

# SCTK

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# What is PTK?

- PTK was introduced in 1990
- Treatment that uses the excimer laser to correct opacity or irregularity of the corneal surface.
  - corneal dystrophies family,
  - recurrent epithelial erosions,
  - superficial opacity (trauma or infectious events).

# What is PTK?

The indications for PTK have expanded steadily over the years.

- Improvement of clinical knowledge on the results of corneal refractive surgery
- The use of a modern fluid form<sup>1</sup>
- The technical advances of the excimer laser
- The application of wavefront in refractive surgery

<sup>1</sup> *Vinciguerra P, Inv Ophthalmol Vis Sci, 1994.*

# What is PTK?

For its high precision ablation, the excimer laser is the ideal tool to remove the irregularities of the cornea focally

The intraoperative corneal topography and wavefront provide reliable information about the real shape of the stromal surface

1. Ptk custom
2. Ptk transepithelial

# PTK CUSTOM

Personalized treatment on corneal topography. Optimize the ablation profile treating specific areas of the cornea.

- The technique consists in removing the epithelium, most times, mechanically, on the cornea instill a "fluid mask" which has the purpose of exposing to the action of laser corneal only the ridges in relief.
- The excimer laser for each passage reduces the amplitude of these peaks until reaching a homogeneous and smooth corneal surface.

# Technique of transepithelial approach

- Using the epithelium as if it were stroma, and applying custom ablation to the epithelium, makes it possible to focally ablate the stroma and still achieve significant visual improvement.
- This at the cost of only a minimal amount of stromal tissue

# Why ptk?

- Faster functional restoration
- It is a "refractive surgery"
  - No immunological reaction
  - Reduced risks: infection, high astigmatism post-op, greater resistance to injury ...)
- It can be repeated
- Is an attempt to postpone or eliminate corneal transplantation.
- Allows for intraoperative monitoring results
- After PTK with a good surface, the epithelium grows better and more strongly adherent

# Alternative techniques

**DALK** : is indicated when corneal damage are superficial, but not enough to be removed by the action of the laser only.

**PK** : is indicated when corneal damage are deeper or diseases that deform the cornea are in advanced stage.

**Contact lenses** : they can correct the defect created by the modified architecture of the cornea in the early stages but do not solve the opacity of the cornea.

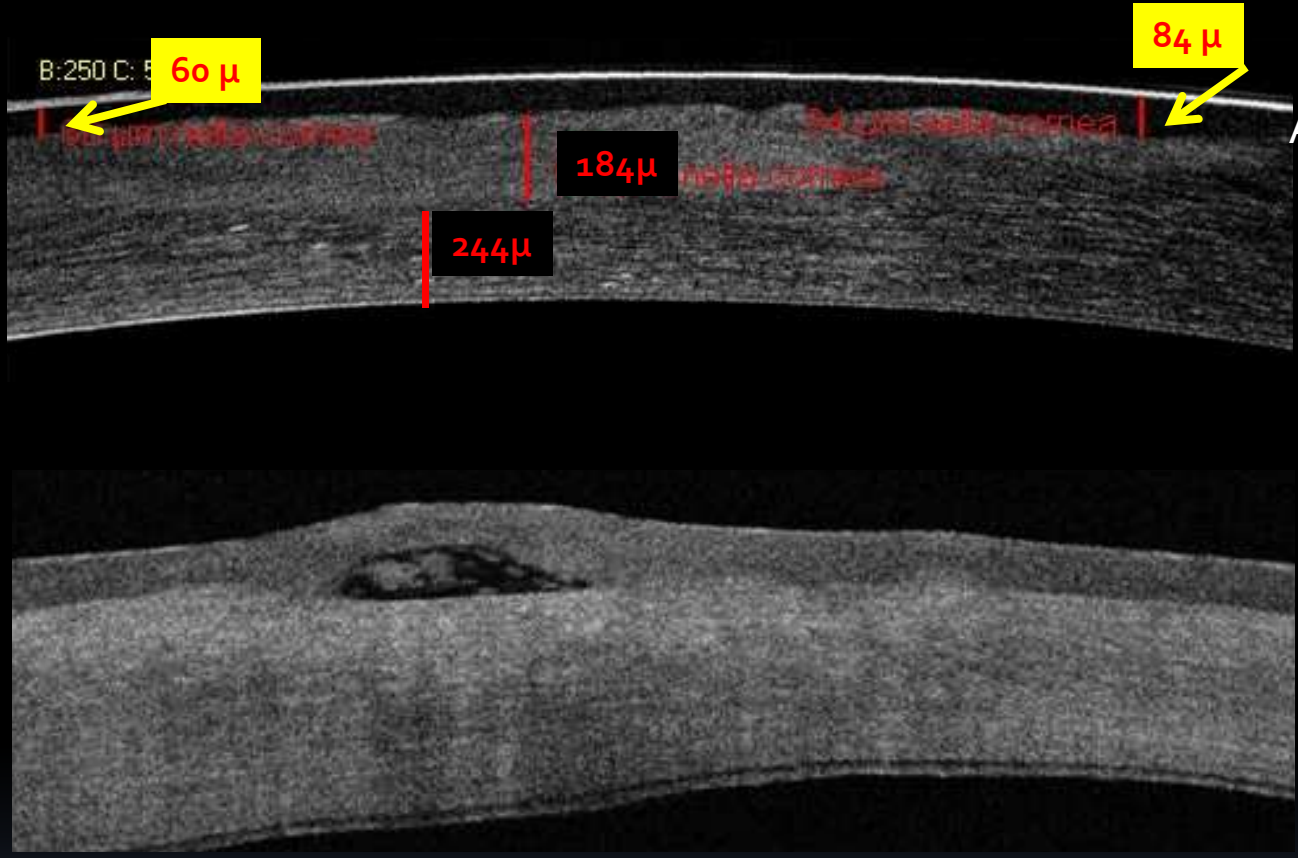


# Indications for PTK

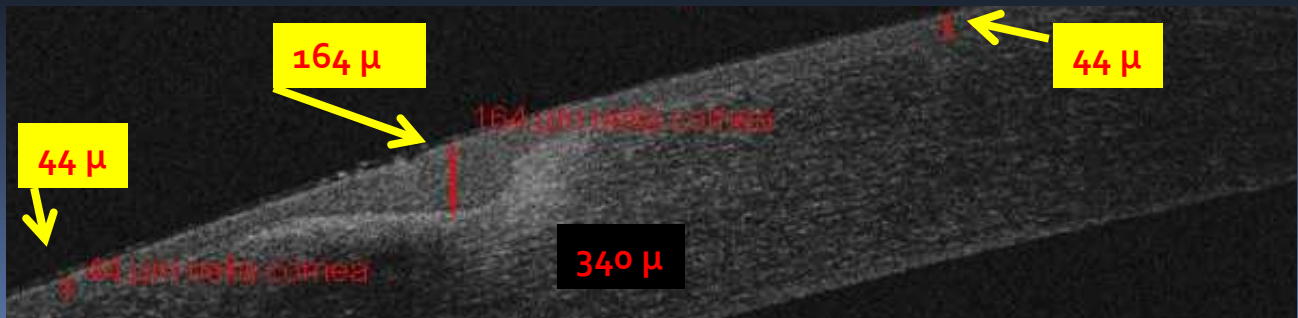
- Superficial stromal dystrophies and degenerations
  - Groenouw, Reis-Bucklers-Keratopathy to bandelletta
- Corneal neovascularization in iperplasiae epithelium
  - The restoration of normal stromal regularity will lead to a normal epithelium with physiological metabolic demand which does not induce the growth of new vessels
- Significant alterations in keratometry
- Topographic astigmatism irregular
- Corneal opacity of 50% surface: OCT SA
- Leucomas or irregularities in trauma, infection.
- Outcomes of refractive surgery

Ptk  
OK

Hyperplasia



After herpetic keratitis



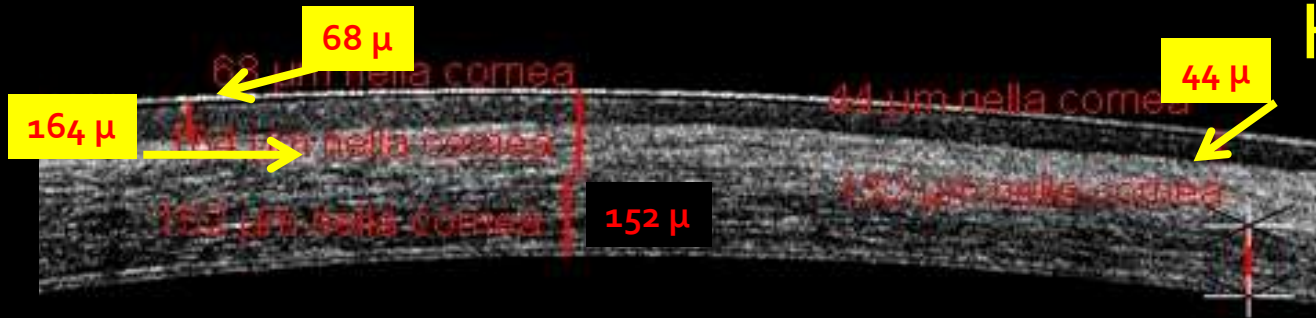
Foreign body

# Exclusion Criteria

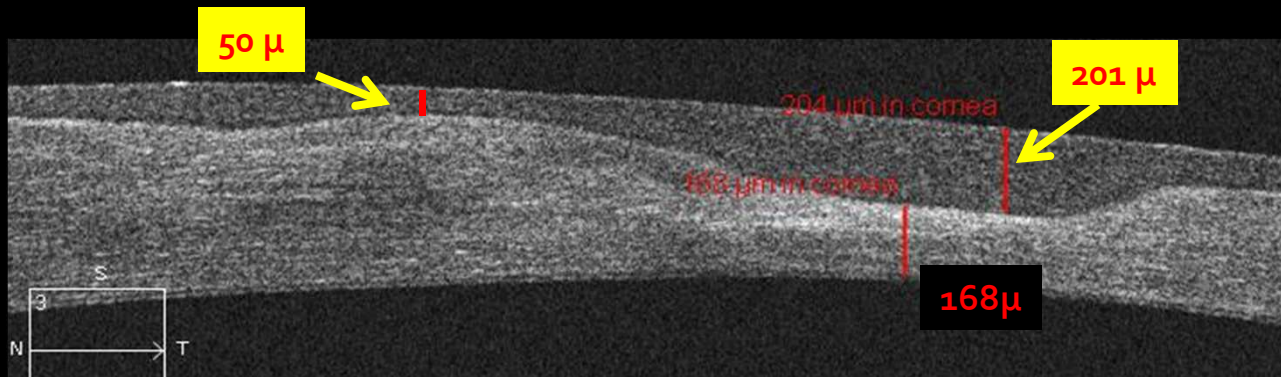
- Corneal
  - Insufficient corneal thickness
  - Ectasia (pellucid degeneration, Mooren's ulcer, Terrien degeneration)
  - Endothelial count reduced
  - keratitis active
- Ocular
  - Increased intraocular pressure
  - ipolacrimia
  - Stem cell deficit (combined treatment)

NO  
Ptk

# Hyperplasia



After herpetic keratitis



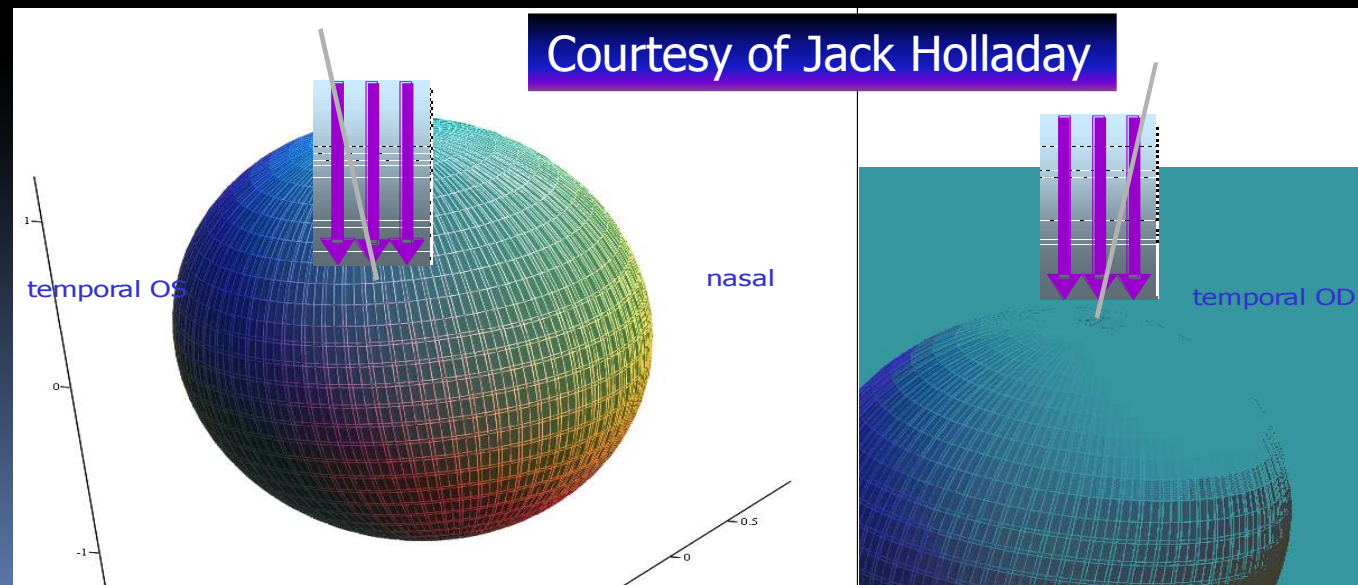
After herpetic keratitis



After clamidya

# “Radial Energy Compensation”

- Differences between Intended vs. Achieved Ablation
  - There is no ‘one size fits all’ compensation matrix
  - Radial energy fall off is not symmetrical
  - Needs to be different for OD and OS
  - Needs to be different for steep and flat eyes



# PTK: One-Step?

The stabilization of the cornea after PTK can take months

The regularization of the corneal curvature can:

- ✧ Changing the thickness of the epithelium
- ✧ Reduce the deposition of collagen in the postoperative period
- ✧ Prevent recurrence of haze

If corneal thickness is adequate and sufficient, a second treatment, 7-8 months later, it can improve the results

# The absolute thickness is not always' a limit!

PTK on corneas with a minimum thickness of 200 microns are stable even today after years

- pachymetry map
- topographic map

Containment of biomechanical response

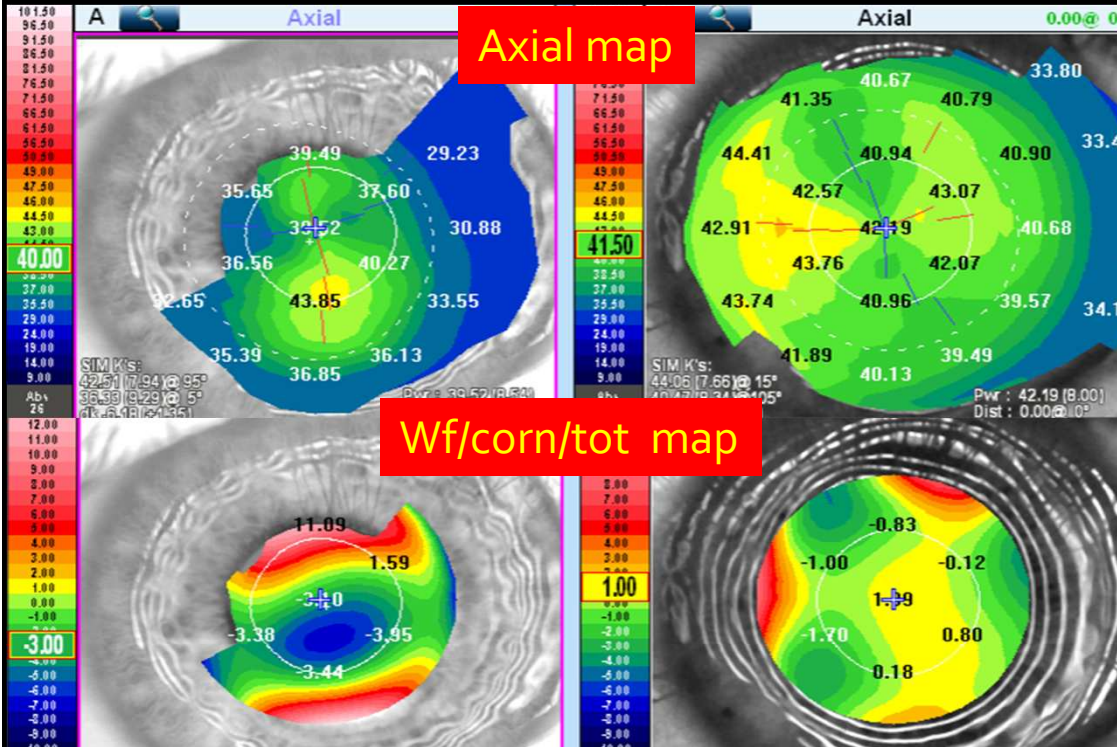
Ptk induces less risk of ectasia in surface treatments than intrastromal (LASIK)

OSV 0,4 -4,00(-5,00)125

OSV 0,8 -7,25(-2,00)80

# Thin PTK (su PK)

Case 1

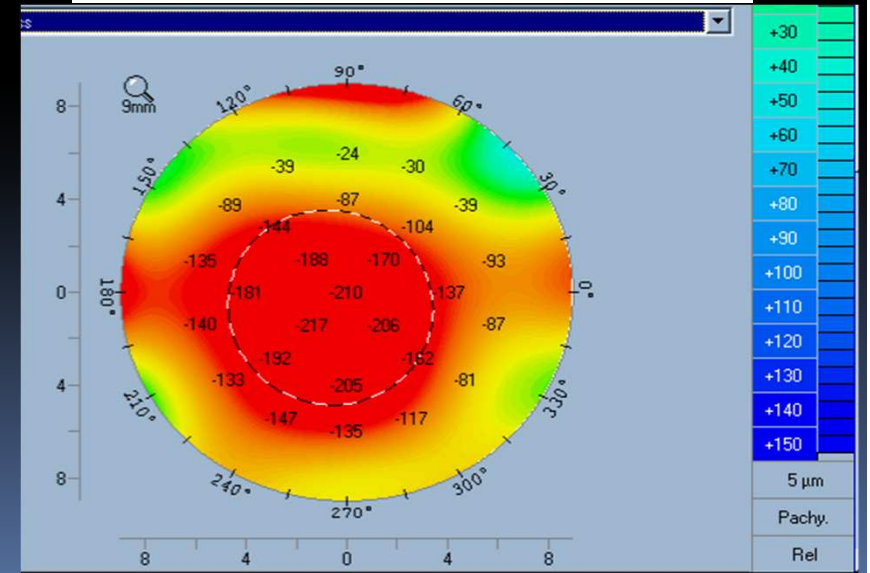
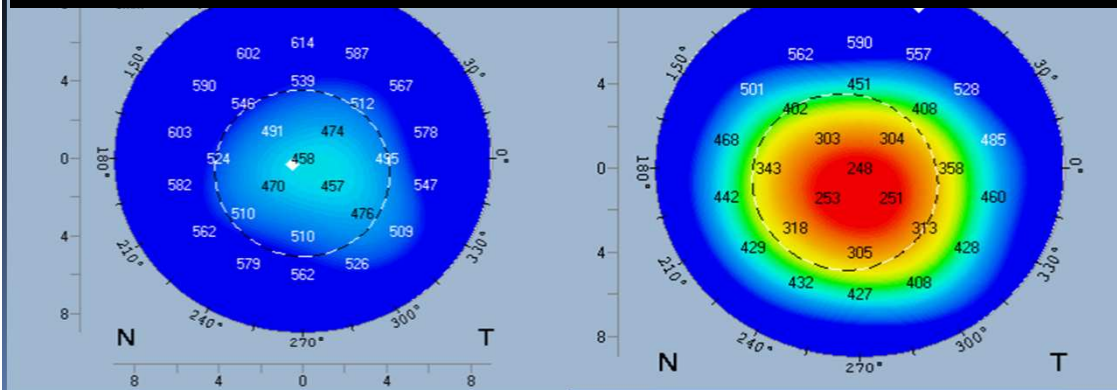


Wf/corn/tot map

Differential pachymetry map  
- 210  $\mu$

Pre:  
Thinnest point 458 $\mu$

Post:  
Thinnest point 248 $\mu$

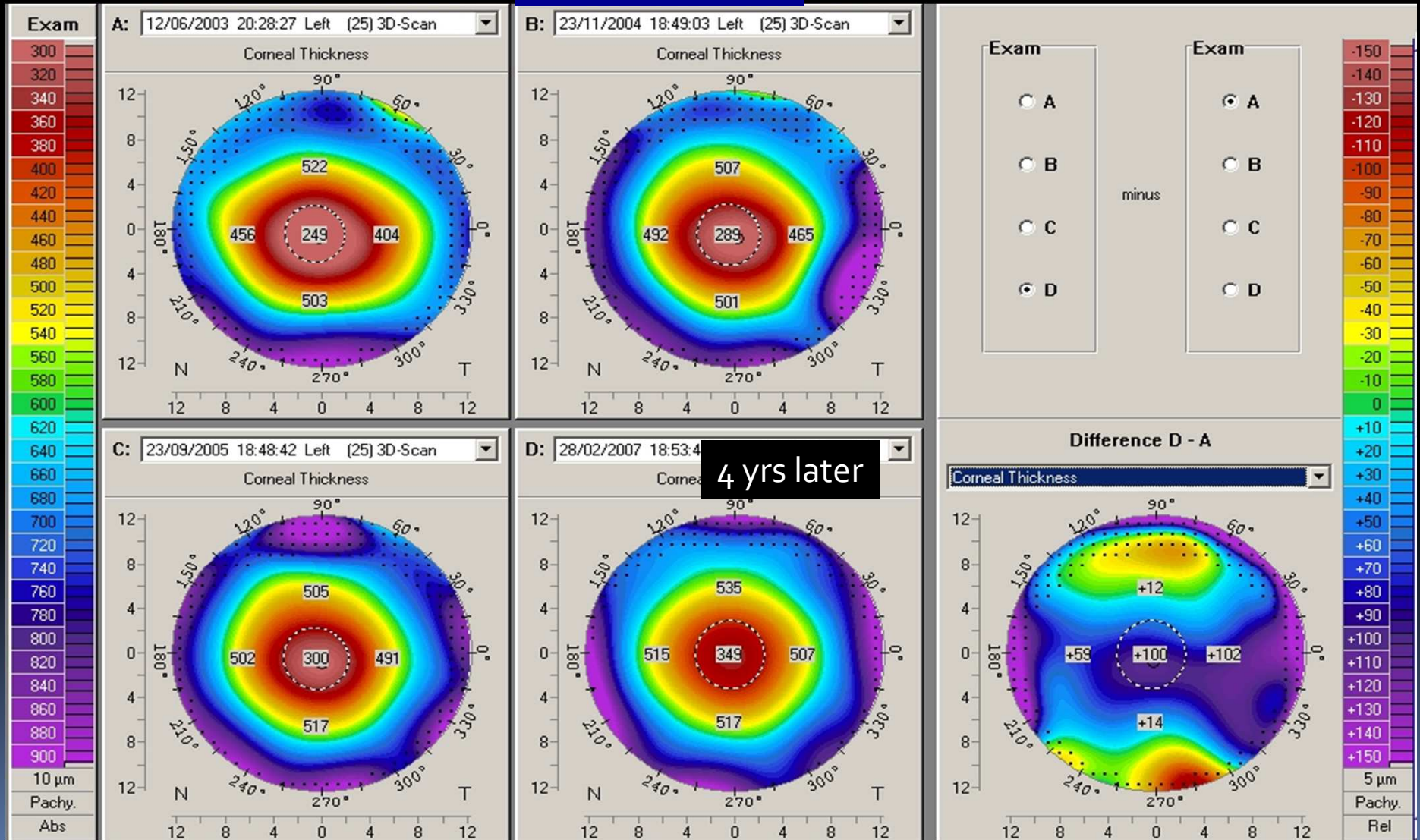




# Case 2

## Ptk on lasik : The risk of ectasia in thin post surface custom corneas is high

### Pachymetry map



# Important

- Multistep approach
- **Ablated with caution!** it is easy to treat too!
- A treatment too excessive, it is difficult to correct
- Do not be intimidated from making many topographies intraoperative
- **The Ptk is an extremely potent technique**

# What is required and how to proceed

## Measurements:

- Preoperative
- Intraoperative
- post-operative

# The preoperative measurements

- Always evaluate topographically and by Scheimpflug
- The preoperative topography, is not always reliable
- Without epithelium there may be surprises.
- Unexpected events are the frequent
- The keratotomy is very important. if there are irregularities evaluate LAF
- The pachymetry map is fundamental
- OCT sa

- Notify the patient of the need for intermediate checks.
- The cooperation of the patient, during surgery, it is essential for achieving the optimal result.

# The intraoperative measurements

- Prefer instruments with easy editing
- Essential is a laser with integrated OCT
- Masking fluid to restore the tear film continuous
- Acquisition only when the film is intact and laminate
- Sometimes assistance is required (small eyes, cooperative patients, induced mydriasis)
- The examination of the LAF is useful after removal of the epithelium

# What to look topographically?

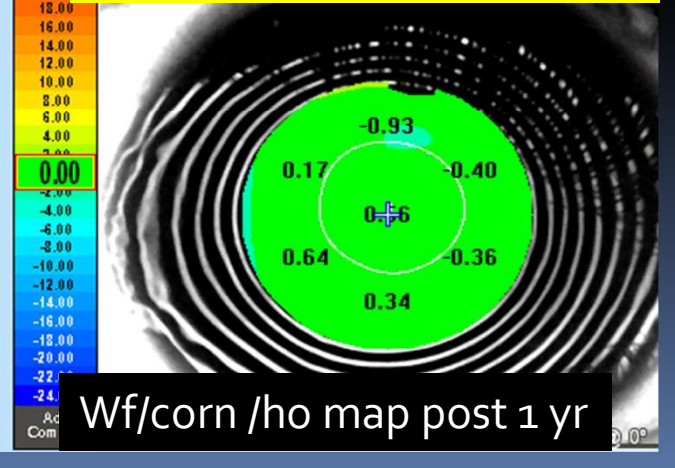
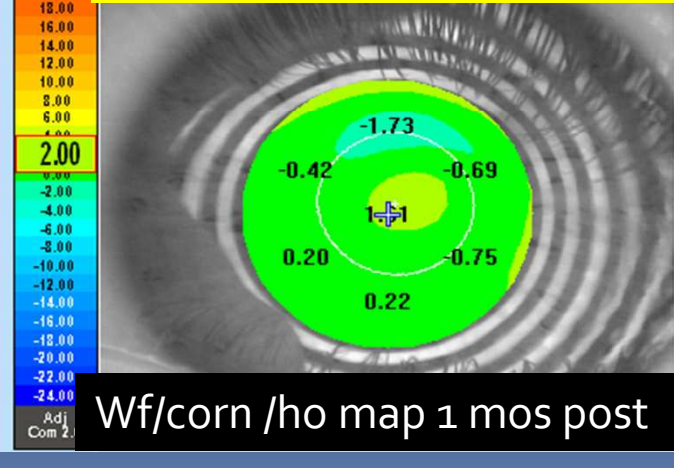
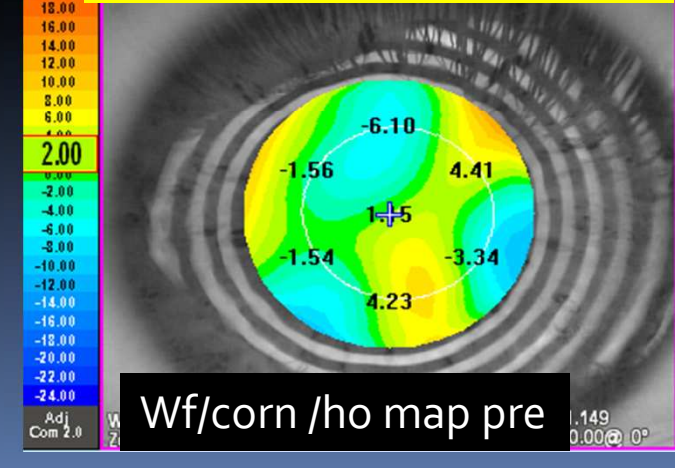
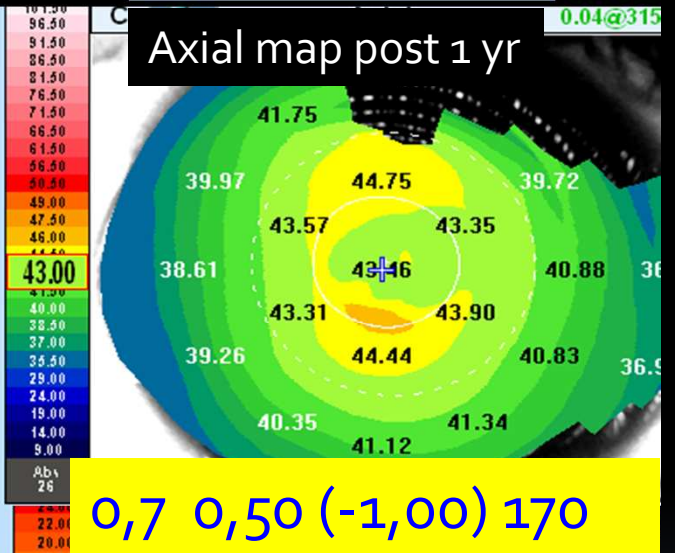
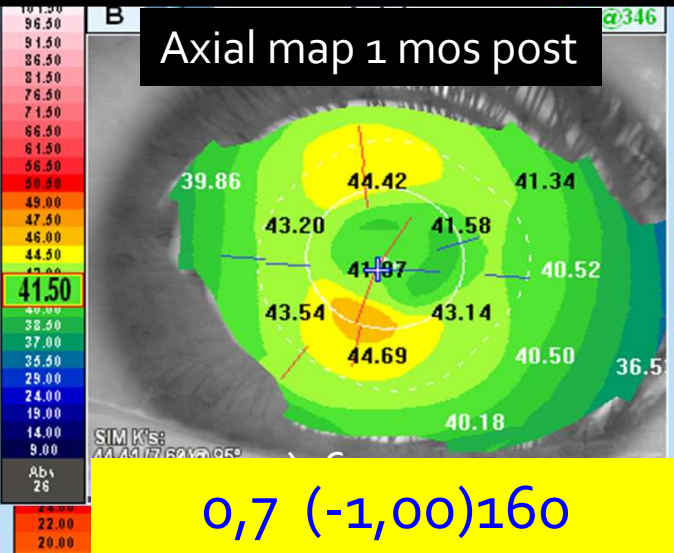
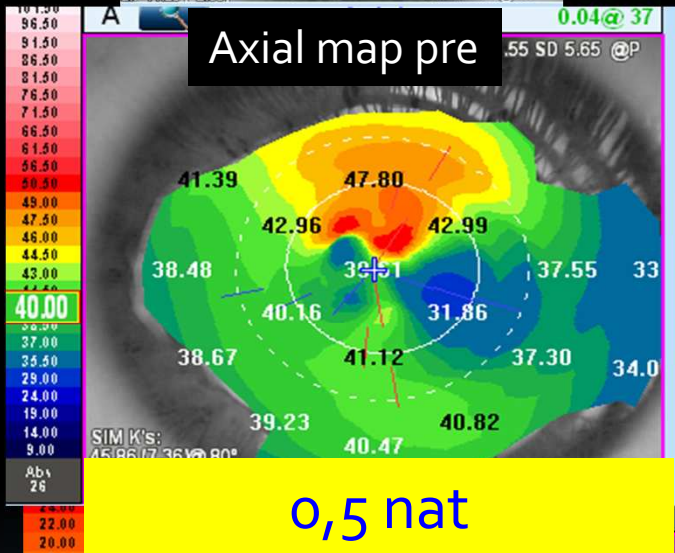
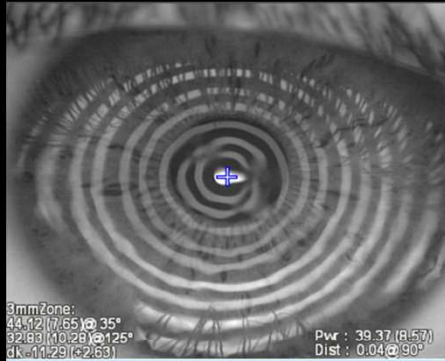
- Thinnest point and asymmetry
  - in the early stages to avoid accidental perforations;
  - during the intermediate and final stages, pachymetry may be distorted for edema intraoperative
- Curvature
- Elevation (microns)
- Curvature Gradient :
  - Two areas adjacent to different curvature create a high gradient
  - The treatment of a decreases also the other; attention to over-corrections
- Proceed gradually

# Opacity vs Irregularity:

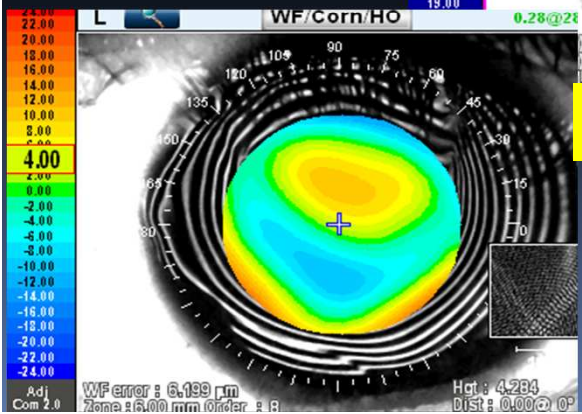
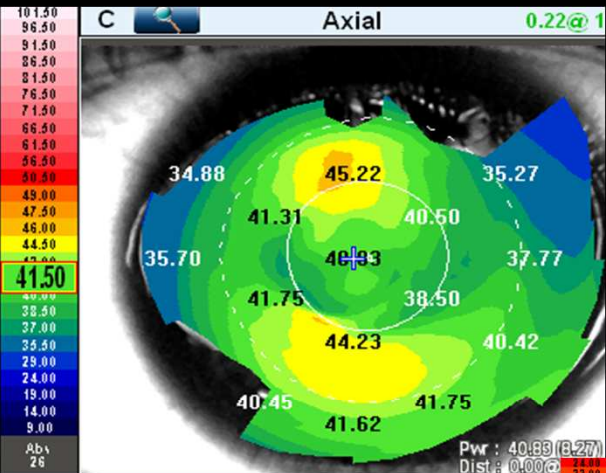
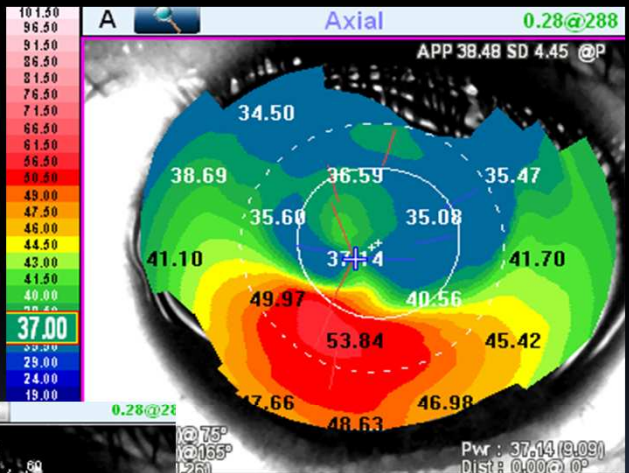
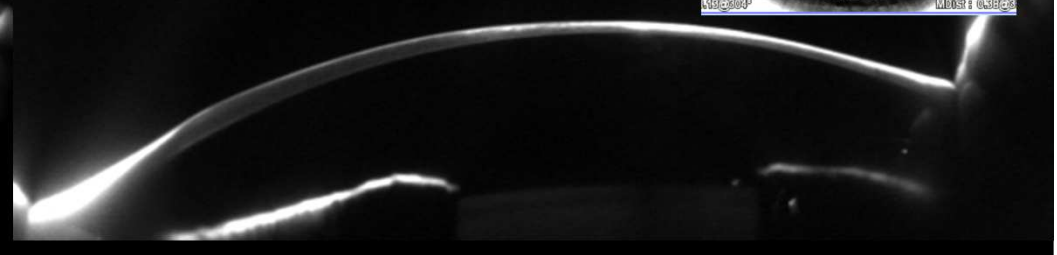
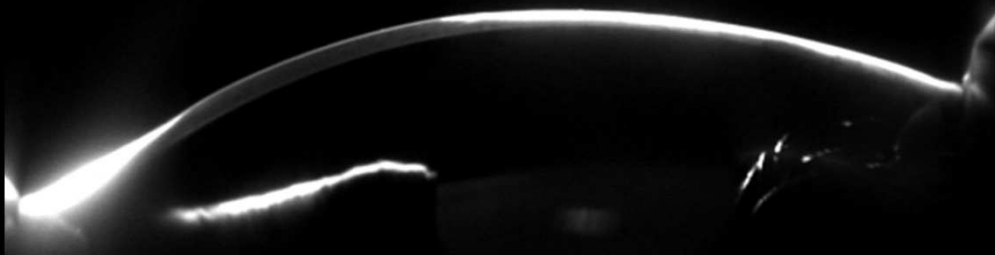
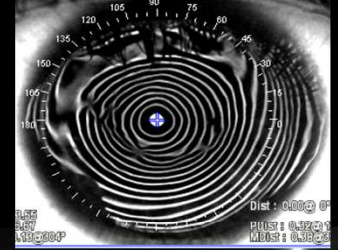
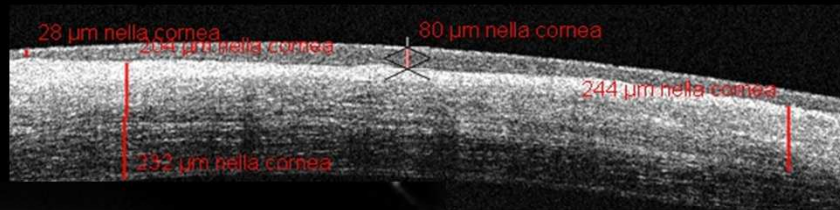
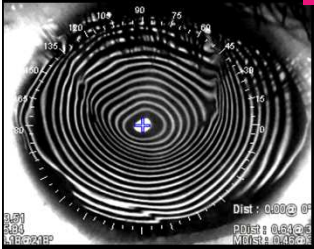
- An opacity is often compatible with good visual acuity, a slight irregularity not!
- When the irregularities of surface are removed, the residual opacity is reduced over time



CASE 1: remain small irregularities

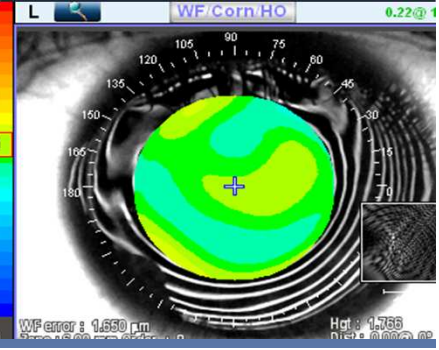


# CASE 2: opacity remains with good visual acuity (abscess for lac)



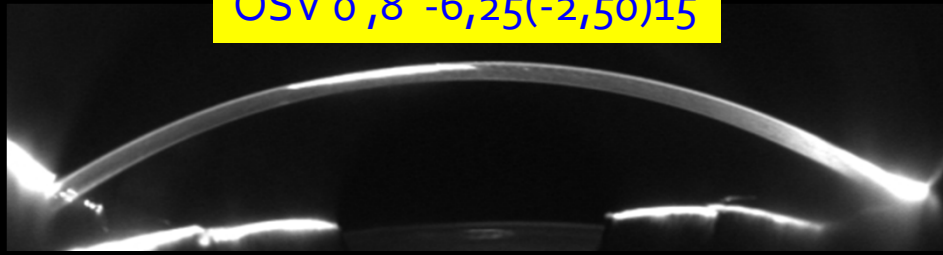
0,3 +1,00 (-8,50)170

0,8 0,75(-5,25)170

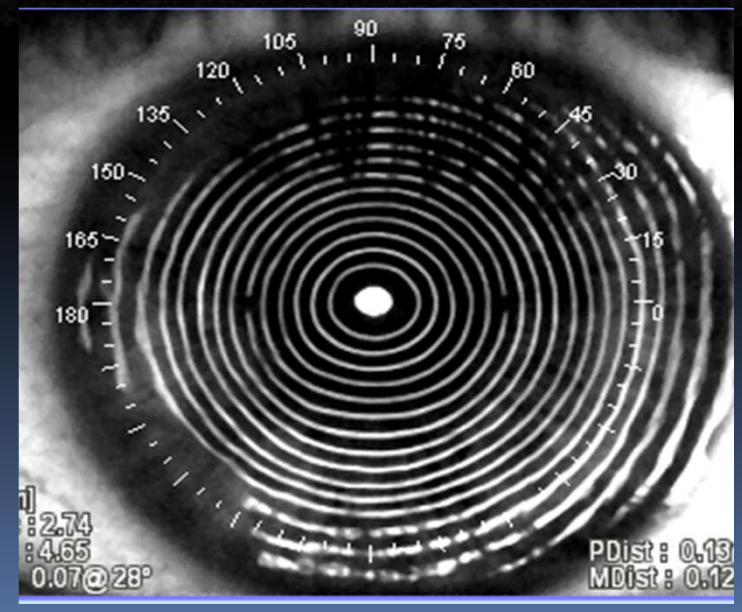
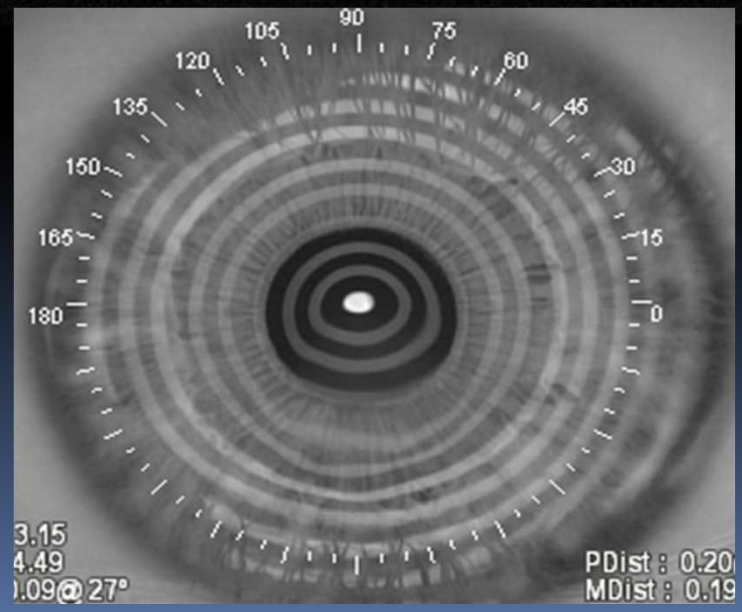
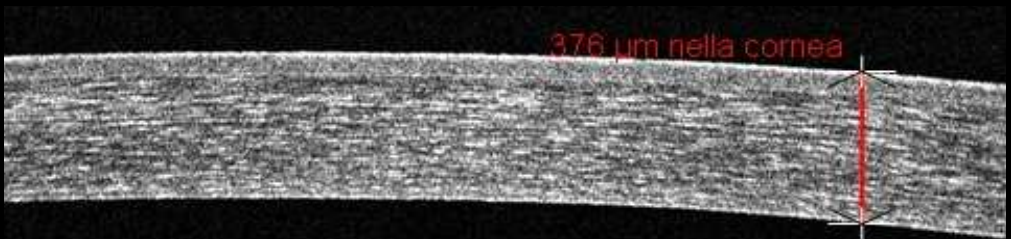
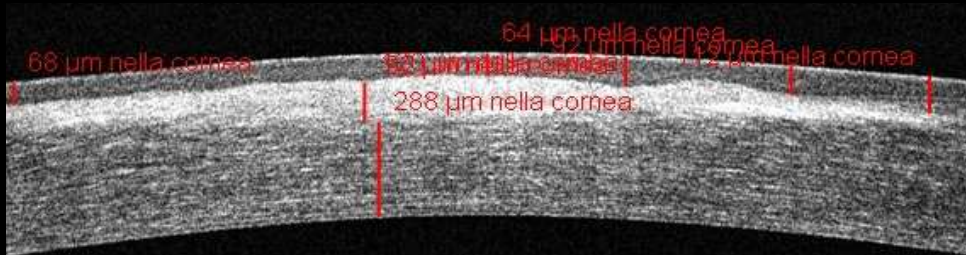
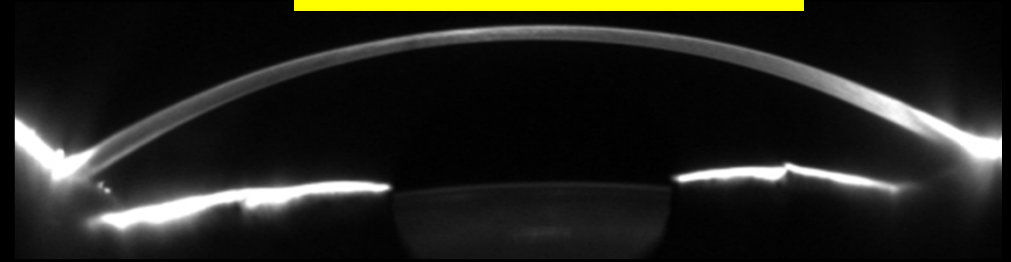


# CASE 3: transparent cornea post ptk

OSV 0,8 -6,25(-2,50)15

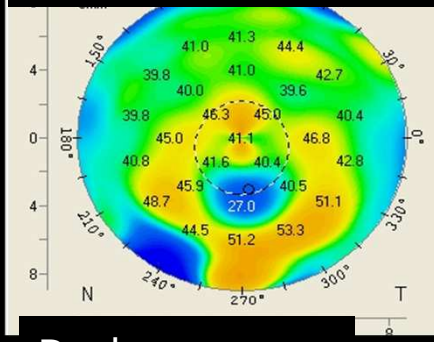


OSV 0,8 0,50(-3,00)180

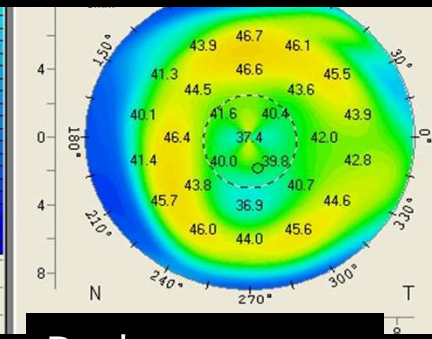


# CASE 3: transparent cornea post ptk

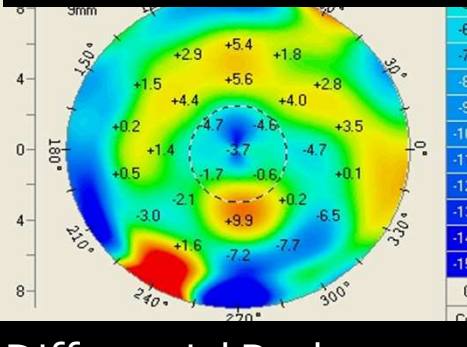
Tangential map pre



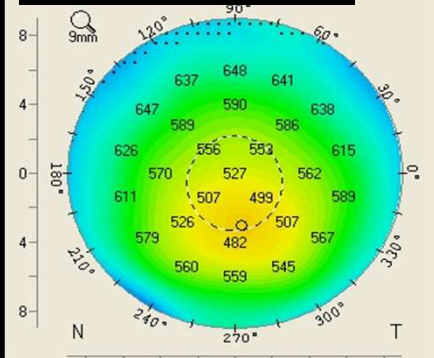
Tangential map post



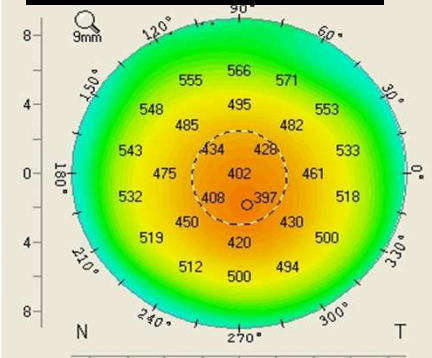
Differential tang map



Pachy map pre

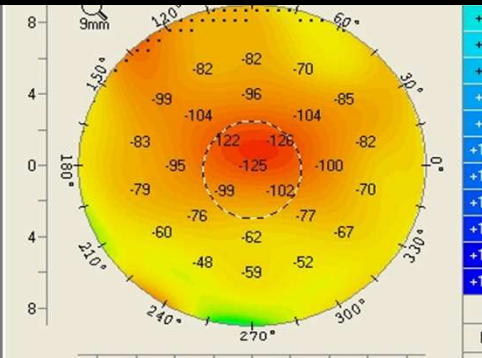


Pachy map post

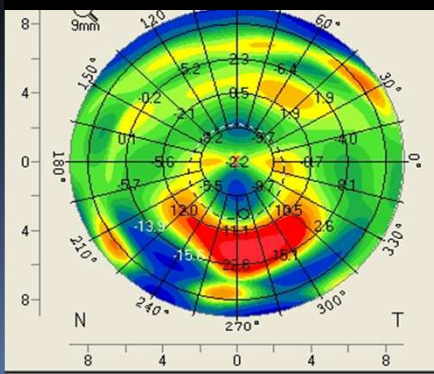


-125 microns

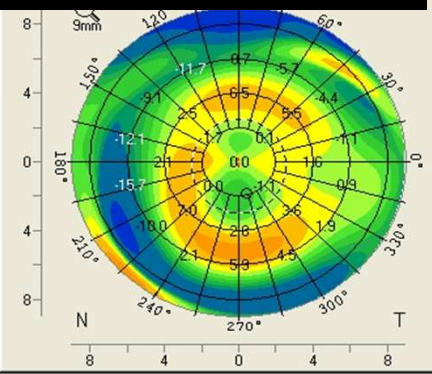
Differential Pachy map



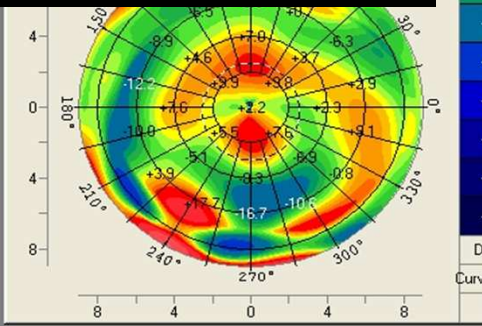
Radial curvature gradient map pre



Radial curvature gradient map post



Differential Radial curvature gradient map



## Transepithelial technique

### Why sequential?

- The final result of single step is unpredictable because of biomechanical response.
- This leads HOA
  - 1) Treat HOA,
  - 2) treat 80% cyl
  - 3) If the corneal thickness is sufficient treat the spherical correction
- Differ from ambitious programs!

# Technique of transepithelial approach

- **Step 1**
  - Custom ablation of the corneal surface ( Epithelium and stroma)
- **Step 2**
  - Dry ablation of 60 micron of tissue with an even 10 mm diameter zone
- **Step 3**
  - Smoothing with masking fluid and intraop topography
- **Step 4**
  - Custom refinement if needed
- **Step 5**
  - Repeat if needed steps 3,4

# Technique of transepithelial

- In combination with corneal wavefront it can be used to treat haze, scarred corneal tissue, and keratoconus before corneal collagen crosslinking
- It is useful in all cases where a difficult epithelial flap is expected or when the epithelium covers corneal irregularities of the stromal tissue.
- Using Transepithelial ablation profiles shortens the overall treatment time, minimises the risk of dehydration, and speeds up the healing process.

# How to decide when to stop?

- Residual thickness (homogeneous)
- keratoscopy
- intraoperative visual acuity



# HOW TO PLAN TREATMENT..

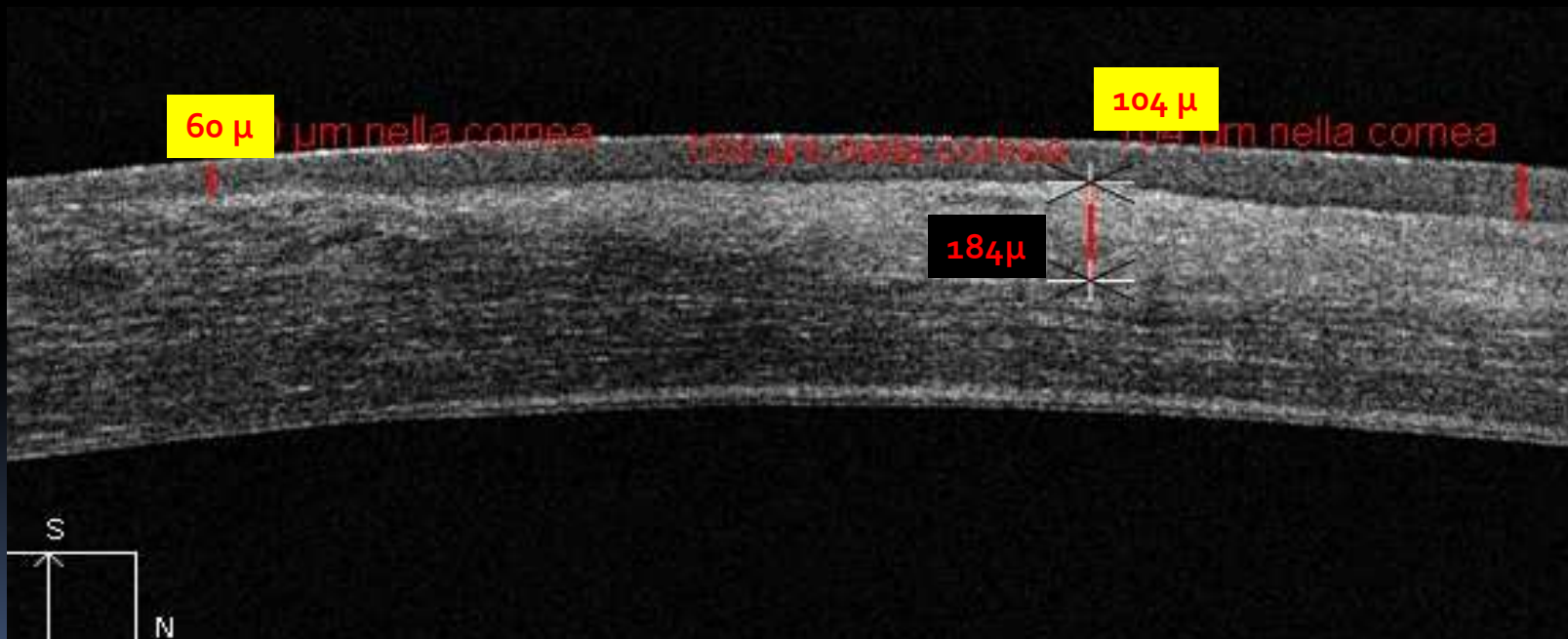
# 1° CASE

What should we have to look for in pre-op?

## Case A

26 yrs old

- Acanthamoeba keratitis in 2009 for abuse of LAC
- Sudden drop in visual acuity
- ODV +1,00 (-7,00) 65



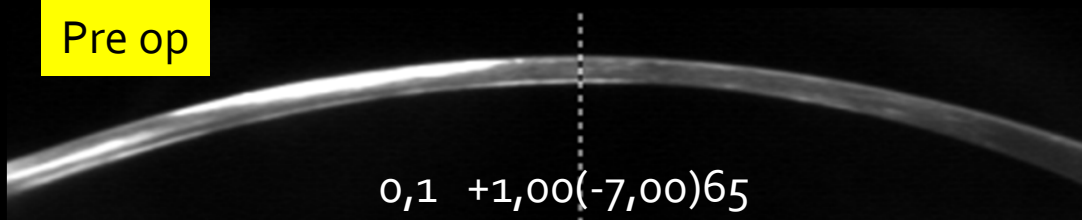


# What should we look to in pre-op?

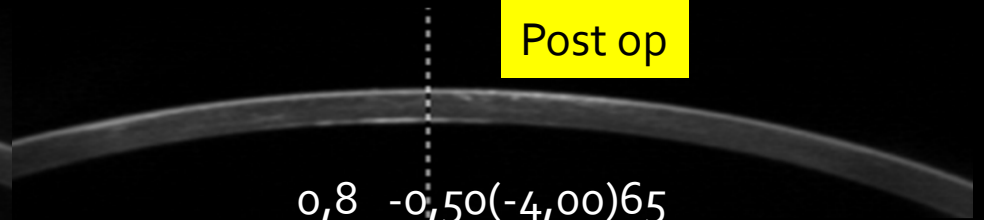
Perform Scheimpflug tomography looking at:

- Thinnest point value
- Pachymetry where the maximum ablation is planned ( consider a safety limit of 300/350 micron residual stromal bed)

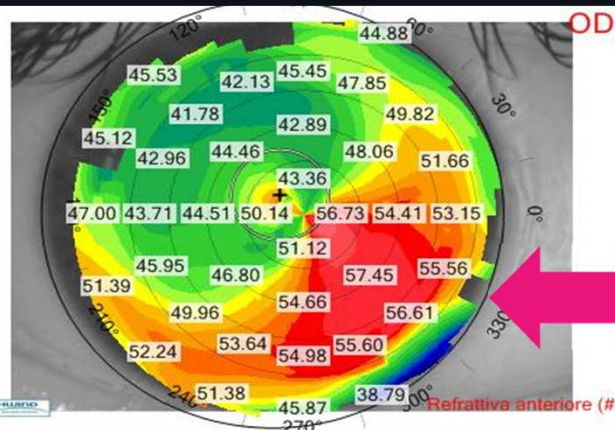
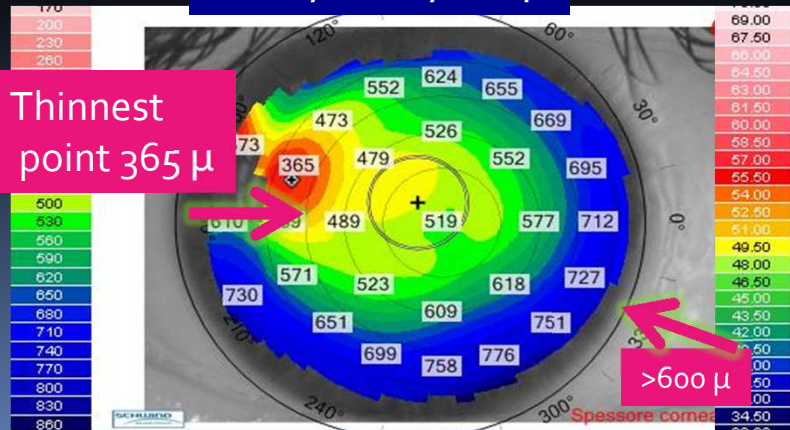
Pre op



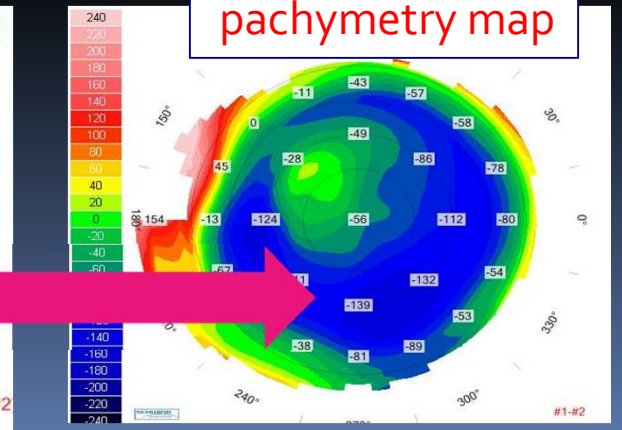
Post op



Pachymetry map



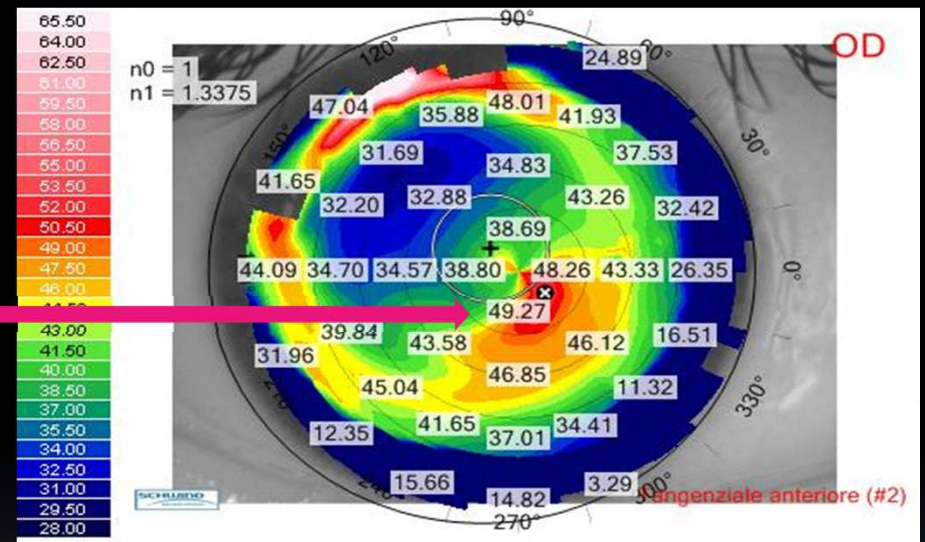
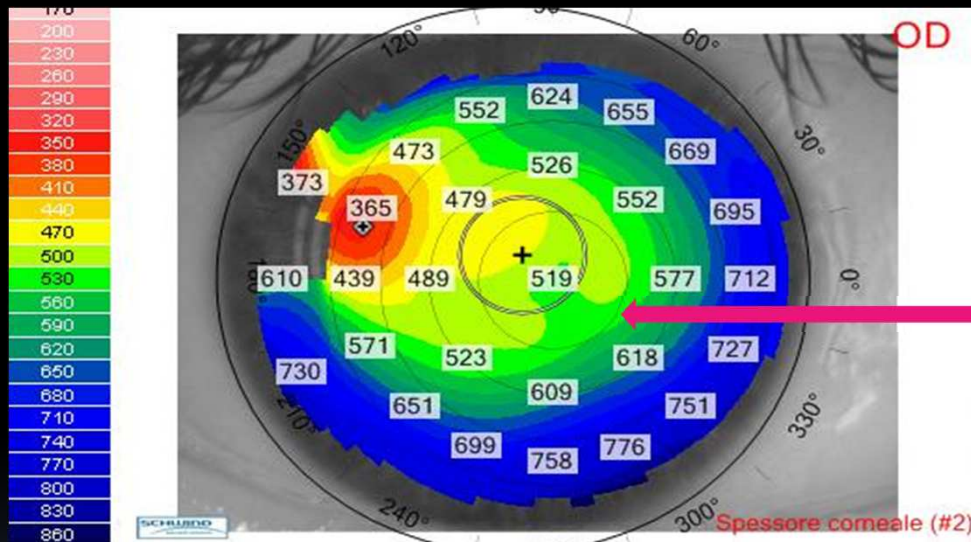
Differential pachymetry map



# Busting myths

- Steep areas are the thinnest

Thinnest point



Steepest point

# What to do in the PTK and retreatment of difficult cases

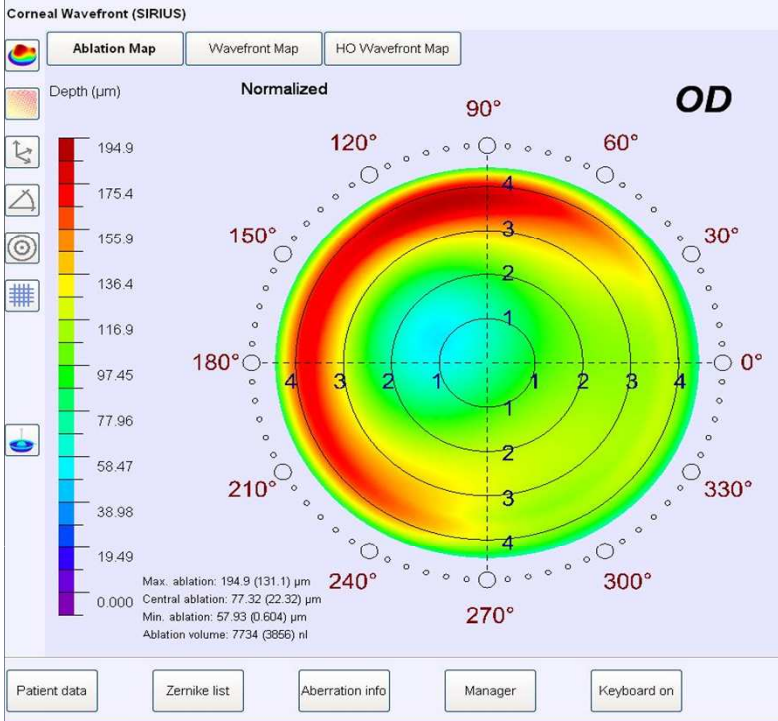
Consider minimize volume more than minimize depth

Min. difference: 7 µm (+3%)  
Max. difference: -105 µm [-54%]  
Volume difference: -1416 nl [-18%]

Min. difference: 9 µm (+4%)  
Max. difference: -86 µm [-44%]  
Volume difference: -1353 nl [-18%]

# What to look in the PTK and retreatment of difficult cases

## Ablation map



Refraction RZ @ 4.00 mm  
 VD (mm): 13.0

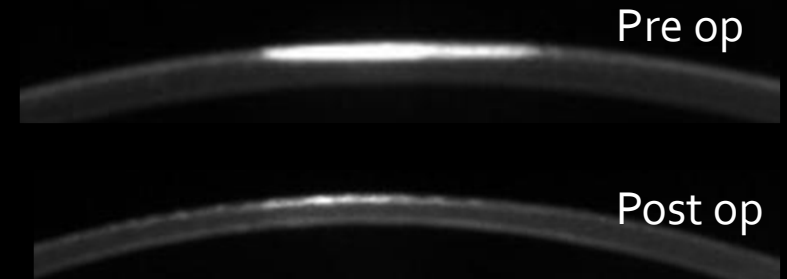
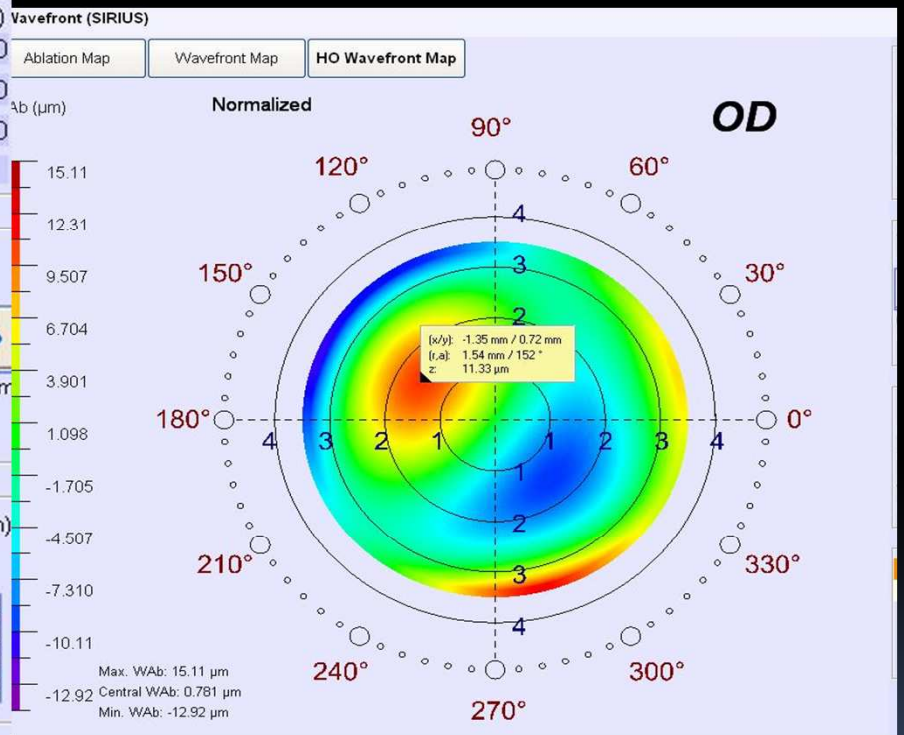
Sph. (D) Cyl. (D) Axis (°)  
 Manifest: +1.00 -6.97 x 60  
 Target: -2.50 0 x 60  
 Laser: +3.29 -6.54 x 60  
 Offset: R: 0.84 mm / Angle: 137 °

Optical zone  
 Total ablation zone: 8.98 mm  
 Selected OZ: 7.00 mm  
 min.: 4.00 mm max.: 7.67 mm  
 Imported Ø: 8.61 mm

RST manager  
 centr. (µm) @ 7.52mm (µm)  
 Pachy: 489 728  
 Epith.thickn.: 0 0  
 Abl. depth: 78 195  
 RST (>250) 411 533

Treatment status  
**Mixed Astigmatism**  
 TransPRK

## HO wavefront Map



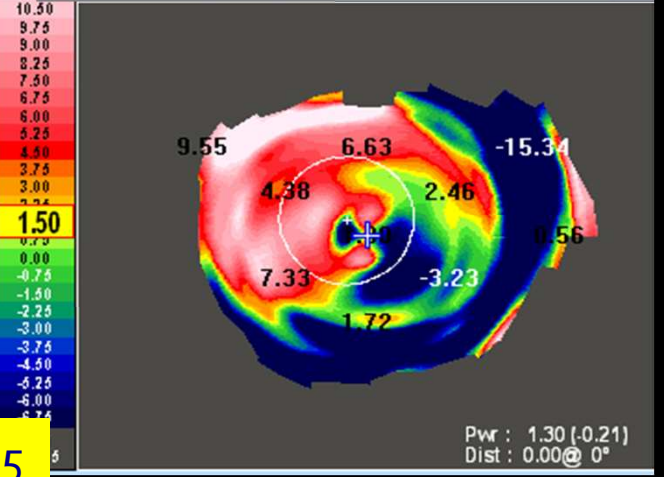
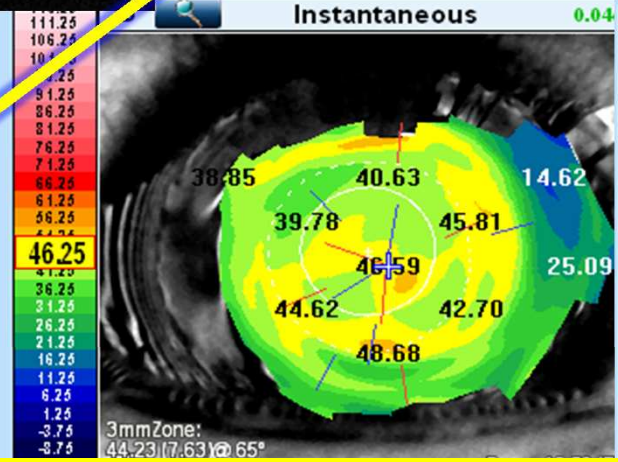
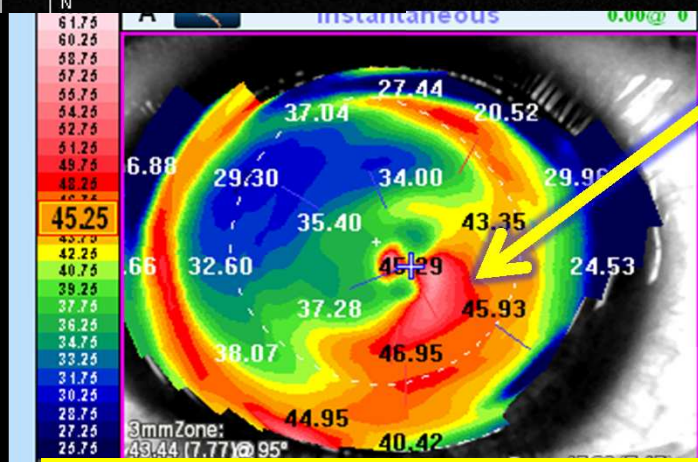
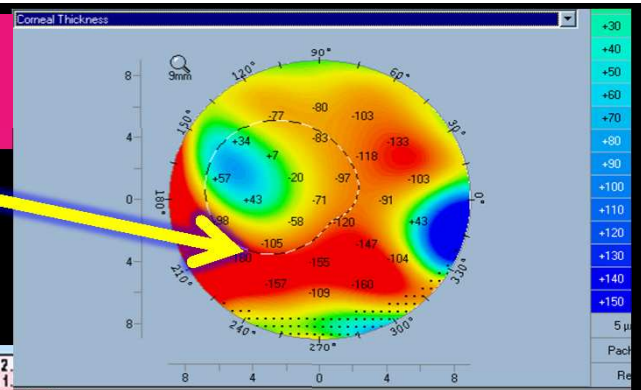
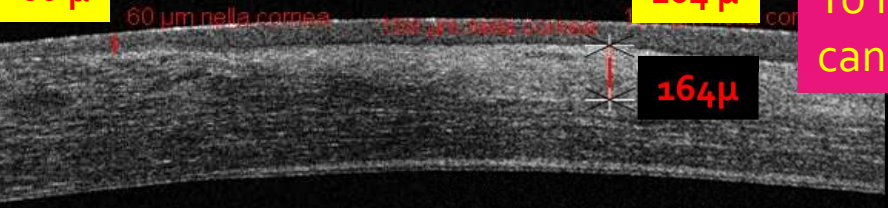


60  $\mu$

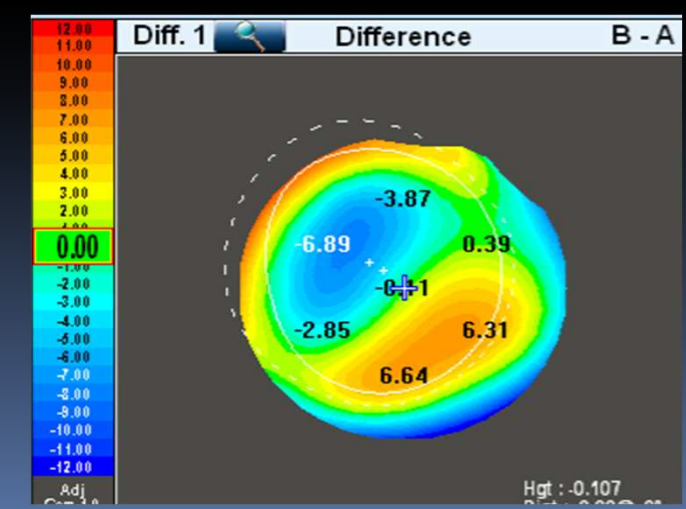
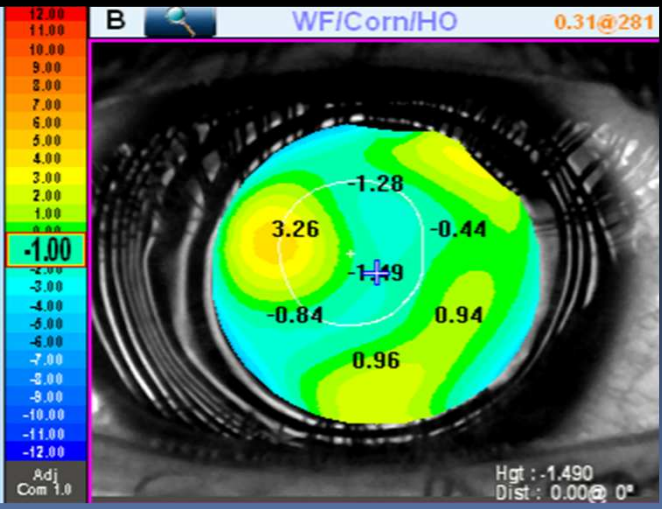
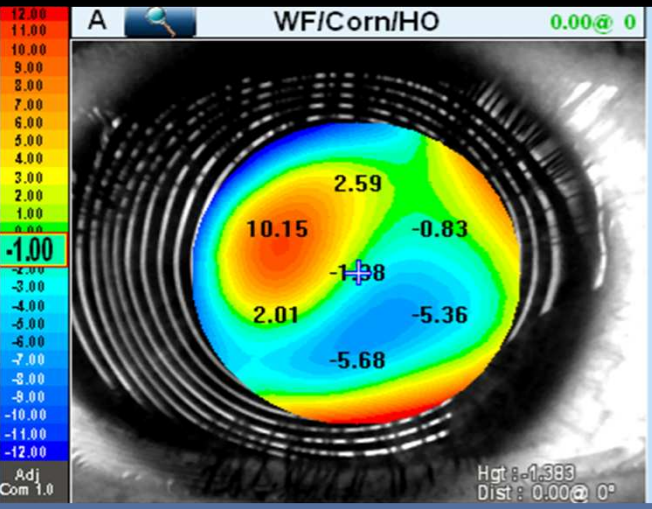
104  $\mu$

164  $\mu$

To regularize a steep spot I can only ablate there



Pre op ODV +1,00 (-7,00) 65      Post op ODV 1,0 -3,75(-0,50) 165

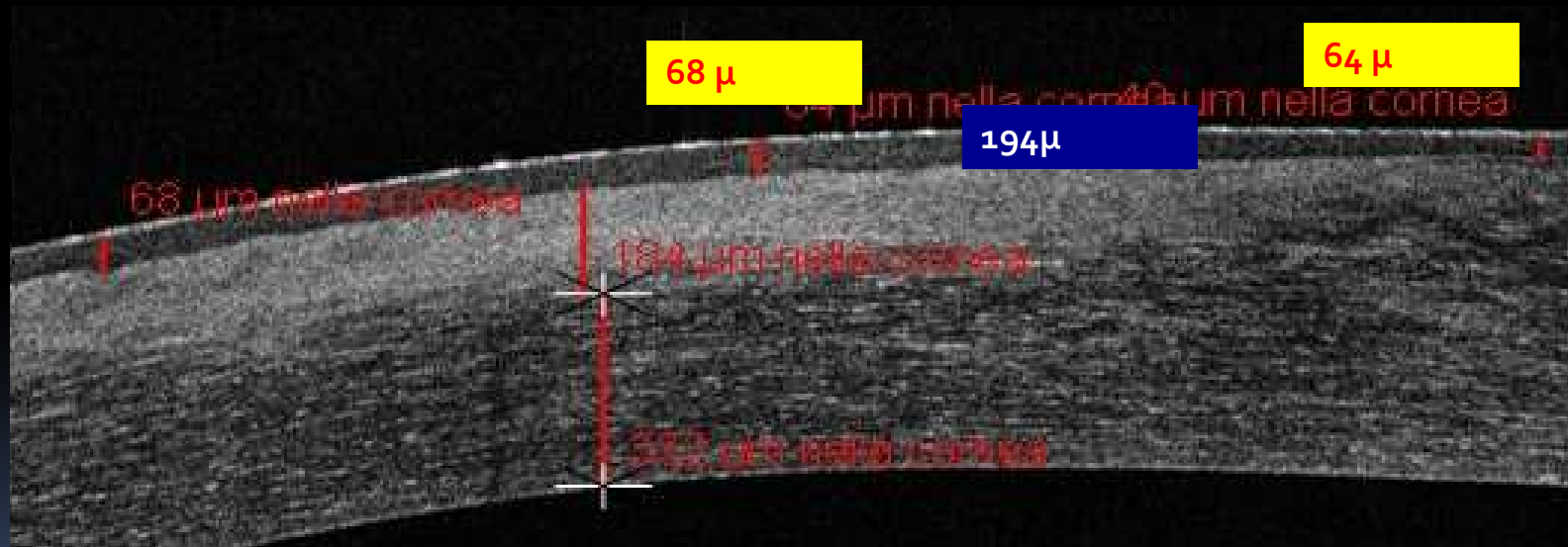




## caso B

66 anni

- Distrofia corneale
- ODV...



# Aims of PTK

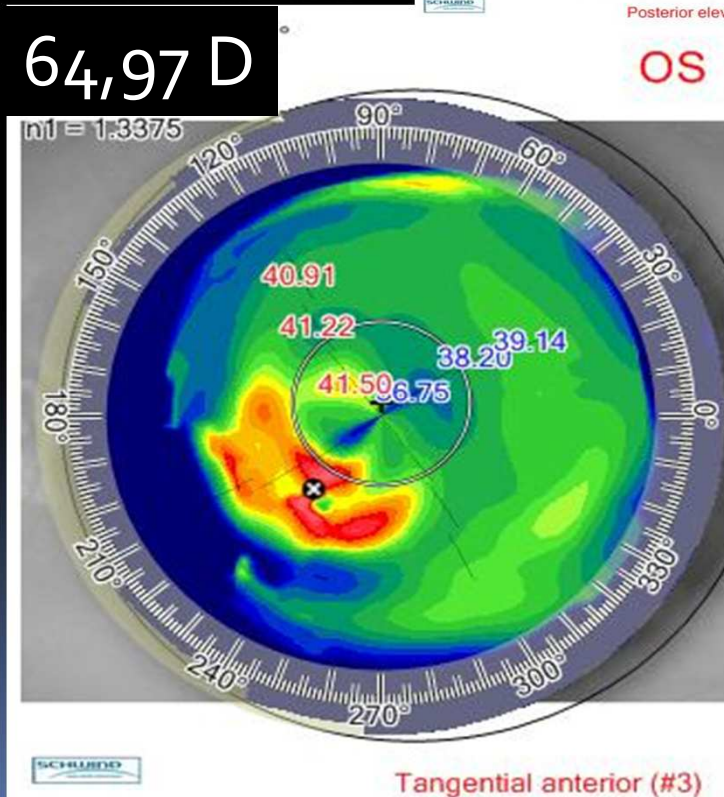
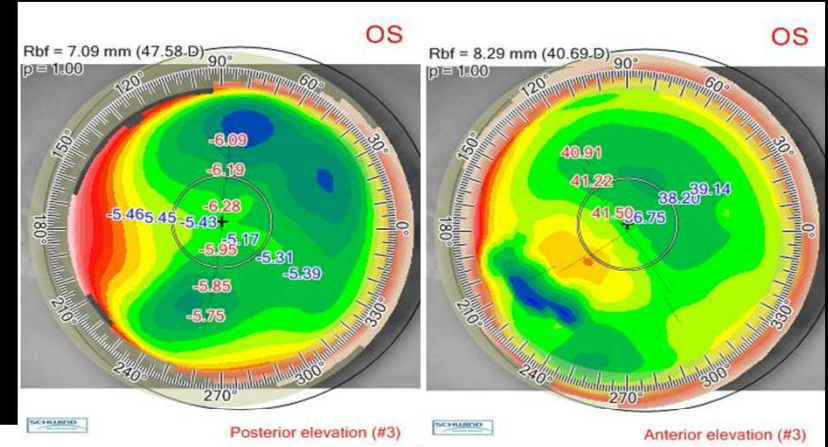
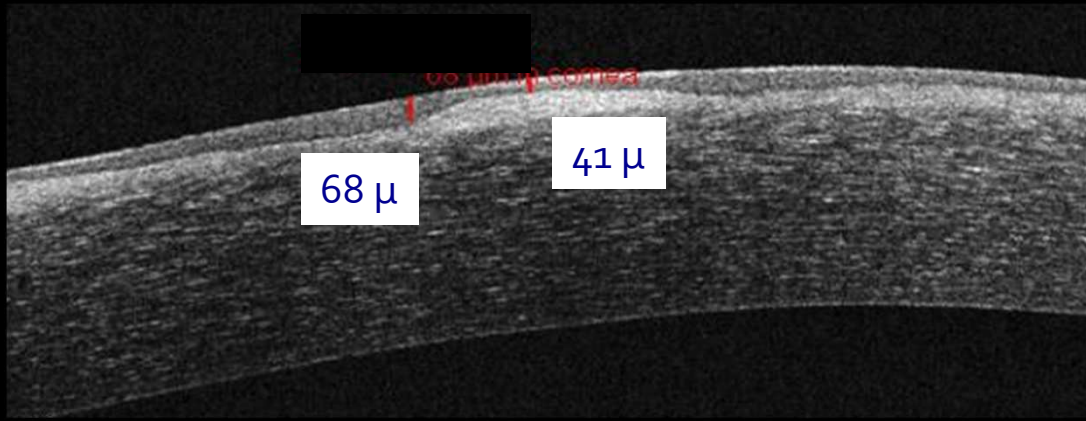
- Restore the transparency and regularity of curvature of the corneal surface
- The regularity of the corneal curvature is more important than transparency in restoring visual function
- The correction of refractive error should not be considered be the primary objective

## 2° CASE

The importance of intraoperative reliable measures

# PRK 1998

## central-paracentral nasal leucoma



Pre op PTK

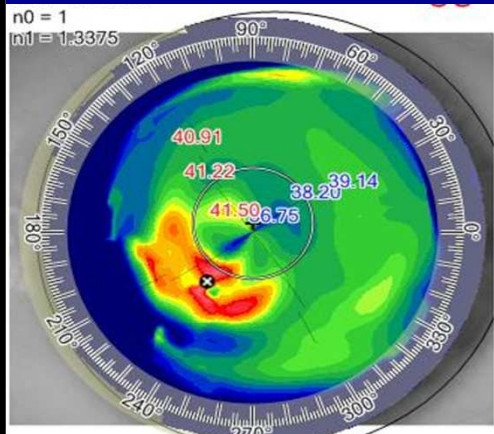
OSV 0,6  
+0,50(-  
2,25)30

Pre op

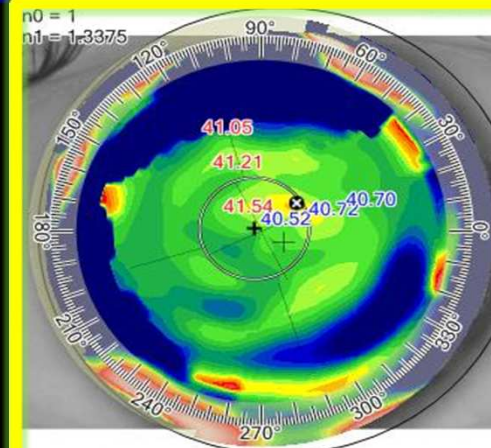
intraoperative

1 week post<sup>3</sup>

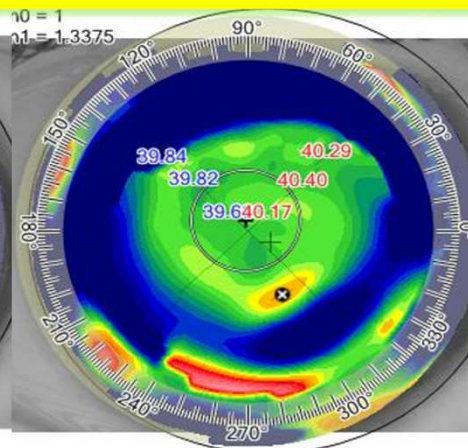
### Tangential map



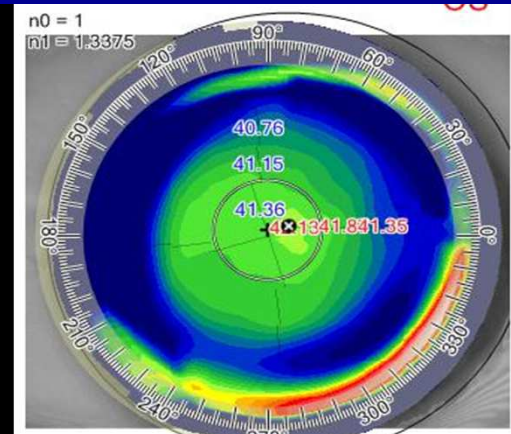
OSV 0,7 +0,50(-2,25)30



Tangential anterior (#2)



Tangential anterior (#1)



OSV 0,8 -1,50

### Pachymetry map



Corneal thickness (#3)



Corneal thickness (#1)



Corneal thickness (#2)



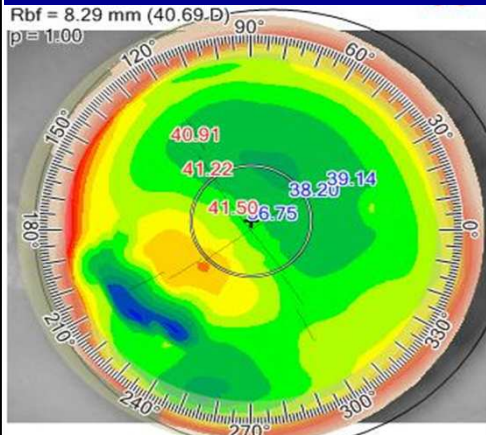
Corneal thickness (#1)

Pre op

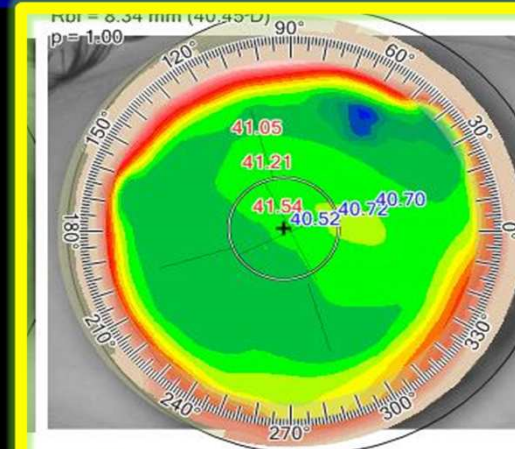
intraoperative

1 week post

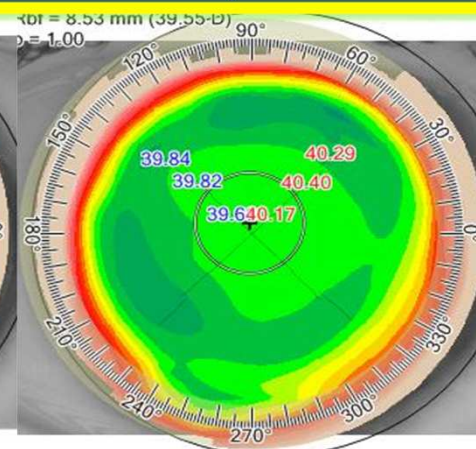
### Anterior elevation map



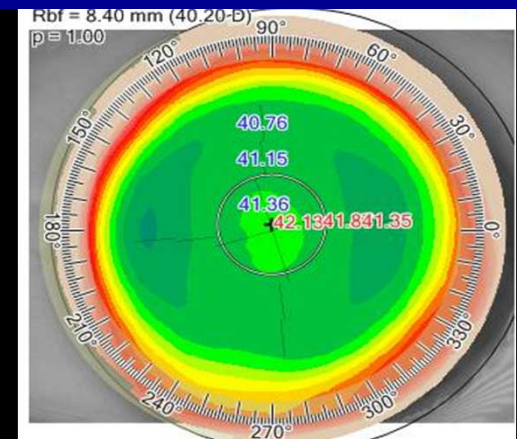
OSV 0,7 +0,50(-2,25)30



Anterior elevation (#2)

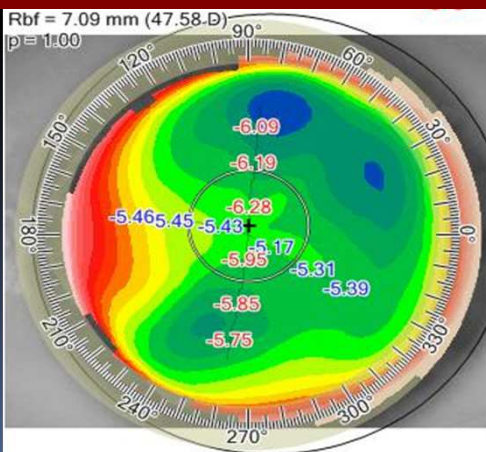


Anterior elevation (#2)

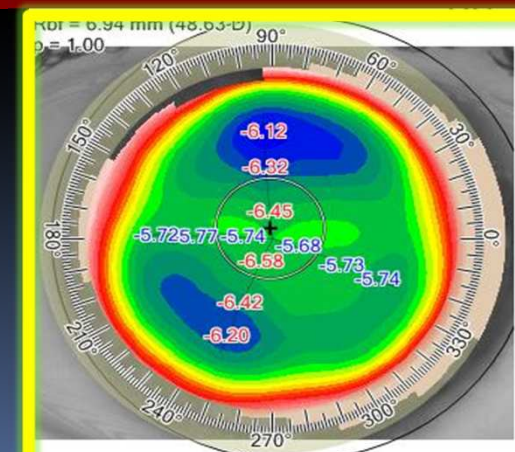


OSV 0,8 -1,50

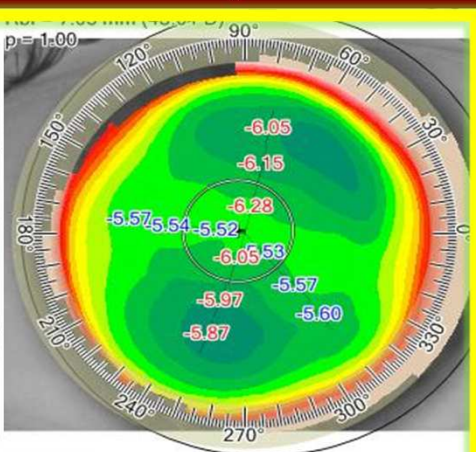
### Posterior elevation map



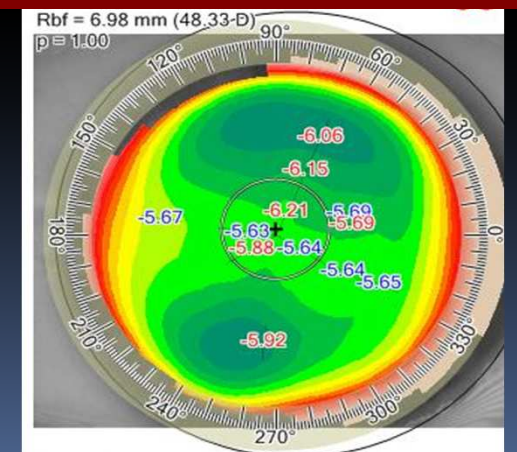
Posterior elevation (#3)



Posterior elevation (#2)

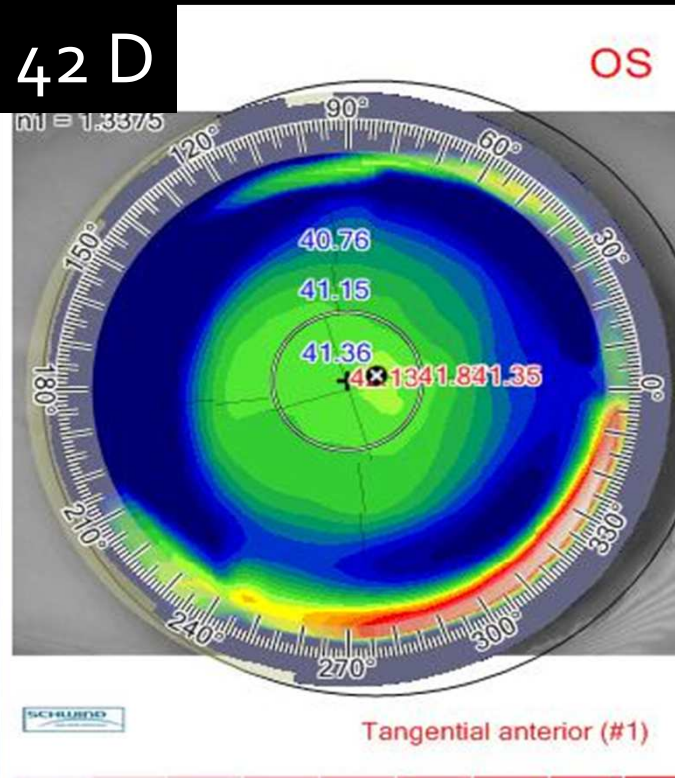
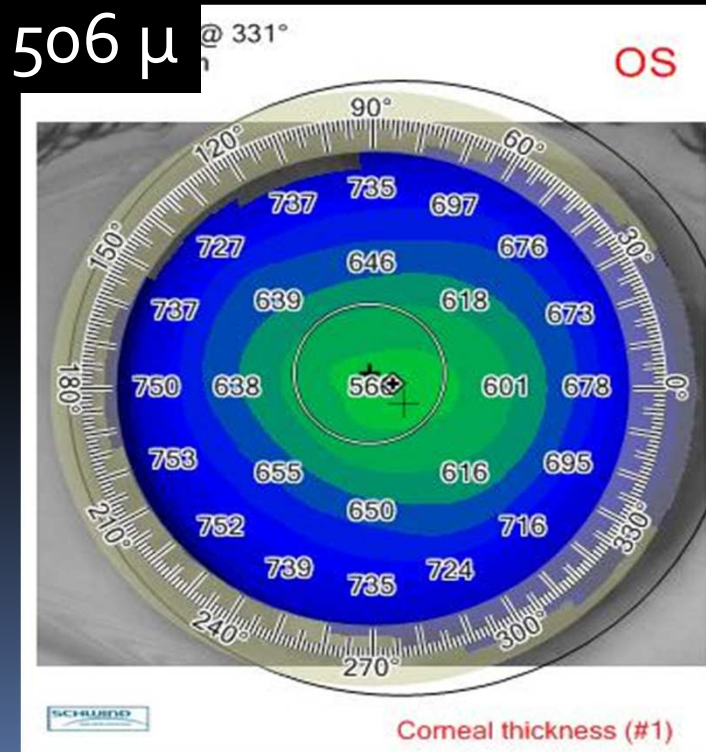
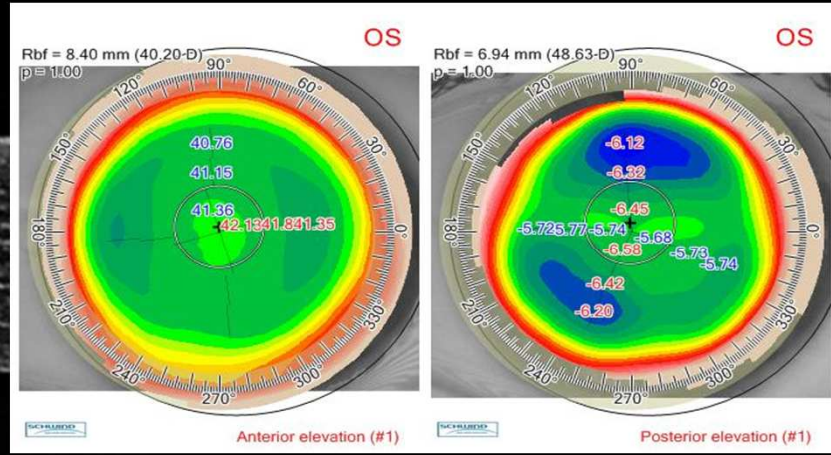
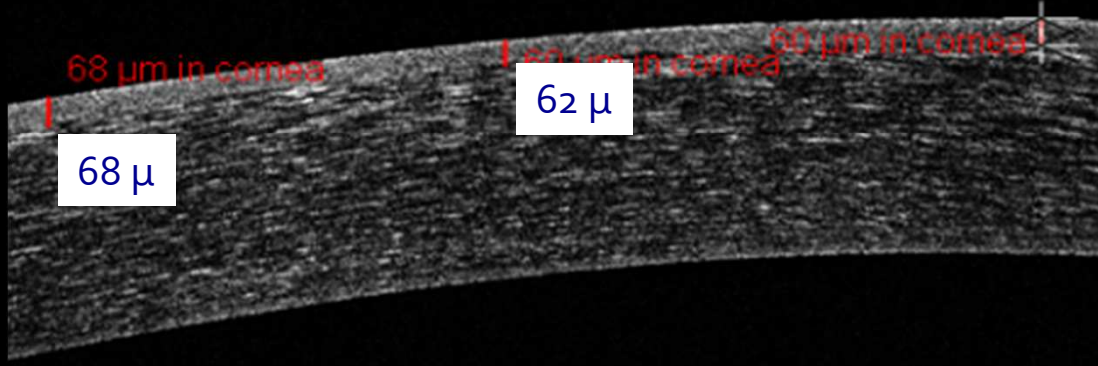


Posterior elevation (#2)



Posterior elevation (#1)





OSV 0,8  
-1,50 sph

1 week  
Post op PTK

## 3° CASE

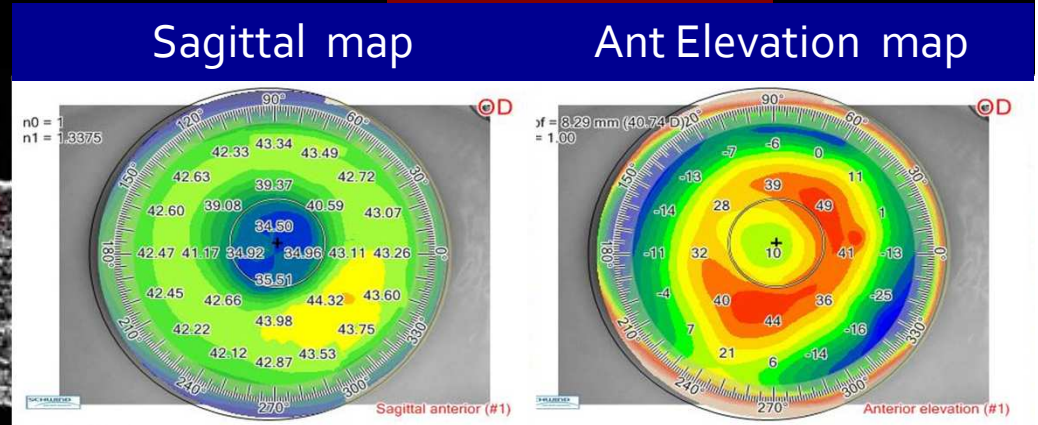
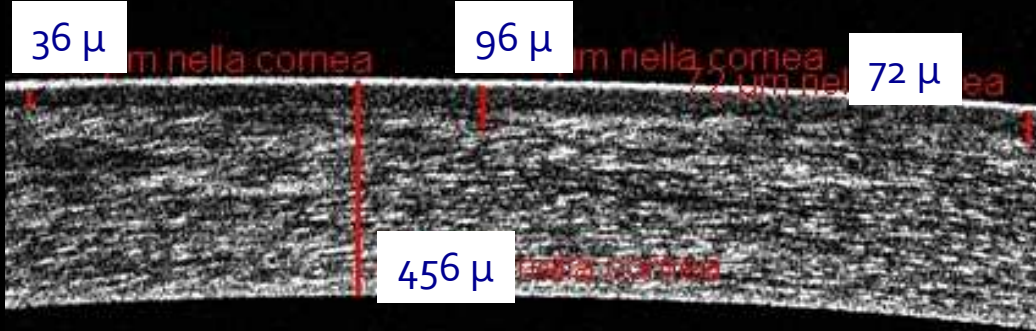
The sure trust on intraoperative measures

PRK 1997 (-13 SphEq)

ODV 0,4 +1,50(-2,50)60

Pre op PTK

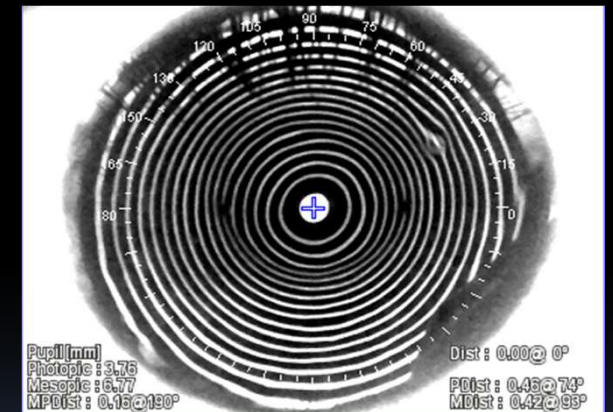
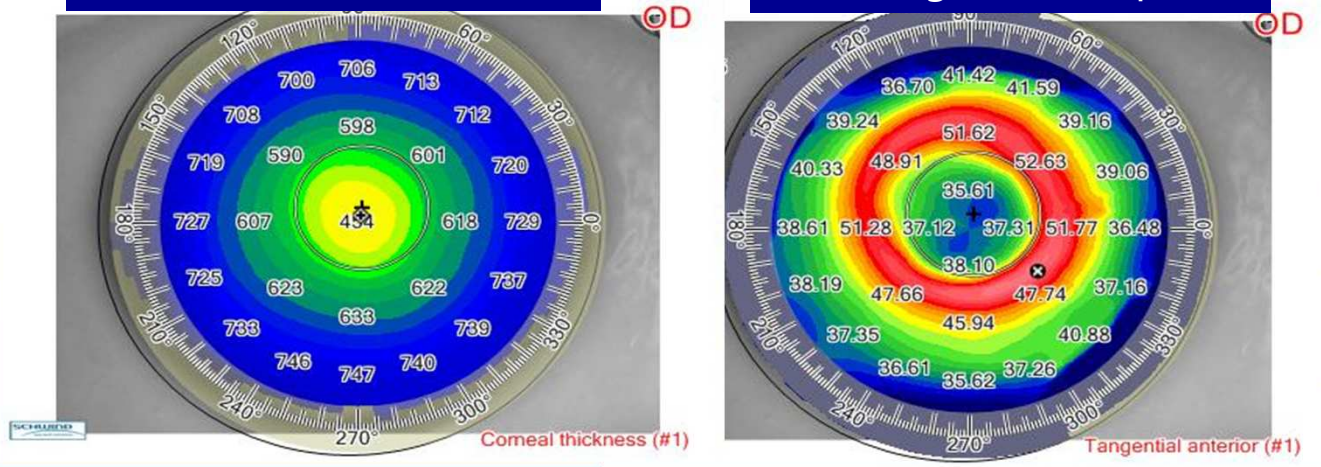
1



454 μm

Pachymetry map

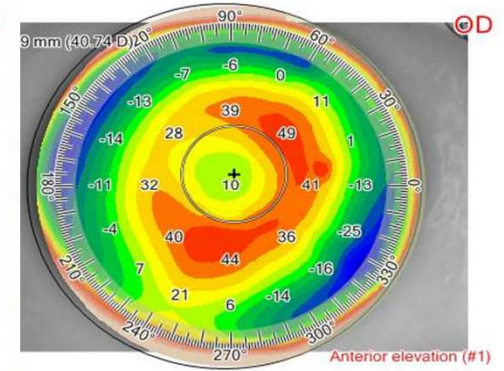
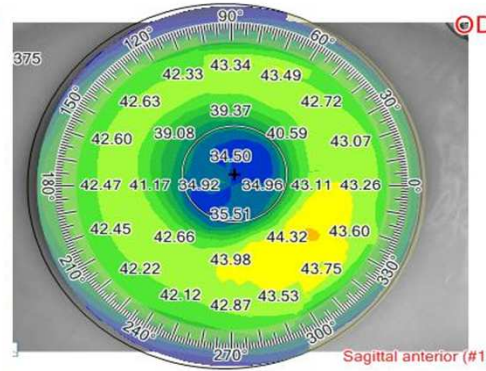
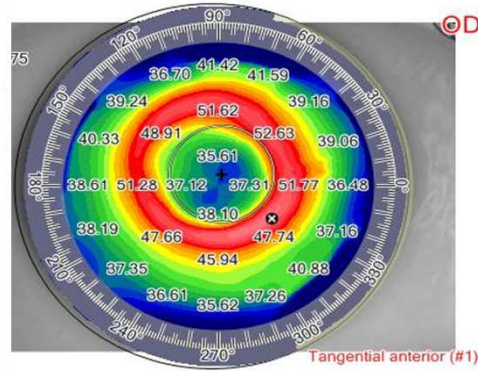
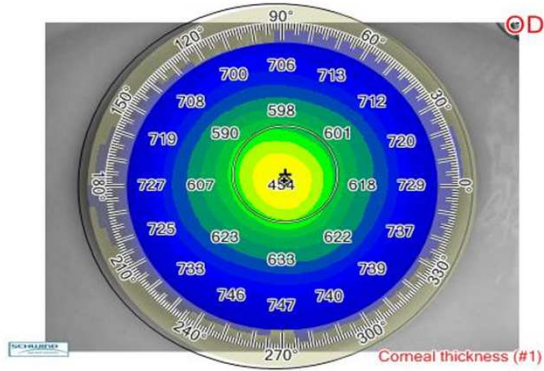
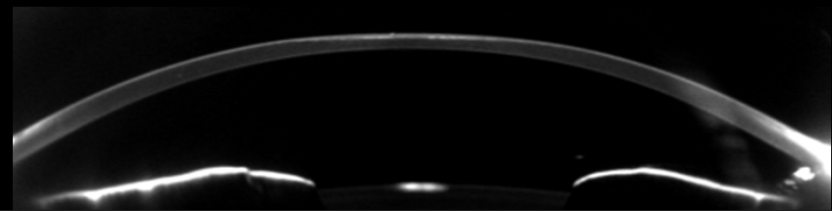
tangential map



Pt G.A.

# Pre op vs intraoperative

Pre op PTK



Corneal thickness

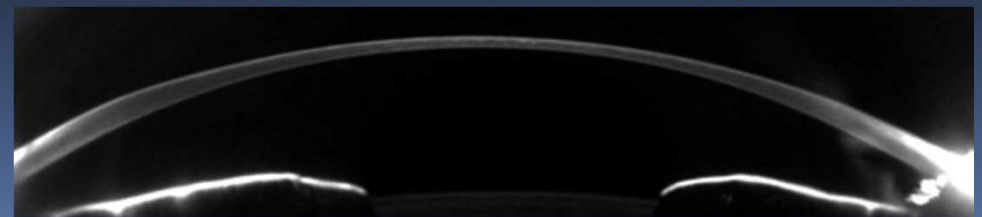
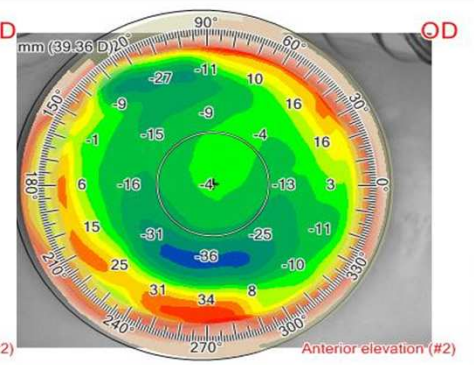
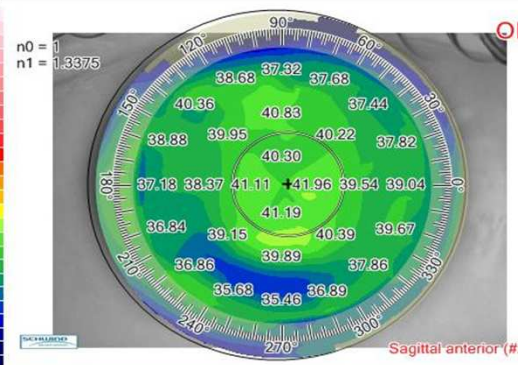
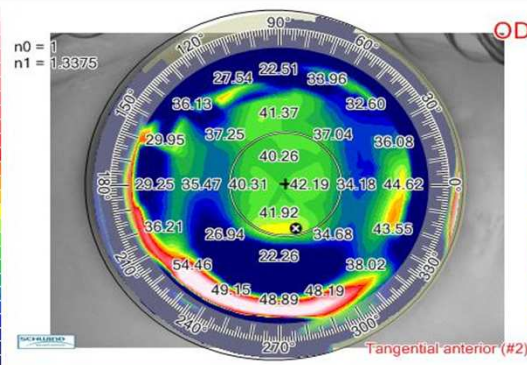
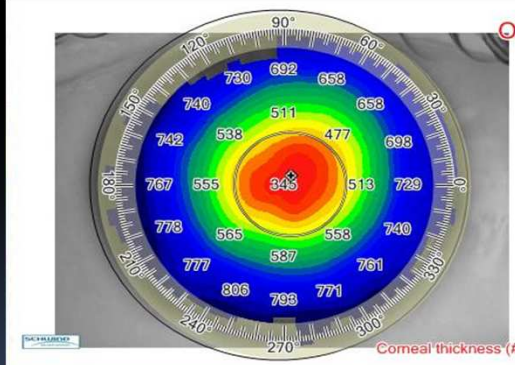
Tangential ant

Sagittal Ant

Anterior elevation

-109 microns

Intraoperative PTK

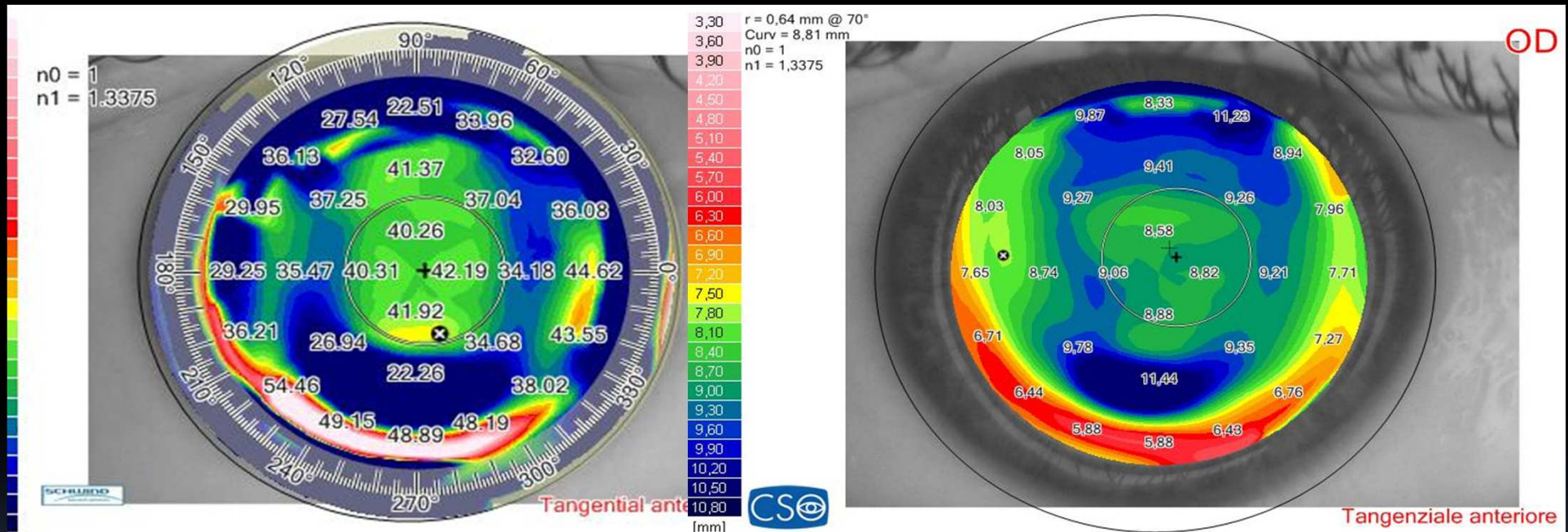


# Intraoperative vs Post Op

-109 microns

Tangential ant

reliability of the  
measures  
3 mos post



Intraoperative PTK

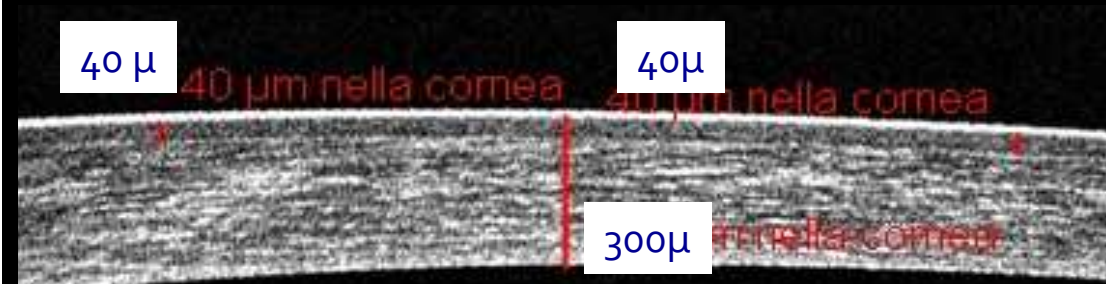
3 mos post  
PTK

ODV 0,8 -7,50 (-1,50)20

40 μ

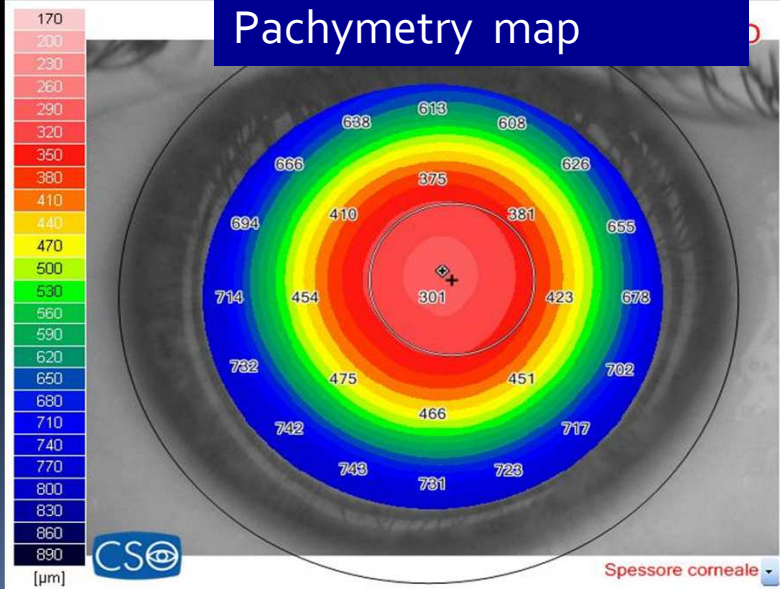
40μ

300μ

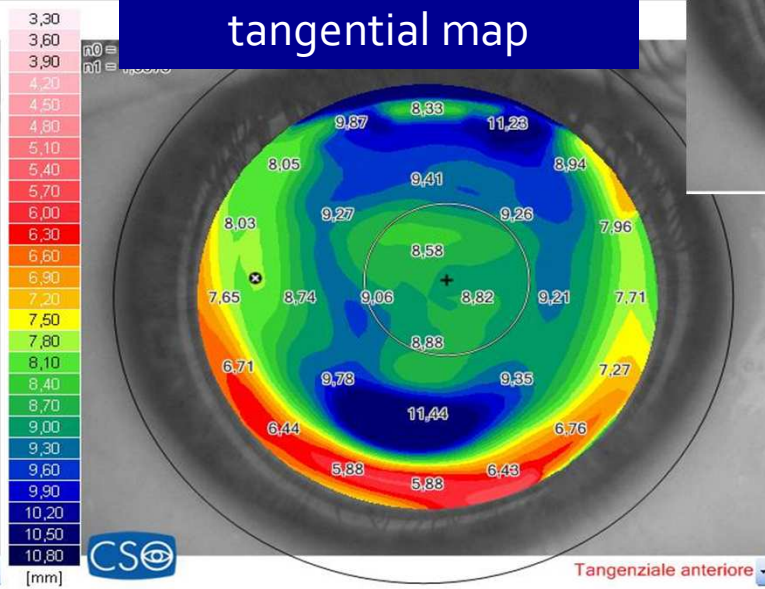


301 μ

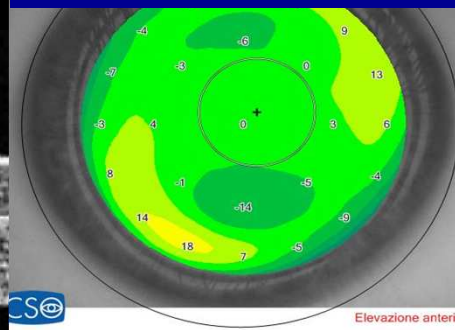
Pachymetry map



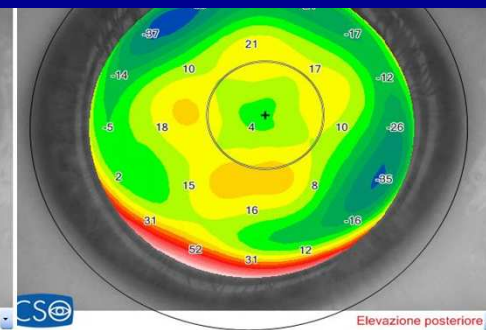
tangential map



Ant Elevation map

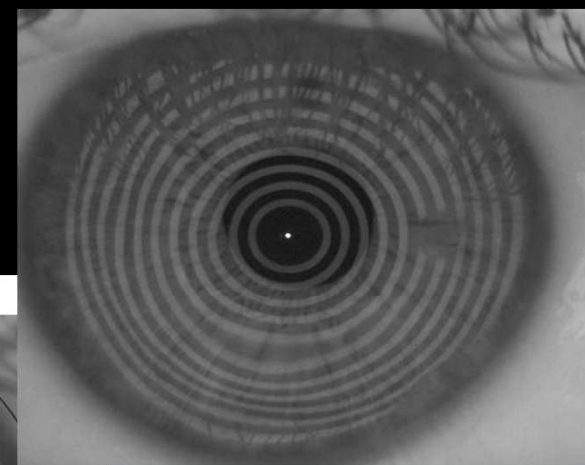


Post Elevation map



Elevazione anteriore

Elevazione posteriore



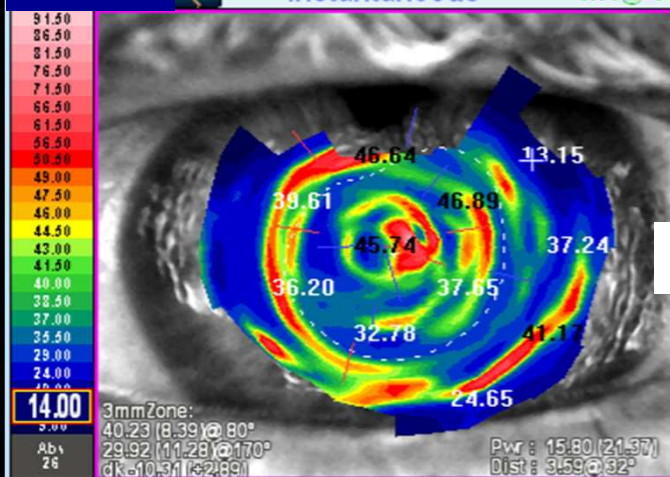
1 mos  
Post op PTK

## 4° CASE

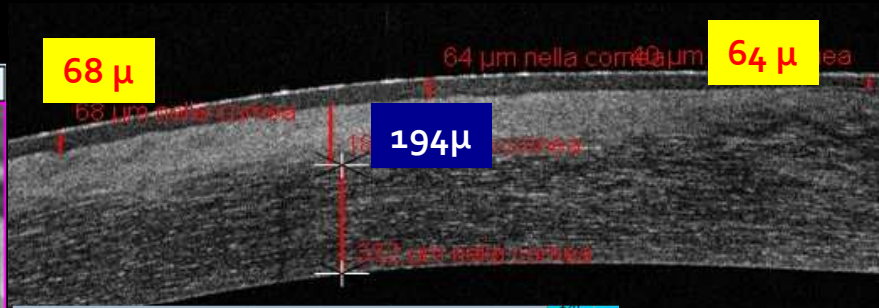
Impossible case

pre -op measurement only intraoperative can  
face this cornea

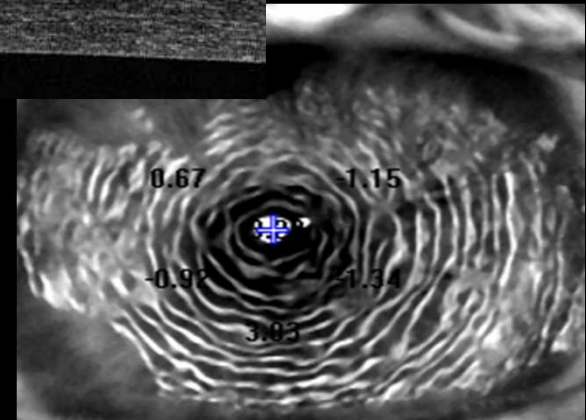
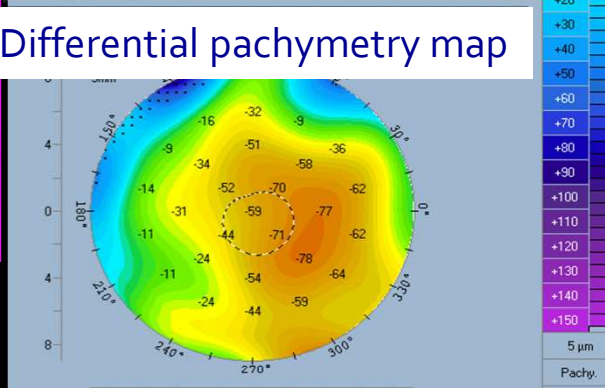
Pre op



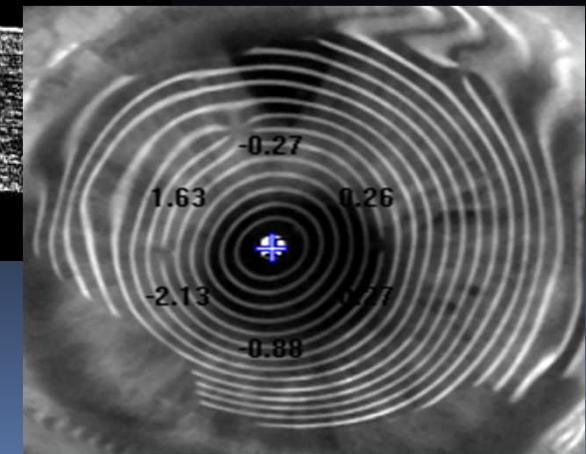
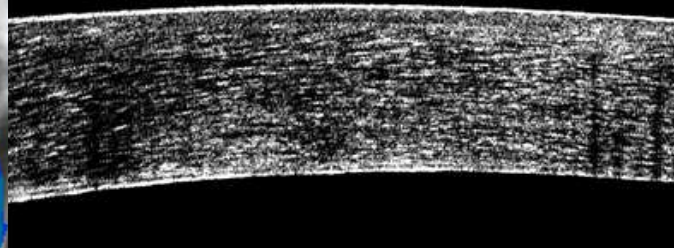
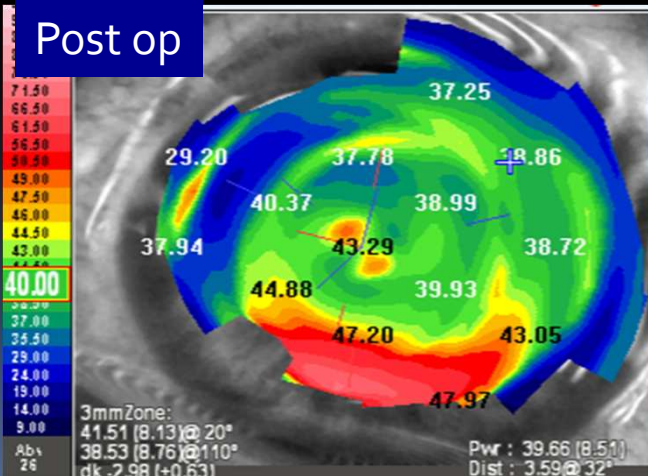
68 μ



Differential pachymetry map



Post op

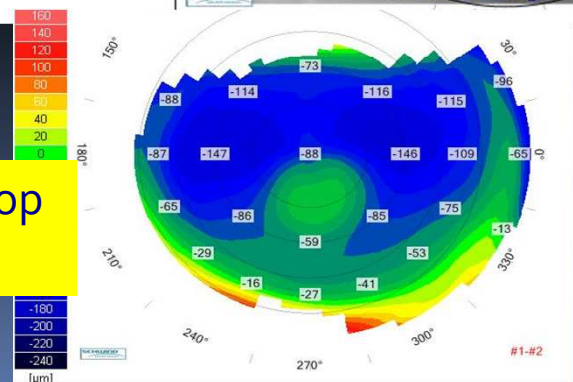
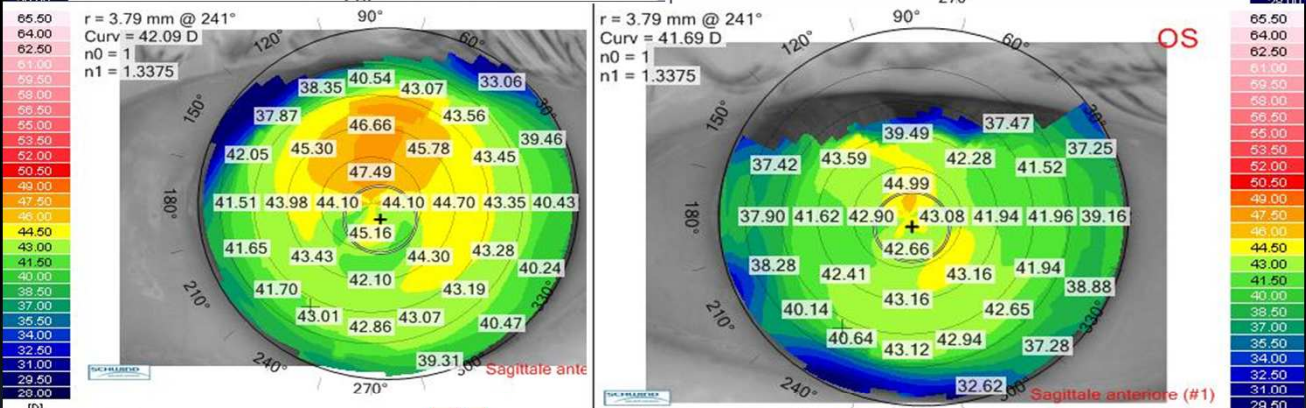
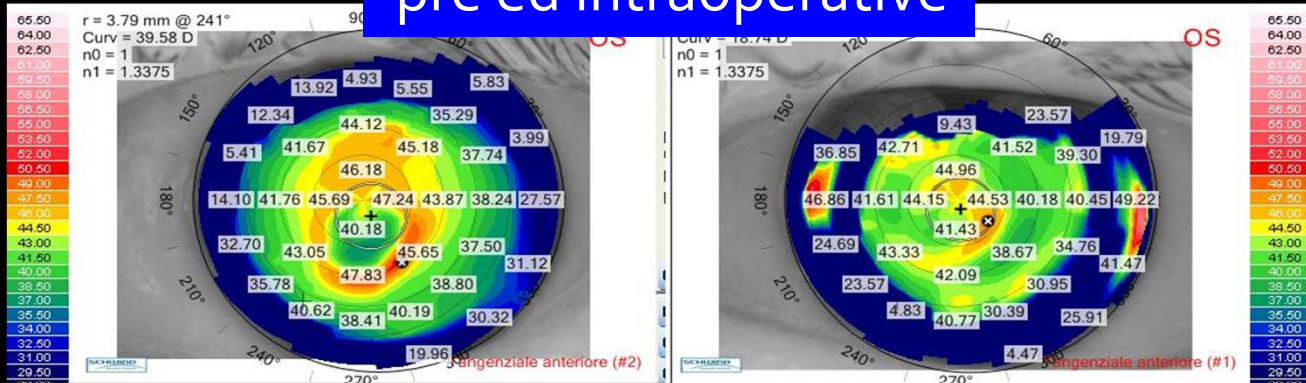


Pt M.G.



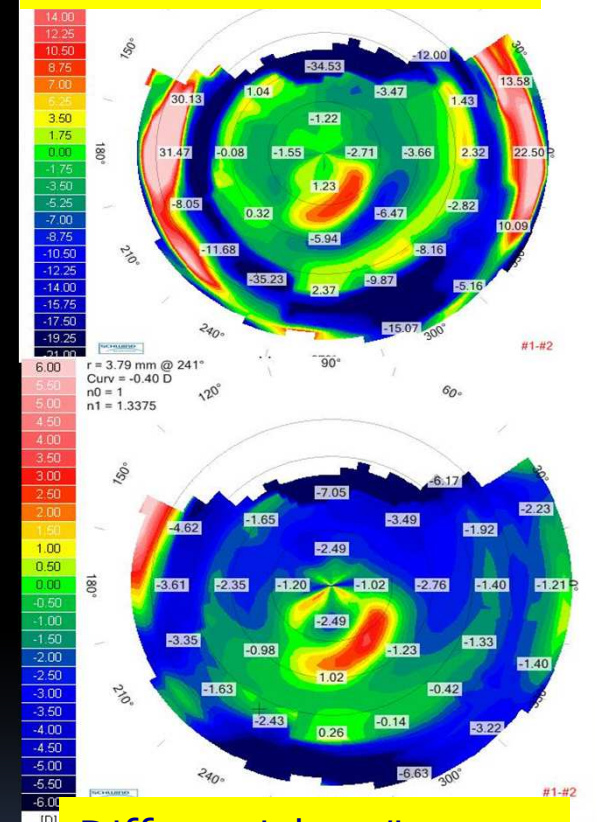
# With the acquired topo re-plan a new Custom ablation if needed.

pre ed intraoperative



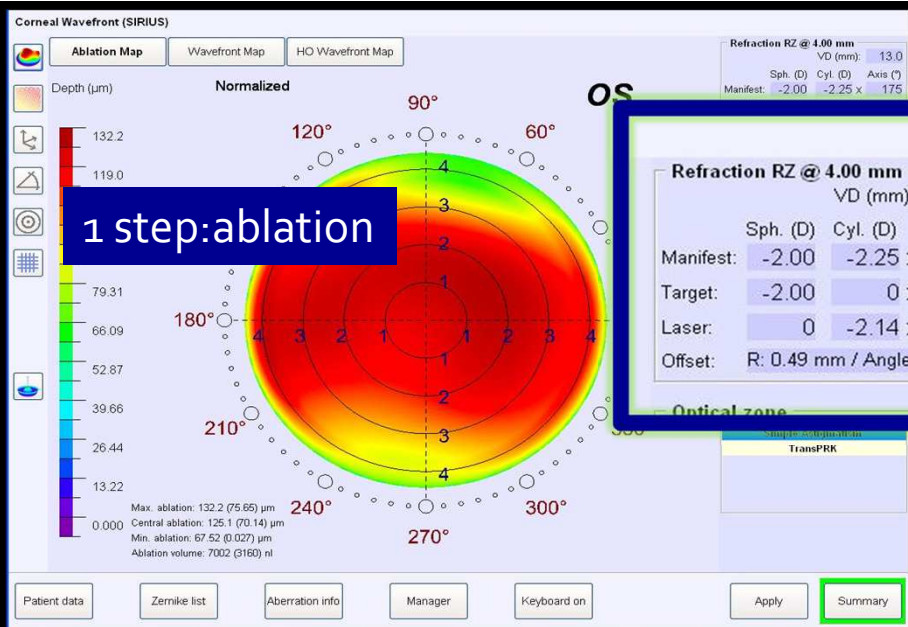
Differential pre/intraop Pachymetry map

Differential pre/intra op tangential map

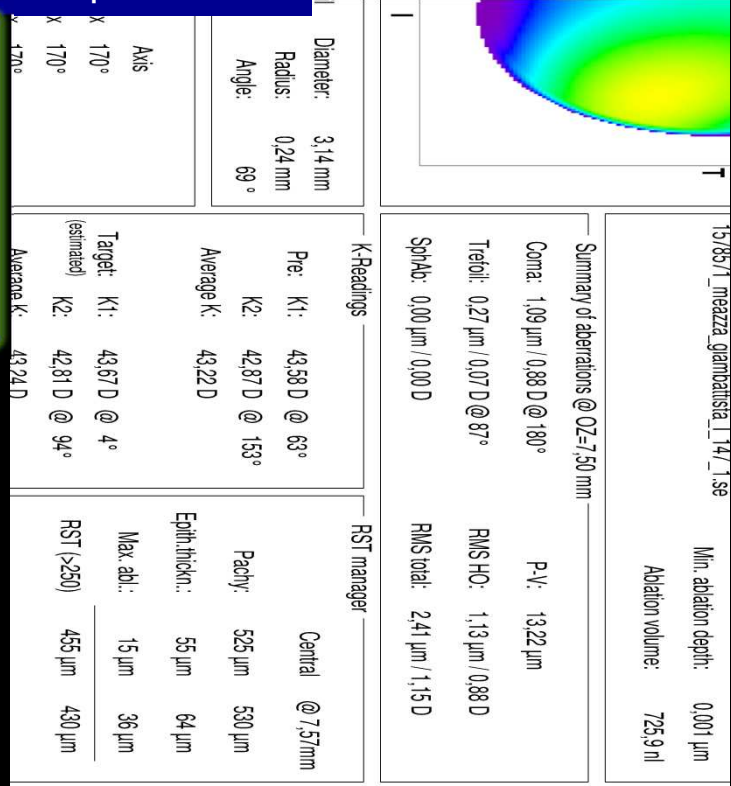


Differential pre/intraop Axial map

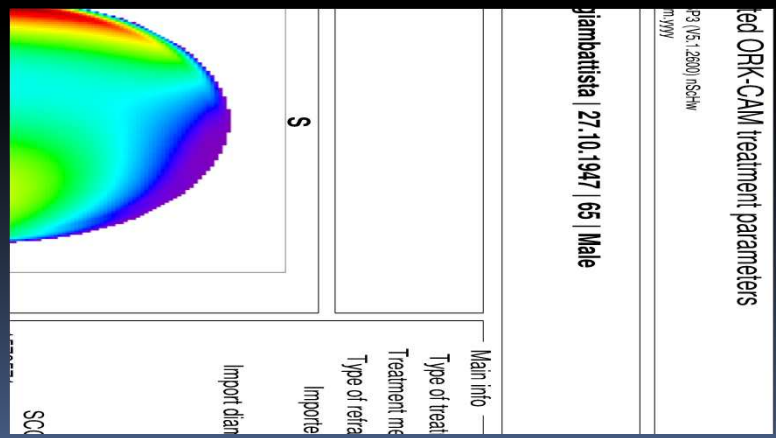
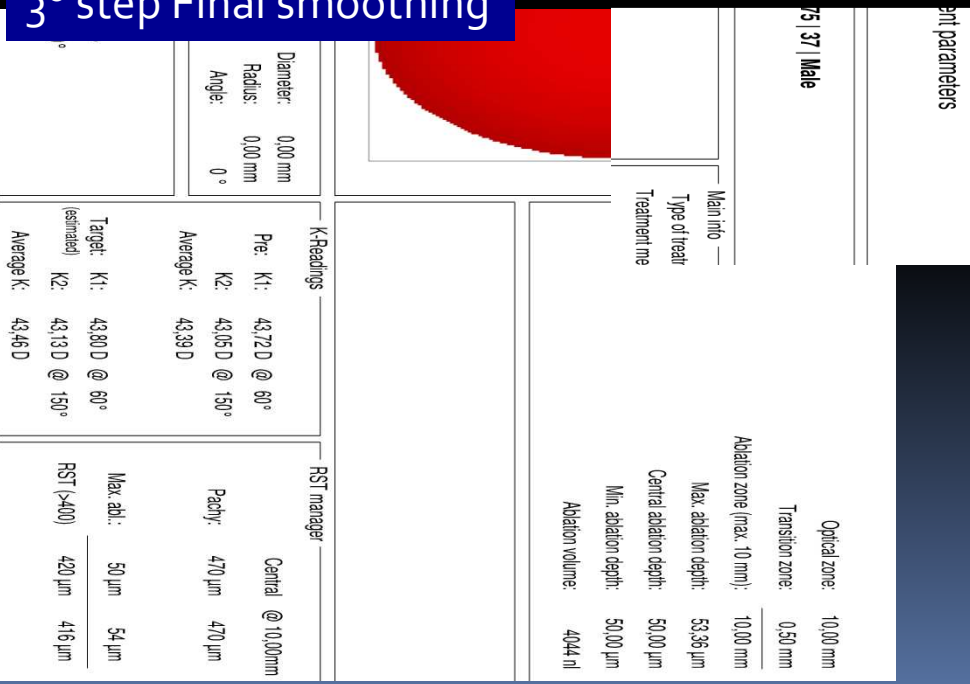
Pt M.G.



**2 step: ablation**



**3° step Final smoothing**

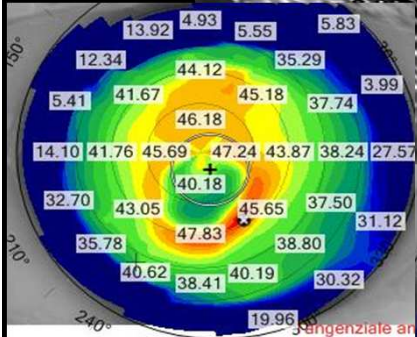
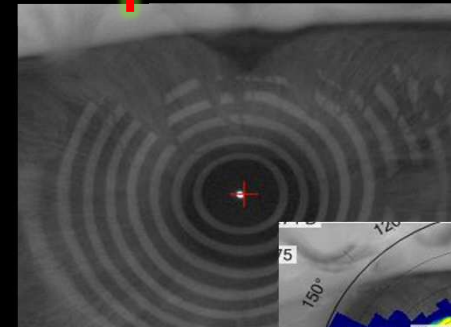
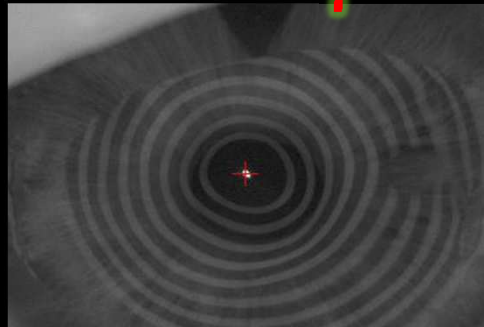
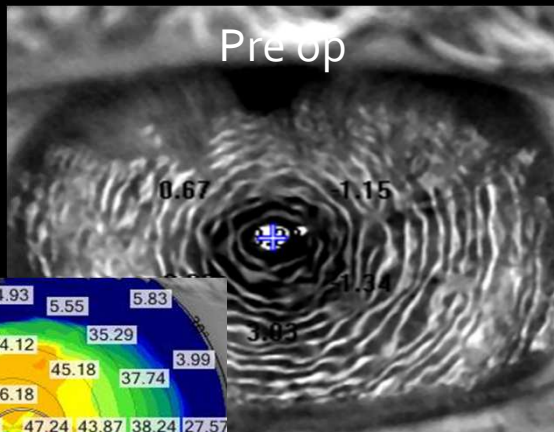


# PTK after Herpes keratitis

intraoperative

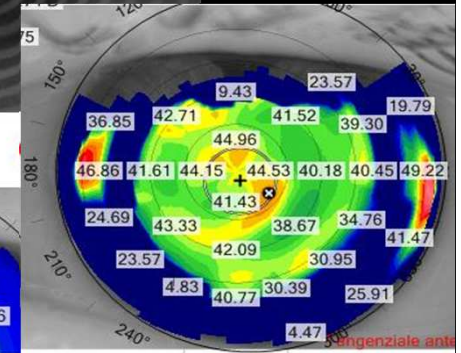
1° step

2° step



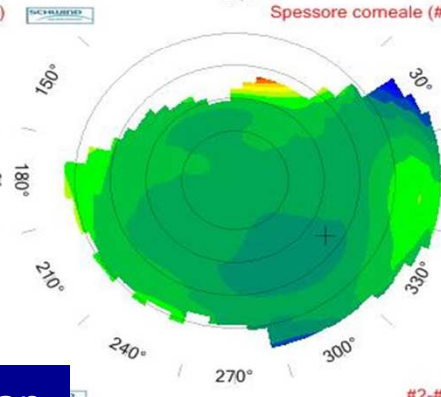
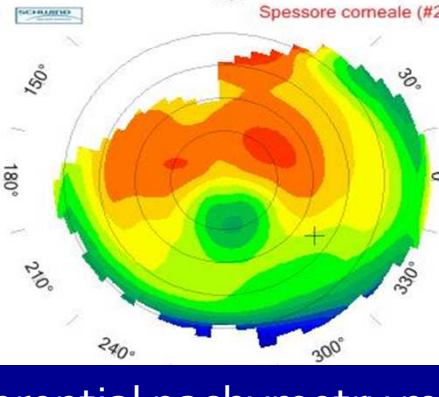
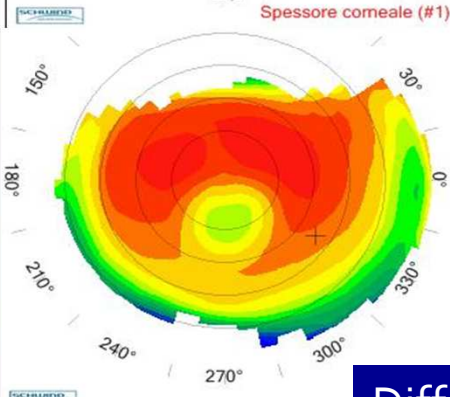
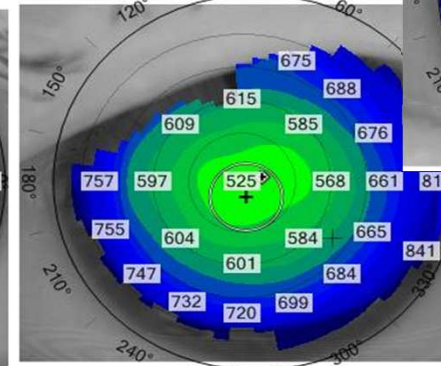
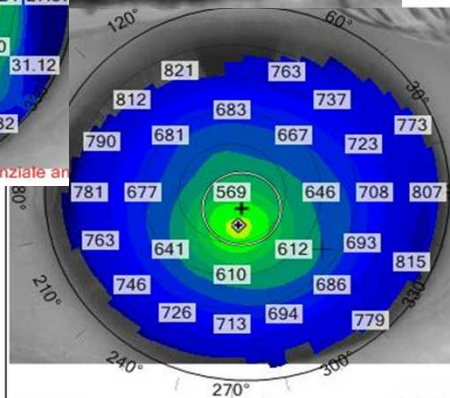
Pachymetry map OS

OS r = 3.05 mm @ 326°  
Thk = 611 μm

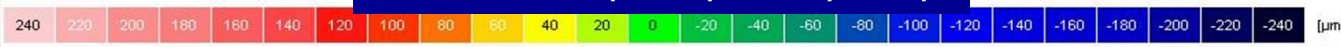


Tangential map

Tangential map



Differential pachymetry map



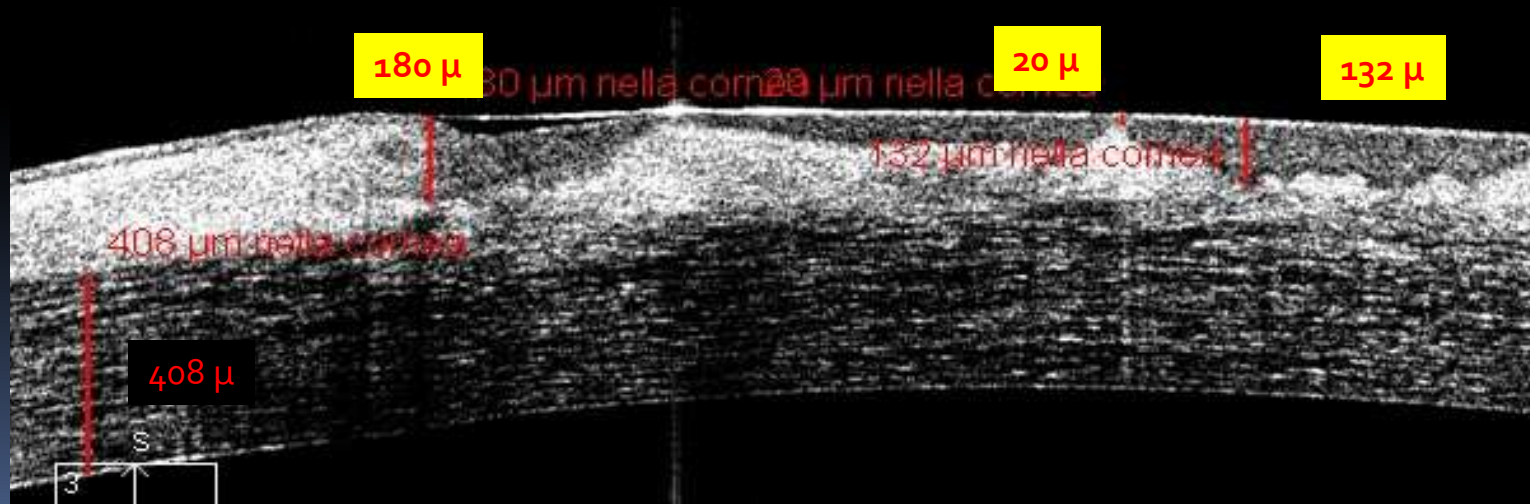
5° CASE

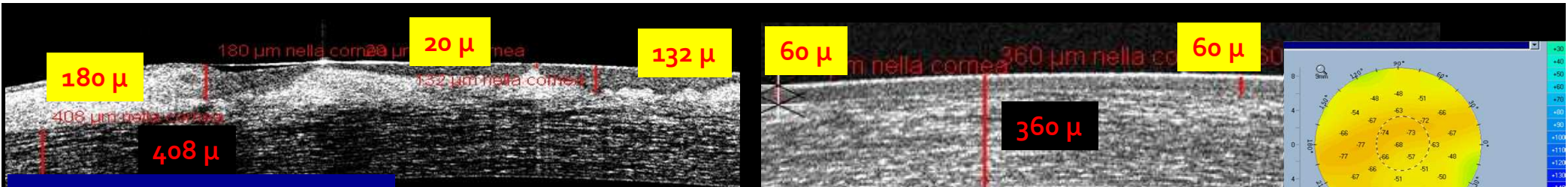
Pre op vs post op

## Case g.t.

36 yrs

- PRK 2001 ODV 0,1 -7,00(-2,00)125
- 2° prk 2011 + mit C
- Haze (tp fluaton coll 9/2012)
- 9/2012 ....suggested Dalk

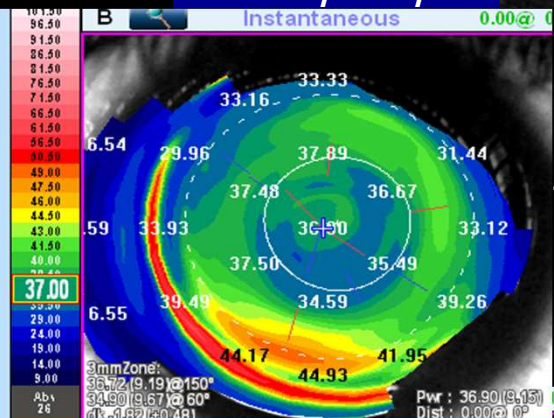
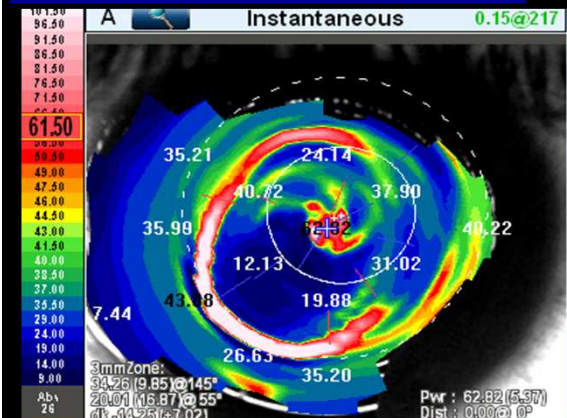
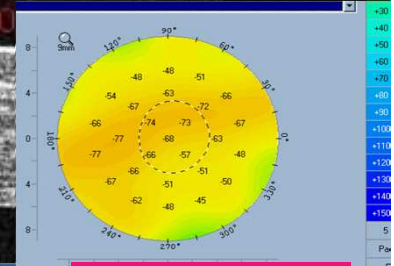




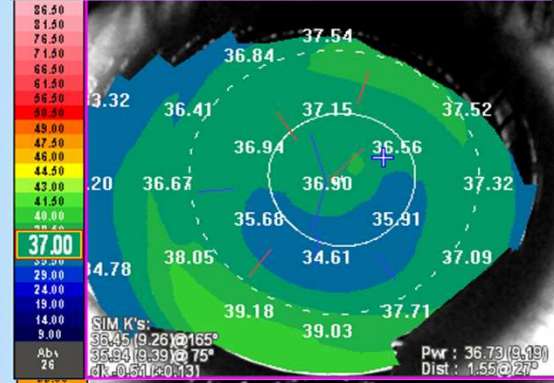
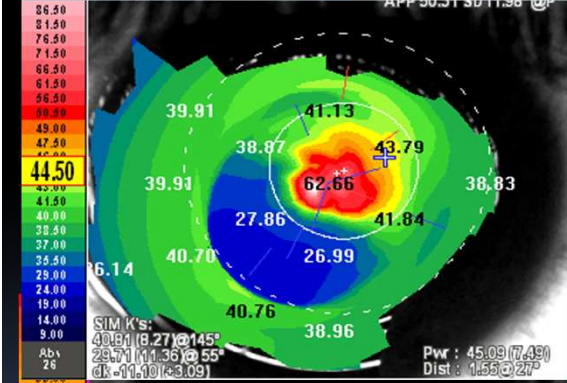
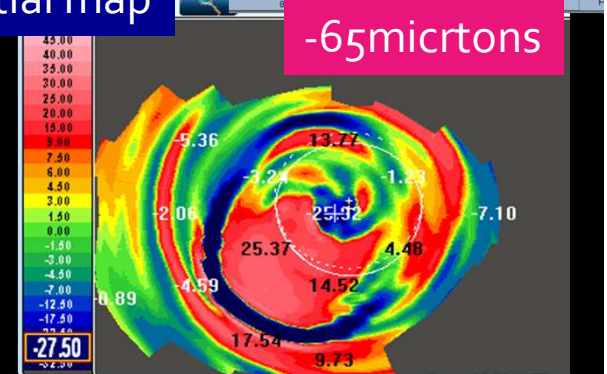
ODV 0,1 -7,00(-2,00)125

ODV 1,0 -1,00

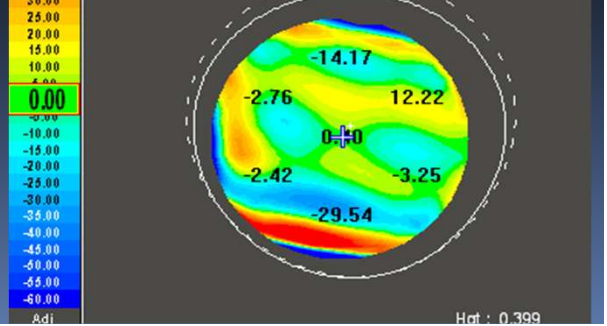
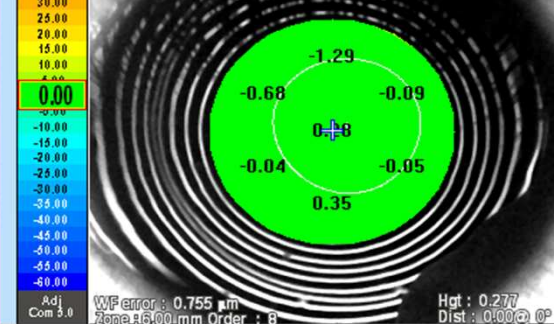
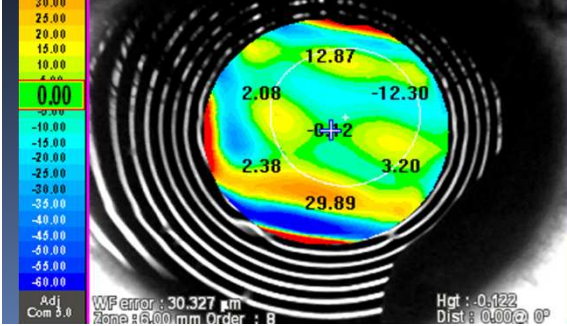
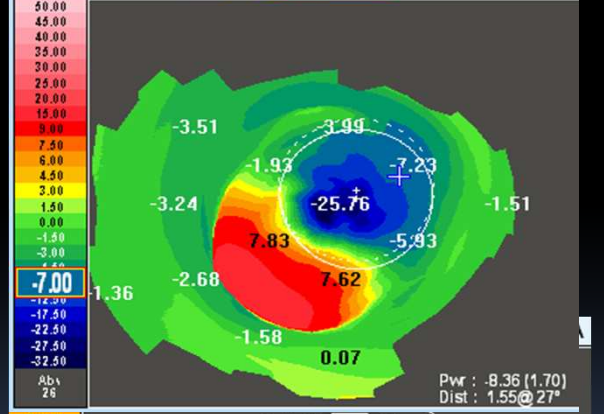
Differential map



36yrs  
-PRK2001  
-prk 2011 + mitC



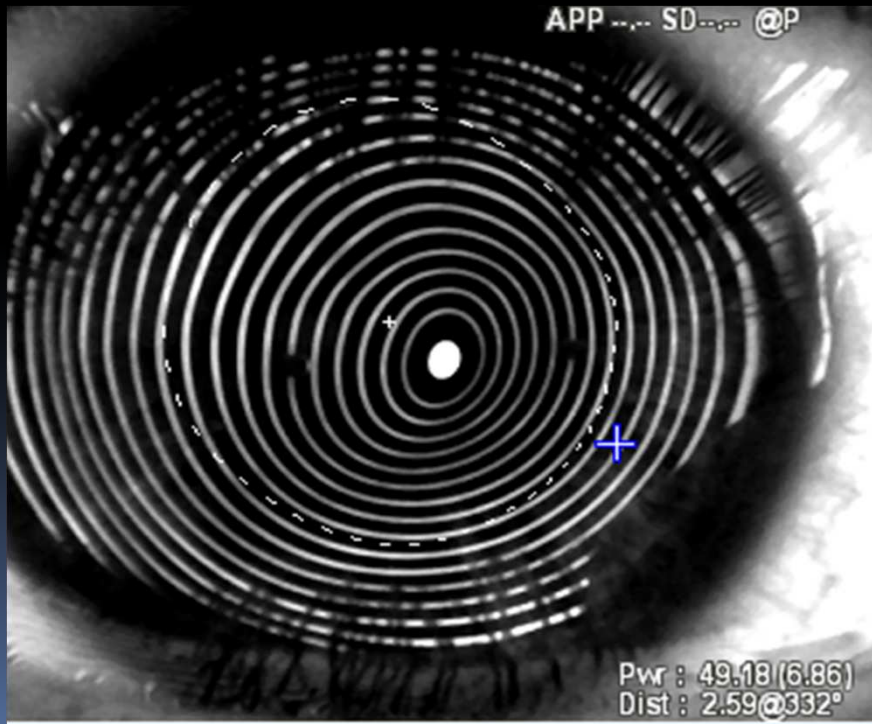
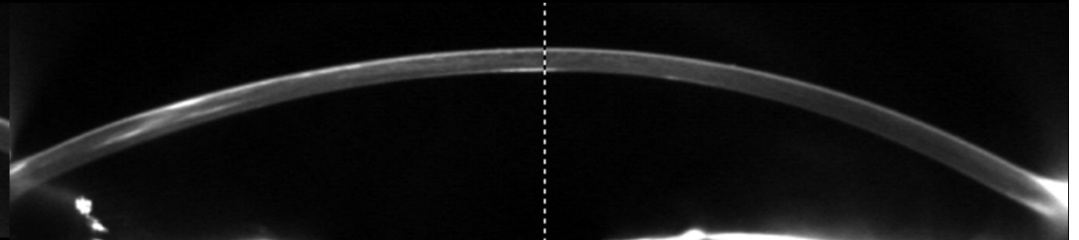
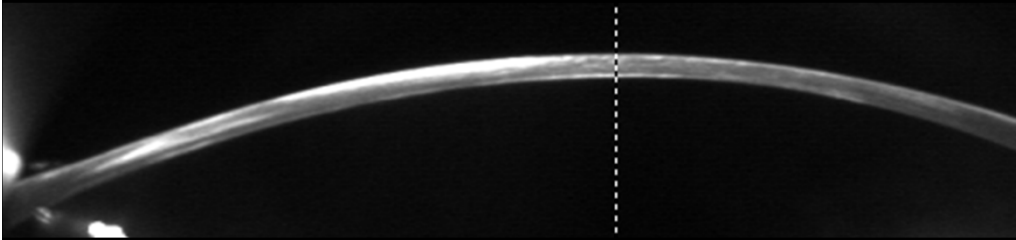
case g.t



# Case g.t.

Pre op ODV 0,1 +1,00 (-7,00) 65

Post op ODV 1,0 -1.0 sph



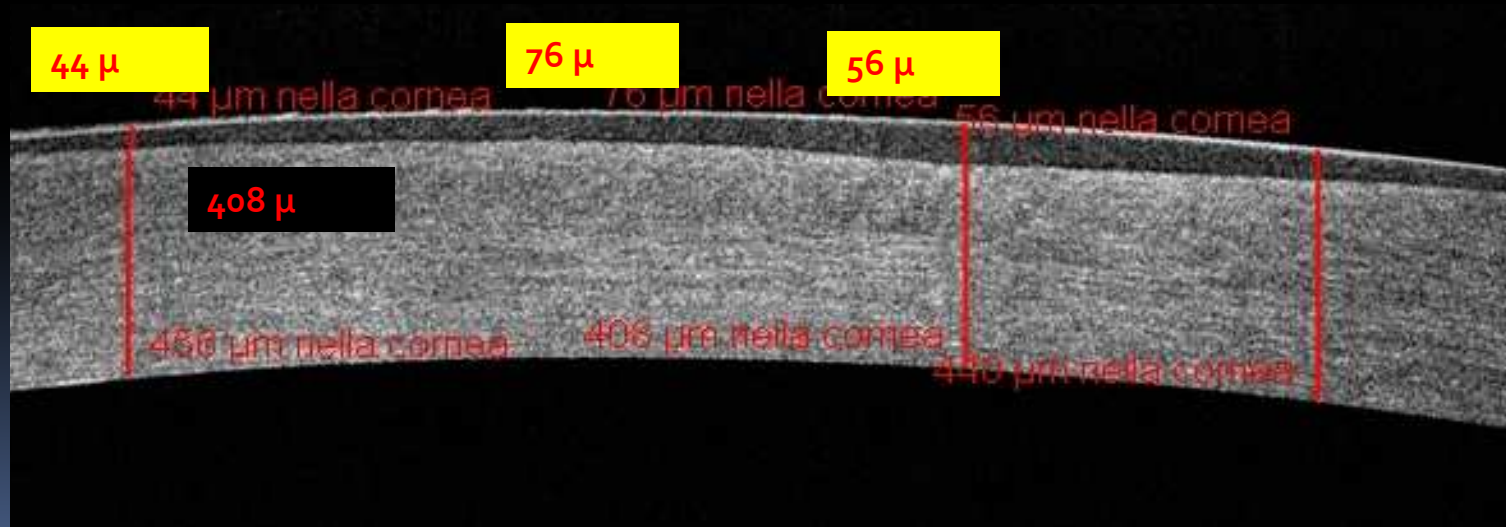
6° CASE

Pre op vs post op

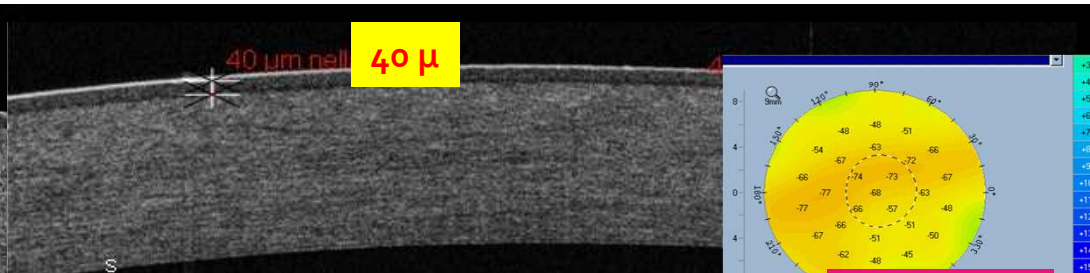
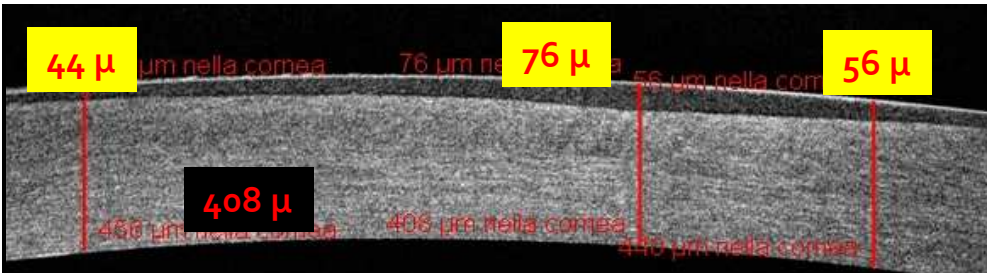


25 yrs

- Reiss-buckler
- ODV 0,5 nmcl



pt r.b.



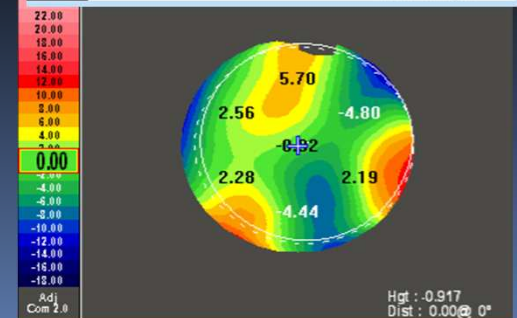
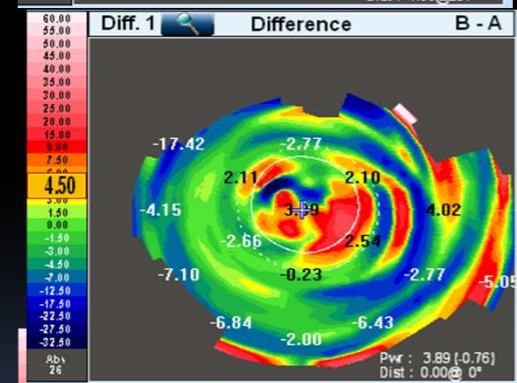
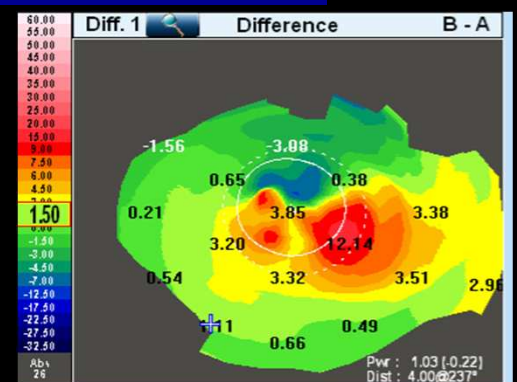
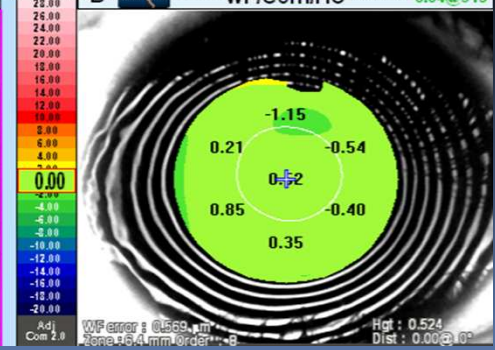
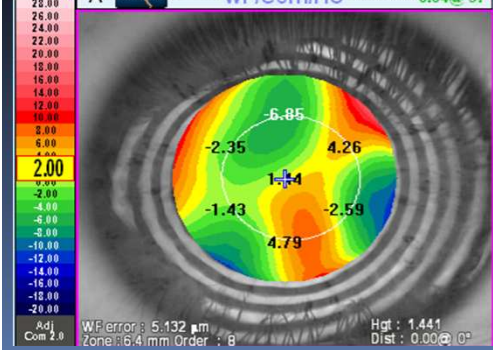
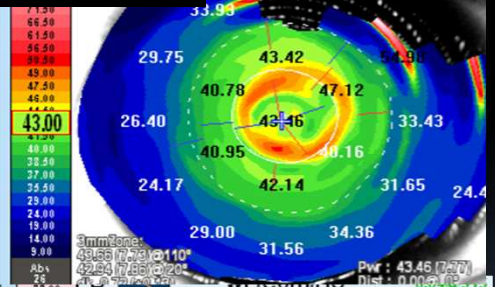
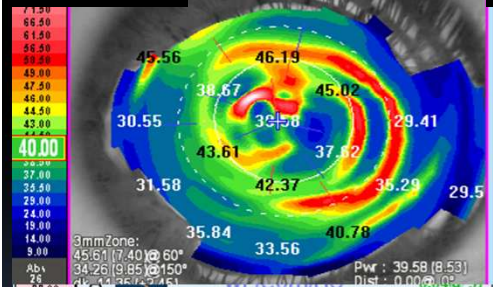
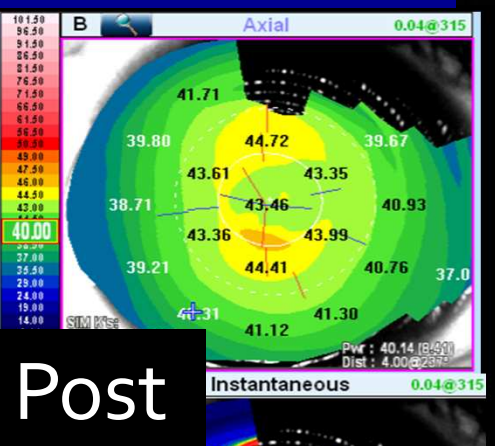
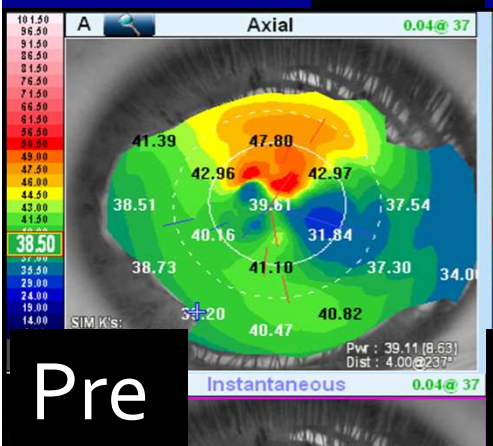
OSV 0,5 nmcl

OSV 0,9 +0,50(-1)160

Differential map

-65microns

REIS-BUCKLER  
25 yrs

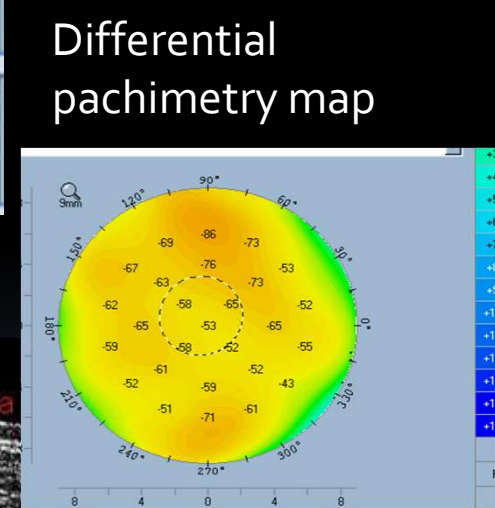
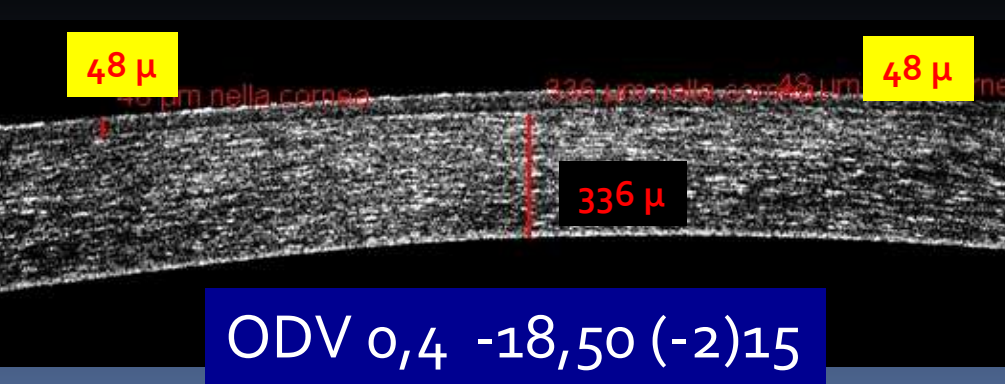
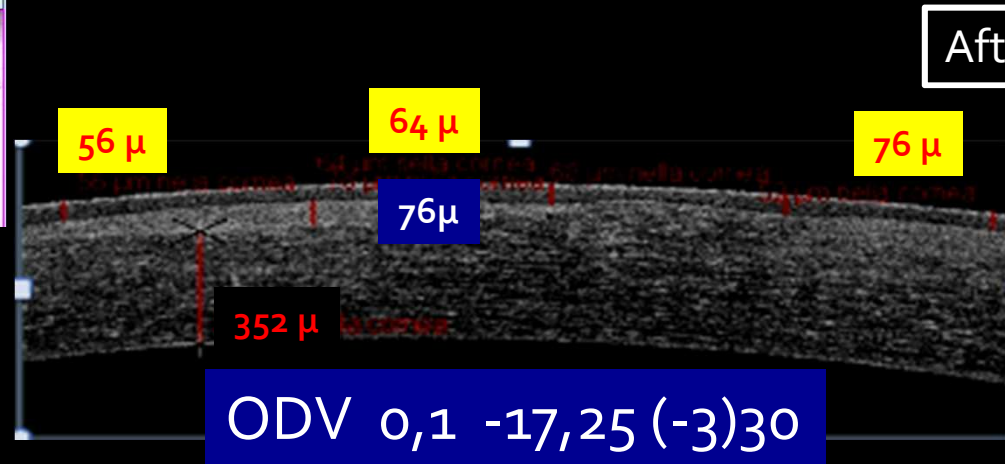
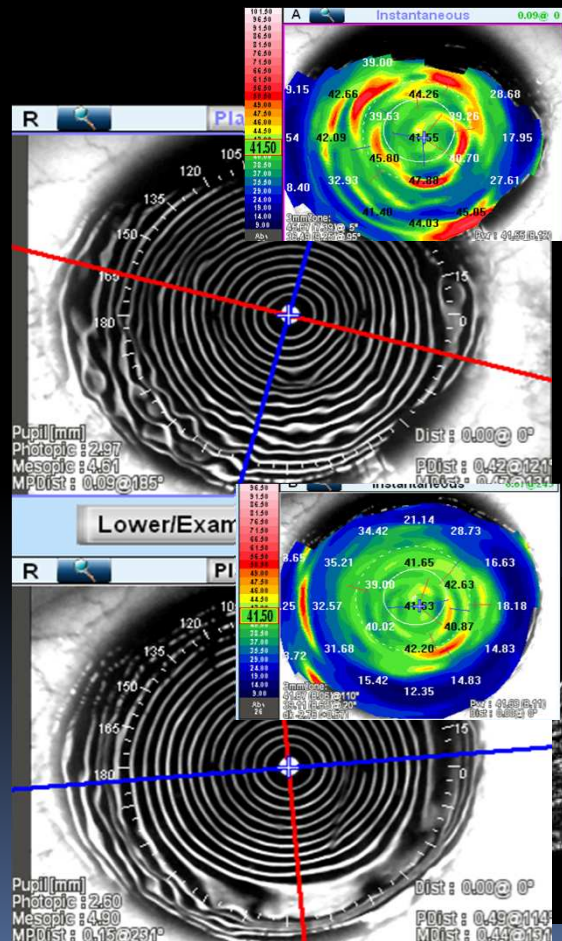


pt r.b

## 7° CASE

What to do in PTK and enhancement of difficult cases.

- Focus on HOA only
- Use sphere setting only to shift the ablation in the thickest areas



**HOA only**

**HOW WE CAN GET THESE  
RESULTS?**

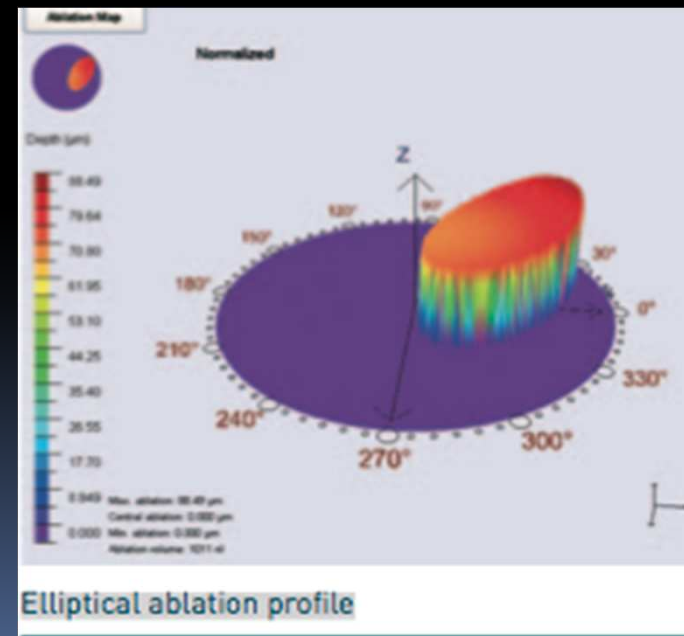
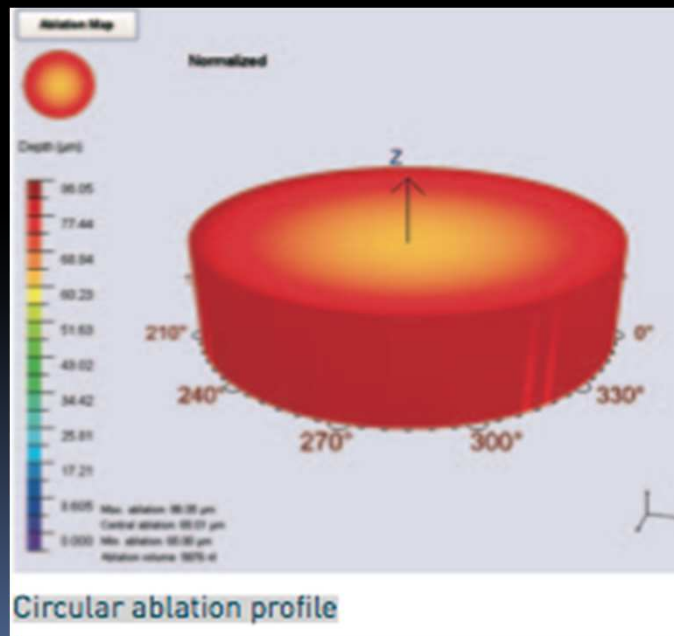
# PTK CAM:

## Two offset options

- PTK-CAM offers two possibilities for adjustment of the ablation profile. The ablation offset allows the entire profile to be moved in accordance with the pathological findings.
- The profile can be shifted to the corneal vertex with the help of the pupil offset.
- Simultaneous use of the two options guarantees transparency and the highest possible precision.
- This allows the exact, topographical localisation of superficial scars and **minimises the tissue ablation volume.**

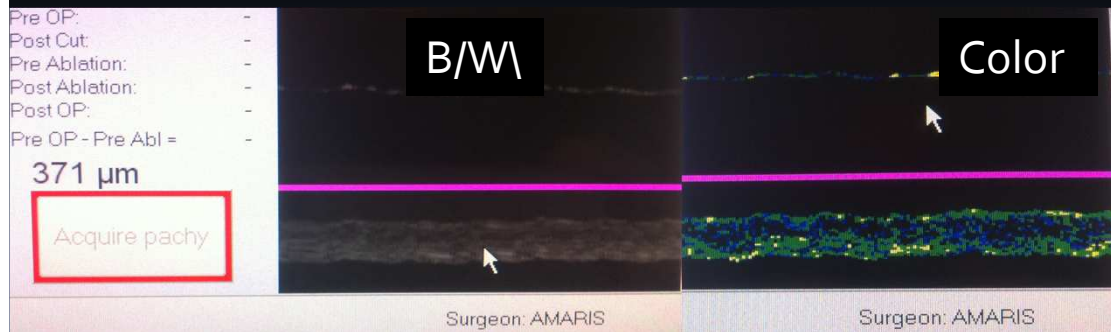
# Circular or elliptical

- The PTK-CAM module can ablate the tissue in both circular and elliptical shapes within a maximum diameter of 10 millimetres.



# Optical coherence pachymetry

- The laser has a sophisticated system that allows to obtain OCT images of corneal thickness with very high resolution, in order to control constantly and in real time, the exact thickness of the cornea and check the progress of the ptk.





# OCT... Advantages

1. During the sequential ablations, corneal edema occurs.
2. The OCT allows to evaluate the residual opacities without moving the patient, and without using LAF
3. Technique no contact. The principle is based on low coherence interferometry, which detects very fine structures in the eye.

# Corneal Thickness

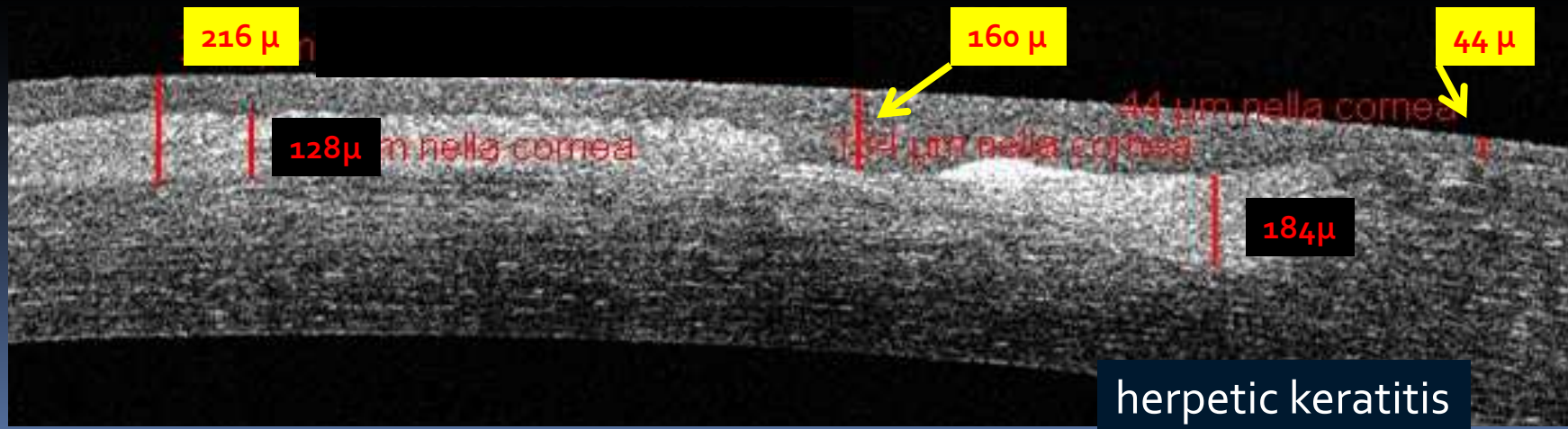
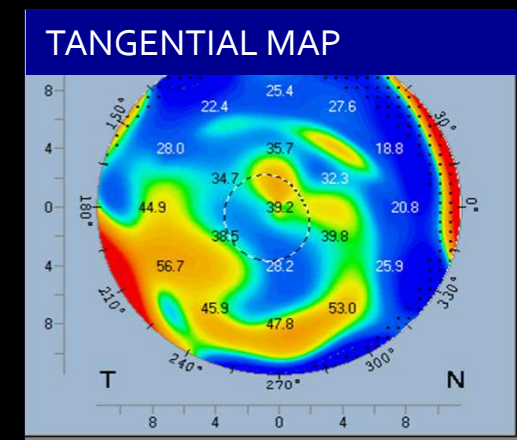
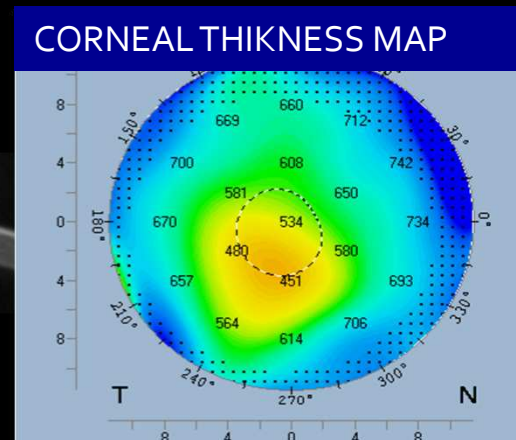
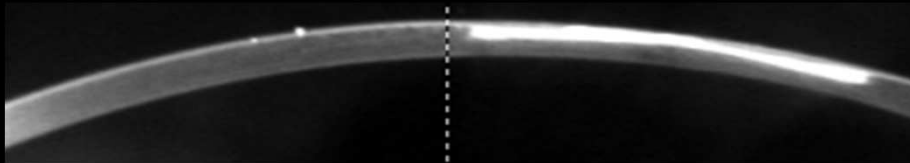
Corneal thickness is a key factor at all stages of a refractive correction.

1. Ablations deeper than planned may lead to overcorrections and inadequate residual corneal thickness increases the risk of postoperative keratectasia.
2. Not always the volume of tissue removal determines the refractive change
3. The remaining cornea should at the same time offer enough stability

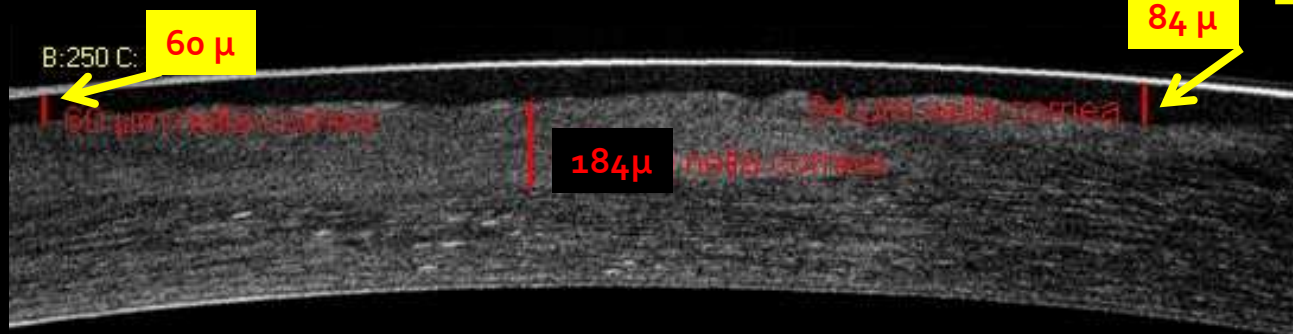
# Frequently epithelium mask the real amplitude of the stromal irregularities

OCT is very useful to:

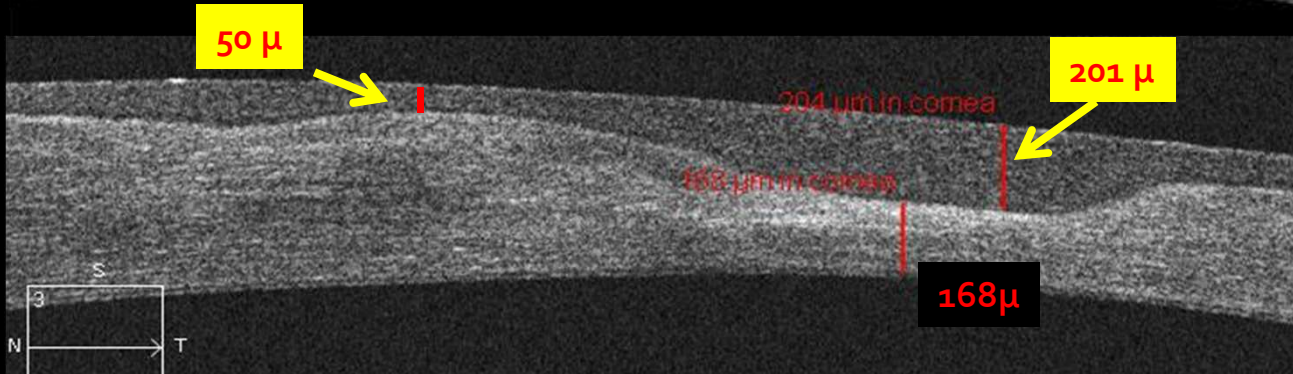
- Evaluate pre op epithelial pachymetry set adequate ablation
- See if in some point epithelium is much more thick than elsewhere



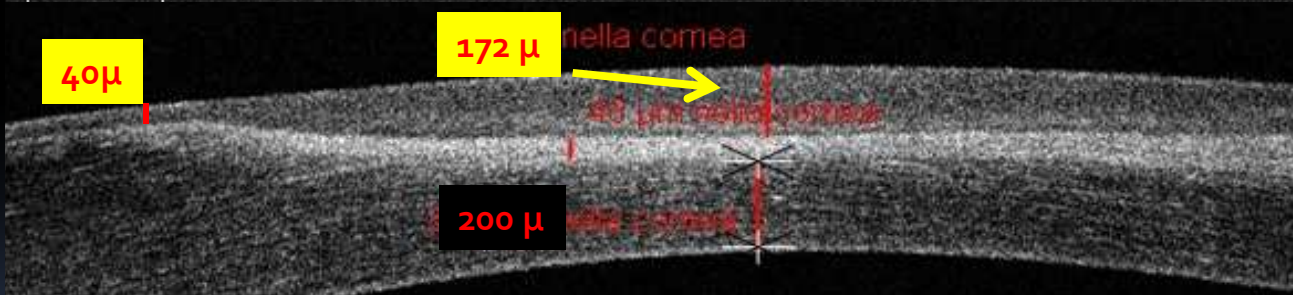
# Iperplasiae



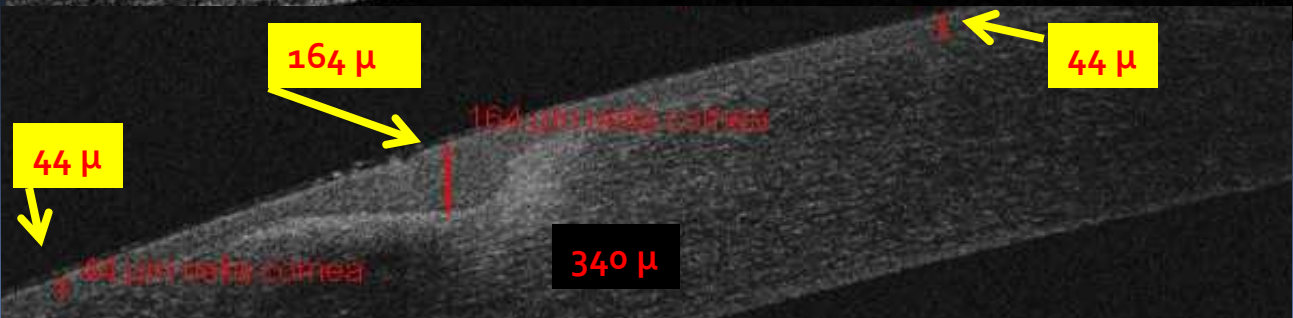
Herpetic keratitis



Herpetic keratitis



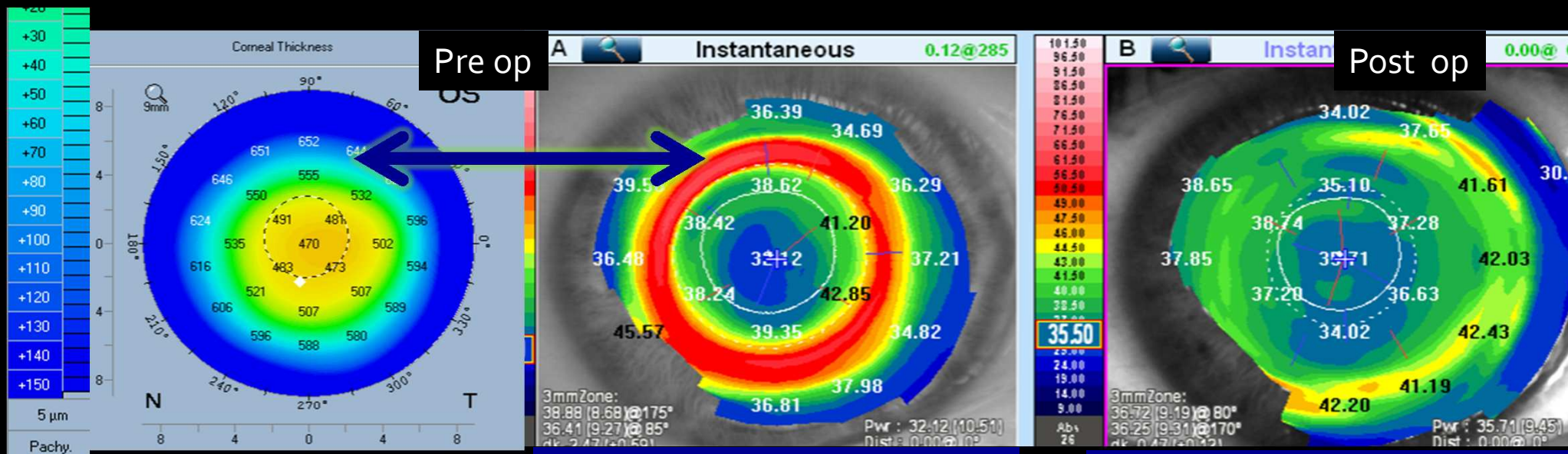
clamidya



Foreign object

# What to do in PTK and enhancement of difficult cases.

- Aim to the minimum ablation possible, BUT do not obtain it with small optical zone → that would induce regression, and persistent visual disturbance

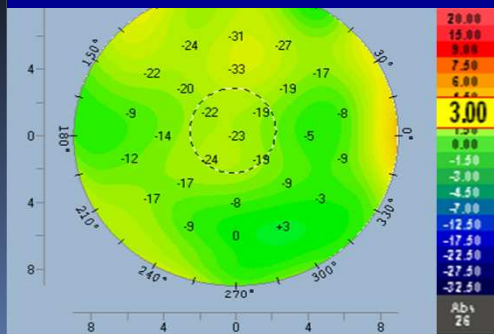


Maximum ablation 25 μ

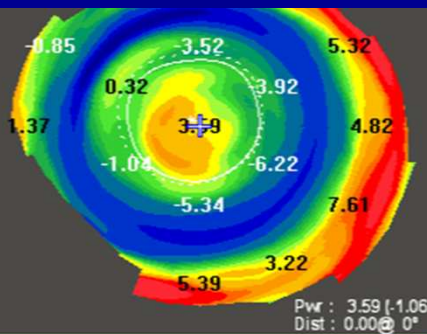
OSV 0,9 +4,25 (-1,75)145

OSV 1,0 -1,50 (-0,50)180

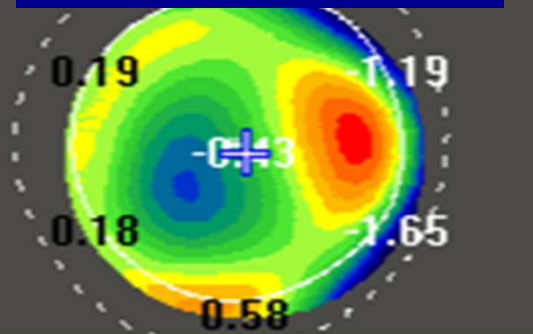
Differential pachymetry map



Differential Tangential map



Differential Wf/corn/map



# Saving tissue in complex cases

- Fix only HOA tolerating the induced refractive changes
- We can set the constrain
- Minimize volume or depth

**Pyramid Refraction** **SCHWIND eye-tech-solutions**

**Laser settings** **OD**

VD: 13.8 mm

	Sphere (D)	Cylinder (D)	Axis (°)
Current:	-4.75	-1.50 X	10
Preview:	-4.75	-1.50 X	10
Residual:	0	0 X	0

**Constraints**

	Range
<input checked="" type="checkbox"/> Tolerance:	0.01 D
<input checked="" type="checkbox"/> Sphere:	0.88 D
<input checked="" type="checkbox"/> Cylinder:	0.63 D
<input checked="" type="checkbox"/> Axis:	8 °

**Current**



Max. ablation: 162  $\mu\text{m}$   
Ablation volume: 7228 nl

**Preview**



Max. ablation: 162  $\mu\text{m}$  ( $\pm 0\%$ )  
Ablation volume: 7228 nl ( $\pm 0\%$ )

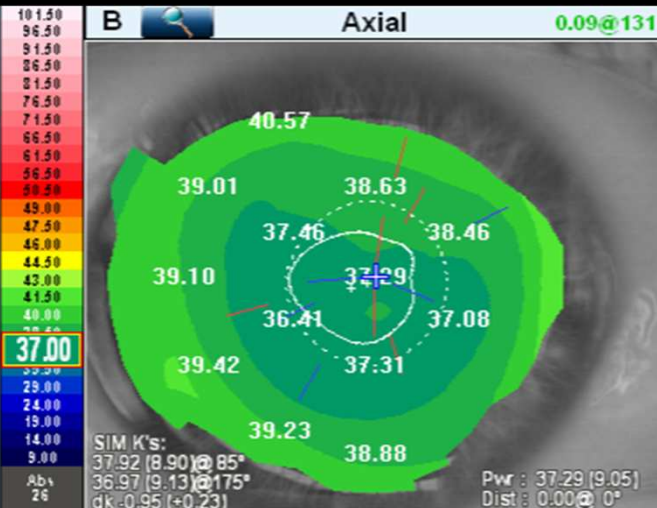
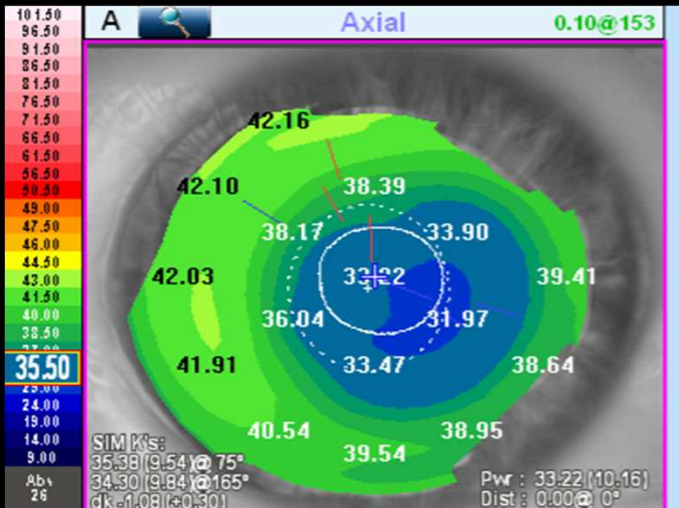
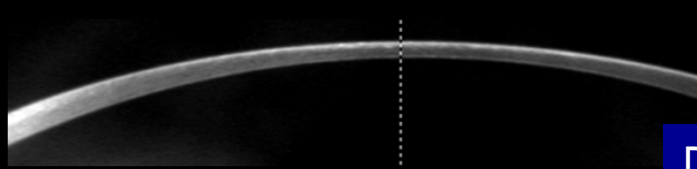
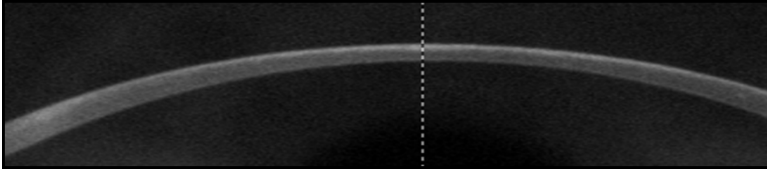
**Residual**

Minimize

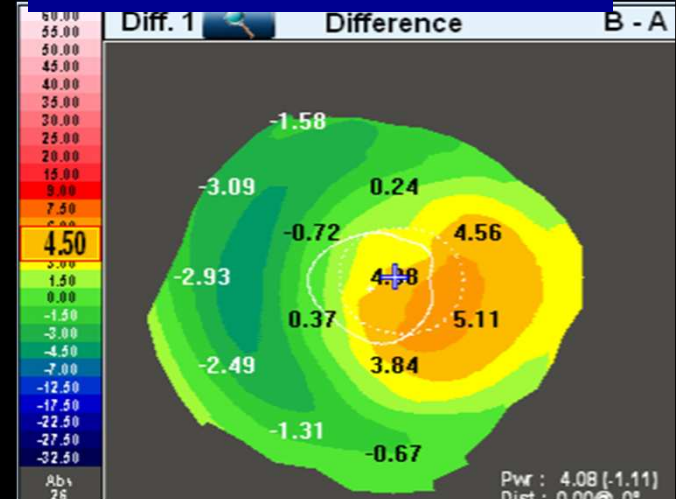
Depth	Volume	Update preview
-------	--------	----------------

Cancel  
Apply  
OK

# PTK can only induce hyperopia



## DIFFERENTIAL AXIAL MAP



ODV 0,6 +2,25(-1,25)75

ODV 0,8 -1,50(-1,00)80

## DIFFERENTIAL AXIAL MAP

