

The spectrograph doublet is based on a standard “crown in front” design. The crown glass (higher Abe number) is IR grade calcium fluoride, the flint glass is IR grade fused silica.

| <i>Glass</i> | $n_1@1.25\mu\text{m}$ | $n_2@1.65\mu\text{m}$ | $n_3@2.20\mu\text{m}$ | $\nu$ (Abe number) | $P$ (Partial dispersion) |
|--------------|-----------------------|-----------------------|-----------------------|--------------------|--------------------------|
| IR F-Silica  | 1.44748               | 1.44280               | 1.43501               | 35.5110            | 0.6246                   |
| IR CaF2      | 1.42746               | 1.42556               | 1.42280               | 91.4696            | 0.5907                   |

With:  $\nu = \frac{n_2 - 1}{n_1 - n_3}$  and  $P = \frac{n_2 - n_3}{n_1 - n_3}$ .

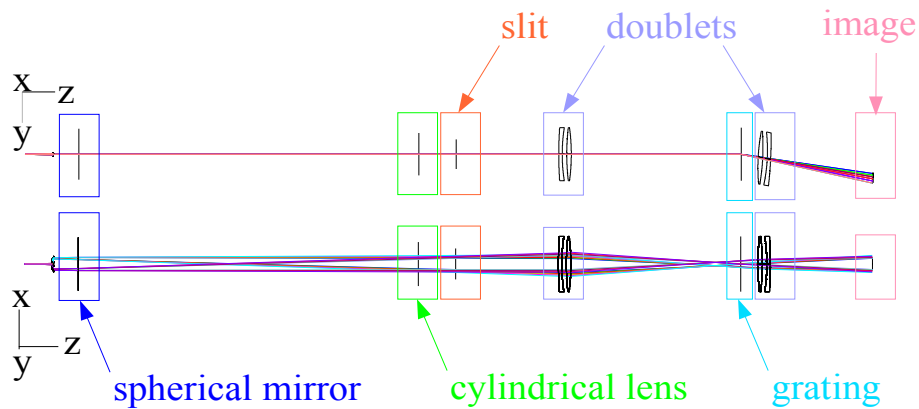
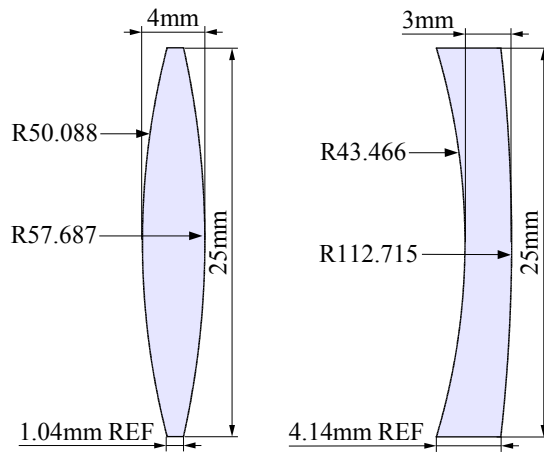
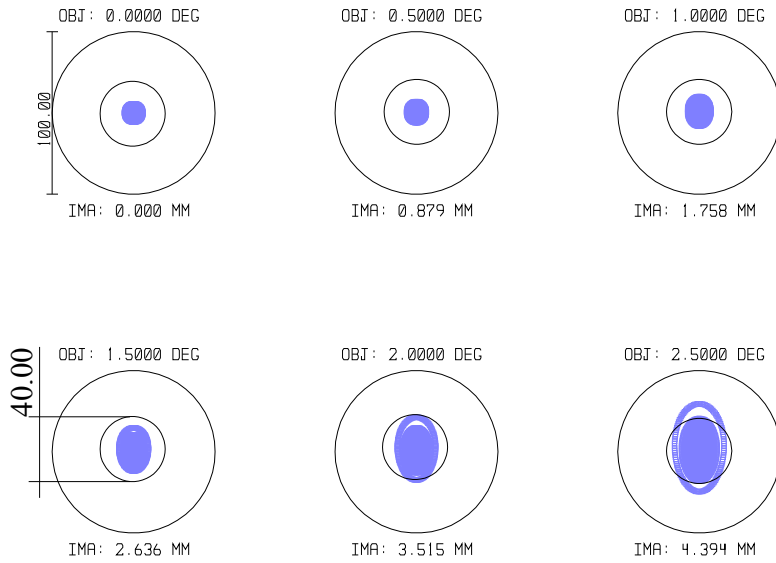


Figure 1 Top and side view of a sequential zemax model of the spectrograph.

Spot diagrams: Doublet only; field: 0-2.5degrees; wavelengths: 1.25, 1.65, 2.2microns.

1.2500



SURFACE: IMA

SPOT DIAGRAM

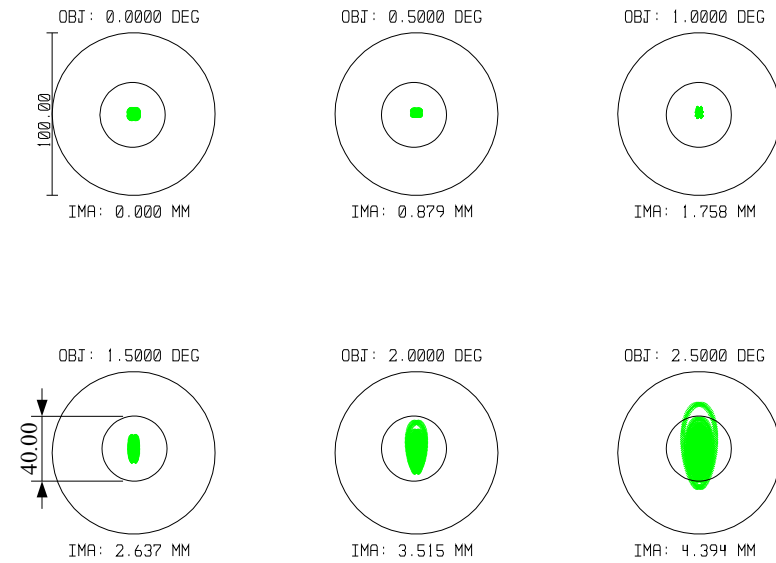
WED APR 20 2005 UNITS ARE  $\mu m$ .

|              |       |       |        |        |        |        |
|--------------|-------|-------|--------|--------|--------|--------|
| FIELD :      | 1     | 2     | 3      | 4      | 5      | 6      |
| RMS RADIUS : | 3.013 | 3.329 | 4.295  | 5.932  | 8.248  | 11.245 |
| GEO RADIUS : | 5.616 | 6.957 | 10.005 | 14.762 | 21.232 | 29.420 |
| CIRCLE DIAM: | 100   |       |        |        |        |        |

REFERENCE : CHIEF RAY

DOUBLELENS3\_ISP\_5.ZMX  
CONFIGURATION 1 OF 1

1.6500



SURFACE: IMA

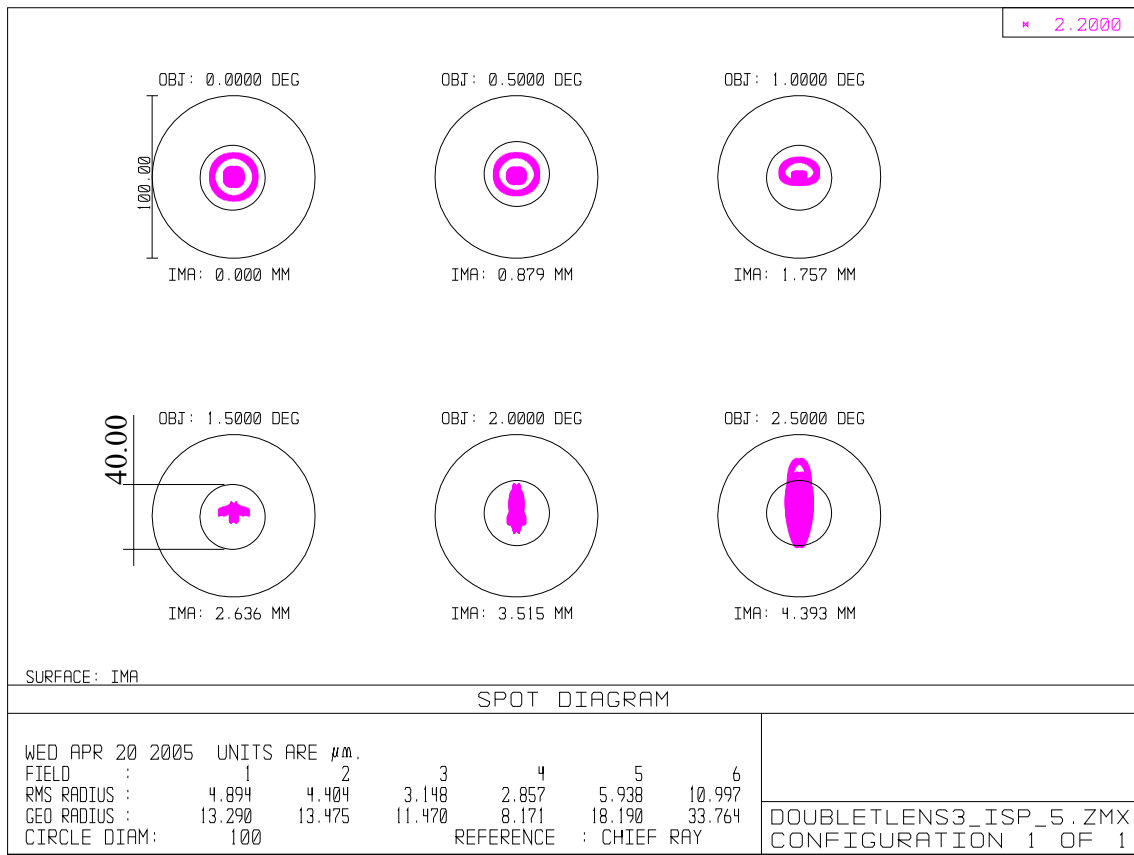
SPOT DIAGRAM

WED APR 20 2005 UNITS ARE  $\mu m$ .

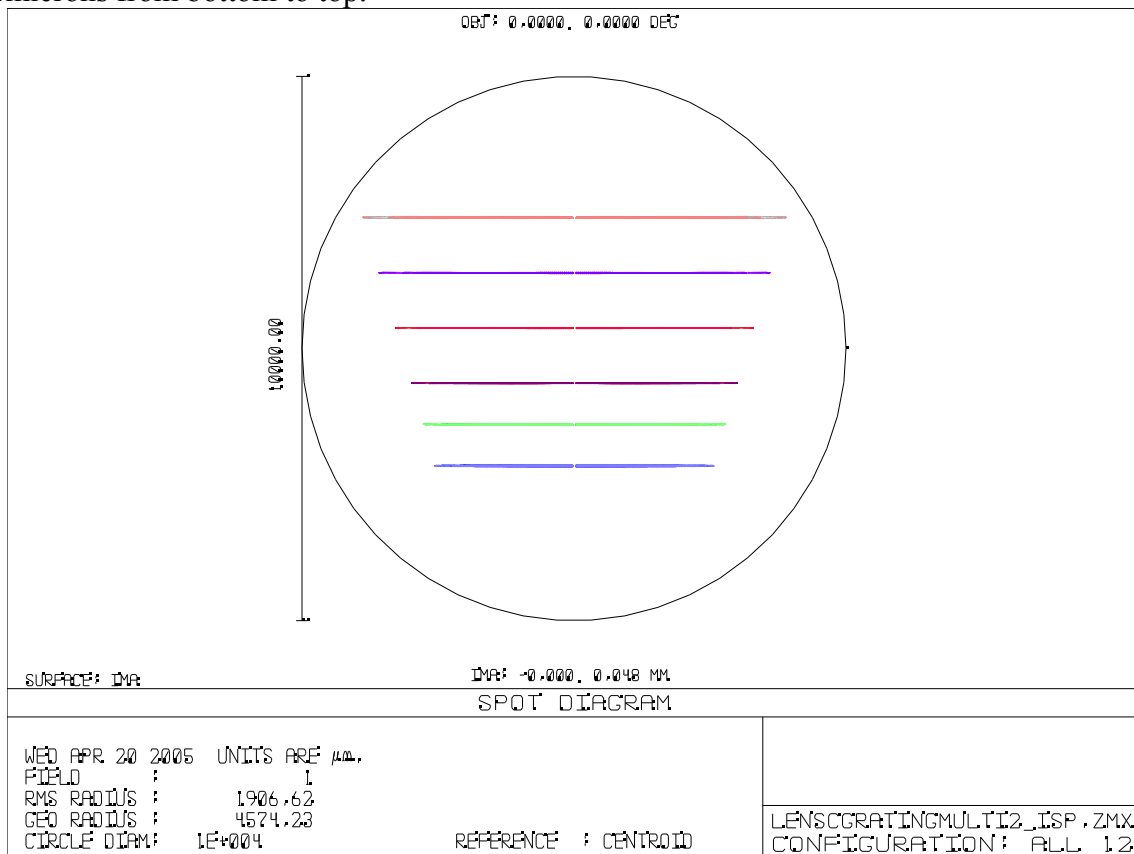
|              |       |       |       |        |        |        |
|--------------|-------|-------|-------|--------|--------|--------|
| FIELD :      | 1     | 2     | 3     | 4      | 5      | 6      |
| RMS RADIUS : | 0.982 | 0.694 | 1.172 | 3.267  | 6.335  | 10.309 |
| GEO RADIUS : | 2.820 | 2.626 | 3.478 | 10.033 | 18.864 | 29.976 |
| CIRCLE DIAM: | 100   |       |       |        |        |        |

REFERENCE : CHIEF RAY

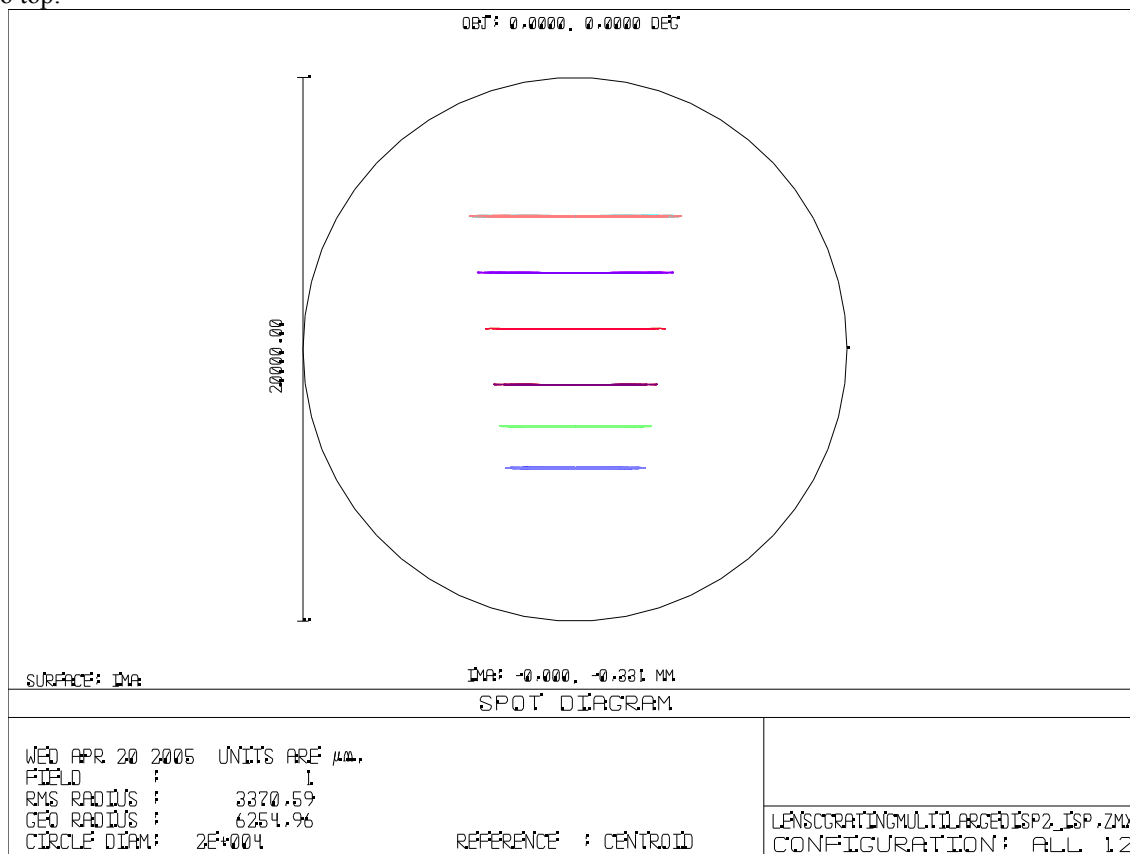
DOUBLELENS3\_ISP\_5.ZMX  
CONFIGURATION 1 OF 1



Spot diagrams: sequential model of the spectrograph; small dispersion; wavelengths: 1.5, 1.65, 1.8, 2.0, 2.2, 2.4 microns from bottom to top.



Spot diagrams: sequential model of the spectrograph; large dispersion; wavelengths: 1.5, 1.65, 1.8, 2.0 2.2, 2.4microns from bottom to top.



Effective focal length as a function of wavelength and environment parameters:

| $\lambda / \mu\text{m}$ | $EFFL1, t = 20^\circ\text{C}, P = 1\text{atm}$ | $EFFL2, t = -196^\circ\text{C}, P = 1e^{-6}\text{atm}$ | $EFFL2/EFFL1$ |
|-------------------------|--|--|---------------|
| 1.25                    | 100.607021                                     | 99.494684  | 0.9889        |
| 1.50                    | 100.690099                                     | 99.580348  | 0.9890        |
| 1.65                    | 100.720604                                     | 99.612232  | 0.9890        |
| 1.80                    | 100.740452                                     | 99.633756  | 0.9890        |
| 2.00                    | 100.753048                                     | 99.649047  | 0.9890        |
| 2.20                    | 100.751078                                     | 99.650318  | 0.9891        |
| 2.40                    | 100.734387                                     | 99.637458  | 0.9891        |

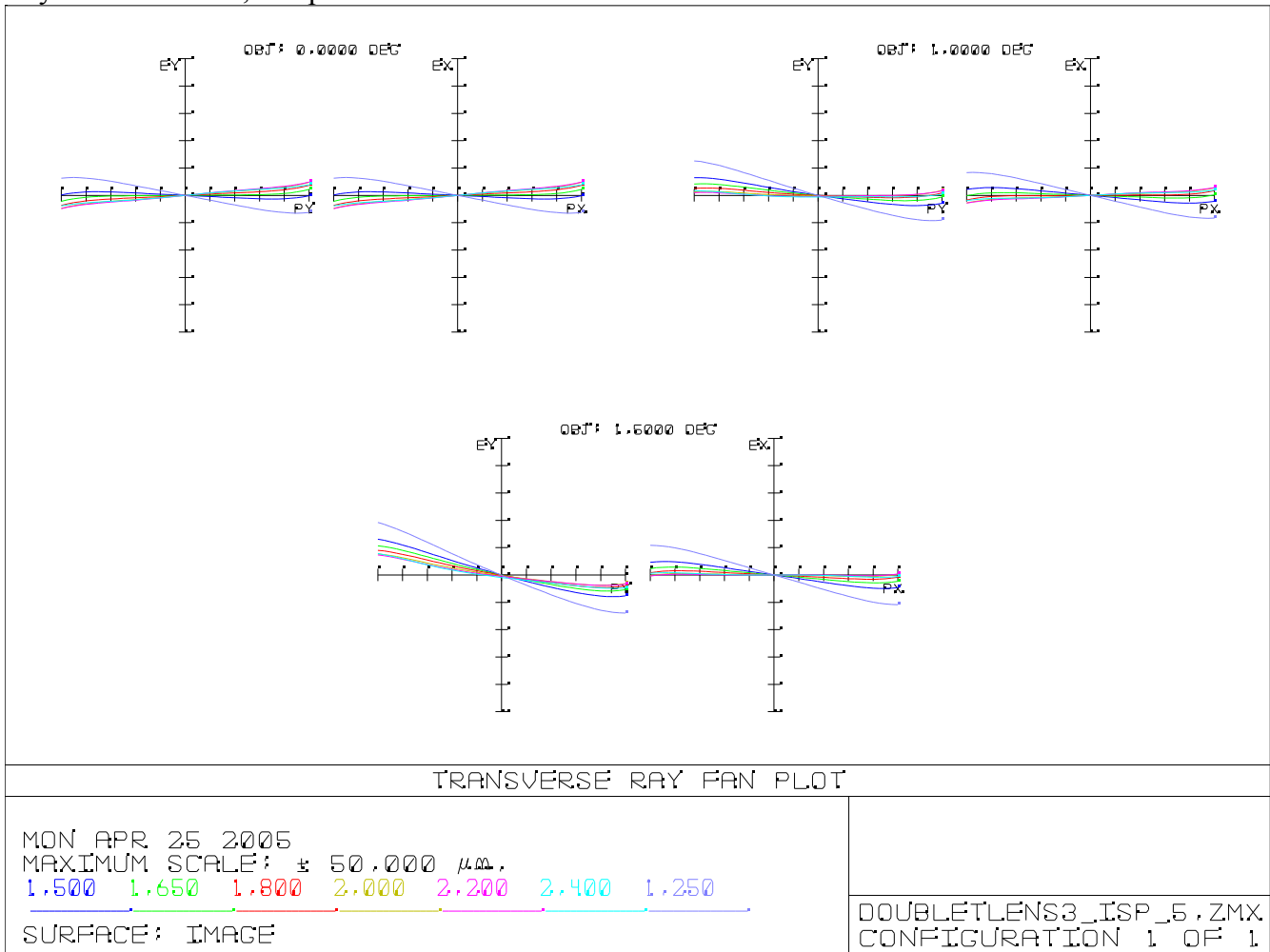
Spot diagrams, and effective focal length as a function of the air space between the lenses @ 1.65 $\mu\text{m}$  – default air space is 4mm, “Quick focus” spot size X only. T = 77K, p=1e-6atm

| <i>Air space / mm</i>  | 2.5    | 3      | 3.5    | 4      | 4.5    | 5      |
|--|--------|--------|--------|--------|--------|--------|
| <b><i>EFFL</i></b>   | 101.08 | 100.9  | 100.10 | 99.61  | 99.13  | 98.66  |
| <b><i>Spot geom radius / <math>\mu\text{m}</math> field 0deg</i></b> | 15.101 | 10.179 | 5.385  | 0.714  | 3.835  | 8.264  |
| <b><i>Field 1deg</i></b>   | 13.102 | 8.207  | 3.554  | 5.753  | 10.967 | 16.034 |
| <b><i>Field 1.5deg</i></b>   | 10.594 | 5.709  | 6.968  | 12.369 | 17.911 | 23.290 |

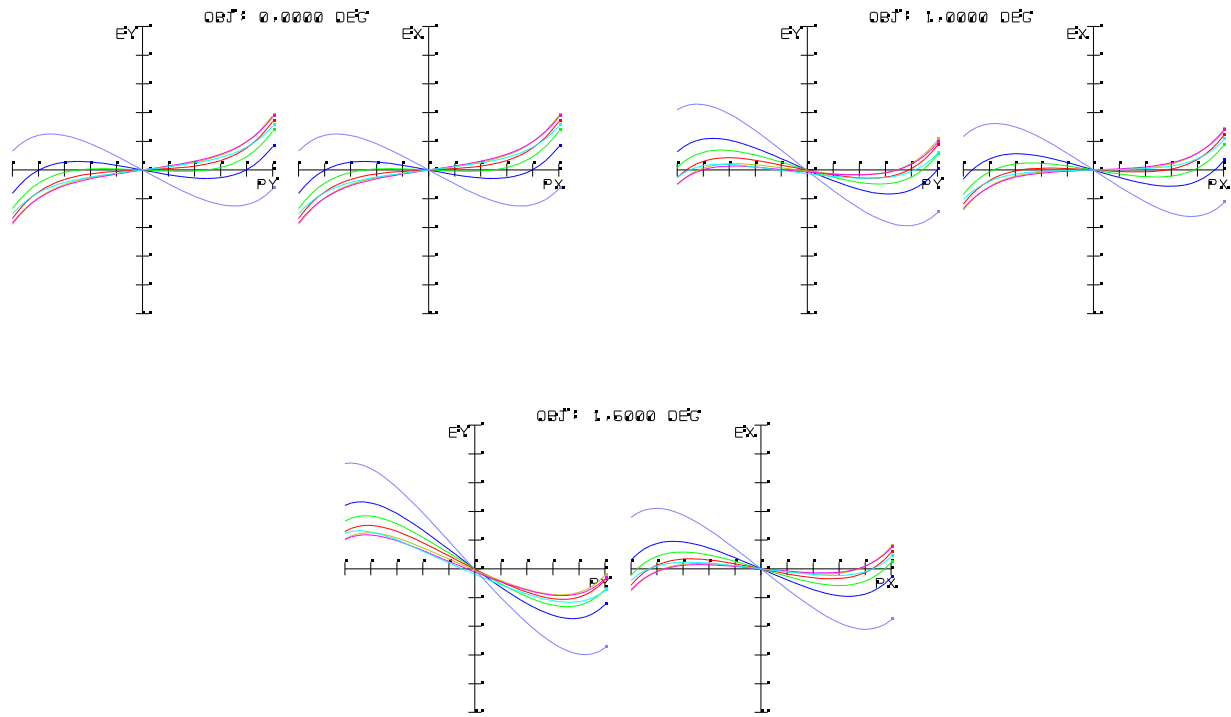
Effective focal length as a function of the air space between the lenses @ 1.65 $\mu\text{m}$  – default air space is 4mm, “Quick focus” spot size X only.

| <i>Air space / mm</i>  | 3      | 3.5    | 4      | 4.5    | 5      |
|--|--------|--------|--------|--------|--------|
| <b><i>EFFL</i></b>   | 101.71 | 101.21 | 100.72 | 100.23 | 99.75  |
| <b><i>Spot geom radius / <math>\mu\text{m}</math></i></b><br><i>field 0deg</i> | 11.660 | 6.847  | 2.158  | 2.409  | 6.857  |
| <b><i>Field 1deg</i></b>   | 9.656  | 4.950  | 4.146  | 9.387  | 14.480 |
| <b><i>Field 1.5deg</i></b>   | 7.140  | 6.525  | 10.708 | 16.280 | 21.689 |

Ray fan aberrations, air space is 4mm.



Ray fan aberrations, air space is 3.5mm, , T = 77K, p=1e-6atm



TRANSVERSE RAY FAN PLOT

MON APR 25 2005  
 MAXIMUM SCALE: ± 20,000 μm.  
 1.500 1.650 1.800 2.000 2.200 2.400 1.250  
 SURFACE: IMAGE

DOUBLETLENS3\_ISP\_5.ZMX  
 CONFIGURATION 1 OF 1