Focal Point: Diagnostica Corneale

Tomografia Corneale: Cosa Aggiunge

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Financial interests: Zeiss, SIFI

OPI
Oculisti della Ospedalità Privata Italiana

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Tomografia Corneale: Cosa Aggiunge

Ma perché mai dovrei usare un tomografo corneale ???

- Studio della cornea
  - Mappe ad elevazione
  - Screening per chirurgia refrattiva
  - Pseudoectasia
  - Ectasia
- Pachimetria
- Chirurgia della cataratta
  - Grading dell'opacità della cataratta
  - TCP
- IOL Fachiche
- Glaucoma
- Imaging cornea e camera anteriore

Pentacam

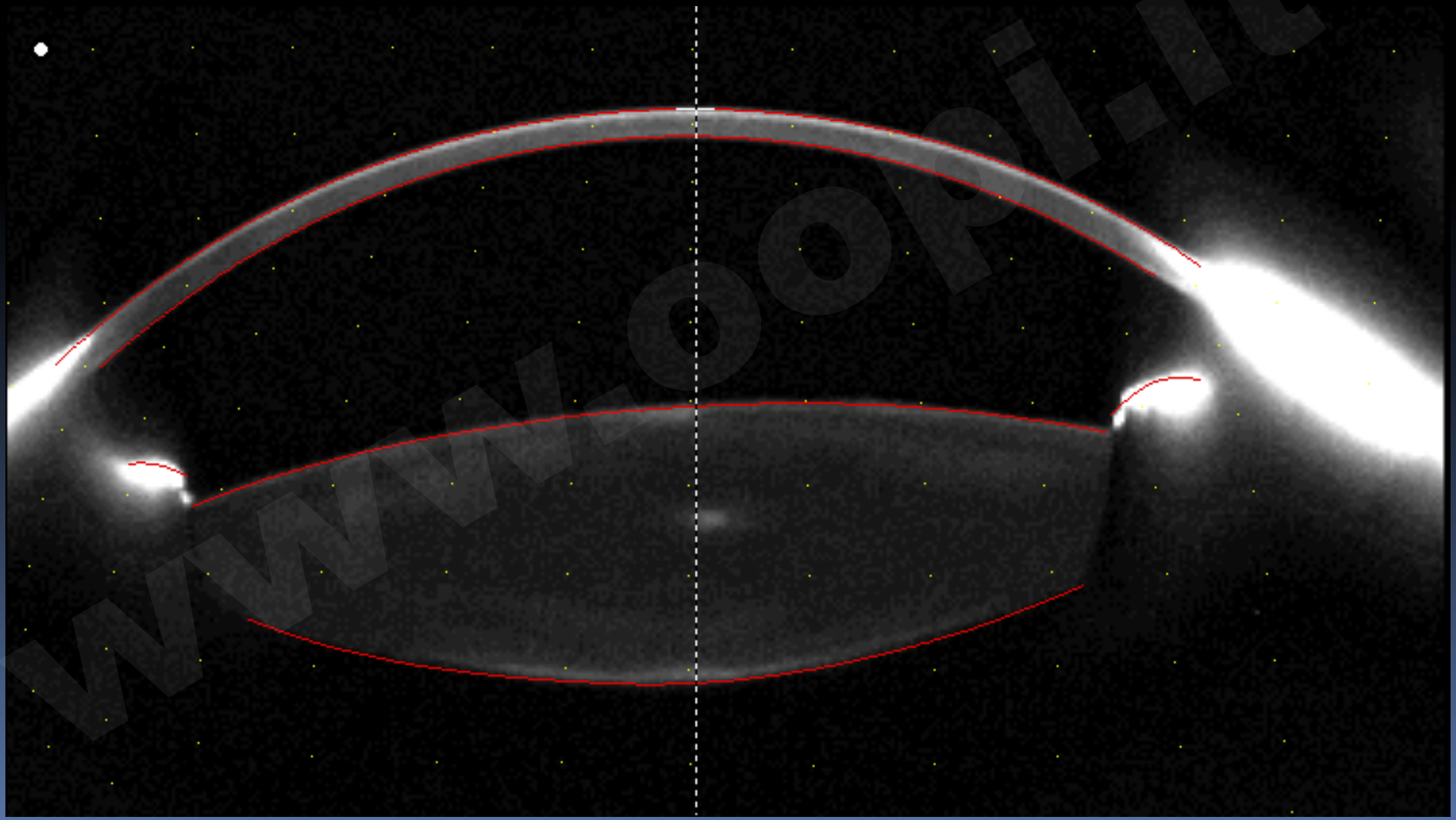
OCULUS

Sirius from CSO

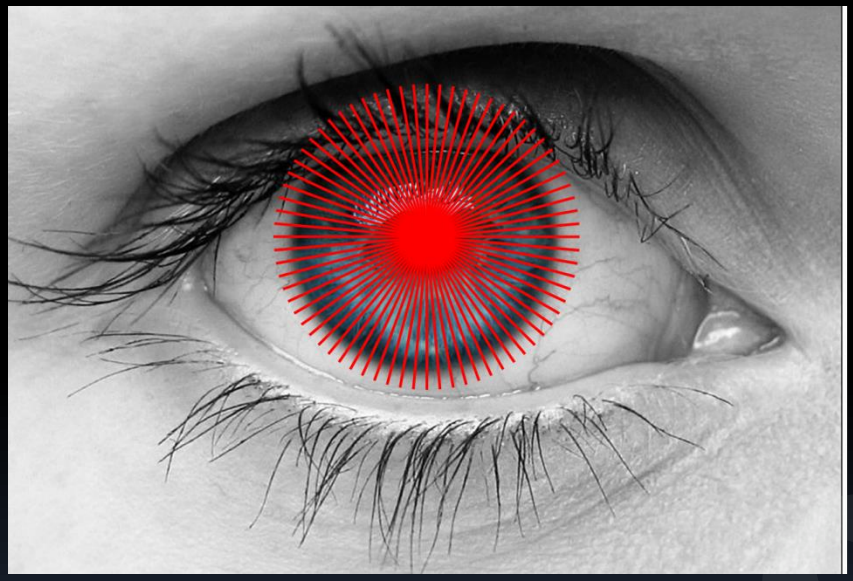
Ziemer Dual Scheimpflug Camera, Galilei

HEIDELBERG ENGINEERING

Identificazione dei margini mediante software dedicato



Confronto tra Scheimpflug (es. Pentacam) vs. Sistemi a Disco di Placido



Scheimpflug

Video Cheratoscopia

Pentacam:
- la maggior parte dei punti misurati è nel centro della cornea (sino a 138000 punti).
- la cornea viene misurata da limbus a limbus
- vengono misurate le superfici corneali anteriore e posteriore

Video Cheratoscopia:
- 25.000 punti
- i valori centrali sono estrapolati
- non misura la cornea estrema
- misura solo la superficie anteriore

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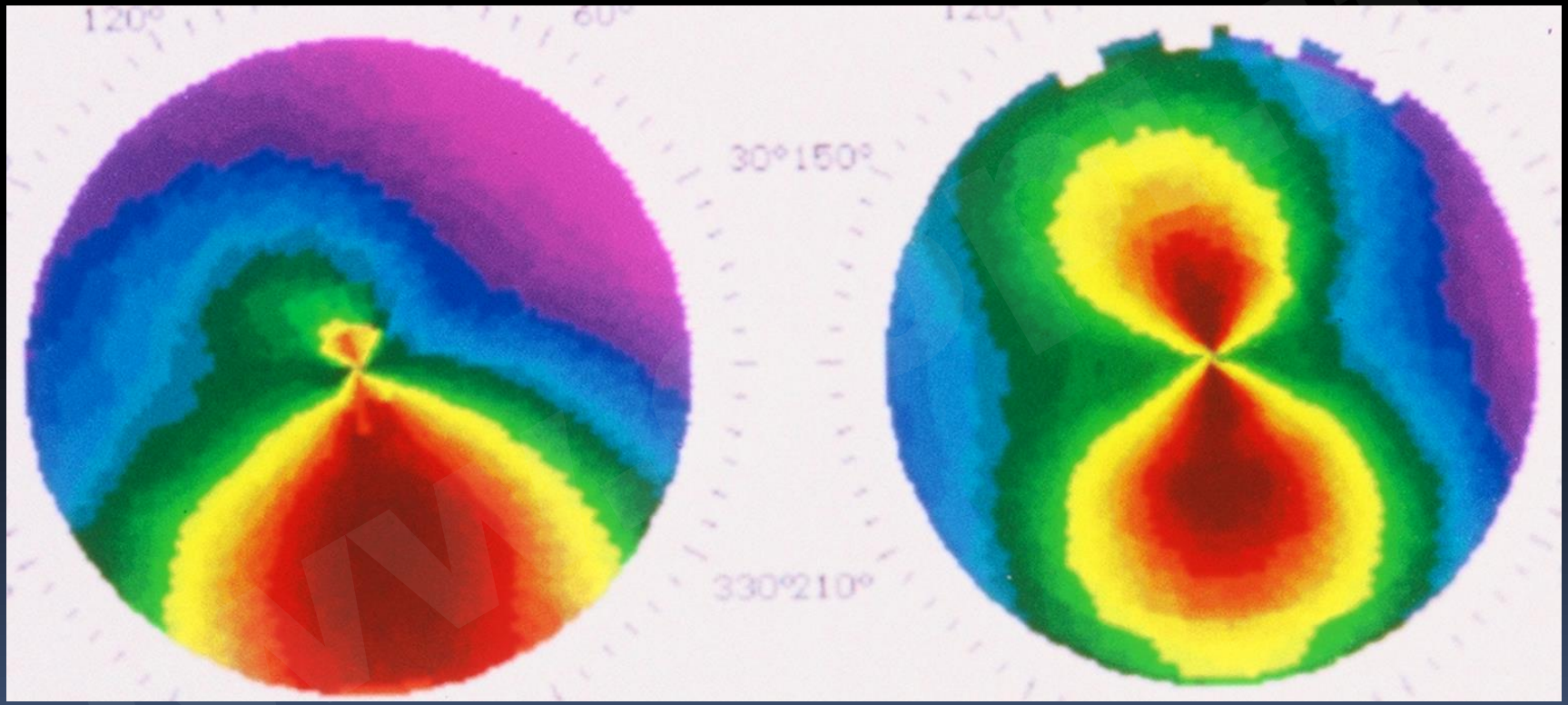
Attenzione Agli Errori !!

Curvatura Corneale Anteriore: Topografia (Disco di Placido)



Basta cambiare l'asse di riferimento…

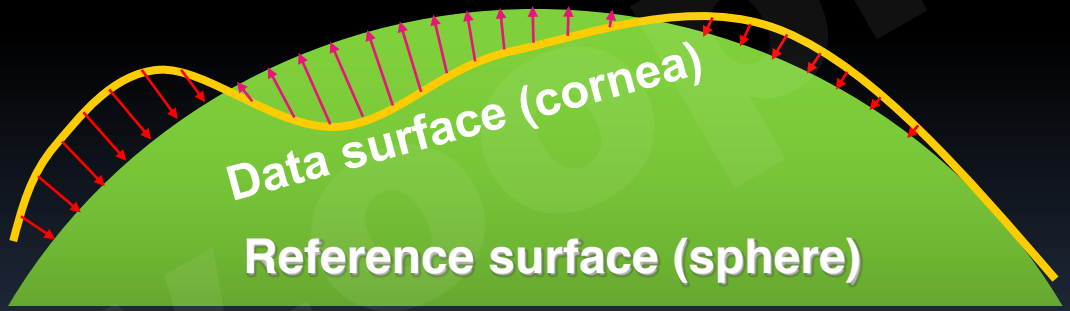
Courtesy of Michael Belin, MD

Mappe ad Elevazione ed Ectasia

Concetto di Forma di Riferimento

Le mappe topografiche della superficie terrestre mostrano i controrni delle zone elevate, misurate partendo dal livello del mare.

Per poter vedere I dettagli più fini, la curvatura globale deve essere rimossa



Per la CORNEA, viene costruita una superficie di riferimento (una sfera, tipicamente) ricercando una superficie di riferimento che si adatti il più possibile alla superficie rilevata

(Best Fit Sphere, BFS)

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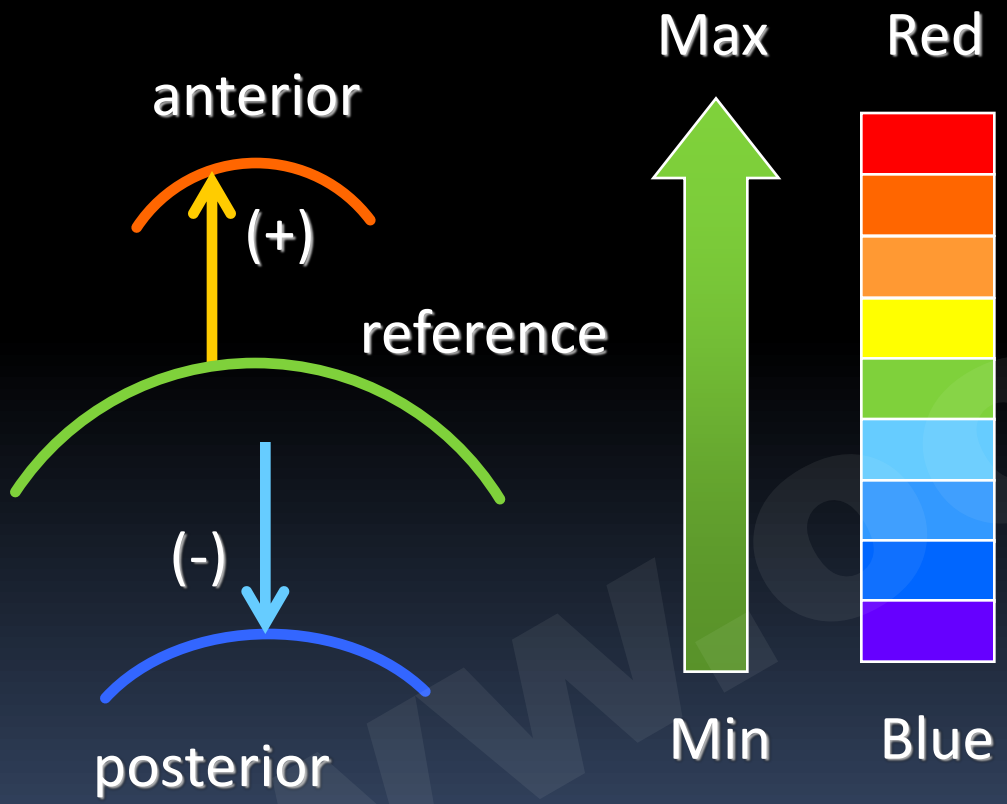
Color Scale: Elevation Map



- high
- anterior to the reference surface

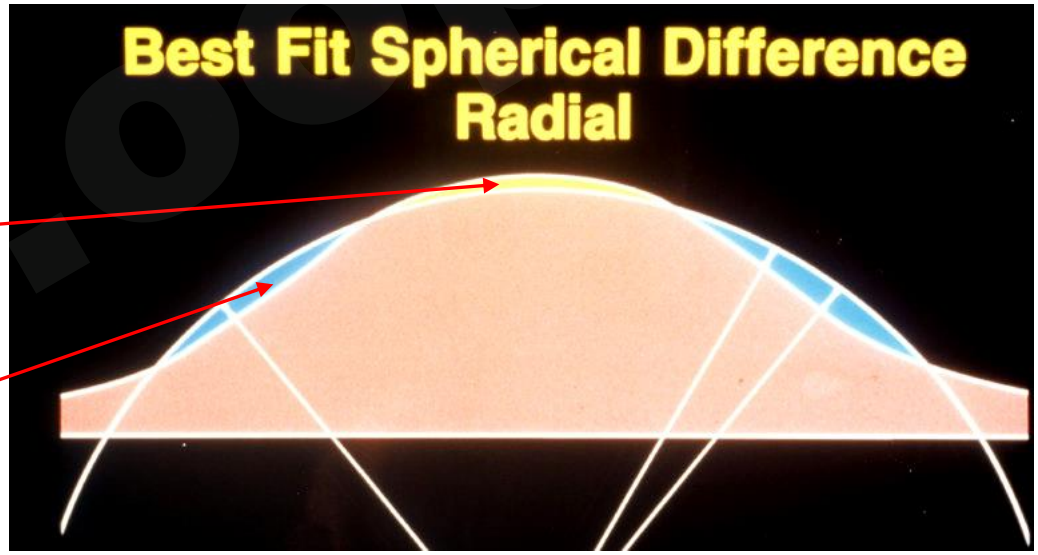
- low
- posterior to the reference surface

- Relative elevation measures height difference in microns from a best-fitting reference body
- In all elevation maps, green is the reference surface or zero level
- Red is high and positive, Blue is low and negative

Presentation of Elevation Data

The most common method is to compare (*amplify*) the raw elevation data to some common shape

- The most common shape used is the Best Fit Sphere (BFS)
- Also used
  - Ellipse
  - Toric Ellipsoid

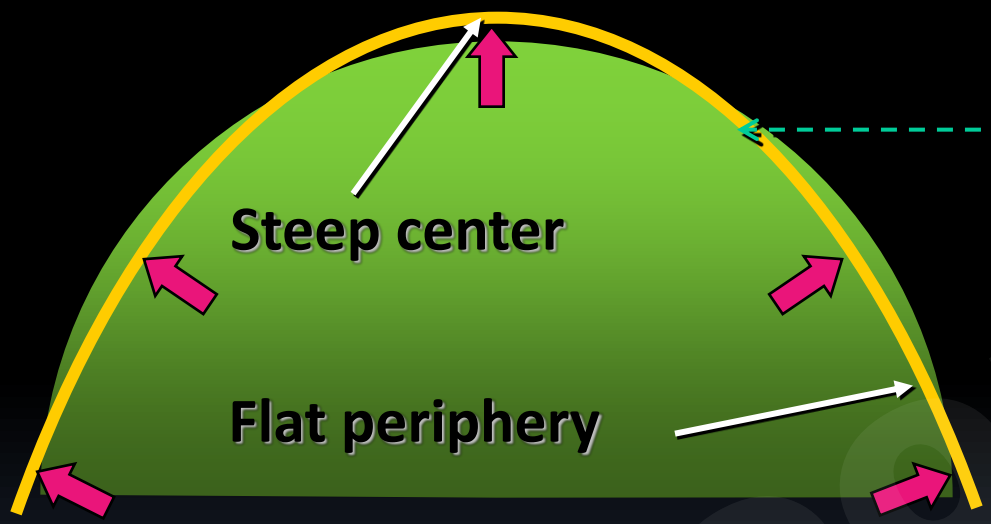


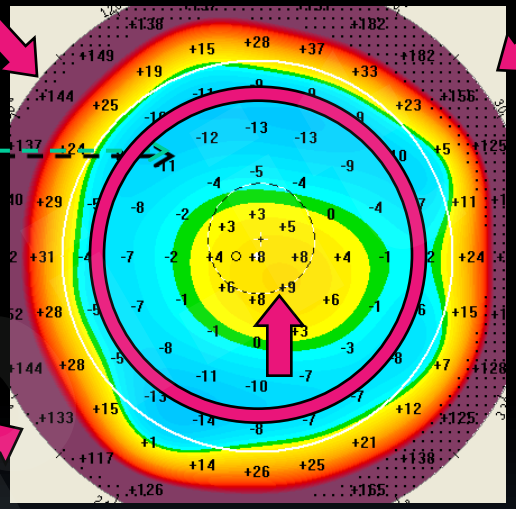
Positive = cornea is above the reference

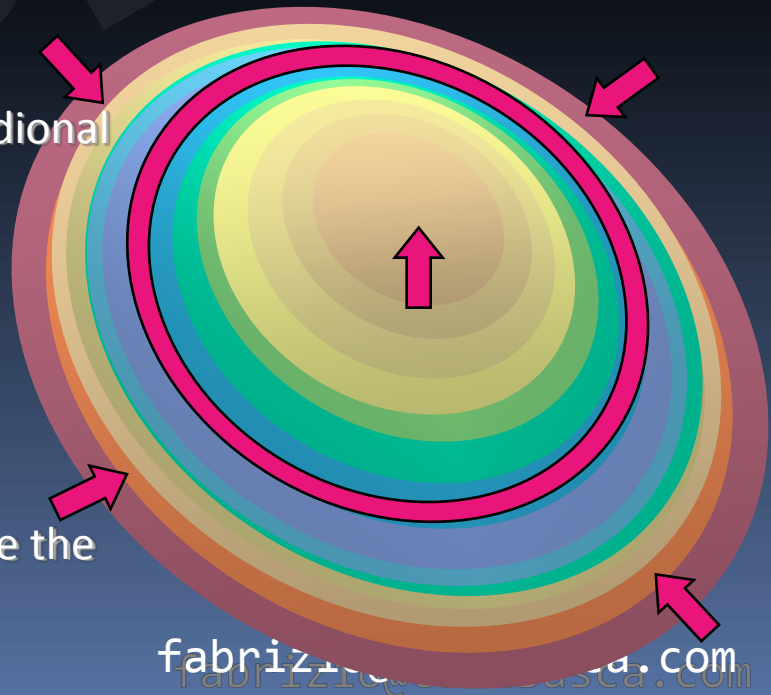
Negative = cornea is below the reference

With courtesy from Prof. Michael Belin

Elevation Maps of the cornea (BFS)







The normal cornea is **prolate, Q < 1**, meaning that meridional curvature decreases from center to periphery.

Prolateness of the normal cornea causes it to rise centrally above the reference sphere. The result is a **central hill**.

Immediately surrounding the central hill is an **annular sea** where the cornea dips below the reference surface.

In the far periphery, the prolate cornea again rises above the reference surface, producing **peripheral highlands**.

With courtesy from Prof. Michael Belin

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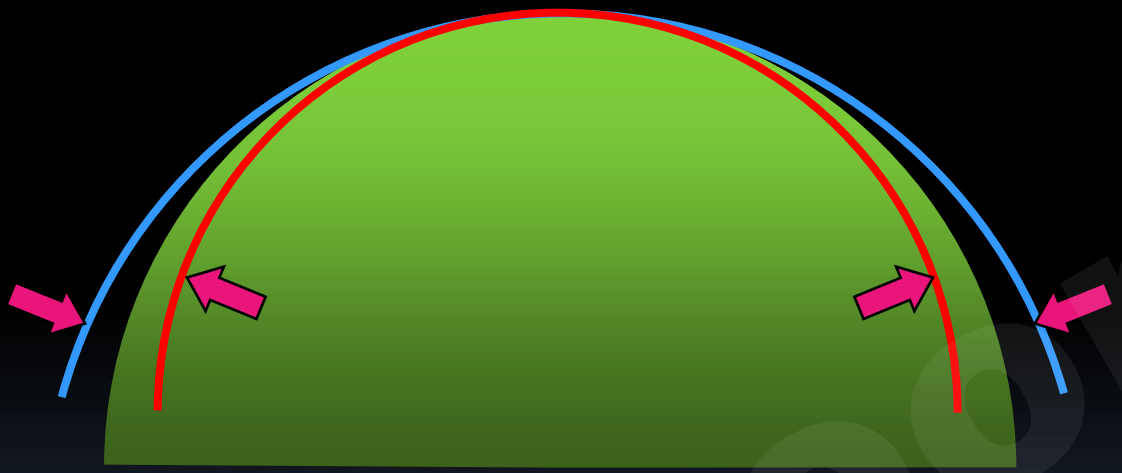
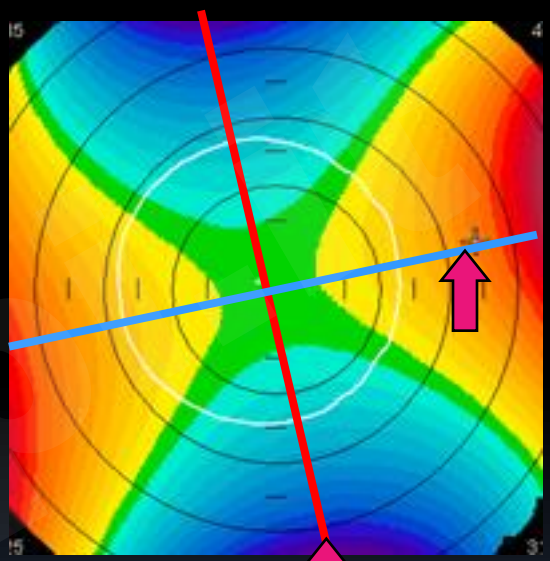
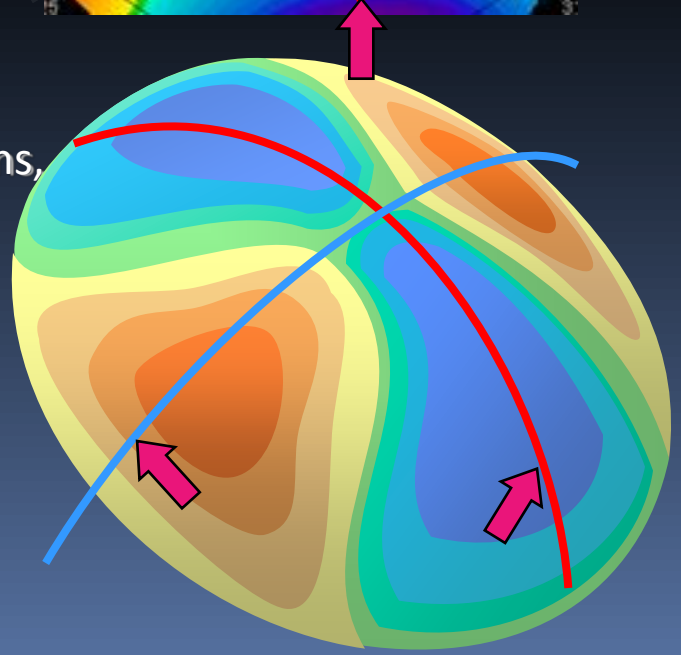
Astigmatic Elevation Maps







The regular astigmatic cornea is **toric**, meaning that meridional curvature has maximum and minimum directions, 90 degrees apart.

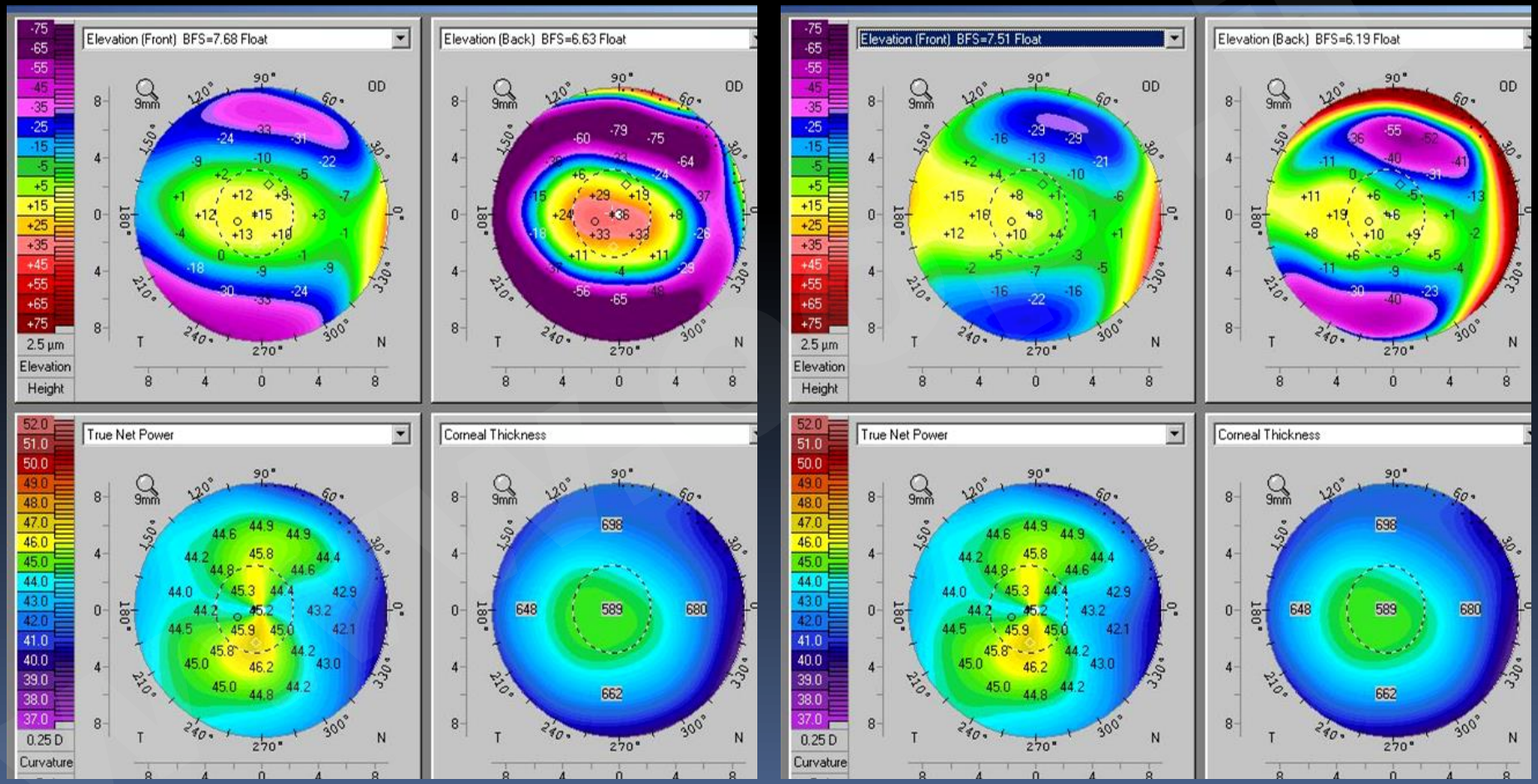
The **sharp (or steep) profile** falls below the reference surface.

The **flat profile** rises above the reference surface.

The resulting elevation topology is a **central saddle**.

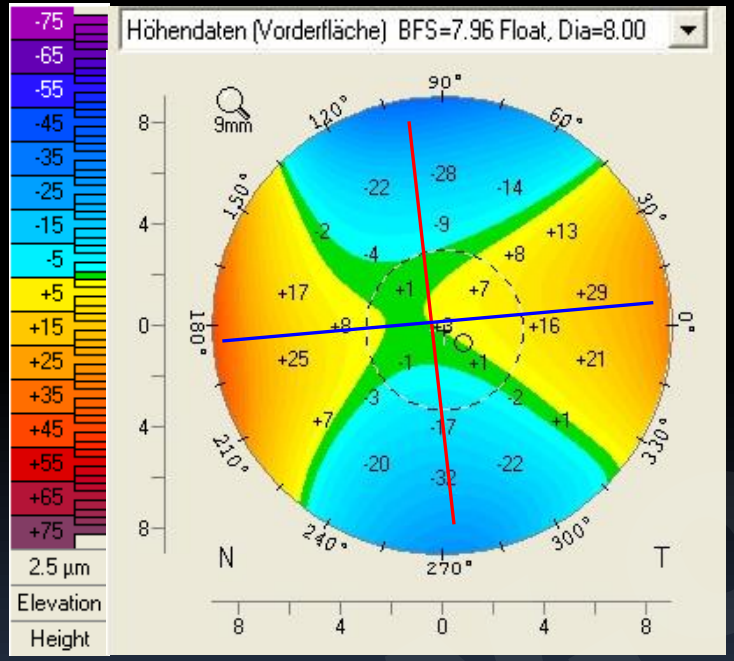
With courtesy from Prof. Michael Belin

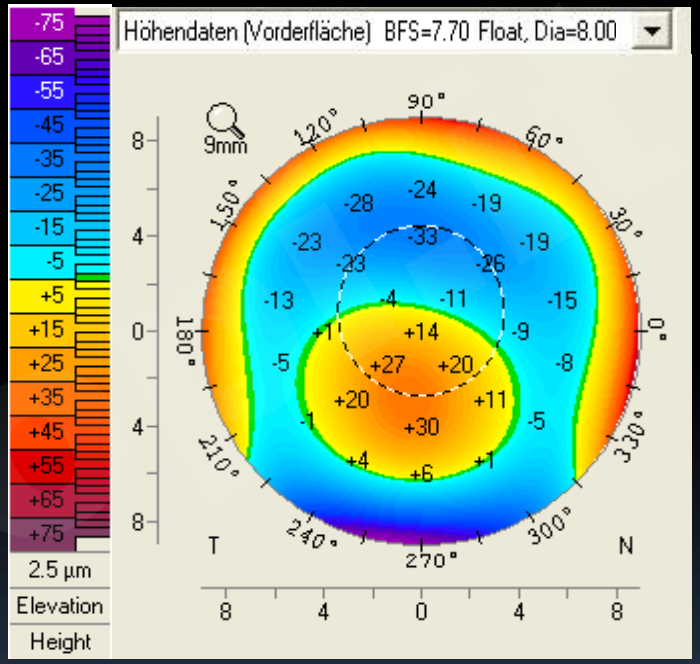
Cos'è Successo Qui ?
Stesso Occhio, Stessa Immagine



Courtesy of Michael Belin, MD

Elevation Maps: Best Fit Sphere (BFS) as Reference Sphere





Astigmatism

Keratoconus

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BAD

- Condizione essenziale dell'ectasia: assottigliamento progressivo
- Mappe pachimetriche elevation-based (Scheimpflug): strumento sensibile
- Misurazione combinata topografica/pachimetrica: meglio
- BAD combina:
  - Cheratometria massima
  - Distribuzione tomografica dello spessore
  - Enhanced elevation
- Enhanced BFS: approssima meglio la cornea normale di un soggetto ed esalta ogni protrusione conica

Ambrosio R Jr, Int Ophthalmol Clin, 2011;51:11-38
Ambrosio R Jr, J Refract Surg, 2011;27:753-8
Belin MW, Elevation Based Topography, Highlights of Ophthalmology, 2008

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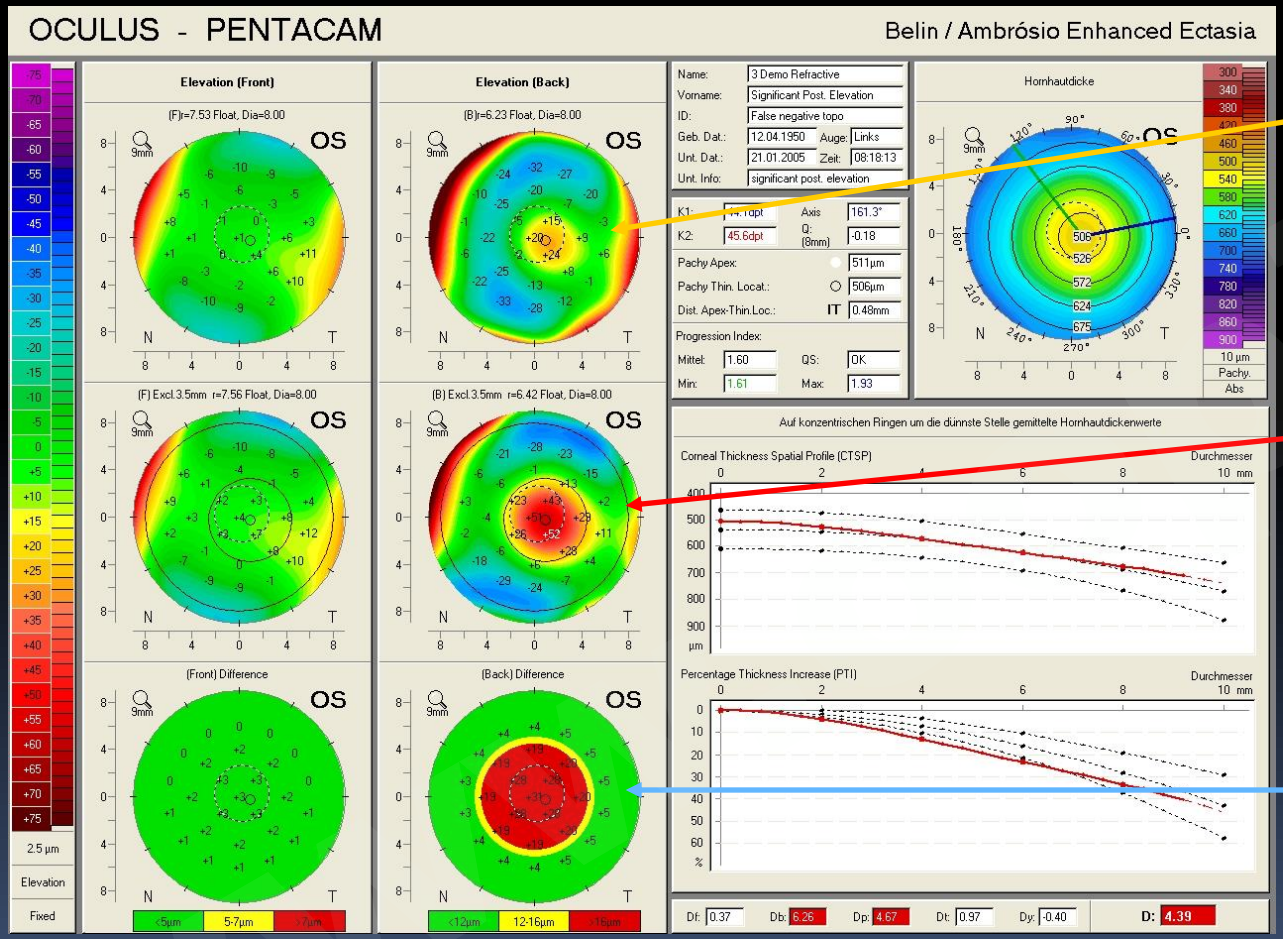
Belin/Ambrosio Enhanced Ectasia Display



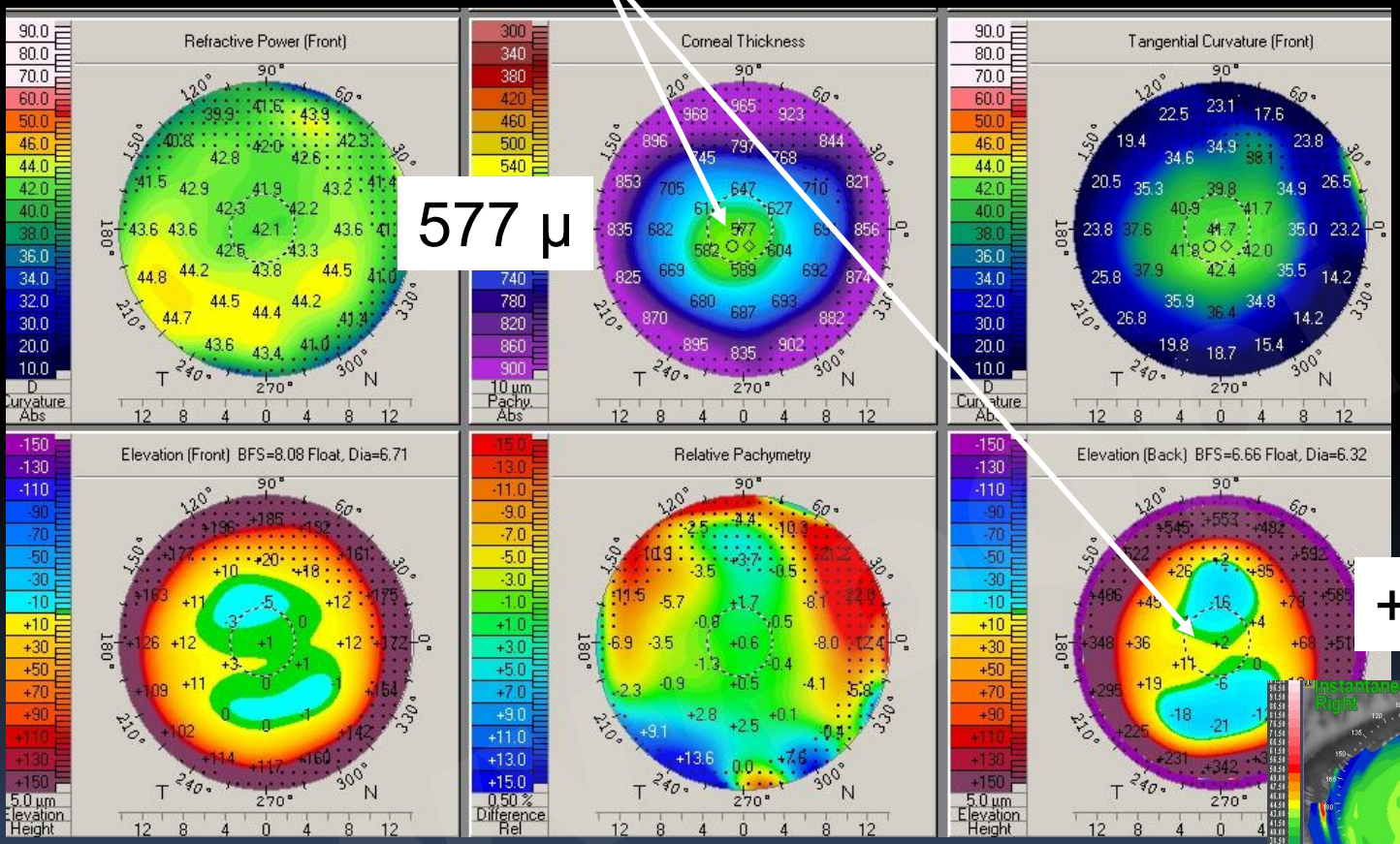
Standard BFS

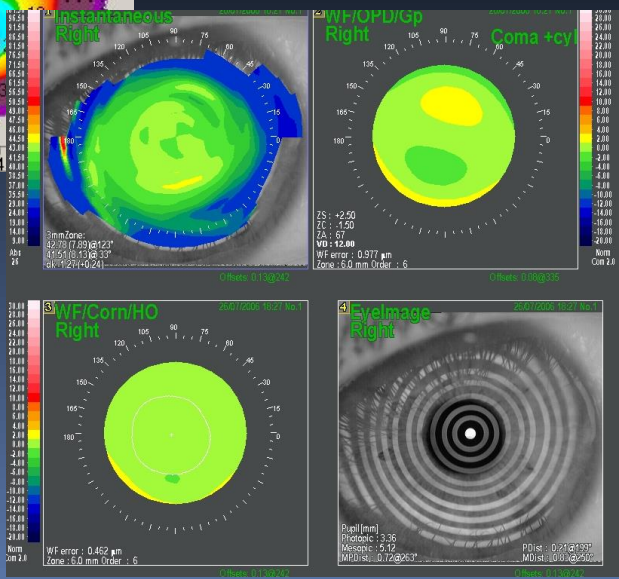
Enhanced BFS

Difference between normal and enhanced BFS

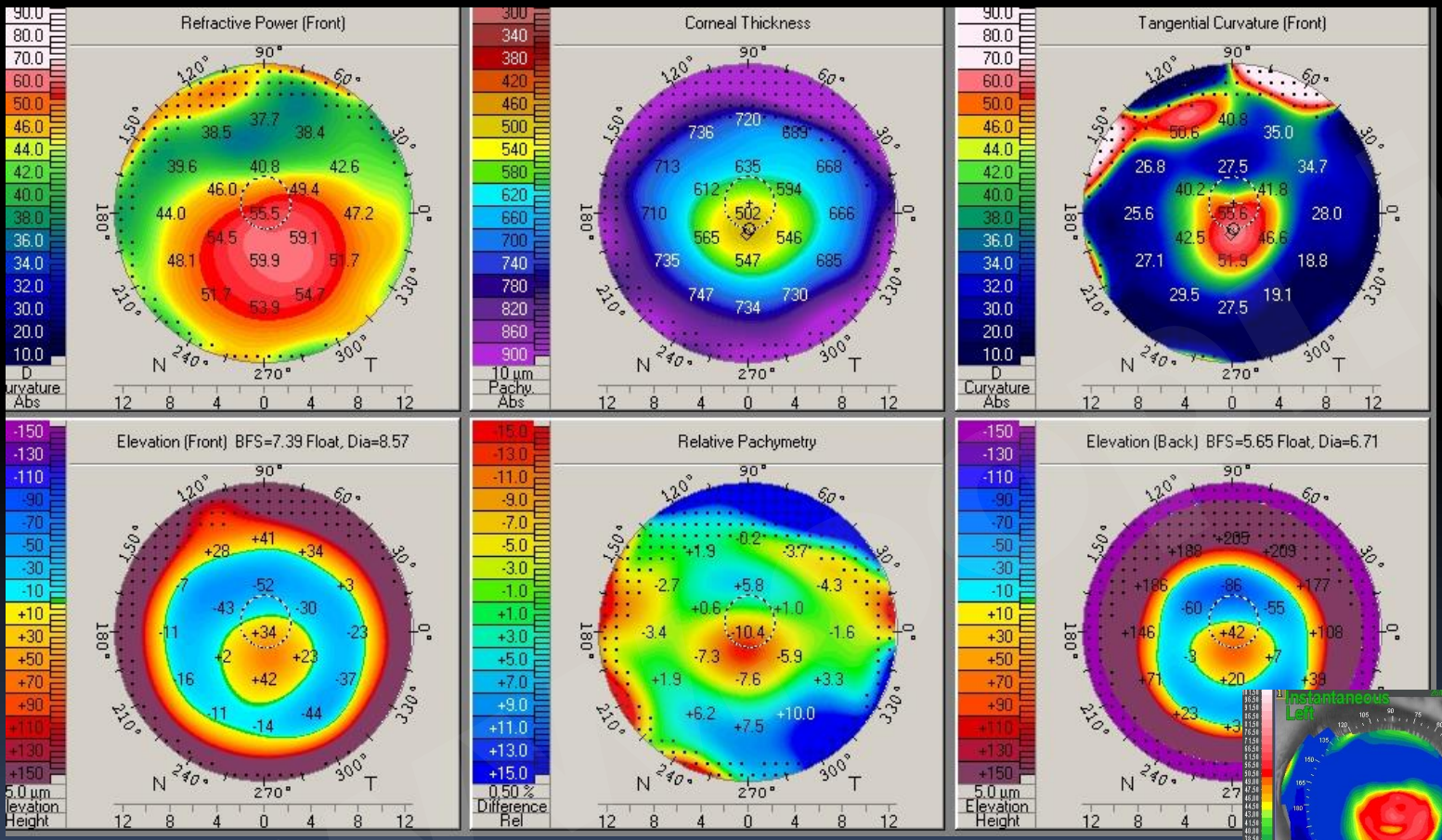
- Signal colours for early keratoconus detection.
- Total Index consisting of 5 single indices.
- Combination of elevation data and pachymetric information, no curvature data.

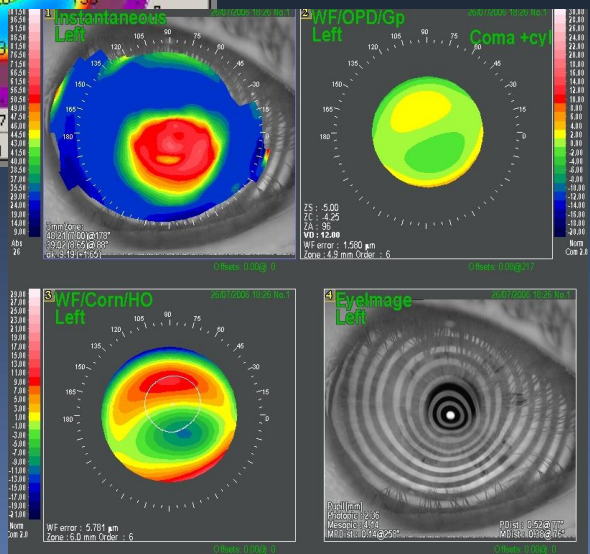
Dei valori normali possono essere ingannevoli…





Occhio controlaterale…





Come Distinguere Ectasia da Pseudoectasia ?

Relazioni Interconnesse: Tomografia

1. Curvatura massima - elevazione anteriore – elevazione posteriore – pachimetria minima
2. Coincidenza dell'elevazione massima anteriore e posteriore
3. Eccentricità del punto più sottile
4. Pattern delle mappe
5. Red on red (Paolo Vinciguerra)

Vinciguerra P, Refr@ctive.online

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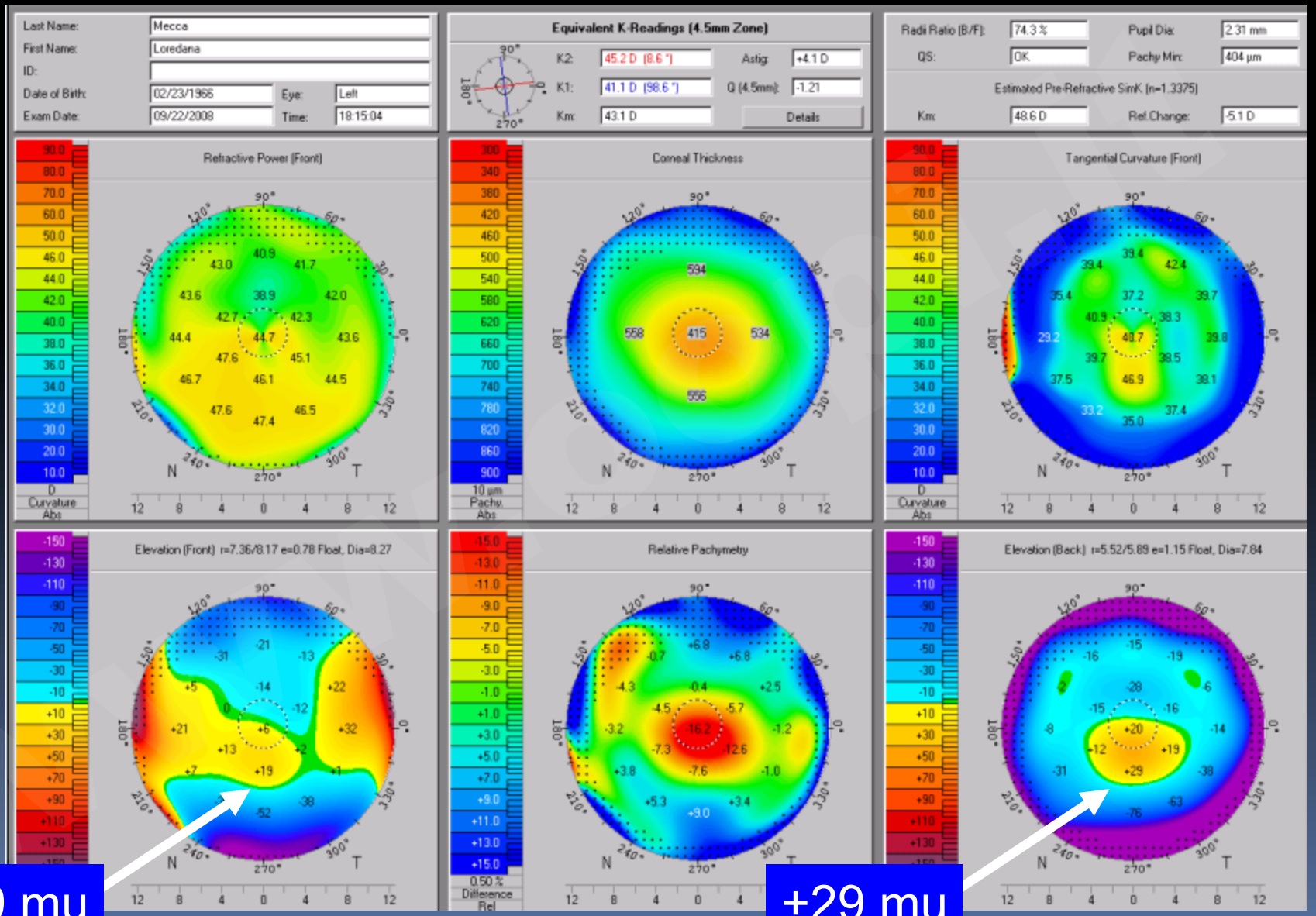
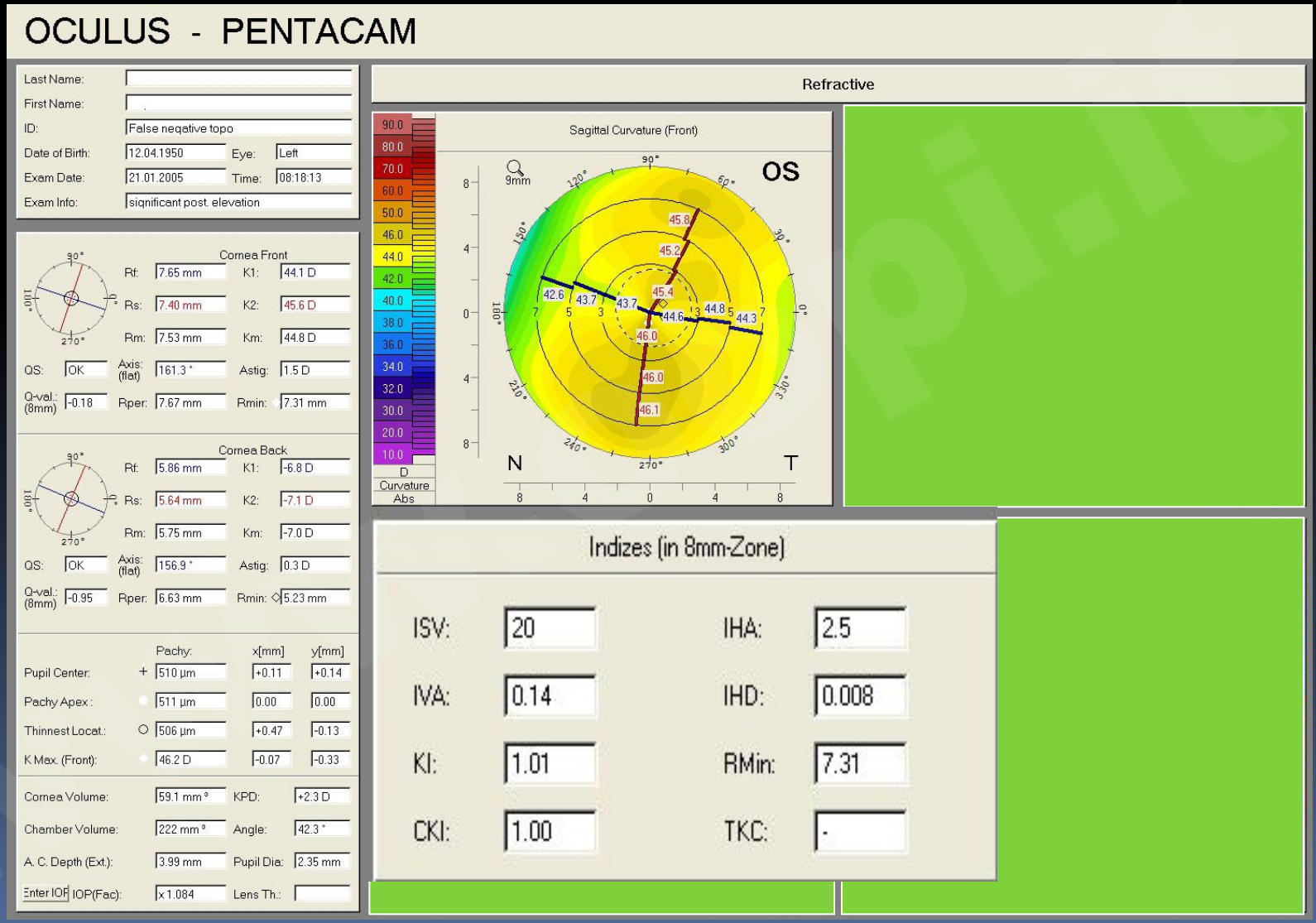
LE 2008 404 µ

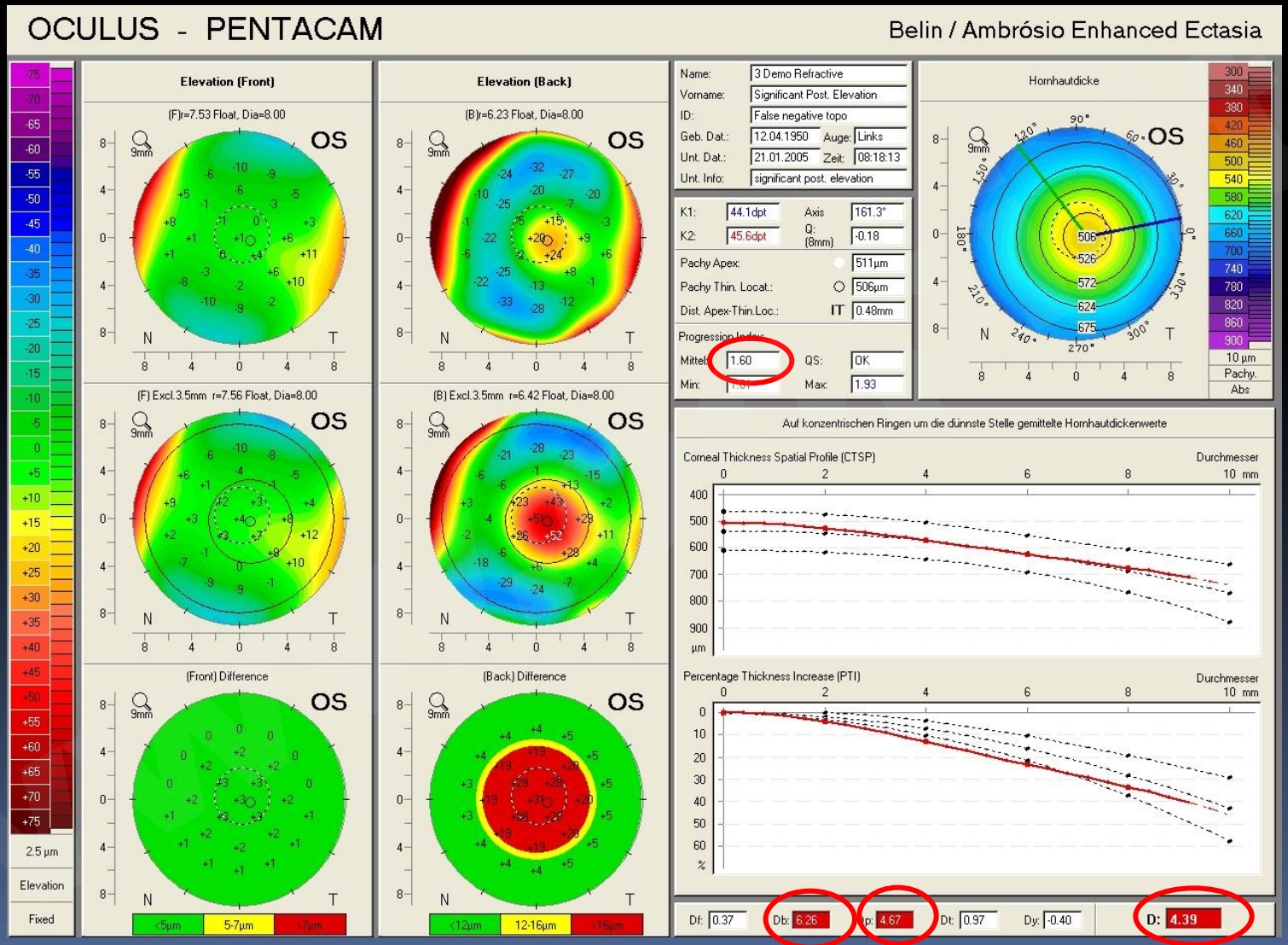

Last Name: Mecca
First Name: Loredana
ID:
Date of Birth: 02/23/1966
Exam Date: 09/22/2008
Eye: Left
Time: 18:15:04
Equivalent K-Readings (4.5mm Zone)
K2: 45.2 D (8.6 °)
K1: 41.1 D (98.6 °)
Km: 43.1 D
Astig: +4.1 D
Q (4.5mm): -1.21
Details
Radii Ratio (B/F): 74.3 %
QS: OK
Pupil Dia: 2.31 mm
Pachy Min: 404 µm
Estimated Pre-Refractive SimK (n=1.3375)
Km: 48.6 D
Ref.Change: -5.1 D
Refractive Power (Front)
Corneal Thickness
Tangential Curvature (Front)
Elevation (Front) r=7.36/8.17 e=0.78 Float, Dia=8.27
Relative Pachymetry
Elevation (Back) r=5.52/5.89 e=1.15 Float, Dia=7.84
+19 mu
+29 mu

How would you decide?



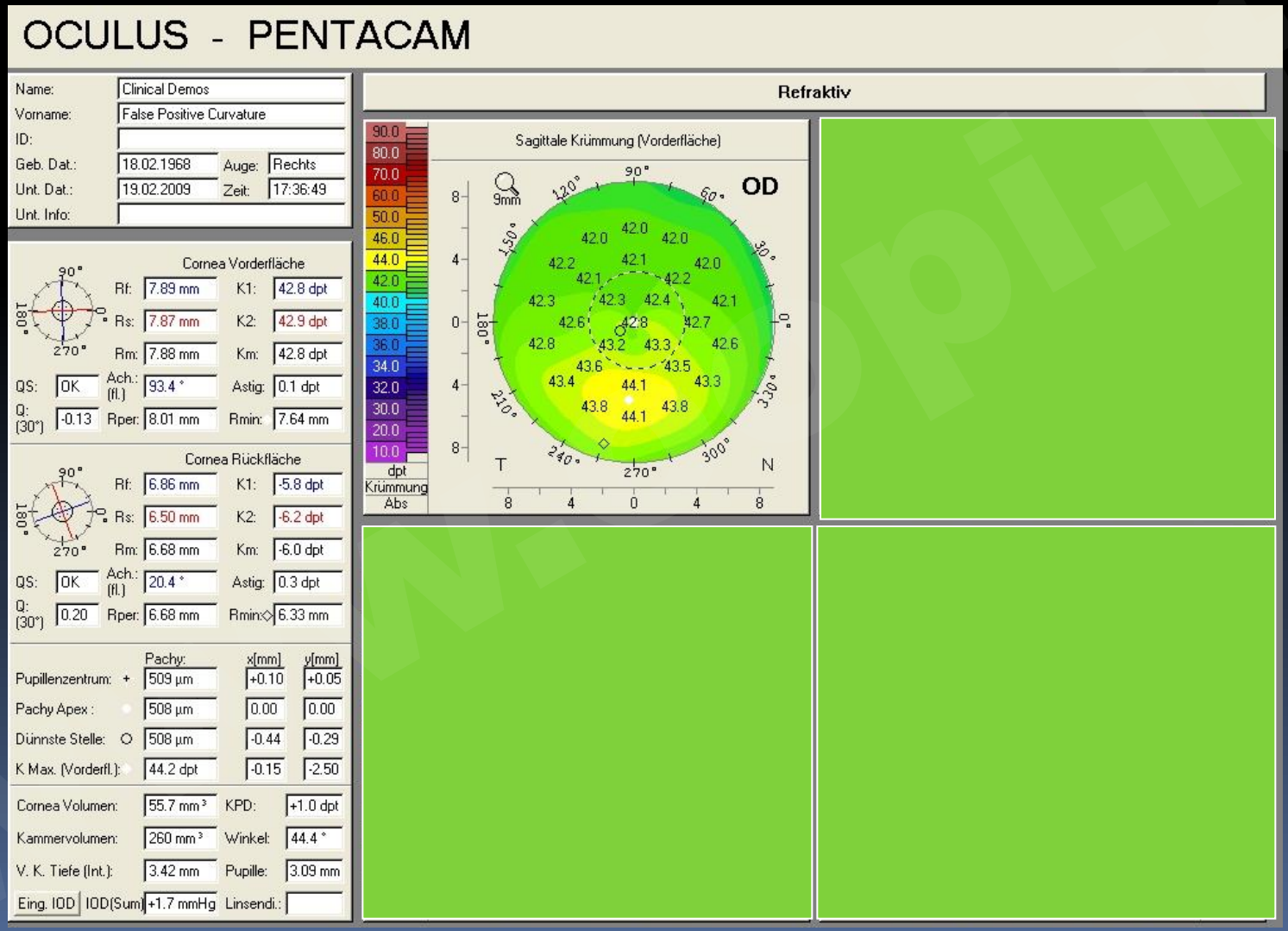
With courtesy from Renato Ambrosio

False-negative Topography, early Ectasia



With courtesy from Renato Ambrosio

How would you evaluate this case? *



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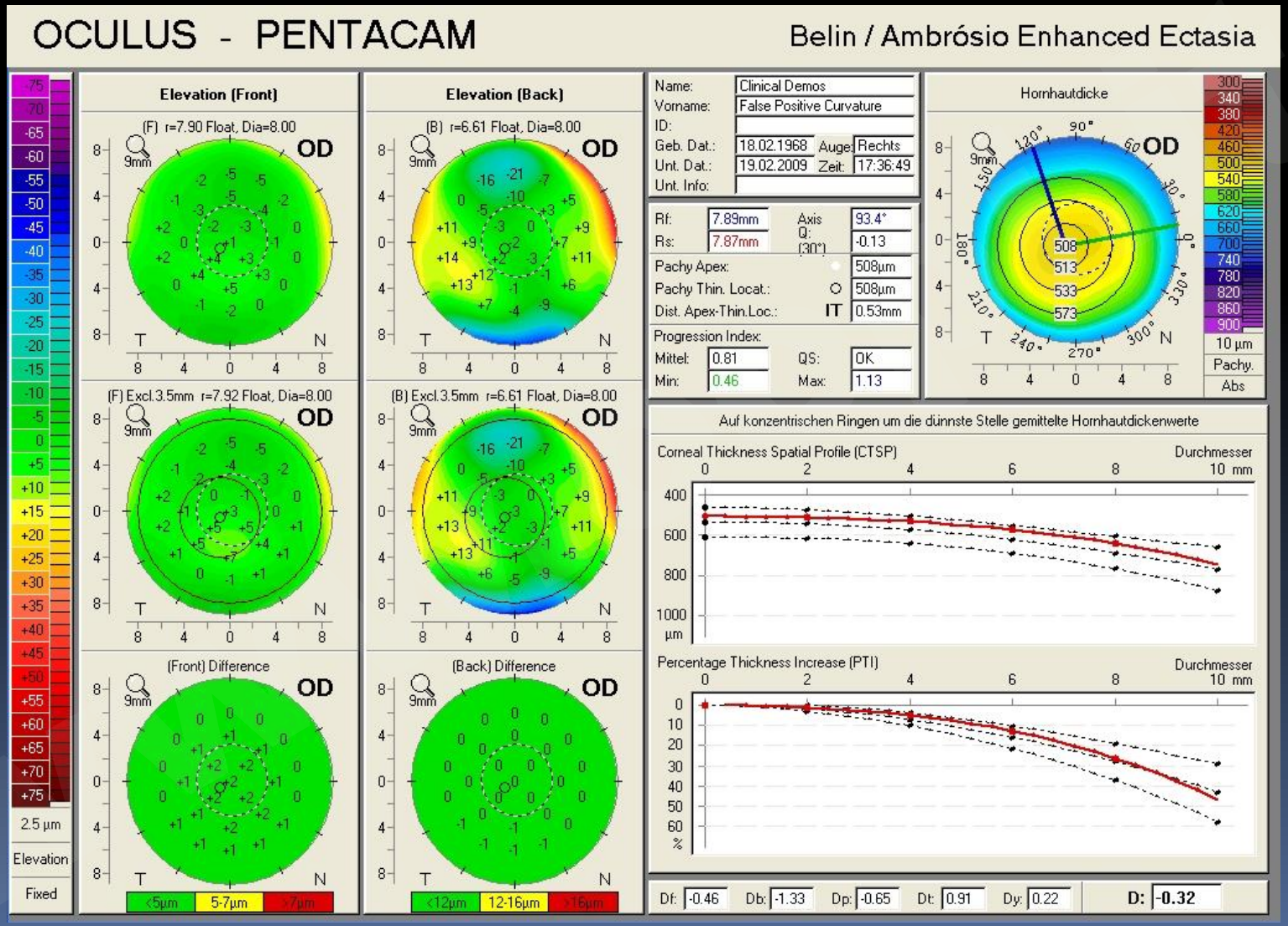
False positive Topography - Corneal Warpage



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Pachimetria

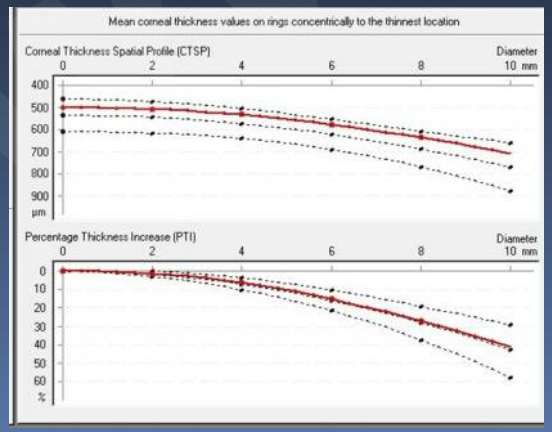
Corneal Thickness Spatial Profile

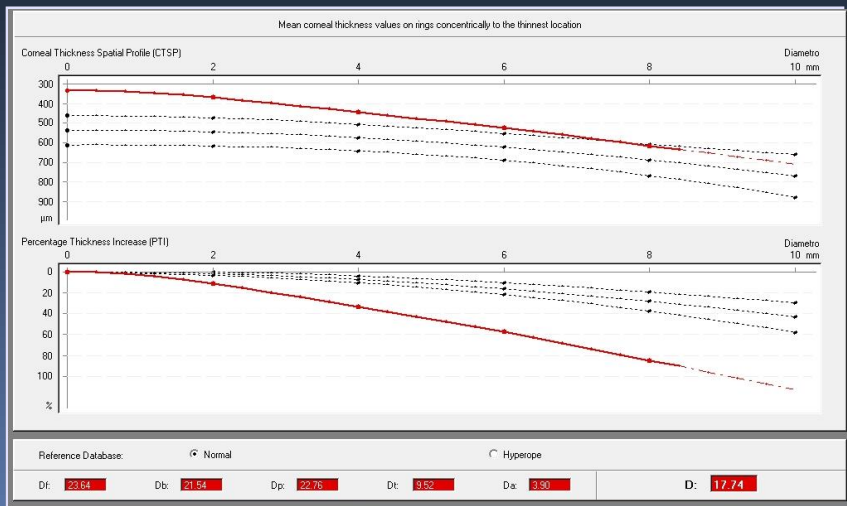
β

sequenza di valori pachimetrici lungo 22 cerchi concentrici a diametro progressivamente maggiore, iniziando e centrati sul punto più sottile (TP)

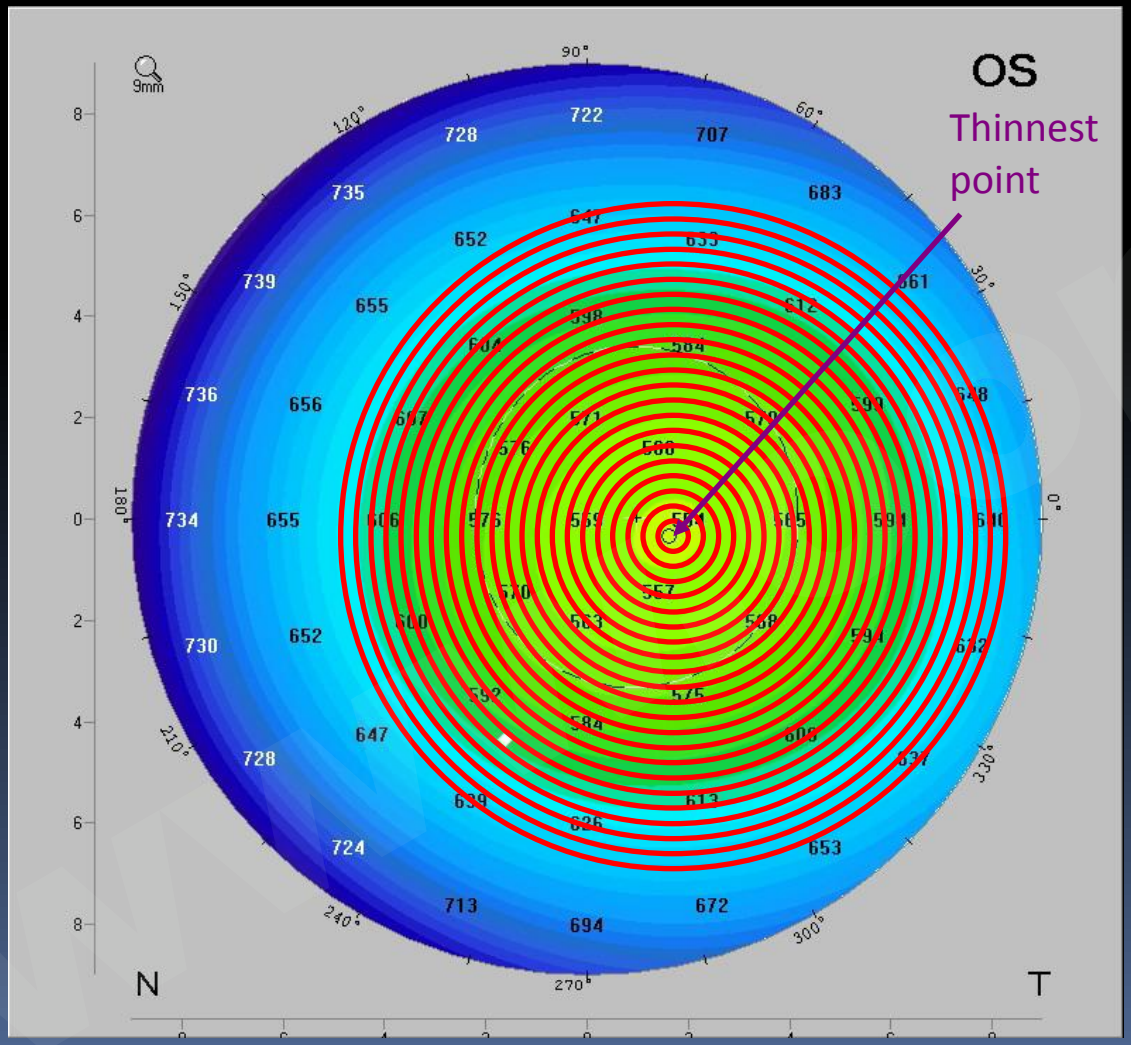
Percentage Thickness Increase

aumento in percentuale dello spessore lungo 22 cerchi immaginari centrati sul punto più sottile, permettono di differenziare una
cornea sottile normale da una
una affetta da iniziale
malattia ectasica

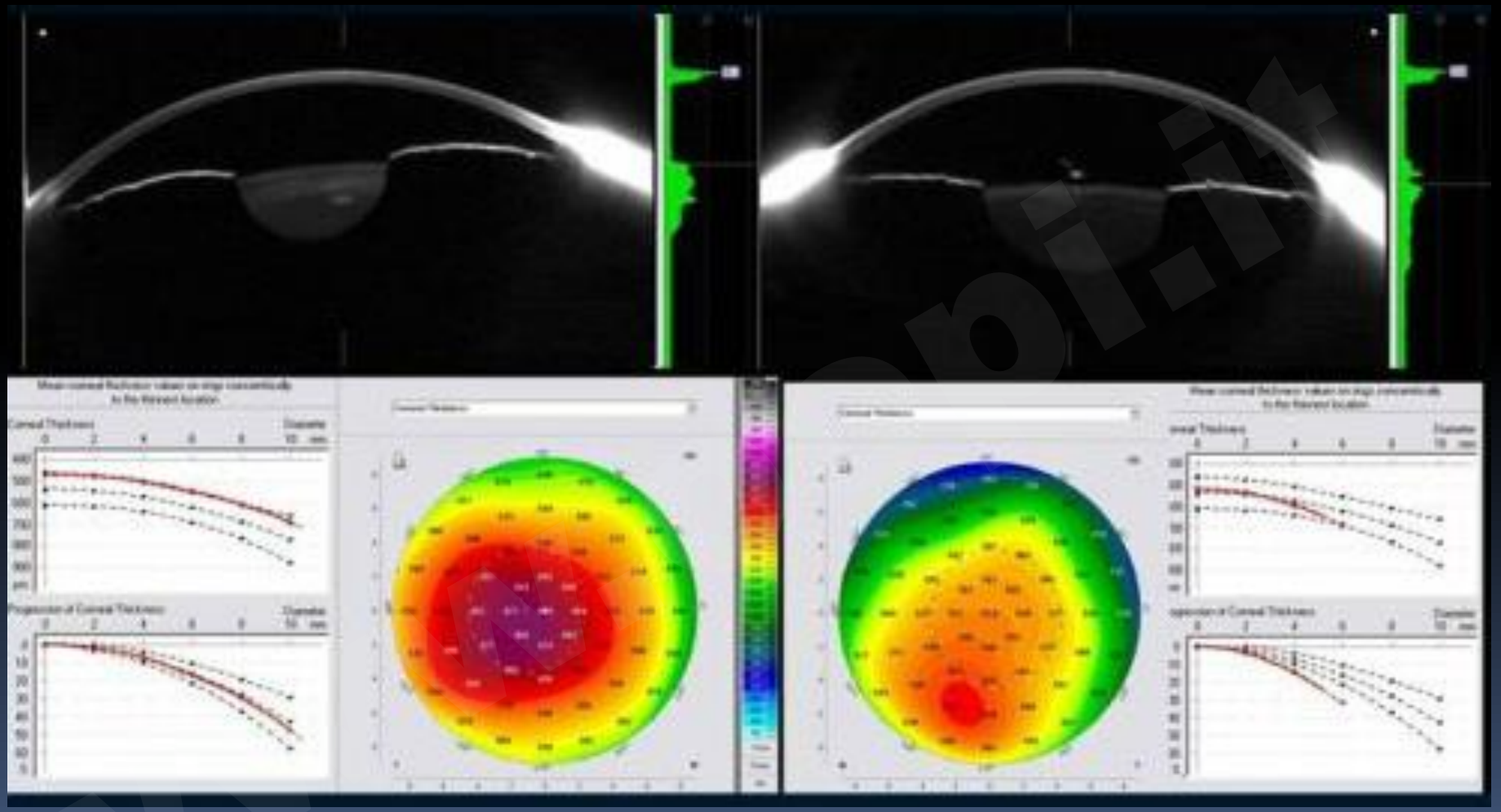




Corneal Thickness Spatial Profile



- Evaluation of the thinnest point
- Concentric rings around the thinnest point
- Evaluation of the mean corneal thickness of each ring.
- Analysis of the thickness progression between each ring



Courtesy of Renato Ambrosio, MD

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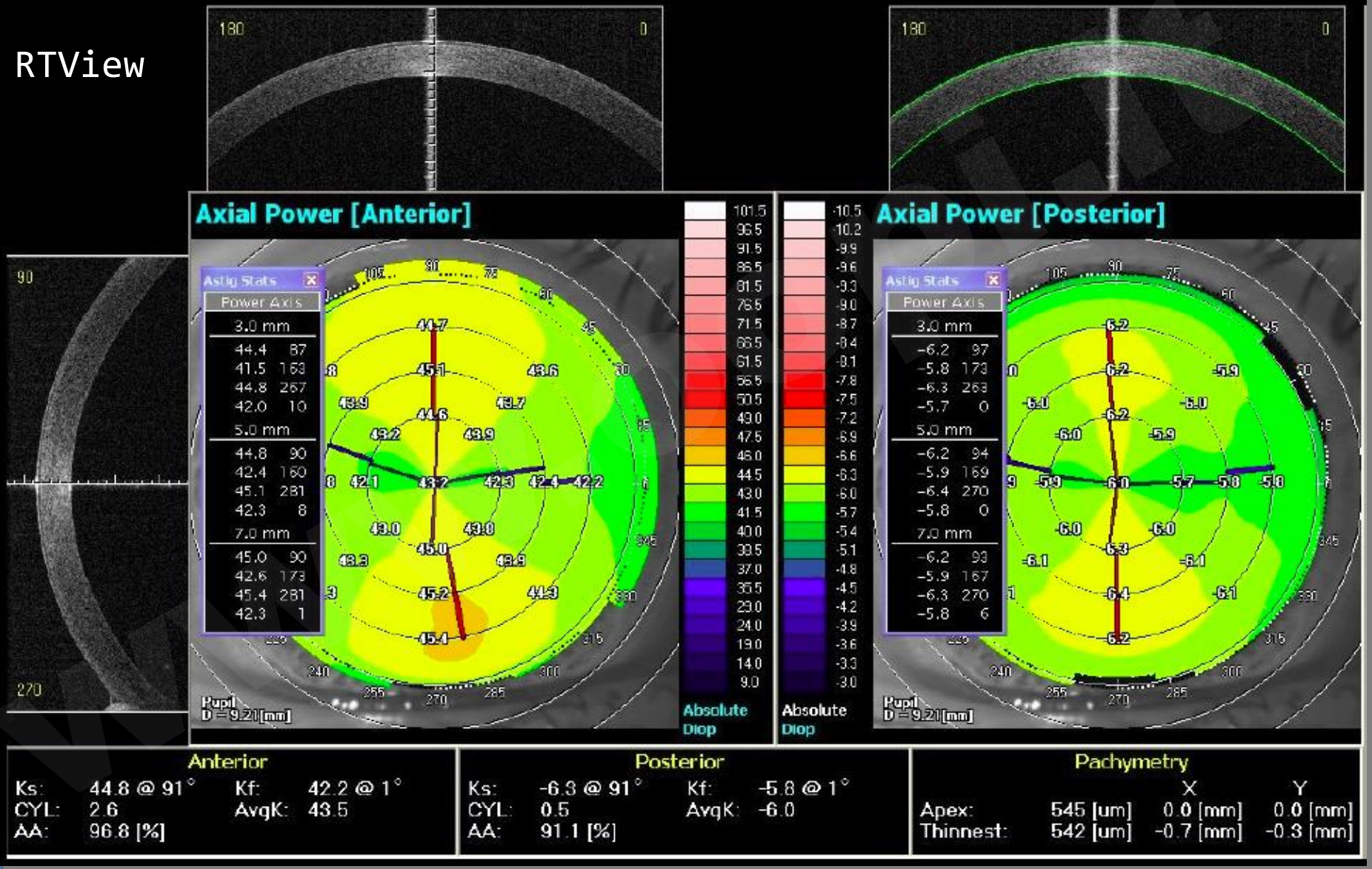
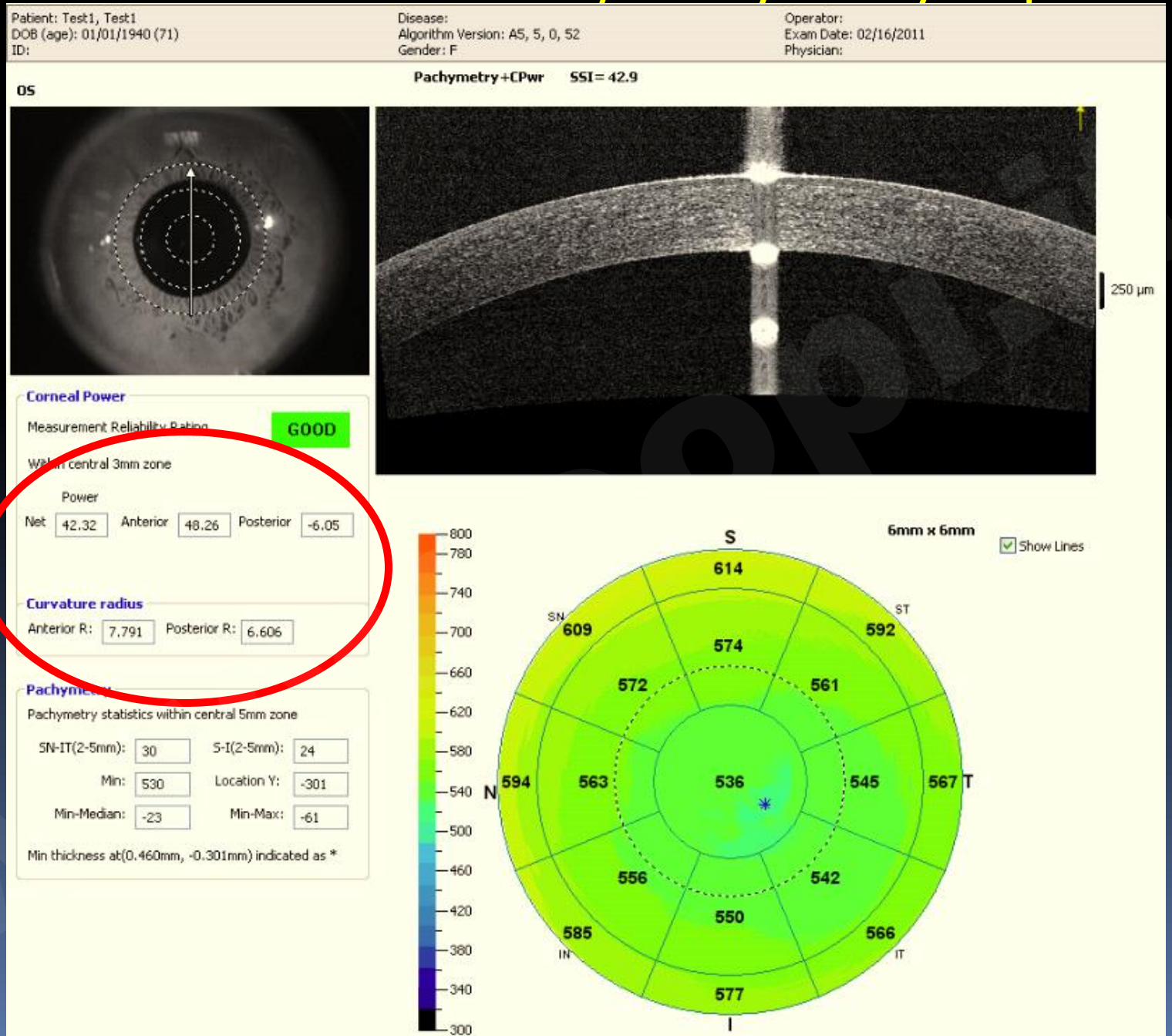
Spessore Corneale e Misurazione del Potere Corneale (TCP)

RTView



RTVue Corneal Power/Pachymetry Report



TCP

- I cheratometri ed i topografi misurano la superficie corneale anteriore
- Estrapolano la superficie posteriore
- Il cambiamento di curvatura e spessore della cornea post-chirurgia refrattiva porta ad una variazione in curvatura – e quindi anche in potere – della cornea posteriore
- Rischio di errore aumentato in pazienti sottoposti a chirurgia refrattiva.
- TCP misura direttamente le superfici anteriore e posteriore fornendo un potere corneale più accurato utile, ad es., nel calcolo delle IOL

Total corneal astigmatism, important for toric IOL's?

Anterior surface only?
Is the posterior surface really important?

"Accuracy of Corneal Astigmatism Estimation by Neglecting the Posterior Corneal Surface Measurement":

10% of eyes with more than 1 D of astigmatism:

- difference in magnitude > 0.5 D
- or difference in angle > 10° (30 % remaining astigmastism) between anterior and total astigmatism.

JAU-DER HO, CHING-YAO TSAI, AND SHIOW-WEN LIOU; © 2009 BY ELSEVIER INC. ALL RIGHTS RESERVED. 0002-9394/09/$36.00; doi:10.1016/j.ajo.2008.12.020

Conclusion, the posterior surface should be considered in terms of angle and amount of the astigmatism

Total Corneal Refractive Power

Clinical use:

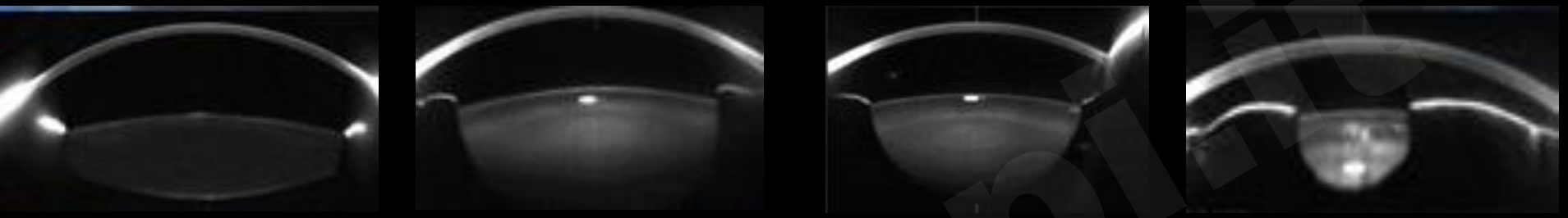
- improved IOL calculation – new Pentacam (LI biometry)
- orientation of toric IOL's
  - selecting the correct axis for implantation
  - Pentacam can/should be linked to online systems (Orange etc)
  - premium IOL's, high patients expectations
- patients selection criteria (eye properties):
  - regular astigmatism
  - corneal asti > 1dpt

Chirurgia della Cataratta

- Valutazione oggettiva dell'opacità del cristallino
- Ruolo della superficie corneale post. nel calcolo delle IOL toriche
- IOL fachiche

Pentacam Nucleus Staging

Staging Example



Pentacam Nucleus Staging:

A software integrates sectional images, providing 3D images of opacity.
The Pentacam-based lens opacity evaluation system grades lens opacity ranging from 0 to 3

Lens Transparency After Cross-Linking: Evaluation with Scheimpflug (Pentacam)

Results

Mean UCVA and BSCVA:

preoperative :180/20 and 20/40

3 years after CXL: 20/50 and 20/25 ($p<.05$)

SE: reduction of 0.96 D

Mean simulated keratometry: reduced ($p<.05$)

Endotelial Cell Counts : unchanged ($p=.13$).

Lens transparency, measured with the Scheimpflug system, three years after CXL remained unchanged, always transparent

Time Interval	Preoperative	1 year	*p*	2 years	*p*	3 years	*p*
Mean opacity (%) (mean ± SD) (range: min to max)	9.05 ± 1.31 (7.30 – 12.70)	8.84 ± 1.00 (7.60 – 11.50)	ns	9.29 ± 1.25 (7.50 – 12.10)	ns	9.15 ± 1.02 (8.00 – 10.90)	ns
Crystalline lens opacity grading scale value	0 - 1	0 - 2	ns	0 - 1	ns	0 - 1	ns

Vinciguerra P, Camesasaca FI, Ophthalmology 2009

Phakic IOLs

- angle supported (NuVita MA 20 B&L)
- iris fixated (Verisys, Artisan), spheric and toric
- angle fixated (Cachet, ALCON)
- ICL (behind the iris in front of the crystalline lens): Staar, spheric and toric

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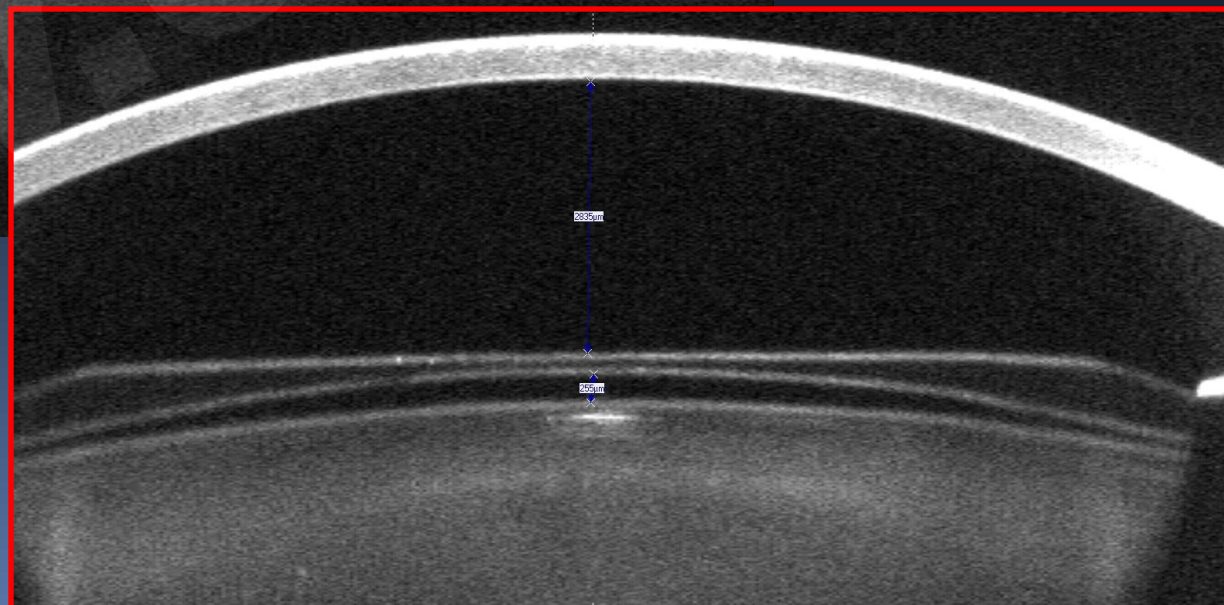
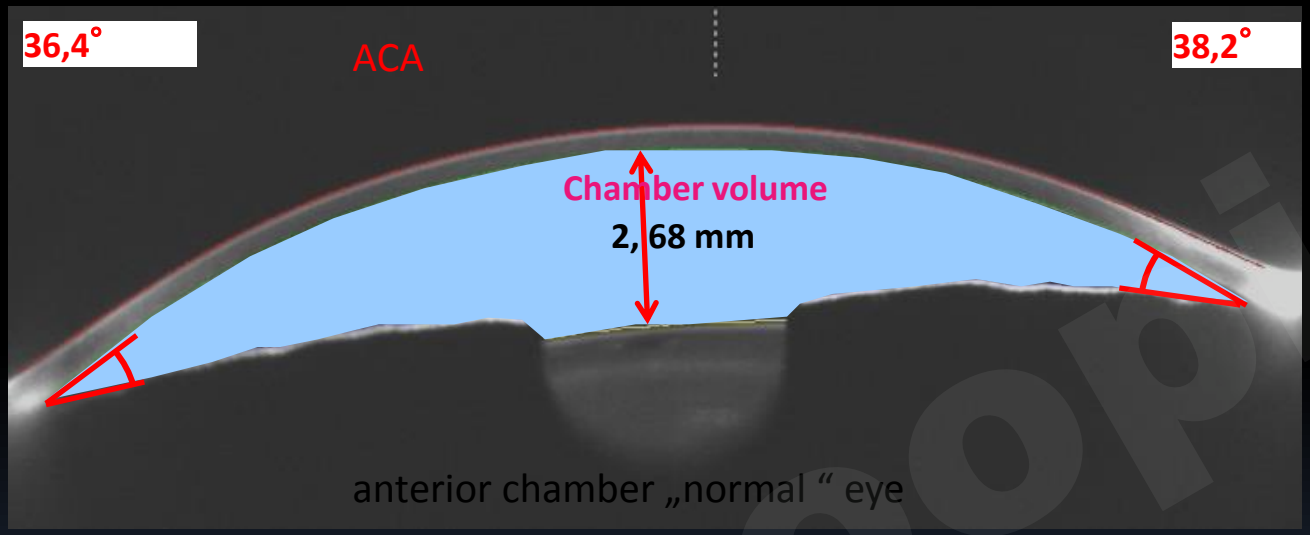
Phakic IOL, PC

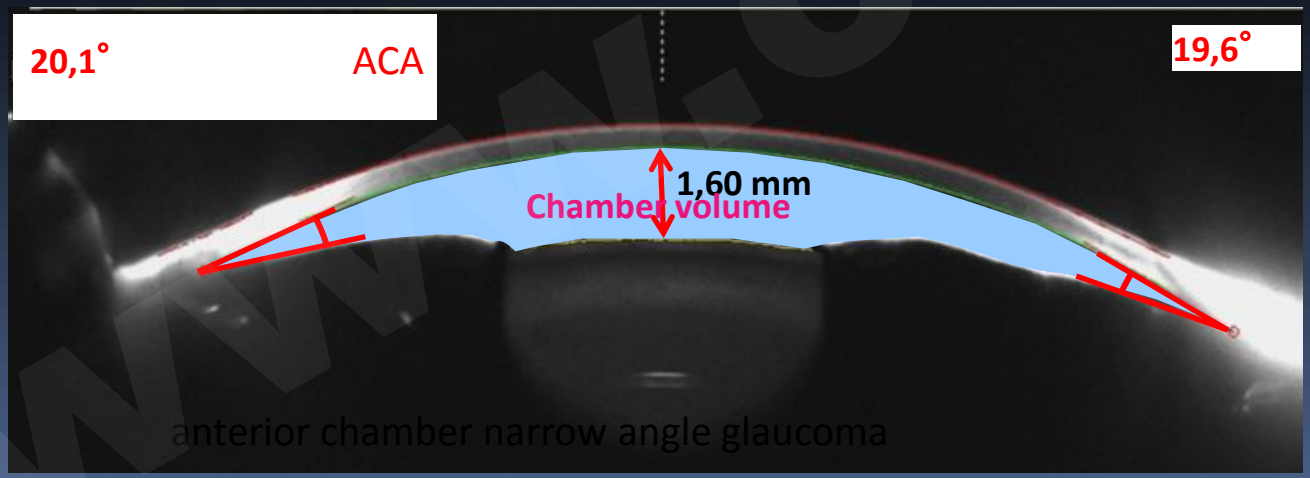


Glaucoma

- anterior eye segment
- ACD, ACD-map, ACV, ACA, IOP correction, pre-post iridectomy
- IOP correction according to corneal thickness

Angolo Irido-Corneale





Pentacam

Automatic Calculation of:

- Anterior chamber depth (ACD): internal/external
- Anterior chamber angle (ACA): in all sectional planes
- Chamber volume (ACV)

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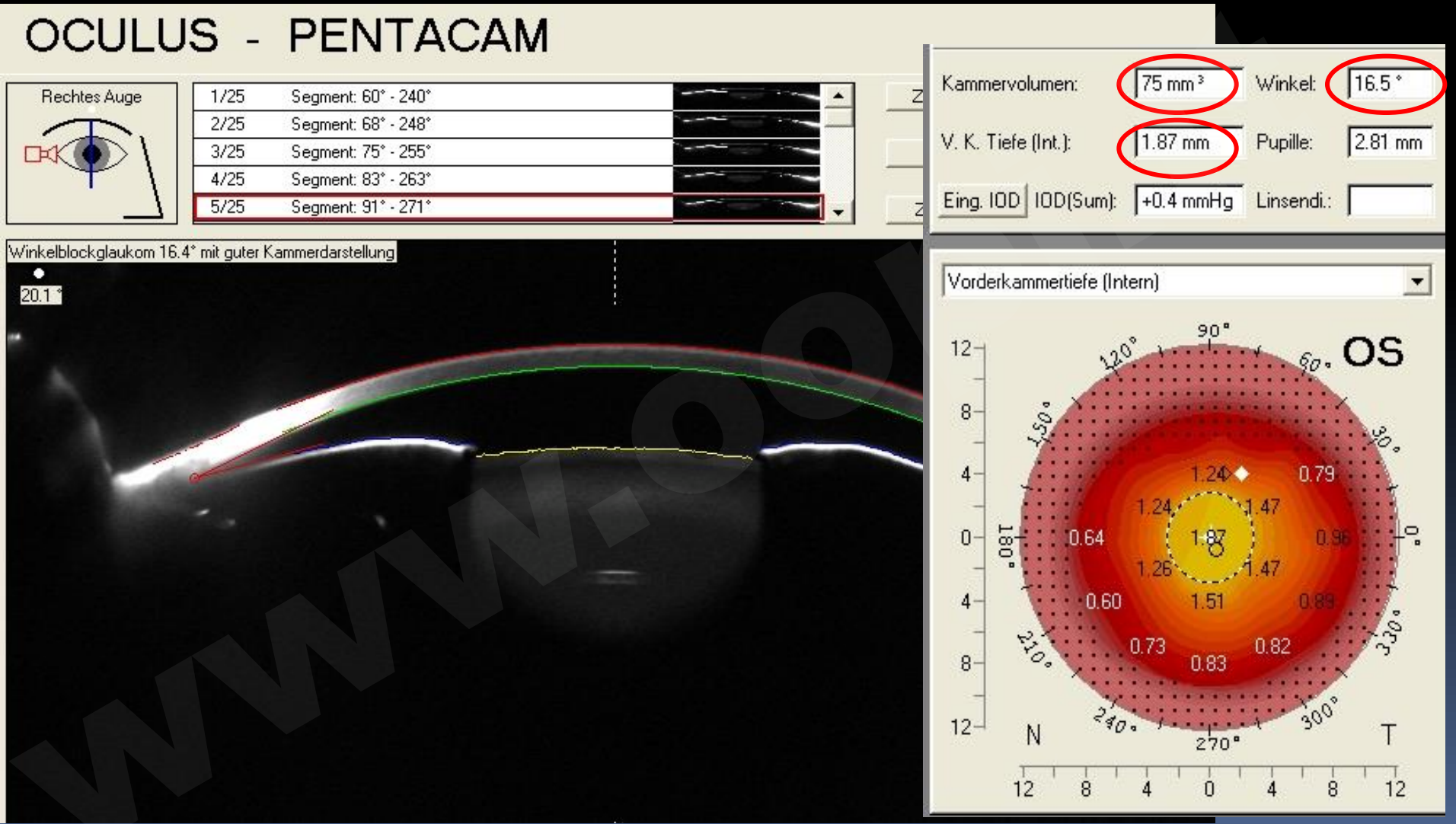
ACD Map



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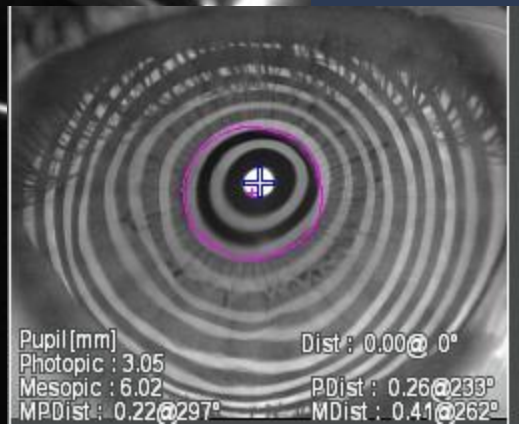
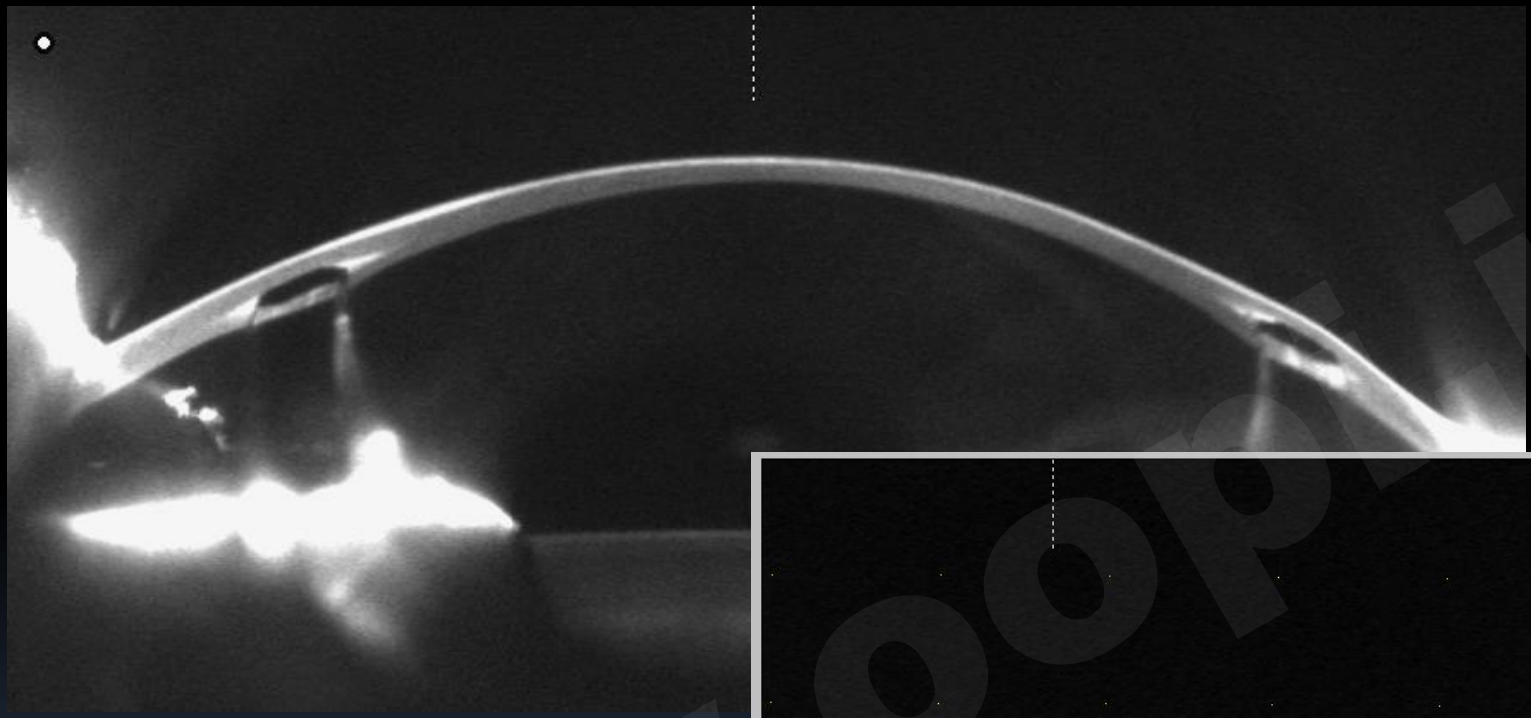
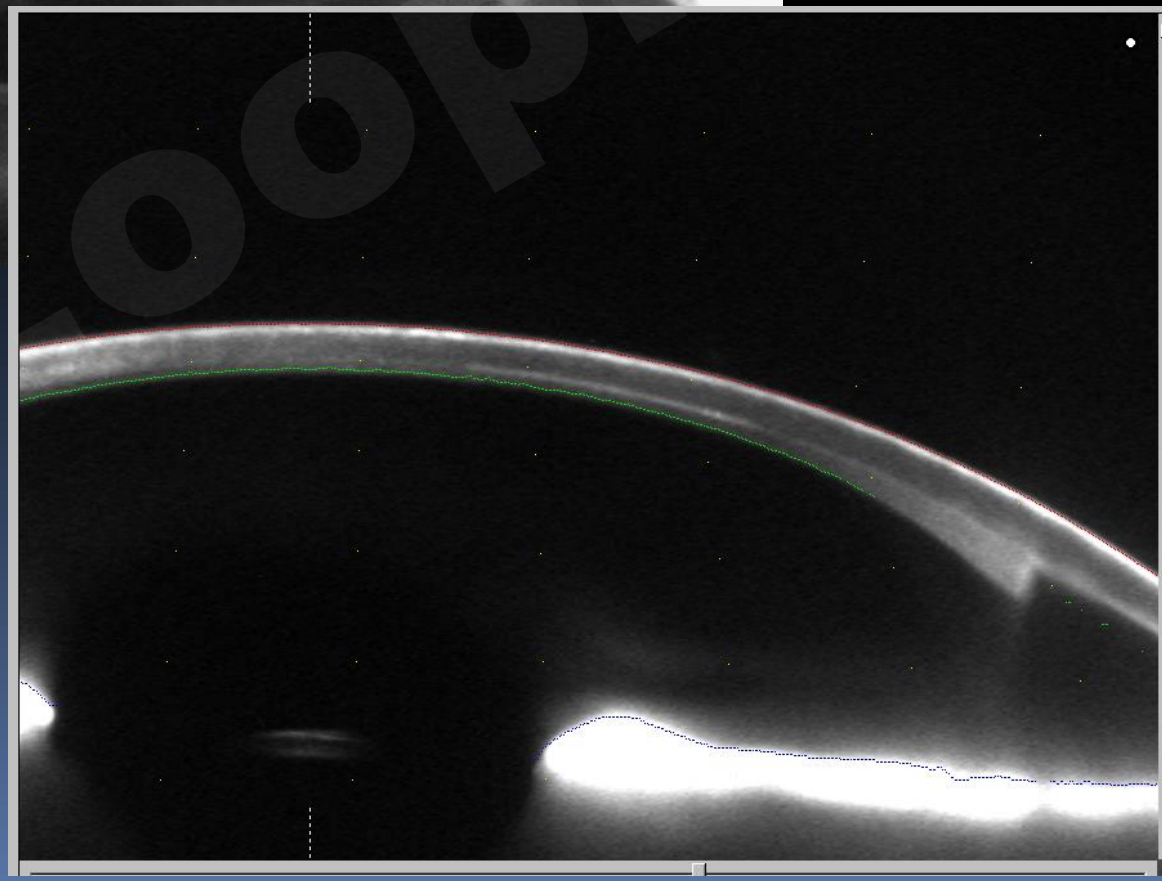
Immagini della Cornea e della Camera Anteriore

Transparent Cornea
(Normal)

Corneal Leukoma
(pseudomonas ulcer scar)







Conclusioni

- Perché usare un tomografo corneale ?
  - Miglioramento della comprensione delle caratteristiche della cornea
  - Selezione del pz per chirurgia refrattiva
  - Diagnosi di pseudoectasia vs. ectasia
  - Valutazione della camera anteriore
  - Valutazione del pz glaucomatoso
  - Documentazione medico-legale

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Grazie per l'Attenzione !!!