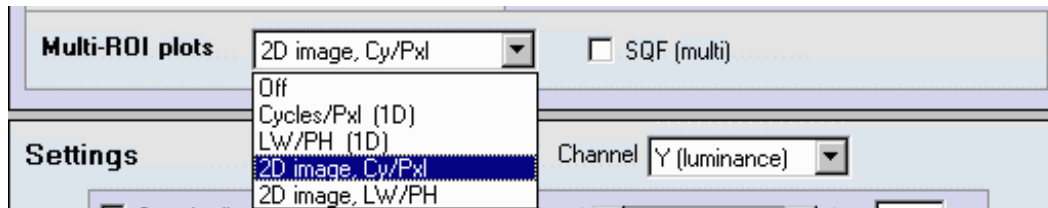


SFR results: Multiple ROI (Region of Interest) plot

Imatest SFR allows you to select several regions of interest (ROIs) in an image. Display options from the SFR input dialog box are shown below.



When one of the Multi-ROI plots (1D or 2D; Cycles/pixel or LW/PH) has been selected, one of the two composite multiple ROI plots shown below is produced. The 1D summary plots, which display MTF, rise distance, and chromatic aberration as a function of the distance from the image center, may be difficult to read for lenses that are poorly centered and hence have asymmetrical response. In such cases the 2D summary plots are far more readable.

Starting with Imatest 2.6 (January 2008) a number of new options facilitate editing and refining multiple ROI selections. They are described [here](#). You can also create Excel plots that summarize results from several multi-ROI runs, as shown on the right using the procedure given [here](#).

2D summary plot

When one of the 2D images (Cy/Pxl or LW/PH) are selected, the image below is displayed. It shows the regions of interest (ROI) and the following parameters for each ROI.

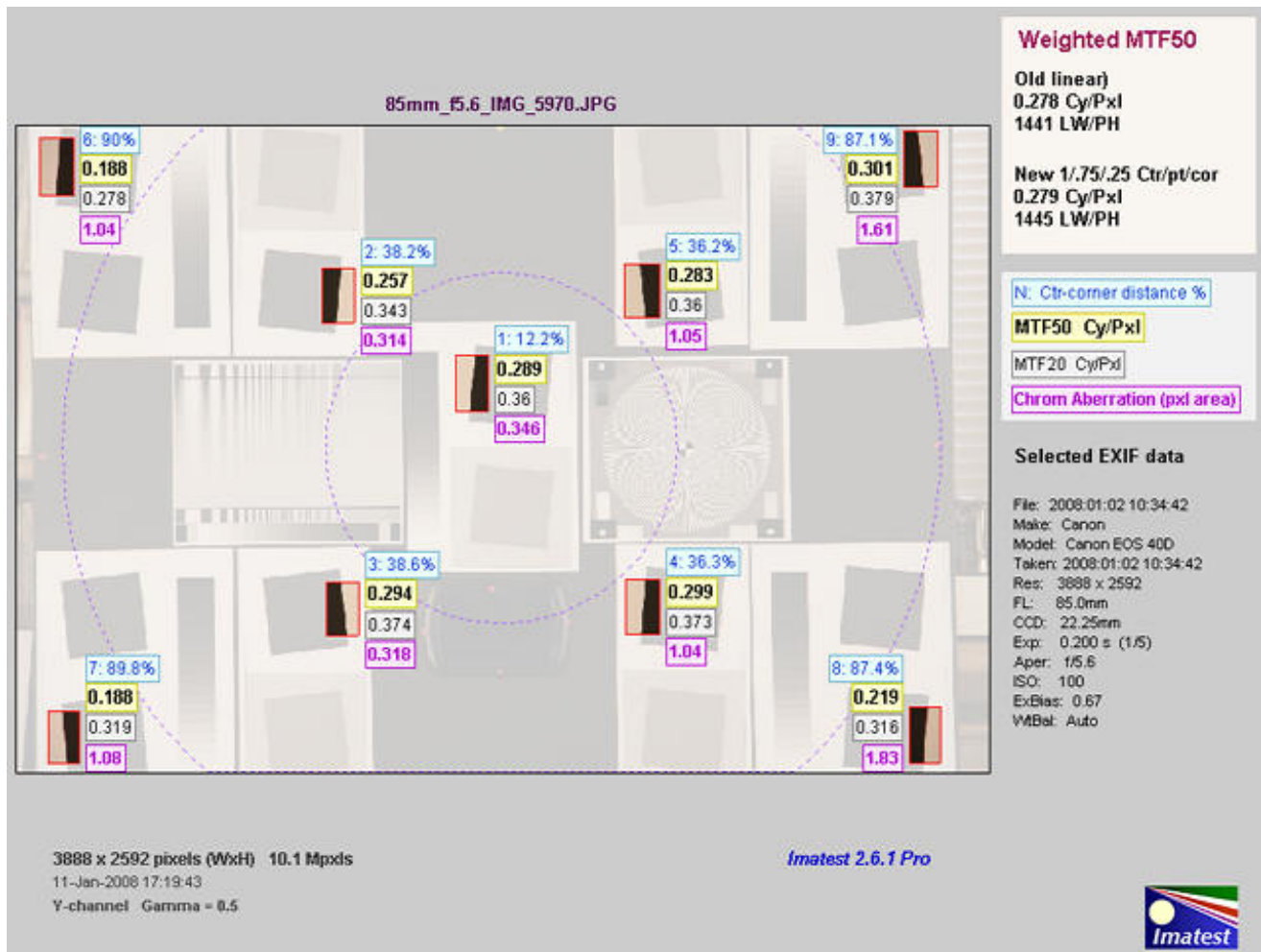
N (ROI number): Center-corner distance in %

MTF50 Cycles/Pixel or LW/PH (displayed boldface for emphasis)

MTF20 Cycles/Pixel or LW/PH

[Chromatic Aberration](#) (area in pixels)

The dotted circles delimit the central region (up to 30% of the center-to-corner distance), the part-way region, and the corner region (over 75% of the center-to-corner distance). The New Weighted MTF50 is the weighted mean of the mean MTFs in the three areas, where the weights are 1 (Central), 0.75 (part-way), and 0.25 (corner).



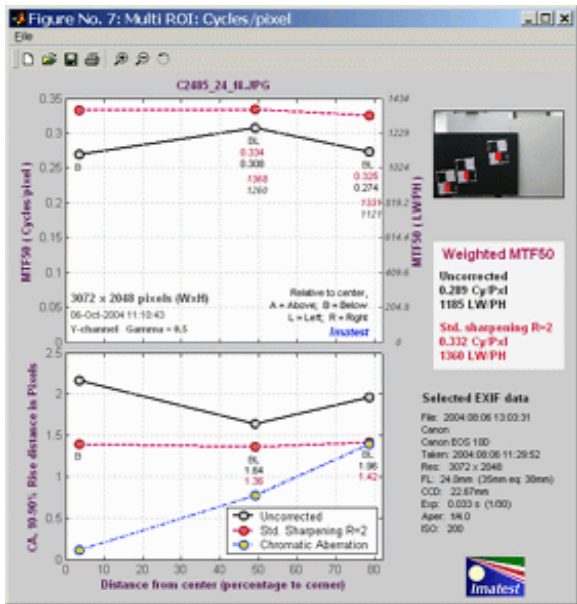
Multi-ROI 2D summary plot, showing Center-corner distance, MTF50, MTF20, and CA superimposed on image.

This display can be particularly useful because lenses are not always centered properly. If they were, performance would be a simple function of the distance from image center. You can quickly review the summary results, then look at the detailed results for individual regions. It was developed because about 9 regions (center, 4 – part-way out, 4 – corner) is sufficient to characterize lens performance, but not sufficient for a meaningful 2D or 3D contour plot (which requires about 20 regions). Also, contour plots can only show one parameter (e.g., MTF50), while this display shows several.

1D Summary plot showing results as a function of distance from the center

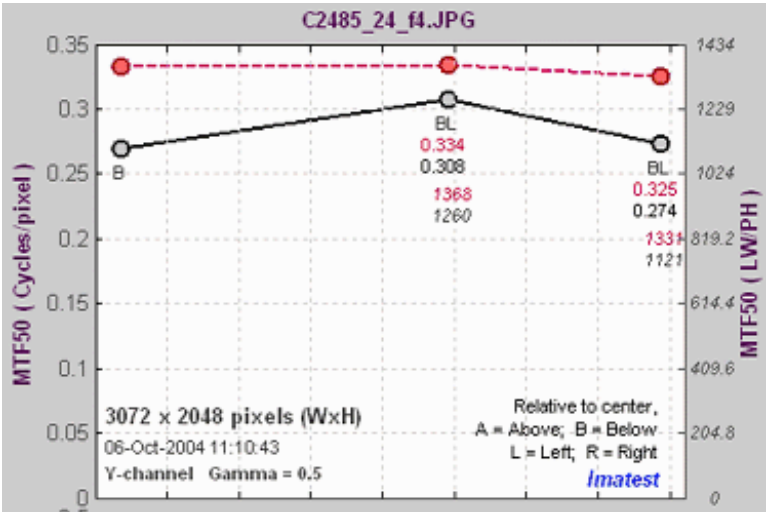
This figure contains two plots: MTF50 (upper left) and 10-90% rise distance (lower left). If Cycles/pixel is selected, units are relative to pixels; if LW/PH is selected, units are relative to image height. These figures show performance (MTF50 and rise distances without and with standardized sharpening). The Cycles/pixel Figure also plots Chromatic Aberration as a function of distance from the center of the image, scaled as the percentage of distance from center to corner (0 = center; 1 = corner).

The most important results below are shown in **Bold**.
Illustrations are for the first figure (Cycles per pixel in this case).



Upper left: MTF50 (Half-contrast frequency)

This plot shows MTF50 (the half-contrast spatial frequency) as a function of distance from the center of the image, scaled as the percentage from center to corner (0 = center; 100 = corner). There are two vertical (y) axes. The primary axis is on the left; the secondary axis (*italicized*) is on the right. These alternate for the two plots. In this plot, the primary axis is in Cycles/pixel for MTF50 and Pixels for 10-90% rise distance. It can also be in Cycles/mm or Cycles/inch if specified in the [SFR data window](#).



Black line (bold) MTF50 (half-contrast spatial frequency) for the luminance (Y) channel. Unprocessed. *This is the number to use for measuring lens sharpness.*

Red line (bold, dashed) MTF50 for the luminance (Y) channel with [Standardized sharpening](#). *This is the number to use when making general comparisons of different cameras with different degrees of sharpening.*

Symbols and numbers

below data
points,

Orientation: Location of region relative to image center. A = Above, B = Below, L = Left, R = Right.

top to bottom

MTF50, Uncorrected and with Standardized sharpening, in units corresponding to the primary vertical (y) axis scale on the left.

The vertical order is determined by the order of the data points, i.e., if the Uncorrected MTF50 is higher, its value is on top.

MTF50, Uncorrected and with Standardized sharpening, in units corresponding to the secondary vertical (y) axis scale on the right. These numbers are *italicized*. The vertical order is determined by the order of the data points, i.e., if the Uncorrected MTF50 is higher, its value is on top.

Right column: Crop, Results summary, and EXIF data

Top right image

Thumbnail of the entire image, showing the locations of the selected regions of interest (ROI) in red.

Middle right box:

Weighted MTF50

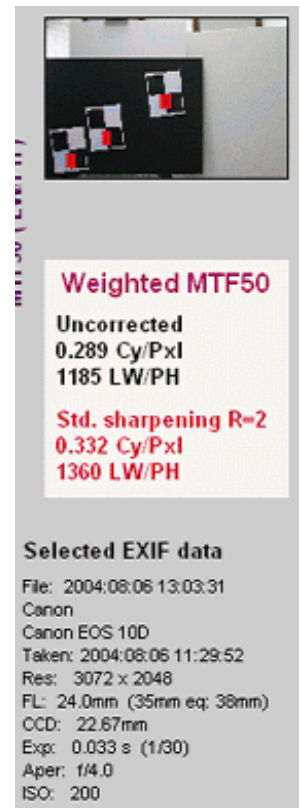
Results summary

Summary of key results of multiple ROI runs:

Weighted mean values for MTF50, in cycles per ... and LW/PH units, without and with standardized sharpening. The MTF value at the middle of each (sorted) line segment is weighted according to the length of the line segment and the distance from the center: the center is weighted twice as strongly as the corner. These weights are used to calculate a weighted mean. This algorithm prevents closely spaced points from being given excessive weight.

Lower right text

Selected EXIF data: Data recorded by the digital camera. Only for JPEG files. May include ISO speed, aperture, and other details. Thanks to [Matthias Wandel](#) for [jhead.exe](#).



Lower left: 10-90% Edge rise distance

**Black line
(bold)**

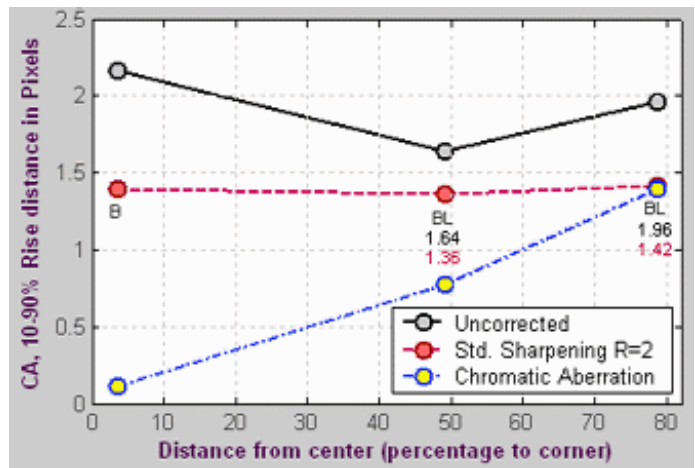
The 10-90% rise distance, uncorrected (without Standardized sharpening).

**Red line
(bold, dashed)**

The 10-90% rise distance, with Standardized sharpening.

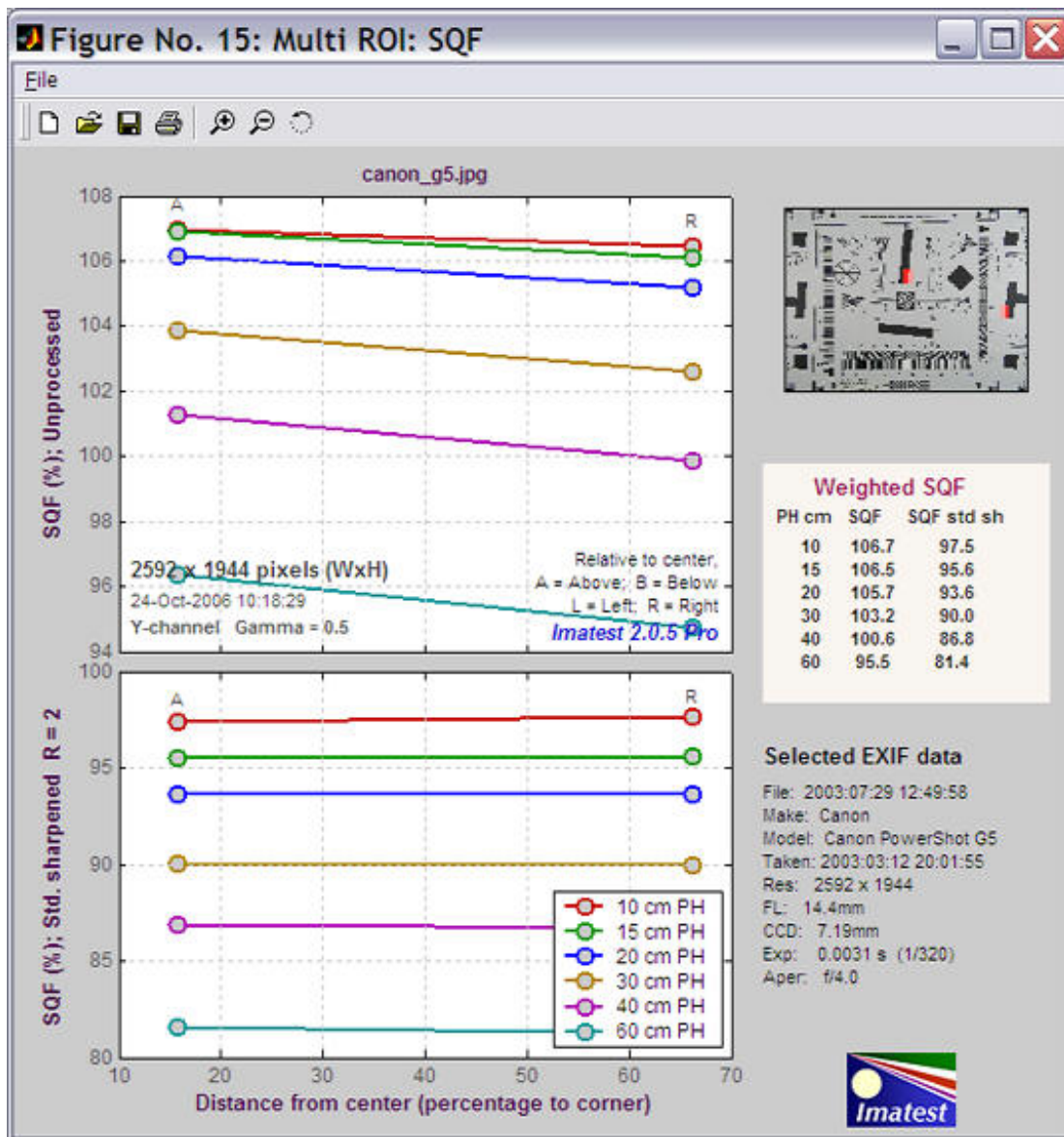
**.Blue line
(bold, dashed)
with yellow circles.**

Chromatic aberration (Area-based) in pixels. An indicator of the severity of CA. The area between the channels with the highest and lowest levels. In units of pixels because the x-axis is in pixels and the y-axis is normalized to 1. Explained in detail in the page on [Chromatic aberration](#). **Meaning:** Under 0.5; insignificant. 0.5-1: minor; 1-1.5: moderate; 1.5 and over: serious.



The Legend at the lower right of the 10-90% Rise distance plot sometimes covers data points. It can be moved by clicking and dragging it with a mouse.

When the **SQF (multi)** checkbox in the SFR input dialog box has been checked, a multiple ROI [SQF](#) Figure is produced.

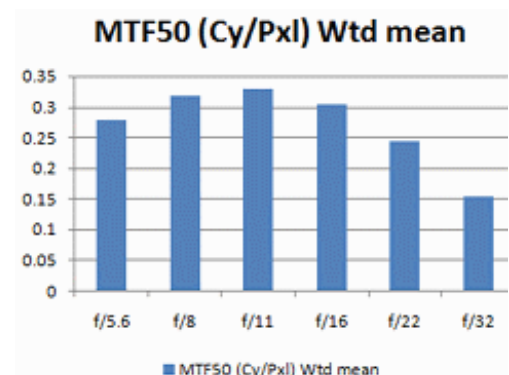


The upper plot shows [SQF](#) without standardized sharpening (unprocessed) for picture heights from 10 to 60 cm. The lower plot shows [SQF](#) with standardized sharpening ($R = 2$). Weighted SQFs are shown in the table on the right. The weighting formula is the same as the one used for MTF: readings near the center are given twice the weight of readings near the edge.

CSV output file

The CSV output file has been upgraded (version 2.6.1, January 2008) to facilitate the handling of a large volume of results and creation of [Excel summary plots that combine results of several runs](#). It is designed to be opened in Excel. The following data shows the contents of the CSV file for the Canon 17-85 IS lens tested on the EOS-40D. It has been imported from Excel.

Summary plot



Header shows version, input file, and run date

Imatest	2.6.1	Pro	SFR multi-ROI
File	85mm_f5.6_IMG_5970.JPG		
Run date	1/9/2008 10:25		

Geometry & file shows the Regions of interest (ROIs) in pixels and the CSV summary files for each location.

Geometry & file: changed with Imatest 2.5.8. Origin at upper left.								
N	Distance %	Direction	X1	Y1	X2	Y2	Region	CSV s
1	12.1	AL	1749	922	1894	1161	Center	D:\Ca 85_IS'
2	38.7	BL	1244	1839	1380	2044	Pt Way	D:\Ca 85_IS'
3	38.3	AL	1221	577	1355	798	Pt Way	D:\Ca 85_IS'
4	36.1	AR	2432	551	2575	781	Pt Way	D:\Ca 85_IS'
5	36.2	BR	2446	1817	2576	2032	Pt Way	D:\Ca 85_IS'

6	90	AL	104	52	238	279	Corner	D:\Ca 85_IS'
7	89.9	BL	133	2364	273	2579	Corner	D:\Ca 85_IS'
8	87.3	BR	3571	2333	3696	2544	Corner	D:\Ca 85_IS'
9	87.1	AR	3550	30	3686	251	Corner	D:\Ca 85_IS'

nroi – roi_mult These four lines are used to define the regions in imatest.ini. These regions can be reused for Imatest runs by copying and pasting the four lines into imatest.ini, replacing the previous lines. Imatest.ini can be opened for editing by clicking **Settings** (in the Imatest main window), **View settings (ini file)**.

nroi = 9	nwid_save = 3888	nht_save = 2592	roi_mult = 1749 922 1894 1161 ; 1244 1839 1380 2044 ; 1221 577 1355 798 ; 2432 551 2575 781 ; 2446 1817 2576 2032 ; 104 52 238 279 ; 133 2364 273 2579 ; 3571 2333 3696 2544 ; 3550 30 3686 251 ;
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Primary results, shown by region

Primary results							
N	MTF50 (Cy/Pxl)	R1090 (pxl)	CA (pxl)	MTF50 (LW/PH)	R1090 (/PH)	Peak MTF	MTF50P (Cy/Pxl)
1	0.289	1.6499	0.3439	1498.2	1571	1	0.289
2	0.2938	1.8284	0.3155	1522.9	1417.6	1	0.2938

3	0.2566	2.1939	0.3113	1330.1	1181.5	1	0.2566
4	0.2821	1.7768	1.0413	1462.5	1458.8	1	0.2821
5	0.2993	1.6187	1.0377	1551.3	1601.3	1	0.2993
6	0.1884	2.7046	1.0397	976.5	958.4	1.0201	0.1857
7	0.1871	2.5718	1.0671	969.9	1007.8	1.0239	0.1834
8	0.2191	2.3951	1.835	1135.8	1082.2	1.0132	0.2171
9	0.3017	1.8871	1.6025	1563.8	1373.5	1.0104	0.3004

Summary results The table contains summary results. These results are repeated in a single-column at the end of the CSV file, shown [below](#). Though it is less readable, it is much better suited for copying and pasting summary results into an Excel file that can be used to produce plots.

Summary	1/9/2008
---------	----------

10:25 85mm_f5.6_IMG_5970.JPG 9Regions1Center4Part way4Corner MTF50

(Cy/Pxl)R1090

(pxl)CA

(pxl)MTF50

(LW/PH)R1090

(/PH)Peak

MTFMTF50P

(Cy/Pxl)MTF50P

(LW/PH)MTF20

(Cy/Pxl)MTF20

(LW/PH)Mean Ctr0.2891.64990.34391498.2157110.2891498.20.35981865.4Mean Pt
Wy0.28291.85440.67651466.71414.810.28291466.70.36261879.6Min Pt
Wy0.25661.61870.31131330.11181.510.25661330.10.3431778.2Mean
Cor0.22412.38971.38611161.51105.51.01690.221611490.3231674.2Min
Cor0.18711.88711.0397969.9958.41.01040.1834950.80.27781440Wtd
mean0.27861.81911.14951444.31454.21.00210.27831442.70.35631846.8

Explanation of summary results Each of the results are presented six times— for different regions of the image and for a weighted sum of the regions, as described below.

Mean Ctr	The mean of the central region (Ctr), up to 30% of the center-to-corner distance.
Mean Pt Wy	The mean of the Part-Way region (Pt Wy), from 30 to 75% of the center-to-corner distance.
Min Pt Wy	The minimum value of the Part-Way region. If the minimum value is much below the mean, the lens may be poorly centered (due to manufacturing tolerances).
Mean Cor	The mean of the corner region, which is over 75% of the center-to-corner distance.
Min Cor	The minimum value of the corner region. If the minimum value is much below the mean, the lens may be poorly centered (due to manufacturing tolerances).
Wtd mean	The weighted mean. For all parameters except chromatic aberration (CA (pxl)) the weights are 1 for Ctr, 0.75 for Pt Wy, and 0.25 for Cor. For CA (pxl) the weights are 1 for Cor and 0.5 for Pt Wy. (Lateral chromatic aberration is not important near the center.)

The column in this table (rows in the single-column table below) contain the following results:

MTF50 (Cy/Pxl)	The spatial frequency where MTF is 50% (0.5) of its low frequency value. Normally in cycles/pixel, but may be in cycles/mm or cycles/in if specified in SFR input dialog box.
R1090 (pxl)	The 10-90% rise distance in pixels.

CA (pxl)	Chromatic Aberration (expressed in area between highest and lowest channel) in pixels.
MTF50 (LW/PH)	MTF50 expressed in Line Widths per Picture Height, where 1 line pair = 2 line widths. (LW/PH is traditional in video.)
R1090 (/PH)	The number of 10-90% rises per picture height.
Peak MTF	The peak value of MTF. Equal to 1 when little or no sharpening is applied; can be much larger than 1 when strong sharpening is applied.
MTF50P (Cy/Pxl)	The spatial frequency where MTF is 50% of the <i>peak</i> value. Differs from MTF50 when strong sharpening is applied.
MTF50P (LW/PH)	MTF50P expressed in Line Widths per Picture Height.
MTF20 (Cy/Pxl)	The spatial frequency where MTF is 20% (0.2) of its low frequency value. Normally in cycles/pixel, but may be in cycles/mm or cycles/in if specified in SFR input dialog box.
MTF20 (LW/PH)	MTF30 expressed in Line Widths per Picture Height.

Secondary results These include results with standardized sharpening (suffix C).

Secondary results: C denotes standardized sharpening			
N	MTF50C		

(Cy/Pxl)R1090C

(pxl)MTF50C

(LW/PH)R1090C

(/PH)MTF20

(Cy/Pxl)

MTF20

(LW/PH)

10.2941.56891524.21652.10.35981865.420.30131.53041561.91693.70.3741939.130.28411.59414

Miscellaneous values

Image WxH & Mpxls	3888	2592	10.1
Channel	Y		
Gamma	0.5		
Sharpening radius	2		
Pixels per inch			
Pixels per mm			
um per pixel			
MTF50 wtd Cy/Pxl (uncorr)	0.278		
MTF50 wtd LW/PH (uncorr)	1440		
MTF50 wtd Cy/Pxl (corr)	0.294		
MTF50 wtd LW/PH (corr)	1525		

SQF summary. SQF is the Subjective Quality Factor, described [here](#).

SQF (Subjective Quality Factor): mean values
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Print

heightViewing

dist
(cm)SQFSQF_corr11599.5899.7621598.9899.66316.4398.4599.62418.9798.199.55521.2197.7599.

Exif data

Exif data

File: 2008:01:02 10:34:42

Make: Canon

Model: Canon EOS 40D

Taken: 2008:01:02 10:34:42

Res: 3888 x 2592

FL: 85.0mm

CCD: 22.25mm

Exp: 0.200 s (1/5)

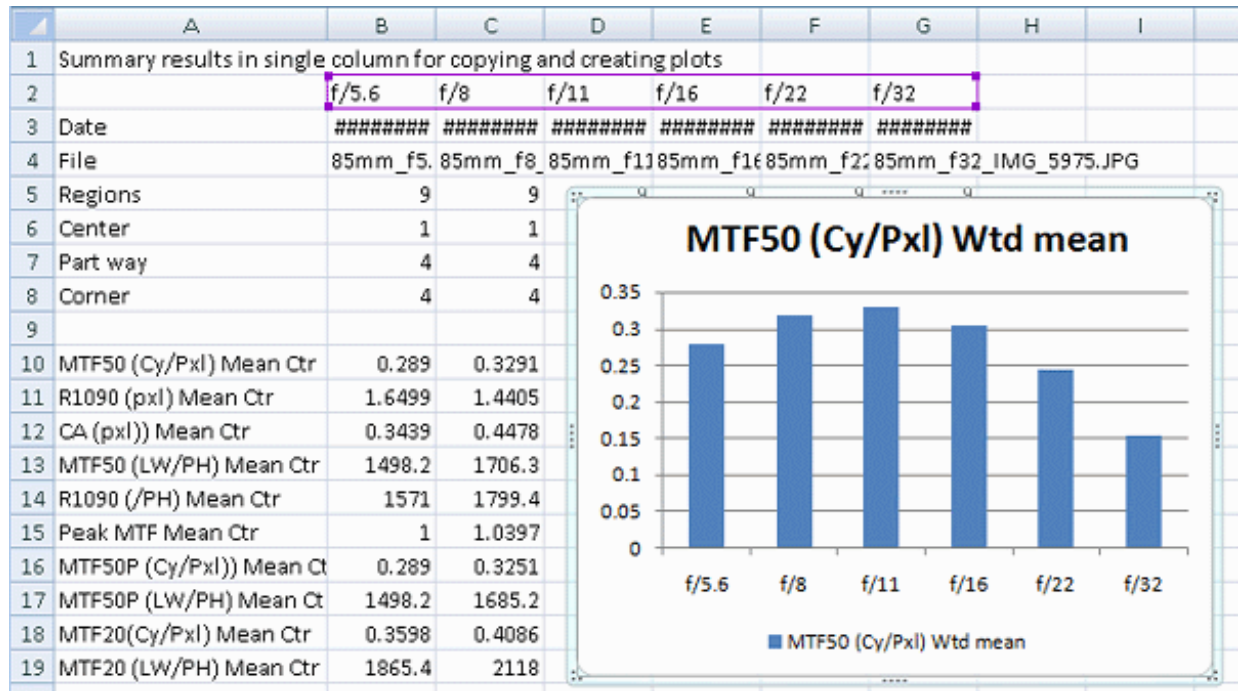
Aper: f/5.6

ISO: 100

ExBias: 0.67

Creating Excel plots

The single column summary is the last table in the multi-ROI CSV file. It contains the same data as the summary results (above), but it is formatted so it can be easily copied and pasted into another Excel file for creating plots that summarize several runs. For multi-ROI batch runs, this data is combined into a CSV output file with a name of the form, *filename_Y_sfrbatch.csv*.



Summary plot for 6 multi-ROI runs (f/5.6-f/32) for the Canon 17-85mm IS lens on the EOS-40D (JPEG)

The Excel file was created by combining single-column summary results from the 6 runs.

Any of the parameters in the summary can be plotted. To obtain a plot,

- Run a sequence of multi-ROI runs for a several apertures (or other settings if appropriate). If possible, select one ROI near the center, 4 part-way out, and 4 near the corners: 9 total as shown in the 2D summary plot, [above](#). This is sufficient to completely characterize a lens. Be sure to save the CSV summary file, which has a name of the form *{input file name}_Y_multi.csv*, where Y denotes the luminance channel.

Summary results in single column for c and creating plots	
	(enter descrip
Date	1/9/2
File	85mm_f5.6_IMG_

- If the sequence is run as a batch, a combined summary file with a name of the form *filename_Y_sfrbatch.csv* will be created. You may skip the next four steps.
- Open the first CSV summary file (for f/5.6 in this case) in Excel. This can usually be done by double-clicking on the file name in Windows Explorer.
- Select and copy (ctrl-C) the first two columns of the summary results, located near the end of the CSV summary file.
- Open a new Excel (XLS) file. Paste the selection in the new file.
- Open the remaining CSV summary files in Excel. For each file, copy the *second* column of summary data, and paste it into the next Excel file so that it is aligned with the previous data, as shown above.
- In the row 2 of the new Excel file, between Summary results... and Date, (or the line labeled Plot title in the combined summary file) enter a brief description of the run to be used to label the plot, for example, f/5.6, f/8, ..., f/32 (shown above).
- Now you can create the plot. Select the cells for the x and y-displays. The remaining details depend on your version of Excel. For the above plot, the range of data is =Sheet1!\$A\$2:\$G\$2,Sheet1!\$A\$65:\$G\$65

Single-column summary results (incomplete)

The parameters in the table are described [here](#).

Regions	
Center	
Part way	
Corner	
MTF50 (Cy/Pxl) Mean Ctr	
R1090 (pxl) Mean Ctr	
CA (pxl)) Mean Ctr	
MTF50 (LW/PH) Mean Ctr	
R1090 (/PH) Mean Ctr	
Peak MTF Mean Ctr	
MTF50P (Cy/Pxl)) Mean Ctr	
MTF50P (LW/PH) Mean Ctr	
MTF20(Cy/Pxl) Mean Ctr	

MTF20 (LW/PH) Mean Ctr	
MTF50 (Cy/Pxl) Mean Pt Wy	
R1090 (pxl) Mean Pt Wy	
CA (pxl)) Mean Pt Wy	
MTF50 (LW/PH) Mean Pt Wy	
R1090 (/PH) Mean Pt Wy	
Peak MTF Mean Pt Wy	
MTF50P (Cy/Pxl)) Mean Pt Wy	
MTF50P (LW/PH) Mean Pt Wy	
MTF20(Cy/Pxl) Mean Pt Wy	
..., etc. (The whole table is not sh	