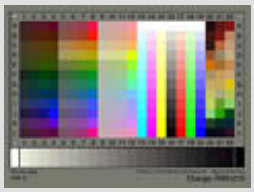
Imatest - Multicharts

Measure color accuracy, tonal response, and noise from a large variety of test charts

Introduction

Colorchecker

IT8.7

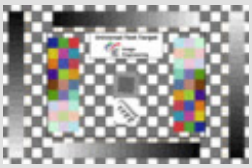


CMP DT 003

Colorchecker SG

QPcard 201

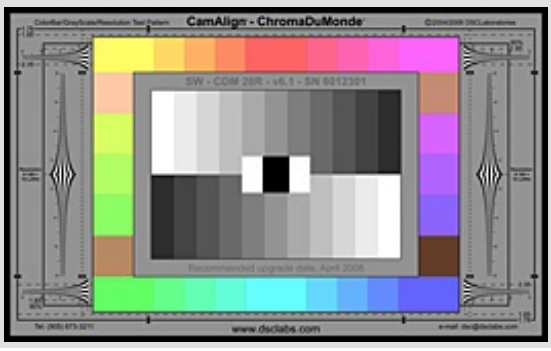
Q-13



Universal Test Target (UTT)

ChromaDuMonde 28/28R

Also: SpyderCHECKR (8×6), SFRplus 20-patch color, SMPTE/Hale Color Bars (6 patches), TE226 (9×5) chart, General *m* rows x *n* columns.



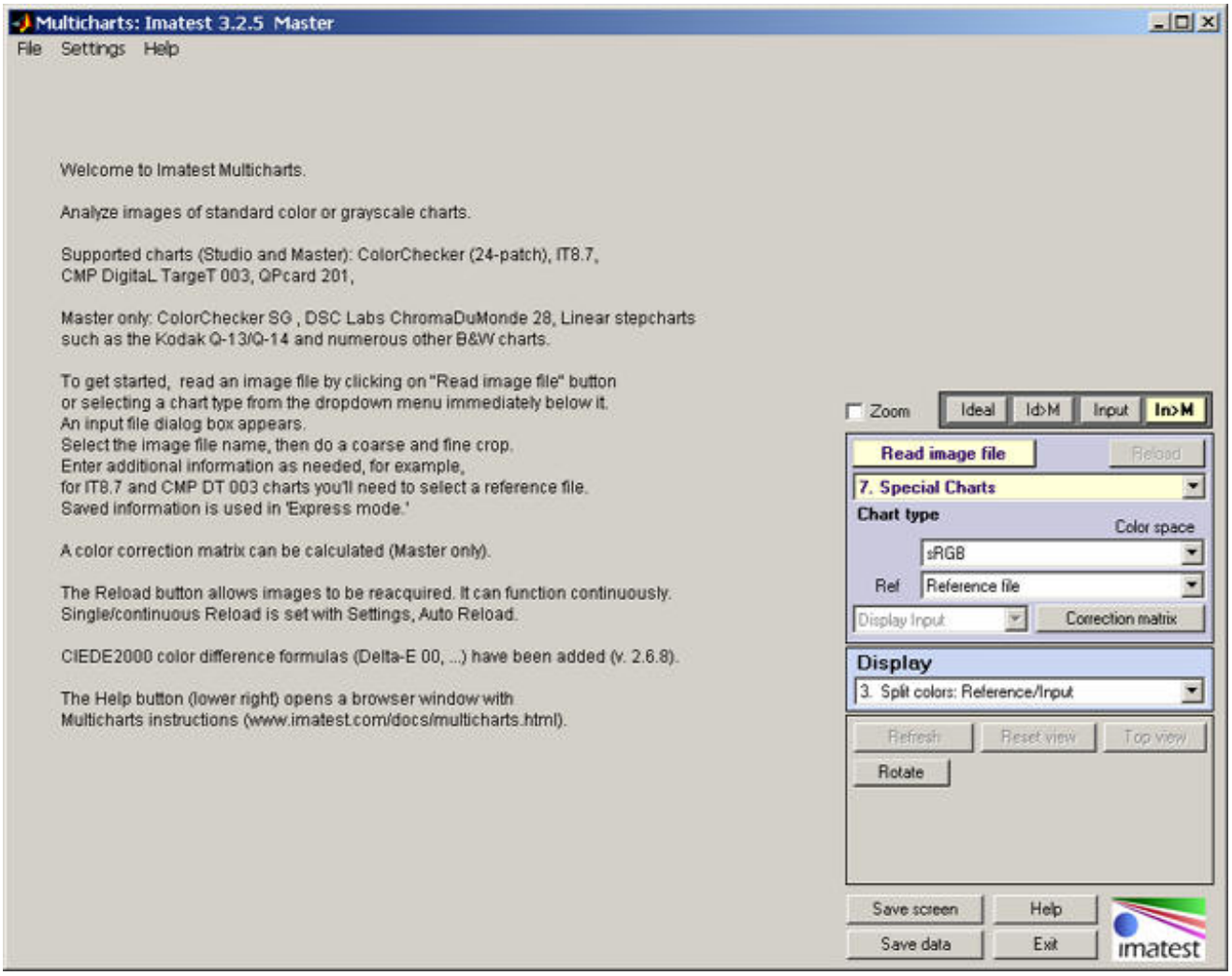
Imatest™ Multicharts analyzes images of several test charts for color accuracy, tonal response, noise, and ISO sensitivity using a highly interactive user interface. It can be used to measure white balance and color response for a wide range of lighting conditions and scenes. It can also display the tonal response of monochrome charts (or monochrome portions of color charts). A color correction matrix can be calculated (Imatest Master only) and used to correct images.

Several of the supported test charts are shown on the left. The ChromaDuMonde, linear grayscale stepcharts, Universal Test Target (UTT), and several additional Special Charts are supported by Imatest Master only.

Getting started

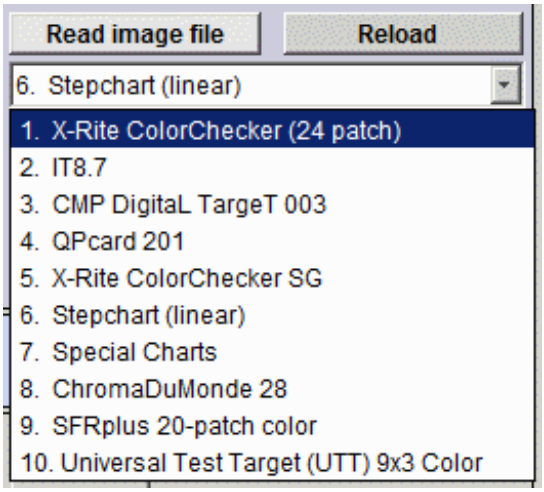
Photograph or scan the chart, taking care to illuminate the chart evenly (±5%), and to avoid glare, which can be problematic in charts with semigloss (SG) and glossy surfaces such as the reflective IT8.7 and ColorChecker SG. Glare can be especially difficult to control with wide angle lenses. A low-cost lighting setup is described here. For testing white balance, you can photograph the chart in a scene under a variety of lighting conditions. The mini ColorChecker is especially suitable for this purpose. Rectangular charts may be rotated by multiples of ±90° if they are geometrically symmetrical (these include the two ColorCheckers, the CMP DT003, QPCard 01, and the Kodak/Tiffen Q-13/Q-14, but *not* the IT8.7 (where top and bottom are different).

To start Multicharts, run Imatest, then click the button. The Multicharts window will appear with brief instructions, which may be more up-to-date than the one shown below.



Multicharts opening window with brief instructions

Select a chart to read.

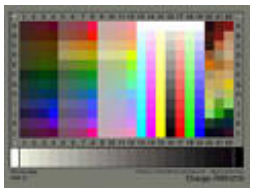


Select a chart to analyze by clicking on one of the entries in the popup menu below **Chart type** or by clicking on if the correct **Chart type** is displayed. The button and popup menu (shown on the right) are highlighted (yellow background) when Multicharts starts. Multicharts supports the following charts:

The standard 24-patch X-Rite ColorChecker®. ColorChecker charts (standard and SG) are available from a great many suppliers, including ColorHQ, Adorama, ColorManaged.com, and X-Rite.

The industry-standard **IT8.7** chart. IT8.7 charts come in several formats (reflective and transmissive), available from Wolf Faust (in the USA from Digital

Light & Color), Fuji, and others. Reflective IT8.7/2 charts are relatively inexpensive. IT8.7 charts are printed on photographic paper or film (consisting of three dye layers). They must be used with reference files, which are available from manufacturer's websites.



IT8.7 (Kodak Q-60) test images can be found in Imaging-Resource.com test reports. Look for the Samples page in the review for the camera of interest, then click on **Multi Target**. Example: Sigma DP1 | Sigma DP1 Test Image. The reference file for IR's target (Kodak Q-60R1 2006:06) is in this file on the Kodak Q60 targets FTP site.

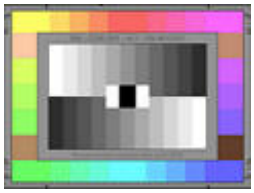
The 285-patch CMP (Christophe Metairie Photographie) DigitaL TargeT 003 (CMP DT003), which comes with an individually calibrated reference file containing XYZ and L*a*b* data. It can be used to generate extremely precise camera profiles.

The inexpensive 30-patch QPcard 201, which can be used with free downloadable QPcolorsoft 501 software for profiling cameras. Designed by Lars Kjellberg, founder of the outstanding lens test site, Photodo.com, which uses Imatest. The QPcard should be photographed in landscape mode with the *Qpcard* logo on the right.

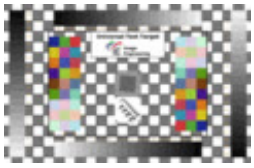
The 140-patch X-Rite Colorchecker SG (Imatest Master only), which has a semigloss (SG) surface. It contains a 6×4 patch area in the upper-middle that is similar to the 24-patch Colorchecker, except that the colors are more saturated.

Linear grayscale step charts such as the Kodak/Tiffen Q-13/Q-14 (Imatest Master only) or the Stouffer T4110. Both reflection and transmission charts are supported. Available from most major photography dealers. Other stepcharts are discussed in Using Stepchart.

Special charts (Imatest Master only): Several additional monochrome charts as well as 7-12 squares, arranged on a circle, useful for analyzing pie or circular charts. Described on a separate page.



DSC Labs ChromaDuMonde 28/28R widely used in the cinema and broadcasting industries for calibrating cameras. Designed for use with the vectorscope display. Imatest Master can display vectorscope images from still frames. The Imatest Image Sensor version features auto-refresh for full vectorscope functionality.



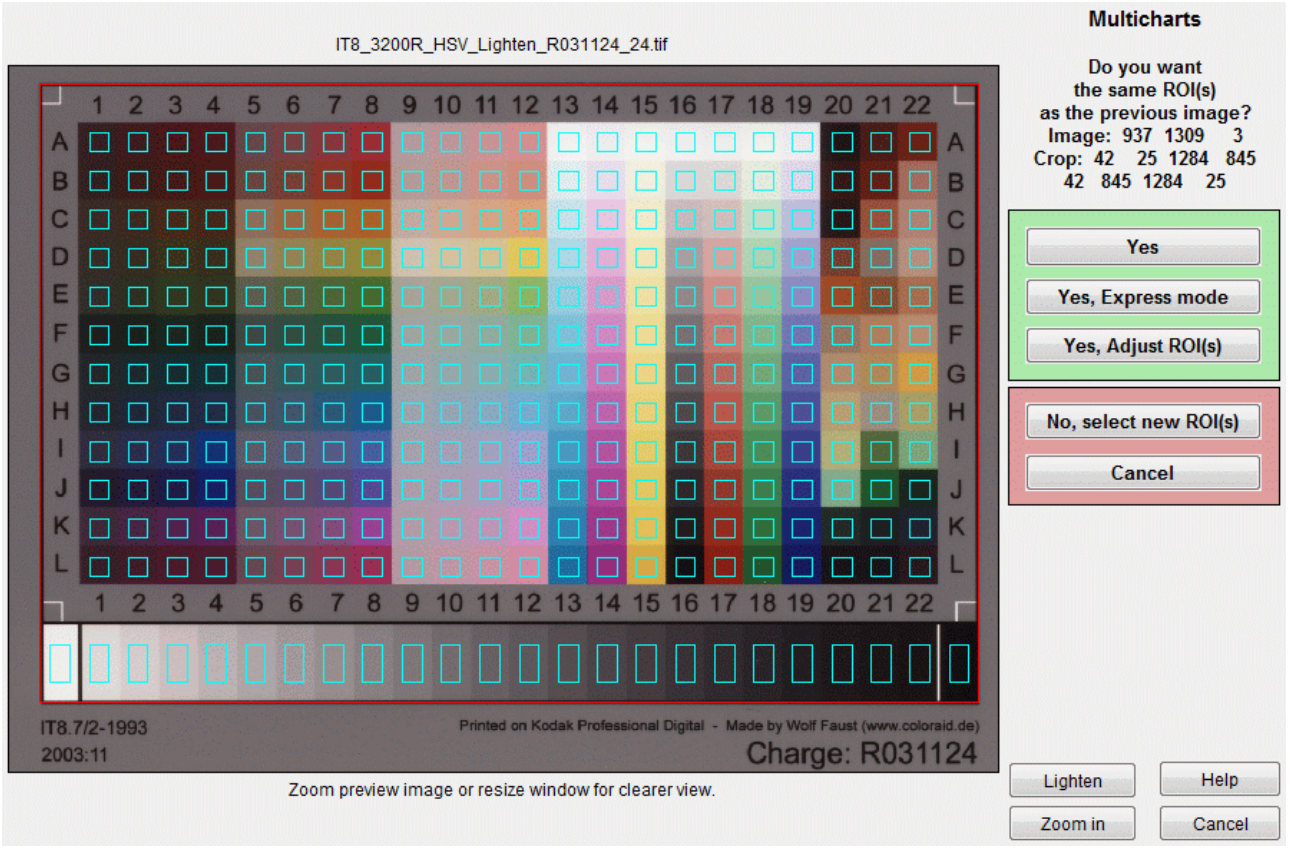
The Universal Test Target (crop shown on right) is primarily designed for testing scanners. Multicharts can analyze the 9×3 color pattern to the left of center (with the 9 light regions at the botton) as well as the 20-step grayscale step charts (which have step increments of L* = 5). When the stepchart is analyzed (using 6. Stepchart (linear)), Ref (Reference file or data source) should be set to L* = 95:-5:5,1 (20-step UTT).

General *mxn* charts (4×12 shown on the left). ***Any*** chart with an *mxn* grid can be analyzed. You must specify the grid size (click **Settings**, **ISO speed & *mxn* chart settings** to set the number of rows (*m*) and columns (*n*). You must also enter a CSV file with reference patch settings (typically L*, a*, b* values, one set per line).

Other charts: SpyderCHECKR (8×6), SFRplus 20-patch color, SMPTE/Hale Color Bars (6 patches), Image Engineering TE226 (9×5), Image Science Associates ColorGauge.

A standard Windows dialog appears with the chart type indicated in the title. Open the image file.

If the image is the same size and type as the previous image analyzed by Multicharts, you'll be asked if you want to use the same ROI (region of interest).



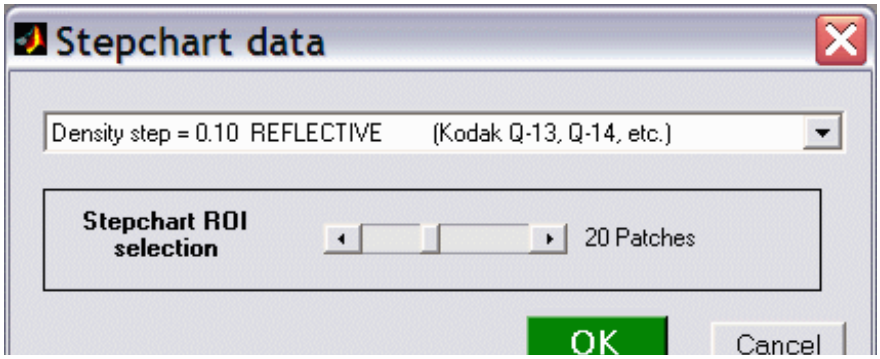
ROI repeat dialog shown with IT8.7 chart

If the image is not the same size and type, or if you answer No, a coarse cropping box appears. The initial crop doesn't have to be precise: you'll have a chance to refine it shortly. The crop box can be enlarged or maximized to make the selection easier.

- For either of the ColorCheckers (24-patch or SG) or the QPcard, leave a margin around the sides slightly smaller than the spacing between patches.
- For Stepcharts, select the entire chart (all patches), choosing boundaries that give even patch size. (The white patch on the Q-13 and Q-14 is larger than the rest.)
- For IT8.7 charts, select an area that includes the boundaries around the color chart and the entire grayscale (the red rectangle in the fine adjustment box below).

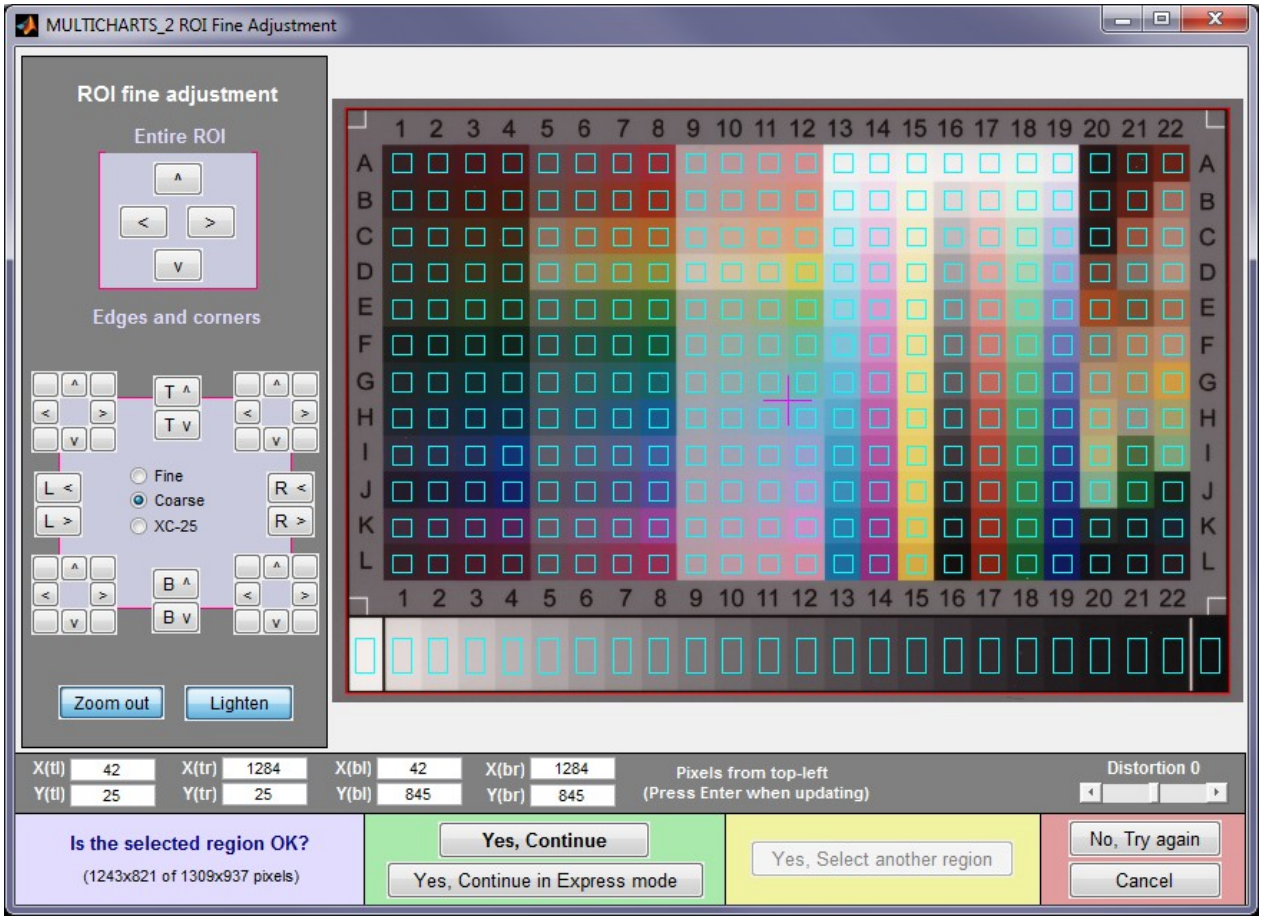
Stepchart type (reflective/transmissive, density step)

If you selected a Stepchart, the box shown on the right appears. Select the chart type (which specifies the



density step) and the number of patches (between 6 and 41).
Kodak/Tiffen Q-13/Q-14 charts have 20 patches; the Stouffer T4110 (a transmission chart with a density range of 4.0) has 41. For the Universal Test Chart (UTT) L* = 95:-5:5,1 (20-step UTT) and 20 patches should be selected.

After you've made the rough crop, the fine adjustment box appears. The original crop is displayed as the red rectangle. The patch regions to be selected are the small cyan squares or rectangles. This dialog box can be enlarged or maximized to facilitate the adjustment. It offers numerous options.



Fine region selection shown for the IT8.7 chart

- The entire ROI can be moved (, upper-left).
- The top, bottom, left, or right sides can be moved (, middle-left).
- Corners can be moved individually (any of the 8 buttons in each of the four corners, middle-left).
- Pixel values for the four corners can be entered (**X(tl)**, **Y(br)**, …, where **tl** = top-left, **br** = bottom right, etc.). The origin is the upper-left. Be sure to press the key after entering a value.
- You can choose between Fine and Coarse movement (1 or 5 pixels of movement per click).

- The display can be zoomed out or in.
- The display can be lightened to view the dark regions more clearly.
- For some charts (those with relatively large patches) a **Fill factor (linear)** slider in the gray area above the button specifies the relative size of the squares. Its default value is 0.5. Smaller values can be used where lens distortion or pattern alignment makes alignment difficult.
- The distortion slider allows highly distorted images (barrel or pincushion) to be analyzed.

When you have completed the fine adjustment, click one of the buttons on the bottom of the window. If you click , an additional dialog box may appear. For example, for the IT8.7 chart it will ask for the required reference file. Some of the entries in the input dialog boxes, like color space, can be changed later. If you click , it will go directly to the Multicharts window, using saved (most recent) values. For example, it saves the IT8.7 reference file name.

Reference files

Several charts allow reference files to be entered using the **Ref.** dropdown menu in the image area on the right of the Multicharts window, below the **Color space** box. (IT8.7 and CMP DT003 charts require them.) The available settings depends on the chart type. The previous file is generally available in the dropdown list. Here is a summary of the available reference sources.

Chart	Default values	Options (data from files)
X-Rite ColorChecker (24-patch)	Default values from GMB, BabelColor, or Danes Picta (a chart with the same geometry but different colors)	L*a*b*, xyY D50, or xyY D65 files in CSV format.
IT8.7	Requires a reference file in IT8.7 format, available from the chart manufacturer, generally available on their websites.	—
CMP DigitaL TargeT 003	Individually measured reference files are supplied with each target.	—
X-Rite ColorChecker SG	Default values from GMB (L*a*b* D50); See Note below	L*a*b*, xyY D50, or xyY D65 files in CSV format.
Stepchart (linear)	Even density steps of 0.1, 0.15, 0.20, or 0.30. For the UTT only, L* = 95 to 5 in steps of -5 for the first 19 steps and 1 for	an ASCII density reference file with one density value per line can

	step 20. (20-step UTT) should be selected.	be entered.

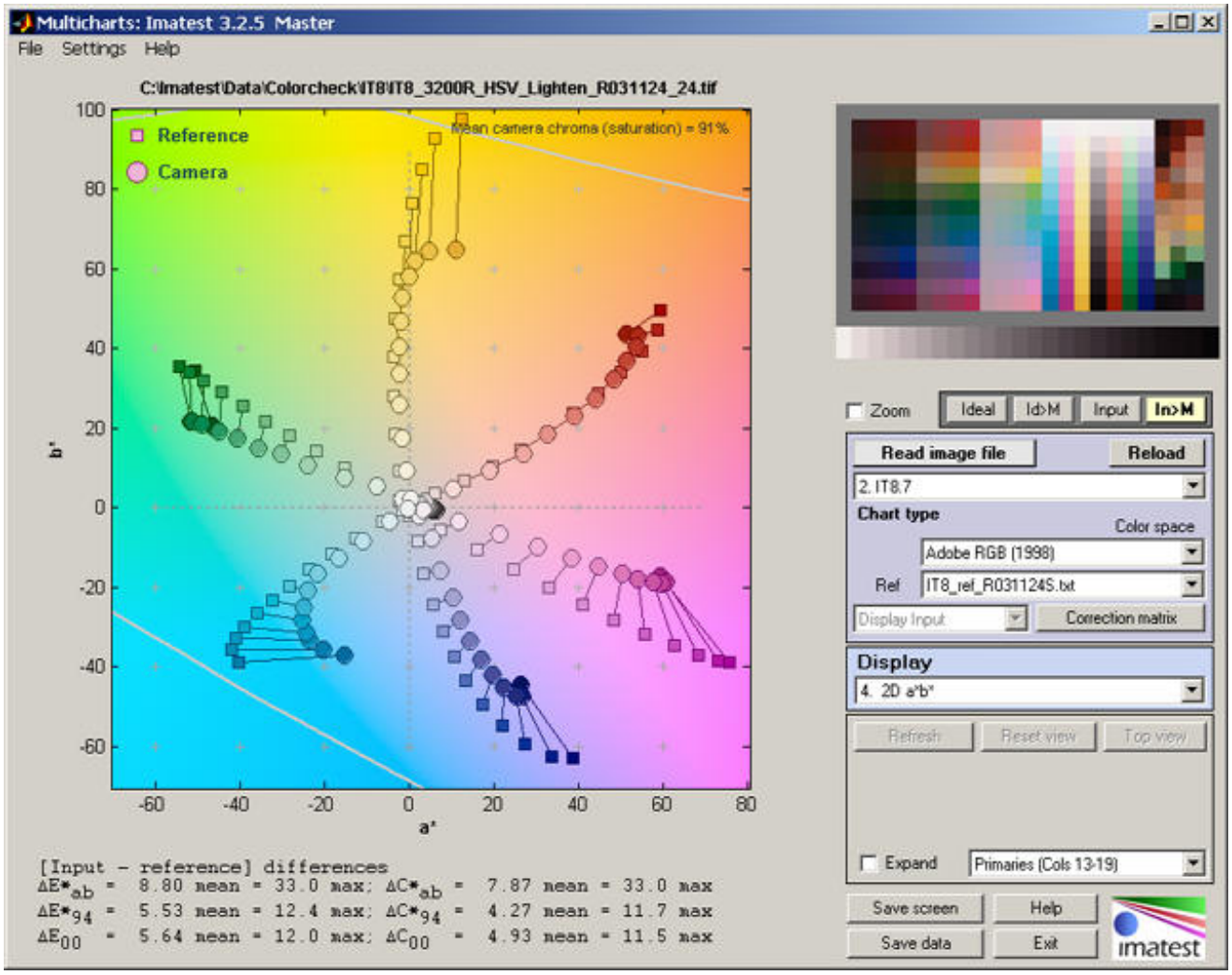
Note: Several of the default reference values are derived from L*a*b* D50 values, i.e., L*a*b* values acquired under D50 illumination. When the color space has a different reference temperature (sRGB and Adobe RGB both have D65) a Bradford transformation is applied, resulting in a small change in the L*a*b* values. This is rarely a significant concern if you're making images under a different illuminant: if the white balance algorithm is working properly, it should transform image colors to the appropriate values for the color space.

Except for the IT8.7 and CMP DT 003, reference files must be in CSV (comma-separated file) format, which can be opened and edited in Excel. Color files (L*a*b*, xyY D50, and xyY D65) have three entries per line.

Here is an example of an L*a*b* file.	55.261, -38.342,31.37
The format is CSV (comma-separated variables).	28.778, 14.179, -50.297
The format is the same for xyY files.	65.711, 18.13, 17.81
Spaces are for visual clarity (readability) only.	51.038, -28.631,-28.638
	51.935, 49.986, -14.574
	81.733, 4.039, 79.819
	42.101, 53.378, 28.19

The Multicharts window

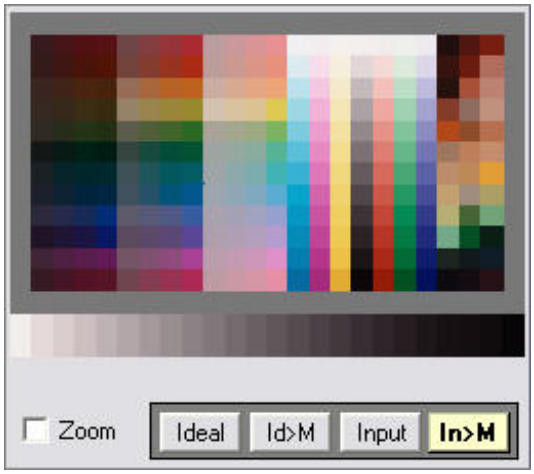
After the image file has been entered, the most recent Chart view is displayed. The 2D a*b* view (ideal and input values on the CIELAB a*b*) is shown below.



2D a*b* display of IT8 chart (CMYKRGB primaries)

The main display image is on the upper left. Color differences are summarized below this image, except when the Probe is turned on (available for the pseudocolor and split color displays). The various Δ*E** and Δ*C** values are described in Gamutvision equations. A synthesized image of the chart is shown on the upper right. Available options are described below. The remainder of the right side is the control area.

IT8.7 chart

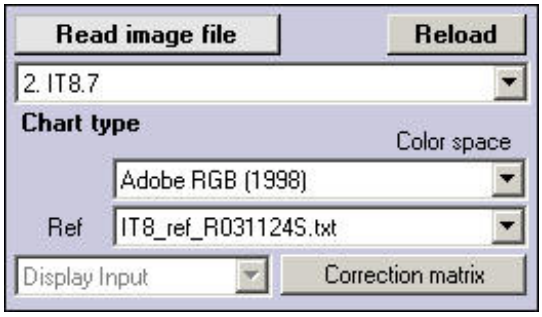


The checkbox turns Zoom on and off. 3D plots can be rotated when Zoom is turned off.

The four buttons to the right of control the display of the synthesized image on the upper-right.

- displays the ideal image with no gamut mapping. Colors will not be accurate for large gamut color spaces.
- displays the ideal image mapped from its native color space to sRGB, which is similar to typical monitor color spaces.
- displays the input image with no gamut mapping.
- displays the input image mapped from its native color space to sRGB, which is similar to typical monitor color spaces.

Image area



The pale blue box is the image area. It includes the and buttons, the **Chart type** dropdown menu (described above), entries for image properties, and color correction matrix functions .

reloads an image from a file or reacquires it from a device or video stream (depending on how the image was originally acquired). It is most valuable for versions of Imatest that can acquire images from devices or streams.

Color space allows the input file color space to be selected: ***the color space is not automatically read into Multicharts; it must be entered manually.*** One of six color spaces can be selected (more may be added in the future).

sRGB	The default space of Windows and the Internet. Limited color gamut based on typical CRT phosphors. Gamma = 2.2 (approximately), White point = 6500K (D65).
Adobe RGB (1998)	Medium gamut, with stronger greens than sRGB. Often recommended for high quality printed output. Gamma = 2.2, White point = 6500K (D65).
Wide Gamut RGB	Extremely wide gamut with primaries on the spectral locus at 450, 525, and 700 microns. One of the color spaces supported by the Canon DPP RAW

	converter. 48-bit color files are recommended with wide gamut spaces: banding can be a problem with 24-bit color. Gamma = 2.2, White point = 5000K (D50).
ProPhoto RGB	Extremely wide gamut. Gamma = 1.8, White point = 5000K (D50).
Apple RGB	Small gamut. Used by Apple. Gamma = 1.8, White point = 6500K (D65).
ColorMatch RGB	Small gamut. Used by Apple. Gamma = 1.8, White point = 5000K (D50).

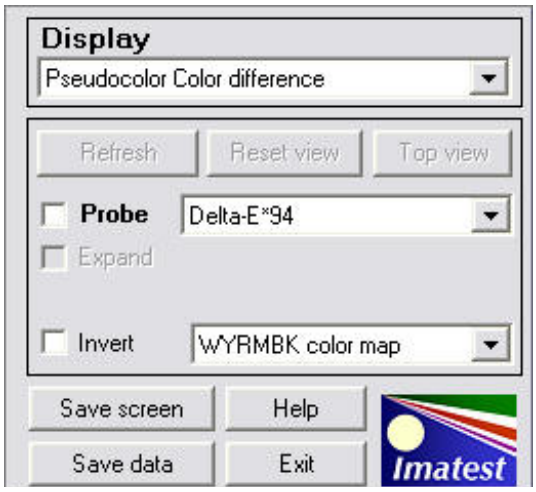
Danny Pascale's A Review of RGB Color Spaces is recommended for readers interested in an in-depth explanation of color spaces.

Ref is the reference source for the ideal chart values. The contents of the popup menu depends on the chart type. For the 24-patch ColorChecker and the ColorChecker SG you can select either standard chart reference values or you can read in values from data files (Imatest Master only). Values for the two ColorCheckers have been supplied courtesy of X-Rite. You can select between six image file color spaces: sRGB, Adobe RGB (1998), Wide Gamut RGB, ProPhoto RGB, Apple RGB, or ColorMatch. Danny Pascale/Babelcolor's page on the ColorChecker contains nearly everything you want to know about the chart. Ian Lyons has a nice description of IT8.7 charts.

calculates the color correction matrix (Imatest Master only). After has been pressed it changes to , highlighted with a pink background. The correction matrix cannot be recalculated until a property of the image (new image, color space, reference file, or color matrix setting) changes. The **Display input** (or **Corrected**) dropdown menu, immediately to its left, is enabled. More details on using the color correction matrix can be found here.

Display selection box and area

The selection box allows you to select one of the following displays.

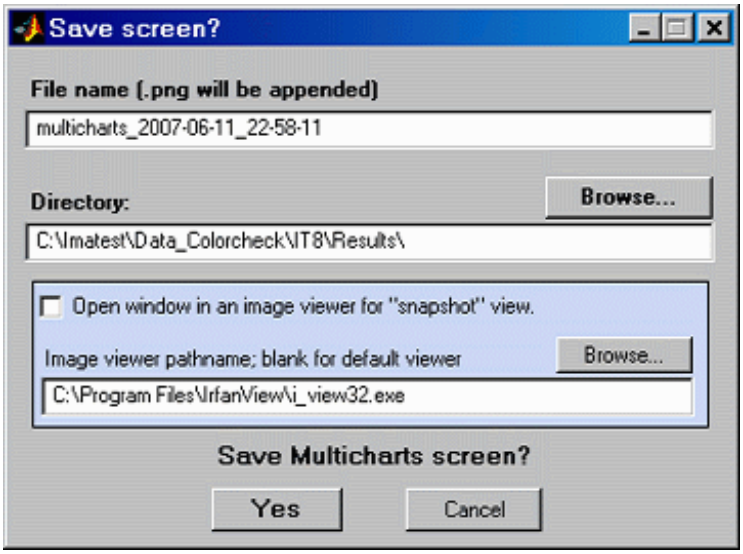


1. **Pseudocolor color difference.** Shows the difference between the ideal and input color patches using any of several metrics. The pseudocolor scale is shown adjacent to the image (below, right). Probe is available for this display.
2. **3D color difference.**
3. **Split colors: ideal/input.** Shows the patches split so

that the ideal and input values are displayed in the upper left and the lower right or each patch region, respectively. Probe is available for this display.

4. 2D a*b*
5. **xy chromaticity.**
6. **u'v' chromaticity.**
7. **Black & White density.**
8. **3D L*a*b*.** Shown on the right. L*a*b* coordinates can be difficult to visualize when viewed from a single angle. It needs to be rotated to be useful.
9. **EXIF data and Color matrix.** Shows EXIF data if available and the color correction matrix if it has been calculated.
10. Vectorscope preview.

The Display area, immediately below the Display selection box, contains display options. The contents, which depend on the display selection, are described below in the sections for the individual displays.



(shown on the right) saves a snapshot of the current display (the entire Multicharts screen) as a PNG file (a widely-used losslessly compressed format). It also allows you to immediately view the snapshot so it can be used a reference for comparing with other results.

File name and Directory at the top of the window set the location of the file to save.

When you check the Open window in an image viewer… box, the current screen will be opened either the system default viewer (if the box under Image viewer is blank) or a viewer/editor of your choice (if the box contains the path name to the viewer/editor). I recommend using Irfanview, which is fast, compact, free, and supports an amazing number of image file formats. Its normal location in English language installations is C:\Program Files\IrfanView\i_view32.exe.

Saves the key data in CSV and XML formats. This includes the input R, G, and B values, the input and reference L*, a*, b* values, and several of the color difference metrics.

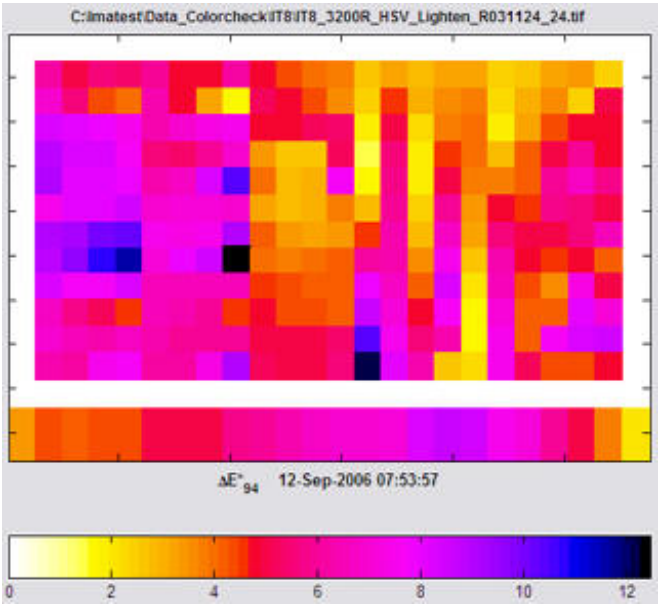
opens this web page in an HTML browser window.

terminates Imatest Multicharts, but the Imatest main window is still available.

Displays and options

1. Pseudocolor Color difference

Shows the difference between the ideal and input color patches using any of several metrics using a pseudocolor color map. If a color correction matrix has been calculated, the difference between the ideal and corrected patches are shown at the bottom. The pseudocolor scale is shown adjacent to the image.

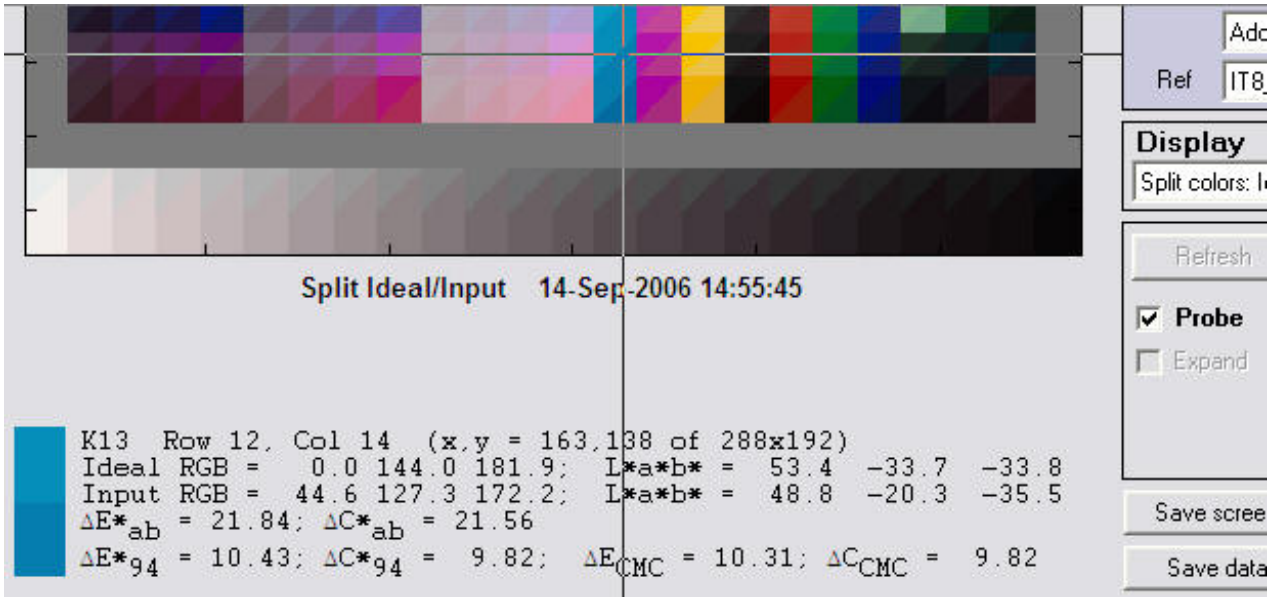


Pseudocolor display for IT8.7

(Checkbox; Pseudocolor and Split views) turns on the probe, illustrated below. When the probe is on, you can probe any patch by clicking on it. The probe data (for the individual patch), shown below the split display, includes an image of the ideal and input patch colors, ideal and input RGB and L*a*b* values, and several Δ*E** and Δ*C** color difference metrics. (Corrected colors are used if a color correction matrix has been calculated and **Display corrected** has been selected.)

ΔE^*_{ab}, the geometric distance in L*a*b* space, is the most familiar, but ΔE^*_{94}, which is lower for chroma differences in highly chromatic colors (with large $a^{*2} + b^{*2}$), is a better measure of visual color difference. ΔE^*_{00} is the latest and most accurate metric (based on an exceedingly complex designed-by-committee equation). More detail on color difference equations can be found here.

It's easy to correlate Δ*E** metrics with visual color differences using this display. None of the metrics are perfect! The probe is turned off by clicking outside either of the images.



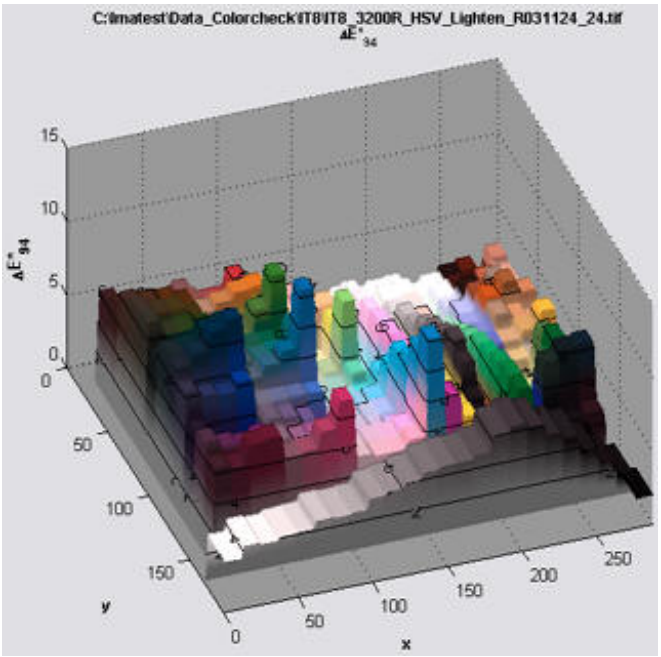
Split display for IT8.7 illustrating Probe

(Popup menu to the right of the Probe checkbox; also in 3D Color difference) Contains a list of color metrics (mostly difference metrics) including ΔE^*_{ab}, ΔC^*_{ab}, ΔE^*_{94}, ΔC^*_{94}, ΔE_{00}, ΔC_{00}, ΔL^*, ΔChroma, Δ|Hue distance| , Δ(Hue angle) , Chroma (input) and Chroma (output).

(Checkbox) inverts the color map. For the map shown (above, right), 0 would be black; maximum would be white.

(Popup menu) allows you to select the color map. The WYRMBK color map shown goes from White – Yellow – Red – Magenta – Blue – Black.

2. 3D Color difference



Uses the height of the patches to display the difference between the ideal and input colors. Any of several metrics can be chosen. Can be zoomed and rotated.

(Checkbox) Turns on light to highlight the shape of the plot. Default is On.

(Toggle button; short for Auto rotate) starts rotating the image. Rotation is quite slow; it may be less useful than the 3D L*a*b* plot (below). The image continues to rotate until the next time you press the button. It's best to turn off

rotation before switching to other views.

(Popup menu) Described above under Pseudocolor display.

(Slider) sets the background gray level.

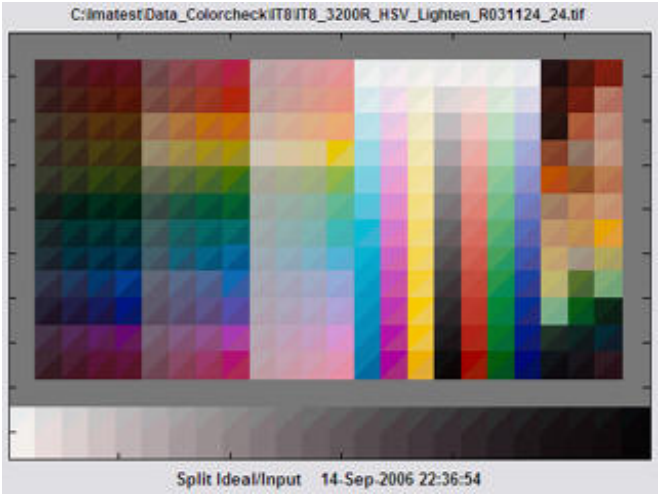
(Checkbox) inverts the up-down orientation of the 3D plot.

3D Color difference display for IT8.7

3. Split colors

Displays a synthesized chart image with each patch split so the ideal value is in the upper left and the input (measured) value is in the lower right. If a color correction matrix has been calculated, corrected colors are shown at the bottom.

(Checkbox) is the only option. Described above under Pseudocolor display.



Split Color display for IT8.7

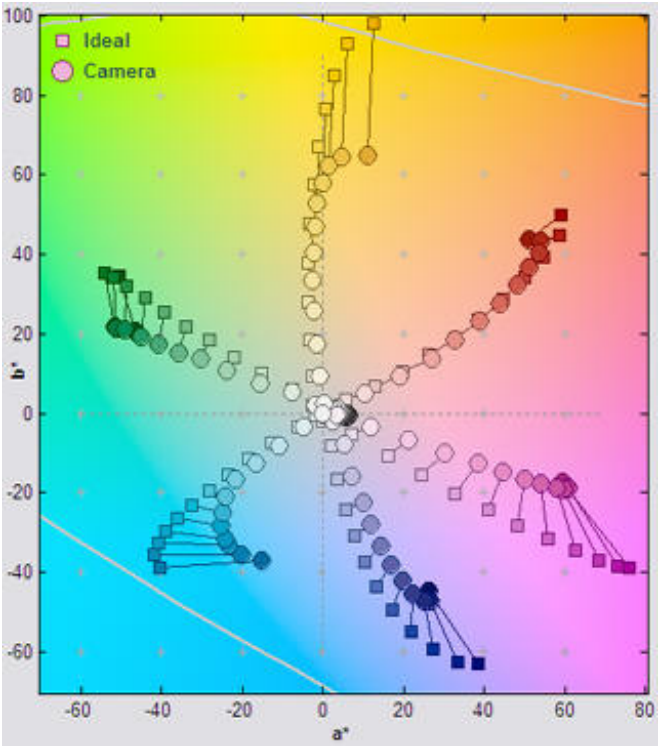
4. 2D a*b*

Displays patch values on the CIELAB a*b* plane. Ideal values are displayed as squares; Input values are displayed as circles.

(Checkbox; 2D a*b*, xy chromaticity, u'v' chromaticity, and 3D L*a*b*) Zoom in so the data fills the image.

(Popup menu in the lower right of the Display area; also in xy chromaticity, u'v' chromaticity, and 3D L*a*b*) selects the region of the chart to display. For the IT8.7 and ColorChecker SG charts only. Avoids clutter from the large number of patches in these charts.

- **For the IT8.7:** Selections are Columns 1-4 (dark), 5-8



(middle), 9-12 (light), 13-19 (CMYKRGB primaries), and 20-22 (miscellaneous; unique to each chart manufacturer). Columns 13-19 are the most interesting.

- **For the CMP DT 003:** Selections are Saturated & Misc. (a distribution of middle tones including the most saturated colors), Primary sequences (R, G, B,C, and Y for a range of lightnesses), and Pastels & skin tones.
- **For the ColorChecker SG:** Regions are less geometrically regular. Selections are 24-patch replica (middle), Pastels & skin tones, mid tones, and dark tones.

2D a*b* display for ITT8.7

5. xy and 6. u'v' Chromaticity

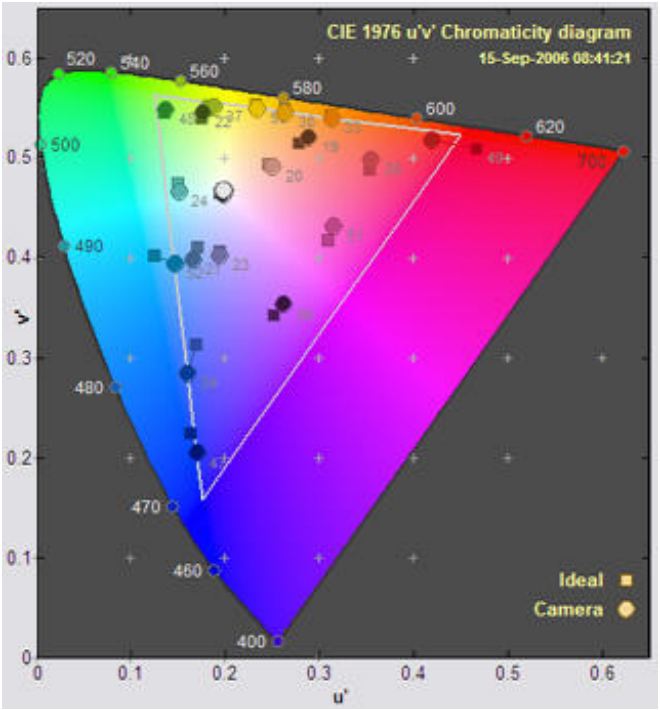
Displays the xy and u'v' Chromaticity diagrams, which separate the visible and invisible color values into colored and gray regions. Ideal values are displayed as squares; Input values are displayed as circles. The u'v' Chromaticity diagram, which is more perceptually uniform than the more familiar xy diagram (shown in the Tour) is illustrated on the right.

(Checkbox) Turns the wavelength display (400-700 microns) on the periphery of the locus of visible colors on or off.

(Popup menu to the right of Wavelth) selects between normal color (about as good a representation as is possible on a monitor) and lightened color (slightly easier to see the patch values).

(Checkbox) Zoom in so the data fills the image.

(Popup menu in the lower right of



u'v' display for ColorChecker SG

the Display area) Described above under 2D a*b* display.

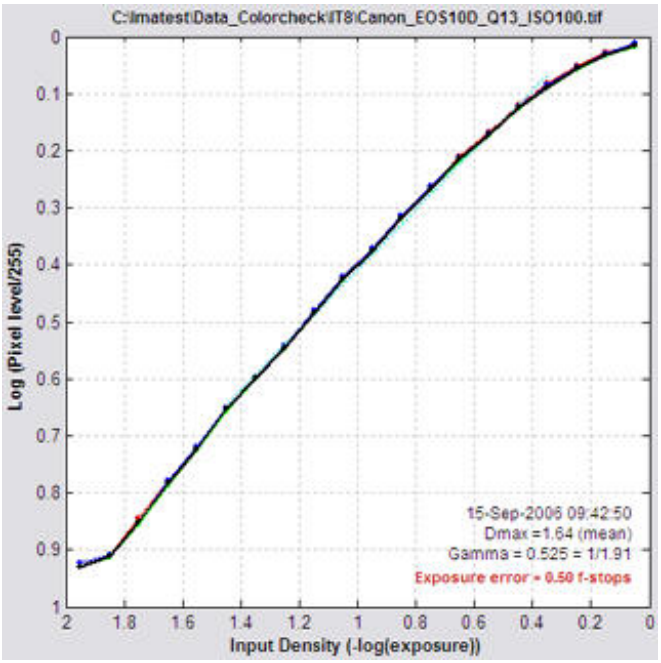
7. Black & White density

Shows the grayscale response curve. Available for all currently-supported color charts because all of them contain grayscale regions.

(Popup menu) allows you to select one of several B&W displays.

- **Log pixels vs. input density.** (shown on right) Gamma is the average slope for the lighter levels. The luminance (Y) channel is emphasized, but R, G, and B channels are also shown.
- **Output vs. input density.** The slope is ideally 1. Density is proportional to -Log_{10}(Luminance).
- **Output vs. input luminance.** Shown on a linear scale.
- **Output vs. input L* a* b* c*.** Uses CIELAB values instead of density or (linear) luminance. Includes color values: a* (green-red), b* (blue -yellow), and c* (chrominance: $(a^{*2} + b^{*2})^{1/2}$).

When the B&W density plot is displayed, you can enter the incident lux level into a box in the Display area on the lower right of the Multicharts window. If the value is a positive number (not blank or zero) ISO Sensitivity will be calculated and displayed on the plot.



Log pixels vs. input density for Q-13

8. 3D L*a*b*

Displays patch values in 3D CIELAB L*a*b* space with a wireframe representing the boundaries of the selected color space. Ideal values are displayed as squares; Input values are displayed as circles. Can be zoomed and rotated; you need to rotate it to be able to visualize patch locations.

(Popup menu) Turns wireframe on, off, or on with minimal (coarse) grid.

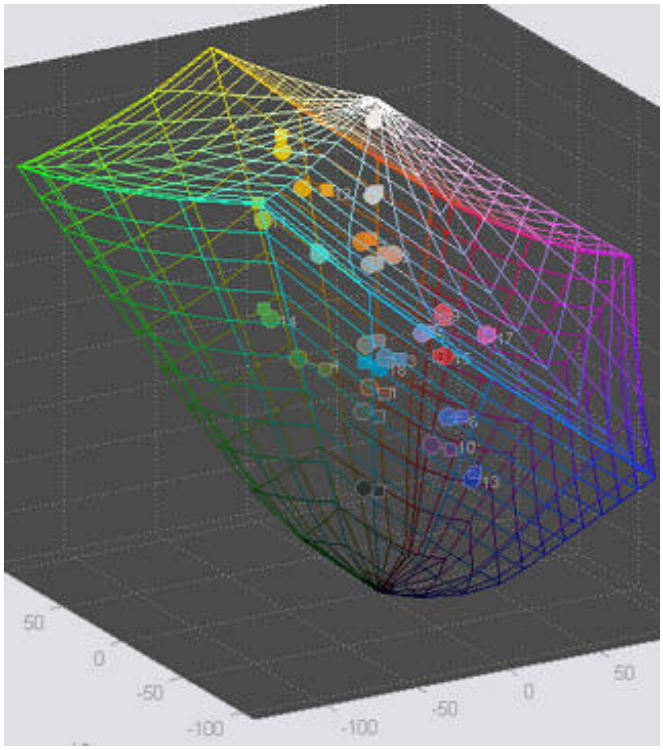
(Toggle button; short for Auto rotate) starts rotating the image. This provides a better visual indication of the color locations. The image continues to rotate until the next time you press the button. It's best to turn off rotation before switching to other views.

(Slider; default = 1) sets the wireframe transparency.Reducing transparency below 1 differentiates patches outside and inside the wireframe gamut boundary. Results are not reliable: patches near the boundary don't always appear as they should.

(Slider) sets the background gray level.

(Popup menu in the lower right of the Display area) Described above under 2D a*b* display.

(Checkbox) Zoom in so the data fills the image.

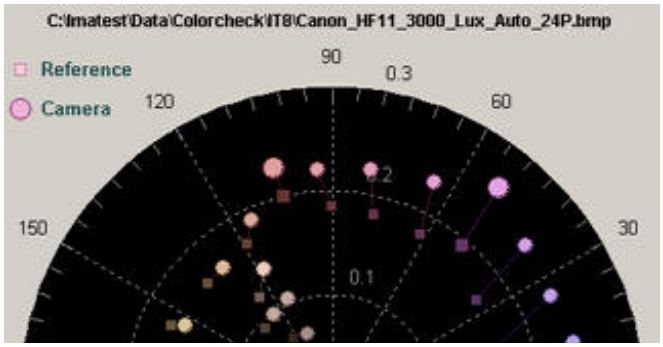


3D L*a*b* display for ColorChecker

10. Vectorscope preview (Master-only)

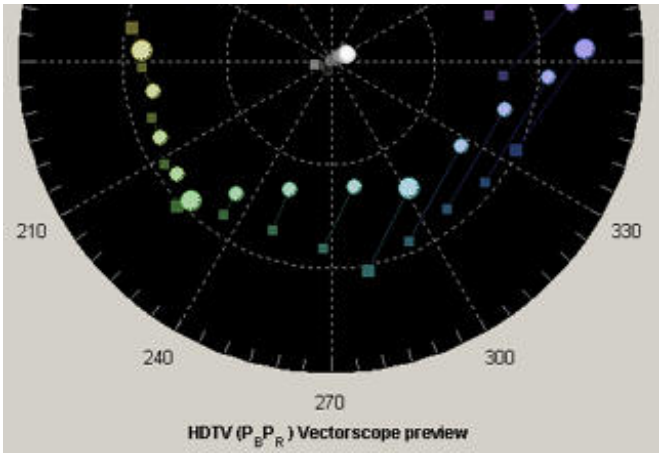
The vectorscope duplicates the display in hardware vectorscopes, used for adjusting and calibrating broadcast and cinema cameras. It is designed to work optimally with the DSC Labs ChromaDuMonde 28 chart. (Other DSC charts will be added as customer demand

Vectorscope preview



warrants.)

There are several display options, including background color, reference and input display color. Llight input colors (circles) and dark reference colors (squares) are shown on a dark background. HDTV, SDTV, and NTSC/PAL vectorscope patterns can be displayed. The recommended color space for these signals is sRGB. At the present time the vectorscope omits the standard target rectangles because the RGBCMY primaries in the CDM chart are different from the standard color bars.



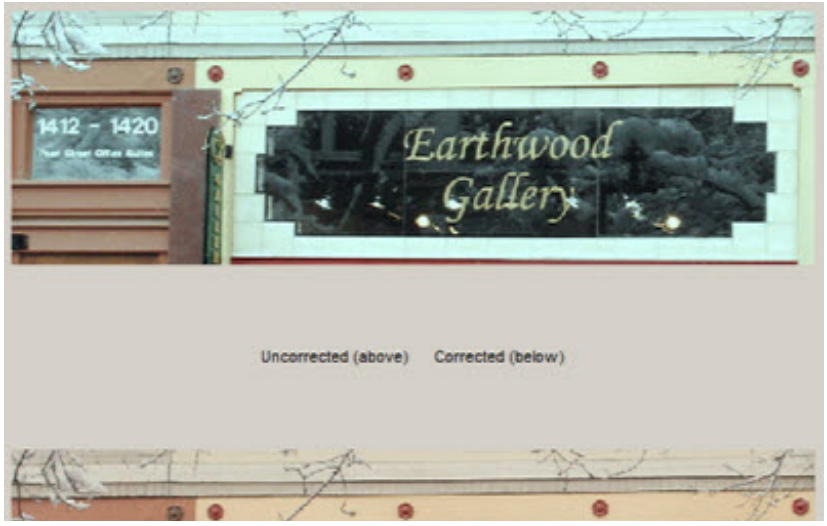
This image is a preview of a full-featured vectorscope function that will be included in an upcoming broadcast/cinema version of Imatest that continuously refreshes frames from a video stream using the button instead of reading individual images from files.

11. Noise analysis (for charts with large enough patches)

12. Display image

13. Read – color correct – Save image

Once a color correction matrix has been calculated, the matrix can be used to correct arbitrary images. To do so, select **11. Read – color correct – save image** in the **Display** box on the right of the Multicharts window. The initial display on the left side contains the message, **Press "Read image to correct", then press "Save corrected**



image" if it looks OK., the color correction matrix and statistics, and two buttons: and .

In the case shown on the right, a (digital) CC20C (cyan) filter was applied to both the Colorchecker and Gallery image. The correction matrix was calculated for the filtered Colorchecker, then the filtered Gallery image (shown uncorrected on the top) was read in. The corrected image is shown on the bottom.

Color correction on an arbitrary scene

You can find a nice introduction to Multicharts on the Multicharts Tour.

Back to Tour