Test Lab Services Report

Drone Camera Comparison

Report ID: SKYDIO

Date: October 10, 2023

Requested by:

Skydio

Prepared by:

JP Westenskow
Jonathan Phillips
Meg Borek

Contents

About Imatest

Imatest is a leader in image quality testing that has been headquartered in Boulder, Colorado since 2004. Imatest team members include a range of engineering disciplines including imaging science, computer science, physics, optical, electrical, and mechanical engineering.

Imatest software, test charts, equipment, and services enable the imaging industry to develop the best products possible. We serve customers across many industries, including automotive, mobile, consumer electronics, security, aerospace, and medical. We provide the tools, resources, and knowledge to test all types of imaging systems, from satellites to camera phones, in visible light or infrared. Imatest helps eliminate bias by providing independent, impartial image quality testing for both design and manufacturing. Our clients can be confident they are testing the aspects of their systems that matter most to their customers. Our team is dedicated to enabling the imaging industry to provide accurate measurements that will help them improve the quality of their imaging products.

Overview of Test Lab Services

As experts in the field of image quality testing, leave the IQ lab work to us. We know that each test lab setup is unique to the needs of your company:

- We help create a customized service that achieves the testing objectives of your organization while working within your budget.
- Trained consultants will spend time with your team to better understand your needs and create a test plan to meet your project goals.
- Our detail-oriented engineers will test your equipment using our hardware, charts, and software to analyze images and interpret results—saving you time and resources.
- Provide consistent, repeatable, and trustworthy results through rigorous testing protocols, allowing you to build a portfolio of reports.

Service Offerings:

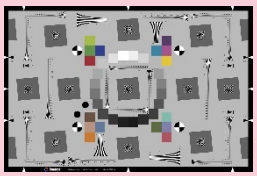
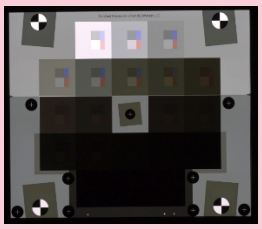
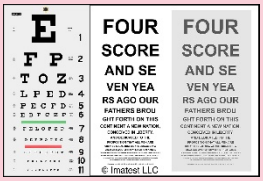
- Sensor evaluation
- Camera hardware design
- ISP tuning
- Benchmarking

Example Image Quality Metrics we provide:

- MTF (modulation transfer function)
- Dynamic Range
- Low light performance
- Temporal noise
- Motion blur
- And more

For more information, visit www.imatest.com/test-lab-services or contact us at LabServices@imatest.com

Test Conditions

KPI	Test Chart	Type	Image	Light Source	Lighting Condition
Color **SFR/Resolution** **Noise**	eSFR ISO	Reflective		Kino Flo PAN-F31	Daylight: 1000 lux, 6500K CCT Lowlight: 25 lux, 3000K CCT
Dynamic Range	Contrast Resolution	Transmissive		Imatest ILB-100K	Bright Daylight: 100,000 lux, 6500K CCT
Subjective	Snellen Chart/Four Score	Reflective		Kino Flo PAN-F31	Daylight: 1000 lux, 6500KCCT Lowlight: 25 lux, 3000K CCT

2525 Frontier Ave, Suite B, Boulder, CO 80301, USA 1-800-599-3154

Camera Systems

Camera	Sensor Resolution	Focal Length	Aperture	Focus	Max Photo Size
Skydio X10 Narrow	64MP	10mm (46mm equivalent)	f/1.8	Hybrid PDAF*, 1m to ∞	9248 x 6944
Skydio X10 Telephoto	48MP	35mm (190mm equivalent)	f/2.2	Hybrid PDAF*, 5m to ∞	8,000 x 6,000
DJI Matrice 30	48MP	21-75mm (405-1113mm equivalent)	f/2.8-4.2	5m to ∞	8,000 x 6,000
DJI Mavic 3E	20MP	84° (24mm equivalent)	f/2.8-f/11	1m to ∞	5280 x 3956
Autel 4T	50MP	4.5mm (23mm equivalent)	f/1.9	PDAF* focus	8192 x 6144 or 4096 x 3072

* Phase Detection Auto Focus

The camera specifications for the Skydio X10 cameras were provided to Imatest directly by the manufacturer, while the specifications of the remaining cameras were pulled from the manufactures' websites.

2525 Frontier Ave, Suite B, Boulder, CO 80301, USA 1-800-599-3154

Drone Images

Skydio X10	
DJI Matrice 30	
DJI Mavic 3E	
Autel 4T	

2525 Frontier Ave, Suite B, Boulder, CO 80301, USA 1-800-599-3154

Camera Modes and Capture Distances

Camera Model	Camera Modes Tested		
	Full Resolution	Binned Photo	High Dynamic Range (HDR)
Skydio X10 Narrow	✓	✓	✓
Skydio X10 Telephoto*	✓	✓	✓
DJI Mavic 3E	✓		
DJI Matrice 30*	✓	✓	
Autel 4T*	✓		

*Tested at a 5m distance – The other camera models were tested at 1 or 2 meter distances

The DJI Mavic 3E images were captured at 1 meter while the Skydio X10 Narrow images were captured at 2 meters. Distances resulted in matched FOV for each to allow for an equivalent objective comparison. All the telephoto cameras were tested at 5 meters as a typical use of the drone telephoto cameras in this comparison is for remote inspection where safe distances are limited to ~5 meters. Thus, we tested them all at 5 meters and we did not match the FOV between the cameras.

Definitions and Descriptions of Metrics

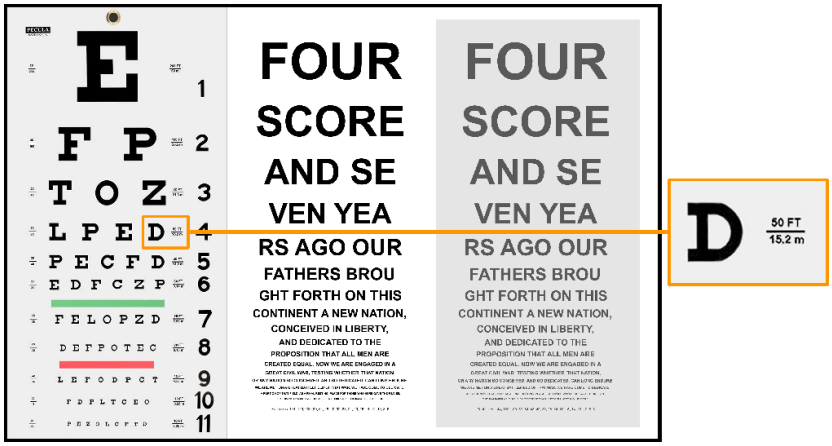
- **Spatial Frequency Response (SFR) / Modular Transfer Function (MTF)** – The MTF measures a camera system's ability to reproduce the original frequencies in an image. Generally, higher MTF values indicate better sharpness performance.
- **Signal to Noise Ratio (SNR) / Noise** – SNR is the ratio of the signal power verses the background noise power. Generally, higher SNR values indicate better noise performance.
- **Color Accuracy** – Delta E is a single number that represents the distance between 2 colors in 3-dimensional perceptual space, which includes the lightness axis. Delta C is singularly the chroma difference between 2 colors. The color pairs being compared in these metrics are the reference values in the charts and the camera's reproduced color. Generally, lower mean Delta E and Delta C numbers indicate better color accuracy performance.
- **Dynamic Range (DR)** – DR is the working range of exposure in decibels (dB) over which a camera responds with good contrast and good SNR. Generally, higher dB values indicate better performance of the camera system and the system's ability to capture a wider signal range.

Spatial Frequency Response (SFR) - MTF50P

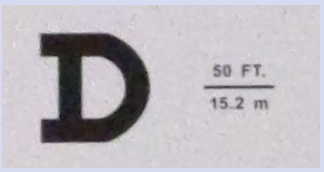
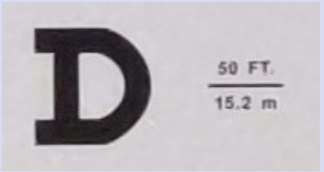
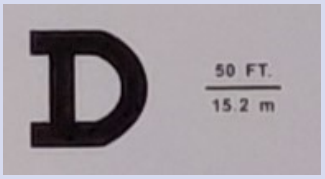
Best Daylight Results

Best Lowlight Results

Generally, higher MTF values indicate better sharpness performance.



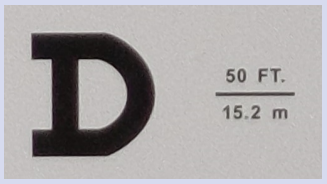
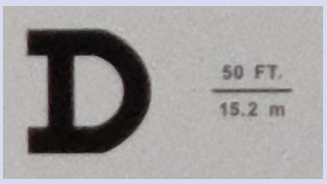
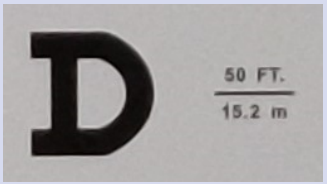
Narrow System SFR – Matched Field of View

imatest®	Daylight: 6500K at 1000 Lux		Lowlight: 3000K at 25 Lux	
Device	**MTF50P [LW/PH]**	**Snellen Chart Crop**	**MTF50P [LW/PH]**	**Snellen Chart Crop**
Skydio X10 Narrow Full Res - Standard	**5330**		2007	
Skydio X10 Narrow 1/4 Res - Standard	3221		**2929**	
Skydio X10 Narrow 1/4 Res - HDR	2514		2060	
DJI Mavic 3E*	3632		2198	

* Captured at 1m. Others captured at 2m. Distances resulted in matched FOV for each to allow for an equivalent objective comparison between camera systems.

Telephoto System SFR – 5m Capture Distance

imatest®

Device	Daylight: 6500K at 1000 Lux		Lowlight: 3000K at 25 Lux	
	MTF50P [LW/PH]	Snellen Chart Crop	MTF50P [LW/PH]	Snellen Chart Crop
Skydio X10 Tele Full Res - Standard	**3491**		1268	
Skydio X10 Tele 1/4 Res - Standard	2945		**2147**	
Skydio X10 Tele 1/4 Res - HDR	1814		1269	
DJI M30 Full Resolution	2977		1413	
DJI M30 Binned	1894		1538	
Autel 4T	1824		1770	

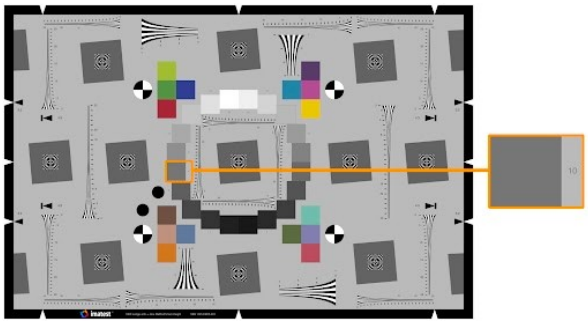
2525 Frontier Ave, Suite B, Boulder, CO 80301, USA 1-800-599-3154

Noise

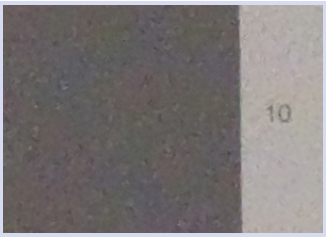
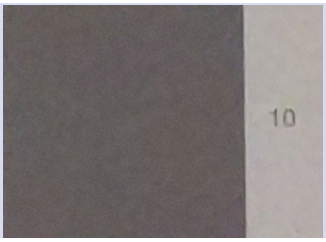
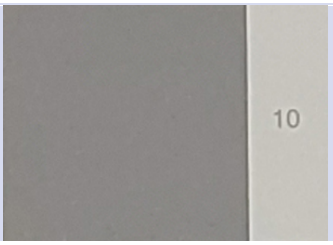
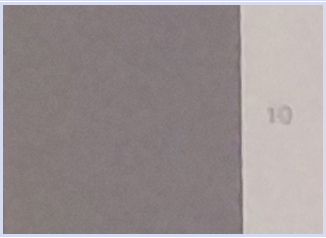
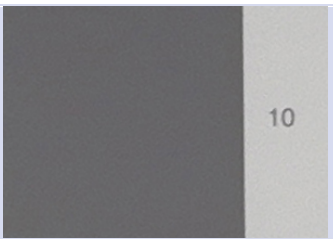
Best Daylight Results

Best Lowlight Results

Generally, higher SNR values indicate better noise performance.

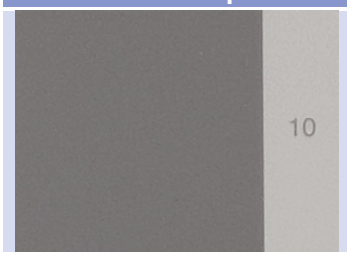
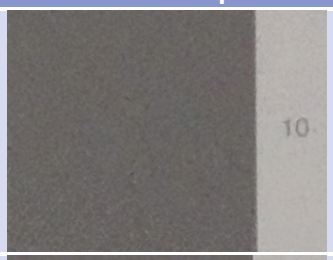
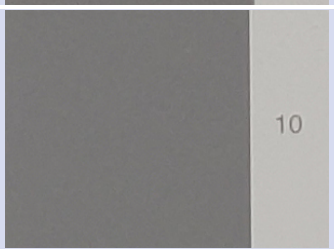
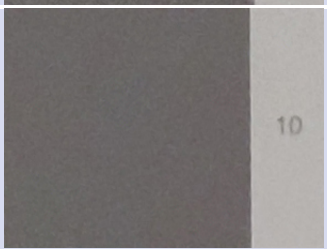
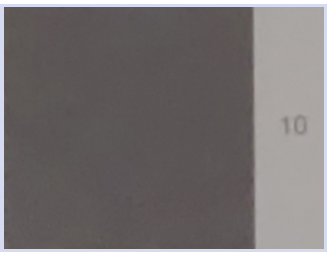
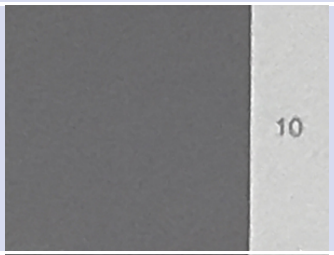
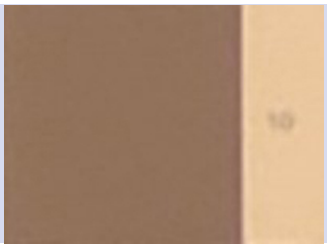


Narrow System Signal to Noise (SNR) – Matched Field of View

imatest®	Daylight: 6500K at 1000 Lux		Lowlight: 3000K at 25 Lux	
Device	**SNR [dB]**	**Chart Crop**	**SNR [dB]**	**Chart Crop**
Skydio X10 Narrow Full Res - Standard	36.9		32.5	
Skydio X10 Narrow 1/4 Res - Standard	**44.3**		36.0	
Skydio X10 Narrow 1/4 Res - HDR	41.7		37.2	
DJI Mavic 3E*	43.4		**39.2**	

*Captured at 1m. Others captured at 2m. Distances resulted in matched FOV for each to allow for an equivalent objective comparison between camera systems.

Telephoto System Signal to Noise (SNR) – 5m Capture Distance

imatest®	Daylight: 6500K at 1000 Lux		Lowlight: 3000K at 25 Lux	
Device	**SNR [d]**	**Chart Crop**	**SNR [dB]**	**Chart Crop**
Skydio X10 Tele Full Res - Standard	40.0		35.1	
Skydio X10 Tele 1/4 Res - Standard	42.9		39.1	
Skydio X10 Tele 1/4 Res - HDR	43.4		45.3	
DJI M30 Full Resolution	43.2		35.9	
DJI M30 Binned	44.3		36.0	
Autel 4T*	**51.6**		**50.1**	

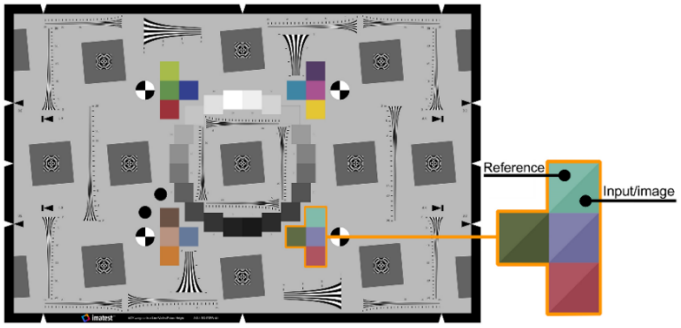
* SNR values should be compared with a subjective evaluation because high SNR values are likely attributed to strong noise reduction. Our subjective evaluation of the Autel 4T indicates strong loss in fine details and quality due to presumed noise reduction. Refer to the cropped images in the SFR section above for examples.

Color Accuracy - CIE 2000

Best Daylight Results

Best Lowlight Results

Generally, lower mean ΔE and ΔC values indicate better color accuracy.



Narrow System Color Error – Matched Field of View - ΔE

imatest®	Daylight: 6500K at 1000 Lux		Lowlight: 3000K at 25 Lux	
Device	**Color Error: CIE 2000**	**Split [Reference/Input]**	**Color Error: CIE 2000**	**Split [Reference/Input]**
Skydio X10 Narrow Full Res - Standard	**ΔE_{00}: 6.16**		ΔE_{00}: 8.46	
Skydio X10 Narrow 1/4 Res - Standard	ΔE_{00}: 6.20		ΔE_{00}: 8.30	
Skydio X10 Narrow 1/4 Res - HDR	ΔE_{00}: 6.72		**ΔE_{00}: 4.12**	
DJI Mavic 3E*	ΔE_{00}: 6.48		ΔE_{00}: 17.15	

* Captured at 1m. Others captured at 2m. Distances resulted in matched FOV for each to allow for an equivalent objective comparison between camera systems.

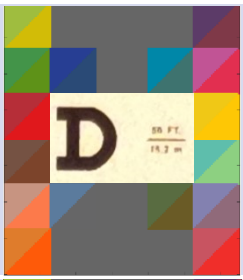
Narrow System Color Error – Matched Field of View - ΔC

imatest®	Daylight: 6500K at 1000 Lux		Lowlight: 3000K at 25 Lux	
Device	**Color Error: CIE 2000**	**Split [Reference/Input]**	**Color Error: CIE 2000**	**Split [Reference/Input]**
Skydio X10 Narrow Full Res - Standard	ΔC_{00}: 3.35		**ΔC_{00}: 3.06**	
Skydio X10 Narrow 1/4 Res - Standard	ΔC_{00}: 3.37		ΔC_{00}: 3.25	
Skydio X10 Narrow 1/4 Res - HDR	ΔC_{00}: 3.95		ΔC_{00}: 10.77	
DJI Mavic 3E*	**ΔC_{00}: 2.72**			

* Captured at 1m. Others captured at 2m. Distances resulted in matched FOV for each to allow for an equivalent objective comparison between camera systems.

2525 Frontier Ave, Suite B, Boulder, CO 80301, USA 1-800-599-3154

Telephoto System Color Error - ΔE

imatest®	Daylight: 6500K at 1000 Lux		Lowlight: 3000K at 25 Lux	
Device	**Color Error: CIE 2000**	**Split [Reference/Input]**	**Color Error: CIE 2000**	**Split [Reference/Input]**
Skydio X10 Tele Full Res - Standard	ΔE_{00}: 6.59		ΔE_{00}: 9.37	
Skydio X10 Tele 1/4 Res - Standard	ΔE_{00}: 5.77		**ΔE_{00}: 8.87**	
Skydio X10 Tele 1/4 Res - HDR	ΔE_{00}: 7.71		ΔE_{00}: 12.63	
DJI M30 Full Resolution	**ΔE_{00}: 4.75**		ΔE_{00}: 13.52	
DJI M30 Binned	ΔE_{00}: 4.92		ΔE_{00}: 12.75	
Autel 4T	ΔE_{00}: 11.11		ΔE_{00}: 10.78	

2525 Frontier Ave, Suite B, Boulder, CO 80301, USA 1-800-599-3154

Telephoto System Color Error - ΔC

imatest®	Daylight: 6500K at 1000 Lux		Lowlight: 3000K at 25 Lux	
Device	**Color Error: CIE 2000**	**Split [Reference/Input]**	**Color Error: CIE 2000**	**Split [Reference/Input]**
Skydio X10 Tele Full Res - Standard	ΔC_{00}: 4.16		ΔC_{00}: 6.66	
Skydio X10 Tele 1/4 Res - Standard	ΔC_{00}: 3.96		**ΔC_{00}: 5.27**	
Skydio X10 Tele 1/4 Res - HDR	ΔC_{00}: 4.14		ΔC_{00}: 5.73	
DJI M30 Full Resolution	ΔC_{00}: 2.89		ΔC_{00}: 12.49	
DJI M30 Binned	**ΔC_{00}: 2.84**		ΔC_{00}: 12.22	
Autel 4T	ΔC_{00}: 5.91		ΔC_{00}: 10.16	

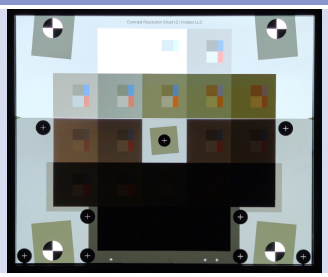
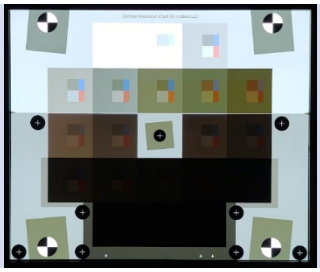
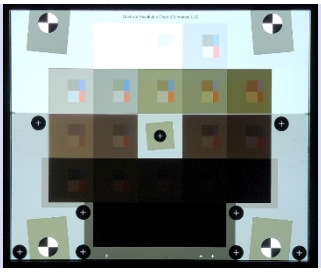
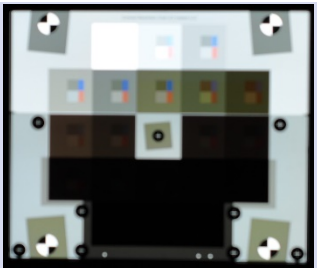
2525 Frontier Ave, Suite B, Boulder, CO 80301, USA 1-800-599-3154

Dynamic Range (DR) – Quality-Based

Best Daylight Results

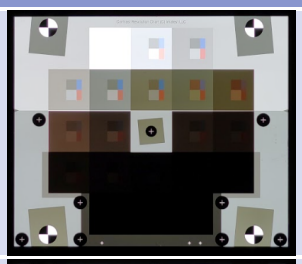
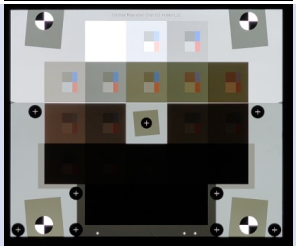
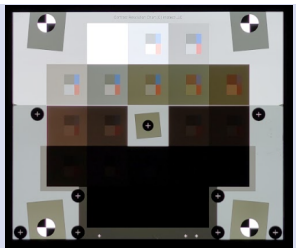
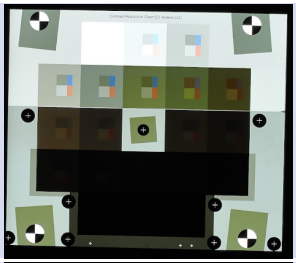
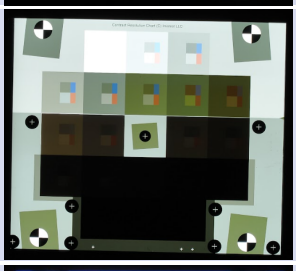
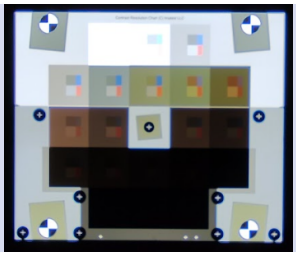
Generally, higher dB values indicate better performance of the camera.

Narrow System Dynamic Range

imatest®	Daylight: 6500K at 100,000 Lux	
Device	**DR at SNR = 0 [dB]**	**Chart Crop**
Skydio X10 Narrow Full Res - Standard	60.7	
Skydio X10 Narrow 1/4 Res - Standard	60.9	
Skydio X10 Narrow 1/4 Res - HDR	58.7	
DJI Mavic 3E	**65.3**	

2525 Frontier Ave, Suite B, Boulder, CO 80301, USA 1-800-599-3154

Telephoto System Dynamic Range

imatest®	Daylight: 6500K at 100,000 Lux	
Device	**DR at SNR = 0 [dB]**	**Chart Crop**
Skydio X10 Tele Full Res - Standard	68.2	
Skydio X10 Tele 1/4 Res - Standard	66.0	
Skydio X10 Tele 1/4 Res - HDR	**80.2**	
DJI M30 Full Resolution	66.0	
DJI M30 Binned	67.1	
Autel 4T	67.4	

Results and Discussion

We applied an image quality assessment with four key image quality factors (IQFs)—spatial frequency response (sharpness), noise, color accuracy, and dynamic range—to benchmark the autofocus cameras for a given set of drones. The body of this report contains representative salient metrics of these four IQFs as well as image content from the analyzed files for visual inspection. The Appendix contains additional metrics for all IQFs, including data plots, objective results, and more image content from analyzed files.

The camera systems tested include: Skydio X10 Narrow (full resolution - standard, 1/4 resolution - standard and 1/4 resolution - HDR settings), Skydio X10 Telephoto (full resolution - standard, 1/4 resolution - standard, and 1/4 resolution - HDR settings), DJI Matrice 30 (full resolution and binned settings), DJI Mavic 3E (full resolution), and Autel 4T (full resolution).

Four systems were evaluated for sharpness, noise, and color accuracy at a capture distance of 1 or 2 meters in order to have matched fields of view for an application of close range of an operating drone. The additional six systems were evaluated for the same IQFs at a capture distance of 5 meters to allow for assessment of their telephoto properties. These IQFs of sharpness, noise and color accuracy were evaluated at both simulated daylight (1,000 lux at 6500K) and warm, lowlight (25 lux at 3,000K) illumination conditions. For all testing, dynamic range was evaluated in a manner such that the chart was 40% of the image content at a bright level and color temperature representing high dynamic range performance in simulated bright daylight (100,000 lux at 6,500K).

Spatial Frequency Response (SFR)

For the closer capture condition set, the Skydio X10 camera system (with narrow field of view and full resolution - standard setting) exhibited the sharpest mean MTF50P of 5440 line widths/picture height (LW/PH) under daylight illumination. The Skydio X10 camera system (with narrow field of view and 1/4 resolution - standard setting) exhibited the sharpest mean MTF50P (2929 LW/PH) under lowlight illumination. Note that all systems exhibited lower sharpness at lowlight conditions, which is typical for captures at such conditions due to other factors, such as noise, that reduce image quality. Both of these X10 capture settings achieved high sharpness with minimal over sharpening, as can be observed by the low amount of ringing in the fine font of the related Snellen/Four Score chart crops. Ringing is more apparent for the Skydio X10 1/4 resolution - HDR setting in daylight, seen as light halos around the font. One can also observe the peak MTF value of over 2 in the MTF plot of the Appendix, an indicator of over sharpening for this Skydio 1/4 resolution - HDR setting. However, a concerning aspect to mention in this set of drones is that DJI Mavic 3E system in lowlight conditions exhibited issues with autofocusing. We chose to show the sharpest of the set of captures in the summary comparison, with a maximum mean MTF50P of 2198 LW/PH. However, note that there were also captures with autofocus failures, resulting in a poor mean MTF50P as low as 561.7 LW/PH as shown in the Appendix. This range of sharpness points to the challenge of obtaining focused images with M3E under lowlight, a challenge that was not apparent with other systems we tested, including those in the telephoto set.

For the telephoto capture condition, we observed a much bigger spread in the performance of the camera systems. Once again, the Skydio X10 camera system (with telephoto field of view and full resolution – standard setting) exhibited the sharpest mean MTF50P of 3491 LW/PH under daylight illumination. Similarly, the Skydio X10 camera system (with telephoto and 1/4 resolution - standard setting) exhibited

the sharpest mean MTF50P of 2147 LW/PH under lowlight illumination here, too. Again, all systems exhibited lower sharpness at lowlight conditions. In this telephoto set, the DJI Matrice 30 showed the most sharpening, with a peak MTF value nearly 2 under Daylight conditions, as with the Skydio X10 1/4 resolution - HDR setting in first comparison set. The sharpness concerns in this telephoto set can be seen in the crop of the Snellen/Four Score chart, particularly the finest font. While the MTF50P values are solid for the edge performance of the systems, the image content breaks down in the finest of detail, i.e., the "50 FT." and "15.2 m" content. For the DJI Matrice 30 full resolution and binned as well as the Autel 4T, these fonts are quite degraded, particularly at the lowlight condition. In fact, for the Autel, even at daylight condition, character recognition is difficult to decipher. Typically, this is due to the noise cleaning approach of the system's ISP (image signal processing).

Noise

The results from the closer capture condition set reveal that the Skydio X10 camera system (with narrow field of view and 1/4 resolution - standard setting) exhibited the highest (best) Signal-to-Noise (SNR) value of 44.3 dB in daylight condition, while the DJI Mavic 3E has the highest SNR value of 39.2 dB in lowlight conditions. One can also note in systems with lower SNR that there is stronger appearance of noise such as the colored noise seen in the Skydio X10 camera system (with narrow field of view and full resolution - standard setting) under lowlight condition with an SNR of 32.5 dB.

In the telephoto set, the Autel 4T demonstrated high SNR values for daylight (51.6 dB) and lowlight (50.1 dB) conditions. However, these 4T SNR values must also be paired with subjective evaluation of content outside of the flatfield, or low frequency, area used to measure SNR. Of note is the observation that the font quality of the "10" in the Autel 4T captures shown in the Snellen chart crops is strongly degraded. This type of high SNR with lack of detail in non-flatfield regions is typical of camera systems that use strong denoising that causes other IQFs, such as texture and details, to suffer. One can also note in systems with lower SNR that there is stronger appearance of noise such as the DJI Matrice 30 full resolution and binned (SNR = 35.9 dB and 36.0 dB, respectively), which both have strong apparent noise, accentuated by the lack of white balance correction for the lowlight captures. Note that the reported SNR values are for the luma channel only, and color assessment is also an important IQF to consider in conjunction with noise.

Color Accuracy

The color accuracy of the closer capture condition set under daylight was fairly similar across systems, with the the Skydio X10 camera system (with narrow field of view and full resolution – standard setting) showing a slight advantage with ΔE 2000 of 6.16 and the DJI Mavic 3E's ΔC 2000 of 2.72. In lowlight conditions, however, showed a strong difference in color accuracy for the DJI Mavic 3E, which reached ΔE 2000 and ΔC 2000 errors of 17.15 and 10.77, respectively, due to a lack of white balance correction. The extent of these errors can be seen in the length of the color shift lines in the a*b* plot and in the high ΔC values of the neutrals in the ΔC versus L* plot in the Appendix. The Skydio X10 applied white balance correction and had the lowest errors for the narrow field of view and full resolution - standard setting (ΔC 2000 of 3.06) and 1/4 resolution - HDR setting (ΔE 2000 of 4.12).

The color errors were lower (better) for the telephoto set in the daylight condition, with the DJI Matrice 30 at the full resolution setting having the lowest error of ΔE 2000 of 4.75. The DJI Matrice 30 also had the

lowest ΔC 2000 value of 2.84 in this set for its binned setting. Again, in the telephoto set, the Skydio X10 had the lowest color errors for the lowlight condition, with both minimum color errors for the 1/4 resolution - standard setting (ΔE 2000 of 5.77 and ΔC 2000 of 3.96). The ΔE 2000 and ΔC 2000 errors were high under lowlight for the DJI Matrice 30 in full resolution and binned settings as well as for the Autel 4T due to their lack of white balance correction (all values over 10). Note that even in Daylight conditions, the Autel 4T had noticeably higher color errors compared to the other systems. Again, see the a*b* plots and in the high ΔC values of the neutrals in the ΔC versus L* plots in the Appendix to better explore these color errors.

Dynamic Range

Imatest uses a quality (SNR)-based approach to assessing dynamic range, which also takes into account the presence of tone mapping. This assessment takes into account the impact of noise on the performance, which can be especially high in the dark portion of the range. A strength of the quality-based approach is that it is robust against flare light and uncorrected black level offsets. To consider all of the dynamic range that is visually meaningful, we look at the value obtained for all patches that have SNR greater than 0 dB. More details about our chart and our analysis can be found at our webpage, https://www.imatest.com/solutions/dynamic-range/.

For the closer capture systems, the DJI Mavic 3E had the highest dynamic range of 65.3 dB, influenced by its higher SNR levels observed, especially at lower light levels. The Skydio X10 versions ranged from 58.7 to 60.9 dB, impacted, in part, by slightly lower SNR at lower light levels. For the telephoto capture systems, the highest dynamic range was observed with the Skydio X10 camera system (with telephoto and 1/4 resolution - HDR setting) at a very strong 80.2 dB, aided by its HDR processing and strong SNR levels.

Conclusions

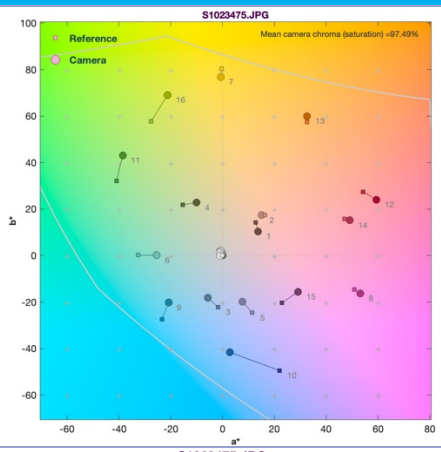
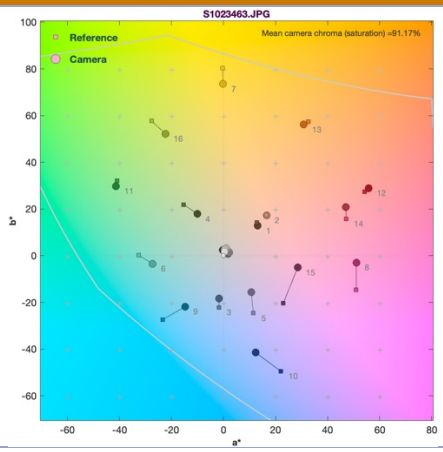
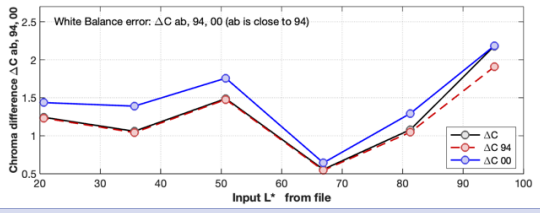
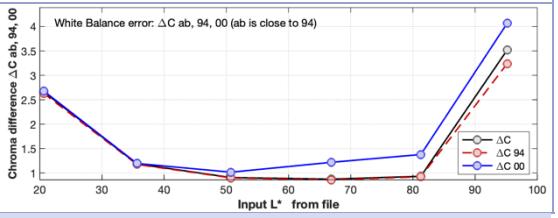
For the given set of drones in this report, we evaluated sharpness, noise, color accuracy, and dynamic range. The Skydio X10 camera systems, both narrow and telephoto, had winners in all four IQFs, notably with their solid sharpness and color accuracy results. Their lowlight SNR performance in full resolution – standard mode for narrow field of view and telephoto exhibited noise at a more visible level than other X10 settings we tested. The DJI Mavic 3E camera system had wins in noise, color (daylight), and dynamic range. In warm lowlight conditions, the DJI Mavic 3E exhibited a highly variable autofocus that frequently failed, and the lack of white balance correction reduced image quality in measurable amounts. The DJI Matrice M30 had wins in color (daylight), but had poor color accuracy and low SNR in warm, lowlight conditions. While the Autel 4T had the highest SNR in both daylight and lowlight conditions, the overall image quality suffered from strong loss of texture and fine detail, which usually corresponds ~~to~~ with too much denoising without consideration of other IQFs. In addition, the Autel 4T had high color accuracy errors, particularly under lowlight conditions.

Disclaimer: These results are indicative of the particular systems we tested. The DJI Mavic 3E, DJI Matrice 30 and Autel 4T drone camera systems were integrated products purchased off the shelf and updated with the latest

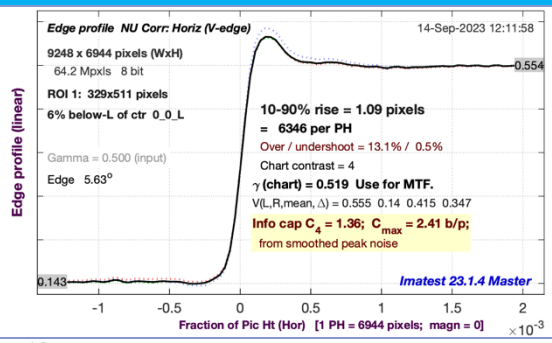
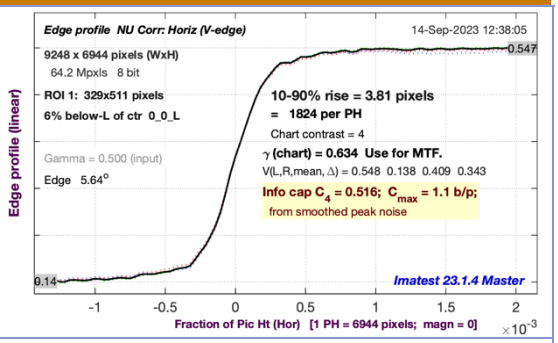
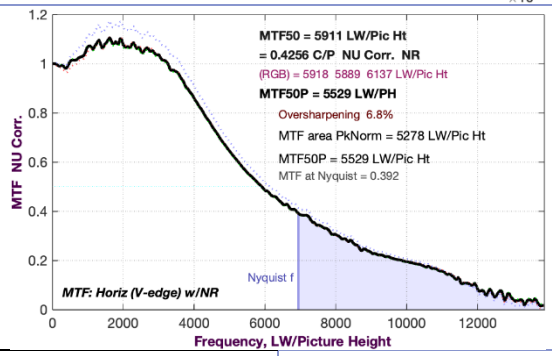
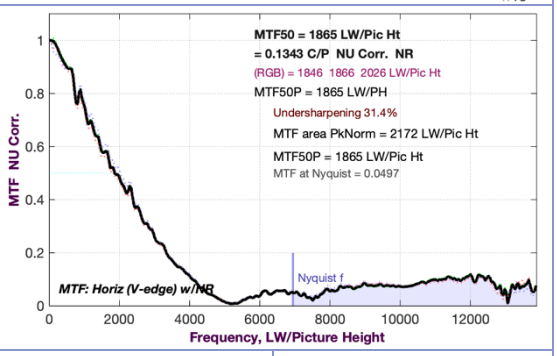
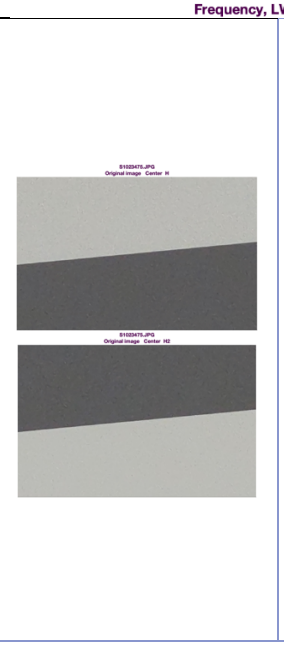
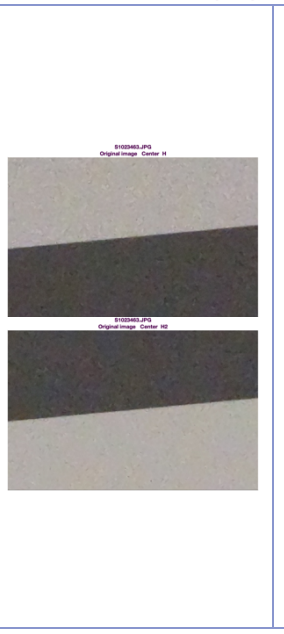
firmware and software at time of testing. The Skydio X10 camera system was a self-contained camera module system with launch firmware and software.

Appendix

Skydio X10 Narrow, Full Res - Standard, Color and Lightness Accuracy (CIE 2000)

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
2D a*b* plot		
Split Color Reference		
ΔC* vs ΔL* (Neutrals Only)		
Summary	Mean ΔE 2000: 6.16 Mean ΔC 2000: 3.35 Mean Camera Chroma: 97.49%	Mean ΔE 2000: 8.46 Mean ΔC 2000: 3.06 Mean Camera Chroma: 91.17%

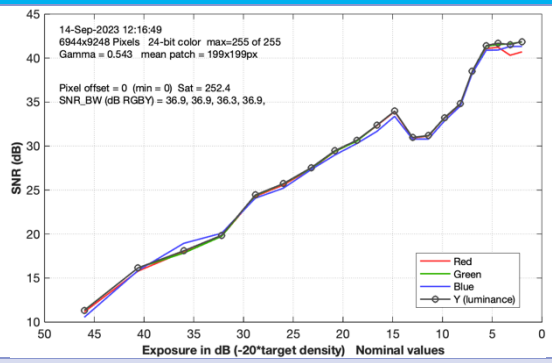
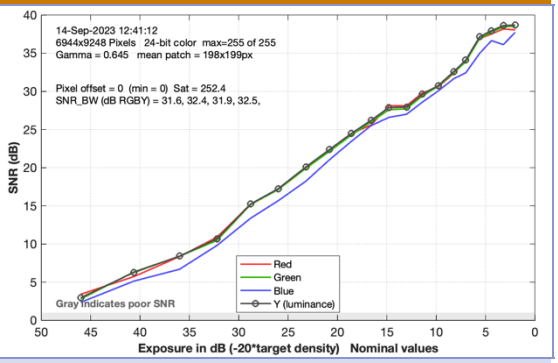
Skydio X10 Narrow, Full Res - Standard, SFR/Resolution Analysis

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
ESF Edge Spread Function		
MTF Modular Transfer Function		
Slanted Edge Images (From ROI)		

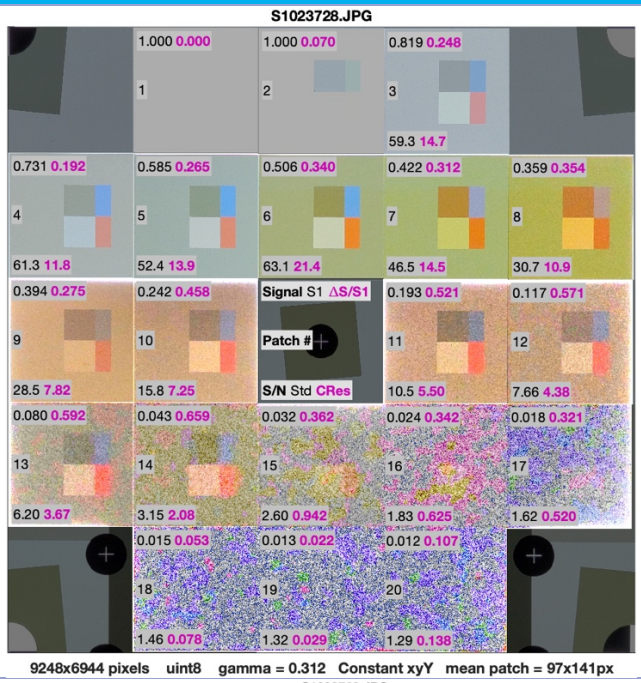
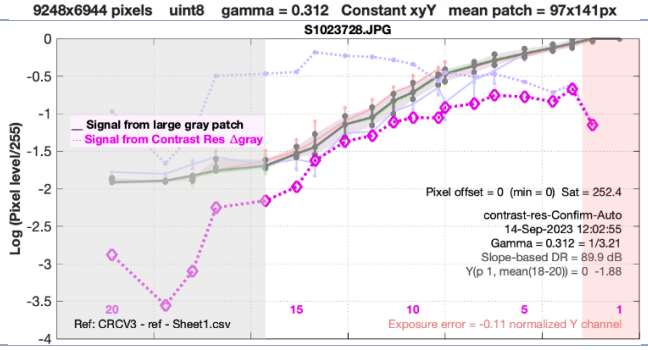
2525 Frontier Ave, Suite B, Boulder, CO 80301, USA 1-800-599-3154

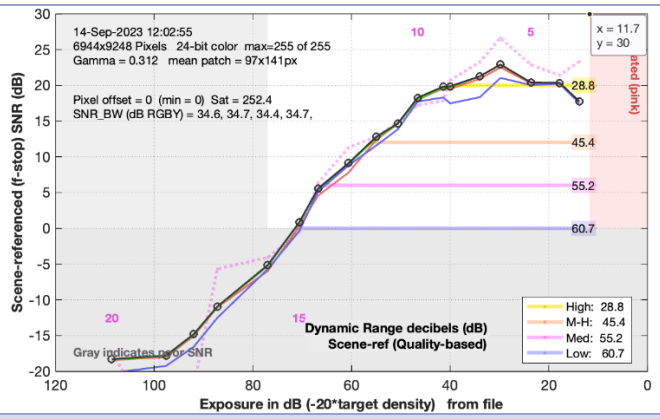
Summary	Mean MTF50P: 5330 LW/PH Over Sharpening (Freq Domain): 6.8% Over Shoot (Spatial Domain): 13.1% Area Under Curve MTF: 5278 LW/PH Information Capacity, Cmax: 2.41 b/p	Mean MTF50P: 2007 LW/PH Over Sharpening (Freq Domain): -31.4% Over Shoot (Spatial Domain): 0% Area Under Curve MTF: 2172 LW/PH Information Capacity, Cmax: 1.1 b/p

Skydio X10 Narrow, Full Res - Standard, Noise

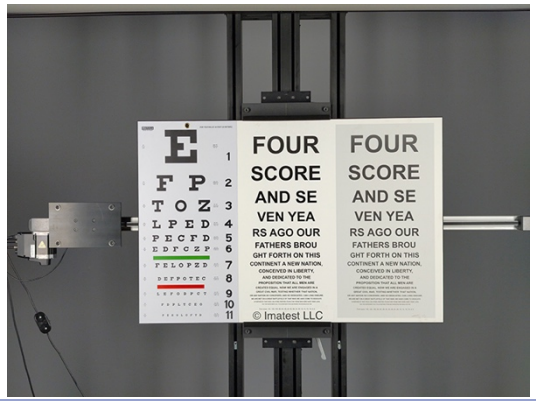
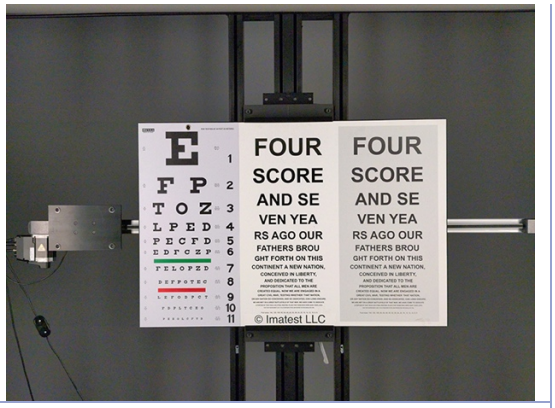
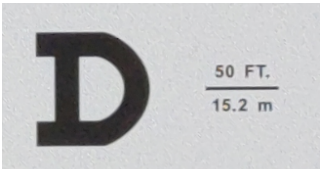
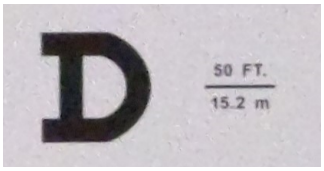
imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
SNR Signal to Noise Ratio		
Summary	Signal to Noise Ratio, Y Channel: 36.9 dB	Signal to Noise Ratio, Y Channel: 32.5 dB

Skydio X10 Narrow, Full Res - Standard, Dynamic Range

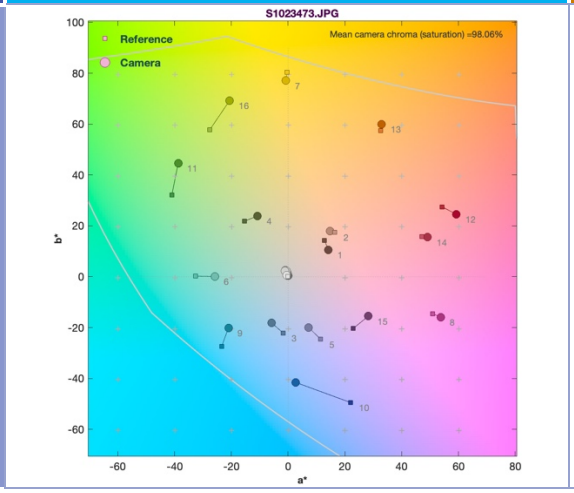
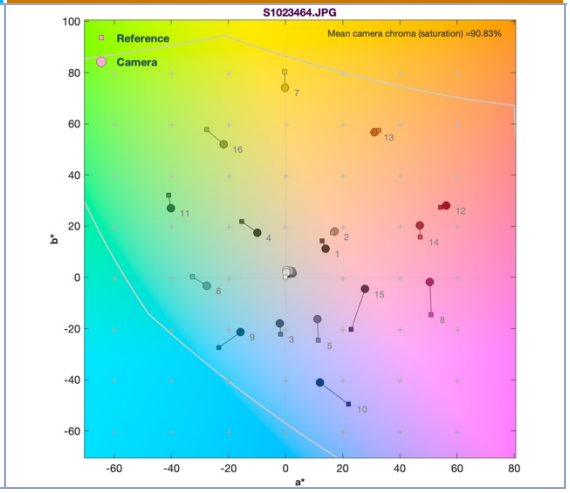
imatest® Plot/Chart	Daylight: 6500K at 100,000 Lux
Display Image with Objective Values	
Contrast Resolution	

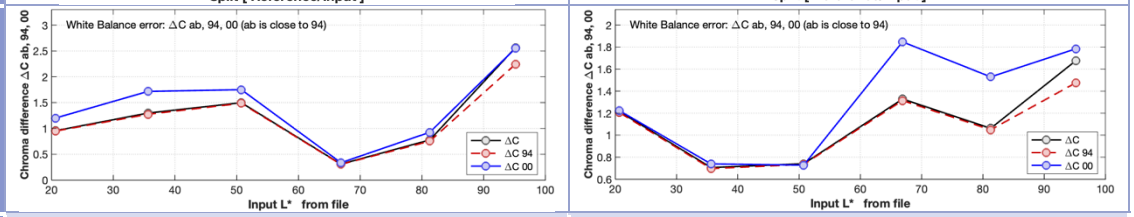
Scene Referenced SNR vs Exposure	
Summary	Dynamic Range at SNR equals 1 (Low): 60.7 dB

Skydio X10 Narrow, Full Res - Standard, Snellen Chart (Subjective Only)

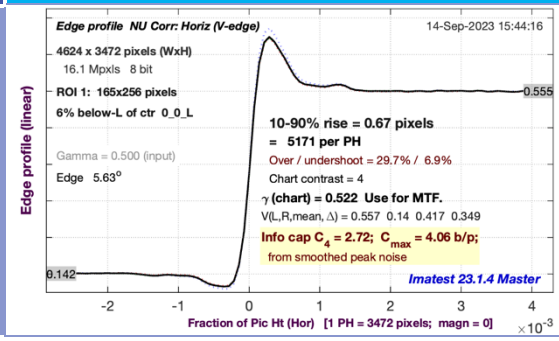
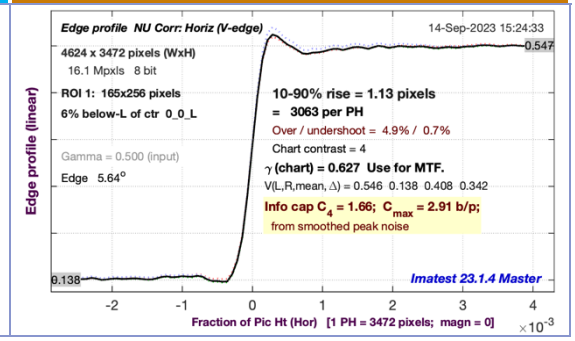
imatest Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
Snellen Eye Chart – Full Image		
Snellen Eye Chart Crop		

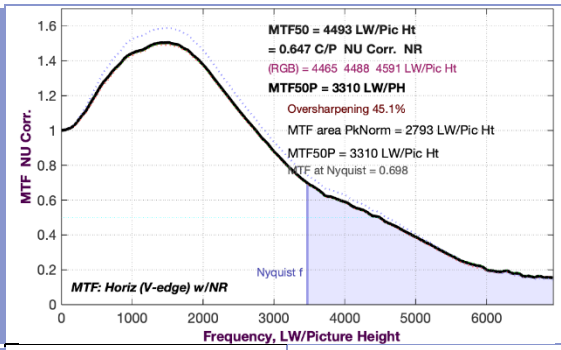
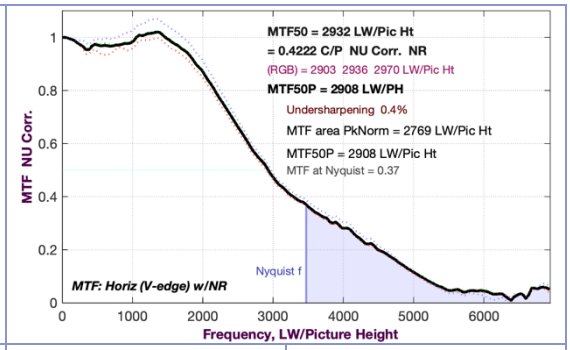
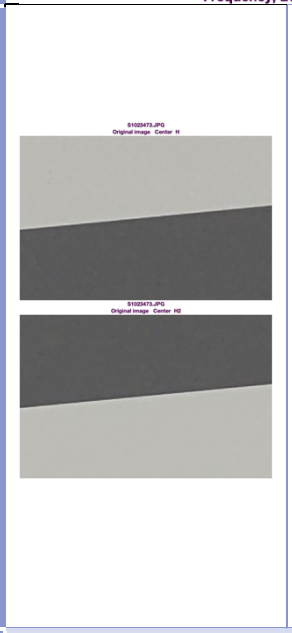
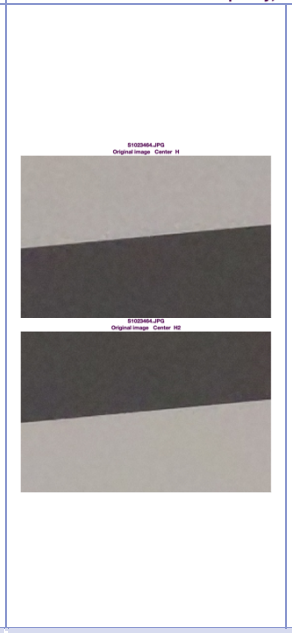
Skydio X10 Narrow, 1/4 Res - Standard, Color and Lightness Accuracy (CIE 2000)

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
2D a*b* plot		

Split Color Reference		
ΔC* vs ΔL* (Neutrals Only)		
Summary	Mean ΔE 2000: 6.20 Mean ΔC 2000: 3.37 Mean Camera Chroma: 98.06%	Mean ΔE 2000: 8.30 Mean ΔC 2000: 3.25 Mean Camera Chroma: 90.83%

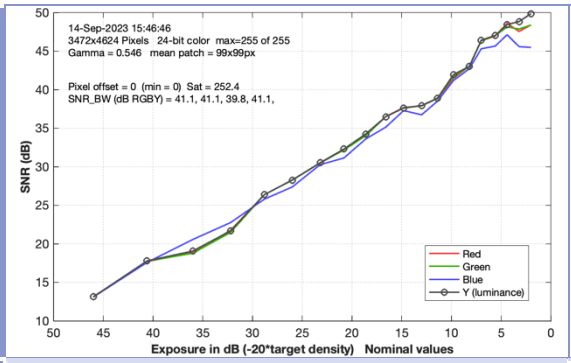
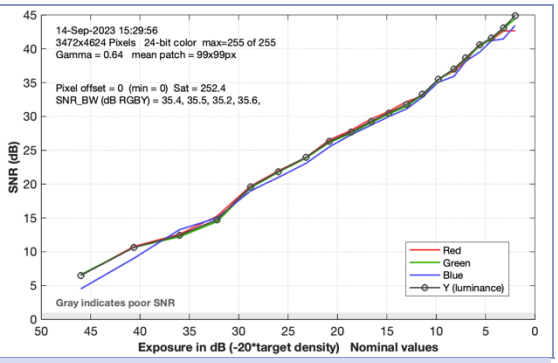
Skydio X10 Narrow, 1/4 Res - Standard, SFR/Resolution Analysis

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
ESF Edge Spread Function		

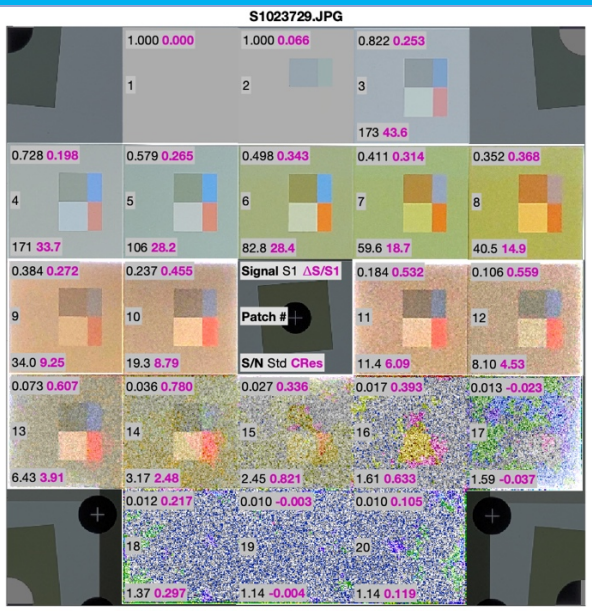
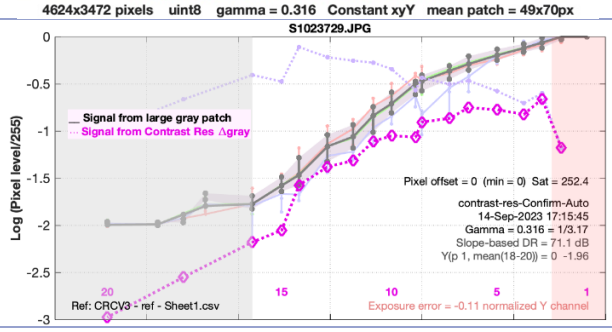
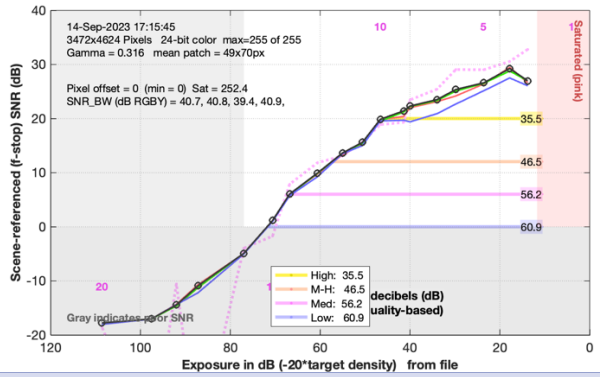
MTF Modular Transfer Function		
Slanted Edge Images (From ROI)		
Summary	Mean MTF50P: 3221 LW/PH Over Sharpening (Freq Domain): 45.1% Over Shoot (Spatial Domain): 29.7% Area Under Curve MTF: 2793 LW/PH Information Capacity, $Cmax$: 4.06 b/p	Mean MTF50P: 2929 LW/PH Over Sharpening (Freq Domain): -0.4% Over Shoot (Spatial Domain): 4.9% Area Under Curve MTF: 2769 LW/PH Information Capacity, $Cmax$: 2.91 b/p

Skydio X10 Narrow, 1/4 Res - Standard, Noise

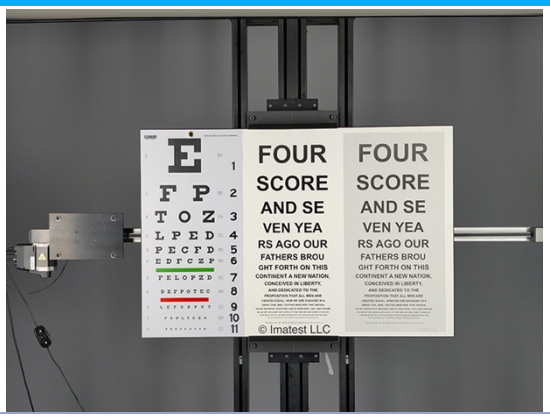
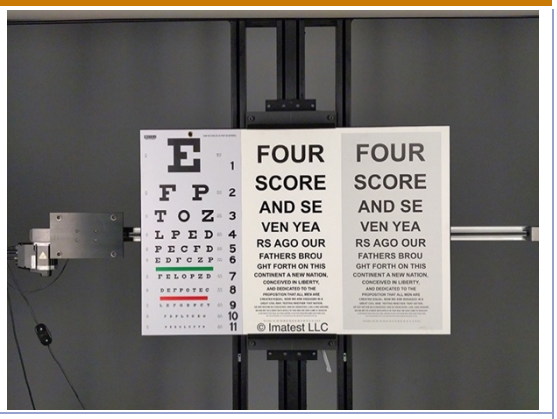
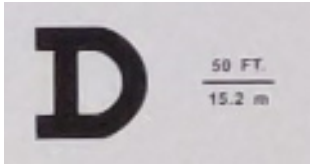
imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux

SNR Signal to Noise Ratio		
Summary	Signal to Noise Ratio, Y Channel: 41.1 dB	Signal to Noise Ratio, Y Channel: 35.6 dB

Skydio X10 Narrow, 1/4 Res - Standard, Dynamic Range

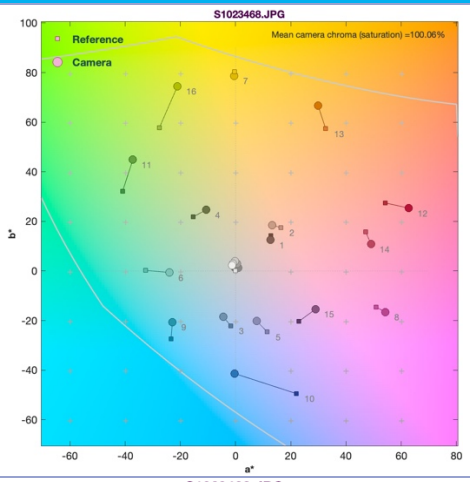
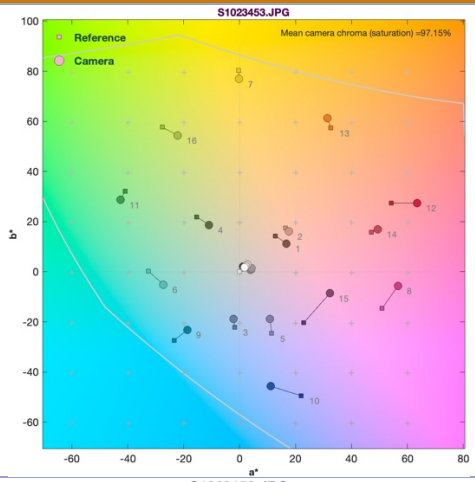
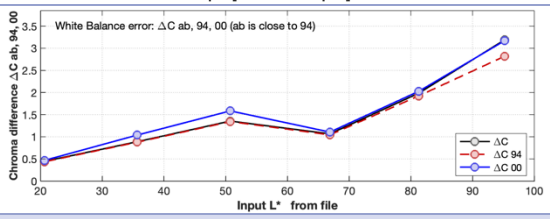
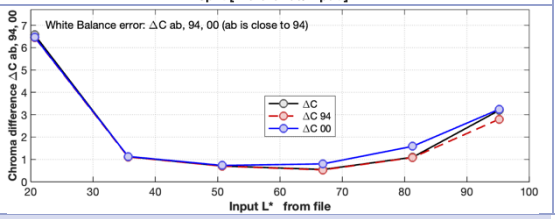
imatest® Plot/Chart	Daylight: 6500K at 100,000 Lux
Display Image with Objective Values	
Contrast Resolution	
Scene Referenced SNR vs Exposure	
Summary	Dynamic Range at SNR equals 1 (Low): 60.9 dB

Skydio X10 Narrow, 1/4 Res - Standard, Snellen Chart (Subjective Only)

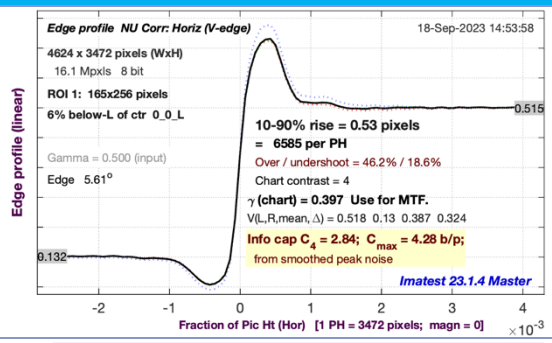
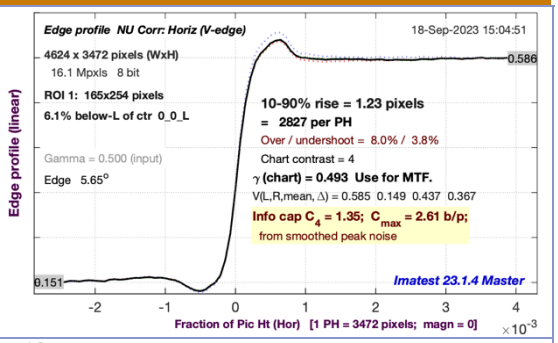
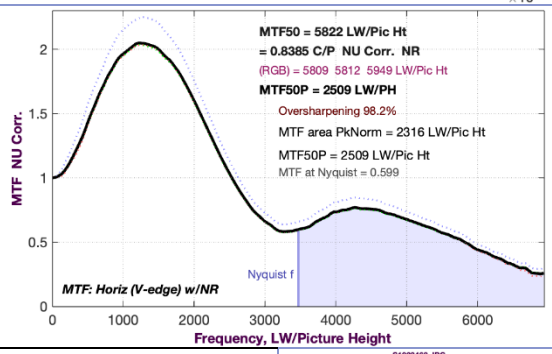
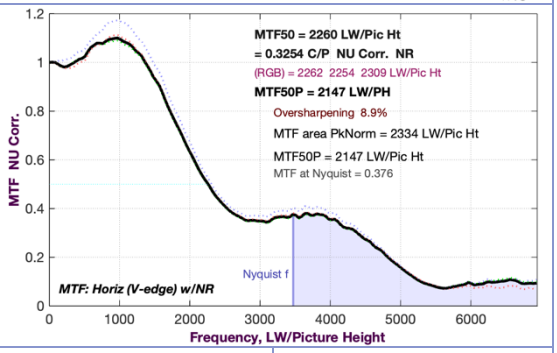
imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
Snellen Eye Chart – Full Image		
Snellen Eye Chart Crop		

2525 Frontier Ave, Suite B, Boulder, CO 80301, USA 1-800-599-3154

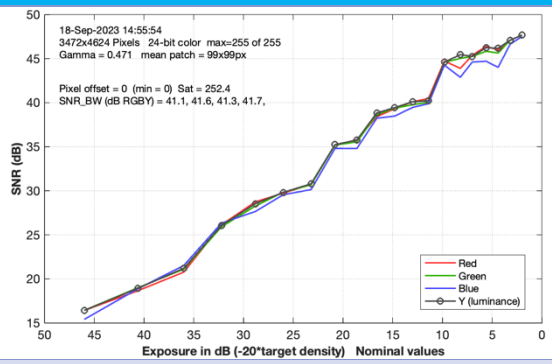
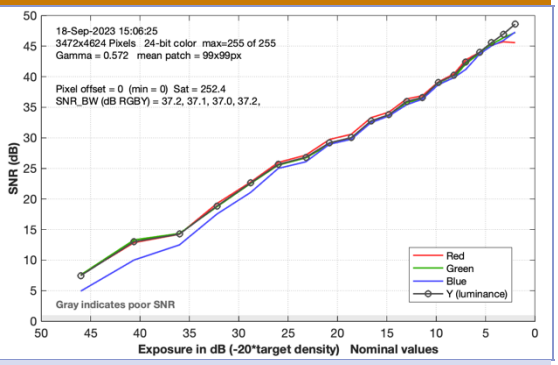
Skydio X10 Narrow, 1/4 Resolution - HDR, Color and Lightness Accuracy (CIE 2000)

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
2D a*b* plot		
Split Color Reference		
ΔC* vs ΔL* (Neutrals Only)		
Summary	Mean ΔE 2000: 6.72 Mean ΔC 2000: 3.95 Mean Camera Chroma: 100.06%	Mean ΔE 2000: 4.12 Mean ΔC 2000: 3.21 Mean Camera Chroma: 97.15%

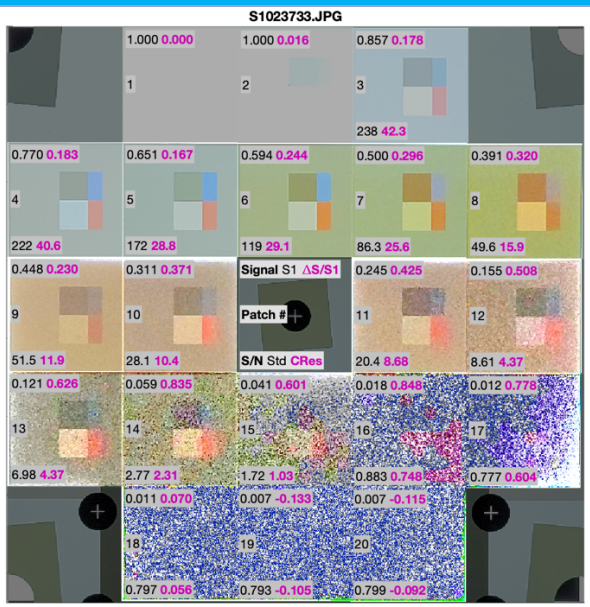
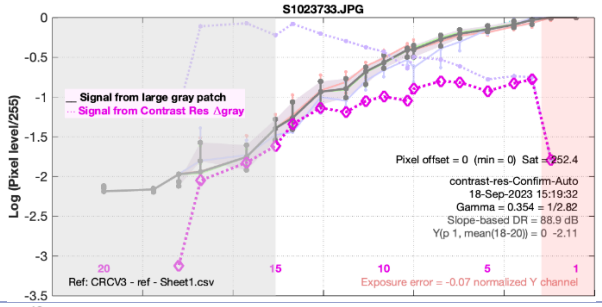
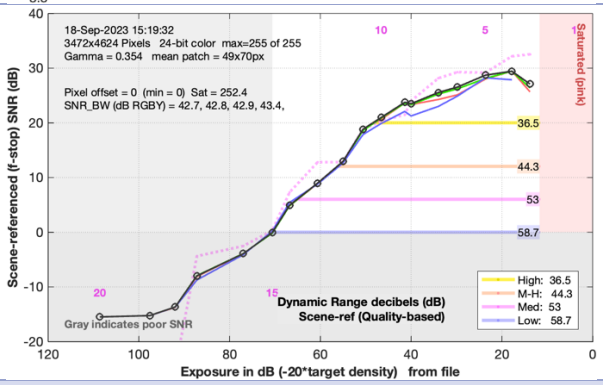
Skydio X10 Narrow, 1/4 Resolution - HDR, SFR/Resolution Analysis

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
ESF Edge Spread Function		
MTF Modular Transfer Function		
Slanted Edge Images (From ROI)		
Summary	Mean MTF50P: 2514 LW/PH Over Sharpening (Freq Domain): 98.2% Over Shoot (Spatial Domain): 46.2% Area Under Curve MTF: 2316 LW/PH Information Capacity, Cmax: 4.28 b/p	Mean MTF50P: 2060 LW/PH Over Sharpening (Freq Domain): 8.9% Over Shoot (Spatial Domain): 8.0% Area Under Curve MTF: 2334 LW/PH Information Capacity, Cmax: 2.61 b/p

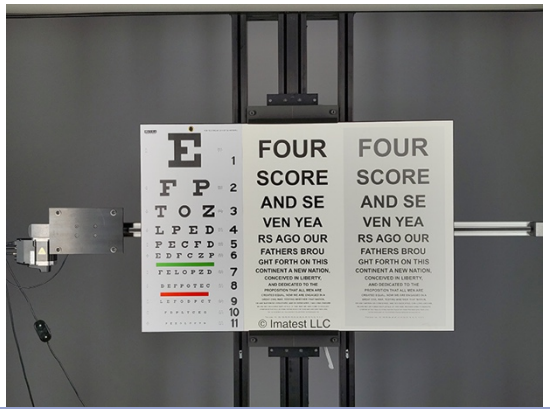
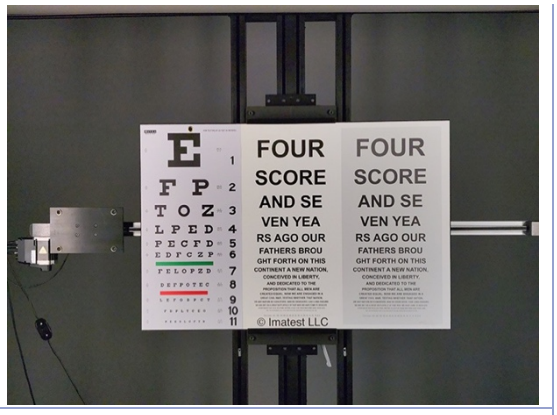
Skydio X10 Narrow, 1/4 Resolution - HDR, Noise

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
SNR Signal to Noise Ratio		
Summary	Signal to Noise Ratio, Y Channel: 41.7 dB	Signal to Noise Ratio, Y Channel: 37.2 dB

Skydio X10 Narrow, 1/4 Resolution - HDR, Dynamic Range

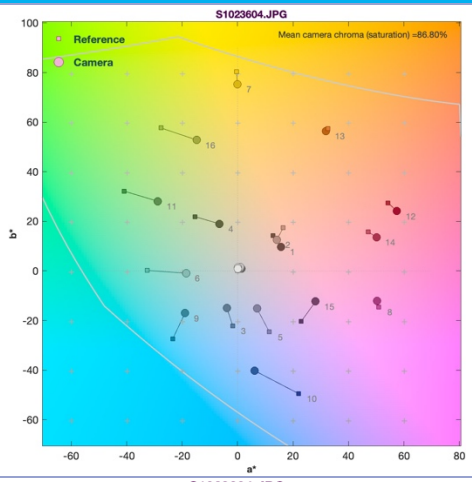
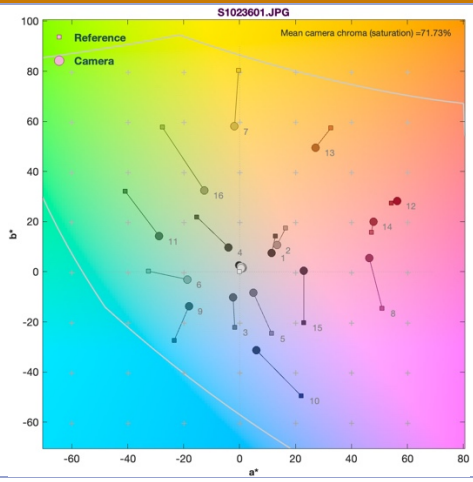
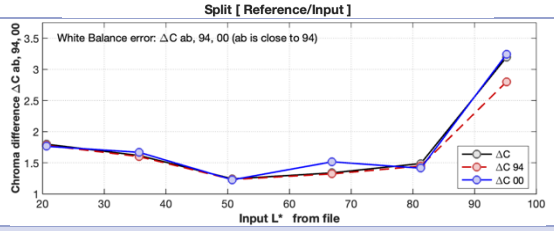
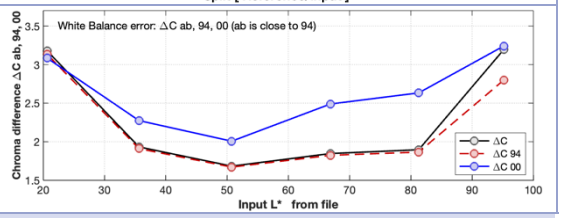
imatest® Plot/Chart	Daylight: 6500K at 100,000 Lux
Display Image with Objective Values	
Contrast Resolution	
Scene Referenced SNR vs Exposure	
Summary	Dynamic Range at SNR equals 1 (Low): 58.7 dB

Skydio X10 Narrow, 1/4 Resolution - HDR, Snellen Chart (Subjective Only)

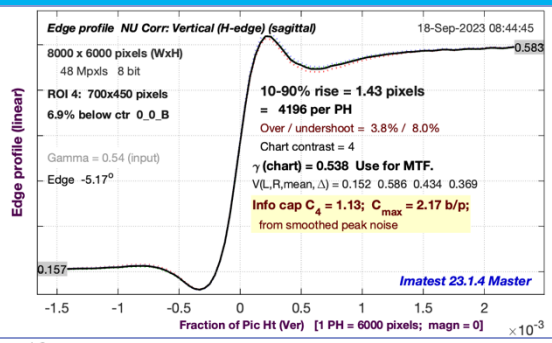
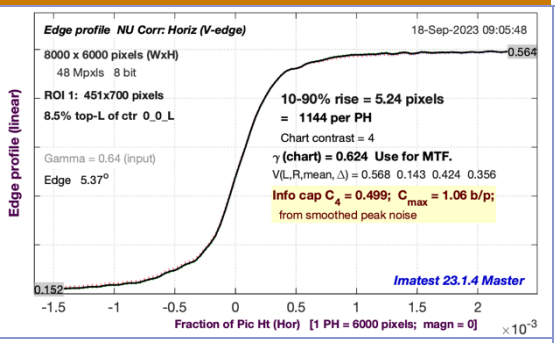
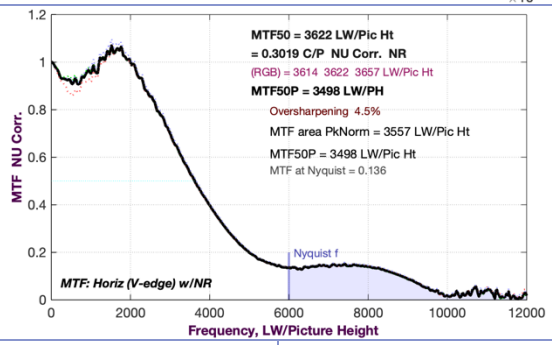
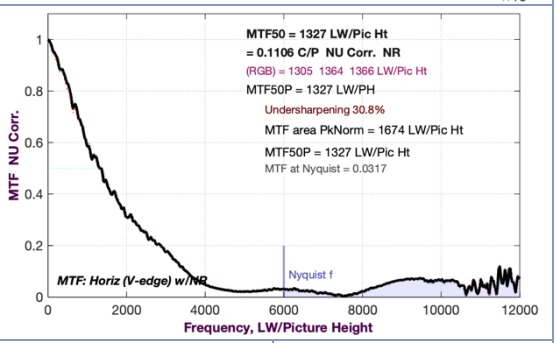
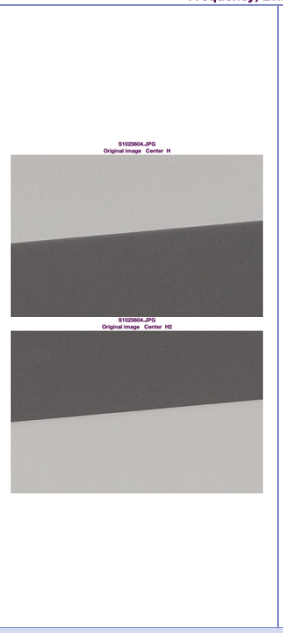
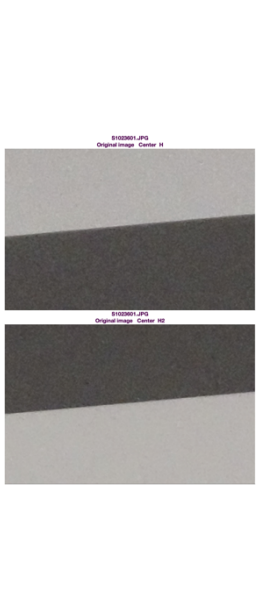
imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
Snellen Eye Chart – Full Image		
Snellen Eye Chart Crop		

2525 Frontier Ave, Suite B, Boulder, CO 80301, USA 1-800-599-3154

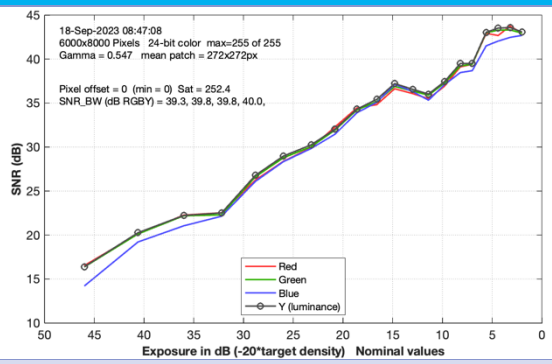
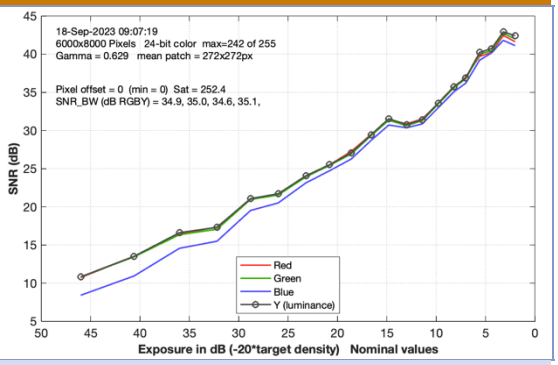
Skydio X10 Telephoto, Full Res - Standard, Color and Lightness Accuracy (CIE 2000)

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
2D a*b* plot		
Split Color Reference		
ΔC* vs ΔL* (Neutrals Only)		
Summary	Mean ΔE 2000: 6.59 Mean ΔC 2000: 4.16 Mean Camera Chroma: 86.80%	Mean ΔE 2000: 9.37 Mean ΔC 2000: 6.66 Mean Camera Chroma: 71.73%

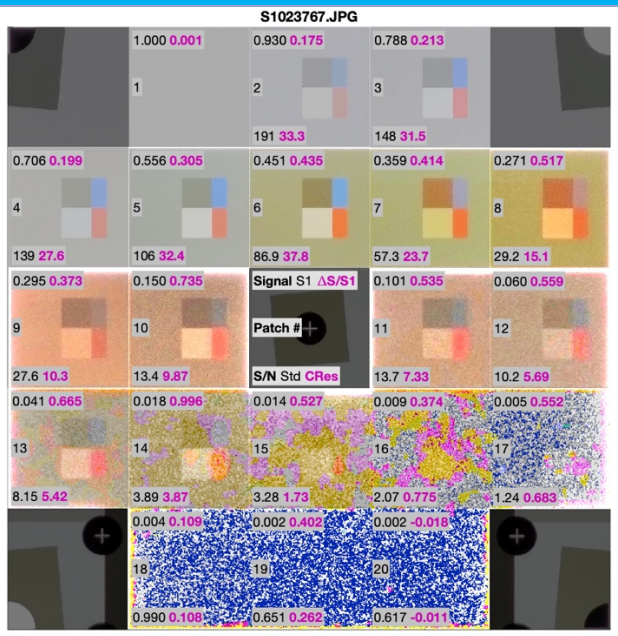
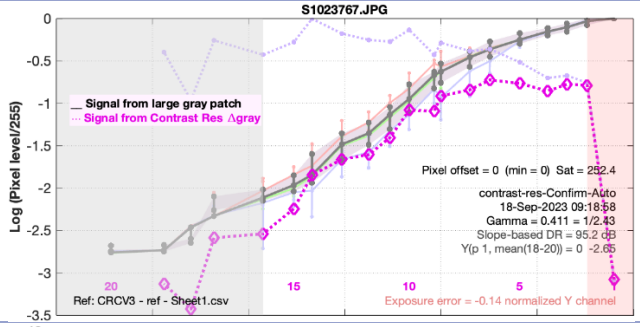
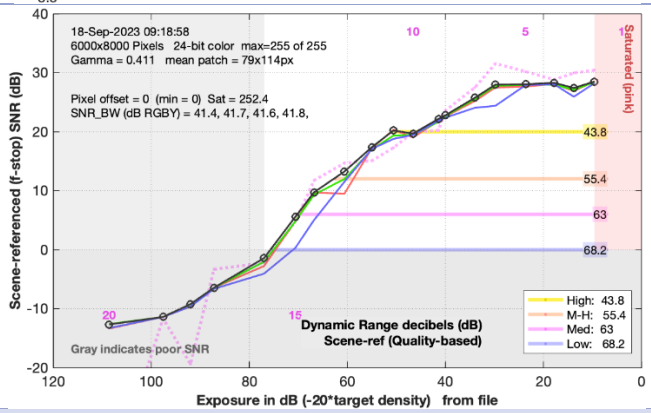
Skydio X10 Telephoto, Full Res - Standard, SFR/Resolution Analysis

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
ESF Edge Spread Function		
MTF Modular Transfer Function		
Slanted Edge Images (From ROI)		
Summary	Mean MTF50P: 3491 LW/PH Over Sharpening (Freq Domain): 4.5% Over Shoot (Spatial Domain): 9.3% Area Under Curve MTF: 3557 LW/PH Information Capacity, $Cmax$: 1.9 b/p	Mean MTF50P: 1268 LW/PH Over Sharpening (Freq Domain): -30.8% Over Shoot (Spatial Domain): 0% Area Under Curve MTF: 1674 LW/PH Information Capacity, $Cmax$: 1.06 b/p

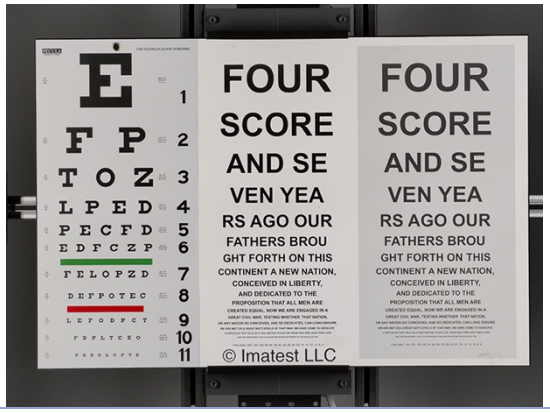
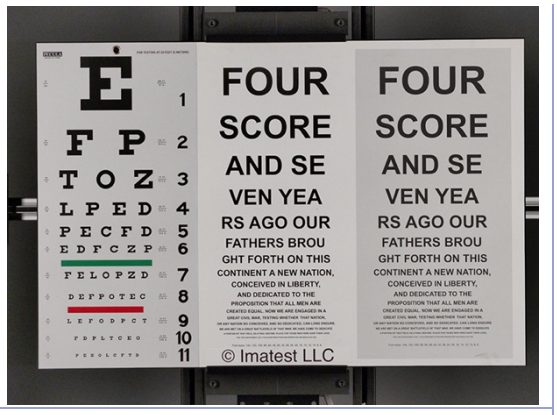
Skydio X10 Telephoto, Full Res - Standard, Noise

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
SNR Signal to Noise Ratio		
Summary	Signal to Noise Ratio, Y Channel: 40.0 dB	Signal to Noise Ratio, Y Channel: 35.1 dB

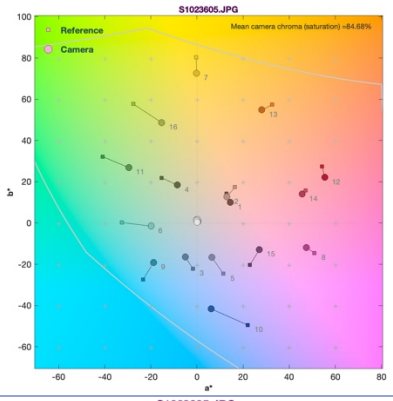
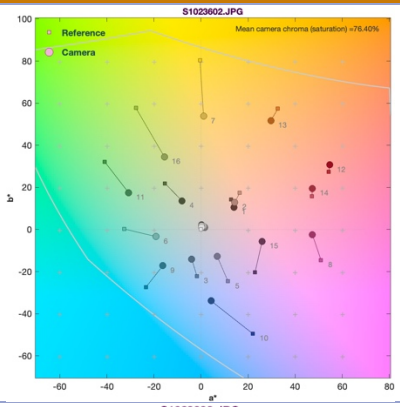
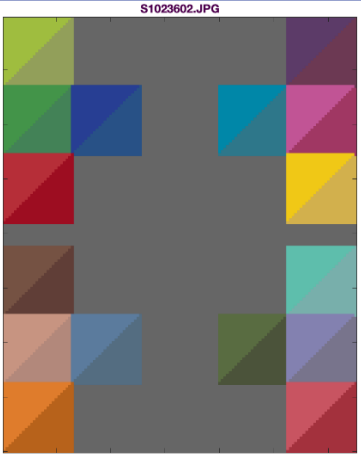
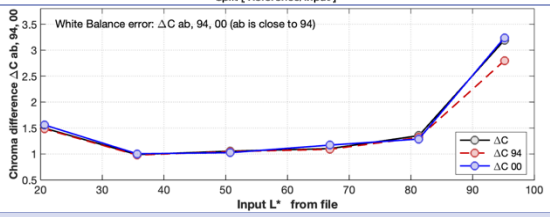
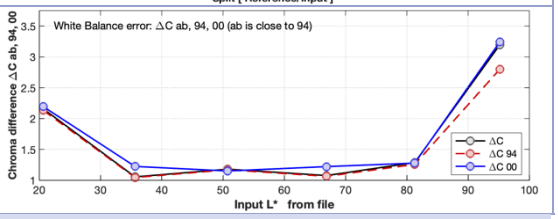
Skydio X10 Telephoto, Full Res - Standard, Dynamic Range

imatest® Plot/Chart	Daylight: 6500K at 100,000 Lux
Display Image with Objective Values	
Contrast Resolution	
Scene Referenced SNR vs Exposure	
Summary	Dynamic Range at SNR equals 1 (Low): 68.2 dB

Skydio X10 Telephoto, Full Res - Standard, Snellen Chart (Subjective Only)

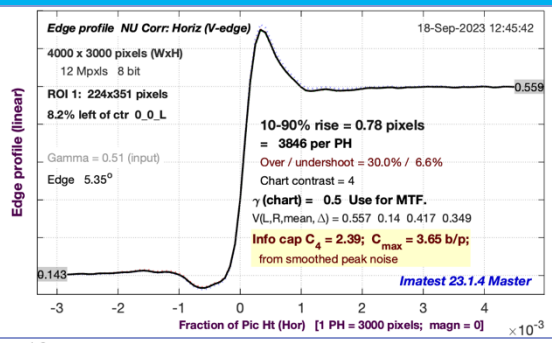
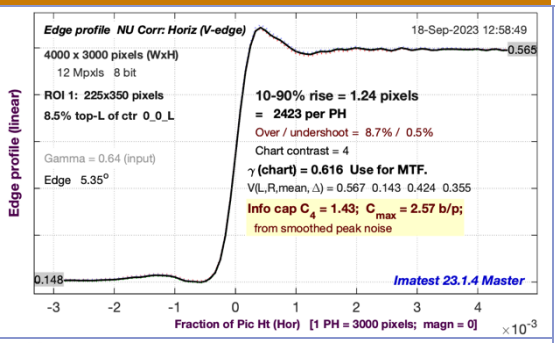
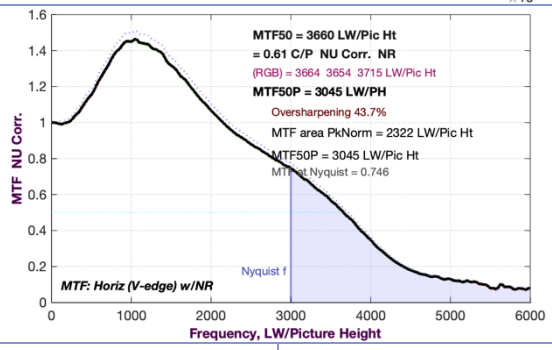
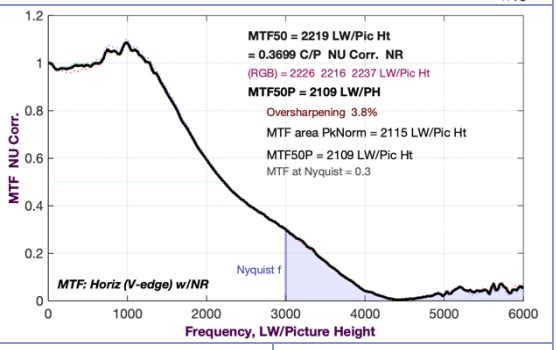
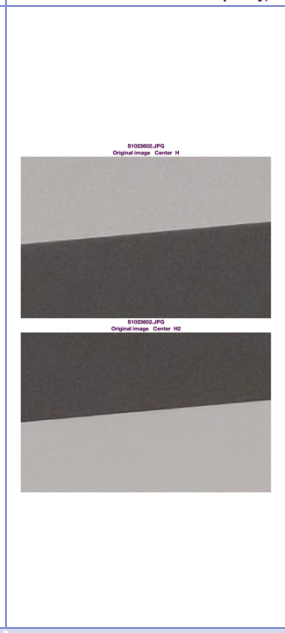
imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
Snellen Eye Chart – Full Image		
Snellen Eye Chart Crop		

Skydio X10 Telephoto, 1/4 Res - Standard, Color and Lightness Accuracy (CIE 2000)

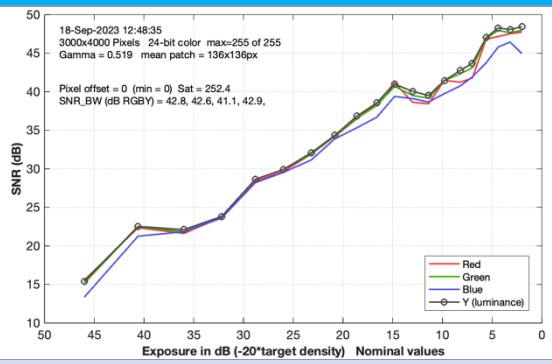
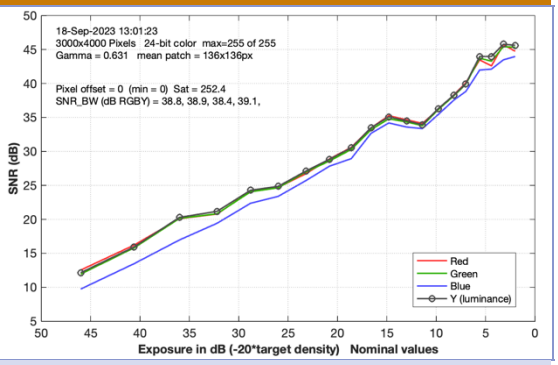
Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
2D a*b* plot		
Split Color Reference		
ΔC* vs ΔL* (Neutrals Only)		
Summary	Mean ΔE 2000: 5.77 Mean ΔC 2000: 3.96 Mean Camera Chroma: 84.66%	Mean ΔE 2000: 8.87 Mean ΔC 2000: 5.27 Mean Camera Chroma: 76.40%

2525 Frontier Ave, Suite B, Boulder, CO 80301, USA 1-800-599-3154

Skydio X10 Telephoto, 1/4 Res - Standard, SFR/Resolution Analysis

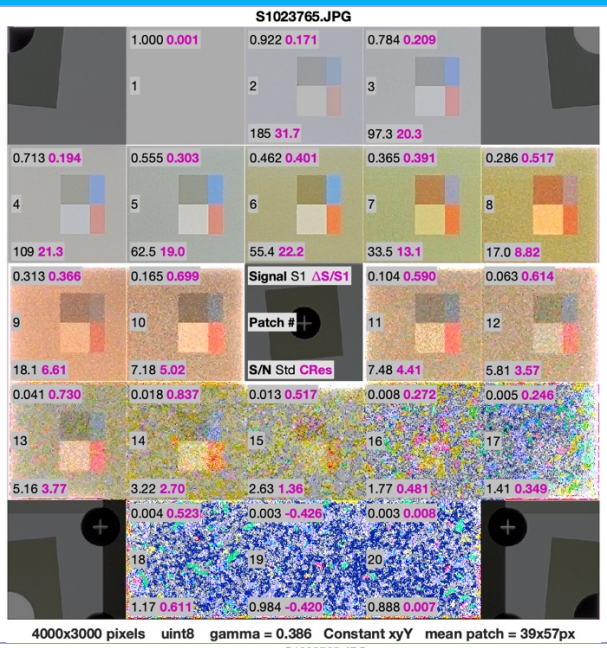
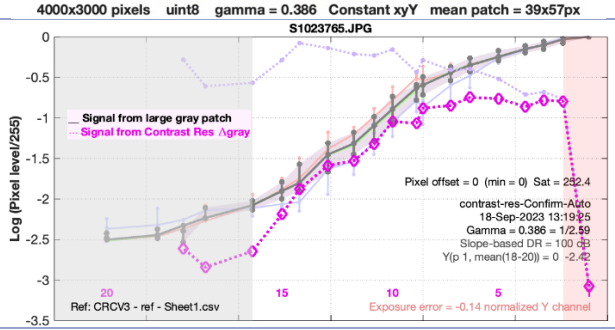
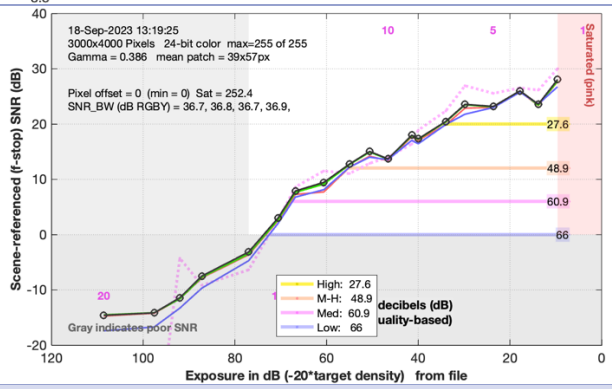
imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
ESF Edge Spread Function		
MTF Modular Transfer Function		
Slanted Edge Images (From ROI)		
Summary	Mean MTF50P: 2945 LW/PH Over Sharpening (Freq Domain): 43.7% Over Shoot (Spatial Domain): 30.0% Area Under Curve MTF: 2322 LW/PH Information Capacity, $Cmax$: 3.65 b/p	Mean MTF50P: 2147 LW/PH Over Sharpening (Freq Domain): 3.8% Over Shoot (Spatial Domain): 8.7% Area Under Curve MTF: 2115 LW/PH Information Capacity, $Cmax$: 2.57 b/p

Skydio X10 Telephoto, 1/4 Res - Standard, Noise

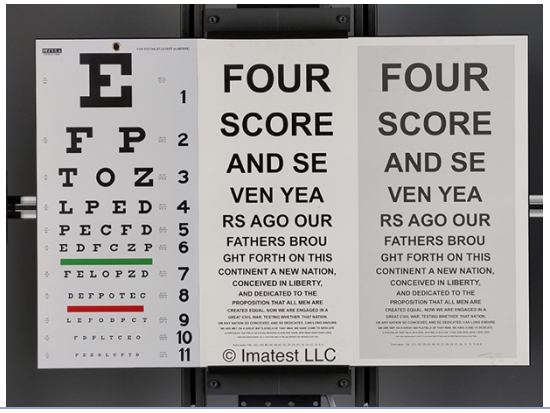
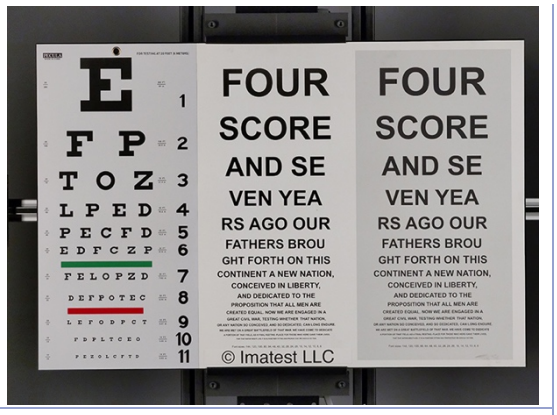
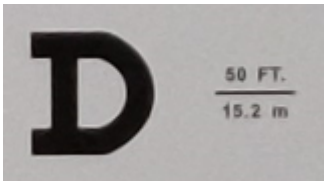
imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
SNR Signal to Noise Ratio		
Summary	Signal to Noise Ratio, Y Channel: 42.9 dB	Signal to Noise Ratio, Y Channel: 39.1 dB

Skydio X10 Telephoto, 1/4 Res - Standard, Dynamic Range

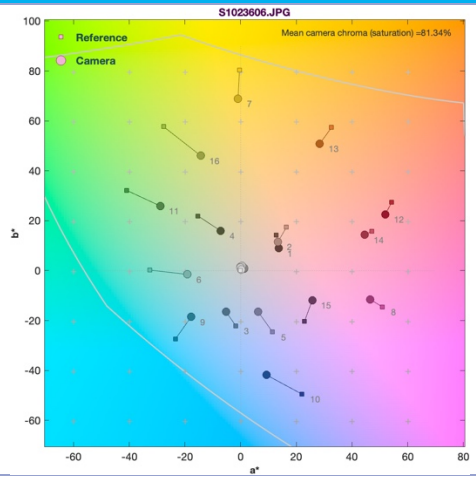
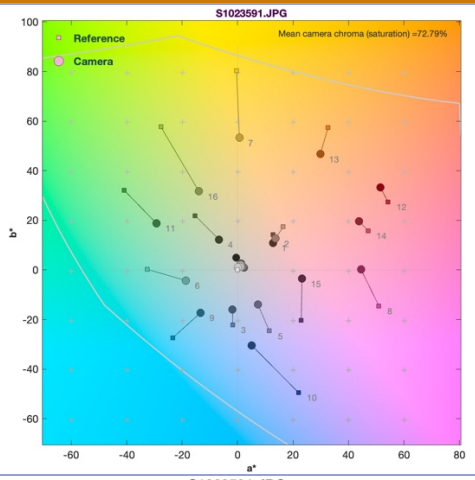
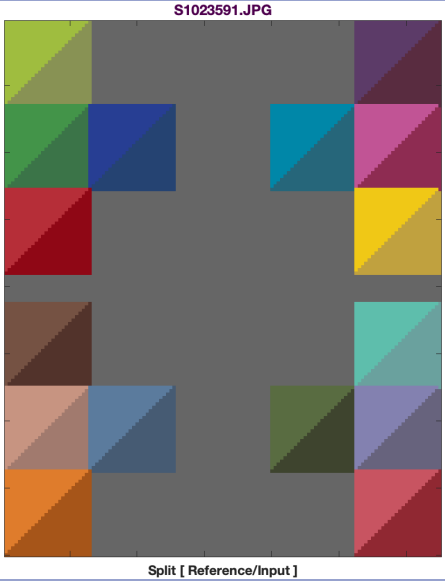
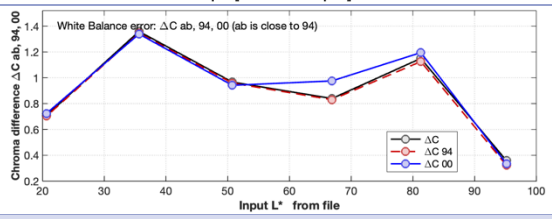
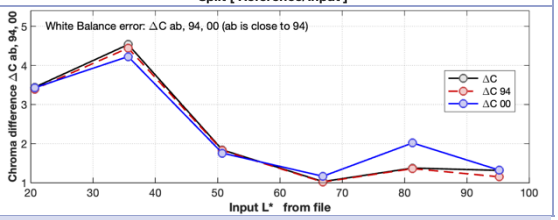
imatest®

Plot/Chart	Daylight: 6500K at 100,000 Lux
Display Image with Objective Values	
Contrast Resolution	
Scene Referenced SNR vs Exposure	
Summary	Dynamic Range at SNR equals 1 (Low): 66 dB

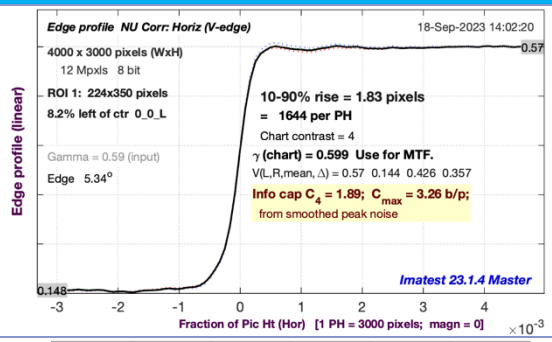
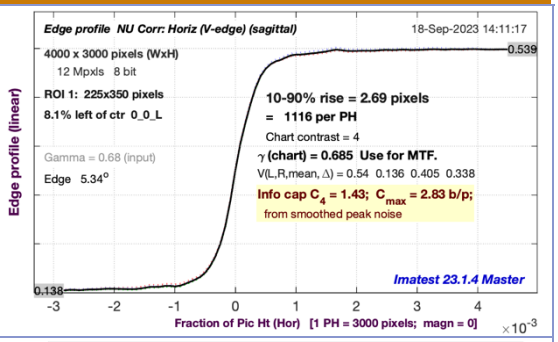
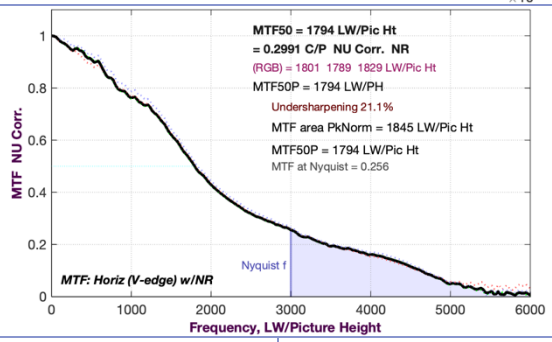
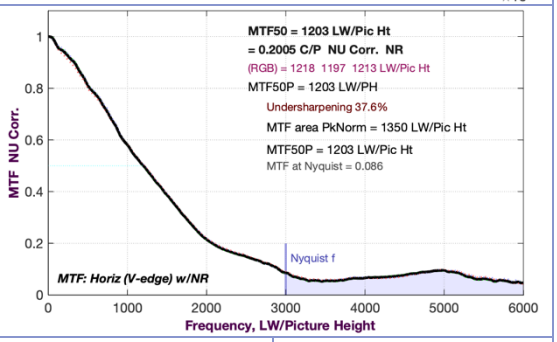
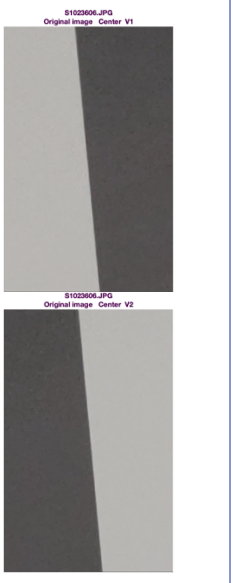
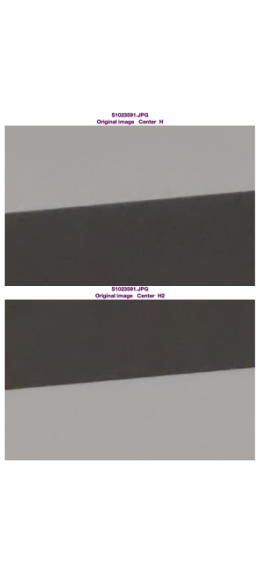
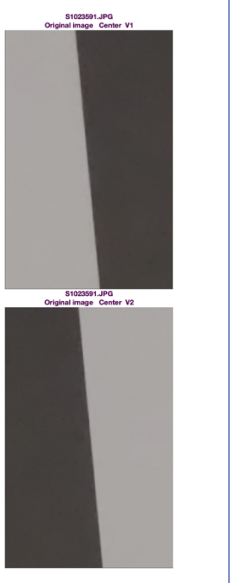
Skydio X10 Telephoto, 1/4 Res - Standard, Snellen Chart (Subjective Only)

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
Snellen Eye Chart – Full Image		
Snellen Eye Chart Crop		

Skydio X10 Telephoto, 1/4 Resolution - HDR, Color and Lightness Accuracy (CIE 2000)

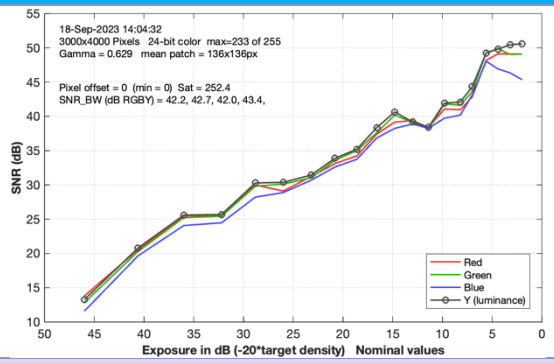
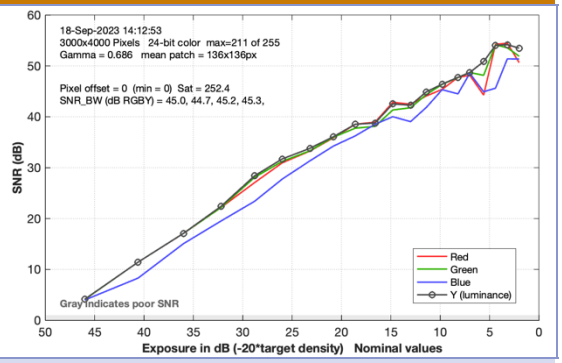
imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
2D a*b* plot		
Split Color Reference		
ΔC* vs ΔL* (Neutrals Only)		
Summary	Mean ΔE 2000: 7.71 Mean ΔC 2000: 4.14 Mean Camera Chroma: 81.34%	Mean ΔE 2000: 12.63 Mean ΔC 2000: 5.73 Mean Camera Chroma: 72.79%

Skydio X10 Telephoto, 1/4 Resolution - HDR, SFR/Resolution Analysis

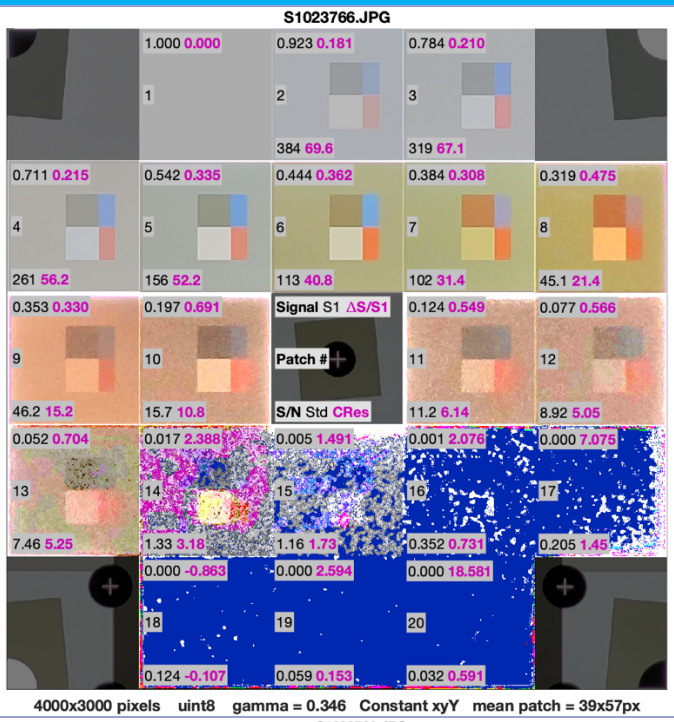
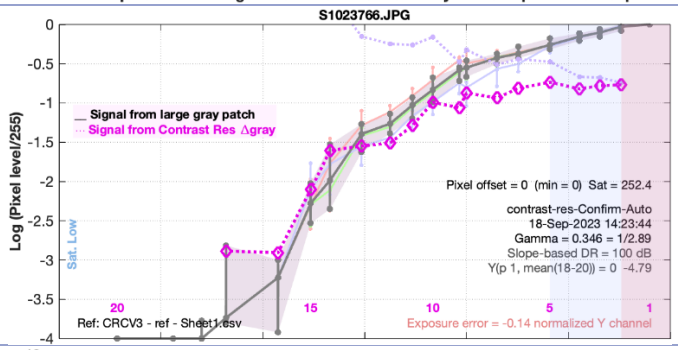
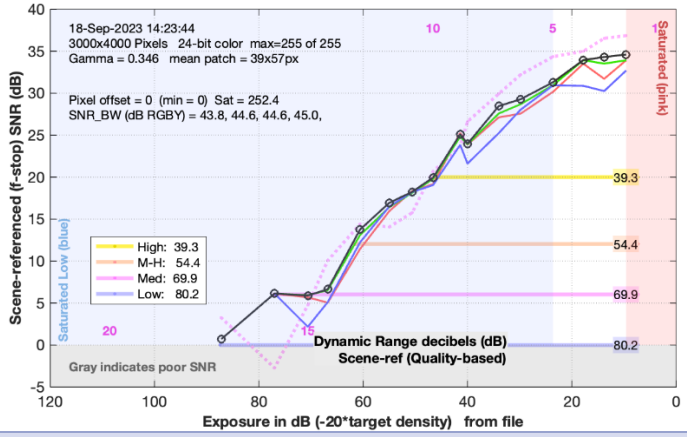
imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
ESF Edge Spread Function		
MTF Modular Transfer Function		
Slanted Edge Images (From ROI)	 	 

Summary	Mean MTF50P: 1814 LW/PH Over Sharpening (Freq Domain): -21.1% Over Shoot (Spatial Domain): 0% Area Under Curve MTF: 1845 LW/PH Information Capacity, Cmax: 3.26 b/p	Mean MTF50P: 1269 LW/PH Over Sharpening (Freq Domain): -37.6% Over Shoot (Spatial Domain): 0% Area Under Curve MTF: 1350 LW/PH Information Capacity, Cmax: 2.83 b/p

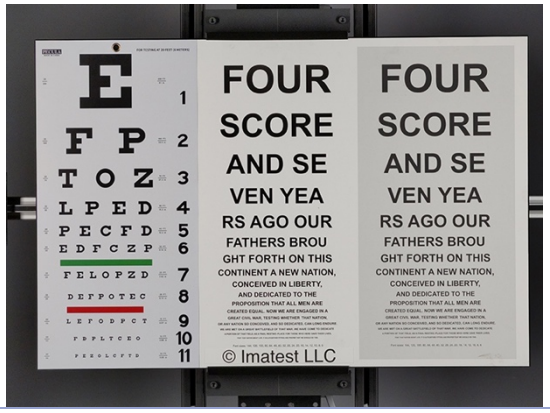
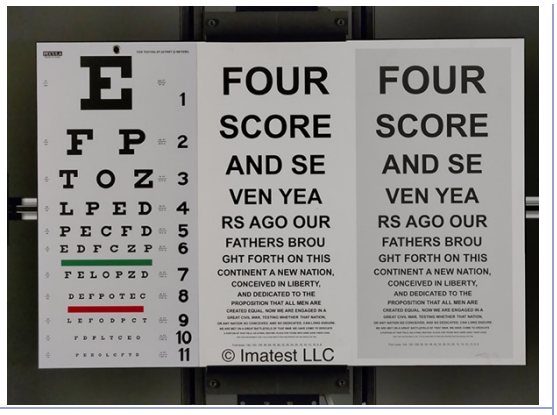
Skydio X10 Telephoto, 1/4 Resolution - HDR, Noise

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
SNR Signal to Noise Ratio		
Summary	Signal to Noise Ratio, Y Channel: 43.4 dB	Signal to Noise Ratio, Y Channel: 45.3 dB

Skydio X10 Telephoto, 1/4 Resolution - HDR, Dynamic Range

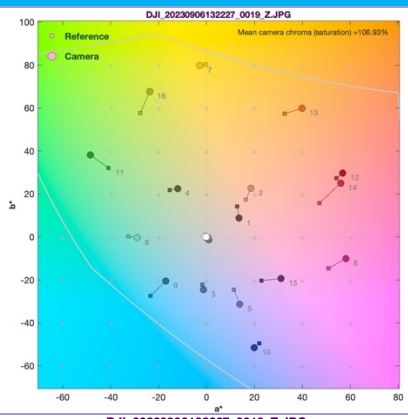
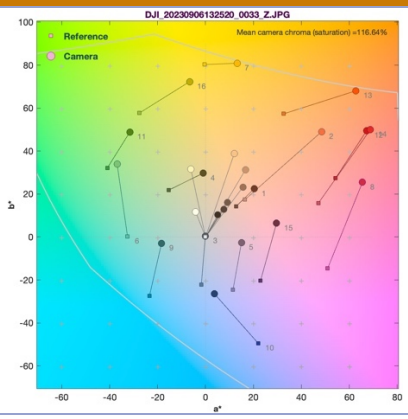
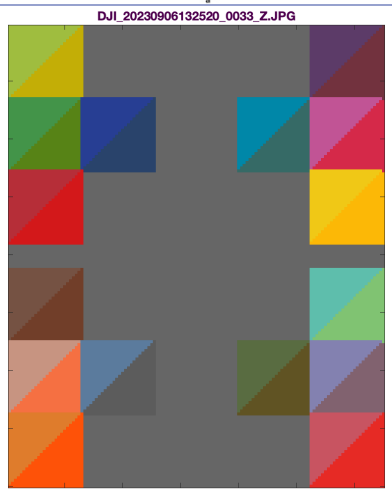
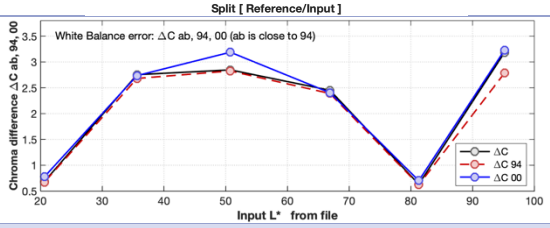
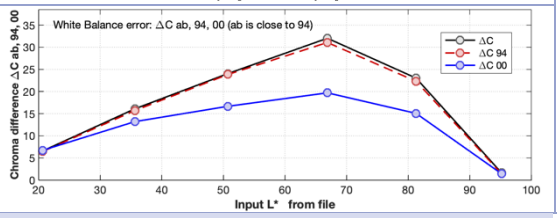
imatest® Plot/Chart	Daylight: 6500K at 100,000 Lux
Display Image with Objective Values	
Contrast Resolution	
Scene Referenced SNR vs Exposure	
Summary	Dynamic Range at SNR equals 1 (Low): 80.2 dB

Skydio X10 Telephoto, 1/4 Resolution - HDR, Snellen Chart (Subjective Only)

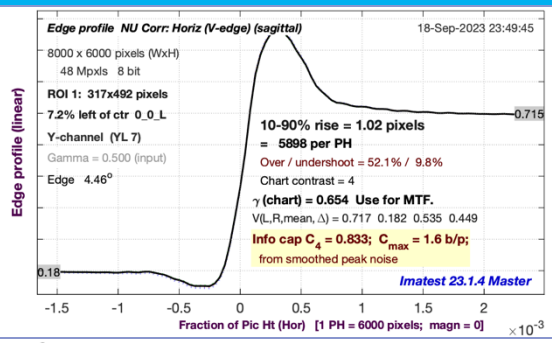
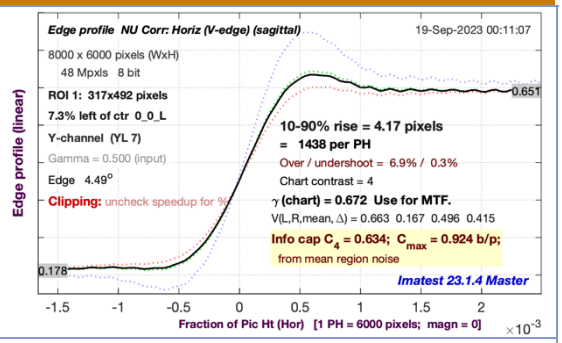
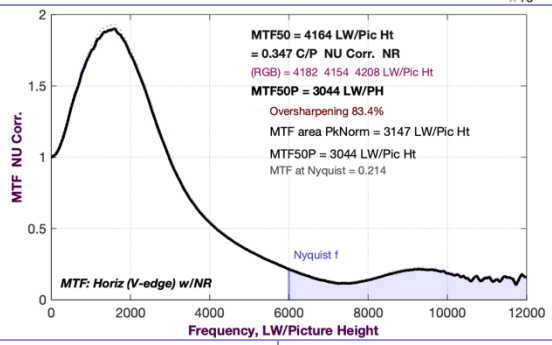
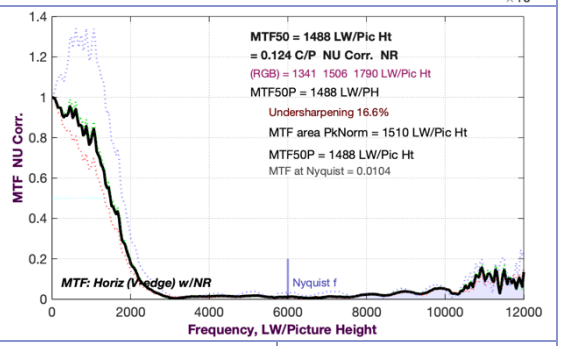
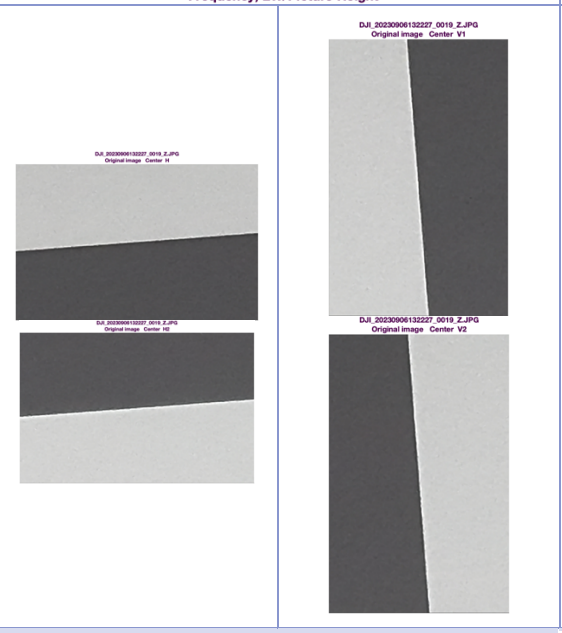
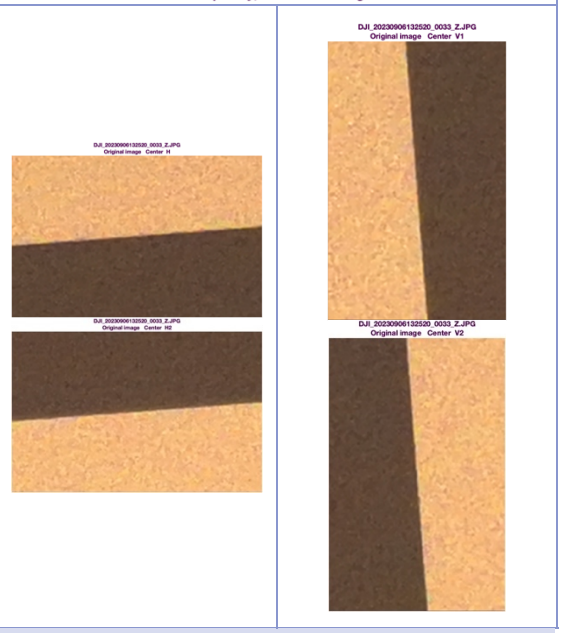
imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
Snellen Eye Chart – Full Image		
Snellen Eye Chart Crop		

2525 Frontier Ave, Suite B, Boulder, CO 80301, USA 1-800-599-3154

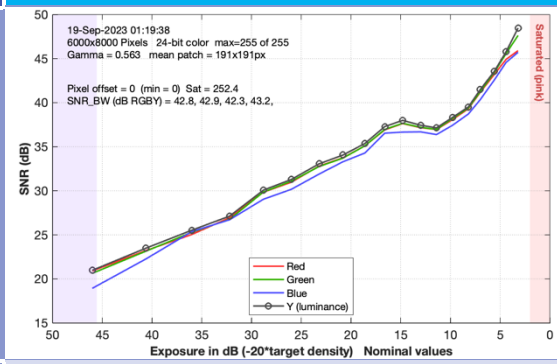
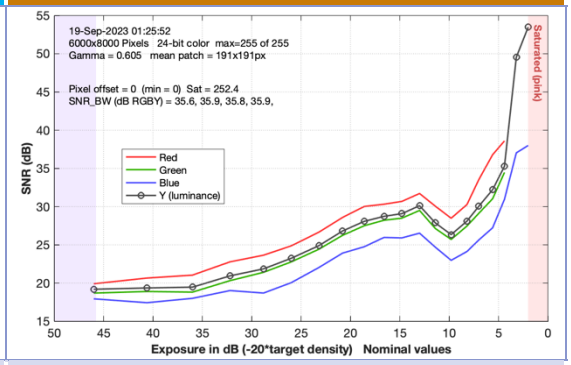
DJI Matrice M30, Full Resolution, Color and Lightness Accuracy (CIE 2000)

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
2D a*b* plot		
Split Color Reference		
ΔC* vs ΔL* (Neutrals Only)		
Summary	Mean ΔE 2000: 4.75 Mean ΔC 2000: 2.89 Mean Camera Chroma: 106.93%	Mean ΔE 2000: 13.52 Mean ΔC 2000: 12.49 Mean Camera Chroma: 116.64%

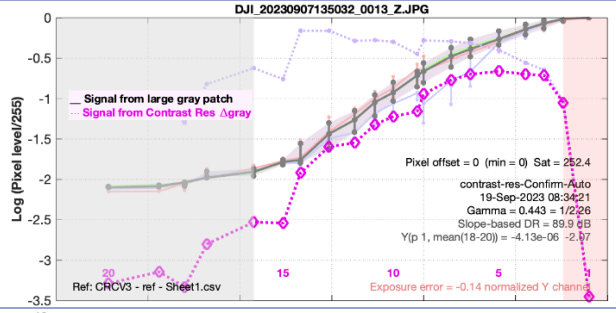
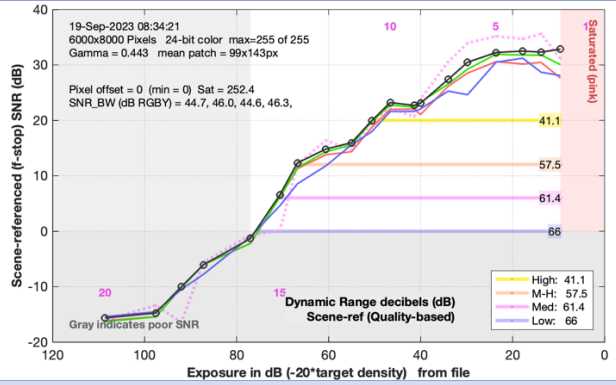
DJI Matrice M30, Full Resolution, SFR/Resolution Analysis

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
ESF Edge Spread Function		
MTF Modular Transfer Function		
Slanted Edge Images (From ROI)		
Summary	Mean MTF50P: 2977 LW/PH Over Sharpening (Freq Domain): 83.4% Over Shoot (Spatial Domain): % Area Under Curve MTF: LW/PH Information Capacity, $Cmax$: b/p	Mean MTF50P: 1413 LW/PH Over Sharpening (Freq Domain): -16.6% Over Shoot (Spatial Domain): 6.9% Area Under Curve MTF: 1510 LW/PH Information Capacity, $Cmax$: 0.924 b/p

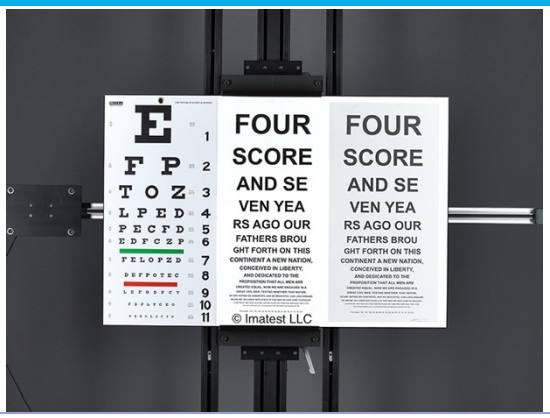
DJI Matrice M30, Full Resolution, Noise

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
SNR Signal to Noise Ratio		
Summary	Signal to Noise Ratio, Y Channel: 43.2 dB	Signal to Noise Ratio, Y Channel: 35.9 dB

DJI Matrice M30, Full Resolution, Dynamic Range

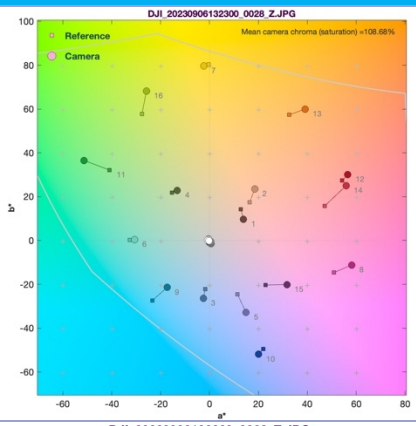
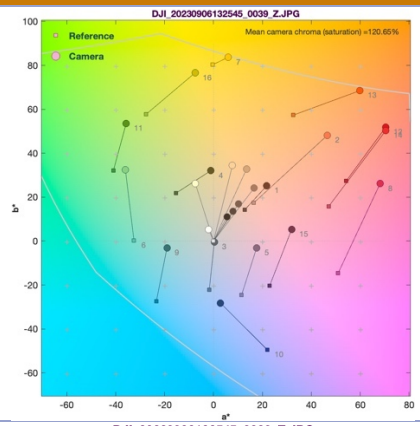
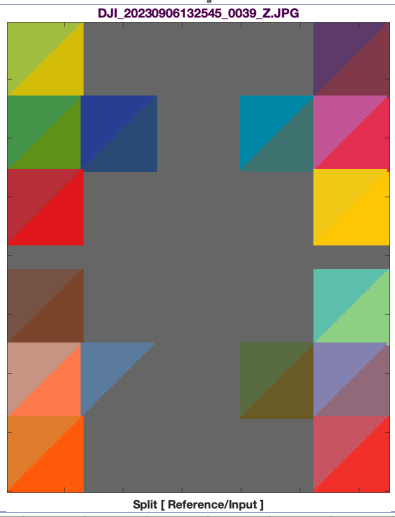
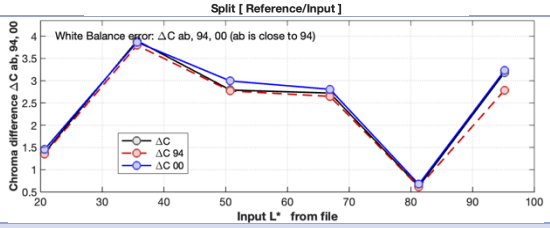
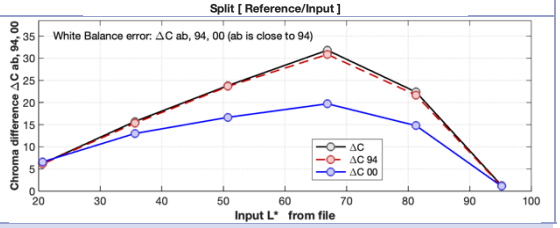
imatest® Plot/Chart	Daylight: 6500K at 100,000 Lux
Display Image with Objective Values	
Contrast Resolution	
Scene Referenced SNR vs Exposure	
Summary	Dynamic Range at SNR equals 1 (Low): 66 dB

DJI Matrice M30, Full Resolution, Snellen Chart (Subjective Only)

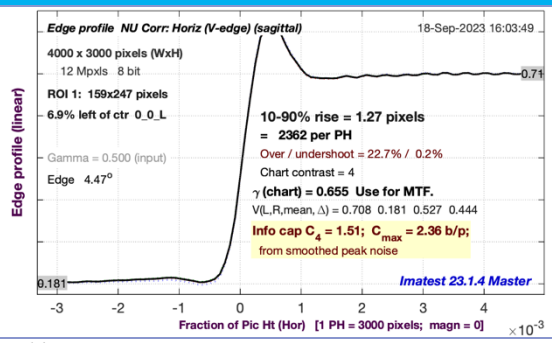
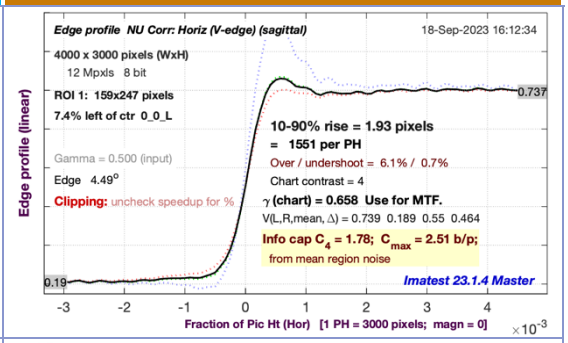
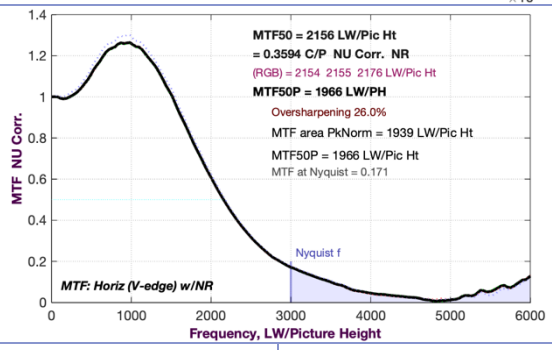
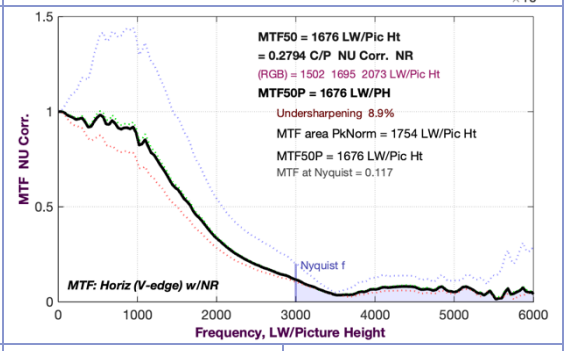
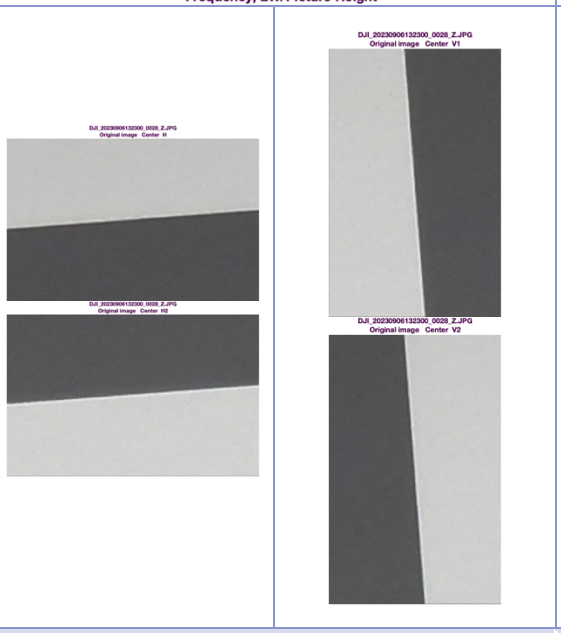
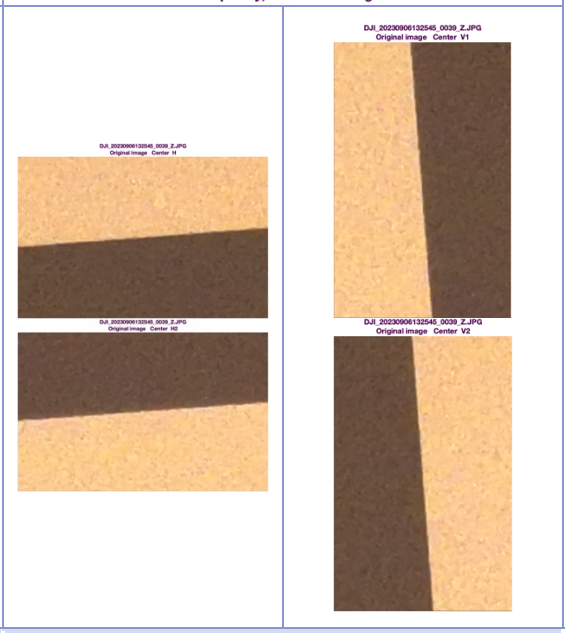
imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
Snellen Eye Chart – Full Image		
Snellen Eye Chart Crop		

2525 Frontier Ave, Suite B, Boulder, CO 80301, USA 1-800-599-3154

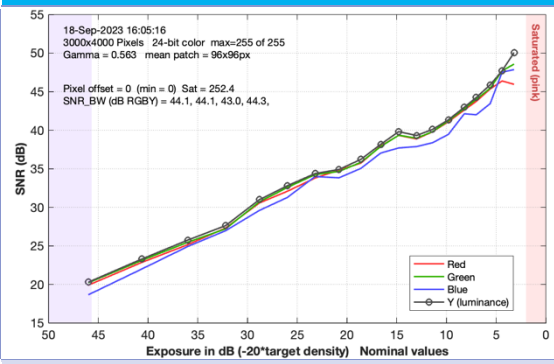
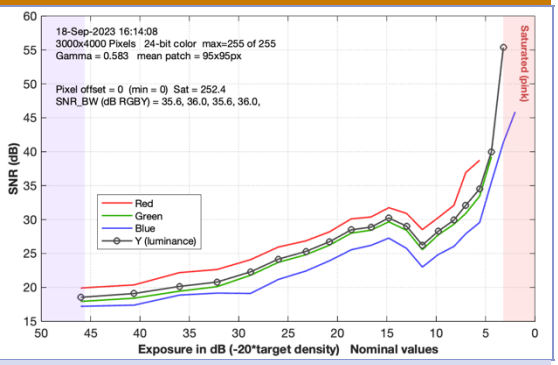
DJI Matrice M30, Binned, Color and Lightness Accuracy (CIE 2000)

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
2D a*b* plot		
Split Color Reference		
ΔC* vs ΔL* (Neutrals Only)		
Summary	Mean ΔE 2000: 4.92 Mean ΔC 2000: 2.84 Mean Camera Chroma: 108.68%	Mean ΔE 2000: 12.75 Mean ΔC 2000: 12.22 Mean Camera Chroma: 120.65%

DJI Matrice M30, Binned, SFR/Resolution Analysis

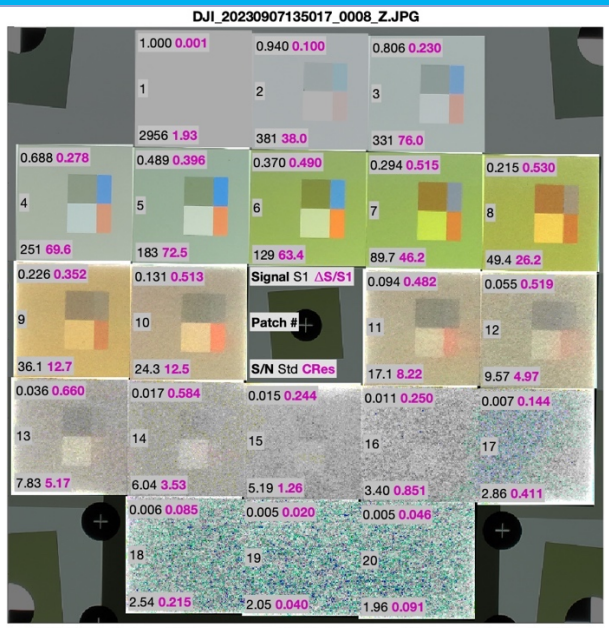
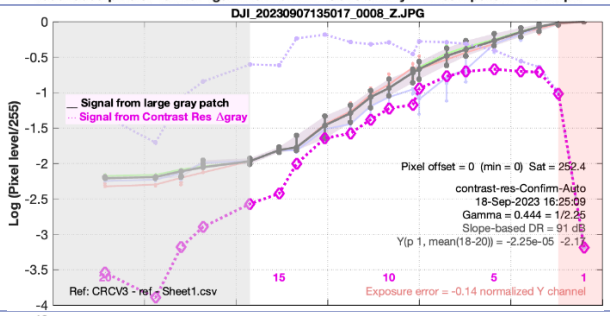
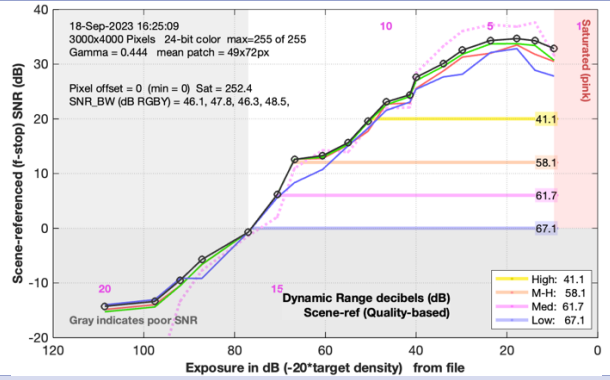
imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
ESF Edge Spread Function		
MTF Modular Transfer Function		
Slanted Edge Images (From ROI)		
Summary	Mean MTF50P: 1894 LW/PH Over Sharpening (Freq Domain): 26.0% Over Shoot (Spatial Domain): 22.7% Area Under Curve MTF: 1939 LW/PH Information Capacity, $Cmax$: 2.36 b/p	Mean MTF50P: 1538 LW/PH Over Sharpening (Freq Domain): 8.9% Over Shoot (Spatial Domain): 6.1% Area Under Curve MTF: LW/PH Information Capacity, $Cmax$: 2.51 b/p

DJI Matrice M30, Binned, Noise

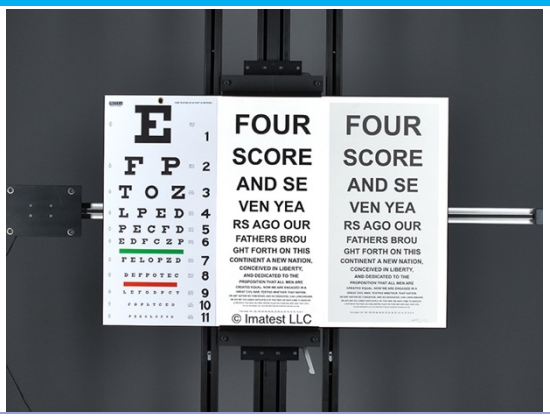
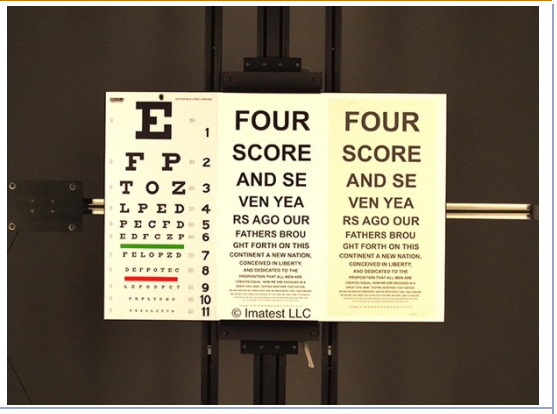
imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
SNR Signal to Noise Ratio		
Summary	Signal to Noise Ratio, Y Channel: 44.3 dB	Signal to Noise Ratio, Y Channel: 36.0 dB

2525 Frontier Ave, Suite B, Boulder, CO 80301, USA 1-800-599-3154

DJI Matrice M30, Binned, Dynamic Range

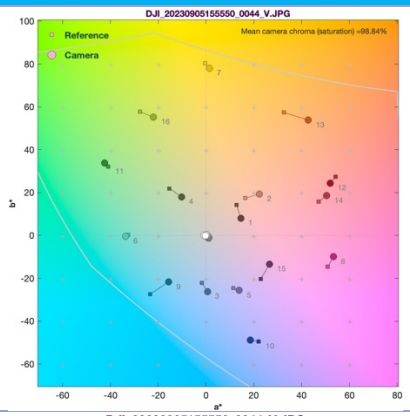
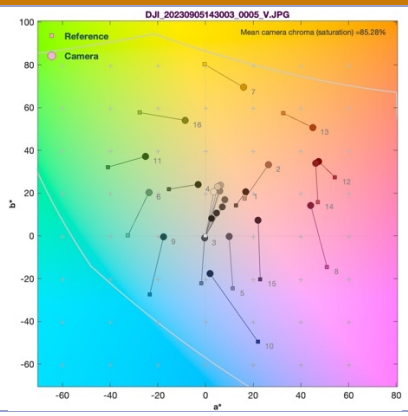
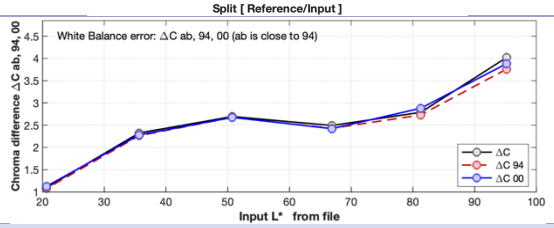
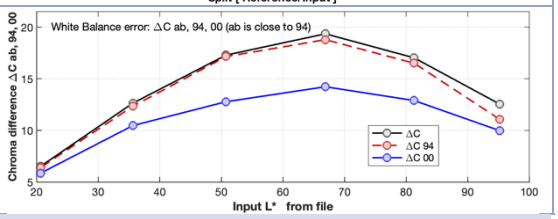
imatest® Plot/Chart	Daylight: 6500K at 100,000 Lux
Display Image with Objective Values	
Contrast Resolution	
Scene Referenced SNR vs Exposure	
Summary	Dynamic Range at SNR equals 1 (Low): 67.1 dB

DJI Matrice M30, Binned, Snellen Chart (Subjective Only)

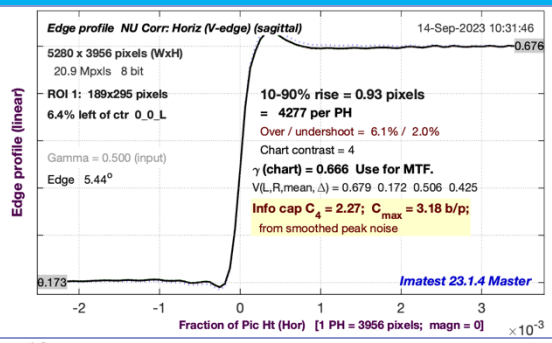
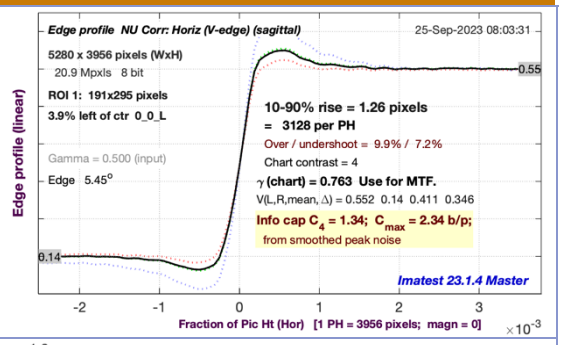
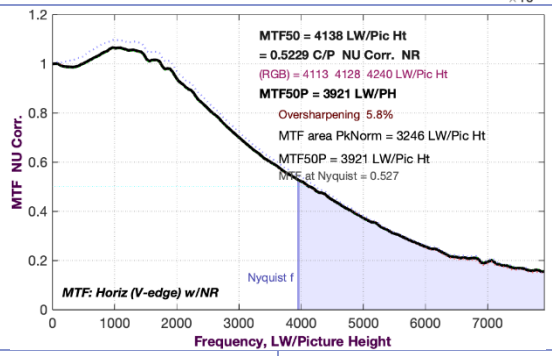
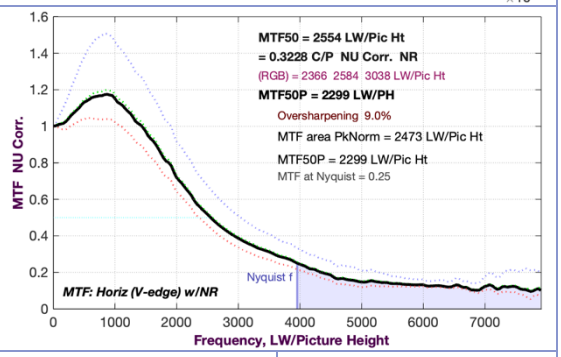
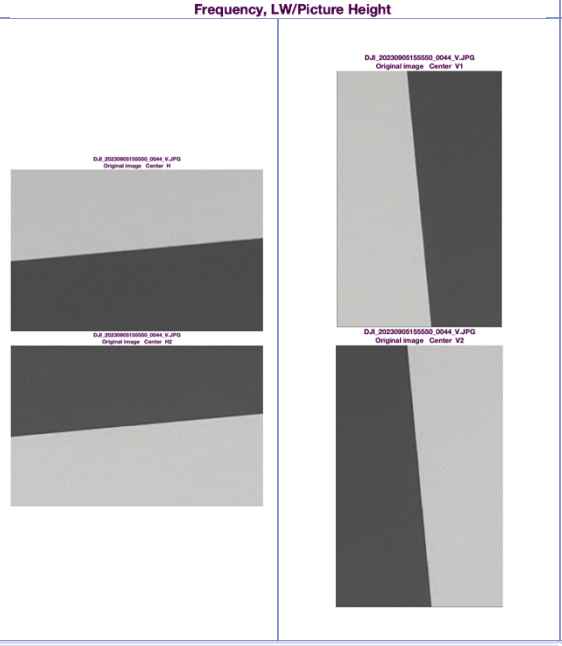
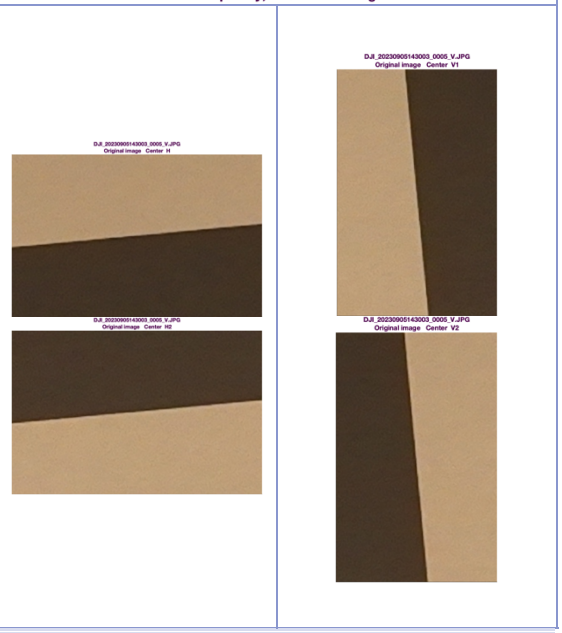
imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
Snellen Eye Chart – Full Image		
Snellen Eye Chart Crop		

2525 Frontier Ave, Suite B, Boulder, CO 80301, USA 1-800-599-3154

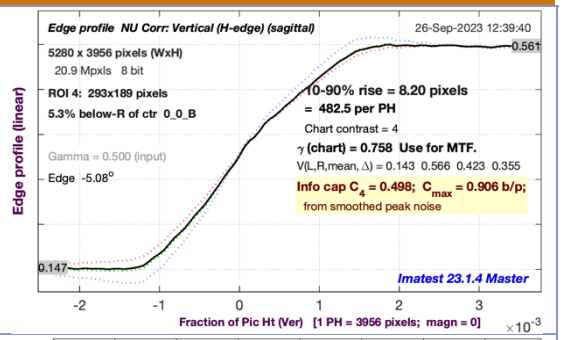
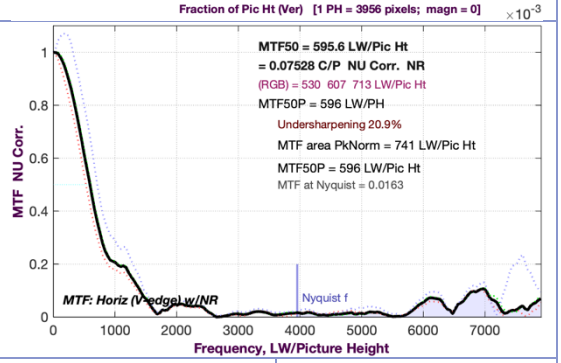
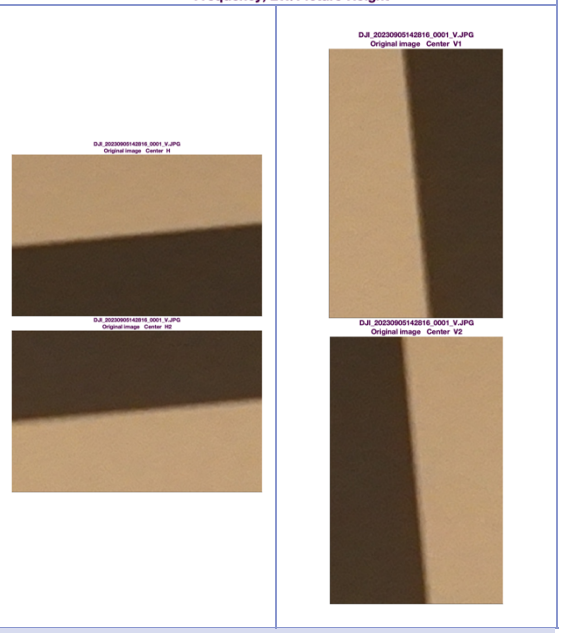
DJI Mavic M3E, Full Resolution, Color and Lightness Accuracy (CIE 2000)

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
2D a*b* plot		
Split Color Reference		
ΔC* vs ΔL* (Neutrals Only)		
Summary	Mean ΔE 2000: 6.48 Mean ΔC 2000: 2.72 Mean Camera Chroma: 98.84%	Mean ΔE 2000: 17.89 Mean ΔC 2000: 10.94 Mean Camera Chroma: 85.28%

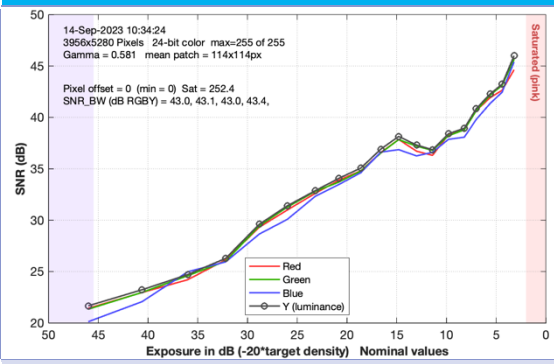
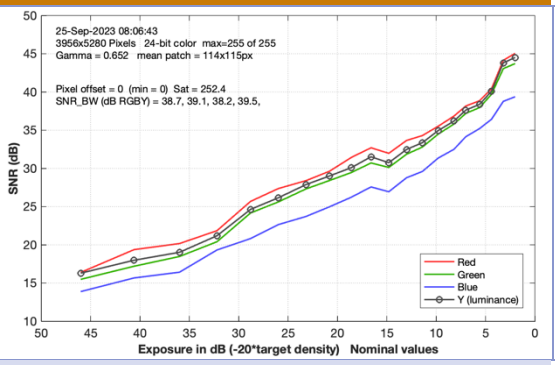
DJI Mavic M3E, Full Resolution, SFR/Resolution Analysis

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux *Sharpest image of autofocus set
ESF Edge Spread Function		
MTF Modular Transfer Function		
Slanted Edge Images (From ROI)		
Summary	Mean MTF50P: 3632 LW/PH Over Sharpening (Freq Domain): 5.8% Over Shoot (Spatial Domain): 6.1% Area Under Curve MTF: 3246 LW/PH Information Capacity, $Cmax$: 3.18 b/p	Mean MTF50P: 2198 LW/PH Over Sharpening (Freq Domain): 9.0% Over Shoot (Spatial Domain): 9.9% Area Under Curve MTF: 2473 LW/PH Information Capacity, $Cmax$: 2.34 b/p

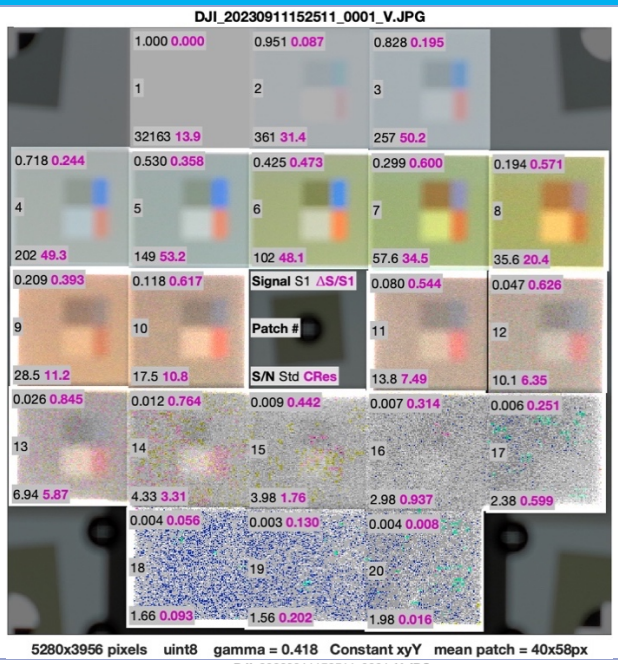
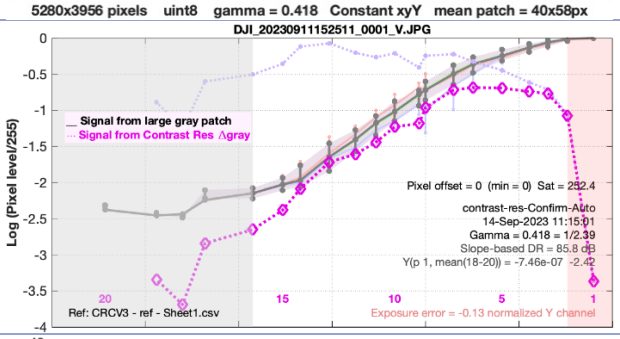
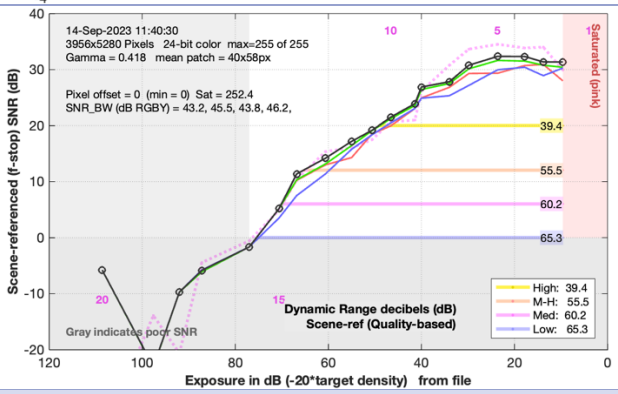
DJI Mavic M3E, Full Resolution, SFR/Resolution Analysis (Continued)

imatest® Plot/Chart	Lowlight: 3000K at 25 Lux *Most out of focus image from autofocus set
ESF Edge Spread Function	
MTF Modular Transfer Function	
Slanted Edge Images (From ROI)	
Summary	Mean MTF50P: 561.7 LW/PH Over Sharpening (Freq Domain): -20.9% Over Shoot (Spatial Domain): 1.8% Area Under Curve MTF: 741 LW/PH Information Capacity, $Cmax$: 0.951 b/p

DJI Mavic M3E, Full Resolution, Noise

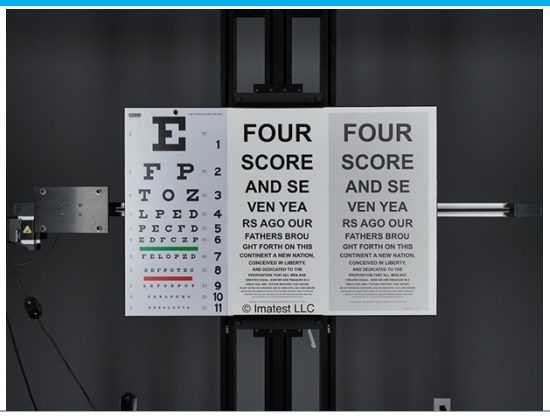
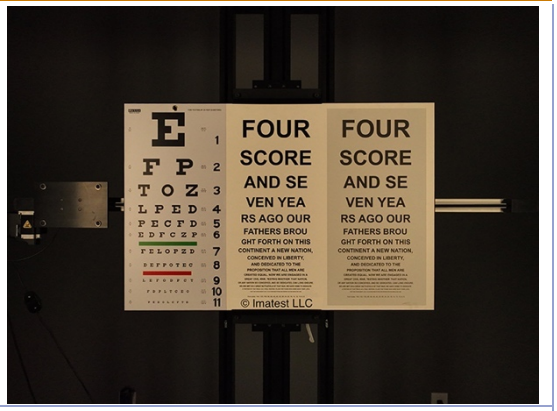
imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
SNR Signal to Noise Ratio		
Summary	Signal to Noise Ratio, Y Channel: 43.4 dB	Signal to Noise Ratio, Y Channel: 39.5 dB

DJI Mavic M3E, Full Resolution, Dynamic Range

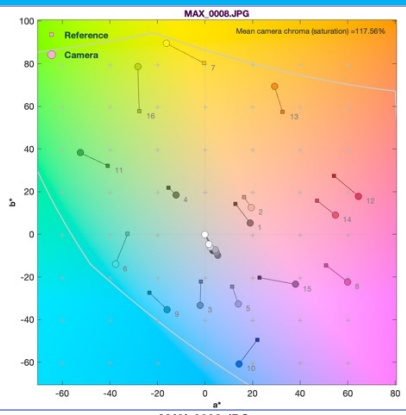
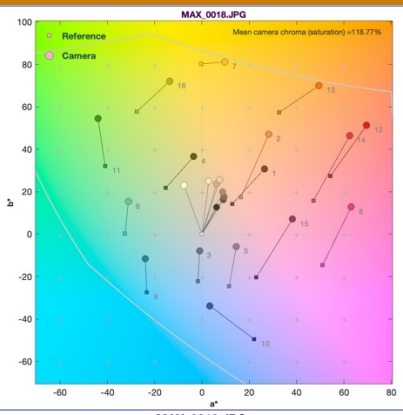
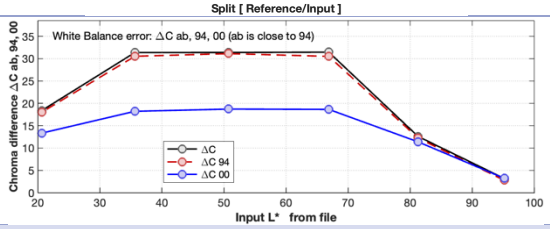
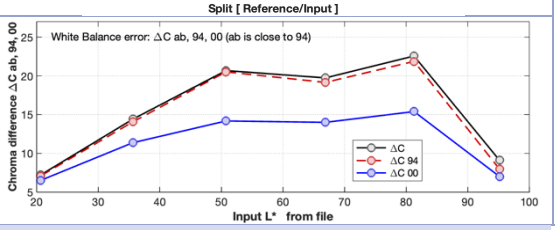
imatest® Plot/Chart	Daylight: 6500K at 100,000 Lux
Display Image with Objective Values	
Contrast Resolution	
Scene Referenced SNR vs Exposure	
Summary	Dynamic Range at SNR equals 1 (Low): 65.3 dB

2525 Frontier Ave, Suite B, Boulder, CO 80301, USA 1-800-599-3154

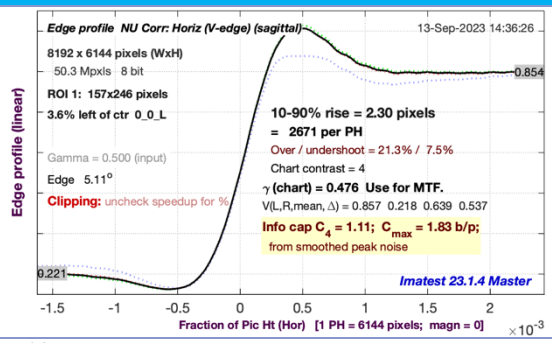
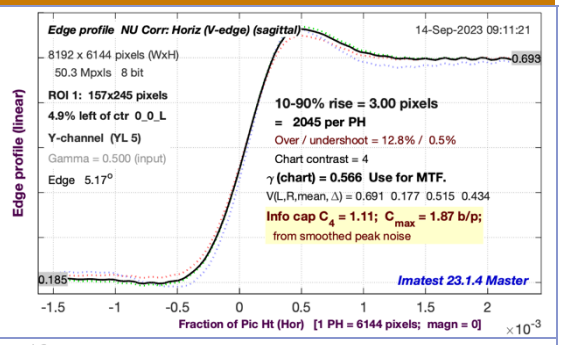
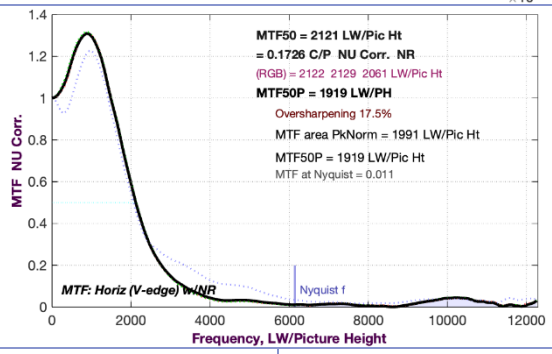
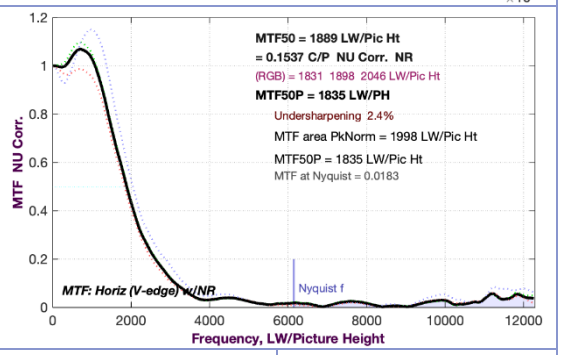
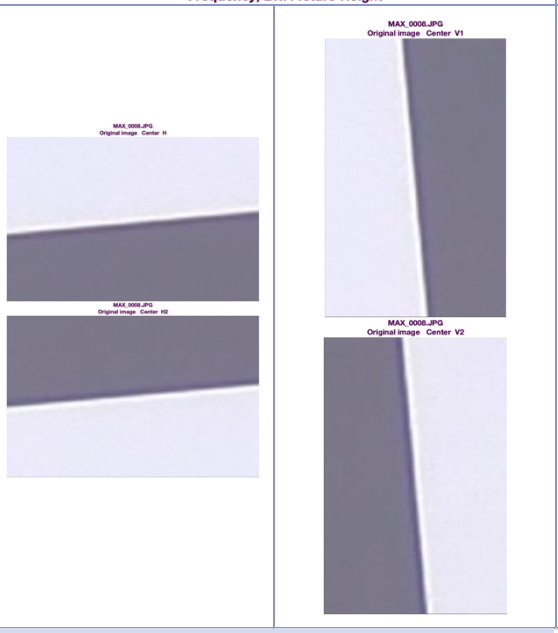
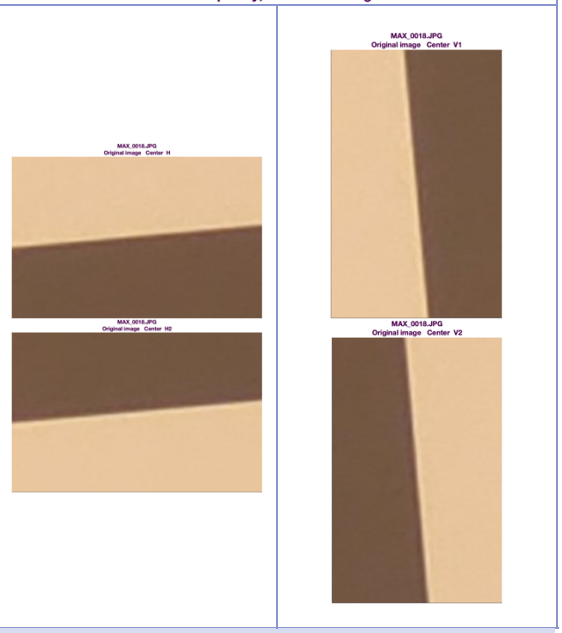
DJI Mavic M3E, Full Resolution, Snellen Chart (Subjective Only)

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
Snellen Eye Chart – Full Image		
Snellen Eye Chart Crop		

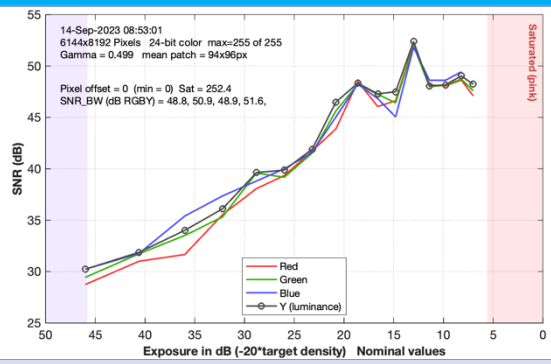
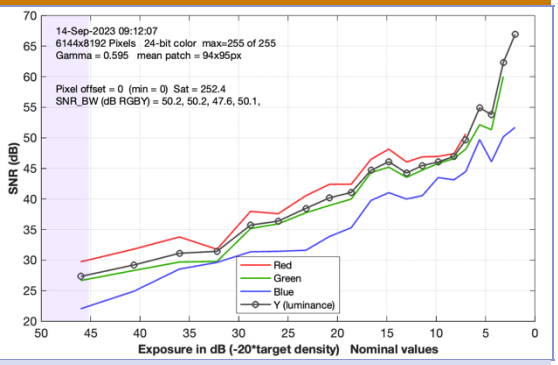
Autel4T, Full Resolution, Color and Lightness Accuracy (CIE 2000)

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
2D a*b* plot		
Split Color Reference		
ΔC* vs ΔL* (Neutrals Only)		
Summary	Mean ΔE 2000: 11.11 Mean ΔC 2000: 5.91 Mean Camera Chroma: 117.56%	Mean ΔE 2000: 10.78 Mean ΔC 2000: 10.16 Mean Camera Chroma: 118.77%

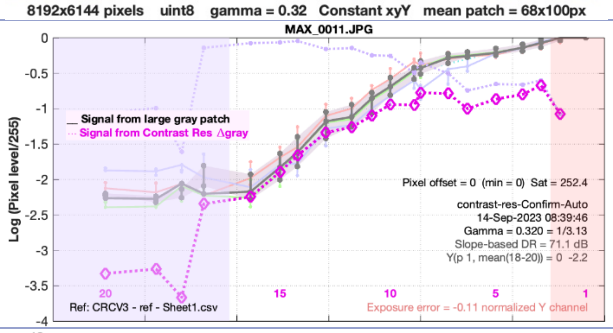
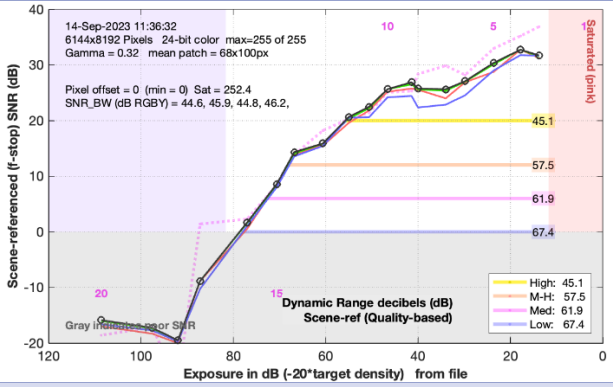
Autel 4T, Full Resolution, SFR/Resolution Analysis

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
ESF Edge Spread Function		
MTF Modular Transfer Function		
Slanted Edge Images (From ROI)		
Summary	Mean MTF50P: 1824 LW/PH Over Sharpening (Freq Domain): 17.5% Over Shoot (Spatial Domain): 21.3% Area Under Curve MTF: 1919 LW/PH Information Capacity, $Cmax$: 1.83 b/p	Mean MTF50P: 1770 LW/PH Over Sharpening (Freq Domain): -2.4% Over Shoot (Spatial Domain): 12.8% Area Under Curve MTF: 1998 LW/PH Information Capacity, $Cmax$: 1.87 b/p

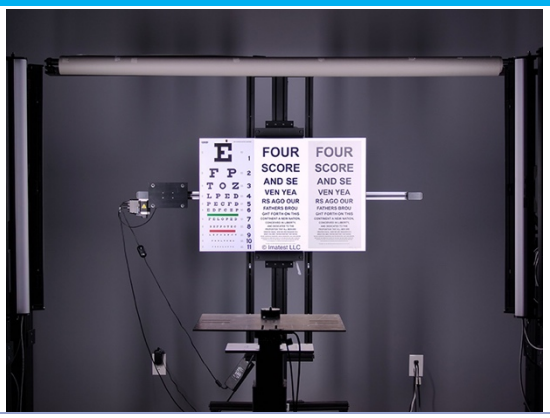
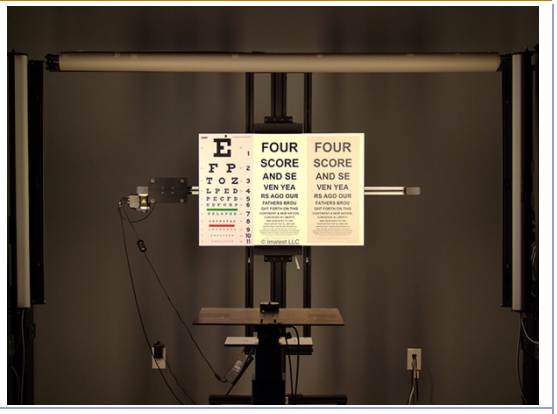
Autel 4T, Full Resolution, Noise

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
SNR Signal to Noise Ratio		
Summary	Signal to Noise Ratio, Y Channel: 51.6 dB	Signal to Noise Ratio, Y Channel: 50.1 dB

Autel 4T, Full Resolution, Dynamic Range

imatest® Plot/Chart	Daylight: 6500K at 100,000 Lux
Display Image with Objective Values	
Contrast Resolution	
Scene Referenced SNR vs Exposure	
Summary	Dynamic Range at SNR equals 1 (Low): 67.4 dB

Autel 4T, Full Resolution, Snellen Chart (Subjective Only)

imatest® Plot/Chart	Daylight: 6500K at 1000 Lux	Lowlight: 3000K at 25 Lux
Snellen Eye Chart – Full Image		
Snellen Eye Chart Crop