

Keck NGAO

Work Breakdown Dictionary (entries for some items, D. Gavel, 8/25/06)

Statements of work for the system design phase 9/15/06 – 3/31/08

All work in this phase is to be at the Conceptual Design level

1.1.1.4 Project Office

1.2 Science Advisory

1.3 Systems Engineering

1.3 Subsystems

1.3.2.3 Laser Subsystem

Based on system requirements and an error budget, develop a system for producing laser beacons sufficient for NGAO. An input to this process is the result of a trade study determining the field of view, number of guidestar beacons, and constellations for various science observing conditions. Produce as output: the system architecture and design/specifications for creating and projecting the guidestars, controlling the pointing, maintaining output beam quality, diagnostics, and user control.

1.3.2.3.1 Laser

Based on system requirements and an error budget, specify a laser or set of lasers to produce guidestars. Take into consideration the current state of the art and availability of lasers. An input to this process is the result of a trade study determining the desirable pulse format or formats and power per guidestar. Produce as output: specifications and requests for quotes from laser vendors, reports of discussions with vendors.

1.3.2.3.4 Laser Launch

Based on system requirements and an error budget, develop the systems required for delivering the laser power from the laser to the sky.

1.3.2.3.4 Laser Beam Transport

1.3.2.3.6 Laser Launch Telescope

1.3.2.3.5 Laser Beam and Launch Diagnostics

1.3.2.2.3 AO Optical Bench Subsystem

Based on system requirements, design the opto-mechanical layout and specify components for the optical paths of the receiver system (“receiver” means guidestar, tip/tilt star, and science beam handling and diagnostics; as distinguished from “transmitter” which indicates the laser transport and launch system).

1.3.2.2.3.1 Optical Design (AO Optical Bench)

Based on system requirements and performance budgets, design the optical relays and specify optical components for the optical paths of the receiver. Perform analyses to verify performance consistent with system error budgets (terms assigned to static and non-common path wavefront errors, temperature induced drifts, and optical component tolerances) and modify design accordingly to meet these error budgets. Perform similar analyses and rectifications for meeting throughput, emissivity, and stability budget requirements.

1.3.2.2.xxx Mechanical Design (AO Optical Bench)

Based on system requirements and performance budgets, design the mechanical system that supports the optical and electronic components of the receiver. Perform analyses to verify performance and rectify as necessary

1.3.2.2.xyy Optical Layout (AO Optical Bench)

Based on system requirements and performance budgets, design the optical system layout that supports the optical design for the receiver. Perform analyses to verify performance consistent with system error budgets: terms assigned to mechanical drift, flexure, temperature, and machine tolerances.

1.3.2.2.xxx.yyy Optical Mount (AO Optical Bench)

Based on system requirements, design the mounting system for the optical bench and electronics. Output is size, weight, and weight distribution for the system as a whole as mounted on the telescope.

1.3.2.2 Enclosure/Environment (AO Optical Bench)

Based on system requirements and performance budgets, design an enclosure to control air flow, temperature, humidity, scattered light, etc. as required. Input to this process are results of a trade study determining optical surface temperatures required to meet emissivity requirements. Also input to this process is a determination of humidity requirements for certain components such as DMs. The work includes interaction with the optical designer to assess scattered light issues and to design appropriate baffles and beam blocks. Output is an enclosure system design with specifications for components of this system along with recommendations for vendor sources.

1.3.2.2.xxx Electrical Design (AO Optical Bench)

Based on system requirements and in corroboration with the optical and mechanical designers, determine the electrical system requirements for supporting the optical bench including motors, shutters, filter wheels, and other robotic or remotely operable control stages. Also, determine requirements for drive electronics and control boxes for these stages and the associated cabling, connectors, and interfacing. Also, determine the power requirements and design the control signal and power routing to meet overall system noise requirements (this is exclusive of real-time control and wavefront sensing, which is covered in a separate description). Corroborate with the software team to determine computer interface and operability requirements. Output is an electronic/electrical component and wiring layout, control box placement (in corroboration with the mechanical designer), power load analyses, specifications for components, and review/summary of vendor sources for the components.

1.3.2.2 AO System Wavefront Sensing & Control

- 1.3.2.2.3.2 High Order WFS
- 1.3.2.2.3.3 Low Order WFS
- 1.3.2.2.3.4 Deformable Mirrors
- 1.3.2.2.3.5 Tip/Tilt Correctors

x.x.x.x System Software

Based on system operations requirements and in corroboration with the AO Optical Bench design and AO System design, develop a software architecture and maintenance plan for all remote and automatic real time control software. Also, develop data collection and management systems.

1.3.2.2.5 Real Time Control

Based on system requirements, operations requirements, and error budgets, determine an architecture for the real-time controller, including both hardware and software configuration. Input to this process includes candidate wavefront sensing, tomography, tip/tilt, and DM control and signal processing algorithms as provided by the system engineering group as a result of trade studies. Design work includes specification of hardware interface requirements, hardware processor speed, data rate, and storage requirements, design of the data flow, design of the algorithm implementation software, and design of the diagnostic and telemetry streams. Work includes analysis and modeling of performance at the low-level of implementation, e.g. taking into account data transmission delays, processor delays, and data resolution.

1.3.2.2.5.x RTC Architecture Analysis and Design Study

Based on system requirements, operations requirements, and error budgets, determine an architecture for the real-time controller, including both hardware and software configuration. Input to this process includes candidate wavefront sensing, tomography, tip/tilt, and DM control and signal processing algorithms as provided by the system engineering group as a result of trade studies. Output of this process is an analysis

of candidate architectures, simulations of expected real-time performance, and guidance (in the form of strawman designs) for the RTC software module definition and RTC hardware module definition tasks.

1.3.2.2.5.x RTC Software Module Definition (& later, programming)

Given the architectural design and results of the RTC design study, specify the software development environment tools required (& analyze vendors of such), develop a software top level block diagram, define software data structures and data flow paths, define software command language for interface to the system controller/user interface, design diagnostic and telemetry streams, specify software module functions at a detailed level. Develop a real-time software implementation and test plan.

1.3.2.2.5.x RTC Hardware Module Definition, Specification (& later, implementation)

Given the architectural design and results of the RTC design study, specify the hardware platform (or platform options, through PDR phase), specify the hardware interfaces, including required cabling, in consideration of real-time data flow and diagnostic/telemetry streams, determine the overall size, mounting, and power requirements. If specifying custom processor boards (likely, with a transputer/FPGA architecture) design the board layout in conformance with fab-house design rules, specify the component processors and all other components needed to enable assembly of the boards. Develop a hardware acceptance test plan. Specify test equipment needed.

1.3.2.2.x User Interface

1.3.2.2.4 System Control and Observatory Interface

x.x.x.x.x Data Management