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WIYN Project: 3.5m Telescope on Kitt Peak

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1. INTRODUCTION

The WIYN Consortium is comprised of the University of Wisconsin, Indiana University, Yale University and the National Optical Astronomy Observatories (NOAO). The purpose of WIYN is to build and operate a 3.5 Meter optical telescope on Kitt Peak, AZ. Observing time on the telescope will be shared by the three universities and, through NOAO, by observers from the general astronomical community.

The telescope will be located on the site of the former #1-0.9 Meter telescope. The existing building was removed and is being replaced with a new enclosure and control building, Figure 1. The telescope will be housed in a three story enclosure that contains no heated space for telescope control stations. The adjacent building contains the control room and other heated laboratory and office space.

The telescope uses an alt-az mount modeled after the Astronomical Research Corporation (ARC) design. The principal focal positions will be the two Nasmyth foci and a modified Cassegrain focus behind the primary mirror. The tertiary mirror will be articulated to direct the beam to instruments mounted at the various positions. This motion will be remotely activated and allow switching of ports during the night. This and other controls involved in observing (main axes control, instrument rotators, dome rotation, guiders, etc.) are handled entirely by the control system and can be commanded by remote observers.

Instruments currently being developed as facility instruments available to all users include (a) a fiber-fed multi-object spectrograph and (b) a large-format CCC imager. Other instruments are being planned by the universities for their own use.

2. STATUS & SCHEDULE

The project is currently in the construction phase. Enclosure construction at the site started March 23. Completion of both buildings is scheduled for late 1992.

The telescope mount is being designed and fabricated at L&F Industries in California. All major weldments are in various stages of completion with delivery of the completed assembly expected in late March 1993.

The primary mirror has been polished to a sphere and installed in its cell for testing of the thermal controls and supports. It is now waiting the development of a polishing lap before being generated and polished to the final asphere. The mirror is scheduled to be installed in the telescope early in 1994.

The control system for the observatory is being developed at the University of Wisconsin. A preliminary design has been completed and is currently being implemented.

The fiber positioner, HYDRA, and MultiObject Spectrograph developed for the Kitt Peak 4-Meter Telescope will eventually be moved to WIYN. Development of the wide-field CCD imager has just started.

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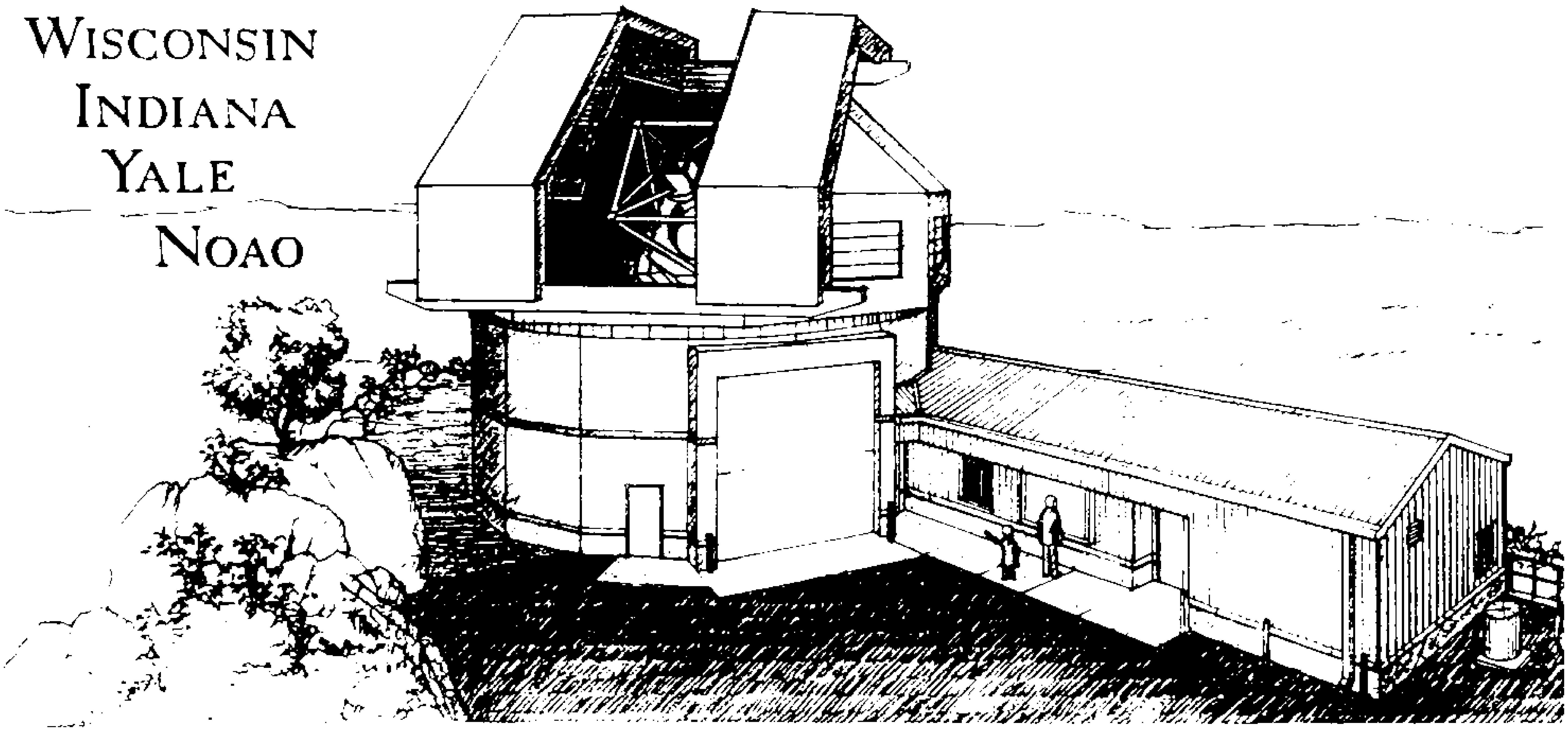

Figure 1. WIYN Observatory

3. WIYN SCIENCE

3.1 MultiObject Spectroscopy

NOAO plans to assign most of its time on the WIYN Telescope to multi-object spectroscopy. This is intended to relieve the oversubscribed number of requests for spectroscopy on the Kitt Peak 4-Meter telescope. The time will be made available to the general community through the Telescope Allocation Committee (TAC).

3.2 University Research Examples

The WIYN Telescope is expected to support a broad range of university research projects. In addition to multi-object spectroscopy, these will include: (a) CCD imaging, (b) fiber-fed echelle spectroscopy, and (c) polarimetry. The telescope will also provide a teaching platform for the universities.

3.3 Observing Modes

A goal of the project is to provide flexible scheduling to allow, for example, service observing and queued programs. We also anticipate that there will be nights when the telescope will be shared between projects, either on a more-or-less equal basis or when a subsidiary project is allowed to interrupt the main project to fill in a program. These scheduling modes are facilitated if the principal observer is not required to be at the telescope.

4. REMOTE OBSERVING PLANS

4.1 Status

WIYN's remote observing program is still being formulated as part of the operational planning for the observatory. Our purpose in attending the current workshop is to learn from those groups with working experience in applying various levels of remote observing to different types of observing programs.

4.2 Approach

We plan to develop a remote observing facility in an evolutionary process by starting off with a system with modest capabilities and expand it as our experience and the demand from observers accumulates. In this way we hope to avoid building a system that is inappropriate and/or overly expensive for the science of WIYN.

4.3 Objectives

The remote observing system should meet the following objectives:

a. Provide flexible observing options: The remote observer will have the opportunity to participate in the observation in near real time to encourage the use of the flexible scheduling schemes mentioned above.

b. Enlarge educational opportunities: The universities have education as their primary function. We see remote observing as a way of involving a greater number of students in the science of the observatory in way that would not be otherwise possible. Dedicated facilities for supporting remote observing on WIYN are being set-up in the astronomy departments at the universities.

c. Develop techniques for the future: Remote observing is clearly a developing technique that will play an important role at many observatories. WIYN wants to be part of that development and sees it as a way of encouraging collaboration between institutions both within WIYN and within the general community.

d. Provide instrument support: The experience of Kitt Peak has shown the advantages of being able to access instruments on the telescope remotely from Tucson. The universities will be developing their own instruments for WIYN and the instrument engineer will seldom be within commuting distance to the Observatory. Enabling the engineer to communicate directly with his instrument over the remote link will provide better support for the observer.

4.4 System Outline

The current plan is to start off providing an eavesdropping style of remote observing. This will involve:

a. A voice link using phone lines.

b. Exchange of telescope/instrumental parameters.

c. Transmission of selected acquisition frames.

d. Transmission of sample data.

e. Most telescope and science instrument control remains on-site.

Data in b, c, and d will be transmitted over the network. The bulk of science data will be recorded on disk and later copied to portable magnetic media for transport.

With these links an effective monitoring capability is provided allowing interaction with the observer/operator at the telescope, quality control of data, verification of field and object, and program tuning in response to a first look at the data and/or changing conditions. It will allow the remote observer to participate and monitor the results when his data are being taken by a service observer, student or collaborator.

We anticipate that this style of observing will be most effective for simple and well defined projects. It will also be used when the inefficiencies imposed by the limited capabilities of the system are outweighed by the ability to make an observation that would not be feasible without remote observing. Targets-of-opportunity (e.g. supernovae) and periodic monitoring of long period variables are examples.

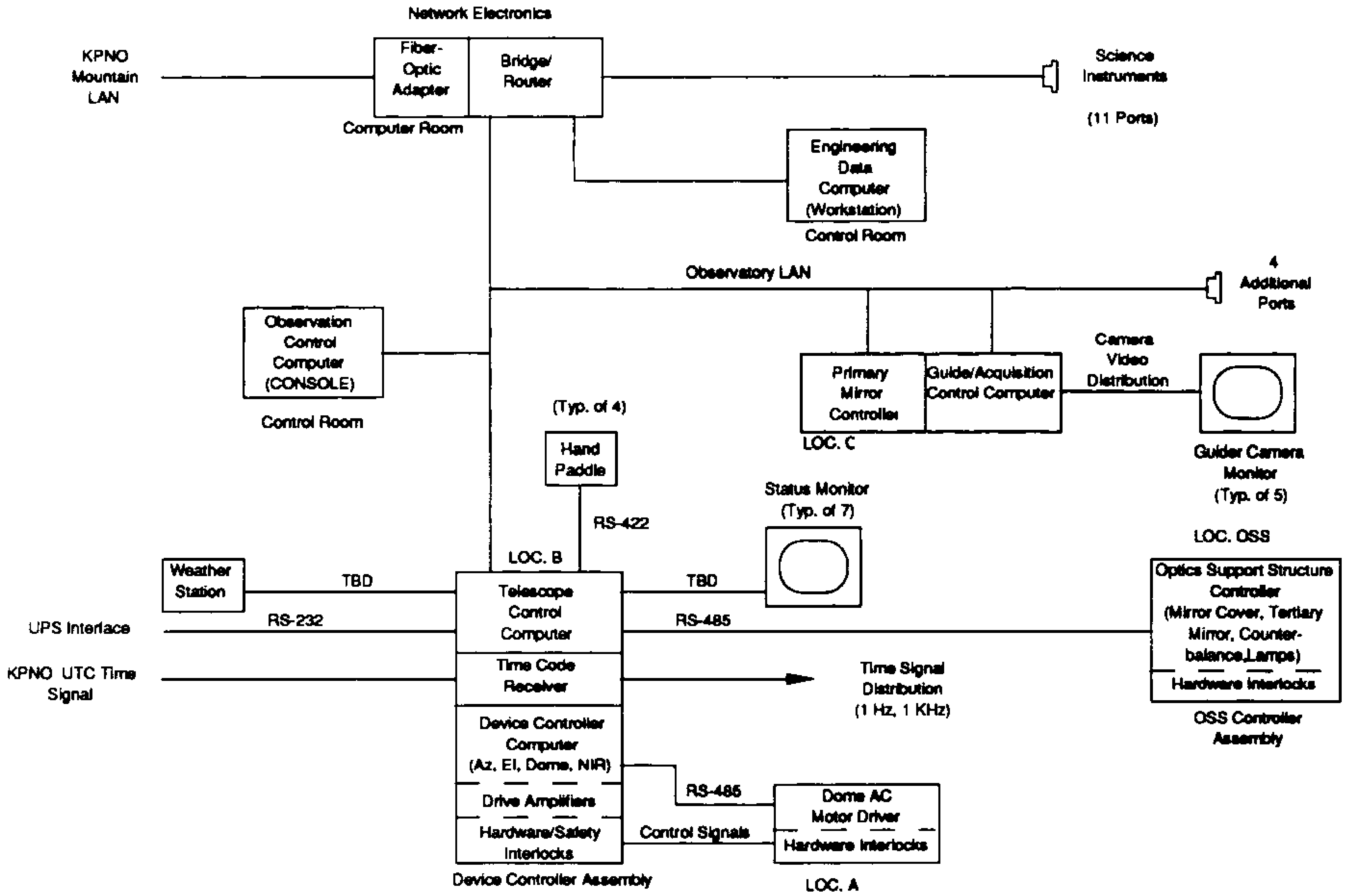

Figure 2. WIYN Control System Block Diagram

5. CONTROL SYSTEM

The control system is being designed from the start with remote operation in mind. Functions that need to be accessible to the remote observer are provided in software rather than by hardwired switches and pots. Mechanisms for transporting data and commands between widely separated control stations are incorporated in the basic design of the system. The block diagram is shown in Figure 2. Some of the features of the design relevant for remote observing are:

1. All high level computers communicate with each other over the Observatory LAN. A bridge/router to the Kitt Peak mountain LAN provides remote observer access over the Internet.
2. State information (telescope and dome pointing and status, instrument status, engineering data, etc.) is transmitted across the net as telemetry.
3. The system is designed on a client/server model for transmitting commands and telemetry between local and remote nodes. Remote nodes appear the same as local nodes to the telescope control.
4. Commands and telemetry are encapsulated in TCP-based messages in machine-independent ("network byte order") format. Messages are passed via standard UNIX socket connections.
5. The flow of telemetry is asynchronous. Critical real-time functions all occur in the low level controllers.
6. Displays and user interfaces run on the remote nodes and use messages to exchange data. This eliminates character transmission latency and X-traffic bandwidth problems.
7. All high level software will be written in standard UNIX/C and users will be provided with a utility library for connecting instruments to the system.
8. Images will be sent over the net in a format yet to be decided. Some form of compression will be used to reduce bandwidth requirements.

The baseline system will be capable of supporting the remote observing objectives outlined above. It will, in fact, provide a higher degree of control for the remote observer than is planned for initial operation and thus provides a path for expansion.

A byproduct of including remote operation in the system design is that it leads us to adopt well defined and uniform protocols for communication between processes. This is an advantage regardless of whether the processes are running in local or remote mode.