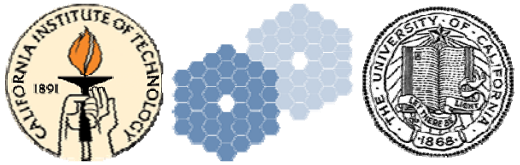


Electronics Architecture Mini-Review

Contributors: Ed Wetherell, Erik Johansson, Jason Chin, Kevin Tsubota

26 Jan 2010

Schedule

The agenda for the review is as follows (times are HST):

- 8:15 AM: Welcome and introductions
- 8:30 AM: Presentation
- 9:30 AM: Break (Lunch in CA)
- 10:00 AM: Open discussion
- 11:00 AM: Review committee closed session
- 11:45 AM: Review committee feedback to team

Agenda

- Review Committee Charter
- Scope of the Review
- Nasmyth Enclosures (definition)
- Requirements
- Control Electronics and Status
  - AO
  - Laser
  - Common Equipment
- Review Committee Comments
- Summary of Concerns
- Plans for PDR

Review Committee Charter

- Reviewers:

  Thomas Stalcup (WMKO, chair)
  Tomas Krasuski (WMKO)
  Rich Dekany (CalTech)

- Are the requirements understood?
- Does the proposed electronics satisfy the requirements?
- Is the architecture
  - Complete?
  - Technically feasible?
  - Cost effective?
- Is the architecture sufficiently mature that it can be developed to the PDR level by the 2nd Qtr of 2010?

Scope of the Review

- Control electronics architecture
  - Electronics used throughout the various NGAO subsystems to provide some form of configuration, control and / or status
  - Includes power control, environmental control, camera configuration, general sub-system control (e.g., the laser units, the RTC) and the controls infrastructure
- Not in the scope of this review:
  - Overall architecture of the NGAO control system or the top-level design of the NGAO control system
  - Motion control devices
  - Real-time control devices for wavefront sensing and correction
  - Software controls
  - Effort Estimates
  - Budget
  - Schedule

Nasmyth Enclosures

- *Nasmyth Lab (AO clean room / enclosure)*
  - *Clean room with TBD classification*
  - *Temperature regulated to ~0°C (dome ambient)*
  - *May require humidity control*
- *Cold Box*
  - *Enclosure housing the AO bench*
  - *Located within the Nasmyth Lab*
  - *Temperature regulated to -15°C (+/- TBD)*
  - *Humidity controlled*
- *Electronics Vault (e-vault)*
  - *Isolated area for electronics racks*
    - *Some equipment located inside Nasmyth Lab*
  - *On Nasmyth platform*
    - *Joined to (shares wall with) the Nasmyth Lab*
  - *Temperature regulated to ~17°C (+/- TBD)*

Requirements Compliance (1)

- Given the broad scope, locating all of the relevant requirements has proven challenging
- More effort required to
  - Verify all requirements have been identified
  - Determine compliance
  - Address deficiencies in requirements and compliance
- Not in compliance
  - NGAO Power Requirements (FR-3, 1442, 1907, 1297)
    - 30kW maximum, entire system (FR-3)
    - Subsystem allowances already exceed this
    - Requirement(s) will be revised/added
  - Vibration monitoring / accelerometers (FR-23, INT-169)
    - Currently not part of design (KAON 668/701)
    - Required for Interferometer OPD correction
    - Need to work out what is needed, refine requirements and update design

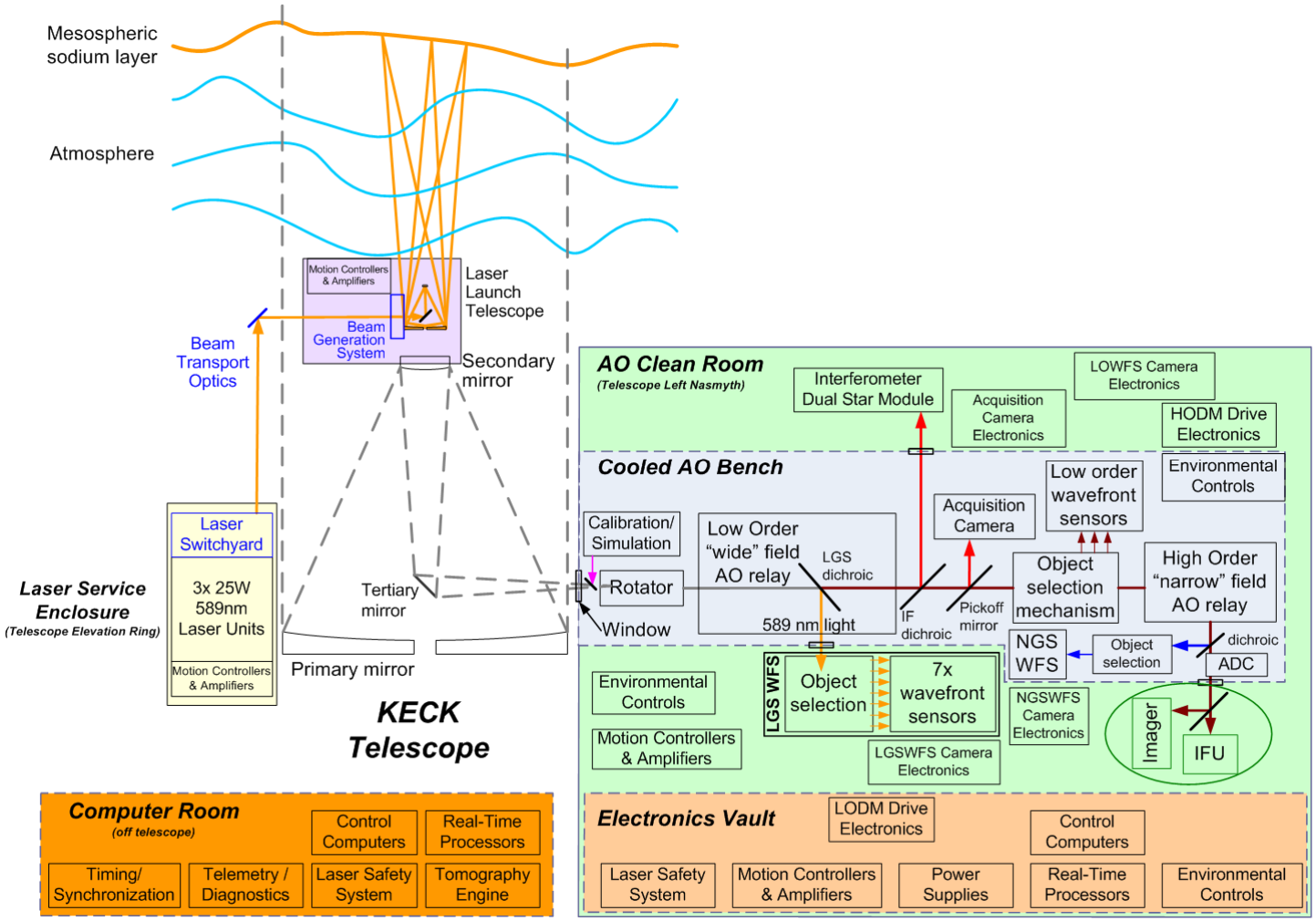
Requirements Compliance(2)

- Not understood / not clearly defined
  - Clean up locations (FR-24, 25, 26, 27, 28, probably more)
    - Not sufficient distinction between various enclosures
      - Nasmyth Lab (AO clean room), Cold Box (AO cold bench), Electronics-Vault, Laser Service Enclosure
    - Some requirements specify location, others don't
    - Some locations incorrect
    - Some requirements apply to multiple locations
  - Background light monitors (FR-29)
    - Not understood
    - Should be addressed by existing components/architecture
    - Revise requirement
  - Clean up device lists (FR-1829, 1830, 1834, 2144, 2149)
    - Requirements do not match current design
    - De-couple requirements from specific devices ?
  - Clarify the requirements for Interferometer support (INT-162, 169, 170)
    - Revise to address supported modes: ASTRA and OHANA (?)
    - V^2 and Nuller not supported; collimated output not available from NGAO
  - Clarify requirements for Uninterruptible Power (UPS)
    - Requirements not complete or missing

Requirements Compliance(3)

- New requirements
  - Itemized in compliance spreadsheet
  - Lots of infrastructure things
    - Phone
    - (Emergency) Lighting
    - Electrical
    - UPS
    - Smoke detection / Fire suppression
  - Emergency stop input/output
  - Electrical panel(s) with shunt-trip
    - Hardware protection for enclosures from over-temp
  - Covers for IF ports in NasLab floor

Control Electronics Overview



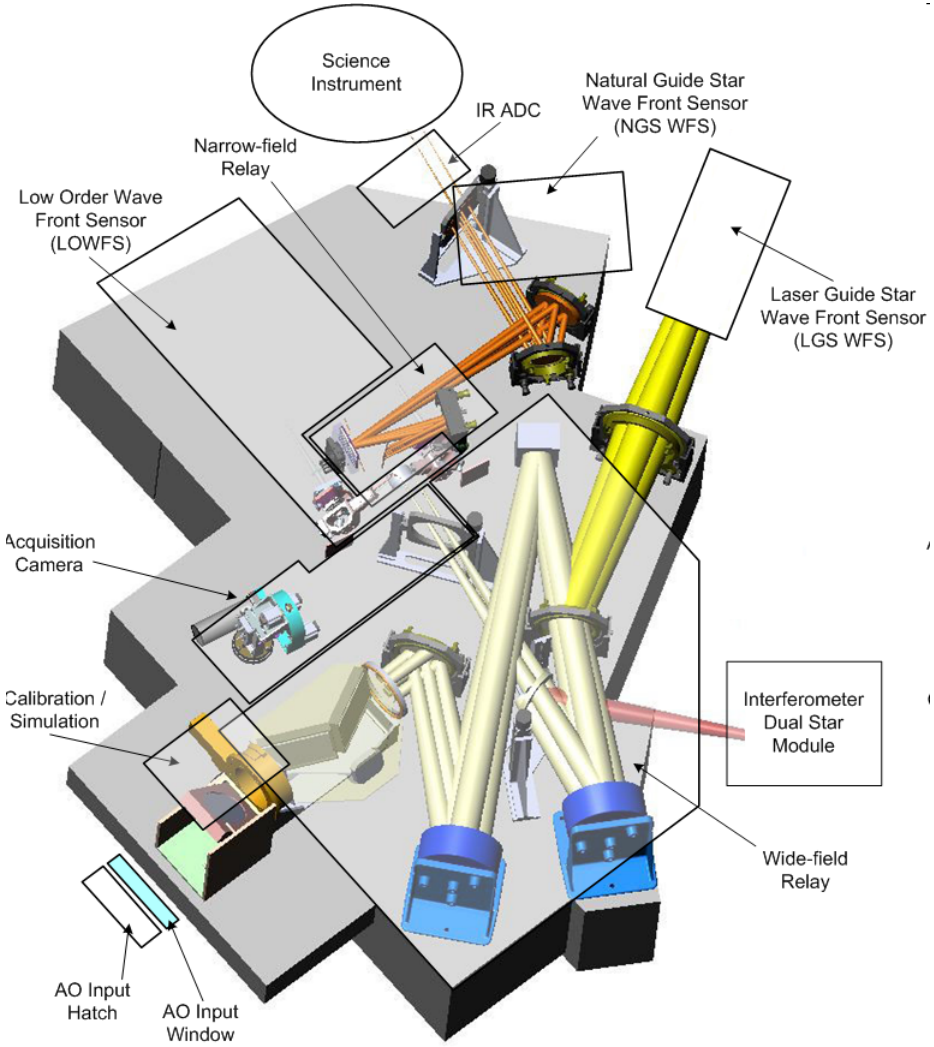
Control Architecture Overview (1)

- Ethernet is primary means of communication
  - Distributed control
    - Limit use of crates
  - Low cost, robust infrastructure
  - Use terminal servers if needed
  - Use industrial protocols (ModbusTCP, etc); avoid HTTP
  - Design network with appropriate VLANs and private areas
- Dedicated interface for safety critical systems
  - Emergency Stop
  - Laser Safety System
  - Local/remote capability for motion devices
- Equipment will be rack-mounted whenever possible
  - Standard 19” form factor
  - Easier to manage heat/power
  - Distributed nodes may be different

Control Architecture Overview (2)

- Architecture also includes
  - Cabling
    - Nasmyth area will be challenging
    - Goal to include cabling in SolidWorks model
    - Cold box
      - Bulkhead connections whenever possible
      - Clamp seal as required
      - Some cabling has (sort) length constraints
    - Telescope cable wraps
      - Space concerns
  - Power
    - UPS
  - Timing/Synchronization
  - Volume and mass estimates
  - Glycol, CCR

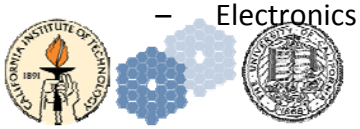
AO System


Science Instrument
IR ADC
Natural Guide Star Wave Front Sensor (NGS WFS)
Narrow-field Relay
Low Order Wave Front Sensor (LOWFS)
Laser Guide Star Wave Front Sensor (LGS WFS)
Acquisition Camera
Calibration / Simulation
Interferometer Dual Star Module
Wide-field Relay
AO Input Hatch
AO Input Window

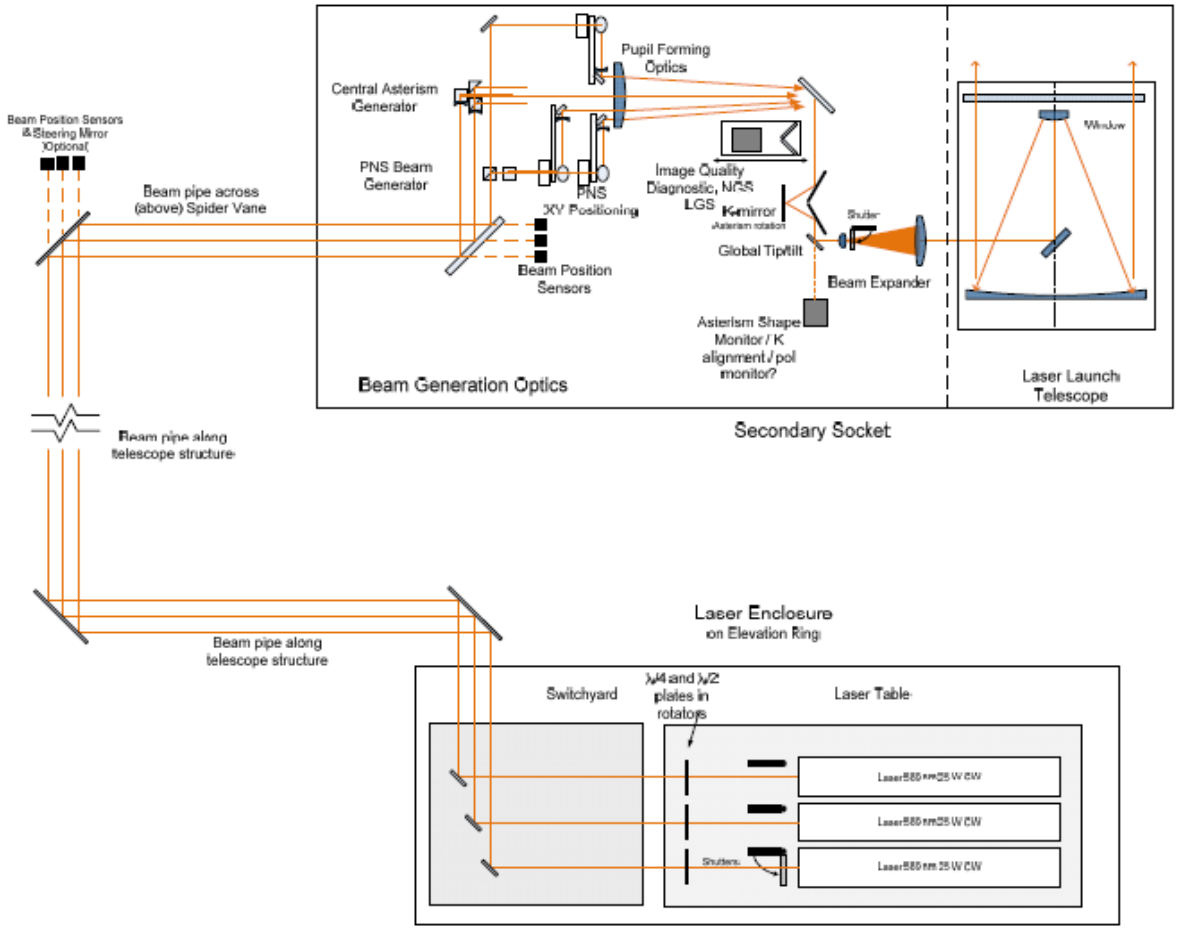
Design Status: AO System

- RED = problems; Blue= not done/no problems foreseen; Green= (nearly) complete

- Relays
  - Wide-field: complete except for T/T stage
  - Narrow-field: complete except for T/T stage
- Wavefront Sensors
  - Laser Guide Star: complete except for details on cameras
  - Natural Guide Star: more research required
  - Low Order:
    - Mini-review scheduled for February
    - Received input from Kent Wallace regarding design
- AO Input Hatch: complete
- Calibration / Simulation: design not mature, documented at a conceptual level
- Acquisition Camera: complete except for details on cameras
- Atmospheric Dispersion Compensator: complete – only motion control identified
- Real Time Control System Computers: more research required
  - Mostly documentation work remaining
  - Need to work on power/volume tables
  - More research on synchronization system
  - Understand camera interfaces
- Enclosures: Dependant on incomplete subsystem designs
  - Cold Bench
  - AO Clean
  - Electronics Vault



Laser Guide Star Facility



Design Status:
Laser Guide Star Facility

- Laser units: pending vendor selection
- Switchyard: nearly complete
- Beam Transport Optics System: complete, minimal impact on electronics architecture
- Beam Generation System: nearly complete
- Launch Telescope: In progress
- Laser Safety System: In progress
- Laser Service Enclosure: In Progress

Design Status: Common Components/Infrastructure (1)

- Motion Controllers: Revisit once motion control architecture is finalized
  - Rack space, power and digital I/O will be required
- Control Computers: Dependant on incomplete subsystem designs
- Communication Infrastructure: Nearly Complete
  - Understood, need to consolidate subsystem requirements
- Time Infrastructure (synchronization): Area of Concern
  - Trying to understand what is needed by NGAO
    - Specifically sync between various (distributed) components
  - Initial investigations indicate that existing infrastructure (GPS time) meets requirements for UT accuracy
  - Work w/ RTC designers to understand the breakdown of responsibility
  - Work w/ TCS upgrade project to ensure compatibility

Design Status:
Common Components/Infrastructure (2)

- Off-Telescope Cabling: Area of Concern
  - Consolidating needs of NGAO
  - Working with OID/facilities and TCS upgrade project to understand available space in cable wraps
    - Existing usage not well documented
    - Additional research required
- Power: Area of Concern
  - Working on subsystem power budgets
  - Initial discussion w/ observatory to understand what is available

BREAK

Review Committee Comments(1)

- Mahalo to everyone for your detailed review of this material
- Revision to documents forthcoming
- Environmental controls for NasLab
  - Controls group understood that humidity control was required
  - Decision has not been made (PW)
  - Requirements for all locations should be reviewed
- Vibration monitoring (all reviewers)
  - Controls group understood that this was not required
    - KAON 680 and various email/conversation
  - Reviewers question if this is correct
  - Need to sort out what is required to achieve the project goals

Review Committee Comments(2)

- Requirements
  - Solidify SR-79, 80 & 81 regarding cable wraps (PW/TK)
    - Initiated discussions to determine available space
    - Quick review of drawings suggests minimal usage by existing AO
      - AZ wrap: 2x coax bundle, 1x fiber bundle, e-stop
    - Dye Laser requirements less clear, but significant
  - Work out power budgets (FR-3, 1442, 1907 & 1297) (RD/PW/TS)
    - ChrisN involved on the SysE side
  - Clean up requirements for various locations (RD)
    - Monitoring equipment, power, UPS, Lighting, smoke alarms, etc.
    - Nasmyth Lab (clean room), AO Cold Box, E-vault, Laser Service Enclosure

Review Committee Comments(3)

- KAON 668 – Device Architecture
  - Concern regarding interface response time (RD)
    - Agreed, as written could impact operational efficiency
    - Revise to read 'timeframe of a second'
      - this should not have adverse impact
  - Concern regarding reliance on Ethernet network (RD)
    - Ethernet is quite reliable
    - Proper design of network will help (VLANs, private networks, etc.)
    - Amount of Broadcast traffic needs to be managed (EPICS is a big offender)
    - Hardware does fail
      - spares
      - backup/restoration process that has been verified
      - configuration control of hardware settings and configurations
    - Design components to tolerate network faults
      - no user intervention to recover
        - » no reboots after network fault
      - use heart-beats when required
      - hard-wire safety (personnel or equipment) critical signals
    - Reliance on computer systems administration group for support

Review Committee Comments(4)

- Need to clarify control that is directly to device as opposed to an interface provided by the RTC (PW)
  - When a device is required to provide real-time control, the device is under the complete management of the RTC.
  - RTC must support an interface for Configuration and non-real-time commands
  - The MCS will interface with RTC to reconfigure these devices
- Acquisition camera mistakenly listed as RTC device (PW)
- Truth WFS mistakenly listed as RTC device (PW, KW, VV)

Review Committee Comments(5)

- KAON 701 – Preliminary Electronics Design
  - Clean up internal vs. external interfaces (PW, TK)
    - Not consistent throughout document, definition may need clarification
    - Three categories may be required
      - internal to NGAO subsystem
      - external to NGAO subsystem but still within NGAO facility
      - external to NGAO facility
  - Work with design teams to solidify needs of various cameras (PW, TS)
    - To much uncertainty in the document
    - Information should be available
  - Glycol cooling for cold bench point sources
    - Tracking motors, acquisition camera, NGS WFS camera
    - Nasmyth cooling system generates cold glycol
    - Design system so that return temp is < cold box set point
  - Vibration isolation not explicit for equipment on telescope (e-vault, NasLab, LSE, secondary) (PW)
  - Operating temp of E-vault 17°C (PW)
    - Reviewer Concern about temperature differential between e-vault and NasLab
    - Investigate impact of lowering temp
    - Equipment and personnel don't like being too cold

Reviewer Feedback

- Any questions?
- Detailed responses to individual comments are posted on the TWiki

Summary of Concerns (1)

- Detectors/Cameras/FPAs
  - Incomplete information from subsystem designers
  - Need a table that covers the whole system:
    - Subsystem, Detector, head electronics, cabling, head cooling, readout electronics, power supply, readout rate, data output format/cabling, configuration format/cabling, target (controller) computer, target interface

Subsystem	Detector	Camera Electronics	Cabling	Head cooling	Readout Electronics	Power Supply	Readout Rate	Data Interface Format	Data Interface Cabling	Configuration Interface Format	Configuration Interface Cabling	Target(controller) Computer	Target Interface Board
Acquisition Camera	CCID xxxx	SciMeasure	2x video (coax) 2x control	TEC + Glycol	SciMeasure (3U) 3 cards	internal to readout	1Hz	CameraLink (copper) w/ Fiber converter	1x fiber pair	p/o data link	p/o data link		COTS PCI card
LGS WFS (7)	CCID 74	SciMeasure	2x control 64x video (coax)	TEC + Glycol	SciMeasure (3U) 18 cards	internal to readout	2kHz	CameraLink (copper) w/ Fiber converter	2x fiber pair				COTS PCI card
TT (2)	HxRG		1x clocks 1x biases 1x signals	CryoTiger	Leach	Leach		Proprietary	1x fiber pair				Custom PCI card
TTFA	HxRG		1x clocks 1x biases 1x signals	CryoTiger	Leach	Leach		Proprietary	1x fiber pair				Custom PCI card
TWFS		SciMeasure	2x video (coax) 2x control	TEC + Glycol	SciMeasure (3U) 3 cards	internal to readout		CameraLink (copper) w/ Fiber converter	1x fiber pair	p/o data link	p/o data link		COTS PCI card
NGS WFS		SciMeasure	4x video (coax) 2x control	TEC + Glycol	SciMeasure (3U) 3 cards	internal to readout		CameraLink (copper) w/ Fiber converter	1x fiber pair	p/o data link	p/o data link		COTS PCI card

- Itemized power budget
  - Required to operate system
  - Required to design cooling systems

Summary of Concerns (2)

- Understand cabling requirements
  - Clean enclosure
    - work out baseline for connectors
  - Telescope cable wraps
    - involve TCS Upgrade project
- Understand Timing/synchronization
  - Is existing GPS system good enough for UT sync?
  - Which components require this and at what accuracy?
  - What does RTC need, who is making it happen?
  - Collaborate w/ TCSU project

- This review has reiterated the broad scope of the electronics design
  - “Everything but the kitchen sink”
  - Manpower / Schedule
  - Requirements need work
  - Motion controls require significant work
  - Insufficient detail on some subsystem designs
  - Need to clarify goals for the Preliminary Design phase

Plans for PDR

- Work with Systems Engineering to get a complete approved set of requirements
- Work with subsystem designers to complete the electronics design
- Revise (and keep current) KAON 668 (Device Control Architecture)
- Maintain KAON 682 (Master Device List)
- Complete KAON 701 (Preliminary Electronics Design)
- Identify risks and mitigation plans
- Budget and Schedule