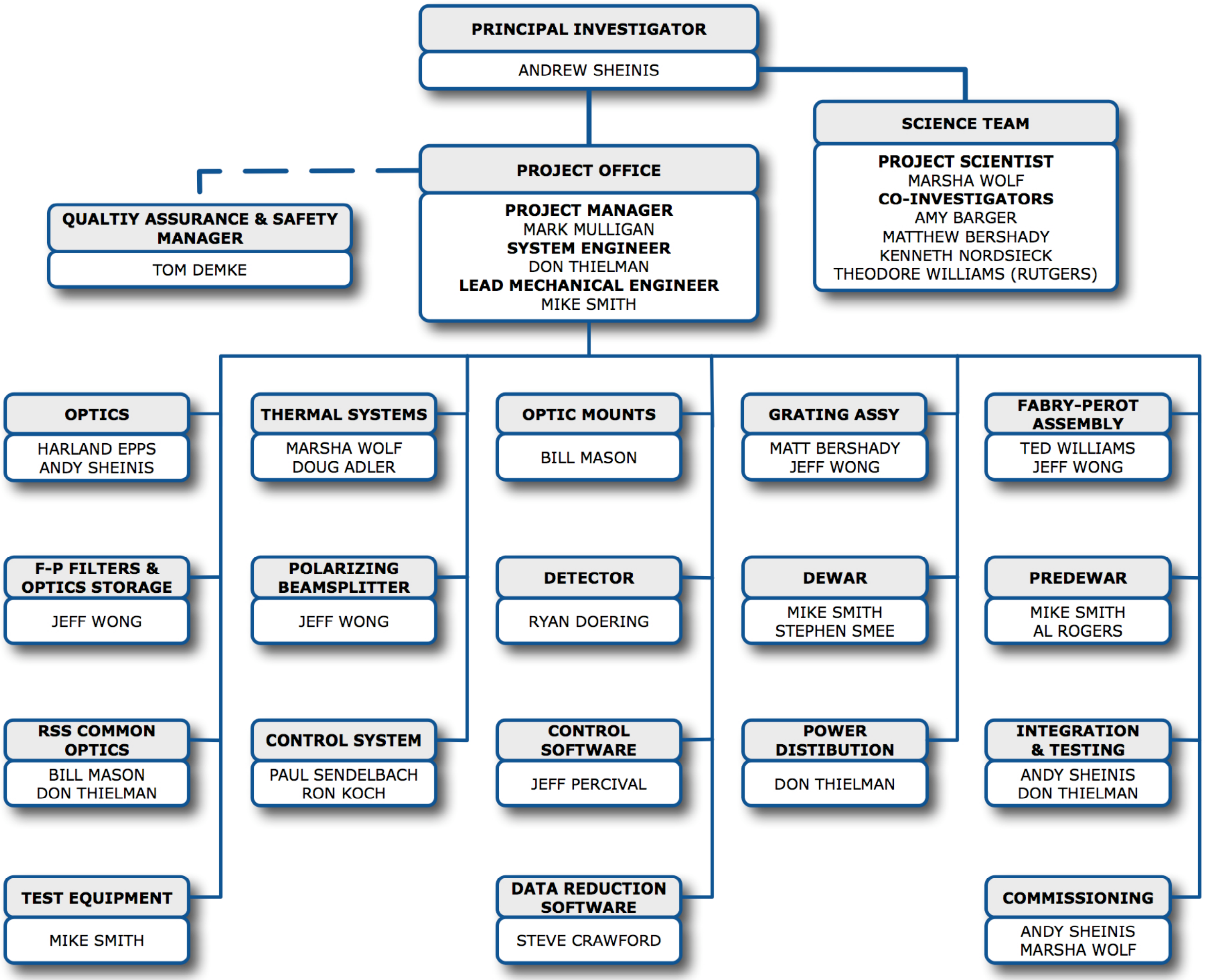

Figure 1. *SALT RSS-NIR Spectrograph Organization Chart*

2.1.1. ***Principal Investigator (PI):*** Andrew Sheinis, Department of Astronomy and SAL, has the overall authority and responsibility for the delivery of the instrument to the SALT Foundation. He is responsible for defining the scientific objectives of the instrument to meet his and the science team's research goals. The PI provides the programmatic guidelines to which he would like the project managed. Ultimately, the PI is responsible for all scientific, technical, financial, and programmatic decisions. For this project, Dr. Sheinis will also have an integral role in the design, fabrication, integration, and testing of the optical system.

2.1.2. ***Project Scientist (PS):*** Marsha Wolf, Department of Astronomy, is responsible for formally defining and documenting the instrument scientific objectives and ensuring they are met within the design and operation limits of the instrument and the facility. In addition, the PS provides guidance to the PI on instrument scientific and programmatic matters. Specific to his project, Dr. Wolf is responsible for modeling the optical and thermal performance of the instrument.

2.1.3. ***Co-Investigator (Co-I):*** Matthew Bershady, Department of Astronomy, provides advice and guidance to the PI. Along with the PS, he will formally define and document the instrument scientific objectives. Both he and the PS will work with the systems engineer to ensure the science objectives are properly flowed into engineering requirements.

2.1.4. ***Co-Investigator (Co-I***): Kenneth Nordsieck, SAL, provides advice and guidance to the PI and advises on the overall instrument design. As the PI for the RSS-Vis, he functions as the advocate for the RSS-Vis to ensure that the RSS-NIR design does not have a negative impact on the RSS-Vis.

2.1.4 ***Co-Investigator (Co-I):*** Amy Barger, Department of Astronomy, provides advice and guidance to the PI regarding the scientific objectives and instrument development. Dr. Barger will provide commissioning support.

2.1.5 ***Co-Investigator (Co-I):*** Theodore Williams, Rutgers University, provides advice and guidance to the PI regarding scientific objectives and instrument development. Specifically, Dr. Williams is responsible for the implementation of the Fabry-Perot etalon.

2.1.5. ***Project Manager (PM):*** Mark Mulligan, SSEC, reports directly to the PI. The PM supports the PI in defining programmatic guidelines and is then responsible for their execution. He is responsible for managing the project on a day-to-day basis. The PM works together with the appropriate engineering disciplines to formulate plans and processes ensuring good communication across the project. This philosophy encourages team members to contribute ideas as well as an attitude that success starts with good planning at the lowest levels. The PM is responsible for executing the agreed upon project development plans while ensuring the project scope, schedule, and budget are met.

2.1.6. ***Systems Engineer (SE):*** Don Thielman, SSEC, provides oversight for the entire design. The SE is responsible for flowing the science requirements into engineering requirements to define the instrument design. He is responsible for assessing the current design against the functional performance requirements and the operational modes (as defined in the operational concepts definition document), developing and maintaining the required interface control documents to manage internal and external interfaces, ensuring acceptance testing (subsystem and instrument) verifies all performance requirements, supporting instrument commissioning, and developing an Operations and Maintenance Manual. In addition, the SE is tasked with identifying, tracking, and mitigating design, integration, and testing risks.

2.1.7. ***Quality Assurance and Safety Manager (QAS):*** Tom Demke, SSEC, is responsible for assuring that all instrumentation meets its design and safety requirements. The QAS plays an integral role in instrument development as he is responsible for implementing the project safety program, ensuring design reviews are conducted, conducting safety reviews, checking design documentation, and examining all test procedures and results. The QAS works together with the PI and PM to integrate safety and quality into the instrument development; however, to avoid any conflict of interest, he does not report to the Project Office, rather, he provides independent oversight to the project and reports directly to the management of SSEC.

2.2. Facilities

SAL and SSEC each have machine shops capable of fabricating the structure and mechanisms required to build the RSS-NIR instrument. The project will primarily utilize the physics shop, but may use SSEC, other campus, or outside vendor shops if expertise or time warrants it. The optical elements will be fabricated, figured and coated by outside vendors.

SAL has a new remodeled optics assembly lab specifically designed to support the assembling, aligning, and testing of an optical instrument. The integration, verification, and testing of the RSS-NIR will occur in this lab.

If required for subassembly testing, SSEC has two thermal chambers capable of cooling down to -80° C. If larger scale testing is required, other facilities exist on campus that can be utilized. For example, the UW Physical Science Lab has a large freezer lab capable of housing the entire assembled instrument and capable of reaching -40° C.

2.3. Equipment

The project requires several significant capital equipment purchases all of which will be made within the UW and state purchasing rules and regulations. The purchases include:

Teledyne HAWAII-2RG 18µm detectors (or equiv)
Optical elements (blanks, fab, & coating)
Interference filters
VPH Gratings
Cryogenic dewar assembly
Fabry-Perot etalon & controller
Polarizing beamsplitter
Predewar chiller

3. SCHEDULE, BUDGET & KEY DELIVERABLES

3.1. Work Breakdown Structure

The RSS-NIR instrument WBS is divided into 15 level 2 elements comprised of subsystems (grating assembly, interference filter wheel….), project phases (IV&T and commissioning), and project administration.

The budget was developed at level 2 with the exception of element 2.0, Optical Elements, which was done at level 3.

Spending will be tracked at level 2 starting after PDR. **Figure 2** presents the WBS. The WBS is also provided in the Appendix in greater detail, typically to level 4.

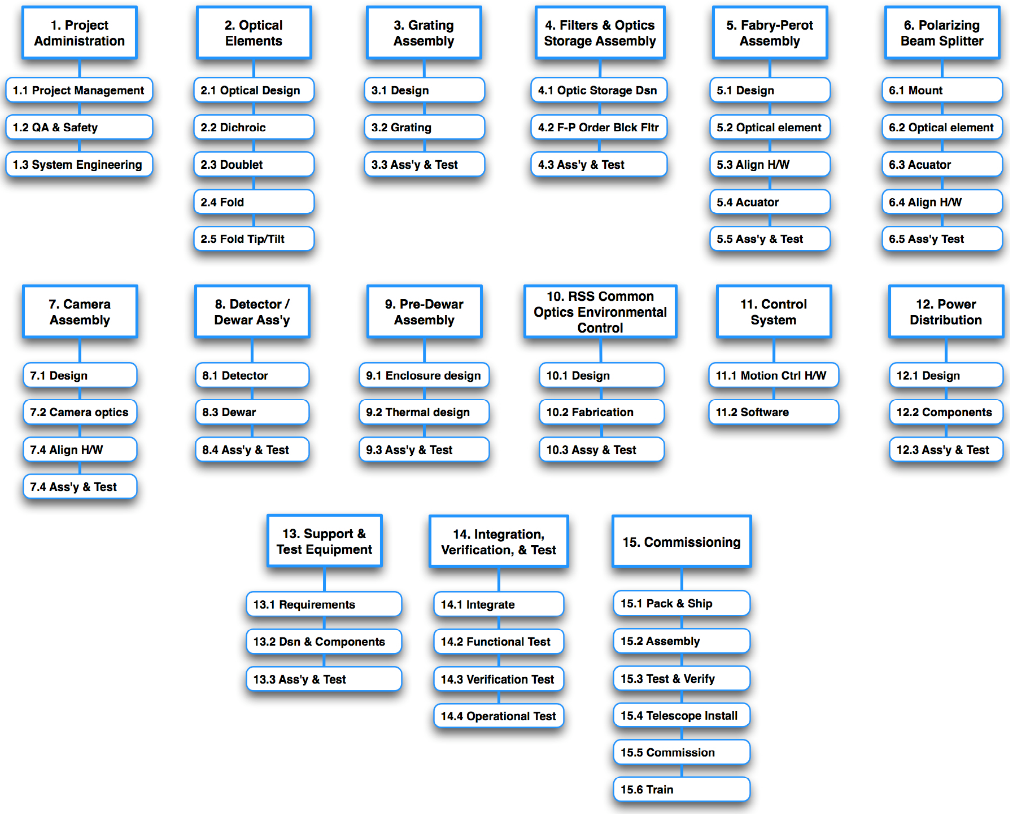

Figure 2. *RSS-NIR Work Breakdown Structure*

3.2. Schedule

The critical path of the detailed schedule is provided in **Figure 3**. See RSS-NIR document SALT-3501BP0002 for a completely updated and detailed schedule.

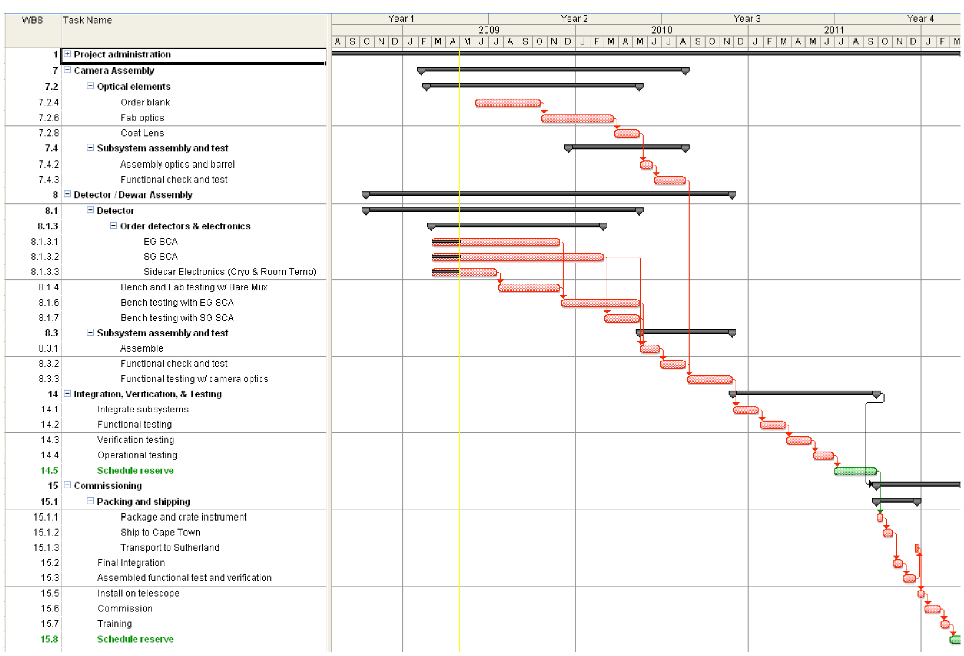

Figure 3. *RSS-NIR Spectrograph summary schedule.*

The flow of the instrument development is shown in Figure 4. While the figure does not provide insight into the timing and duration of the events, it does present a simplified view of the interdependence of the tasks. The critical path is highlighted in red.

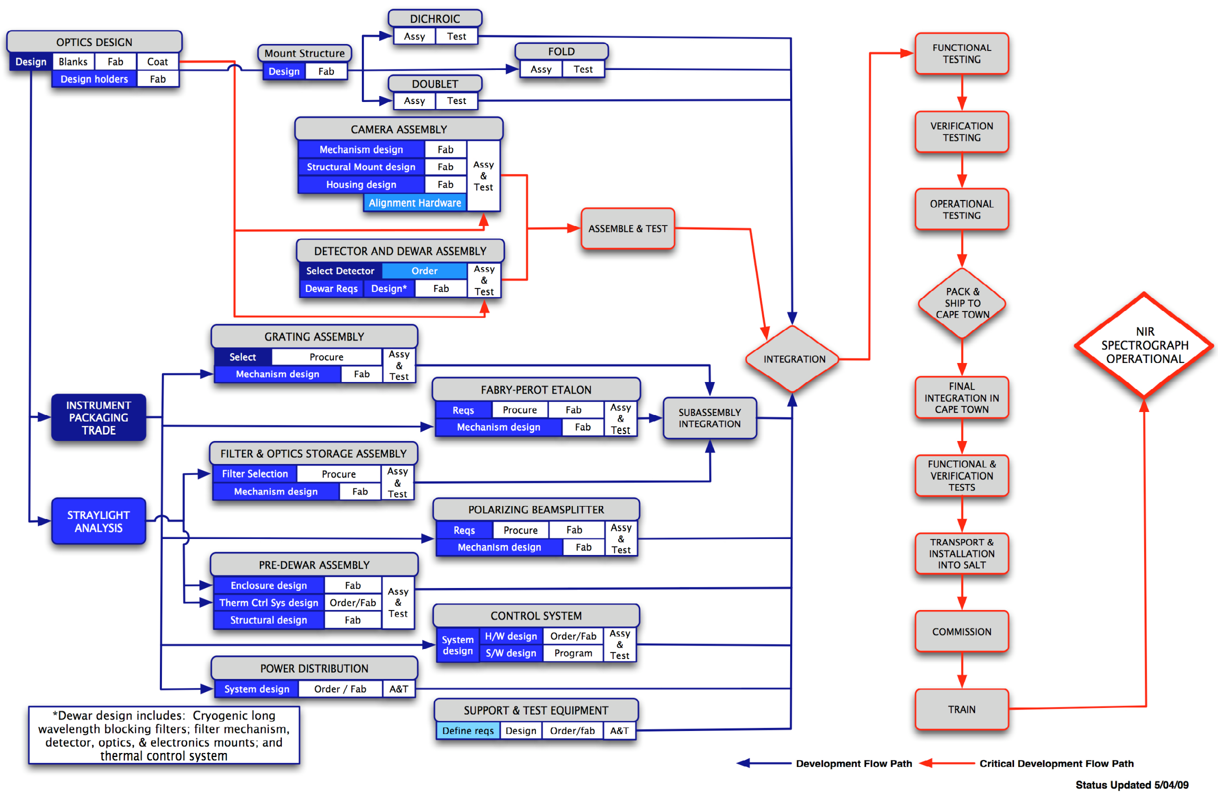

Figure 4. *RSS-NIR Spectrograph development flow diagram.*

3.3. Budget

This section has been updated as of the Mid-Term Review in May 2009.

Funding. The RSS-NIR has received $3.3M from the Wisconsin Alumni Research Foundation and just under $2.0M from the National Science Foundation. The SALT consortium has provided $145k and is committed to providing an additional $155k. Another $925k was formally requested at a SSWG in 2008. The total RSS-NIR funding is just over $6.5M as shown in **Table 1**.

Table 1. *RSS-NIR Funding Summary*

WARF		**$3,300,000**
NSF		**$1,996,775**
SALT		
Initial Rec'd	**$145,000**	
Committed	**$155,000**	
Requested	**$925,000**	
		$1,225,000
TOTAL FUNDING		**$6,521,775**

Spending. Through March 2009, $446,216 has been spent leaving a balance of $6,075,559. The Department of Astronomy/Space Astronomy Lab tracked project spending prior to July 1, 2008. Spending through then was $59,773. Since then, the Space Science and Engineering Center has been responsible for the project accounting. **Table 2** summarizes the spending and balance remaining.

Table 2. *RSS-NIR Spending Summary*

Funding	**$6,521,775**
Spending prior to 7/1/08	**$59,733**
Spending post to 6/30/08	**$386,483**
BALANCE	**$6,075,559**

Budget. The budget estimate to complete the project is $5,364,831. This leaves $710,728 for contingency, which represents 15.2% of the budget. Please note, the cost of the detector (on order, $520,000) and the camera and doublet optic blanks (formal bids received, $155,495) are not included in the percent contingency calculations since there costs are known. The budget and contingency are summarized in **Table 3**.

Table 3. *RSS-NIR Budget and Contingency Summary. Please note, the cost of the detector (on order, $520,000) and the camera and doublet optic blanks (formal bids received, $155,495) are not included in the percent contingency calculations since there costs are known.*

Balance of Funding		**$6,075,559**
Budget (04/09-03/12)		**$5,364,831**
Contingency	**15.2%**	**$710,728**
	TOTAL BUDGET	**$6,075,559**

This does not include the purchase of the Fabry-Perot etalon and controller. In April, a ROM estimate was received from ICOS for an etalon with water free silica (Infrasil 302) glass and a controller in the amount of $271,920. A request has been submitted to the NSF for a 10% increase in their funding support through the MRI program. The project hopes to have an answer by July 2009. An informal agreement has been made with Ted Williams at Rutgers University to fund the purchase of the controller. Combined, this will provide for the purchase. The Rutgers funding is contingent upon receiving the NSF funding. The purchase of the etalon brings the total cost of the RSS-NIR is $6,793,695.

Table 4. *RSS-NIR Total Cost with Fabry-Perot*

Spending to date (3/31/09)		**$446,216**
Budget to complete		**$5,364,831**
Contingency	**15.2%**	**$710,728**
Fabry-Perot w/ controller ROM		**$271,920**
		$6,793,695

The project duration is 45 months, including 4 month of schedule reserve, which started in July 2008 (for budget purposes) and ends March 2012. Project years run July 1 to June 30. We are in the 4th quarter of Project Year 1. Financial status and progress reports are submitted quarterly David Buckley, SALT Project Scientist.

3.4. Key Deliverables

The objective of this project is to deliver a near infrared spectrograph to the SALT facility. Key deliverables in the development of the instrument are listed in sections 4.4.1through 4.4.6.

4. PROCESS CONTROL

4.1. Quality

4.1.1. ***Overview Of Quality Processes*** – Quality is defined as meeting the needs and expectations of the customer. The quality goal for the project is to fulfill the requirements as defined by the science community.

SSEC has developed a number of quality processes that may be used for the RSS-NIR project. These processes were all designed to be compliant with ISO 9001. Some of the processes that may be used in the development, testing, installation, commissioning, service and operation of the RSS-NIR are:

Document #	Topic
1008-0002	Document Control
1008-0004	Change Control
1008-0005	Training
1008-0006	Test Equipment Calibration
1008-0007	Project Life Cycle Process (Design Control)
1008-0012	Complaint Handling
1008-0014	Project Safety
1008-0017	Quality Records
1008-0021	Software Development
1008-0024	Project Management Plan

4.1.2. ***Reliability –*** The SALT RSS-NIR is expected to operate during the nighttime hours every day with an anticipated uptime greater than 99.0% (1 hour of downtime per 100 hours of expected operation).

4.1.3. ***Expected Life Of Device*** – The minimum expected operational life of the RSS-NIR is 5 years with a goal of 15 years operational life.

4.2. Configuration Management

4.2.1. ***Document Control*** – Document Control shall be accomplished through processes described in the SSEC Document Control Procedure, 1008-0002, except as noted in 4.2.1.1 and 4.2.1.2 to comply with SALT documentation formats.

4.2.1.1. *Document Format* – The documents written for the RSS-NIR will not use the standard SSEC document template, but will use a document template made specifically for this project.

4.2.1.2. *Document Numbers* – Document numbers will be assigned using the SALT system for document numbering. The numbering format is SALT-XXXXYYZZZZ-NNNN. The first two digits of XXXX are the project number assigned by SALT. The second two reference the appropriate level 2 WBS element. YY is the type of document, described as follows:

- AS – Specification or Interface Control Dossier
- AP – Acceptance Test Procedure
- AR – Acceptance Test Report
- AM – Maintenance or Operation Procedure
- AD – Drawings
- AE – Design Description
- AA – Analysis Document
- AW – Software Code
- BP – Project Plan
- BD – Project Directive
- BS – Project Standard
- EP – Engineering Change Proposal

ZZZZ is a sequential document number. NNNN is the item number on the drawing. If no item numbers are called out on a document or drawing, the –NNNN designator can be dropped.

4.2.2. ***Change Control*** – Document changes will be handled through an Engineering Change Notice (ECN), described in SSEC Change Control Procedure, 1008-0004. Changes to released project design and documentation shall undergo formal review and approval prior to release.

4.2.2.1. Changes shall be approved by the same functions that approved the original document or design.

4.2.3. ***Software Control***

4.2.3.1. *Content Traceability* – The content of product software shall be traceable to its release version. Software content shall be managed as a part of the software development process.

4.2.3.2. *Control Of Releases* – A release candidate shall be approved prior to release. This process shall be managed per the software development process.

4.2.3.3. *Identification Of Software In Use* – All software used on or with the RSS-NIR shall be identified by a discrete identifier and revision number.

4.2.3.3.1. *Product Software* – The identity and version of the product software shall be stated in the configuration records and identifiable from the RSS-NIR itself.

4.2.3.3.2. *Application Software* – Where application software is used in the RSS-NIR, the type, identity and version of software shall be stated in the configuration records and identifiable from the RSS-NIR itself.

4.2.3.3.3. *Test Software* – Where software is used to test or analyze data from the RSS-NIR, the type, identity and version of software shall be stated in the configuration records.

4.2.4. ***Hardware Control*** – The configuration of the hardware will be managed through the document and change control systems identified earlier in this section.

4.2.4.1. Project staff shall identify those parts, components, assemblies and materials that need to be traceable in the system (configuration items). These items shall be traceable per a product/model identifier and a serial/batch number. Examples of configuration items may be:

- Custom data acquisition printed circuit boards.
- Power supplies
- Specialty optical devices (mirrors, lenses, beam splitters)
- Optical gel

4.2.4.2. Project records shall identify the traceable parts, components, assemblies and materials used in the RSS-NIR per their product/model identifier and serial/batch/lot number.

4.2.4.3. Part lists for assemblies shall be maintained in the controlled documents for the project.

4.3. Safety

The health and safety of individuals involved in the development and use of the RSS-NIR is the requirement of highest importance. Safety of the system and its components are of secondary importance. While safety is an aspect of quality, the project office believes that safety should be emphasized in the planning process in order to ensure the RSS-NIR system is designed, assembled, tested, serviced and operated in a safe manner. The protection of personnel and equipment is approached by: (1) Eliminating or reducing the likelihood that a hazardous condition can occur by design, and (2) Minimizing the severity of the adverse consequences if an incident occurs by controls, training, and design to reduce propagation of problems. The entire project team is responsible for the safety of those using the instrument and the instrument itself.

4.3.1. ***Approach*** – The QAS will conduct a safety assessment of the RSS-NIR system per SSEC Project Safety Procedure, 1008-0014. The purpose of this assessment is to determine what the potential safety risks are to staff involved in the development, assembly, installation, commissioning, service and operation of the RSS-NIR system, and how to minimize these risks. This assessment will include a determination of the:

- Need for a formal hazard analysis.
- Safety programs needed for the RSS-NIR, such as cryogen, pressure vessel, fire and chemical safety.
- Safety training needed.

4.3.2. ***Standards & Regulations*** – The QAS and/or Project Staff will determine what (if any) safety standards or government regulations apply to the RSS-NIR project. It is the project office's intent to comply with all applicable standards and regulations for the RSS-NIR project.

4.3.2.1 In some instances, the nature of the project makes compliance with a given standard or regulation impractical or unacceptable. In such cases, a waiver shall be submitted to the Authority Having Jurisdiction per section 7.7 of 1008-0014. For the RSS-NIR project, the SALT facility staff will evaluate waivers.

4.3.3. ***Design Safety*** – The safe operation and maintenance of the RSS-NIR system begins with its design and testing. The QAS together with assigned team members will conduct a safety assessment in consultation with the PM to determine the safety needs of the project. In addition, members of the project team will review safety issues using the design review process described in 1008-0014. Safety analysis will continue throughout the project as changes are made to the RSS-NIR system. Objectives of the analyses and reviews include:

- Identification and avoidance of hazards to personnel and equipment or the minimization of the impacts of the hazard if unavoidable.
- Ensuring compliance with applicable codes and standards.
- Resolution of any outstanding issues previously identified.

- Better understanding of the system that can be used in the development of operating and maintenance procedures.

4.3.4. ***Operational Safety & Training*** – The initial project safety assessment shall determine the types of operational safety and training that is needed for the RSS-NIR project.

4.3.4.1 This assessment shall include all tasks involved in the assembly, installation, commissioning, service and operation of the device.

4.3.4.2 This safety assessment should be reviewed periodically throughout the course of the project to determine whether the safety program needs to be modified.

4.3.4.3 Any safety issues discovered in the field shall be reported and addressed per the SSEC Complaint Handling Procedure, 1008-0012.

4.3.4.4 If needed, the QAS and PM will develop a safety-training plan, oversee the development of the training program and ensure that project personnel understand the safety aspects of the RSS-NIR.

4.3.5. ***Environmental Protection*** – It is the project office's intent to minimize the impact of its projects upon the surrounding environment, including air, land, water, flora and fauna. Environmental impact will be evaluated as part of the system safety assessment. The QAS is the point-of-contact for environmental issues.

4.4. Design Control

Project development follows the process as outlined in SSEC Project Life Cycle Process, 1008-0007. The document describes a process in which the project progresses through a series of phases or stages. At the end of each phase, a review, by an internal or external panel, is held to determine if the project is ready to proceed to the next phase. The reviews serve to determine if the project has produced deliverables or met milestones before it can proceed. As appropriate to the particular review, they ensure that:

- Science goals have been defined and agreed upon
- Engineering requirements are sufficient to meet the scientific goals
- Project planning and monitoring is in place
- Interfaces are established, defined, and documented
- Design is compliant with applicable standards
- Safety hazards are identified and mitigated
- Design meets the engineering requirements
- Components are adequately specified
- Subsystems are tested and integration ready
- Instrument performance is verified
- Instrument is operationally ready

The project team is responsible for producing a set of deliverables or a review package for each review that provides the verification to the review panel that the instrument development is mature enough to progress to the next phase. These are listed in the sections below. At each review, the project team is likely to have a set of issues or action items that they will need to address in a timely manner following the review.

4.4.1. *Preliminary Design Review Deliverables*

- Draft Functional Performance Requirements Document
- Draft Operational Concepts Definition Document
- Science Decision Matrix
- Draft Project Management Plan
- Work Breakdown Structure
- Schedule
- Budget
- Draft Interface Control Document between the instrument and the facility
- Trade analysis for key design drivers
- Functional block diagram
- Mass and power budgets

4.4.2. *Critical Design Review*

- Functional Performance Requirements Document complete
- Draft Commissioning Science Plan
- Draft Optical Integration and Test Plan
- Project Management Plan complete
- Operational Concepts Definition Document updated
- Budget and schedule status updated
- Interface control documents complete
- System requirement document complete
- Subsystem requirements documents complete
- Subsystem verification test documents started
- Hazard analyses complete
- Detail drawings complete
- Long lead items on order

4.4.3. *Test Readiness Review*

- Budget and schedule status updated
- Optical Integration and Test Plan complete
- Commissioning Science Plan complete
- Operational Concepts Definition Document complete
- Hazard analyses updated
- Subsystem verification test documents complete
- Receipt of long lead items complete
- Component fabrication complete
- Subsystem assembled and tested
- Detail drawings updated
- Instrument configuration updated

4.4.4. *Pre-Ship Review*

- Budget and schedule status updated
- Instrument test performance verified against validation plan and any deviations explained or rectified
- Shipping and packing plans in place
- Export control documents complete, if required
- SALT facility ready to accept instrument in Cape Town

4.4.5. *Pre-Installation Readiness Review*

- Conducted prior to shipping the instrument from Cape Town to the SALT facility in Sutherland.
- Instrument must be fully integrated and functionally tested in all operational modes.
- Facility is ready for integration activities.
- All necessary staff on hand to support integration activities.
- Integration plan reviewed and all staff understand their roles.

4.4.6. *Commissioning Review*

- Budget and schedule status updated
- Instrument integration into the facility complete
- Instrument functional testing complete
- Instrument commissioning tests complete
- Facility staff training complete

4.5. Risk Management

There are four areas of risk that are assessed, monitored, and mitigated throughout the life of the project: safety, technology, cost, and schedule.

4.5.1. *Safety*

The QAS is responsible for assessing the potential safety risks of the instrument and the mitigations to those risks. As stated in section 4.3, the safety of the project staff is the priority of the project.

Working with the project team engineers, the QAS performs a safety assessment to identify all potential safety hazards. An analysis is done of each potential hazard to assess the severity of its impact, probability it will occur, and the ability to detect it. A score is assigned to each of those criteria. These scores are multiplied together to produce a Risk Priority Number (RPN). Hazards with a score above 36 must be mitigated. This may involve replacing a component, a design change, an operational requirement or other mitigation. With each change, the hazard is re-evaluated to produce a new RPN. If the RPN is below 13, no further action is required (the hazard is considered a minor risk and acceptable). If the score remains at 13 or higher, it needs to either be further mitigated or a justification written explaining why it is acceptable. Typically, the QAS determines the validity of the justification, but it may require a waiver to the SALT facility. The goal of the safety risk mitigation is to retire all hazards to a RPN of 12 or less.

4.5.2. Technology

It is the responsibility of the SE to identify and monitor all technical risks. The RSS-NIR development team is taking the following approach towards minimizing technical risk on the project:

- Keep design as simple as possible, for example, minimizing the number of mechanisms
- Borrow from the RSS-VIS design wherever possible
- Do not reinvent the wheel – use off-the-shelf components or borrow from other successful instruments

The results of some design trades will result in the project assuming some technical risks. To manage it, the PM and SE will assign the suitable technical expertise (internal or external to the UW) and, where possible, simplify the design. The performance of the design will be verified at the earliest possible level (component, device, subassembly, or assembly) to minimize the impact a negative result may have on the rest of the development.

4.5.3. Cost

The PM is responsible for managing the cost risk on the project. A ground-based instrument development project like RSS-NIR, may assign 15-20% of its budget to contingency. As previously stated, $301k has been set aside for funded schedule reserve and an additional $900k for contingency to be form a $1.2M budget reserve. This represents 20% of the baseline budget. Since the project is now through the preliminary design phase and technical issues have been identified, this is a reasonable amount of contingency. The contingency will be applied to the WBS elements as situations warrant the need for additional budget.

The baseline plan is a reasonable estimate of the time and resources required to fully test the instrument. Invariably, projects of this size and scope encounter issues during the initial integration and testing of the instrument that require additional time and resources to address. To help mitigate this need, the project has planned for three months of funded schedule reserve during IV&T and another month during commissioning at the SALT facility.

4.5.4. Schedule

The PM is responsible for managing the schedule risk on the project. The primary means to mitigate schedule risk is to identify the critical path and manage it. For the RSS-NIR spectrograph development, the design of the optical system; ordering of optical blanks; and fabricating, figuring, and coating the optical elements forms the critical path. To manage the critical path, the project office must maintain good communication with the staff and vendors responsible for the optics, provide the appropriate resources as needed, and ensure that the design develops per the plan.

In addition to the critical path, long lead items present risks to the schedule. All long lead items need to be identified as early as possible and orders placed as soon as the technical maturity of the design and the project spending profile allows. Once placed on order, the project office must be in communication with the vendor to monitor progress.

Additions key to mitigating schedule risk include good communication between the project office and the staff to identify resource requirements and to apply them as required to sustain progress for both critical path and non-critical path tasks. This is primarily accomplished through weekly status and progress meetings. The project office is responsible for monitoring progress versus the plan, identifying deviations, and determining if resources need to be applied to keep the project on schedule.

As mentioned in the cost section, to help mitigate schedule risk, the baseline plan includes three months of funded schedule reserve for IV&T and Commissioning, as these two activities often require more time than originally scheduled.

4.6. Supplier Management

Depending on the scope, criticality, cost, and risk associated with the component or service being provided, the project office maintains regular contact with vendors to confirm progress and delivery. This may include periodic calls or regularly scheduled status updates with the vendor. In some cases, staff may visit the vendor site to audit work processes and discuss solutions to technical issues.

Vendor awards are done following UW purchasing regulations. The process may simply select the lowest bidder to a request (request for bid) or allow the project team to evaluate each vendor against a predetermined set of criteria (request for proposal). In cases where only one vendor is capable of meeting the project needs, a sole source justification may be prepared. UW purchasing reviews all sole source requests and determines whether or not the justification is suitable.

5. COMMUNICATION

5.1. Reports

The project office submits quarterly reports to the SALT Board summarizing progress and spending against the baseline plan. The report provides updates on continuing issues and highlights any new issues. The reports are due within 30 days of the end of each quarter.

The project office is informally in communication with the SALT Board and facilities via email and telephone conversations as required to work on interface needs (mass, power, and facilities needs) and other issues as they arise.

The project office will submit annual reports to the NSF.

The project office will submit reports to the WARF as requested.

5.2. Meetings

The project team meets weekly to review and discuss design and development issues. This provides an opportunity for the team to be aware of each other’s work and to discuss issues that cross engineering discipline boundaries.

The PI will attend the biannual SALT Science Working Group meetings.

5.3. Reviews

The project successfully passed it Conceptual Design Review in May 2006 and completed its Preliminary Design Review in July 2008. The schedule for the remaining reviews is shown in Table 1.

Table 5. *RSS-NIR review schedule*

Review	Review Panel	Date
Conceptual Design Review	External Review Panel	May 2006
Preliminary Design Review	External Review Panel	July 2008
Mid-Term Review	External Review Panel	May 2009
Critical Design Review	External Review Panel	Feb 2010
Safety Review	RSS-NIR Project Team	Aug 2010
Test Readiness Review	RSS-NIR Project Team	Nov 2010
Hazard Analysis Review	RSS-NIR Project Team	Apr 2011
Pre-Ship Review	RSS-NIR Project Team	Jun 2011
Pre-Installation Review	RSS-NIR Project Team & SALT Facility Staff	Oct 2011
Commissioning Review	SALT & RSS-NIR Project Team	Feb 2012
Project Complete	-	Mar 2012

APPENDIX

Work Breakdown Structure

1 Project administration
- 1.1 Project management
  - 1.1.1 Management
  - 1.1.2 Resource track & report
  - 1.1.3 Risk assessment and mitigation
  - 1.1.4 Reviews / Milestones / Meetings
- 1.2 Quality assurance and safety
  - 1.2.1 Quality assurance
  - 1.2.2 Safety assurance
  - 1.2.3 Configuration management
  - 1.2.4 Quality control systems
- 1.3 Systems engineering
  - 1.3.1 Detail Design & Development Support
  - 1.3.2 Testing support
  - 1.3.3 Commissioning support

2 Optical Elements
- 2.1 Optical design
  - 2.1.1 Finalize optical layout
  - 2.1.2 Straylight analysis
  - 2.1.3 Summarize straylight analysis
  - 2.1.4 Noise evaluation review
  - 2.1.5 Finalize filter selection
  - 2.1.6 Coatings
- 2.2 Dichroic
  - 2.2.1 Mount
  - 2.2.2 Optical element
  - 2.2.3 Alignment hardware
  - 2.2.4 Subsystem assembly and test
- 2.3 Doublet
  - 2.3.1 Mount
  - 2.3.2 Optical Element
  - 2.3.3 Alignment hardware
  - 2.3.4 Subsystem assembly and test
- 2.4 Fold
  - 2.4.1 Mount
  - 2.4.2 Optical Element
  - 2.4.3 Alignment hardware
  - 2.4.4 Subsystem assembly and test
- 2.5 Fold Mirror Tip/Tilt
  - 2.5.1 Design & Justification
  - 2.5.2 Fabrication

3 Grating Mechanism
- 3.1 Design
  - 3.1.1 Grating Element Frame/Holder
  - 3.1.2 Exchanger
  - 3.1.3 Rotation Stage
- 3.2 Grating Element
  - 3.2.1 Final spec
  - 3.2.2 RFQ process
  - 3.2.3 Gratings on order
  - 3.2.4 Receive grating
- 3.3 Subsystem assembly and test
  - 3.3.1 Acceptance test procedure
  - 3.3.2 Assemble
  - 3.3.3 Checkout and test

4 FP Order Blocking Filters & Optics Storage Assembly
- 4.1 Optics Storage Assembly
  - 4.1.1 Preliminary design
  - 4.1.2 Detail design
  - 4.1.3 Fabricate
  - 4.1.4 Actuator & Encoder
- 4.2 FP Order Blocking Filters
  - 4.2.1 Prepare filter specs
  - 4.2.2 Prepare RFQ & release
  - 4.2.3 Place order for filter fab
  - 4.2.4 Filter Frame/Holder
  - 4.2.5 Actuator & Encoder
- 4.3 Subsystem assembly and test
  - 4.3.1 Assemble & test plan
  - 4.3.2 Assemble
  - 4.3.3 Operational check

5 Fabry-Perot
- 5.1 Design - structure & mechanism
  - 5.1.1 Preliminary design
  - 5.1.2 Detail design
  - 5.1.3 Fab
- 5.2 Etalon optical element & controller
  - 5.2.1 Preliminary spec
  - 5.2.2 Final spec
  - 5.2.3 RFQ process
  - 5.2.4 Award bid and order etalons
- 5.3 Actuator & Encoder
  - 5.3.1 Develop bid spec
  - 5.3.2 Release RFQ
  - 5.3.3 Award bid and order
- 5.4 Alignment hardware
  - 5.4.1 Preliminary specs
  - 5.4.2 Final specs
  - 5.4.3 Design / research purchase parts
  - 5.4.4 Fabricate / purchase parts
- 5.5 Subsystem assembly and test
  - 5.5.1 Acceptance test procedure
  - 5.5.2 Assemble
  - 5.5.3 Functional check and test

6 Polarizing Beam Splitter
- 6.1 Mount
  - 6.1.1 Preliminary design and analysis
  - 6.1.2 Detail design and analysis
  - 6.1.3 Fabricate
- 6.2 Optical Element
  - 6.2.1 Preliminary spec
  - 6.2.2 Final spec
  - 6.2.3 Blank RFQ process
  - 6.2.4 Order blank
  - 6.2.5 RFQ: Lens Fab
  - 6.2.6 Fab lens
  - 6.2.7 RFQ: Coating
  - 6.2.8 Coat Lens
- 6.3 Actuator & Encoder
  - 6.3.1 Develop bid spec
  - 6.3.2 Release RFQ
  - 6.3.3 Award bid and order
- 6.4 Alignment hardware
  - 6.4.1 Preliminary specs
  - 6.4.2 Final specs
  - 6.4.3 Design / research purchase parts
  - 6.4.4 Fabricate / purchase parts
- 6.5 Subsystem assembly and test
  - 6.5.1 Test procedure
  - 6.5.2 Assemble
  - 6.5.3 Functional check and test

7 Camera Assembly
- 7.1 Design
  - 7.1.1 Cradle
  - 7.1.2 Articulation Mechanism
  - 7.1.3 Drive components
  - 7.1.4 Barrel
  - 7.1.5 Camera Focus
- 7.2 Optical elements
  - 7.2.1 Preliminary spec
  - 7.2.2 Final spec
  - 7.2.3 Blank RFQ process
  - 7.2.4 Order blank
  - 7.2.5 RFQ: Optics Fab
  - 7.2.6 Fab optics
  - 7.2.7 RFQ: Coating
  - 7.2.8 Coat Lens
- 7.3 Alignment hardware
  - 7.3.1 Preliminary specs
  - 7.3.2 Final specs
  - 7.3.3 Design / research purchase parts
  - 7.3.4 Fabricate / purchase parts
- 7.4 Subsystem assembly and test
  - 7.4.1 Assembly and test plan
  - 7.4.2 Assembly optics and barrel
  - 7.4.3 Functional check and test
  - 7.4.4 Assembly cradle, articulation, and alignment hardware
  - 7.4.5 Functional check and test

8 Detector / Dewar Assembly
- 8.1 Detector

- 8.1.1 "Develop final spec for SG, EG, & Electronics"
- 8.1.2 Prepare and release sealed bid
- 8.1.3 Order bare mux
- 8.1.4 Order detectors & electronics Room Temp)
- 8.1.5 Bench and Lab testing w/ Bare Mux
- 8.1.6 Bench testing EG SCA
- 8.1.7 Bench testing SG SCA

8.2 Dewar
- 8.2.1 Develop design concept
- 8.2.2 Dewar housing
- 8.2.3 Cryocooler
- 8.2.4 Cooling control system
- 8.2.5 Cryo-Filter Mechanism
- 8.2.6 Cryogenic long wavelength blocking filter spec

8.3 Subsystem assembly and test
- 8.3.1 Assemble
- 8.3.2 Functional check and test
- 8.3.3 Functional testing w/ camera optics

9 Pre-Dewar

9.1 Enclosure design
- 9.1.1 Structure
- 9.1.2 Panels
- 9.1.3 Feed-thrus
- 9.1.4 Mechanisms
- 9.1.5 Baffling

9.2 Thermal design
- 9.2.1 Design and analysis refinement
- 9.2.2 Components

9.3 Subsystem assembly and test
- 9.3.1 Assemble & test plan
- 9.3.2 Assemble
- 9.3.3 Functional check and test

10 RSS Common Optics Environmental Control

10.1 Slit cooling
- 10.1.1 Design
- 10.1.2 Fabrication
- 10.1.3 Test

10.2 Common optics enclosure
- 10.2.1 Design
- 10.2.2 Fabrication
- 10.2.3 Test

11 Control System

11.1 Motion Control system
- 11.1.1 Develop a preliminary set of requirements
- 11.1.2 Finalize requirements document
- 11.1.3 Detail design of system
- 11.1.4 Fabricate mounting hardware
- 11.1.5 System controllers
- 11.1.6 Wiring Diagram
- 11.1.7 Subsystem assembly and test

11.2 Software
- 11.2.1 Control system

12 Power distribution

12.1 Design
- 12.1.1 Requirements definition
- 12.1.2 Preliminary design (block diagram)
- 12.1.3 Detail design

12.2 Components
- 12.2.1 Produce RFB/Ps and release orders
- 12.2.2 Components on order
- 12.2.3 Fabricate mounting hardware

12.3 Subsystem assembly and test
- 12.3.1 Assemble
- 12.3.2 Functional check and test

13 Support and test equipment

13.1 Develop requirements

13.2 Design or acquire equipment
- 13.2.1 Design required hardware
- 13.2.2 Fabricate hardware
- 13.2.3 Specify required purchased components
- 13.2.4 Prepare RFB/Ps and release orders
- 13.2.5 Components on order

- 13.3 Performance verification
  - 13.3.1 Test plan
  - 13.3.2 Checkout and test
- 14 Integration, Verification, & Testing
  - 14.1 Integrate subsystems
  - 14.2 Functional testing
  - 14.3 Verification testing
  - 14.4 Operational testing
  - 14.5 Schedule reserve
- 15 Commissioning
  - 15.1 Packing and shipping
    - 15.1.1 Package and crate instrument
    - 15.1.2 Ship to Cape Town
    - 15.1.3 Transport to Sutherland
  - 15.2 Final Integration
  - 15.3 Assembled functional test and verification
  - 15.4 Install on telescope
  - 15.5 Commission
  - 15.6 Training
  - 15.7 Schedule reserve