Wisconsin
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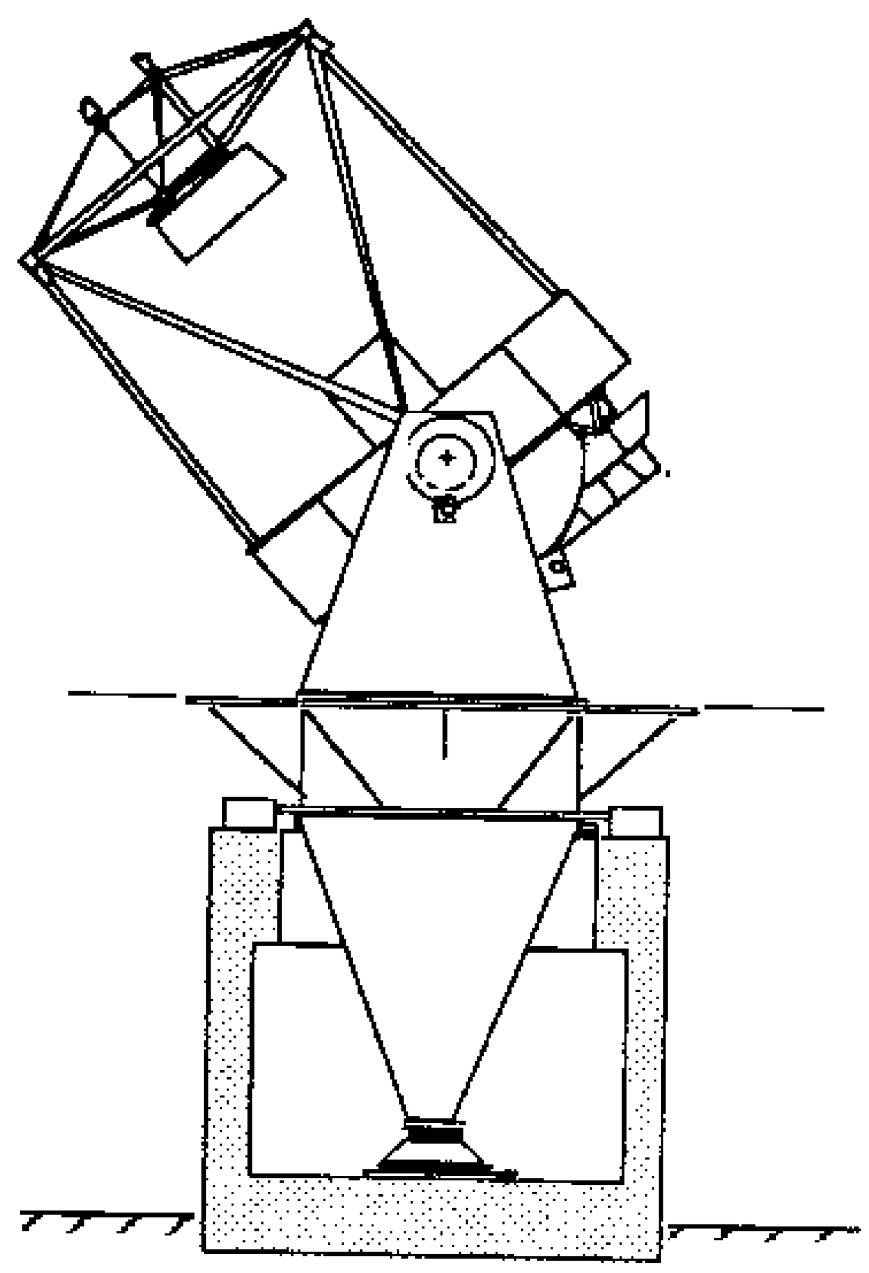

3.5 Meter Telescope

Tertiary Mirror Assembly Design Requirements for the WIYN 3.5 Meter Telescope

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1. Purpose and scope

This document describes the functional design requirements for the tertiary assembly for the WIYN telescope. The WIYN telescope is a Ritchey Chretien telescope primarily used in a Nasmyth configuration. The light beam from the secondary mirror can be directed to either of two confocal Nasmyth foci by a 45° inclined flat tertiary mirror. The tertiary can also direct the light beam to a third, confocal folded Cassegrain focus equivalent to the Nasmyth foci but located on the moving elevation structure. Beam switching between foci is accomplished by rotating the tertiary mirror about the optical axis.

A fourth focus, called the modified Cassegrain focus, can only be illuminated by removing the tertiary from the light beam. This will be done by tilting the tertiary about a hinged axis normal to the optical axis. The tertiary is "folded up" out of the path of the Cassegrain beam.

Functionally the tertiary assembly must:

a) provide support for the tertiary with minimum surface distortion

b) hold the tertiary in place with minimum displacement and tilt due to gravity.

c) provide fine adjustment mechanisms for collimating the tertiary in focus and tilt

d) provide remote rotation of the tertiary about the optical axis

e) provide positive, repeatable registration at three rotation positions

f) provide for a fold up motion which leaves the beam clear to pass through to the modified Cass focus

g) provide repeatable registration for the fold up axis

h) provide adequate minimum obscuration baffling for the Nasmyth foci

i) have minimal adverse impact on the focal plane images due to mirror seeing or other effects.

j) provide a central support at the midspan of the mirror cover to prevent catastrophic failure of the cover.

k) provide an air seal around the inner edge of the primary mirror

2. System Description

The tertiary assembly consists of the mirror itself, its support cell, a support frame, a fold up mechanism, a rotator mechanism, and the #2 baffle.

The tertiary mirror is a plano, quasi-elliptical shaped mirror 1.1 meters by .77 meters. It will be made of Zerodur in a lightweight configuration to reduce thermal inertia thus promoting rapid thermal equalization with the ambient air. The tertiary mirror will be housed in a cell which provides definition of the mirror in space and provides adequate support to maintain the optical integrity of the surface. The cell assembly will be hinged and provided with a motorized actuator so that the tertiary and cell can be folded up out of the path of the Cassegrain beam.

The tertiary, support cell, support frame, and fold up mechanism will reside above the primary mirror supported on a rotatable indexing pedestal (the tertiary rotator). Three index positions will be provided to direct the beam to either Nasmyth foci, or towards the folded Cassegrain position. This pedestal will be bolted to the primary mirror cell. The tertiary will be located so that a point near to the center and on its front surface will intersect both the optical axis and the elevation axis, and will be inclined at a 45° angle to both axes.

Nasmyth configured telescopes are usually fitted with a cone shaped baffle which extends above the primary mirror and houses the tertiary mirror. A baffle of this kind is needed to provide adequate stray light rejection with a minimum central obscuration. The WIYN tertiary baffle will depart from the traditional cone shape in order to provide free circulation of air in and around the tertiary and its support cell. This "open" baffle must still perform all the optical functions of a traditional cone shaped baffle.

3. Requirements

3a. Image error budget

The telescope error budget (WODC 01-03) sets two error allowances to sources associated with the tertiary subassembly. These are expressed as allowable FWHM image aberrations:

tertiary mirror support	$0.04\ [1 + \cos^{-3/5}(z)]$ arcseconds
tertiary thermal effects	$0.06\ [1 + \cos^{-3/5}(z)]$ arcseconds

where z is zenith distance

It should be noted that these allowances are goals rather than hard requirements.

3b. Collimation adjustment

Manual collimation adjustments will be provided to allow precision positioning of the tertiary mirror surface. Each of the three positions of the tertiary rotator will be provided with an adjustable index to allow adjustment of the tertiary mirror in rotation about the optical axis. In addition, the hinged folding axis will be provided with an adjustable stop for the "down" position - when the tertiary is in place to direct the light beam towards the Nasmyth or folded Casssegrain positions. This will be adjusted to a best compromise between the three folded focal positions. Adjustments of the tertiary mirror in azimuth (ie rotation about the optical axis) deviate reflected light beam through the same azimuthal angle. Adjustments of the tertiary in elevation (ie tilt about the hinge axis) deviate the beam by twice the adjustment angle.

Collimation adjustments will be done from the back of the mirror cell. Adjustment mechanisms must be easily accessible from the back of the primary mirror cell, or they may be fitted with motors remote collimation.

In addition to the rotation and tilt adjustments, the tertiary mirror will be located in its cell with three adjustable hard points. These will be set at installation and will not be readily accessible for collimation.

3c. Mirror hardpoint adjustment range

Piston adjustment range	0.5 mm
Rotation/tilt adjustment range	180 arcseconds
Minimum increment	4 arcseconds

3d. Tertiary rotator

Number of index positions	three
Time to beam switch	30 seconds
Rotational repeatability	4 arcseconds
Manual rotation adjustment range (at each index position)	+/- 15 arcminutes

3e. Tertiary fold up

Number of index positions	two; one repeatable
Time to fold up	60 seconds
Repeatability	
folded up	not applicable
folded down	4 arcseconds
Manual adjustment range	+/- 7.5 arcminutes

3f. Physical limitations

When folded down the tertiary assembly must reside completely within the shadow cone defined by the minimum obscuration baffle for a 1 degree field. When the tertiary is folded up there will be a clear path for light cone of six arcminutes diameter to pass along the optical axis to the modified Cassegrain position. In this position the tertiary mirror assembly is allowed to protrude 3" beyond the edge of the cone of minimum obscuration.

The fold up mechanism need only operate when the tertiary is indexed to direct the beam towards the WIYN Nasmyth port.

The tertiary rotator pedestal will fit inside the Cassegrain hole of the primary with adequate clearance for safe installation or removal. The rotator pedestal will locate on the face of the primary cell using an existing bolt circle pattern.

3g. Structural

The tertiary assembly must hold the tertiary in place with minimum tilts and despace, and must not introduce low structural resonant frequencies. 20 Hz is a reasonable goal for minimum structural resonant frequency for the tertiary assembly (assuming the pedestal is rigidly fixed). Maximum allowable structural deflections due to a 90° rotation of the optics support structure (OSS) are:

Tilt	30 arcseconds
Despace (normal to surface)	0.4 mm

Where possible, deflections should be matched to the global telescope deflections so that there is zero or very low net image motion.

Structural deflections must be repeatable with low or no hysteresis.

All construction will be light weight and low thermal mass, and designed to allow free circulation of air to all parts of the tertiary subassembly.

Rotation and fold actuator mechanisms will be provided with latches to prevent unwanted motion. Safety interlock sensors and signals will be implemented.

3h. Thermal

All powered devices such as motors, clutches sensors, switches and control electronics will be designed for minimal heat dissipation. When the tertiary is locked in position the total power dissipation will be less than 10 W.

3i. Optical

The tertiary assembly must provide an adequate forward baffle stop for stray light rejection with minimum central obscuration. Surfaces used as baffle stops will be coated with a TBD low reflectivity coating.

4. Maintenance

On a yearly or bi-yearly basis the tertiary mirror will be removed for realuminizing. Only the tertiary mirror need be removed from telescope. For safety during this operation the tertiary will remain in its cell until it is removed from the telescope and placed onto a cart on the dome floor.

At yearly intervals the primary will be removed for realuminization. At these time all portions of the tertiary assembly which protrude above the primary (ie the support frame as well as the cell) must be removed to permit primary mirror removal.

Time to remove/install tertiary assembly above primary mirror	3 hours
Method of removal:	TBD temporary rigging

The tertiary assembly will be designed with lifting points to facilitate installation and removal.

All prudent measures to protect the primary mirror at all times will be taken.

5. Seals

A loose fitting air seal will be provided between the rotator pedestal and the inner edge of the primary mirror.

All lubricated mechanisms will be provided with seals to prevent the migration of lubricants to the optics and to other telescope sub-assemblies.

6. Environmental

The tertiary assembly will meet specification in any orientation of the OSS from zenith to horizon pointing and under the following operating conditions:

Temperature:	0° to 100° F
Humidity:	98% non-condensing
Altitude:	6838 ft.