# **Lens Design Archive**

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| NAME                        | Petzval portrait lenses |  |
|-----------------------------|-------------------------|--|
| wavelengths                 | 480-656nm visible       |  |
| EFFL                        | 30mi                    |  |
| F/#                         | 2.8/2                   | .0   |
| FOV                         | 15°                     | JAPAN PATENT 51_13 CITFFACTION LIMIT WAVELENGTH MELONT   |
|                             |                         | DAFFEN   TAPLENT S1  |
|                             | F/#=2.8                 | 75 130 225 300 375 450 525 640 675 SPATIAL FREQUENCY (CYCLES/MM)   |
| Layout & MTF<br>CodeV model | F/#=2                   | JAPAN PATENT 51 13  53 760501  DIFFRACTION NTF  ORA  11-Jan-16  1.6 FIELD (5.18*)  1.7 FIELD (5.18*)  1.6 FIELD (5.18*)  1.7 FIELD (5.18*)  1.8 FIELD (5.18*)  1.9 FIELD (7.28*)  1.0 FIELD (7.28*)  DEFOCUSING 0.00000  0.1  0.1  0.7  0.7  0.8  0.9  0.1  0.1  0.1   |
|                             | 1/17 2                  | 115 250 373 500 635 750 673 1000 SPATIAL FREQUENCY (CYCLES/P8)   |
|                             |                         | JAPAN PATENT 51_13  53 760501  DIFFRACTION HTF  ORA  11-Jan-16  10.0 FIELD (1.40) 565.0 DM 2  00.1 ZMC 1  00.1 ZMC |
|                             | F/#=2                   | 133 250 373 550 62 155 1090 SPATIAL FREQUENCY (CYCLES/NO)  |

| NAME               | Wide_angle            | lenses  |
|--------------------|-----------------------|---|
| wavelengths        | 480-656nm visible     |   |
| EFFL               | 5.8mm/5.45mm/4.0mm    |   |
| F/#                | 1.4/2.                | 0   |
| FOV                | 84° /92° /            | /122°   |
| Elements<br>number | 9                     |   |
|                    | 84° F/#=1.4 135 lp/mm | JAPAN PATENT 49_20  535 740525  DIFFRACTION MTF  ORA  04-Jun-15  0.6 FIELD (35.00)  0.7 FIELD (35.00)  0.8 FIELD (35.00)  0.9 Separatal Frequency (cycles/984)  |
| Layout&MTF         |                       | New lens from CVMACR  |
| CodeV model        |                       | 0.8   1.0 |
|                    | 92° F/#=1.4 135 lp/mm | SPATIAL FREQUENCY (CYCLES/MM)   |
|                    |                       | Fish eye for PI fiel  |
|                    | 122° F/#=1.4 135lp/mm | GENTIAL PROMUDENT (UTULES/MM)   |

| NAME                   | Fishe     | eye_lens  |  |
|------------------------|-----------|---|--|
| wavelengths            | 480-656   | 480-656nm visible   |  |
| EFFL                   | 1.        | 7mm   |  |
| F/#                    |           | 1.6   |  |
| FOV                    |           | 180°  |  |
| Elements<br>number     |           | 9   |  |
| Layout&MTF Zemax model | 125 la/mm | TS DIFF. LIMIT TS 60.00 DEG TS 60.00 DEG TS 60.00 DEG TS 60.00 DEG TS 89.00 DEG TS |  |
|                        | 135 lp/mm |   |  |

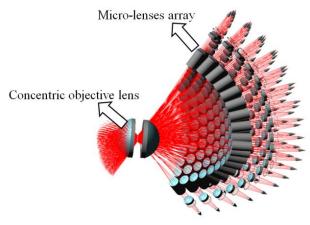
| NAME                   | Und               | lerwater Lenses  |
|------------------------|-------------------|--|
| wavelengths            | 434-656nm visible |  |
| EFFL                   |                   | 10mm   |
| F/#                    |                   | 2.5  |
| FOV                    |                   | 66°  |
| Elements number        |                   | 6  |
| Layout&MTF CodeV model | 135 lp/mm         | JAPAN PATENT 51_23  348 760716  DIFFRACTION MTF  ORA  11-Jan-16  10.4 FIELD (23.00*)  10.8 FIELD (23.00*)  11-Jan-16  DEFOCUSING 0.00000  DEFOCUSING 0.00000 |
|                        | 135 lp/mm         | USA PATENT 3012476  ZIMMERMAN DIFFRACTION MTF  ORA  11-Jan-16  1.0  0.9  0.8  0.7  MO.6  DIFFRACTION LIMIT AXIS  |
|                        | 1                 | 20 40 60 80 100 120 SPATIAL FREQUENCY (CYCLES/MM)  |

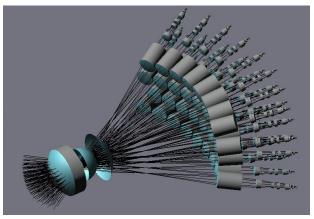
| NAME               | Microsco              | pe Objectives |
|--------------------|-----------------------|---------------|
| wavelengths        | 450-680nm visible     |               |
| EFFL               | 100/50/20/10/5mm      |               |
| NA                 | 0.1/0.2/0.25/0.5/0.75 |               |
| FOV(height)        | 10/5/2                | 2/1/0.5mm     |
| Elements<br>number |                       | 5-6           |
|                    |                       |               |
|                    | 2X                    | 4X            |
| Layout CodeV model |                       |               |
|                    | 10X                   | 20X           |
|                    |                       |               |
|                    | 402                   | K             |

# **Ultrathin lenses**

| NAME                   | Ul                | trathin Lenses  |
|------------------------|-------------------|---|
| wavelengths            | 434-656nm visible |   |
| EFFL                   | 20                | 0mm & 30mm  |
| F/#                    |                   | 2 & 1.73  |
| FOV                    |                   | 17° & 5°  |
| Layout&MTF Zemax model | 12mm 6.32mm 7mm   | 1.0 0.8 0.6 0.0 0.1 0.0 0.2 0.2 0.2 0.30.0 60.0 90.0 120.0 150.0 180.0 210.0 240.0 270.0 300.0 Spatial Frequency in cycles per mm |
|                        | 18mm<br>6.48mm    | 1.0<br>0.8<br>0.6<br>0.4<br>0.0<br>0.2<br>0.0<br>0.0<br>0.0<br>0.0<br>0.0<br>0.0  |

### **MULTISCALE Lenses**

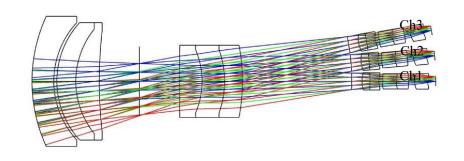




| NAME                          | Monocentric Multisca | le lenses of Keplerian style   |
|-------------------------------|----------------------|--|
| wavelengths                   | 434-656nm visible    |  |
| EFFL                          | 3                    | 31mm   |
| F/#                           |                      | 3  |
| MFOV                          | 10° (FoV of          | a single channel)  |
| Layout&MTF Zemax& CodeV model | 357 lp/mm            | TS DIFF. LIMIT TS 0.0000 DEG TS 1.00 TS 2.5000 DEG TS 5.0000 DEG   |
|                               |                      | TS DIFF. LIMIT TS 0.0000 DEG TS 1.0000 DEG TTS 2.5000 DEG TTS 5.0000 DEG TTS 7.000 DEG T |
|                               | 357 lp/mm            | SPATIAL FREQUENCY IN CYCLES PER MILLIMETER   |

| NAME                          | Monocentric Multis | cale lenses of Galilean style  |
|-------------------------------|--------------------|--|
| wavelengths                   | 434-656nm visible  |  |
| EFFL                          |                    | 34mm   |
| F/#                           |                    | 2.5  |
| MFOV                          |                    | 9.6°   |
| Layout&MT<br>F<br>Zemax model |                    | 0.8<br>0.4<br>0.2<br>0 82.0 164.0 246.0 328.0 410.0 492.0 574.0 656.0 738.0 820.0 Spatial Frequency in cycles per mm                   |
|                               |                    | 1.0<br>0.8<br>0.2<br>0.2<br>0.2<br>0.2<br>0.2<br>0.2<br>0.328.0 410.0 492.0 574.0 656.0 738.0 820.0 Spatial Frequency in cycles per mm |

| NAME                             | Multiscale Lenses wi  | ith VCM based focusing  |
|----------------------------------|---|---|
| wavelengths                      | 434-656   | onm visible   |
| EFFL                             | 50mr  | m/45mm  |
| F/#                              |   | 2.5   |
| MFOV                             | 9   | .6°   |
| Layout&MT<br>F<br>Zemax<br>model |   | 1.0<br>9th<br>0.6<br>0.2<br>0.2<br>0.6<br>0.9<br>0.138.0 207.0 276.0 345.0 414.0 483.0 552.0 621.0 690.0 Spatial Frequency in cycles per mm   |
|                                  | Concentric objective lens $R = 43.07mm$ $\theta = 7^{\circ}$ $\text{Microcamera array}$ | 0.8<br>9t 0.6<br>0.6<br>0.0<br>0.2<br>0.2<br>0.2<br>0.3<br>0.4<br>0.6<br>0.6<br>0.6<br>0.6<br>0.7<br>0.7<br>0.7<br>0.7<br>0.8<br>0.9<br>0.9<br>0.9<br>0.9<br>0.9<br>0.9<br>0.9<br>0.9 |

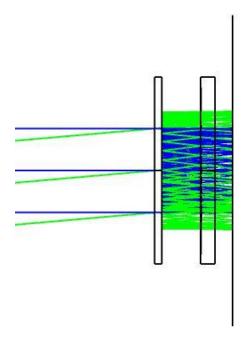


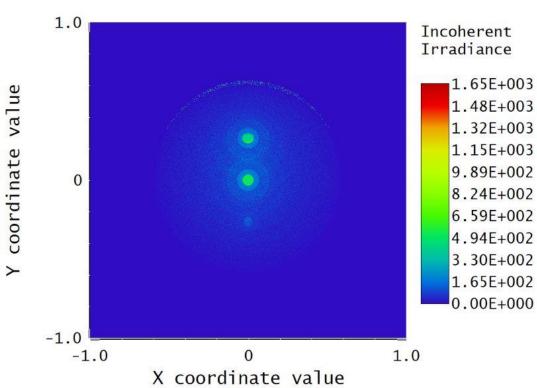
| NAME            | Telephoto Multiscale lenses  |  |
|-----------------|--|--|
| wavelengths     | 434-656nm visible  |  |
| EFFL            | 150mm  |  |
| F/#             | 3  |  |
| MFOV            | 2°   |  |
| MTF Zemax model | Ch1  1.0  0.8  0.74.0 148.0 222.0 296.0 370.0 444.0 518.0 592.0 666.0 740.0  Ch2  0.74.0 146.0 222.0 396.0 370.0 444.0 518.0 592.0 666.0 740.0  Ch2  1.0  73.0 146.0 222.0 396.0 370.0 444.0 518.0 592.0 666.0 740.0  Spatial Frequency in cycles per mm  Ch3  Ch3  Ch3  Ch3  Ch3  Ch3  Ch3  C |  |

### **Grin Lens**

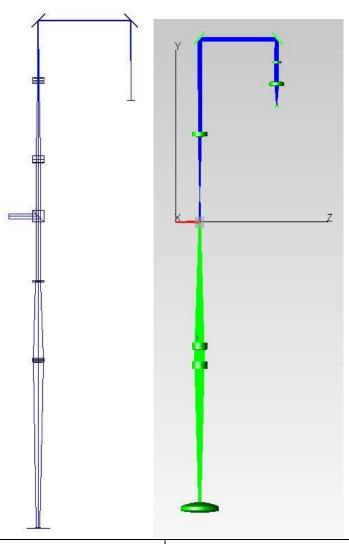
| NAME        | Grin lens for biological tissue probe  |  |
|-------------|--|--|
|             | 810nm  |  |
| wavelengths |  |  |
| NA          | 0.5  |  |
| FoV         | $180\mu m$   |  |
|             |  |  |
|             |  |  |
|             |  |  |
|             |  |  |
|             |  |  |
| Layout&MTF  |  |  |
| Zemax model |  |  |
|             |  |  |
|             | 1.0  |  |
|             | ± 0.8  |  |
|             | Modulus of the OTF   |  |
|             | of the state of th |  |
|             | Sn 0.4   |  |
|             | ž 0.2  |  |
|             | 0 38.0 76.0 114.0 152.0 190.0 228.0 266.0 304.0 342.0 380.0  |  |
|             | Spatial Frequency in cycles per mm   |  |
|             | □ Diff. Limit-Tangential □ Diff. Limit-Sagittal □ 0.0000 mm-Tangential □ 0.0000 mm-Sagittal □ 0.0450 mm-Tangential □ 0.0450 mm-Sagittal □ 0.0900 mm-Tangential □ 0.0900 mm-Sagittal  |  |
|             |  |  |
|             |  |  |
|             |  |  |

**Fabry Perot Cavity** 





# LENS CENTERING TOOL



| Wavelengths   | 635nm solid state red laser |
|---------------|-----------------------------|
| Magnification | 8X                          |

Zemax and lightTools model