

Photogrammetric Measurement Error Associated with Lens Distortion

William T.C. Neale, David Hessel, Toby Terpstra
Kineticorp, LLC

Copyright © 2011 SAE International

ABSTRACT

All camera lenses contain optical aberrations as a result of the design and manufacturing processes. Lens aberrations cause distortion of the resulting image captured on film or a sensor. This distortion is inherent in all lenses because of the shape required to project the image onto film or a sensor, the materials that make up the lens, and the configuration of lenses to achieve varying focal lengths and other photographic effects. The distortion associated with lenses can cause errors to be introduced when photogrammetric techniques are used to analyze photographs of accident scenes to determine position, scale, length and other characteristics of evidence in a photograph. This paper evaluates how lens distortion can affect images, and how photogrammetrically measuring a distorted image can result in measurement errors. Lens distortion from a variety of cameras is analyzed, and the ultimate effect that this distortion has on the image is evaluated, with a discussion on the overall difference this distortion would cause to measuring evidence in an image, such as tire mark distances and curvature. Ways of correcting this distortion are also addressed.

INTRODUCTION

Accident reconstruction relies on physical evidence that is visible in photographs such as tire marks, gouge marks, or rest positions of vehicle. Photogrammetric methods such as photographic rectification and camera matching are used to analyze photographs, and these methods can determine the size, shape, and position of objects in the photograph. However, these methods rely on the quality of the image being analyzed to accurately measure and place what is in the photograph. And since all camera lenses contain some aberrations or imperfections, due to the physical characteristics of the lens, photographic images contain distortion resulting from lens aberrations. In short, these aberrations can shift the location of the image on the pixel matrix, and hence shift the position, size and shape of the geometry the pixels represent. As a result, when measuring a distorted image, the size, shape and position of an object of interest may be misrepresented. This paper examines some of the aberrations that are common in camera lenses, specifically, the aberrations that would cause errors in photogrammetric analysis. The distortions for 35 different camera lens types were analyzed, the affect this distortion has on the digital image is analyzed, and the ultimate effect that this distortion can have on measurements relied upon in accident reconstruction methodologies are evaluated. Ways of correcting this distortion are also discussed, since commonly available software exists that can remove different types of distortion.

BACKGROUND

Imperfections in the design and manufacturing processes of camera lenses inherently cause distortion in the image captured by the sensors or by film of the camera [1]. As light is collected, focused, and transformed through the lens structure, the final collection of this light on a sensor plate or film sheet is distorted to some degree. Figure 1 below is a simple diagram showing light being collected by the optical system in a camera lens, and the projection of that light on to a recording surface such as film, or digital sensor.

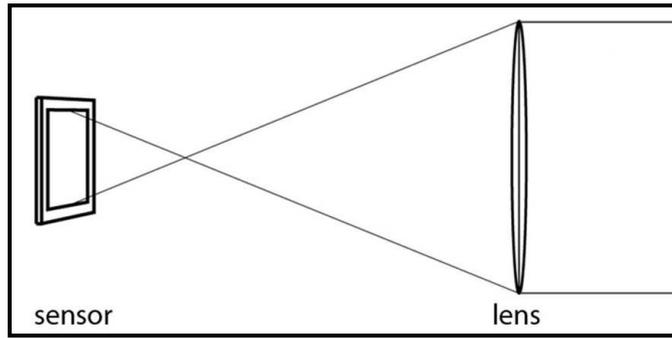


Figure 1

As light passes through the lens of the camera, aberrations from the lens design and manufacturing can cause various effects on the light that result in a distorted image. While this is an unavoidable aspect of lens design, certain lenses can be optimized to reduce certain types of distortion. However, there is a tradeoff, in that reducing distortion in some ways may increase other types of distortion. As this study shows, two cameras of the same make, model and focal length will have the same distortion, though changing focal length or changing the camera make and model will result in different distortion patterns. The degree to which the design and manufacturing processes affect the resulting image differs not only between each of the manufactured lenses, but also differs for the same lens with varying focal lengths [2]. For instance, a wide angle focal length can have a different distortion effect than the same lens with a telephoto focal length. Some of the types of distortion that can occur include spherical aberrations, coma, and chromatic distortion. These imperfections affect the resulting image quality, clarity, and color, but the distortion types that would most affect the accuracy in obtaining distances, dimensions, and the shapes of objects seen in photos are geometrical distortions.

The two most common geometrical distortions, and also the types that most affect measurement through photogrammetry processes such as camera matching are pincushion and barrel distortions. Figure 2 below uses a grid to simply illustrate the concept of these two types of distortion. The grid on the left shows the effect of barrel distortion, and the grid on the right shows the effect of pin cushioning for an orthogonal grid.

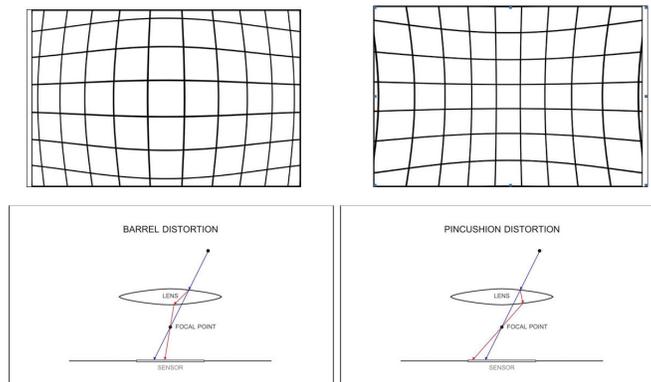


Figure 2 – Barrel and Pin Cushion Distortions

Barrel distortion, as shown on the left, is a lens effect which causes the image to be expanded in a barrel shape from its center [2]. This effect is typically associated with wide angle focal lengths, and the effect of this type of distortion is that lines that are actually straight appear bent in the image. The image on the right shows pin cushioning, which is a lens effect that causes images to be pinched at their center. Like barrel distortion, the effect is that lines that, in reality, are straight appear bent in the distorted image (but, bent in the opposite direction from barrel distortion). Pin cushion distortion is typically associated with telephoto focal lengths. However, in the study of lenses in this paper, the distortion of some focal lengths was characterized as a mixture of both barrel and pin cushioning. The effect is a type of wavy distortion of a straight line, and appeared when a lens was between a typical wide angle and zoom focal length, as if the wavy distortion resulted when the focal length would transition between a wide and zoom lens. Barrel and pin cushion distortion, unlike other distortions which may affect color or clarity, affect the position of pixels in the image, and hence affect the geometry represented in the image. Since photogrammetry processes analyze the location of objects in the image, these two distortion effects are most relevant to accident reconstruction methods that determine distances, geometry and positions of objects in photographs through photogrammetric processes. Decentering distortion, which is caused by variations in the assembly of the lens elements can also cause a geometric distortion due to misalignment of the optical axis, however, this condition is not evaluated in this

paper. In addition, it should be noted that a calibrated camera and lens may not yield the same distortion results as published in this paper.

TESTING PROCEDURE

In order to assess the distortion for the 35 cameras that were chosen for this study, an image without distortion was compared to a distorted version of the same image. An image was generated in the computer to insure it has no distortion, and contains a symmetrical grid whose lines are perfectly horizontal or vertical. This image was distorted in the same way an actual lens would distort an image if photographed in the real world. In other words, an idealized, undistorted image was first created in a 3D modeling program using rectilinear, orthographic cameras created in that program. Because the camera was computer generated and not manufactured, the camera does not have any lens distortion and an image was rendered from the camera view in the same way a real life camera takes a photograph, but without any distortion. This image was then be digitally distorted according to characteristics of any specific lens [3]. Knowing the distortion of a specific camera was made possible since there is published data that mathematically describes the lens distortion for hundreds of common camera lenses. This mathematical description can be applied to a digital image, and the results of the distortion characteristics quantified in terms of how an image shifts on the pixel matrix. Since the distortion can be described mathematically, having the actual camera is not necessary. Another benefit of digitally assessing distortion is that detailed measurements of the distortion can be taken when using computer modeling to create idealized and distorted images. This is also useful since a simulated environment for assessing distortion makes it possible to test how lens distortion would ultimately affect the measurement of an object in the image, such as the length and shape of a tire mark. This testing procedure relies on distortion data that was collected, measured, and published independently by other authors or manufacturers. This data was provided mathematically, and likewise the procedure estimates lenses distortion through a mathematical process.

CREATING AN UNDISTORTED IMAGE

Most 3D software packages allow creation of 3D environments as well as 3D cameras with properties similar to a real-world camera. These 3D cameras have field of view properties and can be rendered out at any given resolution. As the 3D cameras do not contain a physically manufactured lens, there is no lens distortion on the rendered images. For purposes of this paper, Autodesk's 3D Max 2010 was used to generate an idealized 3D environment containing a perfectly horizontal and vertical grid. 3648 x 2736 is the number of pixels in the normalized camera sensor matrix defined for the analysis in this paper. An image of the grid environment was rendered from a 3D camera view using a 28mm field of view, with dimensions (3648 x 2736) and proportions (4:3) consistent with a common 8 megapixel, real-world camera. (Figure 3)

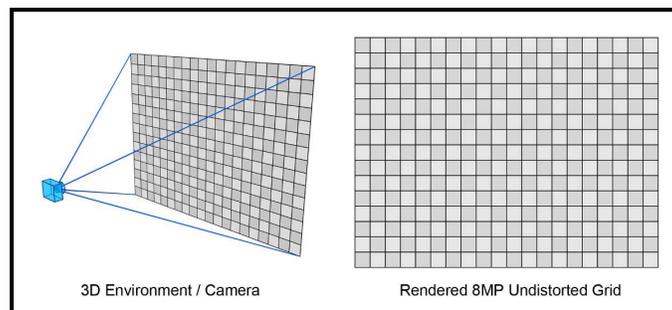


Figure 3 – Computer model of the idealized grid

This idealized image was then be distorted according to coefficients that mathematically describe the lens distortion. There are multiple programs available that use databases of distortion coefficients to automatically correct for lens distortion. Three such examples, Epaperpress Ptlens [4], Hugin [5] and Adobe Photoshop CS5, use the information stored in an image's exif data [6] to lookup the distortion coefficients from an internal or external database. These distortion coefficients are published for many camera types by the manufacturer, or are calculated independently and then published for use in correcting distortion. Distortion programs rely on these coefficients to remove lens distortion from images as the effects of lens distortion vary from camera to camera, and for this study the same coefficients were then used to add lens distortion to an idealized image. The actual effect of this distortion in the resulting image was then measured by determining the distance pixels moved as result of this distortion.

Distortion correction relies on a polynomial function, below, that modifies the distance a pixel is from the center of the image. This distortion correction only corrects for radial distortion and does not correct for any of the other types of distortion that can be present

in a photograph, it also assumes the distortion is uniform for any pixel with the same radius from the center of the image. The distortion coefficients appear in the equation:

$$y = ax^4 + bx^3 + cx^2 + dx \quad (1)$$

Where y is radius of the distorted pixel, x is the radius of the undistorted pixel. The coefficients a , b , and c determine the distortion of the pixel. All radius values are normalized where a value of 1 is equal to $\frac{1}{2}$ the size of the shortest side of the image. While the coefficients a , b , and c all perform similar modifications to the image, they differ in that each one has a greater effect on different areas of the image. Coefficient a primarily affects the edges of the image, c affects the inside, and b affects the image as a whole. The d coefficient is related to the other coefficients through the equation below.

$$d = 1 - (a + b + c) \quad (2)$$

This equation controls the scale of the corrected image and is used to maintain the overall size of the resulting image. Image adjustment programs, such as Photoshop CS5 even contain distortion correction plug-ins where values for a , b , c and d can be manually entered, and through an iterative process, adjusted till the desired distortion correction is achieved.

For this study, the database for the distortion for each of the cameras was publically available [7]. These coefficients were applied to the idealized image, and the measurement of the distortion created by this mathematical function was measured, and the results reported in Appendix A.

MANUALLY ASSESSING LENS DISTORTION COEFFICIENTS IN A CAMERA

Not every manufactured camera has distortion coefficients that are publically available. For these cameras, there is a method described here for manually determining the coefficients. A photograph of a grid on a wall can be used to determine what the distortion is for a specified camera and focal length. Figure 4 shows the setup needed for manually assessing the distortion in an image. The grid is mounted on the wall, parallel to the camera so that the vertical and horizontal lines will be captured parallel to the digital image. When a photograph is taken with a digital camera, information about that occurrence is embedded in the digital file. Information such as the make and model of the camera, the exposure setting, f-stop and other camera settings, even the time and date the photo is taken. This metadata is referred to as EXIF data (exchangeable image file format) and represents a type of “finger print” for the photograph taken [8]. The camera’s make and model, and the focal length for the camera can be obtained from the EXIF data, and used in the image editing programs to complete the manual assessment of distortion. There can be differences in the nominal focal length recorded in the EXIF data compared the actual focal length used when taking the photo and these differences could vary from camera to camera. Therefore there will be some uncertainty in determining the focal length/correction coefficients for a camera if the specific camera used to take the photos is not available. After the photo is taken and imported into the image processing program, in this case Photoshop CS4, distortion correction plug-ins are used that allow the user to manually input the distortion coefficients until the desired effect is achieved. For the case of the grid image, coefficients can, through an iterative process, be input in to the distortion parameters until the vertical and horizontal lines match the overlaid grid lines, as shown in Figure 5.

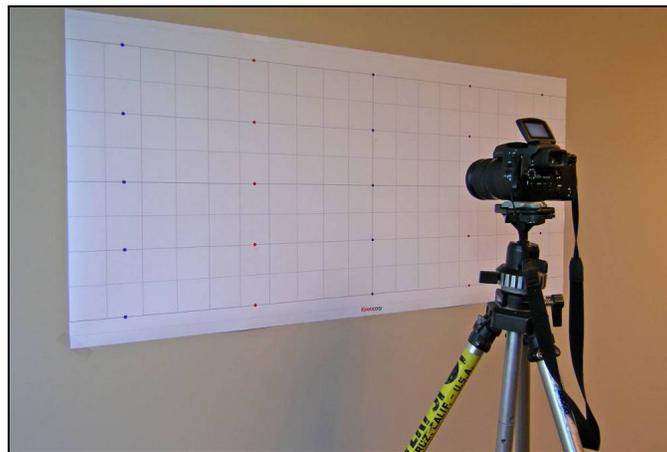


Figure 4 – Setup for photographing a grid

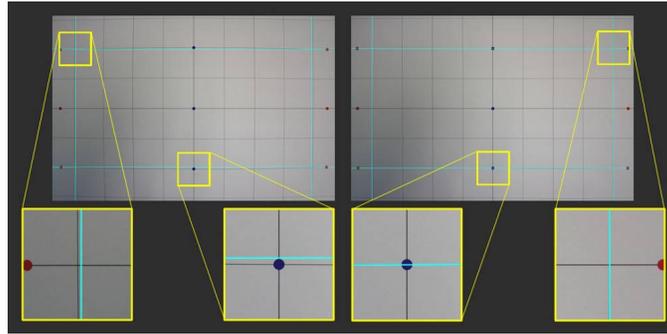


Figure 5 – Manually assessing the grid

The effect of distortion essentially bends vertical and horizontal lines, so assessing when an image has been manually corrected requires looking at lines that are on the grid. They should eventually appear parallel through the iterative process. Once the desired effect has been achieved, the coefficients that are used to get the image corrected can then be stored. When correcting distortion, as discussed in the conclusion, distortion coefficients obtained through this process are helpful in removing distortion in images through other programs.

In order to choose cameras for this study, there were several criteria each camera needed to meet in order for the analysis to be performed. First, the camera had to have a variable focal length. This criteria was needed to determine how a change in the focal length (from a wide angle to a zoom for instance) would change the degree and type of distortion manifested in the photograph. To determine what focal length range would be appropriate for this study, thousands of digital photographs taken by police officers at the scene of an accident were analyzed. The authors felt that the focal lengths and camera types used by police would be a good gauge for the types of photographs often provided to accident reconstruction companies that might undergo photogrammetric analysis. Police photos are typically taken close to the time of an accident, and can represent some of the best photographs of the physical evidence. Through this analysis of police photographs, the range for the focal lengths most common was 30mm to 60mm. This range encompasses the vast majority of all images and represents a good range for most cameras and lenses that are affordable and easily available. Second, the cameras needed to be readily available, and not too rare. Commonly available and popular cameras would make a much better representation of the images that might take photographs used in accident reconstruction. The third criterion was that each camera needed to have published distortion coefficients. A complete list of all the cameras and specifications has been included in Appendix B.

SAMPLE PROCEDURE

To see how this process worked, a sample of assessing distortion for one camera has been provided below. This same process was performed on all the cameras, and presented in the next section “Results of Study”.

The general process for assessing distortion in this paper follows this methodology:

- 1) Create a idealized digital image, with grid markings that can be measured
- 2) Use the distortion coefficients from each camera to distort the idealized image. This creates a distorted image for each camera model
- 3) Compare the distorted image to the idealized image it was created from, and measure the change in pixel location for known pixels
- 4) Create an idealized flat scene with a grid and tire mark, viewed in perspective. Create a distorted image of this idealized scene, and determine how the location and shape of the tire mark, as created from the image being distorted, would change its measured length, or curvature when analyzed photogrammetrically.

As described before, the idealized image was created in the computer environment and renderings of the 20” by 15” grid were created at the resolution chosen (3648 x 2736) for this paper. So each camera being analyzed has its own idealized, undistorted grid that was used in the comparison. A rendering of the idealized grid, prior to being distorted, is shown in Figure 6.

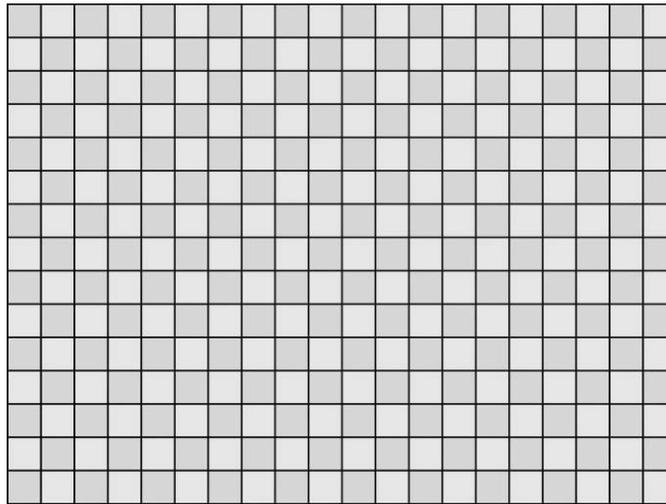


Figure 6 - Rendering of the idealized image, 20"x15"grid

A grid was used since the distortion effects from both barreling and pin cushioning could both be assessed. In addition, because the grid proportions were all the same, the distortion effects can be assessed over the entire image, to see how distortion can be more localized in some areas of the image. As described below, the image was then distorted according to the distortion coefficients for that specific camera lens, then the distortion of the grid was quantified by measuring the resulting shift of the grid relative to the idealized image the distorted image was made from. The process was repeated for each camera lens, but for the example below, a Nikon 8400 WC-E75 was evaluated. The Exif data for the Nikon 8400 WC-E75 shown in this example is listed below in Figure 7 along with the distortion coefficients which were obtained from Panorama Tools.

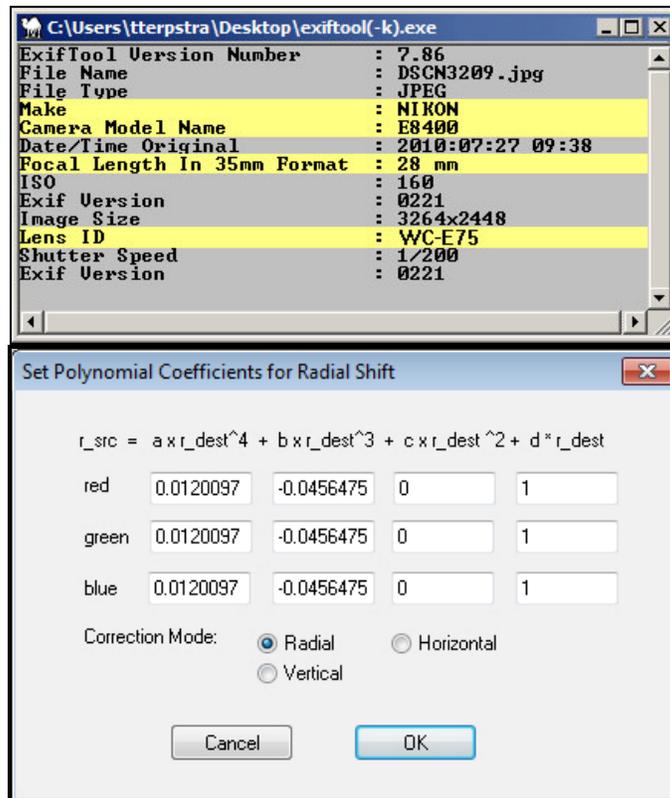


Figure 7 – Exif data and Distortion Coefficients

With the idealized undistorted image created, the coefficients defining the distortion for this camera were used to distort the idealized image. A comparison of both these images is shown in Figure 8. The coefficients obtained were then applied to the image to distort it in the same manner that the image would be distorted if it were photographed in the real world. This distorted image is shown on the Page 6 of 54

right, and while visually the distortion may not be very apparent, upon closer examination distortion can be visible, particularly in the corners of the image.

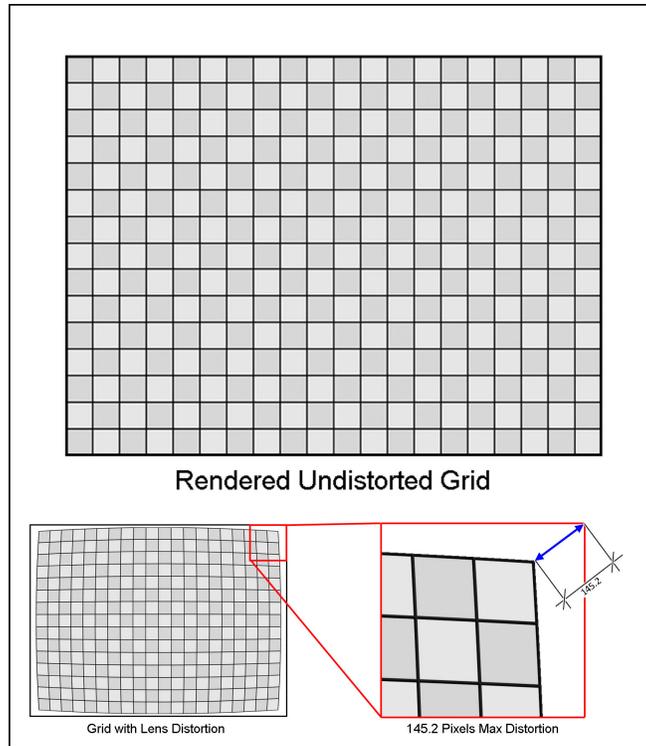


Figure 8 – Visual Effect of Distortion

Since both images can be overlaid digitally, the location of the grid points in each image can be compared, and the change in the distance, in pixels, for each image can be measured. This measurement is the effective distortion quantified in pixels. The image was broken into 336 separate regions. Sixteen rows by 21 columns of pixels areas were analyzed. Measurements for each region obtained to understand how the distortion changes over the entire image. Radial distortion is dependent on a pixels distance from the center of the image, therefore the effect of the distortion is the same for each quadrant. For the sample images above, a matrix of the difference in how points on the grid moved as a result of lens distortion is listed in a matrix below in Figure 9. Green represents pixels with the least amount of shifting, while red represents the pixels that shifted the most.

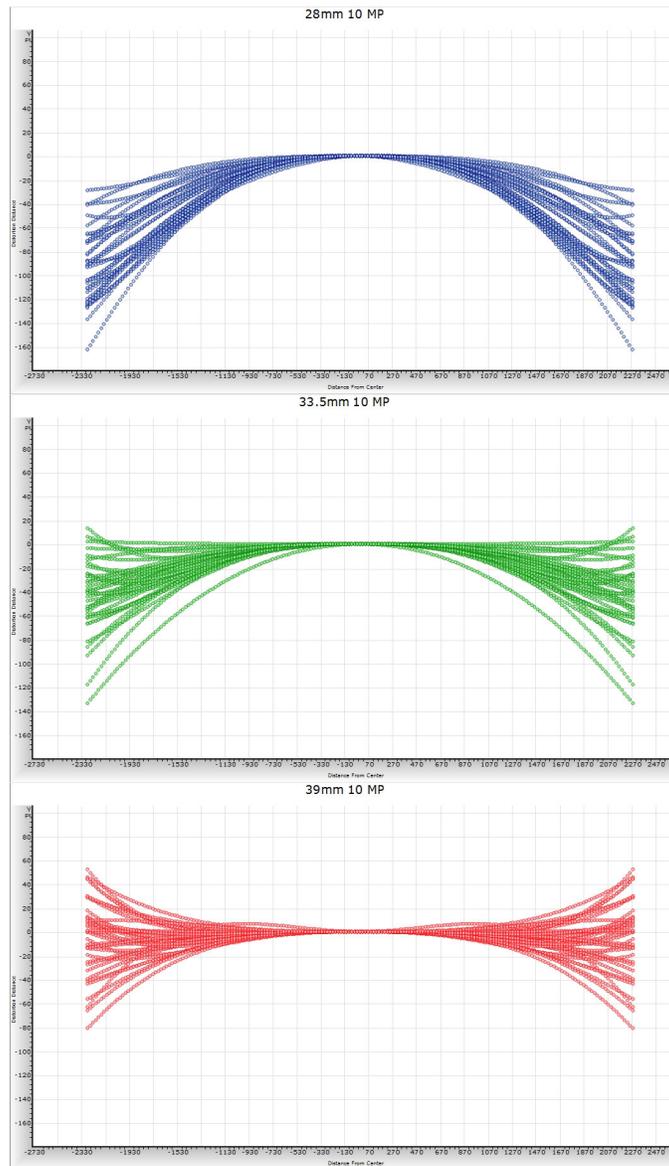
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|----|------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| 1 | -145 | -125 | -107 | -92 | -78 | -66 | -57 | -50 | -45 | -42 | -41 | -42 | -45 | -50 | -57 | -66 | -78 | -92 | -107 | -125 | -145 |
| 2 | -131 | -111 | -93 | -77 | -63 | -52 | -43 | -36 | -32 | -29 | -28 | -29 | -32 | -36 | -43 | -52 | -63 | -77 | -93 | -111 | -131 |
| 3 | -118 | -98 | -80 | -64 | -51 | -40 | -32 | -25 | -21 | -19 | -18 | -19 | -21 | -25 | -32 | -40 | -51 | -64 | -80 | -98 | -118 |
| 4 | -107 | -87 | -69 | -54 | -41 | -31 | -23 | -17 | -13 | -11 | -10 | -11 | -13 | -17 | -23 | -31 | -41 | -54 | -69 | -87 | -107 |
| 5 | -99 | -79 | -61 | -46 | -34 | -24 | -16 | -11 | -7 | -6 | -5 | -6 | -7 | -11 | -16 | -24 | -34 | -46 | -61 | -79 | -99 |
| 6 | -93 | -73 | -55 | -40 | -28 | -19 | -12 | -7 | -4 | -2 | -2 | -2 | -4 | -7 | -12 | -19 | -28 | -40 | -55 | -73 | -93 |
| 7 | -88 | -68 | -51 | -36 | -25 | -15 | -9 | -4 | -2 | -1 | 0 | -1 | -2 | -4 | -9 | -15 | -25 | -36 | -51 | -68 | -88 |
| 8 | -86 | -66 | -49 | -35 | -23 | -14 | -7 | -3 | -1 | 0 | 0 | 0 | -1 | -3 | -7 | -14 | -23 | -35 | -49 | -66 | -86 |
| 9 | -86 | -66 | -49 | -35 | -23 | -14 | -7 | -3 | -1 | 0 | 0 | 0 | -1 | -3 | -7 | -14 | -23 | -35 | -49 | -66 | -86 |
| 10 | -88 | -68 | -51 | -36 | -25 | -15 | -9 | -4 | -2 | -1 | 0 | -1 | -2 | -4 | -9 | -15 | -25 | -36 | -51 | -68 | -88 |
| 11 | -93 | -73 | -55 | -40 | -28 | -19 | -12 | -7 | -4 | -2 | -2 | -2 | -4 | -7 | -12 | -19 | -28 | -40 | -55 | -73 | -93 |
| 12 | -99 | -79 | -61 | -46 | -34 | -24 | -16 | -11 | -7 | -6 | -5 | -6 | -7 | -11 | -16 | -24 | -34 | -46 | -61 | -79 | -99 |
| 13 | -107 | -87 | -69 | -54 | -41 | -31 | -23 | -17 | -13 | -11 | -10 | -11 | -13 | -17 | -23 | -31 | -41 | -54 | -69 | -87 | -107 |
| 14 | -118 | -98 | -80 | -64 | -51 | -40 | -32 | -25 | -21 | -19 | -18 | -19 | -21 | -25 | -32 | -40 | -51 | -64 | -80 | -98 | -118 |
| 15 | -131 | -111 | -93 | -77 | -63 | -52 | -43 | -36 | -32 | -29 | -28 | -29 | -32 | -36 | -43 | -52 | -63 | -77 | -93 | -111 | -131 |
| 16 | -145 | -125 | -107 | -92 | -78 | -66 | -57 | -50 | -45 | -42 | -41 | -42 | -45 | -50 | -57 | -66 | -78 | -92 | -107 | -125 | -145 |

Figure 9 - Matrix of the Values of the pixel shift due to distortion

RESULTS OF STUDY

The figures below show plots of the measured distortion. The Y axis represents the linear distance a pixel has shifted relative to the camera sensor, and the X axis shows the distance the pixel is from the center of the camera sensor. Distances are in pixels based of a 10 MP (3648 x 2736 pixel) image. Five different lens focal lengths that range from 28mm to 50mm, and a total of 69 cameras were all analyzed in this study. This criterion was used to be able to gain a broad range of how distortion differs among different cameras, how the focal length affects the type and magnitude of the distortion, and how the distortion may be different depending on the region of the image itself.

Several interesting patterns emerge from these graphs. First, the center of the image contains the least amount of distortion, and as distortion is measured away from the center the distortion increases. In other words a straight line would demonstrate no distortion, so the curved lines show distortion more prevalent the farther away from the center that region is. The shape in these graphs also visually demonstrates the type of distortion. Barrel distortion, which in a sense expands the image, shows the pixels moving closer to the center when distorted, and hence the graphs that curve downward are barrel distortions. In contrast as the curve becomes more convex, it demonstrates the pixels pinched at the center, which is called pin cushioning. In short, barreling is exhibited more by the focal lengths that are wide angle, while pin cushioning is exhibited by zoom focal lengths.



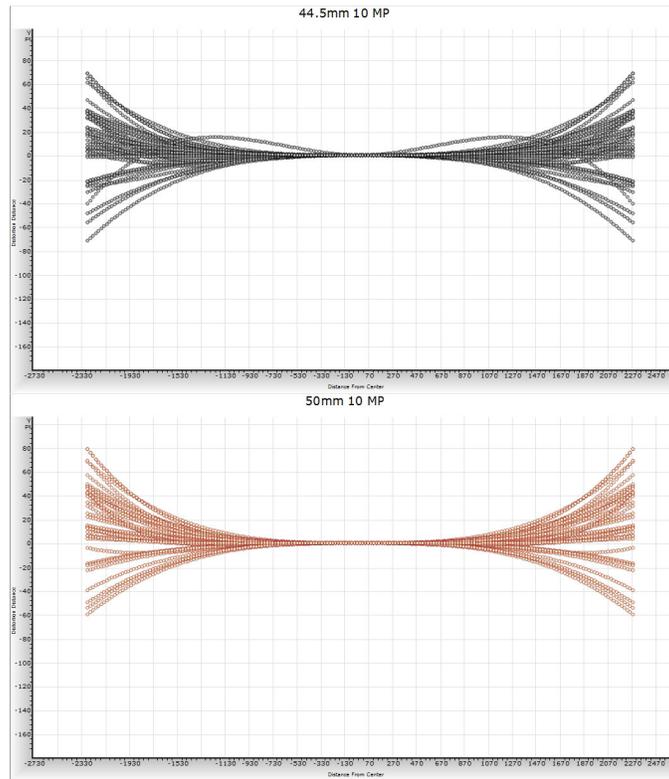


Figure 10 – *Graphs of distortion of varying focal lengths (all cameras)*

To see how the average distortion for each focal length compares, the graph in Figure 11 shows all focal lengths together. A best fit curve was used for each focal length, to obtain an average distortion. Each average has been represented here in a different color to illustrate how distortion differs based on the focal length used.

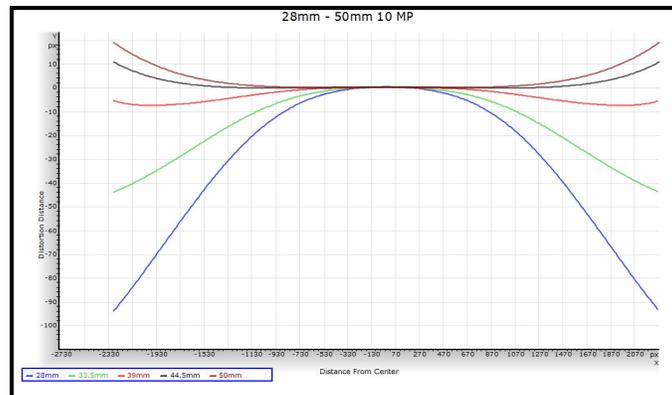


Figure 11 – *Graph of average distortion of the focal lengths for all cameras*

The graph in Figure 11 represents the average distortion for each specific focal length. An average of all 35 cameras for each focal length was plotted, and then represented with the other focal lengths to get a generalized idea of how focal length affects the amount of lens distortion in the image. The wide angle focal length of 28mm, showed the most distortion, and this distortion was most prevalent in the edges of the image. This may be significant since many investigator photos, or police photos that are later used in photogrammetric process of accident reconstruction, are often taken with wide angle focal lengths. The wide angle affords the documentation of a wide field of view, allowing more information to be obtained in one photograph. Police photographs often use wide angle focal lengths to benefit from this larger field of view. Using a wider field of view is particularly useful, for instance, when photographing objects up close such as damage on a vehicle. Focal lengths around 50mm tended to contain the least amount of lens distortion, though it was around this focal length, that many camera lenses began changing from barrel distortion to pin cushion distortion.

EFFECT OF LENS DISTORTION IN REAL-WORLD MEASUREMENTS

To evaluate how lens distortion might ultimately play a role in accident reconstruction methods, an idealized scene was created that has a tire mark on a flat surface. This tire mark is representative of a yaw mark consistent with a highway accident. It has known dimensions, curvature, length etc since it is a computer generated in a scaled computer environment. It is also “photographed” or rendered with an idealized computer camera so there is no distortion in the rendered image. While an idealized scene may differ from actual scene since it does not include features such as roadway pitch, roadway elevation and curvature, the affect of lens distortion can still be assessed.

Below, in Figure 12 is an idealized scene, with a flat road, and a tire mark representative of a yaw mark commonly found on a roadway involving an accident. On the right side of the image is the same tire mark and flat roadway grid viewed from above. It is in this view from above that measurements can be compared of the location of the tire mark in its undistorted form and its distorted form. Figure 12 shows on the left the idealized flat roadway, and tire mark rendered in the computer, and on the right is the same roadway and mark but viewed from above.

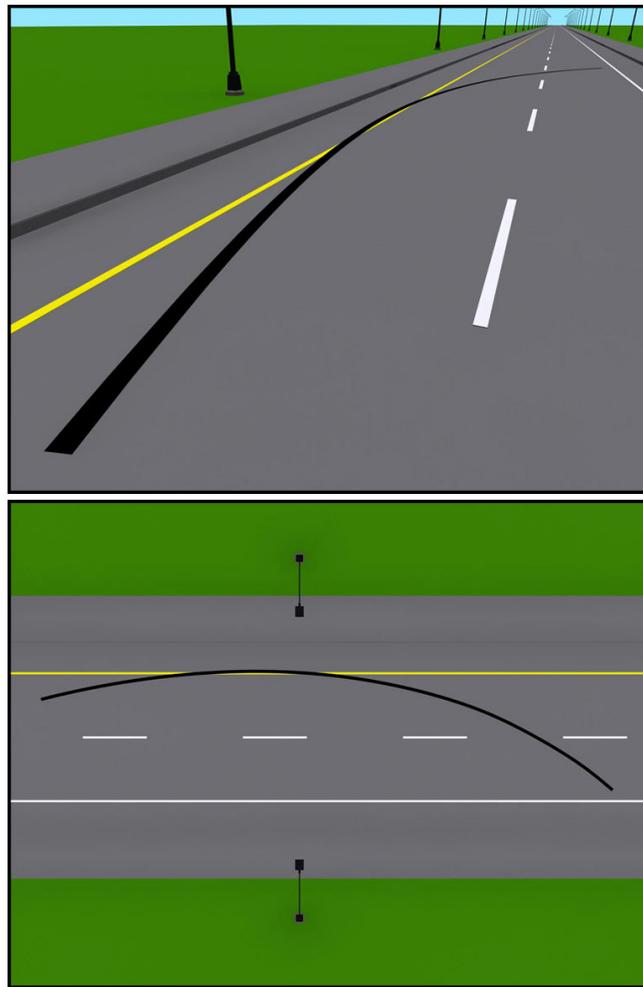


Figure 12 – *Computer generated idealized tire mark*

Using a Canon SLR EF 28-300mm f/3.5-5, which is a fairly common digital SLR camera, the idealize image was distorted according to the distortion coefficients obtained from the PT Lens Database. These coefficients are quantified as follows” $A = .013512$, $B = -.044163$, and $C = 0.0$. Shown in Figure 13 below, is the comparison of the results, viewed from above of the tire mark in the undistorted form, and the tire mark in the distorted form. The undistorted form of the tire mark is labeled and shown in black, with the distorted mark shown in blue. The radius of the tire mark from the undistorted image is 94.83’, while the radius measured for the tire mark after being distorted is 73.75’. This is an overall change in the curvature of 21.08’. Regardless of how this data is used, the difference in shape, position, and measurement of the tire mark can make a difference when using accident reconstruction methods. As

an example, the critical speed formula was applied to demonstrate how a difference in the measurement of the tire mark can make a difference in the ending results of the accident reconstruction analysis.

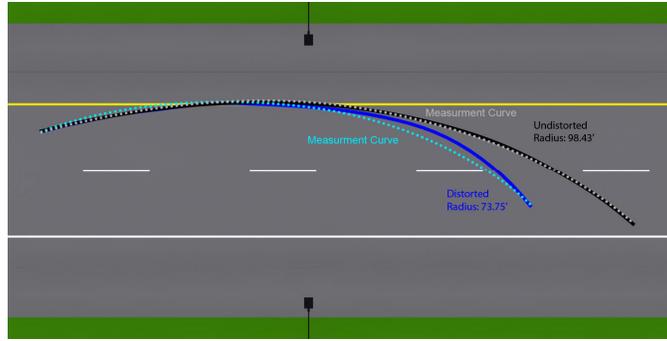


Figure 13 – Comparison of tire marks from distorted and undistorted images

The undistorted image yielded a circle with a radius of 94.83’ inches while the uncorrected image yielded a radius of 73.75’ inches. To illustrate how the different measurements obtained from uncorrected and corrected images can affect a speed analysis; the following critical speed formula was used [9]:

$$V_{cr} = \sqrt{g \cdot f \cdot R} \tag{3}$$

Where g is gravity, f is the tire frictional coefficient and R is the radius of the path of the leading front tire. A typical tire frictional coefficient of .75, for dry asphalt, was used in this analysis. The difference in radius yielded a total difference in the speed calculation from 47.8 mph to 42.2 mph, a total difference of 5.6mph simply from the affects of lens distortion. In addition to creating differences in speed analysis through critical speed formulas, photogrammetric measurements of corrected images can also create differences in where the location of the point of impact is, or the points of rest for a vehicle. The length of a tire mark and its location to other evidence can also be off, adding to potential errors in accident reconstruction analysis.

CONCLUSIONS

The graphs shown in Figures 10 represent the actual distortion measured for each camera, and though some cameras exhibit more distortion than other the general pattern of distortion is still present. The pattern also shows that distortion is more apparent the farther away from the center of the image. What makes a bigger difference than what camera is used however, is the focal length at which the image is taken. This is exhibited most clearly in Figure 11, where averages for all the cameras are provided for each specific focal length measured. It is clear from these plots that a 50 mm lens has the least distortion, and as the focal length decreases or increases from a 50mm lens there is also an increase in distortion. The amount of distortion in an image is usually not visually evident because the distortion is continues across the image. For this reason, correcting distortion may not be needed for all practices in analyzing photographs, where precise location, scale or measurements are not required. Objects that are straight in the real world, such as a sign pole, may appear curved in an image, offering a suitable reference for distortion, but without such a reference, it may be difficult to visually recognize the distortion. However, when this distortion is assessed for its impact on measurements needed to perform accident reconstruction calculations, the importance of correcting distortion becomes clear. One of the reasons that distortion may affect measurements of evidence such as tire marks lies in the principles that define perspective. Objects that are farther away appear smaller. Objects diminish according to inverse square laws. This makes a tire mark which continues to recede in the distance of a photograph, susceptible to the affects of a diminishing perspective. As a result the parts of the tire mark that are farther away are represented with fewer pixels. Since fewer pixels define the object, even small changes in the shift of pixels can affect an overall measurement or curvature for the tire mark. Photos taken more parallel to the surface one is photographing has even more effect from distortion than a photo taken more perpendicular to the surface, such as satellite images, or aerial photographs from aircraft. For this reason, photographs taken from above, and that offer more of a top view than a perspective may have minimal effects from lens distortion when performing photogrammetric measurements. However, photographs taken at eye level, particularly photos taken with focal lengths that are wide angle or zoom, and most susceptible to the effects of lens distortion should be corrected prior to any photogrammetric analysis. Fortunately, some of the more widely used image editing tools such as Photoshop CS 5 package now have built in lens correction modules that can be used by entering distortion coefficients (obtained manually as described above, or downloaded from sites listed in the references that publish these coefficients). In addition, several popular photogrammetry software programs such as Photomodeler also have tools for assessing and correcting lens distortion.

The analysis presented in this paper demonstrates that eliminating distortion from an image improves the accuracy of the photogrammetric methods. Further studies related to other sources of photogrammetric measurement error would be useful to help understand all errors associated with photogrammetric processes, but this is beyond the scope of this study. In the study reported here, each camera exhibited a different amount of geometric distortion and as Appendix A shows, the error changes even depending on the region that the distortion was measured. Hence, factors that influence the final measurements include the location of the point being measured, the camera type used, and the focal length.

REFERENCES

1. Goldberg, Norman. *Camera Technology – The Dark Side of the Lens*. San Diego: Academic Press Inc., 1992. Print
2. Taylor, J. Traill. *The Optics of Photography and photographic Lenses*. Adamant Media Corporation, 2005. Print.
3. PanoTools Contributors. *Lens correction model*. 2010. Retrieved September 29, 2010 from http://wiki.panotools.org/Lens_correction_model.
4. [Tom Niemann](http://epaperpress.com/ptlens/index.html). EpaperPress. Ptlens. Version 8.7.8. <http://epaperpress.com/ptlens/index.html>.
5. Pablo d'Angelo. Hugin. Version 2009.4.0. <http://hugin.sourceforge.net>
6. Liu, Dale. *Cisco Router and Switch Forensics: Investigating and Analyzing Malicious Network Activity*. Burlington, MA: Syngress Publ., 2009. Print. Page 30.
7. [Tom Niemann](http://epaperpress.com/ptlens/index.html). EpaperPress. Ptlens. Version 8.7.8. <http://epaperpress.com/ptlens/index.html>
8. Kelby, Scott. *The Adobe Photoshop CS4 Book for Digital Photographers*. 1st ed. Indianapolis, IN: New Riders Press, 2009. Print.
9. Daily, John, Shigemura, Nathan, Daily, Jeremy. "Fundamentals of Traffic Crash Reconstruction." IPTM, 2006.

CONTACT INFORMATION

William T.C. Neale
Kineticorp, LLC
6070 Greenwood Plaza Blvd. #200
Greenwood Village, CO 80111
303-733-1888
wneale@kineticorp.com

APPENDIX A (DISTORTION DISTANCE, PER CAMERA, PER FOCAL LENGTH)

| canonEfsSLR Canon EF-S 17-85mm f/4-5.6 IS USM | | | | | | | | | | | | | |
|---|---------------|--------|-------|--------|-------|--------|-------|--------|--------|--------|--------|--------|-------|
| 28.0mm | | | | | | | | | | | | | |
| Radius (pixels) | Dist (pixels) | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.3 | 342 | -1 | 456 | -2.4 | 570 | -4.5 | 684 | -7.6 |
| 798 | -11.6 | 912 | -16.6 | 1026 | -22.6 | 1140 | -29.6 | 1254 | -37.6 | 1368 | -46.4 | 1482 | -56 |
| 1596 | -66.1 | 1710 | -76.6 | 1824 | -87.3 | 1938 | -97.9 | 2052 | -108.1 | 2166 | -117.6 | 2280 | -126 |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.2 | 342 | -0.6 | 456 | -1.5 | 570 | -2.7 | 684 | -4.5 |
| 798 | -6.8 | 912 | -9.6 | 1026 | -12.8 | 1140 | -16.5 | 1254 | -20.4 | 1368 | -24.5 | 1482 | -28.6 |
| 1596 | -32.5 | 1710 | -36.1 | 1824 | -39.1 | 1938 | -41.2 | 2052 | -42.1 | 2166 | -41.5 | 2280 | -39.2 |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.3 | 456 | -0.6 | 570 | -1.2 | 684 | -1.9 |
| 798 | -2.8 | 912 | -3.8 | 1026 | -4.9 | 1140 | -5.9 | 1254 | -6.8 | 1368 | -7.4 | 1482 | -7.6 |
| 1596 | -7.3 | 1710 | -6.2 | 1824 | -4.2 | 1938 | -1 | 2052 | 3.4 | 2166 | 9.7 | 2280 | 17.8 |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.2 | 570 | -0.4 | 684 | -0.6 |
| 798 | -0.8 | 912 | -1 | 1026 | -1 | 1140 | -0.8 | 1254 | -0.4 | 1368 | 0.3 | 1482 | 1.6 |
| 1596 | 3.5 | 1710 | 6.2 | 1824 | 9.8 | 1938 | 14.5 | 2052 | 20.4 | 2166 | 27.7 | 2280 | 36.8 |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 4.5 | 228 | 0 | 342 | 0 | 456 | 0 | 570 | 0.1 | 684 | 0.3 |
| 798 | 0.6 | 912 | 1.1 | 1026 | 1.8 | 1140 | 2.8 | 1254 | 4.2 | 1368 | 6 | 1482 | 8.3 |

| | | | | | | | | | | | | | |
|--------------------------------------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|
| 1596 | 11.2 | 1710 | 14.9 | 1824 | 19.4 | 1938 | 24.8 | 2052 | 31.3 | 2166 | 38.9 | 2280 | 47.9 |
| | | | | | | | | | | | | | |
| canonSLR Canon EF 24-70mm f/2.8L USM | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.6 | 456 | -1.4 | 570 | -2.7 | 684 | -4.5 |
| 798 | -6.9 | 912 | -9.8 | 1026 | -13.3 | 1140 | -17.4 | 1254 | -21.9 | 1368 | -26.9 | 1482 | -32.2 |
| 1596 | -37.7 | 1710 | -43.3 | 1824 | -48.8 | 1938 | -54 | 2052 | -58.8 | 2166 | -62.9 | 2280 | -66.1 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.3 | 456 | -0.7 | 570 | -1.3 | 684 | -2.2 |
| 798 | -3.4 | 912 | -4.9 | 1026 | -6.6 | 1140 | -8.6 | 1254 | -10.9 | 1368 | -13.3 | 1482 | -15.8 |
| 1596 | -18.5 | 1710 | -21.1 | 1824 | -23.7 | 1938 | -26.1 | 2052 | -28.1 | 2166 | -29.8 | 2280 | -30.9 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.2 | 570 | -0.4 | 684 | -0.8 |
| 798 | -1.2 | 912 | -1.7 | 1026 | -2.4 | 1140 | -3.1 | 1254 | -3.9 | 1368 | -4.8 | 1482 | -5.8 |
| 1596 | -6.9 | 1710 | -7.9 | 1824 | -9 | 1938 | -10.1 | 2052 | -11 | 2166 | -11.9 | 2280 | -12.7 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0 | 570 | 0 | 684 | 0.1 |
| 798 | 0.2 | 912 | 0.3 | 1026 | 0.5 | 1140 | 0.7 | 1254 | 1 | 1368 | 1.3 | 1482 | 1.6 |
| 1596 | 2 | 1710 | 2.5 | 1824 | 3.1 | 1938 | 3.7 | 2052 | 4.4 | 2166 | 5.2 | 2280 | 6 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0.1 | 570 | 0.2 | 684 | 0.3 |
| 798 | 0.6 | 912 | 0.8 | 1026 | 1.2 | 1140 | 1.7 | 1254 | 2.3 | 1368 | 3 | 1482 | 3.8 |

| | | | | | | | | | | | | | |
|--|-------|--------|------|--------|-------|--------|-------|--------|-------|--------|-------|--------|------|
| 1596 | 4.8 | 1710 | 5.9 | 1824 | 7.1 | 1938 | 8.6 | 2052 | 10.2 | 2166 | 12 | 2280 | 14 |
| | | | | | | | | | | | | | |
| canonSLR Canon EF 24-105mm f/4L IS USM | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.4 | 456 | -1 | 570 | -1.9 | 684 | -3.2 |
| 798 | -4.9 | 912 | -6.9 | 1026 | -9.4 | 1140 | -12.1 | 1254 | -15.2 | 1368 | -18.5 | 1482 | -22 |
| 1596 | -25.5 | 1710 | -29 | 1824 | -32.2 | 1938 | -35.1 | 2052 | -37.5 | 2166 | -39.2 | 2280 | -40 |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.2 | 456 | -0.4 | 570 | -0.8 | 684 | -1.3 |
| 798 | -1.9 | 912 | -2.7 | 1026 | -3.5 | 1140 | -4.2 | 1254 | -5 | 1368 | -5.6 | 1482 | -6 |
| 1596 | -6.2 | 1710 | -5.9 | 1824 | -5 | 1938 | -3.6 | 2052 | -1.3 | 2166 | 1.9 | 2280 | 6.3 |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | -0.1 | 570 | -0.2 | 684 | -0.3 |
| 798 | -0.4 | 912 | -0.4 | 1026 | -0.3 | 1140 | 0 | 1254 | 0.4 | 1368 | 1.1 | 1482 | 2.3 |
| 1596 | 3.9 | 1710 | 6.1 | 1824 | 8.9 | 1938 | 12.5 | 2052 | 17 | 2166 | 22.6 | 2280 | 29.4 |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0.1 | 570 | 0.2 | 684 | 0.4 |
| 798 | 0.8 | 912 | 1.3 | 1026 | 2.1 | 1140 | 3.2 | 1254 | 4.6 | 1368 | 6.4 | 1482 | 8.7 |
| 1596 | 11.6 | 1710 | 15.1 | 1824 | 19.4 | 1938 | 24.6 | 2052 | 30.6 | 2166 | 37.8 | 2280 | 46.2 |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0.1 | 456 | 0.2 | 570 | 0.5 | 684 | 1 |

| | | | | | | | | | | | | | |
|---|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|--------|--------|--------|
| 798 | 1.7 | 912 | 2.6 | 1026 | 3.8 | 1140 | 5.4 | 1254 | 7.4 | 1368 | 9.9 | 1482 | 13 |
| 1596 | 16.7 | 1710 | 21.1 | 1824 | 26.3 | 1938 | 32.4 | 2052 | 39.5 | 2166 | 47.5 | 2280 | 56.8 |
| | | | | | | | | | | | | | |
| canonSLR Canon EF 28-105mm f/3.5-4.5 II USM | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.2 | 342 | -0.7 | 456 | -1.7 | 570 | -3.3 | 684 | -5.6 |
| 798 | -8.6 | 912 | -12.5 | 1026 | -17.1 | 1140 | -22.6 | 1254 | -29 | 1368 | -36.1 | 1482 | -44 |
| 1596 | -52.5 | 1710 | -61.7 | 1824 | -71.3 | 1938 | -81.2 | 2052 | -91.2 | 2166 | -101.3 | 2280 | -111.1 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.3 | 456 | -0.7 | 570 | -1.4 | 684 | -2.4 |
| 798 | -3.7 | 912 | -5.3 | 1026 | -7.2 | 1140 | -9.5 | 1254 | -12 | 1368 | -14.8 | 1482 | -17.8 |
| 1596 | -20.9 | 1710 | -24.2 | 1824 | -27.4 | 1938 | -30.6 | 2052 | -33.6 | 2166 | -36.3 | 2280 | -38.6 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | -0.1 | 570 | -0.3 | 684 | -0.5 |
| 798 | -0.7 | 912 | -1 | 1026 | -1.3 | 1140 | -1.6 | 1254 | -1.8 | 1368 | -2 | 1482 | -2.1 |
| 1596 | -2 | 1710 | -1.7 | 1824 | -1.2 | 1938 | -0.4 | 2052 | 0.8 | 2166 | 2.4 | 2280 | 4.6 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0.1 | 570 | 0.3 | 684 | 0.6 |
| 798 | 1 | 912 | 1.6 | 1026 | 2.3 | 1140 | 3.2 | 1254 | 4.4 | 1368 | 5.8 | 1482 | 7.5 |
| 1596 | 9.6 | 1710 | 12 | 1824 | 14.9 | 1938 | 18.2 | 2052 | 21.9 | 2166 | 26.2 | 2280 | 31.1 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0.1 | 456 | 0.3 | 570 | 0.7 | 684 | 1.3 |

| | | | | | | | | | | | | | |
|--|-------|--------|-------|--------|-------|--------|-------|--------|--------|--------|--------|--------|-------|
| 798 | 2.1 | 912 | 3.1 | 1026 | 4.4 | 1140 | 6.1 | 1254 | 8.1 | 1368 | 10.6 | 1482 | 13.5 |
| 1596 | 16.9 | 1710 | 20.7 | 1824 | 25.2 | 1938 | 30.2 | 2052 | 35.9 | 2166 | 42.2 | 2280 | 49.2 |
| | | | | | | | | | | | | | |
| canonSLR Canon EF 28-300mm f/3.5-5.6L IS USM | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.2 | 342 | -0.8 | 456 | -2 | 570 | -3.8 | 684 | -6.3 |
| 798 | -9.8 | 912 | -14.2 | 1026 | -19.6 | 1140 | -26 | 1254 | -33.4 | 1368 | -41.9 | 1482 | -51.3 |
| 1596 | -61.6 | 1710 | -72.8 | 1824 | -84.7 | 1938 | -97.3 | 2052 | -110.3 | 2166 | -123.6 | 2280 | -137 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.4 | 456 | -1 | 570 | -2 | 684 | -3.3 |
| 798 | -5.1 | 912 | -7.2 | 1026 | -9.8 | 1140 | -12.8 | 1254 | -16.1 | 1368 | -19.7 | 1482 | -23.6 |
| 1596 | -27.6 | 1710 | -31.6 | 1824 | -35.6 | 1938 | -39.3 | 2052 | -42.6 | 2166 | -45.4 | 2280 | -47.5 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0.1 | 456 | 0.3 | 570 | 0.6 | 684 | 1 |
| 798 | 1.7 | 912 | 2.6 | 1026 | 3.7 | 1140 | 5.2 | 1254 | 7 | 1368 | 9.2 | 1482 | 11.8 |
| 1596 | 14.9 | 1710 | 18.5 | 1824 | 22.7 | 1938 | 27.5 | 2052 | 32.9 | 2166 | 39 | 2280 | 45.9 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0.2 | 456 | 0.4 | 570 | 0.9 | 684 | 1.6 |
| 798 | 2.6 | 912 | 3.9 | 1026 | 5.5 | 1140 | 7.6 | 1254 | 10.1 | 1368 | 13.1 | 1482 | 16.7 |
| 1596 | 20.9 | 1710 | 25.7 | 1824 | 31.2 | 1938 | 37.5 | 2052 | 44.5 | 2166 | 52.3 | 2280 | 61 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0.2 | 456 | 0.5 | 570 | 1 | 684 | 1.8 |

| | | | | | | | | | | | | | |
|---|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|--------|
| 798 | 2.9 | 912 | 4.3 | 1026 | 6.2 | 1140 | 8.5 | 1254 | 11.3 | 1368 | 14.7 | 1482 | 18.7 |
| 1596 | 23.4 | 1710 | 28.8 | 1824 | 34.9 | 1938 | 41.9 | 2052 | 49.8 | 2166 | 58.5 | 2280 | 68.3 |
| | | | | | | | | | | | | | |
| canonSLR Canon EF 28-135mm f/3.5-5.6 IS USM | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.2 | 342 | -0.8 | 456 | -1.8 | 570 | -3.5 | 684 | -5.9 |
| 798 | -9 | 912 | -13 | 1026 | -17.7 | 1140 | -23.3 | 1254 | -29.7 | 1368 | -36.9 | 1482 | -44.7 |
| 1596 | -53.1 | 1710 | -61.9 | 1824 | -70.9 | 1938 | -80.1 | 2052 | -89.3 | 2166 | -98.1 | 2280 | -106.3 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.5 | 456 | -1.1 | 570 | -2.1 | 684 | -3.5 |
| 798 | -5.4 | 912 | -7.7 | 1026 | -10.5 | 1140 | -13.7 | 1254 | -17.2 | 1368 | -21.2 | 1482 | -25.3 |
| 1596 | -29.7 | 1710 | -34.1 | 1824 | -38.4 | 1938 | -42.5 | 2052 | -46.3 | 2166 | -49.5 | 2280 | -52 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0 | 570 | -0.1 | 684 | -0.2 |
| 798 | -0.2 | 912 | -0.3 | 1026 | -0.4 | 1140 | -0.4 | 1254 | -0.4 | 1368 | -0.3 | 1482 | -0.2 |
| 1596 | 0 | 1710 | 0.4 | 1824 | 1 | 1938 | 1.9 | 2052 | 2.9 | 2166 | 4.3 | 2280 | 6 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0.1 | 456 | 0.3 | 570 | 0.5 | 684 | 1 |
| 798 | 1.6 | 912 | 2.4 | 1026 | 3.4 | 1140 | 4.7 | 1254 | 6.2 | 1368 | 8.1 | 1482 | 10.3 |
| 1596 | 12.9 | 1710 | 15.8 | 1824 | 19.2 | 1938 | 23.1 | 2052 | 27.4 | 2166 | 32.2 | 2280 | 37.6 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0.1 | 456 | 0.3 | 570 | 0.7 | 684 | 1.2 |

| | | | | | | | | | | | | | |
|--------------------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|--------|--------|--------|
| 798 | 2 | 912 | 3 | 1026 | 4.3 | 1140 | 5.9 | 1254 | 7.8 | 1368 | 10.2 | 1482 | 13 |
| 1596 | 16.2 | 1710 | 20 | 1824 | 24.3 | 1938 | 29.1 | 2052 | 34.6 | 2166 | 40.7 | 2280 | 47.4 |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| fujiS9000 Standard | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.3 | 342 | -1 | 456 | -2.3 | 570 | -4.4 | 684 | -7.4 |
| 798 | -11.3 | 912 | -16.1 | 1026 | -21.9 | 1140 | -28.5 | 1254 | -36 | 1368 | -44.2 | 1482 | -53 |
| 1596 | -62.2 | 1710 | -71.5 | 1824 | -80.7 | 1938 | -89.6 | 2052 | -97.7 | 2166 | -104.8 | 2280 | -110.4 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.5 | 456 | -1.3 | 570 | -2.5 | 684 | -4.1 |
| 798 | -6.3 | 912 | -9.1 | 1026 | -12.4 | 1140 | -16.2 | 1254 | -20.5 | 1368 | -25.3 | 1482 | -30.4 |
| 1596 | -35.8 | 1710 | -41.4 | 1824 | -47 | 1938 | -52.5 | 2052 | -57.7 | 2166 | -62.4 | 2280 | -66.5 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.3 | 456 | -0.6 | 570 | -1.3 | 684 | -2.1 |
| 798 | -3.3 | 912 | -4.8 | 1026 | -6.6 | 1140 | -8.7 | 1254 | -11.1 | 1368 | -13.8 | 1482 | -16.8 |
| 1596 | -20 | 1710 | -23.4 | 1824 | -26.9 | 1938 | -30.5 | 2052 | -34.2 | 2166 | -37.7 | 2280 | -41.1 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.2 | 456 | -0.5 | 570 | -1 | 684 | -1.7 |
| 798 | -2.7 | 912 | -3.8 | 1026 | -5.2 | 1140 | -6.8 | 1254 | -8.6 | 1368 | -10.5 | 1482 | -12.6 |
| 1596 | -14.7 | 1710 | -16.9 | 1824 | -19.1 | 1938 | -21.2 | 2052 | -23 | 2166 | -24.6 | 2280 | -25.9 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.4 | 570 | -0.7 | 684 | -1.2 |

| | | | | | | | | | | | | | |
|--|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|
| 798 | -1.8 | 912 | -2.5 | 1026 | -3.3 | 1140 | -4.2 | 1254 | -5.1 | 1368 | -6 | 1482 | -6.8 |
| 1596 | -7.5 | 1710 | -8 | 1824 | -8.2 | 1938 | -8 | 2052 | -7.3 | 2166 | -6.1 | 2280 | -4.1 |
| | | | | | | | | | | | | | |
| genericSLR Sigma 17-35mm f/2.8-4 EX DG | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.4 | 456 | -1 | 570 | -1.9 | 684 | -3.3 |
| 798 | -5.1 | 912 | -7.4 | 1026 | -10.2 | 1140 | -13.5 | 1254 | -17.4 | 1368 | -21.9 | 1482 | -26.8 |
| 1596 | -32.3 | 1710 | -38.2 | 1824 | -44.6 | 1938 | -51.3 | 2052 | -58.3 | 2166 | -65.5 | 2280 | -72.8 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.4 | 456 | -1 | 570 | -1.9 | 684 | -3.2 |
| 798 | -4.9 | 912 | -7.1 | 1026 | -9.8 | 1140 | -12.9 | 1254 | -16.5 | 1368 | -20.5 | 1482 | -25 |
| 1596 | -29.7 | 1710 | -34.8 | 1824 | -40.1 | 1938 | -45.6 | 2052 | -51.1 | 2166 | -56.5 | 2280 | -61.7 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.2 | 456 | -0.6 | 570 | -1.2 | 684 | -2 |
| 798 | -3.1 | 912 | -4.5 | 1026 | -6.3 | 1140 | -8.3 | 1254 | -10.7 | 1368 | -13.4 | 1482 | -16.4 |
| 1596 | -19.7 | 1710 | -23.2 | 1824 | -27 | 1938 | -31 | 2052 | -35.1 | 2166 | -39.3 | 2280 | -43.5 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | -0.1 | 570 | -0.3 | 684 | -0.5 |
| 798 | -0.9 | 912 | -1.4 | 1026 | -2 | 1140 | -2.7 | 1254 | -3.6 | 1368 | -4.7 | 1482 | -6 |
| 1596 | -7.5 | 1710 | -9.2 | 1824 | -11.2 | 1938 | -13.5 | 2052 | -16 | 2166 | -18.8 | 2280 | -22 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | -0.1 | 570 | -0.2 | 684 | -0.4 |

| | | | | | | | | | | | | | |
|---|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|--------|
| 798 | -0.7 | 912 | -1.1 | 1026 | -1.6 | 1140 | -2.1 | 1254 | -2.9 | 1368 | -3.7 | 1482 | -4.8 |
| 1596 | -6 | 1710 | -7.4 | 1824 | -8.9 | 1938 | -10.7 | 2052 | -12.8 | 2166 | -15 | 2280 | -17.5 |
| | | | | | | | | | | | | | |
| genericSLR Sigma 17-70mm f/2.8-4.5 DC Macro | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.2 | 342 | -0.8 | 456 | -2 | 570 | -3.8 | 684 | -6.3 |
| 798 | -9.7 | 912 | -13.9 | 1026 | -18.9 | 1140 | -24.8 | 1254 | -31.4 | 1368 | -38.8 | 1482 | -46.7 |
| 1596 | -55.1 | 1710 | -63.9 | 1824 | -72.7 | 1938 | -81.4 | 2052 | -89.8 | 2166 | -97.6 | 2280 | -104.4 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.5 | 456 | -1.2 | 570 | -2.3 | 684 | -3.9 |
| 798 | -6 | 912 | -8.6 | 1026 | -11.8 | 1140 | -15.4 | 1254 | -19.6 | 1368 | -24.2 | 1482 | -29.3 |
| 1596 | -34.6 | 1710 | -40.2 | 1824 | -45.9 | 1938 | -51.5 | 2052 | -57 | 2166 | -62.2 | 2280 | -66.9 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.2 | 456 | -0.4 | 570 | -0.9 | 684 | -1.5 |
| 798 | -2.3 | 912 | -3.3 | 1026 | -4.6 | 1140 | -6 | 1254 | -7.6 | 1368 | -9.4 | 1482 | -11.3 |
| 1596 | -13.4 | 1710 | -15.5 | 1824 | -17.6 | 1938 | -19.7 | 2052 | -21.7 | 2166 | -23.5 | 2280 | -25.1 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0 | 570 | 0.1 | 684 | 0.2 |
| 798 | 0.3 | 912 | 0.4 | 1026 | 0.5 | 1140 | 0.7 | 1254 | 0.8 | 1368 | 1 | 1482 | 1.1 |
| 1596 | 1.2 | 1710 | 1.2 | 1824 | 1.2 | 1938 | 1 | 2052 | 0.8 | 2166 | 0.4 | 2280 | 0 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0.2 | 570 | 0.4 | 684 | 0.6 |

| | | | | | | | | | | | | | |
|--------------------------------------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|
| 798 | 1 | 912 | 1.4 | 1026 | 1.9 | 1140 | 2.5 | 1254 | 3.2 | 1368 | 3.9 | 1482 | 4.6 |
| 1596 | 5.4 | 1710 | 6.2 | 1824 | 7 | 1938 | 7.7 | 2052 | 8.4 | 2166 | 8.9 | 2280 | 9.3 |
| | | | | | | | | | | | | | |
| genericSLR Sigma 18-50mm f/2.8 EX DC | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.2 | 342 | -0.6 | 456 | -1.5 | 570 | -3 | 684 | -5 |
| 798 | -7.6 | 912 | -11 | 1026 | -15.1 | 1140 | -19.8 | 1254 | -25.3 | 1368 | -31.4 | 1482 | -38 |
| 1596 | -45.2 | 1710 | -52.8 | 1824 | -60.6 | 1938 | -68.6 | 2052 | -76.5 | 2166 | -84.1 | 2280 | -91.4 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.3 | 456 | -0.8 | 570 | -1.6 | 684 | -2.8 |
| 798 | -4.2 | 912 | -6 | 1026 | -8.2 | 1140 | -10.8 | 1254 | -13.7 | 1368 | -16.8 | 1482 | -20.2 |
| 1596 | -23.8 | 1710 | -27.5 | 1824 | -31.2 | 1938 | -34.8 | 2052 | -38.3 | 2166 | -41.4 | 2280 | -44 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | -0.2 | 570 | -0.3 | 684 | -0.6 |
| 798 | -1 | 912 | -1.4 | 1026 | -1.9 | 1140 | -2.5 | 1254 | -3.2 | 1368 | -3.9 | 1482 | -4.7 |
| 1596 | -5.6 | 1710 | -6.5 | 1824 | -7.3 | 1938 | -8.2 | 2052 | -9 | 2166 | -9.7 | 2280 | -10.4 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0 | 570 | 0 | 684 | 0 |
| 798 | 0.1 | 912 | 0.2 | 1026 | 0.3 | 1140 | 0.4 | 1254 | 0.5 | 1368 | 0.7 | 1482 | 0.9 |
| 1596 | 1.1 | 1710 | 1.4 | 1824 | 1.7 | 1938 | 2.1 | 2052 | 2.5 | 2166 | 2.9 | 2280 | 3.4 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0 | 570 | 0 | 684 | 0.1 |

| | | | | | | | | | | | | | |
|--|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|
| 798 | 0.2 | 912 | 0.3 | 1026 | 0.5 | 1140 | 0.7 | 1254 | 1 | 1368 | 1.3 | 1482 | 1.6 |
| 1596 | 2 | 1710 | 2.5 | 1824 | 3.1 | 1938 | 3.7 | 2052 | 4.4 | 2166 | 5.2 | 2280 | 6.1 |
| | | | | | | | | | | | | | |
| genericSLR Sigma 18-125mm f/3.3-5.6 (3.5-5.6) DC | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.3 | 342 | -1.1 | 456 | -2.5 | 570 | -4.8 | 684 | -7.9 |
| 798 | -11.9 | 912 | -16.9 | 1026 | -22.7 | 1140 | -29.4 | 1254 | -36.7 | 1368 | -44.4 | 1482 | -52.5 |
| 1596 | -60.5 | 1710 | -68.2 | 1824 | -75.2 | 1938 | -81.2 | 2052 | -85.6 | 2166 | -88.1 | 2280 | -88 |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.2 | 342 | -0.6 | 456 | -1.4 | 570 | -2.6 | 684 | -4.3 |
| 798 | -6.5 | 912 | -9.1 | 1026 | -12 | 1140 | -15.3 | 1254 | -18.8 | 1368 | -22.3 | 1482 | -25.6 |
| 1596 | -28.6 | 1710 | -31.1 | 1824 | -32.7 | 1938 | -33.2 | 2052 | -32.3 | 2166 | -29.6 | 2280 | -24.7 |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.2 | 570 | -0.4 | 684 | -0.6 |
| 798 | -0.7 | 912 | -0.8 | 1026 | -0.7 | 1140 | -0.4 | 1254 | 0.2 | 1368 | 1.3 | 1482 | 3 |
| 1596 | 5.3 | 1710 | 8.6 | 1824 | 12.9 | 1938 | 18.4 | 2052 | 25.3 | 2166 | 33.8 | 2280 | 44.2 |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0.1 | 570 | 0.3 | 684 | 0.6 |
| 798 | 1.1 | 912 | 1.8 | 1026 | 2.9 | 1140 | 4.4 | 1254 | 6.5 | 1368 | 9.1 | 1482 | 12.5 |
| 1596 | 16.8 | 1710 | 22 | 1824 | 28.4 | 1938 | 36.2 | 2052 | 45.3 | 2166 | 56.2 | 2280 | 68.8 |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0.1 | 456 | 0.2 | 570 | 0.5 | 684 | 1 |

| | | | | | | | | | | | | | |
|--|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|
| 798 | 1.8 | 912 | 2.9 | 1026 | 4.4 | 1140 | 6.4 | 1254 | 8.9 | 1368 | 12.2 | 1482 | 16.3 |
| 1596 | 21.3 | 1710 | 27.4 | 1824 | 34.7 | 1938 | 43.3 | 2052 | 53.4 | 2166 | 65.2 | 2280 | 78.8 |
| | | | | | | | | | | | | | |
| genericSLR Sigma 18-125mm f/3.3-5.6 (3.5-5.6) DC | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.3 | 342 | -1.1 | 456 | -2.5 | 570 | -4.8 | 684 | -7.9 |
| 798 | -11.9 | 912 | -16.9 | 1026 | -22.7 | 1140 | -29.4 | 1254 | -36.7 | 1368 | -44.4 | 1482 | -52.5 |
| 1596 | -60.5 | 1710 | -68.2 | 1824 | -75.2 | 1938 | -81.2 | 2052 | -85.6 | 2166 | -88.1 | 2280 | -88 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.2 | 342 | -0.6 | 456 | -1.4 | 570 | -2.6 | 684 | -4.3 |
| 798 | -6.5 | 912 | -9.1 | 1026 | -12 | 1140 | -15.3 | 1254 | -18.8 | 1368 | -22.3 | 1482 | -25.6 |
| 1596 | -28.6 | 1710 | -31.1 | 1824 | -32.7 | 1938 | -33.2 | 2052 | -32.3 | 2166 | -29.6 | 2280 | -24.7 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.2 | 570 | -0.4 | 684 | -0.6 |
| 798 | -0.7 | 912 | -0.8 | 1026 | -0.7 | 1140 | -0.4 | 1254 | 0.2 | 1368 | 1.3 | 1482 | 3 |
| 1596 | 5.3 | 1710 | 8.6 | 1824 | 12.9 | 1938 | 18.4 | 2052 | 25.3 | 2166 | 33.8 | 2280 | 44.2 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0.1 | 570 | 0.3 | 684 | 0.6 |
| 798 | 1.1 | 912 | 1.8 | 1026 | 2.9 | 1140 | 4.4 | 1254 | 6.5 | 1368 | 9.1 | 1482 | 12.5 |
| 1596 | 16.8 | 1710 | 22 | 1824 | 28.4 | 1938 | 36.2 | 2052 | 45.3 | 2166 | 56.2 | 2280 | 68.8 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0.1 | 456 | 0.2 | 570 | 0.5 | 684 | 1 |

| | | | | | | | | | | | | | |
|--|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|--------|--------|-------|
| 798 | 1.8 | 912 | 2.9 | 1026 | 4.4 | 1140 | 6.4 | 1254 | 8.9 | 1368 | 12.2 | 1482 | 16.3 |
| 1596 | 21.3 | 1710 | 27.4 | 1824 | 34.7 | 1938 | 43.3 | 2052 | 53.4 | 2166 | 65.2 | 2280 | 78.8 |
| | | | | | | | | | | | | | |
| genericSLR Sigma 18-200mm f/3.5-6.3 DC | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.3 | 342 | -1.1 | 456 | -2.6 | 570 | -4.9 | 684 | -8.1 |
| 798 | -12.3 | 912 | -17.5 | 1026 | -23.6 | 1140 | -30.6 | 1254 | -38.4 | 1368 | -46.8 | 1482 | -55.7 |
| 1596 | -64.7 | 1710 | -73.6 | 1824 | -82.2 | 1938 | -89.9 | 2052 | -96.4 | 2166 | -101.3 | 2280 | -104 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.5 | 456 | -1.1 | 570 | -2.2 | 684 | -3.5 |
| 798 | -5.3 | 912 | -7.4 | 1026 | -9.8 | 1140 | -12.4 | 1254 | -15.1 | 1368 | -17.8 | 1482 | -20.4 |
| 1596 | -22.6 | 1710 | -24.3 | 1824 | -25.2 | 1938 | -25.1 | 2052 | -23.6 | 2166 | -20.6 | 2280 | -15.7 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.4 | 456 | -1 | 570 | -1.9 | 684 | -3.1 |
| 798 | -4.6 | 912 | -6.4 | 1026 | -8.4 | 1140 | -10.5 | 1254 | -12.7 | 1368 | -14.8 | 1482 | -16.7 |
| 1596 | -18.2 | 1710 | -19.1 | 1824 | -19.2 | 1938 | -18.2 | 2052 | -15.9 | 2166 | -12 | 2280 | -6.2 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.3 | 456 | -0.7 | 570 | -1.3 | 684 | -2.2 |
| 798 | -3.2 | 912 | -4.3 | 1026 | -5.5 | 1140 | -6.7 | 1254 | -7.7 | 1368 | -8.4 | 1482 | -8.8 |
| 1596 | -8.5 | 1710 | -7.4 | 1824 | -5.4 | 1938 | -2.1 | 2052 | 2.7 | 2166 | 9.3 | 2280 | 18 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.2 | 456 | -0.4 | 570 | -0.8 | 684 | -1.2 |

| | | | | | | | | | | | | | |
|--------------------------------------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|
| 798 | -1.6 | 912 | -2 | 1026 | -2.3 | 1140 | -2.5 | 1254 | -2.2 | 1368 | -1.6 | 1482 | -0.3 |
| 1596 | 1.7 | 1710 | 4.7 | 1824 | 9 | 1938 | 14.6 | 2052 | 21.9 | 2166 | 31.2 | 2280 | 42.7 |
| | | | | | | | | | | | | | |
| genericSLR Sigma 28-70mm f/2.8 EX DG | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.2 | 342 | -0.6 | 456 | -1.5 | 570 | -2.9 | 684 | -4.9 |
| 798 | -7.5 | 912 | -10.6 | 1026 | -14.5 | 1140 | -18.9 | 1254 | -23.8 | 1368 | -29.2 | 1482 | -34.9 |
| 1596 | -40.9 | 1710 | -47 | 1824 | -52.9 | 1938 | -58.6 | 2052 | -63.8 | 2166 | -68.2 | 2280 | -71.6 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | -0.1 | 570 | -0.3 | 684 | -0.5 |
| 798 | -0.8 | 912 | -1.1 | 1026 | -1.5 | 1140 | -1.9 | 1254 | -2.4 | 1368 | -2.8 | 1482 | -3.2 |
| 1596 | -3.6 | 1710 | -4 | 1824 | -4.2 | 1938 | -4.3 | 2052 | -4.2 | 2166 | -3.9 | 2280 | -3.3 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.3 | 570 | -0.6 | 684 | -1 |
| 798 | -1.4 | 912 | -2 | 1026 | -2.5 | 1140 | -3.1 | 1254 | -3.5 | 1368 | -3.9 | 1482 | -4 |
| 1596 | -3.9 | 1710 | -3.4 | 1824 | -2.5 | 1938 | -0.9 | 2052 | 1.2 | 2166 | 4.3 | 2280 | 8.3 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | -0.1 | 570 | -0.2 | 684 | -0.3 |
| 798 | -0.4 | 912 | -0.4 | 1026 | -0.4 | 1140 | -0.2 | 1254 | 0 | 1368 | 0.5 | 1482 | 1.4 |
| 1596 | 2.6 | 1710 | 4.3 | 1824 | 6.6 | 1938 | 9.4 | 2052 | 13.1 | 2166 | 17.5 | 2280 | 23 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0.1 | 456 | 0.3 | 570 | 0.6 | 684 | 1.1 |

| | | | | | | | | | | | | | |
|--|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|--------|--------|--------|
| 798 | 1.7 | 912 | 2.6 | 1026 | 3.8 | 1140 | 5.2 | 1254 | 6.9 | 1368 | 9 | 1482 | 11.4 |
| 1596 | 14.3 | 1710 | 17.6 | 1824 | 21.3 | 1938 | 25.6 | 2052 | 30.4 | 2166 | 35.8 | 2280 | 41.7 |
| | | | | | | | | | | | | | |
| genericSLR Tamron 18-200mm f/3.5-6.3 XR Di II LD | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.2 | 342 | -0.8 | 456 | -1.8 | 570 | -3.5 | 684 | -6 |
| 798 | -9.2 | 912 | -13.3 | 1026 | -18.2 | 1140 | -24.2 | 1254 | -31 | 1368 | -38.7 | 1482 | -47.2 |
| 1596 | -56.5 | 1710 | -66.5 | 1824 | -77 | 1938 | -88 | 2052 | -99.2 | 2166 | -110.5 | 2280 | -121.7 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.2 | 342 | -0.6 | 456 | -1.5 | 570 | -2.8 | 684 | -4.7 |
| 798 | -7.2 | 912 | -10.3 | 1026 | -14.1 | 1140 | -18.5 | 1254 | -23.6 | 1368 | -29.2 | 1482 | -35.2 |
| 1596 | -41.7 | 1710 | -48.5 | 1824 | -55.4 | 1938 | -62.4 | 2052 | -69.2 | 2166 | -75.6 | 2280 | -81.5 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.4 | 456 | -0.9 | 570 | -1.7 | 684 | -2.7 |
| 798 | -4.1 | 912 | -5.8 | 1026 | -7.7 | 1140 | -9.8 | 1254 | -12.1 | 1368 | -14.4 | 1482 | -16.7 |
| 1596 | -18.9 | 1710 | -20.7 | 1824 | -22.1 | 1938 | -22.9 | 2052 | -22.8 | 2166 | -21.7 | 2280 | -19.4 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.2 | 456 | -0.5 | 570 | -0.9 | 684 | -1.5 |
| 798 | -2.1 | 912 | -2.9 | 1026 | -3.6 | 1140 | -4.2 | 1254 | -4.7 | 1368 | -5 | 1482 | -4.8 |
| 1596 | -4.2 | 1710 | -2.8 | 1824 | -0.6 | 1938 | 2.5 | 2052 | 7 | 2166 | 13 | 2280 | 20.6 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.3 | 570 | -0.6 | 684 | -0.9 |

| | | | | | | | | | | | | | |
|---------------------------------------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|
| 798 | -1.2 | 912 | -1.5 | 1026 | -1.7 | 1140 | -1.7 | 1254 | -1.4 | 1368 | -0.7 | 1482 | 0.5 |
| 1596 | 2.4 | 1710 | 5.2 | 1824 | 9.1 | 1938 | 14.2 | 2052 | 20.7 | 2166 | 29 | 2280 | 39.1 |
| | | | | | | | | | | | | | |
| genericSLR Tamron 28-75mm f/2.8 XR Di | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.2 | 342 | -0.6 | 456 | -1.5 | 570 | -2.8 | 684 | -4.6 |
| 798 | -7.1 | 912 | -10.1 | 1026 | -13.7 | 1140 | -17.8 | 1254 | -22.4 | 1368 | -27.4 | 1482 | -32.8 |
| 1596 | -38.3 | 1710 | -43.8 | 1824 | -49.2 | 1938 | -54.3 | 2052 | -58.8 | 2166 | -62.5 | 2280 | -65.1 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.3 | 456 | -0.8 | 570 | -1.6 | 684 | -2.6 |
| 798 | -3.9 | 912 | -5.5 | 1026 | -7.3 | 1140 | -9.4 | 1254 | -11.6 | 1368 | -13.8 | 1482 | -16 |
| 1596 | -18 | 1710 | -19.8 | 1824 | -21.2 | 1938 | -21.9 | 2052 | -21.9 | 2166 | -20.9 | 2280 | -18.7 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.2 | 456 | -0.4 | 570 | -0.8 | 684 | -1.3 |
| 798 | -1.9 | 912 | -2.7 | 1026 | -3.5 | 1140 | -4.4 | 1254 | -5.3 | 1368 | -6.1 | 1482 | -6.7 |
| 1596 | -7.2 | 1710 | -7.3 | 1824 | -7 | 1938 | -6.2 | 2052 | -4.7 | 2166 | -2.5 | 2280 | 0.6 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0 | 570 | 0 | 684 | 0 |
| 798 | 0 | 912 | 0.1 | 1026 | 0.3 | 1140 | 0.5 | 1254 | 0.9 | 1368 | 1.5 | 1482 | 2.2 |
| 1596 | 3.1 | 1710 | 4.4 | 1824 | 5.9 | 1938 | 7.9 | 2052 | 10.2 | 2166 | 13 | 2280 | 16.4 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0.1 | 456 | 0.2 | 570 | 0.5 | 684 | 0.9 |

| | | | | | | | | | | | | | |
|---|-------|--------|-------|--------|-------|--------|-------|--------|--------|--------|--------|--------|--------|
| 798 | 1.4 | 912 | 2.1 | 1026 | 3.1 | 1140 | 4.2 | 1254 | 5.7 | 1368 | 7.4 | 1482 | 9.4 |
| 1596 | 11.7 | 1710 | 14.4 | 1824 | 17.5 | 1938 | 21 | 2052 | 25 | 2166 | 29.4 | 2280 | 34.3 |
| | | | | | | | | | | | | | |
| genericSLR Tamron 28-105mm f/2.8 SP LD IF | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.3 | 342 | -1 | 456 | -2.4 | 570 | -4.5 | 684 | -7.5 |
| 798 | -11.5 | 912 | -16.5 | 1026 | -22.5 | 1140 | -29.5 | 1254 | -37.4 | 1368 | -46.1 | 1482 | -55.6 |
| 1596 | -65.7 | 1710 | -76.2 | 1824 | -86.8 | 1938 | -97.3 | 2052 | -107.4 | 2166 | -116.8 | 2280 | -125.2 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.6 | 456 | -1.4 | 570 | -2.6 | 684 | -4.4 |
| 798 | -6.7 | 912 | -9.5 | 1026 | -12.9 | 1140 | -16.8 | 1254 | -21.2 | 1368 | -25.9 | 1482 | -31 |
| 1596 | -36.2 | 1710 | -41.4 | 1824 | -46.5 | 1938 | -51.3 | 2052 | -55.5 | 2166 | -59 | 2280 | -61.5 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.2 | 456 | -0.6 | 570 | -1.1 | 684 | -1.8 |
| 798 | -2.6 | 912 | -3.6 | 1026 | -4.6 | 1140 | -5.6 | 1254 | -6.6 | 1368 | -7.3 | 1482 | -7.7 |
| 1596 | -7.6 | 1710 | -6.9 | 1824 | -5.4 | 1938 | -2.9 | 2052 | 0.6 | 2166 | 5.7 | 2280 | 12.5 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.2 | 570 | -0.4 | 684 | -0.5 |
| 798 | -0.7 | 912 | -0.9 | 1026 | -0.9 | 1140 | -0.8 | 1254 | -0.4 | 1368 | 0.2 | 1482 | 1.4 |
| 1596 | 3 | 1710 | 5.4 | 1824 | 8.5 | 1938 | 12.6 | 2052 | 17.8 | 2166 | 24.2 | 2280 | 32.1 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0 | 570 | 0 | 684 | 0.1 |

| | | | | | | | | | | | | | |
|--------------------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|
| 798 | 0.2 | 912 | 0.6 | 1026 | 1.1 | 1140 | 1.9 | 1254 | 3.1 | 1368 | 4.7 | 1482 | 6.8 |
| 1596 | 9.5 | 1710 | 13 | 1824 | 17.3 | 1938 | 22.6 | 2052 | 29.1 | 2166 | 36.8 | 2280 | 46 |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| nikon8400 Standard | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.2 | 456 | -0.5 | 570 | -1.1 | 684 | -1.9 |
| 798 | -3 | 912 | -4.5 | 1026 | -6.5 | 1140 | -8.9 | 1254 | -11.9 | 1368 | -15.4 | 1482 | -19.6 |
| 1596 | -24.5 | 1710 | -30.2 | 1824 | -36.6 | 1938 | -43.9 | 2052 | -52.2 | 2166 | -61.4 | 2280 | -71.6 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.4 | 570 | -0.8 | 684 | -1.4 |
| 798 | -2.3 | 912 | -3.4 | 1026 | -4.9 | 1140 | -6.7 | 1254 | -8.9 | 1368 | -11.6 | 1482 | -14.8 |
| 1596 | -18.5 | 1710 | -22.8 | 1824 | -27.6 | 1938 | -33.2 | 2052 | -39.4 | 2166 | -46.3 | 2280 | -54 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.3 | 570 | -0.6 | 684 | -1 |
| 798 | -1.6 | 912 | -2.5 | 1026 | -3.5 | 1140 | -4.9 | 1254 | -6.5 | 1368 | -8.5 | 1482 | -10.8 |
| 1596 | -13.5 | 1710 | -16.6 | 1824 | -20.1 | 1938 | -24.1 | 2052 | -28.7 | 2166 | -33.7 | 2280 | -39.4 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.2 | 570 | -0.4 | 684 | -0.8 |
| 798 | -1.3 | 912 | -1.9 | 1026 | -2.8 | 1140 | -3.8 | 1254 | -5.1 | 1368 | -6.6 | 1482 | -8.4 |
| 1596 | -10.5 | 1710 | -12.9 | 1824 | -15.7 | 1938 | -18.8 | 2052 | -22.4 | 2166 | -26.3 | 2280 | -30.7 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | -0.1 | 570 | -0.3 | 684 | -0.6 |

| | | | | | | | | | | | | | |
|------------------|-------|--------|-------|--------|-------|--------|--------|--------|--------|--------|--------|--------|--------|
| 798 | -0.9 | 912 | -1.4 | 1026 | -2 | 1140 | -2.8 | 1254 | -3.8 | 1368 | -4.9 | 1482 | -6.3 |
| 1596 | -7.8 | 1710 | -9.6 | 1824 | -11.7 | 1938 | -14 | 2052 | -16.7 | 2166 | -19.6 | 2280 | -22.9 |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| nikon8400 WC-E75 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.2 | 342 | -0.9 | 456 | -2.1 | 570 | -4 | 684 | -6.7 |
| 798 | -10.4 | 912 | -15.2 | 1026 | -21.1 | 1140 | -28.2 | 1254 | -36.4 | 1368 | -46 | 1482 | -56.7 |
| 1596 | -68.7 | 1710 | -81.8 | 1824 | -96 | 1938 | -111.3 | 2052 | -127.5 | 2166 | -144.6 | 2280 | -162.3 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.4 | 456 | -1.1 | 570 | -2.2 | 684 | -3.7 |
| 798 | -5.9 | 912 | -8.7 | 1026 | -12.2 | 1140 | -16.6 | 1254 | -21.9 | 1368 | -28.1 | 1482 | -35.3 |
| 1596 | -43.5 | 1710 | -52.9 | 1824 | -63.4 | 1938 | -75.2 | 2052 | -88.1 | 2166 | -102.3 | 2280 | -117.8 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.2 | 456 | -0.6 | 570 | -1.2 | 684 | -2.1 |
| 798 | -3.4 | 912 | -5.1 | 1026 | -7.3 | 1140 | -10.1 | 1254 | -13.4 | 1368 | -17.4 | 1482 | -22.2 |
| 1596 | -27.7 | 1710 | -34.1 | 1824 | -41.4 | 1938 | -49.6 | 2052 | -58.9 | 2166 | -69.3 | 2280 | -80.9 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.2 | 456 | -0.5 | 570 | -1.1 | 684 | -1.9 |
| 798 | -3 | 912 | -4.5 | 1026 | -6.5 | 1140 | -8.9 | 1254 | -11.9 | 1368 | -15.4 | 1482 | -19.6 |
| 1596 | -24.5 | 1710 | -30.2 | 1824 | -36.6 | 1938 | -43.9 | 2052 | -52.2 | 2166 | -61.4 | 2280 | -71.6 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.2 | 456 | -0.4 | 570 | -0.9 | 684 | -1.6 |

| | | | | | | | | | | | | | |
|--------------------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|--------|--------|--------|
| 798 | -2.5 | 912 | -3.8 | 1026 | -5.4 | 1140 | -7.4 | 1254 | -9.9 | 1368 | -12.8 | 1482 | -16.3 |
| 1596 | -20.4 | 1710 | -25.1 | 1824 | -30.5 | 1938 | -36.6 | 2052 | -43.5 | 2166 | -51.1 | 2280 | -59.6 |
| | | | | | | | | | | | | | |
| nikon5000 Standard | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | -0.4 | 228 | -1.5 | 342 | -3.3 | 456 | -5.7 | 570 | -8.7 | 684 | -12.2 |
| 798 | -16.1 | 912 | -20.5 | 1026 | -25.4 | 1140 | -30.7 | 1254 | -36.6 | 1368 | -43.1 | 1482 | -50.2 |
| 1596 | -58 | 1710 | -66.6 | 1824 | -76.1 | 1938 | -86.7 | 2052 | -98.5 | 2166 | -111.5 | 2280 | -126.1 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | -0.1 | 228 | -0.4 | 342 | -1 | 456 | -2 | 570 | -3.2 | 684 | -4.9 |
| 798 | -6.9 | 912 | -9.4 | 1026 | -12.4 | 1140 | -15.9 | 1254 | -19.9 | 1368 | -24.5 | 1482 | -29.7 |
| 1596 | -35.5 | 1710 | -42 | 1824 | -49.3 | 1938 | -57.2 | 2052 | -66 | 2166 | -75.6 | 2280 | -86 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | -0.1 | 570 | -0.4 | 684 | -1.1 |
| 798 | -2.2 | 912 | -3.6 | 1026 | -5.4 | 1140 | -7.7 | 1254 | -10.5 | 1368 | -13.7 | 1482 | -17.5 |
| 1596 | -21.8 | 1710 | -26.5 | 1824 | -31.7 | 1938 | -37.3 | 2052 | -43.4 | 2166 | -49.8 | 2280 | -56.5 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.2 | 342 | -0.5 | 456 | -1 | 570 | -1.6 | 684 | -2.5 |
| 798 | -3.6 | 912 | -4.9 | 1026 | -6.4 | 1140 | -8.3 | 1254 | -10.4 | 1368 | -12.9 | 1482 | -15.8 |
| 1596 | -19 | 1710 | -22.7 | 1824 | -26.9 | 1938 | -31.5 | 2052 | -36.7 | 2166 | -42.4 | 2280 | -48.8 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.4 | 456 | -0.7 | 570 | -1.2 | 684 | -1.7 |

| | | | | | | | | | | | | | |
|--------------------------------------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|
| 798 | -2.4 | 912 | -3.3 | 1026 | -4.3 | 1140 | -5.5 | 1254 | -7 | 1368 | -8.8 | 1482 | -10.8 |
| 1596 | -13.3 | 1710 | -16.2 | 1824 | -19.6 | 1938 | -23.5 | 2052 | -28.1 | 2166 | -33.3 | 2280 | -39.3 |
| | | | | | | | | | | | | | |
| nikonSLR Nikkor 17-35mm f/2.8 ED-AFS | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.2 | 456 | -0.6 | 570 | -1.1 | 684 | -1.9 |
| 798 | -3.1 | 912 | -4.5 | 1026 | -6.4 | 1140 | -8.6 | 1254 | -11.3 | 1368 | -14.4 | 1482 | -18 |
| 1596 | -22.2 | 1710 | -26.8 | 1824 | -32 | 1938 | -37.7 | 2052 | -44 | 2166 | -50.8 | 2280 | -58.1 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | -0.1 | 570 | -0.1 | 684 | -0.3 |
| 798 | -0.5 | 912 | -0.8 | 1026 | -1.1 | 1140 | -1.5 | 1254 | -2.1 | 1368 | -2.7 | 1482 | -3.5 |
| 1596 | -4.3 | 1710 | -5.3 | 1824 | -6.5 | 1938 | -7.8 | 2052 | -9.3 | 2166 | -10.9 | 2280 | -12.7 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | -3 | 228 | 0 | 342 | 0 | 456 | 0 | 570 | 0 | 684 | 0 |
| 798 | 0 | 912 | 0 | 1026 | 0 | 1140 | 0 | 1254 | 0 | 1368 | 0 | 1482 | 0 |
| 1596 | 0 | 1710 | 0 | 1824 | -0.1 | 1938 | -0.1 | 2052 | -0.1 | 2166 | -0.1 | 2280 | -0.2 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0 | 570 | 0.1 | 684 | 0.1 |
| 798 | 0.2 | 912 | 0.4 | 1026 | 0.6 | 1140 | 0.8 | 1254 | 1.1 | 1368 | 1.4 | 1482 | 1.9 |
| 1596 | 2.3 | 1710 | 2.9 | 1824 | 3.5 | 1938 | 4.2 | 2052 | 5 | 2166 | 5.9 | 2280 | 6.9 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0.1 | 570 | 0.2 | 684 | 0.3 |

| | | | | | | | | | | | | | |
|--|-------|--------|-------|--------|------|--------|-------|--------|------|--------|-------|--------|-------|
| 798 | 0.6 | 912 | 0.9 | 1026 | 1.3 | 1140 | 1.8 | 1254 | 2.4 | 1368 | 3.1 | 1482 | 4 |
| 1596 | 5 | 1710 | 6.1 | 1824 | 7.4 | 1938 | 8.9 | 2052 | 10.6 | 2166 | 12.5 | 2280 | 14.6 |
| | | | | | | | | | | | | | |
| nikonSLR Nikkor 17-55mm f/2.8G ED-IF AF-S DX | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.3 | 570 | -0.6 | 684 | -1.1 |
| 798 | -1.7 | 912 | -2.6 | 1026 | -3.7 | 1140 | -5.1 | 1254 | -6.8 | 1368 | -8.8 | 1482 | -11.3 |
| 1596 | -14.1 | 1710 | -17.3 | 1824 | -21 | 1938 | -25.2 | 2052 | -30 | 2166 | -35.2 | 2280 | -41.1 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0 | 570 | 0 | 684 | 0 |
| 798 | 0 | 912 | 0.1 | 1026 | 0.1 | 1140 | 0.2 | 1254 | 0.3 | 1368 | 0.4 | 1482 | 0.5 |
| 1596 | 0.7 | 1710 | 0.8 | 1824 | 1 | 1938 | 1.2 | 2052 | 1.5 | 2166 | 1.7 | 2280 | 2 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0.2 | 570 | 0.4 | 684 | 0.7 |
| 798 | 1.2 | 912 | 1.8 | 1026 | 2.5 | 1140 | 3.5 | 1254 | 4.7 | 1368 | 6.1 | 1482 | 7.7 |
| 1596 | 9.7 | 1710 | 11.9 | 1824 | 14.5 | 1938 | 17.3 | 2052 | 20.6 | 2166 | 24.2 | 2280 | 28.3 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0.1 | 456 | 0.2 | 570 | 0.5 | 684 | 0.9 |
| 798 | 1.5 | 912 | 2.2 | 1026 | 3.2 | 1140 | 4.4 | 1254 | 5.8 | 1368 | 7.6 | 1482 | 9.7 |
| 1596 | 12.1 | 1710 | 14.9 | 1824 | 18.1 | 1938 | 21.7 | 2052 | 25.7 | 2166 | 30.3 | 2280 | 35.3 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0.1 | 456 | 0.3 | 570 | 0.6 | 684 | 1.1 |

| | | | | | | | | | | | | | |
|---|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|
| 798 | 1.7 | 912 | 2.6 | 1026 | 3.7 | 1140 | 5.1 | 1254 | 6.8 | 1368 | 8.9 | 1482 | 11.3 |
| 1596 | 14.1 | 1710 | 17.4 | 1824 | 21.1 | 1938 | 25.4 | 2052 | 30.1 | 2166 | 35.4 | 2280 | 41.3 |
| | | | | | | | | | | | | | |
| nikonSLR Nikkor 18-35mm f/3.5-4.5D ED-IF AF | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.4 | 456 | -1.1 | 570 | -2.1 | 684 | -3.6 |
| 798 | -5.7 | 912 | -8.3 | 1026 | -11.5 | 1140 | -15.5 | 1254 | -20.1 | 1368 | -25.4 | 1482 | -31.4 |
| 1596 | -38.2 | 1710 | -45.6 | 1824 | -53.8 | 1938 | -62.6 | 2052 | -72 | 2166 | -82 | 2280 | -92.5 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.2 | 456 | -0.6 | 570 | -1.1 | 684 | -1.9 |
| 798 | -3 | 912 | -4.5 | 1026 | -6.2 | 1140 | -8.4 | 1254 | -11 | 1368 | -14 | 1482 | -17.4 |
| 1596 | -21.3 | 1710 | -25.7 | 1824 | -30.5 | 1938 | -35.8 | 2052 | -41.5 | 2166 | -47.7 | 2280 | -54.3 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.2 | 570 | -0.5 | 684 | -0.8 |
| 798 | -1.3 | 912 | -2 | 1026 | -2.9 | 1140 | -4 | 1254 | -5.3 | 1368 | -6.9 | 1482 | -8.8 |
| 1596 | -11 | 1710 | -13.6 | 1824 | -16.5 | 1938 | -19.7 | 2052 | -23.5 | 2166 | -27.6 | 2280 | -32.2 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | -0.1 | 570 | -0.3 | 684 | -0.6 |
| 798 | -1 | 912 | -1.5 | 1026 | -2.2 | 1140 | -3 | 1254 | -4 | 1368 | -5.3 | 1482 | -6.7 |
| 1596 | -8.4 | 1710 | -10.3 | 1824 | -12.5 | 1938 | -15.1 | 2052 | -17.9 | 2166 | -21 | 2280 | -24.5 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | -0.1 | 570 | -0.2 | 684 | -0.4 |

| | | | | | | | | | | | | | |
|---|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|
| 798 | -0.7 | 912 | -1 | 1026 | -1.5 | 1140 | -2.1 | 1254 | -2.8 | 1368 | -3.6 | 1482 | -4.6 |
| 1596 | -5.8 | 1710 | -7.1 | 1824 | -8.6 | 1938 | -10.4 | 2052 | -12.3 | 2166 | -14.5 | 2280 | -16.9 |
| | | | | | | | | | | | | | |
| nikonSLR Nikkor 18-55mm f/3.5-5.6G ED AF-S DX | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.3 | 456 | -0.9 | 570 | -1.7 | 684 | -2.9 |
| 798 | -4.6 | 912 | -6.7 | 1026 | -9.4 | 1140 | -12.7 | 1254 | -16.6 | 1368 | -21.1 | 1482 | -26.4 |
| 1596 | -32.3 | 1710 | -38.9 | 1824 | -46.3 | 1938 | -54.3 | 2052 | -63.1 | 2166 | -72.6 | 2280 | -82.8 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.2 | 456 | -0.6 | 570 | -1.2 | 684 | -2 |
| 798 | -3.1 | 912 | -4.6 | 1026 | -6.5 | 1140 | -8.7 | 1254 | -11.4 | 1368 | -14.5 | 1482 | -18.1 |
| 1596 | -22.1 | 1710 | -26.7 | 1824 | -31.7 | 1938 | -37.1 | 2052 | -43.1 | 2166 | -49.5 | 2280 | -56.4 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.2 | 570 | -0.4 | 684 | -0.8 |
| 798 | -1.2 | 912 | -1.8 | 1026 | -2.6 | 1140 | -3.6 | 1254 | -4.8 | 1368 | -6.2 | 1482 | -7.8 |
| 1596 | -9.7 | 1710 | -11.9 | 1824 | -14.4 | 1938 | -17.2 | 2052 | -20.3 | 2166 | -23.7 | 2280 | -27.5 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | -0.1 | 570 | -0.3 | 684 | -0.5 |
| 798 | -0.9 | 912 | -1.3 | 1026 | -1.9 | 1140 | -2.6 | 1254 | -3.5 | 1368 | -4.6 | 1482 | -5.9 |
| 1596 | -7.3 | 1710 | -9 | 1824 | -11 | 1938 | -13.2 | 2052 | -15.7 | 2166 | -18.4 | 2280 | -21.5 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | -0.1 | 570 | -0.2 | 684 | -0.5 |

| | | | | | | | | | | | | | |
|--|-------|--------|-------|--------|-------|--------|-------|--------|--------|--------|--------|--------|--------|
| 798 | -0.7 | 912 | -1.1 | 1026 | -1.6 | 1140 | -2.3 | 1254 | -3 | 1368 | -4 | 1482 | -5.1 |
| 1596 | -6.3 | 1710 | -7.8 | 1824 | -9.5 | 1938 | -11.4 | 2052 | -13.5 | 2166 | -15.9 | 2280 | -18.6 |
| | | | | | | | | | | | | | |
| nikonSLR Nikkor 18-70mm f/3.5-4.5G ED-IF AF-S DX | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.3 | 342 | -1.1 | 456 | -2.5 | 570 | -4.8 | 684 | -8 |
| 798 | -12.2 | 912 | -17.5 | 1026 | -23.8 | 1140 | -31 | 1254 | -39.3 | 1368 | -48.3 | 1482 | -58 |
| 1596 | -68.1 | 1710 | -78.5 | 1824 | -89 | 1938 | -99 | 2052 | -108.5 | 2166 | -116.9 | 2280 | -123.9 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.2 | 342 | -0.6 | 456 | -1.5 | 570 | -2.8 | 684 | -4.7 |
| 798 | -7.2 | 912 | -10.2 | 1026 | -13.7 | 1140 | -17.8 | 1254 | -22.3 | 1368 | -27.2 | 1482 | -32.3 |
| 1596 | -37.4 | 1710 | -42.5 | 1824 | -47.3 | 1938 | -51.5 | 2052 | -55 | 2166 | -57.5 | 2280 | -58.7 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.2 | 456 | -0.6 | 570 | -1.1 | 684 | -1.8 |
| 798 | -2.7 | 912 | -3.9 | 1026 | -5.2 | 1140 | -6.6 | 1254 | -8.2 | 1368 | -9.7 | 1482 | -11.3 |
| 1596 | -12.8 | 1710 | -14 | 1824 | -15 | 1938 | -15.6 | 2052 | -15.6 | 2166 | -15 | 2280 | -13.5 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.4 | 570 | -0.7 | 684 | -1.2 |
| 798 | -1.7 | 912 | -2.4 | 1026 | -3.1 | 1140 | -3.9 | 1254 | -4.6 | 1368 | -5.2 | 1482 | -5.7 |
| 1596 | -6 | 1710 | -5.9 | 1824 | -5.4 | 1938 | -4.4 | 2052 | -2.7 | 2166 | -0.3 | 2280 | 3 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | -0.1 | 570 | -0.2 | 684 | -0.4 |

| | | | | | | | | | | | | | |
|---|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|--------|--------|--------|
| 798 | -0.6 | 912 | -0.7 | 1026 | -0.9 | 1140 | -1 | 1254 | -0.9 | 1368 | -0.8 | 1482 | -0.4 |
| 1596 | 0.1 | 1710 | 1.1 | 1824 | 2.4 | 1938 | 4.2 | 2052 | 6.5 | 2166 | 9.5 | 2280 | 13.3 |
| | | | | | | | | | | | | | |
| nikonSLR Nikkor 18-200mm f/3.5-5.6 G ED-IF AF-S VR DX | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.2 | 342 | -0.9 | 456 | -2 | 570 | -3.9 | 684 | -6.5 |
| 798 | -10 | 912 | -14.4 | 1026 | -19.7 | 1140 | -25.9 | 1254 | -33 | 1368 | -41 | 1482 | -49.7 |
| 1596 | -59.1 | 1710 | -69 | 1824 | -79.2 | 1938 | -89.7 | 2052 | -100 | 2166 | -110.1 | 2280 | -119.7 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.5 | 456 | -1.2 | 570 | -2.3 | 684 | -3.9 |
| 798 | -5.9 | 912 | -8.3 | 1026 | -11.2 | 1140 | -14.4 | 1254 | -18 | 1368 | -21.7 | 1482 | -25.5 |
| 1596 | -29.4 | 1710 | -33 | 1824 | -36.2 | 1938 | -38.8 | 2052 | -40.6 | 2166 | -41.3 | 2280 | -40.7 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.4 | 456 | -0.9 | 570 | -1.6 | 684 | -2.6 |
| 798 | -3.8 | 912 | -5.3 | 1026 | -6.8 | 1140 | -8.4 | 1254 | -9.9 | 1368 | -11.1 | 1482 | -12 |
| 1596 | -12.3 | 1710 | -11.8 | 1824 | -10.3 | 1938 | -7.6 | 2052 | -3.3 | 2166 | 2.7 | 2280 | 11.1 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.2 | 456 | -0.6 | 570 | -1 | 684 | -1.6 |
| 798 | -2.3 | 912 | -3.1 | 1026 | -3.8 | 1140 | -4.3 | 1254 | -4.6 | 1368 | -4.5 | 1482 | -3.8 |
| 1596 | -2.3 | 1710 | 0 | 1824 | 3.6 | 1938 | 8.7 | 2052 | 15.4 | 2166 | 24.1 | 2280 | 35.2 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.3 | 570 | -0.5 | 684 | -0.7 |

| | | | | | | | | | | | | | |
|---|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|
| 798 | -0.9 | 912 | -1.1 | 1026 | -1.1 | 1140 | -0.9 | 1254 | -0.4 | 1368 | 0.5 | 1482 | 2 |
| 1596 | 4.2 | 1710 | 7.3 | 1824 | 11.4 | 1938 | 16.8 | 2052 | 23.6 | 2166 | 32 | 2280 | 42.4 |
| | | | | | | | | | | | | | |
| nikonSLR Nikkor 24-85mm f/3.5-4.5G ED-IF AF-S | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.2 | 342 | -0.9 | 456 | -2.1 | 570 | -4.1 | 684 | -6.8 |
| 798 | -10.3 | 912 | -14.6 | 1026 | -19.8 | 1140 | -25.8 | 1254 | -32.4 | 1368 | -39.7 | 1482 | -47.4 |
| 1596 | -55.3 | 1710 | -63.2 | 1824 | -70.9 | 1938 | -78.1 | 2052 | -84.5 | 2166 | -89.7 | 2280 | -93.3 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.4 | 456 | -0.9 | 570 | -1.6 | 684 | -2.6 |
| 798 | -3.8 | 912 | -5.2 | 1026 | -6.7 | 1140 | -8.2 | 1254 | -9.6 | 1368 | -10.8 | 1482 | -11.5 |
| 1596 | -11.7 | 1710 | -11 | 1824 | -9.3 | 1938 | -6.3 | 2052 | -1.7 | 2166 | 4.7 | 2280 | 13.4 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.3 | 570 | -0.6 | 684 | -0.9 |
| 798 | -1.2 | 912 | -1.4 | 1026 | -1.4 | 1140 | -1.2 | 1254 | -0.5 | 1368 | 0.5 | 1482 | 2.4 |
| 1596 | 5.1 | 1710 | 8.9 | 1824 | 14 | 1938 | 20.6 | 2052 | 29 | 2166 | 39.4 | 2280 | 52.2 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | -0.1 | 570 | -0.1 | 684 | -0.1 |
| 798 | 0 | 912 | 0.2 | 1026 | 0.8 | 1140 | 1.7 | 1254 | 3.2 | 1368 | 5.2 | 1482 | 8 |
| 1596 | 11.7 | 1710 | 16.6 | 1824 | 22.7 | 1938 | 30.3 | 2052 | 39.6 | 2166 | 50.9 | 2280 | 64.4 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0 | 570 | 0.1 | 684 | 0.3 |

| | | | | | | | | | | | | | |
|----------------------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|
| 798 | 0.6 | 912 | 1.2 | 1026 | 2.2 | 1140 | 3.5 | 1254 | 5.3 | 1368 | 7.8 | 1482 | 11.1 |
| 1596 | 15.2 | 1710 | 20.5 | 1824 | 27 | 1938 | 34.8 | 2052 | 44.3 | 2166 | 55.7 | 2280 | 69 |
| | | | | | | | | | | | | | |
| olympus8080 Standard | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.2 | 342 | -0.6 | 456 | -1.6 | 570 | -3 | 684 | -5 |
| 798 | -7.6 | 912 | -11 | 1026 | -15 | 1140 | -19.8 | 1254 | -25.2 | 1368 | -31.2 | 1482 | -37.7 |
| 1596 | -44.8 | 1710 | -52.1 | 1824 | -59.7 | 1938 | -67.4 | 2052 | -74.9 | 2166 | -82.2 | 2280 | -88.9 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.3 | 456 | -0.6 | 570 | -1.2 | 684 | -2.1 |
| 798 | -3.2 | 912 | -4.5 | 1026 | -6.1 | 1140 | -7.9 | 1254 | -9.9 | 1368 | -12.1 | 1482 | -14.4 |
| 1596 | -16.8 | 1710 | -19.1 | 1824 | -21.3 | 1938 | -23.3 | 2052 | -25 | 2166 | -26.3 | 2280 | -27 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0 | 570 | 0.1 | 684 | 0.3 |
| 798 | 0.5 | 912 | 0.9 | 1026 | 1.4 | 1140 | 2.1 | 1254 | 3.1 | 1368 | 4.3 | 1482 | 5.8 |
| 1596 | 7.6 | 1710 | 9.9 | 1824 | 12.7 | 1938 | 16 | 2052 | 19.9 | 2166 | 24.4 | 2280 | 29.8 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0 | 570 | 0.1 | 684 | 0.2 |
| 798 | 0.4 | 912 | 0.8 | 1026 | 1.3 | 1140 | 2.1 | 1254 | 3.1 | 1368 | 4.5 | 1482 | 6.2 |
| 1596 | 8.5 | 1710 | 11.3 | 1824 | 14.8 | 1938 | 19 | 2052 | 24 | 2166 | 30 | 2280 | 37 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | -0.1 | 570 | -0.2 | 684 | -0.2 |

| | | | | | | | | | | | | | |
|----------------------|-------|--------|-------|--------|-------|--------|-------|--------|--------|--------|--------|--------|--------|
| 798 | -0.3 | 912 | -0.2 | 1026 | -0.1 | 1140 | 0.2 | 1254 | 0.7 | 1368 | 1.6 | 1482 | 2.8 |
| 1596 | 4.6 | 1710 | 6.9 | 1824 | 9.9 | 1938 | 13.7 | 2052 | 18.4 | 2166 | 24.2 | 2280 | 31.2 |
| | | | | | | | | | | | | | |
| olympus5060 Standard | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | -0.2 | 228 | -1 | 342 | -2.2 | 456 | -4.1 | 570 | -6.5 | 684 | -9.5 |
| 798 | -13.2 | 912 | -17.5 | 1026 | -22.4 | 1140 | -28.1 | 1254 | -34.4 | 1368 | -41.5 | 1482 | -49.4 |
| 1596 | -58 | 1710 | -67.4 | 1824 | -77.7 | 1938 | -88.8 | 2052 | -100.8 | 2166 | -113.6 | 2280 | -127.4 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | -0.3 | 228 | -1.2 | 342 | -2.7 | 456 | -4.9 | 570 | -7.7 | 684 | -11.2 |
| 798 | -15.3 | 912 | -20.1 | 1026 | -25.6 | 1140 | -31.8 | 1254 | -38.7 | 1368 | -46.2 | 1482 | -54.5 |
| 1596 | -63.5 | 1710 | -73.3 | 1824 | -83.8 | 1938 | -95 | 2052 | -107 | 2166 | -119.8 | 2280 | -133.3 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0.2 | 228 | 0.9 | 342 | 1.9 | 456 | 3 | 570 | 4.2 | 684 | 5.3 |
| 798 | 6.2 | 912 | 6.7 | 1026 | 6.7 | 1140 | 6.1 | 1254 | 4.7 | 1368 | 2.4 | 1482 | -0.7 |
| 1596 | -5.2 | 1710 | -10.8 | 1824 | -18 | 1938 | -26.6 | 2052 | -36.9 | 2166 | -49 | 2280 | -63.1 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0.3 | 228 | 1.4 | 342 | 2.9 | 456 | 4.8 | 570 | 6.8 | 684 | 9 |
| 798 | 11 | 912 | 12.8 | 1026 | 14.1 | 1140 | 15 | 1254 | 15.1 | 1368 | 14.3 | 1482 | 12.6 |
| 1596 | 9.6 | 1710 | 5.4 | 1824 | -0.2 | 1938 | -7.5 | 2052 | -16.6 | 2166 | -27.5 | 2280 | -40.6 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.3 | 570 | -0.6 | 684 | -1.2 |

| | | | | | | | | | | | | | |
|--|-------|--------|-------|--------|-------|--------|-------|--------|--------|--------|--------|--------|--------|
| 798 | -2 | 912 | -3 | 1026 | -4.5 | 1140 | -6.2 | 1254 | -8.4 | 1368 | -11.1 | 1482 | -14.3 |
| 1596 | -18 | 1710 | -22.3 | 1824 | -27.3 | 1938 | -32.9 | 2052 | -39.3 | 2166 | -46.4 | 2280 | -54.4 |
| | | | | | | | | | | | | | |
| olympusSLR Zuiko Digital 14-45mm f/3.5-5.6 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.2 | 342 | -0.8 | 456 | -2 | 570 | -3.8 | 684 | -6.4 |
| 798 | -9.9 | 912 | -14.2 | 1026 | -19.5 | 1140 | -25.8 | 1254 | -32.9 | 1368 | -41 | 1482 | -49.8 |
| 1596 | -59.3 | 1710 | -69.5 | 1824 | -80 | 1938 | -90.8 | 2052 | -101.7 | 2166 | -112.5 | 2280 | -122.8 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.4 | 456 | -0.9 | 570 | -1.9 | 684 | -3.2 |
| 798 | -5 | 912 | -7.4 | 1026 | -10.4 | 1140 | -14.1 | 1254 | -18.4 | 1368 | -23.5 | 1482 | -29.3 |
| 1596 | -36 | 1710 | -43.4 | 1824 | -51.7 | 1938 | -60.9 | 2052 | -70.9 | 2166 | -81.7 | 2280 | -93.3 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.2 | 456 | -0.5 | 570 | -1 | 684 | -1.7 |
| 798 | -2.8 | 912 | -4.2 | 1026 | -5.9 | 1140 | -8.2 | 1254 | -10.9 | 1368 | -14.1 | 1482 | -18 |
| 1596 | -22.5 | 1710 | -27.7 | 1824 | -33.6 | 1938 | -40.3 | 2052 | -47.9 | 2166 | -56.3 | 2280 | -65.7 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.4 | 570 | -0.8 | 684 | -1.5 |
| 798 | -2.4 | 912 | -3.5 | 1026 | -5.1 | 1140 | -7 | 1254 | -9.3 | 1368 | -12.1 | 1482 | -15.4 |
| 1596 | -19.2 | 1710 | -23.7 | 1824 | -28.7 | 1938 | -34.5 | 2052 | -40.9 | 2166 | -48.2 | 2280 | -56.2 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.3 | 570 | -0.7 | 684 | -1.3 |

| | | | | | | | | | | | | | |
|--|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|
| 798 | -2.1 | 912 | -3.1 | 1026 | -4.5 | 1140 | -6.2 | 1254 | -8.2 | 1368 | -10.7 | 1482 | -13.6 |
| 1596 | -17 | 1710 | -20.9 | 1824 | -25.4 | 1938 | -30.5 | 2052 | -36.2 | 2166 | -42.6 | 2280 | -49.7 |
| | | | | | | | | | | | | | |
| olympusSLR Zuiko Digital 14-54mm f/2.8-3.5 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.2 | 342 | -0.7 | 456 | -1.7 | 570 | -3.1 | 684 | -5.2 |
| 798 | -7.8 | 912 | -11 | 1026 | -14.7 | 1140 | -18.9 | 1254 | -23.5 | 1368 | -28.4 | 1482 | -33.3 |
| 1596 | -38.1 | 1710 | -42.5 | 1824 | -46.4 | 1938 | -49.4 | 2052 | -51.2 | 2166 | -51.5 | 2280 | -49.9 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.5 | 456 | -1.2 | 570 | -2.3 | 684 | -3.7 |
| 798 | -5.6 | 912 | -7.8 | 1026 | -10.4 | 1140 | -13.3 | 1254 | -16.4 | 1368 | -19.6 | 1482 | -22.7 |
| 1596 | -25.7 | 1710 | -28.2 | 1824 | -30.1 | 1938 | -31.2 | 2052 | -31.2 | 2166 | -29.8 | 2280 | -26.7 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.2 | 456 | -0.6 | 570 | -1.1 | 684 | -1.9 |
| 798 | -2.8 | 912 | -3.8 | 1026 | -5 | 1140 | -6.3 | 1254 | -7.5 | 1368 | -8.7 | 1482 | -9.7 |
| 1596 | -10.4 | 1710 | -10.6 | 1824 | -10.3 | 1938 | -9.3 | 2052 | -7.3 | 2166 | -4.3 | 2280 | 0 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.2 | 570 | -0.4 | 684 | -0.6 |
| 798 | -0.9 | 912 | -1.3 | 1026 | -1.6 | 1140 | -1.8 | 1254 | -2 | 1368 | -2 | 1482 | -1.7 |
| 1596 | -1.2 | 1710 | -0.4 | 1824 | 0.9 | 1938 | 2.8 | 2052 | 5.3 | 2166 | 8.6 | 2280 | 12.8 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0 | 570 | 0 | 684 | -0.1 |

| | | | | | | | | | | | | | |
|---|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|
| 798 | -0.1 | 912 | -0.1 | 1026 | 0 | 1140 | 0 | 1254 | 0.3 | 1368 | 0.6 | 1482 | 1.1 |
| 1596 | 1.8 | 1710 | 2.7 | 1824 | 3.9 | 1938 | 5.5 | 2052 | 7.3 | 2166 | 9.7 | 2280 | 12.5 |
| | | | | | | | | | | | | | |
| pentaxSLR Pentax 16-45mm f/4.0 P-DA J ED/AL | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.4 | 456 | -1.1 | 570 | -2.1 | 684 | -3.5 |
| 798 | -5.5 | 912 | -7.9 | 1026 | -10.8 | 1140 | -14.3 | 1254 | -18.4 | 1368 | -22.9 | 1482 | -27.9 |
| 1596 | -33.4 | 1710 | -39.2 | 1824 | -45.3 | 1938 | -51.6 | 2052 | -58.1 | 2166 | -64.5 | 2280 | -70.9 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.3 | 456 | -0.6 | 570 | -1.2 | 684 | -2.1 |
| 798 | -3.2 | 912 | -4.7 | 1026 | -6.4 | 1140 | -8.4 | 1254 | -10.6 | 1368 | -13.1 | 1482 | -15.8 |
| 1596 | -18.7 | 1710 | -21.6 | 1824 | -24.6 | 1938 | -27.6 | 2052 | -30.5 | 2166 | -33.1 | 2280 | -35.5 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0 | 570 | 0 | 684 | 0 |
| 798 | 0 | 912 | 0 | 1026 | 0.1 | 1140 | 0.1 | 1254 | 0.2 | 1368 | 0.2 | 1482 | 0.3 |
| 1596 | 0.4 | 1710 | 0.5 | 1824 | 0.6 | 1938 | 0.7 | 2052 | 0.9 | 2166 | 1 | 2280 | 1.2 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0.1 | 570 | 0.2 | 684 | 0.4 |
| 798 | 0.7 | 912 | 1.1 | 1026 | 1.6 | 1140 | 2.2 | 1254 | 3 | 1368 | 3.9 | 1482 | 5 |
| 1596 | 6.2 | 1710 | 7.7 | 1824 | 9.3 | 1938 | 11.2 | 2052 | 13.3 | 2166 | 15.6 | 2280 | 18.2 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0.1 | 570 | 0.3 | 684 | 0.5 |

| | | | | | | | | | | | | | |
|------------------------------------|------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|
| 798 | 0.9 | 912 | 1.4 | 1026 | 2 | 1140 | 2.7 | 1254 | 3.6 | 1368 | 4.7 | 1482 | 6 |
| 1596 | 7.5 | 1710 | 9.3 | 1824 | 11.3 | 1938 | 13.5 | 2052 | 16.1 | 2166 | 18.9 | 2280 | 22.1 |
| | | | | | | | | | | | | | |
| pentaxSLR Pentax 18-55mm f/3.5-5.6 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.1 | 342 | -0.4 | 456 | -0.9 | 570 | -1.8 | 684 | -3.1 |
| 798 | -4.8 | 912 | -7 | 1026 | -9.8 | 1140 | -13.2 | 1254 | -17.2 | 1368 | -21.8 | 1482 | -27 |
| 1596 | -33 | 1710 | -39.5 | 1824 | -46.8 | 1938 | -54.6 | 2052 | -63.1 | 2166 | -72.1 | 2280 | -81.7 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.4 | 570 | -0.8 | 684 | -1.4 |
| 798 | -2.2 | 912 | -3.3 | 1026 | -4.6 | 1140 | -6.3 | 1254 | -8.2 | 1368 | -10.5 | 1482 | -13 |
| 1596 | -16 | 1710 | -19.2 | 1824 | -22.8 | 1938 | -26.8 | 2052 | -31.1 | 2166 | -35.8 | 2280 | -40.8 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | -0.1 | 570 | -0.2 | 684 | -0.3 |
| 798 | -0.5 | 912 | -0.8 | 1026 | -1.2 | 1140 | -1.6 | 1254 | -2.2 | 1368 | -2.9 | 1482 | -3.7 |
| 1596 | -4.6 | 1710 | -5.6 | 1824 | -6.9 | 1938 | -8.2 | 2052 | -9.8 | 2166 | -11.5 | 2280 | -13.4 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0 | 570 | 0 | 684 | 0 |
| 798 | 0 | 912 | -0.1 | 1026 | -0.1 | 1140 | -0.2 | 1254 | -0.2 | 1368 | -0.3 | 1482 | -0.4 |
| 1596 | -0.5 | 1710 | -0.6 | 1824 | -0.8 | 1938 | -1 | 2052 | -1.1 | 2166 | -1.4 | 2280 | -1.6 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0 | 570 | 0 | 684 | 0.1 |

| | | | | | | | | | | | | | |
|-----------------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|
| 798 | 0.1 | 912 | 0.2 | 1026 | 0.3 | 1140 | 0.4 | 1254 | 0.6 | 1368 | 0.8 | 1482 | 1 |
| 1596 | 1.3 | 1710 | 1.6 | 1824 | 1.9 | 1938 | 2.3 | 2052 | 2.8 | 2166 | 3.2 | 2280 | 3.8 |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| sonyR1 Standard | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.2 | 456 | -0.6 | 570 | -1.2 | 684 | -2 |
| 798 | -3.1 | 912 | -4.4 | 1026 | -6 | 1140 | -7.8 | 1254 | -9.9 | 1368 | -12.1 | 1482 | -14.5 |
| 1596 | -16.9 | 1710 | -19.3 | 1824 | -21.7 | 1938 | -23.9 | 2052 | -25.9 | 2166 | -27.5 | 2280 | -28.6 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.2 | 456 | -0.6 | 570 | -1.1 | 684 | -1.8 |
| 798 | -2.6 | 912 | -3.7 | 1026 | -4.9 | 1140 | -6.3 | 1254 | -7.7 | 1368 | -9.1 | 1482 | -10.4 |
| 1596 | -11.6 | 1710 | -12.6 | 1824 | -13.2 | 1938 | -13.3 | 2052 | -12.8 | 2166 | -11.5 | 2280 | -9.4 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.2 | 570 | -0.4 | 684 | -0.6 |
| 798 | -0.9 | 912 | -1.2 | 1026 | -1.4 | 1140 | -1.7 | 1254 | -1.9 | 1368 | -1.9 | 1482 | -1.7 |
| 1596 | -1.3 | 1710 | -0.6 | 1824 | 0.5 | 1938 | 2.1 | 2052 | 4.3 | 2166 | 7.3 | 2280 | 11 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0.1 | 570 | 0.3 | 684 | 0.6 |
| 798 | 0.9 | 912 | 1.4 | 1026 | 2.1 | 1140 | 2.9 | 1254 | 3.8 | 1368 | 5 | 1482 | 6.3 |
| 1596 | 7.9 | 1710 | 9.8 | 1824 | 11.8 | 1938 | 14.2 | 2052 | 16.9 | 2166 | 19.9 | 2280 | 23.2 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0.1 | 570 | 0.3 | 684 | 0.6 |

| | | | | | | | | | | | | | |
|------------------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|--------|--------|--------|
| 798 | 1 | 912 | 1.5 | 1026 | 2.2 | 1140 | 3.1 | 1254 | 4.1 | 1368 | 5.3 | 1482 | 6.8 |
| 1596 | 8.5 | 1710 | 10.5 | 1824 | 12.7 | 1938 | 15.3 | 2052 | 18.1 | 2166 | 21.3 | 2280 | 24.9 |
| | | | | | | | | | | | | | |
| sony828 Standard | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 28.0mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | -0.2 | 342 | -0.9 | 456 | -2.1 | 570 | -4 | 684 | -6.6 |
| 798 | -10.2 | 912 | -14.6 | 1026 | -19.9 | 1140 | -26.1 | 1254 | -33.2 | 1368 | -41.1 | 1482 | -49.6 |
| 1596 | -58.7 | 1710 | -68.2 | 1824 | -77.9 | 1938 | -87.5 | 2052 | -97 | 2166 | -105.9 | 2280 | -113.9 |
| | | | | | | | | | | | | | |
| 33.5mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | -0.1 | 456 | -0.4 | 570 | -0.8 | 684 | -1.3 |
| 798 | -2.1 | 912 | -3 | 1026 | -4.2 | 1140 | -5.7 | 1254 | -7.3 | 1368 | -9.2 | 1482 | -11.4 |
| 1596 | -13.8 | 1710 | -16.4 | 1824 | -19.3 | 1938 | -22.3 | 2052 | -25.5 | 2166 | -28.9 | 2280 | -32.4 |
| | | | | | | | | | | | | | |
| 39.0mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0.1 | 456 | 0.3 | 570 | 0.6 | 684 | 1 |
| 798 | 1.5 | 912 | 2.1 | 1026 | 2.8 | 1140 | 3.6 | 1254 | 4.5 | 1368 | 5.4 | 1482 | 6.4 |
| 1596 | 7.3 | 1710 | 8.1 | 1824 | 8.8 | 1938 | 9.4 | 2052 | 9.7 | 2166 | 9.7 | 2280 | 9.3 |
| | | | | | | | | | | | | | |
| 44.5mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0.1 | 570 | 0.3 | 684 | 0.6 |
| 798 | 0.9 | 912 | 1.3 | 1026 | 1.8 | 1140 | 2.3 | 1254 | 3 | 1368 | 3.6 | 1482 | 4.4 |
| 1596 | 5.1 | 1710 | 5.9 | 1824 | 6.7 | 1938 | 7.5 | 2052 | 8.1 | 2166 | 8.8 | 2280 | 9.3 |
| | | | | | | | | | | | | | |
| 50.0mm | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist | Radius | Dist |
| 0 | 0 | 114 | 0 | 228 | 0 | 342 | 0 | 456 | 0 | 570 | 0 | 684 | -0.1 |

| | | | | | | | | | | | | | |
|------|------|------|------|------|------|------|------|------|-----|------|-----|------|-----|
| 798 | -0.1 | 912 | -0.1 | 1026 | -0.1 | 1140 | -0.1 | 1254 | 0 | 1368 | 0 | 1482 | 0.2 |
| 1596 | 0.5 | 1710 | 1 | 1824 | 1.6 | 1938 | 2.3 | 2052 | 3.3 | 2166 | 4.5 | 2280 | 6 |

APPENDIX B (CORRECTION COEFFICIENT DATABASE)

This database was sourced from the software PTLens (<http://epaperpress.com/ptlens/>) and is available on their website. Since lens distortion is a property of the lens and SLR cameras can be used with different lenses, many of the listings are for specific lenses and not for specific camera / lens combinations. In many cases the specific camera body used is not available.

group: Denotes either a camera or camera manufacturer.

If the manufacturer is listed the camera was calibrated using a SLR camera body from that manufacturer and only the lens was calibrated.

If the camera is listed the calibration was performed on that specific camera.

If generic is list only the lens was calibrated independently of any manufacturer.

multiplier: Denotes the scale factor of the EXIF focal length to 35mm.

menu_lens: Denotes the model of the lens calibrated in the case of an SLR camera, if standard the cameras built in lens was calibrated.

calc_abc: Focal Length and corresponding coefficients in the format Focal Length, A, B, C.

group: canonEfs (SLR)

multiplier: 1.6

menu_lens: Canon EF-S 17-85mm f/4-5.6 IS USM

cal_abc: 17 0.021181 -0.055581 0.000000

cal_abc: 20 0.019344 -0.043786 0.000000

cal_abc: 22 0.015491 -0.026682 0.000000

cal_abc: 28 0.008084 -0.007472 0.000000

cal_abc: 30 0.005522 -0.001763 0.000000

cal_abc: 35 0.003149 0.002207 0.000000

cal_abc: 44 0.000000 0.008269 0.000000

cal_abc: 53 0.000000 0.008792 0.000000

cal_abc: 61 0.000000 0.007380 0.000000

cal_abc: 72 0.000000 0.006226 0.000000

cal_abc: 78 0.000000 0.007095 0.000000

cal_abc: 85 0.000000 0.007288 0.000000

group: canon (SLR)

multiplier: 1.0

menu_lens: Canon EF 24-70mm f/2.8L USM

cal_abc: 24 0.015298 -0.039413 0.000000

cal_abc: 27 0.014041 -0.034436 0.000000

cal_abc: 30 0.013341 -0.031051 0.000000

cal_abc: 34 0.006539 -0.015390 0.000000

cal_abc: 38 0.003138 -0.007742 0.000000

cal_abc: 43 0.000000 0.000233 0.000000

cal_abc: 48 0.000000 0.001510 0.000000

cal_abc: 55 0.000000 0.003988 0.000000

cal_abc: 64 0.000000 0.005787 0.000000

group: canon (SLR)

multiplier: 1.0

menu_lens: Canon EF 24-105mm f/4L IS USM

cal_abc: 24 0.017263 -0.049244 0.000000

cal_abc: 28 0.010878 -0.024454 0.000000

cal_abc: 35 0.007152 -0.009799 0.000000

cal_abc: 50 0.002502 0.004803 0.000000

cal_abc: 70 0.000000 0.009685 0.000000

cal_abc: 88 0.000000 0.008781 0.000000

cal_abc: 105 0.000000 0.009598 0.000000

group: canon (SLR)

multiplier: 1.0

menu_lens: Canon EF 28-105mm f/3.5-4.5 II USM

cal_abc: 28 0.013305 -0.039730 0.000000

cal_abc: 35 0.005643 -0.012771 0.000000

cal_abc: 50 0.000000 0.007781 0.000000

cal_abc: 70 0.000000 0.010884 0.000000
cal_abc: 105 0.000000 0.011749 0.000000

group: canon (SLR)
multiplier: 1.0
menu_lens: Canon EF 28-300mm f/3.5-5.6L IS USM
cal_abc: 28 0.013512 -0.044163 0.000000
cal_abc: 35 0.008844 -0.017730 0.000000
cal_abc: 40 0.000000 0.008261 0.000000
cal_abc: 60 0.000000 0.012093 0.000000
cal_abc: 70 0.000000 0.012516 0.000000
cal_abc: 105 0.000000 0.009065 0.000000
cal_abc: 135 0.000000 0.008196 0.000000
cal_abc: 200 0.000000 0.007773 0.000000
cal_abc: 300 0.000000 0.008177 0.000000

group: canon (SLR)
multiplier: 1.0
menu_lens: Canon EF 28-135mm f/3.5-5.6 IS USM
cal_abc: 28 0.015307 -0.042304 0.000000
cal_abc: 35 0.009116 -0.020624 0.000000
cal_abc: 41 0.000000 0.003439 0.000000
cal_abc: 53 0.000000 0.008157 0.000000
cal_abc: 60 0.000000 0.008848 0.000000
cal_abc: 70 0.000000 0.009719 0.000000
cal_abc: 85 0.000000 0.009196 0.000000
cal_abc: 100 0.000000 0.008576 0.000000
cal_abc: 117 0.000000 0.010397 0.000000
cal_abc: 135 0.000000 0.010546 0.000000

group: fujiS9000 (SLR)
multiplier: 4.48
menu_lens: Standard
cal_abc: 6.2 0.022449 -0.054880 0.000000
cal_abc: 7.2 0.014932 -0.036434 0.000000
cal_abc: 8.1 0.006337 -0.018767 0.000000
cal_abc: 9.3 0.005262 -0.014600 0.000000
cal_abc: 10.8 0.005679 -0.011186 0.000000
cal_abc: 12.8 0.004792 -0.004670 0.000000
cal_abc: 17.0 0.000000 0.004675 0.000000
cal_abc: 21.6 0.000000 0.003203 0.000000
cal_abc: 42.6 0.000000 0.002282 0.000000
cal_abc: 67.0 0.000000 0.003859 0.000000

group: generic (SLR)
multiplier: 1.5
menu_lens: Sigma 17-35mm f/2.8-4 EX DG
cal_abc: 17 0.007263 -0.024540 0.000000
cal_abc: 20 0.006421 -0.021536 0.000000
cal_abc: 24 0.008849 -0.023843 0.000000
cal_abc: 28 0.000000 -0.004158 0.000000
cal_abc: 35 0.000000 -0.002715 0.000000

group: generic (SLR)
multiplier: 1.5
menu_lens: Sigma 17-70mm f/2.8-4.5 DC Macro
cal_abc: 17 0.019088 -0.048894 0.000000
cal_abc: 19 0.010938 -0.030356 0.000000
cal_abc: 23 0.010630 -0.026746 0.000000
cal_abc: 25 0.001877 -0.005367 0.000000
cal_abc: 30 -0.001844 0.003931 0.000000
cal_abc: 40 -0.002705 0.008106 0.000000
cal_abc: 53 0.000000 0.003542 0.000000
cal_abc: 70 0.000000 0.003858 0.000000

group: generic (SLR)
multiplier: 1.5
menu_lens: Sigma 18-50mm f/2.8 EX DC

cal_abc: 18 0.011366 -0.034328 0.000000
cal_abc: 21 0.006142 -0.017401 0.000000
cal_abc: 24 0.004800 -0.013589 0.000000
cal_abc: 28 0.000000 0.000000 0.000000
cal_abc: 35 0.000000 0.002094 0.000000
cal_abc: 43 0.000000 0.002878 0.000000
cal_abc: 50 0.000000 0.003021 0.000000

group: generic (SLR)
multiplier: 1.5

menu_lens: Sigma 18-125mm f/3.3-5.6 (3.5-5.6) DC

cal_abc: 18 0.022110 -0.050462 0.000000
cal_abc: 23 0.016565 -0.027307 0.000000
cal_abc: 30 0.011429 -0.013359 0.000000
cal_abc: 38 0.000000 0.012386 0.000000
cal_abc: 51 0.000000 0.013262 0.000000
cal_abc: 67 0.000000 0.011758 0.000000
cal_abc: 87 0.000000 0.011008 0.000000
cal_abc: 109 0.000000 0.011450 0.000000
cal_abc: 125 0.000000 0.009078 0.000000

group: generic (SLR)
multiplier: 1.5

menu_lens: Sigma 18-200mm f/3.5-6.3 DC

cal_abc: 18 0.027521 -0.063244 0.000000
cal_abc: 22 0.016154 -0.029806 0.000000
cal_abc: 26 0.014824 -0.025689 0.000000
cal_abc: 34 0.011421 -0.011743 0.000000
cal_abc: 46 0.000000 0.014338 0.000000
cal_abc: 78 0.000000 0.009621 0.000000
cal_abc: 135 0.000000 0.012591 0.000000
cal_abc: 200 0.000000 0.011133 0.000000

group: generic (SLR)
multiplier: 1.0

menu_lens: Sigma 28-70mm f/2.8 EX DG

cal_abc: 28 0.015080 -0.036446 0.000000
cal_abc: 30 0.013280 -0.029560 0.000000
cal_abc: 34 0.001964 -0.003604 0.000000
cal_abc: 40 0.006628 -0.009598 0.000000
cal_abc: 45 0.004477 -0.003544 0.000000
cal_abc: 50 0.000000 0.006595 0.000000
cal_abc: 60 0.000000 0.007800 0.000000
cal_abc: 70 0.000000 0.008656 0.000000

group: generic (SLR)
multiplier: 1.5

menu_lens: Tamron 18-200mm f/3.5-6.3 XR Di II LD

cal_abc: 18 0.013640 -0.042157 0.000000
cal_abc: 28 0.010678 -0.016742 0.000000
cal_abc: 35 0.009558 -0.008863 0.000000
cal_abc: 50 0.000000 0.011197 0.000000
cal_abc: 72 0.000000 0.010552 0.000000
cal_abc: 102 0.000000 0.007166 0.000000
cal_abc: 135 0.000000 0.007026 0.000000
cal_abc: 150 0.000000 0.006778 0.000000
cal_abc: 200 0.000000 0.006016 0.000000

group: generic (SLR)
multiplier: 1.0

menu_lens: Tamron 28-75mm f/2.8 XR Di

cal_abc: 28 0.014690 -0.034774 0.000000
cal_abc: 30 0.012441 -0.026997 0.000000
cal_abc: 35 0.009958 -0.018577 0.000000
cal_abc: 50 0.000000 0.005421 0.000000
cal_abc: 60 0.000000 0.007520 0.000000
cal_abc: 75 0.000000 0.007321 0.000000

group: generic (SLR)
multiplier: 1.0
menu_lens: Tamron 28-105mm f/2.8 SP LD IF
cal_abc: 28 0.020983 -0.054749 0.000000
cal_abc: 32 0.018015 -0.042871 0.000000
cal_abc: 35 0.010940 -0.023520 0.000000
cal_abc: 39 0.010993 -0.016341 0.000000
cal_abc: 44 0.007493 -0.007606 0.000000
cal_abc: 63 0.002757 0.006995 0.000000
cal_abc: 75 0.000000 0.012653 0.000000
cal_abc: 93 0.000000 0.011546 0.000000
cal_abc: 105 0.000000 0.012148 0.000000

group: nikon8400 (Point and Shoot)
multiplier: 3.933
menu_lens: Standard
cal_abc: 6.1 0.000000 -0.014928 0.000000
cal_abc: 7.0 0.000000 -0.011637 0.000000
cal_abc: 8.1 0.000000 -0.009313 0.000000
cal_abc: 10.0 0.000000 -0.006115 0.000000
cal_abc: 12.3 0.000000 -0.004044 0.000000
cal_abc: 15.2 0.000000 -0.001226 0.000000
cal_abc: 21.6 0.000000 0.000000 0.000000

group: nikon8400 (Point and Shoot)
multiplier: 3.933
menu_lens: WC-E75
converter_factor: 0.75
converter_detected: 0
cal_abc: 6.1 0.016500 -0.057649 0.000000
cal_abc: 7.5 0.009749 -0.039706 0.000000
cal_abc: 9.3 0.000000 -0.014859 0.000000
cal_abc: 11.5 0.000000 -0.011079 0.000000
cal_abc: 14.2 0.000000 -0.007817 0.000000
cal_abc: 17.5 0.000000 -0.005923 0.000000
cal_abc: 21.6 0.000000 -0.003667 0.000000

group: nikon (SLR)
multiplier: 1.5
menu_lens: Nikkor 17-35mm f/2.8 ED-AFS
cal_abc: 17 0.005000 -0.020000 0.000000
cal_abc: 20 0.000000 -0.005500 0.000000
cal_abc: 24 0.000000 -0.001000 0.000000
cal_abc: 28 0.000000 0.000500 0.000000
cal_abc: 35 0.000000 0.002500 0.000000

group: nikon (SLR)
multiplier: 1.5
menu_lens: Nikkor 17-55mm f/2.8G ED-IF AF-S DX
cal_abc: 17 0.000000 -0.010424 0.000000
cal_abc: 19 0.000000 -0.005670 0.000000
cal_abc: 22 0.000000 -0.000148 0.000000
cal_abc: 26 0.000000 0.004472 0.000000
cal_abc: 30 0.000000 0.005657 0.000000
cal_abc: 38 0.000000 0.007283 0.000000
cal_abc: 55 0.000000 0.005143 0.000000

group: nikon (SLR)
multiplier: 1.5
menu_lens: Nikkor 18-35mm f/3.5-4.5D ED-IF AF
cal_abc: 18 0.005981 -0.024888 0.000000
cal_abc: 21 0.005045 -0.019527 0.000000
cal_abc: 23 0.001429 -0.009890 0.000000
cal_abc: 26 0.000000 -0.005090 0.000000
cal_abc: 30 0.000000 -0.003797 0.000000
cal_abc: 35 0.000000 -0.002437 0.000000

group: nikon (SLR)

multiplier: 1.5
menu_lens: Nikkor 18-55mm f/3.5-5.6G ED AF-S DX
cal_abc: 18 0.003409 -0.019128 0.000000
cal_abc: 20 0.004200 -0.018625 0.000000
cal_abc: 24 0.001149 -0.008657 0.000000
cal_abc: 28 0.000000 -0.003041 0.000000
cal_abc: 31 0.000000 -0.003664 0.000000
cal_abc: 35 0.000000 -0.002371 0.000000
cal_abc: 45 0.000000 -0.001655 0.000000
cal_abc: 55 0.000000 -0.001004 0.000000

group: nikon (SLR)
multiplier: 1.5
menu_lens: Nikkor 18-70mm f/3.5-4.5G ED-IF AF-S DX
cal_abc: 18 0.023969 -0.060001 0.000000
cal_abc: 22 0.016845 -0.038289 0.000000
cal_abc: 24 0.010564 -0.022097 0.000000
cal_abc: 27 0.006823 -0.012539 0.000000
cal_abc: 31 0.006238 -0.009315 0.000000
cal_abc: 34 0.003441 -0.003404 0.000000
cal_abc: 38 0.000969 0.001935 0.000000
cal_abc: 44 -0.000246 0.004105 0.000000
cal_abc: 50 0.000958 0.002277 0.000000
cal_abc: 55 -0.000474 0.005767 0.000000
cal_abc: 62 -0.000546 0.005724 0.000000
cal_abc: 70 0.000042 0.006308 0.000000

group: nikon (SLR)
multiplier: 1.5
menu_lens: Nikkor 18-200mm f/3.5-5.6 G ED-IF AF-S VR DX
cal_abc: 18 0.017598 -0.049569 0.000000
cal_abc: 20 0.013846 -0.036284 0.000000
cal_abc: 26 0.014876 -0.023039 0.000000
cal_abc: 34 0.008669 -0.007258 0.000000
cal_abc: 38 0.000000 0.012308 0.000000
cal_abc: 44 0.000000 0.012651 0.000000
cal_abc: 56 0.000000 0.010344 0.000000
cal_abc: 65 0.000000 0.011336 0.000000
cal_abc: 82 0.000000 0.009171 0.000000
cal_abc: 105 0.000000 0.010009 0.000000
cal_abc: 130 0.000000 0.007883 0.000000
cal_abc: 170 0.000000 0.006480 0.000000
cal_abc: 200 0.000000 0.005237 0.000000

group: nikon (SLR)
multiplier: 1.0
menu_lens: Nikkor 24-85mm f/3.5-4.5G ED-IF AF-S
cal_abc: 24 0.023939 -0.061462 0.000000
cal_abc: 35 0.013898 -0.018385 0.000000
cal_abc: 52 0.007150 -0.000592 0.000000
cal_abc: 70 0.003769 0.007774 0.000000
cal_abc: 85 0.003412 0.008900 0.000000

group: olympus8080 (Point and Shoot)
multiplier: 3.933
menu_lens: Standard
cal_abc: 7.1 0.013182 -0.036019 0.000000
cal_abc: 8.4 0.007334 -0.017216 0.000000
cal_abc: 10.7 0.001287 0.004729 0.000000
cal_abc: 11.9 0.006157 -0.005368 0.000000
cal_abc: 15.8 0.001207 0.003221 0.000000
cal_abc: 20.6 0.003286 0.001466 0.000000
cal_abc: 27.1 0.004701 -0.005662 0.000000
cal_abc: 31.9 -0.005630 0.017601 0.000000
cal_abc: 35.6 0.013081 -0.014879 0.000000

group: olympus5060 (Point and Shoot)

multiplier: 4.843
menu_lens: Standard
cal_abc: 5.7 0.000000 -0.004736 -0.025632
cal_abc: 7.3 0.000000 -0.001423 -0.032997
cal_abc: 8.6 0.000000 -0.043809 0.067939
cal_abc: 10.0 0.000000 -0.010586 0.000919
cal_abc: 11.8 0.000000 -0.007287 0.002822
cal_abc: 12.8 0.000000 -0.007539 -0.014107
cal_abc: 13.4 0.000000 -0.015426 0.020200
cal_abc: 14.5 0.000000 -0.011352 0.021863
cal_abc: 15.8 0.000000 -0.000188 -0.010549
cal_abc: 18.9 0.000000 -0.009209 0.013324
cal_abc: 20.4 0.000000 0.000000 0.000000
cal_abc: 22.9 0.000000 0.000000 0.000000

group: olympusSLR (Point and Shoot)
multiplier: 2.0
menu_lens: Zuiko Digital 14-45mm f/3.5-5.6
cal_abc: 14.0 0.015865 -0.045846 0.000000
cal_abc: 18.0 0.000000 -0.012163 0.000000
cal_abc: 25.0 0.000000 -0.007852 0.000000
cal_abc: 35.0 0.000000 -0.002850 0.000000
cal_abc: 45.0 0.000000 -0.001233 0.000000

group: olympus (SLR)
multiplier: 2.0
menu_lens: Zuiko Digital 14-54mm f/2.8-3.5
cal_abc: 14.0 0.019325 -0.040094 0.000000
cal_abc: 19.0 0.010371 -0.017732 0.000000
cal_abc: 25.0 0.002227 -0.001738 0.000000
cal_abc: 35.0 0.000000 0.000000 0.000000
cal_abc: 54.0 0.000000 -0.001107 0.000000

group: pentax (SLR)
multiplier: 1.5
menu_lens: Pentax 16-45mm f/4.0 P-DA J ED/AL
cal_abc: 16 0.012341 -0.035947 0.000000
cal_abc: 18 0.009928 -0.029930 0.000000
cal_abc: 20 0.005774 -0.016410 0.000000
cal_abc: 23 0.006045 -0.015109 0.000000
cal_abc: 26 0.000000 0.000197 0.000000
cal_abc: 29 0.000000 0.002637 0.000000
cal_abc: 34 0.000000 0.003505 0.000000
cal_abc: 40 0.000000 0.003288 0.000000
cal_abc: 45 0.000000 0.003622 0.000000

group: pentax (SLR)
multiplier: 1.5
menu_lens: Pentax 18-55mm f/3.5-5.6
cal_abc: 18 0.004593 -0.021008 0.000000
cal_abc: 21 0.003710 -0.014625 0.000000
cal_abc: 24 0.000000 -0.004166 0.000000
cal_abc: 33 0.000000 0.000528 0.000000
cal_abc: 55 0.000000 0.003215 0.000000

group: sonyR1 (SLR)
multiplier: 1.68
menu_lens: Standard
cal_abc: 14.3 0.016048 -0.042510 0.000000
cal_abc: 14.8 0.013923 -0.036204 0.000000
cal_abc: 16.0 0.007736 -0.019699 0.000000
cal_abc: 17.8 0.006109 -0.012654 0.000000
cal_abc: 19.7 0.007790 -0.014520 0.000000
cal_abc: 22.2 0.006436 -0.009769 0.000000
cal_abc: 26.2 0.000000 0.003560 0.000000
cal_abc: 28.7 0.000000 0.003947 0.000000
cal_abc: 32.3 0.000000 0.003852 0.000000
cal_abc: 35.4 0.000000 0.003556 0.000000

cal_abc: 39.5 0.000000 0.003135 0.000000
cal_abc: 49.8 0.000000 0.002513 0.000000
cal_abc: 65.7 0.000000 0.000510 0.000000
cal_abc: 71.5 0.000000 0.000000 0.000000

group: sony828 (SLR)

multiplier: 3.933

menu_lens: Standard

cal_abc: 7.1 0.018095 -0.048162 0.000000
cal_abc: 8.1 0.014132 -0.032924 0.000000
cal_abc: 8.7 -0.000660 -0.002438 0.000000
cal_abc: 10.6 -0.004167 0.008802 0.000000
cal_abc: 12.2 0.001366 -0.001343 0.000000
cal_abc: 14.3 0.000869 0.000672 0.000000
cal_abc: 17.5 -0.010260 0.019351 0.000000
cal_abc: 20.5 0.002486 -0.001685 0.000000
cal_abc: 25.5 0.016746 -0.028622 0.000000
cal_abc: 29.3 -0.008873 0.019679 0.000000
cal_abc: 33.4 -0.000440 0.003954 0.000000
cal_abc: 40.7 0.010042 -0.013474 0.000000
cal_abc: 51.0 -0.005786 0.018882 0.000000