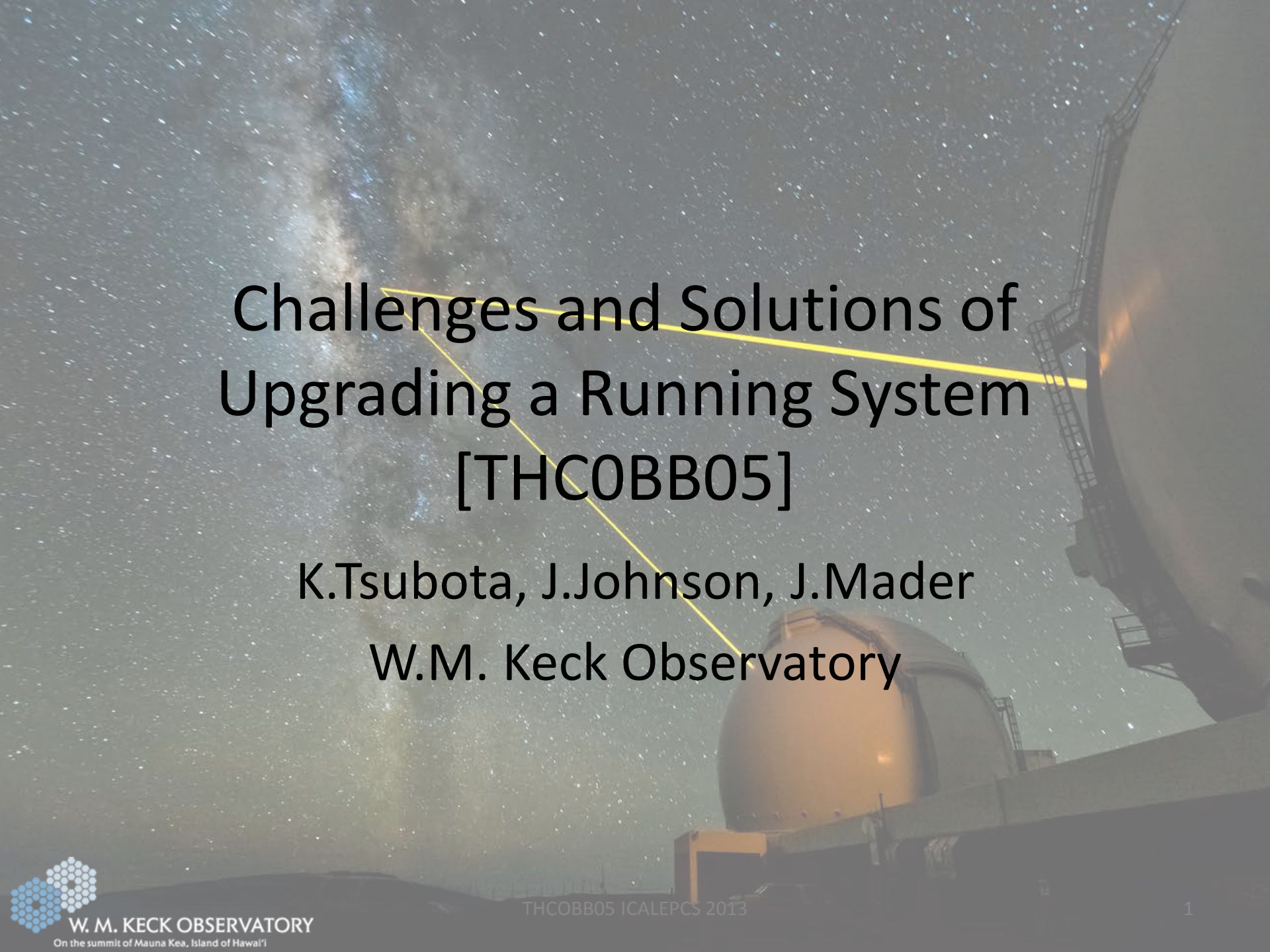

Challenges and Solutions of Upgrading a Running System [THC0BB05]

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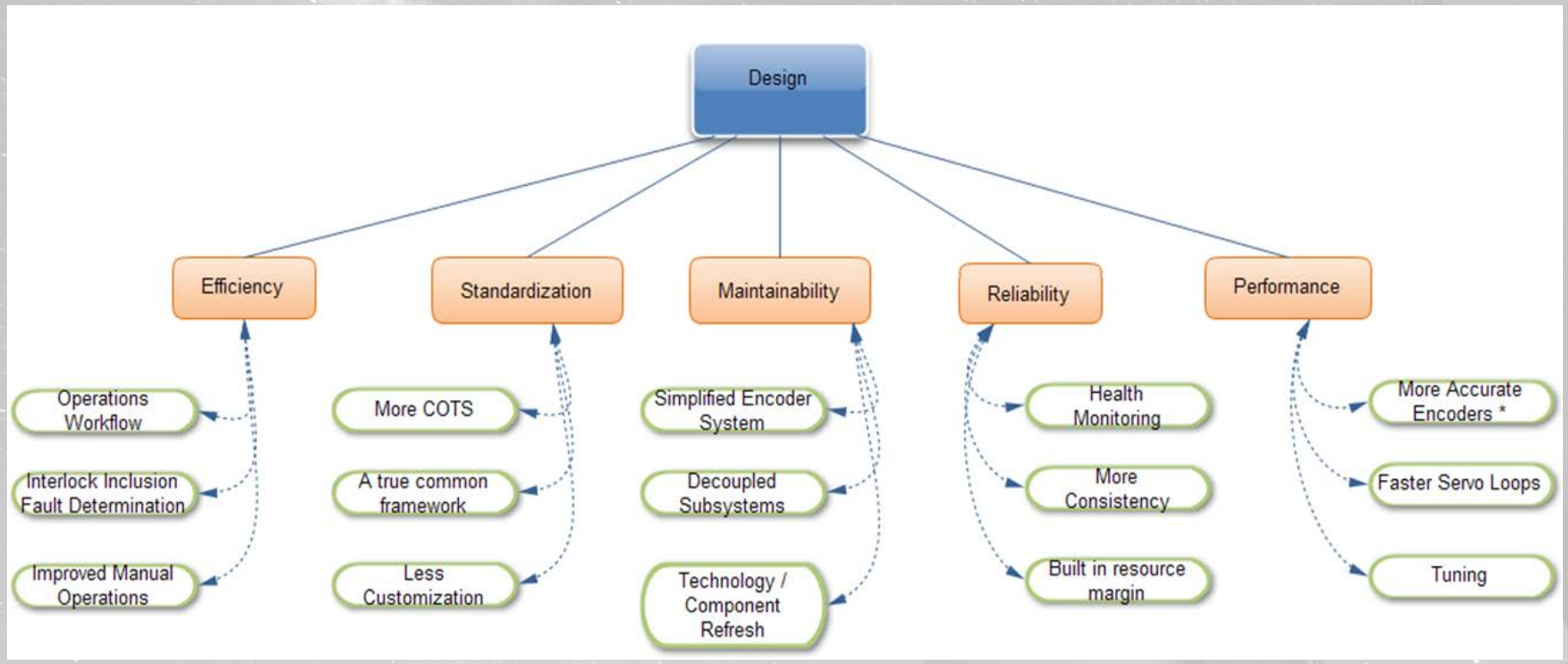
On the summit of Mauna Kea, Island of Hawai'i

Overview

- MOCOAAB05: Keck Telescope Control System Upgrade Project Status
  - Major telescope control system upgrade
  - Knowledge and technology refresh to
    - Improve efficiency, maintainability, reliability, standardization, and address obsolescence
  - Changes include hardware interface cards, telescope encoders, controllers, servers, and software
- Biggest challenge will be during integration and commissioning
  - Minimize telescope downtime
  - Ensure fail-safe reversion

Design Goals



Switchover Criteria

- Ability to quickly and reliably switch between existing and new systems
- Minimal telescope down time
- Allow subsystem by subsystem upgrades
- Backwards compatibility
- No “point of no return”

Solutions Identified

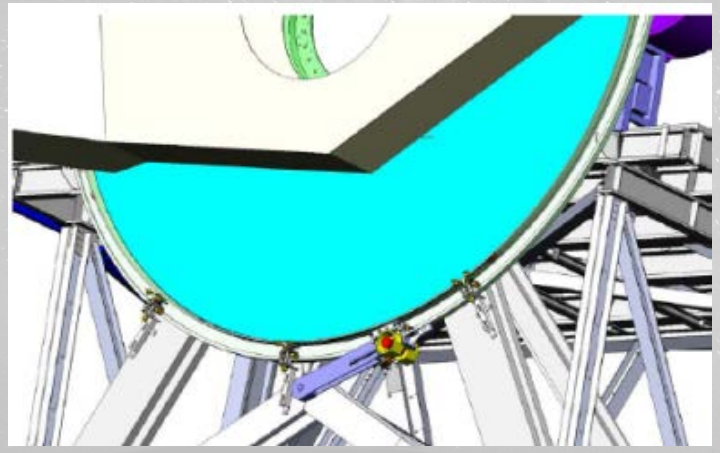
- Analysing the areas impacted by the upgrade resulted in a multiple solution approach
  - Parallel operations
  - Signal splitting
  - Switching signals
  - Modularity
  - Software backwards compatible

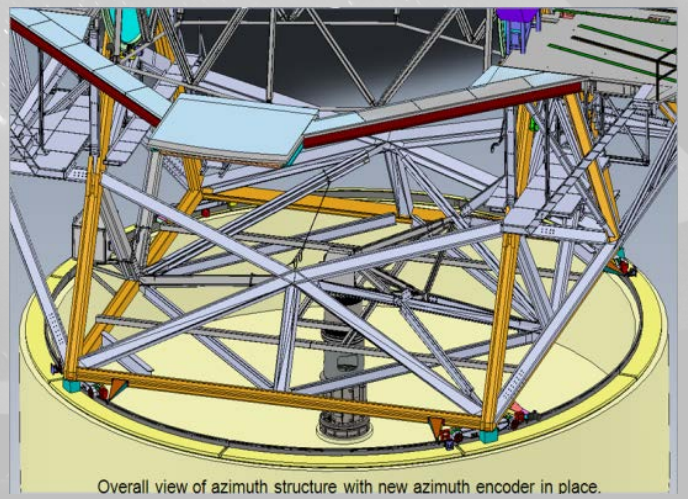
Parallel Solution

- Allows work on the new system without impacting the existing system
- Not necessary to revert back to an operational system
- The preferred approach
- Identified key areas for parallelism
  - Telescope azimuth and elevation encoder systems
  - Secondary controller
  - Pointing software subsystem

Parallel Solution: Telescope Encoders

- Involved finding a suitable place to install the new system without interfering with the existing system
- Elevation prototype implemented
- Azimuth prototype just starting

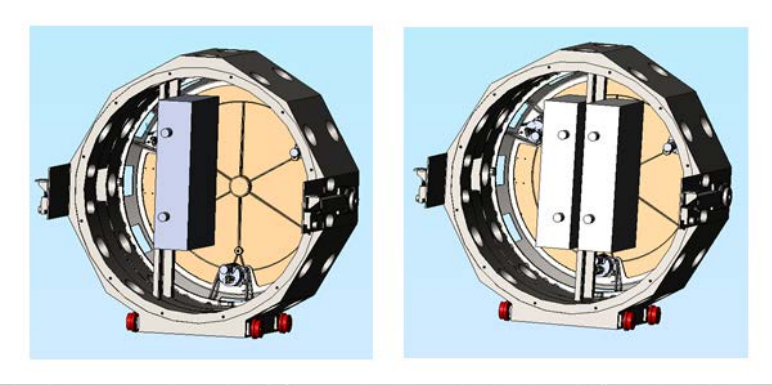


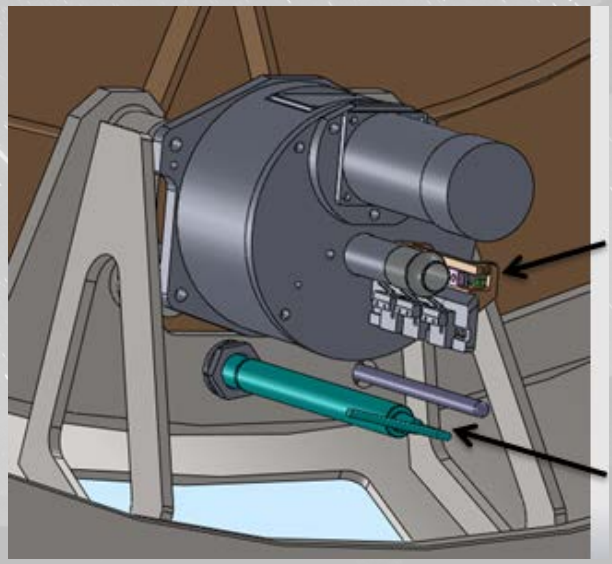


Overall view of azimuth structure with new azimuth encoder in place.

Parallel Solution: Secondary

- Adding additional electronics cabinet side by side
  - Requires cable switching for drives and flex I/O
- Also adding new position encoder and home switch in parallel





Parallel Solution: Pointing Software

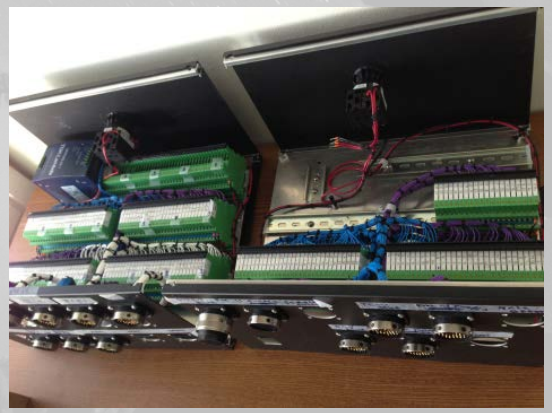
- Pure software solution
- Deployed on a new server
- Running in parallel with operational system
  - Uses different name prefix ID
  - Reads actual operational inputs to calculate outputs
  - Logs inputs and outputs to compare with operational system

Signal Splitting Solution

- Simple tapping/teeing off of a signal so both systems receive them simultaneously
- Requires careful cable construction and installation
- About 1/3 of all telescope and rotator signals are split using this method
- Signals include current monitoring, faults indicators, limits switches, control switches, and status signals

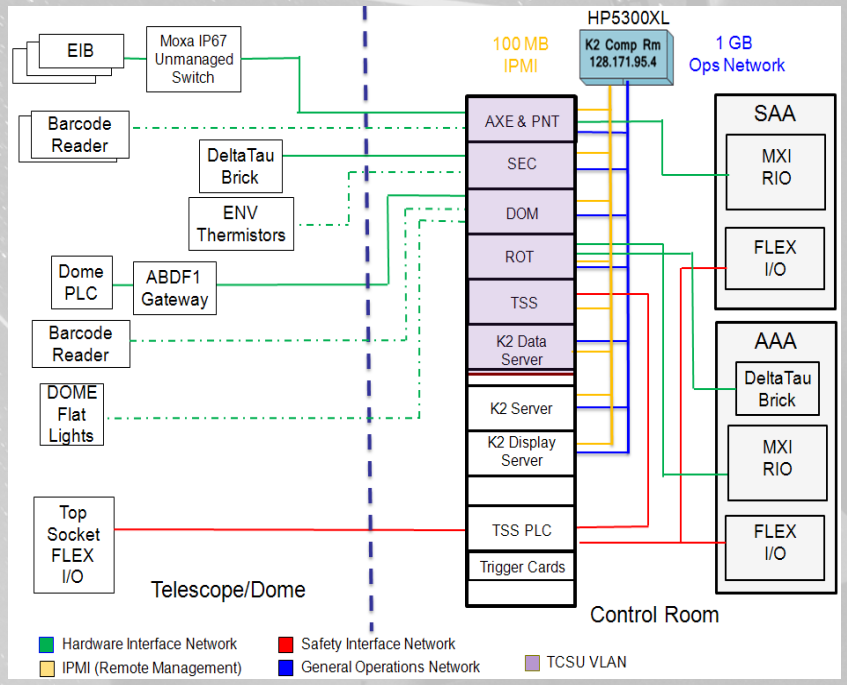
Signal Switching Solution

- Physical switch box to route signals to one or the other system, not both
- Implemented as a simple relay solution
- Operates off a single control line that will switch all connected field I/O
- Switching will not be a casual over and back operation
  - Requires some downtime



Modular Solution

- Functional and physical split of systems
- Migrated from 2 VME crates to 5 Linux servers, one for each hardware subsystem
- Additional Linux servers for high capacity archiving, logging, alarming, and supervisory control



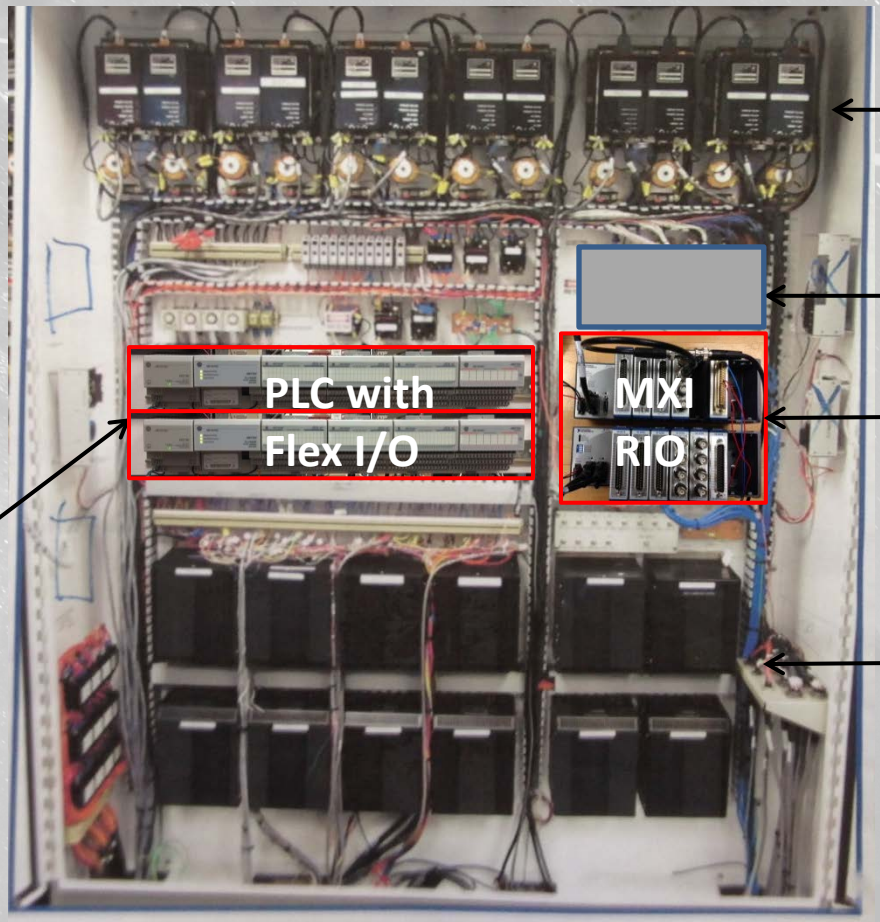
Modular Solution: Field I/O

- Subsystem controller and field I/O hardware attempt to share common implementation
  - Linux server supports PCI-e bus
  - Preferred solution is Ethernet based hardware
    - Delta Tau Brick, Heidenhain EIB, Allen Bradley Control Logix PLC with Flex I/O

	Controller Hardware			External Hardware									
				New					Existing				
Subsystem	BC635	RocketPort Express	NI MXI I/F	NI RIO	Delta Tau Brick	Heidenhain EIB	AB Control Logix PLC	AB Flex I/O	AB PLC-2/5	Daytronics Thermistors	Accusort Barcode	Keithley Temp Sensors
AXE/PNT	X	X	X	X		X		X			X	
DOM	X	X							X		X	X
ROT	X		X	X	X			X				
SEC	X	X			X			X		X		
TSS	X						X					

Modular Solution: Servo Amplifier Assembly

- Modular with switching



Software Backwards Compatible

- Maintaining backwards compatibility with the existing software control system was a key design goal
- Decided to stay with EPICS and upgrade to newer OSI versions and newer EPICS tools

  - Supports parallel solution model
  - Custom Keck Transport Layer (KTL) for high level interfacing and operational tools (maps logical names to EPICS PVs) remains 100% reusable
- Easily allows for subsystem by subsystem replacement
- No existing high level scripts or tools need to be updated
  - Newer tools can be released in parallel

Conclusions

- It can be done!
- Integration needs to be thought through and designed into the upgrade from the beginning
  - But you should still expect some complications
- Applying these solutions allows
  - Standalone testing with minimal interference
  - On-sky testing without affecting operations
  - Less risk to operations