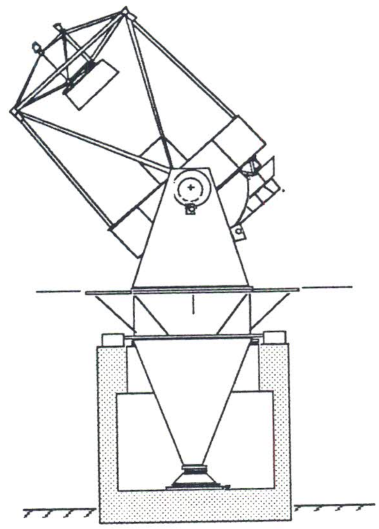
Wisconsin
Indiana
Yale
Noao



3.5 Meter Telescope

System Definition & Configuration for the WIYN 3.5 Meter Telescope

WODC 01-01-02

6/25/91

WODC 01-01

SYSTEM DEFINITION & CONFIGURATION

FIGURES

SYSTEM DEFINITION & CONFIGURATION

1. Purpose and Scope

This document outlines the general layout of the WIYN Observatory including the telescope, optical configuration, telescope enclosure, control building, control system, and the various coordinate systems used to define subsystem orientations, are introduced here.

Throughout this document the WIYN Observatory document control (WODC) code references other WIYN documents. The numbering system is defined in the document index, WODC 00-02. (The third set of numbers which relate to the revision level are not included here.)

2. General Layout of the Telescope

The telescope is an alt-azimuth mount design with a 3.5 meter primary mirror and is described in WODC 01-10. This configuration was chosen for its mechanical advantages over equatorial types, and for its light weight and stiffness. Figure 1 shows a drawing of the telescope.

The principle instrument mounting locations are at the two Nasmyth foci. Instrument rotators, defined in WODC 01-15, at each focus compensate for field rotation. A 200-optical fiber positioner, Hydra, will be semi-permanently mounted at the Nasmyth focus designated as the MOS port. It will have its own built-in guide probes. The fibers will feed a Multiobject Spectrograph (MOS) permanently installed in its own thermally isolated room on the bottom floor of the enclosure.

The other Nasmyth focus, designated the WIYN port, will interface with a variety of instruments through a common instrument adapter, defined in WODC 01-18. The instrument adapter subsystem will function as a guider, providing guide errors to the telescope control subsystem and wavefront images to the primary mirror control subsystem defined in WODC 01-12. An instrument lift will be provided to enable mounting and access to scientific instruments on the Nasmyth ports.

Future development includes two other focal positions. A folded Cassegrain focus will be available on the telescope center section and a modified Cassegrain focus will be available through the center of the primary mirror cell.

3. Optical Configuration

The telescope will be a Ritchey-Chretien design with the primary mirror focal ratio of f/1.75 and the system focal ratio of f/6.3. The resulting plate scale of 9.36 arcseconds/mm is well matched to optical fibers for the MOS and pixel sizes of currently available CCD detectors. An optical layout is shown in figure 2.

3.1 Primary Mirror and Active Support

The primary is a light weight 3.5 m borosilicate honeycomb mirror which was cast using the spin cast method. It weighs 2012 kg and will be supported entirely from the back by 66 axial and 24 lateral activators, defined in WODC 01-12. The telescope's fast optical system requires very tight alignment tolerances to produce images within image size and blur specifications. The tight image specifications can only be achieved with an active alignment system and with mirror temperature control.

The active alignment system will correct deformations of the telescope structure due to temperature and gravity loading in near real time by controlling the mirror figure and collimation. Primary mirror figure will be controlled by forces actively applied to the axial actuators to adjust mirror figure correcting for distortions sensed by a wavefront sensor. Collimation data, obtained from the wavefront calculation, is passed to the telescope control computer to control the secondary tip/tilt. A wavefront sensor and associated hardware and software is being developed for the WIYN telescope and will be part of the WIYN port instrument adapter subsystem.

The primary mirror's temperature will be controlled to be uniform to within +/- .04 degrees C across its surface and within +/- .5 degrees C of ambient air temperature. This will be accomplished by circulating conditioned air through the honeycomb structure of the primary mirror to insure distortions due to thermal bowing and seeing do not cause image degradation. It has been found that mirror seeing effects become negligible if the mirror is within these specifications.

3.2 Secondary

All foci of the telescope are designed to be confocal with only one secondary. The secondary is a 1.2 m diameter lightweight mirror and can be positioned under control of either an automatic alignment system for autofocus and autocollimation or manually by changing piston for focus control and tip/tilt in conjunction with the primary for collimation control.

3.3 Tertiary

A Tertiary mirror is mounted on a rotating platform and is able to flip up out of the optical beam, defined in WODC 01-14. The tertiary switches the main telescope beam between all four focal positions defined as the wide field Nasmyth focus, medium and narrow field Nasmyth focus, folded Cassegrain focus, and modified Cassegrain focus.

3.4 Correctors

The WIYN port instrument adapter will have a combined atmospheric dispersion compensator and field corrector (ADC), shown in figure 3, that can be inserted or removed from the optical path. With the ADC out of the optical path, the field of view will be 15 arcminutes, which is large enough for many applications, with a field curvature radius of 2.11 m. This is the narrow field configuration.

With the ADC inserted into the optical path, a flat 30 arcminute field of view can be achieved for the wavelength range 0.35 to 1.0 micron. This is the medium field configuration.

The MOS port will have a corrector mounted permanently in the fork tine of the telescope to flatten the image plane to provide a 1 degree unvignetted mildly curved field of view. This is the wide field configuration. The MOS port corrector, shown in figure 4, has two meniscus fused silica elements with all spherical surfaces and a clear aperture of 478mm. It produces a worst case image size of 0.17 arcseconds over a spectral range of 0.33 to 1.5 microns respectively. The focal surface has a 5.5m radius of curvature and .64% maximum pincushion distortion at the edge of the field.

Possible telescope optical configurations are shown in the following table.

Table 1. **TELESCOPE OPTICAL CONFIGURATIONS for f/6.3**

configuration	wavelength	dist to exit pupil	field radius of curvature	linear field	field of view
wide field	.33-1.5	7.3 m	5.51 m	385 mm	1 degree
med. field	.35-1.1		plano	192 mm	30 arcsec
nar. field	reflective	8.5 m	2.11 m	96 mm	15 arcsec
folded cass.	reflective	8.5 m	2.11 m	96 mm	15 arcsec

Table 2. **TELESCOPE OPTICAL CONFIGURATION for f/13-13.5 TBD**

configuration	wavelength	dist to exit pupil	field radius of curvature	linear field	field of view
modified cass	reflective	TBD	TBD	82 mm	6 arcsec

4. Dome and Enclosure Configuration

The architectural design of the dome, enclosure, and control building is shown in figure 5. The dome is a compact light weight octagonal design with low thermal mass. The observing floor of the enclosure remains stationary while the dome and telescope rotate independently. Pointing of the dome slit and telescope is controlled by the observatory control system.

5. Control Building

The control building is located adjacent to the enclosure and connected by an unheated passageway. The control building has heated spaces in the control room, laboratory, office, and computer area. Unwanted heat is ducted to an outlet remote to the telescope. Unwanted heat includes heat from control system electronics, instrument electronics, mechanical systems, computers and heat from the structure. Figure 6. is the plan view of the observatory showing the location of major spaces in the control building and enclosure levels.

6. Thermal Control

Heated air from sources in the dome and enclosure will be limited or exhausted away from the observatory. The upper truss structure exposed to the night sky will be coated with low emissivity aluminum tape to reduce over-cooling from radiation losses to the night sky. The dome will also be coated with low emissivity aluminum tape to reduce radiative cooling during the night.

The dome is ventilated through 7 large vent openings in the vertical walls of the octagon and by the shutter opening. The vents are situated so that at least 2 and generally 3 openings will be windward forcing ambient air around the telescope and through the dome. The dome and enclosure are insulated to reduce heating of the telescope and fluctuations in air temperature due to sun heating during the day. The enclosure contains no conditioned spaces and outside air is actively drawn through the enclosure's lower levels during the night.

7. Control System

The control system is responsible for pointing the telescope to track celestial objects across the sky. The control system, defined in WODC 01-20, also controls dome movement to keep a clear field of view, telescope balance by adjusting trim weight positions, telescope focus and collimation by controlling the secondary actuators, tertiary mirror position control for selecting an instrument, plus several other control functions and computing functions. Figure 7 schematically illustrates the complexity of the observing floor's electromechanical systems that need to be controlled.

8. Spatial Coordinate Systems

The spatial coordinate systems shown in figure 8 are all cartesian systems and illustrate the five major systems in use; the world (WORLD), the telescope fork (FORK), the telescope tube (TUBE), the nasmyth instrument rotators (NIR), and the optical axis (OPTICAL).

WORLD: Zw is the local vertical vector, positive upward. Yw is pointing true North and is positive in that direction. Xw is pointing toward the East. Increasing azimuth angle is from North to East.

FORK: Zf is defined by the fork rotation axis as defined by the azimuth bearings and is positive upward. Yf is perpendicular to the line through the centers of the elevation bearing journals on the fork and is positive North with the telescope South pointing.

TUBE: Xt is coincident with the elevation axis as defined by the center line of the elevation bearing journals on the center section. Yt passes through the center of the folded cassegrain port on the center section. Zt is nominally coincident with the optical axis.

NIR: The NIR coordinate systems are local to the individual fork tines. The Xr-Yr plane is defined by the instrument mounting surface. The axis of rotation of this plane defines the Zr axis which points positively toward the focal plane. At stow position (pointing up), positive Xr is perpendicular to the Zw axis and points to the right as viewed from the focal plane. The NIR coordinate systems rotate with the NIRs and the rotation angle is increasing positively in the clockwise direction as viewed from the focal plane.

OPTICAL: Zo is coincident with the optical axis of the primary mirror and positive upward at zenith pointing. The origin is at the vertex of the primary mirror. Yo is perpendicular to the elevation rotational axis when mounted in the telescope.

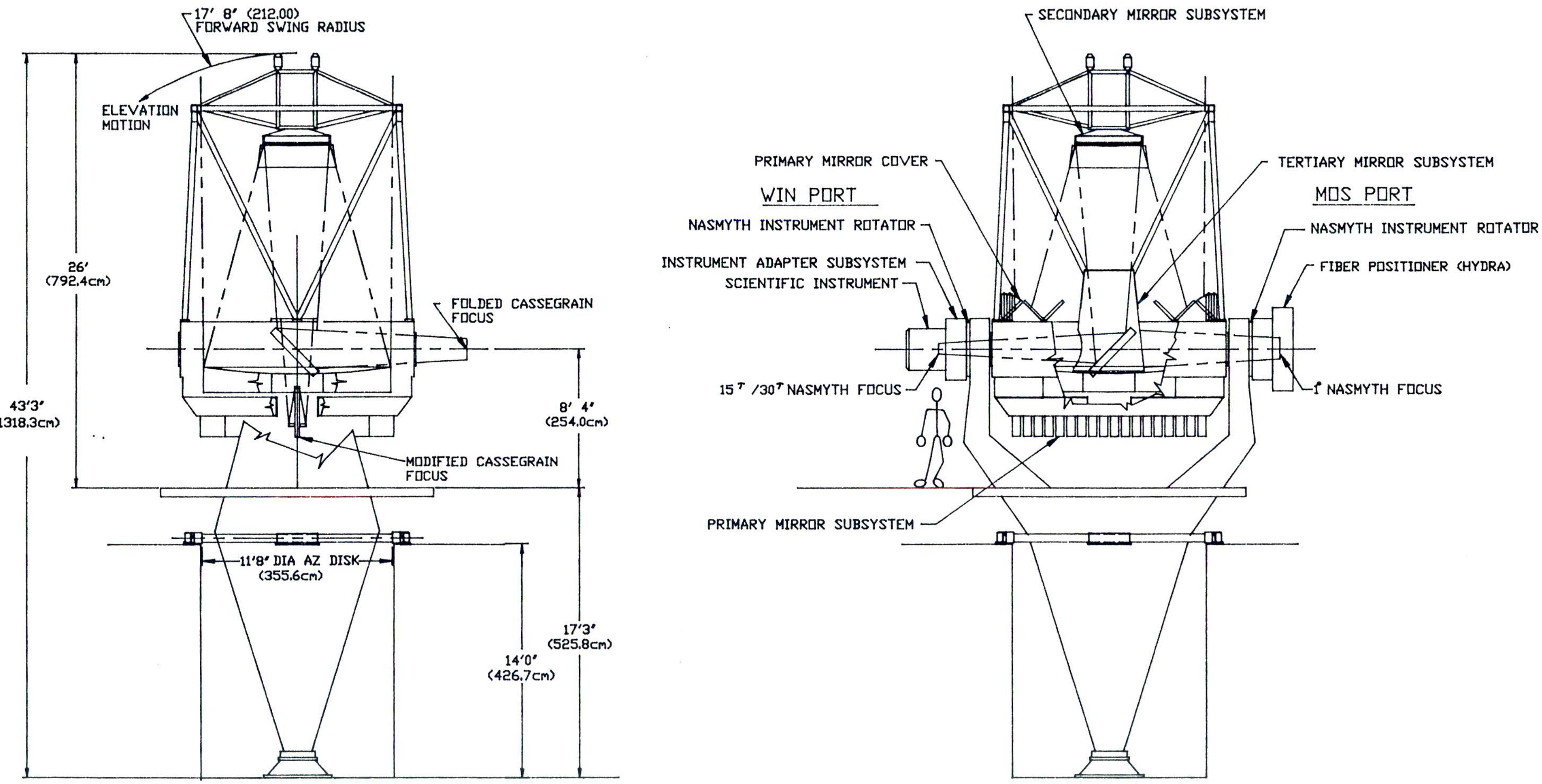


FIGURE 1. PLAN OF WIYN 3.5 METER TELESCOPE

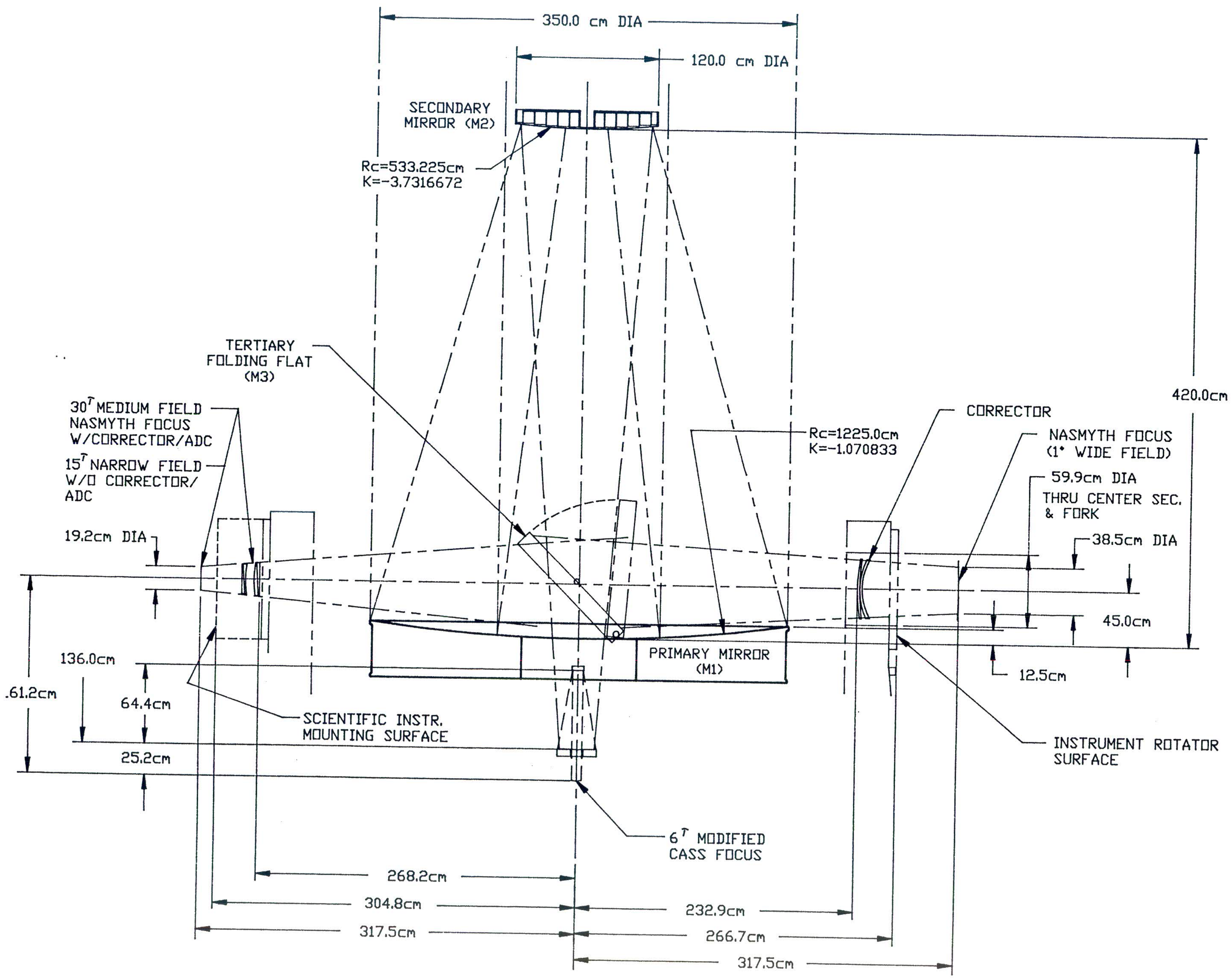


FIGURE 2. OPTICAL LAYOUT

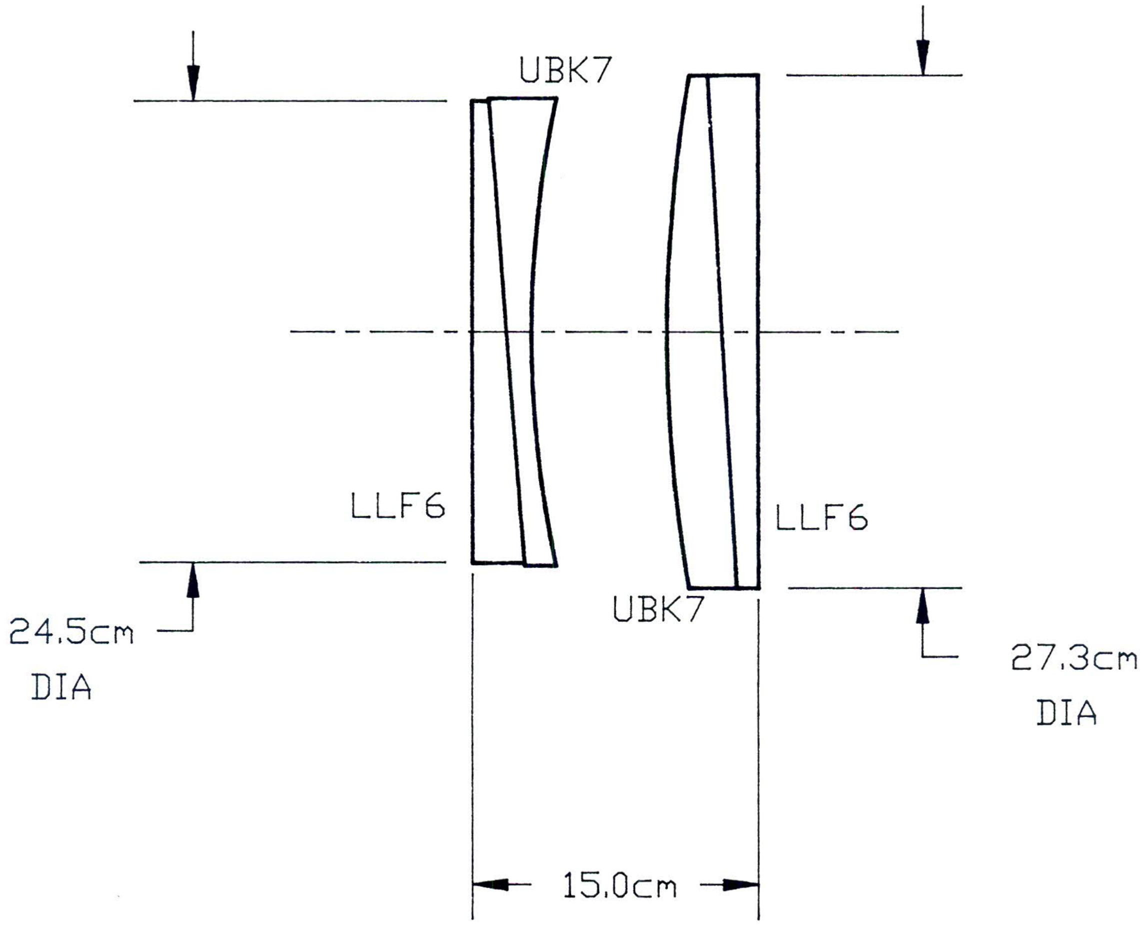


FIGURE 3. WIYN PORT 30' CORRECTOR/ADC

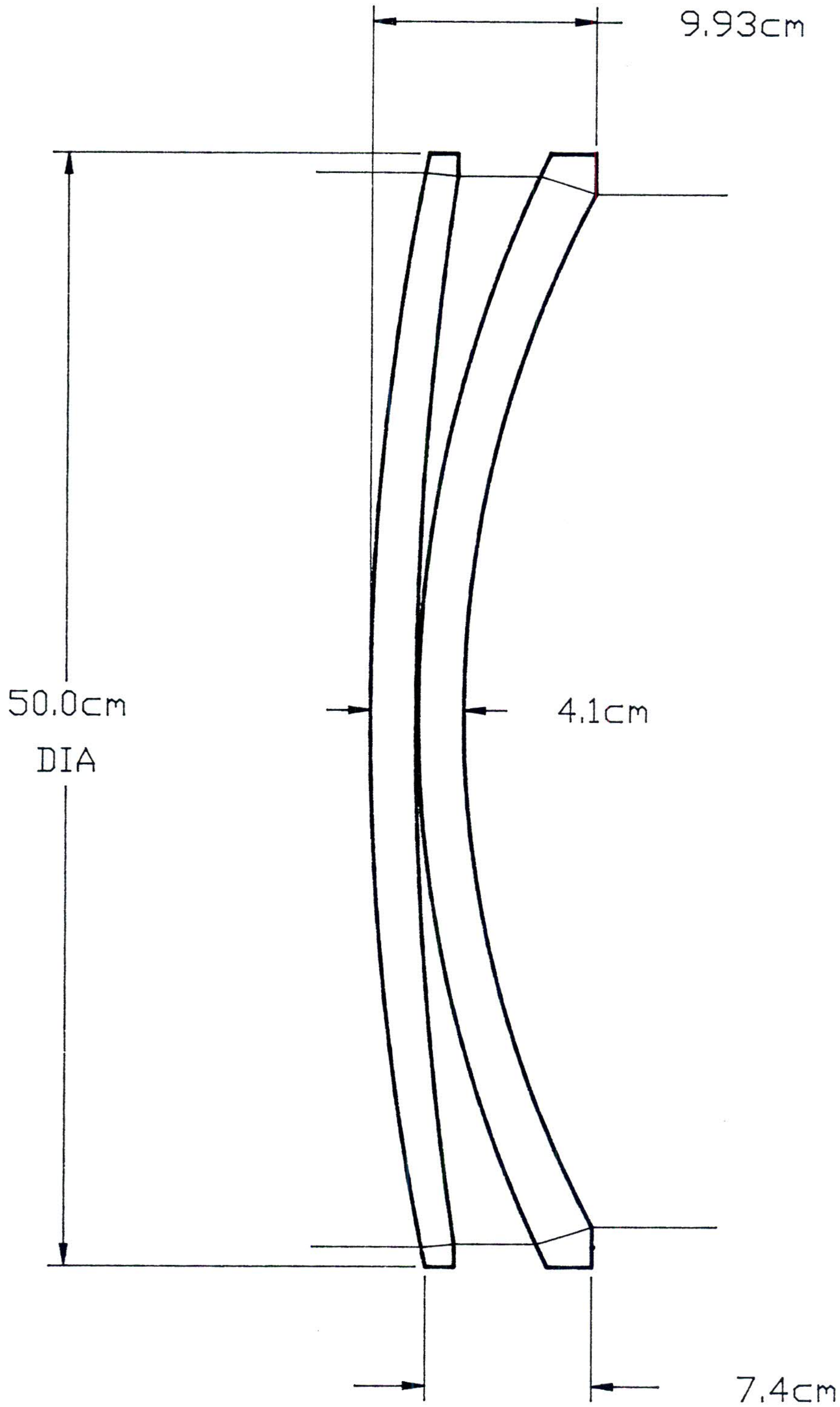


FIGURE 4. MOS PORT 1° WIDE FIELD CORRECTOR

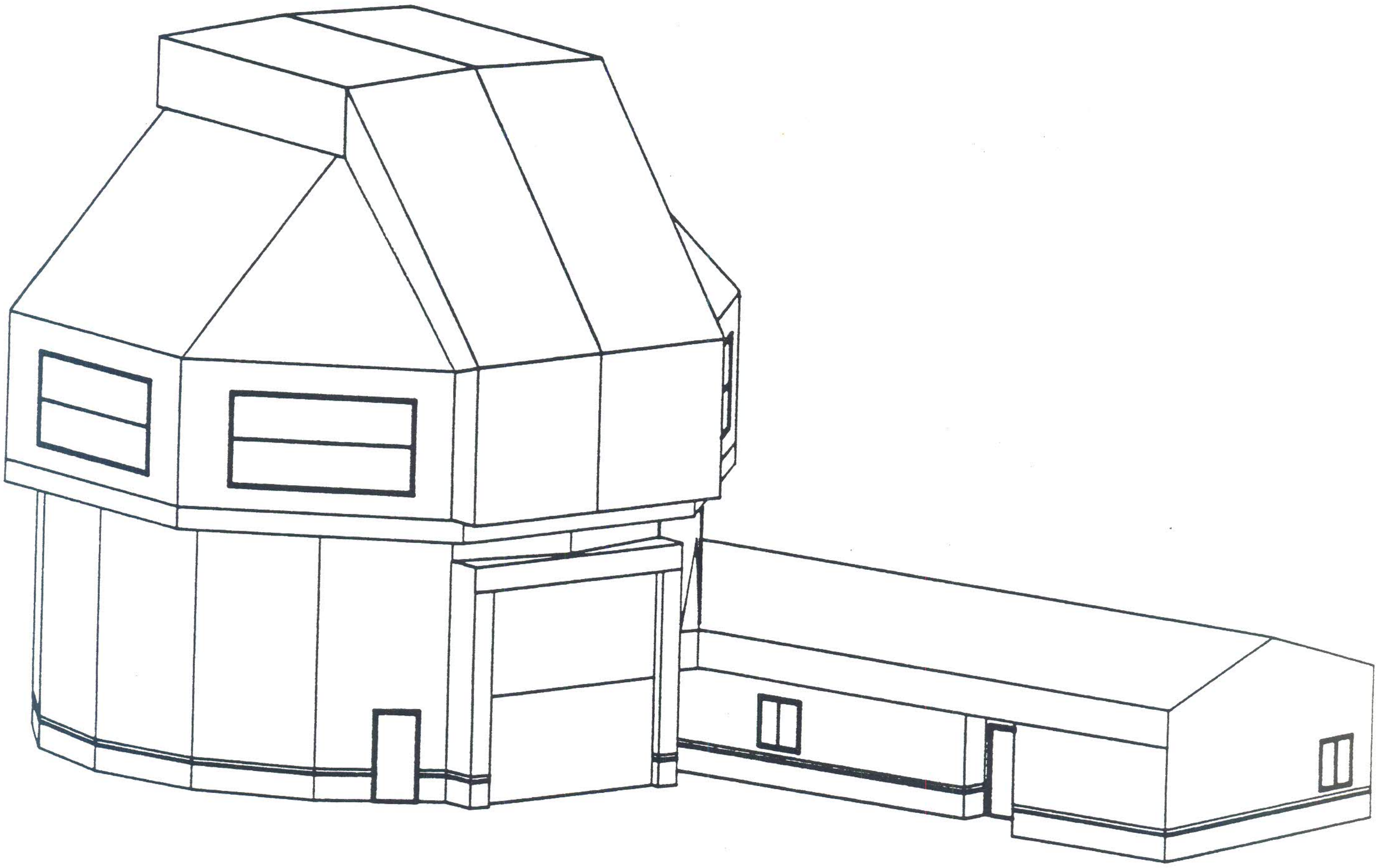


FIGURE 5. DOME ENCLOSURE AND CONTROL BUILDING DESIGN

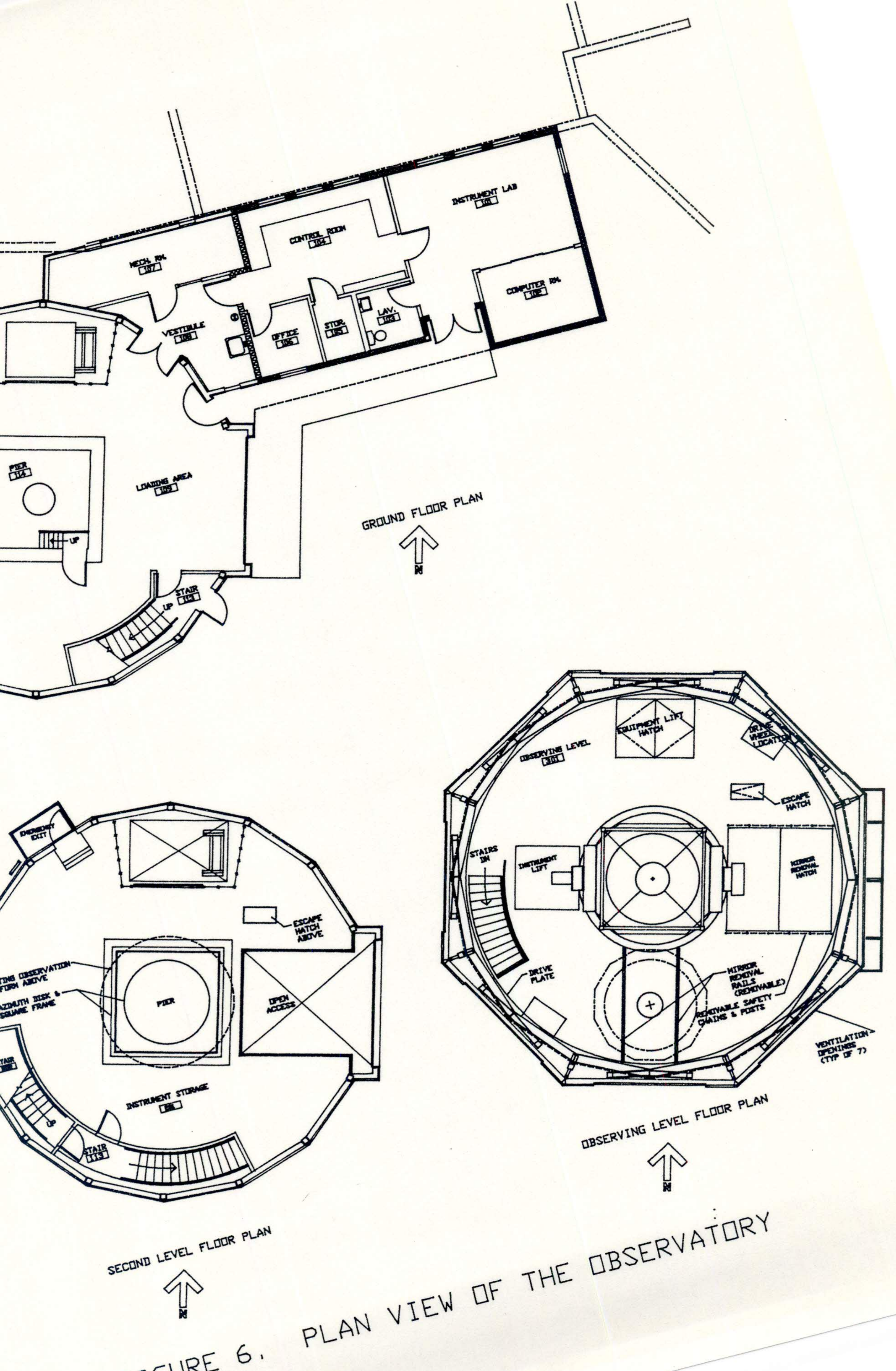
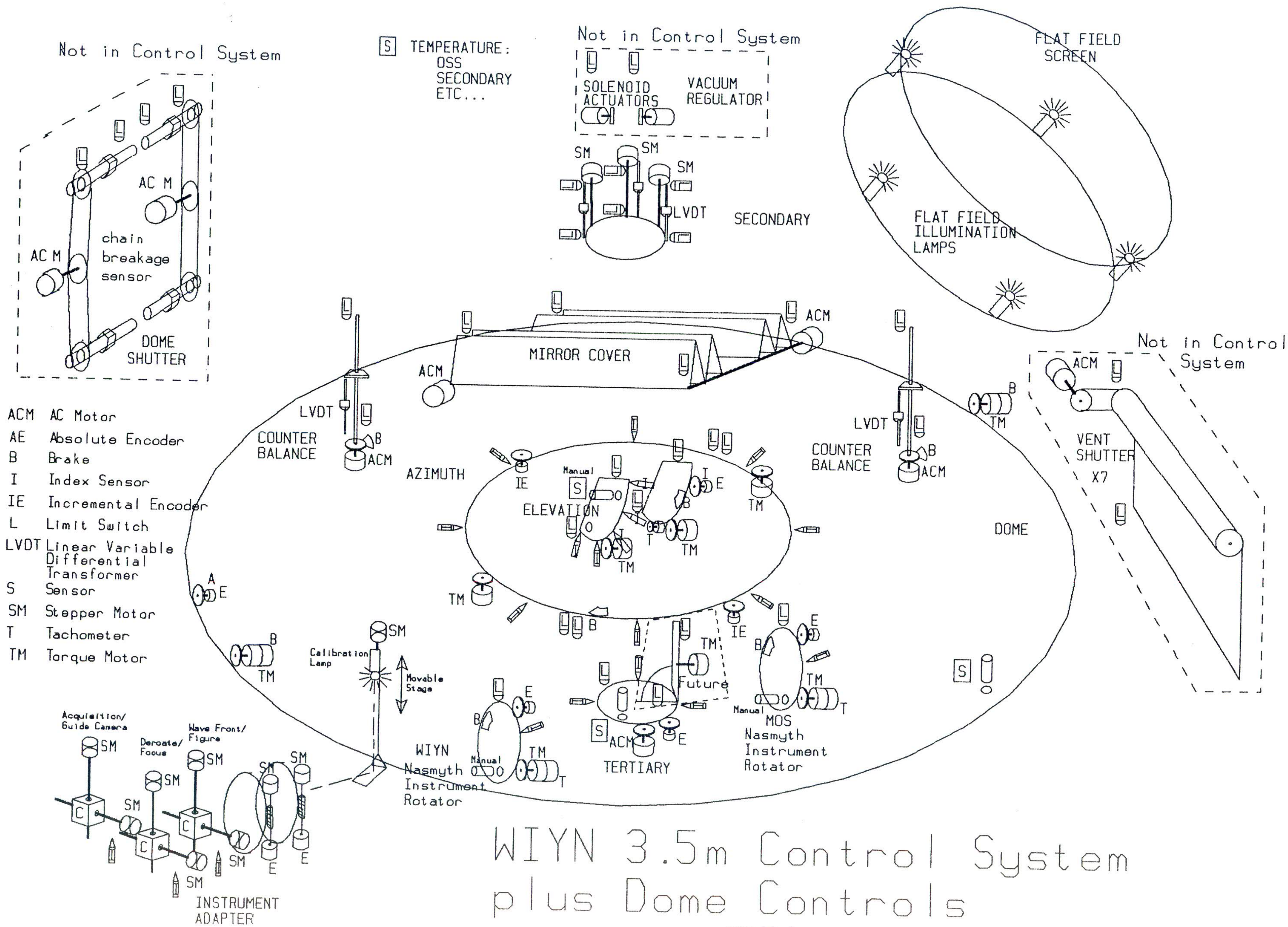


FIGURE 6. PLAN VIEW OF THE OBSERVATORY



WIYN 3.5m Control System
plus Dome Controls

FIGURE 7.

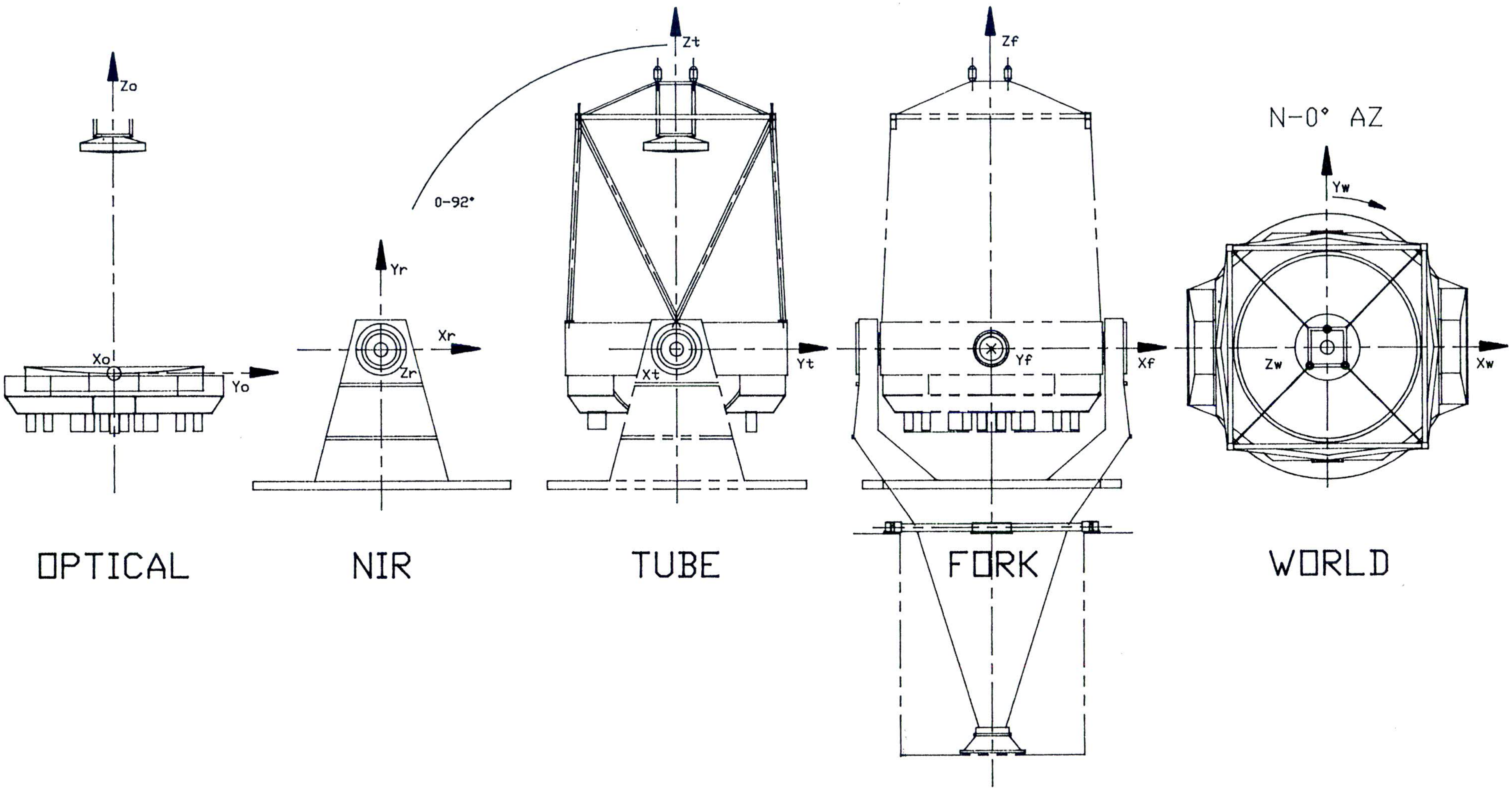


FIGURE 8. WIYN 3.5m COORDINATE SYSTEMS