Summary of Benefits

- Improved image quality and contrast sensitivity, specifically in low light conditions.
- Lower refractive index of hydrophilic material may lead to minimum internal reflections.
- Unlike first generation aspheric IOLs, consistent results may be expected even in cases of clinically occurring lens decentration or tilt, as shown by wavefront analysis...

Wavelength Analysis also called “wavefront error” is the analysis of the deviation of real wavelength from ideal spherical wavelength.

“Wavefront” is a term appropriate for describing the wave nature of light. In a perfect optical system, rays from a single object point converge to a single image point and the object, resulting in a spherical wavefront. In an aberrated optical system, the refracted rays no longer converge to a unique image point and the image wavefronts are no longer spherical.

RMS (root mean square) is a measure of wavefront error. It is the square root of the average of the squares of all the wavefront errors over the full aperture of the optical system. Total RMS and Wavefront Error RMS (HRA RMS) are each defined by the integration of the Zernike coefficients, representing total and high order wavefront errors respectively.

Total RMS varies with Post-Op refraction but HRA RMS does not. Since Higher Order Aberrations can’t be corrected by spectacle lenses, they impact vision even at best corrected conditions. Therefore, HRA RMS is a more relevant measure of aspheric lens performance...

Results in the table below show Aaren Scientific Adaptiv™ Optics lenses have lower Total RMS and HRA RMS compared to first generation aspheric lenses for off-centered conditions. In addition, Adaptiv Optics have comparable or lower RMS measurements than spherical lenses for these same conditions...

The optics of all Aaren Scientific Adaptiv™ Optics lenses are designed to compensate for aberrations of the eye to achieve exceptional optical performance - even in cases of clinically occurring IOL misalignment.

Decentration and Tilt

An IOL placed in the posterior chamber of the eye of pseudophakic subjects will generally manifest some tilt and decentration. Decentration means range from about 0.3 to 0.7 mm, while tilt means range from 3 to 7 degrees, with lower numbers reported by more recent studies. Secondly, even an IOL perfectly centered in the capsular bag may be significantly decentered with respect to the visual axis. This is because structurally, the human eye is not optically symmetrical, i.e. the optical axis of the eye doesn’t generally coincide with its visual axis.

Unlike a camera, the eye is a decentered optical system with non-rotationally symmetric components (Fig 1). The principle elements of the eye’s optical system are the cornea, pupil, and crystalline lens. Each is decentered and tilted with respect to other components rendering an optical system that is typically dominated by coma at the foveola.

The cornea, pupil, and crystalline lens are decentered and tilted with respect to each other rendering the eye a decentered optical system that is different between individuals and eyes within the same individual. The line is centered with respect to the sclera represented here as being spherical.

IOL Position in Eye Model

<table>
<thead>
<tr>
<th>Spherical IOL (µm)</th>
<th>1st Generation Aspheric IOL (µm)</th>
<th>AdaptivOptics (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfectly Centered</td>
<td>Total RMS 0.59</td>
<td>HRA RMS 0.00</td>
</tr>
<tr>
<td>Decentered 0.5 mm</td>
<td>Total RMS 0.63</td>
<td>HRA RMS 0.01</td>
</tr>
<tr>
<td>Decentered 1.0 mm</td>
<td>Total RMS 0.63</td>
<td>HRA RMS 0.20</td>
</tr>
</tbody>
</table>

7 Degree y-tilt and 0.5 mm y-decentration

<table>
<thead>
<tr>
<th>Total RMS</th>
<th>HRA RMS</th>
<th>RMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.61</td>
<td>0.00</td>
<td>0.17</td>
</tr>
</tbody>
</table>

** 7 Degree y-tilt and 0.5 mm y-decentration is designed to correct for spherical aberrations only at the centered position.


The cornea, pupil, and crystalline lens are decentered and tilted with respect to each other rendering the eye a decentered optical system that is different between individuals and eyes within the same individual. The line is centered with respect to the sclera represented here as being spherical.

"Wavefront" is a term appropriate for describing the wave nature of light. In a perfect optical system, rays from a single object point converge to a single image point and the object, resulting in a spherical wavefront. In an aberrated optical system, the refracted rays no longer converge to a unique image point and the image wavefronts are no longer spherical.

Aspheric IOLs: The Next Generation

One type of 1ST GENERATION aspheric IOL is designed with a prolate aspheric surface to compensate for corneal aberrations when the lens is centered. Because the optics of these lenses are optimized for a centered position, they can perform poorly if they become decentered or tilted - often to the point of performing worse than a spherical lens under the same degree of decenteration.

Unfortunately, clinically occurring lens decenteration and tilt are common occurrences. Even the typical human eye itself, is not optically symmetrical. Aaren Scientific recognizes this, and has designed Adaptiv™ Optics to represent the NEXT GENERATION of aspheric lenses. Adaptiv Optic design takes into account a broad range of aberrations arising with lens misalignment. Its aspheric surface is non-prolate which physically distinguishes its shape from 1st generation aspherics. Consequently, Aaren’s Adaptiv Optic enables better image quality under a variety of real world conditions.

MTF (Modulation Transfer Function) analysis shows the significantly improved image quality of an Aaren aspheric-Adaptiv Optics lens to a typical aspheric lens, under various degrees of decenteration and tilt. In addition, the MTF of the Adaptiv Optic is comparable to or better than that of a spherical optic in cases of significant lens decenteration and tilt.

Regardless of lens spherical aberration, the optics of 1st generation aspheric IOLs are optimized for the centered position. Because of this some perform poorly if they become decentered or tilted - often to the point of performing worse than a spherical lens under the same conditions. And unfortunately, very few IOLs are perfectly centered in the eye.

Aaren Scientific recognizes this and designed Adaptiv™ Optics with more than just perfect conditions in mind. This optic design takes into account a broad range of aberrations arising with lens misalignment. Adaptiv Optics are also optimized for the range of corneal asphericity to offer benefits for patients of different cornea shapes. Consequently, Aaren’s Adaptiv Optics enable better image quality under real world conditions.