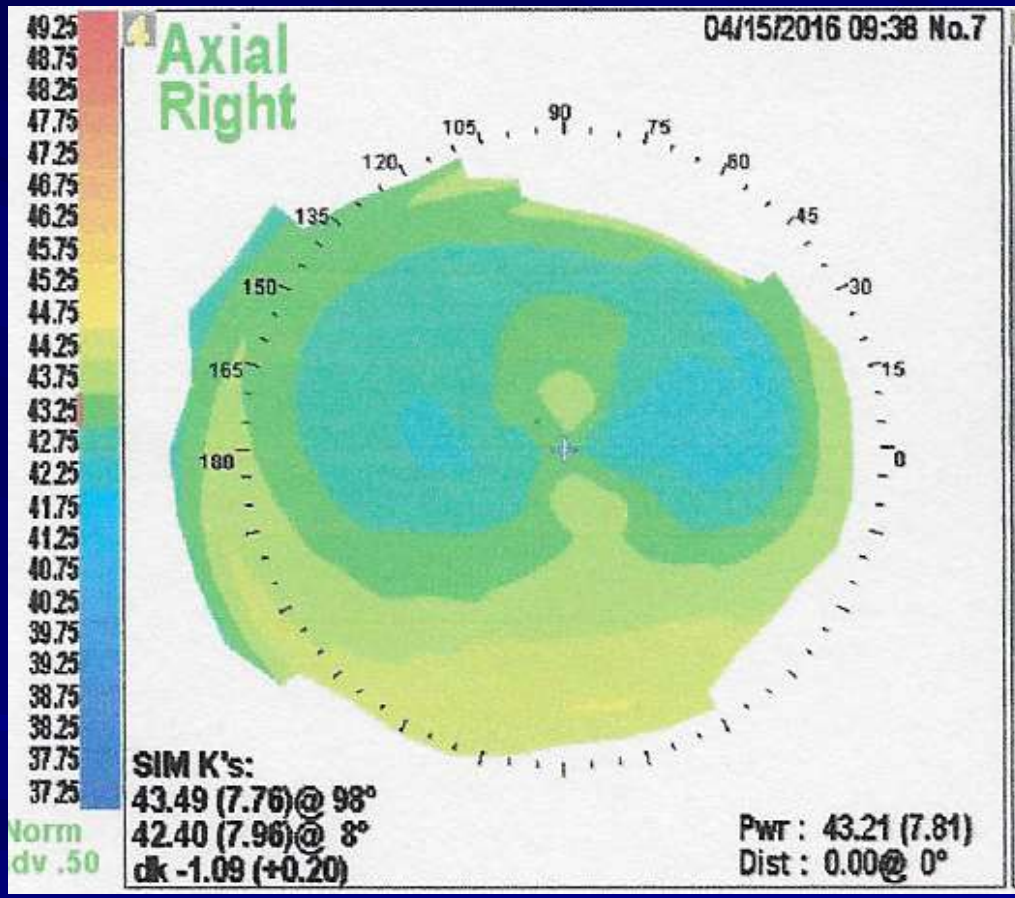
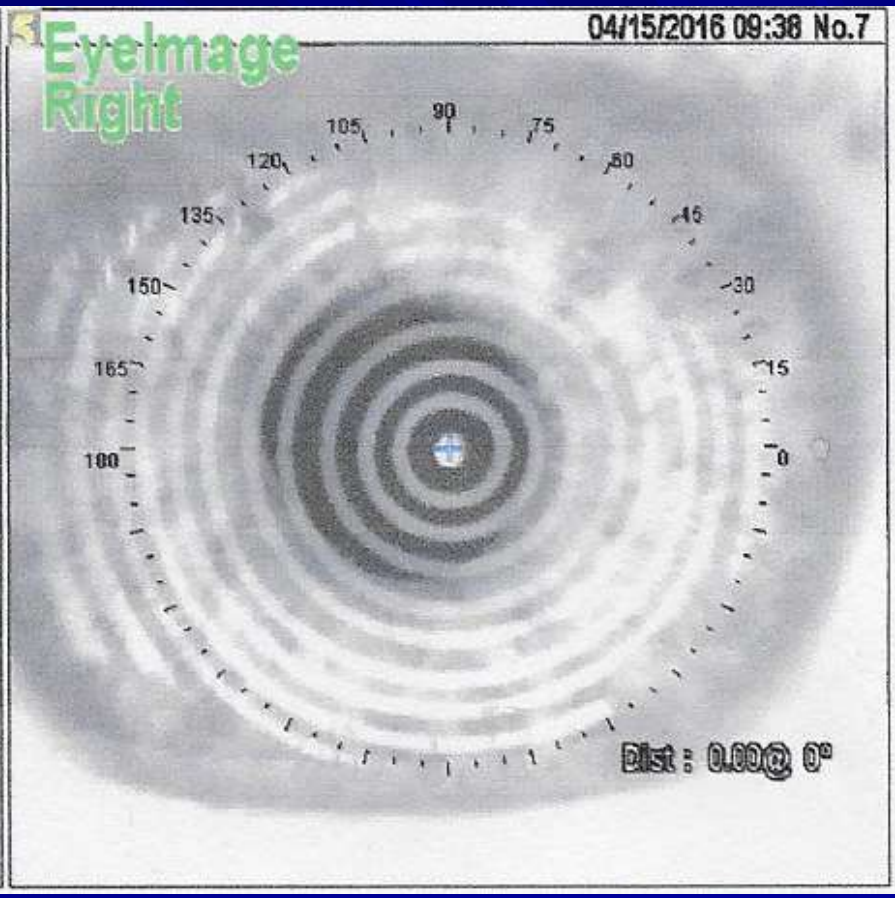
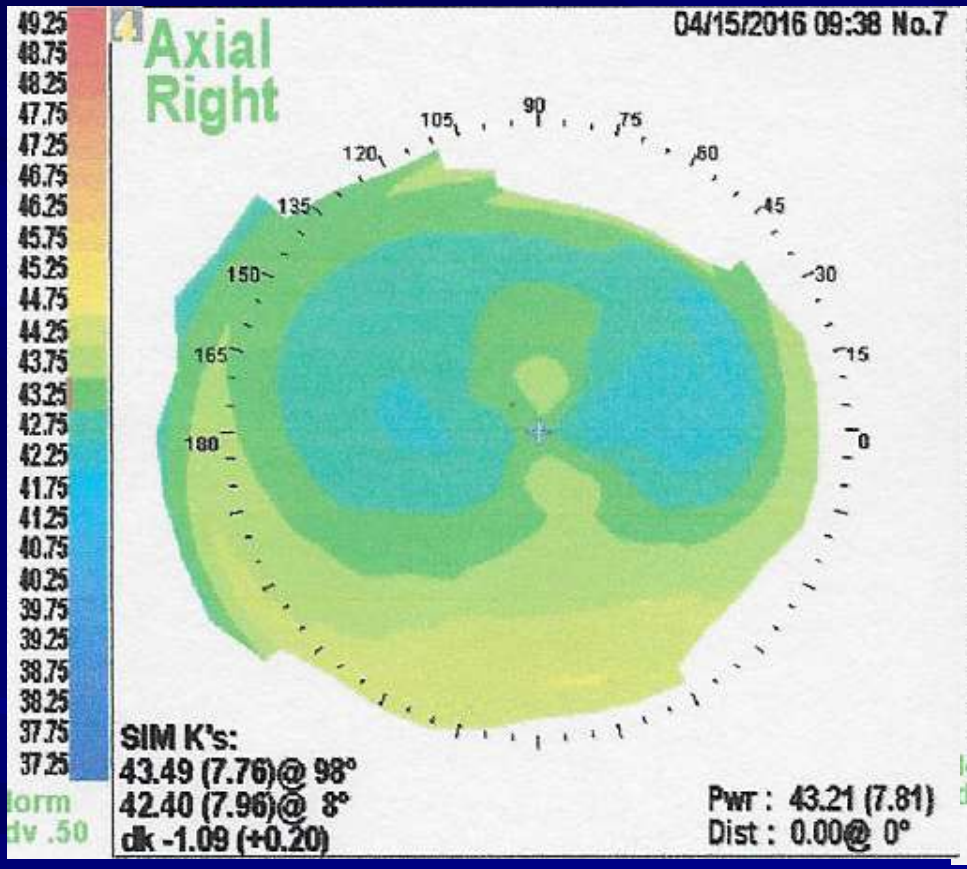

Spring 2016
Nebraska Laser Eye Associates

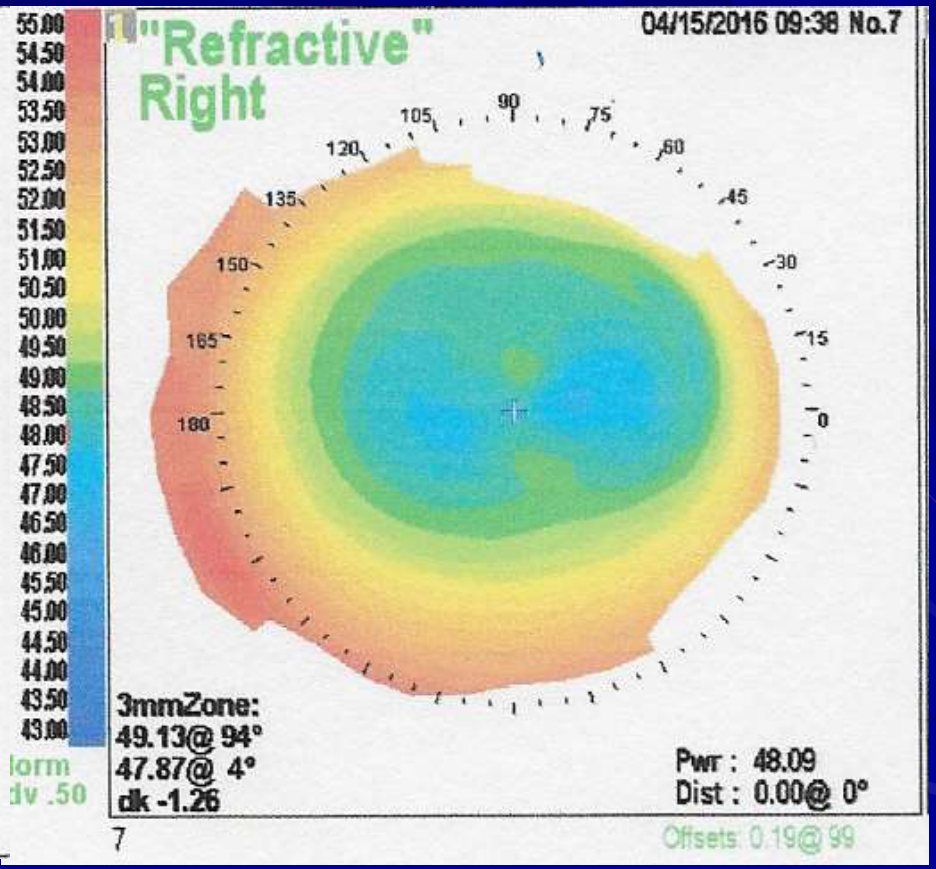
Enhancement surgery



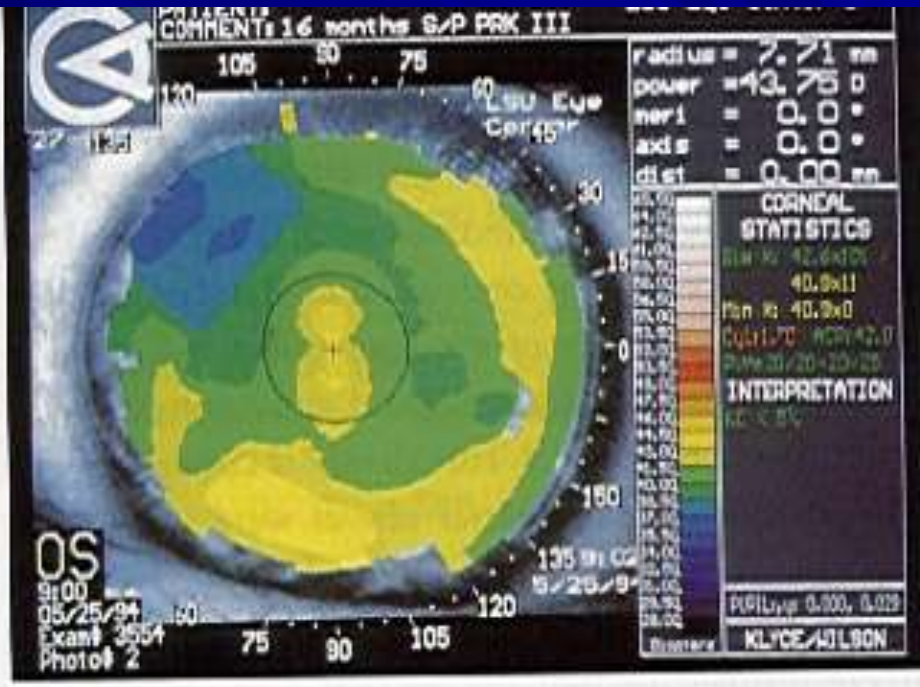


Axial Map Refractive Map

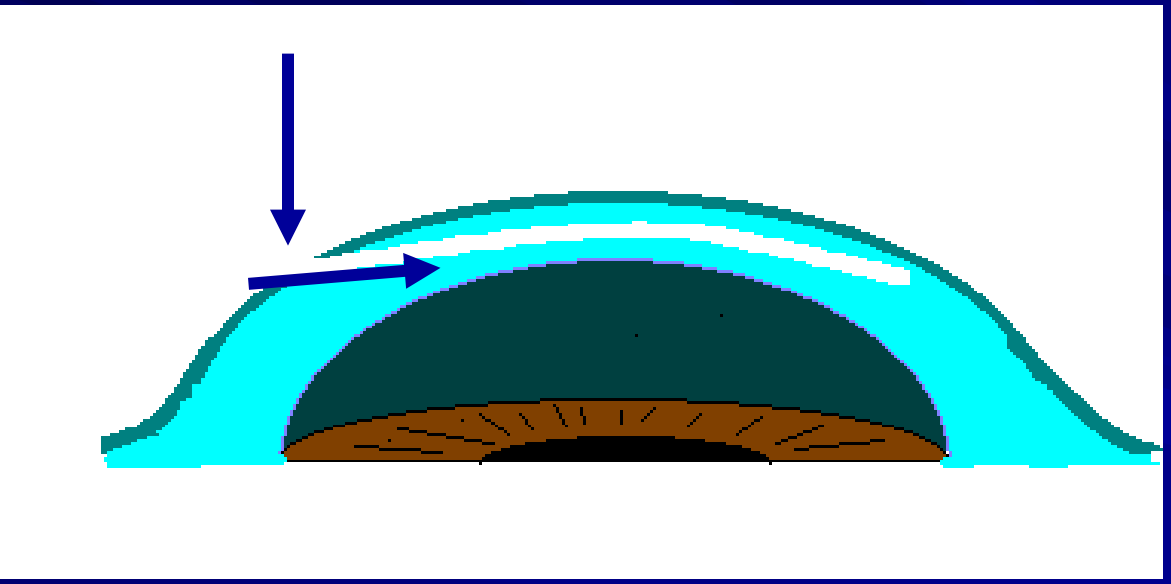




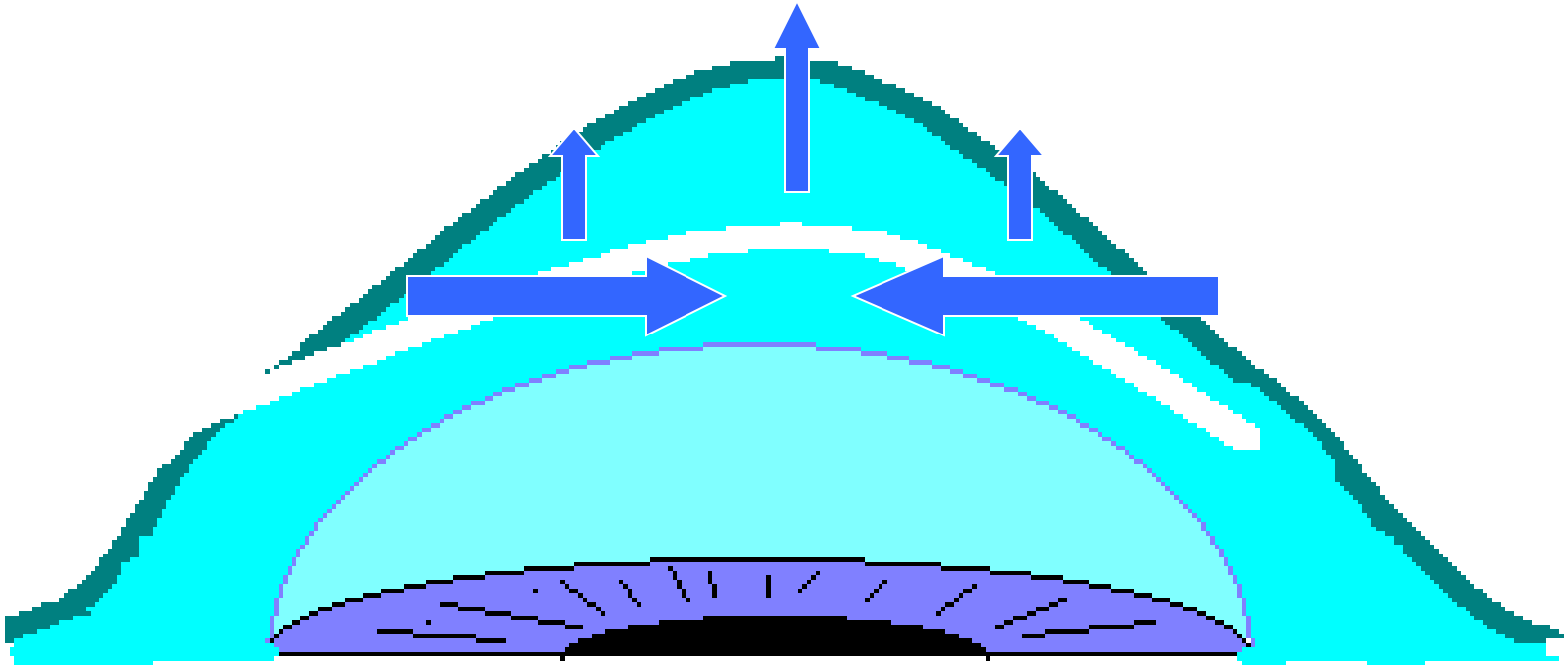
Laser-induced central island
Very common with early lasers
Partly topographic artifact



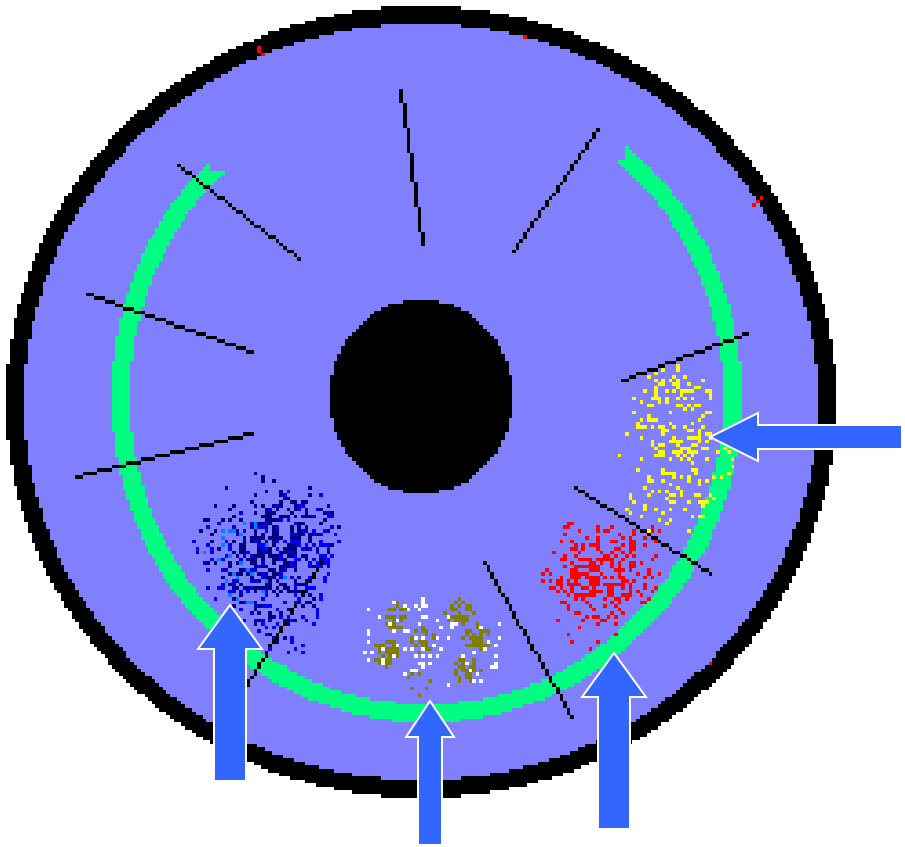
Epithelial Defect



- Lasik creates a circular epithelial defect (gutter) confluent with the **potential space** in the Lasik interface



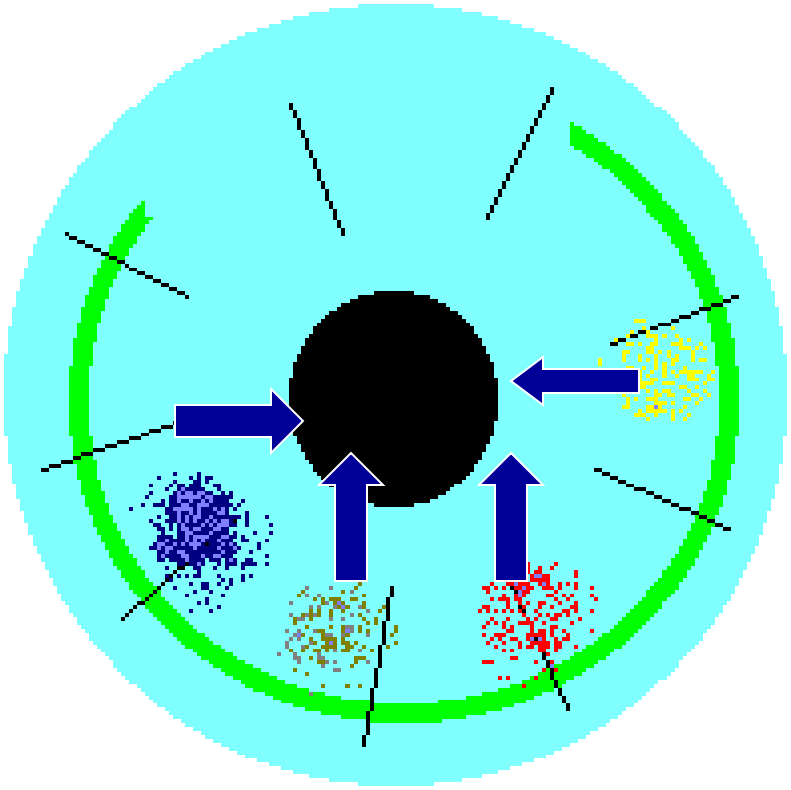
The corneal swelling pressure draws fluid and debris into the Lasik interface. The swelling pressure is greatest centrally and draws fluid and debris into the central cornea (thereby creating central islands).



Until the epithelium is intact debris and fluid are actively aspirated into LASIK gutter and the potential space in the LASIK interface

DLK

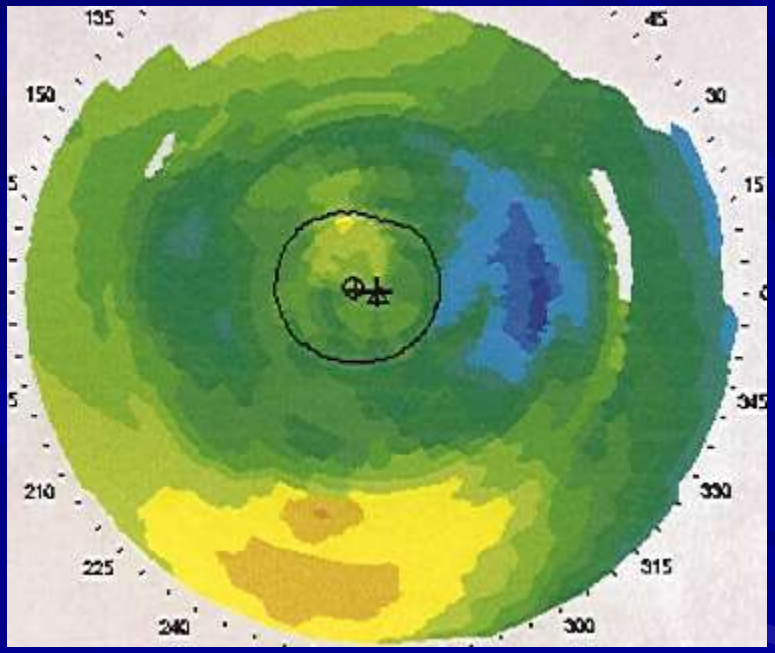
- White cells enter through gutter and are drawn towards the center
  - May be nonspecific aspiration of white cells from the tear film
    - atopic patient with conjunctival reaction
  - May have toxic factor in interface pulling in cells
    - Endotoxin on keratome or blade



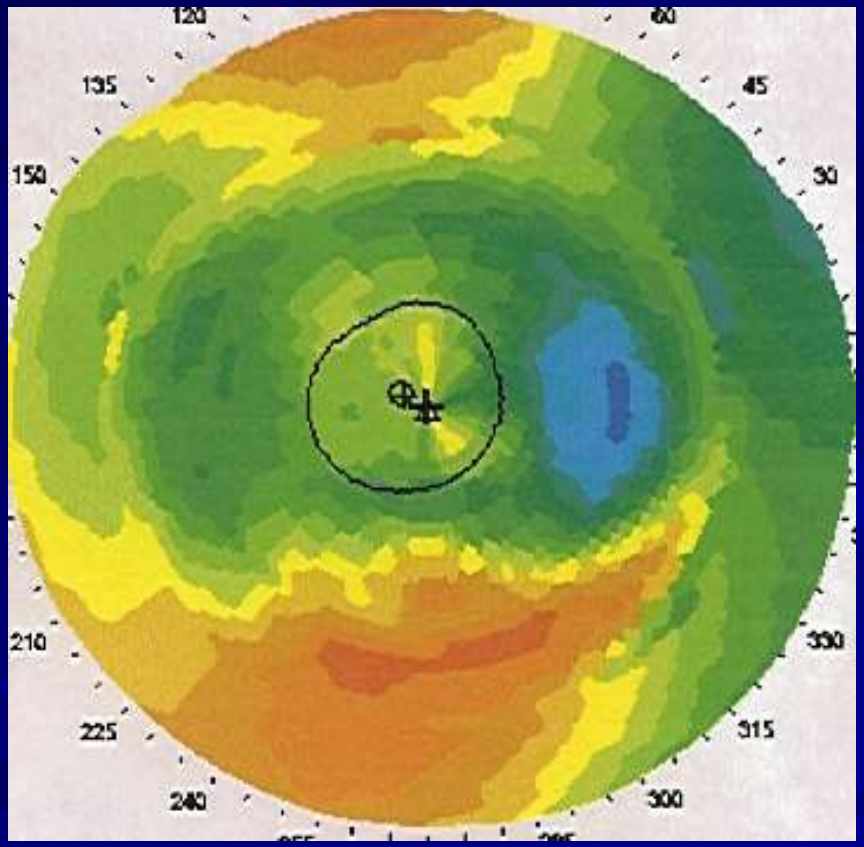
Peripheral debris and fluid are drawn towards the central cornea by the higher central corneal swelling pressure.

Case 4- Day 1- AM

- Vision 20/20
- **Fine granular material** in the inferior **LASIK interface**
  - Material consistent with desquamated corneal epithelial cells

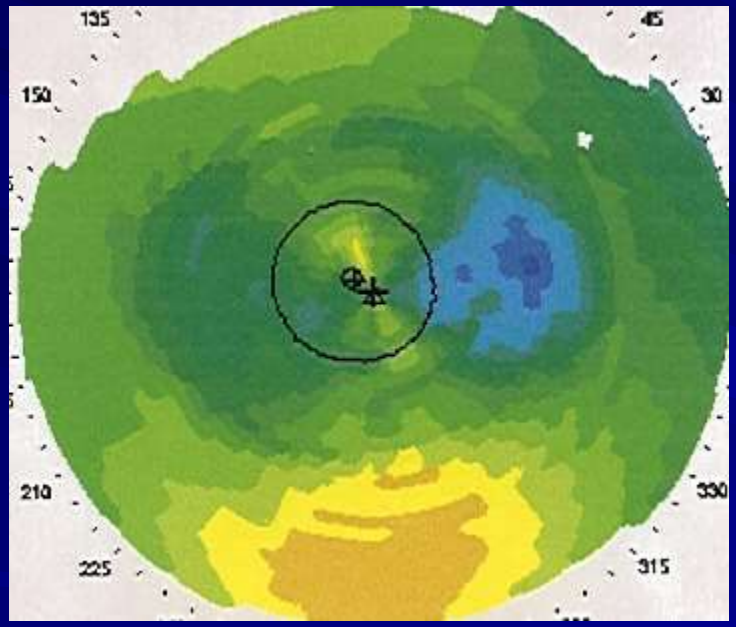


Case 4- Day 1 -PM

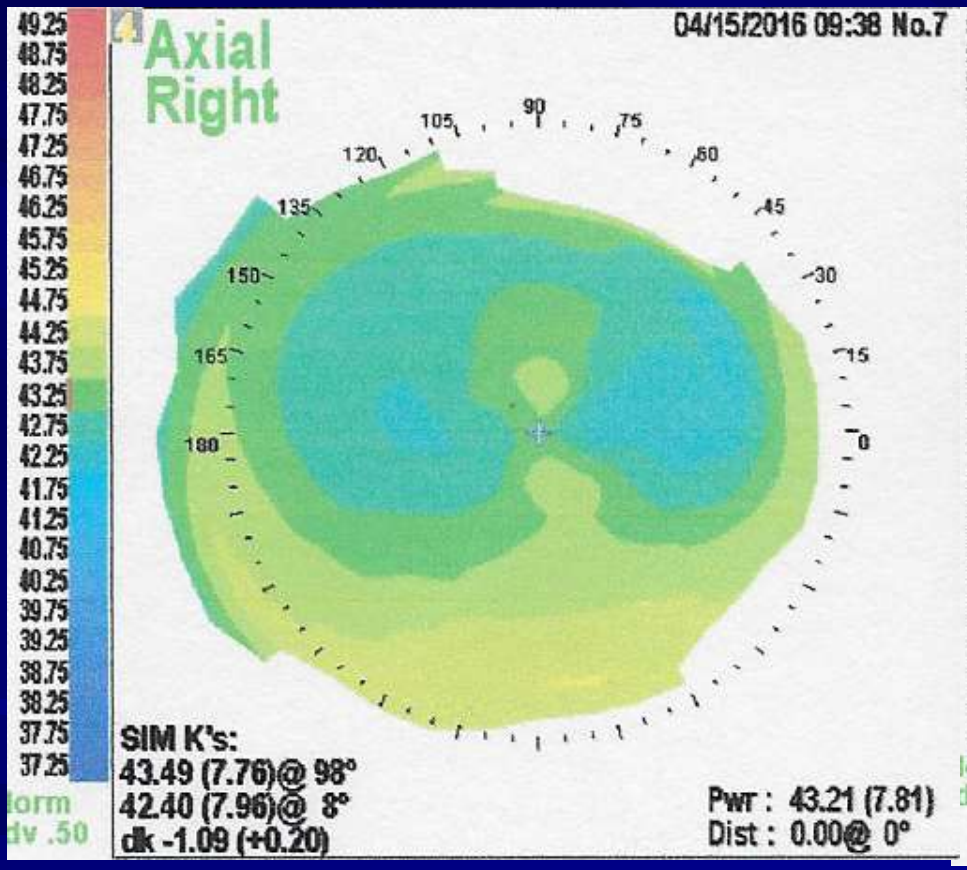


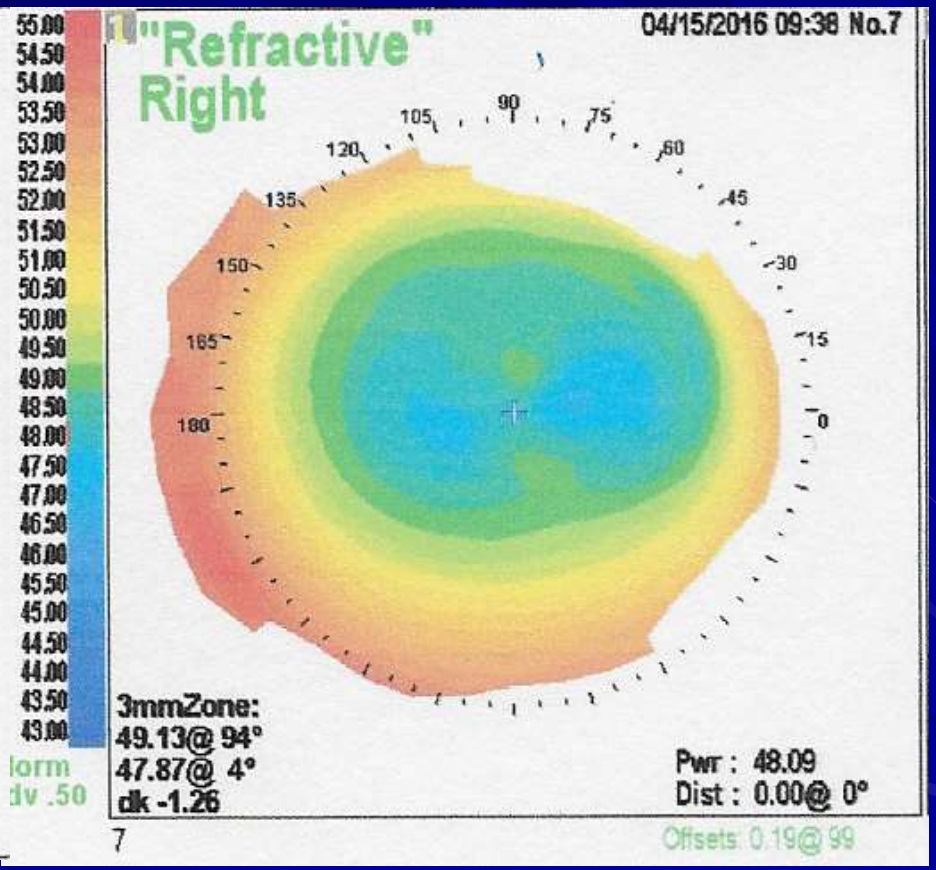
- Vision 20/30
- **Migration** of the interface **debris** into the inferior mid-peripheral interface
- **Topography** showed increased corneal thickness in the area of the shifting debris

Case 4- day 4



- The island is resolved
- Further migration noted
- Vision has improved to 20/25


Axial
Right
04/15/2016 09:38 No.7
49.25
48.75
48.25
47.75
47.25
46.75
46.25
45.75
45.25
44.75
44.25
43.75
43.25
42.75
42.25
41.75
41.25
40.75
40.25
39.75
39.25
38.75
38.25
37.75
37.25
90
105
75
120
60
135
45
150
30
165
15
180
0
SIM K's:
43.49 (7.76)@ 98°
42.40 (7.96)@ 8°
dk -1.09 (+0.20)
Pwr : 43.21 (7.81)
Dist : 0.00@ 0°


"Refractive"
Right
04/15/2016 09:38 No.7
55.00
54.50
54.00
53.50
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52.00
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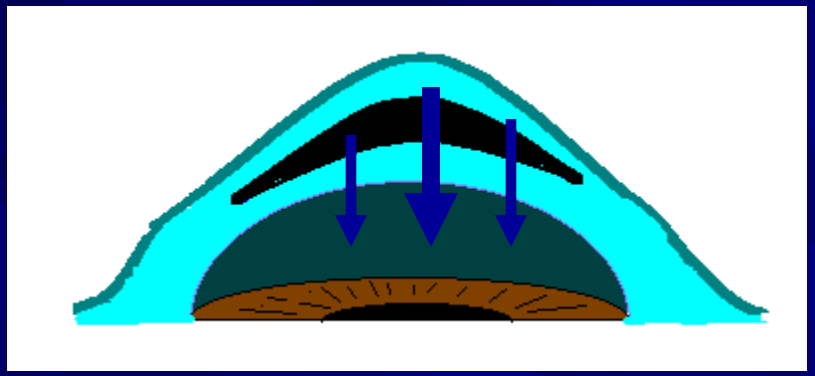
45.00
44.50
44.00
43.50
43.00
90
105
75
120
60
135
45
150
30
165
15
180
0
3mmZone:
49.13@ 94°
47.87@ 4°
dk -1.26
Pwr : 48.09
Dist : 0.00@ 0°
7
Offsets: 0.19@ 99

Etiology of Microstriae

Microstriae
Related to Excess Tissue

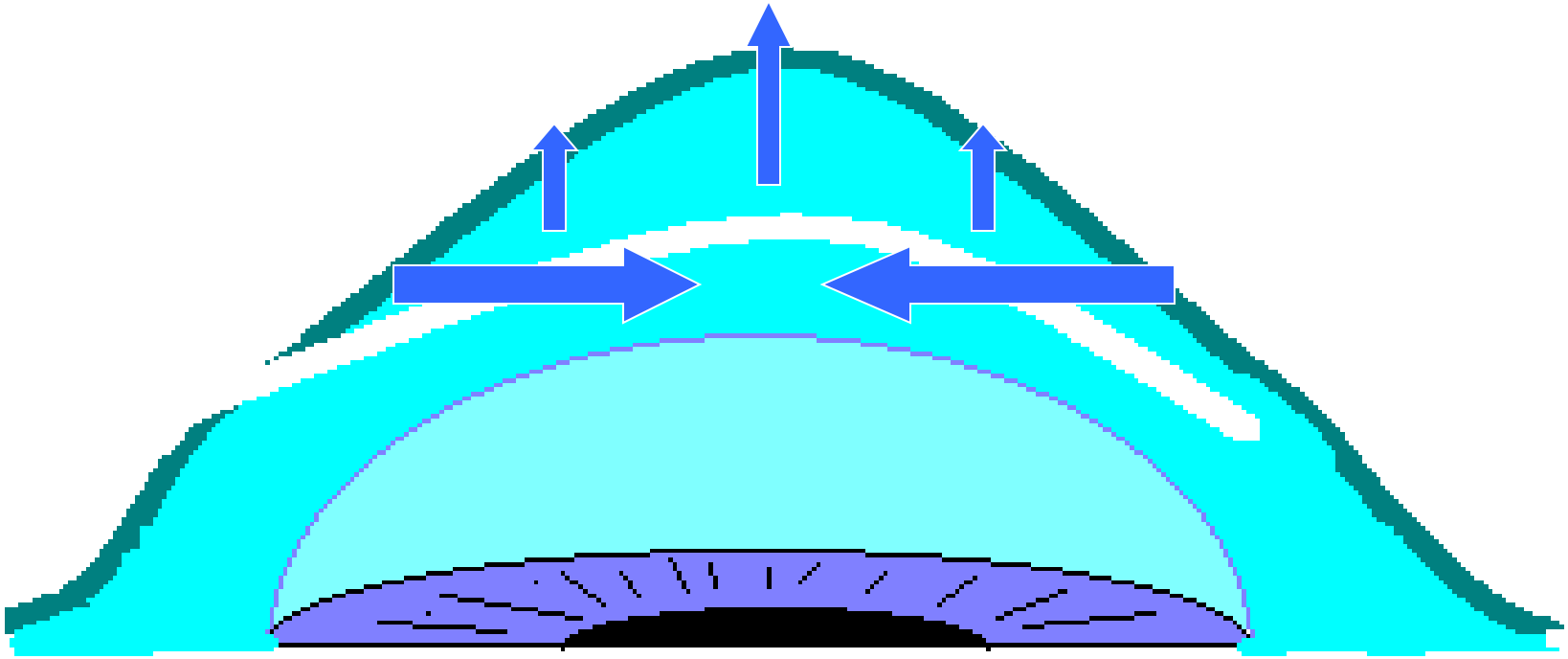


- **Standard teaching:**
- **Excess tissue folds in on itself. Theory consistent with microstriae being more common after high corrections**

- Does not explain the distribution in our patients (AV SE:-5.94+/-2.7D)

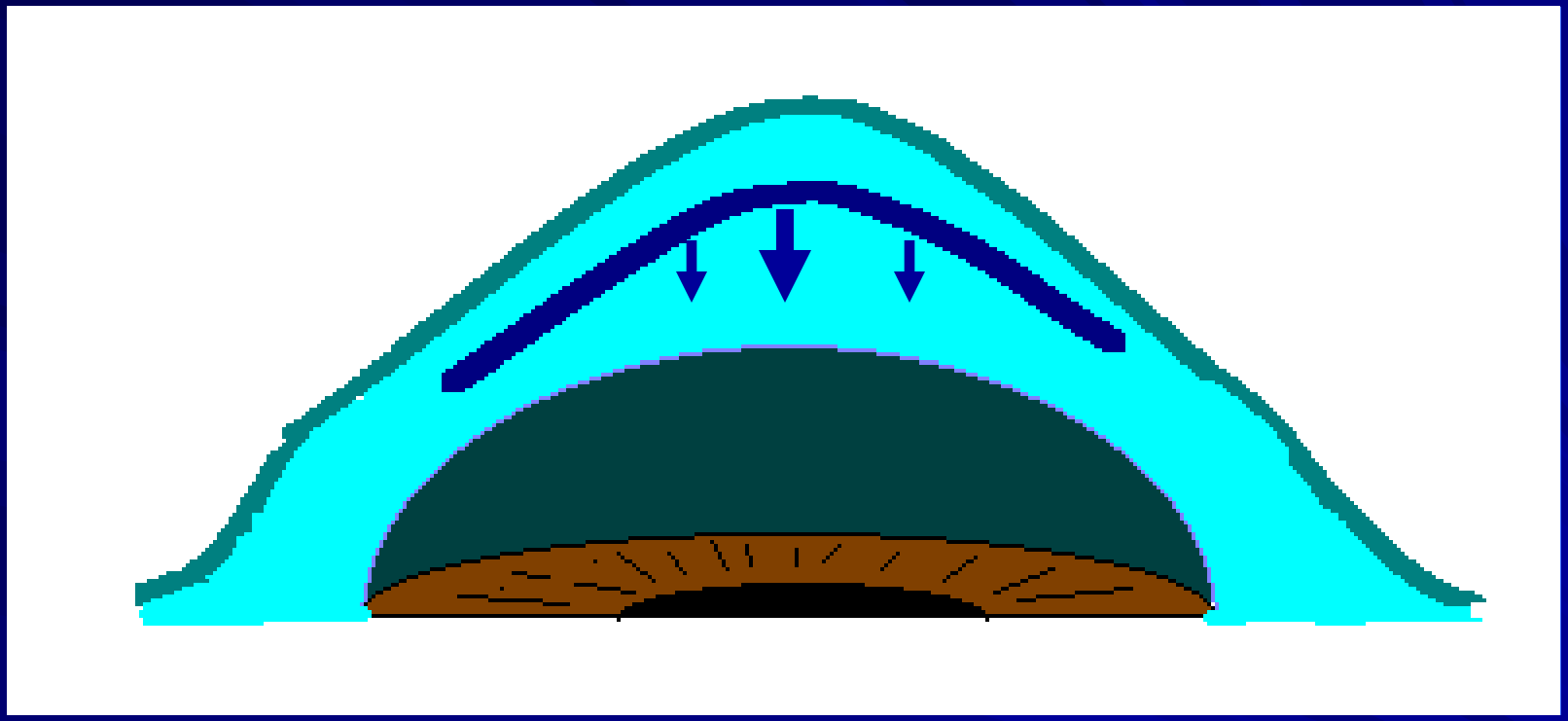
Risk factors-Microstriae

- Thinner flap
  - 160 Hansatome keratome head had a 3.12 risk ratio compared to the 180 head
- Dry eye
- Above average correction
  - AV SE:-5.94+/-2.7D



Etiology of Microstriae: excess corneal swelling

Microstria Formation



After surgery, the cornea dehydrates and the excess flap tissue infolds with secondary microstria of the cornea.

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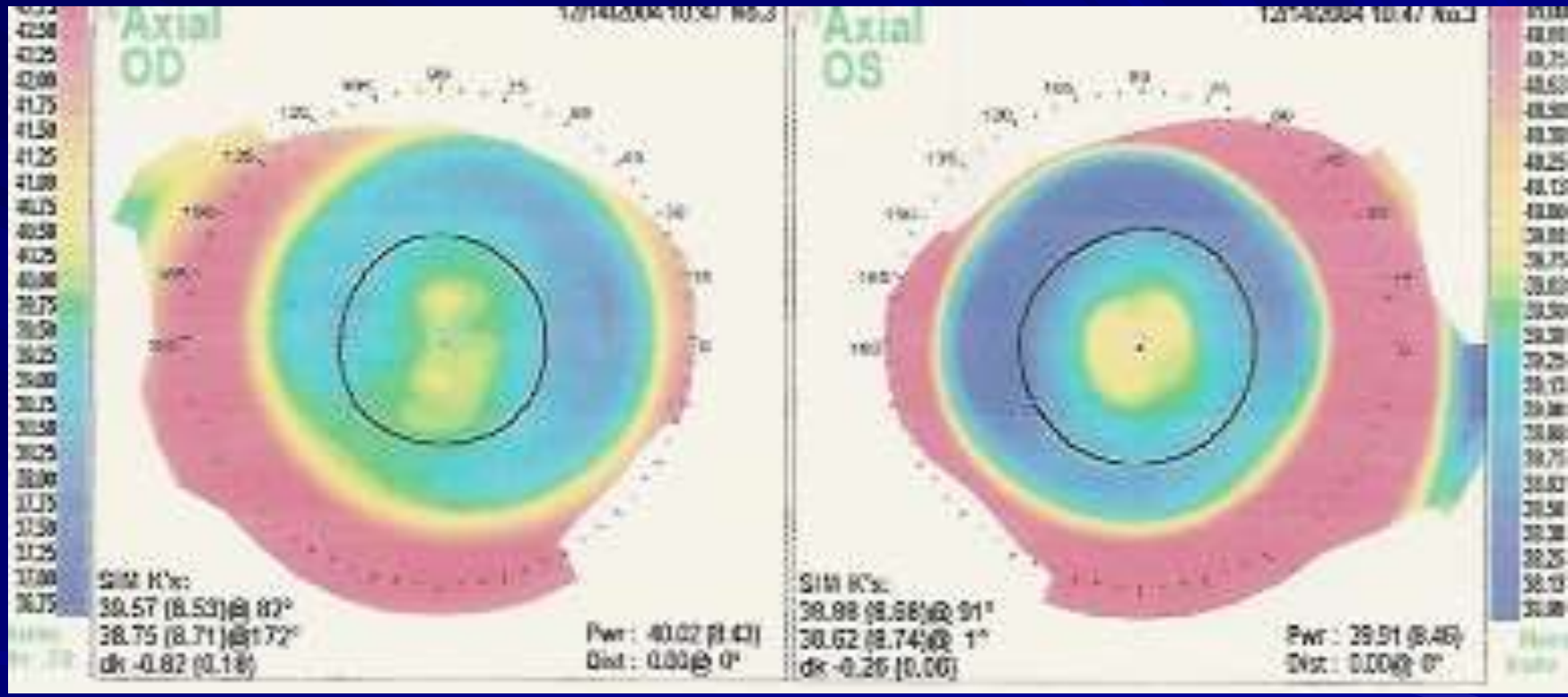
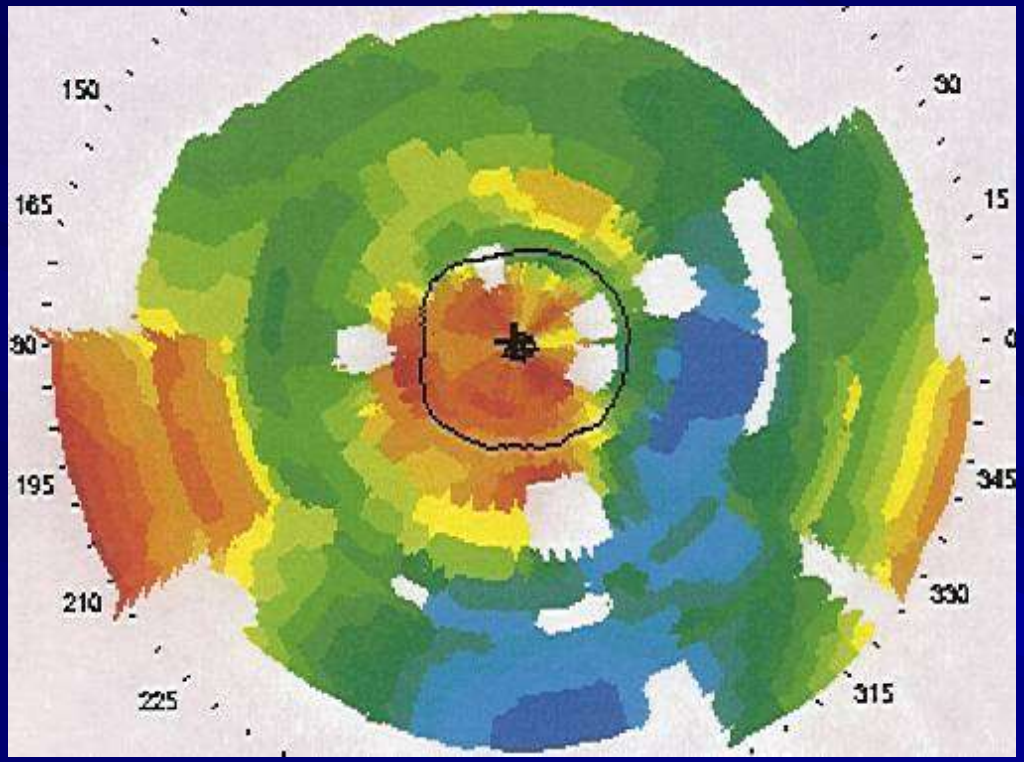
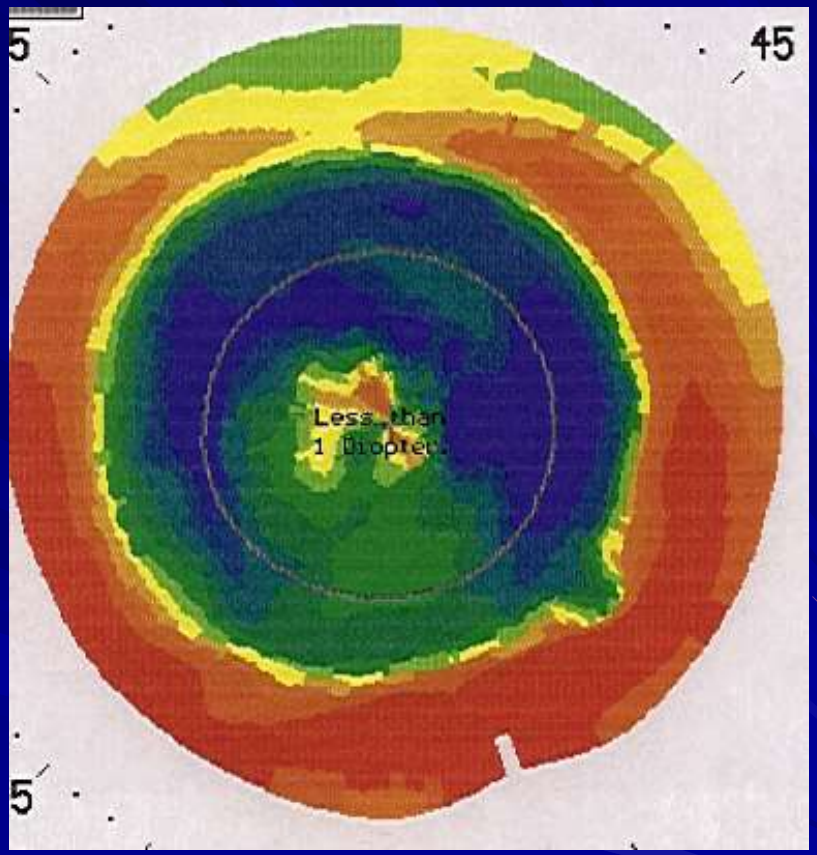
Other causes of Central islands – Elevated IOP



Central Island formation

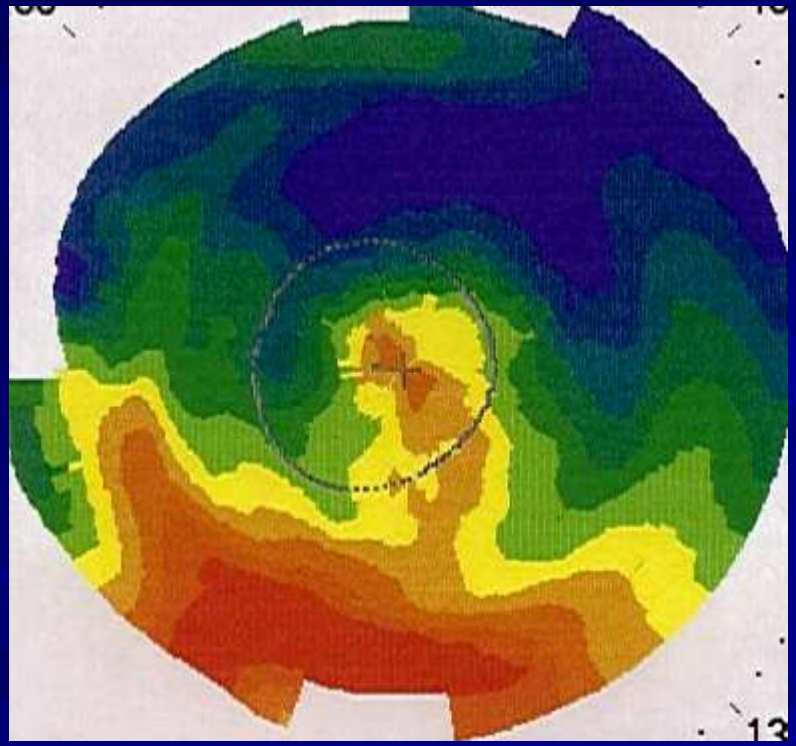




Case 5. A. Left: Thirty minutes after surgery a central island and moderate flap and deep stromal edema are noted. B. Right: Six weeks after surgery a central island persists.

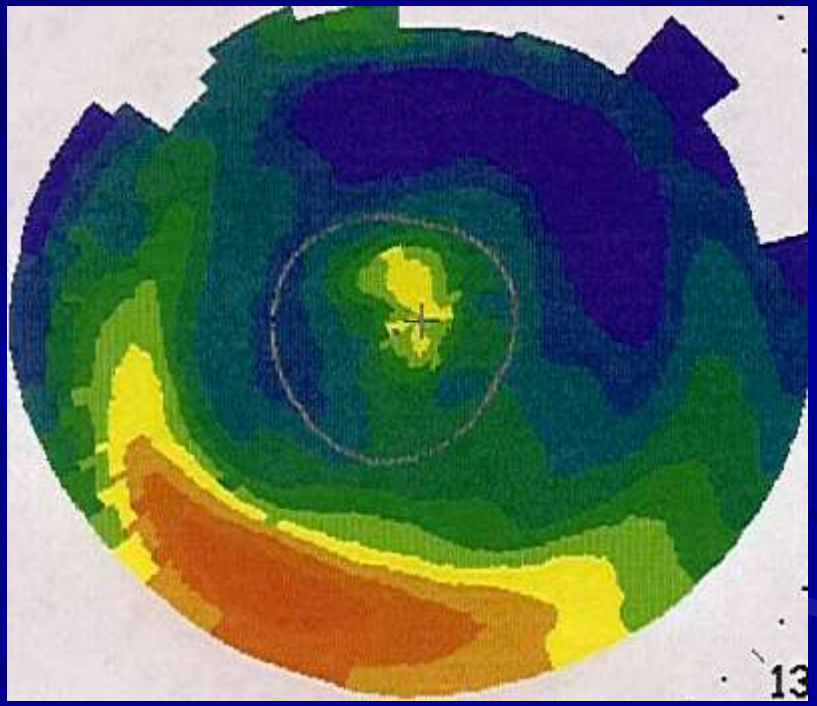
One day after surgery diffuse lipid is noted under the flap.

Topography shows a central island and an inferior peninsula;

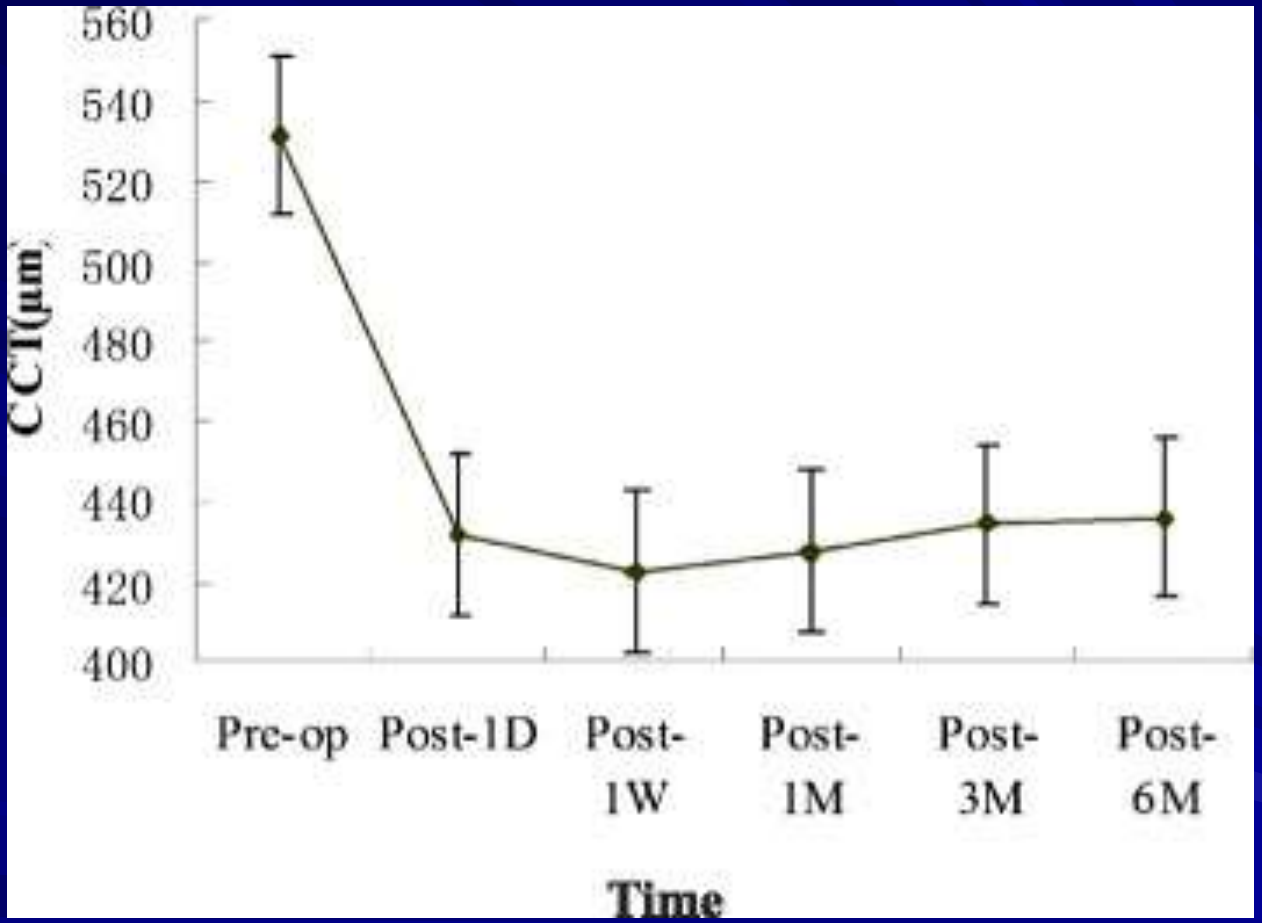


Three days after surgery less lipid is noted under theflap

Topography shows significant resolution

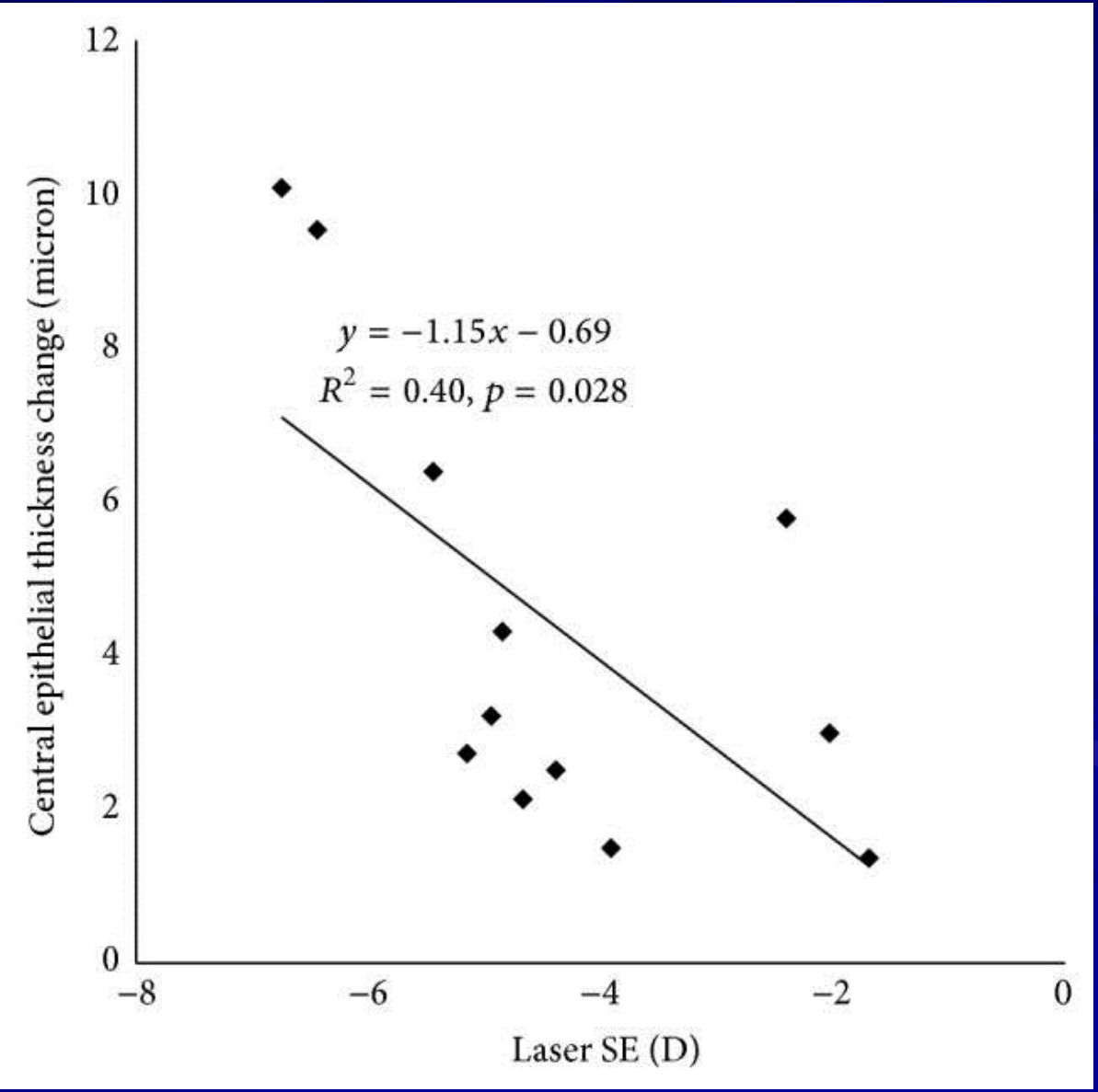


Myopia: Corneal thickness over time Presumed Epithelial



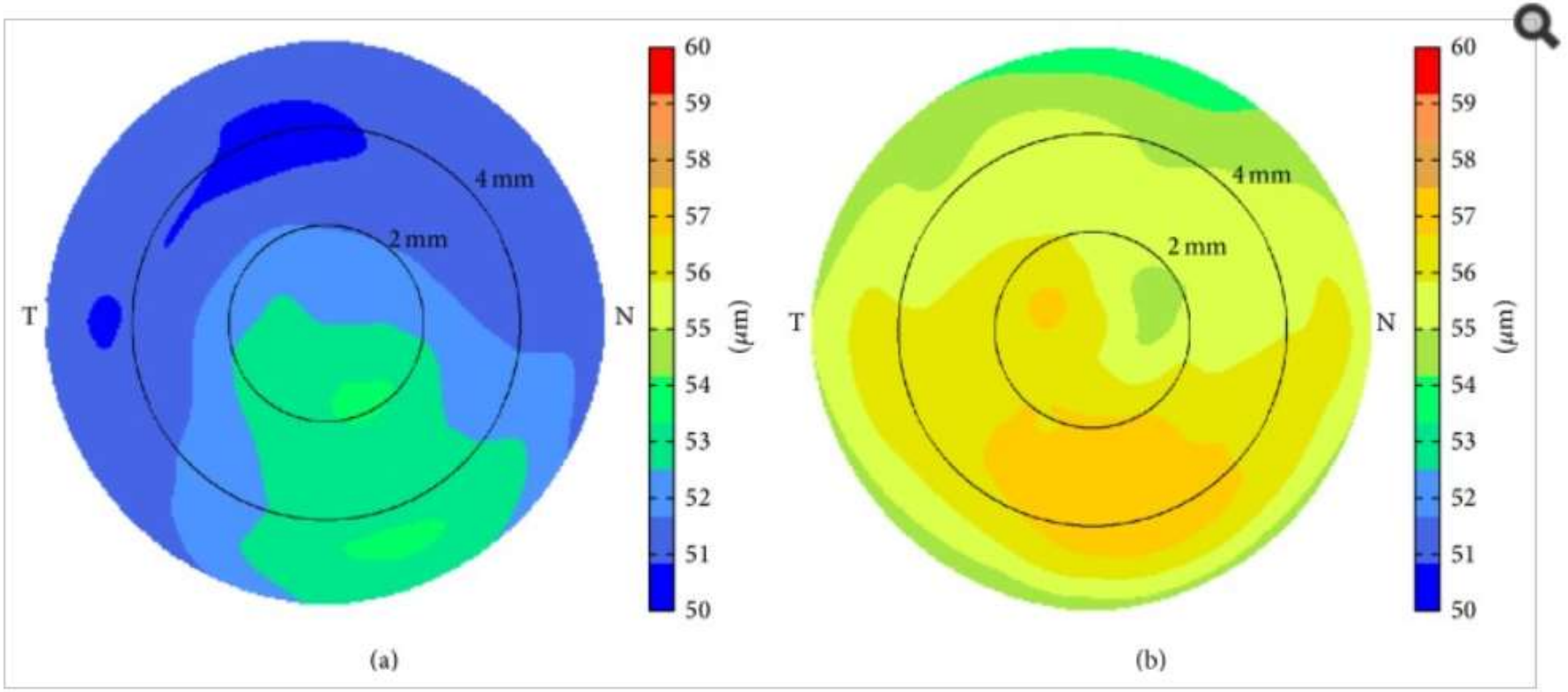
BMC Ophthalmol. 2015 Jul 29;15:86. doi: 10.1186/s12886-015-0083-2.
Changes in central corneal thickness and refractive error after thin-flap laser in situ keratomileusis in Chinese eyes.
Zhao MH1, Wu Q2, Jia LL3, Hu P4.

Thickening and regression greater with high corrections



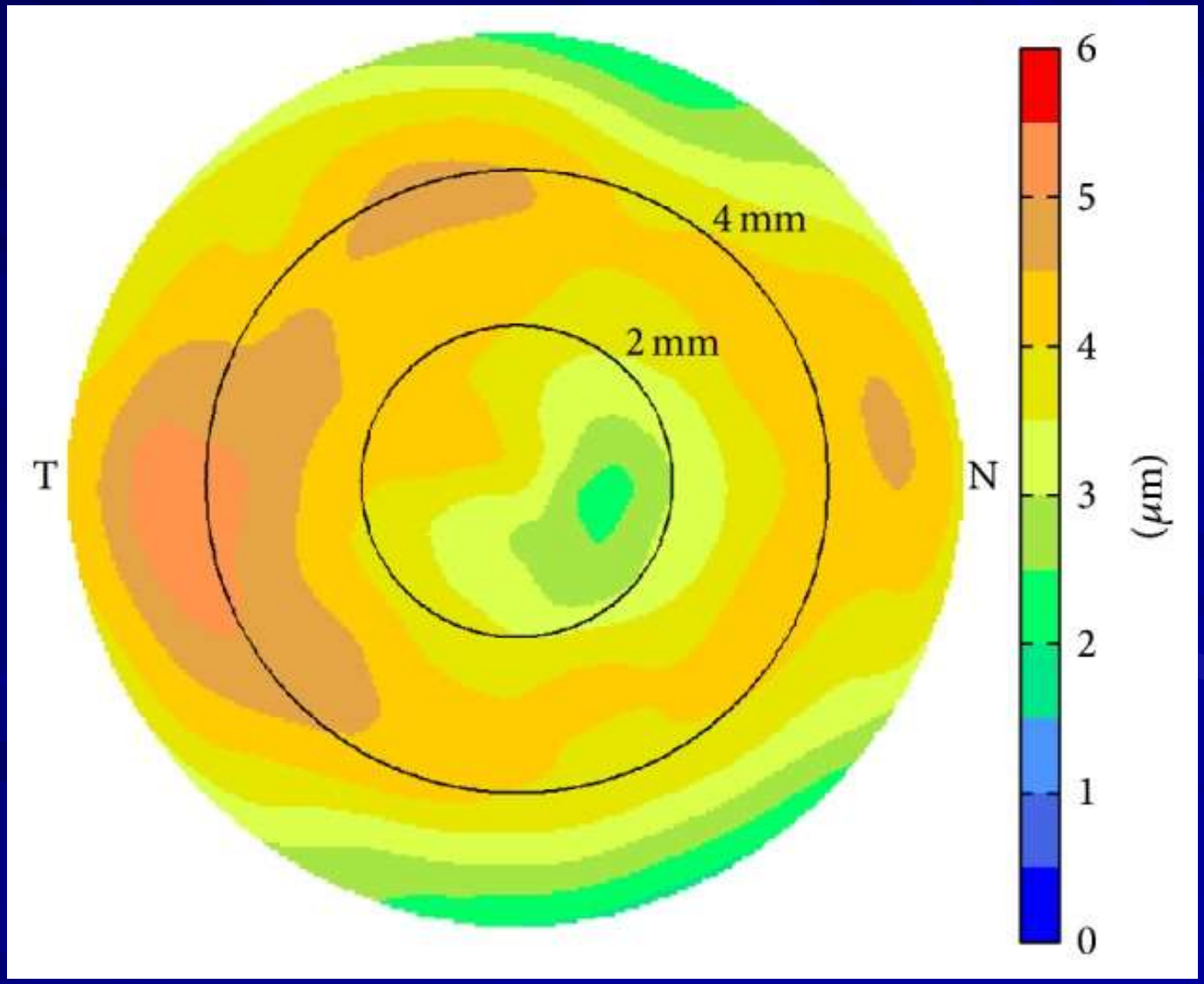
Pre-Post Lasik Epithelium

Figure 1

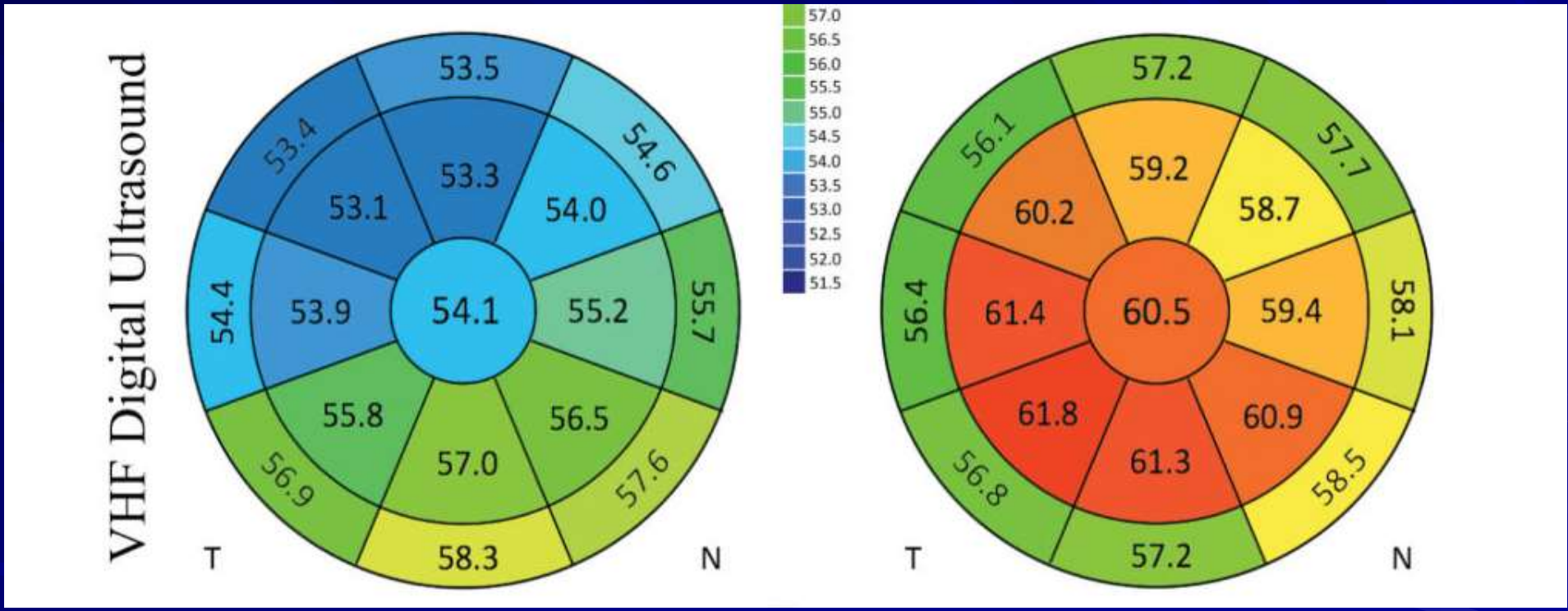


Average epithelial thickness map (a) before LASIK and (b) 3 months after LASIK measured by a Fourier-domain OCT system.

Average epithelial thickness change map after myopic LASIK



Pre-post Lasik Epithelium



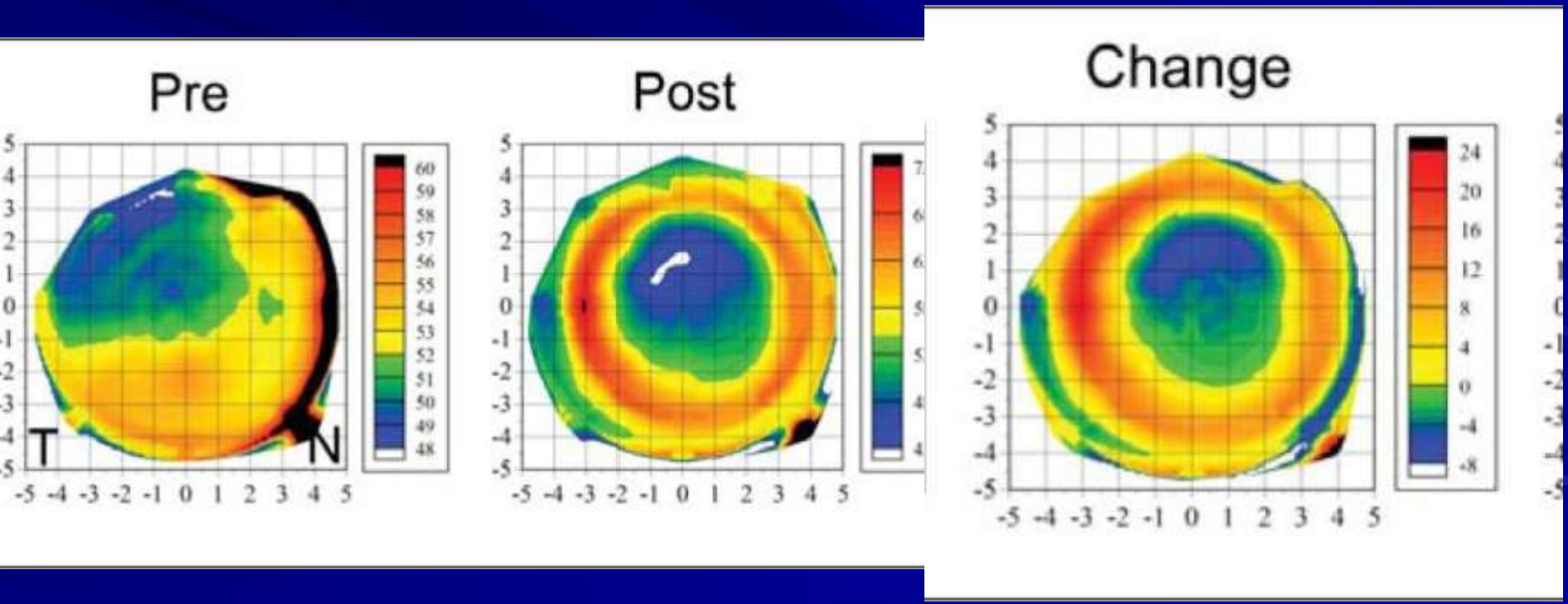
J Refract Surg. 2015 Jul;31(7):438-45. doi: 10.3928/1081597X-20150623-01.
Comparison of Corneal Epithelial Thickness Measurement Between Fourier-Domain OCT and Very High-Frequency Digital Ultrasound.
Reinstein DZ, Yap TE, Archer TJ, Gobbe M, Silverman RH.

J Refract Surg. 2010 Aug;26(8):555-64. doi: 10.3928/1081597X-20091105-02.

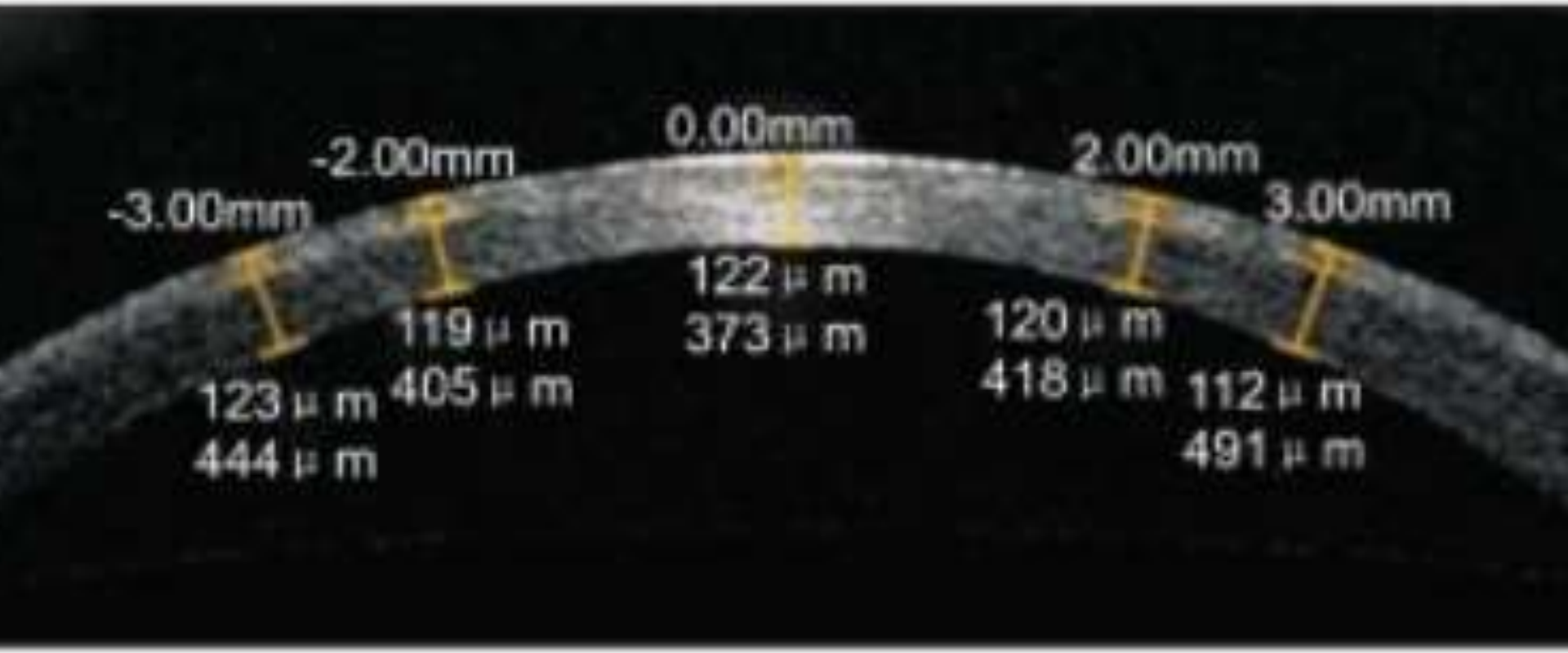
Epithelial thickness after hyperopic LASIK:

three-dimensional display with Artemis very high-frequency digital ultrasound.

Reinstein DZ1, Archer TJ, Gobbe M, Silverman RH, Coleman DJ.



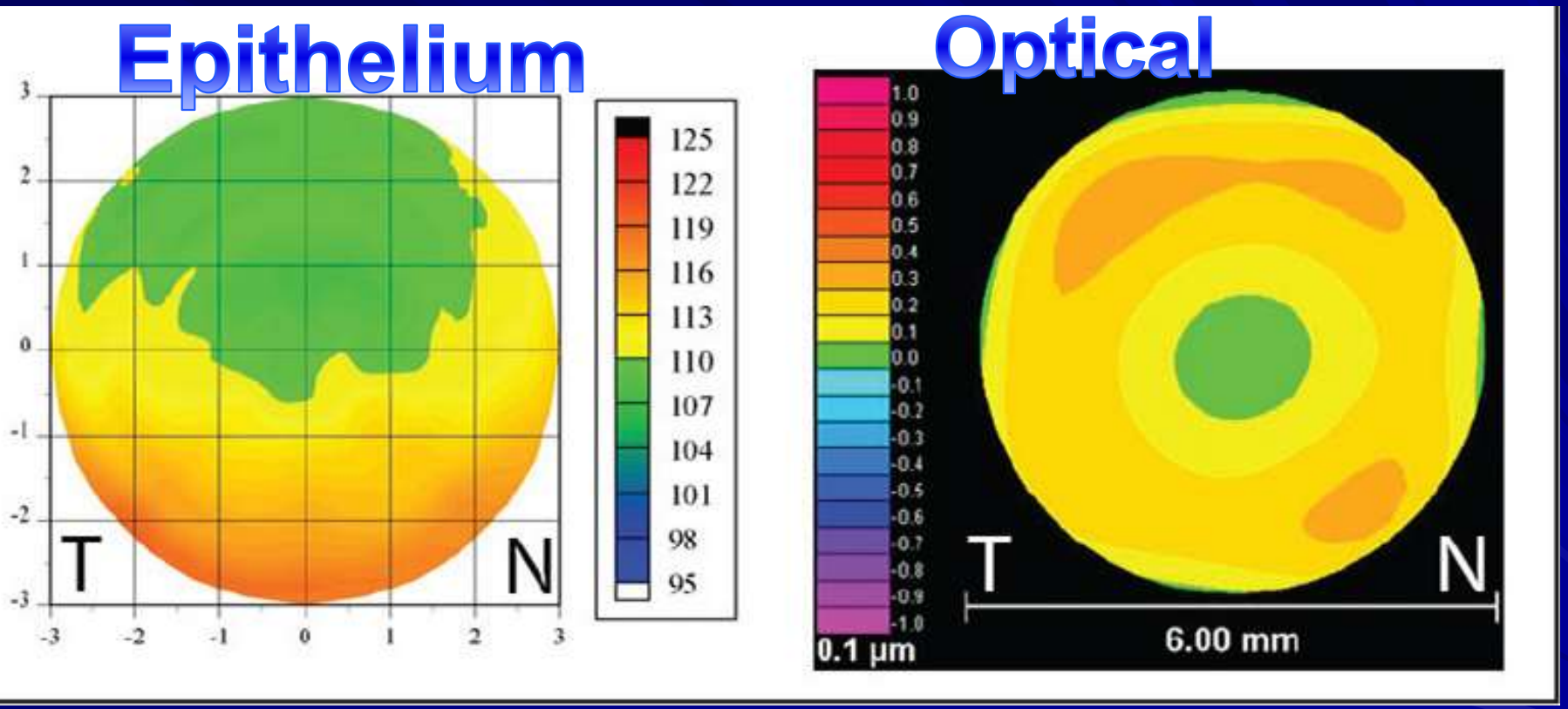
Flap thickness



Int J Ophthalmol. 2012; 5(3): 338–342.
Comparisons of morphologic characteristics between thin-flap LASIK and SBK
Yi Sun, Ying-Ping Deng, Lin Wang, Yong-Zhi Huang, and Le-Mei Qiu

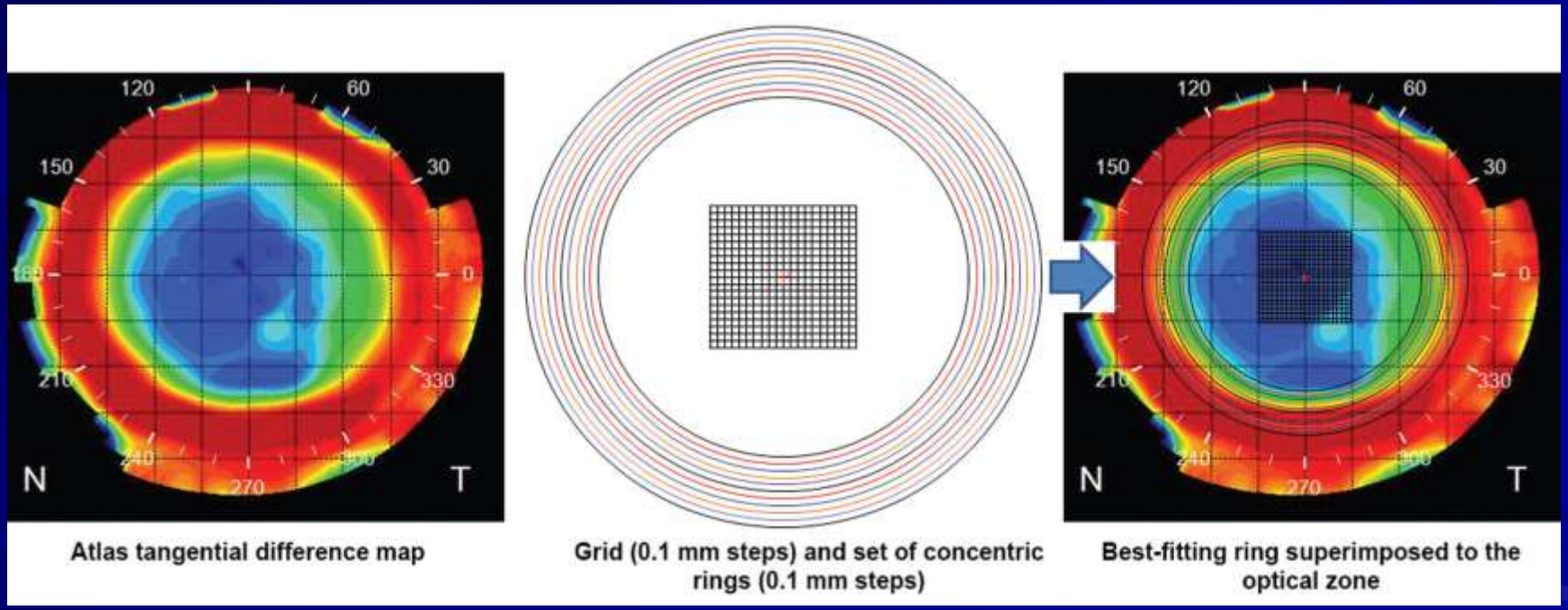
Thickness Profile Map

Higher Order Aberrations Map



J Refract Surg. 2015 Feb;31(2):130-5. doi: 10.3928/1081597X-20150122-09.
Comparison of higher-order aberration induction between ..
Yvon C, Archer TJ, Gobbe M, Reinstein DZ.

Centration Evaluation



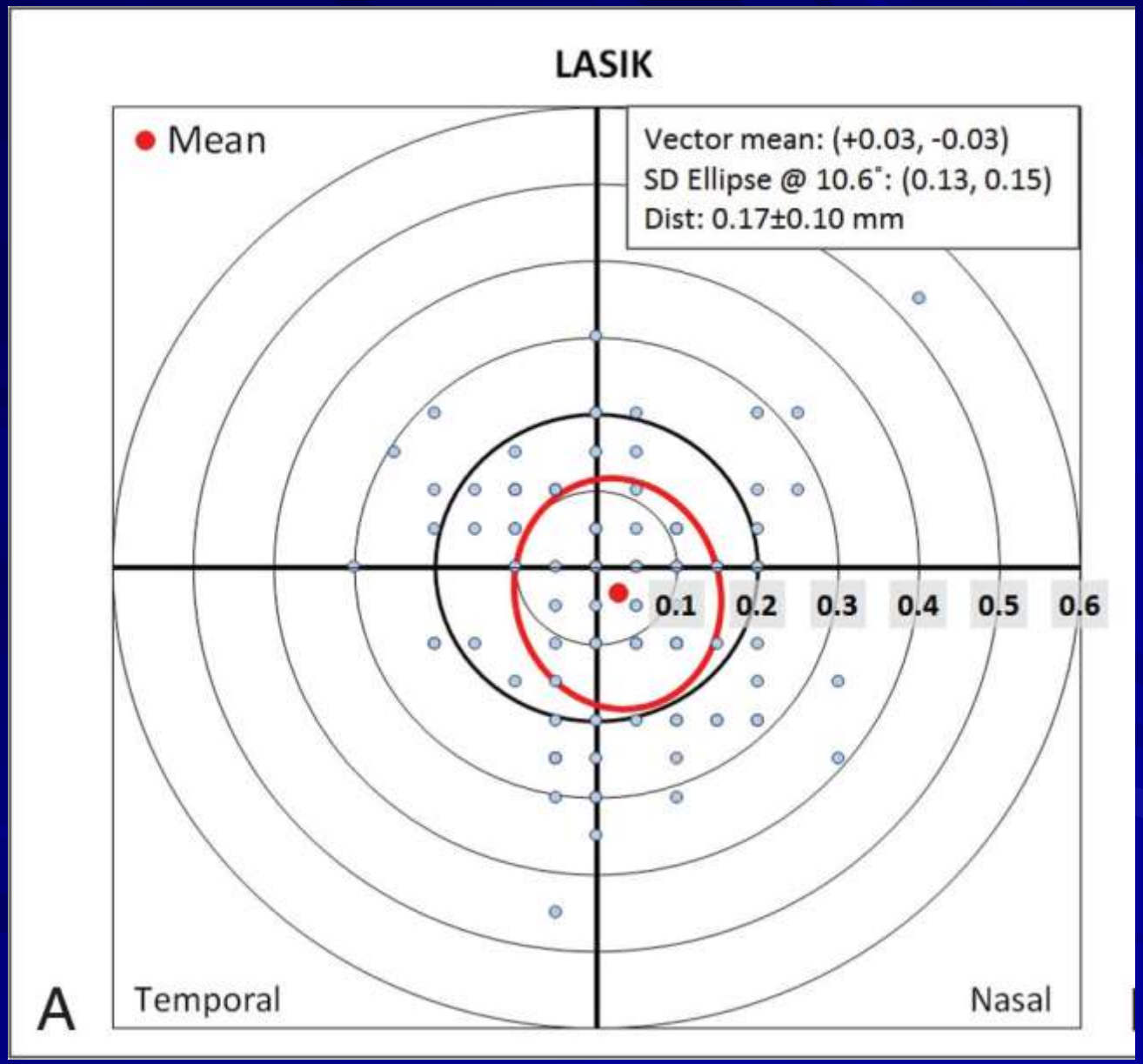
Atlas tangential difference map

Grid (0.1 mm steps) and set of concentric rings (0.1 mm steps)

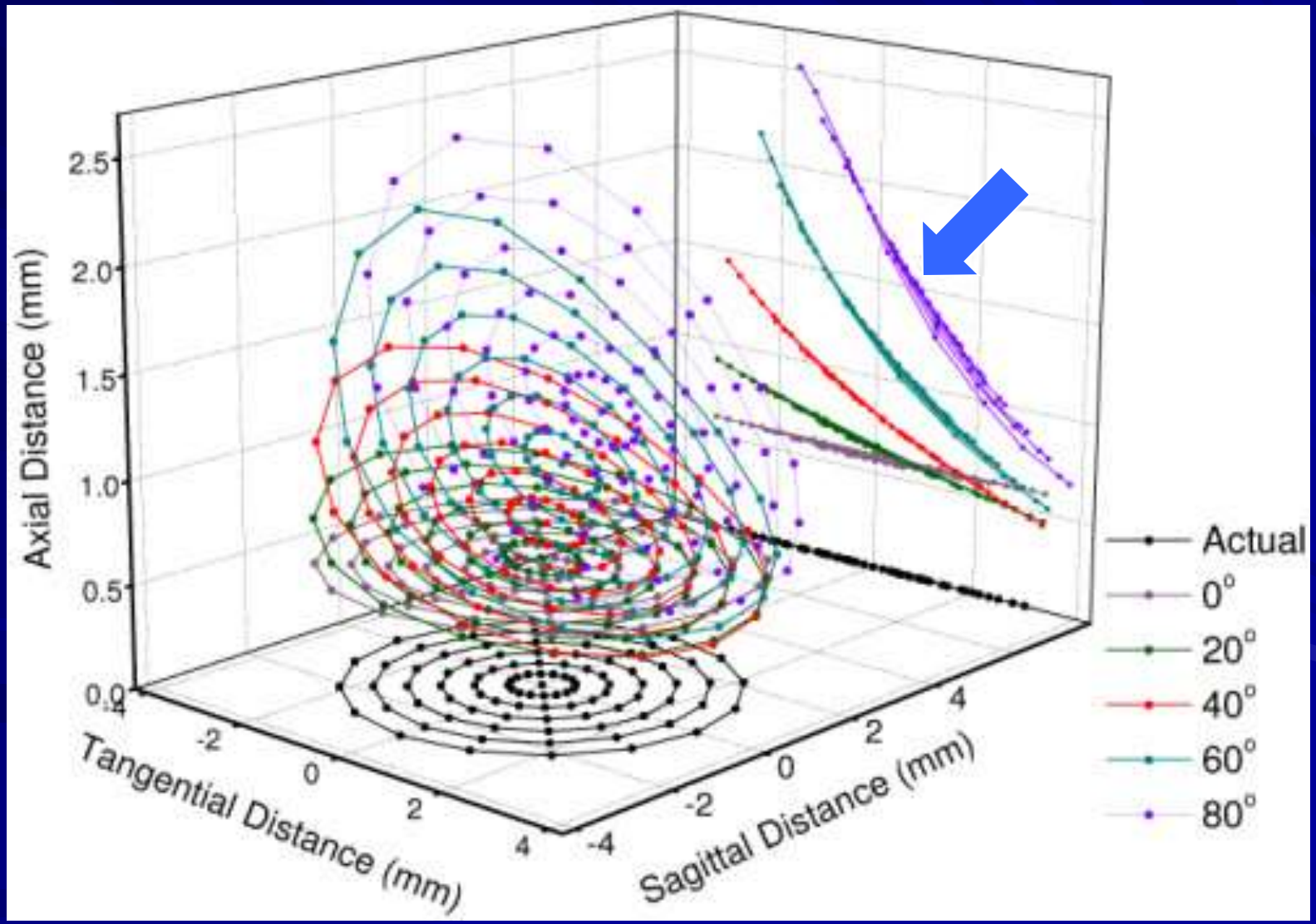
Best-fitting ring superimposed to the optical zone

Dan Z. Reinstein, MD, MA(Cantab), FRCOphth; Marine Gobbe, PhD, MSTOptom; Louis Gobbe; Timothy J. Archer, MA(Oxon DipCompSci(Cantab); Glenn I. Carp, MBBCh, FCOphth(SA)
Optical Zone Centration Accuracy Using Corneal Fixation-based SMILE Compared to Eye Tracker-based Femtosecond Laser-assisted LASIK for Myopia
Journal of Refractive Surgery
September 2015 - Volume 31 · Issue 9: 586-592

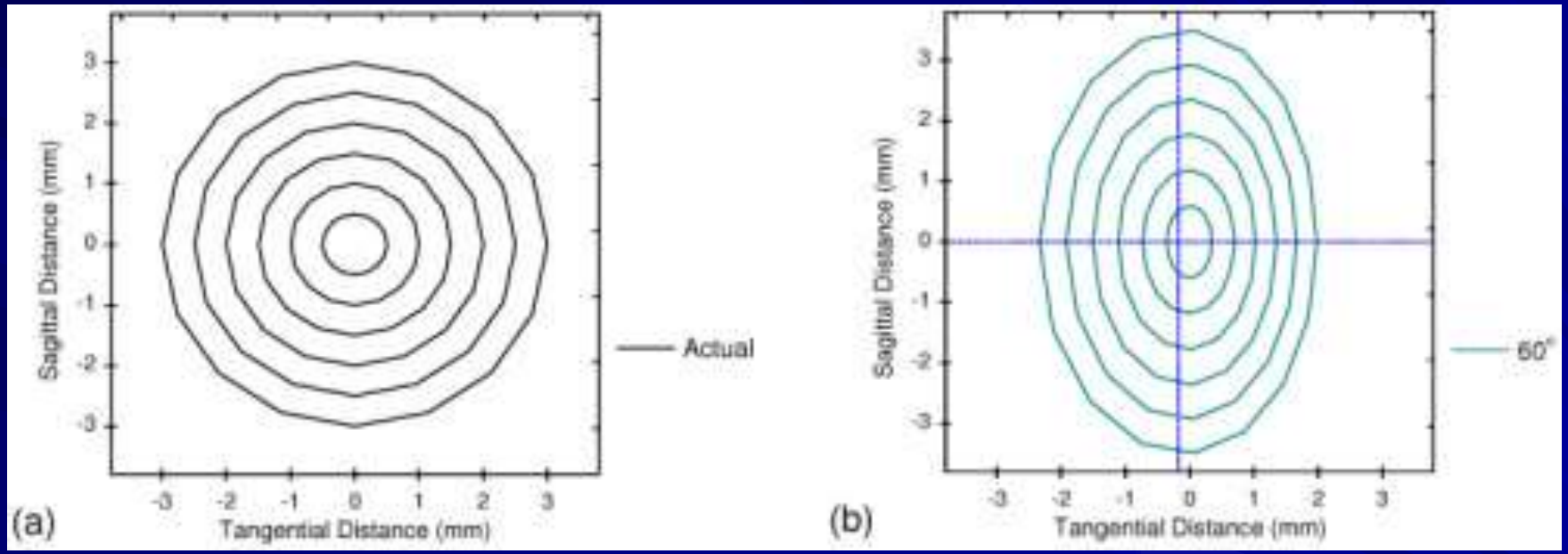
Centration offset between the center of the ablation zone and the corneal vertex



Calculated position of virtual pupil
With off axis appears up to 0.4 mm closer

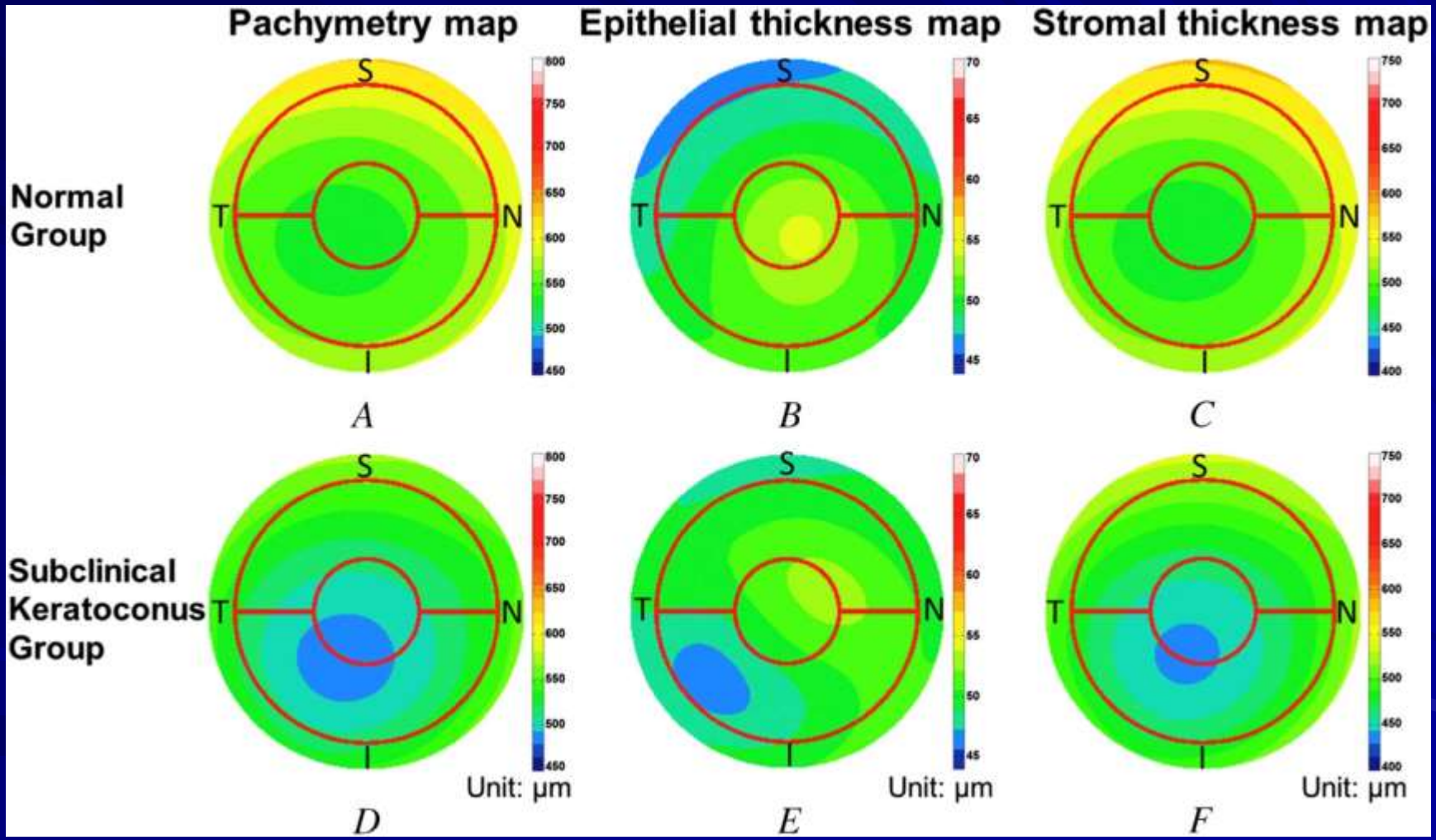


Pupil shifts when viewed off axis



http://www.opticsinfobase.org/oe/fulltext.cfm?uri=oe-18-21-22364#&slider2=1

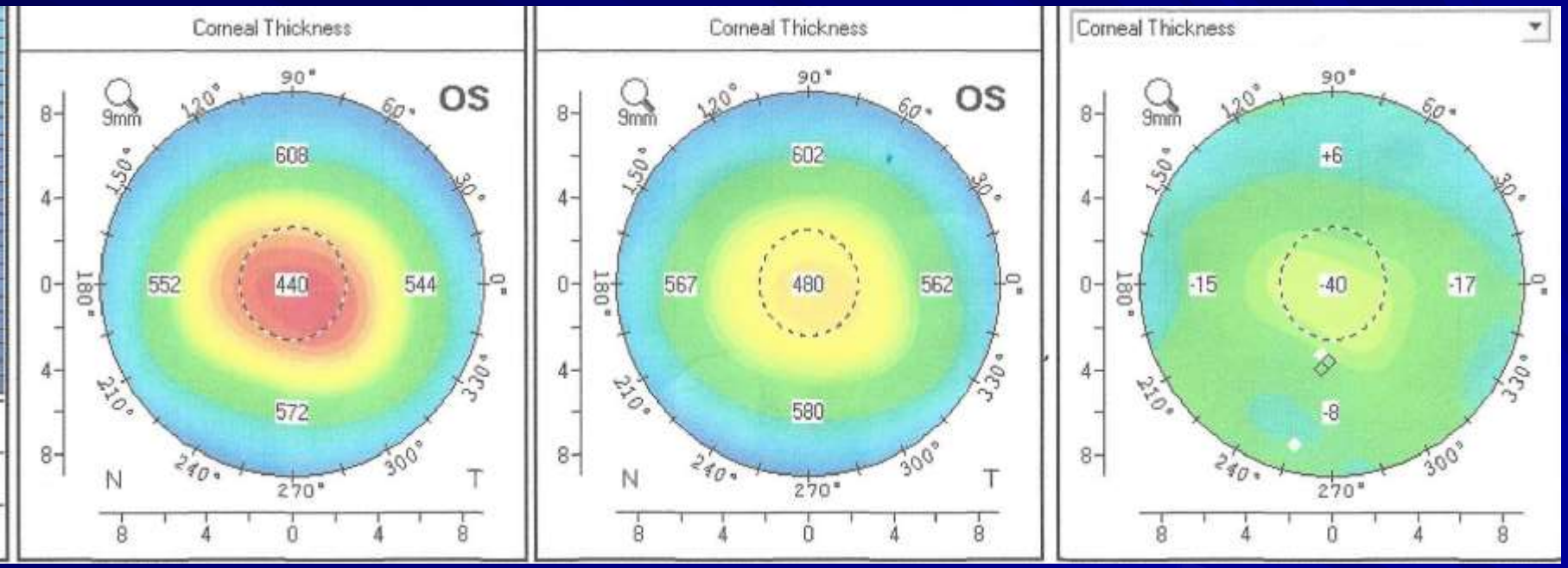
Thinnest area usually less than 1 mm IT from the apex



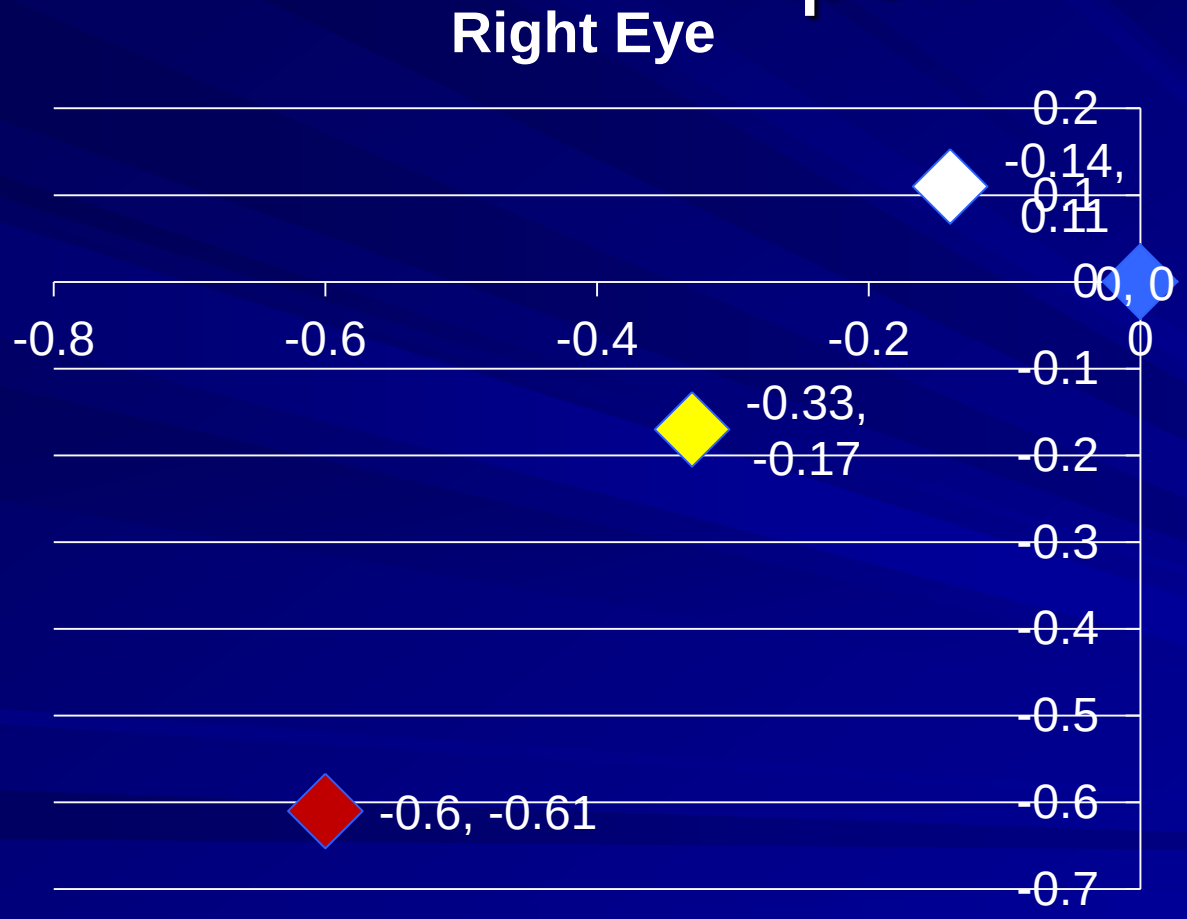
Average pachymetric, corneal epithelial, and stromal thickness maps of normal eyes (A to C) and subclinical keratoconus eyes (D to F). Maps of the left eyes that were included were mirrored before averaging. The red circles overlaid on the map had diameters of 2.0 mm and 5.0 mm. The color scale represents the thickness in microns (I = inferior; N = nasal; S = superior; T = temporal).

Journal of Cataract & Refractive Surgery 2016 42, 284-295
DOI: (10.1016/j.jcrs.2015.09.021)

Pre-post Thickness



NLEA: Ablation moves the Thinnest Area, Inferior-Temporal, towards the Apex



Pupil center

Apex

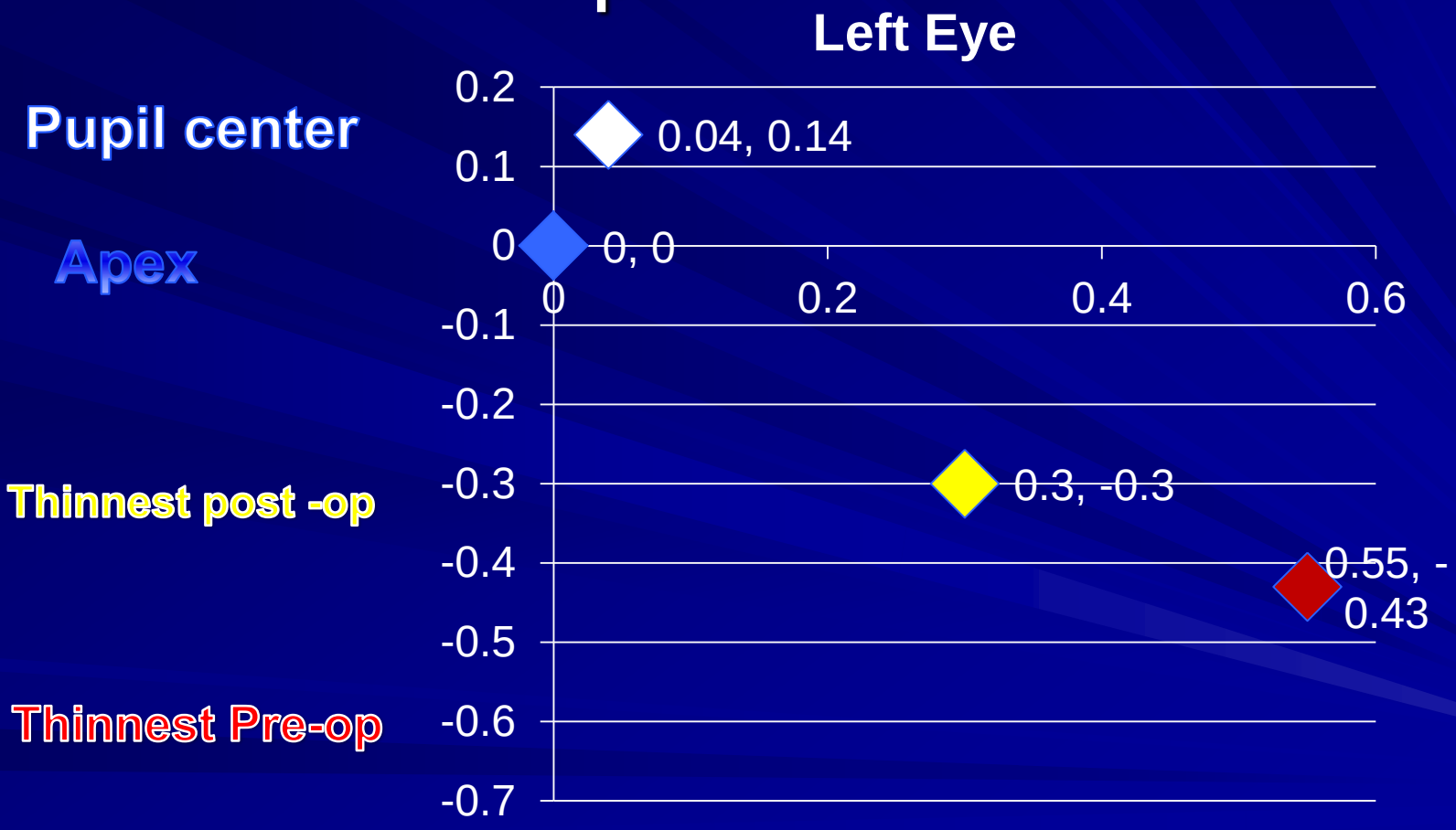
Thinnest post -op

Thinnest Pre-op

Distances from Apex in mm

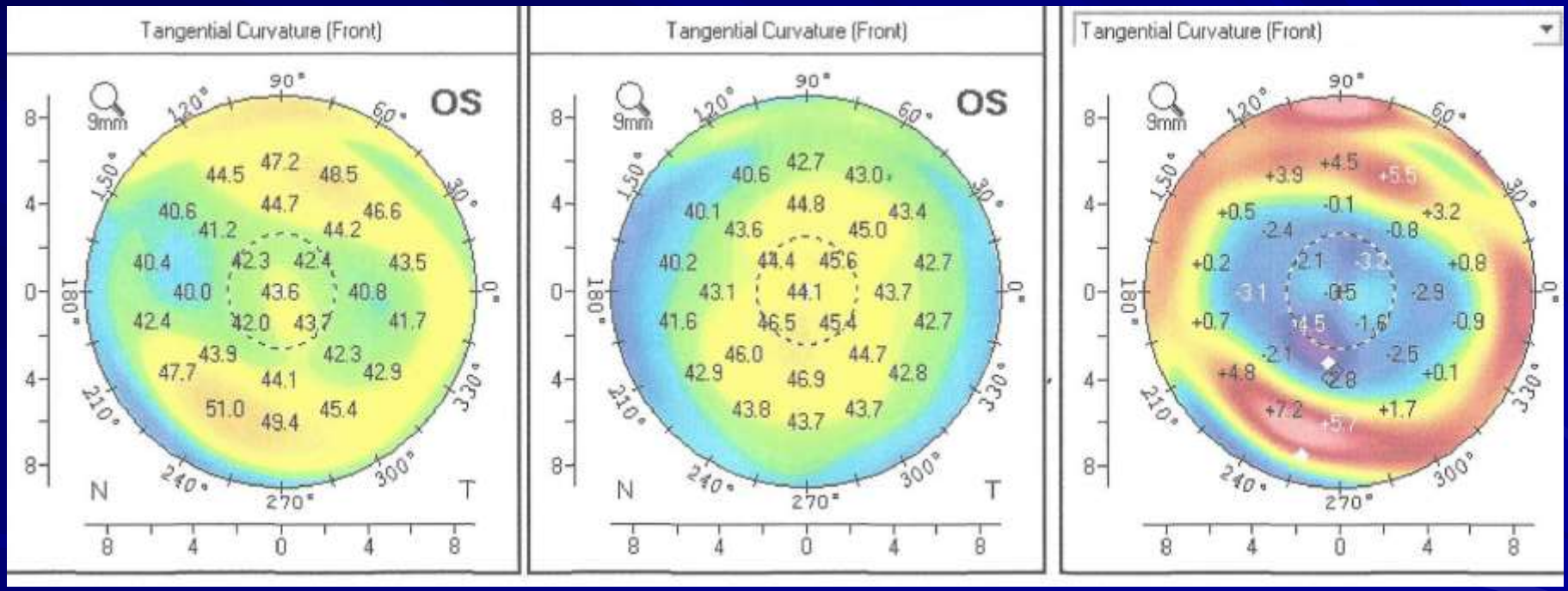
N : Rt 15 / Lt 12

NLEA: Ablation moves the Thinnest Area, Inferior-Temporal, towards the Apex

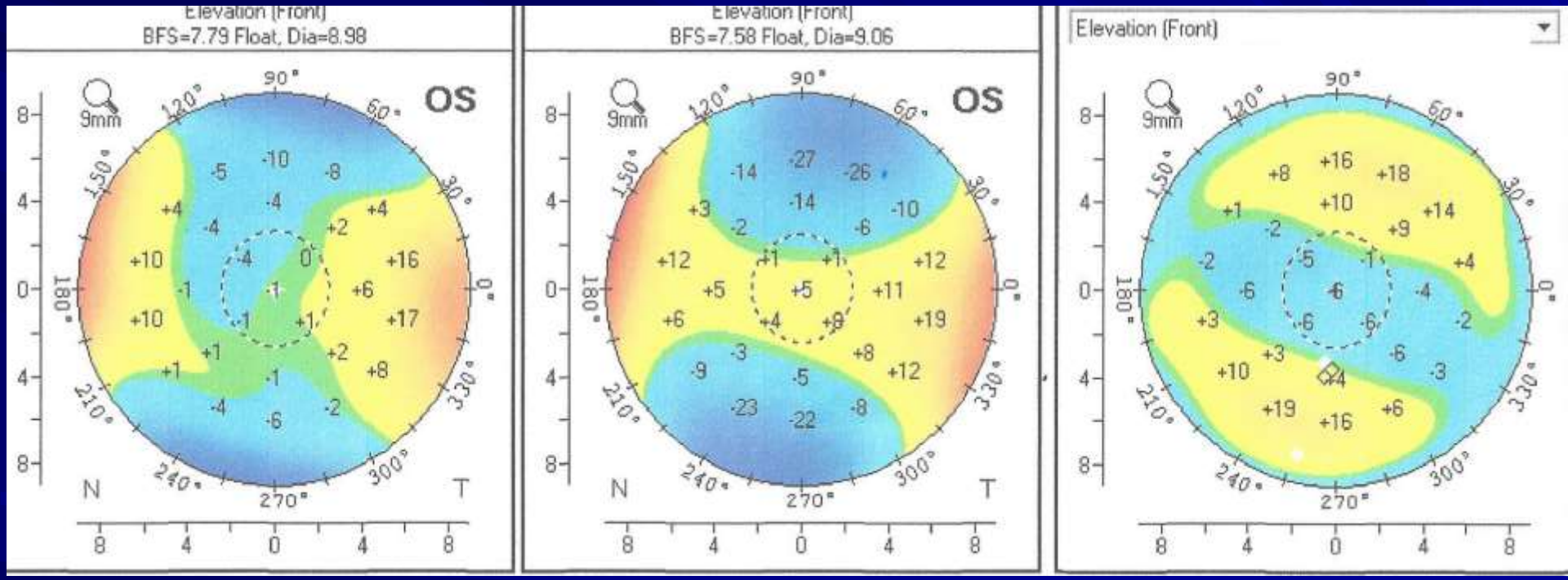


Distances from Apex in mm

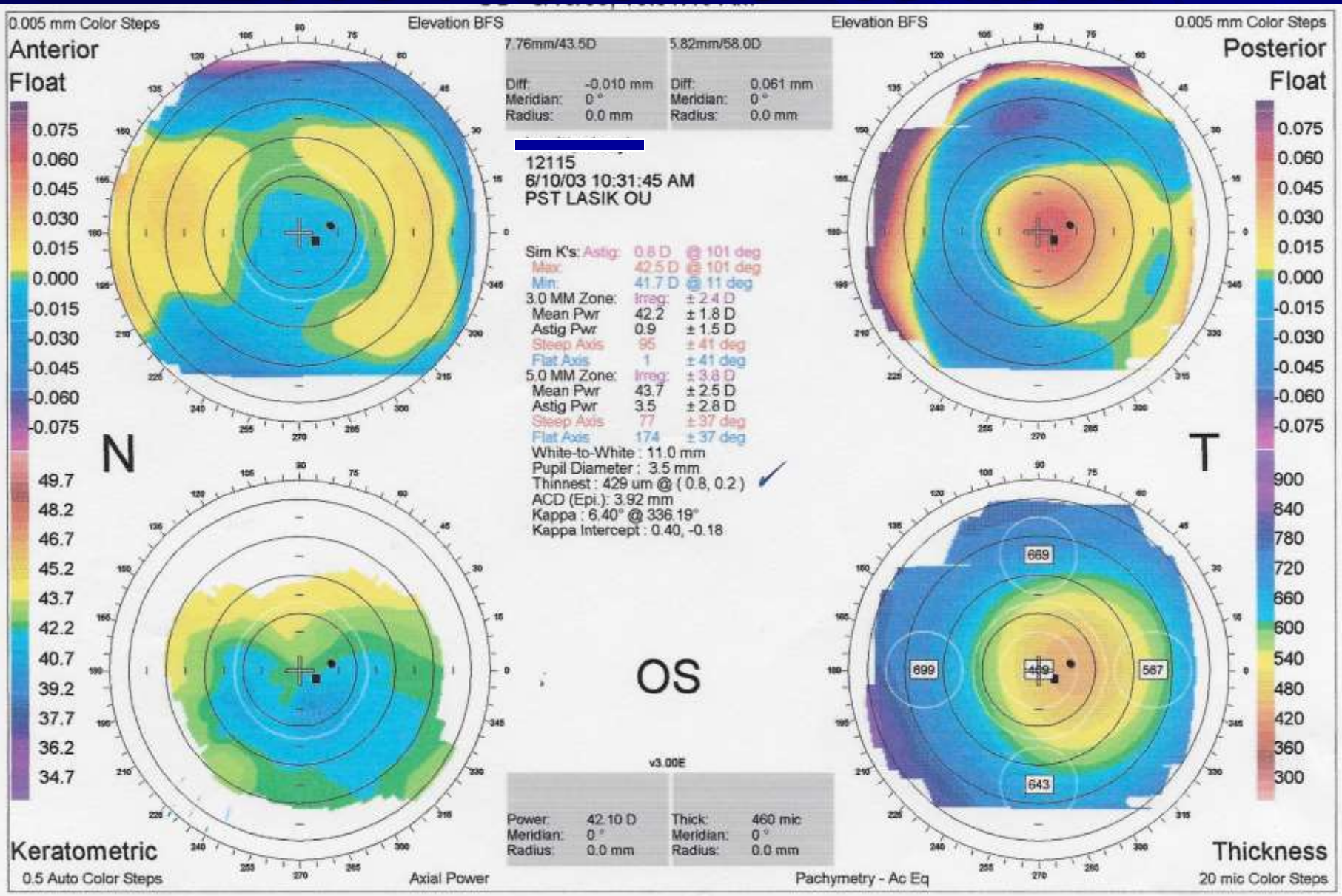
Pre-post Topography



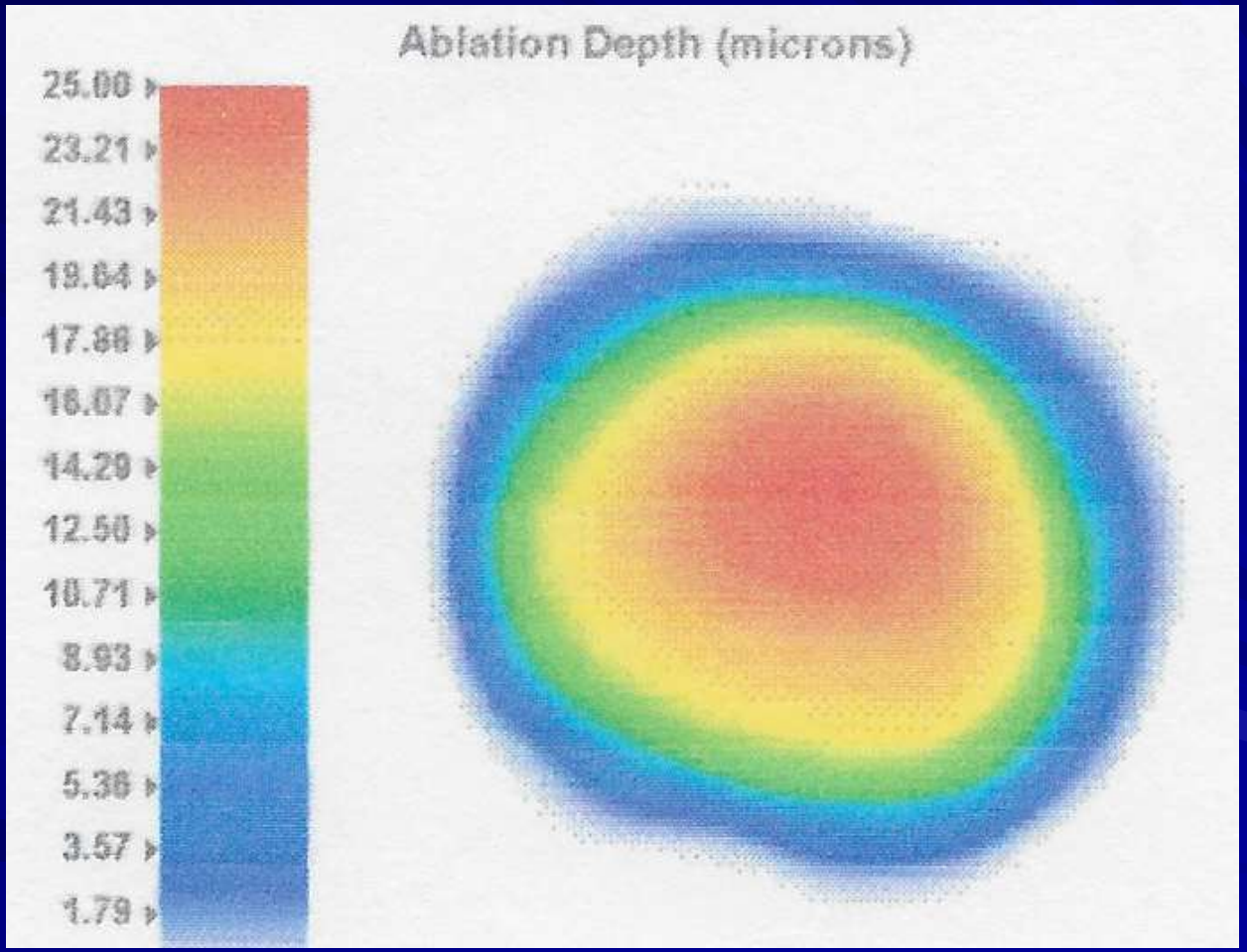
Pre-Post Elevation



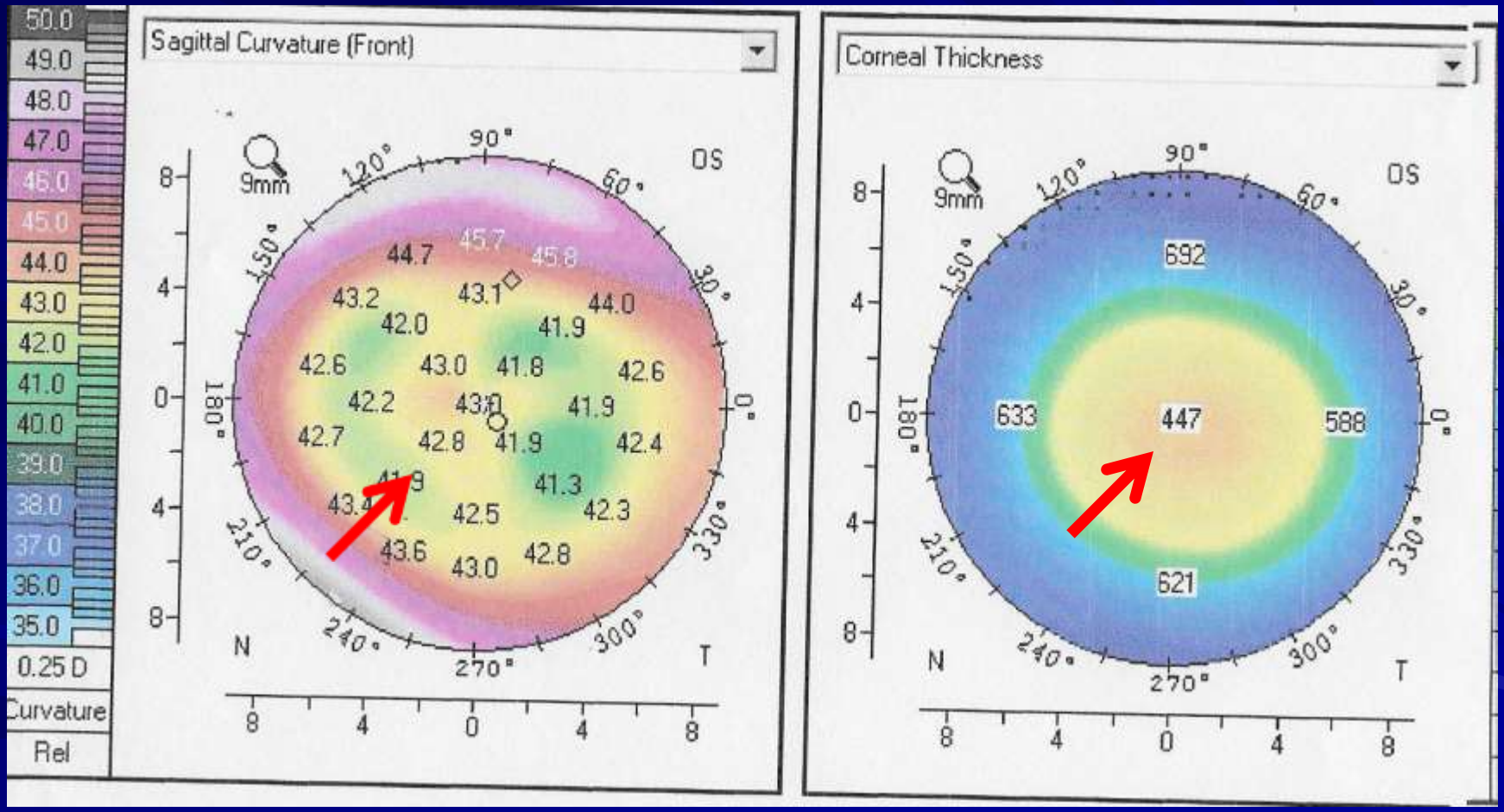
2003 Pre-enhancement



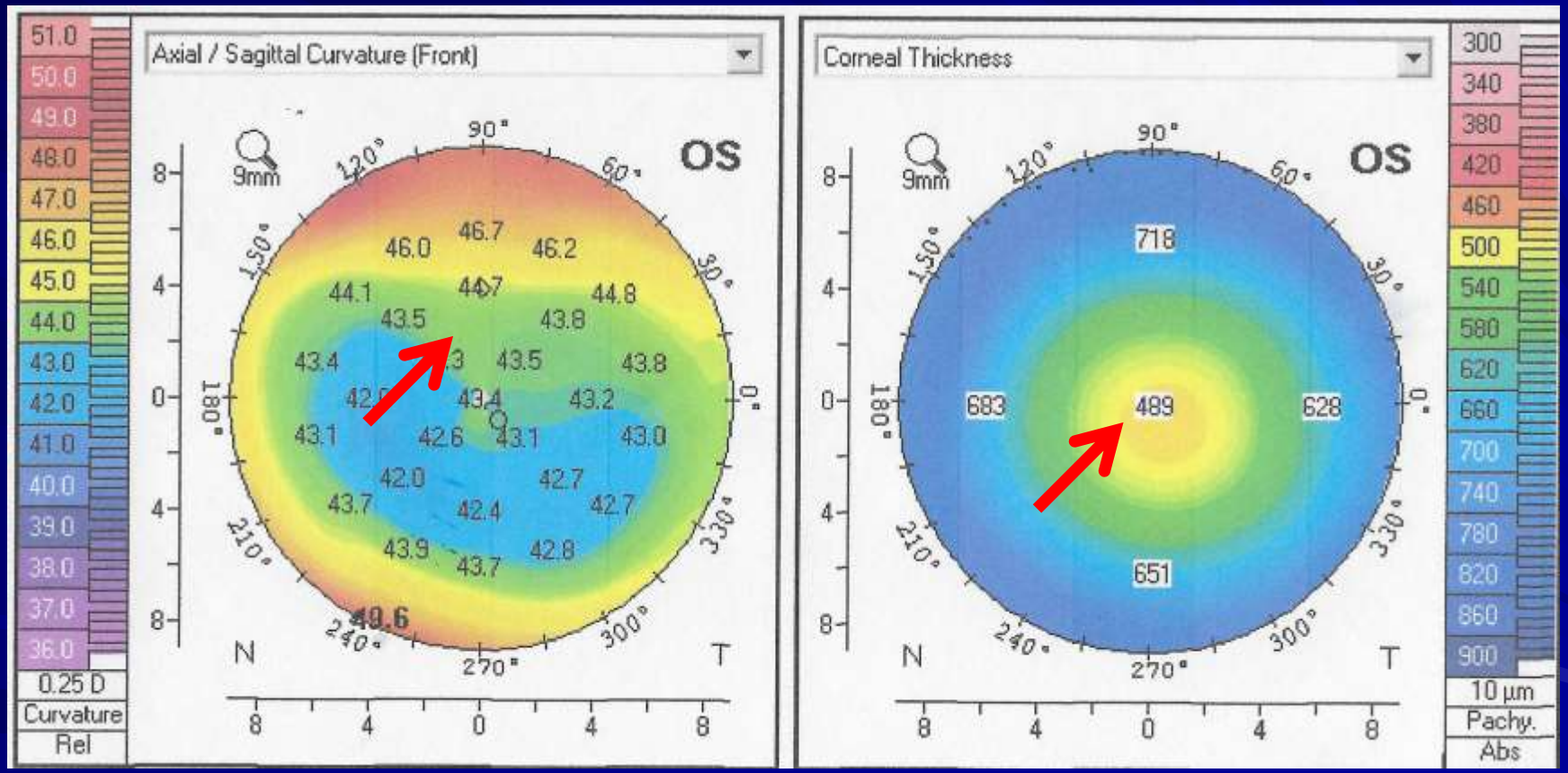
2003 Wavefront Enhancement



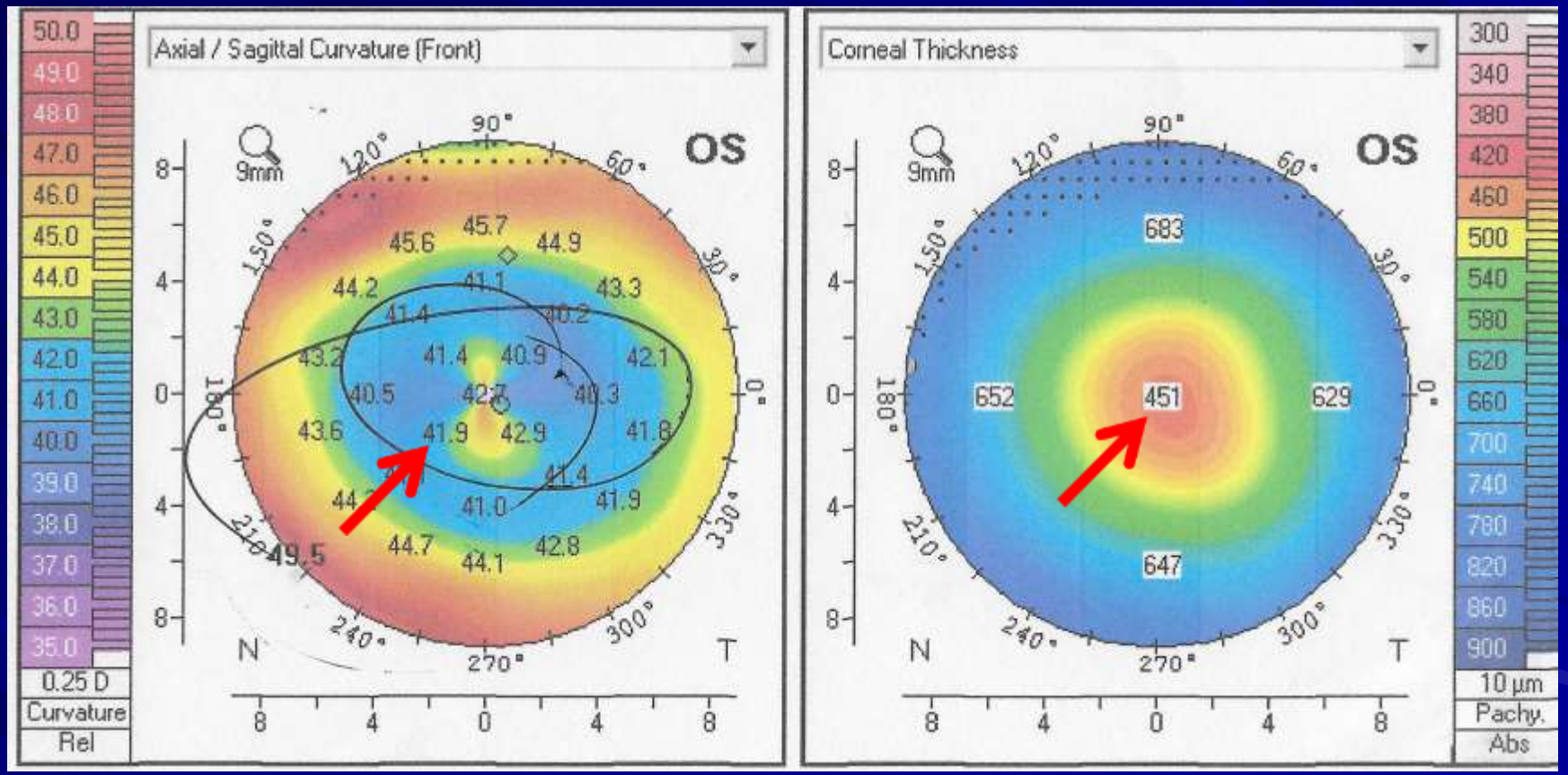
2007
Pre-op enhancement

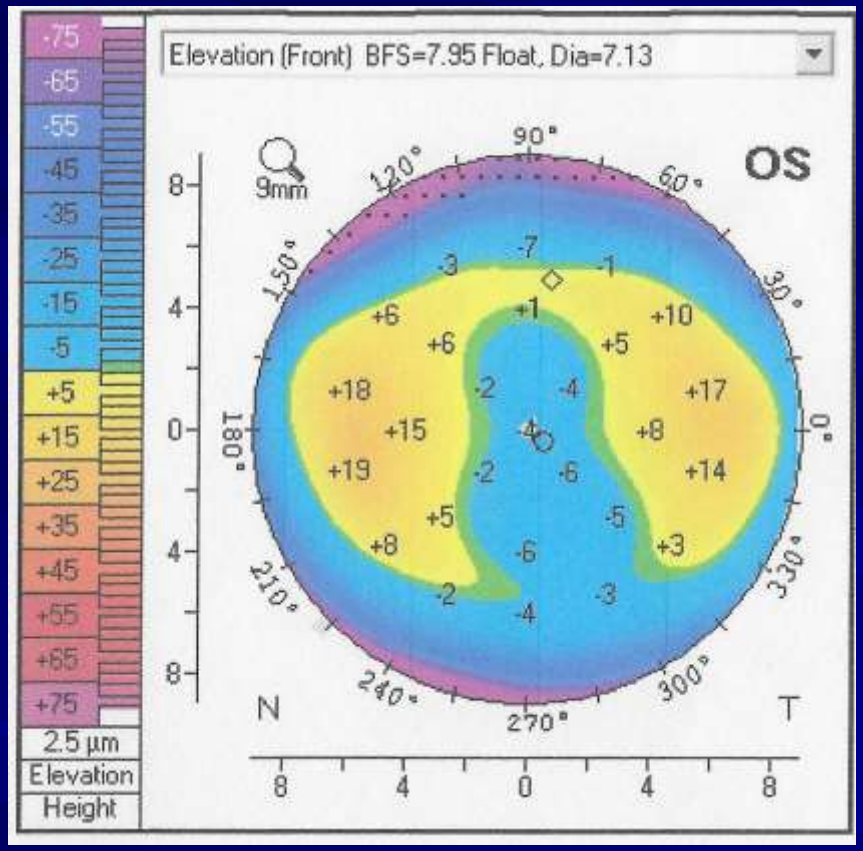


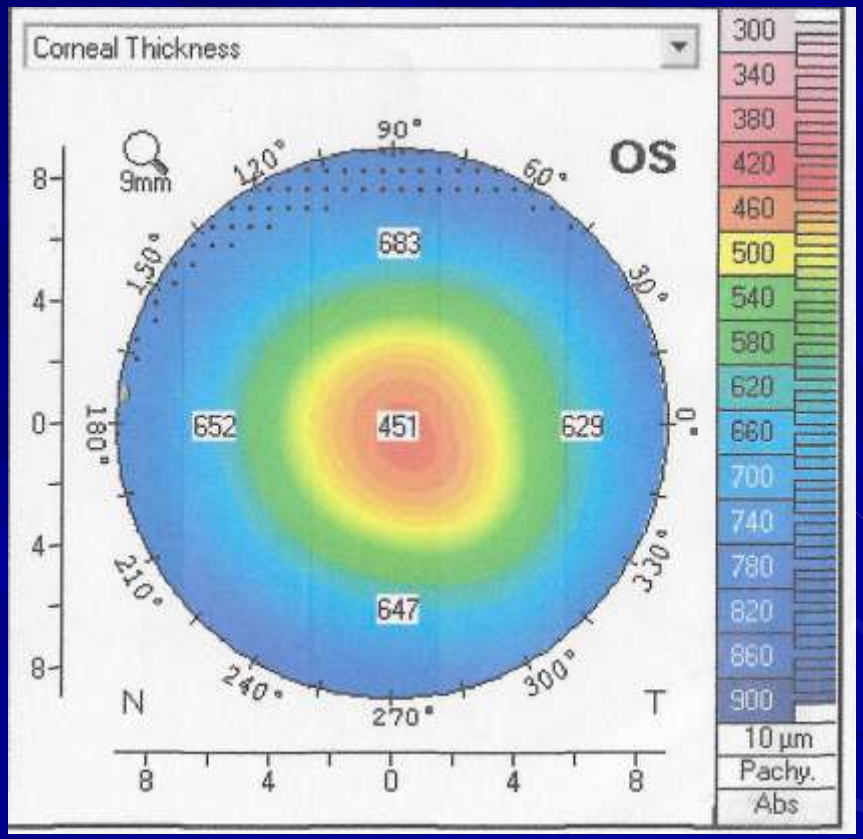
2014
Pre-Op PRK Enhancement



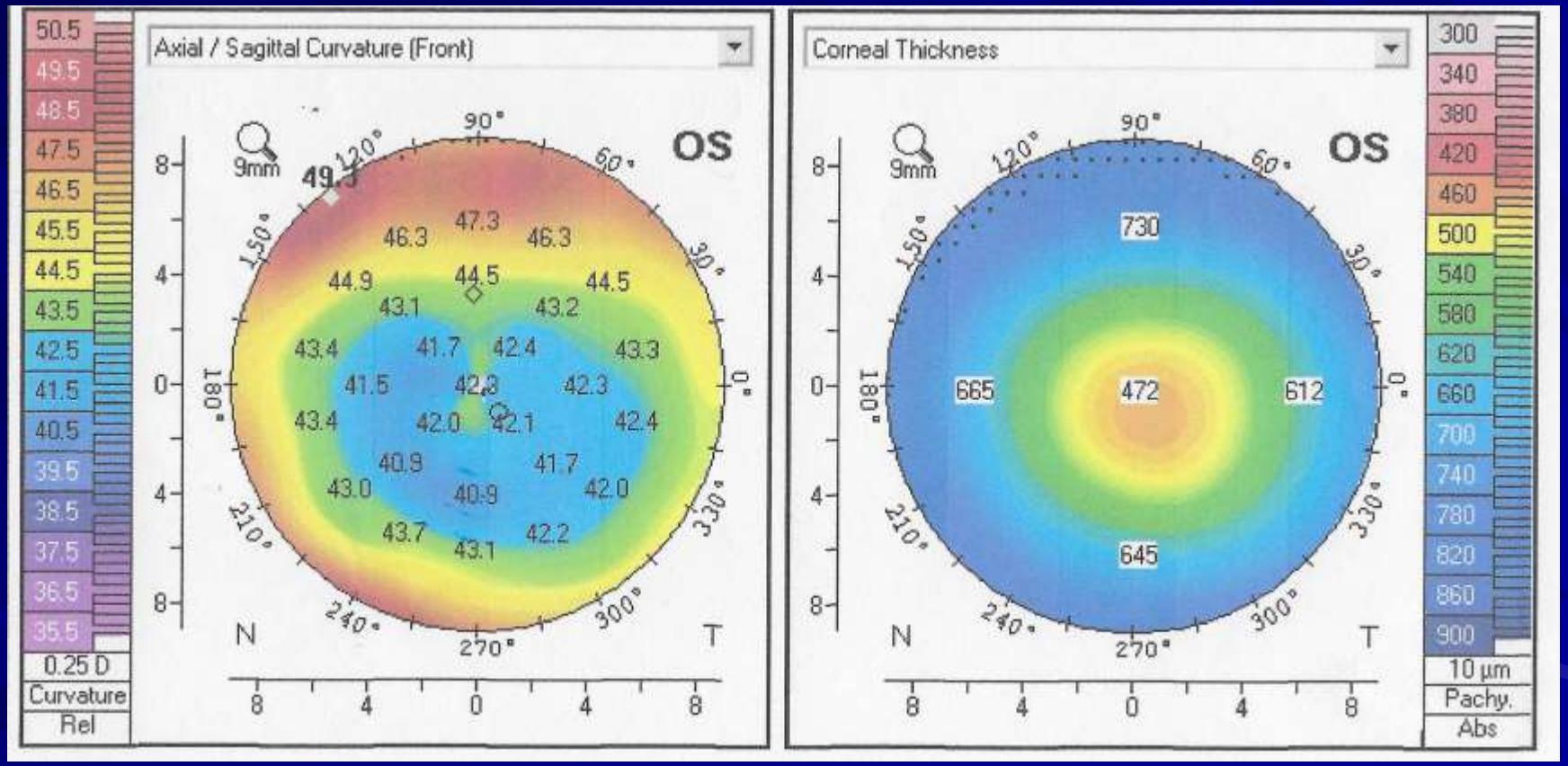
6 weeks
Post–Op PRK Enhancement

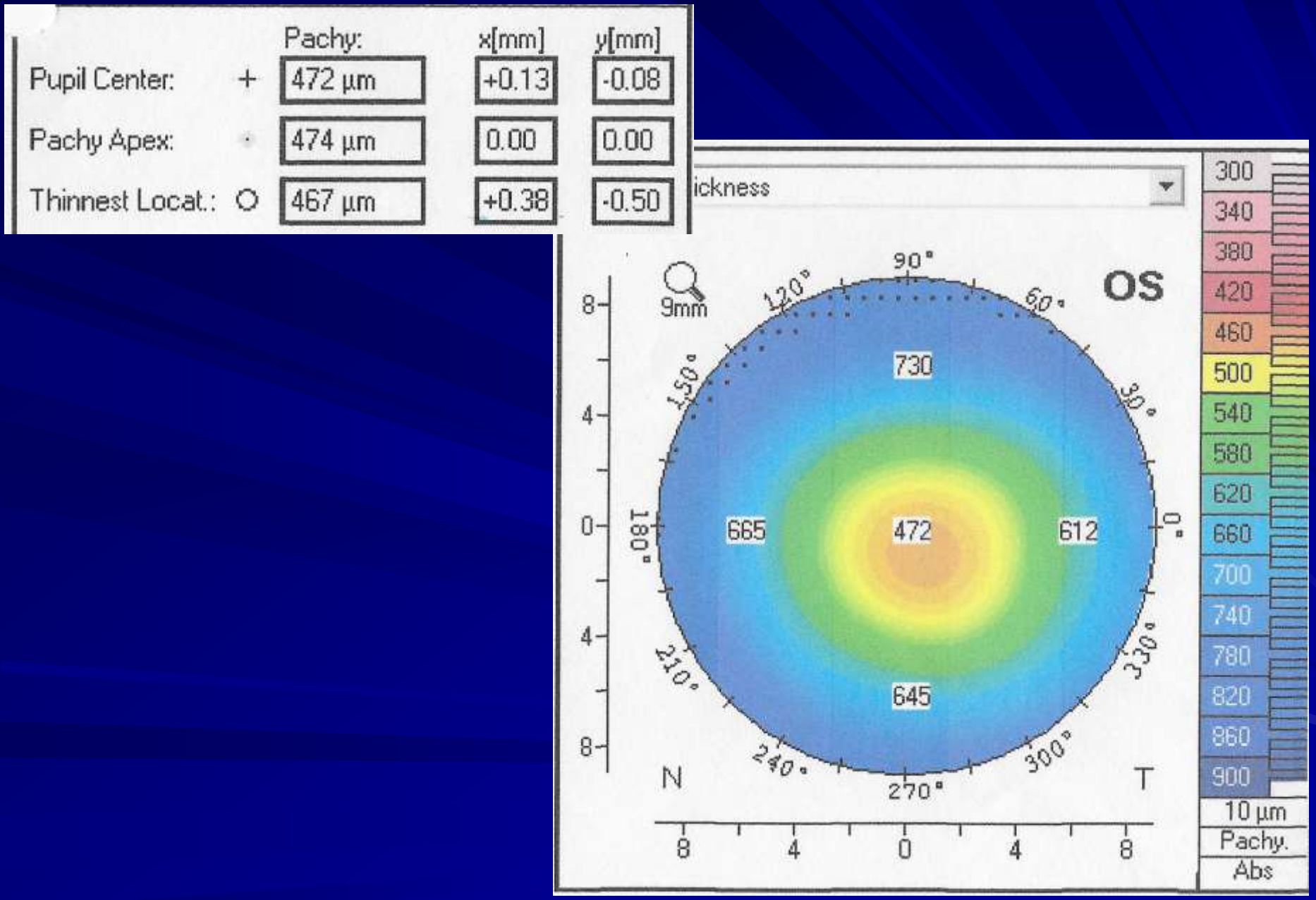



Elevation (Front) BFS=7.95 Float, Dia=7.13
OS
9mm
90°
120°
60°
150°
30°
180°
0°
210°
330°
240°
300°
270°
N
T
-7
-3
-1
+6
+1
+10
+6
+5
+18
-2
-4
+17
+15
-4
+8
+19
-2
-6
+14
+5
-5
+8
-6
+3
-2
-4
-3
8
4
0
4
8
-75
-65
-55
-45
-35
-25
-15
-5
+5
+15
+25
+35
+45
+55
+65
+75
2.5 µm
Elevation
Height

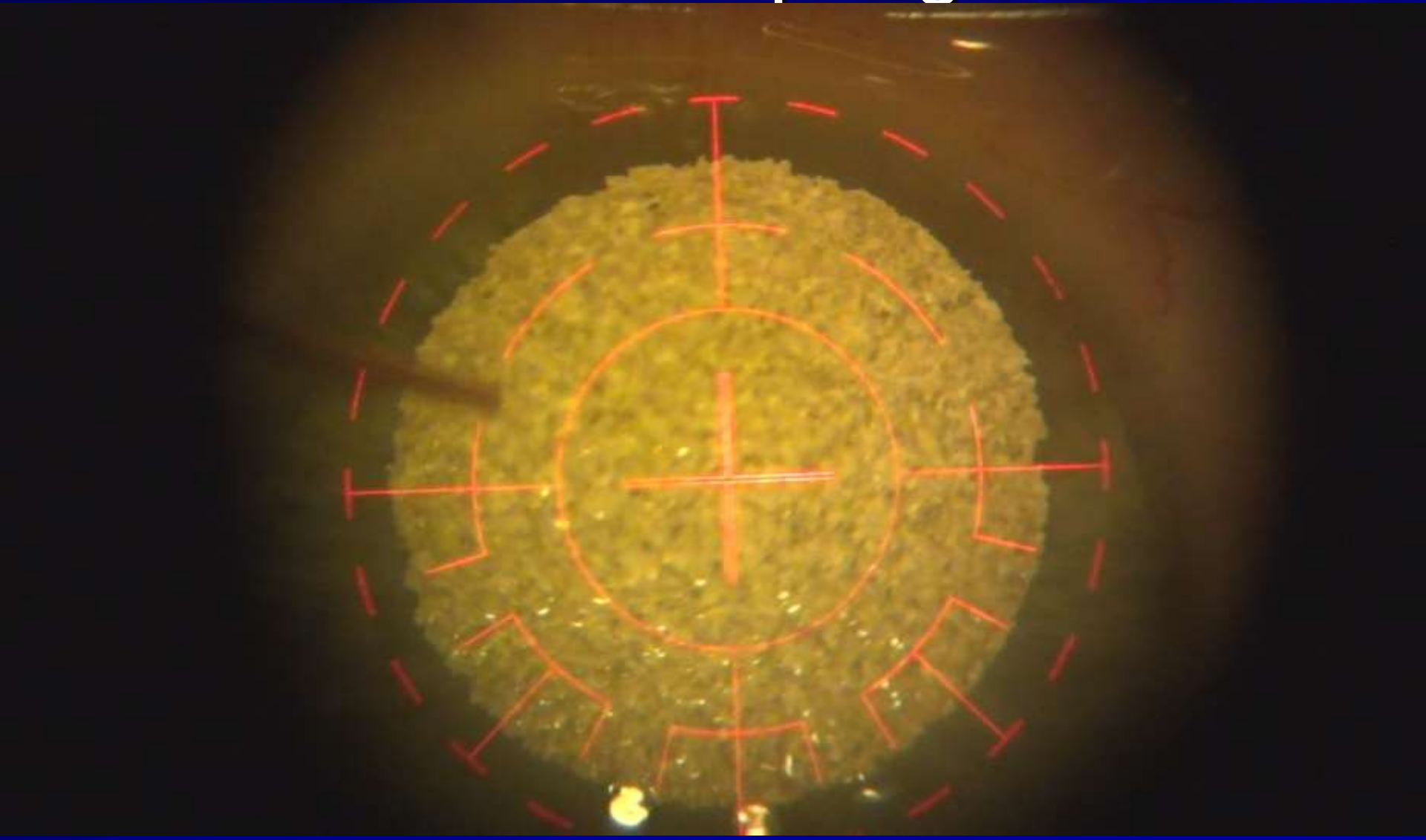

Corneal Thickness
OS
9mm
90°
120°
60°
150°
30°
180°
0°
210°
330°
240°
300°
270°
N
T
683
652
451
629
647
8
4
0
4
8
300
340
380
420
460
500
540
580
620
660
700
740
780
820
860
900
10 µm
Pachy.
Abs

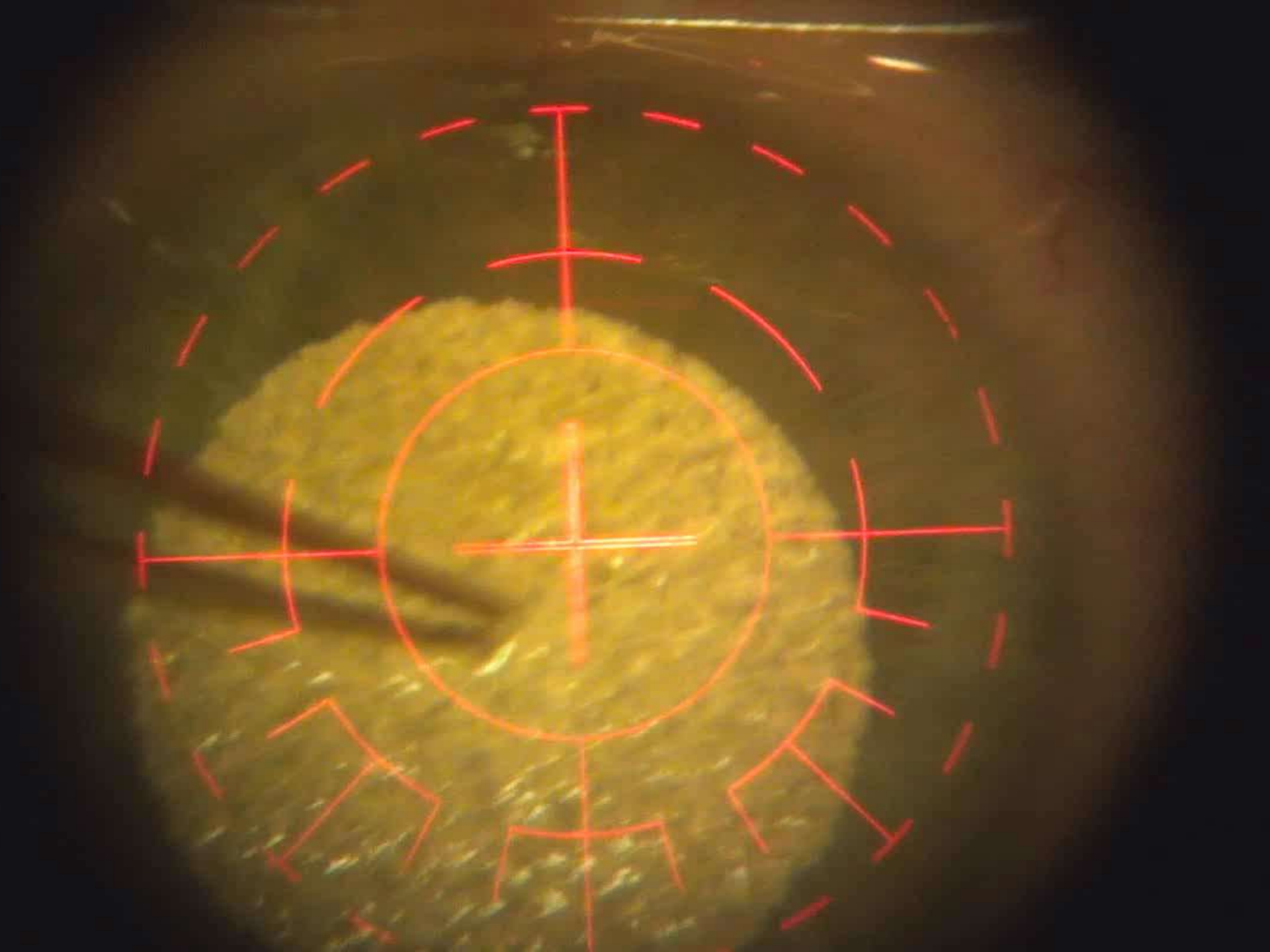
10 months Post –Op PRK Enhancement

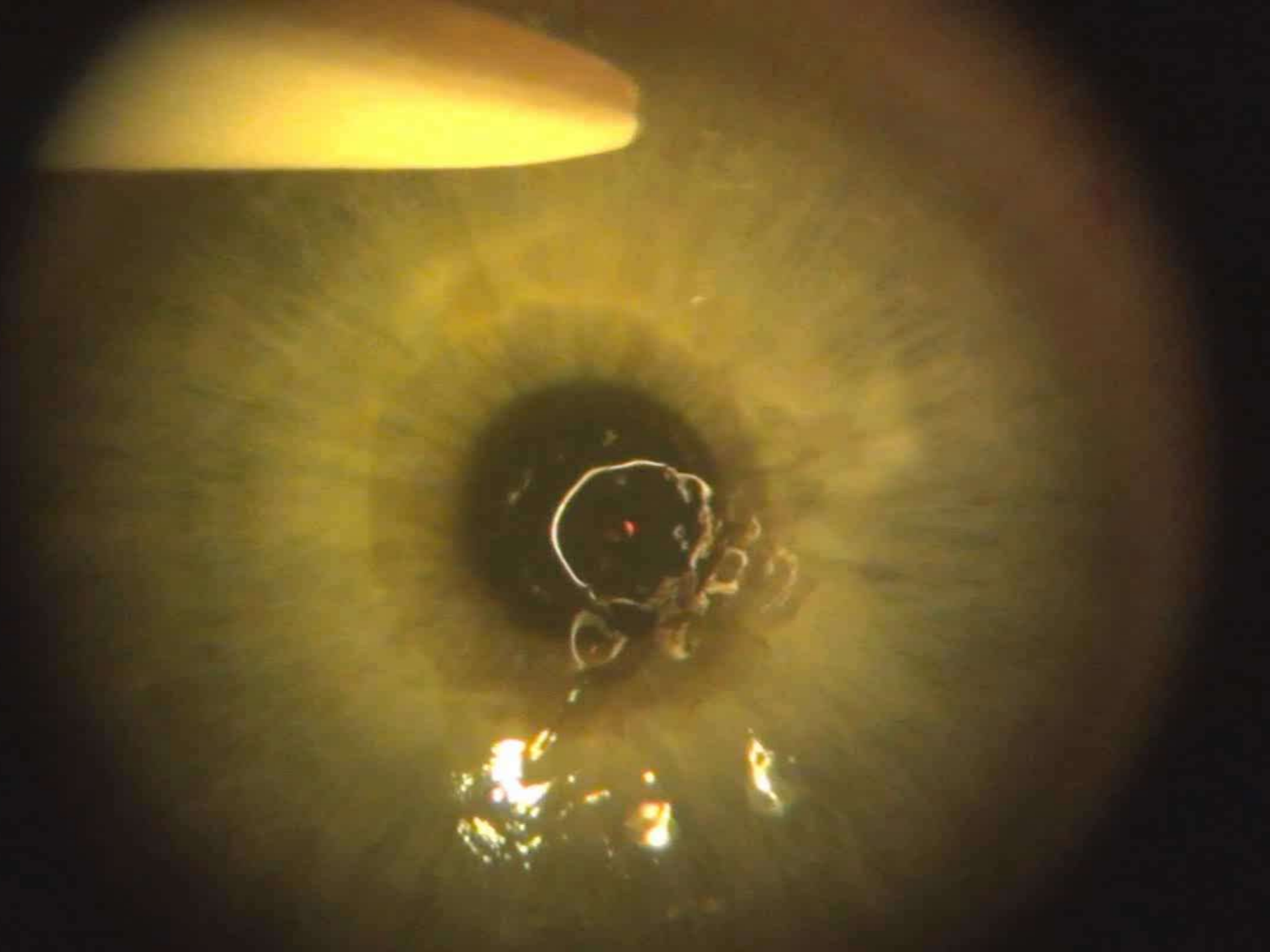



Pachy:
x[mm]
y[mm]
Pupil Center:
472 µm
+0.13
-0.08
Pachy Apex:
474 µm
0.00
0.00
Thinnest Locat.:
467 µm
+0.38
-0.50
ickness
OS
9mm
90°
120°
60°
150°
30°
180°
0°
210°
330°
240°
300°
270°
730
665
472
612
645
N
T
8
4
0
4
8
300
340
380
420
460
500
540
580
620
660
700
740
780
820
860
900
10 µm
Pachy.
Abs

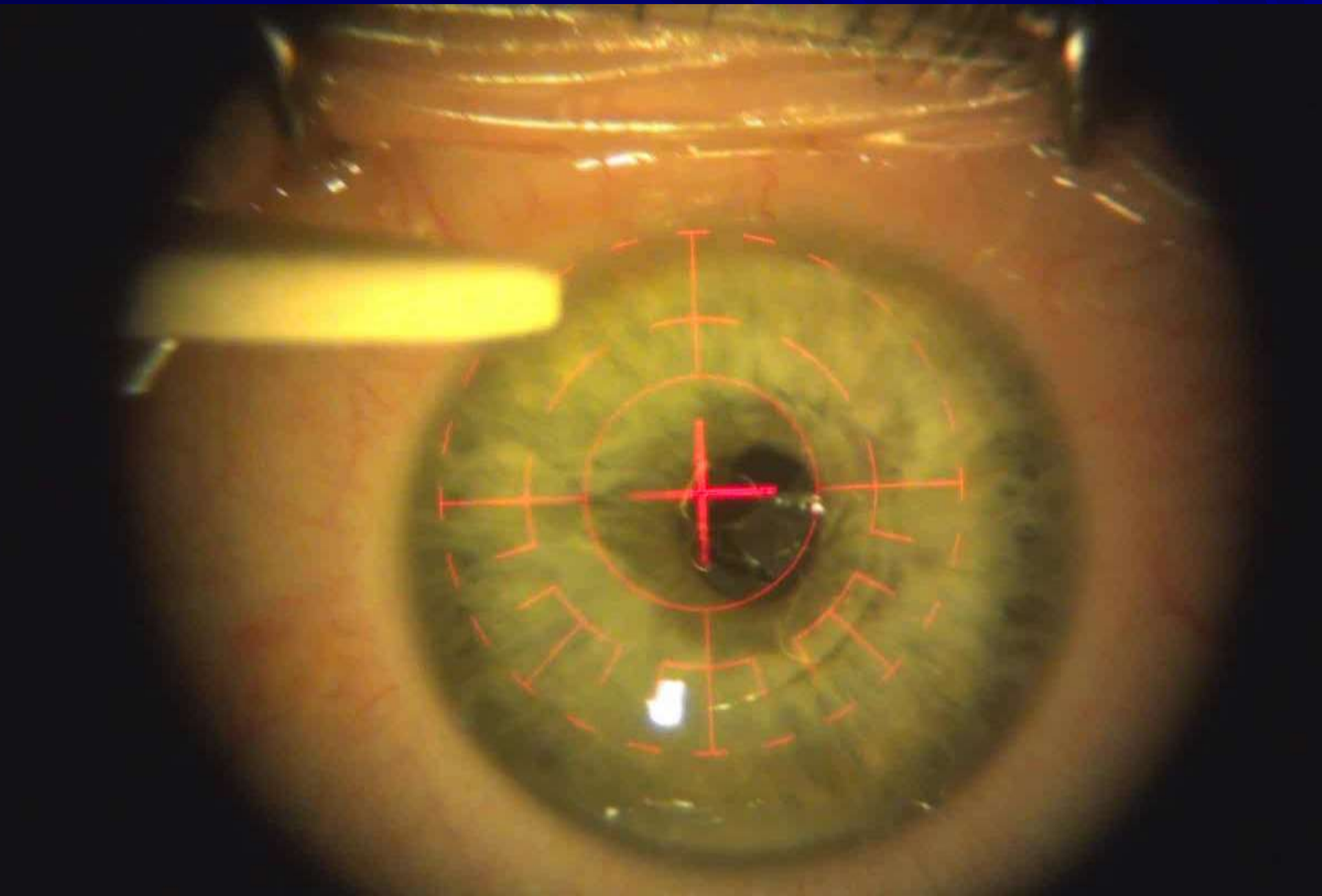
PRK enhancement
Alcohol sponge

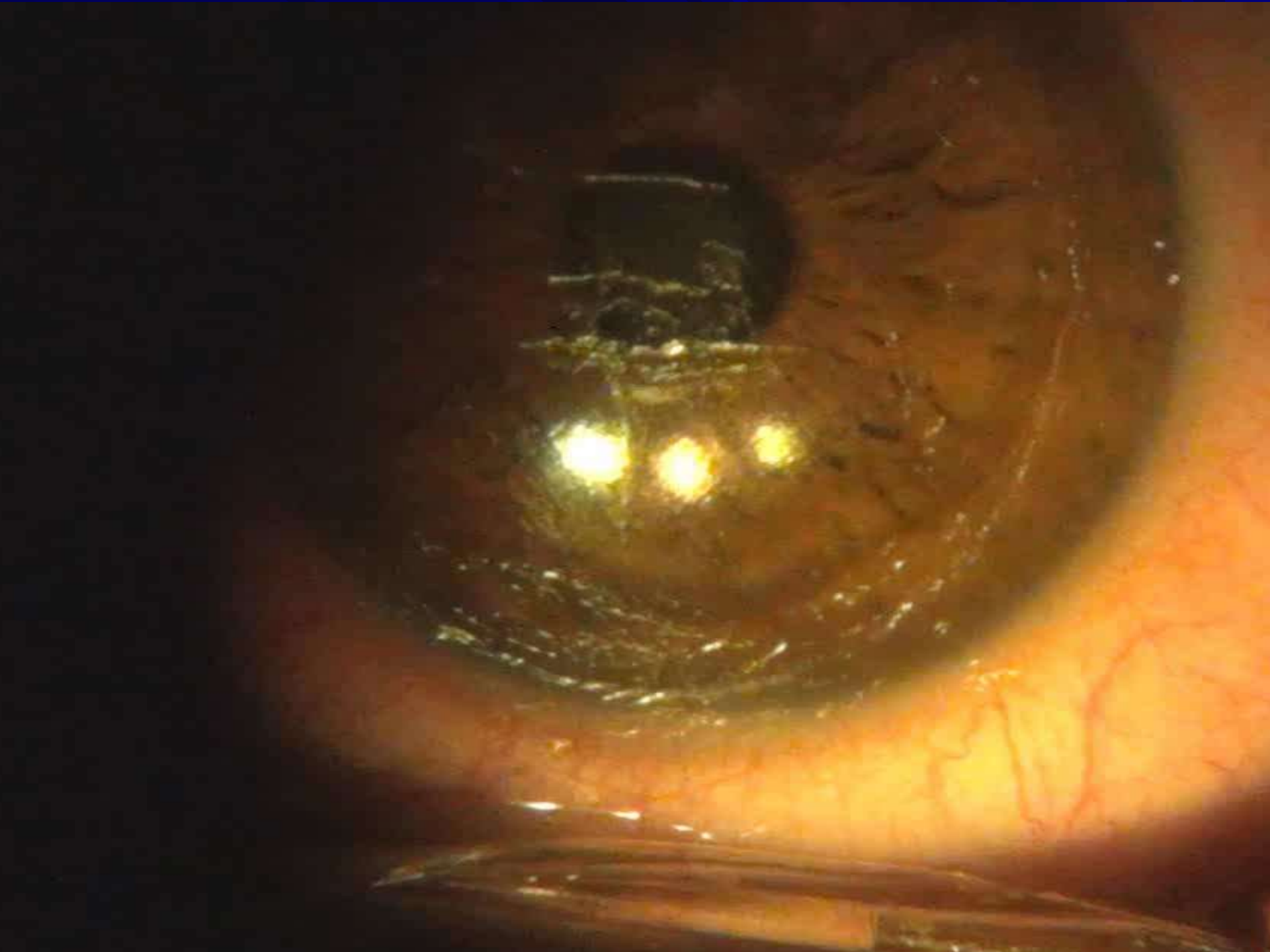


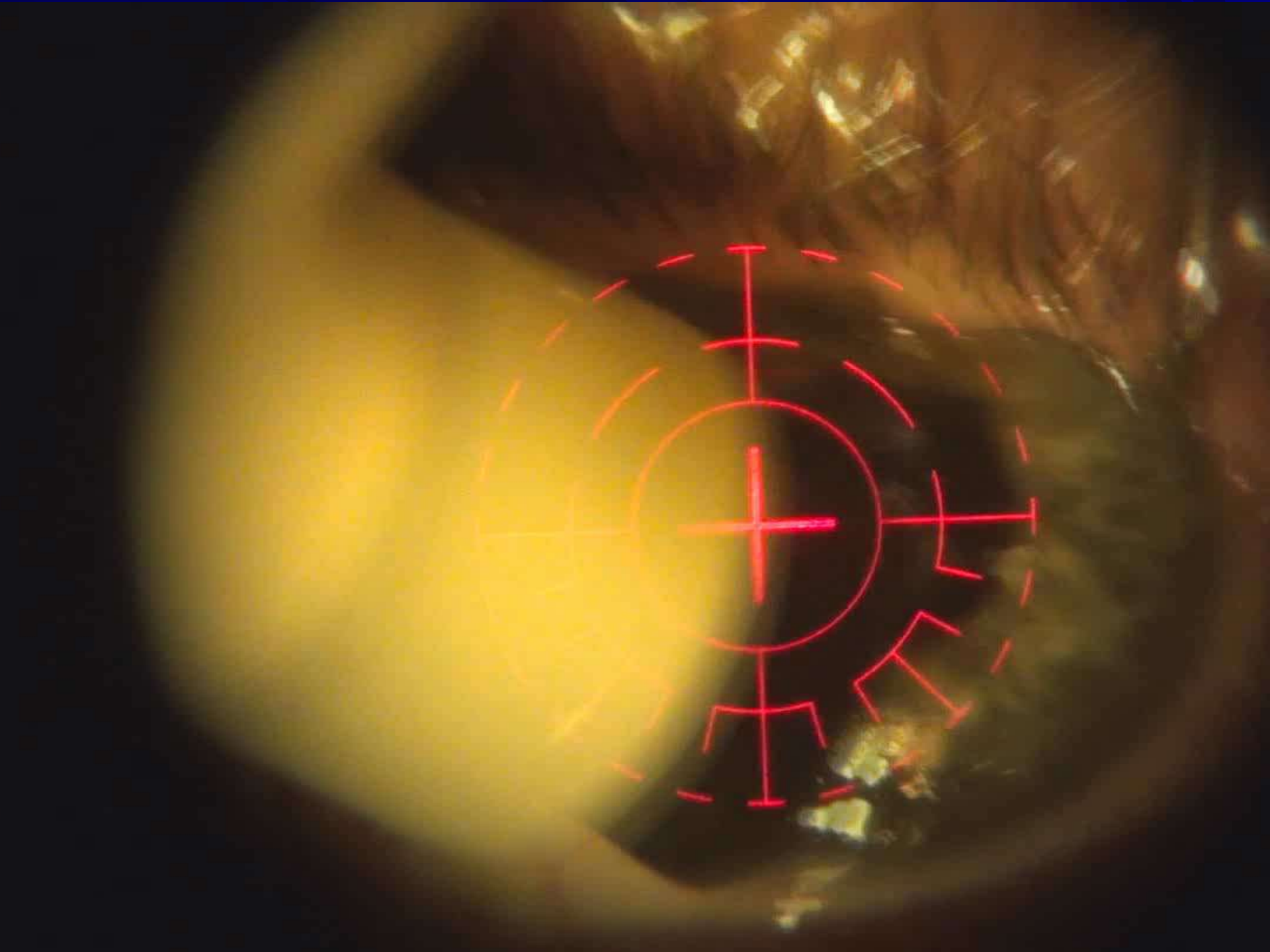


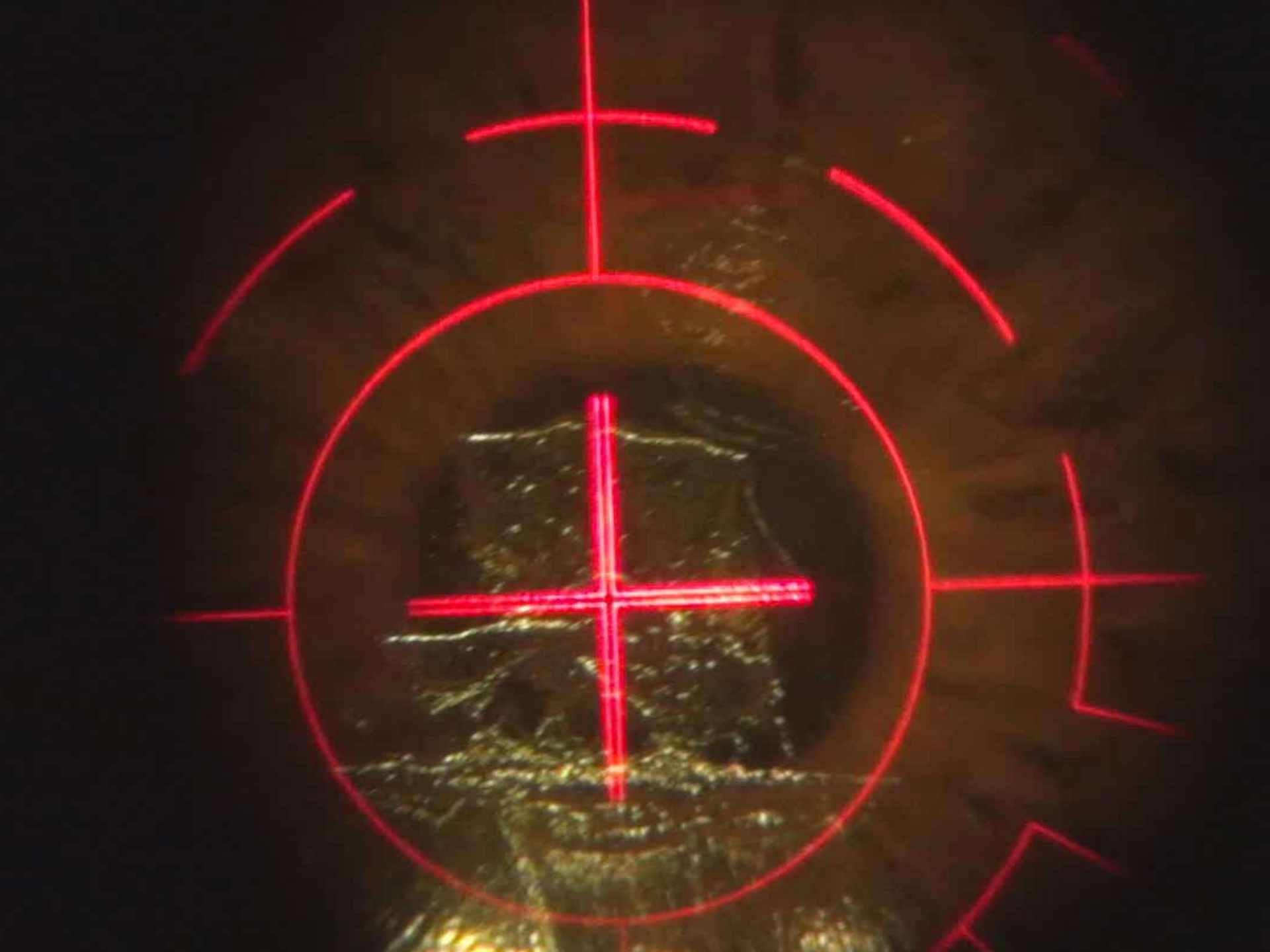


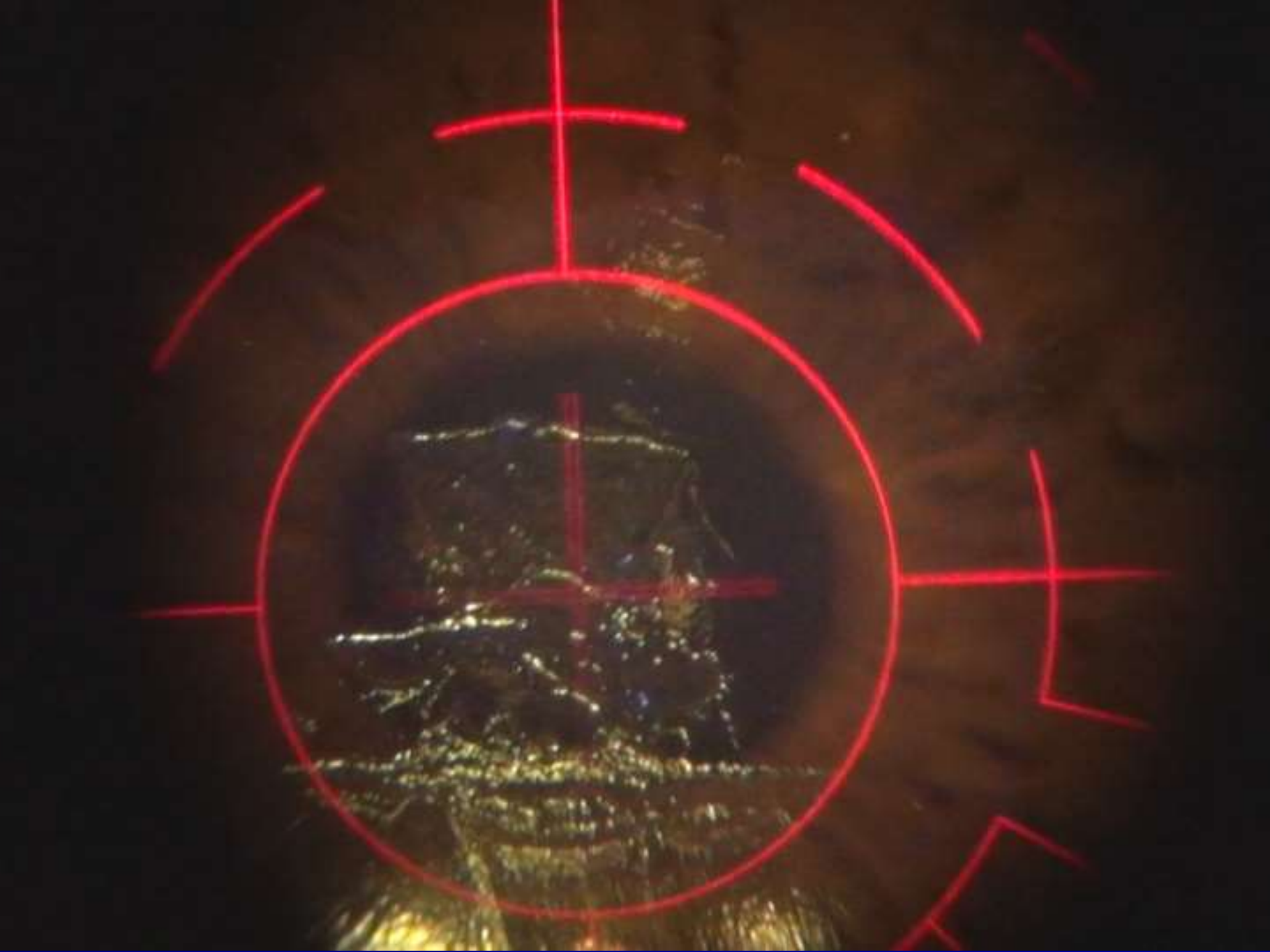
ABMD –no alcohol











www.nebraskaeye.com

www.markjohnstonlasik.com

Our Doctors

Meet Dr. Johnston

Mark E. Johnston, MD, FRCSC is the most experienced LASIK surgeon in the region, having performed over 30,000 procedures. He is Medical Director and Chief Surgeon at Nebraska Laser Eye Associates.

- Undergraduate education: MIT (Massachusetts Institute of Technology)
- Medical degree: Dalhousie University, Halifax, Nova Scotia
- Residency, Ophthalmology: University of Western Ontario, London, Ontario
- Fellowship - Corneal and External Diseases: University of Michigan, Ann Arbor, Michigan
- Member of the American Academy of Ophthalmology, American Society of Cataract and Refractive Surgeons and International Society of Cataract and Refractive Surgeons

Honors:

- Diplomat - American Board of Ophthalmology
- Fellow - Royal College of Physicians and Surgeons of Canada

My Professional Website

For more information about Dr. Mark Johnston, please visit his professional website.

Dr. Johnston has been performing refractive procedures since 1… …orneal procedures since 1985. He underwent LASIK himself in 1998. His numerous scientific articles, papers and pre… …can be found at here.

Mark E. Johnston
MD, FRCSC

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  Presented at ASCRS 2014, Boston
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  Presented at the 2014 ASCRS, Boston
- **Cause and Prevention of Microkeratome Jamming related to Lid Squeezing** DOWNLOAD
  Presented at ASCRS,Chicago, April 2012
  See related materials on "Videos" on this webpage.
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  Presented ASCRS Paper, San Diego 2011
- **Laser in Situ Keratomileusis Decentration With and Without Active Eye-Tracking System** DOWNLOAD
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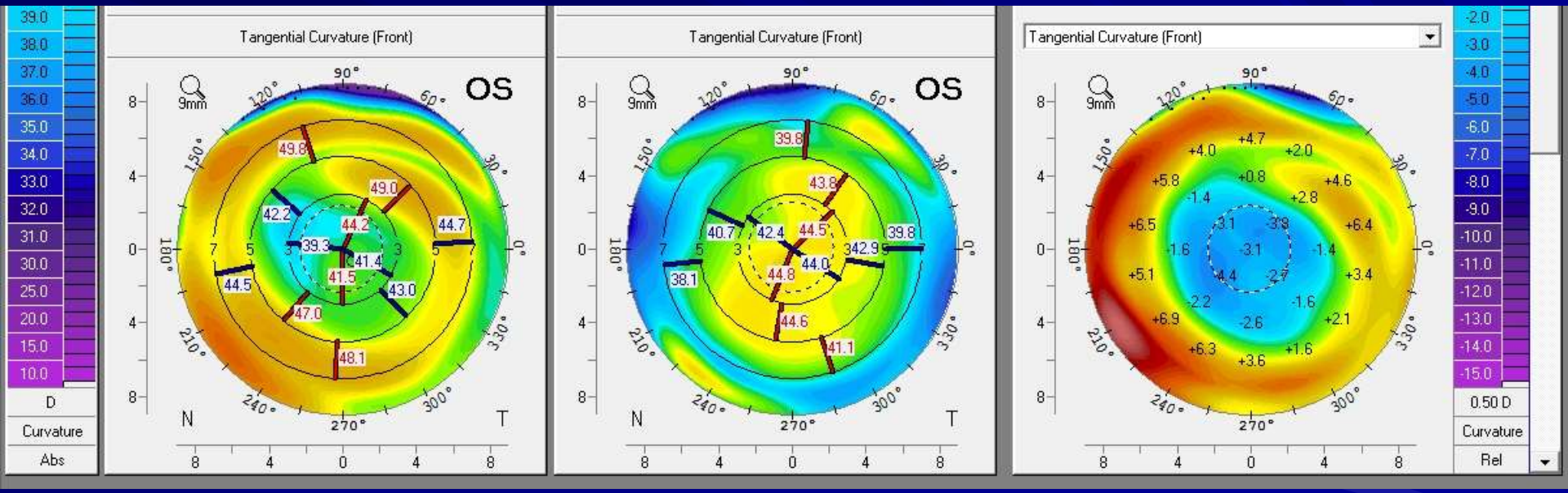
  Presented: Chicago ASCRS, April 2008


Enhancement overview 2016

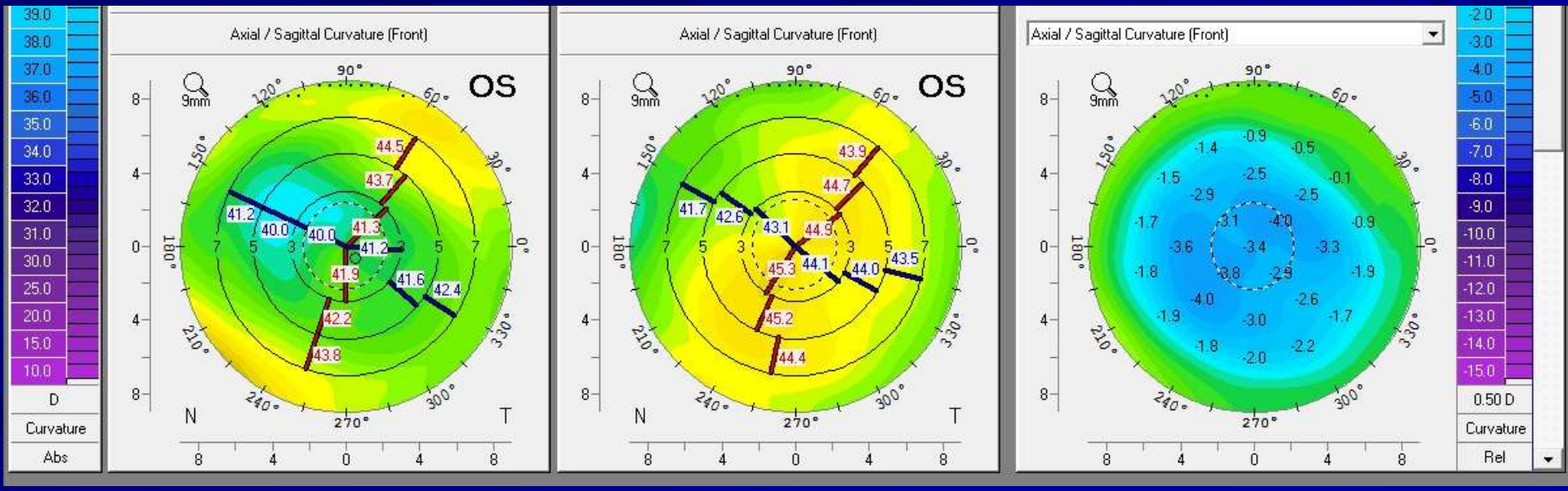
Visx: Small residual cylinder
Tangential maps

Post Pre Difference

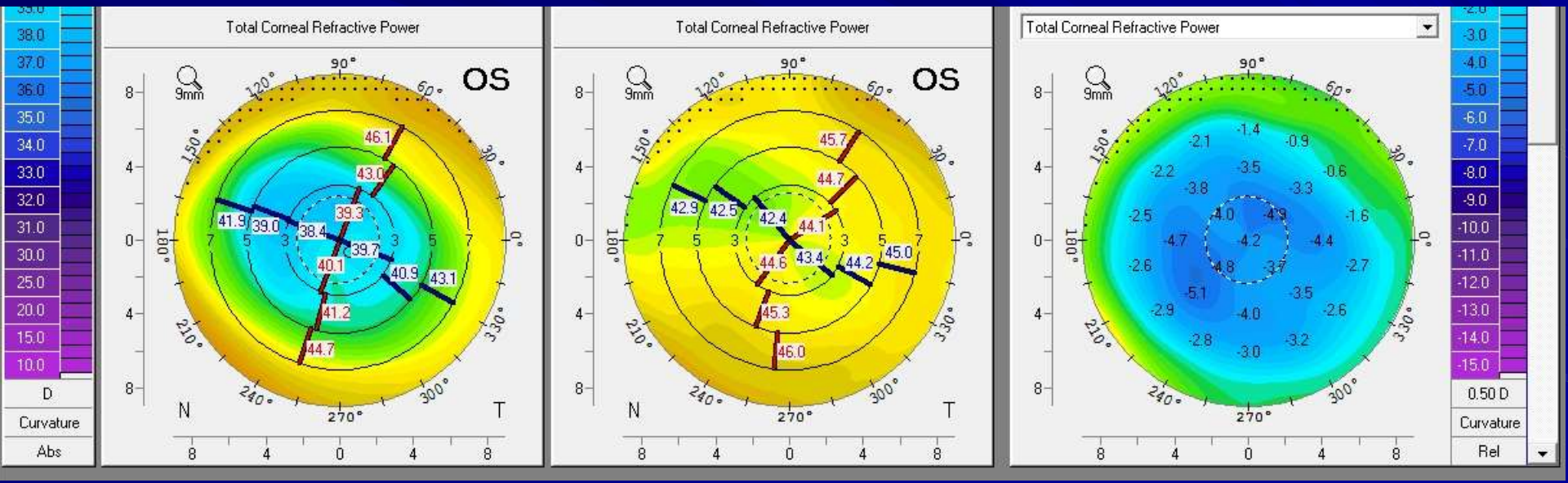


Visx: Small residual cylinder
Axial / Sagital maps

Post Pre Difference

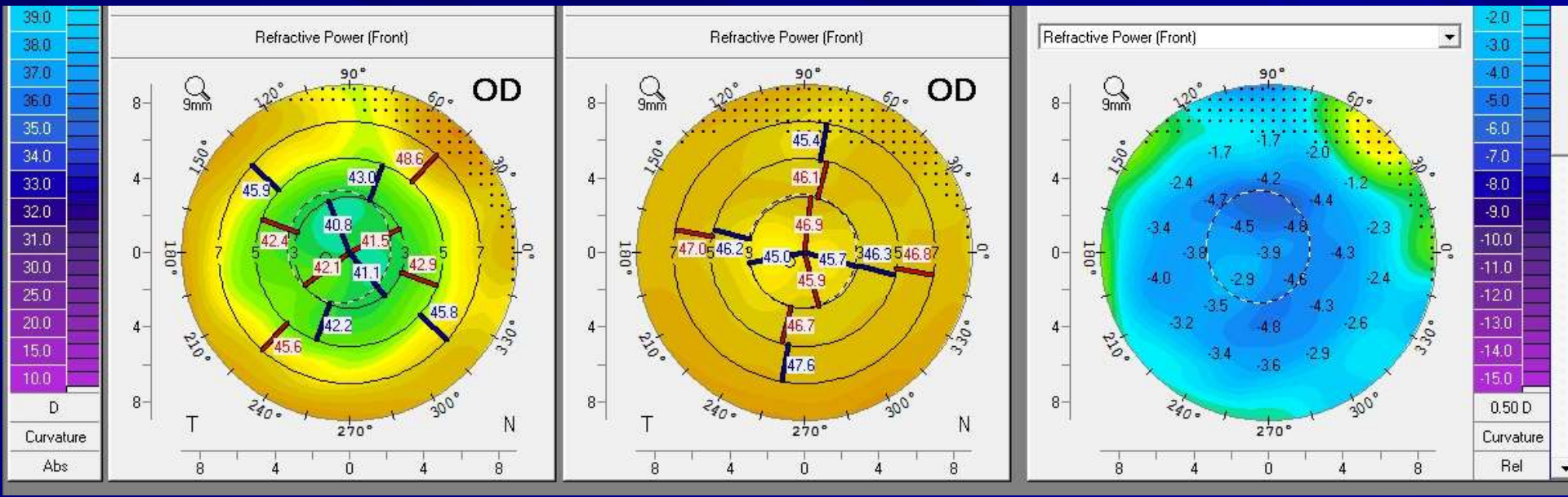


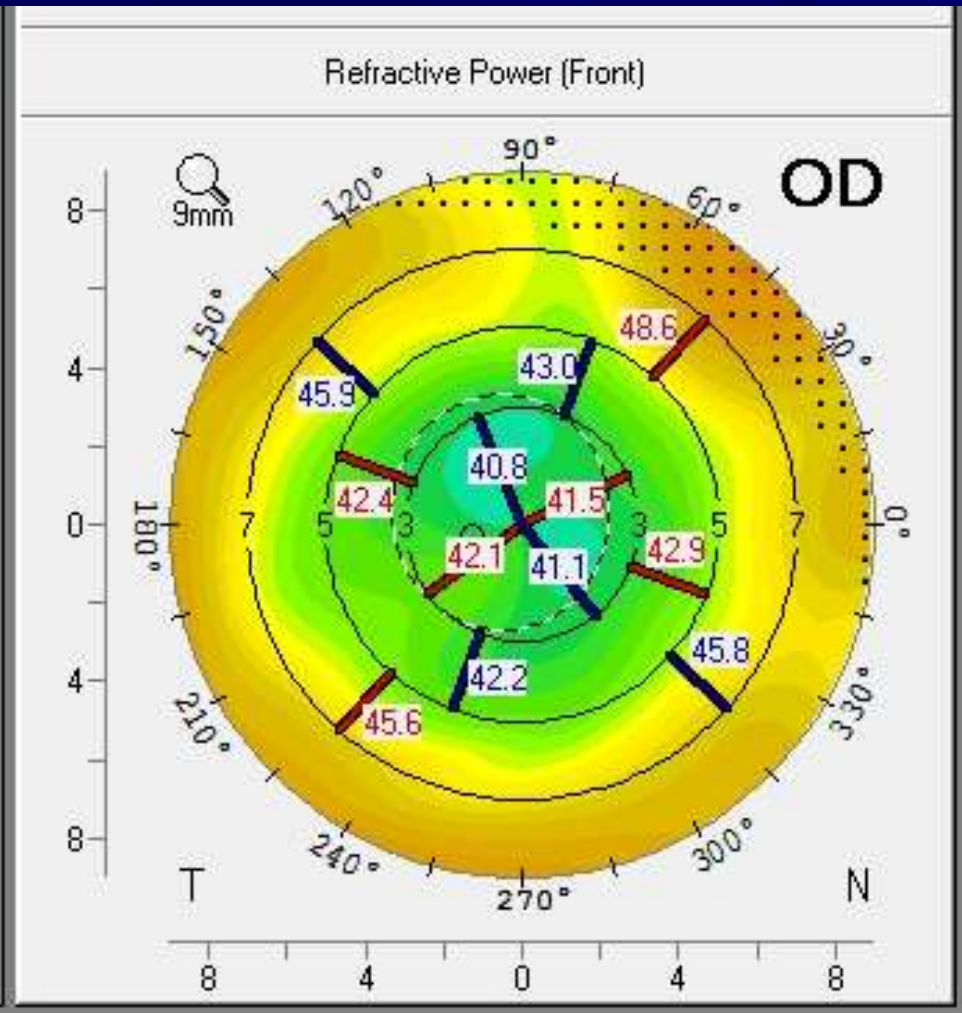
Visx: Small residual cylinder
Total Corneal Refractive Maps
Post Pre Difference

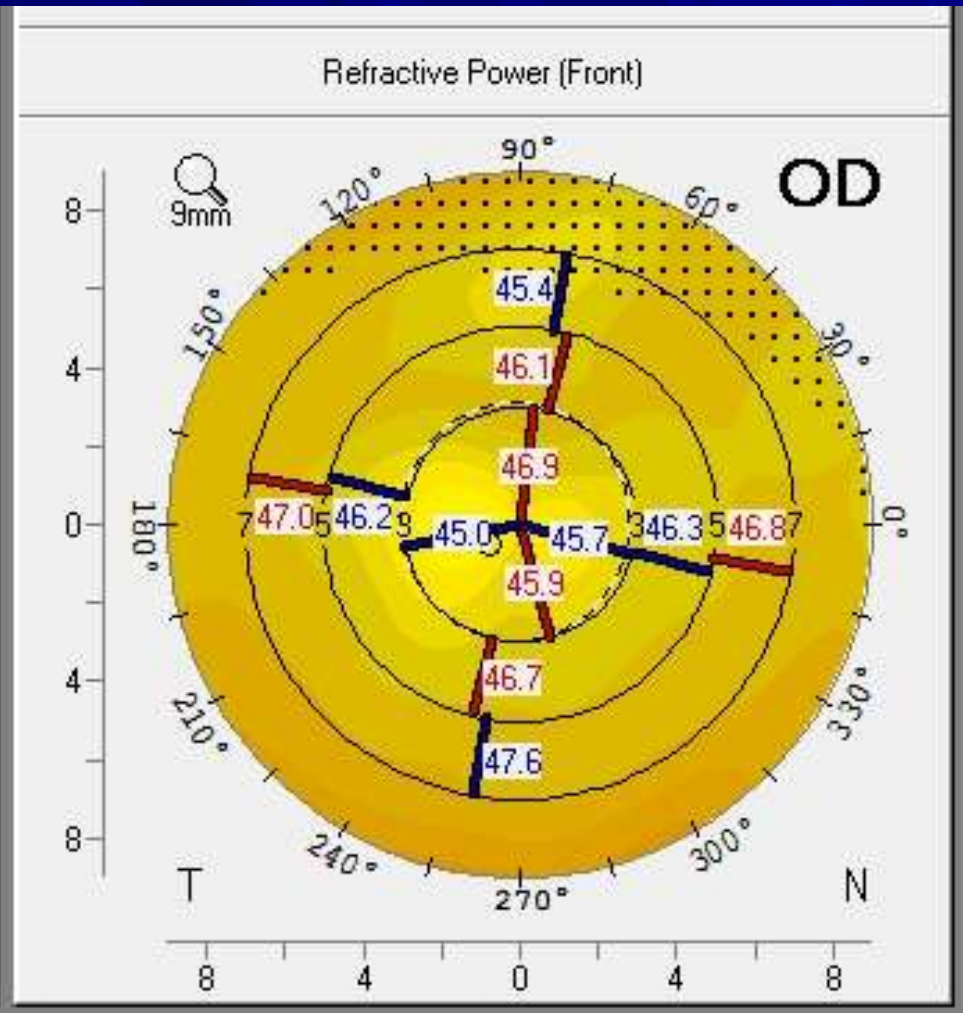


Visx: Residual Sphere Refractive Power Maps

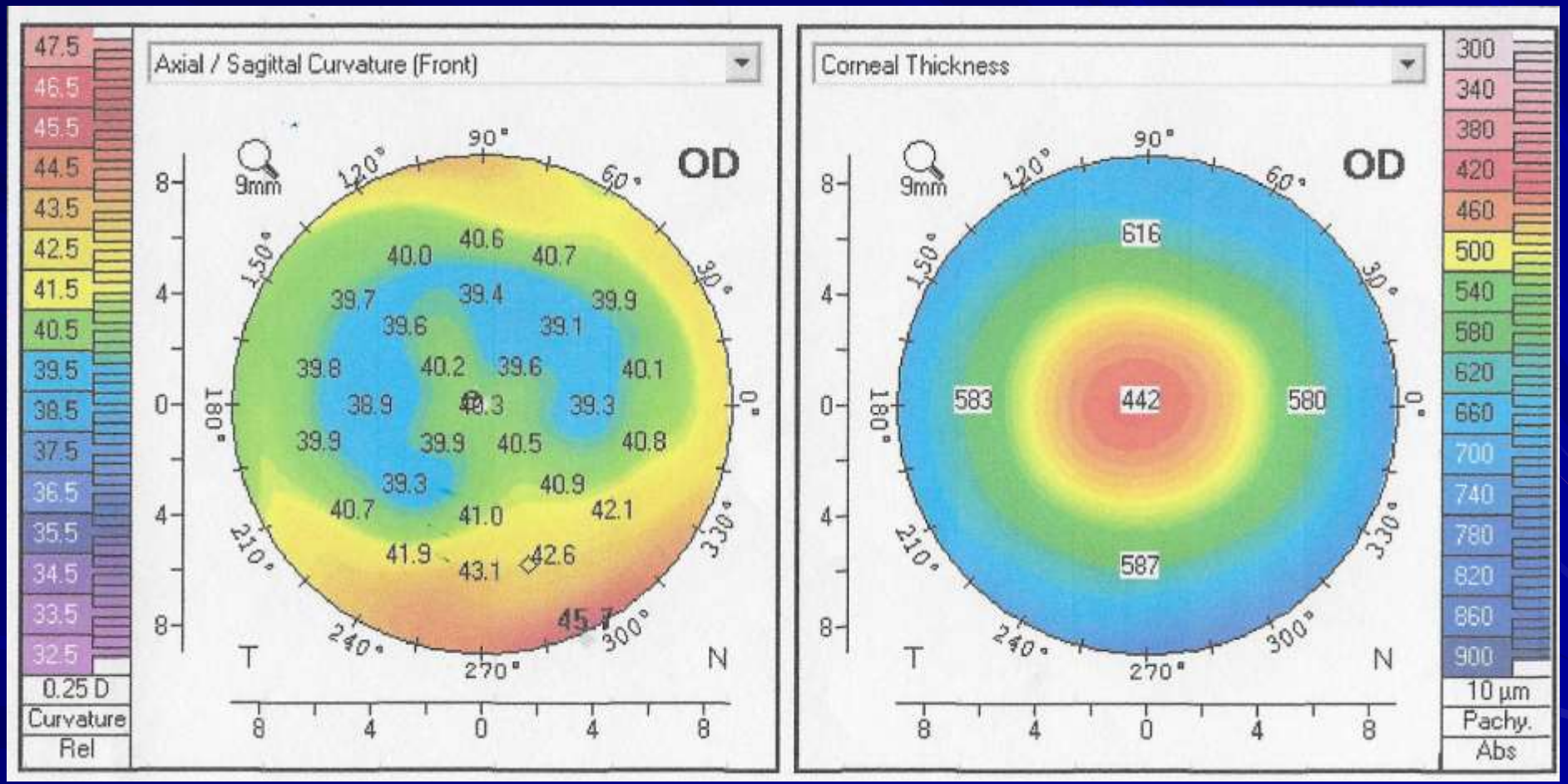
Post Pre Difference




Refractive Power (Front)
OD
9mm
90°
120°
60°
150°
30°
180°
0°
210°
330°
240°
300°
270°
T
N
48.6
43.0
45.9
40.8
42.4
41.5
42.1
41.1
42.9
45.8
42.2
45.6


Refractive Power (Front)
OD
9mm
90°
120°
60°
150°
30°
180°
0°
210°
330°
240°
300°
270°
T
N
45.4
46.1
46.9
47.0
46.2
45.0
45.7
46.3
46.8
45.9
46.7
47.6

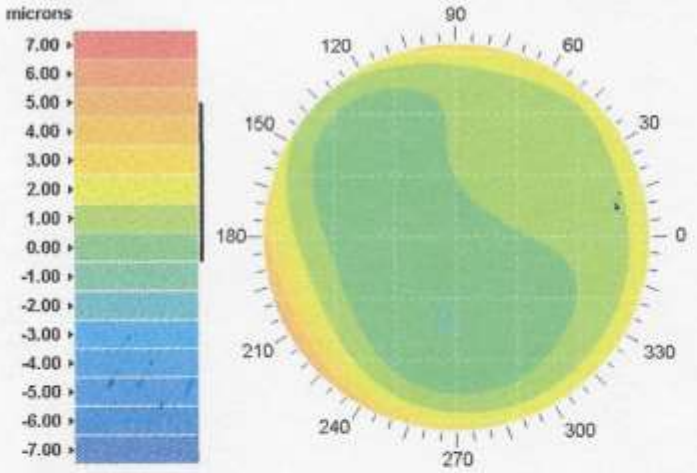
High myopia


Axial / Sagittal Curvature (Front)
OD
9mm
47.5
46.5
45.5
44.5
43.5
42.5
41.5
40.5
39.5
38.5
37.5
36.5
35.5
34.5
33.5
32.5
0.25 D
Curvature
Rel
40.6
40.0
40.7
39.7
39.4
39.9
39.6
39.1
39.8
40.2
39.6
40.1
38.9
39.3
39.9
39.9
40.5
40.8
39.3
40.9
40.7
41.0
42.1
41.9
43.1
42.6
45.7
T
N
Corneal Thickness
OD
9mm
616
583
442
580
587
300
340
380
420
460
500
540
580
620
660
700
740
780
820
860
900
10 µm
Pachy.
Abs

Visx Wavefront

OD -0.06 DS -0.41 DC x 119° @12.5 mm (5.00 Rx Calc)
12-Mar-2015 10:37:51 W.F. Diam (mm): **6.25** High Order: **54.8 %**
Eff. Blur (D): **0.66** Rms Err.(μ): **0.93** Quality:

Acuity Map Rms Error (μ): **0.93**

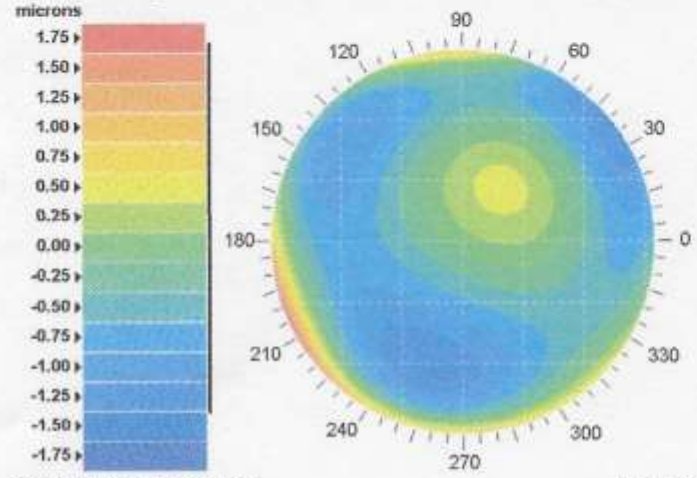


Range: -0.5 to +4.9 microns Grid spacing: 1 mm.

Normalized Polar Zernike Coefficients (μ) **High Order Aberrations Graph**

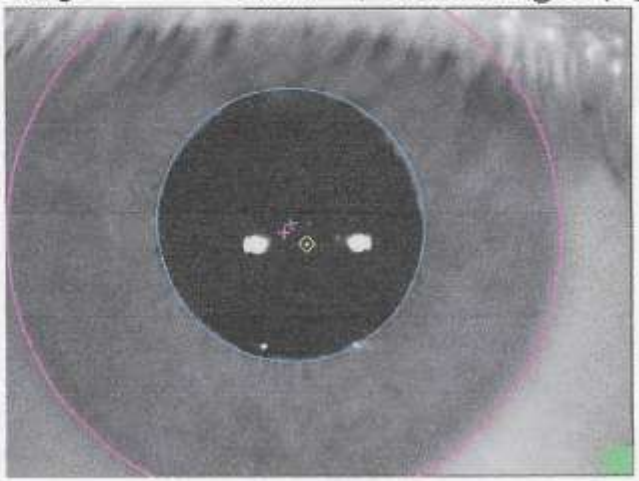
	Value	Name	0.0 — 0.35421	Axis
Z_{20}	0.72117	Defocus		
Z_{22}	0.31543 @ 34°	Astigmatism		
Z_{31}	0.35421 @ 230°	Coma		
Z_{33}	0.19829 @ 84°	Trefoil		
Z_{40}	0.26801	Sph. Aberration		
Z_{42}	0.05980 @ 104°			
Z_{44}	0.07252 @ 11°			
Z_{51}	0.03102 @ 107°			
Z_{53}	0.04252 @ 110°			
Z_{55}	0.00627 @ 17°			
Z_{60}	0.06147			
Z_{62}	0.02540 @ 71°			
Z_{64}	0.02439 @ 89°			
Z_{66}	0.01797 @ 25°			

Wavefront High Order Aberrations Rms Error (μ): **0.50**



Range: -1.4 to +1.7 microns Grid spacing: 1 mm.

Eye Image Limbus Diam: **13.1 mm** Pupil: **6.5 x 6.3 mm @101° (avg 6.4)**

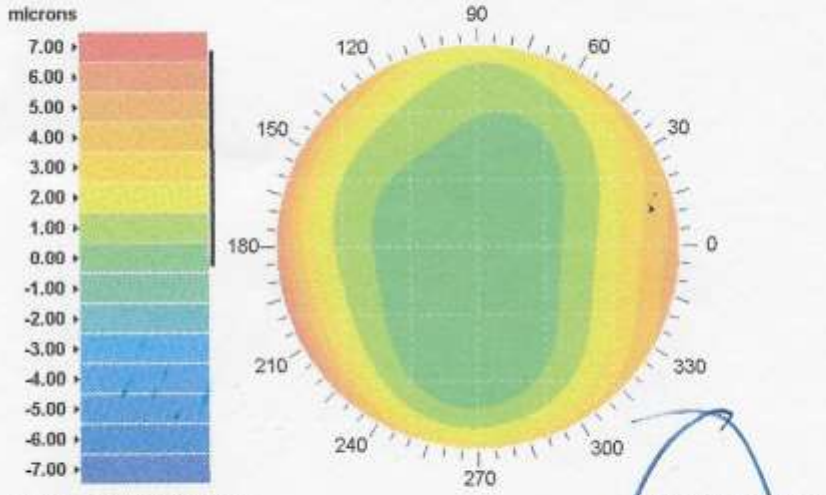


Nebraska Laser Eye Assoc.

Technolas with Wavefront and Iris Registration

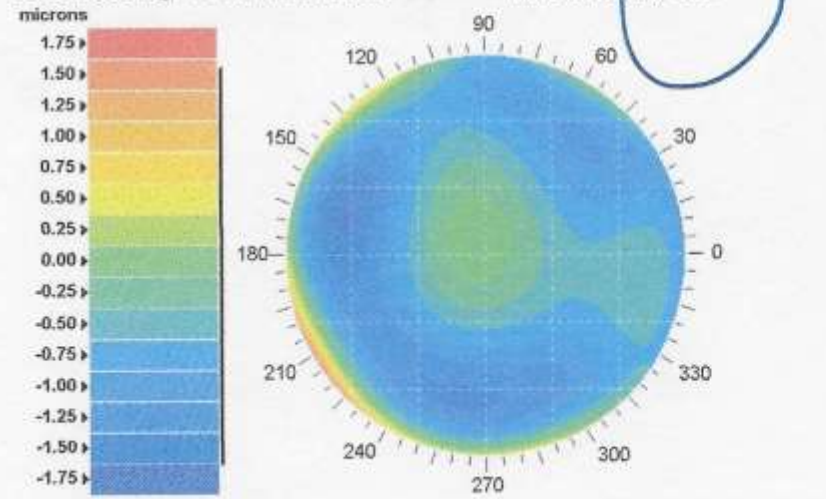
OD -0.31 DS -0.67 DC x 89° @12.5 mm (5.00 Rx Calc)
13-Mar-2015 09:29:59 W.F. Diam (mm): **6.00** High Order: **34.7 %**
Eff. Blur (D): **1.15** Rms Err.(µ): **1.50** Quality: ✓ ✓ ✓ ✓

Acuity Map Rms Error (µ): **1.50**



Range: -0.3 to +6.8 microns Grid spacing: 1 mm.

Wavefront High Order Aberrations Rms Error (µ): **0.45**

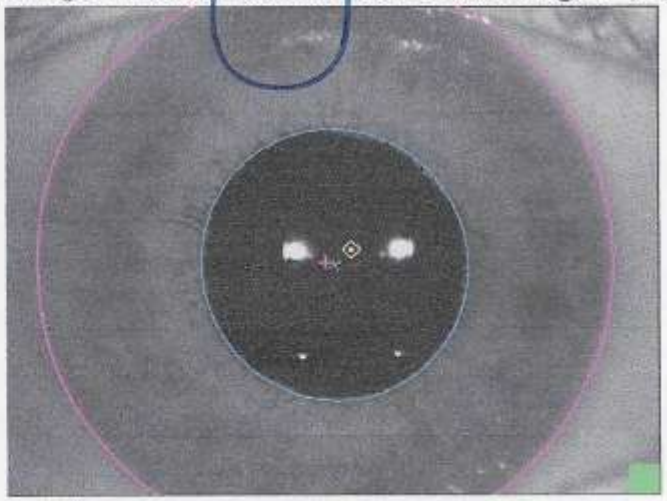


Range: -1.6 to +1.5 microns Grid spacing: 1 mm.

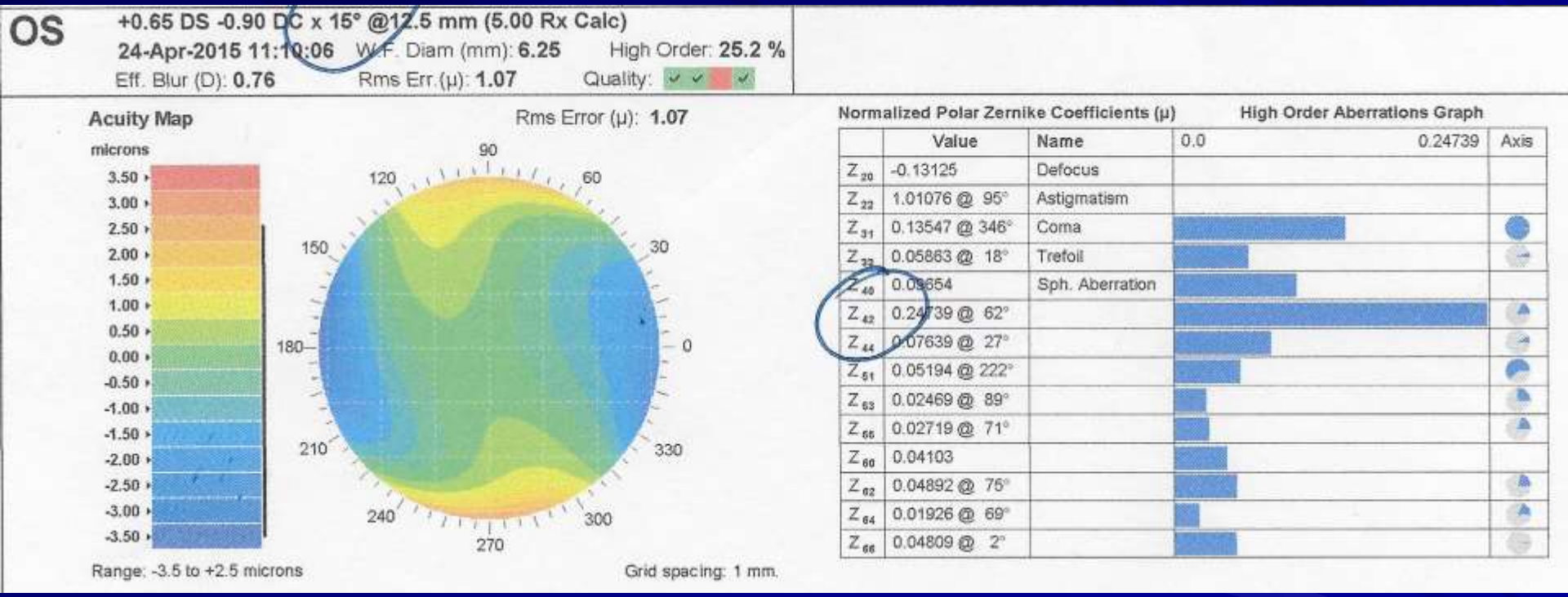
Normalized Polar Zernike Coefficients (µ) **High Order Aberrations Graph**

	Value	Name	0.0 — 0.33672	Axis
Z_{20}	1.27111	Defocus		
Z_{22}	0.64351 @ 179°	Astigmatism		
Z_{31}	0.19189 @ 218°	Coma		
Z_{33}	0.11377 @ 102°	Trefoil		
Z_{40}	0.33672	Sph. Aberration		
Z_{42}	0.04672 @ 52°			
Z_{44}	0.08092 @ 32°			
Z_{51}	0.12889 @ 188°			
Z_{53}	0.09132 @ 46°			
Z_{55}	0.07055 @ 60°			
Z_{60}	0.01656			
Z_{62}	0.04208 @ 88°			
Z_{64}	0.03928 @ 46°			
Z_{66}	0.01514 @ 59°			

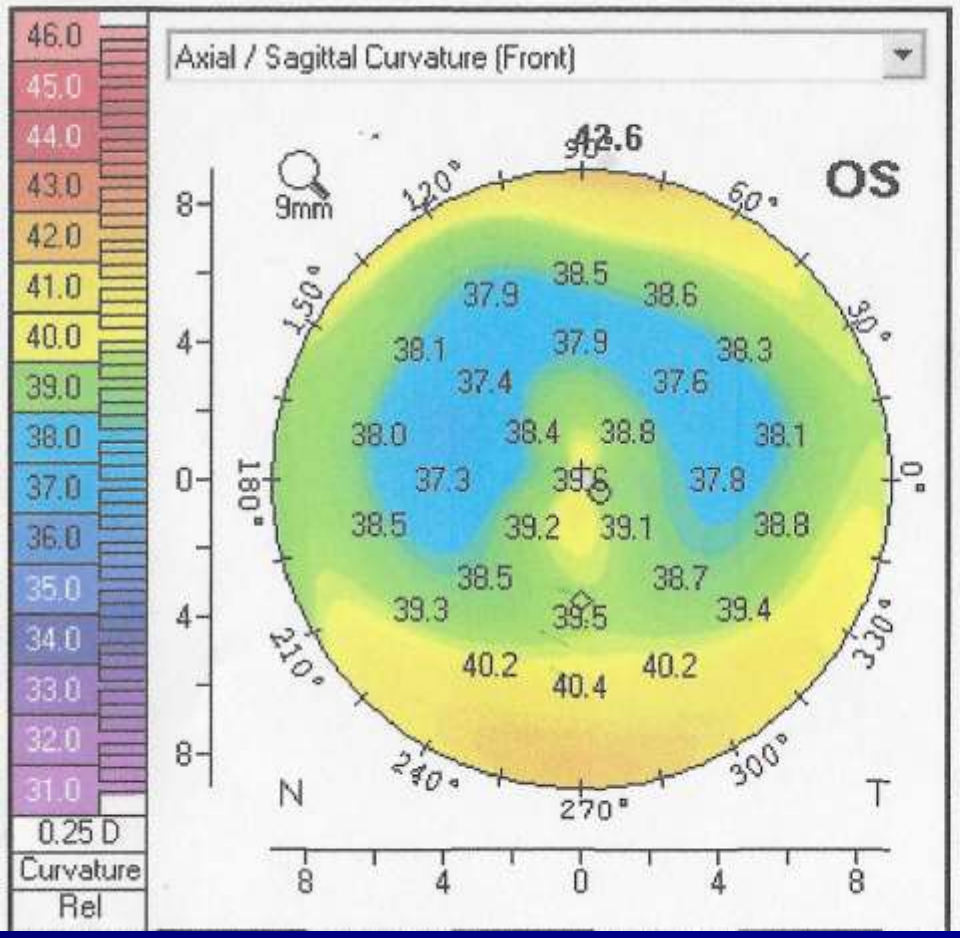
Eye Image Limbus Diam: **13.1 mm** Pupil: **6.2 x 6.0 mm @115° (avg 6.1)**

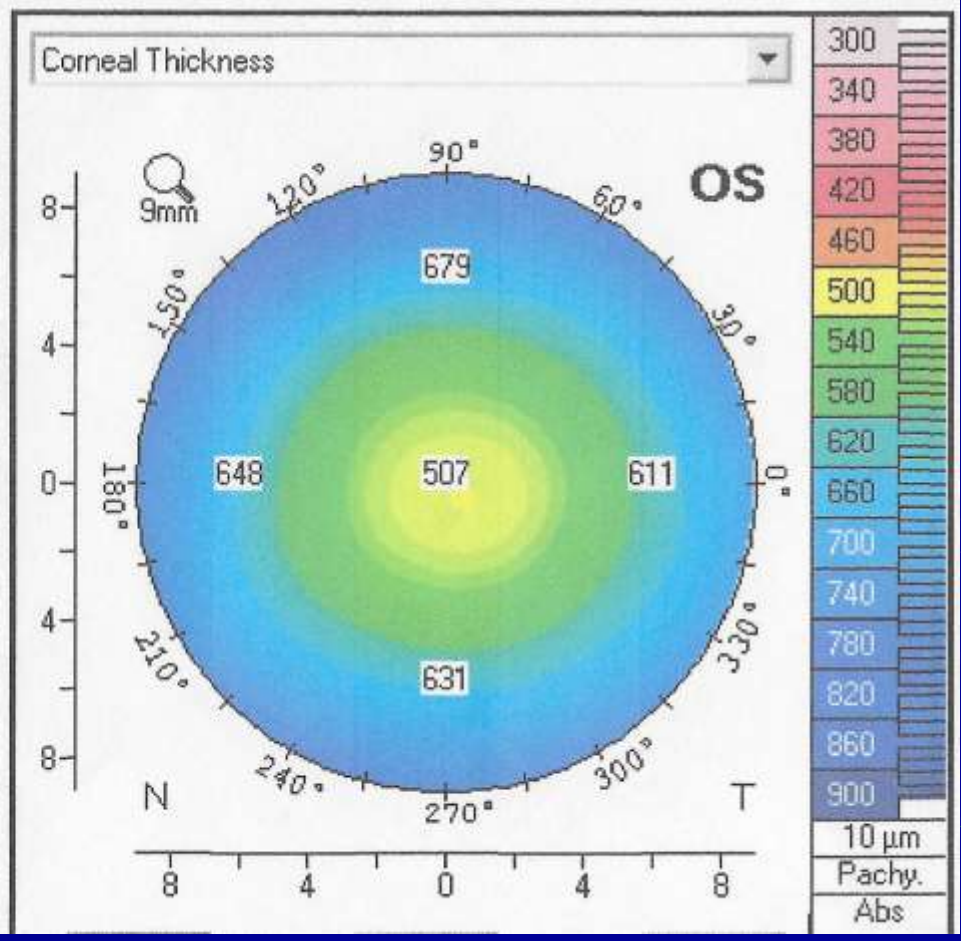


Secondary Cylinder

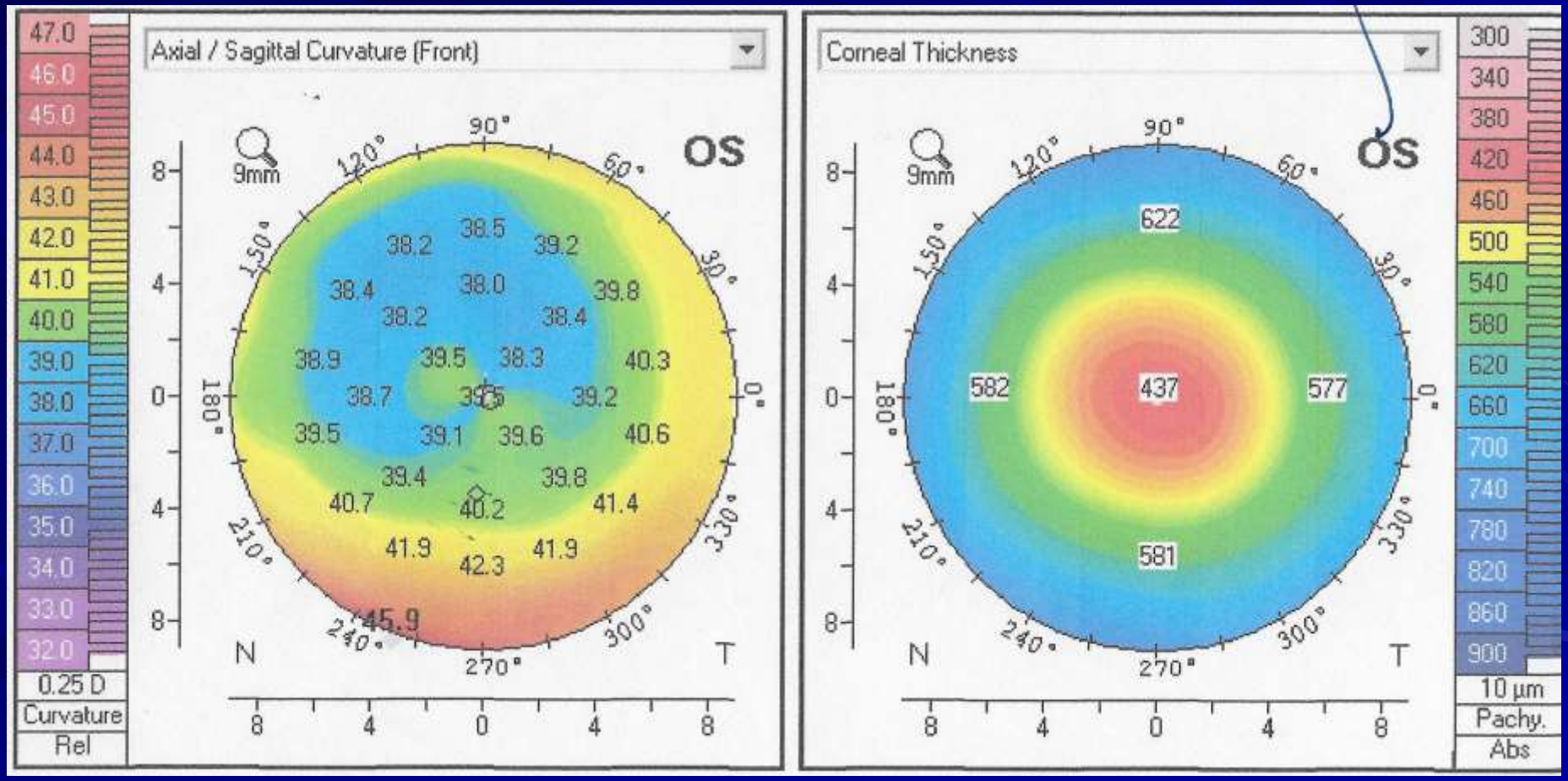


Inferior steepening
Epithelium, Flap, or Ablation

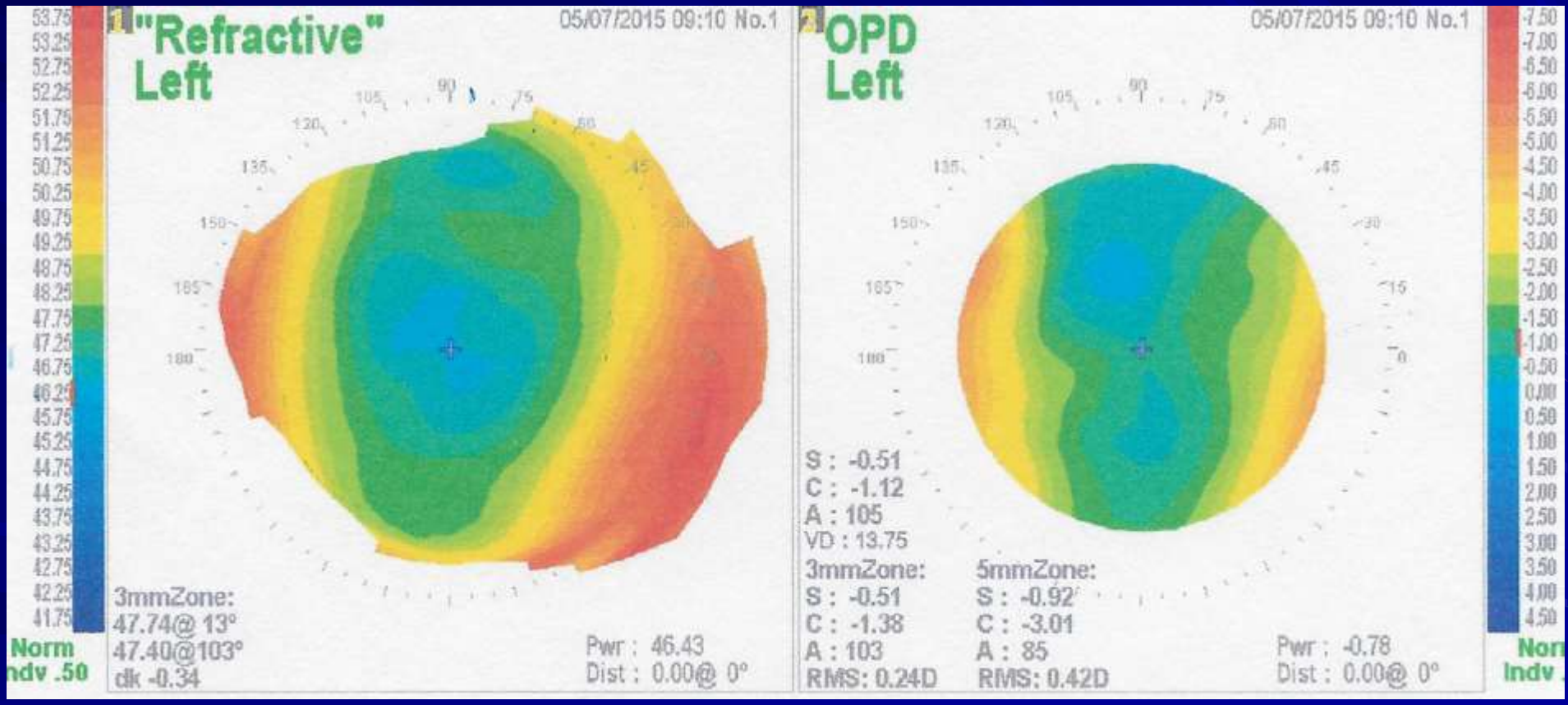




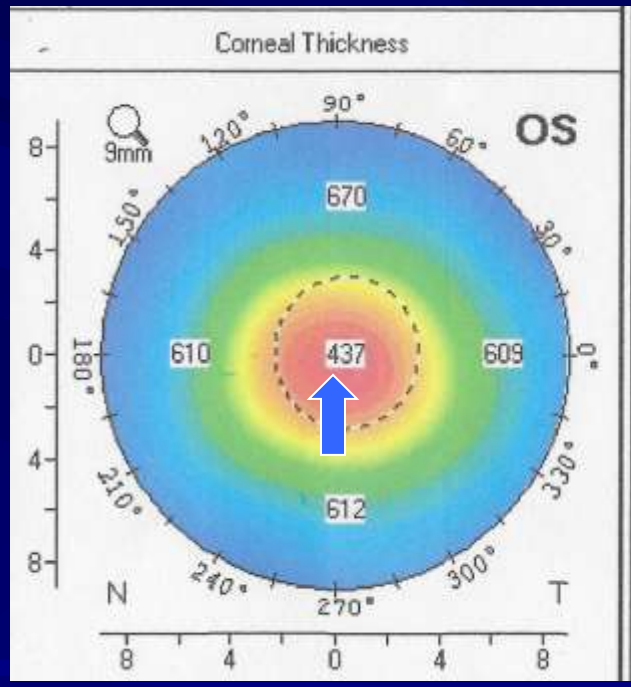
Technolas iris registration

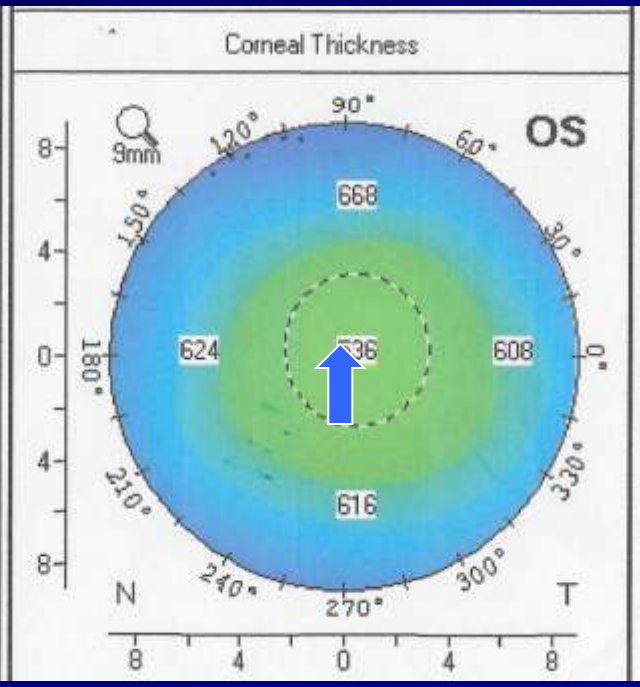


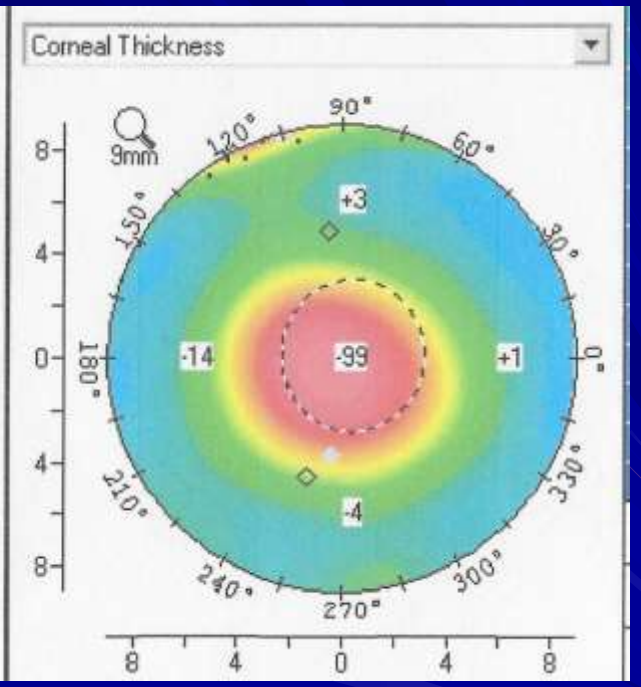
Against the Rule



Apex Nasal / Inferior
x= -0.24, y= -0.12





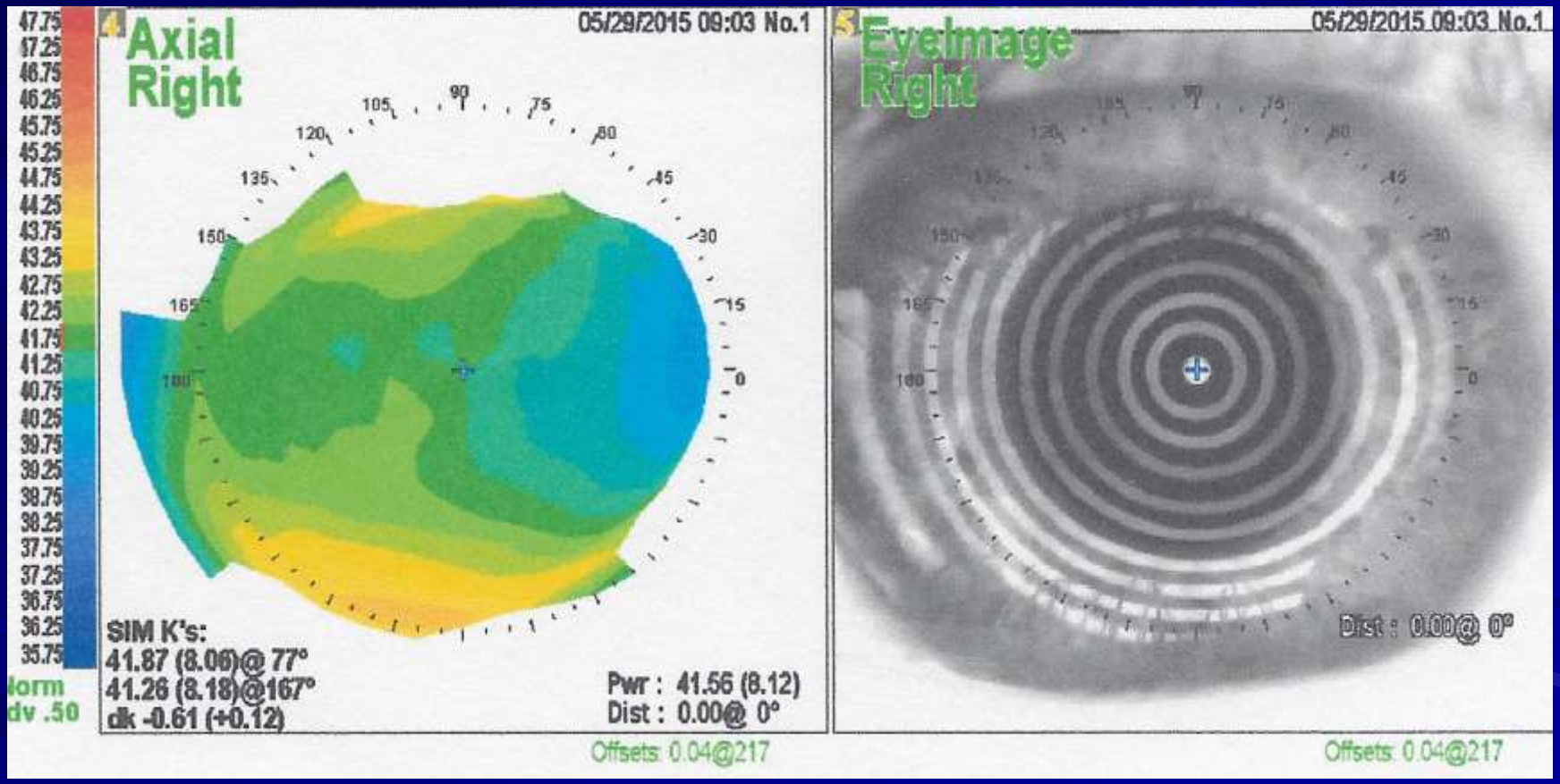


	Pachy:	x[mm]	y[mm]
Pupil Center: +	437 µm	+0.22	+0.05
Thinnest Locat.: ○	435 µm	+0.13	-0.19

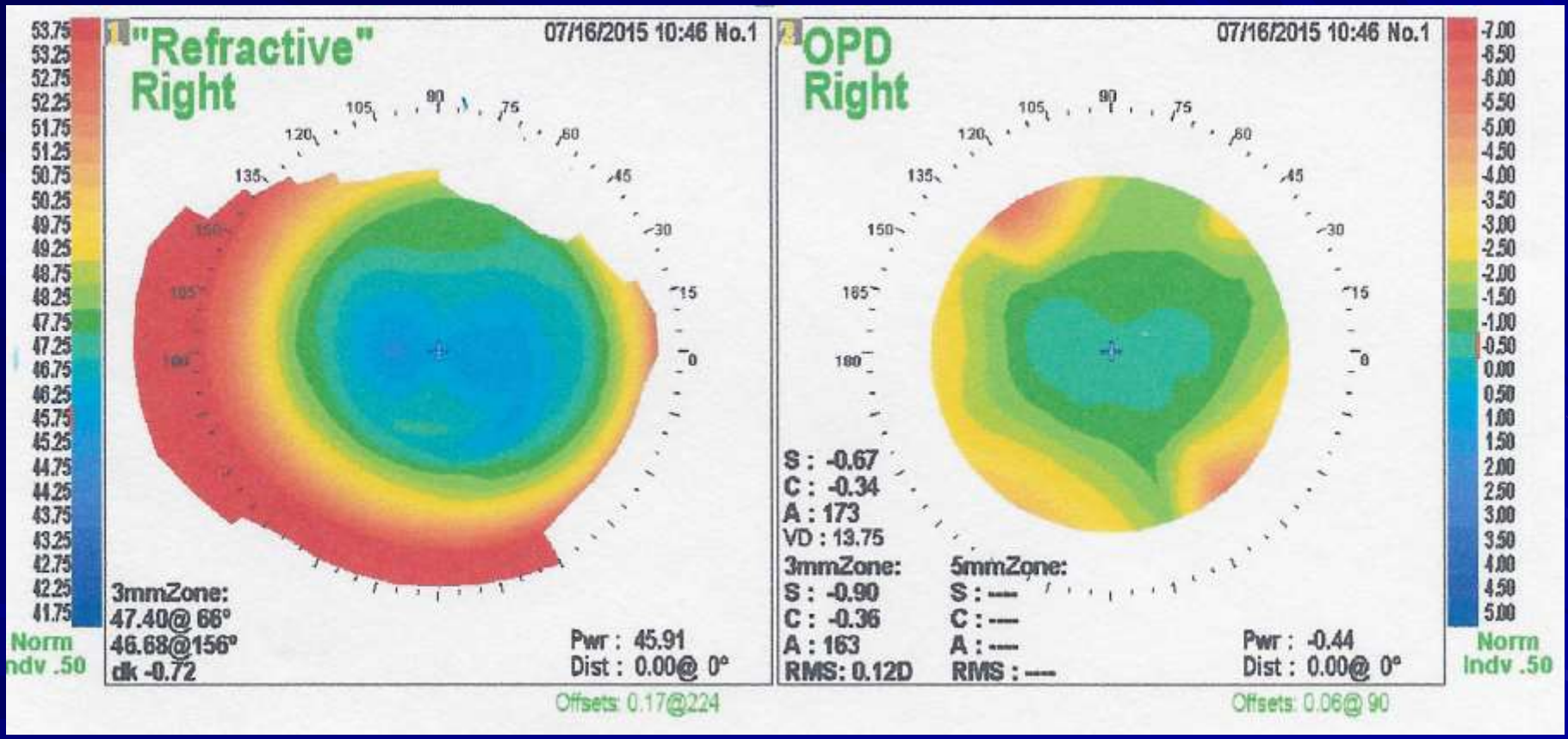
	Pachy:	x[mm]	y[mm]
Pupil Center: +	536 µm	+0.24	+0.12
Thinnest Locat.: ○	535 µm	+0.57	-0.13

	Pachy:	x[mm]	y[mm]
Pupil Center: +	-99 µm	-0.02	-0.07
Thinnest Locat.: ○	-99 µm	-0.45	-0.06

Technolas high cylinder



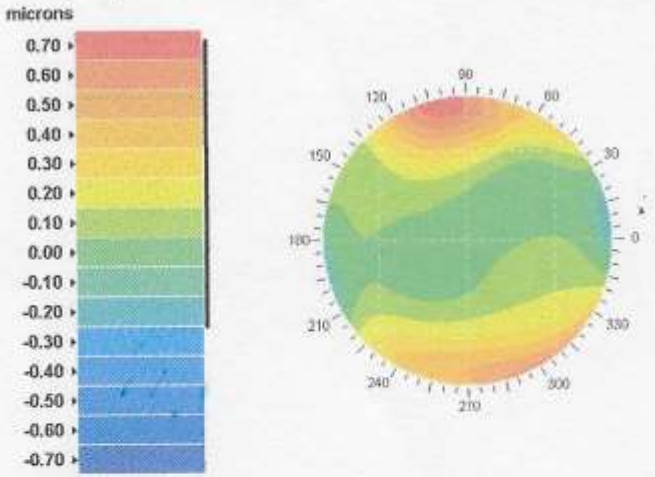
High Myopia


"Refractive"
Right
07/16/2015 10:46 No.1
3mmZone:
47.40@ 66°
46.68@156°
dk -0.72
Pwr : 45.91
Dist : 0.00@ 0°
Offsets: 0.17@224
OPD
Right
07/16/2015 10:46 No.1
S : -0.67
C : -0.34
A : 173
VD : 13.75
3mmZone:
S : -0.90
C : -0.36
A : 163
RMS: 0.12D
5mmZone:
S : ----
C : ----
A : ----
RMS : ----
Pwr : -0.44
Dist : 0.00@ 0°
Offsets: 0.06@ 90
Norm
Indv .50
Norm
Indv .50

Minus SA

OD +0.05 DS -0.54 DC x 9° @12.5 mm (3.25 Rx Calc)
16-Jul-2015 10:46:49 W.F. Diam (mm): **3.25** High Order: **32.8 %**
Eff. Blur (D): **0.46** Rms Err.(μ): **0.18** Quality: ✓ ✓ ✓ ✓

Acuity Map Rms Error (μ): **0.18**

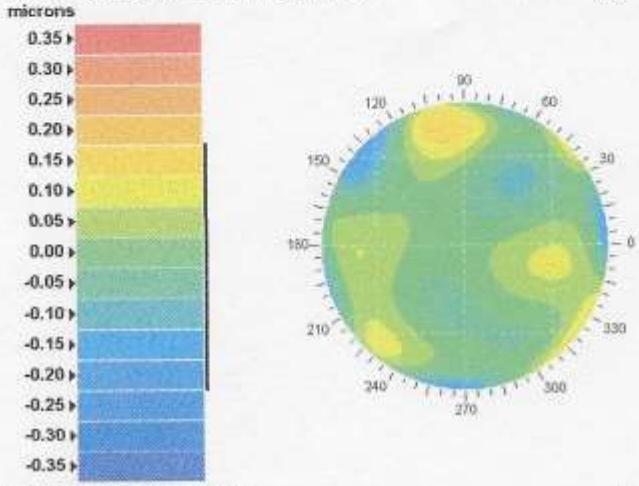


Range: -0.3 to +0.7 microns Grid spacing: 1 mm.

Normalized Polar Zernike Coefficients (μ) **High Order Aberrations Graph**

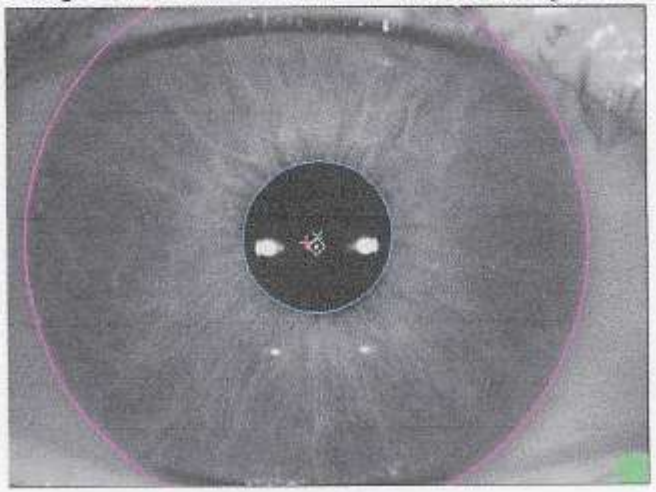
	Value	Name	0.0 — 0.03186	Axis
Z_{20}	0.08234	Defocus		
Z_{22}	0.14356 @ 99°	Astigmatism		
Z_{31}	0.00683 @ 3°	Coma		
Z_{33}	0.03186 @ 91°	Trefoil		
Z_{40}	-0.01236	Sph. Aberration		
Z_{42}	0.01521 @ 71°			
Z_{44}	0.00214 @ 8°			
Z_{51}	0.00960 @ 344°			
Z_{53}	0.01567 @ 52°			
Z_{55}	0.02163 @ 29°			
Z_{60}	-0.00793			
Z_{62}	0.01564 @ 156°			
Z_{64}	0.01908 @ 47°			
Z_{66}	0.01941 @ 45°			

Wavefront High Order Aberrations Rms Error (μ): **0.06**

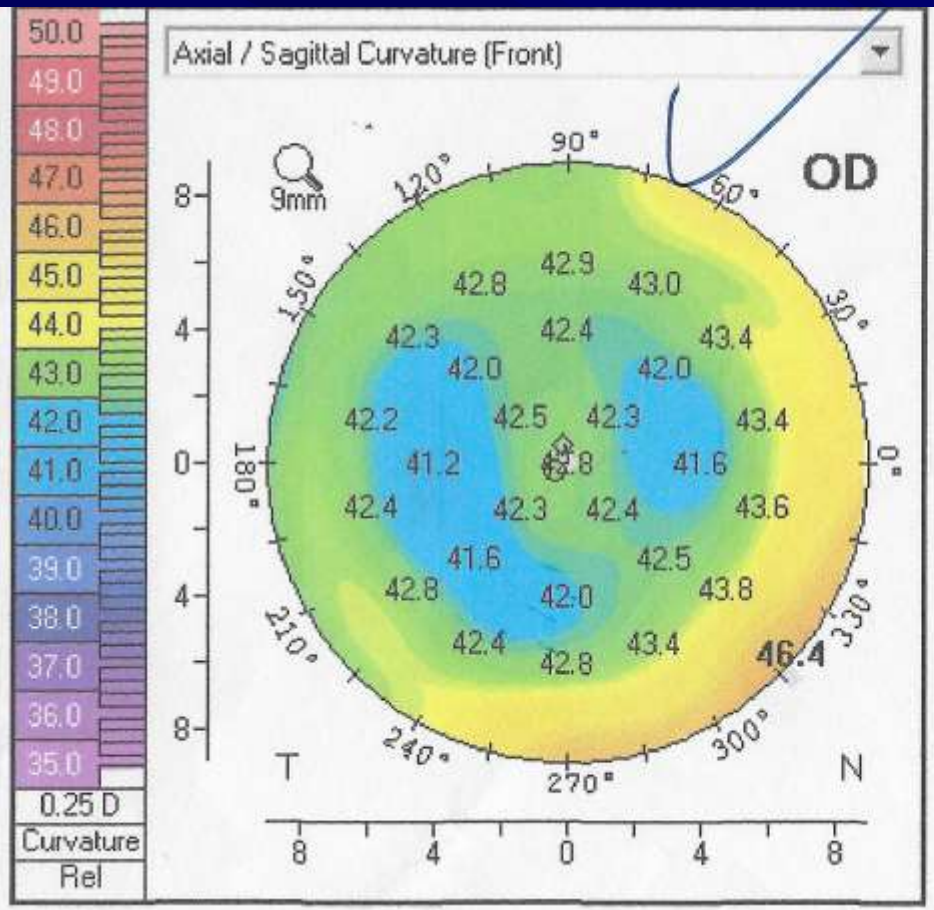


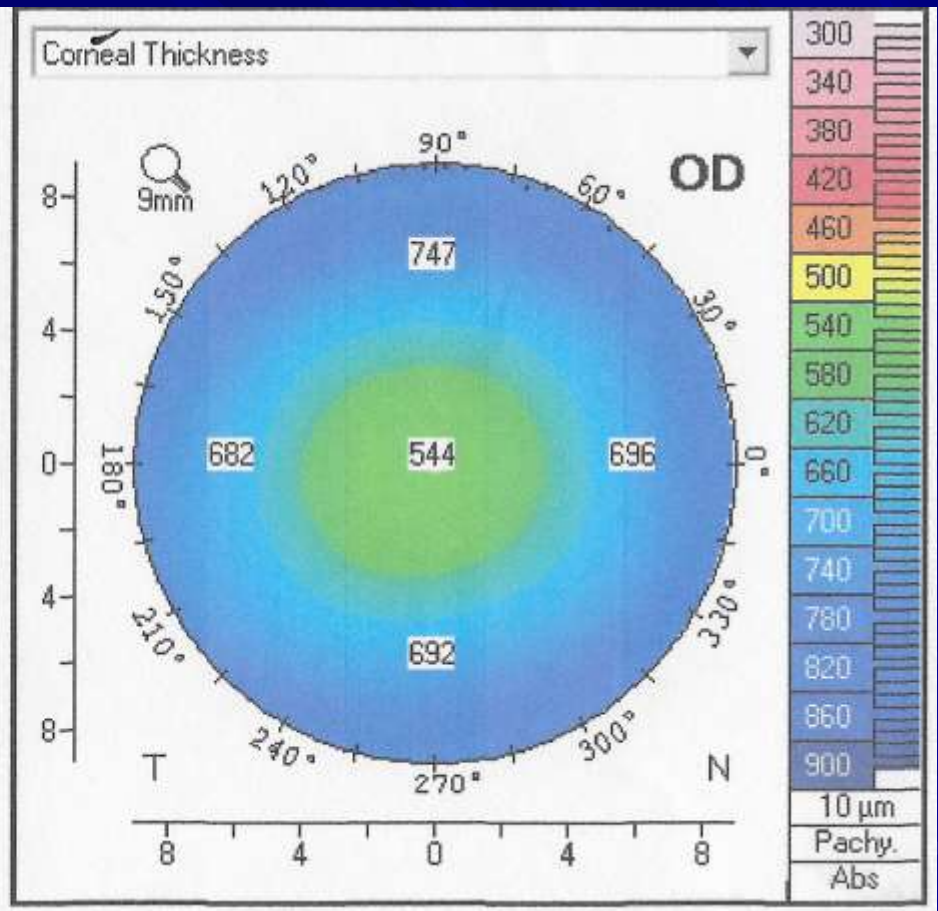
Range: -0.2 to +0.2 microns Grid spacing: 1 mm.

Eye Image Limbus Diam: **13.0 mm** Pupil: **3.5 x 3.4 mm @54° (avg 3.5)**

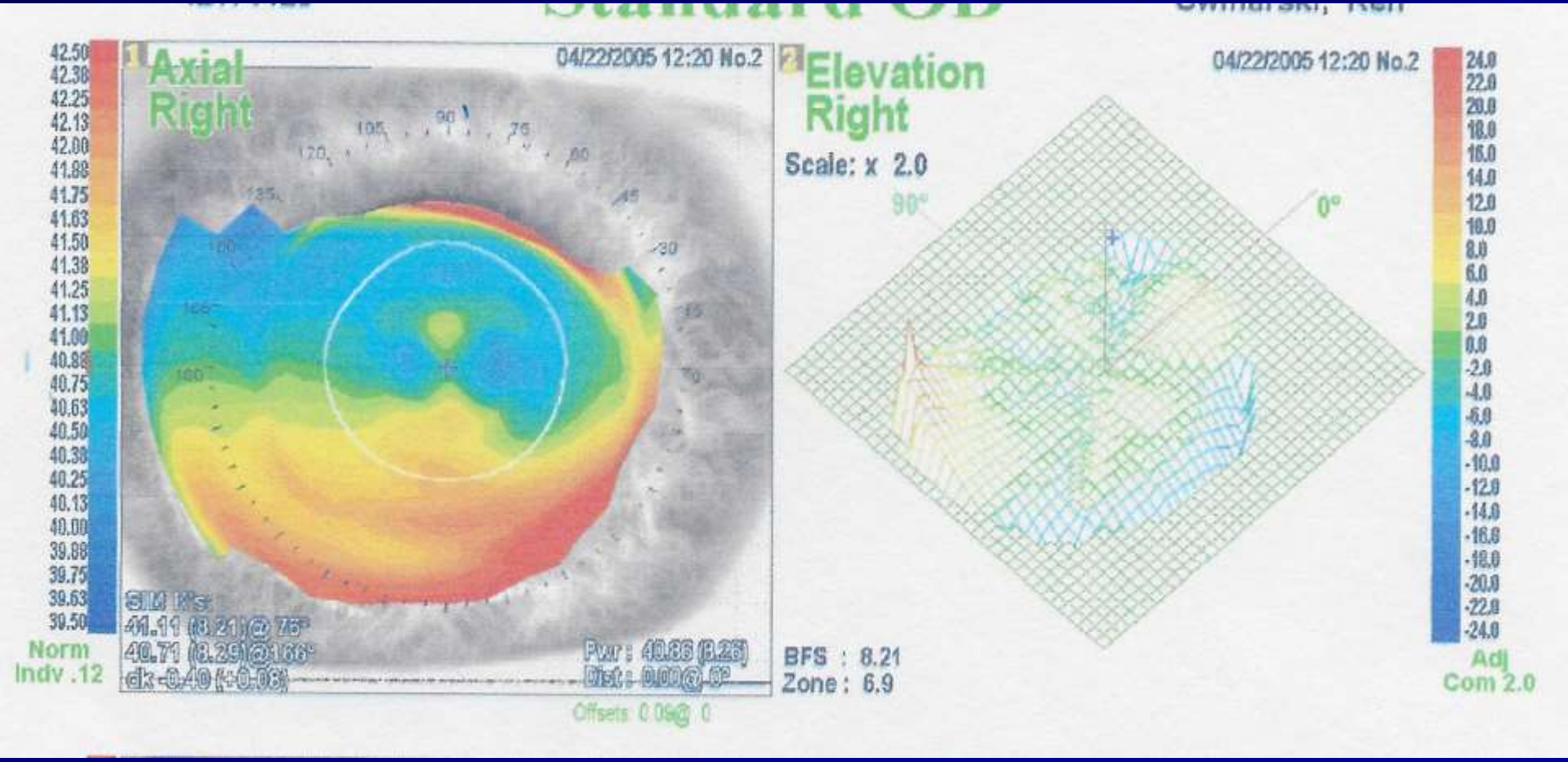


Island

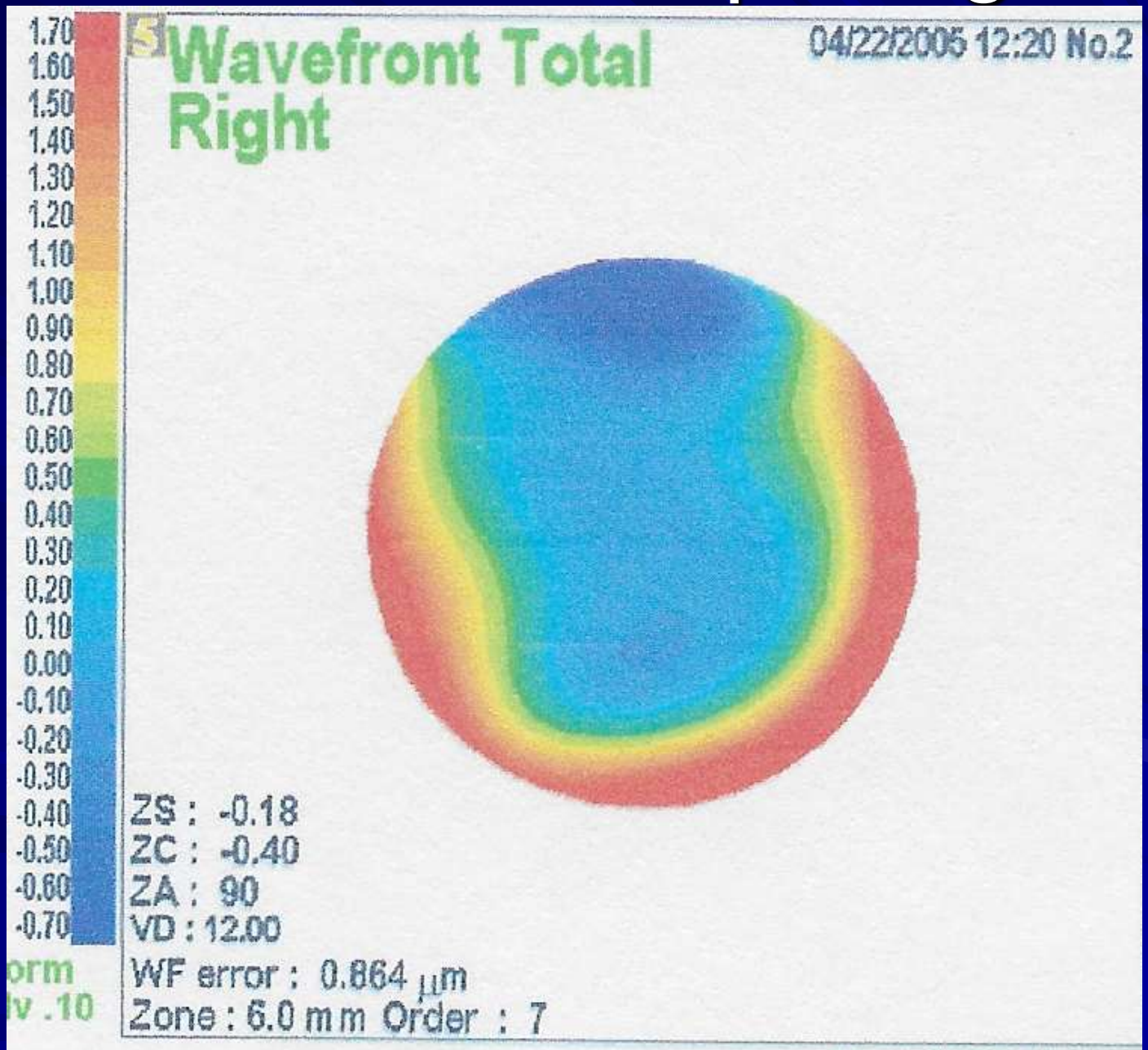

Axial / Sagittal Curvature (Front)
OD
9mm
90°
120°
60°
150°
30°
180°
0°
210°
330°
240°
300°
270°
T
N
8
4
0
4
8
42.8
42.9
43.0
42.3
42.4
43.4
42.0
42.0
42.2
42.5
42.3
43.4
41.2
41.6
42.4
42.3
42.4
43.6
41.6
42.5
42.8
42.0
43.8
42.4
43.4
46.4
42.8
50.0
49.0
48.0
47.0
46.0
45.0
44.0
43.0
42.0
41.0
40.0
39.0
38.0
37.0
36.0
35.0
0.25 D
Curvature
Rel


Corneal Thickness
OD
9mm
90°
120°
60°
150°
30°
180°
0°
210°
330°
240°
300°
270°
T
N
8
4
0
4
8
747
682
544
696
692
300
340
380
420
460
500
540
580
620
660
700
740
780
820
860
900
10 µm
Pachy.
Abs

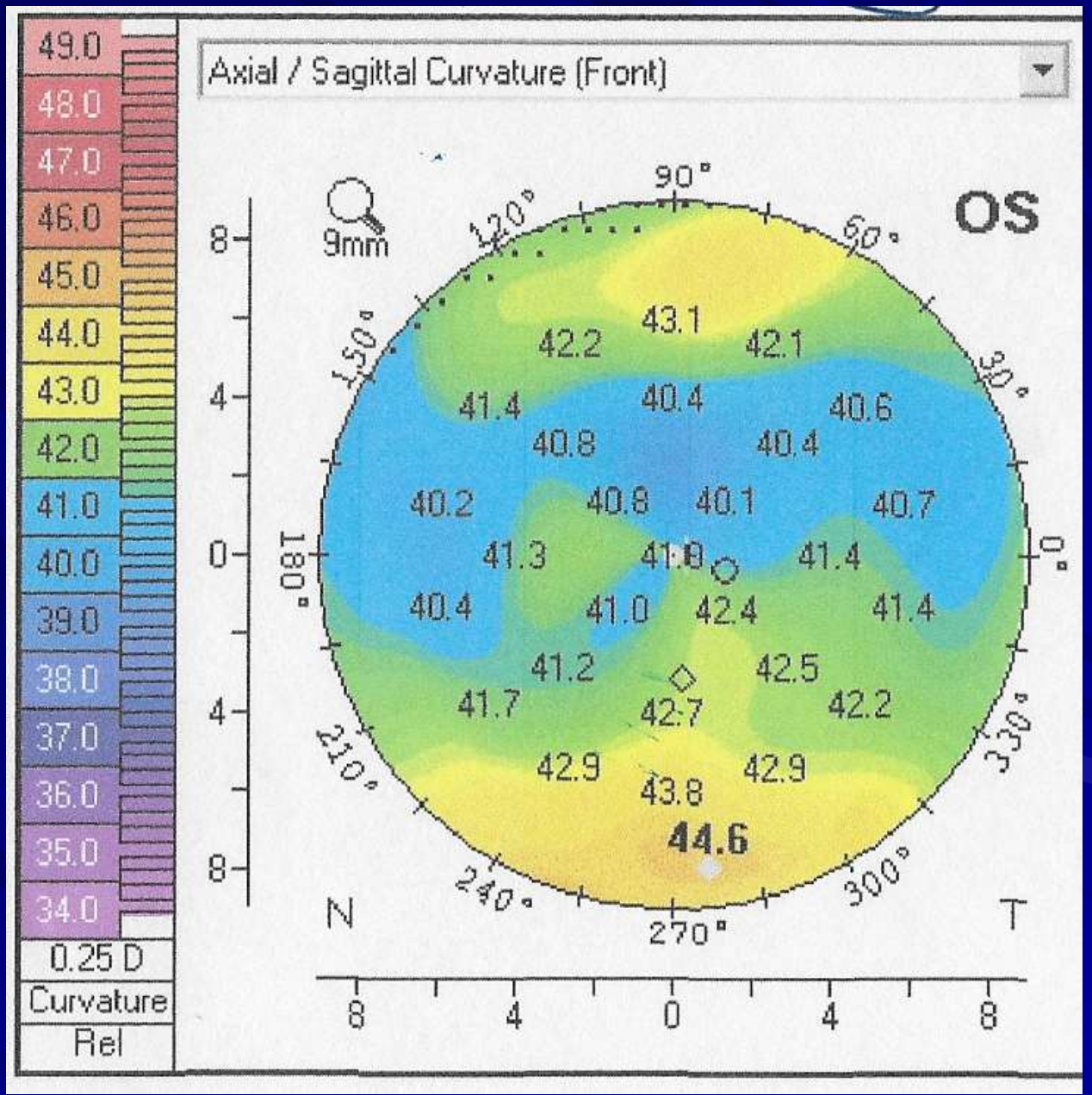
Inferior Steepening



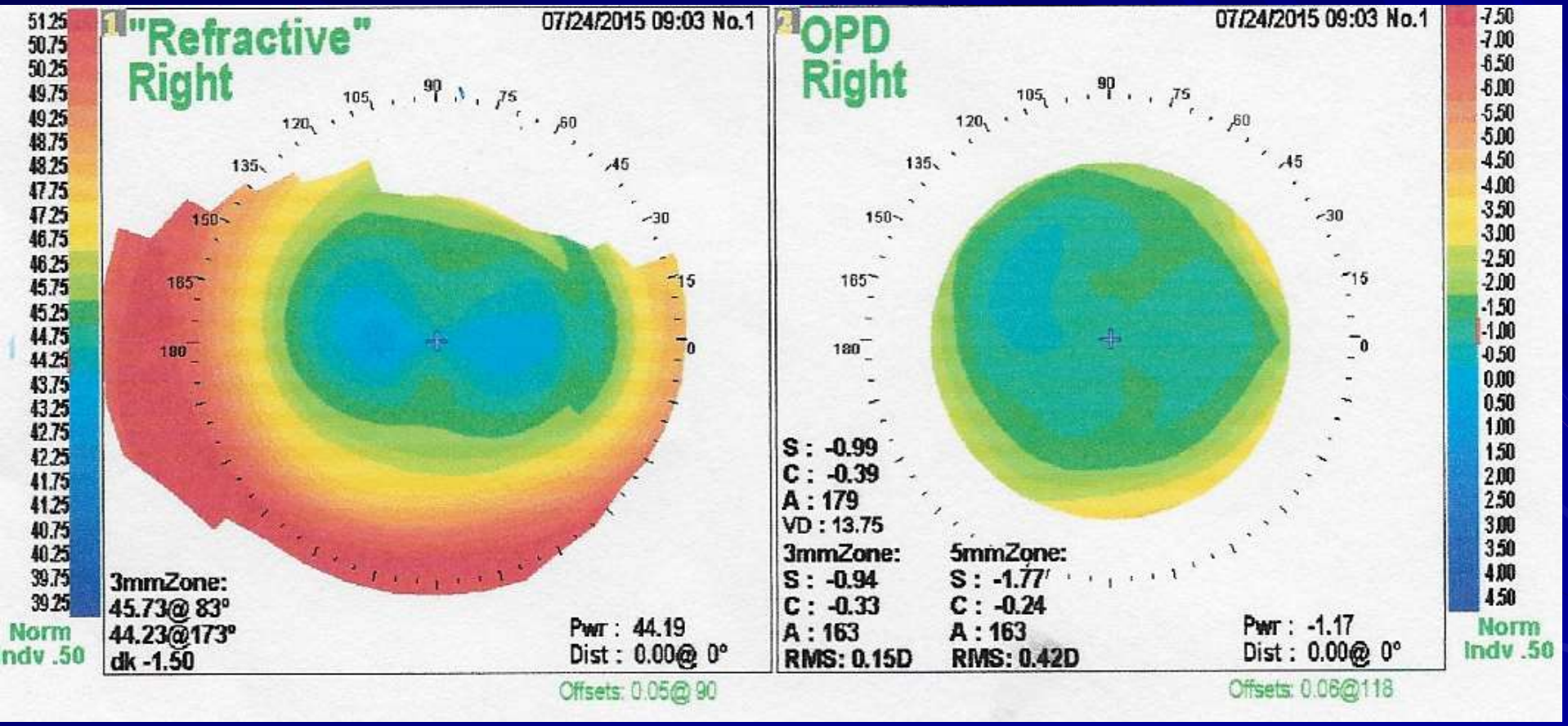
Inferior Steepening



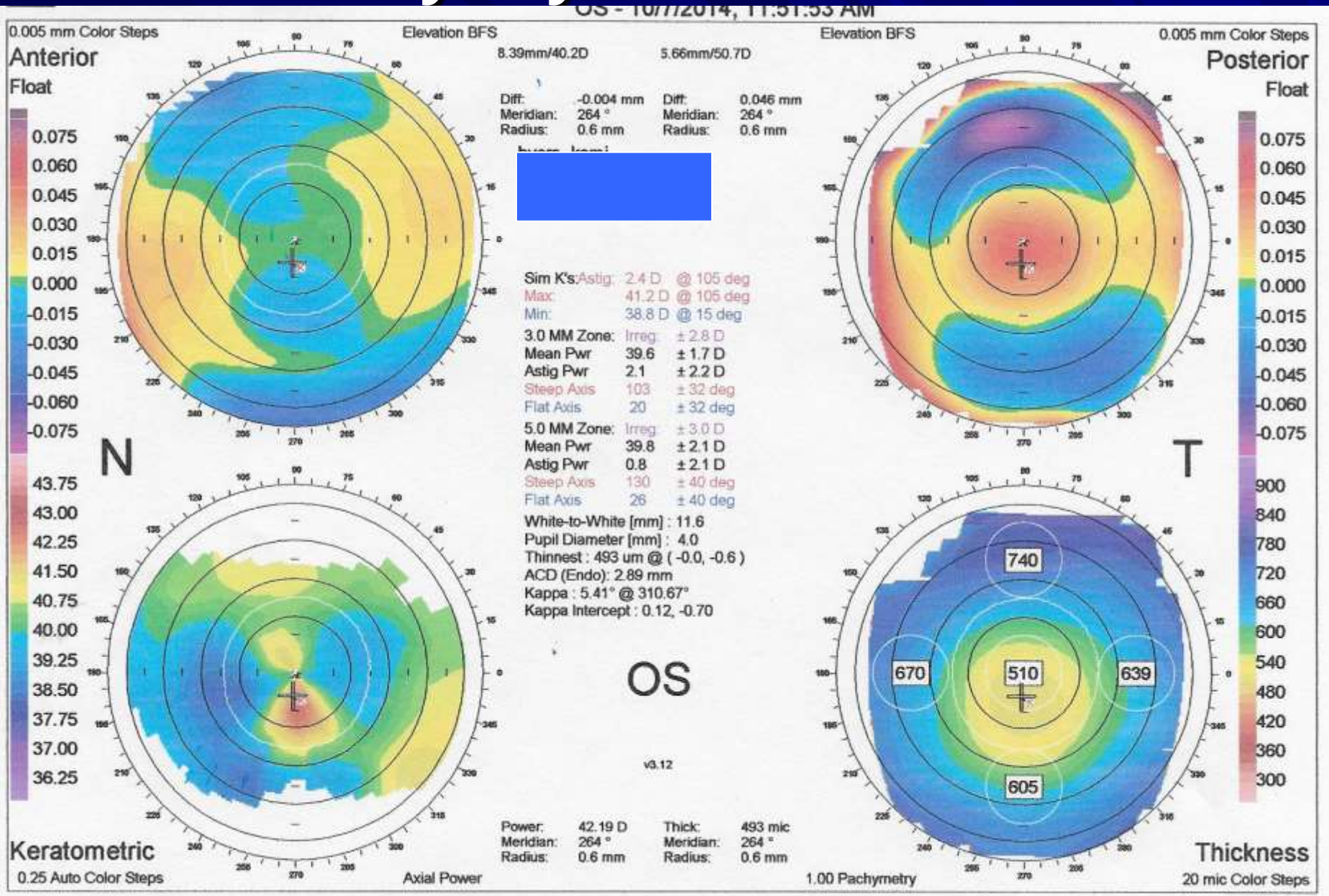
ABMD


49.0
48.0
47.0
46.0
45.0
44.0
43.0
42.0
41.0
40.0
39.0
38.0
37.0
36.0
35.0
34.0
0.25 D
Curvature
Rel
Axial / Sagittal Curvature (Front)
OS
9mm
90°
120°
60°
150°
30°
180°
0°
210°
330°
240°
300°
270°
N
T
43.1
42.2
42.1
41.4
40.4
40.6
40.8
40.4
40.2
40.8
40.1
40.7
41.3
41.8
41.4
40.4
41.0
42.4
41.4
41.2
42.5
41.7
42.7
42.2
42.9
43.8
42.9
44.6
8
4
0
4
8

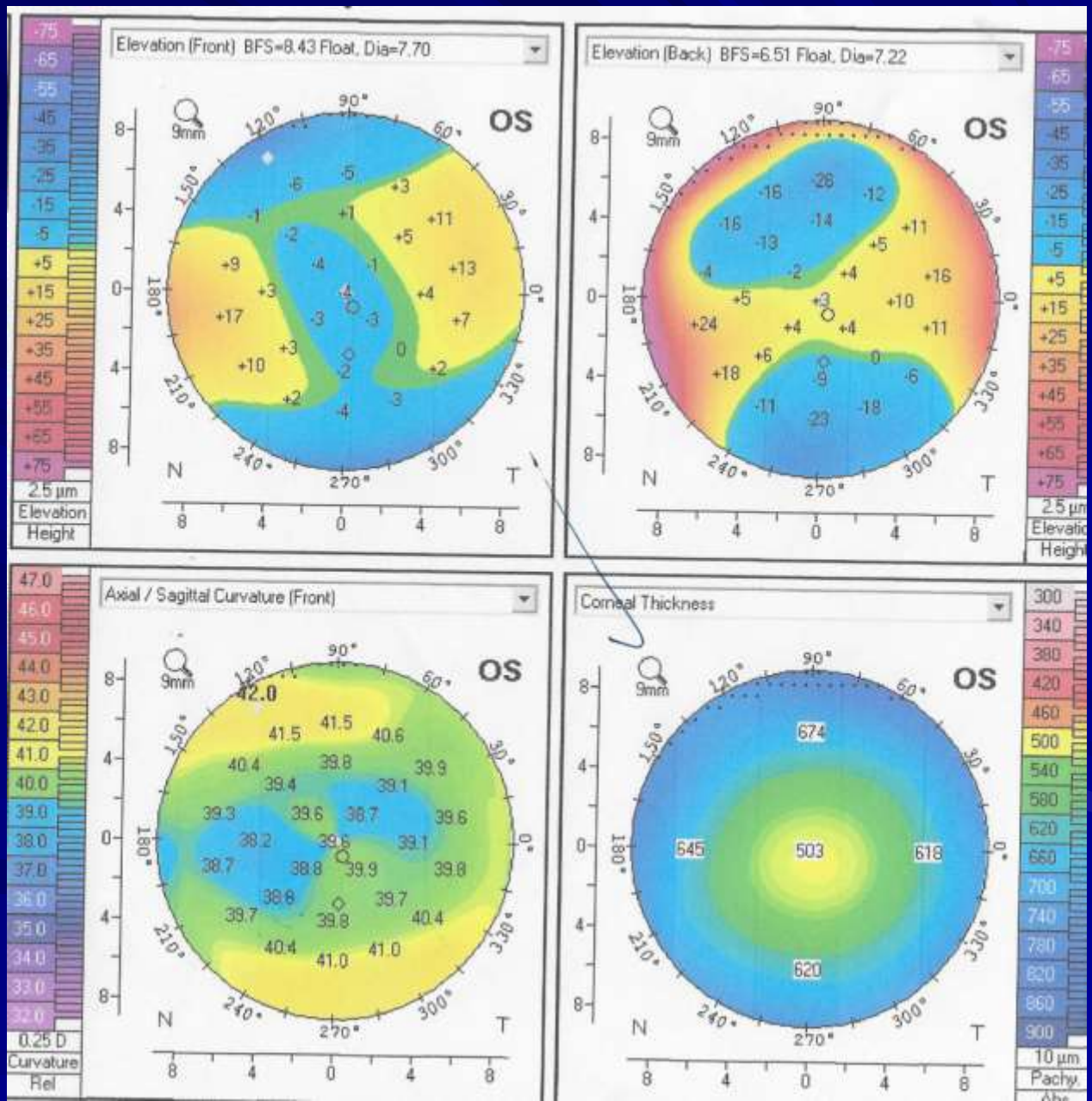
Technolas: Deep Ablation



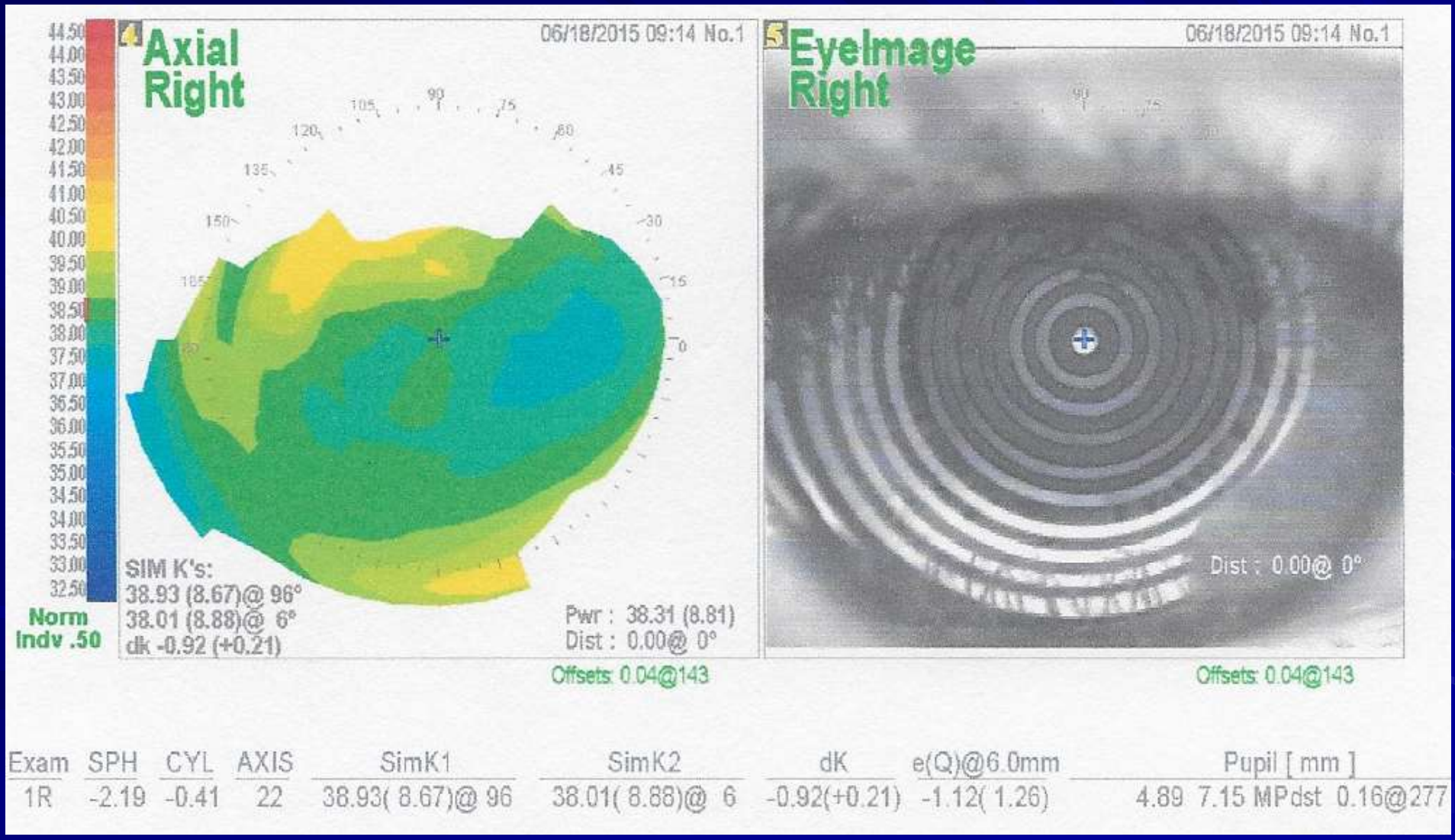
Early Cylinder island



Cylinder island pre-enhancement

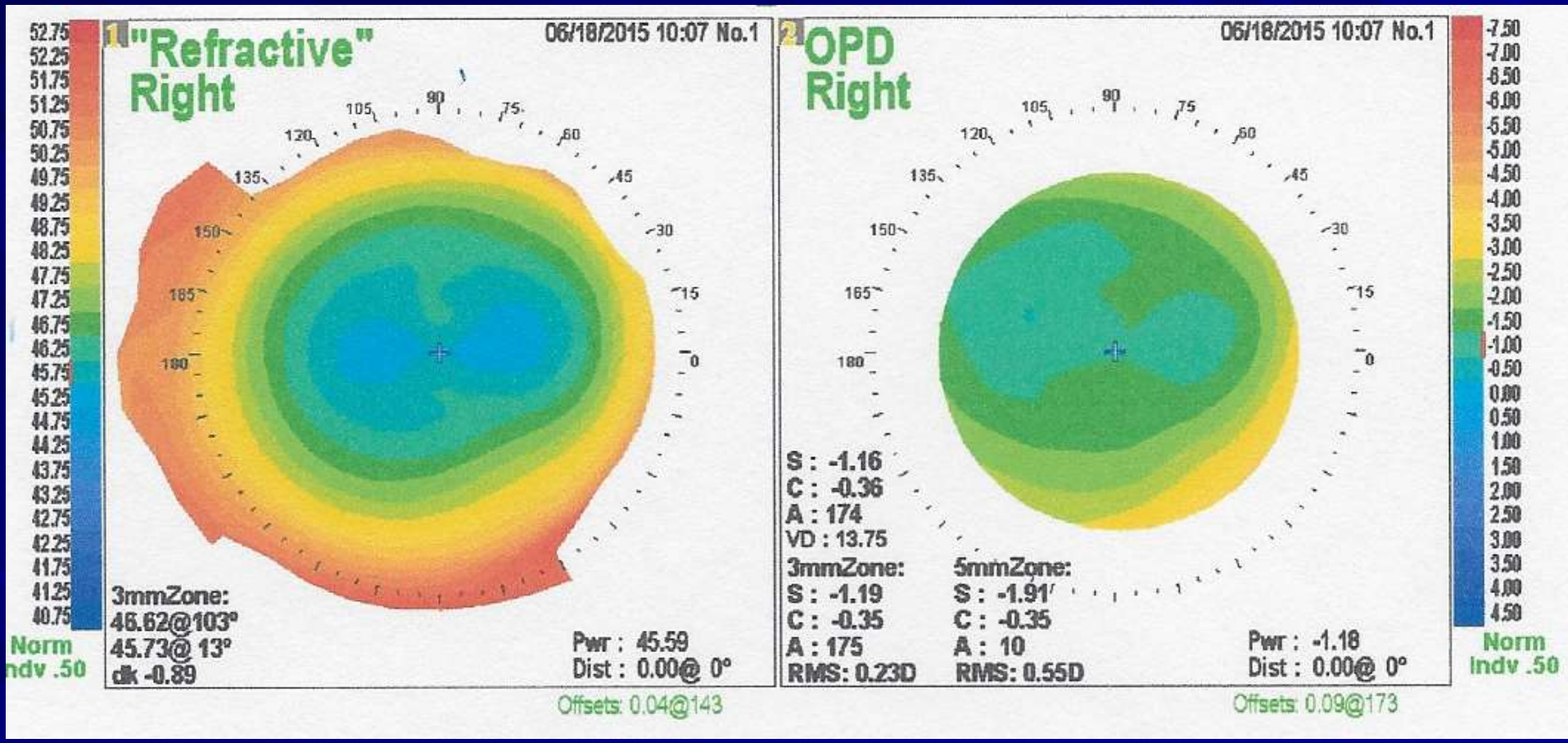


Technolas



Exam	SPH	CYL	AXIS	SimK1	SimK2	dK	e(Q)@6.0mm	Pupil [mm]
1R	-2.19	-0.41	22	38.93(8.67)@ 96	38.01(8.88)@ 6	-0.92(+0.21)	-1.12(1.26)	4.89 7.15 MPdst 0.16@277

Technolas


1 "Refractive" Right
06/18/2015 10:07 No.1
3mmZone:
46.62@103°
45.73@ 13°
dk -0.89
Pwr : 45.59
Dist : 0.00@ 0°
Offsets: 0.04@143
2 OPD Right
06/18/2015 10:07 No.1
S : -1.16
C : -0.36
A : 174
VD : 13.75
3mmZone:
S : -1.19
C : -0.35
A : 175
RMS: 0.23D
5mmZone:
S : -1.91
C : -0.35
A : 10
RMS: 0.55D
Pwr : -1.18
Dist : 0.00@ 0°
Offsets: 0.09@173
Norm
Indv .50
Norm
Indv .50

Technolas high cyl