STATUS REPORT FOR FEBRUARY 2002

Spartan IR Camera for the SOAR Telescope

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1 Tasks

1.1 Requisition for mirrors

The mirrors are collimator and camera mirrors for the f/12 channel, collimator and camera mirrors for the f/21 channel, and two fold mirrors. See Figure 1. Request for quotes for the mirrors and aluminum cells were sent to Space Optics Research Laboratory (SORL) of Waltham, MA, Hastings Controls (HCI) of Pittsburgh, PA, REOSC of France, and Axsys Technologies of Rochester Hills, MI.

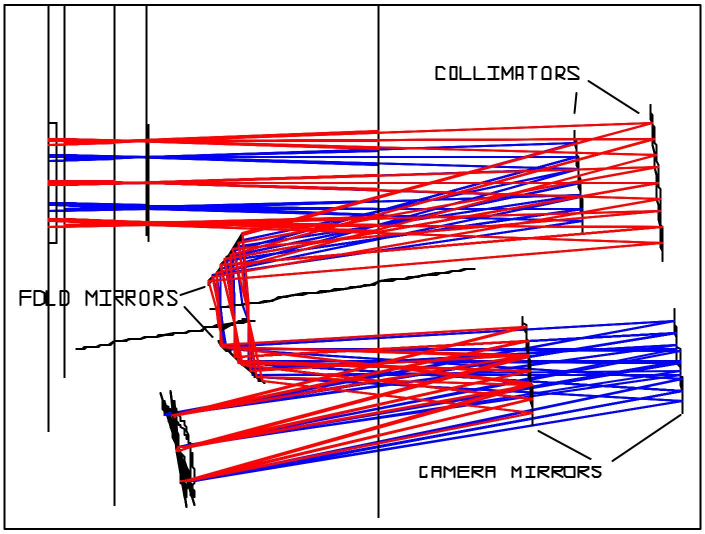


Figure 1 Optical layout.

We chose Axsys because of cost and three technical reasons. SORL's quote is 26% higher. HCI's quote is 60% higher.

1.1.1 Alignment

The accuracy of the location of the off-axis, aspheric f/12 collimator mirror is (±0.15, ±0.55, ±1.) mm, and the accuracy of its tilt is (±0.2, ±0.5, ±4) mrad to achieve a loss in the Strehl at 1.65µ of 4% for 37 alignment parameters. The accuracies of the other mirrors are comparable.

We plan to position the optics with a DEA Diamond 01.02 coordinate measuring machine (CMM). For short strokes, the 1-σ accuracy is 1µ independent of direction. The error is linear with the length of the stroke and doubles at a stroke of 300mm.

With Axsys mirrors, the positional errors of the optics are all well within the accuracy of our CMM, and no optical alignment is necessary. The only optical adjustment is focus.

1.1.2 Focus change between room temperature and 77K

With a glass mirror and aluminum cryogenic optical box, the focus changes between installation at room temperature and operation at 77K. Aluminum shrinks 4mm/m, and the focal lengths of the mirrors are 0.5–0.8 m. Glass shrinks 40 times less. Since the mirrors move 2–3 mm, which is more than the tolerance, refocusing is necessary.

With the aluminum mirrors from Axsys, the mirror and cryogenic optical box are both made of the same material, and the focus does not shift. Design and fabrication of a focus shifting jig and the cool-down cycles needed to check focus are avoided.

1.1.3 Project management

Axsys appears to manage its projects professionally. They delivered their quotes close to the promised dates. They respond to questions in a timely fashion. Within 4–6 weeks after receipt of the order, they will deliver drawings and a schedule for our approval. The schedule will have milestones, which we can monitor.

1.2 Software

We plan to write the software in stages (Table 1) that allow testing with the hardware. The umbilical card now communicates with the NI 6533 card (the first two stages).

Table 1 Plan for software.

WBS	Task	Completed
1.5.3	Minimal Software	
1.5.3.1	Write Communications Test Software	1/30/2002
1.5.3.2	Test Communications Link between Umbilical & NI6533	2/20/2002
1.5.3.3	Write Software with Simulated CCD	
1.5.3.4	Replace CTIO Camera with Spartan in ArcView	
1.5.3.5	Write Software for Filter Wheels	
1.5.3.6	Write Software for Averaging Data	
1.5.4	Baseline Software	
1.5.4.1	Submit GUI for Comments	
1.5.4.2	Modify GUI	
1.5.4.3	Write software for 2nd Detector	
1.5.5	Software for Upgrades	
1.5.5.1	Write Software for 2nd Focal Ratio	
1.5.5.2	Write Software for Spectroscopy	
1.5.5.3	Write Software for Region of Interest	

1.3 Testing the rotation stage

We plan to use Phytron PRS-110 cryogenic rotation stages for all motions. The tightest requirement is for inserting the f/21 collimating mirror or the f/12 camera mirror. There the stage must tilt by less than 17 µrad to maintain boresight alignment with the tip-tilt guider to one pixel. Used to turn the filter wheel or mask wheel, the requirement is much looser.

We have started testing the rotation stage for tilt. For this purpose, we built a test jig for measuring the tilt when a torque is applied. (See Figure 1.) A screw pushes on the ends of the two forcing pipes to exert a torque on the rotation stage. The tilt is measured by measuring the distance between the ends of the sensing posts.

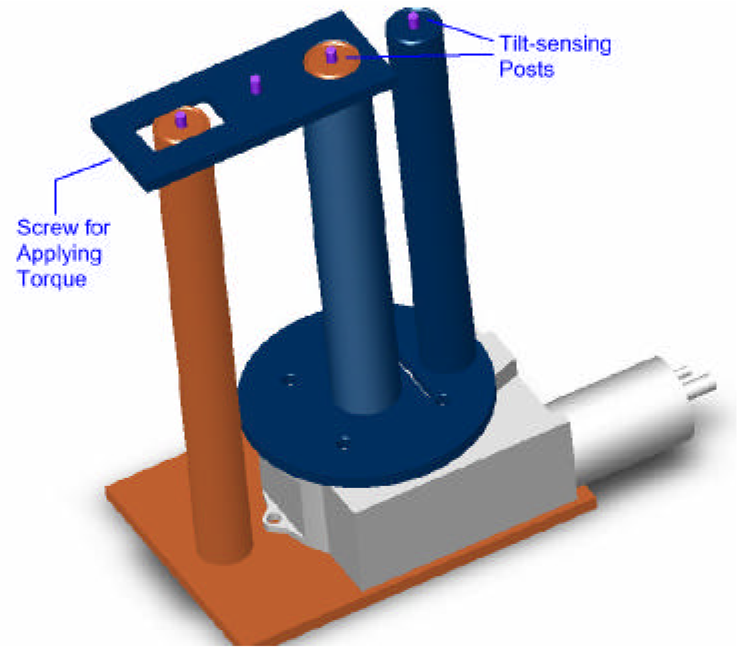


Figure 1 Jig for testing the rotation stage. The blue parts form a welded unit, and so do the red parts. A screw exerts a torque on the stage by forcing the long red post and the top plate together. The tilt is sensed by measuring the distance between the tilt-sensing posts.

The measurements appear to jump by 100–200µrad, and we have not determined whether the stage or our test jig causes these jumps.

The rotation stage works well enough for turning the filter wheels, and we have bought another stage for the second filter wheel.

Whether the rotation stage is stiff enough for inserting the f/21 collimating mirror and f/12 camera mirror is a critical issue. If not, these mechanisms must be redesigned, and we must determine whether a new mechanism fits the space constraints.

1.4 Cryogenic getter

We analyzed the cryogenic getter to show that it can handle the permeation through the o-rings for about 4 years, after which the instrument must be pumped. (The estimate for time is from published permeation rates of He and Ne; if we use our measurement with a test dewar, the estimated time is 1.5 years.)

The pump adsorbs N_2, O_2, and Ar, but not He and Ne. (See Table 2 for the estimated partial pressures.) The length of o-ring is 4.4 m, and the volume is 0.43m^3. The permeation rates are for Viton. After 4 years, thermal conduction by He and Ne increases the thermal load by a third. The instrument must be warmed to at least 97K to release nitrogen, oxygen, and argon and then pumped to remove helium and neon.

Table 2 Partial pressure after 4 years without and with a 10-gm charcoal getter

Gas	**Pressure**		**Remainder**
	w/o Getter	**w Getter**	
N2	5 Pa	0.04 mPa	0.0009%
O2	30 Pa	small	small
H2	0.1 mPa	0.1 mPa	88%
CO2	0.3 Pa	small	small
He	6 mPa	6 mPa	100%
Ar	3 Pa	0.001 mPa	0.00005%
Ne	4 mPa	4 mPa	100%
Kr	0.3 mPa	small	?
Total	39 Pa	10 mPa	

We measured the total permeation rate with a test dewar over a period of 110 days. The test dewar has a Zeolite getter. With the getter cold, the measured pressure was 2.5 times that of the estimated pressure. The agreement is as well as can be expected, since the published permeation rates vary considerably.

The getter is 10 gm of charcoal at 77K. The temperature of the charcoal can warm to 89K before the pressure of nitrogen equals that of helium. Therefore the getter does not require careful design of heat paths.

1.5 Electronics

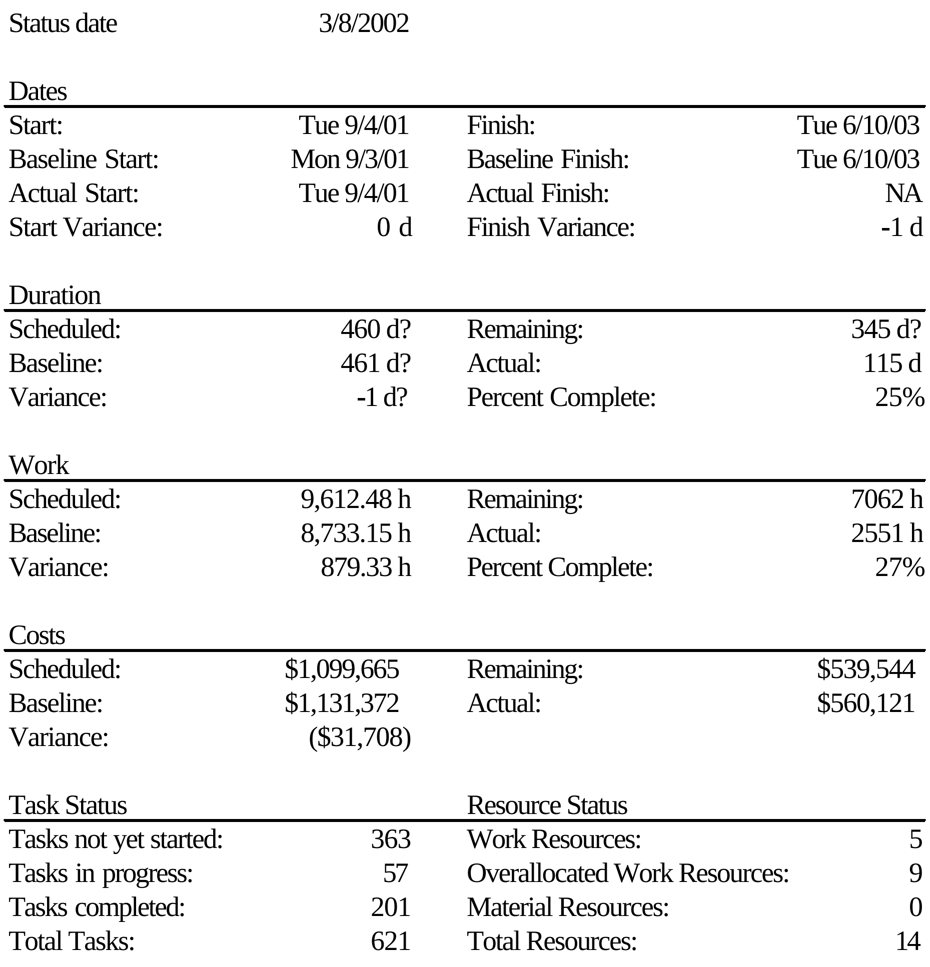
The detector board, which holds the detector, is finished. Initially the vendor fabricated the board without connecting the ground and power planes; they fixed the error with the second set of boards.

We measured the crosstalk with the entire set of electronics, controller, flexible cable, and detector board, and we found that the crosstalk agrees with the prediction. The crosstalk between the detector output and digital lines has a peak of 20mV, and it decays with an e-fold time of 20 ns. It is repeatable.

2 Project Management

The project summary is in Table 3.

Table 3 Project summary



Status date	3/8/2002		
Dates			
Start:	Tue 9/4/01	Finish:	Tue 6/10/03
Baseline Start:	Mon 9/3/01	Baseline Finish:	Tue 6/10/03
Actual Start:	Tue 9/4/01	Actual Finish:	NA
Start Variance:	0 d	Finish Variance:	-1 d
Duration			
Scheduled:	460 d?	Remaining:	345 d?
Baseline:	461 d?	Actual:	115 d
Variance:	-1 d?	Percent Complete:	25%
Work			
Scheduled:	9,612.48 h	Remaining:	7062 h
Baseline:	8,733.15 h	Actual:	2551 h
Variance:	879.33 h	Percent Complete:	27%
Costs			
Scheduled:	$1,099,665	Remaining:	$539,544
Baseline:	$1,131,372	Actual:	$560,121
Variance:	($31,708)		
Task Status		**Resource Status**	
Tasks not yet started:	363	Work Resources:	5
Tasks in progress:	57	Overallocated Work Resources:	9
Tasks completed:	201	Material Resources:	0
Total Tasks:	621	Total Resources:	14

2.1 Earned value analysis

The earned value analysis of the schedule shows several tasks are behind schedule. (See columns BCWS, BCWP, and SV of Table 4.) The "schedule variance," SV, shows $175k of work should have been performed but has not. The greatest part is in WBS 1.3, Mechanical.

Earned value analysis does not apply here to work done by Biel, Davis, and Loh; therefore it cannot show problems in work done by them. It can show problems with purchased parts and labor that is charged by the hour.

Table 4 Earned value analysis and % complete. A positive "schedule variance," SV, indicates the project is ahead of schedule. A positive "cost variance," CV, or "variance at completion," VAC, indicate the project is less costly than budgeted.

WBS	Task	BCWS	BCWP	ACWP	SV	CV	EAC	BAC	VAC
1	Spartan IR Camera	$745,458	$570,639	$560,121	($174,819)	$10,518	$1,099,665	$1,131,372	$31,708
1.1	Project Management	$57,709	$52,159	$52,289	($5,550)	($130)	$161,619	$161,619	$0
1.2	System Engineering	$720	$720	$2,208	$0	($1,488)	$2,268	$720	($1,548)
1.3	Mechanical	$181,466	$38,949	$29,267	($142,517)	$9,682	$340,773	$368,060	$27,287
1.4	Electronics	$9,505	$6,385	$6,352	($3,120)	$33	$13,136	$12,705	($431)
1.5	Software	$10,231	$2,000	$2,000	($8,231)	$0	$10,800	$10,800	$0
1.6	Integration	$2,100	$0	$0	($2,100)	$0	$3,800	$3,800	$0
1.7	Deliverables	$0	$0	$0	$0	$0	$20,800	$20,800	$0
1.8	Procurement	$51,407	$38,105	$35,685	($13,302)	$2,420	$114,148	$120,548	$6,400
1.9	Preplan Spending	$432,321	$432,321	$432,321	$0	$0	$432,321	$432,321	$0
1	Change from 2/9/02	$61,128	$14,263	$17,280	($46,865)	($3,017)	($19,163)	$0	$19,163
Baselin	Baseline cost								
Cost	Estimated cost at completion								
BCWS	Budgeted cost of work scheduled								
BCWP	Budgeted cost of work performed								
ACWP	Actual cost of work performed								
SV	Earned value schedule variance; SV=BCWP-BCWS								
CV	Earned valve cost variance; CV=BCWP-ACWP.								
EAC	Estimate at completion								
BAC	Budget at completion								
VAC	Variance at completion; VAC=BAC-EAC								

What can we do to reduce the schedule variance by the end of March? Consider the 11 tasks with the greatest schedule variance (Table 5). Since we have issued requisitions for the top two tasks, Mirrors and Rotation Stage, $100k of the schedule variance will decrease over time. The task requiring immediate attention is to order filters. Comments about the other tasks are in the table.

Table 5 Tasks with the greatest schedule variance.

WBS	Task	SV	BAC		Will SV decrease by next monthly report?
1.3.6.1	Mirrors	($72,141)	$95,975	y	Requisition for mirrors was issued.
1.3.5.15	Vendor Delivers Rotational S	($18,022)	$26,000	y	Requisition for rotation stage was issued.
1.3.1.2	CryoBox	($13,992)	$19,880	y	Design work will resume soon.
1.3.7	Filters	($11,769)	$51,000	?	Will make this a priority.
1.3.3	Vacuum Enclosure	($10,100)	$27,380	y	Design is in progress.
1.5	Software	($8,231)	$10,800	y	Faster progress expected, now that communications link works.
1.1.6	Consultants	($6,700)	$10,000	n	Need for consultants has not arisen.
1.8.8	Procure Parts for Vacuum E	($5,303)	$7,163	y	Wil issue requisitions in March, but delivery is not expected.
1.3.1.1	MLI Blanket	($4,047)	$4,047	n	RFQ has been sent, but fabrication is not expected in March.
1.3.1.5	N2 Can	($3,861)	$10,061	y	Fabrication will start soon after shop has finished move.
1.4.1	Detector Assembly	($3,120)	$6,920	y	Fabrication will start soon after shop has finished move.

The estimated cost at completion (EAC) is $31.7k under the budgeted cost at completion (BAC). The item with the largest variance is Mirrors. (See Table 6.)

Table 6 Items with the largest Variance at Completion. A positive number means the Estimated Cost at Completion is lower than the Budget at Completion.

WBS	Item	EAC	VAC	Reason
1.3.6.1	Mirrors	$95,975	$15,253	Axsys's bid is lower.
1.3.1.4	A-Frame	$5,600	$5,155	Time for detailing and fabrication are lower.
1.3.1.5	N2 Can	$10,061	$4,129	Time for detailing is lower.
1.3.5.16	Vendor Delivers Motor Controller	$10,490	$3,490	NI's motor controller costs less.
1.3.1.1	MLI Blanket	$4,047	($2,395)	Preliminary quote is higher than ballpark estimate.

2.2 Schedule

A simple metric for analyzing the schedule is the slack between construction of the parts and integration (Table 7). In the baseline schedule, the shortest slack at this point was 12 weeks. The most critical task is to order filters. The long delivery time, on which the schedule is built, may help here. The second most critical task is the mirrors for the second focal ratio. More slack can be found by installing the second focal ratio after the first is checked out. For the other tasks, the slack is not critical.

Table 7 Slack of tasks that precede Integration

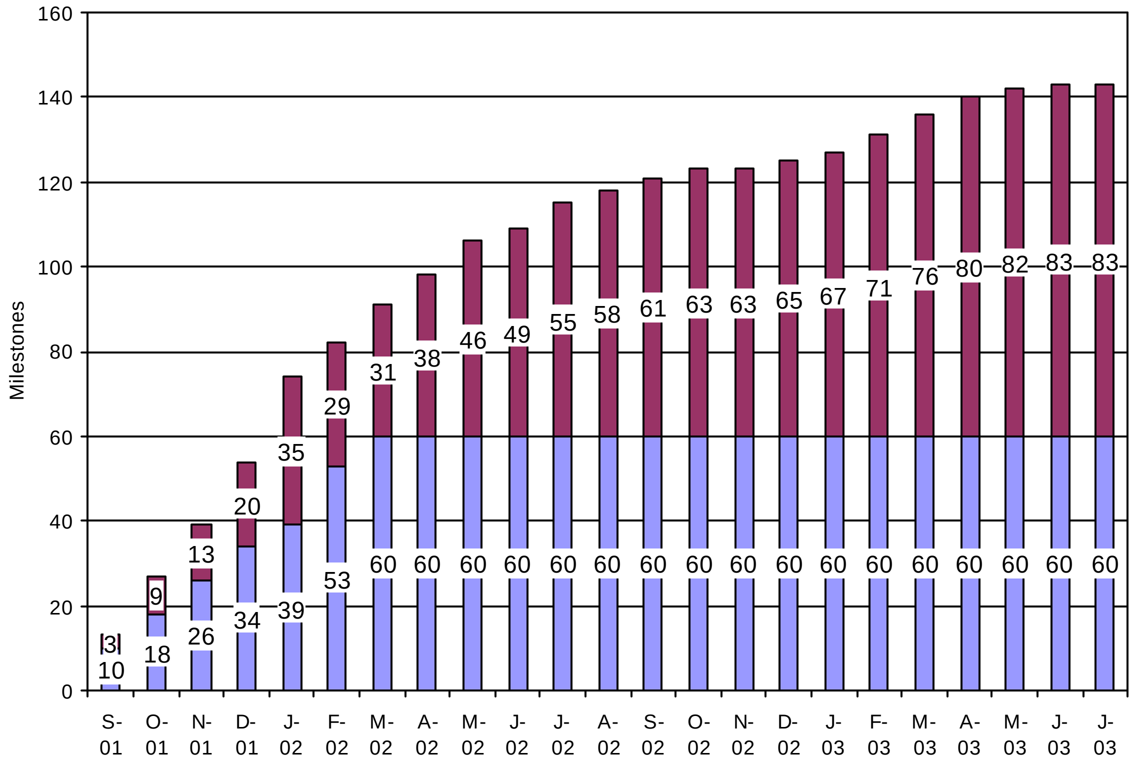
WBS	Task	Slack [wk]	Comments
1.3.1.2	CryoBox	11	
1.3.4	Filter Wheel	9	
1.3.6	Mirrors & Mounts	9	
1.3.7.4	Basic Filters Delivered	0	12-mo delivery assumed
1.3.8.1	2nd Channel Mirrors & Mounts [Upgra	2	Installation with 1st channel is assumed.
1.3.8.2	Mask Wheel Upgrade	15	
1.4.1	Detector Assembly	15	

2.3 Milestones

The time-phased completion of the milestones is in Figure 3, and a complete list of milestones is in Table 8 in the Appendix. During February and the first part of March, we completed 21 milestones.

A group (numbers 34, 35, 55, and 66) of milestones with large delay are linked to the detector holder prototype and the test dewar. Fabrication of these parts should start soon.

Figure 2 Cumulative number of milestones completed (blue) and not completed (magenta) vs. date.



3 Personnel

René Laporte will arrive on 20 March.

4 Appendix

Table 8 Milestones

Milestone		Date			Variance
		Baseline	Completed	Scheduled	
1	Requisition for Flexible Cable Issued	4-Sep-01	1-Oct-01		18 d
2	Requisition for Rotation Stage Issued	6-Sep-01	6-Sep-01		0 d
3	Optical Design Finished	7-Sep-01	7-Sep-01		0 d
4	N2 Can Engineered	7-Sep-01	7-Sep-01		0 d
5	A-Frame Strut Engineered	17-Sep-01	13-Nov-01		42 d
6	Requirements for Optical Alignment Written	17-Sep-01	17-Sep-01		0 d
7	Requisition for Vacuum Blukhead Issued	17-Sep-01	7-Sep-01		-7 d
8	Vacuum Enclosure & Cryo Box ICD Written	18-Sep-01	28-Sep-01		9 d
9	Controller Card SCA Tested (Existing Computer	21-Sep-01	12-Dec-01		57 d
10	Detector Physical Dimensions Measured	24-Sep-01	20-Sep-01		-3 d
11	Requisition for Mirrors Issued	28-Sep-01	21-Feb-02		104 d
12	Software Requirements Written	28-Sep-01	28-Sep-01		0 d
13	Requisition for Detector PCB Issued	28-Sep-01	19-Nov-01		35 d
14	Method for Optical Alignment Created	1-Oct-01	3-Jan-02		68 d
15	Specifications for Telescope Simulator Written	3-Oct-01	3-Oct-01		0 d
16	Requisition for Coordinate-Measuring Machine	5-Oct-01	27-Nov-01		36 d
17	Detector Assembly Concept Developed	8-Oct-01	3-Dec-01		39 d
18	Solidworks License Delivered	11-Oct-01	9-Oct-01		-3 d
19	Mounting Blocks Engineered	12-Oct-01	26-Sep-01		-12 d
20	Test-Dewar Concept Sketch Finished	15-Oct-01	19-Oct-01		3 d
21	Vacuum Bulkhead Delivered	15-Oct-01	27-Feb-02		96 d
22	Select SW Vendor	16-Oct-01	16-Oct-01		0 d
23	N2 Can Designed	18-Oct-01	10-Jan-02		60 d
24	Requisitions for Computer for Laboratory Issued	19-Oct-01	17-Oct-01		-3 d
25	Detector Holder Prototype Designed	25-Oct-01	4-Feb-02		71 d
26	Mounting Blocks Designed	29-Oct-01	8-Mar-02		94 d
27	Rotation Stage Test Fixture Engineered	31-Oct-01	10-Dec-01		28 d
28	Coordinate-Measuring Machine Delivered	2-Nov-01	12-Feb-02		72 d
29	Rotation Stage Test Fixture Designed	7-Nov-01	7-Jan-02		43 d
30	Flex Cable Finished	9-Nov-01	8-Nov-01		-2 d
31	Computers for Laboratory Delivered	9-Nov-01	11-Dec-01		21 d
32	Project Plan Finished	16-Nov-01	19-Dec-01		24 d
33	Cryo-Optical Box Engineering Finished	16-Nov-01	28-Nov-01		8 d
34	Detector Holder Prototype Fabricated	19-Nov-01		19-Nov-01	
35	Test-Dewar Fabricated	19-Nov-01		19-Nov-01	
36	Detector PCB Finished	21-Nov-01	21-Nov-01		0 d
37	Master Layout Designed	26-Nov-01	23-Nov-01		-1 d

39	A-Frame Strut 3D Designed	30-Nov-01	30-Nov-01		0 d
40	Specifications for Vacuum Enclosure Written	6-Dec-01	24-Oct-01		-31 d
41	Rotation Stage Test Fixture Fabricated	7-Dec-01	8-Feb-02		45 d
42	Requisition for Field-flattening Lenses Issued	7-Dec-01		7-Dec-01	
43	Mask Plate Engineering Finished	7-Dec-01	1-Mar-02		59.44 d
44	MLI Requisition Issued	10-Dec-01		5-Mar-02	
45	Requisition for Window Issued	10-Dec-01	8-Feb-02		43 d
46	Flex Cable/Bulkhead Assembly Finished	11-Dec-01	27-Feb-02		55 d
47	Specification for Filter Wheels Written	14-Dec-01	10-Dec-01		-4 d
48	Rotation Stage Tested	14-Dec-01		14-Dec-01	
49	Mounting Blocks Fabricated	14-Dec-01		25-Apr-02	
50	Joined Filter Consortium	14-Dec-01		14-Dec-01	
51	Requisitions for Vacuum Parts Initiated	20-Dec-01		20-Dec-01	
52	Requisition for Rotation Stage Controller & 2nd	25-Dec-01	1-Mar-02		48 d
53	Cable for Motors Analyzed	28-Dec-01	8-Feb-02		29 d
54	Mask Plate Designed	28-Dec-01		22-Mar-02	
55	Detector Holder Prototype Thermal Test Finishe	1-Jan-02		1-Jan-02	
56	Vacuum Enclosure Engineered	3-Jan-02	31-Oct-01		-46 d
57	MLI Designed	8-Jan-02	12-Feb-02		25 d
58	Thermal Reflector Engineered	9-Jan-02	4-Mar-02		38 d
59	Communications Test Software Delivered	14-Jan-02	30-Jan-02		11 d
60	Requirements for Window Written	15-Jan-02	18-Jan-02		3 d
61	Requirements for Field-Flattening Lens Written	15-Jan-02	8-Feb-02		18 d
62	Requirements for Telescope Simulator Modified	15-Jan-02	10-Dec-01		-26 d
63	Requirements for Pyramidal MirrorWritten	15-Jan-02	8-Feb-02		18 d
64	Motor PCB Designed	18-Jan-02		22-Feb-02	
65	Filter Wheel Mounting Block Specified	21-Jan-02	21-Sep-01		-87 d
66	MUX Tested at Room Temperature	22-Jan-02		22-Jan-02	
67	Parts for Test Dewar Assembled	25-Jan-02	8-Feb-02		9 d
68	Cryo-Optical Box Drawings Finished	30-Jan-02		10-Apr-02	
69	Motor Software Delivered	30-Jan-02		30-Jan-02	
70	Complete Software Delivered	30-Jan-02		30-Jan-02	
71	Reworked Software Delivered	30-Jan-02		30-Jan-02	
72	Basic Software Delivered	30-Jan-02		30-Jan-02	
73	Vacuum Parts Delivered	31-Jan-02		31-Jan-02	
74	Telescope Simulator Engineered	31-Jan-02		20-Mar-02	
75	MUX Tested at Cold Temperature	1-Feb-02		1-Feb-02	
76	Requistions for Parts for Telescope Simulator Is	8-Feb-02		8-Feb-02	
77	Motor PCB Fabricated	8-Feb-02		15-Mar-02	
78	Communication with NI6533 Tested	20-Feb-02	20-Feb-02		-1 d
79	Vacuum Enclosure Designed	22-Feb-02		12-Apr-02	
80	Hardware & Software Tested	26-Feb-02		4-Apr-02	
81	Upgrade Decision for 2nd Channel Made	28-Feb-02		28-Feb-02	
82	Web Site Created	28-Feb-02	8-Mar-02		5 d
83	MLI Blanket Delivered	7-Mar-02		2-May-02	
84	Thermal Reflector Concept Analyzed	8-Mar-02	1-Mar-02		-6 d
85	Telescope Simulator Designed	11-Mar-02		17-Apr-02	
86	Parts for Telescope Simulator Delivered	13-Mar-02		13-Mar-02	
87	A-Frame Strut Fabricated	15-Mar-02	14-Dec-01		-65 d
88	Mask Plate Finished	22-Mar-02		26-Apr-02	
89	Thermal Reflector Designed	22-Mar-02	8-Mar-02		-10 d

91	N2 Can Fabricated	28-Mar-02	6-Aug-02
92	Detector Tested in Lab	2-Apr-02	2-Apr-02
93	Rotation Stage Controller & 2nd Stage Delivere	8-Apr-02	8-Apr-02
94	Cryo-Optical Box Fabricated	9-Apr-02	18-Jun-02
95	Detector Tested with Sky	10-Apr-02	10-Apr-02
96	Filter Wheel Designed	12-Apr-02	12-Apr-02
97	Detector Assembly Designed	30-Apr-02	30-Apr-02
98	Scripts Tested	30-Apr-02	30-Apr-02
99	Reworked Electronics Finished	1-May-02	1-May-02
100	Mirrors Delivered	6-May-02	27-Sep-02
101	Window Delivered	9-May-02	9-May-02
102	Thermal Reflector Fabricated	15-May-02	8-May-02
103	Telescope Simulator Fabricated	17-May-02	25-Jun-02
104	Mirrors Installed in Mounts	20-May-02	11-Oct-02
105	Mask Wheel Engineered	21-May-02	21-May-02
106	Vacuum Enclosure Finished	24-May-02	12-Jun-02
107	Collimator and Camera Mirror Mount Designed	14-Jun-02	14-Jun-02
108	Mask Wheel Designed	18-Jun-02	18-Jun-02
109	Cryo-Optical Box Thermal Test Finished	21-Jun-02	10-Sep-02
110	Filter Wheels Fabricated	12-Jul-02	12-Jul-02
111	Field-Flattening Lenses Delivered	12-Jul-02	12-Jul-02
112	Test Plan for Filter Wheel Written	12-Jul-02	12-Jul-02
113	Detector Assembly Fabricated	15-Jul-02	15-Jul-02
114	Detector Assembly Finished	22-Jul-02	22-Jul-02
115	Mask Wheel Fabricated	31-Jul-02	31-Jul-02
116	Filter Wheel #1 Tested Warm	7-Aug-02	7-Aug-02
117	Filter Wheel #1 Tested Cold	15-Aug-02	15-Aug-02
118	Filter Wheel #2 Tested	22-Aug-02	22-Aug-02
119	Mask Wheel Tested	3-Sep-02	3-Sep-02
120	2nd Collimator and Mirror Mount Fabricated	13-Sep-02	13-Sep-02
121	Procure F/21 Collimator & Camera Mirrors Deli	13-Sep-02	18-Sep-02
122	Telescope Simulator Finished	7-Oct-02	7-Oct-02
123	2nd Collimator and Mirror Mount Tested	17-Oct-02	17-Oct-02
124	Basic Filters Delivered	13-Dec-02	13-Dec-02
125	All Filters Delivered	13-Dec-02	13-Dec-02
126	Instrument Assembled & Aligned at Room Tem	21-Jan-03	21-Jan-03
127	Flexure Tested	28-Jan-03	28-Jan-03
128	Draft Maintenance Manual Written	14-Feb-03	14-Feb-03
129	Draft Software Manual Written	14-Feb-03	14-Feb-03
130	Cold Test #1 Finished	18-Feb-03	18-Feb-03
131	As-Built Drawing Package Assembled	28-Feb-03	28-Feb-03
132	Draft Operating Manual Written	14-Mar-03	14-Mar-03
133	Maintenance Manual Finished	31-Mar-03	31-Mar-03
134	Software Manual Finished	31-Mar-03	31-Mar-03
135	Draft Acceptance Test Written	31-Mar-03	31-Mar-03
136	Shipping Container Finished	31-Mar-03	31-Mar-03
137	Cold Tests Finished	11-Apr-03	11-Apr-03
138	Image Quality Tested in Laboratory	18-Apr-03	18-Apr-03
139	Image Quality Tested on Sky	28-Apr-03	28-Apr-03
140	Operating Manual Finished	30-Apr-03	30-Apr-03
141	Acceptance Test Written	7-May-03	7-May-03
142	Pre-Ship Acceptance Test Finished, Integration	14-May-03	14-May-03
143	Project Complete	10-Jun-03	10-Jun-03