

University of Wisconsin Department of Astronomy

SOUTHERN AFRICAN LARGE TELESCOPE
ROBERT STOBIE SPECTROGRAPH
NEAR INFRARED INSTRUMENT
FIBER FEED

STATUS REPORT

SUBMITTED
NOV 3, 2015

PROJECT YEAR 8
JUL – SEP 2015

PRINCIPAL INVESTIGATOR: MARSHA WOLF
PROJECT MANAGER: MARK MULLIGAN

EXECUTIVE SUMMARY

The UW team continues to move forward with the implementation of the fiber feed option for the RSS NIR instrument.

Status of Key Tasks (additional information provided in the subsystem sections)

- *Detector, Science Grade (SG) Characterization/Optimization*: Greg Mosby, along with Nathan Eggen, has characterized the detector's persistence response and they are in the process of characterizing the persistence suppression and measuring thermal background levels for different pre-dewar temperatures.
- *Enclosure & Cooling System*: A request for bid document was released during the last week of October.
- *Electronics Enclosure*: An enclosure has been ordered and is expected in November.
- *Camera Assembly*: Mike Smith is preparing for a cold soak and passive warm up test of the camera to verify the integrity of the lenses.
- *Collimator Design:* Through an arrangement with Andrew Sheinis at the Australian Astronomical Observatory, we have received a preliminary re-optimization of Darragh O'Donoghue's initial collimator design from Ross Zhelem. Marsha needs to work with Ross to better adapt the design to physical constraints of the RSS-NIR layout.

Budget & Schedule

The budget and schedule have been updated through September 30th. The data is presented in the same one-page summary, Table 1, followed by the development flow in Figure 1, and the critical path in Figure 2. Spending through September 2015 is $8.572M and we estimate the cost to ready the instrument for delivery to South Africa at $1.446M. The funds needed to ready the instrument for shipping is estimated at $510k, up from the $441k last quarter. This reflects the funds needed to address the L5 lens coating. Marsha Wolf has been and continues to be in communication with the UW Department of Astronomy concerning the status of the NIR project. The budget does not include contingency, so the cost of any issues that arise cannot readily be absorbed.

The commissioning is estimated at $330k. This estimate is unlikely to change as the instrument matures over the next year or so.

The critical path for the development is the new fiber feed collimator and we have slipped approximately 1 month in the last quarter. We have received a preliminary optical design from Ross Zhelem, but we need to work with him to address some RSS-NIR specific issues. We hope to mature the design to the point that we can release bid document for blanks soon.

Table 1. *The table summarizes the financial state of the RSS-NIR. The left column presents the spending-to-date, estimate to get ready-to-ship, and estimate to commission the instrument. On the right, the source and amount of funding contributions. Below, the summed available are presented and the funding required to get ready-to-ship and commission the instrument.*

RSS-NIR FIBER FEED SPENDING, BUDGET AND FUNDING SUMMARY

STATUS: SEPTEMBER 30, 2015 - FIGURES IN THOUSANDS OF DOLLARS

SPENDING & BUDGET SUMMARY	
Spending-to-date	$8,572
Estimated Ready-to-Ship Budget	$1,446
Estimated Commissioning Budget	$334
Estimated Instrument Total Cost	$10,353

FUNDING SUMMARY		
Wisconsin Alumni Research Foundation		$3,300
National Science Foundation		$1,997
UW-Astronomy		$2,800
UW-Astronomy	$1,400	
Washburn Labor Contribution Ready-to-Ship[1]	$1,267	
Washburn Labor Contribution Commission[2]	$133	
SALT		$932
UW-Space Science & Engineering Center[3]		$612

Funds Available to Ready-to-Ship	$9,508	= Sum of funding less Washburn contribution to Commissioning
Total Funds Available	$9,641	= Sum of all funding
Funds Needed to be Ready-to-Ship	$510	= Spending-to-date + Ready-to-Ship - Ready-to-ship Funds
Funds Needed to Commission the Instrument (cumulative)	$711	= Est. Total Instrument Cost - Total Funds Available
Balance of $1.4M UW-Astronomy Funds	$125	= WARF + NSF + UW Astro + SALT + SSEC - Spending-to-date

1. The dollar figures includes contributions to-date plus estimated future contributions. WAL = Washburn Astronomical Laboratories.

2. The dollar is an estimate of future contributions.

3. The dollar figures includes contributions to-date plus estimated future contributions.

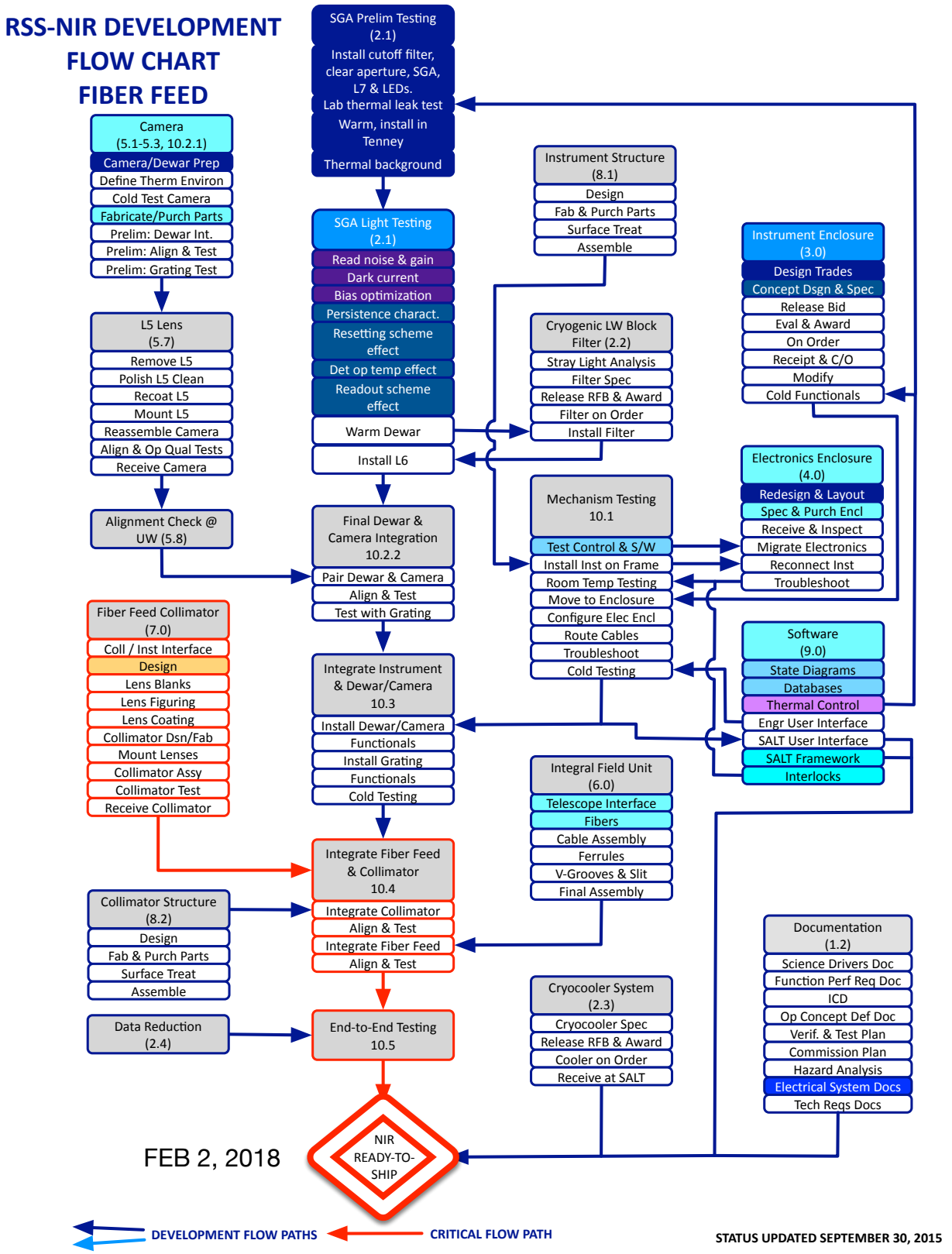


Figure 1. *RSS-NIR Fiber Feed Development flow chart, updated September 30, 2015.*

ID	WBS	Task Name	Duration	Start	Finish
153	7	Fiber Feed Collimator (Wolf)	550 d	Mon 6/29/15	Fri 8/4/17
156	7.3	Optical Design	88 d	Wed 7/1/15	Fri 10/30/15
158	7.3.2	Complete the optical design	65 d	Mon 8/3/15	Fri 10/30/15
159	7.4	Lens Blanks	135 d	Mon 11/2/15	Fri 5/6/16
160	7.4.1	Develop specification	20 d	Mon 11/2/15	Fri 11/27/15
161	7.4.2	Develop purchasing documentation & release for bid	25 d	Mon 11/30/15	Fri 1/1/16
162	7.4.3	Evaulate responses and make award	10 d	Mon 1/4/16	Fri 1/15/16
163	7.4.4	Blanks On Order	80 d	Mon 1/18/16	Fri 5/6/16
164	7.4.4.1	Blank 1 C1	80 d	Mon 1/18/16	Fri 5/6/16
169	7.5	Lens Figuring	180 d	Mon 1/18/16	Fri 9/23/16
173	7.5.4	Lens Figuring	100 d	Mon 5/9/16	Fri 9/23/16
174	7.5.4.1	Lens 1 C1	100 d	Mon 5/9/16	Fri 9/23/16
179	7.6	Lens Coating	200 d	Mon 4/25/16	Fri 1/27/17
183	7.6.4	Lens Coating	90 d	Mon 9/26/16	Fri 1/27/17
184	7.6.4.1	Lens 1 C1	90 d	Mon 9/26/16	Fri 1/27/17
189	7.7	Collimator	460 d	Mon 11/2/15	Fri 8/4/17
194	7.7.5	Mounts Lenses	50 d	Mon 1/30/17	Fri 4/7/17
195	7.7.5.1	Lens 1 C1	10 d	Mon 1/30/17	Fri 2/10/17
196	7.7.5.2	Lens 2 C2	10 d	Mon 2/13/17	Fri 2/24/17
197	7.7.5.3	Lens 3 C3	10 d	Mon 2/27/17	Fri 3/10/17
198	7.7.5.4	Lens 4 C4	10 d	Mon 3/13/17	Fri 3/24/17
199	7.7.5.5	Lens 4 C5	10 d	Mon 3/27/17	Fri 4/7/17
200	7.7.6	Assemble Collimator	25 d	Mon 4/10/17	Fri 5/12/17
201	7.7.7	Test Collimator	50 d	Mon 5/15/17	Fri 7/21/17
202	7.7.8	Package & Ship Collimator to UW	10 d	Mon 7/24/17	Fri 8/4/17
203	7.7.9	Collimator Ready	0 d	Fri 8/4/17	Fri 8/4/17
237	10	Integration & Acceptance Testing - UW (Wolf)	678 d	Wed 7/1/15	Fri 2/2/18
262	10.4	Fiber Feed & Collimator	60 d	Mon 8/7/17	Fri 10/27/17
263	10.4.1	Integrate the collimator	15 d	Mon 8/7/17	Fri 8/25/17
264	10.4.2	Align and optically test	20 d	Mon 8/28/17	Fri 9/22/17
265	10.4.3	Integrate fiber feed	10 d	Mon 9/25/17	Fri 10/6/17
266	10.4.4	Align and optically test	15 d	Mon 10/9/17	Fri 10/27/17
267	10.5	End-to-End Instrument Testing	70 d	Mon 10/30/17	Fri 2/2/18
268	10.5.1	Room Temp Functional	10 d	Mon 10/30/17	Fri 11/10/17
269	10.5.2	Thermal Testing	20 d	Mon 11/13/17	Fri 12/8/17
270	10.5.3	End-to-End Optical Path Testing	20 d	Mon 12/11/17	Fri 1/5/18
271	10.5.4	Mechanism Testing	20 d	Mon 1/8/18	Fri 2/2/18
272	10.6	READY TO SHIP	0 d	Fri 2/2/18	Fri 2/2/18
273	11	Integration, Test, & Commissioning - South Africa (Wolf)	95 d	Mon 2/5/18	Fri 6/15/18

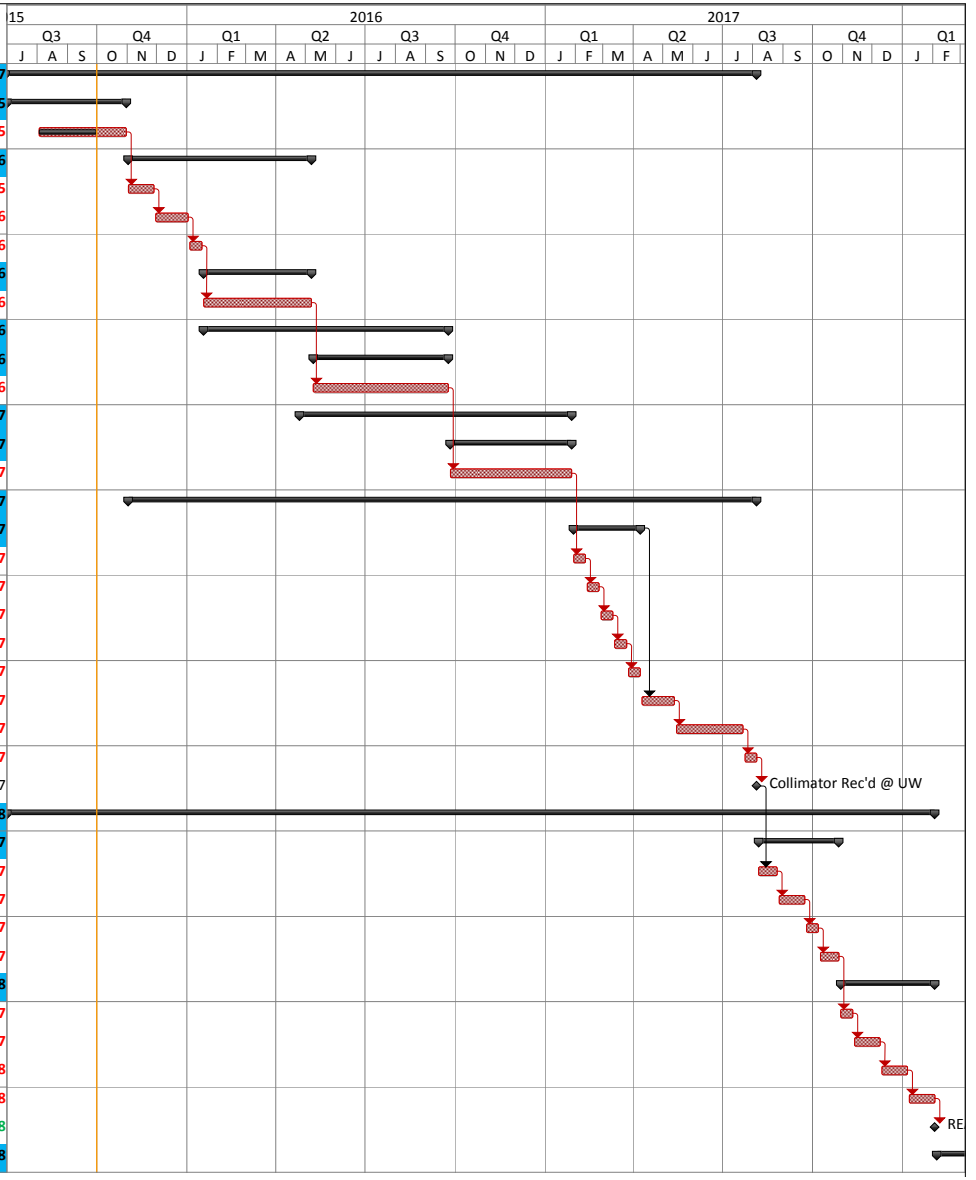


Figure 2. *RSS-NIR Fiber Feed Design Critical Path updated September 30, 2015.*

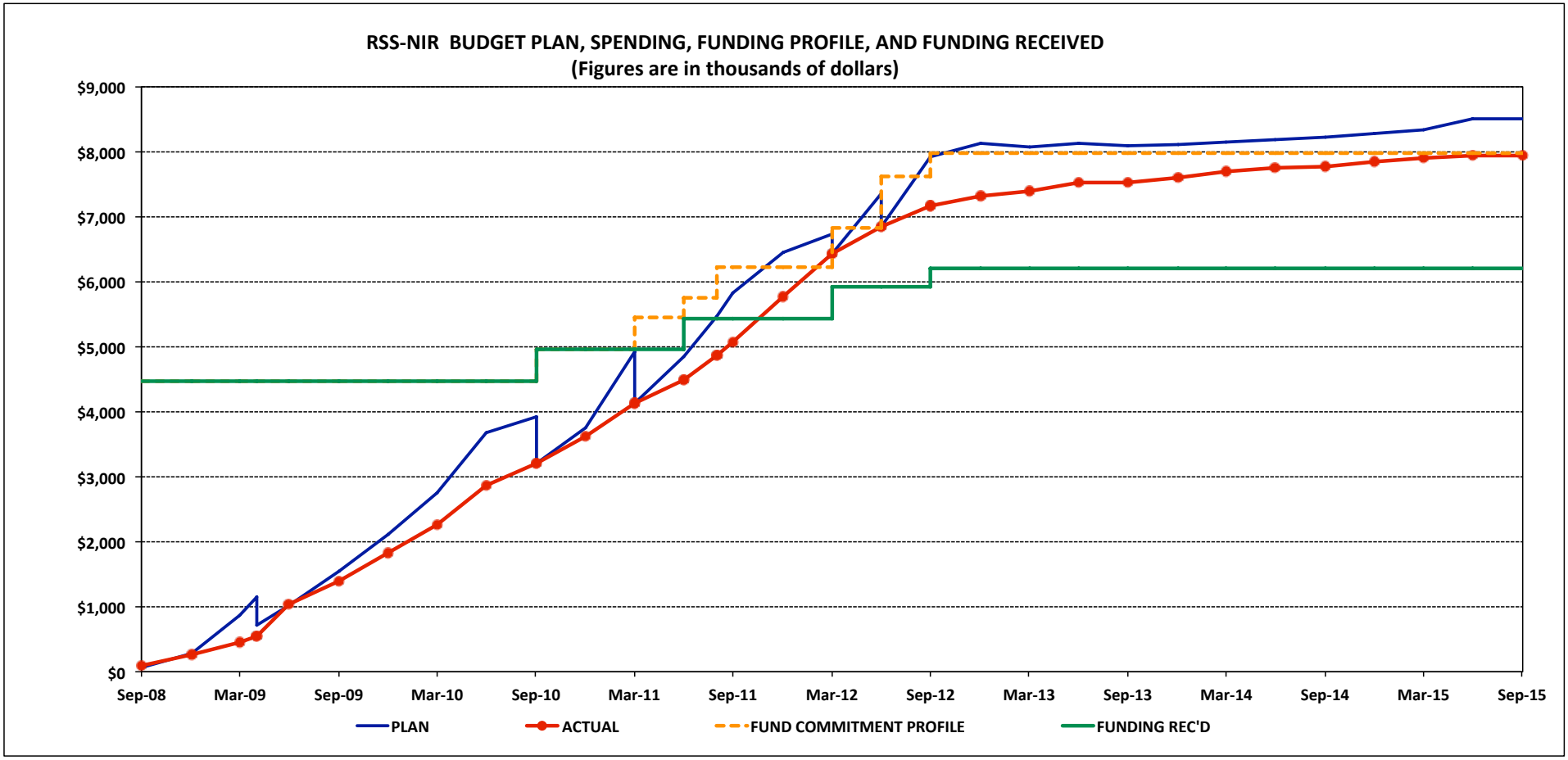


Figure 3. *RSS-NIR financial status since the Preliminary Design Review in July 2008. The adjustments in Sep'10, Mar'11, Mar'12, and Jun '12 are due to re-baselining cost projections. Project accounting is conducted monthly and the cost data updated quarterly. Please note: 1) the actual and planned spending presented does not include the contributions and spending made by the Washburn Astronomy Laboratories and 2) the planned spending does include the "Funds needed to be ready to ship" estimate from Table 1.*

Table 2. *Risk Summary (updates are in blue). Items closed in the previous quarter have been removed.*

Risk	Type	Impact Assessment	Mitigation Plan	State
2. *ADC*: Must be corrected to allow simultaneous VIS and NIR observations.	Technical	Medium	Darragh O'Donoghue developed a design for reworking the existing ADC elements to work for both VIS and NIR instruments. This needs to be implemented.	Open
3. *Instrument Delivery:* Target delivery for the commissioned instrument is December 2012.	Schedule Cost	Low Significant	The updated project ready-to-ship date is Feb 2, 2018.	Open
9. L5: Moisture or coating delamination spots have been observed on L5 when the purge bag is opened up. Further, some peeling of the coating has been observed on the opposite side of the lens around the perimeter. This may have been caused by some tooling during coating or mounting.	Cost Schedule	Significant Low	We are still evaluating what the cause of the bubbles is – delamination or humidity bubbles. It seems likely that we will have to recoat the lens regardless of what the cause is.	Open
10. Budget: The budget and schedule have been updated to reflect the fiber feed option.	Cost	Significant	Eric Wilcots has been making arrangements and agreements with Astronomy, College of L&S, and SSEC to contribute towards the NIR. He is working towards securing funds to fully commission the instrument.	Open

Status and Issues by Subsystems

1. *Project Administration*

- *Documentation:* There is no significant progress on documentation to report.

2. *Detector / Dewar Assembly – Science Grade Detector*

- *Thermal Background:* It was suggested to Greg Mosby that the "parked position" of the filter prior to the measurement might be affecting the measurement. For example, if the opaque filter was parked out of the beam and exposed to colder surface prior to being rotated into the beam position for a thermal background measurement, we may measure a quieter thermal background. Through tests, Greg did observe slightly different background measurements if a filter (opaque, clear, or cutoff) had been in the beam position for a while or if it was rotated into that position prior to the measurement. He has adopted consistent procedure for measuring the thermal background going forward.

  Greg has measured the thermal background with the Tenney chamber at -38°, -40°, and -42° C. We wanted to verify that the thermal background is not sensitive to the 4° range since the instrument enclosure temperature may vary that much. With the opaque or cutoff filter in place, the thermal background was immeasurably low. He measured 0.03 e-/s with the clear filter in place.

- *Characterizing Persistence:* Greg has completed the persistence characterization of the detector and has produced a plot of persistence decay for different signal strengths (Figure 4).

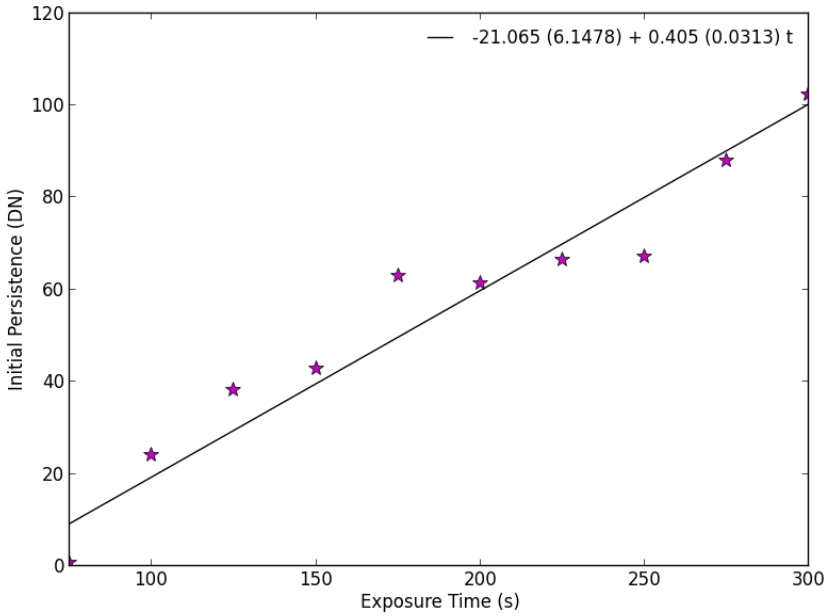


Figure 4. *Mean persistence as a function of signal level (exposure time) using a 940 nm LED at constant flux.*

- *Characterizing Persistence Suppression*: Greg and Nathan Eggen are collecting data to characterize the detector's persistence from a previous exposure in the presence of signal in a subsequent exposure. As expected, Greg has observed that the persistence becomes suppressed if the signal strength of the previous signal and current signal are close to one another. Marsha and Greg have decided to collect data at ten different varied signal strengths. To-date, Greg and Nathan have collected eight signal strength pairs. Each data collection takes on the order of five hours to collect
- *Up-the-Ramp Sampling*: Greg developed software to use up-the-ramp group samples to generate low noise, cosmic ray-less images from the multiple reads. The processing of the data is time consuming to run with large numbers of samples, so Ralf Kotulla (software programmer) modified it to take advantage of the multi-cores in a processor. The improved software runs 4x faster. Greg and Ralf Kotulla did observe a very subtle difference in the data between the serial and parallelized versions. After significant investigation into the difference, Ralf recently tracked down the source. Greg had done 64-bit calculations and converted them to 32-bit. Ralf had done the parallelized software all in 32-bit processing. Ralf corrected the difference and the serial and parallel versions have the same results.

3. Enclosure & Cooling System

- *Enclosure & Cooling System*: Following the July 16th videoconference with SALT (summarized in the last report), Mike Smith updated the enclosure specification. It was reviewed and discussed with SALT via videoconferences on August 6th and September 3rd. There was a general agreement on the specification, but Ockert and Martin did voice some concern about inducing vibration into the floor of the facility. The SALT System Specification document (1000AS0007 Issue B) does not define an allowable vibration requirement, but simply states the "platform must be stable – no vibration allowed". UW will be moving forward with the procurement of an enclosure and cooling system while this issue is resolved. UW has agreed to require that the compressor not be hard mounted to the system so that some vibration damping can be added.

  A request for bid document was released during the last week of October and provided to vendors Mike has been in contact with.

4. Electronics Enclosure

- *Enclosure*: Ron Koch worked with Rick Vander Geest to layout the NIR electronics in a standard electronics cabinet in a CAD model. They have iterated on the design with the vendor and Ron placed an order during the first week of October. The vendor will provide final detail drawings for Ron's approval in 1-2 weeks and delivery the cabinet 3-4 weeks after that. In the meantime, Ron will work with Rick to detail the whole pattern on the back panel to mount the electronics. We will be drilling and tapping the holes in house.

5. Camera Assembly

- *L5 Coating:* We have been exchanging email with Geza Keller at Infinite Optics, but there is no significant progress to report. For now, we are focusing on conducting a cold test of the camera, a -40°F soak with a passive warm-up that follows a profile it would see in the event of cooling and/power failure. This will be followed by camera and Dewar integration and alignment on the laboratory bench. Once those tasks are complete, we will address the L5 coating issue in the camera.

6. Integral Field Unit (IFU)

- *IFU:* We have a baseline working design for which science tradeoffs are being weighed by astronomers at UW. The baseline configuration is shown in Figure 5 and spectral resolution as a function of fiber size is given in Figure 6. The baseline design has the following characteristics:

  217 fibers in a hexagon (28” on-sky) or elongated hexagon (16” x 38”)
  2 sets of 15 sky fibers
  1.33” core fibers spaced at 1.65”
  Achieves R ~ 2000 – 6000 over λ = 900-1700 nm
  Slit V-groove blocks (25 fibers each) tilted for telecentricity
  Final fiber size selection will interplay with the collimator design

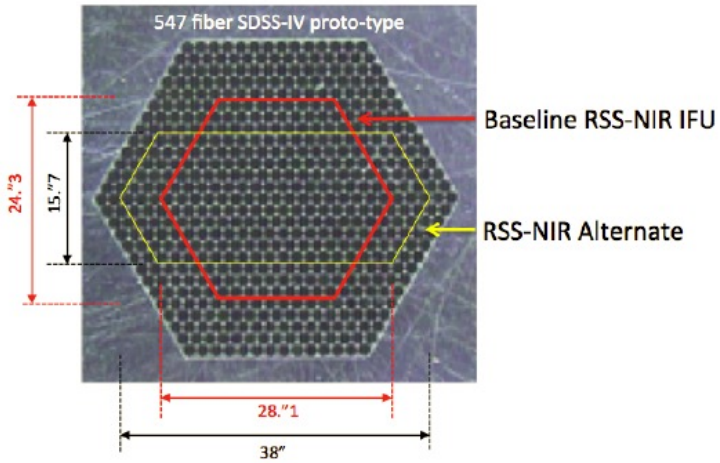


Figure 5. *Baseline IFU geometry with 1.33” fibers with one possible alternative configuration*.

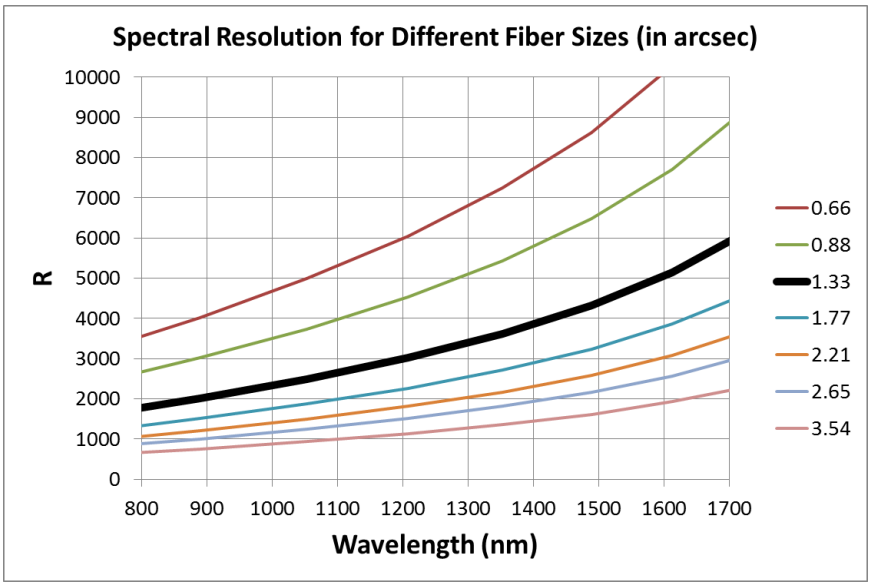


Figure 6. *Spectral resolution of RSS-NIR as a function of fiber size for the 950 l/mm grating. The baseline design fiber size is the thick black line.*

- *IFU telescope feed:* During the July 16th videoconference with SALT, the IFU interface was discussed. SALT installed a 6-port fiber instrument feed for HRS, but only 4 are being used. The other two are available to the RSS-NIR. Mike Smith has done some preliminary conceptual design changes to the SDSS-IV MaNGA IFU ferrule to fit into the SALT port spacing.

7. Fiber Feed Collimator

- *Design:* Ross Zhelem, from the Australian Astronomical Observatory, started with Darragh's initial design and provided an updated preliminary optical design for the collimator. The main objective of this update was to increase the distance from the last collimator element to the pupil location where the grating is inserted. Our goal is to keep the existing fold mirror (which sits between the collimator and the grating) in the RSS-NIR light path to minimize changes that would impact a future installation at prime focus, and to minimize required mechanical redesign of mechanisms for the fiber fed installation. Ross adjusted the design to increase the back pupil distance, but now the beam overfills the existing fold mirror. This likely also has implications for overfilling the camera. Marsha will be checking the collimator design in the spectroscopy mode Zemax model to investigate this issue. She will work with Ross to correctly adapt the design for our instrument.

  The required image quality of the collimator design depends on the fiber spacing along the slit, so the collimator and IFU designs will iterate.

8. Structure

- *Design*: There has been no significant work on the structure in the last quarter.

9. Software

- *Digital I/O*: Jeff Percival addressed a number of issues he had identified with the digital I/O.
- *RFID*: Jeff, Ron Koch, and Paul Sendelbach addressed all of the outstanding issues with the RFID tagging system for gratings and filters.
- *Dewar Filter Wheel*: Jeff updated the filter control software to make filter selection more robust and efficient.
- *User Interface*: Jeff has expanded the engineering user interface. He has started to provide a simple user interface as part of his preliminary work with Anthony's framework.

10. Integration, Verification and Testing (@ UW)

- *Camera / Dewar Integration*: Mike Smith has developed a new design that will allow for some dynamic alignment adjustment between Dewar and the camera. Mike has detailed his design and Scott Buckley is machining the parts.
- *Mechanism Alignment*: Mike Smith and Jeff Percival verified and adjusted, if necessary, the alignment of all of the mechanisms.

Budget and Spending Detail

RSS-NIR SUMMARY	2011		2012		2013				2014				2015					PROJECT TOTAL
	PROJECT YEAR 4				PROJECT YEAR 5				PROJECT YEAR 6				PROJECT YEAR 7				PY 08	
QUARTERLY SPENDING	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	
LABOR	$210,544	$232,976	$231,359	$209,190	$77,307	$30,663	$21,459	$17,900	**($3,899)**	$16,147	$9,377	$15,206	$2,540	$13,025	$15,201	$8,142	**($1,872)**	$3,241,753
MATERIAL	$27,277	$27,127	$32,330	$20,137	$11,535	**($2,755)**	$9,742	$2,850	$11,734	$4,422	$8,402	$2,161	$6,081	$2,610	$13,138	$2,089	$495	$475,333
CAPITAL EQUIPMENT	$140,304	$144,011	$111,847	$33,948	$6,457	$3,403	$0	$49,878	$0	$24,255	$42,419	$6,195	$0	$15,000	$14,700	$0	$0	$1,383,050
TRAVEL	$8,407	$13	$870	$6,144	$6,746	$0	$0	$0	$0	$3,243	$0	$0	$0	$0	$0	$0	$0	$112,959
SUBCONTRACTS	$124,229	$121,029	$110,393	$156,407	$92,600	$46,874	$25,081	$25,744	$45,623	$14,138	$19,657	$17,266	$11,345	$16,690	$8,170	$14,891	$0	$1,737,714
TUITION REMISSION	$0	$889	$2,889	$1,778	$6,408	$0	$0	$0	**($4,000)**	$0	$0	$0	$0	$0	$0	$0	$0	$42,331
OVERHEAD	$65,181	$172,027	$168,409	$4,391	$118,837	$68,247	$21,257	$24,484	**($50,714)**	$13,800	$16,789	$15,585	$12,577	$14,547	$16,429	$11,305	**($620)**	$951,184
QUARTERLY TOTAL	$575,941	$698,071	$658,096	$431,994	$319,889	$146,431	$77,539	$120,857	**($1,256)**	$76,005	$96,645	$56,414	$32,543	$61,872	$67,639	$36,428	**($1,997)**	$7,944,324
QUARTERLY BUDGET																		
LABOR	$346,776	$242,188	$185,906	$216,498	$82,664	$197,888	$182,180	$172,018	$0	$0	$0	$0	$0	$0	$0	$0	$0	$3,649,949
MATERIAL	$86,883	$41,812	$18,850	$70,889	$5,542	$7,542	$24,542	$21,875	$0	$0	$0	$0	$0	$0	$0	$0	$0	$468,320
CAPITAL EQUIPMENT	$270,131	$151,290	$20,000	$251,440	$10,000	$165,100	$97,750	$68,750	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,558,800
TRAVEL	$32,282	$3,397	$0	$12,764	$0	$31,000	$1,500	$1,500	$0	$0	$0	$0	$0	$0	$0	$0	$0	$143,715
SUBCONTRACTS	$193,980	$79,050	$50,250	$189,918	$12,500	$32,500	$0	$20,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,544,734
TUITION REMISSION	$900	$2,700	$0	$1,600	$1,000	$3,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$49,331
OVERHEAD	$57,297	$110,223	$0	$190,765	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$787,497
QUARTERLY TOTAL	$988,249	$630,659	$275,006	$933,873	$111,706	$437,029	$305,972	$284,143	$0	$0	$0	$0	$0	$0	$0	$0	$0	$8,202,347
NET (BUDGET - SPEND)																		
LABOR	$136,232	$9,212	**($45,453)**	$7,308	$5,358	$167,225	$160,721	$154,118	$3,899	**($16,147)**	**($9,377)**	**($15,206)**	**($2,540)**	**($13,025)**	**($15,201)**	**($8,142)**	$1,872	$408,196
MATERIAL	$59,607	$14,685	**($13,480)**	$50,752	**($5,993)**	$10,297	$14,799	$19,025	**($11,734)**	**($4,422)**	**($8,402)**	**($2,161)**	**($6,081)**	**($2,610)**	**($13,138)**	**($2,089)**	**($495)**	($7,013)
CAPITAL EQUIPMENT	$129,827	$7,279	**($91,847)**	$217,492	$3,543	$161,697	$97,750	$18,872	$0	**($24,255)**	**($42,419)**	**($6,195)**	$0	**($15,000)**	**($14,700)**	$0	$0	$175,750
TRAVEL	$23,875	$3,384	**($870)**	$6,620	**($6,746)**	$31,000	$1,500	$1,500	$0	**($3,243)**	$0	$0	$0	$0	$0	$0	$0	$30,757
SUBCONTRACTS	$69,751	**($41,979)**	**($60,143)**	$33,511	**($80,100)**	**($14,374)**	**($25,081)**	**($5,744)**	**($45,623)**	**($14,138)**	**($19,657)**	**($17,266)**	**($11,345)**	**($16,690)**	**($8,170)**	**($14,891)**	$0	($192,980)
TUITION REMISSION	$900	$1,811	**($2,889)**	**($178)**	**($5,408)**	$3,000	$0	$0	$4,000	$0	$0	$0	$0	$0	$0	$0	$0	$7,000
OVERHEAD	**($7,884)**	**($61,804)**	**($168,409)**	$186,374	**($118,837)**	**($68,247)**	**($21,257)**	**($24,484)**	$50,714	**($13,800)**	**($16,789)**	**($15,585)**	**($12,577)**	**($14,547)**	**($16,429)**	**($11,305)**	$620	($163,687)
QUARTERLY NET	$412,308	**($67,411)**	**($383,090)**	$501,880	**($208,183)**	$290,598	$228,432	$163,286	$1,256	**($76,005)**	**($96,645)**	**($56,414)**	**($32,543)**	**($61,872)**	**($67,639)**	**($36,428)**	$1,997	$258,023

Table 3: *Only the last four years of spending is presented. The adjustments in Mar'12, and Jun '12 are due to re-baselining cost projections. Project accounting is conducted monthly and the cost data updated quarterly.*