Review of Samyang 8 mm f/3.5 Proportional Projection Ultra-wide Angle Lens.
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Left: Samyang 8 mm f/3.5 Wide Angle Lens. Right: Lens with box, caps, pouch, and manual.

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1.0 Introduction:

The Samyang 8 mm f/3.5 wide angle lens is, at least for now, a relatively unique lens due to the unusual radial distribution (e.g. projection) of its image. Images formed by the Samyang 8 mm lens have a projection between that of a conventional fisheye lens and that of a wide angle rectilinear lens, though the projection (and field of view) is closer to that of the fisheye lens than the rectilinear lens. The Samyang lens curves straight non-radial lines in subject matter like a conventional "equidistant" projection fisheye lens does, but not as severely.

The best part of the 8 mm Samyang lens projection is that it substantially preserves the proportions of three dimensional objects in its two dimensional image space better than either an ultra-wide rectilinear lens or a fisheye lens. For example, a spherical object appears to be more or less spherical (not egg shaped or squashed) anywhere in the image, regardless of where it's located in the field of view. This is accomplished by an image scale that increases with off-axis distance, though to a lesser degree than occurs with a rectilinear wide angle.

Initial tests of the 8 mm f/3.5 Samyang lens show that an old fashioned manual "Zone Focus" method could be the best way to get optimum results. This is covered in more detail below.

The term "Stereographic" has been used in some literature to describe the projection of the Samyang 8 mm lens. This description is in the ball park, but the Samyang projection differs slightly from true stereographic projection in that its image is only about 87 percent of the way to achieving pure stereographic projection. (In stereographic projection, radial and circumferential image scales increase equally with off-axis angle.) Still, it is closer to true stereographic projection than any commercial still camera lens I've seen to date (2.0 and 2.6 mm f/1.0 Computar video lenses have a similar projection, but are not as sharp or as wide), so the Samyang 8 mm lens projection will be referred to as quasi-stereographic here. A more descriptive term for benefits of the image would be "proportional" projection, in that the lens substantially preserves the proportions of objects in the 3D subject matter throughout its 2D image. Stereographic or proportional projection is compatible with a field of view even beyond a full hemisphere, though it cannot quite image a full sphere on a finite 2D image.

The Samyang 8 mm f/3.5 lens has been rumored to also be marketed under the brand names of Bower, Vivitar, etc. Of these, I have confirmed that the Bower 8 mm f/3.5 is exactly the same lens, but do not have enough information to comment about similarity of other brands.

In order to be sure I acquired the "real" Samyang lens for wide angle photos with the desired projection, I acquired a "real" Samyang branded lens from Foto-Tip via eBay. [2] This way, a known Samyang 8 mm f/3.5 lens could also be used as a "gold standard" for comparison with other brands, to see which ones are actually the Samyang lens, and which ones are not.

2.0 Optical Attributes of Samyang 8 mm f/3.5 Proportional Projection Wide Angle Lens

The lens is comprised of 10 elements in 7 groups. Its f/ratio is adjustable from f/3.5 to f/22.

2.1 Resolution:

Below are preliminary test results for the Samyang 8 mm lens, compared to a Soligor 180 degree fisheye attachment, a Sigma 14 mm f/3.5 wide angle lens, Nikon 10.5 and 16 mm f/2.8 fisheye lenses, and 20 mm f/4 Nikkor lens. A Sigma VF1 fisheye attachment frequently used on my Sony DSC-F707 is not shown here, partly because I don't yet have quantifiable data, but it is safe to say that the Samyang lens image quality exceeds that of the VF-1 at off-axis angles over about 50 degrees. (The Sigma VF1 was one of the best "affordable" afocal fisheye lens attachments made that works with long zoom cameras, but was discontinued years ago.) The Samyang 8 mm lens results are shown for both the Olympus/Panasonic 4/3 format and the APS digital format. Results here are not for absolute sharpness, but are instead to establish the widest f/ratio that provides good to excellent results.

Definitions of parameters in table headings are as follows:
ShVid = Maximum aperture at which no axial aberrations detected with 4 mm eyepiece
ShAx = Max. aperture at which axial aberrations grain limited (or pixel ltd. on 2/3" format)
Sh34 = Max. aperture at which off-axis aberrations at corner of 4:3 aspect acceptable
FAFm = Maximum aperture that illuminates full format without cutoff by lens barrel
FA34 = Max. aperture that illuminates 3x4 aspect of format without cutoff by lens barrel
UseAt = Max. aperture that provides sharp and well illuminated image over 4:3 aspect
Cont/F = Contrast and flare. E is excellent; V is very good, G is good, F is fair,
A is acceptable, P is poor

Table 2.1A: Comparison of Samyang 8 mm f/3.5 lens and selected other lenses.

Lens	**Type/S. No.**	**ShVid**	**ShAx**	**Sh34**	**FAFm**	**FA34**	**UseAt**	**Cont/F**
7.5mm via Soligor 0.15x	**Arg/U77C90**	**5.6**	**5.6**	**9.5**	**NA**	**NA**	**9.5**	**A**
Comments: Off-axis astigmatism, chromatic aberration. Afocal attachment used with 50 f/3.5 Argus Cintar.								
8 f/3.5 Samyang MF (4/3)	**FE / No SN**	**4.8**	**3.5**	**4.5**	**4.0**	**4.0**	**4.5**	**V**
Comments: 4/3 format, 22.5 diagonal. Approx. 81 x 108 x 130 deg. (About like 14mm lens on 35mm format.)								
8 f/3.5 Samyang MF (APS)	**FE / No SN**	**4.8**	**3.5**	**6.8**	**5.0**	**4.2**	**6.8**	**V**
Comments: APS format, 29 mm diagonal, 180 deg. FOV. Off-axis astigmatism visible if wider than f/6.8.								
10.5 f/2.8 Nikon FE (APS)	**FE / 325104**	**4.0**	**2.8**	**4.0**	**5.0**	**4.5**	**4.5**	**V+**
Comments: APS format; 29 mm image circle. Reduced radial scale toward very edge.								
14 f/3.5 Sigma (35 mm)	**FE/2000489**	**5.6**	**5.6**	**6.8**	**9.5**	**8.0**	**6.8**	**G**
Comments: Sharp except at corners, f/5.6 max useful f/ratio.								
16 f/2.8 Nikkor (35 mm)	**FE / 193040**	**4.0**	**4.0**	**5.6**	**5.6**	**4.0**	**5.6**	**E**
f/4.0 OK for astrophotography.								
20 f/4 Nikkor (35 mm)	**RE / 116778**	**5.6**	**5.0**	**9.5**	**7.5**	**6.0**	**9.5**	**V**
Comments: 1:600 lateral chromatic aberration at edge.								

Results above show that the Samyang 8 mm lens will provide a decent image over the 4/3 format if used at f/4.5 or slower, and a good image on the larger APS format if used at f/6.8 or slower. There are some subjects, including those with bright highlights, for which the Samyang 8 mm lens works best at f/6.8 or a little slower regardless of the format.

For best performance with digital cameras, the Samyang lens (or any lens for that matter) should not be used at f/stops slower than f/9.5 to f/11 because the image will lose resolution at small apertures due to the diffraction effects common to all lenses at slow f/ratios. This provides a relatively narrow, though still useful, range of recommended f/stops.

2.2 Performance Comparisons

As shown above, the Samyang 8 mm f/3.5 lens blows away the Soligor fisheye attachment, but the 10.5 mm and 16 mm f/2.8 Fisheye Nikkor lenses are a little sharper than the Samyang at a given aperture. The "fairest" comparison is between the 10.5 mm Nikon fisheye and the Samyang 8 mm, where the 10.5 mm Nikkor appears to have a slight edge.

However, if the projection characteristics of the Samyang and Nikon lenses are taken into account and the angular resolution (versus lines/mm at the focal plane) is evaluated, the Samyang lens actually has *angular* resolution that is comparable to the 10.5 mm Nikkor, toward the edge of the field of view. This is important if an image is to be post-processed into a rectilinear projection.

In other words, at a given f/ratio, the corner resolution at the focal plane for the 10.5 mm Nikon fisheye lens exceeds that of the 8 mm Samyang lens. However, since the radial image scale of the Samyang lens actually exceeds that of the 10.5 mm Nikkor at the corner of the picture, angular resolution of both lenses come out to be pretty similar, particularly if the primary image colors are scaled to compensate for the higher degree of lateral chromatic aberration in the Samyang image. Thus, for applications including de-warping of the fisheye image to provide a rectilinear image, or where images are stitched to provide an immersive full sphere image, either lens will provide about the same final image resolution. My own impression is the Samyang lens provides better images for stitching into panoramas or VR spheres, since it is easier to identify features near the edge due to relatively low distortion.

Comparison to a 16 mm Fisheye Nikkor lens is not all that applicable because the 16 mm is a full frame 35 mm format lens (44 mm image circle), while the Samyang 8 mm lens has a 29 mm image circle. There is little question that the 16 mm Nikkor on a full frame DSLR will capture more subject detail than either the 10.5 mm Nikon lens of the Samyang 8 mm lens.

For the different application of rotating panoramic cameras, it would be interesting to analyze if the Samyang might have less image blurring over the slit width on a rotating panoramic camera than the 14 mm Sigma lens, even though the Samyang is not a rectilinear lens such as what is usually used on such a camera. For the Samyang, a rotating (film) camera would be best if it used 35 mm film (or 24+ mm high digital sensor) and only utilized about 135 degrees of the 8 mm lens coverage for the vertical dimension of the panorama. However, rotating panoramic film cameras have not been as popular with the advent of better image mapping and stitching software, and are just mentioned here for rotating camera buffs. A rotating electronic camera could be less "fussy" about which lenses are used with it.

2.3 Contrast and Flare:

Some articles by other authors mention that the Samyang 8 mm lens has considerable flare when the sun is in the picture. It is true that there is some flare in the image in this case, but in comparison to many other lenses, the flare in the Samyang 8 mm is actually less severe.

This is particularly true in cases where the sun is not in the picture but direct sunlight still impinges on the front element. For example, the flare in my 14 mm Sigma lens is far more severe than in the Samyang 8 mm, yet I found ways to get decent pictures with the 14 mm Sigma anyway, usually by shading the front element when the sun is out of the picture.

When the sun is in the picture, flare can be reduced through use of the patented Versacorp “Sun Zapper” (TM) occulting object, but some post processing of the image is required to remove artifacts introduced by the Sun Zapper (TM). The 16 mm and 10.5 mm fisheye Nikkor lenses generally have less flare than the Samyang 8 mm, but the radial distribution (e.g. projection) of the Samyang image (between that of a fisheye and a rectilinear lens) is more pleasing than the projection of the other fisheyes.

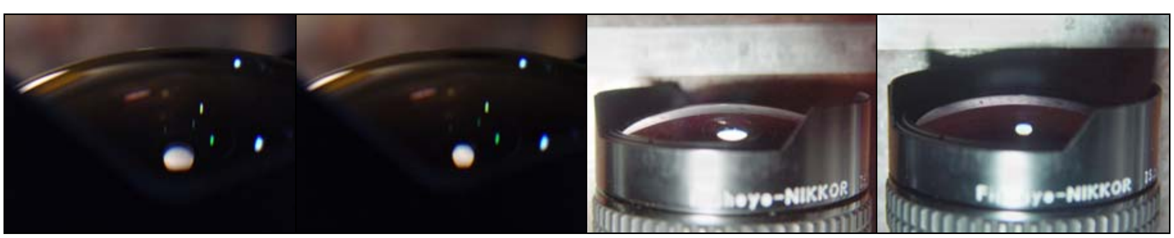
2.4 Measured Focal Length:

Fisheye lenses rumored to be the same product as the Samyang lens have been marketed with a focal length specified anywhere between 6.5 mm and 8.0 mm, and some web articles have stated that the actual focal length of the Samyang lens may be as long as 8.7 mm. The purpose of this section is to define the effective focal length of the Samyang 8 mm lens at the center of the image, since this has been the standard way to define focal length. To measure the focal length, a subject of relatively small angular size (less than 10 or 15 degrees) was imaged in the center of the field of view, then the width of the image was measured.

Based on imaging an object at 5 times its own width, then measuring its image width in the picture and multiplying by 5, the measured focal length is 8.55 mm. After allowing for the slight image enlargement at 5.7 degrees off-axis, the actual focal length comes to 8.54 mm.

2.5 Aperture (e.g. Entrance Pupil) Attributes:

Due to the proportional projection characteristics of the Samyang 8 mm lens (covered below) the effective aperture area of the lens actually INCREASES a little toward the edge of the field of view. In fact, at about 80 degrees off-axis, the aperture area of the 8 mm f/3.5 Samyang lens actually begins to exceed that of the 10.5 mm f/2.8 Nikon fisheye lens. This is partly due to the entrance pupil of the 10.5 mm Nikon lens becoming more distorted (e.g. elliptical) toward the edge of the field of view. In some (but not all) lenses, distortion of the entrance pupil shape more or less maps to distortion of the image of a spherical object in a corresponding part of the field of view, after compensating for any aperture clipping by the lens barrel and the incident angle of the light rays on the image focal plane.



Left 2 Images: Effective aperture area of the 8 mm f/3.5 Samyang lens actually INCREASES a little as you move from the center toward the edge of the field of view. Toward the edge of the field of view, the Samyang 8 mm f/3.5 lens entrance pupil is elongated due to clipping by barrel when the lens is used at full aperture. Stopping the lens down to about f/5 eliminates clipping, and reveals an almost round off-axis pupil. The right two images show the size reduction and distortion for the off-axis pupil of a conventional fisheye lens at f/2.8 and f/5.6.

2.5.1 Aperture Clipping

It is interesting to note that the Samyang has less clipping of the aperture at wider f/ratios than either the 10.5 mm or the 16 mm fisheye Nikkor lenses. This is true even though the Samyang has a maximum aperture of only f/3.5, and by comparison, a tiny rear element diameter. Proximity of the Samyang rear element to the aperture blades probably helps here. Specifically, the Samyang 8 mm lens stops clipping its aperture at f/5 for its whole field of view on the APS format. By comparison, the 10.5 and 16 mm Nikkor lenses clip the aperture near the edge of the field of view on their respective formats until stopped down to f/5.6.

Aperture clipping at wider apertures in 8 mm f/3.5 Samyang and 16 mm f/2.8 fisheye Nikkor lenses. Left two images: The Samyang 8 mm lens has some aperture clipping by the barrel at f/3.5, but virtually none when stopped down only a little more than an f/stop to f/5.0. Right two images: Even though the 16 mm f/2.8 fisheye Nikkor lens has a relatively large rear element, clipping of the aperture still occurs unless the lens is stopped down to about f/5.6.

2.6 Image Projection Properties:

The radial distribution (e.g. projection) of the image from the Samyang 8 mm lens is between that of a fisheye and a rectilinear lens, though closer to that of the fisheye. Specifically, straight non-radial lines in the subject are curved in the Samyang image, as would be the case in the image from a conventional "equidistant" projection fisheye lens, but not as severely.

More importantly, the image from the Samyang preserves proportions of three dimensional objects in its two dimensional image space better than either an ultra-wide rectilinear lens or a fisheye lens. For example, a spherical object will appear to be more or less spherical (e.g. not excessively egg shaped or squashed) in the image, regardless of where it is located in the field of view. This is accomplished with an image scale that increases with off-axis distance. This is the same general principle as a rectilinear lens, but less pronounced.

Actually, the 8 mm Samyang lens is neither a conventional wide angle nor a fisheye, but is a hybrid falling between the two. The term "stereographic" has been used to describe this projection, but for this review, I’ll often refer to the projection as simply "*proportional*".

Accordingly, it may be proper if a name for a new class of lens, such as “proportional wide angle” is coined for the Samyang lens. This will eliminate confusion between proportional projection lenses and conventional fisheye or rectilinear wide angle lenses, and will probably be easier to remember and market than “stereographic”. For background, a rectilinear lens would be considered as having proportional projection when (and only when) imaging a two dimensional object that is oriented parallel to the focal plane.

Top row: Sample images with 14 mm Sigma rectilinear lens (left), Samyang 8 mm lens (center) and Nikon 16 mm fisheye (right), cropped to 104 deg. horizontal field of view. Color differs because afocal method used to acquire images from the 35 mm lenses. Bottom Row: Round objects (paper plates, oriented to face the lens), each of 14 degrees angular diameter, imaged by the same lenses. The center of the field of view is at the left of each image, and the edge of the field is at right. Center of subject near edge of field is 49 degrees off-axis for 14 mm Sigma lens, 82 deg. off-axis for 8 mm Samyang lens, and 79 deg. for Nikon 16 mm. At the edge of the field, the Samyang 8 mm lens distorts the round object about 13 percent. This is less distortion than the other lenses, but is not quite a true stereographic projection.

2.6.1 Description of Stereographic (or Proportional) Projection.

Stereographic projection is capable of providing a low distortion polar projection of more than a full 3D hemisphere onto a 2D image surface, but cannot provide a low distortion polar projection of a full sphere onto a 2D surface because one pole would be infinitely magnified.

There are two relatively simple ways to visualize the stereographic projection. The first is to picture a sphere with its south pole resting on a plane surface. If an imaginary point light source is then located at the north pole of the sphere, it will project through surface features on the sphere and map them out onto the plane surface. In mathematics, the resulting projection is related to the Reimann Sphere. The projection formed by light passing from the point source through the southern hemisphere of a sphere would correspond to the 180 degree angle covered by the Samyang 8 mm lens. The second way to visualize stereographic projection is to picture the same sphere, plane surface and point light source, but with the plane passing through the equator of the sphere. Stereographic projection is also called "conformal" because it preserves angles of features on the sphere in the 2D image.

2.6.2 Non-Linear Radial Image Scale.

When the plane surface mentioned above is tangent to the south pole of the sphere, a feature on the south pole of the sphere will be imaged on the plane surface at the same size and shape as the original feature on the sphere. As we go farther from the south pole, the part of the sphere being projected becomes ever closer to the light source at the north pole, but the plane surface onto which the corresponding feature of the sphere's surface is projected resides farther from the sphere, resulting in increasing image scale on the outer parts of the plane surface, though the shape of each local feature on the 3D sphere is preserved. Thus, the radial and circumferential image scales increase equally with off-axis angle.

A second method of visualizing Stereographic projection was presented by Ulf Leonhardt in the 29 September, 2009 New Journal of Physics. In this paper on "Perfect imaging without negative refraction" [5], stereographic projection is visualized as a sphere and a plane surface, but in this case the plane surface passes through the equator of the sphere. This model makes it easier to describe a simple proof of the change in local image scale versus off-axis distance that is associated with Stereographic projection. In this model, the part of the plane used to map the southern hemisphere of the sphere resides inside the sphere, and the part used to map the northern hemisphere is outside the sphere.

When a line is drawn through the sphere, from the "north pole", through a plane intersecting the equator, and down to the south pole, it obviously intersects the plane at a point half way between the north pole and south pole. Therefore, if the line traces any surface features on the sphere that are right by the south pole, it will provide an outline of those features near the center of the plane that intersects the equator, but the features as outlined on the plane surface will be half the size of the corresponding features at the south pole of the sphere.

Now, we will consider the same sphere having a plane through its equator, but this time, the feature on the surface of the sphere being traced (e.g. projected) is a small circle at the equator. In this case, a line from the north pole is slanted 45 degrees in order to intersect the surface of the sphere at the equator. When this line traces out the small circle on the sphere, the width of the circle in longitude will be reproduced at its actual width where the line simultaneously intersects the plane surface. Likewise, since the line from the pole is tilted 45 degrees on average, the height of the small circle at the equator will also be reproduced at its actual size on the substantially perpendicular plane surface. This area corresponds to 180 degree zone of coverage in a stereographic lens, since it is at the equator of the sphere.

Thus, by considering that the object at the south pole was traced onto the flat surface at half its actual size, and the object on the equator was traced out at its full size, we can easily see that stereographic projection will image subject matter 90 degrees off-axis at an image scale twice as large as the image scale at the center of the image. What is unique is that the image scale is magnified the same amount in both directions (radial and circumferential), resulting in virtually zero distortion of an object's shape, regardless of where it is imaged in the picture. Only the imaged size is changed, based on off-axis distance.

The increase in image scale versus off-axis angle, when compared to image scale at the center of the image, can be described as: s=1/[cos(radiusTheta/2)]^2
where "s" is the image scale relative to the image center, and Theta is the off-axis angle.

Thus, we get the following relative image scales versus off-axis angle:

For 0 degrees:	1/[cos(0/2)]^2	=1/(1.000)^2	s=1.000
For 45 degrees:	1/[cos(45/2)]^2	=1/(0.924)^2	s=1.172
For 60 degrees:	1/[cos(60/2)]^2	=1/(0.866)^2	s=1.333
For 90 degrees:	1/[cos(90/2}]^2	=1/(0.707)^2	s=2.00
For 120 degrees:	1/[cos(120/2)]^2	=1/(0.500)^2	s=4.00
For 135 degrees:	1/[cos(135/2)]^2	=1/(0.383)^2	s=6.83
For 180 degrees:	1/[cos(180/2)]^2	=1/(0.000)^2	s=Infinity

The results show that the image scale does not really start to increase much until more than 60 degrees off-axis. Beyond 180 degrees, the image scale increase becomes dramatic. This occurs because a “great circle” surrounding the lens is imaged at 180 degrees coverage. At wider angles of view, subject matter of a given angular size begins to occupy proportionately larger parts of “small circles” that correspond to areas in surrounding subject matter that are located at increasingly large angles behind the entrance pupil of the lens. There may be other expressions that define relative image scale versus off-axis angle in stereographic projection, but this is just one I worked out for my own use in the absence of finding references for it.

By comparison, an equidistant fisheye lens reproduces features on a sphere at a constant scale in the radial direction in the 2D image (corresponding to latitude on the sphere), but increases the image scale by half pi (1.57x) in the circumferential direction at the 180 degree zone on the 2D mage (corresponding to longitude at the equator on the sphere). Thus, the image of a spherical object at the 180 degree zone of an equidistant projection fisheye image is distorted into an elongated 1:1.57 oval in the image. Rectilinear lenses are not compared here because they are incapable of achieving 180 degrees of coverage.

3.0 Mechanical Attributes:

3.1 Dimensions

Length of the Samyang 8 mm f/3.5 lens depends on the camera mount, since different camera mounts require different back focus distances. For a Nikon mount version, the length is 74.8 mm. When a 4/3 format adapter is added, the length increases to about 82.5 mm from the camera lens mount. The maximum diameter is at the front, where the diameter reaches 75 mm. Farther back, the diameter is 66.5 mm or less. The lens is noticeably smaller and lighter than the 14 mm Sigma lens, but not as small as a full frame fisheye Nikkor lens.

3.2 Build Quality

Unlike many modern lenses, most of the Samyang 8 mm lens barrel is made of metal! Specifically, the focus ring, focus index mark ring, the inner barrel under the focus ring, and the bayonet lens mount are all metal.

Major plastic parts are limited to the built-in plastic lens hood, the lens cell for the front 4 elements, and the aperture ring. Some aspects of the front plastic cell also appear to use a thermally formed flange to hold the forward element in, meaning that this section of the lens would not be very serviceable. However, there are no moving parts in this part of the lens.

The plastic lens hood actually is not a bad idea, since it can potentially absorb mechanical shock better than a metal one. The plastic lens hood also has the neat feature of molded 72 mm filter threads in the top and bottom petals. These threads allow the lens cap to actually clip on, rather than just being friction fit. This should lead to a lot fewer lost lens caps!

There have been a number of articles about people cutting or “shaving” off the front lens hood petals to permit more effective use of the Samyang 8 mm lens on “full frame” digital SLRs. [3] The fact that the lens hood is plastic makes the task is much easier, and lowers risk to the optics. Even better, it is comparatively easy to remove the Samyang 8 mm front element group and lens hood, to reduce risk to the optics even more.

Removal of the lens hood involves first removing the stop screw on the focus ring, then spinning the focus ring toward close focus far enough that 3 screws become visible on the back part of the lens hood. To access these lens hood screws, it may also be necessary to loosen the focus scale adjustment set screws at the front of the focus ring to permit sliding the focus ring back a little. (Loosening the focus scale set screws should not be considered lightly, and is covered more in the section about adjusting the focus distance scale.)

After this, remove 3 screws holding on the lens hood, then, since the lens hood is plastic, it usually flexes enough all you have to do is gently squeeze it to indirectly grasp the OD of the front element cell and then just use the lens hood as a grip to unscrew the front element group from the main lens barrel! After the front elements in their plastic cell are unscrewed from the main metal barrel, the lens hood simply slips off the back of the front element cell as a separate part, making it easy and (mechanically) no-risk for the optics to cut off the hood! The lens warranty may go south if you do this, so it is a “do at your own risk” modification.

3.3 Lens Mount.

The lens mount of the Nikon version Samyang lens is metal, but it has slight dimensional differences from the bayonet mount found on a Nikon brand lens. Most notably, the distance between the back mounting face of the lens and the front side of the bayonet flange is slightly longer than on a Nikkor lens. Specifically, the mounting surface to bayonet flange distance on an average Nikon lens is 2.30 mm (0.0906"), while the same feature on the Samyang lens measures 2.36 mm (0.0929"). The difference is only about the thickness of a piece of paper, but it can make a noticeable difference in some applications.

The small difference in the lens mount face to bayonet flange dimension is not a problem when the lens is mounted directly on a Nikon camera, since the lens mount on a Nikon camera body usually includes flat springs that push back on the front side of each bayonet flange on the lens. However, when the lens is used with third party adapters or accessories, the lens may fit so loosely that it wobbles on the mount. This is the case when the lens is used on a third party Nikon to Olympus 4/3 lens mount adapter.

Fortunately, many of these third party adapters are easily modified to provide a tighter fit by prying the back half of a split ring spring (in the adapter's bayonet flange) away from the front part to an extent that the Samyang lens fits tightly enough it won't rattle. This prevents attachment of Nikon brand lenses on the same adapter unless the split ring springs are returned to their original form. Therefore, if the Samyang lens is used on a third party lens mount adapter, that adapter should be dedicated to the lens.

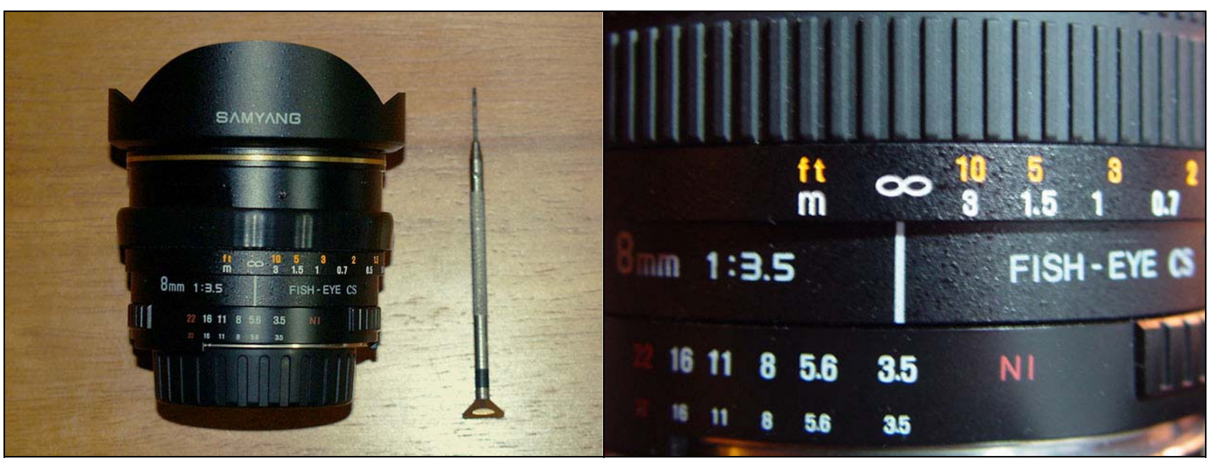
Another consideration related to third party adapters is that the thickness of the adapter may have manufacturing tolerances that need to be compensated for. This compensation can be implemented by modifying the adapter, or, by adjusting the focus distance scale and infinity stop on the lens. Adjusting the distance scale on the lens is covered in another section of this review, but adding suitable shims to the adapter is recommended over adjusting the distance scale more than a small amount. This is due in part to the limited available focus travel.

3.4 Distance Scale and Infinity Stop.

The focus distance scale on the manual focus ring of my Samyang lens was way out of adjustment when the lens arrived, showing the sharpest image of a distant subject in my Nikon F and F2 camera viewfinders when focus distance scale read only about 0.7 meters. Also, rapidly reversing the direction of focus caused what felt like some possible slippage in the focus ring, so this was looked into. The source of the problem was minor, where one set screw on the focus ring (located under a piece of tape that is in turn under the front half of the rubber focus grip) was completely loose, with its top being flush with the outer surface of the focus ring, as opposed to being recessed a turn or two like the other set screws.

The focus scale being out of adjustment is not all that unusual for a modern lens, though the scale is usually off by a lesser amount. In fact, about 1 in 3 lenses I've either owned or used at one time or another have had inaccurate focus scales and infinity stops. Pleasantly notable exceptions I've observed are Leica lenses and early Nikkor lenses from before rubberized focus grips were used. All such Leica and Nikkor lenses I’ve used to date had accurate infinity stops and distance scales.

Since I usually try to validate infinity stop and focus distance scale accuracy on any manual focus lens I acquire (and adjust it if necessary), correcting the Samyang lens focus scale was not a problem for me. Construction of the Samyang lens makes adjustment of the focus scale (and thus infinity stop) very simple, to such an extent that any qualified repair shop (or perhaps even mechanically inclined individual) with proper tools (1.2~1.4 mm jeweler’s screw driver) should be able to make the adjustment, though it is not known what this adjustment may do to the lens warranty. As we will see below, an accurately adjusted focus scale and infinity stop will make it far easier to get optimum results from the Samyang lens.



Left: Three set screws on the Samyang 8 mm lens focus ring are located under the front half of the rubberized focus grip. Photo shows front of focus grip rolled back, plus a screwdriver to loosen and retighten the screws to adjust the focus scale. Right: Close up of Samyang 8 mm lens focus scale, near infinity symbol. The focus scale is useful for zone focusing.

The mechanical design of the Samyang lens focus mechanism is similar to that of some fixed focal length Soligor and Vivitar lenses from the 1960's and 1970's. This design provides for very easy adjustment of the focus scale and infinity stop. In the Samyang lens, the functional infinity stop is on the focus ring itself, so the infinity stop will automatically be correct once the focus scale is properly adjusted to match the actual subject distance. The focus ring is mechanically coupled to the helical focus mechanism by 3 set screws.

On the Samyang 8 mm lens, the 3 set screws on the focus ring are located under the front half of the rubberized focus grip. To access the screws, gently peel back the front half of the rubber grip (without tearing it) until it is inside out and wrapped around the back half of itself, all the way around the lens. The central gap in the grip ridges on the rubber ring will help keep it in its pulled back position, freeing both hands for the focus ring adjustment.

The only screws that need to be touched are the 3 recessed set screws that accept a straight blade 1.2 mm screwdriver. The fourth screw with the small Philips head should be left alone.

It is not necessary to uncover the back half of the focus ring (in fact you don't want to uncover it) because that is where two pieces of tape couple the front part of the focus ring having the mechanical infinity stop to the back part having the focus distance scale.

Adjusting the focus scale to match the lens focus distance is simply a matter of manually focusing the lens on a subject at a known distance (for example, 3 meters if indoors, infinity if outdoors), then loosening the 3 set screws on the focus ring and turning the focus ring (without spinning the inner focus mechanism) so the focus distance scale matches the actual distance, then re-tightening the 3 set screws. It is best to gently push the focus ring toward the front of the lens when re-tightening the set screws so it will be properly seated on the internal focus mechanism when the set screws are tightened.

Given that the focal length of the Samyang lens is very short, it is not really possible to tell the difference between a focus setting of 2 or 3 meters and infinity via just looking into the viewfinder of most SLRs. The image will "look" sharp at either setting.

Therefore, the best way to validate focus is to take digital pictures at the maximum resolution of your camera while incrementally making slight changes in the manual focus position of the Samyang lens (maybe steps of 1/4 the distance between infinity and 3 meters on the focus scale) and then correlate the focus positions to each picture. The picture that is the sharpest will be the one for which the distance scale should be set to match the actual subject distance.

If the lens is used on a film camera, you probably won’t want to wait for film to be developed and will instead probably want to just use the focus screen. For this, you will need to use a relatively very high magnification to look at the focus screen. This can be accomplished by using a close focusing 6x to 8x monocular behind the camera eyepiece, or even better, if you have a camera with a removable viewfinder (such as a Nikon F, F2, or F3 camera) you can remove the top prism and use a strong magnifying lens to look directly at the focusing screen in the camera. To observe the focusing screen on my Nikon F2, I looked backwards through an 8 mm f/1.2 C-mount video lens that was held close to the focus screen. This provided a 1:1 visual scale of the subject via the image from the Samyang 8 mm lens, for accurate evaluation of focus.

When using the focus screen, it is important not to use any central split image spot, but to instead look beside any central specialized focusing spot, etc. This is recommended because many of split image spots can be “fooled” by the centering of your eye behind the viewfinder or magnifier. Therefore, use a part of the plain matte screen that is relatively near the center.

Left: To accurately adjust the focus scale for use in zone focusing, a very strong focusing screen magnifier (in this case, a video zoom lens set at 8 mm focal length) is used to evaluate focus on a 35 mm camera having a focusing screen that is known to be very accurate. If the lens will be used only on a digital camera, digital photos may be used to evaluate focus instead of using the focusing magnifier. Right: Modifying the lens to focus down to 16 cm (rather than the normal 30 cm) is a more involved process, but should be within capabilities of a competent specialty photo service shop. The lens hood and front element group cell at lower left are plastic, but most other parts of the lens barrel (except aperture ring) are metal. The lens hood and front lens group cell are separate parts, simplifying hood modification.

When using either a viewfinder magnifier or digital photos to evaluate the best focus, it is probably best to set the Samyang lens somewhere between f/4.5 and f/5.6. This is because the lens has slight color fringing and other aberrations at f/3.5 that could make the proper focus setting harder to evaluate. Also, due to the reduced performance of the lens when used "wide open" at f/3.5, you may not want to take many pictures at f/3.5 anyway. It is not unusual for a lens to have a softer image at full aperture, so this should not be seen as a "defect".

3.5 Accurate Focusing with the Samyang 8 mm f/3.5 Lens.

Once the Samyang 8 mm lens focus scale has been adjusted to the desired accuracy, you should be able to manually adjust the focus by using the focus scale in comparison to measured or estimated subject distances to obtain far more accurate focus than would be possible by focusing via the camera viewfinder. Zone focus is beneficial over SLR finders only for ultra wide angle lenses, usually when used at a subject distance of at least 1 meter.

For subject distances of a meter or more, use of the focus distance scale should be many times more accurate than even the AF confirm light in the camera, assuming the AF light in the camera used works with a manual focus (MF) lens. For example, if I have my digital SLR with the Samyang 8 mm lens pointed at an object 2 meters away, the AF confirm light stays on at any focus setting between 1 meter and infinity. It is possible to find the center of the focus range where the AF confirm light is on, but this can take longer than simply judging the distance and then setting the distance scale to match the estimated distance.

The method of manually focusing a lens by setting the focus scale to correspond with a measured or estimated subject distance is called "zone focus" for film photography, so the same term will be carried forward here.

For an example of how accurate "zone focus" can be with an ultra wide angle lens, let's assume you are using the 8 mm Samyang lens to photograph an object that is 3 meters from the lens, while using an f/stop of f/4.5:

In a digital SLR camera viewfinder, you probably will not be able to discern any difference in the image when the focus ring is set on infinity, 3 meters, or 1.5 meters, but with a properly adjusted focus distance scale, you can get the focus almost right on for an object at 3 meters distance just by setting the focus to 3 meters via the focus distance scale. If you instead just use the camera finder to focus (or if the distance scale was off by the difference between 1.5 meters and 3 meters), the resulting image could easily be out of focus by about 5 microns, corresponding to about one pixel of defocus in most newer interchangeable lens digital SLRs or digital live view EVF cameras.

Specifically, the aperture of the 8 mm lens at f/4.5 is theoretically about 1.78 mm, which is 1/1685th of the 3 meter distance to the subject. If we then divide the 8 mm focal length of the lens by 1685, we get a 4.7 micron decrease in resolution due to defocus. The defocus can be calculated in other ways that are more accurate by a fraction of a percent in this case, but this method is used for its simplicity. Thus, by using the distance scale instead of the focus screen, we can arrive at a more accurate focus setting and obtain a more satisfying picture.

3.6 Using the Samyang 8 mm f/3.5 Lens on 4/3 Format Digital Cameras.

One thing that has thus far plagued 4/3 format digital cameras is the lack of an "affordable" ultra-wide lens that is wider than the equivalent of a 28 mm lens on the 35 mm film format. Even though the Samyang lens is designed for the larger 23x15 mm APS digital format, it still covers a very respectable angle on the smaller 18 x 13.5 mm 4/3 format.

Specifically, the Samyang 8 mm lens on a 4/3 format camera will cover about 130 degrees across the diagonal, 108 degrees horizontally, and 81 degrees vertically. This is measured through the center of the frame. When vertical or horizontal coverage is measured near the edge of the frame, the value will be somewhat less, due to the image scale increasing with off-axis distance.

Thus, the horizontal and vertical field of view of the Samyang 8 mm lens on the 4/3 format is about the same as that of a 14 mm rectilinear lens on the 35 mm film format.

For reference, angular coverage of the Samyang 8 mm lens on the APS digital format is 162 to 180 degrees diagonally, about 130~135 degrees horizontally, & 90~95 degrees vertically. This is about the same field of view as a 16 mm full frame fisheye lens on a 35 mm camera.

Left: Nikon mount Samyang 8 mm f/3.5 lens, shown with a Nikon to Olympus 4/3 adapter and Olympus E-500 camera. Right: Samyang 8 mm lens mounted on Olympus E-500 via a Nikon to 4/3 adapter. Need an "affordable" ultra wide lens for 4/3 format? Problem solved!

3.6.1 Using a Nikon Mount Samyang 8 mm Lens on an Olympus E-500 Camera

I presently use the relatively affordable Olympus E-500 DSLR for digital images, and adapt lenses from my Nikon film cameras lenses to it. When using the Nikon mount Samyang lens on the 4/3 format, it is necessary to adapt the lens to the 4/3 camera via a third party adapter.

When the 8 mm lens was attached to either of the two third party Nikon to Olympus 4/3 adapters I have, it initially fit the adapter so loose it rattled. However, the adapter was easily modified to provide a tighter fit by prying the front and back halves of a split ring spring (in each of the adapter's bayonet flanges) apart to an extent that the Samyang lens fit tight enough and didn't rattle. This prevented attachment of Nikon brand lenses on the same adapter, so the modified adapter was simply dedicated to the Samyang lens, which I expect will continue to be used on the adapter quite often.

The Nikon lens to Olympus 4/3 adapters I have are also too shallow, which causes the distance scale on the Samyang lens to be off by a considerable degree. Since I use a Nikon camera for film pictures and hope to eventually get a Nikon digital SLR that will meter with Nikon AI mount lenses (expensive compared to the Olympus E-500 and an adapter), the Samyang 8 mm lens distance scale was adjusted to be right on when used on my Nikon F2. With it being desirable to keep the Samyang lens focus distance scale configured to be accurate on a Nikon, modifying the depth of the Nikon to Olympus adapter (by simply adding suitable shims) was the best solution.

Adapting the Samyang 8 mm lens to a 4/3 lens mount, and adjusting its distance scale to be accurate enough for zone focus, has provided an affordable and outstanding wide angle lens for 4/3 format. Many aberrations visible near the corner of the APS format are not visible at all at the corner of the 4/3 format, making the Samyang lens a good performer for 4/3 camera users. Also, several image processing programs permit easy conversion of an image from the Samyang 8 mm lens to the equivalent to what an ultra-wide rectilinear lens would provide.

Left: Field of view covered by Olympus E-500 kit lens (28 mm equivalent.) Some camera shake is in this example, which was taken at dusk. Right: Sweeping ultra wide field of view provided by Samyang 8 mm lens, even on the relatively small 4/3 digital camera format. Note the relatively accurate proportions of subject matter even at the edge of the field. This image was taken f/4.5. Fine backlit detail is better captured at f/ratios between f/6.8 and f/9.5.

3.6.2 Idiosyncrasies of Currently Available Lens Adapters for 4/3 Format:

Several third party Nikon to Olympus lens adapters with an “AF Confirm” chip are available. The chip enables the Olympus AF confirm light to come on when correct manual focus is achieved. However, the two adapters I’ve acquired thus far, each from a different vendor, have major issues. Fortunately, the AF confirm light is less accurate than the previously mentioned “zone focus” method for subjects over a meter from the lens, so the AF confirm light isn’t really needed with the Samyang 8 mm lens anyway. The moral of the story: Get an adapter without the AF confirm function unless you have an affinity to using the AF confirm function with manual focus lenses.

Since some may desire to use AF confirm, idiosyncrasies in the AF confirm Nikon to 4/3 adapters observed to date will be covered below. This section has no bearing whatsoever on the quality of the Samyang lens because the lens adapters are made my other manufacturers.

The first AF confirm Nikon to Olympus 4/3 adapter I acquired had the AF confirm light command circuit board relatively close to the right longitudinal position, but it still was not quite close enough to the right position to be workable. The AF confirm circuit board with its associated chip are just glued into the adapter. In this adapter, the top of the AF confirm chip protruded behind the adapter’s Olympus 4/3 bayonet mount flanges, and the protrusion was enough for the AF confirm chip package to rub (more like gouge) the inside of my E-500 camera body, generating particulates that could contaminate the sensor cover glass.

The AF confirm adapter manufacturer had already filed down the top of the AF confirm command chip package, but not far enough. In order to keep the chip from rubbing the inside of the Olympus camera body, I filed if a little more, but it still kept rubbing the camera and generating particulates. Finally, I thought I was getting low enough on the chip package to take it slow, so I started checking the chip every couple of light file strokes. However, even when taking this precaution, I happened to file down to and through two of the thin gold leads on the inside the chip package, in effect disabling the chip's AF confirm light command function. So, scratch one AF confirm chip.

The longitudinal position of the circuit board was such that it could only be moved forward about another 0.4 mm before it would interfere with some Nikon lenses, so the longitudinal placement of the AF confirm circuit board MUST be controlled very accurately. This is something that AF confirm adapter manufacturers need to get a handle on by using some sort of accurate jig in the assembly process. On the second adapter, the circuit board was angled and the AF confirm chip projected even farther back, making it useless. Therefore, the AF confirm board will probably be removed from this adapter entirely.

An additional issue with the adapters is that in the first one, the pads on the circuit board did not quite properly line up with the pins in the camera, due to the board being at a slightly incorrect rotational position. Therefore, it only worked reliably when I held in the lens release button and let the adapter rotate around a degree of so past the lock pin on the camera body, where it was stopped by the small stop screw under one of the bayonet flanges. This was corrected by elongating the bayonet lock registration hole enough that the lens could be turned a little farther to get the pins in the camera body to line up with the pads on the AF confirm board in the lens mount adapter.

Since I don't need the AF confirm light with the Samyang 8 mm lens (zone focus with such a wide lens is 3x more accurate than the AF confirm light and over twice as accurate as using the focusing screen, as noted earlier in this review) I just dedicated the adapter with the dead chip to the Samyang lens. An AF confirm command chip is more useful with telephoto lenses, and it is advisable to dedicate an adapter to the Samyang lens anyway.

Because the Samyang focus travel is limited, some lens mount adapters may have to be shimmed a little to get the Samyang lens to focus through its normal range. In the case of the Nikon to 4/3 adapters I had, the optimum shim thickness was 0.4 mm. The stock I had on hand was 0.025 mm thinner than this, so the shim can be brought closer to the optimum thickness with some extremely thin shim stock or foil.

4.0 Conclusions:

* The proportional (also referred to as quasi-stereographic) projection of the 8 mm f/3.5 Samyang lens is very pleasing compared to a conventional fisheye lens, but is not to be confused with the more conventional projection of a rectilinear lens.
* Flare from the Samyang 8 mm f/3.5 lens is considerably lower than many other super-wide angle lenses, though not as low as the Nikon fisheye lenses it was compared to.
* Light falloff toward the edge of the field is very minimal. This was surprising after noting the small diameter of the rear element.
* The lens begins to provide its best results over the full 4/3 format when used at f/ratios of f/4.5 or slower, and f/6.8 or slower on APS format. Aberrations visible at wider apertures.
* The lens is a good, affordable wide angle solution for 4/3 format camera users. (A must-have lens for those who can't afford high priced 4/3 format wide angle lenses!)
* For now, it is best to get a 4/3 format adapter that does not have an AF confirm chip.
* The lens produces even more dramatic results on APS format digital cameras.
* With lens hood cut off (e.g. shaved) results are still more dramatic on full frame cameras.

* Within the central 100 degrees of the image, projection of the Samyang 8 mm lens is not dramatically different from that of a conventional fisheye (e.g. Nikon 10.5 mm or 16 mm), but the difference is increasingly obvious beyond 100 degrees, and significant at 180 degrees.
* The "zone focus" method is likely to provide the best results for subject distances of 1 meter or more. However, the focus scale of the lens must be properly adjusted to get the optimum results from this manual focus method.

4.1 Suggestions for Future Versions:

* Put serial number on lens. It is unusual for an item of this price to lack a serial number.
* Provide a close focus of 13~18 cm versus the current 30 cm. (This would be equivalent to focus down to 1~6 cm from the front element.) Many interesting pictures could be taken at such a close focus distance. The existing focus threads in the lens are long enough, so this close focus distance could be implemented by simply relocating the close focus stop screw (on the inner lens barrel under the front part of the focus ring) to extend the focus ring travel about 120 degrees, then adding distance scales to the newly utilized part of the focus ring. This would allow the focus ring to rotate almost twice as far as it does now, to provide the closer focus distance without having to change the focus thread pitch.
* Add a filter holder, even if it is only a rear filter holder for thin gel filters like the filter holder on the back of the 14 mm f/3.5 Sigma lens. This VERY important feature could be a retrofit that replaces the ringed baffle that surrounds the small barrel for the rear elements.
* Include depth of field marks for at least f/5.6, plus an infrared focus reference mark.
* Provide an optional accessory lens hood for use with the lens on 4/3 format cameras.
* Provide a "pre-shaved" lens hood that can be swapped for the standard one, or make the lens with a user-removable hood, possibly implemented as a two stage lens cap.
* Provide detailed instructions for user adjustment of the focus distance scale for zone focus.
* Add felt to inside of font lens cap so it will not chatter as much when sliding it onto lens.
* Increase field of view slightly, so vignette does not begin to darken image at 178 degrees.
* Make an additional version of the lens, having rear elements tailored to provide an f/2.8 f/ratio and an image circle that just covers the 22.5 mm diagonal of the 4/3 format yet still fits within the 24 mm width of a "full frame" 35 mm and digital camera format. It is best if lens hood petals are removable, such as being the rear part of a two piece lens cap.
* Make a version with no lens hood (or with a removable lens hood) and with same aperture (about 2.4 mm maximum aperture for the axial part of the field), but that has an f/ratio of f/1.4 or faster, and that fits the entire 180 degree image onto a 12 mm or smaller image sensor, for all sky meteor imaging and other low light applications, etc.
* This one is wishful thinking, but here goes: Make an additional version having the same proportional projection (or maybe something slightly closer to true stereographic projection), but that has at least 225 degrees of coverage, for interesting properly proportioned images of the horizon or building interiors when the lens is pointed straight up or straight down. (I've occasionally generated images like this since the 1970's using my own technique, and they can be pretty interesting.) Ideally, the first version having this angle of view would have a 23 mm image circle, but later versions could have a 13~15 mm circle for APS and 4/3 formats. The added angle could also benefit full frame images on 23 x 15 or 36 x 24 mm formats. This angle also provides more overlap for stitching immersive images. A maximum f/ratio of 5.6 would probably be acceptable for the wider angle version, as long as the off-axis image was sharp at that f/ratio.

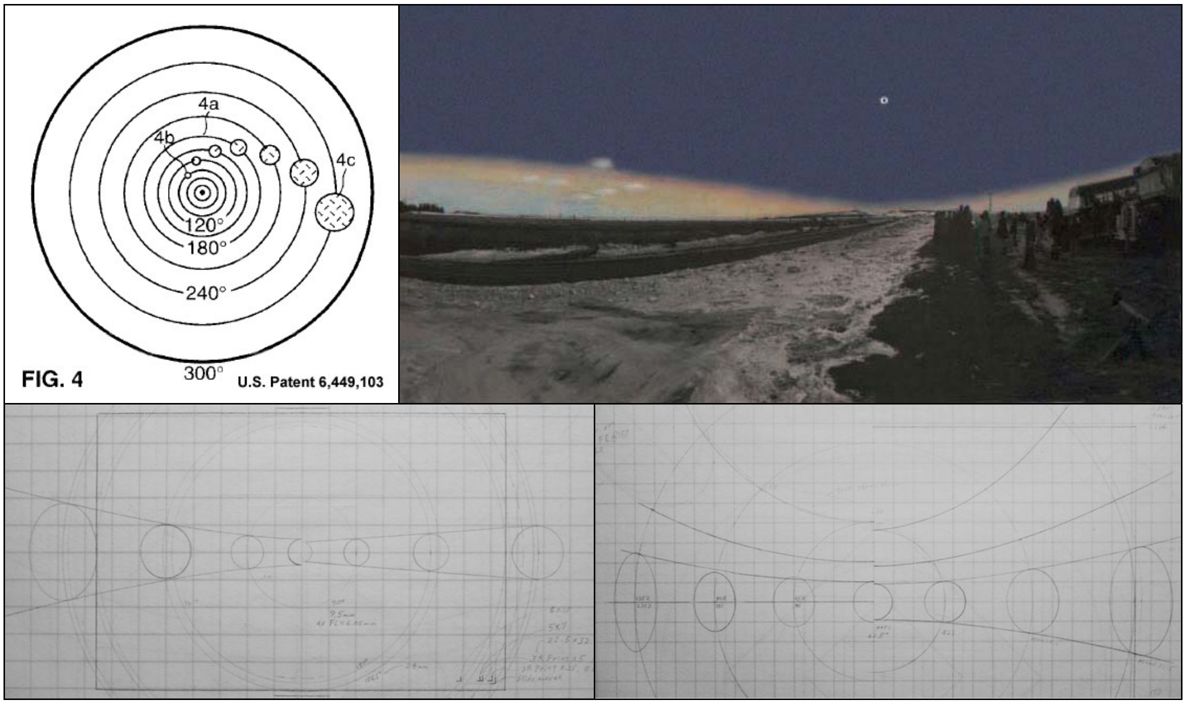
Left Image: Samyang 8 mm f/3.5 lens (center), shown with 14 mm Sigma (left) and 16 mm Fisheye Nikkor (right). Right Image: Rear view of Samyang 8 mm lens (lacks filter holder) and 14 mm Sigma and 16 mm Nikkor lenses, with their rear filter holders. The filter holder on the back of 14 mm f/3.5 Sigma lens is very versatile, accepting a variety of gelatin filters. It would be preferred if Samyang would implement such a filter holder on the 8 mm lens, and also make it available as a retrofit (to replace the rear baffle) for their existing 8 mm lenses.

5.0 Desirability of a Proportional Projection Lens Prior to its Commercial Inception.

The concept of stereographic projection has been around in concept for centuries, but it is also a type of projection is also one I independently came up with on my own starting in the late 1970's, while living in a small town that did not have a great deal of optical research resources. (In some circumstances during that era, it was easier to unknowingly reinvent the wheel than to access research material for what already existed in a given technical field.)

The attraction of the proportional projection is that it provided correct proportions in imaged subject matter on the horizon for one shot 360 degree panoramic images that were captured by simply pointing an optical system having more than 180 degrees coverage either straight up or straight down. During this time, I assembled some prototypes that used strong aspheric reflectors to provide this and other projections over angles exceeding 180 degrees. In addition, I also on occasion converted a conventional fisheye picture to this proportion through use of a fisheye lens on an enlarger, focused at a close enough distance (and thus located far enough from the original film image) that it did not make the projected image completely rectilinear. Other more complex image morphing performed in a darkroom during this earlier time has been covered in some of my other papers. [10]

An illustration of the proportional projection is shown in drawing Figure 4 in two of my patents (6,333,826 and 6,449,103), which emphasize optical systems having coverage wider than 180 degrees. The drawing below is not right on, since there is actually a little more increase in radial image scale versus off-axis angle in a proportional projection, but it adequately shows the projection concept. I'd submitted a corrected drawing that got this right on (and only went out to 290 degrees versus the shown 300 degrees) and was approved for one of the patents, but for some reason, it did not make it into the published version.



Upper Left: Drawing of Proportional Projection from my U.S. patent 6,449,103. [7] Upper Right: Rendering of 1979 total solar eclipse [9] in which the foreground was photographed with a fisheye lens and converted via darkroom techniques in the mid 1990’s to have a more proportional projection. Bottom: Two of my circa 1976 (when a teenager) drawings showing the imaged shape of a spherical objects with different projections versus off-axis angle. [11] The object was to develop an optical system of about 290 degrees coverage with an “almost” stereographic projection (left of lower left image, right of lower right image), having minimal (0~15 percent) distortion at 180 degrees. The purpose of the system, first version prototyped in 1977, was to capture one shot 360 degree panoramas in which subject matter looked relatively proportional, even if images were not “unwrapped” into more conventional shapes.

The wide angle prototype of 1977 used a reflector, so the center part of subject matter was obscured due to either a camera or secondary mirror. This optical system and subsequent improvements [8] (some of which were patented in 2000) [6] achieved the intended purpose, but did not address the desirability of a “lens” (rather than reflector) that provides such a projection in a more “modest” 180 degree field of view. I'd hoped a 185+ degree (preferably 230 degree) lens with proportional projection would be marketed even in the 1970's, since I did not then have means to produce one. At the time, I had no idea I'd have to wait over 30 years before even a 180 degree version would be available. I had on occasion considered designing, manufacturing and marketing such a lens, but decided it was then too large a risk to be taken on by anything other than a relatively large company. Ray tracing & manufacture of refracting optics was a pretty big deal back then, compared to that for reflecting optics.

5.1 Proportional Projection Becomes Reality in the Samyang 8 mm Lens

Fortunately, Samyang did all the engineering work and all I had to do was come up with a few hundred $ to get one! The projection of the Samyang 8 mm lens is its main attraction for me, because the projection substantially preserves proportions of 3D objects in a 2D image.

Left Image: The Samyang 8 mm lens front element (center) is curved almost as much as that of the 14 mm Sigma rectilinear lens (left), and likely plays a role in achieving stereographic projection. The front element of the Nikon fisheye at right has a relatively shallow curvature. Right Image: 8 mm f/3.5 Samyang lens optical design diagram, from Samyang web site. [1]

In a lens, the radial distribution of its image can be controlled by the relative angles of refraction at the front versus the back of the forward optical elements. For example:
* To cause the radial image scale to decrease with off-axis angle, the front element is designed to refract light MORE at the front and LESS at the back.
* To cause the radial image scale to increase with off-axis angle, the front element is designed to refract light LESS at the front and MORE at the back.

This can be observed in practice by examining the front of element a super-wide rectilinear lens like the 14 mm Sigma, which has even more curvature than most fisheye lenses. This added curvature permits incoming rays near the edge of the field to enter the front element almost perpendicular to its surface, but the same light rays are refracted a considerable angle when exiting the back surface of the front element. This process can be repeated through multiple elements to provide the desired projection attributes with spherical surfaces. A single aspheric surface can produce most of the effect with fewer elements, but costs more.

The front element of the Samyang 8 mm lens has more curvature than the front element of a conventional "full frame" fisheye lens, which contributes to the Samyang lens' proportional projection characteristics. However, the front element does not provide the proportional projection all by itself. Other lens elements and the angle at which the image intersects the focal plane are also involved. Specifically, observation of the virtual image formed by the front elements in their removable cell revealed a virtual image having a distribution that looked pretty much like a conventional fisheye image, and which did not retain correct proportions in subject matter. Therefore, the rear elements, combined with the above mentioned angle of incidence of rays on the focal plane, combine to produce the end result.

The proportional projection is more pleasing than the projection of conventional fisheye lenses because it better substantially preserves proportions of the subject matter imaged in the picture. Based on examples I've seen in other articles, the projection of the Samyang 8 mm lens also seems to hold up better than some conventional fisheye images when images are stitched to form a panorama or full sphere image using computer software.

5.2 Other Lenses with Proportional (or nearly so) Projection Characteristics

A few wide angle video lenses introduced over the last few years have had a stereographic (e.g. proportional) projection, or very close to it, though these lenses did not achieve a 180 degree field of view. Examples that have been discontinued include the 2.0 mm f/1.0 and 2.6 mm f/1.0 Computar video lenses, which each cover about 144 degrees. Left: The compact Computar 2.3 mm f/1.4 lens is a current model as of the writing of this review, and produces images that are almost (though not quite) as proportional as the discontinued 2.0 mm f/1.0. Right: Interior image acquired with Computar 2.0 mm f/1.0 lens, using a 0.5 inch (6.8 x 4.8 mm) format video camera and showing extraordinarily good proportions even in subject matter near the edge of the field. The center part of the image that is in color indicates the 1/3 inch video format (4.8 x 3.6 mm) that the 2.0 mm Computar lens was designed for.

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End of Samyang 8 mm f/3.5 Proportional Projection Ultra-wide Angle Lens Review.
 Draft version 0.4: 091121.