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**Director of Refractive Surgery**  
**Co-Chief of Cornea Service**  
**Wills Eye Hospital**

# Pre-op Cataract Patient With Keratoconus: What Do I Do?

New Orleans Academy of Ophthalmology  
75th Annual Symposium

# Cataract evaluation w/ known KCN

- 61 year old male with progressive decrease in vision over the last ~two years
  - Wears glasses and was told by OD MRx is changing
  - Two children with keratoconus that had CXL
- 

VAcc  $\left\{ \begin{array}{ll} 20/50 & -7.50 + 4.00 \times 135 \\ 20/30 & -4.25 + 1.25 \times 165 \end{array} \right.$

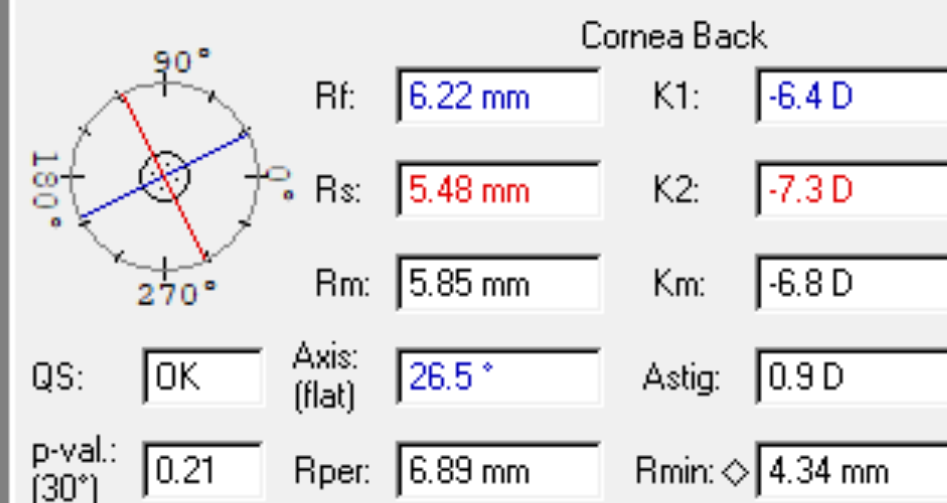
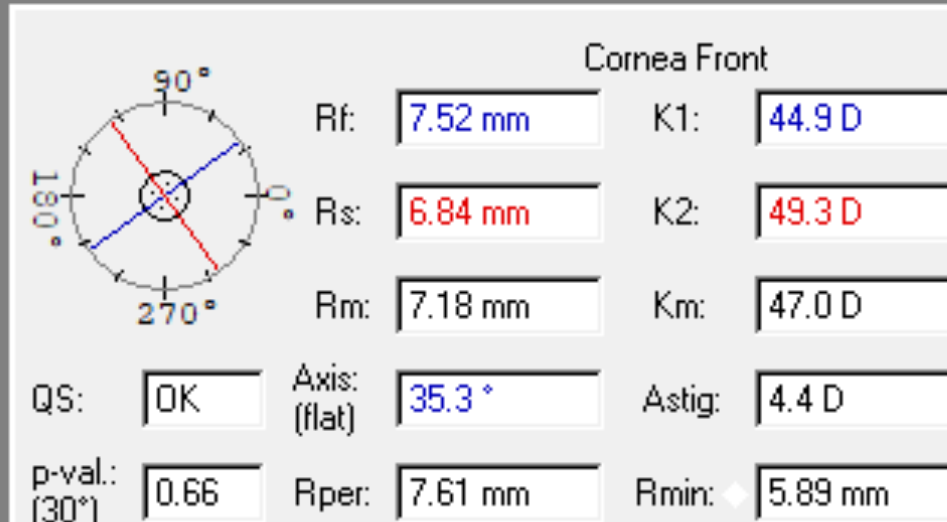
2-3 + NSC OU



# OCULUS - PENTACAM 4 Maps Refractive

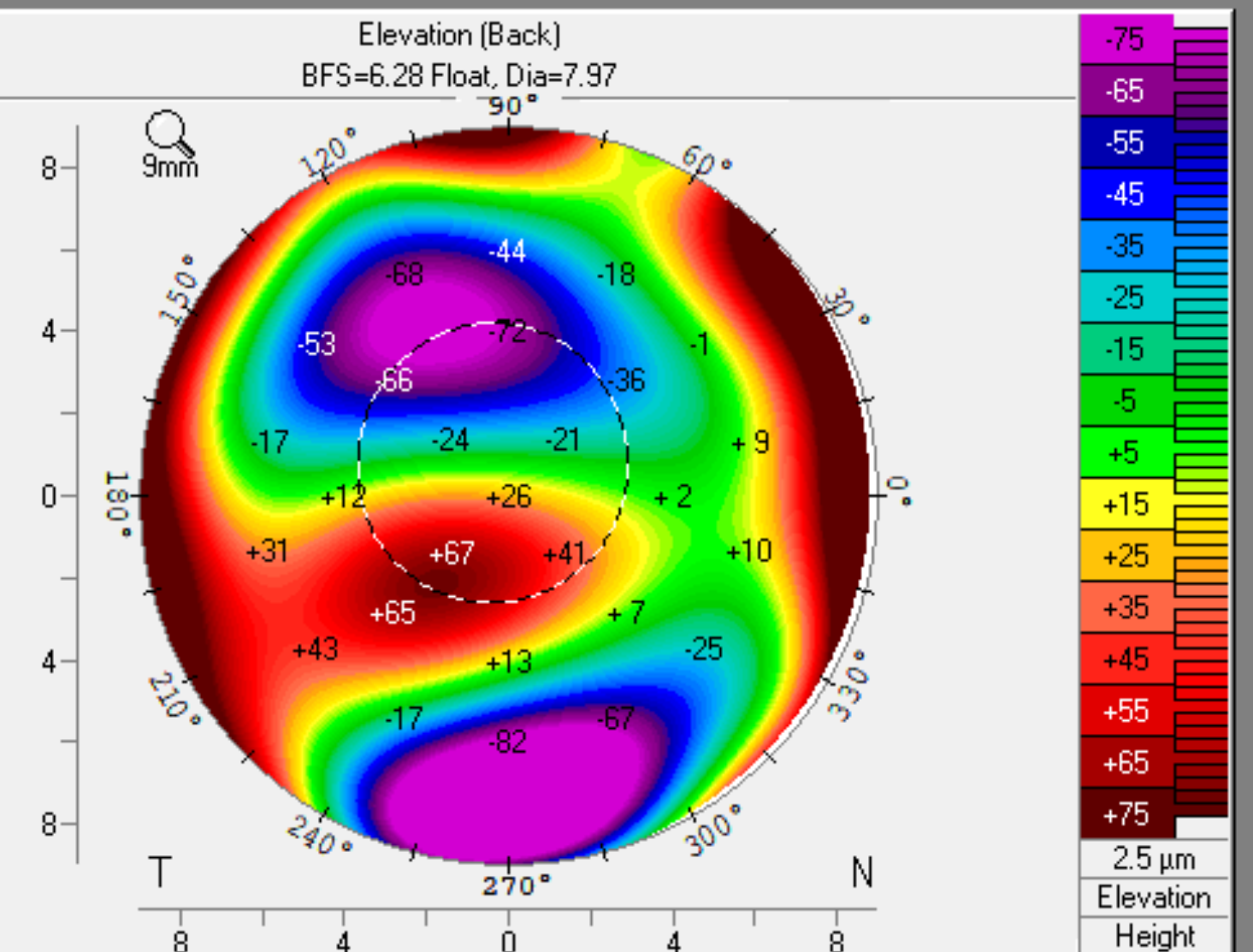
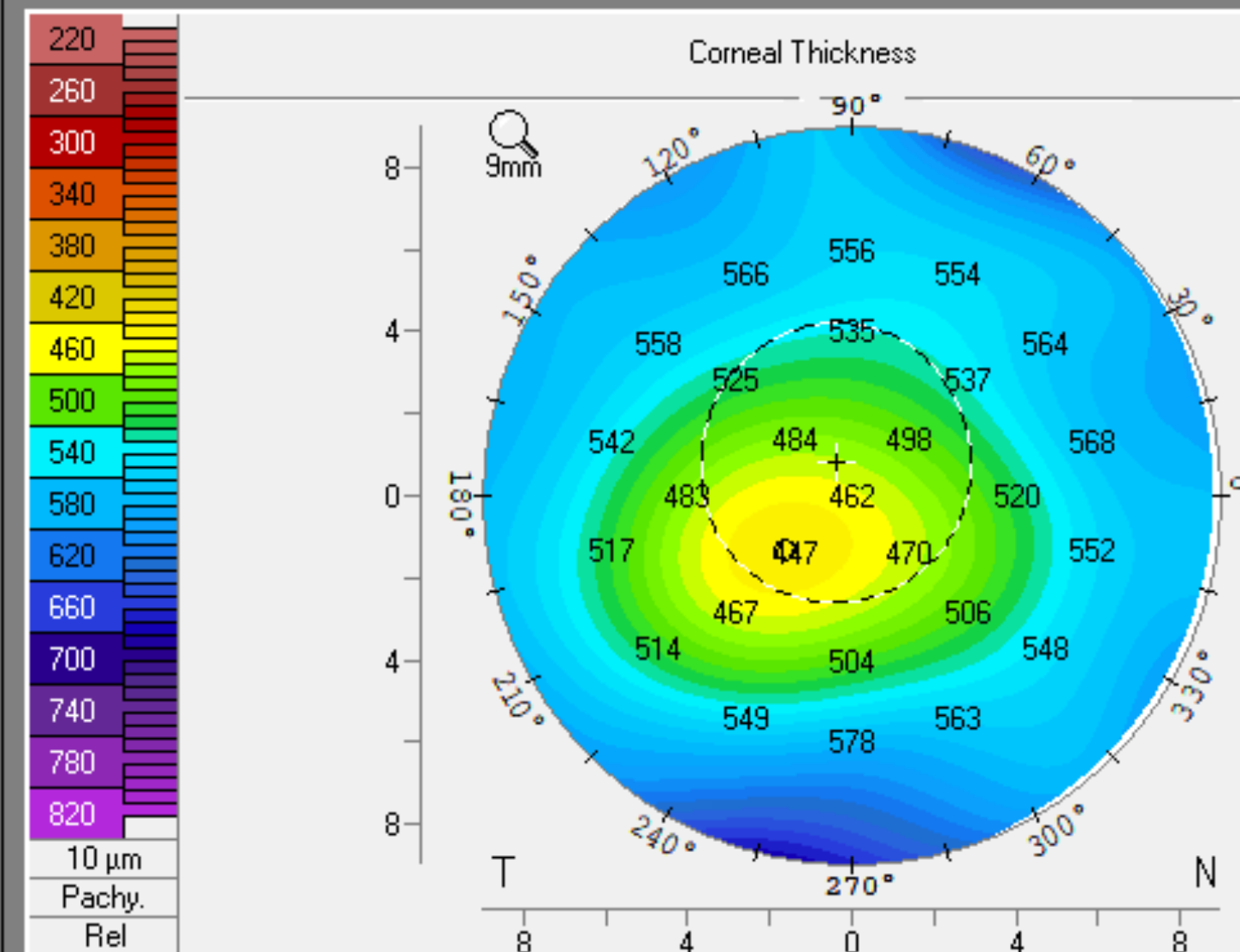
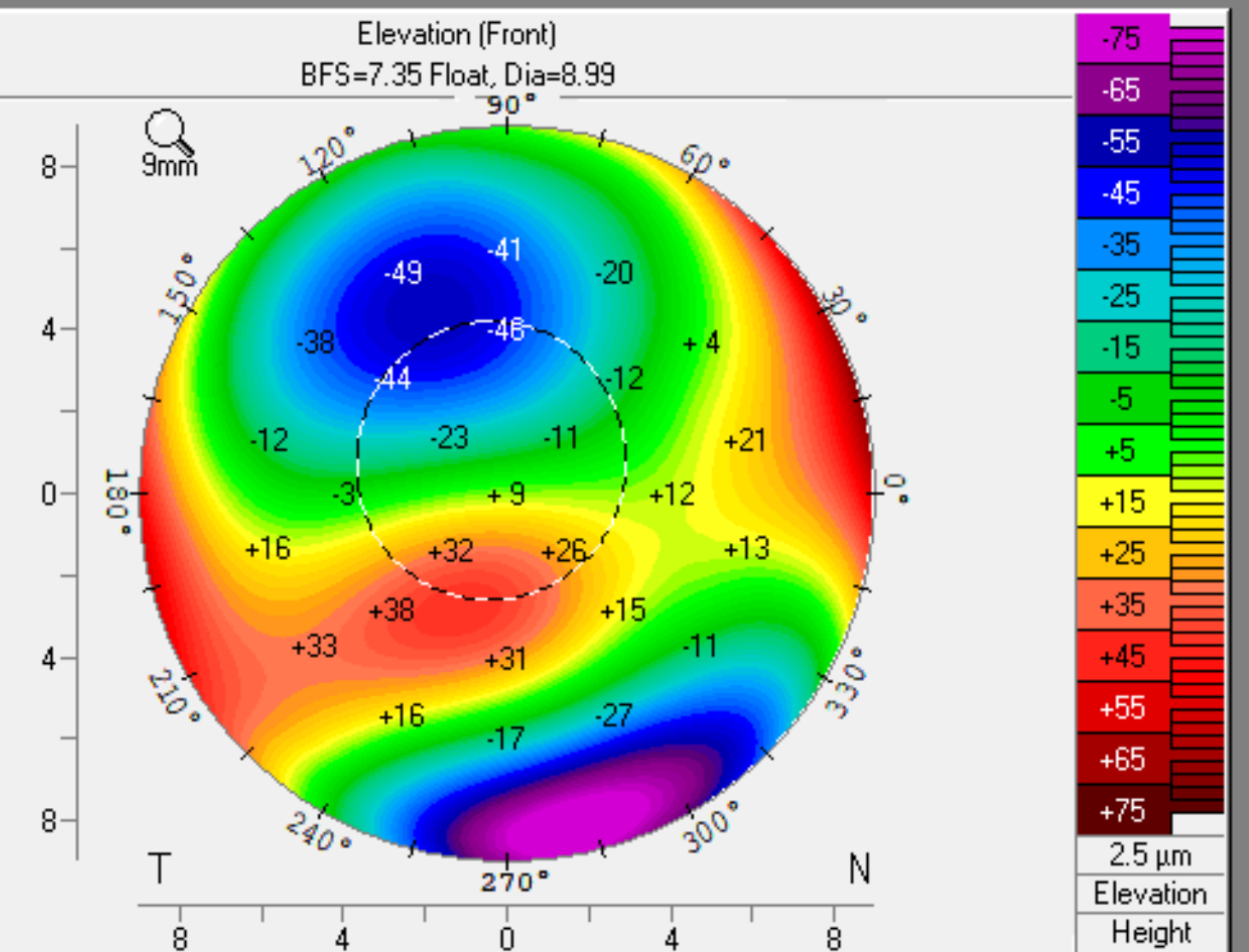
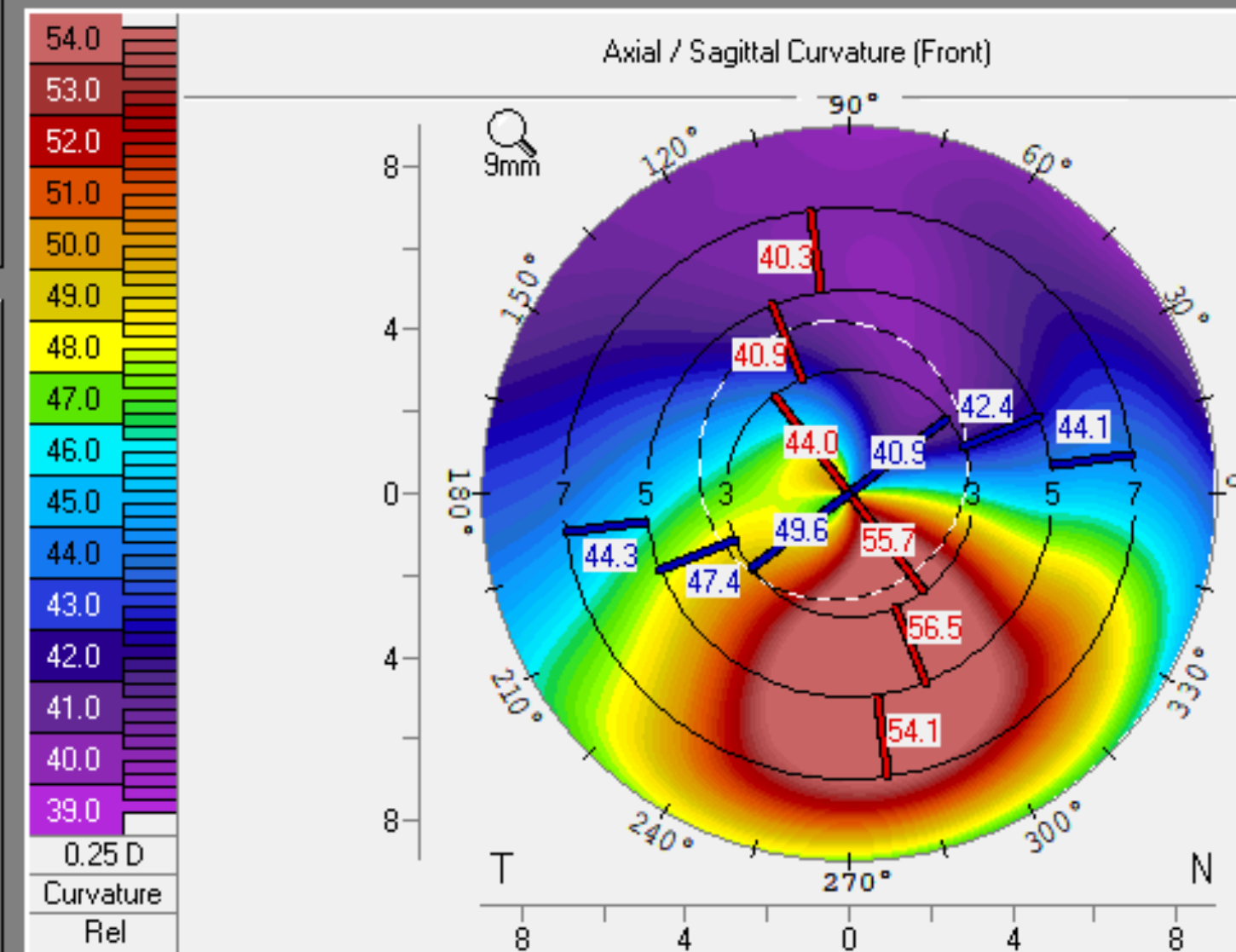
1.25/15

Last Name:   
 First Name:   
 ID:   
 Date of Birth: 07/07/1964 Eye: Right  
 Exam Date: 01/23/2025 Time: 13:31:47  
 Exam Info:



Pupil Center: + 472 μm x[mm] -0.20 y[mm] +0.39  
 Pachy Vertex N.: • 462 μm 0.00 0.00  
 Thinnest Locat.: ○ 447 μm -0.81 -0.68  
 K Max. (Front): • 57.3 D +0.41 -2.03  
 Cornea Volume: 51.6 mm<sup>3</sup> HWTW: 12.1 mm  
 Chamber Volume: 210 mm<sup>3</sup> Angle: 32.8°  
 A. C. Depth (Int.): 3.01 mm Pupil Dia: 3.35 mm  
 Enter IOP IOP(cor):  Lens Th.:

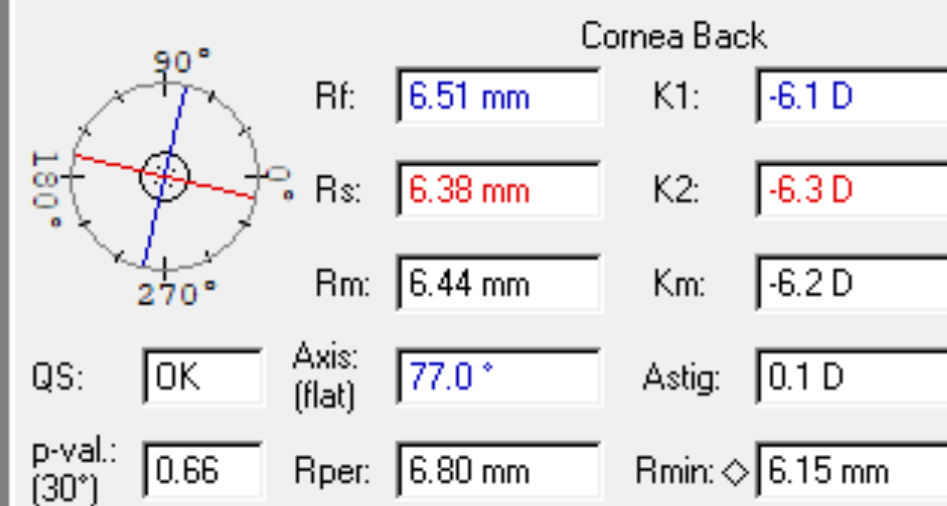
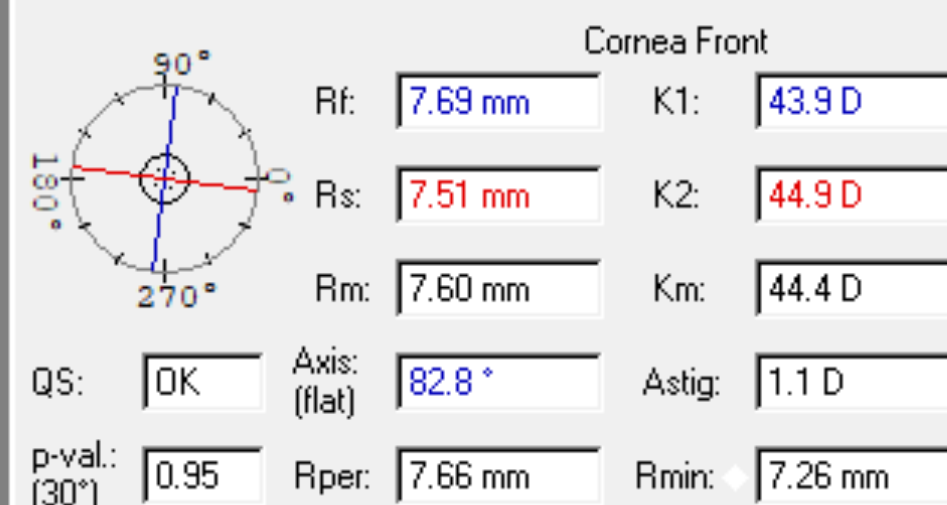
## Refractive



# OCULUS - PENTACAM 4 Maps Refractive

1.25/15

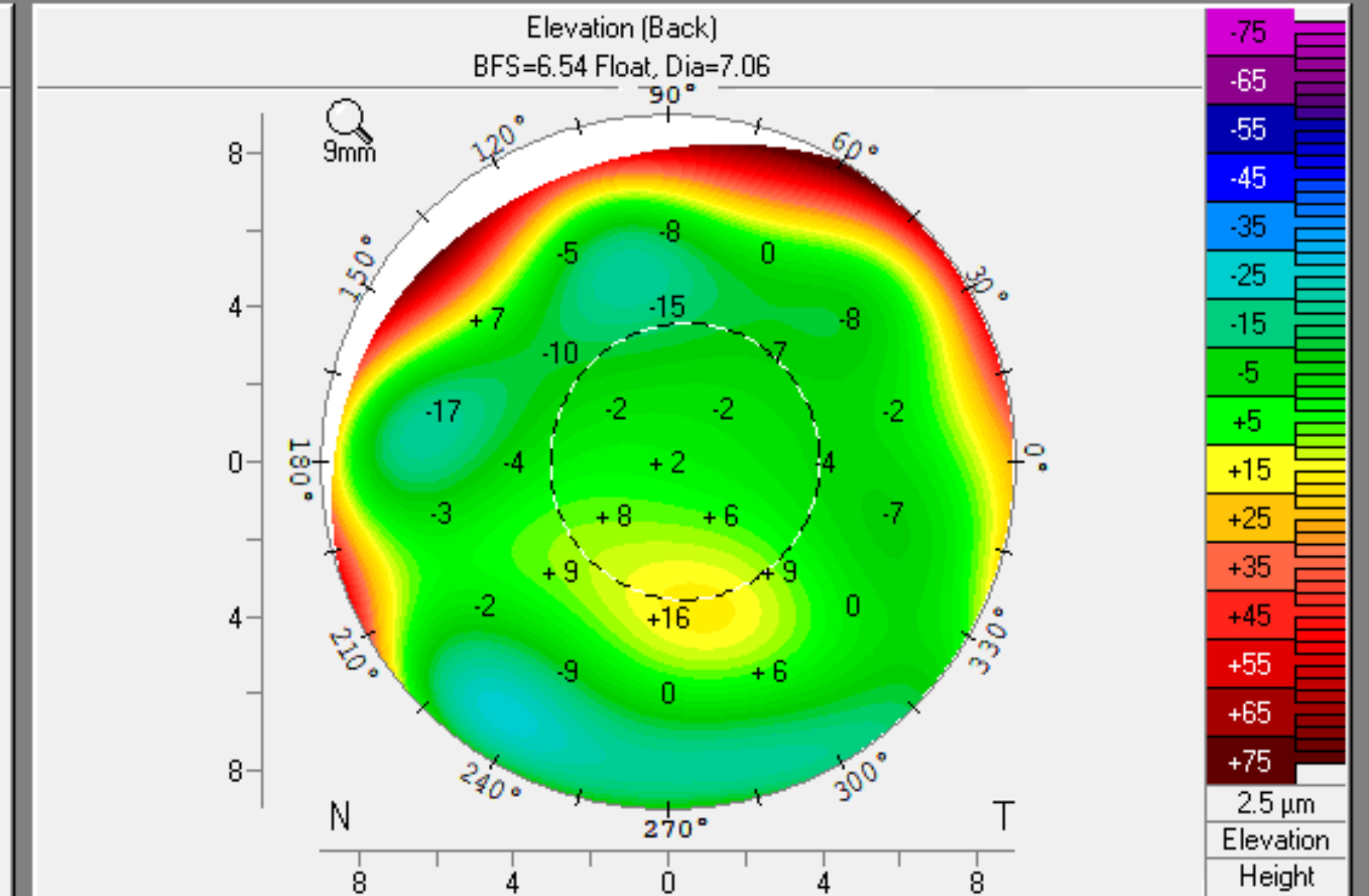
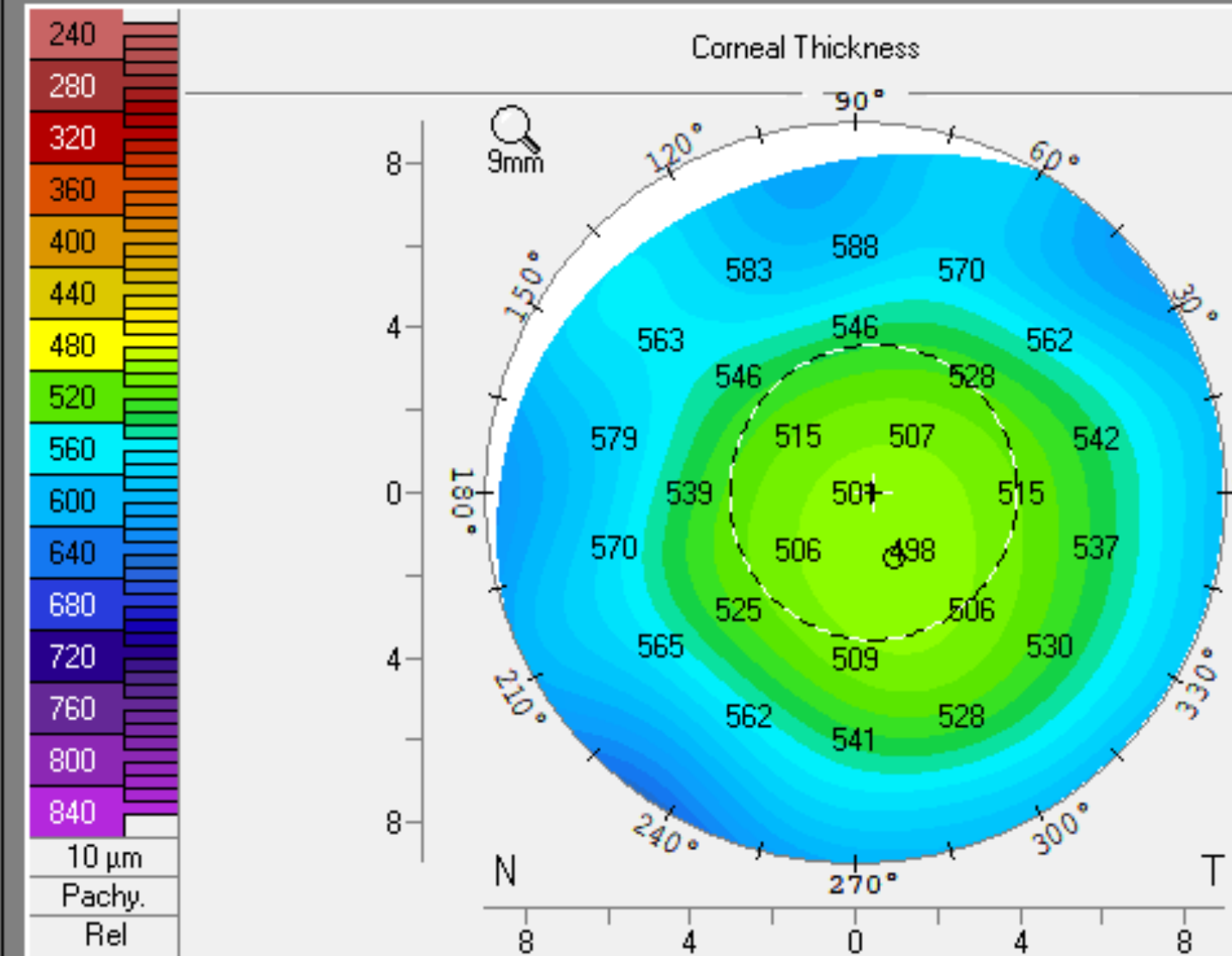
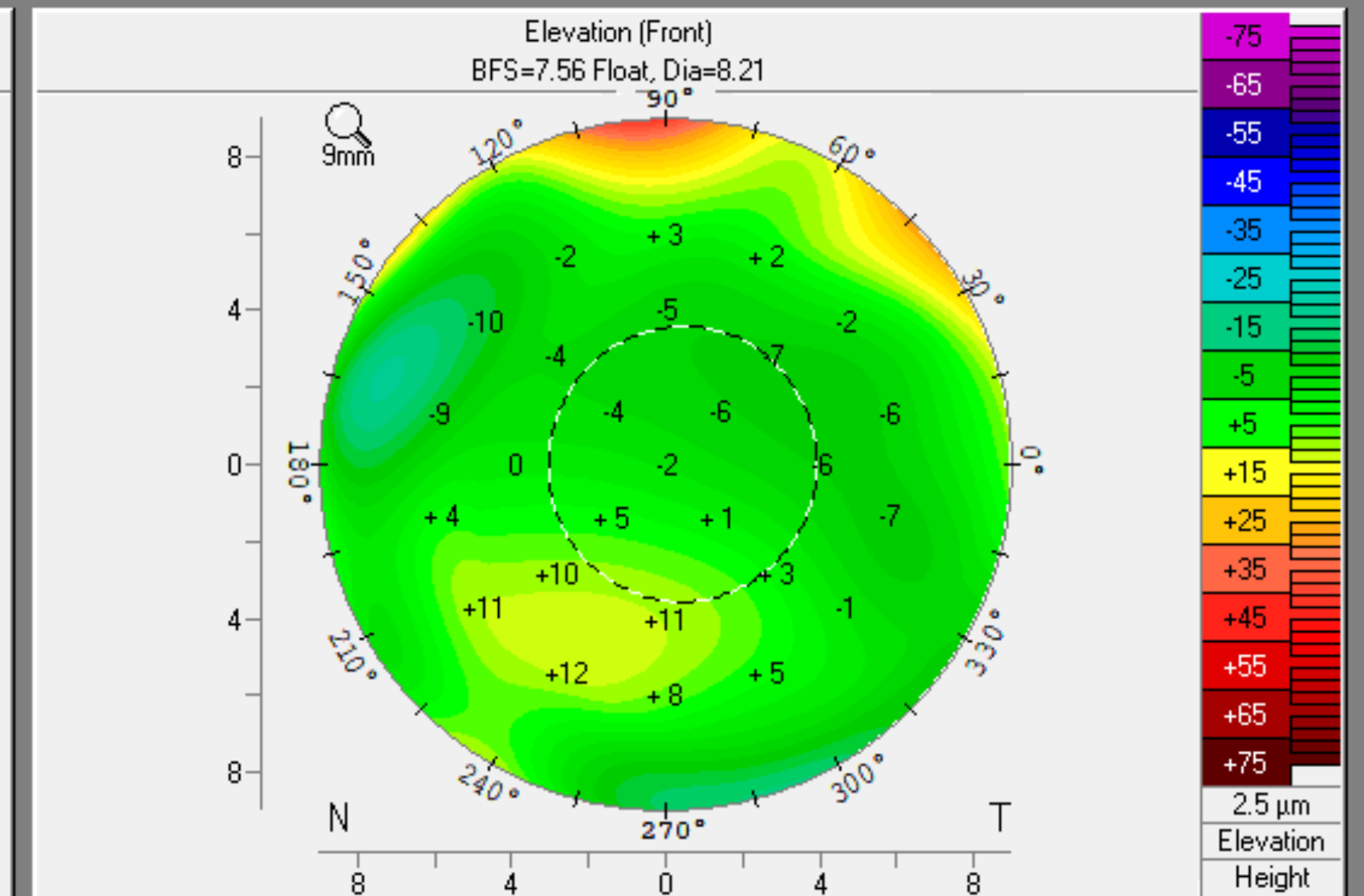
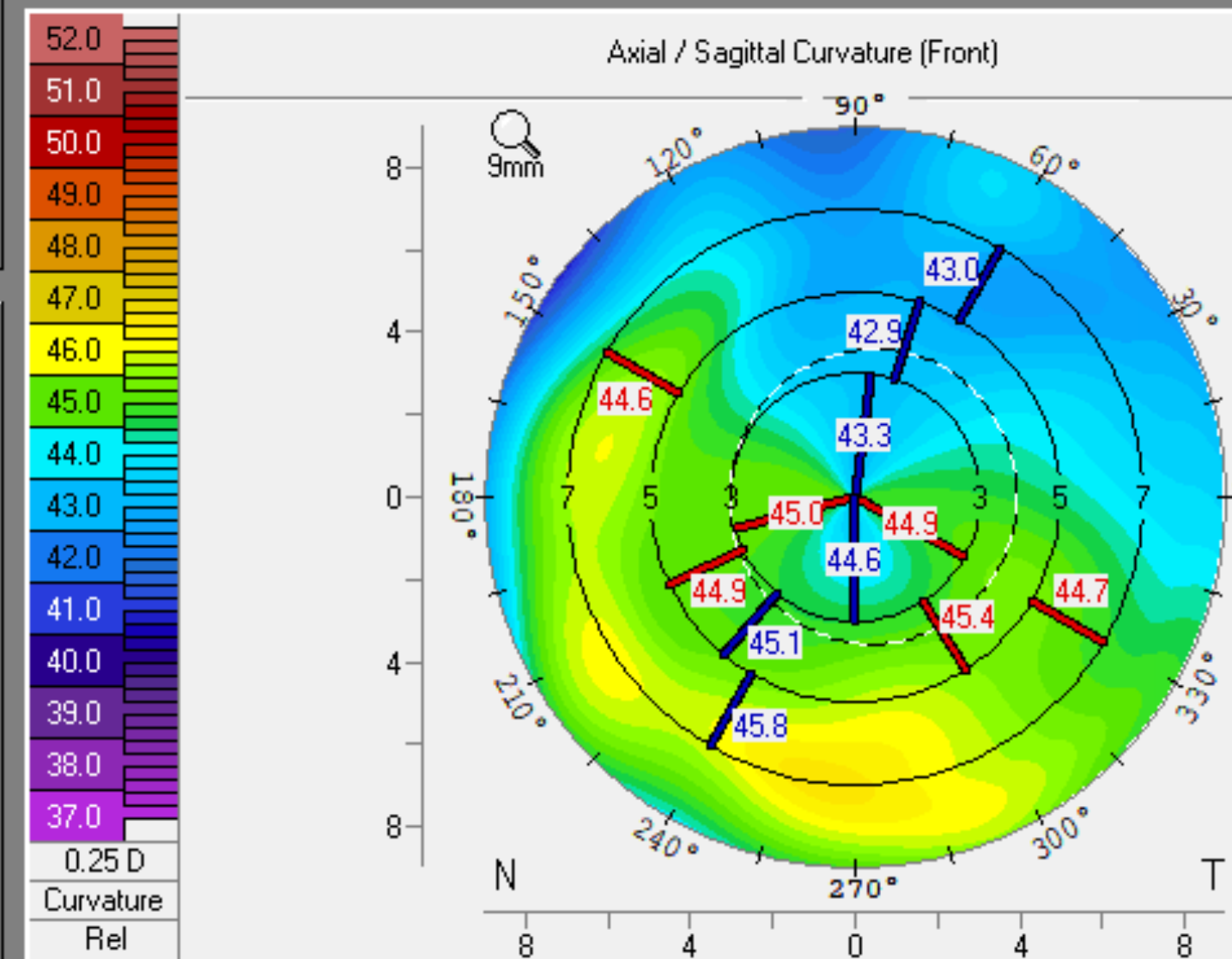
Last Name:   
 First Name:   
 ID:   
 Date of Birth: 07/07/1964 Eye: Left  
 Exam Date: 01/23/2025 Time: 13:31:13  
 Exam Info:



Pupil Center: + 500 µm x[mm] +0.22 y[mm] 0.00  
 Pachy Vertex N.: • 501 µm 0.00 0.00  
 Thinnest Locat.: ○ 498 µm +0.47 -0.80  
 K Max. (Front): • 46.5 D -0.33 -3.46

Cornea Volume: 52.2 mm³ HWTW: 12.0 mm  
 Chamber Volume: 193 mm³ Angle: 26.9°  
 A. C. Depth (Int.): 2.86 mm Pupil Dia: 3.53 mm  
 Enter IOP IOP(cor):  Lens Th.:

## Refractive





# Should the patient be cross-linked?

*Is the patient progressing?*



- Chance of progression at this age is very low, but is it zero?
- Peer reviewed literature is limited
- How long should we monitor before determining stability?

# Should the patient be cross-linked?

*Is it practical to stabilize cornea before cataract surgery?*



- Are you willing to wait 1 year after cross-linking?
- If you are considering a toric IOL, then exercise in patience may be worth it



# Should the patient be cross-linked?

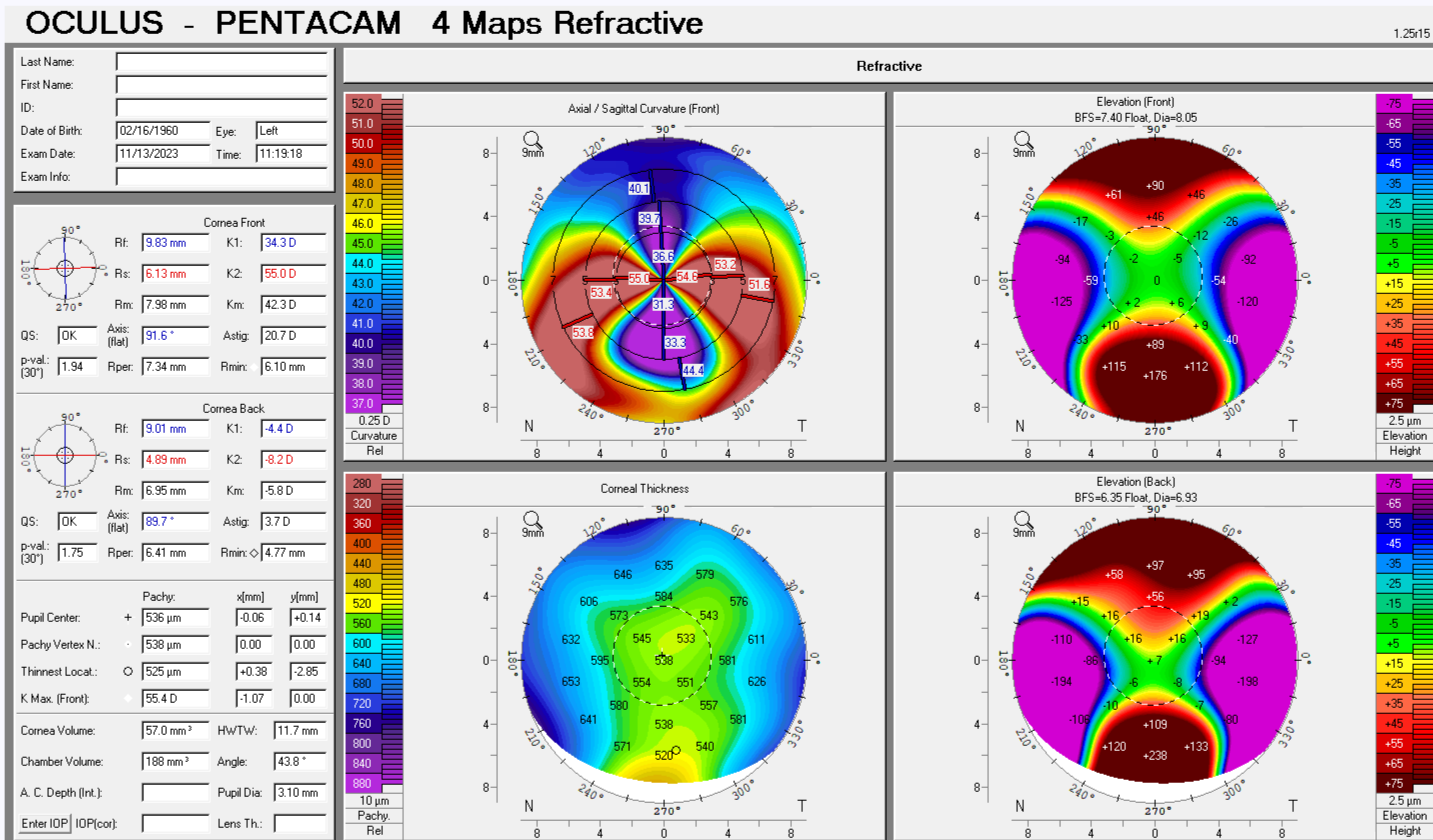


*Will cataract surgery cause progression?*

- Very little in peer reviewed literature
- Does the outcome change if we CXL after?
- It is important to monitor after

Kmax:  
11/23: 55.4

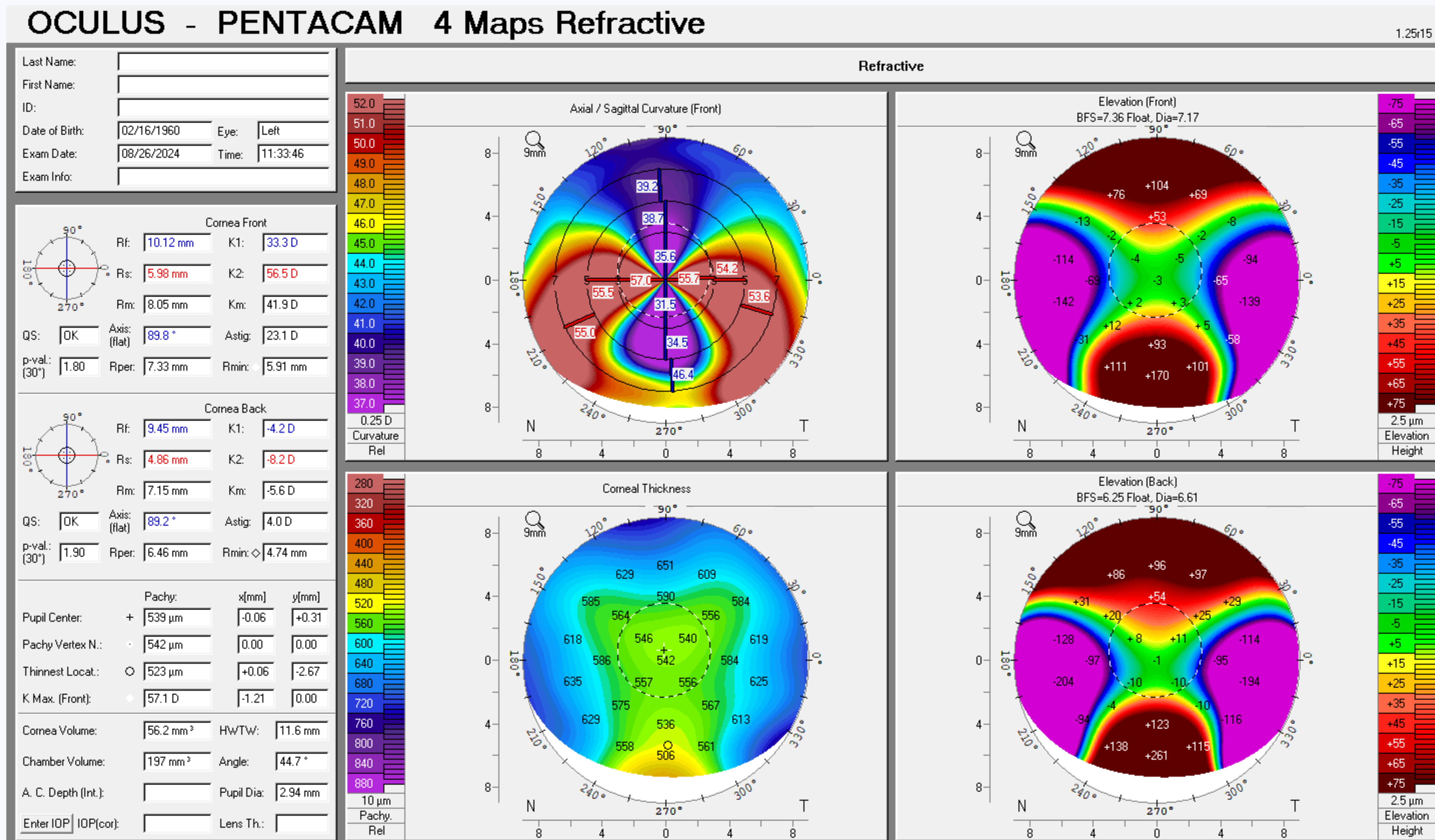
Astigmatism:  
11/23: 20.7





Kmax:  
11/23: 55.4  
08/24: 57.1

Astigmatism:  
11/23: 20.7  
08/24: 23.1

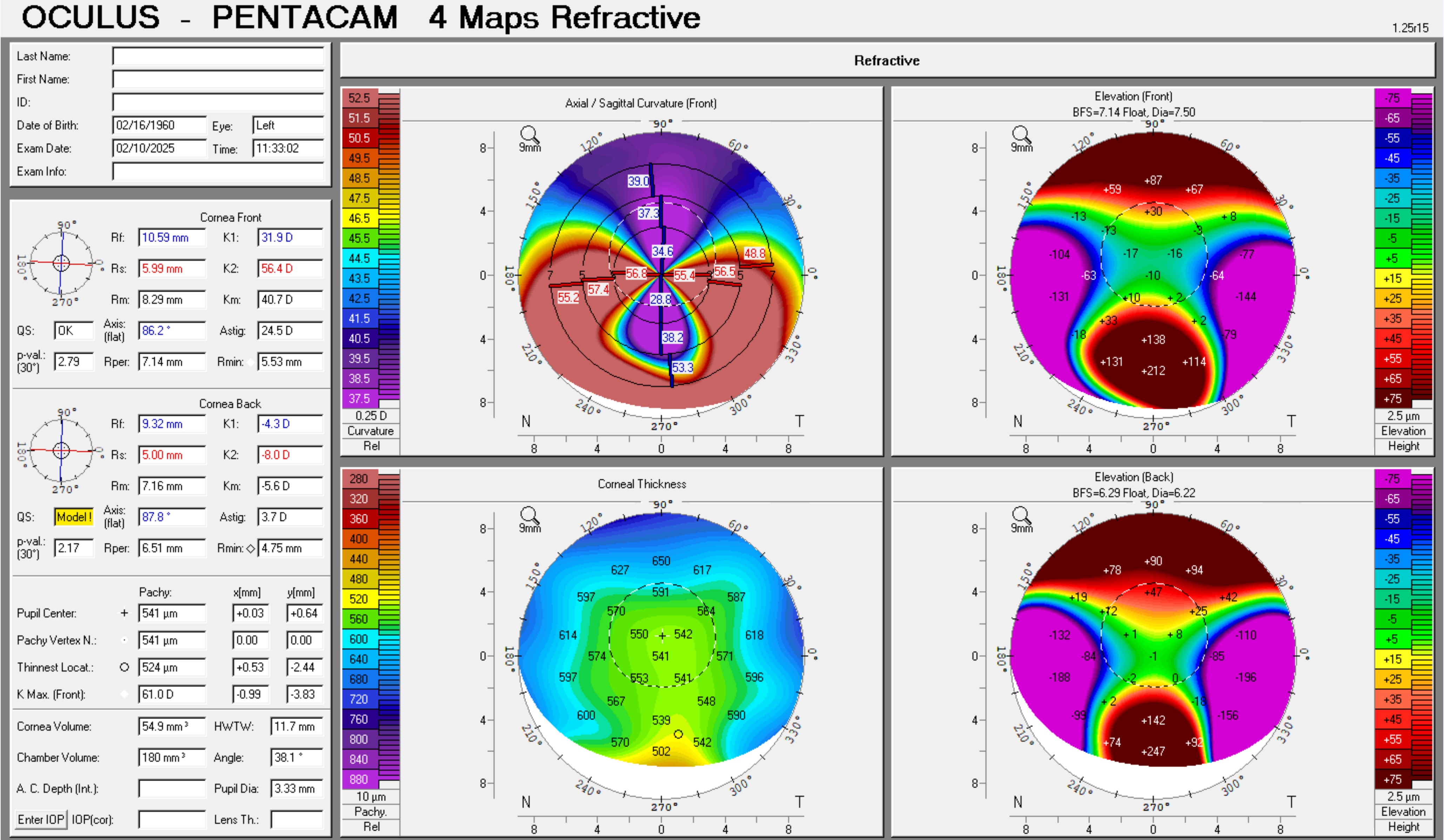




Kmax:  
11/23: 55.4  
08/24: 57.1  
02/25: 61.0

Astigmatism:  
11/23: 20.7  
08/24: 23.1  
02/25: 24.5

CXL March  
2025



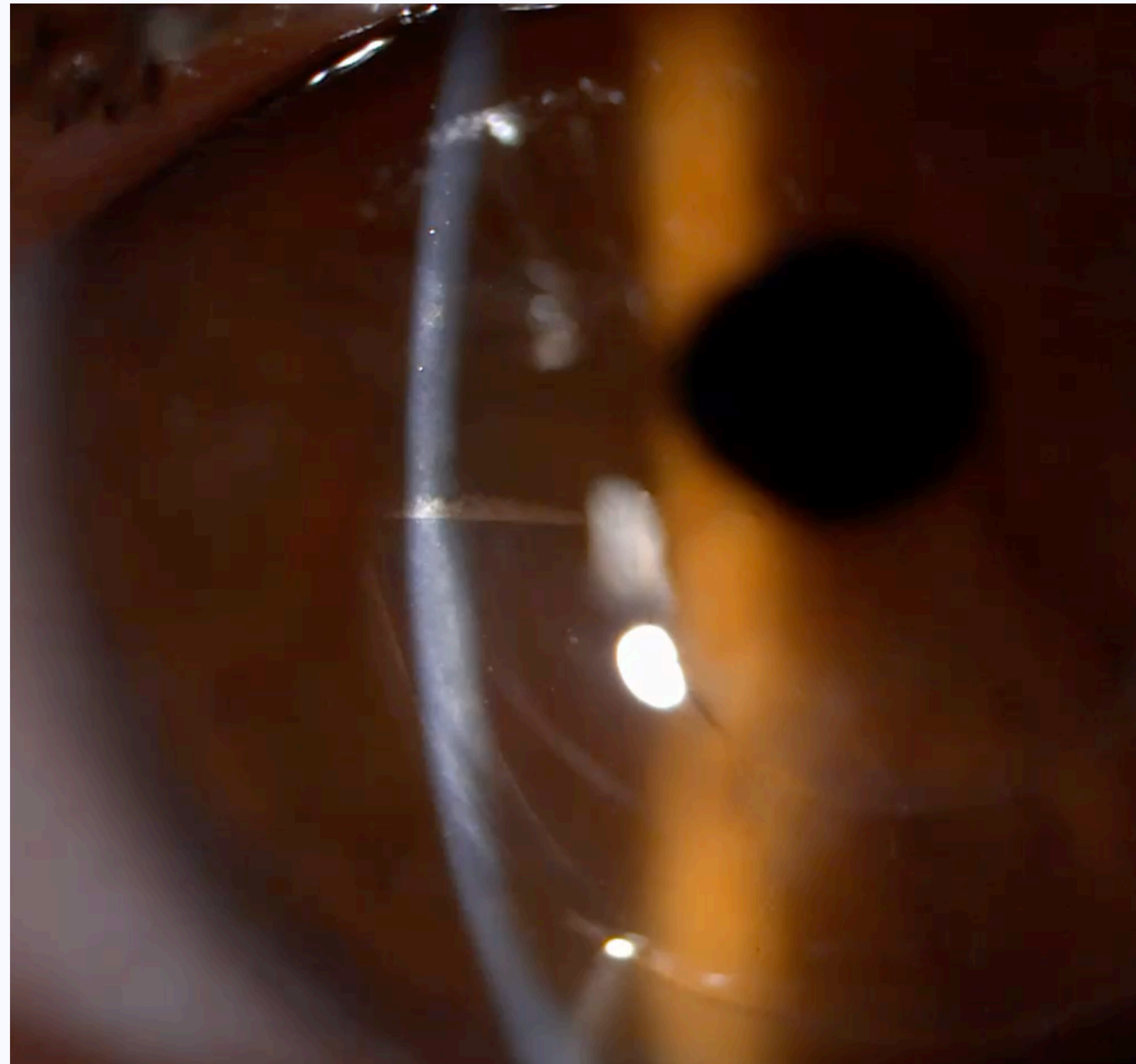
Cataract surgery with monofocal IOL January 2024



# Current Practice

- I perform cataract surgery, monitor regularly for keratoconus progression, and perform CXL if needed after
- If considering a toric IOL, it may be worth cross-linking prior
- Should pellucid-like changes be looked at differently?

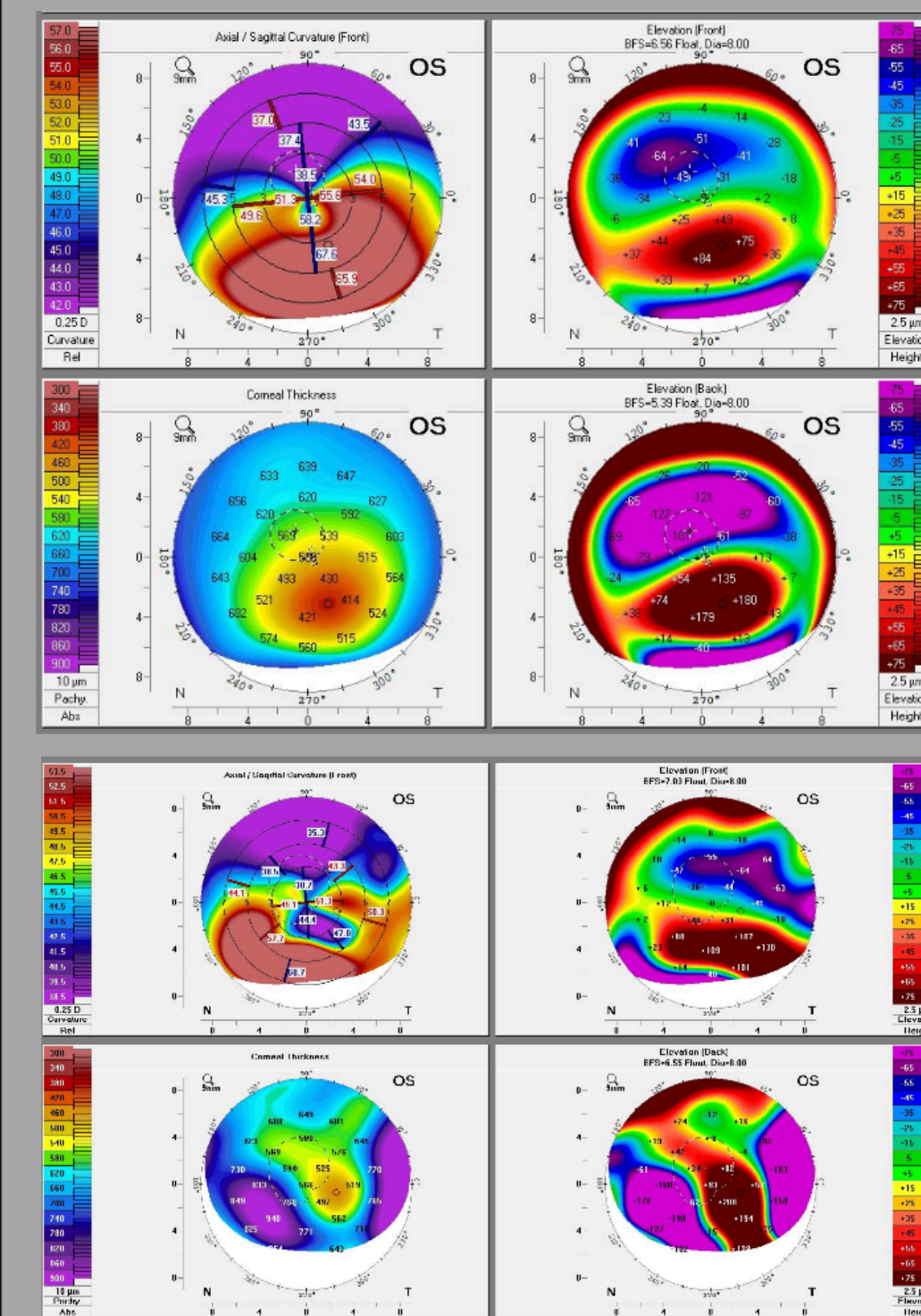
... BUT



Post Op Month 3

Pre Op Va: 20/80 cc

Post Op Va: 20/30 sc





1

How do I select  
IOL power?

2

What type of IOL  
should I use?

# The Challenge

**1** Keratometric index is not 1.3375

**2** Keratometry less accurate

**3** Error in ELP calculation

**4** Curvature not constant along given meridian

**5** Corneal apex off visual axis

**6** Central apex overestimates power



# Which Formula?

## All tend to result in hyperopic errors

## SRK/T most accurate of older generation formulas

- SRK/T leads to myopic prediction errors in non-KCN eyes

### Intraocular lens power calculation in eyes with keratoconus



*Giacomo Savini, MD, Rosa Abbate, MD, Kenneth J. Hoffer, MD, FACS, Alessandro Mularoni, MD, Aurelio Imburgia, MD, Luca Avoni, MD, Domenico D'Eliseo, MD, Domenico Schiano-Lomoriello, MD*

**Purpose:** To assess the refractive accuracy of different formulas for intraocular lens (IOL) power calculation in eyes with keratoconus.

**Setting:** IRCCS Fondazione Bietti, Rome, Italy.

**Design:** Multicenter retrospective interventional study.

**Methods:** A consecutive series of eyes with keratoconus that had cataract surgery were evaluated. Keratometry, anterior chamber depth, and axial length were measured preoperatively with optical biometry; IOL power was calculated with the Barrett Universal II, Haigis, Hoffer Q, Holladay 1, and SRK/T formulas. Subjective refraction was assessed at 1 month. The mean prediction error (PE), median absolute error (MedAE) and percentage of eyes with a PE within  $\pm 0.50$  diopters (D),  $\pm 0.75$  D, and  $\pm 1.00$  D were calculated.

**Results:** The final spherical equivalent was  $-0.52 \text{ D} \pm 1.61$  (SD). In the whole sample (41 eyes), the mean PE was positive (hyperopic surprise) with all formulas; the lowest PE (0.91 D) and MedAE (0.62 D) were obtained with the SRK/T formula. In stage I eyes ( $n = 21$ ), the MedAE ranged between 0.43 and 0.91 D; the SRK/T formula achieved the lowest MedAE and the highest rate of eyes with a PE within  $\pm 0.50$  (61.9%). In stage II eyes ( $n = 13$ ), the MedAE ranged between 0.75 D and 1.50 D; the SRK/T formula achieved the lowest MedAE and the highest rate of eyes with a PE within  $\pm 0.50$  (30.8%). In stage III eyes ( $n = 7$ ), the MedAE was higher than 2.50 D with all formulas.

**Conclusions:** In keratoconus eyes, all formulas led to a hyperopic refractive outcome. The SRK/T was the most accurate formula. The results were worse in advanced stages of the disease.

*J Cataract Refract Surg 2019; 45:576–581 © 2018 ASCRS and ESCRS*



# Modern Formulas

## Barrett Universal

TABLE 4. Percentage of Eyes Within Predicted Error Ranges.

Formula	Error Within $\pm 0.50$ D (%)			Error Within $\pm 0.75$ D (%)			Error Within $\pm 1.00$ D (%)		
	Stage I	Stage II	Stage III	Stage I	Stage II	Stage III	Stage I	Stage II	Stage III
Hoffer Q	41	18	0	61	27	0	67	50	0
SRK/T	48	18	0	61	36	0	72	50	0
Holladay I	39	41	0	61	45	0	74	50	0
Haigis	39	23	40	61	27	40	70	36	40
Barrett	52	50	n/a	63	55	n/a	76	59	n/a
Holladay II	39	23	0	57	32	0	73	46	0

Accuracy of Intraocular Lens Formulas in Eyes With Keratoconus

KENDRICK M. WANG, ALBERT S. JUN, JOHN G. LADAS, AAZIM A. SIDDIQUI, FASIKA WORETA, AND DIVYA SRIKUMARAN



# “Special” Formulas

Kane  
Keratoconus

Holladay 2  
Keratoconus

Barrett True-K for  
Keratoconus

KANE FORMULA

ABOUT

CONSTANTS

CONTACT

Surgeon

Meghpara

Index

1.3375

Patient

Meghpara

ID

Sex

M

F

OD

RIGHT

Non-toric

Toric

Keratoconus

AL: 24.00 mm

A-Constant: 119.30

K1: 46.00 D

Target Ref: 0.00 D

K2: 50.00 D

LT: 4.50 mm

ACD: 3.50 mm

CCT: 450 µm

IOL Power (D)	Refraction (D)
17.0	-1.46
16.5	-1.14
16.0	-0.83
15.5	-0.52
15.0	-0.22
14.5	0.08
14.0	0.38

OS

LEFT

Non-toric

Toric

Keratoconus

AL: 24.00 mm

A-Constant: 119.30

K1: 46.00 D

Target Ref: 0.00 D

K2: 50.00 D

LT: 4.50 mm

ACD: 3.50 mm

CCT: 450 µm

IOL Power (D)	Refraction (D)
16.0	-1.25
15.5	-0.94
15.0	-0.64
14.5	-0.34
14.0	-0.04
13.5	0.26
13.0	0.55

EDIT

PRINT

NEW PATIENT

# “Special” Formulas

Kane  
Keratoconus

Holladay 2  
Keratoconus

Barrett True-K  
for Keratoconus

## BARRETT TRUE K FORMULA - FOR PRIOR MYOPIC OR HYPEROPIC LASIK/PRK/RK + KC

Patient Data Universal Formula Formula Guide

K INDEX 1.3375 ☒ K INDEX 1.332 ☐

Calculate

Reset Form

☐ ENTER DATA AND CALCULATE

Doctor Name

Patient Name

Patient ID

Lens Factor

(-2.0~5.0)

or A Constant

(112~125)

Personal Constant



History OD:

Myopic Lasik



History OS:

Keratoconus



Pre-Lasik Ref. (R)

Post-Lasik Ref. (R)

Pre-Lasik Ref. (L)

Post-Lasik Ref. (L)

Measurements:

OD

OS

Axial Length (R)

(12~38 mm)

Axial Length (L)

(12~38 mm)

Measured K1 (R)

(30~60 D)

Measured K1 (L)

(30~60 D)

Measured K2 (R)

(30~60 D)

Measured K2 (L)

(30~60 D)

Optical ACD (R)

(0~6 mm)

Optical ACD (L)

(0~6 mm)

Target Ref. (R)

(-10~10 D)

Target Ref. (L)

(-10~10 D)

Optional:

Lens Thickness (R)

(2~8 mm)

Lens Thickness (L)

(2~8 mm)

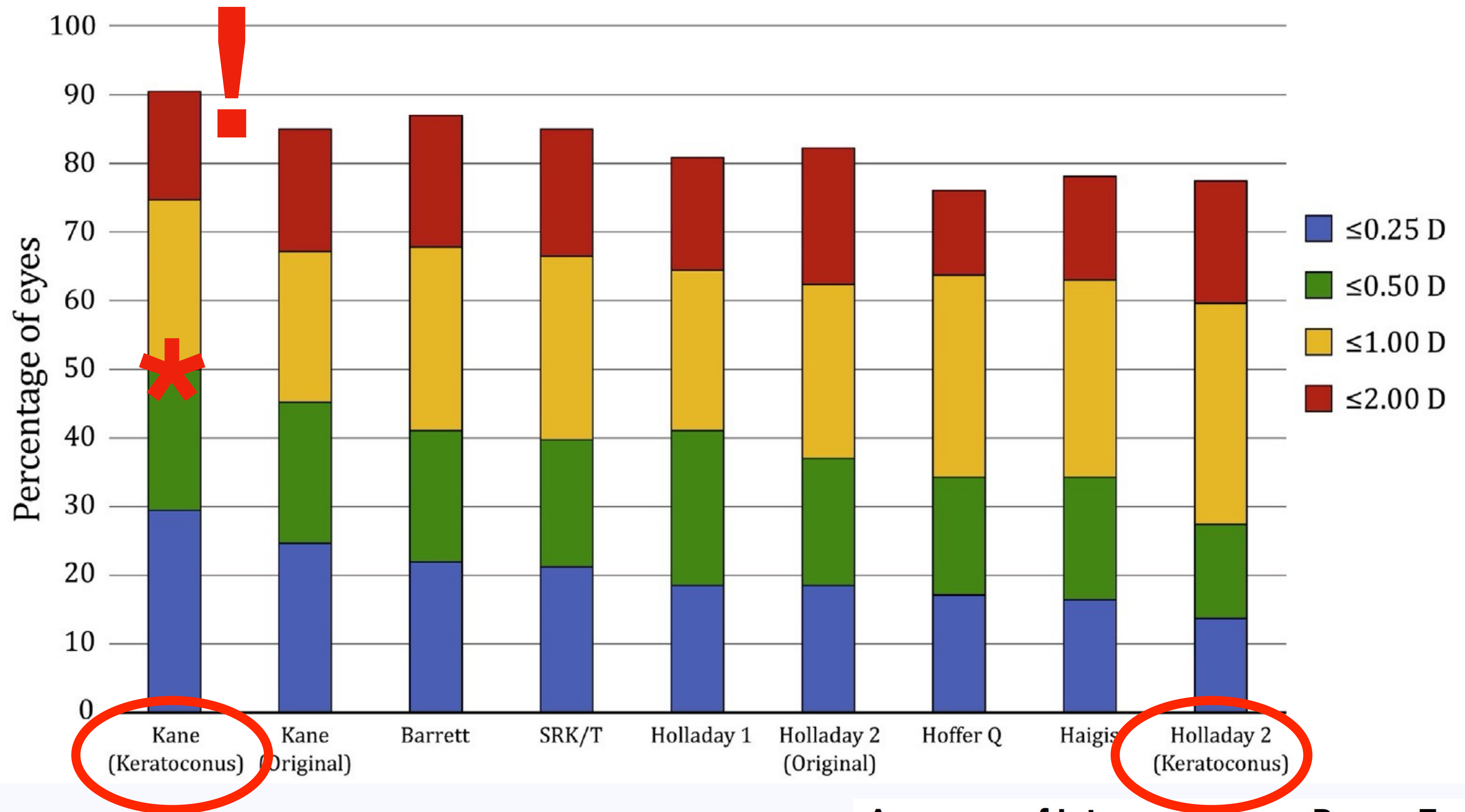
WTW (R)

(8~14 mm)

WTW (L)

(8~14 mm)





## Accuracy of Intraocular Lens Power Formulas Modified for Patients with Keratoconus

Jack X. Kane, MBBS,<sup>1</sup> Benjamin Connell, MBBS,<sup>1,2</sup> Harry Yip, MBBS,<sup>1</sup> James C. McAlister, MBBS,<sup>3</sup> Peter Beckingsale, MBBS,<sup>4</sup> Grant R. Snibson, MBBS,<sup>2</sup> Elsie Chan, MBBS<sup>1</sup>

Formula Name	ME	MAE	MedAE	RMSE	Max AE	±0.5 D (%)	±1.0 D (%)
BU2 KCN: M-PCA <sup>a</sup>	0.12	0.779	0.583	1.043	4.29	46.3	74.6
EVO 2.0 (TK)	0.48	0.799	0.572	1.141	4.67	49.3	68.7
BU2 KCN: P-PCA <sup>a</sup>	0.26	0.834	0.598	1.147	4.52	46.3	64.2
Kane KCN (K) <sup>a</sup>	0.26	0.844	0.663	1.170	4.93	41.8	70.1
Kane (TK)	0.54	0.848	0.642	1.186	4.79	43.3	68.7
BU2 (TK)	0.60	0.864	0.653	1.207	4.83	44.8	67.2
Cooke K6 (TK)	0.55	0.868	0.601	1.208	5.11	41.8	65.7
EVO 2.0 (K)	0.56	0.833	0.415	1.219	4.82	55.2	65.7
Pearl DGS (TK)	0.58	0.885	0.650	1.233	4.79	41.8	65.7
SRK/T (TK)	0.27	0.932	0.674	1.258	4.67	35.8	61.2
Kane (K)	0.62	0.884	0.440	1.268	4.93	53.7	64.2
Cooke K6 (K)	0.64	0.895	0.528	1.289	5.27	46.3	62.7
BU2 (K)	0.69	0.905	0.494	1.298	4.98	50.7	62.7
Pearl DGS (K)	0.68	0.925	0.615	1.305	4.94	40.3	67.2
SRK/T (K)	0.36	0.956	0.651	1.322	4.78	40.3	59.7
Holladay 1 (TK)	0.70	0.987	0.715	1.354	5.14	38.8	56.7
Haigis (TK)	0.69	0.967	0.689	1.355	5.31	38.8	65.7
Haigis (K)	0.80	1.022	0.763	1.439	5.48	38.8	65.7
Hoffer Q (TK)	0.84	1.084	0.893	1.451	5.37	32.8	55.2
Holladay 1 (K)	0.80	1.043	0.640	1.460	5.28	41.8	58.2
Hoffer Q (K)	0.94	1.144	0.948	1.541	5.54	35.8	53.7



# What Do I Do?

## *Measure Total Keratometry*

- Barrett True K Keratoconus with measured posterior cornea

## *If you only have standard keratometry*

- Barrett True K Keratoconus with predicted posterior cornea
- Kane KCN
- EVO 2.0

1

How do I select  
IOL power?

2

What type of IOL  
should I use?



# Multifocal IOL



# Toric IOL

## *Use With Caution*

- Mild keratoconus
- Fairly regular astigmatism
- Good prior spectacle corrected vision
- Zero desire to wear contact lenses post-op
- Goal is to reduce total refractive error but not eliminate it

**Not candidates for corneal  
refractive surgery touch-up**

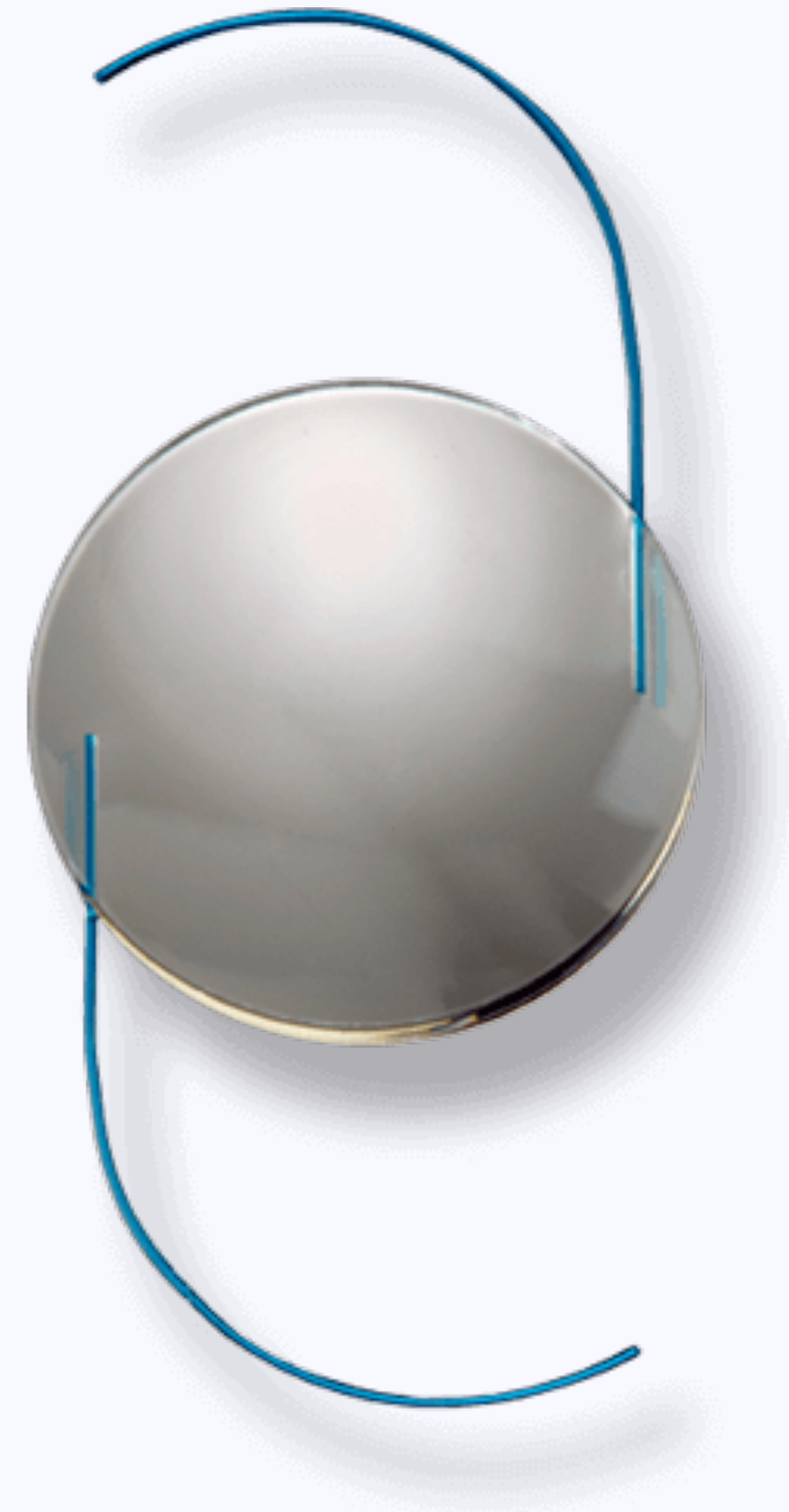




# Light Adjustable Lens

## *Intriguing Option*

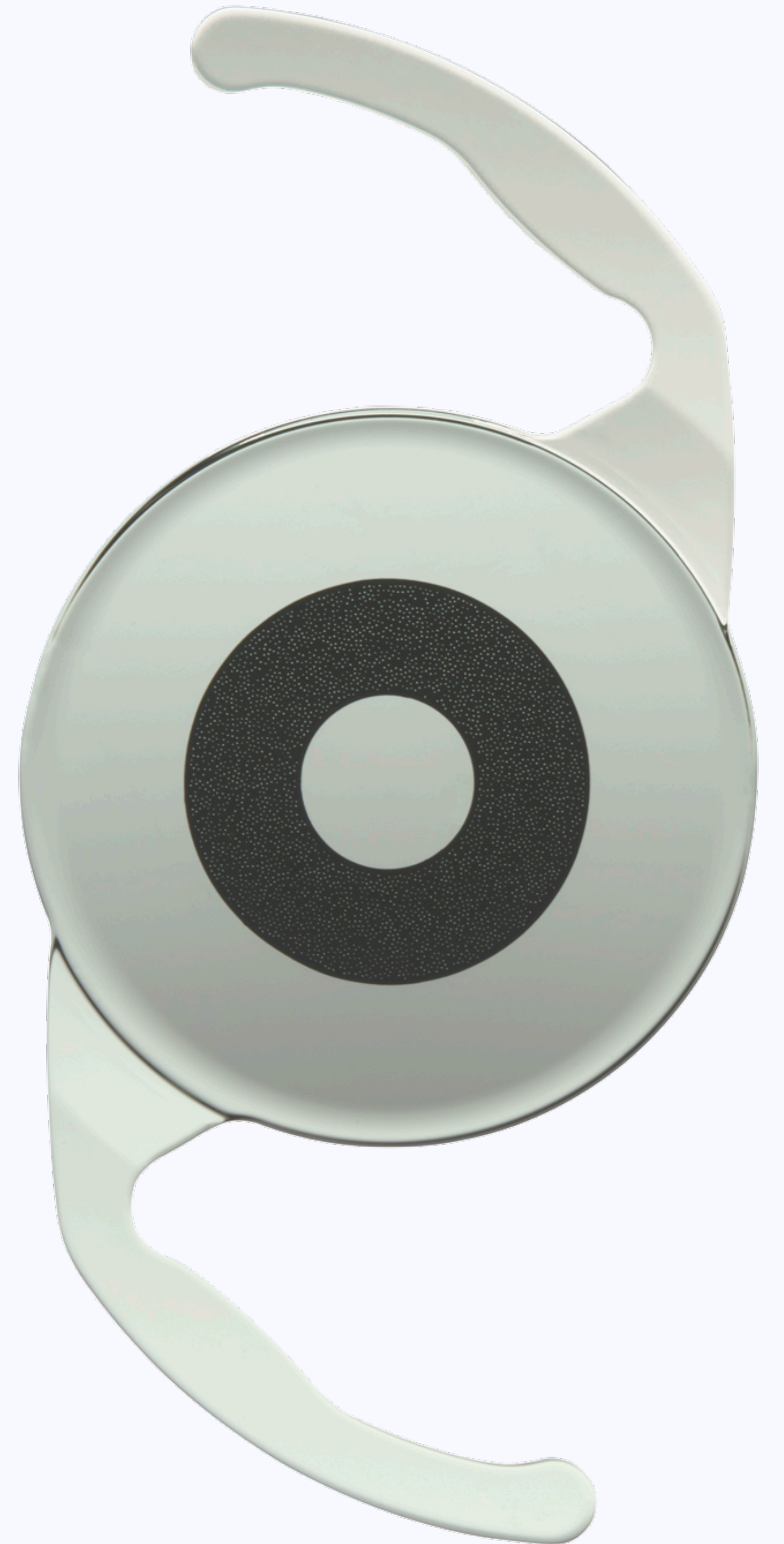
- There are limits to how much you can adjust
- Need accurate post-op refractions
- Setting expectations in the setting of expensive technology



# IC-8 Aphthera

## *Intriguing Option*

- Tolerate  $\sim 1\text{D}$  refractive miss
- Corrects  $\sim 1.5\text{D}$  astigmatism
- Reduced higher order aberration
- Label is increased depth of focus with implant in non-dominant eye

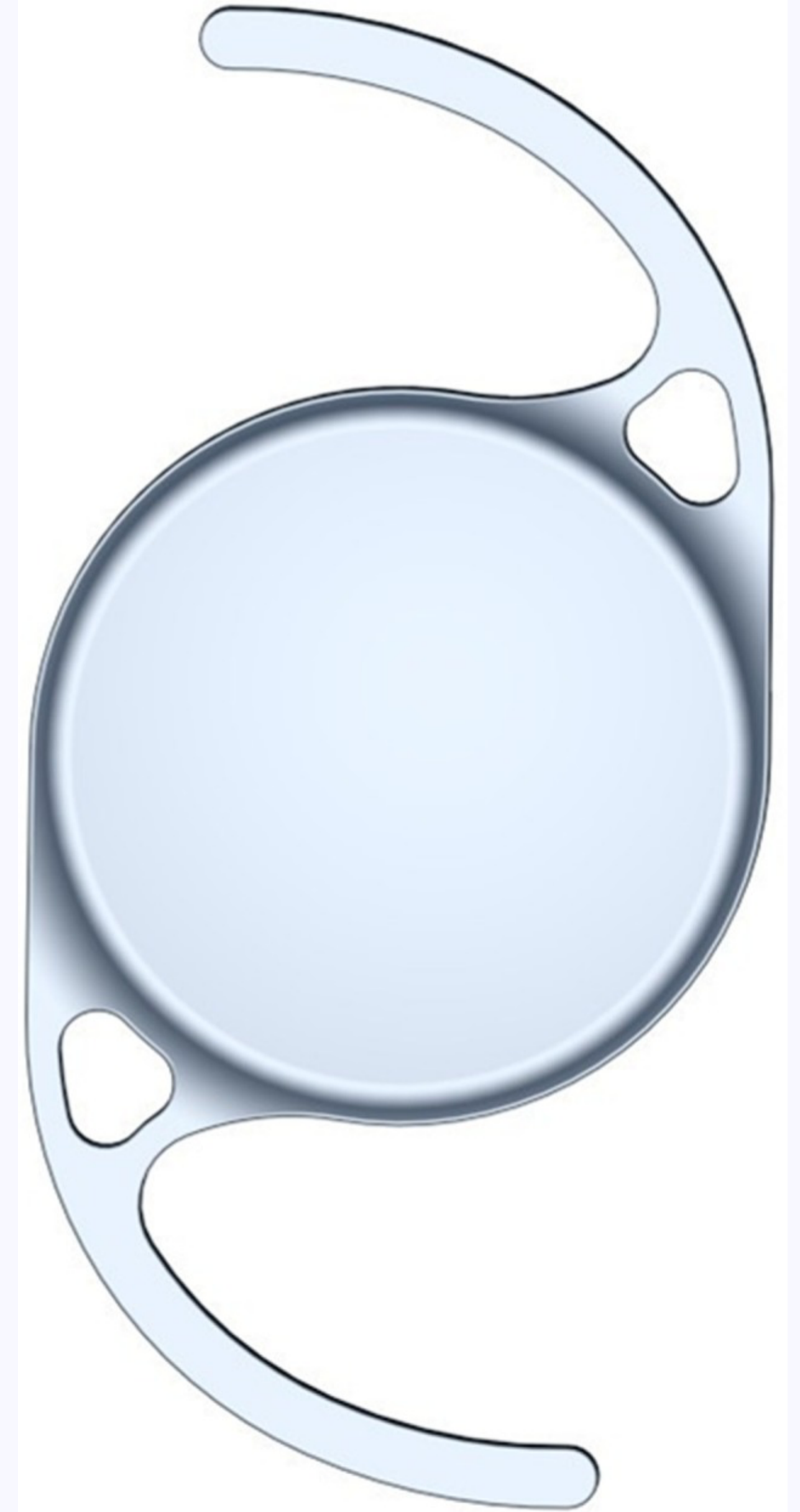




# What Do I Do?

## *enVista*

- Zero aberration single piece hydrophobic monofocal IOL
- Typical cornea has positive spherical aberration, but keratoconus cornea typically with negative spherical aberration







Thank you  
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