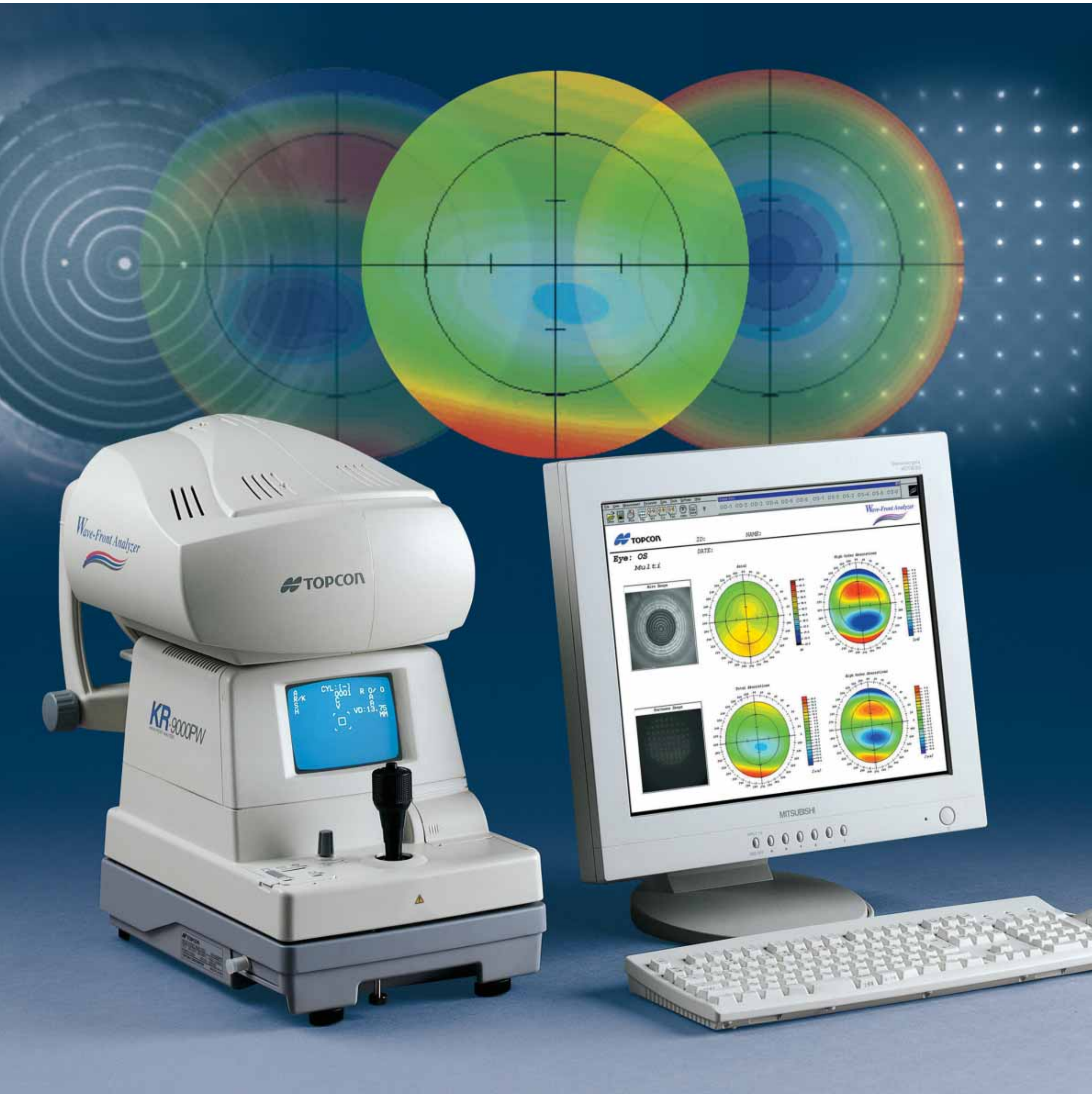
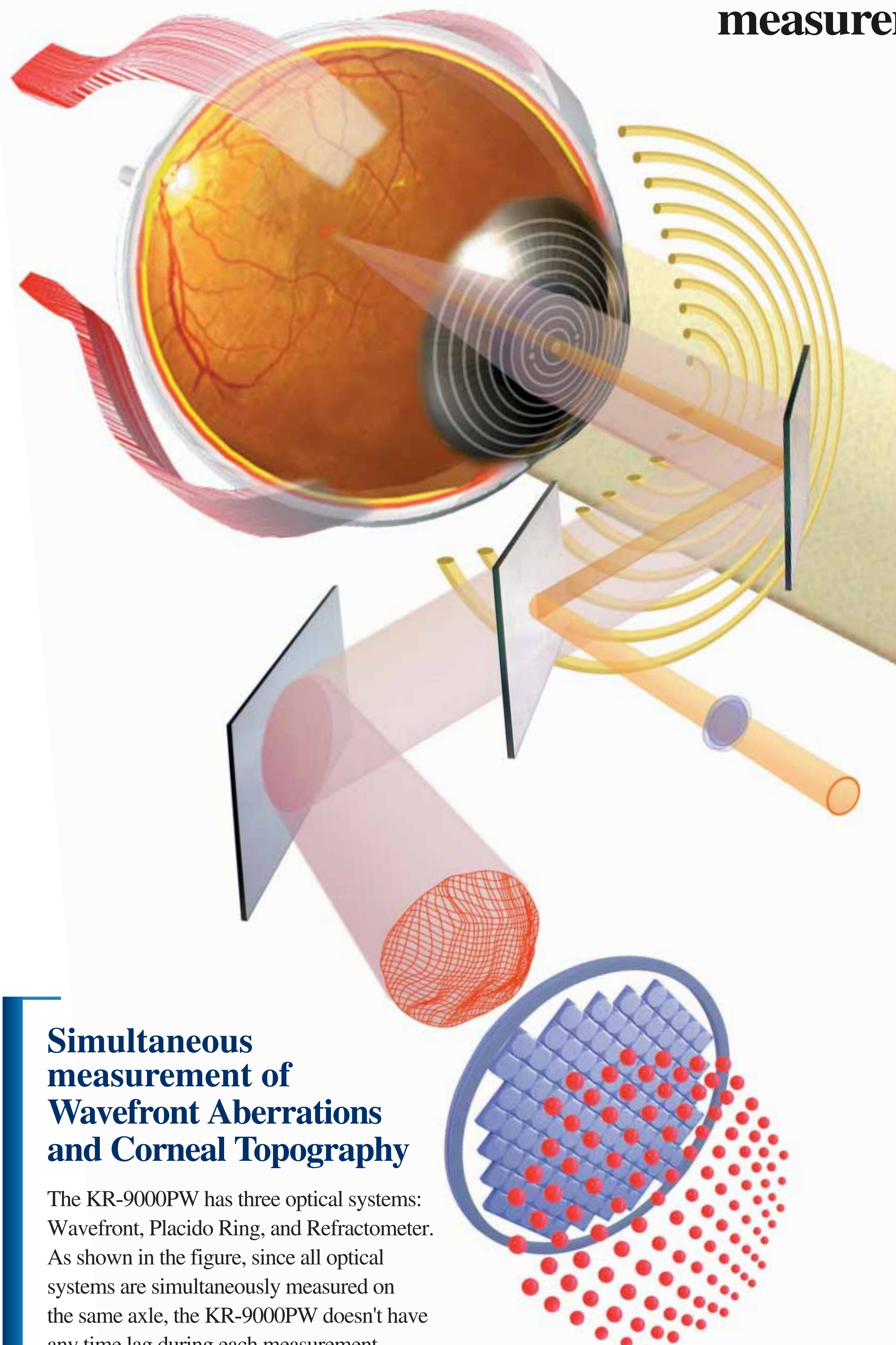
TOPCON

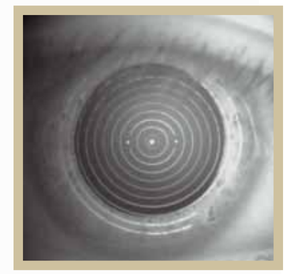
Wave-Front Analyzer
KR-9000PW



A Brand New Refraction Meas

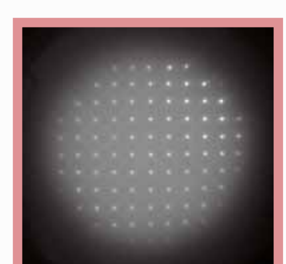
The TOPCON KR-9000PW
measurement of the eye's





Placido Optical System

Refractometer Optical System



Wavefront Optical System

Simultaneous measurement of Wavefront Aberrations and Corneal Topography

The KR-9000PW has three optical systems: Wavefront, Placido Ring, and Refractometer. As shown in the figure, since all optical systems are simultaneously measured on the same axle, the KR-9000PW doesn't have any time lag during each measurement.

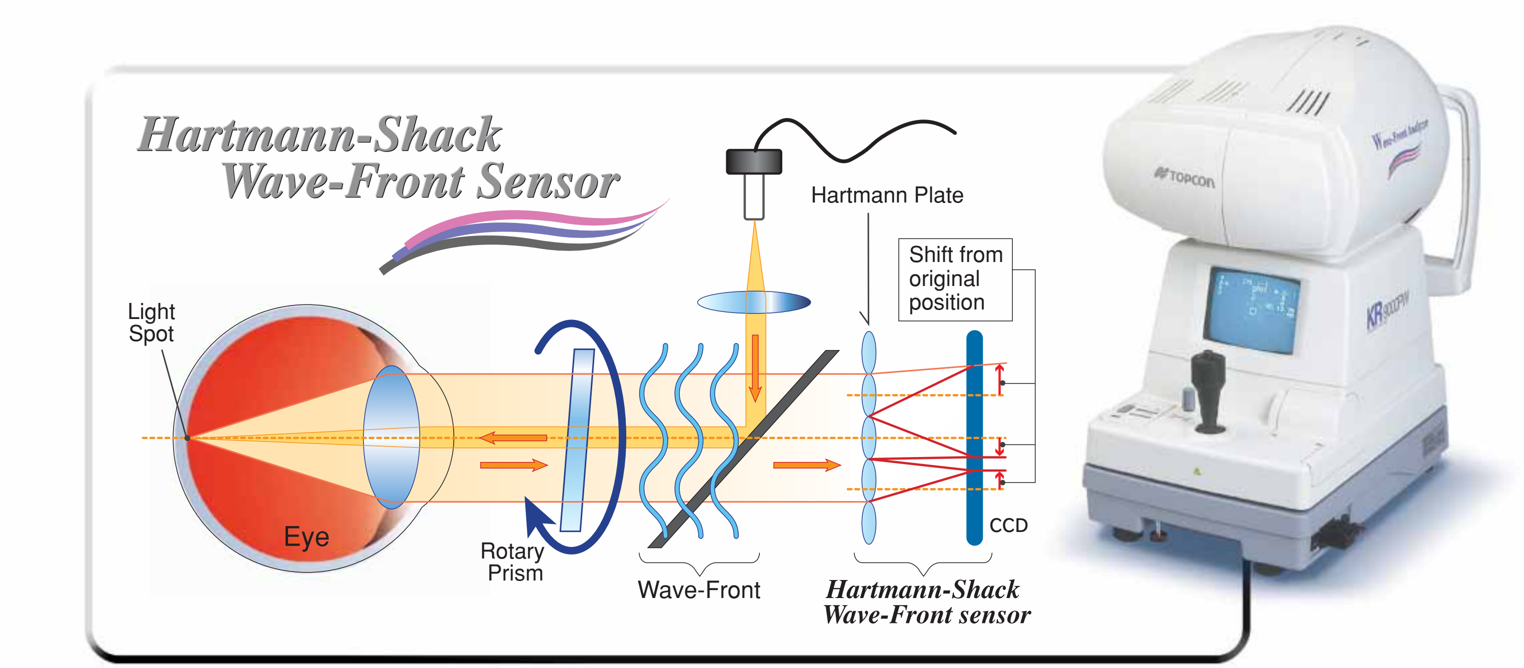
urement Instrument

WAVEFRONT ANALYZER incorporates comprehensive total optical system which has not been achieved until now, and is the new solution for refraction analysis !

The new Topcon KR-9000PW can provide a quantitative analysis of wavefront aberration including Irregular Astigmatism (High Order Aberration).
It can also acquire reliable, accurate information to estimate the best corrected visual acuity, and can be used for pre-operative screening and post-operative follow up.

The KR-9000PW is an innovative product which incorporates a Hartmann-Shack Wavefront Sensor and a Placido Ring, to provide accurate measurements of both refractive aberration and corneal aberration. The KR-9000PW can measure slight refractive disorders extremely accurately and with full dimensionality, which conventional Auto Refractometers and Auto Kerato Refractometers cannot do.The KR-9000PW is ideal for refractive surgery (LASIK etc...), for planning or pre/post-operation comparison, or can be used to provide essential data for all ophthalmologic operations, such as a cataract, the retinal diseases, and diseases on vitreous body.

The KR-9000PW combines the most reliable wavefront measurement principles (Hartmann-Shack wave-front sensor and Zernike Polynomials) with our integrated Rotary Prism technology to deliver objective data that is unmatched in accuracy and reliability. The instrument provides sphere, cylinder and axis measurements as well as indicating spherical aberrations, coma and other high order aberrations of the eye. With a measuring range of -25 to +22 diopters of sphere, the new KR-9000PW is a practical wavefront tool for use in the everyday practice.



One of the important gains provided by successful wavefront-guided corrections occurs when the pupil dilates in photopic and scotopic conditions.
The value of isolating the higher order data is an excellent way of determining if surgical intervention is appropriate.
The KR-9000PW is the perfect compliment to laser treatment, allowing you to learn more about the high order issues that can lead to complications!

Topcon's Wavefront Analyzer
checks both ocular aberration and corneal

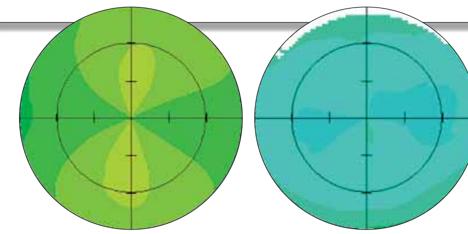
Topcon Multiple Wavefront Map

1) Ocular total aberration map
Shows whether the patient has refractive error such as asmyopia or regular astigmatism.

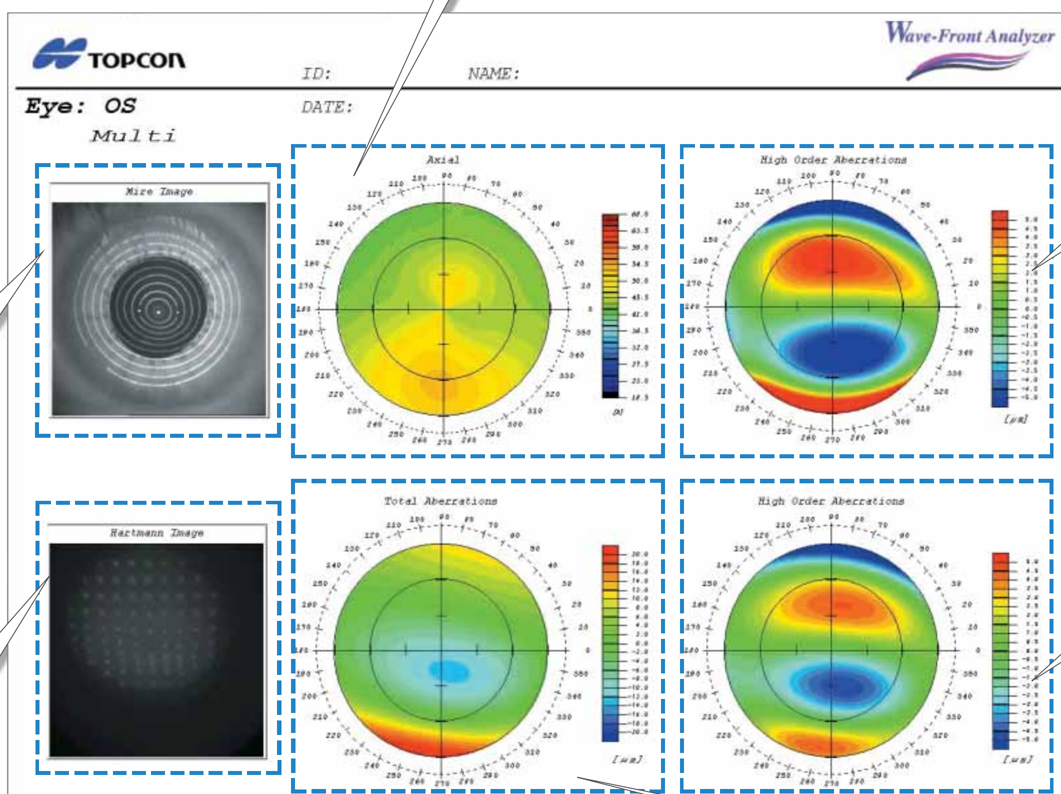
2) Ocular higher order aberration map
Shows the severity of irregular astigmatism following LASIK.

3) Corneal and ocular higher order aberration maps
Shows whether the higher order aberrations are corneal based or elsewhere.

Axial power maps
Axial power map from the Topcon wavefront sensor conventional videokeratoscopes. An instantaneas



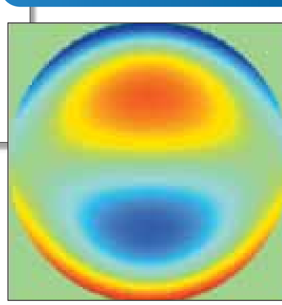
Astigmatism LASIK



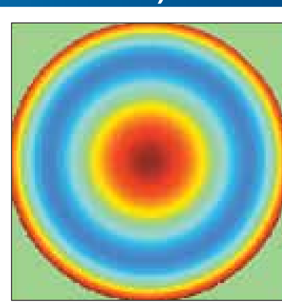
Videokerato-scope
Standard Corneal Topographer with placido ring. Infrared placido ring illumination makes patient comfortable during examination.

Wavefront sensor
Topcon Wave-Front Analyzer uses a Hartmann-Shack sensor. It analyzes higher order aberrations in a central 4mm (Photopic) and 6mm (Scotopic) circle on the pupil.
It will collect up to six readings per eye.
The integrated database function saves examination time in a busy clinic.

Zernike terms (aberrations)



Astigmatism

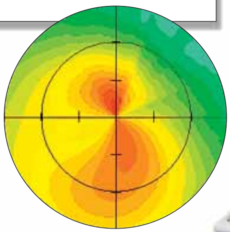


Astigmatism

Keratoconic eye has a large coma aberration induced by cornea and Post-LASIK treatment. The eye reveals a small spherical aberration, whereas emmetropia shows uniform patterns.

aberration with ease.

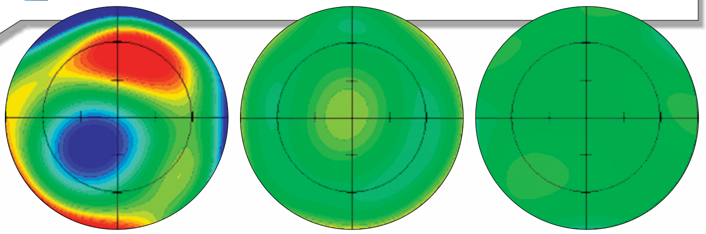
is compatible with
map is also available



Keratoconus

Corneal higher order aberrations

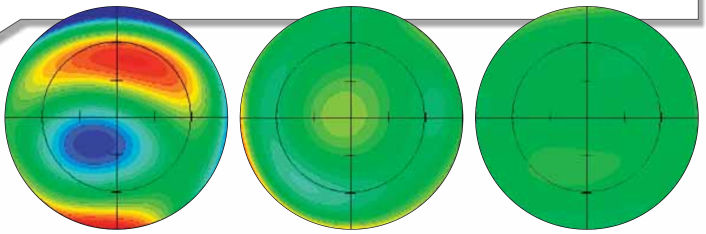
Irregular aberration can be corrected by hard contact lenses.



Keratoconus LASIK Normal

Ocular higher order aberrations

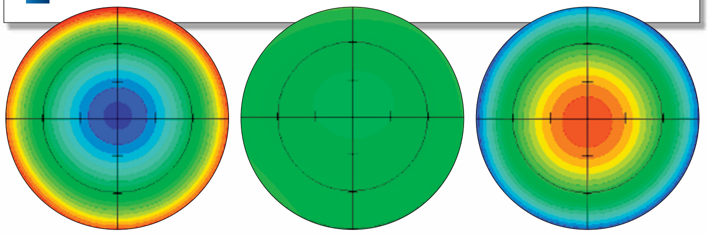
Related to the best corrected visual acuity (BCVA)



Keratoconus LASIK Normal

Ocular total aberrations

Related to uncorrected visual acuity (UCVA)



Myopia Emmetropia Hyperopia

PSF, MTF and Simulation function

PSF (Point Spread Function)

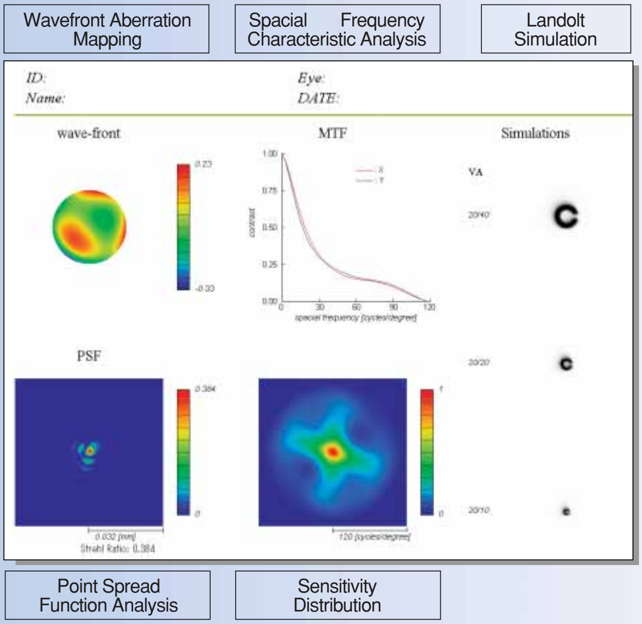
The PSF simulates the spot light projected on the retina when a spot shape ray of light is entered into the eye.
The S.C.A. of the eye is already corrected by the Zernike Polynomials calculation. The ideal situation is to have exact spot on the retina as it enters, however even an ideal lens system can not achieve it due to its diffraction etc.
Strehl ratio is a ratio between the central intensity of the ideal lens and that of the measured eye. Therefore, the reading closer to 1.00 means better optical quality.
By analyzing this image as well as the Strehl ratio, it is possible to know if there is aberration that can not be corrected by spectacles etc such as irregular astigmatism.

MTF (Modulation Transfer Function)

The MTF indicates the relation between optical resolution and contrast. On the graph below, the vertical direction indicates the strength of contrast and the horizontal direction indicates the resolution power.
As shown on the graph, when the resolution is higher (when there are more lines per millimeter), the contrast (ability to define black and white) becomes lower and vice versa.

Landolt Simulations

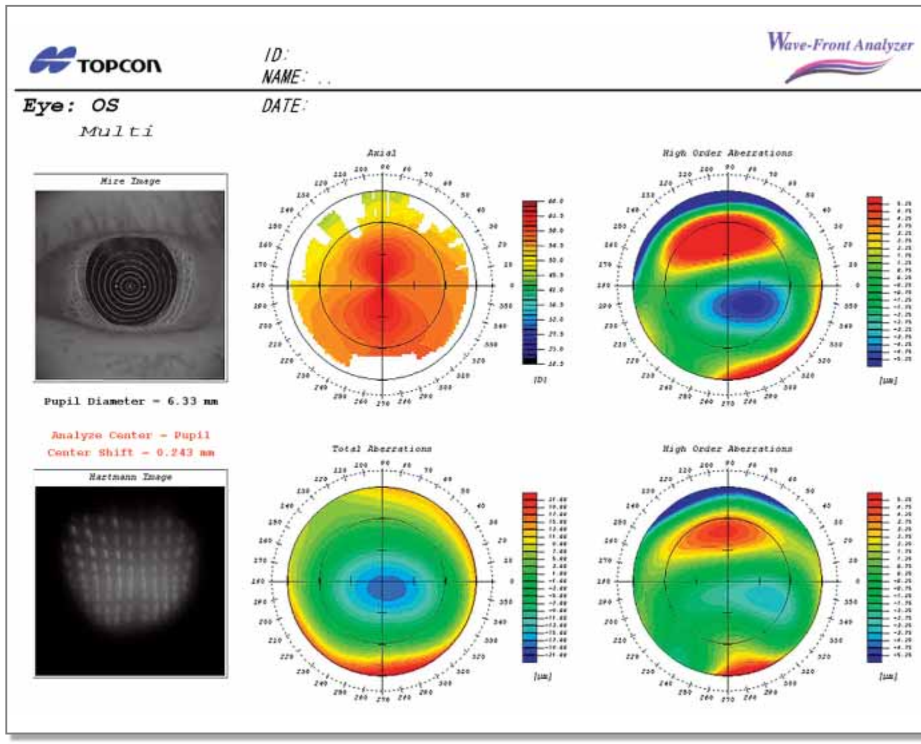
By using the PSF data from the above, the"Landolt Simulation" simulates how the Landolt rings will be projected on the patient's retina after S.C.A. is corrected by spectacles etc.
Notes :Objects are projected as an inverted mirror image on the human retina, therefore the simulated image is also an inverted mirror image.
When a human observes an object, the eye constantly moves around the object. Therefore, even the simulated Landolt Ring image can not be recognized. The patient might be able to recognize the Landolt Ring in real life after the correction.



Clinical case examples and ana

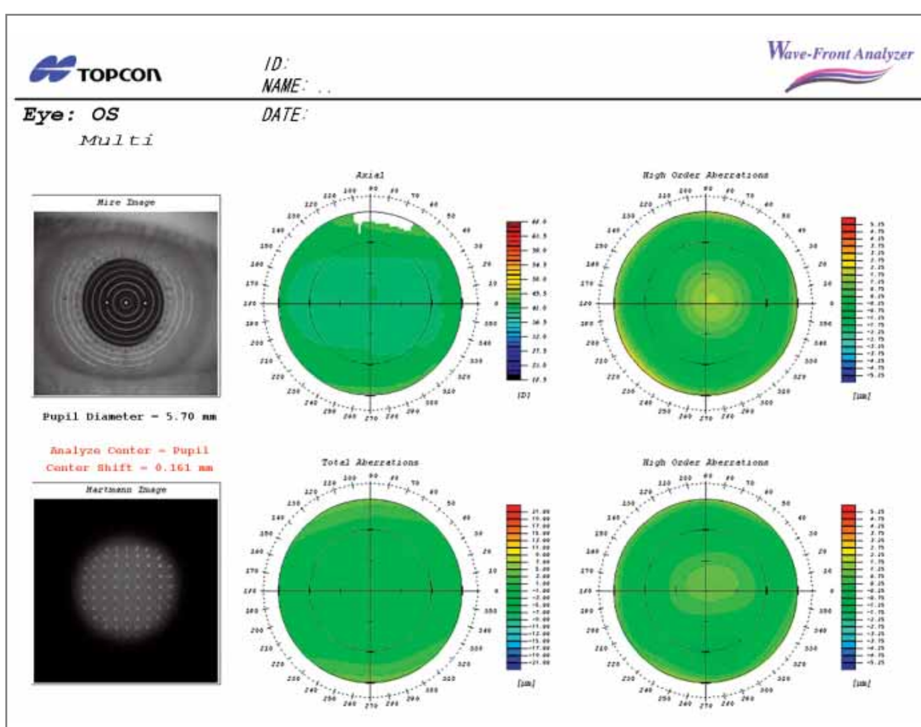
Case-1 Keratoconic eye

The Corneal Axial Power Map shows strong corneal refractive power, and its shape is displayed as an asymmetric bow-tie.
The upper part of the corneal higher-order aberration map shows a delay of the wavefront, and the lower part of the map shows an advance. This type of shape is frequently observed in Coma-like aberration.
The central area of the refractive aberration map displays a delay of the wavefront in an oval shape pattern. Based on this pattern, we assume the patient has myopic astigmatism and a reduction in uncorrected visual acuity is expected.
The shape of the refractive higher-order aberration map shows almost the same pattern as the corneal higher order aberration map.
This suggests that the refractive irregular astigmatism comes mostly from cornea, and the patient is not able to achieve fully corrected visual acuity.



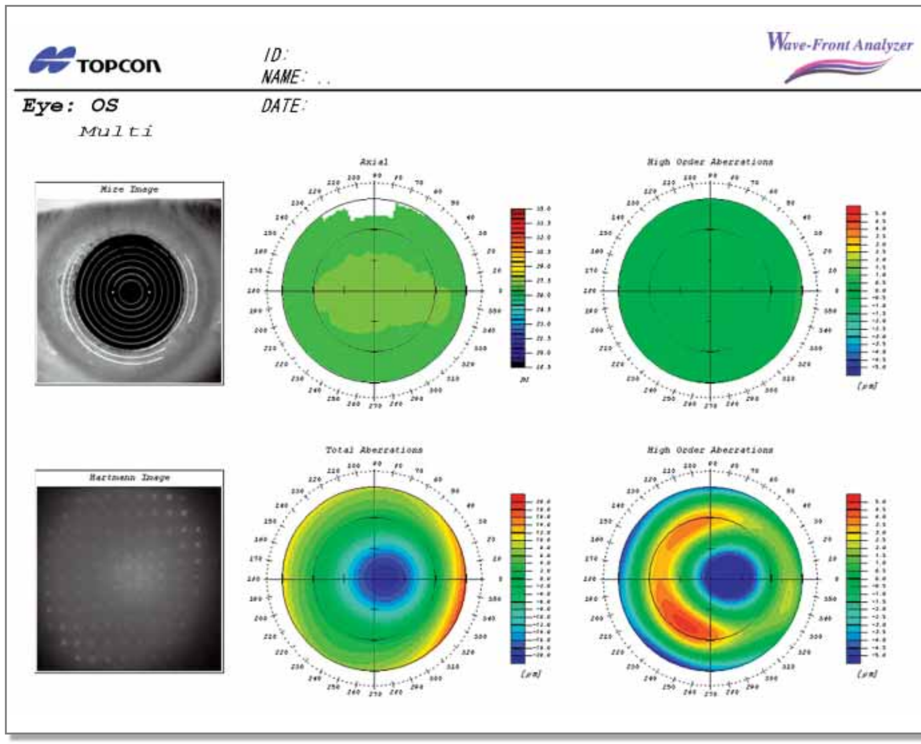
Case-2 Post-LASIK eye

In the center of Corneal Axial map, a round and flat area appears. In that area, the corneal refractive power is relatively weak. This type of pattern is frequently observed after myopic correction is performed by refractive surgery.
The central part of the corneal higher-order aberration map shows an advancement of the wavefront, which means a slightly increased spherical-like aberration. The total aberration map displays a relatively plain wavefront. In this case, the myopia was corrected by LASIK and the patient successfully achieved a better visual acuity.
The shape of refractive higher-order aberration map is almost identical to the corneal higher order aberration map. In this case, the patient successfully achieved better corrected visual acuity, yet a small irregular astigmatism is still present and it mainly derives from cornea.



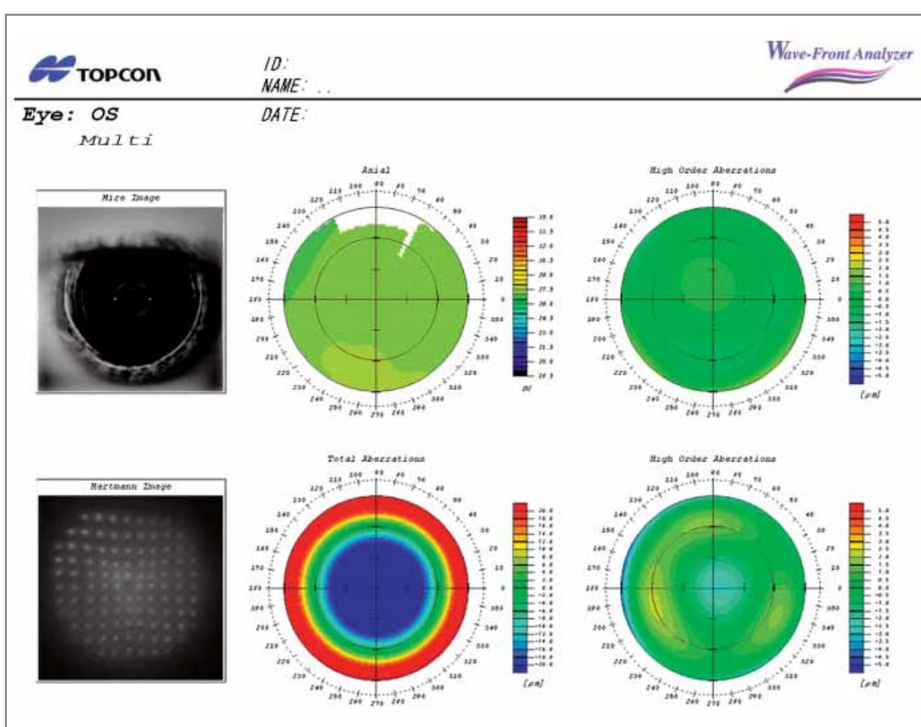
Case-3 Lenticonus eye

In the corneal axial power map, the power at the central area is uniform and the peripheral area is weak. That means the patient has a normal cornea with a slight ATR astigmatism.
In the corneal higher-order aberration map, the wavefront is relatively plain and there is no corneal irregular astigmatism.
The central part of the total aberration map shows a delay of the wavefront. In this case, the patient has myopia and the uncorrected visual acuity is insufficient.
Note that the shape of the refractive higher-order aberration map is quite different from that of the corneal higher-order aberration map. The central area of the map shows a delay of the wavefront, which is surrounded by an area showing an advance of the wavefront. When observing a Lenticular irregular astigmatism due to lenticonus, the shape of the map is more similar to the map of the spherical-like astigmatism.



Case-4 Nuclear cataract eye

The shape of the Corneal Axial Map basically shows a normal condition of the cornea.
In the corneal higher-order aberration map, the wavefront is relatively plain and we find no corneal irregular astigmatism.
In the central area of the total aberration map there is a clear delay of the wavefront. In this case, the patient has myopia and the the uncorrected visual acuity is insufficient.
The shape of the refractive higher-order aberration map is quite different from that of the corneal higher-order aberration map. The central area of the map shows a delay of the wavefront, and it is surrounded by an area showing an advancement of the wavefront .
This demonstrates that when observing a crystalline lens irregular astigmatism by lens nucleus, the shape of the map quite similar to the map of spherical-like astigmatism.



Clinical data: From the Department of Ophthalmology, Osaka University Medical School, Osaka, JAPAN

SPECIFICATIONS (Main unit)

Refractive power measurement Measuring range	Hyperopia : 0 to +22D 0.25D step display (switchable to 0.12D display) Myopia : 0 to -25D 0.25D step display (switchable to 0.12D step display) Astigmatism : 0 to 8D(+ or -) 0.25D step display(switchable to 0.12D step display) Axial angle : 0 to 180˚ 1˚ step display (switchable to 5˚ step display)
Corneal curvature measurement Measuring range	Radius of corneal curvature : 5.00~10.00mm, 0.01mm step display Corneal refractory power: 67.50~33.75D 0.25D step display (switchable to 0.12D step display) (corneal refractive index=1.3375) Corneal astigmatic power : 0~10D(+ or-) 0.25D step display (switchable to 0.12D step display) Corneal astigmatic axial angle : 0~180˚(1˚ step display)
Refractive aberration measurement	Hartmann-Shack wave-front analyzer High order aberration : Zernike polynominal up to 6th order or up to 4th order Aberration display : Total aberration, High order aberration Measuring range : 0±15D Measuring area : 7.0mmϕ
Corneal mapping/ Corneal wave-front aberration measurement	Number of Placido rings : 11 Number of measurement sampling points : 3,960 Radius of corneal curvature : 5.00~10.00mm Corneal refractory power : 67.50~33.75D(corneal refractive index=1.3375) Measuring area : ϕ0.8mm~ϕ9.2mm (radius of corneal curvature=8mm) Color corneal mapping display High order aberration : Zernike polynominal up to 6th order or up to 4th order. Aberration display : Total aberration, High order aberration
Minimum pupil diameter measurable(REF)	ϕ2.0mm
Target fixation	Auto fog system
Measurement data display	TV monitor screen
Measurement data recording	Built-in printer (Data of 10 measurements of right and left eyes)
Collimation	TV monitor screen
TV monitor	5"
PD measurement	85mm measuring range max., 1mm display unit
External output terminal	RS232C, VIDEO-OUT (ANALOG, DIGITAL)
Power source/power consumption	AC 100, 120, 220, 230 and 240V, 50/60Hz, 160VA
Operating temperature	10-40˚C
Main body travel	back & forth : 40mm, sides : 86mm, up & down : 30mm
Chinrest travel	60mm(up & down)
Dimensions	310(W)x475(D)x500(H)mm
Weight	23kg

*Subject to change in design and/or specifications without advanced notice.

IMPORTANT In order to obtain the best results with this instrument, please be sure to review all user instructions prior to operation.