PRECISION RADIAL VELOCITY SPECTROMETER

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CHANGE RECORD

Issue	Date	Section affected	Change Description
0.1	5 August 2006	All	First issue.
1.0	20th September 2006		Final issued before release to Gemini

APPLICABLE DOCUMENTS

Reference	Document Title	Document Number	Issue & Date
AD01	PRVS Contract	0084699-GEM01056	6TH Jan 2006
AD02	UK ATC Project Management Procedures	189-PMG-01-0001	Issue 1 – May 2001
AD03	PRVS Phase 2 Configuration Management Plan	PRVS-PLA-00002-0001	Issue 1.0 14th September 2006

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1. SCOPE OF DOCUMENT

In this document we describe the processes and procedures that will be used to manage the work required to take the conceptual design of a Precision Radial Velocity Spectrometer (PRVS) and complete the design, fabrication, integration, test and delivery of that Instrument to the Gemini Observatory. Although, of necessity, it will describe the current version of some of the basic structures that will underpin the work, namely the System Architecture, the Work Breakdown Structure, the Organisational Structure, work shares across the Consortium etc, it is primarily a procedures manual. The details about how much we expect the Project to cost and the risks, options etc that go with that estimate are covered in more detail in the separate pricing information.

In reference to the Statement of Work (AD01), this document will therefore cover the following sub-paragraphs of section 4.3.4.

Para	Description	Management Plan	Pricing Document
a)	Delivery Schedule	How derived, Level 1 Gantt plus expected key milestones	Key Milestones and Payment milestones
b)	WBS	How derived, Diagram plus Level 1 WBS descriptions	Full descriptions
c)	Resource Requirements	How managed – see l)	Full description
d)	Procurement List		All
e)	Budget and payment plan	Management of Contingency	All
f)	Options Prices		All
g)	Price Qualifications		All
h)	Team Organisation	All	
i)	Management Techniques	All	
j)	Lab Facilities	All	
k)	Key Milestones	List of Key technical milestones	Repeated
l)	Resource Allocation	Description of local processes	
m)	Quality Control	Description of local processes	
n)	Configuration Management	Sub-document	
o)	Key Risks and Mitigations	Sub-document for procedures	Full current Risk Register

As noted above, the Management Plan will have two sub-documents, a Configuration Management plan and a Risk Management Plan.

2. INTRODUCTION

PRVS is an Instrument that requires a high degree of thermal & mechanical stability. To complete it's design and build in a timely and cost effective manner will require ingenuity, experience, robust simple procedures and discipline. We are sure that, as a team, we have the necessary ingenuity and relevant technical and managerial experience. The application of a strong systems engineering approach, as described in the project Systems Engineering document, is something the UK ATC in particular has been developing extensively in recent years. That, allied to the management procedures to be described in this document, will provide the remaining key elements.

This document is based on the well developed set of Project Management Procedures already in place at the UK ATC and on Management Plans developed for recent consortium projects such as KMOS (ESO VLT), the Gemini HRNIRS proposal for Phase 2 and JWST MIRI (ESA-NASA). Those procedures, and this document, will be updated regularly as we gain further practical experience. It should be noted that the UK ATC have adopted the Body of Knowledge from the Project Management Institute (PMI) as the guidelines to follow in detailing all future amendments to those procedures and are currently implementing a Configuration Management Tool which will encapsulate all this procedures in a single system.

3. APPROACH

The instrument will be built by a collaboration between the UK Astronomy Technology Centre (UK ATC), the Institute for Astronomy (IFA) at the University of Hawaii, Department of Astronomy & Astrophysics at Pennsylvania State University (PSU) and Centre for Astrophysics Research at the University of Hertfordshire (UoH). The collaboration will bring together the significant combined expertise of instrument groups with a well established track record in building a range of instrumentation for 4-metre and 8-metre class telescopes. These include SCUBA (with first on-line pipeline), GMOS (and ancillary instruments), MICHELLE, CGS4, UIST and WFCAM at the UK ATC ; SpeX, IRCS, NIRI, AEOS spectrograph, ULB camera and PAN-STARRS at the IfA ; LRS, MRS and HRS at Penn State. That combined expertise covers all the critical requirements for the PRVS instrument including cryogenic optics and mechanisms, performance modelling, infrared detectors, spectrographs, fibre systems, instrument control and data processing pipelines. The team will adopt a systems-led approach co-ordinated by a single project management team in order to deliver the instrument within budget and on schedule. In addition, a Science Team will be drawn from relevant experts across the two countries to ensure that the maximum scientific advantage can be planned for the capabilities of the Instrument.

4. STAKEHOLDERS

The following are key stakeholders in PRVS:

4.1 PRVS CONSORTIUM

The UK Astronomy Technology Centre in Edinburgh is providing leadership and expertise in overall management of the Consortium, systems engineering, optical and mechanical design, data pipeline software, detector electronics and science.

The Institute for Astronomy at the University of Hawaii in the USA is providing expertise in high-resolution science, instrument modelling, mechanical design and instrument software associated with the PRVS instrument design.

Department of Astronomy & Astrophysics at Pennsylvania State University in the USA is providing expertise in science, spectrographs, fibre systems and data pipeline software.

Centre for Astrophysics Research at University of Hertfordshire in the UK is providing science leadership via the Principal Investigator (PI).

A Memorandum of Understanding (MOU) between the parent bodies of the consortium partners will be adopted for Phase 2 should the Consortium be successful and Gemini decide to go ahead with the build of PRVS. The MOU will provide mechanisms for dealing with the issues of cost sharing, workshare, contract changes, IPR etc through the life of the Project

Details of the four organisations can be found in the Appendices to this document.

4.2 PARTICLE PHYSICS AND ASTRONOMY RESEARCH COUNCIL (PPARC)

The UK ATC will be the lead organisation in the collaboration with the IFA, UoH, PSU. As the funding agency for the UK ATC, PPARC will, in reality, be the organisation that signs the Contract with the Gemini Observatory (AURA). PPARC has in place approval procedures for all major projects that will have to be completed before the Contract can be signed. This will be particularly necessary on PRVS where the Gemini Observatory's 'fixed price' approach could leave PPARC contractually obliged to underwrite an unexpected overspend. A process for PPARC approval of the Contract Price and Management systems has been agreed and it is hoped to complete that before the Panel Review Meeting on 5 October (assuming availability of PPARC Panelllists) and certainly no later than the end of October 2006

PPARC will require an MOU with the other consortium partners as a necessary condition before contract approval with Gemini. Work on that will be in parallel to Contract negotiations but all parties have seen the proposed amendments to the draft Phase 2 contract.

During the execution of the contract, PPARC procedures require the monitoring of the project by a Project Board. This is made up of appropriate senior personnel representing all the consortium Institutes interested parties as well as an independent PPARC appointment from outside the collaboration.

4.3 UNIVERSITY OF HAWAII (UH)

The IFA is a small subset of the overall University of Hawaii who will ultimately be the legal entity signing the Consortium MOU. The UH have reviewed all the likely issues previously with the HRNIRS Study and are comfortable with the approach required. It is expected that UH will agree with IFA on the choice of Senior Staff Member to represent them on the Project Board.

4.4 PENN STATE UNIVERSITY (PSU)

Likewise PSU will be the legal entity representing the Department of Astronomy & Astrophysics and will agree the MOU with PPARC and appoint a member to the Project Board.

4.5 UNIVERSITY OF HERTFORDSHIRE (UOH)

As above, the Consortium MOU will be signed by the UoH on behalf of the Centre for Astrophysics Research. Again UoH will appoint a representative to the Board.

4.6 GEMINI (AURA)

The Gemini Observatory, as represented by the Director of Instrumentation, or his nominated Deputy, is the Customer. A normal Fixed Price Contract is based around the delivery of equipment or services to a fixed set of requirements and as such, customer involvement could be limited to the discussion of progress reports and intermittent reviews of particular aspects. However, that level of involvement would be seriously deficient in this case where many technical challenges will need to be addressed in the course of the project, particularly early on, and customer involvement in those decisions, especially at Design Reviews etc will be required. In particular, considerable interaction may be required to handle items which represent calls on the 'AURA reserve' for 'AURA Assumed Risks'.

5. PROJECT TEAM ORGANISATION

5.1 PROJECT TEAM STRUCTURE

The Structure of the PRVS Project Team shown below is designed to provide clear definition of the responsibilities of the Consortium Management Team and thereby ensure efficient control of the Project. The Team will be led by a Project Manager reporting to a Project Board. This section gives an outline of the key elements of the structure and the associated roles within that structure.

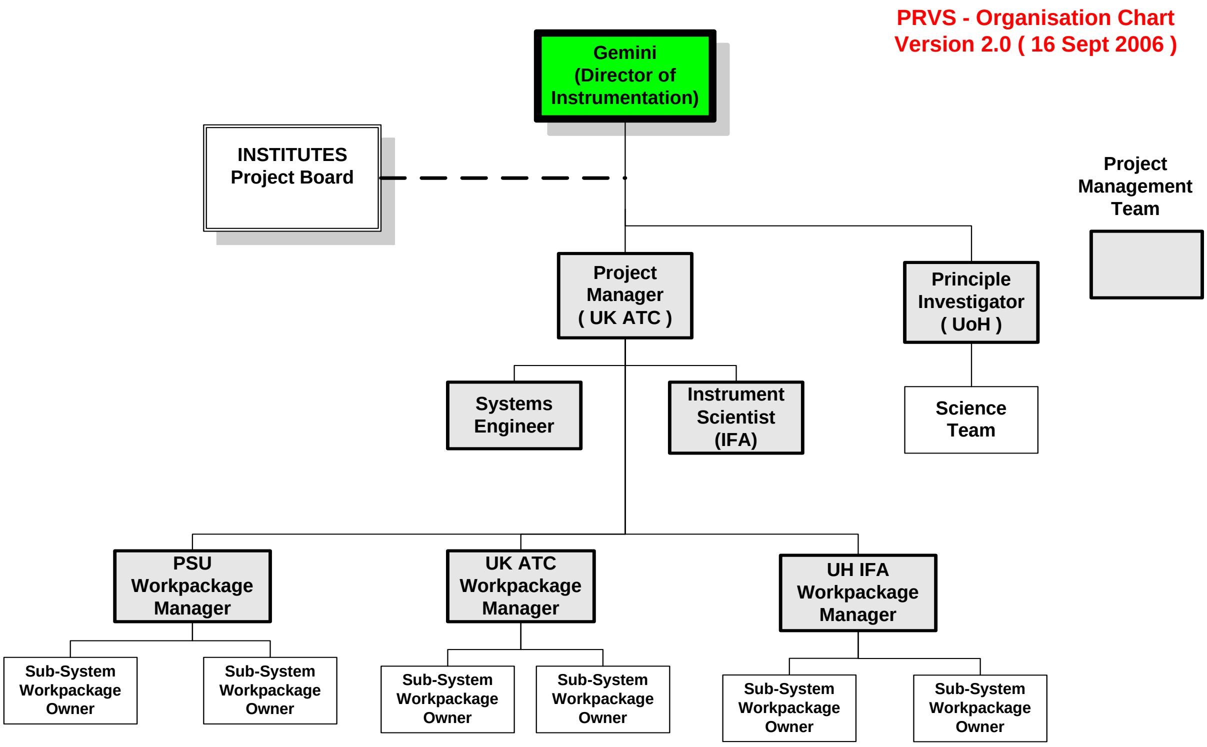


Figure 1 PRVS Organisation Chart

5.2 ROLES

5.2.1 Project Board

The Project Board represents the interests of the PPARC/UK ATC, IFA, PSU & UoH and is charged with the following tasks:

- Setting priorities and resolving conflicts within the project
- Approval of any change in workshare between partners or the entry of a new partner
- Advising the Project Manager on resolving non straightforward requests and demands to/from the customer
- Advising on and Approving changes to the contract with AURA, most notably when these result from calls on the AURA Reserve per the contract provisos.
- Approving the release of working margin within the project for specific work packages
- Approving final bill to customer

The Project Board will consist of :-

PPARC	- Dr Colin Vincent plus an independent UK expert
UK ATC	– Professor Ian Robson
IFA	– Alan Tokunaga
UoH	– Professor Jim Hough
PSU	– Dr Karin Foley

The Project Manager, Principal Investigator, Systems Engineer, Instrument Scientist and the PSU Workpackage Manager will attend all meetings as reportees.

5.2.2 Project Manager

The Project Manager (David Lunney) has overall responsibility for all aspects of the project's performance and delivery. As such he will :-

- ensure through the Science Team that the instrument delivers maximum science capabilities
- ensure that the engineering solutions meet, as a minimum, the specified requirements
- provide overall coordination and management of the management activities to ensure timely delivery within the approved budget. This will include a top-level budget controlling allocations of base-budget, working allowances and contingency, and a top-level schedule
- act as first point of contact with the customer and oversight bodies
- set priorities and resolve conflicts within the project
- own the Project's top 10 risks, regularly monitor all high risks and have overall responsibility for all management risks

5.2.3 Principal Investigator

The Principal Investigator (Hugh Jones) is responsible to the Project Manager for defining the top-level science requirements and ensuring that the instrument delivers its scientific aims. As such the Principal Investigator will:-

- continuously review and maintain the Science Case and top-level requirements
- lead the PRVS Science Team(s) and interface to the relevant Gemini and UK Science Committees
- represent the Project at appropriate conferences etc
- maintain an overview of the Instrument Design and potential opportunities for, risks to Science
- lead preparation of a Science Verification Programme for post Engineering Commissioning
- prepare a Science Implementation plan for any surveys etc post commissioning

5.2.4 Instrument Scientist

The Instrument Scientist (John Rayner) is responsible for ensuring that the instrument design meets the science requirements. As such the Instrument Scientist will :-

- continuously review and maintain the OCDD including the flowdown of science requirements to the FPRD and the preparation of operational scenarios
- maintain close links to ongoing engineering activities, especially Pipeline, to ensure compatibility with the Science aims and requirements
- advise on potential risks to the Science capability of the instrument
- verify the scientific performance of the instrument by preparing and executing Verification Plans for lab AIV and initial telescope performance testing
- lead the preparation and maintenance of appropriate instrument performance models and simulations
- preparation of user manuals

5.2.5 Systems Engineer

The Systems Engineer (Phil Rees) will ensure that the team follows sound systems engineering principles. He will therefore :-

- Continuously review and maintain an FPRD which captures all the technical requirements from the OCDD and Gemini documents
- Agree on a system architecture and ensure that all interfaces are defined and documented
- ensure that all technical budgets are created, allocated and maintained

- monitor the work of the consortium Workpackage Owners to ensure that standards and requirements are being met and that any deviations or non-conformances are identified and dealt with correctly
- in conjunction with the Instrument Scientist and Workpackage Owners, ensure that all trade-offs are managed in a pragmatic and sensible manner
- manage the verification of the functional performance of the instrument by the preparation and execution of Verification Plans for sub-system AIV, system level AIV in the lab, and initial telescope performance testing
- with the aid of the Instrument Scientist, agree an Acceptance Plan for the Instrument with the Customer and lead the Project's side of the Acceptance Test
- act as auditor on all risks impacting performance

5.2.6 Institute Workpackage Managers

Each Institute will appoint a Workpackage Manager who will be responsible for the delivery to time and cost of all work packages and activities based at their site. Their duties will therefore include :-

- day-to-day planning and execution of all activities at their site including negotiation for local resource with Site Management
- maintaining detailed schedules of current work packages at their site which will show local critical activities
- instituting and maintaining local budget management of effort and cash resources to at least level 2 of the WBS
- ensuring that local work package Owners are delivering on their activities and helping resolve local priorities
- providing regular reports to the Project Manager on programme issues, time and cost and collating technical reports for the Systems Engineer as required
- owning the local top 10 'High' risks

5.2.7 Work Package Owners

Each work package will be assigned an Owner who will be responsible for:-

- Ensuring that the particular work package meets its requirements
- On Engineering work packages this will include the agreement of ICD's, requirements and technical budgets, the agreement of a Verification Plan with the Systems Engineer, the execution of the Verification tests and the delivery of appropriate supporting documentation
- Identifying and owning/auditing risks associated with that work package
- Working with the local WP Manager to create and maintain detailed schedules for that workpackage
- Working with the local WP Manager to review resource and cost requirements

5.3 OTHER KEY ROLES

5.3.1 Lead Engineers

Lead Engineers will be appointed for each discipline. They will be responsible for ensuring the overall quality of all activities on the Project within their discipline. This will be a kind of matrix role. The nominated Lead Engineers are :-

Optical	David Henry
Software	Andy Vick
Electronic	Derek Ives
Mechanical	David Montgomery

5.3.2 Safety Officers

The Project Manager will have overall responsibility for the Health and Safety related activities required of the Project. This will include those driven by the design and the specific operational requirements of assembly and use. He will delegate local responsibility to one individual at each site, probably the Institute WP Manager. Those Individuals will be responsible for ensuring that local practices are followed.

5.3.3 Product Assurance

This is the process of ensuring that the given item meets its requirements. This will be for Workpackage Owners and the Systems Engineer to agree within Verification plans. It may require the help of Lead Engineers.

5.3.4 Quality Assurance

This is the process that ensures that appropriate procedures and processes are in place for local activities. Some assessment of compatibility between UK ATC and other consortium members procedures will be required early in the project to see if local methods can be followed or whether project specific methods are needed. This analysis will be handled by Lead Engineers working with the local QA representatives.

6. PRODUCT BREAKDOWN STRUCTURE

In collaboration with the Lead Engineers, the Systems Engineer has created a Systems Architecture by partitioning the instrument into subsystems for which clear interfaces and requirements can be defined and verified. The main systems at level 1 are :-

1) Instrument control sub-system

2) Data pipeline sub-system

3) Infrastructure sub-system (electrical support and power, vacuum, thermal, mechanical support)

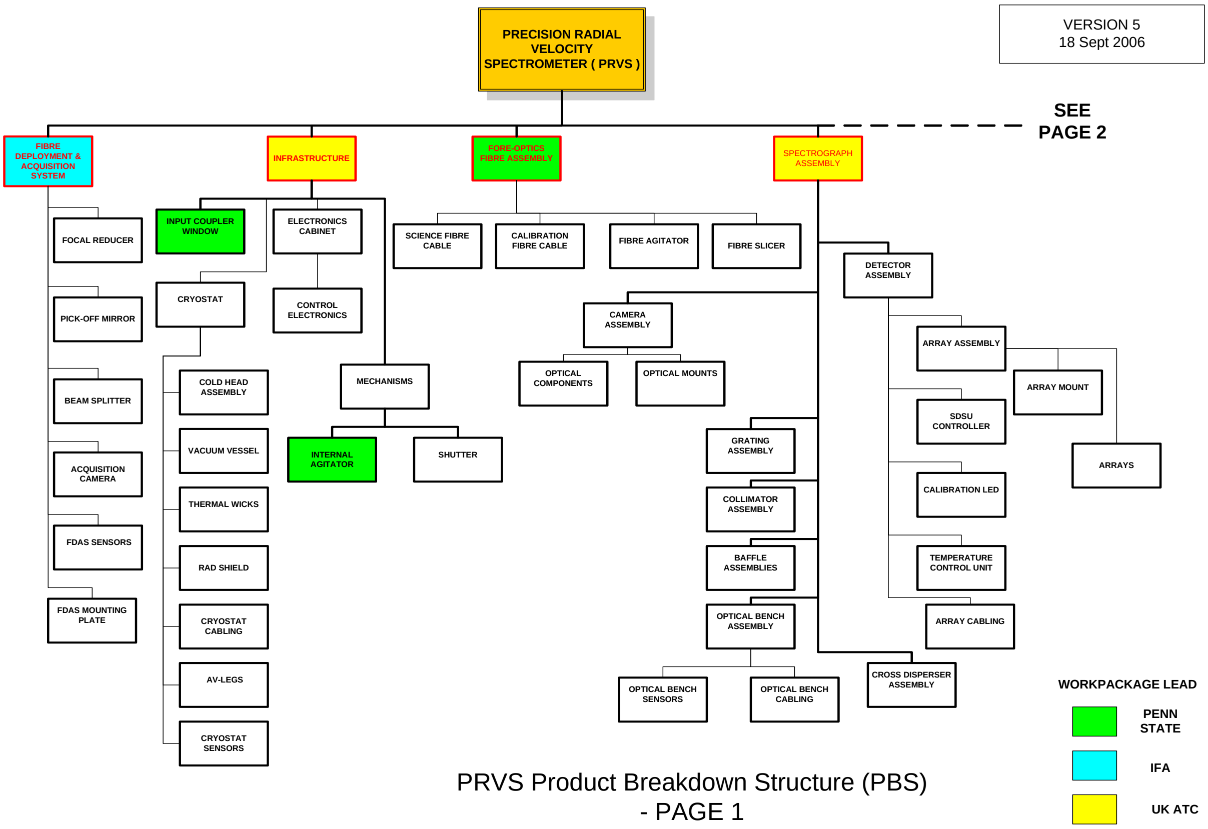
4) Fibre Deployment and Acquisition Unit

5) Fore-optics Fibre Assembly

6) Calibration Unit

7) Spectrograph sub-system

and their function, interfaces etc have been described comprehensively elsewhere in the Study Report Documentation. However the full Product Breakdown Structure is repeated here (along with the collaboration workshare) as it is a key basic ingredient of the Work Breakdown Structure (WBS):-



PRVS Product Breakdown Structure (PBS) - PAGE 1

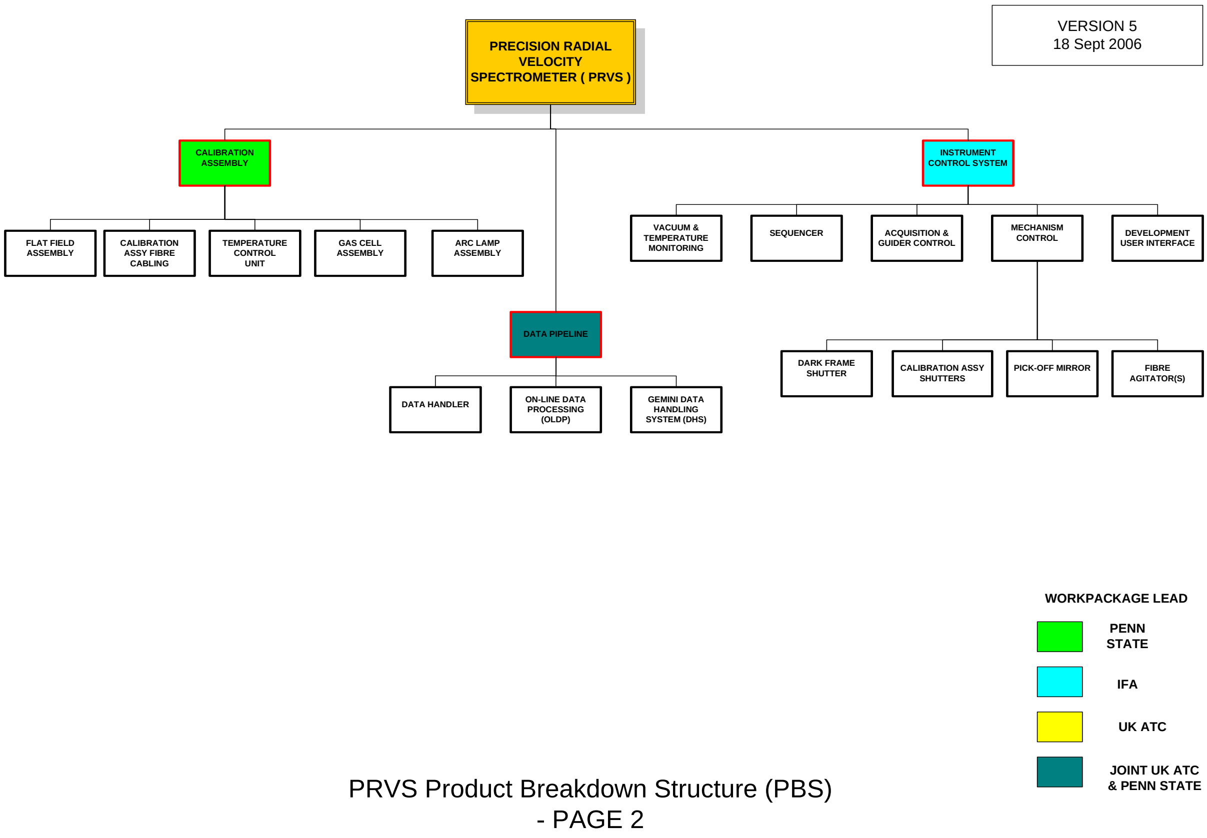


Figure 2 System Product Breakdown Structure and Workshares

7. WORK BREAKDOWN STRUCTURE (WBS)

Whatever the technical challenges to the Project, the Management Team need to control the time and cost aspects but they can only do that if the information they have has been organised in a way that aids decision making. Those decisions are likely to be of the form:-

- Scope – given the nature of the funding we need to have clearly identified options for descopes, upscopes and the implications thereof
- Cost – Are we on track , what is our earned value, can we easily modify cost-to-go without altering structure, allocation of working margin and contingency
- Schedule – a good WBS will form the basis of a simple means of controlling the project through sub-schedules and will make for clear critical path analysis
- Resourcing – do we have enough of the right people at the right times or do can we identify less critical elements of work to delay
- Risk – what specific areas are causing concern and need particular attention

The key to that whole process is the WBS which is derived primarily from knowledge of the deliverables, the system architecture and the key decision points and milestones on a project. The deliverables should be assigned as outputs of specific elements of the WBS. The WBS should reflect the system architecture as closely as possible: if the architecture has identified distinct verifiable sub-systems, then the WBS element will have distinct measurable completion points, which will make the identification of progress easier. In addition earned value analysis will be practical and accurate.

The deliverables requested in the draft Statement of Work are :-

- Kick-off Meeting
- Design Documentation including
  - Preliminary Design Review
  - Final Design Review
- The Instrument Hardware including
  - Special Handling and Test equipment
  - Agreed spares
- Software including
  - Instrument Control
  - Data Pipeline
- Engineering Commissioning at the Telescope Site (i.e. excluding Science Verification)
- Operation and Maintenance Manuals
- Safety Documentation

The System Architecture has already been described above and the final stage is to establish suitable milestones or decision points. Those should be:-

- Systems Architecture Review – where, should we be successful, we finalise the system architecture after the feedback from the Study Review process has been analysed and any necessary additional layout work has been done
- Preliminary Design Review – an Instrument-wide review at which point the optical design will be very well advanced and many major design choices such as Array Control methodology can be frozen or prototyping reports can be discussed. This is likely to be the last point for major decisions on functional scope.
- Level 1 System FDRs – we are likely to press for individual FDRs for each of the level 1 systems rather than a global FDR. This process will allow us to prioritise resourcing of those elements likely to affect the critical path and give flexibility. These reviews would include a Systems Level FDR to ensure all top-level issues are captured
- Typical subsystems would then proceed through a cycle of "Manufacturing Readiness Reviews" before build or coding began. Each subsystem's integration would end with a mini-acceptance review before the level 1 system had its own period of Integration and Acceptance Review. These additional reviews would be used to measure progress through the otherwise long gap between FDR and AIV starting
- Only then would the Integration and Verification phases of the Instrument as a whole begin. In this phase mini-milestones can be created against the achievement of particular technical requirements
- Acceptance Review at the end of AIV
- Commissioning – divided into lab assembly and test and on-sky testing of performance
- End date of Project. The draft Gemini contract for the build phase defines the end as when the Instrument is ready for Science Verification

Given all the above elements we have chosen a WBS based on a combination of project phasing and system architecture. The five phases are:-

- **B** Preliminary Design, leading to PDR
- **C** Detailed Design, leading to System 1 level FDRs
- **D** Sub-System Build and Test, leading to fully proven sub-systems
- **E** Instrument Integration and Verification leading to customer acceptance
- **F** Commissioning leading to Instrument being "science ready".

Three additional "activities" are added to cover the essentially all encompassing roles of

- **SE** Systems Engineering
- **SC** Project Science
- **PM** Project Management

In practice it was found necessary to divide the largest element of Sub-system Build and Test into five elements **D1** to **D7**, one for each of the Level 1 Systems of the System Architecture as shown below.

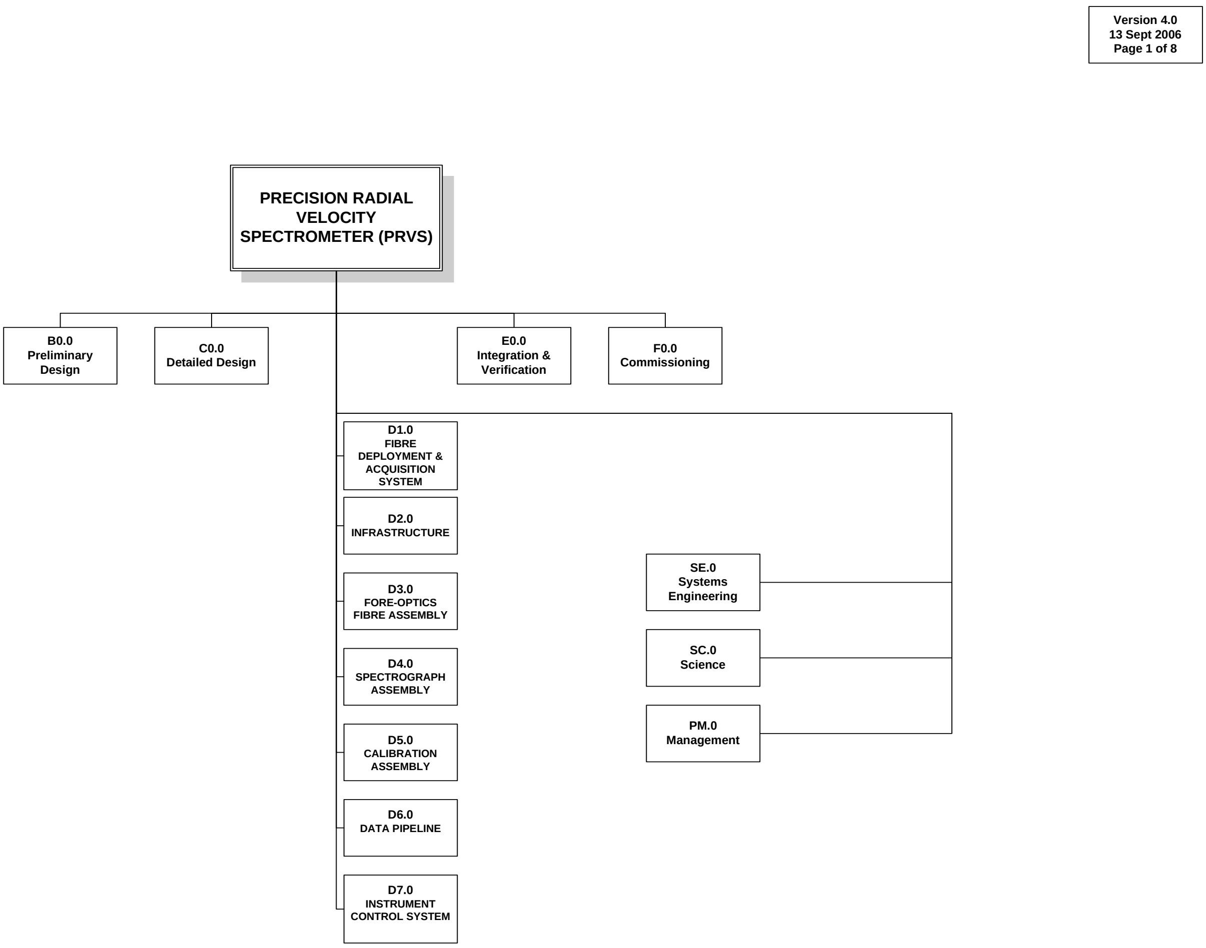


Figure 3 WBS to Level 1

Full details of the WBS are given in the pricing documentation though a sample top-level work package description is shown here.

Work Package Description

		Issue:	1				
Project:	PRVS	**Date:**	01 September 2006				
WP Title:	INSTRUMENT	**WP Ref No:**	0	0	0		
WP Start Event:	PROJECT START						
WP End Event:	READY FOR SCIENCE VERIFICATION						
WP Owner:	DAVID LUNNEY	**Organisation Responsible:**	UK ATC				

Aims of WP:	
1	Gather full Requirements and review design Options
2	Design Instrument meeting requirements and review
3	Build Instrument and verify performance at home Institute
4	Deliver to telescope and Confirm performance on Sky
5	Provide documentation as required

Inputs to WP:	
1	Proposal
2	Science Case
3	
4	
5	
6	

WP Tasks:		**Duration**	**Effort (weeks)**			**Material**		
		(Cal Weeks	**Total**	**ATC**	**PSU/IFA**	**Total**	**£k**	**$k**
B0	PRELIMINARY DESIGN	0	310.8	146	164.8	24.65458	0	46.93
C0	DETAILED DESIGN PHASE	0	223.3	124	99.3	485.6765	50.163	829
D0	SUB-ASSEMBLY AIV	0	218.4	115	103.4	625.4879	353.2	518.3
E0	INTEGRATION & VERIFICATION	0	207.8	165	42.8	0	0	0
F0	COMMISSIONING	0	112	92	20	98.9	98.9	0
SE	SYTEMS ENGINEERING	0	76	76	0	0	0	0
SC	SCIENCE	0	136	94	42	81.52088	50	60
PM	PROJECT MANAGEMENT	0	177.8	160	17.8	82.02088	50.5	60
	WP Sub-Totals:		**1462.1**	**972**	**490.1**	**1398.261**	**602.763**	**1514.23**
	Working Allowance		145	97	48	148.3327	64.96	158.7
	Total Inc. Working Allowance		1607.1	1069	538.1	1546.594	667.723	1672.93
	Contingency		156	106	50	145.3383	64.96	153
	Total inc. allowance & contingency		1763.1	1175	588.1	1691.932	732.683	1825.93

Outputs of WP:	
1	Fully Operational System
2	Acceptance Test reports
3	Final System Budgets
4	Final Versions of Design, User and Maintenance Manuals
5	Special Test, assembly and Handling equipment
6	Spares as agreed (cost will be covered via separate contract)

Figure 4 Sample Level 1 Workpackage Description

8. PROJECT SCHEDULE

PRVS has added complexity due to the consortium nature of the project. It is the responsibility of the Project Manager to create a top-level Project Schedule and ensure that it is kept up to date. That process has to include an understanding of how potential risks and opportunities might affect the schedule.

Institute WP Managers will be responsible for reporting progress locally against detailed schedules for each workpackage. They will also be expected to understand their plans sufficiently to model various potential impacts and improvements and in particular, the effects of resource constraints at their location. Clearly the Institute WP Managers will require significant support in this area from the local workpackage owners.

The project schedules will be maintained using Microsoft Project. This allows a clear view of the critical path and the effects of change. The regular project management meetings will ensure that all schedules are maintained and co-ordinated. In addition these meetings will discuss the risk to the schedules and any planning or resourcing changes that should be affected to reduce risk on the project.

8.1 DEVELOPING THE SCHEDULE

The first stage of the process is for the WP Managers to collate experience from previous similar projects to develop an outline schedule. In this case we have collated information on not just UK ATC and other consortium members projects but also data collected for the Gemini Lessons learned workshops on the average duration of 8m class instruments projects. However because these were generally much more complicated instruments, we have tailored the information gleaned to suit PRVS, resulting in an outline target schedule of 34 months, which also takes account of expected improvements in AIV performance with better systems engineering methodologies. We expect the risk analysis to indicate some additional contingency time should be kept in reserve. The initial sub-division of the 34 months was again based on actual data from past projects and is shown schematically here to also reflect the phased nature of the WBS and the possibility of phasing the subsystem FDRs. Although not shown in the diagram, we recognise the need to release long lead items mid-way through PDR so that we can adhere to a rapid completion and early science delivery.

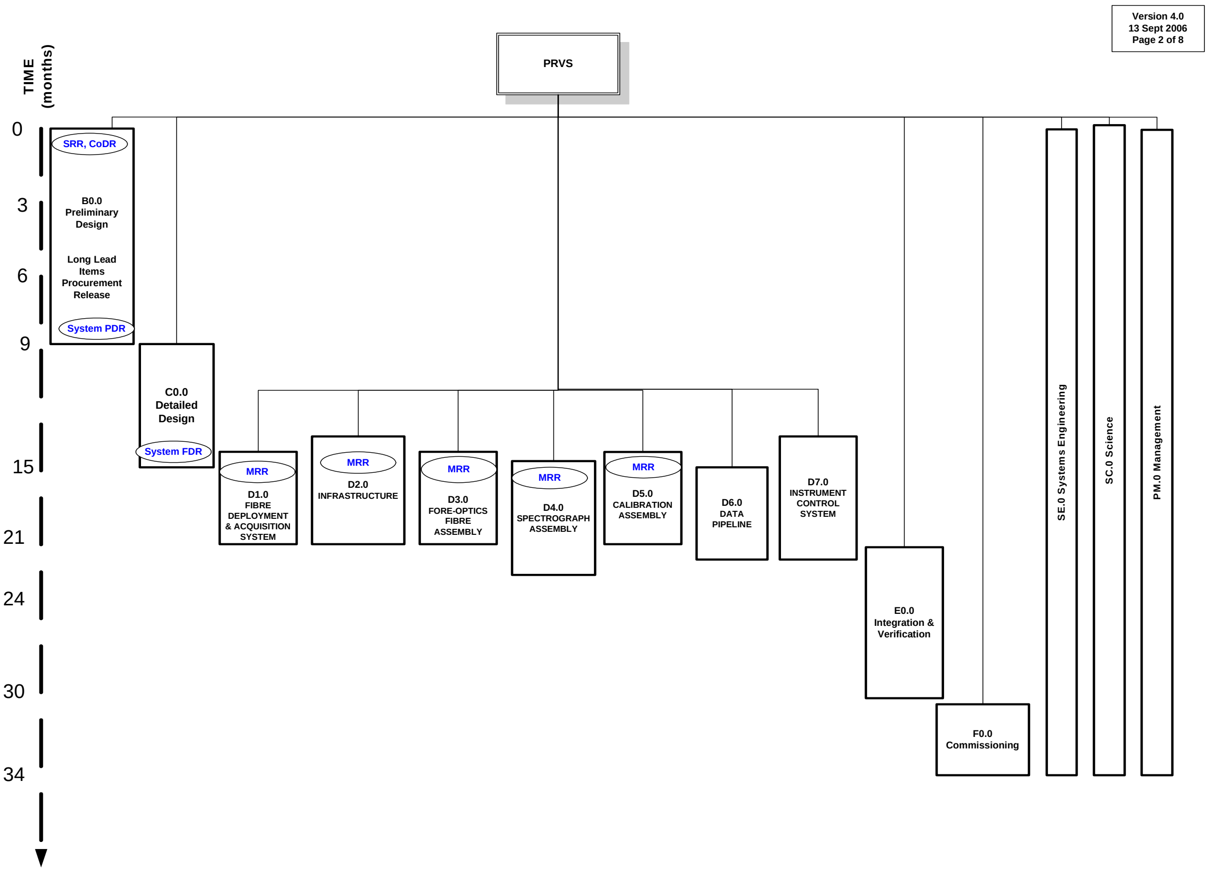


Figure 5 Schematic of Level 1 WBS and Time

8.2 INITIAL PROJECT SCHEDULE AND KEY MILESTONES

The initial project schedule is assumed to be as above. The Gantt chart showing these milestones is available in the Appendices.

Milestone	Month	Comment
Kick-off	0	
Detector choice review and procurement release	3	
Release of long lead optical components	6	
PDR	9	
FDR	15	
Phase 1 AIV– Sub systems	19	
Phase 2 AIV - Instrument	21	
Commissioning Start	31	

8.3 MANAGING PROGRESS ACROSS THE CONSORTIUM

As noted above the Project Manager will hold a master schedule for the consortium. The master schedule as shown has tasks for all WBS items to level 3. Institute WP Managers will hold detailed schedules for workpackages at their locations. They will start at level 2 and plan tasks down to the equivalent of level 3 depending on the detail available at present. An example of this might be as follows:-

Master Schedule

WBS	Task	Dur'n	Start	Finish	
C.1.3	Detailed design of Beam Splitter	6w	27 Sep '07	06 Nov '07	This is the Detailed Design Phase

The Detailed Schedule might have tasks as below but which have a clear overall start and finish matched to the task in the master schedule. Thus, as long as the master schedule gives the equivalent task a start and duration to match the latest detailed plan, the master schedule will have a true reflection of the critical path.

ID	WBS	Task Name	Duration	Start	Finish
98	**B.0**	**PHASE B.0 - CoDR TO PDR**	**36 wks**	**01 Feb '07**	**25 Sep '07**
99	**B.1**	**FIBRE DEPLOYMENT & ACQUISITION SYSTEM**	**28 wks**	**01 Feb '07**	**03 Aug '07**
100	B.1.1	OPTICAL ANALYSIS	12 wks	01 Feb '07	20 Apr '07
101	B.1.2	MECHANICAL LAYOUT	20 wks	01 Feb '07	12 Jun '07
102	B.1.3	CONTROL ARCHITECTURE	16 wks	01 Feb '07	16 May '07
103	**B.8**	PDR PREPARATION (I.E DOCS & PRESENTATIONS)	8 wks	12 Jun '07	03 Aug '07
104	**B.2**	**INFRASTRUCTURE**	**34 wks**	**01 Feb '07**	**12 Sep '07**
105	B.2.1	OPTICAL ANALYSIS	8 wks	01 Feb '07	26 Mar '07
106	B.2.2	MECHANICAL LAYOUT	26 wks	01 Feb '07	20 Jul '07
107	B.2.3	HANDLING EQUIPMENT & TEST EQUIPMENT PLANS	16 wks	01 Feb '07	16 May '07
108	**B.8**	PDR PREPARATION (I.E DOCS & PRESENTATIONS)	8 wks	20 Jul '07	12 Sep '07
109	**B.3**	**FORE-OPTICS ASSEMBLY**	**24 wks**	**01 Feb '07**	**09 Jul '07**
110	B.3.1	OPTICAL ANALYSIS	16 wks	01 Feb '07	16 May '07
111	B.3.2	MECHANICAL LAYOUT	12 wks	01 Feb '07	20 Apr '07
112	B.3.3	CONTROL ARCHITECTURE	8 wks	01 Feb '07	26 Mar '07
113	**B.8**	PDR PREPARATION (I.E DOCS & PRESENTATIONS)	8 wks	17 May '07	09 Jul '07
114	**B.4**	**SPECTROGRAPH**	**36 wks**	**01 Feb '07**	**25 Sep '07**
115	B.4.1	OPTICAL ANALYSIS	28 wks	01 Feb '07	03 Aug '07
116	B.4.2	MECHANICAL LAYOUT	24 wks	01 Feb '07	09 Jul '07
117	B.4.3	CONTROL ARCHITECTURE	16 wks	01 Feb '07	16 May '07
118	B.4.4	DETECTOR ARCHITECTURE	12 wks	01 Feb '07	20 Apr '07
119	**B.8**	PDR PREPARATION (I.E DOCS & PRESENTATIONS)	8 wks	03 Aug '07	25 Sep '07
120	**B.5**	**CALIBRATION ASSEMBLY**	**28 wks**	**01 Feb '07**	**03 Aug '07**
121	B.5.1	OPTICAL ANALYSIS	12 wks	01 Feb '07	20 Apr '07
122	B.5.2	MECHANICAL LAYOUT	20 wks	01 Feb '07	12 Jun '07
123	B.5.3	CONTROL ARCHITECTURE	16 wks	01 Feb '07	16 May '07
124	**B.8**	PDR PREPARATION (I.E DOCS & PRESENTATIONS)	8 wks	12 Jun '07	03 Aug '07
125	**B.6**	**DATA PIPELINE**	**28 wks**	**01 Feb '07**	**03 Aug '07**
126	B.6.1	INDENTIFY POSSIBLE TEST SOURCES	8 wks	01 Feb '07	26 Mar '07
127	B.6.2	PRELIMINARY SIMULATIONS	12 wks	26 Mar '07	12 Jun '07
128	**B.8**	PDR PREPARATION (I.E DOCS & PRESENTATIONS)	8 wks	12 Jun '07	03 Aug '07
129	**B.7**	**INSTRUMENT CONTROL SYSTEM**	**34 wks**	**01 Feb '07**	**12 Sep '07**
130	B.7.1	UPDATE DESIGN STUDY ANALYSIS	8 wks	01 Feb '07	26 Mar '07
131	B.7.2	UPDATE SYSTEMS ARCHITECTURE	10 wks	26 Mar '07	30 May '07
132	B.7.3	PLAN DEVELOPMENT PROTOTYPING	8 wks	30 May '07	20 Jul '07
133	B.8	PDR PREPARATION (I.E DOCS & PRESENTATIONS)	8 wks	20 Jul '07	12 Sep '07

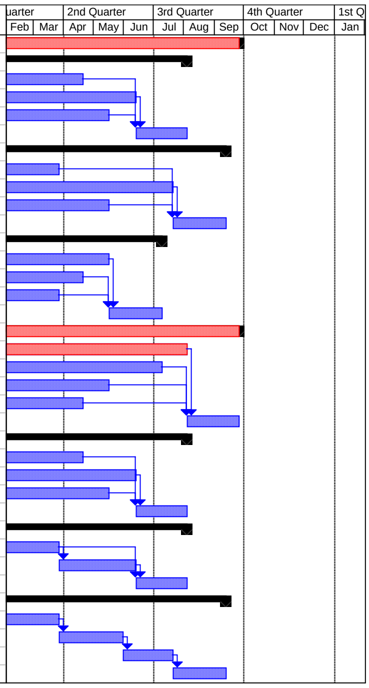


Figure 6 Sample Detailed Project Plan

9. FINANCIAL MANAGEMENT

This is essentially a fixed price contract and will require close monitoring of spend on all activities. As discussed below, management of resources is covered by time recording and appropriate resource allocation systems at each site. These will allow the Institute WP Managers to closely monitor effort spend and the Project Manager's role will be to enforce regular and accurate earned value analysis to ensure that we are aware early on if a workpackage is overspending. This is the key area to concentrate on as it is generally easier to monitor the accuracy of actual cash spend on hardware elements against the initial estimates obtained during the bid preparation.

The Project has provided an estimate of a 'Contract Price' to Gemini which assigns a formulaic value to the 'Internal Contingency' to be held by the Consortium. However in preparing the estimate, the Project has also established their own estimate of working allowance (WA) and contingency for each element of the WBS. These will be used for an initial allocation of working allowance to each Insitutue and for the retention of a 'Project Contingency (PC)' to be allocated for the occurrence of unknowns per the terms of an MOU between the partners. The occurrence of 'AURA Assumed Risks' will result in a request for release of AURA Reserve funds which will then be allocated to the relevant partner(s). It is expected that as the project progresses, the management of the Project Contingency (and AURA Reserve) will become easier as we start turning unknowns into risks with probabilities and possible cost, schedule and specification impacts. This is described further in the Risk Management Plan.

The allocation of 'Internal Contingency' to Institute working allowance and Project Contingency will be at the recommendation of the Project Manager and approval of the Project Board (subject to the MOU processes) Requests for access to 'AURA Reserve' will be triggered by the occurrence of an 'AURA Assumed Risk', with the final approval of the agreed Contract change by the Project Board. As this is against specific well defined risks, it is expected that decisions are likely to be quite straightforward.

Institute WP Managers will be free to transfer money between the effort and requisition elements of a particular workpackage (for sub-contract design for example) as long as the overall budget is not exceeded. This 'virement' or transfer is normally only subject to local management approval unless it will result in a call for working allowance in which case the Project Manager will need to be informed.

9.1 COST ESTIMATE FROM THE STUDY

The pricing information document gives details of the total cost we estimate for PRVS and how this is broken up into the different work packages as effort and hardware.

9.2 DEALING WITH BASELINES AND UPDATES

Following an offer of the contract by Gemini, there will be a period of negotiation, not just between Gemini and the Consortium to tidy up some areas of the estimate but also both the UK ATC and the consortium partners will have to agree the MOU. This process might include some element of re-alignment of the workshares to suit both parties. Only at this point will it be possible to set a baseline that will be captured in a definitive release/update of the pricing information document.

Changes to baselines will be infrequent and will only be allowed for major changes in scope, workshare or design. Scope changes might occur if a high risk identified actually occurs and a back-up solution has to be evoked or Gemini invoked a design solution option through one of their contingency lines. A workshare change might be agreed if one or other Institutes had resource shortages or difficulties. Significant changes to design are only likely to occur in the PDR or early FDR phases and would arise to overcome some technical difficulty. Such baseline updates would, with the exception of the scope changes, be discussed within the consortium team prior to approval by the Project Board.

9.3 WORKING ALLOWANCE AND CONTINGENCY

Working allowance has been included in all the workpackages to cover situations where some known potential problems arise. It is to be hoped that with good estimating it will not all be required all the time but it should be enough that at least 3 out of every 4 workpackages can be completed within the baseline plus working allowance. The working allowances for the Project will held by the Project Manager and he will keep an account of the total working allowance available to each of the Institutes. Institute WP Managers may request release of working allowance for specific workpackages which the Project Board will approve on the recommendation of the Project Manager. There should be plenty of warning of a need to release working allowance with proper earned value processes in place on each workpackage.

It is to be hoped that, given proper estimating, each Institute will not use all the working allowance on every workpackage. Any unused allowance at the end of a workpackage will continue to be held in credit for that Institute's use at a later date if it is necessary. The Project Manager will therefore maintain a balance sheet for each Institute showing their record against baseline costs and their current net balance of working margin.

Spend in excess of the working allowance on a particular workpackage will either mean a transfer of allowance from other workpackages, a request for release of Project Contingency or the absorption of the additional cost by the relevant Institute. Release of contingency would require the approval of the Project Board. This is unlikely to be given if the Institute has a healthy "working allowance balance".

Note that increased costs because of viring effort for cash will not necessarily be seen as justification for release of working allowance unless this was agreed with the Project Manager to avoid schedule delay on a critical path item.

The release of AURA reserve to the project will almost certainly result in a direct increase in the overall allocation for a specific workpackage/Institute.

9.4 INCOME ATTRIBUTION

Assuming Gemini will pay the UK ATC on a milestone basis and that this will be approximately cash neutral for the project, the UK ATC will distribute the income in a ratio based on actual spend in the period since the last payment. An account will be kept at each Institute of their net cash position on the project and updated at least every 3 months for the Project Board review. We do not expect to need multiple currency conversions to allow this to happen, we will operate with the Gemini, PSU and the UH in US dollars.

9.5 VAT, DUTIES AND TAXES

The consortium is proceeding with the development of PRVS under the following assumptions on VAT, Duties and Tax :

- All purchases will be UK VAT exempt or UK VAT refundable;
- PRVS will be exempt from USA sales Tax;
- PRVS will be exempt from Import duty on delivery to the telescope site;
- Equipment transferred from PSU & IFA to UK ATC can be on temporary import so no duties will be paid ;

Should any of the above conditions not apply ; the additional costs will not be the responsibility of the consortium.

10. RESOURCE MANAGEMENT

This project is expected to require significant resource from limited pools of effort at both sites. It will therefore be important that the detailed planning at lower levels includes appropriate resource information so that local site management can plan for and provide what is needed. Sections 10.1 and 10.3 describe how that Institute level management is handled. Thereafter, as described in section 10.3, it is up to Institute WP Managers and Work package Owners to ensure the resources are used effectively.

10.1 UK ATC RESOURCE PLANNING PROCESS

The UK ATC has over 65 science and technical staff working on a large number of projects. Allocating those resources across the projects is a complex process for which we have developed a Management Information System (MIS) and associated procedures. For staff resources the MIS has two elements, a network accessible Time Recording system using "TimeSheet Professional" software. Each individual records time against project and subsystem codes so that at any point in time a project manager can assess the actual data charged by individual, by discipline or by WBS item. This ability will be essential in establishing earned value records as the project proceeds. Indeed those historic records have been very helpful in estimating future work as we now have typical spend profiles, discipline splits and FTE numbers for equivalent past activities.

The allocation of future resource is web accessible to all staff via the Effort Allocation System (EAS). This is managed by the Head of Strategic Development (HoSD – Ian Bryson). Project and Activity Managers submit requests for effort via a standard spreadsheet template. Those requests are discussed with Engineering Group Heads to ensure that the most suitable staff have been requested, that the totals and timescale are sensible and that overall budgets are not being exceeded. The HoSD adds the new or revised request to the EAS and reviews where individual clashes occur. These are then levelled by delaying or rescheduling activities in discussion with appropriate Group Heads and Managers.

Major updates occur on about a 2 monthly cycle or whenever a project goes through a major revamp or review. However, the MIS also provides the process by which managers complete their monthly outturns. As part of that process they view TimeSheet 'actuals' data and upcoming EAS data and may feel the need to signal the need for adjustments to their future allocation within the EAS. Those requests are, where significant, acted upon immediately by the HoSD.

This process is essential in ensuring that the UK ATC is able to escape the over-commitment of resources that is a distinct threat to any organisation managing a n umber of complex, time-critical projects. Nevertheless, even this process will fail if there is no slack in the system to allow for the inevitable technical problems, illness etc. Thus, for several years the UK ATC has been allowed to operate with a PPARC underwritten "effort buffer". In this way the HoSD can allocate non time-critical 'buffer work' to key staff so that they are available to step in to solve problems and hence minimise delays on the time-critical projects, such as PRVS. The additional unplanned effort afforded the project is paid for by the relevant budgets working margin or, in the worst case scenario, contingency. The 'buffer' projects are typically internal UK ATC workpackages aimed at improving procedures, furthering the technical ability, or exploring different technical options of the work of the UK ATC.

Where necessary, the UK ATC has a pool of sub-contract engineering and manufacturing facilities that can be called upon to help with peaks at specific times.

10.2 IFA RESOURCE PLANNING PROCESS

Work to be performed at the IFA is undertaken by faculty as well as engineering and technical staff members. Most, but not all, of the engineering and technical staff are part of the Job Order System (JOS). The JOS is a job matrix system that allows engineers and technical staff to work on multiple projects.

Each project has a job number with fixed number of hours for each job that is determined by the project manager or principal investigator. Bi-weekly timesheets are turned in and the hours are logged into a database.

Due to the complexity of the workforce at the IFA, namely some are in the JOS, some working for UH directly, and some working for the Research Corporation of Hawaii, the IFA will implement a tracking system for work hours expended on the PRVS project. Data will be collected from the JOS and individuals on a bi-weekly basis by a staff member assigned to the PRVS project. This data will be summarized for the IFA WP Manager to ensure that the hours spent on the various workpackages are in-line with the proposed budget and schedule. He will be able to cross-check these reports against the progress reports he gets from staff at his weekly project meetings.

The allocation of future resources across the IFA projects is handled by the Instrumentation Division Associate Director. He is responsible for making manpower projections, allocation of resources, and for providing oversight on the IFA workshops. Since PRVS is a large project, most of the staff working on PRVS will be working full-time solely on PRVS. Some additional short-term help can be obtained as needed through requests made to the Associate Director for Instrumentation directly or at the regular 'Instrument Advisory Committee' meetings that he chairs. The Institute WP Manager will attend those meetings.

10.3 IFA RESOURCE PLANNING PROCESS

PSU Accountability - All grants and contracts at the Pennsylvania State University are managed in accordance with US Government accounting and auditing rules as well as the conditions of the particular grant or contract. For grants and contracts within the Department of Astronomy & Astrophysics oversight is conducted by the Eberly College of Science (ECoS) research office. The ECoS office assures that procurement and accounting rules are followed at the top level. In practice for the PRVS project the detailed reporting and accounting will be done at the department level using university wide Financial Information Tools (FIT) software. The FIT package will implement cost centers for each major Work Breakdown Structure (WBS) element for which PRVS project management wants detailed accounting. Each such cost center will break out salary, wages, supplies, equipment, communications, etc as appropriate. In addition a record of each and every charge to the grant or contract associated with the cost centers is available. While the FIT reports are a Penn State package they are easily downloaded into spreadsheets for integration with other information. To allow cost tracking by PRVS project management, reports will be generated (monthly??) and sent electronically in a spreadsheet workbook format. There will be a worksheet for each WBS element and that will consist of the breakdown of cumulative expenditures in salary, wages, supplies, etc (as well as a cumulative detailed listing of each expenditure if desired). The ECoS research office requires each grant or contract have the level of effort be verified for each person who draws salary or wages from that grant or contract. This is required annually and must be signed by the PI and an administrative official. This does not entail a formal weekly or monthly time charging system. However, the department has an auditable system for time accounting down to an hourly basis for technical and computer support personnel as their salaries are distributed across many research grants and contracts. This system will be adapted for use on the PRVS project were appropriate.

10.4 WITHIN THE PROJECT

Institute WP Managers (IWPM) will handle the local requests for and allocation of available staff to workpackages. An important part of that process will be advising staff of and agreeing the expected timescales and costs for each element of work as it starts, not as it finishes. Those allocations will be prioritised to minimise risk to the Project. Should the allocated staff actually be unavailable or inadequate and schedule slack is not available to cope with the shortage, the first ports of call for the IWPM will be local line management who will be expected to either re-allocate staff from other projects, initiate a local sub-contract or request support from the partner Institute.

The IWPMs will be expected to discuss progress and costs regularly with Workpackage Owners to ensure that effort limits are not being exceeded or to identify when working allowance may need to be released. The Project Manager will require regular (≤3 monthly) detailed reports of earned value on all current workpackages. This will be a measure of actual + forecast effort against budget allocation based on the original and latest durations.

11. CONFIGURATION MANAGEMENT (COVERS DOCUMENTATION)

The UK ATC have recently strengthened the overall site-wide procedures for Configuration management on projects and consortia (this includes how documents are managed). The data items we will be managing are not just the deliverable documents for customer reviews etc., but also all the critical internal items such as sub-system specifications, ICDs, drawings, verification plans and acceptance reports, safety plans etc. Project communications, meeting reports, actions databases and cost records will also be tracked. The UK ATC will act as a central repository and so will be the reference source for PSU, IFA & UoH documents.

This is all described in more detail in the Configuration Management Plan [AD03].

12. SYSTEMS ENGINEERING MANAGEMENT

The systems engineering processes that will apply to PRVS are described in a separate document, the Systems Design Document. This document describes the process of requirements capture, system partition, sub-system specification, including ICDs and then the process of verification planning and verification testing from sub-systems to system level. The document includes details of how we currently envisage the integration and verification of the instrument being done. Applying systems engineering properly may appear to slow the project up at the start but as we have learned through recent complex ground- and space-based projects, the clear benefits will be reaped in the final Integration and Verification, when we can truly test the instrument functionality and performance and not whether sub-systems are working. The Systems Engineer is therefore a key member of the Management Team and will be part of the Project Board.

Through the whole systems engineering process the Systems Engineer will essentially also be responsible for the product assurance planning for the instrument. In that role he will manage the PRVS fault log, which will be based on the web accessible system in place at the UK ATC. This already has data from past projects such as Michelle, UIST and WFCAM and will have current data from JWST MIRI and KMOS as they proceed. This is a very useful database for ensuring we do not repeat previous mistakes.

13. RISK MANAGEMENT

Managing the risk of the project is another key area. Risk management is now well embedded into the UK ATC as reflected in the Risk Management Plan and risk register provided with this study. We have found this to a particularly useful tool at quantifying the impact and therefore directing the appropriate response to critical areas. It can also be used as a tool for estimating the potential exposure of working allowance and Project Contingency for the known risks on a project and how that exposure will reduce as key milestones pass. However, at this very early stage such planning is a little meaningless as many risks are yet to be identified. As shown below, the period from CoDR to CDR is a phase of understanding the risks and hence producing new risks faster than the existing risks can be retired. Indeed the number of risks only start to fall as systems are being made or tested.

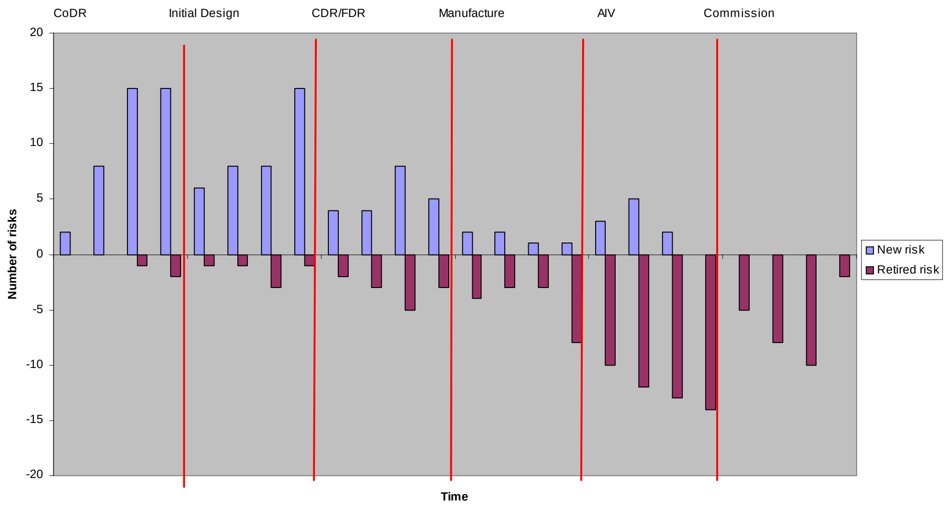


Figure 7 Identification and retiral of risks during a project (New risks above line, retired below)

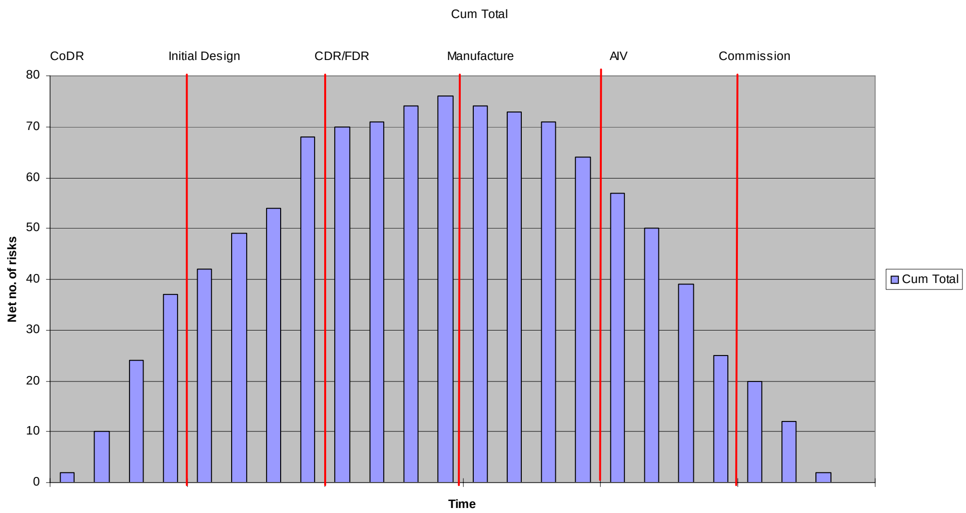


Figure 8 Net result on Cumulative Project risk count

If the risks come with a cost then in fact what one is doing through this process is reducing uncertainty but increasing our understanding of potential pitfalls that may require access to the working allowance and Project Contingency.. This is one of the key reasons that, in asking for fixed prices at such an early stage of these technically challenging projects, has from our direct experience and the experience of many other instrument contracts, resulted in due prudence in the cost estimation and a clear mandate not to under-estimate the overall cost. To knowingly undertake such a process in an attempt to win the contract on a lowest bidder scenario is utterly worthless to the Gemini Observatory, the instrument builders and the community of astronomers who need the best instrumentation that Gemini can afford and in a timescale commensurate with the scientific needs and opportunities.

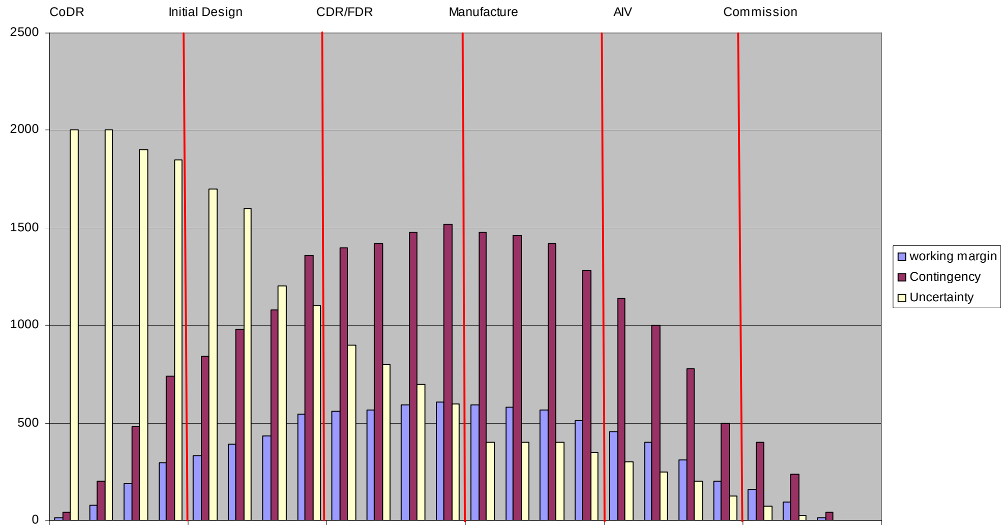


Figure 9 Showing the conversion of uncertainty to known risks

14. COMMUNICATION MANAGEMENT

14.1 PROJECT COMMUNICATIONS

The PRVS programme is to be constrained by a fixed budget and a challenging schedule that could cause loss of the consortium's guaranteed observing time if it is exceeded. Added to that the project requirements are technically very challenging. If the project is to succeed it will need an efficient management structure with clearly defined responsibilities and communication channels. The biggest area of concern will be the technical communication of issues where strict control and understanding of requirements and ICDs will be required. This can be simplified by using the System Architecture to define interfaces clearly as described in the Systems Engineering Plan so that there is the minimal chance of error. However, such interfaces take time to agree initially and a lot of effective communication will be required up to PDR in particular and probably thereafter to FDR. That will not be easy given the time differences between the four sites and so regular visits and telecons/videocons will be needed to overcome the potential pitfalls of emails and paper. This will require a significant travel budget but is justified by the potential dangers avoided. We certainly found during the study that the creation of a Project Office at the UK ATC and the co-location of the Instrument Scientist for long period stays were immensely productive.

14.2 COMMON TOOLS

In order to facilitate sharing of information, designs and models the Consortium members will use common tools such as Zemax for optics design, STEP for 3D drawing files, IDEAS for FEM, etc. Project Management information and tools will use MS Office tools. Documents will be written in MS-Word, but also distributed and stored in PDF format. Written communication will be by email, ftp, Web Pages, fax, etc.

14.3 COMMUNICATION WITH AURA/GEMINI

The Project Manager will be the formal point of contact to the nominated Gemini individual. His particular responsibility will be for issues relating to the contract, schedule and cost. He will, however, delegate responsibility for communication on technical or science issues to the Principal Investigator, Instrument Scientist and Systems Engineer. Informal contact between other Workpackage owners/Lead Engineers and appropriate Gemini personnel will be allowed but any changes to or waivers against the specification and ICDs will only be formalised once agreed through an appropriate formal process. That formal process will require the creation of a change note process at the time of Project start.

The Project will provide a regular progress report to Gemini, which will represent a collation of an appropriate subset of the Institute Monthly reports detailed below.

A more detailed report will be produced on a quarterly basis or at appropriate times to coincide with meetings of the Project Board.

14.4 MEETINGS & TELECONS

The project will have the normal range of local and collaboration wide meetings on a schedule that will vary according to the phase of the project. For instance, while management progress meetings and oversight meetings will be on a regular schedule, technical meetings will be a lot more regular in the early design phases but more problem oriented or 'review' oriented at later stages.

All formal meetings will be minuted.

14.5 AD-HOC INTERNAL CONSORTIUM MEETINGS

These meetings are 'event driven' and set-up as the need arises.

- Risk Review meetings when a risk with a significant probability / impact score is identified (see the PRVS Risk Management Plan)
- Health and Safety Review meetings in the advent of a significant health and safety incident.
- Design issues meetings – by telecon or video-conference or face-to-face meeting as appropriate
- Engineering Management meetings - to resolve major Non-Conformances
- Change Control Boards (to formalise changes to ICDs)

14.6 REPORTING

Each Institute Project Manager will compile a regular report containing the following information:

Overview

- Project Manager's Overview

Status

- Overall workpackage status, engineering status, PA status, manufacturing / AIV status

Critical issues

- Highlighting of critical issues, problems, potential problems and adverse trends, and proposed corrective and/or mitigating actions

Schedule and milestones

- Current Detailed Working Schedule
- Reporting against milestones

Financial and Manpower

- Cash flow in reporting period
- Manpower used in reporting period, cumulative manpower used.
- Earned value of each active workpackage

Risks, Actions and Configuration

- Risk assessment update (per the Risk management plan)
- Action Item List

- Documentation Status List

Planning

- Meetings Plan

Documentation Status List

The Systems Engineer will also organise some level of reporting on a technical level from workpackage owners to address interfacing or technical concerns and ensure that consortium wide issues are not overlooked.

APPENDIX A – DETAILS OF CONSORTIUM MEMBERS

A.1 UK ASTRONOMY TECHNOLOGY CENTRE

The UK Astronomy Technology Centre (UK ATC) is the UK's National centre for the design and production of world leading astronomical telescopes, instruments and systems. Our customers include both Space missions and the telescopes of the European Southern Observatory (Chile), the Gemini Observatory (Hawaii and Chile), the Isaac Newton Group of Telescopes (La Palma), the UK Infrared Telescope (Hawaii), the James Clerk Maxwell Telescope (Hawaii) and the upcoming ALMA telescopes (Chile).

The UK ATC exists "To support the mission and strategic aims of PPARC and to help keep the UK at the forefront of world astronomy by providing a UK focus for the design, production and promotion of state of the art astronomical technology". Such a mission statement requires the organization to be efficient and cost effective in the design and production of a range of instruments from fast track to facility class. We recognize that success is dependent not just on strong science lead but also on the quality of Systems Engineering and Project Management.

The UK ATC is thus a science driven professional engineering organisation employing some 88 staff with specialist expertise in:-

On the Science side:-

- infrared and sub-mm astronomy including observational and theoretical studies of circumstellar disks and star-formation
- development of scientific cases for large telescope instrumentation
- capture of scientific requirements
- commissioning of complex facility class instrumentation on large telescopes

And on the engineering side

- systems engineering and Project management
- infrared/sub-mm optical design and baffling,
- cryogenics and low-temperature engineering
- mechanism design and analysis,
- stiff structures with low vibration,
- software control systems, and real-time/pipeline data processing algorithms and software
- Detector Control systems and Detector Characterisation over optical to Far IR devices.

These staff are organized into a matrix management structure with the work organised into projects with well defined multi-disciplinary teams. We are well accustomed to working on projects with cash limited budgets which may vary from a year's effort to systems requiring 70+ staff years and $2M+ in requisitions. As the ever increasing size and complexity of our Projects has meant that many involve significant collaboration with other Institutes both within the UK and abroad, we have been expanding our Project Management and, in particular, our Systems Engineering experience to address the resultant challenges of communication, organization and risk management.

The project staff at the UK ATC are broken down as follows:-

Discipline	No.
Project Science	10
Project Management	9
Systems Engineering	4
Applied Optics	5
Mechanical Engineering	11
Software Engineering	10
Electronics Engineering	6
Workshop	6
Technology Development	4
Support (Procurement, Project Assist)	5

The direct project staff are underpinned by project assistants and business support services comprising finance, human-resources and information technology. The finance group includes procurement services and includes the Head of PPARC Procurement.

A.1.1 AIV Facilities

PPARC have recently completed the $7.25M construction of a new building at the UK ATC which, in addition to modern new flexible office space, also provides two large (11m * 7 m * 6m high) Integration labs plus a third test area equipped with a flexure rig capable of testing Instruments up to 10 ton in weight. The new Lab areas also include larger clean areas (8m * 5m) and a control room (to right in picture) for assembly of sub-systems and we are currently installing a large Class 100 clean-room for work on JWST MIRI. The existing lab spaces are being retained and already include a 2 ton Flexure rig, large test cryostat (cold area 1m square * 0.5m high) capable of operating down to 20K, and a small Class 1000 clean-room for detector assembly.

Figure 10 View of new AIV facilities showing 3 assembly bays and Flexure Rig (with SCUBA 2)

A.1.2 Projects Experience

The UK ATC (previously ROE) has been involved in many projects over the years. The sample list of projects below highlights expertise of relevance to this bid (Projects in *italics* were/are collaborations).

Recent Projects include:-

- *WFCAM, a near IR wide field camera for the UK Infrared Telescope*
- *Beam steering assembly for the SPIRE instrument on the FIRST space mission*
- *GMOS*, two optical spectrometers with MOS and long slit modes for both Gemini North and South Telescopes
- GPol and GCal, facility polarimetry and calibration units for Gemini North and South
- Michelle, a thermal (8-28μm) infrared Imager and Spectrometer for both UKIRT and Gemini
- UIST, near-infrared imaging spectrometer with IFU capability for UKIRT
- CGS4, near-infrared spectrometer for UKIRT
- *SCUBA*, a sub-mm camera for the JCMT

Current major projects include:

- *ACSIS, data reduction software for the JCMT*
- *MIRI, a mid-Infrared Instrument for the JWST which will replace the Hubble Telescope – we host the European PI, Instrument Scientist and systems team*
- *VISTA, a 4m wide field telescope and IR instrument for Chile (includes Data Pipeline contributions)*
- *SCUBA 2, a wide field sub millimetre camera for the JCMT*
- *ALMA, observation preparation and pipeline software*
- *KMOS, a near-infrared Multi-object IFU Spectrograph for the ESO VLT*

We also have major roles in various aspects of the EU funded Opticon project which includes work on SMART Focal Planes (devices that enable the efficient sampling of a telescope's focal plane) and are also bidding for work on Instrumentation studies for the Extremely Large Telescopes of the next decade.

A.1.3 PRVS Project Staff (UK ATC)

The following key staff are currently expected to work on the PRVS Project. Oversight by Engineering and Science Group Managers is seen as a key aspect in the delivery of a quality output.

UK ATC Project Manager	David Lunney
Instrument Scientist	Bill Dent
Electronic Design	Derek Ives
Optical Design	David Henry
Mechanical Design	David Montgomery
Systems Engineer	Phil Rees
Pipeline Lead	Andy Vick

Other support engineers will be allocated as required and following procedures indicated in the resources section.

A.2 INSTITUTE FOR ASTRONOMY, UNIVERSITY OF HAWAII CV

The Institute for Astronomy (IFA) is the astronomical research organization of the University of Hawaii (UH). Its headquarters is located in Honolulu on the island of Oahu near the UH-Manoa, the main UH campus. As an organized research institute within the university, the IFA is committed to research, teaching, and the development of astronomical instruments.

An Associate Director for Instrumentation manages instrumentation at the IFA. He provides overall management of engineering, technical, and machine shop resources within the three facilities of the IFA (Manoa, Maui, and Hilo). Engineers and technicians are either direct hire or work within the Job Order System. The latter allows the distribution of manpower as required by the various projects within the IFA. Within the machine shop, the shop manager coordinates the work in the machines of Manoa and Hilo. Instrumentation projects are managed directly by the Principal Investigators.

The IFA instrument scientists, engineers, and technicians have extensive experience in the design and fabrication of cryogenic infrared instruments. In addition the IFA have had for many years aggressive development programs for the development of optical CCDs and infrared arrays. One of the strongest areas for the IFA is access to state-of-the-art detectors and array controllers. A major project in progress is the construction of PAN-STARRS, an all-sky survey telescope. This project will incorporate the world's largest CDD array.

The total staff complement of the Institute is 201 people. Table 1 shows the distribution in terms of both function and location.

Table 1: Staff of the IFA

Type of Personnel	Manoa	Maui	Hilo
Ph.D	52	1	5
Graduate Students	30	0	1
Engineers	14	5	7
Technician	3	8	7
Machinists	5	0	1
Support Staff	40	3	18

The engineering and technical staff at the IFA are distributed as follows:

Discipline	No.
Principal Investigators	7
Project Managers	4
Mechanical Engineering	6
Software Engineering	4
Electronic Engineering	12
Machinists	6
Technicians	18

The total number of engineers, machinists, and technicians is 48. Of these about 20 are engaged in observatory support. The others are involved in instrumentation and PAN-STARRS development.

Facilities

The main facility at Manoa consists of a 51,000 sq. ft. building that includes offices, laboratories, classrooms, library, an auditorium, a large machine shop, and computer facilities. It is the primary facility for research and teaching, with a total of 52 Ph.D. astronomers (43 tenure or tenure-track astronomers) and 30 graduate students. Major telescope and instrumentation projects are also managed at the Manoa facility. Current major telescope projects include the management of the NASA Infrared Telescope Facility and the construction of the PAN-STARRS all-sky survey telescope.

On Haleakala (Maui), the IFA operates the Mees Solar Observatory and a satellite-ranging facility (for NASA). It also hosts the MAGNUM and Faulkes telescopes. The current base support facility for Maui operations is the Waiakoa Laboratory, located in Kula, a 45-minute drive from Haleakala. This facility comprises 3,000 sq. ft. of general office space, a small library, optical and electronics labs, and an auto shop. A new building for IFA-Maui is presently under construction.

The IFA-Hilo facility was completed in the fall of 2000. The 35,000 sq. ft. building provides an operations base for the IFA's activities on Mauna Kea, plus expansion space for our research, instrumentation, teaching, and outreach programs. At present, the building also houses UH-Hilo astronomers, the Office of Mauna Kea Management, and the offices of the Research Corporation of the Univ. of Hawaii. The machine shop and laboratory spaces were specifically designed to accommodate large instrument projects.

Instrumentation is developed primarily at Manoa and Hilo. Major shop facilities for electronics and machining exist at both sites. Recent projects include:

- SpeX, a moderate-resolution spectrograph for the IRTF.
- IRCS, a camera and echelle spectrograph for the Subaru telescope.
- NIRI, a camera for Gemini-North.
- OPTIC orthogonal transfer CCD camera at the UH 2.2-m telescope.
- AEOS spectrograph, an optical and infrared high resolution spectrograph.
- ULB camera, world's first 4Kx4K 1-2.5 micron camera on the UH 2.2-m telescope.
- Development of a 0.5-m off-axis telescope for solar corona research.

Current major projects include:

- 2Kx4K CCD and mosaic development headed by Gerry Luppino.
- 2Kx2K HgCdTe IR array and mosaic development headed by Don Hall.
- Development of giga-pixel CCD cameras for PAN-STARRS.
- Completion of Hokupa'a-85 adaptive optics system for Gemini-South.
- Completion of the IRTF's 36-element adaptive optics system.
- Completion of a wide-field optical imager for the UH 2.2-m telescope.
- Upgrading the IRTF's NSFCAM with a 2Kx2K Hawaii-2RG IR array.

PRVS Project Staff

The following key staff are expected to work on the PRVS instrument design :

Instrument scientist	John Rayner
Software design	Hubert Yamada
Mechanical design	Werner Stahlberger
Science team	Michael Lui, W. Vacca

A.3 DEPARTMENT OF ASTRONOMY & ASTROPHYSICS, PENN STATE UNIVERSITY CV

The Department of Astronomy & Astrophysics is a both a research and educational enterprise and is part of the Eberly College of Science at the Pennsylvania State University. In addition to a strong research program, our faculty teaches the largest number introductory astronomy non-science majors in the United States according to the 2003, 2004 & 2005 American Institute of Physics and we run a highly visible local outreach program. There are over 100 personnel in the department administrative area with the following breakdown:

- 17 tenured and tenure track faculty plus one instructor
- 2 Research Professors & 3 Senior Research Associates
- 4 Joint appointments with Physics (with budget in Physics)
- 4 Adjunct appointments at US and Foreign Institutions
- 21 Research Associates and Postdoctoral Associates including 4 working at Swift
- 31 Research & administrative staff including 16 working at Swift.
- 27 Graduate Students
- 25 Undergraduate Majors and 51 Pre-majors

Research programs in the department garner external research funding that has been averaging $5.6 million per year in the last half decade. Programs currently active in the department include:

- Instrument Development - (gamma ray, X-ray, ultraviolet, optical, infrared)
- Extrasolar Planetary Astronomy
- Multiwavelength Observational Studies
- High-energy Theoretical Studies
- Stellar Astrophysics & Star Formation
- Gravitational Astrophysics
- Active Galactic Nuclei
- Observational Cosmology
- Theoretical Cosmology
- Astro-Statistics

Penn State has a substantial experience in large collaborative projects. Penn State University, under the leadership of Professor John Nousek, is the PI institution of the Swift Swift gamma-ray burst mission X-ray telescope (Instrument PI: Professor David Burrows) and Ultraviolet and Optical Telescope (UVOT) (Instrument PI: Dr. Peter Roming). The Swift Mission Operations Center (MOC) is located in State College, PA; operated by the Pennsylvania State University on behalf of the Goddard-led Swift project. The MOC is responsible for safely operating Swift, and carrying out the program of discovery and follow-up of gamma-ray bursts (GRB). Ever since 80 minutes after the Swift launch (when the satellite separated from the last stage of the rocket), total responsibility for commanding, monitoring and downloading data fell on the MOC. The MOC is only the centerpiece of a complex web of support provided by the Goddard Space Flight Center (which processes the downloaded data the Swift Data Center), the Italian space agency (which provides the primary ground station at Malindi, Kenya), and an international team of scientists and engineers (which provide science analysis and engineering analysis from United Kingdom Data Center [Univ. of Leicester and the Mullard Space Sciences Lab] and the Italian Data Center [Astronomical Obseratory of Brera]).

Professor Gordon Garmire is the PI of the Advanced CCD Imaging Spectrometer (ACIS) instrument on the Chandra X-ray observatory. Development of the ACIS instrument specifications, hardware design, calibration requirements, and science goals has been an integral part of the Penn State Astronomy and Astrophysics Department since the early 1980's. In the last ten years, the ACIS team has been particularly active, supporting ground calibration of individual hardware components as well as the integrated observatory, providing calibration and analysis software used both before and after launch, and executing a diverse and far-reaching program of Guaranteed Time (GTO) observations and data analysis.

Penn State is the originator of the concept for the Hobby-Eberly telescope (HET) and has played a leadership role in its design, construction and commissioning. Professor Larry Ramsey served as Project Scientist from inception through 2004. Penn State currently engages in a wide range of astrophysical research using its ~25% share of the HET. The Hobby-Eberly telescope (HET) is an international collaboration between The Pennsylvania State University, The University of Texas at Austin and Stanford University in the United States, and Ludwig-Maxmilians Universität München, and Georg-August-Universität Göttingen in Germany. It is located at the University of Texas's McDonald Observatory at an altitude of 2000 meters. This southwestern site remains exceptional among developed US mainland sites for it dark sky.

Ramsey also was the PI for the Medium Resolution Spectrograph and Fiber Instrument Feed on the HET. The Medium Resolution Spectrograph (MRS) is the newest instrument on the HET. It is a fiber-fed echelle spectrograph designed for a wide range of scientific investigations and includes single-fiber inputs for the study of point-like sources, synthetic slits of fibers for long slit spectroscopy, several independently positionable probes for multi-object spectroscopy. The MRS was designed for two beams. The visible beam has wavelength coverage from 450 - 900 nm in a single exposure with resolving power between 5,300 and 20,000, depending on the fibers configuration selected. This beam also has capability in the ranges 380 - 950 nm by altering the angles of the cross-disperser gratings. A second beam is possible in the future; it would operate in the near-infrared has coverage of 900 - 1300 nm with resolving power between 5,300 and 10,000. The MRS was funded by Penn State University, Robert E. Eberly and the Eberly family trust and the US National Science Foundation. The PI is L. Ramsey and commissioning began in summer 2003. There are numerous modes on the MRS and at this time, on the simplest modes in the visible beam are used in routine queue operations.

We are currently forming a Center for Extrasolar Planetary Research (CEPR) at Penn State that would be devoted to broad, interdisciplinary research in the field of extrasolar planets. The Center will promote collaborations among scientists at Penn State and between Penn State and other institutions, and attract young, capable researchers to Penn State in this exciting field. In addition, the Center will provide a solid platform for a coordinated effort to improve science education on campus and in the general public. The founding members of the CEPR and their areas of expertise are as follows. Except where noted, they are tenure-track faculty in the Department of Astronomy & Astrophysics.

- Eric Feigelson

Researches star and planet formation through high-energy observations. With colleagues affiliated with NASA's Chandra X-ray Observatory, he is establishing the energetic photons and particles in young stellar systems and their effect on the cold protoplanetary disk where planets form. He also searches for nearby very young stellar systems for planet formation study, and measures stellar magnetic activity evolution for habitability calculations.

- James Kasting (EMS)

Expert in the field of planetary habitability, co-PI in the Penn State Astrobiology Research Center (PSARC), and Co-chair of the Terrestrial Planet Finder (C) Science and Technology Definition Team.

- Kevin Luhman

Leader in the field of formation of low-mass stars and brown dwarfs through optical and infrared observations, and most notably has discovered a majority of the known brown dwarfs in star-forming regions. He is experienced with most of the world's largest ground-based telescopes and is a close collaborator with the instrument teams for the Spitzer Space Telescope.

- Larry Ramsey

Experienced in high-precision radial velocity techniques, he was a member of one of the first teams to use these techniques in the late 1980s to measure non-radial pulsations on main sequence stars. He has an active interest in applying this experience to developing instrumentation and techniques to search for extrasolar planets and other low mass companions around M dwarfs. He is also experienced in the design and operation of large ground-based telescopes.

- Donald Schneider

Leader in the Sloan Digitized Sky Survey (SDSS) and co-I in a planet survey using one of the SDSS telescopes which is expected to survey ~1 million stars using visible and near-IR spectrographs starting in 2006.

- Steinn Sigurdsson

Theoretical and observational research on planetary system formation and detection. He predicted and discovered the first planets in globular clusters, and models planetary systems around white dwarfs and neutron stars. He has conducted transit and imaging searches for planets, and studies the formation and dynamical evolution of planetary systems. He serves as a co-PI of the PSARC.

- Alex Wolszczan

Discoverer of terrestrial-mass planets around the millisecond pulsar PSR B1257+12 - the first planets detected around a star other than the Sun. He is involved in the studies of neutron star planets, which include long-term timing observations of PSR B1257+12 and large-scale pulsar surveys. He also leads a planet search of a large sample of G and K-giants with the Hobby-Eberly Telescope. Wolszczan is a co-PI on one of the two key planet search projects for the Space Interferometry Mission (SIM) and a co-PI in PSARC.

The department does not employ a dedicated engineering staff but obtains staff as needed form other units of the university such as engineering services, Applied Research lab or other on-going projects such as Swift or Chandra as needed. Both Pat Broos and Leland Engel who are identified for this study are such individuals whose availability is highly likely. Back up personnel are also available should the need arise.

A.4 CENTRE FOR ASTROPHYSICS RESEARCH, UNIVERSITY OF HERTFORDSHIRE CV

The Centre for Astrophysics Research carries out research on a wide range of current problems in astronomy, ranging from the detection of supermassive black holes in other galaxies to the properties of dust in the interstellar medium of our own. The Group has a high international profile and uses all of the major UK telescopes, together with international facilities such as the Hubble Space Telescope, to observe a variety of astronomical sources at wavelengths ranging from the radio to the X-ray. Many of these studies utilize the specialist techniques of imaging- and spectro-polarimetry in which the Group has world-leading expertise. The observational work is supported by extensive computer modelling of the physical processes responsible for the observed phenomena. The Group also maintains a strong instrumentation programme and is currently involved in the design and development of polarimetry modules for new 8 metre-class telescopes, including the multi-national GEMINI twin 8.1 metre project and the Japanese SUBARU 8.3 metre telescope. It has been at the forefront in developing both private polarimeters and common-user polarimetry systems, having designed and built multi-wavelength, near infra-red imaging- and optical spectro-polarimeters for the 3.9m Anglo-Australian Telescope (AAT), and imaging- and spectro-polarimeters for the 4m UK Infra-Red Telescope (UKIRT) on Mauna Kea.

As of October 2004, the Group includes 11 full-time academic staff engaged in research and 3 research fellows (with a further 3 appointments pending). In addition there are 2 visiting Professors and 4 visiting Research Fellows. The Research Areas are supported by grants from the UK Particle Physics and Astrophysics Research Council (PPARC) which fund 5 post-doctoral research assistantships (PDRAs). There are currently 11 PPARC-funded full-time PhD students, 1 UH-funded PhD student, 2 self-funded students PhD students and 6 MSc students.

PRVS Project Staff

The following key staff are expected to work on the PRVS instrument design :

Principal Investigator Hugh Jones

APPENDIX B – CVS OF KEY TECHNICAL STAFF

1. UK ASTRONOMY TECHNOLOGY CENTRE - CVS

1.1 DAVID LUNNEY

Name:	Mr David Lunney
Organisation:	UK ATC
Position:	Project Manager
Project Role:	Project Management
Time allocated to project: 80%	80% over duration, peaking at 100%

Year	Qualification	Subject
1981	**HND**	**Applied Physics (with Electronics)**
1994	**MSc (Dist)**	**Manufacturing Engineering**

Employment:
2000 – Present : UK ATC
2000 - 1988 : BAE Systems
1988 – 1984 : Motorola Semiconductors

Related Experience:
Project manager on HRNIRS Design Study
Project manager on Wide Field camera for UKIRT
Project manager on GMOS North & South – delivered April 2001 & October 2002
Project manager on Ultracam – delivered May 2002
Member of the Association for Project Management since 1996

Other non-related Experience:
Project manager on following major programmes at BAE Systems :-

Airborne Video Recording System for Sea King Helicopters

Head Up Display cameras for Eurofighter

Precision Guide Missile for UAE

TIALD (Thermal Imaging Airborne Laser Designator) for RAF Tornados

Contingency Options:
The UKATC has a strong Project Management group with 6 members, and a Project Manager could be deployed from this group if so required.

1.2 DAVID HENRY

Name:	David Henry
Organisation:	UK ATC
Position:	Head of Optics Group
Project Role:	Optical Design /Optical Engineering
Time allocated to project: TBD	78%

Year	Qualification	Subject
1987	**BSc**	**Physics, Aberdeen, Scotland**
1989	**MSc**	**Physics, Aberdeen, Scotland**

Employment:
1998 - Present: Optical Engineer, UK ATC
1996 – 1998: Project/Systems Engineer, GEC Marconi
1993 – 1996: Optical Engineer, VLSI Vision Ltd
1990 – 1993: Optical Engineer, Ferranti Defence Systems

Related Experience:

- 15 years experience of optical design and engineering, including astronomical instrumentation, military IR systems and commercial imaging
- Responsible for optical design and engineering of wide field camera (WFCAM) on UKIRT from conceptual design review to commissioning
- Led team for successful instrumentation conceptual design reviews on VISTA
- Contributed to integration and test of MICHELLE, GMOS, GCAL

Contingency Options:
The UKATC Applied Optics Group has 6 members of staff, and most (including Martyn Wells) could be deployed on the PRVS study if required.

1.3 DEREK IVES

Name:	Derek Ives
Organisation:	UKATC
Position:	Head of Electronics
Project Role:	Lead Detector/Electronics Engineer
Time allocated to project:	64%

Year	Qualification	Subject
1985	**B.Sc.**	**Electrical and Electronics Engineering**
1997	**C.Eng., M.I.E.E.**	**Chartered Engineer**

Employment:
1998-present – Senior Engineer/Head of Electronics at UKATC.
1993-1998 – Senior Engineer at Royal Greenwich Observatory, Cambridge.
1988-1993 – Support Electronics/Detector Engineer at ING, La Palma

Related Experience:
Lead Electronics/Detector Engineer on WFCAM for UKIRT – a focal plane mosaic of 4 Rockwell HAWAII-2 detectors.

Lead Electronics/Detector Engineer on MICHELLE at UKIRT/GEMINI – a large mid IR imager/spectrometer.

Lead Electronics/Detector Engineer on NAOMI – the AO system for the WHT on La Palma.

Lead Engineer/Project Manager on INT WFC – the first mosaic of 2k x 2k thinned CCDs used in a wide field optical camera – at the INT on Lap Palma.

Other non-related Experience:
Experience on multiple CCD and IR detector types from manufacturers such as E2V, SITe, Loral, Rockwell and Raytheon etc.

Many years industrial experience working in avionics.

Contingency Options:
The UK ATC Electrical Engineering Group has several members of staff who could be redeployed if required.

1.4 ANDREW VICK

Name:	Mr. Andy Vick
Organisation:	UK ATC
Position:	Software Engineer
Project Role:	Lead Software Engineer
Time allocated to project:	80%

Year	Qualification	Subject
1989	**BSc (Hons)**	**Computer Science and Physics**
1992	**MSc**	**Measurements and Instrumentation**

Employment:
1999- Present: UK ATC
1992-1999: University of Durham, Instrumentation group
1989-1991: Planning consultancy Ltd, Heathrow. (Senior systems programmer)
1986-1987: Graham Bannock and Partners, Baker St, London. (Statistics and survey developer)

Related Experience:
Lead software engineer for WFCam (ATC). Specific areas: camera control, data handling, DR pipeline.
Lead software engineer for Ultracam (ATC). Specific areas: camera control, data handling
Software engineer for the NAOMI adaptive optics system (ATC). Specific areas: observatory systems, wavefront sensing camera control.
Development of AO wavefront sensing and reconstruction codes (Durham)
Development of AO simulation codes (Durham)

Other non-related Experience:

Contingency Options:
The Software Engineering Group at the UKATC has 13 members of staff, most of whom would be well-fitted for use on PRVS.

1.5 DAVID MONTGOMERY

Name:		**David Montgomery**
Organisation:		**UKATC**
Position:		**Head of mechanical engineering**
Project Role:		**Lead Mechanical engineer**
Time allocated to project:		80%
Year	**Qualification**	**Subject**
1978	**Bsc (ii)1**	**Mechanical Engineering**

Employment:
Employed by the ROE (later UKATC) from 1987 to the present.
Seconded to the Gemini telescopes project (AURA) for 8 years (see below).

Related Experience:
Mechanical design, build and commission of CGS4 (1987-1992)
Mechanical engineer with the instrumentation group of the Gemini telescopes project (1992-2000)
Lead mechanical engineer for WFCAM (2000-2004)
Lead mechanical engineer for SCUBA2 (2004-2005)
Head of UKATC mechanical engineering group 2004 to present

Other non-related Experience:

Contingency Options:
There are 13 members of staff in the UK ATC Mechanical Engineering Group, including senior engineers such as Peter Hastings and Richard Bennett. Redeployment into PRVS would be used if required.

1.6 DR ADRIAN WEBSTER

Name:	Dr. Adrian S. Webster
Organisation:	IFA, University of Edinburgh
Position:	Senior Research Fellow
Project Role:	Consultant
Time allocated to project:	10%

Year	Qualification	Subject
1967	BA (Hons)	Theoretical Physics
1972	PhD	Radio Astronomy

Employment:
1998- Present: IFA
1982-1998: UK ATC

Related Experience:
Lecturing on Astronomical Instrumentation
Many types of astronomical observation
First Astronomer-in-Charge of the JCMT
Design of configurations for ALMA

Other non-related Experience:
Theoretical Astronomy and astrophysics research, wide range of topics
Statistical, Applied Mathematical expertise
Mathematical modelling, lately with Mathematica
Wide range of programming languages
Senior Management experience

Contingency Options:

1.7 BILL DENT

Name:	Bill Dent
Organisation:	UK ATC
Position:	Project scientist
Project Role:	Local instrument scientist
Time allocated to project:	30%

Year	Qualification	Subject
1986	**BSc**	**Physics**
1982	**MSc**	**Radio Astronomy**
1986	**PhD**	**Electronics/Astronomy**

Employment:
1986-1987: Astronomer, Marshall Space Flight Center
1987-1988: Telescope Operator/Support, James Clerk Maxwell Telescope
1988-1990: Support Staff, ROE
1990-1998: Support Scientist, JCMT
1998-present: Project Scientist, UK ATC

Related Experience:

- Published papers on IR spectroscopy, observations and modelling, of star formation regions
- IR observing experience at UKIRT
- Extensive experience in reducing large spectroscopic datasets from submm
- Leading proposal for a high resolution IR spectrometer for the eELT
- Lab testing & acceptance and telescope commissioning of several new instruments on Mauna Kea
- Local support of instruments on Mauna Kea (fault finding and fixing)

Other non-related Experience:

- Radiative transfer modelling of discs (IR through sub-mm)
- Designing & building sub-mm heterodyne spectrometers (RF techniques and autocorrelators)
- Papers on star & planet formation, particularly outflows and discs

Contingency Options:

1.8 PHIL REES

Name:	Phil Rees
Organisation:	UK ATC
Position:	Systems Engineer
Project Role:	Systems Engineer
Time allocated to project:	55%

Year	**Qualification**	**Subject**
1986	BSc (Hons)	Applied Physics and Electronics

Employment:
2004-2006 Systems Engineer, UKATC, Edinburgh
2001-2004 Principal Systems Engineer, BAE Systems, EO Division, Edinburgh
1990-2001 Project Engineer, Land Infrared Ltd, Sheffield
1986-1990 Higher Scientific Officer, Royal Aerospace Establishment, Farnborough

Related Experience:

- Systems Engineer for ESO KMOS project
- Systems Engineer for the TIALD T500 laser designator upgrade project

  Responsible for the design and test of infrared and visible imaging systems of 50 off airborne pods
- Infrared pyrometer development for industrial applications

  Responsible for design, manufacture and testing of infrared non-contact thermometers in quantities of several thousand..

Other non-related Experience:

Infrared detector readout and lineraisation analogue electronic design.
Product support – solving maintenance, reliability, procurement and applications problems for manufactured products.
Infrared proximity sensor development
Technical contact for development sub-contracts

Contingency Options:

2. INSTITUTE FOR ASTRONOMY, UNIVERSITY OF HAWAII - CVS

2.1 DR JOHN RAYNER

Name:		**Dr. John Rayner**
Organisation:		**Institute for Astronomy, Univ. of Hawaii**
Position:		**Associate Astronomer**
Project Role:		**Instrument Scientist**
Time allocated to project:		**36% over duration**
Year	**Qualification**	**Institute**
1983	**B.Sc., Physics (First Class Honours)**	**QEC, University of London, U.K.**
1984	**M.Sc., Astronomical Technology**	**University of Edinburgh, U.K**
1988	**Ph.D., Astronomy**	**University of Edinburgh, U.K.**

Employment:
1988-1996: Assistant Astronomer, Institute for Astronomy, Univ. of Hawaii
1996-present: Associate Astronomer, Institute for Astronomy, Univ. of Hawaii
1996-2003: IRTF Deputy Division Chief, Institute for Astronomy, Univ. of Hawaii

Related Experience:
NSFCAM2 IR Imager for IRTF, PI (2048x2048 H2RG array)
Medium-Resolution Cross-Dispersed IR Spectrograph (SpeX) for IRTF, PI
Optical design for Gemini NICI cryogenic camera, NICI science team member
IRTF support astronomer for medium (SpeX) and high resolution (CSHELL) IR spectrographs

Other non-related Experience:
NOAO Extremely Wide Field IR Imager PDR, panel member 2003
Gemini South Adaptive Optics Imager CDR, panel member 2003
Institute for Astronomy TAC, committee member 2000-2001
Airborne, Far-IR Echelle Spectrometer for SOFIA Independent Review, panel member, 2001
Gemini Near Infrared Integral Field Spectrograph (NIFS) CDR, panel member, 2001
Gemini Near Infrared Integral Field Spectrograph (NIFS) PDR, panel member, 2000
Gemini Near Infrared Spectrograph (GNIRS) CDR, panel member, 1997

Relevant Publications:
Spextool: A Spectral Extraction Package for SpeX, a 0.8-5.5 micron Cross-Dispersed Spectrograph; M.C. Cushing, W.D. Vacca and J.T. Rayner, PASP in press, 2004
SpeX: A Medium-Resolution 0.8-5.5 micron Spectrograph and Imager for the NASA Infrared Telescope Facility; J.T. Rayner et al. , PASP 155, 362, 2003
A Method for Correcting Near-IR Spectra for Telluric Absorption; W.D. Vacca, M.C. Cushing and J.T. Rayner; PASP 155, 389, 2003
A Near-Infrared Spectral Sequence of Late M, L and T Dwarfs; M.C. Cushing, J.T. Rayner and W.D. Vacca; in Brown Dwarfs, Proc. IAU Symp. 211. Edited E. Martin, 2003.

2.2 DR MICHAEL LIU

Name:	**Dr. Michael C. Liu**
Organisation:	**Institute for Astronomy, Univ. of Hawaii**
Position:	**Assistant Astronomer**
Project Role:	**Science Team member**
Time allocated to project:	**5%**

Year	**Qualification**	**Subject**
1992	**B.A., Physics**	**Cornell University**
2000	**Ph.D., Physics**	**University of California, Berkeley**

Employment:
2000-2002: Beatrice Watson Parrent Fellow, Institute for Astronomy, Univ. of Hawaii
2003: Hubble Postdoctoral Fellow, Institute for Astronomy, Univ. of Hawaii
2003-present: Assistant Astronomer, Institute for Astronomy, Univ. of Hawaii

Related Experience:
- Science expertise in circumstellar disks, low mass stars, brown dwarfs.
- Design and commissioning of IRCAL (IR Camera for Adaptive Optics at Lick observatory).

Other non-related Experience:
- NASA Origins/TPF Detection of Extrasolar Planets panel, 2003
- Keck Adaptive Optics Working Group, 2002-present
- Gemini-South Near-IR Coronagraphic Imager (NICI) Science team, 2002-present
- IR Camera Science Working group, Taiwan/ASIAA, 1999

Relevant Publications:
Liu, M. et al. 2004. A Sub-Millimeter Survey of Nearby Young Stars for Cold Dust: Discovery of Debris Disks around Two Low Mass Stars. ApJ, in press.
Liu, M. et al. 2003. Survey for Circumstellar Disks around Young Substellar Objects, ApJ, 585, 372.
Liu, M. et al. 2002. Discovery of a Methane Dwarf from the IfA Deep Survey. ApJL, 568, L107.
Liu, M. et al. 2002. Crossing the Brown Dwarf Desert Using Adaptive Optics: A Very Close L-Dwarf Companion to the Nearby Solar Analog HR 7672. ApJ, 571, 519.
Patience, J. et al. 2002. A Search for Stellar Companions to Stars with Planets. ApJ, 581, 654.
Lloyd, J., Liu, M., et al. 2000. IRCAL: The Near-Infrared Camera for Adaptive Optics at Lick Observatory. Proc of the SPIE, 4008, 814.

2.3 WERNER STAHLBERGER

Name:	**Werner Stahlberger**
Organisation:	**Institute for Astronomy, University of Hawaii**
Position:	**Mechanical Designer**
Project Role HRGNIRS	**Lead IFA Mechanical Designer**
Time allocated to project:	**24%**

Employment:
1968-present: Institute for Astronomy, University of Hawaii 2680 Woodlawn Drive Honolulu, HI

Related Experience at IFA;
CGAS: Cooled Grating Array Spectrograph; Mechanical Design+Detailing
CSHELL: Cryogenic Echelle; Mechanical Design+Detailing
NSFCAM: 1-5.5 micron Camera; Mechanical Design+Detailing
SPEX: 0.8-5.4 Spectrograph and Imager; Mechanical Design+Detail+FEA
NSFCAM2: Mechanical Design+Detail+FEA

Other-related Experience;
Subcontractor for MKIR (Mauna Kea Infrared; HILO; HI)
NICI: Near Ir Coronagraphic Imager; GEMINI; Mech. Design+Detail (Cryostat)
ASTROCAM: Facility Instrument; USNO; Mechanical Design+Detailing+FEA
ETD: Facility Instrument; Harvard Smithsonian Observ. Mech.Design+Detail

2.4 HUBERT YAMADA

Name:	**Hubert Yamada**
Organisation:	**Institute for Astronomy, Univ. of Hawaii**
Position:	**Electrical Engineer**
Project Role:	**Lead IFA Software Engineer**
Time allocated to project:	**82%**

Year	**Qualification**	**Subject**
1983	**B.S., Physics**	**University of Hawaii, Manoa**
1986	**M.S., Physics**	**California Institute of Technology**

Employment:
1987-1987: Casual hire (programmer), Research Corporation of the University of Hawaii
1987-1998: Software support programmer, Research Corporation of the University of Hawaii
1998-Present: Electrical Engineer, University of Hawaii

Related Experience:
Near Infra-Red Imager (NIRI) for Gemini North Telescope, Lead software engineer for mechanisms and systems integration and testing
High Resolution Spectrograph for AEOS Telescope, Lead software engineer for infra-red mechanisms, detector control, and detector readout, supporting software engineer for optical channel
Ultra-Low Background Camera (ULBCAM) for University of Hawaii 2.2 m telescope, Software engineer in charge of detector readout software.
Tip-Tilt System, University of Hawaii 2.2 m Telescope, software engineer
University of Hawaii 2.2 m Telescope, software engineer for numerous mechanisms and projects, including autoguiders and hexapod

Other non-related Experience:
University of Hawaii 2.2 m Telescope, software support and assistant systems administrator
University of Hawaii, Institute for Astronomy, assistant systems administrator

Relevant Publications:
Hodapp, K. W., et al. 2003. The Gemini Near Infrared Image. PASP: 115, p. 1388.

3. DEPARTMENT OF ASTRONOMY & ASTROPHYSICS, PENN STATE UNIVERSITY - CVS

3.1 DR ALEXANDER WOLSZCZAN

Name:	**Dr. Alexander Wolszczan**
Organisation:	**The Pennsylvania State University**
Position:	**Evan Pugh Professor of Astronomy and Astrophysics**
Project Role:	**Science Team**
Time allocated to project:	**5% over duration**

Year	**Qualification**	**Institution**
1969	**MS Astronomy**	**Nicolaus Copernicus University, Torun, Poland**
1975	**Ph.D., Physics**	**Nicolaus Copernicus University, Torun, Poland**

Employment:
Distinguished Professor of Astronomy and Astrophysics, Penn State U., Department of Astronomy and Astrophysics, 1995-1998
Professor of Astronomy and Astrophysics, Penn State U., Department of Astronomy and Astrophysics, 1992-1995
Research Associate, Senior Research Associate, Cornell U., National Astronomy and Ionosphere Center, Arecibo Observatory, Arecibo, Puerto Rico, 1983-1992
Research Associate, Polish Academy of Sciences, Copernicus Astronomical Center, Torun, Poland, 1979-1983
Senior Assistant and Assistant Professor, N. Copernicus U., Torun, Poland, 1974-1979
Assistant, N. Copernicus U., Torun, Poland, 1969-1973

Related Experience:
1992-Present: Discoveries of the first extrasolar planetary system and binary millisecond pulsars using the precision pulse timing technique, construction of timing hardware
2002-Present: co-PI, SIM/EPIcS key project to search for terrestrial-mass planets
2003-Present: PI, Precision RV search for planets around GK-giants with the Hobby-Eberly Telescope (HET)
2000-Present: Chair, Polish Foundation for Southern African Large Telescope (SALT)

1. Wolszczan, A. and Cordes, J. M., "Interstellar Interferometry of the Pulsar PSR 1237+25" 1987, Ap. J. (Letters), 320, L35.
2. Wolszczan, A., "A Nearby 37.9–ms Radio Pulsar in a Relativistic Binary System" 1991, Nature, 350, 688.
3. Taylor, J. H., Wolszczan, A., Damour, T. and Weisberg, J. M., "Experimental Constraints on Strong–Field Relativistic Gravity" 1992, Nature, 355, 132.
4. Wolszczan, A. and Frail, D. A., "A Planetary System Around the Millisecond Pulsar PSR1257+12" 1992, Nature, 355, 145.
5. Wolszczan, A., "Confirmation of Earth–Mass Planets Orbiting the Millisecond Pulsar PSR B1257+12" 1994, Science, 264, 538.
6. Wolszczan, A., "Binary Pulsars and Relativistic Gravitation" 1994, Class. Quantum Grav., 11, A227.
7. Wolszczan, A., "Searches for Planets Around Neutron Stars" 1997, Celestial Mechanics, 68, 13. 8. Konacki, M. and Wolszczan, A., "Masses and Orbital Inclinations of Planets in the PSR B1257+12 System", 2003, Ap. J., 591, L147.
9. Löhmer, Wielebinski, R. and Wolszczan, A. "A Search for Cold Dust Around Neutron Stars", 2004, Astron. & Astrophys., 425, 763.
10. Goździewski, K., Konacki, M. and Wolszczan, A. "Long Term Stability and Dynamical Environment of the PSR B1257+12 Planetary System", 2005, Ap. J., 619, 1084.

3.2 DR KEVIN LUHMAN

Name:	**Dr. Kevin L. Luhman**
Organisation:	**The Pennsylvania State University**
Position:	**Professor of Astronomy and Astrophysics**
Project Role:	**Science Team**
Time allocated to project:	**5%**

Year	**Qualification**	**Institution**
1993	**B. A. Astronomy, B. S. Physics**	**The University of Texas at Austin**
1998	**PhD Astronomy**	**The University of Arizona**

Employment:
1998-2002 CfA Fellow, Harvard-Smithsonian Center for Astrophysics
2002-2005 Astrophysicist, Smithsonian Astrophysical Observatory
2005- Assistant Professor, Dept.of Astronomy & Astrophysics, The Pennsylvania State University

1) *Spectroscopy of a Young Brown Dwarf in the rho Ophiuchi Cluster*
K. L. Luhman, J. Liebert, and G. H. Rieke, Ap. J. **489,** L165-L168, 1997
2) *Young Low-Mass Stars and Brown Dwarfs in IC 348*
K. L. Luhman, Ap. J. **525**, 426-481, 1999
3) *A Census of the Young Cluster IC 348*
K. L. Luhman, et al., Ap. J. **593**,1093-1115, 2003
4) *Spectroscopic Confirmation of the Least Massive Known Brown Dwarf in Chamaeleon*
K. L. Luhman, D. E. Peterson, and S. T. Megeath, Ap. J. **617**, 565-568, 2004
5) *The First Discovery of a Wide Binary Brown Dwarf*
K. L. Luhman, Ap. J. **614**, 398-403, 2004
6) *Spitzer Identification of the Least Massive Known Brown Dwarf with a Circumstellar Disk*
K. L. Luhman, et al., Ap. J. **620**, L51-L54, 2005

3.3 DR LAWRENCE RAMSEY

Name:	**Dr. Lawrence W. Ramsey**
Organisation:	**The Pennsylvania State University**
Position:	**Professor of Astronomy and Astrophysics**
Project Role:	**Instrument & Science Team**
Time allocated to project:	**22% over duration**

Year	Qualification	Institution
1980	**A.B., Physics & math**	**University of Missouri, St. Louis**
1972	**MS Physics**	**Kansa State University**
1976	**Ph.D., Astronomy**	**Indiana University, Bloomington Indiana**

Employment:
7/88-Present Professor, The Pennsylvania State University.
7/82-6/88 Associate Professor, The Pennsylvania State University.
9/76-6/82 Assistant Professor, The Pennsylvania State University.
9/66-8/70 Aircraft and Spacecraft Simulator Systems Engineer, McDonnell-Douglas Corp.

Related Experience:
1/90-10/04: PSU/UT Hobby-Eberly Telescope (HET) Project Scientist
1996-Present: PI, HET Medium Resolution Spectrograph & Fiber instrument Feed
7/03-Present: Astronomy & Astrophysics Department Head
1997-Present: Member, Southern African Large Telescope (SALT) Board of directors
2002-April 2006: Chair, Associated Universities for Research in Astronomy (AURA) Oversight Committee for Gemini

1) *Dectection of Possible P-Mode Oscillations in Procyon*
T.M. Brown, R.L. Gilliland, R.W. Noyes, L.W. Ramsey, Ap. J. **368,** 599-609, 1991
2) *Scrambling Properties of Optical Fibers and the Performance of a Double Scrambler*
T.R. Hunter and L.W. Ramsey, PASP **104**, 1244-1251, 1992.
3) *Rotational modulation of the photospheric and chromospheric activity in the young, single K2-dwarf PW And*
J. Lopez-Santiago , D. Montes , M.J. Fernandez-Figueroa , L.W. Ramsey, Astronomy and Astrophysics, 411,489-502 (2003)
4) *SparsePak: A Formatted Fiber Field Unit for the WIYN Telescope Bench Spectrograph. I. Design, Construction, and Calibration*
Bershady, Matthew A.; Andersen, David R.; Harker, Justin; Ramsey, Larry W.; Verheijen, Marc A. W., 2004, The Publications of the Astronomical Society of the Pacific, 116, 565-590.
5) *The Hobby-Eberly Telescope medium resolution spectrograph and fiber instrument feed*
Lawrence W. Ramsey, Leland G. Engel, Nicholas Sessions, Christopher DeFilippo, Michelle Graver, Jeffery Mader Proc. SPIE Vol. 4841, p. 1036-1044, Instrument Design and Performance for Optical/Infrared Ground-based Telescopes; Masanori Iye, Alan F. Moorwood; Eds. Mar 2003
6) *Stellar Astrophysics on the Hobby Eberly Telescope*
Lawrence W. Ramsey American Institute of Physics Proceedings in press (2004)

3.4 LELAND ENGEL

Name:		Mr. Leland Engel
Organization:		Penn State University
Position:		Mechanical Engineer
Project Role:		Mechanical Design Engineer
Time allocated to project:		63%
Year	**Qualification**	**Subject**
1982	**BS**	**Mechanical Engineering**
1989	**MS**	**Engineering Management**

Employment:
1991- Present: Penn State University (Mechanical Engineer / ME Capstone Design Instructor)
1984-1990: Honeywell - Avionics Division (Reliability Engineer)
1982-1984: Copes-Vulcan, Inc. (Project Engineer)
1972-1978: US Navy (Electronics Tech./ Reactor Operator)

Related Experience:

- Mechanical Design, Fiber Instrument Feed (FIF) and Medium Resolution Spectrograph (MRS) (HET)
- Mechanical Design and Silicon Nano-fabrication, X-Ray Mirror, (NASA)
- Mechanical Design, XRT Instrument, Swift mission (NASA satellite).
- Finite Element Analysis, Chandra ACIS instrument (NASA satellite).
- Mechanical and Thermal Design, SAC-B/CUBIC instrument (NASA satellite).
- Mechanical and Thermal Design, aided graduate students (four sounding rocket flights for NASA)

Other non-related Experience:

Contingency Options:

3.5 PATRICK BROOS

Name:	Mr. Patrick Broos
Organisation:	**Penn State University**
Position:	Software Engineer
Project Role:	Lead Software Engineer
Time allocated to project:	35%

Year	Qualification	Subject
1985	BS	Electrical Engineering
1987	MS	Electrical Engineering
1993	MS	Computer Science

Employment:
1994- Present: Penn State University (Software Engineer)
1989-1991: Hewlett Packard, Inc. (Production Engineer)
1987-1989: ESL, Inc. (Digital Hardware Engineer)

Related Experience:

- Flight software systems engineering, UVOT Instrument, Swift mission (NASA).
- Science applications software development, Chandra ACIS instrument team.
- Flight software development, CUBIC instrument (NASA).
- Calibration support, calibration software, Chandra ACIS instrument team.

Other non-related Experience:

- Served on CDR panel for UVOT instrument.

Contingency Options:

4. UNIVERSITY OF HERTFORDSHIRE - CVS

4.1 DR HUGH JONES

Name:	Dr H.R.A. Jones
Organisation:	University of Hertfordshire
Position:	Academic Manager / Reader
Project Role:	Principal Investigator
Time allocated to project:	40%

Year	Qualification	Subject
1988	**BSc (Hons)**	**Physics with Astronomy**
1990	**MSc**	**Astrophysics**
1995	**PhD**	**Astrophysics**

Employment:
1990-1992: Blackwell Scientific Productions
1991-Present: MadLab Ltd
1995-Present: Liverpool John Moores University
1998- Present: Liverpool University

Related Experience:
- Reduction and scientific interpretation of infrared echelle data
- UK PI for Anglo-Australian planet search
- Close work with producers of atomic and molecular data for infrared

Other non-related Experience:
- Fellow of Royal Astronomical Society
- Fellow of American Astronomical Society
- Member International Astronomical Union

Contingency Options:

PRECISION RADIAL VELOCITY SPECTROMETER

Document No:	PRVS-PLA--00003-0001
Issue:	1.0
Category:	Plan
Status:	Issued
Author:	David Lunney
Date:	20th September 2006

APPENDIX C

ID	WBS	Task Name	Duration	Start	Finish
1		**PRVS - PHASE 2 - PLAN**	**157.4 wks**	**17 Nov '06**	**14 Oct '09**
2		**CONTRACTUAL**	**8 wks**	**17 Nov '06**	**18 Jan '07**
7		**PROJECT SUPPORT**	**148 wks**	**18 Jan '07**	**06 Oct '09**
8	**PM.0**	**PROJECT MANAGEMENT (PM.0)**	**148 wks**	**18 Jan '07**	**06 Oct '09**
16	**SE.0**	**SYSTEMS ENGINEERING (SE.0)**	**148 wks**	**18 Jan '07**	**06 Oct '09**
26	**SC.0**	**PROJECT SCIENCE (SC.0)**	**148 wks**	**18 Jan '07**	**06 Oct '09**
34		**MAJOR PROJECT REVIEWS**	**135.4 wks**	**18 Jan '07**	**15 Jul '09**
42		**PROJECT PROCUREMENT**	**94.4 wks**	**01 Feb '07**	**22 Oct '08**
98	**B.0**	**PHASE B.0 - CoDR TO PDR**	**36 wks**	**01 Feb '07**	**25 Sep '07**
99	**B.1**	**FIBRE DEPLOYMENT & ACQUISITION SYSTEM**	**28 wks**	**01 Feb '07**	**03 Aug '07**
104	**B.2**	**INFRASTRUCTURE**	**34 wks**	**01 Feb '07**	**12 Sep '07**
109	**B.3**	**FORE-OPTICS ASSEMBLY**	**24 wks**	**01 Feb '07**	**09 Jul '07**
114	**B.4**	**SPECTROGRAPH**	**36 wks**	**01 Feb '07**	**25 Sep '07**
120	**B.5**	**CALIBRATION ASSEMBLY**	**28 wks**	**01 Feb '07**	**03 Aug '07**
125	**B.6**	**DATA PIPELINE**	**28 wks**	**01 Feb '07**	**03 Aug '07**
129	**B.7**	**INSTRUMENT CONTROL SYSTEM**	**34 wks**	**01 Feb '07**	**12 Sep '07**
134	**C.0**	**PHASE C.0 - PDR TO FDR**	**24 wks**	**27 Sep '07**	**13 Mar '08**
135	**C.1**	**FIBRE DEPLOYMENT & ACQUISITION SYSTEM**	**20 wks**	**27 Sep '07**	**15 Feb '08**
145	**C.2**	**INFRASTRUCTURE**	**24 wks**	**27 Sep '07**	**13 Mar '08**
152	**C.3**	**FORE-OPTICS ASSEMBLY**	**22 wks**	**27 Sep '07**	**28 Feb '08**
160	**C.4**	**SPECTROGRAPH**	**24 wks**	**27 Sep '07**	**13 Mar '08**
170	**C.5**	**CALIBRATION ASSEMBLY**	**22 wks**	**27 Sep '07**	**28 Feb '08**
178	**C.6**	**DATA PIPELINE**	**22 wks**	**27 Sep '07**	**28 Feb '08**
188	**C.7**	**INSTRUMENT CONTROL SYSTEM**	**22 wks**	**27 Sep '07**	**28 Feb '08**
197		**PHASE D.0 & E.0 - SUB-SYSTEM & INSTRUMENT AIV**	**51.6 wks**	**24 Jul '08**	**08 Jul '09**
198	**D.0**	**PHASE D.0 (SUB-SYSTEM AIV)**	**21.6 wks**	**24 Jul '08**	**12 Dec '08**
199	D1.0	Fibre Deployment & Acquisition System	12 wks	24 Jul '08	10 Oct '08
200	D2.0	Infrastructure	12 wks	24 Jul '08	10 Oct '08
201	D3.0	Fore-Optics Fibre Assembly	12 wks	24 Jul '08	10 Oct '08
202	D4.0	Spectrograph Assembly	8 wks	22 Oct '08	12 Dec '08
203	D5.0	Calibration Assembly	12 wks	24 Jul '08	10 Oct '08
204	D6.0	Data Pipeline	12 wks	24 Jul '08	10 Oct '08
205	D7.0	Instrument Control System	12 wks	24 Jul '08	10 Oct '08
206	**E.0**	**PHASE E.0 (INSTRUMENT AIV)**	**39.6 wks**	**13 Oct '08**	**08 Jul '09**
207	E.1	Instrument Assembly	8 wks	13 Oct '08	03 Dec '08
208	E.2	Thermal Tests	8 wks	15 Dec '08	13 Feb '09
209	E.3	Detector Intergration	8 wks	13 Feb '09	07 Apr '09
210	E.4	Functuional Tests	4 wks	08 Apr '09	04 May '09
211	E.5	Performance Tests	8 wks	04 May '09	25 Jun '09
212	E.6	Acceptance Tests	2 wks	25 Jun '09	08 Jul '09
213		Produce Acceptance Tests Reports	2 wks	11 Jun '09	25 Jun '09
214		Produce Design, User and Maintenance Manuals	10 wks	04 May '09	08 Jul '09
215	**F.0**	**PHASE F.0 - COMMISSIONING**	**14 wks**	**15 Jul '09**	**14 Oct '09**
216	F.1	PACK INSTRUMENT	2 wks	15 Jul '09	28 Jul '09
217	F.1	SHIP INSTRUMENT	2 wks	28 Jul '09	11 Aug '09
218	F.2	UNPACK & RE-ASSEMBLE	2 wks	11 Aug '09	24 Aug '09
219	F.3	FUNCTIONAL & PERFORMANCE TESTS	8 wks	24 Aug '09	14 Oct '09
220		PROJECT COMPLETE - READY FOR SCIENCE VERIFICATION	0 days	14 Oct '09	14 Oct '09
221		**MAJOR PROJECT MILESTONES**	**147.4 wks**	**31 Jan '07**	**14 Oct '09**
222		PROJECT KICK-OFF MEETING COMPLETE	0 days	31 Jan '07	31 Jan '07
223		DETECTORS ARRAYS ORDERED	0 days	27 Mar '07	27 Mar '07
224		COMPLETE REVIEW OF LONG LEAD OPTICAL COMPONENTS	0 days	11 Jul '07	11 Jul '07
225		PROJECT PDR COMPLETE	0 days	27 Sep '07	27 Sep '07
226		CRYOSTAT REVIEW COMPLETE	0 days	21 Nov '07	21 Nov '07
227		OPTICAL FDR COMPLETE	0 days	18 Dec '07	18 Dec '07
228		DETECTOR ARRAYS DELIVERED	0 days	12 Mar '08	12 Mar '08
229		PROJECT FDR COMPLETE	0 days	14 Mar '08	14 Mar '08
230		START SUB-SYSTEM AIV	0 days	24 Jul '08	24 Jul '08
231		START INSTRUMENT AIV	0 days	13 Oct '08	13 Oct '08
232		THERMAL PERFOMANCE CONFIRMED	0 days	13 Feb '09	13 Feb '09
233		ACCEPTANCE TESTS COMPLETE	0 days	08 Jul '09	08 Jul '09
234		INSTRUMENT DELIVERED TO GEMINI	0 days	11 Aug '09	11 Aug '09
235		INSTRUMENT READY FOR TEST AT TELESCOPE	0 days	24 Aug '09	24 Aug '09
236		INSTRUMENT READY FOR SCIENCE VERIFICATION	0 days	14 Oct '09	14 Oct '09
237		**FIBRE CABLE INSTALLATION ON TELESCOPE**	**39 wks**	**14 Dec '07**	**05 Sep '08**