

Lens Charts

This paper offers information useful for selecting a microvideo or C-mount lens for the iVu series vision sensor.

Working Distance and Field of View

The two main variables involved when discussing a camera's lens choice are the **Working Distance** and the **Field of View** size. The Working Distance, or WD, is the distance from the camera to the target object. In the case of this collection of lens charts, the Working Distance is measured from the front surface of the focusing window (for microvideo lens models) or the end of the black PBT sensor housing (for C-mount lens models). The distance is not measured from the end of the lens because different lenses from different manufacturers, even with the same focal length, can vary in length. Because there are two choices for length, WD is not measured from the end of the C-mount lens cover.

The Field of View, or FOV, is the real-world size of the picture the camera takes. This can also be broken down into a horizontal FOV size and a vertical FOV size. Note that the picture taken by an iVu vision sensor is not square. The imager used in the iVu sensor is 752×480 pixels, making a rectangular image where the vertical FOV is about 64% the size of the horizontal FOV.

The Working Distance and Field of View sizes are related by linear equations determined by the focal length of the lens. Choosing the correct lens for a given application might be a matter of selecting the desired size of the FOV, then seeing which of the options for focal length result in a good fit for camera Working Distance. The situation might also be reversed, where the desired mounting location of the camera is known (and thus the Working Distance is fixed) and the various focal length lenses give a range of FOV sizes to choose from. In all cases, only one of these two variables may be freely selected. The second variable then becomes a function of the first. This is the reason why we offer a broad range of lens focal lengths—to provide as many options as possible to suit different WD/FOV size requirements.

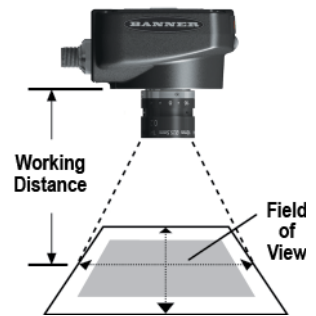


Figure 1 C-Mount Lens

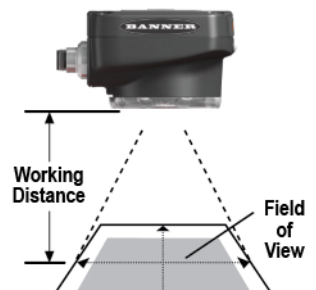


Figure 2 Microvideo Lens

Multiple Manufacturers and Format Size

Banner does not manufacture any microvideo or C-mount lenses used by our vision sensors. Instead we offer a range of lenses from different suppliers.

Imager Resolution: 752 px (H) \times 480 px (V)
Pixel Size: 6.0 μ m \times 6.0 μ m
Image Size: 4.51 mm (H) \times 2.88 mm (V), 5.35 mm

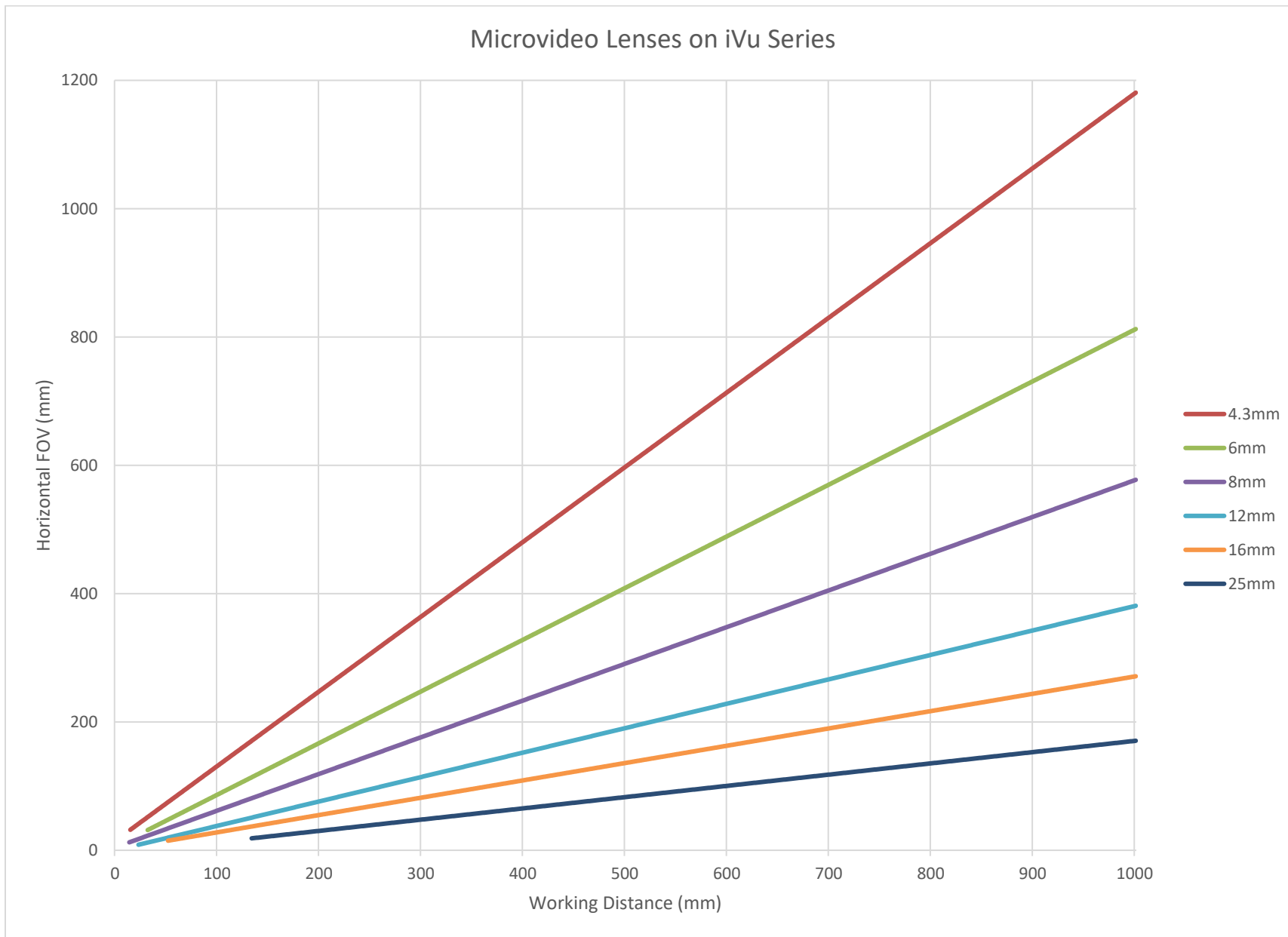
Off the Charts

In the pages that follow, graphical views of the Working Distance versus Horizontal FOV relationships are shown, out to a maximum working distance of 1 meter. These graphs offer a quick and easy way to estimate the FOV size for a given Working Distance and lens focal length. Also provided are two tables

with entries out to 1.5 meters. The first shows FOV size as a function of Working Distance and the second shows Working Distance as a function of FOV size. The mathematical equations that describe the relationship between these two variables are also provided, allowing for calculations beyond what the chart and tables offer.

Each lens has a natural minimum Working Distance. If a camera using this lens were to move closer to the target than this minimum distance, the image would be out of focus and the lens alone would not be able to fix it. This is where extension tubes and shims are used. Extension tubes allow a lens to come into focus at a Working Distance closer than the minimum. The relationship between Working Distance and FOV size remains in effect as extension tubes are added, and so extension tubes are usually used to generate very small FOVs. A microscope is basically a high focal length lens with a large amount of extension tubes applied.

Microvideo Lenses on iVu Series



Microvideo Lenses on iVu Series, FOV as a function of WD Chart

WD (mm)	FOV (mm)					
	4.3mm	6mm	8mm	12mm	16mm	25mm
Minimum	32 x 20 @ 14mm	32 x 20 @ 31mm	12 x 8 @ 13mm	8 x 5 @ 22mm	15 x 10 @ 51mm	19 x 12 @ 133mm
20	39 x 25		16 x 10	8 x 5		
40	62 x 40	39 x 25	28 x 18	15 x 10		
60	86 x 55	55 x 35	39 x 25	23 x 15	17 x 11	
80	109 x 69	71 x 45	51 x 32	31 x 20	23 x 15	
100	132 x 84	87 x 56	62 x 40	38 x 24	28 x 18	
120	155 x 99	103 x 66	74 x 47	46 x 29	34 x 21	
140	179 x 114	119 x 76	85 x 54	54 x 34	39 x 25	20 x 13
160	202 x 129	135 x 86	97 x 62	61 x 39	44 x 28	23 x 15
180	225 x 144	152 x 97	108 x 69	69 x 44	50 x 32	27 x 17
200	249 x 159	168 x 107	119 x 76	76 x 49	55 x 35	30 x 19
220	272 x 174	184 x 117	131 x 84	84 x 54	61 x 39	34 x 22
240	295 x 188	200 x 128	142 x 91	92 x 58	66 x 42	37 x 24
260	319 x 203	216 x 138	154 x 98	99 x 63	71 x 46	41 x 26
280	342 x 218	232 x 148	165 x 105	107 x 68	77 x 49	44 x 28
300	365 x 233	248 x 158	177 x 113	114 x 73	82 x 52	48 x 31
320	388 x 248	264 x 169	188 x 120	122 x 78	88 x 56	51 x 33
340	412 x 263	281 x 179	200 x 127	130 x 83	93 x 59	55 x 35
360	435 x 278	297 x 189	211 x 135	137 x 88	98 x 63	58 x 37
380	458 x 293	313 x 200	222 x 142	145 x 93	104 x 66	62 x 40
400	482 x 307	329 x 210	234 x 149	153 x 97	109 x 70	65 x 42
420	505 x 322	345 x 220	245 x 157	160 x 102	115 x 73	69 x 44
440	528 x 337	361 x 231	257 x 164	168 x 107	120 x 77	72 x 46
460	552 x 352	377 x 241	268 x 171	175 x 112	125 x 80	76 x 48
480	575 x 367	393 x 251	280 x 179	183 x 117	131 x 83	79 x 51
500	598 x 382	409 x 261	291 x 186	191 x 122	136 x 87	83 x 53
520	622 x 397	426 x 272	303 x 193	198 x 127	142 x 90	86 x 55
540	645 x 412	442 x 282	314 x 200	206 x 131	147 x 94	90 x 57
560	668 x 426	458 x 292	326 x 208	214 x 136	152 x 97	94 x 60
580	691 x 441	474 x 303	337 x 215	221 x 141	158 x 101	97 x 62
600	715 x 456	490 x 313	348 x 222	229 x 146	163 x 104	101 x 64
620	738 x 471	506 x 323	360 x 230	236 x 151	169 x 108	104 x 66
640	761 x 486	522 x 333	371 x 237	244 x 156	174 x 111	108 x 69
660	785 x 501	538 x 344	383 x 244	252 x 161	179 x 114	111 x 71
680	808 x 516	555 x 354	394 x 252	259 x 165	185 x 118	115 x 73
700	831 x 531	571 x 364	406 x 259	267 x 170	190 x 121	118 x 75
720	855 x 545	587 x 375	417 x 266	274 x 175	196 x 125	122 x 78
740	878 x 560	603 x 385	429 x 274	282 x 180	201 x 128	125 x 80
760	901 x 575	619 x 395	440 x 281	290 x 185	206 x 132	129 x 82
780	924 x 590	635 x 405	451 x 288	297 x 190	212 x 135	132 x 84
800	948 x 605	651 x 416	463 x 295	305 x 195	217 x 139	136 x 87
820	971 x 620	667 x 426	474 x 303	313 x 199	223 x 142	139 x 89
840	994 x 635	683 x 436	486 x 310	320 x 204	228 x 146	143 x 91
860	1018 x 650	700 x 447	497 x 317	328 x 209	233 x 149	146 x 93
880	1041 x 664	716 x 457	509 x 325	335 x 214	239 x 152	150 x 96
900	1064 x 679	732 x 467	520 x 332	343 x 219	244 x 156	153 x 98
920	1088 x 694	748 x 477	532 x 339	351 x 224	250 x 159	157 x 100
940	1111 x 709	764 x 488	543 x 347	358 x 229	255 x 163	160 x 102
960	1134 x 724	780 x 498	554 x 354	366 x 234	260 x 166	164 x 104
980	1158 x 739	796 x 508	566 x 361	373 x 238	266 x 170	167 x 107
1000	1181 x 754	812 x 519	577 x 369	381 x 243	271 x 173	171 x 109
1020	1204 x 769	828 x 529	589 x 376	389 x 248	277 x 177	174 x 111
1040	1227 x 783	845 x 539	600 x 383	396 x 253	282 x 180	178 x 113
1060	1251 x 798	861 x 549	612 x 390	404 x 258	287 x 183	181 x 116
1080	1274 x 813	877 x 560	623 x 398	412 x 263	293 x 187	185 x 118
1100	1297 x 828	893 x 570	635 x 405	419 x 268	298 x 190	188 x 120
1120	1321 x 843	909 x 580	646 x 412	427 x 272	304 x 194	192 x 122
1140	1344 x 858	925 x 591	658 x 420	434 x 277	309 x 197	195 x 125
1160	1367 x 873	941 x 601	669 x 427	442 x 282	314 x 201	199 x 127
1180	1391 x 888	957 x 611	680 x 434	450 x 287	320 x 204	202 x 129
1200	1414 x 902	974 x 621	692 x 442	457 x 292	325 x 208	206 x 131
1220	1437 x 917	990 x 632	703 x 449	465 x 297	331 x 211	209 x 134
1240	1460 x 932	1006 x 642	715 x 456	472 x 302	336 x 214	213 x 136
1260	1484 x 947	1022 x 652	726 x 464	480 x 306	341 x 218	216 x 138
1280	1507 x 962	1038 x 663	738 x 471	488 x 311	347 x 221	220 x 140
1300	1530 x 977	1054 x 673	749 x 478	495 x 316	352 x 225	223 x 143
1320	1554 x 992	1070 x 683	761 x 485	503 x 321	358 x 228	227 x 145
1340	1577 x 1007	1086 x 693	772 x 493	511 x 326	363 x 232	230 x 147
1360	1600 x 1021	1102 x 704	783 x 500	518 x 331	368 x 235	234 x 149
1380	1624 x 1036	1119 x 714	795 x 507	526 x 336	374 x 239	237 x 151
1400	1647 x 1051	1135 x 724	806 x 515	533 x 340	379 x 242	241 x 154
1420	1670 x 1066	1151 x 735	818 x 522	541 x 345	385 x 245	244 x 156
1440	1693 x 1081	1167 x 745	829 x 529	549 x 350	390 x 249	248 x 158
1460	1717 x 1096	1183 x 755	841 x 537	556 x 355	395 x 252	251 x 160
1480	1740 x 1111	1199 x 765	852 x 544	564 x 360	401 x 256	255 x 163
1500	1763 x 1126	1215 x 776	864 x 551	571 x 365	406 x 259	258 x 165

Microvideo Lenses on iVu Series, WD as a function of FOV Chart

		WD (mm)					
FOV (mm)		4.3mm	6mm	8mm	12mm	16mm	25mm
Minimum		32 x 20 @ 14mm	32 x 20 @ 31mm	12 x 8 @ 13mm	8 x 5 @ 22mm	15 x 10 @ 51mm	19 x 12 @ 133mm
20 x 15				26	52	70	141
40 x 30		21	48	61	104	144	255
60 x 45		38	72	96	157	218	369
80 x 60		55	95	131	209	292	483
100 x 75		72	119	166	262	366	597
120 x 90		90	143	201	314	440	711
140 x 105		107	166	236	367	514	825
160 x 120		124	190	271	419	588	939
180 x 135		141	214	306	472	662	1053
200 x 150		158	237	341	525	736	1167
220 x 165		175	261	376	577	810	1281
240 x 180		193	285	411	630	885	1395
260 x 195		210	308	446	682	959	1509
280 x 210		227	332	480	735	1033	1623
300 x 225		244	356	515	787	1107	1737
320 x 240		261	380	550	840	1181	1851
340 x 255		278	403	585	892	1255	1965
360 x 270		296	427	620	945	1329	2079
380 x 285		313	451	655	997	1403	2193
400 x 300		330	474	690	1050	1477	2307
420 x 315		347	498	725	1102	1551	2421
440 x 330		364	522	760	1155	1625	2535
460 x 345		381	545	795	1207	1699	2649
480 x 360		399	569	830	1260	1773	2763
500 x 375		416	593	865	1312	1847	2877
520 x 390		433	616	900	1365	1922	2991
540 x 405		450	640	935	1417	1996	3106
560 x 420		467	664	970	1470	2070	3220
580 x 435		484	687	1005	1522	2144	3334
600 x 450		502	711	1040	1575	2218	3448
620 x 465		519	735	1074	1627	2292	3562
640 x 480		536	759	1109	1680	2366	3676
660 x 495		553	782	1144	1733	2440	3790
680 x 510		570	806	1179	1785	2514	3904
700 x 525		587	830	1214	1838	2588	4018
720 x 540		605	853	1249	1890	2662	4132
740 x 555		622	877	1284	1943	2736	4246
760 x 570		639	901	1319	1995	2810	4360
780 x 585		656	924	1354	2048	2885	4474
800 x 600		673	948	1389	2100	2959	4588
820 x 615		690	972	1424	2153	3033	4702
840 x 630		708	995	1459	2205	3107	4816
860 x 645		725	1019	1494	2258	3181	4930
880 x 660		742	1043	1529	2310	3255	5044
900 x 675		759	1066	1564	2363	3329	5158
920 x 690		776	1090	1599	2415	3403	5272
940 x 705		793	1114	1634	2468	3477	5386
960 x 720		810	1137	1668	2520	3551	5500
980 x 735		828	1161	1703	2573	3625	5614
1000 x 750		845	1185	1738	2625	3699	5728
1020 x 765		862	1209	1773	2678	3773	5842
1040 x 780		879	1232	1808	2730	3847	5956
1060 x 795		896	1256	1843	2783	3922	6070
1080 x 810		913	1280	1878	2835	3996	6184
1100 x 825		931	1303	1913	2888	4070	6298
1120 x 840		948	1327	1948	2941	4144	6412
1140 x 855		965	1351	1983	2993	4218	6526
1160 x 870		982	1374	2018	3046	4292	6640
1180 x 885		999	1398	2053	3098	4366	6754
1200 x 900		1016	1422	2088	3151	4440	6868
1220 x 915		1034	1445	2123	3203	4514	6982
1240 x 930		1051	1469	2158	3256	4588	7096
1260 x 945		1068	1493	2193	3308	4662	7210
1280 x 960		1085	1516	2228	3361	4736	7324
1300 x 975		1102	1540	2262	3413	4810	7438
1320 x 990		1119	1564	2297	3466	4885	7553
1340 x 1005		1137	1587	2332	3518	4959	7667
1360 x 1020		1154	1611	2367	3571	5033	7781
1380 x 1035		1171	1635	2402	3623	5107	7895
1400 x 1050		1188	1659	2437	3676	5181	8009
1420 x 1065		1205	1682	2472	3728	5255	8123
1440 x 1080		1222	1706	2507	3781	5329	8237
1460 x 1095		1240	1730	2542	3833	5403	8351
1480 x 1110		1257	1753	2577	3886	5477	8465
1500 x 1125		1274	1777	2612	3938	5551	8579

Microvideo Lens equations for iVu Series

H = horizontal FOV size, W = working distance



4.3mm lens

Banner model: LMF04 (p/n 10853)

ML Optics model: ML-4.3E

1/3-inch format, fixed iris f/2.6

H(W), mm

$H = 1.165 \times W + 15.61$ (minimum W ~ 14mm)

W(H), mm

$W = (H - 15.61)/1.165$ (minimum H ~ 32mm)



6 mm lens

Banner model: LMF06 (p/n 10854)

ML Optics model: ML-6020

1/3-inch format, fixed iris f/1.8

H(W), mm

$H = 0.806 \times W + 6.57$ (minimum W ~ 13mm)

W(H), mm

$W = (H - 6.57)/0.806$ (minimum H ~ 7mm)



8 mm lens

Banner model: LMF08 (p/n 80943)

ML Optics model: ML-8020

1/3-inch format, fixed iris f/2.0

H(W), mm

$H = 0.572 \times W + 4.98$ (minimum W ~ 13mm)

W(H), mm

$W = (H - 4.98)/0.572$ (minimum H ~ 12mm)



12 mm lens

Banner model: LMF12 (p/n 80944)

ML Optics model: ML-12020

1/3-inch format, fixed iris f/2.0

H(W), mm

$H = 0.381 \times W + 0.258$ (minimum W ~ 22mm)

W(H), mm

$W = (H - 0.258)/0.381$ (minimum H ~ 8mm)



16 mm lens

Banner model: LMF16 (p/n 80945)

Evetar model: E3057Q

1/3-inch format, fixed iris f/1.8

H(W), mm

$H = 0.27 \times W + 1.18$ (minimum $W \sim 51\text{mm}$)

W(H), mm

$W = (H - 1.18)/0.27$ (minimum $H \sim 15\text{mm}$)



25 mm lens

Banner model: LMF25 (p/n 80951)

Fuzhou Senview Photoelectric model: TN2502B

1/3-inch format, fixed iris f/2.0

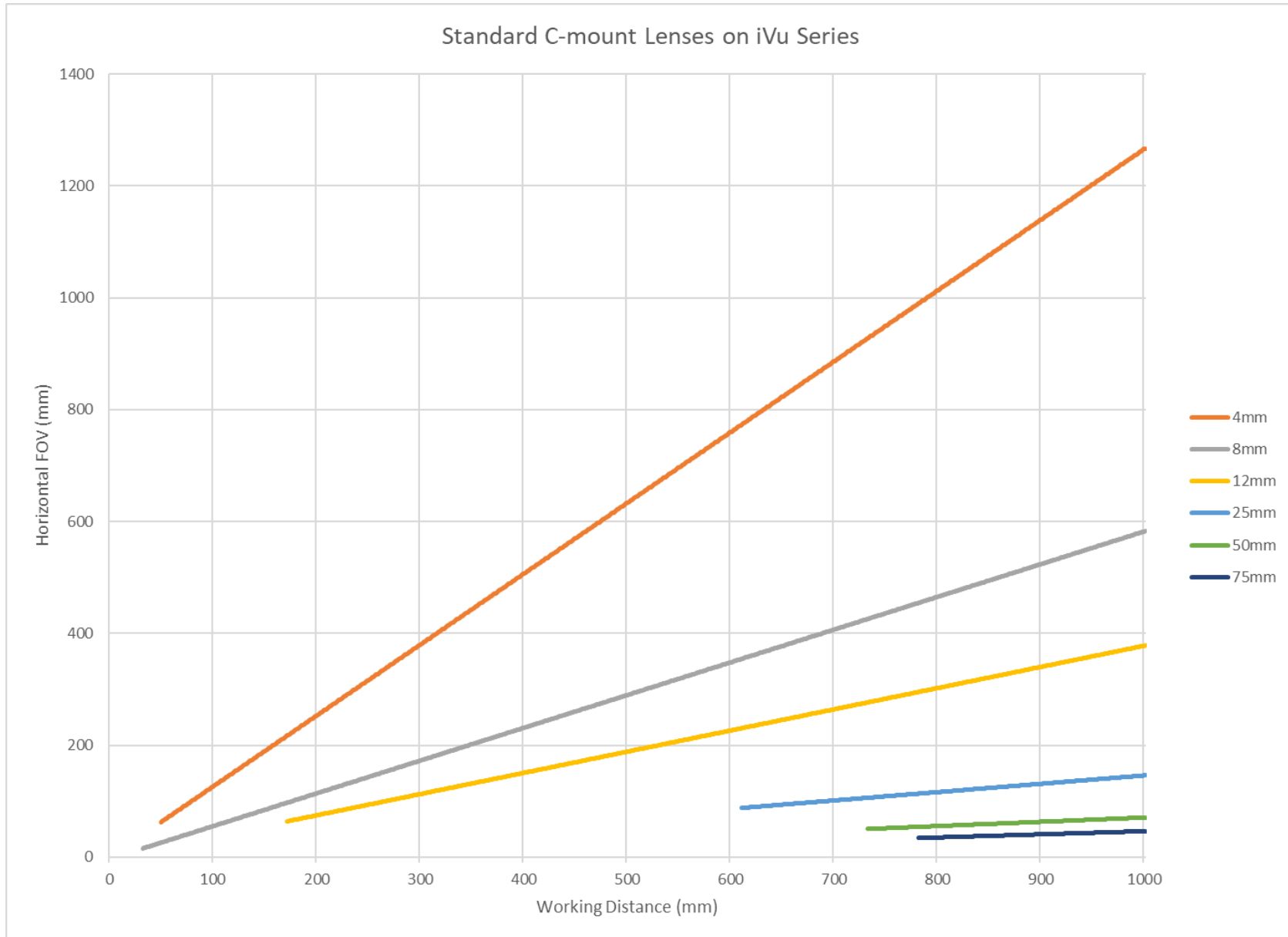
H(W), mm

$H = 0.175 \times W - 4.71$ (minimum $W \sim 133\text{mm}$)

W(H), mm

$W = (H + 4.71)/0.175$ (minimum $H \sim 19\text{mm}$)

Standard Resolution C-mount Lenses on iVu Series



Standard C-mount Lenses on iVu Series, FOV as a function of WD Chart

WD (mm)	FOV (mm)					
	4mm	8mm	12mm	25mm	50mm	75mm
Minimum	63 x 40 @ 49mm	15 x 10 @ 31mm	64 x 41 @ 171mm	88 x 56 @ 610mm	50 x 32 @ 732mm	34 x 22 @ 781mm
20						
40		21 x 13				
60	77 x 49	32 x 21				
80	102 x 65	44 x 28				
100	127 x 81	56 x 36				
120	153 x 98	68 x 43				
140	178 x 114	79 x 51				
160	203 x 130	91 x 58				
180	229 x 146	103 x 66	67 x 43			
200	254 x 162	114 x 73	75 x 48			
220	279 x 178	126 x 80	83 x 53			
240	305 x 195	138 x 88	90 x 58			
260	330 x 211	149 x 95	98 x 62			
280	355 x 227	161 x 103	105 x 67			
300	381 x 243	173 x 110	113 x 72			
320	406 x 259	185 x 118	120 x 77			
340	431 x 275	196 x 125	128 x 82			
360	457 x 292	208 x 133	136 x 87			
380	482 x 308	220 x 140	143 x 91			
400	507 x 324	231 x 148	151 x 96			
420	533 x 340	243 x 155	158 x 101			
440	558 x 356	255 x 163	166 x 106			
460	583 x 372	267 x 170	174 x 111			
480	609 x 389	278 x 178	181 x 116			
500	634 x 405	290 x 185	189 x 120			
520	659 x 421	302 x 193	196 x 125			
540	685 x 437	313 x 200	204 x 130			
560	710 x 453	325 x 208	211 x 135			
580	735 x 469	337 x 215	219 x 140			
600	761 x 486	349 x 223	227 x 145			
620	786 x 502	360 x 230	234 x 149	89 x 57		
640	811 x 518	372 x 237	242 x 154	92 x 59		
660	837 x 534	384 x 245	249 x 159	95 x 61		
680	862 x 550	395 x 252	257 x 164	98 x 63		
700	887 x 566	407 x 260	265 x 169	101 x 65		
720	913 x 583	419 x 267	272 x 174	104 x 67		
740	938 x 599	431 x 275	280 x 179	107 x 68	51 x 32	
760	963 x 615	442 x 282	287 x 183	110 x 70	52 x 33	
780	989 x 631	454 x 290	295 x 188	113 x 72	54 x 34	
800	1014 x 647	466 x 297	302 x 193	116 x 74	55 x 35	35 x 22
820	1039 x 663	477 x 305	310 x 198	119 x 76	57 x 36	36 x 23
840	1065 x 680	489 x 312	318 x 203	122 x 78	59 x 37	37 x 24
860	1090 x 696	501 x 320	325 x 208	125 x 80	60 x 38	38 x 25
880	1115 x 712	513 x 327	333 x 212	128 x 82	62 x 39	40 x 25
900	1141 x 728	524 x 335	340 x 217	131 x 84	63 x 40	41 x 26
920	1166 x 744	536 x 342	348 x 222	134 x 86	65 x 41	42 x 27
940	1191 x 760	548 x 350	355 x 227	137 x 88	66 x 42	43 x 27
960	1217 x 777	559 x 357	363 x 232	140 x 89	68 x 43	44 x 28
980	1242 x 793	571 x 365	371 x 237	143 x 91	69 x 44	45 x 29
1000	1267 x 809	583 x 372	378 x 241	146 x 93	71 x 45	46 x 30
1020	1293 x 825	595 x 379	386 x 246	149 x 95	72 x 46	47 x 30
1040	1318 x 841	606 x 387	393 x 251	152 x 97	74 x 47	49 x 31
1060	1343 x 857	618 x 394	401 x 256	155 x 99	75 x 48	50 x 32
1080	1369 x 874	630 x 402	409 x 261	158 x 101	77 x 49	51 x 32
1100	1394 x 890	641 x 409	416 x 266	161 x 103	78 x 50	52 x 33
1120	1419 x 906	653 x 417	424 x 270	164 x 105	80 x 51	53 x 34
1140	1445 x 922	665 x 424	431 x 275	167 x 107	81 x 52	54 x 35
1160	1470 x 938	677 x 432	439 x 280	170 x 108	83 x 53	55 x 35
1180	1495 x 954	688 x 439	446 x 285	173 x 110	84 x 54	56 x 36
1200	1521 x 971	700 x 447	454 x 290	176 x 112	86 x 55	57 x 37
1220	1546 x 987	712 x 454	462 x 295	179 x 114	87 x 56	59 x 37
1240	1571 x 1003	723 x 462	469 x 300	182 x 116	89 x 57	60 x 38
1260	1597 x 1019	735 x 469	477 x 304	185 x 118	91 x 58	61 x 39
1280	1622 x 1035	747 x 477	484 x 309	188 x 120	92 x 59	62 x 40
1300	1647 x 1051	759 x 484	492 x 314	191 x 122	94 x 60	63 x 40
1320	1673 x 1068	770 x 492	500 x 319	194 x 124	95 x 61	64 x 41
1340	1698 x 1084	782 x 499	507 x 324	197 x 126	97 x 62	65 x 42
1360	1723 x 1100	794 x 507	515 x 329	200 x 128	98 x 63	66 x 42
1380	1749 x 1116	805 x 514	522 x 333	203 x 129	100 x 64	68 x 43
1400	1774 x 1132	817 x 522	530 x 338	206 x 131	101 x 65	69 x 44
1420	1799 x 1148	829 x 529	537 x 343	209 x 133	103 x 66	70 x 45
1440	1825 x 1165	840 x 536	545 x 348	212 x 135	104 x 67	71 x 45
1460	1850 x 1181	852 x 544	553 x 353	215 x 137	106 x 68	72 x 46
1480	1875 x 1197	864 x 551	560 x 358	218 x 139	107 x 68	73 x 47
1500	1901 x 1213	876 x 559	568 x 362	221 x 141	109 x 69	74 x 47

Standard C-mount Lenses on iVu Series, WD as a function of FOV Chart

FOV (mm)		WD (mm)					
		4mm	8mm	12mm	25mm	50mm	75mm
Minimum		63 x 40 @ 49mm	15 x 10 @ 31mm	64 x 41 @ 171mm	88 x 56 @ 610mm	50 x 32 @ 732mm	34 x 22 @ 781mm
20 x 15			39				
40 x 30			73				888
60 x 45			107			859	1245
80 x 60		63	141	213		1122	1602
100 x 75		78	175	266	691	1384	1959
120 x 90			210	319	825	1647	2316
140 x 105		110	244	372	959	1909	2673
160 x 120		126	278	424	1093	2172	3031
180 x 135		142	312	477	1227	2434	3388
200 x 150		157	346	530	1362	2697	3745
220 x 165		173	380	583	1496	2959	4102
240 x 180		189	415	635	1630	3222	4459
260 x 195		205	449	688	1764	3484	4816
280 x 210		220	483	741	1898	3747	5173
300 x 225		236	517	794	2032	4009	5531
320 x 240		252	551	846	2166	4272	5888
340 x 255		268	585	899	2300	4534	6245
360 x 270		284	619	952	2434	4796	6602
380 x 285		299	654	1005	2568	5059	6959
400 x 300		315	688	1057	2702	5321	7316
420 x 315		331	722	1110	2836	5584	7673
440 x 330		347	756	1163	2970	5846	8031
460 x 345		363	790	1216	3104	6109	8388
480 x 360		378	824	1268	3238	6371	8745
500 x 375		394	859	1321	3372	6634	9102
520 x 390		410	893	1374	3506	6896	9459
540 x 405		426	927	1427	3640	7159	9816
560 x 420		442	961	1479	3774	7421	10173
580 x 435		457	995	1532	3908	7684	10531
600 x 450		473	1029	1585	4043	7946	10888
620 x 465		489	1063	1638	4177	8209	11245
640 x 480		505	1098	1690	4311	8471	11602
660 x 495		521	1132	1743	4445	8733	11959
680 x 510		536	1166	1796	4579	8996	12316
700 x 525		552	1200	1849	4713	9258	12673
720 x 540		568	1234	1901	4847	9521	13031
740 x 555		584	1268	1954	4981	9783	13388
760 x 570		599	1303	2007	5115	10046	13745
780 x 585		615	1337	2060	5249	10308	14102
800 x 600		631	1371	2113	5383	10571	14459
820 x 615		647	1405	2165	5517	10833	14816
840 x 630		663	1439	2218	5651	11096	15173
860 x 645		678	1473	2271	5785	11358	15531
880 x 660		694	1507	2324	5919	11621	15888
900 x 675		710	1542	2376	6053	11883	16245
920 x 690		726	1576	2429	6187	12146	16602
940 x 705		742	1610	2482	6321	12408	16959
960 x 720		757	1644	2535	6455	12670	17316
980 x 735		773	1678	2587	6589	12933	17673
1000 x 750		789	1712	2640	6723	13195	18031
1020 x 765		805	1747	2693	6858	13458	18388
1040 x 780		821	1781	2746	6992	13720	18745
1060 x 795		836	1815	2798	7126	13983	19102
1080 x 810		852	1849	2851	7260	14245	19459
1100 x 825		868	1883	2904	7394	14508	19816
1120 x 840		884	1917	2957	7528	14770	20173
1140 x 855		900	1951	3009	7662	15033	20531
1160 x 870		915	1986	3062	7796	15295	20888
1180 x 885		931	2020	3115	7930	15558	21245
1200 x 900		947	2054	3168	8064	15820	21602
1220 x 915		963	2088	3220	8198	16083	21959
1240 x 930		978	2122	3273	8332	16345	22316
1260 x 945		994	2156	3326	8466	16607	22673
1280 x 960		1010	2191	3379	8600	16870	23031
1300 x 975		1026	2225	3431	8734	17132	23388
1320 x 990		1042	2259	3484	8868	17395	23745
1340 x 1005		1057	2293	3537	9002	17657	24102
1360 x 1020		1073	2327	3590	9136	17920	24459
1380 x 1035		1089	2361	3642	9270	18182	24816
1400 x 1050		1105	2395	3695	9404	18445	25173
1420 x 1065		1121	2430	3748	9538	18707	25531
1440 x 1080		1136	2464	3801	9673	18970	25888
1460 x 1095		1152	2498	3853	9807	19232	26245
1480 x 1110		1168	2532	3906	9941	19495	26602
1500 x 1125		1184	2566	3959	10075	19757	26959

Standard C-mount Lens equations for iVu Series

H = horizontal FOV size, W = working distance



4 mm lens

Banner model: LCF04 (p/n 68884)

Marshall Electronics model: V-4504ML

1/3-inch format, no filter, fixed iris f/2.5, fits with either IVUSLC50 or IVUSLC75 lens covers

H(W), mm

$$H = 1.267 \times W + 0.775 \text{ (minimum } W \sim 49\text{mm)}$$

W(H), mm

$$W = (H - 0.775)/1.267 \text{ (minimum } H \sim 63\text{mm)}$$

NOTE: Banner recommends using a 0.25 mm spacer (LEKS)



8 mm lens

Banner model: LCF08 (p/n 57298)

Azure Photonics model: AZURE-0813F

1/2-inch format, no filter, fixed iris f/1.3, fits with either IVUSLC50 or IVUSLC75 lens covers

H(W), mm

$$H = 0.586 \times W - 2.77 \text{ (minimum } W \sim 31\text{mm)}$$

W(H), mm

$$W = (H + 2.77)/0.586 \text{ (minimum } H \sim 15\text{mm)}$$



12 mm lens

Banner model: LCF12 (p/n 57299)

Marshall Electronics model: V-4512

1/3-inch format, no filter, fixed iris f/2.0, fits with either IVUSLC50 or IVUSLC75 lens covers

H(W), mm

$$H = 0.379 \times W - 0.855 \text{ (minimum } W \sim 171\text{mm)}$$

W(H), mm

$$W = (H + 0.855)/0.379 \text{ (minimum } H \sim 64\text{mm)}$$



25mm lens

Banner model: LCF25R (p/n 68885)

Goyo Optical model: GMG42514C

1-inch format, 37.5 mm filter, min f/1.4, fits with IVUSLC75 lens cover

H(W), mm

$$H = 0.149 \times W - 3.14 \text{ (minimum } W \sim 610\text{mm)}$$

W(H), mm

$$W = (H + 3.14)/0.149 \text{ (minimum } H \sim 88\text{mm)}$$



50mm lens

Banner model: LCF50L2R (p/n 68888)

Goyo Optical model: GMG45018MCN

1-inch format, 40.5 mm filter, min f/1.8, fits with IVUSLC75 lens cover, requires LHWK-1 set screws

H(W), mm

$H = 0.0762 \times W - 5.49$ (minimum $W \sim 732\text{mm}$)

W(H), mm

$W = (H + 5.49)/0.0762$ (minimum $H \sim 50\text{mm}$)

75mm lens

Banner model: LCF75LR (p/n 70545)

Goyo Optical model: GMG47518MCN

1-inch format, 46 mm filter, min f/1.8, does not fit with a sealed lens cover

H(W), mm

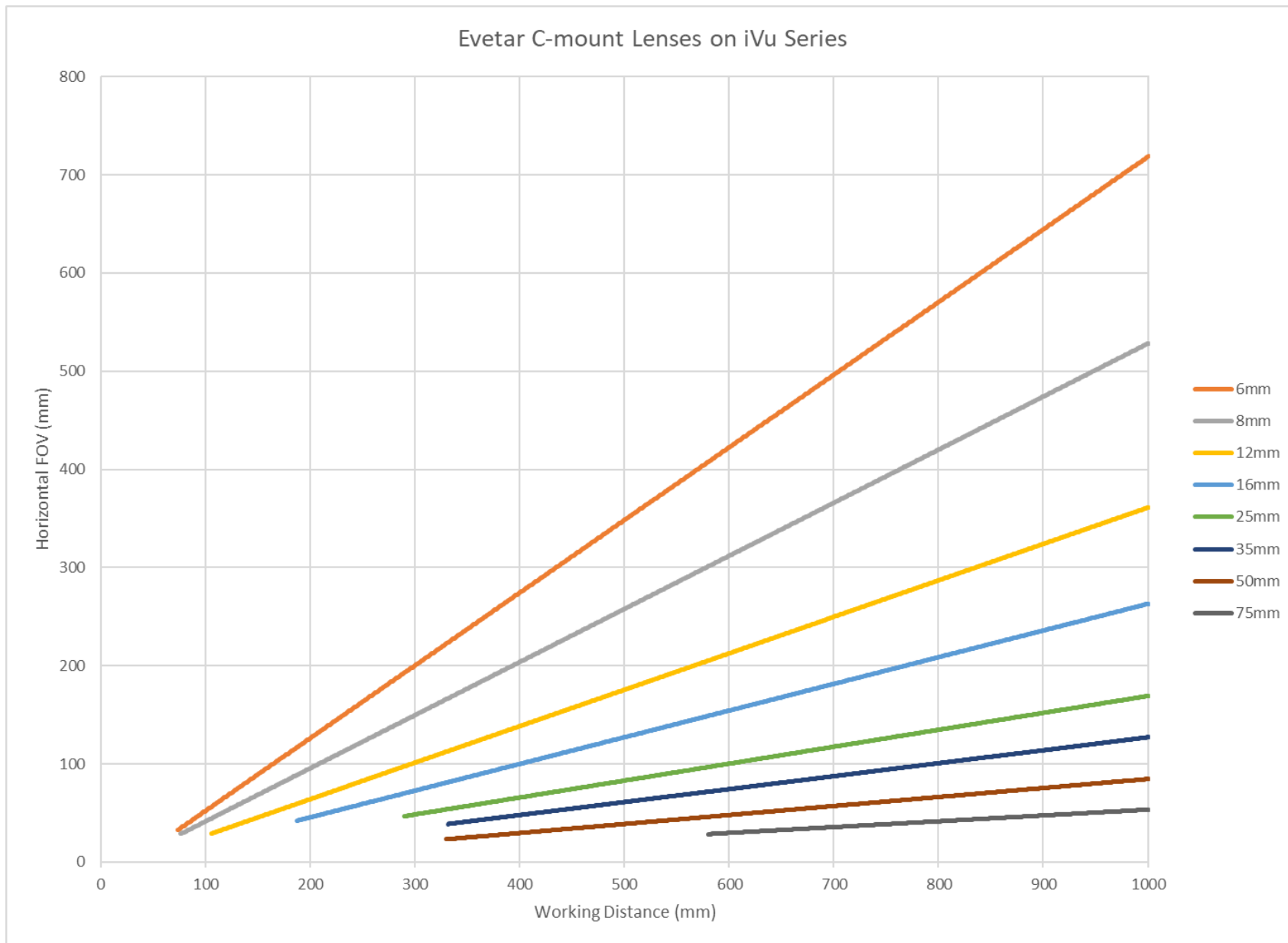
$H = 0.056 \times W - 9.71$ (minimum $W \sim 781\text{mm}$)

W(H), mm

$W = (H + 9.71)/0.056$ (minimum $H \sim 34\text{mm}$)



Evetar C-mount Lenses on iVu Series



Evetar C-mount Lenses on iVu Series, FOV as a function of WD Chart

WD (mm)	FOV (mm)							
	6mm	8mm	12mm	16mm	25mm	35mm	50mm	75mm
Minimum	34 x 22 @ 73mm	29 x 19 @ 76mm	29 x 19 @ 105mm	42 x 27 @ 187mm	46 x 29 @ 290mm	39 x 25 @ 331mm	23 x 15 @ 330mm	28 x 18 @ 580mm
20								
40								
60								
80	38 x 24	31 x 20						
100	52 x 33	42 x 27						
120	67 x 43	52 x 33	34 x 22					
140	82 x 52	63 x 40	42 x 27					
160	97 x 62	74 x 47	49 x 31					
180	112 x 71	85 x 54	57 x 36					
200	126 x 81	96 x 61	64 x 41	46 x 29				
220	141 x 90	107 x 68	72 x 46	51 x 33				
240	156 x 100	117 x 75	79 x 50	56 x 36				
260	171 x 109	128 x 82	86 x 55	62 x 40				
280	186 x 119	139 x 89	94 x 60	67 x 43				
300	201 x 128	150 x 96	101 x 65	73 x 46	48 x 31			
320	215 x 137	161 x 103	109 x 69	78 x 50	52 x 33			
340	230 x 147	171 x 109	116 x 74	84 x 53	55 x 35	40 x 26	24 x 15	
360	245 x 156	182 x 116	124 x 79	89 x 57	59 x 38	43 x 27	26 x 17	
380	260 x 166	193 x 123	131 x 84	95 x 60	62 x 40	45 x 29	28 x 18	
400	275 x 175	204 x 130	138 x 88	100 x 64	66 x 42	48 x 31	30 x 19	
420	289 x 185	215 x 137	146 x 93	105 x 67	69 x 44	51 x 32	31 x 20	
440	304 x 194	226 x 144	153 x 98	111 x 71	73 x 46	53 x 34	33 x 21	
460	319 x 204	236 x 151	161 x 103	116 x 74	76 x 49	56 x 36	35 x 22	
480	334 x 213	247 x 158	168 x 107	122 x 78	80 x 51	58 x 37	37 x 24	
500	349 x 223	258 x 165	176 x 112	127 x 81	83 x 53	61 x 39	39 x 25	
520	363 x 232	269 x 172	183 x 117	133 x 85	86 x 55	64 x 41	41 x 26	
540	378 x 241	280 x 178	190 x 122	138 x 88	90 x 57	66 x 42	42 x 27	
560	393 x 251	290 x 185	198 x 126	143 x 92	93 x 60	69 x 44	44 x 28	
580	408 x 260	301 x 192	205 x 131	149 x 95	97 x 62	72 x 46	46 x 29	28 x 18
600	423 x 270	312 x 199	213 x 136	154 x 99	100 x 64	74 x 47	48 x 31	30 x 19
620	437 x 279	323 x 206	220 x 141	160 x 102	104 x 66	77 x 49	50 x 32	31 x 20
640	452 x 289	334 x 213	228 x 145	165 x 105	107 x 68	80 x 51	52 x 33	32 x 21
660	467 x 298	345 x 220	235 x 150	171 x 109	111 x 71	82 x 52	53 x 34	33 x 20
680	482 x 308	355 x 227	242 x 155	176 x 112	114 x 73	85 x 54	55 x 35	34 x 22
700	497 x 317	366 x 234	250 x 159	182 x 116	117 x 75	87 x 56	57 x 36	36 x 23
720	511 x 326	377 x 241	257 x 164	187 x 119	121 x 77	90 x 58	59 x 38	37 x 23
740	526 x 336	388 x 248	265 x 169	192 x 123	124 x 79	93 x 59	61 x 39	38 x 24
760	541 x 345	399 x 254	272 x 174	198 x 126	128 x 82	95 x 61	63 x 40	39 x 25
780	556 x 355	409 x 261	280 x 178	203 x 130	131 x 84	98 x 63	64 x 41	40 x 26
800	571 x 364	420 x 268	287 x 183	209 x 133	135 x 86	101 x 64	66 x 42	42 x 26
820	586 x 374	431 x 275	294 x 188	214 x 137	138 x 88	103 x 66	68 x 43	43 x 27
840	600 x 383	442 x 282	302 x 193	220 x 140	142 x 90	106 x 68	70 x 45	44 x 28
860	615 x 393	453 x 289	309 x 197	225 x 144	145 x 93	109 x 69	72 x 46	45 x 29
880	630 x 402	464 x 296	317 x 202	230 x 147	149 x 95	111 x 71	74 x 47	46 x 30
900	645 x 412	474 x 303	324 x 207	236 x 151	152 x 97	114 x 73	75 x 48	47 x 30
920	660 x 421	485 x 310	332 x 212	241 x 154	155 x 99	117 x 74	77 x 49	49 x 31
940	674 x 430	496 x 317	339 x 216	247 x 158	159 x 101	119 x 76	79 x 50	50 x 32
960	689 x 440	507 x 323	346 x 221	252 x 161	162 x 104	122 x 78	81 x 52	51 x 33
980	704 x 449	518 x 330	354 x 226	258 x 164	166 x 106	124 x 79	83 x 53	52 x 33
1000	719 x 459	528 x 337	361 x 231	263 x 168	169 x 108	127 x 81	85 x 54	53 x 34
1020	734 x 468	539 x 344	369 x 235	269 x 171	173 x 110	130 x 83	86 x 55	55 x 35
1040	748 x 478	550 x 351	376 x 240	274 x 175	176 x 112	132 x 84	88 x 56	56 x 36
1060	763 x 487	561 x 358	384 x 245	279 x 178	180 x 115	135 x 86	90 x 57	57 x 36
1080	778 x 497	572 x 365	391 x 250	285 x 182	183 x 117	138 x 88	92 x 59	58 x 37
1100	793 x 506	583 x 372	398 x 254	290 x 185	186 x 119	140 x 90	94 x 60	59 x 38
1120	808 x 516	593 x 379	406 x 259	296 x 189	190 x 121	143 x 91	96 x 61	60 x 39
1140	822 x 525	604 x 386	413 x 264	301 x 192	193 x 123	146 x 93	97 x 62	62 x 39
1160	837 x 534	615 x 393	421 x 269	307 x 196	197 x 126	148 x 95	99 x 63	63 x 40
1180	852 x 544	626 x 399	428 x 273	312 x 199	200 x 128	151 x 96	101 x 65	64 x 41
1200	867 x 553	637 x 406	436 x 278	318 x 203	204 x 130	153 x 98	103 x 66	65 x 42
1220	882 x 563	647 x 413	443 x 283	323 x 206	207 x 132	156 x 100	105 x 67	66 x 42
1240	896 x 572	658 x 420	450 x 288	328 x 210	211 x 134	159 x 101	107 x 68	68 x 43
1260	911 x 582	669 x 427	458 x 292	334 x 213	214 x 137	161 x 103	108 x 69	69 x 44
1280	926 x 591	680 x 434	465 x 297	339 x 217	218 x 139	164 x 105	110 x 70	70 x 45
1300	941 x 601	691 x 441	473 x 302	345 x 220	221 x 141	167 x 106	112 x 72	71 x 45
1320	956 x 610	702 x 448	480 x 306	350 x 223	224 x 143	169 x 108	114 x 73	72 x 46
1340	971 x 619	712 x 455	488 x 311	356 x 227	228 x 145	172 x 110	116 x 74	74 x 47
1360	985 x 629	723 x 462	495 x 316	361 x 230	231 x 148	175 x 111	118 x 75	75 x 48
1380	1000 x 638	734 x 469	502 x 321	366 x 234	235 x 150	177 x 113	119 x 76	76 x 48
1400	1015 x 648	745 x 475	510 x 325	372 x 237	238 x 152	180 x 115	121 x 77	77 x 49
1420	1030 x 657	756 x 482	517 x 330	377 x 241	242 x 154	183 x 117	123 x 79	78 x 50
1440	1045 x 667	766 x 489	525 x 335	383 x 244	245 x 156	185 x 118	125 x 80	79 x 51
1460	1059 x 676	777 x 496	532 x 340	388 x 248	249 x 159	188 x 120	127 x 81	81 x 51
1480	1074 x 686	788 x 503	540 x 344	394 x 251	252 x 161	190 x 122	129 x 82	82 x 52
1500	1089 x 695	799 x 510	547 x 349	399 x 255	255 x 163	193 x 123	130 x 83	83 x 53

Evetar C-mount Lenses on iVu Series, WD as a function of FOV Chart

		WD (mm)								
FOV (mm)		6mm	8mm	12mm	16mm	25mm	35mm	50mm	75mm	
Minimum		34 x 22 @ 73mm	29 x 19 @ 76mm	29 x 19 @ 105mm	42 x 27 @ 187mm	46 x 29 @ 290mm	39 x 25 @ 331mm	23 x 15 @ 330mm	28 x 18 @ 580mm	
20 x 15										
40 x 30		83	97	135			340	514	775	
60 x 45		110	134	189	253	367	492	732	1112	
80 x 60		137	171	243	327	483	643	950	1449	
100 x 75		164	208	296	400	599	795	1168	1786	
120 x 90		191	245	350	474	715	946	1386	2124	
140 x 105		218	282	404	547	831	1098	1604	2461	
160 x 120		245	319	458	621	947	1249	1822	2798	
180 x 135		272	356	512	694	1062	1401	2041	3136	
200 x 150		299	393	566	768	1178	1552	2259	3473	
220 x 165		326	430	620	841	1294	1704	2477	3810	
240 x 180		353	467	673	915	1410	1855	2695	4147	
260 x 195		380	504	727	989	1526	2007	2913	4485	
280 x 210		407	541	781	1062	1642	2158	3131	4822	
300 x 225		434	578	835	1136	1758	2310	3349	5159	
320 x 240		461	615	889	1209	1874	2462	3567	5496	
340 x 255		488	652	943	1283	1990	2613	3785	5834	
360 x 270		515	689	997	1356	2106	2765	4003	6171	
380 x 285		542	726	1050	1430	2222	2916	4222	6508	
400 x 300		569	763	1104	1503	2338	3068	4440	6845	
420 x 315		596	800	1158	1577	2454	3219	4658	7183	
440 x 330		623	836	1212	1651	2570	3371	4876	7520	
460 x 345		650	873	1266	1724	2686	3522	5094	7857	
480 x 360		677	910	1320	1798	2802	3674	5312	8195	
500 x 375		704	947	1373	1871	2918	3825	5530	8532	
520 x 390		731	984	1427	1945	3033	3977	5748	8869	
540 x 405		759	1021	1481	2018	3149	4128	5966	9206	
560 x 420		786	1058	1535	2092	3265	4280	6185	9544	
580 x 435		813	1095	1589	2165	3381	4431	6403	9881	
600 x 450		840	1132	1643	2239	3497	4583	6621	10218	
620 x 465		867	1169	1697	2313	3613	4734	6839	10555	
640 x 480		894	1206	1750	2386	3729	4886	7057	10893	
660 x 495		921	1243	1804	2460	3845	5037	7275	11230	
680 x 510		948	1280	1858	2533	3961	5189	7493	11567	
700 x 525		975	1317	1912	2607	4077	5340	7711	11905	
720 x 540		1002	1354	1966	2680	4193	5492	7929	12242	
740 x 555		1029	1391	2020	2754	4309	5643	8147	12579	
760 x 570		1056	1428	2074	2827	4425	5795	8366	12916	
780 x 585		1083	1465	2127	2901	4541	5946	8584	13254	
800 x 600		1110	1502	2181	2975	4657	6098	8802	13591	
820 x 615		1137	1539	2235	3048	4773	6249	9020	13928	
840 x 630		1164	1576	2289	3122	4889	6401	9238	14265	
860 x 645		1191	1613	2343	3195	5004	6552	9456	14603	
880 x 660		1218	1650	2397	3269	5120	6704	9674	14940	
900 x 675		1245	1687	2450	3342	5236	6855	9892	15277	
920 x 690		1272	1724	2504	3416	5352	7007	10110	15614	
940 x 705		1299	1761	2558	3489	5468	7158	10328	15952	
960 x 720		1326	1798	2612	3563	5584	7310	10547	16289	
980 x 735		1353	1835	2666	3637	5700	7462	10765	16626	
1000 x 750		1380	1872	2720	3710	5816	7613	10983	16964	
1020 x 765		1407	1909	2774	3784	5932	7765	11201	17301	
1040 x 780		1434	1946	2827	3857	6048	7916	11419	17638	
1060 x 795		1461	1983	2881	3931	6164	8068	11637	17975	
1080 x 810		1488	2020	2935	4004	6280	8219	11855	18313	
1100 x 825		1515	2057	2989	4078	6396	8371	12073	18650	
1120 x 840		1542	2094	3043	4151	6512	8522	12291	18987	
1140 x 855		1569	2131	3097	4225	6628	8674	12509	19324	
1160 x 870		1596	2168	3151	4299	6744	8825	12728	19662	
1180 x 885		1623	2205	3204	4372	6860	8977	12946	19999	
1200 x 900		1650	2242	3258	4446	6976	9128	13164	20336	
1220 x 915		1677	2279	3312	4519	7091	9280	13382	20673	
1240 x 930		1704	2316	3366	4593	7207	9431	13600	21011	
1260 x 945		1731	2352	3420	4666	7323	9583	13818	21348	
1280 x 960		1758	2389	3474	4740	7439	9734	14036	21685	
1300 x 975		1785	2426	3527	4813	7555	9886	14254	22023	
1320 x 990		1812	2463	3581	4887	7671	10037	14472	22360	
1340 x 1005		1839	2500	3635	4961	7787	10189	14691	22697	
1360 x 1020		1866	2537	3689	5034	7903	10340	14909	23034	
1380 x 1035		1893	2574	3743	5108	8019	10492	15127	23372	
1400 x 1050		1920	2611	3797	5181	8135	10643	15345	23709	
1420 x 1065		1947	2648	3851	5255	8251	10795	15563	24046	
1440 x 1080		1974	2685	3904	5328	8367	10946	15781	24383	
1460 x 1095		2001	2722	3958	5402	8483	11098	15999	24721	
1480 x 1110		2028	2759	4012	5475	8599	11249	16217	25058	
1500 x 1125		2055	2796	4066	5549	8715	11401	16435	25395	

Evetar C-mount Lens equations for iVu Series

H = horizontal FOV size, W = working distance



6mm Megapixel lens

Banner model: LCF06LEVMP (p/n 97345)

Evetar model: MV118FM06C

1/1.8-inch format, 34 mm filter, min f/1.6, fits with IVUSLC75 lens cover

H(W), mm

$H = 0.74 \times W - 21.6$ (minimum W ~ 730mm)

W(H), mm

$W = (H + 21.6)/0.74$ (minimum H ~ 34mm)



8mm Megapixel lens

Banner model: LCF08LEVMP (p/n 97346)

Evetar model: MV118FM08C

1/1.8-inch format, 27 mm filter, min f/1.4, fits with IVUSLC75 lens cover

H(W), mm

$H = 0.541 \times W - 12.46$ (minimum W ~ 76mm)

W(H), mm

$W = (H + 12.46)/0.541$ (minimum H ~ 29mm)



12mm Megapixel lens

Banner model: LCF12LEVMP (p/n 97347)

Evetar model: MV23FM12C

2/3-inch format, 27 mm filter, min f/1.6, fits with IVUSLC75 lens cover

H(W), mm

$H = 0.371 \times W - 10.1$ (minimum W ~ 105mm)

W(H), mm

$W = (H + 10.1)/0.371$ (minimum H ~ 29mm)



16mm Megapixel lens

Banner model: LCF16LEVMP (p/n 97348)

Evetar model: MV23FM16CR1

2/3-inch format, 27 mm filter, min f/1.6, fits with IVUSLC75 lens cover

H(W), mm

$H = 0.272 \times W - 8.78$ (minimum W ~ 187mm)

W(H), mm

$W = (H + 8.78)/0.272$ (minimum H ~ 42mm)



25mm Megapixel lens

Banner model: LCF25LEVMP (p/n 97349)

Evetar model: MV23FM25C

2/3-inch format, 27 mm filter, min f/1.8, fits with IVUSLC75 lens cover

H(W), mm

$$H = 0.173 \times W - 3.27 \text{ (minimum } W \sim 290\text{mm)}$$

W(H), mm

$$W = (H + 3.27)/0.173 \text{ (minimum } H \sim 46\text{mm)}$$



35mm Megapixel lens

Banner model: LCF35LEVMP (p/n 97350)

Evetar model: MV23FM35C

2/3-inch format, 27 mm filter, min f/2.0, fits with IVUSLC75 lens cover

H(W), mm

$$H = 0.132 \times W - 4.921 \text{ (minimum } W \sim 331\text{mm)}$$

W(H), mm

$$W = (H + 4.921)/0.132 \text{ (minimum } H \sim 39\text{mm)}$$



50mm Megapixel lens

Banner model: LCF50LEVMP (p/n 97351)

Evetar model: MV23FM50C

2/3-inch format, 30.5 mm filter, min f/2.6, fits with IVUSLC75 lens cover

H(W), mm

$$H = 0.092 \times W - 7.12 \text{ (minimum } W \sim 330\text{mm)}$$

W(H), mm

$$W = (H + 7.12)/0.092 \text{ (minimum } H \sim 23\text{mm)}$$



75mm Megapixel lens

Banner model: LCF75LEVMP (p/n 97352)

Evetar model: MV11FM75C

1-inch format, 34 mm filter, min f/2.8, does not fit with a sealed lens cover

H(W), mm

$$H = 0.059 \times W - 5.94 \text{ (minimum } W \sim 580\text{mm)}$$

W(H), mm

$$W = (H + 5.94)/0.059 \text{ (minimum } H \sim 28\text{mm)}$$