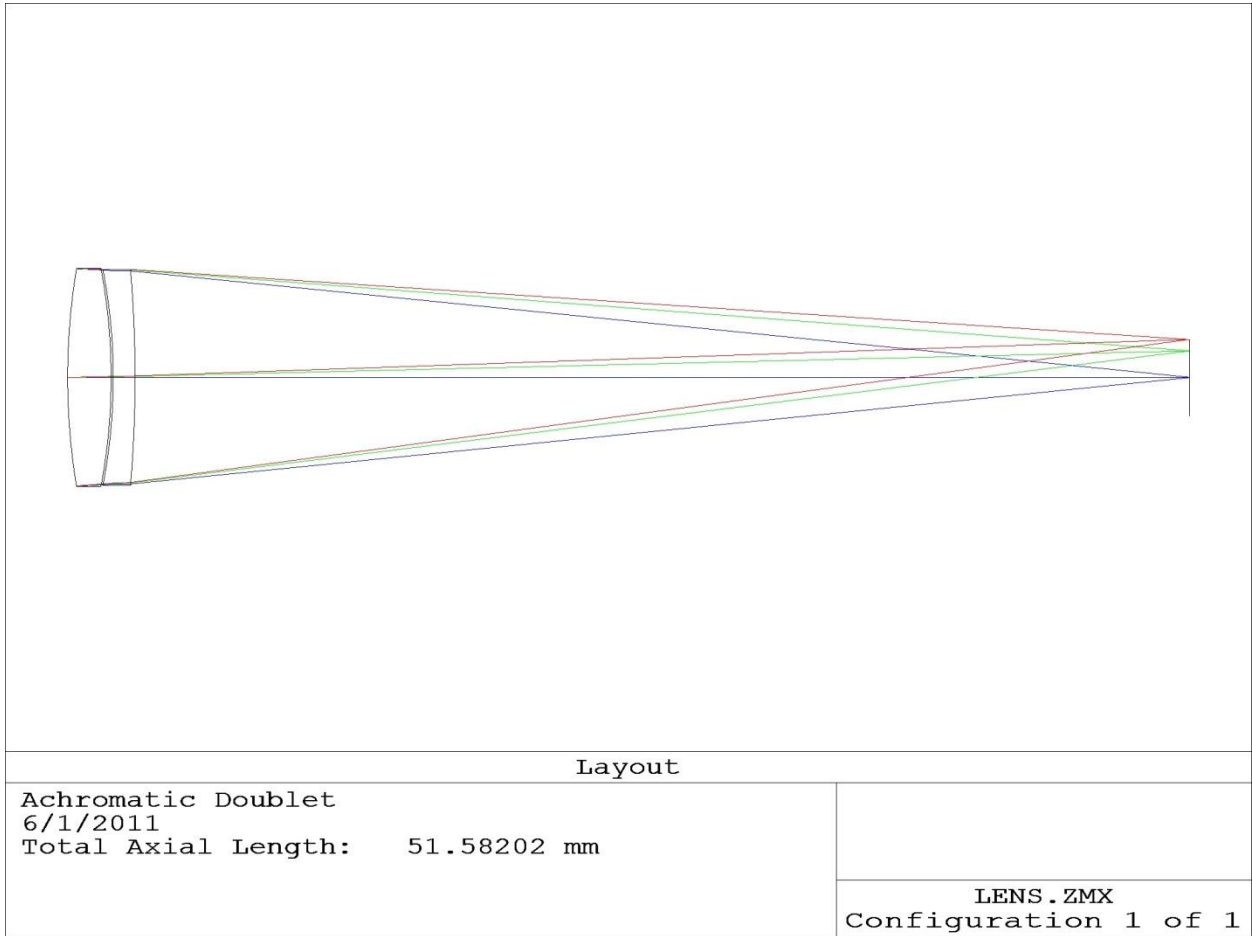


# Achromatic Doublet

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John S. Loomis

50-mm focal length, f/5, 2° HFOV



## GENERAL LENS DATA:

Surfaces : 5  
Stop : 1  
System Aperture : Entrance Pupil Diameter = 10  
Glass Catalogs : SCHOTT  
Ray Aiming : Off  
Effective Focal Length : 50 (in air at system temperature and pressure)  
Effective Focal Length : 50 (in image space)  
Back Focal Length : 48.48202  
Total Track : 51.58202  
Image Space F/# : 5  
Paraxial Working F/# : 5  
Working F/# : 5.004565  
Image Space NA : 0.09950372  
Object Space NA : 5e-010  
Stop Radius : 5  
Paraxial Image Height : 1.746038  
Paraxial Magnification : 0  
Entrance Pupil Diameter : 10  
Entrance Pupil Position : 0  
Exit Pupil Diameter : 10.10109  
Exit Pupil Position : -50.50543  
Field Type : Angle in degrees  
Maximum Radial Field : 2  
Primary Wavelength : 0.5875618  $\mu\text{m}$   
Lens Units : Millimeters  
Angular Magnification : 0.9899925

Fields : 3

Field Type : Angle in degrees

#	X-Value	Y-Value	Weight
1	0.000000	0.000000	1.000000
2	0.000000	1.400000	1.000000
3	0.000000	2.000000	1.000000

Wavelengths : 3

Units:  $\mu\text{m}$

#	Value	Weight
1	0.486133	1.000000
2	0.587562	1.000000
3	0.656273	1.000000

## SURFACE DATA SUMMARY:

Surf	Type	Radius	Thickness	Glass	Diameter	Conic
OBJ	STANDARD	Infinity	Infinity		0	0
STO	STANDARD	30.74682	2	N-BK7	10.02875	0
2	STANDARD	-27.11051	0.1		9.954126	0
3	STANDARD	-25.88817	1	N-SF10	9.93012	0
4	STANDARD	-59.04416	48.48202		9.923887	0
IMA	STANDARD	Infinity			3.506038	0

## SURFACE DATA DETAIL:

Surface OBJ STANDARD  
Surface STO STANDARD  
Surface 2 STANDARD  
Surface 3 STANDARD  
Surface 4 STANDARD  
Surface IMA STANDARD

## EDGE THICKNESS DATA:

Surf	Edge
STO	1.127586
2	0.080189
3	1.271717
4	48.690882
IMA	0.000000

## SOLVE AND VARIABLE DATA:

Curvature of 1 : Variable  
Curvature of 2 : Variable  
Curvature of 3 : Variable  
Curvature of 4 : Solve, Marginal ray exit angle = -0.1  
Thickness of 4 : Solve, Marginal ray height = 0 at pupil zone 0

## INDEX OF REFRACTION DATA:

System Temperature: 20.0000 Celsius  
System Pressure : 1.0000 Atmospheres  
Absolute air index: 1.000272 at wavelength 0.587562  $\mu\text{m}$   
Index data is relative to air at the system temperature and pressure.  
Wavelengths are measured in air at the system temperature and pressure.

Surf	Glass	Temp	Pres	0.486133	0.587562	0.656273
0		20.00	1.00	1.00000000	1.00000000	1.00000000
1	N-BK7	20.00	1.00	1.52237629	1.51680003	1.51432235
2		20.00	1.00	1.00000000	1.00000000	1.00000000
3	N-SF10	20.00	1.00	1.74643051	1.72827707	1.72090617
4		20.00	1.00	1.00000000	1.00000000	1.00000000
5		20.00	1.00	1.00000000	1.00000000	1.00000000

## THERMAL COEFFICIENT OF EXPANSION DATA:

Surf	Glass	TCE *10E-6
0		0.00000000
1	N-BK7	7.10000000
2		0.00000000
3	N-SF10	9.40000000
4		0.00000000
5		0.00000000

## ELEMENT VOLUME DATA:

For centered elements with plane or spherical circular faces, exact volumes are computed by assuming edges are squared up to the larger of the front and back radial aperture.

For all other elements, approximate volumes are numerically integrated to 0.1% accuracy. Zero volume means the volume cannot be accurately computed.

Single elements that are duplicated in the Lens Data Editor for ray tracing purposes may be listed more than once yielding incorrect total mass estimates.

Element surf	1 to	2	Volume cc	Density g/cc	Mass g
Element surf	1 to	2	0.123345	2.510000	0.309596
Element surf	3 to	4	0.087904	3.050000	0.268108
Total Mass:					0.577704

## F/# DATA:

F/# calculations consider vignetting factors and ignore surface apertures.

#	Wavelength: Field	0.486133		0.587562		0.656273	
		Tan	Sag	Tan	Sag	Tan	Sag
1	0.0000 (deg):	5.0074	5.0074	5.0046	5.0046	5.0071	5.0071
2	1.4000 (deg):	5.0048	5.0063	5.0020	5.0035	5.0045	5.0060
3	2.0000 (deg):	5.0021	5.0051	4.9993	5.0023	5.0018	5.0049

## CARDINAL POINTS:

Object space positions are measured with respect to surface 1.  
Image space positions are measured with respect to the image surface.  
The index in both the object space and image space is considered.

	Object Space	Image Space
W = 0.486133		
Focal Length :	-49.999223	49.999223
Focal Planes :	-49.508490	0.000448
Principal Planes :	0.490733	-49.998775
Anti-Principal Planes :	-99.507713	49.999672
Nodal Planes :	0.490733	-49.998775
Anti-Nodal Planes :	-99.507713	49.999672
W = 0.587562 (Primary)		
Focal Length :	-50.000000	50.000000
Focal Planes :	-49.499623	-0.000000
Principal Planes :	0.500377	-50.000000
Anti-Principal Planes :	-99.499623	50.000000
Nodal Planes :	0.500377	-50.000000
Anti-Nodal Planes :	-99.499623	50.000000
W = 0.656273		
Focal Length :	-50.036586	50.036586
Focal Planes :	-49.532415	0.035740
Principal Planes :	0.504171	-50.000846
Anti-Principal Planes :	-99.569000	50.072326
Nodal Planes :	0.504171	-50.000846
Anti-Nodal Planes :	-99.569000	50.072326

## FILES USED:

### ZEMAX File

C:\Users\loomisjs\ZEMAX\doublet\doublet1.ZMX

### Session File

C:\Users\loomisjs\ZEMAX\doublet\doublet1.SES

### Glass Catalogs

C:\Users\loomisjs\Documents\ZEMAX\GLASSCAT\SCHOTT.AGF

### Coating Data

C:\Users\loomisjs\Documents\ZEMAX\COATINGS\COATING.DAT

### ABg Data

C:\Users\loomisjs\Documents\ZEMAX\ABG\_DATA\ABG\_DATA.DAT

## Ray Trace Data

File : C:\Users\loomisjs\ZEMAX\doublet\doublet1.ZMX

Title: Achromatic Doublet

Date : 6/1/2011

Units : Millimeters

Wavelength : 0.587562  $\mu\text{m}$

Coordinates : Local

Paraxial angles are the ratio of the cosines after refraction or reflection from the surface or object.

Angles are in degrees.

Trace of Paraxial Y marginal, U marginal, Y chief, U chief only.

Surf	Y marginal	U marginal	Y chief	U chief
OBJ	0.0000000000E+000	0.0000000000E+000	Infinity	3.4920769492E-002
1	5.0000000000E+000	-5.5406927265E-002	0.0000000000E+000	2.3022658688E-002
2	4.8891861455E+000	-1.7724241788E-001	4.6045317375E-002	3.4043020479E-002
3	4.8714619037E+000	-2.3260222930E-002	4.9449619423E-002	2.0502569311E-002
4	4.8482016808E+000	-1.0000000000E-001	6.9952188734E-002	3.4571298725E-002
5	-8.8817841970E-016	-1.0000000000E-001	1.7460384746E+000	3.4571298725E-002

## Listing of Aberration Coefficient Data

File : C:\Users\loomisjs\ZEMAX\doublet\doublet1.ZMX  
 Title: Achromatic Doublet  
 Date : 6/1/2011

Wavelength : 0.5876  $\mu\text{m}$   
 Chief Ray Slope, Object Space : 0.0349  
 Chief Ray Slope, Image Space : 0.0346  
 Marginal Ray Slope, Object Space: 0.0000  
 Marginal Ray Slope, Image Space : -0.1000  
 Petzval radius : -68.9243  
 Optical Invariant : 0.1746

### Seidel Aberration Coefficients:

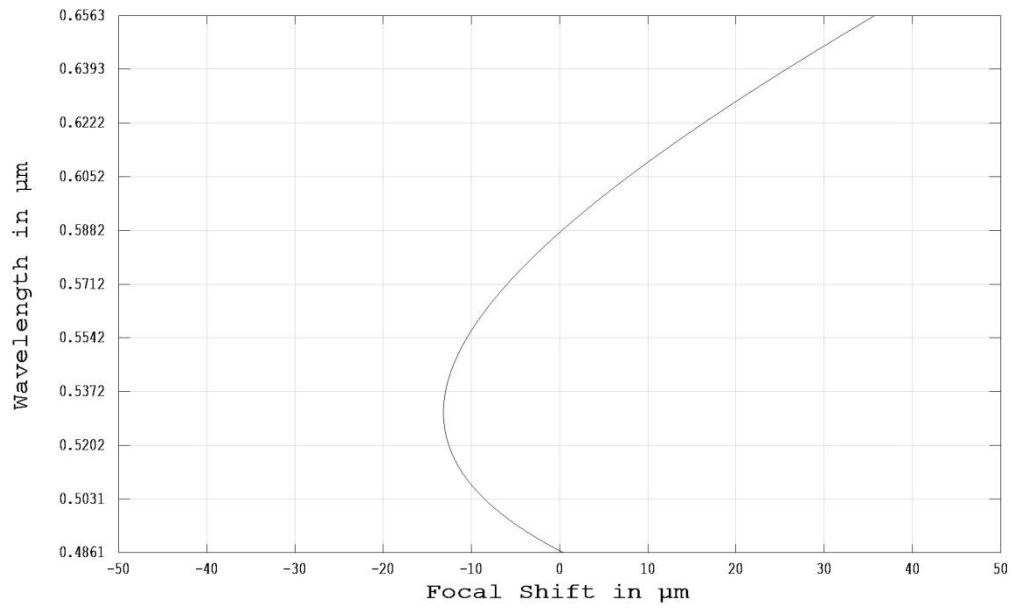
Surf	SPHA S1	COMA S2	ASTI S3	FCUR S4	DIST S5	CLA (CL)	CTR (CT)
STO	0.004830	0.001037	0.000223	0.000338	0.000120	-0.004317	-0.000927
2	0.087969	-0.007957	0.000720	0.000383	-0.000100	-0.009283	0.000840
3	-0.106538	0.009368	-0.000824	-0.000496	0.000116	0.026290	-0.002312
4	0.013915	-0.002551	0.000468	0.000218	-0.000126	-0.013039	0.002391
IMA	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
TOT	0.000176	-0.000102	0.000586	0.000442	0.000011	-0.000350	-0.000009

### Seidel Aberration Coefficients in Waves:

Surf	W040	W131	W222	W220P	W311	W020	W111
STO	1.027548	0.882624	0.189535	0.143743	0.102436	-3.673978	-1.577904
2	18.714934	-6.771273	0.612481	0.163024	-0.084892	-7.899741	1.429107
3	-22.665285	7.972303	-0.701046	-0.211143	0.098780	22.371968	-3.934566
4	2.960298	-2.170850	0.397983	0.092576	-0.106906	-11.096234	4.068553
IMA	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
TOT	0.037495	-0.087196	0.498953	0.188201	0.009417	-0.297983	-0.014809

### Wavefront Aberration Coefficient Summary:

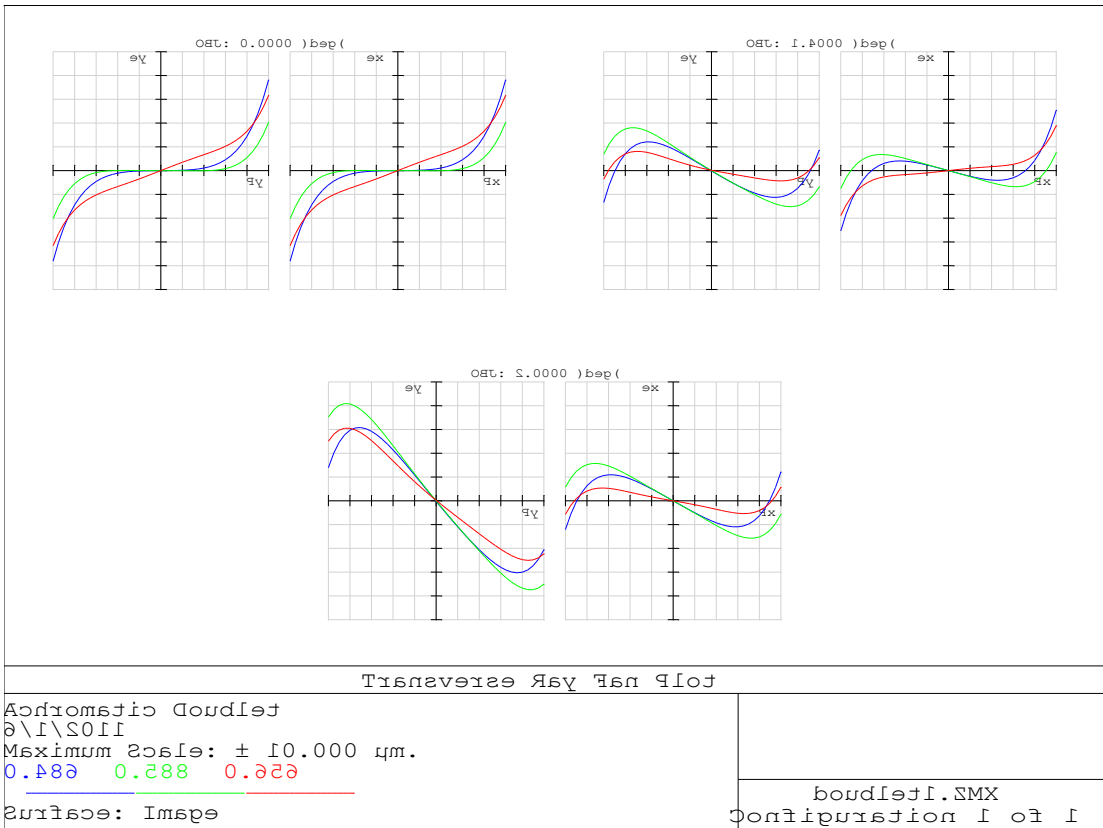
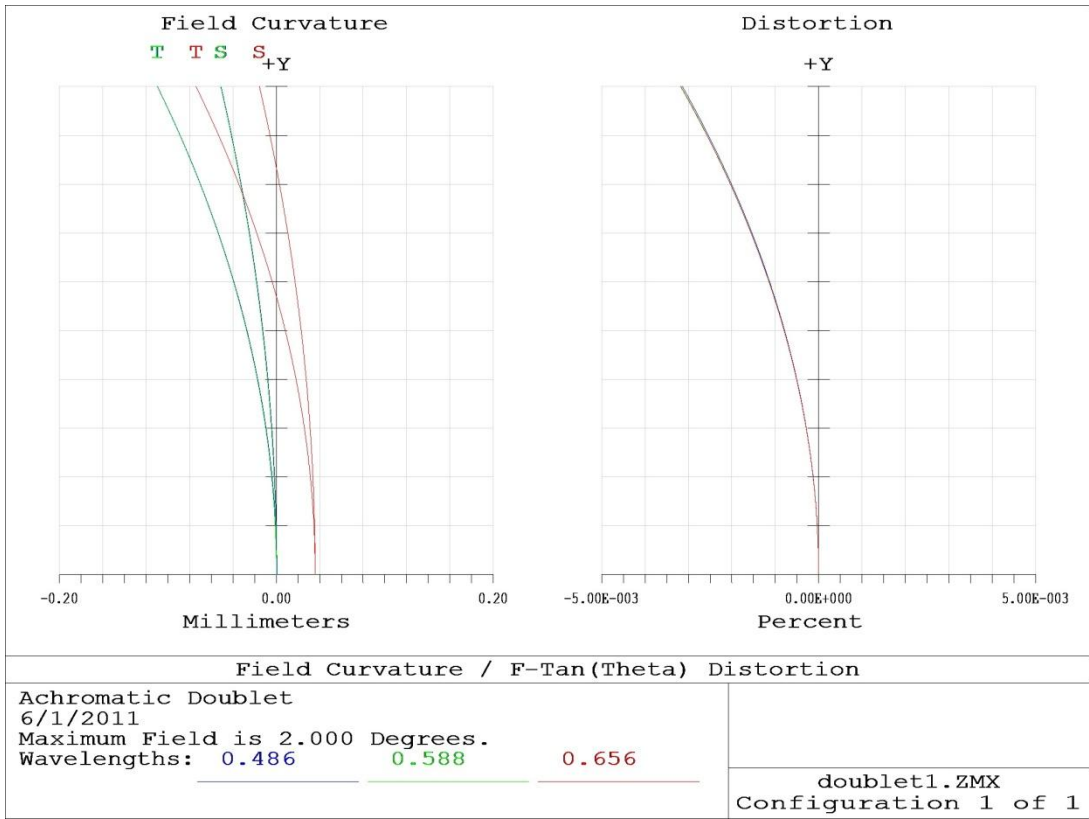
	W040	W131	W222	W220P	W311	W020	W111
TOT	0.0375	-0.0872	0.4990	0.1882	0.0094	-0.2980	-0.0148
	W220S	W220M	W220T				
TOT	0.4377	0.6872	0.9366				

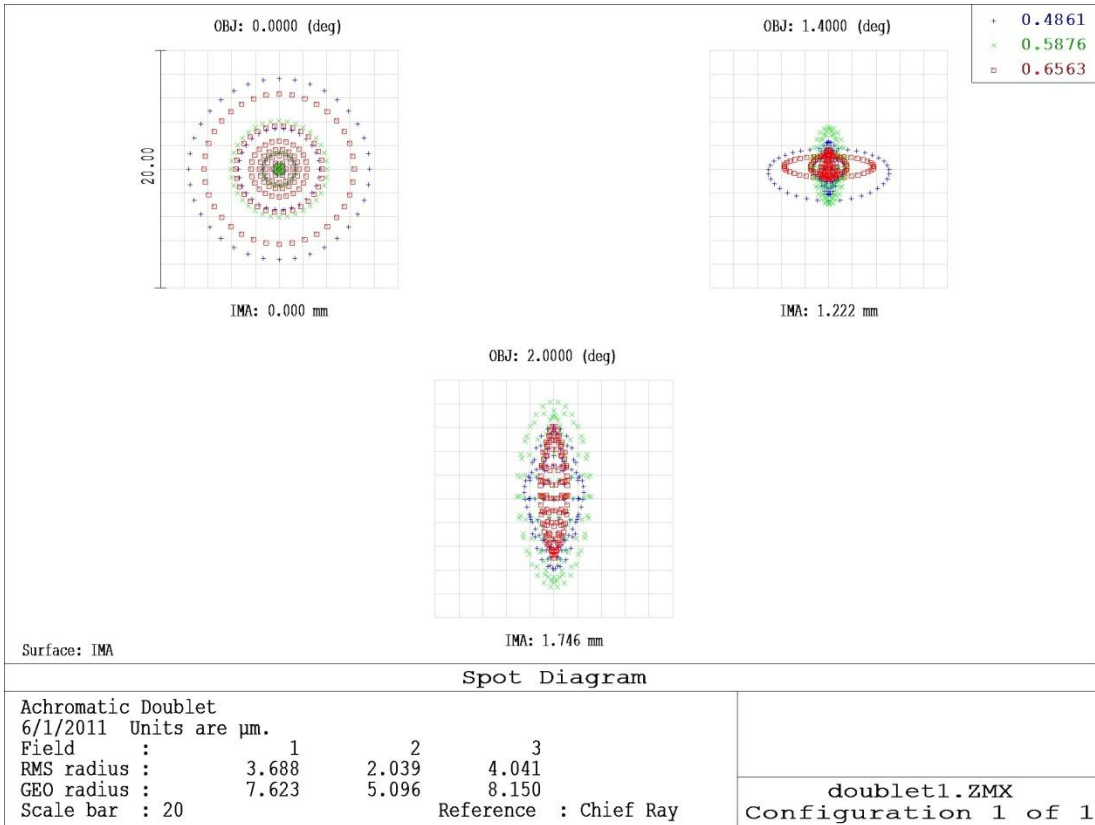


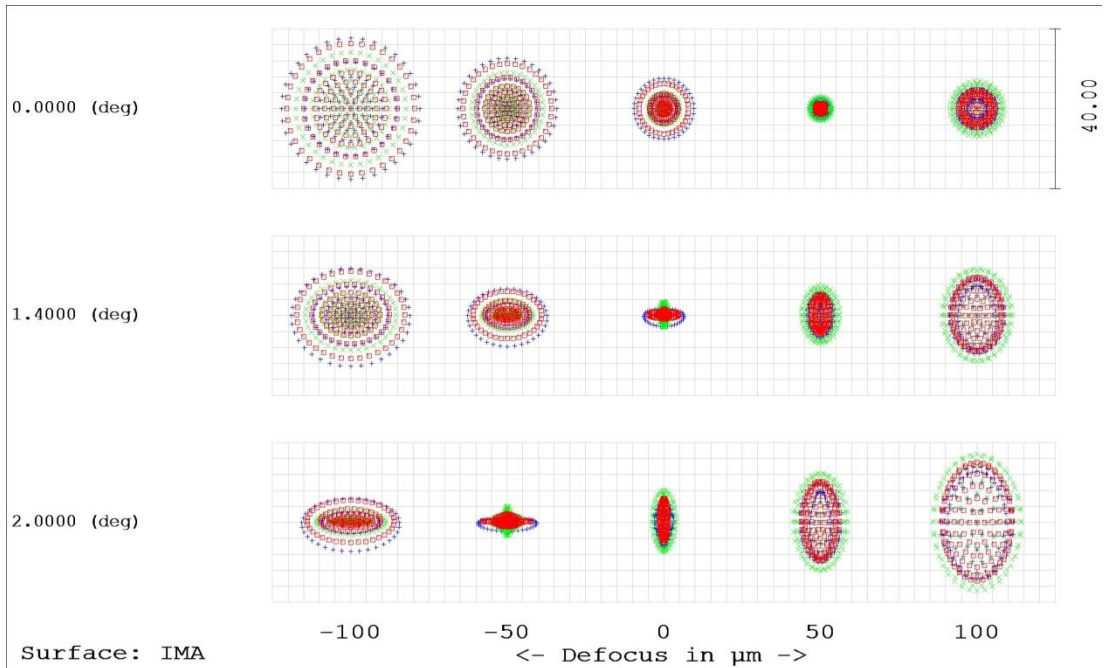
Chromatic Focal Shift

Achromatic Doublet  
 6/1/2011  
 Maximum Focal Shift Range: 48.9052  $\mu\text{m}$   
 Diffraction Limited Range: 58.864  $\mu\text{m}$   
 Pupil Zone: 0.0000

doublet1.ZMX  
 Configuration 1 of 1







Through Focus Spot Diagram

Achromatic Doublet  
 6/1/2011 Units are  $\mu\text{m}$ .  
 Field :            1            2            3  
 RMS radius :    3.688       2.039       4.041  
 GEO radius :    7.623       5.096       8.150  
 Scale bar : 40

Reference : Chief Ray

doublet1.ZMX  
 Configuration 1 of 1