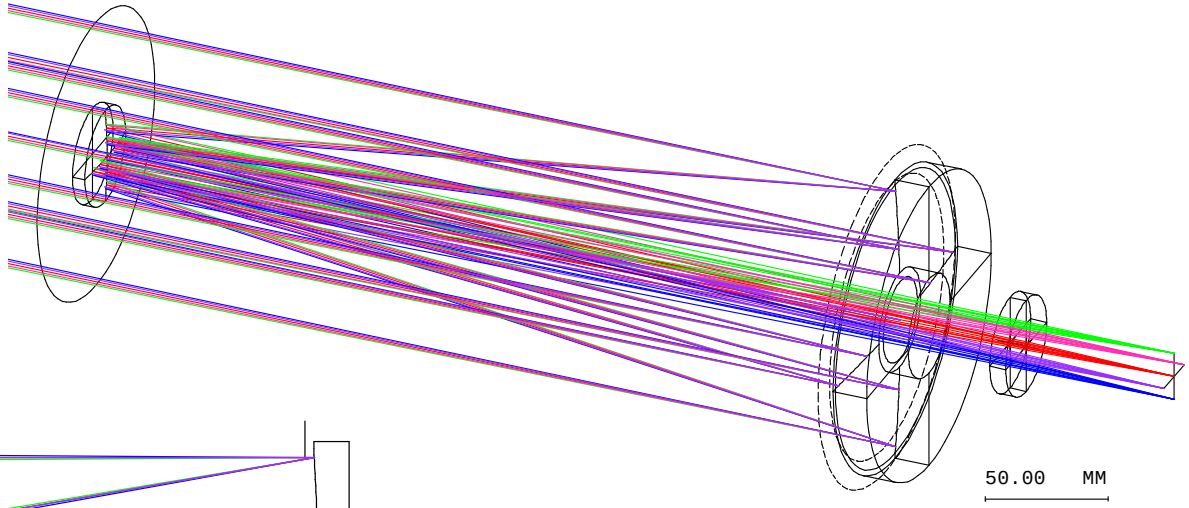
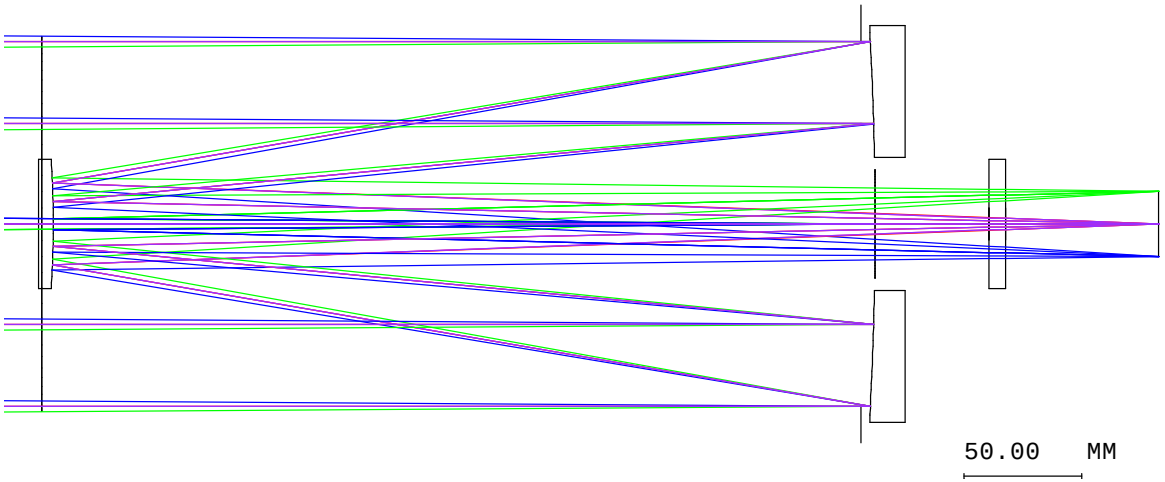
Opto-Mechanical Sub-System
MRI Telescope Optics

Medium Resolution Instrument Telescope (MRIT)

- **Design has no significant changes since last review**
  - **Mirrors are unchanged**
  - **Filters are thicker, normal to the beam**



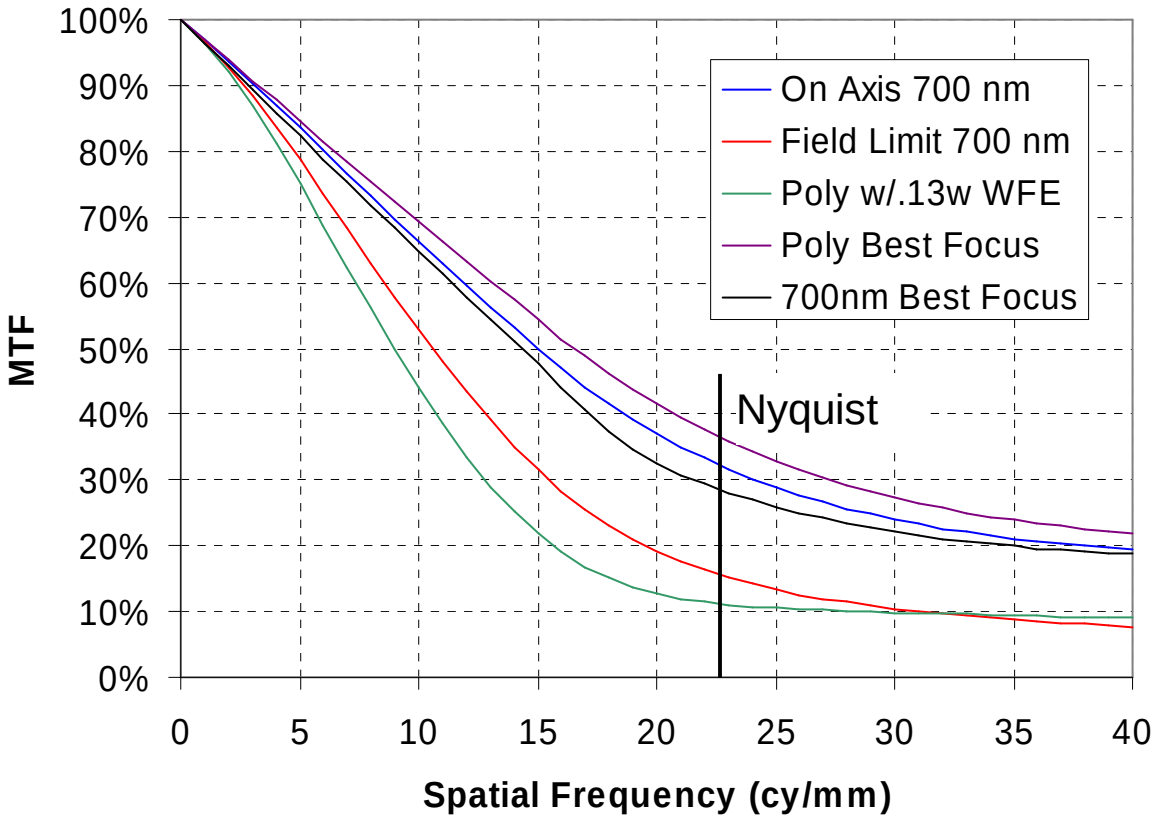


MRI Optical Requirements

Parameter	Value	Source / Performance
Wavelength Range	300 to 950 nm MRI 400 to 950 nm ITS	300 to 1000 nm
IFOV	10.0 ± 1.2 microradians (~2 arc-seconds)	B-Spec Requirement
Visible CCD Pixel Size	0.021 mm x 0.021 mm	System Implementation
Focal Length	2100 mm	Derived To be verified in testing
Array size	1024 x 1024	By Design
FOV	0.293^0 To the Edge of Array (0.415^0 To Corners of Array)	Derived from IFOV & array
Collecting Area	71 square centimeters	Sensitivity Requirement Equivalent to 9.5cm unobscurred
Baffling	No direct illumination of the focal plane	B-Spec, good practice
Central Obscuration Linear Area	53.3% 28.4%	Acceptable
Entrance Pupil Diameter	120 mm	Yields 79.5 sqcm collecting area
Primary to secondary mirror spacing	350.0 mm	Driven by ability to Baffle
Primary mirror vertex to image distance (BFL)	120 mm	Limited by ITS envelope, Will be set in integration
Primary mirror F/#	F/3.8	Derived
Secondary mirror magnification	4.7x	Derived
Axial Magnification	21.7x	Derived, Large but acceptable
Wavefront Error Limit	0.13 λ/ at 700 nm	B-Spec interpretation of MSRR FWHM spot size limit

MRIT Provides Adequate MTF Performance

- **Not field independent**
  - **Significant curvature of field**
  - **Performance held over included 0.6° diameter field**
- **Shown "as designed" and with 0.13 λ RMS WFE**

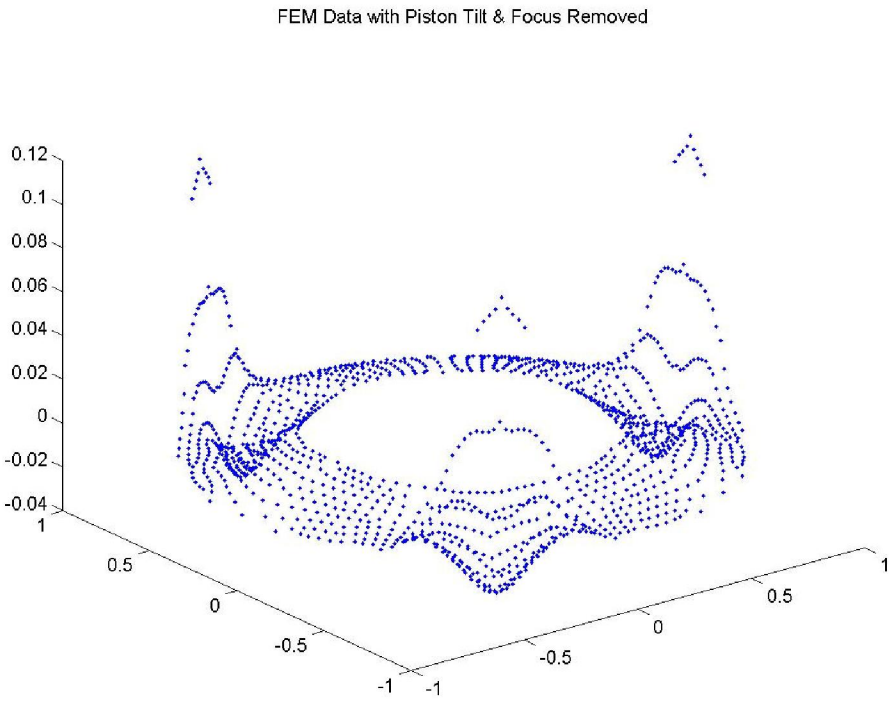


Telescope Design Incorporates Stray Light Suppression

- **Telescope is fully baffled against direct illumination of the detector**
- **Diffuse black masks around Primary & Secondary**
- **Deep vanes in Telescope structure trap most out of field light**
- **Vanes incorporated inside primary conical baffle**
- **Secondary cone modified to redirect specular out of field light**
- **Many surfaces left unpainted with approval of stray light analyst**

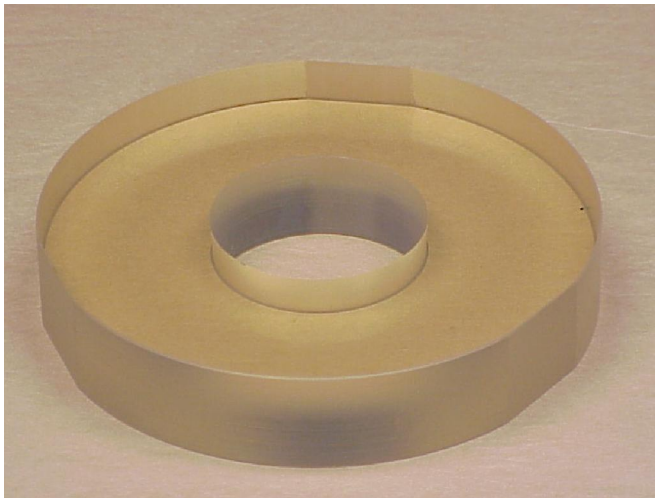
Structural Analysis for Primary Mirror

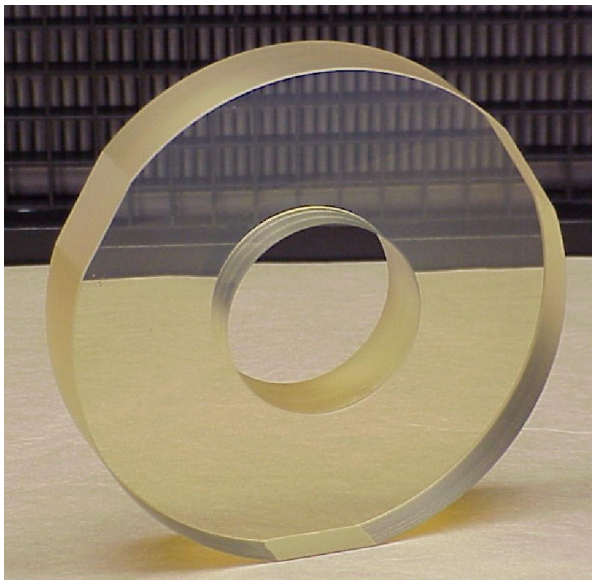
- **Used to estimate surface deformation from perturbations**
  - **Isothermal drop to operational temperature**
  - **Differential expansion of mounting pads (shown in figure)**
    - **Added WFE 0.026: acceptable**
  - **Shimming of flexures**
    - **Insignificant added WFE**
- **Zernike decompositions used to separate compensated changes like power**
- **All deformations included in tolerance analysis**



Telescope Mirrors Progressing Well

- **Contract in place with Light Works Optics of Irvine, CA**
- **All telescope mirror substrates complete**
  - **Shaped, cryo-cycled, & acid etched**
  - **EM Primary at BATC for bond testing, no optical surface**
- **Secondary mirrors polished to hyperbolic figure**
  - **Tested as spheres and with Hindle spheres**
- **Primary mirrors polished to parabolic figure**
  - **S/N1 is coated**





UV-Visible-NIR Filters

- **Filters for 9 position wheels in HRI & MRI**
  - **Narrow bands for MRI based on IHW and Hale-Bopp filter sets**
  - **Two broadband filters, duplicates of HRI filters**
- **Filters being coated**
  - **Most substrates at vendor, sized and edged**
  - **Multi-layer filters will be measured at operating temperature**
  - **Coatings may be annealed to bring central wavelength to spec**
  - **First coating complete: S/N -006 λ_c=526 nm, right on target**

Filter #	Wavlength	Bandpass	Purpose	Wheel	Blocker	Avg Trans
-1	Clear	N/A	Parfocality	Both	N/A	>90%
-2	309.0 ±0.8	6.2 ± 0.7	OH	MRI	UG-11	>40%
-3	345.5 ±0.8	6.8 ± 0.8	UV Cont.	MRI	UG-11	>40%
-4	387.0 ±1.2	6.2 ± 0.7	CN	MRI	S-8612	>55%
-5	514.1 ±1.2	11.8 ± 1.2	C2	MRI	GG-475	>70%
-6	526.0 ± 0.7	5.6 ±0.7	Green Cont.	MRI	GG-495	>70%
-7	<400 ± 5.0	N/A	UV Short Pass	HRI	Coated FS	>50%
-8	450 ± 5.0	100± 5.0	Blue BP	HRI	S-8612	>70%
-9	550 ± 5.0	100± 5.0	Green BP	HRI	GG-475	>70%
-10	650 ± 5.0	100± 5.0	Orange BP	HRI	OG-570	>70%
-11	750 ± 5.0	100± 5.0	Red BP	Both	RG-645	>70%
-12	850 ± 5.0	100± 5.0	NIR BP	Both	RG-715	>70%
-13	>900.0 ± 5.0	N/A	IR LWP	HRI	RG-830	>70%

MRI Telescope Optical Alignment

- **Telescope Optical Alignment Measurements**
  - **Focus position**
  - **Telescope wavefront distortion (RMS)**
  - **1G alignment compensation (wavefront distortion balance)**
  - **Boresite alignment**
  - **Telescope EFL**
- **Optical alignment (@ 20^{o}C & ~ 30% RH) with corrections for CME and CTE**
- **Alignment measurements using ZYGO GPI interferometer in conjunction with precision motorized stage assemblies and alignment station.**
- **Telescope alignment optimization via secondary mirror positioning adjustment.**