WOO UNIVERSITY

Clinical Applications Of Corneal Topography

Aaron Wolf, OD, FAAO, FSLS, FIAOMC

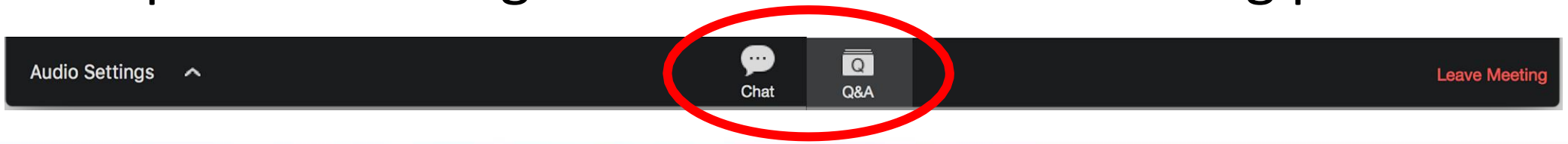
WOO UNIVERSITY

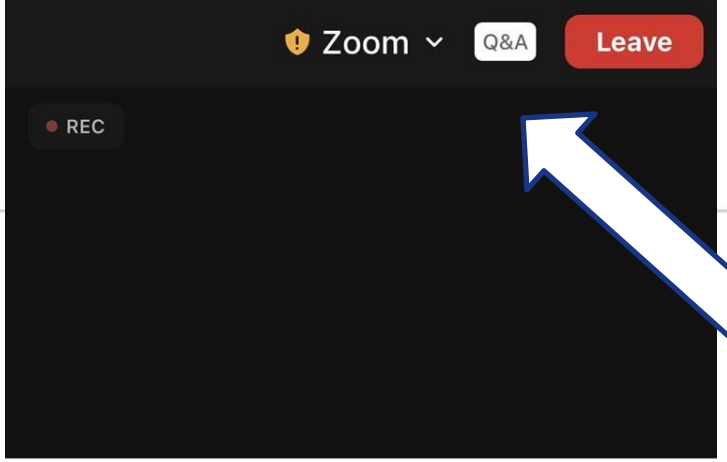
WELCOME!

Host: Dr. Elise Kramer

Thank you to Zeiss
for exhibiting this event.

- For each hour of CE units, **attendees must be online for a minimum of 50 minutes**
- For a COPE certificate, please fill out the survey link in the chat. Also, the survey link will appear when the webinar ends.
- CE certificates will be delivered by email and sent to ARBO with OE tracker numbers
- We will also display a QR code at the end of the event if you have the OE tracker app on your phone.
- **CE certificates will be emailed within 4 weeks**
- Ask questions using the zoom on-screen floating panel





Opportunity to Partner

Optometrists are at the frontline to recommend treatment for cataract and glaucoma patients.

Established relationships with patients

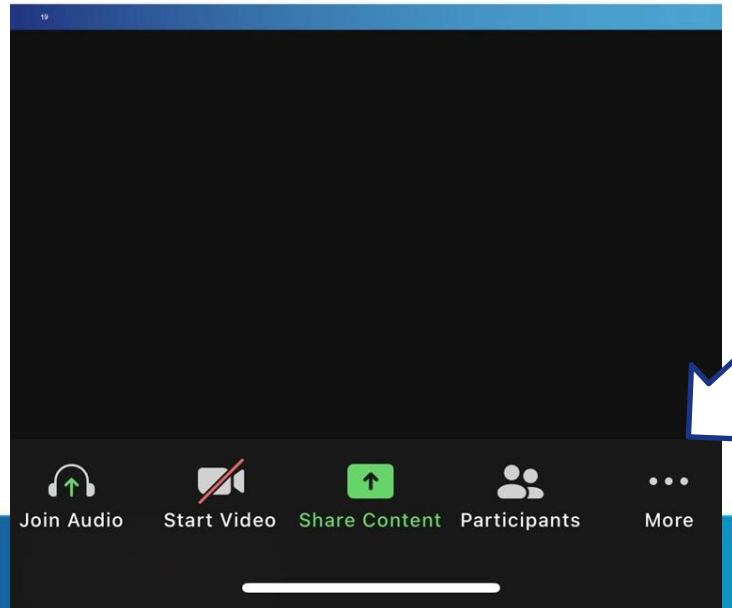
- Ability to inform patients of the best technologies available
- Needs, wants, expectations, and lifestyle

Reduce patient and physician burden

- Cost/pharmacy visits and prior authorizations
- Ocular surface disease and potential effects on visual acuity

Ability to impact patients' post-operative lifestyle

- ONE TIME opportunity during cataract surgery to address a patient's cataract, refractive needs (astigmatism and presbyopia) as well as their glaucoma



Speaker Bio –

Aaron Wolf, OD, FAAO, FSLS, FIAOMC

Owner of Austin Optometry Group in Austin, Texas

Dr. Aaron Wolf received his Doctor of Optometry degree from the University of Houston in 2009. He is the owner of Austin Optometry Group, a private practice in Austin, Texas, focusing on ocular surface disease and specialty contact lenses, including scleral lenses and orthokeratology.

Dr. Wolf provides topography-guided and tomography-guided corneal, scleral, and orthokeratology lenses, ocular impression-based lenses, and custom HOA correcting lenses. He has fitted more than 1,500 scleral lens cases and more than 500 orthokeratology cases.

Dr. Wolf is the first doctor in Texas to earn all of the following clinical fellowships: Fellow of the American Academy of Optometry, Fellow of the Scleral Lens Society, and Fellow of the International Academy of Orthokeratology and Myopia Control.

He has served as a product development consultant, IRB research participant, and is a Key Opinion Leader for numerous anterior surface imaging manufacturers and specialty contact lens manufacturers

Financial Disclosures

Ovitz (USA), consulting, speaking and teaching, honoraria
Medmont International (Australia), consulting, speaking and teaching, honoraria
Eaglet Eye (Netherlands), consulting, speaking and teaching, honoraria
EyeSpace (New Zealand), consulting, speaking and teaching, honoraria
Oculus WAVE (USA) , consulting, speaking and teaching, honoraria
Gaudi/EyeXY Inc. (USA), consulting, speaking and teaching, honoraria
AccuLens (USA), consulting, speaking and teaching, honoraria
BostonSight (USA), consulting, speaking and teaching, honoraria
SynergEyes (USA), consulting, speaking and teaching, honoraria
Johnson & Johnson Vision Care (USA), consulting, speaking and teaching, honoraria

All financial relationships have been mitigated.

Clinical Applications of Corneal Topography

AARON WOLF, OD, FAAO, FSLS, FIAOMC

AUSTIN OPTOMETRY GROUP

AUSTIN, TEXAS

Tonight's Objectives

1. Distinguish between Placido disc corneal topography, Scheimpflug tomography, AS-OCT, and Fourier projection corneoscleral profilometry

2. Clinical Indications for ordering corneal topography

3. Daily applications of topography/tomography

4. Basic principles in interpretating maps

5. Billing/Revenue Opportunities (No fees discussed)

Corneal (-scleral) Measurement Technologies

1. Keratometry
2. Placido Disc Corneal Topography
3. Slit Scan or Scheimpflug Corneal Tomography
4. AS-OCT Corneal Tomography
5. Corneo-scleral Profilometry
    a) Scheimpflug
    b) Fourier Projection
6. Ocular impression 3D scan

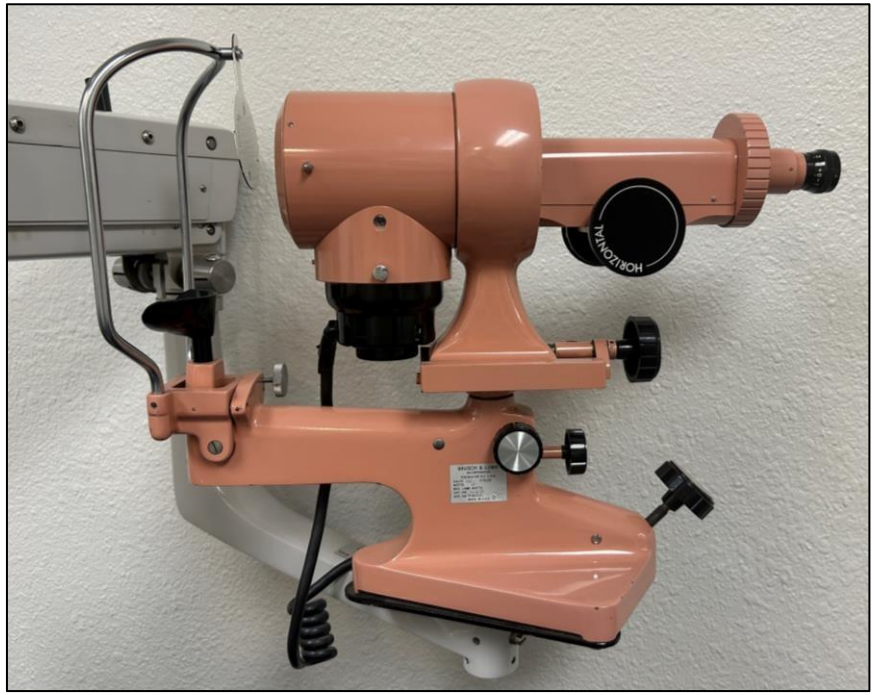
Keratometry

Keratometry is the measurement of the curvature of the anterior corneal surface, usually across a fixed chord length of 2 to 3 mm, which falls within the spherical optic zone of the cornea.

Limitations:

- Small area
- Data from only 2 principal meridians
- Inaccurate if mire distortions (dryness, scarring, ectasia, etc)

<u>Not very useful</u>



Gurnani B, Kaur K. Keratometer. 2023 Jun 11. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan–. PMID: 35593824.

Placido Disc Corneal Topography

Projection of concentric rings onto the cornea (Keratoscopy). Central camera captures their reflection and algorithms determine radius of curvature and dioptric power of cornea based on separation & deformation of mires, compared to a known sphere projection on calibration ball (Videokeratography).

Large cone (further from eye, fewer rings, smaller diameter projection 7-10mm chord, 5,000-10,000 data points)

Small cone (closer to eye, more rings, larger projection diameter 10-12mm chord, >100,000 data points)

Maps surface of cornea only

Color coded curvature (primary) and elevation (secondary)

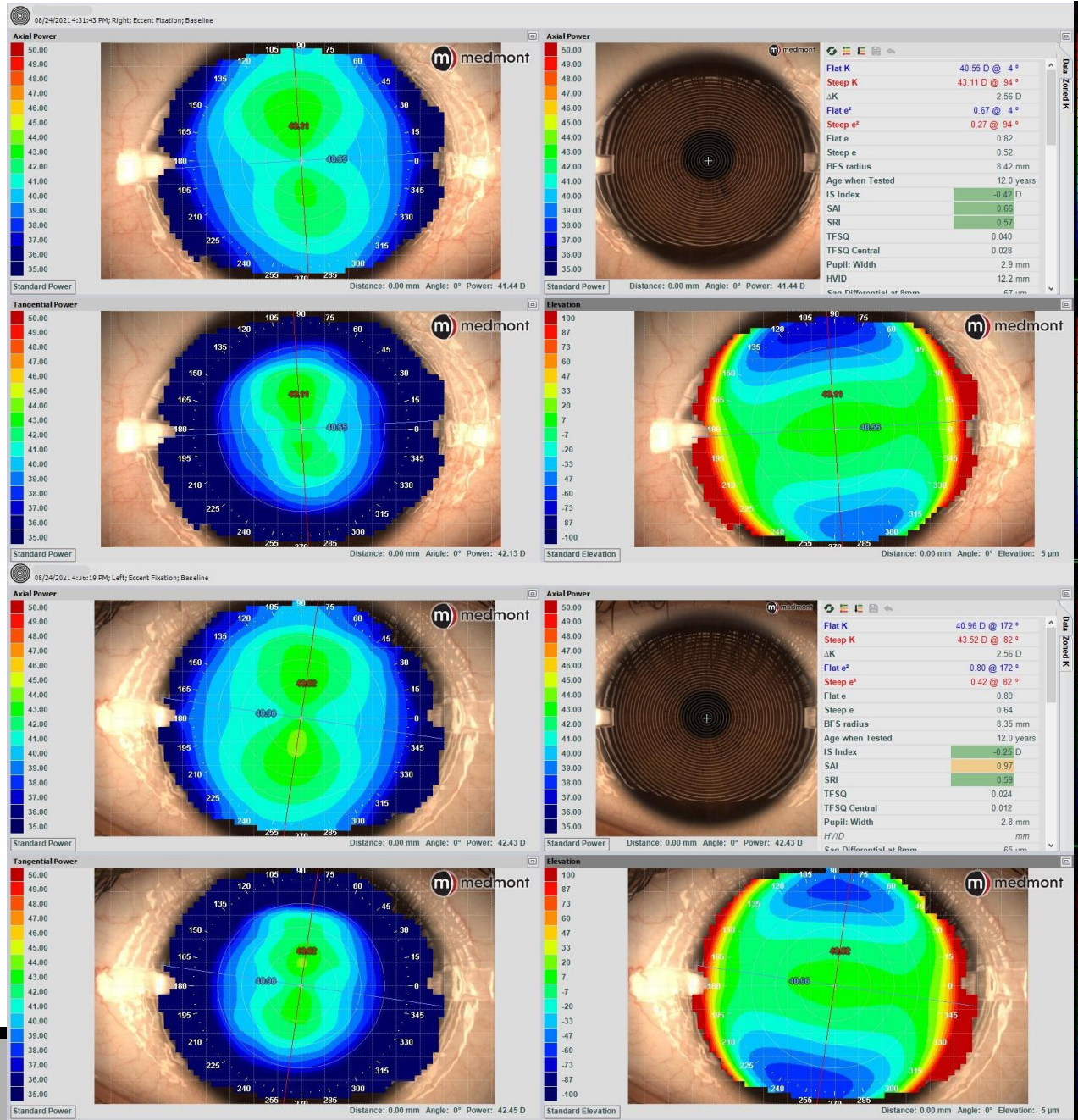
Best technology for mapping optics over contact lenses

Tear film analysis is possible

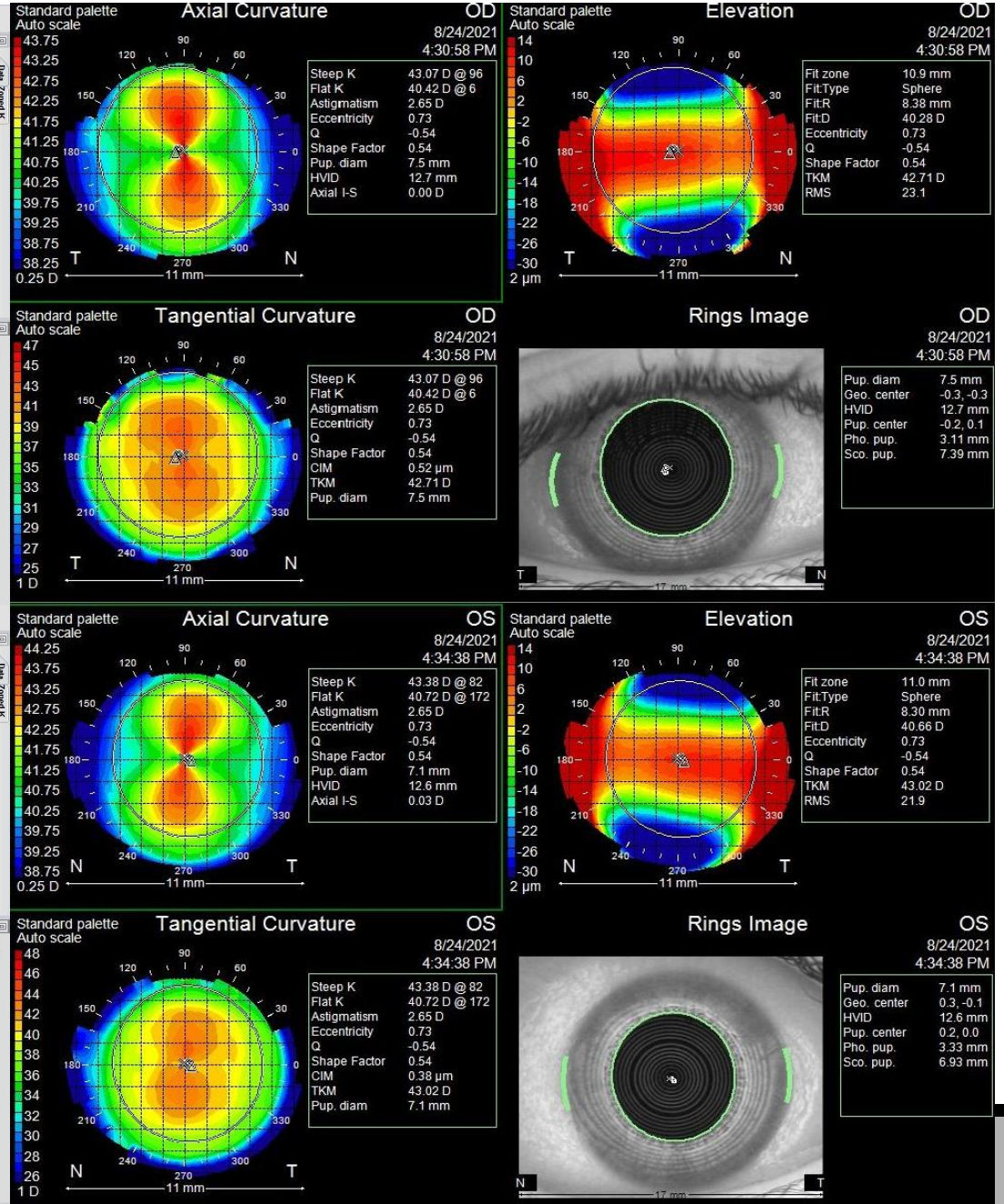
Interpolates data: blends data through neighboring known values to smooth out artifacts

Sridhar U, Tripathy K. Corneal Topography. [Updated 2023 Sep 4]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK585055/

Small Cone Topographer



Large Cone Topographer



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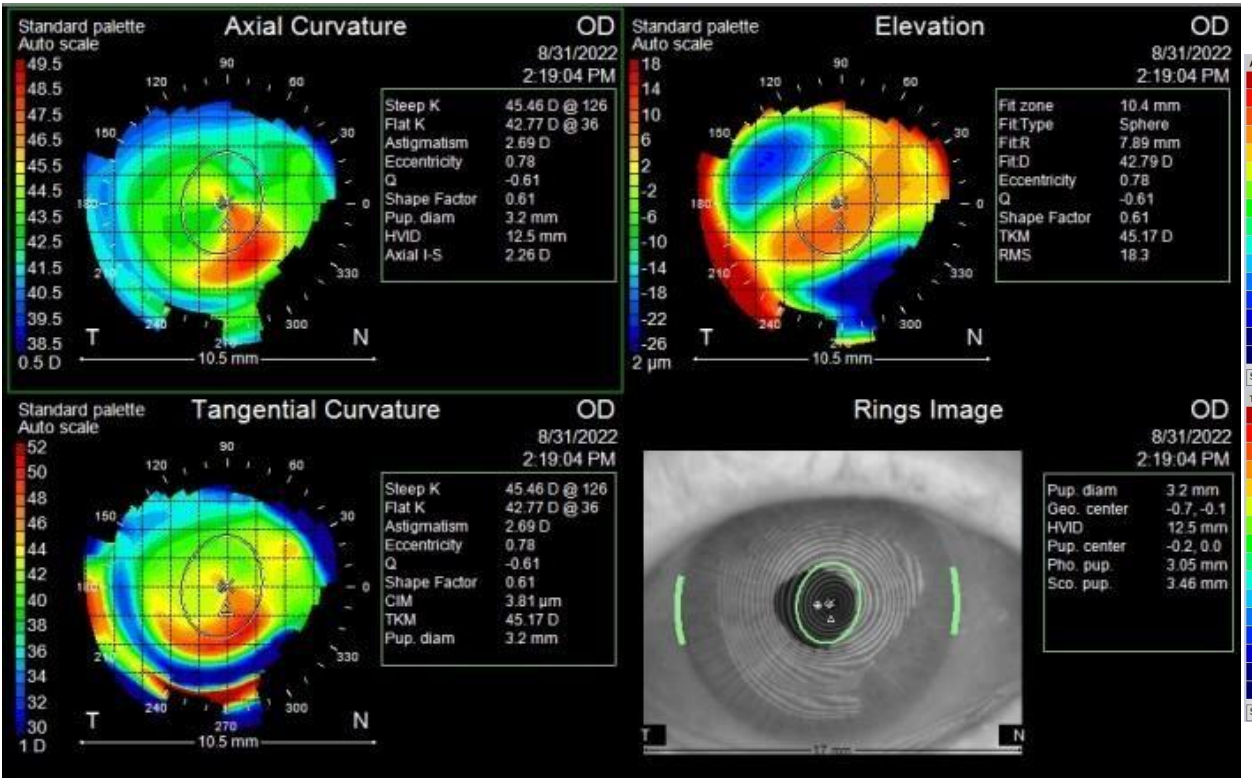
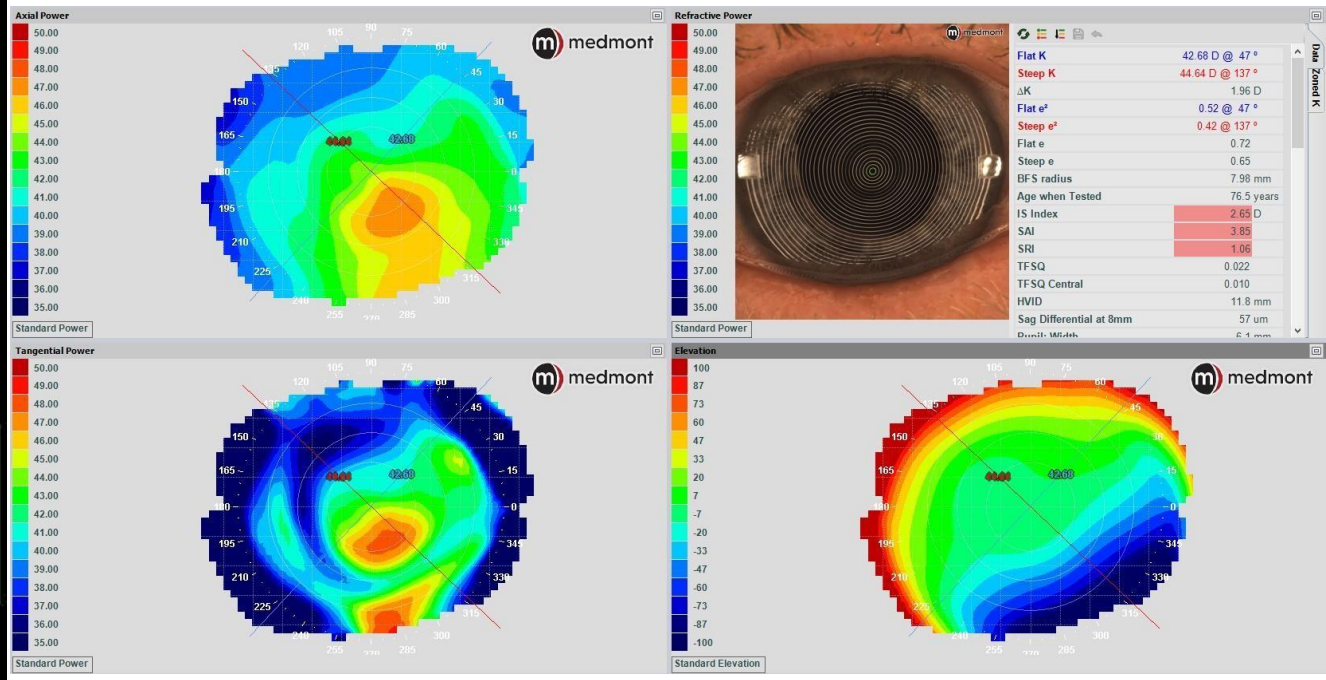
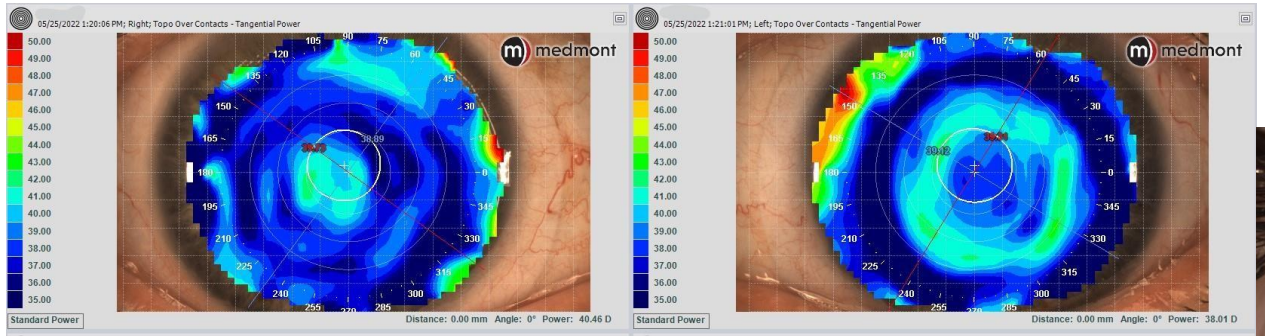
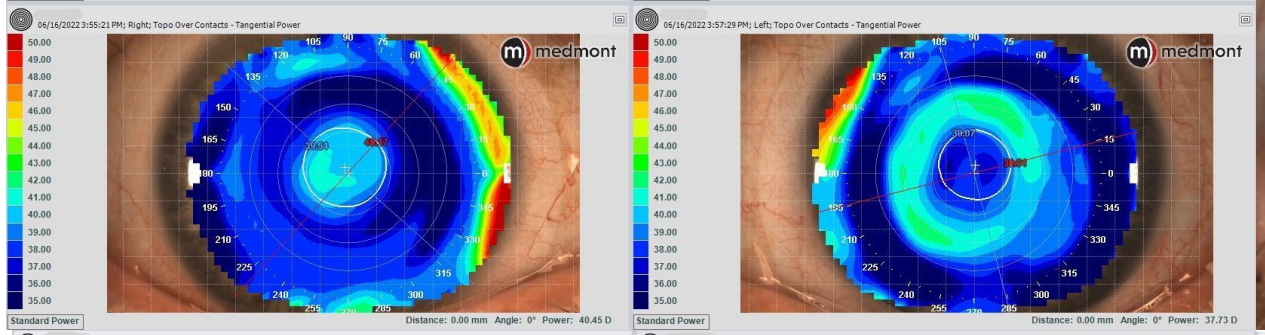


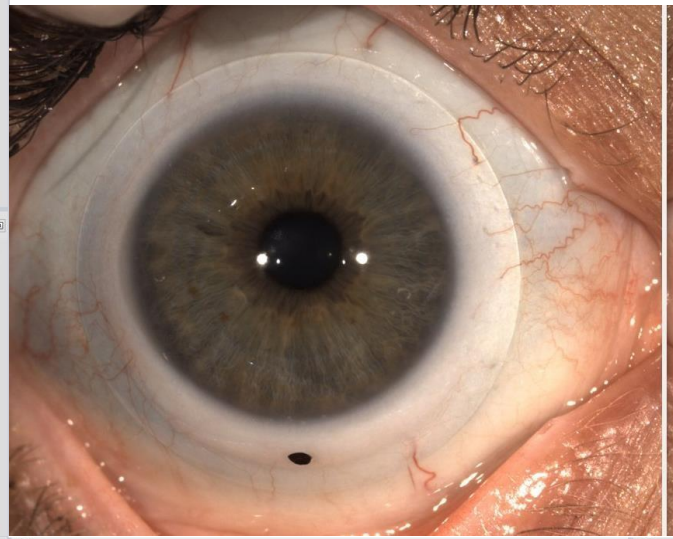
Large Cone Topographer

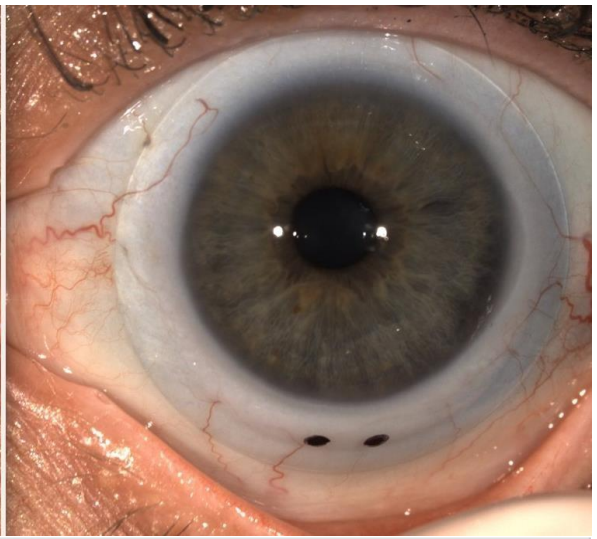


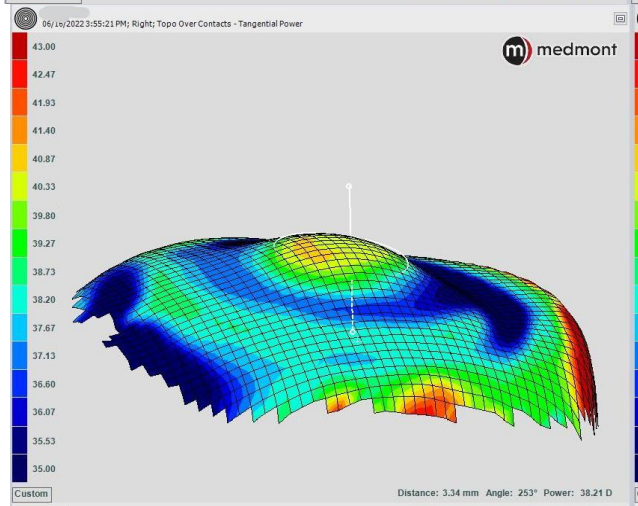
Placido Topography Over Contact Lenses

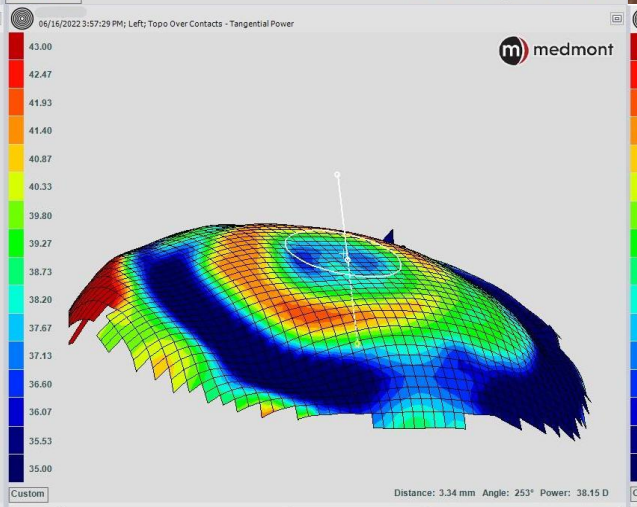


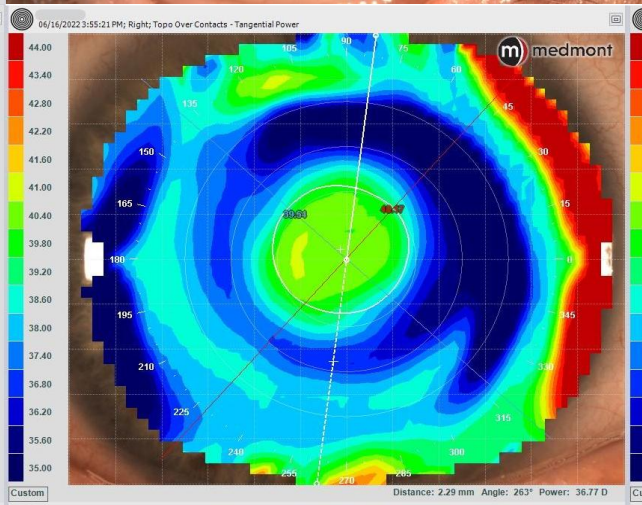


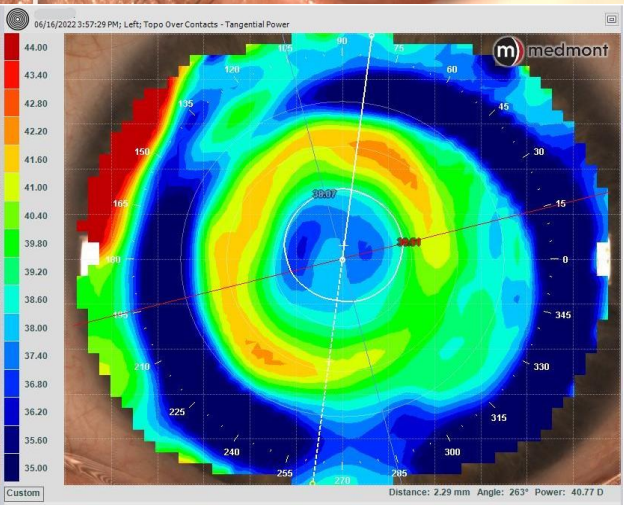






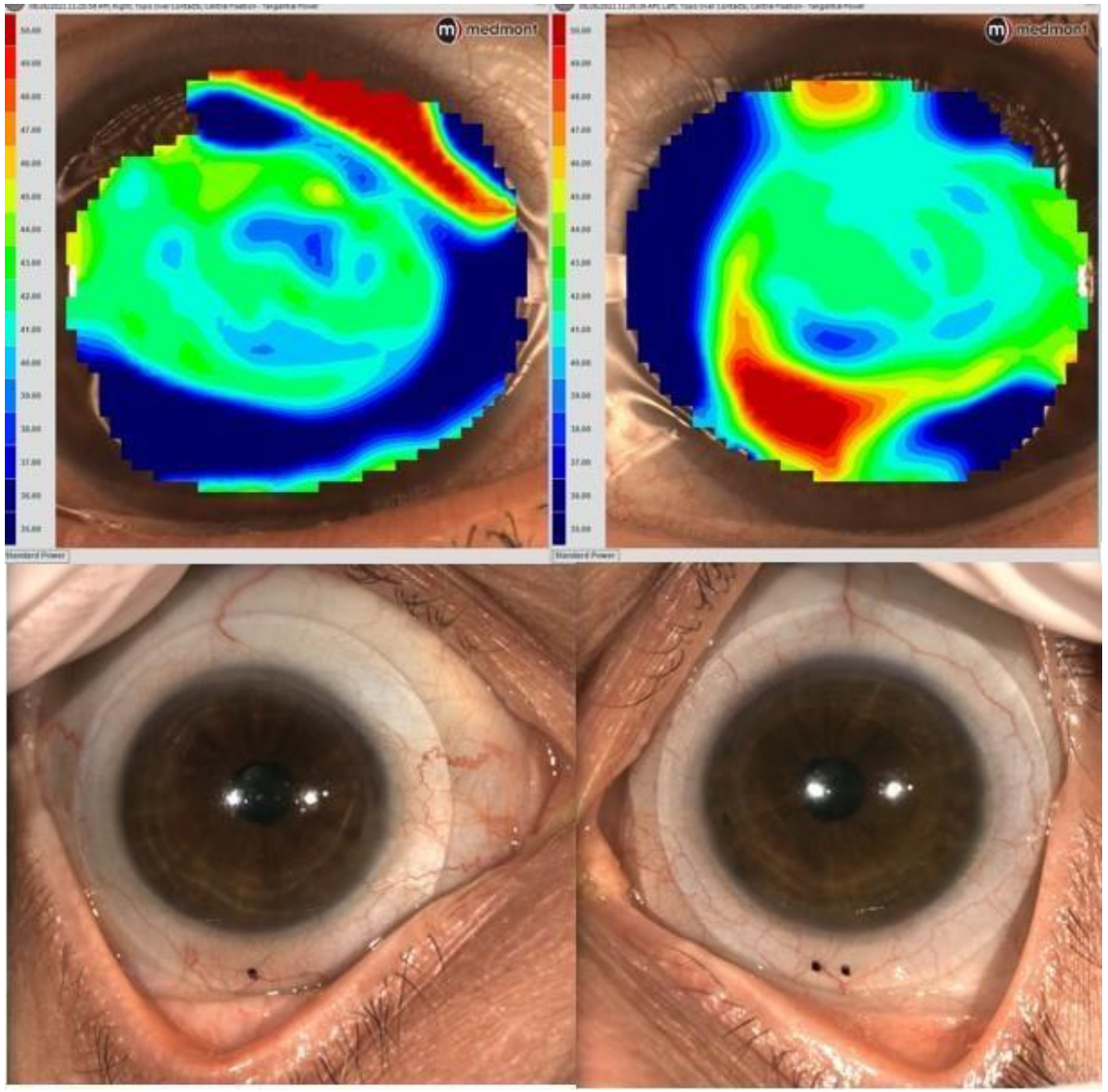






Placido Topography Over Contact Lenses

BI + Vertical Prism



Slit Scanning Tomography

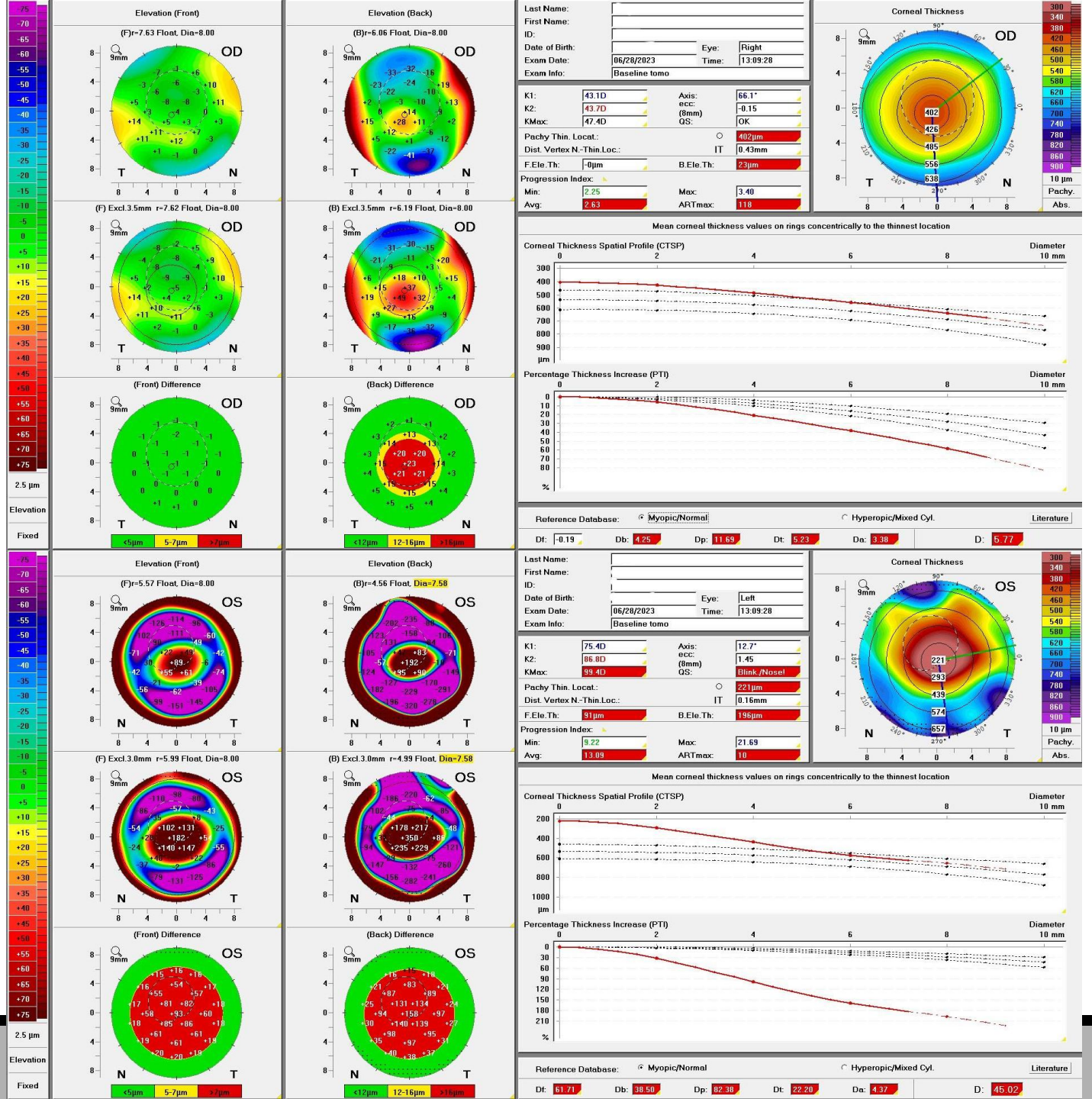
- Measures the dimensions of a slit scanning beam projected on the cornea, 40 slits projected at 45 degree to camera.
- Measures anterior, posterior, and pachymetry
- Combines slit scanning and placido disc to calculate elevation and curvature respectively
- Interpolates data
- Not used much anymore
- Not as accurate as other topography and tomography devices

Rozema JJ, Wouters K, Mathysen DG, Tassignon MJ. Overview of the repeatability, reproducibility, and agreement of the biometry values provided by various ophthalmic devices. *Am J Ophthalmol* 2014; **158**: 1111–1120.e1

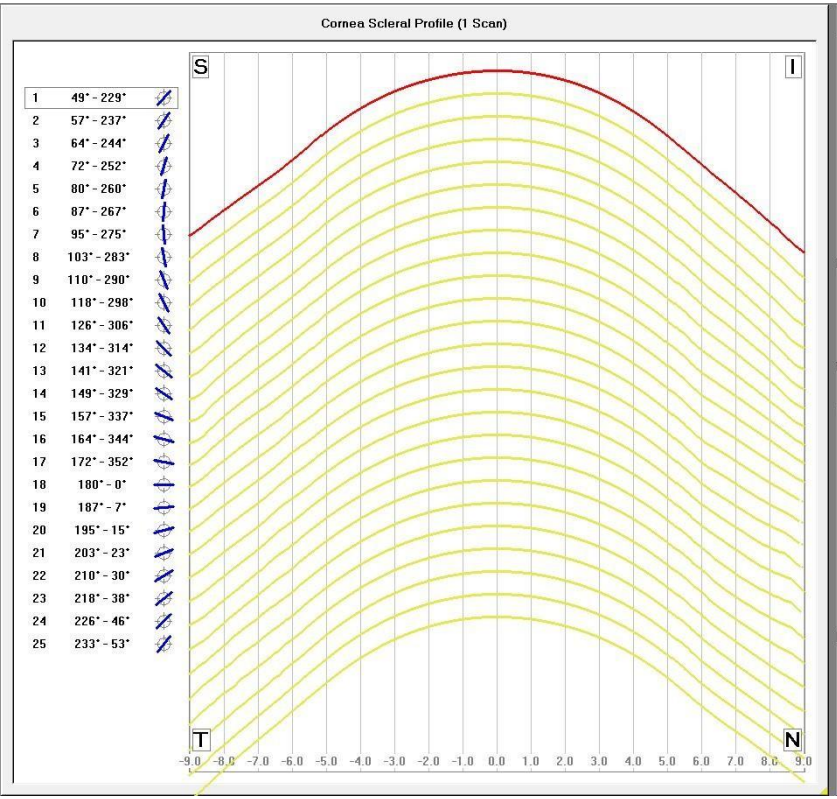
Scheimpflug Tomography

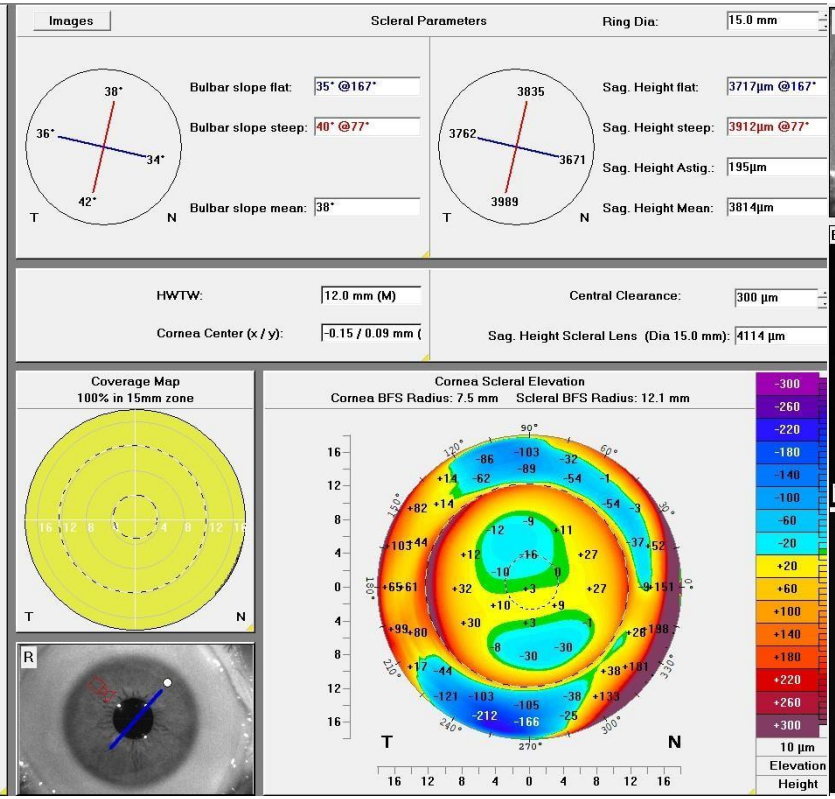
- Rotating camera captures reflection of a bright slit beam that sweeps across the cornea allowing 3D reconstruction of the entire cornea. Includes both a rotating camera with a static camera.
- 50 images with ~25,000 elevation points over ~2 second rotation
- Measures anterior, posterior, and pachymetry
- Elevation (primary) and curvature data (secondary)
- Can extend to map scleral elevation as well as corneal (18mm diameter)
- Interpolates data
- Best technology for Dx and Tx of KC and other ectasia

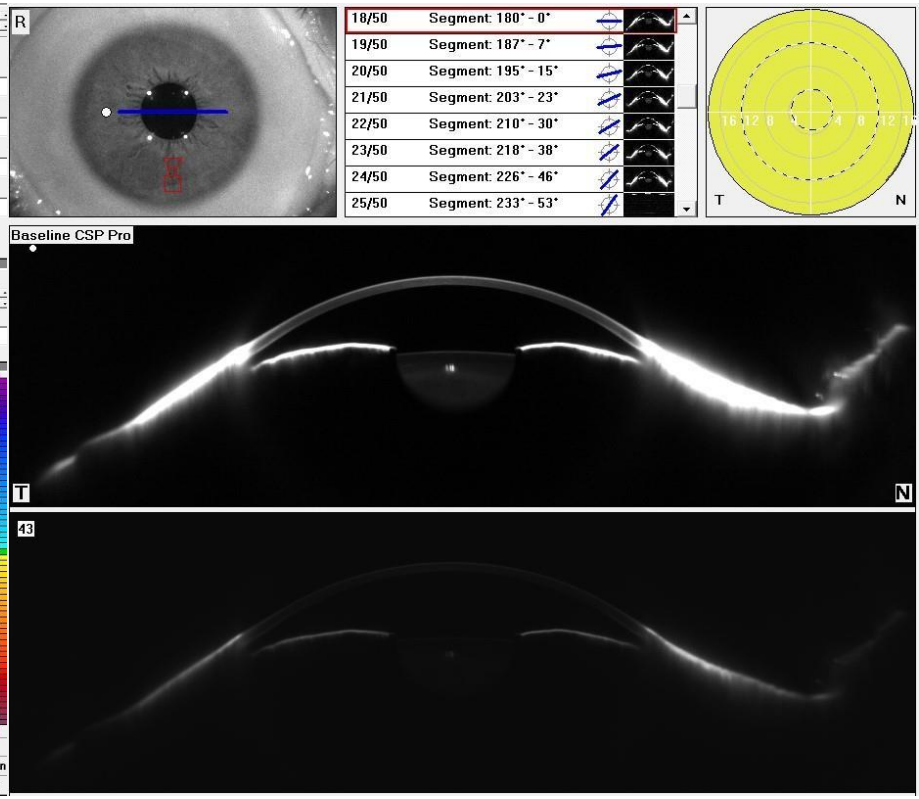
Scheimpflug Ectasia Detection



Scheimpflug corneo-scleral profilometry (CSP)







Anterior Segment Optical Coherence Tomography (AS-OCT)

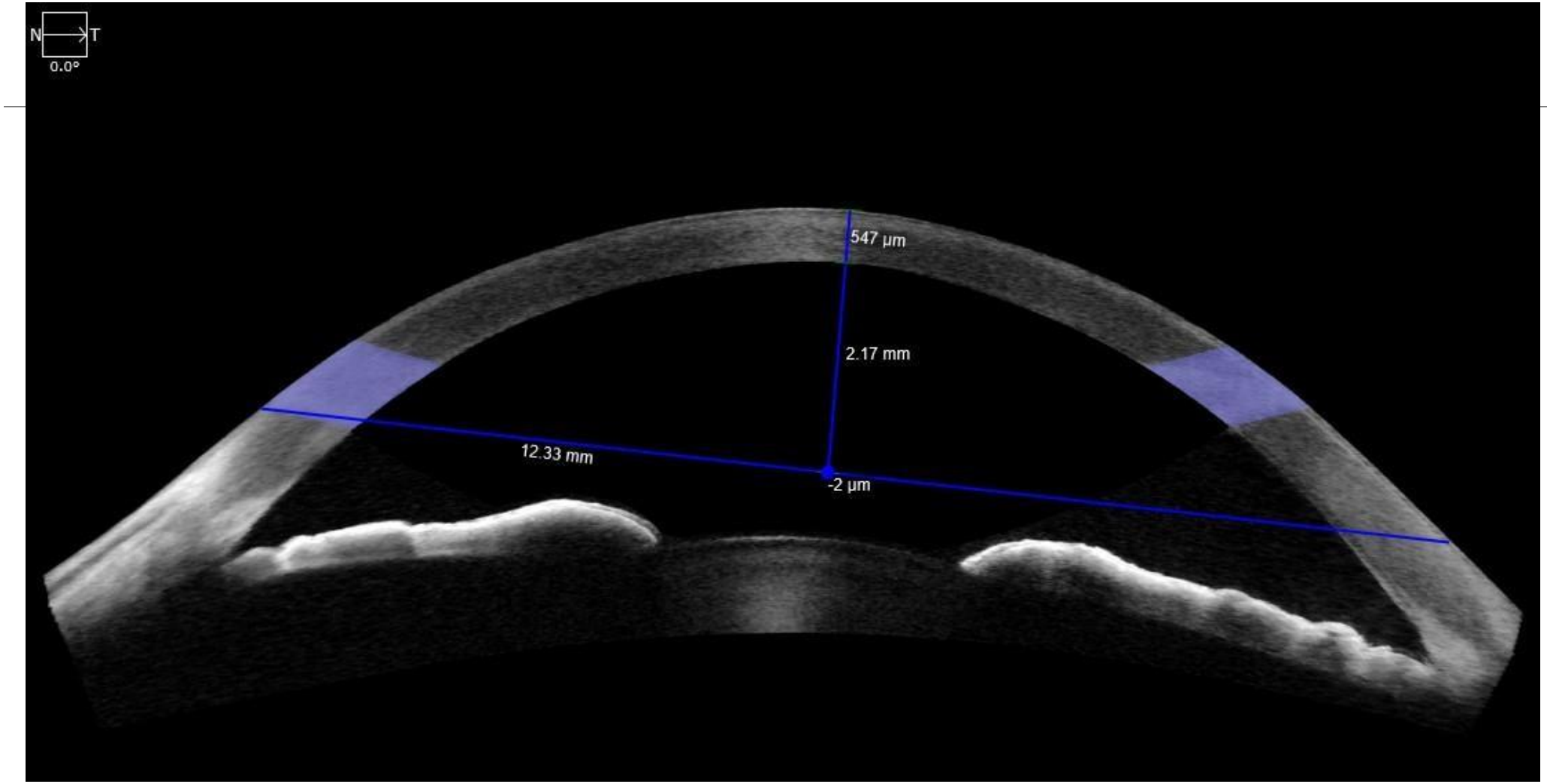
Spectral Domain (SD): ~25,000 A-scans/sec, can be used to measure ≤16mm scan in specified meridian. Have to manually measure sagittal height in one meridian.

Swept Source (SS): ~50,000 A-scans/sec, higher definition than SD, takes ~16,000 data points across entire cornea to create elevation map of anterior and posterior surface and pachymetry. ≤16.5mm scan. Currently, color-coded maps for cornea only, not yet scleral.

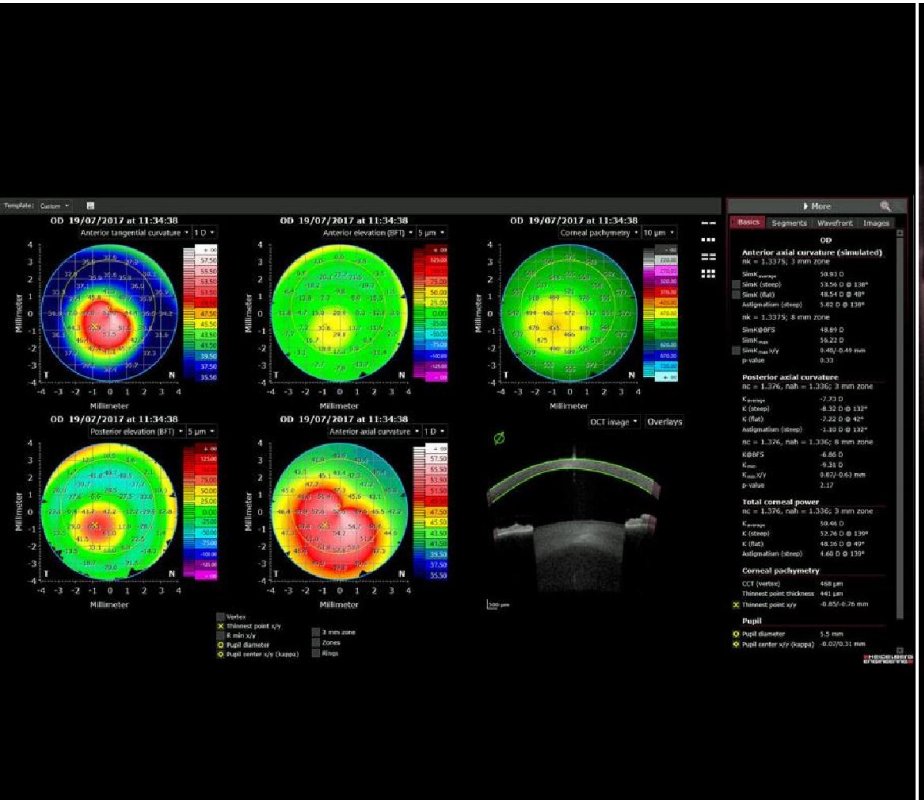
Hyper-parallel (HP): >300,000 A-scans/sec, Ultra-HD images, uses a 2-dimensional grid of 1008 beams to take simultaneously image across a wide area of the eye allowing 3D recreation of eye. Currently, color-coded maps for cornea only, not yet sclera.

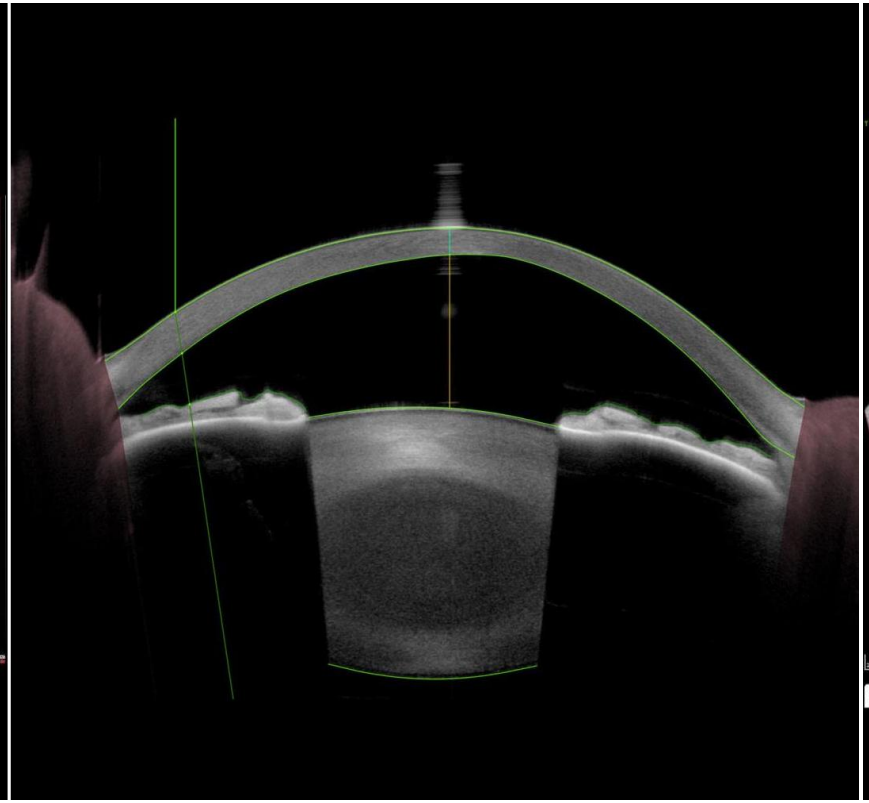
Steve Frisken, Trevor Anderson, Armin Segref, Dirk Lorenser, and Grant Frisken, "Anterior and posterior imaging with hyperparallel OCT," Biomed. Opt. Express 14, 2678-2688 (2023)

Spectral Domain AS-OCT



Swept Source AS-OCT





c/o Heidelberg

Hyper-Parallel AS-OCT

c/o Cylite

Fourier Projection Corneoscleral Profilometry

Projection of two grids on eye from two projectors 45 degrees from central camera. Grid distances and deformity used to create sagittal elevation map across entire surface.

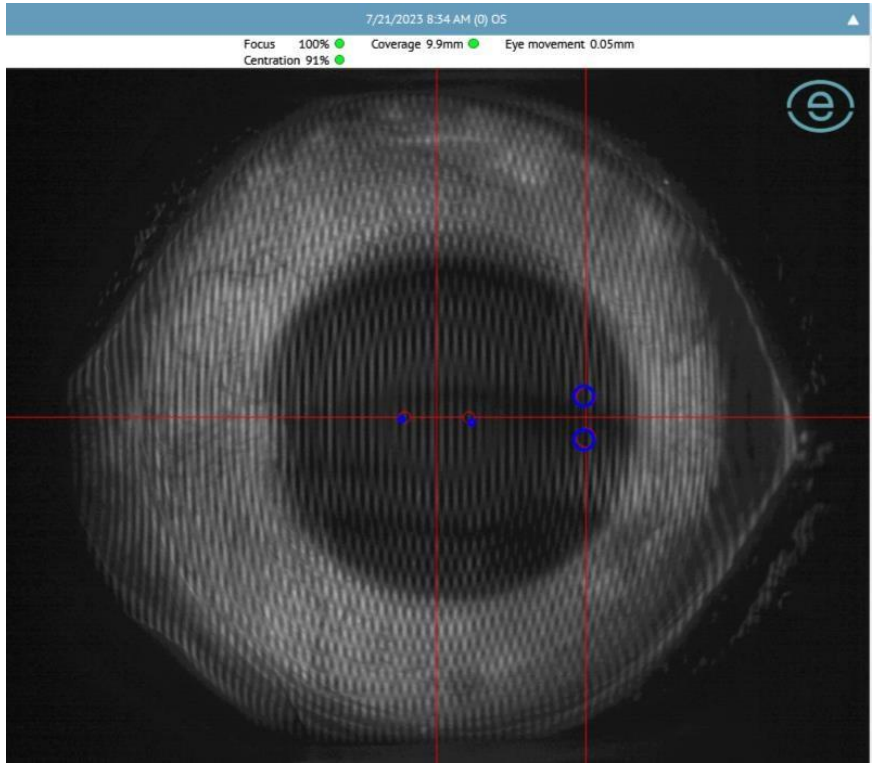
>20mm diameter with ~500,000 data points

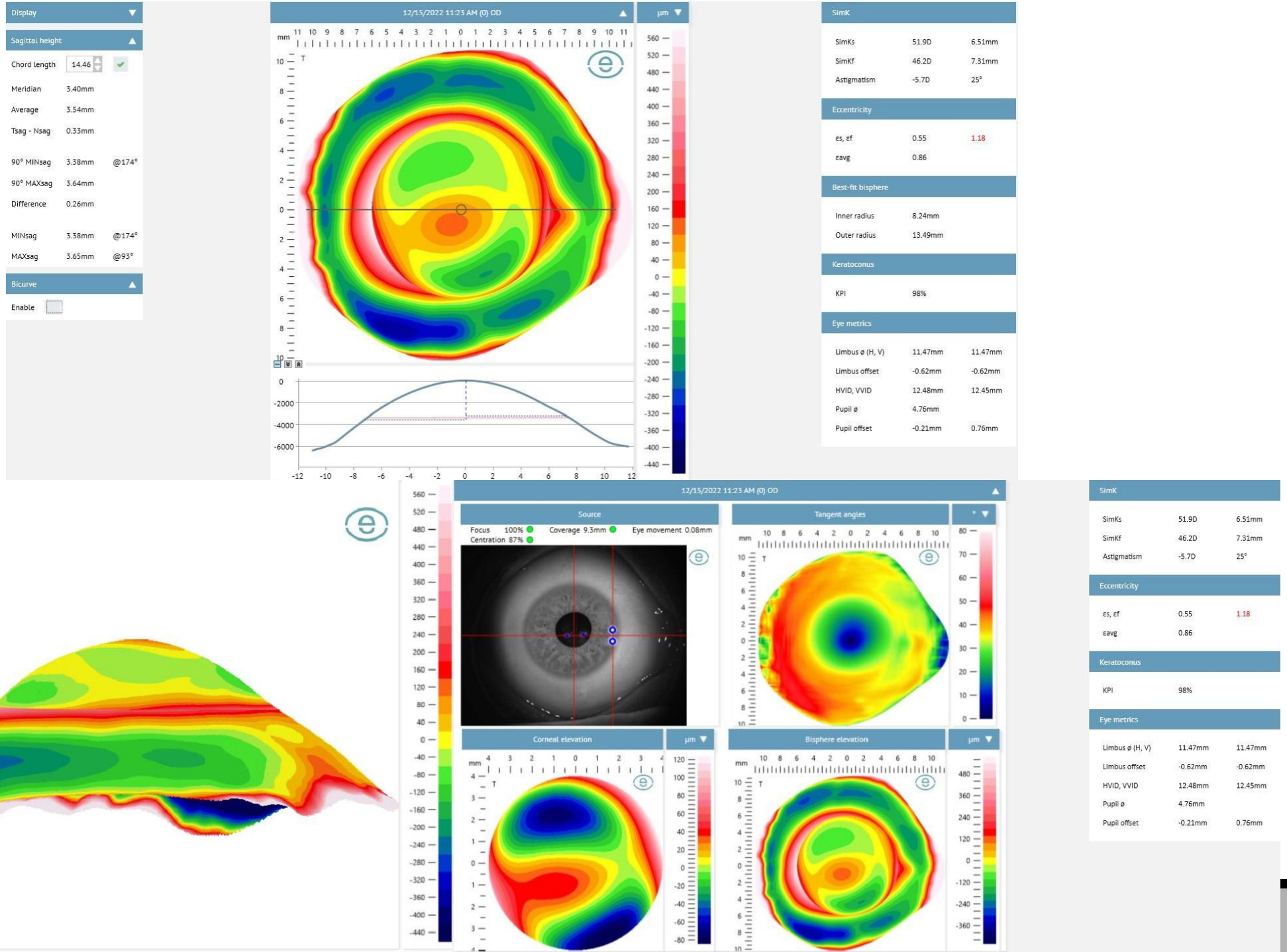
Maps only anterior surface

Tear film analysis possible

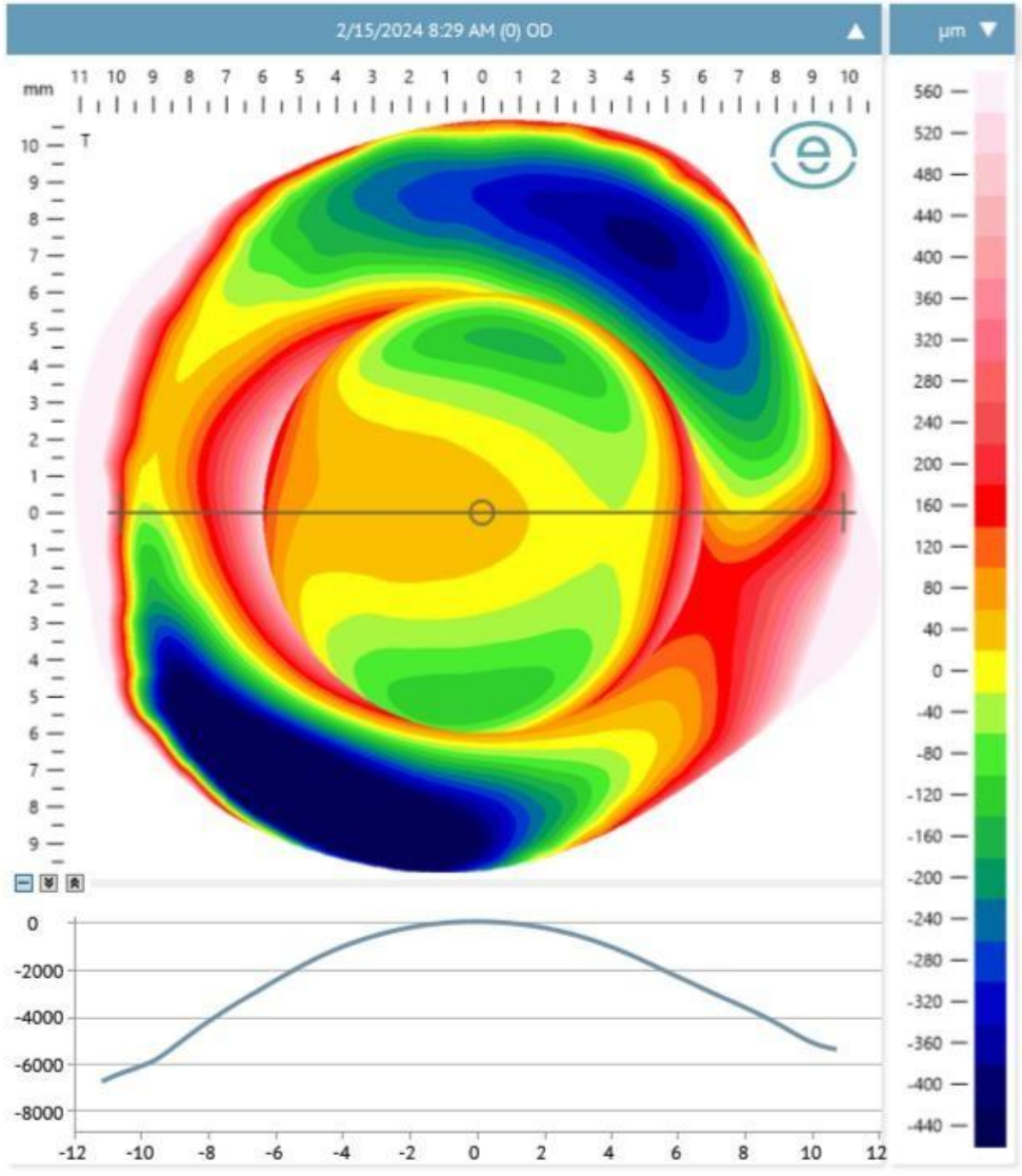
Elevation (primary), curvature (secondary)

Does NOT interpolate data

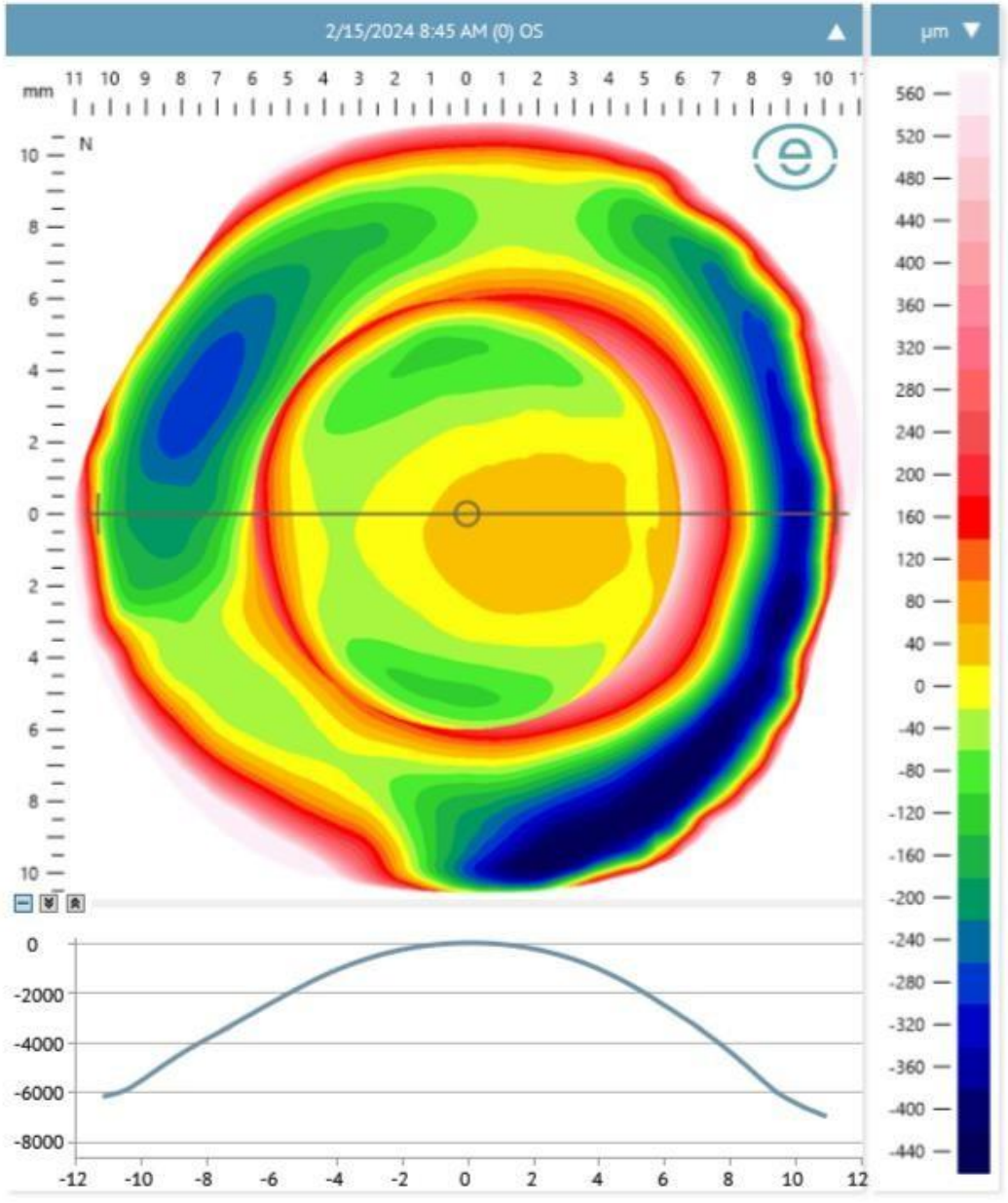



Display
Sagittal height
Chord length 14.46
Meridian 3.40mm
Average 3.54mm
Tsag - Nsag 0.33mm
90° MINsag 3.38mm @174°
90° MAXsag 3.64mm
Difference 0.26mm
MINsag 3.38mm @174°
MAXsag 3.65mm @93°
Bicurve
Enable
12/15/2022 11:23 AM (0) OD
µm
SimK
SimKs 51.9D 6.51mm
SimKf 46.2D 7.31mm
Astigmatism -5.7D 25°
Eccentricity
ES, EF 0.55 1.18
EAVG 0.86
Best-fit bisphere
Inner radius 8.24mm
Outer radius 13.49mm
Keratoconus
KPI 98%
Eye metrics
Limbus ø (H, V) 11.47mm 11.47mm
Limbus offset -0.62mm -0.62mm
HVID, VVID 12.48mm 12.45mm
Pupil ø 4.76mm
Pupil offset -0.21mm 0.76mm
12/15/2022 11:23 AM (0) OD
Source
Focus 100%
Coverage 9.3mm
Eye movement 0.08mm
Centration 87%
Tangent angles
Corneal elevation
Bisphere elevation
SimK
SimKs 51.9D 6.51mm
SimKf 46.2D 7.31mm
Astigmatism -5.7D 25°
Eccentricity
ES, EF 0.55 1.18
EAVG 0.86
Keratoconus
KPI 98%
Eye metrics
Limbus ø (H, V) 11.47mm 11.47mm
Limbus offset -0.62mm -0.62mm
HVID, VVID 12.48mm 12.45mm
Pupil ø 4.76mm
Pupil offset -0.21mm 0.76mm

Corneal WTR + Scleral WTR



Corneal WTR + Scleral ATR



Ocular Impression

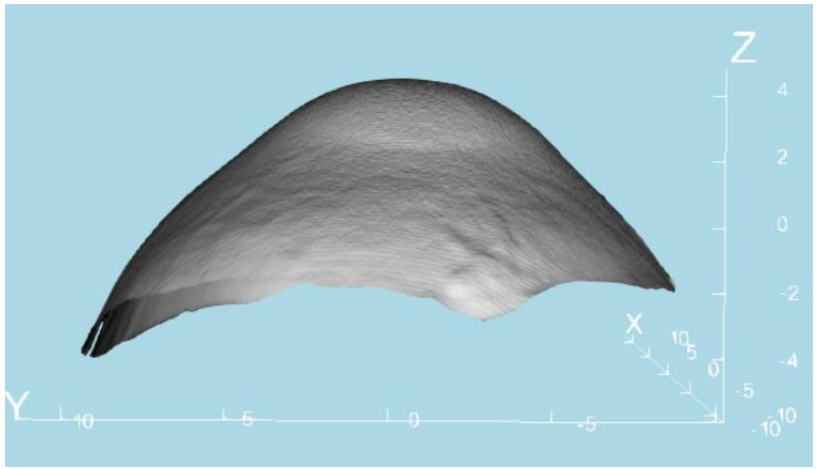
Polyvinylsiloxane impression material placed on eye to collect 3D mold of ocular surface, then read by 3D scanner

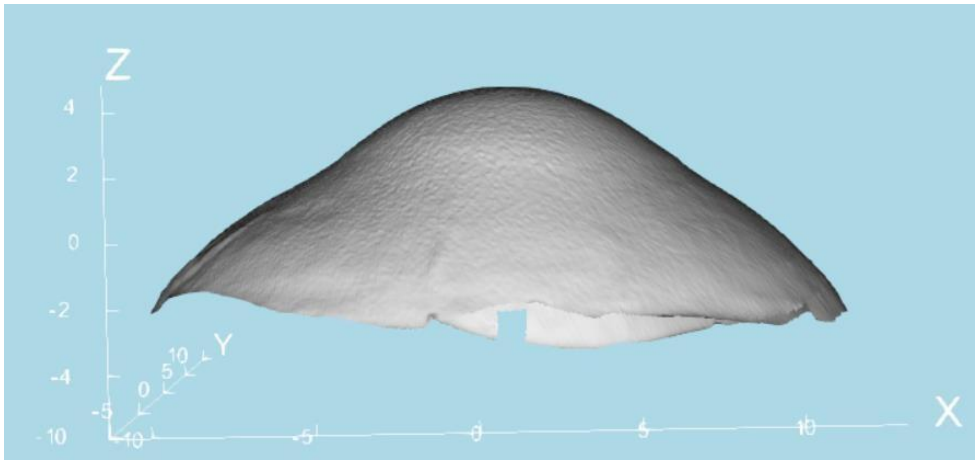
>20mm diameter with ~1 million data points

Maps only anterior surface

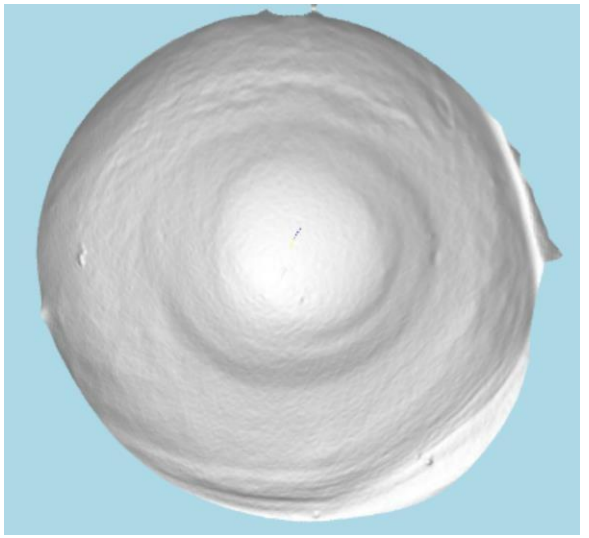
No quantitative or color-coded elevation or curvature metrics

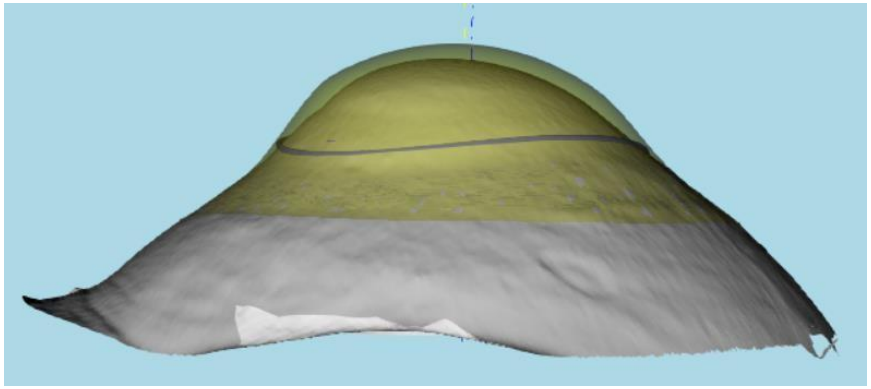
Does NOT interpolate data

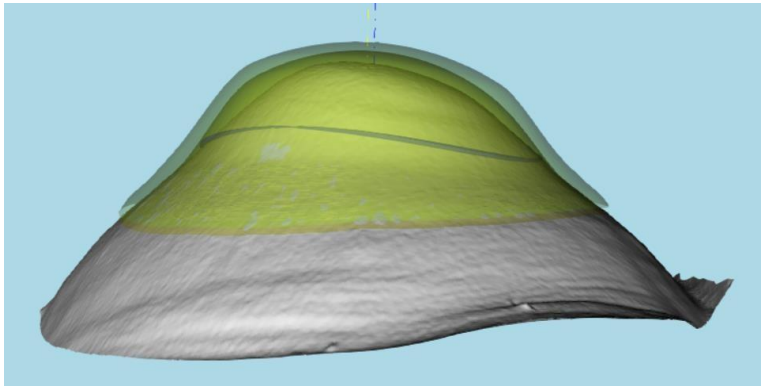


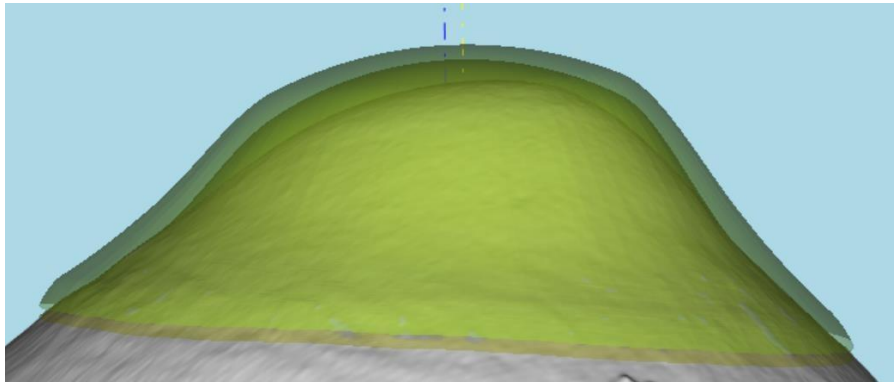


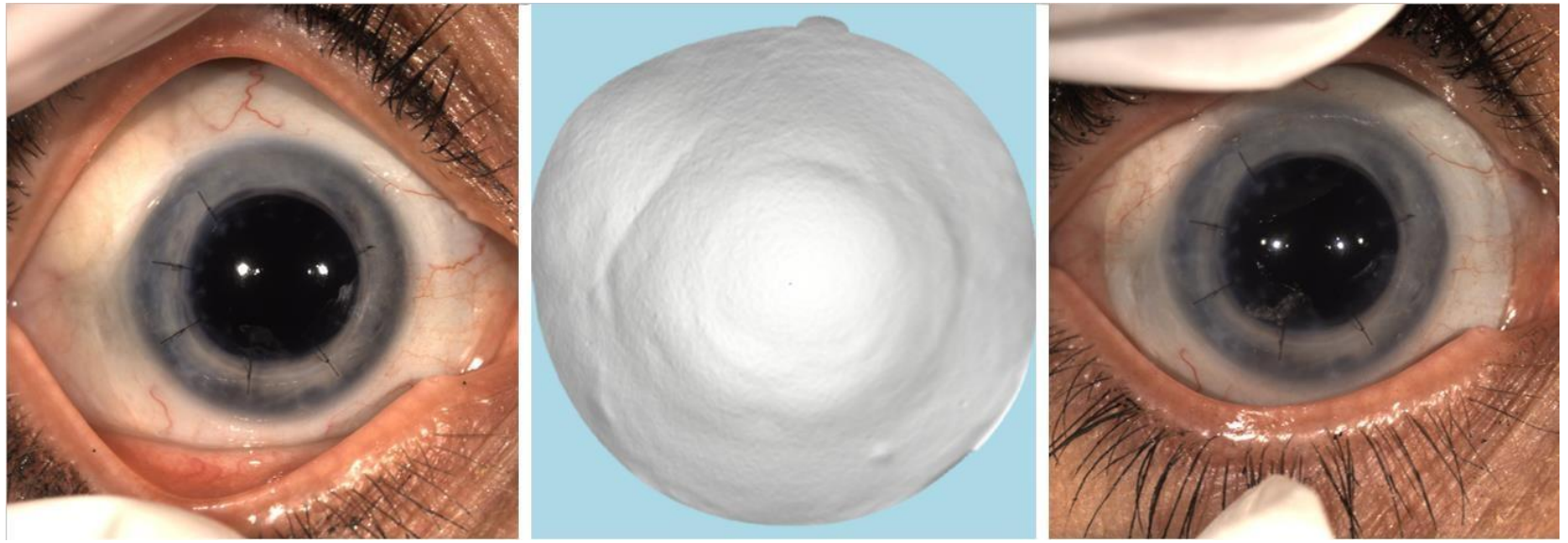
Impressions Mailed to 3D Scanner & Lab Design

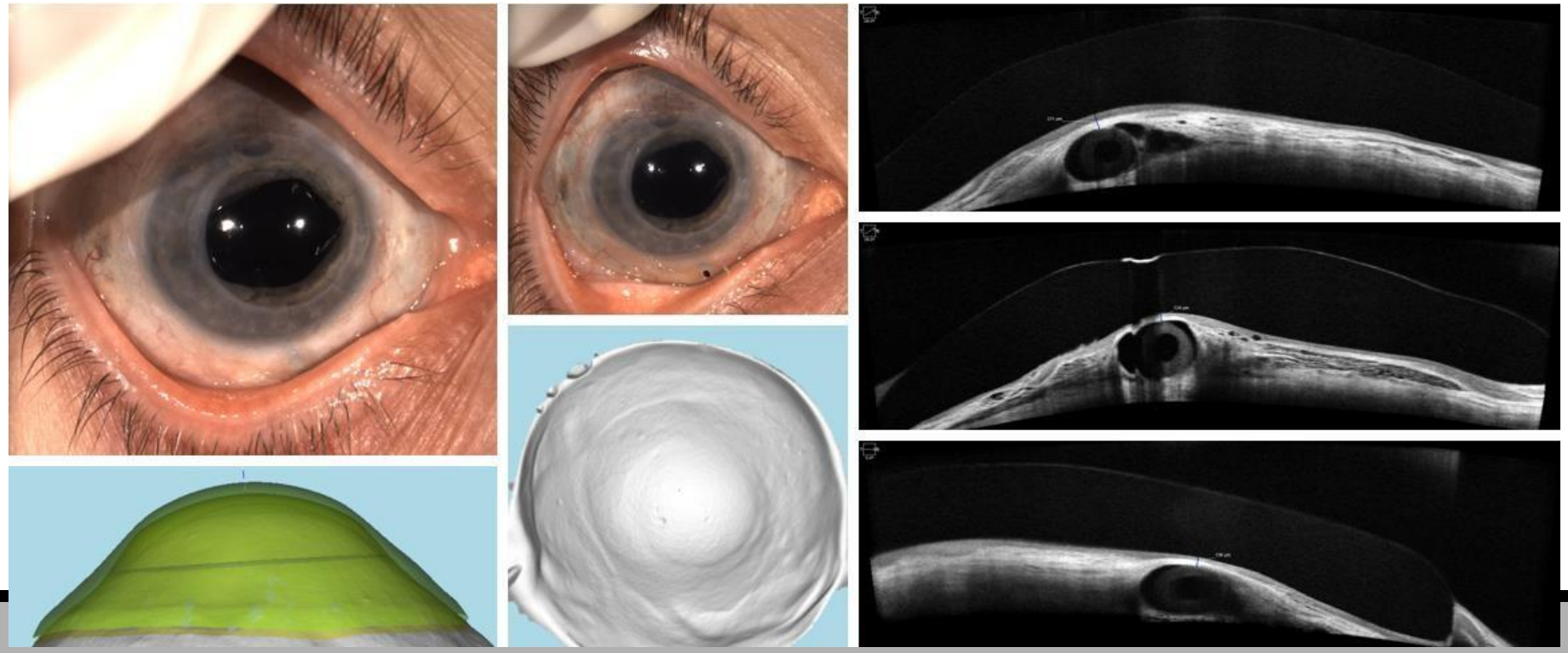












Imaging Technology Comparison

	Anterior Cornea	Entire / Posterior Cornea	Cornea & sclera	Tear Film Independent	Angle Kappa Independent	Corneal Opacity Independent
Keratometry	☑	☒	☒	☒	☒	☑
Placido Disc Topography	☑	☒	☒	☒	☒	☑
Fourier Projection Profilometry	☑	☒	☑	☒	☑	☑
Scheimpflug Tomography	☑	☑	☑	☑	☑	☒
AS-OCT (SD, SS, HP)	☑	☑	☑	☑	☑	☑ (SS,HP) ☒ (SD)
Ocular Impression	☑	☒	☑	☑	☑	☑

Clinical Indications of Corneal Topography
(basically, what you can bill to insurance)

CMS LCD L33810 listing of Medicare approved indications:

- pre-operatively for evaluation of irregular astigmatism prior to cataract surgery
- monocular diplopia
- bullous keratopathy
- post surgical or post traumatic astigmatism, measuring at a minimum of 3.5 diopters;
- post penetrating keratoplasty surgery;
- post surgical or post traumatic irregular astigmatism;
- corneal dystrophy;
- complications of transplanted cornea;
- post traumatic corneal scarring;
- keratoconus; and/or
- pterygium and/or corneal ectasia that cause visual impairment.

Approved indications will vary by insurance payer. Verify with each payer if submitting to medical insurance.

LASIK/PRK Pre-Op evaluation and follow-up clinical indication, but not billed to insurance

Daily Applications of Topography/Tomography (the WHY?)

Disease detection and monitoring not easily visible otherwise

- Keratoconus, post-surgical ectasia, etc.

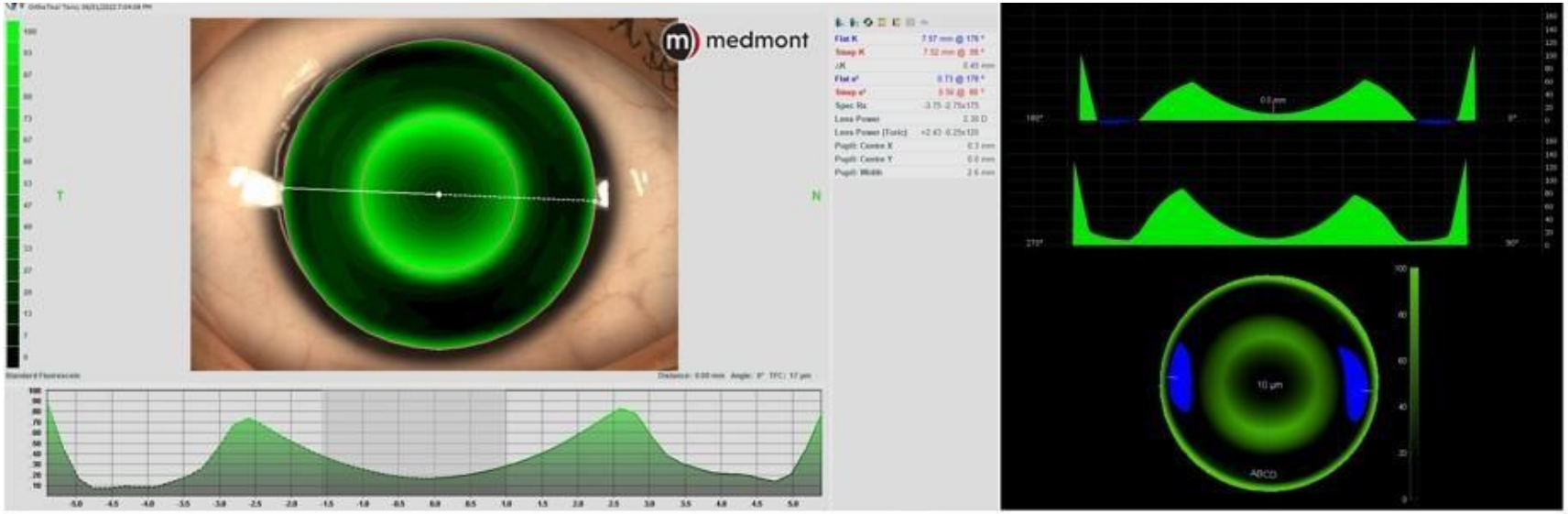
Regular vs. Irregular Astigmatism determination

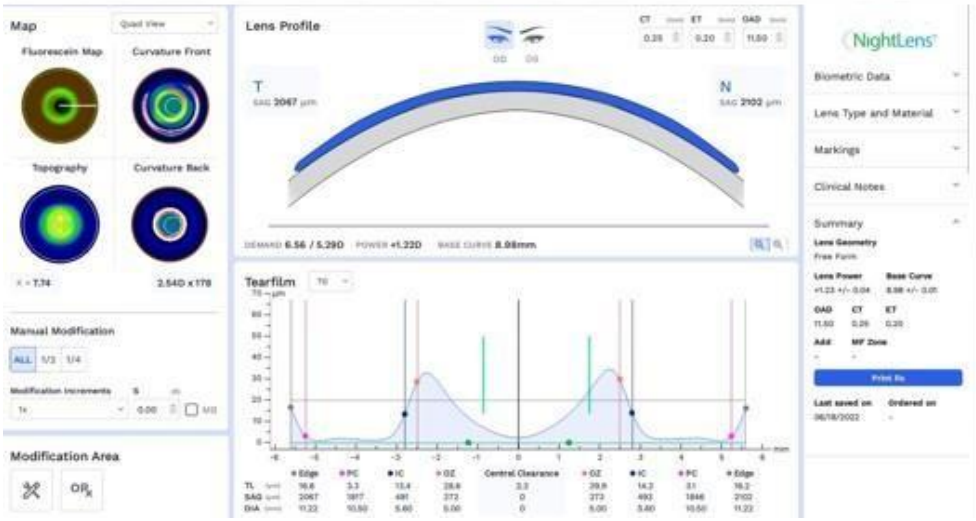
- Extensive symmetry analytics!
- Candidacy for laser refractive surgery, premium PCIOL, Orthokeratology, etc.

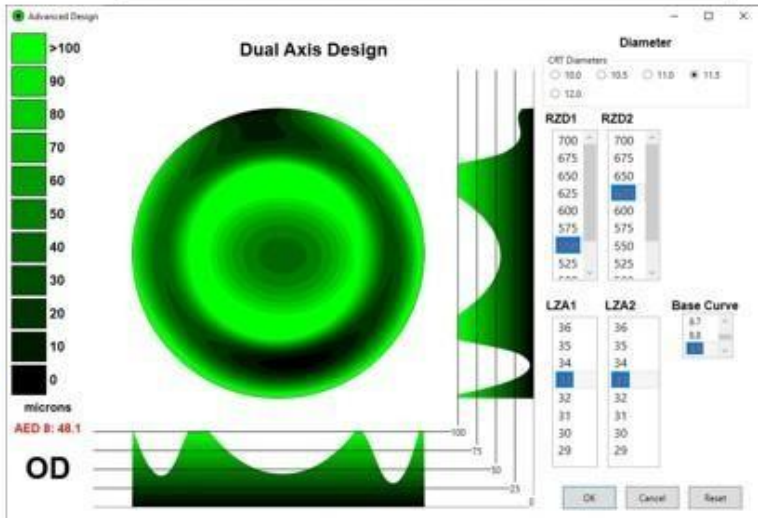
Contact lens fitting

- Pre-fit: K's, eccentricity, toricity, symmetry, corneal size, etc
- Post: intentional or unintentional corneal reshaping
- In-situ: Optic zone centration and size (multifocals), Lens flexure (toricity over lens), Optical prism
- CAD/CAM design software (corneal, scleral, and orthokeratology design)
- Internal CL design module w/ simulated fluorescein and tear film thickness (TFT) profile

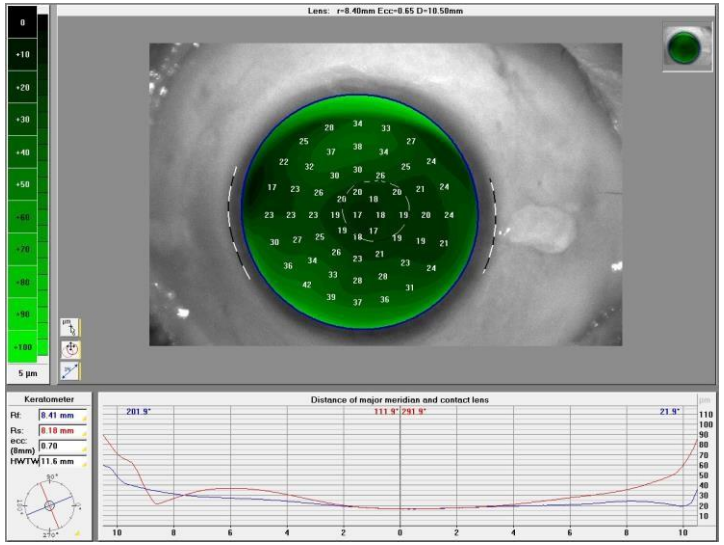
Internal CL Design or External CAD/CAM Design

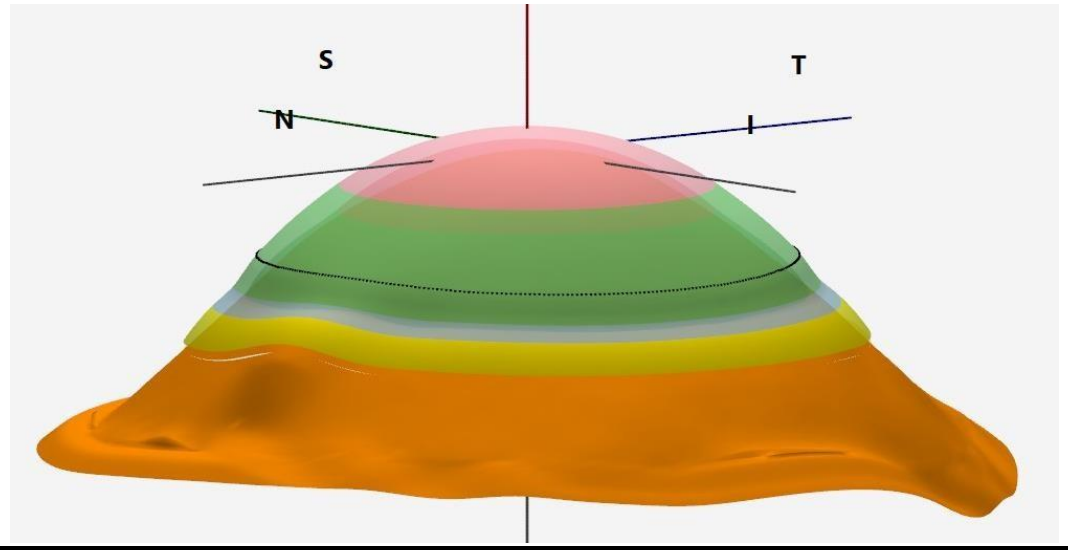


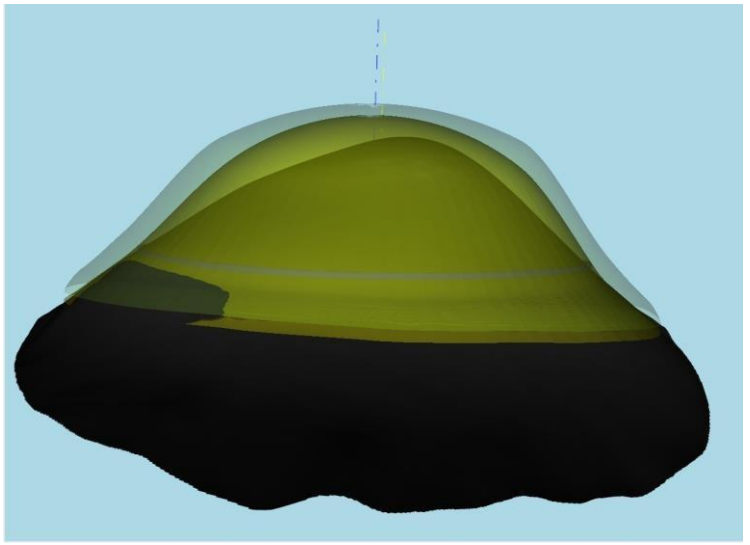


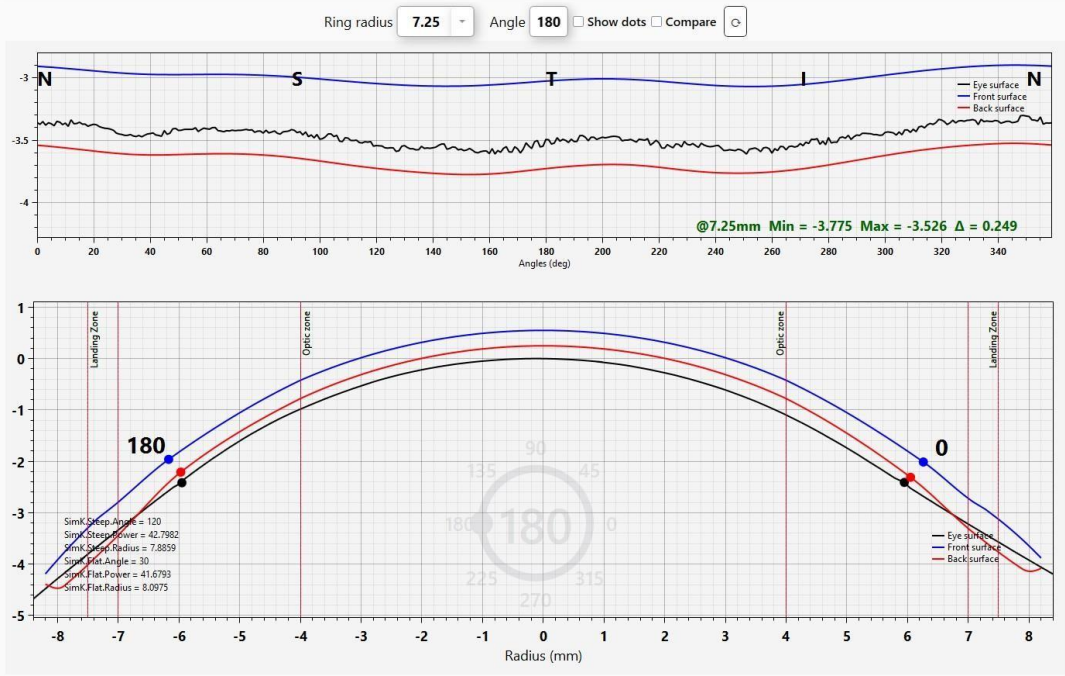


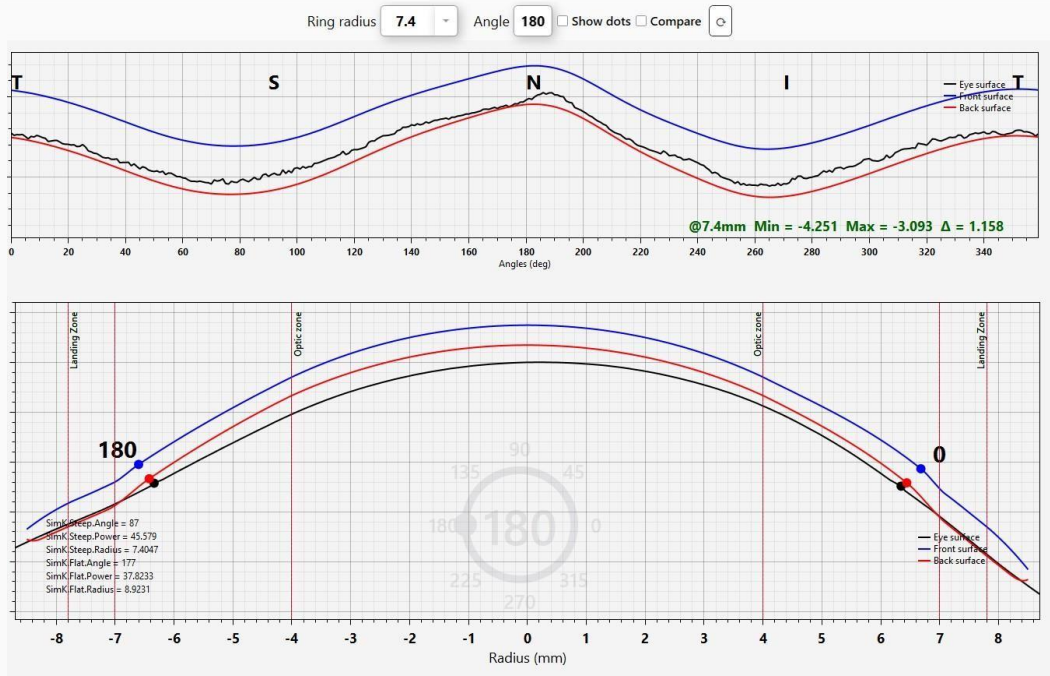
Internal CL Design or External CAD/CAM Design



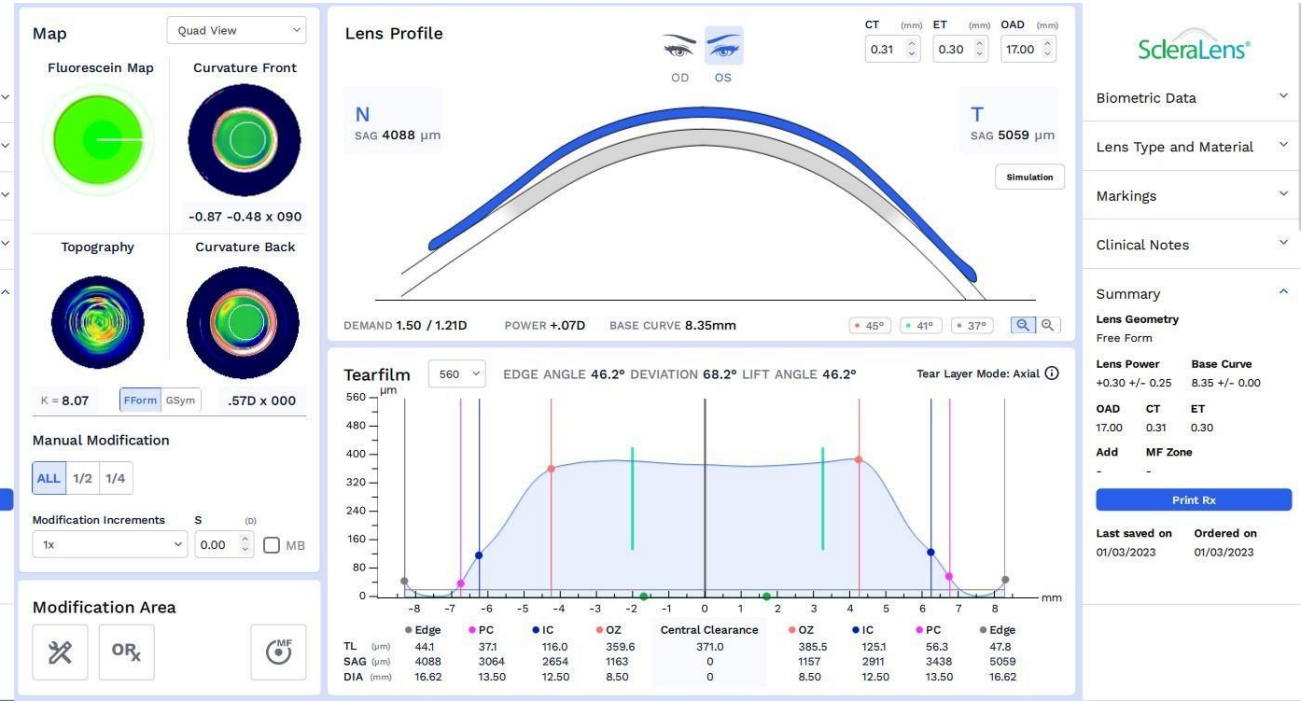





Ring radius 7.25
Angle 180
Show dots
Compare
N
S
T
I
N
Eye surface
Front surface
Back surface
@7.25mm Min = -3.775 Max = -3.526 Δ = 0.249
Angles (deg)
Landing Zone
Optic zone
Optic zone
Landing Zone
180
0
SimK.Steep.Angle = 120
SimK.Steep.Power = 42.7982
SimK.Steep.Radius = 7.8859
SimK.Flat.Angle = 30
SimK.Flat.Power = 41.6793
SimK.Flat.Radius = 8.0975
Radius (mm)


Ring radius 7.4
Angle 180
Show dots
Compare
T
S
N
I
T
Eye surface
Front surface
Back surface
@7.4mm Min = -4.251 Max = -3.093 Δ = 1.158
Angles (deg)
Landing Zone
Optic zone
Optic zone
Landing Zone
180
0
SimK.Steep.Angle = 87
SimK.Steep.Power = 45.579
SimK.Steep.Radius = 7.4047
SimK.Flat.Angle = 177
SimK.Flat.Power = 37.8233
SimK.Flat.Radius = 8.9231
Radius (mm)

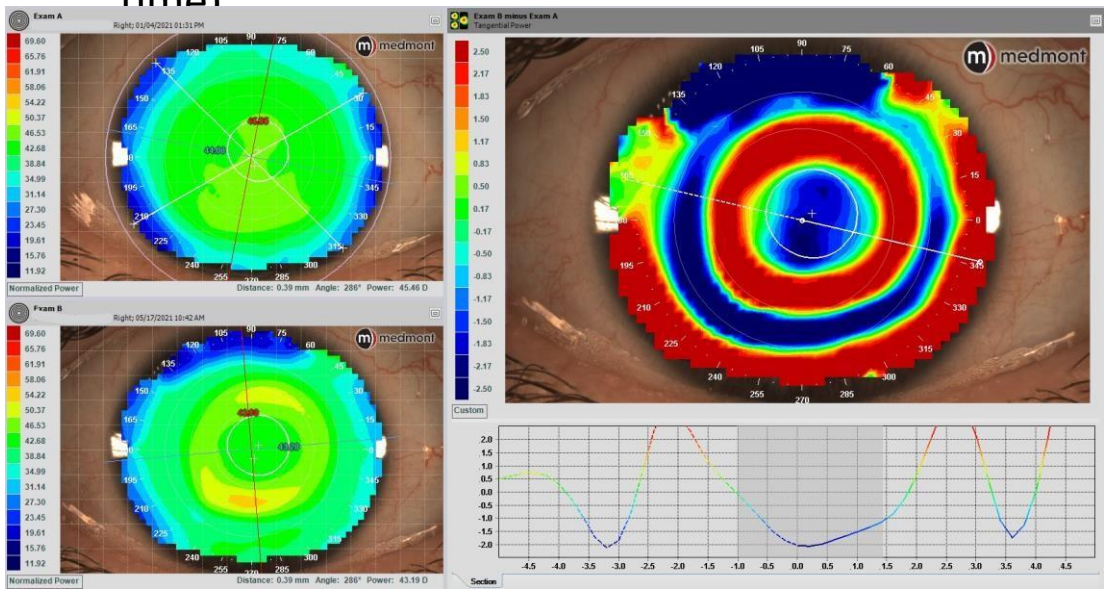

Map
Quad View
Fluorescein Map
Curvature Front
-5.66 0.00 x 091
Topography
Curvature Back
K = 7.08
FForm
GSym
1.39D x 000
Manual Modification
ALL
1/2
1/4
Modification Increments
S
(D)
1x
0.00
MB
Modification Area
Lens Profile
OD
OS
CT (mm) 0.36
ET (mm) 0.30
OAD (mm) 17.00
T
SAG 5087 µm
N
SAG 4192 µm
Simulation
DEMAND 9.67 / 8.98D
POWER +1.07D
BASE CURVE 8.17mm
45°
41°
37°
Tearfilm
560
EDGE ANGLE 35.9° DEVIATION 99.5° LIFT ANGLE 34.7°
Tear Layer Mode: Axial
µm
mm
Edge PC IC OZ Central Clearance OZ IC PC Edge
TL (µm) 98.1 26.7 103.3 457.2 353.5 454.7 102.4 30.4 102.0
SAG (µm) 5087 3533 2993 1168 0 1180 2734 3108 4192
DIA (mm) 16.62 13.50 12.50 8.50 0 8.50 12.50 13.50 16.62
ScleraLens
Biometric Data
Lens Type and Material
Markings
Clinical Notes
Summary
Lens Geometry
Free Form
Lens Power
+1.09 +/- 0.04
Base Curve
8.17 +/- 0.00
OAD
17.00
CT
0.36
ET
0.30
Add
-
MF Zone
-
Print Rx
Last saved on
01/03/2023
Ordered on
01/03/2023

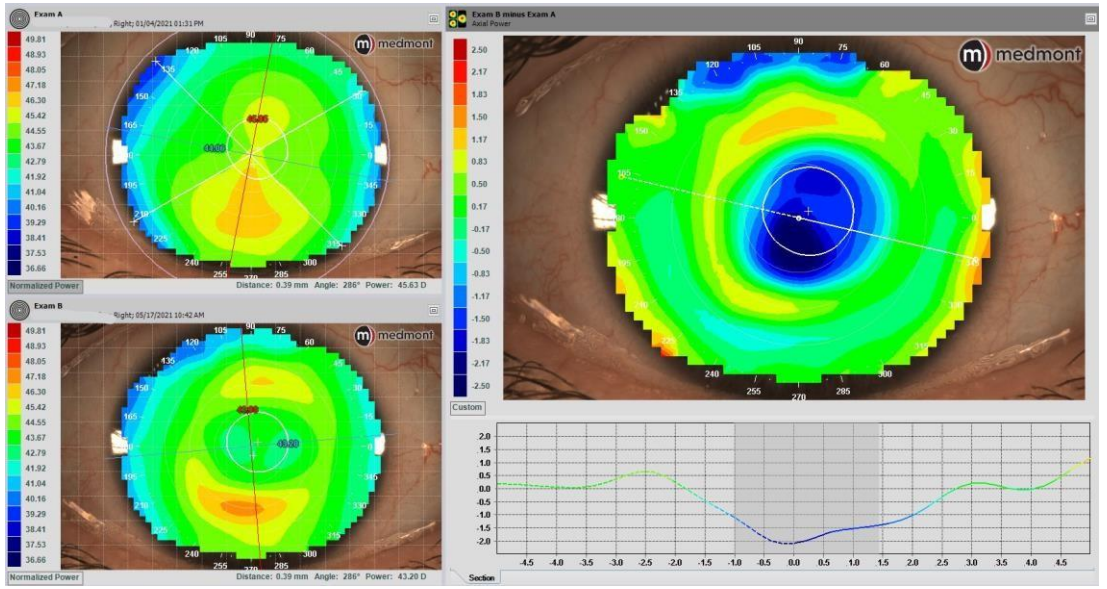

Map
Quad View
Fluorescein Map
Curvature Front
-0.87 -0.48 x 090
Topography
Curvature Back
K = 8.07
FForm
GSym
.57D x 000
Manual Modification
ALL
1/2
1/4
Modification Increments
S
(D)
1x
0.00
MB
Modification Area
Lens Profile
OD
OS
CT (mm) 0.31
ET (mm) 0.30
OAD (mm) 17.00
N
SAG 4088 µm
T
SAG 5059 µm
Simulation
DEMAND 1.50 / 1.21D
POWER +.07D
BASE CURVE 8.35mm
45°
41°
37°
Tearfilm
560
EDGE ANGLE 46.2° DEVIATION 68.2° LIFT ANGLE 46.2°
Tear Layer Mode: Axial
µm
mm
Edge PC IC OZ Central Clearance OZ IC PC Edge
TL (µm) 44.1 37.1 116.0 359.6 371.0 385.5 125.1 56.3 47.8
SAG (µm) 4088 3064 2654 1163 0 1157 2911 3438 5059
DIA (mm) 16.62 13.50 12.50 8.50 0 8.50 12.50 13.50 16.62
ScleraLens
Biometric Data
Lens Type and Material
Markings
Clinical Notes
Summary
Lens Geometry
Free Form
Lens Power
+0.30 +/- 0.25
Base Curve
8.35 +/- 0.00
OAD
17.00
CT
0.31
ET
0.30
Add
-
MF Zone
-
Print Rx
Last saved on
01/03/2023
Ordered on
01/03/2023

Daily Applications of Topography/Tomography cont.

Orthokeratology

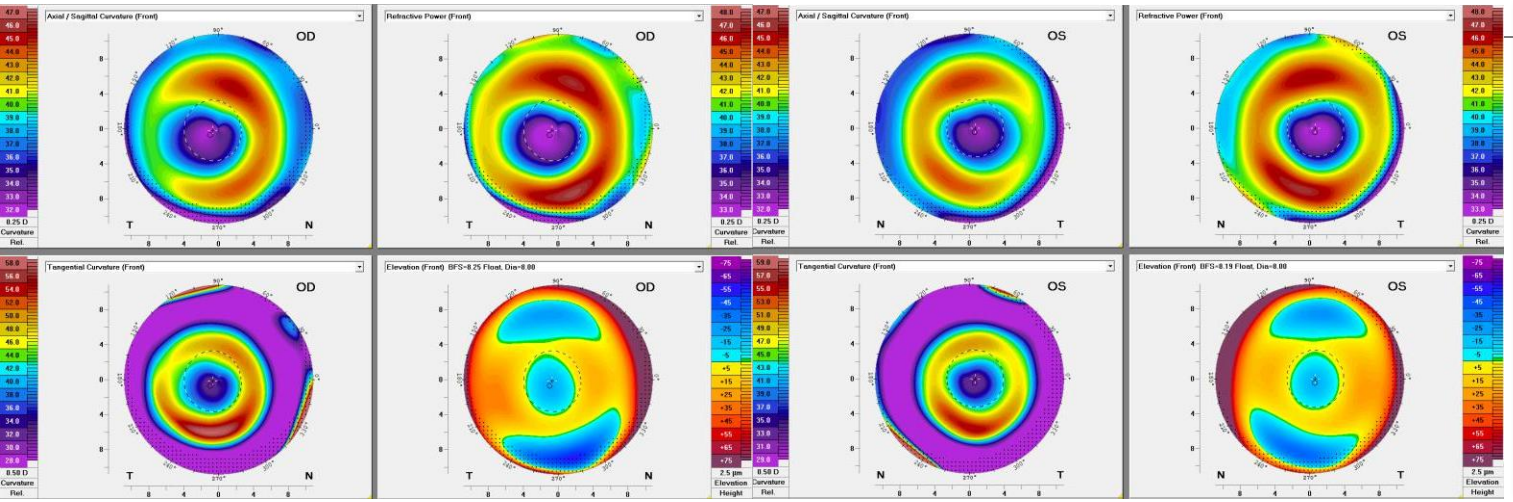
- Absolute MUST HAVE topography to do Orthokeratology
- Candidacy determination
- Dx fitting, empirical, or CAD/CAM software design
- Post-wear reshaping evaluation
- In-situ flexure evaluation (OrthoK lens will warp over time)
- In-situ base curve (BC, BOZR) confirmation (OrthoK BOZR changes over time)



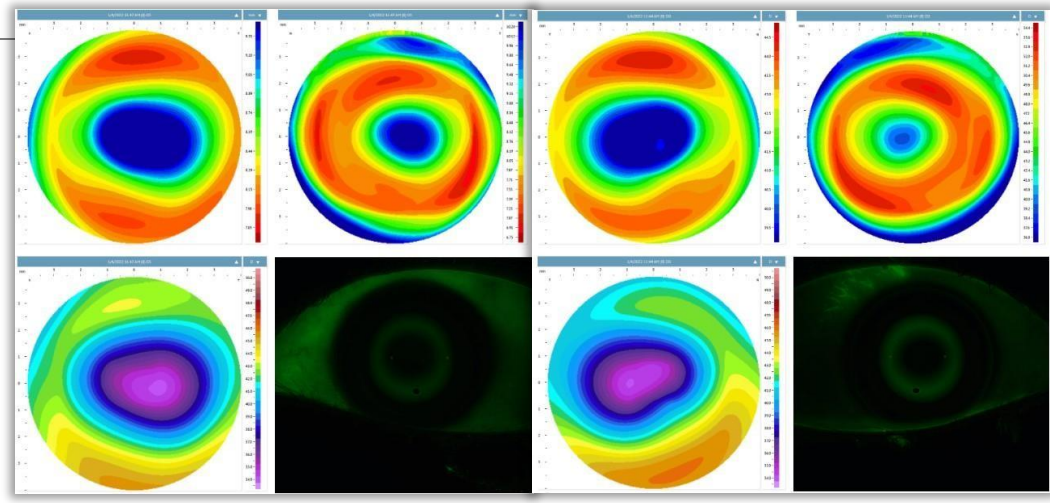


Orthokeratology Maps Across Technologies (same patient's eyes)

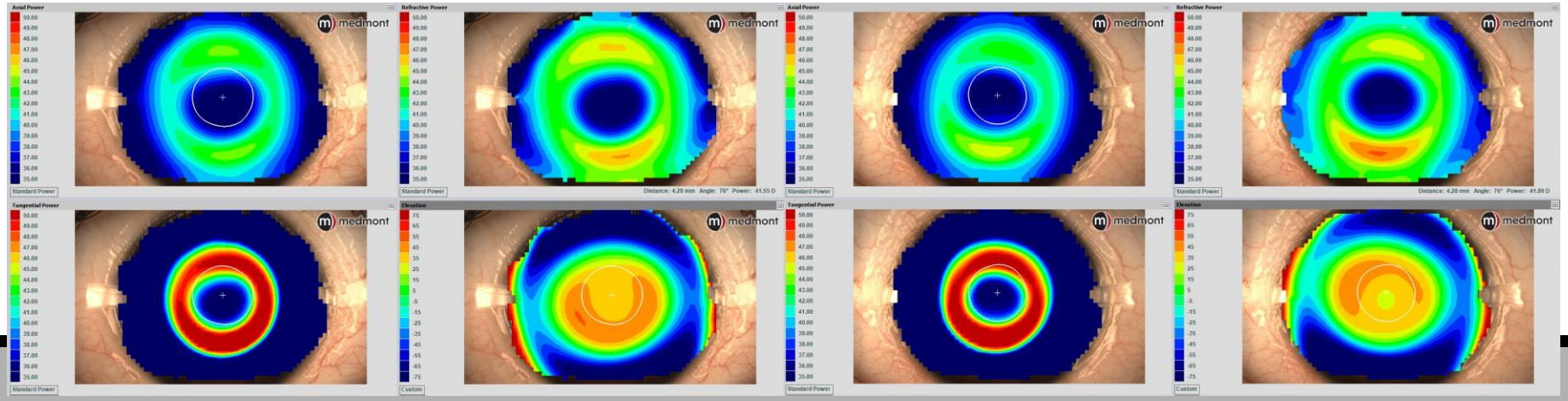
Pentacam AXL WAVE Scheimpflug Tomography



Eaglet ESP Fourier Projection Profilometry



Medmont Meridia Placido Disc Topography



Daily Applications of Topography/Tomography cont.

Dry Eye Analysis

- Placido mires “ring jam”
- Non-invasive tear film break-up time (NIBUT)
- Tear Meniscus Height (TMH)
- Tear Film Surface Quality (TFSQ, TFSQ Area), % of compromised tear film vs uncompromised
- Meibography
- Fluorescein imaging
- Lissamine Green/Rose Bengal vital dyes
- Pre-set or Custom Dry Eye Reports

AUSTIN OPTOMETRY GROUP
Dr. Aaron Wolf & Associates
www.austinoptometrygrp.com

8105 Shoal Creek Blvd., Ste. A
Austin, TX 78757
P (512) 454-4641
F (512) 454-1265

medmont meridia™ DRY EYE REPORT

Patient Information

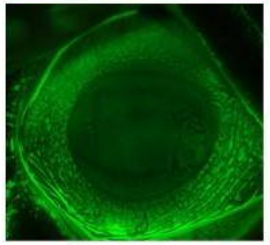
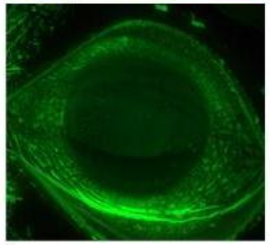
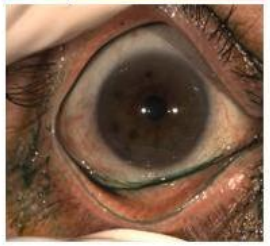
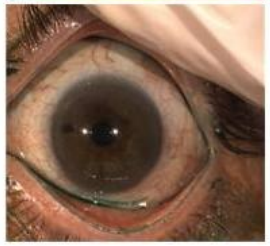
Name: [redacted]
DOB: 01/03/1960
Age: 61
Sex: M

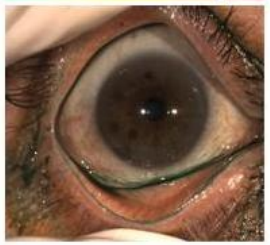
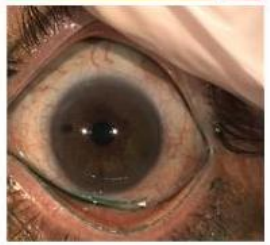
Screening

Risk Factor Analysis

Demodex Infestation, Computer Use, Hormone Replacement Therapy, Diabetes, Aging

DIAGNOSTIC

OD		OS
5.3s	Medmont TBUT	2.6s
0	Corneal Staining (Efron Scale)	1
		
1	Conjunctival Staining (Efron Scale)	0
		

OD		OS
25	Lid Wiper Epitheliopathy	25
		
0.11mm		0.07mm
1	Lower Meibo Scale	1
		
3	Bulbar Redness (Efron Scale)	3
		

SUBTYPING

Aqueous Deficient
Tear Meniscus Height

Evaporative

Other Tests

2	Blepharitis	2
		
Absent	Demodex	Absent

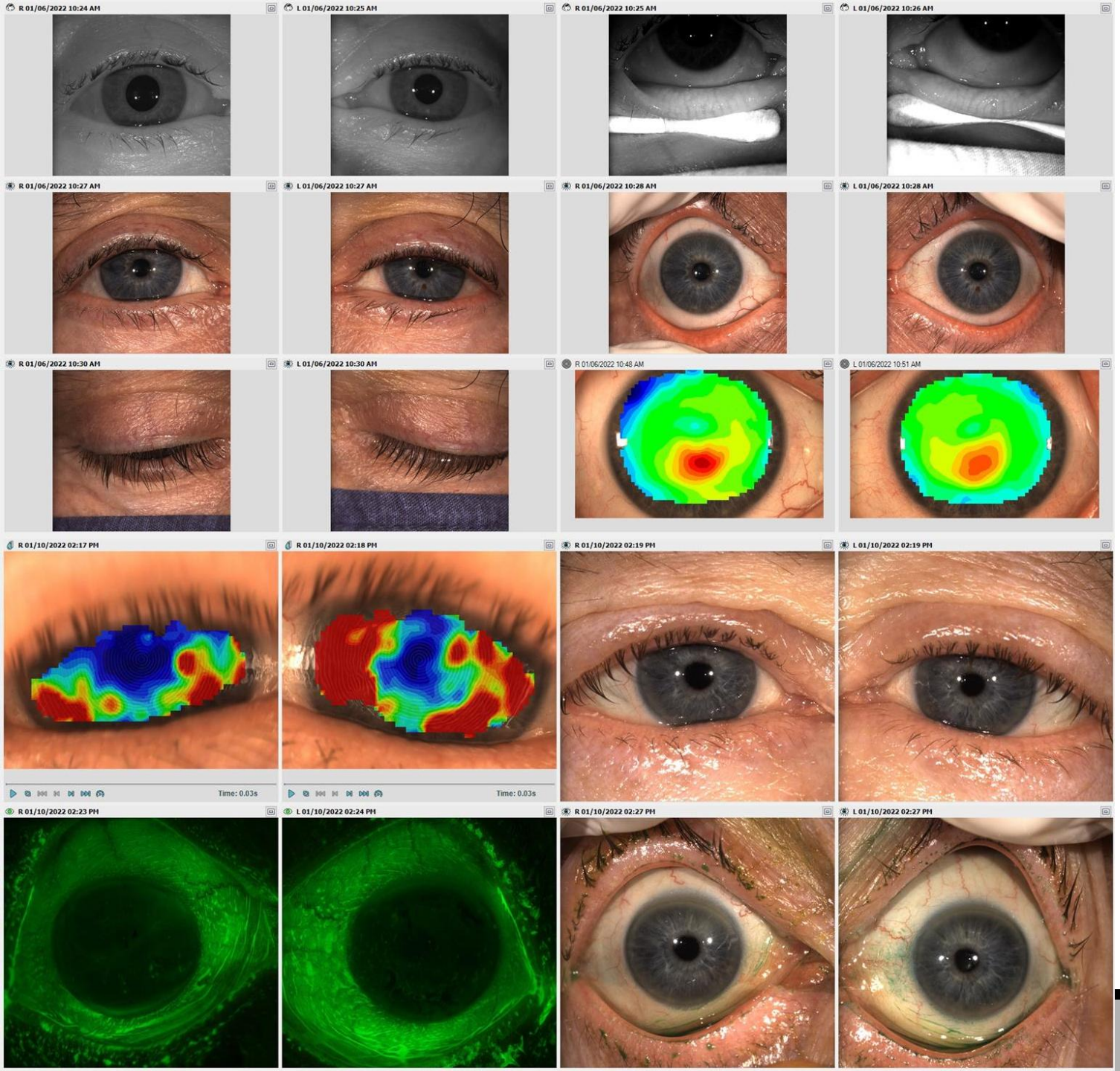
SUMMARY

Diagnosis: Dry Eye
Severity: MODERATE
Subtype: Aqueous-Deficient

TREATMENT RECOMMENDATIONS

HydroEye omegas, RegenerEyes drops, punctal plugs

Multi-Functionality of Topography Devices



Daily Applications of Topography/Tomography cont.

Topography/Tomography + Optical Biometry combination devices

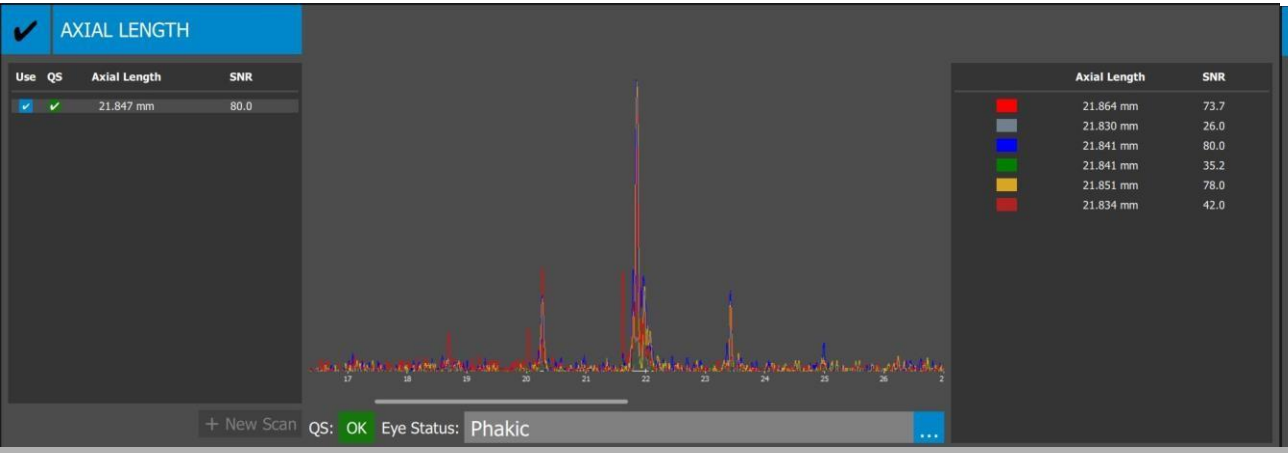
- Axial Length (AXL) via optical biometry > A-scan ultrasonography Pereria et al. Int Ophthalmol. 2021
- Normal AXL ~23-25mm, varies by age, gender, ethnicity

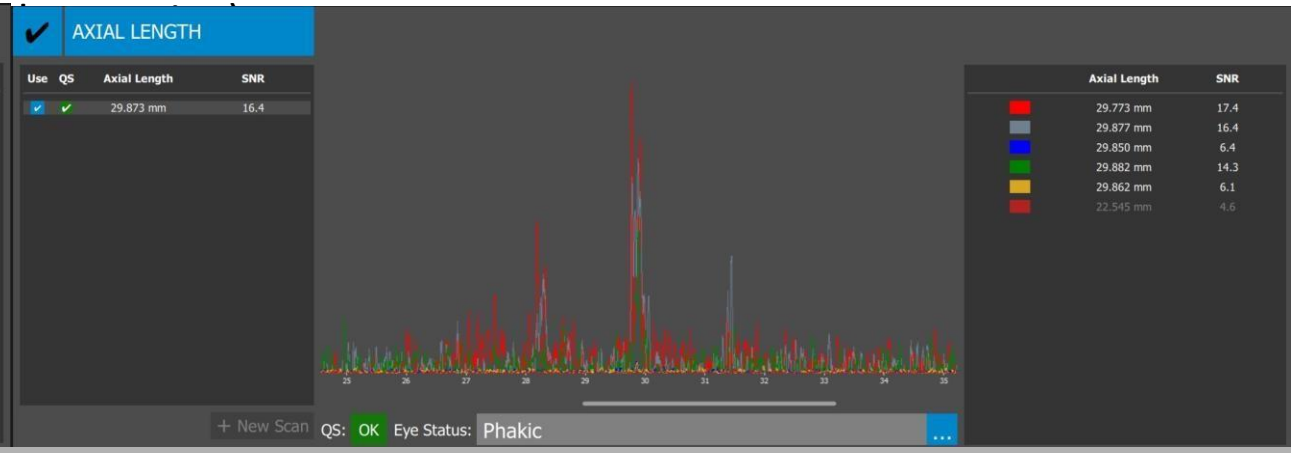
Refractive vs. Axial Myopia determination

- e.g. -5.00D myopia, K 44.00D, AXL 26.5mm (Degenerative Myopia = >26.5mm) Ryan et al. Retina. 2013
- e.g. -5.00D myopia, K 47.00D, AXL 24.0mm (Ks >47D = probable KC) Maeda et al. *Invest Ophthalmol Vis Sci.* 1994
- e.g. -5.00D myopia, K 45.00D, AXL 24.5mm (non-threatening)

Refractive vs. Axial Hyperopia determination

- e.g. +4.00D hyperopia, K 44.00D, AXL 22.0mm (AACG risk = <23mm) Sherpa et al. Kathmandu Univ Med J 2008
- e.g. +4.00D hyperopia, K 39.00D, AXL 23.5mm (poor candidate corneal lenses?)





Daily Applications of Topography/Tomography cont.

Corneal wavefront analysis

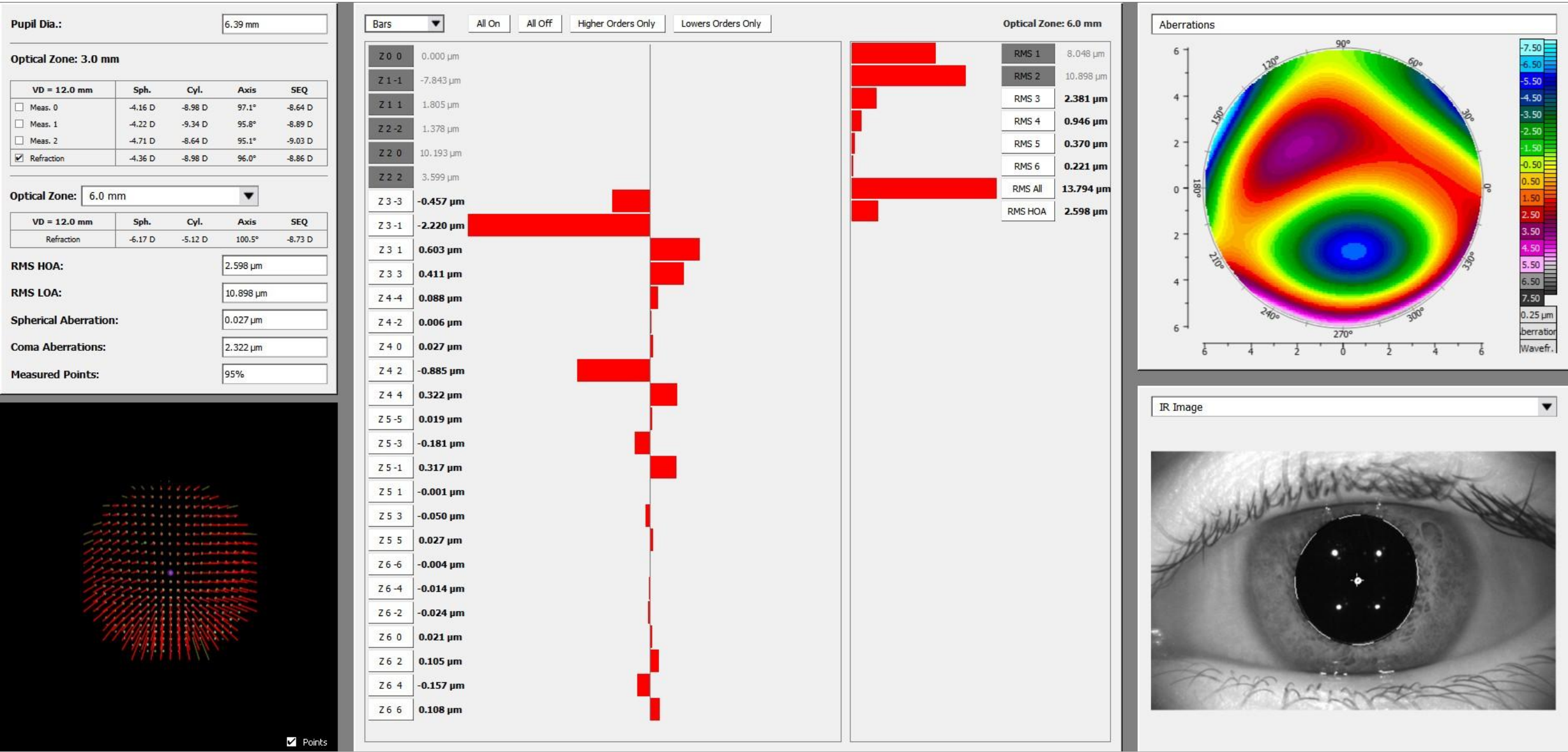
- Anterior cornea only
- Not applicable to Quality of Vision (QOV), stromal opacity, effects from other media, or posterior corneal
  elevation.

Shack-Hartmann or Laser Ray Tracing aberrometry

- Total eye aberrometry along visual axis by imaging point sources on the retina
- More clinically useful as applicable to QOV and more representative of true optical system
- S-H uses lenslet to measure many points simultaneous
- LRT measures deviation of retinal spot from known reference one at a time

Objective Auto-Refraction

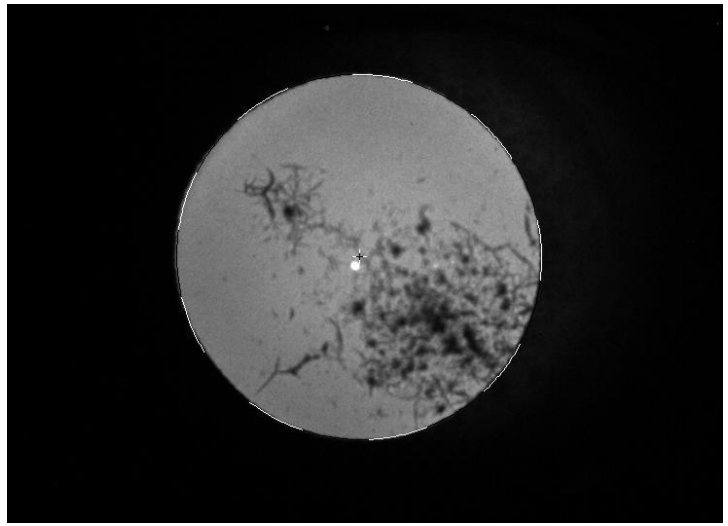
Shack-Hartmann Aberrometry



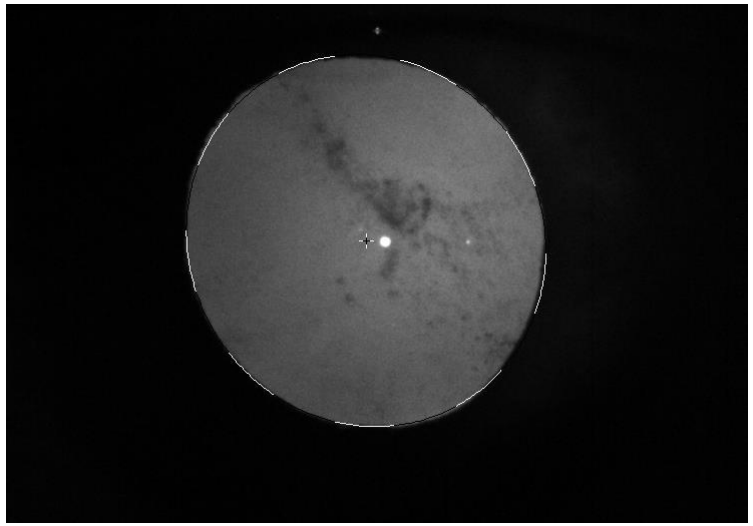
Daily Applications of Topography/Tomography cont.

Retro-illumination

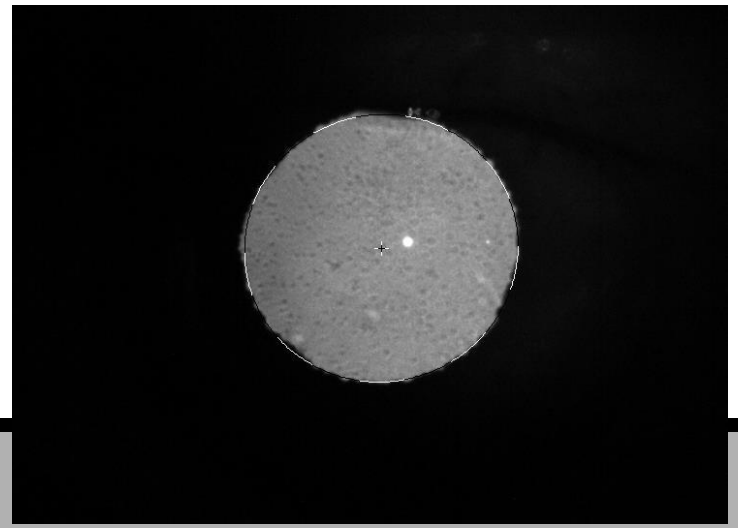
Corneal Lattice Dystrophy



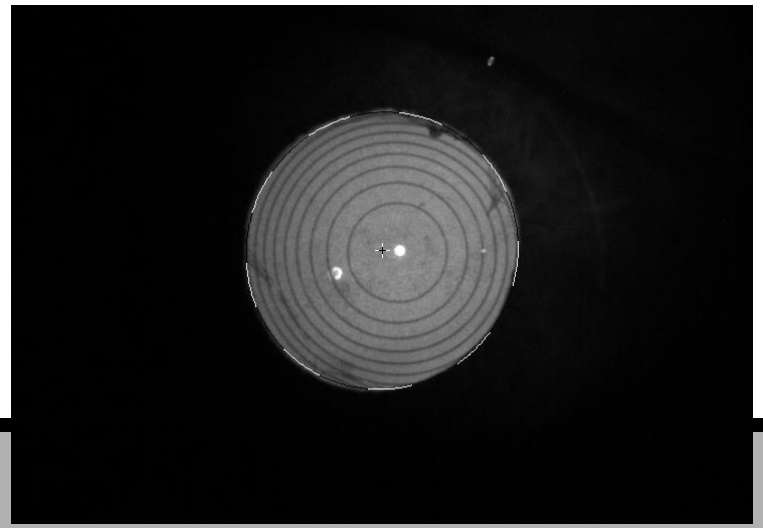
PSC



Endothelial guttatae



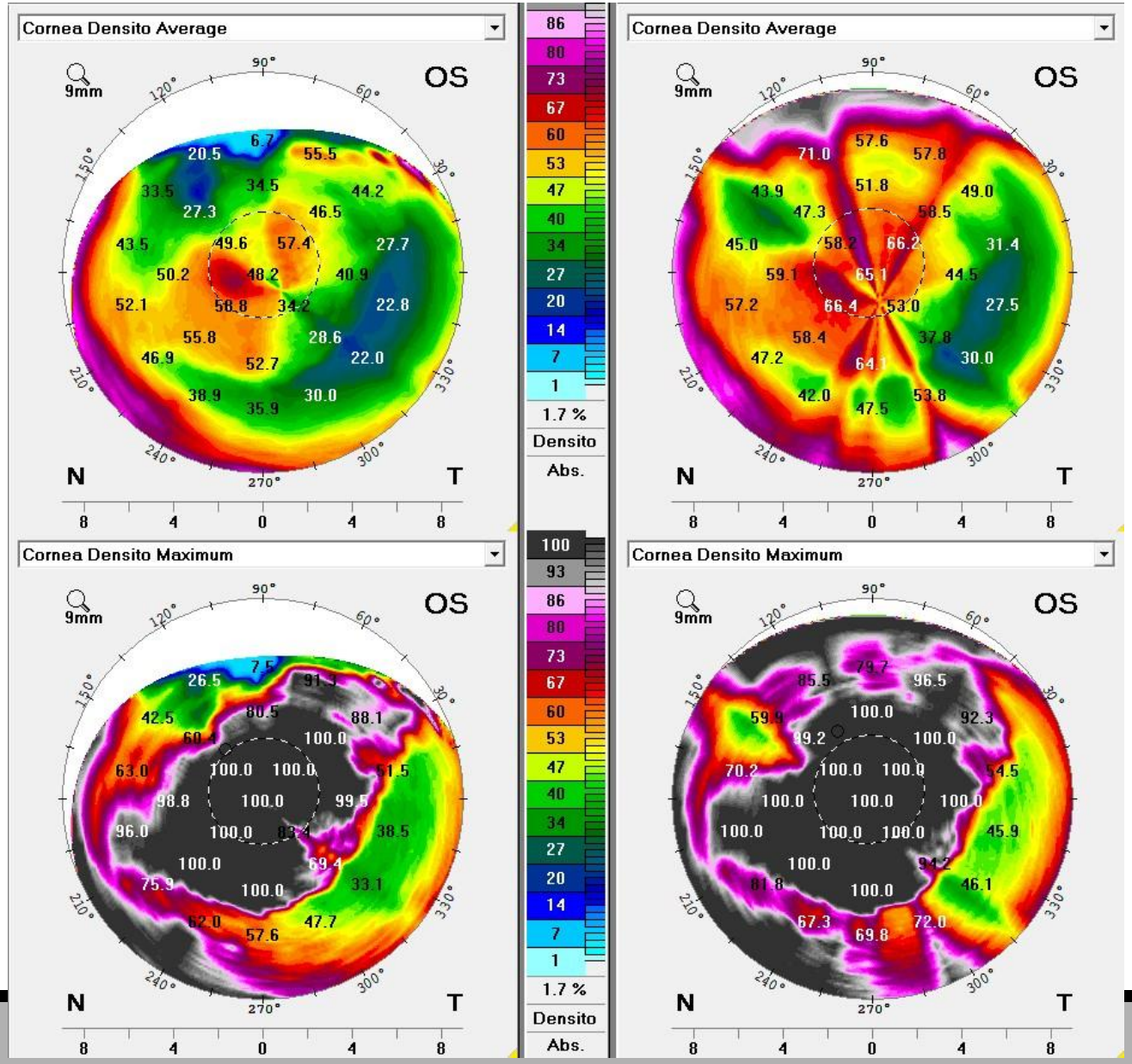
MF IOL



Daily Applications of Topography/Tomography cont.

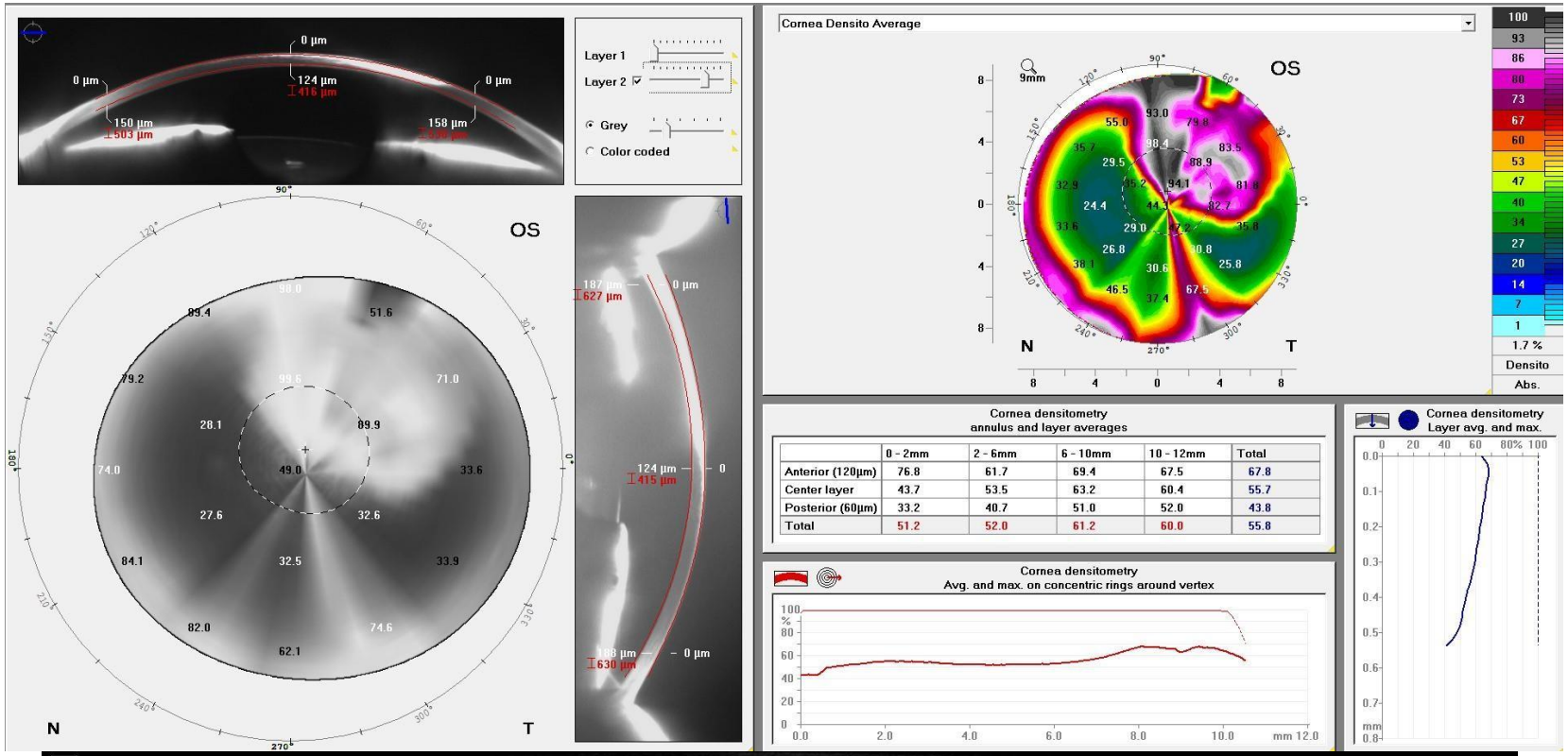
Corneal Densitometry

- Opacity density and area detection and progression

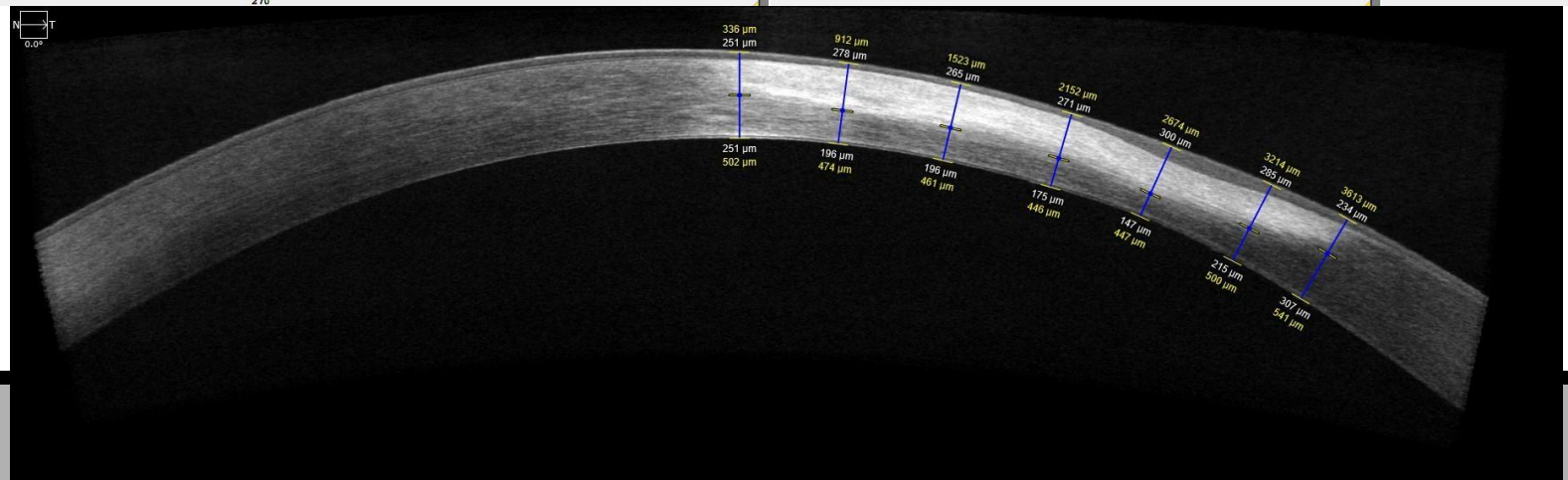


Scheimpflug vs. SD AS-OCT Optical Densitometry

Scheimpflug Tomography



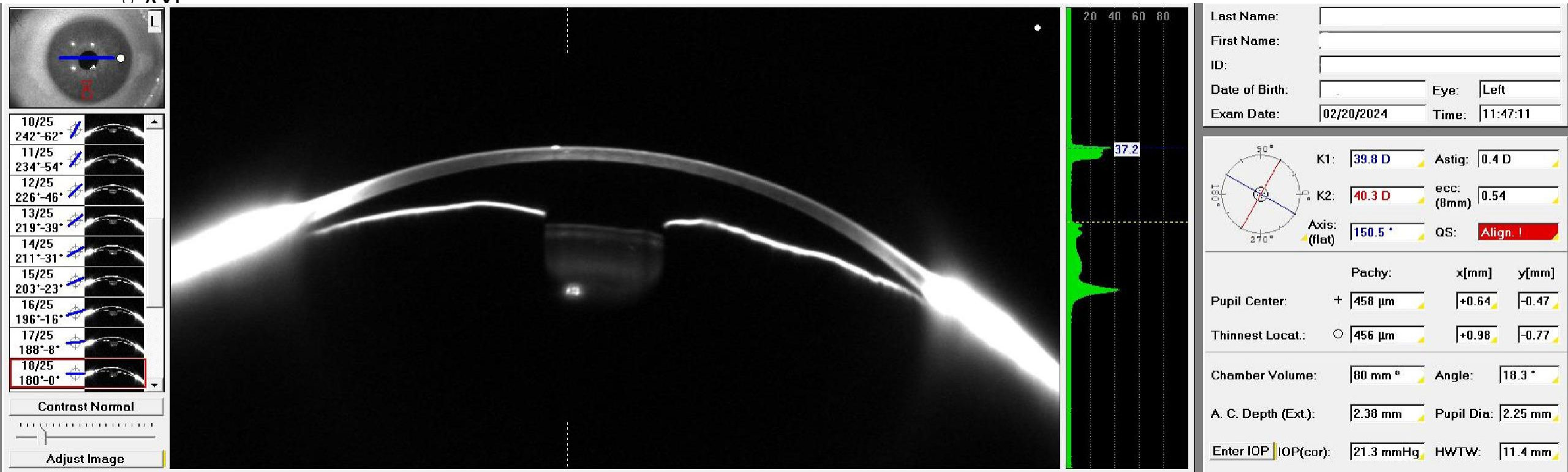
SD AS-OCT



Daily Applications of Topography/Tomography cont.

Glaucoma risk evaluation

- Pachymetry
- Corrected IOP
- Anterior Chamber Depth (ACD)
- Anterior Chamber Angle (ACA)
- AXL



Basic Principles in Map Interpretation

Axial (aka Sagittal) Power and Curvature Maps (D, mm) (Flatter = Cooler Colors, Steeper = Warmer Colors)

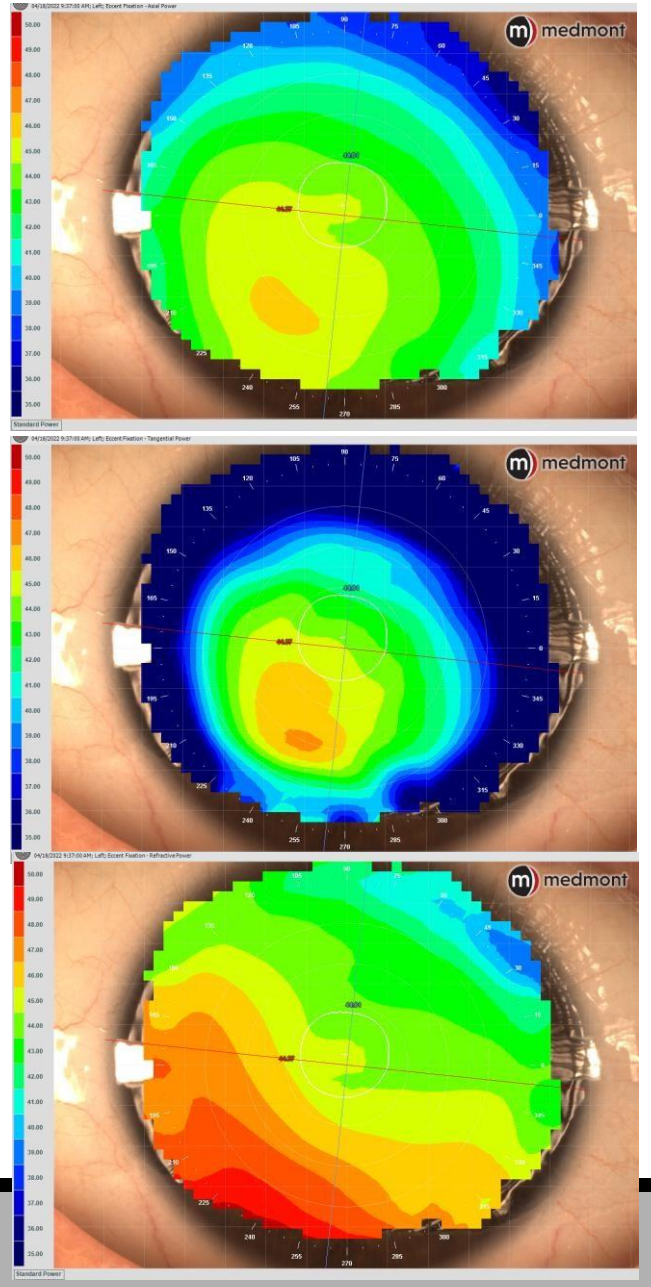
- Curvatures **relative to optical axis**
- Assumes a spherical cornea (not the case in reality)
- Not as quantitatively accurate, but more qualitative since it softens the blends in the color maps
- ***More useful in interpreting power/vision, but not shape***

Tangential (aka Instantaneous) Power and Curvature Maps (D, mm) (Flatter = Cooler Colors, Steeper = Warmer Colors)

- Curvature radii not centered on optical axis but based on many tangential points of the cornea
- More quantitatively accurate measurements of peripheral cornea
- ***More sensitive and better for monitoring ectasia***
- ***More useful in interpreting shape***

Refractive Power Maps (Flatter = Cooler Colors, Steeper = Warmer Colors)

- Similar to Axial Maps



Basic Principles in Map Interpretation

Difference (Subtraction) Maps

- Evaluating change over time in KC/ectasia
- Critical in Orthokeratology or laser refractive surgery

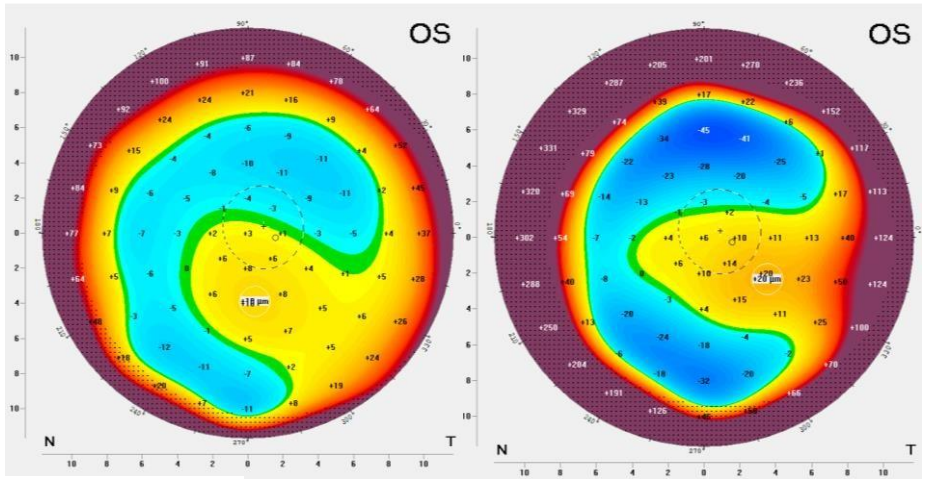
Elevation Maps (micrometers) (Higher Elevation = Warmer Colors, Lower Elevation = Cooler Colors)

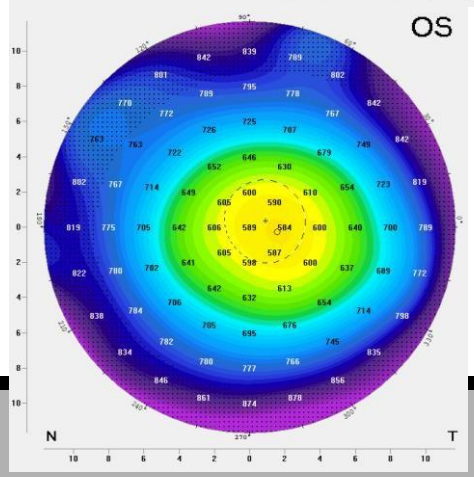
- Front Surface and Back surface
- Absolute Sagittal Height vs. best-fit line variance (best-fit sphere/ellipsoid)
- ***Highly sensitive and therefore may be better for Dx ectasia***

Pachymetric/Thickness Maps (Thinner = Warmer Colors, Thicker = Cooler Colors)

- Derived from difference in Anterior and Posterior elevation maps

Front Back





Basic Principles in Map Interpretation

SimK
- Keratometry from two principal meridians of central 3-4mm, K1 and K2

Mean K (Km)
- Average of Flat and Steep SimK

Corneal Astigmatism (ΔK)
- Difference between K1 and K2
- Compare to refractive astigmatism to find residual astigmatism

Asphericity, Eccentricity, Shape Factor, Q-value
- The rate in which the cornea flattens peripherally
- Prolate (P for "Pointy") vs Oblate

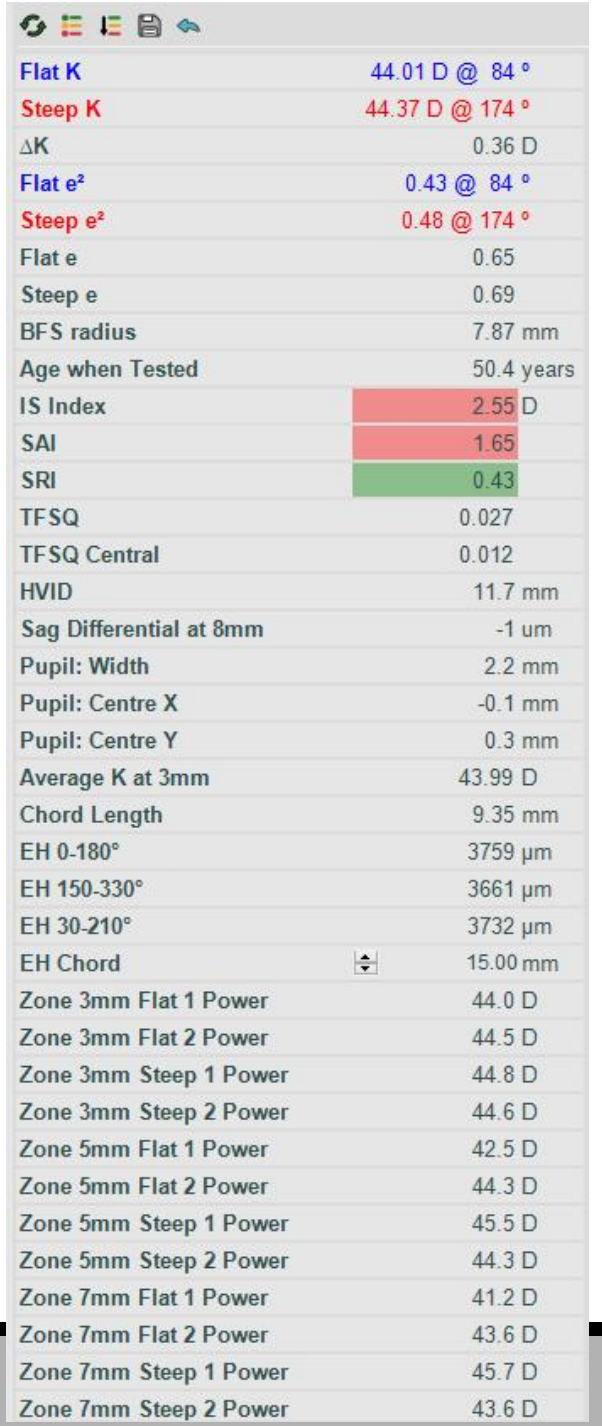
Corneal Size
- HVID, VVID, WTW
- Manual ruler/caliper measurement

Pupil size

Angle Kappa

Corneal Zernike polynomials
- Based on anterior curvature, not truly indicative of total optical system
- Not relative to pupil size

Total Zernike Wavefront Map (LOA and/or HOA RMS)
- Very relevant to pupil size; will increase as pupil size increases
- ≤0.3um RMS normal, ≥0.6um RMS abnormal
- Typically compared at 6mm pupil, but really only relevant to each patient's pupil size



Flat K	44.01 D @ 84 °
Steep K	44.37 D @ 174 °
ΔK	0.36 D
Flat e²	0.43 @ 84 °
Steep e²	0.48 @ 174 °
Flat e	0.65
Steep e	0.69
BFS radius	7.87 mm
Age when Tested	50.4 years
IS Index	2.55 D
SAI	1.65
SRI	0.43
TFSQ	0.027
TFSQ Central	0.012
HVID	11.7 mm
Sag Differential at 8mm	-1 um
Pupil: Width	2.2 mm
Pupil: Centre X	-0.1 mm
Pupil: Centre Y	0.3 mm
Average K at 3mm	43.99 D
Chord Length	9.35 mm
EH 0-180°	3759 µm
EH 150-330°	3661 µm
EH 30-210°	3732 µm
EH Chord	15.00 mm
Zone 3mm Flat 1 Power	44.0 D
Zone 3mm Flat 2 Power	44.5 D
Zone 3mm Steep 1 Power	44.8 D
Zone 3mm Steep 2 Power	44.6 D
Zone 5mm Flat 1 Power	42.5 D
Zone 5mm Flat 2 Power	44.3 D
Zone 5mm Steep 1 Power	45.5 D
Zone 5mm Steep 2 Power	44.3 D
Zone 7mm Flat 1 Power	41.2 D
Zone 7mm Flat 2 Power	43.6 D
Zone 7mm Steep 1 Power	45.7 D
Zone 7mm Steep 2 Power	43.6 D

Basic Principles in Map Interpretation

Symmetry Analytics (these are just SOME of the possible analytics!)

- KPI: Keratoconus Prediction Index; multivariate analysis of anterior surface prediction of KC; >20% = KC, >30% = PMD (Doctor et al. Indian J Ophthalmol. 2020)
- I-S Index: difference in dioptric power between the inferior and superior cornea 3mm from corneal apex; ≥1.4-≤1.8 = Suspected KC; >1.8 = KC (Rabinowitz et al. *J Cataract Refract Surg* 1999)
- SAI: Surface Asymmetry Index; radial asymmetry of 128 meridians 180deg equally distant from center; ≥1.0 = pathology (Cavas-Martínez et al. Eye Vis. 2016)
- SRI: Surface Regularity Index; regularity of power progression of 256 semi-meridians outwards within central 4mm; great correlation to expected visual acuity; ≥0.57 = pathology (Cavas-Martínez et al. Eye Vis. 2016)
- CIM; Corneal Irregularity Measurement; Deviation of surface from best-fit line; ≥0.69um = suspicious, ≥1.0um = pathology (Cavas-Martínez et al. Eye Vis. 2016)
- Kmax: more valuable for evaluation of progression (>1D) or flattening x/p CXL rather than Dx indicator (Gomes et al. *Cornea* 2015)
- Rmin: Minimal Sagittal Curvature; steepest radius in axial curvature map (Gomes et al. *Cornea* 2015)
- Central K: K value at center of cornea; ≥47.2D = KC (Rabinowitz et al. *J Cataract Refract Surg* 1999)

Basic Principles in Map Interpretation

Symmetry Analytics cont.

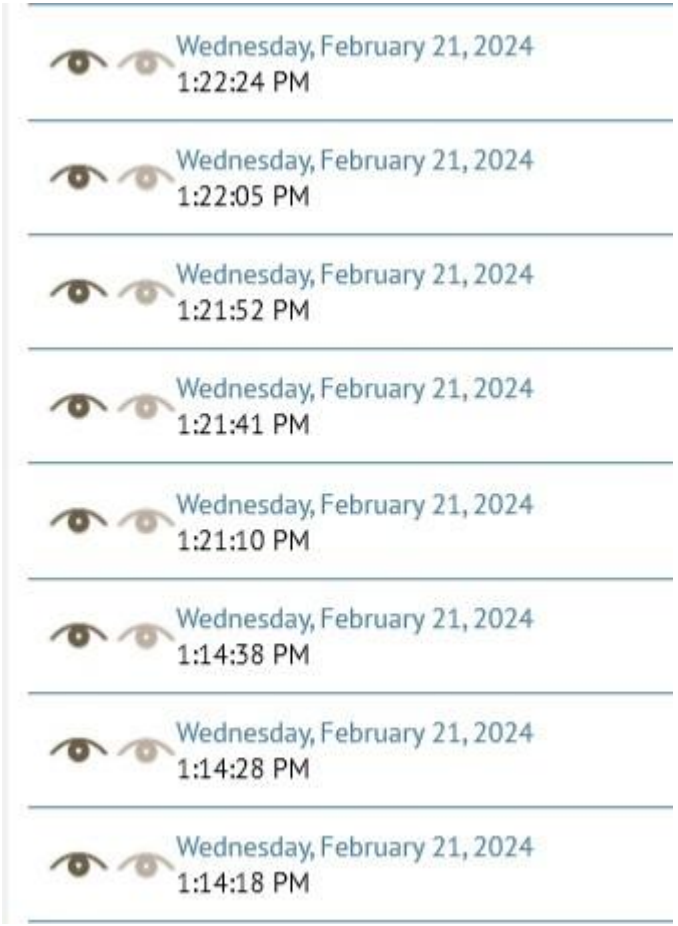
- KISA%: Highly sensitive multivariant calculation; 100% = KC, 60-99% = KC suspect, ≤ 60 = normal (Rabinowitz et al. *J Cataract Refract Surg* 1999)
- ISV: Index of Surface Variance; measurement of variation from mean anterior corneal curvature
- IVA: Index of Vertical Asymmetry; curvature symmetry relative to horizontal meridian; >0.20um = pathology (Hashemi et al. Eye Contact Lens. 2019)
- KI/KCI: Keratoconus Index; distinguishes normal from KC and also central KC from peripheral KC; ≥5% = KC (Cavas-Martínez et al. Eye Vis. 2016)
- IHA: Index of Height Asymmetry; anterior surface height symmetry comparison
- IHD: Index of Height Decentration; measures how much decentration there is of anterior surface height data in the vertical meridian
- Belin-Ambrosio Display (BAD): deviation of normality of the front elevation, back elevation, pachymetric progression, corneal thinnest point and relational thickness; <1.6 SD = Normal; ≥1.6-2.6 SD = Suspicious; ≥2.6 SD = Pathological (Belin et al. *Klin Monatsbl Augenheilkd* 2016)
- Front Elevation/Df: highest deviation reported as standard deviations on corneal front surface from BFS line within 8mm; ≥1.6SD suspicious, ≥2.6SD pathology (Villavencio et al. IJKECD 2014)
- Back Elevation/Db: highest deviation reported as standard deviations on corneal back surface from BFS line within 8mm; ≥1.6SD suspicious, ≥2.6SD pathology (Villavencio et al. IJKECD 2014)
- Pachy Min: thinnest pachymetric value; <511um suspicious, <477um pathology (Ambrósio et al. J Refract Surg. 2011)
- Pachy Vertex: corneal thickness at apex/vertex normal position; <516um suspicious, <482um pathology (Ambrósio et al. J Refract Surg. 2011)
- Pachymetric Progression Index Average; progression from thinnest spot to periphery; >1 = pathology
- TKC: Topographic Keratoconus Index; Pentacam screening terminology; ≥1 = Suspect, ≥2 = KC (Goebels et al. Comput Math Methods Med. 2017)

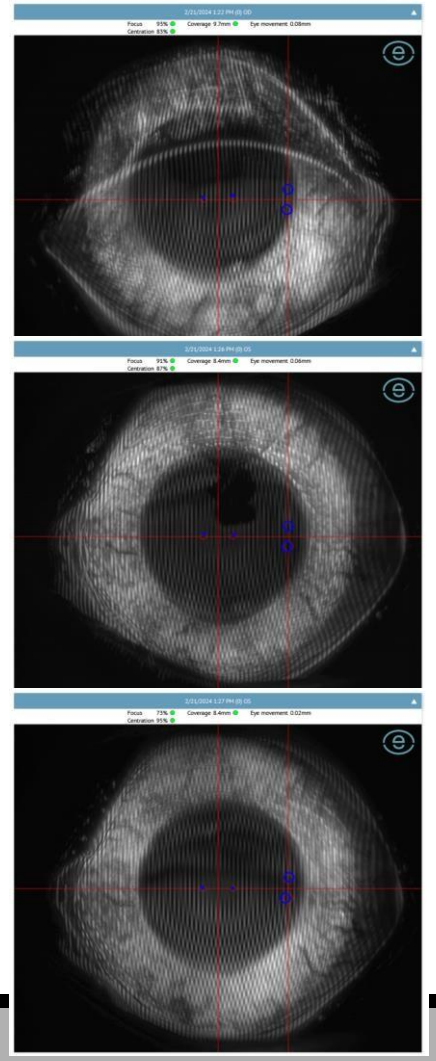
…AND MANY MORE

Reference your particular device's User Manual

Top 10 Topography Tips

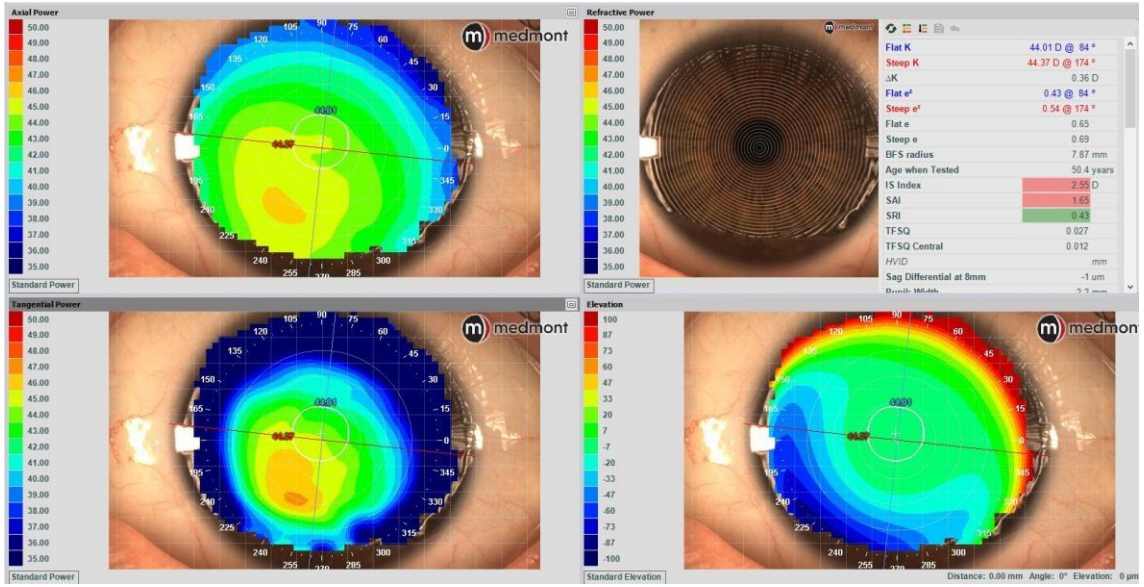
#1. Need multiple maps of good quality (“Rinse & Repeat!!”) to confidently evaluate pathology or design custom lenses. RTC to try again if needed.

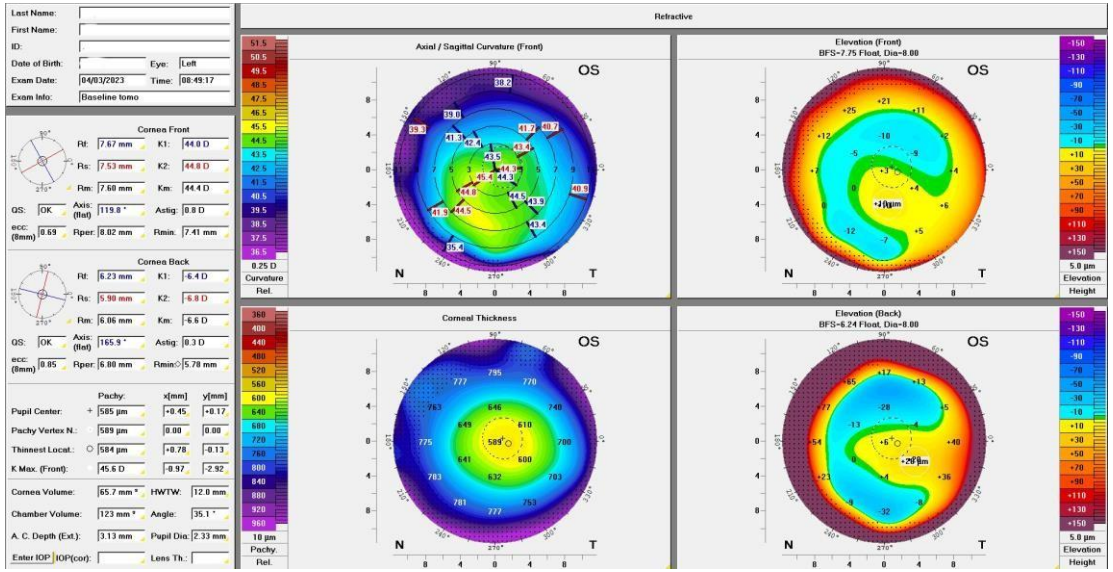


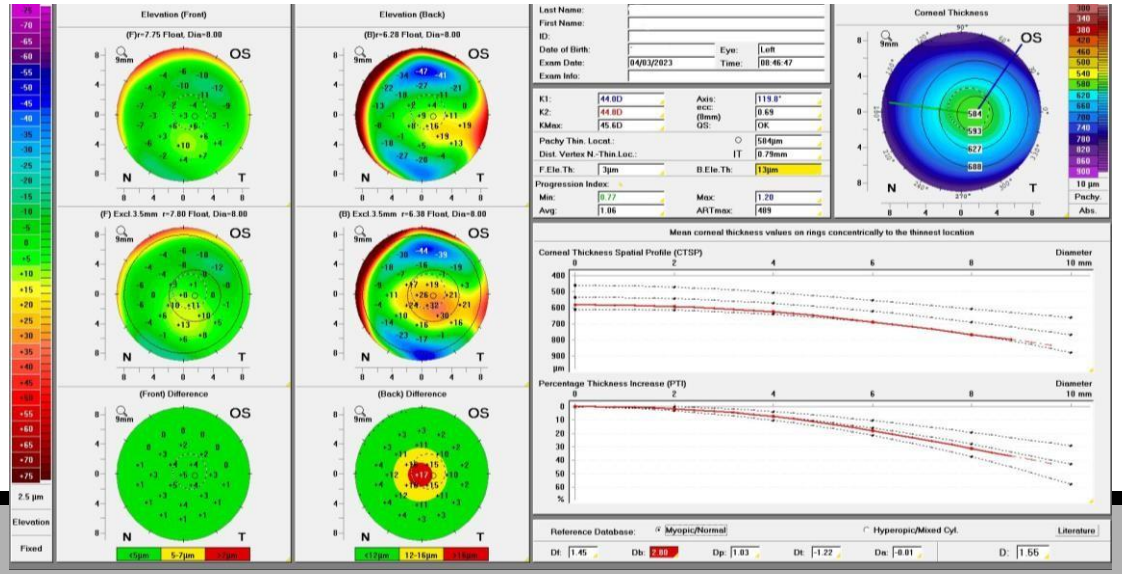


Top 10 Topography Tips

#2. If surface ectasia, can presume posterior ectasia. Refer for CXL or tomography confirmation.







Top 10 Topography Tips

#3. If it looks like PMD on topography, it's probably just KC.

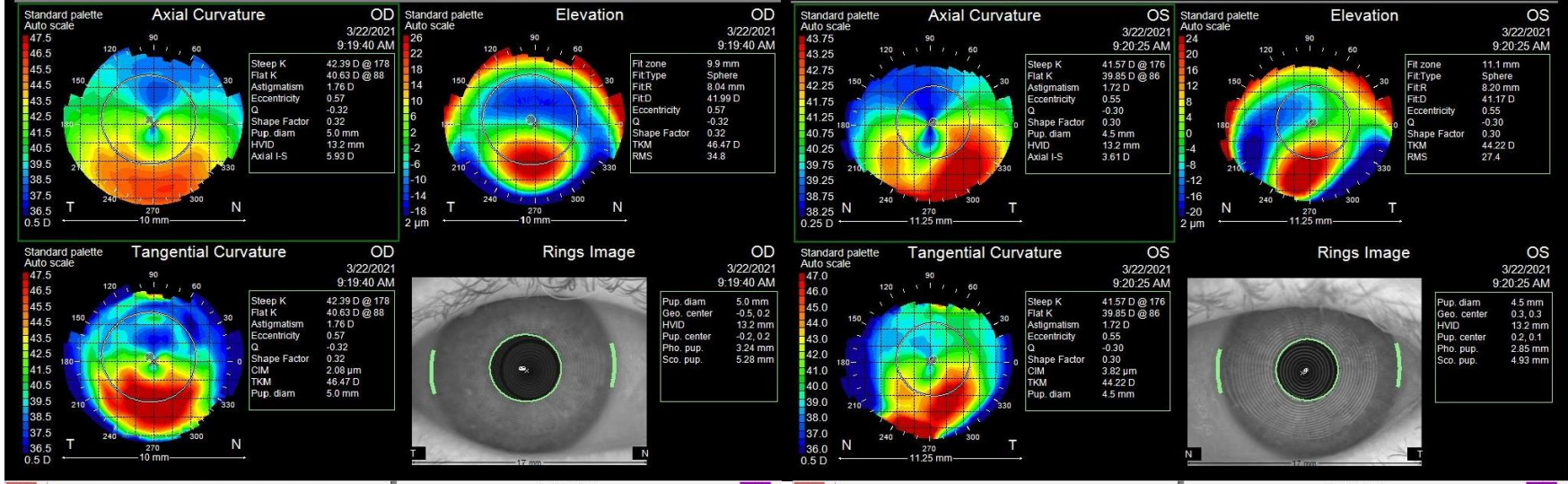
PMD or ***KC***??

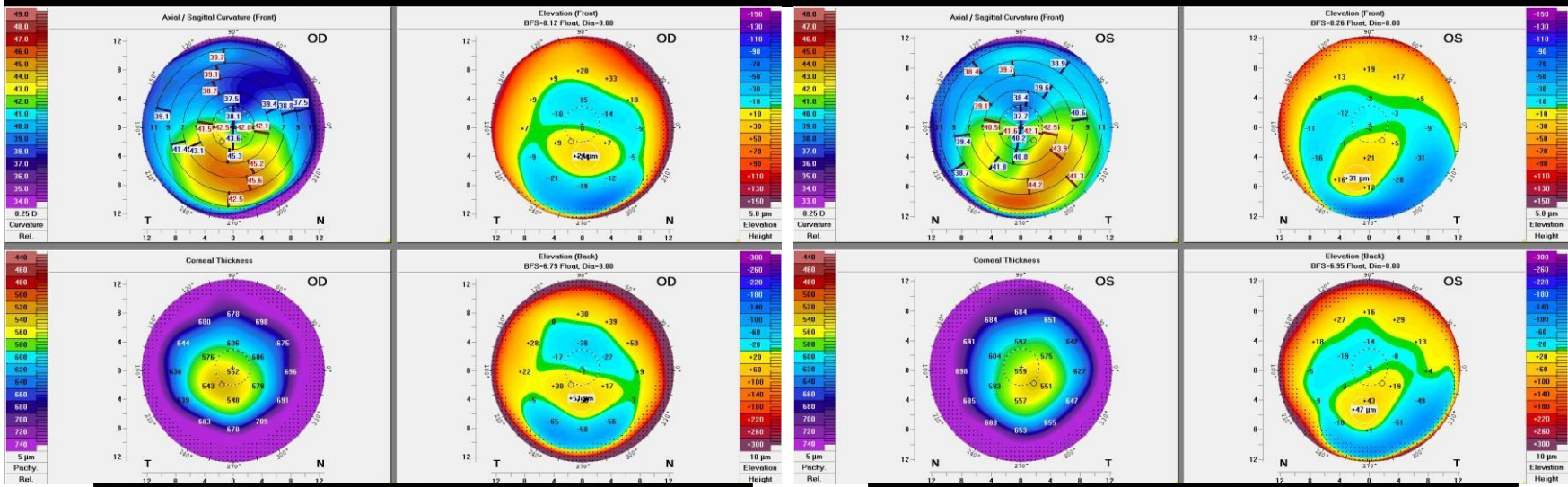
Pellucid **MARGINAL** Degeneration

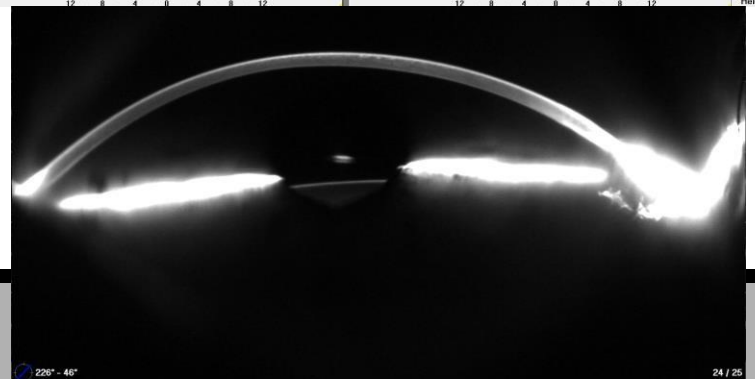
Must be thinning at corneal margins, not mid-periphery

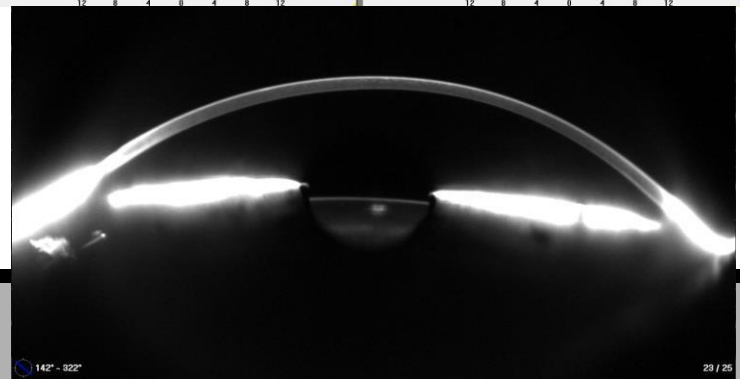
Very rare

Need tomography to confidently Dx









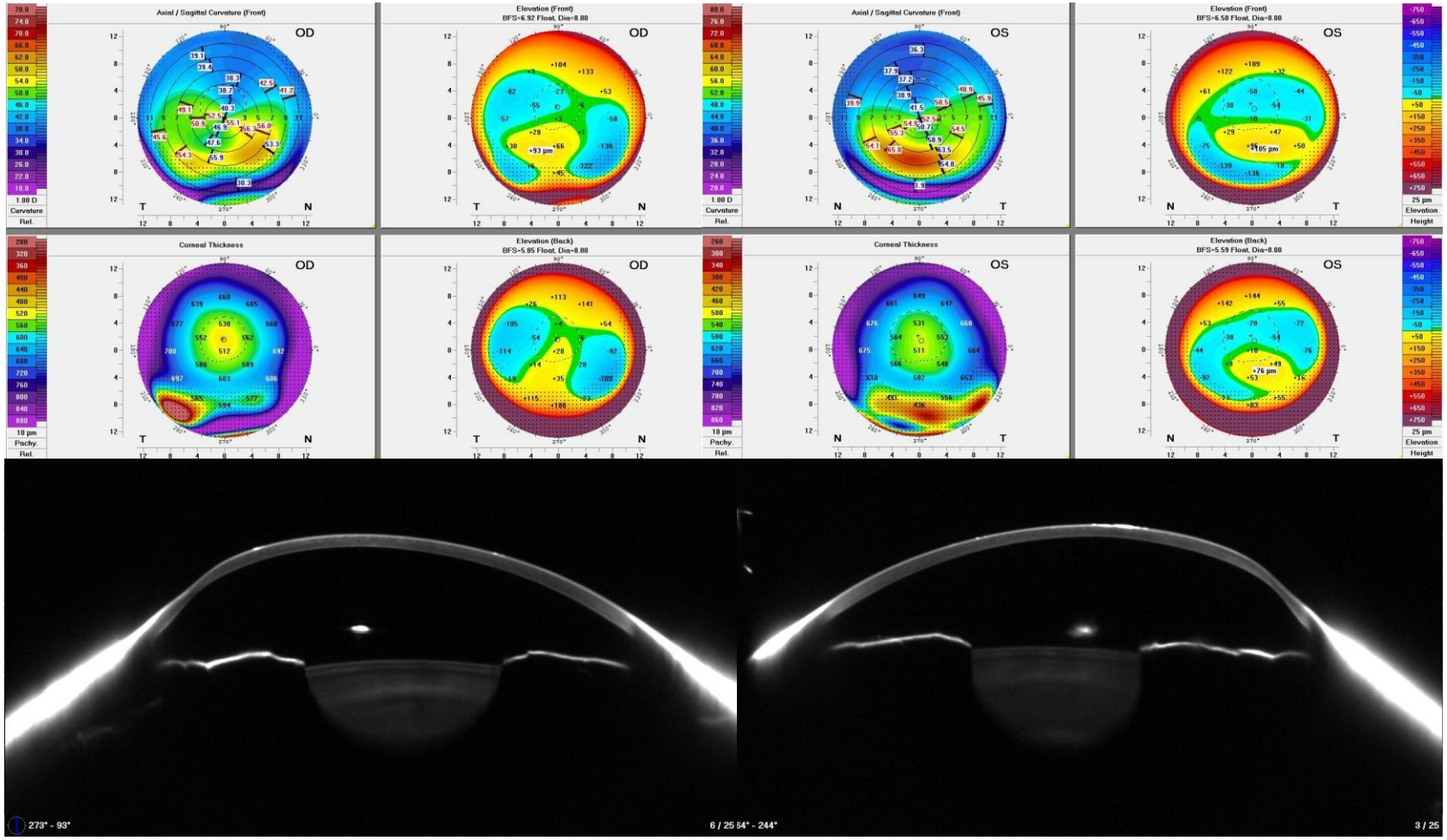
PMD or KC?

Pellucid **<u>MARGINAL</u>** Degeneration

Must be thinning at corneal margins, not mid-periphery

Very rare

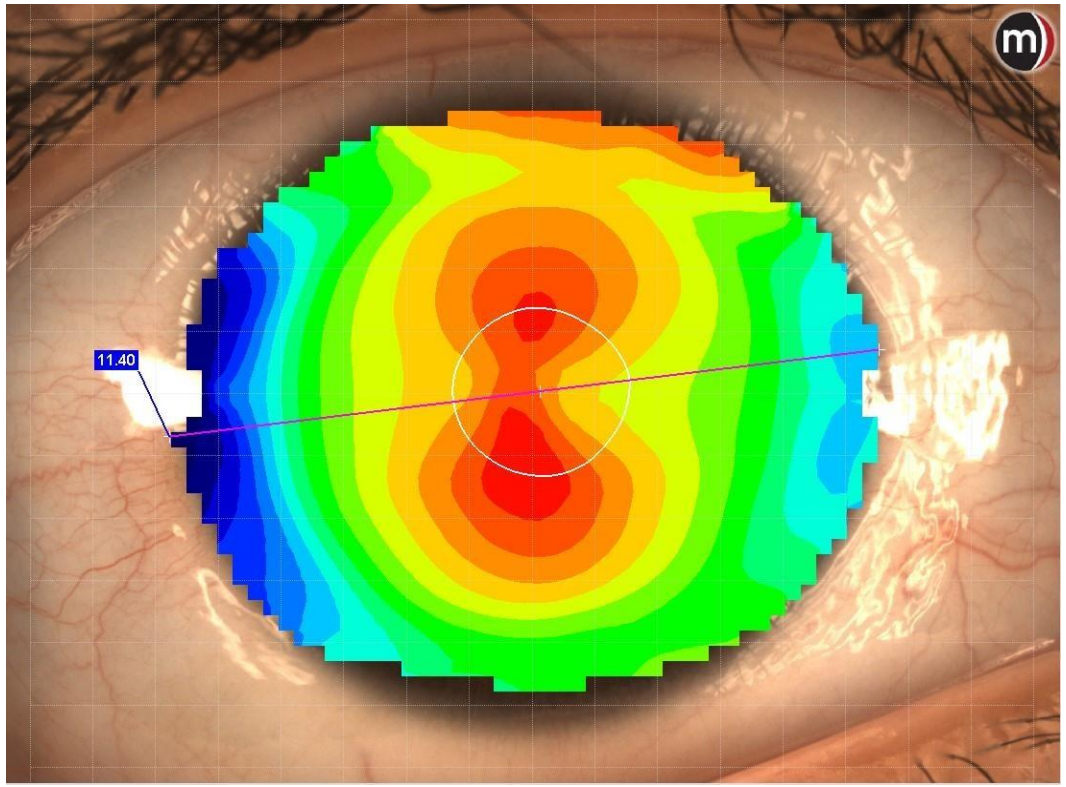
Need <u>tomography</u> to confidently Dx



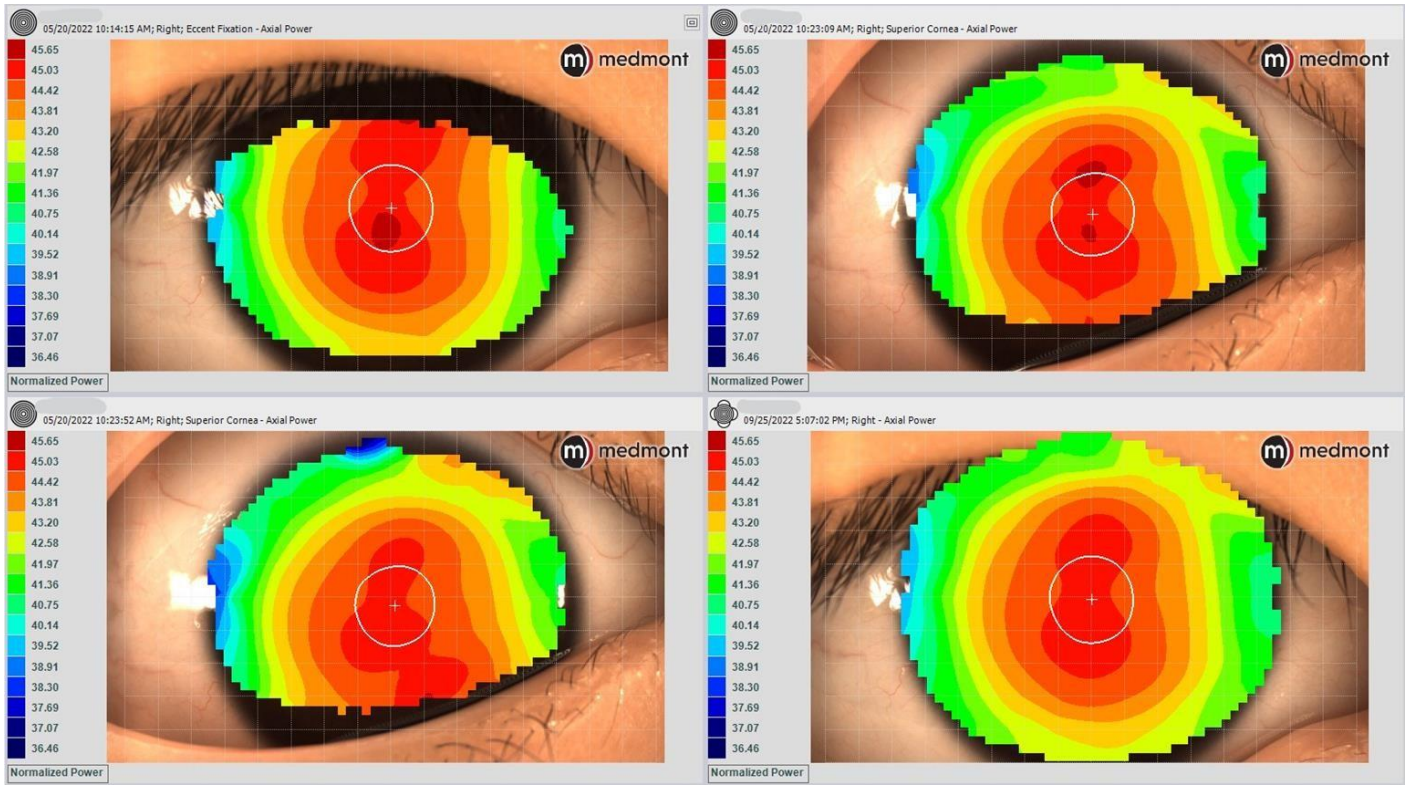
Top 10 Topography Tips

#4. Design lenses from best single-capture map; not stitched/composite map

11-12 mm topography in single capture.
Design lenses from single capture maps.



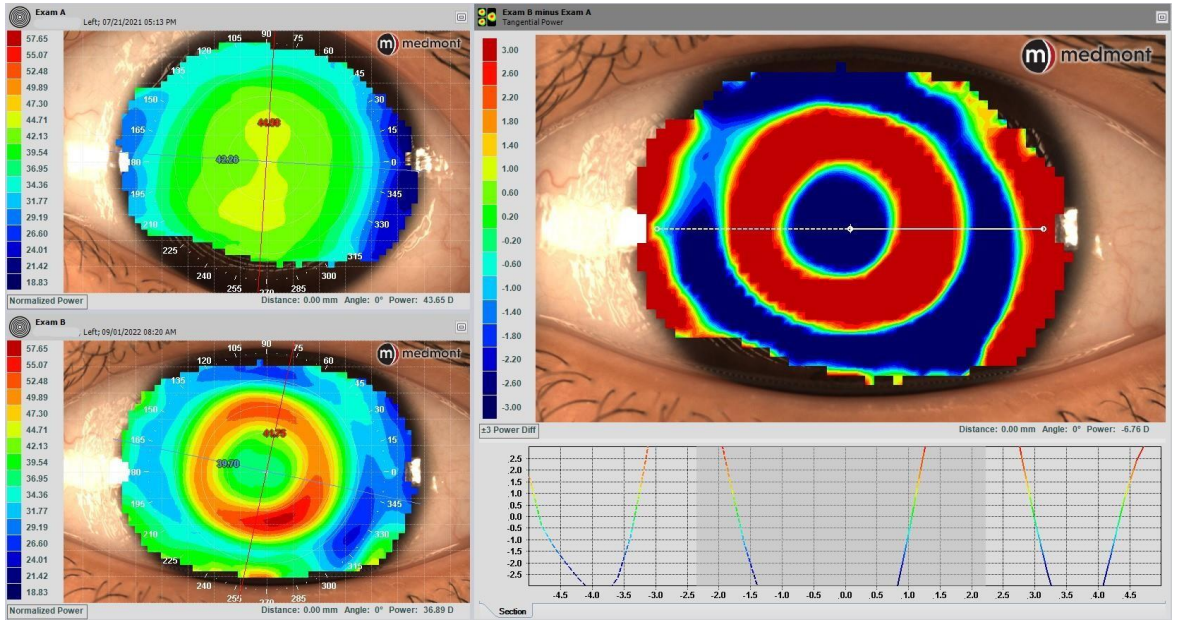
11-12 mm topography in ≥2 composite maps.
Good for visualization, not as much for design.



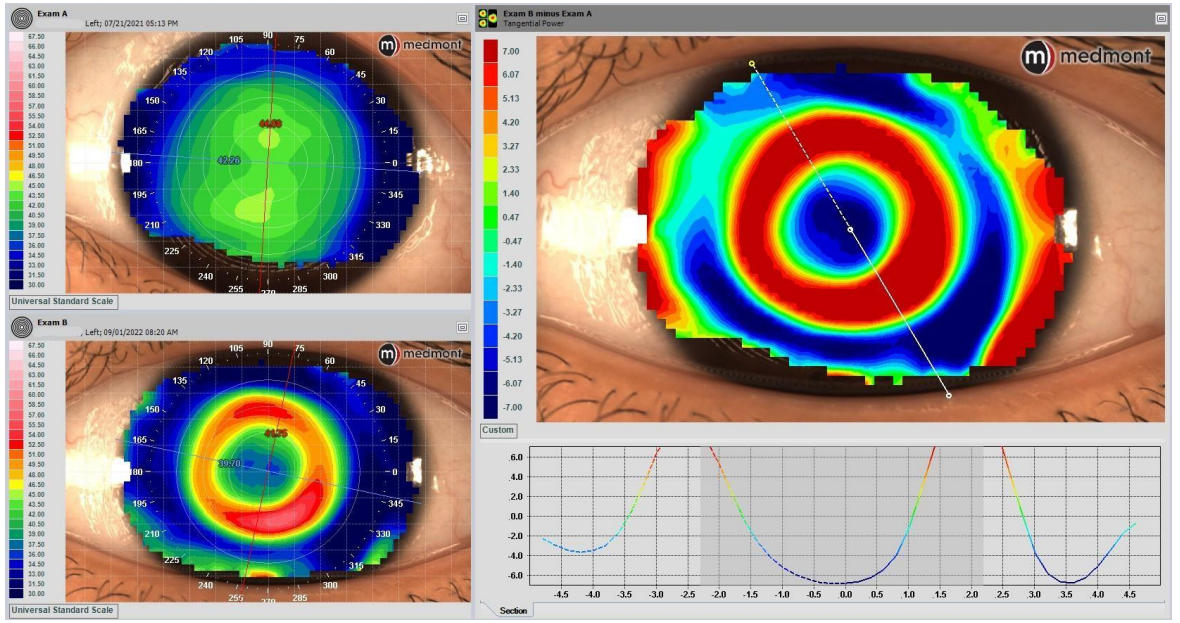
Top 10 Topography Tips

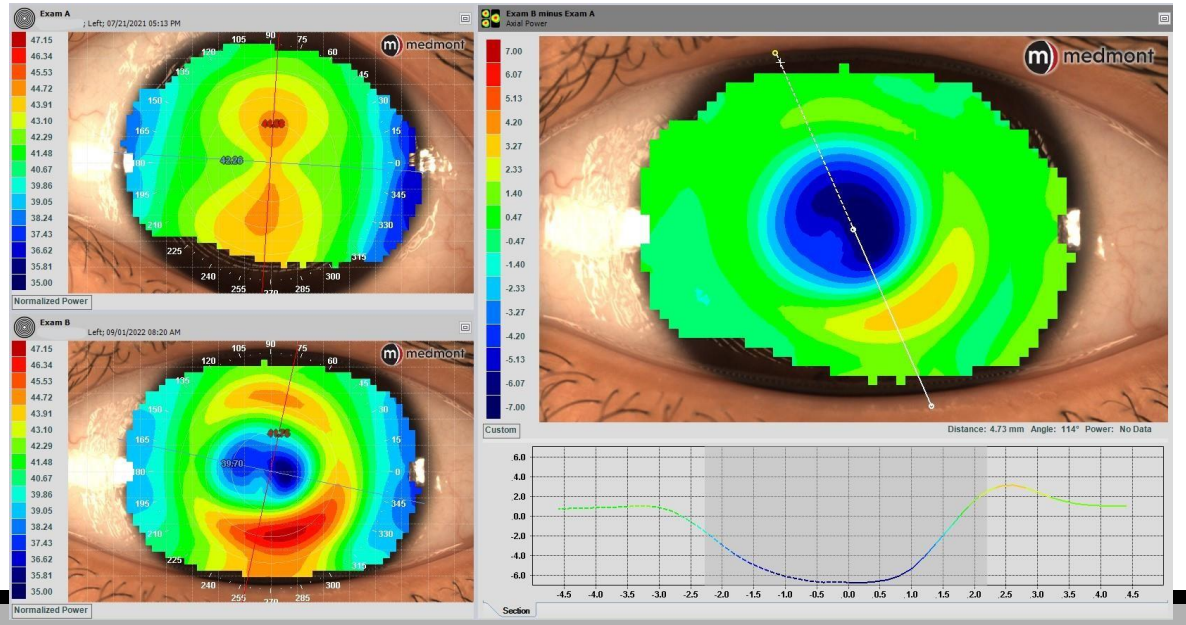
#5. Adjust Your Scales

BAD!! ☹



GOOD!! ☺



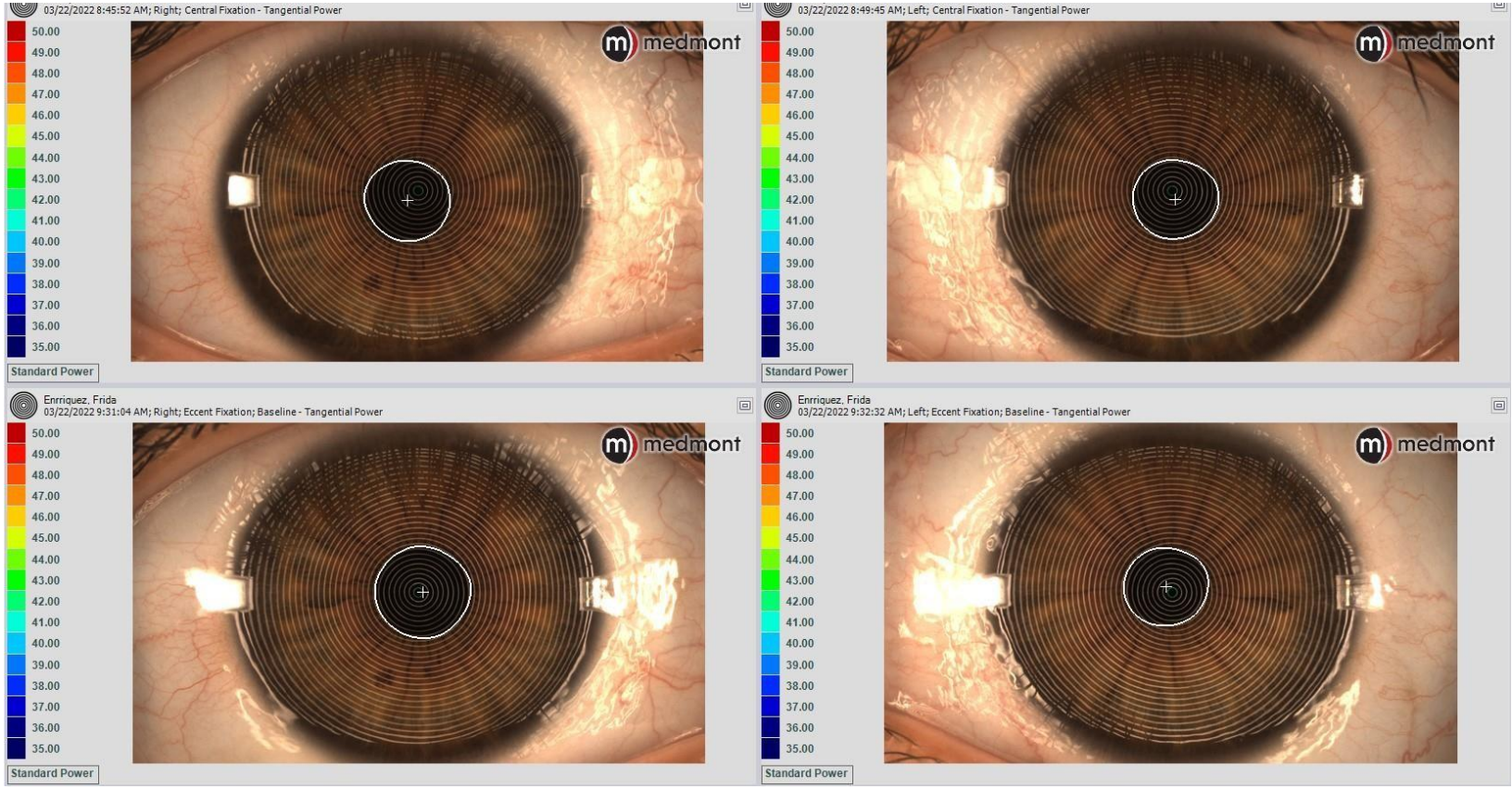


Top 10 Topography Tips

#6. Understand capture alignment

Axial Alignment/Visual Alignment

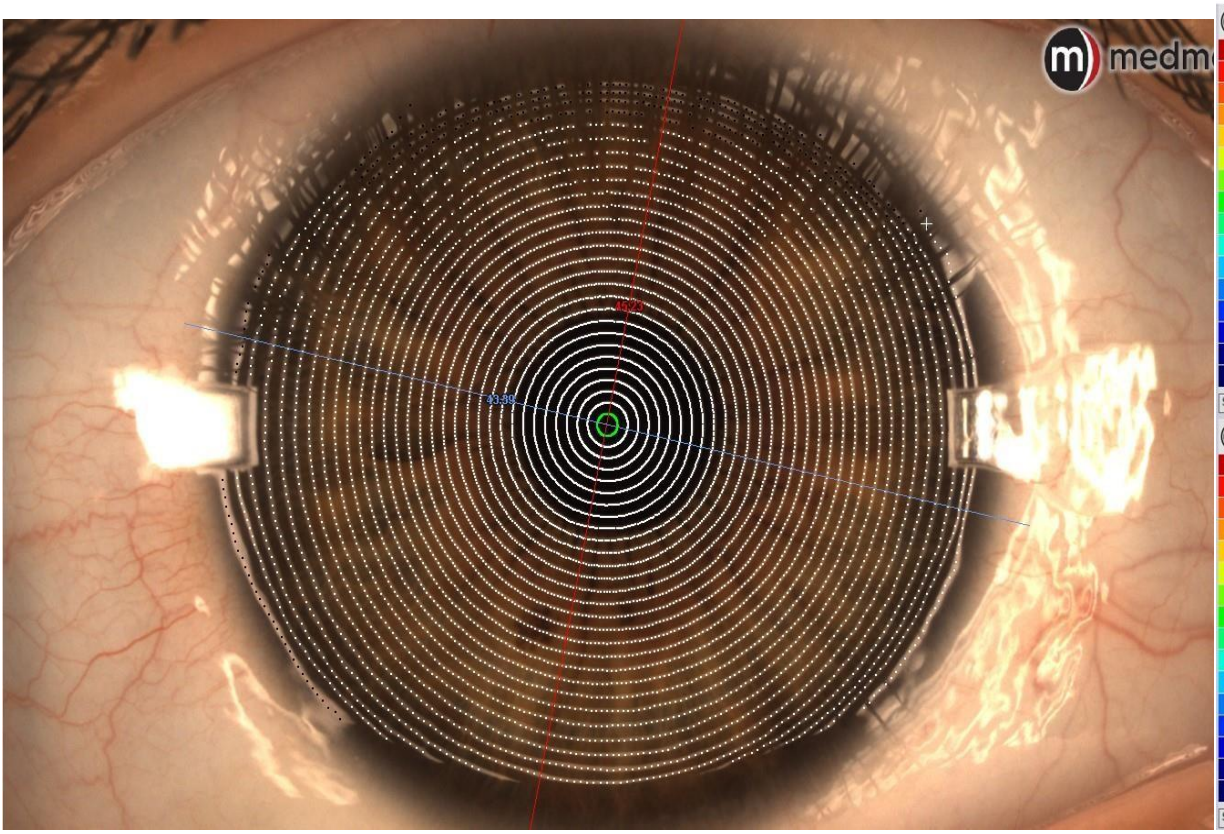
Geometric Alignment

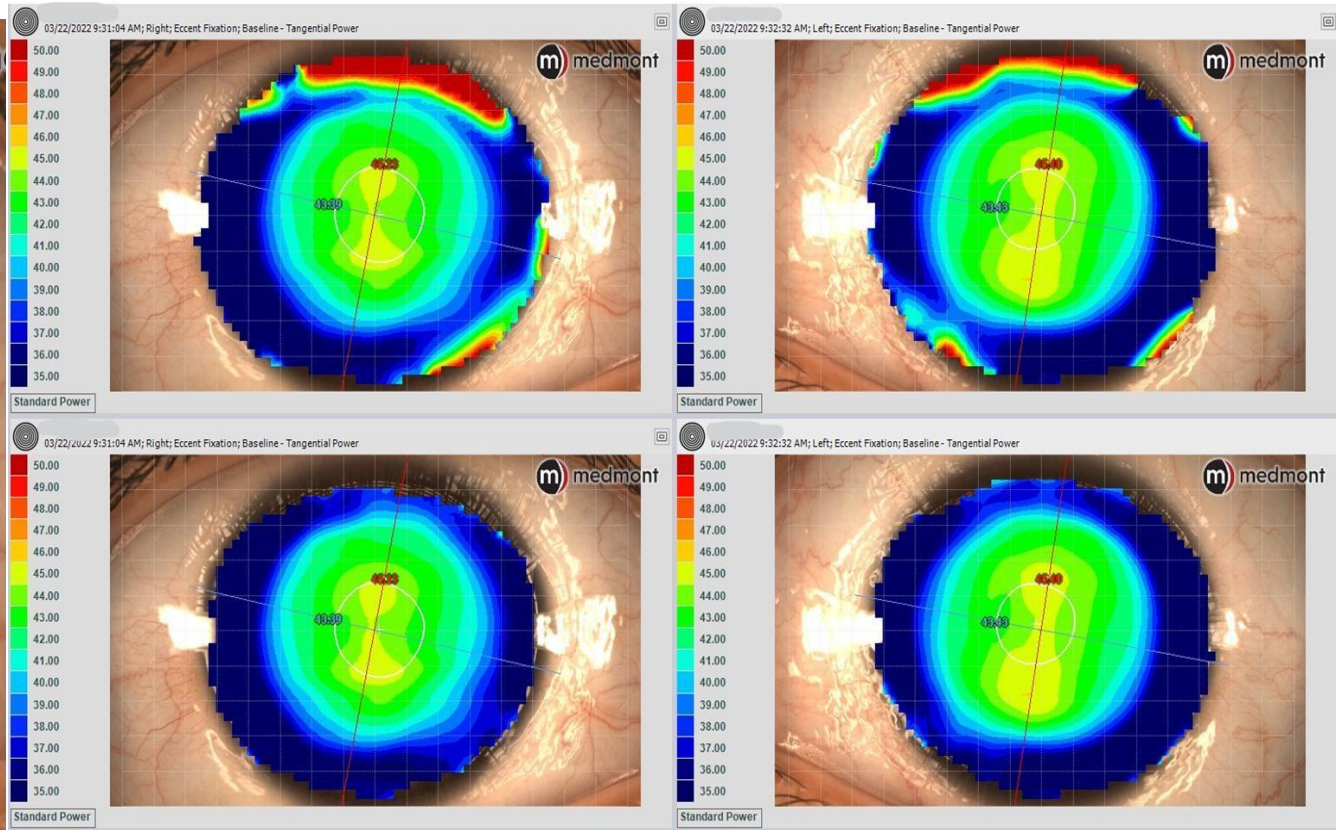


Top 10 Topography Tips

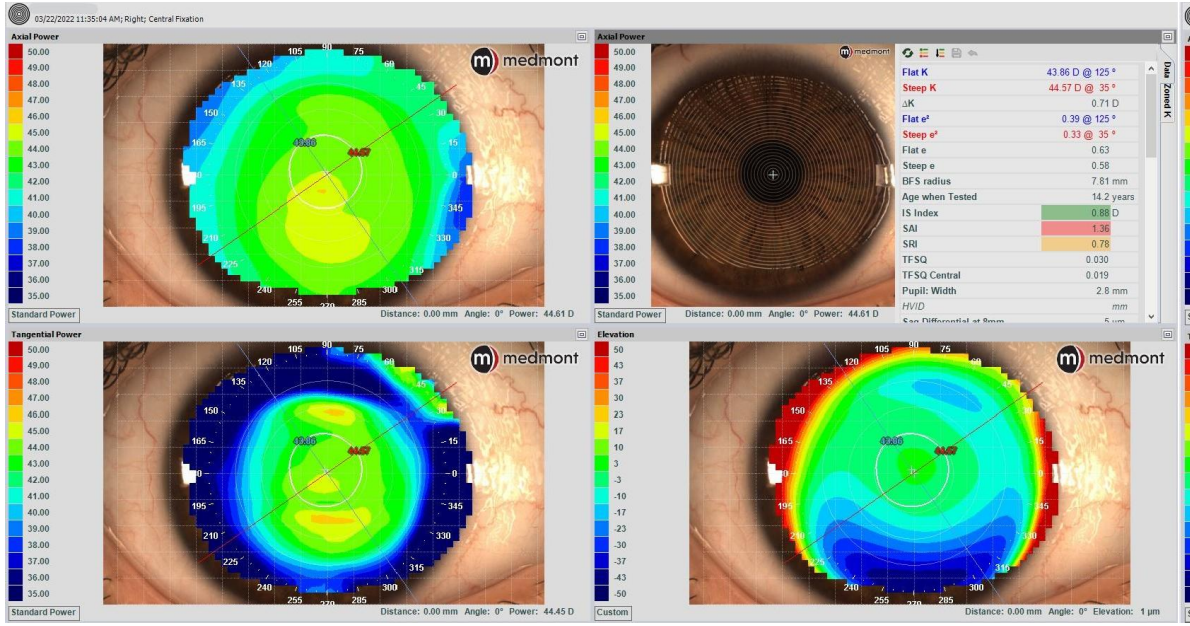
#7. Topography Editing

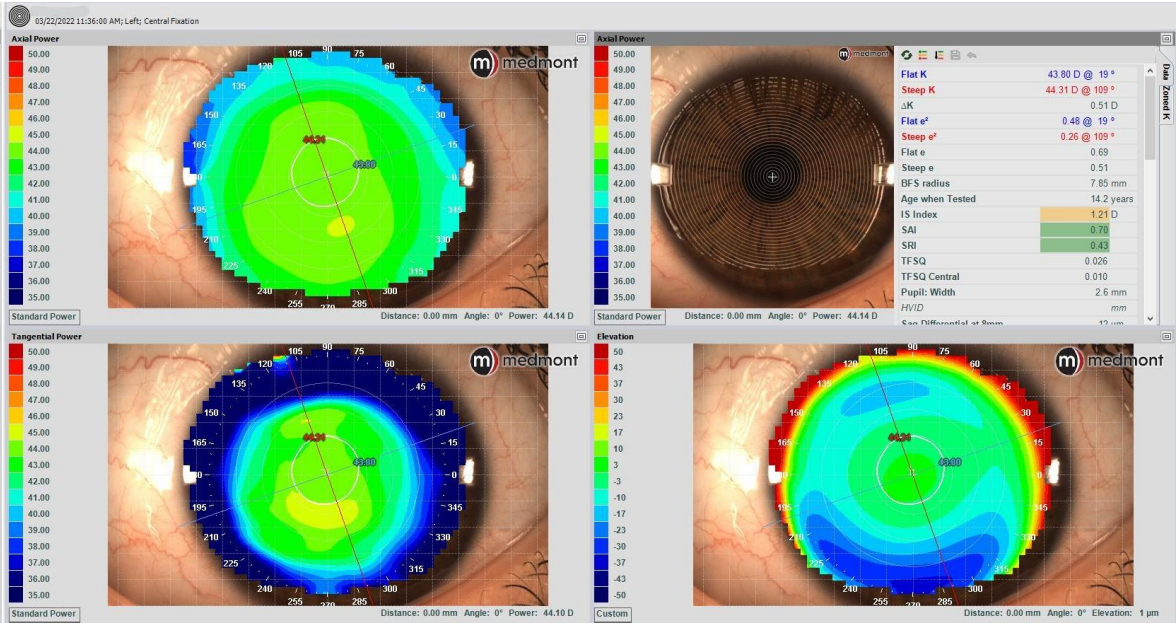
Avoid shadows, tear meniscus, ring jam…and delete erroneous data if possible.



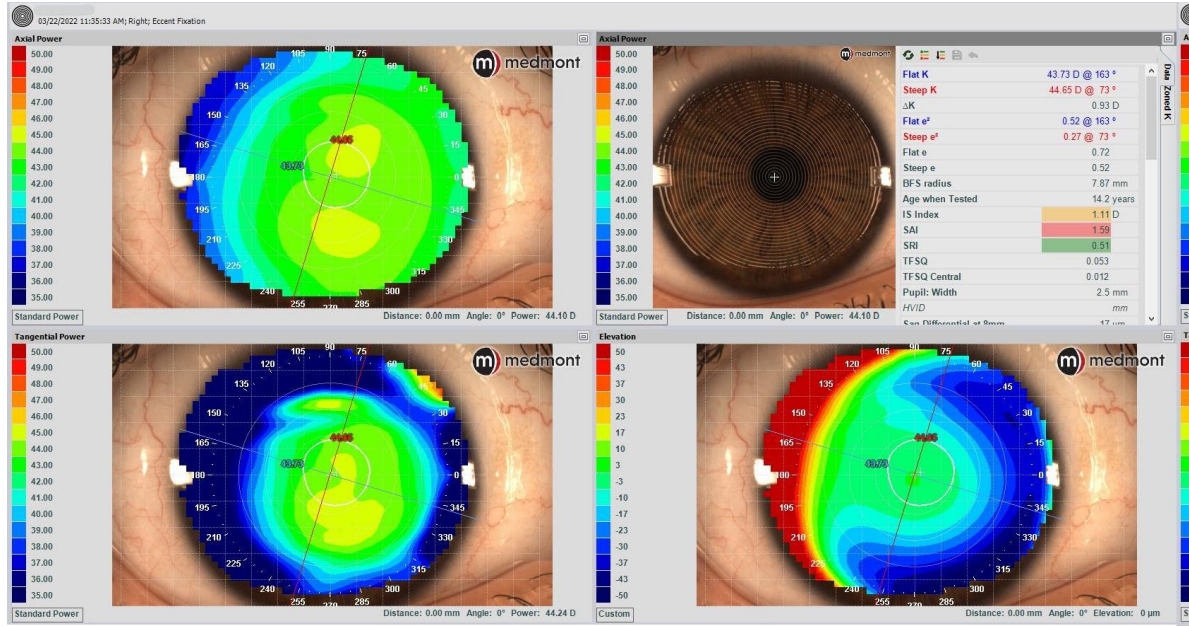


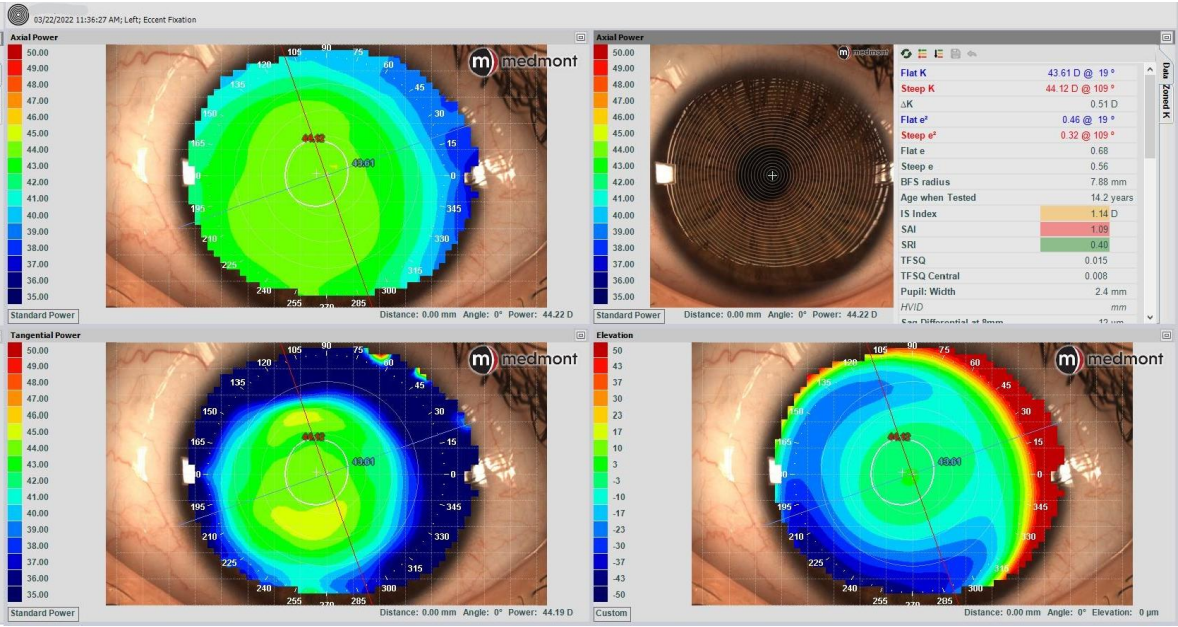
Axial Alignment





Geometric Alignment

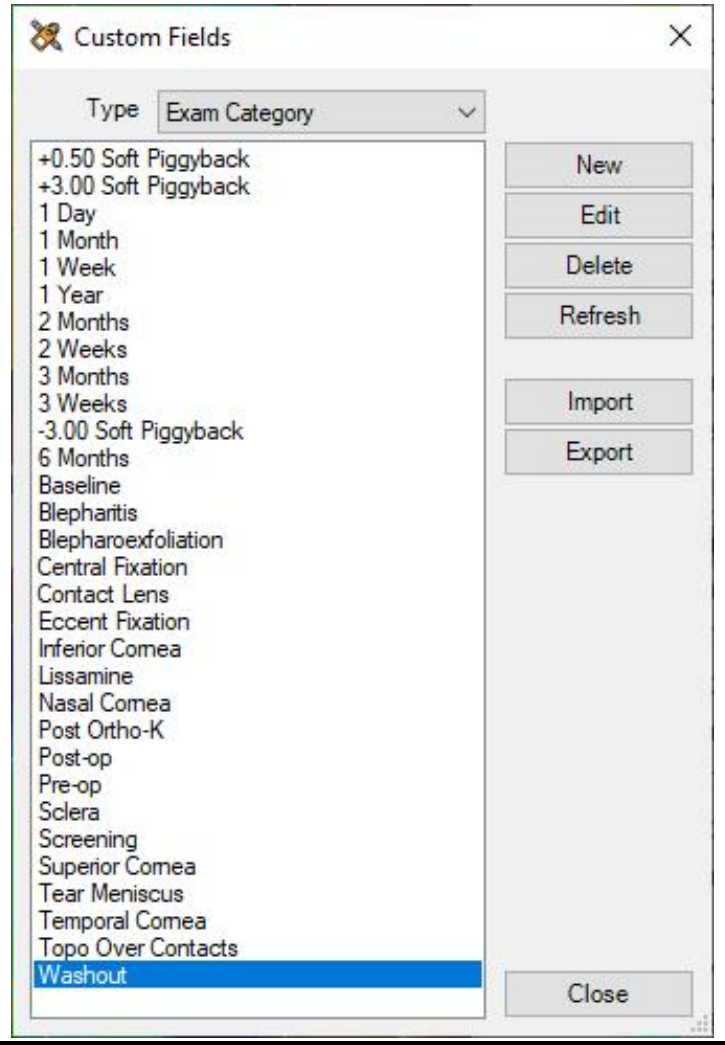


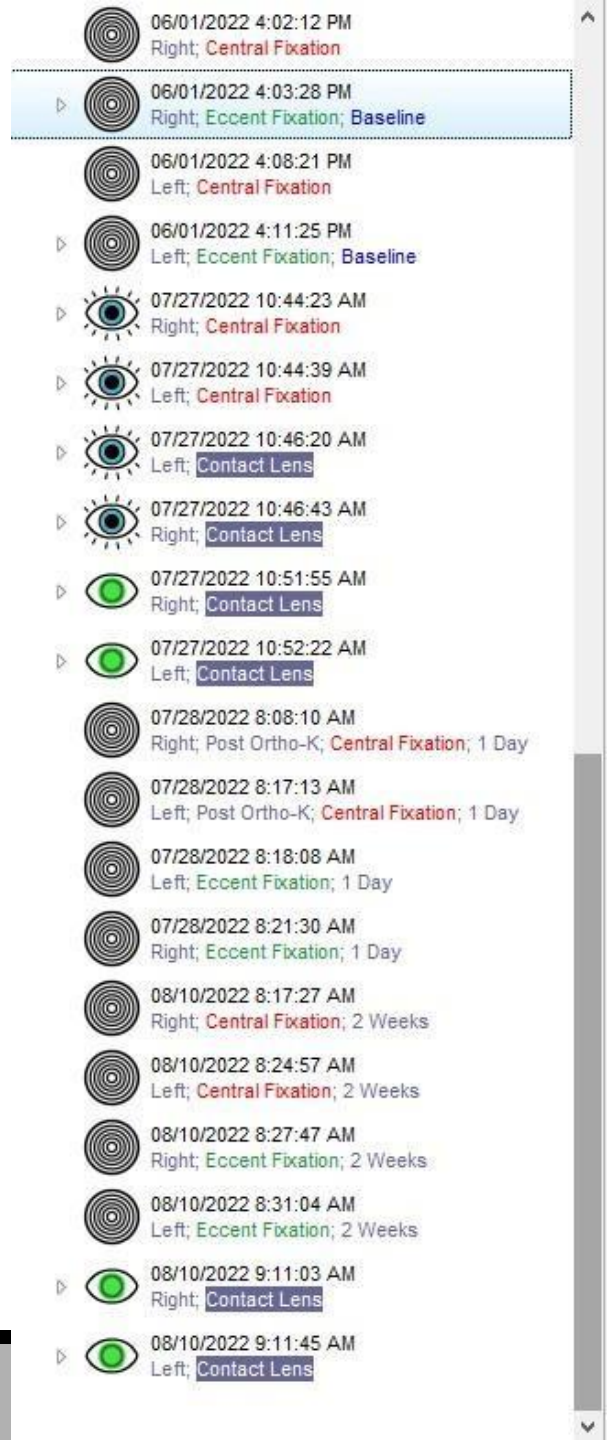


Top 10 Topography Tips

#8. Label your maps! You'll be glad you did later!

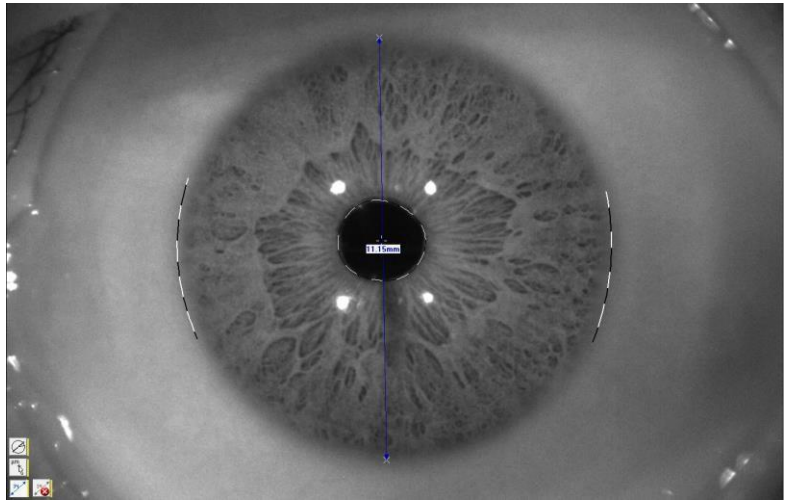
Time	Device	Eye	Type of exam.	Infotext
8:50:39 AM	Pentacam	Left	(25) 3D-Scan HR	1mo. translimbal WAVE OK #2
8:50:01 AM	Pentacam	Left	Aberrometry	
8:49:03 AM	Pentacam	Right	(25) 3D-Scan HR	1mo. translimbal WAVE OK #2
8:48:37 AM	Pentacam	Right	Aberrometry	
8:48:05 AM	Pentacam	Binocular	Full Sequence	
8:05:28 AM	Pentacam	Left	(25) 3D-Scan HR	6wk translimbal WAVE OK
8:05:02 AM	Pentacam	Left	Aberrometry	
8:04:13 AM	Pentacam	Right	(25) 3D-Scan HR	6wk translimbal WAVE OK
8:03:43 AM	Pentacam	Right	Aberrometry	
8:03:04 AM	Pentacam	Binocular	Full Sequence	
8:41:10 AM	Pentacam	Left	(25) 3D-Scan HR	1mo. 4th WAVE GSym OK
8:40:00 AM	Pentacam	Right	(25) 3D-Scan HR	3mo. 3rd WAVE GSym OK
8:12:48 AM	Pentacam	Left	(25) 3D-Scan HR	2mo. 3rd WAVE GSym OK
8:10:59 AM	Pentacam	Right	(25) 3D-Scan HR	2mo. 3rd WAVE GSym OK
8:15:52 AM	Pentacam	Left	(25) 3D-Scan HR	1wk 2nd WAVE GSym OK
8:15:07 AM	Pentacam	Right	(25) 3D-Scan HR	1wk 2nd WAVE GSym OK
8:05:45 AM	Pentacam	Left	(25) 3D-Scan HR	2wk WAVE GSym OK f/u
8:05:08 AM	Pentacam	Right	(25) 3D-Scan HR	2wk WAVE GSym OK f/u
8:03:56 AM	Pentacam	Left	(25) 3D-Scan HR	1 Day WAVE OK f/u
8:03:15 AM	Pentacam	Right	(25) 3D-Scan HR	1 Day WAVE OK f/u
1:11:20 PM	Pentacam	Left	(25) 3D-Scan HR	Baseline
1:10:48 PM	Pentacam	Left	AXL	
1:10:13 PM	Pentacam	Left	Aberrometry	
1:10:12 PM	Pentacam	Left	Retro Illumination	
1:09:28 PM	Pentacam	Right	(25) 3D-Scan HR	Baseline

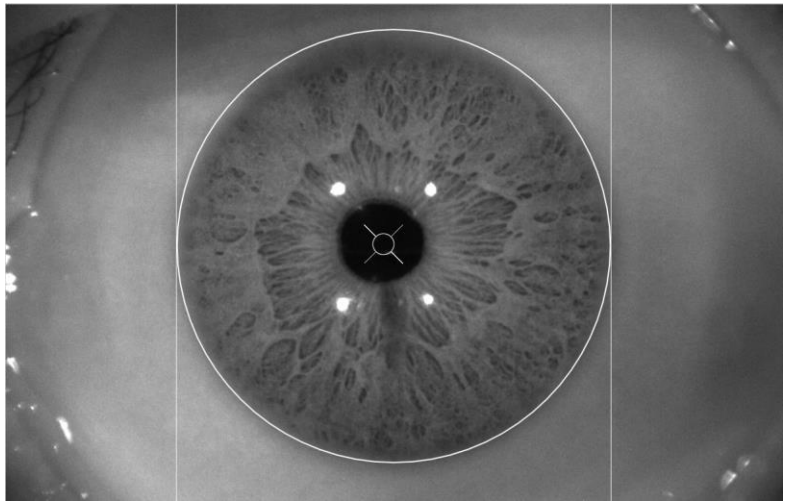


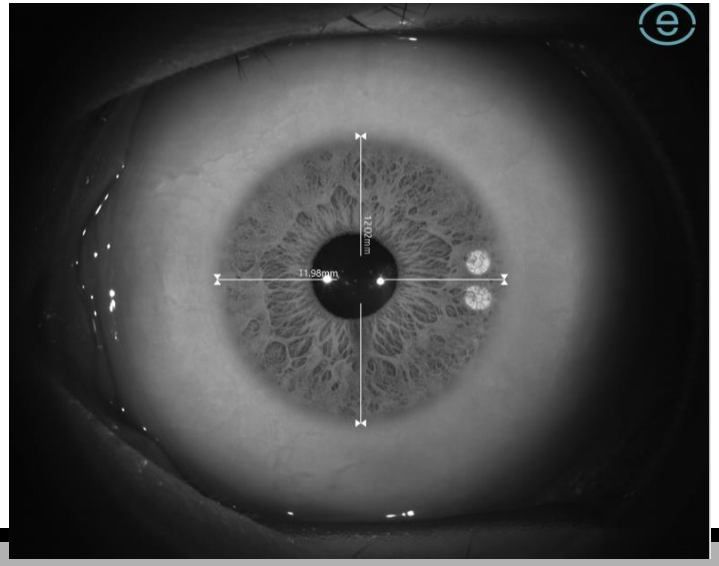


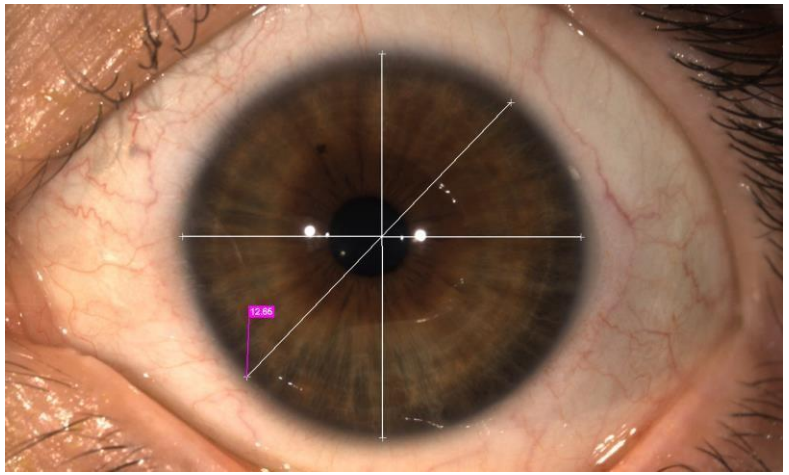
Top 10 Topography Tips

#9. Confirm auto-HVID/VVID, or manually measure.



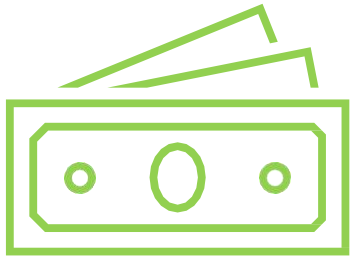




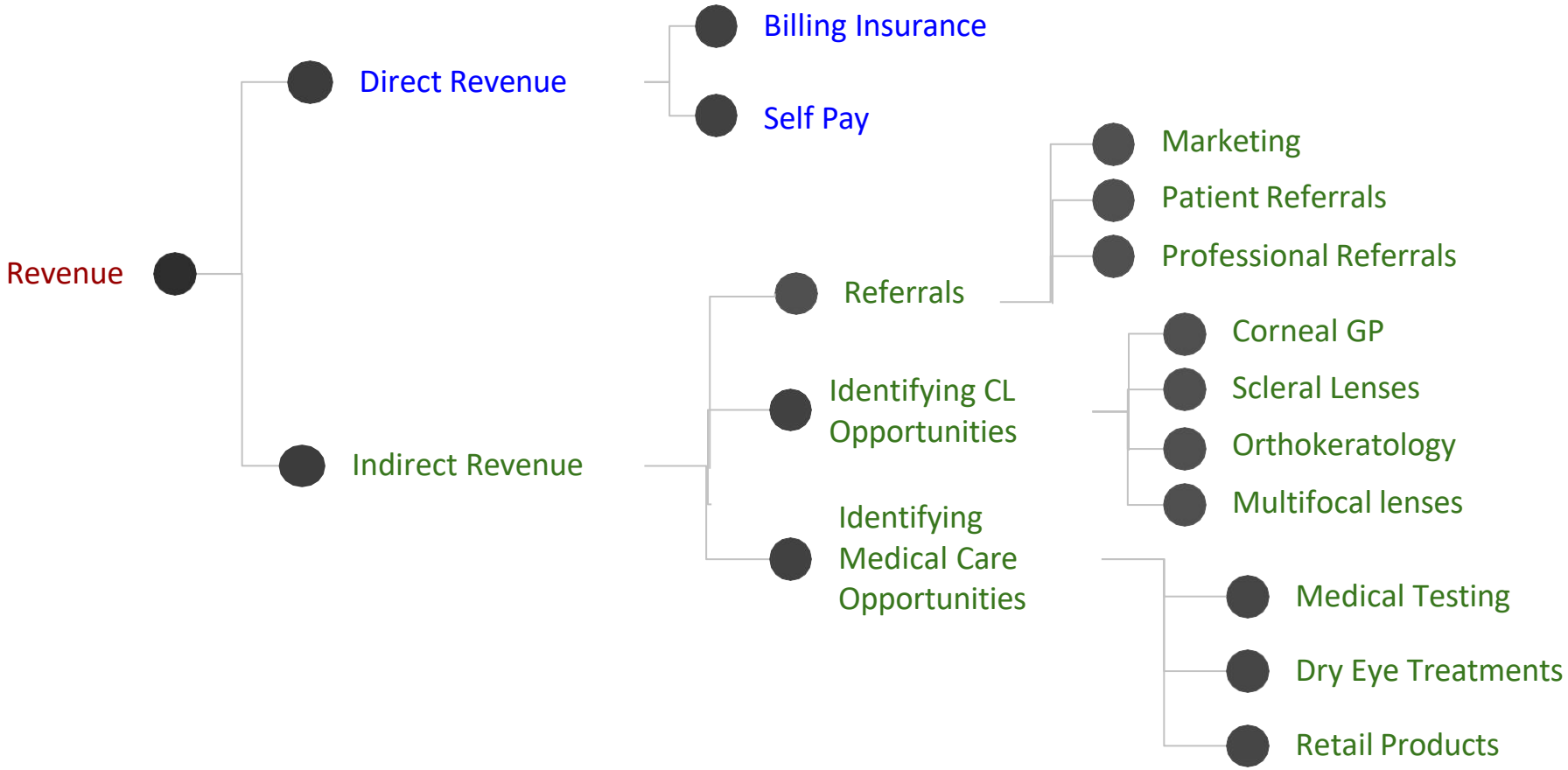


Top 10 Topography Tips

#10. Charge appropriately for what this technology is worth



Return On Investment –
Why should you invest in Corneal Imaging?



Billing CPT Codes

Corneal topography 92025
Anterior segment tomography 92132
Anterior photography 92285
Optical biometry 92136
Tear Film Imaging 0330T
Meibomian Gland Imaging 0507T
Non-covered services codes 92499
Office Visit 920xx/992xx
Contact lens codes:

- 92310, corneal lens fitting
- 92311, aphakia unilateral
- 92312, aphakia bilateral
- 92313, corneoscleral lens fitting
- 92072, keratoconus fitting

THE END!

Are you still awake?