ADC – Preliminary Design Phase
Project Plan: Revision 1.1

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1. Introduction

The purpose of the LRIS ADC project is to provide an Atmospheric Dispersion Corrector that will fully compensate for effects of atmospheric dispersion down to a 60º zenith angle of the Keck 1 telescope for a wavelength range of 0.32 to 1.1 microns.

An ADC for the Keck telescopes was envisioned with the original project plan for the telescopes. The ADC Conceptual Design Study determined that a "global" ADC serving all instruments at both the Nasymth and Cassegrain foci was not feasible and that the best approach would be to design ADCs for specific foci or instruments. It was concluded that LRIS was the instrument most in need of an ADC. The Conceptual Design Study recommended two possible options to fill this need. Both options mount directly ahead of LRIS in the telescope but do not directly attach to the instrument. One option was for a subaperture field that would rotate with LRIS and the other was for a full aperture alternative that would not require rotation. The CARA board approved proceeding with the full aperture version in April, 2003.

This work plan deals directly with the next stage in a process that would involve: a Preliminary Design (PD) phase that would complete the detailed specification of the ADC (complete the optical design, complete the engineering design to the point that detailed fabrication drawings be done, and determine a detailed budget and schedule for the next phases), a Critical Design (CD) phase that would complete the detailed fabrication drawings; a Fabrication phase; and finally the Installation and Commissioning phase. The next step in proceeding to fabricate and commission an ADC for LRIS is to complete a Preliminary Design Study. A slight departure from the normal process that will be recommended in the PD phase will have us ordering the optical glass at the start of the CD phase.

2. Work Scope

2.1. Instrument Specifications and Requirements

The Conceptual Design Report gave a preliminary set of specifications and requirements. They will be completed and finalized in the Preliminary Design phase.

2.2. Telescope/Observatory Interface Control Document (ICD)

CARA will be asked to complete the ICD as part of the PD phase. This will need to include:

- 2.2.1. Location of the attachment points to the telescope
- 2.2.2. Specification of the attachments
- 2.2.3. Weight and balance restrictions
- 2.2.4. Permissible heat loss to the telescope environment
- 2.2.5. Vibration constraints
- 2.2.6. Safety and operations constraints
- 2.2.7. LRIS Hatch modifications
- 2.2.8. Electronic and electrical interface

2.2.9. Cooling capacity and interface
2.2.10. Testing requirements on the telescope
2.2.11. Envelope specification - instrument
2.2.12. Envelope specification - electronics enclosure
2.2.13. Envelope specification and interface – storage position
2.2.14. Envelope specification and interface – auxiliary hoist

2.3. Optical Design

The optical design will need to be completed in the Preliminary Design Phase. The plan is to order the optical glass at the start of the Critical Design phase. Factors to be completed include:

2.3.1. Diameter of the prisms
2.3.2. Resulting vignetting of both the science and TV guider fields
2.3.3. Thickness of the prisms
2.3.4. Prism angle
2.3.5. Prism stroke
2.3.6. Throughput
2.3.7. Specify optical material
2.3.8. Specify homogeneity
2.3.9. Dispersion Correction performance between zenith and 72 degrees zenith angle, with full correction to 60 degrees zenith angle
2.3.10. Analysis of expected ghosting caused by ADC as designed
2.3.11. Specify antireflective coatings
2.3.12. Imaging performance with and without LRIS

2.4. Mechanical Design

Mechanical Design will be completed to the point that detailed fabrication drawings can be directly produced in the Critical Design Phase. Factors included in the mechanical design:

2.4.1. Prism cell design including athermalization
2.4.2. Analysis of gravity deformation of prisms
2.4.3. Structural analysis of ADC cells, mechanisms, attachments, and mechanical structure, including gravity deformations
2.4.4. Specification of all materials and mechanisms
2.4.5. Specification of mechanical performance
2.4.6. Detailed cost estimate
2.4.7. Assembly and part drawings exclusive of fabrication dimensions but with required tolerances
2.4.8. Specification of encoder, fiducial and limit locations, mounting and logic

2.5. Electrical Design

Electrical Design will include specification and a cost estimate of all electrical/electronic components including:

2.5.1. Motor controller
2.5.2. Motors
2.5.3. Interface connections

2.6. Software

The basic software control scheme will be described, along with an outline of the keywords required to operate the system and the keywords, information, and bandwidth required from the DCS and LRIS.

2.7. Schedule

The schedule will be updated to the end of the project and detailed to the end of the Critical Design phase.

2.8. Budget

The Budget will be updated to the end of the project and detailed to the end of the Critical Design phase.

3. Specifications

Listed are specifications as defined by the conceptual design phase. These will be updated and expanded during the PD phase

3.1.1. Mounted directly to the telescope structure using CARA supplied defining points and attachment mechanisms
3.1.2. Stable center of gravity
3.1.3. Weighs less than 500kg
3.1.4. Fits into the tertiary tower of the Keck 1 Telescope
3.1.5. Fits on the tertiary mirror transfer module for storage
3.1.6. Has a separate device to lift it free of the tertiary mirror transfer module when the module is needed to transfer the tertiary mirror
3.1.7. Full aperture correction
3.1.8. Atmospheric dispersion correction from zenith to 60 degrees telescope angle
3.1.9. Covers the spectral wavelength range of 0.315 to 1.05 microns
3.1.10. Throughput better than 90%
3.1.11. Image quality degradation of less than 0.5 arcsecs FWHM
3.1.12. Communicates via internet connection
3.1.13. Uses less than 1.5 kw and releases less that 100w to the telescope environment

4. Challenges

This is not seen as a particularly difficult or challenging project. We will use the technology and methods with which we have prior experience when possible.

5. Project Team

Principle Investigator – Joe Miller
Project Scientist, Optical Designer, and Deputy PI – Drew Phillips
Optician – David Hilyard
Mechanical Engineer – Vern Wallace
Electronic Design – Barry Alcott
Software – Will Diech
Project Management – David Cowley
CARA Instrument Program Oversight – Sean Adkins

6. Decision Matrix

6.1. The PI and the Deputy PI will make all performance decisions.
6.2. Staffing decisions will be made by the Project Manager in consultation with the PIs and CARA.
6.3. Budget decisions within the approved budget will be made by the Project Manager in consultation with the PIs and CARA.
6.4. Budget decisions exceeding the approved budget will be made by the PIs and CARA in consultation with the Project Manager.
6.5. Telescope interface decisions will be made by CARA through the Instrument Program Manager.

7. Risk and Contingency

The technical and budget risks are considered low at this stage (PD) of the development. There is a 20% project contingency, but we do not expect to use any of this money during this phase.

The major risk at this phase is that a key participant becomes unavailable to the project and that we are unable to proceed until they are available or can be replaced.

8. Work Breakdown Structure

Preliminary Design Phase

1 Preliminary Design
  1.1 Optical Design
    1.1.1 Optical material specification
    1.1.2 Image quality analysis

1.1.3 Throughput analysis
1.1.4 Ghosting analysis

1.2 Mechanical Design
1.2.1 Modeling of telescope structure and attachment points
1.2.2 Design of attachment points
1.2.3 Design of static structure
1.2.4 Design of slides and ball screw translation system
1.2.5 Design of drive system
1.2.6 Design of prism cells and attachments to translation mechanism
1.2.7 Design of covers
1.2.8 Design of handling fixture(s)
1.2.9 Design of electronics enclosure

1.3 Electrical
1.3.1 Design/specification of motor controller system
1.3.2 Design of enclosure temperature control

1.4 Software
1.4.1 Specification of SW control and keywords

1.5 Preparation for Preliminary Design Review

9. Deliverables

- Preliminary Design Report
- Materials for the Preliminary Design Review

10. Milestones

- Preliminary Design Start June 5/03
- Start of Preparations for PD review Aug 20/03
- Preliminary Design Review Sept 3/03

11. Schedule

The project schedule is attached (attachment 1)

12. Budget

The proposed budget tracking sheet and cost codes are attached (attachment 2). A graph showing the rate of expenditures is also attached. This graph would be updated monthly at the time of the budget report and would include actual expenditures.

13. Project Tracking

Monthly reports will be sent to the project team, SSC and CARA on about the 20th of each month. The report will include an update of the technical and budgetary status, and the schedule.

14. Revision History

Revision 1.0 April 17, 2003
Revision 1.1 April 24, 2003