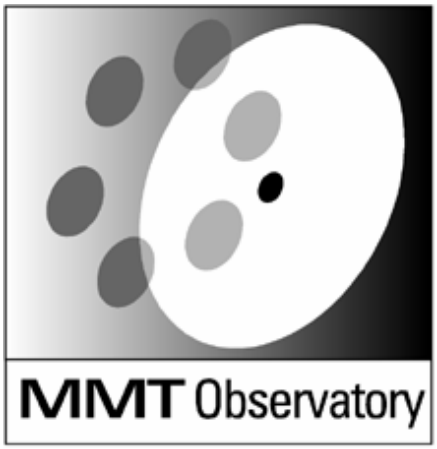
MMTO Conversion Technical Memorandum #00-1

(Revision of MMTO Conversion Technical Memo #99-1)



Smithsonian Institution &
The University of Arizona®

6.5 m Instrument Rotator Performance

Goals and Specifications, Rev. 3

D. Clark, S. Callahan, J.T. Williams

January 14, 2000

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Dusty Clark, Shawn Callahan, J.T. Williams
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The following is an update of the original 6.5m Telescope Instrument Rotator Goals and Specifications, by J.T. Williams, et al., 2/20/92, 9/9/98, and 2/17/99. It has been four years since the last major design effort for the system, and many details have since been incorporated due to changes in the mirror cell and instrument configurations and design improvements in the drive systems by MMTO engineering staff.

Mechanical Requirements

- Instrument mounting flange, 72 inches diameter bolt circle, at Z = -57.75 inches or 84 inches above floor, nominal. The plane of the mounting flange will be clear out to 85" diameter. For an Autocad drawing or .dxf file of the instrument rotator see: ftp://couloir.as.arizona.edu/6.5m_conversion/Autocad_files/02--/mmt0217e.dwg.

  Instrument maximum swing radius about the telescope Z axis may not exceed 42.5" from Z = -57.75 to -79.75" or 0.0" to 22" aft of the instrument rotator mounting flange. This 85" diameter envelope is consistent with the rotator's mechanical specifications defined in 1992. This 42.5" swing radius just clears instrument and top box cable/hose wrap-up mechanisms, allowing $\pm$180°, rotation of all instruments.

  Instrument swing radius about Z may exceed 42.5" from Z = -80.0" to -130.0" or 22.3" to 72.0" aft of the rotator flange. Instrument designers must recognize that greater swing radius extremities *may* limit the instrument rotation range to less than ±180°.

  Maximum instrument swing radius about Z must not exceed 29.5" near the observing floor, from Z = -131.0" to -141.5" or 73.0" to 83.5" aft of the rotator mounting flange. This recently imposed envelope limitation is defined by the facility floor-lift mechanism, which has 10" high curbs 60.0" apart. (These curbs house hydraulic / mechanical linkages to raise the floor level instrument lift.)

  The finished observing chamber floor defines the maximum instrument length and, hence, swing radius. Instrument extremities must swing wholly inside a 169.0" (Z = -142.0") radius about the telescope elevation axis.

- Instrument designers and users are reminded that the instrument rotator is a precision bearing/drive system equivalent to a third axis of the telescope. Accordingly, there are finite limits to weight and moment that can be safely applied to the mechanism. The instrument mounting flange will support and rotate a load of up to 3,000 lbs. with c.g. at Z = -109 inches or 49.5 inches aft of the rotator flange, resulting in a maximum moment specification of 12,500 ft. lbs. The total instrument weight must not exceed 4400 lbs.

  Therefore:

  - Maximum instrument weight, including cable/hose loads imparted to the rotator, must not exceed 4400 lbs., 2 metric tons, inclusive. Heavier instruments will not be mounted. (We have a scale!)

  - Instruments with any combination of weight and c.g. location that exceeds 12,500 ft. lbs. moment load on the rotator bearing will not be mounted. This maximum moment exposure must include cable/hose loads, and especially any additional moment loads due to tethered devices.

  - Instruments must be designed such that there are no collisions with the telescope, building, instrument lift, cable wrap, etc. over the entire range of the rotator's travel and telescope's elevation motion.

- For instruments in compliance with the total weight and moment limits, the rotator assembly and its mounting have been optimized for high stiffness, with a lowest resonant frequency goal greater than 15 Hz. Drive stiffness goal is 109 ft-lbs/radian.

- The rotator maximum flexure goal will maintain the instrument flange center of rotation on the mirror cell Z axis to 0.004 inches, and normal to the Z axis of the telescope to + 0.004 inches (tilt) at the edge of a 1 degree sky field, approximately 24 inches diameter. This corresponds to 0.1 arcsec of defocusing due to axial deformation.

Drive System Requirements

- Rotator flange will be gear driven with multiple brush-type DC motors/pinions in a 'zero backlash' configuration, powered by PWM amplifiers selected with appropriate bus voltage/output current.

- Motor torque will provide for maximum instrument loads with c.g. off-axis up to 10 inches, with a full complement of cables and hoses in the adjacent wrap-up system.

- Motor drive will be under computer control normally, with software settable velocity limits and rotator/instrument position angle limits.

- Rotator limits at ±180° nominal (due to cable-wrap and utility connections) will override both computer and manual operation.

- A manual remote paddle will be provided using hardware control with rotation direction, stop and on-off controls, for testing and default instrument mounting. In addition, a portable remote IO digital control with a full menu of velocity and position angle commands will be available at the rotator.

Servo System Performance Requirements

- Maximum slew velocity will be software and hardware limited to 2 degrees per second (rotator), nominal. (Limited due to cable-wrap and utility connections).

- 'Tracking' velocity range will be ZERO to 1.3 degrees per second (sky @ 89°50' El), nominal.

- 'Tracking' resolution goal is 0.05 arcsec at the edge of a 1 degree sky field (f/5.27), or approximately 18 bits, over the angular velocity range 1.5 arcsec/second to 1.3 degrees/second (sky @ 89°50' El).

- 'Tracking' performance goal is 0.1 arcsec RMS at the edge of a 1 degree sky field.

- 'Pointing' accuracy goal is 0.5 arcsec RMS on the sky at the edge of a 1 degree field, dead reckoned from a fixed rotator position angle.

- 'Offset' accuracy goal is 0.2 arcsec over 10 degrees range of rotator position angle.

- 'Positioning' accuracy (repeatability) goal is 0.1 arcsec peak on the sky at the edge of a 1 degree sky field over a 10 degree range of rotator position angle.

- Servo bandwidth goal is 8 Hz or higher over the sky angular velocity range 1.5 arcsec/second to 1.3 degrees/second.

References:

Conversion Technical Memo 92-1, S. Groff "Instrument Rotator Control System"
MMTO Internal Memo March 31, 1992.

* **Supersedes:** Feb. 20, 1992 memo "6.5m Instrument Rotator Performance Goals and Specifications" – J.T. Williams, and MMTO Conversion Technical Memoranda #98-3 and #99-1.