OpenDICE (v1.3) User Manual

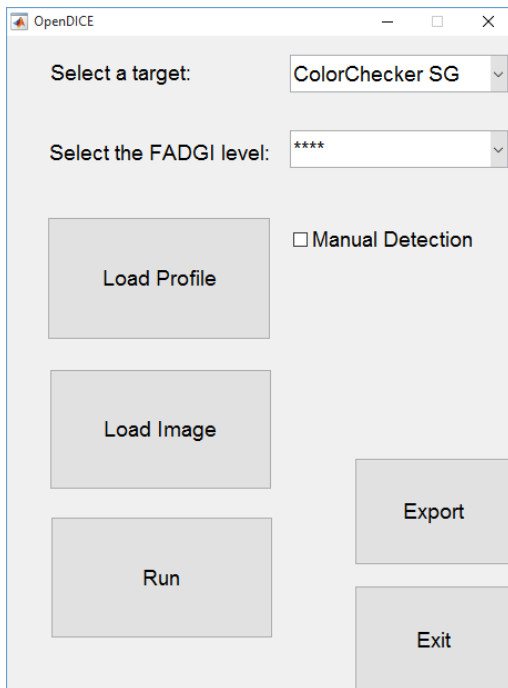Lei He

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1-202-707-8239

Figure 1. OpenDICE user interface

1. In the interface (Figure 1), the default setting for the target is ColorChecker SG. User may change it to DICE.

2. The default FADGI level for image quality assessment is 4 star, which may be changed to 3 or 2 star. If the analysis results fail to meet 2 star level, then it's 1 star level.
A configuration file is provided to allow the user change the criteria settings (Figure 2). The current values follow the specifications in FADGI v2010.

	A	B	C	D
1	FADGI Criteria	****	***	**
2	Hi_freq Low	0.95	0.9	0.8
3	Hi_freq Up	0.2	0.3	0.4
4	Mid_freq Low	0.45	0.35	0.25
5	Mid_freq Up	0.65	0.75	0.85
6	Sampling Freq	0.005	0.0075	0.015
7	Nyquist Amp	0.2	0.3	0.4
8	Sharpening	1	1.1	1.2
9	OECF band	3	6	9
10	White Balance	3	4	6
11	Uniformity	0.01	0.03	0.05
12	Noise	2.5	4	6
13	Max DeltaE	6	10	15
14	Mean DeltaE	3	5	10
15	Max DeltaEab	3	5	8
16	Mean DeltaEab	2	3	6
17	Color Regis	0.33	0.5	0.8
18				
19				

Figure 2. FADGI criteria values

3. (1). User will load the profile first according to the target selection. It should be an Excel file, with the measurements as the ground truth for color accuracy assessment (L*a*b*) and tonescale analysis (density), respectively. For example, a DICE profile and a Colorchecker SG profile are shown in Figure 3 and Figure 4.

(2). The profile format is strictly defined, with the L*, a*, b*, and D as the table head. The patches are listed from 1 to 30 (DICE), or from A1…A10 to N1…N10 (Colorchecker SG).

(3). Note that the DICE target has density measurements for its 12 gray patches (#10 - #21), and Colorchecker SG target has density measurements for its central 12 gray patches (#E5 - #J6).

(4). The profile must match with the selected target, otherwise an error message will be displayed. Then user may reselect either the profile or target.
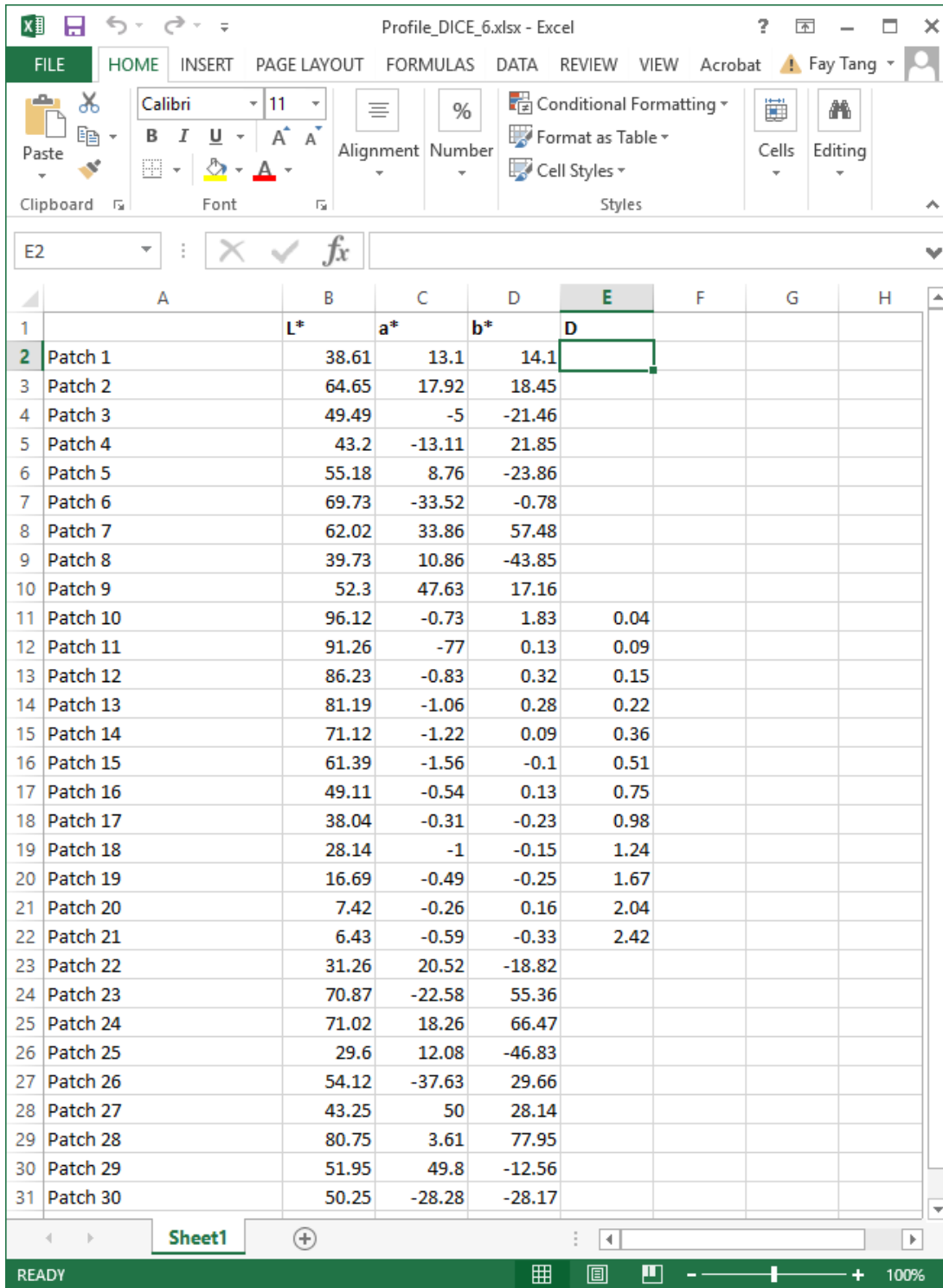
	A	B (L*)	C (a*)	D (b*)	E (D)
1		L*	a*	b*	D
2	Patch 1	38.61	13.1	14.1	
3	Patch 2	64.65	17.92	18.45	
4	Patch 3	49.49	-5	-21.46	
5	Patch 4	43.2	-13.11	21.85	
6	Patch 5	55.18	8.76	-23.86	
7	Patch 6	69.73	-33.52	-0.78	
8	Patch 7	62.02	33.86	57.48	
9	Patch 8	39.73	10.86	-43.85	
10	Patch 9	52.3	47.63	17.16	
11	Patch 10	96.12	-0.73	1.83	0.04
12	Patch 11	91.26	-77	0.13	0.09
13	Patch 12	86.23	-0.83	0.32	0.15
14	Patch 13	81.19	-1.06	0.28	0.22
15	Patch 14	71.12	-1.22	0.09	0.36
16	Patch 15	61.39	-1.56	-0.1	0.51
17	Patch 16	49.11	-0.54	0.13	0.75
18	Patch 17	38.04	-0.31	-0.23	0.98
19	Patch 18	28.14	-1	-0.15	1.24
20	Patch 19	16.69	-0.49	-0.25	1.67
21	Patch 20	7.42	-0.26	0.16	2.04
22	Patch 21	6.43	-0.59	-0.33	2.42
23	Patch 22	31.26	20.52	-18.82	
24	Patch 23	70.87	-22.58	55.36	
25	Patch 24	71.02	18.26	66.47	
26	Patch 25	29.6	12.08	-46.83	
27	Patch 26	54.12	-37.63	29.66	
28	Patch 27	43.25	50	28.14	
29	Patch 28	80.75	3.61	77.95	
30	Patch 29	51.95	49.8	-12.56	
31	Patch 30	50.25	-28.28	-28.17	

Figure 3. DICE target profile with the L*a*b* and density (D) measurements

	L*	a*	b*	D
A1	96.2985	-0.5458	1.5096	
A2	10.6935	-0.3352	-1.0118	
A3	49.6154	-0.3103	0.3653	
A4	96.0415	-0.4857	1.5149	
A5	10.5923	-0.2674	-1.1508	
A6	49.6400	-0.3304	0.3381	
A7	95.9526	-0.5028	1.5657	
A8	9.3874	-0.1372	-0.0766	
A9	49.4682	-0.3192	0.3523	
A10	95.9029	-0.4957	1.6006	
B1	49.4967	-0.3075	0.3672	
B2	32.3653	51.3666	-9.5427	
B3	60.8987	26.5011	-17.9100	
B4	28.6267	49.7678	-41.5218	
B5	49.7842	-14.6395	-47.9136	
B6	60.5414	-29.8247	-27.1129	
B7	20.1867	-25.3903	-6.5301	
B8	59.6112	-39.3237	-12.9951	
B9	18.7166	1.8405	13.5833	
B10	49.3193	-0.3254	0.3267	
C1	10.7087	-0.8095	-3.0684	
C2	20.3979	19.7419	-18.3000	
C3	41.0532	19.2361	-37.6173	
C4	19.8193	0.0502	-36.5187	
C5	59.5206	-16.8785	-31.6820	
C6	19.5360	-17.8335	-21.9442	
C7	60.1240	-5.0684	-32.3263	
C8	50.1326	-47.6600	-10.4349	
C9	59.9544	-39.5472	19.7771	
C10	11.3559	-0.3692	-0.8035	
D1	96.0416	-0.5016	1.5184	
D2	83.3154	-1.6797	-8.3638	
D3	84.6238	14.7581	0.6289	
D4	84.1672	-19.3436	-1.1577	
D5	84.5380	13.0762	7.7844	
D6	83.7328	-11.8838	26.8741	
D7	61.5088	29.5637	36.7664	
D8	63.6373	20.9805	18.8030	
D9	50.5350	-53.4541	13.8062	
D10	95.9202	-0.5152	1.4722	
E1	49.5449	-0.3344	0.3185	
E2	32.4478	19.8755	22.5671	
E3	61.8556	37.5262	69.0939	
E4	19.5480	22.8684	-58.0487	
E5	96.1938	-0.5133	1.4307	0.05
E6	10.8849	-1.0436	-2.6829	1.89
E7	76.3084	20.2970	23.5270	

Figure 4. Colorchecker SG target profile with the L*a*b* and density (D) measurements

4. After loading the profile, user may import the target image for quality assessment. Similarly, the image must match with the target. Otherwise an error message will be display for re-selection. With the current version, OpenDICE support only well scanned images with tilt angle less than 5°, i.e., no automatic rotation or adjustment is applied to the input image.

5. Once the image is loaded, the regions of interest (ROI) on the image will be automatically identified, as shown with the rectangles. User may resize or drag the rectangles for minor location adjustment. If the ROI are far away from the ideal regions, manual selection is suggested, i.e., user check the Manual Detection option and load the image again.
Note that manual detection generally provides faster and more accurate ROI identification, with the user interaction. User must click the four corner points (for DICE targets) or cross points (for Colorchecker SG and UTT) in a clockwise manner (double click is needed for the last click on point 1 when finish the loop), see Figure 5.
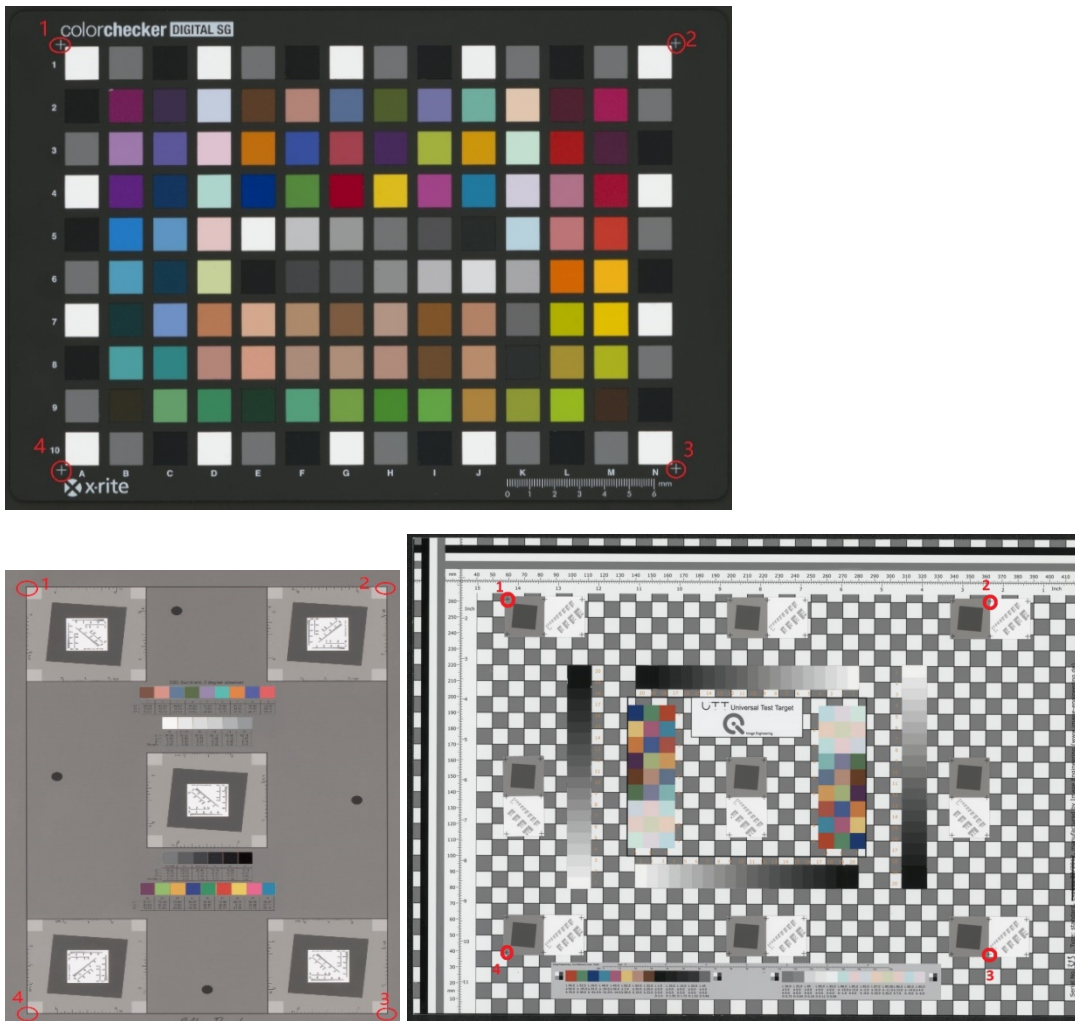
Figure 5. Landmark points for user manual selection to identify the ROI

6. Once the ROI are identified, user will see the images overlapped with a set of rectangles, see Figure 6. In this identification process, user cannot click any buttons on the interface. Again, user may be drag or resize the rectangles for more accurate location. Depending on the image size, this step may take a couple of minutes to identify the ROI on Colorchecker SG images. In such cases, we recommend Manual Detection option before loading the image.
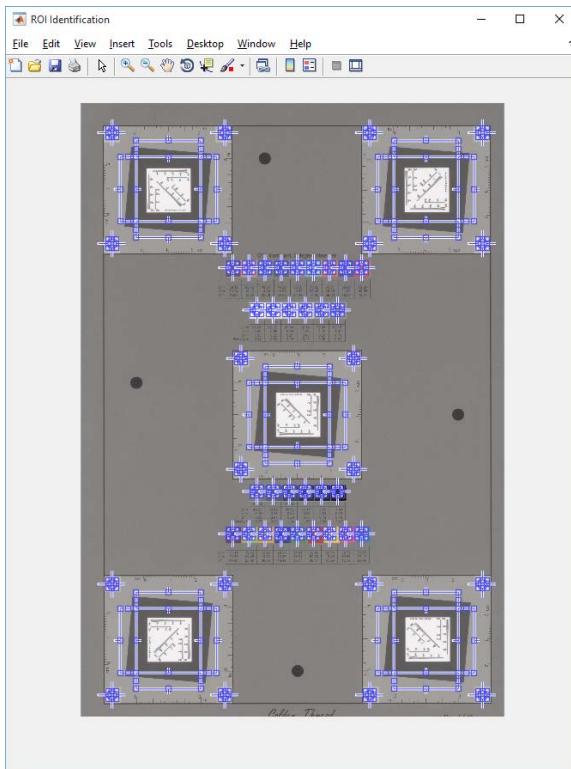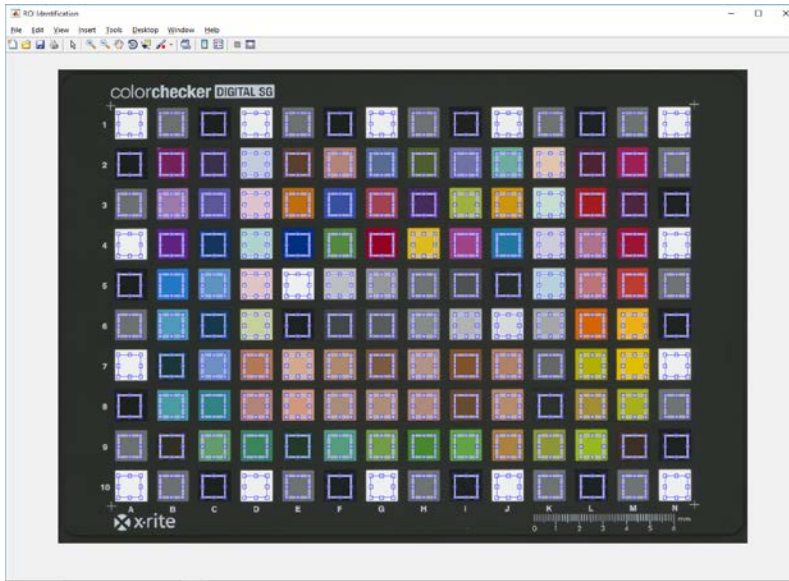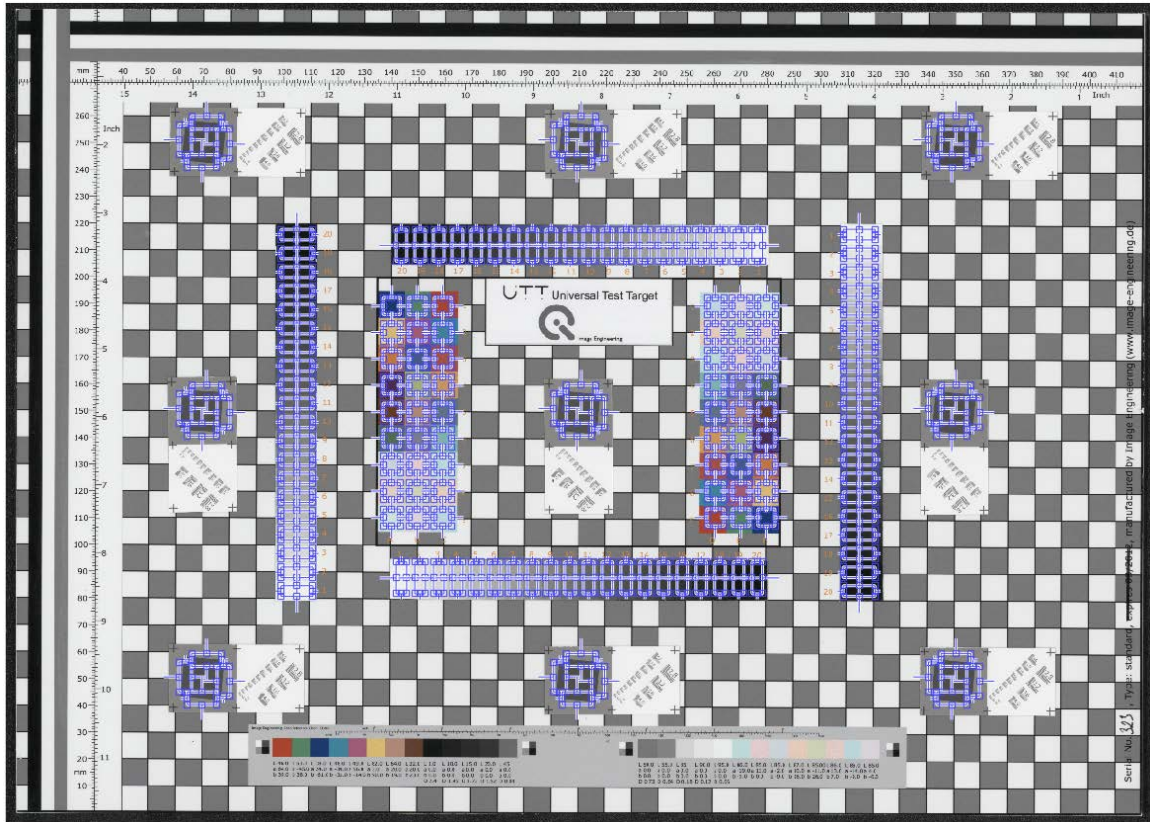
Figure 6. ROI identification for Colorchecker SG, DICE and UTT target images.

7. User confirm the ROI are acceptable, then click Run button to start assessment. The assessment results are displayed on two (Colorchecker SG target) or three (DICE target) windows. For the Colorchecker SG target, the first window displays color accuracy analysis results and the second window presents tonescale analysis results. DICE target images have the third window for resolution analysis results.

(1). Color accuracy window consists of four tabs: Luminance, Delta E 2000, Color Registration Accuracy, and Summary.
Luminance tab shows the difference between the aim (ground truth from the measurements) and the actual image values for all patches, as shown in Figure 7.
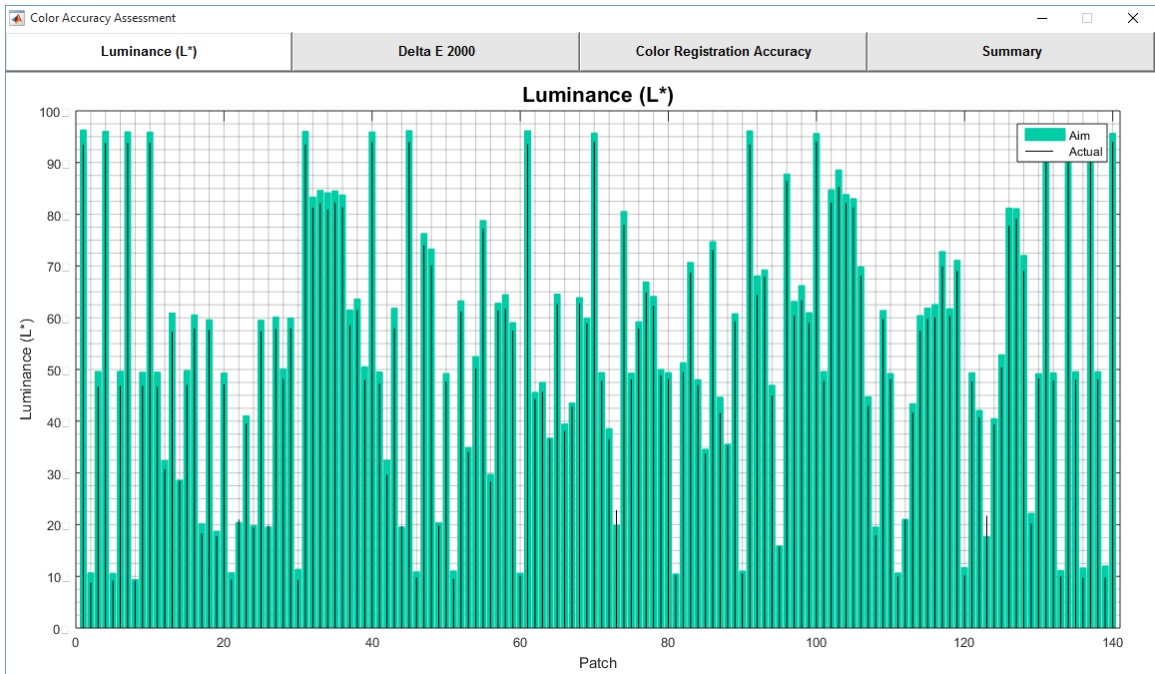
Figure 7. Luminance tab in Color Accuracy Analysis window

Delta E 2000 tab shows the ΔE2000 between the ground truth and the actual image values for all patches, as shown in Figure 8. The vertical black lines with black dots represent the actual ΔE2000 values, and the vertical red lines with red dots show the actual ΔE2000(a*b*) values. The horizontal magenta line shows the maximum upper limit for ΔE2000 according to the user FADGI level selection. Similarly, the horizontal blue line shows the mean upper limit for ΔE2000. The horizontal black line shows the actual mean ΔE2000, and the horizontal green line shows the actual median ΔE2000.
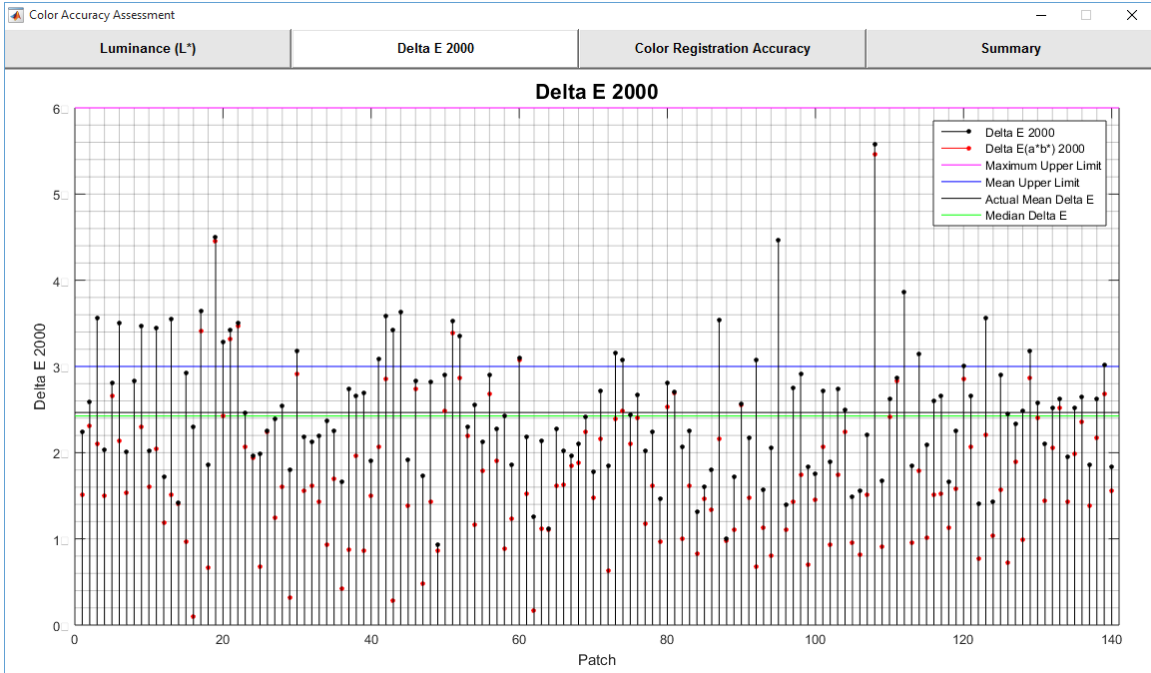
Figure 8. Delta E 2000 tab in Color Accuracy Analysis window

Color Registration Accuracy tab is not applicable to Colorchecker SG target. Figure 9 shows an example of DICE target.
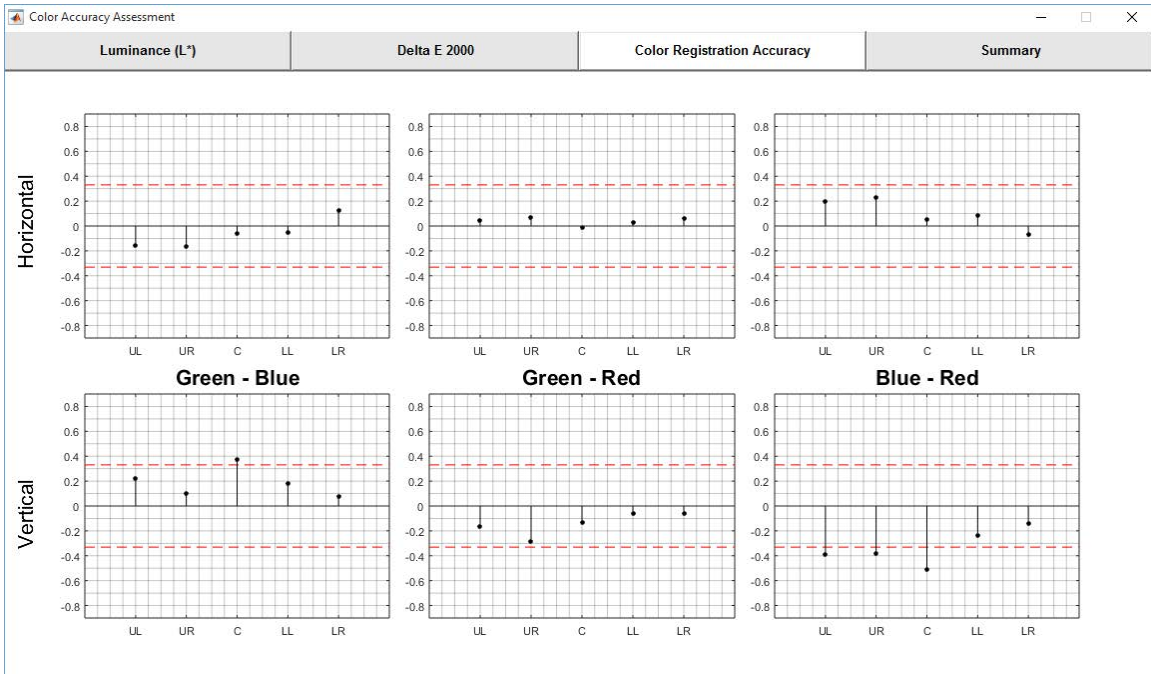
Figure 9. Color Registration Accuracy tab in Color Accuracy Analysis window (only for DICE target)

Summary tab shows the detail results (value) according to the FADGI guideline performance level (lower limit and upper limit), see Figure 10.

Color Accuracy Assessment					— □ ×
Luminance (L*)	**Delta E 2000**	**Color Registration Accuracy**		**Summary**	

FADGI Performance Level: -----4 star -----

Measurements	Pass/Fail	Lower Limit	Value	Upper Limit
Max DeltaE 2000	Pass	0.0	5.6	6.0
Mean DeltaE 2000	Pass	0.0	2.5	3.0
Median DeltaE 2000			2.4	
Max DeltaE(a*b*) 2000	Fail	0.0	5.5	3.0
Mean DeltaE(a*b*) 2000	Pass	0.0	1.8	2.0
Median DeltaE(a*b*) 2000			1.6	
A1_DeltaE 2000	Pass	0.0	2.2	6.0
A2_DeltaE 2000	Pass	0.0	2.6	6.0
A3_DeltaE 2000	Pass	0.0	3.6	6.0
A4_DeltaE 2000	Pass	0.0	2.0	6.0
A5_DeltaE 2000	Pass	0.0	2.8	6.0
A6_DeltaE 2000	Pass	0.0	3.5	6.0
A7_DeltaE 2000	Pass	0.0	2.0	6.0
A8_DeltaE 2000	Pass	0.0	2.8	6.0
A9_DeltaE 2000	Pass	0.0	3.5	6.0
A10_DeltaE 2000	Pass	0.0	2.0	6.0
B1_DeltaE 2000	Pass	0.0	3.4	6.0
B2_DeltaE 2000	Pass	0.0	1.7	6.0
B3_DeltaE 2000	Pass	0.0	3.6	6.0
B4_DeltaE 2000	Pass	0.0	1.4	6.0
B5_DeltaE 2000	Pass	0.0	2.9	6.0
B6_DeltaE 2000	Pass	0.0	2.3	6.0
B7_DeltaE 2000	Pass	0.0	3.6	6.0
B8_DeltaE 2000	Pass	0.0	1.9	6.0
B9_DeltaE 2000	Pass	0.0	4.5	6.0
B10_DeltaE 2000	Pass	0.0	3.3	6.0

Figure 10. Summary tab in Color Accuracy Analysis window

(2). Tonescale analysis window consists of four tabs: OECF Curves, Difference to Aim, White Balance, Uniformity, Noise, and Summary.

OECF tab shows the OECF curves for RGB and luminance components, as shown in Figure 11. User may change the gamma, gain, and offset to adjust the curves in order to fit them into the range defined by the current FADGI level (magenta curves).
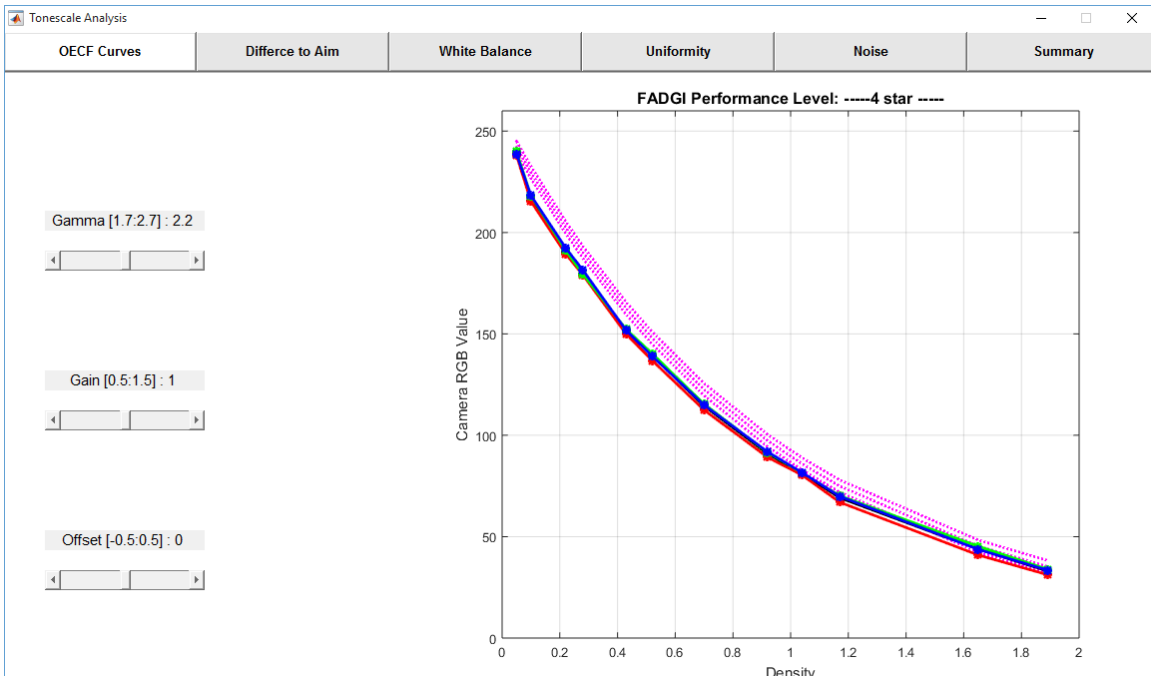
Figure 11. OECF Curves tab in Tonescale Analysis window

Difference to Aim tab shows error of the OECF curves, and the ideal range defined by the current FADGI level (magenta curves), see Figure 12.
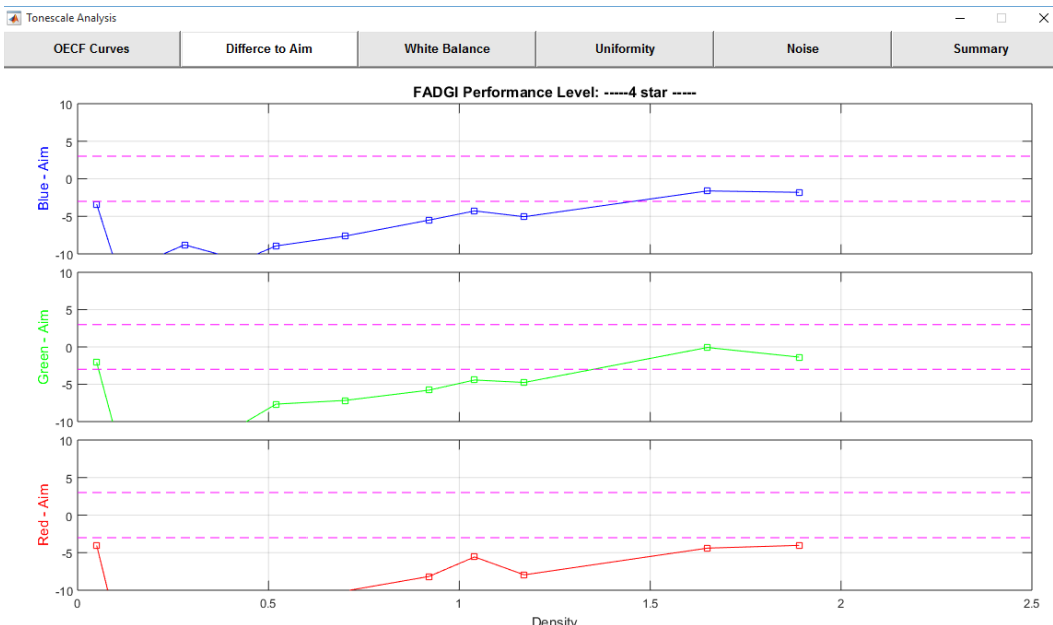

Figure 12. Difference to Aim tab shows the OECF curve errors in Tonescale Analysis window

White Balance tab shows white balance error (blue-red, green-red, and green-blue) of the neutral patches, and the ideal range defined by the current FADGI level (magenta curves), see Figure 13.
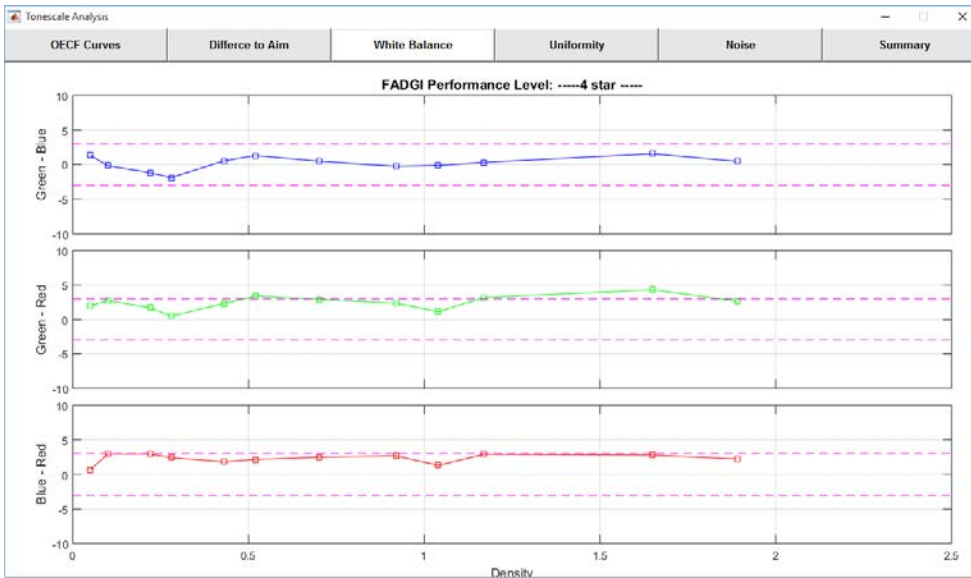

Figure 13. White Balance tab shows the white balance errors in Tonescale Analysis window

Uniformity assessment is not applicable to Colorchecker SG target. Figure 14 shows an example of DICE target.
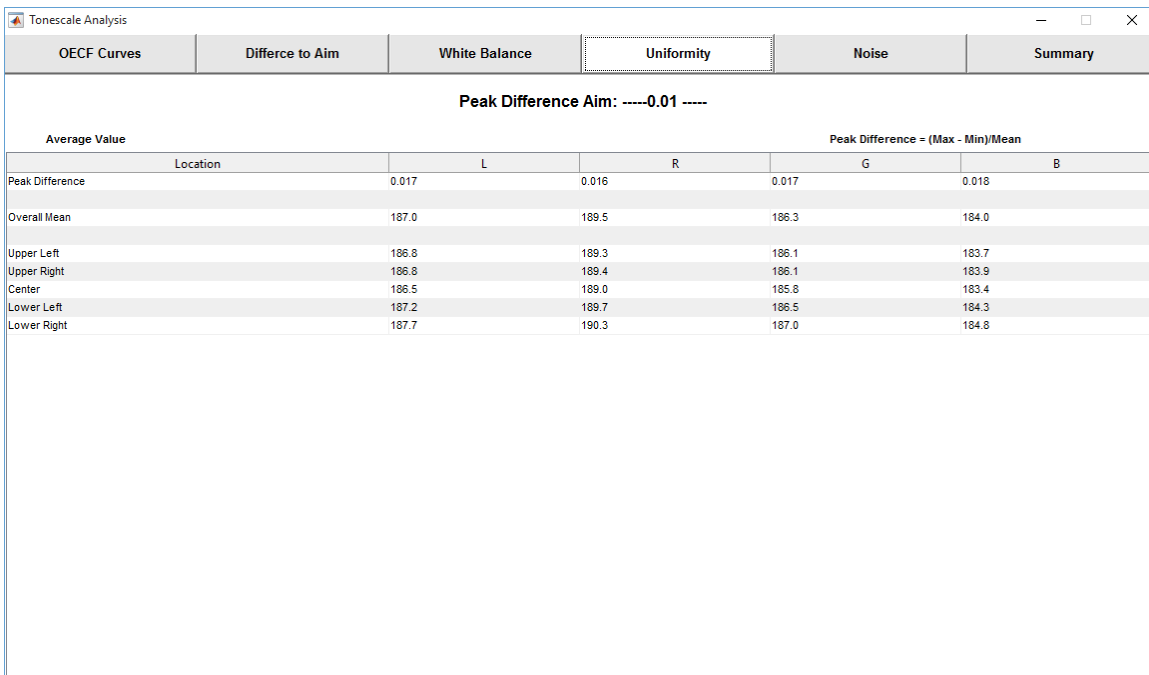

Figure 14. Uniformity tab shows the illuminance uniformity error in Tonescale Analysis window (only for DICE target)

Noise tab shows the noise level for the neutral patches, see Figure 15.
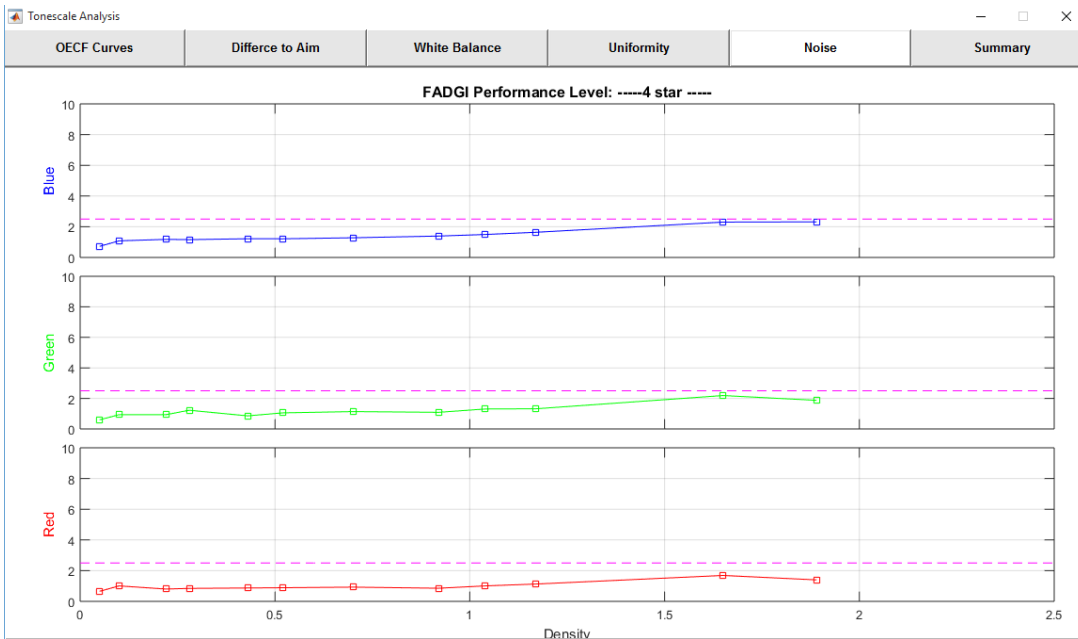

Figure 15. Noise tab shows the noise levels in Tonescale Analysis window

Summary tab shows the detail results (value) according to the FADGI guideline performance level (lower limit and upper limit), see Figure 16.

Measurements	Pass/Fail	Lower Limit	Value	Upper Limit
Tone Response				
E5 Red	Fail	239.0	237.9	245.0
E5 Green	Pass	239.0	239.9	245.0
E5 Blue	Fail	239.0	238.6	245.0
J6 Red	Fail	226.7	215.3	232.7
J6 Green	Fail	226.7	218.1	232.7
J6 Blue	Fail	226.7	218.2	232.7
F5 Red	Fail	199.6	189.5	205.6
F5 Green	Fail	199.6	191.2	205.6
F5 Blue	Fail	199.6	192.4	205.6
I6 Red	Fail	187.2	179.0	193.2
I6 Green	Fail	187.2	179.5	193.2
I6 Blue	Fail	187.2	181.4	193.2
G5 Red	Fail	159.6	149.9	165.6
G5 Green	Fail	159.6	152.2	165.6
G5 Blue	Fail	159.6	151.7	165.6
H6 Red	Fail	145.0	136.9	151.0
H6 Green	Fail	145.0	140.3	151.0
H6 Blue	Fail	145.0	139.0	151.0
H5 Red	Fail	119.6	112.4	125.6
H5 Green	Fail	119.6	115.4	125.6
H5 Blue	Fail	119.6	114.9	125.6
G6 Red	Fail	94.4	89.2	100.4
G6 Green	Fail	94.4	91.6	100.4
G6 Blue	Fail	94.4	91.8	100.4
I5 Red	Fail	82.9	80.3	88.9
I5 Green	Fail	82.9	81.4	88.9
I5 Blue	Fail	82.9	81.6	88.9

Figure 16. Summary tab shows the tonescale analysis results

(3). Specifically for DICE target, there is a resolution analysis window which consists of nine tabs: Efficiency, SFR (10%), SFR (50%), Center, Upper Left, Upper Right, Lower Left, Lower Right, and Summary.

Efficiency tab shows the average sampling efficiency for red, green, and blue components, see Figure 17.
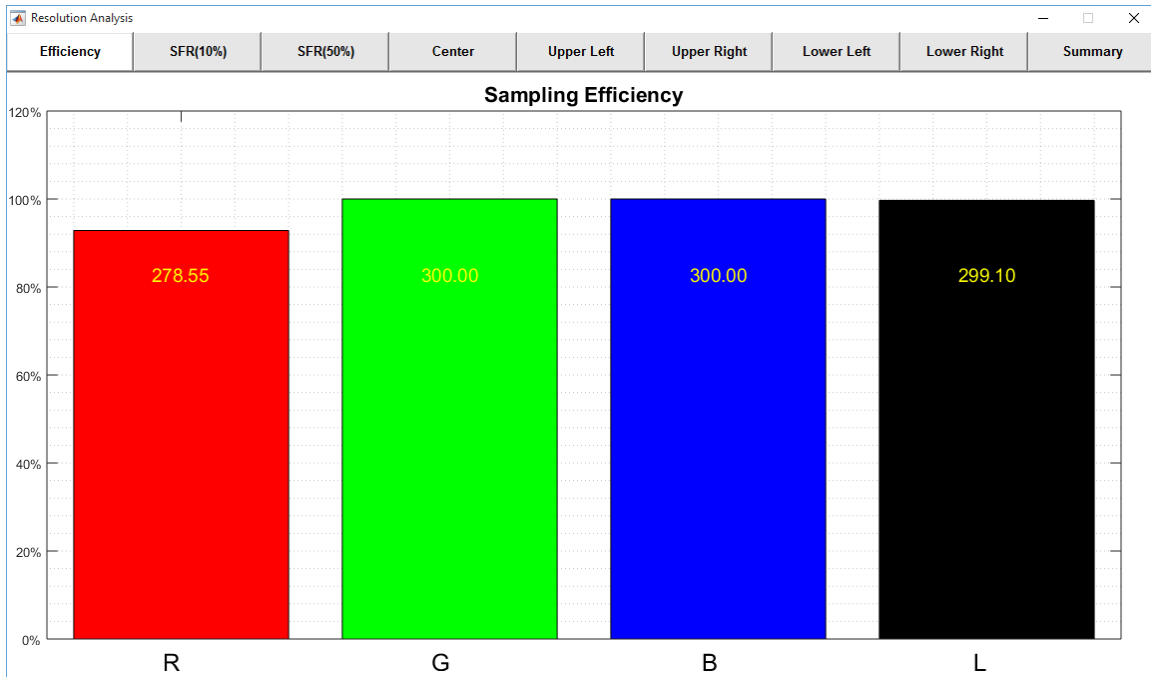

Figure 17. Efficiency tab shows the sampling efficiency values in resolution analysis window

8. With these results, user may click the Export button to write all the results to an Excel file as the results. The file will be saved in the same folder as that of the image, with an extension of the FADGI star level. Note that Microsoft Excel is required in order to write the results.