OpenDICE (v2.5) User Manual

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1.0 Introduction

1.1 Purpose of this Manual

OpenDICE is a software tool for measuring and analyzing the conformance of a digital imaging system to the goals of a digitization program in the context of the cultural heritage community. OpenDICE supports the digitization guidelines promulgated through the Federal Agencies Digital Guidelines Initiative (FADGI).[1] OpenDICE is an open source and simplified alternative to the Digital Imaging Conformance Environment (DICE) system pioneered by Image Science Associates (ISa) with its GoldenThread proprietary software.[2] ISa has confirmed that the OpenDICE analysis methodology and results are consistent with the results obtained with the ISa GoldenThread software.[3]

This manual provides an overview of the OpenDICE software program (ver 2.5) and a step-by-step guide for using the software to help you analyze the quality of your imaging equipment to produce FADGI-compliant digital images that meet the needs of your institution. It is important to note that the validity of the results (output) obtained with OpenDICE image processing routines are largely determined by the measurements (input) derived from the targets chosen for the analysis.

1.2 OpenDICE and FADGI

OpenDICE provides one way to measure the performance quality of an imaging system. OpenDICE bases this evaluation on the 2016 version of FADGI's *Technical Guidelines for Digitizing Cultural Heritage Materials.*[4] Central to the *Technical Guidelines* is the FADGI star system for establishing quality goals for digital images of a variety of documentary resources typically held by cultural heritage organizations. Based on extensive research and experience within the imaging profession, the FADGI Still Imaging Working Group defined ideal imaging aim values for a set of standardized measurements, including color accuracy, tonescale, and resolution. The group then developed recommendations that specify how far an imaging system can deviate from these aims for a given level of expected quality.

The FADGI guidelines establish four levels of "star quality" representing categories of acceptable error. A "4-star" level deviates least from the ideal aims, whereas a "1-star" level deviates the most. The FADGI star levels are similar to the quality levels established by ISO 19264-1:2017.[5] The FADGI *Technical Guidelines* state, "Higher star ratings relate to more consistent image quality, but require greater technical performance of both operator and imaging system to achieve. The appropriate star performance level for a particular project should be carefully considered in the planning stage of the project." FADGI provides a summary of the qualities associated with each star level.[6]

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[1] Federal Agencies Digital Guidelines Initiative. http://www.digitizationguidelines.gov/

[2] Image Science Associates. http://www.imagescienceassociates.com/

[3] FADGI. OpenDICE. http://www.digitizationguidelines.gov/guidelines/digitize-OpenDice.html.

[4] Federal Agencies Digital Guidelines Initiative, *Technical Guidelines for Digitizing Cultural Heritage Materials: Creation of Raster Image Files*, ed. Thomas Rieger (September 2016). http://www.digitizationguidelines.gov/guidelines/digitize-technical.html

[5] International Standards Organization. ISO 19264-2017. Photography-Archiving systems-Image quality analysis-Part 1: Reflective originals. https://www.iso.org/standard/64221.html

[6] FADGI, *Technical Guidelines for Digitizing Cultural Heritage Materials* (2016), p. 9.

- One star imaging should only be considered informational, in that images are not of a sufficient quality to be useful for optical character recognition (OCR) or other information processing techniques. One star imaging is appropriate for applications where the intent is to provide a reference to locate the original, or the intent is textual only with no repurposing of the content.
- Two star imaging is appropriate where there is no reasonable expectation of having the capability of achieving three or four star performance. These images will have informational value only, and may or may not be suitable for OCR.
- Three star imaging defines a very good professional image capable of serving for almost all uses.
- Four star [imaging] defines the best imaging practical today. Images created to a four star level represent the state of the art in image capture and are suitable for almost any use.

The star level chosen for a given project should reflect both the types of materials in an imaging project and the expected uses of the resulting archival master images. The FADGI *Technical Guidelines* (pp. 18-51) contain further details about the aim values, tolerances, and limits for various types of cultural heritage resources.

1.3 Significant Differences between v2.4 and v2.5

There are several important changes between OpenDICE version 2.4 and the current version, 2.5, described in this manual. The following list provides an overview of these major changes:

- It changes the flow of material and target selection from version 2.4.
- It adds four new targets (FADGI 19264 Commercial target, DT-NGT target, positive 35mm target, and IT8.7/1 transparent target) and supports 14 targets overall.
- It supports a barcode scanning function for the DICE target.
- It has two separate forms to support Excel and text profile input and output.
- It simplifies the installation and running OpenDICE on the Mac system.
- In v2.5, the default material setting is *Bound Volumes: General Collections* while in v2.4 the material setting was *Bound Volumes: Rare and Special Materials*.
- In v2.5, you can export test results to an Excel file or a text file rather than just an Excel file as in v2.4. This feature enables the support of systems without Excel.

1.4 Download Instructions

To download OpenDICE, navigate to http://www.digitizationguidelines.gov/guidelines/digitize-OpenDice.html and choose the appropriate download for Windows or Mac under **OpenDICE Downloads**.

1.4.1 Windows

OpenDICE is a fully functional program for the Windows operating system, created in Matlab. OpenDICE is optimized for use in Windows.

1.4.2 Mac

If you are a Mac user, don't despair! Many users run OpenDICE on a Mac using Windows environment emulator, typically those marketed by Fusion or Parallels.

There is a Mac version of OpenDICE available to download, but there may be some hurdles to overcome when using OpenDICE on a Mac.

1.4.3 Additional Necessary Files

Regardless of whether you run OpenDICE on a Mac or Windows, there are additional files that you must download to allow OpenDICE to work.

Download the latest version of:

1. Config_materials.xls
2. Sample_profiles.xls
3. icon files (.jpg)

There are also a variety of images files (.tif) that you can use for reference.

Note: The icon images have to be placed in the same location as the OpenDICE program in a subfolder labeled "Icon." Without these files, OpenDICE cannot run. It is convenient, however, to save all these files in the same location as the OpenDICE program so the program can reference them. For example, the OpenDICE will automatically locate the subfolder "Profile" to search for the Excel files. Otherwise, the user needs to locate the files by themselves.

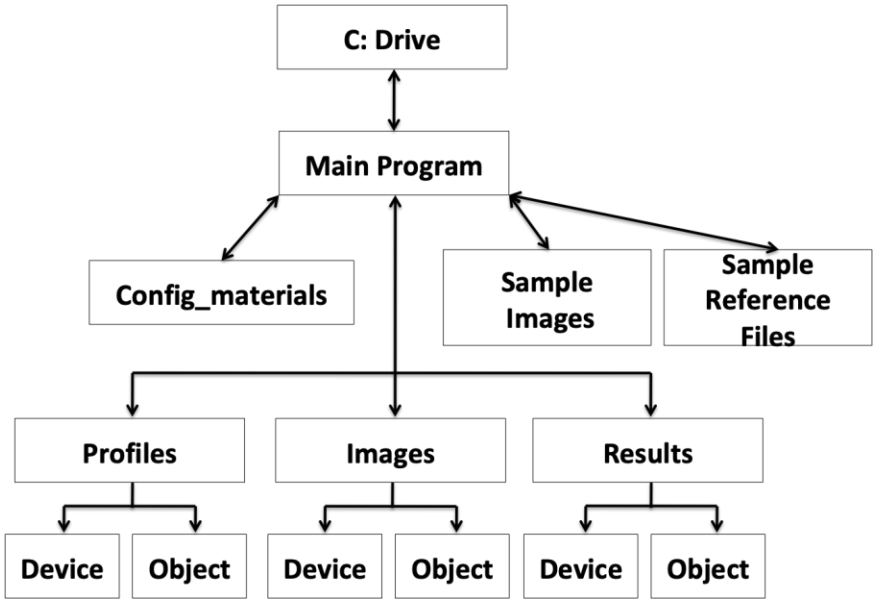


Fig. 1.4.3: OpenDICE Program Architecture

2.0 Image Target

The first step in using the OpenDICE analysis software is capturing a digital image of the target you will be using for your analysis. For more information about the types of targets available to use in OpenDICE, see 3.2 Select Target. Make careful note of the make and model of the scanner that you use to create the target image, so that some of the problems that OpenDICE may identify with the target image can be traced to a particular device.

2.1 Naming and Saving

Before capturing images, it is important to establish a file naming scheme to use consistently throughout your project. Consider whether you would like to use a meaningful naming system (e.g., a name that connects the image file to the source material) or a non-descriptive naming system (e.g., a sequential number string). See the FADGI *Technical Guidelines* (pp. 83-84) for more information about creating file naming conventions.

According to FADGI's list of general guidelines for file names, you will want to consider if your file names:

- Are unique - no other digital resource should duplicate or share the same identifier as another resource. In a meaningful file-naming scheme, names of related resources may be similar, but will often have different characters, prefixes, or suffixes appended to delineate certain characteristics of the file. Make an attempt to streamline multiple versions and/or copies.
- Are consistently structured - file names should follow a consistent pattern and contain consistent information to aid in identification of the file as well as management of all digital resources in a similar manner. All files created in digitization projects should contain this same information in the same defined sequence.
- Are well-defined - a well-defined rationale for how/why files are named assists with standardization and consistency in naming and will ease in identification of files during the digitization process and long afterwards. Formalize an approach to file naming for digitization projects and integrate the file naming approach into systems that manage digital resources.
- Are persistent – files should be named in a manner that has relevance over time and is not tied to any one process or system. Information represented in a file name should not refer to anything that might change over time. The concept of "persistent identifiers" establishes file names in an online environment that remain persistent and relevant across location changes or changes in protocols to access the file.
- Observe any technical restrictions – file names should be compliant with any character restrictions (such as the use of special characters, spaces, or periods in the name, except in front of the file extension), as well as with any limitations on character length. Ideally, file names should not contain too many characters. Most current operating systems can handle long file names, although some applications will truncate file names in order to open the file, and certain types of networking protocols and file directory systems will shorten file names during transfer. Best practice is to limit character length to no more than 32 characters per file name.
- Take into account the maximum number of items in a given scanning project and account for that total in the number of digits used (if following a numerical scheme).
- Use leading zeros to facilitate sorting in numerical order (if following a numerical scheme).

- Do not use an overly complex or lengthy naming scheme that is susceptible to human error during manual input.
- Use lowercase characters and file extensions.

2.2 File Formats

Image input into OpenDICE v2.5 only supports TIFF files.

3.0 Getting Started

At startup, the OpenDICE user interface opens.

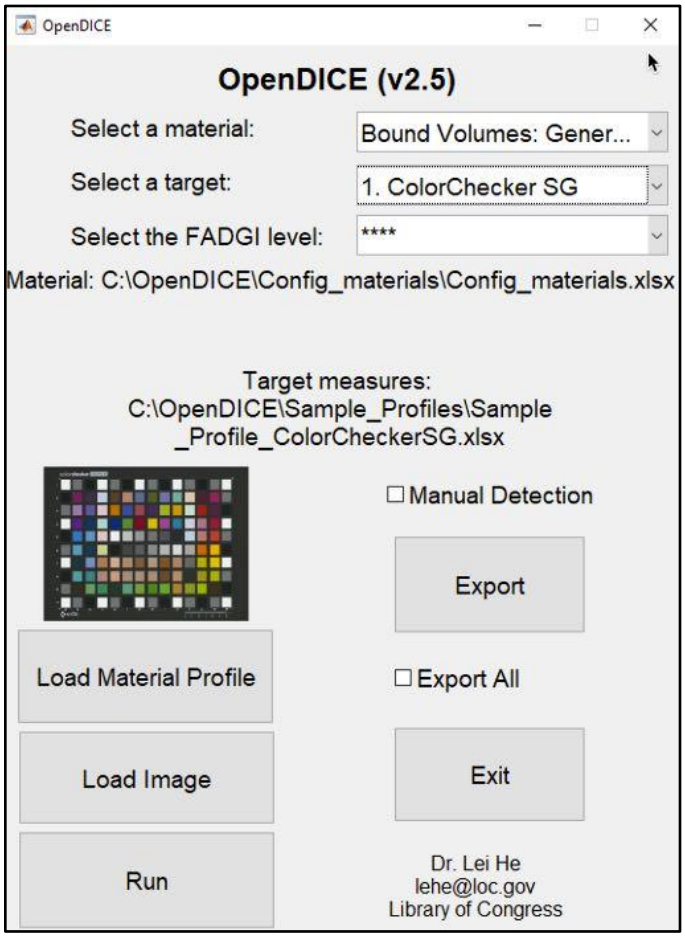


Fig. 3.0: OpenDICE user interface

3.1 Select Material

Select the material you will digitize by clicking on the **Select a material** dropdown menu. The default setting for material is **Bound Volumes: General Collections.**

Materials options include:

- Bound Volumes: General Collections

- Bound Volumes: Rare and Special Materials
- Documents (Unbound): General Collections
- Documents (Unbound): Manuscripts and Other Rare and Special Materials
- Oversize Items: Maps, Posters, and Other Materials
- Newspapers
- Prints and Photographs
- Paintings and Other Two-Dimensional Art (other than prints)
- Photographic Transparencies: 35mm to 4"x5"
- Photographic Transparencies: >4"x5"
- Photographic Negatives: 35mm to 4"x5"
- Photographic Negatives: > 4"x5"
- X-ray Film: (Radiographs)
- Printed Matter, Manuscripts, and Other Documents on Microfilm

For more information on these material options, see the FADGI *Technical Guidelines* (pp. 18-51).

3.1.1 Load Material Profile

By default, the OpenDICE searches the **Config_materials.xlsx** file in the subfolder of Profile, which is located in the same location as the OpenDICE program. If the file cannot be located, the user must manually identify the file by clicking the **Load Material Profile** button. A window will pop up, and this should show you a list of the files you downloaded according to the instructions in 1.5.3 Additional Necessary Files (above). Select the subfolder you used to store the Excel files, and then select the **Config_materials.xlsx** file. You should now see a line of text reading "Material:" with the file path to the location in which you saved the Config_materials file (Fig. 3.1.1A).

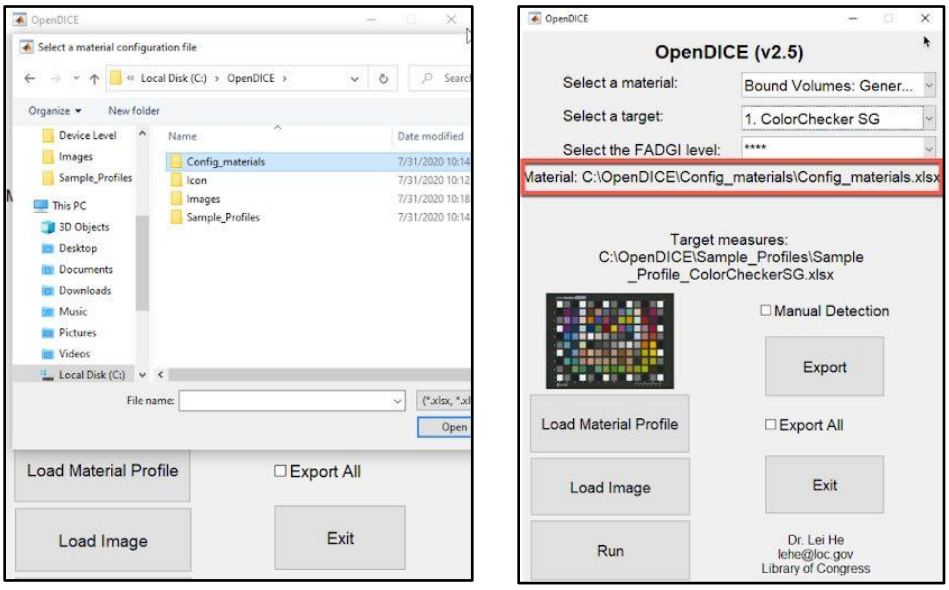


Fig. 3.1.1A: Opening Config_materials and Config_materials file path

Note: If the window shows blank space on the material profile, i.e., no default material setting profile is located (Fig. 3.3.1B), a warning box will appear to ask for the material configuration

file if you try to load an image or start to run. If you do not need to change the material, skip this step.

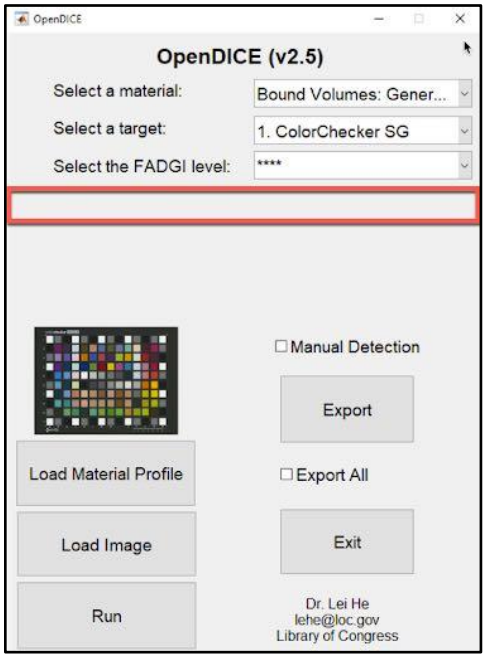


Fig. 3.3.1B: Material profile not loaded

Troubleshooting: If you are having trouble loading the material profile automatically, double check that you have saved the Config_materials.xlsx in the Profiles folder in the same location as the OpenDICE application.

After the material selection, users can select the target and FADGI star level if they are different from the default (see below).

3.2 Select Target

Select the target you will use by clicking on the **Select a target** dropdown menu. OpenDICE v2.5 supports 14 targets. The default setting for the target is **ColorChecker SG**.

OpenDICE (ver 2.5) supports 14 different targets. The first nine targets work with the first eight materials, while the last five targets work only with film negatives. Those targets with "manual" after their names means manual selection of landmarks are necessary. 3.5 Manual Detection contains more information on manual selection.

Target options include:[7]

1. ColorChecker SG
2. DICE
3. ObjectDICE (small)

[7] Follow links for more information about each target. There are many places where you can purchase these targets. We chose the links to provide the best quick overview of what the target does, not as an endorsement of certain companies or products.

4. FADGI 19264 [8]
5. FADGI 19264 Commercial [9]
6. NGT (manual)[10]
7. DT-NGT
8. IT8.7/2 (manual)
9. UTT
10. Negative/Positive Small 35mm
11. Negative Large 4x5
12. Negative Small 35mm 2
13. Negative Middle 120x120
14. IT8.7/1 (manual)

Note: The DICE device targets now come with 2D barcodes that provide OpenDICE with the measurements of the color values (CIE L*a*b*) on the targets. These barcodes allow the program to ensure accurate results with the ground truth measurements on the individual targets. When present, OpenDICE will try to scan the barcode and report that the values encoded in the barcode have replaced preloaded measurements (Fig. 3.2).

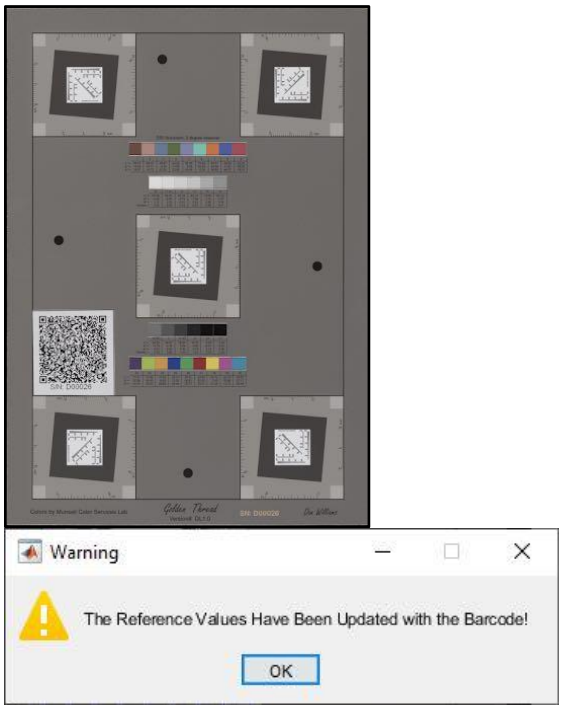


Fig. 3.2: DICE device target with barcode and warning on barcode reference values

3.2.1 Load Sample Profile

[8] At the time this manual was published, the new FADGI 19264 target was not yet available to purchase.
[9] At the time this manual was published, the new FADGI 19264 target was not yet available to purchase.
[10] The old Next Generation Target is no longer available for purchase. OpenDICE is, however, backward compatible with the old NGT target and compatible with the new DT-NGT target, so you can use either one for your imaging project.

Before analyzing the image of your target with OpenDICE, select a sample profile against which to evaluate your image. The sample profile is an ideal example of the aim points, tolerances, and limits available for the target you are using.

To load a sample profile, click on the **target** you want to use from the **Select a target** dropdown menu. When you select a target, a window will pop up. This should show you a list of the files you downloaded in 1.5.3 Additional Necessary Files. Click on the **Sample_Profiles** folder and select the appropriate profile for the target you are using (for example, if you chose the ColorChecker SG target, you would choose the Profile_ColorChecker SG) (Fig. 3.2.1A).

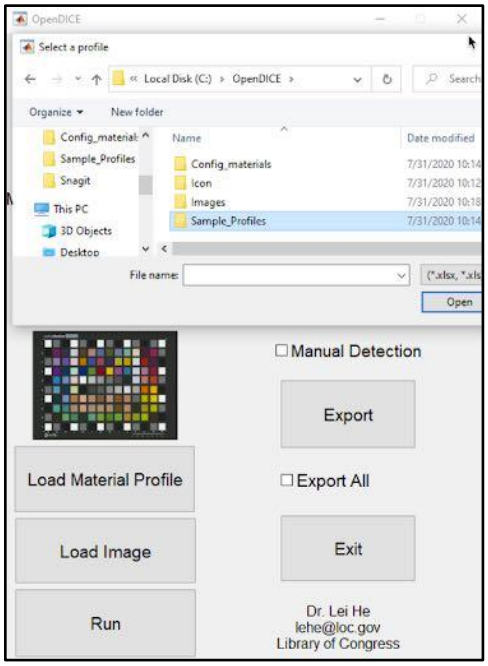


Fig. 3.2.1A: Load Sample Profile

NOTE: The sample profile should be an Excel or text file providing the ground truth measurements for color accuracy assessment (L*a*b*) and tonescale analysis (density). The profile must match the selected target or an error message will appear requiring the user to reselect either the profile or target.

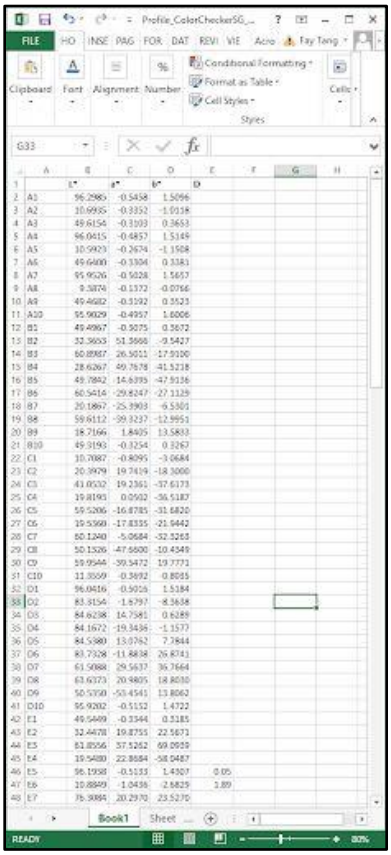
The profile format is strictly defined, with the L*, a*, b*, and D as the column headings. The patches are listed from 1 to 30 (DICE), or from A1…A10 to N1…N10 (Colorhecker SG). Note that the DICE target has density measurements for its 12 gray patches (#10 - #21) while the Colorhecker SG target has density measurements for its central 12 gray patches (#E5 - #J6).

Examples: Sample profiles are shown for a ColorCheckerSG target and a DICE target in Figures 3.2.1B and 3.2.1C.

After loading the sample profile, you should see a line of text reading “Target measures:” with the file path to the location in which you saved the Sample_profiles file. **Do not leave this line blank**. An image of the target you chose should also appear. (Fig. 3.2.1D).

Each time you select a target, upload the sample profile file again as a confirmation for this target. This also confirms the corresponding profile is uploaded.

Troubleshooting: If you are having trouble loading the target profile, double check that you have saved the Sample_profiles folder in the same location as the OpenDICE application.



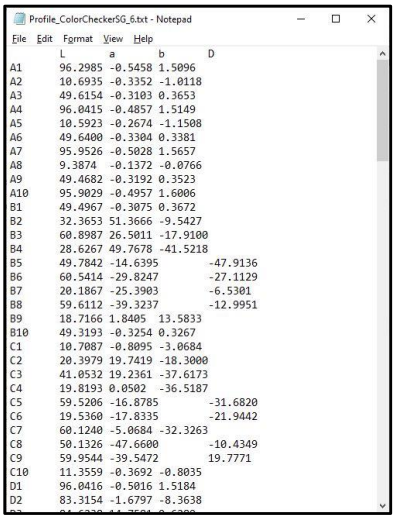
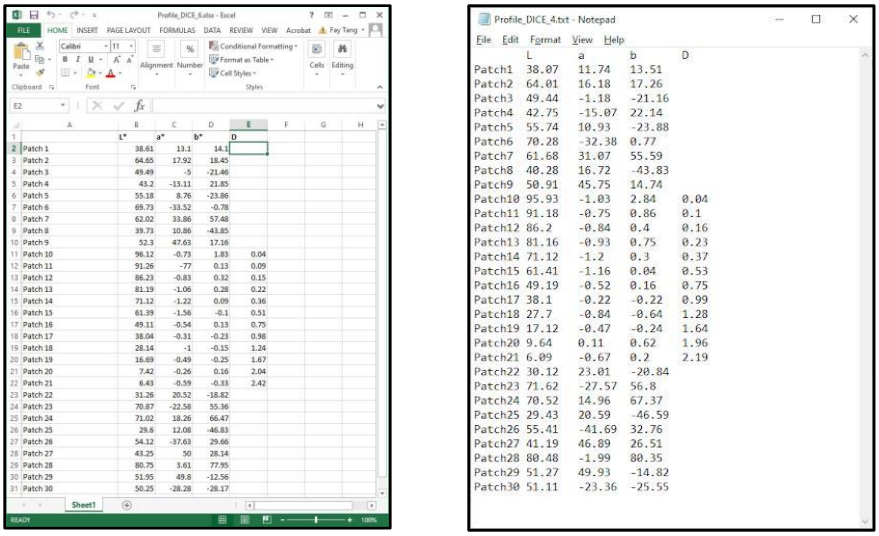


Fig. 3.2.1B: ColorChecker SG target profile with the L*a*b* and density (D) measurements



	L	a	b	D
Patch1	38.07	11.74	13.51	
Patch2	64.01	16.18	17.26	
Patch3	49.44	-1.18	-21.16	
Patch4	42.75	-15.07	22.14	
Patch5	55.74	10.93	-23.88	
Patch6	70.28	-32.38	0.77	
Patch7	61.68	31.07	55.59	
Patch8	40.28	16.72	-43.83	
Patch9	50.91	45.75	14.74	
Patch10	95.93	-1.03	2.84	0.04
Patch11	91.18	-0.75	0.86	0.1
Patch12	86.2	-0.84	0.4	0.16
Patch13	81.16	-0.93	0.75	0.23
Patch14	71.12	-1.2	0.3	0.37
Patch15	61.41	-1.16	0.04	0.53
Patch16	49.19	-0.52	0.16	0.75
Patch17	38.1	-0.22	-0.22	0.99
Patch18	27.7	-0.84	-0.64	1.28
Patch19	17.12	-0.47	-0.24	1.64
Patch20	9.64	0.11	0.62	1.96
Patch21	6.09	-0.67	0.2	2.19
Patch22	30.12	23.01	-20.84	
Patch23	71.62	-27.57	56.8	
Patch24	70.52	14.96	67.37	
Patch25	29.43	20.59	-46.59	
Patch26	55.41	-41.69	32.76	
Patch27	41.19	46.89	26.51	
Patch28	80.48	-1.99	80.35	
Patch29	51.27	49.93	-14.82	
Patch30	51.11	-23.36	-25.55	

Fig. 3.2.1C: DICE target profile with the L*a*b* and density (D) measurements

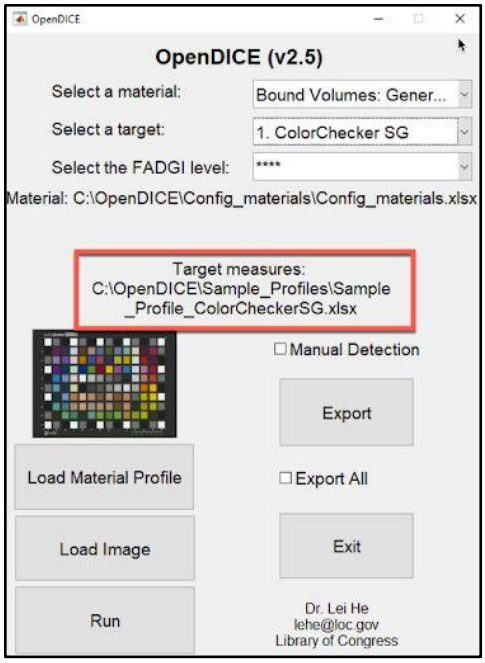


Fig. 3.2.1D: Target measures file path

3.3 Select FADGI Level

Select the FADGI criteria (star level) by clicking on the **Select the FADGI level** dropdown menu.

The default setting for the FADGI level is 4 star.

FADGI level options include:

- 4 star
- 3 star
- 2 star
- 1 star

Note: Each time you change the material and target, reset the star level as a confirmation.

3.4 Load Image

After the material, target, and star level selection, import the image of the target for quality assessment by clicking the **Load Image** button.[11]

Image specifications:

- The image must be a TIFF file.
- The chosen image file must match the selected target. Otherwise, an error message will be displayed prompting re-selection.
- OpenDICE v2.5 supports only well-scanned images with tilt angle less than 5°; no automatic rotation or adjustment can be applied to the input image.

After loading the image, OpenDICE will automatically identify the regions of interest (ROIs) on the image as a set of overlapped rectangles (Fig. 3.4A). A warning box will pop up stating, "Please check all ROIs! You may drag them to the right position" (Fig. 3.4B). Click **OK**.

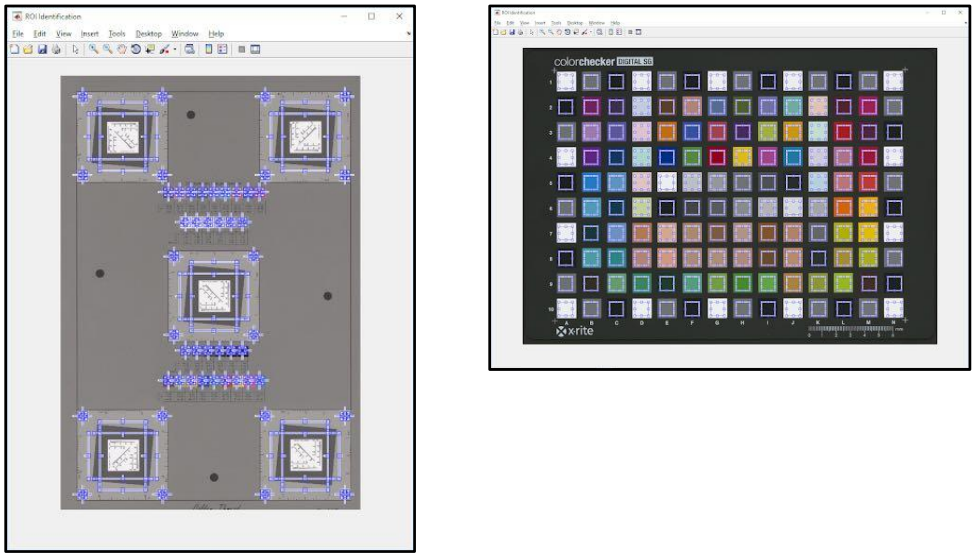


Fig. 3.4A: Examples of ROI identification

Notes:

- On the targets, the slanted edges of each patch must be aligned in the center of the rectangles. If the rectangles are not aligned this way, you will receive an error message when you try to run OpenDICE.

[11] Sample images are available at http://www.digitizationguidelines.gov/guidelines/digitize-OpenDice.html. We suggest saving the digital images you produce in an "Images" folder in the same location as the OpenDICE application.

- On the targets, the ROIs on the color patches should be aligned on the center of the patches. If the ROI rectangles are off-center, you may receive inaccurate results on the color tests.

Fig. 3.4B: ROI adjustment message

Click and drag the ROI rectangles for minor location adjustment. If the ROIs are far away from the ideal regions, use the "Manual Detection" function (see 3.5 Manual Detection).

3.5 Manual Detection

To use the Manual Detection option, check the Manual Detection option and re-load the image. To select ROIs manually, click the four corner points (for DICE targets and Negative Large 4x5) or cross points (for ColorChecker SG, UTT, and Negative Small 35mm) in a clockwise manner. Double click on the last click on point 1 when the loop is finished (Fig. 3.5).

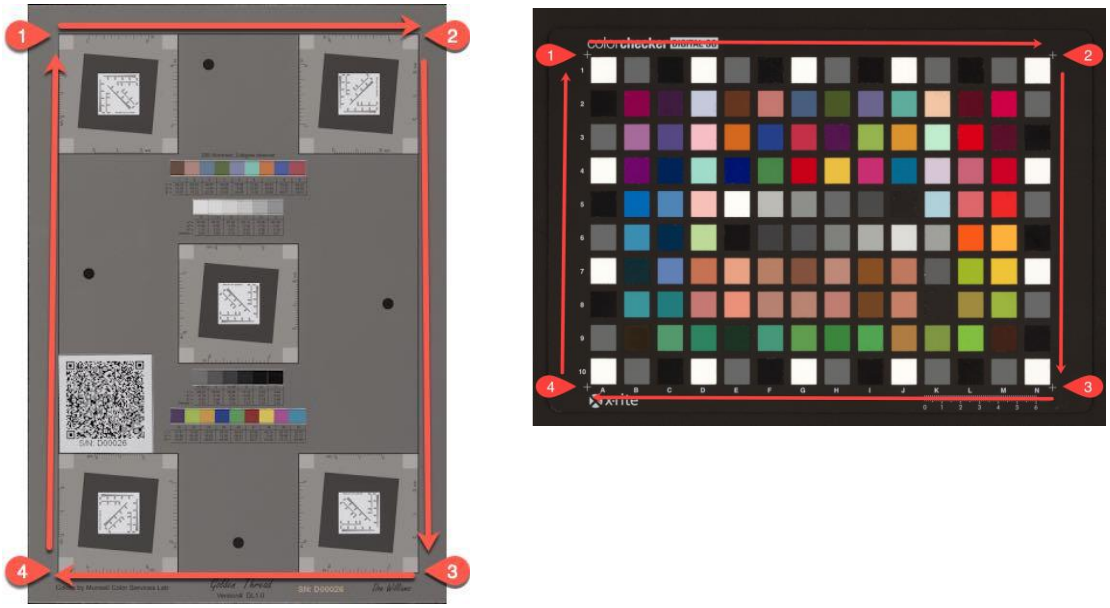


Fig. 3.5: Examples of manual ROI selection

After identifying the ROIs, you will see the ROIs overlapped with a set of rectangles. As with automatic detection, you can drag the rectangles for more accurate ROI location.

Notes:

- Depending on the image size, identifying ROIs may take a couple of minutes.
- If, after running automatic ROI detection, you see that most of the ROIs are not in the correct position, we recommend checking the Manual Detection option and re-running

the image for faster and more accurate ROI identification.

3.6 Run

Click **Run** to run the OpenDICE program, assessing the quality of the image you loaded according to various metrics (see section 4.0 Assessment for explanations of these tests).

3.7 Export

To write the test results to an Excel file or text file, click the **Export** button. Checking **Export All** will export all the test results besides those required by the FADGI. OpenDICE saves the file in the same folder as that of the image, with an extension of the FADGI star level. Note that Microsoft Excel is required to write the results if you want to write the results in an Excel file. Otherwise you may save the results to a text file, which requires that you select a text version of Config_materials.txt in the beginning.

3.8 Exit

Clicking the **Exit** button will close OpenDICE.

4.0 Assessment

Confirm that the ROIs are acceptable, and then click the **Run** button to start the image assessment. The assessment results are displayed on two (targets with only color patches, e.g., ColorChecker SG target) or three (targets with slanted edge features, e.g., DICE target) windows. For all targets, the first window displays color accuracy analysis results and the second window presents tonescale analysis results. For the targets with the slanted edges, a third window for resolution analysis results will appear.

Note: All images of assessment tabs are available in a larger size in 5.2 Test Results Images and all images are linked to this section.

4.1 Color Accuracy (All Targets)

Color accuracy measures the accuracy of the color patches in a scanned image of a target. The Color Accuracy window contains the results of four tests: Luminance, Delta E 2000, Color Registration Accuracy, and Summary. Each test result has its own tab.

4.1.1 Luminance tab

The luminance tab shows the difference between the aim point as specified on the target and the actual values for all patches (Fig. 4.1.1):

- The teal bars show the aim points for luminance
- The black lines within the teal bars show the actual values for the various patches

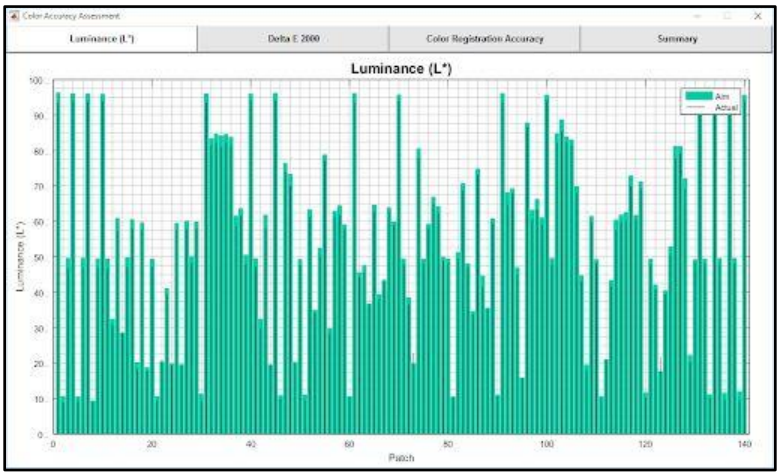


Fig. 4.1.1: Luminance tab

4.1.2 Delta E 2000 Tab

The Delta E 2000 tab shows the values of the ΔE2000 calculation between the aim point and the actual image values for all patches (Fig. 4.1.2):

- The vertical black lines with black dots represent the actual ΔE2000 values
- 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 FADGI star level you selected
- The horizontal blue line shows the mean upper limit for ΔE2000

- The horizontal black line shows the actual mean ΔE2000
- The horizontal green line shows the actual median ΔE2000.

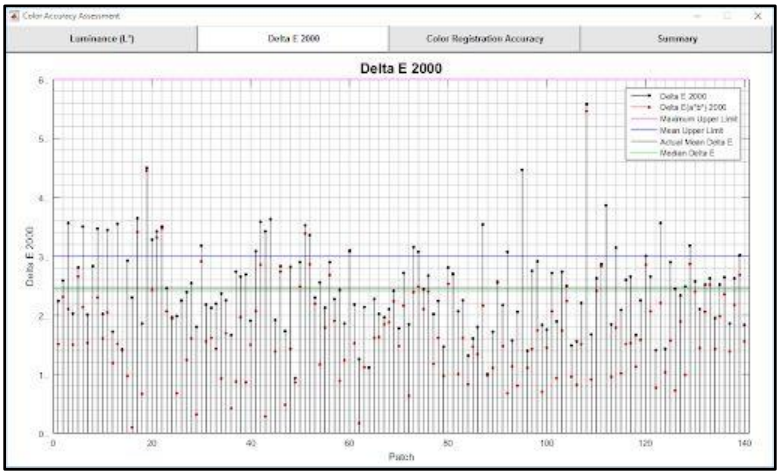


Fig. 4.1.2: Delta E 2000 tab

4.1.3 Color Registration Accuracy Tab (only for targets with slanted edges)

The Color Registration Accuracy tab describes the degree to which the color planes (horizontal and vertical planes across Green-Blue, Green-Red, and Blue-Red color channels) are properly aligned (Fig. 4.1.3):

- The red dotted lines indicate the upper and lower limits acceptable for color misregistration according to the FADGI star level you have selected.
- The vertical black lines with black dots represent the actual color registration accuracy.

Note: Color Registration Accuracy is shown only for targets with slanted edges, e.g., DICE target; this measurement is not applicable to targets with only color patches, e.g., the ColorChecker SG target.

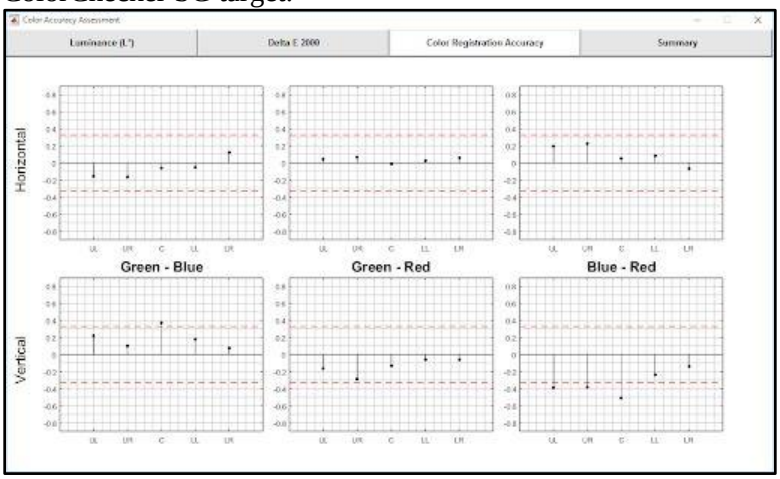


Fig. 4.1.3: Color Registration Accuracy tab (only for targets with slanted edges)

4.1.4 Summary Color Accuracy Tab

The summary tab shows the detailed numerical results for color accuracy according to the FADGI guideline performance level you chose (Fig. 4.1.4):

- The first column shows the color tests that you ran
- The second column indicates whether the image you uploaded passed or failed according to the FADGI star level you selected
- The third column shows the lower limits acceptable according to the FADGI star level you selected
- The fourth column gives the actual value OpenDICE measured for the image you uploaded
- The fifth column shows the upper limits acceptable according to the FADGI star level you selected.

Note: Previous versions of OpenDICE based the pass/fail measurements for color on the individual color patches, but the current version of OpenDICE bases the pass/fail measurements for color on the average of the color patch measurements. This change reflects the alignment of the FADGI (2016) guidelines with ISO 19264-2017 and ISO 19263-2017.

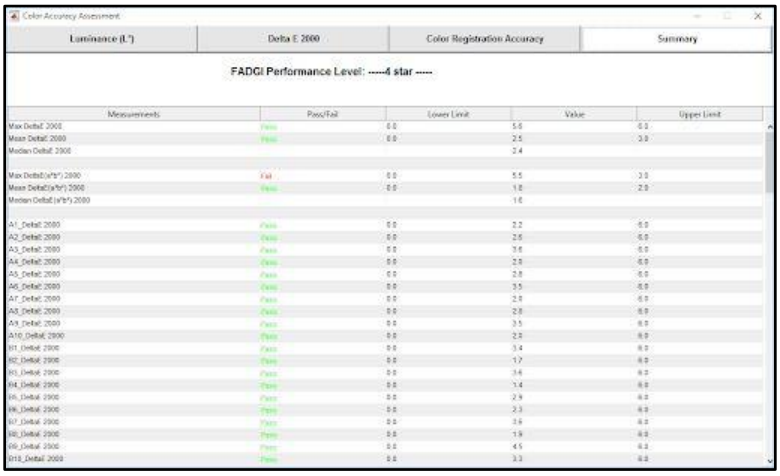


Fig. 4.1.4: Color Accuracy Summary tab

4.2 Tonescale (All Targets)

The tonescale analysis window consists of four tabs: OECF Curves, Difference to Aim, White Balance, Uniformity, Noise, and Summary.

4.2.1 OECF Curves Tab

The OECF tab shows the Opto-Electric Conversion Function curves for the RGB components (Fig. 4.2.1). The magenta curves are the aims defined by the FADGI star level you selected while the Red, Green, and Blue lines show the actual OECF value.

You may change the gamma, gain, and offset to adjust the curves in order to fit them into the range defined by the FADGI star level you chose.

- The gamma default value is 2.2.
- The gain default value is 1.
- The offset default value is 0.

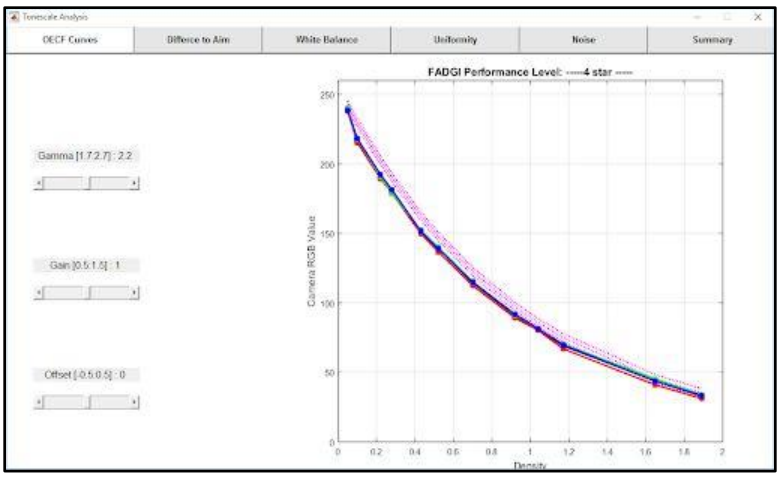


Fig. 4.2.1: OECF Curves tab

4.2.2 Difference to Aim Tab

The Difference to Aim tab shows the ideal aims defined by the FADGI star level you selected (Fig. 4.2.2):

- The dotted magenta lines indicate the upper and lower accepted tolerances.
- The blue, green, and red lines show how close to or far from the aims the OECF curves fall.

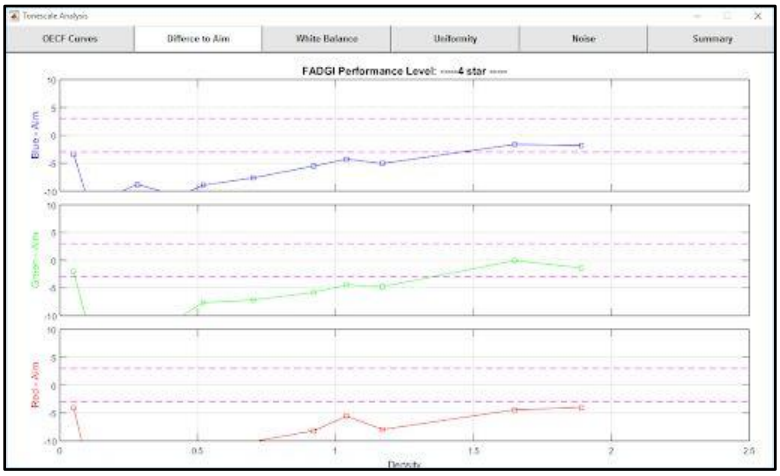


Fig. 4.2.2: Difference to Aim tab

4.2.3 White Balance Tab

The White Balance tab shows ideal aims defined by the FADGI star level you selected (Fig. 4.2.3):

- The dotted magenta lines indicate the upper and lower accepted tolerances
- The lines show the white balance error of the neutral patches on the target in the Green-Blue, Green-Red, and Blue-Red color channels

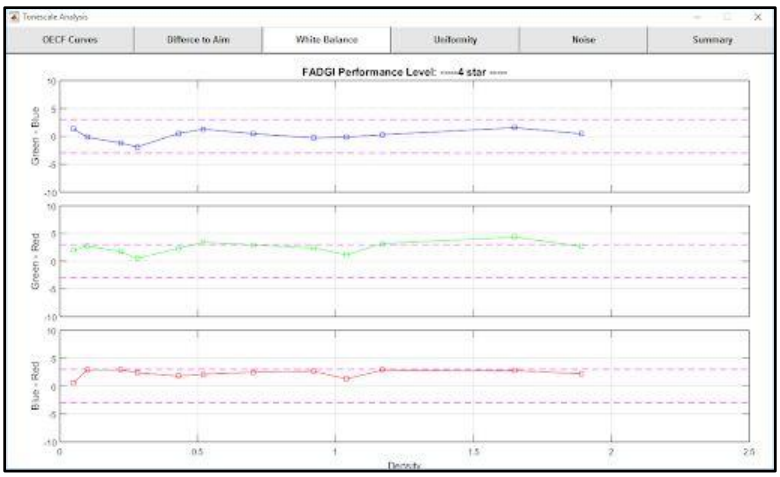


Fig. 4.2.3: White Balance tab

4.2.4 Uniformity Tab (DICE target only)

The Uniformity tab describes the different values measured for identical patches located in different areas of the image (Fig. 4.2.4):

- The first column indicates the location of the patches
- The second through fifth columns show the Luminance, Red, Green, and Blue values, respectively

Note: Uniformity Assessment is shown only for DICE targets; this measurement is not applicable to other targets.

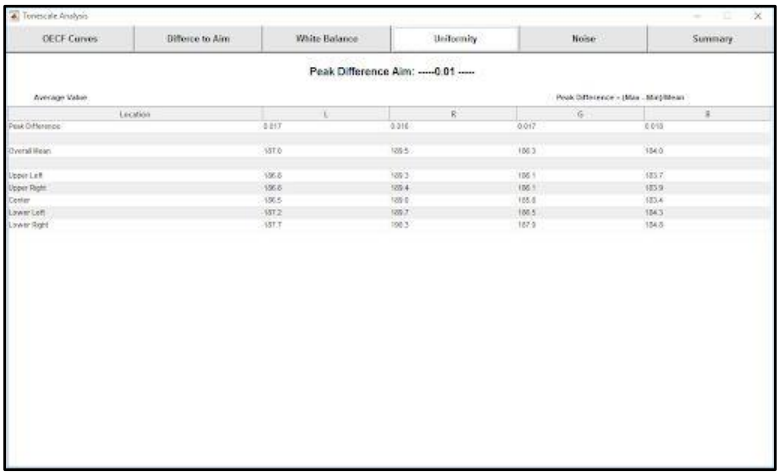


Fig. 4.2.4: Uniformity tab

4.2.5 Noise Tab

The noise tab shows the noise level present in the neutral patches (Fig. 4.2.5):

- The dotted magenta line indicates the upper noise limit acceptable for the FADGI star level you chose.
- The black line indicates the actual noise levels according to luminance levels and density.

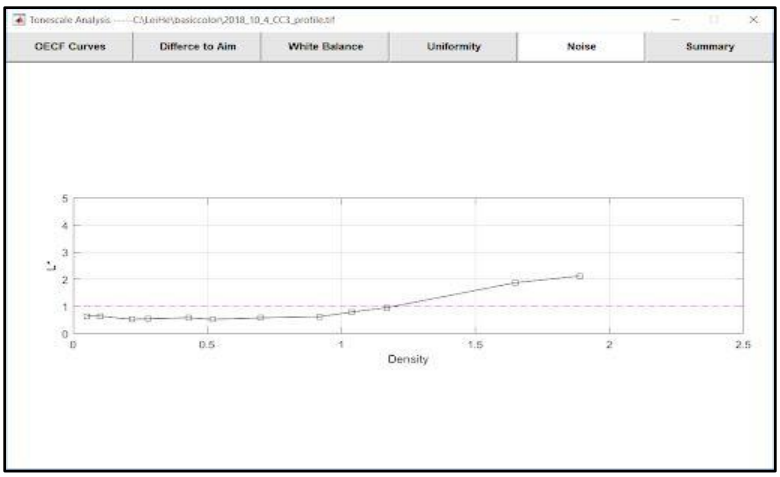


Fig. 4.2.5: Noise tab

4.2.6 Summary Tonescale Tab

The Summary tab shows the detailed numerical results for tonescale according to the FADGI guideline performance (star) level you chose (Fig. 4.2.6):

- The first column shows the tonescale tests that you ran.
- The second column indicates whether the image you uploaded passed or failed according to the FADGI star level you selected.
- The third column shows the lower limits acceptable according to the FADGI star level you selected.
- The fourth column gives the actual value OpenDICE measured for the image you uploaded.
- The fifth column shows the upper limits acceptable according to the FADGI star level you selected.

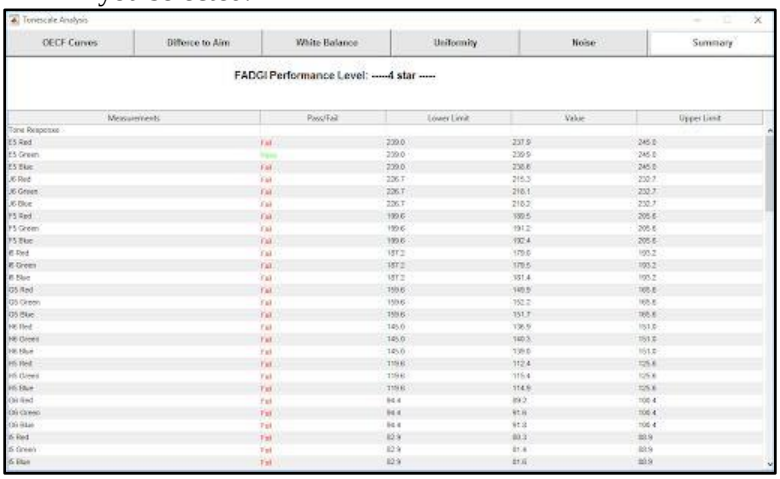


Fig. 4.2.6: Tonescale Summary tab

4.3 Resolution Analysis (DICE, FADGI 19264, UTT, and Negative Targets)

OpenDICE also analyses resolution for the DICE, FADGI 19264, UTT, and negative targets. The resolution analysis window consists of a set of tabs according to the target edge feature locations:

Efficiency, SFR (e.g., Center, Upper Left, Upper Right, Lower Left, Lower Right for DICE target), and Summary.

4.3.1 Efficiency Tab

The efficiency tab shows the sampling efficiency for the Red, Green, and Blue components. The L (luminance) bar displays the average performance of these components. The yellow numbers indicate the actual sampling efficiency value (Fig. 4.3.1).

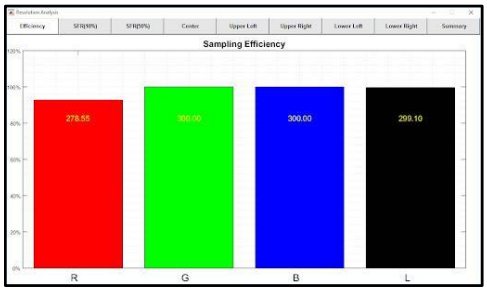


Fig. 4.3.1: Efficiency tab

4.3.2 SFR Curves Tabs

The Center, Upper Left, Upper Right, Lower Left, and Lower Right SFR Tabs shows the Spatial Frequency Response for the center, upper left, upper right, lower left, and lower right SFR patches on a device-level DICE target. The graphs display RGB curves along the Red, Green, and Blue lines. The black (luminance) line shows the average of the RGB curves (Fig. 4.3.2).

The dashed magenta lines in the middle of the graphs demonstrate the aim points for mid frequency SFR (50%) while the dashed magenta lines on the bottom right of the graph demonstrate the aim points for the high frequency SFR (10%). The average luminance (black) lines must pass through the middle of these areas to satisfy the selected FADGI star level.

Note: Previous versions of OpenDICE based the pass/fail measurements for SFR on the individual RGB curves, but the current version of OpenDICE bases the pass/fail measurements for SFR on the average of the three RGB curves, represented by the black line. This change reflects the alignment of the FADGI (2016) guidelines with ISO 19264-2017 and ISO 19263-2017.

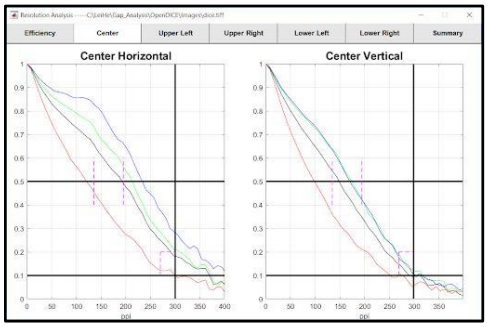


Fig. 4.3.2: SFR curves tab shows the frequency response at high and middle resolutions

4.3.3 Summary SFR Tab

The summary tab shows the detailed numerical results for SFR according to the FADGI guideline performance level you chose (Fig. 4.3.3):

- The first column shows the SFR tests that you ran.
- The second column indicates whether the image you uploaded passed or failed according to the FADGI star level you selected.
- The third column shows the lower limits acceptable according to the FADGI star level you selected.
- The fourth column gives the actual value OpenDICE measured for the image you uploaded.
- The fifth column shows the upper limits acceptable according to the FADGI star level you selected.

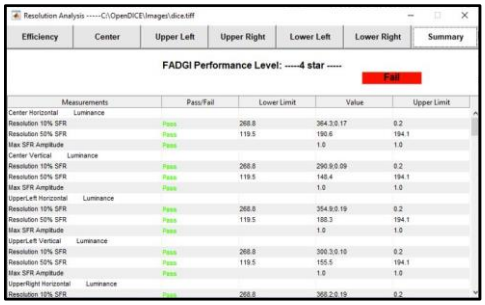


Fig. 4.3.3: SFR Summary tab

5.0 Appendix

5.1 Target Images

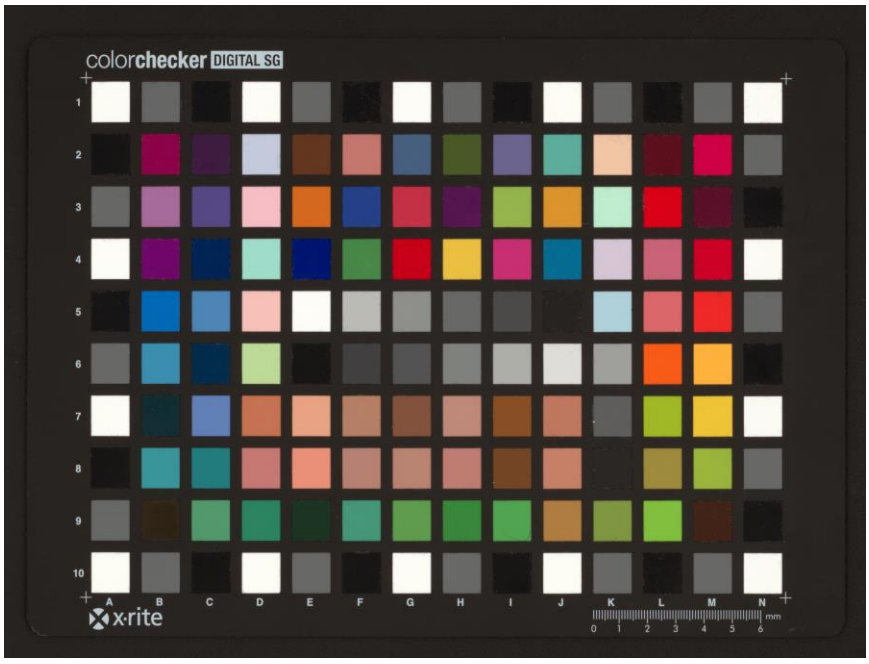


Fig. 5.1A: ColorChecker SG Target

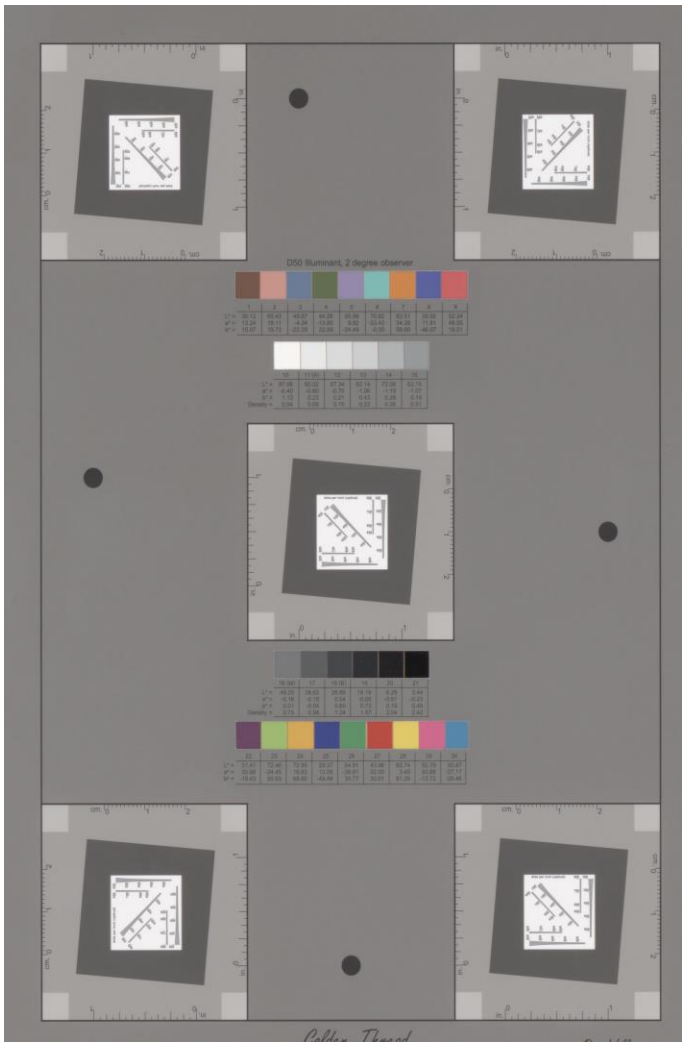


Fig. 5.1B: DICE Target

Fig. 5.1C: DICE Object Target

Fig. 5.1D: FADGI 19264 Target

Fig. 5.1E: NGT (Next Generation Target)

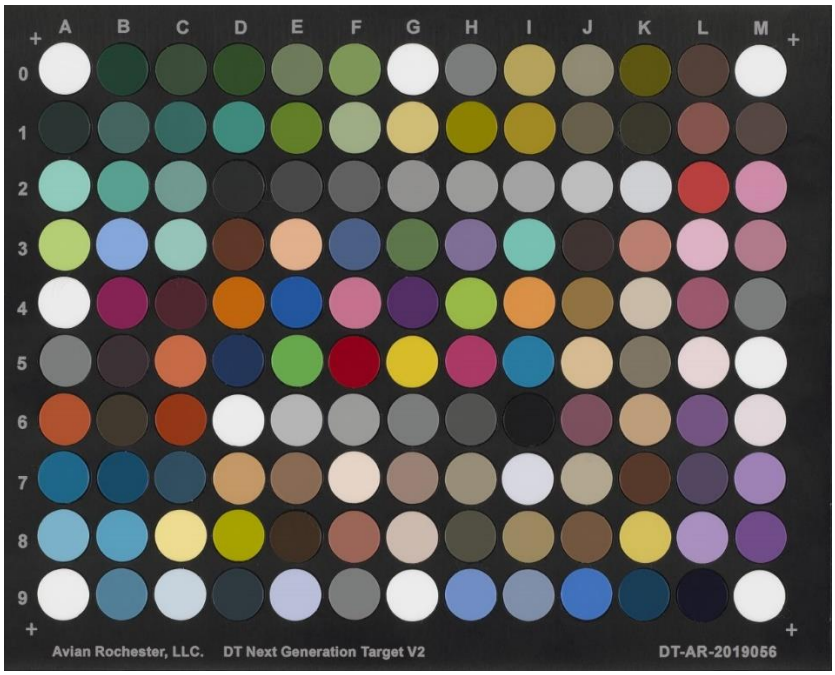


Fig. 5.1F: DT-NGT (DT-Next Generation Target)

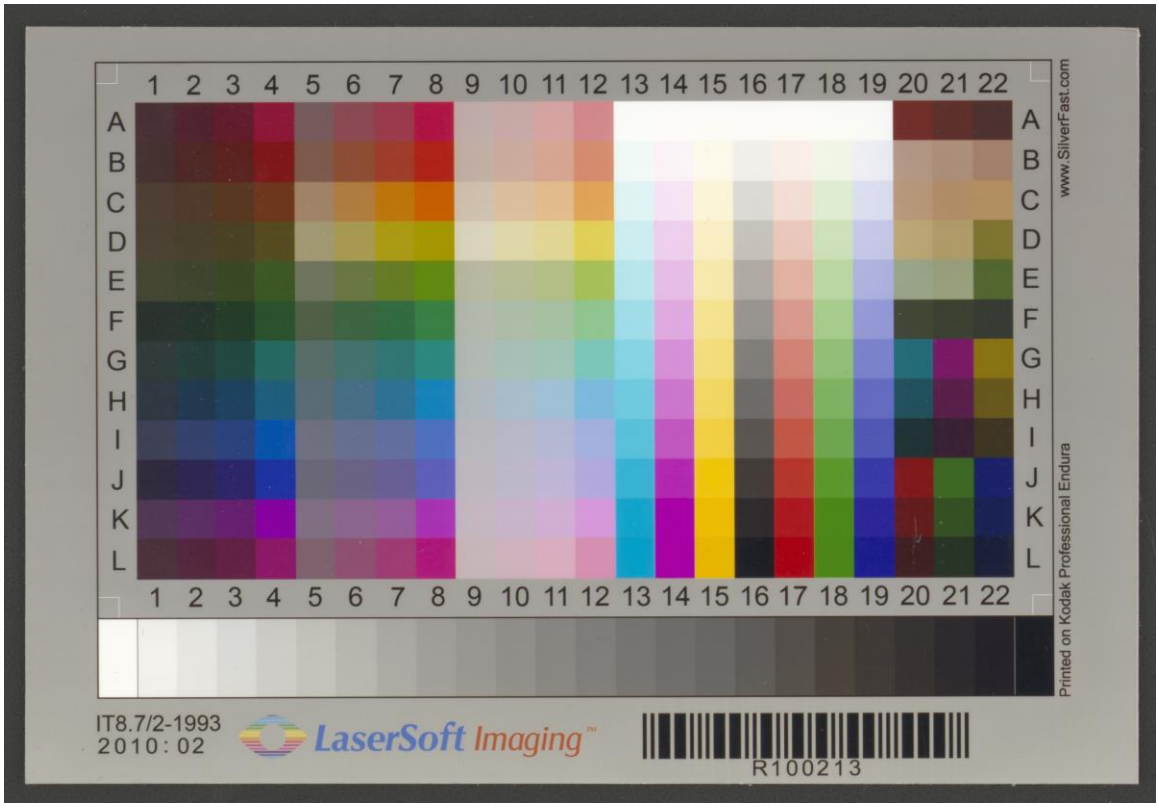


Fig. 5.1G: IT8.7/2 Target

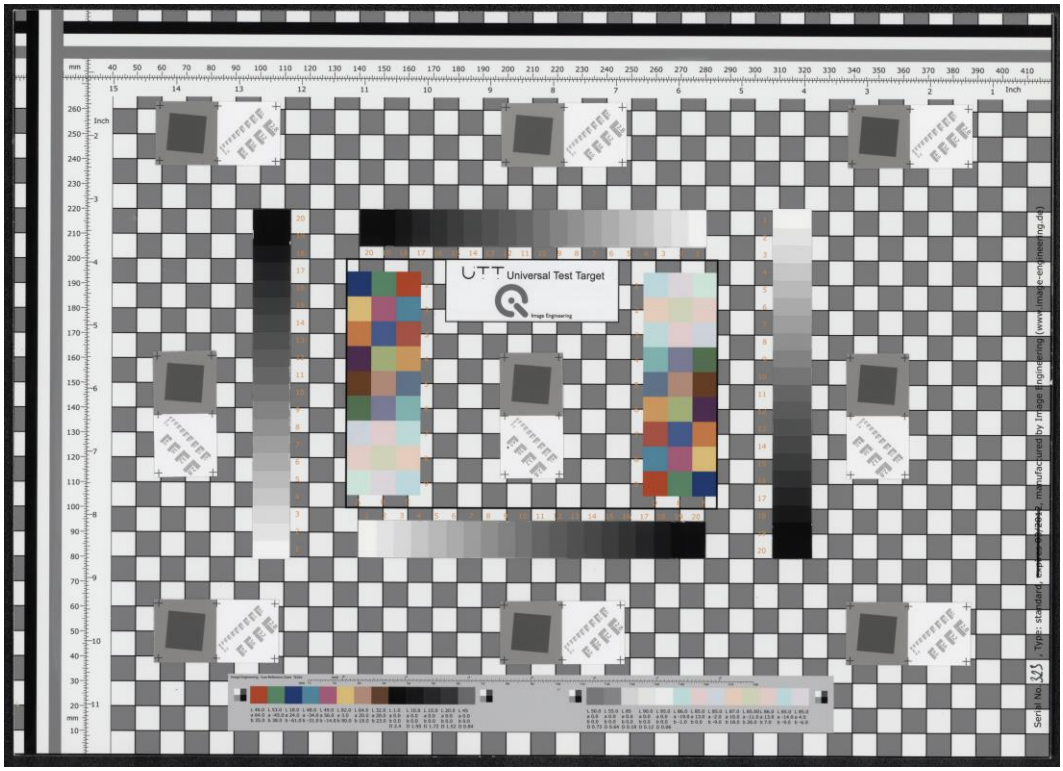


Fig. 5.1H: UTT (Universal Test Target)

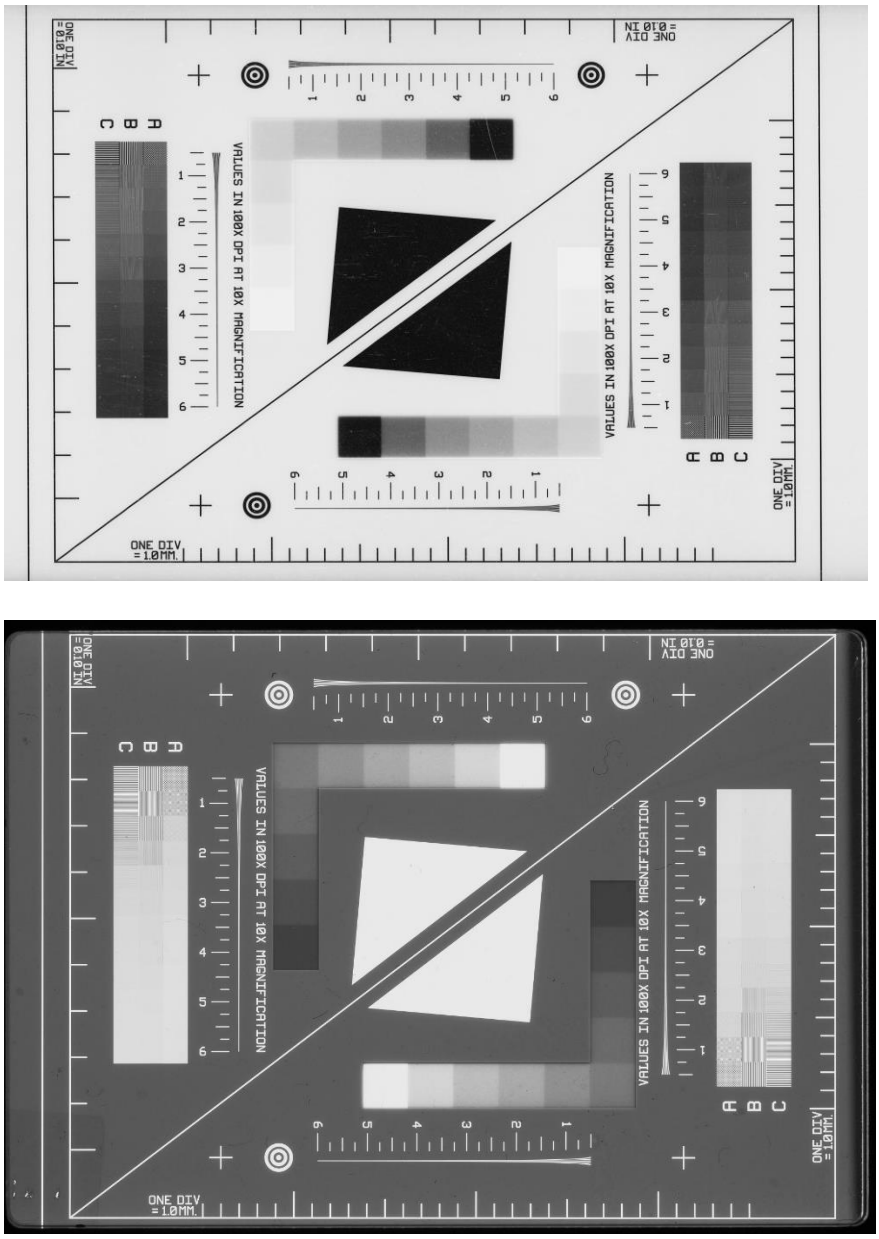


Fig. 5.1I: Negative and Positive Small 35mm Target

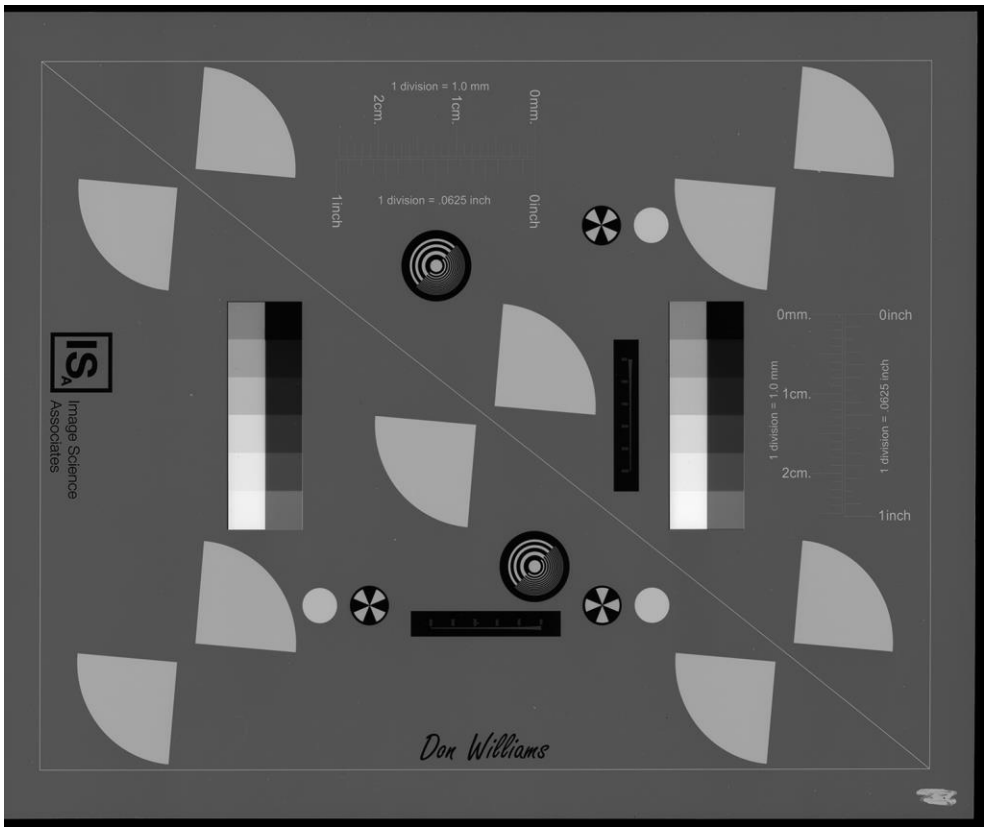


Fig. 5.1J: Negative Large 4” x 5” Target

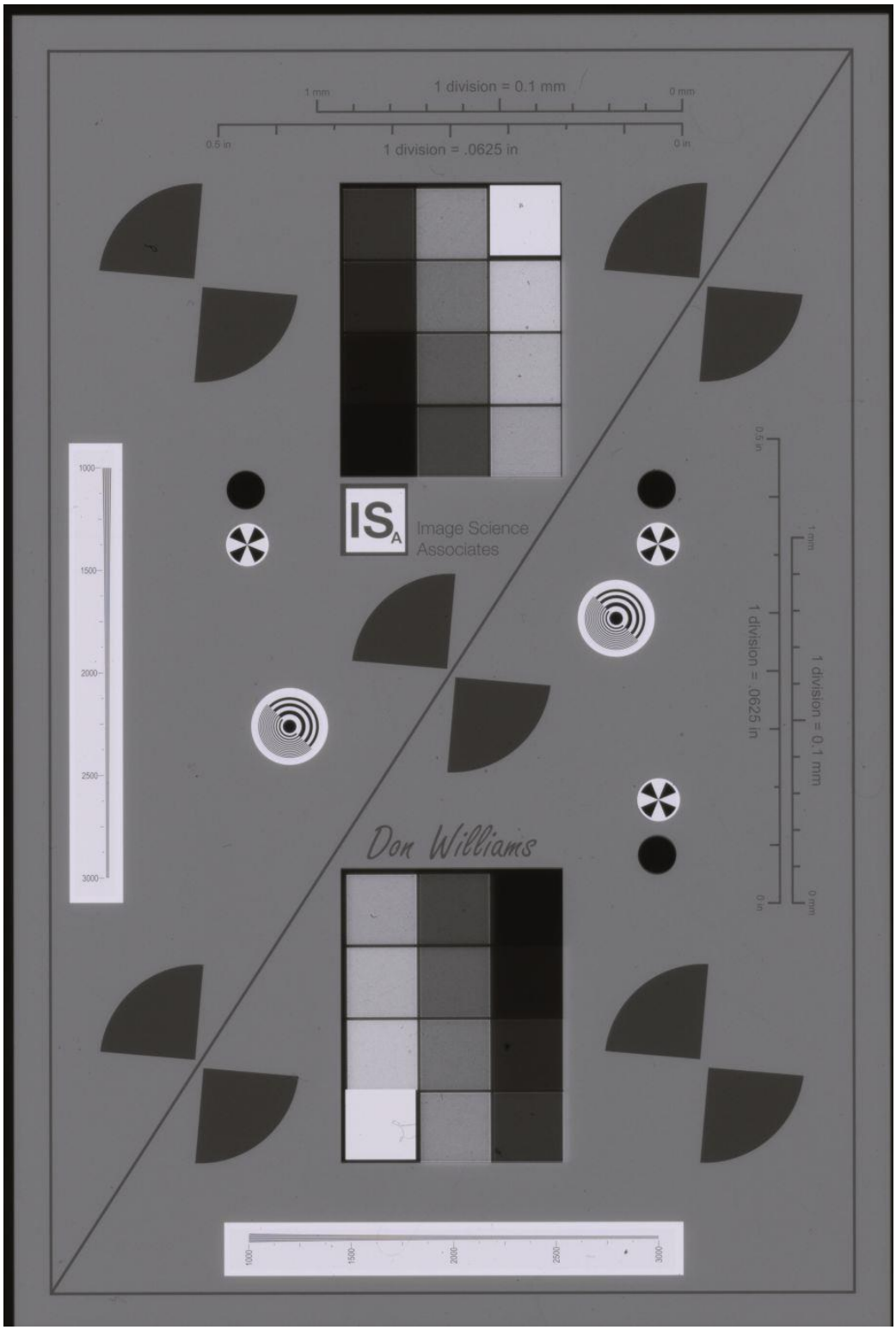


Fig. 5.1K: Negative Small 35mm Target (2)

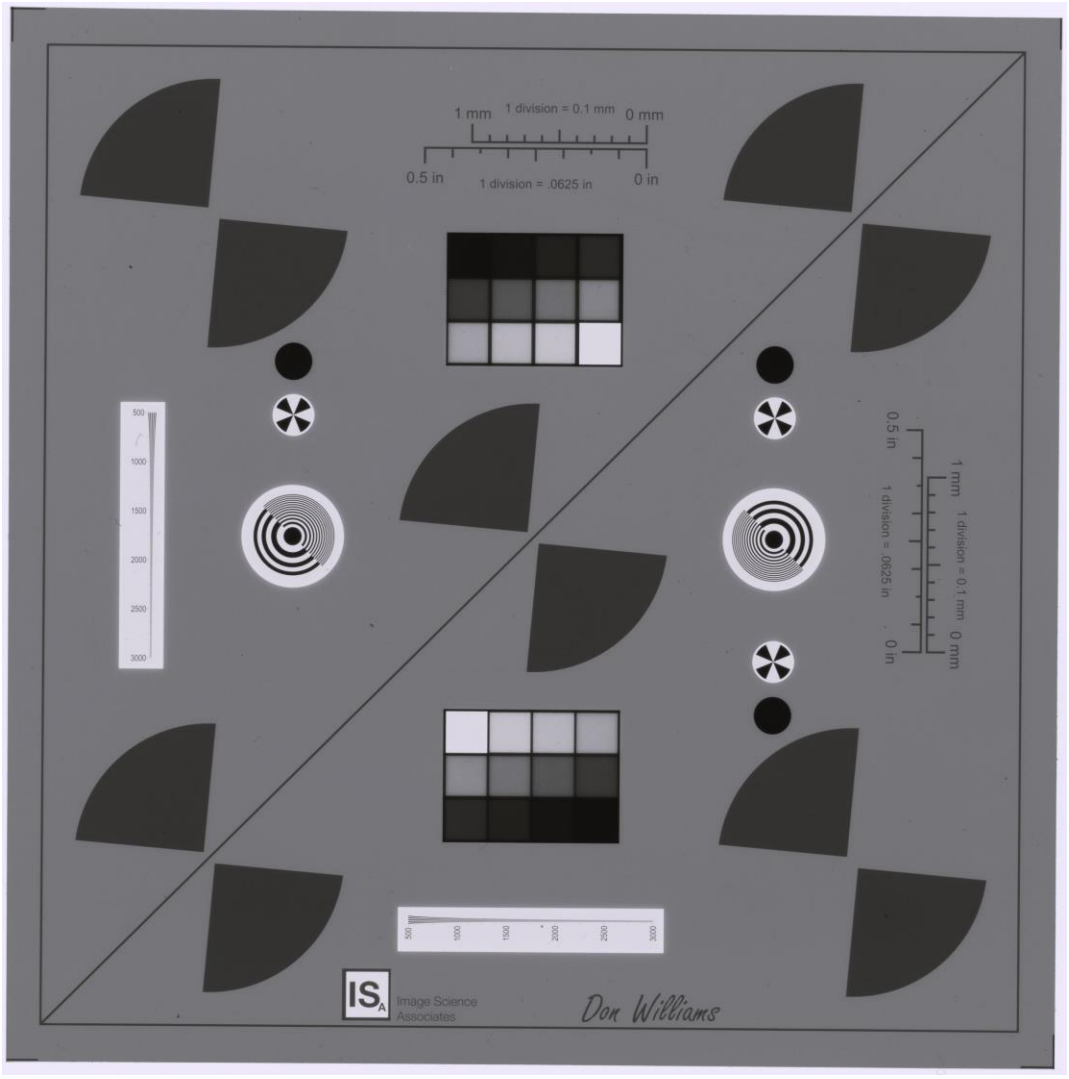
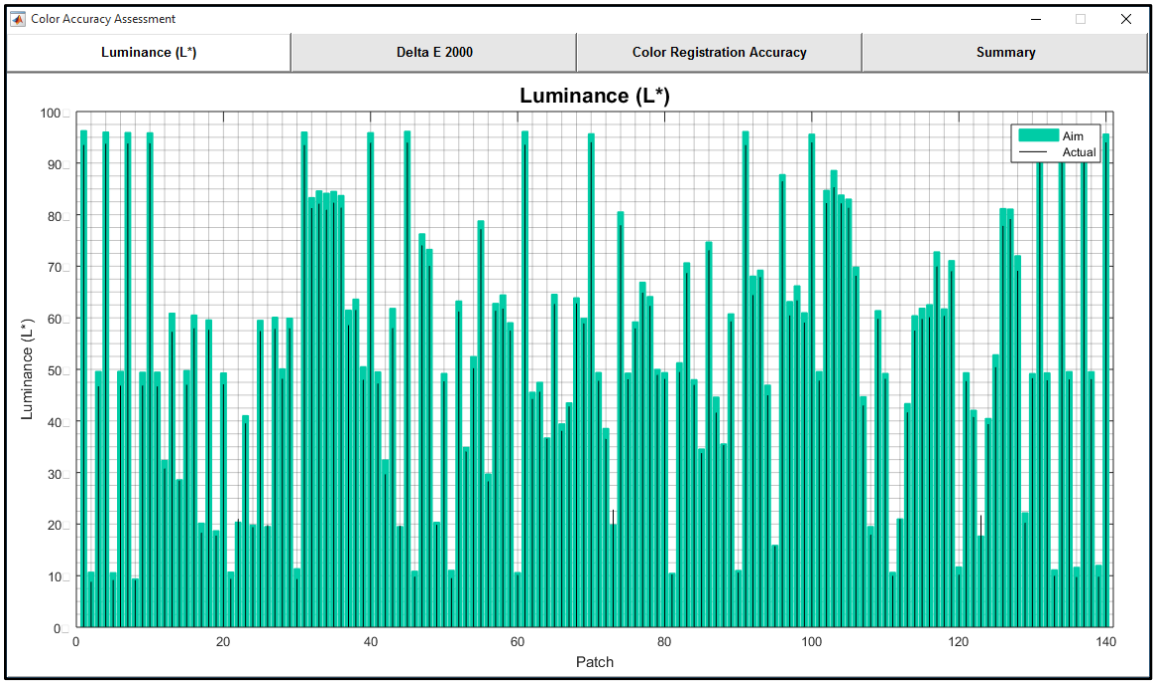


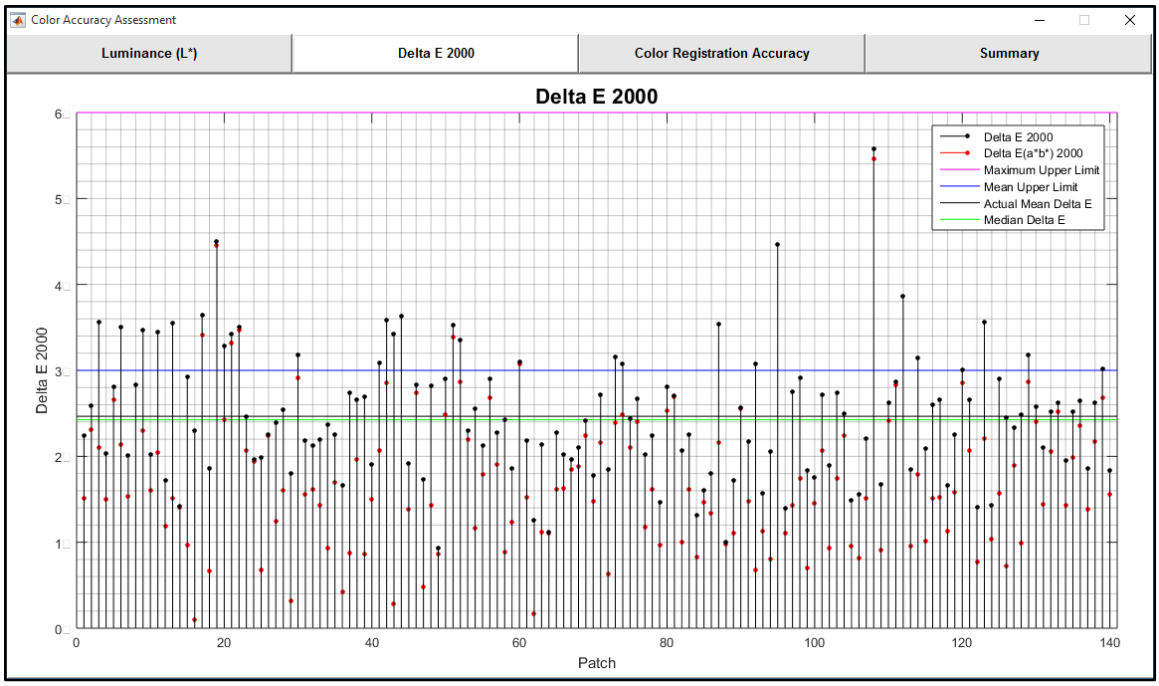
Fig. 5.1L: Negative Middle 120mm x 120mm

Fig. 5.1M: Transparent IT8.7/1 Target

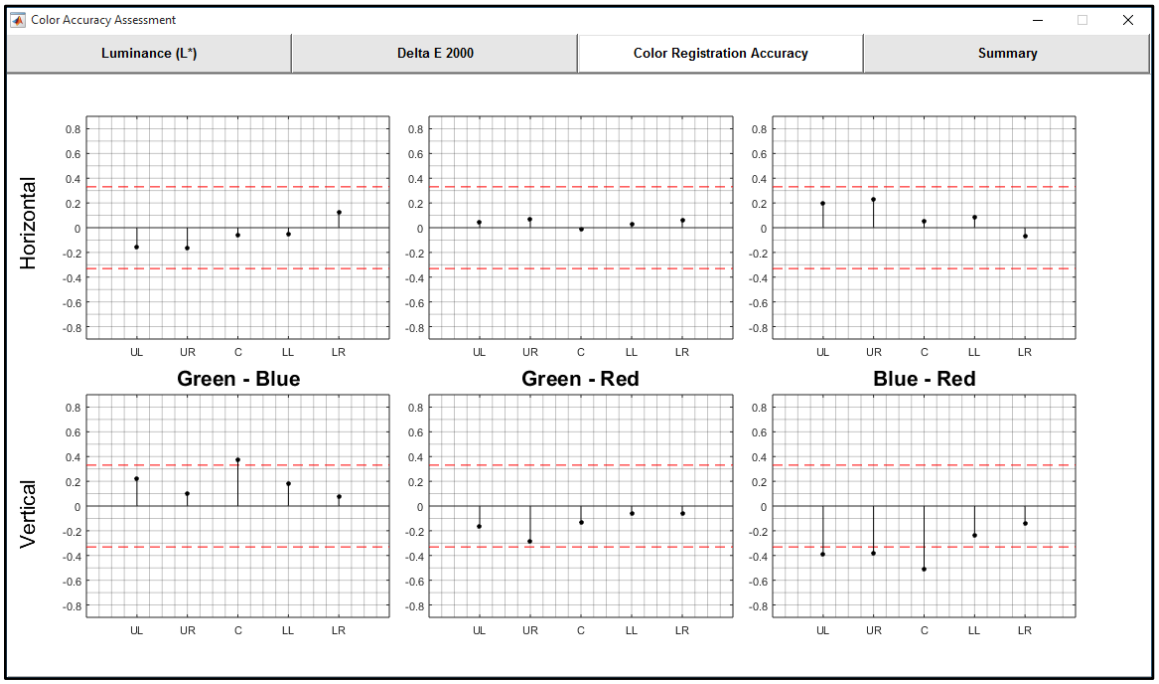
5.2 Test Results Images



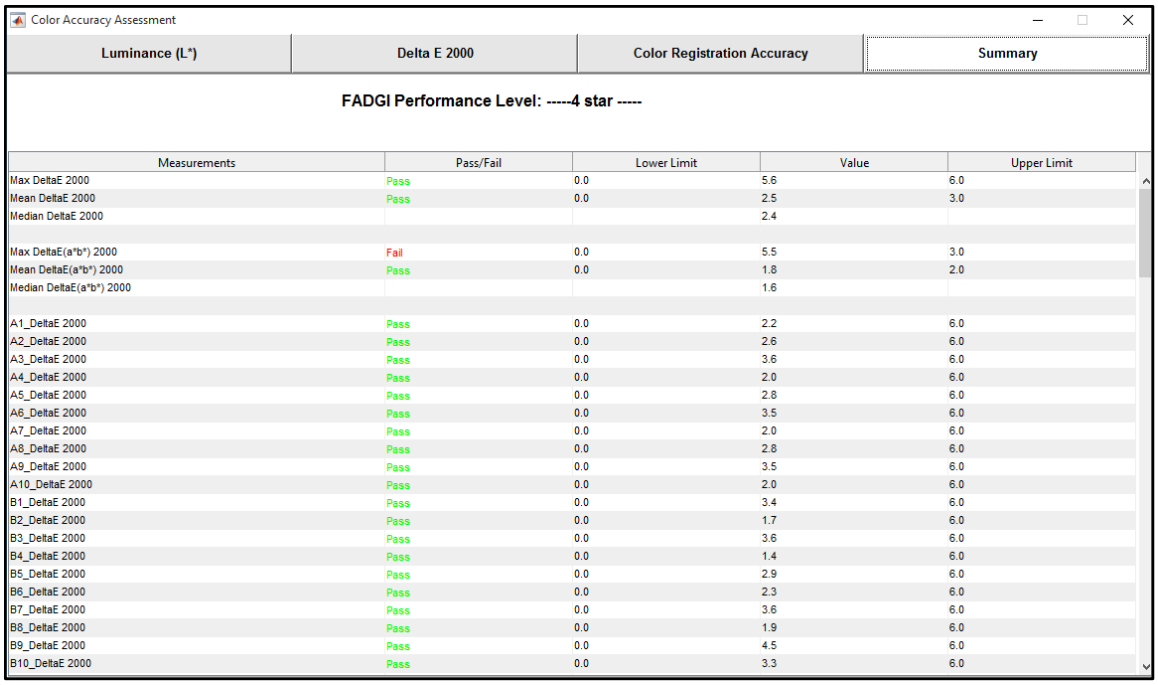
Luminance Tab



[Delta E 2000 Tab]

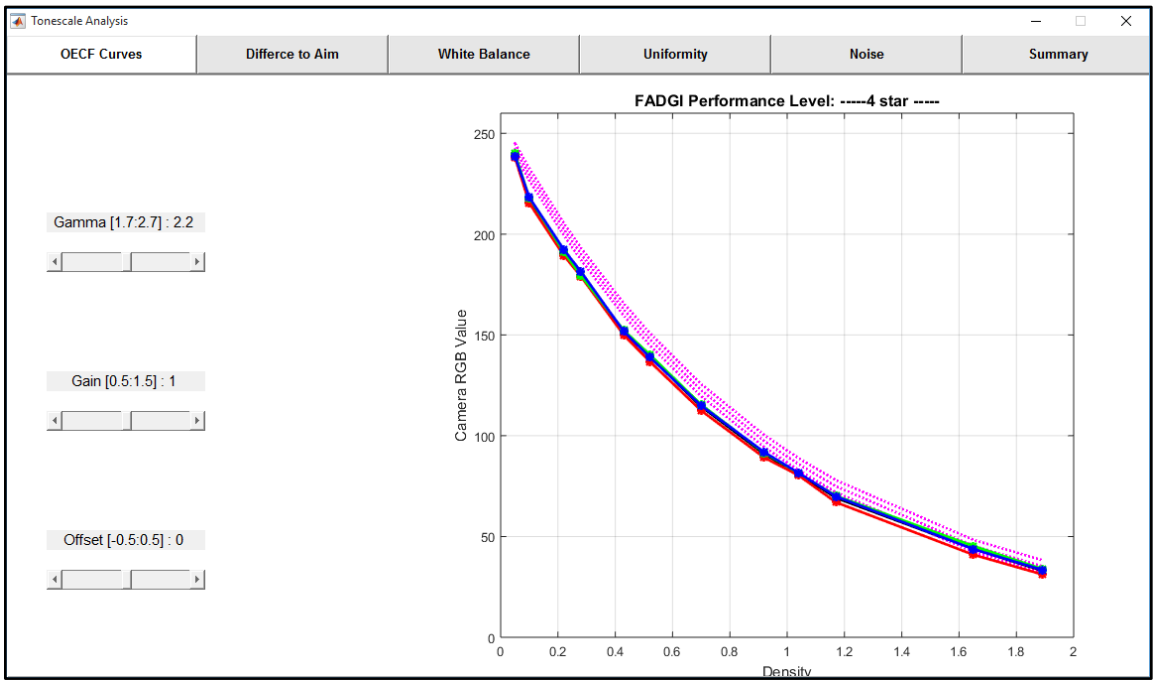


[Color Registration Accuracy Tab]

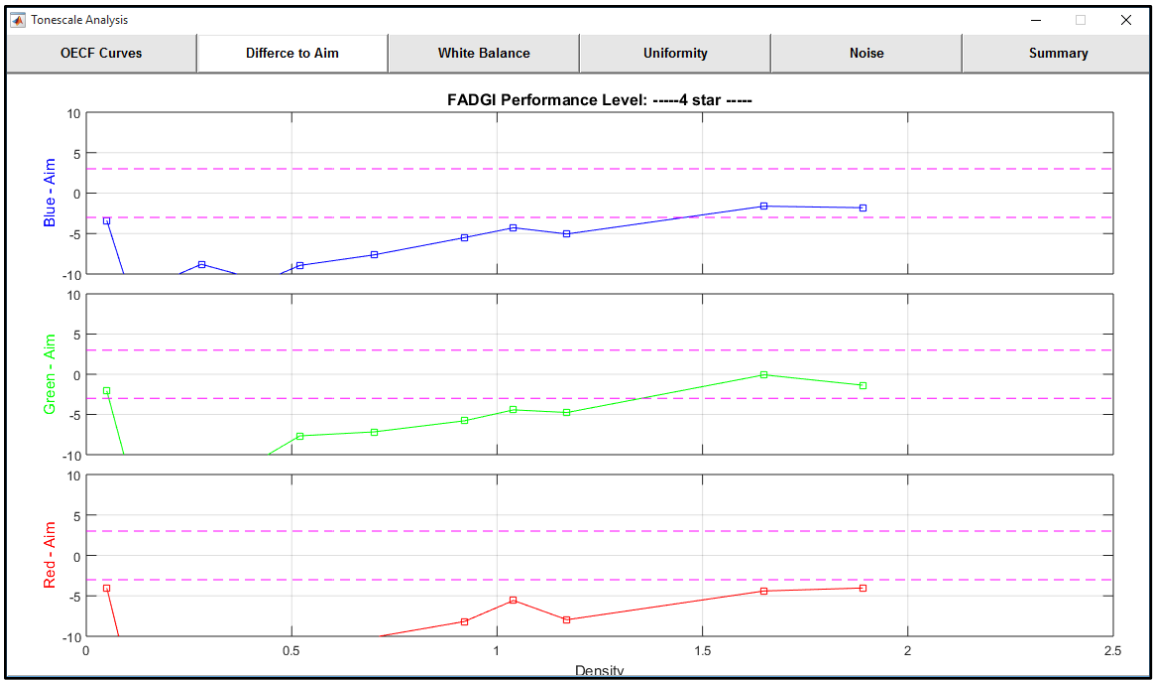


Measurements	Pass/Fail	Lower Limit	Value	Upper Limit
Max DeltaE 2000	Pass	0.0	5.6	6.0
Mean DeltaE 2000	Pass	0.0	2.5	3.0
Median DeltaE 2000			2.4	
Max DeltaE(a*b*) 2000	Fail	0.0	5.5	3.0
Mean DeltaE(a*b*) 2000	Pass	0.0	1.8	2.0
Median DeltaE(a*b*) 2000			1.6	
A1_DeltaE 2000	Pass	0.0	2.2	6.0
A2_DeltaE 2000	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

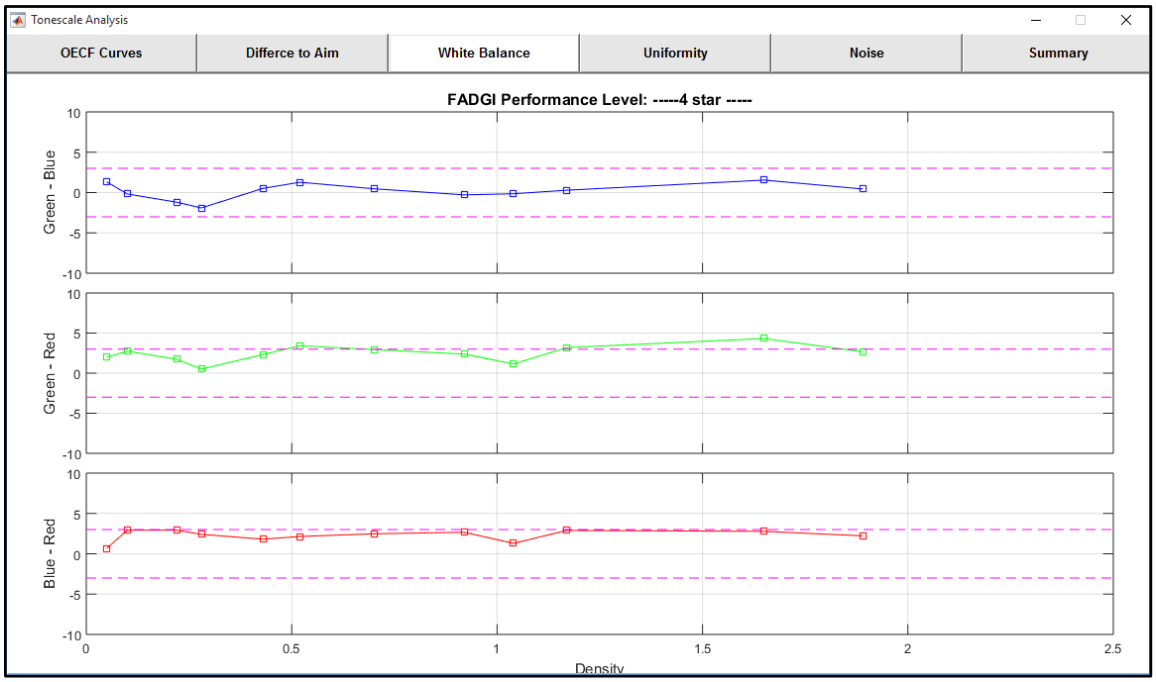
Color Accuracy Summary Tab



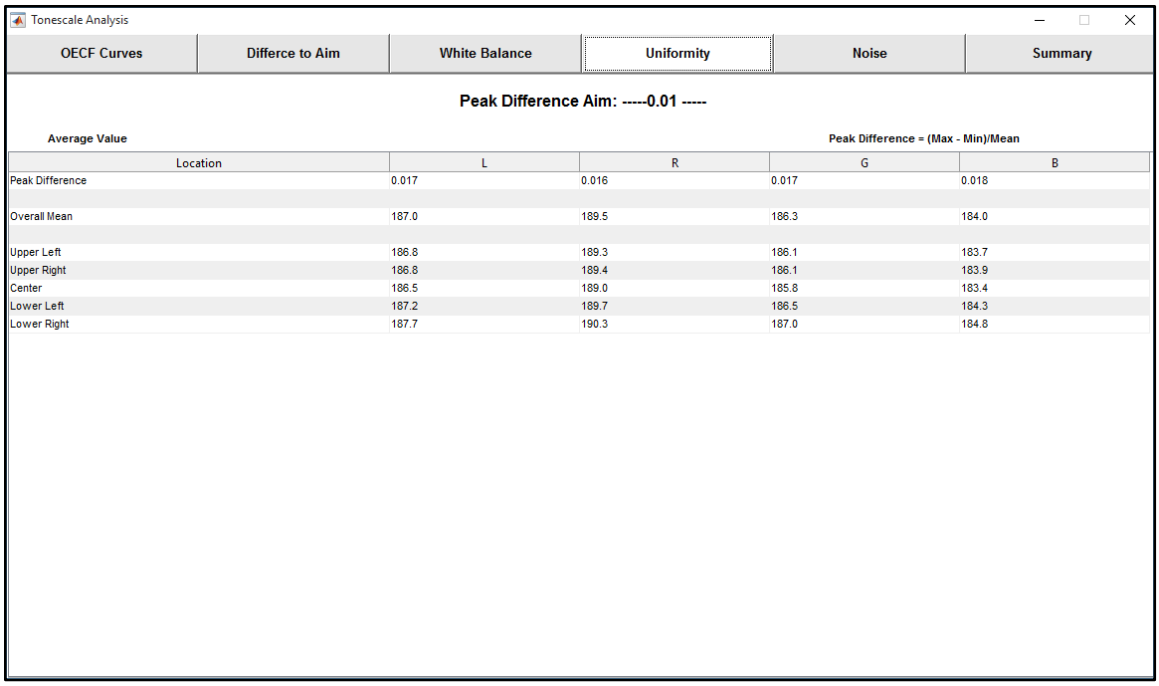
OECF Curves Tab



[Difference to Aim Tab]

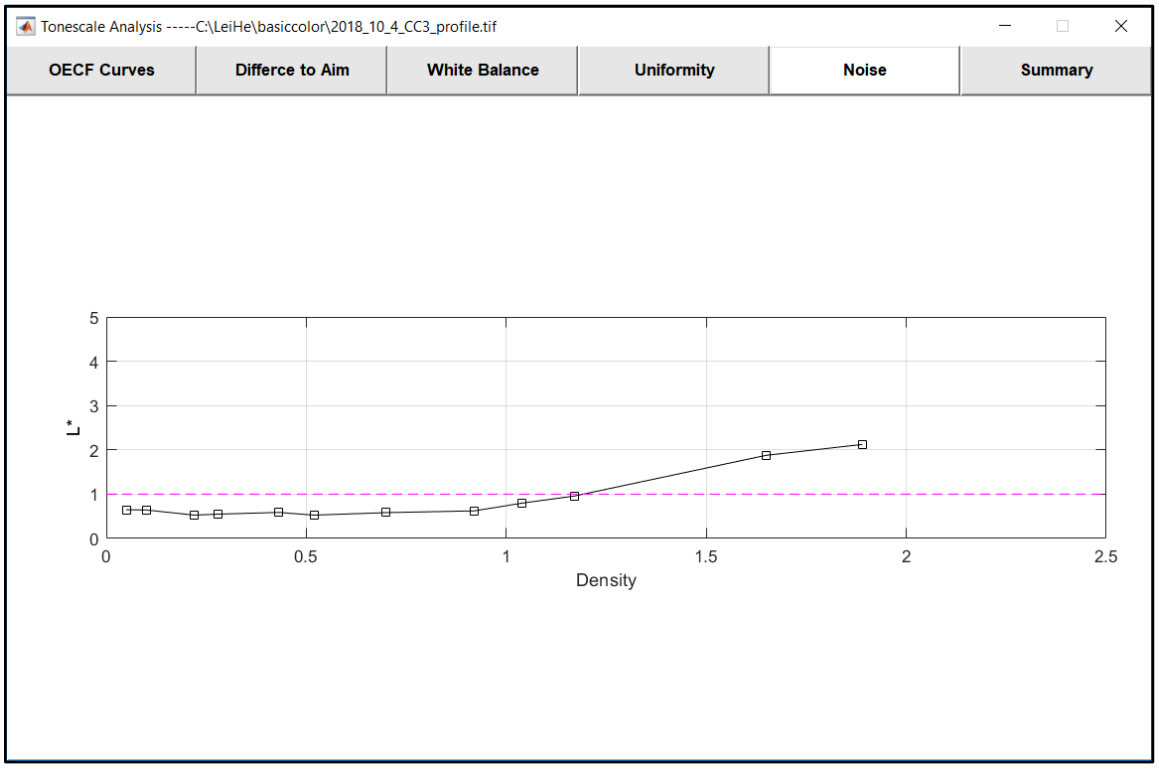


[White Balance Tab]

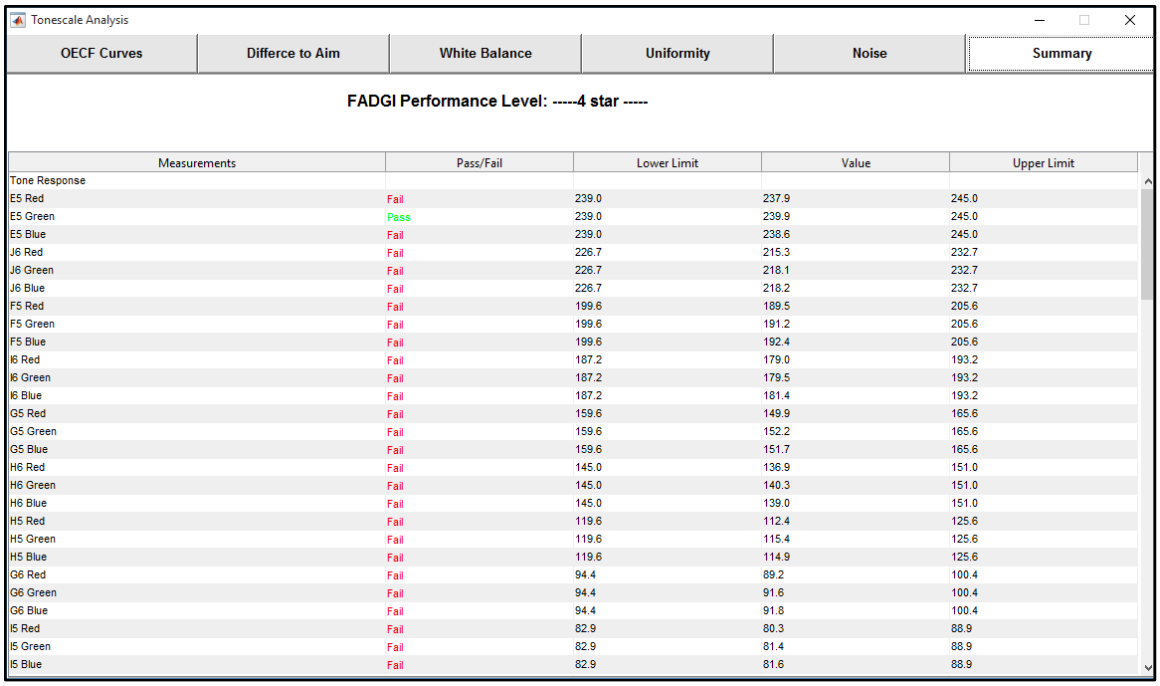


Location	L	R	G	B
Peak Difference	0.017	0.016	0.017	0.018
Overall Mean	187.0	189.5	186.3	184.0
Upper Left	186.8	189.3	186.1	183.7
Upper Right	186.8	189.4	186.1	183.9
Center	186.5	189.0	185.8	183.4
Lower Left	187.2	189.7	186.5	184.3
Lower Right	187.7	190.3	187.0	184.8

Uniformity Tab

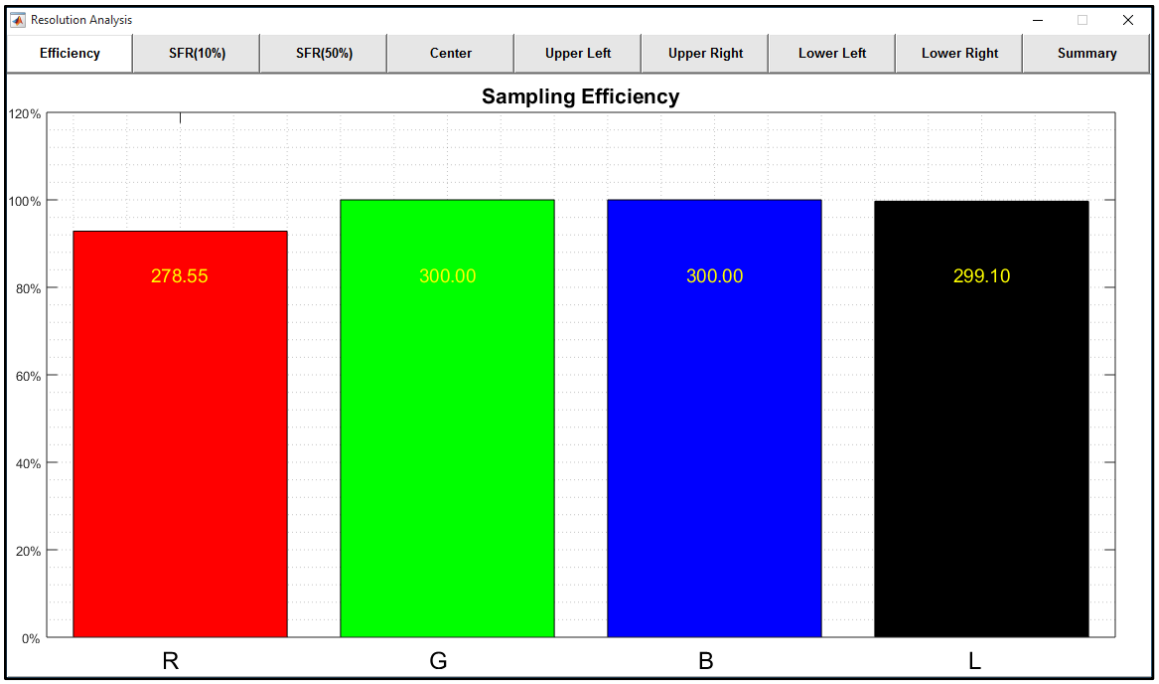


Noise Tab

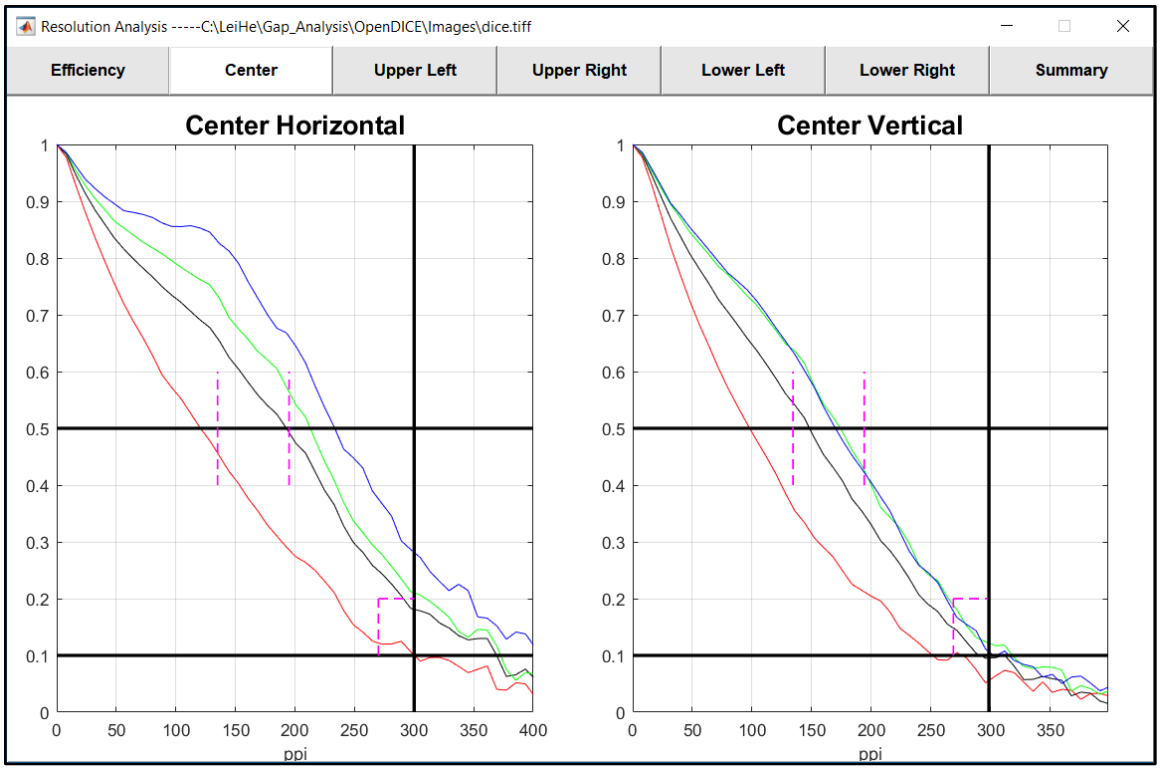


Measurements	Pass/Fail	Lower Limit	Value	Upper Limit
Tone Response				
E5 Red	Fail	239.0	237.9	245.0
E5 Green	Pass	239.0	239.9	245.0
E5 Blue	Fail	239.0	238.6	245.0
J6 Red	Fail	226.7	215.3	232.7
J6 Green	Fail	226.7	218.1	232.7
J6 Blue	Fail	226.7	218.2	232.7
F5 Red	Fail	199.6	189.5	205.6
F5 Green	Fail	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

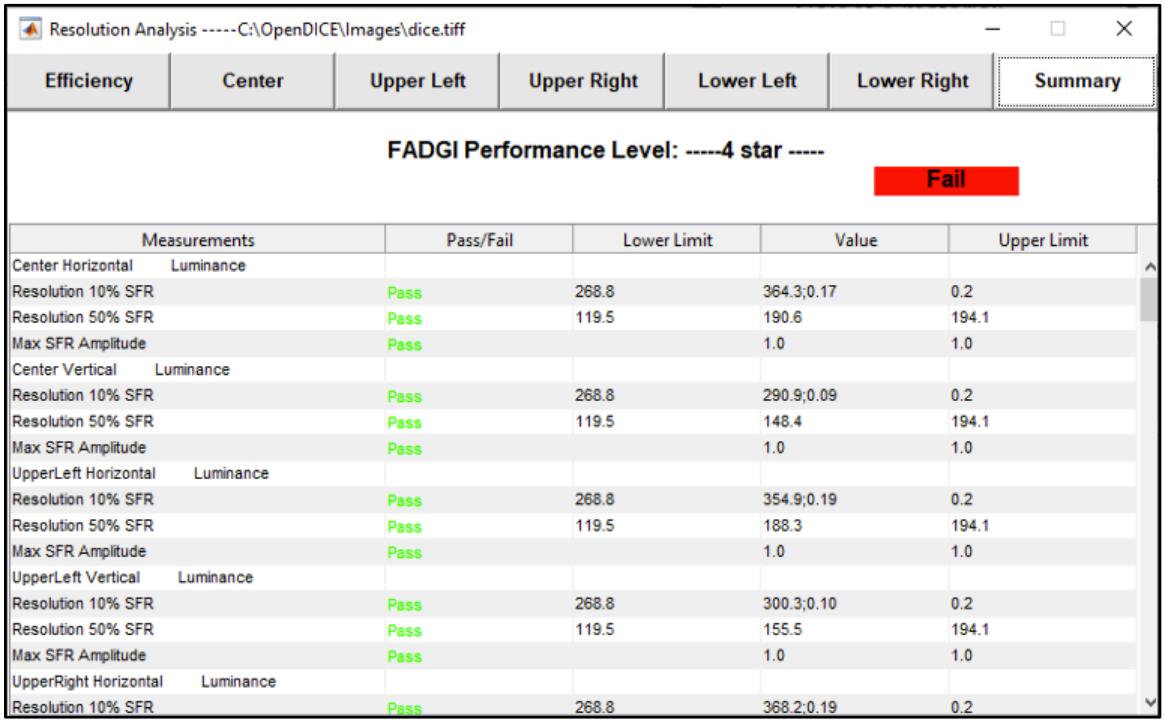
Tonescale Summary Tab



Efficiency Tab



SFR Curves Tabs



Measurements	Pass/Fail	Lower Limit	Value	Upper Limit
Center Horizontal Luminance				
Resolution 10% SFR	Pass	268.8	364.3;0.17	0.2
Resolution 50% SFR	Pass	119.5	190.6	194.1
Max SFR Amplitude	Pass		1.0	1.0
Center Vertical Luminance				
Resolution 10% SFR	Pass	268.8	290.9;0.09	0.2
Resolution 50% SFR	Pass	119.5	148.4	194.1
Max SFR Amplitude	Pass		1.0	1.0
UpperLeft Horizontal Luminance				
Resolution 10% SFR	Pass	268.8	354.9;0.19	0.2
Resolution 50% SFR	Pass	119.5	188.3	194.1
Max SFR Amplitude	Pass		1.0	1.0
UpperLeft Vertical Luminance				
Resolution 10% SFR	Pass	268.8	300.3;0.10	0.2
Resolution 50% SFR	Pass	119.5	155.5	194.1
Max SFR Amplitude	Pass		1.0	1.0
UpperRight Horizontal Luminance				
Resolution 10% SFR	Pass	268.8	368.2;0.19	0.2

SFR Summary Tab

5.3 Additional Links and Resources

5.3.1 Websites

FADGI General

FADGI Technical Guidelines for Digitizing Cultural Heritage Materials

International Organization for Standardization (ISO)

OpenDICE

Society for Imaging Science and Technology (IS&T)

5.3.2 Supplemental Readings

Burns, Peter and Don Williams. "Ten Tips for Maintaining Digital Image Quality." IS&T Archiving 2007 Final Program and Proceedings, 16-22.

Dahlstrom, Mats. 2010. “Critical Editing and Critical Digitization.” In Text Comparison and Digital Creativity: The Production of Presence and Meaning in Digital Text Scholarship, edited by W. Th. Van Peursen, Ernst Thoutenhoofd, and Adriaan van der Weel. Brill, pp. 80-97.

Gabriëls, Nele et al. “Managing the Digitisation Chain.” IS&T Archiving 2019 Final Program and Proceedings, 17-20.

Geffert, W. Scott. “Transitioning to International Imaging Standards at the Metropolitan Museum of Art's Photograph Studio.” IS&T Archiving 2011 Final Program and Proceedings, 205-210.

Hankiewicz, Steffen. “Dos and Don'ts for digitisation workflows.” IS&T Archiving 2018 Final Program and Proceedings, 99-104.

Hoffman, Martina. “Quality Assurance in Mass Digitization Projects.” IS&T Archiving 2016 Final Program and Proceedings, 107-110.

Horsley, Michael and John Berezich. “Implementing a Quality Assurance Plan for Monitoring Scanner Performance.” IS&T Archiving 2011 Final Program and Proceedings, 97-100.

Kesjer, Ulla Bøgvas et al. “State of the Art of Cost and Benefit Models for Digital Curation.” IS&T Archiving 2014 Final Program and Proceedings, 144-149.

Knijn, Margot. “DIGITISE MORE, PAY LESS - Optimising the preparation for digitising large collections of images.” IS&T Archiving 2011 Final Program and Proceedings, 223-226.

Mildren, Rob. “Achieving Quality in Digitisation Workflow.” IS&T Archiving 2006 Final Program and Proceedings, 225-227.

Stelmach, Michael and Don Williams. “When Good Scanning Goes Bad.” IS&T Archiving 2006 Final Program and Proceedings, 237-243.

Williams, Don. “A Decade of Experience with Digital Imaging Performance Guidelines.” IS&T Archiving 2017 Final Program and Proceedings, 165-169.

Willams, Don and Peter D. Burns. “Preparing for the Image Literate Decade.” IS&T Archiving 2009 Final Program and Proceedings, 124-127.

Wueller, Dietmar. “What if the image quality analysis rates my digitization system a ‘no go’?.” IS&T Archiving 2011 Final Program and Proceedings, 211-215.

Wueller, Dietmar and Ulla Bøgvad Kesjer. “Standardization of Image Quality Analysis – ISO 19264.” IS&T Archiving 2016 Final Program and Proceedings. April 2016, 111-116.

Zhou, Yongli. “Fulfill Your Digital Preservation Goals with a Budget Studio.” IS&T Archiving 2016 Final Program and Proceedings, 38-44.