2018

Orbscan Corneal Imaging

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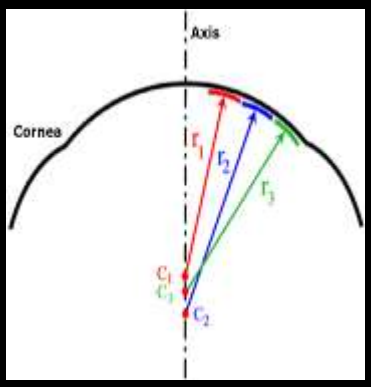
Corneal Imaging

Corneal imaging refers to the study of shape of corneal surfaces.

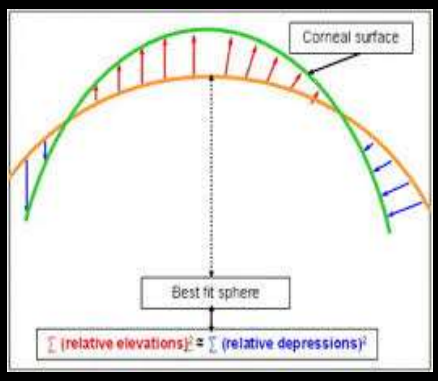
It is a diagnostic tool that shows the overall architecture of the cornea including surface power, thickness, front and back shape

Assessment of Corneal Surface

Corneal Slope

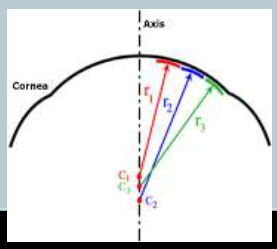


Corneal Height



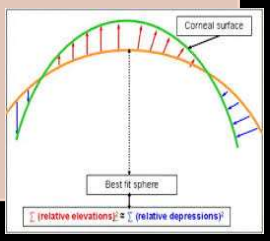
Reflection Based

- Measurement based on reflected images
- Measured slope used to calculate radius of curvature and power.
- Corneal elevation can't be calculated from measurements of slope alone.



Projection Based

- Direct measurement of corneal height
- measure the elevation and use this to calculate slope, curvature, and power



Types of Corneal Topographers

- **Reflection Based Technology**

  1. Keratometer

  2. Keratoscope (Photokeratoscopy & Videokeratoscopy)

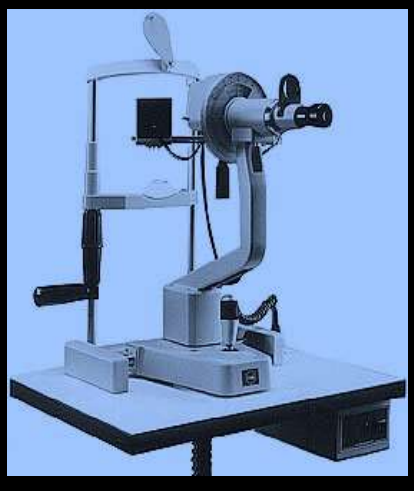
- **Projection Based Technology:**

  1. Scanning Slit Technology (Orbscan)

  2. Scheimpflug imaging (pentacam)

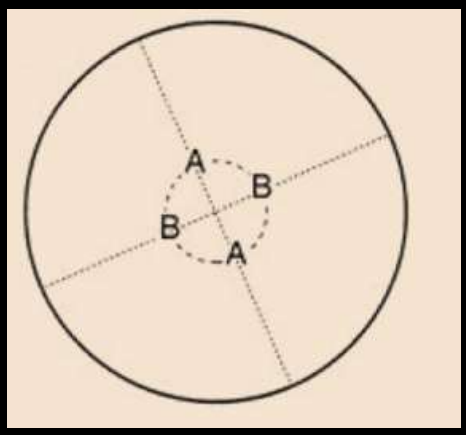
Keratometer

Javal-Schiotz Keratometer

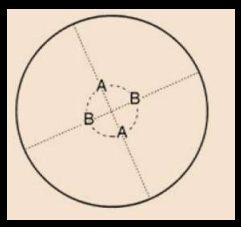


Bausch & Lomb Keratometer

Keratometer is an objective method for determining curvature (diopteric power) of the cornea.



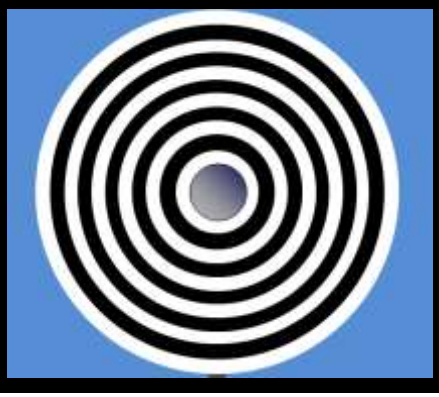
Keratometer disadvantages



- Measures only central 3 mm (6%) of cornea
- Corneal epithelial irregularity → defocussing
- Inaccurate post-refractive surgery readings

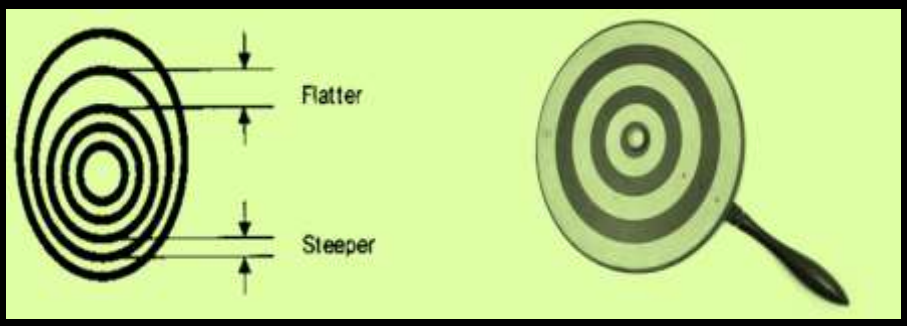
Keratoscope

It is an instrument that projects multiple concentric rings (mires) on the cornea



Keratoscope takes data from the whole cornea.

- Steep cornea → narrow mires and close rings.
- Flat cornea → broad mires and wide separation.



Keratoscopes

Photo-keratoscope

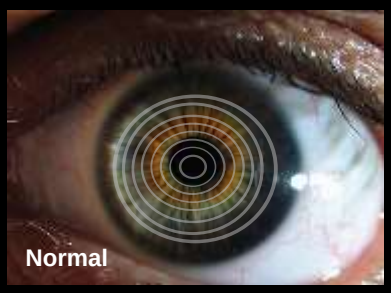
Still camera is added to photograph the mires

Video-keratoscope

Video camera is added

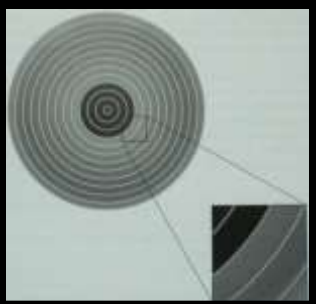
Photo-keratoscope

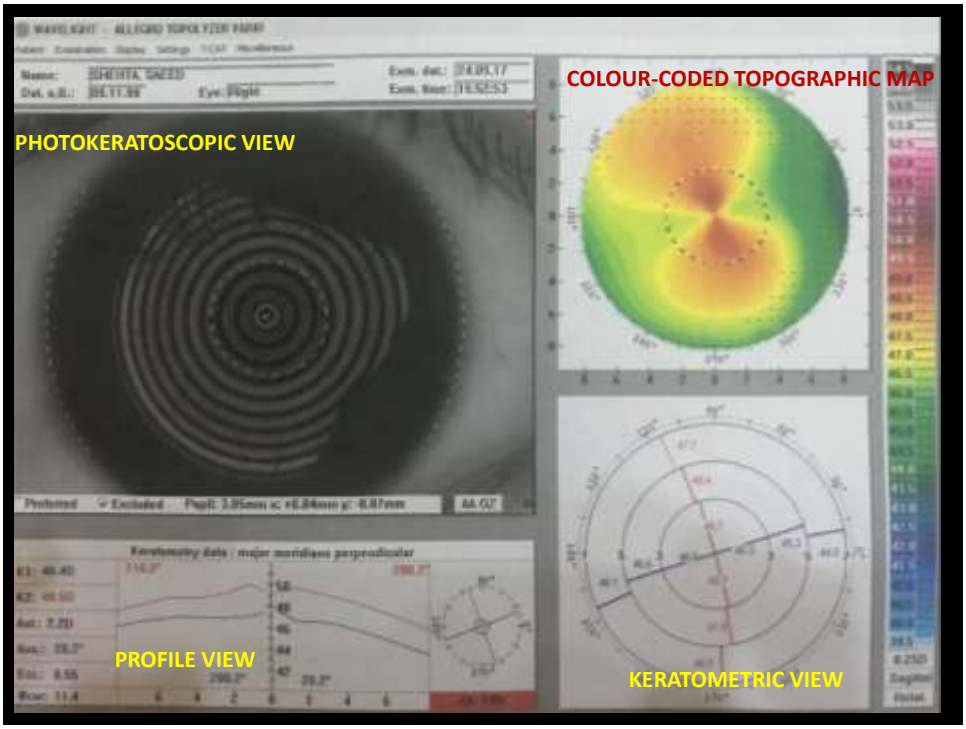
Placido disc appearing corneas



Video-Keratoscopy

- Computerized VideoKeratoscopy
- Capturing the keratoscopic details onto a video and displaying data analysed with mutiple algorithms
- Measures larger area with more points (256 circumferential points on each ring are identified)





Keratometer → Photo-keratoscope → Video-keratoscope

All of them analyze & visualize anterior corneal surface

ORBSCAN SYSTEM

- Orbscan I: only slit scan topography
- Orbscan II: the placido disc is added
- Orbscan IIz: with wave front analysis

Orbscan IIz

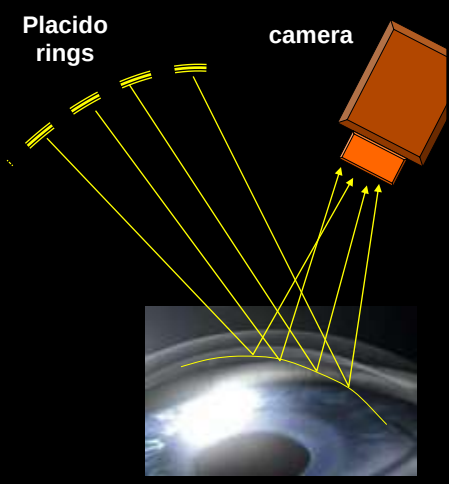
Combines two principles

Placido disc

Scanning slit

Placido disc principle

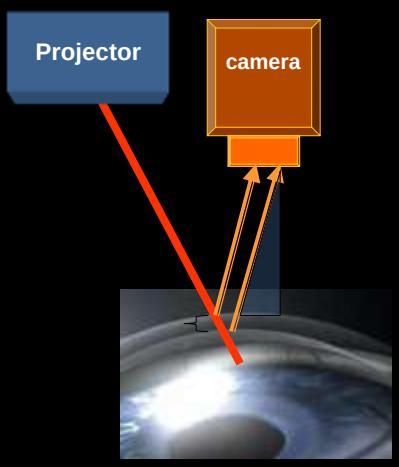
- The location of the placido rings in relation to the camera is already known.
- The radial slope of the surface at the point of reflection can be determined by ray tracing.



Used for keratometric analysis

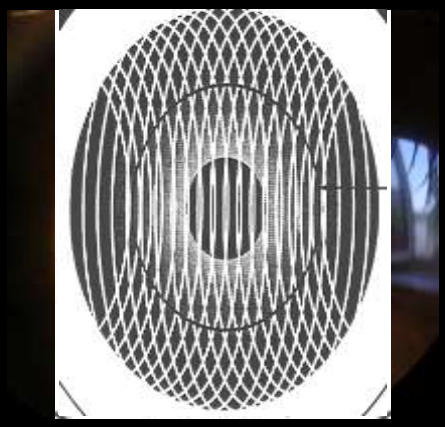
Scanning slit principle

- It uses a series of light slits (40 slits) passing over the cornea at an angle of about 45° to the camera.



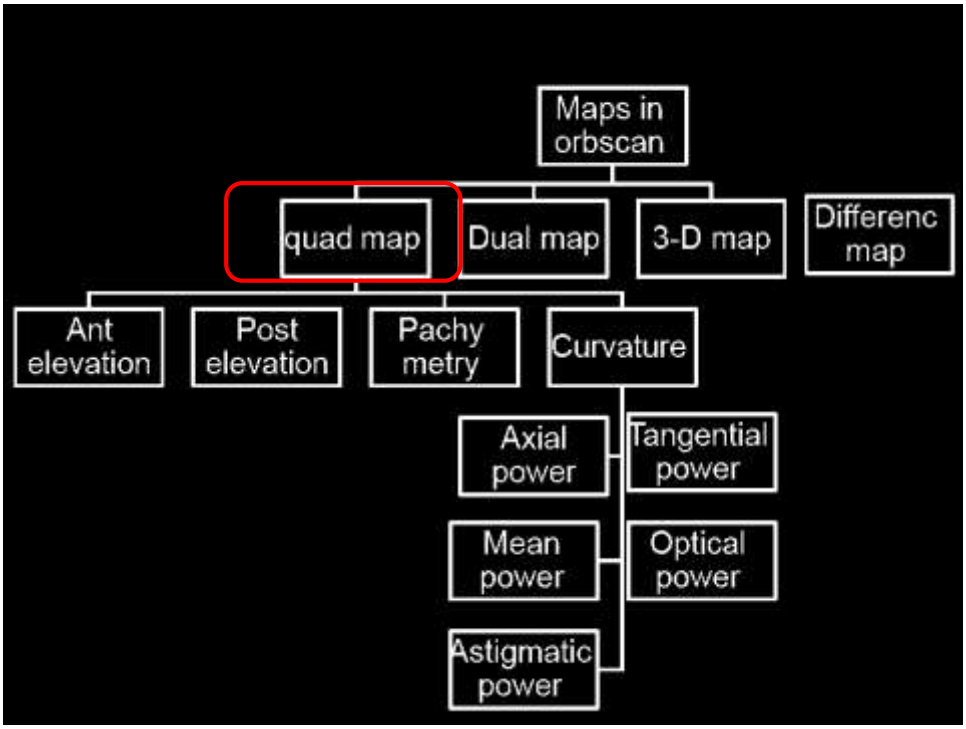
ORBSCAN SYSTEM

- 40 scanning slit beams (20 from the left and 20 from the right) with up to 240 data points per slit, used to scan the cornea and measure independently the X,Y & Z locations
- The central 5 mm area is scanned twice

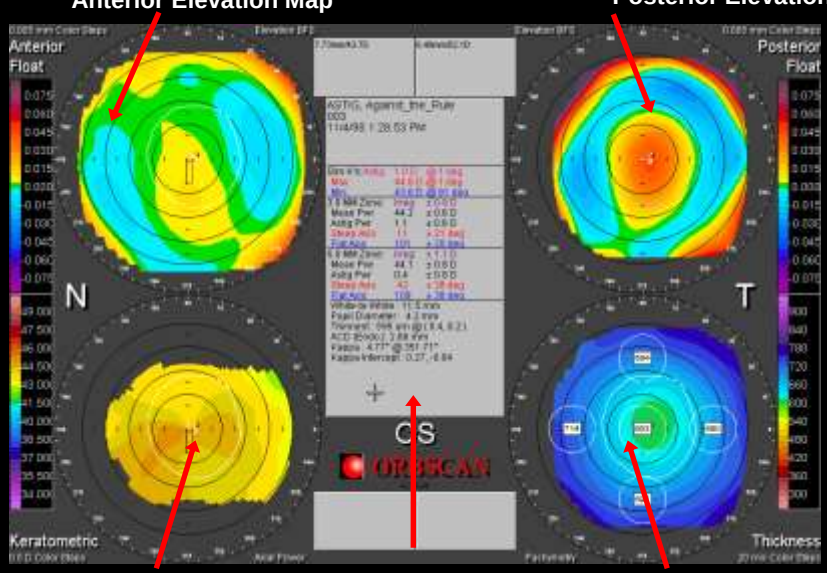


- The Orbscan has the capability to record 9000 data points of a cornea.
- Each data point is 1 micron.
- As corneas have a diameter of 11 mm, the Orbscan provides a highly accurate map
- It takes a mere 1.5 seconds to scan one eye.

Interpretation of Orbscan Map


Maps in orbscan
quad map
Dual map
3-D map
Differenc map
Ant elevation
Post elevation
Pachy metry
Curvature
Axial power
Tangential power
Mean power
Optical power
Astigmatic power

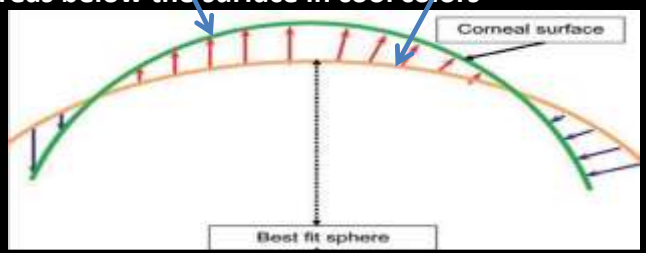
Quad Map


Anterior Elevation Map
Posterior Elevation Map
Anterior
Float
Posterior
Float
N
T
CS
ORBSCAN
Keratometric
Thickness
Curvature Map
Statistics and Data
Pachymetry Map

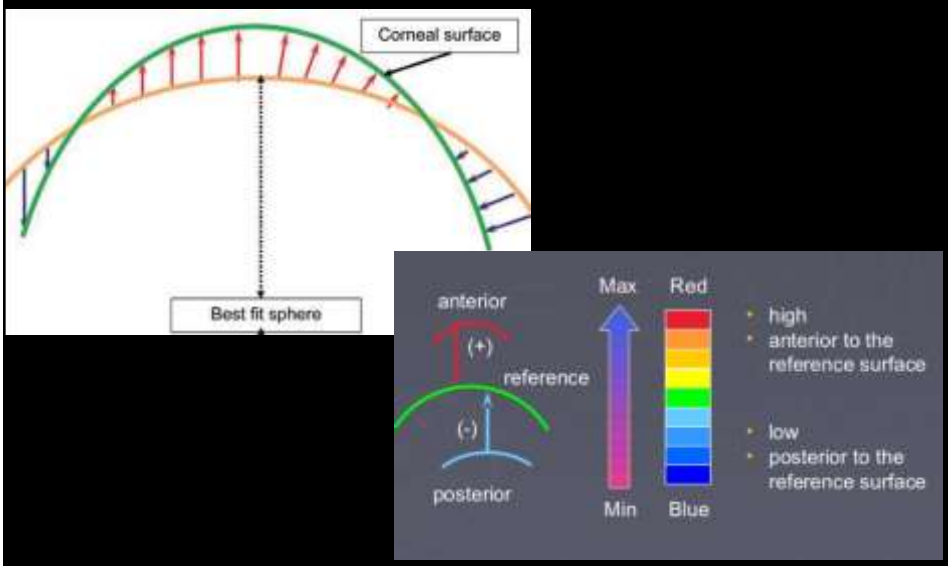
Elevation Maps

Best Fit Sphere

- The computer calculates a hypothetical sphere that matches as close as possible to the actual corneal shape being measured
- Compares the real surface to the hypothetical sphere showing areas above the surface of the sphere in warm colors and areas below the surface in cool colors

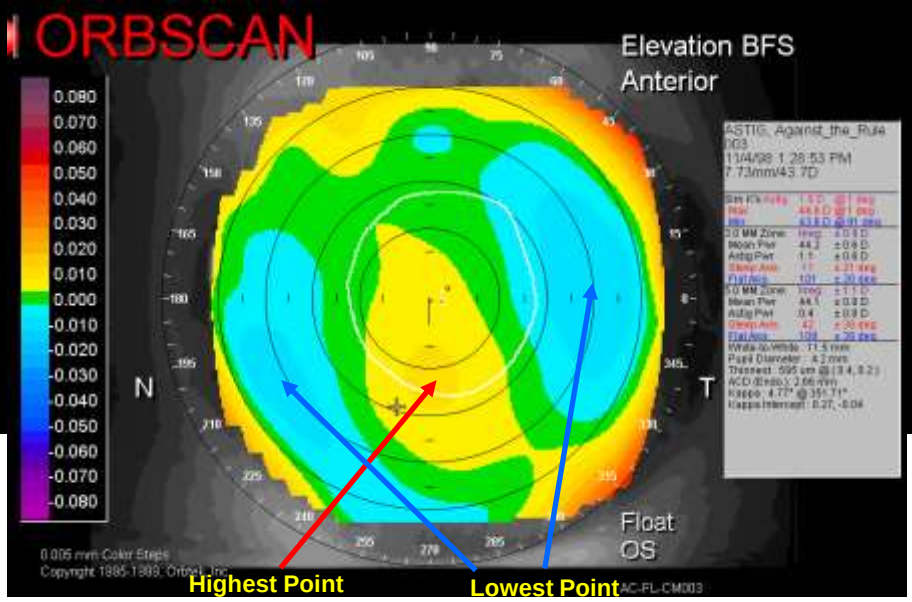


Color scale for relative elevation

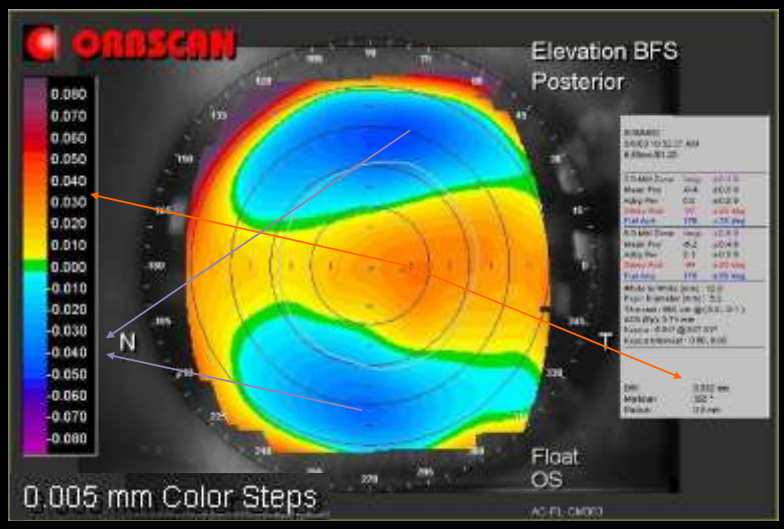


Anterior Elevation Map

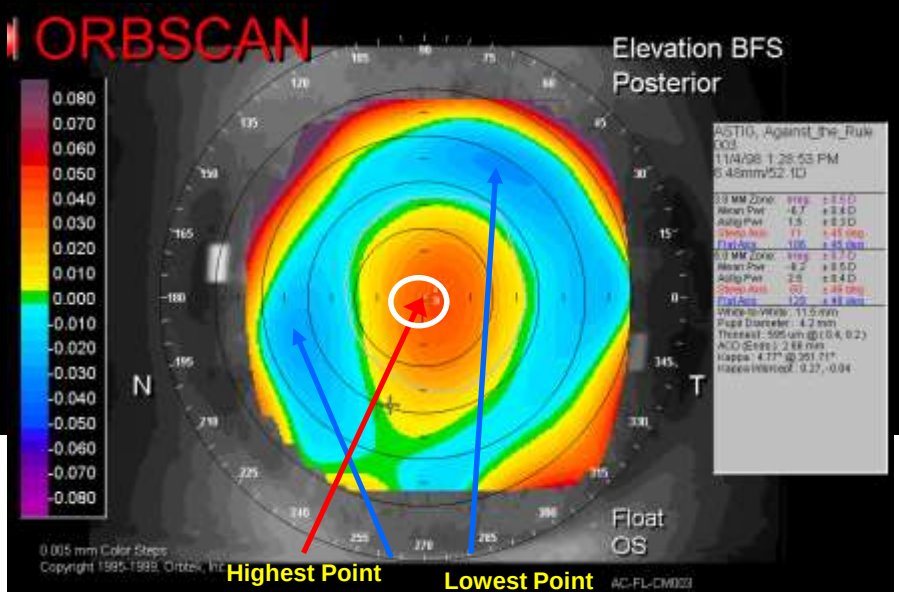
Anterior Elevation Map



Posterior Elevation Map

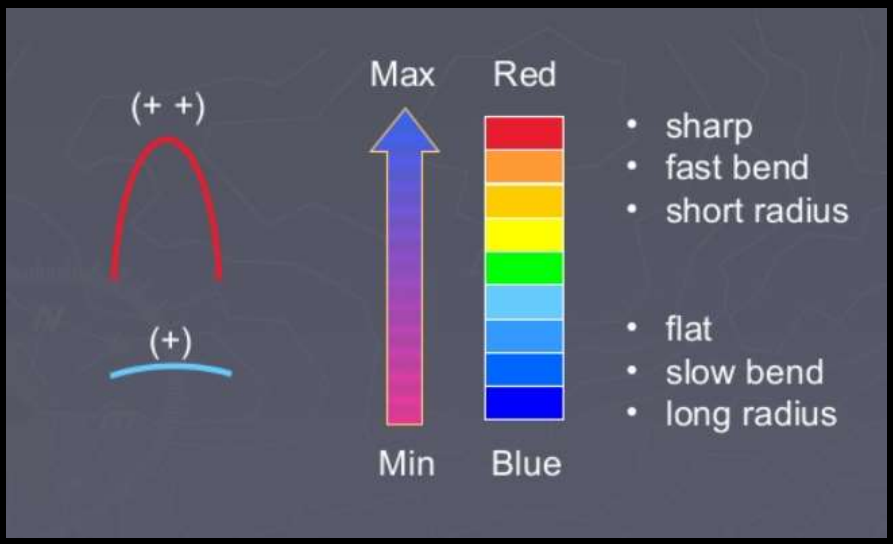


Posterior Elevation Map

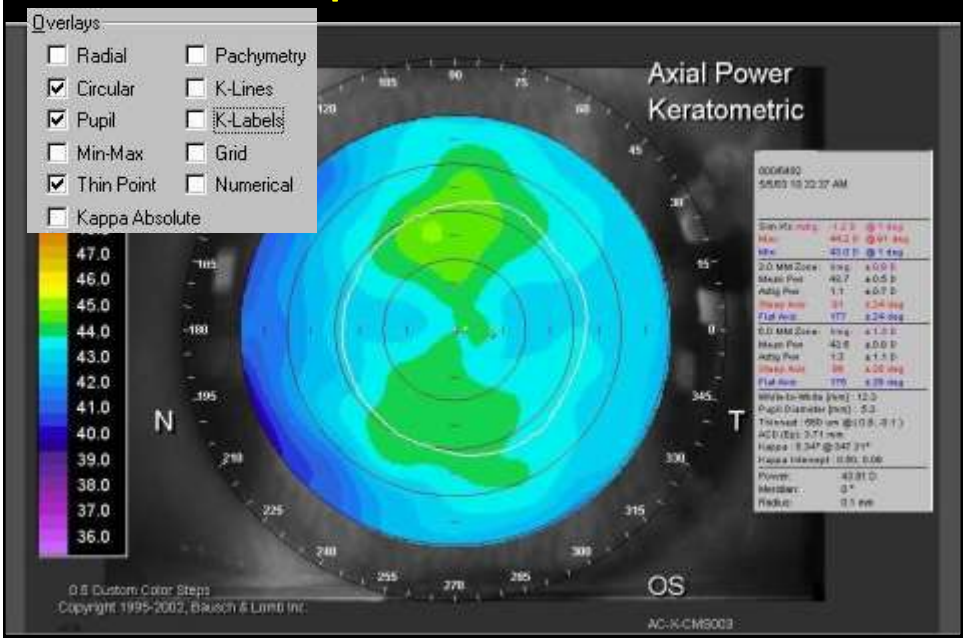


Curvature Map

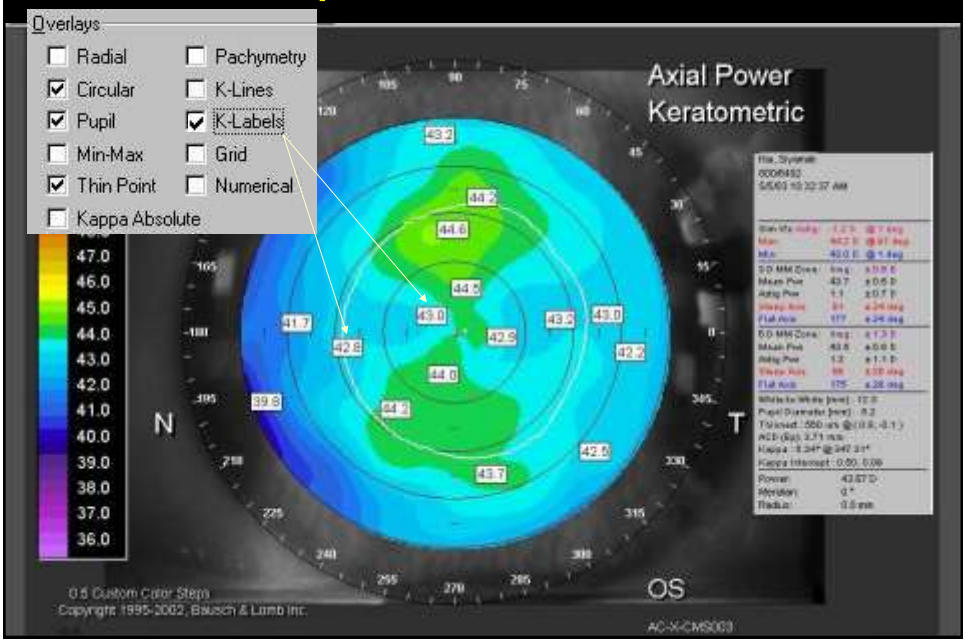
Color scale for surface curvature



Curvature Map



Curvature Map



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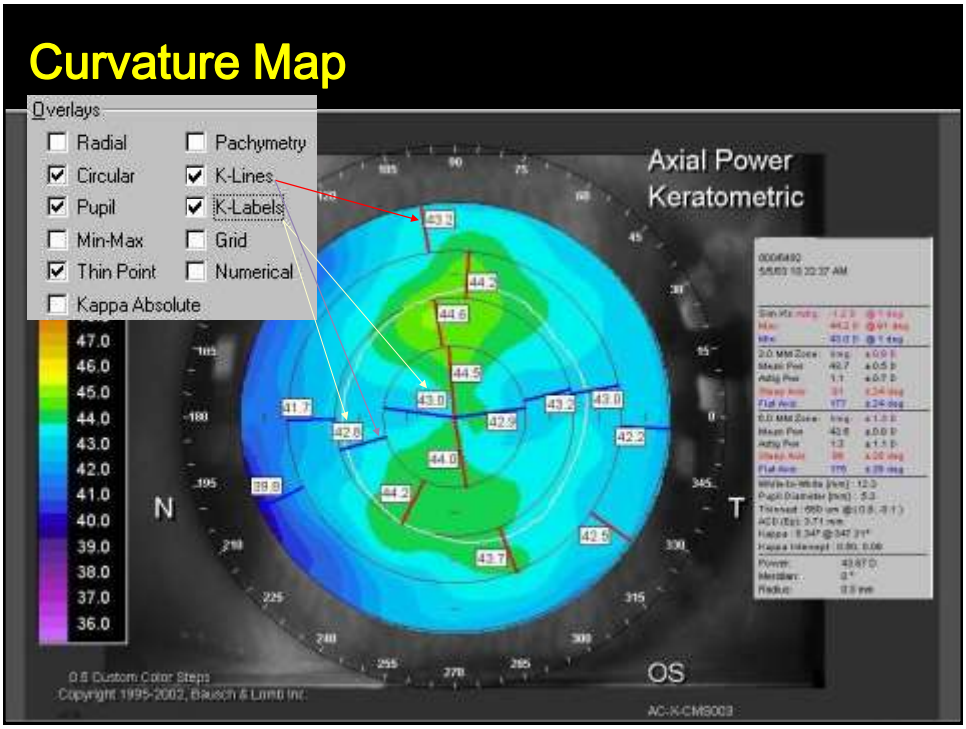
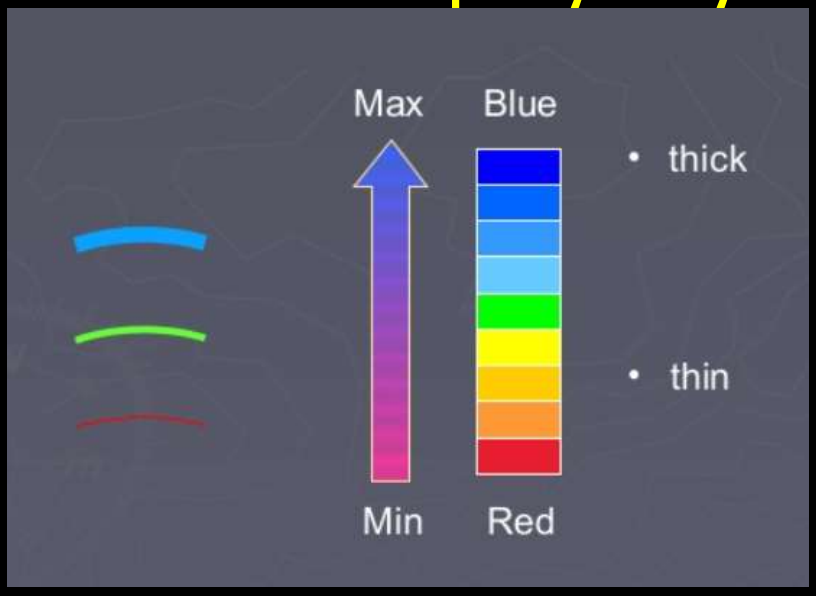


Corneal thickness (pachymetry) Map

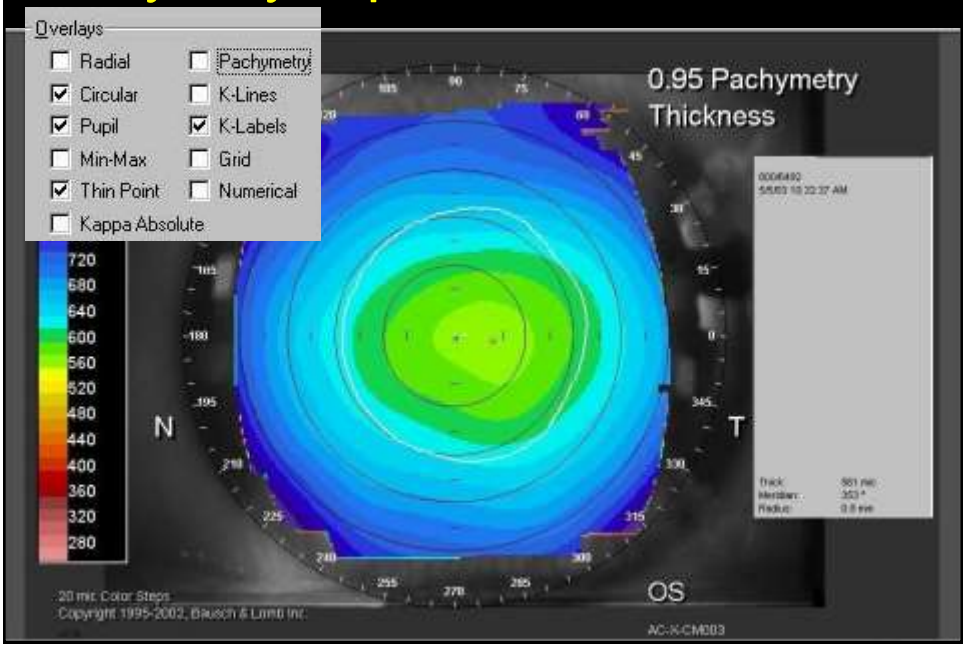
Pachymetry Map

- The orbscan measures thickness from the tear film layer to descemet's membrane and is thicker than that obtained with ultrasound
- Provides a reading showing the thinnest point of the cornea that may not necessarily be the central reading

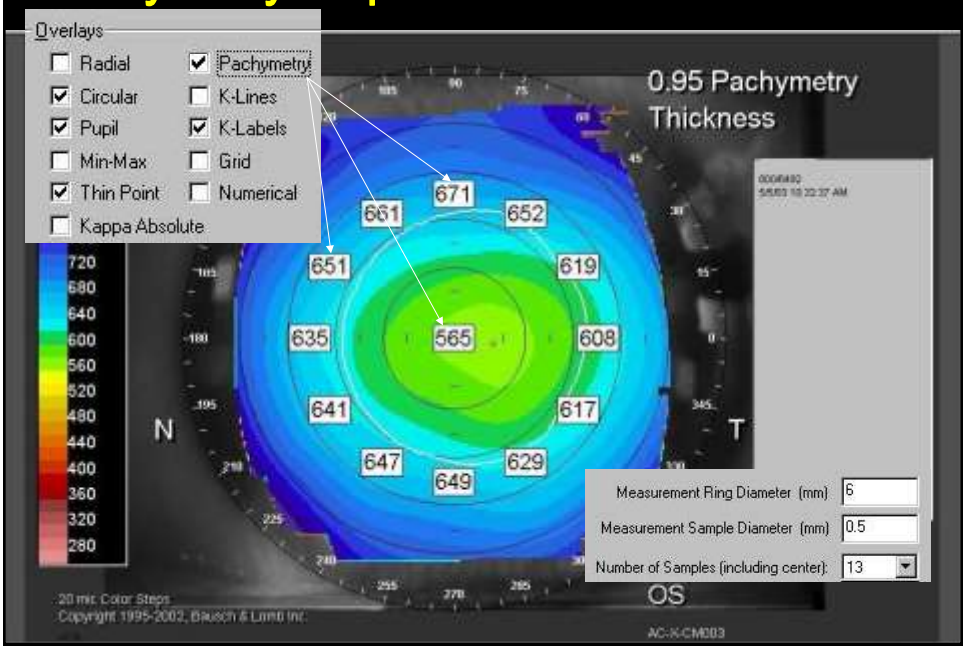
Color scale for pachymetry



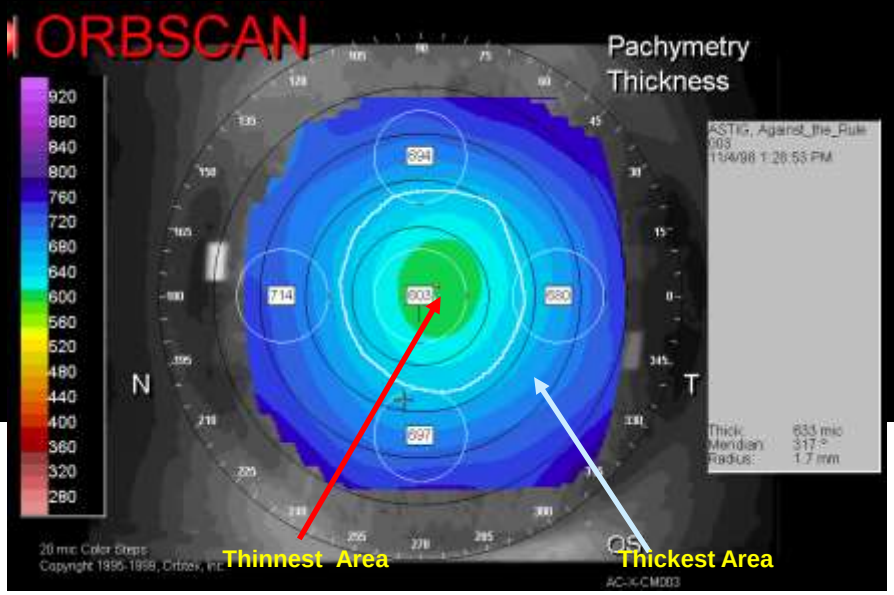
Pachymetry Map



Pachymetry Map



Pachymetry Map



Pachymetry Map

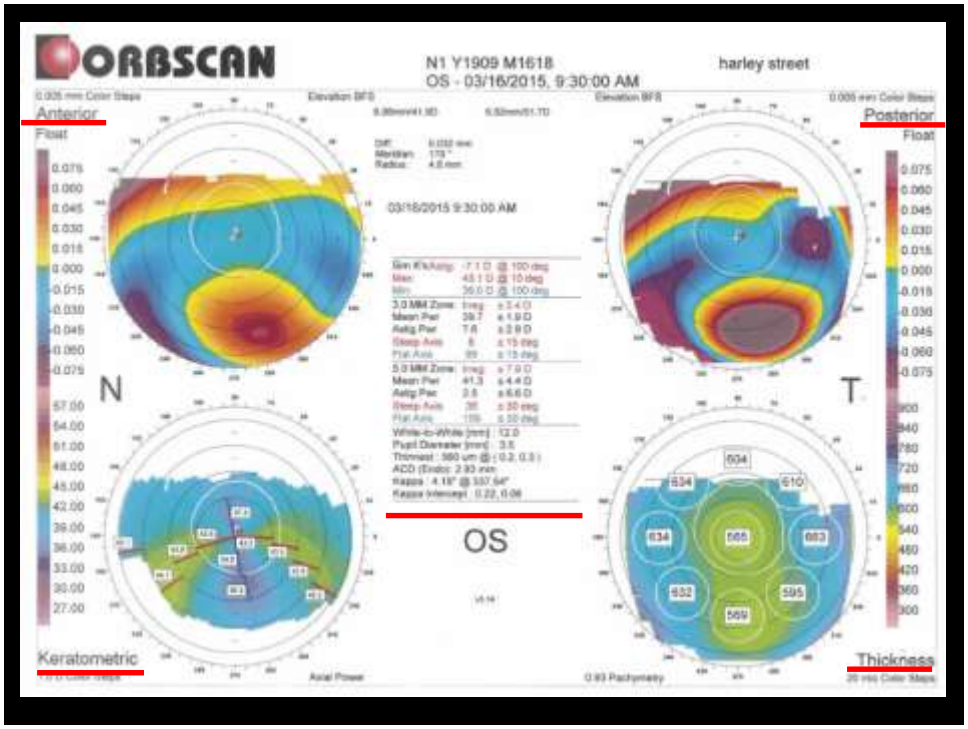
- Cooler Colors
- Thicker Areas

- Warmer Colors
- Thinner Areas

Data measurements

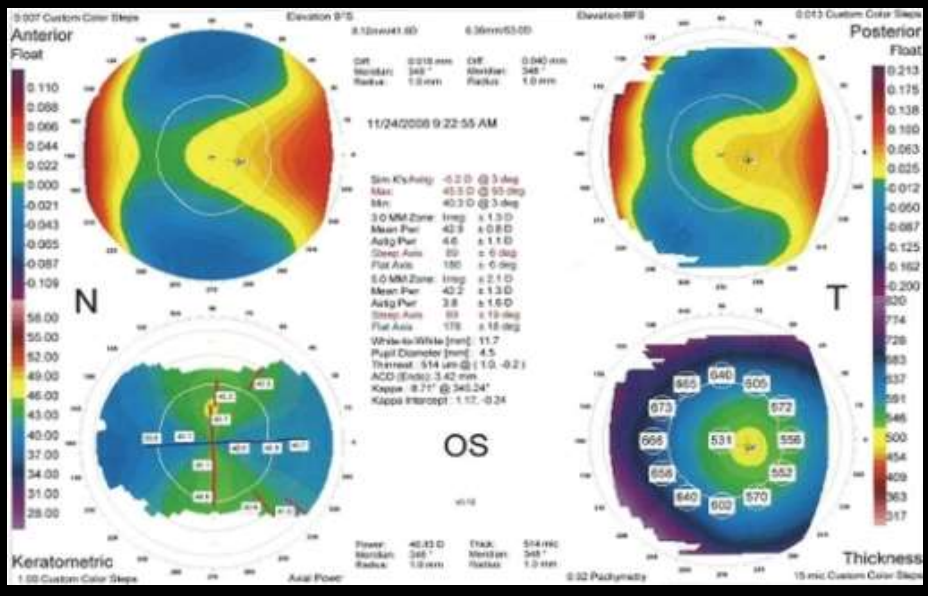
- Sim K (Max. & Min.)
- Mean corneal power
- Astigmatism with its axis (in 3 mm & 5 mm zones)
- White-to- white
- Pupil diameter
- Thinnest corneal thickness
- Ant. Chamber depth
- Angle K

Sim K's: Astig:	-0.4 D	@ 138 deg
Max:	46.7 D	@ 48 deg
Min:	46.3 D	@ 138 deg
3.0 MM Zone:	Irreg:	± 0.8 D
Mean Pwr	46.4	± 0.6 D
Astig Pwr	0.4	± 0.5 D
Steep Axis	53	± 47 deg
Flat Axis	150	± 47 deg
5.0 MM Zone:	Irreg:	± 1.4 D
Mean Pwr	45.9	± 1.0 D
Astig Pwr	0.1	± 1.0 D
Steep Axis	35	± 49 deg
Flat Axis	176	± 49 deg
White-to-White [mm] : 11.6		
Pupil Diameter [mm] : 4.2		
Thinnest : 504 um @ (0.4, 0.1)		
ACD (Ep): 4.13 mm		
Kappa : 6.42° @ 353.27°		
Kappa Intercept : 0.55, 0.22		



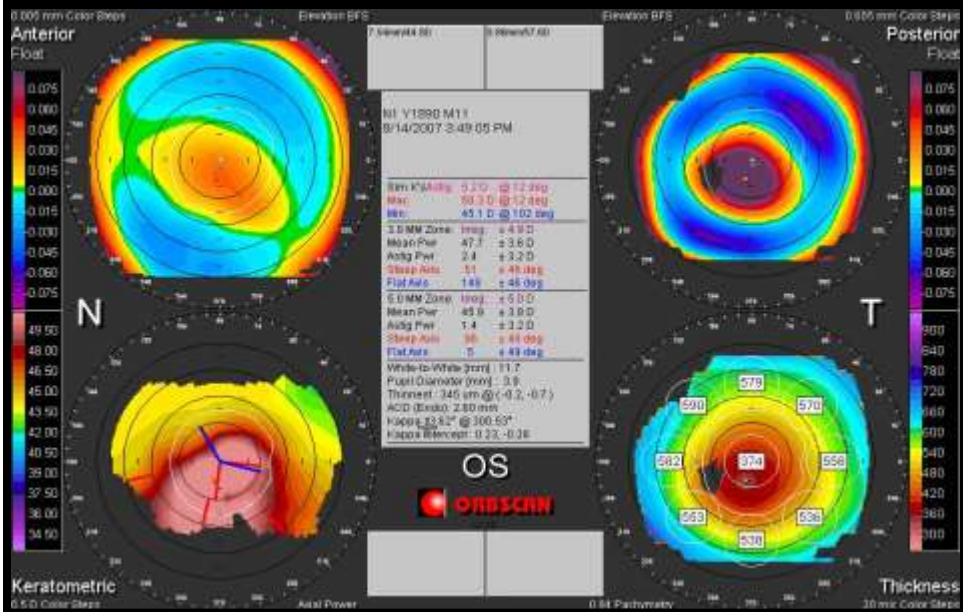
Orbscan Cases

Regular Astigmatism



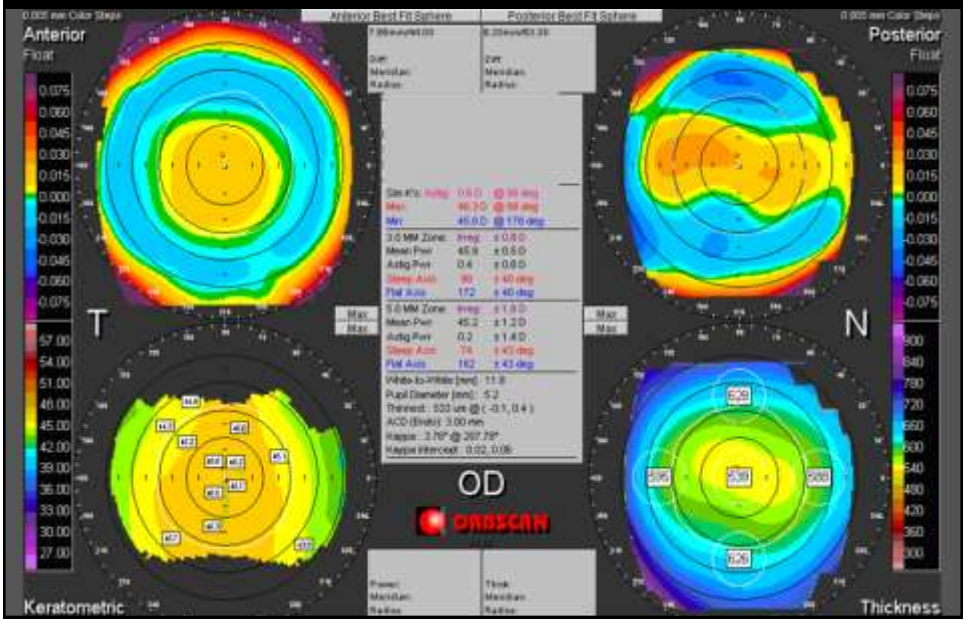
Steep vertical axis, centrally thin cornea , high posterior float

Keratoconus

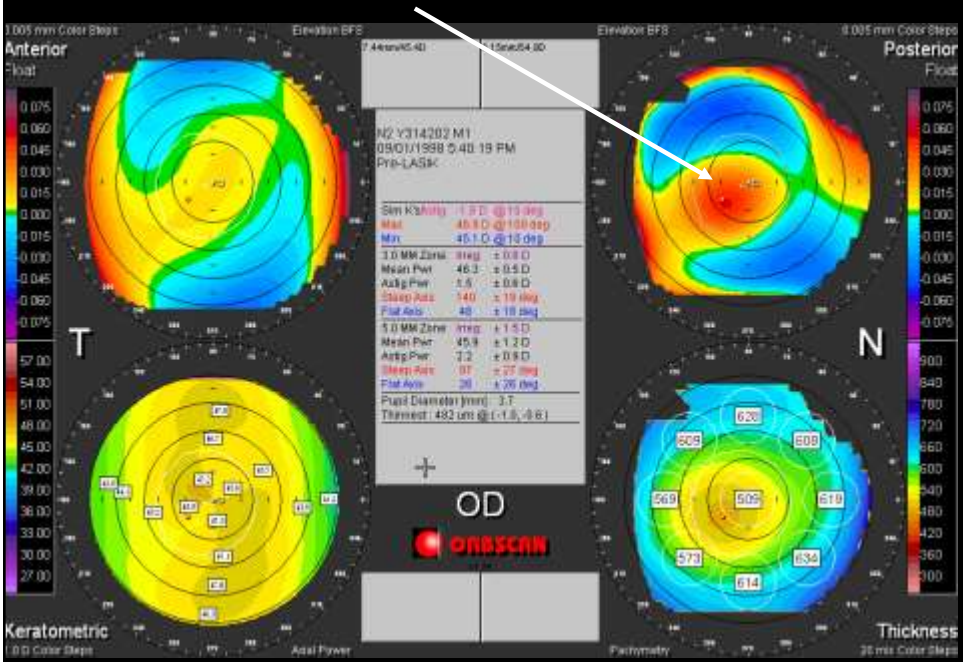


21 y. female (-2.5 D) . Can she undergo lasik ?

Normal corneal orbscan



Posterior surface elevation



Relations between 4 Maps

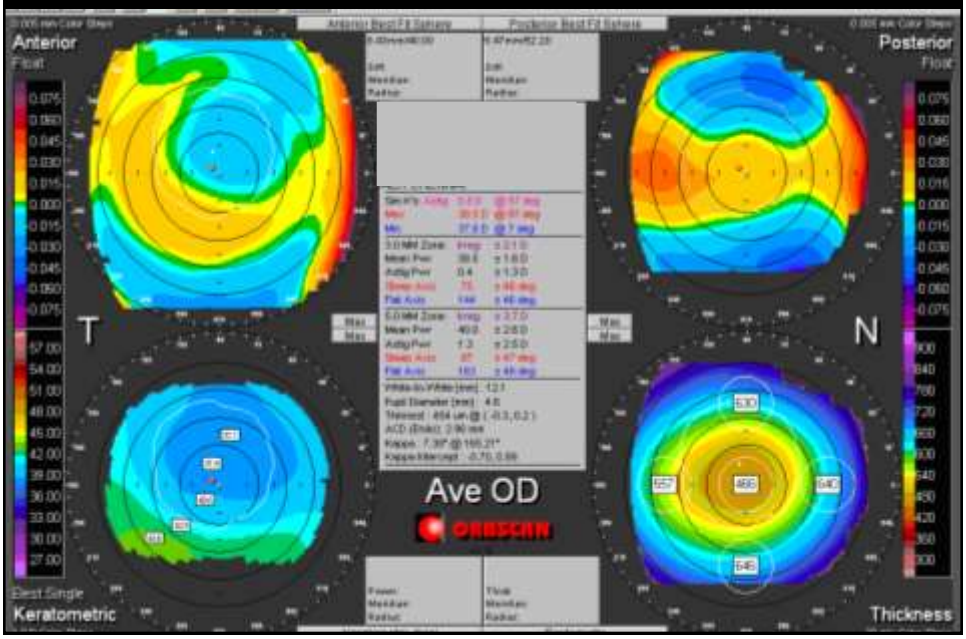
Three step rule

- 1 abnormal map → Caution
- 2 abnormal maps → Concern
- 3 abnormal maps → Contraindication

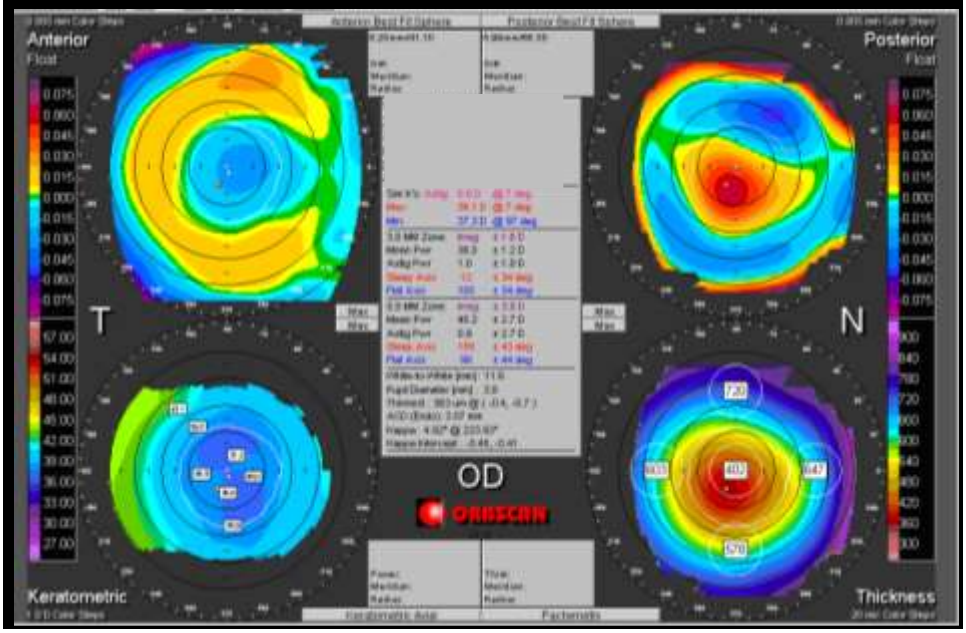
The posterior highest point correlates with:

- Anterior highest point
- Anterior steepest point
- Thinnest corneal point

Post-LASIK ablation



History of LASIK surgery **Post Lasik Ectasia**



Orbscan versus Pentacam

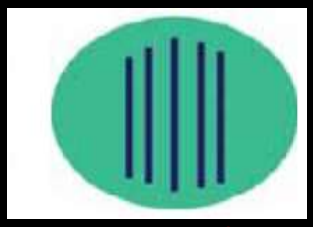
- Both Orbscan IIz & Pentacam Topographic analyze cornea's front and back surfaces based on the true elevation measurement compared to a derived reference surface.

Pentacam

- It uses rotating Scheimpflug camera to take optical cross sections of the anterior segment.

Orbscan

- It uses a series of slit imaging



The optical slices used by the pentacam share a common point, allowing for more accurate image registration.

- Intrasystem reliability showed the difference between two consecutive measurements taken by the same machine.
- With the Pentacam, the results showed overall good reproducibility.
- While Orbscan was less reliable with low reproducibility

- Orbscan IIz was incapable of imaging the postoperative cornea accurately
- Edge-detection algorithms (the slit-lamp–based Orbscan IIz) are vulnerable to interference from artifacts introduced by the corneal reshaping

- The Orbscan IIz in particular exaggerates the posterior corneal surface's contour (locates the surface too anteriorly).
- Orbscan IIz pachymetry reading is too thin


Thank You