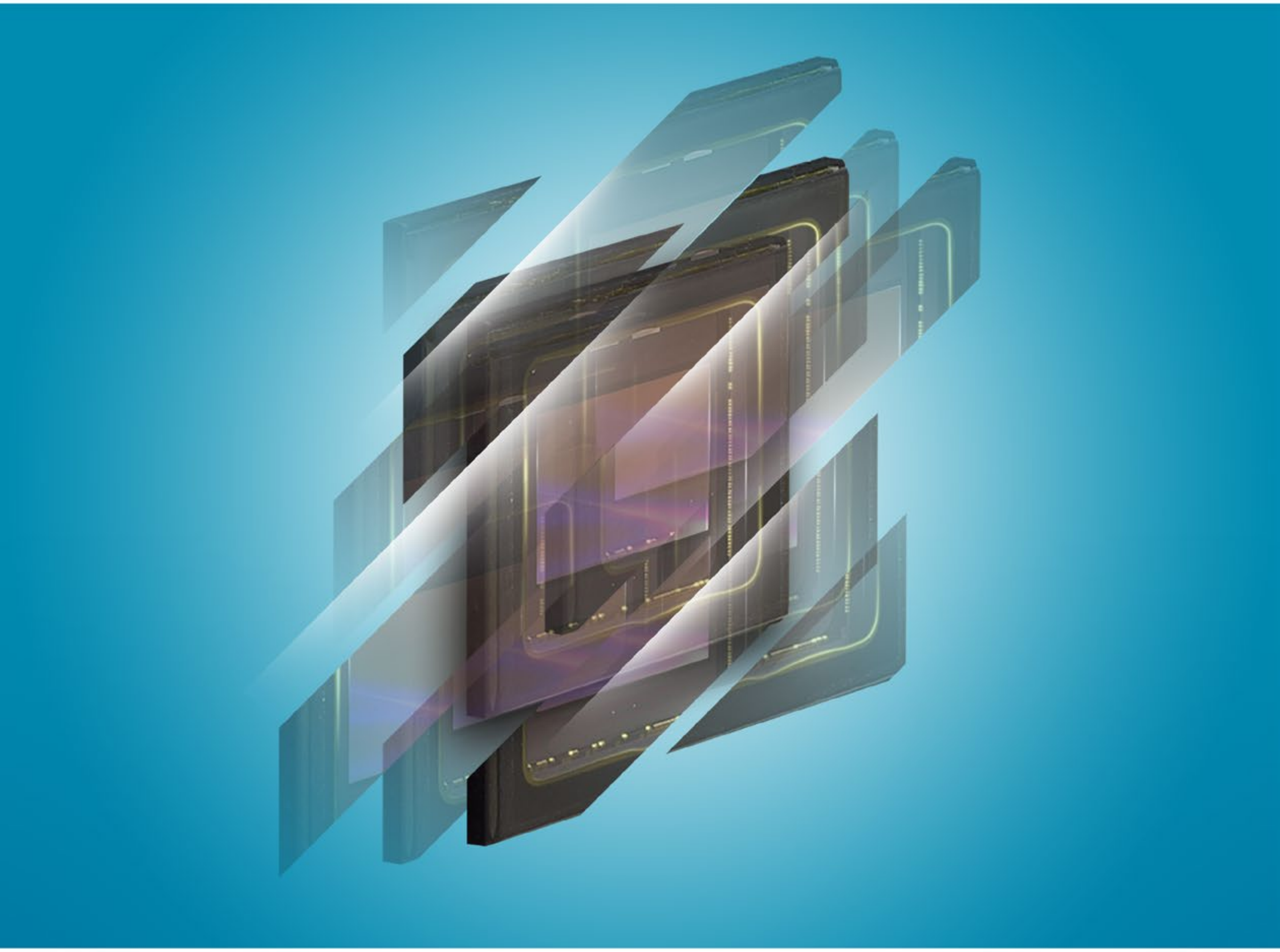
POINT GREY

Innovation in Imaging



MONO CAMERA SENSOR REVIEW

Q3 2015

1288 EMVA Standard Compliant

Measurements are taken based on guidelines in the EMVA 1288 standard; the full definition can be found at EMVA.org. Camera settings are at maximum exposure time and bit depth unless otherwise noted. The pixel format is Mono 16 for mono cameras and Raw 16 for color cameras. Results are captured at room temperature (20°C).

CONTENT

RELEASE NOTES:

Q2 2015
ADDED:
- GRASSHOPPER3 GS3-U3-32S4M-C (SONY IMX252)
- GRASSHOPPER3 GS3-U3-51S5M-C (SONY IMX250)
- GRASSHOPPER3 GS3-U3-120S6M-C (SONY ICX834)

Q1 2015
ADDED:
- GRASSHOPPER3 GS3-U3-15S5M-C (SONY ICX825)
- CHAMELEON3 CM3-U3-13Y3M-CS (ON SEMI PYTHON1300)

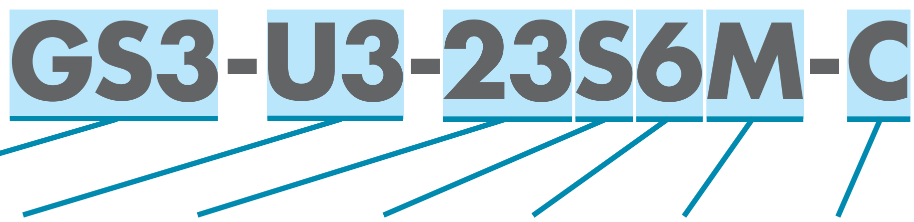
Q4 2014
ADDED:
- BLACKFLY GIGE BFLY-PGE-23S6M-C (SONY IMX249)
- BLACKFLY GIGE BFLY-PGE-50H5M-C (SHARP RJ32S4AA0DT)

Q3 2014
REMOVED:
- FIREWIRE CAMERAS
- CHAMELEON USB 2.0, FLEA3-GE-03S3M-C (ICX424)
- COST PER MB/S OF THROUGHPUT CHART

ADDED:
- FLEA3 USB3 FL3-U3-20E4M-C (E2V EV76C570)
- GRASSHOPPER3 USB3 GS3-U3-60QS6M-C-C (SONY ICX964 CMOS) *QUAD TAP
- BLACKFLY GIGE BFLY-PGE-03S3M-C (SONY ICX414 CCD)
- ABSOLUTE SENSITIVITY THRESHOLD CHART

Our Model Numbers Mean Something!

Here is one example of our model numbers and what each section means. Understanding this will give you a quick explanation of the model's specifications and help you when comparing models.



Camera Family	Interface	Megapixels	Sensor Brand	Sensor Size	Color/Mono	Lens Mount
GS3=Grasshopper3	U3=USB 3.0	23=2.3 MP	S=Sony	6=1"	M=Mono	C=C-Mount
BFLY=Blackfly	FW=FireWire	03=0.3 MP	A=Aptina	0=Unassigned	C=Color	CS=CS-Mount
FL3=Flea3	GE=GigE	08=0.8 MP	M=Micron	1=1/4"		
FFMV=FireflyMV FireWire	PGE=PoE GigE	13=1.3 MP	K=Kodak	2=1/3", 1/2.8", 1/2.5"		
GS2=Grasshopper2		20=2.0 MP	C=CMOSIS	3=1/2"		
GX=Grasshopper Express		50=5.0 MP	Y=Cypress	4=1/1.8"		
		etc	E=E2V	5=2/3"		
			H=Sharp			

The data presented in this PDF might vary depending on your camera firmware and system setup. While we strive to keep this data current, camera model firmware updates might change data results which might not make it into this PDF. Please download our Camera Family Imaging Performance PDFs for the most up to date results.

Please note that all measurements are taken based on guidelines in the EMVA 1288 standard. Camera settings are at maximum exposure time and bit depth unless otherwise noted. The pixel format is Mono 16 for mono cameras except for the last two Bandwidth and Throughput graphs which are done at Mono 8. Results are captured at room temperature (20°C). For more information on the EMVA 1288 standard please visit EMVA.org. Thanks for considering Point Grey and please enjoy our mono camera sensor review.

MONO CAMERA SENSOR REVIEW SORTED BY SENSOR TYPE (CCD/CMOS) AND RESOLUTION

CCD

MODEL ID	SENSOR	SENSOR SIZE	INTERFACE	SENSOR TYPE	SHUTTER	MAX RESOLUTION	MAX FRAME RATE	PIXEL SIZE
BFLY-PGE-03S2M-CS	**Sony ICX424**	1/3"	PoE GigE	CCD	Global	648 x 488	84	7.4 µm
BFLY-U3-03S2M-CS	**Sony ICX424**	1/3"	USB 3.0	CCD	Global	648 x 488	84	7.4 µm
BFLY-PGE-03S3M-CS	**Sony ICX414**	1/2"	PoE GigE	CCD	Global	648 x 488	90	9.9 µm
FL3-GE-03S1M-C	**Sony ICX618**	1/4"	GigE	CCD	Global	648 x 488	120	5.6 µm
BFLY-PGE-05S2M-CS	**Sony ICX693**	1/3"	PoE GigE	CCD	Global	808 x 608	50	6.0 µm
FL3-GE-08S2M-C	**Sony ICX204**	1/3"	GigE	CCD	Global	1032 x 776	31	4.65 µm
BFLY-PGE-09S2M-CS	**Sony ICX692**	1/3"	PoE GigE	CCD	Global	1288 x 728	30	4.08 µm
BFLY-U3-13S2M-CS	**Sony ICX445**	1/3"	USB 3.0	CCD	Global	1288 x 964	30	3.75 µm
BFLY-PGE-13S2M-CS	**Sony ICX445**	1/3"	PoE GigE	CCD	Global	1288 x 964	22	3.75 µm
FL3-GE-13S2M-C	**Sony ICX445**	1/3"	PoE GigE	CCD	Global	1288 x 964	31	3.75 µm
FL3-GE-14S3M-C	**Sony ICX267**	1/2"	GigE	CCD	Global	1384 x 1032	18	4.65 µm
GS3-U3-15S5M-C	**Sony ICX825**	2/3"	USB 3.0	CCD	Global	1384 x 1032	45	6.45 µm
GS3-U3-14S5M-C	**Sony ICX285**	2/3"	USB 3.0	CCD	Global	1384 x 1036	30	6.45 µm
FL3-GE-20S4M-C	**Sony ICX274**	1/1.8"	GigE	CCD	Global	1624 x 1224	15	4.4 µm
GS3-U3-28S5M-C	**Sony ICX674**	2/3"	USB 3.0	CCD	Global	1920 x 1440	26	4.54 µm
FL3-GE-28S4M-C	**Sony ICX687**	1/1.8"	GigE	CCD	Global	1928 x 1448	15	3.69 µm
GS3-U3-28S4M-C	**Sony ICX687**	1/1.8"	USB 3.0	CCD	Global	1928 x 1448	26	3.69 µm
GS3-U3-41S4M-C	**Sony ICX808**	1/1.8"	USB 3.0	CCD	Global	2024 x 2024	18	3.1 µm
FL3-GE-50S5M-C	**Sony ICX655**	2/3"	GigE	CCD	Global	2448 x 2048	8	3.45 µm
GS3-U3-50S5M-C	**Sony ICX625**	2/3"	USB 3.0	CCD	Global	2448 x 2048	15	3.45 µm
GS3-PGE-50S5M-C	**Sony ICX625**	2/3"	PoE GigE	CCD	Global	2448 x 2048	15	3.45 µm
BFLY-PGE-50H5M-C	**Sharp RJ32S4AA0DT**	2/3"	PoE GigE	CCD	Global	2448 x 2048	7.5	3.45 µm
GS3-U3-60S6M-C	**Sony ICX694**	1"	USB 3.0	CCD	Global	2736 x 2192	13	4.54 µm
GS3-U3-60QS6M-C	**Sony ICX694**	1"	USB 3.0	CCD	Global	2736 x 2192	25	4.54 µm
GS3-PGE-60S6M-C	**Sony ICX694**	1"	PoE GigE	CCD	Global	2736 x 2192	13	4.54 µm
GS3-U3-91S6M-C	**Sony ICX814**	1"	USB 3.0	CCD	Global	3376 x 2704	9	3.69 µm
GS3-U3-120S6M-C	**Sony ICX834**	1"	USB 3.0	CCD	Global	4240 x 2824	7	3.1 µm

CMOS

MODEL ID	SENSOR	SENSOR SIZE	INTERFACE	SENSOR TYPE	SHUTTER	MAX RESOLUTION	MAX FRAME RATE	PIXEL SIZE
FFMV-03M2M-CS	**Micron MT9V022177ATC**	1/3"	FireWire	CMOS	Global	752 x 480	60	6.0 µm
BFLY-PGE-12A2M-CS	**Aptina AR0134**	1/3"	PoE GigE	CMOS	Global	1280 x 960	52	3.75 µm
FL3-U3-13E4M-C	**e2v EV76C560**	1/1.8"	USB 3.0	CMOS	Global	1280 x 1024	60	5.3 µm
BFLY-PGE-13E4M-CS	**e2v EV76C560**	1/1.8"	PoE GigE	CMOS	Global	1280 x 1024	60	5.3 µm
FL3-U3-13Y3M-C	**ON Semi VITA1300**	1/2"	USB 3.0	CMOS	Global	1280 x 1024	150	4.8 µm
CM3-U3-13Y3M-CS	**ON Semi PYTHON1300**	1/2"	USB 3.0	CMOS	Global	1280 x 1024	149	4.8 µm
FL3-U3-13S2M-CS	**Sony IMX035**	1/3"	USB 3.0	CMOS	Rolling	1328 x 1048	120	3.63 µm
BFLY-PGE-20E4M-CS	**e2v EV76C570**	1/1.8"	PoE GigE	CMOS	Global	1600 x 1200	47	4.5 µm
FL3-U3-20E4M-C	**e2v EV76C570**	1/1.8"	USB 3.0	CMOS	Global	1600 x 1200	60	4.5 µm
GS3-U3-23S6M-C	**Sony IMX174**	1/1.2"	USB 3.0	CMOS	Global	1920 x 1200	162	5.86 µm
GS3-PGE-23S6M-C	**Sony IMX174**	1/1.2"	PoE GigE	CMOS	Global	1920 x 1200	46	5.86 µm
BFLY-PGE-23S6M-C	**Sony IMX249**	1/1.2"	PoE GigE	CMOS	Global	1920 x 1200	41	5.86 µm
FL3-U3-32S2M-CS	**Sony IMX036**	1/2.8"	USB 3.0	CMOS	Rolling	2080 x 1552	60	2.5 µm
GS3-U3-32S3M-C	**Sony IMX252**	1/1.8"	USB 3.0	CMOS	Global	2048 x 1536	121	3.45 µm
GS3-U3-41C6M-C	**CMOSIS CMV4000**	1"	USB 3.0	CMOS	Global	2048 x 2048	90	5.5 µm
GS3-U3-41C6NIR-C	**CMOSIS CMV4000 NIR**	1"	USB 3.0	CMOS	Global	2048 x 2048	90	5.5 µm
GS3-U3-51S5M-C	**Sony IMX250**	2/3"	USB 3.0	CMOS	Global	2448 x 2048	75	3.45 µm
BFLY-PGE-50A2M-CS	**Aptina MT9P031**	1/2.5"	PoE GigE	CMOS	Rolling	2592 x 1944	13	2.2 µm

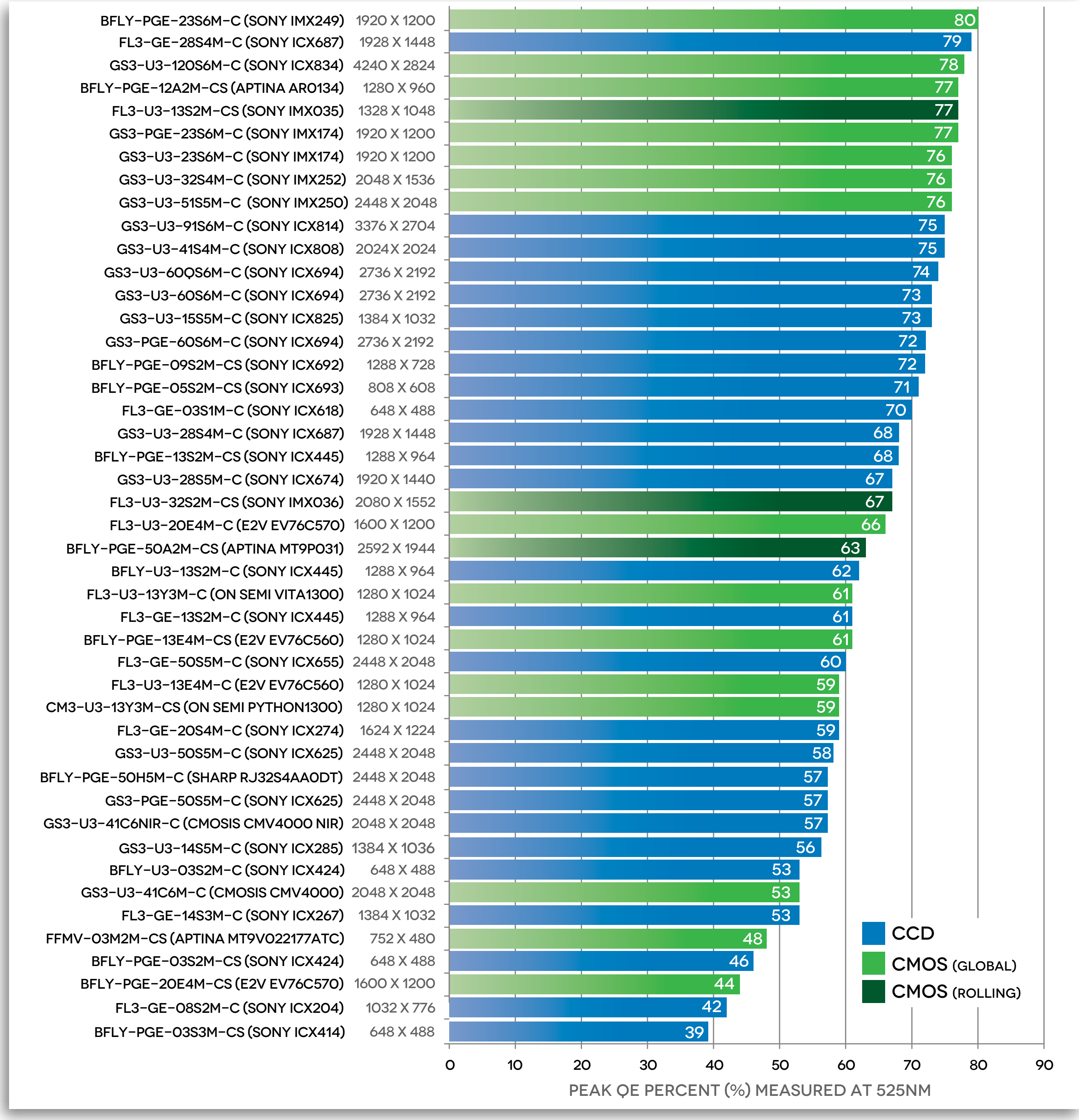
QE 525nm %	QE NEAR IR 850nm / 950nm %	TEMPORAL DARK NOISE (READ NOISE) e−	S/N RATIO MAX dB	S/N RATIO MAX Bits	ABSOLUTE SENSITIVITY THRESHOLD γ	SATURATION CAPACITY (WELL DEPTH) e−	DYNAMIC RANGE dB	DYNAMIC RANGE Bits	GAIN e-/ADU
46	7/2	12.86	41.44	6.88	29.74	13932	60.37	10.03	0.22
53	8 / 3	12.03	41.37	6.87	24.76	13701	60.78	10.10	0.22
39	7/2	19.43	44.14	7.33	51.72	25949	62.29	10.35	0.41
70	21 / 8	11.73	41.62	6.91	17.57	14508	61.49	10.21	0.22
71	14 / 4	11.22	43.02	7.14	16.97	20024	64.66	10.74	0.36
42	6 / 2	12.13	40.77	6.77	30.70	11944	59.51	9.89	0.19
72	15 / 5	8.56	40.63	6.75	12.76	11551	62.11	10.32	0.24
62	16 / 5	10.30	39.86	6.62	17.78	9686	59.06	9.81	0.15
68	16 / 5	9.27	39.60	6.58	14.72	9126	59.67	9.91	0.15
61	15 / 4	7.61	38.66	6.42	13.63	7347	59.14	9.82	0.12
53	7 / 2	11.48	40.16	6.67	23.63	10366	58.75	9.76	0.18
73	22 / 7	8.31	43.59	7.24	12.15	22856	68.28	11.34	0.37
56	9 / 3	11.9	42.15	7.00	23.19	16408	62.43	10.37	0.28
59	7 / 2	8.35	39.01	6.48	15.77	7969	59.09	9.82	0.13
67	17 / 5	9.39	41.67	6.92	14.86	14693	63.43	10.54	0.24
79	17 / 6	9.68	40.64	6.78	13.13	11586	61.12	10.15	0.19
68	15 / 5	10.17	39.56	6.57	15.78	9039	58.56	9.73	0.15
75	14/4	9.29	38.10	6.33	13.32	6459	56.39	9.37	0.10
60	9 / 4	9.43	37.68	6.26	17.23	5856	55.42	9.20	0.09
58	9 / 3	8.73	37.90	6.30	16.30	6168	56.50	9.38	0.10
57	8 / 3	8.18	37.71	6.26	15.69	5903	56.66	9.41	0.10
57	8 / 2	5.48	39.08	6.49	10.67	8086	62.61	10.4	0.13
73	16 / 5	10.54	41.60	6.91	15.22	14446	62.34	10.35	0.23
74	16 / 5	10.88	41.53	6.90	15.43	14227	61.94	10.29	0.23
72	16 / 5	10.87	41.56	6.93	13.87	14959	63.40	10.53	0.24
75	16 / 4	9.43	40.00	6.64	13.53	9996	60.06	9.98	0.16
78	13 / 4	10.87	37.87	6.29	14.82	6125	54.63	9.07	0.10
48	37 / 15	40.45	41.83	6.75	85.67	15239	51.41	8.53	0.27
77	21 / 7	6.58	37.44	6.22	9.30	5542	57.87	9.61	0.10
59	22 / 4	25.14	39.24	6.52	43.18	8384	50.29	8.35	0.16
61	22 / 8	25.32	38.76	6.44	43.00	7506	49.27	8.18	0.16
61	21 / 8	26.26	40.10	6.66	44.13	10226	51.64	8.58	0.21
59	20 / 8	9.28	37.82	6.28	16.14	6057	55.84	9.28	0.15
77	12 / 4	6.00	41.90	6.96	8.72	15491	67.55	11.22	0.27
44	15 / 6	20.47	38.55	6.40	47.44	7167	50.68	8.42	0.13
66	22 / 9	24.17	38.92	6.46	37.84	7788	49.99	8.30	0.13
76	13 / 4	6.83*	45.12	7.49	9.77*	32513	72.94	12.11	0.52
77	14 / 4	6.83*	45.14	7.50	9.75*	32691	72.99	12.12	0.51
80	15 / 5	7.11*	45.19	7.50	9.45*	33105	72.77	12.08	0.52
67	13 / 4	6.71	40.03	6.65	10.99	10066	62.90	10.45	0.19
76	19 / 6	2.34*	40.20	6.68	3.98*	10482	71.34	11.85	0.17
53	18 / 7	16.81	38.82	6.45	33.38	7620	52.87	8.78	0.15
57	32 / 13	17.99	39.59	6.58	31.01	9094	53.84	8.94	0.15
76	19 / 6	2.37*	40.15	6.67	4.03*	10361	71.15	11.82	0.17
63	14 / 5	7.64	38.26	6.35	13.00	6693	58.30	9.68	0.11

*Mode 7 (Low Noise Imaging Mode)

MONO SINGLE LENS CAMERAS

QUANTUM EFFICIENCY (%) AT 525 NM (HIGHER IS BETTER)

Quantum efficiency (QE) is the ability of the sensor to turn photons into electrons, or in other words, turn incoming light into an electrical signal for imaging. A higher QE % means greater sensitivity for detecting light. A sensor with a measurement of 79% means that for every 100 photons that hit the sensor an average of 79 will be detected. Please note that the results below are taken at the wavelength of 525nm.



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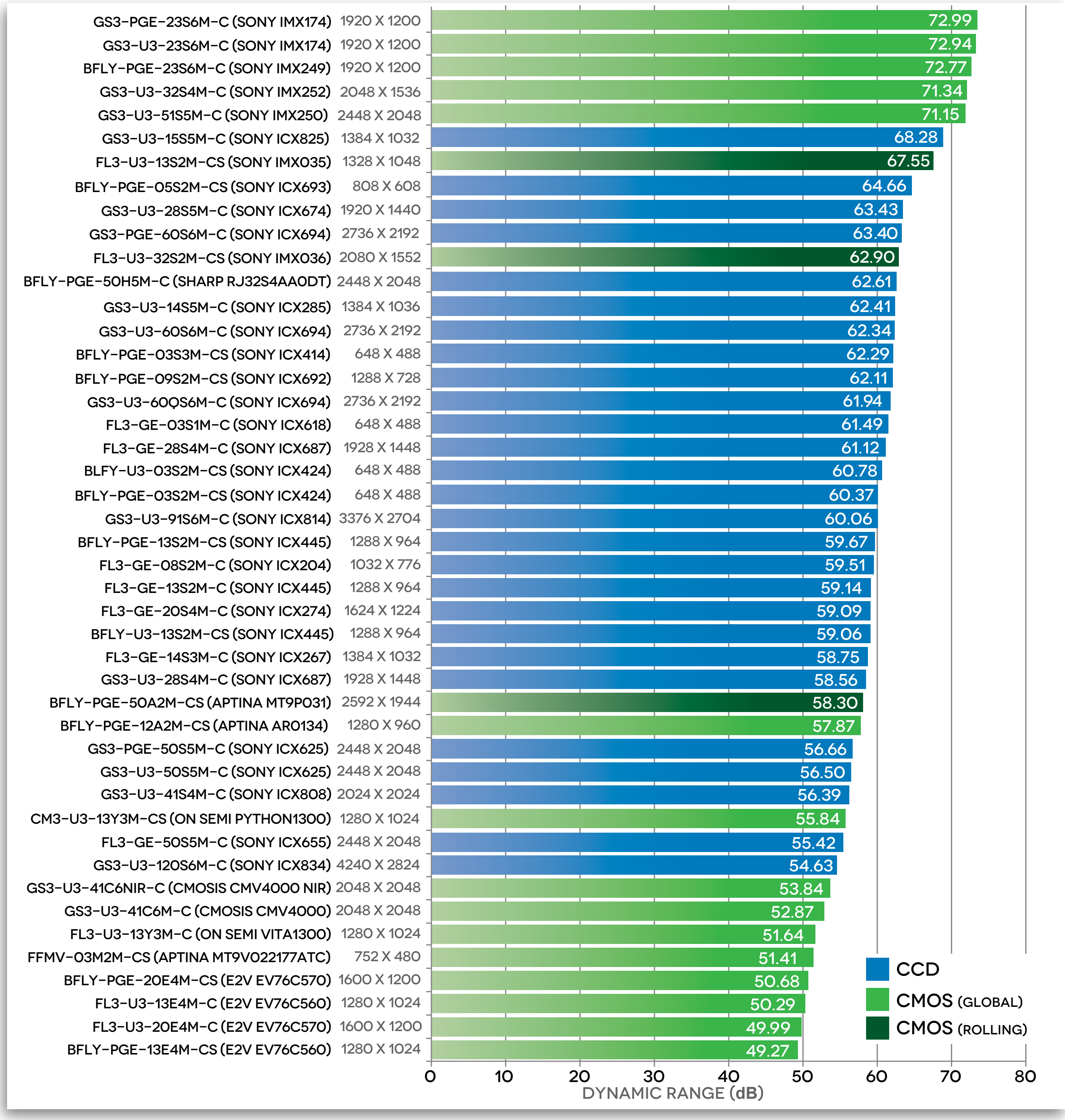
MONO SINGLE LENS CAMERAS

DYNAMIC RANGE dB (HIGHER IS BETTER)

Dynamic range describes the camera model's ability to detect the maximum and minimum of light intensities (shadows and highlights). Models with higher dynamic range can detect more detail in the darks and lights.



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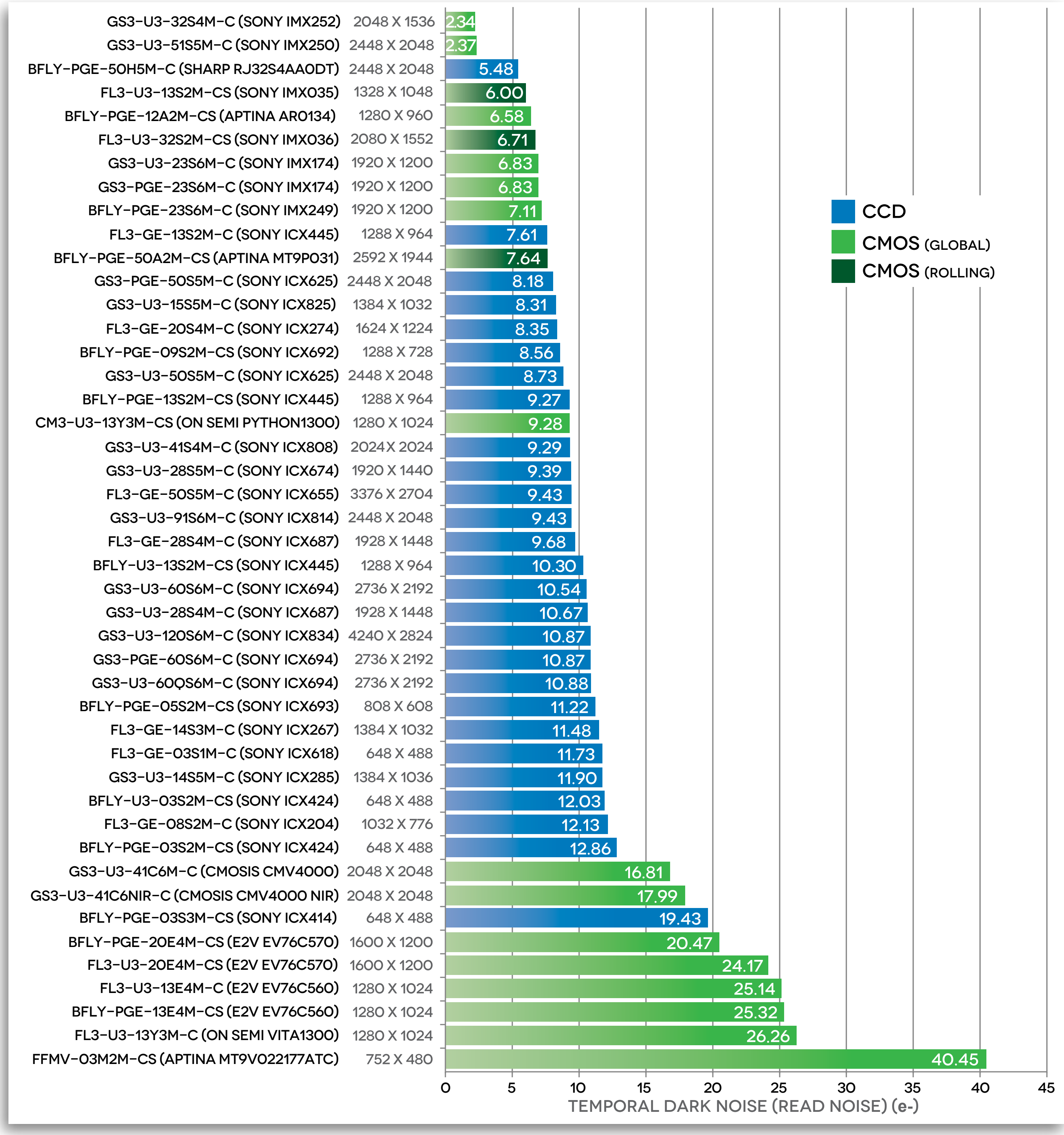
MONO SINGLE LENS CAMERAS

TEMPORAL DARK NOISE / READ NOISE e− (LOWER IS BETTER)

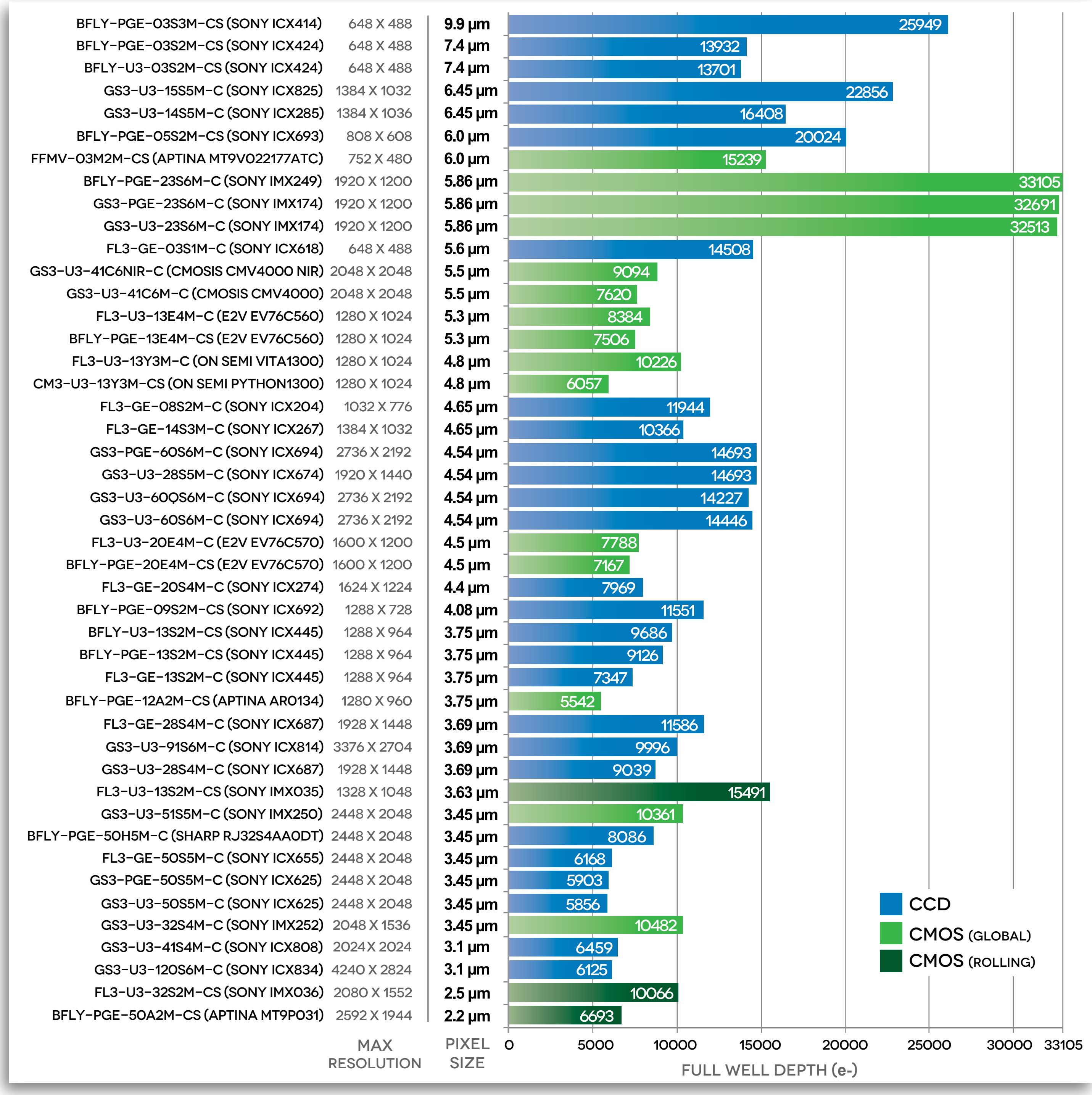
Temporal dark noise (also known as read noise) comes from energy within the sensor and the surrounding sensor electronics. Over time, random electrons are created that fall into the sensor wells and are detected and turned into signal. Models with lower read noise measurements produce cleaner images.



MONO SINGLE LENS CAMERAS

SATURATION CAPACITY (WELL DEPTH) e− (HIGHER IS BETTER, SORTED BY PIXEL SIZE)

The saturation capacity (well depth) is the largest charge a pixel can hold before over-saturation occurs and signal degradation begins. Saturation must be avoided because it diminishes the quantitative ability of the sensor and in the case of CCDs produces image smearing due to a phenomenon known as blooming.



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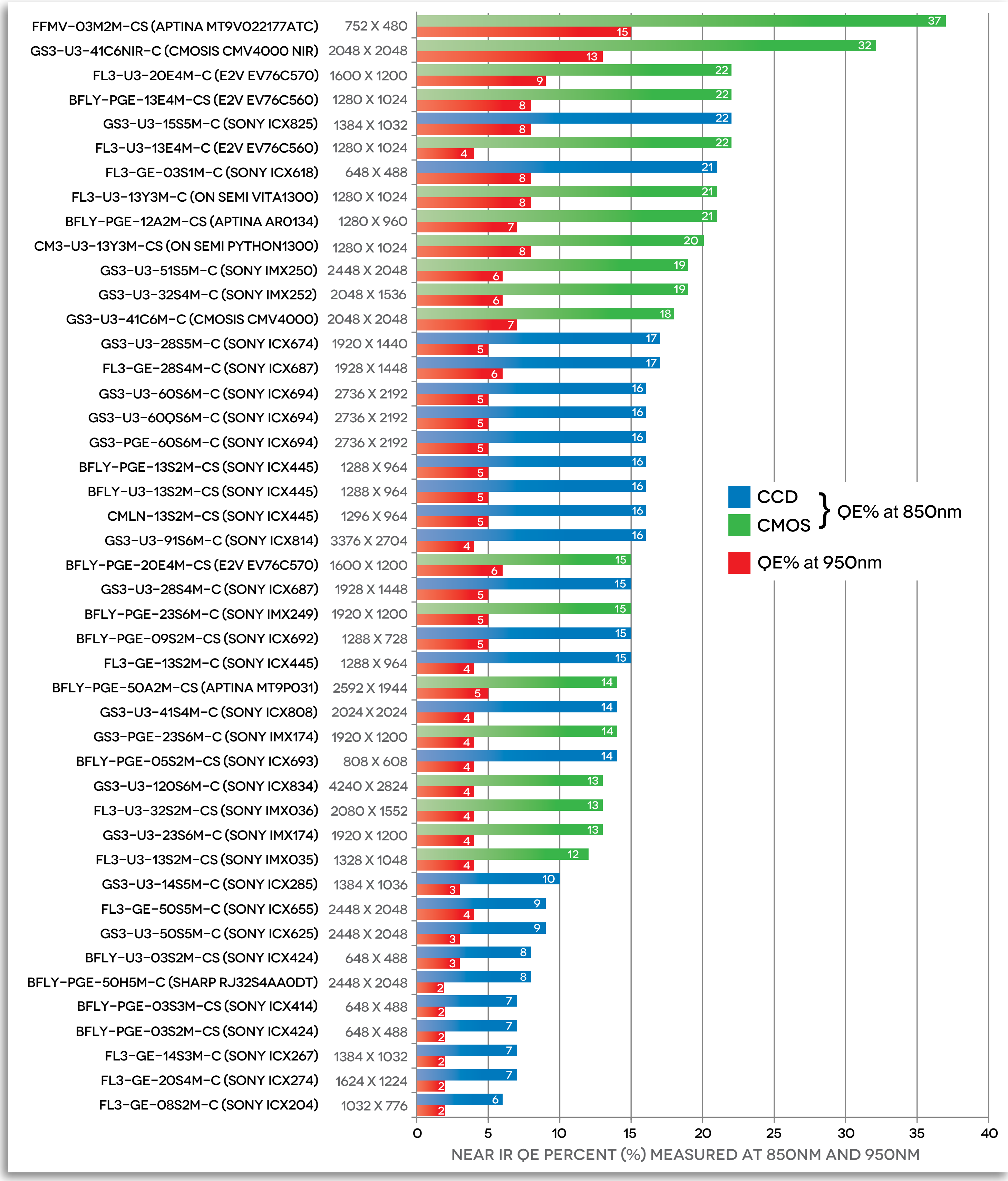
MONO SINGLE LENS CAMERAS

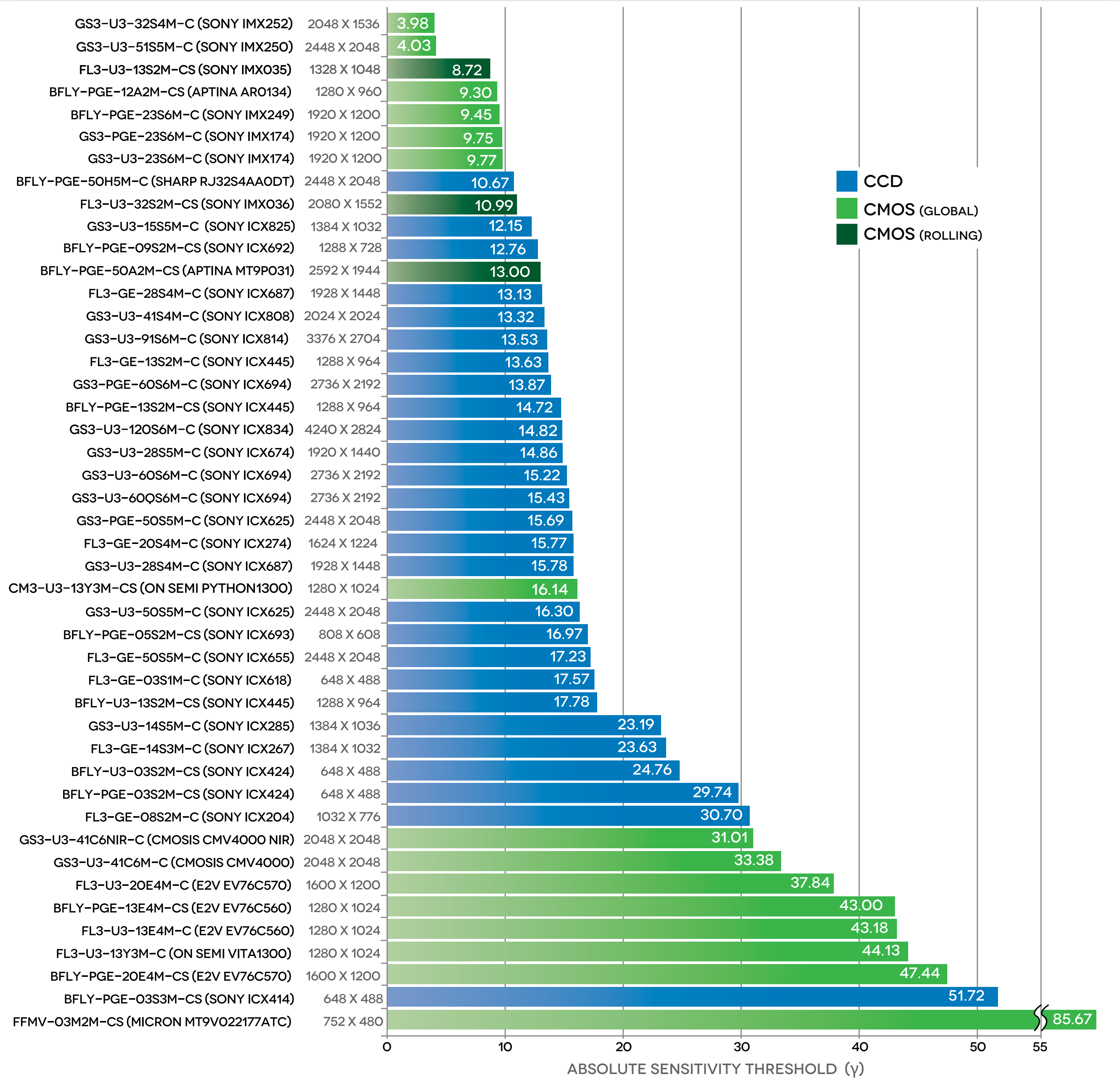
NEAR IR QE (%) (HIGHER IS BETTER)



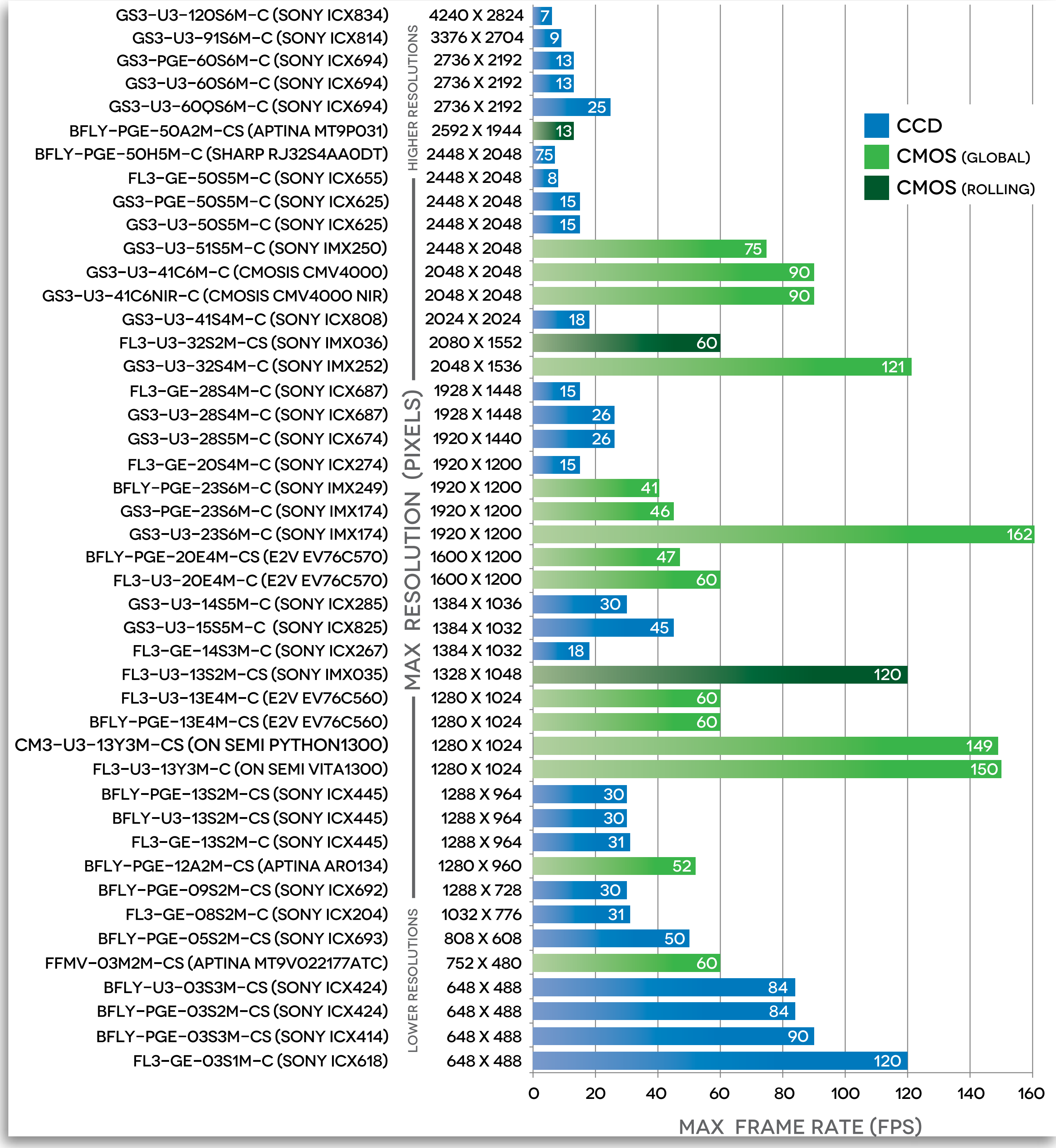
MONO SINGLE LENS CAMERAS

ABSOLUTE SENSITIVITY THRESHOLD (γ) (LESS IS BETTER)

Absolute sensitivity threshold is the minimum number of photons needed to equal the noise level. The lower the number the less light is needed to detect useful imaging data.



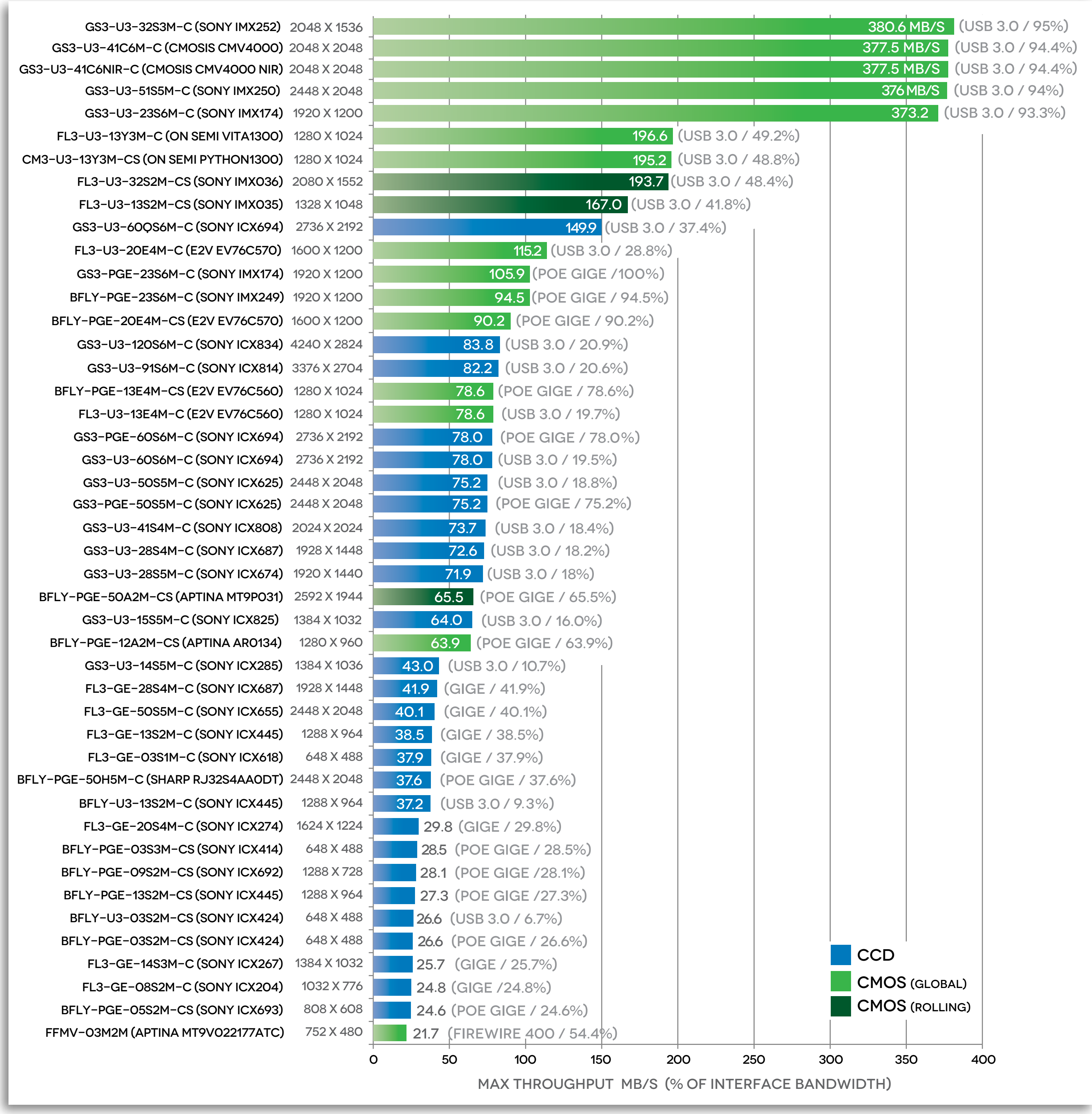
MAX RESOLUTION TO MAX FRAME RATE



MONO SINGLE LENS CAMERAS

CAMERA THROUGHPUT (MB/S) AND % OF INTERFACE BANDWIDTH

When considering multi-camera setups bandwidth considerations are a must. We calculated the maximum throughput (MB/s) by multiplying the maximum resolution by the maximum frame rate (note: to simplify these calculations an image data format of Mono8 was used). In addition we added the percentage of interface bandwidth which the camera model pumped out. For those calculations we used 400 MB/s for USB 3.0, 100 MB/s for GigE, 80 MB/s for FireWire 800, and 40 MB/s for both FireWire 400 and USB 2.0.



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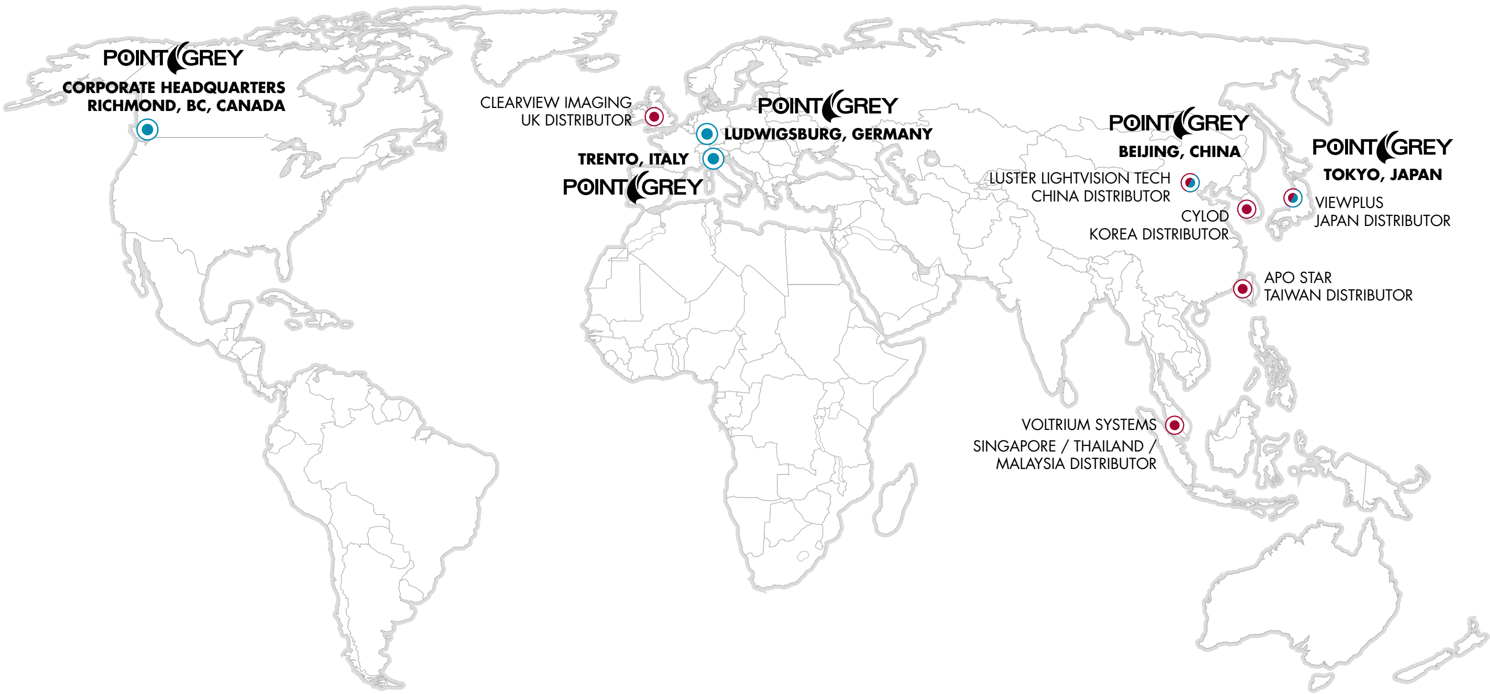

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