



*smart*  
**Objectives**  
**UV, NUV, VISIBLE & NIR**

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## Classification of objective lenses

An objective lens with tunable glass thickness compensation function is also available. Please contact our Sales Team.

| Parfocal distance / Screw size | Corresponding wavelength   | Glass thickness compensation | Product Name<br>Part Number                                       | Main purpose of use                                       |
|--------------------------------|----------------------------|------------------------------|-------------------------------------------------------------------|-----------------------------------------------------------|
| 45mm<br>φ20.32×0.706           | Visible                    | None                         | Bright field long working Objective Lenses<br><b>EPL / EPLE</b>   | Visual observation                                        |
| 95mm<br>φ26×0.706              | Visible                    | None                         | Bright field long working Objective Lenses<br><b>PAL / PAL-L</b>  | Visual observation                                        |
|                                | Visible /Near ultra-violet | None/0.7mm/1.1mm             | Bright field near ultra-violet Objective Lenses<br><b>PAL-NUV</b> | Visual /Near ultra violet observation<br>Laser processing |
|                                | Visible /Near-infrared     | None/0.7mm/1.1mm             | Bright field near-infrared Objective Lenses<br><b>PAL-NIR</b>     | Visual/ Near-infrared observation<br>Laser processing     |
|                                | Visible / Ultra-violet     | None/0.7mm/1.1mm             | Bright field ultra-violet Objective Lenses<br><b>PFL-UV-AG</b>    | Visual/ultra-violet observation<br>Laser processing       |

## Part number description

**PAL-50-NIR-□-□-LC00-A**

①

②

③

④

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⑦

⑧

### ① Lens type

**PAL** : Plan apochromat

**PFL** : Plan semi-apochromat  
(Plan Flour)

### ② Magnification

The magnification of objective lenses

### ③ Wavelength

None: Visible range

**NIR**: Near-infrared

**NUV**: Near ultra-violet

**UV**: Ultra-violet

### ④ Resolution

None: Normal resolution

**HR**: High resolution

⑤ Working distance L: Long working distance

⑥ AG Air gap type (Only to the UV type)

⑦ Glass thickness

**LC00**: Glass thickness is not corrected

**LC07**: Glass thickness is corrected to t=0.7mm

**LC11** : Glass thickness is corrected to t=1.1mm

⑧ Ver information A ~ Last updated ver.

\*Blank are omitted left-justified

Exp.)PAL-50-NUV-HR-L-LC11-A

# [Reference] Objectives List



| Type                                                              | Magnification | Part Number                   | Description                    | NA    | W.D.       | Page |
|-------------------------------------------------------------------|---------------|-------------------------------|--------------------------------|-------|------------|------|
| Visible<br>Normal type                                            | 2x            | <b>PAL-2-B</b>                | MPlanApo 2x                    | 0.055 | 34         | P7   |
|                                                                   | 5x            | <b>PAL-5</b>                  | MPlanApo 5x                    | 0.14  | 41         |      |
|                                                                   | 10x           | <b>PAL-10-A</b>               | MPlanApo 10x                   | 0.3   | 34         |      |
|                                                                   | 20x           | <b>PAL-20</b>                 | MPlanApo 20x                   | 0.42  | 20         |      |
|                                                                   | 50x           | <b>PAL-50</b>                 | MPlanApo 50x                   | 0.55  | 13         |      |
| Visible<br>Super long type                                        | 20x           | <b>PAL-20-L-A</b>             | MPlanApo SL 20x                | 0.3   | 31.1       | P8   |
|                                                                   | 100x          | <b>PAL-100-L</b>              | MPlanApo SL 100x               | 0.53  | 12.1       |      |
| UV(266 532)<br>Normal type<br>Air gap                             | 10x           | <b>PFL-10-UV-AG</b>           | MPlan UV 10x                   | 0.2   | 13.5       | P9   |
|                                                                   | 20x           | <b>PFL-20-UV-AG-A</b>         | MPlan UV 20x                   | 0.36  | 15.07      |      |
|                                                                   | 50x           | <b>PFL-50-UV-AG-A</b>         | MPlan UV 50x                   | 0.42  | 12         |      |
|                                                                   | 80x           | <b>PFL-80-UV-AG-LC00</b>      | MPlan UV 80x                   | 0.55  | 10         |      |
| UV(266 532)<br>Glass Thickness Compensation (t0.7)Type<br>Air gap | 20x           | <b>PFL-20-UV-AG-LC07-A</b>    | LCD MPlan UV 20x (t0.7)        | 0.36  | 15.15(Air) | P10  |
|                                                                   | 50x           | <b>PFL-50-UV-AG-LC07-A</b>    | LCD MPlan UV 50x (t0.7)        | 0.42  | 11.99(Air) |      |
|                                                                   | 80x           | <b>PFL-80-UV-AG-LC07</b>      | LCD MPlan UV 80x (t0.7)        | 0.55  | 9.78(Air)  |      |
| UV(266 532)<br>Glass Thickness Compensation (t1.1)Type<br>Air gap | 20x           | <b>PFL-20-UV-AG-LC11-A</b>    | LCD MPlan UV 20x (t1.1)        | 0.36  | 15.2(Air)  |      |
|                                                                   | 50x           | <b>PFL-50-UV-AG-LC11-A</b>    | LCD MPlan UV 50x (t1.1)        | 0.42  | 12.02(Air) |      |
|                                                                   | 80x           | <b>PFL-80-UV-AG-LC11</b>      | LCD MPlan UV 80x (t1.1)        | 0.55  | 9.65(Air)  |      |
| NUV(355 532)<br>Normal type                                       | 20x           | <b>PAL-20-NUV-A</b>           | MPlan NUV 20x                  | 0.4   | 17.25      | P11  |
|                                                                   | 50x           | <b>PAL-50-NUV-A</b>           | MPlan NUV 50x                  | 0.45  | 15.1       |      |
|                                                                   | 100x          | <b>PAL-100-NUV-A</b>          | MPlan NUV 100x                 | 0.57  | 11.23      |      |
| NUV(355 532)<br>HR type                                           | 50x           | <b>PAL-50-NUV-HR-L</b>        | MPlan NUV HR 50x               | 0.65  | 10         |      |
|                                                                   | 100x          | <b>PAL-100-NUV-HR</b>         | MPlan NUV HR 100x              | 0.7   | 10         |      |
| NUV(355 532)<br>Glass Thickness Compensation (t0.7)Type           | 20x           | <b>PAL-20-NUV-LC07-A</b>      | LCD MPlan NUV 20x (t0.7)       | 0.4   | 17.35(Air) | P12  |
|                                                                   | 50x           | <b>PAL-50-NUV-LC07-A</b>      | LCD MPlan NUV 50x (t0.7)       | 0.45  | 15.05(Air) |      |
|                                                                   | 100x          | <b>PAL-100-NUV-LC07-A</b>     | LCD MPlan NUV 100x (t0.7)      | 0.57  | 11.17(Air) |      |
| NUV(355 532)<br>Glass Thickness Compensation (t1.1)Type           | 20x           | <b>PAL-20-NUV-LC11-A</b>      | LCD MPlan NUV 20x (t1.1)       | 0.4   | 17.4(Air)  |      |
|                                                                   | 50x           | <b>PAL-50-NUV-LC11-A</b>      | LCD MPlan NUV 50x (t1.1)       | 0.45  | 15.01(Air) |      |
|                                                                   | 100x          | <b>PAL-100-NUV-LC11-A</b>     | LCD MPlan NUV 100x (t1.1)      | 0.57  | 11.13(Air) |      |
| NUV(355 532) HR<br>Glass Thickness Compensation (t0.7)Type        | 50x           | <b>PAL-50-NUV-HR-L-LC07-A</b> | LCD MPlan NUV HR 50x (t0.7)    | 0.65  | 9.91(Air)  |      |
| NUV(355 532) HR<br>Glass Thickness Compensation (t1.1)Type        | 50x           | <b>PAL-50-NUV-HR-L-LC11-A</b> | LCD MPlan NUV HR 50x (t1.1)    | 0.65  | 9.89(Air)  |      |
| NIR(1064 532)<br>Normal type                                      | 10x           | <b>PAL-10-NIR</b>             | MPlan NIR 10x                  | 0.3   | 31         | P14  |
|                                                                   | 20x           | <b>PAL-20-NIR-LC00</b>        | MPlan NIR 20x                  | 0.4   | 20.2       |      |
|                                                                   | 50x           | <b>PAL-50-NIR-L</b>           | MPlan NIR 50x                  | 0.45  | 15.1       |      |
|                                                                   | 100x          | <b>PAL-100-NIR</b>            | MPlan NIR 100x                 | 0.53  | 12.14      |      |
| NIR(1064 532)<br>HR type                                          | 20x           | <b>PAL-20-NIR-HR-LC00</b>     | MPlan NIR HR 20x               | 0.45  | 20         |      |
|                                                                   | 50x           | <b>PAL-50-NIR-HR-LC00</b>     | MPlan NIR HR 50x               | 0.67  | 10         |      |
| NIR(1064 532)<br>Glass Thickness Compensation (t0.7)Type          | 20x           | <b>PAL-20-NIR-LC07</b>        | LCD MPlan NIR 20x (t0.7)       | 0.4   | 19.98(Air) | P15  |
|                                                                   | 50x           | <b>PAL-50-NIR-L-LC07</b>      | LCD MPlan NIR 50x (t0.7)       | 0.45  | 15.01(Air) |      |
|                                                                   | 100x          | <b>PAL-100-NIR-L-LC07</b>     | LCD MPlan NIR 100x (t0.7)      | 0.53  | 12.18(Air) |      |
| NIR(1064 532)<br>Glass Thickness Compensation (t1.1)Type          | 20x           | <b>PAL-20-NIR-LC11</b>        | LCD MPlan NIR 20x (t1.1)       | 0.4   | 19.85(Air) |      |
|                                                                   | 50x           | <b>PAL-50-NIR-L-LC11</b>      | LCD MPlan NIR 50x (t1.1)       | 0.45  | 14.97(Air) |      |
|                                                                   | 100x          | <b>PAL-100-NIR-LC11</b>       | LCD MPlan NIR 100x (t1.1)      | 0.53  | 12.16(Air) |      |
| NIR(1064 532) HR<br>Glass Thickness Compensation (t0.7)Type       | 50x           | <b>PAL-50-NIR-HR-LC07</b>     | LCD MPlan NIR HR 50x (t0.7)    | 0.67  | 10.48(Air) |      |
| UV/NUV(266 355 532)<br>Normal type<br>Air gap                     | 10x           | <b>PFL-10-UV/NUV-AG</b>       | MPlan UV/NUV 10                | 0.2   | 13.5       | P16  |
|                                                                   | 20x           | <b>PFL-20-UV/NUV-AG-A</b>     | MPlan UV/NUV 20                | 0.36  | 15.07      |      |
|                                                                   | 50x           | <b>PFL-50-UV/NUV-AG-A</b>     | MPlan UV/NUV 50                | 0.42  | 12         |      |
| Femtosecond NIR (780)<br>Glass Thickness Compensation (t0.7)Type  | 20x           | <b>PAL-20-NIR(780)-LC07</b>   | LCD MplanApo NIR(780) 20x(780) | 0.45  | 17.2(Air)  | P17  |
|                                                                   | 50x           | <b>PAL-50-NIR(780)-LC07</b>   | LCD MplanApo NIR(780) 50x(780) | 0.8   | 3.8(Air)   |      |

## Tokyo Head Office

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Midori, Sumida-ku, Tokyo, 130-0021, JAPAN

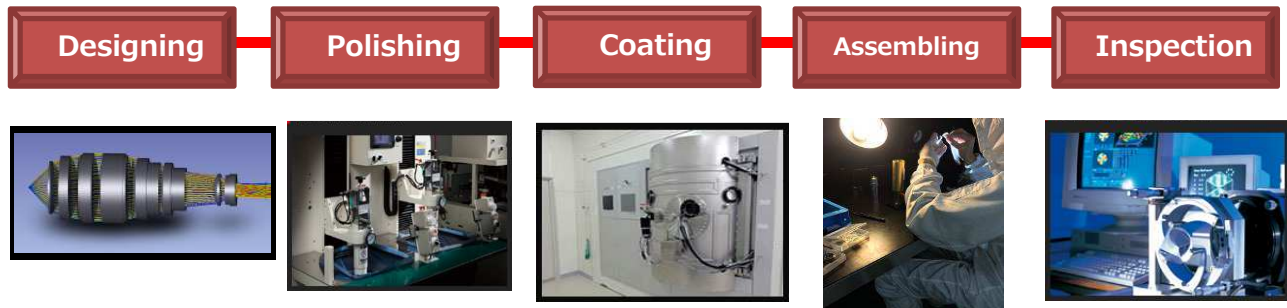
TEL. +81-3-5638-8228 / FAX. +81-3-5638-6550  
E-mail international@sigma-koki.com



3

## Reliable integrated in-house production systems

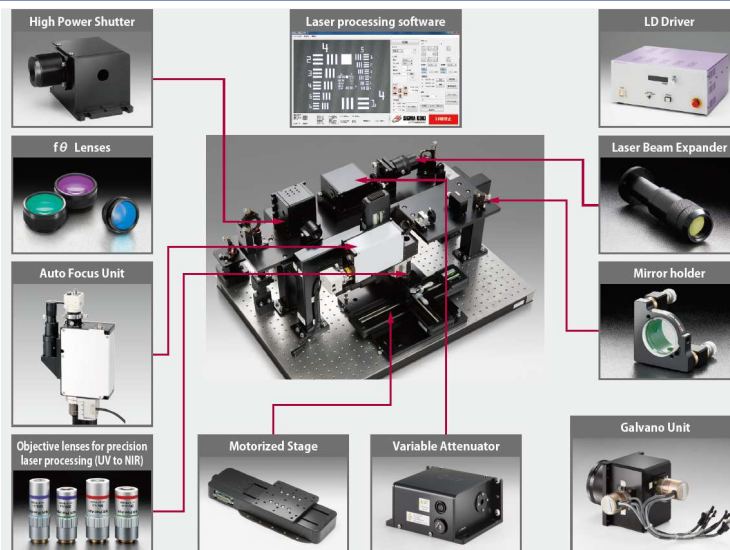
We are operating an integrated in-house production system from planning, designing, manufacturing and to assembly. This one-stop production system contributes a lot about higher quality and shorter production time of our products as well as quality assurance and capability to deal with any technical issues.



We are doing transmitted wave front inspection for all of the objectives when assembling. Totally eliminating the production error of each part and assembly errors, we are maintaining continual high quality of our products.

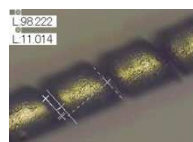
## Applications

### Laser processing System

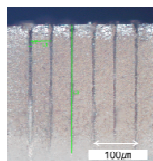


### Applications (Process example, Sample image)

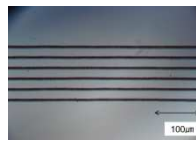
- Cutting
- Drilling
- Scribing
- Trimming
- Marking
- Welding
- Hardening
- Annealing
- Laser deposition
- Glazing



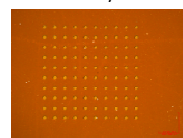
Spiral processing to steel wire



Scribing to Silicon wafer



Direct etching to photomask blanks  
100mm/s



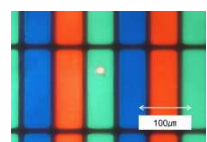
Through hole (dia. 50μm)  
on a polyimide film



Pattern placement to Au thin film.



Trimming to resistor chip



LCD color filter repair



Patterning to ITO thin film  
100mm/s

# Application SYSTEMS

## Laser Processing system



The laser oscillator part in the photo is "Callisto" from V-technology co., ltd..

### UV laser processing system with OUCI-M1Y4

High precision and high quality laser processing available with combination of UV/NUV/NIR objective lens.

Application

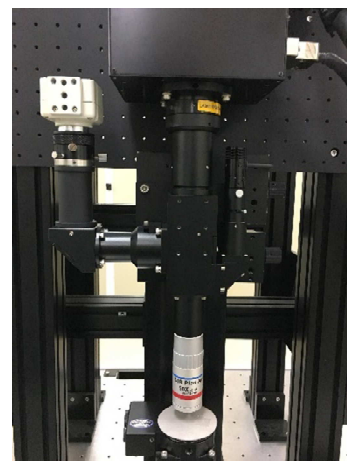
- FPD detect correction
- Cut and remove metal wiring
- Remove protective film, organic film, etc.
- Photomask correction
- Trimming, scribing, etc.

\*Please refer application example on page 4.

We also offer customization service. Please contact our sales for customization request.



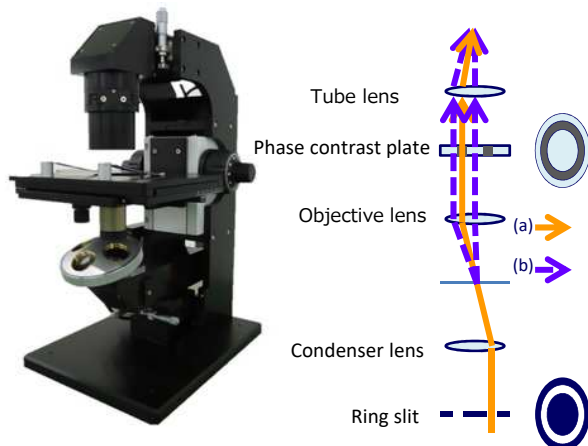
Overview of laser processing system



Enlarged image of OUCI-M1Y4

## Inverted OUCI unit (Phase-contrast)

The phase contrast inverted OUCI unit can observe the colorless and transparent sample by increasing the contrast using the refractive index difference between the sample and background light (diffraction and interference). Inverted OUCI unit is highly versatile to observe small samples (cells, microorganisms etc.).



► Sample image (Cellulose) (Bacillariophyceae)  
(Color Camera 2/3inch 2-Mega pixel CMOS Camera)



Phase-contrast observation

Bright field observation

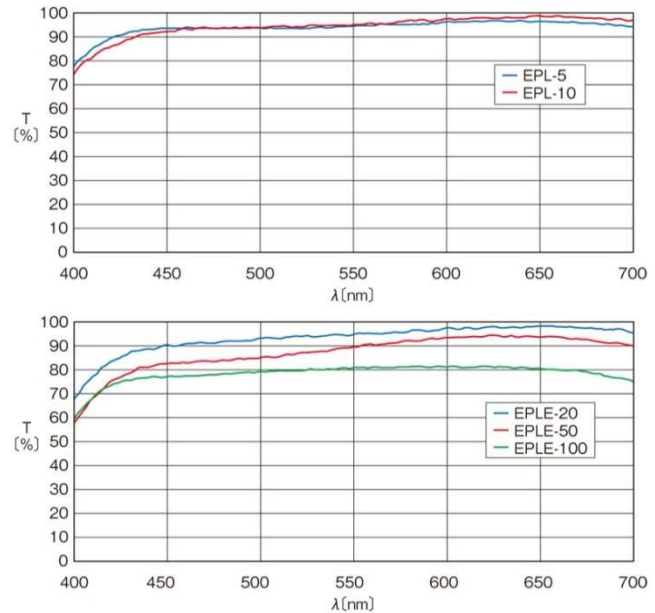
## Long Working Distance Objective Lenses

**EPL/EPL**
**RoHS**
**Catalog Code**
**W3086**

- Bright Field Inspection
- Infinity Corrected
- Plan Apochromat
- Well work with an Auto-Focusing system due to compact and lightweight design.

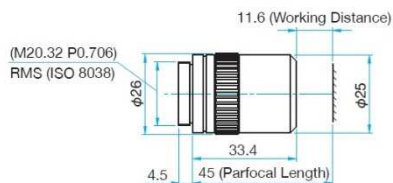


Typical Transmittance Data

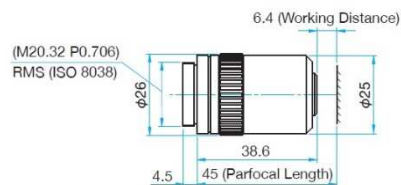


### Outline Drawing

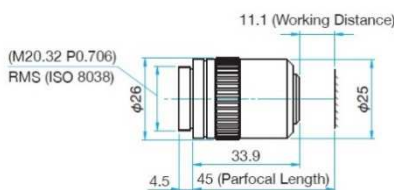
EPL-5



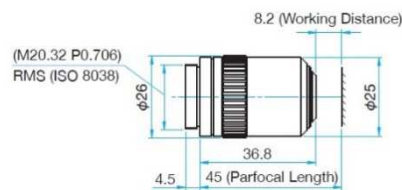
EPL-10



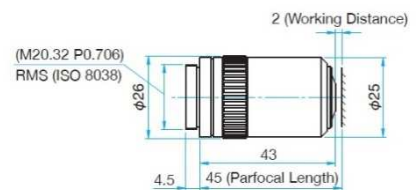
EPL-20



EPL-50



EPL-100



| Part Number | Magnification | Focal length [mm] | N.A. | Working distance (W.D.) [mm] | Resolution [μm] | Focal depth ± D.F. [μm] | Real field of View [mm] |             | Weight [kg] |
|-------------|---------------|-------------------|------|------------------------------|-----------------|-------------------------|-------------------------|-------------|-------------|
|             |               |                   |      |                              |                 |                         | (Eyepiece φ24mm) [mm]   | (1/2" CCD)  |             |
| EPL-5       | 5x            | 40                | 0.13 | 11.6                         | 2.1             | 16.3                    | φ 4.8                   | 0.96 x 1.28 | 0.085       |
| EPL-10      | 10x           | 20                | 0.3  | 6.4                          | 0.9             | 3.1                     | φ 2.4                   | 0.48 x 0.64 | 0.085       |
| EPL-20      | 20x           | 10                | 0.4  | 11.1                         | 0.7             | 1.7                     | φ 1.2                   | 0.24 x 0.32 | 0.085       |
| EPL-50      | 50x           | 4                 | 0.55 | 8.2                          | 0.5             | 0.9                     | φ 0.48                  | 0.10 x 0.13 | 0.095       |
| EPL-100     | 100x          | 2                 | 0.8  | 2                            | 0.3             | 0.4                     | φ 0.24                  | 0.05 x 0.06 | 0.105       |

\*Resolution and focal depth are calculated value at wavelength of 0.55μm.

# Long Work Distance Objective Lenses

**PAL**

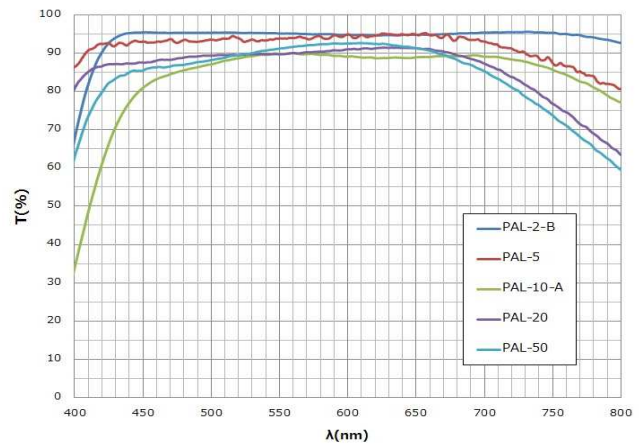
**RoHS**

**Catalog Code** W3456

- Bright Field Inspection
- Infinity Corrected
- Plan Apochromat

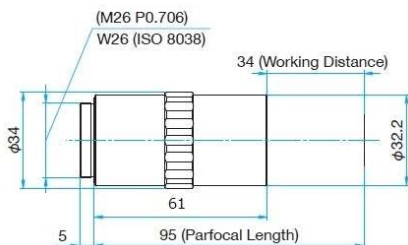


Typical Transmittance Data

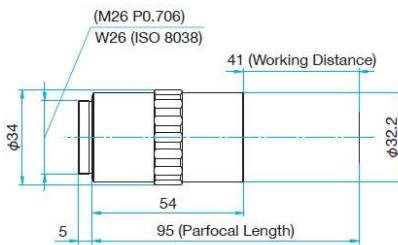


## Outline Drawing

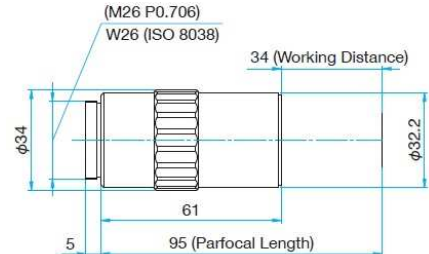
**PAL-2-B**



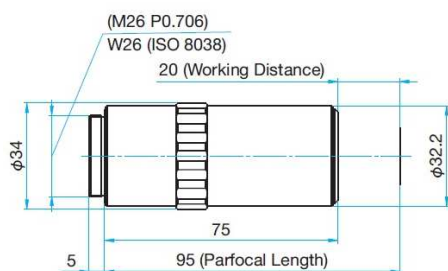
**PAL-5**



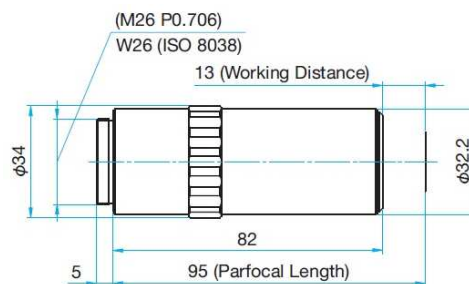
**PAL-10-A**



**PAL-20**



**PAL-50**



| Part Number | Item name    | Magnification | Focal length [mm] | N.A.  | Working distance (W.D.) [mm] | Resolution [μm] | Focal depth ±D.F.[μm] | Real field of View [mm] |             | Weight [kg] |
|-------------|--------------|---------------|-------------------|-------|------------------------------|-----------------|-----------------------|-------------------------|-------------|-------------|
|             |              |               |                   |       |                              |                 |                       | (Eyepiece φ24mm)        | (1/2" CCD)  |             |
| PAL-2-B     | MPlanApo 2x  | 2×            | 100               | 0.055 | 34                           | 5               | 91                    | φ 12                    | 2.4 x 3.2   | 0.25        |
| PAL-5       | MPlanApo 5x  | 5×            | 40                | 0.14  | 41                           | 2               | 14                    | φ 4.8                   | 0.96 x 1.28 | 0.24        |
| PAL-10-A    | MPlanApo 10x | 10×           | 20                | 0.3   | 34                           | 0.92            | 3.1                   | φ 2.4                   | 0.48 x 0.64 | 0.24        |
| PAL-20      | MPlanApo 20x | 20×           | 10                | 0.42  | 20                           | 0.65            | 1.6                   | φ 1.2                   | 0.24 x 0.32 | 0.29        |
| PAL-50      | MPlanApo 50x | 50×           | 4                 | 0.55  | 13                           | 0.5             | 0.9                   | φ 0.48                  | 0.10 x 0.13 | 0.31        |

\*Resolution and focal depth are calculated value at wavelength of 0.55μm.

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 **SIGMAKOKI**

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## Long Work Distance Objective Lenses

**PAL-L**

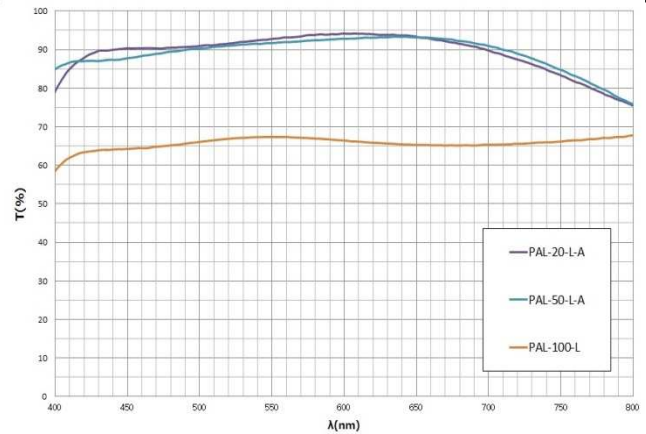
**RoHS**

Catalog Code **W3456**

- Bright Field Inspection
- Infinity Corrected
- Plan Apochromat

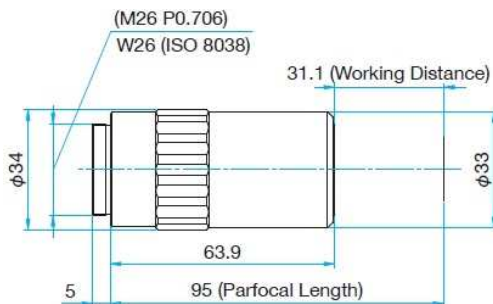


Typical Transmittance Data

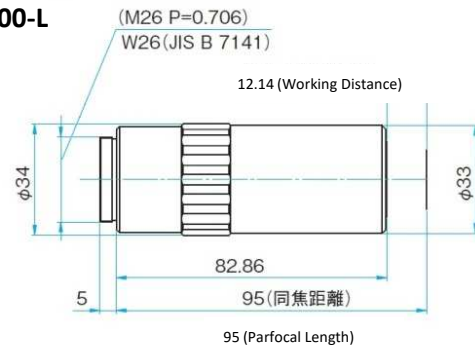


### Outline Drawing

#### PAL-20-L-A

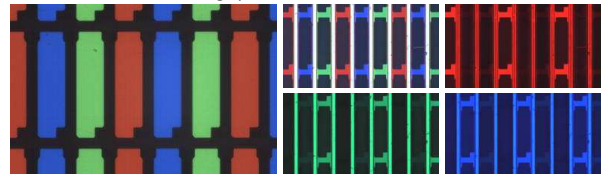


#### PAL-100-L



### Sample Image

(Observation unit with coaxial illumination OUCI-2, Objective Lens PAL-20-L-A, Color Camera 2/3inch 2-Mega pixel CMOS Camera)



Color Filter  
(Transmitted lighting)

Color Filter (Epi illumination)  
NA 0.3(Resolution 0.9μm\*)

\*Calculated value: Reference Wavelength  
Field of vision 0.55mm × 0.3mm  
(Observation magnification 20x)

| Part Number | Item name        | Magnification | Focal length [mm] | N.A. | Working distance (W.D.) [mm] | Resolution [μm] | Focal depth ± D.F[μm] | Real field of View [mm] |             | Weight [kg] |
|-------------|------------------|---------------|-------------------|------|------------------------------|-----------------|-----------------------|-------------------------|-------------|-------------|
|             |                  |               |                   |      |                              |                 |                       | (Eyepiece φ24mm)        | (1/2" CCD)  |             |
| PAL-20-L-A  | MPlanApo SL20x   | 20×           | 10                | 0.3  | 31.1                         | 0.92            | 3.1                   | φ1.2                    | 0.24 × 0.32 | 0.28        |
| PAL-100-L   | MPlanApo SL 100x | 100×          | 2                 | 0.53 | 12.14                        | 0.52            | 0.98                  | φ0.24                   | 0.05 × 0.06 | 0.34        |

\*Resolution and focal depth are calculated value at wavelength of 0.55μm.

# Ultra-violet Objective Lenses

## PFL-UV-AG

RoHS

Catalog Code W3459

- Bright Field Inspection and Laser processing
- Infinity Corrected
- 266nm and 532nm
- Higher Laser damage threshold with Air-gap design.

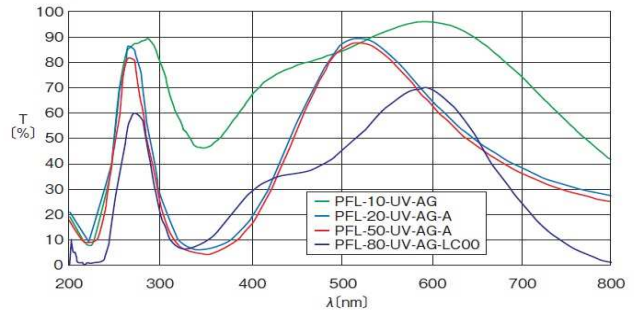
### Laser damage threshold

※Pulse width:10ns, Frequency:20Hz ,reference value

0.09 J/cm<sup>2</sup> (266nm) , 0.2 J/cm<sup>2</sup> (532nm)

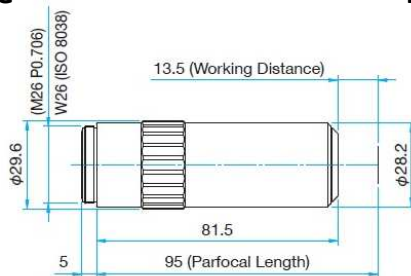


### Typical Transmittance Data

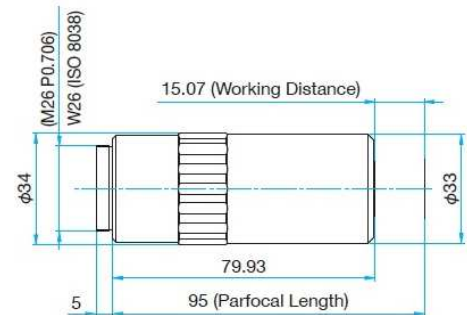


### Outline Drawing

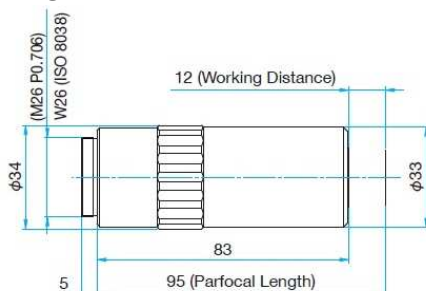
#### PFL-10-UV-AG



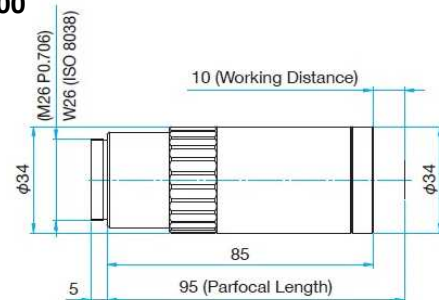
#### PFL-20-UV-AG-A



#### PFL-50-UV-AG-A



#### PFL-80-UV-AG-LC00



| Part Number       | Item name    | Magnification | Focal length [mm] | N.A. | Working distance (W.D.) [mm] | Resolution [μm] | Focal depth ±D.F.[μm] | Real field of View [mm] |             | Weight [kg] |
|-------------------|--------------|---------------|-------------------|------|------------------------------|-----------------|-----------------------|-------------------------|-------------|-------------|
|                   |              |               |                   |      |                              |                 |                       | (Eyepiece φ24mm) [mm]   | (1/2" CCD)  |             |
| PFL-10-UV-AG      | MPlan UV 10x | 10x           | 20                | 0.2  | 13.5                         | 1.4             | 6.9                   | φ2.4                    | 0.48 x 0.64 | 0.3         |
| PFL-20-UV-AG-A    | MPlan UV 20x | 20x           | 10                | 0.36 | 15.07                        | 0.76            | 2.1                   | φ1.2                    | 0.24 x 0.32 | 0.35        |
| PFL-50-UV-AG-A    | MPlan UV 50x | 50x           | 4                 | 0.42 | 12                           | 0.65            | 1.6                   | φ0.48                   | 0.10 x 0.13 | 0.41        |
| PFL-80-UV-AG-LC00 | MPlan UV 80x | 80x           | 2.5               | 0.55 | 10                           | 0.5             | 0.9                   | φ0.3                    | 0.06 x 0.08 | 0.35        |

\*Resolution and focal depth are calculated value at wavelength of 0.55μm.

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# Ultra-violet Objective Lenses with Cover Glass thickness compensation **PFL-UV-AG-LC**

- Bright Field Inspection and Laser processing
- Infinity Corrected
- 266nm and 532nm
- Cover glass thickness compensation (t=0.7mm and 1.1mm)
- Higher Laser damage threshold with Air-gap design

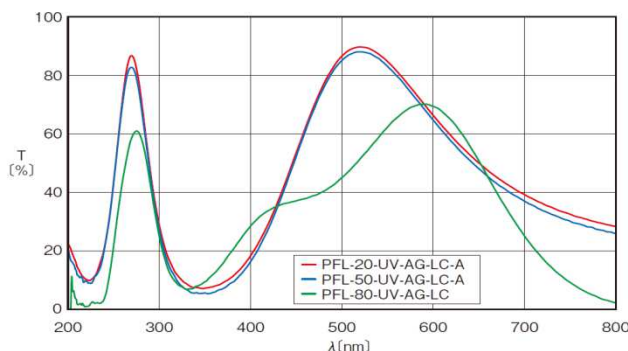
## Laser damage threshold

※Pulse width:10ns, Frequency:20Hz ,reference value

0.09 J/cm<sup>2</sup> (266nm), 0.2 J/cm<sup>2</sup> (532nm)

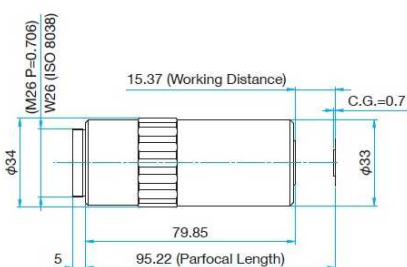


## Typical Transmittance Data

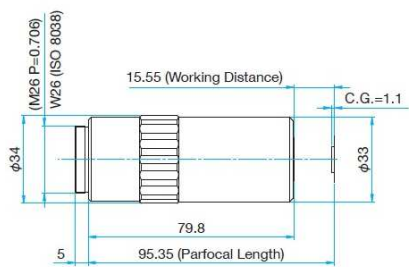


## Outline Drawing

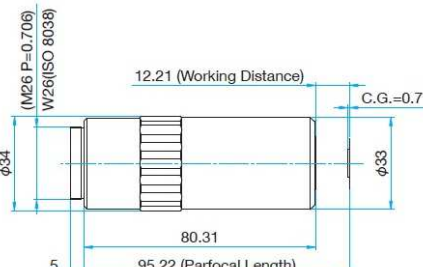
### PFL-20-UV-AG-LC07-A



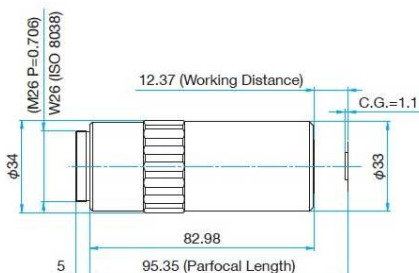
### PFL-20-UV-AG-LC11-A



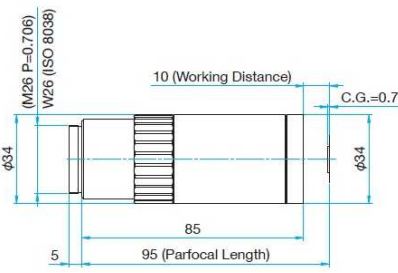
### PFL-50-UV-AG-LC07-A



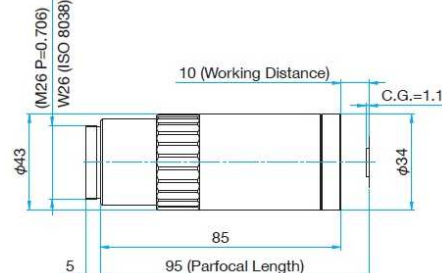
### PFL-50-UV-AG-LC11-A



### PFL-80-UV-AG-LC07



### PFL-80-UV-AG-LC11



| Part Number         | Item name              | Magnification | Focal length [mm] | N.A. | Working distance (W.D.) [mm] | Resolution [μm] | Focal depth ±D.F.[μm] | Real field of View [mm] |             | Weight [kg] |
|---------------------|------------------------|---------------|-------------------|------|------------------------------|-----------------|-----------------------|-------------------------|-------------|-------------|
|                     |                        |               |                   |      |                              |                 |                       | (Eyepiece φ24mm)        | (1/2" CCD)  |             |
| PFL-20-UV-AG-LC07-A | LCD MPlan UV 20x(t0.7) | 20x           | 10                | 0.36 | 15.15                        | 0.76            | 2.1                   | φ1.2                    | 0.24 x 0.32 | 0.35        |
| PFL-20-UV-AG-LC11-A | LCD MPlan UV 20x(t1.1) | 20x           | 10                | 0.36 | 15.2                         | 0.76            | 2.1                   | φ1.2                    | 0.24 x 0.32 | 0.35        |
| PFL-50-UV-AG-LC07-A | LCD MPlan UV 50x(t0.7) | 50x           | 4                 | 0.42 | 11.99                        | 0.65            | 1.6                   | φ0.48                   | 0.10 x 0.13 | 0.4         |
| PFL-50-UV-AG-LC11-A | LCD MPlan UV 50x(t1.1) | 50x           | 4                 | 0.42 | 12.02                        | 0.65            | 1.6                   | φ0.48                   | 0.10 x 0.13 | 0.4         |
| PFL-80-UV-AG-LC07   | LCD MPlan UV 80x(t0.7) | 80x           | 2.5               | 0.55 | 9.78                         | 0.5             | 0.9                   | φ0.3                    | 0.06 x 0.08 | 0.35        |
| PFL-80-UV-AG-LC11   | LCD MPlan UV 80x(t1.1) | 80x           | 2.5               | 0.55 | 9.65                         | 0.5             | 0.9                   | φ0.3                    | 0.06 x 0.08 | 0.35        |

\*Resolution and focal depth are calculated value at wavelength of 0.55μm. \*Working distance: value at air

# Near Ultra-violet Objective Lenses **PAL-NUV**

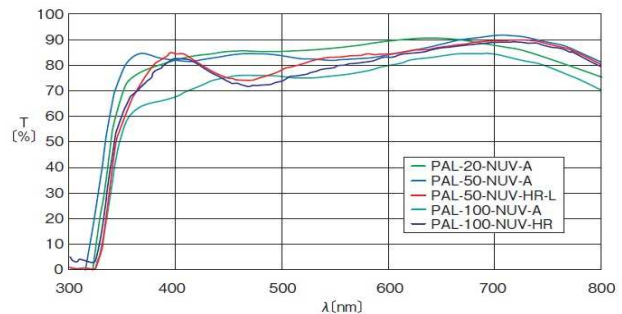
**RoHS**
**Catalog Code** W3458

- Bright Field Inspection and Laser processing
- Infinity Corrected
- Plan Apochromat
- Near-UV 355nm and 532nm
- Laser damage threshold

※Pulse width:10ns, Frequency:20Hz, reference value  
**0.05 J/cm<sup>2</sup> (355nm), 0.1 J/cm<sup>2</sup> (532nm)**

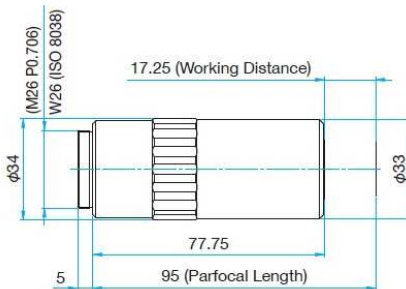


Typical Transmittance Data

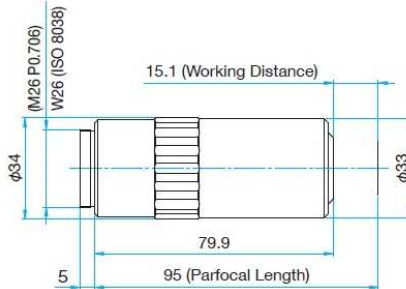


## Outline Drawing

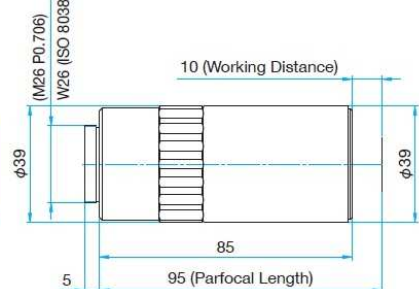
**PAL-20-NUV-A**



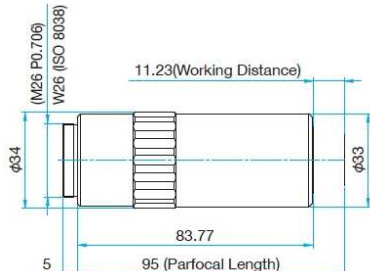
**PAL-50-NUV-A**



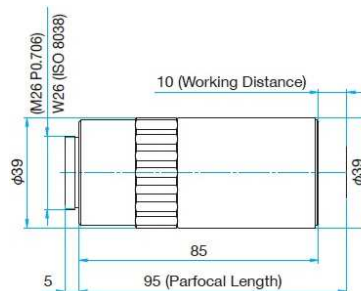
**PAL-50-NUV-HR-L**



**PAL-100-NUV-A**



**PAL-100-NUV-HR**



| Part Number     | Item name            | Magnification | Focal length [mm] | N.A. | Working distance (W.D.) [mm] | Resolution [μm] | Focal depth ±D.F[μm] | Real field of View [mm] |             | Weight [kg] |
|-----------------|----------------------|---------------|-------------------|------|------------------------------|-----------------|----------------------|-------------------------|-------------|-------------|
|                 |                      |               |                   |      |                              |                 |                      | (Eyepiece φ24mm)        | (1/2" CCD)  |             |
| PAL-20-NUV-A    | MPlanApo NUV 20x     | 20x           | 10                | 0.4  | 17.25                        | 0.69            | 1.7                  | φ1.2                    | 0.24 x 0.32 | 0.35        |
| PAL-50-NUV-A    | MPlanApo NUV 50x     | 50x           | 4                 | 0.45 | 15.1                         | 0.61            | 1.4                  | φ0.48                   | 0.10 x 0.13 | 0.36        |
| PAL-50-NUV-HR-L | MPlanApo NUV HR 50x  | 50x           | 4                 | 0.65 | 10                           | 0.42            | 0.65                 | φ0.48                   | 0.10 x 0.13 | 0.51        |
| PAL-100-NUV-A   | MPlanApo NUV 100x    | 100x          | 2                 | 0.57 | 11.23                        | 0.48            | 0.8                  | φ0.24                   | 0.05 x 0.06 | 0.38        |
| PAL-100-NUV-HR  | MPlanApo NUV HR 100x | 100x          | 2                 | 0.7  | 10                           | 0.39            | 0.6                  | φ0.24                   | 0.05 x 0.06 | 0.53        |

\*Resolution and focal depth are calculated value at wavelength of 0.55μm.

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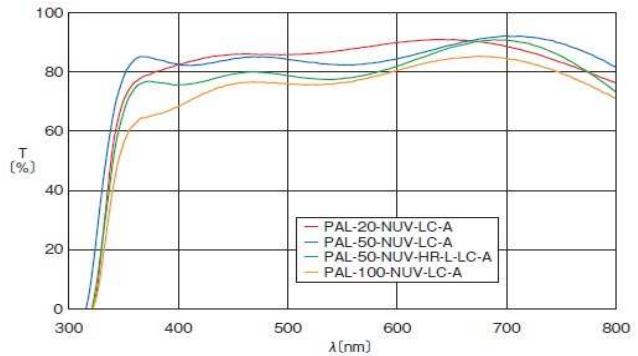
# Near Ultra-violet Objective Lenses with Cover Glass thickness compensation **PAL-NUV-LC**

- Bright Field Inspection and Laser processing
- Infinity Corrected
- Near UV (355nm)
- Cover glass thickness compensation (t=0.7mm and 1.1mm)
- Plan Apochromat
- Laser damage threshold

※Pulse width:10ns, Frequency:20Hz, reference value  
0.05 J/cm<sup>2</sup> (355nm), 0.1 J/cm<sup>2</sup> (532nm)

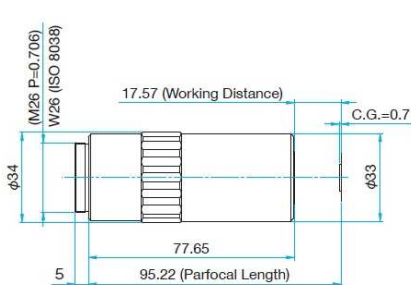


Typical Transmittance Data

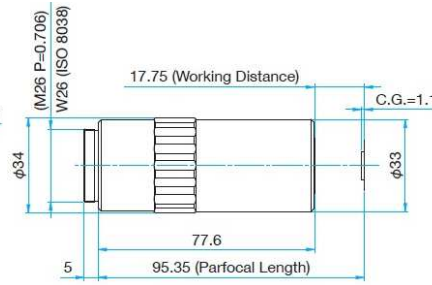


## Outline Drawing

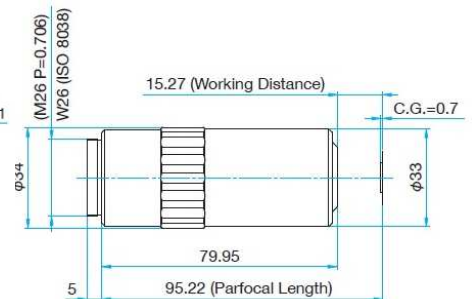
PAL-20-NUV-LC07-A



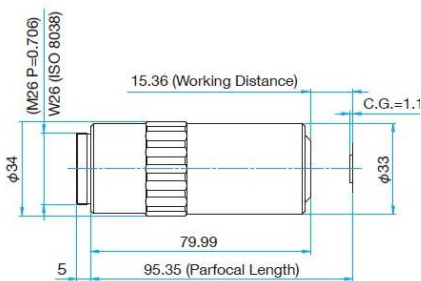
PAL-20-NUV-LC11-A



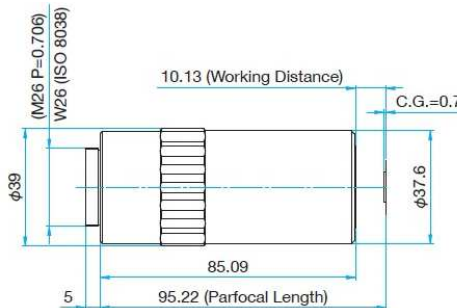
PAL-50-NUV-LC07-A



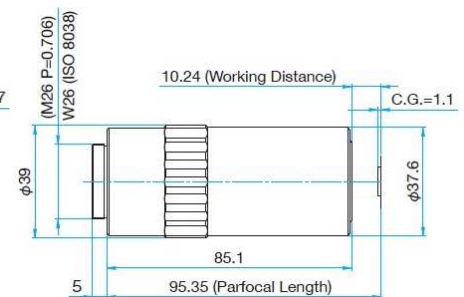
PAL-50-NUV-LC11-A



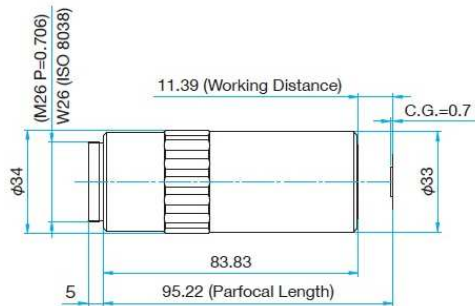
PAL-50-NUV-HR-L-LC07-A



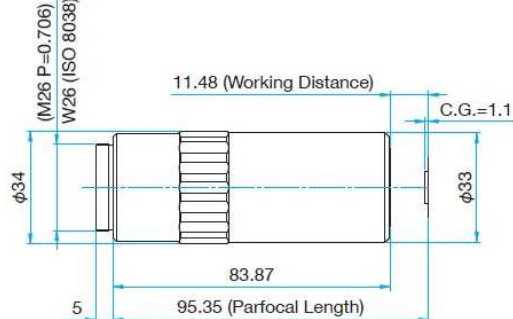
PAL-50-NUV-HR-L-LC11-A



## PAL-100-NUV-LC07-A



## PAL-100-NUV-LC11-A



| Part Number            | Item name                     | Magnification | Focal length [mm] | N.A. | Working distance (W.D.) [mm] | Resolution [μm] | Focal depth ± D.F[μm] | Real field of View [mm] |             | Weight [kg] |
|------------------------|-------------------------------|---------------|-------------------|------|------------------------------|-----------------|-----------------------|-------------------------|-------------|-------------|
|                        |                               |               |                   |      |                              |                 |                       | (Eyepiece φ24mm) [mm]   | (1/2" CCD)  |             |
| PAL-20-NUV-LC07-A      | LCD MPlanApo NUV 20x (t0.7)   | 20x           | 10                | 0.4  | 17.35                        | 0.69            | 1.7                   | φ1.2                    | 0.24 x 0.32 | 0.35        |
| PAL-20-NUV-LC11-A      | LCD MPlanApo NUV 20x(t1.1)    | 20x           | 10                | 0.4  | 17.4                         | 0.69            | 1.7                   | φ1.2                    | 0.24 x 0.32 | 0.35        |
| PAL-50-NUV-LC07-A      | LCD MPlanApo NUV 50x (t0.7)   | 50x           | 4                 | 0.45 | 15.05                        | 0.61            | 1.4                   | φ0.48                   | 0.10 x 0.13 | 0.36        |
| PAL-50-NUV-LC11-A      | LCD MPlanApo NUV 50x(t1.1)    | 50x           | 4                 | 0.45 | 15.01                        | 0.61            | 1.4                   | φ0.48                   | 0.10 x 0.13 | 0.36        |
| PAL-50-NUV-HR-L-LC07-A | LCD MPlanApo NUV HR 50x(t0.7) | 50x           | 4                 | 0.65 | 9.91                         | 0.42            | 0.7                   | φ0.48                   | 0.10 x 0.13 | 0.51        |
| PAL-50-NUV-HR-L-LC11-A | LCD MPlanApo NUV HR 50x(t1.1) | 50x           | 4                 | 0.65 | 9.89                         | 0.42            | 0.7                   | φ0.48                   | 0.10 x 0.13 | 0.51        |
| PAL-100-NUV-LC07-A     | LCD MPlanApo NUV 100x (t0.7)  | 100x          | 2                 | 0.57 | 11.17                        | 0.48            | 0.8                   | φ0.24                   | 0.05 x 0.06 | 0.39        |
| PAL-100-NUV-LC11-A     | LCD MPlanApo NUV 100x(t1.1)   | 100x          | 2                 | 0.57 | 11.13                        | 0.48            | 0.8                   | φ0.24                   | 0.05 x 0.06 | 0.39        |

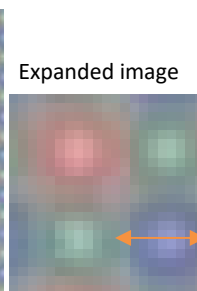
\*Resolution and focal depth are calculated value at wavelength of 0.55μm. \*Working distance: value at air.

### Comparison of sample image of conventional objective lens and HR objective lens

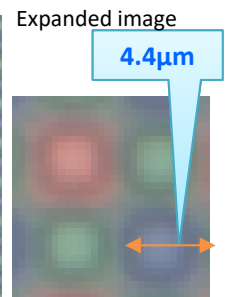
(Observation unit with coaxial illumination OUCI-2, 2/3 inch 2 million pixels CMOS color camera, filed of vision 0.22mm×0.12mm[magnification 20x])



CCD [50x] : PAL-50 (Conventional model)



CCD [×50HR] : PAL-50-NIR-HR-LC00



Observation unit with coaxial illumination that can be customized is also available.

 **W2012**



# Near Infrared Objective Lenses

## PAL-NIR

RoHS

Catalog Code W3457

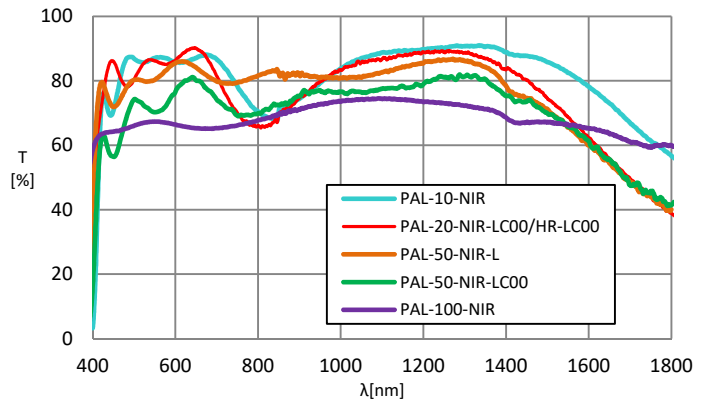
- Bright Field Inspection and Laser processing
- Infinity Corrected
- 1064nm
- Plan Apochromat
- Laser damage threshold

※Pulse width:10ns, Frequency:20Hz ,reference value

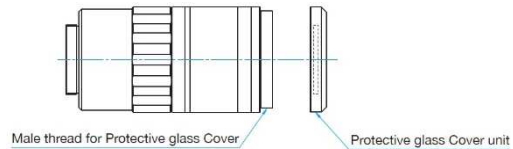
0.1 J/cm<sup>2</sup> (532nm), 0.2 J/cm<sup>2</sup> (1064nm)



Typical Transmittance Data

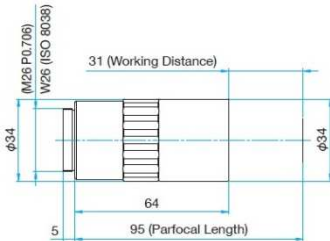


How to replace the protective glass unit of PAL-20-NIR-HR-LC00/PAL-50-NIR-HR-LC00

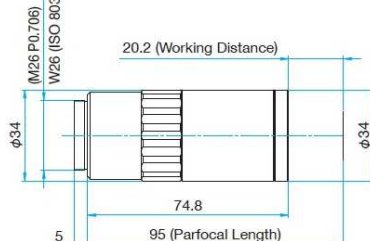


### Outline Drawing

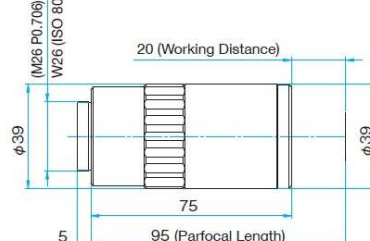
#### PAL-10-NIR



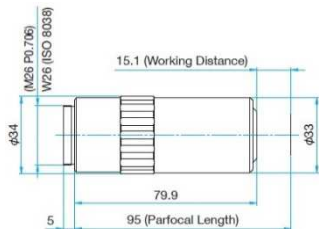
#### PAL-20-NIR-LC00



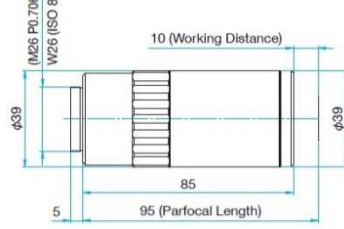
#### PAL-20-NIR-HR-LC00



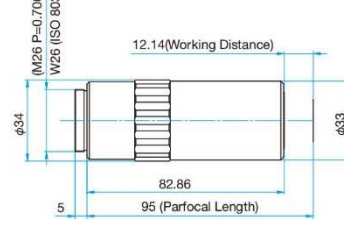
#### PAL-50-NIR-L



#### PAL-50-NIR-HR-LC00



#### PAL-100-NIR



| Part Number        | Item name           | Magnification | Focal length [mm] | N.A. | Working distance (W.D.) [mm] | Resolution [μm] | Focal depth ±D.F [μm] | Real field of View [mm] |             | Weight [kg] |
|--------------------|---------------------|---------------|-------------------|------|------------------------------|-----------------|-----------------------|-------------------------|-------------|-------------|
|                    |                     |               |                   |      |                              |                 |                       | (Eyepiece φ24mm)        | (1/2" CCD)  |             |
| PAL-10-NIR         | MPlanApo NIR 10x    | 10x           | 20                | 0.3  | 31                           | 0.92            | 3.1                   | φ2.4                    | 0.48 x 0.64 | 0.3         |
| PAL-20-NIR-LC00    | MPlanApo NIR 20x    | 20x           | 10                | 0.4  | 20.2                         | 0.69            | 1.7                   | φ1.2                    | 0.24 x 0.32 | 0.36        |
| PAL-20-NIR-HR-LC00 | MPlanApo NIR HR 20x | 20x           | 10                | 0.45 | 20                           | 0.61            | 1.4                   | φ1.2                    | 0.24 x 0.32 | 0.44        |
| PAL-50-NIR-L       | MPlanApo NIR 50x    | 50x           | 4                 | 0.45 | 15.1                         | 0.61            | 1.4                   | φ0.48                   | 0.10 x 0.13 | 0.34        |
| PAL-50-NIR-HR-LC00 | MPlanApo NIR HR 50x | 50x           | 4                 | 0.67 | 10                           | 0.41            | 0.61                  | φ0.48                   | 0.10 x 0.13 | 0.48        |
| PAL-100-NIR        | MPlanApo NIR 100x   | 100x          | 2                 | 0.53 | 12.14                        | 0.52            | 0.98                  | φ0.24                   | 0.05 x 0.06 | 0.34        |

\*Resolution and focal depth are calculated value at wavelength of 0.55μm.

# Near Infrared Objective Lenses with Cover Glass thickness compensation **PAL-NIR-LC**

RoHS

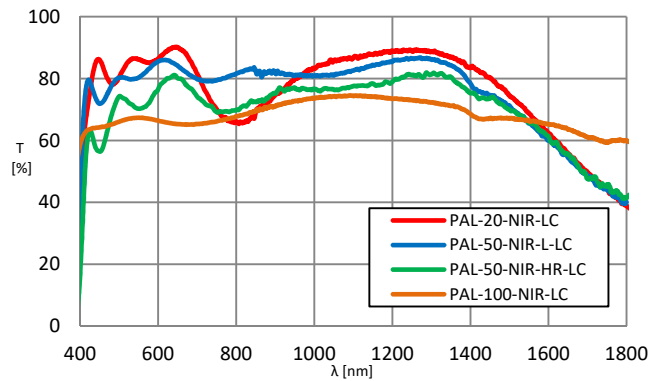
Catalog Code W3465

- Bright Field Inspection and Laser processing
- Infinity Corrected
- Near UV (355nm)
- Cover glass thickness compensation (t=0.7mm and 1.1mm)
- Plan Apochromat
- Laser damage threshold

※Pulse width:10ns, Frequency:20Hz, reference value  
0.05 J/cm<sup>2</sup> (355nm), 0.1 J/cm<sup>2</sup> (532nm)

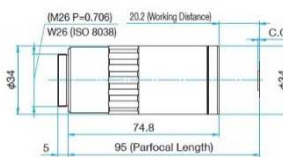


Typical Transmittance Data

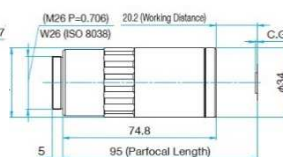


## Outline Drawing

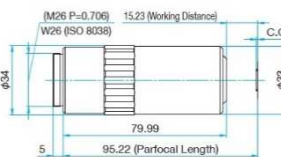
PAL-20-NIR-LC07



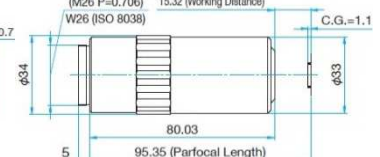
PAL-20-NIR-LC11



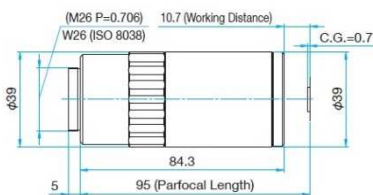
PAL-50-NIR-L-LC07



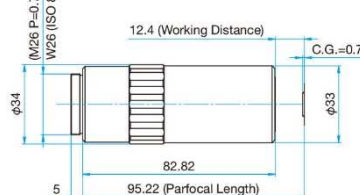
PAL-50-NIR-L-LC11



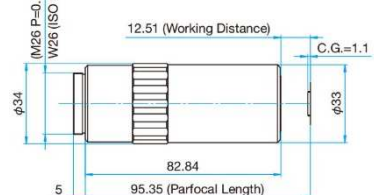
PAL-50-NIR-HR-LC07



PAL-100-NIR-LC07



PAL-100-NIR-LC11



| Part Number        | Item name                    | Magnification | Focal length [mm] | N.A. | Working distance (W.D.) [mm] | Resolution [μm] | Focal depth ±D.F[μm] | Real field of View [mm] |             | Weight [kg] |
|--------------------|------------------------------|---------------|-------------------|------|------------------------------|-----------------|----------------------|-------------------------|-------------|-------------|
|                    |                              |               |                   |      |                              |                 |                      | (Eyepiece φ24mm)        | (1/2" CCD)  |             |
| PAL-20-NIR-LC07    | LCD MPlanApo NIR 20x(t0.7)   | 20x           | 10                | 0.4  | 19.98                        | 0.69            | 1.7                  | φ1.2                    | 0.24 x 0.32 | 0.36        |
| PAL-20-NIR-LC11    | LCD MPlanApo NIR 20x(t1.1)   | 20x           | 10                | 0.4  | 19.85                        | 0.69            | 1.7                  | φ1.2                    | 0.24 x 0.32 | 0.36        |
| PAL-50-NIR-L-LC07  | LCD MPlanApo NIR 50x(t0.7)   | 50x           | 4                 | 0.45 | 15.01                        | 0.61            | 1.4                  | φ0.48                   | 0.10 x 0.13 | 0.34        |
| PAL-50-NIR-L-LC11  | LCD MPlanApo NIR 50x(t1.1)   | 50x           | 4                 | 0.45 | 14.97                        | 0.61            | 1.4                  | φ0.48                   | 0.10 x 0.13 | 0.34        |
| PAL-50-NIR-HR-LC07 | LCD MPlanApo NIR HR50x(t0.7) | 50x           | 4                 | 0.67 | 10.48                        | 0.41            | 0.61                 | φ0.48                   | 0.10 x 0.13 | 0.48        |
| PAL-100-NIR-LC07   | LCD MPlanApo NIR 100x(t0.7)  | 100x          | 2                 | 0.53 | 12.18                        | 0.52            | 1                    | φ0.24                   | 0.05 x 0.06 | 0.33        |
| PAL-100-NIR-LC11   | LCD MPlanApo NIR 100x(t1.1)  | 100x          | 2                 | 0.53 | 12.16                        | 0.52            | 1                    | φ0.24                   | 0.05 x 0.06 | 0.33        |

\*Resolution and focal depth are calculated value at wavelength of 0.55μm. \*Working distance: value at air

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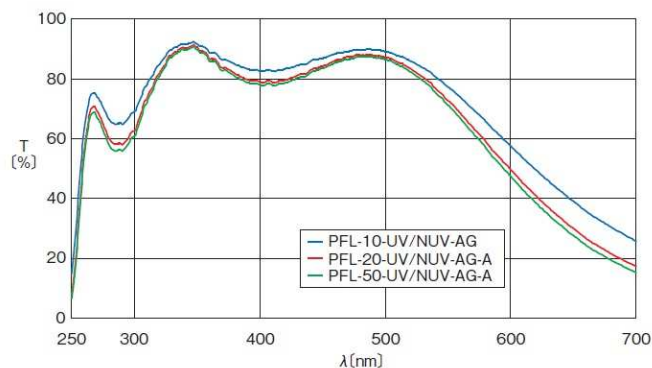
# Ultra-violet Objective Lenses **PFL-UV/NUV-AG** RoHS Catalog Code W3460

- Bright Field Inspection and Laser processing
- Infinity Corrected
- 266nm/355nm/532nm
- Higher Laser damage threshold with Air-gap design
- Laser damage threshold

※Pulse width:10ns, Frequency:20Hz ,reference value  
**0.09 J/cm<sup>2</sup> (266nm), 0.1 J/cm<sup>2</sup> (355nm)**  
**0.2 J/cm<sup>2</sup> (532nm)**

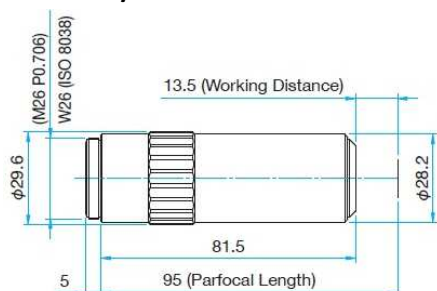


Typical Transmittance Data

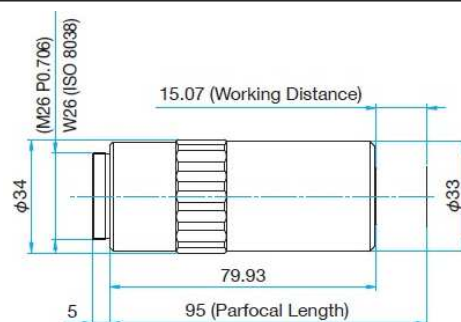


## Outline Drawing

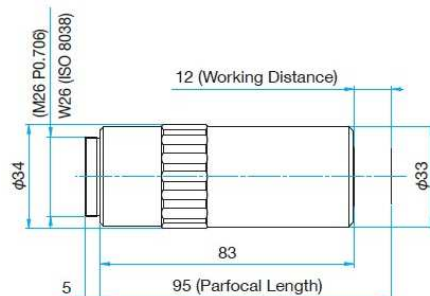
**PFL-10-UV/NUV-AG**



**PFL-20-UV/NUV-AG-A**



**PFL-50-UV/NUV-AG-A**



| Part Number        | Item name        | Magnification | Focal length [mm] | N.A. | Working distance (W.D.) [mm] | Resolution [μm] | Focal depth ±D.F.[μm] | Real field of View [mm] |             | Weight [kg] |
|--------------------|------------------|---------------|-------------------|------|------------------------------|-----------------|-----------------------|-------------------------|-------------|-------------|
|                    |                  |               |                   |      |                              |                 |                       | (Eyepiece φ24mm) [mm]   | (1/2" CCD)  |             |
| PFL-10-UV/NUV-AG   | MPlan UV/NUV 10x | 10x           | 20                | 0.2  | 13.5                         | 1.4             | 6.9                   | φ2.4                    | 0.48 x 0.64 | 0.3         |
| PFL-20-UV/NUV-AG-A | MPlan UV/NUV 20x | 20x           | 10                | 0.36 | 15.07                        | 0.76            | 2.1                   | φ1.2                    | 0.24 x 0.32 | 0.35        |
| PFL-50-UV/NUV-AG-A | MPlan UV/NUV 50x | 50x           | 4                 | 0.42 | 12                           | 0.65            | 1.6                   | φ0.48                   | 0.10 x 0.13 | 0.41        |

\*Resolution and focal depth are calculated value at wavelength of 0.55μm.

# Near Infrared Objective Lenses with Cover Glass thickness compensation

**PAL-NIR(780)**

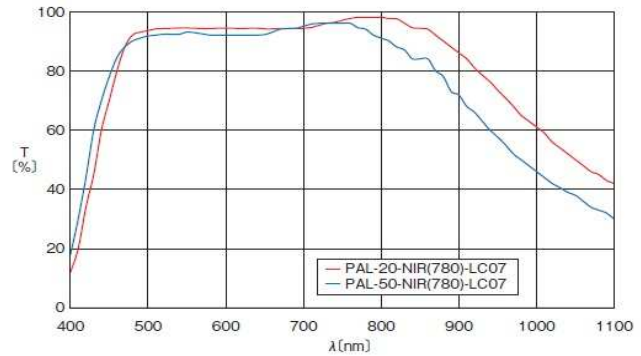
- Bright Field Inspection and Laser processing
- Infinity Corrected
- Plan Apochromat
- 780nm
- Laser damage threshold

※Pulse width:10ns, Frequency:20Hz, reference value

0.1 J/cm<sup>2</sup> (532nm), 0.15 J/cm<sup>2</sup> (780nm)

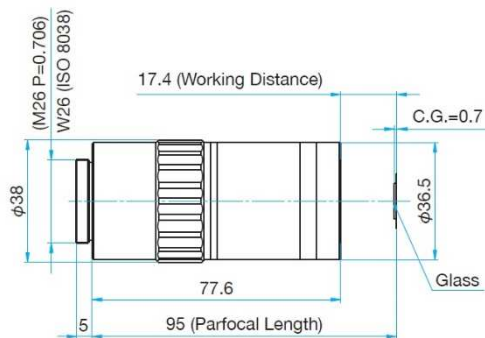


Typical Transmittance Data

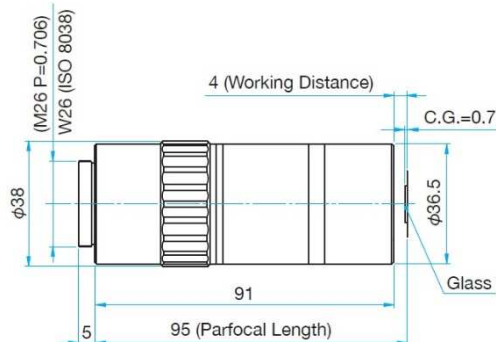


## Outline Drawing

### PAL-20-NIR(780)-LC07



### PAL-50-NIR(780)-LC07



| Part Number          | Item name                       | Magnification | Focal length [mm] | N.A. | Working distance (W.D.) [mm] | Resolution [μm] | Focal depth ±D.F[μm] | Real field of View [mm] |             | Weight [kg] |
|----------------------|---------------------------------|---------------|-------------------|------|------------------------------|-----------------|----------------------|-------------------------|-------------|-------------|
|                      |                                 |               |                   |      |                              |                 |                      | (Eyepiece φ24mm)        | (1/2" CCD)  |             |
| PAL-20-NIR(780)-LC07 | LCD MPlanApo NIR(780) 20x(t0.7) | 20x           | 10                | 0.45 | 17.2                         | 0.6             | 1.4                  | φ1.2                    | 0.24 x 0.32 | 0.34        |
| PAL-50-NIR(780)-LC07 | LCD MPlanApo NIR(780) 50x(t0.7) | 50x           | 4                 | 0.8  | 3.8                          | 0.3             | 0.4                  | φ0.48                   | 0.10 x 0.13 | 0.44        |

\*Resolution and focal depth are calculated value at wavelength of 0.55μm.

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# Tube Lenses

**TL-Y**

**RoHS**

**Catalog Code**

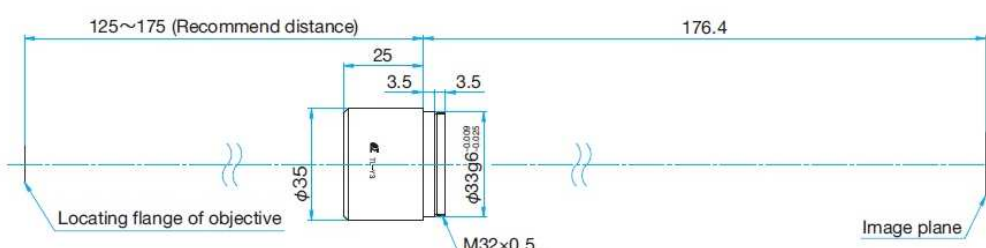
**W3462**



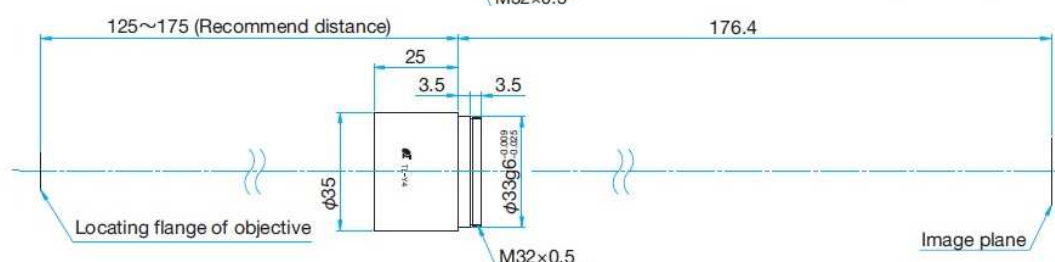
- Designed specifically for fundamental and harmonic wavelengths of YAG and Fiber lasers.
- Two types are available.
- TL-Y3 : Compatible with wavelengths from fundamental to 3rd harmonic.
- TL-Y4 : Compatible with wavelengths from fundamental to 4th harmonic.

## Outline Drawing

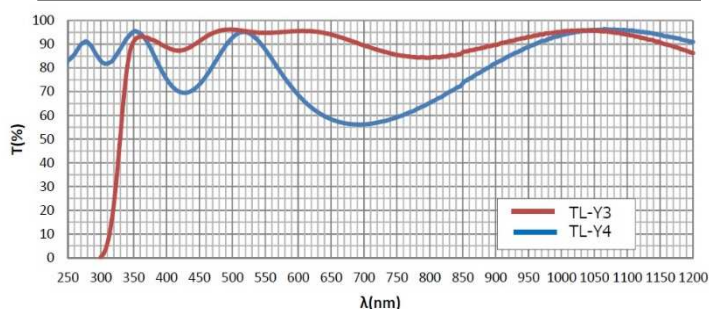
### TL-Y3



### TL-Y4



## Typical Transmittance Data



\*These tube lenses must be used by inputting collimated light from the end without threading. Inputting collimated beam from the threaded end results in large focusing spot size and blurred image due to large chromatic and spherical aberration.

\*Operating at unspecified wavelengths might result in large aberration and low transmittance.

| Part Number | Wavelengths                                              | Focal length [mm] | Imaging magnification | Entrance pupil [mm] | Image field size [mm] | Weight [kg] |
|-------------|----------------------------------------------------------|-------------------|-----------------------|---------------------|-----------------------|-------------|
| TL-Y3       | 343nm, 355nm, 515nm, 532nm, 1030nm, 1064nm               | 200               | 1x                    | φ11.0               | φ24                   | 0.055       |
| TL-Y4       | 257nm, 266nm, 343nm, 355nm, 515nm, 532nm, 1030nm, 1064nm | 200               | 1x                    | φ11.0               | φ24                   | 0.055       |

## Water immersion objective lens (Purified water)

Water immersion objective lens is filled with water between the objective lens and sample.

No spherical aberration is caused when there are water between the sample and cover glass. It is susceptible to the thickness error because of the increased refractive index difference between the cover glass and water



- High NA, water immersion objective lens
- Low aberration (Field curvature image height :  $<0.6\mu\text{m}$ )
- Magnification 20x 40x
- Application Observation of biological sample, bright observation required fluorescence imaging, etc.

\*Custom design available

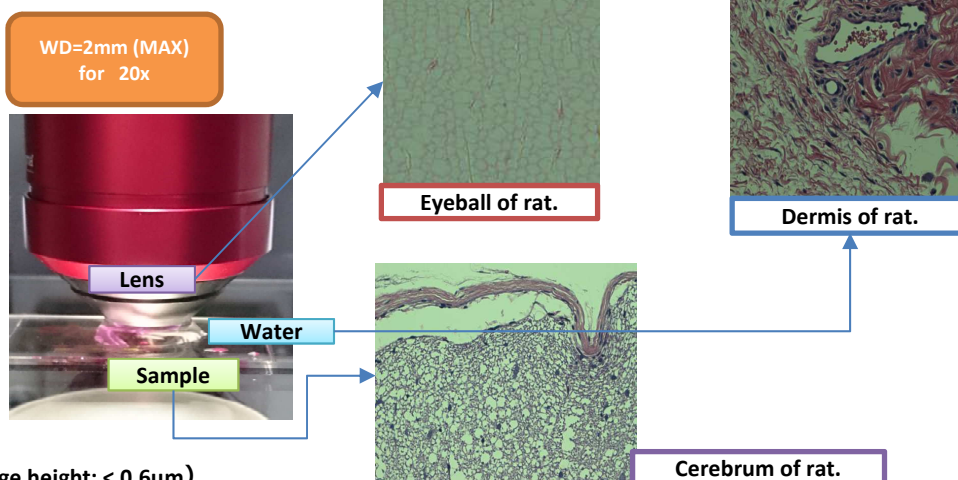
\*Oil immersion type also available.



| Product                 | 40x water immersion objective lens                  | 20x water immersion objective lens                  |
|-------------------------|-----------------------------------------------------|-----------------------------------------------------|
| Lens type               | Plan Apochromat                                     |                                                     |
| Wavelength              | Visible (400 - 700nm)                               |                                                     |
| Magnification           | 40x (tube lens $f=180\text{mm}$ )                   | 20x (tube lens $f=180\text{mm}$ )                   |
| NA                      | 1                                                   | 0.97                                                |
| Working distance (W.D.) | 0.3mm                                               | 2.0mm                                               |
| Resolution              | $0.34\mu\text{m}(\lambda=0.55\mu\text{m})$          | $0.35\mu\text{m}(\lambda=0.55\mu\text{m})$          |
| Focal length            | $\pm 0.28\mu\text{m}$                               | $\pm 0.29\mu\text{m}(\lambda=0.55\mu\text{m})$      |
| Transmittance           | $550\text{nm} \geq 85\%$ * $365\text{nm} \geq 45\%$ | $550\text{nm} \geq 87\%$ * $365\text{nm} \geq 25\%$ |
| Parfocal length         | 75.0mm                                              | 75.0mm                                              |
| Immersion               | Water immersion                                     |                                                     |
| Thread                  | M25 P=0.75                                          |                                                     |
| Field curvature         | $< 0.6\mu\text{m}$ (at maximum image height)        |                                                     |
| TWE                     | RMS : $< 70\text{m}\lambda$                         |                                                     |
| Weight                  | 0.5kg                                               | 0.4kg                                               |
| Others                  | Water proof and spring at tip end                   |                                                     |

## High performance lens unit

High performance lens unit with water immersion objective lens. Ideal to observe the thick sample, sample is apart from the cover glass or observe inside the sample.



- High NA (NA=1.0)
- Low aberration (field curvature image height:  $< 0.6\mu\text{m}$ )

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## Custom-made

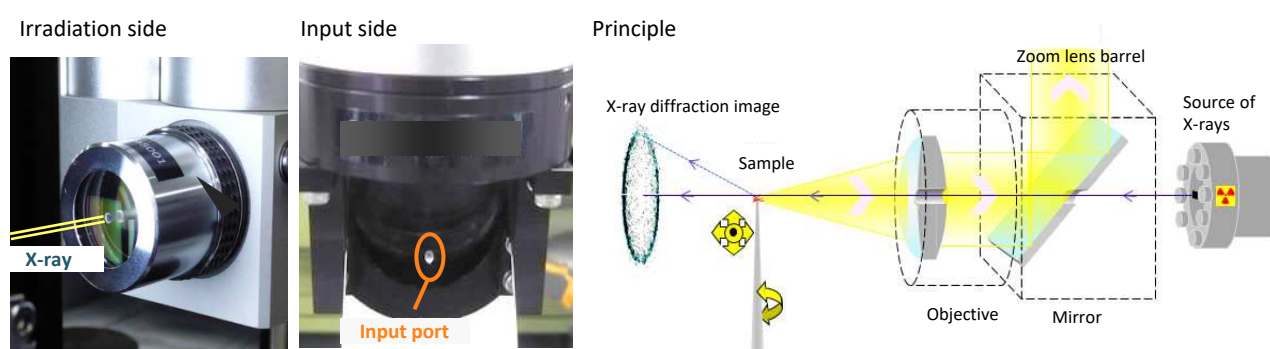
# X-ray Coaxial Zoom Observation System

When aligning microcrystals such as proteins in line analysis, a transmission hole is required at the center of the objective lens in order to irradiate X-rays simultaneously with observation.

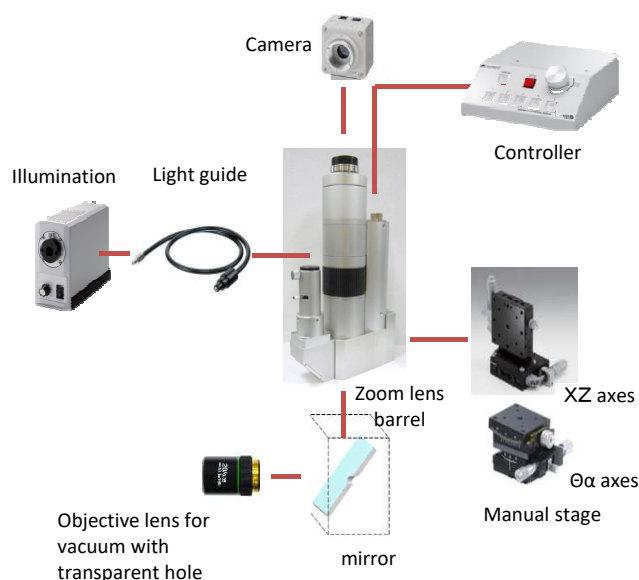
We offer integrated manufacturing from lens polishing to coating and assembly, so custom-made products for various objective lenses are available according to customer requirements.

It can also be used as an application using neutron beams or vacuum ultraviolet beams.

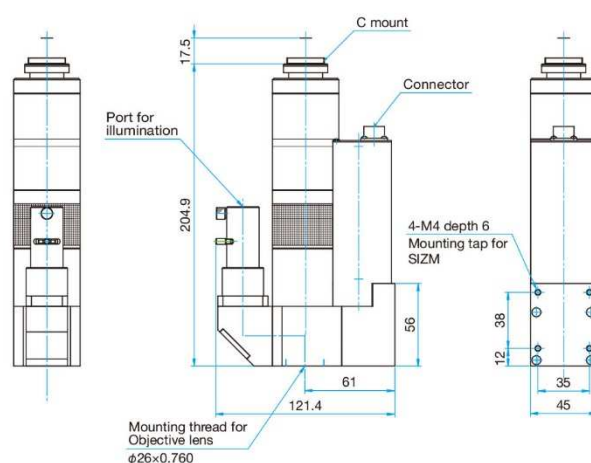
### ● Application example : X-ray coaxial zoom observation system with standard zoom lens barrel.



### System configuration example



### Outline drawing (Reference: Zoom lens barrel)



## Custom-made

# Objective Lens for Vacuum with Transparent Hole PLLW/PALLW



Objective lens for vacuum with transparent hole.

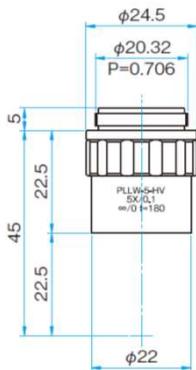
Stainless steel without surface treatment to prevent outgassing.

A through hole for degassing to discharge air between the lens at the side of the lens barrel.

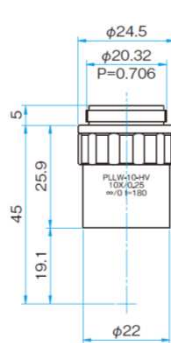
A transparent hole to transmit X-ray at the center of the hole. Objective lens for vacuum without transparent hole also available.

### Outline Drawing

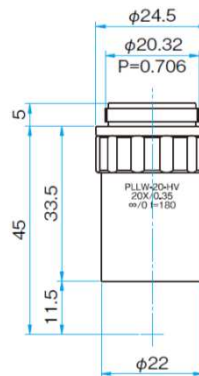
PLLW-5-HV



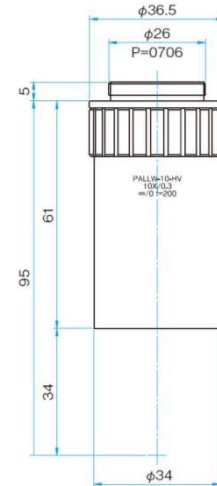
PLLW-10-HV



PLLW-20-HV



PALLW-10-HV



### Specs combined with Telecentric zoom microscope (SIZM)

| Part Number | Optical Magnification *1 | Hole dia.(cavity*2) [mm] | Focal length[mm] | Parforal length[mm] | Working distance (W.D.) [mm] | NA   | resolution [μm] | Image circle [mm] | FOV of camera (1/2 inch)*1[mm] |
|-------------|--------------------------|--------------------------|------------------|---------------------|------------------------------|------|-----------------|-------------------|--------------------------------|
| PLLW-5-HV   | 1.4 - 19.4               | φ1.5                     | 36               | 45                  | 22.5                         | 0.1  | 3.4             | φ5.2 - φ11        | X 3.7 - 0.33<br>Y 3.4 - 0.25   |
| PLLW-10-HV  | 2.8 - 38.8               | φ1.5                     | 18               | 45                  | 19                           | 0.25 | 1.4             | φ5.2 - φ11        | X 1.9 - 0.16<br>Y 1.7 - 0.12   |
| PLLW-20-HV  | 5.6 - 77.6               | φ1.5                     | 9                | 45                  | 11.5                         | 0.35 | 1               | φ5.2 - φ11        | X 0.93 - 0.08<br>Y 0.86 - 0.06 |
| PALLW-10-HV | 2.5 - 35                 | φ1.5                     | 20               | 95                  | 34                           | 0.3  | 1.2             | φ5.2 - φ11        | X 2.1 - 0.18<br>Y 1.9 - 0.14   |

\*1 Optical magnification is the magnification combined with zoom lens (SZL)

\*2 Field of view will be narrowed due to the performance for low magnification.

## Custom Lens Design

We support to design, manufacture and OEM supply of various kinds of custom lens based on our many years of experiences on optical design, polishing, coating and assembly technology.

### ■ Custom lens design example

- Large aperture fθ lens (scan area 180mm)
- Machine vision lens with mega-pixels
- Projection lens for exposure system
- objective lens for fs laser
- Variable spherical aberration correction objective lens
- Phase contrast microscope unit
- Differential interference microscope unit

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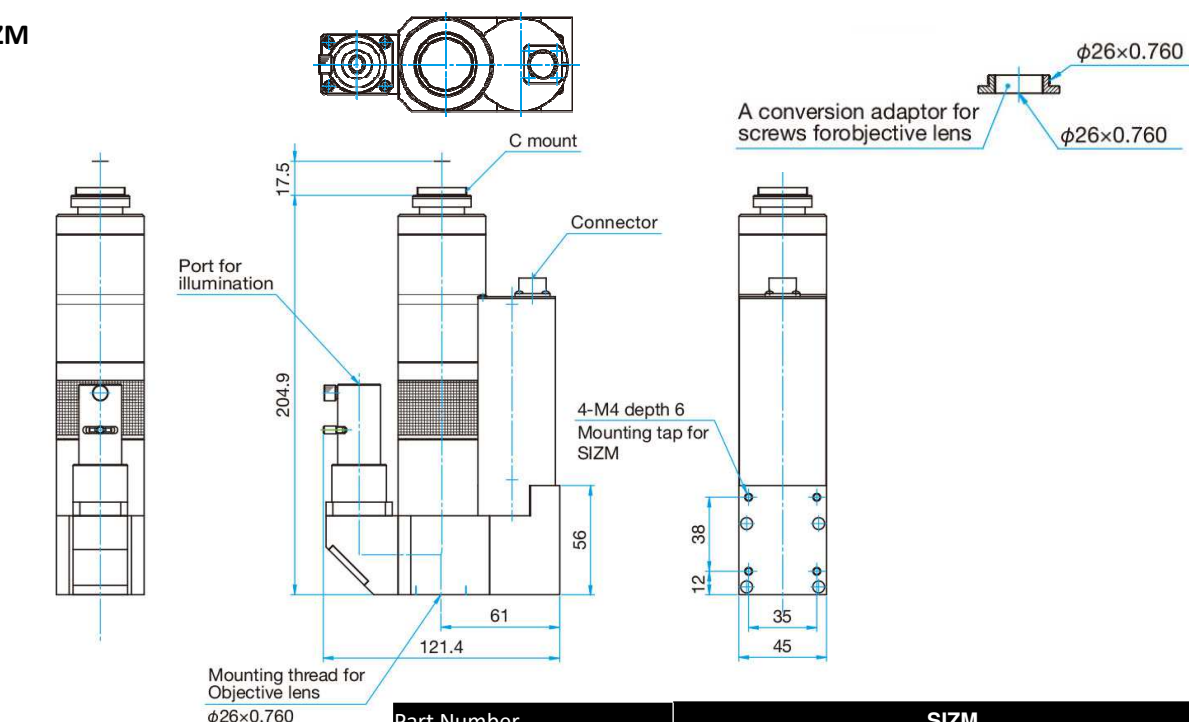
# Telecentric Zoom Microscope

**SIZM**
**RoHS**
**Catalog Code**
**W2067**

Infinity corrected type lens tube with zoom.

- Compact light body
- Zoom ratio: 14x
- C mount designed
- Equipped with a port for coaxial epi-illumination
- Infinity corrected objective lens can be used
- Motorized zooming type
- Compatible from low to high magnification

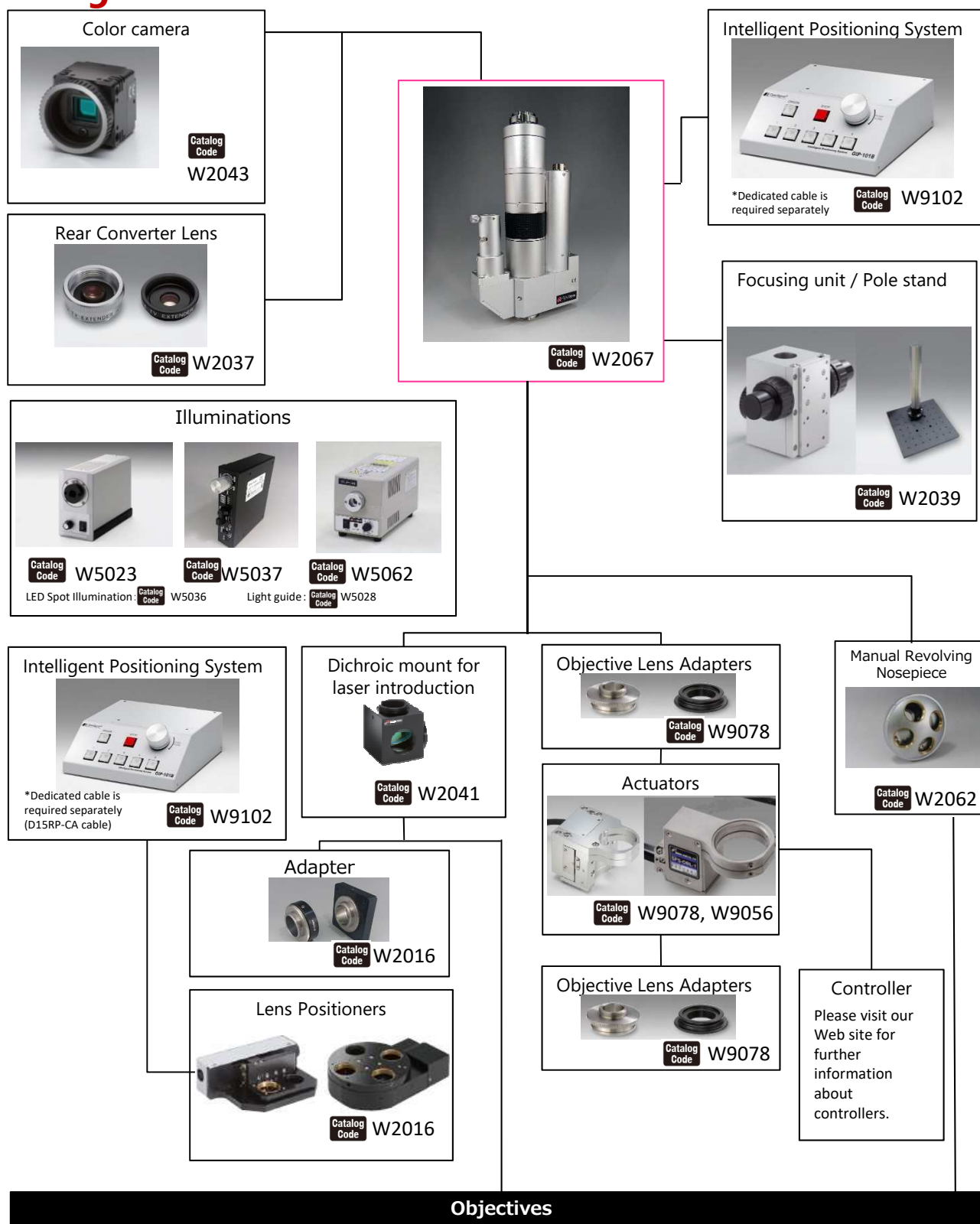
## Outline Drawing

**SIZM**


| Part Number                        | SIZM                                                                        |
|------------------------------------|-----------------------------------------------------------------------------|
| Manipulation for zoom              | Motorized by controller                                                     |
| Zoom ratio                         | 14                                                                          |
| Focal length [mm]                  | 50 - 700                                                                    |
| Type                               | Infinity correction                                                         |
| Corrected Wavelength range [nm]    | 400 - 700                                                                   |
| Image size [mm]                    | φ8 (for 1/2 inch sensor size)                                               |
| Camera Mount                       | C mount                                                                     |
| Illumination                       | Coaxial epi-illumination (standard)                                         |
| Mounting screws for objective lens | φ26 x 0.760<br>φ20.32 x 0.760<br>Please use the attached conversion adaptor |
| Outline Drawing [mm]               | 204.9 x 121.4 x 45                                                          |
| Weight [kg]                        | 1.5                                                                         |

\* Vignetting at four corners of the screen for the wide are zoom.

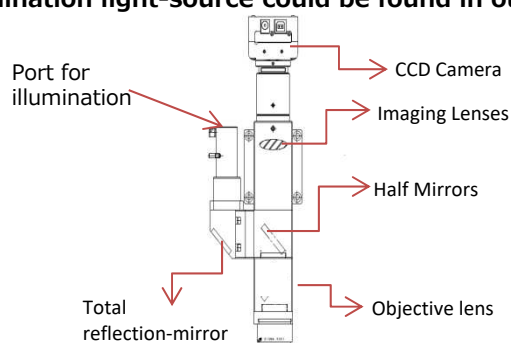
# Diagram



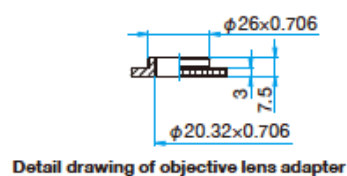
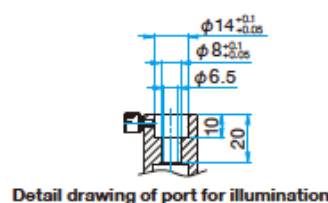
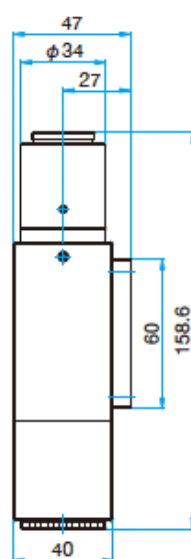
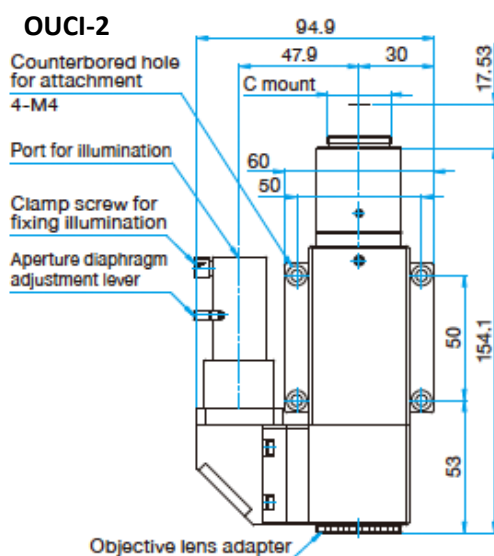
**Observation Unit with Coaxial Illumination****OUCI**   W2012

**This compact microscope is a customizable high performance imaging system for use in a wide range of applications from scientific research to industrial production equipment.**

- A wide variety of options is available for Infinity corrected optical systems.
- Optional parts such as translation stages or illumination light-source could be found in our catalog.
- Optional parts such as translation stages or Illumination light-source could be found in our catalog.



## Outline Drawing



| Part Number                    | OUCI-2                                         |
|--------------------------------|------------------------------------------------|
| Imaging lens focal length      | 1x (200mm)                                     |
| Observation image              | Bright field                                   |
| Camera mount                   | C mount (flange back 17.526mm)                 |
| Applicable camera illumination | less than 2/3 inch<br>Coaxial epi-illumination |
| Port for illumination          | Refer the drawing above                        |
| Applicable objective lens      | Infinity corrected objective lens              |
| Thread for objective lens      | φ26×0.706, φ20.32×0.706                        |
| Weight [kg]                    | 0.65                                           |

# Observation Unit with Coaxial Illumination with 2 Camera Port

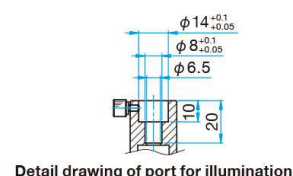
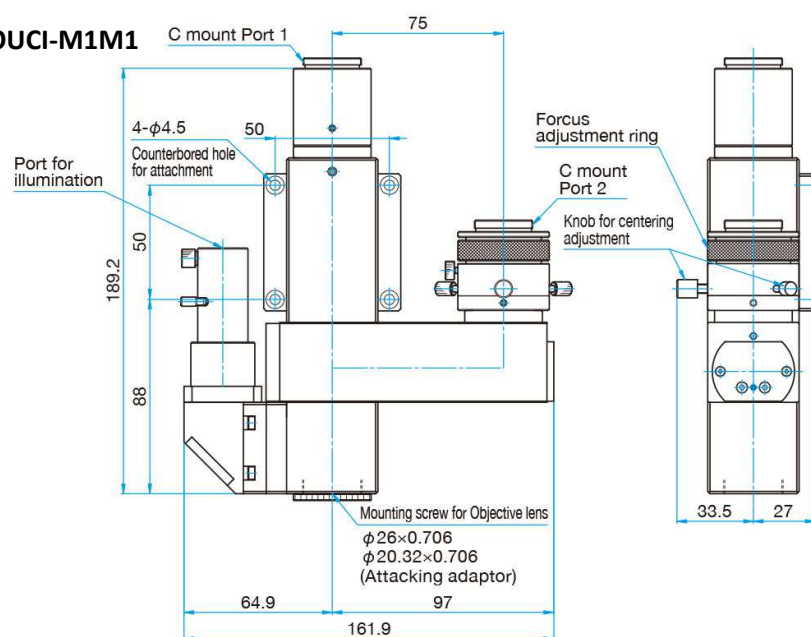
**OUCI-M1M1**
**RoHS**
**Catalog  
Code**
**W2012**

- Observation with coaxial illumination by 2 cameras is possible
- Possible to be combined with a large range of optional parts in accordance with its application.
- Optional parts such as translation stages or Illumination light-source could be found in our catalog.

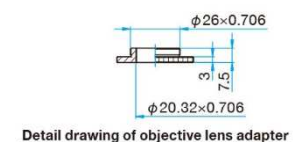


## Outline Drawing

### OUCI-M1M1



Detail drawing of port for illumination



Detail drawing of objective lens adapter

| Part Number               |        | OUCI-M1M1                         |
|---------------------------|--------|-----------------------------------|
| Imaging lens focal length | Port 1 | 1x (200 mm)                       |
|                           | Port 2 | 1x (200 mm)                       |
| Observation image         |        | Bright field                      |
| Camera mount              |        | C mount (flange back 17.526mm)    |
| Applicable camera size    |        | Less than 2/3 inch                |
| Illumination              |        | Coaxial epi-illumination          |
| Illumination port         |        | Refer the drawing above           |
| Applicable objective lens |        | Infinity corrected objective lens |
| Thread for objective lens |        | Φ26 x 0.706, φ20.32 x 0.706       |
| Weight[kg]                |        | 1.25                              |

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# Diagram



Visible

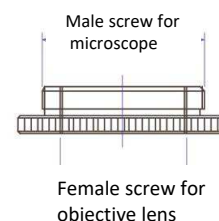
UV

NUV



Near-infrared

Custom-made



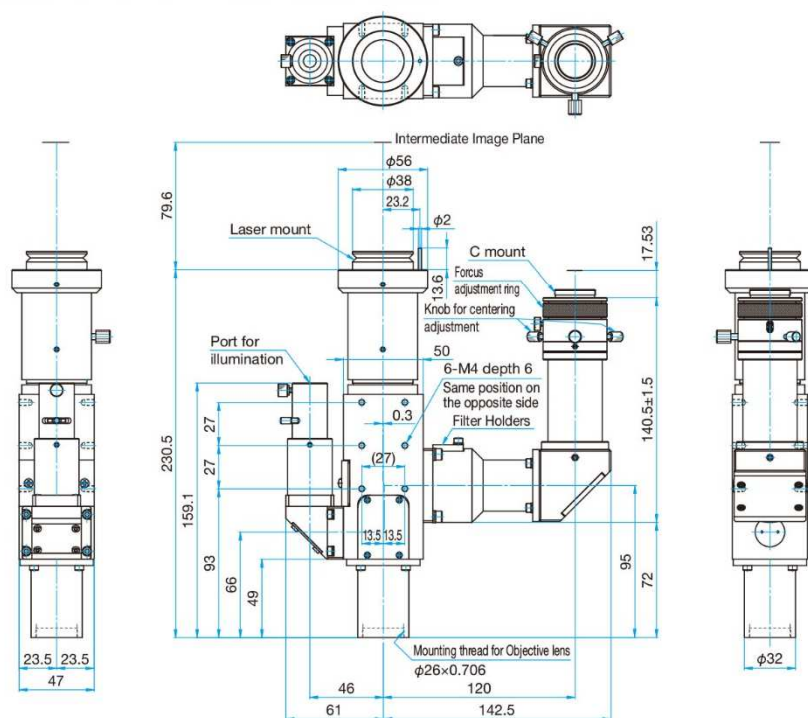
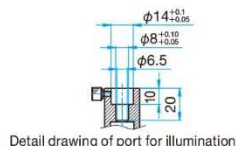
# Laser Processing Lens Barrel **OUCI-M1Y4** RoHS

Observation lens barrel with a laser port, camera port and illumination port.

- 4 wavelength compatible, 1064nm, 532nm, 355nm, 266nm
- Coaxial optical axis of observation and laser is ideal for incorporating into a laser processing machine
- Wide-field observation with 1 inch(diagonal 15.9mm) camera
- Various applications with out catalog products (sage, light source, etc.)

## Outline Drawing

### OUCI-M1Y4



| Part Number                   |                              | OUCI-M1Y4                                              |
|-------------------------------|------------------------------|--------------------------------------------------------|
| Laser port *1                 | Wavelength                   | 266nm・355nm・532nm・1064nm                               |
|                               | Focal length of tube lens    | 200mm (Magnification 1x)                               |
|                               | Mount                        | With focus adjustment function                         |
| Camera port                   | Wavelength                   | Visible (460 - 650nm) Magnification 1x                 |
|                               | Focal length of tube lens    | 200mm (Magnification 1x)                               |
|                               | Mount                        | C mount (with centering and focus adjustment function) |
|                               | Observation image            | Bright field, erect image                              |
|                               | Applicable camera            | 1 inch (diagonal 15.9mm), C-mount camera               |
|                               | Applicable size of filter *2 | Dia.25mm t=8.5mm or less                               |
| Illumination                  | Method                       | Telecentric illumination with aperture stop            |
| Objective lens mounting screw |                              | Dia.26 x 0.706                                         |
| Weight                        |                              | approx. 1.5kg                                          |

\*1 OUCI-M1Y4 is designed on the premise of diverging laser from the intermediate image. When the collimated light is input, the objective lens may be damaged by the laser focused inside the objective lens.

\*2 No filters are attached.

\*3 The camera may be damaged by the laser for 532nm due to the laser going around the camera. Please prepare a filter separately.

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## Option

### Dichroic mount for laser introduction **DIMC**

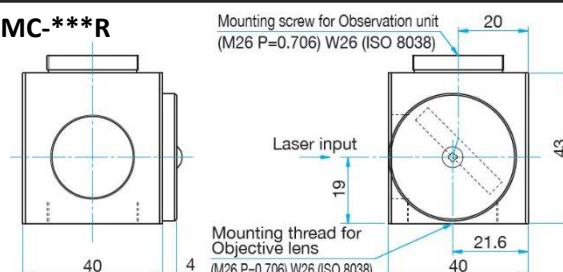
**RoHS** Catalog Code W2041

Allows the introduction of a laser beam into the optical path of the OUCI micrometer body products.



#### Outline Drawing

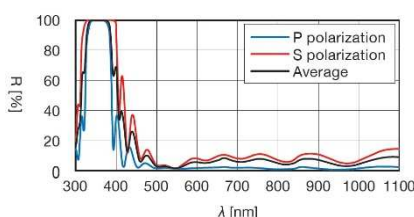
##### DIMC-\*\*\*R



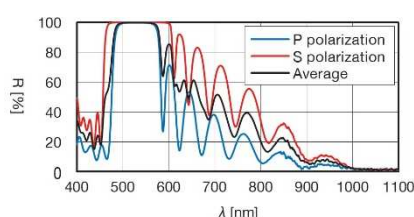
| Part Number | Wavelength Range [nm] | Input aperture [mm] | Reflectance [%] | Laser Damage Threshold [J/cm²]* |
|-------------|-----------------------|---------------------|-----------------|---------------------------------|
| DIMC-355R   | 355                   | φ10                 | >99.5 (355nm)   | 5 (355nm)                       |
| DIMC-532R   | 532                   | φ10                 | >99.5 (532nm)   | 8 (532nm)                       |
| DIMC-1064R  | 1064                  | φ10                 | >99.5 (1064nm)  | 20 (1064nm)                     |

\*Laser pulse width 10ns, repetition frequency 20Hz.

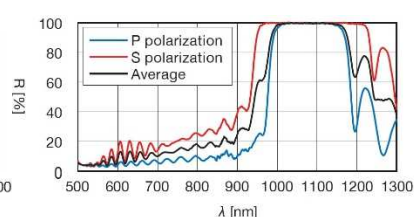
#### Spectral Distribution



DIMC-355R



DIMC-532R



DIMC-1064R

### Actuator for Objective Lenses

**SGSP-OBL**

**RoHS** Catalog Code W9078

### Piezo Actuator for Objective Lens

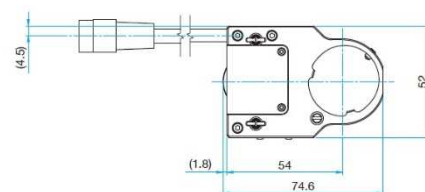
**SFS-OBL**

**RoHS** Catalog Code W9056

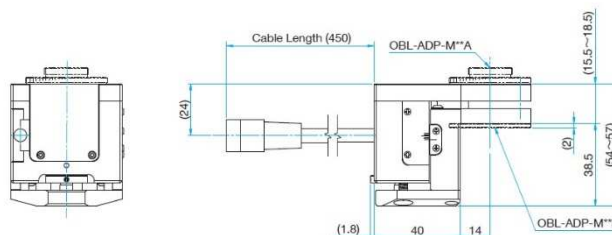


#### Outline Drawing

##### SGSP-OBL-3



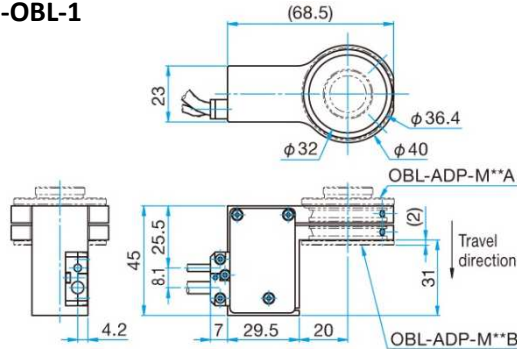
| Part Number                                     | SGSP-OBL-3     |
|-------------------------------------------------|----------------|
| Actuator                                        | Stepping Motor |
| Travel                                          | 3mm            |
| Resolution [FULL/HALF]                          | 1μm / 0.5μm    |
| Positioning Accuracy / Positional Repeatability | 5μm / 2μm      |
| Load Capacity [N]                               | 4.9 (0.5kgf)   |
| Weight [kg]                                     | 0.4            |



\*Optional adaptor should be needed when connect with a microscope or mount an objective lens. Please visit our Web site for further information.

## Outline Drawing

### SFS-OBL-1



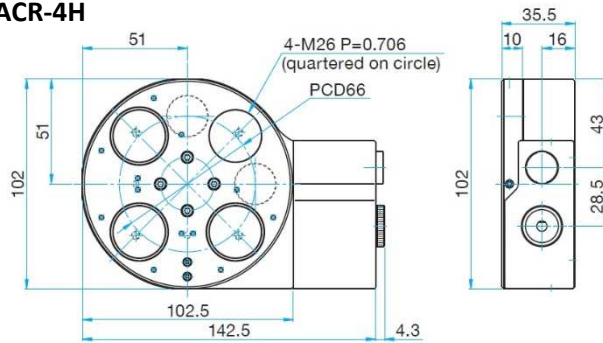
| Part Number                        | SFS-OBL-1                 |
|------------------------------------|---------------------------|
| Actuator                           | Piezo element             |
| Travel                             | 100μm ±15%                |
| Theoretical Resolution (open-loop) | 1nm [when using FINE-01]  |
| Resolution (closed-loop)           | 10nm [when using FINE-01] |
| Positional Repeatability           | <0.1μm                    |
| Weight [kg]                        | 0.15                      |

## Lens Positioners LACR/LACS

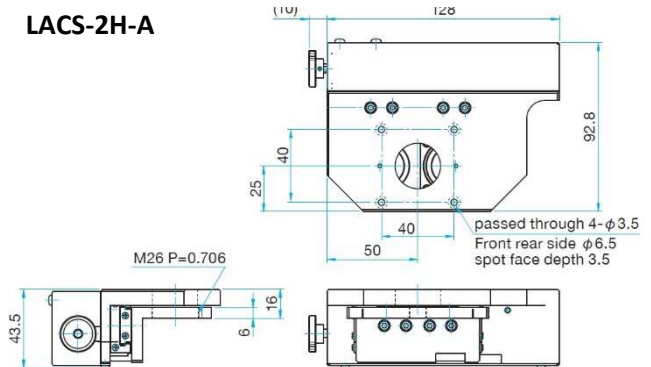
CE RoHS Catalog Code W2016

## Outline Drawing

### LACR-4H

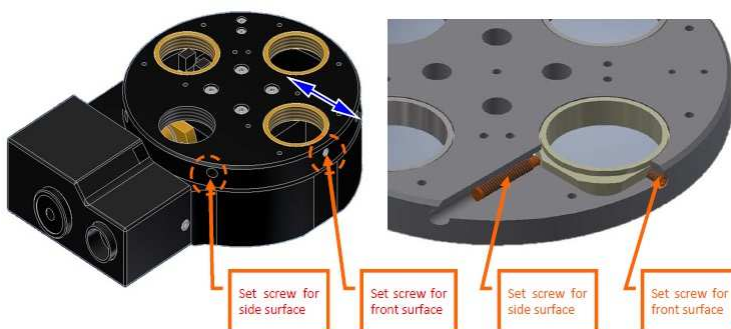


### LACS-2H-A



| Part Number               | LACR-4H                                                                              | LACS-2H-A                                                                   |
|---------------------------|--------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| Number of switched lens   | 4 holes (90° x4) (1hole: datum hole, 3holes: one-directional center core adjustment) | 2 holes (1hole: datum hole, 1holes: one-directional center core adjustment) |
| Motor                     | 5-phase stepping motor (0.75A/phase)                                                 | 5-phase stepping motor (0.75A/phase)                                        |
| Travel                    | ∞ for both of clockwise and anticlockwise directions                                 | 35mm                                                                        |
| Travel per 1 pulse        | 0.01° (FULL) / 0.0002° (1/50 DIV)                                                    | 2μm(FULL) / 0.1μm (20 divided)                                              |
| Positional repeatability  | ≤0.02deg                                                                             | —                                                                           |
| Switching reproducibility | ≤ ±3μm (at the tip of objective lens)                                                | ≤ ±3μm (by the tip of objective lens)                                       |
| Objective lens size       | φ26x0.706 [Option: φ20.32 x 0.706]                                                   | φ26x0.706 [Option: φ20.32 x 0.706]                                          |
| Weight [kg]               | 0.85                                                                                 | 0.7                                                                         |

## To align electric revolver (LACR-4H)



- 1) To adjust the angle in rotation the direction, adjust the number of pulses of the controller.
- 2) One-way center adjustment (blue arrow direction) can be performed as electric revolver.
- 3) By adjusting the M4 set screw on front/side, can adjust front/rear of about ± 0.3 mm.
- 4) Centering can be adjusted at three points with the same adjustment.

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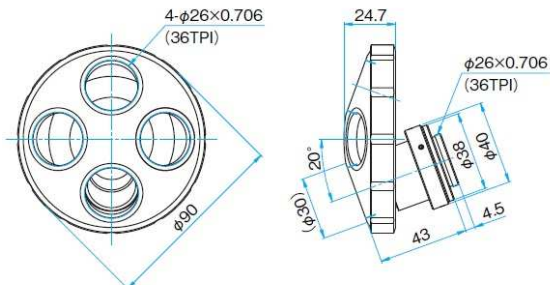
# Manual Revolving Nosepiece

## MLT-4H

Catalog Code W2062

### Outline Drawing

#### MLT-4H



It is compatible with our observation unit with coaxial illumination (OUCI-2) and can be fixed in place.

| Part Number                 | MLT-4H                                  |
|-----------------------------|-----------------------------------------|
| Number of switched lens     | 4 Holes (spaced at 90 degree intervals) |
| Observation Method          | Bright field Observation                |
| Compatible Objective Thread | φ26 x 0.706 (36 threads per inch)       |
| Compatible Barrel Thread    | φ26 x 0.706 (36 threads per inch)       |
| Weight [kg]                 | 0.57                                    |

# C mount adapter

## CACM

RoHS Catalog Code W2042



It is used for centering with C mount camera , or for focus adjustment.  
(Can be attached to OUCI-2 or two port type observation unit with coaxial illumination.)

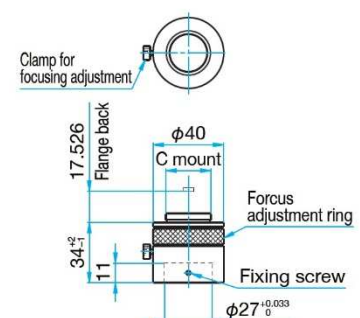
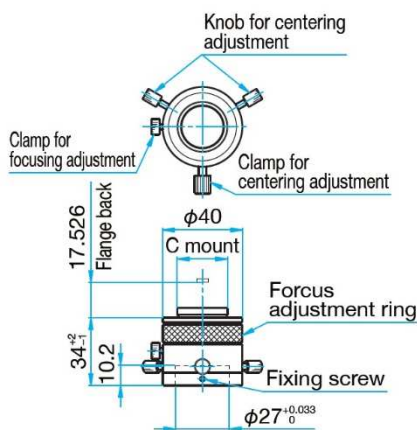
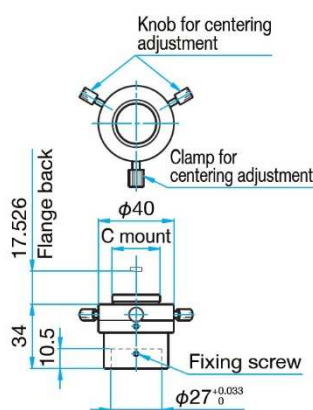
| Part Number                     | CACM-1 | CACM-2 | CACM-3 |
|---------------------------------|--------|--------|--------|
| Centering adjustment range [mm] | φ0.2   | φ0.2   | —      |
| Focusing Adjustment range [mm]  | —      | 3      | 3      |
| Weight [kg]                     | 0.1    | 0.11   | 0.08   |

### Outline Drawing

#### CACM-1

#### CACM-2

#### CACM-3



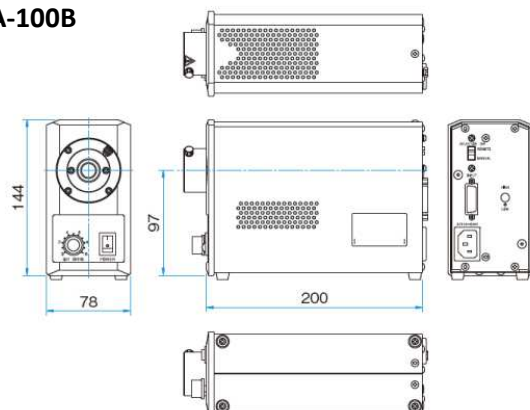
## LED Light Source Device

## SLA-100B

Catalog Code W5023

### Outline Drawing

#### SLA-100B



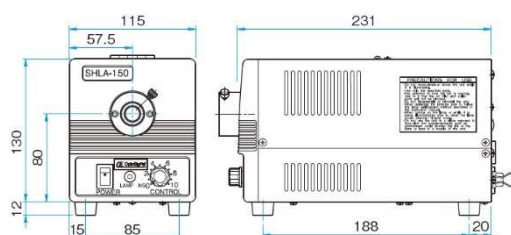
|                    |                      |
|--------------------|----------------------|
| Part Number        | SLA-100A             |
| Luminescence color | White light          |
| Power Consumption  | 20W [AC100-240V±10%] |
| Weight [kg]        | 2.0                  |

## Halogen Light Source Illuminating Systems SHLA-150

Catalog Code W5062

### Outline Drawing

#### SHLA-150



|                   |                         |
|-------------------|-------------------------|
| Part Number       | SHLA-150                |
| Color Temperature | 3,100K - 3,200K         |
| Power Consumption | 180W [AC100 - 120V±10%] |
| Weight [kg]       | 2.6                     |

## Light Guides

## MSL

Catalog Code W5028

RoHS



|             |                   |           |
|-------------|-------------------|-----------|
| Part Number | MSL-1000F         | MSL-1500F |
| Type        | Straight flexible |           |
| Coating     | Tube              |           |
| Length [mm] | 1,000             | 1,500     |

## Others

Catalog Code W2039



Focusing unit

Pole stand

Various types are available.  
Please visit our Web site for further information.

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## LED Spot Illumination **SLSI**

Catalog Code **W5036**

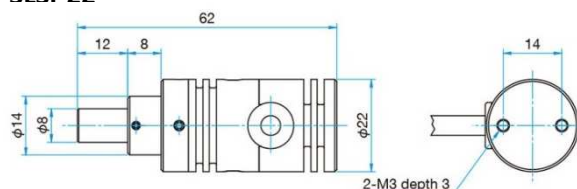
It is suit for being used with an observation unit or microscope which has coaxial illumination. There are four types of variation : White, Red, Green and Blue.



- Useful for coaxial epi-illumination for our zoom microscope, ultra long working distance zoom microscope, observation unit with coaxial illumination, and various telecentric lenses.
- Useful for spot illumination.
- Extension cable (Option : FCB/FRCB series) are available. Catalog Code W5047
- Light guide for LED spot illumination (Option : S1/S2 series)
- An adaptor for Light guide is available (Option : AD-0808). After connect with LED spot illumination, it can realize Ring illumination or Line illumination

### Outline Drawing

SLSI-22\*



| Part Number | Luminescence Color | Maximum Rated Current [A] | Weight [kg] |
|-------------|--------------------|---------------------------|-------------|
| SLSI-22W    | White ○            | 0.7                       | 0.04        |
| SLSI-22R    | Red ●              | 0.7                       | 0.04        |
| SLSI-22G    | Green ●            | 0.7                       | 0.04        |
| SLSI-22B    | Blue ●             | 0.7                       | 0.04        |

## Power Supply for LED Spot Illumination **SPS-SLSI**

Catalog Code **W5037**

SPS-SLSI is a power supply for LED Illuminations. It features a palm-size slim body capable of being mounted on a DIN rail.

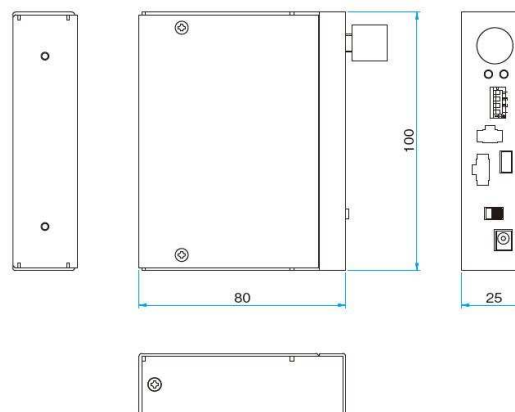
In addition, it allows dimming by volume or USB control.



- Easy connection to the spot light and brightness control. Adapter available for connection to DIN rail.
- LED ON/OFF and brightness control are possible by PC with USB interface.
- Flash function is available with external trigger input.

### Outline Drawing

SPS-SLSI



| Part Number                               | SPS-SLSI                                                                         |
|-------------------------------------------|----------------------------------------------------------------------------------|
| Controllable Number of LED                | 1ch                                                                              |
| Power Voltage                             | AC100 - 240V ± 10%                                                               |
| Apparent Power                            | 30VA                                                                             |
| Operating Temperature/Storage Temperature | 5 - 40°C/ -20 - 60°C                                                             |
| Functions                                 | Dimming by volume control, USB control, flash operation, external gate operation |
| External Output                           | Output for LED                                                                   |
| Interface                                 | USB (Mini-B type) USB1.1 compliant<br>Trigger (Gate) Input Connector             |

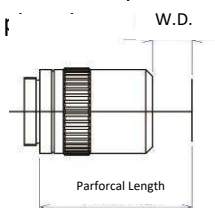
## Technical Data

### 1. Parfocal Distance

The parfocal distance is the distance from the mounting shoulder of the objective to the focal plane where the specimen or cover glass is placed at. The parfocal distance of EPL/EPL series objectives is 45mm and it is 95mm for other objectives.

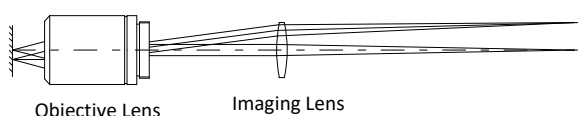
### 2. W.D. (Working Distance)

The working distance is the distance from the vertex of the objective lens to the focal plane where the specimen or cover glass is placed.



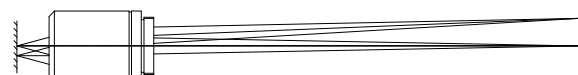
### 3. Infinity-Corrected Optical System

In the infinity-corrected optical system, the object is imaged by objective and the imaging lens. The collimated beam between the objective and the imaging lens allows the beam splitters or filters to be introduced into the optical path.



### 4. Finite Optical System

In the finite optical system, the object is imaged by objective only.



### 5. Focal Length and Magnification of Objective

The optical magnification of infinity-corrected optical system is given by the ratio of focal length of imaging lens to that of the objective.

$$\text{Objective Magnification} = \frac{\text{Focal Length of Imaging Lens}}{\text{Focal Length of Objective}}$$

### 6. Field Number and Field of View

The field size in the specimen plane of the microscope is controlled by the size of the field stop inside the eyepiece. The diameter of the field stop measured in millimeters is called field number of eyepiece.

The field size which can be viewed through eyepiece is expressed as

$$\text{Field of View (Diameter)} = \frac{\text{Field Number of Eyepiece}}{\text{Objective Magnification}} \text{ (mm)}$$

The field size displayed on the TV monitor is expressed as

$$\text{Field of View (W} \times \text{H)} = \frac{\text{Size of Image Sensor (W} \times \text{H)}}{\text{Objective Magnification}}$$

• Common image sensor sizes

| Format | Diagonal | Width | Height |
|--------|----------|-------|--------|
| 1/3"   | 6.0mm    | 4.8mm | 3.6mm  |
| 1/2"   | 8.0mm    | 6.4mm | 4.8mm  |
| 2/3"   | 11.0mm   | 8.8mm | 6.6mm  |

### 7. Monitor Magnification and Magnification on Monitor

Monitor magnification and magnification on the TV monitor are expressed as

$$\text{Monitor Magnification} = \frac{\text{Monitor Size (Diagonal)}}{\text{Image Sensor Size (Diagonal)}}$$

Magnification on Monitor = Objective Magnification

\*Monitor Magnification

### 8. N.A. (Numerical Aperture)

Numerical aperture is expressed as

$$\text{N.A.} = n \times \sin \theta$$

where n is the refractive index of the medium between the specimen and objective (n = 1.0 in air),  $\theta$  is the angle between a marginal ray and the axis. The resolving power, the depth of focus, and the brightness of the microscope are determined by the NA of the objective.

### 9. Resolving Power

Resolving power is the ability to resolve two points which are close together at object surface. It is determined by the objective N.A. and the operating wavelength (generally 0.55μm for visible light) and can be given by the Rayleigh criterion:

$$\text{Resolving Power (r)} = 0.61 \times \frac{\text{Lambda}}{\text{N.A.}}$$

However, two points separated by

$$0.5 \times \frac{\lambda}{\text{N.A.}}$$

can be barely resolved by Sparrow criterion.

The larger the N.A., the higher the resolving power.

## 10. D.F. (Depth of Focus)

When the specimen is being focused, the image may be shifted longitudinally somewhat and this will not introduce unacceptable blur. The amount of such shift is called depth of the focus.

The abilities of the human eye's focus adjustment vary widely from individual to individual. This results in the variation of the depth of focus when an eyepiece is used for observation. Berek's formula which gave good agreement with the experiments is presently used to express the depth of focus

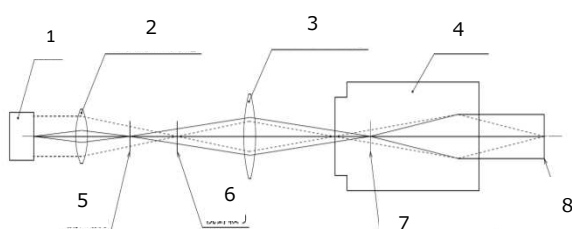
$$\text{Depth of Focus } \pm D = \frac{\omega \times 250000}{N.A. \times M} + \frac{\text{Lambda}}{2 \times N.A.}$$

(Berek's formula)

Where  $\omega$  is resolving power of eye (0.0014 when the visual angle of the eye is 5 arcmins), N.A. is numerical aperture of objective, M is total magnification (=Objective Magnification \* Eyepiece Magnification), Lambda is operating wavelength (0.55 $\mu$ m for visible light), and 250000 is distance of distinct vision.

## 11. Kohler Illumination

Kohler illumination is an optical system that provides uniform illumination over the specimen plane. The light source is imaged at aperture stop of the condenser lens and then relayed to the exit pupil of the objective. Therefore the specimen plane is uniformly illuminated with the light source at infinity.



- |                   |                                       |
|-------------------|---------------------------------------|
| 1: Light Source   | 6: Field Stop                         |
| 2: Condenser Lens | 7: Objective Lens exit pupil position |
| 3: Condenser Lens | 8: Plane of a Specimen                |
| 4: Objective lens |                                       |
| 5: Aperture Stop  |                                       |

## - Field Diaphragm

The field diaphragm is used to block the illumination outside the field of view. This serves to eliminate excess incident light and prevent glare.

## - Aperture Stop

Aperture stop is used to adjust the N.A. of the light for the illuminating. Usually, a good balance between the resolving power and contrast can be achieved by adjusting the diameter of the aperture stop to 80% of the pupil diameter.

## 12. Pupil Diameter of the Objective

The maximum diameter of a collimated light beam that can enter from the rear side of the objective along optical axis is called pupil diameter of an objective. It is given by

$$\text{Pupil Diameter} = 2 \times f \times N.A.$$

Where  $f$  is the focal length of objective and N.A. is the numerical aperture respectively.

## 13. Spot Diameter Focused by the Objective

When a collimated laser beam with flat intensity across the field enters the objective from the rear side, the focused spot size can be roughly given as

$$\text{Spot Diameter} = 1.22 \times \frac{\text{Lambda}}{N.A.}$$

Where Lambda is wavelength and N.A. is the numerical aperture of objective.

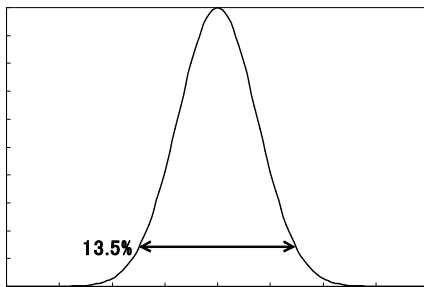
The intensity distribution of the focused spot is given by besell function and the spot diameter is equal to the diameter of the first dark ring (Airy disk).

## 14. Gaussian Beams

The laser beam intensity has Gaussian distribution that is rotationally symmetric about the central axis (optical axis). The radius at where the beam intensity decreases by the factor  $1/e^2$  (13.5%) with respect to the peak value on the beam axis is called beam radius.

$$I(r) = I_0 e^{-2r^2/w^2}$$

where  $I_0$  is the peak intensity,  $w$  is beam radius, and  $r$  is the radial distance



## 15. Beam Waist and Divergence Angle

There is a minimum beam diameter also called the beam waist somewhere between the two mirrors of a laser resonator. The wavefront is planar at beam waist and curved away from the beam waist due to effects of diffraction. The beam width increases monotonically with distance  $z$  from the beam waist and can be expressed as

$$w(z) = w_0 \left[ 1 + \left( \frac{\lambda z}{\pi w_0^2} \right)^2 \right]^{1/2}$$

where  $w_0$  is the radius of beam waist and  $\lambda$  is the wavelength.

when  $z$  is large and  $w_0$  is small

$$w(z) \approx \frac{\lambda}{\pi w_0} \times z$$

The divergence angle is inversely proportional to the waist diameter.



## 16. Focusing of Gaussian Beam

When a Gaussian beam is focused by a lens placed sufficiently far away from the beam waist, the focusing spot diameter can be expressed as the equation below. The lens must have an aperture diameter larger than twice the beam diameter to keep Gaussian intensity distribution over focusing spot.

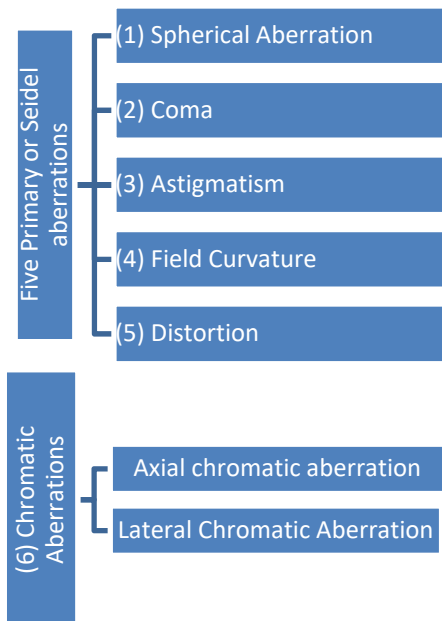
$$\text{Spot Diameter } \varphi = 2 \times \frac{\lambda \times f}{\pi w(s)}$$

where  $\lambda$  is the wavelength of the laser,  $f$  is the focal length of the lens,  $s$  is the distance from the beam waist, and  $w(s)$  is the incident beam radius on the lens.

## 17. The Lens Aberrations

Aberrations that affect imaging performance can be classified as following.

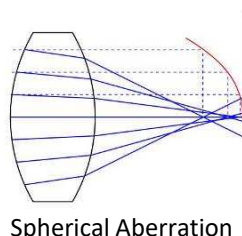
Five Primary or Seidel aberrations



Aberrations (1)-(3) affect the size and shape of the point spread function. Aberrations (4)-(5) deform the image. Aberration (6) is wavelength dependent aberration.

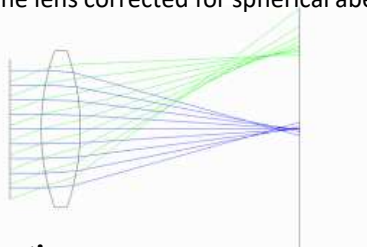
### (1) Spherical Aberration

Rays issued from an on-axis source at infinity do not all converge at the same point and the focus of the marginal rays is different from the focus of the paraxial rays. The larger the incident beam diameter, the larger the effect of spherical aberration.



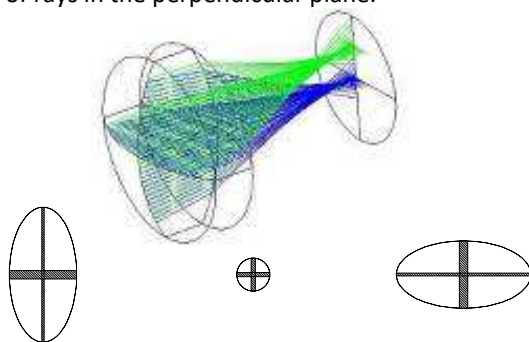
### (2) Coma

Aberration which causes the image of an off axis point object to be deformed like a comet tail is called coma. Aplanat is the lens corrected for spherical aberration and coma.



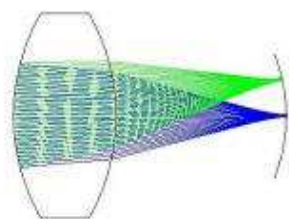
### (3) Astigmatism

The focus of rays in the plane containing the system axis and an off-axis object point is different from the focus of rays in the perpendicular plane.



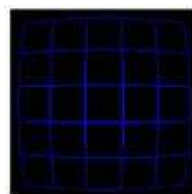
### (4) Field Curvature

Field curvature causes a planar object perpendicular to the system axis to have curved image plane. Usually, both the object and the image sensor are plane and field curvature must be corrected to obtain focused image from the center to the edges.

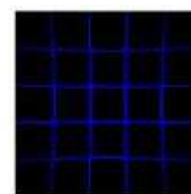


### (5) Distortion

The shape of the image does not match with that of the object and shows difference depending upon the position in the field. Such monochromatic aberration is called distortion. In a lens without distortion, the image height is given by  $f \times \tan \theta$ , where  $f$  is the focal length of the lens and  $\theta$  is the angle of incidence. In a lens with distortion, the image points shift from their ideal height. F-theta lenses are designed to have deliberate distortion so that the image height is proportional to the scanning angle  $\theta$  rather than  $\tan \theta$ .



Barrel Distortion



Pincushion Distortion

### (6) Chromatic Aberrations

Light of different wavelengths is focused at different points along the optical axis is called axial chromatic aberration, and the image size varies with the wavelength is called lateral chromatic aberration.

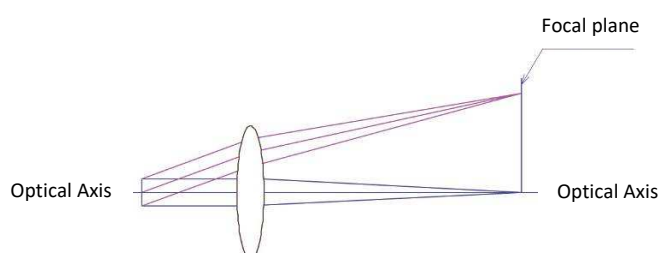
achromat and apochromat are objectives in which chromatic aberration is corrected for two wavelengths and three wavelengths respectively.

### 18. Cover Glass Thickness Compensation

The cover glass between the objective and the object can introduce spherical aberration and reduce imaging performance. By use of an objective which is designed to be corrected for spherical aberration for a specific cover glass thickness, microscope observation or laser processing through the cover glass can be achieved.

## 19. F-theta Lens

An f-theta lens is designed to produce constant linear scan velocity over its focal plane when the incident laser beam is turned under constant angular velocity by use of the polygon-mirror or the galvano-mirror. The angle of the incident chief ray upon the focal plane increases with that of the incident scan beam upon the lens. F-theta lenses are commonly used in the applications such as laser printer and laser marker.



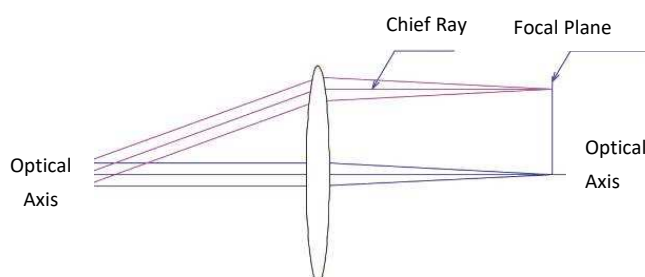
## 20. Telecentric F-theta Lens

Such f-theta lens is designed to let the chief ray of the scanning laser beam output from the lens be parallel with the axis. The chief ray of the laser beam with any incident angle upon the lens always strikes the focal plane normally.

The using of a non-telecentric f-theta lens for laser drilling may result in the tilted axis of the hole at the position away from the axis of the lens. The axis of the hole is still normal to the focal plane when a telecentric f-theta is used.

Telecentric f-theta lens provides a perpendicular angle of the laser beam onto the focal plane. This means that the size of the lens at the output side must be larger than the scan area so that a telecentric f-theta lens is usually larger and heavier than a non-telecentric f-theta lens.

Telecentric f-theta lenses are commonly used in the applications such as via hole drilling and cutting.



## 21. Maximum Input Beam Diameter

This spec gives the maximum beam diameter incident to the f-theta lens. To achieve designed performance at the focal plane, the input beam diameter must be smaller than this value. The maximum input beam diameter of our f-theta lenses is defined as the beam diameter measured at  $1/e^2$  of the peak intensity.

## 22. Entrance Pupil

The scanning element such as galvano-mirror and polygon-mirror is positioned at the entrance pupil of the scan lens.

## 23. Maximum Scan Angle

This spec gives the maximum angle (optical angle) of the incident laser beam upon the f-theta lens.

## 24. Telecentricity Error

The chief ray emerges from a telecentric lens is ideally normal to the focal plane. Actually, it often deviates from the focal plane normal depending on the lens performance or the scanner position. The deviation (calculated value) is expressed as telecentricity error. For our f-theta lenses, it is defined assuming that the galvano scanner is placed at the given mirror distance.

## 25. Scan angle and Scanning Range

Scanning range of an f-theta lens is mathematically expressed as

$$y = f \times 2\theta$$

where  $y$  is ideal image height (mm),  $f$  is the focal length (mm), and  $\theta$  is the angle of scanned (rad)

## 26. Laser Damage Threshold

The laser damage threshold is defined as the highest fluence at which the extrapolated probability of damage caused by the laser irradiation is zero.

The laser damage threshold of our products was tested based on 200-on-1 testing procedure according to the international ISO 21254 standard. 200-on-1 test is a testing procedure that uses 200 shots of laser radiation on each unexposed site on the target optical component to confirm whether this causes damage or not. Another test procedure, called 1-to-1 test (one shot of laser radiation on each unexposed site), is adopted by some manufacturers. However, in most cases, continued laser irradiation is required and 1-to-1 test finishes before the occurrence of damage. Therefore, we adopt 200-on-1 test which is more practical.

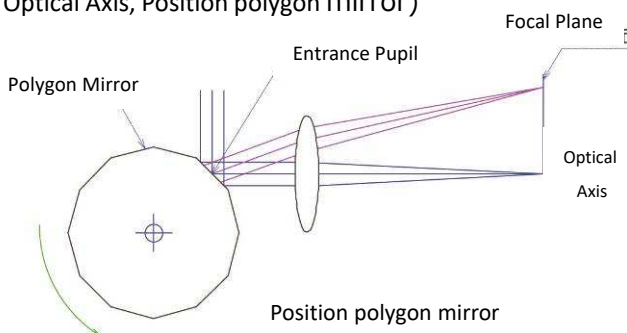
The laser damage threshold tests of the antireflection (AR) coating on our f-theta lenses were done under the following laser condition: TEM<sub>00</sub> Mode, 10ns, 20Hz, AOI=0 Deg., Linear Polarization. Please note that the laser damage threshold is a tested value but not a guaranteed value.

For a proper evaluation of the laser damage threshold, the laser operating environment and the laser characteristics such as the pulse width, the repetition rate, and the state of polarization should be considered.

## 27. Position Polygon Mirror

In the case of one-dimensional scanning, the polygon mirror or one-axis galvano mirror is placed at the entrance pupil of the scanning lens.

(Figure: Polygon Mirror, Entrance Pupil, Focal Plane, Optical Axis, Position polygon mirror)

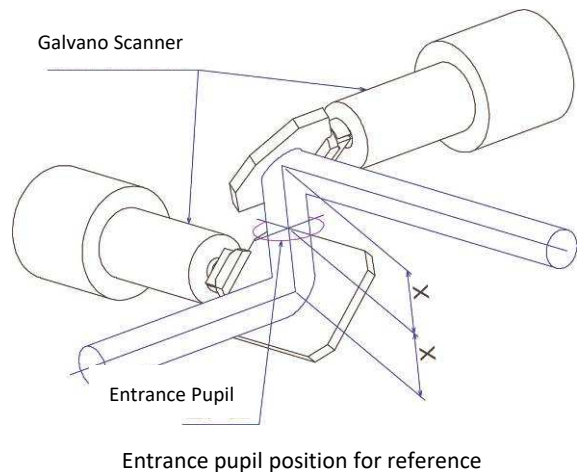


## 28. Galvano Scanner and Displacement between the Galvano Mirrors

A two dimensional laser scan at the focal plane of a scanning lens is commonly achieved by use of galvano scanner.

In order to get the full design performance, the mirror should be positioned at the entrance pupil of the f-theta lens. However, this is physically impossible because there are two mirrors. While the small changes in f-theta characteristics, field curvature, and telecentricity might be introduced, placing the two mirrors symmetrically with respect to the entrance pupil, and keeping them as close as possible may help to get best performance.

Using the f-theta lenses outside the given maximum input beam diameter and mirror displacement specifications may result in undesired effect.



## F-theta Lens

Most lenses follow the relationship that the image height  $y$  at the focal plane is equal to  $f \times \tan \theta$ , where  $f$  is the focal length of the lens and  $\theta$  is the angle of laser beam upon to the lens. On the other hand, the f-theta lenses follow the relationship of  $y = f \times \theta$ .

In the former case,  $y$  is approximately proportional to  $\theta$  at small incident angle only.

By intentionally introducing a negative or barrel distortion, in the latter case,  $y$  is still proportional to  $\theta$ . Therefore, without applying the electronic compensation, the scanning system produce constant linear scan velocity over full focal plane of f-theta lens when the incident laser beam is turned under constant angular velocity by use of the polygon-mirror or the Galvano-mirror.

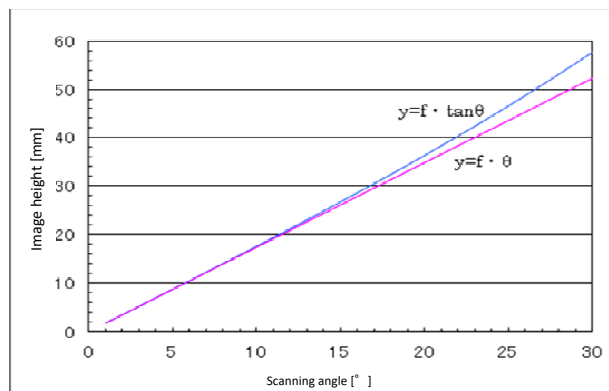


Image height vs. Scan angle (f=100)

## RoHS

### About our RoHS notation along with the revised "RoHS 2.0 Directive"

The substances prohibited by RoHS 2.0 will be changed to 10 substances from 6 substances with the revised RoHS Directive (RoHS 2.0) from July 22nd, 2019.

Four kinds of phthalate substances will be additionally prohibited as below.

| Prohibited substances                 | Regulatory threshold | Note                 |
|---------------------------------------|----------------------|----------------------|
| Lead                                  | Less than 1,000ppm   |                      |
| Mercury                               | Less than 1,000ppm   |                      |
| Hexavalent chromium                   | Less than 1,000ppm   |                      |
| Polybrominated biphenyls (PBB)        | Less than 1,000ppm   |                      |
| Polybrominated diphenyl ethers (PBDE) | Less than 1,000ppm   |                      |
| Cadmium                               | Less than 100ppm     |                      |
| Bis(2-ethylhexyl)phthalate (DEHP)     | Less than 1,000ppm   | Additional substance |
| Butyl benzyl phthalate (BBP)          | Less than 1,000ppm   | Additional substance |
| Dibutyl phthalate (DBP)               | Less than 1,000ppm   | Additional substance |
| Diisobutyl Phthalate (DIBP)           | Less than 1,000ppm   | Additional substance |

※The RoHS mark on our Website defines the ten(10) prohibited substances of the RoHS2.0 directive.

※The RoHS mark on our Catalog 02 and PDF catalog which can be downloaded from our website defines the six(6) prohibited substances of the RoHS directive.

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**SIGMAKOKI**

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This time, we published 「*smart* SIGMAKOKI」 as an introductory of Sigma Koki's products.

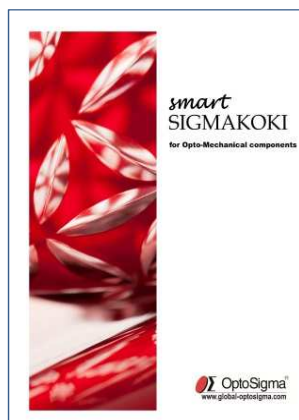
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