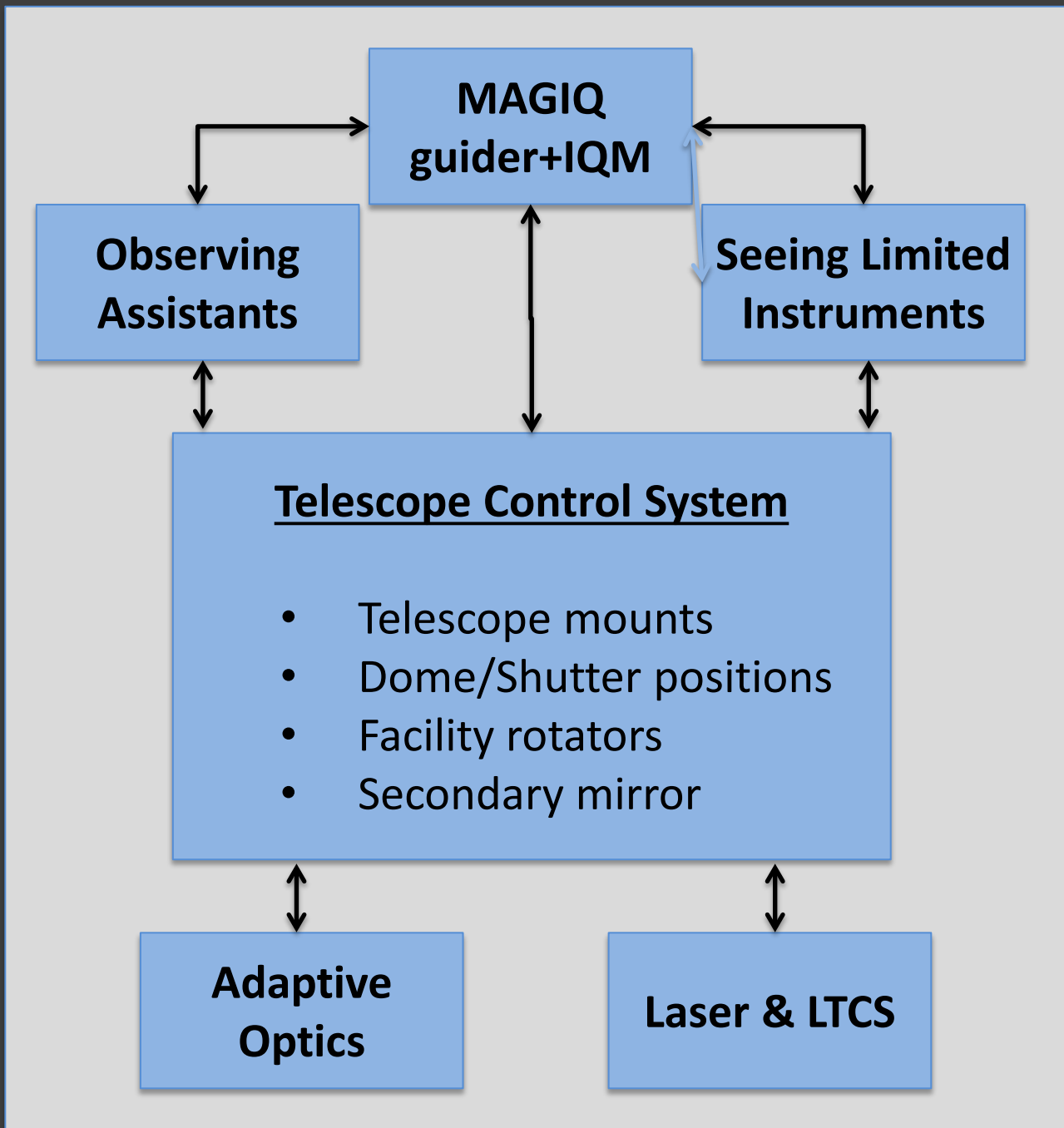# Keck Telescope Control System Upgrade

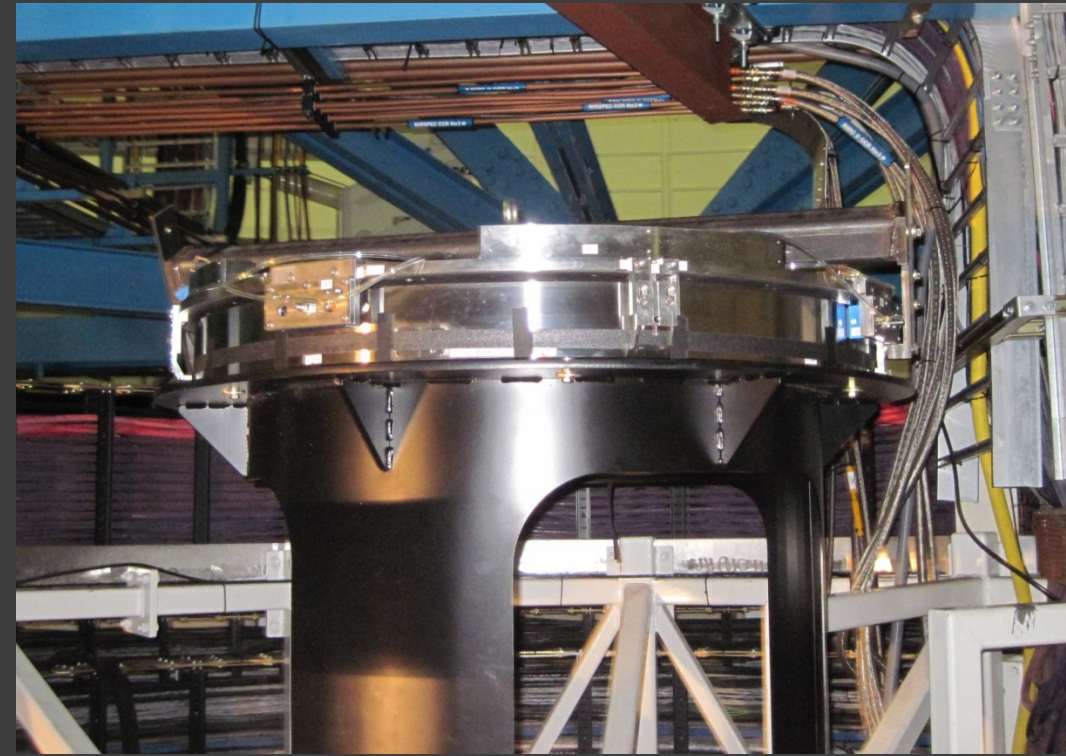## K. Tsubota, J. A. Mader
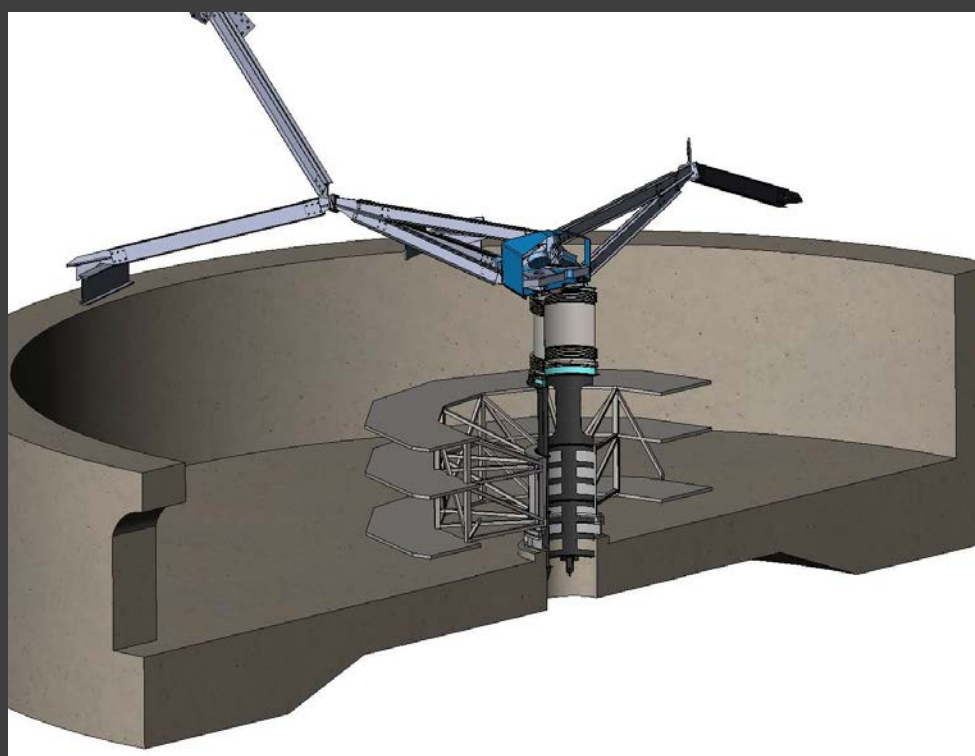
W. M. KECK OBSERVATORY
On the summit of Mauna Kea, Island of Hawai'i
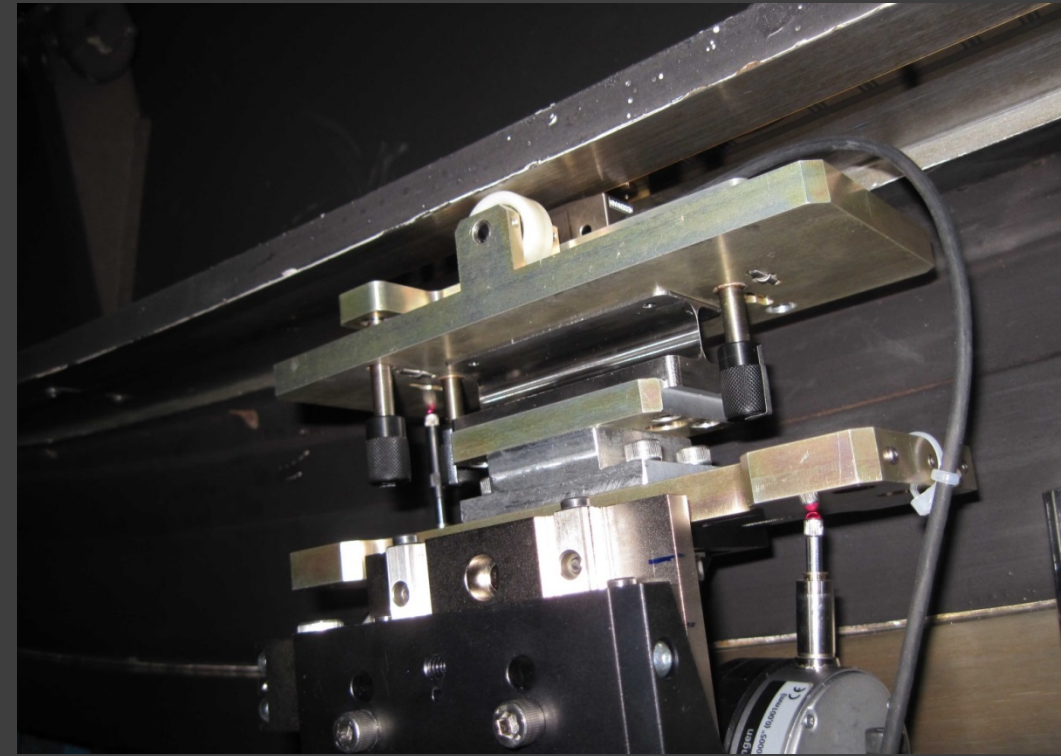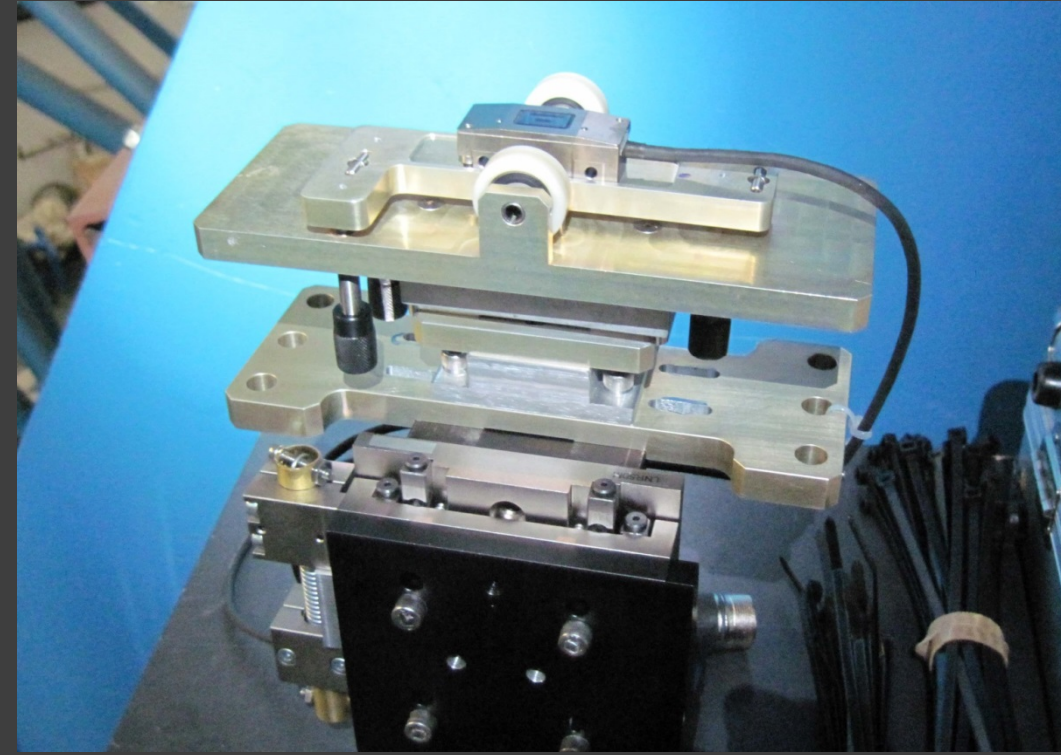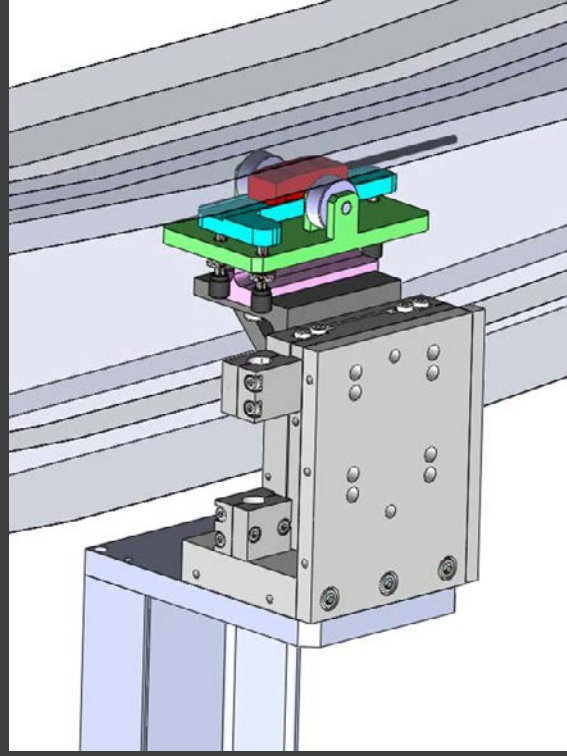
Overview

The Keck telescopes, located at one of the world's premier sites for astronomy, were the first of a new generation of very large ground-based optical/infrared telescopes wit the first Keck telescope beginning science operations in May of 1993, and the second in October of 1996. The components of the telescopes and control systems are more than 15 years old. The upgrade to the control systems of the telescopes consists of mechanical, electrical, software and network components with the overall goals of improving performance, increasing reliability, addressing serious obsolescence issues and providing a knowledge refresh. This poster will detail the implementation and testing for the Keck II telescope.

Telescope Control System (diagram)

MAGIQ guider+IQM

Observing Assistants

Seeing Limited Instruments

Telescope Control System
- Telescope mounts
- Dome/Shutter positions
- Facility rotators
- Secondary mirror

Adaptive Optics

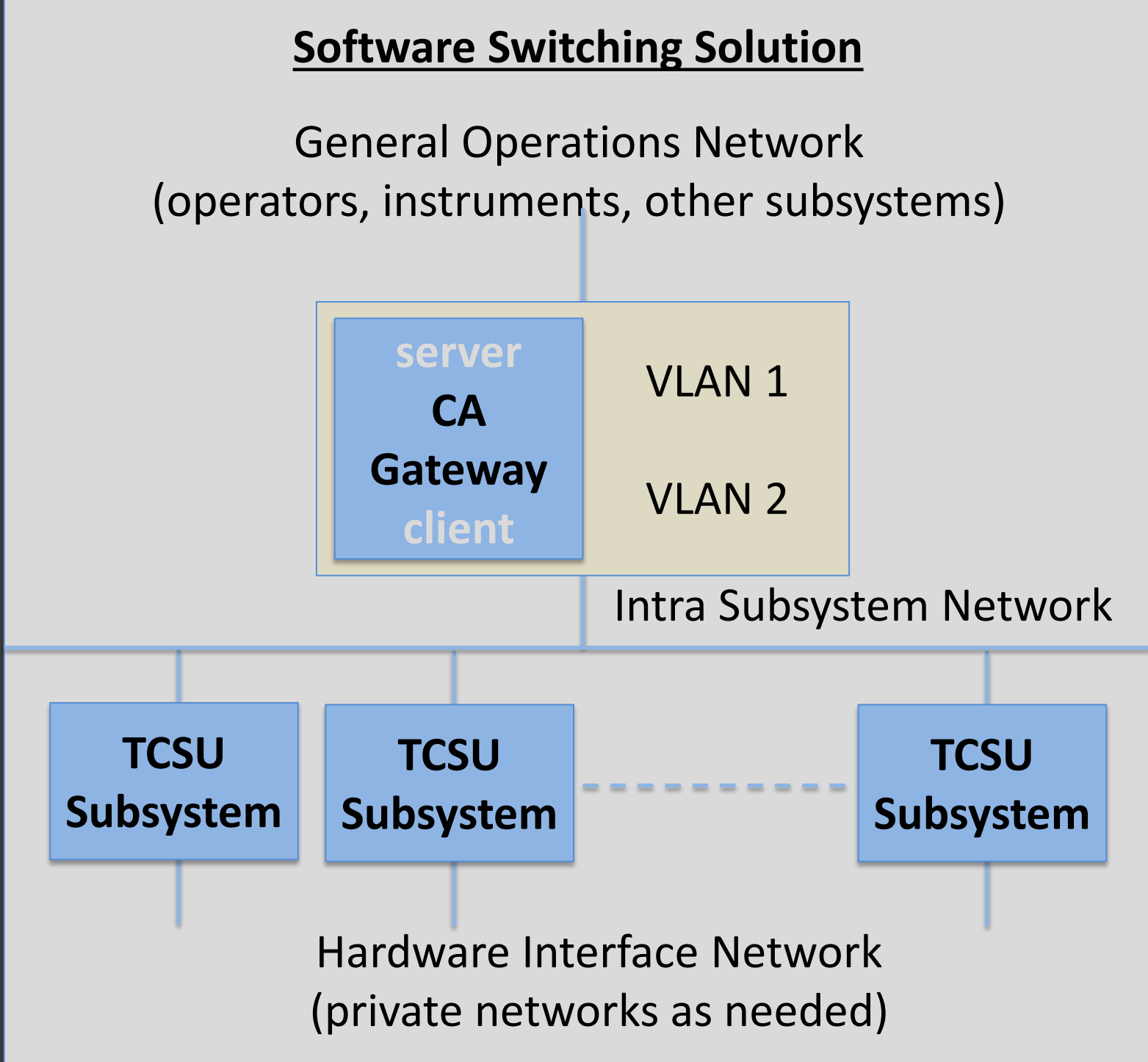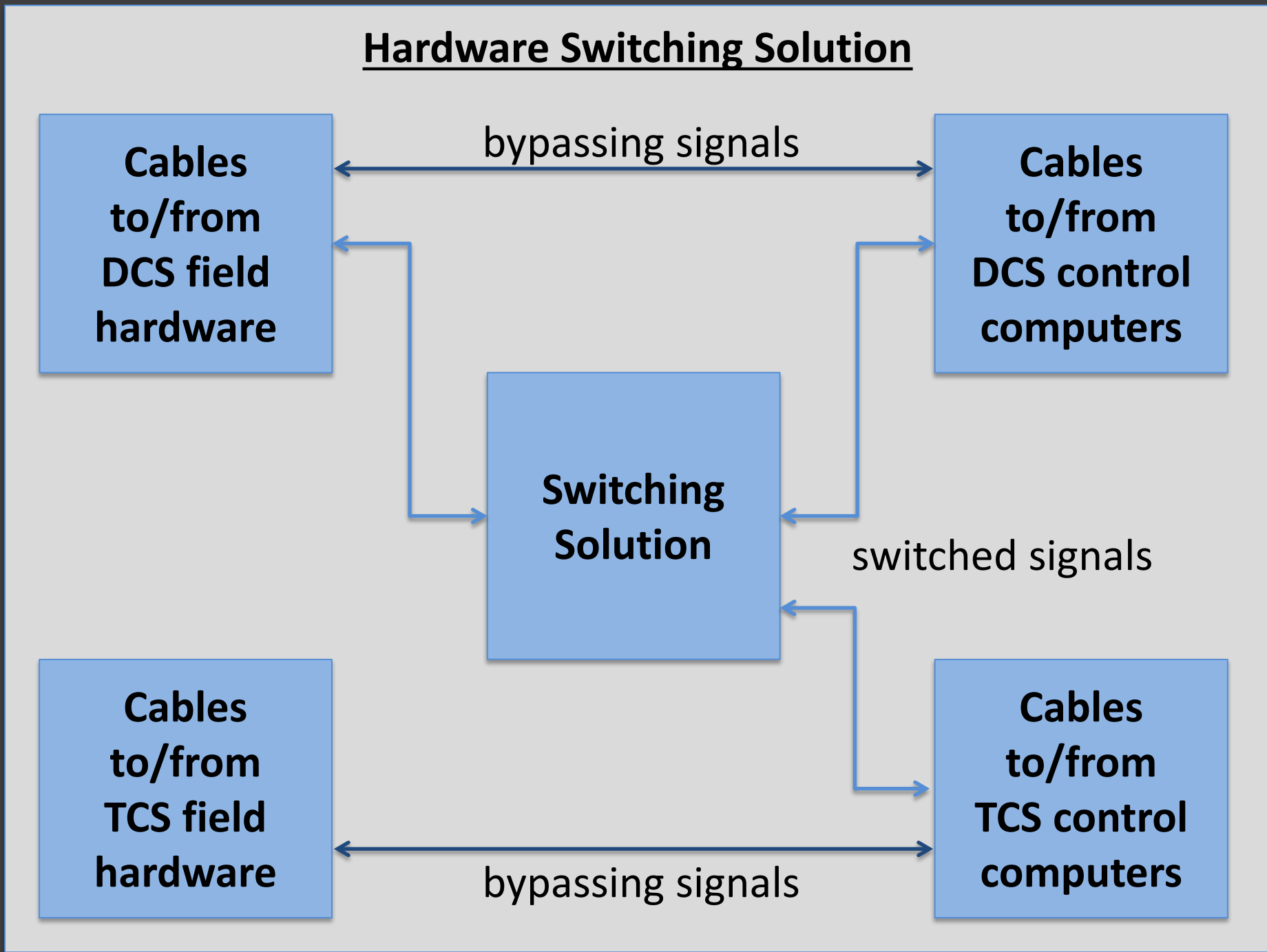Laser & LTCS
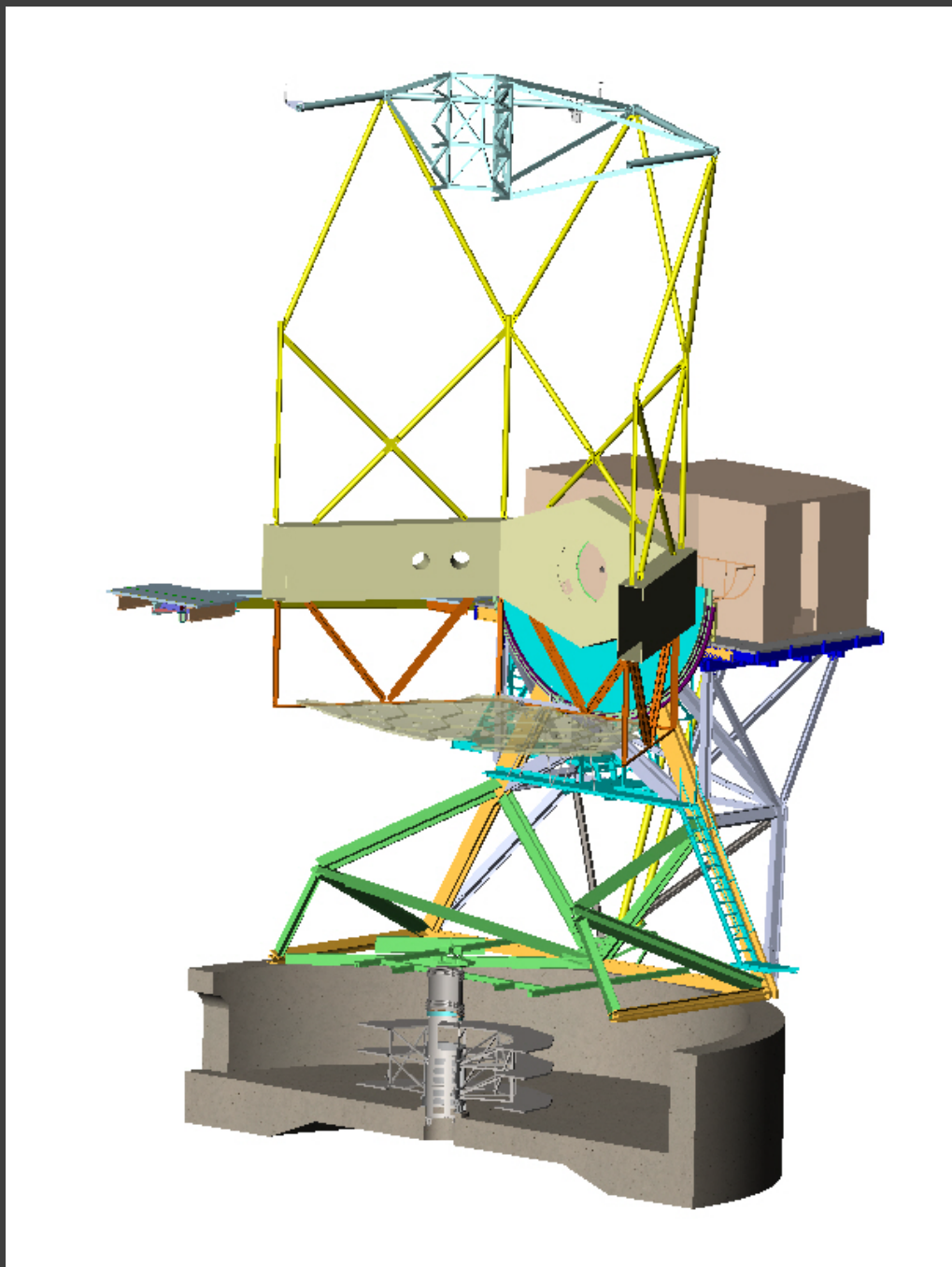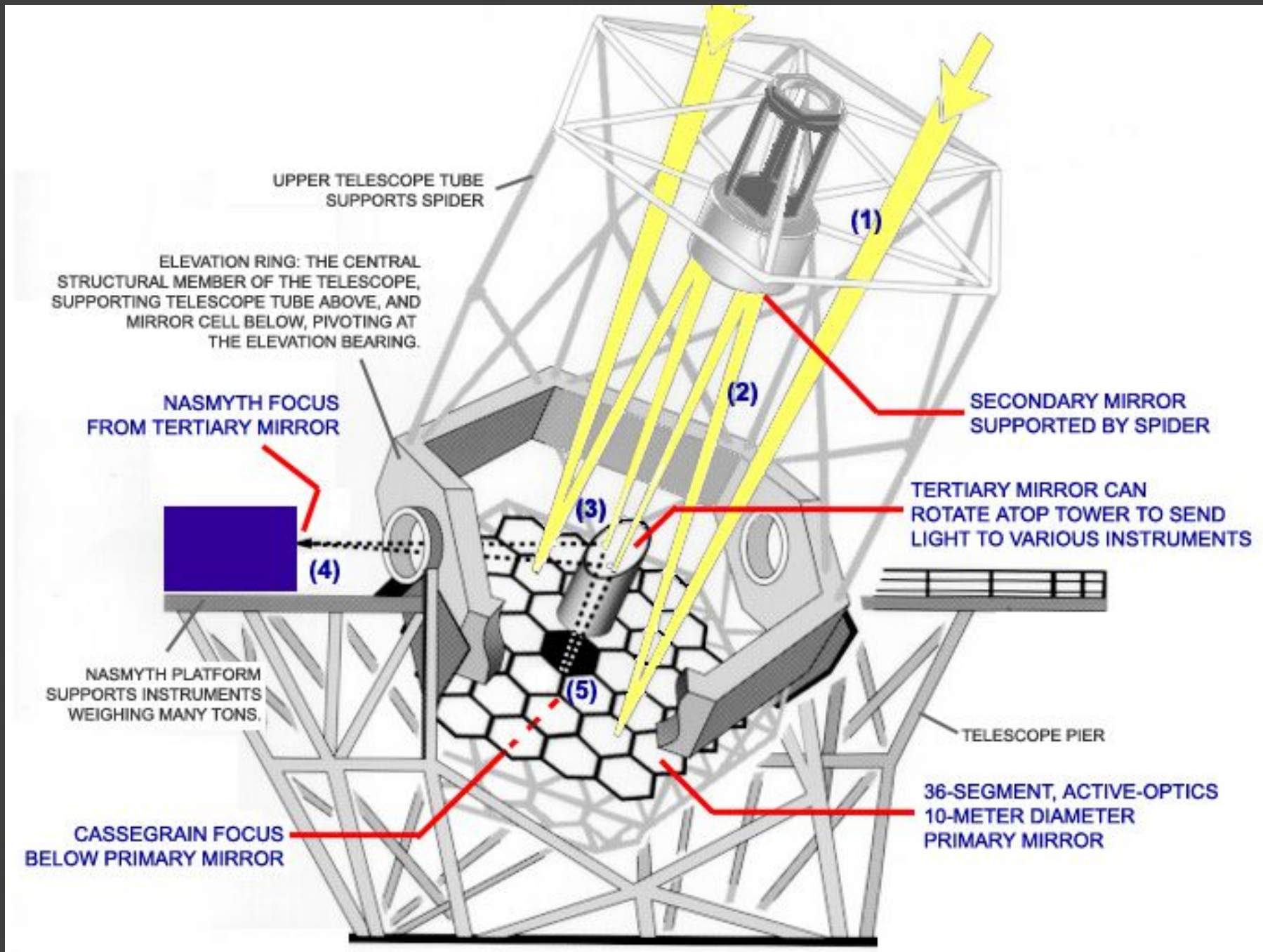
Azimuth Encoder System


Elevation Encoder System

Implementation

A switching solution has been implemented for both hardware and software systems to allow quick and easy switching between the operational and upgraded control systems.

Hardware Switching Solution

Cables to/from DCS field hardware — bypassing signals — Cables to/from DCS control computers

Switching Solution — switched signals

Cables to/from TCS field hardware — bypassing signals — Cables to/from TCS control computers

Software Switching Solution

General Operations Network
(operators, instruments, other subsystems)

server
CA Gateway client
VLAN 1
VLAN 2

Intra Subsystem Network

TCSU Subsystem — TCSU Subsystem — TCSU Subsystem

Hardware Interface Network
(private networks as needed)

Testing

Levels of Testing

- Developer
- Hardware Checkout
- Unit Testing
- Functional Unit Testing
- System/Acceptance Testing
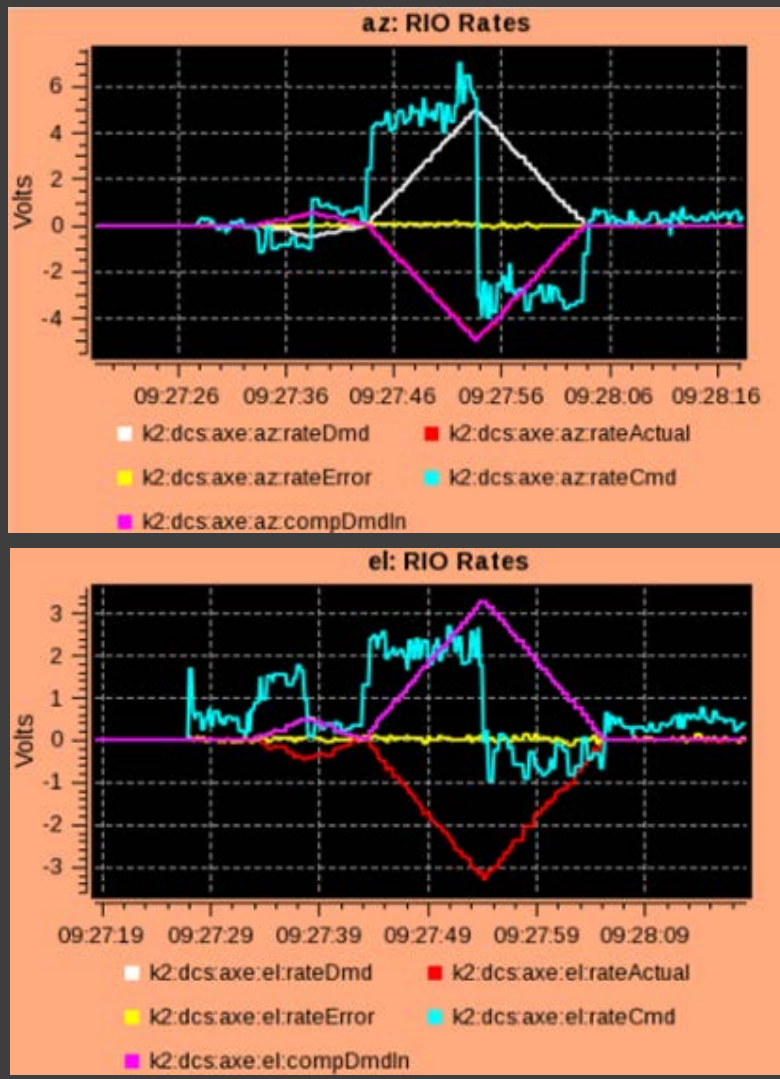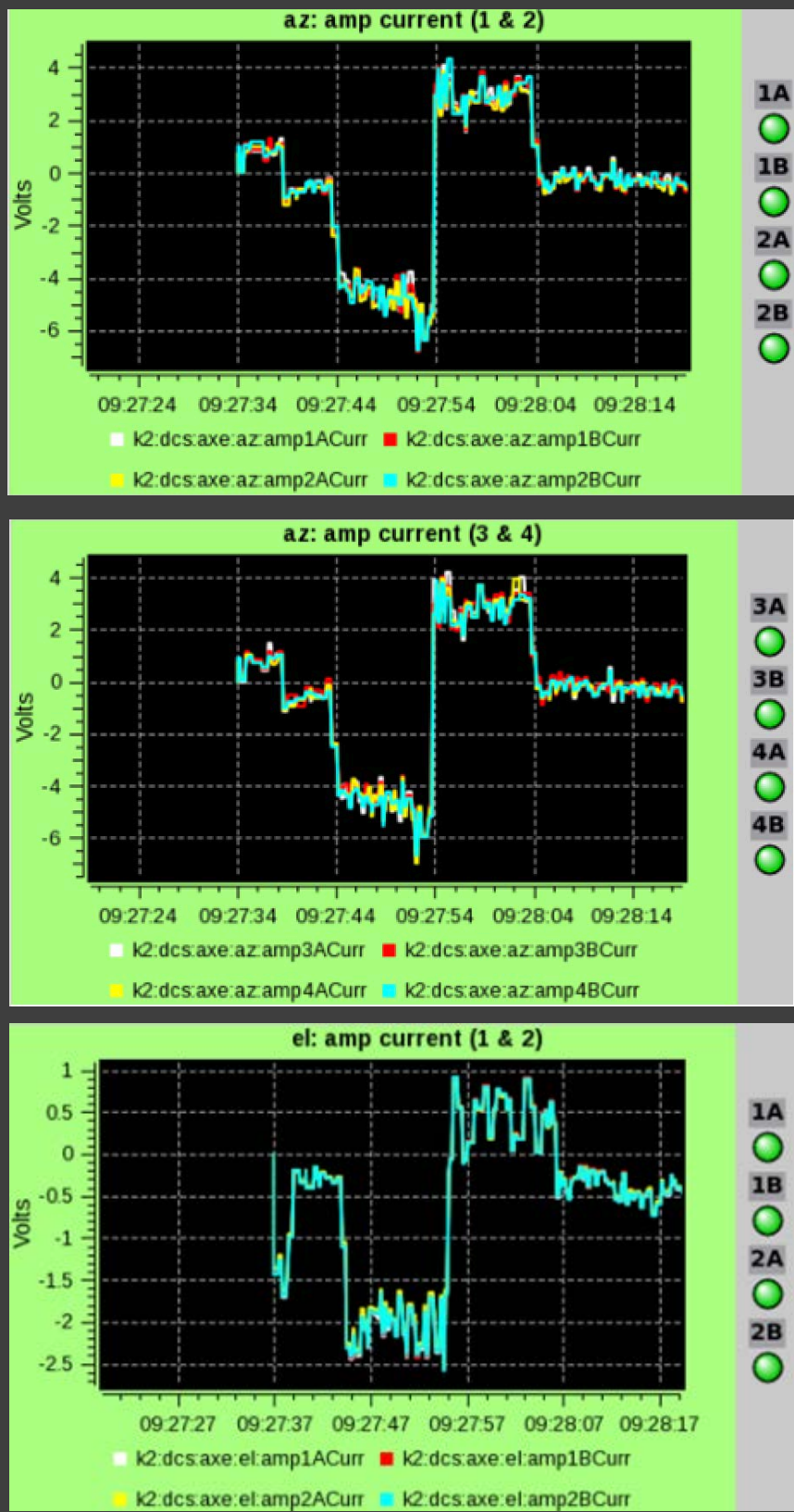
Keck II Offset Moves Settling Times

Telescope Moves (arcsec)	1	5	10	50	100	1000	10000
Time Requirement (sec)	0.3	1.0	1.0	3.0	3.0	10.0	20.0
AZIMUTH							
DCS System (2011)	0.8	2.7	2.8	-	5.0	9.9	19.2
TCS No Feed Forward	1.8	2.4	2.5	3.9	4.8	-	-
TCS Single Path With FF	1.1	1.2	1.5	2.7	3.3	-	-
TCS Double Path With FF	0.7	0.9	1.2	2.4	5.8	-	-
ELEVATION							
DCS System (2011)	3.2	2.6	2.6	-	5.7	10.3	23.4
TCS No Feed Forward	2.7	4.2	5.1	6.0	-	-	-
TCS Single Path With FF	0.9	2.6	3.1	3.7	5.2	-	-
TCS Double Path With FF	2.1	2.9	2.6	3.8	5.1	-	-

Successes

Hardware switching solution
- Simple procedure
- Three switches
- A couple cables
- Implemented on a subsystem by subsystem basis
- Freedom in testing

Software switching solution
- Change port number
- Run in parallel with current system day and night

Backwards compatibility
- Didn't have to re-validate existing client applications

Challenges

Coordinating with other projects
- Operations has highest priority
- May get bumped by other projects

On-sky testing
- Scheduled months in advance
- Need to ensure readiness
- Weather

Servo tuning

Timing issues at 100 Hz

Current Status

Keck II	All subsystems fully integrated and tested	Operations Readiness Review Dec. 2015
	Successful on-sky tests completed	Deploy in late Jan. 2016
	Continuing fine-tuning of servo	
Keck I	Hardware installation to be completed in Nov. 2015	Integration and testing expected by Mar. 2016