

7X and 12.5X Zoom Lens Configuration

A zoom lens provides adjustable magnification in a system without the need to refocus. Our [7X and 12.5X High Precision Zoom Lenses](#) allow for configurability for a wide variety of application needs, covering a 1/4" format C-Mount camera to 43mm F-mount format camera. The specific components selected are based on the desired zoom range, working distance, and FOV.

Required Components

Camera Mount

Camera mounts connect the camera to the rest of the system. Please refer to the table below to select the appropriate mount based on the intended camera's mount:

Camera Tube

Camera tubes thread into the camera mount, providing the final magnification of the system. The available options can be seen below, but since the field of view they provide also depends on the zoom module and lower lens, please see the selection guide table to choose the correct camera tube.

Zoom Module

The zoom module provides zoom functionality to the system, either 7:1 or 12.5:1. Both have manual, manual with detents and motorization options. If opting for no zoom, please select the fixed aperture set. Please note that the motorization options require a controller and cable for control, which are listed further in this document. To secure the zoom module to the camera tube, use the 2mm hex wrench and the 3 set screws on the lower end of the camera tube.

Lower Function Module

The lower function module integrates focus capability, in-line illumination, and polarization options available. This module also features a dovetail mount.

Lower Lens

Lower lenses aid in magnification for the system and determines the working distance of the system. If using an objective, select the objective adapter instead of a lower lens. It is also not recommended to use an objective with

magnification higher than 20X. The lower lens or objective adapter will thread into the lower function module.

Configuring a System

Selecting the components depends on your answers to the following questions:

1. What is the camera's mount that will be used with this system? This ensures that the correct camera adapter is selected.

C-Mount Camera Adapter	89-860
F-Mount Camera Adapter	89-861
EOS Camera Adapter	89-862
K-Mount Camera Adapter	89-863
4/3" Mount Camera Adapter	89-864
Micro 4/3" Mount Camera Adapter	89-865
Sony Alpha Camera Adapter	89-866

2. What, if any, are the requirements for working distance? This helps to narrow down the appropriate lower lens, as it determines working distance. If using an objective, select the adapter. A table of working distances is shown below:

0.4X Lower Lens	89-894	490mm
0.5X Lower Lens	89-895	390mm
0.67X Lower Lens	89-896	290mm
1.0X Lower Lens	89-897	190mm
1.25X Lower Lens	89-898	155mm
1.43X Lower Lens	89-899	135mm
1.67X Lower Lens	89-900	110mm
2.0X Lower Lens	89-901	95mm
3.0X Lower Lens	89-902	50mm
4.0X Lower Lens	89-903	32mm
Mitutoyo Objective Adapter (M26 x 36TPI)	89-904	N/A

3. What, if any, zoom range is required? Are motorization and/or detents needed? At the top of the next page are options for 7X and 12.5X zoom, along with detents and motorization. If not using zoom, please select the fixed aperture. Please note the required accessories for motorization.

Manual 7X Zoom Module	89-878	
Manual 7X Zoom Module w/ Detents	89-879	
Motorized 7X Zoom Module	89-880	Requires 89-913 , and either 89-915 , 89-916 , or 89-917 for control
Manual 12.5X Zoom Module	89-881	
Manual 12.5X Zoom Module w/ Detents	89-882	
Motorized 12.5X Zoom Module	89-883	Requires 89-913 , and either 89-915 , 89-916 , or 89-917 for control
Fixed Aperture Set	89-884	

4. Is focus, either manual or motorized, required? Is in-line illumination or polarization needed? The options below include the different options.

Basic Lower Module w/ No Focus	89-885	
15mm Manual Focus Lower Module	89-886	
Lower Module w/15mm Stepper Motorized Focus	89-887	Requires 89-914 , 89-913 , and either 89-915 , 89-916 , or 89-917 for control. Please note that 89-913 will control both a zoom and focus module, so the required accessories from the motorized zoom module would not need to be purchased twice.
Lower Module w/ In-Line Illumination	89-888	
Lower Module w/ In-Line Illumination & Analyzer	89-889	Includes Fixed Polarizer Inside
Lower Module w/ In-Line Illumination & 5mm Manual Focus	89-890	
Lower Module w/ In-Line Illumination, Analyzer & 5mm Manual Focus	89-891	Includes Fixed Polarizer Inside
Lower Module w/ In-Line Illumination & 5mm Stepper Motorized Focus	89-892	Requires 89-914 , 89-913 , and either 89-915 , 89-916 , or 89-917 for control. Please note that 89-913 will control both a zoom and focus module, so the required accessories from the motorized zoom module would not need to be purchased twice.
Lower Module w/In-Line, Analyzer & 5mm Stepper Motorized Focus	89-893	Requires 89-914 , 89-913 , and either 89-915 , 89-916 , or 89-917 for control. Please note that 89-913 will control both a zoom and focus module, so the required accessories from the motorized zoom module would not need to be purchased twice.

5. Once these components are selected, the last step is selecting a camera tube. The options are below:

0.4X Camera Tube	89-867
0.5X Camera Tube	89-868
0.6X Camera Tube	89-869
0.8X Camera Tube	89-870
1.0X Camera Tube	89-871
0.8X Mini-Camera Tube	89-872
1.0X Mini-Camera Tube	89-873
1.5X Mini-Camera Tube	89-874
2.0X Mini-Camera Tube	89-875
2.5X Mini-Camera Tube	89-876
3.0X Mini-Camera Tube	89-877

The camera tube provides the final magnification for the system and will determine the resulting field of view. To calculate the anticipated minimum and maximum field of view, please follow the equations below. If using an objective instead of a lower lens, please substitute its magnification for *lower lens mag*,

For 7X Zoom:

$$\text{Minimum Mag} = \text{Lower Lens Mag} * 0.42 * \text{Camera Tube Mag}$$

$$\text{Maximum Mag} = \text{Lower Lens Mag} * 2.9 * \text{Camera Tube Mag}$$

For 12.5X Zoom:

$$\text{Minimum Mag} = \text{Lower Lens Mag} * 0.28 * \text{Camera Tube Mag}$$

$$\text{Maximum Mag} = \text{Lower Lens Mag} * 3.5 * \text{Camera Tube Mag}$$

For No Zoom:

$$\text{Mag} = \text{Lower Lens Mag} * \text{Camera Tube Mag}$$

To see what field of view these magnifications yield, please use the following equations:

$$\text{Horizontal Field of View} = \frac{\text{Horizontal Sensor Size}}{\text{Mag}}$$

$$\text{Vertical Field of View} = \frac{\text{Vertical Sensor Size}}{\text{Mag}}$$

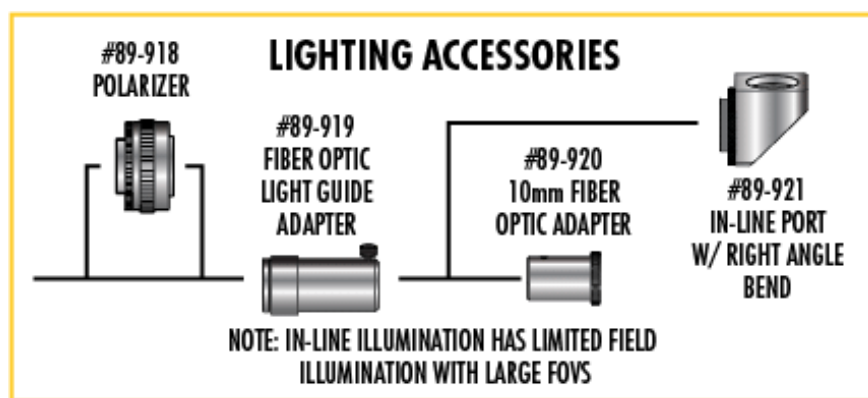
To see example field of view calculations and additional optical performance information when using accessories, please see the appendix of this document.

In-line Illumination

If a lower function module with in-line illumination was selected, there are several available accessories to integrate in-line illumination directly.

If using a 10mm fiber optic, please see the available options and diagram below:

#89-918	Polarizer Illumination Accessory	Optional
#89-919	Fiber Optic Light Guide Adapter	Required
#89-920	10mm Fiber Optic Adapter	Required
#89-921	Right Angle bend for the In-line Port	Optional



If using a 8mm or 1/4" (0.312") spotlight, please see below:

#89-918	Polarizer Illumination Accessory	Optional, but connects directly to the in-line lower function module
#89-921	Right Angle Bend for the In-line Port	Optional, but connects to the in-line lower function module for a right angle bend
#53-047	C-Mount Light Guide Adapter	Can screw right into the in-line lower function module, or into #89-918 and/or #89-921
#38-944	Adapter for Spotlight	Inserts into the C-Mount Light Guide Adapter and holds a 0.312" spotlight

Other Accessories

The accessories below are available with this system. These accessories can be integrated between required components using their dovetail mounts.

Mirror Cube ([#89-906](#))

- Function:
 - Allows for 90 degree turn in the system
 - Will result in reversed image unless another mirror is used
- Placement:
 - Preferred between the zoom module and camera tube
 - Can be placed between zoom and lower function modules
 - Can be placed between lower function and lower lens, but requires [#89-907](#)

50/50 Beamsplitter Cube ([#89-905](#))

- Function:
 - Contains a beamsplitter cube for attaching another camera tube that does not have to be the same magnification
 - One tube will produce a reversed image
 - Adding a right-angle module can allow for a multi-camera system
- Placement:
 - Preferred between the zoom module and camera tube
 - Can be placed between zoom and lower function modules

In-line Mount ([#89-910](#))

- Function:
 - Mounting support in the system
 - Mounting surface to optical centerline is 2"
 - Tapped mounting holes – one 1/4"-20 and two M6
- Placement:
 - Between the camera tube and zoom module or zoom and lower function modules

Camera Tube Clamp ([#89-911](#))

- Function:
 - Has a screw to tighten
 - Has 1/4"-20 tap in the center and 4 M4 taps
 - Mounting surface to optical centerline is 2"
- Placement:

- Clamps anywhere on the camera tube

Adjustable Iris ([#89-909](#))

- Function:
 - Allows adjustment of light to the camera, resolution, and depth of field
- Placement:
 - Preferred between the zoom lens and camera tube

Filter Mount ([#89-908](#))

- Function
 - Allows a filter that is 25mm-1" in diameter and up to 3mm thick to be inserted into the system
 - Retainer ring included
- Placement:
 - Can be placed between the camera tube and zoom module or zoom and lower function modules

System Stand ([#89-912](#))

- Function:
 - Adjustable support stand for the system
- Placement:
 - Can be used with both the In-line Mount and Camera Tube Clamp ([#89-911](#)) or In-line Mount ([#89-910](#)), separately or together

Par-Focalization Instructions

If utilizing zoom, par-focalization will be important for maintaining focus as zoom is adjusted. Once the proper components are assembled, zoom to high magnification and focus. This can be done with the lower function model with focus, if used, or by moving the object up and down. Once the object is in focus then zoom to low magnification, then repeat the same procedure.

Lower on the Camera Tubes is a hex socket button head screw and opposite this screw a set screw. These take the same 2mm hex wrench. Loosen the set screw and the button head screw. With the hex wrench in the button head screw slide it up or down to focus the image. This screw moves an inner lens cell to the correct position. Once par-focality is achieved, tighten the button head screw and then the opposite set screw.

For fixed magnification systems it is recommended to adjust this lens position with just the Camera Mount and the Camera Tube attached to the camera. Point the system out a window and adjust the inner cell for infinity. Then

attach the Lower Function Module. Setting the Camera Tube at infinity optimizes the system and makes sure that when using a focus module, the magnification remains consistent.

Par-Centering Instructions

Zoom to high magnification and center a feature to the monitor screen. Then, zoom to low magnification and use the 3 set screws on the camera tube to re-center the same feature. Repeat these 2 steps if necessary.

Thumbscrews are available for easy centering of the camera. These thumbscrews can then be tightened with the same 2mm hex wrench. Just replace the setscrews. Adjusting the Camera Tube focus before final clamping is recommended to allow smooth movement of the inner lens cell during adjustment.

Appendix of Performance Data – Fixed Magnification with Standard Camera Tubes

		0.4X Lower Lens 89-894 WD: 490mm EFL: 500mm	0.5X Lower Lens 89-895 WD: 390mm EFL: 400mm	0.67X Lower Lens 89-896 WD: 290mm EFL: 300mm	1X Lower Lens 89-897 WD: 190mm EFL: 200mm	1.25X Lower Lens 89-898 WD: 155mm EFL: 160mm	1.43X Lower Lens 89-899 WD: 135mm EFL: 140mm	1.67 Lower Lens 89-900 WD: 110mm EFL: 120mm	2X Lower Lens 89-901 WD: 95mm EFL: 100mm	3X Lower Lens 89-902 WD: 50mm EFL: 67mm	4X Lower Lens 89-903 WD: 32mm EFL: 50mm
	Max FOV Dia.	100	80	60	40	32	28	24	20	15	10
	Max Coax FOV Dia.	13	13	14	12	12	13	14	15	15	10
0.4X Camera Tube EFL: 80mm 5mm Stop 89-867	FOV (mm)	NA	0.0050	0.0063	0.0083	0.013	0.016	0.018	0.021	0.037	0.050
		Res (lp/mm)	15	19	25	38	47	54	63	112	150
		Mag	0.16	0.20	0.27	0.40	0.50	0.57	0.67	1.2	1.6
		DOF (mm)	23	15	8.2	3.6	2.3	1.8	1.3	0.40	0.23
	Cam Format	1/3"	23 x 30	18 x 24	14 x 18	9.0 x 12	7.2 x 9.6	6.3 x 8.4	5.4 x 7.2	3.0 x 4.0	2.3 x 3.0
		1/2"	30 x 40	24 x 32	18 x 24	12 x 16	9.6 x 13	8.4 x 11	7.2 x 9.6	4.0 x 5.3	3.0 x 4.0
		2/3"	41 x 55	33 x 44	25 x 33	17 x 22	13 x 18	12 x 15	9.9 x 13	5.5 x 7.3	4.1 x 5.5
	FOV (mm)	NA	0.0050	0.0063	0.0083	0.013	0.016	0.018	0.021	0.037	0.050
		Res (lp/mm)	15	19	25	38	47	54	63	112	150
		Mag	0.20	0.25	0.33	0.50	0.63	0.71	0.83	1.5	2.0
		DOF (mm)	23	15	8.2	3.6	2.3	1.8	1.3	0.40	0.23
0.5X Camera Tube EFL: 100mm 5mm Stop 89-868	FOV (mm)	NA	0.0050	0.0063	0.0083	0.013	0.016	0.018	0.021	0.037	0.050
		Res (lp/mm)	15	19	25	38	47	54	63	112	150
		Mag	0.20	0.25	0.33	0.50	0.63	0.71	0.83	1.5	2.0
		DOF (mm)	23	15	8.2	3.6	2.3	1.8	1.3	0.40	0.23
	Cam Format	1/3"	18 x 24	14 x 19	11 x 14	7.2 x 9.6	5.8 x 7.7	5.0 x 6.7	4.3 x 5.8	2.4 x 3.2	1.8 x 2.4
		1/2"	24 x 32	19 x 26	14 x 19	9.6 x 13	7.7 x 10	6.7 x 9.0	5.8 x 7.7	3.2 x 4.3	2.4 x 3.2
		2/3"	33 x 44	26 x 35	20 x 26	13 x 18	11 x 14	9.2 x 12	7.9 x 11	4.4 x 5.9	3.3 x 4.4
	FOV (mm)	NA	0.0080	0.010	0.013	0.020	0.025	0.029	0.033	0.040	0.060
		Res (lp/mm)	24	30	40	60	75	86	100	120	180
		Mag	0.24	0.30	0.40	0.60	0.75	0.86	1.0	1.2	1.8
		DOF (mm)	8.9	5.7	3.2	1.4	0.91	0.69	0.51	0.35	0.16
0.6X Camera Tube EFL: 120mm 8mm Stop 89-869	FOV (mm)	NA	0.0080	0.010	0.013	0.020	0.025	0.029	0.033	0.040	0.060
		Res (lp/mm)	24	30	40	60	75	86	100	120	180
		Mag	0.24	0.30	0.40	0.60	0.75	0.86	1.0	1.2	1.8
		DOF (mm)	8.9	5.7	3.2	1.4	0.91	0.69	0.51	0.35	0.16
	Cam Format	1/3"	15 x 20	12 x 16	9.0 x 12	6.0 x 8.0	4.8 x 6.4	4.2 x 5.6	3.6 x 4.8	2.0 x 2.7	1.5 x 2.0
		1/2"	20 x 27	16 x 21	12 x 16	8.0 x 11	6.4 x 8.5	5.6 x 7.5	4.8 x 6.4	2.7 x 3.6	2.0 x 2.7
		2/3"	28 x 37	22 x 29	17 x 22	11 x 15	8.8 x 12	7.7 x 10	6.6 x 8.8	5.5 x 7.3	3.7 x 4.9
	FOV (mm)	NA	0.012	0.015	0.020	0.030	0.038	0.043	0.050	0.060	0.090
		Res (lp/mm)	36	45	60	90	113	129	150	180	270
		Mag	0.32	0.40	0.53	0.80	1.0	1.1	1.3	1.6	2.4
		DOF (mm)	3.9	2.5	1.4	0.63	0.40	0.31	0.23	0.16	0.070
0.8X Camera Tube EFL: 160mm 12mm Stop 89-870	FOV (mm)	NA	0.012	0.015	0.020	0.030	0.038	0.043	0.050	0.060	0.090
		Res (lp/mm)	36	45	60	90	113	129	150	180	270
		Mag	0.32	0.40	0.53	0.80	1.0	1.1	1.3	1.6	2.4
		DOF (mm)	3.9	2.5	1.4	0.63	0.40	0.31	0.23	0.16	0.070
	Cam Format	1/3"	11 x 15	9.0 x 12	6.8 x 9.0	4.5 x 6.0	3.6 x 4.8	3.2 x 4.2	2.7 x 3.6	2.3 x 3.0	1.5 x 2.0
		1/2"	15 x 20	12 x 16	9.0 x 12	6.0 x 8.0	4.8 x 6.4	4.2 x 5.6	3.6 x 4.8	3.0 x 4.0	2.0 x 2.7
		2/3"	21 x 28	17 x 22	12 x 17	8.3 x 11	6.6 x 8.8	5.8 x 7.7	5.0 x 6.6	4.1 x 5.5	2.8 x 3.7
	FOV (mm)	NA	0.018	0.023	0.030	0.045	0.056	0.064	0.075	0.090	0.18
		Res (lp/mm)	54	68	90	135	169	193	225	270	405
		Mag	0.40	0.50	0.67	1.0	1.25	1.43	1.67	2.0	3.0
		DOF (mm)	1.8	1.1	0.63	0.28	0.18	0.14	0.10	0.070	0.031
1X Camera Tube EFL: 200mm 18mm Stop 89-871	FOV (mm)	NA	0.018	0.023	0.030	0.045	0.056	0.064	0.075	0.090	0.18
		Res (lp/mm)	54	68	90	135	169	193	225	270	405
		Mag	0.40	0.50	0.67	1.0	1.25	1.43	1.67	2.0	3.0
		DOF (mm)	1.8	1.1	0.63	0.28	0.18	0.14	0.10	0.070	0.031
	Cam Format	1/3"	9.0 x 12	7.2 x 9.6	5.4 x 7.2	3.6 x 4.8	2.9 x 3.8	2.5 x 3.4	2.2 x 2.9	1.8 x 2.4	1.2 x 1.6
		1/2"	12 x 16	9.6 x 13	7.2 x 9.6	4.8 x 6.4	3.8 x 5.1	3.4 x 4.5	2.9 x 3.8	2.4 x 3.2	1.6 x 2.1
		2/3"	17 x 22	13 x 18	9.9 x 13	6.6 x 8.8	5.3 x 7.0	4.6 x 6.2	4.0 x 5.3	3.3 x 4.4	2.2 x 2.9
	FOV (mm)	NA	0.018	0.023	0.030	0.045	0.056	0.064	0.075	0.090	0.18
		Res (lp/mm)	54	68	90	135	169	193	225	270	405
		Mag	0.40	0.50	0.67	1.0	1.25	1.43	1.67	2.0	3.0
		DOF (mm)	1.8	1.1	0.63	0.28	0.18	0.14	0.10	0.070	0.031

Useable FOV Limited by Coax illumination (>50% Illumination)

FOV Limited by vignetting

Appendix of Performance Data – Fixed Magnification with Mini Camera Tubes

		0.4X Lower Lens	0.5X Lower Lens	0.67X Lower Lens	1X Lower Lens	1.25X Lower Lens	1.43X Lower Lens	1.67 Lower Lens	2X Lower Lens	3X Lower Lens	4X Lower Lens
		89-894 WD: 490mm EFL: 500mm	89-895 WD: 390mm EFL: 400mm	89-896 WD: 290mm EFL: 300mm	89-897 WD: 190mm EFL: 200mm	89-898 WD: 155mm EFL: 160mm	89-899 WD: 135mm EFL: 140mm	89-900 WD: 110mm EFL: 120mm	89-901 WD: 95mmE FL: 100mm	89-902 WD: 50mm EFL: 67mm	89-903 WD: 32mm EFL: 50mm
	Max FOV Dia.	100	80	60	40	32	28	24	20	15	10
	Max Coax FOV Dia.	13	13	14	12	12	13	14	15	15	10
1.5X Mini Camera Tube EFL: 3000mm 12mm Stop 89-874	NA	0.012	0.015	0.020	0.030	0.038	0.043	0.050	0.060	0.090	0.12
	Res (lp/mm)	36	45	60	90	113	129	150	180	270	360
	Mag	0.60	0.75	1.0	1.5	1.9	2.1	2.5	3.0	4.5	6.0
	DOF (mm)	3.9	2.5	1.4	0.63	0.40	0.31	0.23	0.16	0.070	0.039
	2/3"	11 x 15	8.8 x 12	6.6 x 8.8	4.4 x 5.9	3.5 x 4.7	3.1 x 4.1	2.6 x 3.5	2.2 x 2.9	1.5 x 2.0	1.1 x 1.5
	1"	16 x 21	13 x 17	9.6 x 13	6.4 x 8.5	5.1 x 6.8	4.5 x 6.0	3.8 x 5.1	3.2 x 4.3	2.1 x 2.8	1.6 x 2.1
	4/3"	23 x 30	18 x 24	14 x 18	9.0 x 12	7.2 x 9.6	6.3 x 8.4	5.4 x 7.2	4.5 x 6.0	3.0 x 4.0	2.3 x 3.0
	APS-C	28 x 42	22 x 33	17 x 25	11 x 17	8.9 x 13	7.8 x 12	6.7 x 10	5.6 x 8.4	3.7 x 5.6	2.8 x 4.2
	NA	0.018	0.023	0.030	0.045	0.056	0.064	0.075	0.090	0.13	0.18
	Res (lp/mm)	54	68	90	135	169	193	225	270	405	540
2X Camera Tube EFL: 400mm 18mm Stop 89-875	Mag	0.80	1.0	1.3	2.0	2.5	2.9	3.3	4.0	6.0	8.0
	DOF (mm)	1.8	1.1	0.63	0.28	0.18	0.14	0.101	0.070	0.031	0.018
	2/3"	8.3 x 11	6.6 x 8.8	5.0 x 6.6	3.3 x 4.4	2.6 x 3.5	2.3 x 3.1	2.0 x 2.6	1.7 x 2.2	1.1 x 1.5	0.83 x 1.1
	1"	12 x 16	9.6 x 13	7.2 x 9.6	4.8 x 6.4	3.8 x 5.1	3.4 x 4.5	2.9 x 3.8	2.4 x 3.2	1.6 x 2.1	1.2 x 1.6
	4/3"	17 x 23	14 x 18	10 x 14	6.8 x 9.0	5.4 x 7.2	4.7 x 6.3	4.1 x 5.4	3.4 x 4.5	2.3 x 3.0	1.7 x 2.3
	APS-C	21 x 31	17 x 25	13 x 19	8.4 x 13	6.7 x 10	5.8 x 8.8	5.0 x 7.5	4.2 x 6.3	2.8 x 4.2	2.1 x 3.1
	NA	0.018	0.023	0.030	0.045	0.056	0.064	0.075	0.090	0.13	0.18
	Res (lp/mm)	54	68	90	135	169	193	225	270	405	540
	Mag	1.0	1.3	1.7	2.5	3.1	3.6	4.2	5.0	7.5	10
	DOF (mm)	1.8	1.1	0.63	0.28	0.18	0.14	0.10	0.070	0.031	0.018
2.5X Camera Tube EFL: 500mm 18mm Stop 89-876	1"	9.6 x 13	7.7 x 10	5.8 x 7.7	3.8 x 5.1	3.1 x 4.1	2.7 x 3.6	2.3 x 3.1	1.9 x 2.6	1.3 x 1.7	0.96 x 1.3
	4/3"	14 x 18	11 x 14	8.1 x 11	5.4 x 7.2	4.3 x 5.8	3.8 x 5.0	3.2 x 4.3	2.7 x 3.6	1.8 x 2.4	1.4 x 1.8
	APS-C	17 x 25	13 x 20	10 x 15	6.7 x 10	5.3 x 8.0	4.7 x 7.0	4.0 x 6.0	3.3 x 5.0	2.2 x 3.3	1.7 x 2.5
	35mm (FULL)	24 x 36	19 x 29	14 x 22	9.6 x 14	7.7 x 12	6.7 x 10	5.8 x 8.6	4.8 x 7.2	3.2 x 4.8	2.4 x 3.6
	NA	0.018	0.023	0.030	0.045	0.056	0.064	0.075	0.090	0.13	0.18
	Res (lp/mm)	54	68	90	135	169	193	225	270	405	540
	Mag	1.2	1.5	2.0	3.0	3.8	4.3	5.0	6.0	9.0	12
	DOF (mm)	1.8	1.1	0.63	0.28	0.18	0.14	0.10	0.070	0.031	0.018
	1"	8.0 x 11	6.4 x 8.5	4.8 x 6.4	3.2 x 4.3	2.6 x 3.4	2.2 x 3.0	1.9 x 2.6	1.6 x 2.1	1.1 x 1.4	0.80 x 1.1
	4/3"	11 x 15	9.0 x 12	6.8 x 9.0	4.5 x 6.0	3.6 x 4.8	3.2 x 4.2	2.7 x 3.6	2.3 x 3.0	1.5 x 2.0	1.1 x 1.5
3X Camera Tube EFL: 600mm 18mm Stop 89-877	APS-C	14 x 21	11 x 17	8.4 x 13	5.6 x 8.4	4.5 x 6.7	3.9 x 5.9	3.3 x 5.0	2.8 x 4.2	1.9 x 2.8	1.4 x 2.1
	35mm (FULL)	20 x 30	16 x 24	12 x 18	8.0 x 12	6.4 x 9.6	5.6 x 8.4	4.8 x 7.2	4.0 x 6.0	2.7 x 4.0	2.0 x 3.0

— Useable FOV Limited by Coax illumination (>50% illumination)

— FOV Limited by vignetting

	Height	x	Width	Diag.
2/3"	6.6	x	8.8	11
1"	9.6	x	12.8	16
4/3"	13.5	x	18	22.5
APS-C*	16.7	x	25.1	30
35mm (Full)	24	x	36	43.3

Appendix of Performance Data – 7:1 Zoom with Standard Camera Tubes

		0.4X Lower Lens 89-894 WD: 490mm EFL: 500mm		0.5X Lower Lens 89-895 WD: 390mm EFL: 400mm		0.67X Lower Lens 89-896 WD: 290mm EFL: 300mm		1X Lower Lens 89-897 WD: 190mm EFL: 200mm		1.25X Lower Lens 89-898 WD: 155mm EFL: 160mm		1.43X Lower Lens 89-899 WD: 135mm EFL: 140mm		1.67 Lower Lens 89-900 WD: 110mm EFL: 120mm		2X Lower Lens 89-901 WD: 95mm EFL: 100mm		3X Lower Lens 89-902 WD: 50mm EFL: 67mm		4X Lower Lens 89-903 WD: 32mm EFL: 50mm	
Max FOV Dia.		155		125		94		63		50		44		35		31		21		16	
Max Coax FOV Dia.		NR		NR		NR		19		19		19		18		19		13		9.4	
0.4X Camera Tube EFL: 80mm	NA	0.0047	0.016	0.0059	0.019	0.0079	0.026	0.012	0.039	0.015	0.048	0.017	0.055	0.020	0.065	0.024	0.078	0.035	0.12	0.047	0.16
	Res (lp/mm)	14	47	18	58	24	78	35	116	44	145	51	166	59	194	71	233	106	349	142	465
	Mag	0.067	0.46	0.084	0.58	0.11	0.77	0.17	1.2	0.21	1.5	0.24	1.7	0.28	1.9	0.34	2.3	0.50	3.5	0.67	4.6
	DOF (mm)	25	2.4	16	1.5	9.2	0.85	4.1	0.38	2.6	0.24	2.0	1.9	1.5	0.14	1.0	0.094	0.45	0.042	0.25	0.024
89-867	FOV (mm)	1/3"	54 x 71	7.8 x 10	43 x 57	6.2 x 8.3	32 x 43	4.7 x 6.2	21 x 29	3.1 x 4.1	17 x 23	2.5 x 3.3	15 x 20	2.2 x 2.9	13 x 17	1.9 x 2.5	11 x 14	1.6 x 2.1	7.1 x 9.5	1.0 x 1.4	5.4 x 7.1
	FOV (mm)	1/2"	71 x 95	10 x 14	57 x 76	8.3 x 11	43 x 57	6.2 x 8.3	29 x 38	4.1 x 5.5	23 x 30	3.3 x 4.4	20 x 27	2.9 x 3.9	17 x 23	2.5 x 3.3	14 x 19	2.1 x 2.8	9.5 x 13	1.4 x 1.8	7.1 x 10
	FOV (mm)	2/3"	98 x 131	14 x 19	79 x 105	11 x 15	59 x 79	8.5 x 11	39 x 52	5.7 x 7.6	31 x 42	4.6 x 6.1	28 x 37	4.0 x 5.3	24 x 31	3.4 x 4.6	20 x 26	2.8 x 3.8	13 x 17	1.9 x 2.5	10 x 13
	Cam Format	2/3"	98 x 131	14 x 19	79 x 105	11 x 15	59 x 79	8.5 x 11	39 x 52	5.7 x 7.6	31 x 42	4.6 x 6.1	28 x 37	4.0 x 5.3	24 x 31	3.4 x 4.6	20 x 26	2.8 x 3.8	13 x 17	1.9 x 2.5	10 x 13
0.5X Camera Tube EFL: 100mm	NA	0.0047	0.016	0.0059	0.019	0.0079	0.026	0.012	0.039	0.015	0.048	0.017	0.055	0.020	0.065	0.024	0.078	0.035	0.12	0.047	0.16
	Res (lp/mm)	14	47	18	58	24	78	35	116	44	145	51	166	59	194	71	233	106	349	142	465
	Mag	0.084	0.58	0.11	0.73	0.14	0.97	0.21	1.5	0.26	1.8	0.30	2.1	0.35	2.4	0.42	2.9	0.63	4.3	0.84	5.8
	DOF (mm)	25	2.4	16	1.5	9.2	0.85	4.1	0.38	2.6	0.24	2.0	1.9	1.5	0.14	1.0	0.094	0.45	0.042	0.25	0.024
89-868	FOV (mm)	1/3"	43 x 57	6.2 x 8.3	34 x 46	5.0 x 6.6	26 x 34	3.7 x 5.0	17 x 23	2.5 x 3.3	14 x 18	2.0 x 2.6	12 x 16	1.7 x 2.3	10 x 14	1.5 x 2.0	8.6 x 11	1.24 x 1.7	5.7 x 7.6	0.83 x 1.1	4.3 x 5.7
	FOV (mm)	1/2"	57 x 76	8.3 x 11	46 x 61	6.6 x 8.8	34 x 46	5.0 x 6.6	23 x 30	3.3 x 4.4	18 x 24	2.6 x 3.5	16 x 21	2.3 x 3.1	14 x 18	2.0 x 2.6	11 x 15	1.7 x 2.2	7.6 x 10	1.1 x 1.5	5.7 x 7.6
	FOV (mm)	2/3"	79 x 105	11 x 15	63 x 84	9.1 x 12	47 x 63	6.8 x 9.1	31 x 42	4.6 x 6.1	25 x 34	3.6 x 4.9	22 x 29	3.2 x 4.2	19 x 25	2.7 x 3.6	16 x 21	2.3 x 3.0	10 x 14	1.5 x 2.0	7.9 x 10
	Cam Format	2/3"	79 x 105	11 x 15	63 x 84	9.1 x 12	47 x 63	6.8 x 9.1	31 x 42	4.6 x 6.1	25 x 34	3.6 x 4.9	22 x 29	3.2 x 4.2	19 x 25	2.7 x 3.6	16 x 21	2.3 x 3.0	10 x 14	1.5 x 2.0	7.9 x 10
0.6X Camera Tube EFL: 120mm	NA	0.0047	0.016	0.0059	0.019	0.0079	0.026	0.012	0.039	0.015	0.048	0.017	0.055	0.020	0.065	0.024	0.078	0.035	0.12	0.047	0.16
	Res (lp/mm)	14	47	18	58	24	78	35	116	44	145	51	166	59	194	71	233	106	349	142	465
	Mag	0.10	0.70	0.13	0.87	0.17	1.2	0.25	1.7	0.32	2.2	0.36	2.5	0.42	2.9	0.50	3.5	0.76	5.2	1.0	7.0
	DOF (mm)	25	2.4	16	1.5	9.2	0.85	4.1	0.38	2.6	0.24	2.0	1.9	1.5	0.14	1.0	0.094	0.45	0.042	0.25	0.024
89-869	FOV (mm)	1/3"	36 x 48	5.2 x 6.9	29 x 38	4.1 x 5.5	21 x 29	3.1 x 4.1	14 x 19	2.1 x 2.8	11 x 15	1.7 x 2.2	10 x 13	1.4 x 1.9	8.6 x 11	1.2 x 1.7	7.1 x 9.5	1.0 x 1.4	4.8 x 6.4	0.69 x 0.92	3.6 x 4.8
	FOV (mm)	1/2"	48 x 63	6.9 x 9.2	38 x 51	5.5 x 7.4	29 x 38	4.1 x 5.5	19 x 25	2.8 x 3.7	15 x 20	2.2 x 2.9	13 x 18	1.9 x 2.6	11 x 15	1.7 x 2.2	9.5 x 13	1.4 x 1.8	6.4 x 8.5	0.92 x 1.2	4.8 x 6.3
	FOV (mm)	2/3"	65 x 87	9.5 x 13	52 x 70	7.6 x 10	39 x 52	5.7 x 7.6	26 x 35	3.8 x 5.1	21 x 28	3.0 x 4.0	18 x 24	2.7 x 3.5	16 x 21	2.3 x 3.0	13 x 17	1.9 x 2.5	8.7 x 12	1.3 x 1.7	6.5 x 8.7
	Cam Format	2/3"	65 x 87	9.5 x 13	52 x 70	7.6 x 10	39 x 52	5.7 x 7.6	26 x 35	3.8 x 5.1	21 x 28	3.0 x 4.0	18 x 24	2.7 x 3.5	16 x 21	2.3 x 3.0	13 x 17	1.9 x 2.5	8.7 x 12	1.3 x 1.7	6.5 x 8.7
0.8X Camera Tube EFL: 160mm	NA	0.0047	0.016	0.0059	0.019	0.0079	0.026	0.012	0.039	0.015	0.048	0.017	0.055	0.020	0.065	0.024	0.078	0.035	0.12	0.047	0.16
	Res (lp/mm)	14	47	18	58	24	78	35	116	44	145	51	166	59	194	71	233	106	349	142	465
	Mag	0.13	0.93	0.17	1.2	0.22	1.5	0.34	2.3	0.42	2.9	0.48	3.3	0.56	3.9	0.67	4.6	1.0	7.0	1.3	9.3
	DOF (mm)	25	2.4	16	1.5	9.2	0.85	4.1	0.38	2.6	0.24	2.0	1.9	1.5	0.14	1.0	0.094	0.45	0.042	0.25	0.024
89-870	FOV (mm)	1/3"	27 x 36	3.9 x 5.2	21 x 29	3.1 x 4.1	16 x 21	2.3 x 3.1	11 x 14	1.6 x 2.1	8.6 x 11	1.2 x 1.7	7.5 x 10	1.1 x 1.4	6.4 x 8.6	0.93 x 1.2	5.4 x 7.1	0.78 x 1.0	3.6 x 4.8	0.52 x 0.69	2.7 x 3.6
	FOV (mm)	1/2"	36 x 48	5.2 x 6.9	29 x 38	4.1 x 5.5	21 x 29	3.1 x 4.1	14 x 19	2.1 x 2.8	11 x 15	1.7 x 2.2	10 x 13	1.4 x 1.9	8.6 x 11	1.2 x 1.7	7.1 x 9.5	1.0 x 1.4	4.8 x 6.4	0.69 x 0.92	3.6 x 4.8
	FOV (mm)	2/3"	49 x 65	7.1 x 9.5	39 x 52	5.7 x 7.6	29 x 39	4.3 x 5.7	20 x 26	2.8 x 3.8	16 x 21	2.3 x 3.0	14 x 18	2.0 x 2.7	12 x 16	1.7 x 2.3	9.8 x 13	1.4 x 1.9	6.6 x 8.7	0.95 x 1.3	4.9 x 6.5
	Cam Format	2/3"	49 x 65	7.1 x 9.5	39 x 52	5.7 x 7.6	29 x 39	4.3 x 5.7	20 x 26	2.8 x 3.8	16 x 21	2.3 x 3.0	14 x 18	2.0 x 2.7	12 x 16	1.7 x 2.3	9.8 x 13	1.4 x 1.9	6.6 x 8.7	0.95 x 1.3	4.9 x 6.5
1X Camera Tube EFL: 200mm	NA	0.0047	0.016	0.0059	0.019	0.0079	0.026	0.012	0.039	0.015	0.048	0.017	0.055	0.020	0.065	0.024	0.078	0.035	0.12	0.047	0.16
	Res (lp/mm)	14	47	18	58	24	78	35	116	44	145	51	166	59	194	71	233	106	349	142	465
	Mag	0.17	1.2	0.21	1.5	0.28	1.9	0.42	2.9	0.53	3.6	0.60	4.1	0.70	4.8	0.84	5.8	1.3	8.7	1.7	12
	DOF (mm)	25	2.4	16	1.5	9.2	0.85	4.1	0.38	2.6	0.24	2.0	1.9	1.5	0.14	1.0	0.094	0.45	0.042	0.25	0.024
89-871	FOV (mm)	1/3"	21 x 29	3.1 x 4.1	17 x 23	2.5 x 3.3	13 x 17	1.9 x 2.5	8.6 x 11	1.2 x 1.7	6.9 x 9.1	0.99 x 1.3	6.0 x 8.0	0.87 x 1.2	5.1 x 6.9	0.74 x 0.99	4.3 x 5.7	0.62 x 0.83	2.9 x 3.8	0.41 x 0.55	2.1 x 2.9
	FOV (mm)	1/2"	29 x 38	4.1 x 5.5	23 x 30	3.3 x 4.4	17 x 23	2.5 x 3.3	11 x 15	1.7 x 2.2	9.1 x 12	1.3 x 1.8	8.0 x 11	1.2 x 1.5	6.9 x 9.1	0.99 x 1.3	5.7 x 7.6	0.83 x 1.1	3.8 x 5.1	0.55 x 0.74	2.9 x 3.8
	FOV (mm)	2/3"	39 x 52	5.7 x 7.6	31 x 42	4.6 x 6.1	24 x 31	3.4 x 4.6	16 x 21	2.3 x 3.0	13 x 17	1.8 x 2.4	11 x 15	1.6 x 2.1	9.4 x 13	1.4 x 1.8	7.9 x 10	1.1 x 1.5	5.2 x 7.0	0.76 x 1.0	3.9 x 5.2
	Cam Format	2/3"	39 x 52	5.7 x 7.6	31 x 42	4.6 x 6.1	24 x 31	3.4 x 4.6	16 x 21	2.3 x 3.0	13 x 17	1.8 x 2.4	11 x 15	1.6 x 2.1	9.4 x 13	1.4 x 1.8	7.9 x 10	1.1 x 1.5	5.2 x 7.0	0.76 x 1.0	3.9 x 5.2

— Useable FOV Limited by Coax illumination (>50% illumination)

— FOV Limited by vignetting

NR = Not recommended for Coax illumination

Appendix of Performance Data – 7:1 Zoom with Mini Camera Tubes

		0.4X Lower Lens 89-894 WD: 490mm EFL: 500mm		0.5X Lower Lens 89-895 WD: 390mm EFL: 400mm		0.67X Lower Lens 89-896 WD: 290mm EFL: 300mm		1X Lower Lens 89-897 WD: 190mm EFL: 200mm		1.25X Lower Lens 89-898 WD: 155mm EFL: 160mm		1.43X Lower Lens 89-899 WD: 135mm EFL: 140mm		1.67 Lower Lens 89-900 WD: 110mm EFL: 120mm		2X Lower Lens 89-901 WD: 95mm EFL: 100mm		3X Lower Lens 89-902 WD: 50mm EFL: 67mm		4X Lower Lens 89-903 WD: 32mm EFL: 50mm		
Max FOV Dia.		156		125		94		63		50		44		38		31		21		16		
Max Coax FOV Dia.		NR		NR		NR		19		19		19		18		19		13		9.4		
1.5X MiniCT	FOV (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	Low Mag	High Mag	Low Mag	High Mag	Low Mag	High Mag	
		NA	0.0047	0.016	0.0059	0.019	0.0079	0.026	0.012	0.039	0.015	0.048	0.017	0.055	0.020	0.065	0.024	0.078	0.035	0.12	0.047	0.16
		Res (Ip/mm)	14	47	18	58	24	78	35	116	44	145	51	166	59	194	71	233	106	349	142	465
		Mag	0.25	1.7	0.32	2.2	0.42	2.9	0.63	4.4	0.79	5.4	0.90	6.2	1.1	7.3	1.3	8.7	1.9	13	2.5	17
		DOF (mm)	25	2.4	16	1.5	9.2	0.85	4.1	0.38	2.6	0.24	2.0	0.19	1.5	0.14	1.0	0.094	0.45	0.042	0.25	0.024
89-874	Cam Format	2/3"	26 x 35	3.8 x 5.1	21 x 28	3.0 x 4.0	16 x 21	2.3 x 3.0	10 x 14	1.5 x 2.0	8.4 x 11	1.2 x 1.6	7.3 x 10	1.1 x 1.4	6.3 x 8.4	0.91 x 1.2	5.2 x 7.0	0.76 x 1.0	3.5 x 4.7	0.51 x 0.67	2.6 x 3.5	0.38 x 0.51
		1"	38 x 51	5.5 x 7.4	30 x 41	4.4 x 5.9	23 x 30	3.3 x 4.4	15 x 20	2.2 x 2.9	12 x 16	1.8 x 2.4	11 x 14	1.5 x 2.1	9.1 x 12	1.3 x 1.8	7.6 x 10	1.1 x 1.5	5.1 x 6.8	0.74 x 0.98	3.8 x 5.1	0.55 x 0.74
		4/3"	54 x 71	7.8 x 10	43 x 57	6.2 x 8.3	32 x 43	4.7 x 6.2	21 x 29	3.1 x 4.1	17 x 23	2.5 x 3.3	15 x 20	2.2 x 2.9	13 x 17	1.9 x 2.5	11 x 14	1.6 x 2.1	7.1 x 9.5	1.0 x 1.4	5.4 x 7.1	0.78 x 1.0
		APS-C	66 x 100	10 x 14	53 x 80	7.7 x 12	40 x 60	5.8 x 8.7	27 x 40	3.8 x 5.8	21 x 32	3.1 x 4.6	19 x 28	2.7 x 4.0	16 x 24	2.3 x 3.5	13 x 20	1.9 x 2.9	8.8 x 13	1.3 x 1.9	6.6 x 10	0.96 x 1.4
		35mm (Full)	57 x 86	8.3 x 12	46 x 69	6.6 x 9.9	34 x 51	5.0 x 7.4	23 x 34	3.3 x 5.0	18 x 27	2.6 x 4.0	16 x 24	2.3 x 3.5	14 x 21	2.0 x 3.0	11 x 17	1.7 x 2.5	7.6 x 11	1.1 x 1.7	5.7 x 8.6	0.83 x 1.2
2X MiniCT	FOV (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	Low Mag	High Mag	Low Mag	High Mag	Low Mag	High Mag	
		NA	0.0047	0.016	0.0059	0.019	0.0079	0.026	0.012	0.039	0.015	0.048	0.017	0.055	0.020	0.065	0.024	0.078	0.035	0.12	0.047	0.16
		Res (Ip/mm)	14	47	18	58	24	78	35	116	44	145	51	166	59	194	71	233	106	349	142	465
		Mag	0.34	2.3	0.42	2.9	0.56	3.9	0.84	5.8	1.1	7.3	1.2	8.3	1.4	9.7	1.7	12	2.5	17	3.4	23
		DOF (mm)	25	2.4	16	1.5	9.2	0.85	4.1	0.38	2.6	0.24	2.0	0.19	1.5	0.14	1.0	0.094	0.45	0.042	0.25	0.024
89-875	Cam Format	2/3"	20 x 26	2.8 x 3.8	16 x 21	2.3 x 3.0	12 x 16	1.7 x 2.3	7.9 x 10	1.1 x 1.5	6.3 x 8.4	0.91 x 1.2	5.5 x 7.3	0.80 x 1.1	4.7 x 6.3	0.68 x 0.91	3.9 x 5.2	0.57 x 0.76	2.6 x 3.5	0.38 x 0.51	2.0 x 2.6	0.28 x 0.38
		1"	29 x 38	4.1 x 5.5	23 x 30	3.3 x 4.4	17 x 23	2.5 x 3.3	11 x 15	1.7 x 2.2	9.1 x 12	1.3 x 1.8	8.0 x 11	1.2 x 1.5	6.9 x 9.1	0.99 x 1.3	5.7 x 7.6	0.83 x 1.1	3.8 x 5.1	0.55 x 0.74	2.9 x 3.8	0.41 x 0.55
		4/3"	40 x 54	5.8 x 7.8	32 x 43	4.7 x 6.2	24 x 32	3.5 x 4.7	16 x 21	2.3 x 3.1	13 x 17	1.9 x 2.5	11 x 15	1.6 x 2.2	9.6 x 13	1.4 x 1.9	8.0 x 11	1.2 x 1.6	5.4 x 7.1	0.78 x 1.0	4.0 x 5.4	0.58 x 0.78
		APS-C	50 x 75	7.2 x 11	40 x 60	5.8 x 8.7	30 x 45	4.3 x 6.5	20 x 30	2.9 x 4.3	16 x 24	2.3 x 3.5	14 x 21	2.0 x 3.0	12 x 18	1.7 x 2.6	9.9 x 15	1.4 x 2.2	6.6 x 10	0.96 x 1.4	5.0 x 7.5	0.72 x 1.1
		35mm (Full)	57 x 86	8.3 x 12	46 x 69	6.6 x 9.9	34 x 51	5.0 x 7.4	23 x 34	3.3 x 5.0	18 x 27	2.6 x 4.0	16 x 24	2.3 x 3.5	14 x 21	2.0 x 3.0	11 x 17	1.7 x 2.5	7.6 x 11	1.1 x 1.7	5.7 x 8.6	0.83 x 1.2
2.5X MiniCT	FOV (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	Low Mag	High Mag	Low Mag	High Mag	Low Mag	High Mag	
		NA	0.0047	0.016	0.0059	0.019	0.0079	0.026	0.012	0.039	0.015	0.048	0.017	0.055	0.020	0.065	0.024	0.078	0.035	0.12	0.047	0.16
		Res (Ip/mm)	14	47	18	58	24	78	35	116	44	145	51	166	59	194	71	233	106	349	142	465
		Mag	0.42	2.9	0.53	3.6	0.70	4.8	1.1	7.3	1.3	9.1	1.5	10	1.8	12	2.1	15	3.1	22	4.2	29
		DOF (mm)	25	2.4	16	1.5	9.2	0.85	4.1	0.38	2.6	0.24	2.0	0.19	1.5	0.14	1.0	0.094	0.45	0.042	0.25	0.024
89-876	Cam Format	1"	23 x 30	3.3 x 4.4	18 x 24	2.6 x 3.5	14 x 18	2.0 x 2.6	9.1 x 12	1.3 x 1.8	7.3 x 9.8	1.1 x 1.4	6.4 x 8.5	0.93 x 1.2	5.5 x 7.3	0.79 x 1.1	4.6 x 6.1	0.66 x 0.88	3.0 x 4.1	0.44 x 0.59	2.3 x 3.0	0.33 x 0.44
		4/3"	32 x 43	4.7 x 6.2	26 x 34	3.7 x 5.0	19 x 26	2.8 x 3.7	13 x 17	1.9 x 2.5	10 x 14	1.5 x 2.0	9.0 x 12	1.3 x 1.7	7.7 x 10	1.1 x 1.5	6.4 x 8.6	0.93 x 1.2	4.3 x 5.7	0.62 x 0.83	3.2 x 4.3	0.47 x 0.62
		APS-C	40 x 60	5.8 x 8.7	32 x 48	4.6 x 6.9	24 x 36	3.5 x 5.2	16 x 24	2.3 x 3.5	13 x 19	1.8 x 2.8	11 x 17	1.6 x 2.4	9.5 x 14	1.4 x 2.1	8.0 x 12	1.2 x 1.7	5.3 x 8.0	0.77 x 1.2	4.0 x 6.0	0.58 x 0.87
		35mm (Full)	57 x 86	8.3 x 12	46 x 69	6.6 x 9.9	34 x 51	5.0 x 7.4	23 x 34	3.3 x 5.0	18 x 27	2.6 x 4.0	16 x 24	2.3 x 3.5	14 x 21	2.0 x 3.0	11 x 17	1.7 x 2.5	7.6 x 11	1.1 x 1.7	5.7 x 8.6	0.83 x 1.2
		35mm (Full)	57 x 86	8.3 x 12	46 x 69	6.6 x 9.9	34 x 51	5.0 x 7.4	23 x 34	3.3 x 5.0	18 x 27	2.6 x 4.0	16 x 24	2.3 x 3.5	14 x 21	2.0 x 3.0	11 x 17	1.7 x 2.5	7.6 x 11	1.1 x 1.7	5.7 x 8.6	0.83 x 1.2
3X MiniCT	FOV (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	Low Mag	High Mag	Low Mag	High Mag	Low Mag	High Mag	
		NA	0.0047	0.016	0.0059	0.019	0.0079	0.026	0.012	0.039	0.015	0.048	0.017	0.055	0.020	0.065	0.024	0.078	0.035	0.12	0.047	0.16
		Res (Ip/mm)	14	47	18	58	24	78	35	116	44	145	51	166	59	194	71	233	106	349	142	465
		Mag	0.50	3.5	0.63	4.4	0.84	5.8	1.3	8.7	1.6	11	1.8	12	2.1	15	2.5	17	3.8	26	5.0	35
		DOF (mm)	25	2.4	16	1.5	9.2	0.85	4.1	0.38	2.6	0.24	2.0	0.19	1.5	0.14	1.0	0.094	0.45	0.042	0.25	0.024
89-877	Cam Format	1"	19 x 25	2.8 x 3.7	15 x 20	2.2 x 2.9	11 x 15	1.7 x 2.2	7.6 x 10	1.1 x 1.5	6.1 x 8.1	0.88 x 1.2	5.3 x 7.1	0.77 x 1.0	4.6 x 6.1	0.66 x 0.88	3.8 x 5.1	0.55 x 0.74	2.5 x 3.4	0.37 x 0.49	1.9 x 2.5	0.28 x 0.37
		4/3"	27 x 36	3.9 x 5.2	21 x 29	3.1 x 4.1	16 x 21	2.3 x 3.1	11 x 14	1.6 x 2.1	8.6 x 11	1.2 x 1.7	7.5 x 10	1.1 x 1.4	6.4 x 8.6	0.93 x 1.2	5.4 x 7.1	0.78 x 1.0	3.6 x 4.8	0.52 x 0.69	2.7 x 3.6	0.39 x 0.52
		APS-C	33 x 50	4.8 x 7.2	27 x 40	3.8 x 5.8	20 x 30	2.9 x 4.3	13 x 20	1.9 x 2.9	11 x 16	1.5 x 2.3	9.3 x 14	1.3 x 2.0	8.0 x 12	1.2 x 1.7	6.6 x 10	0.96 x 1.4	4.4 x 6.6	0.64 x 0.96	3.3 x 5.0	0.48 x 0.72
		35mm (Full)	48 x 71	6.9 x 10	38 x 57	5.5 x 8.3	29 x 43	4.1 x 6.2	19 x 29	2.8 x 4.1	15 x 23	2.2 x 3.3	13 x 20	1.9 x 2.9	11 x 17	1.7 x 2.5	9.5 x 14	1.4 x 2.1	6.4 x 9.5	0.92 x 1.4	4.8 x 7.1	0.69 x 1.0
		35mm (Full)	48 x 71	6.9 x 10	38 x 57	5.5 x 8.3	29 x 43	4.1 x 6.2	19 x 29	2.8 x 4.1	15 x 23	2.2 x 3.3	13 x 20	1.9 x 2.9	11 x 17	1.7 x 2.5	9.5 x 14	1.4 x 2.1	6.4 x 9.5	0.92 x 1.4	4.8 x 7.1	0.69 x 1.0

NR -- Useable FOV Limited by Coax illumination (>50% Illumination)

NR -- FOV Limited by vignetting

NR = Not recommended for Coax illumination

	Height	x	Width	Diag.
2/3"	6.6	x	8.8	11
1"	9.6	x	12.8	16
4/3"	13.5	x	18	22.5
APS-C*	16.7	x	25.1	30
35mm (Full)	24	x	36	43.3

Appendix of Performance Data – 12:5:1 Zoom with Standard Camera Tubes

		0.4X Lower Lens 89-894 WD: 490mm EFL: 500mm		0.5X Lower Lens 89-895 WD: 390mm EFL: 400mm		0.67X Lower Lens 89-896 WD: 290mm EFL: 300mm		1X Lower Lens 89-897 WD: 190mm EFL: 200mm		1.25X Lower Lens 89-898 WD: 155mm EFL: 160mm		1.43X Lower Lens 89-899 WD: 135mm EFL: 140mm		1.67 Lower Lens 89-900 WD: 110mm EFL: 120mm		2X Lower Lens 89-901 WD: 95mm EFL: 100mm		3X Lower Lens 89-902 WD: 50mm EFL: 67mm		4X Lower Lens 89-903 WD: 32mm EFL: 50mm	
Max FOV Dia.		145		116		87		58		46		41		35		29		19		15	
Max Coax FOV Dia.		N R		NR		NR		20		19		19		17		13		13		9.9	
Camera Tube	EFL	Low Mag		High Mag		Low Mag		High Mag		Low Mag		High Mag		Low Mag		High Mag		Low Mag		High Mag	
		NA	Res (lp/mm)	Mag	DOF (mm)	NA	Res (lp/mm)	Mag	DOF (mm)	NA	Res (lp/mm)	Mag	DOF (mm)	NA	Res (lp/mm)	Mag	DOF (mm)	NA	Res (lp/mm)	Mag	DOF (mm)
		11	58	0.045	44	14	72	0.056	44	18	96	0.075	44	27	144	0.11	44	34	288	0.18	44
		0.0036	0.019	0.0045	0.024	0.0060	0.032	0.0090	0.048	0.011	0.060	0.013	0.069	0.015	0.080	0.018	0.096	0.027	0.14	0.036	0.19
89-867	1/3"	80 x 107	6.5 x 8.7	64 x 86	5.2 x 7.0	48 x 64	3.9 x 5.2	32 x 43	2.6 x 3.5	26 x 34	2.1 x 2.8	23 x 30	1.8 x 2.4	19 x 26	1.6 x 2.1	16 x 21	1.3 x 1.7	11 x 14	0.87 x 1.2	8.0 x 11	0.65 x 0.87
	1/2"	107 x 143	8.7 x 12	86 x 114	7.0 x 9.3	64 x 86	5.2 x 7.0	43 x 57	3.5 x 4.6	34 x 46	2.8 x 3.7	30 x 40	2.4 x 3.2	26 x 34	2.1 x 2.8	21 x 29	1.7 x 2.3	14 x 19	1.2 x 1.5	11 x 14	0.87 x 1.2
	2/3"	147 x 196	12 x 16	118 x 157	9.6 x 13	88 x 118	7.2 x 9.6	59 x 79	4.8 x 6.4	47 x 63	3.8 x 5.1	41 x 55	3.3 x 4.5	35 x 47	2.9 x 3.8	29 x 39	2.4 x 3.2	20 x 26	1.6 x 2.1	15 x 20	1.2 x 1.6
89-868	1/3"	64 x 86	5.2 x 7.0	51 x 69	4.2 x 5.6	39 x 51	3.1 x 4.2	26 x 34	2.1 x 2.8	21 x 27	1.7 x 2.2	18 x 24	1.5 x 1.9	15 x 21	1.3 x 1.7	13 x 17	1.0 x 1.4	8.6 x 11	0.70 x 0.9	6.4 x 8.6	0.52 x 0.70
	1/2"	86 x 114	7.0 x 9.3	69 x 91	5.6 x 7.4	51 x 69	4.2 x 5.6	34 x 46	2.8 x 3.7	27 x 37	2.2 x 3.0	24 x 32	1.9 x 2.6	21 x 27	1.7 x 2.2	17 x 23	1.4 x 1.9	11 x 15	0.9 x 1.2	8.6 x 11	0.70 x 0.93
	2/3"	118 x 157	9.6 x 13	94 x 126	7.7 x 10	71 x 94	5.7 x 7.7	47 x 63	3.8 x 5.1	38 x 50	3.1 x 4.1	33 x 44	2.7 x 3.6	28 x 38	2.3 x 3.1	24 x 31	1.9 x 2.6	16 x 21	1.3 x 1.7	12 x 16	0.96 x 1.3
89-869	1/3"	54 x 71	4.3 x 5.8	43 x 57	3.5 x 4.6	32 x 43	2.6 x 3.5	21 x 29	1.7 x 2.3	17 x 23	1.4 x 1.9	15 x 20	1.2 x 1.6	13 x 17	1.0 x 1.4	11 x 14	0.87 x 1.2	7.1 x 10	0.58 x 0.77	5.4 x 7.1	0.43 x 0.58
	1/2"	71 x 95	5.8 x 7.7	57 x 76	4.6 x 6.2	43 x 57	3.5 x 4.6	29 x 38	2.3 x 3.1	23 x 30	1.9 x 2.5	20 x 27	1.6 x 2.2	17 x 23	1.4 x 1.9	14 x 19	1.2 x 1.5	10 x 13	0.77 x 1.0	7.1 x 9.5	0.58 x 0.77
	2/3"	98 x 131	8.0 x 11	79 x 105	6.4 x 8.5	59 x 79	4.8 x 6.4	39 x 52	3.2 x 4.3	31 x 42	2.6 x 3.4	28 x 37	2.2 x 3.0	24 x 31	1.9 x 2.6	20 x 26	1.6 x 2.1	13 x 17	1.1 x 1.4	9.8 x 13	0.80 x 1.1
89-870	1/3"	40 x 54	3.3 x 4.3	32 x 43	2.6 x 3.5	24 x 32	2.0 x 2.6	16 x 21	1.3 x 1.7	13 x 17	1.0 x 1.4	11 x 15	0.91 x 1.2	9.6 x 13	0.78 x 1.0	8.0 x 11	0.65 x 0.87	5.4 x 7.1	0.44 x 0.58	4.0 x 5.4	0.33 x 0.43
	1/2"	54 x 71	4.3 x 5.8	43 x 57	3.5 x 4.6	32 x 43	2.6 x 3.5	21 x 29	1.7 x 2.3	17 x 23	1.4 x 1.9	15 x 20	1.2 x 1.6	13 x 17	1.0 x 1.4	11 x 14	0.87 x 1.2	7.1 x 10	0.58 x 0.77	5.4 x 7.1	0.43 x 0.58
	2/3"	74 x 98	6.0 x 8.0	59 x 79	4.8 x 6.4	44 x 59	3.6 x 4.8	29 x 39	2.4 x 3.2	24 x 31	1.9 x 2.6	21 x 28	1.7 x 2.2	18 x 24	1.4 x 1.9	15 x 20	1.2 x 1.6	10 x 13	0.80 x 1.1	7.4 x 9.8	0.60 x 0.80
89-871	1/3"	32 x 43	2.6 x 3.5	26 x 34	2.1 x 2.8	19 x 26	1.6 x 2.1	13 x 17	1.0 x 1.4	10 x 14	0.83 x 1.1	9.0 x 12	0.73 x 0.97	7.7 x 10	0.63 x 0.83	6.4 x 8.6	0.52 x 0.70	4.3 x 5.7	0.35 x 0.46	3.2 x 4.3	0.26 x 0.35
	1/2"	43 x 57	3.5 x 4.6	34 x 46	2.8 x 3.7	26 x 34	2.1 x 2.8	17 x 23	1.4 x 1.9	14 x 18	1.1 x 1.5	12 x 16	0.97 x 1.3	10 x 14	0.83 x 1.1	8.6 x 11	0.70 x 0.93	5.7 x 7.6	0.46 x 0.62	4.3 x 5.7	0.35 x 0.46
	2/3"	59 x 79	4.8 x 6.4	47 x 63	3.8 x 5.1	35 x 47	2.9 x 3.8	24 x 31	1.9 x 2.6	19 x 25	1.5 x 2.0	17 x 22	1.3 x 1.8	14 x 19	1.1 x 1.5	12 x 16	0.96 x 1.3	7.9 x 10	0.64 x 0.85	5.9 x 7.9	0.48 x 0.64

— Useable FOV Limited by Coax illumination (>50% Illumination)

— FOV Limited by vignetting

NR = Not recommended for Coax illumination

Appendix of Performance Data – 12:5:1 Zoom with Mini Camera Tube

		0.4X Lower Lens		0.5X Lower Lens		0.67X Lower Lens		1X Lower Lens		1.25X Lower Lens		1.43X Lower Lens		1.67 Lower Lens		2X Lower Lens		3X Lower Lens		4X Lower Lens		
		89-894 WD: 490mm EFL: 500mm		89-895 WD: 390mm EFL: 400mm		89-896 WD: 290mm EFL: 300mm		89-897 WD: 190mm EFL: 200mm		89-898 WD: 155mm EFL: 160mm		89-899 WD: 135mm EFL: 140mm		89-900 WD: 110mm EFL: 120mm		89-901 WD: 95mm EFL:100mm		89-902 WD: 50mm EFL: 67mm		89-903 WD: 32mm EFL: 50mm		
Max FOV Dia.		145		116		87		58		46		41		35		29		19		15		
Max Coax FOV Dia.		NR		NR		NR		20		19		19		17		20		13		9.9		
		Low Mag		High Mag		Low Mag		High Mag		Low Mag		High Mag		Low Mag		High Mag		Low Mag		High Mag		
1.5X MiniCT	FOV (mm)	NA	0.0036	0.019	0.0045	0.024	0.0060	0.032	0.0090	0.048	0.011	0.060	0.013	0.069	0.015	0.080	0.018	0.096	0.027	0.14	0.036	0.19
		Res (lp/mm)	11	58	14	72	18	96	27	144	34	180	39	206	45	240	54	288	81	432	108	576
		Mag	0.17	2.1	0.21	2.6	0.28	3.5	0.42	5.2	0.53	6.5	0.60	7.4	0.70	8.6	0.84	10	1.3	16	1.7	21
		DOF (mm)	44	1.5	28	0.98	16	0.55	7.0	0.25	4.5	0.16	3.4	0.12	2.5	0.089	1.8	0.062	0.78	0.027	0.44	0.015
		2/3"	39 x 52	3.2 x 4.3	31 x 42	2.6 x 3.4	24 x 31	1.9 x 2.6	16 x 21	1.3 x 1.7	13 x 17	1.0 x 1.4	11 x 15	0.89 x 1.2	9.4 x 13	0.77 x 1.0	7.9 x 10	0.64 x 0.85	5.2 x 7.0	0.43 x 0.57	3.9 x 5.2	0.32 x 0.43
		1"	57 x 76	4.6 x 6.2	46 x 61	3.7 x 4.9	34 x 46	2.8 x 3.7	23 x 30	1.9 x 2.5	18 x 24	1.5 x 2.0	16 x 21	1.3 x 1.7	14 x 18	1.1 x 1.5	11 x 15	0.93 x 1.2	7.6 x 10	0.62 x 0.82	5.7 x 7.6	0.46 x 0.62
89-874	Cam Format	4/3"	80 x 107	6.5 x 8.7	64 x 86	5.2 x 7.0	48 x 64	3.9 x 5.2	32 x 43	2.6 x 3.5	26 x 34	2.1 x 2.8	23 x 30	1.8 x 2.4	19 x 26	1.6 x 2.1	16 x 21	1.3 x 1.7	11 x 14	0.87 x 1.2	8.0 x 11	0.65 x 0.87
		APS-C	99 x 149	8.1 x 12	80 x 120	6.5 x 9.7	60 x 90	4.8 x 7.3	40 x 60	3.2 x 4.9	32 x 48	2.6 x 3.9	28 x 42	2.3 x 3.4	24 x 36	1.9 x 2.9	20 x 30	1.6 x 2.4	13 x 20	1.1 x 1.6	9.9 x 15	0.81 x 1.2
2X MiniCT	FOV (mm)	NA	0.0036	0.019	0.0045	0.024	0.0060	0.032	0.0090	0.048	0.011	0.060	0.013	0.069	0.015	0.080	0.018	0.096	0.027	0.14	0.036	0.19
		Res (lp/mm)	11	58	14	72	18	96	27	144	34	180	39	206	45	240	54	288	81	432	108	576
		Mag	0.22	2.8	0.28	3.5	0.37	4.6	0.56	6.9	0.70	8.6	0.80	9.9	0.93	12	1.1	14	1.7	21	2.2	28
		DOF (m m)	44	1.5	28	0.98	16	0.55	7.0	0.25	4.5	0.16	3.4	0.12	2.5	0.089	1.8	0.062	0.78	0.027	0.44	0.015
		2/3"	29 x 39	2.4 x 3.2	24 x 31	1.9 x 2.6	18 x 24	1.4 x 1.9	12 x 16	0.96 x 1.3	9.4 x 13	0.77 x 1.0	8.3 x 11	0.67 x 0.89	7.1 x 9.4	0.57 x 0.77	5.9 x 7.9	0.48 x 0.64	3.9 x 5.2	0.32 x 0.43	2.9 x 3.9	0.24 x 0.32
		1"	43 x 57	3.5 x 4.6	34 x 46	2.8 x 3.7	26 x 34	2.1 x 2.8	17 x 23	1.4 x 1.9	14 x 18	1.1 x 1.5	12 x 16	0.97 x 1.3	10 x 14	0.83 x 1.1	8.6 x 11	0.70 x 0.93	5.7 x 7.6	0.46 x 0.62	4.3 x 5.7	0.35 x 0.46
89-875	Cam Format	4/3"	60 x 80	4.9 x 6.5	48 x 64	3.9 x 5.2	36 x 48	2.9 x 3.9	24 x 32	2.0 x 2.6	19 x 26	1.6 x 2.1	17 x 23	1.4 x 1.8	14 x 19	1.2 x 1.6	12 x 16	0.98 x 1.3	8.0 x 11	0.65 x 0.87	6.0 x 8.0	0.49 x 0.65
		APS-C	75 x 112	6.1 x 9.1	60 x 90	4.8 x 7.3	45 x 67	3.6 x 5.5	30 x 45	2.4 x 3.6	24 x 36	1.9 x 2.9	21 x 31	1.7 x 2.5	18 x 27	1.5 x 2.2	15 x 22	1.2 x 1.8	9.9 x 15	0.81 x 1.2	7.5 x 11	0.61 x 0.91
2.5X MiniCT	FOV (mm)	NA	0.0036	0.019	0.0045	0.024	0.0060	0.032	0.0090	0.048	0.011	0.060	0.013	0.069	0.015	0.080	0.018	0.096	0.027	0.14	0.036	0.19
		Res (lp/mm)	11	58	14	72	18	96	27	144	34	180	39	206	45	240	54	288	81	432	108	576
		Mag	0.28	3.5	0.35	4.3	0.47	5.8	0.70	8.6	0.88	11	1.0	12	1.2	14	1.4	17	2.1	26	2.8	35
		DOF (mm)	44	1.5	28	0.98	16	0.55	7.0	0.25	4.5	0.16	3.4	0.12	2.5	0.09	1.8	0.062	0.78	0.027	0.44	0.015
		1"	34 x 46	2.8 x 3.7	27 x 37	2.2 x 3.0	21 x 27	1.7 x 2.2	14 x 18	1.1 x 1.5	11 x 15	0.89 x 1.2	9.6 x 13	0.78 x 1.0	8.2 x 11	0.67 x 0.89	6.9 x 9.1	0.56 x 0.74	4.6 x 6.1	0.37 x 0.49	3.4 x 4.6	0.28 x 0.37
		4/3"	48 x 64	3.9 x 5.2	39 x 51	3.1 x 4.2	29 x 39	2.3 x 3.1	19 x 26	1.6 x 2.1	15 x 21	1.3 x 1.7	14 x 18	1.1 x 1.5	12 x 15	0.94 x 1.3	9.6 x 13	0.78 x 1.0	6.4 x 8.6	0.52 x 0.70	4.8 x 6.4	0.39 x 0.52
89-876	Cam Format	APS-C	60 x 90	4.8 x 7.3	48 x 72	3.9 x 5.8	36 x 54	2.9 x 4.4	24 x 36	1.9 x 2.9	19 x 29	1.5 x 2.3	17 x 25	1.4 x 2.0	14 x 22	1.2 x 1.7	12 x 18	0.97 x 1.5	8.0 x 12	0.65 x 0.97	6.0 x 9.0	0.48 x 0.73
		35mm(Full)	86 x 129	7.0 x 10	69 x 103	5.6 x 8.3	51 x 77	4.2 x 6.3	34 x 51	2.8 x 4.2	27 x 41	2.2 x 3.3	24 x 36	1.9 x 2.9	21 x 31	1.7 x 2.5	17 x 26	1.4 x 2.1	11 x 17	0.93 x 1.4	8.6 x 13	0.70 x 1.0
3X MiniCT	FOV (mm)	NA	0.0036	0.019	0.0045	0.024	0.0060	0.032	0.0090	0.048	0.011	0.060	0.013	0.069	0.015	0.080	0.018	0.096	0.027	0.14	0.036	0.19
		Res (lp/mm)	11	58	14	72	18	96	27	144	34	180	39	206	45	240	54	288	81	432	108	576
		Mag	0.34	4.1	0.42	5.2	0.56	6.9	0.84	10	1.1	13	1.2	15	1.4	17	1.7	21	2.5	31	3.4	41
		DOF (mm)	44	1.5	28	0.98	16	0.55	7.0	0.25	4.5	0.16	3.4	0.12	2.5	0.089	1.8	0.062	0.78	0.027	0.44	0.015
		1"	29 x 38	2.3 x 3.1	23 x 30	1.9 x 2.5	17 x 23	1.4 x 1.9	11 x 15	0.93 x 1.2	9.1 x 12	0.74 x 0.99	8.0 x 11	0.65 x 0.87	6.9 x 9.1	0.56 x 0.74	5.7 x 7.6	0.46 x 0.62	3.8 x 5.1	0.31 x 0.41	2.9 x 3.8	0.23 x 0.31
		4/3"	40 x 54	3.3 x 4.3	32 x 43	2.6 x 3.5	24 x 32	2.0 x 2.6	16 x 21	1.3 x 1.7	13 x 17	1.0 x 1.4	11 x 15	0.91 x 1.2	9.6 x 13	0.78 x 1.0	8.0 x 11	0.65 x 0.87	5.4 x 7.1	0.44 x 0.58	4.0 x 5.4	0.33 x 0.43
89-877	Cam Format	APS-C	50 x 75	4.0 x 6.1	40 x 60	3.2 x 4.9	30 x 45	2.4 x 3.6	20 x 30	1.6 x 2.4	16 x 24	1.3 x 1.9	14 x 21	1.1 x 1.7	12 x 18	0.97 x 1.5	9.9 x 15	0.81 x 1.2	6.6 x 10	0.54 x 0.81	5.0 x 7.5	0.40 x 0.61
		35mm(Full)	71 x 107	5.8 x 8.7	57 x 86	4.6 x 7.0	43 x 64	3.5 x 5.2	29 x 43	2.3 x 3.5	23 x 34	1.9 x 2.8	20 x 30	1.6 x 1.4	17 x 26	1.4 x 2.1	14 x 21	1.2 x 1.7	9.5 x 14	0.77 x 1.2	7.1 x 11	0.58 x 0.91