University of Wisconsin – Madison
Contract Number 11-0124
Jenoptik Q11236

JENOPTIK

Prepared for Professor Mark Saffman Ph.D.
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Tolis Deslis 18 May 2011

Specifications - I

		MEET SPECIFICATIONS	
ITEM	**DESCRIPTION**	**YES**	**NO**
	Lens A:		
1	Designed for projection and imaging tasks with light of wavelengths 455, 685, 780, 852, 915 and 1038 nm.	X	
2	NA slightly less than 0.5	X	
3	Outside tube diameter 20 mm	< 20 mm	
4	Working distance: 1 mm air + 7.3 mm pyrex + 10 mm vacuum	X	
5	Better than diffraction limited for a field of view of 200 micron diameter	X	
6	Optical transmission >94% at above wavelengths		X
7	Lens assembly constructed from non-magnetic materials	X	
8	Total weight < 500 g	X	
9	Bid must include calculated rms wavefront error and chromatic focal shifts as a function of off-axis coordinate at focal plane	X	
10	Delivered items must include a measured verification of performance	X	
11	Quote for 2 units with an option for 2 more.		

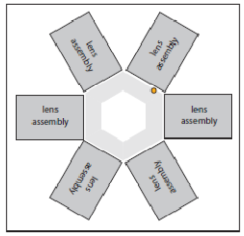
Specifications – II
Packaging Requirements

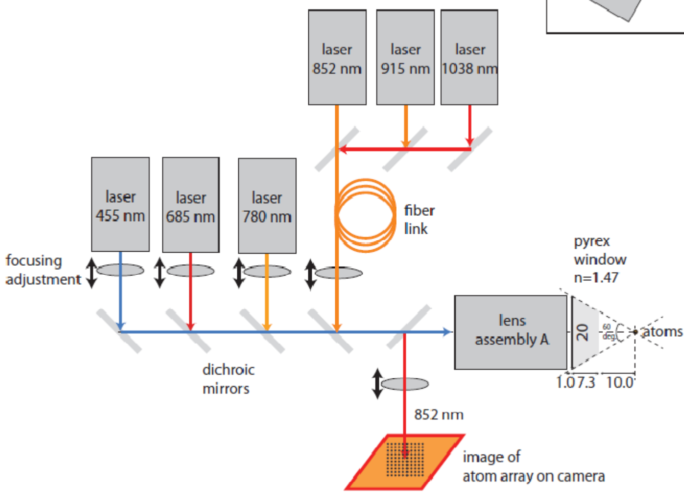
Mark Saffman
msaffman@wisc.edu

Custom lens systems usage

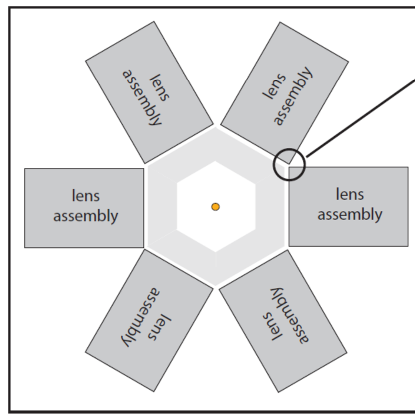
all dimensions in mm

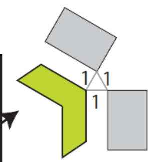
6 units placed around atoms





6 units placed around atoms





With 1 mm air gap between lens and window there will be 1 mm gap between adjacent lens tubes.

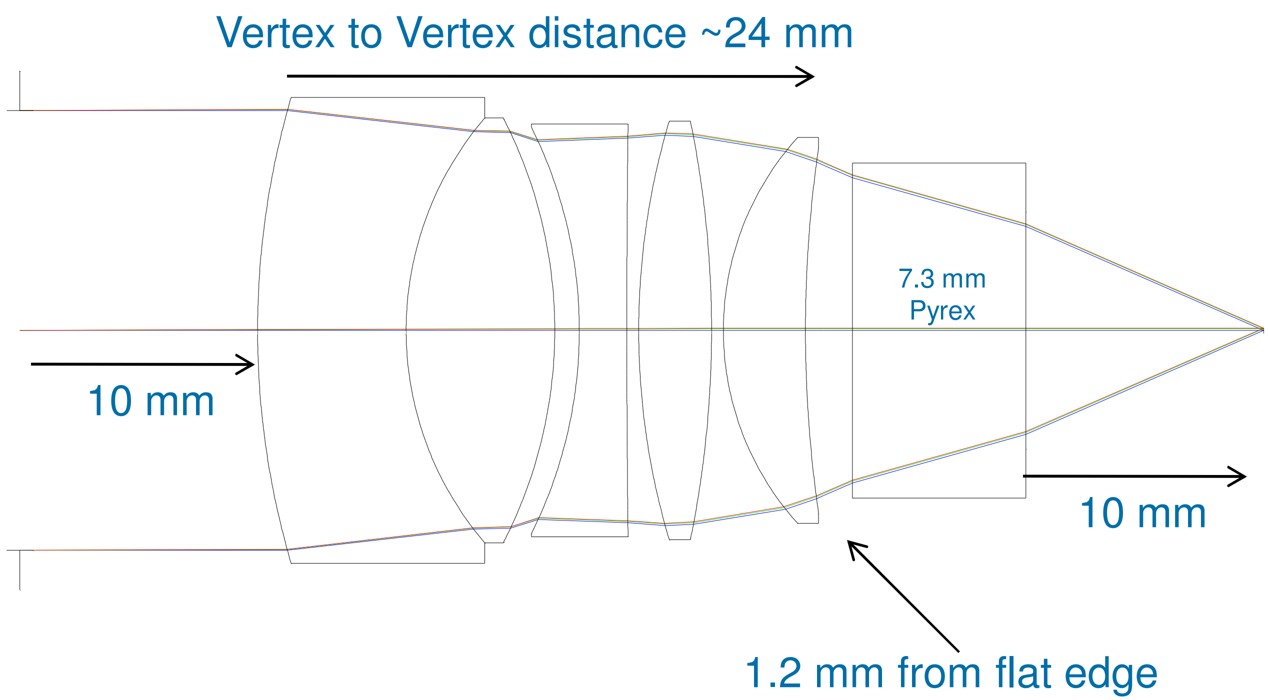
I expect 0.1 - 0.2 mm assembly tolerances on hex cell so lens tube with 20 mm diameter +/- 0.2 mm should be good.

We could go a few tenths larger but 20.0 seems safe.

The lenses used for focusing adjustment will compensate for the variation in focal length of the lens assembly at different wavelengths. Since these lenses will be used at low numerical aperture I am assuming they can be standard catalog achromats. The projected wavelengths will all be Gaussian beams set to have a waist that is about 1/4 of the lens assembly aperture diameter. Focusing will be adjusted so that all wavelengths are simultaneously focused onto the atomic plane where they will have diffraction limited spot sizes of a few microns.

Note that the 850, 915 and 1038 nm light will be delivered through a single optical fiber. Thus there is only one focusing adjustment for those wavelengths, and it is important that the lens assembly has not too large focal length shifts between 850, 915, 1038 nm. Beam scanning to different off-axis points in the focal plane will be accomplished using small tilts of the beams provided by optical systems which are not shown in the above figure, but are upstream of the focusing adjustment lenses.

Optical Layout



Layout

Wisconsin NA ~0.4 Objective lens
5/18/2011
Total Axial Length: 52.31782 mm

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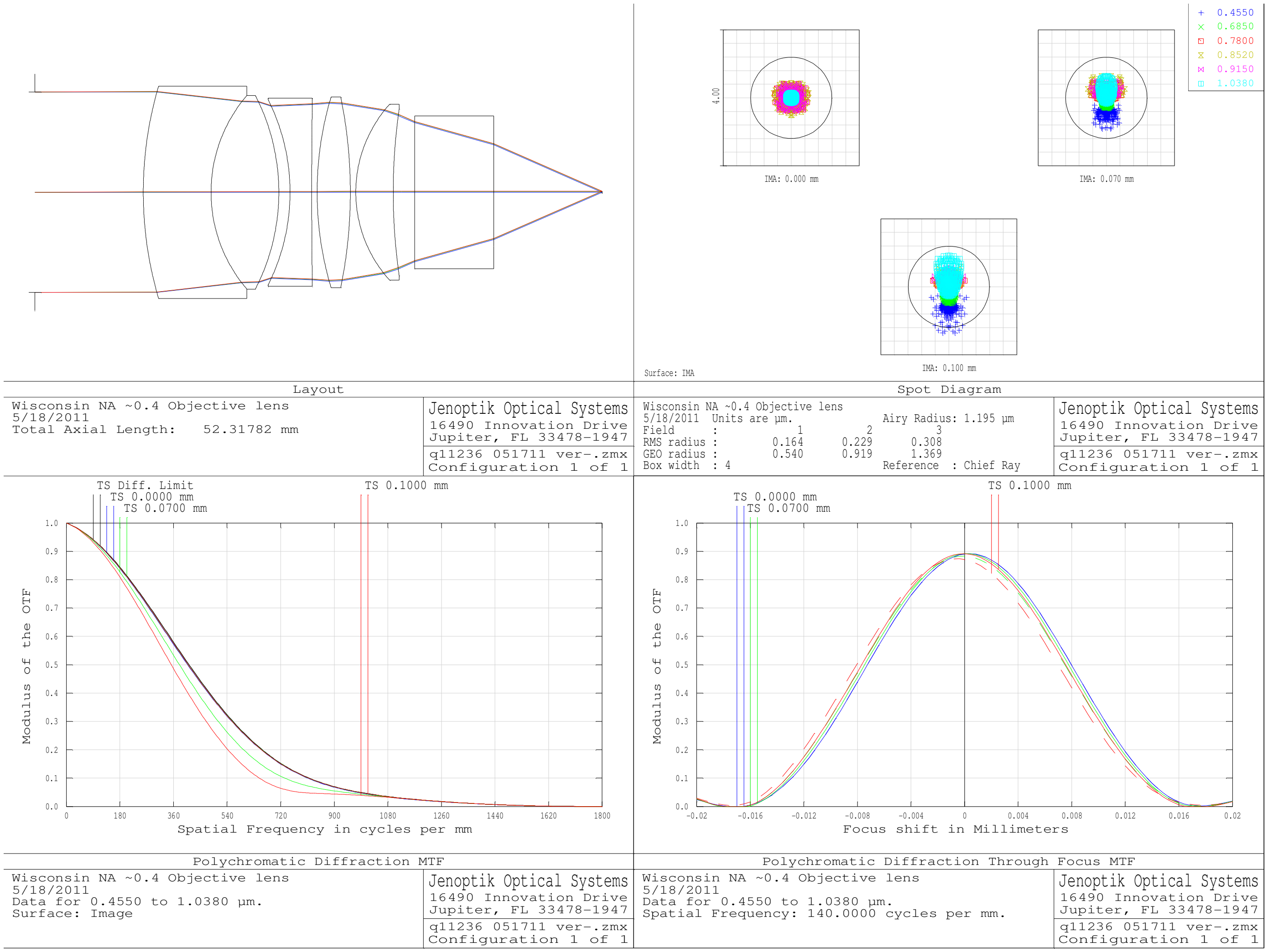
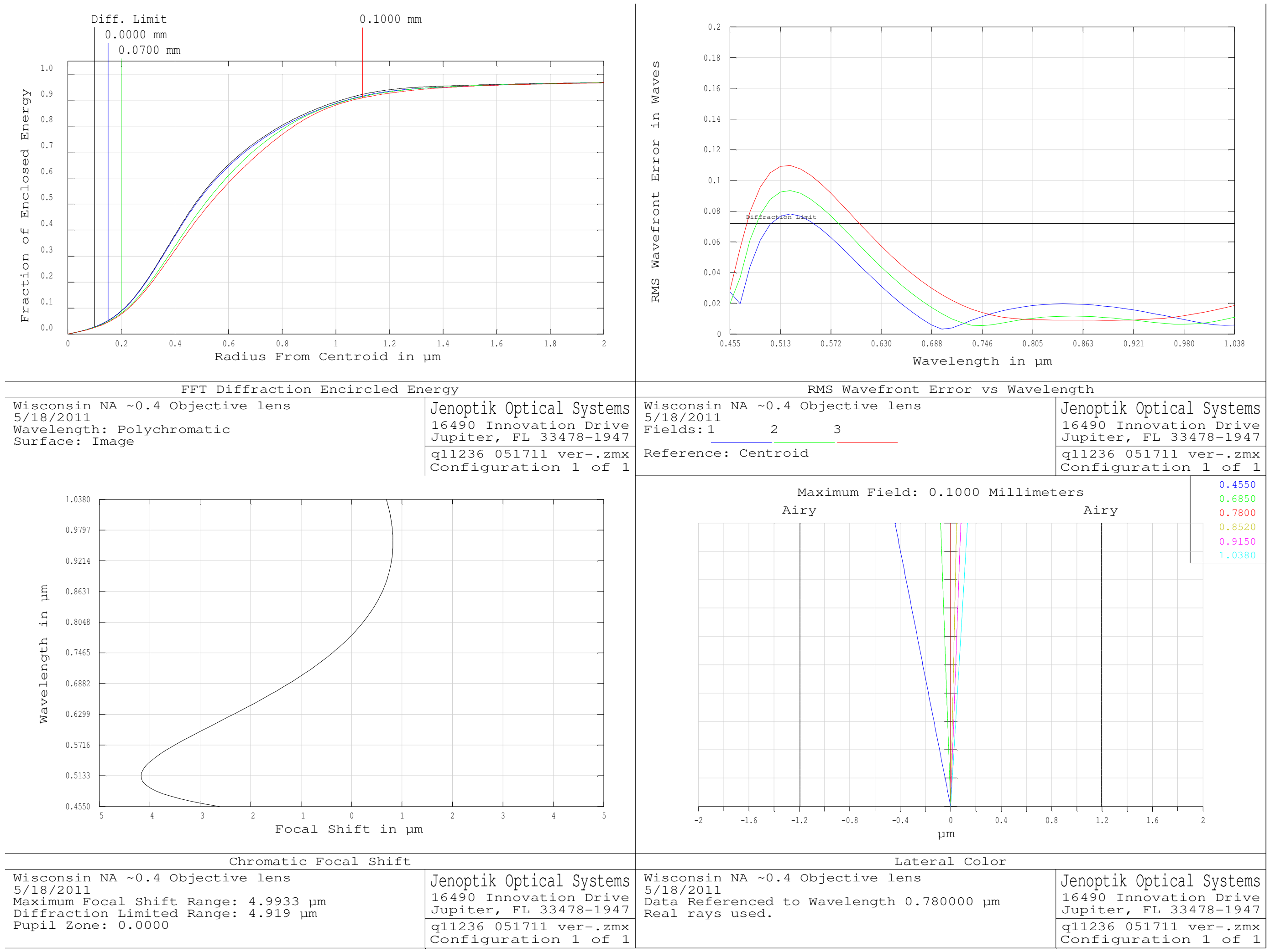
q11236 051711 ver-.zmx
Configuration 1 of 1

Performance with all wavelengths present
Black circle in spot diagram is Airy disk

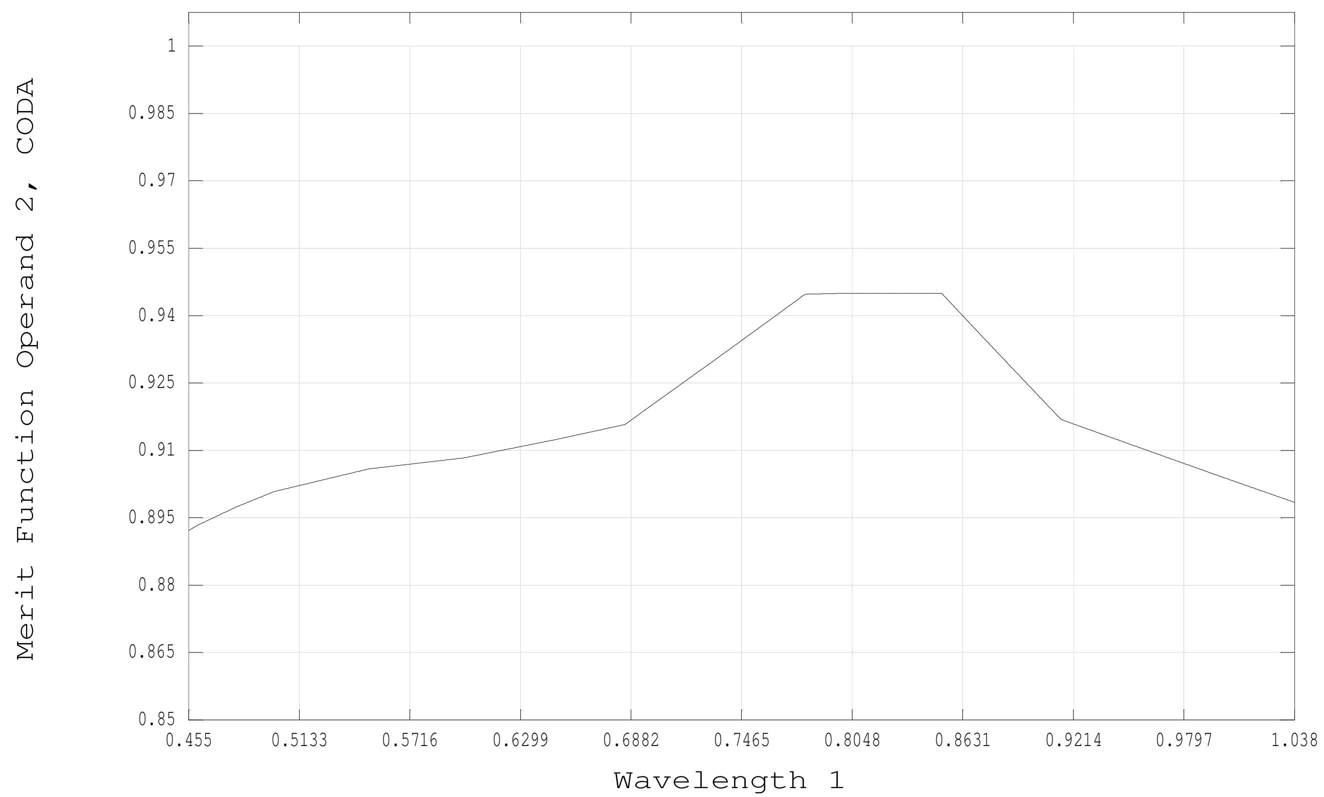


Performance with all wavelengths present

Encircled Energy – RMS Wavefront Error – Axial Color – Lateral Color



Transmittance with Pyrex window



Universal Plot

Wisconsin NA ~0.4 Objective lens
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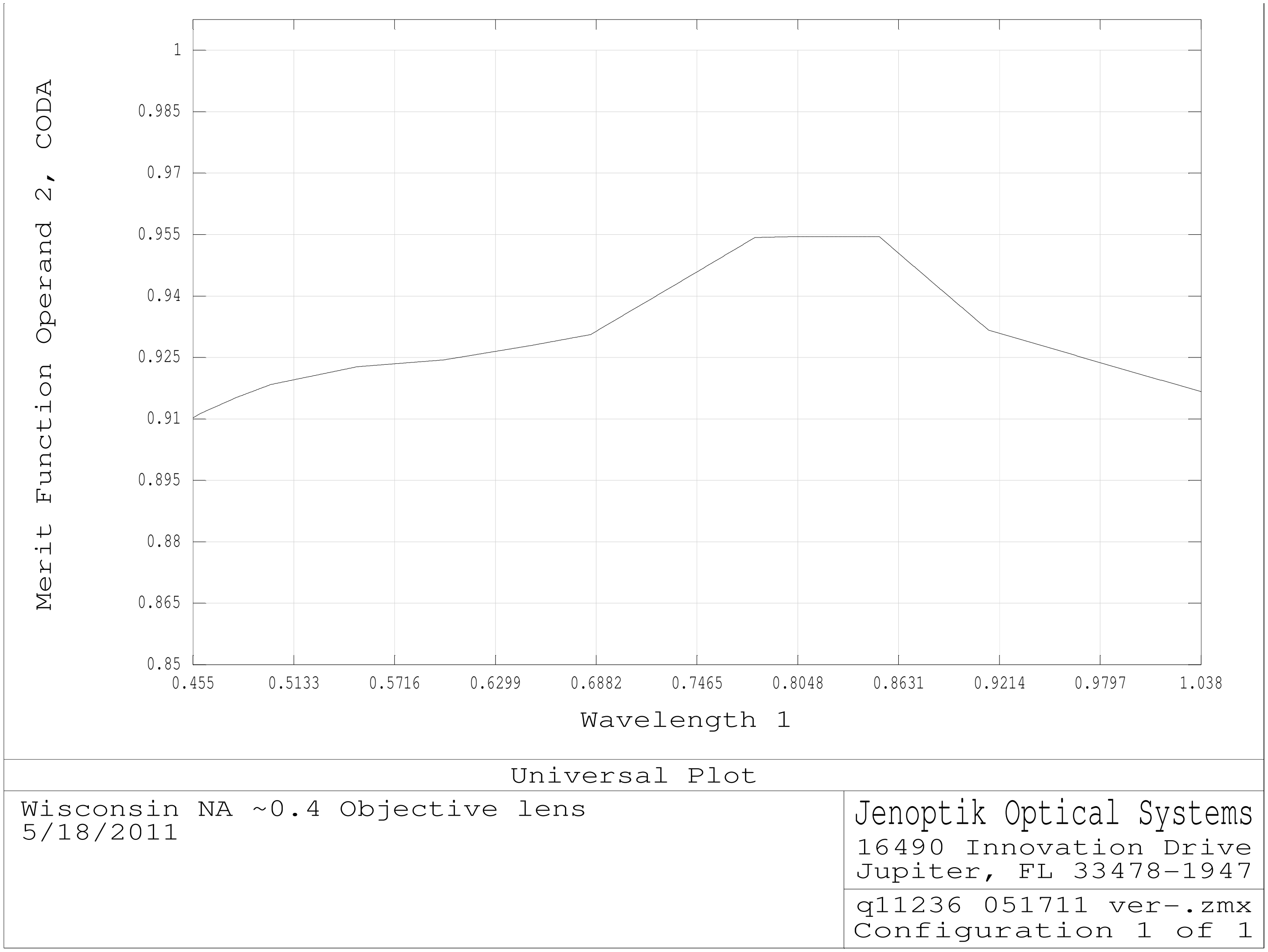
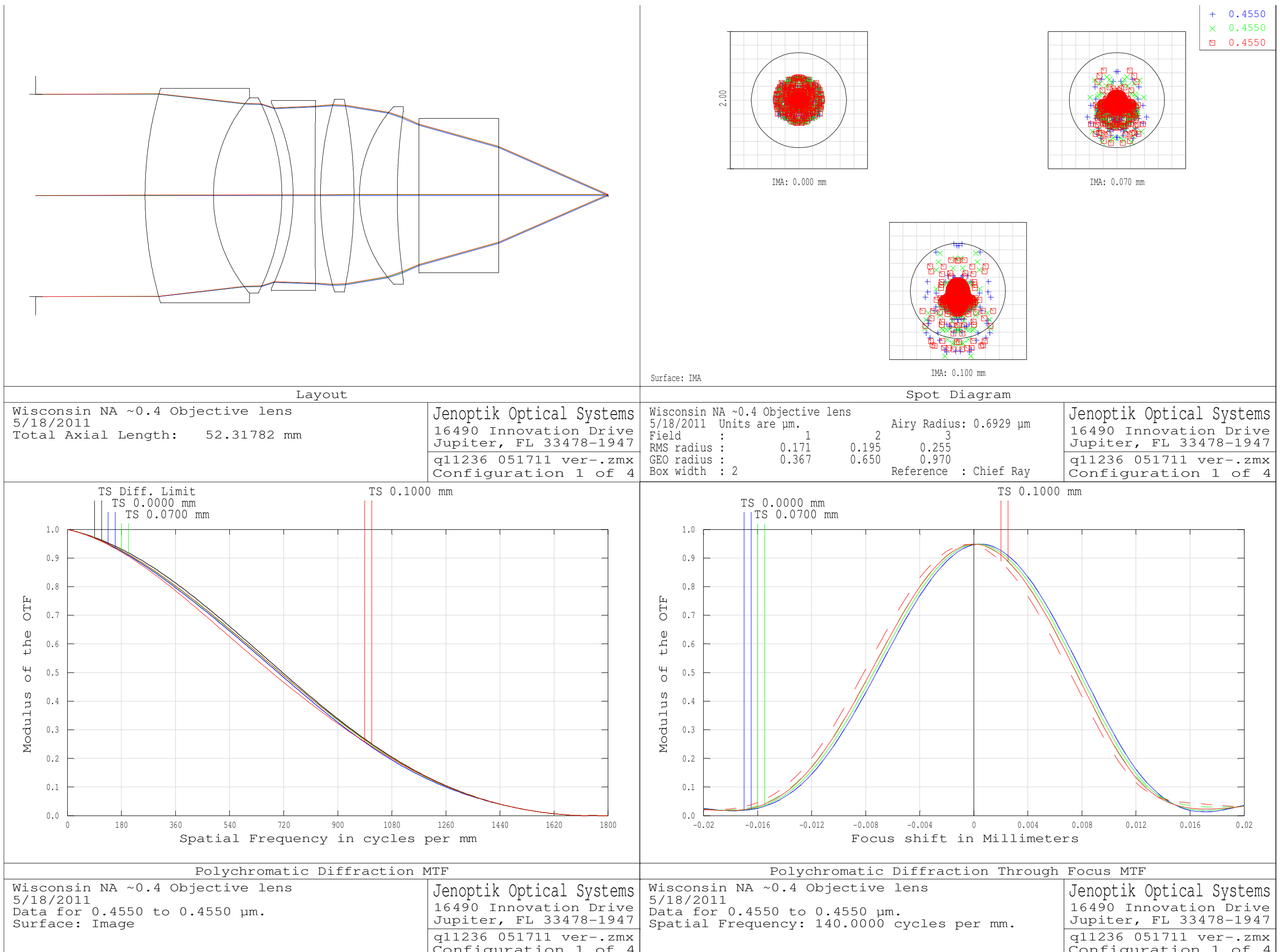
Configuration 1 of 1

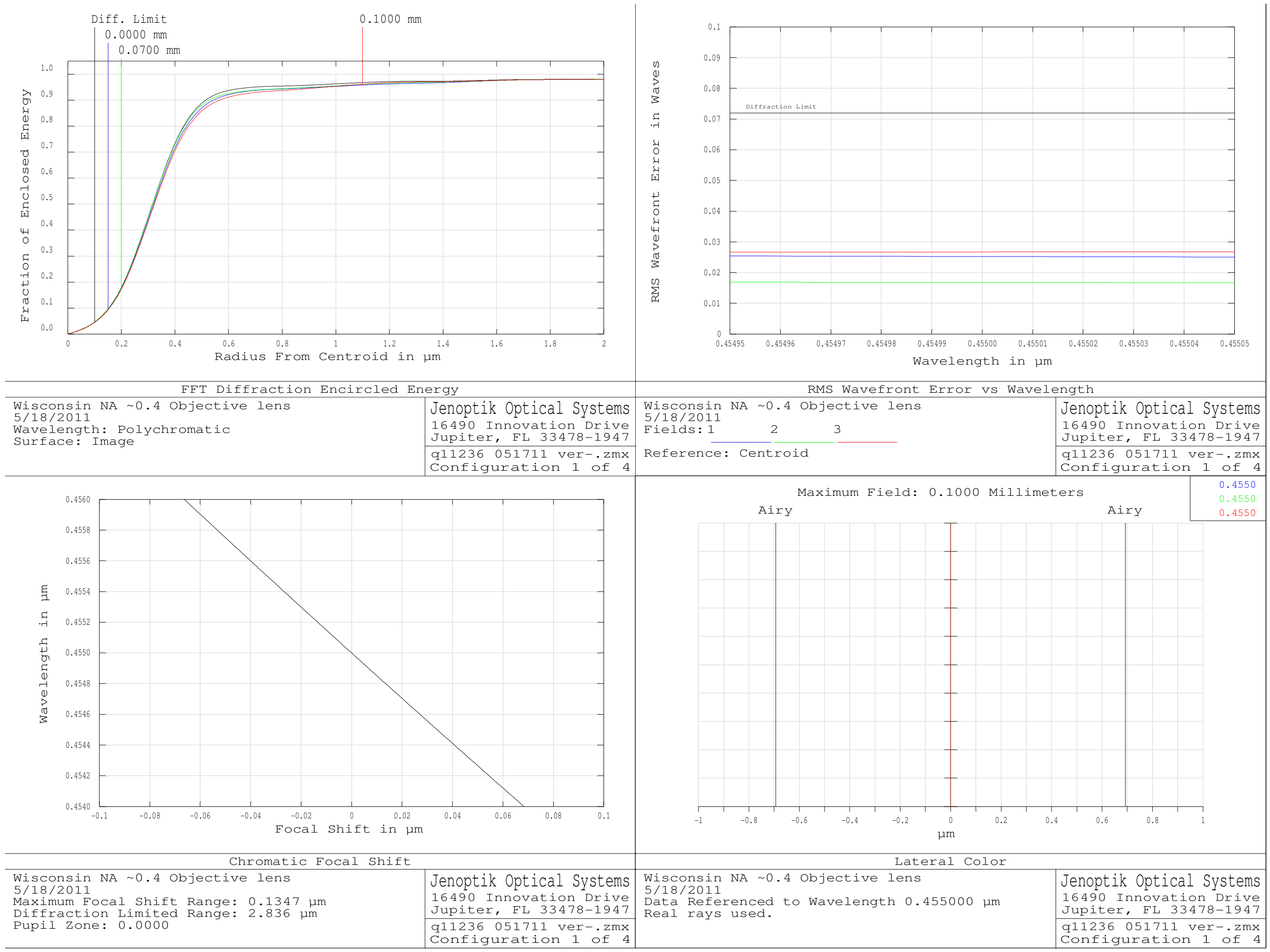
Transmittance of lens only excluding Pyrex Window



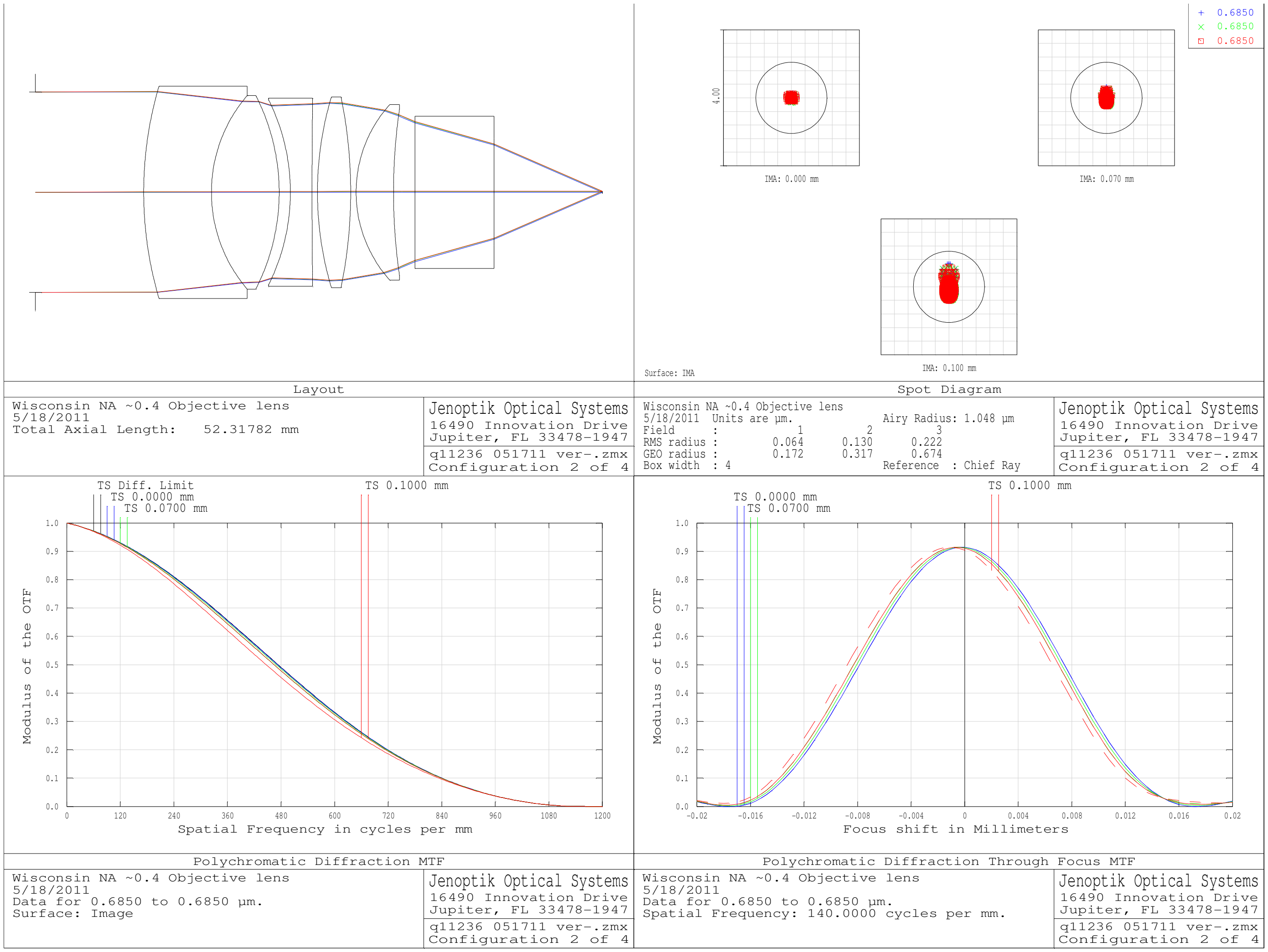
Performance for Laser 455 nm
Black circle in spot diagram is Airy disk



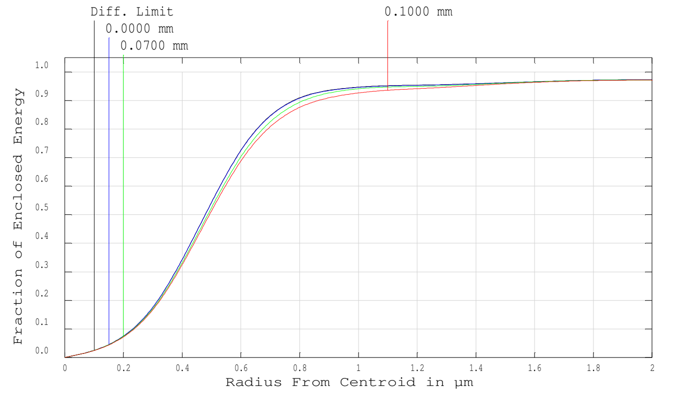
Performance for Laser 455 nm
Encircled Energy – RMS Wavefront Error – Axial Color – Lateral Color



Performance for 685 nm
Black circle in spot diagram is Airy disk



Performance for 685 nm
Encircled Energy – RMS Wavefront Error – Axial Color – Lateral Color



FFT Diffraction Encircled Energy

Wisconsin NA ~0.4 Objective lens
5/18/2011
Wavelength: Polychromatic
Surface: Image

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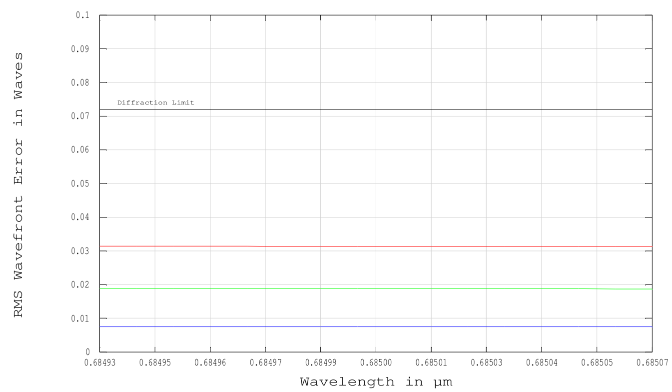
Configuration 2 of 4



RMS Wavefront Error vs Wavelength

Wisconsin NA ~0.4 Objective lens
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Fields: 1 2 3
Reference: Centroid

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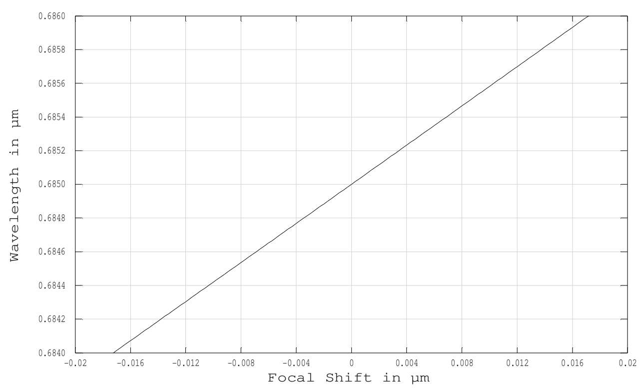
Configuration 2 of 4



Chromatic Focal Shift

Wisconsin NA ~0.4 Objective lens
5/18/2011
Maximum Focal Shift Range: 0.0344 µm
Diffraction Limited Range: 4.311 µm
Pupil Zone: 0.0000

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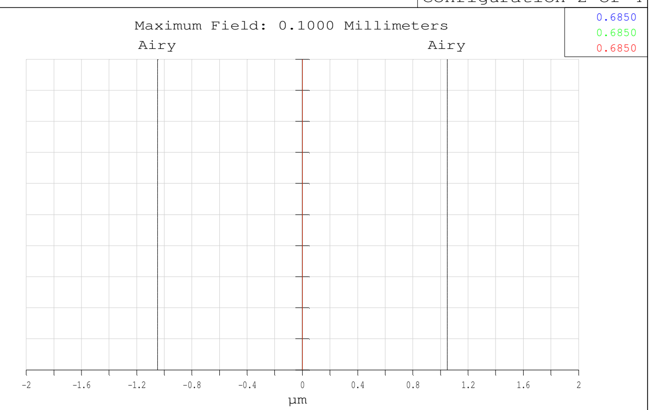
Configuration 2 of 4



Lateral Color

Wisconsin NA ~0.4 Objective lens
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Data Referenced to Wavelength 0.685000 µm
Real rays used.

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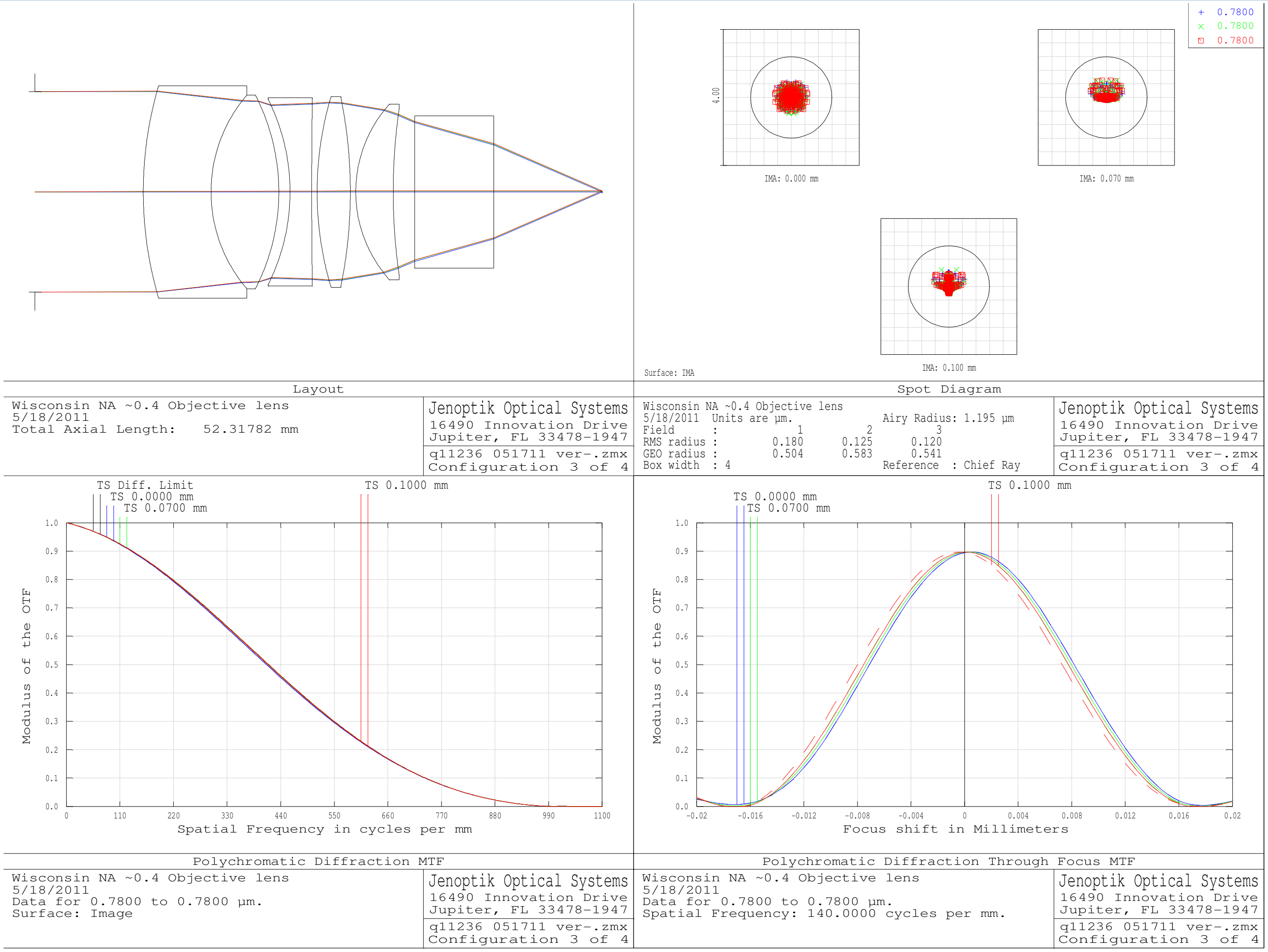
Configuration 2 of 4

Performance for 780 nm
Black circle in spot diagram is Airy disk



Performance for 780 nm

Encircled Energy – RMS Wavefront Error – Axial Color – Lateral Color

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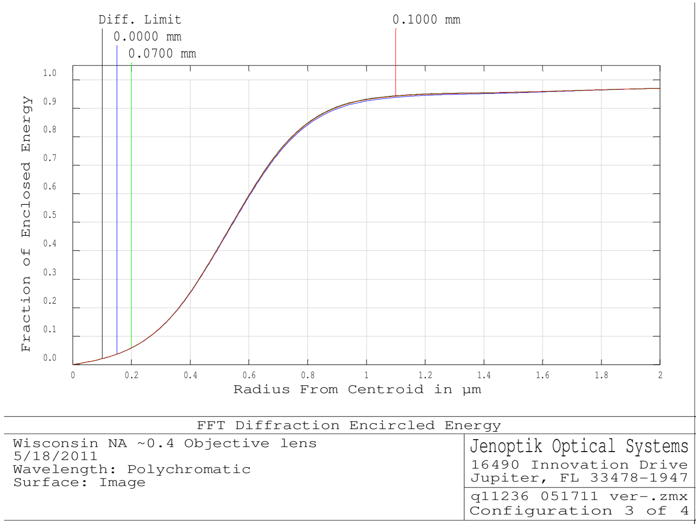
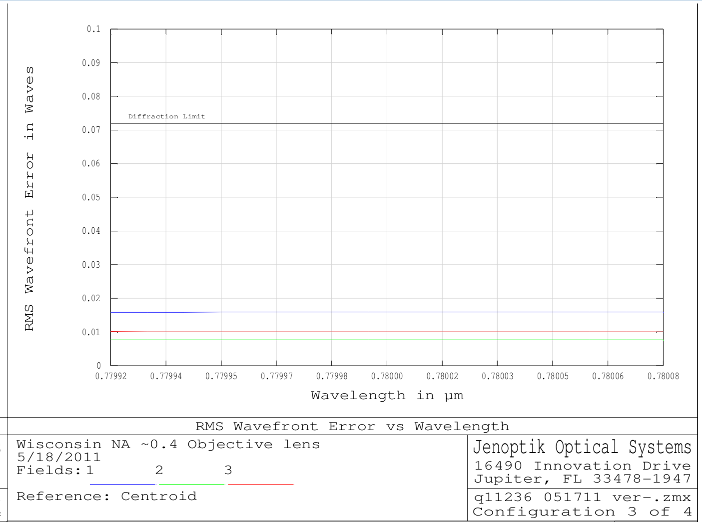
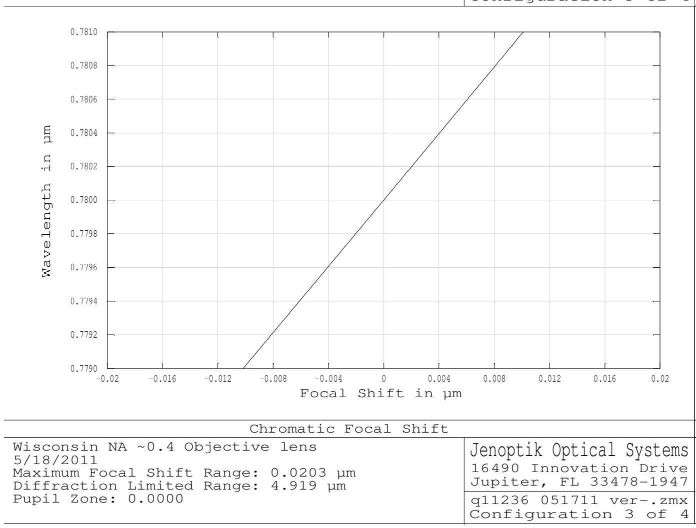
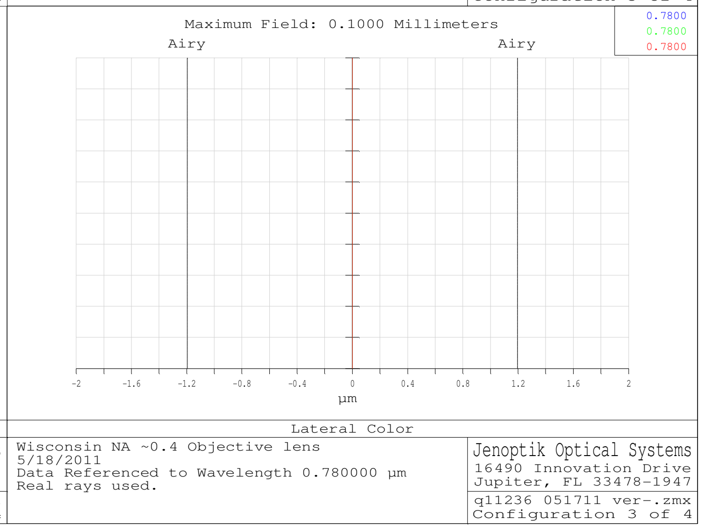
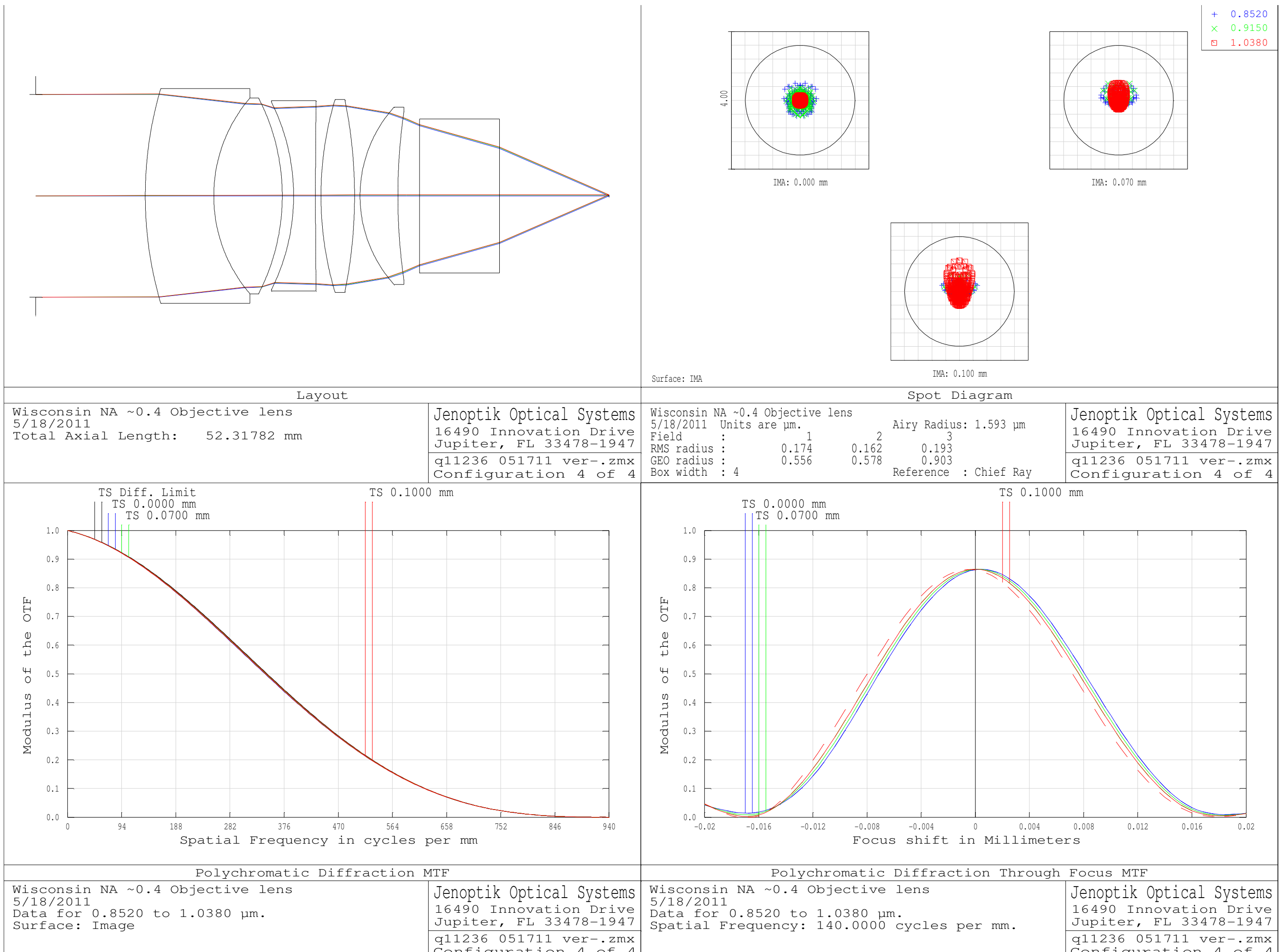




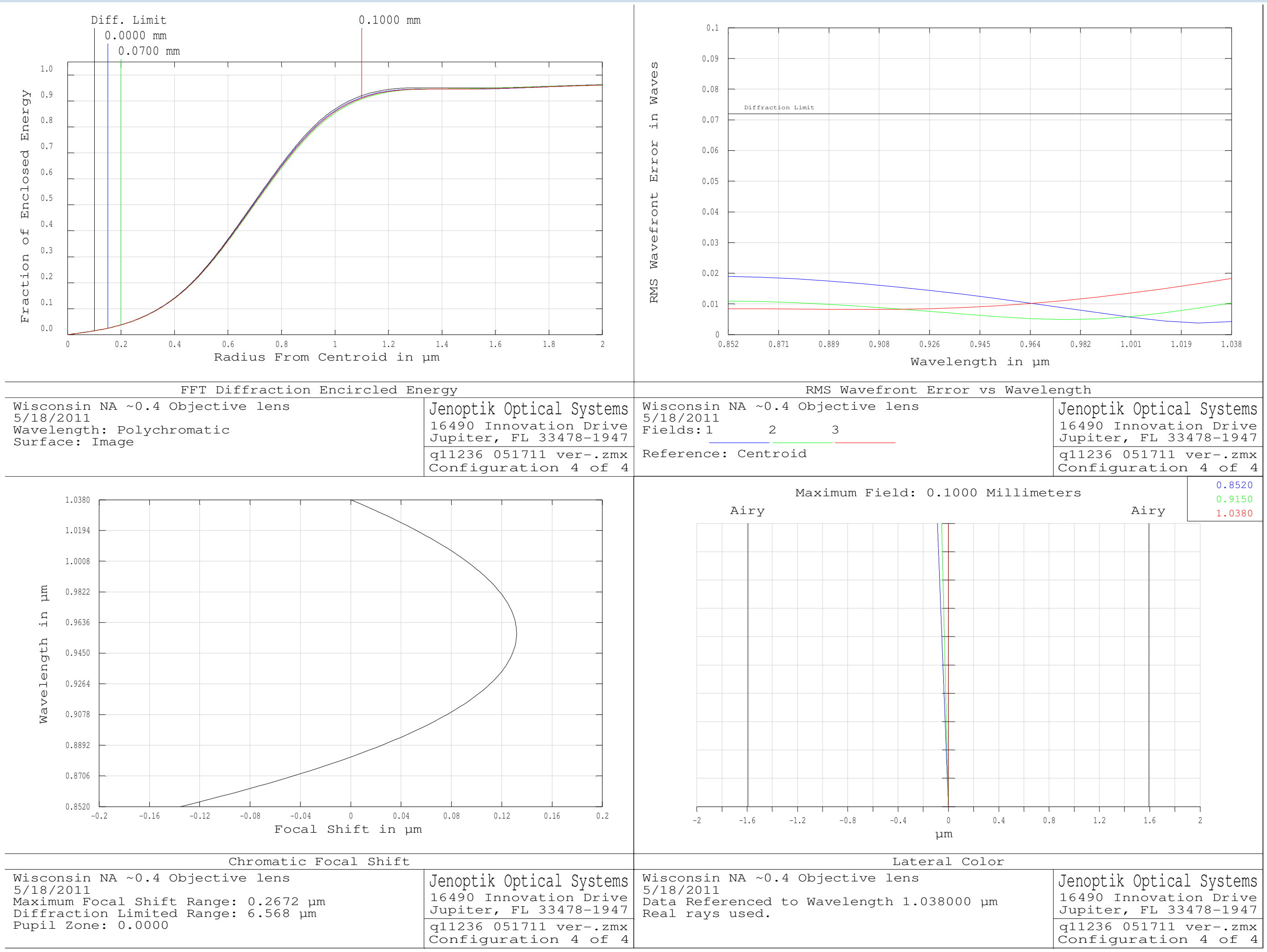




Performance 852 nm & 915 nm & 1038 nm
Black circle in spot diagram is Airy disk



Performance for 852 nm 915 nm and 1038 nm
Encircled Energy – RMS Wavefront Error – Axial Color – Lateral Color



Preliminary Mechanical Design

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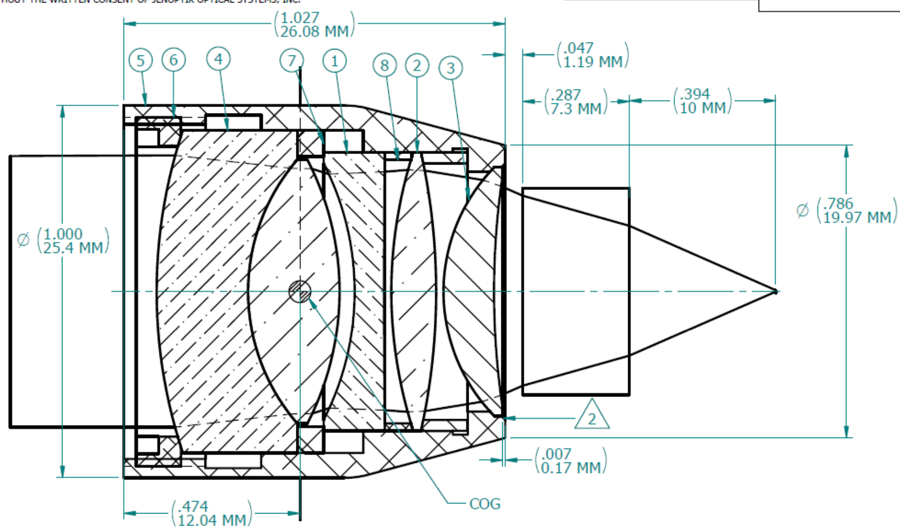
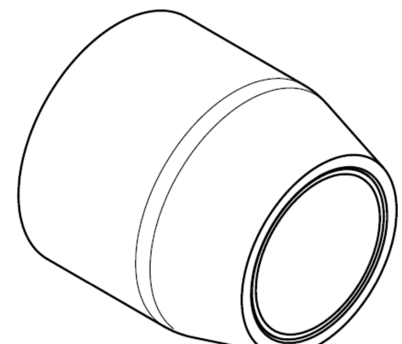
PRELIMINARY

ASSEMBLY NO. USED ON: -

REVISION HISTORY				
ZONE & ECO NO	REV	DESCRIPTION	DATE	APPROVED





10	2	11236012	-	FRONT CAP
9	1	11236011	-	SPACER 3
8	1	11236010	-	SPACER 2
7	1	11236009	-	SPACER 1
6	1	11236008	-	RETAINER 1
5	1	11236007	-	HOUSING
4	1	11236006	-	DOUBLET 1-2
3	1	11236005	-	ELEMENT 5
2	1	11236004	-	ELEMENT 4
1	1	11236003	-	ELEMENT 3
ITEM	QTY	PART NUMBER	REV	DESCRIPTION

NOTES:

1. APPLY 262 LOCTITE AFTER ALL ADJUSTMENTS ARE COMPLETED.
2. BOND WITH NORLAND 61 ALL AROUND DIAMETER.
3. LENS CAPS SHOWN ON SHEET 2.
4. WEIGHT = 26.21 g

DECENTER	
ELEMENTS	DECENTER (MM)
1	± 0.xx
3	± 0.xx
4	± 0.xx
5	± 0.xx

AIRSPACE	
ELEMENTS	AIRSPACE (MM)
1-3	1.033 ± 0.xx
3-4	0.5 ± 0.xx
4-5	0.5 ± 0.xx

MAT'L: AS BUILT

FINISH: N/A

BREAK ALL SHARP CORNERS R.01" MIN

SURFACE TEXTURE .125 UNLESS OTHERWISE SPECIFIED

	NAME	DATE
DRAWN	tony.victorio	5-18-11
CHECKED	TV	5-18-11
MGR APPR	TV	5-18-11

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE APPLIED FINISH TOLERANCES

TOLERANCE ON ANGLES = ±.5 DEG.
LINEAR DIM X.XX = ±.01 X.XXX = ±.005
HOLE DIA X.XX = ±.01 X.XXX = ±.005

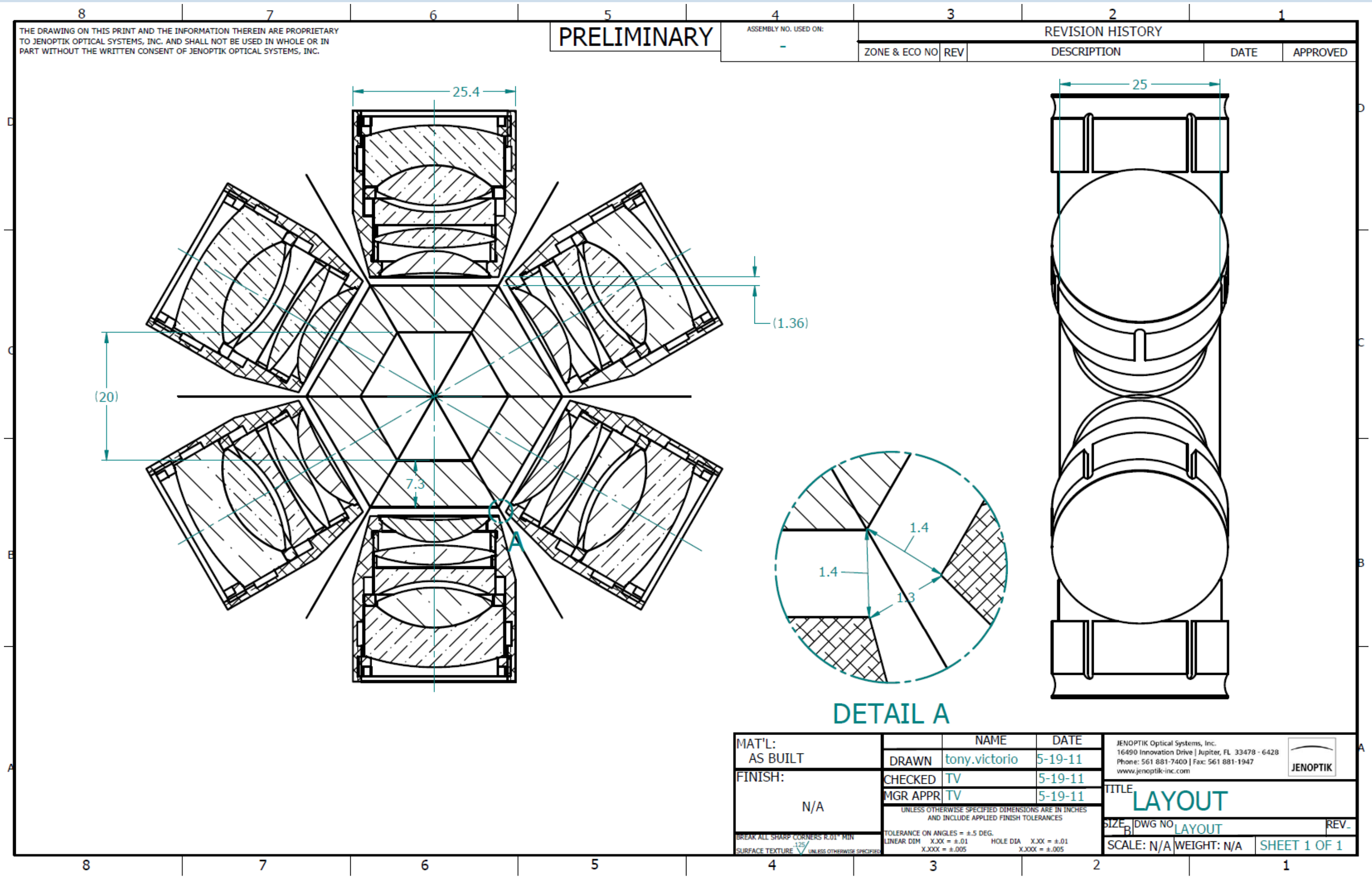
JENOPTIK Optical Systems, Inc.
16490 Innovation Drive | Jupiter, FL 33478 - 6428
Phone: 561 881-7400 | Fax: 561 881-1947
www.jenoptik-inc.com

TITLE OBJECTIVE LENS ASSY

SIZE B | DWG NO 11236000 | REV -

SCALE: N/A | WEIGHT: N/A | SHEET 1 OF 2

Assembly of six units



Summary

The optical design meets or exceeds all optical design requirements. In particular

1. It is diffraction limited for each waveband
2. It meets the axial color of < 0.015 mm. Current design is at 0.005 mm
3. It meets all the working distance requirements.
4. Each lens (and most likely all six lenses together) will be much less than 0.5Kg. Currently the glass for the lens only excluding the Pyrex window weighs17 grams.
5. The current NA is 0.4 due to the aperture constraint requirements and it will be maximized taking into account the housing dimensions imposed by the packaging requirements of the six assemblies.
6. We do meet transmittance > 94%. The transmittance values shown in the previous pages are the theoretical values and therefore the system transmittance values shown below of our offer letter stand.

455 nm	R < 1.0% per surface	System Transmittance = 88.6%
685 nm	R < 0.8% per surface	System Transmittance = 90.8%
780 nm	R < 0.5% per surface	System Transmittance = 94.1%
852 nm	R < 0.5% per surface	System transmittance = 94.1%
915 nm	R < 0.8% per surface	System Transmittance = 90.8%
1038 nm	R < 1.0% per surface	System Transmittance = 88.6%