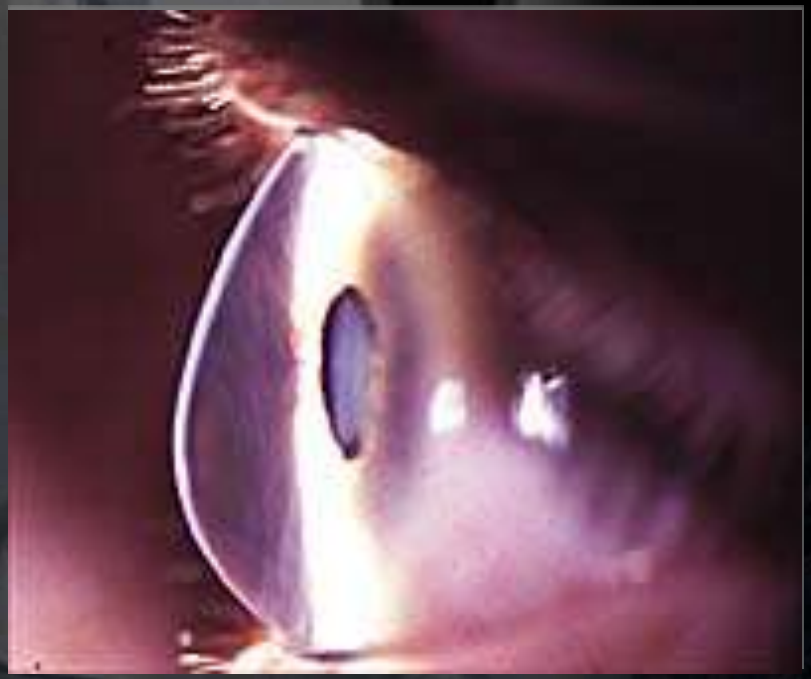
área oftalmológica avanzada
Vergés

Seminarios sobre los **Nuevos Avances** en **Oftalmología**

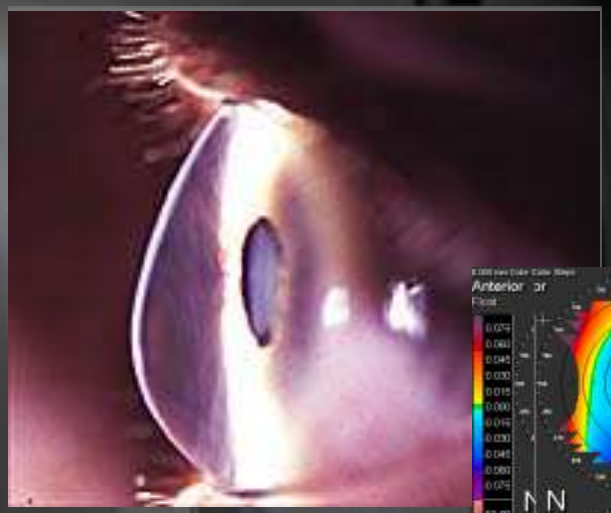
Actualización en CrossLinking y Segmentos Intraestromales

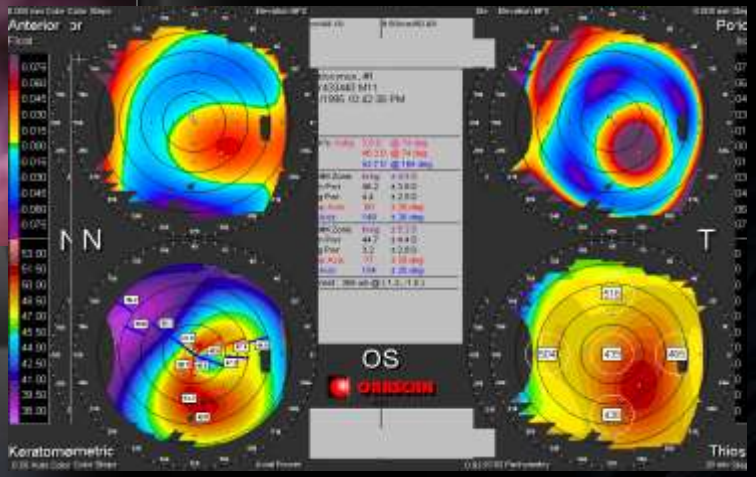
Carlos Vergés, Jesus Marín

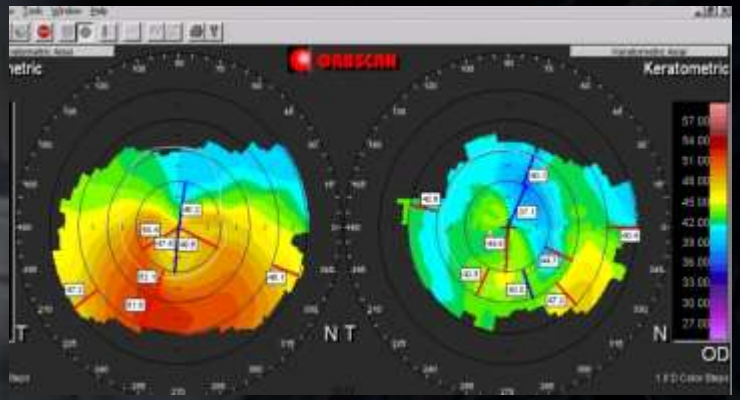
El Queratocono es una enfermedad degenerativa de la cornea, de carácter hereditario, bilateral, asimétrica, que cursa con debilitamiento de la estructura biomecánica y ectasia anterior








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T
OS
ORBSCAN
Keratometric


ORBSCAN
Keratometric
NT
N
OD







OCULUS - PENTACAM

Last Name:	
First Name:	
ID:	128495
Date of Birth:	07/10/1976
Eye:	Right
Exam Date:	23/11/2006
Time:	17:08:51
Exam Info:	

Cornea Front

Rh:	7.84 mm	K1:	43.0 D
Rv:	7.72 mm	K2:	43.7 D
Rm:	7.78 mm	Km:	43.4 D
QS:	OK	Axis: (flt.)	35.0 °
Astig:	-0.7 D		
ecc: (30°)	0.29	Rper:	7.99 mm
Rmin:	7.08 mm		

Cornea Back

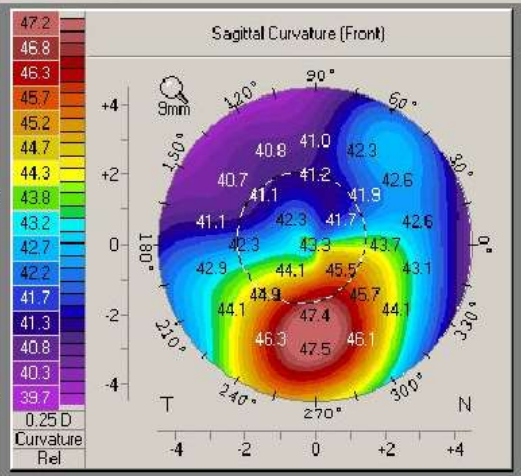
Rh:	6.49 mm	K1:	-6.2 D
Rv:	6.18 mm	K2:	-6.5 D
Rm:	6.33 mm	Km:	-6.3 D
QS:	Model	Axis: (flt.)	18.8 °
Astig:	+0.3 D		
ecc: (30°)	0.01	Rper:	6.62 mm
Rmin:	5.32 mm		

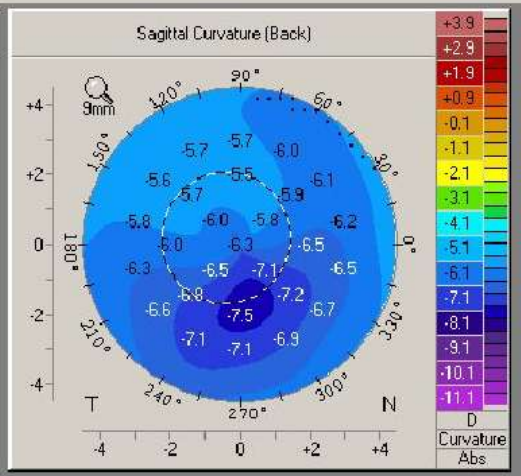
True Net Power

Astig:	-0.5 D	K1:	41.8 D
Axis: (flt.)	33.0 °	K2:	42.3 D
P.Max:	45.8 D	Km:	42.1 D

	Pachy:	x[mm]	y[mm]
Pupil Center:	532 µm	-0.41	+0.19
Pachy Apex :	532 µm	0.00	0.00
Thinnest Locat.:	516 µm	-0.96	-0.64
K Max. (Front):	47.7 D	0.00	-2.56

Cornea Volume:	60.6 mm³	KPD:	+1.4 D
Chamber Volume:	202 mm³	Angle:	37.9 °
A. C. Depth (Int.):	3.28 mm	Pupil Dia:	3.71 mm
IOP(cor):		Lens Th.:	





Numeric Ecc. (Front) of Major Meridians

		Degrees peripheral				
		20°	25°	30°	35°	40°
Nas	(ecc)	0.58	0.46	0.48	0.58	0.69
Temp	(ecc)	-0.57	-0.29	0.23	0.35	0.40
Inf	(ecc)	-1.01	-0.67	-0.31	0.36	0.55
Sup	(ecc)	0.98	0.84	0.76	0.75	0.77
Mean Value	(ecc)	-0.00	0.08	0.29	0.51	0.60

Front:
- (•) Ecc
- ( ) Sag. curvature

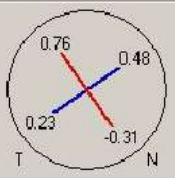
Back:
- ( ) Ecc
- ( ) Sag. curvature

Indices (in 8mm zone)

ISV:	45	IHA:	29.0
IVA:	0.57	IHD:	0.051
KI:	1.13	RMin:	7.08
CKI:	1.00	TKC:	KC 1

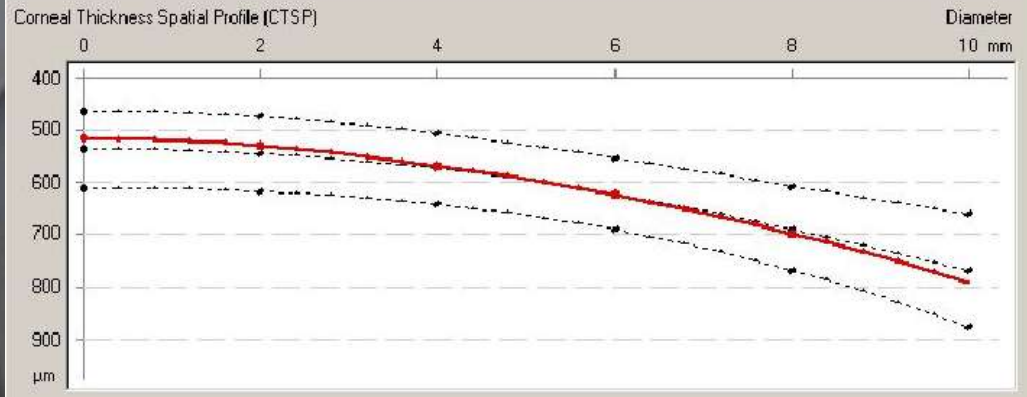
Numeric Ecc. (Front) at 30°

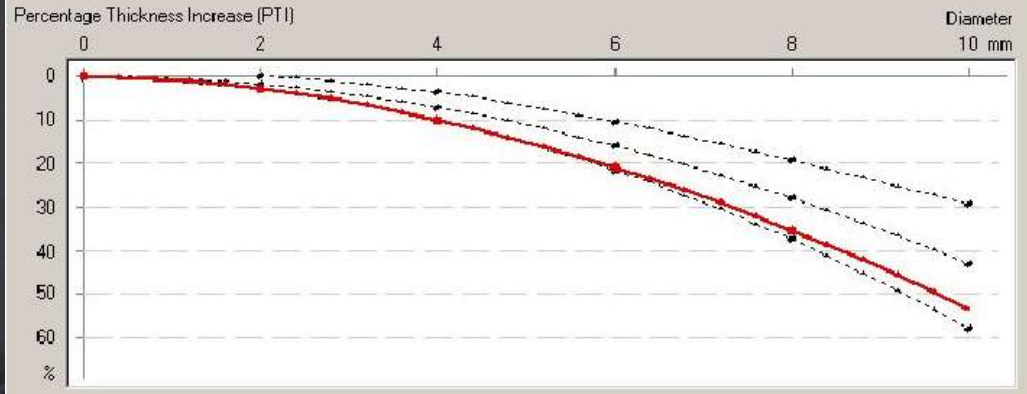
Hor.: 0.36
Vert.: 0.23



OCULUS - PENTACAM

Mean corneal thickness values on rings concentrically to the thinnest location



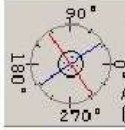


	0 mm	2 mm	4 mm	6 mm	8 mm	10 mm
C. Thickness / µm	516 ± 1	530 ± 3	568 ± 13	624 ± 28	698 ± 42	792 ± 53
Progression / %	0 ± 0	3 ± 1	10 ± 4	21 ± 10	35 ± 19	53 ± 28

Prog.-Index Axis

Min:	0.9	7°
Avg:	1.4	
Max:	1.8	251°

Name:
ID:
Date of Birth: 07/10/1976 Eye: Right
Exam Date: 23/11/2006 Time: 17:08:51
Exam Info:

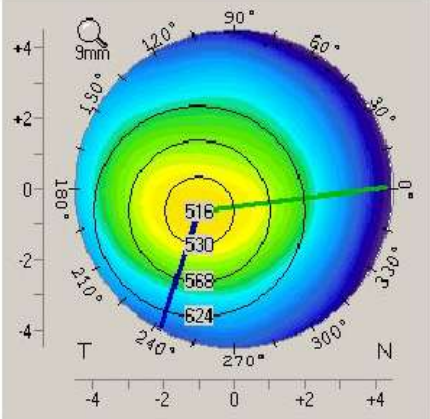


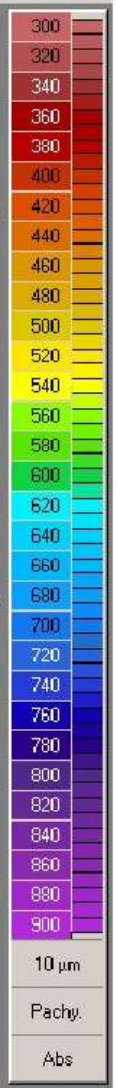
K1: 43.0 D Astig: -0.7 D
K2: 43.7 D ecc: [30°] 0.29
Axis: (flat) 35.0° QS: Model !

	Pachy:	x[mm]	y[mm]
Pupil Center: +	532 µm	-0.41	+0.19
Thinnest Locat.: O	516 µm	-0.96	-0.64

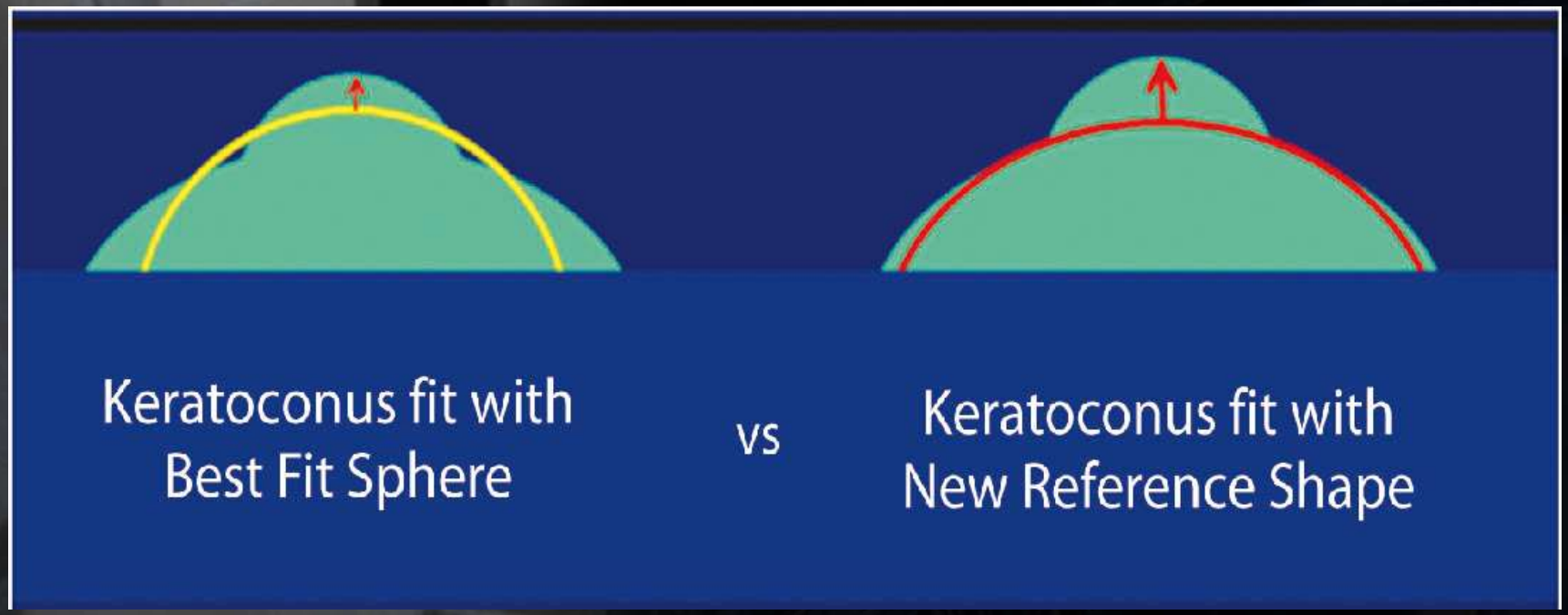
Chamber Volume: 202 mm³ Angle: 37.9°
A. C. Depth (Int.): 3.28 mm Pupil Dia: 3.71 mm
Enter IOP IOP(cor): Lens Th.:

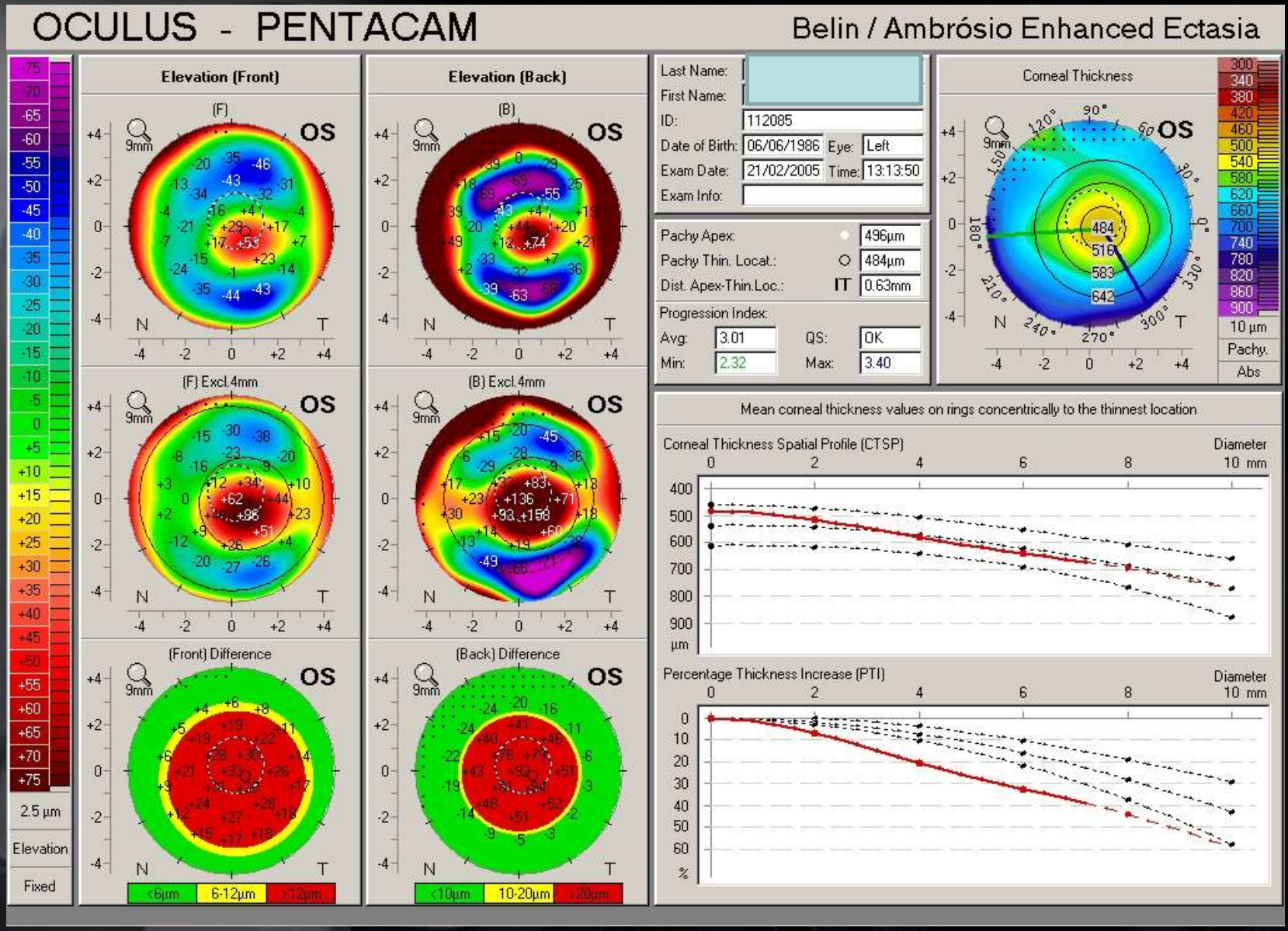
Corneal Thickness

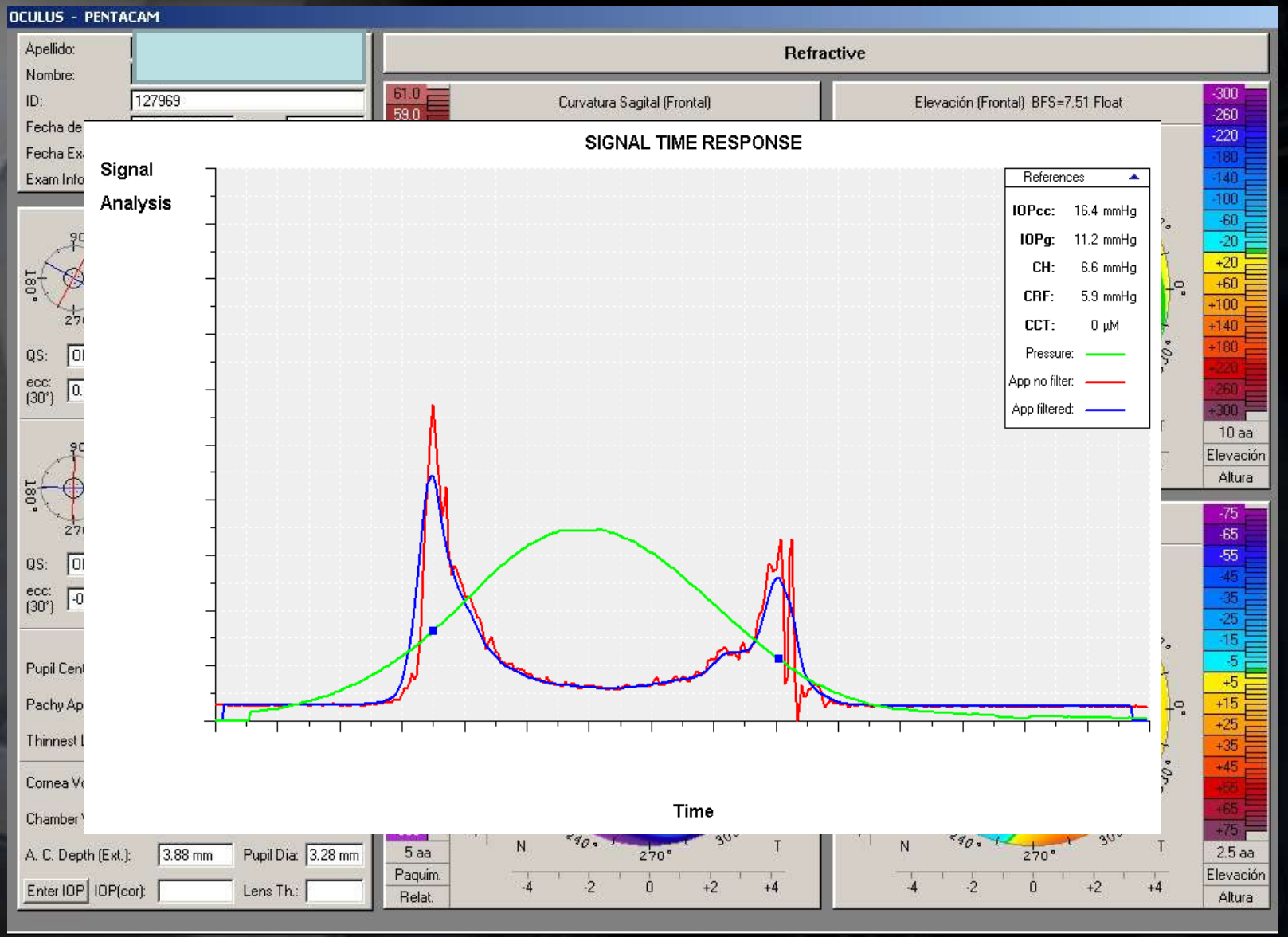




Belin / Ambrósio Enhanced Ectasia Display




OCULUS - PENTACAM
Belin / Ambrósio Enhanced Ectasia
Elevation (Front)
Elevation (Back)
(F)
(B)
(F) Excl.4mm
(B) Excl.4mm
(Front) Difference
(Back) Difference
OS
9mm
N
T
2.5 µm
Elevation
Fixed
<6µm
6-12µm
>12µm
<10µm
10-20µm
>20µm
Last Name:
First Name:
ID: 112085
Date of Birth: 06/06/1986
Eye: Left
Exam Date: 21/02/2005
Time: 13:13:50
Exam Info:
Pachy Apex: 496µm
Pachy Thin. Locat.: 484µm
Dist. Apex-Thin.Loc.: IT 0.63mm
Progression Index:
Avg: 3.01
QS: OK
Min: 2.32
Max: 3.40
Corneal Thickness
484
516
583
642
10 µm
Pachy.
Abs
Mean corneal thickness values on rings concentrically to the thinnest location
Corneal Thickness Spatial Profile (CTSP)
Diameter
10 mm
µm
Percentage Thickness Increase (PTI)
%

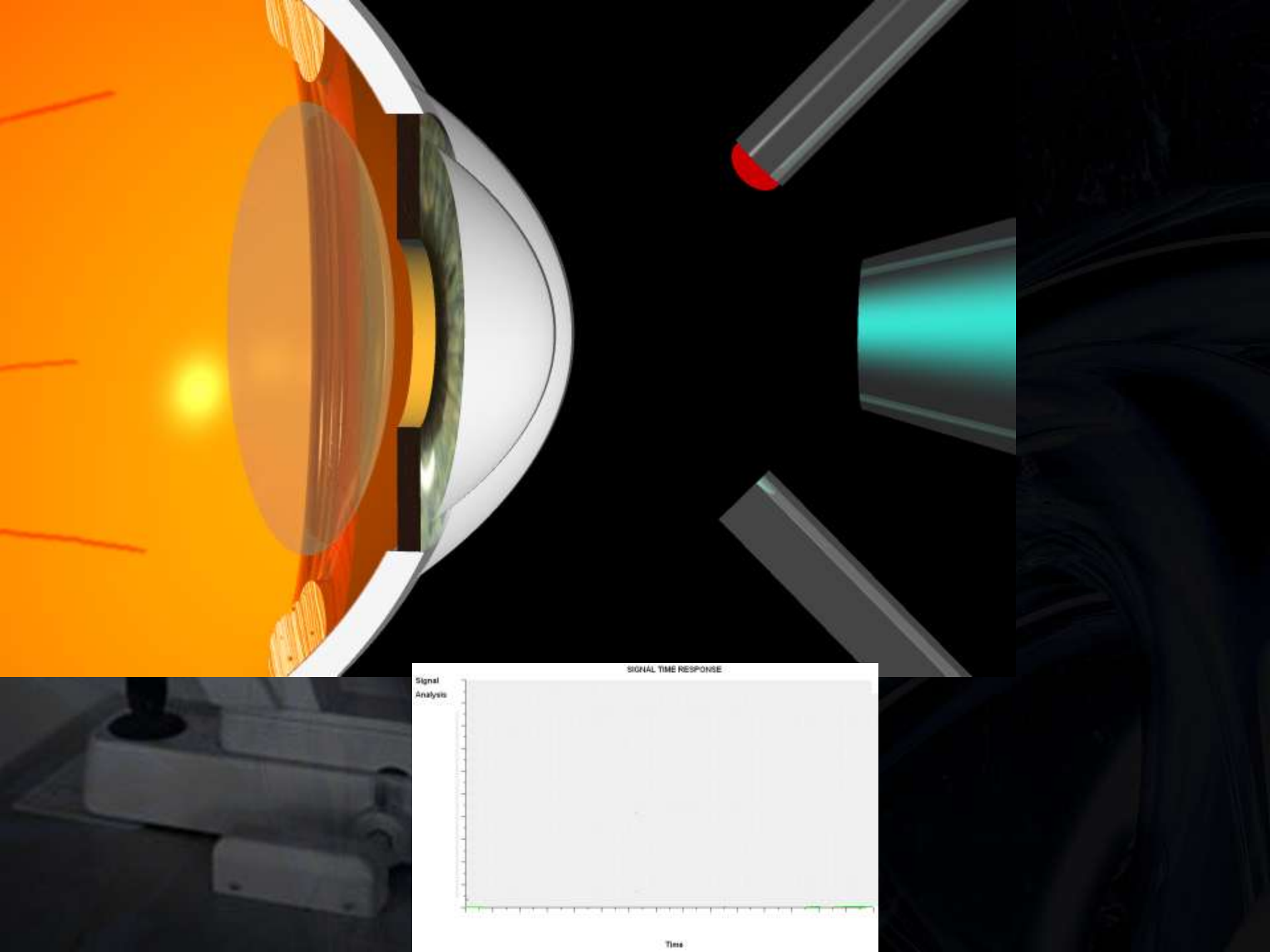

OCULUS - PENTACAM
Apellido:
Nombre:
ID:
127969
Refractive
Curvatura Sagital (Frontal)
Elevación (Frontal) BFS=7.51 Float
SIGNAL TIME RESPONSE
Signal
Analysis
References
IOPcc: 16.4 mmHg
IOPg: 11.2 mmHg
CH: 6.6 mmHg
CRF: 5.9 mmHg
CCT: 0 µM
Pressure:
App no filter:
App filtered:
Time
A. C. Depth (Ext.): 3.88 mm
Pupil Dia: 3.28 mm
Enter IOP
IOP(cor):
Lens Th.:
10 aa
Elevación
Altura
5 aa
Paquim.
Relat.
2.5 aa

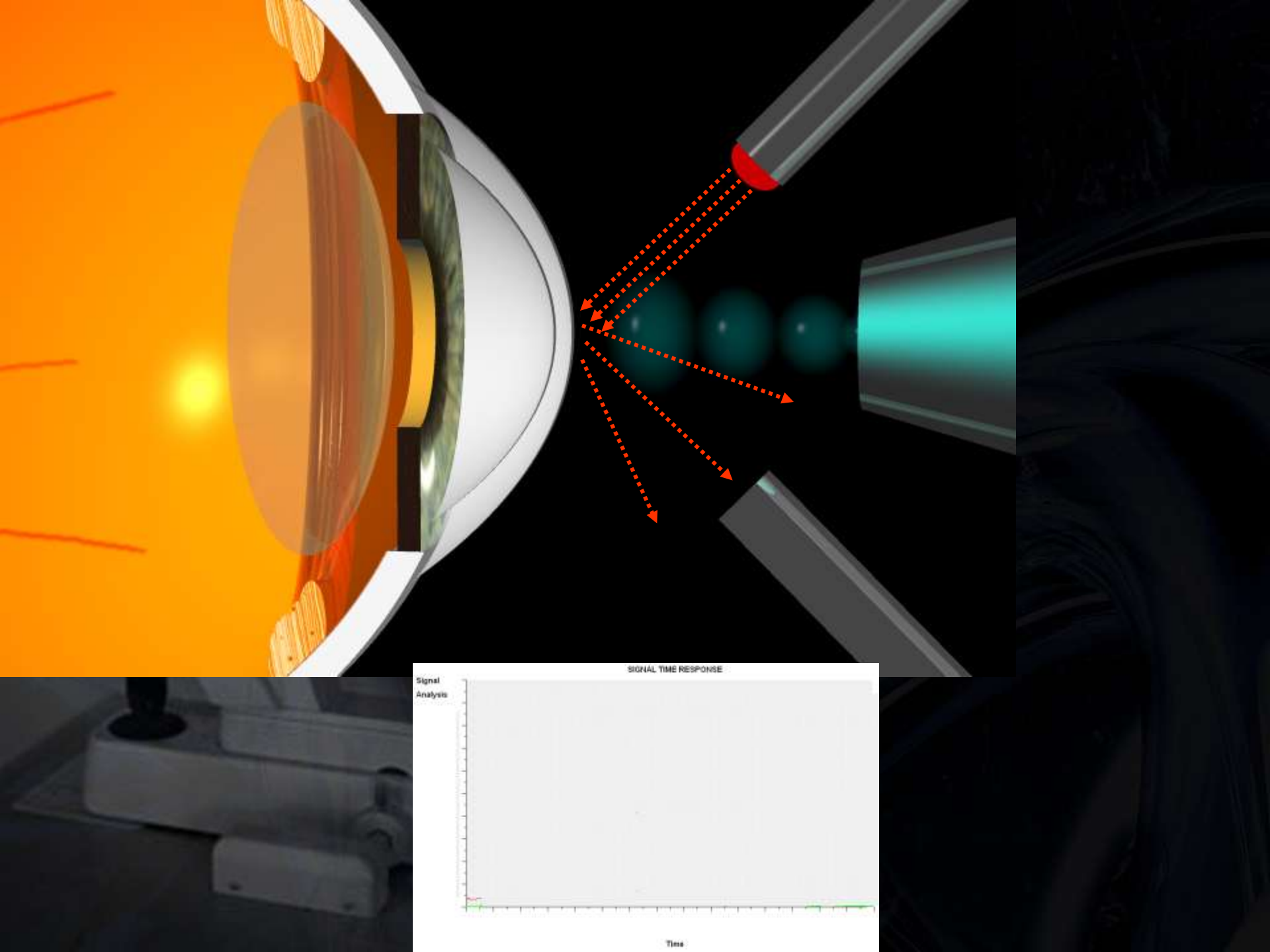
OCULAR RESPONSE ANALYZER

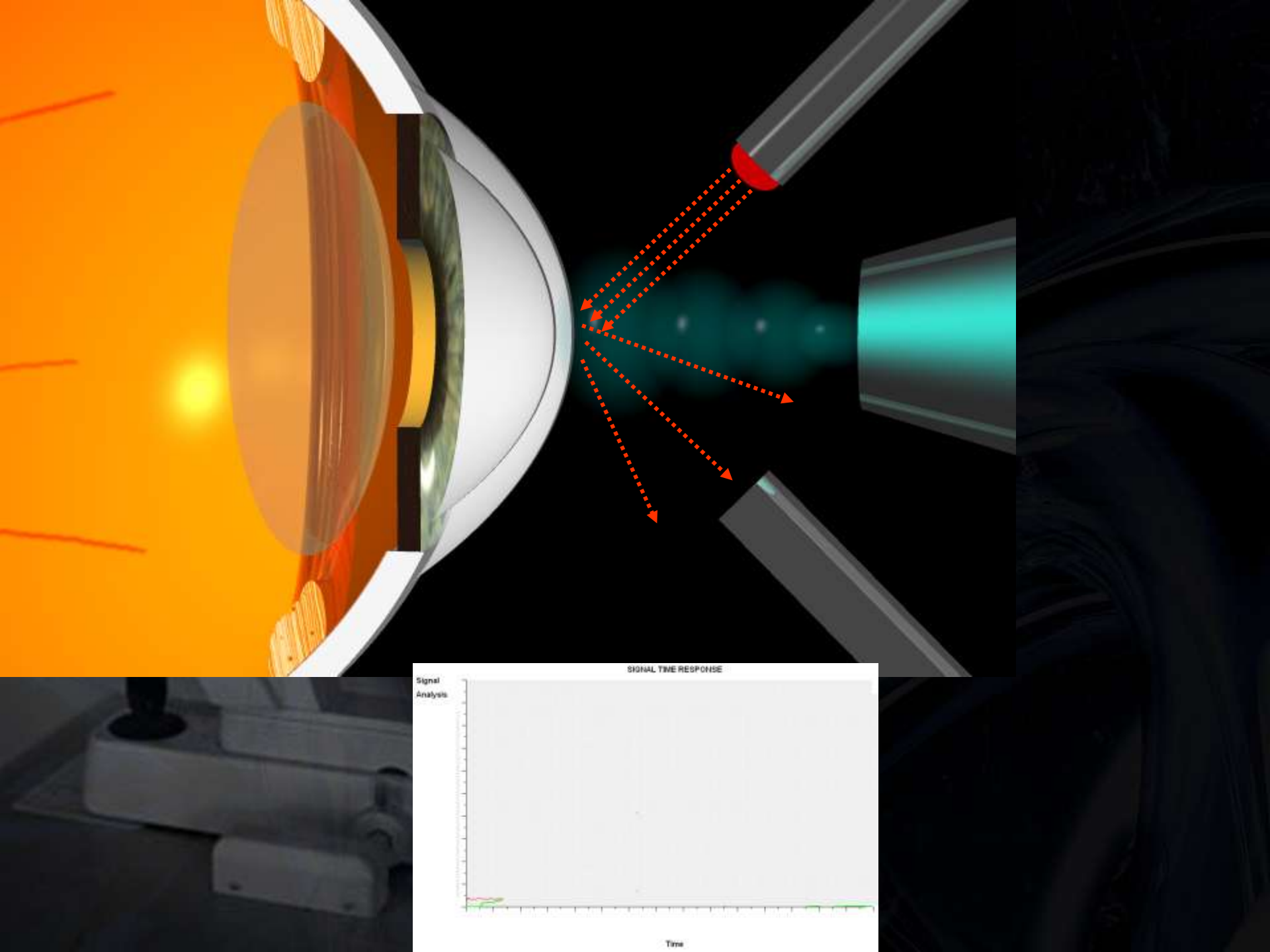
One Device, Five Parameters

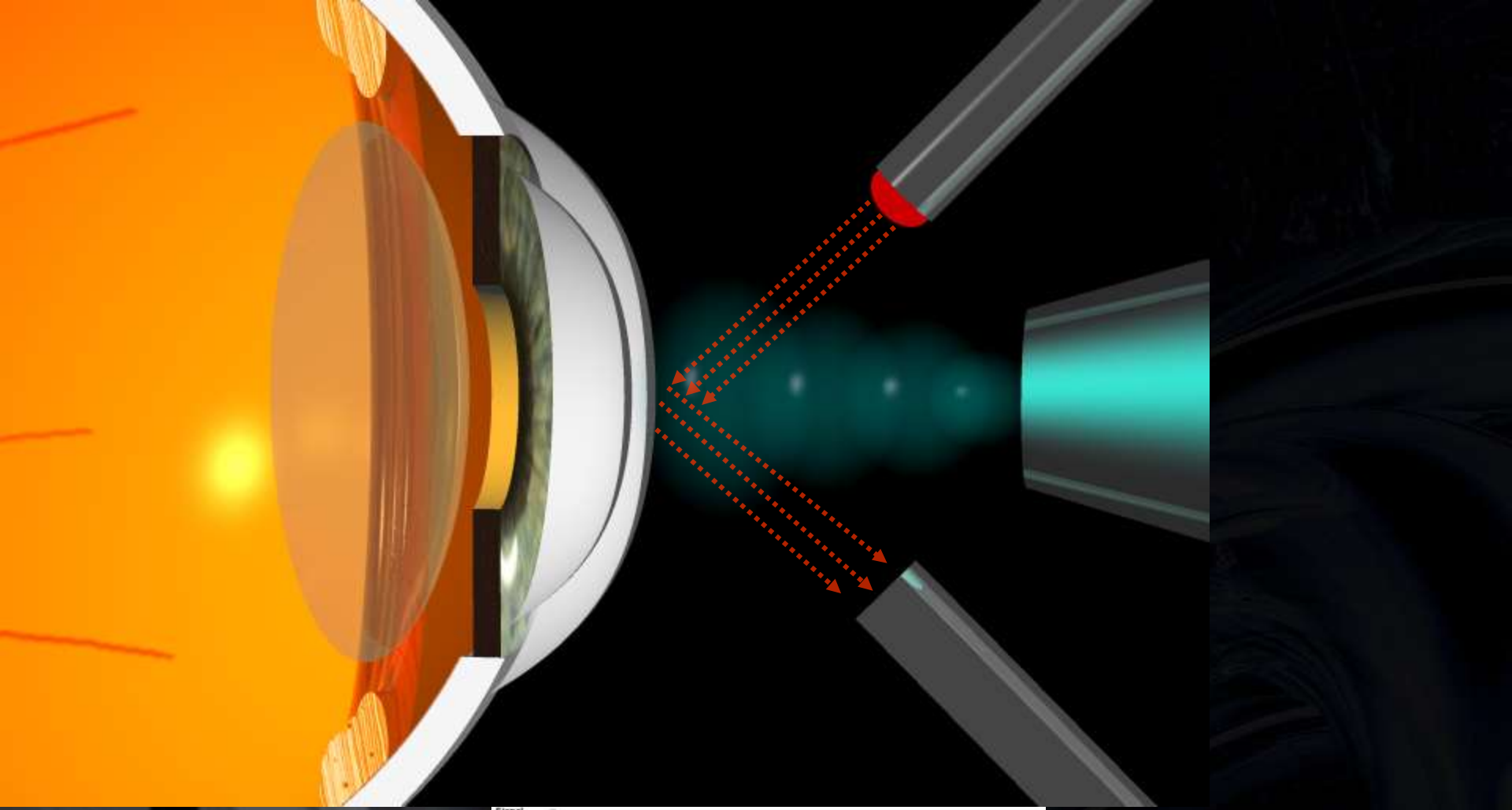


- **IOPG** - Goldmann Correlated IOP
- **IOPCC** – Corneal Compensated IOP
- **CH** - Corneal Hysteresis
- **CRF** - Corneal Resistance Factor
- **CCT** - Central Corneal Thickness

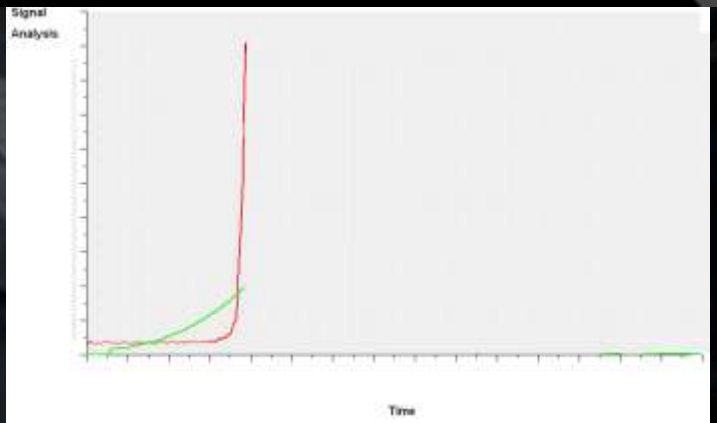

SIGNAL TIME RESPONSE
Signal
Analysis
Time

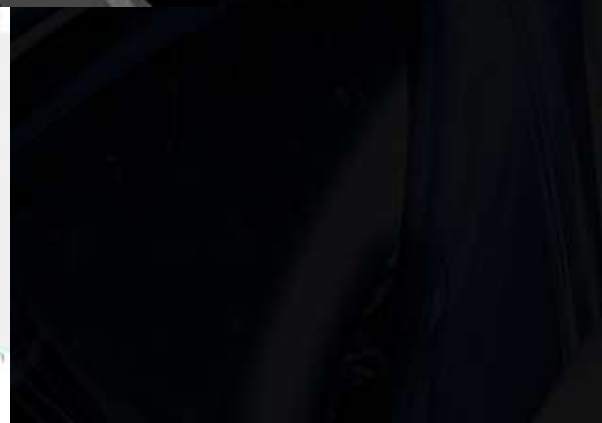

SIGNAL TIME RESPONSE
Signal
Analysis
Time

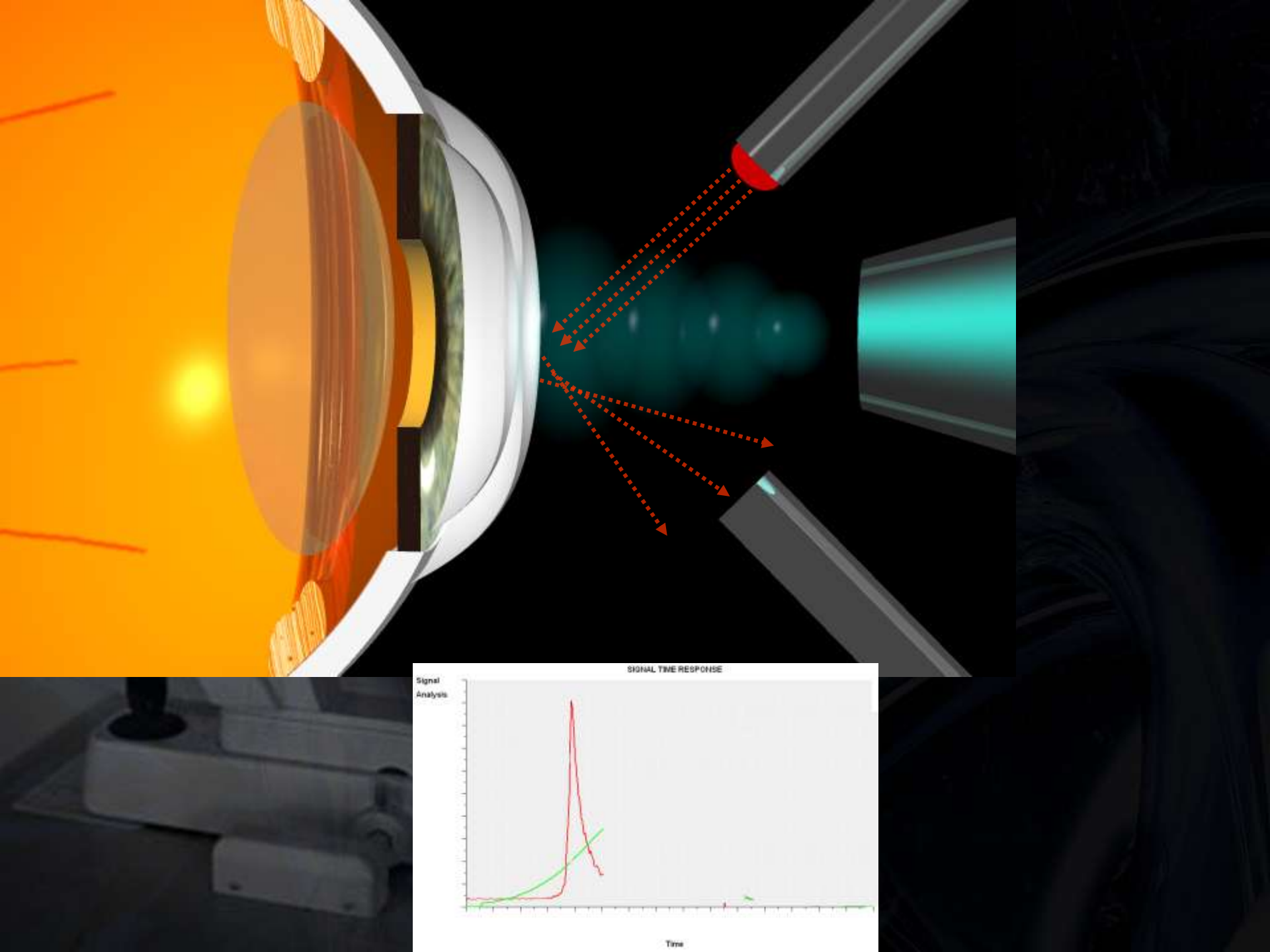

SIGNAL TIME RESPONSE
Signal
Analysis
Time

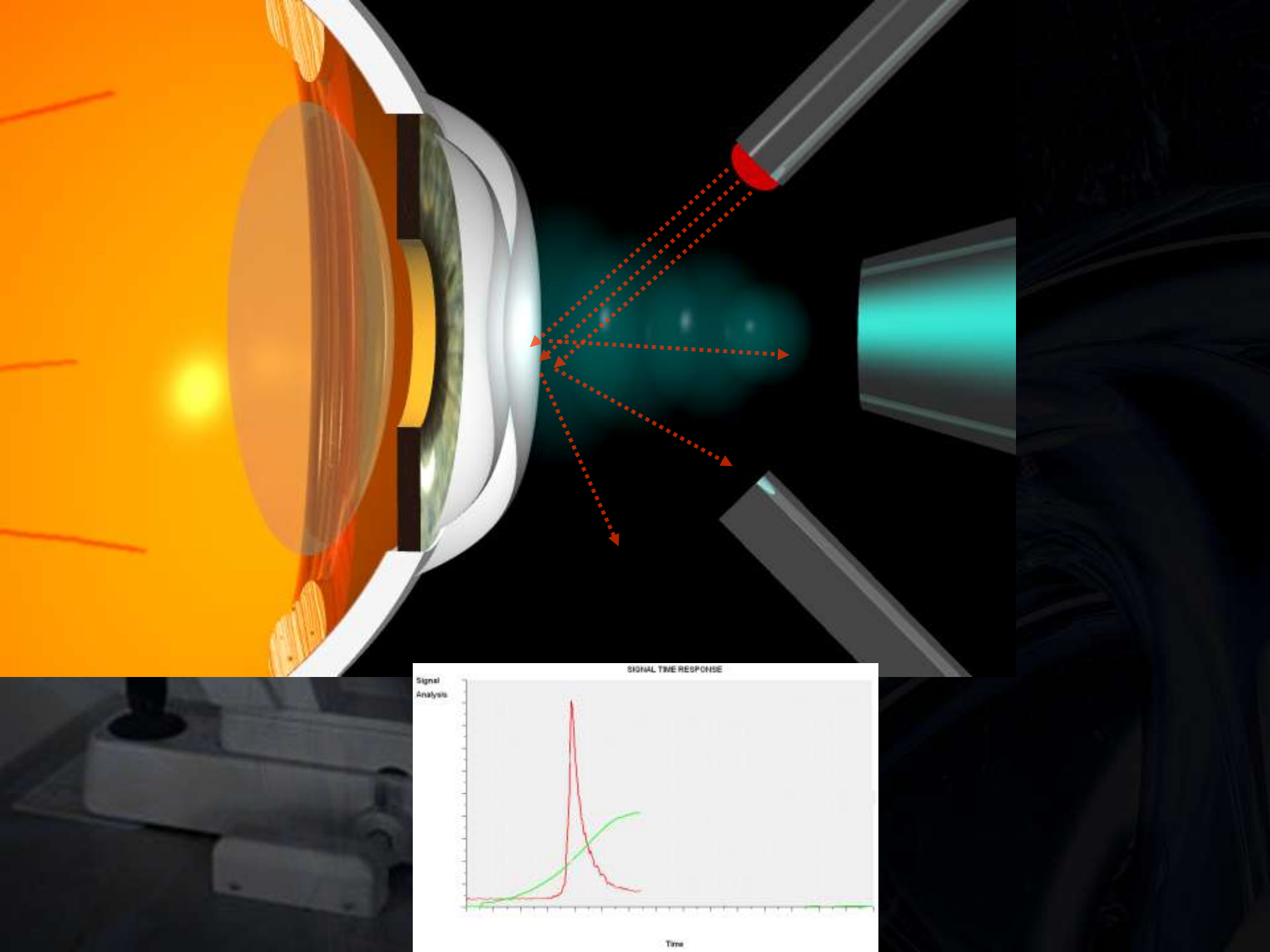


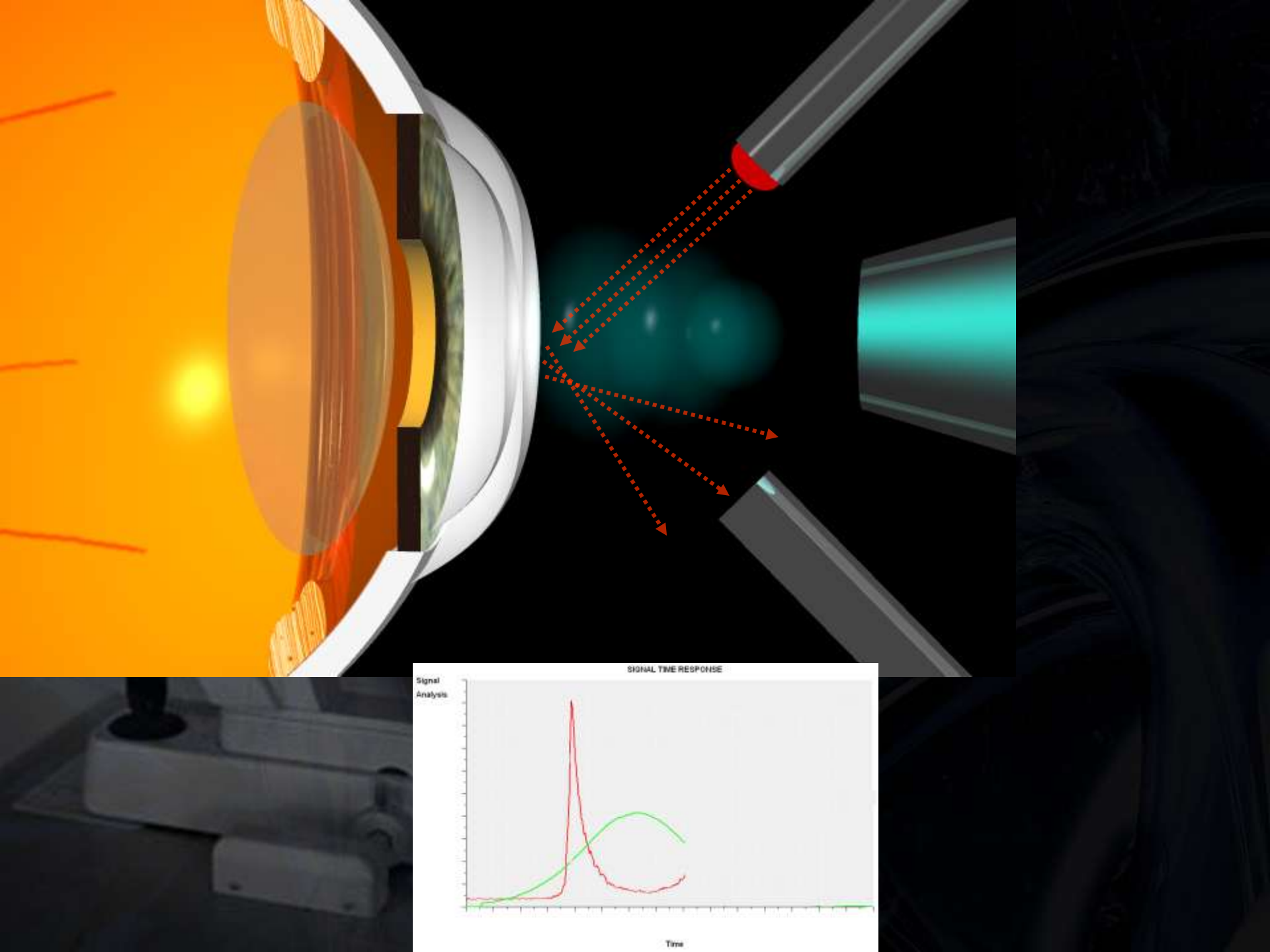


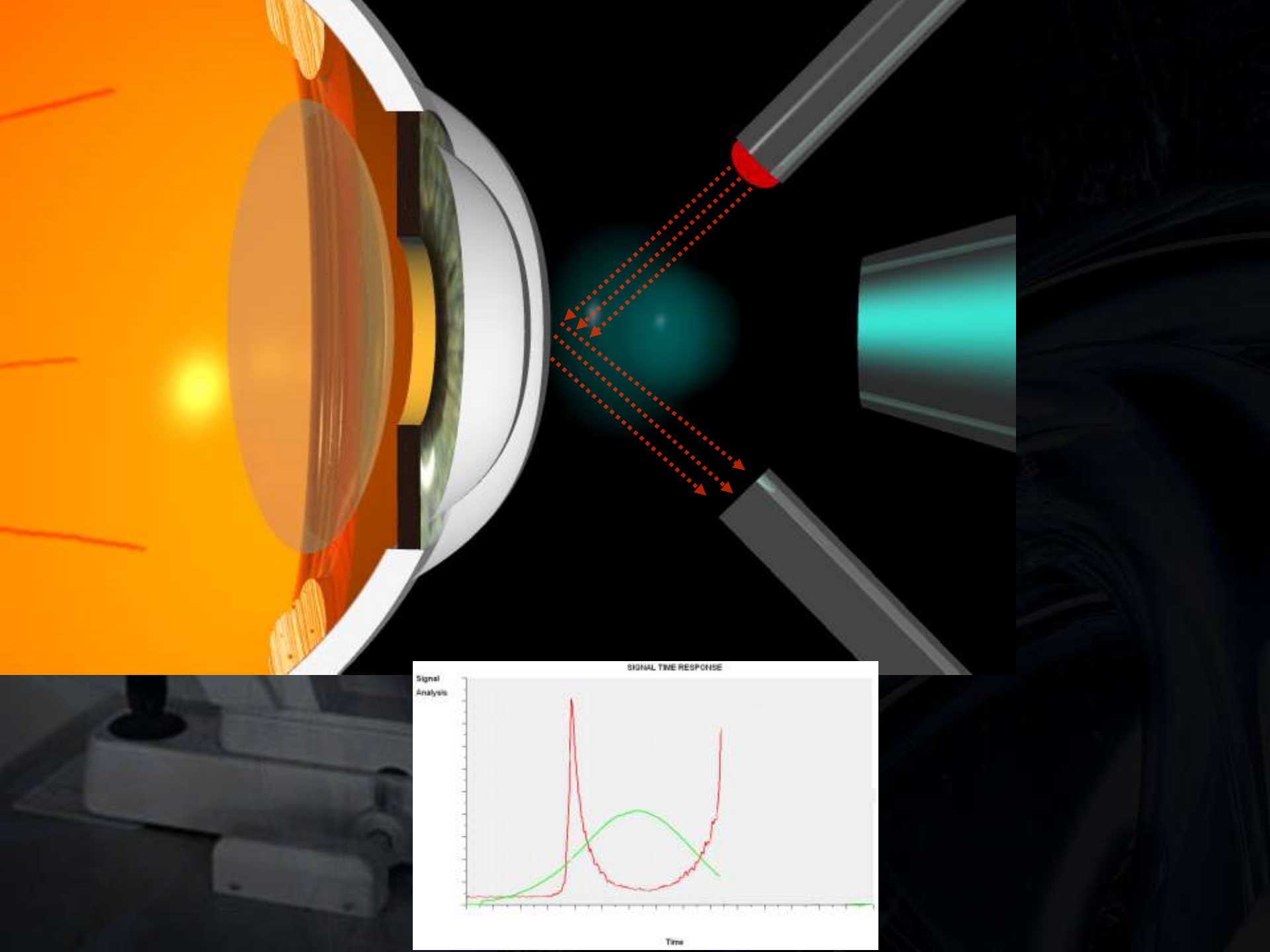

Signal
Analysis
Time

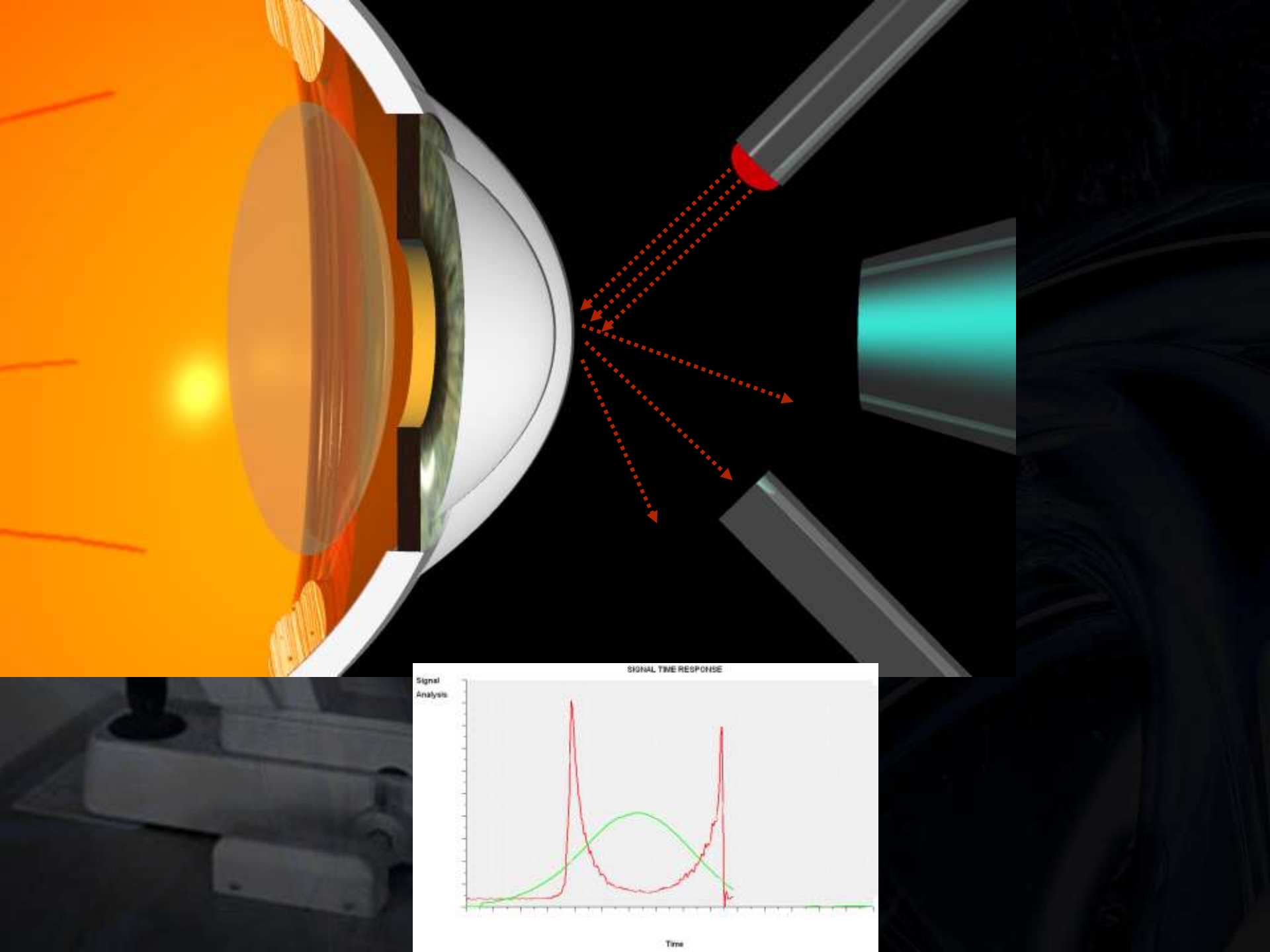


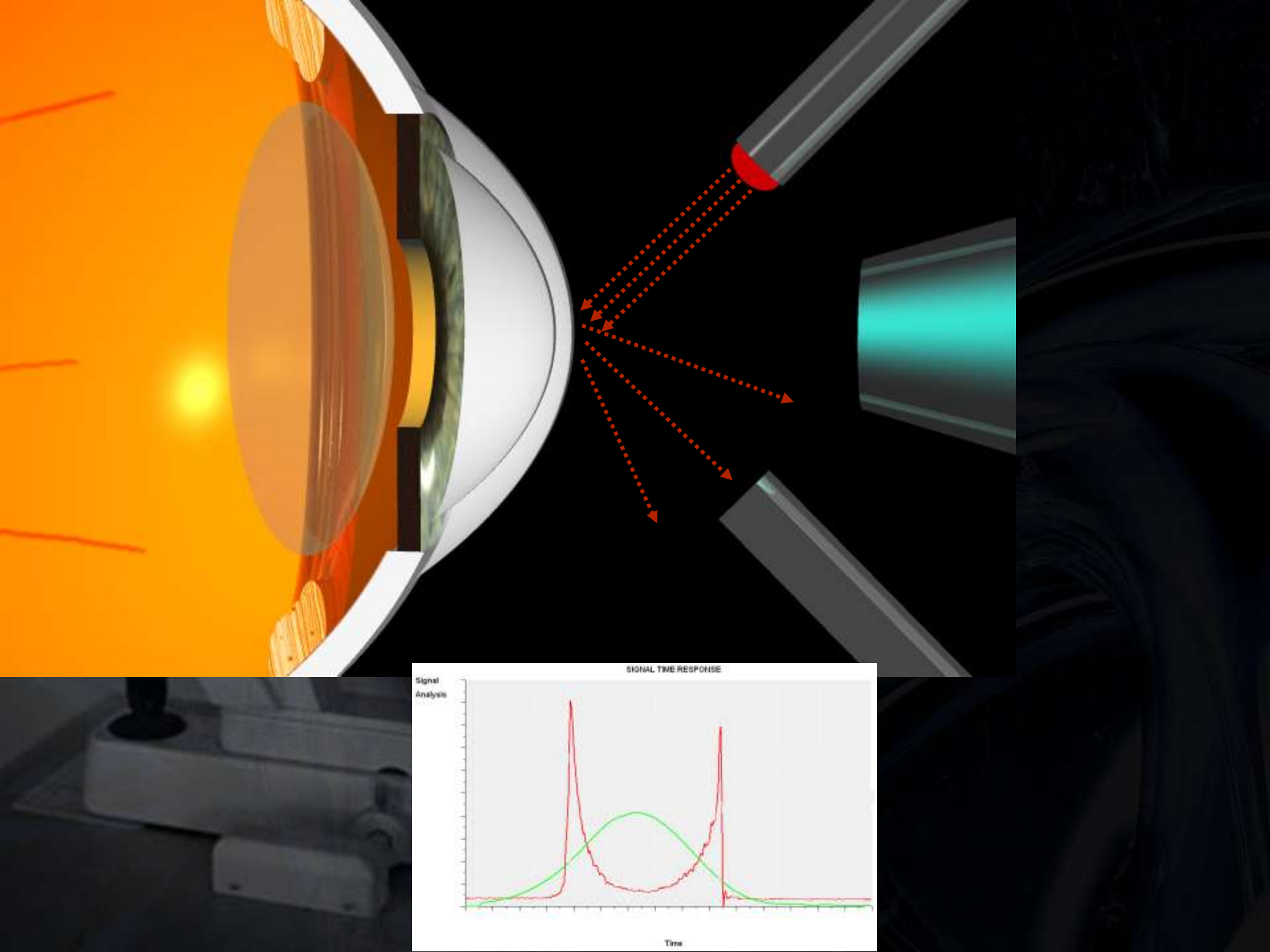

SIGNAL TIME RESPONSE
Signal
Analysis
Time

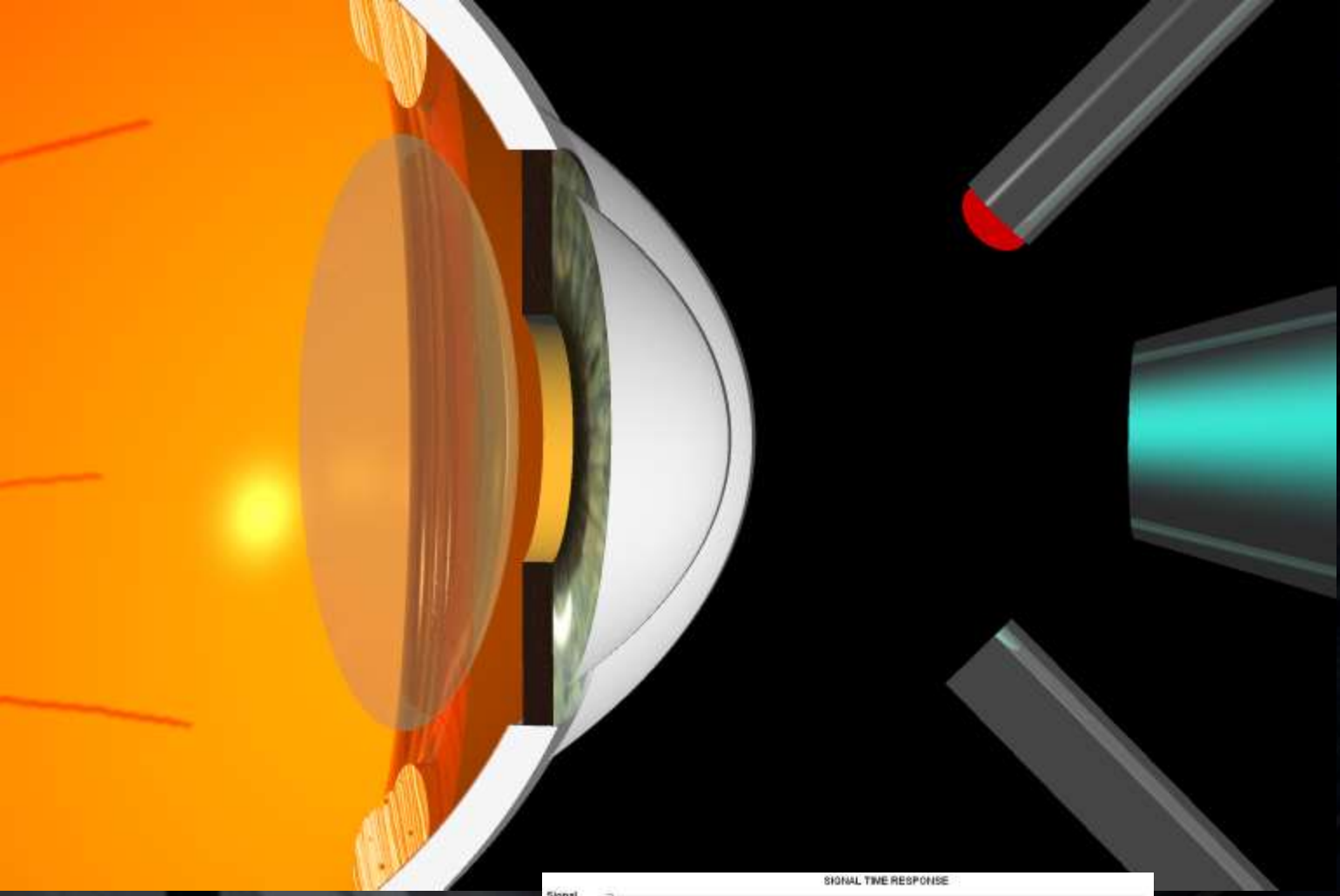

SIGNAL TIME RESPONSE
Signal
Analysis
Time


SIGNAL TIME RESPONSE
Signal
Analysis
Time

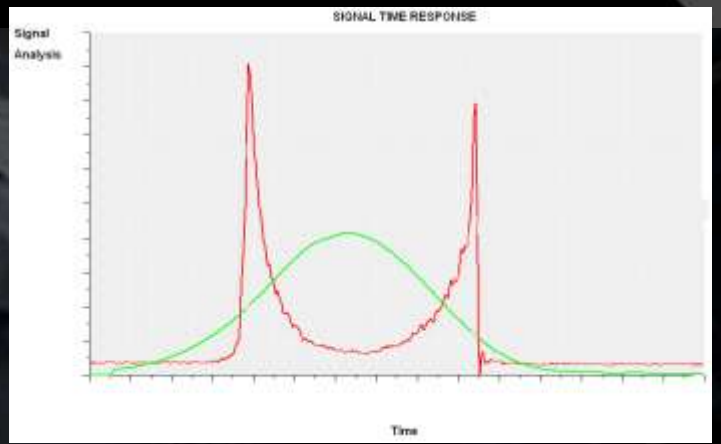

SIGNAL TIME RESPONSE
Signal
Analysis
Time

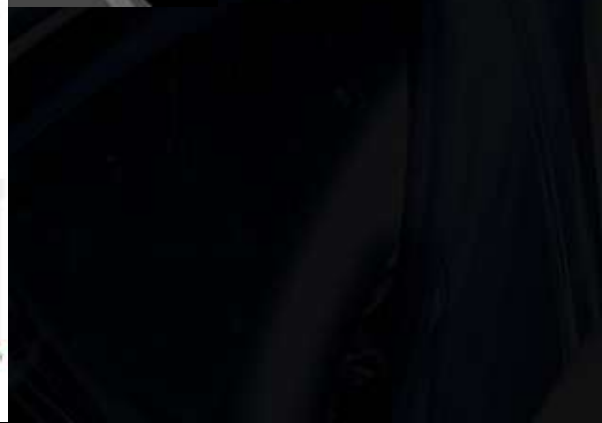

SIGNAL TIME RESPONSE
Signal
Analysis
Time

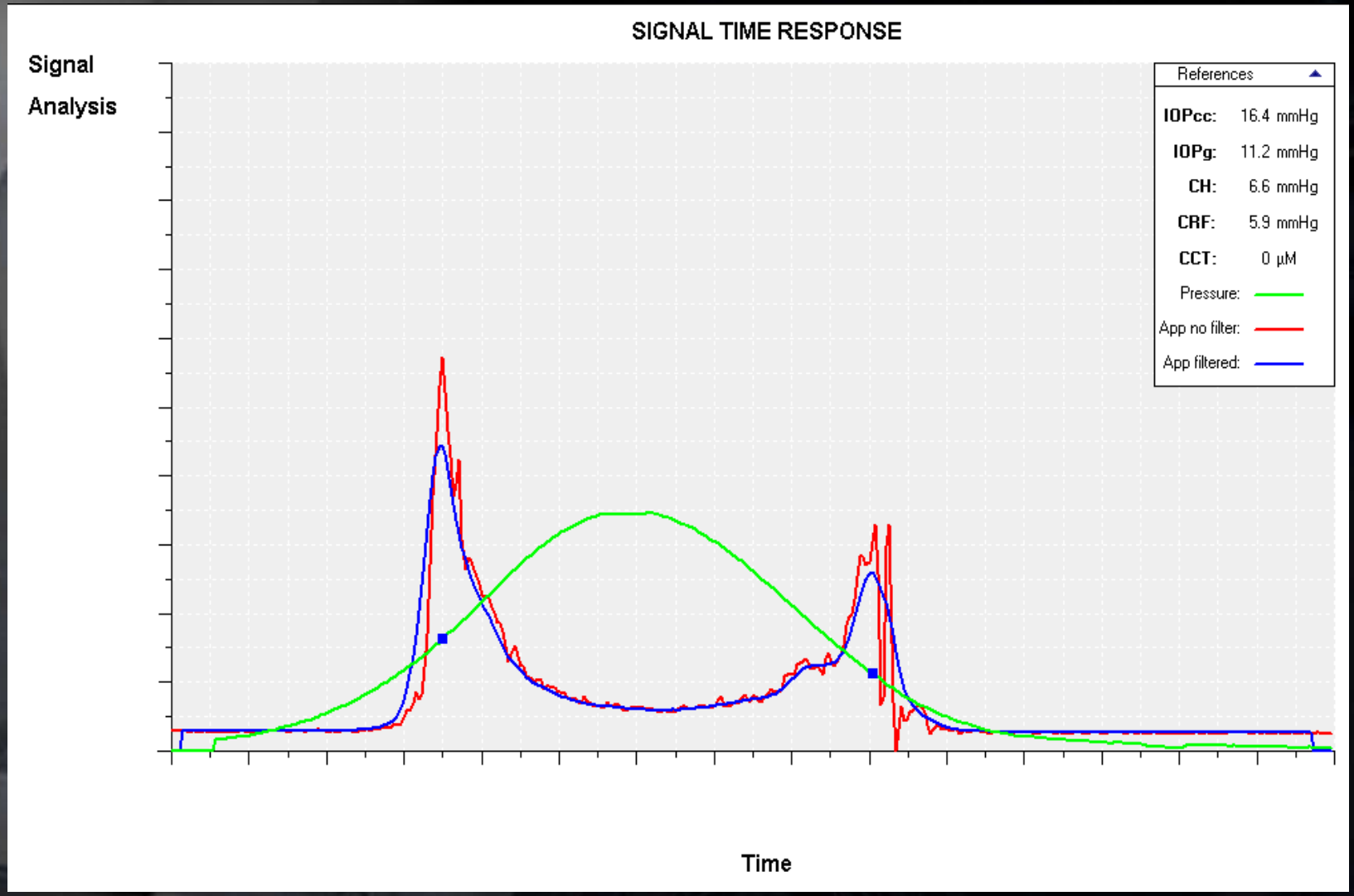

SIGNAL TIME RESPONSE
Signal
Analysis
Time






SIGNAL TIME RESPONSE
Signal
Analysis
Time




SIGNAL TIME RESPONSE
Signal
Analysis
References
IOPcc: 16.4 mmHg
IOPg: 11.2 mmHg
CH: 6.6 mmHg
CRF: 5.9 mmHg
CCT: 0 µM
Pressure:
App no filter:
App filtered:
Time

Keratoconus - the Past

Classic Treatment Options:

- Intitial Stage: Spectacles
- Moderate Stage: Hard Contact Lenses
- Advanced Stage: Corneal Transplant





Keratoconus - the Present

- **Intitial Stage:** Spectacles, soft contact lenses, Corneal Collagen Crosslinking
- **Moderate Stage:** RGP Contact Lenses, ICRS (Intacs, Kerarings), Phakic IOLs and combinations
- **Advanced Stage:** ICRS, PKP, Lamellar, Femtosecond laser assisted corneal grafts

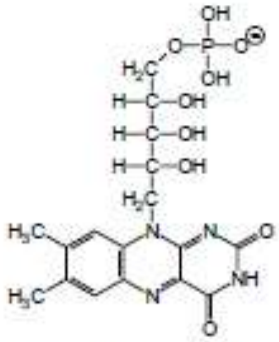




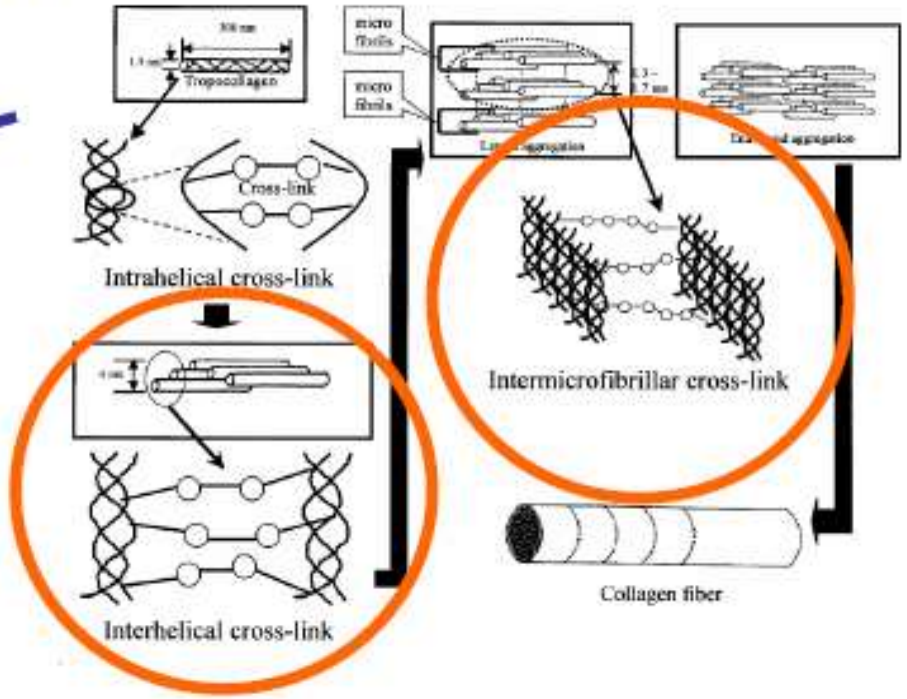
Background of corneal cross linking

1. Combined application of UVA and riboflavin

riboflavin (vit. B2) **Ultraviolet irradiation**







2. Production of oxygen radicals

O_2^-

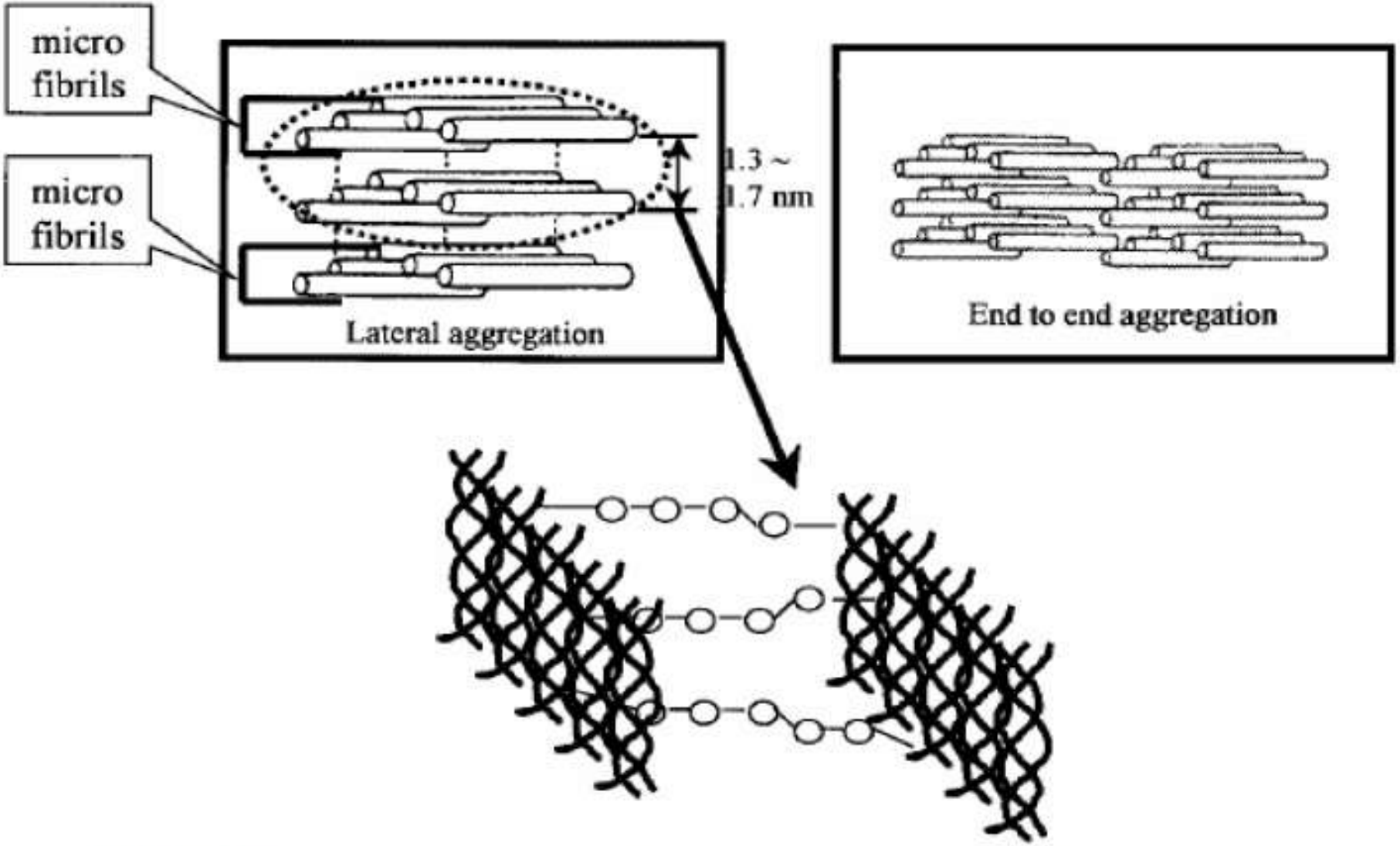
3. Induction of collagen cross-links



collagen fibril **collagen fibril**

Prof. Dr. Michael Mrochen,

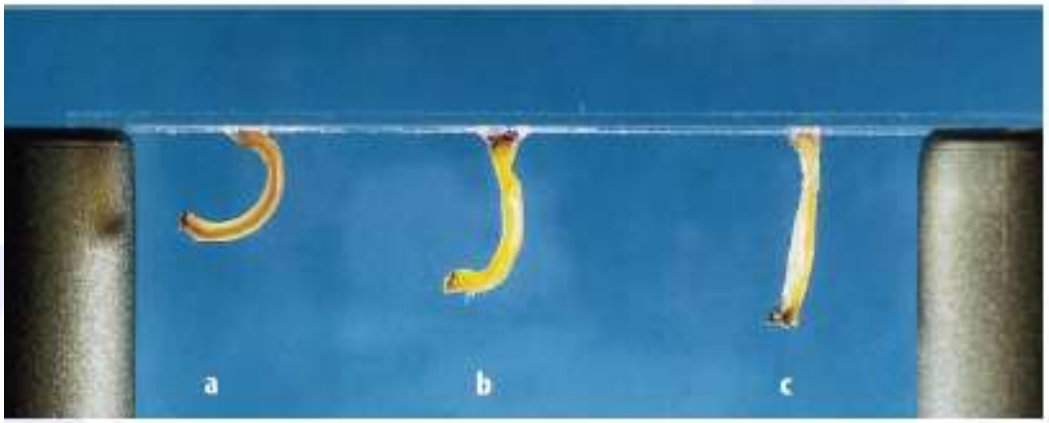
Intermicrofibrillar cross-link



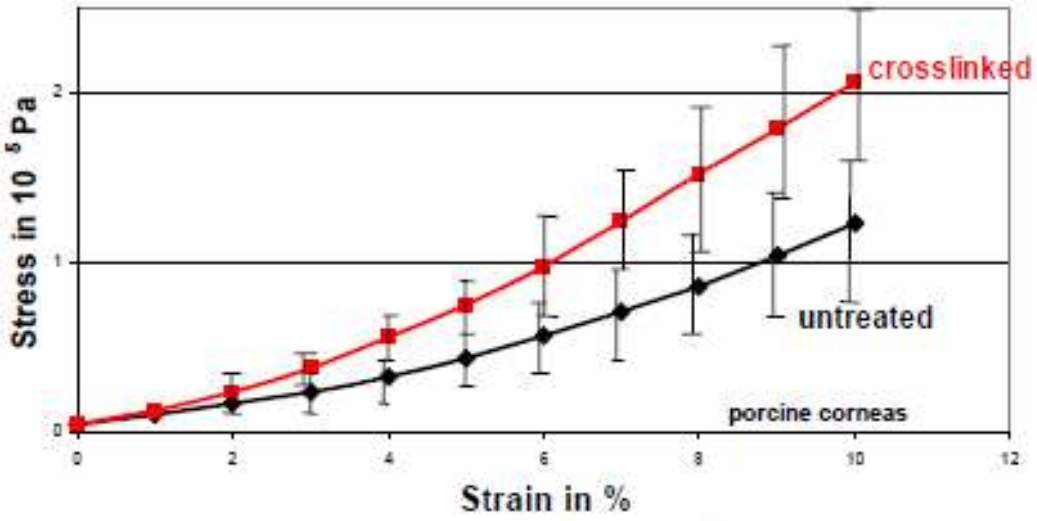
Prof. Dr. Michael Mrochen,

Background of corneal cross linking









Prof. Dr. Michael Mrochen,

Corneal Cross-Linking





Physico-chemical changes

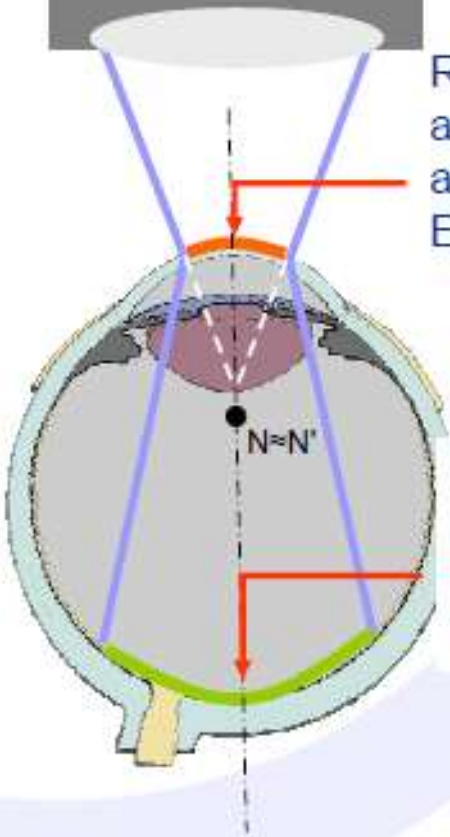
- Increase
  - stiffness and Young‘s-modulus
  - bending stiffness
  - thickness of collagen fibers
  - shrinking temperature
  - resistance to swelling
  - resistance against enzymatic degradation
  - turn-over time
  - high-molecular-weight aggregate
  - propagation of ultrasound
  - autofluorescence ???

UV-X™ illumination





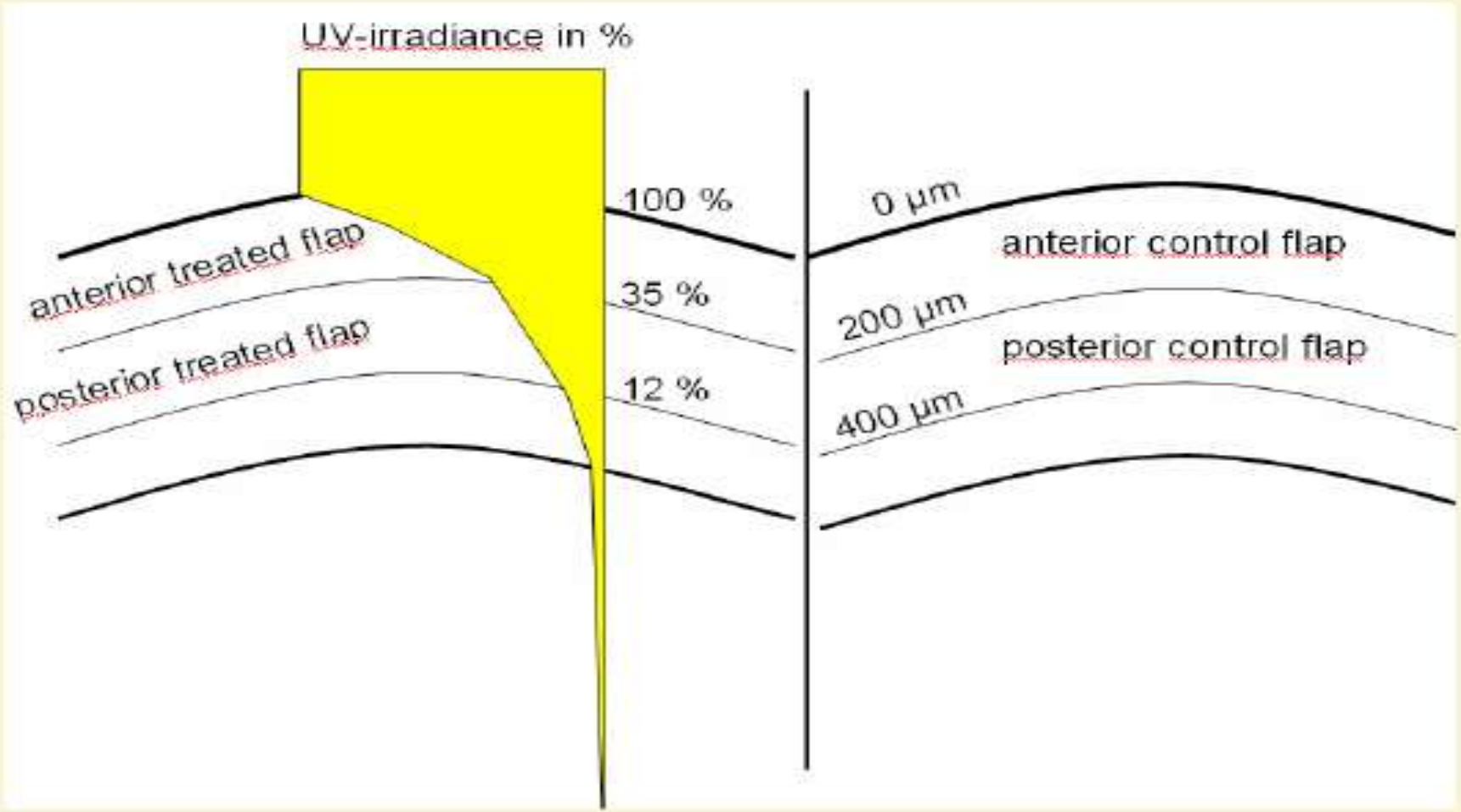
Koehler's beam path



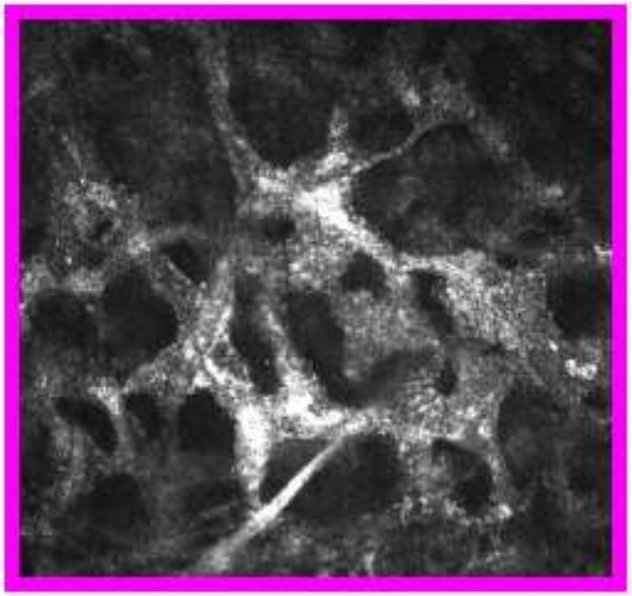
Radiant exposure
at the cornea
after 30 min:
E ~ 5.4 J/cm²

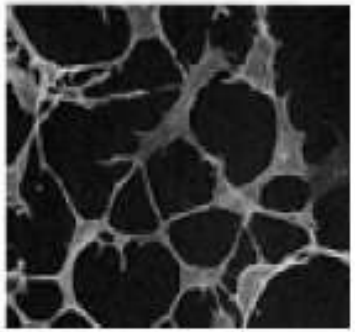
Radiant exposure
at the retina
after 30 min.:
F ~ 0.006 J/cm²

Riboflavin/UVA application 370 nm; 3 mW/cm²; 30 min

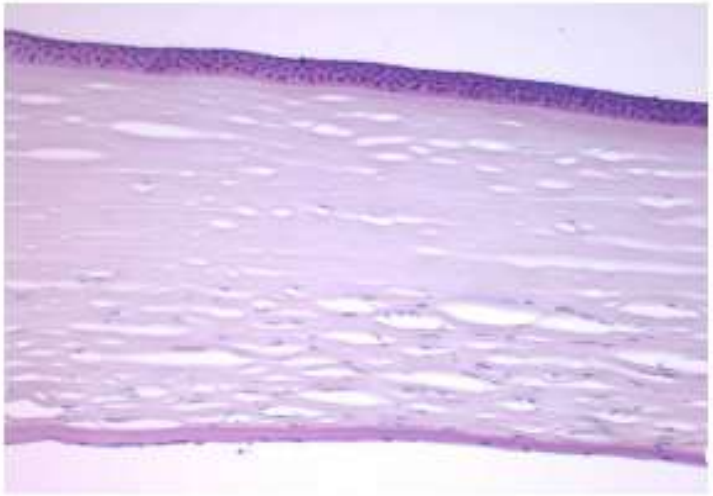


Activated keratocytes?





Guerriero et al., 2007; IOVS



H.E. staining of a human cornea; 1 month after crosslinking. Only rare cells were visualised in the anteriro stroma. None of them was immunoreactive for Ki-67 or α-smooth muscle actin-markers of „activated" keratocytes

cross-linked cornea was kindly provided by **Prof. Seiler** (Zürich)

Aspectos a tener en cuenta…

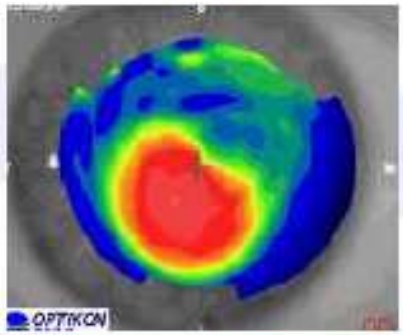
- *Confirmación de progresión de queratocono o ectasia.*
  - *Historia previa.*
  - *Cambios topográficos.*
  - *Disminución de AV.*
  - *Cambios frecuentes de adaptación de las LC.*
- *Paquimetría mínima de 400 micras.*
  - *La radiación UVA puede llegar a ser nociva para el endotelio corneal[5], además de para cristalino y retina.*

Protección del endotelio:
- *Un espesor mínimo (400 micras)*
- *La absorción de UVA que realiza la Riboflavina*

Riboflavina 2 funciones: crear enlaces y protección

5. Spoerl E, Mrochen M, Sliney D, et al. Safety of UVA-Riboflavin cross-linking of the cornea. Cornea.2007 May;26(4):385-9.

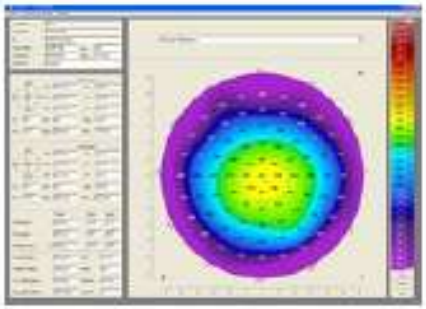
Treatment procedure



1. Topography
Progressive type
of keratoconus



4. Apply Riboflavin
1 drop every 2 min
for 30 min.



2. Pachymetry
Corneal thickness
> 400 microns



5. Slit lamp inspection
(blue light)
Staining of anterior
chamber



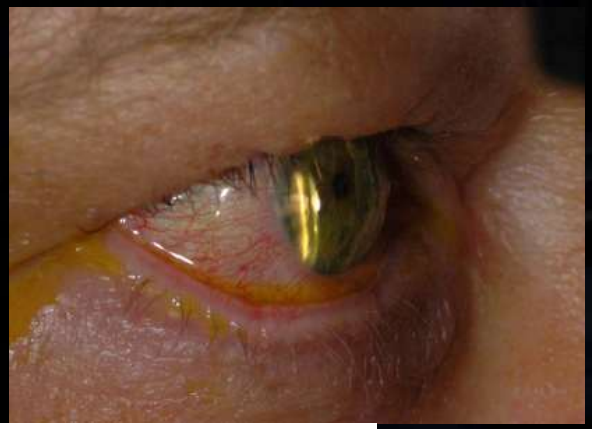
3. Partial epithelium
removal (abrasio)



6. Start UV-illumination
with UV-X;
1 drop of Riboflavin
every 2 min for 30 min.





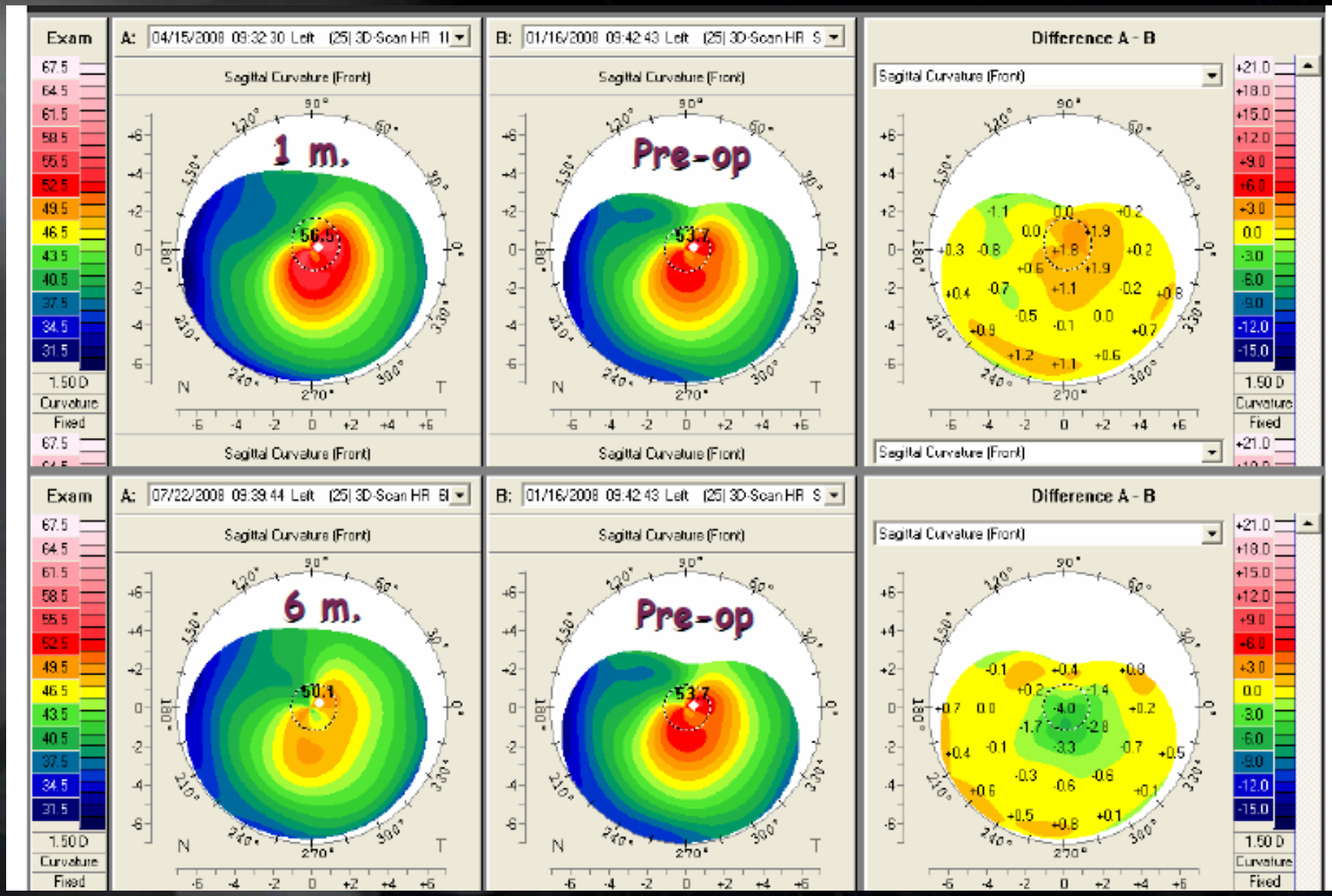


„Crosslinking“: method

4. UV-A radiation (365nm, 3 mW/cm²) for 30 minutes under Riboflavin eye drops every 2 minutes






Exam
A: 04/15/2008 09:32:30 Left (25) 3D-Scan HR II
B: 01/16/2008 09:42:43 Left (25) 3D-Scan HR S
Sagittal Curvature (Front)
1 m.
56.5
Pre-op
53.7
Difference A - B
Sagittal Curvature (Front)
1.50 D
Curvature
Fixed
A: 07/22/2008 09:39:44 Left (25) 3D-Scan HR BI
6 m.
50.1

Typical clinical observations and results

Inclusion criteria:

- Progressive form of keratectasia
- Thickness of cornea stroma >400 microns (or swelling process)
- Epithelium must be removed for proper diffusion
- Kmax < 55dpt ?? (visual benefits, contact lens tolerance, ect..)?

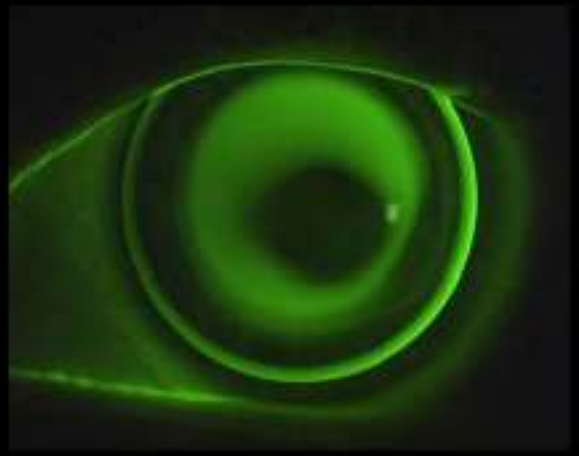
Typical clinical outcomes

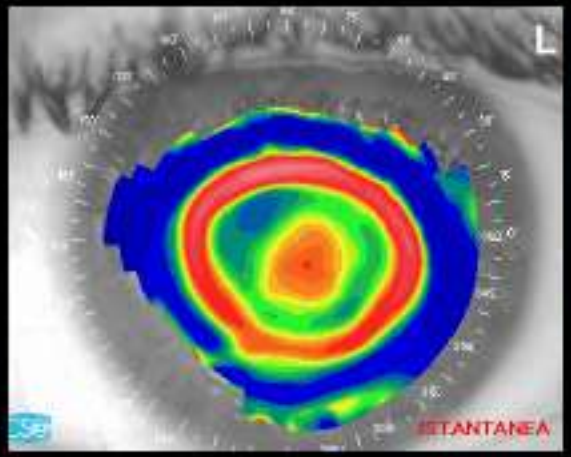
- Reduction of max. K-Value by 1.0 to 2.0 D
- Stability statistically proven over 48 months
- 1 to 2 line gain in BSCVA (do not promise to patients)
- low to moderate haze up to to 6 months post surgery

Complications

- delayed corneal reepithalization
- corneal endothelium cell damage (thin corneas)
- Sevier corneal haze (very seldom) – 6 cases

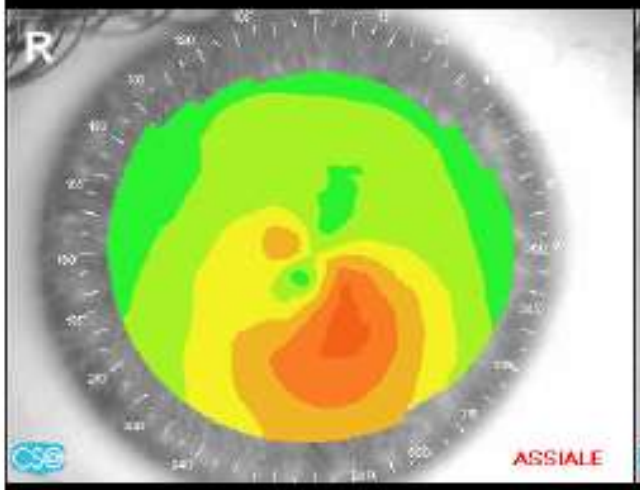
Conclusions

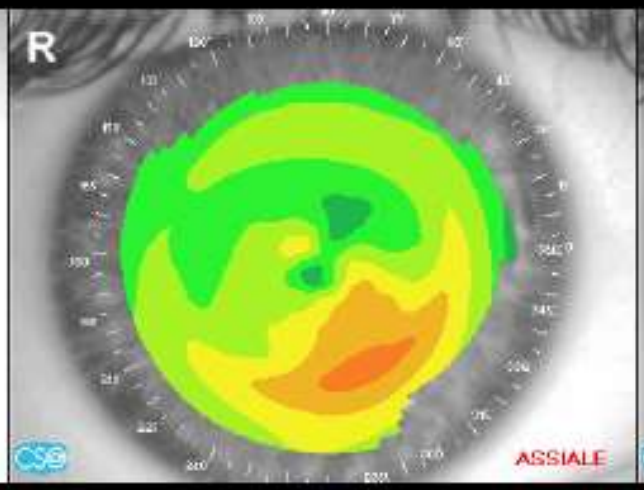


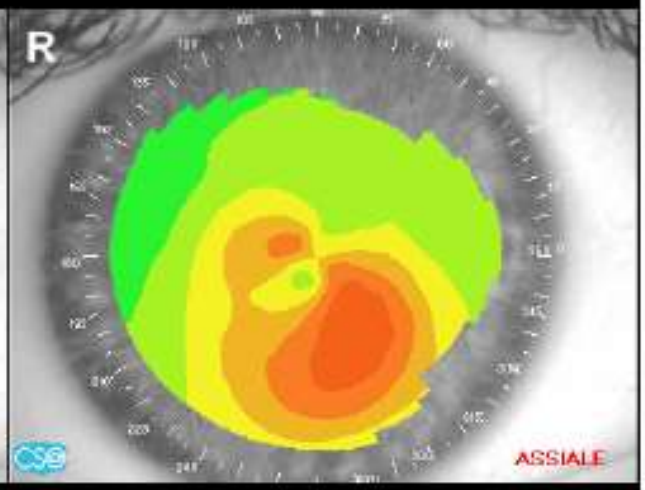


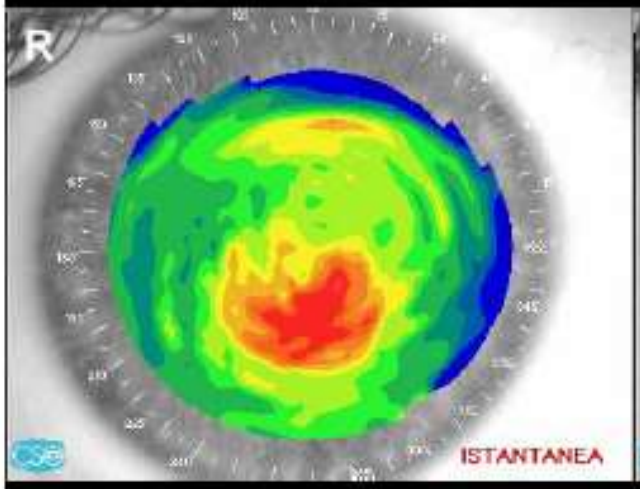


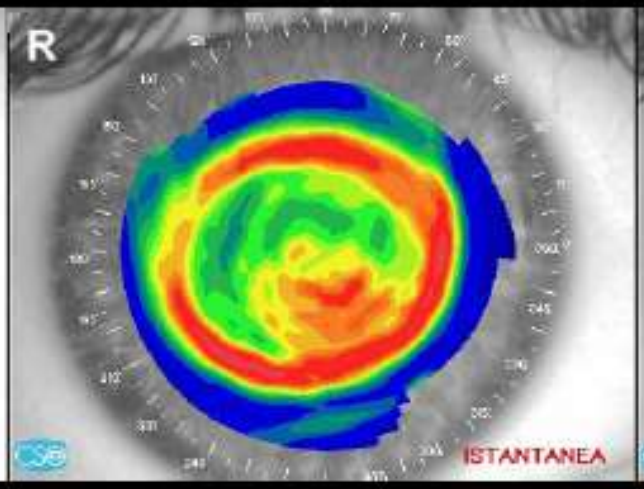
- Overnight orthokeratology may reshape the keratoconic cornea without significant adverse reactions
- Riboflavin-UVA corneal collagen cross-linking is quite safe, but it is not able to stabilize the OK molding effect
- Nevertheless, UCVA and BSCVA did not go back to the baseline level
- At the present time, we are not able to explain this discrepancy

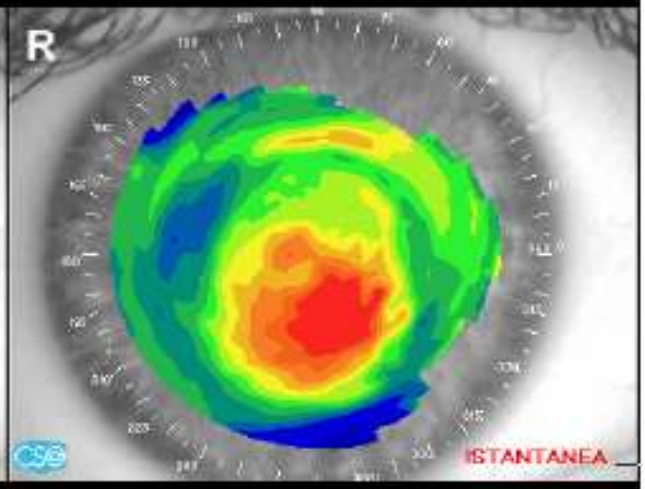












Pre
UCVA 0.4
(20/50)

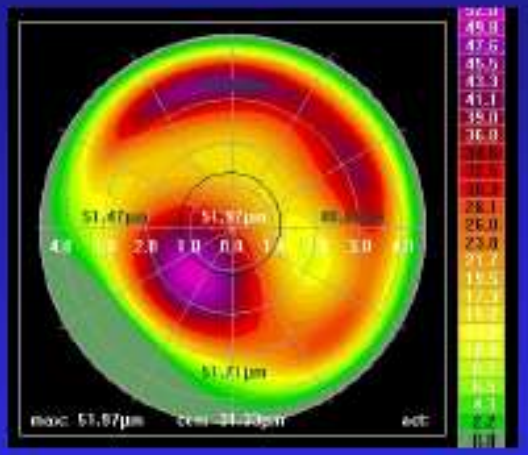
Post OK
UCVA 0.8
(20/25)

Post CXL
UCVA 0.3
(20/70)

#2

Surgical visual rehabilitation techniques after UV-CXL

- Topography-guided surface ablations (TG-PRK)
  - Seiler (Zürich, Switzerland)
  - Kanellopoulos (Athens, Greece)



- Implantation of toric Artisan or Artiflex IOL's (PIOL)
  - Nuijts (Maastricht, The Netherlands)



„Crosslinking“: complications

→ **Failure**: progression despite of crosslinking

→ **Endothelial decompensation** (with pachymetry < 400 µm)

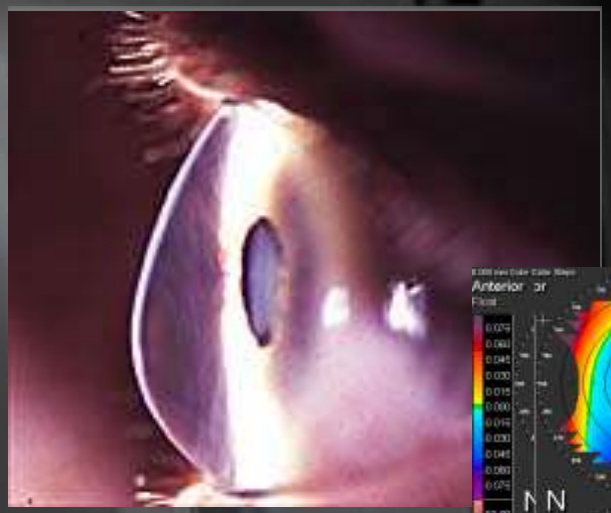
→ **Keratitis**

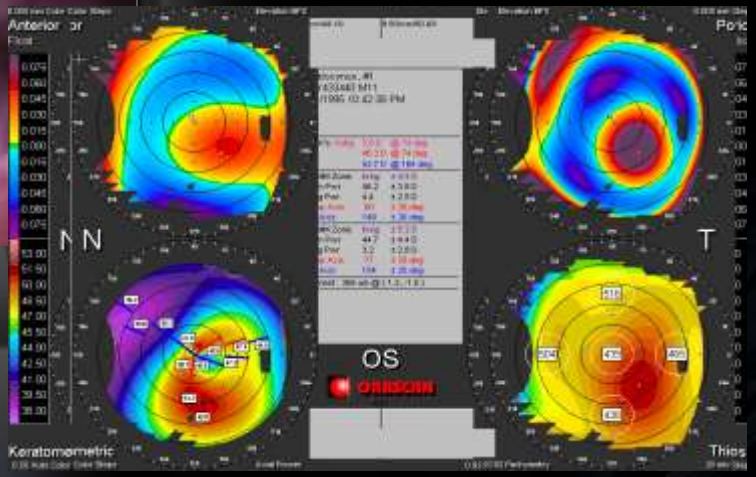
→Bacterial

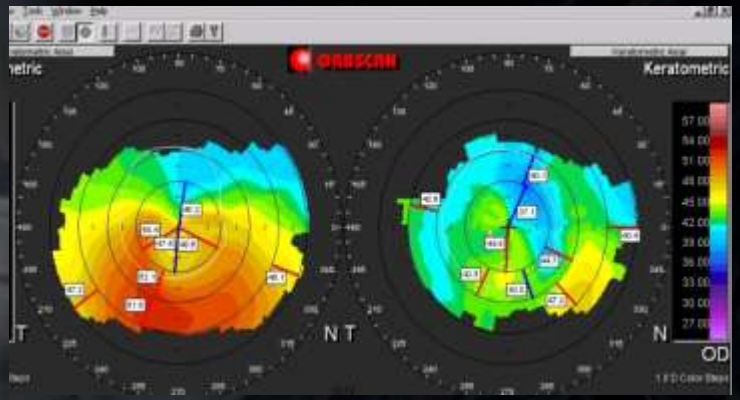
→Herpetic keratitis

→ **Corneal haze**






N N
T
OS
ORBSCAN
Keratometric


ORBSCAN
Keratometric
NT
N
OD







Blavatskaya Nomogram (Russia - 1960's)

Espesor del Anillo mm.	Modificación Dioptrías
0.29-0.30	18.0-21.0
0.15-0.17	9.00-12.0
0.10-0.12	6.00-8.00

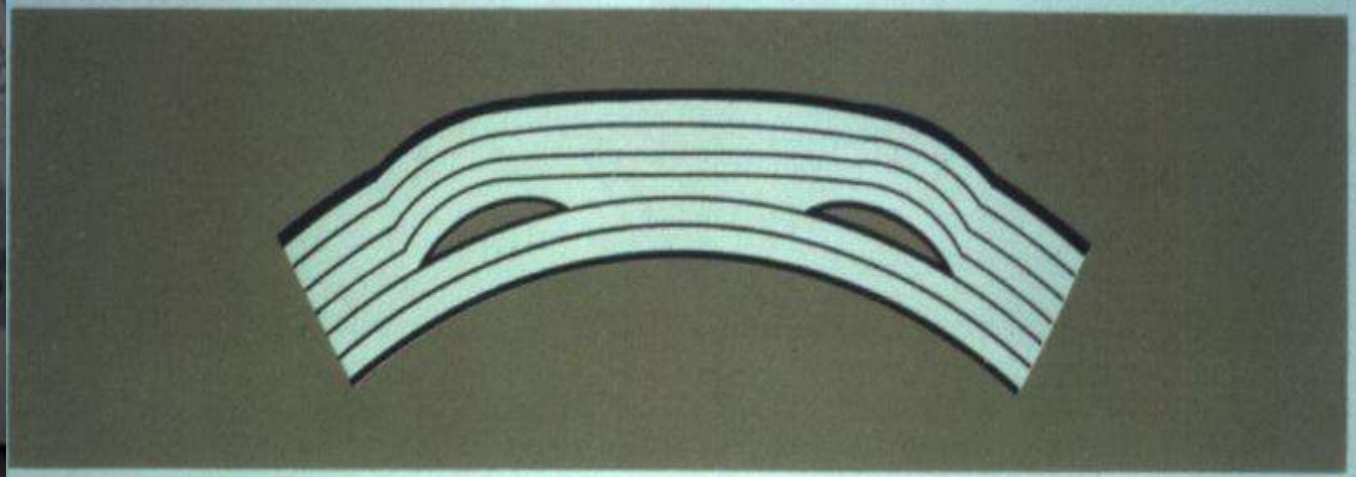
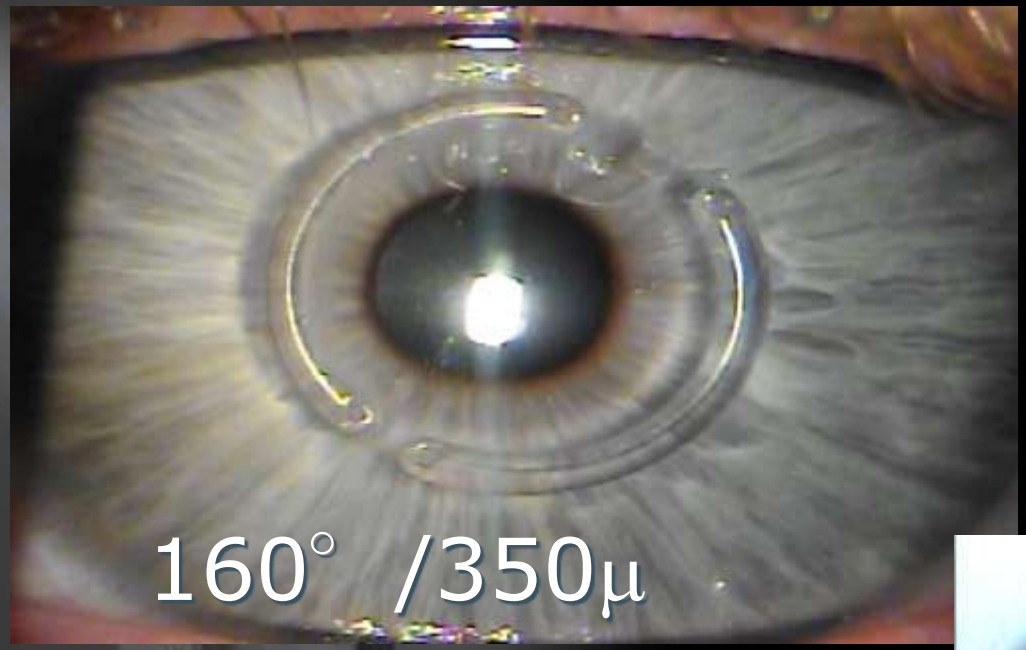
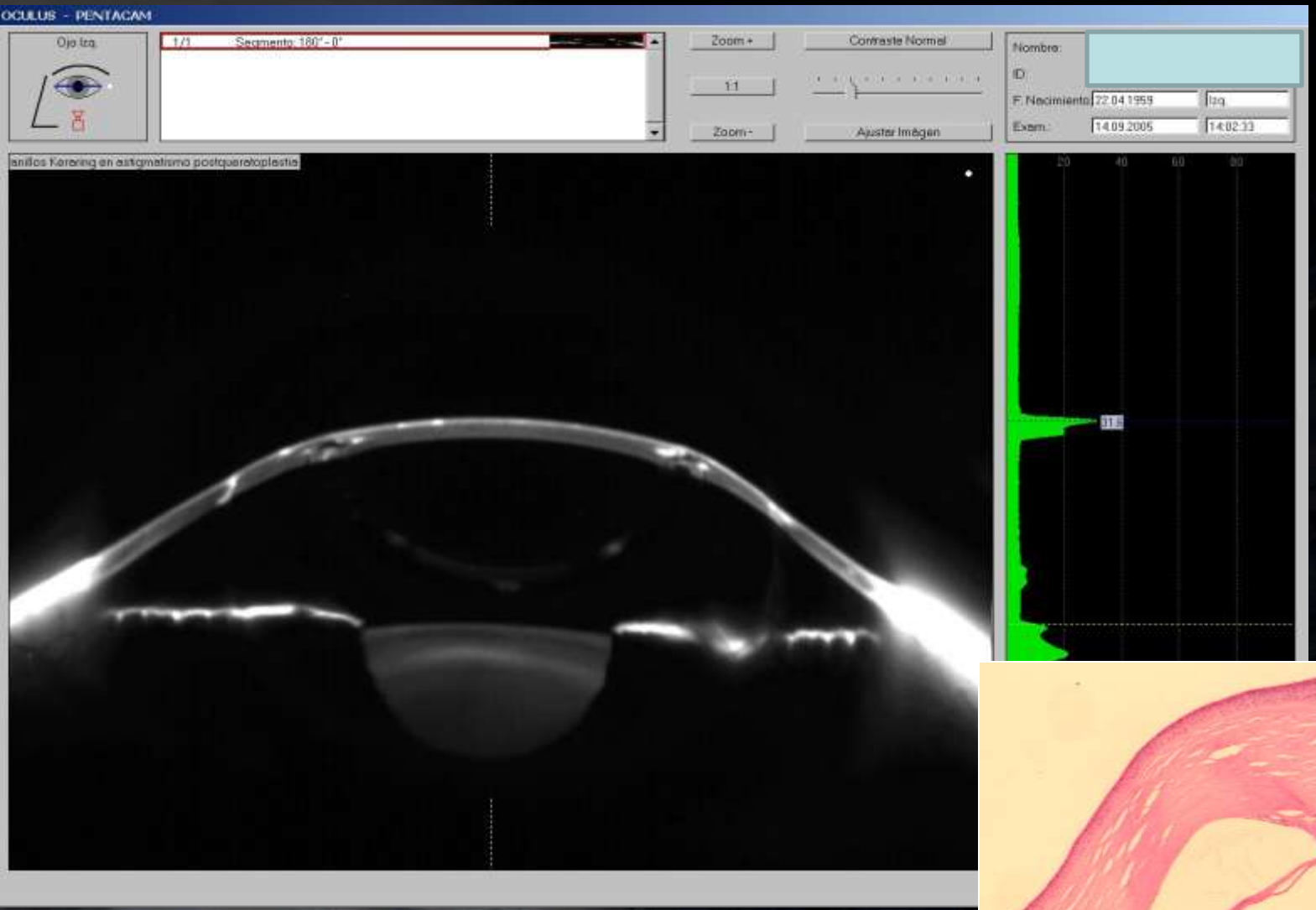
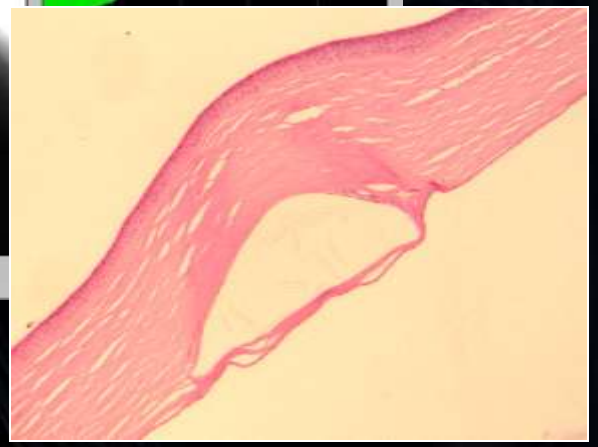


Fig. I-54 Efecto de la inclusión intracorneal de un anillo. (Blavatskaya)

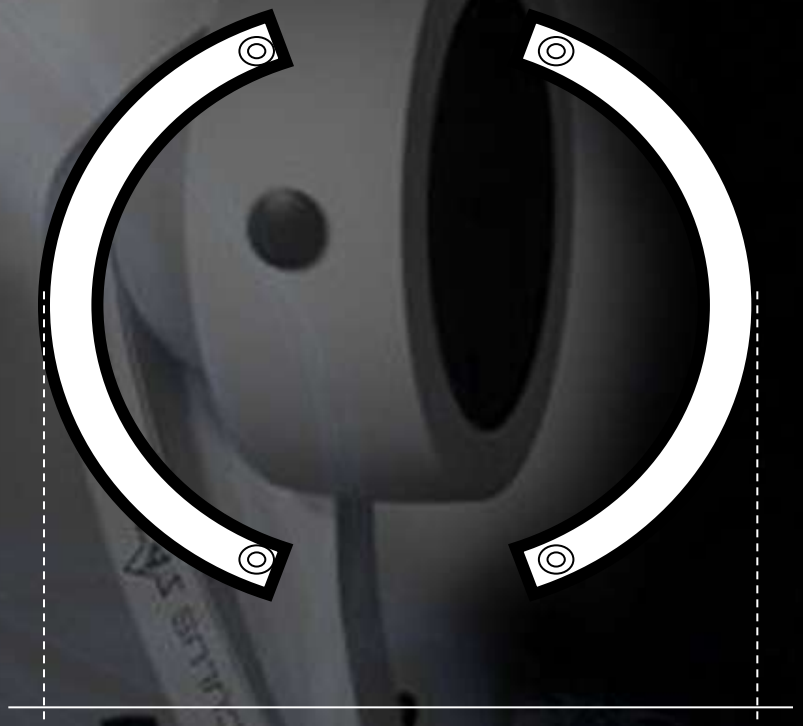

160° /350µ


250 µ / 210°

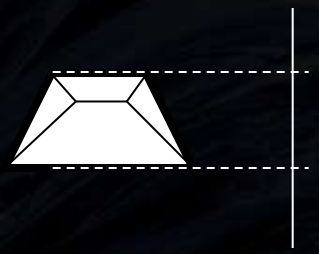

OCULUS - PENTACAM
Ojo Izq.
1/1
Segmento: 180° - 0°
Zoom +
Contraste Normal
1:1
Zoom -
Ajustar Imagen
Nombre:
ID:
F. Nacimiento:
22.04.1959
Izq
Exam.:
14.09.2005
14:02:33
anillos Keraring en astigmatismo postqueratoplastia
20
40
60
80
31



KERARING

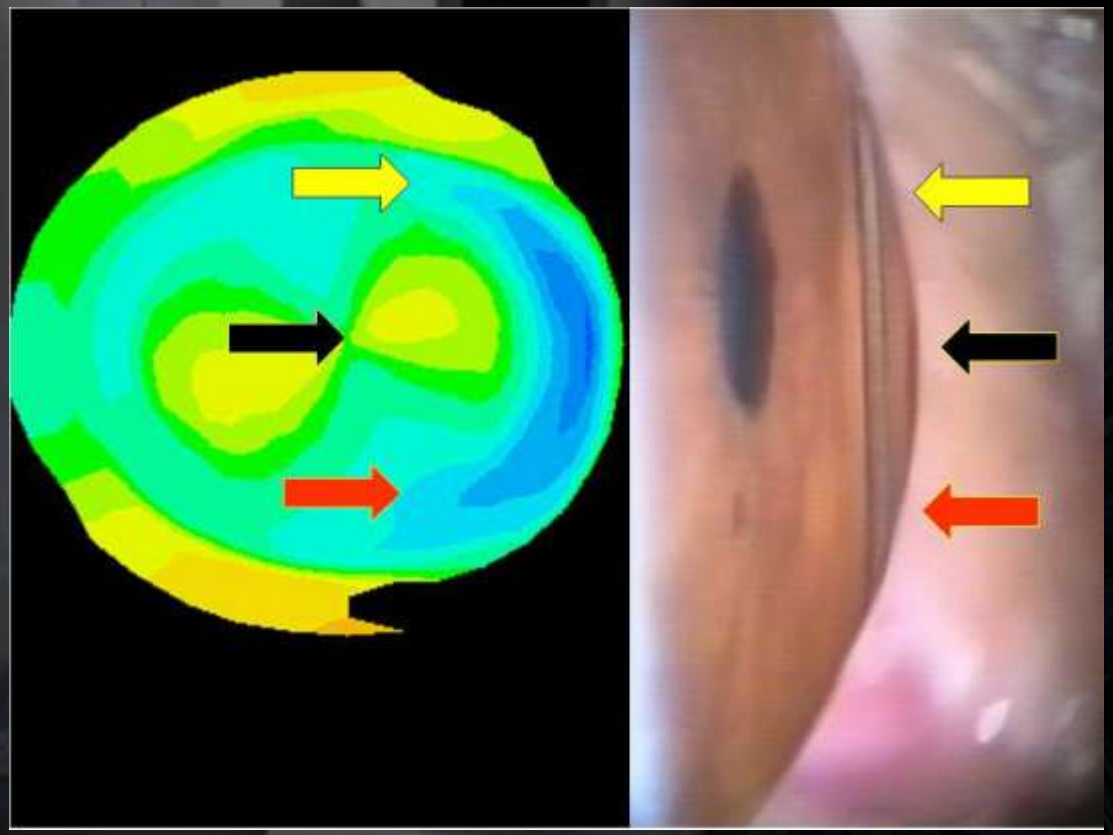


Diameter
The smaller the diameter,
The greater the correction
(Blavatskaya)



Thickness
The greater the thickness,
The greater the correction
(Barraquer)

Mechanism of Action

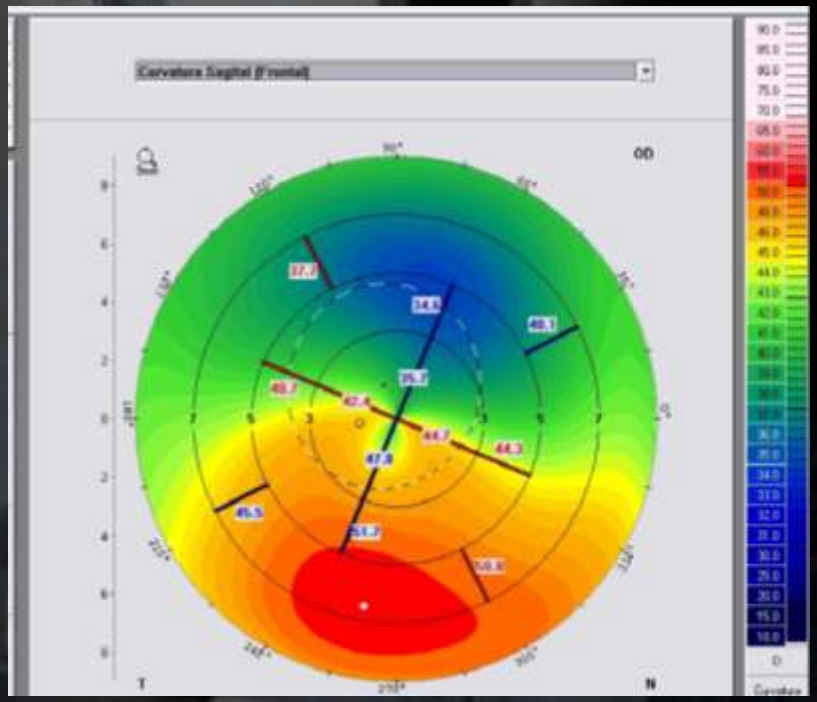


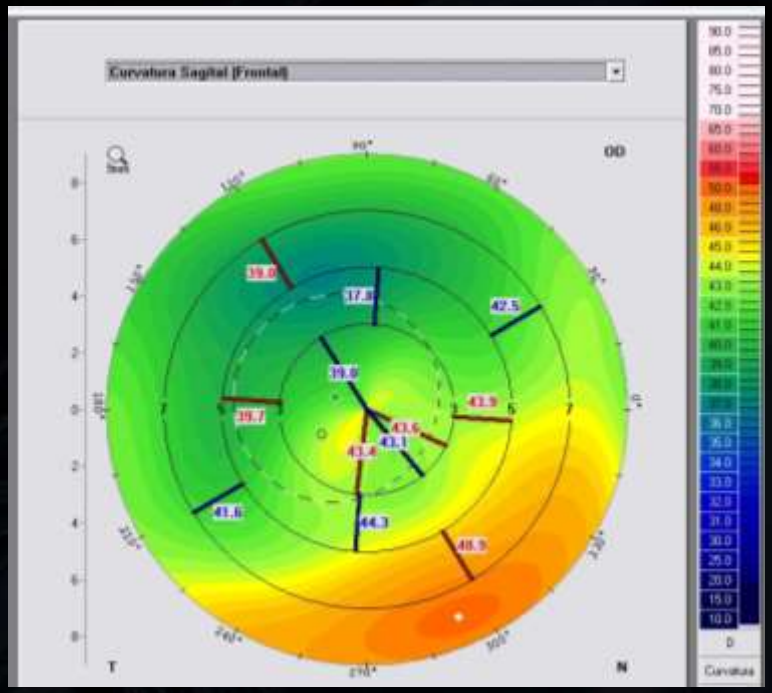
Addition technique =

Preserves corneal positive asphericity

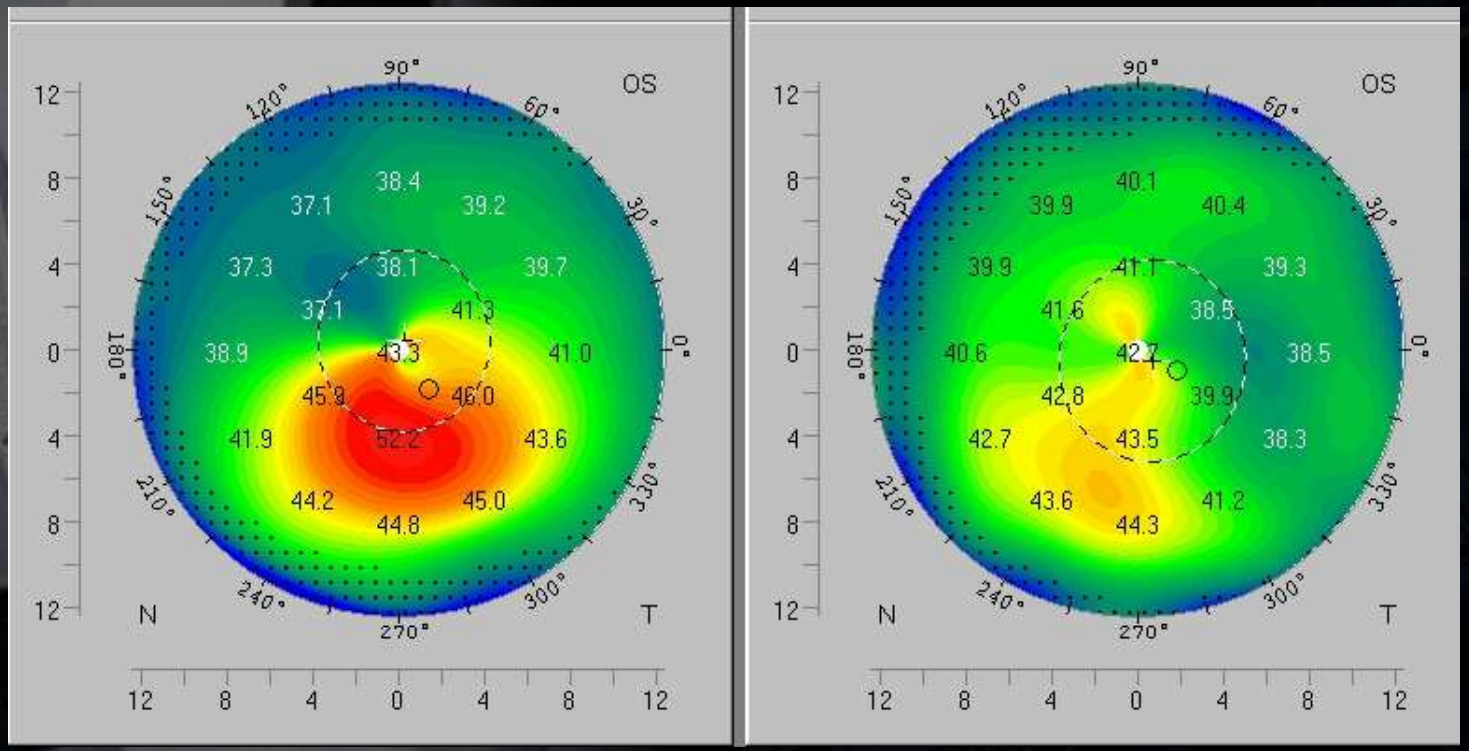
Mechanism of Action

- Central and peripheral flatening





Mechanism of Action



Displacement of corneal apex to central pupil

Keraring

- 160º-Triangular
- 0.15mm -2.00 a-4.00
- 0.20mm -4.25 a-6.00
- 0.25mm -6.25 a-8.00
- 0.30mm -8.25 a-10.00
- 0.35mm -10.25 a-12.0

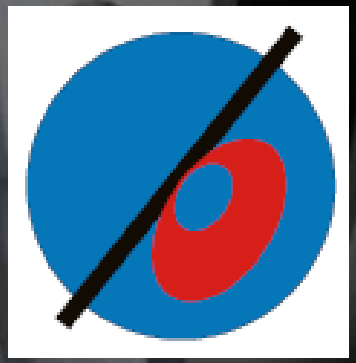


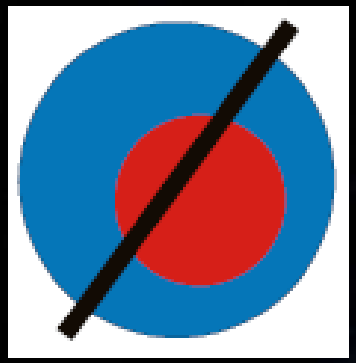


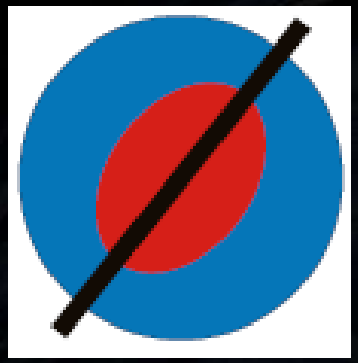
KeraRing

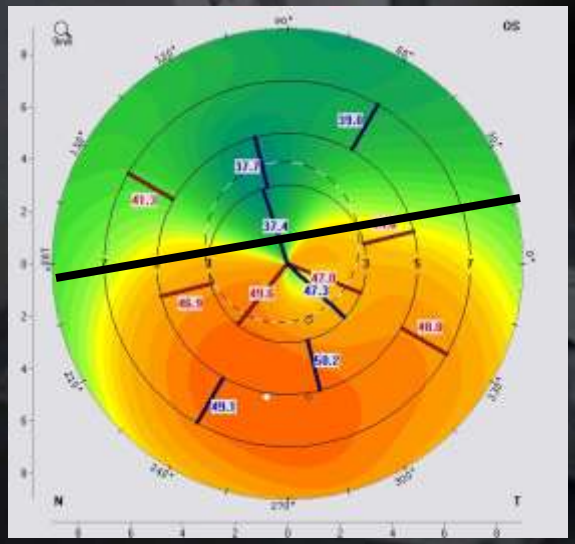


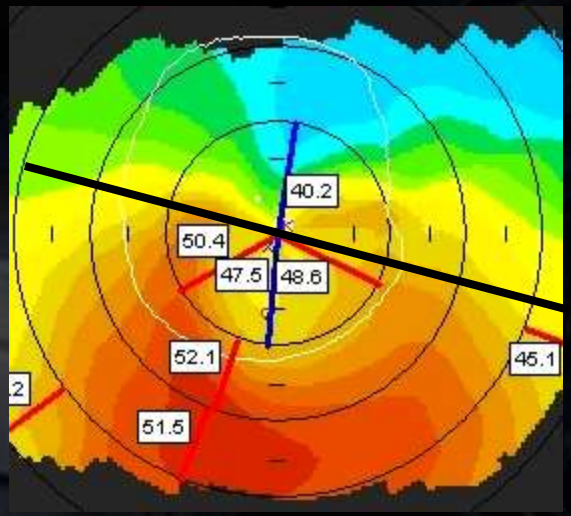
TOPOGRAPHIC PATTERNS

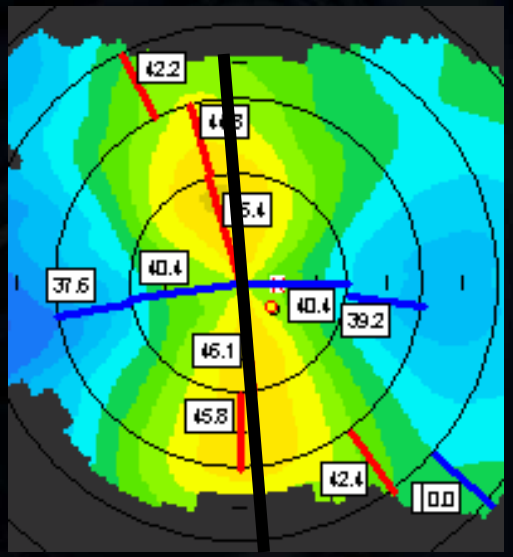




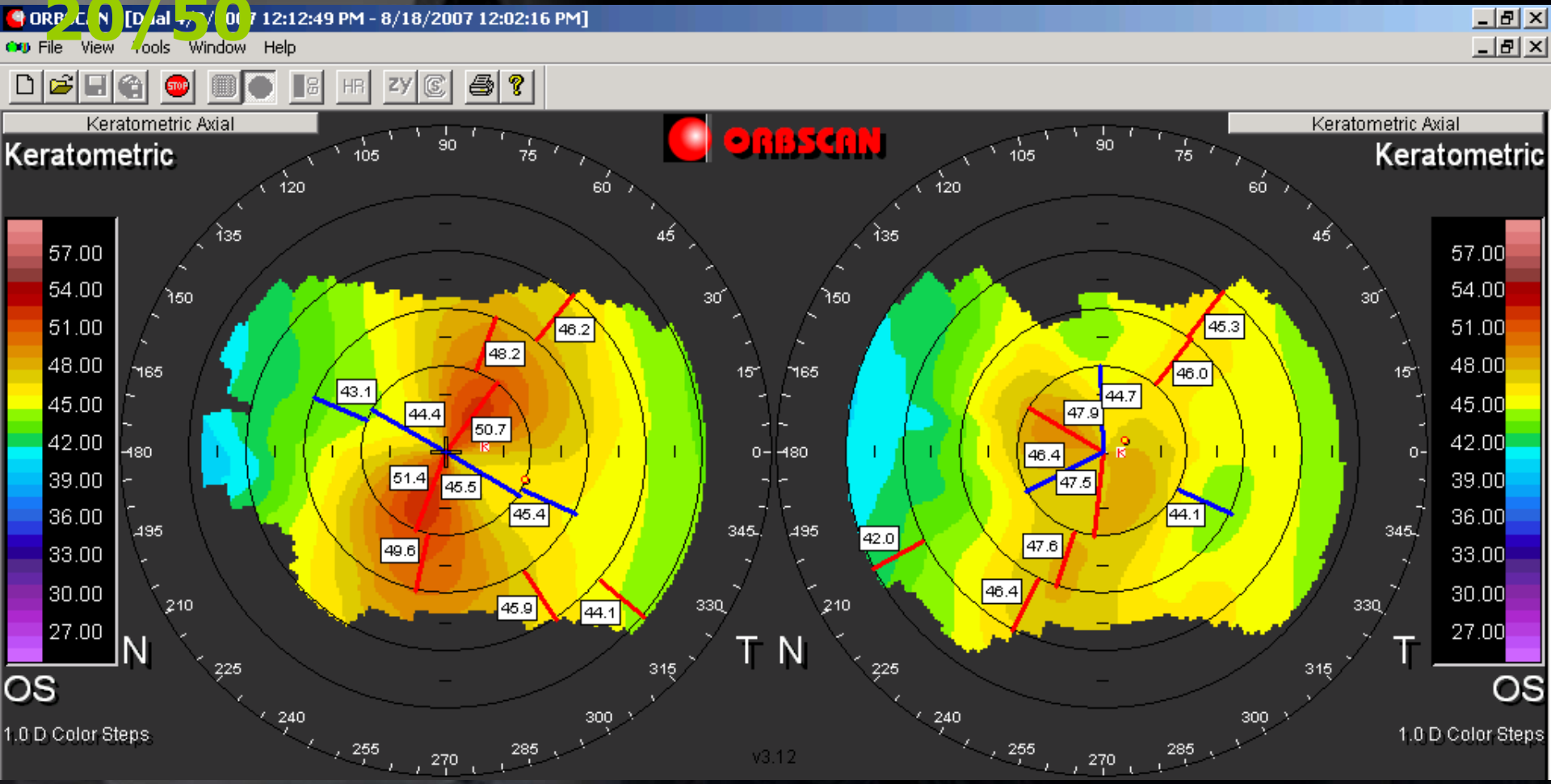






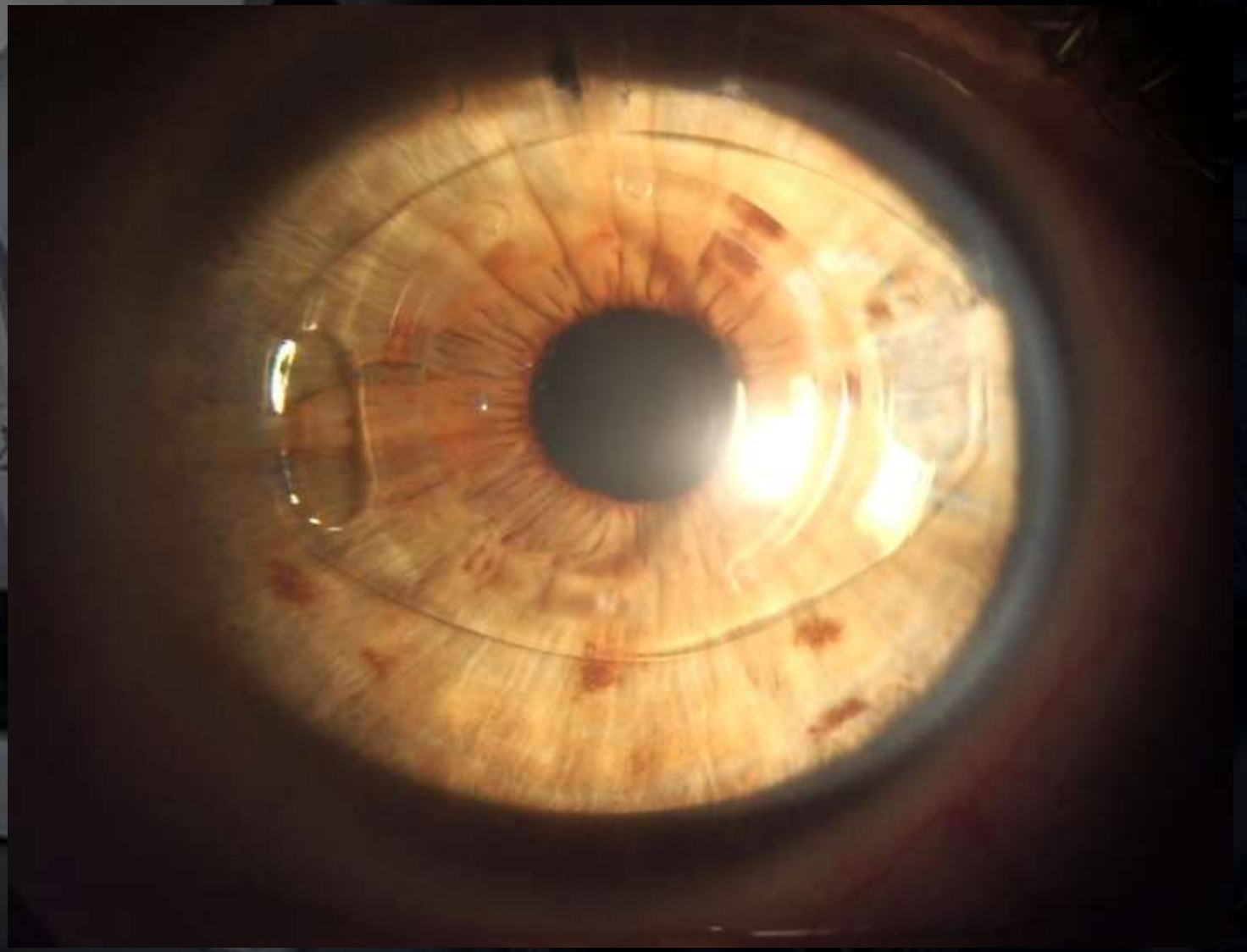


Plano -7.50 X 145° =
20/50



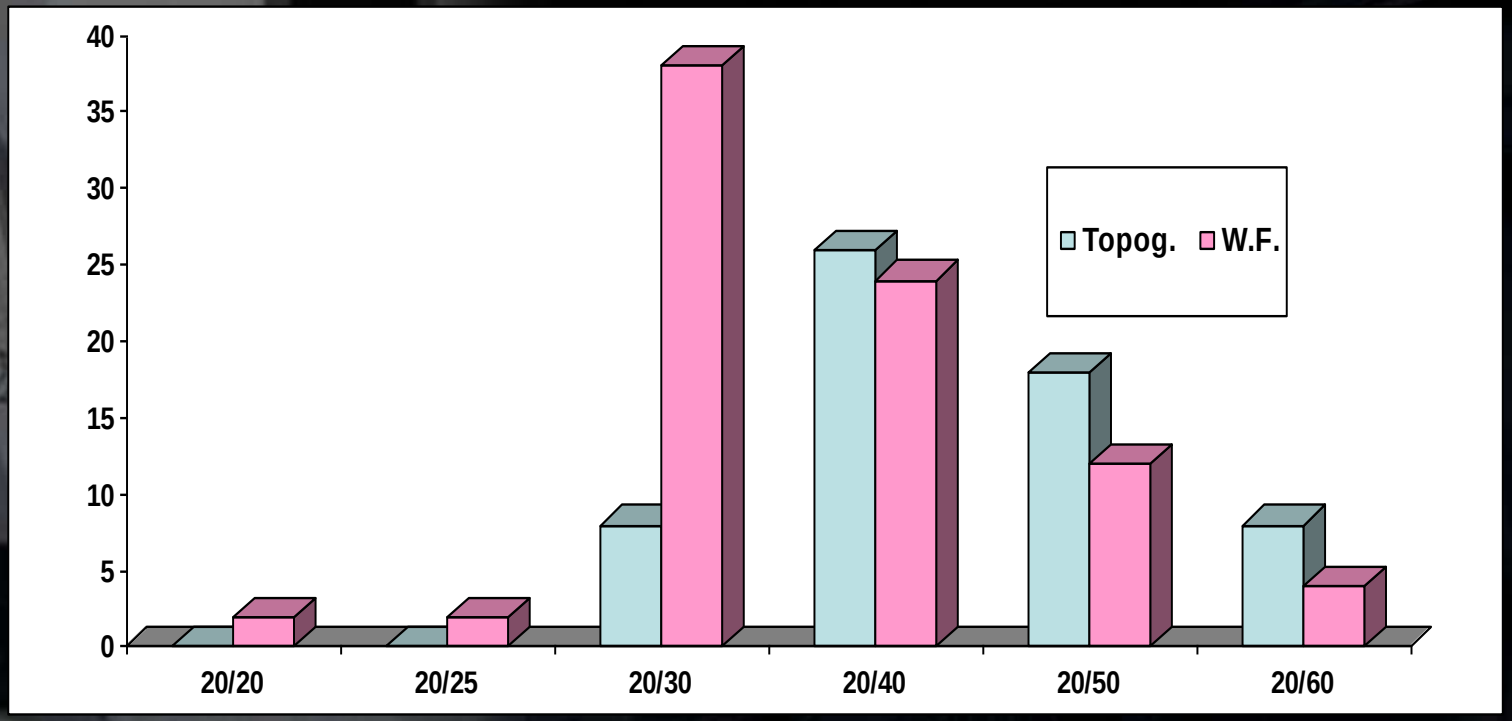
+0.50/-1.00 X 65° = 20/25

Keraring con Lente Fáquica



Safety Analysis. BCVA

N: 24



P > 0.02

Safety Analysis
BCVA Gained/Lost

N: 24



P> 0.04

Conclusión:

Los problemas ectásicos de la cornea, Queratocono, Degeneración Pelucida o Ectasia Post-LASIK, tienen un pronóstico mejor con la llegada del Crosslinking y los Segmetos Intraestromales.