TCS3 Project Overview

May 2003

1. Introduction

The purpose of this document is to outline the goals and the resources needed or available to accomplish the TCS3 upgrade project.

TCS3 project home page is located at http://irtfweb.ifa.hawaii.edu/~tcs3/

Preparation for the TCS3 Upgrade Project stated in April 2000. Various in-house proposals and estimates were generated to estimate the manpower, schedule, and cost for replacing the LSI-11 based TCS. Avenues to accomplish the upgrade were investigated, including in-house funding, cooperation with other observatories, and external funding. Eventually, a NASA proposal for funding was submitted in June 2001. This proposal (Replacement of the Telescope Control System for the IRTF, NRA-01-OSS-01 PAST) was awarded in June 2002. The original scheduled was from 3rd Qtr 2003 to 4th Qtr 2004 (2.5 years). Due to delay in hiring, and conflicts with existing projects the official start of the TCS3 project was delay until May 2003.

Since significant time has elapse since the proposal was written and the start of the TCS3 project, an overview is appropriate. Before proceeding with the design phase, a review of the project goal, preliminary schedule, manpower requirement, and budget allocation is necessary. This review will insure the tcs3 project members, IRTF management and staff shared similar expectations.

2. Project Goals and Objectives:

2.1 Replace the LSI 11/23. Replace the LSI 11/23 with a modern x86 based computer. Used a widely supported bus (PCI, VME, CompatPCI). Run a modern Unix-like OS (Solaris, Linux, QNX). May contain assorted peripheral devices for digital IO, analog IO, and servo motor control to interface with the IRTF Facility and TCS hardware. This will be the TCS3 computer(s).

2.2 Replace the CCS & MCC MCB (QBus). The obsolete QBUS and associated analog and digital interface boards will be replaced. A new customized interface between the TCS3 computer/peripheral boards and IRTF mechanical systems will be built. Much of the functionality currently performed in hardware may be replaced by the TCS3 control software.

2.3 Replace MCC Panels. A replacement for the MCC interface panels will be constructed. There may a period when tcs1 MCC and the tcs3 replacments will co-exist at the IRTF. If they can't physically co-exist, a smaller temporary MCC may need to be built to allow the current one to be removed. The TCS3 replacement for the MCC would be:

- A minimal tcs3 TO Panel that would interface with the servo electronic directly.
- A Software GUI will replace most of the existing MCC hardware.

2.4 Software: The Forth TCS and TCS daemon with be replaced by the TCS3 application. This application will be written in C and developed for the Unix (POSIX API) operating system. The application will be command oriented, with an X-based graphical user interface for the TO. Network communication will be provided using remote procedures calls or sockets. Other facility software may be folded into the tcs3 application, for example hexed.

2.5 Replace the observer's hand paddle: A replacement for the observer hand paddle will be constructed. Ideally this would be an Ethernet based panel that can be used by the Daycrew, TO, and Observers.

2.6 RA/DEC Encoders: We would like to improve the encoding of the RA, DEC axis with higher resolution and with a system not subject to encoding ratio changes or slippage. Hopefully, combining the absolute and incremental into a single unit.

2.7 Provide Spares: A spare TCS3 system will be assembly in the Hilo facility: TCS3 computer, peripherals, and some external electronics. Some of the TCS hardware will be duplicated or simulated (ie: servo simulator) to allow continue software developing & testing. Also spare of critical components will be purchased.

2.8 Switching Between the ForthTCS and TCS3: TCS3 will interface with the same servo amplifiers, DC tachometers, and encoders currently in use, as well as the dome and shutter mechanism. A method of switching between the old and new systems within a 1 day time frame is highly desirable. This will allow the TCS team to switch between the ForthTCS and TCS3 during development and testing. The goal is to not have any a long-term shutdown of the IRTF Facility.

2.9 Motor – Replacement of the current TCS RA and DEC motor and drive system (servo amplifiers) is desired, but not required. Because switching between the tcs1 and tcs3 is required, the new motor and drive system must be compatible with the current system. This task can be done independently from the rest of the upgrade project.

2.10 Remote Operations. Remote operation is not a requirement. However, it should be possible to implement remote operations as a future enhancement.

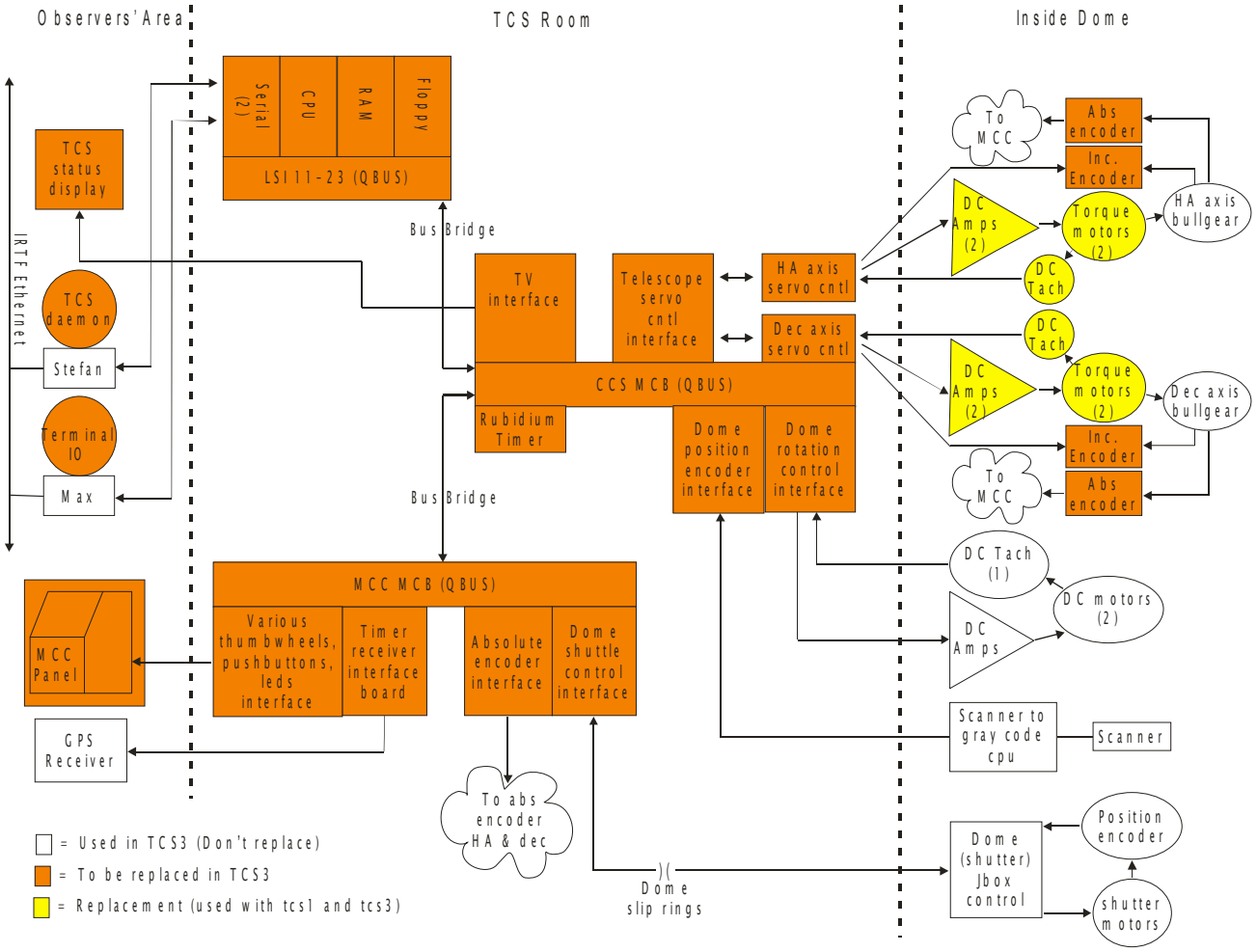


Figure 1.1 is a simple diagram of the Forth TCS system.

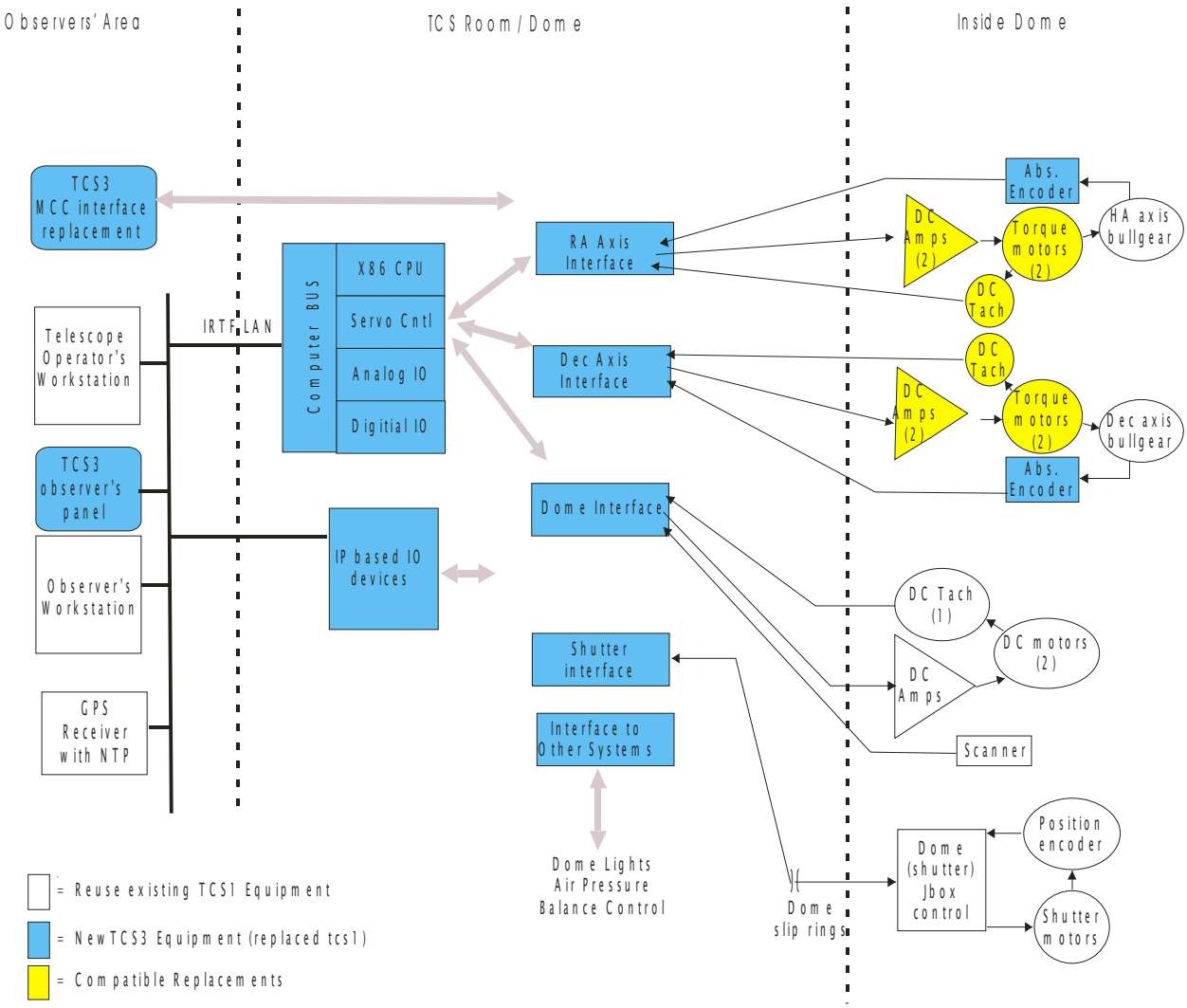


Figure 1.2 is a simple diagram of the TCS3 system.

3. Schedule and Milestones

3.1 Task List

1 **Task**: Conceptual Design.
Project Man-months: 2
Major Milestone: Present Conceptual Design.

2. **Task**: Build TCS3 computer and test servo controller.
Select/Purchase servo controller (RA, Dec, Dome).
Select/Purchase Computer System (2 each, tcs3 & development/spare system)
Select/Purchase TCS3 Electronics Rack.
Implement Servo Simulator (Lab test motors)
Project Man-months: 6
Major Milestone: Control servo simulator using computer system/servo controller.

3. **Task:** Position feedback for Ra and Dec axis, and Dome.
Select/Purchase RA, Dec, Dome encoding devices.
Install computer system at summit.
Install encoding for RA, Dec & Dome.
Project Man-months: 3
Major Milestone: TCS3 computer system provides RA, Dec, Dome positional information.

4 **Task**: Install initial MCC replacement at summit.
Install at summit and switch some non critical MCC Functions to TCS3
Project Man-months: 3
Major Milestone: TCS3 used in operations (replacing some non critical MCC functions).

5 **Task**: TO Panel
Construct the TO Panels (2 each, summit and development system).
Implement Development system Panels.
Install TO Panel at summit.
Project Man-months: 4
Major Milestone: TO Panel completed.

6 **Task**: Drive RA, Dec, Dome.
Purchase hardware to enable tcs1/tcs3 switch over.
Test Dome control.
Test RA, Dec Axis Control.
Project Man-months: 4
Major Milestone: TCS3 Drives RA, Dec, and Dome sucessfully

7. **Task**: Observers Paddles
Select/Purchase Observer's Hand Paddle replacement (3 each, summit(2) and development/Spare).
Implement Hand Paddle in Lab system, and install at summit.
Project Man-months: 3

Major Milestone: Hand Paddle completed.

8. **Task**: Replace motors
   Select/Purchase Motor Replacements. Install at summit.
   Project Man-months: 2
   Major Milestone: IRTF using new motors.

9. **Task**: Daytime Test
   Schedule Engineering (Daytime) Test:
   Switch from TCS1 to TCS3. Test RA, Dec, Dome control.
   Project Man-months: 2
   Major Milestone: TCS3 is ready for nighttime engineering

10. **Task:** Night Engineering
    Pointing calibration: Take pointing data, reduce, and input into TCS.

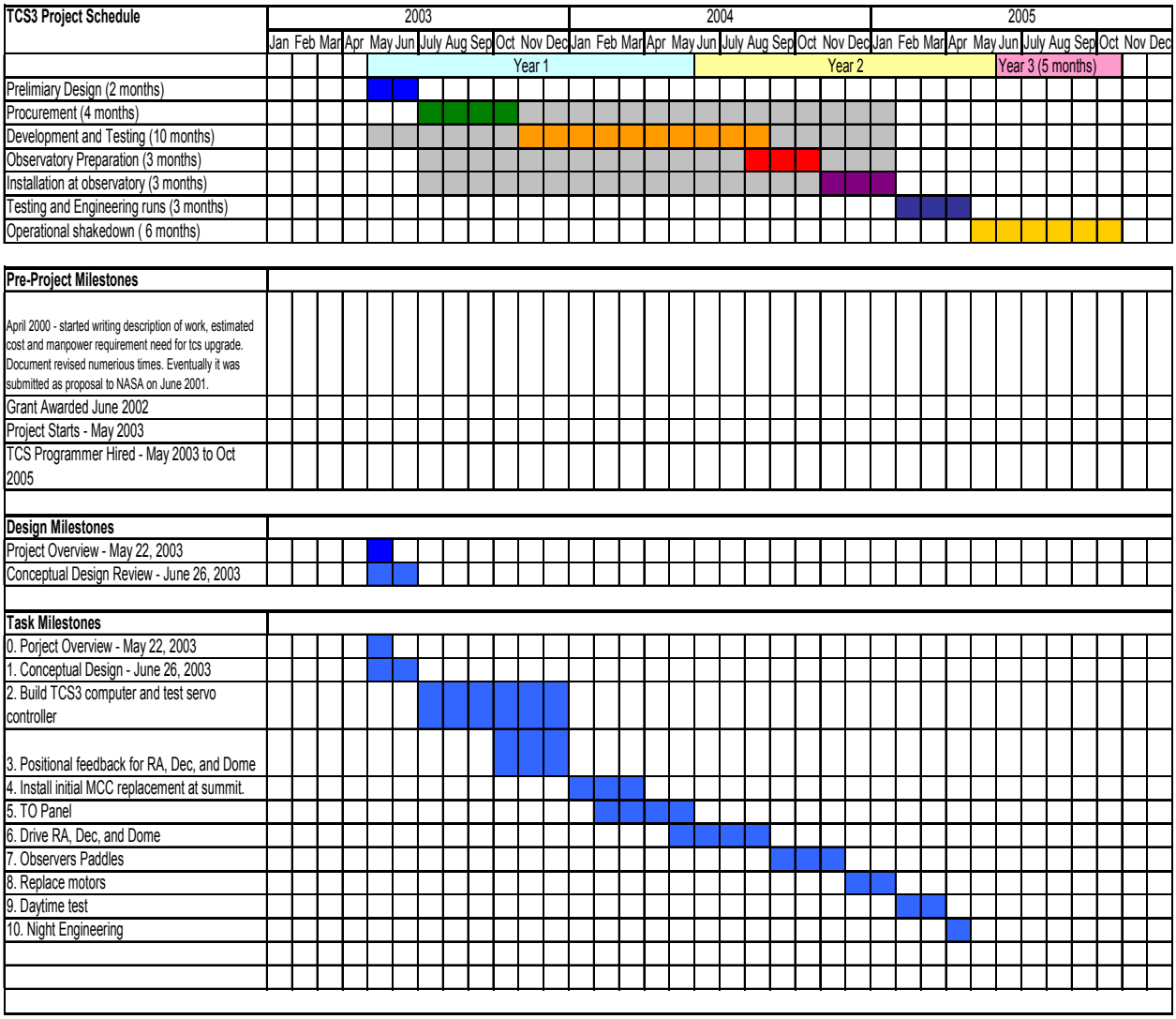


Figure 3.1 provides an estimated schedule and lists the major milestones.

4. Man Power

4.1 Core Project members:

Manager/Software Engineer: Tony Denault, 15 man-months. Provide day-to-day supervision of the TCS work. Participate in the development of the TCS software and assume responsibility for maintenance of the TCS software after the project is complete.

Electronic Engineer: Fred Keske, 19.5 man-months. Designs the electronics for the MCC and MCB replacements. Develops the interface between the TCS computer, and the observatory's analog/digital/mechanical systems.

Programmer: James Pantaleo, 30.0 months. Assembles computer system. Writes software.

Electronic Technician: Darryl Watanabe, 16.5 man-months. Build, test, and integrate all TCS hardware under the direction of the Project Manager and Electronic Engineer.

Figure 4.1 details the manpower estimates for the core members.

In addition to the core members, the various IRTF staff would assist in the TCS development.

Principal Investigator: (Alan Tokunaga, 1.5 man-months) – Checks up on everyone else.

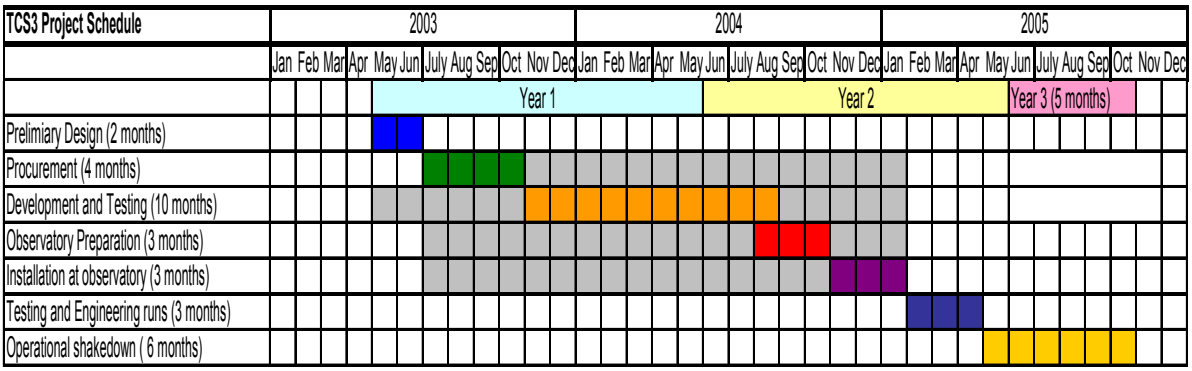
IRTF Chief Engineer: (Peter Onaka, 3 man-month) – Coordinates IRTF projects and man loading. Provide input to TCS design. Monitor status of technical project.

Mechanical Engineer: (TBD, 3 man-months) – Advise and oversee on selection, purchase, and installation of mechanical hardware. Two key area would be encode of RA, Dec axis, and replacement of the RA, Dec motors.

Day Crews support: (TBD, 12 man-months) – Provides input, support, and manpower during development and installation of the TCS.

Astronomer/TO (TBD, 6 man-months) – Provide input during the design and testing phase to insure a practical and efficient TCS is produced.

Facility Software Engineer (TBD, 3 man-months) – Update existing facility software (instrumentation software) to interface with the new TCS.



Man Power																																						Total
																																							Man-Months
Project Manager / Software					0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	15.00
Electronic Engineer					0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.25	0.25	0.25	0.25	0.25	0.25	0.25	19.50
Electronic Technician							0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75								16.50
TCS Programmer. Direct Hire					1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	30.00

Figure 4.1 – Core team member's man-power estimates

5. Budget

The TCS3 project is fund through the NASA grant, Replacement of the Telescope Control System for the IRTF, NRA-01-OSS-01 PAST. This is a 3 year project. The yearly awarded are:

Year 1	07/01/02 – 06/30/03	$300,000
Year 2	07/03/03 – 06/30/04	$322,000
Year 3	07/01/04 – 06/30/06	$ 72,000

The actually start of the project was delayed for almost a year. The actually Year 1 is 05/01/03 to 04/30/04. Year 2 and 3 should be adjusted accordingly. Figure 5.1 provide the current estimates of the TCS3 budget allocations.

	Year 1		Year 2		Year 3	
Awarded	$300,000.00		$322,000.00		$72,000.00	
Consulting	$24,800.00					
Equipment						
Computer & electonics						
computer system(s)	$13,000.00					
servo boards	$8,000.00					
Analog IO	$5,000.00					
Digitial IO	$5,000.00					
software	$4,000.00					
Computer & electronics (spares)	$35,000.00					
Servo simulator	$5,000.00					
Control Panels - TO and Observers						
MCC replacement	$3,000.00					
Observer's hand panel	$3,000.00		$7,000.00			
TO Interface Panel	$10,000.00					
TCS equipment rack						
19 rack &enclosures	$8,000.00					
Rack electronics	$15,000.00		$3,000.00			
cable & misc supplies	$3,000.00		$4,000.00			
TO Table	$3,000.00					
Observatory Hardware						
encoder replacement	$15,000.00					
switching between tcs1 & tcs3	$10,000.00		$4,000.00			
tcs drive, motor, servo amp			$40,000.00			
Supplies	$820.00		$1,000.00			
misc	$2,000.00		$5,000.00			
Personnel						
Software Engineer	$104,500.00	1 yr	$109,800.00	1 yr	$54,900.00	6 mon.
Electronic Engineer	$13,364.80	1 mon.	$40,094.40	3 mon.		
Electronic Technician	$0.00		$106,214.40	1 yr.		
Facilities/Admministrative Cost	$7,782.00		$230.00		$123.00	
Total	$298,266.80		$320,338.80		$55,023.00	

Figure 5.1 – Budget Summary