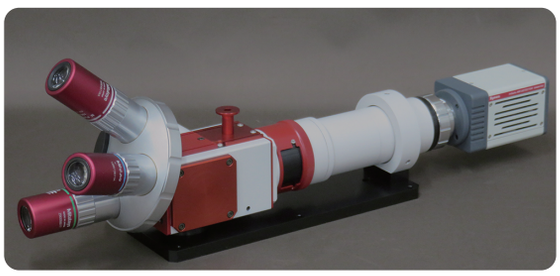
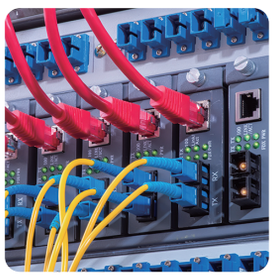
Synos

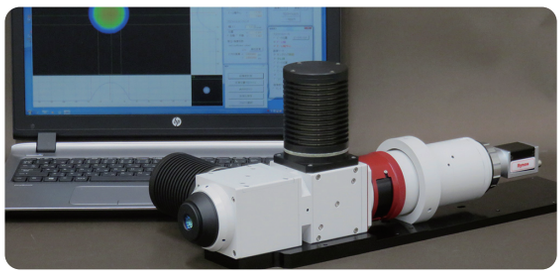
DRIVE FOR OPTICS & SENSING INNOVATION

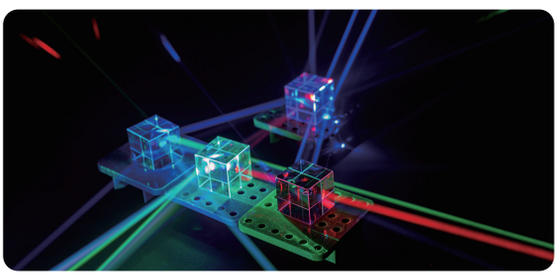
OPTICS AND OPTICAL MEASUREMENT SYSTEM SOLUTION

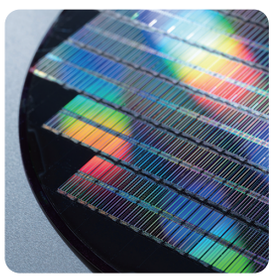
# *OPTICS & OPTICAL MEASUREMENT SYSTEM GENERAL CATALOG*

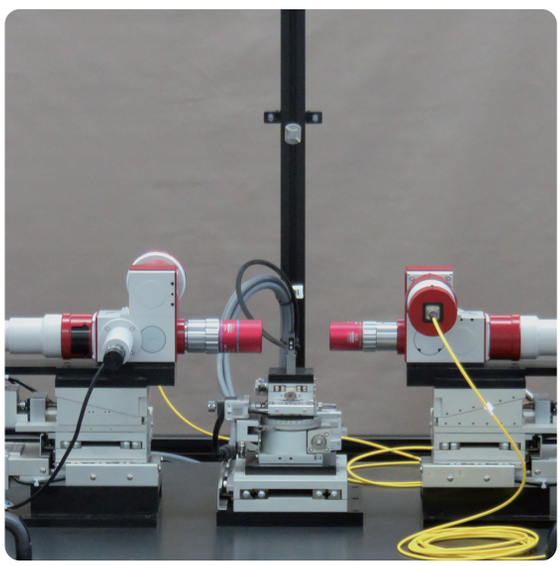










*July, 2022 ver.6.0.2.E*

https://www.synos.jp/

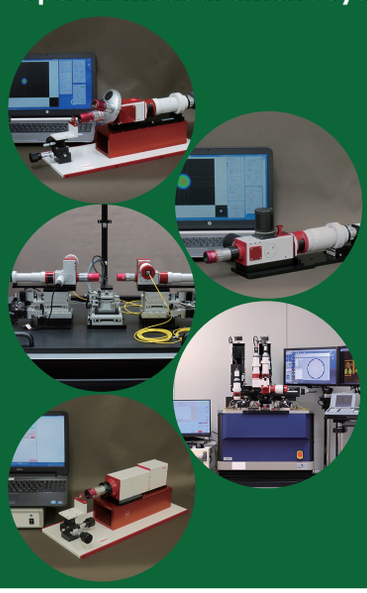
*SYNERGY OPTOSYSTEMS CO., LTD.*

# Contents

## ●Optics and related products



## ●Optical measurement system





## ●Imaging detector related product

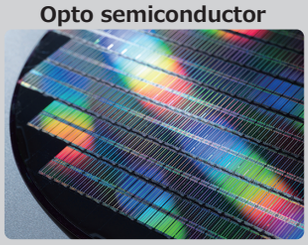


## ●Light source, accessories

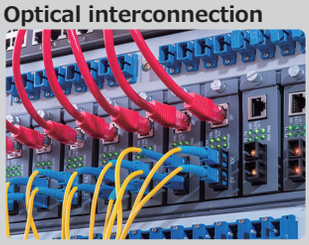
# Application

## ○Synos' optical measurement system is used in research and development in various fields.

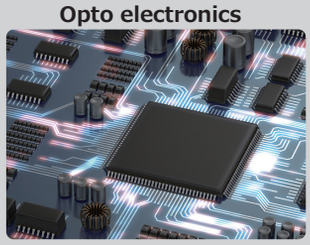
Opto semiconductor



Optical communication
Optical interconnection

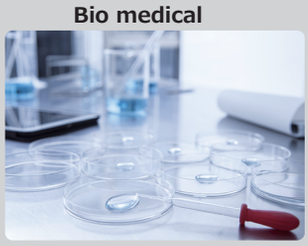


Opto electronics



Automotive electronics
Automotive photonics

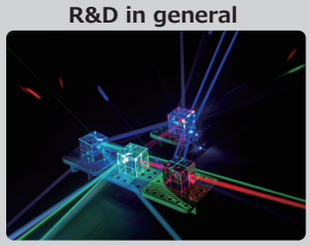
Bio medical



Information equipment

New functional materials

R&D in general



| ○Light irradiation and detection measurement by optical system | | |
|---|---|---|
| Measurement by micro beam irradiation<br>Measurement by micro beam detection | Optical measurement optics<br>M-Scope type I<br>M-Scope type J<br>M-Scope type M | ○**Micro beam irradiation**<br>Light sensitivity, response of photo diodes, optical sensing devices、Bio medical application such as light introduction to bio cells.<br>○**Micro beam detection**<br>Emission characteristic measurement of LDs, VCSELs. Insertion measurement of waveguides |

| ○Optical beam profile measurement and analysis application in general | | |
|---|---|---|
| Optical beam NFP measurement<br>Optical beam profile analysis<br>Optical beam observation in general | NFP measurement optics M-Scope type S,<br>M-Scope type L<br>NFP measurement system | Laser diodes, optical fibers, optical waveguides, Silicon photonics devices, various optical modules, etc. |
| FFP measurement・emission N.A. measurement | FFP measurement optics M-Scope type F,<br>M-Scope type FW<br>FFP measurement system | |
| Collimated beam measurement | Collimated beam measurement optics M-Scope type C, Collimated beam meas. system | |
| NFP/FFP simultaneous measurement | NFP/FFP simultaneous meas. optics M-Scope type D, NFP/FFP simultaneous meas. system | |

| ○Other optical parameter measurement | | |
|---|---|---|
| Polarization, extinction ratio measurement | Polarization measurement module PMD002/POL | Laser diodes, optical fibers, various optical modules, etc. |
| IVL characteristic of light emitting devices | IVL measurement module PMD002/IVL | |

| ○Evaluation of light propagation characteristic of multi mode optical fibers | | |
|---|---|---|
| EF (Encircled Flux) measurement | EF measurement system | Multi mode optical fibers, plastic optical fibers, malti mode waveguides (polymer waveguides), etc. |
| EAF (Encircled Angular Flux) measurement | EAF measurement system | |
| Evaluation of light propagation charcteristic under special launch condition | Underfilled launch optics M-Scope type G, mode-selective launch optics M-Scope type ML | |

| ○Optical beam profile measurement of output power ~10W class high power lasers | | |
|---|---|---|
| NFP measurement of high power laser<br>Beam profile analysis of high power lasers | NFP measurement optics for high power laser M-Scope type HS, M-Scope type HL<br>NFP measurement system for high power laser | Output power ~10W class high power laser devices, modules, etc. |
| FFPmeasurement, emission N.A. measurement of high power lasers | FFP measurement optics for high power laser M-Scope type HF, FFP measurement system for high power laser | |
| NFP/FFP simultaneous measurement of blue high power lasers | NFP/FFP simultaneous meas. optics for high power M-Scope type HD<br>NFP/FFP si,ultaneous meas. system for high power laser | |

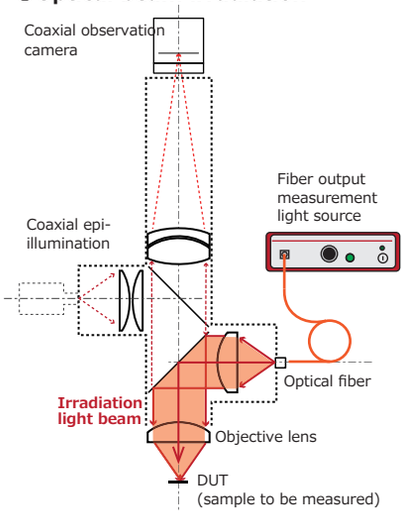
| ○For specific applications | | |
|---|---|---|
| Manual insertion loss measurement | Optical method insertion loss measurement system | Polymer waveguides, optical connectors, etc. |
| Automatic insertion loss measurement | Optical method Insertion loss measurement system | Si photonics devices, near field optics, etc. |
| Mass production continuity test of polymer waveguide | Optical continuity tester | Polymer waveguides, optical connectors, etc. |
| Focul point, beam waste measurement | Focal position measurement system | LD modules, mocro lenses, etc. |
| Wafer level testing of detector devices | Wafer level optical characteristic meas. system | Photodiodes, Photo sensors, etc. |
| Wafer level testing of light emitting devices | Wafer level optical characteristic meas. system | VCSELs, etc. |
| YAG welding fixation of minute parts | Beam irradiation optics for YAG laser micro welding | YAG welding of optical module and minute parts |

## SUMMERY OF SYNOS' OPTICAL MEASUREMENT OPTICS

Synos' original and specially-designed multi-purpose optics for optical beam irradiation & detection, beam profile measurement.

Synos' optical measurement optics is highly functional optics, specially-designed for optical beam irradiation & detection measurement. In the field of optical applied measurement in recent years, with miniaturization, high integration and functionality of various optical semiconductor devices and elements, optical characteristic measurement by irradiating micro light beam to the microstructural sample, or detecting measurement light emitted from microstructural sample, is widely needed. Synos' optical measurement optics is equipped with optical fiber connection port and imaging detector connection port for image observation. With these functions, it becomes easy to introduce probe light from fiber light source to the sample, or to detect the measurement light from the sample, by monitoring sample image. It can be applied to a wide range of fields and applications, such as optical characteristic measurement of photo detector devices and light-emitting devices, irradiation of probe light to microscopic samples such as biocells, etc.

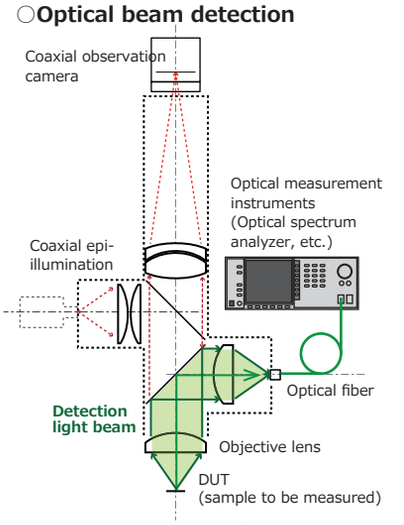
### ○Optical beam irradiation




### ○Light beam irradiation measurement

The left figure shows the simple internal structure of Synos' optical measurement optics.
In beam irradiation measurement, the light from the fiber light source is applied to the sample surface to be measured. The light emitted from the optical fiber connected to the optical fiber connection port, travels along the optical path shown in red in the left figure, and is focused and irradiated to the sample that is placed at the focus position of objective lens. The core of the connected optical fiber is relayed to the sample at a ratio of 1: 1 (using 10× the objective lens). For example, if an optical fiber with a core diameter of 10um is used, the sample will be irradiated with a spot of 10umφ. The condition of the sample surface can be checked directly with the coaxial observation camera. In this way, it is possible to easily irradiate the sample with minute irradiation light equivalent to the diameter of the optical fiber core connected to the optical fiber port. The spot diameter of the irradiation light beam can be adjusted by changing the optical fiber core or objective lens magnification. In this way, by using optical measurement optics, it is possible to easily and reliably introduce minute measuring light to the sample. This method has been applied to the measurement of optical characteristics of light receiving elements such as photodiodes and optical sensors, introduction of light beams into optical waveguides and optical passive elements, and irradiation of light into biocells, etc.

### ○Optical beam detection



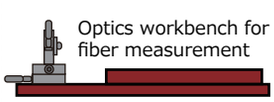

### ○Light detection measurement

In the case of received light measurement, contrary to light irradiation measurement, the measured light from the measured sample is coupled to the optical fiber connected to the optical fiber connection port.
The light emitted from the sample travels along the optical path shown in green on the left and is coupled to the optical fiber connected to the optical fiber connection port. At this time, the measuring light from the sample corresponding to the core diameter of the connected optical fiber is relayed to the optical fiber core with 1: 1 (using 10× objective lens). For example, if optical fiber with a core diameter of 50 μm is used, the measured light from the portion corresponding to 50 umφ on the measured sample will be relayed to the optical fiber. Similar to the light irradiation measurement, the condition of the sample can be checked directly with the coaxial observation camera, including the light emitting position and light emitting condition, so easily checked the measurement position and light emission status by checking the image of the coaxial observation camera. As with light irradiation, the diameter of the light receiving measurement target can be adjusted by changing the diameter of the optical fiber core or the magnification of the objective lens. This method is applied to the measurement of light emission characteristics of semiconductor lasers and VCSELs, insertion loss and optical characteristic measurement of optical waveguides, optical fibers, etc.

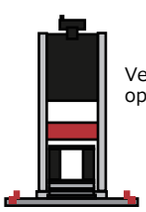
### 【Component selection】

**●Stage, optics bench**

Sample stage
Optics stage



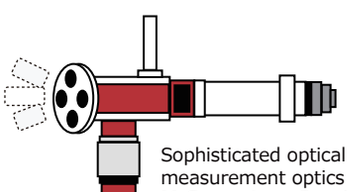
Optics workbench for fiber measurement



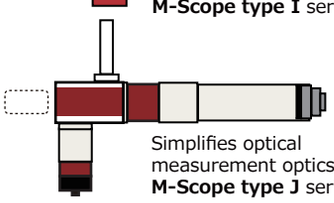
Vertical setting optics bench

＊Possible to combine various manual/motorized stages

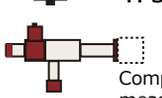
**●Optical measurement optics**



Sophisticated optical measurement optics **M-Scope type I** series



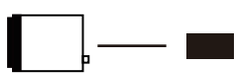
Simplifies optical measurement optics **M-Scope type J** series



Compact-type optical measurement optics **M-Scope type M** series

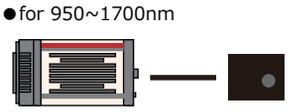
**●Imaging detector**

●for visible~1100nm



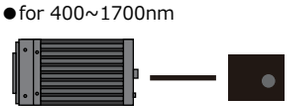
High resolution CMOS detector **ISA071**

●for 950~1700nm



InGaAs high sensitivity NIR detector **ISA041H2**

●for 400~1700nm



InGaAs high resolution NIR detector **ISA041HRA/HRVA**

**●Image processing & analysis**

Image processing & data analysis system

・Optical beam analysis software **Optometrics BA Standard**
・Special software : optical characteristic measurement, stage & system control, etc.

**●Accessories**

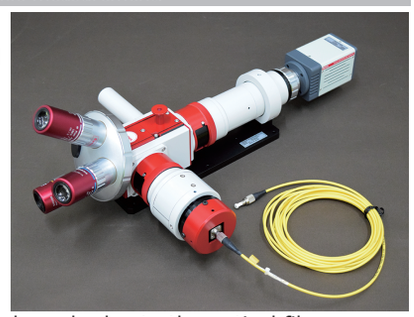
ND filter

Objective lens

Coaxial epi-illumination light source

## M-Scope type I　SOPHISTICATED OPTICAL MEASUREMENT OPTICS

Synos' original and specially-designed multi-purpose optics for optical beam irradiation & detection, beam profile measurement.



Sophisticated optical measurement optics **M-Scope type I** is designed to correspond with various requirements in optical measurement. **M-Scope type I** has two functional ports, optical fiber connect port and imaging detector port. Furthermore, **M-scope type I** has the enhanced scalability for various purpose, and additional optical measurement ports can be added. **M-Scope type I** is the high-end optics available for wide range of optical measurement application such as optical beam irradiation to various light receiving devices, bio cells, etc., and light detection measurement of light emitting devices, optical waveguides, etc.

**【Features】**

○Optical fiber connect port is equipped.
- ●Optical beam irradiation: Pinpoint irradiation of measurement light beam onto the target sample precisely and easily.
- ●Light detection measurement: Pinpoint detection of measurement light from the target sample and relay to the optical fiber. Best for optical power measurement, wavelength measurement, optical alignment, etc.

○Imaging port for imaging detector is equipped.
- ●Direct observation of beam irradiating and detectiing position.
- ●It is also possible to apply for NFP/beam profile measurement.

**【Sammary of specifications】**

○Optical fiber connect port
- ●Relay magnification:　1 : 1 (when using 10x objective lens)
- ●Irradiation and detection beam diameter:

| Obj. lens | Irradition and detection beam diameter |
|---|---|
| 10× (std) | 1:1 of core diameter of connected optical fiber |
| 20× | 1/2 of core diameter of connected optical fiber |
| 50× | 1/5 of core diameter of connected optical fiber |

○Objective lens change:　by manual revolver
○Objective lens:　Mitsutoyo M-Plan Apo series
○Imaging port
- ●Intermediate lens:　1×
- ●Maximum optical magnification: 100× (100× objective lens)

○Epi-illumination port:　Standard (Outer diameter: 8mmφ)
○Epi-illumination system: Option
○Attenuate:　By neutral density filter
○Camera mount:　C mount

**【Available detectors selection】**

○for 400~1100nm: Hi-resolution CMOS detector **ISA071**, etc.
○for 950~1700nm: InGaAs NIR detector **ISA041H2**, etc.
○for 400~1700nm: InGaAs NIR derector **ISA041HRA**, etc.

**【Standard component】**

○Main optics:　1
- ●Fiber connect port:　1
- ●Imaging port (1×):　1
- ●Epi-illumination port: 1

○Optics base:　1

**【Option】**

○Intermediate lens port
- ●2× intermediate lens port　**MS-OP011-RL2**
  Intermediate lens unit that doubles the overall magnification of the optical system. (up to 200× with 100× objective lens)
- ●1/2× intermediate lens port　**MS-OP011-RLH**
  Intermediate lens unit that halves the overall magnification of the optical system.

○Variable spot size converter unit **MS-OP011-VFPJ**
Fiber port that can continuously change irradiation and receiving diameters.

| Obj. lens | Continuous variable range |
|---|---|
| 10× (std) | 1.11~3.33× of core diameter of connected optical fiber |
| 20× | 0.55~1.66× of core diameter of connected optical fiber |
| 50× | 0.22~0.66× of core diameter of connected optical fiber |

○Accessories
- ●Objective lens, ND filter, coaxial epi- illumination system, optics bench, etc.

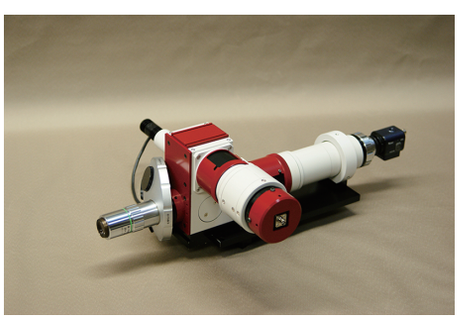
**【Customization of optics】**

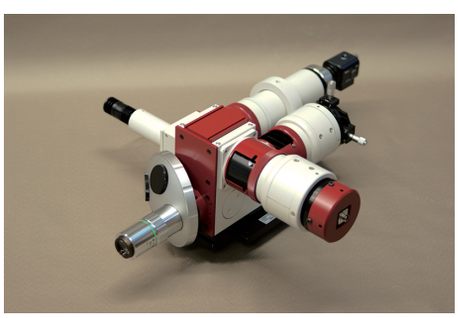
○M-Scope type I allows customized design of optical components and port layout according to the purpose and application.
- ●Customized items
  - ・Additional measurement optical port and new design
  - ・Specification of built-in optical parts (mirror, lens, etc.)
  - ・Customization of Irradiation/reception relay magnification

  etc.

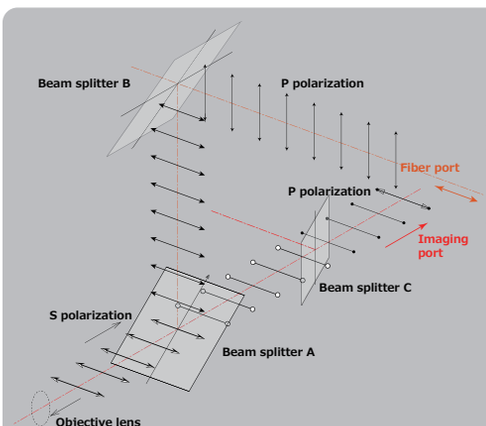
## M-Scope type I/PF　POLARIZATION COMPENSASION SOPHISTICATED OPTICAL MEASUREMENT OPTICS

Improves measurement stability by polarization compensasion by arrangement of half mirror





○Polarization compensasion sophisticated optical measurement optics **M-Scope type I/PF**
When using single mode optical fiber for introducing measurement light, polarization state may changes inside the single mode fiber due to the influence of stress such as bending applied to the optical fiber due to the influence of the external environment. For this reason, the measurement accuracy of the entire system may become unstable due to the polarization dependence of half mirror for splitter. **M-Scope type I/PF** is the optics that realizes stable and highly accurate measurement by removing the influence of polarization by arrangement of half mirror.

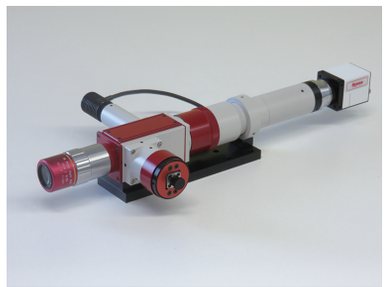



**☞Technical information【Polarizaion compensasion of half mirror】**

Half mirror used for splitter has different transmittance and reflectance depending on the polarization direction. For this reason, the polarization state during irradiation and reception may affect the measurement. Our polarization compensasion optics has the structure that compensates for polarization dependence of the half mirror by arrangement structure as shown in the left figure.

## M-Scope type J　SIMPLIFIED OPTICAL MEASUREMENT OPTICS

Synos' original and specially-designed multi-purpose optics for optical beam irradiation & detection, beam profile measurement.



**M-Scope type J** is a compact and simplified optical system designed to correspond with various requirements in optical measurement. **M-Scope type J** has two functional ports, optical fiber connect port and imaging detector port. It is available for multi purpose optical measurement application such as optical irradiation, optical beam observation and image observation at the same time. It is monocular type and compact optical unit, suitable for embedding in equipment.

**【Features】**

○Optical fiber connect port is equipped.
- ●Optical beam irradiation: Pinpoint irradiation of measurement beam onto the target sample precisely and easily.
- ●Light detection measurement: Pinpoint detection of measurement light from the target sample and relay to the optical fiber. Best for optical power measurement, wavelength measurement, optical alignment, etc.

○Imaging port for imaging detector is equipped.
- ●Direct observation of beam irradiating and detecting position.
- ●It is also possible to apply for NFP/beam profile measurement.

○Compact optical unit, suitable for embedding in equipment

**【Summary of specifications】**

○Optical fiber connect port
- ●Relay magnification: 1:1(when using 10x objective lens)
- ●Irradiation and detection beam diameter:

| Obj. lens | Irradition and detection beam diameter |
|---|---|
| 10× (std) | 1:1 of core diameter of connected optical fiber |
| 20× | 1/2 of core diameter of connected optical fiber |
| 50× | 1/5 of core diameter of connected optical fiber |

○Objective lens change: By re-mounting objective lens
○Objective lens: Mitsutoyo M-Plan Apo series
○Imaging port
- ●Intermediate lens: 1×
- ●Maximum optical magnification: 100× (100× objective lens)

○Epi-illumination port: Standard (Outer diameter: 8mmφ)
○Epi-illumination system: Option
○Attenuate: By neutral density filter
○Camera mount: C mount

**【Standard component】**

○Main optics: 1
- ●Fiber connect port: 1
- ●Imaging port (1×): 1
- ●Epi-illumination port: 1

○Optics base: 1

**【Available detectors selection】**

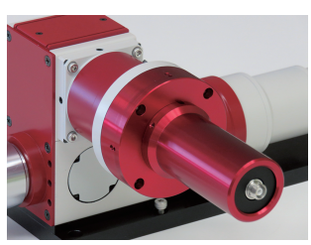
○for 400~1100nm: Hi-resolution CMOS detector **ISA071**, etc.
○for 950~1700nm: InGaAs NIR detector **ISA041H2**, etc.
○for 400~1700nm: InGaAs NIR derector **ISA041HRA**, etc.

**【Option】**

○Variable spot size converter unit **MS-OP012-VFPJ**
Fiber port that can continuously change irradiation and receiving diameters.

| Obj. lens | Continuous variable range |
|---|---|
| 10× (std) | 1.11~3.33× of core diameter of connected optical fiber |
| 20× | 0.55~1.66× of core diameter of connected optical fiber |
| 50× | 0.22~0.66× of core diameter of connected optical fiber |

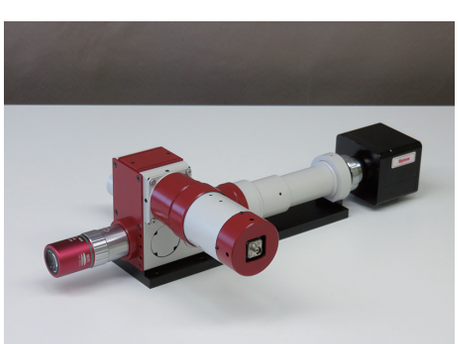
○Accessories
- ●Objective lens, ND filter, coaxial epi-illumination system, optics bench, etc.



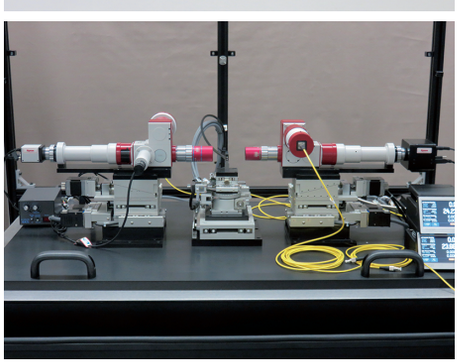
Variable spot size converter unit
**MS-OP012-VFPJ**

## M-Scope type J/PF　POLARIZATION COMPENSATION SIMPLIFIED OPTICAL MEASUREMENT OPTICS

Improves measurement stability by polarization compensation by arrangement of half mirror



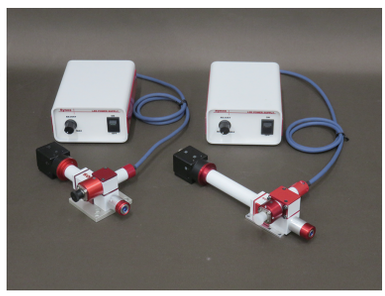
○Polarization compensation simplified optical measurement optics **M-Scope type J/PF**
When using single mode optical fiber for introducing measurement light, polarization state may changes inside the single mode fiber due to the influence of stress such as bending applied to the optical fiber due to the influence of the external environment. For this reason, the measurement accuracy of the entire system may become unstable due to the polarization dependence of half mirror for splitter. **M-Scope type J/PF** is the optics that realizes stable and highly accurate measurement by removing the influence of polarization by arrangement of half mirror.



【Applied system of **M-Scope type J/PF**】**Optical method insertion loss measurement system for micro structural waveguide device**
This is the system for insertion loss measurement of micro structural waveguide device using **M-Scope type J/PF**. It realizes high-speed and accurate insertion loss measurement of micro structural waveguide such as silicon photonics waveguides. By combining optical fiber and coaxial observation imaging detector mounted on **M-Scope type J/PF**, and motorized stage system, you can directly observe input and output face and core of optical waveguide to be measured, and at the same time perform power alignment by optical fiber. By using coarse alignment by image processing and fine alignment by optical fiber (optical power alignment), insertion loss measurement of micro structural waveguide can be performed at high speed and high reproducibility.
☞About optical method insertion loss measurement system in detail, please refer to P30.

## M-Scope type M　COMPACT TYPE OPTICAL MEASUREMENT OPTICS

Synos' original and specially-designed multi-purpose optics for optical beam irradiation & detection, beam profile measurement.



**M-Scope type M** is a compact type optical beam irradiation & detection measurement optics that equips coaxial observation camera for observing target position. It is monocular type and ultra-compact optical unit, suitable for embedding in equipment. It can be used for a wide range of applications such as light incident measurement of light receiving elements, light receiving measurement of light emitting elements, and light incident on bio cells, etc. There are two types of **M-Scope type M**, one is **M-Scope type M6** with 6x objective lens model, another is **M-Scope type M20** with 20x objective lens model.

**【Features】**

○Imaging port for coaxial observation camera is equipped. Direct observation of irradiating beam position and light detecting position.
○Compact and light weight, suitable for mounting on various stage system and bulit-in use.
○Two types of **M-Scope type M6** with 6x objective lens, and **M-Scope type M20** with 20x objective lens
○Polization compensation optical fiber connect port is equipped as standard equipment.
○Various commercially available fiber light sources can be used.

**【Summary of specifications】**

| | M-Scope type M6 | M-Scope type M20 |
|---|---|---|
| Relay magnifications | 1:1 | |
| Light irradiation | Irradiate the core diameter of connected fiber on the target sample with 1:1 magnification | |
| Light detection | Detect the light from target sample area equivalent to the core diameter of conected fiber with 1:1 magnification | |
| Fiber connector | FC connector | |
| Measurement wavelength | Select and specify the measurement wavelength from 400~1550 nm spectral range | |
| Epi-illumination | LED coaxial epi-illumination (dedicated M-Scope type M) | |
| Coaxial observation camera | 1/1.8" CMOS detector ISA071 (recommended), other detectors can be used | |
| Optical magnifications | approx. 6.25× | approx. 22× |
| W.D. | approx. 4.9mm | approx. 2.5mm |
| Field of view (ISA071) | approx. 1.13mm×0.84mm (1/1.8" CMOS) | approx. 320μm×240μm (1/1.8" CMOS) |

**【Standard component】**

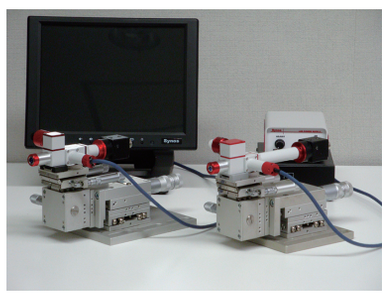
○Main optics: 1
　●Fiber connect port: 1
　●Imaging port (1×): 1
　●LED epi-illumination system (dedicated): 1
○Optics base: 1

**【Available detectors selection】**

○for 400~1100nm: Hi-resolution CMOS detector **ISA071**, etc.
○for 950~1700nm: InGaAs NIR detector **ISA041H2**, etc.
○for 400~1700nm: InGaAs NIR derector **ISA041HRA**, etc.

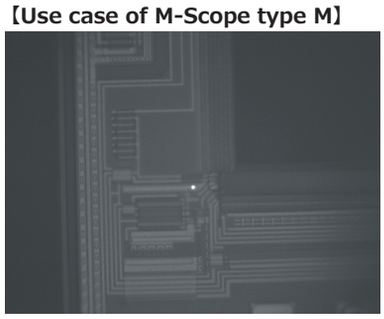
**【Option】**

○Accessories
　●Manual/motorized stage system, etc.

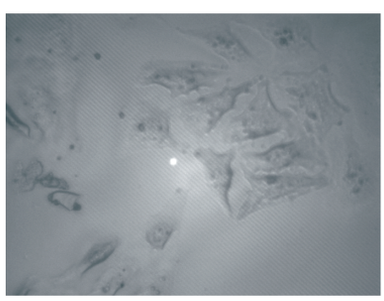


M-Scope type M mounted on a manual positioning stage

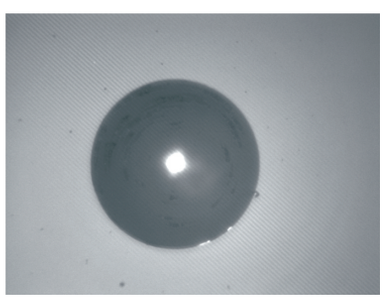
**【Use case of M-Scope type M】**



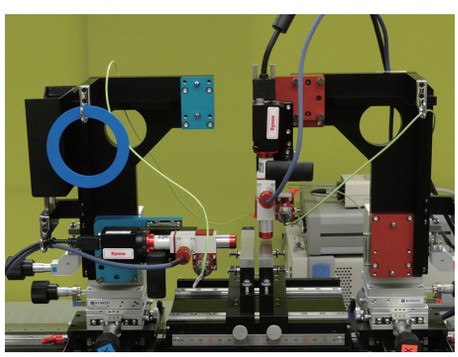
Beam irradiation onto semiconductor chip



Beam irradiation of bio cell



Beam introduction to the optical fiber



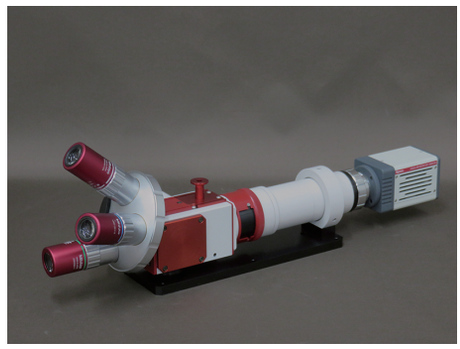
**【Applied system of M-Scope type M】Optical method insertion loss measurement system**

This is the optical method insertion loss measurement system using **M-Scope type M**. By using coaxial observation camera mounted on **M-Scope type M**, it becomes possible to perform direct image observation of input and output end faces of the measured optical waveguide. While checking the observed core image of the optical waveguide, it is possible to directly introduce the measurement beam into the core and receive the beam emitted from the waveguide for measurement. In this way, insertion loss measurement similar to optical fiber alignment can be performed easily and quickly even when combined with a manual precision positioning stage. Best for manual insertion loss measurement of polymer waveguide module for OPCB substrate.

☞About optical method insertion loss measurement system in detail, please refer to P29.

## M-Scope type S　SOPHISTICATED OPTICAL BEAM NFP MEASUREMENT OPTICS

Best suit for optical beam pattern observation and analysis. Widely applied general purpose microscope-type NFP optics.



**M-Scope type S** is a high-performance optical system for optical beam observation, beam profile measurement and analysis, NFP measurement of laser diodes, optical fibers, optical waveguides, and various light-emitting devices and modules.

**【Features】**

○Equipped with manual 4-hole objective revolver as standard
○Can be equipped with coaxial epi-illumination port (optional). Possible to observe real microscopic image observation and positioning.
○Up to 200x optical magnification with 2x intermediate lens port (optional) and 100x objective lens.
○Possible to measure in 400nm to 1700nm wavelength range by selecting detector.
○High-performance NFP measurement system can be constructed by using Synos' optical beam analysis module **AP013** together.

**【Summary of specifications】**

○Mesurement method: Magnifying optics & image processing
○Objective lens change: By manual revolver
○Objective lens: Mitsutoyo M-Plan Apo series
○Intermediate lens: 1×
○Maximum optical magnification: 100× (100× objectibe lens)
○Epi-illumination: Option
○Attenuate: By neutral density filter
○Camera mount: C mount

**【Available detectors selection】**

○for 400~1100nm: Hi-resolution CMOS detector **ISA071**, etc.
○for 950~1700nm: InGaAs NIR detector **ISA041H2**, etc.
○for 400~1700nm: InGaAs NIR derector **ISA041HRA**, etc.
☞Regarding the field of view and pixel resolution during NFP measurement by the detector used, please refer to P50 【Detector selection and NFP measurement specifications】

**【Option】**

○Option for **M-Scope type S** optics
- ●2× intermediate lens port **MS-OP011-RL2**
  Intermediate lens unit that doubles the overall magnification of the optical system. (up to 200× with 100× objective lens)
- ●1/2× intermediate lens port **MS-OP011-RLH**
  Intermediate lens unit that halves the overall magnification of the optical system.
- ●Coaxial epi-illumination port **MS-OP011-CEP**
  Coaxial epi-illumination port with removable half mirror.

○Accessories for optics
- ●Objective lens, ND filter, coaxial epi- illumination light source, optics bench, etc.

**【Standard component】**

○Main optics: 1
○Optics base: 1

## M-Scope type L　SIMPLIFIED OPTICAL BEAM NFP MEASUREMENT OPTICS

Cost-effective model of NFP optics with simplified functionality.

**M-Scope type L** is a simple functionality, less expensive model, without manual revolver and LED coaxial epi-illumination port.

**【Features】**

○Simple functionality, less expensive model, without manual revolver and coaxial epi-illumination port.
○Possible to measure in 400nm to 1700nm wavelength range by selecting detector.
○NFP measurement system can be constructed by using Synos' optical beam analysis module **AP013** together.
○Easy to mount on various stages in a small housing.

**【Summary of specifications】**

○Mesurement method: Magnifying optics & image processing
○Objective lens change: By re-mounting objective lens
○Objective lens: Mitsutoyo M-Plan Apo series
○Intermediate lens: 1×
○Maximum optical magnification: 100× (100× objectibe lens)
○Epi-illumination: Not available
○Attenuate: By neutral density filter
○Camera mount: C mount

**【Available detectors selection】**

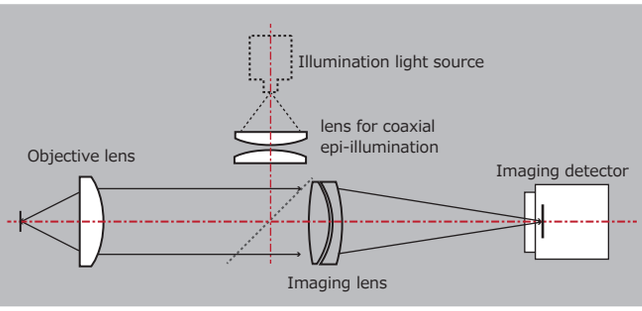
○for 400~1100nm: Hi-resolution CMOS detector **ISA071**, etc.
○for 950~1700nm: InGaAs NIR detector **ISA041H2**, etc.
○for 400~1700nm: InGaAs NIR derector **ISA041HRA**, etc.
☞Regarding the field of view and pixel resolution during NFP measurement by the detector used, please refer to P50 【Detector selection and NFP measurement specifications】

**【Standard component】**

○Main optics: 1
○Optics base: 1

**【Option】**

○Accessories for optics
- ●Objective lens, ND filter, optics bench, etc.




**☞Technical information【Simple structure of M-Scope type S】**

The measurement light emitted from the sample is magnified by the first-stage objective lens and imaged on the image detector at the latter stage of the optical system by the imaging lens. The captured images are processed on a PC and analyzed for the emission beam profile, beam width, power distribution, etc. of the sample.

## M-Scope type F　　FFP (FAR FIELD PATTERN) MEASUREMENT OPTICS

Far-field pattern measurement optics using optical method. Realtime measurement in combination with dedicated optics and image analysis.

**M-Scope type F** is specially-designed optics for optical method FFP (Far-Field Pattern) measurement. It is possible to analyze beam divergence angle distribution in real time.

**【Features】**
○Specially designed optics for real-time observation and analysis of FFP
○Long working distance design of approx. 6 mm.
○Possible to measure in 400nm to 1700nm wavelength range by selecting detector.
○High-performance FFP measurement system can be constructed by using Synos' optical beam analysis module **AP013** together.

**【Optics selection】**
○for 650~1700nm　　**M-Scope type F**
○for 400~650nm　　**M-Scope type F/BL**

**【Summary of specifications】**
○Measurement method: Dedicated f-θ optics & image processing
○Measurement light flux diameter: Approx. 1mmφ
○W.D.:　　Approx. 6mm±0.8mm
○Attenuate:　　By neutral density filter
○Camera mount:　　C mount

**【Standard component】**
○Main optics:　1
○Optics base:　1

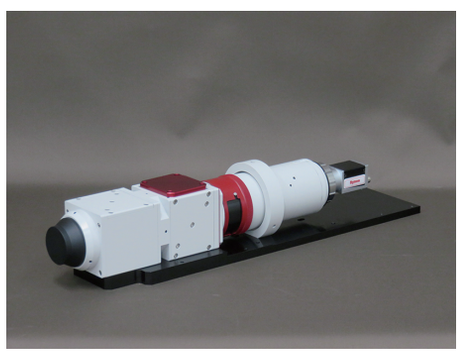
**【Available detectors selection】**
○for 400~1100nm: Hi-resolution CMOS detector **ISA071**, **ISA071GL**
○for 950~1700nm: InGaAs NIR detector **ISA041H2**
○for 400~1700nm: InGaAs NIR derector **ISA041HRA**
☞Regarding the measurement angle coverage and pixel resolution during FFP measurement by the detector used, please refer to P50 【Detector selection and FFP measurement specifications】

**【Option】**
○Accessories for optics
●ND filter, optics bench, etc.

## M-Scope type FW　　WIDE AREA FFP (FAR FIELD PATTERN) MEASUREMENT OPTICS

Far-field pattern measurement optics for measurable beam diameter 3mmφ. Applicable to the device with large light emitting area.

**M-Scope type FW** is specially-designed wide area type FFP optics with measurable luminous flux diameter of approx. 3mm φ.



**【Features】**
○Covers a wide range of measurement luminous flux diameters of approx. 3mmφ
○Wide measurement angle coverage of approx. ±43°
○Specially designed optics for real-time observation and analysis of FFP
○Long working distance of approx. 4mm
○High-performance FFP measurement system can be constructed by using Synos' optical beam analysis module **AP013** together.

**【Optics selection】** * Please contact us regarding the measurement wavelength.
○for 650~1700nm　　**M-Scope type FW**
○for 400~650nm　　**M-Scope type FW/BL**

**【Summary of specifications】**
○Measurement method: Dedicated f-θ optics & image processing
○Measurement light flux diameter: Approx. 3mmφ
○W.D.:　　Approx. 4mm±0.4mm
○Attenuate:　　By neutral density filter (dedicated 35mmφ ND filter)
○Camera mount:　　C mount

**【Standard component】**
○Main optics:　1
○Optics base:　1

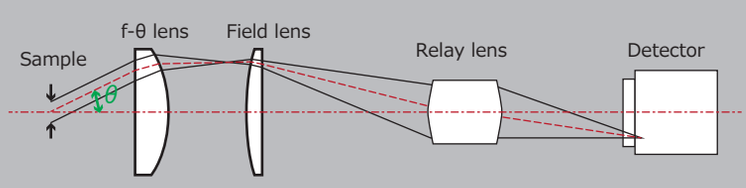
**【Option】**
○Accessories for optics
●ND filter (dedicated 35mmφ) , optics bench, etc.

**【Available detectors selection, measurement angle coverage, pixel resolution】**

| Detector model | ISA061 | ISA041VH |
|---|---|---|
| Detector name | 1" Hi-resolution CMOS detector | VGA InGaAs high sensitivity NIR detector |
| Spectral range | 400~1100nm | 950~1700nm |
| Sensor size | 1 inch | 12.8mm×10.24mm |
| Total pixels | 2048×2048 | 640×512 |
| Pixels pitch | 5.5μm | 20μm |
| Measurement angle coverage | approx. ±43° / N.A. 0.68 | approx. ±43°(H)×±40°(V) |
| Pixel angle resolution | approx. 0.05° | approx. 0.167° |

*Pixel angle resolution: The measurement angle corresponding to 1 pixel of the detector, calculated from the measurement angle range and the pixel pitch of the detector.

**☞Technical information【Principle of optical method (f-θ lens method) FFP measurement】**




As shown in the figure on the left, the light flux, having incident angle θ from the sample, is focused at a point on the detector through f-θ lens, field lens and relay lens module. By this way, FFP image of the sample is formed and acquired by imaging detector, and analyzed directly and quickly by image processing method.

## M-Scope type C　COLLIMATED BEAM MEASUREMENT OPTICS

High precision beam divergence angle measurement optics for collimated beam. Best for evaluation, assembling adjustment of various collimator modules.

**M-Scope type C** is designed for beam divergence angle measurement of collimated beam with high resolution and in real time. It can be used for assembling adjustment of collimator module and quality evaluation of collimated beam.

**【Features】**

○Dedicated optics and image processing method enable real-time beam divergence angle measurement of collimated beam (collimated beam parallelism) with high resolution and high accuracy.
○Possible to measure in 400nm to 1700nm wavelength range by selecting detector.
○High-performance collimated beam measurement system can be constructed by using Synos' optical beam analysis module **AP013** together.

**【Summary of specifications】**

○Measurement method:　Dedicated optics & image processing
○Measurement luminous flux diameter: Approx. 15mmφ
○Attenuate:　By neutral density filter
○Camera mount:　C mount

**【Optics selection】**

○focul length 200mm:　M-Scope type C/200
○focul length 150mm:　M-Scope type C/150
○focal length 100mm:　M-Scope type C/100

**【Available detectors selection】**

○for 400~1100nm: Hi-resolution CMOS detector **ISA071**, **ISA071GL**
○for 950~1700nm: InGaAs NIR detector **ISA041H2**
○for 400~1700nm: InGaAs NIR derector **ISA041HRA**
☞Regarding the measurement angle coverage and pixel resolution during collimated beam measurement by the detector used, please refer to P50【Detector selection and collimated beam measurement specifications】

**【Standard component】**

○Main optics:　1
○Optics base:　1

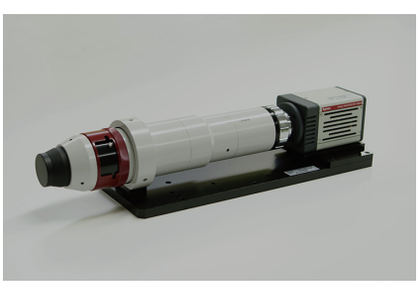
**【Option】**

○Accessories for optics
　●Objective lens, ND filter, optics bench, etc.

## M-Scope type FHR　HIGH RESOLUTION FFP MEASUREMENT OPTICS FOR IR RANGE

High resolution FFP measurement optics for 1310-1550nm spectral range.

**M-Scope type FHR** is the optics for measuring FFP in 1310nm~1550nm NIR spectral range. The combination with VGA type InGaAs high sensitivity NIR detector **ISA041VH** enables high accuracy FFP measurement with an angle pixel resolution of approx. 0.1 ° in 1310-1550nm spectral range. It can be applied to high precision FFP measurement and N.A. measurement of various optical devices in optical communication field such as optical fibers, optical waveguides, silicon photonics devices, and so on.



**【Features】**

○Specially designed optics for real-time observation and analysis of FFP
○Realize high angle pixel resolution of approx. 0.1° in 1310nm~1550nm spectral range
○Long working distance design of approx. 6mm
○High-performance collimated beam measurement system can be constructed by using Synos' optical beam analysis module **AP013** together.

**【Summary of specification】**

○Measurement method: Dedicated f-θ optics & image processing
○Corresponding spectral range: 1300-1600nm
　＊ Please contact us regarding the measurement wavelength.
○Measurement luminous flux diameter: approx. φ1mm
○Working distance:　approx. 6mm±0.8mm
　*W.D. depends on the measured sample size.
○Attenuate:　by Neutral Density Filter
○Camera mount:　C mount

**【Available detector, measurement angle, pixel resolution】**

| | | |
|---|---|---|
| Detector | VGA type InGaAs NIR detector ISA041VH | |
| Spectral range | 950~1700nm | |
| Total pixels | 640×512 pixels | |
| Pixels pitch | 20μm sq. | |
| Measurement angle | Meas. angle coverage | Pixel resolution |
| Pixel resolution | approx.±32°(V)×±25.6°(H) | approx.0.1° |

*Pixel resolution: The measurement angle corresponding to 1 pixel of the detector, calculated from the measurement angle range and the pixel pitch of the detector.

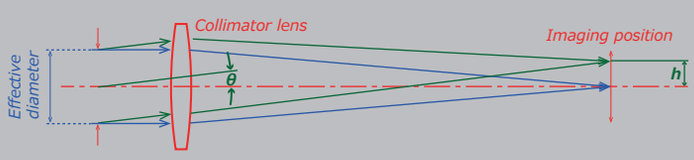
**【Standard component】**

○Main optics:　1
○Optics base:　1

**【Option】**

○Accessories for optics
　●IR ND filter, optics bench, etc.

**☞Technical information【Principle of collimated beam measurement】**

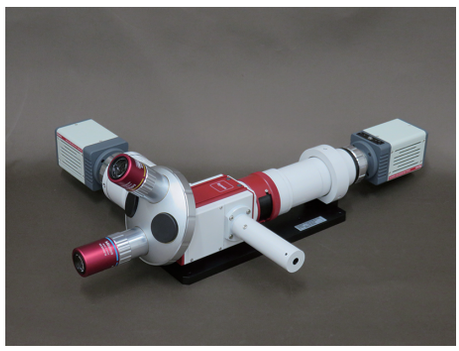



The light flux emitted from the sample enters the collimator lens. If we consider each angle component as parallel light flux, the light flux parallel to the optical axis will be focused at one point on the imaging position on the optical axis. On the other hand, the parallel light beam with incident angle 'θ' is imaged at the position 'h' of the imaging position due to the relationship between the focal length 'f' and the incident angle 'θ'. If the luminous flux has a divergence angle, the size of the beam spot at the imaging position changes depending on the divergence angle. In this way, image processing analysis of the beam formed at the imaging position is performed, and the parallel state of the collimated beam is analyzed in real time and high resolution.

## M-Scope type D　NFP/FFP SIMULTANEOUS MEASUREMENT OPTICS

Realize simultaneous observation and analysis of NFP and FFP by single optical unit.

**M-Scope type D** realizes simultaneous observation and analysis of NFP and FFP by a single optical unit. **M-Scope type D** has NFP measurement port and FFP measurement port in single optical base, and no need to switch the optics during each measurement.



**【Features】**
○Simultaneous analysis of NFP and FFP by a single optical unit.
○Specially designed optics for real-time observation and analsis of NFP/FFP
○Long working distance of approx. 17mm when measuring FFP
○Possible to measure in 400nm to 1700nm wavelength range by selecting detector.
○High-performance NFP/FFP simultaneous measurement system can be constructed by using Synos' optical beam analysis module **AP013** together.

**【Summary of specifications】**
○NFP/FFP measurement common specifications
- ●Objective lens:　M-Plan Apo NIR 50x (fixed)
- ●W.D.:　17mm
- ●Objective lens change: By manual revolver

＊Objective lenses with various magnifications can be used only during NFP measurement.

○NFP measurement port
- ●Intermediate lens:　1×
- ●Maximum optical magnification: 50×
- ●Epi-illumination:　Option
- ●Attenuate:　By neutral density filter
- ●Camera mount:　C mount

○FFP measurement port
- ●Measurement spectral range

Please specify the measurement wavelength because appropriate AR coating is required for optical path splitting half mirror of NFP/FFP port.
- ●Attenuate:　By neutral density filter
- ●Camera mount:　C mount

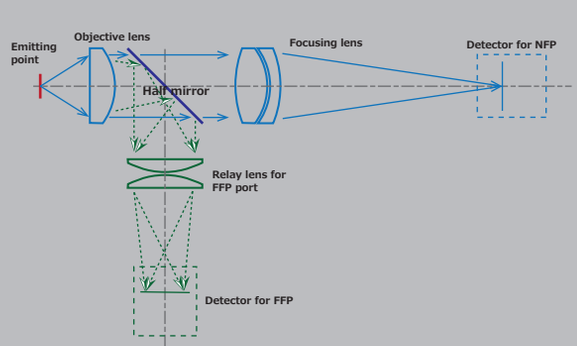
**【Standard component】**
○Main optics:　1
○Optics base:　1

**【Option】**
○Option for **M-Scope type D** optics
- ●2× intermediate lens port　**MS-OP011-RL2**
  Intermediate lens unit that doubles the overall magnification of the optical system. (up to 100× with 50× objective lens)
- ●1/2× intermediate lens port　**MS-OP011-RLH**
  Intermediate lens unit that halves the overall magnification of the optical system.
- ●Coaxial epi-illumination port　**MS-OP011-CEP**
  Coaxial epi-illumination port with removable half mirror.

○Accessories for optics
- ●Objective lens, ND filter, coaxial epi- illumination light source, optics bench, etc.

**【Available detectors selection】**
○for 400~1100nm: Hi-resolution CMOS detector **ISA071**, **ISA071GL**
○for 950~1700nm: InGaAs NIR detector **ISA041H2**
○for 400~1700nm: InGaAs NIR derector **ISA041HRA**
☞Regarding the field of view and pixel resolution during NFP measurement and the measurement angle coverage and pixel resolution during FFP measurement by the detector used, please refer to P50【Detector selection and NFP/FFP simultaneous measurement specifications】

**☞Technical Information　【Principle of NFP/FFP simultaneous measurement】**



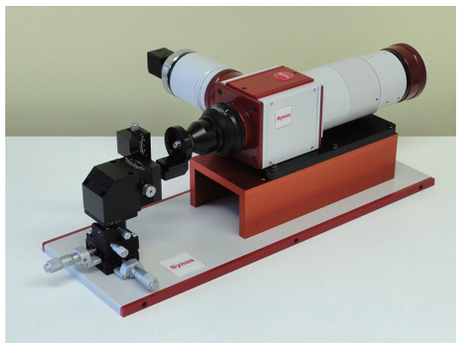

In **M-Scope type D**, FFP is measured using objective lens. In the figure on the left, the luminous flux emitted from the emitting point is incident on the objective lens and then the optical path is split by the half mirror. The light flux that has passed through the half mirror advances to the NFP port side and is imaged on the NFP measurement detector via the focusing lens. On the other hand, the light flux reflected by the half mirror advances to the FFP port side and is imaged on the FFP measurement detector via the FFP relay lens. In this way, NFP and FFP images obtained from each port branched into two optical paths are analyzed by image processing, and NFP/FFP measurement are realized with a single optical unit. Since this optics uses objective lens to measure NFP/FFP, the diameter of the light flux to be measured is very narrow (about 100 μm), it is necessary to adjust the position and focus on the NFP image. Additionally, the measurement wavelength is limited because appropriate AR coating is required for optical path splitting half mirror of NFP/FFP port. These are major differences from the FFP measurement method using f-θ lens.

**【Differences in methods and advantages and disadvantages of optical method FFP measurement】**

| Meas. Method | Optics | Advantage | Disadvantage |
|---|---|---|---|
| f -θ lens method | M-Scope type F<br>M-Scope type FW<br>etc. | ○Basic method of FFP analysis by optics<br>○No need for strict focus adjustment<br>○Wide angle coverage of approx. ±40 ° | ●Cannot observe real image<br>●Short W.D. of approx. 6mm<br>●Possible to secure wide measurement spectral range |
| Objective lens method | M-Scope type D | ○Enables NFP/FFP analysis in single optics<br>○Can observe real image by NFP image<br>○Long W.D. of approx. 17mm | ●Strict focus & position adjustment is required<br>●Nallow angle coverage of approx. ±24.5°<br>●Accuracy on the wide-angle side deteriorates<br>●Measurement wavelength is limited due to the use of HM. Affected by interference due to half mirror. |

## M-Scope type G　UNDERFILLED LAUNCH OPTICAL SYSTEM

Possible to control underfilled launch condition such as N.A., diameter of input light. Best for evaluation of multi-mode optical device.



**M-Scope type G** is underfilled launch optical system, possible to control launch condition such as N.A., diameter of input light by specially designed optical method. As **M-Scope type G** has camera system for observation, it is possible to observe the launch light position and launch condition directly. It is widely applicable for optical characteristic evaluation and measurement of MMF, POF, polymer waveguide in OPCB substrate, and various multimode devices and modules. Additionaly, in combination with SYNOS' NFP and FFP measurement system, EF/EAF measurement system, highly advanced optical characteristic evaluation of various multi-mode device will be realized.

**【Features】**

○Evaluation of various multi-mode device by changing launch condition
　●Adjustable launch light spot diameter and N.A.
○Possible to select various kind of measurement light source such as LED, SLD, LD, etc.
○Equips camera system for coaxial direct observation. Possible to observe the launch light position and launch light condition onto the sample surface.

**【Summary of specification】**

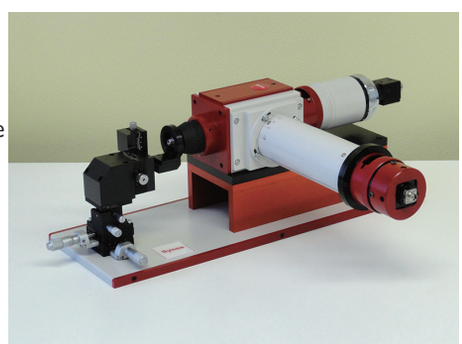
| | |
|---|---|
| ○N.A. adjustment of launch light: | 0.1-0.65 (Sequentially variable) |
| ○Diameter of launch light: | φ10,20,40,80,120 (by aperture) |
| ○Measurement wavelength: | 850nm (reccomendation) |
| ○Optical fiber: | φ1mm Large core fiber |
| ○Camera mount: | C-mount |

**【Standard component】**

| | |
|---|---|
| ○Main optics: | 1 |
| ○Optics base: | 1 |
| ○Aperture | 5 pieces/set |
| ○CMOS camera | 1 |

## M-Scope type ML　MODE-SELECTIVE LAUNCH OPTICAL SYSTEM

Possible to control launch condition by specified mode and N.A. Best for evaluation of multi-mode optical device.



**M-Scope type ML** is mode-selective launch optical system, possible to select specified angle (N.A.) component of launch light to the sample fibers by specially designed optical method. As **M-Scope type ML** has camera system for observation, it is possible to observe the launch light position and launch condition directly. It is widely applicable for optical characteristic evaluation of MMF, POF, polymer waveguide, and various multimode devices and modules under controlled launch condition. Additionaly, in combination with SYNOS' NFP measurement system, FFP measurement system, EF/EAF measurement system etc, highly advanced optical characteristic evaluation and measurement of various multimode device will be realized.

**【Features】**

○Evaluation of various multi-mode device by changing launch condition
　●Select specified angle (N.A.) component of launch light to the sample fibers.
○Possible to select various kind of measurement light source such as LED, SLD, LD.
○Equips camera system for coaxial direct observation. Possible to observe the launch light position and launch light condition onto the sample surface.

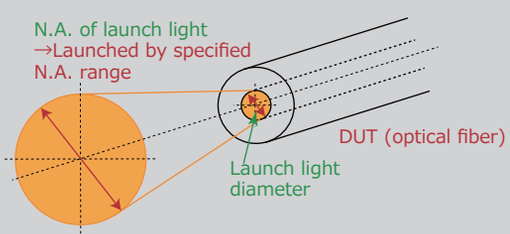
**【Summary of specification】**

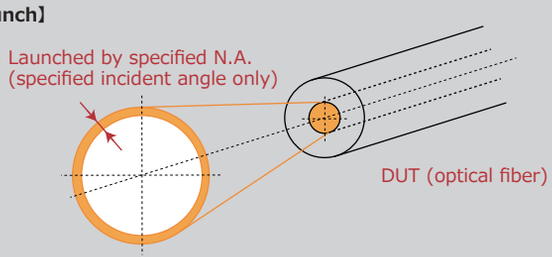
○Mode-selective port
　●N.A. adjustment of launch light: 0.1-0.6 (Sequentially variable)
　●Launch light width: approx. 0.05/0.1 (N.A. conversion value) (variable by aperture)
○Optical magnification for observation: approx. 2.95x
○View of observation: approx. 2.39mm x 1.79mm (with 1/1.8" CMOS camera)
○Fiber connector type for input light: FC connector

**【Standard component】**

| | |
|---|---|
| ○Main optics: | 1 |
| ○Optics base: | 1 |
| ○Aperture: | 1set |
| ○CMOS camera | 1 |

**☞Technical information【Underfilled launch and mode-selective launch】**




**●Underfilled launch**

Underfilled launch optical system is the special launch optics that changes the spot size and iraddiation N.A. (Numerical Aperture) of launch light, and analyze the optical diffusion of multimode optical fiber, plastic optical fiber, etc. Image of underfilled launch method is shown above. In case of underfilled launch, sample fiber is launched by all the light flux as specified N.A. In this case, beam profile of launch light on sample fiber core has flat shape.

●Mode selective launch

In case of mode-selective launch, sample fiber is launched by the light flux of only the specified N.A. In other words, mode-selective launch optics generate the launch light that has the specified incident angle only. Image of mode-selective launch method is shown above. Launch light has only specified N.A. light flux (specified incident angle light flux), launch light has ring condition incident angle light flux.

## M-Scope type Y　　MOCRO SPOT IRRADIATION OPTICS FOR YAG LASER WELDING

Realize high accuracy YAG laser welding of precision parts such as various optical modules, harddisk drive, etc..

**M-Scope type Y** is the micro spot irradiation optcis for YAG laser welding system, best for assembly by micro spot welding for various optical modules, precision component, etc. As coaxial observation camera and illumination are equipped, easy and accurate welding process can be realized by observing welding position of precision component directly. Furthermore, as double beam simultaneous irradiation system is adopted, high accuracy micro welding is realized.

**【Feature】**

○Easy and accurate welding by direct observation of welding position
- ●As coaxial observation TV camera and illumination are equipped, easy and accurate welding process can be realized by observing welding position of precision component directly.

○Double beam simultaneous irradiation system
- ●Double beam simultaneous irradiation system by beam bifurcation is equipped. laser beam introduced by single fiber is bifurcated into equally divided double beams through optics. Equally divided double beams are focused on the same plane through the same focusing lens. This system realizes two beam simultaneous and well-balanced welding, and contributes to make welding declination minimize and realize high accuracy micro welding.
- ●Single beam irradiation model is also prepared.

○Prepared two types of iradiation spot magnification :
- ●1:1 type / irrdaiate the same spot size of input optical fiber core diameter
- ●1:2 type / irradiate half size of input optical fiber core diameter

**【Summary of specification】**

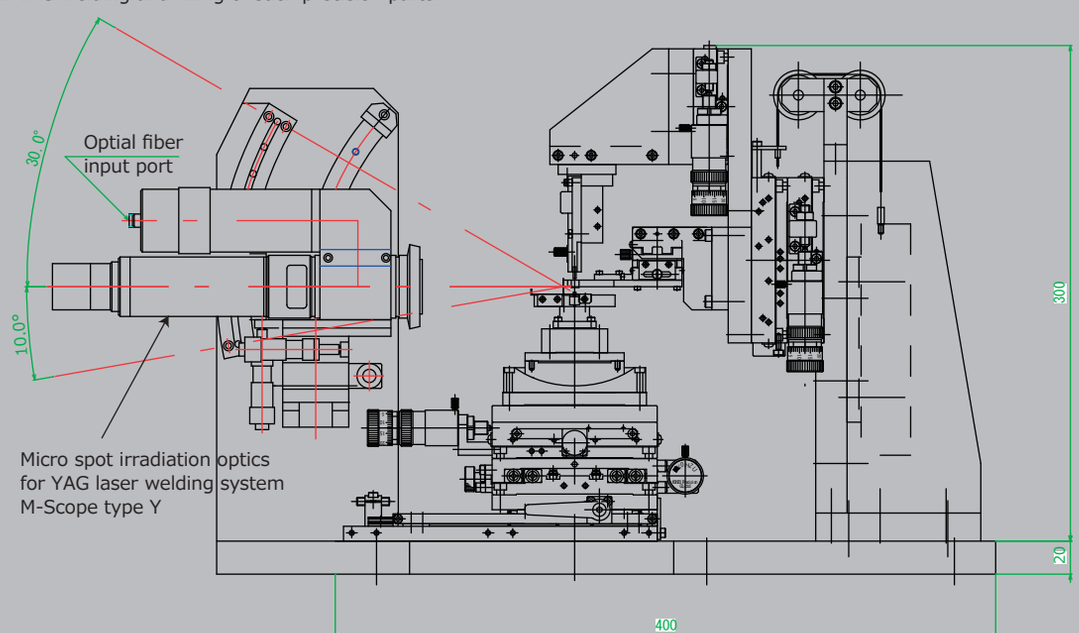
| | |
|---|---|
| ○Optics type: | Double beam simultaneous irradiation system<br>*Single beam irradiation system is also prepared |
| ○Irradiation spot magnification selection: | 1:1 (Standard, irrdaiate the same spot size of input optical fiber core diameter)<br>1:2 (Option, irradiate half size of input optical fiber core diameter) |
| ○Irrdadiation spot diameter (nugget diameter): | Approx. 400umφ (Standard, input fiber diameter:400umφ, Magnification: 1:1)<br>Approx. 200umφ (Option, input fiber diameter:200umφ, Magnification: 1:2) |
| ○Optical magnification of observation: | Approx. 1× |
| ○View of observation: | Approx. 7mm×5.2mm (with 1/1.8” CMOS camera) |
| ○Aberration correction wavelength: | 1.06um (guidance light wavelength: 633nm) |
| ○W.D.: | Approx. 87.7mm |
| ○Illumination: | LED ring illumination |
| ○Fiber connector: | D-80 fit connector for fiber input |

**【Standard component】**

| | |
|---|---|
| ○Main optics: | 1 |
| ○Optics base: | 1 |
| ○LED rign illumination: | 1 |
| ○CMOS camera system | 1 |

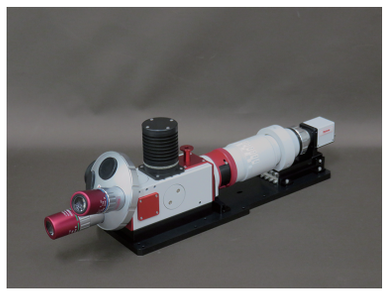
**【Application example of manual alignment and welding system for optical module】**

Among electronic components, optical components such as optical modules are composed of many optical components such as LDs, lenses and optical fibers. In this assembly, it is necessary to adjust the position of each part by using actual light and fix it by YAG welding so that the optimum optical coupling state is achieved. For this reason, YAG welding fixation with high accuracy is required. M-Scope type Y is designed for high precision YAG welding and fixing of such precision parts.



## M-Scope type HS　SOPHISTICATED OPTICAL BEAM NFP MEASUREMENT OPTICS FOR HIGH POWER LASER

Optical beam profile measurement optics, customized especially for output ~10W class high power laser.



**M-Scope type HS** is optics for beam profile measurement of output ~10W class high power lasers. After passing through the objective lens, the luminous flux from sample is 99.99% attenuated by two-stage beam sampler, and imaged on the detector.

**【Features】**

○Attenuation of incident beam with two-stage beam sampler and ND filters
○Various objective lens can be selected (M-Plan Apo NUV/NIR series objective lens)
○High-performance NFP measurement system can be constructed by using Synos' optical beam analysis module **AP013** together.

**【Optics selection】** * Please contact us regarding the measurement wavelength.

○for 850-940nm　**M-Scope type HS/NIR**
○for 400-450nm　**M-Scope type HS/BL**

**【Summary of specification】**

○Measurement method: dedicated optics & image processing
○Attenuation method: Approx. 99.99% attenuated by two-stage beam sampler, and ND filter (combined)
○Polarization dependent compensation: Compensated by 2-stage orthogonal arrangement of attenuation mirrors in beam sampler
○Target input power: Approx. ~10W
○Objective lens: M-Plan Apo NUV, M-Plan Apo NIR
○Objective lens change: By manual revolver
○Intermediate lens: 1×
○Epi-illumination: Option
○Camera mount　C mount

**【Standard component】**

○Main optics: 1
○Optics base: 1

**【Available detector】**

○Hi-resolution CMOS detector **ISA071/ISA071GL**

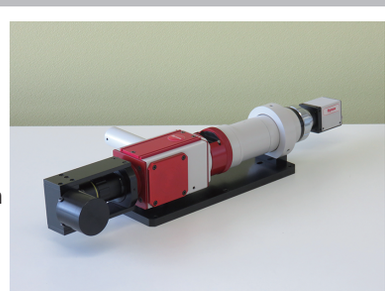
**【Option】**

○Option for M-Scope type HS optics
- ●2× intermediate lens port **MS-OP016-RL2**
  Intermediate lens unit that doubles the overall magnification of the optical system. (up to 200× with 100× objective lens)
- ●1/2× intermediate lens port **MS-OP016-RLH**
  Intermediate lens unit that halves the overall magnification of the optical system.
- ●Coaxial epi-illumination port **MS-OP016-CEP**
  Coaxial epi-illumination port with removable half mirror.
- ●Dummy filters **MS-OP016-DF**
  wedge type dummy filters for pulse/low power measurement

○Accessories for optics
- ●Objective lens, ND filter, coaxial epi-illumination light source, optics bench, etc.

## M-Scope type HL　HIGH POWER LASER NFP MEASUREMENT OPTICS

Optical beam profile measurement optics, customized especially for high power laser.



**M-Scope type HL** is optimized especially for optical beam profile measurement of high power laser. Approximately 5% of the optical beam emitted from sample is reflected by beam sampler which is installed in front of objective lens. Reflected beam is introduced to imaging detector through NFP optics.

**【Features】**

○Attenuation of incident beam with beam sampler before objective lens, and ND filter
○High-performance NFP measurement system can be constructed by using Synos' optical beam analysis module **AP013** together.
○Optical magnification is maximum 20x (option, 10x objective lens and 2x intermediate lens.)

**【Summary of specification】**

○Measurement method:dedicated optics & image processing
○Attenuation method:Approx. 95% attenuated by beam sampler, and ND filter (combined)
○Measurement wavelength:Select one wavelength from the range of 400 nm to 1100 nm
○Target input power: Approx. ～ 10W
○Objective lens: M-plan 10x/N.A.0.28
○Intermediate lens: 1×
○Field of view: Approx. 706×529μm
○Pixels resolution: Approx. 0.345μm
* The value of field of view and pixel resolution is approximate value when using Hi-resolution CMOS detector **ISA071/ISA071GL**.
○Epi-illumination: Option
○Camera mount: C mount

**【Standard component】**

○Main optics: 1
○Optics base: 1

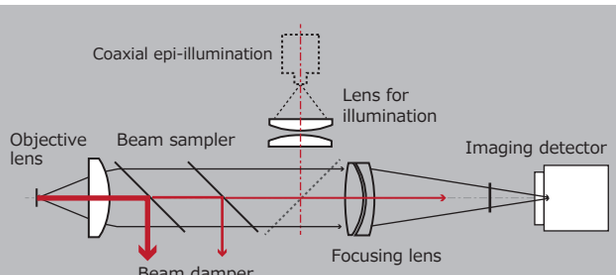
**【Available detector】**

○Hi-resolution CMOS detector **ISA071/ISA071GL**

**【Option】**

○Option for M-Scope type HL optics
- ●2× intermediate lens port **MS-OP011-RL2**
  Intermediate lens unit that doubles the overall magnification of the optical system. (up to 20× with 10× objective lens)
- ●1/2× intermediate lens port **MS-OP011-RLH**
  Intermediate lens unit that halves the overall magnification of the optical system.
- ●Coaxial epi-illumination port **MS-OP011-CEP**
  Coaxial epi-illumination port with removable half mirror.

○Accessories for optics
- ●Objective lens, ND filter, coaxial epi-illumination light source, optics bench, etc.

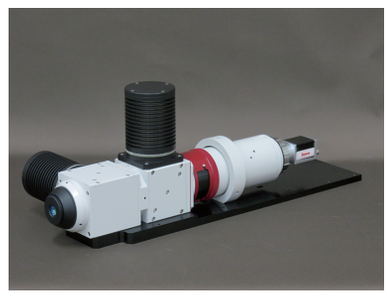



**☞Technical information【Simple structure of M-Scope type HS】**

The light flux emitted from the sample is attenuated to approximately 99.99% by two beam samplers installed in the latter stage of the objective lens. The beam reflected by the beam sampler is absorbed by the beam damper installed in the optical system. The beam that has passed through the beam sampler is further attenuated to an appropriate amount by ND filter and then introduced to image detector for image processing analysis.

## M-Scope type HF　FFP MEASUREMENT OPTICS FOR HIGH POWER LASER

Far field pattern measurement optics, customized especially for output ~10W class high power laser.



M-Scope type HF is optics for measuring FFP(Far-Field Pattern) of output 1~10 W class high power laser. After passing through f-θ lens, the luminous flux from sample is 99.99% attenuated by two-stage beam sampler, and imaged on the detector.

**【Features】**
○Uses specially designed f-θ lens module for high power laser measurement
○Attenuation of incident beam with two-stage beam sampler and ND filters
○High-performance FFP measurement system can be constructed by using Synos' optical beam analysis module AP013 together.

**【Optics selection】** * Please contact us regarding the measurement wavelength.
○for 850-940nm　**M-Scope type HF/NIR**

**【Summary of specification】**
○Measurement method: Dedicated f−θ optics & image processing
○Attenuation method: Approx. 99.99% attenuated by two-stage beam sampler, and ND filter (combined)
○Polarization dependent compensation: Compensated by 2-stage orthogonal arrangement of attenuation mirrors in beam sampler
○Target input power: Approx. ~10W
○Measurement luminous flux diameter: Approx. 3mmφ
○W.D.: Approx. 4mm±0.4mm
○Intermediate lens: 1×
○Camera mount: C mount

**【Standard component】**
○Main optics: 1
○Optics base: 1

**【Option】**
○Accessories for optics
●ND filter (dedicated φ35mm), optics bench, etc.

**【Available detector, measurement angle, pixel resolution】**

| Detector | 1″ CMOS detector　ISA061 | |
|---|---|---|
| Spectral range | 400~1100nm | |
| Total pixels | 2048×2048 pixels | |
| Pixels pitch | 5.5μm sq. | |
| Meas. angle/ Pixel resolution | Measurement angle | Pixel resolution |
| | approx.±43°/N.A. 0.68 | Approx. 0.05° |

## M-Scope type HF+　FFP MEASUREMENT OPTICS FOR HIGH POWER LASER (LARGE EMITTING AREA)

Far field pattern measurement optics, customized especially for high power laser having large emitting area device.

**M-Scope type HF+** is optics for measuring FFP(Far-Field Pattern) of output 1~10 W class high power laser, covering large luminous flux diameter of approx. 10mmφ.

**【Features】**
○Covers large luminous flux diameter of approx. 10mmφ.
○Uses specially designed f-θ lens module for high power laser measurement
○Attenuation of incident beam with beam sampler and ND filters
○High-performance FFP measurement system can be constructed by using Synos' optical beam analysis module AP013 together.

**【Optics selection】** * Please contact us regarding the measurement wavelength.
○for 850-940nm　**M-Scope type HF+/NIR**

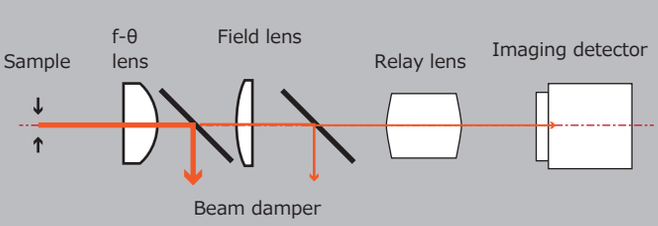
**【Summary of specification】**
○Measurement method: Dedicated f−θ optics & image processing
○Attenuation method: Approx. 90% attenuated by beam sampler, and ND filter (combined)
○Target input power: Approx. ~10W
○Measurement luminous flux diameter: Approx.10mmφ
○W.D.: Approx. 30mm
○Camera mount: C mount

**【Standard component】**
○Main optics: 1
○Optics base: 1

**【Option】**
○Accessories for optics
●ND filter (dedicated φ30mm), optics bench, etc.

**【Available detector, measurement angle, pixel resolution】**

| Detector | 2/3″ CCD detector　ISA011-01 | |
|---|---|---|
| Spectral range | 400~1100nm | |
| Total pixels | 1392×1040 pixels | |
| Pixels pitch | 6.45μm sq. | |
| Meas. angle/ Pixel resolution | Measurement angle | Pixel resolution |
| | approx.±12°/N.A. 0.2 | Approx. 0.026° |

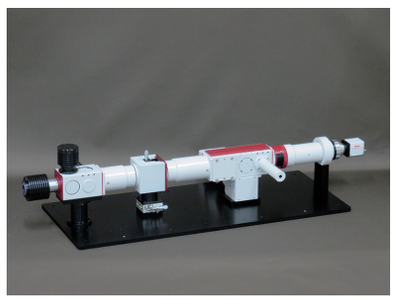



**☞Technical information【Simple structure of M-Scope type HF】**
The light flux emitted from the sample is attenuated to approximately 99.99% by two beam samplers installed in the latter stage of f-θ lens. The beam reflected by the beam sampler is absorbed by the beam damper installed in the optical system. The beam that has passed through the beam sampler is further attenuated to an appropriate amount by ND filter and then introduced to image detector for image processing analysis.

The f-θ lens module uses a high-power laser compatible lens module that takes into consideration damage caused by high-power lasers.

## M-Scope type HD/BL　NFP/FFP SIMULTANEOUS MEASUREMENT OPTICS FOR BLUE HIGH POWER LASER

NFP/FFP simultaneous measurement optics, customized especially for output ~10W class high power blue laser.



**M-Scope type HD** is the optics for simultaneous measurement of NFP and FFP for output 1~10W class high power blue lasers by single optical unit. After passing through the objective lens, the luminous flux emitted from the sample is 99.99% attenuated by two-stage beam sampler unit, and imaged on the detector. The optical system is equipped with an NFP measurement port and an FFP measurement port. Luminous flux incident on the optical system is branched to each measurement port. In this way, NFP measurement and FFP measurement can be performed simultaneously with a single optical system.

**【Features】**

○Simultaneous NFP and FFP measurement of high power blue laser by single optical unit
○Attenuation of incident beam with two-stage beam sampler and ND filters
○In combination with a coaxial epi-illumination, alignment by microscopic image is possible.
○High-performance NFP measurement system can be constructed by using Synos' optical beam analysis module AP013 together.

**【Optics selection】** * Please contact us regarding the measurement wavelength.

○for 400-460nm　**M-Scope type HF/BL**

**【Summary of specification】**

○Measurement method: Dedicated NFP/FFP simultaneous measurement optics & image processing
○Attenuation method: Approx. 99.99% attenuated by two-stage beam sampler, and ND filter (combined)
○Polarization dependent compensation: Compensated by 2-stage orthogonal arrangement of attenuation mirrors in beam sampler
○Target input power: Approx. ~10W
○Objective lens: 50× (fixed, NUV objective lens M-Plan Apo NUV 50×)
○N.A.: 0.42
○W.D.: Approx. 15mm
○Epi-illumination: Option
○Intermediate lens: 1×
○Camera mount: C mount

**【Available detector, field of view, measurement angle, pixel resolution】**

| | | | | |
|---|---|---|---|---|
| Detector | High resolution CMOS detector ISA071/ISA071GL | | | |
| Spectral range | 400~1100nm | | | |
| Total pixels | 2048×1536 pixels | | | |
| Pixels pitch | 3.45μm sq. | | | |
| Objective lens | M-Plan Apo NUV 50× | | | |
| Meas. flux diameter | Approx. 0.1mm | | | |
| Measurement item | FFP (unit:degree) | | NFP (unit:μm) | |
| Meas. angle/field of view/resolution | Meas. angle | Resolution | Field of view | Resolution |
| | Approx.±24° | Approx.0.037° | Approx. 140×100 | Approx. 0.069 |

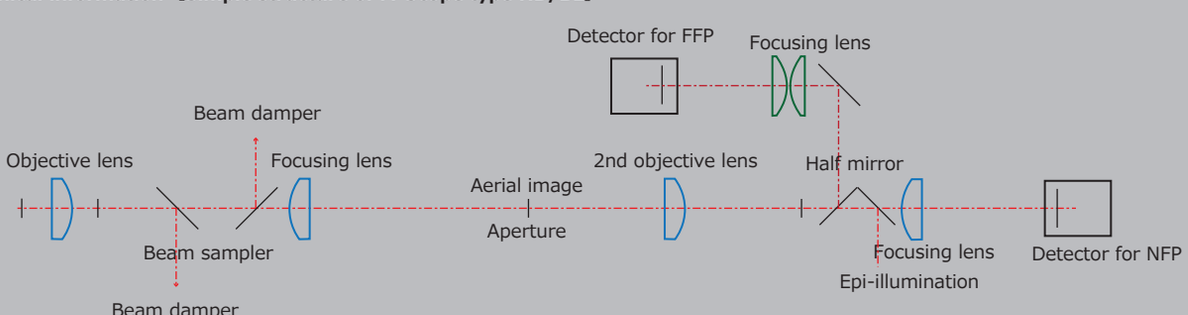
**【Option】**

○Objective lens (for NFP/image observation)
　●NUV objective lens M-Plan Apo NUV 50
○●2× intermediate lens port　MS-OP016-RL2
　Intermediate lens unit that doubles the overall magnification of the optical system.
　●1/2× intermediate lens port　MS-OP016-RLH
　Intermediate lens unit that halves the overall magnification of the optical system.
　●Coaxial epi-illumination port　MS-OP016-CEP
　Coaxial epi-illumination port with removable half mirror.
○Accessories for optics
　●Objective lens, ND filter, coaxial epi- illumination light source, etc.

**【Standard component】**

○Main optics:　1
○Optics base:　1

☞☞**Technical information【Simple structure of M-Scope type HD/BL】**




The light flux emitted from the sample is attenuated to approximately 99.99% by two beam samplers installed in the latter stage of 1st objective lens. The beam reflected by the beam sampler is absorbed by the beam damper installed in the optical system. The light flux that has passed through the beam sampler forms an aerial image through the imaging lens. After that, the light flux is split by the half mirror after the second objective lens, the transmitted light flux is relayed to the NFP detector, and the reflected light flux is relayed to the FFP detector. The image formed on the image detector for NFP/FFP is subjected to each NFP/FFP analysis by image processing analysis. An aperture can be inserted in the aerial image part in the middle of the optical path.

## ○*GLOSSARY【OPTICAL SYSTEM RELATED】*

**●NFP**

**NFP** is an abbreviation for Near Field Pattern and is also called a near-field image. The NFP can be used by the surface distribution of the spot light intensity at the emitting end face of the light emitting element such as an optical fiber or LD, the MFD measurement of the single mode fiber, the evaluation of the excitation state of the GI multimode fiber and the emission point size measurement of the light emitting element, etc.

**●FFP**

FFP is an abbreviation for Far Field Pattern and is also called a far-field image. The FFP can be used by intensity (angle) distribution of the light emitted from the light emitting element such as an optical fiber or LD at a location sufficiently distant from the emission end face, measurement of the divergence angle of the emitted light of the single mode fiber or the light emitting element, evaluation of the excitation state of the SI multimode fiber, etc. In addition, before, it was difficult to obtain a highly accurate two-dimensional image sensor in the communication band wavelength (1.31/1.55μm), so the method of calculating MFD in the communication band SMF from FFP measurement data has been standardized.

**●f-θ lens**

A lens designed so that the image height at the imaging position of incident light at a certain angle θ is f×θ. It has barrel-shaped distortion that makes it an equidistant projection. It is used as a lens for FFP measurement and as a lens for laser lithography equipment because it has a linear relationship between the amount of change in the image position and the amount of change in the angle.

**●FFP measurement with objective lens**

Our optical system (**M-Scope Type D**) can measure NFP and FFP at the same time. In this optical system, the FFP is measured using an objective lens instead of the f-θ lens. However, since the objective lens is used, there is a deviation from the f-θ characteristic in the peripheral part of the field of view, which causes a slight decrease in measurement accuracy.

**●Beam sampler**

A device that reflects a small amount of light by using the surface reflection of optical glass and crystal substrates, and performs optical sampling for monitoring. There is a parallel plate or wedge plate type, and the wedge plate type can prevent the influence of reflection on the back side. In our company, there is a beam sampler that uses a dielectric multilayer mirror to transmit a small amount of light instead of using the reflection on the substrate surface.

**●Beam damper**

It is an optical device that safely blocks high-power laser beams and is also called a beam block or beam trap. A light beam is terminated by absorbing a laser beam and converting it into heat by using a material having an absorption characteristic for the internal structure. We use it to terminate unnecessary light other than sampling light when analyzing the beam profile of high-power light.

**●N.A.**

The N.A. is abbreviation for numerical aperture. It called the numerical aperture.

◎In case of lens

The N.A. of the lens is expressed by the following formula, where θmax is the maximum angle of the light beam incident on the objective lens from the object with respect to the optical axis, and n is the refractive index of the medium between the object and the objective lens. (Note that this is not the refractive index of the lens)

$$NA = n \sin\theta$$

◎In case of optical fiber

The N.A. of an optical fiber is given by the following formula when the maximum incident angle θmax is the incident angle at which light is totally reflected in the core. (When the refractive index on the output side is 1.) Light incident from an angle outside this range cannot propagate in the optical fiber.

$$NA = \sin\theta_{max} = n_1 \sqrt{2\frac{n_1^2 - n_2^2}{2n_1^2}}$$

*n1: Refractive index of core n2: Refractive index of clad*

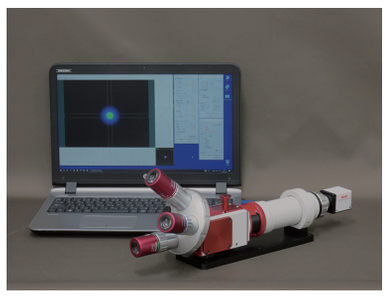
**●W.D.**

The W.D. is abbreviation for working distance. It called working distance. It is the distance from the lens tip to the subject.

## OPTICAL BEAM NFP MEASUREMENT SYSTEM

High performance optical beam profile measurement and analysis system in combination with NFP measurement optics & image processing.

**Optical beam NFP measurement system** is a general-purpose high-performance optical beam profiler system with image processing method that can be widely applied from observation and measurement of optical beam profile of light emitting element, optical fiber, optical waveguide, various optical modules, etc. to emission characteristic analysis.



**【Features】**

○**M-Scope type S**, sophisticated NFP measurement optics
- ● Equipping manual revolver to switch multiple objective lens
- ● Microscope image observation is possible with the coaxial epi-illumination system (option)

○Possible to measure in 400nm to 1700nm wavelength range by selecting detector.

○Optical beam analysis module **AP013**, specially designed high-functional image processing software for optical beam profile analysis
- ● All-in-one package of PC, optical beam analysis software, detector driver, correction data.
- ● High-performance image processing software for optical beam profile measurement **Optimetrics BA Standard** is pre-installed.

○It is also possible to build a low-cost system using the simplified NFP measurement optical system **M-Scope type L**.

**【Standard component】**

○NFP measurement optics selection
- ● Sophisticated NFP measurement optics **M-Scope type S** : Equipped with manual revolver, high functionality and expandability
- ● Simplified NFP measurement optics **M-Scope type L** : Monocular type, not compatible with epi-illumination

○Available detector selection
- ● 400~1100nm : Hi-resolution CMOS detector **ISA071/ISA071GL**
- ● 950~1700nm : InGaAs high sensitivity NIR detector **ISA041H2**
- ● 400~1700nm: InGaAs high resolution NIR derector **ISA041HRA**

☞Regarding the field of view and pixel resolution during NFP measurement by the detector used, please refer to P50 【Detector selection and NFP measurement specifications】

☞ Other detectors can also be used.

○Optical beam analysis module **AP013**
- ● PC for image processing, optical beam analysis software **Optometrics BA Standard**, detector driver, calibration data, USB key

○Accessories
- ● Cables, instruction manuals, etc.

**【Option】**

○Objective lens selection
- ● Select the objective lens according to the optical magnification (field of view), pixel resolution, N.A., wavelength, etc.

○Option for optics (for **M-Scope type S**)
- ● 2× intermediate lens port **MS-OP011-RL2** : Intermediate lens unit that doubles the overall magnification
- ● 1/2× intermediate lens port **MS-OP011-RLH** : Intermediate lens unit that halves the overall magnification
- ● Coaxial epi-illumination port **MS-OP011-CEP** : Coaxial epi-illumination port with removable half mirror

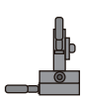
○ND filter
- ● Visible (400~700nm): **NDF-5** (5 types per set)
- ● NIR (700~1100nm): **NDF NIR-5** (5 types per set)
- ● IR (1310~1550nm): **NDF IR-5** (5 types per set)

○Coaxial epi-illumination light source (for M-Scope type S)
- ● Visible~NIR: LED epi-illumination system
- ● IR: 950nm IR-LED epi-illumination system (for InGaAs-type detectors)

○Optics bench
- ● Optics bench for fiber measurement with manual stages
- ● Vertical setting optics bench

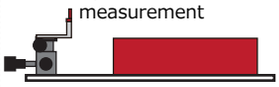
**【Component selection of optical beam NFP measurement system】**

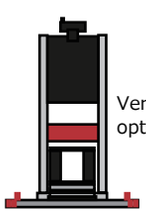
○Stages・optics bench



Sample stages
Optics stages

Optics bench for fiber measurement



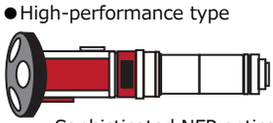


Vertical setting optics bench

＊Can be combined with various motorized/manual stages

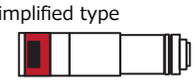
○NFP measurement optics selection

●High-performance type



Sophisticated NFP optics
**M-Scope type S**

●Simplified type

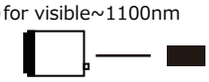


Simplified NFP optics
**M-Scope type L**

●Option for **M-Scope type S**
- ・2× intermediate lens port **MS-OP011-RL2**
- ・1/2× intermediate lens port **MS-OP011-RLH**
- ・Coaxial epi-illumination port **MS-OP011-CEP**

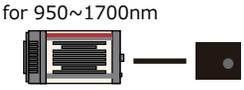
○Detector selection

●for visible~1100nm



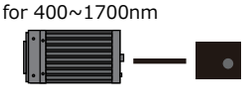
High resolution CMOS detector **ISA071**

●for 950~1700nm



InGaAs high sensitivity NIR detector **ISA041H2**

●for 400~1700nm



InGaAs high resolution NIR detector **ISA041HRA/HRVA**

*Detectors other than the above can also be used.

○Optical beam analysis module **AP013**

●Personal computer
- ・Main unit
- ・Accessories

●Optical beam analysis software **Optometrics BA Standard**
●Detector driver
●Calibration data
●USB licence key

○Accessories

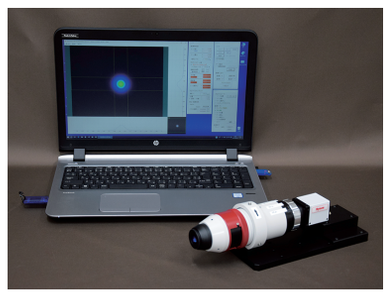
●ND filter

●Objective lens

●Coaxial epi-illumination system (for **M-Scope type S**)

## FFP MEASUREMENT SYSTEM

FFP measurement and analysis system in combination with dedicated FFP measurement optics & image processing method.



**FFP (far field pattern) measurement system** is for measuring FFP (far field pattern) of semiconductor lasers, optical fibers, optical waveguides, various optical modules and so on. With dedicated f-θ lens optics and image processing method, it can be applied to FFP measurement, radiation angle distribution measurement, emission N.A. measurement and analysis of various optical devices.

**【Features】**

○**M-Scope type F**, FFP measurement optics
- ● Quick and easy measurement by dedicated f-θ lens optics and image processing method.
- ● Long working distance design with the working distance of approx. 6±0.8mm.

○Possible to measure in 400nm to 1700nm wavelength range by selecting detector.

○Optical beam analysis module **AP013**, specially designed high-functional image processing software for optical beam profile analysis
- ● All-in-one package of PC, optical beam analysis software, detector driver, correction data.
- ● High-performance image processing software for optical beam profile measurement **Optimetrics BA Standard** is pre-installed.

**【Standard component】**

○FFP measurement optics selection
- ● 650~1700nm:**M-Scope type F**
- ● 400-650nm:**M-Scope type F/BL**

○Available detector selection
- ● 400-1100nm : Hi-resolution CMOS detector **ISA071/ISA071GL**
- ● 950-1700nm : InGaAs high sensitivity NIR detector **ISA041H2**
- ● 400~1700nm : InGaAs high resolution NIR detector **ISA041HRA**

☞Regarding the measurement angle coverage and pixel resolution during FFP measurement by the detector used, please refer to P50 【Detector selection and FFP measurement specifications】

○Optical beam analysis module **AP013**
- ● PC for image processing, optical beam analysis software **Optometrics BA Standard**, detector driver, calibration data, USB key

○Accessories
- ● Cables, instruction manuals, etc.

**【Option】**

○ND filter
- ● Visible (400~700nm): **NDF-5** (5 types per set)
- ● NIR (700~1100nm): **NDF NIR-5** (5 types per set)
- ● IR (1310~1550nm): **NDF IR-5** (5 types per set)

○Optics bench
- ● Optics bench for fiber measurement with manual stages
- ● Vertical setting optics bench

### ● HIGH RESOLUTION FFP MEASUREMENT OPTICS FOR IR RANGE

High-resolution IR FFP measurement system exclusively for the 1310~1550 nm spectral range

**【Standard component】**

○High resolution FFP measurement optics for IR **M-Scope type FHR**

○VGA-type InGaAs NIR detector **ISA041VH**

○Optical beam analysis module **AP013**

【Option】

○IR ND filter, optics bench, etc.

**【Available detector, angle coverage, pixel resolution (approx.)】**

| | | |
|---|---|---|
| Detector | VGA-type InGaAs NIR detector **ISA041VH** | |
| Spectral range | 950~1700nm | |
| Total pixels | 640×512 pixels | |
| Pixels pitch | 20μm sq. | |
| Meas. angle / pixel resolution | Meas. angle | Pixel resolution |
| | ±32°(V)×±25.6°(H) | 0.1° |

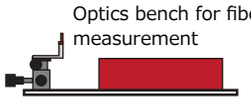
*Pixel resolution: Measured angle equivalent to the detector pixel calculated from measured angle range and sensor pitch of the detector.

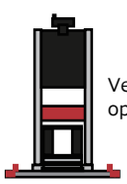
**【Component selection of FFP measurement system】**

○Stages・optics bench

Sample stages
Optics stages

Optics bench for fiber measurement

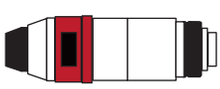




Vertical setting optics bench

＊Can be combined with various motorized/manual stages

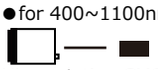
○FFP measurement optics selection



●M-Scope type F (for 650-1700nm)
●M-Scope type F/BL (for 400-650nm)

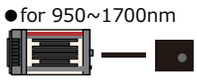
○Detector selection

●for 400~1100nm



Hi-resolution CMOS detector **ISA071/ISA071GL**

●for 950~1700nm



InGaAs NIR detector **ISA041H2・ISA041HRA**

○Optical beam analysis module **AP013**

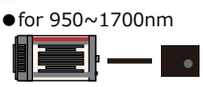
●Personal computer
・Main unit
・Accessories

●Optical beam analysis software **Optometrics BA Standard**
●Detector driver
●Calibration data
●USB licence key

○High resolution IR FFP measurement optics

●M-Scope type FHR (for 1300-1600nm)

●for 950~1700nm



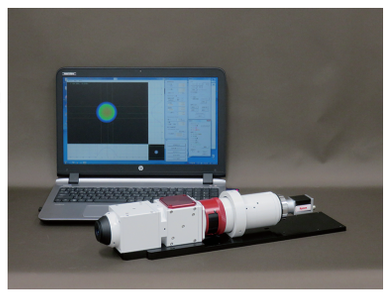
VGA-type InGaAs NIR detector ISA041VH

○Accessories

●ND filter

## WIDE AREA FFP MEASUREMENT SYSTEM

FFP measurement and analysis system in combination with dedicated wide area FFP measurement optics & image processing method.



**Wide area FFP measurement system** is a radiation angle distribution (far field pattern) measurement system that uses wide area FFP measurement optics **M-Scope type FW** with the measurement target luminous flux diameter of about 3 mm. It is suitable for FFP measurement, emission angle distribution measurement, N.A. measurement and analysis of beam emitted from a large area light emitting elements or large core optical fibers.

**【Features】**

○**M-Scope type FW**, wide area FFP measurement optics
- ● Quick measurement by dedicated wide area f-θ lens optics and image processing method.
- ● Covers samples with a wide emission area with a luminous flux diameter of about 3 mmφ.
- ● Long working distance design with the working distance of approx. 4mm±0.4mm.

○Possible to measure in 400nm to 1700nm wavelength range by selecting detector.

○Optical beam analysis module **AP013**, specially designed high-functional image processing software for optical beam profile analysis
- ● All-in-one package of PC, optical beam analysis software, detector driver, correction data.
- ● High-performance image processing software for optical beam profile measurement **Optimetrics BA Standard** is pre-installed.

**【Standard component】**

○Wide area FFP measurement optics selection
- ● 650~1700nm: **M-Scope type FW**
- ● 400~650nm: **M-Scope type FW/BL**

○Available detector selection
- ● 400~1100nm : 1″ CMOS detector **ISA061**
- ● 950~1700nm : VGA InGaAs NIR detector **ISA041VH**

○Optical beam analysis module **AP013**
- ● PC for image processing, optical beam analysis software **Optometrics BA Standard**, detector driver, calibration data, USB key

○Accessories
- ● Cables, instruction manuals, etc.

**【Option】**

○Dedicated φ35mm ND filter
- ● NIR (700~1100nm): **NDF NIR35-5** (5 types per set)
- ● IR (1310~1550nm): **NDF IR35-5** (5 types per set)

○Optics bench
- ● Optics bench for fiber measurement with manual stages
- ● Vertical setting optics bench

**【Available detectors, angle coverage, pixel resolution (approx.)】**

| Detector | 1″ CMOS detector **ISA061** | | VGA InGaAs NIR detector **ISA041VH** | |
|---|---|---|---|---|
| Spectral range | 400~1100nm | | 950~1700nm | |
| Total pixels | 2048×2048 pixels | | 640×512 pixels | |
| Pixels pitch | 5.5μm sq. | | 20μm sq. | |
| Meas. angle / | Meas. angle | Resolution | Meas. angle | Resolution |
| Pixel resolution | approx. ±43° N.A. 0.68 | approx. 0.05° | approx. ±43° (H)×±40°(V) | approx. 0.167° |

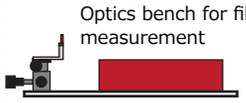
*Pixel resolution: Measured angle equivalent to the detector pixel calculated from measured angle range and sensor pitch of the detector.

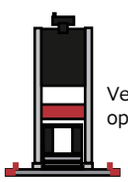
**【Component selection of wide area FFP measurement system】**

○Stages・optics bench

Sample stages
Optics stages

Optics bench for fiber measurement





Vertical setting optics bench

＊Can be combined with various motorized/manual stages

○Wide area FFP measurement optics selection

Wide area FFP measurement optics
M-Scope type FW

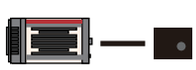
- ● M-Scope type FW (for 650-1700nm)
- ● M-Scope type FW/BL (for 400-650nm)

○Detector selection

● for 400~1100nm

1″ CMOS detector
ISA061

● for 950-1700nm



VGA InGaAs NIR detector
ISA041VH

○Optical beam analysis module **AP013**

- ● Personal computer
  - ・Main unit
  - ・Accessories

- ● Optical beam analysis software **Optometrics BA Standard**
- ● Detector driver
- ● Calibration data
- ● USB licence key

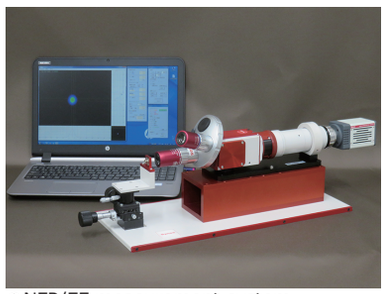
○Accessories

35φ ND filter

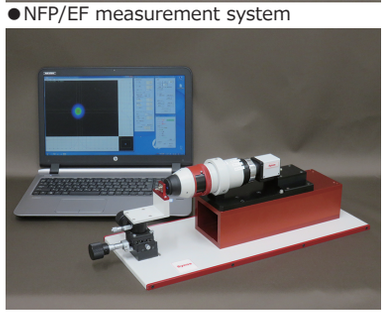
## EF (ENCIRCLED FLUX) ANALYSIS SYSTEM & EAF (ENCIRCLED ANGULAR FLUX) ANALYSIS SYSTEM

Rapid evaluation of encircled flux and encircled angular flux parameter of multi-mode optical fiber.

**EF (Encircled Flux) and EAF (Encircled Angular Flux) measurement system** is to measure the mode diffusion of GI/SI type multimode optical fibers with image processing of NFP and FFP images. NFP measurement optics **M-Scope type S/L** and FFP measurement optics **M-Scope type F/FW** are used as measurement optics. EF/EAF measurement can be performed quickly and easily by optical beam analysis software **Optometrics BA Standard**.



●NFP/EF measurement system



●FFP/EAF measurement system

**☞Technical information【EF (Encircled Flux) · EAF (Encircled Angular Flux) analysis】**

○**EF/EAF analysis**
Since the loss of multimode optical fiber changes depending on the launch condition, it is necessary to specify the launch condition during measurement. EF/EAF analysis is used as a new measurement method to define its launch condition. In particular, EF/EAF analysis plays an important role in high-speed multimode optical fiber transmission.

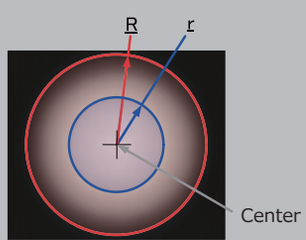
○**EF (Encircled Flux) analysis**
'EF' is the value obtained by analyzing the NFP image of the end face of optical fibers and integrating the distribution of beam intensity from the center toward the outer periphery. It is an index that shows what proportion of the mode distribution to the total intensity exists in the range from the center to the radius(r), and is shown in the following figure, calculation formula, and graph.

○**EAF (Encircled Angular Flux) analysis**
'EAF' is the value obtained by analyzing output FFP image of optical fibers and integrating the intensity distribution of the output angle from the center toward the spread direction (N.A.) of the output angle, and is shown in the following figures, formulas and graphs.

○**EF/EAF analysis and type of optical fiber to be measured**
Generally, EF analysis is applied to GI type (graded index type optical fiber), and EAF analysis is applied to SI type (step index type optical fiber).

○**Measurement standard**
In order to support high-speed transmission such as 10 Gbps, encircled flux measurement method is specified by IEC61280-1-4 as a new method for defining the excitation conditions for GI type multimode optical fibers. On the other hand, regarding SI type multimode optical fiber, encircled angular flux measurement method is specified in IEC61300-3053.

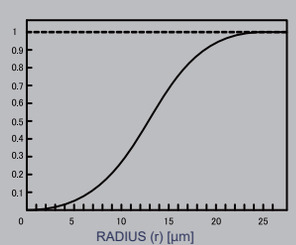
**【Figure, formula, graph of EF/EAF analysis】**



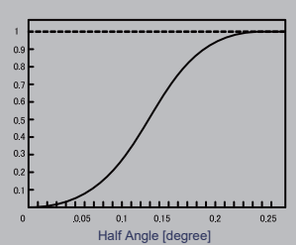

●EF/EAF analysis

$$EF = \frac{\int_0^r x \cdot I(x)\,dx}{\int_0^R x \cdot I(x)\,dx}$$

●EF/EAF formula




●EF graph
*horizontal axis: radius(r)




●EAF graph
*horizontal axis: half angle(degree)

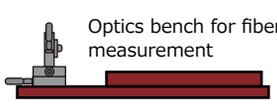
**【Features】**

○Realization of quick and easy EF/EAF measurement by dedicated optics and image processing method
○Possible to measure in 400nm to 1700nm wavelength range by selecting detector.
○Optical beam analysis module **AP013**, specially designed high functional image processing software for beam profile analysis
- ●All-in-one package of PC, optical beam analysis software, detector driver, correction data.
- ●High-performance image processing software for optical beam profile measurement **Optimetrics BA Standard** is pre-installed. In addition to the general-purpose beam profiler analysis function, EF/EAF measurement function is enhanced and standardized parameter measurement function is installed.

○Optional special launch system (underfilled launch optics, mode-selective launch system), mode conditioner, and various light sources are also available

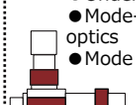
**【Component selection of EF/EAF measurement system】**

○Stages · optics bench



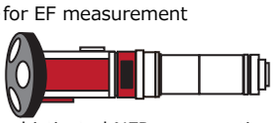
Optics bench for fiber measurement

○Light source etc.
- ●Underfilled launch optics
- ●Mode-selective launch optics
- ●Mode conditioner



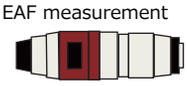
SLD light source
LD light source etc.

○Optics selection
●for EF measurement



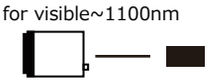
Sophisticated NFP meas. optics
**M-Scope type S**
· option
Coaxial epi-illumination port
**MS-OP011-CEP**

●for EAF measurement



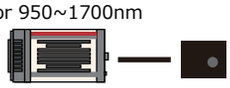
FFP measurement optics
**M-Scope type F**

○Detector selection
●for visible~1100nm



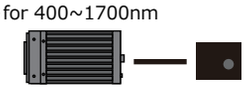
High resolution CMOS detector **ISA071**

●for 950~1700nm



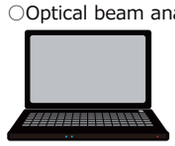
InGaAs high sensitivity NIR detector **ISA041H2**

●for 400~1700nm



InGaAs high resolution NIR detector **ISA041HRA/HRVA**

○Optical beam analysis module **AP013**



●Personal computer
· Main unit
· Accessories

●Optical beam analysis software **Optometrics BA Standard**
●Detector driver
●Calibration data
●USB licence key

○Accessories

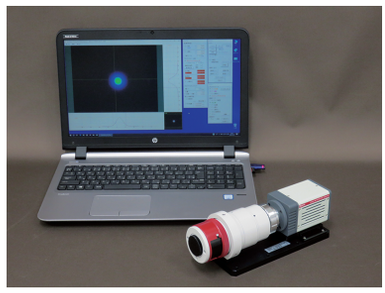
Objective lens (M-Scope type S)

Coaxial epi-illumination system (M-Scope type S)

ND filter

## COLLIMATED BEAM MEASUREMENT SYSTEM

Collimated beam pattern measurement system in combination with collimated beam measurement optics & image processing.



**Collimated beam measurement system** is for measurement of beam divergence angle of collimated beam with high resolution by image processing method. Since the beam divergence angle of collimated beam can be observed and measured in real time, it can be used for beam quality evaluation of collimator modules and assembling adjustment of collimator lenses, etc.

**【Features】**

○**M-Scope type C**, collimated beam measurement optics
- ● Quick and easy measurement by dedicated optics and image processing method.
- ● Divergence angle of collimated beam can be observed and measured in real time with high angular resolution.

○Possible to measure in 400nm to 1700nm wavelength range by selecting detector.

○Optical beam analysis module **AP013**, specially designed high-functional image processing software for optical beam profile analysis
- ● All-in-one package of PC, optical beam analysis software, detector driver, correction data.
- ● High-performance image processing software for optical beam profile measurement **Optimetrics BA Standard** is pre-installed.

○By combining with various automatic precision positioning stages and image processing, it is possible to automate the collimated beam adjustment process for collimator module assembling adjustment.

**【Standard component】**

○Collimated beam measurement optics selection
- ● Focal length 200mm:**M-Scope type C/200**
- ● Focal length 150mm:**M-Scope type C/150**
- ● Focal length 100mm:**M-Scope type C/100**

○Available detector selection
- ● 400~1100nm : Hi-resolution CMOS detector **ISA071/ISA071GL**
- ● 950~1700nm : InGaAs NIR detector **ISA041H2**
- ● 400~1700nm : InGaAs high resolution NIR detector **ISA041HRA**

☞Regarding the measurement angle coverage and pixel resolution during collimated beam measurement by the detector used, please refer to P50【Detector selection and collimated beam measurement specifications】

○Optical beam analysis module **AP013**
- ● PC for image processing, optical beam analysis software **Optometrics BA Standard**, detector driver, calibration data, USB key

○Accessories
- ● Cables, instruction manuals, etc.

**【Option】**

○Objective lens
- ●NFP measurement is also possible if an objective lens is attached. Select the objective lens according to the optical magnification (field of view), pixel resolution, N.A., wavelength, etc.

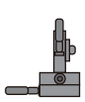
☞Regarding the field of view and pixel resolution during NFP measurement by the detector used, please refer to P51【Detector selection and NFP measurement specifications】

○ND filter
- ● Visible (400~700nm): **NDF-5** (5 types per set)
- ● NIR (700~1100nm): **NDF NIR-5** (5 types per set)
- ● IR (1310~1550nm): **NDF IR-5** (5 types per set)

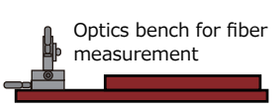
○Optics bench
- ● Optics bench for fiber measurement with manual stages
- ● Vertical setting optics bench

**【Component selection of collimated beam measurement system】**

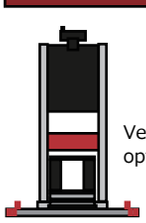
○Stages・optics bench



Sample stages
Optics stages



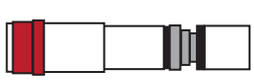
Optics bench for fiber measurement



Vertical setting optics bench

＊Can be combined with various motorized/manual stages

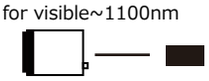
○FFP measurement optics selection



Collimated beam measurement optics
M-Scope type C/200
M-Scope type C/150
M-Scope type C/100

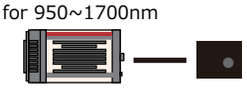
○Detector selection

●for visible~1100nm



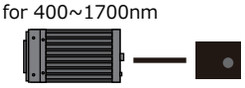
High resolution CMOS detector **ISA071**

●for 950~1700nm



InGaAs high sensitivity NIR detector **ISA041H2**

●for 400~1700nm



InGaAs high resolution NIR detector **ISA041HRA/HRVA**

○Optical beam analysis module **AP013**

- ●Personal computer
  - ・Main unit
  - ・Accessories
- ●Optical beam analysis software **Optometrics BA Standard**
- ●Detector driver
- ●Calibration data
- ●USB licence key

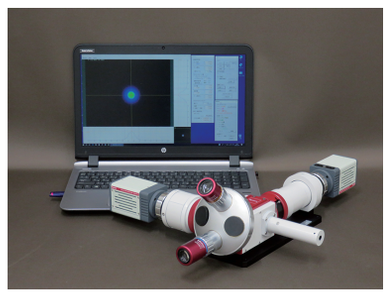
○Accessories

ND filter

Objective lens

## NFP/FFP SIMULTANEOUS MEASUREMENT SYSTEM

Simultaneous measurement of NFP & FFP by a single optical unit.



**NFP/FFP Simultaneous measurement system** realizes simultaneous observation and analysis of NFP and FFP by a single optical unit. Previously, for measurement and analysis of NFP and FFP by optical method, dedicated two kinds of optics, NFP and FFP measurement optics are needed each. **NFP&FFP simultaneous measurement system with M-Scope type D** realized simultaneous observation and analysis of NFP and FFP without changing optics.

**【Features】**

○**M-Scope type D**, NFP/FFP simultaneous measurement optics
- ●Simultaneous observation & analysis of NFP and FFP by a single optical unit.

○Working distance during FFP measurement is approx. 17 mm.

○Possible to measure in 400nm to 1700nm wavelength range by selecting detector.

○Optical beam analysis module **AP013**, specially designed high-functional image processing software for optical beam profile analysis
- ●All-in-one package of PC, optical beam analysis software, detector driver, correction data.
- ●High-performance image processing software for optical beam profile measurement **Optimetrics BA Standard** is pre-installed.

**【Standard component】**

○Optics
- ● NFP/FFP simultaneous measurement optics **M-Scope type D**

○Measurement wavelength
- ●Please specify the measurement wavelength because AR coating to some optical parts is required.

○Available detectors selection
- ●400~1100nm : Hi-resolution CMOS detector **ISA071/ISA071GL**
- ●950~1700nm : InGaAs high sensitivity NIR detector **ISA041H2**
- ●400~1700nm : InGaAs high resolution NIR detector ISA041HRA

☞Regarding the field of view and pixel resolution during NFP measurement and the measurement angle coverage and pixel resolution during FFP measurement by the detector used, please refer to P50【Detector selection and NFP/FFP simultaneous measurement specifications】

○Optical beam analysis module **AP013**
- ● PC for image processing, optical beam analysis software **Optometrics BA Standard**, detector driver, calibration data, USB key

○Accessories
- ● Cables, instruction manuals, etc.

**【Option】**

○Objective lens selection
- ●Objective lens for FFP measurement: 50× (fixed)
- ●Objective lens for NFP measurement: Selectable

○Option for optics (for **M-Scope type D**)
- ●2× intermediate lens port **MS-OP011-RL2** : Intermediate lens unit that doubles the overall magnification
- ●1/2× intermediate lens port **MS-OP011-RLH** : Intermediate lens unit that halves the overall magnification
- ●Coaxial epi-illumination port **MS-OP011-CEP** : Coaxial epi-illumination port with removable half mirror

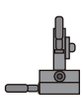
○ND filter
- ●Visible (400~700nm): **NDF-5** (5 types per set)
- ●NIR (700~1100nm): **NDF NIR-5** (5 types per set)
- ●IR (1310~1550nm): **NDF IR-5** (5 types per set)

○Coaxial epi-illumination light source
- ●Visible~NIR : LED epi-illumination system
- ●IR : 950nm IR-LED epi-illumination system

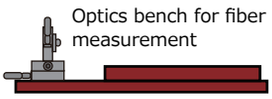
○Optics bench
- ●Optics bench for fiber measurement with manual stages
- ●Vertical setting optics bench

**【Component selection of NFP/FFP simultaneous measurement system】**

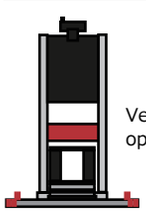
○Stages・optics bench



Sample stages
Optics stages



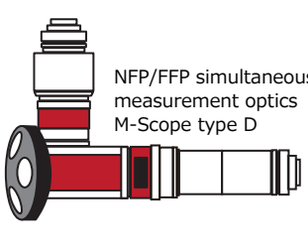
Optics bench for fiber measurement



Vertical setting optics bench

＊Can be combined with various motorized/manual stages

○Optics selection

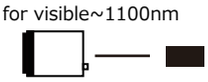


NFP/FFP simultaneous measurement optics
M-Scope type D

●Option
- ・2× intermediate lens port **MS-OP011-RL2**
- ・1/2× intermediate lens port **MS-OP011-RLH**
- ・Coaxial epi-illumination port **MS-OP011-CEP**

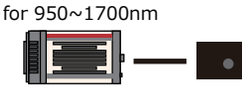
○Detector selection

●for visible~1100nm



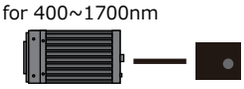
High resolution CMOS detector **ISA071**

●for 950~1700nm



InGaAs high sensitivity NIR detector **ISA041H2**

●for 400~1700nm



InGaAs high resolution NIR detector **ISA041HRA/HRVA**

○Optical beam analysis module **AP013**

●Personal computer
・Main unit
・Accessories

●Optical beam analysis software **Optometrics BA Standard**
●Detector driver
●Calibration data
●USB licence key

○Accessories

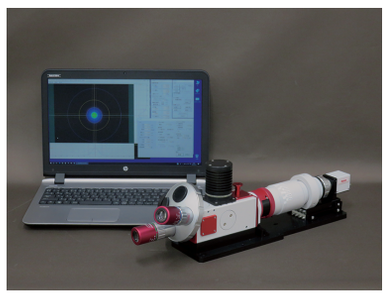
●ND filter

●Objective lens

●Coaxial epi-illumination system

## SOPHISTICATED OPTICAL BEAM NFP MEASUREMENT SYSTEM FOR HIGH POWER LASER

Optical beam profile and NFP measurement system especially targeting for high power laser.



**Sophisticated optical beam NFP measurement system for high power laser** is a high-performance optical beam profile measurement system targeting for ~10W class high power laser. Sophisticated NFP measurement optics for high power laser **M-Scope type HS** is used. The light flux emitted from high power laser sample is attenuated by beam sampler unit after passing through objective lens, and is further attenuated by ND filter at subsequent stage . The NFP image that has been attenuated to appropriate beam power is captured and image processing analysis is performed. In addition, the radiation angle distribution (FFP) can be measured in a narrow angle range by measuring without the objective lens.

**【Features】**

○**M-Scope type HS**, sophisticated NFP measurement optics for high power laser
- Attenuation of incident beam with two-stage beam sampler and ND filters
- Can be used with a variety of high power resistant objectives (M-Plan Apo NUV/NIR series)

○Optical beam analysis module **AP013**, specially designed high-functional image processing software for optical beam profile analysis
- All-in-one package of PC, optical beam analysis software, detector driver, correction data.
- High-performance image processing software for optical beam profile measurement **Optimetrics BA Standard** is pre-installed.

**【Standard component】**

○High power laser NFP measurement optics laser selection
- 850~940nm: **M-Scope type HS/NIR**
- 400~650nm: **M-Scope type HS/BL**

*Please specify the measurement wavelength because AR coating to some optical parts is required.

○Available detector
- 400-1100nm : High resolution CMOS detector **ISA071/ISA071GL**

○Optical beam analysis module **AP013**
- PC for image processing, optical beam analysis software **Optometrics BA Standard**, detector driver, calibration data, USB key

○Accessories
- Cables, instruction manuals, etc.

**【Option】**

○Objective lens selection
- Select the objective lens according to the optical magnification (field of view), pixel resolution, N.A., wavelength, etc.

○Option for optics (for **M-Scope type HS**)
- 2× intermediate lens port **MS-OP011-RL2**
  Intermediate lens unit that doubles the overall magnification
- 1/2× intermediate lens port **MS-OP011-RLH**
  Intermediate lens unit that halves the overall magnification
- Coaxial epi-illumination port **MS-OP011-CEP**
  Coaxial epi-illumination port with removable half mirror
- Dummy filters **MS-OP016-DF**
  wedge type dummy filters for pulse/low power measurement

○ND filter (for M-Scope type HS, dedicated 30φ)
- Visible (400~700nm): **NDF 30-5** (5 types per set)
- NIR (700~1100nm): **NDF NIR 30-5** (5 types per set)

○Coaxial epi-illumination light source
- Visible~NIR: LED epi-illumination system

○Optics bench
- Optics bench for fiber measurement with manual stages
- Vertical setting optics bench

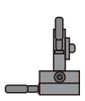
**【Detector selection, angle coverage,field of view, pixel resolution (approx. value)】**

| Detector | High resolution CMOS detector **ISA071/ISA071GL** | |
|---|---|---|
| Spectral range | 400~1100nm | |
| Sensor size | 1/1.8 inch | |
| Total pixels | 2048×1536 | |
| Pixels pitch | 3.45μm | |
| Magnification | Field of view (unit:mm) | Resolution (unit:μm) |
| 5× | 1.41×1.05 | 0.69 |
| 10× | 0.70×0.52 | 0.345 |
| 20× | 0.35×0.26 | 0.173 |
| 50× | 0.14×0.1 | 0.069 |
| 100× | 0.07×0.05 | 0.035 |
| FFP meas. (unit:degree) | Meas. angle | Resolution |
| | ±1.01x±0.75 | 0.001 |

*Pixel resolution: The measurement length equivalent to 1 pixel of the detector calculated from filed of view and sensor pitch of the detector.
*The optical magnification when using **MS-OP011-RL2** is 2 times the magnification in the table on the left, and the actual field of view and pixel resolution are 1/2. The maximum optical magnification is 200x when using a 100x objective lens.
＊The optical magnification when using the **MS-OP011-RLH** is 1/2 of each magnification in the table on the left, and the actual field of view and pixel resolution are 2 times.

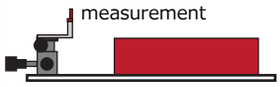
**【Component selection of high power laser NFP measurement system】**

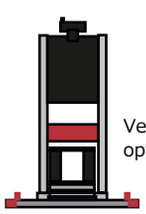
○Stages・optics bench



Sample stages
Optics stages

Optics bench for fiber measurement

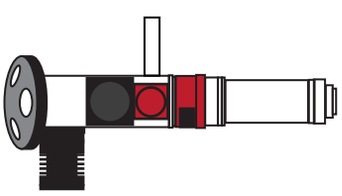




Vertical setting optics bench

＊Can be combined with various motorized/manual stages

○Optics selection

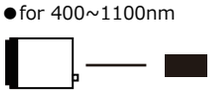


NFP measurement optics for high power laser
**M-Scope type HS**

●Option
- 2× intermediate lens port **MS-OP011-RL2**
- 1/2× intermediate lens port **MS-OP011-RLH**

○Detector selection

●for 400~1100nm



Hi-resolution CMOS detector
**ISA071/ISA071GL**

○Optical beam analysis module **AP013**

●Personal computer
- Main unit
- Accessories

●Optical beam analysis software **Optometrics BA Standard**
●Detector driver
●Calibration data
●USB licence key

○Accessories

ND filter

Objective lens
(M-Plan apo NIR/NUV)

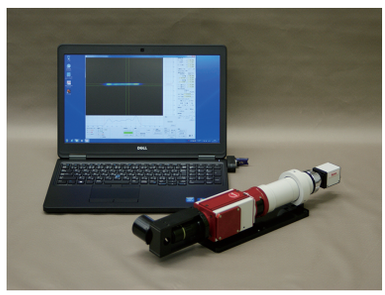
Coaxial epi-illumination system

Dummy filters
**MS-OP016-DF**
(for low power, pulse emission sample)

## SIMPLIFIED OPTICAL BEAM NFP MEASUREMENT SYSTEM FOR HIGH POWER LASER

Simplified optical beam profile and NFP measurement system especially targeting for high power laser.

**Simplified optical beam NFP measurement system for high power laser** is a optical beam profile measurement system targeting for ~10W class high power laser. NFP measurement optics for high power laser **M-Scope type HL** is used. The light flux emitted from high power laser sample is attenuated by beam sampler unit placed before objective lens, and is further attenuated by ND filter at subsequent stage. The NFP image that has been attenuated to appropriate beam power is captured and image processing analysis is performed.



**【Features】**

○**M-Scope type HL**, simplified NFP measurement optics for high power laser
- Attenuation of incident beam with beam sampler placed before objective lens and ND filters
- Optical magnification is maximum 20x (option, 10x objective lens and 2x intermediate lens)

○Optical beam analysis module **AP013**, specially designed high-functional image processing software for optical beam profile analysis
- All-in-one package of PC, optical beam analysis software, detector driver, calibration data.
- High-performance image processing software for optical beam profile measurement **Optimetrics BA Standard** is pre-installed.

**【Standard component】**

○Optics
- **M-Scope type HL**

*Please specify the measurement wavelength from 400~1100 range because AR coating to some optical parts is required.

○Objective lens
- M-Plan Apo 10× (fixed)

○Detector selection
- 400-1100nm : Hi-resolution CMOS detector **ISA071/ISA071GL**

○Optical beam analysis module **AP013**
- PC for image processing, optical beam analysis software **Optometrics BA Standard**, detector driver, calibration data, USB key

○Accessories
- Cables, instruction manuals, etc.

**【Option】**

○Option for optics (for **M-Scope type HL**)
- 2× intermediate lens port **MS-OP011-RL2**
  Intermediate lens unit that doubles the overall magnification
- 1/2× intermediate lens port **MS-OP011-RLH**
  Intermediate lens unit that halves the overall magnification
- Coaxial epi-illumination port **MS-OP011-CEP**
  Coaxial epi-illumination port with removable half mirror

○ND filter (for M-Scope type HS, dedicated 30φ)
- Visible (400~700nm): **NDF-5** (5 types per set)
- NIR (700~1100nm): **NDF NIR-5** (5 types per set)

○Coaxial epi-illumination light source
- Visible~NIR: LED epi-illumination system

○Optics bench
- Optics bench for fiber measurement with manual stages
- Vertical setting optics bench

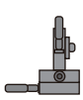
**【Detector selection, field of view, pixel resolution (approx. value)】**

| Detector | High resolution CMOS detector **ISA071/ISA071GL** | |
|---|---|---|
| Spectral range | 400~1100nm | |
| Sensor size | 1/1.8 inch | |
| Total pixels | 2048×1536 | |
| Pixels pitch | 3.45μm | |
| Magnification | Field of view (unit:mm) | Pixel resolution (unit:μm) |
| 10× | 0.7×0.52 | 0.345 |

*Pixel resolution: The measurement length equivalent to 1 pixel of the detector calculated from filed of view and sensor pitch of the detector.
*The optical magnification when using **MS-OP011-RL2** is 2 times the magnification in the table on the left, and the actual field of view and pixel resolution are 1/2. The maximum optical magnification is 20x when using a 10x objective lens.
＊The optical magnification when using the **MS-OP011-RLH** is 1/2 of each magnification in the table on the left, and the actual field of view and pixel resolution are 2 times.

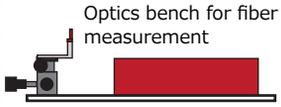
**【Component selection of simplified NFP measurement system for high power laser】**

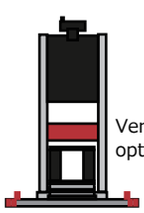
○Stages・optics bench



Sample stages
Optics stages

Optics bench for fiber measurement

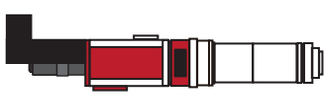




Vertical setting optics bench

＊Can be combined with various motorized/manual stages

○Optics selection



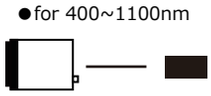
Simplified NFP measurement optics for high power laser
**M-Scope type HL**

Objective lens 10× (fixed)

●Option
- 2× intermediate lens port **MS-OP011-RL2**
- 1/2× intermediate lens port **MS-OP011-RLH**
- Coaxial epi-illumination port **MS-OP011-CEP**

○Detector selection

●for 400~1100nm



Hi-resolution CMOS detector **ISA071/ISA071GL**

○Optical beam analysis module **AP013**

●Personal computer
- Main unit
- Accessories

●Optical beam analysis software **Optometrics BA Standard**
●Detector driver
●Calibration data
●USB licence key

○Accessories

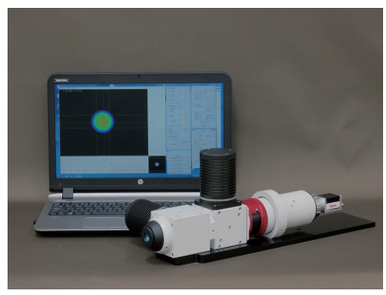
ND filter

Coaxial epi-illumination system

## FFP MEASUREMENT SYSTEM FOR ~10W CLASS HIGH POWER LASER

FFP measurement system especially targeting for ~10W output class high power laser.

**FFP measurement system for high power laser** is suitable for measuring the emission angle distribution of ~10W class high power laser. FFP measurement optics for high power laser **M-Scope type HF** is used. The light flux emitted from high power laser sample is attenuated by beam sampler unit after passing through f-θ lens module, and is further attenuated by ND filter at subsequent stage. The FFP image that has been attenuated to appropriate beam power is captured and image processing analysis is performed.



**【Features】**

○**M-Scope type HF**, FFP measurement optics for high power laser
- Specially designed f-θ lens optics for high power laser measurement
- Attenuation of incident beam with two-stage beam sampler and ND filters
- Covers a wide range of measurement luminous flux diameters of approx. 3mmφ
- Wide measurement angle coverage of approx. ±43°

○1″ high resolution CMOS detector **ISA061** is used as dedicated detector

○Optical beam analysis module **AP013**, specially designed high-functional image processing software for optical beam profile analysis
- All-in-one package of PC, optical beam analysis software, detector driver, calibration data.
- High-performance image processing software for optical beam profile measurement **Optimetrics BA Standard** is pre-installed.

**【Standard component】**

○Optics
- 850~940nm : **M-Scope type HF/NIR**

*Please specify the measurement wavelength because AR coating to some optical parts is required.

○Available detector (dedicated)
- 400~1100nm : 1″ HR CMOS detector **ISA061**

○Optical beam analysis module **AP013**
- PC for image processing, optical beam analysis software **Optometrics BA Standard**, detector driver, calibration data, USB key

○Accessories
- Cables, instruction manuals, etc.

**【Detector, angle coverage, pixel resolution (approx. value)】**

| | | |
|---|---|---|
| Detector | 1″ HR CMOS detector **ISA061** | |
| Spectral range | 400~1100nm | |
| Total pixels | 2048×2048 pixels | |
| Pixels pitch | 5.5μm sq. | |
| Meas. angle / pix. resolution | Meas. angle | Pix. resolution |
| | ±43°/N.A. 0.68 | 0.05° |

*Pixel resolution: The measurement angle corresponding to 1 pixel of the detector, calculated from the measurement angle range and the pixel pitch of the detector.

**【Option】**

○ND filter (for M-Scope type HF, dedicated 35φ)
- NIR (700~1100nm): **NDF NIR 35-5** (5 types per set)

○Optics bench
- Optics bench for fiber measurement with manual stages
- Vertical setting optics bench

**【Large emission area compatible model】**

It is possible to configure system using FFP measurement optics for high power laser of large emitting area **M-Scope type HF+**.

○Optics
- 850nm~940nm : **M-Scope type HF+/NIR**

*Please specify the measurement wavelength because AR coating to some optical parts is required.

○Detector (recommended)
- 400-1100nm : 2/3″ digital CCD detector **ISA011-01**

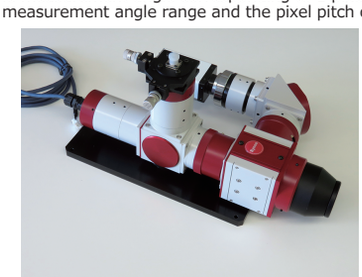
○Optical beam analysis module **AP013**
- PC for image processing, optical beam analysis software **Optometrics BA Standard**, detector driver, calibration data, USB key

○Accessories
- Cables, instruction manuals, etc.

**【Detector, angle coverage, pixel resolution (approx. value)】**

| | | |
|---|---|---|
| Detector | 2/3″ digital CCD detector ISA011-01 | |
| Spectral range | 400~1100nm | |
| Total pixels | 1392×1040 pixels | |
| Pixels pitch | 6.45μm sq. | |
| Meas. angle / Pix resolution | Meas. angle | Pix. resolution |
| | ±12°/N.A.0.2 | 0.026° |

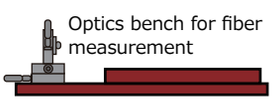
*Pixel resolution: The measurement angle corresponding to 1 pixel of the detector, calculated from the measurement angle range and the pixel pitch of the detector.



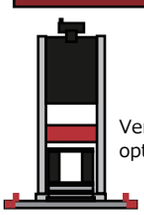
**【Component selection of high power laser FFP measurement system】**

○Stages・optics bench

Sample stages
Optics stages



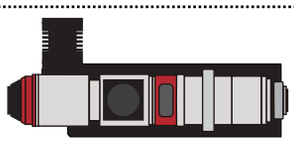
Optics bench for fiber measurement



Vertical setting optics bench

＊Can be combined with various motorized/manual stages

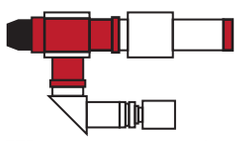
○Optics & detector selection



FFP measurement optics for high power laser M-Scope type HF

●for 400~1100nm

1″ HR CMOS detector ISA061



FFP measurement optics for high power laser M-Scope type HF+

●for 400~1100nm

2/3″ digital CCD detector ISA011-01

○Optical beam analysis module **AP013**

- Personal computer
  - ・Main unit
  - ・Accessories

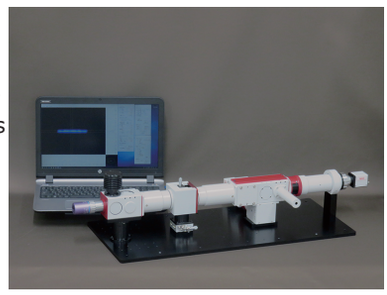
- Optical beam analysis software **Optometrics BA Standard**
- Detector driver
- Calibration data
- USB licence key

○Accessories

●35φ NIR ND filter

## NFP/FFP SIMULTANEOUS MEASUREMENT SYSTEM FOR ~10W CLASS BLUE HIGH POWER LASER

NFP/FFP simultaneous measurement system especially targeting for ~10W output class blue high power laser.



**NFP/FFP Simultaneous measurement system for high power laser** realizes simultaneous observation and analysis of NFP and FFP of output ~10W class blue high power laser by a single optical unit. FFP/NFP simultaneous measurement optics for high power laser **M-Scope type HD** is used. The light flux emitted from the sample is attenuated by a two-stage beam sampler after the objective lens, and is further attenuated by ND filter at subsequent staget. NFP & FFP images that has been attenuated to appropriate beam power are captured and image processing analysis is performed each.

**【Features】**

○**M-Scope type HD**, NFP/FFP simultaneous measurement optics for high power laser
- Simultaneous NFP and FFP measurement of high power blue laser by single optical unit
- Attenuation of incident beam with two-stage beam sampler and ND filters

○Optical beam analysis module **AP013**, specially designed high-functional image processing software for optical beam profile analysis
- All-in-one package of PC, optical beam analysis software, detector driver, calibration data.
- High-performance image processing software for optical beam profile measurement **Optimetrics BA Standard** is pre-installed.

**【Standard component】**

○Optics
- 400~460nm : NFP/FFP simultaneous measurement optics for high power laser **M-Scope type HD/BL** *Please contact us for measurements in other wavelength ranges.

○Objective lens : M-Plan Apo NUV 50×

○Available detector (recommended)
- 400~1100nm : Hi-resolution CMOS detector **ISA071/ISA071GL** (for NFP and FFP)

○Optical beam analysis module **AP013**
- PC for image processing, optical beam analysis software **Optometrics BA Standard**, detector driver, calibration data, USB key

○Accessories
- Cables, instruction manuals, etc.

**【Option】**

○Option for optics (for **M-Scope type HD**)
- 2× intermediate lens port **MS-OP011-RL2** Intermediate lens unit that doubles the overall magnification. The maximum optical magnification is 100x when using a 50x objective lens.
- 1/2× intermediate lens port **MS-OP011-RLH** Intermediate lens unit that halves the overall magnification

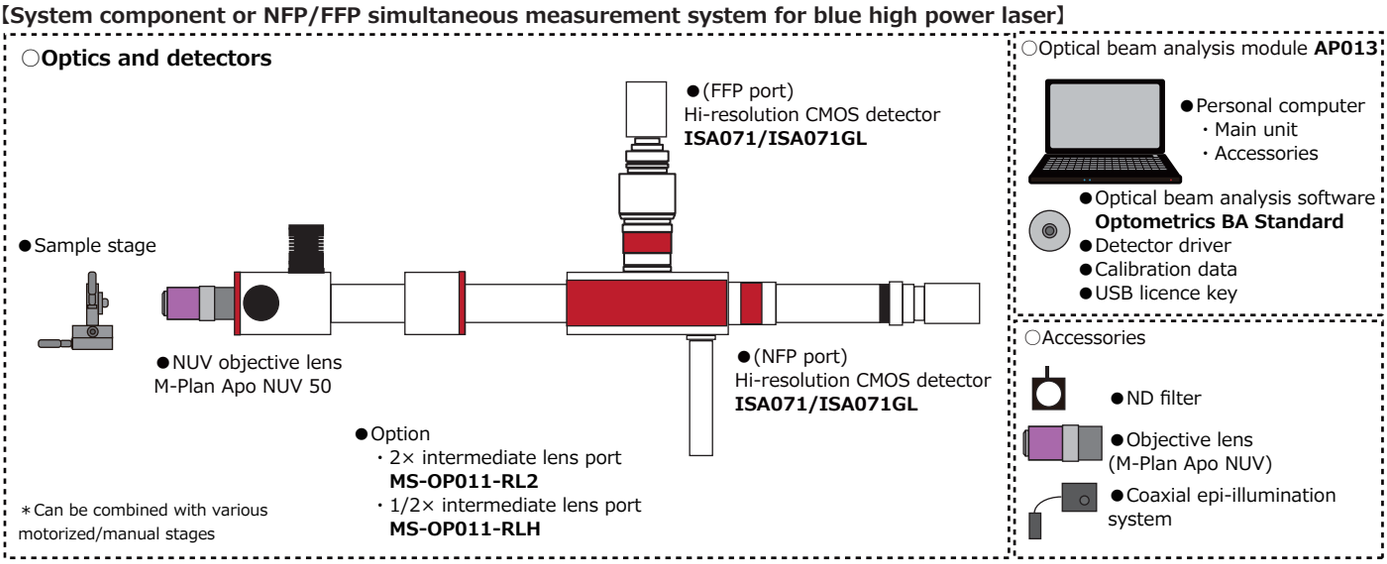
○Accessories
- Objective lens, ND filter (dedicated φ30), aperture, coaxial epi-illumination system, optics bench, etc.

**【Available detector, field of view, measurement angle, pixel resolution】**

| | | | | |
|---|---|---|---|---|
| Detector | High resolution CMOS detector ISA071/ISA071GL | | | |
| Spectral range | 400~1100nm | | | |
| Total pixels | 2048×1536 pixels | | | |
| Pixels pitch | 3.45μm sq. | | | |
| Objective lens | M-Plan Apo NUV 50× | | | |
| Meas. flux diameter | Approx. 0.1mm | | | |
| Measurement item | FFP (unit:degree) | | NFP (unit:μm) | |
| Meas. angle/field of view/resolution | Meas. angle | Resolution | Field of view | Resolution |
| | Approx.±24° | Approx.0.037° | Approx. 140×100 | Approx. 0.069 |

*Pixel resolution: Measured angle and length equivalent to the detector pixel calculated from measured angle range, field of view and sensor pitch of the detector.

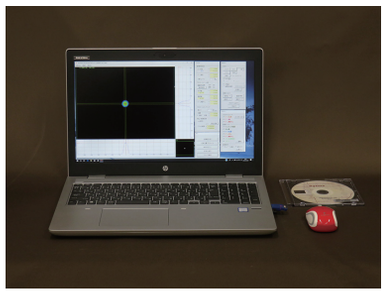
**【System component or NFP/FFP simultaneous measurement system for blue high power laser】**



## OPTICAL BEAM ANALYSIS MODULE　AP013

Image processing hardware and software package for optical beam profile measurement. EF/EAF analysis function is supported as standard function.

**Optical beam analysis module AP013** is the image prosessing and data analysis system focusing on optical beam profile measurement and analysis, widely applicable to optical beam profile measurement application such as NFP, FFP, collimated beam and various application in combination with Synos' optical system **M-Scope series** and imaging detectors **ISA series**. **AP013** is composed of personal computer for image processing and data analysis, optical beam analysis software **Optometrics BA Standard**, calibration data set, and detector driver interface. Additionally, **Optometrics BA Standard** is equipped with power distribution analysis function such as flux analysis function (EF/EAF) that is the standard analysis parameters for MMF, D86 analysis function, D4σ analysis function, etc.



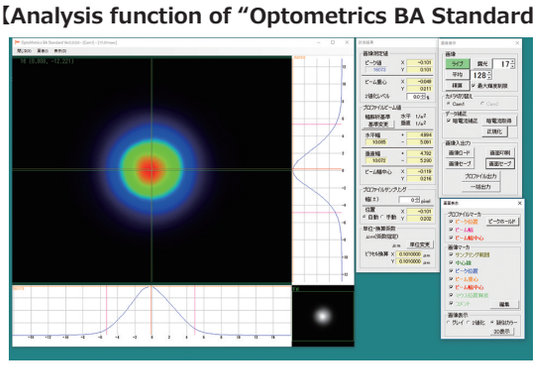
## OPTICAL BEAM ANALYSIS SOFTWARE　Optometrics BA Standard　(Ver.3.0.0)

Optical beam analysis software **Optometrics BA Standard** is image processing/analysis software equipped with our unique and abundant optical beam measurement and analysis functions, including general-purpose beam profile measurement, beam width measurement, optical power distribution amalysis such as EF/EAF analysis, D86 analysis, D4σ analysis.

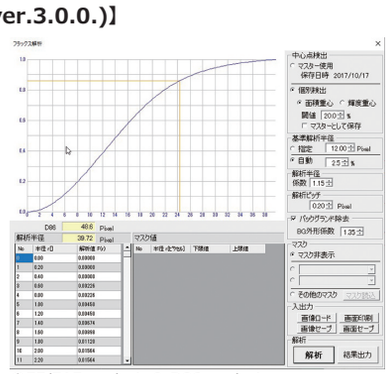
**【features of optical beam analysis software Optometrics BA Standard】**

| |
|---|
| **○Image acquisition and processing** |
| Live image display, Image averaging and accumulation, Dark current correction, Storage and read out of image data |
| **○Center setting function** |
| Peak intensity position of the image, Center of gravity position of the beam, Profile peak position, Center of beam profile width, any specified position |
| **○Conversion value (unit conversion) setting function** |
| Conversion value setting, Analysis by converted value（unit: pixel/μm/degree) |
| **○Indicator display** |
| Peak intensity position & value (maximum intensity value in the image and its postion), Beam center of gravity position |
| **○Measurement and Analysis function** |
| ●***Optical beam profile analysis*** |
| Realtime beam profile display(vertical/horizontal, by automatic search or manual set of center position), Beam profile display of arbitrary direction, 3D display of intensity profile, Peak hold display, Gaussian fitting beam profile |
| ●***Width measurement and analysis*** |
| Beam width analysis (FWHM, 1/e2, arbitrary% down width), Unit setting & conversion |
| ●***Optical power distribution analysis (*These functions are included only in "Optometrics BA standard" )*** |
| EF(Encircled Flux)/EAF(Encircled Angular Flux) analysis, D86 analysis(based on EF/EAF analysis), D4σ analysis |
| ●***Other analysis function*** |
| Total intensity analysis in any area, etc. |
| **○Image display** |
| Gray scale, binarized image, pseudo color, 3D intensity display, equal intensity line display |
| **○Image and data storage** |
| Image storage (TIFF/BMP/CSV), intensity profile data (CSV), EF/EAF data (CSV), hard copy of measurement screen (JPEG/BMP) |

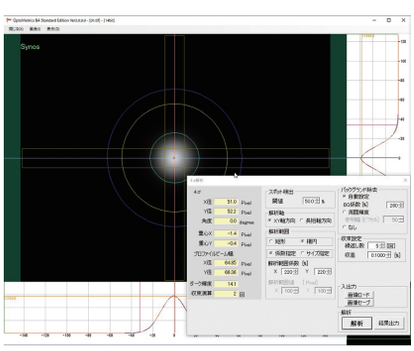
**【Analysis function of "Optometrics BA Standard (ver.3.0.0.)】**



○Main operation window of "Optometrics BA Standard"



○EF/EAF analysis & D86 analysis



○D4σ analysis

**【Main component】**

- ●Personal computer system for image processing and data analysis … 1set
  - ・OS: Microsoft Windows 10 professional 64bit
  - ・Prosessor: Intel core i5 (or corresponding specification)
  - ・Main memory: 16GB (or corresponding specification)
- ●Optical beam analysis software Optometrics BA Standard (ver. 3.0.0) … 1 license
  - ・Software install media: 1 (including Optometrics BA Standard, Driver and interface software for detector, Calibration data),
  - ・Software license key (USB key): 1

**【AP013 System selection】**

| MODEL | SOFTWARE | OUTLINE |
|---|---|---|
| AP013 | Optometrics BA Standard | Supports all the above features |
| AP013B | Optometrics BA Basic | Among the functions of Optometrics BA Standard, it supports functions excluding the optical power distribution analysis function |
| Option | Socket communication external control software AP013-ExC | Software for external control of Optometrics BA Standard・Optometrics BA Basic. |

## ○*GLOSSARY【OPTICAL DATA ANALYSIS RELATED】*

**●EF（Encircled Flux）/EAF（Encircled Angular Flux）**
Both EF/EAF are used as an index for defining the excitation state of the multimode fiber. EF applies to GI fiber and EAF applies to SI fiber.

◎EF (Encircled Flux)
EF (Encircled Flux) is the ratio of the total near-field optical power to the total output optical power. It is expressed as a function of the radial distance r measured from the optical center of the optical fiber core and is defined by the following formula.

$$EF = \frac{\int_0^r x \cdot I(x)dx}{\int_0^R x \cdot I(x)dx}$$

◎EAF (Encircled Angular Flux)
EAF (Encircled Angular Flux) is the ratio of the total far-field optical power to the total output optical power. It is expressed as a function of the angle θ' between the optical center axis of the far field image and the emitted light, and is defined by the following formula.

$$EAF = \frac{\int_0^{2\pi}\int_0^{\theta'} I(r,\varphi)\frac{\sin(\theta)}{\cos^3(\theta)}\,d\theta\,d\varphi}{\int_0^{2\pi}\int_0^{\theta max} I(r,\varphi)\frac{\sin(\theta)}{\cos^3(\theta)}\,d\theta\,d\varphi}$$

**●D86**
It is one of the definitions of beam diameter. When the circular area with radius r is set from the center of gravity position of the NFP beam profile, it represents the diameter (=2r) of the circle when 86.5% of the total power is included in the circular area. It can be obtained by calculating the value of r when the EF value is 86.5% from the EF measurement result. When the beam profile shape is Gaussian distribution, it has the same value as 1/e2 width.

**●D4σ**
It is one of the definitions of beam diameter. It is calculated by finding the second moment (dispersion) from the luminance distribution of the NFP beam profile. The values of D4σ in the X direction and the Y direction are represented by the following formula.

$$D4\sigma_x = 4\sqrt{\sigma_x^2} = 4\sqrt{\frac{\iint I(x,y)\,(x-\bar{x})^2\,dx\,dy}{\iint I(x,y)\,dx\,dy}}$$

*$\sigma_x^2$: Second moment in X directionX (dispersion)*
*$\bar{X}$: Center of gravity in X direction  I: Light intensity distribution*

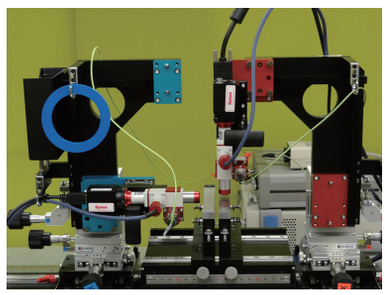
$$D4\sigma_y = 4\sqrt{\sigma_y^2} = 4\sqrt{\frac{\iint I(x,y)\,(y-\bar{y})^2\,dx\,dy}{\iint I(x,y)\,dx\,dy}}$$

*$\sigma_y^2$: Second moment in Y directionY (dispersion)*
*$\bar{y}$: Center of gravity in X direction  I: Light intensity distribution*

Since the value of D4σ is sensitive to the influence of noise around the beam spot, it is necessary to be careful in processing dark noise components and setting the analysis range. When the beam profile shape is Gaussian distribution, it has the same value as 1/e2 width.

## OPTICAL METHOD INSERTION LOSS MEASUREMENT SYSTEM (MANUAL ALIGNMENT TYPE)

Optical method insertion loss manual measurement system for optical waveguide modules, using optical measurement optics M-Scope type M



**Optical method insertion loss measurement system** is the optical method insertion loss measurement system using Synos' optical measurement optics **M-Scope type M**. By using a coaxial observation camera system of **M-Scope type M**, it becomes possible to perform direct image observation of input and output end faces of the measured optical waveguide. While checking the observed core image of the optical waveguide, it is possible to directly introduce the measurement beam into the core and receive the beam emitted from the waveguide for measurement. In this way, insertion loss measurement similar to optical fiber alignment can be performed easily and quickly even when combined with a manual precision positioning stage. Best for manual insertion loss measurement of polymer waveguide module for OPCB substrate.

**【Features】**

○**M-Scope type M**, compact-type optical measurement optics
- ●It is possible to easily adjust the incident position of measuring beam and the detecting position of emitted beam while observing the image of the object directly by equipped coaxial observation camera system.
- ●Observation magnification can be selected from 6× and 20×.

○Possible to measure insertion loss similar to conventional optical fiber alignment method
- ●Input side: Irradiate the sample surface with a 1: 1 core diameter of the optical fiber connected to the optical fiber port.
- ●Output side: Light flux, with the diameter equivalent to the core diameter of the optical fiber connected to the optical fiber port, is relayed 1: 1 from the sample surface to the optical fiber.
- ●Optical fibers of various types and core diameters can be used..

○In addition to loss measurement using optical power meter, spectral measurement by combining with optical spectrum analyzer, spectrometer is also available.

○Low cost system can be constructed in combination with a manual stage.

**【Standard component】**

○Optics (input side/output side)
- ●Compact type optical measurenet optics **M-Scope type M**

○Measurement wavelength
- ●Please specify the measurement wavelength.

○Available detectors selection
- ●400-1100nm : Hi-resolution CMOS detector **ISA071/ISA071GL**
- ●950-1700nm : InGaAs NIR detector **ISA041M, ISA041H2**
- ●400~1700nm : InGaAs high resolution NIR detector **ISA041HRA/HRVA**

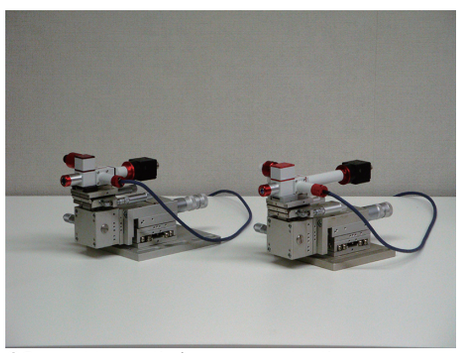
○Stages (input side, output side, sample position adjustment)
- ● Various manual stage system

*Please contact us for stage configuration and selection

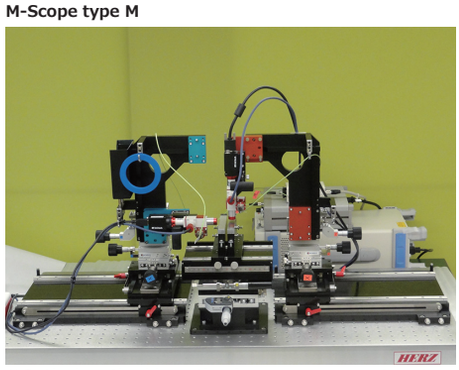
○ Support structure
- ●Equipment support structures, bread board, brackets, etc.

○Accessories
- ●Measurement instrument
  - ・Optical powermeter, etc.
- ●Control & data analysis system
  - ・PC, Image observation, data analysis software, etc.
- ●Measurement light source
  - ・LED, SLD, LD light source, etc.
- ●Peripherals
  - ・Vibration isolating table, breadboard, etc.

*We will propose system with various configurations and specifications depending on the measurement sample, specifications, operating method, and budget.



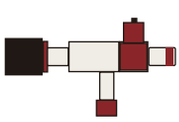
○Compact type optical measurement optics
**M-Scope type M**



○**Optical method insertion loss measurement system** for polymer waveguide

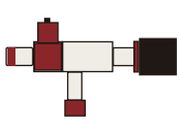
**【Component selection of optical method insertion loss measurement system manual alignment type】**

○Optics for input side



●M-Scope typeM6/M20

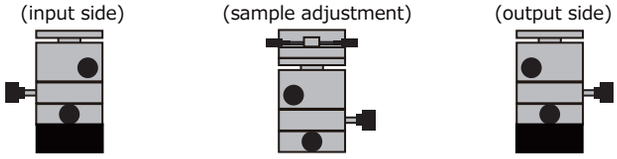
○Optics for output side



●M-Scope typeM6/M20

○Manual stage system and equipment support structure

(input side) (sample adjustment) (output side)

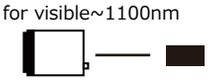


●High precision manual positioning stage system

●Vibration isolation table, bread board, support structure, brackets, etc.

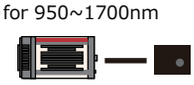
○Detector selection

●for visible~1100nm



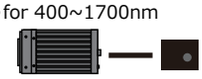
High resolution CMOS detector **ISA071**

●for 950~1700nm



InGaAs high sensitivity NIR detector **ISA041H2**

●for 400~1700nm



InGaAs high resolution NIR detector **ISA041HRA/HRVA**

○measurement instruments & data analysis

●Optical powermeter, etc. (Optical measurement instruments)

●Measurement light source (LED, SLD, LD, etc.)

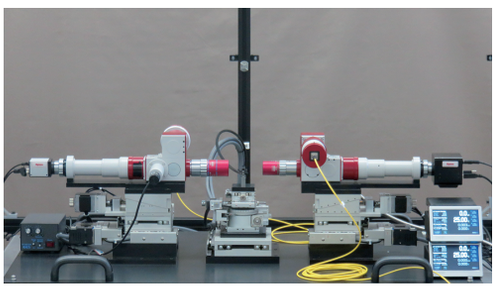
●PC for data analysis & image observation

●Insertion loss measurement software

# OPTICAL METHOD INSERTION LOSS AUTOMATIC MEASUREMENT SYSTEM FOR MICROSTRUCTURAL WAVEGUIDE DEVICE

Insertion loss automatic measurement system targeting for micro structural waveguide modules, using optical measurement optics M-Scope type J

**Optical method insertion loss automatic measurement system** is insertion loss test system with automatic alignment using optical measurement optics **M-Scope type J**. In this system, the observation camera mounted on **M-Scope type J** directly observes input and output end faces of the measured optical waveguide. At the same time, optical power alignment is performed using optical fiber connected to the optical fiber port. By using both coarse alignment by image processing and fine alignment by optical power, high speed insertion loss measurement of fine waveguides such as Si-photonics devices can be efficiently realized with high reproducibility.



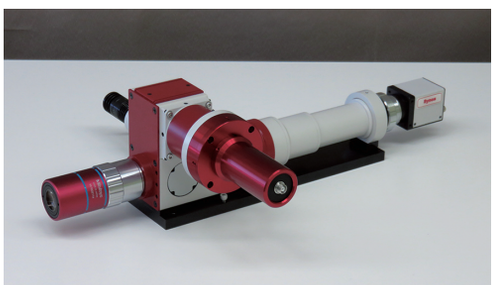
**【Features】**

○ **M-Scope type J/PF**, Simplified optical measurement optics
- ●It is possible to easily adjust the incident position of measuring beam and the detecting position of emitted beam while observing the image of the object directly by equipped coaxial observation camera system.
- ●Polarization compensation type fiber port is used.
- ●Various objective lenses such as NIR type and HR type can be selected.

○Possible to measure insertion loss similar to conventional optical fiber alignment method
- ●Input side: Irradiate the sample surface with a 1: 1 core diameter of the optical fiber connected to the optical fiber port.
- ●Output side: Light flux, with the diameter equivalent to the core diameter of the optical fiber connected to the optical fiber port, is relayed 1: 1 from the sample surface to the optical fiber.

○Dedicated image processing and automatic alignment software is available.
- ●With motorized stage system, high performance automatic measurement is realized. Applicable to mass production inspection.

○Applicable to measurement from visible to IR spectral range by selecting detector.



○M-Scope type J/PF with variable spot size converter port **MS-OP012-VFPJ** (option)

**【Standard component】**

○Optics (input side/output side)
- ● Simplified optical measurement optics **M-Scope type J/PF**
- ● (Option) variable spot size converter unit **MS-OP012-VFPJ**

○Measurement wavelength: Please specify measurement wavelength.

○Available detectors selection
- ● 400-1100nm : Hi-resolution CMOS detector **ISA071/ISA071GL**
- ● 950-1700nm : InGaAs NIR detector **ISA041M, ISA041H2**
- ● 400~1700nm : InGaAs high resolution NIR detector **ISA041HRA/HRVA**

○Stage system (input side, output side, sample position adjustment)
- ● Various motorized stage system

*Please contact us for stage configuration and selection

○Support structure (Equipment support structures, brackets, etc.)

○Accessories
- ●Sample holder
- ●Measurement instrument (Optical powermeter, etc.)
- ●Control & data analysis system (PC, stage system controller,system control & data analysis software, etc.
- ●Measurement light source (LED, SLD, LD light source, etc.)
- ●Peripherals (Vibration isolating table, breadboard, Safety control box Instrument rack, etc.)

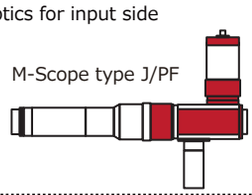
*We will propose system with various configurations and specifications depending on the measurement sample, specifications, operating method, and budget.


○System control & data analysis software

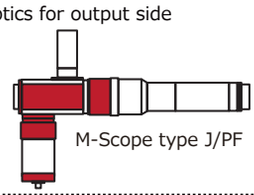
**【Component selection of optical method insertion loss automatic measurement system】**

○Optics for input side

M-Scope type J/PF



○Optics for output side



M-Scope type J/PF

○Accessories

Objective lens

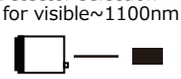
ND filter

Variable spot size converter unit MS-OP012-VFPJ

Coaxial epi-illumination system

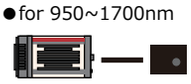
○Detector selection

●for visible~1100nm



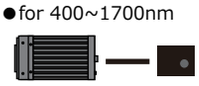
High resolution CMOS detector **ISA071**

●for 950~1700nm



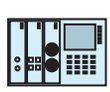
InGaAs high sensitivity NIR detector **ISA041H2**

●for 400~1700nm



InGaAs high resolution NIR detector **ISA041HRA/HRVA**

○measurement instruments & data analysis



●Optical powermeter, etc. (Optical measurement instruments)

●Measurement light source (LED, SLD, LD, etc.)

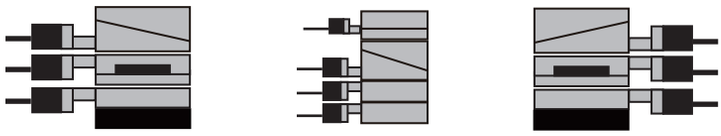
●PC for data analysis & image observation

●System control & data analysis software

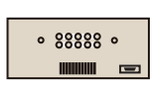
・System control
・Image acquisition & processing
・Motorized stage system control
・Measurement instrument control
・Data analysis, data storage
・Management of variety, operation

○Motorized stage system and equipment support structure

(input side) (sample adjustment) (output side)



●High precision motorized stage system



Stage control hardware

●Vibration isolation table, bread board, support structure, brackets, safety control unit, instrument rack, etc.

## OPTICAL CONTINUITY TESTER

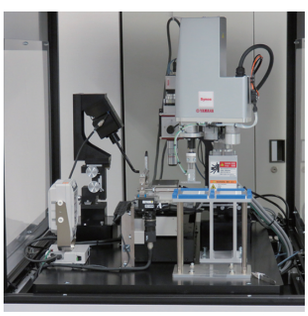
Optical method insertion loss manual measurement system for optical waveguide modules, using optical measurement optics M-Scope type M

**Optical Continuity Tester**, high speed continuity tester for polymer optical waveguide, is continuity inspection system with high speed and accuracy, to test continuity on each channel of multi-channel polymer optical waveguide and related module. Measuring light batch irradiation and image processing method make it possible to measure continuity of multi-channel polymer optical waveguide at one time. This technology realizes high-speed optical continuity test for polymer optical waveguide for OPCB substrate at mass production.

**【Features】**

○Alignmentless high-speed optical continuity inspection
○High accuracy by dedicated large N.A. measurement optics and high resolution CMOS detector
○Dedicated high speed image processing software developed for **Optical Continuity Tester**
- ●Extract, process, and judge only guided wave propagation light of optical waveguide
- ●Applicable to waveguide external shape measurement such as core pitch, core position, etc.
- ●Various measurement mode such as defocus measurement mode, etc.
- ●Supports automation and efficiency of inspection

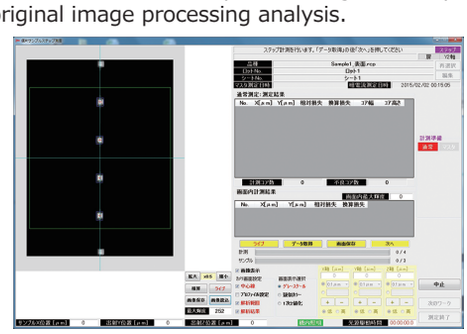
**【Automatic sample loader/unloader mechanism (option for automation support)**
Preparation work for individual pieces sample measurement is greatly reduced, and inspection efficiency and throughput can be greatly improved.

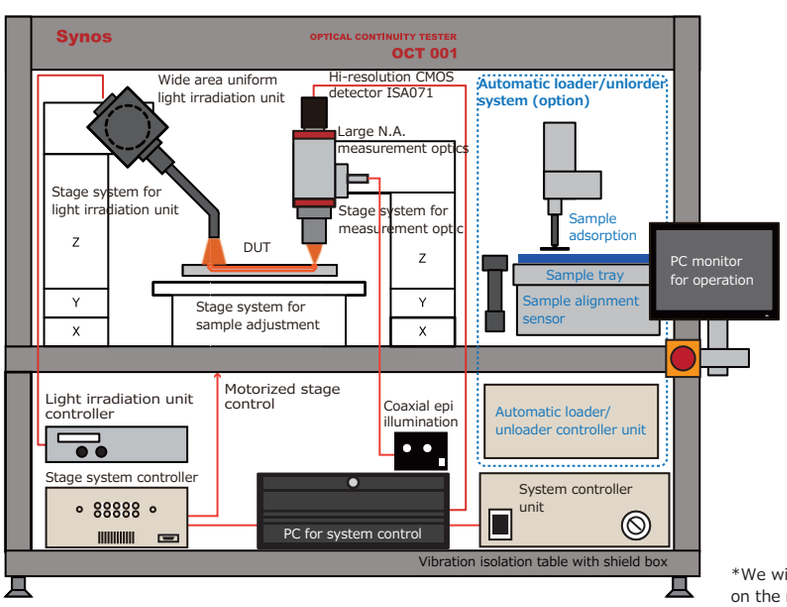


*Automatic sample loader/unloader mechanism

*Sample transfer robot and sample tray for individual pieces sample

**【System control/data analysis software for OCT】**
High-speed measurement and judgment of the conduction state of each channel of the optical waveguide are performed by the original image processing analysis.






**【Optical continuity tester basic specification of main part (light irradiation unit, detection system)】**

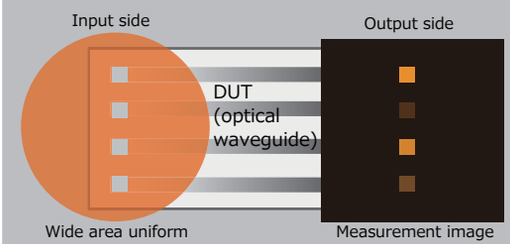
○Wide area uniform light irradiation unit
- ●Output N.A.: 0.57
- ●Irradiation size: φ4mm (@gap 5mm)
- ●Uniformity in irradiation surface: ±2%
- ●Center wavelength of light source: 850nm (FWHM:±40nm)
- ●Maximum output light power: approx. 15mW
- ●Output light stability: ±1%

○Dedicated large N.A. measurement optics
- ●Detection N.A.: 0.4
- ●Optical magnification: 5× (Objective lens 20×)
- ●Field of view: 1.28mm×0.96mm

○Detector (high resolution CMOS detector **ISA071**)
- ●Total pixels: 2048×1536 pixels (approx. 3.2M pixels)
- ●Pixels pitch: 3.45×3.45μm
- ●Sensor size: 1/1.8 inch
- ●Gradation: 12bit

*We will propose system with various configurations and specifications depending on the measurement sample, specifications, operating method, and budget.

**☞Technical information【Measurement method of *optical continuity tester*】**



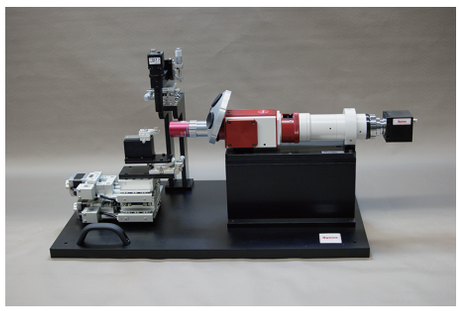

Continuity test of polymer optical waveguide
(The figure shows the upper incidence/upper emission type with built-in 45 ° mirror.)

In OPCB substrate, light emitting and receiving devices for transmission and reception are mounted on a substrate on which optical waveguide is formed, and signal transmission is performed through conversion of electric-optical-electric signal.
Conventionally, to test the continuity of optical waveguides, it was common to align the optical fiber at the optical waveguide input and output ends, measure the insertion loss of the optical waveguide for each channel, and judge the continuity. However, this method required long time for testing and not suitable for mass production inspection.
**Optical continuity tester** is the system intended for mass production high-speed continuity inspection of polymer optical waveguides for OPCB substrate.
●Irradiate highly stable and uniform measurement light onto the optical waveguides of multiple channels at once.
●Large N.A. detection optics and high-speed image processing are combined to collectively process and judge the continuity of multiple channels.
With the above method, we have achieved alignmentless method and highly accurate high-speed continuity inspection of polymer optical waveguides.

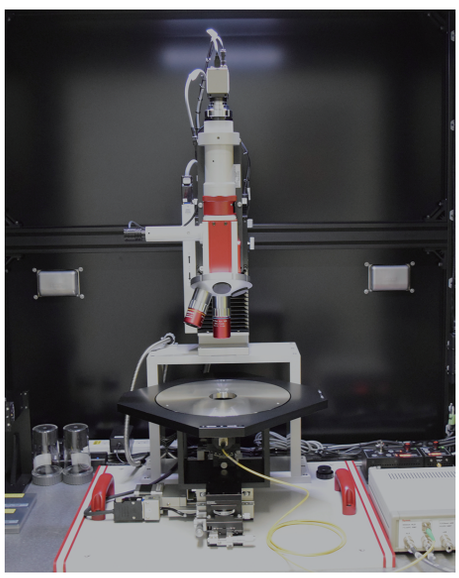
## FOCAL POSITION AUTOMATIC MEASUREMENT SYSTEM

Automatic measurement of focal position and beam waist of lenses, LD modules, etc. by combining NFP measurement and motorized positioning stage.

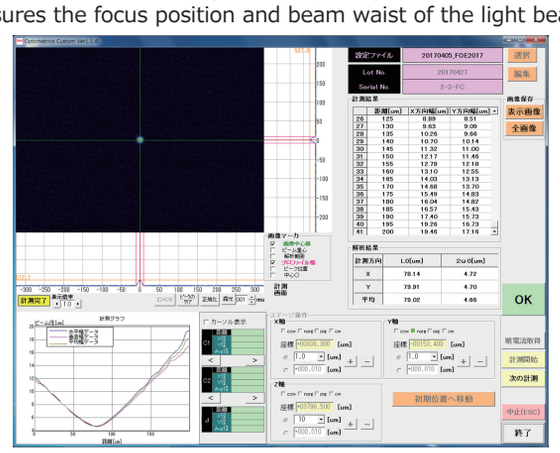
**Focal position automatic measurement system** is a system that realizes automatic measurement of the focal position and the beam waist of lens, LD module, fiber module, etc. by combining NFP measurement system and high precision motorized stage system. By selecting detectors, it is possible to respond to measurement in 400~1100nm and 950~1700nm spectral range.



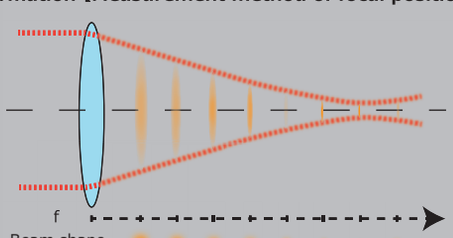
**【Vertical setting focul point automatic measurement system】**
In addition to horizontal installation for optical fibers and fiber modules, vertical installation for measurement of glass substrates and LD modules is also possible.

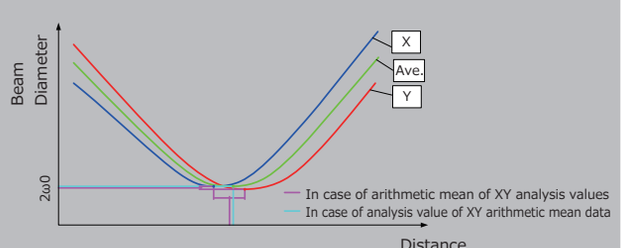


**【Focul position automatic measurement software】**
Performs linked control of the motorized stage and NFP measurement and image processing analysis, and automatically measures the focus position and beam waist of the light beam.




**☞Technical information【Measurement method of focal position/beam waist automatic measurement】**




【Measurement method】
- A motorized stage is used to move optics or sample to focal direction in microsteps.
- Acquire the beam image (NFP image) at each focal position.
- Measure the beam diameter at each focus position.
- The beam diameter at each focus position is analyzed to calculate the focus position.

**【Component selection of focal position measurement system】**

○Stages・optics bench

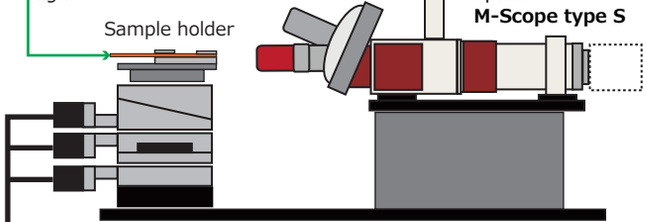
Measurement light source

Measurement light

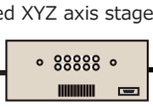
Sample holder

○NFP measurement optics

Sophisticated NFP optics
**M-Scope type S**



Motorized XYZ axis stage system

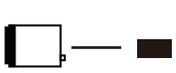


Motorized stage controller

●Vibration isolation table, bread board, support structure, brackets, safety control unit, instrument rack, etc.

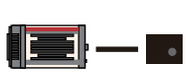
○Detector selection

●for 400~1100nm



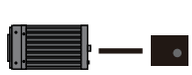
Hi-resolution CMOS detector
**ISA071/ISA071GL**

●for 950~1700nm



InGaAs high sensitivity NIR detector
**ISA041H2**

●for 400~1700nm



InGaAs high resolution NIR detector
**ISA041HRA/HRVA**

○System control & data analysis

●Personal computer
・Main unit
・Accessories

●Focal position automatic measurement software

○Accessories

●ND filter

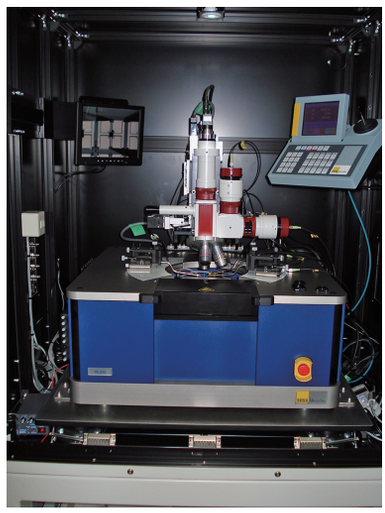
●Objective lens

●Coaxial epi-illumination system

# WAFER LEVEL OPTICAL CHARACTERISTIC MEASUREMENT SYSTEM FOR LIGHT RECEIVING DEVICE

Wafer level testing of optical characteristic for light receiving device in combination with manual/semi automatic prober system

**Wafer level optical characteristic measurement system for light receiving device** is the system that analyzes electrical and optical characteristics of various light receiving device such as photodiodes and photosensors at wafer level. In addition to electrical characteristics measurement, optical characteristics can be measured at wafer level by introducing measurement light. By combining prober systems for semiconductor failure analysis, such as semi-automatic/manual probers, with our high-performance optical measurement optics for prober **M-Scope type I/PFW**, measurement light sources, measuring instruments, etc. various characteristics are measured under wafer level. In addition, it can be used for automatic measurement of mass-produced devices in combination with the semi-automatic prober.



**【Features】**

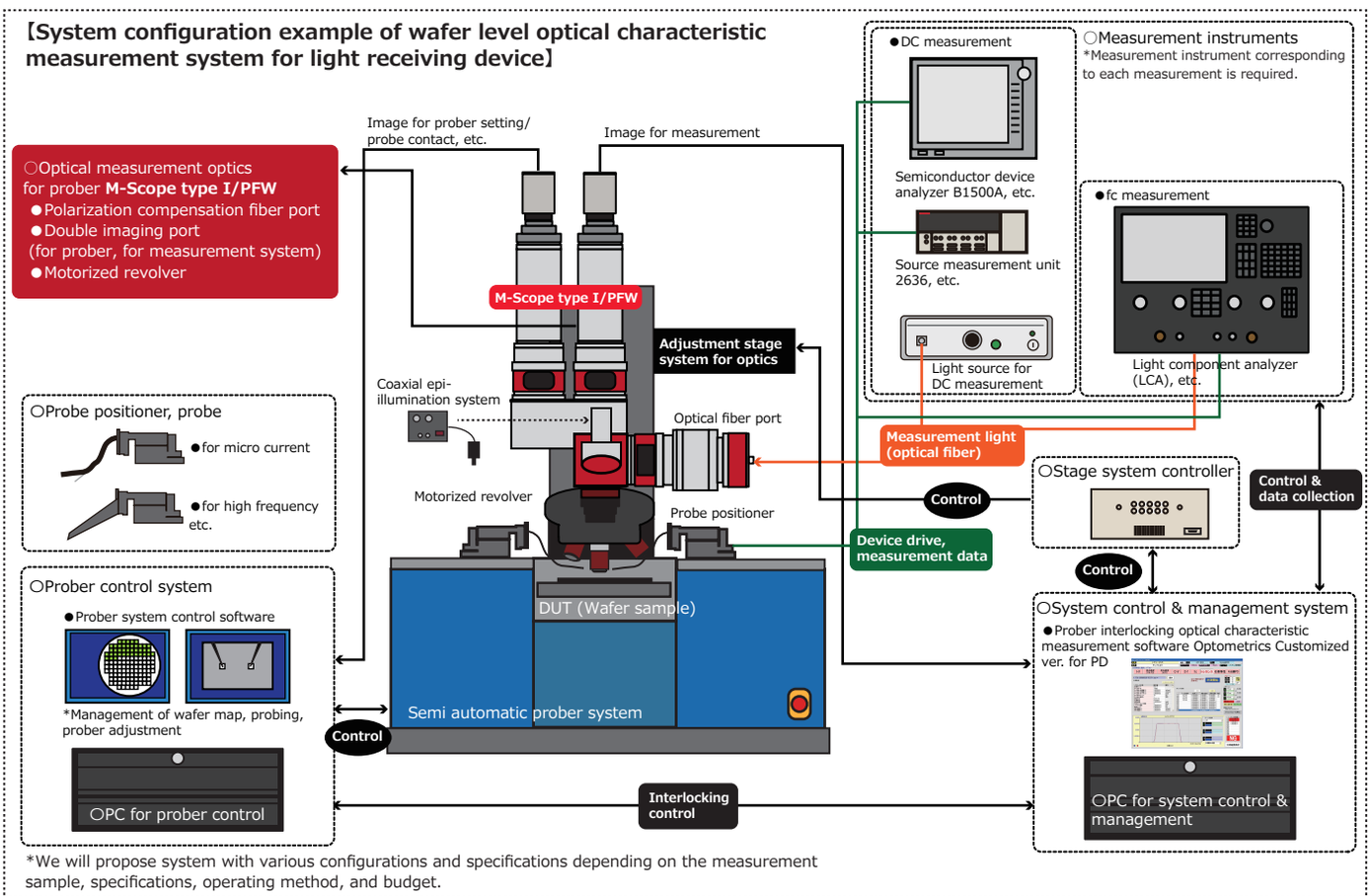
○Wafer level measurement of various electrical and optical characteristics of photo detectors such as photodiodes and photo sensors in combination with semi-automatic/manual prober.
○Achieves automation of various measurements combining with the semi-automatic prober system. Applicable from off-line measurement of individual elements to in-line measurement.
○high-performance optical measurement optics for prober **M-Scope type I/PFW**
　●High functional optical measurement optics designed for wafer level optical measurement.
○Prober interlocking optical measurement software **Optometrics customized version for PD**
　●Semi-automatic prober control and analysis automation, collection of measured data, unified management of measurement types and measurement recipes, etc.

**【Prober interlocking optical characteristic measurement software "Optometrics Customized Version for PD"】**


This software has been developed for wafer-level optical element measurement, which automates analysis by controlling and linking the semi-auto prober, integrates electrical and optical characteristic data collection, and manages measurement types and measurement recipes. A wide range of support is available, from offline measurement to in-line automatic measurement. The measurement item customizes the software according to the measurement target, measurement content, measuring instrument used, measurement procedure and operation.

《Typical measurement items》
○electric and optical characteristic of light receiving device such as PD, optical sensor
　●I-V characteristic, photosensitivity, dark current, capacitance, cutoff frequency, rise time, tolerance, crosstalk, etc.
　***Measurement instrument corresponding to each measurement is required.**

**【System configuration example of wafer level optical characteristic measurement system for light receiving device】**

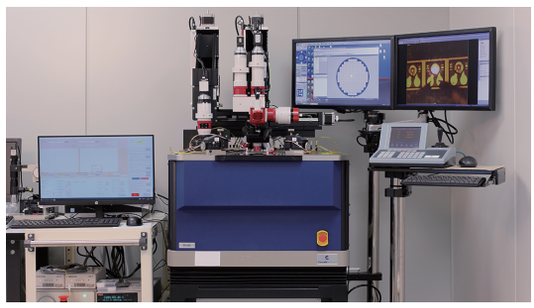



*We will propose system with various configurations and specifications depending on the measurement sample, specifications, operating method, and budget.

# WAFER LEVEL OPTICAL CHARACTERISTIC MEASUREMENT SYSTEM FOR LIGHT EMITTING DEVICE

Wafer level testing of optical characteristic for light emitting device such as VCSEL in combination with manual/semi automatic prober system

**Wafer level optical characteristic measurement system for light emitting device** is the system that analyzes electrical and optical characteristics of light emitting device like VCSEL at wafer level. In addition to electrical characteristics measurement, optical characteristics, such as NFP, FFP, IVL, polarization, etc, can be measured at wafer level. By combining prober systems for semiconductor failure analysis, such as semi-automatic/manual probers, with our high-performance optical measurement optics for prober **M-Scope I/PFW**, FFP measurement optics **M-Scope type F**, IVL measurement module **PMD002/IVL**, polarization measurement module **PMD002/POL**, etc., various characteristics are measured under wafer level. In addition, it can be used for automatic measurement of mass-produced devices in combination with the semi-automatic prober.



**【Features】**

○Wafer level measurement of various electrical and optical characteristics of light emitting device like VCSEL in combination with semi-automatic/manual prober.
○Achieves automation of various measurements combining with the semi-automatic prober system. Applicable from off-line measurement of individual elements to in-line measurement.
○high-performance optical measurement optics M-Scope series and photometric module
　●High functional optical measurement optics designed for wafer level optical beam analysis.
○Prober interlocking optical measurement software **Optometrics customized version for LD**
　●Semi-automatic prober control and analysis automation, collection of measured data, unified management of measurement types and measurement recipes, etc.

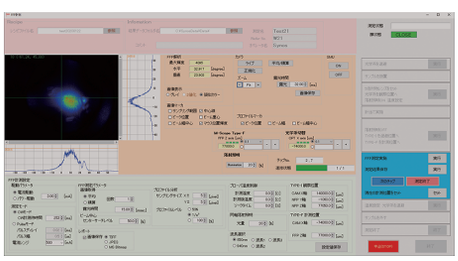
●Optical measurement optics for prober **M-Scope type I/PFW**

**【Prober interlocking optical characteristic measurement software “Optometrics Customized Version for LD”】**

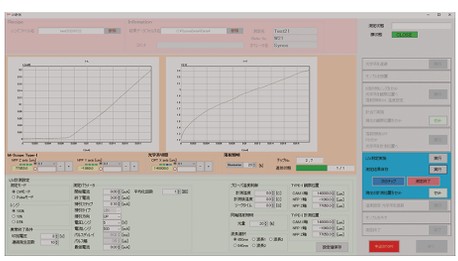
This software has been developed for wafer-level optical element measurement, which automates analysis by controlling and linking the semi-auto prober, integrates electrical and optical characteristic data collection, and manages measurement types and measurement recipes. A wide range of support is available, from offline measurement to in-line automatic measurement. The measurement item customizes the software according to the measurement target, measurement content, measuring instrument used, measurement procedure and operation.

《Typical measurement items》

○electric and optical characteristic of light emitting device such as VCSEL
　●I-V-L characteristic, optical beam profile (NFP/FFP), polarization characteristic, spectrum characteristic, etc.
　***Measurement instrument corresponding to each measurement is required.**



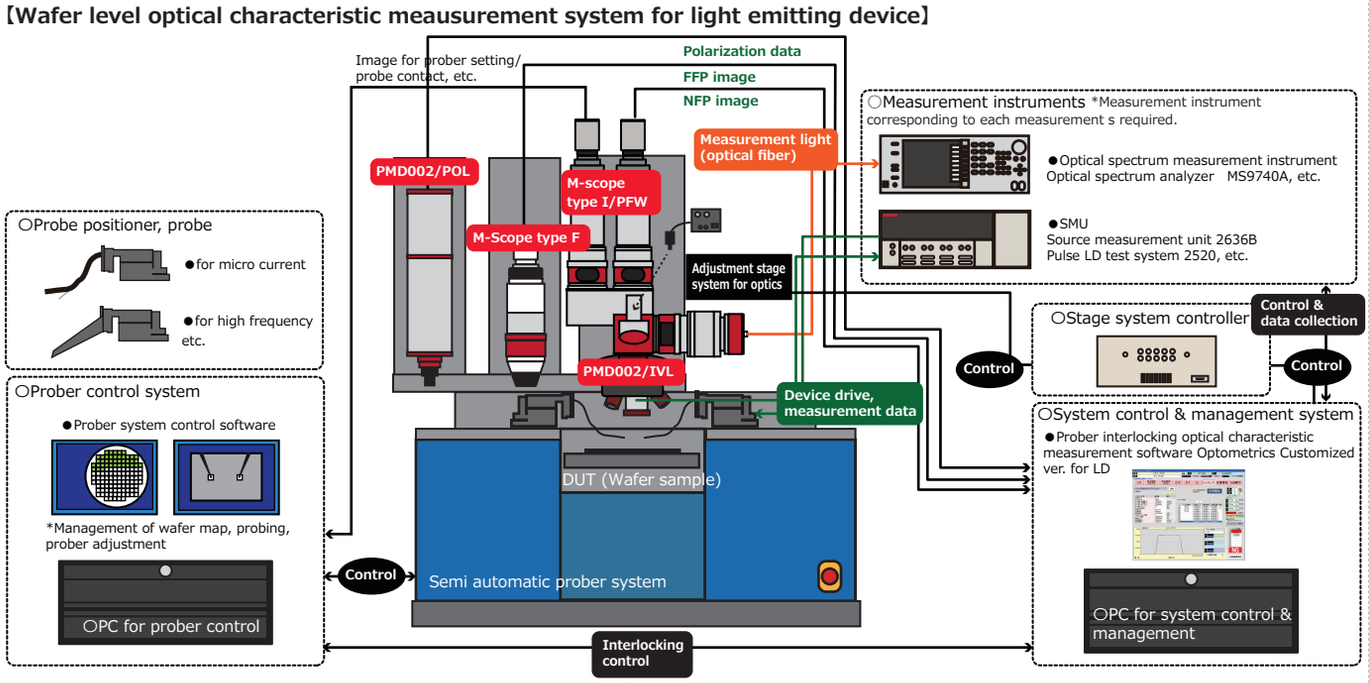
○FFP measurement



○IVL measurement

○Optical spectrum measurement

**【Wafer level optical characteristic meausurement system for light emitting device】**




*We will propose system with various configurations and specifications depending on the measurement sample, specifications, operating method, and budget.

## IVL MEASUREMENT MODULE PMD002/IVL

Easily measure the IVL characteristics of semiconductor laser devices, using a large size Si photodiode.

IVL measurement module **PMD002/IVL** is the photometric sensor module that can easily measure the IVL characteristics of light emitting devices such as semiconductor lasers and VCSELs. The compact and lightweight IVL measuring sensor head can be used as a single unit or mounted on objective lens revolver that is equipped with sophisticated NFP measurfement optics **M-Scope type S**, etc. The sensor uses a 18 mm square large-diameter photodiode and can cover a wide radiation angle.

**【Features】**

○18mm square large Si photodiode is used to cover a wide N.A.
○A wide measurement power range is secured by using a neutral density filter together.
○It can be attached to the manual revolver of NFP measurement optics **M-Scope type S**, etc.
○Can be mounted on a prober system. Supports VCSEL IVL measurement at the wafer level.

**【Summary of specifications】**

○Measurement method: Large size Si PD device + SMU
○Spectral range:
 ●for 340~1000nm: **PMD002/IVL VIS**
 *IR model for 900~1700nm is under development
○Maximum sensitivity wavelength (λp): 960nm
○Photosensitivity (λ=λp): 0.66W
○W.D.: Approx. 10mm
○N.A.: ±30° (at measurement light flux diameter: approx. 10μmφ)
○Measurement range (at 940nm):
 ~15mW (ND: none)
 ~95mW (ND: 10%)
 ~770mW (ND: 0.5%)
○Attenuate: By ND filter (mount on sensor head)

**【Software function】**

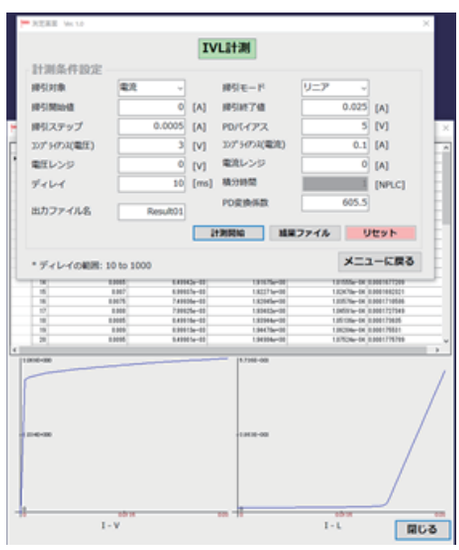
IVL measurement software **Optometrics IVL basic**
(Functions)
○Measurement parameter: Threshold current (Ith) ・ voltage (Vth)
 Drive current (If) ・ voltage (Vf)
 Light output (Pf: optput at If)
 Slope efficiency (SEf: slope at If), etc.
○Function: Graph display, Measurement condition setting
○Data storage and output: Graph data, Output of graph data (csv format)

**【Standard component】**

○Sensor head: 1
○ND filter: 1 each (10%, 0.5%)
○IVL measurement software: **Optometrics IVL basic**

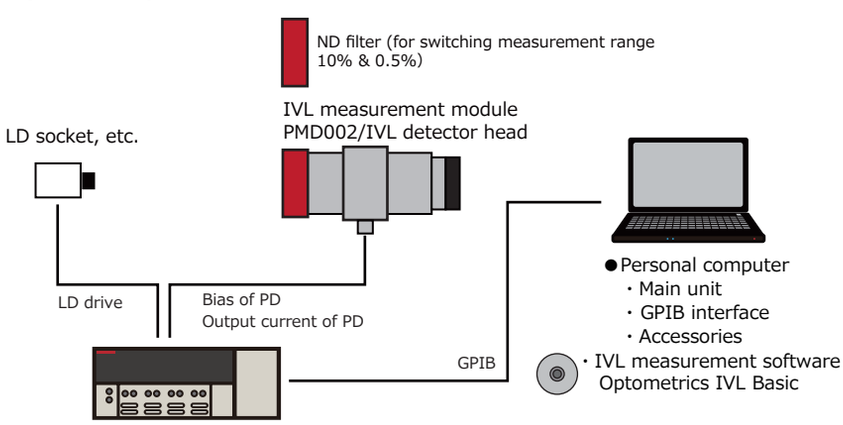
**【Option】**

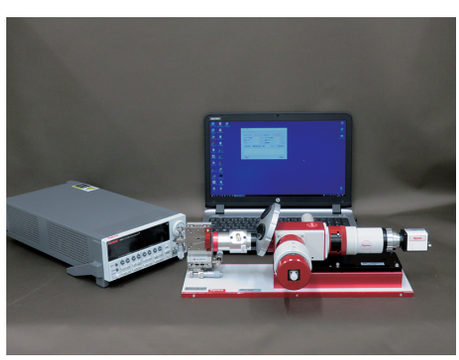
○SMU (source measurement unit)
 ●Keithley 2600 series (for CW measurement)
 ●Keithley 2520 (for pulse measurement)
 *Please contact us for SMUs of other manufacturers and models.




○Graph display of IVL measurement data

**【Required components】**



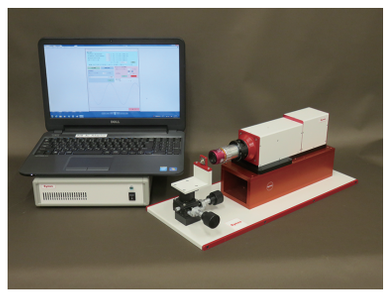



【NFP&IVL measurement system】
Detector head of IVL measurement module **PMD002/IVL** can be mounted on the manual revolver of sophisticated NFP measurement optics **M-Scope type S**.

## POLARIZATION MEASUREMENT MODULE PMD002/POL

Spatial polarizer rotation type polarization/extinction ratio measurement module, suitable for polarization measurement of optical fibers, LDs, VCSELs.

Polarization measurement module **PMD002/POL** is the polarization/extinction ratio measurement module of the spatial polarizer rotation method. It directly measures the polarization state of the collimated incident light. In addition, the output polarization state of optical fibers and laser diodes can be measured by using an objective lens.



**【Features】**

○Possible to measure polarization/extinction ratio with high speed, resolution, reproducibility.
○High angle accuracy is achieved by rotation of polarizer controlled by pulse rotation stage.
○Objective lens can be attached. Spatial light measurement of fibers, various lasers, VCSEL, etc. is also possible.
○Large diameter beam can be measured. (Up to φ10 mm collimated light can be measured.)

**【Summary of specifications】**

○Measurement method: Spatial polarizer rotation method
○Spectral range
- ●for 400~700nm: PMD002/POL VIS
- ●for 600~1100nm: PMD002/POL NIR
- ●for 900~1700nm: PMD002/POL IR (under development)

○Input power level and extinction ratio measurement range

| Input power | Range of Extinction ratio |
|---|---|
| 0.01~0.1(mW) | 20(dB) |
| 0.1~1(mW) | 30(dB) |
| 1~4(mW) | 40(dB) |

○Extinction ratio measurement reproducibility: ±0.5(dB)
○Extinction ratio display resolution: 0.01(dB)
○Target luminous flux diameter: Max. 10mmφ (collimated beam)
○Angle coverage: 360°
○Minimum angle resolution: approx. 0.09°
○Measurement angle resolution: approx. ±0.5° (use fitting)
○Attenuation: By ND filter (One can be inserted into the sensor head)

**【Standard component】**

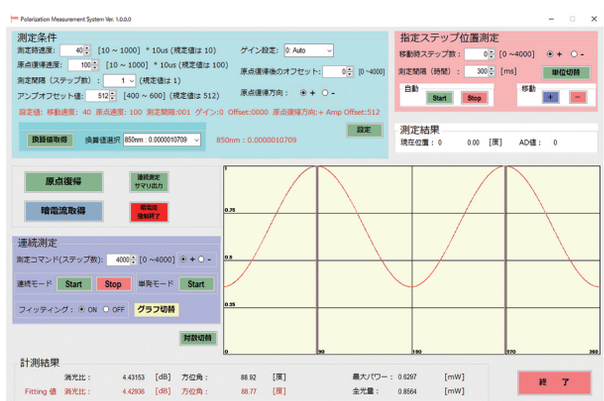
○Sensor head: 1
○Control unit: 1
○Measurement software: **Optometrics POL basic**

**【Option】**

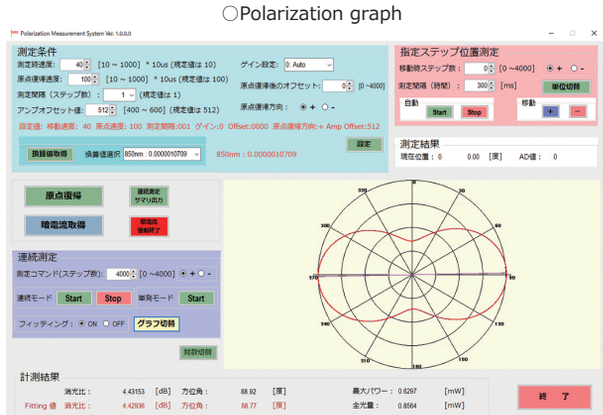
○Optics bench
○Objective lens
○ND filter

**【Software function】**

POL measurement software **Optometrics POL basic**
(Functions)
○Measurement parameter: Extinction ratio, Azimuth, Total incident power, Azimuth power
○Function: Graph display, Azimuth extinction ratio vs power display, Fitting, Measurement condition setting
○Data storage and output: Graph data, Output of graph data (csv format)

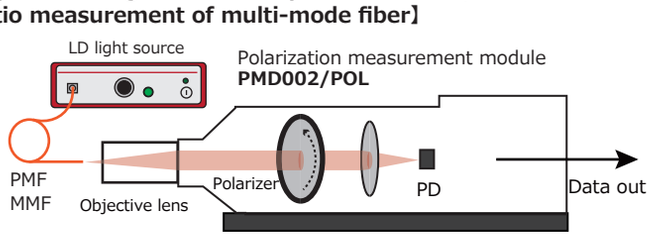


○Polarization graph



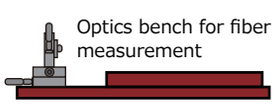
○Azimath vs power graph

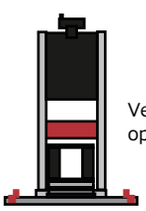
**【System configuration example Polarization/extinction ratio measurement of multi-mode fiber】**




**【Component selection of polarizetion measurement module】**

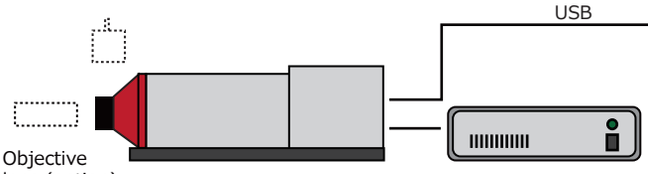
○Stages・optics bench




*Possible to mount on prober

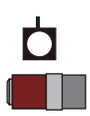
○Polarization measurement module




○Data analysis system

- ●Personal computer
  - ・Main unit
  - ・Accessories
- ●POL measurement software Optometrics POL Basic

○Accessories



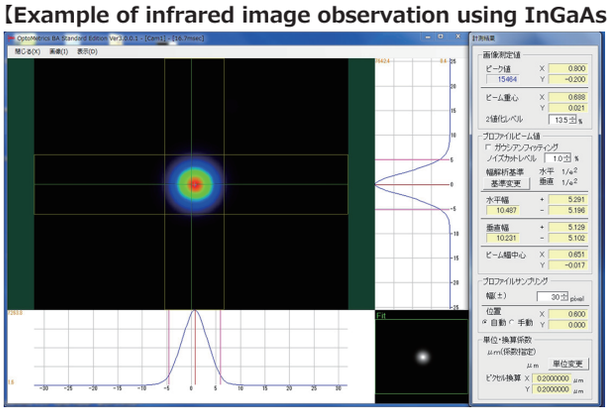
- ●ND filter
- ●Objective lens

## InGaAs HIGH SENSITIVITY NIR DETECTOR ISA041 series

InGaAs solid state image sensing detector, having high sensitivity up to 1700nm NIR wavelength range.

**InGaAs high sensitivity NIR detector** is a NIR detector having high spectral sensitivity from 950nm to 1700nm wavelength range. Especially, it has very high spectral sensitivity in 1310nm-1550nm wavelength range, so it is best for beam profile measurement and analysis, beam observation, inspection, assembling adjustment of various optical devices and modules for optical communication. In addition, it is applicable for inspection of semiconductor device and general purpose NIR image observation.

**【Example of infrared image observation using InGaAs detector】**



This is an example of using a light source of 1550 nm and observing an infrared beam spot of about 10 μmφ collected by the light collection module.

- Optics: NFP measurement optics **M-Scope type S**
- Objective lens: **M-Plan Apo NIR 100x**
- Detector: InGaAs high sensitivity NIR detector **ISA041H2**


This is an example of using a light source of 1550 nm and observing the light from the exit side of Silicon waveguide. At the same time, by using infrared halogen coaxial epi-illumination, microscopic image of exit side of silicon waveguide is observed.

- Optics: Optical measurement optics **M-Scope type J/PF**
- Objective lens: **M-Plan Apo NIR 100x**
- Detector: InGaAs NIR detector **ISA041M**

## InGaAs HIGH SENSITIVITY NIR DETECTOR ISA041H2/ISA041VH

Standard type InGaAs imaging detector for optical beam profile measurement from 950nm to 1700nm spectral range.

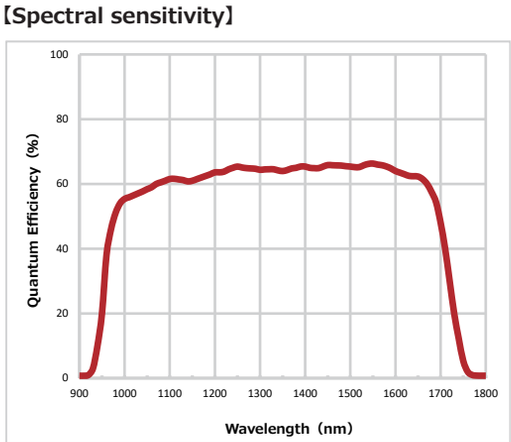
InGaAs high sensitivity NIR detector **ISA041H2/ISA041VH** are NIR detectors using InGaAs solid state imaging detector. Best suits for beam profile measurement and image processing, NIR image observation in 950~1700nm spectral range. **ISA041H2/ISA041VH** are standard imaging detectors for NIR beam profile measurement system in combination with Synos' M-Scope series optics and optical beam analysis module **AP013**.

**【Summary of specification】**

| Model | ISA041H2 | ISA041VH |
|---|---|---|
| Imaging device | InGaAs image densor | |
| Spectral range | 950nm - 1700nm | |
| Pixel number | 320(H) × 256(V) pixels | 640(H)×512(H) pixels |
| Sensor pitch | 20μm × 20μm | |
| Effective device size | 6.4mm(H) × 5.12mm(V) | 12.8mm(H) × 10.24mm(V) |
| Cooling temperature | 10℃ ±0.5℃ (at ambient temperature 25℃, forced-air cooling) | |
| Detector interface | USB3.0 (connector type : USB3.0 microB type) | |
| Exposure time | 4.6ms ~ 1s (at rolling shutter mode)<br>100μs ~ 1s (at global shutter mode) | 16.7ms ~ 1s |
| Maximum frame rate | 216.6 frame/sec (at rolling shutter mode)<br>214.3 frame/sec (at global shutter mode) | 59.774 frame/sec |
| ADC | 14bit | |
| External trigger mode | edge trigger, level trigger, start trigger | |
| Camera mount | C mount | |
| Power consumption | 16W or less | |
| Input voltage | DC+12V | |
| Ambient operation temp.(recommended) | +25℃ ±3℃ | |
| Ambient operation temperature/humidity | 0℃ ~ +40℃ / 30% ~ 80% (no condensation) | |
| Ambient storage temperature/humidity | -10℃ ~ +50℃ / under 90% (no condensation) | |

＊The specification shown above is for use with the detector alone. The functions shown above may be restricted depending on the hardware and software used.
＊With this detector, bright pixels, dark pixels, and unevenness may appear depending on the exposure time setting and environmental temperature. Please note that this is due to the characteristics of the InGaAs sensor and is not a defect or failure.

**【Spectral sensitivity】**




**【Dimension, weight of ISA041H2 detector head】**

* Outside dimension : 56(H) x 56(W) x 98(D) mm (excluding projection portion)
* Weight : approx. 520g

**【Standard component】**

* Detector head: 1
* Camera adapter for ISA041H2: 1
* 12pin camera cable: 1
* USB cable for ISA041H2: 1

【Detector type selestion of InGaAs NIR detector I**SA041H2** / **ISA041VH**】
**ISA041H2** and **ISA041VH** have the same pixel pitch, so the resolution is the same. On the other hand, since total number of pixels is different, effective element size will change. **ISA041H2** is suitable for use in combination with Synos' NFP measurement optics and standard type FFP measurement optics **M-Scope type F**. On the other hand, when used in combination with IR high-resolution FFP measurement optics **M-Scope type FHR** and the wide area FFP measurement optics **M-Scope type FW**, **ISA041VH** is indispensable. Please contact us for the details of the detector selection.

## InGaAs HIGH RESOLUTION NIR DETECTOR　　ISA041HRA / ISA041HRVA

Pixel pitch 5μm high resolution type InGaAs detector, having 400nm ~ 1700nm spectral range

InGaAs high resoluton NIR detector **ISA041HRA / OSA041HRVA are** NIR detectors using 5μm square pixels pitch InGaAs high resolution image sensor. having 400nm ~ 1700nm wide spectral range. Having wide spectral sensitivity from visible to NIR , these detectors can be widely applied to image observation in visible to infrared range. There are two models, **ISA041HRA** with 1280 (H) x 1024 (V) pixels and **ISA041HRVA** with 640 (H) x 512 (V) pixels.

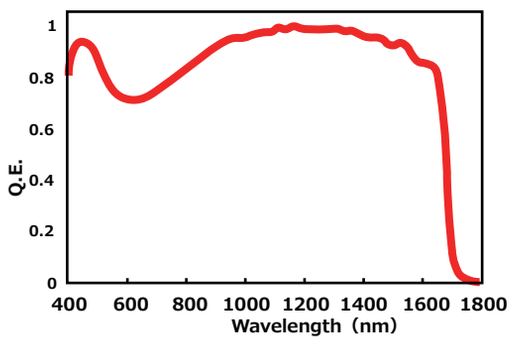
**【Summary of specification】**

| Model | ISA041HRA | ISA041HRVA |
|---|---|---|
| Imaging device | InGaAs image sensor | |
| Spectral range | 400nm ~ 1700nm | |
| Pixel number | 1280(H) × 1024(V) pixels | 640(H) × 512(H) pixels |
| Sensor pitch | 5μm × 5μm | |
| Effective device size | 6.4mm(H) × 5.12mm(V) | 3.2mm(H) × 2.56mm(V) |
| Cooling temperature | +15℃ (peltier cooling setting temperature) | |
| Detector interface | Gigabit Ethernet (1000BASE-T) | |
| Shutter mode | Global shutter | |
| Frame rate (ADC) | 30.0 fps (12bit)<br>60.0 fps (8bit) | 120.0 fps (12bit)<br>240.0 fps (8bit) |
| Exposure time | 6μsec ~ 10msec (6μsec ~ 9.99sec settable) | |
| S/N ratio | 54 d B | |
| Camera mount | C mount | |
| Power consumption | approx. 7W | |
| Input voltage | DC+12V ~ +24V ±1V | |
| Ambient operation temp.(recommended) | +25℃ ±3℃ | |
| Ambient operation temperature/humidity | 0℃ ~ +45℃ / 20% ~ 80% (no condensation) | |
| Ambient storage temperature/humidity | -15℃ ~ +65℃ / 20% ~ 80% (no condensation) | |

＊The specification shown above is for use with the detector alone. The functions shown above may be restricted depending on the hardware and software used.

＊With this detector, bright pixels, dark pixels, and unevenness may appear depending on the exposure time setting and environmental temperature. Please note that this is due to the characteristics of the InGaAs sensor and is not a defect or failure.

**【Spectral sensitivity】**




**【Standard component】**

○Detector head: 1
○Camera adapter for ISA041HRA/HRVA: 1
○12pin camera cable: 1
○LAN cable: 1

**【Dimension, weight of ISA041HRA/HRVA detector head】**

○Outside dimension : 58(H) x 58(W) x 90(D) mm (excluding projection portion)
○Weight : approx. 400g

【InGaAs NIR detector model selection　**ISA041H2/VH · ISA041HRA/HRVA**】

**ISA041H2/VH** have AR coat (antireflection coating) in 1300nm ~ 1550nm spectral range on the cover glass of InGaAs element, so it is most suitable for the sensor for laser beam profile measurement. On the other hand, **ISA041HRA/HRVA** use high-definition InGaAs element with spectral sensitivity in 400 ~ 1700nm, so it is suitable for general-purpose infrared image observation and image processing.

## 16000 PIXELS InGaAs NIR DETECTOR　　ISA041M

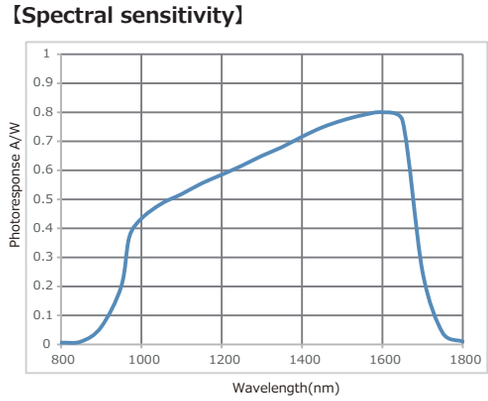
Small pixel number/low cost type general-purpose InGaAs imaging detector, mainly for purpose of observation in NIR range.

16000 pixels InGaAs NIR detector **ISA041M** is low cost type NIR detector using 128x128 pixels InGaAs solid state imaging detector. Best suits for beam monitor, beam observation in NIR spectral range.

**【Summary of specification】**

| Summary of specification / imaging device | |
|---|---|
| Imaging device | InGaAs image sensor |
| Spectral range | 900nm - 1700nm |
| Pixel number | 128 x 128 pixels |
| Sensor pitch | 20μm |
| Sensor size | 2.56 x 2.56mm |
| Summary of specification / Detector | |
| Detector control I/F | USB2.0 bulk transfer |
| Synchronization mode | Internal synchronization |
| Frame rate | 258fps |
| ADC | 14bit |
| Camera mount | C mount |
| Power consumption | 20W or less |
| Power supply | DC12V |
| Operation environment | 0℃ - 35℃/10-80% (no condensation) |

**【Spectral sensitivity】**




**【Standard component】**

○Detector head: 1
○AC adapter for ISA041M: 1
○USB cable for ISA041M: 1

**【Dimension, weight of ISA041M detector head】**

○Outside dimension : 71.5(W) x 61.5(H) x 51.8(D) mm
○Weight : approx. 250g

## HIGH RESOLUTION CMOS DETECTOR ISA071 / ISA071GL

High resolution & high performance, USB 3.0 interface CMOS detector for 400nm~1100nm spectral range

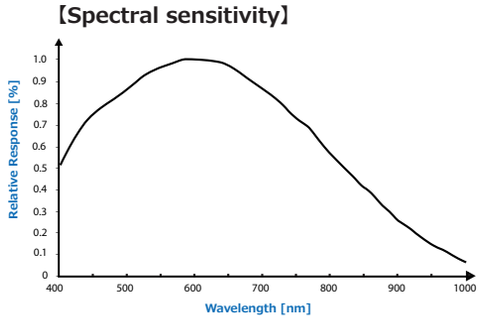
**ISA071/ISA071GL** is high resolution & high performance CMOS detectors for 400nm~1100nm spectral range. It is suitable for optical beam profile analysis of various optical device and module such as laser diodes, optical fiber, etc. in 400~1100nm wavelength range. In combination with Synos' optical measurement optics **M-Scope** series and optical beam analysis module **AD013**, it has wide application field in optical beam observation and beam profile analysis.

**【Summary of specification】**

| | High resolution CMOS detector **ISA071** | High resolution CMOS detector for laser **ISA071GL** |
|---|---|---|
| Specification outline of image sensor | | |
| Imaging device | 1/1.8" CMOS (with cover glass) | 1/1.8" CMOS (cover glassless) |
| Spectral range | 400nm~1100nm | |
| Total pixels | 2048×1536 pixels (approx. 3.2 megapixels) | |
| Pixels pitch | 3.45×3.45 (μm) | |
| Specification outline of detector hardware | | |
| Interface | USB 3.0 | |
| Frame rate | 60fps (at full resolution) | |
| Shutter | Global shutter | |
| Exporsure control | 25μsec~4sec | |
| Gradation | 12bit ADC | |
| Camera mount | C/CS mount | |
| Power supply | USB bus power (4.5~5.5 VDC supply voltage) | |
| Operation environment | +5℃~+45℃ | |

**(CAUTION) High Resolution CMOS Detector For Laser *ISA071GL* is using cover glassless type CMOS image sensor. For this reason, free warranty after delivery does not apply. When selecting *ISA071GL*, please be aware of this in advance and handle with care.**

**【Spectral sensitivity】**




**【Standard component】**

○Detector head: 1

## 1" HIGH RESOLUTION CMOS DETECTOR ISA061

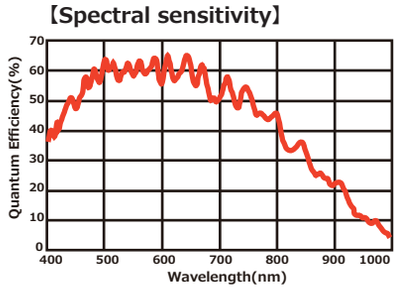
1 inch format high resolution & high performance digital CMOS detector for 400nm~1100nm spectral range

**ISA061** is a CMOS detector using 2048×2048 pixels, NIR enhanced 1" progressive scan CMOS imaging device. ISA061 is the dedicated detector of wide area type FFP measurement optics **M-Scope type FW**, and high power laser FFP measurement optics **M-Scope type HF**.

**【Summary of specification】**

| Summary of specification / Imaging device | |
|---|---|
| Imaging device | 1 inch progressive scan CMOS (NIR enhanced) |
| Spectral range | 400nm - 1100nm |
| Pixels number | 2048 × 2048 pixels / 4M pixels |
| Sensor pitch | 5.5 x 5.5μm |
| Summary of specification / Detector | |
| Detector control I/F | Gigabit Ethernet (GigE Vision) |
| Frame rate | 25fps |
| Shutter | Global |
| Exposure control | Programable mode |
| Gradation | 8/12bit |
| Camera mount | C mount |
| Power supply | 12VDC |

**【Spectral sensitivity】**




**【Standard component】**

○Detector head: 1
○AC adapter: 1

## USB CMOS DETECTOR ISA003-01

General purpose USB CMOS detector, mainly used for image observation and image processing

USB CMOS detector **ISA003-01** is a monochrome USB CMOS detector, mainly used for image observation and image processing in general purpose.

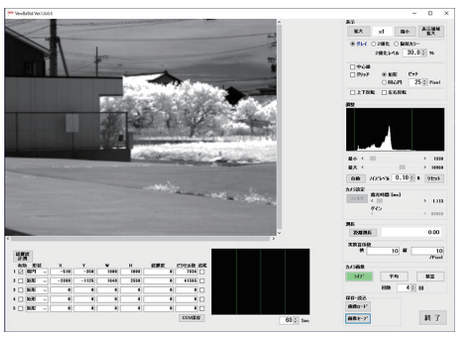
**【Summary of specification】**

○Image sensor: 1/1.8" progressive scan monochrome CMOS
○Shutter: Global/rolling shutter
○Effective total pixels: 1280×1024 pixels (approx. 1.3M pixels)
○Pixels pitch: 5.3×5.3μm
○Frame rate: 60fps
○Camera interface: USB3.0 Super speed (USB3.0 microB)
○Gradation: 8bit /10bit
○Minimum subject illuminance: 0.26Lux at F1.2
○Exposure time: 15.72μsec~10.3sec
○Power supply/power consumption: +5V (typ.)(USB standard compliant)/2.0W or less

## IMAGE VIEWER SOFTWARE　　SYNOS IMAGE VIEWER

The image display software for SYNOS' image detector. Besides image enhancement, it has simple luminance analysis function.

**Synos Image Viewer** is the viewer software for various detectors of SYNOS. By simply installing it on PC, you can easily display image of SYNOS' detectors. Furthermore, **Synos Image Viewer** has a simple luminance analysis function in addition to image display & improvement function.



**【Main function of Synos Image Viewer】**

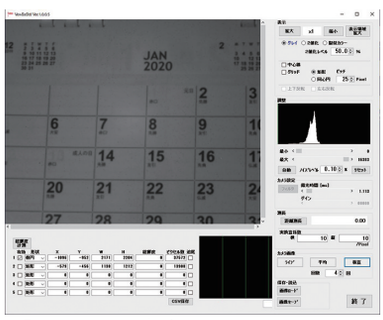
○Image display function
- ●Live display, image average, image accumulation
  - ・Normal image, binarized image, pseudocolor display
- ●Image enhancement (histogram stretching, automatic contrast enhancement)
- ●Grid display
- ●Manual length measurement function

○Simple luminance analysis function
- ●Total luminance measurement function within cursor, total luminance measurement function with time variation

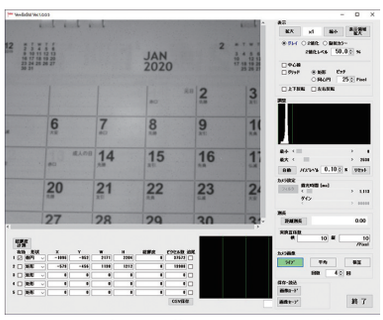
○Save images
- ●Save and read images

**【Image enhancement function】**

●Live
(Detector: InGaAs NIR detector ISA041H2)

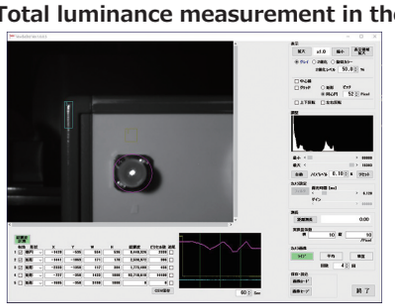


●Image accumlation
(Detector: InGaAs NIR detector ISA041H2)



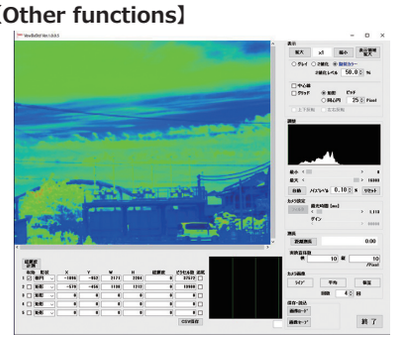
●Image enhance (histogram stretch)
(Detector: InGaAs NIR detector ISA041H2)

**【Total luminance measurement in the set cursor】**

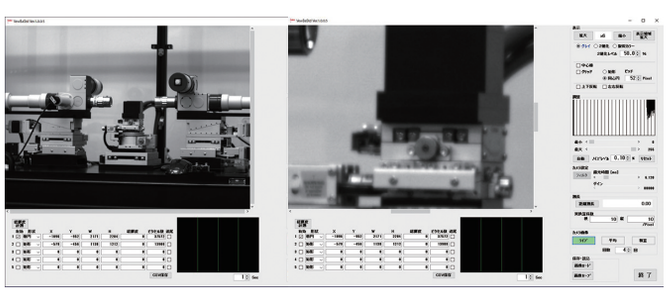


It is a function to set the measurement cursor in the screen and to simply measure the total luminance in the cursor. Up to 5 measurement cursors of circular or rectangular shape can be set. The measurement result display window displays the position and size of each setting cursor, the total number of luminance counts in the cursor, and the total number of pixels in the cursor. Data can be written in csv format. In addition, the time change of the total luminance count number within each setting cursor is displayed on the right side of the measurement result display window. It is possible to apply the power monitoring during optical fiber alignment and the monitoring the time variation of emission from the sample.

**【Other functions】**



●Pseudo color display



1×　　6×

●Digital zoom

**【System Requirements】**

| | |
|---|---|
| ●Supported OS: | Microsoft Windows 10 (32/64 bit) |
| ●Supported hardware: | Intel Chipset ICH series (6 or later) is installed |
| ●CPU performance: | Intel Core 2 duo 2.4 GHz or higher |
| ●Available memory: | 512 MB or more |

**【Corresponding detector】**

○InGaAs NIR detector
- ●**ISA041H2**
- ●**ISA041HRA/HRVA**
- ●**ISA041M**

○High resolution digital CCD detector **ISA011**
○High resolution CMOS detector **ISA071/ISA071GL**

## HIGH STABILITY FC CONNECTOR OUTPUT LD LIGHT SOURCE　LSL002 SERIES

High stability DC-LD light source unit with FC connector output type.

**LSL002 series** is FC connector output type, high stability DC-LD light source unit. As is FC connector output type lightsource, various optical fibers on the market are available. Furthermore, as optional version, it is available to prepare polarization mainraining optical fiber output. As various types of laser diodes on the market are set in, it is possible to choose from various types such as wavelength, output power, etc.

**【Features】**

○Easy to use because of all-in-one unit including light source, driver circuit, power supply, etc.
○Because of using laser diode on the market, it is possible to choose various type of light source in power, wavelength, etc.
○High stability in output power and wavelength with APC and temperature control.
○As standard version, it is singlemode fiber and FC connector output. As optional version, it is available to prepare polarization mainraining optical fiber output.

**【Summary of specifications】**

○Optical output: approx. 1mW (standard)
*Special specifications such as high output are available as an option.
○Optical output connector: SMF+FC connector (standard)
PMF+FC connector (option)
○LD driver: APC+temperature control by peltier device
○Output stability: typ.±1%
○Power supply: AC100V±10%、50/60Hz

**【Standard component】**

○Main unit: 1
○Power supply cable: 1
○Key for key switch: 1

**【LD selection】**

| Peak wavelength (nm) | 375 | 405 | 488 | 520 | 635 | 658 | 785 | 850 | 980 | 1064 | 1310 | 1550 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wavelength tolerance (nm) | ±5 | ±5 | ±5 | ±10 | ±10 | ±10 | ±10 | ±15 | ±10 | ±10 | ±20 | ±30 |
| Max. output power (mW) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Power stability (%) | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 |
| Mode field diameter (μm) | 2.2 | 3 | 3.5 | 3.5 | 4.5 | 4.5 | 5.0 | 5.0 | 5.9 | 5.9 | 9.2 | 10.4 |
| N.A. | 0.13 | 0.13 | 0.12 | 0.12 | 0.12 | 0.12 | 0.13 | 0.13 | 0.14 | 0.14 | 0.14 | 0.14 |

## COMPACT TYPE SMF OUTPUT LD LIGHT SOURCE　LSL011 SERIES

Compact and SMF output type LD light source unit with SM fiber output type.  Low cost and easy to use.

**LSL011 series** is compact and SMF output type LD light source unit. As is SM fiber output type lightsource with LD, driver circuit, TEC, power supply, it is very easy to use. As various types of laser diodes on the market are set in, it is possible to choose from various types such as wavelength, output power, etc. Pulse emmision is also available with external TTL trigger input.

**【Features】**

○Easy to use as is all-in-one unit with SM fiber, driver circuit, TEC, power supply.
○Because of using laser diode on the market, it is possible to choose various type of light source in power, wavelength, etc.
○High stability in output power and wavelength with ACC and temperature control.
○Pulse emmision with external TTL trigger input.

**【Summary of specification】**

○Light source module: SMF coupling FP-LD
○Fiber length: 50cm or more
○Output connector: FC/PC
○Drive control: ACC and temperature control
○Pulse emission: TTL input (high : on, low : off)
(except 532nm) maximum repetition ＞1kHz
○Power supply: AC100-240V　50/60Hz　0.3A
○dimension, weight: 60(W) x 50(H) x 120(D)mm/400g
(except prodection component)
AC100V±10%、50/60Hz

**【Standard component】**

○Main unit: 1

**【LD selection】**

| Peak wavelength (nm) | 375 | 405 | 445 | 473 | 488 | 520 | 635 | 660 | 785 | 850 | 980 | 1064 | 1310 | 1550 | 1620 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wavelength tolerance (nm) | ±5 | ±5 | ±5 | ±5 | ±5 | ±10 | ±10 | ±10 | ±10 | ±10 | ±10 | ±10 | ±10 | ±10 | ±15 |
| Max. output power (mW) | 1 | 1 | 10 | 10 | 10 | 10 | 5 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 4 |
| Power stability (%) | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 |
| Mode field diameter (μm) | 2.9 | 2.9 | 2.9 | 3.5 | 3.5 | 3.5 | 4.0 | 4.0 | 5.0 | 5.0 | 4.2 | 4.2 | 9.0 | 9.0 | 9.0 |
| N.A. | 0.12 | 0.12 | 0.12 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.14 | 0.14 | 0.13 | 0.13 | 0.13 |

## LOW COHERENT 850nm SLD LIGHT SOURCE LSS002/850

High power and low coherent SLD light source having center wavelength at 850nm.

**LSS002/850** is high power and low coherent light source having center wavelength at 850nm, that is most adequate for measuring insertion loss and other optical parameters for optical interconnection application. It equips high intensity SLD (Super Luminescent Diode) as Light-emitting device, with center wavelength at 850nm±20nm/half width is 20nm. Ideal light source for insertion loss measurement, optical characteristic measurement of polymer optical waveguide module for OPCB, optical fiber, and any other optical interconnect application.

**【Feature】**

○High power and low coherent light source equipping high intensity SLD.
○The center wavelength is 850±20nm and half width is 30nm(typ.) . Covers wide bandwidth.
●It can measure insertion loss, optical characteristics of polymer waveguide modules, optical fibers for optical interconnect application at the wavelength of VCSEL light source.
○High stability with temperature control
●Typically less than 0.5% per one hour and less than 2% per 12 hours with 1 hour aging after power on.

**【Summary of specifications】**

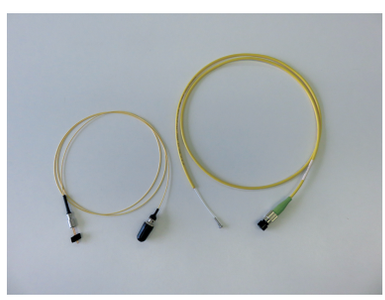
| | |
|---|---|
| ○Optical output: | approx. 2mW (at APC-SM fiber output) |
| ○Optical output connector: | FC connector |
| ○Light emitting device: | 850nm high power SLD |
| ○Center wavelength: | 850nm±20nm |
| ○Wavelength width: | typ. 30nm (full width half maximum) |
| ○Output stability: | typ.0.5% or less (per one hour with 1 hour aging after power on.)<br>typ.2% or less (per 12 hours with 1 hour aging after power on.) |
| ○Power supply: | AC100V±10%、50/60Hz |

**【Standard component】**

○Main unit: 1
○Power supply cable: 1
○Key for key switch: 1

## ● ON DEMAND OPTICAL LIGHT SOURCE MODULE, OPTICAL MODULE DESIGN AND PRODUCTION SERVICE

**According to customers' requirement specification, Synos produces on-demand optical module, from disign to production. Acceptable small-scale orders.**



According to customers' requirement specification, Synos will produce optical modules by request of customers, from disign to production. Acceptable small-scale orders.
○Optical module production in small production such as trial manufacture
○Design and production of special light source for measurement
○Design and Pruduction of special optics and optical unit, module, etc.

**【Example of on demand production service】**

○Fiber output type custom LD module
It is possible to design and produce custom pigtail LD module in combination with LD and optical fiber according to requirement of LD, optical fiber, output connector. As parts of LD and fiber module are fixed by YAG laser welding, it has high reliability in long term. Acceptable small-scale order.

○Custom design optics and optical unit
Synos can design and produce various special optical unit and modules using special lens and optcial components according to customers' requirement.

*** It is necessary to examine and fix the specification before order. Please feel free to ask.**

## OBJECTIVE LENS

It is possible to choose objective lens for measurement object from wide variation of lineup such as normal, NIR, NUV, HR, etc.

- As for measurement of visible spectral range, M-plan Apo series, having long working distance, is recommended.
- As for measurement of NIR spectral range, M-Plan Apo NIR series, having good transmittance ratio and corrected for chromatic aberrasion in 480-1800nm spectral range, is recommended.
- Furthermore, M-Plan Apo HR series, imploved resolution and N.A., is selectable.

About field of view and pixel resolution corresponding to the combination of objective lens and imaging detector, refer to the table below.

**【Specification of objective lens】**

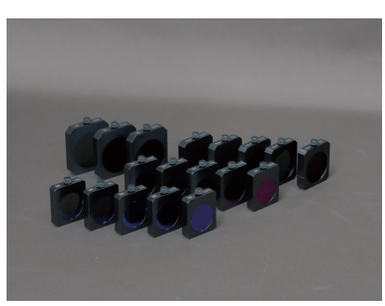
| Magnification | N.A. | W.D.(mm) | Focal length(mm) | Resolution(μm) | Focal depth(μm) |
|---|---|---|---|---|---|
| M-Plan Apo series , infinity-corrected objective lens | | | | | |
| M-Plan Apo 5x | 0.14 | 34.0 | 40.0 | 2.0 | 14.0 |
| M-Plan Apo 10x | 0.28 | 33.5 | 20.0 | 1.0 | 3.5 |
| M-Plan Apo 20x | 0.42 | 20.0 | 10.0 | 0.7 | 1.6 |
| M-Plan Apo 50x | 0.55 | 13.0 | 4.0 | 0.5 | 0.9 |
| M-Plan Apo 100x | 0.7 | 6.0 | 2.0 | 0.4 | 0.6 |
| M-Plan Apo HR series, high-resolution infinity-corrected objective lens | | | | | |
| M-Plan Apo HR 10x | 0.42 | 15.0 | 20.0 | 0.6 | 1.55 |
| M-Plan Apo HR 50x | 0.75 | 5.2 | 4.0 | 0.3 | 0.5 |
| M-Plan Apo HR 100x | 0.9 | 1.3 | 2.0 | 0.3 | 0.3 |
| M-Plan Apo NIR series, infinity-corrected objective lens for NIR | | | | | |
| M-Plan Apo NIR 5x | 0.14 | 37.5 | 40.0 | 2.0 | 14.0 |
| M-Plan Apo NIR 10x | 0.26 | 30.5 | 20.0 | 1.1 | 4.1 |
| M-Plan Apo NIR 20x | 0.40 | 20.0 | 10.0 | 0.7 | 1.7 |
| M-Plan Apo NIR 50x | 0.42 | 17.0 | 4.0 | 0.7 | 1.6 |
| M-Plan Apo NIR 100x | 0.50 | 12.0 | 2.0 | 0.6 | 1.1 |
| M-Plan Apo NIR HR series, high-resolution infinity-corrected objective lens for NIR | | | | | |
| M-Plan Apo NIR HR 50x | 0.65 | 10.0 | 4.0 | 0.42 | 0.65 |
| M-Plan Apo NIR HR 100x | 0.7 | 10.0 | 2.0 | 0.39 | 0.56 |

**【Main detectors, field of view, pixel resolution of NFP measurement (approx. value)】**

| Detector model | **ISA071/ISA071GL** | | **ISA041H2** | | **ISA041HRA** | | **ISA041HRVA** | |
|---|---|---|---|---|---|---|---|---|
| Detector name | Hi-resolution CMOS detector | | InGaAs NIR detector | | InGaAs high resolution NIR detector | | | |
| Spectral range | 400-1100nm | | 950-1700nm | | 400~1700nm | | | |
| Sensor size | 1/1.8 inch | | 6.4mm×5.12mm | | 6.4mm×5.12mm | | 3.2mm×2.56mm | |
| Total pixels | 2048×1536 | | 320×256 | | 1280×1024 | | 640×512 | |
| Pixels pitch | 3.45μm | | 20μm | | 5μm | | | |
| Optical magnification | Field of view (mm) | Pixel resolution (μm) | Field of view (mm) | Pixel resolution (μm) | Field of view (mm) | Pixel resolution (μm) | Field of view (mm) | Pixel resolution (μm) |
| 5× | 1.41×1.05 | 0.69 | 1.28×1.024 | 4 | 1.28×1.024 | 1 | 0.64×0.512 | 1 |
| 10× | 0.70×0.52 | 0.345 | 0.64×0.512 | 2 | 0.64×0.512 | 0.5 | 0.32×0.256 | 0.5 |
| 20× | 0.35×0.26 | 0.173 | 0.32×0.256 | 1 | 0.32×0.256 | 0.25 | 0.16×0.128 | 0.25 |
| 50× | 0.14×0.10 | 0.069 | 0.128×0.102 | 0.4 | 0.128×0.102 | 0.1 | 0.064×0.051 | 0.1 |
| 100× | 0.07×0.05 | 0.035 | 0.064×0.051 | 0.2 | 0.064×0.051 | 0.05 | 0.032×0.025 | 0.05 |

*Pixel resolution: The measurement length equivalent to 1 pixel of the detector calculated from filed of view and sensor pitch of the detector.
*The optical magnification when using **MS-OP011-RL2** is 2 times the magnification in the table on the left, and the actual field of view and pixel resolution are 1/2.
*The optical magnification when using the **MS-OP011-RLH** is 1/2 of each magnificationin the table on the left, and the actual field of view and pixel resolution are 2 times.

## ND FILTER (NEUTRAL DENSITY FILTER)



ND filter with dedicated filter holder for Synos' **M-Scope series** optics. We can prepare not only standard type ND filter but also various type and specification of ND filter as customer's requirement, such as reduction ratio, special coating, etc. In addition, we can supply only filter holder for **M-Scope series** optics. Various optical filters such as polarizer, etc. can be atttached.

| Model | Item name | Specification |
|---|---|---|
| NDF-5 | Visible ND filter set | for Visible, 5 pieces set (transmittance:0.01% ・0.1% ・1% ・5% ・10%) |
| NDF NIR-5 | NIR ND filter set | for NIR, 5 pieces set (transmittance:0.01% ・0.1% ・1% ・5% ・10%) |
| NDF IR-5 | IR ND filter set | for IR, 5 pieces set (transmittance:0.01% ・0.1% ・1% ・5% ・10%) |
| FH | Filter holder | for 25mmφ・ 30mmφ・ 35mmφ |

| Diameter | Target optics |
|---|---|
| 25mmφ | M-Scope type I ・type L ・type S ・type F ・type C ・type D ・type HL ・type HD, etc. |
| 30mmφ | M-Scope type HS, etc. |
| 35mmφ | M-Scope type FW ・type HF, etc. |

## FILTER ROTATION HOLDER　　FHR-25

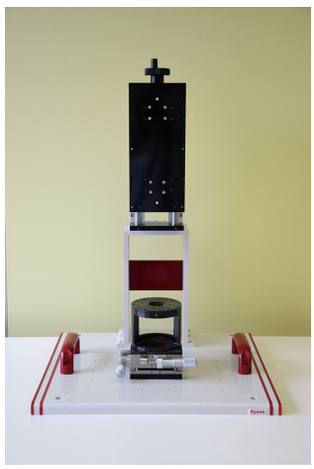
**FHR-25** is filter holder with filter rotation structure, for Synos' optical measurement optics **M-Scope series**. It is possible to rotate and adjust filter such as polarizer.

## OPTICS BENCH FOR SAMPLE MEASUREMENT

### VERTICAL TYPE OPTICS BENCH

This is vertical setting optics bench for optical measurement optics **M-Scope series**. Rough position adjustment function in Z axis is equipped so that it is easy to adjust focusing for various uneven sample. As sample holders and stage system can be designed and selected based on device shape, the measurement system is easily configured.

**【Summary of specification】**
○Loading capacity of optics installation part: approx. 5 kg
○Motion range of Z axis rough position adjustment: approx. 80mm


Vertical type optics bench **OP002**

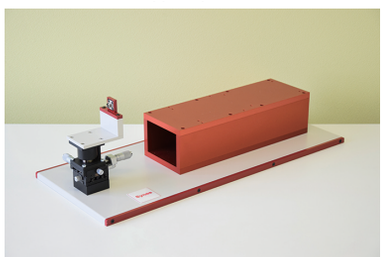
### OPTICS BENCH FOR FIBER MEASUREMENT OP002-F3/OP002-F5

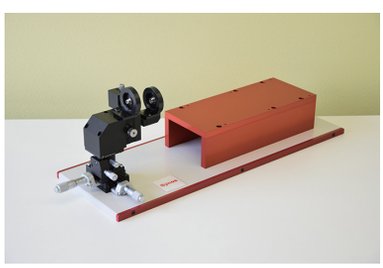
This is optics bench for optical measurement optics **M-Scope series**, especially for optical fiber sample measurement. As manual 3-axis (or 5-axis) stage for fiber position adjustmet is equipped, it is easy to adjust mesurement position of fiber sample in NFP/FFP and various beam profile measurement.

【Optics bench for optical fiber measurement with manual 3axis stage **OP002-F3】**
○Stage system for fiber position adjustment: Manual 3-axis (XYZ axis)
○Motion range of XYZ-axis stage: ±6.5mm
○Minimum readout: 10μm/scale
○Fiber adaptor: FC connector(standard), SC connector and other type fiber connector (option)

【Optics bench for optical fiber measurement with manual 5axis stage **OP002-F5】**
○Stage system for fiber position adjustment: Manual 5-axis (XYZ+θxθy axis)
○Motion range of XY-axis stage: ±6.5mm
○Motion range of Z-axis stage: ±3mm
○Minimum readout of XYZ-axis: 10μm / scale
○Motion range of θxθy axis stage: ±15°
○Fiber adaptor: FC connector (standard), SC connector and other type fiber connector (option)

【Compatible optics for **OP002・OP002-F3・OP002-F5** (common)】
○Synos' optical measurement optics **M-Scope series**
- ●Sophisticated optical measurement optics **M-Scope type I seires**
- ●Simplified optical measurement optics **M-Scope type J series**
- ●Optical beam NFP measurement optics **M-Scope type S, M-Scope type L**
- ●FFP measurement optics **M-Scope type F, M-Scope type FW**
- ●Collimated beam measurement optics **M-Scope type C**
- ●NFP/FFP simultaneous measurement optics **M-Scope type D**
- ●Underfilled launch optical system **M-Scope type G**
- ●Mode selective launch optical system **M-Scope type ML**
- ●NFP measurement optics for high power laser **M-Scope type HS, M-Scope type HL**
- ●FFP measurement optics for high power laser M-Scope type HF
- ●Polarization measurement module **PMD002/POL**


Optics bench for fiber measurement with 3-axis manual stage **OP002-F3**


Optics bench for fiber measurement with 5-axis manual stage **OP002-F5**

## COAXIAL EPI-ILLUMINATION SYSTEM

### LED Coaxial epi-illumination system

This is LED type coaxial epi-illumination unit. In combination with Synos' CCD detector and optical measurement optics **M-Scope series** with coaxial epi-illumination port, it is possible to observe microscopic image of object, such as edge image of optical fiber, optical waveguide module, and so on. There are monochromatic light type (465nm, 520nm, 645nm, 850nm, etc.) and white light type.

**【Summary of specification】**

| Model | Wavelength | Head shape | Tip diameter | Controller type |
|---|---|---|---|---|
| LS-EL001/R | Red (630nm) | Cylindrical (or L-shape) | φ8mm | CCS PJ-1505-2CA |
| LS-EL001/W | White (CCT5600K) | Cylindrical (or L-shape) | φ8mm | CCS PJ-1505-2CA |
| LS-EL001/BL | Blue (465nm) | Cylindrical (or L-shape) | φ8mm | CCS PJ-1505-2CA |
| LS-EL001/GR | Green (520nm) | Cylindrical (or L-shape) | φ8mm | CCS PJ-1505-2CA |
| LS-EL002L/860 | 860nm | L-shape | φ8mm | CCS PJ2-1505-2CA-PE |
| LS-EL002L/950 | 950nm | L-shape | φ8mm | CCS PJ2-1505-2CA-PE |


LED coaxial epi-illumination light source **LS-EL001**

# ○*GLOSSARY【GENERAL TERMS OF OPTICAL RELATED】*

**●Polarization**

Polarized light refers to a state in which the vibration direction of light is biased. Light is a transverse wave (the electric field and magnetic field oscillate in a plane perpendicular to the direction of travel), so in the case of perfect polarization, it can be represented by the composition of two orthogonal vibration components. When polarization is represented by the combination of two orthogonal linearly polarized lights with the same amplitude, a phase difference of 0 or 180° (π) result in linearly polarized light and a phase difference of ±90° (π/2) result in circularly polarized light. And other phase differences result in elliptically polarized light. The polarization extinction ratio (PER) is used as a value that indicates how close the linearly polarized light is to perfection. The polarization extinction ratio is measured as the ratio between the maximum and minimum values when the measurement light is transmitted through a polarizer and the polarizer is rotated to measure the output light amount. The polarization extinction ratio (PER) is generally expressed in dB and is calculated by the following formula.

$$PER = 10 \log \left( \frac{P_{max}}{P_{min}} \right)$$

$P_{max}$: *Maximum amount of transmitted light* $P_{min}$: *Minimum transmitted light amount*

The actual polarization state is often a mixture of perfect polarization (linear polarization/circular (elliptical) polarization) and non-polarization (random). Degree of polarization (DOP) is an index indicating such a polarization state, and is defined as follows using Stokes parameters.

$$DOP = \frac{\sqrt{S_1^2 + S_2^2 + S_3^2}}{S_0}$$

$S_0, S_1, S_2, S_3$: *Stokes parameters*

**●Polarizer**

An optical element that can obtain linearly polarized light by transmitting light. The performance of a polarizer is represented by the value of the polarization extinction ratio of transmitted light.

**●Polarization dependence and polarization dependence compensation**

The surface reflection (transmission) characteristics when light is obliquely incident on a glass substrate or beam splitter are generally different for P-polarized light and S-polarized light. Therefore, in optical systems using these BSs, the intensity of reflected/transmitted light fluctuates when the polarization state of incident light changes (polarization dependence). It is very difficult to eliminate this polarization dependency by designing a dielectric multilayer film in a wide wavelength range. Therefore, the polarization characteristics can be compensated by arranging and using the tilt directions of the two beam splitters having the same characteristics in the orthogonal directions. (Because the component that was P-polarized in the first-stage BS becomes S-polarized in the second-stage BS, and the component that was S-polarized in the first-stage BS plane becomes P-polarized in the second-stage BS plane.) Whether the beam splitter is used for reflection-reflection or transmission-transmission, polarization characteristics can be compensated by making the BS tilt directions orthogonal to each other.

**●Waveguide mode of optical fiber**

Here, the waveguide mode of light propagating in the optical fiber will be described. The waveguide mode (transverse mode) of a fiber changes depending on the size of the core, the refractive index of the core/cladding, and the wavelength. The number of modes varies depending on the type of fiber, and some have 1 to several thousand or more modes. In general, there are single mode fibers (propagating only the fundamental mode) and multimode fibers. The number of modes that can exist in the optical fiber can be determined by the standardized frequency V (V parameter). The standardized frequency V is defined by the following formula.

$$V = \frac{2\pi a}{\lambda} NA$$

*V: Normalized frequency λ: Wavelength a: Radius of fiber core NA: Fiber numerical aperture*

In the case of step index, under the condition that the refractive index distribution of the fiber is V≦2.405, it becomes a single mode fiber in which only the fundamental mode is excited. The wavelength λc at this time is called (theoretical) cutoff wavelength.

$$\lambda_c = \frac{2\pi a}{2.405} NA$$

Further, when the normalized frequency is sufficiently large, the number of modes that can be propagated in the step index type multimode fiber can be approximated by the following formula.

$$N \approx \frac{V^2}{2} = 2\left(\frac{\pi a}{\lambda} NA\right)^2$$

# ○*GLOSSARY【GENERAL TERMS OF OPTICAL RELATED】*

**●SMF (Single mode optical fiber)**
An optical fiber with the characteristic that only the fundamental mode is excited at the wavelength of light used.

**●MMF (Multi mode optical fiber)**
A fiber that can excite multiple modes at the wavelength used. There are two main types of multimode fibers with different structures.

◎SI type MMF
A multimode fiber with a flat core refractive index profile.

◎GI type MMF
A multimode fiber with characteristics that the refractive index distribution of the core gradually decreases from the center to the periphery. Compared to SI type MMF, mode dispersion (difference in propagation velocity due to mode difference) is smaller, so the spread of signal pulse is suppressed and longer distance transmission is possible.

**●Insertion loss**
The ratio of the incident power to the optical component and the output power from the optical component is calculated by the following formula. It represents the amount of attenuation of optical power when an optical component is inserted in the optical path.

$$IL=-10\ log\ \frac{P_{out}}{P_{in}}\ \ [\mathrm{dB}]$$

**●Silicon photonics**
A technology to fabricate optical circuits (optical waveguides, optical switches, wavelength filters, optical modulators, light receivers, and light emitters) on Si substrates using the microfabrication technology of semiconductor manufacturing. Therefore, it becomes possible to fabricate a hybrid device in which optical and electronic components are integrated on the same chip.

**●Silicon waveguide**
An optical circuit constructed by fabricating a Si wire waveguide on an SOI substrate with a thickness and width of sub micron as a Si wire waveguide. Since the Si wire waveguide has a very strong optical confinement effect, a bending radius on the order of μm is possible, and a very small optical circuit can be realized. Generally, a spot size converter or a grating coupler is used for input and output light into and from the waveguide. As applications to passive devices, optical switches using optical couplers and Mach-Zehnder interferometers, wavelength filters using ring interferometers, etc. can be realized.

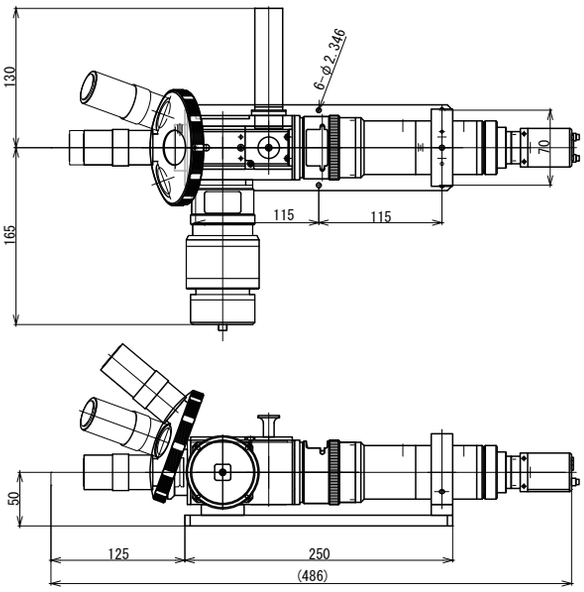
**●Polymer optical waveguide**
An optical waveguide manufactured using a polymer as the material for the optical waveguide. The wavelength used is generally in the 850 nm band, which has good matching with VCSEL. Although SI type multimode waveguides are generally used as the structure, GI type and SMF type ones are being developed. It is expected to be applied to short-distance optical wiring boards and opto-electric hybrid boards.

**●LD(Laser diode) light source**
The following are the LD light sources. A Fabry-Pérot LD that uses the reflection on both end faces of the active layer (light-emitting layer) that has a waveguide structure as a cavity for laser oscillation. Distributed feedback type laser (DFB) that performs laser oscillation at a single wavelength using a diffraction grating. Vertical Cavity Surface Emitting Laser (VCSEL) with a cavity formed vertically on a substrate. A large number of products are being sold that combine laser light from an LD element with an optical fiber to make a fiber emission type, and use an output stabilizing light source for temperature control. Although it depends on the structure of the LD element, it is generally a light source with a narrow wavelength width and good coherence in terms of time and space.

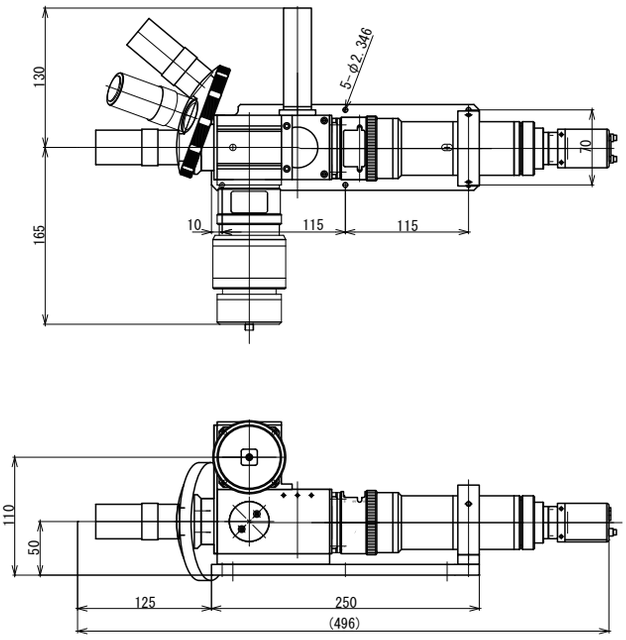
**●SLD(Superluminescent diode) light source**
Like the FP-LD, the SLD generates light in the waveguide, but unlike the FP-LD, because it has a structure that does not form a cavity, it has a broadband wavelength width in which spontaneous emission is amplified by stimulated emission. Since the light is emitted from the end of the waveguide, the spatial coherence is high, but the wavelength coherence is wide, and thus the temporal coherence is low. Utilizing these features, SLD light sources are used in OCT (coherence tomography) and optical fiber gyroscope (FOG).

## OUTSIDE DIMENSIONS OF MAIN PRODUCTS

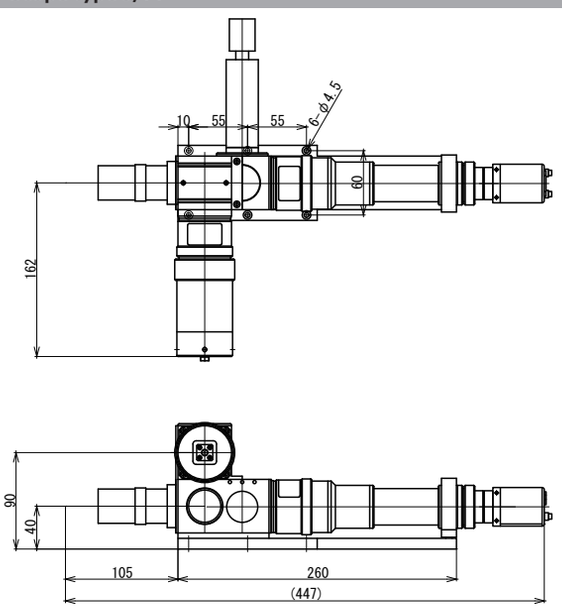
○Sophisticated optical measurement optics **M-Scope type I**



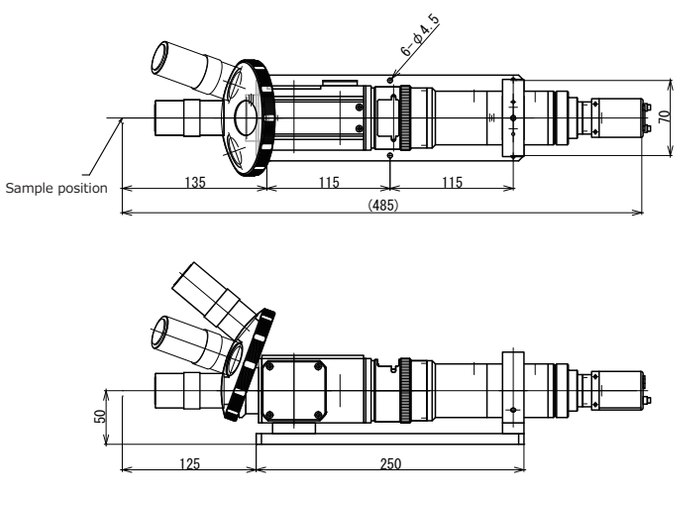

○Polarization compensasion optical measurement optics **M-Scope type I/PF**



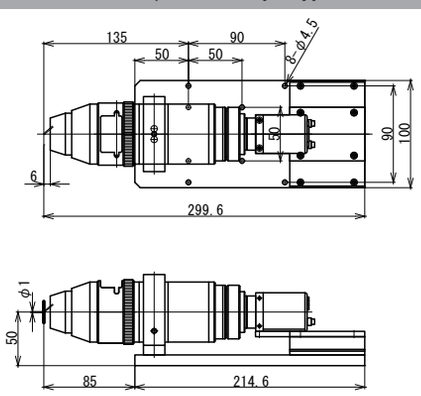

○Polarization compensasion simplified optical measurement optics **M-Scope type J/PF**



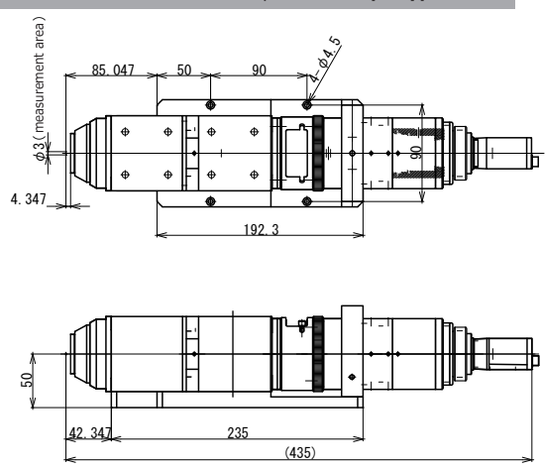

○Sophisticated NFP measurement optics **M-Scope type S**




○FFP measurement optics **M-Scope type F**



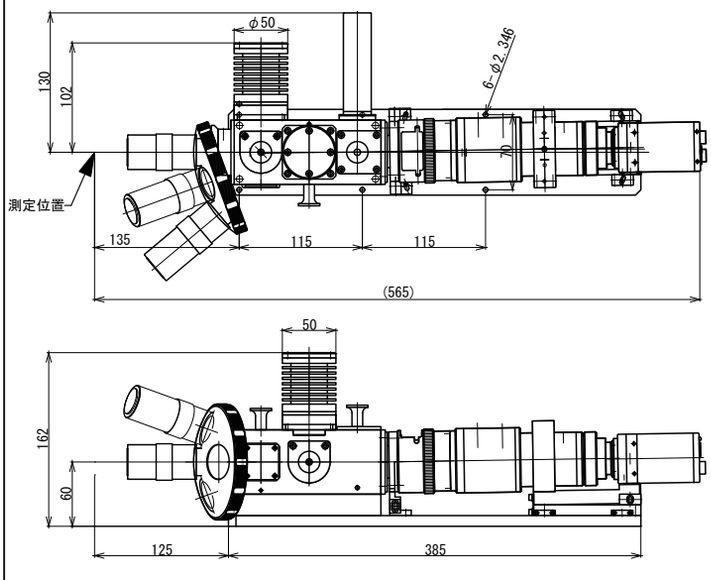

○Wide area FFP measurement optics **M-Scope type FW**




*These external drawings are for reference only. External dimensions vary depending on the detector and options installed. Also, the external dimensions of the device may be changed without notice due to improvements etc. Please contact us for detailed external drawings.

## OUTSIDE DIMENSIONS OF MAIN PRODUCTS

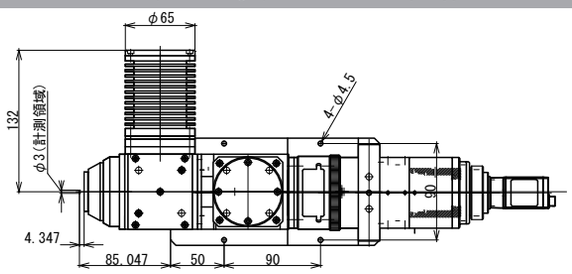
○Sophisticated NFP meas. optics for high power laser **M-Scope type HS**

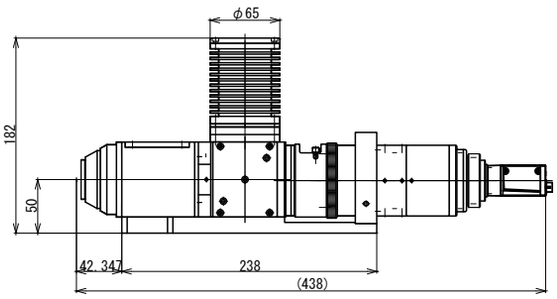




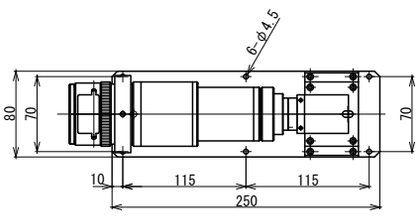


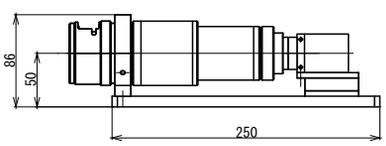
○FFP measurement optics for high power laser **M-Scope type HF**



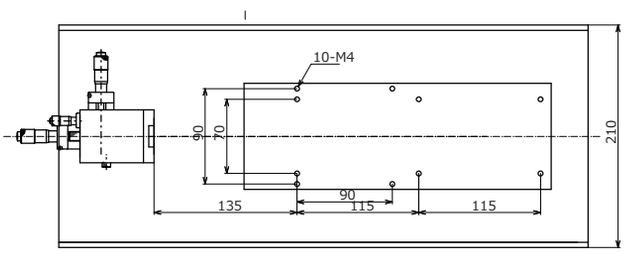



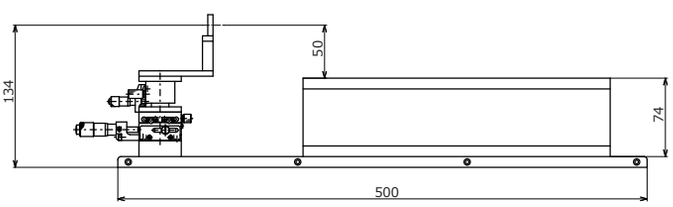

○Collimated beam measurement optics **M-Scope type C/200**



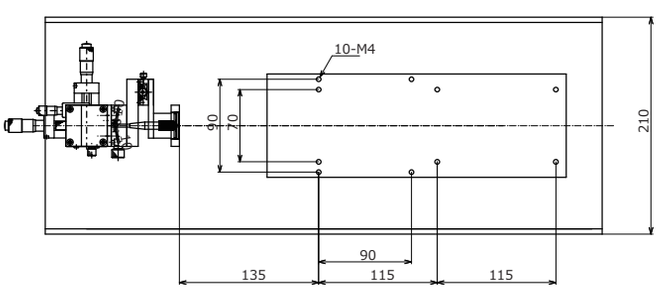



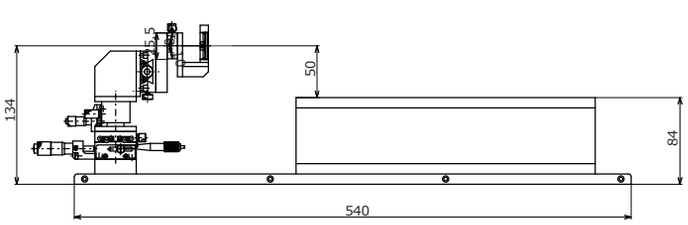

○Optics bench for fiber measurement with 3-axis manual stage **OP002-F3**



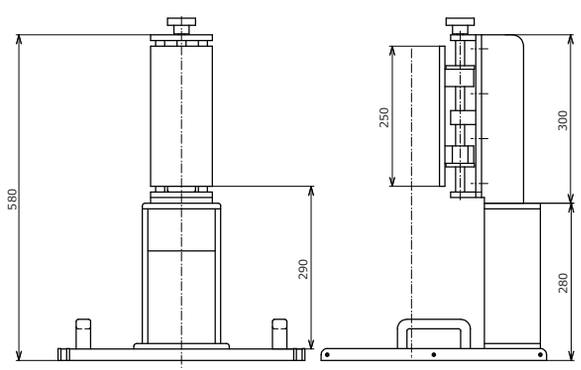



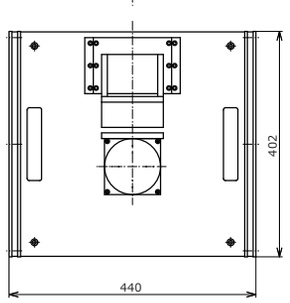

○Optics bench for fiber measurement with 5-axis manual stage **OP002-F5**




○Vertical settiong optics bench **OP002**




*These external drawings are for reference only. External dimensions vary depending on the detector and options installed. Also, the external dimensions of the device may be changed without notice due to improvements etc. Please contact us for detailed external drawings.

# Corporate profile

**【*OUR MISSION AND CORE TECHNOLOGY*】**

**◇*Our mission***

We create new optical equipment, sensing equipment, electronic equipment by fusion of optical technology and various sensing technology, information processing technology, and aim to contribute to the development of science and technology and the future of humanity.

**◇*Core technology***

○Optical design
○Design and development of optical instruments and devices
○Design of optical sensors
○Design and development of various light source, optical modules
○Design and development of optical measurement system
○Design and development of precision mechanism
○Design and development of image processing & data analysis software

**【*CORPORATE PROFILE*】**

| | |
|---|---|
| ◇Company name | SYNERGY OPTOSYSTEMS CO., LTD. |
| ◇Head office | 3625-1 Yuto-cho Yamazaki, Nishi-ku, Hamamatsu-shi, Shizuoka 431-0101, Japan |
| ◇Phone | +81-53-523-8453 |
| ◇Fax | +81-53-523-8459 |
| ◇E-Mail | info@synos.jp |
| ◇WEB | https://www.synos.jp/ |
| ◇Foundation | October 2, 2007 |
| ◇CEO | President & CEO　Manabu Yasukawa |
| ◇Business | Development, manufacturing, and sales of optical equipment, precision equipment, and electronic equipment |

**【*ACCESS*】**

◇By public transport (by train)
JR Tokaido Shinkansen Hamamatsu station -(change train)- JR Tokaido Honsen Maisaka station (nearest station) - about 10 minutes by Taxi from Maisaka station.

◇By car
(Nearest highway I.C.) Tomei express way Hamamatsu-nishi I.C. a
About 20 minutes from Hamamatsu-nishi I.C.

# Appendix

## ●Ref. 1: Detector selection and NFP measurement specifications
## ☞Related optics: M-Scope type I, M-Scope type J, M-Scope type S, M-Scope type L, M-Scope type C

**【Detector selection, field of view, pixel resolution of NFP measurement (approx. value)】**

| Detector model | ISA071/ISA071GL | | ISA041H2 | | ISA041HRA | | ISA041HRVA | |
|---|---|---|---|---|---|---|---|---|
| Detector name | Hi-resolution CMOS detector | | InGaAs NIR detector | | InGaAs high resolution NIR detector | | | |
| Spectral range | 400-1100nm | | 950-1700nm | | 400~1700nm | | | |
| Sensor size | 1/1.8 inch | | 6.4mm×5.12mm | | 6.4mm×5.12mm | | 3.2mm×2.56mm | |
| Total pixels | 2048×1536 | | 320×256 | | 1280×1024 | | 640×512 | |
| Pixels pitch | 3.45μm | | 20μm | | 5μm | | | |
| Optical magnification | Field of view (mm) | Pixel resolution (μm) | Field of view (mm) | Pixel resolution (μm) | Field of view (mm) | Pixel resolution (μm) | Field of view (mm) | Pixel resolution (μm) |
| 5× | 1.41×1.05 | 0.69 | 1.28×1.024 | 4 | 1.28×1.024 | 1 | 0.64×0.512 | 1 |
| 10× | 0.70×0.52 | 0.345 | 0.64×0.512 | 2 | 0.64×0.512 | 0.5 | 0.32×0.256 | 0.5 |
| 20× | 0.35×0.26 | 0.173 | 0.32×0.256 | 1 | 0.32×0.256 | 0.25 | 0.16×0.128 | 0.25 |
| 50× | 0.14×0.10 | 0.069 | 0.128×0.102 | 0.4 | 0.128×0.102 | 0.1 | 0.064×0.051 | 0.1 |
| 100× | 0.07×0.05 | 0.035 | 0.064×0.051 | 0.2 | 0.064×0.051 | 0.05 | 0.032×0.025 | 0.05 |

*Pixel resolution: The measurement length equivalent to 1 pixel of the detector calculated from filed of view and sensor pitch of the detector.

## ●Ref. 2: Detector selection and FFP measurement specifications
## ☞Related optics: M-Scope type F

**【Detector selection, measurement angle coverage, pixel resolution of FFP measurement (approx. value)】**

| Detector model | ISA071/ISA071GL | ISA041H2 | ISA041HRA |
|---|---|---|---|
| Detector name | Hi-resolution CMOS detector | InGaAs high sensitivity NIR detector | InGaAs high resolution NIR detector |
| Spectral range | 400~1100nm | 950~1700nm | 400~1700nm |
| Sensor size | 1/1.8 inch | 6.4mm×5.12mm | 6.4mm×5.12mm |
| Total pixels | 2048×1536 | 320×256 | 1280×1024 |
| Pixels pitch | 3.45μm | 20μm | 5μm |
| Measurement angle coverage | approx. ±40° / N.A. 0.65 | approx. ±39.5° / N.A. 0.65 | approx. ±39.5° / N.A. 0.65 |
| Pixel angle resolution | approx. 0.063° | approx. 0.4° | approx. 0.1° |

*Pixel angle resolution: The measurement angle corresponding to 1 pixel of the detector, calculated from the measurement angle range and the pixel pitch of the detector.

## ●Ref. 3: Detector selection and Collimated beam measurement specifications
## ☞Related optics: M-Scope type C

**【Detector selection, measurement angle, pixel resolution】**

| Detector model | ISA071/ISA071GL | | ISA041H2 | | ISA041HRA | |
|---|---|---|---|---|---|---|
| Detector name | High resolution CMOS detector | | InGaAs high sensitivity NIR detector | | InGaAs high resolution NIR detector | |
| Spectral range | 400~1100nm | | 950~1700nm | | 400nm~1700nm | |
| Total pixels | 2048×1536 pixels | | 320×256 pixels | | 1280×1024 | |
| Pixels pitch | 3.45μm | | 20μm | | 5μm | |
| Focal length | Meas. angle coverage | Resolution | Meas. angle coverage | Resolution | Meas. angle coverage | Resolution |
| 200mm | approx.±1.01°×±0.75° | approx.0.001° | approx.±0.91°×±0.73° | approx.0.0058° | approx.±0.91°×±0.73° | approx.0.00145° |
| 150mm | approx.±1.34°×±1.01° | approx.0.0013° | approx.±1.22°×±0.97° | approx.0.0077° | approx.±1.22°×±0.97° | approx.0.00192° |
| 100mm | approx.±2.02°×±1.51° | approx.0.002° | approx.±1.83°×±1.46° | approx.0.0115° | approx.±1.83°×±1.46° | approx.0.00287° |

*Pixel angle resolution: The measurement angle corresponding to 1 pixel of the detector, calculated from the measurement angle range and the pixel pitch of the detector.

## ●Ref. 4: Detector selection and NFP/FFP simultaneous measurement specifications
## ☞Related optics: M-Scope type D

**【Detector selection, field of view, measurement angle, pixel resolution】**

| Detector model | ISA071/ISA071GL | | ISA041H2 | | ISA041HRA | |
|---|---|---|---|---|---|---|
| Detectoe name | High resolution CMOS detector | | InGaAs high sensitivity NIR detector | | InGaAs high resolution NIR detector | |
| Spectral range | 400~1100nm | | 950~1700nm | | 400~1700nm | |
| Total pixels | 2048×1536 pixels | | 320×256 pixels | | 1280×1024 pixels | |
| Pixels pitch | 3.45μm | | 20μm | | 5μm | |
| Objective lens | M-Plan Apo NIR 50× | | | | | |
| Luminous flux diameter | approx. 0.1mm | | | | | |
| NFP measurement (unit: μm) | Field of view | Pixel resolution | Field of view | Pixel resolution | Field of view | Pixel resolution |
| | 140×100 | 0.069 | 128×100 | 0.4 | 128×100 | 0.1 |
| FFP measurement (unit: degree) | Angle coverage | Pixel resplutiom | Angle coverage | Pixel resolution | Angle coverage | Pixel resolution |
| | ±24.5 | 0.037° | ±24.5° | 0.2° | ±24.5° | 0.05° |

*Pixel resolution: The measurement angle/length corresponding to 1 pixel of the detector, calculated from the measurement angle/field of view range and the pixel pitch of the detector.
*Pixel angle resolution: The measurement angle corresponding to 1 pixel of the detector, calculated from the measurement angle range and the pixel pitch of the detector.

Synos

● **Please contact below for any questions.**

*** Specifications, external appearance, dimensions described in this document subject to change without notice.**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2020.6. Revised (V6.0.0)
2020.12 Revised (V6.0.1.1.E)
2022.7. Reviced (V6.0.2.E)