Title: Nasmyth Instrument Rotator Requirements for the WIYN 3.5 Meter Telescope

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1. Purpose & Scope

This document defines the requirements for the Nasmyth Instrument Rotators (NIR(s)). The NIR provides a mounting surface for instruments at the Nasmyth foci and is the interface between the instrument and the telescope. Two rotators are required: one for each Nasmyth position.

Instrument rotators for the other planned foci are not covered in this document.

The requirements in this document represent engineering tasks of varying difficulty. These requirements, separated into two categories, are classified as specifications or goals according to the following definitions:

Specifications describe the design or performance capabilities of the observatory that have been approved by the board to meet the science goals of the project. These specifications have been reviewed by the project staff for technical difficulty and judged to be achievable with the approved budget and schedule. Changes to specifications require a review by the Scientific Advisory Committee (SAC) and approval by the board.

A goal is a performance capability that has been recommended by the SAC but which requires further study and development due to an uncertainty in its technical feasibility or the project's ability to achieve it with the allocated resources. The project staff will design to the goals and report to the SAC when changes are advisable. Proposed modifications will include an assessment of the technical impact and budgetary and schedule implications. Modifications to goals will be approved by the SAC. Goals will be converted to specifications by the SAC as development allows. Goals which cannot be achieved within the approved budget and schedule and which, in the judgement of the SAC, significantly affect the capabilities of the observatory will be referred to the board with the SAC's recommendation.

Requirements that are goals are labeled with a [G]. A [G] at the head of a subsection or category indicates that all requirements included in the subsection or category are goals. Requirements without a G-label are specifications.

2. General Description

The WIYN Telescope is an alt-azimuth configuration with the two Nasmyth foci being the principal instrument positions. The two ports are named the MOS Port and WIYN Port and will be configured differently as described below. Unless stated otherwise, the specifications that follow apply to both ports.

The Instrument Rotator is the interface between the telescope and instrument package. It provides a rotating stage to compensate for the field rotation inherent in the alt-az design. The control system (CS) will implement a closed position control loop to track the field rotation with the telescope motion.

The MOS Port will be optimized for wide-field (1° FOV) Multi-object Spectroscopy. A corrector will be mounted to the stationary part of the NIR. A mounting adapter for the corrector is part of the NIR task but the corrector and its cell are not.

The WIYN Port is a general purpose focus which will initially have a 0.5° FOV. Clearance through the NIR for future utilization of the full 1° field

is required. Instruments at the WIYN Port will normally attach to an Instrument Adapter that provides acquisition and guide sensors and an Atmospheric Dispersion Compensator (ADC). The Instrument Adapter attaches directly to the NIR. The Instrument Adapter has been included in the weights and moments specified below.

The NIR task includes the rotation stage, the rotation mechanism and motor, brakes, position encoder and mounting, electronic index sensor, limit switches and corrector adapter (MOS only). Motor and brake control, control system input for the encoders, index sensor and limit switches, power supplies and all control software are part of the CS task and are not included here.

3. Mechanical Requirements

3.1 Instrument Weights and Moments

The Instrument Rotator will perform within specifications with the following maximum instrument weights and moments attached to the instrument mounting surface (S):

Instrument weight:	1000 kg.
Cantilever moment from S:	3000 N-m.
Imbalance about axis:	150 N-m.

3.2 Positioning

Operating rotation range:	360°.
Positioning accuracy:	$\pm$5 arcsec. Max.

3.3 Accelerations & Rates

Rotation rate:	-5°/sec. to +5°/sec.	[G]
Track rate:	-0.5°/sec to +0.5°/sec.	[G]
Ramp rate:	$-1°/sec^2$ to $+1°/sec^2$	[G]

3.4 Physical Limitations

The instrument mounting surface on the NIR will be 105.00" from the primary optical axis of the telescope. No part of the NIR shall extend beyond this distance with the exception of instrument registering pins. Adequate clearance shall be provided between stationary parts of the NIR and the mounting plane to prevent interference with the rotating instrument.

Clearance for the beam shall be provided through the center of the NIR including the corrector adapter. The basic geometry is shown in Figure 1.

The NIR shall not extend beyond the fork tines parallel to the mounting surface.

3.5 Mechanical Tolerances

The following apply for all loading conditions and refer to the instrument mounting surface relative to the elevation axis:

Concentricity:	0.001 inch.	[G]
Bearing Jitter:	0.0005 inch.	
Non-perpendicularity:	10 arcseconds.	[G]

3.6 Seals & Covers

Appropriate seals and covers will be provided where necessary to protect drive surfaces and bearings from damage by foreign objects or dust. Encoders and encoded surfaces shall likewise be protected.

Seals shall be provided to prevent lubricants from leaking onto the instrument or corrector.

4. Positioning

4.1 Rotator motor

NIR rotation will be provided by a DC servo motor with appropriate gearing. The motor, integral tachometer, and motor mount are included in the NIR task. Control of the motor is part of the Control System task.

4.2 Brake

A failsafe brake will be provided to prevent unwanted rotation when the drive motor is inactive. The brake will be supplied as part of the NIR task but control of the brake is included in the Control System task. The brake will be capable of holding the rotator stationary in the presence of a 500 N-m torque.

4.3 Rotation Lock

A manually operated locking mechanism will be provided to prevent unwanted rotation during instrument mounting. The locking mechanism shall be designed to hold the rotator stationary in the presence of a 5000 N-m torque. The locking mechanism may be engaged when the rotator is at the index position.

4.4 Encoder

An encoder for measuring the rotation angle of the rotator will be included in the NIR task. The encoder shall have a minimum resolution of 2 arcseconds of rotator angle. The encoder and mounting are included in the NIR task. Encoder readout, power supply, and control software are all part of the control system task.

4.5 Index mark

An electronically readable index position will be provided in the middle of the rotator range for absolute calibration of the rotator angle. The index sensor output will be read by the control system. The repeatability of the index position shall be $\pm$6 arcseconds[G].

4.6 Rotation Limits

Limit switches shall be provided as part of the NIR task to signal the ends of the operating range. Reading the switches and performing the appropriate control functions will be part of the Control System task.

Hard stops will prevent rotation past the end of the mechanical range of the rotator.

5. Interfaces

5.1 Telescope

The NIR will mount to the surface of the telescope altitude axle blocks. Recesses with mounting plates will be provided in the axle blocks for the NIR drive motors and encoders.

5.2 Connection to Ventilation system

Waste heat produced by the rotator motors shall be exhausted by the telescope mount ventilation system. Air passages into the ventilation plenum will be provided by the mount manufacturer. The NIR will provide air passages and filters for make-up air.

5.3 Control System

The Control System will implement the position control loop for tracking the rotator. NIR inputs to the Control System include encoder signals, tachometer output, index sensor, and limit switches. The Control System provides motor control for the servo and all required power supplies.

5.4 Cabling

Cabling from the motor, tachometer, encoders, index sensor and limit switches will terminate at connectors located near the motor, tachometer, etc. and will be included as part of the NIR task. Cabling from the connectors to the electronic controls is included in the Control System task.

Types of connectors and locations are TBD.

5.5 Wide-field Corrector

An adapter for supporting the wide-field corrector shall be provided as part of the NIR task. The adaptor is required on the MOS Port only. The corrector and its cell are not included. Figure 2 shows preliminary details of the corrector mounting. The corrector shall be optionally mountable on either the rotating or stationary part of the NIR.

The corrector adapter shall be designed for easy removal of the corrector assembly from the outboard side of the telescope. The corrector assembly shall positionally register to the NIR with an accuracy of 0.002". An adjustment for centering the corrector shall be provided in the adapter mount. The range of adjustment shall be not less than 0.060".

5.6 Instrument Mounting

A set of threaded holes shall be provided in the instrument mounting surface of the NIR for instrument attachment. A means of registering the instrument shall also be provided. Figure TBD shows the instrument interface.

6. Environmental

The Instrument Rotators will meet specifications under the following operating conditions:

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