

Optem® Zoom 125C

12.5:1 Micro-Inspection Zoom Lens System

The Optem Zoom 125C Lens System is designed to deliver extended zoom imaging performance. With a broad 12.5:1 zoom range and the signature three-piece modular design, the Optem Zoom 125C Lens System can be configured to meet an extensive range of manual and automated zoom imaging parameters.

With the widest selection of modules and accessories in the Optem Lens line, Zoom 125C delivers exceptional flexibility offering options including independent motorized Focus Modules, polarized illumination, and the expanded flexibility to be configured for micro imaging up to 125X, or macro imaging for broad fields-of-view across infinite working distances.



Base Configuration (1X TV Tube with no Aux. Lens)	(@ Low Mag.)	(@ High Mag.)
Magnification Range	0.52X	6.5X
Numerical Aperture	0.019	0.10
Resolution	58 lp/mm	300 lp/mm
Depth-of-Field	1.5 mm	0.057 mm
Working Distance	89 mm	89 mm
FOV (1/3" Camera)	6.92 x 9.23 mm	0.55 x 0.74 mm
FOV (1/2" Camera)	9.23 x 12.3 mm	0.74 x 0.98 mm
FOV (2/3" Camera)	12.7 x 16.9 mm	1.02 x 1.35 mm
FOV (1" Camera)	18.5 x 24.6 mm	1.48 x 1.97 mm
Min. Configuration (0.375X TV Tube + 0.18X Aux. Lens)	(@ Low Mag.)	(@ High Mag.)
Magnification Range	0.035X	0.44X
Numerical Aperture	0.0035	0.018
Resolution	11 lp/mm	55 lp/mm
Depth-of-Field	46.0 mm	1.7 mm
Working Distance	468 mm	468 mm
Max. Configuration (2.0X TV Tube + 20X HR Obj.)	(@ Low Mag.)	(@ High Mag.)
Magnification Range	10X	125X
Numerical Aperture	0.19	0.60
Resolution	555 lp/mm	1800 lp/mm
Depth-of-Field	0.017 mm	0.0016 mm
Working Distance	13 mm	13 mm

Specifying Your Optem Lens System

To specify your Optem 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 Zoom 125C **base configuration** consists of a Manual Zoom, a Basic Lower Function Module and a 1X TV Tube, which yields an optical magnification range of 0.52X - 6.5X.

Given your optical magnification requirement from STEP 1, determine if your needs fall into the **base configuration** range of 0.52X - 6.5X. If you require higher than 6.5X optical magnification, you can add an Auxiliary Lens with a magnification factor greater than 1X, AND/OR you can choose a TV Tube with a magnification factor greater than 1X (keeping in mind that Aux. Lenses affect the working distance of the system and TV Tubes do not).

Referring to the **Optical Performance Charts** (p. 6-9), you can select the best combination of Aux. Lens (if necessary) and TV Tube to best meet the parameters of your application.

STEP 3. Select the Upper Zoom Module: The upper module has the following options available: iris, detents and motorization (see **System Diagram** p. 10-11).

Select the Lower Function Module: Lower Function Modules integrate the features and functions desired in your lens system which include: coaxial illumination, internal focus and motorization (see **System Diagram** p. 10-11).

STEP 4. When completed, you will have identified the following four components required for your functional Zoom 70XL Lens System.

- 1) TV Tube
- 2) Upper Zoom Module
- 3) Lower Function Module
- 4) Auxiliary Lens (if needed)

Optem Lens Systems are specifically designed to deliver maximum versatility for your micro-inspection needs. If you do not see a standard configuration that meets your requirements, Qioptiq offers efficient and affordable custom modifications to meet special parameters.

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.

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

λ = 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.

Zoom and Function Modules

Upper Zoom Modules



The specific Upper Zoom Module selected will determine the type of zoom operation for your Zoom 125C System.

MANUAL ZOOM MODULE – Provides basic hand-driven 12.5:1 optical system.

IRIS DIAPHRAGM MODULE – All Zoom 125C Upper Modules are available with an optional integral iris for better control of light level and increased depth-of-field.

DETENT MODULE – Offers repeatable magnification stops throughout the 12.5:1 zoom range without the complexity and cost of motorization. Detents are ideal for metrology applications where each position can be calibrated. Factory-set stops are located at 0.6X, 1.0X, 2.0X, 3.0X, 4.0X, 5.0X, and 6.0X.



MOTORIZED ZOOM MODULE – Provides automated zoom in either DC or Stepper Motorized Versions. All Stepper Motorized Models come complete with homing and limit sensors.



Lower Function Modules

When configuring your Zoom 125C Lens System, choose from the following Lower Modules to specify the lighting and focus functions of your systems:

- **BASIC MODULE**
- **INTERNAL FOCUS MODULE** (motor avail.)
- **COAXIAL ILLUMINATION MODULE**
- **INTERNAL FOCUS COAXIAL MODULE** (motor avail.)

If you require extended optical performance from your Zoom 125C, select from these specialized Lower Modules.



OBJECTIVE ADAPTER RINGS – Integrate Infinity-Corrected Objectives utilizing one of four Objective Adapter Rings. Choose from M26 x 36T thread Adapter to accept Optem and Mitutoyo Objectives, and 0.800 x 36T thread adapter available for Nikon and Olympus Objectives. *NOTE: Lens will need to be removed from Lower Function Module before integrating Objective Adapters and Objective.*



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.

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

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 Zoom 125C Lens System offers a variety of illumination options to meet a variety of imaging requirements.

You have two basic illumination options which can be integrated with your Zoom 125C System... coaxial illumination or oblique ring light illumination (see System Diagram p. 10-11).

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.

Select from one of several coaxial-equipped lower function modules when specifying your Zoom 125C lens system and integrate one of three coaxial illumination options.

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.



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 traditional Coaxial options.

10W HALOGEN COAXIAL ILLUMINATORS – When economy is high priority, Halogen light sources are available with a 6V Variable Transformer (110V / 220V).

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 Ring light 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 Zoom 125C System.

FIBER OPTIC RING LIGHTS – Ring light Illuminators are ideal to better define features of dimension-rich subjects. Driven with the same VSI Fiber Optic Illuminator as conventional coaxial systems. Optem offers Ring lights specifically designed for a variety of configurations, including integration of objectives. (see System Diagram p. 10-11).

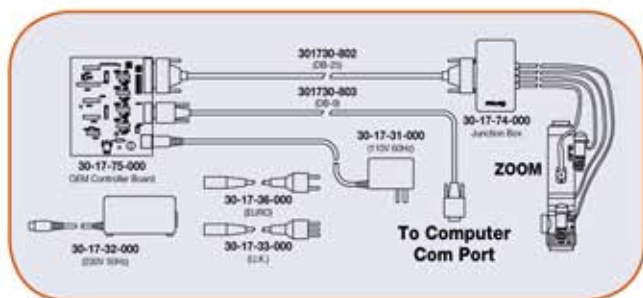
Motorization and Macro Imaging



Motorizing Optem Lens Systems

Optem Lens Systems can be specified with motorized zoom and/or focus functions.

STEPPER MOTORS – 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 MOTORS – DC motors provide continuous control of zoom magnification and/or focus. A desktop joystick controller offers simultaneous control of both zoom and focus functions.



Infinity Macro Lens

When extended working distances and broader fields-of-view are required, integrate the Infinity Macro Lens accessory below a manual or motorized Fine-Focus Lower function Module.



This versatile accessory converts your Zoom 125C from micro-imaging at close working distances to a powerful macro-imaging lens covering broad fields-of-view at working distances from 50mm to infinity (see Optical Performance Chart p. 7).

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Optical Performance - Oblique/Substage Illumination

		0.18X Aux Lens 29-20-09-000 (No Spare) WD: 488 mm		0.25X Aux Lens 29-20-09-000 WD: 310 mm		0.5X Aux Lens 29-20-39-000 WD: 178 mm		0.75X Aux Lens 29-20-39-000 WD: 114 mm		Base Configuration No Aux Lens required WD: 89 mm		1.5X Aux Lens 29-20-49-000 WD: 52 mm		2.0X Aux Lens 29-20-41-000 WD: 32 mm	
		Low Mag	High Mag	Low Mag	High Mag	Low Mag	High Mag	Low Mag	High Mag	Low Mag	High Mag	Low Mag	High Mag	Low Mag	High Mag
0.375X TV Tube	Res (lp/mm)	0.0035	0.018	0.0048	0.025	0.0091	0.048	0.014	0.072	0.019	0.10	0.029	0.15	0.038	0.20
	Mag	11	55	14	75	27	143	42	217	58	300	86	447	114	594
	DOF (mm)	0.035	0.44	0.049	0.61	0.10	1.22	0.15	1.8	0.20	3.7	0.29	3.7	0.39	4.9
	FOV (mm)	103 x 137	8.21 x 10.9	73.8 x 98.5	5.91 x 7.88	36.9 x 49.2	2.95 x 3.94	24.6 x 32.8	1.97 x 2.63	18.5 x 24.6	1.48 x 1.97	12.3 x 16.4	0.98 x 1.31	9.23 x 12.3	0.74 x 0.98
	Can Format	1/3"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"
0.5X TV Tube	Res (lp/mm)	0.0035	0.018	0.0048	0.025	0.0091	0.048	0.014	0.072	0.019	0.10	0.029	0.15	0.038	0.20
	Mag	11	55	14	75	27	143	42	217	58	300	86	447	114	594
	DOF (mm)	0.047	0.59	0.065	0.81	0.13	1.6	0.20	2.4	0.26	3.3	0.39	4.9	0.52	6.5
	FOV (mm)	103 x 137	8.21 x 10.9	73.8 x 98.5	5.91 x 7.88	36.9 x 49.2	2.95 x 3.94	24.6 x 32.8	1.97 x 2.63	18.5 x 24.6	1.48 x 1.97	12.3 x 16.4	0.98 x 1.31	9.23 x 12.3	0.74 x 0.98
	Can Format	1/3"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"
0.67X TV Tube	Res (lp/mm)	0.0035	0.018	0.0048	0.025	0.0091	0.048	0.014	0.072	0.019	0.10	0.029	0.15	0.038	0.20
	Mag	11	55	14	75	27	143	42	217	58	300	86	447	114	594
	DOF (mm)	0.062	0.78	0.087	1.08	0.17	2.2	0.26	3.3	0.35	4.3	0.52	6.5	0.69	8.7
	FOV (mm)	103 x 137	8.21 x 10.9	73.8 x 98.5	5.91 x 7.88	36.9 x 49.2	2.95 x 3.94	24.6 x 32.8	1.97 x 2.63	18.5 x 24.6	1.48 x 1.97	12.3 x 16.4	0.98 x 1.31	9.23 x 12.3	0.74 x 0.98
	Can Format	1/3"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"
1.0X TV Tube	Res (lp/mm)	0.0035	0.018	0.0048	0.025	0.0091	0.048	0.014	0.072	0.019	0.10	0.029	0.15	0.038	0.20
	Mag	11	55	14	75	27	143	42	217	58	300	86	447	114	594
	DOF (mm)	0.094	1.17	0.13	1.6	0.26	3.3	0.39	4.9	0.52	6.5	0.78	9.8	1.0	13
	FOV (mm)	103 x 137	8.21 x 10.9	73.8 x 98.5	5.91 x 7.88	36.9 x 49.2	2.95 x 3.94	24.6 x 32.8	1.97 x 2.63	18.5 x 24.6	1.48 x 1.97	12.3 x 16.4	0.98 x 1.31	9.23 x 12.3	0.74 x 0.98
	Can Format	1/3"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"
1.5X TV Tube	Res (lp/mm)	0.0035	0.018	0.0048	0.025	0.0091	0.048	0.014	0.072	0.019	0.10	0.029	0.15	0.038	0.20
	Mag	11	55	14	75	27	143	42	217	58	300	86	447	114	594
	DOF (mm)	0.14	1.8	0.20	2.4	0.39	4.9	0.59	7.3	0.78	9.8	1.2	15	1.6	20
	FOV (mm)	103 x 137	8.21 x 10.9	73.8 x 98.5	5.91 x 7.88	36.9 x 49.2	2.95 x 3.94	24.6 x 32.8	1.97 x 2.63	18.5 x 24.6	1.48 x 1.97	12.3 x 16.4	0.98 x 1.31	9.23 x 12.3	0.74 x 0.98
	Can Format	1/3"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"
2.0X TV Tube	Res (lp/mm)	0.0035	0.018	0.0048	0.025	0.0091	0.048	0.014	0.072	0.019	0.10	0.029	0.15	0.038	0.20
	Mag	11	55	14	75	27	143	42	217	58	300	86	447	114	594
	DOF (mm)	0.19	2.3	0.26	3.3	0.52	6.5	0.78	9.8	1.0	13	1.6	20	2.1	26
	FOV (mm)	103 x 137	8.21 x 10.9	73.8 x 98.5	5.91 x 7.88	36.9 x 49.2	2.95 x 3.94	24.6 x 32.8	1.97 x 2.63	18.5 x 24.6	1.48 x 1.97	12.3 x 16.4	0.98 x 1.31	9.23 x 12.3	0.74 x 0.98
	Can Format	1/3"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"
Max FOV at Low Mag (Dia.):		120 mm ø	86 mm ø	54 mm ø	36 mm ø	27 mm ø	18 mm ø	14 mm ø	10 mm ø	7 mm ø	5 mm ø	3 mm ø	2 mm ø	1 mm ø	0.5 mm ø

-- FOV limited by vignetting at low mags. Approximate maximum illuminated FOV given as diameter above.

Optical Performance - Coaxial Illumination

NOTE: 0.16X, 0.25X and 0.5X Aux Lenses are not recommended for use with coaxial illumination		0.75X Aux Lens 29-20-28-000 WD: 114 mm		Base Configuration No Aux Lens Required WD: 89 mm		1.5X Aux Lens 29-20-40-000 WD: 52 mm		2.0X Aux Lens 29-20-41-000 WD: 32 mm	
0.5X TV Tube	NA	0.014	0.072	0.019	0.10	0.029	0.15	0.038	0.20
	Res (lp/mm)	42	217	58	300	86	447	114	594
	Mag	0.20	2.4	0.26	3.3	0.39	4.9	0.52	6.5
	DOF (mm)	2.9	0.11	1.5	0.057	0.69	0.026	0.39	0.014
0.67X TV Tube	1/3"	18.5	24.6	1.48	1.11	9.23	12.3	0.74	0.98
	1/2"	24.6	32.8	1.97	1.48	12.3	16.4	0.98	1.31
	2/3"	25.4	33.8	2.03	2.71	16.9	22.6	1.35	1.81
	1"	27.7	36.9	2.21	2.95	18.5	24.6	1.48	1.97
1.0X TV Tube	NA	0.014	0.072	0.019	0.10	0.029	0.15	0.038	0.20
	Res (lp/mm)	42	217	58	300	86	447	114	594
	Mag	0.39	4.9	0.52	6.5	0.78	9.8	1.0	13
	DOF (mm)	2.9	0.11	1.5	0.057	0.69	0.026	0.39	0.014
1.5X TV Tube	1/3"	9.23	12.3	0.74	0.98	6.92	9.23	0.55	0.74
	1/2"	12.3	16.4	0.98	1.31	9.23	12.3	0.74	0.98
	2/3"	16.9	21.6	1.35	1.81	12.7	16.9	1.01	1.35
	1"	24.6	32.8	1.97	2.63	18.5	24.6	1.48	1.97
2.0X TV Tube	NA	0.014	0.072	0.019	0.10	0.029	0.15	0.038	0.20
	Res (lp/mm)	42	217	58	300	86	447	114	594
	Mag	0.59	7.3	0.78	9.8	1.2	15	1.6	20
	DOF (mm)	2.9	0.11	1.5	0.057	0.69	0.026	0.39	0.014
Max FOV at Low Mag (Dia.)	1/3"	6.15	8.21	0.49	0.66	4.62	6.15	0.37	0.49
	1/2"	8.21	10.9	0.66	0.88	6.15	8.21	0.49	0.66
	2/3"	11.3	15.0	0.90	1.20	8.46	11.3	0.68	0.90
	1"	16.4	21.9	1.31	1.75	12.3	16.4	0.98	1.31
Max FOV at High Mag (Dia.)	1/3"	4.62	6.15	0.37	0.49	3.08	4.10	0.25	0.33
	1/2"	6.15	8.21	0.49	0.66	4.10	5.47	0.33	0.44
	2/3"	8.46	11.3	0.68	0.90	5.64	7.52	0.45	0.60
	1"	12.3	16.4	0.98	1.31	8.21	10.9	0.66	0.88
Max FOV at Low Mag (Dia.)	1/3"	4.62	6.15	0.37	0.49	3.08	4.10	0.25	0.33
	1/2"	6.15	8.21	0.49	0.66	4.10	5.47	0.33	0.44
	2/3"	8.46	11.3	0.68	0.90	5.64	7.52	0.45	0.60
	1"	12.3	16.4	0.98	1.31	8.21	10.9	0.66	0.88
Max FOV at High Mag (Dia.)	1/3"	4.62	6.15	0.37	0.49	3.08	4.10	0.25	0.33
	1/2"	6.15	8.21	0.49	0.66	4.10	5.47	0.33	0.44
	2/3"	8.46	11.3	0.68	0.90	5.64	7.52	0.45	0.60
	1"	12.3	16.4	0.98	1.31	8.21	10.9	0.66	0.88

— FOV Limited by illumination at low mags. Approximate maximum illuminated FOV given as diameter above.

— Not recommended due to significant illumination losses throughout entire zoom range.



Optical Performance Infinity Macro Lens Accessory

Working Distance	Auxiliary Lens Mag.
50 mm	0.37
100 mm	0.25
150 mm	0.18
200 mm	0.14
300 mm	0.1
400 mm	0.08

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

	EFL Low	EFL High	F# Low	F# High
500 mm	18	165	13.8	33
1m	18	190	13.8	33
10m - Infinity	18	225	13.8	33

Long-Working Distance Objectives

Achieve significantly higher magnifications and increased resolution. Combine your Zoom 125C with the expanded line of Optem LWD Infinity-Corrected Objectives.

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When integrating objectives onto your Zoom 125C Lens System, You will need to specify one of four Objective Lower Function Modules (see System Diagram p. 10-11).

Optem M-Plan APO, LWD Objectives

Eliminate chromatic aberration across exceptionally flat fields for the ultimate in high-magnification accuracy. Select from 2X, 5X, 10X, and 20X 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

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



Optem High-Resolution, LWD Objectives

Specifically designed to capture maximum resolution at the high-end magnifications of Optem Zoom Lenses, the 5X, 10X and 20X Optem HR Objectives are ideal for applications where distinguishing every finite detail is critical.

LWD Infinity-Corrected Hi Res Objectives

- 5X High-Resolution, LWD 28-20-44-000
- 10X High-Resolution, LWD 28-20-45-000
- 20X High-Resolution, LWD 28-20-46-000



Optical Performance - Objectives with Coaxial Illumination

NOTE: 0.375X TV Tube is not recommended for use with Open Objectives.		2x M Plan APO LWD Objective 28-21-10-000 WD: 24 mm		5x M Plan APO LWD Objective 28-21-02-000 WD: 34 mm		10x M Plan APO LWD Objective 28-21-10-000 WD: 34 mm		20x M Plan APO LWD Objective 28-21-11-000 WD: 20 mm		5X High-Res LWD Objective 28-20-44-000 WD: 34 mm		10X High-Res LWD Objective 28-20-55-000 WD: 19 mm		20X High-Res LWD Objective 28-20-46-000 WD: 13 mm	
		Low Mag		High Mag		Low Mag		High Mag		Low Mag		High Mag		Low Mag	
		Res (lp/mm)	Mag	Res (lp/mm)	Mag	Res (lp/mm)	Mag	Res (lp/mm)	Mag	Res (lp/mm)	Mag	Res (lp/mm)	Mag	Res (lp/mm)	Mag
0.5X TV Tube	NA	0.018	0.055	0.046	0.14	0.092	0.30	0.19	0.42	0.046	0.23	0.092	0.45	0.19	0.60
	Res (lp/mm)	55	165	138	420	277	900	555	1260	138	675	277	1350	555	1800
	Mag	0.25	3.1	0.62	7.8	1.2	16	2.5	31	0.62	7.8	1.2	16	2.5	31
	DOF (mm)	1.7	0.19	0.27	0.029	0.067	0.063	0.017	0.0032	0.27	0.011	0.067	0.0028	0.017	0.0016
0.67X TV Tube	103° FOV (mm)	14.4 x 19.2	1.15 x 1.54	5.77 x 7.69	0.46 x 0.62	2.88 x 3.85	0.23 x 0.31	1.44 x 1.92	0.12 x 0.15	5.77 x 7.69	0.46 x 0.62	2.88 x 3.85	0.23 x 0.31	1.44 x 1.92	0.12 x 0.15
	107° FOV (mm)	19.2 x 25.6	1.54 x 2.05	7.69 x 10.3	0.62 x 0.82	3.85 x 5.13	0.31 x 0.41	1.92 x 2.56	0.15 x 0.21	7.69 x 10.3	0.62 x 0.82	3.85 x 5.13	0.31 x 0.41	1.92 x 2.56	0.15 x 0.21
	203° FOV (mm)	26.4 x 35.3	2.12 x 2.82	10.6 x 14.1	0.85 x 1.13	5.29 x 7.05	0.42 x 0.56	—	—	10.6 x 14.1	0.85 x 1.13	5.29 x 7.05	0.42 x 0.56	2.64 x 3.53	0.21 x 0.28
	NA	0.018	0.055	0.046	0.14	0.092	0.30	0.19	0.42	0.046	0.23	0.092	0.45	0.19	0.60
1.0 TV Tube	Res (lp/mm)	55	165	138	420	277	900	555	1260	138	675	277	1350	555	1800
	Mag	0.50	6.2	1.2	16	2.5	31	5.0	62	1.2	16	2.5	31	5.0	62
	DOF (mm)	1.7	0.19	0.27	0.029	0.067	0.063	0.017	0.0032	0.27	0.011	0.067	0.0028	0.017	0.0016
	103° FOV (mm)	7.21 x 9.62	0.58 x 0.77	2.88 x 3.85	0.23 x 0.31	1.44 x 1.92	0.12 x 0.15	0.72 x 0.96	0.058 x 0.077	2.88 x 3.85	0.23 x 0.31	1.44 x 1.92	0.12 x 0.15	0.72 x 0.96	0.058 x 0.077
1.5X TV Tube	107° FOV (mm)	9.62 x 12.8	0.77 x 1.03	3.85 x 5.13	0.31 x 0.41	1.92 x 2.56	0.15 x 0.21	0.96 x 1.28	0.077 x 0.10	3.85 x 5.13	0.31 x 0.41	1.92 x 2.56	0.15 x 0.21	0.96 x 1.28	0.077 x 0.10
	203° FOV (mm)	13.2 x 17.6	1.06 x 1.41	5.29 x 7.05	0.42 x 0.56	2.64 x 3.53	0.21 x 0.28	1.32 x 1.76	0.11 x 0.14	5.29 x 7.05	0.42 x 0.56	2.64 x 3.53	0.21 x 0.28	1.32 x 1.76	0.11 x 0.14
	1° FOV (mm)	19.2 x 25.6	1.54 x 2.05	7.69 x 10.3	0.62 x 0.82	3.85 x 5.13	0.31 x 0.41	1.92 x 2.56	0.15 x 0.21	7.69 x 10.3	0.62 x 0.82	3.85 x 5.13	0.31 x 0.41	1.92 x 2.56	0.15 x 0.21
	NA	0.018	0.055	0.046	0.14	0.092	0.30	0.19	0.42	0.046	0.23	0.092	0.45	0.19	0.60
2.0X TV Tube	Res (lp/mm)	55	165	138	420	277	900	555	1260	138	675	277	1350	555	1800
	Mag	0.75	9.4	1.9	23	3.7	47	7.5	94	1.9	23	3.7	47	7.5	94
	DOF (mm)	1.7	0.19	0.27	0.029	0.067	0.063	0.017	0.0032	0.27	0.011	0.067	0.0028	0.017	0.0016
	103° FOV (mm)	4.81 x 6.41	0.38 x 0.51	1.92 x 2.56	0.15 x 0.21	0.96 x 1.28	0.08 x 0.10	0.48 x 0.64	0.038 x 0.051	1.92 x 2.56	0.15 x 0.21	0.96 x 1.28	0.077 x 0.10	0.48 x 0.64	0.038 x 0.051
Max FOV at Low Mag (Dia.)	107° FOV (mm)	6.41 x 8.55	0.51 x 0.68	2.56 x 3.42	0.21 x 0.27	1.28 x 1.71	0.10 x 0.14	0.64 x 0.85	0.051 x 0.068	2.56 x 3.42	0.21 x 0.27	1.28 x 1.71	0.10 x 0.14	0.64 x 0.85	0.051 x 0.068
	203° FOV (mm)	8.81 x 11.8	0.71 x 0.94	3.53 x 4.70	0.28 x 0.38	1.76 x 2.35	0.14 x 0.19	0.88 x 1.18	0.071 x 0.094	3.53 x 4.70	0.28 x 0.38	1.76 x 2.35	0.14 x 0.19	0.88 x 1.18	0.071 x 0.094
	1° FOV (mm)	12.8 x 17.1	1.03 x 1.37	5.13 x 6.84	0.41 x 0.55	2.56 x 3.42	0.21 x 0.27	1.28 x 1.71	0.10 x 0.14	5.13 x 6.84	0.41 x 0.55	2.56 x 3.42	0.21 x 0.27	1.28 x 1.71	0.10 x 0.14
	NA	0.018	0.055	0.046	0.14	0.092	0.30	0.19	0.42	0.046	0.23	0.092	0.45	0.19	0.60
Max FOV at Low Mag (Dia.)	Res (lp/mm)	55	165	138	420	277	900	555	1260	138	675	277	1350	555	1800
	Mag	1.0	12	2.5	31	5.0	62	10	125	2.5	31	5.0	62	10	125
	DOF (mm)	1.7	0.19	0.27	0.029	0.067	0.063	0.017	0.0032	0.27	0.011	0.067	0.0028	0.017	0.0016
	103° FOV (mm)	3.61 x 4.81	0.29 x 0.38	1.44 x 1.92	0.12 x 0.15	0.72 x 0.96	0.058 x 0.077	0.36 x 0.48	0.029 x 0.038	1.44 x 1.92	0.115 x 0.15	0.72 x 0.96	0.058 x 0.077	0.36 x 0.48	0.029 x 0.038
Max FOV at Low Mag (Dia.)	107° FOV (mm)	4.81 x 6.41	0.38 x 0.51	1.92 x 2.56	0.15 x 0.21	0.96 x 1.28	0.077 x 0.10	0.48 x 0.64	0.038 x 0.051	1.92 x 2.56	0.15 x 0.21	0.96 x 1.28	0.077 x 0.10	0.48 x 0.64	0.038 x 0.051
	203° FOV (mm)	6.61 x 8.81	0.53 x 0.71	2.64 x 3.53	0.21 x 0.28	1.32 x 1.76	0.11 x 0.14	0.66 x 0.88	0.053 x 0.071	2.64 x 3.53	0.21 x 0.28	1.32 x 1.76	0.11 x 0.14	0.66 x 0.88	0.053 x 0.071
	1° FOV (mm)	9.62 x 12.8	0.77 x 1.03	3.85 x 5.13	0.31 x 0.41	1.92 x 2.56	0.15 x 0.21	0.96 x 1.28	0.077 x 0.10	3.85 x 5.13	0.31 x 0.41	1.92 x 2.56	0.15 x 0.21	0.96 x 1.28	0.077 x 0.10
	NA	0.018	0.055	0.046	0.14	0.092	0.30	0.19	0.42	0.046	0.23	0.092	0.45	0.19	0.60

— FOV Limited by illumination at low mags. Approximate maximum illuminated FOV given as diameter above.

— Not recommended due to significant illumination losses throughout entire zoom range.