



**THE DATASHEET OF  
FC150**



# Optem<sup>®</sup> FMOS

## Fixed-Magnification Optical System

### Micro-Inspection Lens System

Optem FMOS in offers exceptional value and versatility while offering precision micro-inspection imaging over a broad range of parameters. FMOS consists of a wide range of upper and lower lens modules which, when combined in various configurations, yield a broad variety of static working distances and magnifications at the image plane of your CCD.

FMOS Lower Function Modules offer a variety of manual and motorized focus, illumination, custom configuration and objective integration options. The recent expansion of the FMOS line uses a special adapter for coupling Optem Zoom 125C Lower Modules to the FMOS upper tubes. This provides integration options with larger illuminated FOV's, polarized light and motorized focus.

Min. Mag. Configuration	(FT60 Upper Fixed Tube + B190 Lower Module)
Magnification Range	0.3X
Numerical Aperture	0.010
Resolution	30 lp/mm
Depth-of-Field	5.8 mm
Working Distance	195 mm
FOV (1/3" Camera)	11.9 x 15.9 mm
FOV (1/2" Camera)	15.9 x 21.2 mm
FOV (2/3" Camera)	21.9 x 29.2 mm
FOV (1" Camera)	31.8 x 42.4 mm
Max. Mag. Configuration	(FTM500 Upper Fixed Tube + Basic Obj Module + 50X MPlan APO Obj.)
Magnification Range	125X
Numerical Aperture	0.55
Resolution	1650 lp/mm
Depth-of-Field	0.0019 mm
Working Distance	13 mm
FOV (1/3" Camera)	0.029 x 0.038 mm
FOV (1/2" Camera)	0.053 x 0.070 mm
FOV (2/3" Camera)	0.59 x 0.78 mm
FOV (1" Camera)	0.077 x 0.10 mm



# Specifying Your Optem FMOS Lens System

To specify your Optem FMOS Fixed-Magnification Lens System identify the parameters of your application and select the modular components which deliver the optimum imaging solution.

**STEP 1.** Determine the Field-of-View (FOV) you require by choosing your intended camera format (1/3", 1/2", 2/3" etc...), and using the dimensions of that camera format to calculate the optical magnification required (see camera dimensions below):

$$\text{Optical Mag.} = \frac{\text{Camera dimension (mm)}}{\text{FOV desired (mm)}}$$

**STEP 2.** The FMOS System requires a Fixed Tube and a Lower Function Module. First determine what Lower Function Module you require. Options include; **Basic (B), Coaxial Illumination (C), Internal Focus (F) and Internal Focus with Coaxial illumination (FC)**. Note: There are separate [Optical Performance Charts](#) for varying illumination methods and objective integration:

- Oblique (Ring light) or Substage Illumination (p. 06)
- Coaxial Illumination (p. 07)
- Infinity Corrected M PLAN APO Objectives (p. 08)

**STEP 3.** Choose the appropriate working distance you require for your application. By referring to the Optical Performance Charts TOP AXIS, choose the best working distance (WD). Keeping in mind, the higher resolution (NA) will be achieved with the shorter working distances. (see [Optical Performance Charts p. 06-08](#)).

**STEP 4.** Select the Fixed Tube: The Fixed Tubes are shown on the LEFT AXIS of all [Optical Performance Charts](#), and each Fixed Tube has an optical focal length associated to it. When combined with the focal length of the lens in the Lower Function Module, the two create a magnification factor. This magnification factor, in relation to your camera format, will yield a specific Field-of-View (FOV), which is displayed in the box where the LEFT AXIS and TOP AXIS intersect.

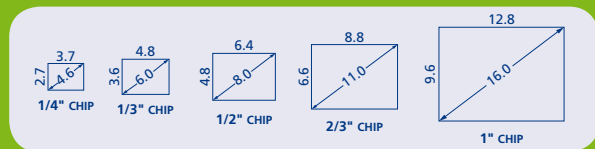
**STEP 5.** When completed, you will have identified the following two components required for your functional FMOS Lens System.

- **Fixed Tube**
- **Lower Function Module**

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## Useful Formulas & Definitions

### CAMERA CHIP DIMENSIONS (mm):



### DEPTH-OF-FIELD (DOF):

The axial depth of the space on both sides of the object plane within which the object can be moved without objectionable loss of sharpness.

$$\text{DOF} = \lambda \div \text{NA}^2$$

$\lambda$  = Wavelength of Light (Green Light = 0.000550mm or 550nm)

### MAGNIFICATION:

The ratio of image size to actual object size.

$$\text{Optical Mag.} = \text{Camera Chip dim.} \div \text{Field-of-View (FOV)}$$

$$\text{Electronic Mag.} = \text{Monitor Diag.} \div \text{Camera Diag.}$$

### NUMERICAL APERTURE (NA):

A measurement of the light collecting ability of the lens. A higher NA translates to a brighter image, better resolution, and shallower depth-of-field.

# Components and New Features

## Upper Fixed Tubes



**FIXED TUBES (FT)** – As the upper most component of your Optem FMOS Lens System, Fixed Tubes function to provide the desired magnification factor and correct back focal distance to the sensor of your C-mount camera.

**FIXED TUBES, MINI (FTM)** – For installations where space is at a premium, Mini Fixed Tubes deliver the same optical performance as FT Fixed Tubes in a fraction of the length.

## Lower Function Modules

Lower Function Modules dictate working distance. When configuring your FMOS Lens System, select from a wide array of Function Modules to integrate the specific functionality desired in your Lens System:



**BASIC (B) MODULE** - This component delivers the most economical and space efficient system when ambient or independent illumination is planned and system focus can be affected through staging.



**INTERNAL FOCUS (F) MODULE** - Self-contained 10mm manual focus for precision image adjustment without manipulating staging or disturbing image stability.



**COAXIAL ILLUMINATION (C) MODULE** - Introduces coaxial (vertical) illumination using fiber optic, halogen or LED coaxial illuminators. (See p. 04 and p. 07)

## INTERNAL FOCUS, COAXIAL ILLUMINATION (FC) MODULE

- Introduces 10mm manual internal focus with coaxial (vertical) illumination.



**OBJECTIVE MODULES** - Afford integration of Infinity-Corrected Objectives utilizing one of the following Modules: **Basic Objectives Module; Coaxial Illumination Objectives Module; Internal Focus Objectives Module; Internal Focus, Coaxial Objectives Module.** Objectives Modules feature M26 x 36T threads to accept Optem and Mitutoyo Objectives (See p. 08). An RMS thread adapter is available for Olympus and Nikon Objectives.



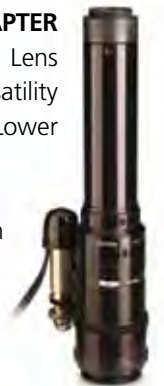
## VARIABLE WORKING DISTANCE AUXILIARY LENS

- Intended for applications requiring working distances from 127 (5") – 432mm (17"), (See p. 09).

## OPTEM ZOOM 125C LOWER MODULE ADAPTER

- Expand the modular flexibility of your FMOS Lens System with the imaging and functional versatility offered by Optem Zoom 125C Lens System Lower Function Modules, including:

- 15mm Manual or motorized fine focus
- 5mm Manual or motorized fine focus with coaxial illumination
- Polarized fiber optic coaxial illumination
- Infinity Macro Lens Accessory (See p. 09)



## RESOLUTION:

The ability to distinguish or separate fine detail. Expressed in line pairs per millimeter (lp/mm). Numerical Aperture (NA) is the controlling factor over resolution... the higher the NA, the brighter the image, and the better the resolution.

Visual Resolution (lp/mm) = 3000 X NA  
 $1 \div \text{lp/mm} = \text{Approx. microns } (\mu) \text{ resolved}$

## VIGNETTING:

The blockage of rays from off-axis object points by constraining apertures. Vignetting results in the darkening of the corners on your monitor.



# Illumination Options

## Illumination Options

The Optem FMOS Lens System offers a variety of illumination options to meet a variety of imaging requirements.

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You have two basic illumination options which can be integrated with your FMOS System... coaxial illumination or oblique ringlight illumination.

## Coaxial Illumination Options

Coaxial (or vertical) illumination is most useful on highly reflective objects. Optem's Coaxial Illuminators project cool, white light perpendicularly onto the specimen for exceptional contrast and field uniformity (Refer p. 07 for performance).

Select from one of several coaxial-equipped lower function modules when specifying your FMOS lens system and integrate one of the three following options of coaxial illumination (See FMOS System Diagram p 10-11).

**LED COAXIAL ILLUMINATORS** – Programmable 1-Watt LED Coaxial Illuminators offer reduced power requirements and heat generation with substantial service life gains. LED Coaxial illuminators are available in straight and right-angle configurations to meet your specific space requirements, and feature compact designs and simplified cable management. These can be driven by stand-alone, single-channel programmable controllers. Coaxial LEDs emit brilliant cool light in the visible spectrum and deliver virtually identical optical performance to our fiber optic and halogen Coaxial Illuminators.



**FIBER OPTIC COAXIAL ILLUMINATORS** – Integrate coaxial illumination from your choice of either 110V or 220V Optem VSI Fiber Optic Illuminators using flexible 40- or 60-inch flexible fiber bundles.

**10W HALOGEN COAXIAL ILLUMINATORS** – When economy is high priority, Halogen light sources are available with a 6V Variable Transformer (110V / 220V). Ventilated lamphouses are required for use with halogen illuminators (see System Diagram p. 10-11).

**POLARIZED LIGHT** – When imaging highly reflective subjects, Polarizer Modules with built-in Analyzers are available to introduce polarization to both LED and Fiber Optic Coaxial Illumination paths.

## Oblique Ringlight Options

Dark Field Illumination is generally used on 3-D objects to cast light rays at an angle onto an object, thus better defining its surface profile. Optem offers the following dark field illuminators for the FMOS System (Refer p. 06 for performance).

**FIBER OPTIC RING LIGHTS** – Oblique Ringlight Illumination is ideal to better define features of dimension rich subjects. Driven with the same VSI Fiber Optic Illuminator as conventional coaxial systems. Qioptiq offers Ringlights specifically designed for a variety of configurations, including integration of objectives (see System Diagram p. 10-11).

# Motorization and Configuration Accessories



## Motorizing Lens System

Optem FMOS Lens Systems can be specified with motorized focus functions utilizing Zoom 125C Lower Function Modules. Select from Stepper or DC Motor options.

**STEPPER MOTOR** – The stepper motors provide accurate repeatability of zoom magnification and/or focus using a Hall-effect sensor to set repeatable home position. A desktop rocker switch controller offers manual control and features an RS-232 port for automated computer control. Includes controller instructions with a list of RS-232 control commands, a Windows® control program, and startup LabVIEW control program. An OEM controller board version is available for streamlined integration.



**DC MOTOR** – DC motors provide continuous, fine adjustment and control of focus function. A desktop joystick controller offers simultaneous control of both zoom and focus functions.



## Configuration Accessories

Extend the versatility of your FMOS Lens System with two new innovations in form and function.

**MID-SYSTEM RIGHT-ANGLE MODULE** – This accessory allows the introduction of a 90° of your optical axis at the mid-body point of your FMOS Lens System. Users can now integrate any FMOS, Zoom 70XL or Zoom 125C Lower Function Modules below the right-angle turn, maintaining full working distance and affording greater configuration flexibility. *NOTE: the Mid-System Right-Angle Module produces a mirror (reversed) image.*

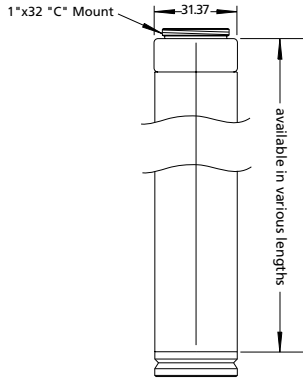


**DUAL-MAGNIFICATION MODULE** – Simultaneously integrate two Optem FMOS Fixed Tubes and/or Zoom 70XL Zoom Modules with TV Tube, over a single subject. This permits real-time dual fixed and/or zoom imaging of your object of interest with your choice of magnifications, FOVs, camera formats and camera types. Integrate any of the full range of FMOS, Zoom 70XL and Zoom 125C Lower Function Modules below the Dual-Mag Module, or integrate compact vertical illumination through the compact Dual-Mag coaxial block.

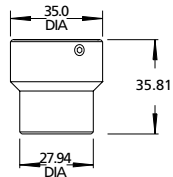
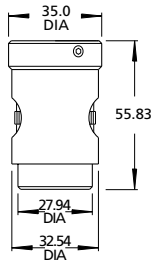


# Optical Performance

## FMOS Substage/Oblique Illumination



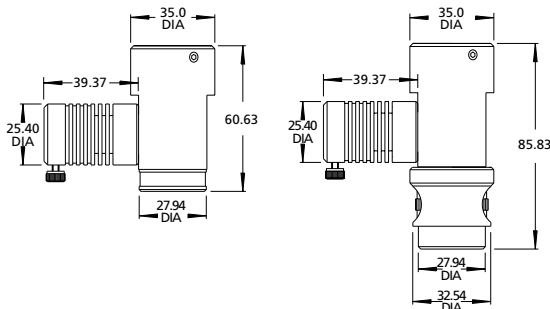
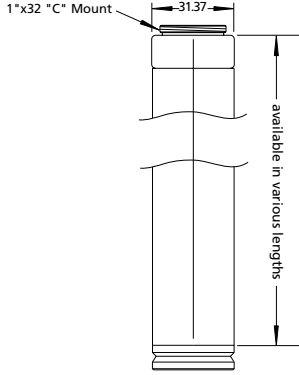
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		B190/F190 WD: 195 mm	B170/F170 WD: 171 mm	B150/F150 WD: 152 mm	B130/F130 WD: 133 mm	B90/F90 WD: 89 mm	B50/F50 WD: 55 mm	B30/F30 WD: 32 mm
FT60	NA	0.010	0.011	0.013	0.014	0.021	0.033	0.050
	Res (lp/mm)	30	34	43	44	63	100	150
	Mag	0.30	0.34	0.38	0.44	0.63	1.0	1.5
	DOF (mm)	5.8	4.5	3.6	2.8	1.3	0.53	0.23
	FOV (mm) Cam Format	1/2" 11.9 x 15.9 1/2" 15.9 x 21.2 2/3" 21.9 x 29.2 1" 31.8 x 42.4	10.5 x 14.0 14.0 x 19 19.3 x 26 28.0 x 37.4	9.39 x 12.5 12.5 x 16.7 17.2 x 23.0 25.0 x 33.4	8.26 x 11.0 11.0 x 14.7 15.1 x 20.2 22.0 x 29.4	5.70 x 7.59 7.59 x 10.1 10.4 x 13.9 15.2 x 20.2	3.60 x 4.80 4.80 x 6.40 6.60 x 8.80 9.60 x 12.8	2.36 x 3.15 3.15 x 4.20 4.33 x 5.77 6.30 x 8.39
FT/FTM 100	NA	0.016	0.018	0.020	0.023	0.034	0.053	0.081
	Res (lp/mm)	48	55	61	70	101	160	244
	Mag	0.49	0.55	0.62	0.71	1.0	1.6	2.5
	DOF (mm)	2.2	1.7	1.4	1.1	0.50	0.20	0.086
	FOV (mm) Cam Format	1/2" 7.36 x 9.82 1/2" 9.82 x 13.1 2/3" 13.5 x 18.0 1" 19.6 x 26.2	6.49 x 8.66 8.66 x 11.5 11.9 x 15.9 17.3 x 23.1	5.80 x 7.73 7.73 x 10.3 10.6 x 14.2 15.5 x 20.6	5.10 x 6.80 6.80 x 9.07 9.35 x 12.5 13.6 x 18.1	3.52 x 4.69 4.69 x 6.25 6.45 x 8.60 9.38 x 12.5	2.22 x 2.96 2.96 x 3.95 4.07 x 5.43 5.93 x 7.90	1.46 x 1.94 1.94 x 2.59 2.67 x 3.56 3.89 x 5.18
FTM 120	NA	0.020	0.022	0.025	0.029	0.041	0.066	0.10
	Res (lp/mm)	59	67	75	86	124	197	300
	Mag	0.59	0.67	0.75	0.86	1.2	1.9	3.0
	DOF (mm)	1.4	1.1	0.90	0.69	0.33	0.13	0.057
	FOV (mm) Cam Format	1/2" 6.06 x 8.08 1/2" 8.08 x 10.8 2/3" 11.1 x 14.8 1" 16.2 x 21.6	5.35 x 7.13 7.13 x 9.50 9.80 x 13.1 13.5 x 19.0	4.77 x 6.36 6.36 x 8.49 8.75 x 11.7 12.7 x 17.0	4.20 x 5.60 5.60 x 7.47 7.70 x 10.3 11.2 x 14.9	2.90 x 3.86 3.86 x 5.15 5.31 x 7.08 7.72 x 10.3	1.83 x 2.44 2.44 x 3.25 3.36 x 4.47 4.88 x 6.51	1.20 x 1.60 1.60 x 2.13 2.20 x 2.93 3.20 x 4.27
FT/FTM 140	NA	0.023	0.026	0.029	0.033	0.048	0.075	0.12
	Res (lp/mm)	68	77	87	99	143	226	345
	Mag	0.69	0.79	0.89	1.0	1.5	2.3	3.5
	DOF (mm)	1.1	0.85	0.68	0.53	0.25	0.10	0.043
	FOV (mm) Cam Format	1/2" 5.20 x 6.93 1/2" 6.93 x 9.24 2/3" 9.53 x 12.7 1" 13.9 x 18.5	4.58 x 6.11 6.11 x 8.15 8.40 x 11.2 12.2 x 16.3	4.09 x 5.45 5.45 x 7.27 7.50 x 10.0 10.9 x 14.5	3.60 x 4.80 4.80 x 6.40 6.80 x 8.80 9.60 x 12.8	2.48 x 3.31 3.31 x 4.41 4.55 x 6.07 6.62 x 8.82	1.57 x 2.09 2.09 x 2.79 2.88 x 3.83 4.18 x 5.58	1.03 x 1.37 1.37 x 1.83 1.89 x 2.51 2.74 x 3.66
FT/FTM 160	NA	0.026	0.029	0.033	0.038	0.054	0.086	0.13
	Res (lp/mm)	78	88	99	115	163	258	394
	Mag	0.79	0.90	1.0	1.1	1.7	2.6	4.0
	DOF (mm)	0.84	0.65	0.52	0.40	0.19	0.077	0.033
	FOV (mm) Cam Format	1/2" 4.55 x 6.06 1/2" 6.06 x 8.08 2/3" 8.34 x 11.1 1" 12.1 x 16.2	4.01 x 5.35 5.35 x 7.13 7.35 x 9.80 10.5 x 14.3	3.58 x 4.77 4.77 x 6.36 6.56 x 8.75 9.55 x 12.7	3.15 x 4.20 4.20 x 5.60 5.78 x 7.70 8.40 x 11.2	2.17 x 2.90 2.90 x 3.86 3.98 x 5.31 5.79 x 7.72	1.37 x 1.83 1.83 x 2.44 2.52 x 3.36 3.66 x 4.88	0.90 x 1.20 1.20 x 1.60 1.65 x 2.20 2.40 x 3.20
FT/FTM 180	NA	0.030	0.034	0.038	0.043	0.062	0.098	0.15
	Res (lp/mm)	89	101	113	129	187	295	450
	Mag	0.89	1.0	1.1	1.3	1.9	3.0	4.5
	DOF (mm)	0.64	0.50	0.40	0.31	0.15	0.059	0.025
	FOV (mm) Cam Format	1/2" 4.04 x 5.39 1/2" 5.39 x 7.19 2/3" 7.41 x 9.88 1" 10.8 x 14.4	3.56 x 4.75 4.75 x 6.34 6.53 x 8.71 9.50 x 12.7	3.18 x 4.24 4.24 x 5.66 5.83 x 7.78 8.49 x 11.3	2.80 x 3.73 3.73 x 4.98 5.13 x 6.84 7.47 x 9.96	1.93 x 2.57 2.57 x 3.43 3.64 x 4.72 5.15 x 6.86	1.22 x 1.63 1.63 x 2.17 2.24 x 2.98 3.25 x 4.34	0.80 x 1.07 1.07 x 1.42 1.47 x 1.96 2.13 x 2.84
FT/FTM 200	NA	0.032	0.036	0.041	0.046	0.067	0.11	0.16
	Res (lp/mm)	96	109	123	139	201	320	488
	Mag	1.0	1.1	1.3	1.4	2.2	3.3	5.0
	DOF (mm)	0.55	0.43	0.34	0.26	0.12	0.050	0.021
	FOV (mm) Cam Format	1/2" 3.64 x 4.85 1/2" 4.85 x 6.47 2/3" 6.67 x 8.89 1" 9.70 x 12.9	3.21 x 4.28 4.28 x 5.70 5.88 x 7.84 8.55 x 11.4	2.86 x 3.82 3.82 x 5.09 5.25 x 7.00 7.64 x 10.2	2.52 x 3.36 3.36 x 4.48 4.62 x 6.16 6.72 x 8.96	1.74 x 2.32 2.32 x 3.09 3.18 x 4.25 4.63 x 6.18	1.10 x 1.46 1.46 x 1.95 2.01 x 2.68 2.93 x 3.90	0.72 x 0.96 0.96 x 1.28 1.32 x 1.76 1.92 x 2.56
FTM 250	NA	0.032	0.036	0.041	0.046	0.067	0.11	0.16
	Res (lp/mm)	96	109	123	139	201	320	488
	Mag	1.2	1.4	1.6	1.8	2.6	4.1	6.3
	DOF (mm)	0.55	0.43	0.34	0.26	0.12	0.050	0.021
	FOV (mm) Cam Format	1/2" 2.91 x 3.88 1/2" 3.88 x 5.17 2/3" 5.34 x 7.11 1" 7.76 x 10.3	2.57 x 3.42 3.42 x 4.56 4.70 x 6.27 6.84 x 9.12	2.29 x 3.05 3.05 x 4.07 4.20 x 5.60 6.11 x 8.15	2.02 x 2.69 2.69 x 3.58 3.70 x 4.93 5.38 x 7.17	1.39 x 1.85 1.85 x 2.47 2.55 x 3.40 3.71 x 4.94	0.88 x 1.17 1.17 x 1.56 1.61 x 2.15 2.34 x 3.12	0.58 x 0.77 0.77 x 1.02 1.06 x 1.41 1.54 x 2.05
FTM 300	NA	0.032	0.036	0.041	0.046	0.067	0.11	0.16
	Res (lp/mm)	96	109	123	139	201	320	488
	Mag	1.5	1.7	1.9	2.1	3.2	4.9	7.5
	DOF (mm)	0.55	0.43	0.34	0.26	0.12	0.050	0.021
	FOV (mm) Cam Format	1/2" 2.43 x 3.23 1/2" 3.23 x 4.31 2/3" 4.45 x 5.93 1" 6.47 x 8.62	2.14 x 2.85 2.85 x 3.80 3.92 x 5.23 5.70 x 7.60	1.91 x 2.55 2.55 x 3.39 3.50 x 4.67 5.09 x 6.79	1.68 x 2.24 2.24 x 2.96 3.08 x 4.11 4.48 x 5.97	1.16 x 1.54 1.54 x 2.06 2.12 x 2.83 3.09 x 4.12	0.73 x 0.98 0.98 x 1.30 1.34 x 1.79 1.95 x 2.60	0.48 x 0.64 0.64 x 0.85 0.88 x 1.17 1.28 x 1.71
FTM 350	NA	0.032	0.036	0.041	0.046	0.067	0.11	0.16
	Res (lp/mm)	96	109	123	139	201	320	488
	Mag	1.7	2.0	2.2	2.5	3.6	5.7	8.8
	DOF (mm)	0.55	0.43	0.34	0.26	0.12	0.050	0.021
	FOV (mm) Cam Format	1/2" 2.08 x 2.77 1/2" 2.77 x 3.70 2/3" 3.81 x 5.08 1" 5.54 x 7.39	1.83 x 2.44 2.44 x 3.26 3.36 x 4.48 4.89 x 6.52	1.64 x 2.18 2.18 x 2.91 3.00 x 4.00 4.36 x 5.82	1.44 x 1.92 1.92 x 2.56 2.64 x 3.52 3.84 x 5.12	0.99 x 1.32 1.32 x 1.76 1.82 x 2.43 2.65 x 3.53	0.63 x 0.84 0.84 x 1.12 1.15 x 1.53 1.67 x 2.23	0.41 x 0.55 0.55 x 0.73 0.75 x 1.01 1.10 x 1.46
FTM 400	NA	0.032	0.036	0.041	0.046	0.067	0.11	0.16
	Res (lp/mm)	96	109	123	139	201	320	488
	Mag	2.0	2.2	2.5	2.9	4.2	6.2	10
	DOF (mm)	0.55	0.43	0.34	0.26	0.12	0.050	0.021
	FOV (mm) Cam Format	1/2" 1.82 x 2.43 1/2" 2.43 x 3.23 2/3" 3.33 x 4.45 1" 4.85 x 6.47	1.60 x 2.14 2.14 x 2.85 2.94 x 3.92 4.28 x 5.70	1.43 x 1.91 1.91 x 2.55 3.23 x 4.31 3.82 x 5.09	1.26 x 1.68 1.68 x 2.24 2.63 x 3.50 3.36 x 4.48	0.87 x 1.16 1.16 x 1.54 2.12 x 2.83 2.32 x 3.09	0.55 x 0.73 0.73 x 0.98 1.34 x 1.79 1.46 x 1.95	0.36 x 0.48 0.48 x 0.64 0.85 x 1.13 0.96 x 1.28
FTM 450	NA	0.032	0.036	0.041	0.046	0.067	0.11	0.16
	Res (lp/mm)	96	109	123	139	201	320	488
	Mag	2.2	2.5	2.8	3.2	4.7	7.4	11
	DOF (mm)	0.55	0.43	0.34	0.26	0.12	0.050	0.021
	FOV (mm) Cam Format	1/2" 1.62 x 2.16 1/2" 2.16 x 2.87 2/3" 2.96 x 3.95 1" 4.31 x 5.75	1.43 x 1.90 1.90 x 2.53 2.61 x 3.51 3.80 x 5.07	1.27 x 1.70 1.70 x 2.26 2.63 x 3.50 3.39 x 4.53	1.12 x 1.49 1.49 x 1.99 2.65 x 3.50 2.99 x 3.98	0.77 x 1.03 1.03 x 1.37 1.92 x 2.59 2.06 x 2.74	0.49 x 0.65 0.65 x 0.87 1.01 x 1.34 1.30 x 1.74	0.32 x 0.43 0.43 x 0.57 0.59 x 0.78 0.85 x 1.14
FTM 500	NA	0.032	0.036	0.041	0.046	0.067	0.11	0.16
	Res (lp/mm)	96	109	123	139	201	320	488
	Mag	2.5	2.8	3.1	3.6	5.2	8.2	13
	DOF (mm)	0.55	0.43	0.34	0.26	0.12	0.050	0.021
	FOV (mm) Cam Format	1/2" 1.46 x 1.94 1/2" 1.94 x 2.59 2/3" 2.67 x 3.56 1" 3.88 x 5.17	1.28 x 1.71 1.71 x 2.28 2.35 x 3.14 3.42 x 4.56	1.15 x 1.53 1.53 x 2.04 2.61 x 3.50 3.05 x 4.07	1.01 x 1.34 1.34 x 1.76 1.85 x 2.50 2.69 x 3.58	0.69 x 0.93 0.93 x 1.24 1.92 x 2.59 1.85 x 2.47	0.44 x 0.59 0.59 x 0.78 1.01 x 1.34 1.17 x 1.56	0.29 x 0.38 0.38 x 0.51 0.53 x 0.70 0.77 x 1.02

# Optical Performance

## FMOS Coaxial Illumination



		B190/F190 Wd: 195 mm	B170/F170 Wd: 171 mm	B150/F150 Wd: 152 mm	B130/F130 Wd: 133 mm	B90/F90 Wd: 89 mm	B50/F50 Wd: 55 mm	B30/F30 Wd: 55 mm	
FT60	NA	0.010	0.011	0.013	0.014	0.021	0.033	0.050	
	Res (p/mm)	30	34	38	43	62	96	150	
	Mag	0.30	0.34	0.38	0.44	0.63	1.0	1.5	
	DOF (mm)	5.8	4.5	3.6	2.8	1.3	0.53	0.23	
	FOV (mm)	1/3" --	10.5 x 14.0	9.39 x 12.5	8.26 x 11.0	5.70 x 7.59	3.60 x 4.80	2.36 x 3.15	
	FOV (mm)	1/2" --	--	--	11.0 x 14.7	7.59 x 10.1	4.80 x 6.40	3.15 x 4.20	
	FOV (mm)	2/3" --	--	--	--	10.4 x 13.9	6.60 x 8.80	4.33 x 5.77	
	FOV (mm)	1" --	--	--	--	--	9.60 x 12.8	6.30 x 8.39	
	NA	0.016	0.018	0.020	0.023	0.034	0.053	0.081	
	Res (p/mm)	48	55	61	70	101	160	244	
FT/FTM 100	Mag	0.49	0.55	0.62	0.71	1.0	1.6	2.5	
	DOF (mm)	2.2	1.7	1.4	1.1	0.50	0.20	0.086	
	FOV (mm)	1/3" 7.36 x 9.82	6.49 x 8.66	5.80 x 7.73	5.10 x 6.80	3.52 x 4.69	2.22 x 2.96	1.46 x 1.94	
	FOV (mm)	1/2" 9.82 x 13.1	8.66 x 11.5	7.73 x 10.3	6.80 x 9.07	4.69 x 6.25	2.96 x 3.95	1.94 x 2.59	
	FOV (mm)	2/3" --	--	10.6 x 14.2	9.35 x 12.5	6.45 x 8.60	4.07 x 5.43	2.67 x 3.56	
	FOV (mm)	1" --	--	--	--	9.38 x 12.5	5.93 x 7.90	3.89 x 5.18	
	NA	0.020	0.022	0.025	0.029	0.041	0.066	0.10	
	Res (p/mm)	59	67	75	86	124	197	300	
	Mag	0.59	0.67	0.75	0.86	1.2	2.0	3.0	
	DOF (mm)	1.4	1.1	0.90	0.69	0.33	0.13	0.057	
FTM 120	FOV (mm)	1/3" 6.06 x 8.08	5.35 x 7.13	4.77 x 6.36	4.20 x 5.60	2.90 x 3.86	1.83 x 2.44	1.20 x 1.60	
	FOV (mm)	1/2" 8.08 x 10.8	7.13 x 9.50	6.36 x 8.49	5.60 x 7.47	3.86 x 5.15	2.44 x 3.25	1.60 x 2.13	
	FOV (mm)	2/3" --	8.80 x 13.1	8.75 x 11.7	7.70 x 10.3	5.21 x 7.08	3.26 x 4.47	2.20 x 2.92	
	FOV (mm)	1" --	--	--	--	7.72 x 10.3	4.88 x 6.51	3.20 x 4.27	
	NA	0.023	0.026	0.029	0.033	0.048	0.075	0.12	
	Res (p/mm)	68	77	87	99	143	226	345	
	Mag	0.69	0.79	0.88	1.0	1.5	2.3	3.5	
	DOF (mm)	1.1	0.85	0.68	0.53	0.25	0.10	0.043	
	FOV (mm)	1/3" 5.20 x 6.93	4.58 x 6.11	4.09 x 5.45	3.60 x 4.80	2.48 x 3.31	1.57 x 2.09	1.03 x 1.37	
	FOV (mm)	1/2" 6.93 x 9.24	6.11 x 8.15	5.45 x 7.27	4.80 x 6.40	3.31 x 4.41	2.09 x 2.81	1.37 x 1.83	
FT/FTM 140	FOV (mm)	2/3" 9.53 x 12.7	8.40 x 11.2	7.50 x 10.0	6.40 x 8.80	4.52 x 6.07	2.84 x 3.83	1.89 x 2.51	
	FOV (mm)	1" --	--	10.9 x 14.5	9.60 x 12.8	6.62 x 8.82	4.18 x 5.58	2.74 x 3.66	
	NA	0.026	0.029	0.033	0.038	0.054	0.086	0.13	
	Res (p/mm)	78	88	99	113	163	258	394	
	Mag	0.79	0.90	1.0	1.1	1.7	2.6	4.0	
	DOF (mm)	0.84	0.65	0.52	0.40	0.19	0.077	0.033	
	FOV (mm)	1/3" 4.55 x 6.06	4.01 x 5.35	3.58 x 4.77	3.15 x 4.20	2.17 x 2.90	1.37 x 1.83	0.90 x 1.20	
	FOV (mm)	1/2" 6.06 x 8.08	5.35 x 7.13	4.77 x 6.36	4.20 x 5.60	2.90 x 3.86	1.83 x 2.44	1.20 x 1.60	
	FOV (mm)	2/3" 8.34 x 11.1	7.35 x 9.80	6.56 x 8.75	5.78 x 7.70	3.98 x 5.31	2.48 x 3.31	1.60 x 2.20	
	FOV (mm)	1" --	10.7 x 14.3	9.55 x 12.7	8.40 x 11.2	5.79 x 7.72	3.66 x 4.88	2.40 x 3.20	
FT/FTM 160	NA	0.030	0.034	0.038	0.043	0.062	0.098	0.15	
	Res (p/mm)	89	101	113	129	187	295	450	
	Mag	0.89	1.0	1.1	1.3	1.9	3.0	4.5	
	DOF (mm)	0.64	0.50	0.40	0.31	0.15	0.059	0.025	
	FOV (mm)	1/3" 4.04 x 5.39	3.56 x 4.75	3.18 x 4.24	2.80 x 3.73	1.93 x 2.57	1.22 x 1.63	0.80 x 1.07	
	FOV (mm)	1/2" 5.39 x 7.19	4.75 x 6.34	4.24 x 5.66	3.73 x 4.98	2.57 x 3.43	1.63 x 2.17	1.07 x 1.42	
	FOV (mm)	2/3" 7.41 x 9.88	6.53 x 8.71	5.83 x 7.78	5.13 x 6.84	3.54 x 4.72	2.24 x 2.98	1.47 x 1.96	
	FOV (mm)	1" --	--	8.49 x 11.3	7.47 x 9.96	5.15 x 6.86	3.25 x 4.34	2.13 x 2.84	
	NA	0.032	0.036	0.041	0.046	0.067	0.11	0.16	
	Res (p/mm)	96	109	123	139	202	320	488	
FT/FTM 200	Mag	1.0	1.1	1.3	1.4	2.1	3.3	5.0	
	DOF (mm)	0.55	0.43	0.34	0.26	0.12	0.050	0.021	
	FOV (mm)	1/3" 3.64 x 4.85	3.21 x 4.28	2.86 x 3.82	2.52 x 3.36	1.74 x 2.32	1.10 x 1.46	0.72 x 0.96	
	FOV (mm)	1/2" 4.85 x 6.47	4.28 x 5.70	3.82 x 5.09	3.36 x 4.48	2.32 x 3.08	1.46 x 1.95	0.96 x 1.28	
	FOV (mm)	2/3" 6.67 x 8.89	5.88 x 7.84	5.25 x 7.00	4.62 x 6.16	3.18 x 4.25	2.01 x 2.68	1.32 x 1.76	
	FOV (mm)	1" --	8.55 x 11.4	7.64 x 10.2	6.72 x 8.96	4.63 x 6.18	2.93 x 3.90	1.92 x 2.56	
	NA	0.032	0.036	0.041	0.046	0.067	0.11	0.16	
	Res (p/mm)	96	109	123	139	202	320	488	
	Mag	1.2	1.4	1.6	1.8	2.6	4.1	6.3	
	DOF (mm)	0.55	0.43	0.34	0.26	0.12	0.050	0.021	
FTM 250	FOV (mm)	1/3" 2.91 x 3.88	2.57 x 3.42	2.29 x 3.05	2.02 x 2.69	1.39 x 1.85	0.88 x 1.17	0.58 x 0.77	
	FOV (mm)	1/2" 3.88 x 5.17	3.42 x 4.56	3.05 x 4.07	2.69 x 3.58	1.85 x 2.47	1.17 x 1.56	0.77 x 1.02	
	FOV (mm)	2/3" 5.34 x 7.11	4.70 x 6.27	4.20 x 5.60	3.70 x 4.93	2.55 x 3.40	1.61 x 2.15	1.06 x 1.41	
	FOV (mm)	1" 7.76 x 10.3	6.84 x 9.12	6.11 x 8.15	5.38 x 7.17	3.71 x 4.94	2.34 x 3.12	1.54 x 2.05	
	NA	0.032	0.036	0.041	0.046	0.067	0.11	0.16	
	Res (p/mm)	96	109	123	139	202	320	488	
	Mag	1.5	1.7	1.9	2.1	3.1	4.9	7.5	
	DOF (mm)	0.55	0.43	0.34	0.26	0.12	0.050	0.021	
	FOV (mm)	1/3" 2.43 x 3.23	2.14 x 2.85	1.91 x 2.55	1.68 x 2.24	1.16 x 1.54	0.73 x 0.98	0.48 x 0.64	
	FOV (mm)	1/2" 3.23 x 4.31	2.85 x 3.80	2.55 x 3.39	2.24 x 2.99	1.54 x 2.06	0.98 x 1.32	0.64 x 0.85	
FTM 300	FOV (mm)	2/3" 4.45 x 5.93	3.92 x 5.23	3.50 x 4.67	3.08 x 4.11	2.12 x 2.83	1.34 x 1.79	0.88 x 1.17	
	FOV (mm)	1" 6.47 x 8.62	5.70 x 7.60	5.09 x 6.79	4.48 x 5.97	3.09 x 4.12	1.95 x 2.60	1.28 x 1.71	
	NA	0.032	0.036	0.041	0.046	0.067	0.11	0.16	
	Res (p/mm)	96	109	123	139	202	320	488	
	Mag	1.7	2.0	2.2	2.5	3.6	5.7	8.8	
	DOF (mm)	0.55	0.43	0.34	0.26	0.12	0.050	0.021	
	FOV (mm)	1/3" 2.08 x 2.77	1.83 x 2.44	1.64 x 2.18	1.44 x 1.92	0.99 x 1.32	0.63 x 0.84	0.41 x 0.55	
	FOV (mm)	1/2" 2.77 x 3.70	2.44 x 3.26	2.18 x 2.91	1.92 x 2.56	1.32 x 1.76	0.84 x 1.12	0.55 x 0.73	
	FOV (mm)	2/3" 3.81 x 5.08	3.36 x 4.48	3.00 x 4.00	2.64 x 3.52	1.82 x 2.43	1.15 x 1.53	0.75 x 1.01	
	FOV (mm)	1" 5.54 x 7.39	4.89 x 6.52	4.36 x 5.82	3.84 x 5.12	2.65 x 3.53	1.67 x 2.23	1.10 x 1.46	
FTM 350	NA	0.032	0.036	0.041	0.046	0.067	0.11	0.16	
	Res (p/mm)	96	109	123	139	202	320	488	
	Mag	2.2	2.5	2.8	3.2	4.7	7.2	11	
	DOF (mm)	0.55	0.43	0.34	0.26	0.12	0.050	0.021	
	FOV (mm)	1/3" 1.82 x 2.43	1.60 x 2.14	1.43 x 1.91	1.26 x 1.68	0.87 x 1.16	0.55 x 0.73	0.36 x 0.48	
	FOV (mm)	1/2" 2.43 x 3.23	2.14 x 2.85	1.91 x 2.55	1.68 x 2.24	1.16 x 1.54	0.73 x 0.98	0.48 x 0.64	
	FOV (mm)	2/3" 3.33 x 4.45	2.94 x 3.92	2.63 x 3.50	2.31 x 3.08	1.59 x 2.12	1.01 x 1.34	0.66 x 0.88	
	FOV (mm)	1" 4.85 x 6.47	4.28 x 5.70	3.82 x 5.09	3.36 x 4.48	2.32 x 3.09	1.46 x 1.95	0.96 x 1.28	
	NA	0.032	0.036	0.041	0.046	0.067	0.11	0.16	
	Res (p/mm)	96	109	123	139	202	320	488	
FTM 400	Mag	2.5	2.8	3.1	3.6	5.2	8.2	13	
	DOF (mm)	0.55	0.43	0.34	0.26	0.12	0.050	0.021	
	FOV (mm)	1/3" 1.62 x 2.16	1.43 x 1.90	1.27 x 1.70	1.12 x 1.49	0.77 x 1.03	0.49 x 0.65	0.32 x 0.43	
	FOV (mm)	1/2" 2.16 x 2.87	1.90 x 2.53	1.70 x 2.26	1.49 x 1.99	1.03 x 1.37	0.65 x 0.87	0.43 x 0.58	
	FOV (mm)	2/3" 2.96 x 3.95	2.61 x 3.48	2.35 x 3.11	2.05 x 2.74	1.42 x 1.89	0.89 x 1.19	0.59 x 0.78	
	FOV (mm)	1" 4.31 x 5.75	3.80 x 5.07	3.39 x 4.53	2.99 x 3.98	2.06 x 2.74	1.30 x 1.74	0.85 x 1.14	
	NA	0.032	0.036	0.041	0.046	0.067	0.11	0.16	
	Res (p/mm)	96	109	123	139	202	320	488	
	Mag	2.5	2.8	3.1	3.6	5.2	8.2	13	
	DOF (mm)	0.55	0.43	0.34	0.26	0.12	0.050	0.021	
FTM 450	FOV (mm)	1/3" 1.46 x 1.94	1.28 x 1.71	1.15 x 1.53	1.01 x 1.34	0.69 x 0.93	0.44 x 0.59	0.29 x 0.38	
	FOV (mm)	1/2" 1.94 x 2.59	1.71 x 2.28	1.53 x 2.04	1.34 x 1.79	0.93 x 1.24	0.59 x 0.78	0.38 x 0.51	
	FOV (mm)	2/3" 2.67 x 3.56	2.35 x 3.14	2.10 x 2.80	1.85 x 2.46	1.27 x 1.70	0.81 x 1.07	0.53 x 0.70	
	FOV (mm)	1" 3.88 x 5.17	3.42 x 4.56	3.05 x 4.07	2.69 x 3.58	1.85 x 2.47	1.17 x 1.56	0.77 x 1.02	
	NA	0.032	0.036	0.041	0.046	0.067	0.11	0.16	
	Res (p/mm)	96	109	123	139	202	320	488	
	Mag	2.5	2.8	3.1	3.6	5.2	8.2	13	
	DOF (mm)	0.55	0.43	0.34	0.26	0.12	0.050	0.021	
	FOV (mm)	1/3" 1.46 x 1.94	1.28 x 1.71	1.15 x 1.53	1.01 x 1.34	0.69 x 0.93	0.44 x 0.59	0.29 x 0.38	
	FOV (mm)	1/2" 1.94 x 2.59	1.71 x 2.28	1.53 x 2.04	1.34 x 1.79	0.93 x 1.24	0.59 x 0.78	0.38 x 0.51	
FTM 500									

# FMOS Coaxial with LWD M-Plan APO Objectives Optical Performance

Achieve significantly higher magnifications and increased resolution. Combine your FMOS with the expanded line of Optem LWD Infinity-Corrected Objectives.

**OPTEM M-PLAN APO** – Eliminate chromatic aberration across exceptionally flat fields for the ultimate in high-magnification accuracy. Select from 2X, 5X, 10X, 20X and 50X Long-Working Distance Objectives. These objectives are exact replacements for Mitutoyo 378 series objectives and are ideal for metrology applications.

## LWD Infinity-Corrected M-Plan APO Objectives

- 28-21-02-000 ..... 2X M Plan APO, LWD
- 28-21-05-000 ..... 5X M Plan APO, LWD
- 28-21-10-000 ..... 10X M Plan APO, LWD
- 28-21-11-000 ..... 20X M Plan APO, LWD
- 28-21-50-000 ..... 50X M Plan APO, LWD



		2X M Plan APO 28-21-02-000 WD: 34 mm	5X M Plan APO 28-21-05-000 WD: 34 mm	10X M Plan APO 28-21-10-000 WD: 34 mm	20X M Plan APO 28-21-11-000 WD: 20 mm	50X M Plan APO 28-21-50-000 WD: 13 mm
FT60	NA	0.020	0.050	0.10	0.20	0.50
	Res (lp/mm)	150	60	30	15	6
	Mag	6.1	1.5	3.1	6.1	15
	DOF (mm)	1.4	0.23	0.057	0.014	0.0023
	FOV (mm) Cam Format	1/3" 5.90 x 7.87 1/2" 7.87 x 10.5 2/3" 10.8 x 14.4 1" 15.7 x 21.0	2.36 x 3.15 3.15 x 4.20 4.33 x 5.77 6.30 x 8.39	1.18 x 1.57 1.57 x 2.10 2.16 x 2.89 3.15 x 4.20	0.59 x 0.79 0.79 x 1.05 1.08 x 1.44 1.57 x 2.10	0.24 x 0.31 0.31 x 0.42 0.43 x 0.58 --
FT/FTM 100	NA	0.033	0.081	0.16	0.33	0.55
	Res (lp/mm)	98	244	488	975	1650
	Mag	0.99	2.5	4.9	9.9	24.7
	DOF (mm)	0.54	0.086	0.021	0.0054	0.0019
	FOV (mm) Cam Format	1/3" 3.64 x 4.86 1/2" 4.86 x 6.48 2/3" 6.68 x 8.91 1" 9.72 x 13.0	1.46 x 1.94 1.94 x 2.59 2.67 x 3.56 3.89 x 5.18	0.73 x 0.97 0.97 x 1.30 1.34 x 1.78 1.94 x 2.59	0.36 x 0.49 0.49 x 0.65 0.67 x 0.89 0.97 x 1.30	0.15 x 0.19 0.19 x 0.26 0.27 x 0.36 0.39 x 0.52
FTM 120	NA	0.040	0.10	0.20	0.40	0.55
	Res (lp/mm)	120	300	600	1200	1650
	Mag	1.2	3.0	6.0	12	30
	DOF (mm)	0.35	0.057	0.014	0.0035	0.0019
	FOV (mm) Cam Format	1/3" 3.00 x 4.00 1/2" 4.00 x 5.33 2/3" 5.50 x 7.33 1" 8.00 x 10.7	1.20 x 1.60 1.60 x 2.13 2.20 x 2.93 3.20 x 4.27	0.60 x 0.80 0.80 x 1.07 1.10 x 1.47 1.60 x 2.13	0.30 x 0.40 0.40 x 0.53 0.55 x 0.73 0.80 x 1.07	0.12 x 0.16 0.16 x 0.21 0.22 x 0.29 0.32 x 0.43
FT/FTM 140	NA	0.046	0.12	0.23	0.42	0.55
	Res (lp/mm)	165	420	900	1260	1650
	Mag	1.4	3.5	7.0	14	35
	DOF (mm)	0.27	0.043	0.011	0.0032	0.0019
	FOV (mm) Cam Format	1/3" 2.57 x 3.43 1/2" 3.43 x 4.57 2/3" 4.71 x 6.29 1" 6.86 x 9.14	1.03 x 1.37 1.37 x 1.83 1.89 x 2.51 2.74 x 3.66	0.51 x 0.69 0.69 x 0.91 0.94 x 1.26 1.37 x 1.83	0.26 x 0.34 0.34 x 0.46 0.47 x 0.63 0.69 x 0.91	0.10 x 0.14 0.14 x 0.18 0.19 x 0.25 0.27 x 0.37
FT/FTM 160	NA	0.053	0.13	0.26	0.42	0.55
	Res (lp/mm)	158	394	788	1260	1650
	Mag	1.6	4.0	8.0	16	40
	DOF (mm)	0.21	0.033	0.0082	0.0032	0.0019
	FOV (mm) Cam Format	1/3" 2.25 x 3.00 1/2" 3.00 x 4.00 2/3" 4.13 x 5.50 1" 6.00 x 8.00	0.90 x 1.20 1.20 x 1.60 1.65 x 2.20 2.40 x 3.20	0.45 x 0.60 0.60 x 0.80 0.83 x 1.10 1.20 x 1.60	0.23 x 0.30 0.30 x 0.40 0.41 x 0.55 0.60 x 0.80	0.09 x 0.12 0.12 x 0.16 0.17 x 0.22 0.24 x 0.32
FT/FTM 180	NA	0.055	0.14	0.30	0.42	0.55
	Res (lp/mm)	165	420	900	1260	1650
	Mag	1.8	4.5	9.0	18	45
	DOF (mm)	0.19	0.029	0.0063	0.0032	0.0019
	FOV (mm) Cam Format	1/3" 2.00 x 2.67 1/2" 2.67 x 3.56 2/3" 3.67 x 4.89 1" 5.33 x 7.11	0.80 x 1.07 1.07 x 1.42 1.47 x 1.96 2.13 x 2.84	0.40 x 0.53 0.53 x 0.71 0.73 x 0.98 1.07 x 1.42	0.20 x 0.27 0.27 x 0.36 0.37 x 0.49 0.53 x 0.71	0.08 x 0.11 0.11 x 0.14 0.15 x 0.20 0.21 x 0.28
FT/FTM 200	NA	0.055	0.14	0.30	0.42	0.55
	Res (lp/mm)	165	420	900	1260	1650
	Mag	2.0	5.0	10	20	50
	DOF (mm)	0.19	0.029	0.0063	0.0032	0.0019
	FOV (mm) Cam Format	1/3" 1.80 x 2.40 1/2" 2.40 x 3.20 2/3" 3.30 x 4.40 1" 4.80 x 6.40	0.72 x 0.96 0.96 x 1.28 1.32 x 1.76 1.92 x 2.56	0.36 x 0.48 0.48 x 0.64 0.66 x 0.88 0.96 x 1.28	0.18 x 0.24 0.24 x 0.32 0.33 x 0.44 0.48 x 0.64	0.07 x 0.10 0.10 x 0.13 0.13 x 0.18 0.19 x 0.26
FTM 250	NA	0.055	0.14	0.30	0.42	0.55
	Res (lp/mm)	165	420	900	1260	1650
	Mag	2.5	6.3	13	25	63
	DOF (mm)	0.19	0.029	0.0063	0.0032	0.0019
	FOV (mm) Cam Format	1/3" 1.44 x 1.92 1/2" 1.92 x 2.56 2/3" 2.64 x 3.52 1" 3.84 x 5.12	0.58 x 0.77 0.77 x 1.02 1.06 x 1.41 1.54 x 2.05	0.29 x 0.38 0.38 x 0.51 0.53 x 0.70 0.77 x 1.02	0.14 x 0.19 0.19 x 0.26 0.26 x 0.35 0.38 x 0.51	0.058 x 0.077 0.077 x 0.10 0.11 x 0.14 0.15 x 0.20
FTM 300	NA	0.055	0.14	0.30	0.42	0.55
	Res (lp/mm)	165	420	900	1260	1650
	Mag	3.0	7.5	15	30	75
	DOF (mm)	0.19	0.029	0.0063	0.0032	0.0019
	FOV (mm) Cam Format	1/3" 1.20 x 1.60 1/2" 1.60 x 2.13 2/3" 2.20 x 2.93 1" 3.20 x 4.27	0.48 x 0.64 0.64 x 0.85 0.88 x 1.17 1.28 x 1.71	0.24 x 0.32 0.32 x 0.43 0.44 x 0.59 0.64 x 0.85	0.12 x 0.16 0.16 x 0.21 0.22 x 0.29 0.32 x 0.43	0.048 x 0.064 0.064 x 0.085 0.088 x 0.12 0.13 x 0.17
FTM 350	NA	0.055	0.14	0.30	0.42	0.55
	Res (lp/mm)	165	420	900	1260	1650
	Mag	3.5	8.8	18	35	88
	DOF (mm)	0.19	0.029	0.0063	0.0032	0.0019
	FOV (mm) Cam Format	1/3" 1.03 x 1.37 1/2" 1.37 x 1.83 2/3" 1.89 x 2.51 1" 2.74 x 3.66	0.41 x 0.55 0.55 x 0.73 0.75 x 1.01 1.10 x 1.46	0.21 x 0.27 0.27 x 0.37 0.38 x 0.50 0.55 x 0.73	0.10 x 0.14 0.14 x 0.18 0.19 x 0.25 0.27 x 0.37	0.041 x 0.055 0.055 x 0.073 0.075 x 0.10 0.11 x 0.15
FTM 400	NA	0.055	0.14	0.30	0.42	0.55
	Res (lp/mm)	165	420	900	1260	1650
	Mag	4.0	10	20	40	100
	DOF (mm)	0.19	0.029	0.0063	0.0032	0.0019
	FOV (mm) Cam Format	1/3" 0.90 x 1.20 1/2" 1.20 x 1.60 2/3" 1.65 x 2.20 1" 2.40 x 3.20	0.36 x 0.48 0.48 x 0.64 0.66 x 0.88 0.96 x 1.28	0.18 x 0.24 0.24 x 0.32 0.33 x 0.44 0.48 x 0.64	0.090 x 0.12 0.12 x 0.16 0.17 x 0.22 0.24 x 0.32	0.036 x 0.048 0.048 x 0.064 0.066 x 0.088 0.096 x 0.13
FTM 450	NA	0.055	0.14	0.30	0.42	0.55
	Res (lp/mm)	165	420	900	1260	1650
	Mag	4.5	11	23	45	113
	DOF (mm)	0.19	0.029	0.0063	0.0032	0.0019
	FOV (mm) Cam Format	1/3" 0.80 x 1.07 1/2" 1.07 x 1.42 2/3" 1.47 x 1.96 1" 2.13 x 2.84	0.32 x 0.43 0.43 x 0.57 0.59 x 0.78 0.85 x 1.14	0.16 x 0.21 0.21 x 0.28 0.29 x 0.39 0.43 x 0.57	0.080 x 0.11 0.11 x 0.14 0.15 x 0.20 0.21 x 0.28	0.032 x 0.043 0.043 x 0.057 0.059 x 0.078 0.085 x 0.11
FTM 500	NA	0.055	0.14	0.30	0.42	0.55
	Res (lp/mm)	165	420	900	1260	1650
	Mag	5.0	13	25	50	125
	DOF (mm)	0.19	0.029	0.0063	0.0032	0.0019
	FOV (mm) Cam Format	1/3" 0.72 x 0.96 1/2" 0.96 x 1.28 2/3" 1.32 x 1.76 1" 1.92 x 2.56	0.29 x 0.38 0.38 x 0.51 0.53 x 0.70 0.77 x 1.02	0.14 x 0.19 0.19 x 0.26 0.26 x 0.35 0.38 x 0.51	0.072 x 0.096 0.096 x 0.13 0.13 x 0.18 0.19 x 0.26	0.029 x 0.038 0.038 x 0.051 0.053 x 0.070 0.077 x 0.10
Max FOV at Low Mag (Dia.):		16 mm ø	9.5 mm ø	5.0 mm ø	2.0 mm ø	0.4 mm ø

# Optical Performance

## Infinity Macro Lens Accessory

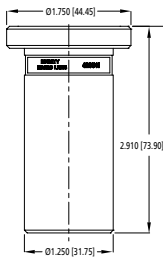
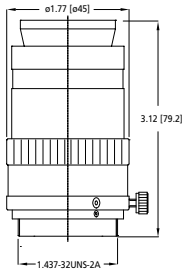
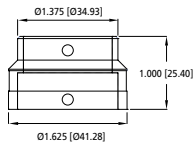


Working Distance	Magnification*
50 mm	0.37X
100 mm	0.25X
150 mm	0.18X
200 mm	0.14X
300 mm	0.1X
400 mm	0.08X

\* Magnification factor is relative to B90/F90 values as shown on p. 06.

Beyond 500 mm, the lens can be thought of as a video lens with focal lengths and f# as follows:

Working Distance	EFL Low	EFL High	F# Low	F# High
500mm	18	165	13.8	33
1m	18	190	13.8	33
10m to infinity	18	225	13.8	33



# Optical Performance

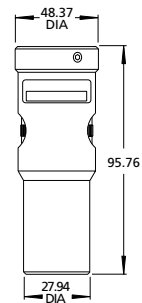
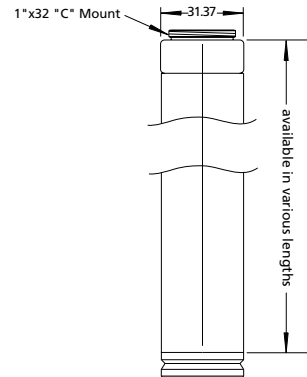
## Variable Working Distance Lower Module



Working Distance	Magnification*
5"	0.288X
6"	0.253X
7"	0.226X
8"	0.202X
9"	0.184X
10"	0.169X
11"	0.158X
12"	0.147X
13"	0.138X
14"	0.130X
15"	0.123X
16"	0.116X
17"	0.109X

\* Magnification factor is relative to B90/F90 values as shown on p. 06.

09



# FMOS Lens System Diagram

## Illumination

30-16-40-000  
40° FLEX BUNDLE

30-16-60-000  
60° FLEX BUNDLE

29-60-83-000  
VSI 110 ILLUMINATOR  
110 VOLT / 150 WATT

29-60-84-000  
VSI 220 ILLUMINATOR  
220VOLT / 150 WATT

29-69-02-000  
POLARIZER  
ZOOM 125 LOWER  
MODULES ONLY

29-69-13-000  
RIGHT ANGLE  
COAX ADAPTER  
ZOOM 125 LOWER  
MODULES ONLY

30-16-01-000  
10MM  
ADAPTER

30-16-02-000  
FIBER OPTIC  
COAXIAL  
LAMPHOUSE  
ZOOM 125 LOWER  
MODULES ONLY

33-04-00-000  
LOW PROFILE, R.A.  
COAXIAL LAMPHOUSE  
FMOS LOWER  
MODULES ONLY

! NOTE: Direct path to Flexible Bundle,  
// FMOS LOWER MODULES ONLY

## Illumination

396010-810  
SINGLE-CHANNEL  
PROGRAMMABLE  
LED CONTROLLER

39-60-10-000  
FMOS STRAIGHT  
1-WATT COAXIAL LED

30-60-10-000  
ZOOM 125 STRAIGHT  
1-WATT COAXIAL LED

39-60-20-000  
FMOS RIGHT-ANGLE  
1-WATT COAXIAL LED

30-60-20-000  
ZOOM 125 RIGHT-ANGLE  
1-WATT COAXIAL LED

27-60-07-000  
110/6 VOLT VARIABLE

27-60-17-000  
220/6 VOLT VARIABLE

29-60-09-000  
10 WATT  
HALOGEN LAMP

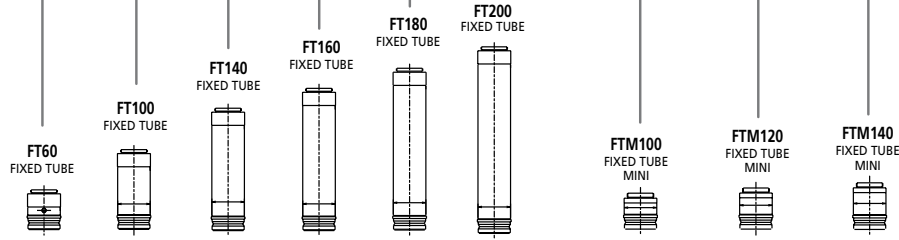
29-69-14-000  
HALOGEN  
LAMPHOUSE

29-60-81-000  
HORIZONTAL RING LIGHT

## Color Key

Optical Path —  
Illumination Path —  
Electrical —

## FMOS Upper Fixed Tubes



NOTE: Yields a reversed image

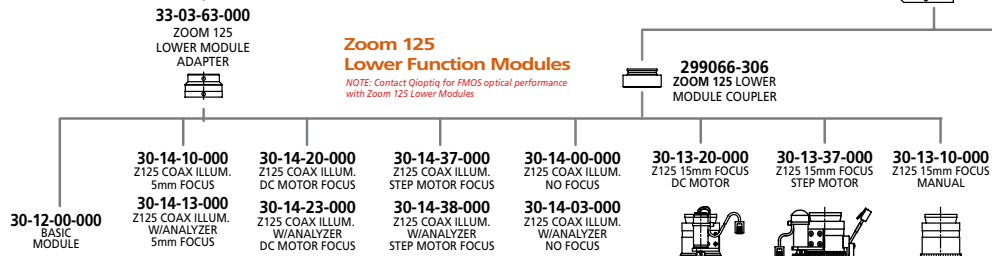
29-90-66-000  
LONG WORKING  
RIGHT-ANGLE  
MODULE

299067-310  
COAXIAL BLOCK

## Zoom 125 Lower Function Modules

### Zoom 125 Lower Function Modules

NOTE: Contact Optiq for FMOS optical performance with Zoom 125 Lower Modules



29-99-01-000  
1.437x32T - M25x0.75T  
ADAPTER

NOTE: Must remove lens from  
Lower Function Module before  
integrating Objective Adapters  
and Objectives

42-35-41-000  
INFINITY  
MACRO LENS

30-17-01-000  
MALE/FEMALE THREAD  
0.5X AUX LENS

30-17-02-000  
MALE/FEMALE THREAD  
0.75X AUX LENS

29-99-02-000  
1.437x32T - M26 x 36T  
OBJECTIVE ADAPTER

30-17-03-000  
25mm - M26 x 36T  
OBJECTIVE ADAPTER  
(FOR FOCUS MODULES)

29-99-03-000  
1.437 x 32T - 0.800 x 36T  
OBJECTIVE ADAPTER

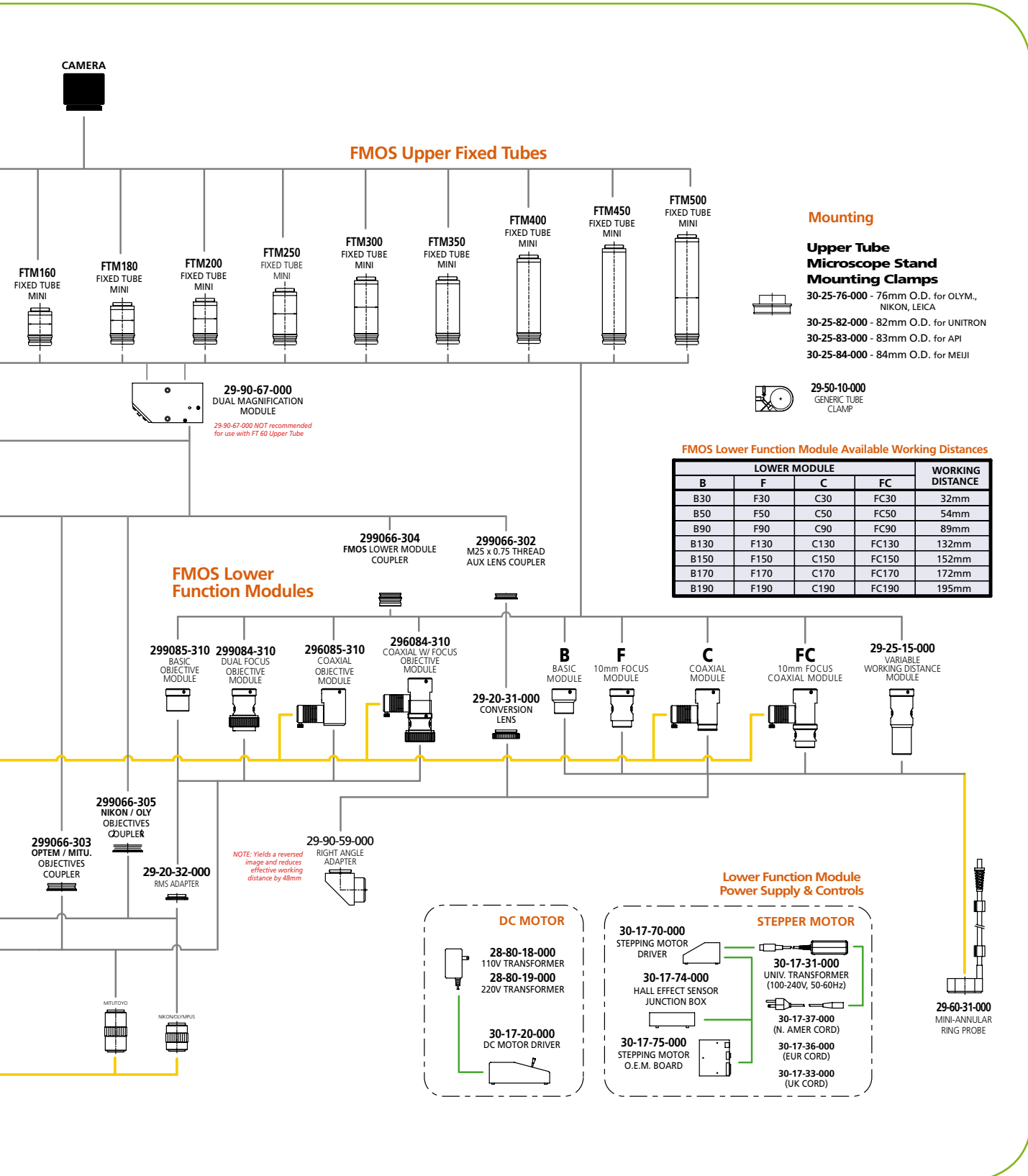
30-17-04-000  
25mm - 0.800 x 36T  
OBJECTIVE ADAPTER  
(FOR FOCUS MODULES)

## High Magnification

### Optem Long Working Distance M-Plan APO Objectives

28-21-02-000 2X M PLAN APO  
28-21-05-000 5X M PLAN APO  
28-21-10-000 10X M PLAN APO  
28-21-11-000 20X M PLAN APO  
28-21-50-000 50X M PLAN APO

30-16-50-000  
OBJECTIVE RING LIGHT



**FMOS Upper Fixed Tubes**

**Mounting**

**Upper Tube Microscope Stand Mounting Clamps**

- 30-25-76-000 - 76mm O.D. for OLYM., NIKON, LEICA
- 30-25-82-000 - 82mm O.D. for UNITRON
- 30-25-83-000 - 83mm O.D. for API
- 30-25-84-000 - 84mm O.D. for MEJII



29-50-10-000  
GENERIC TUBE CLAMP

**FMOS Lower Function Module Available Working Distances**

LOWER MODULE				WORKING DISTANCE
B	F	C	FC	
B30	F30	C30	FC30	32mm
B50	F50	C50	FC50	54mm
B90	F90	C90	FC90	89mm
B130	F130	C130	FC130	132mm
B150	F150	C150	FC150	152mm
B170	F170	C170	FC170	172mm
B190	F190	C190	FC190	195mm



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### For technical information

**Qioptiq**  
[www.qioptiq.com](http://www.qioptiq.com)  
[photonics@qioptiq.com](mailto:photonics@qioptiq.com)

### North America

Qioptiq, Inc.  
Fairport, NY USA  
Toll free: 800-724-4274  
Tel: (585) 223-2370

### Europe

Qioptiq Photonics GmbH  
Göttingen, Germany  
Tel: +49 551 6935-0



### Asia Pacific

Qioptiq Pte Ltd.  
Singapore  
Tel: +65 6499 7766








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