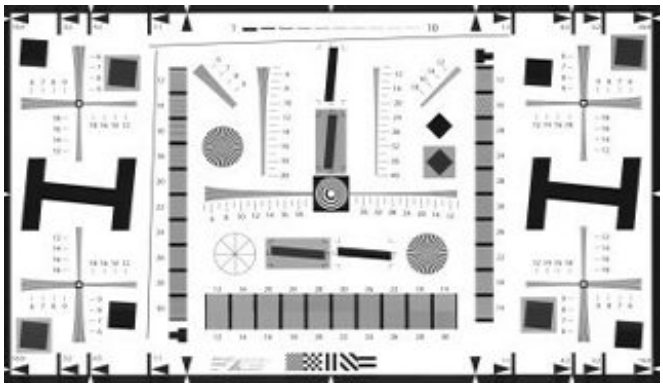
Imatest - Using Rescharts

Interactive Analysis of Resolution-Related Charts

Introduction

Imatest™ Rescharts is a highly-interactive interface for running several Imatest modules that can analyze images of several different test charts for resolution-related parameters such as sharpness (i.e., Spatial Frequency Response SFR, which is equivalent to Modulation Transfer Function MTF), color moiré, and fine detail lost to software noise reduction. Here is a list of the supported chart types:

Slanted-edge SFR



Slanted-edge SFR supports any chart that contains slanted-edges.

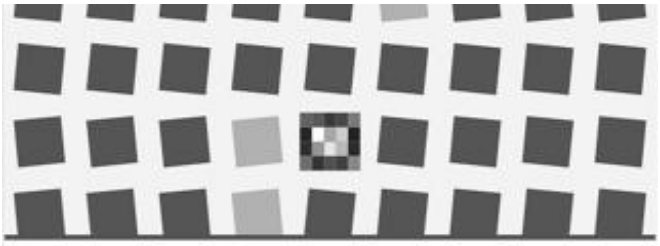
Slanted-edge SFR duplicates SFR, but with a highly interactive interface. It calculates and displays the average edge, SFR (Spatial Frequency Response or MTF), Lateral Chromatic Aberration, Subjective Quality Factor (or Acutance), noise (near the edges), and edge roughness.

Any chart that contains slanted edge patterns is supported, including the old and new ISO-12233 charts. Charts may be purchased from the Imatest Store or created with Test Charts and printed on a high quality inkjet (requires skill). If you are just getting started with MTF testing we recommend using the SFRplus chart (shown below), which has numerous advantages over other slanted-edge charts, especially the old high-contrast ISO-12233 chart.

SFRplus

SFRplus chart

Highly automated analysis of SFR (MTF), Lateral Chromatic Aberration, distortion, tonal response, and optional color response. Uses a special test chart, shown on the left. Unlike other Rescharts modules,



SFRplus does not require manual region (ROI) selection: it is performed automatically. Running SFRplus in Rescharts saves settings for fully automated runs.

Several types of SFRplus test chart are available in the Imatest Store. Media include on inkjet (large charts), photographic paper, photographic film, or chrome on glass. There are options for the grid pattern (5×7 or 5×9 squares), contrast, and wthe optional color pattern.

SFRplus instructions

Log Frequency (simple)

Log frequency chart

Analyzes a sine or bar pattern of increasing spatial frequency. Measures SFR more directly, but less precisely, than the slanted-edge method. Also measures color moiré (Imatest Master only), which is a function of lens sharpness, anti-aliasing filter, and demosaicing algorithm. Spatial frequencies are detected automatically. Charts can be created by Test Charts and printed on a high quality inkjet printer. Also works with the old test chart in Lens testing.

Log Frequency instructions

Log F-Contrast (not in Imatest Studio)

Log Frequency-Contrast chart

Log F-Contrast (Imatest Master only)

Analyzes a sine or bar pattern of increasing spatial frequency on the one axis and decreasing contrast on the other. Measures SFR for a range of contrast levels. Useful for measuring the loss of fine detail caused by software noise reduction— the effects of ***nonlinear (nonuniform) signal processing***. The chart can be purchased from the Imatest store or can be created by Test Charts and printed on a high quality inkjet printer.

Log F-Contrast instructions

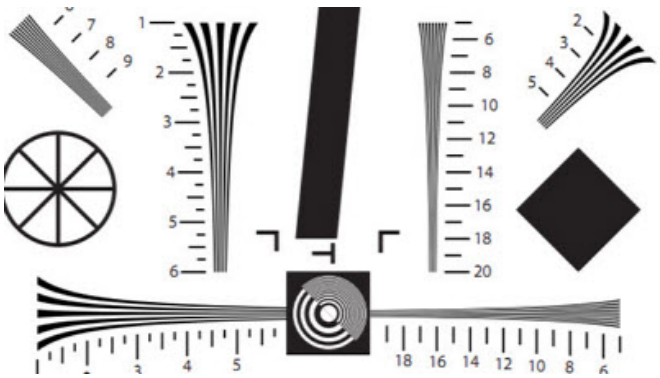
Star chart (not in Imatest Studio)

Analyzes a sinusoidally-modulated Siemens star chart (144, 72, or 48 cycles); proposed for the revised ISO 12233 standard. Measures MTF (SFR) for 8, 12, or 24 segments around the circle. Has a large variety of displays. The chart can be created by Test Charts and printed on a high quality inkjet printer.

Star Chart instructions

Siemens Star chart

Wedge (not in Imatest Studio)



ISO 12233 chart (crop showing wedges)

Analyzes hyperbolic or trapezoidal wedge patterns (converging bars with linear frequency or linear spacing) contained in the ISO 12233, EIA 1956, and other test charts, and included in the proposed revision to the ISO 12233 standard. Measures MTF (SFR) and the onset of aliasing (similar to the CIPA DC-003 standard).

Wedge instructions

Random (Scale-invariant) (not in Imatest Studio)

Scale-invariant random test chart

Random (Scale-invariant) (Imatest Master only)

Analyzes a random (scale-invariant) pattern, which has a 1/*f* fourier transform ($1/f^2$ Power Spectral Density (PSD)). Such a pattern has the same general appearance (the same statistics) regardless of distance. Since images of this pattern typically have little sharpening (due to the lack of contrasty edges) but relatively large amounts of noise reduction, it is an excellent indicator of a camera's ability to render fine low-contrast detail. (Slanted-edges, by comparison, tend to be more sharpened and have less noise reduction, and hence may not give an accurate indication of a camera's response to fine low-contrast detail.) Noise power measured in the smooth regions on the left, is subtracted from the PSD of the random pattern. Two low contrast slanted-edges are used to used to verify the random pattern results. This module also supports the "Dead Leaves" test pattern.

Random (Scale-invariant) instructions

Any scene sharpness (not in Imatest Studio)

Image used for Any scene sharpness

Measures sharpness of any scene. The sharpness metric is nonstandard and applies to the individual scene only (it cannot be used for comparisons with other scenes). (It's the same metric used in Find sharp files.) Useful for optimizing focus during reloads in the Image Sensor edition, which analyzes frames from live (video) feeds. Displays the image and a history showing changes in sharpness as the device is focused.

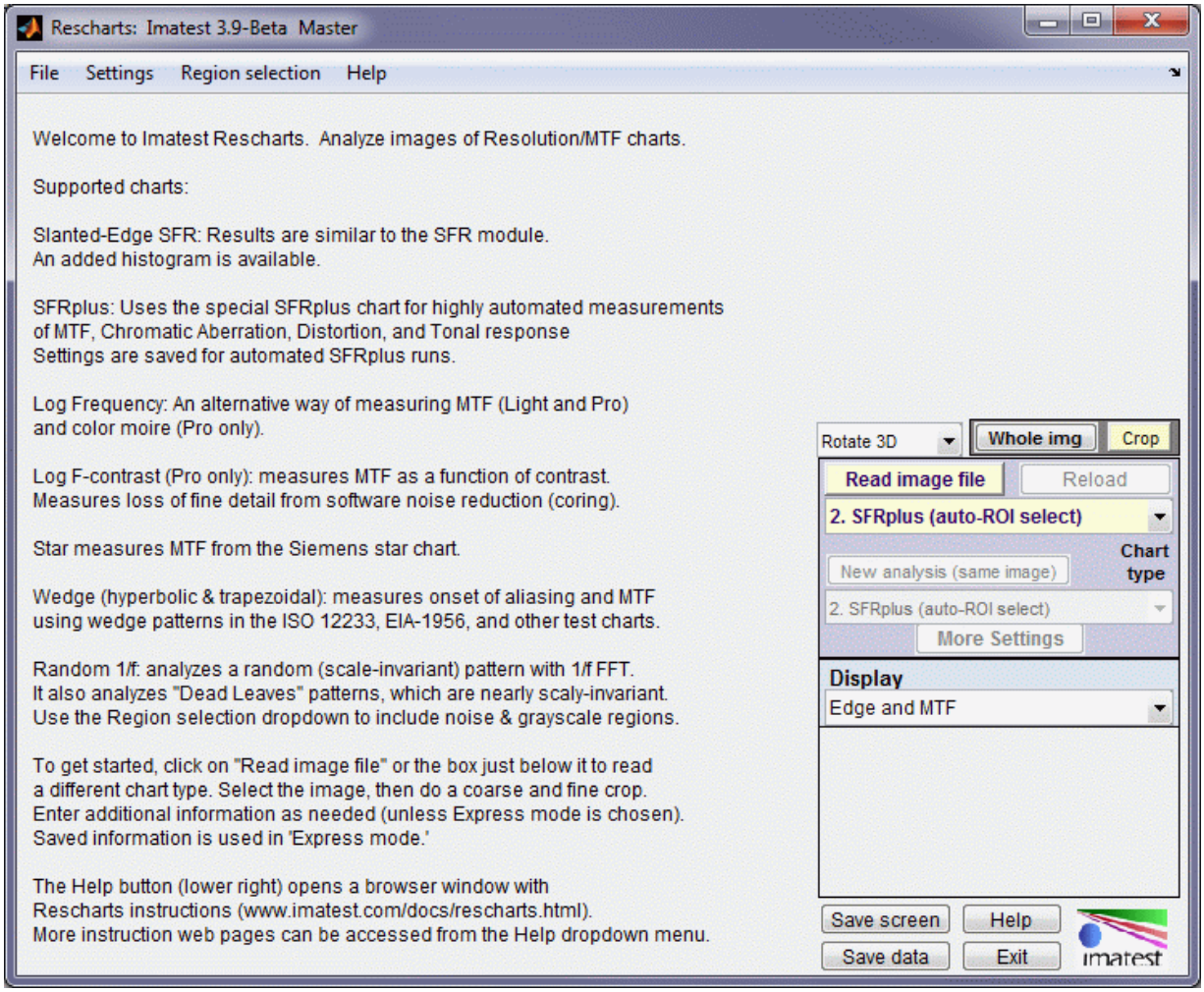
Any scene sharpness instructions

Getting started

Most of the charts described on this page can be purchased from the Imatest store, and many can printed from files created in Test Charts (good equipment and skill required).

Photograph or scan the chart, taking care to avoid glare, which can be problematic in charts with semigloss and glossy surfaces. Glare can be especially difficult to control with wide angle lenses (matte charts are recommended for SFRplus). A recommended lighting setup is described here and in Building a low-cost testing lab.

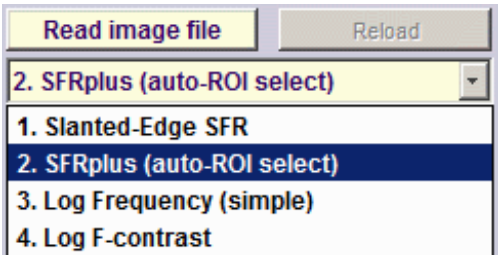
To start Rescharts, run Imatest, then click the button. The Rescharts window will appear with brief instructions, which may be more up-to-date than the ones shown below.



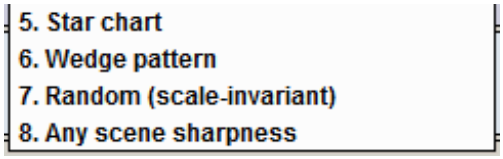
Rescharts opening window, with brief instructions

Select an image to analyze by

- clicking on if the correct **Chart type** is displayed, or by
- clicking on one of the entries in the **Chart type** dropdown menu.



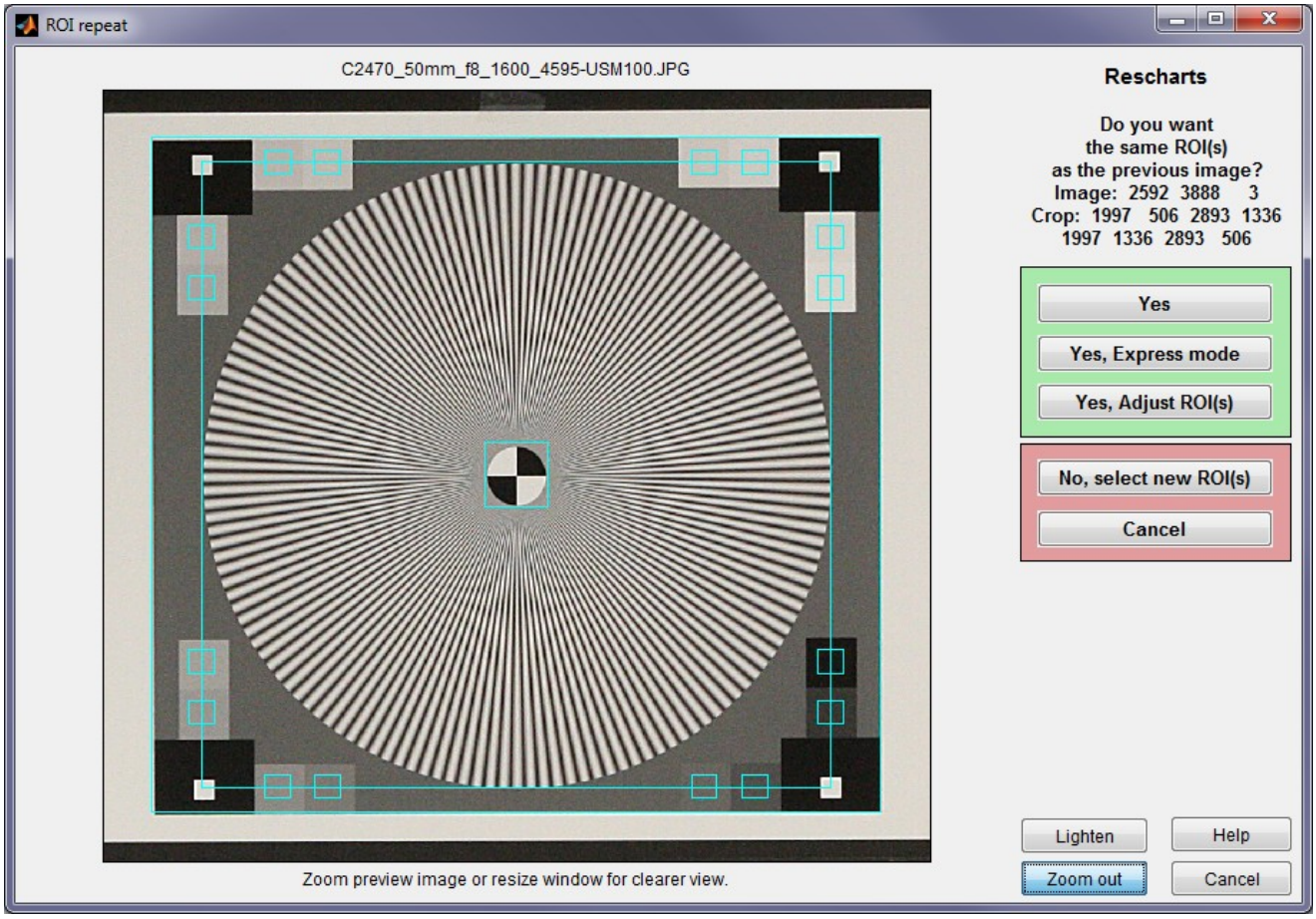
The button and **Chart type** popup menu are highlighted (yellow background) when Rescharts starts.



A standard Windows dialog appears with the chart type indicated in the title. Open the image file. Multiple files can be opened for averaging (but batch (sequential) runs are not supported by Rescharts).

If the folder contains meaningless camera-generated file names such as IMG_3734.jpg, IMG_3735.jpg, etc., you can change them to meaningful names that include focal length, aperture, etc., with the View/Rename Files utility, which takes advantage of EXIF data stored in each file.

For modules other than SFRplus, if the image is the same pixel size as an image previously analyzed by Rescharts (up to 20 saved), you'll be asked if you want to use the same ROI (region of interest). (ROI selection is entirely automatic with SFRplus.)



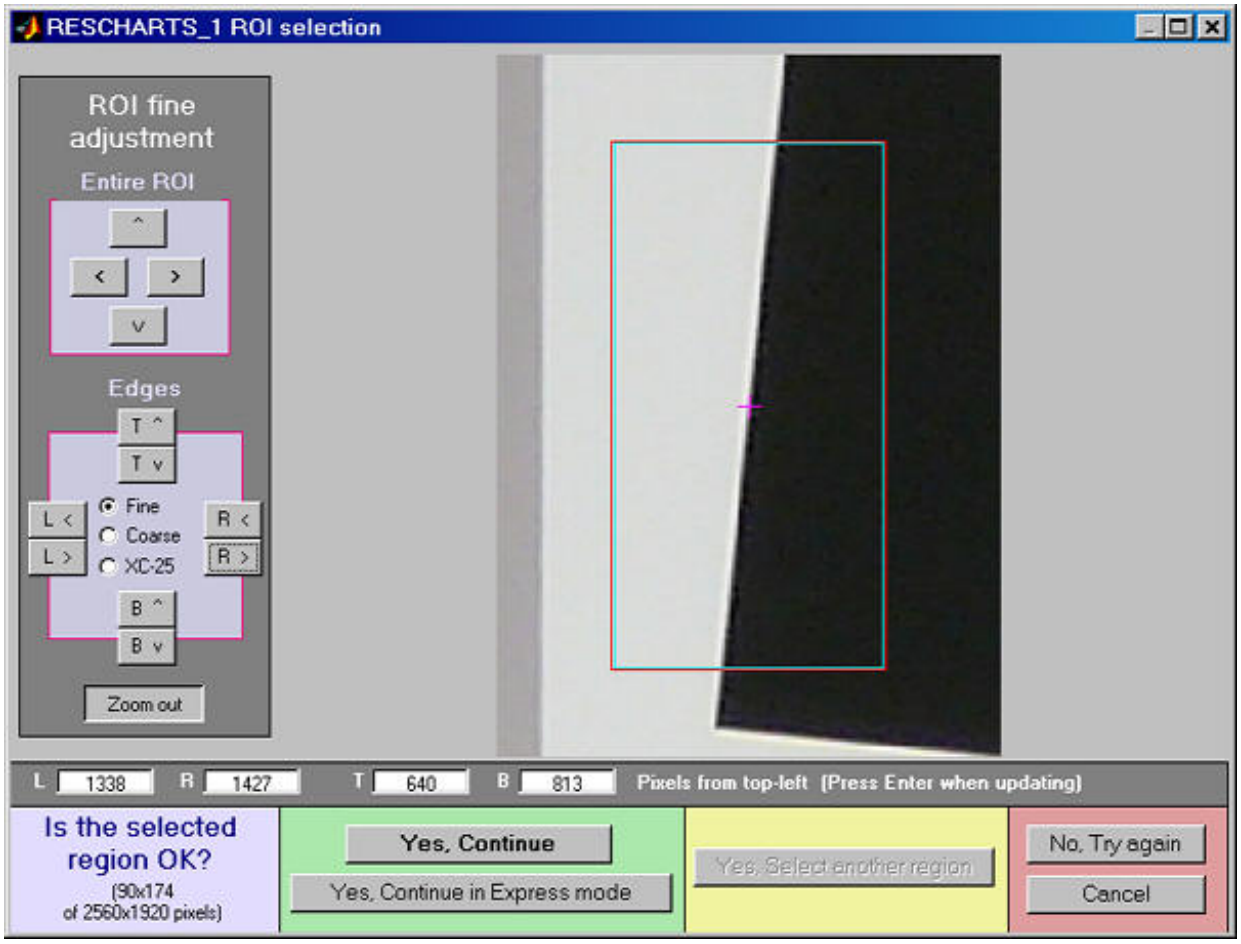
ROI repeat dialog box, shown zoomed in

If the image size or type is different 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.

- For **Slanted-Edge SFR**, select the region you want. Recommended cropping.

- For **Log Frequency (simple)**, select a narrow strip running from along the direction of increasing spatial frequency. Narrow strips of the Log Frequency-Contrast chart can be used.
- For **Log F-Contrast**, select most of the chart image excluding the bar patterns at the top and bottom, leaving small margins (1/2 to 1% of the image dimensions) at the edges.
- See the individual instruction pages for Star chart, Wedge, and Random (scale-invariant).

After the rough crop has been selected, the fine adjustment box appears, showing the coarse crop as a rectangle. This dialog box can be enlarged or maximized to facilitate the adjustment. It offers numerous options.



ROI fine adjustment dialog box for SFR. A more complex box may appear for other modules.

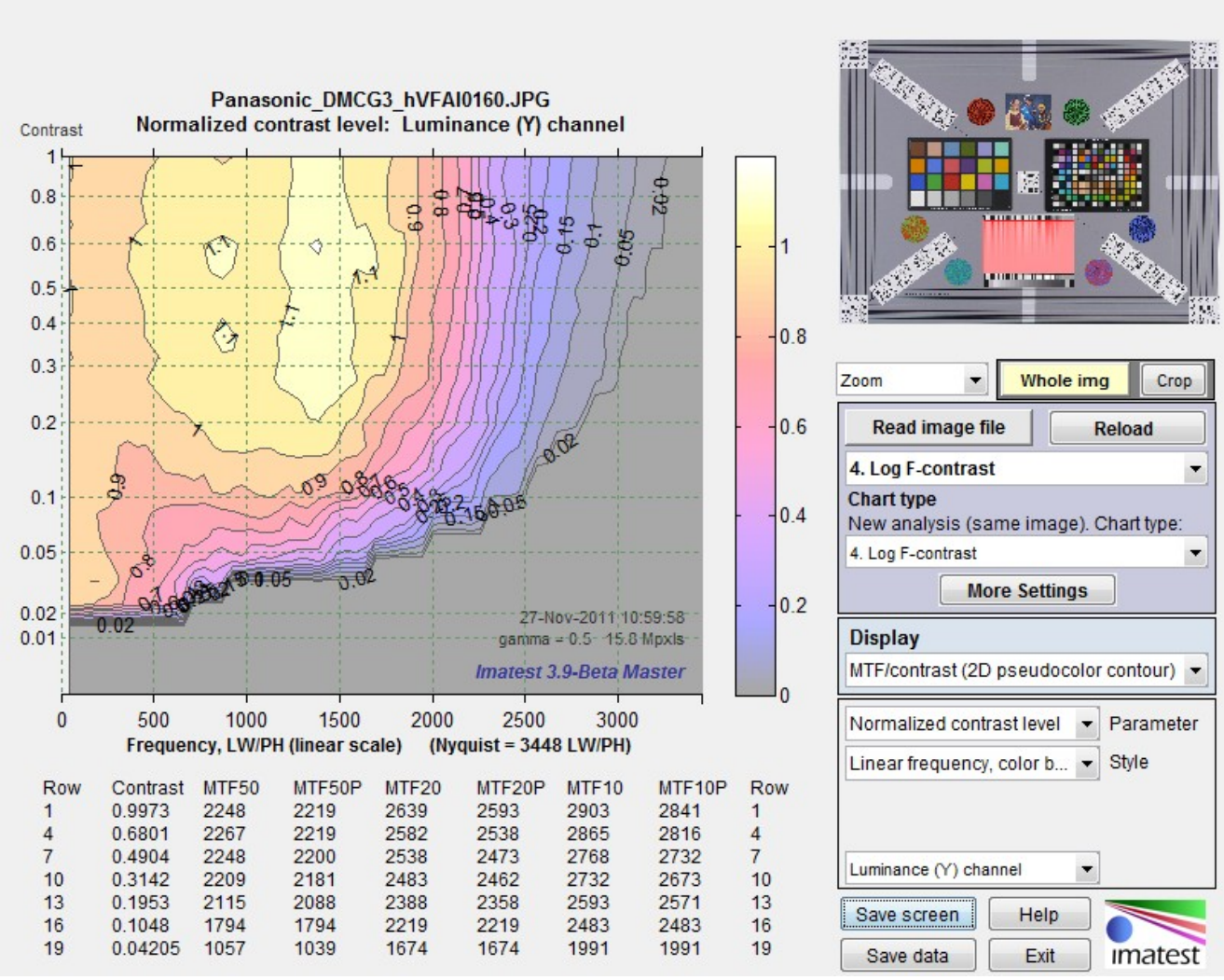
- The entire ROI can be moved (, upper-left).
- The top, bottom, left, or right sides can be moved (, middle-left).
- You can choose between Fine, Coarse, and Extra Coarse movement (1, 5, or 25 pixels of movement per click).
- The display can be zoomed out or in.
- Pixel values for the four corners can 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 Enter key after entering a value.

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 will appear. The entries in this dialog box can be changed later by clicking on in the Rescharts window. If you click , it will go directly to the Rescharts window, using saved values.

The Rescharts window

After the image file has been entered, calculations are performed and the most recent Chart view is displayed. The normalized **MTF/contrast (2D pseudocolor contour)** display for Log F-Contrast is shown below.



Row	Contrast	MTF50	MTF50P	MTF20	MTF20P	MTF10	MTF10P	Row
1	0.9973	2248	2219	2639	2593	2903	2841	1
4	0.6801	2267	2219	2582	2538	2865	2816	4
7	0.4904	2248	2200	2538	2473	2768	2732	7
10	0.3142	2209	2181	2483	2462	2732	2673	10
13	0.1953	2115	2088	2388	2358	2593	2571	13
16	0.1048	1794	1794	2219	2219	2483	2483	16
19	0.04205	1057	1039	1674	1674	1991	1991	19

MTF contours for the Panasonic G3 compact system camera, showing how contrast affects MTF.
Downloaded from Imaging-Resource.com (a great resource:
Find the camera review, click on Samples, then scroll down to Multi-target.)

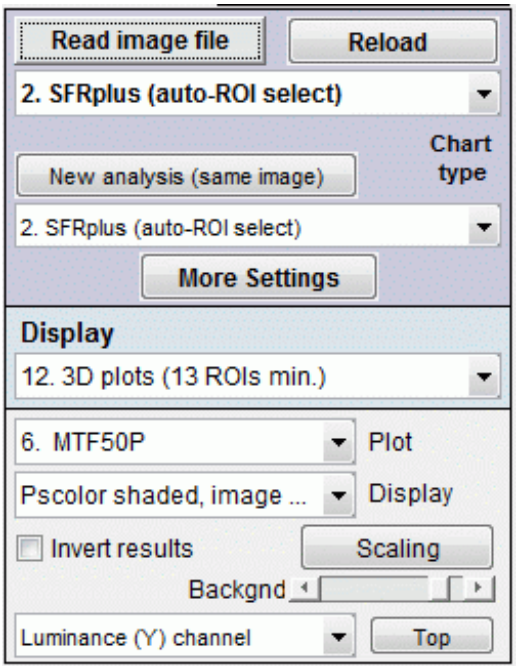
The main display image is on the upper left. Additional text results may appear below this image. An

image of the chart is shown on the upper right. You can choose to display the whole image or the crop (ROI). The remainder of the right side is the control area.

The **Zoom** dropdown menu (below the thumbnail on the upper-right) lets you choose between **Zoom** (double-click on the image to restore the original magnification), **Rotate 3D**, and **Data cursor** (a useful function that lets you examine numerical values at the point of interest).

The buttons to the right of **Zoom** set the display to either the or a of the image (the selected ROI).

Image and Display areas



Display options

The image area on the right of the Rescharts window, just below the and buttons, includes the the and buttons, the **Chart type** dropdown menu (described above), and additional controls.

reloads an image from a file or reacquires it from a device or video stream (depending on how the image was originally acquired). It useful with the Imatest Image Sensor edition.

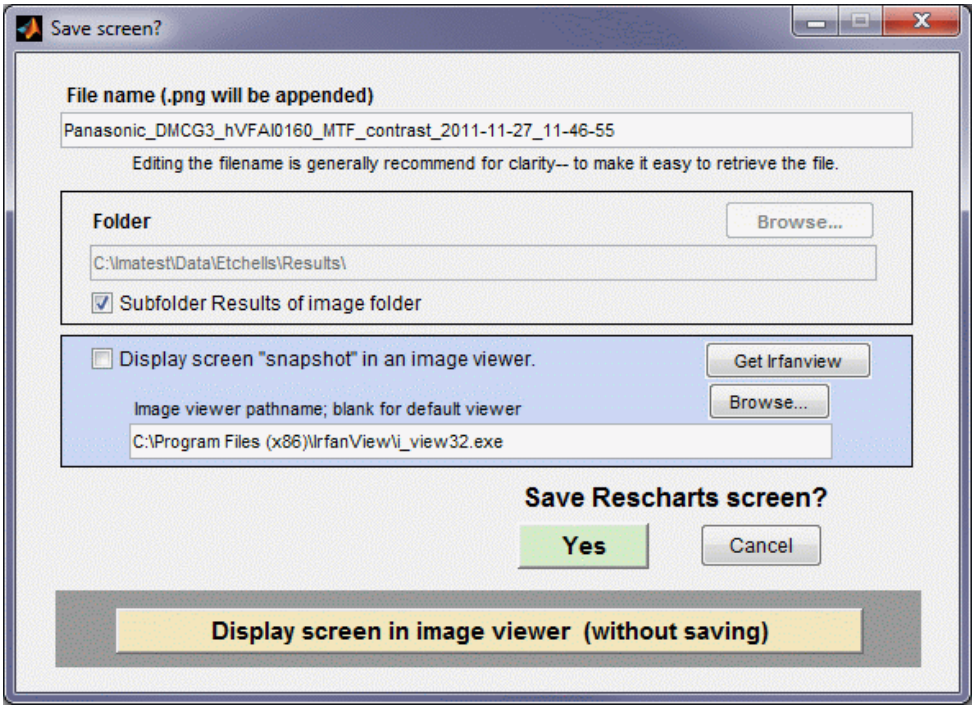
Immediately below the **Chart type** menu is the **New analysis (same image)** button and menu. When the button is pushed or an item is selected on this menu, the image is recropped for analysis by the selected chart type (which may be the same or different). This menu is useful when several regions of an image need to be analyzed or when the target contains more than one chart type.

brings up the input dialog box for the selected chart type. This is the same box that appears when you press (*not* Express mode) in the ROI repeat or ROI selection window.

Display, immediately below the image area, selects the results to display. Choices depend on the chart type.

The Display options area is immediately below **Display**. 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 Rescharts screen) as a PNG file (a widely-used losslessly-compressed format). It also allows you to immediately view the snapshot (if the **Open window…** box is checked) 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). We recommend Irfanview, which is fast, compact, free, and supports an amazing number of image file formats. (It can be valuable for converting nonstandard images to Imatest-readable formats.) Its normal location in English language installations is **C:\Program Files\IrfanView\i_view32.exe**. FastStone viewer is also an excellent choice.

Saves detailed results in CSV, XML, and/or JSON formats. The exact content depends on the module.

opens this web page in an HTML browser window.

terminates Imatest Rescharts and returns to the Imatest main window.

Rescharts modules

This section describes the Rescharts modules, illustrating some of the available displays and options. More information is available in the pages for the individual modules (Chart type analyses).

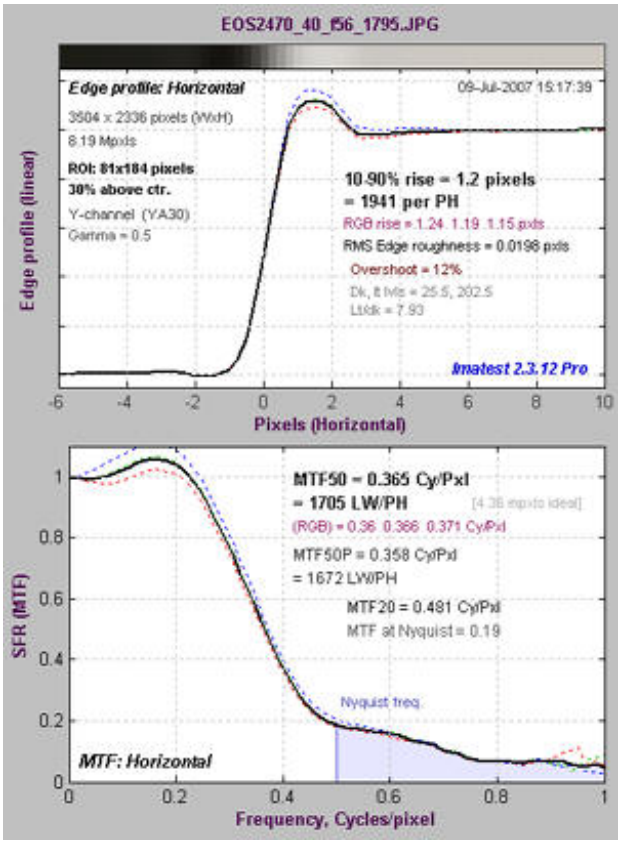
Slanted-edge SFR

Slanted-edge SFR measures sharpness as

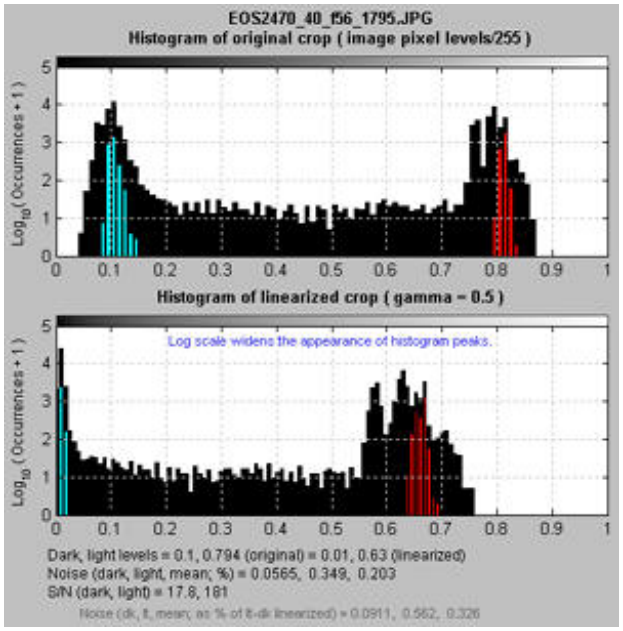
Spatial Frequency Response, also called MTF (Modulation Transfer Function) from images of slanted edges. ROI (Region of Interest) selection, calculations, and output largely duplicate SFR. Available displays

- Edge and MTF (shown on the right). The edge can be displayed linearized or not and normalized or not. LSF (the Line Spread Function) can be displayed in place of the edge.
- Chromatic Aberration (right, below)
- SQF (Subjective Quality Factor)
- Noise spectrum & Shannon capacity
- Histograms & noise stats (left, below)
- Summary & EXIF (for JPEGs)

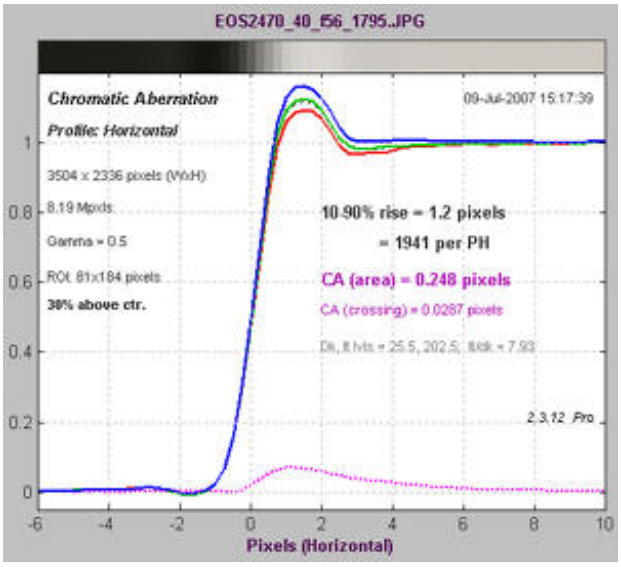
The principal differences from SFR are the highly interactive interface and the limitation that only one ROI can be displayed. In the histogram of ROI levels, shown below, **Black** is the entire ROI. **Cyan** is the portion on the left and **red** is the portion on the right, both away from the edge. The upper histogram is for the original image (pixel levels/255); the lower histogram is for the linearized image (gamma applied).



SFR Edge and MTF display



SFR Histogram



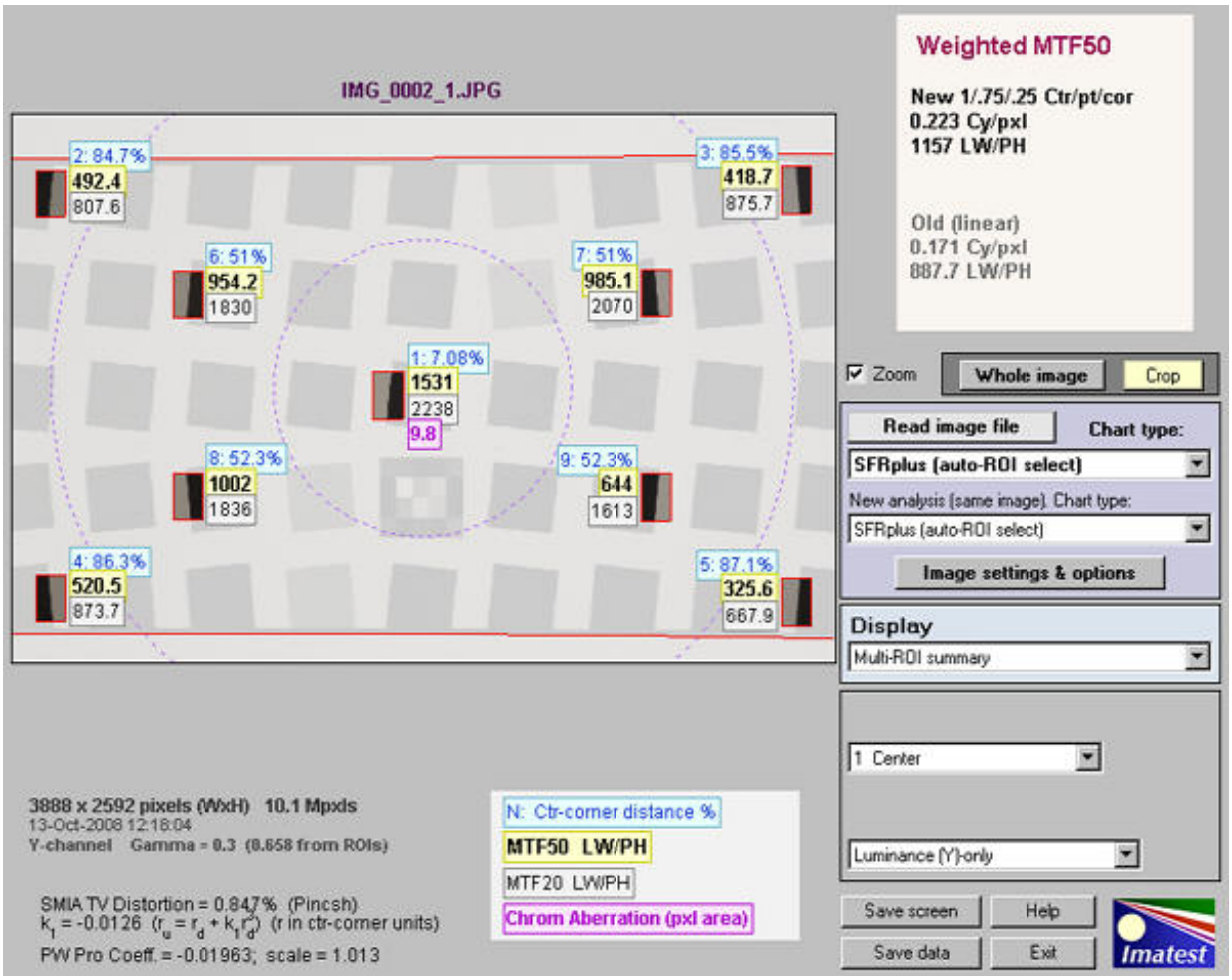
SFR Lateral Chromatic Aberration

SFRplus

SFRplus performs a highly automated analysis of SFR (MTF), lateral chromatic aberration, distortion, tonal response, and (optionally) color, using tha SFRplus test chart, which is available in several options. Unlike other Rescharts modules, SFRplus does not require manual region (ROI) selection: it is performed automatically, based on user settings. Running SFRplus in Rescharts saves settings for fully automated runs, which are invoked by pressing in the Imatest main window..

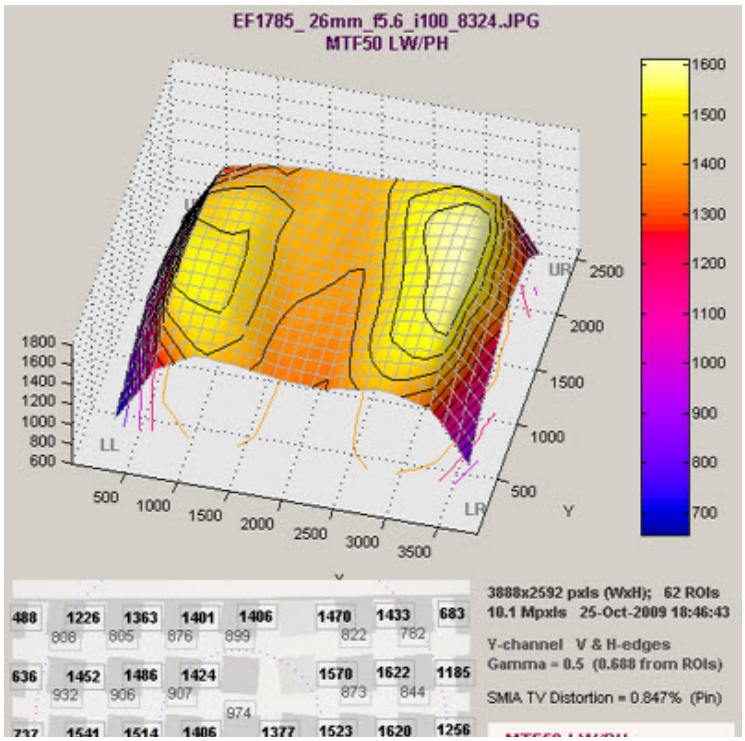
Available displays: Full instructions

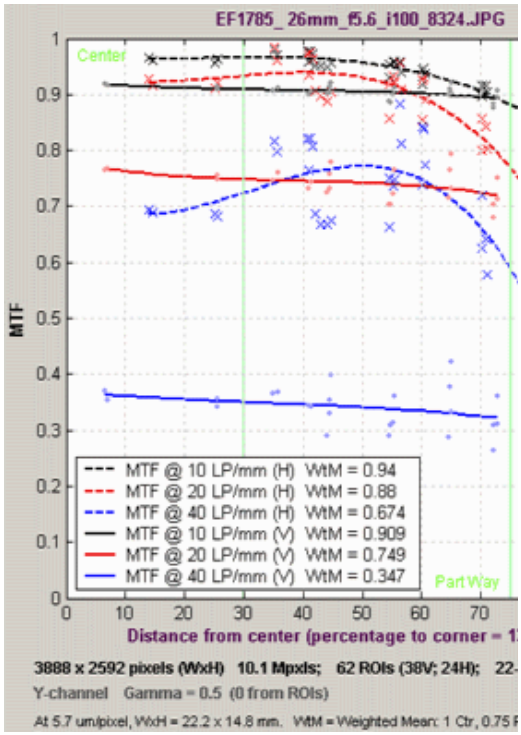
- Edge and MTF
- Chromatic Aberration
- SQF
- Noise spectrum & Shannon capacity
- Multi-ROI summary
- Tonal response & gamma
- Histograms and noise stats
- Summary & EXIF (for JPEGs)
- many more…

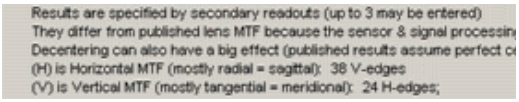


SFRplus multi-region summary display for 9 automatically-selected regions

3D plot of MTF50 (many results available)







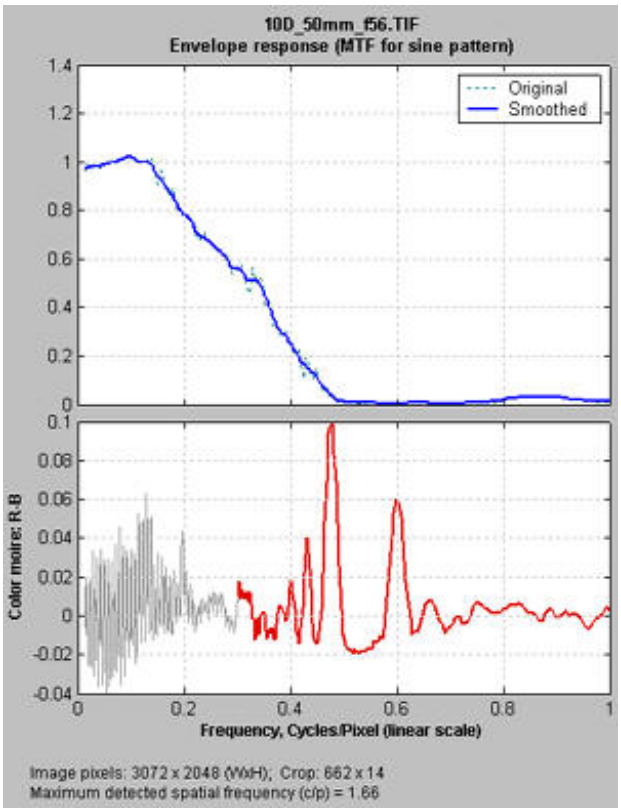
Lens-style MTF plot: Similar to plots on the Canon, Nikon, and Zeiss website

Log Frequency (simple)

Log frequency image: right-click to download an image that can be used for testing.

Log Frequency measures image contrast of sinusoidal charts that increase in spatial frequency on a logarithmic scale (log frequency increases with *x*). For a sinusoidal image pattern (not a bar pattern) the contrast is equivalent to SFR or MTF. This method is more direct than Slanted-edge SFR, but less accurate because it is degraded by noise and sampling phase variation— and it requires a lot more real estate. It also measures color moiré (Imatest Master only). The chart can be created by Test Charts and printed on a high quality inkjet. Also works with narrow strips of the Log Frequency-Contrast chart.

Log Frequency MTF and moire display
(linear x-axis frequency scale)

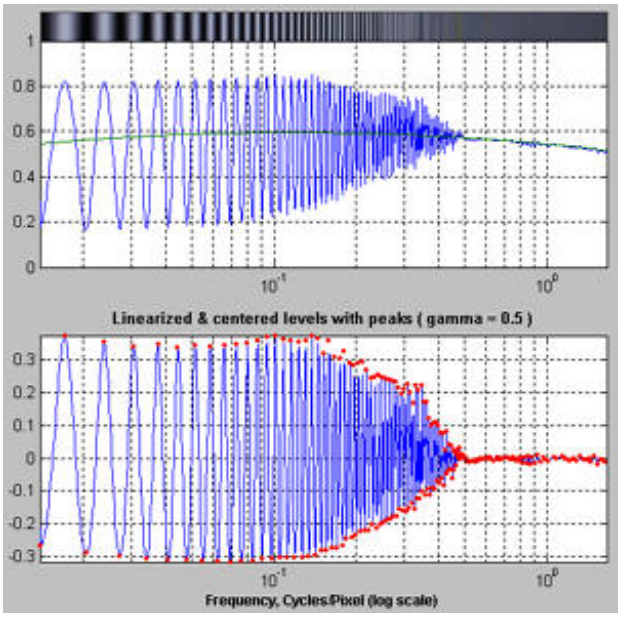


> ***Available displays:*** *Full instructions*

- The Pattern (original pixel levels and linearized)
- MTF and Moire (linear frequency scale)
- MTF and Moire (log frequency scale)
- EXIF data

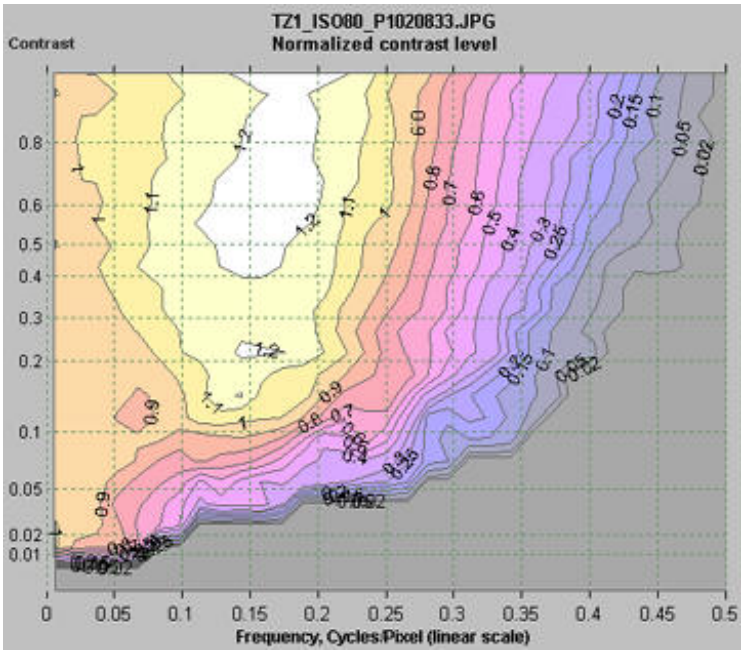
The display on the right shows Contrast (MTF) on the top and color moire on the bottom as a function of spatial frequency (displayed linearly). Color moire can me measured in several ways: R-B (normalized **Red** − **Blue** channel) is shown on the right. The total color moire is the spread of values above 0.3 cycles/pixels (indicated by the **red** curve). Details of the color moire measurement can be found in Log Frequency. The **Correct for color density** box should be checked for best results.

Pattern (original pixel levels and linearized)



Log F-Contrast

[Log F-Contrast](#) (short for ***Log Frequency-Contrast***) measures the image contrast of charts that vary in spatial frequency on one axis (log frequency increases with *x*) and in contrast on the other (contrast is proportional to (*y*/*h*)^2 for image height *h*). When the image pattern is sinusoidal (rather than a bar pattern) the contrast is equivalent to SFR or MTF. This module can be used to measure how much fine, low-contrast detail is lost to software noise reduction. The chart can be created by [Test Charts](#) and printed on a high quality inkjet printer.



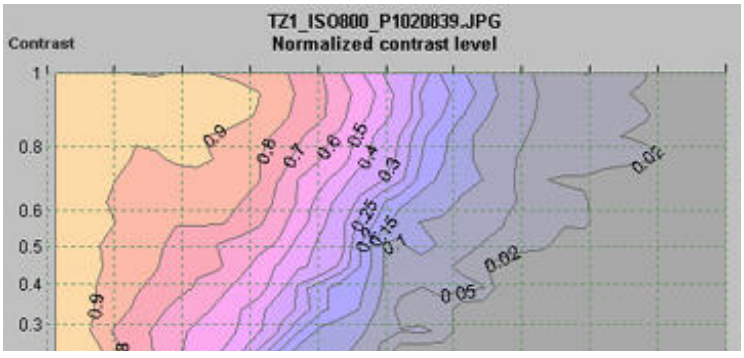
Normalized contrast level (MTF)
(1 at low frequencies for all chart contrasts):
Panasonic TZ1, ISO 80

> ***Available displays:*** *Full instructions*

The Pattern (original pixel levels and linearized)

MTF (linear frequency scale)

MTF (log frequency scale)



2D pseudocolor contour plots that can display any of several MTF-related parameters:

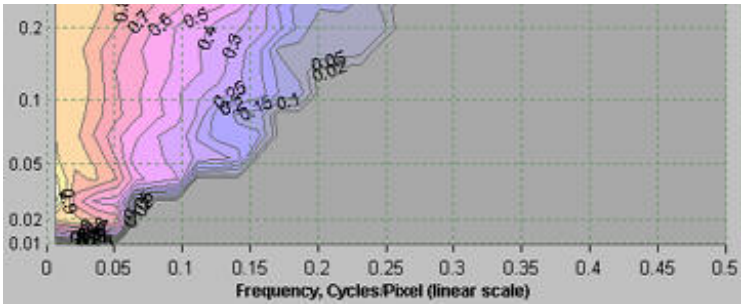
MTF (envelope – standard) (standard MTF, normalized to 1 at maximum contrast and zero spatial frequency)

Normalized contrast level (MTF normalized to 1 at zero spatial frequency for all contrast levels)

Normalized contrast loss (MTF normalized to 1 at zero spatial frequency for all contrast levels as well as all spatial frequencies at the maximum contrast level: shows contrast loss from ideal)

MTF*nn* or MTF*nn*P (spatial frequencies where MTF = *nn*% of the low frequency or peak value

EXIF data



Normalized contrast level: TZ1, ISO 800

The displays on the right show the Normalized contrast level (MTF normalized to 1 at low spatial frequencies for all chart contrast levels) for the Panasonic TZ1 camera with ISO speed set at 80 (top) and 800 (bottom). Spatial frequency is on a linear scale with a maximum displayed frequency of 0.5 cycles/pixel. The difference between the two images is quite striking. The TZ1 has much more noise reduction — and correspondingly less detail— at ISO 800. These plots are explained in detail in Log F-contrast.

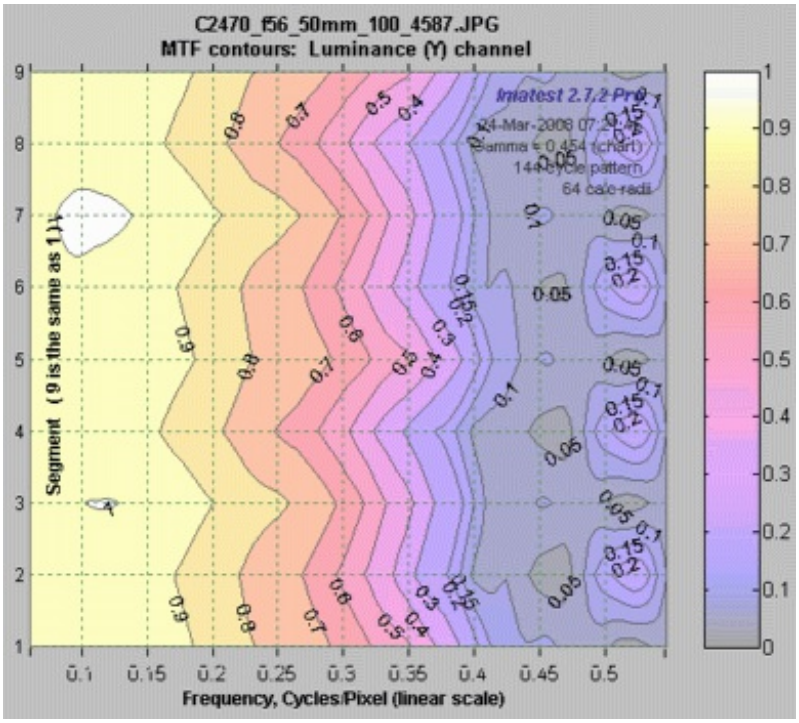
Star chart

Star Chart measures contrast

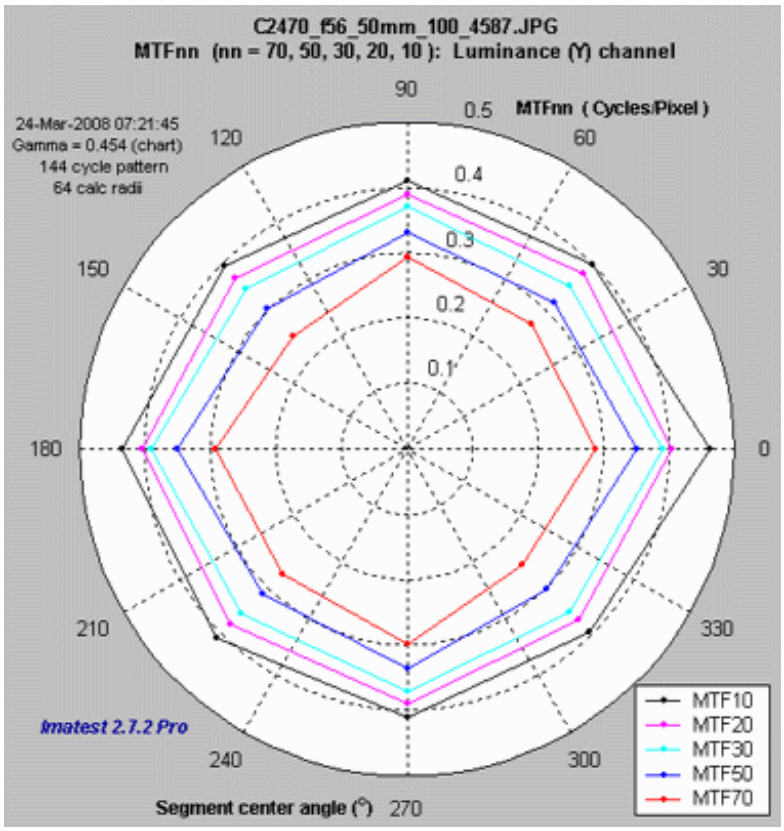
(MTF or SFR) of sinusoidally-modulated star charts (also known as the Siemens star) proposed for inclusion in the updated ISO 12233 standard. Charts have 144, 72, or 48 cycles and can be analyzed in 8, 12, or 24 segments. Star charts can be created by Test Charts and printed on a high quality inkjet printer.

> ***Available displays:*** *Full instructions*

Display	Description
MTF (original and linearized)	MTF for up to 8 segments of the star. Both linear and logarithmic frequency displays are available.
MTFnn or MTFnnP	Display MTFnn (the frequencies where MTF equals nn % of the low frequency values) and MTFnnP (the frequencies where MTF equals nn % of the peak value) for nn = 70, 50, 30, 20,



MTF contours, rectangular display, Linear frequency scale.



MTF70 – MTF10: Polar coordinates, Linear frequency on radius.

	and 10. Both polar (spider) and rectangular plots are available.
MTF contours (rectangular)	Display MTF contours in a rectangular plot with linear or logarithmic frequency display. Similar to the MTFnn rectangular plot.
MTF contours (polar)	Display MTF contours in a polar plot whose geometry duplicates that of the target.
EXIF data	Show EXIF data if available.

The displays on the right show MTF contours and MTF70 through MTF10 (spatial frequencies where MTF = 70 through 10% of the low frequency level). Spatial frequency is displayed in cycles per pixel, but Line Widths per Picture Height (LW/PH), cycles/inch, or cycles/mm can be selected by pressing Image settings & options.

Wedge

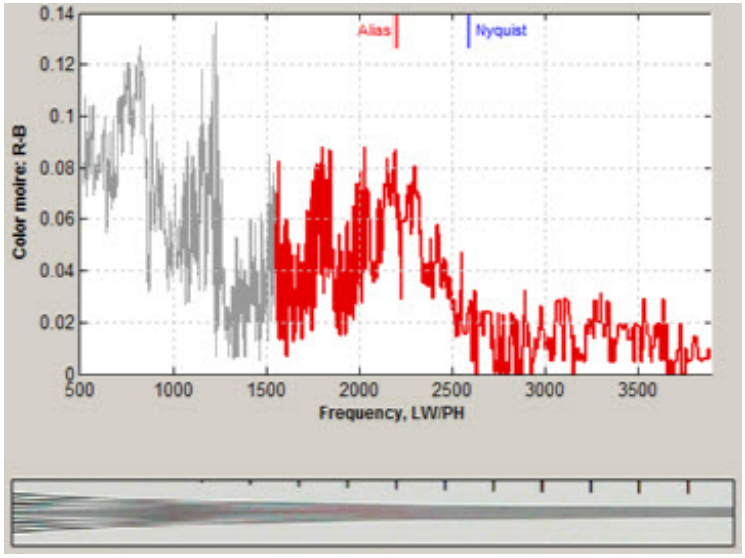
Wedge (Imatest Master-only) measures the MTF (Modulation Transfer Function) and the onset aliasing (related to the vanishing resoultion) from converging bar patterns, called “wedges”, which are a part of many popular resolution test charts. “Hyerbolic” (linear in frequency) wedge patterns are central to the CIPA DC-003 standard for digital camera resolution measurement, which will be incorporated in a revision of the ISO 12233 resolution measurement standard.

Wedge can analyze vertical and horizontal (but not diagonal) wedges. To the best of our knowledge, Imatest Wedge is the only software that can calculate MTF from wedge patterns, but there is a significant limitation with the calculation: the results at the Nyquist frequency (and also 2/3 Nyquist) are highly sensitive tothe phase of the bars relative to the pixels, i.e., the sub-pixel positioning, which is difficult to control in practice.

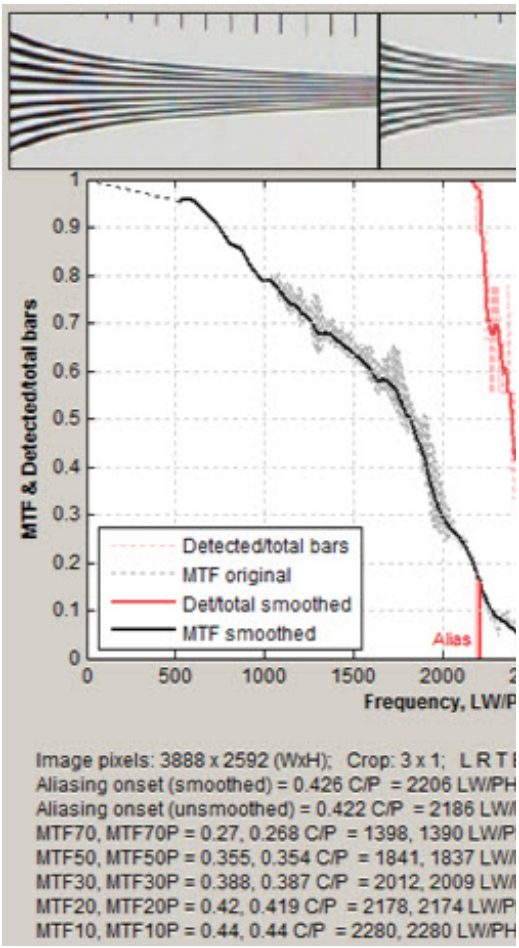
Full instructions

The display on the right shows Contrast (MTF) and the onset of aliasing (the frequency where the number of detected bars (smoothed) drops below the actual number of bars in the chart. The original wedges are shown (with squeezed aspect ratio). Several results including MTF*nn* for *nn* = 70-10 are shown below the image.

The color moire plot for R-B (normalized **Red − Blue** channel) is shown on below.



Color moire

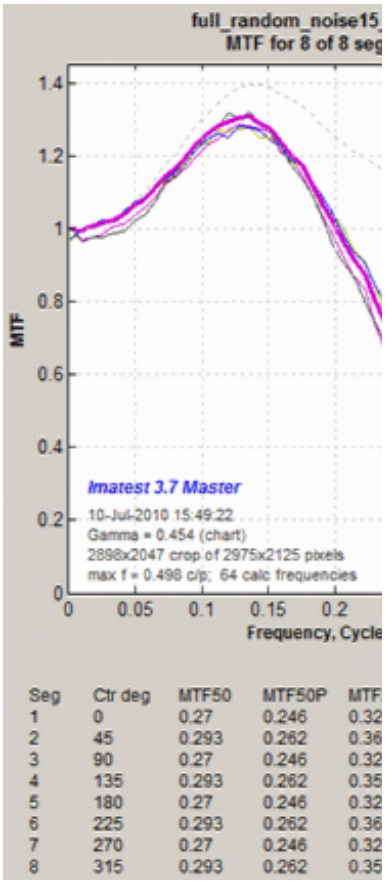


MTF and Aliasing onset (“vanishing

Random (scale-invariant)

Analyzes random pattern, which has a 1/f fourier transform ($1/f^2$ Power Spectral Density (PSD)). Such patterns are scale-invariant, i.e., they have the same general appearance (the same statistics) regardless of distance. Also analyzes the [“Dead Leaves” pattern, recommended for texture measurements](#) in the [I3A CPIQ Phase 2 documentation](#).

MTF from Random scale-inv



Seg	Ctr deg	MTF50	MTF50P	MTF
1	0	0.27	0.246	0.32
2	45	0.293	0.262	0.36
3	90	0.27	0.246	0.32
4	135	0.293	0.262	0.35
5	180	0.27	0.246	0.32
6	225	0.293	0.262	0.36
7	270	0.27	0.246	0.32
8	315	0.293	0.262	0.35

Since the scale-invariant random pattern lacks contrasty edges, images typically have the minimum sharpening and maximum noise reduction for the imaging system, making this pattern an excellent indicator of a camera’s ability to render fine low-contrast detail, i.e., texture. (Slanted-edges, by comparison, tend to have maximum sharpening and minimum noise reduction, and hence may not give an accurate indication of a camera’s response to fine ltexture. Noise power measured in the smooth regions on the left, is subtracted from the PSD of the random pattern. Two low contrast slanted-edges are used to verify the random pattern results.

Any scene sharpness

Measures sharpness of any scene. The sharpness metric is nonstandard and applies to the individual scene only (it cannot be used for comparisons with other scenes). (It’s the same metric used in [Find sharp files](#).) Useful for optimizing focus during reloads in the Image Sensor edition, which analyzes frames from live (video) feeds. Displays the image and a history showing changes in sharpness as the device is focused.

Any scene sharpness display

showing simulated history
(representing focusing to find optimum)