

HighRes Anterior Segment OCT CASIA SS-1000

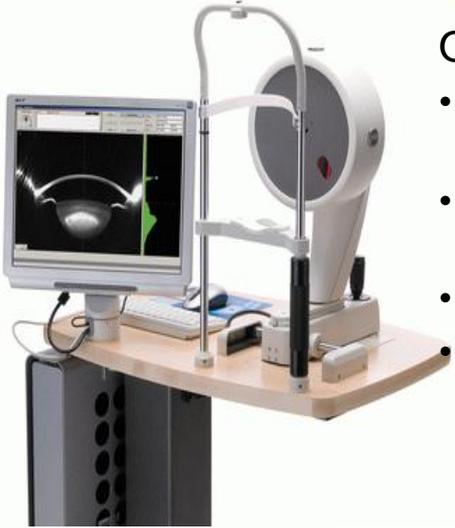
-

Case Reports

A. Langenbucher, T. Eppig

Content

- Imaging modalities for the anterior eye segment and characterization of the CASIA-OCT
- Measurement samples with the Casia 1000
 - Corneal pathologies
 - Following penetrating keratoplasty + complications
 - Anterior segment analysis
 - Refractive surgery and IOL implantation + complications
- Conclusions



- ### Oculus Pentacam HR
- LED with 475 nm UV-free
 - Rotating slit projection
 - 100 images in 2 s
 - 500 axial points



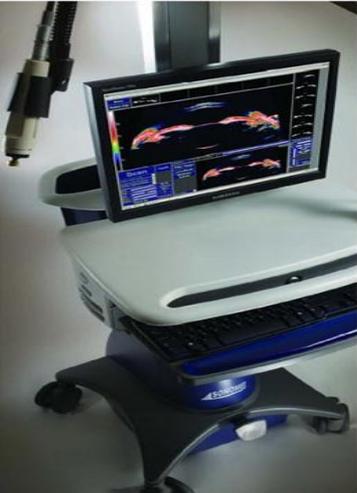
- ### TMS-5 Tomey
- Rot. Slit | Placido
 - 25 or 31 rings x 256 points
 - acquisition time .5 s (n=4)
 - 6400 / 7300 datapoints
 - 64 frames in 1.0 s
 - 40960 measurement points
 - Placido and/or Scheimpflug
 - Data merging & motion correction



- ### Zeiss Visante TD-OCT
- SLD mit 1310 nm
 - 2000 Scans/s
 - Resolution axial/lateral 18/60 μ m
 - AS scan (16x6 mm) 256 A-scans (.125 s/slice)
 - HR cornea scan 512 A-scans (.25 s/slice)



- ### Ziemer Galilei (Bon Optics)
- Placido-topography+Dual Scheimpflug-Imaging (rotating slit)
 - Merging of Placido & Scheimpflug data



- ### Sonomed UBM
- 35 or 50 MHz
 - Resolution (50 MHz) axial/lateral 18/40 μ m
 - Acquisition time HR/3D 3 s
 - No topographic function or image processing



- ### Reichert Reflex UBM
- 35 or 50 MHz
 - Resolution (50 MHz) axial/lateral 16/45 μ m
 - Acquisition time HR/3D 2 s
 - No topographic function or image processing

Tomey SS Casia 1000 (SS-OCT)

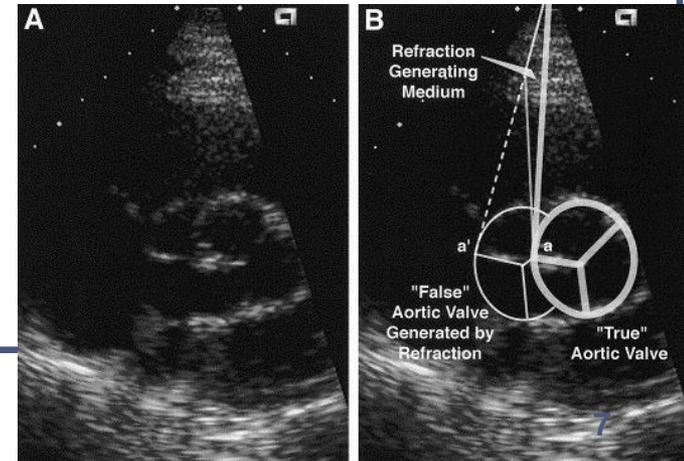


- Light source 1310 nm (NIR)
- Spatial resolution axial 10 μm , lateral 30 μm
- Anterior segment analysis (16x16x6 mm)
- Corneal scan (10x10x3 mm)
- 30.000 A scans/s
- Modalities:
 - 2D/3D measurement and data analysis
 - Corneal topography (anterior and posterior)
 - Anterior segment measurement
 - Pachymetry mapping
 - HR-cornea scan
 - Densitometry map

Optical tomography vs. Ultrasound

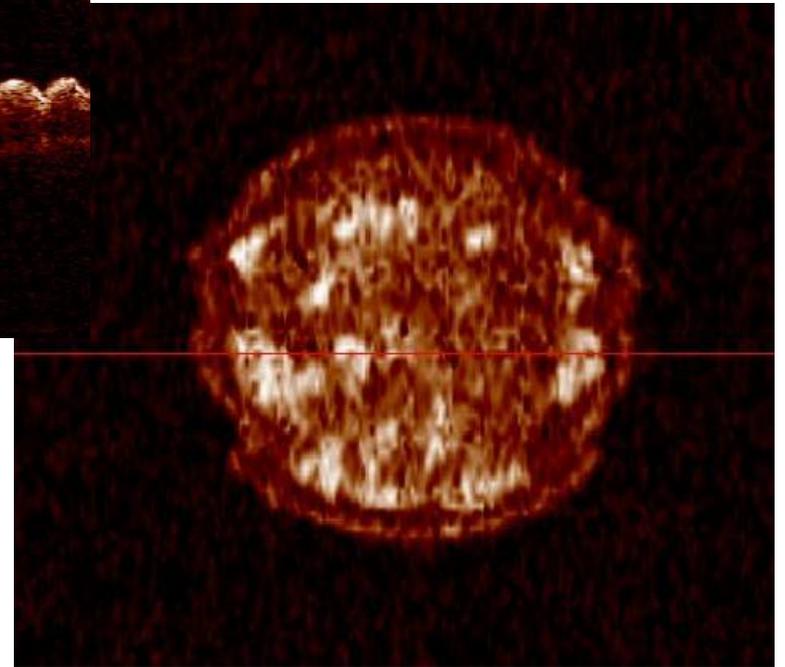
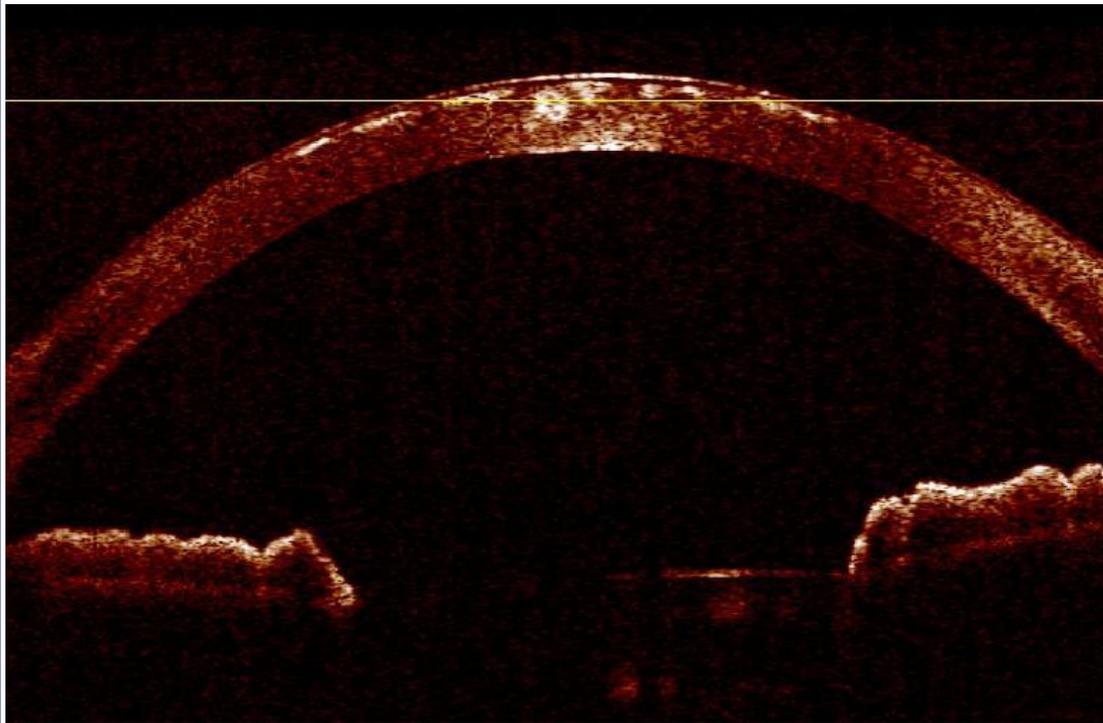
- Refractive index of ALL media must be known
Tissue opacities block light (NIR!!!, e.g. CASIA)
- **Deeper structures MUST be corrected by inverse raytracing through superficial structures!!!!**
- Error propagation if superficial structures are not measured or analyzed appropriately
- Speed of sound of ALL media must be known (especially in pathologic tissue or cataractous lenses unrealistic!!!)
- Refraction at interfaces (e.g. at corneal front surface or vacuoles)
- Error propagation for deeper structures if superficial structures are measured or interpreted uncorrectly.

10th order polynomial fit (CASIA) instead of spherical model in Pentacam



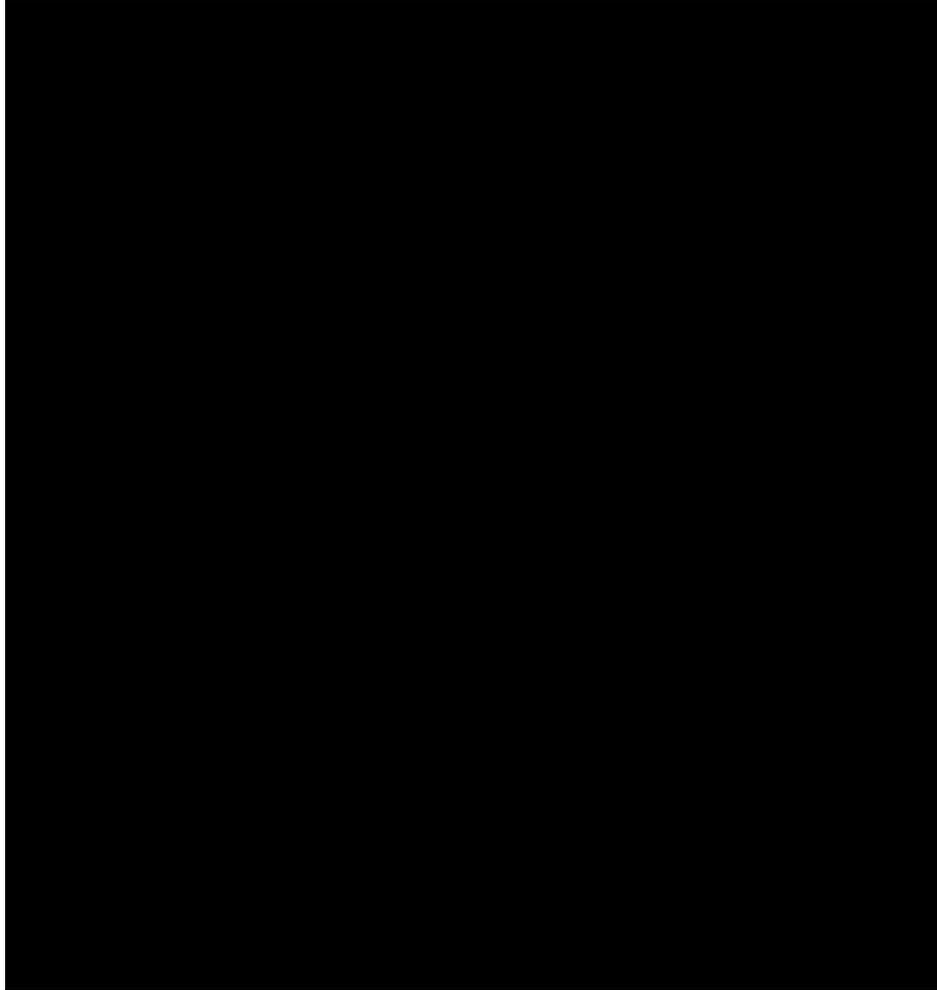
Measurement samples: Measurement with corneal pathologies (e.g. dystrophies and keratoconus)

Stromal corneal dystrophy



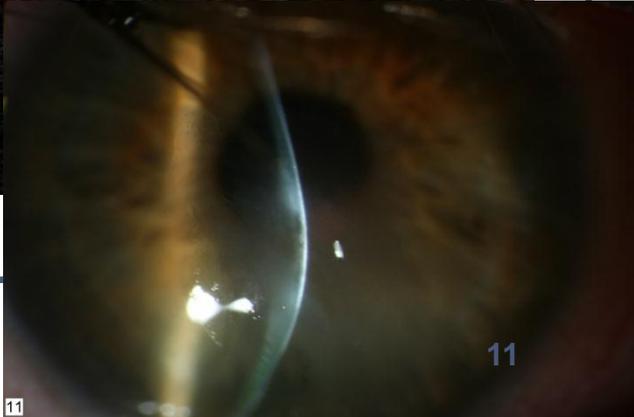
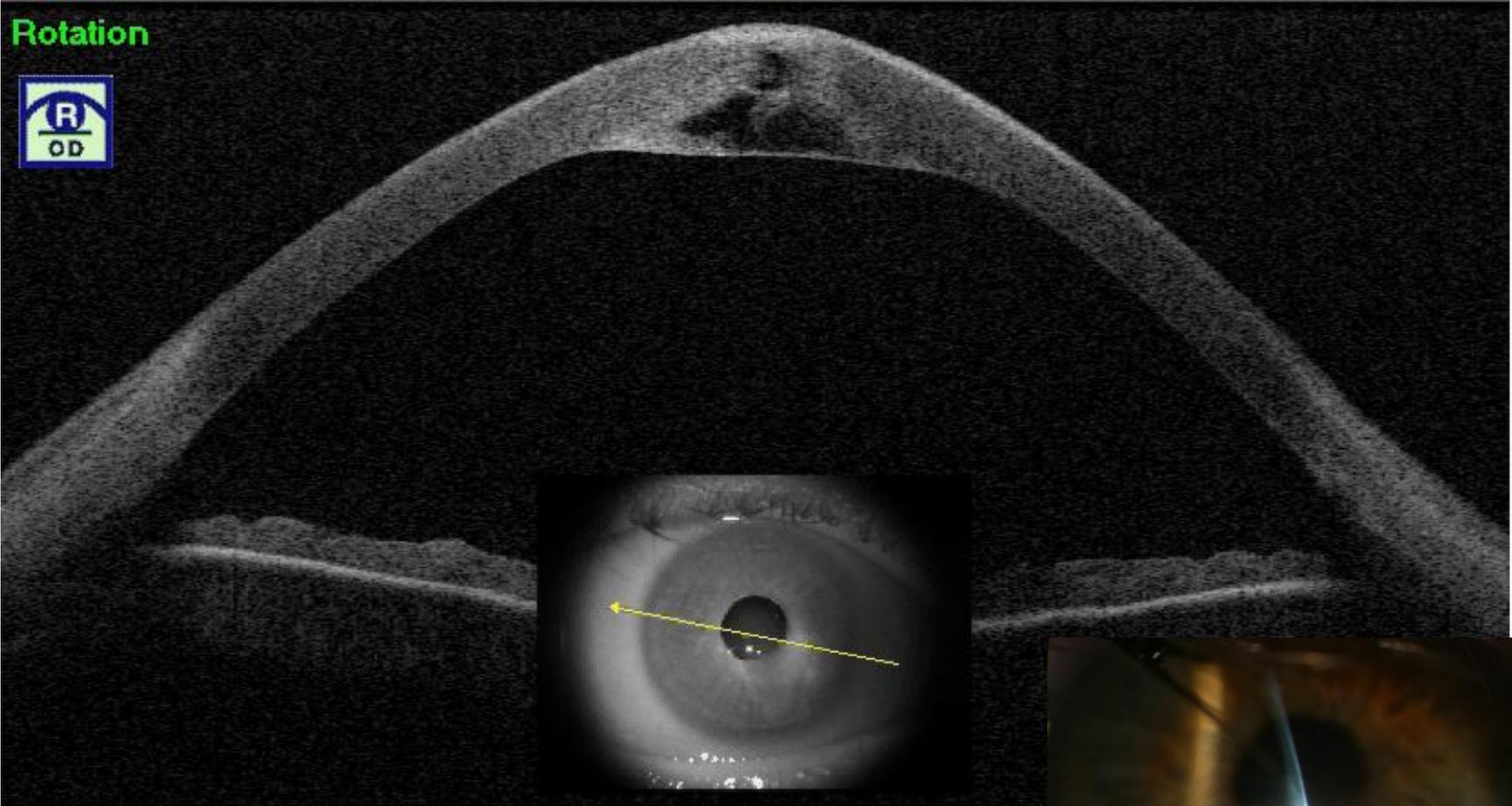
Granular stromal dystrophy

Stromal corneal dystrophy



Keratoconus ante perforationem

Rotation



Overview image: Keratoconus

The screenshot displays a corneal topography software interface. At the top, there is a menu bar with icons for Print, Save, ZoomIn, ZoomOut, 30% (zoom level), 3-D View, Analysis, Move, and MAP. Below the menu bar, a teal header contains patient information: ID, Name, Sex: male, Exam Date: 11/30/2009 9:30:03 AM, and a 'Cornea' tab. A 'Comment' field with a 'Save' button is also present. The TOMEY Ver.5F logo is visible in the top right corner.

The main display area is divided into several panels:

- CCD OD (Right):** A grayscale image of the right eye with a yellow arrow pointing to the center of the pupil. The image is overlaid with a grid and angle markers (90, 180, 270).
- Vertical:** A vertical cross-section of the cornea showing the curvature and the position of the iris and lens. Angle markers 90 and 270 are visible.
- Horizontal:** A horizontal cross-section of the cornea. Angle markers 180 and 0 are visible.
- Rotation:** A rotation cross-section of the cornea. Angle markers 180 and 0 are visible.
- 3D display:** A 3D topographic map of the cornea, showing a prominent central elevation characteristic of Keratoconus.
- Automatic surface detection and characterization:** A close-up of the 3D map with a green line tracing the corneal surface. A red arrow points to a specific area of the surface. The text 'Automatic surface detection and characterization' is overlaid on this panel.

At the bottom left, there is a small owl logo and the text 'UNIVERSITÄT DUISBURG ESSEN'. At the bottom right, there is a timestamp '11/12/2009 1:22:43 PM OS (Left)' and a page number '34'.

Corneal topography in keratoconus

Name:

ID:

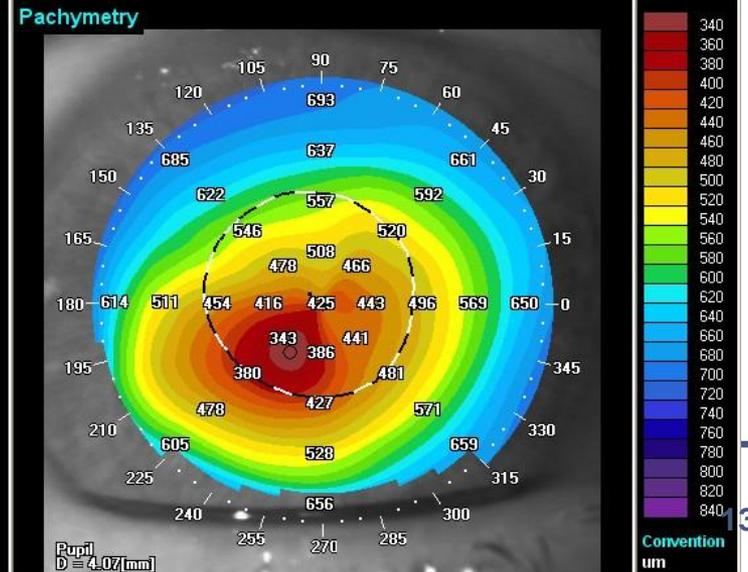
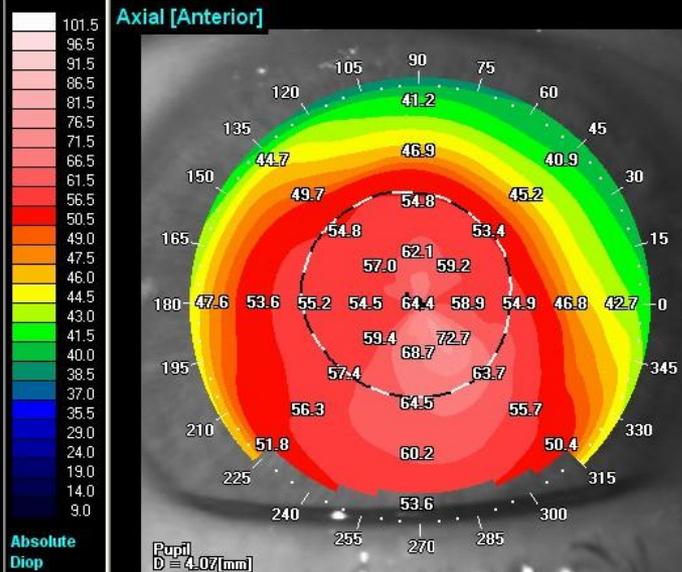
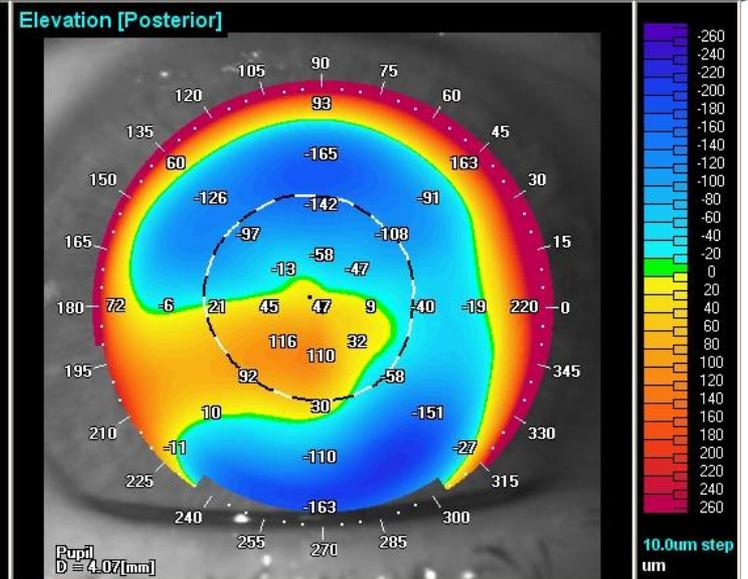
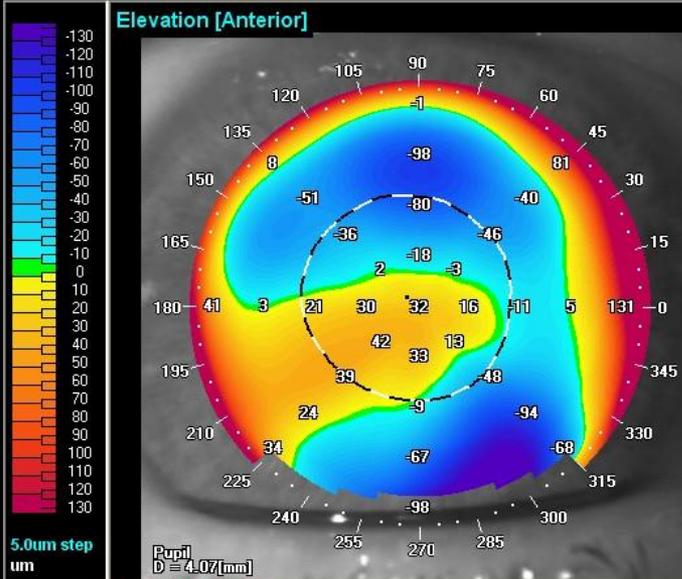
Date: 11/30/2009 Time: 9:30:03 AM

OD (Right)

Ks: 63.6 @ 109°
Kf: 55.0 @ 19°
CYL: 8.6
AvgK: 58.9

PachyApex: 425 [um]
Thinnest: 336 [um]
LocationX: -0.6 [mm]
LocationY: -1.0 [mm]

AA: 95.4 [%]



Dedicated KC screening software



Calibrated No. = 01

Date: 11/9/2010 Time: 10:08:30 AM Pupil

Comment:

D = 4.73 mm
X = 3.09 mm
Y = 3.53 mm

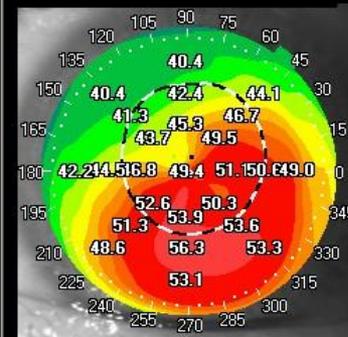
TOMEY CASIA
Ver. 6H.4

Ectasia Screening

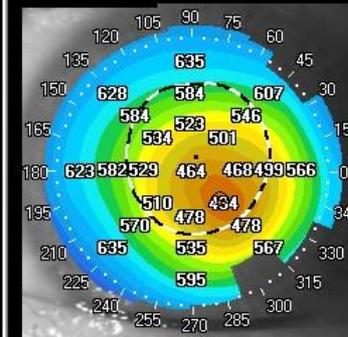
84 % Similarity

Clinical
Ectasia

Axial Power [Keratometric]

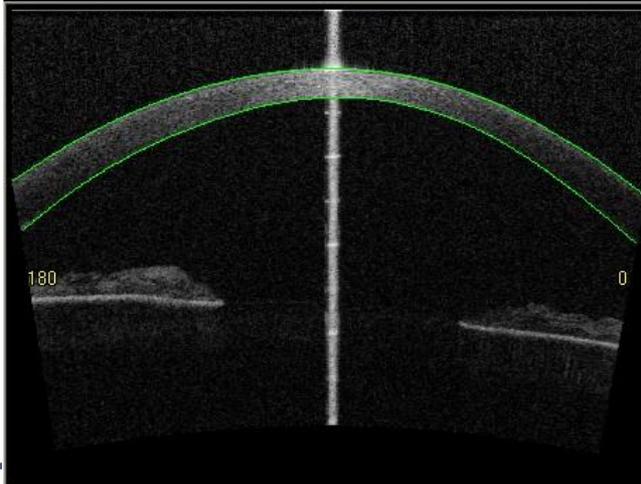


Pachymetry

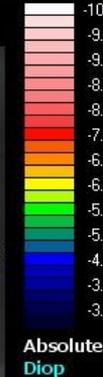
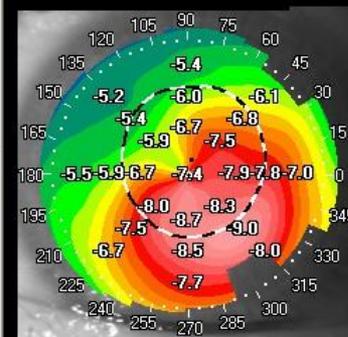


Sph.@6 : 48.86 D Reg.@6 : 1.73 D
Asy.@6 : 4.93 D Hio.@6 : 0.41 D

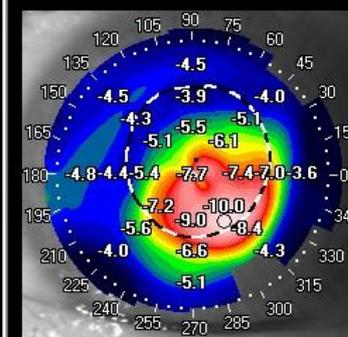
Thinnest : 433 um
X : 0.9 mm
Y : -0.9 mm



Axial Power [Posterior]



Instantaneous Power [Posterior]

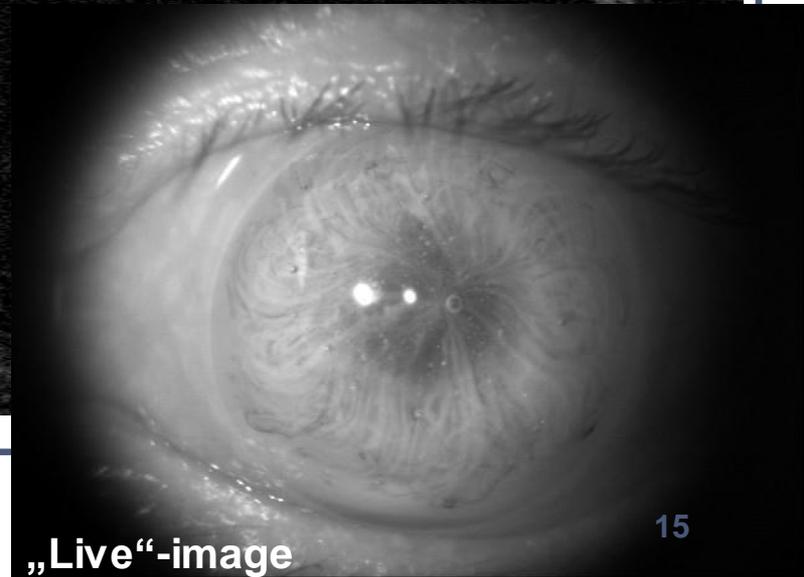
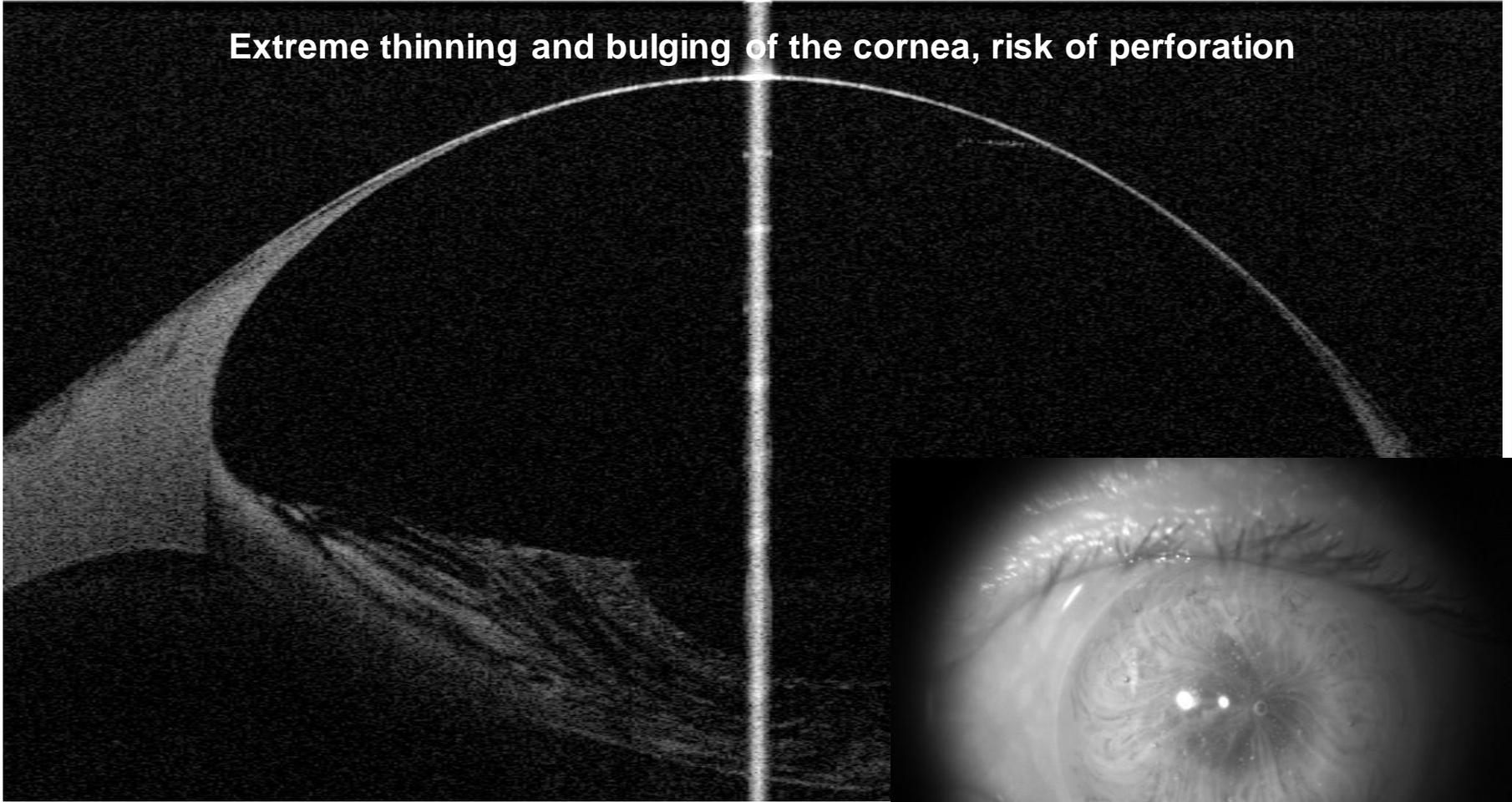


Sph.@6 : -7.33 D Reg.@6 : 0.35 D
Asy.@6 : 1.25 D Hio.@6 : 0.07 D

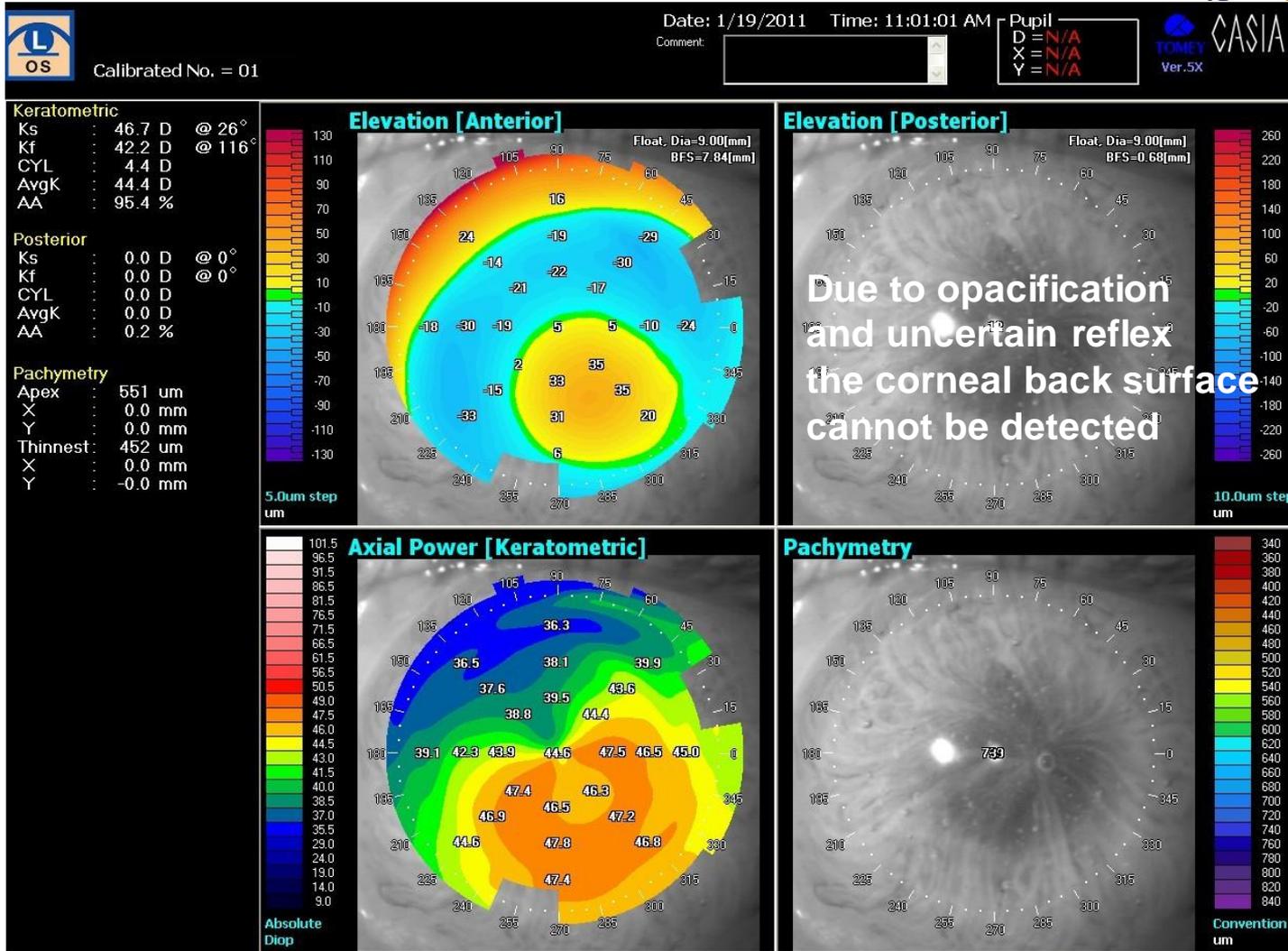
Steepest @6 : 3.86 mm
X : 1.0 mm
Y : -1.5 mm

Cross sectional view in keratoglobus

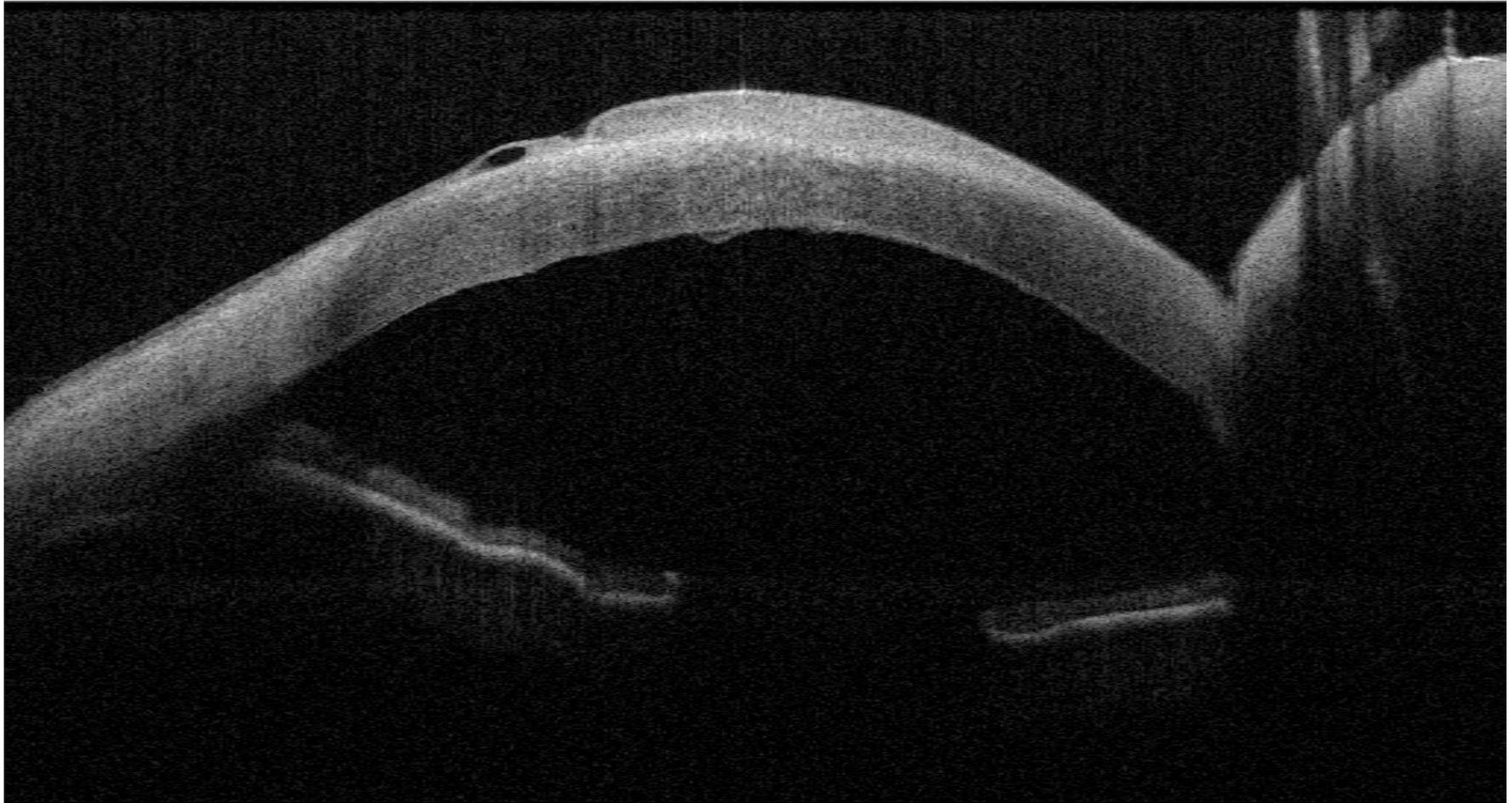
Extreme thinning and bulging of the cornea, risk of perforation



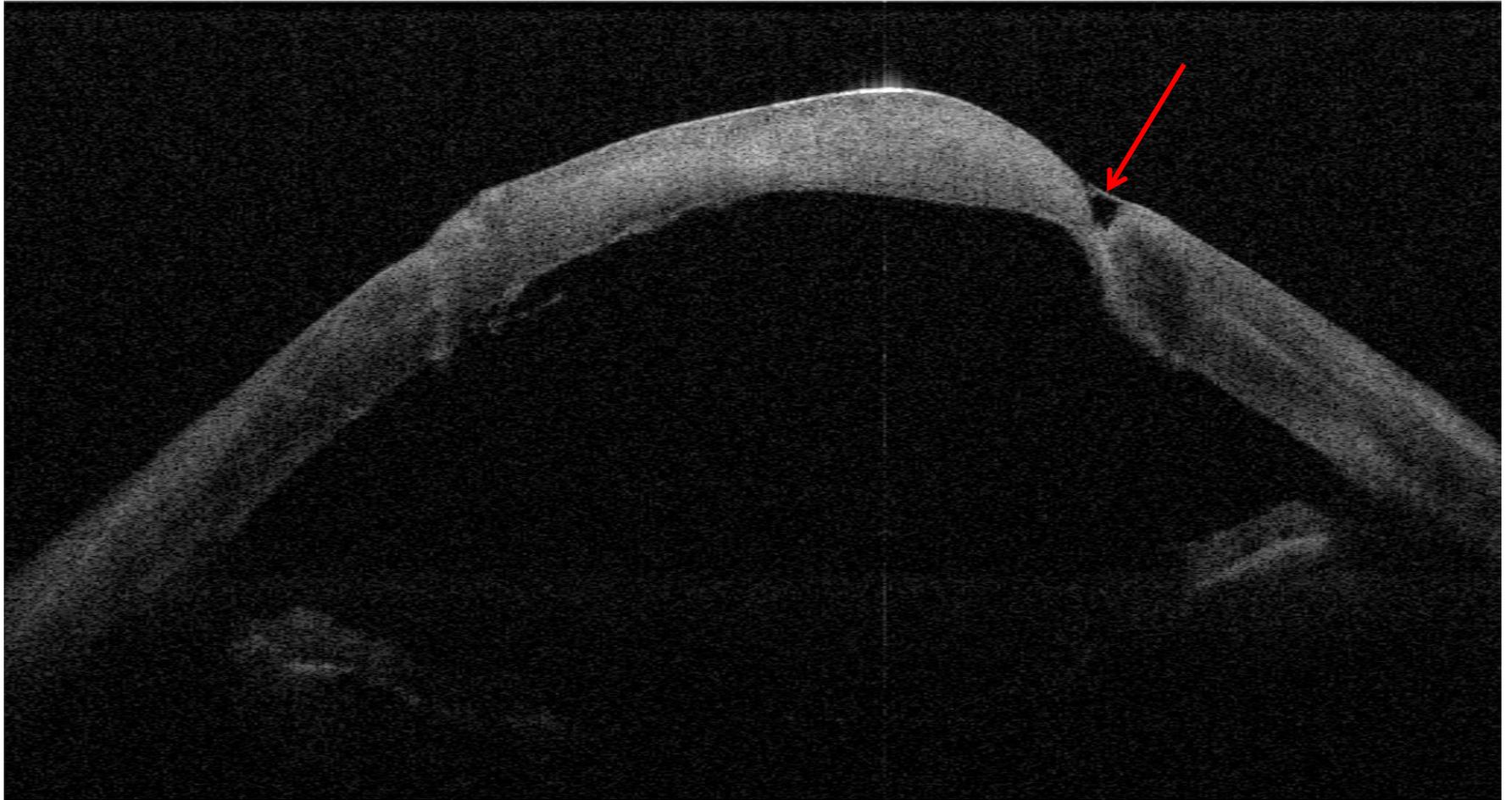
Corneal topography map in keratoglobus



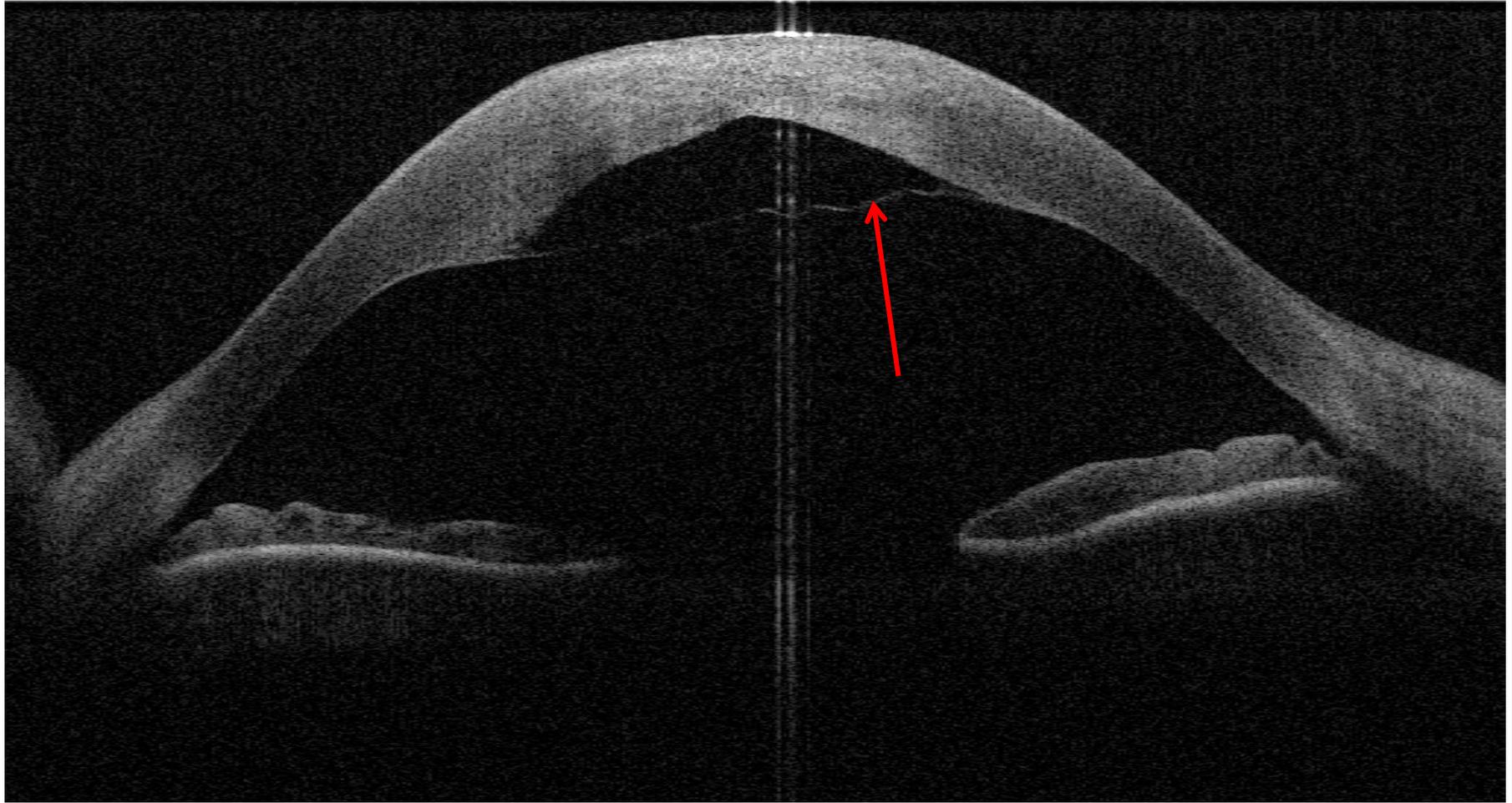
Examination of amniotic membrane in situ



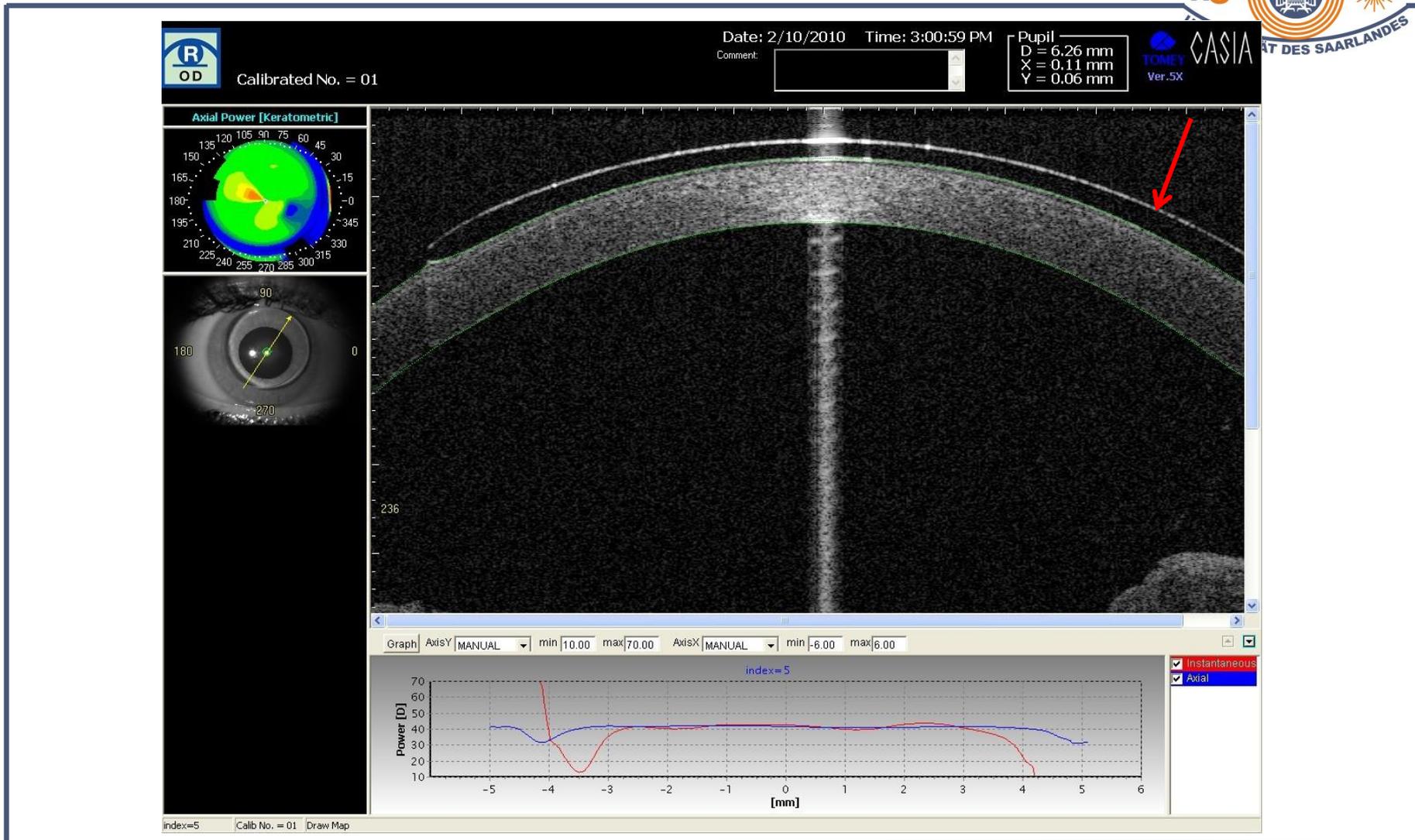
Perforating injury with a steel needle



Descemet detachment and corneal edema in bullous keratopathy



Corneal measurement through a CL



Topography and size of a CL

Keratometric

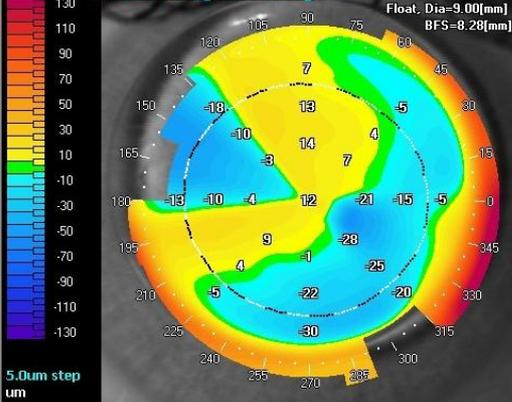
Ks : 43.5 D @ 145°
 Kf : 41.4 D @ 55°
 CYL : 2.1 D
 AvgK : 42.5 D
 AA : 94.6 %

Posterior
 Ks : -5.9 D @ 91°
 Kf : -5.6 D @ 1°
 CYL : 0.4 D
 AvgK : -5.7 D
 AA : 88.7 %

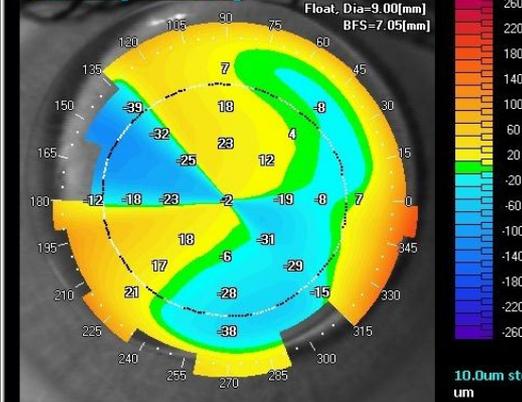
Pachymetry

Apex : 533 um
 X : 0.0 mm
 Y : 0.0 mm
 Thinnest : 510 um
 X : -0.8 mm
 Y : -0.2 mm

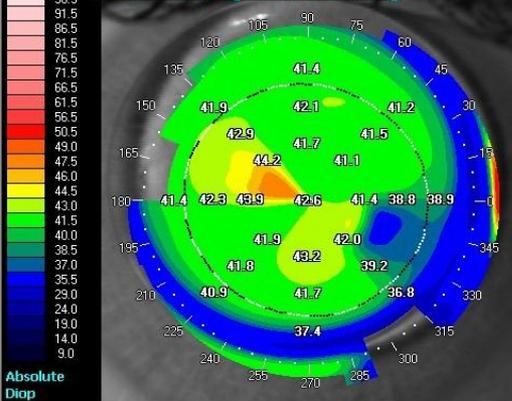
Elevation [Anterior]



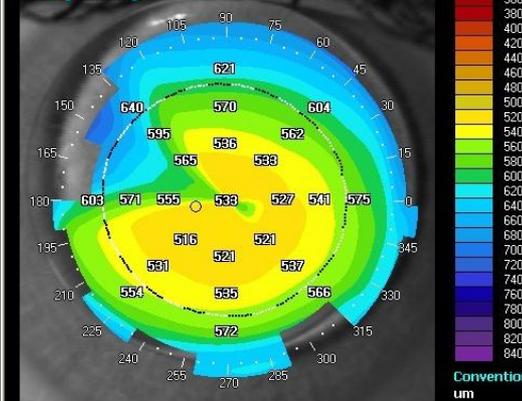
Elevation [Posterior]



Axial Power [Keratometric]



Pachymetry



Auto Corrected

2/10/2010

3:00:59 PM

00 (Right)

0.18 [mm]

9.38 [mm]

Measurement samples: Diagnostics after penetrating (PK) or lamellar (LK) keratoplasty + complications

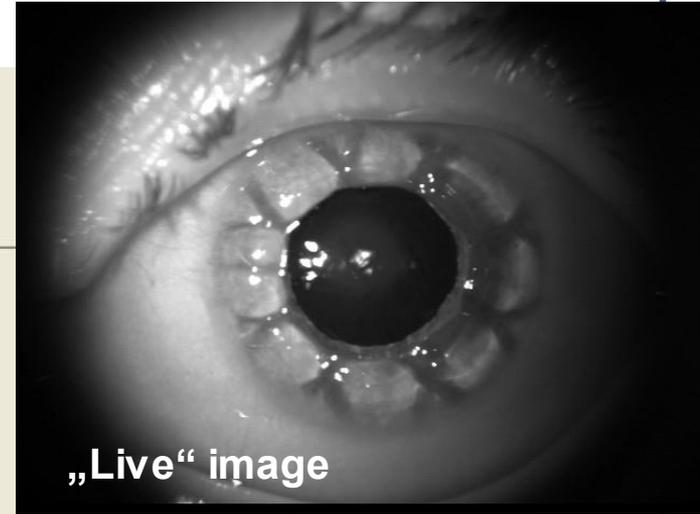
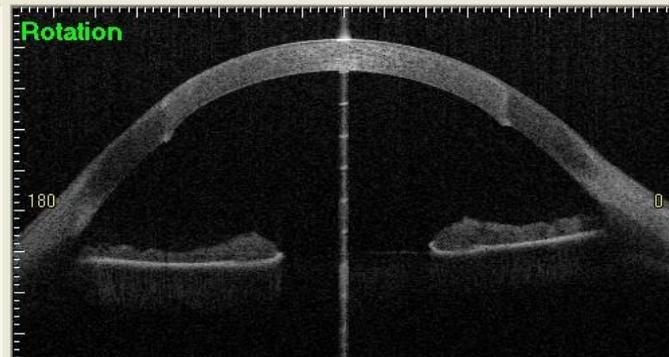
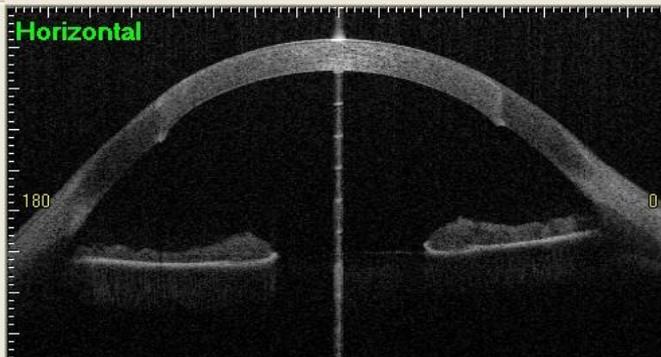
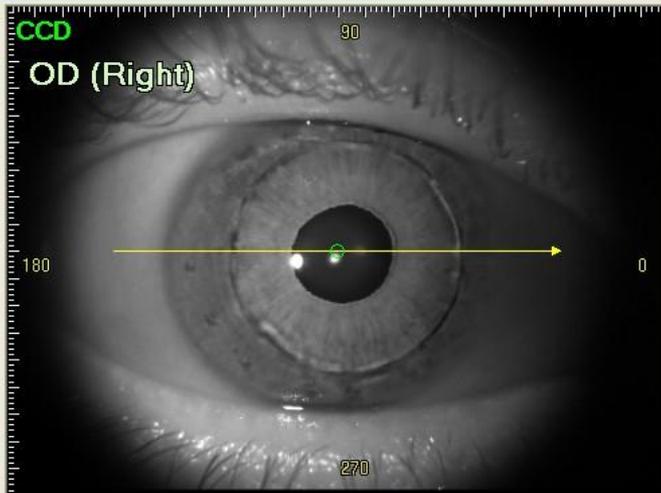
Overview image: following PK

Print Save ZoomIn ZoomOut 30% 3-D View Analysis Analysis Move Analysis

ID: Sex: male Anterior Segment (High Res.)

Name: Exam Date: 12/4/2009 9:06:09 AM Comment

Save



OFF ON

Data Window

log Intensity

Max 100

Min 50

Max=100, Min=50

Max Min

Two vertical sliders for adjusting the maximum and minimum values of the log intensity window.

Corneal topography following PK

Name:

ID:

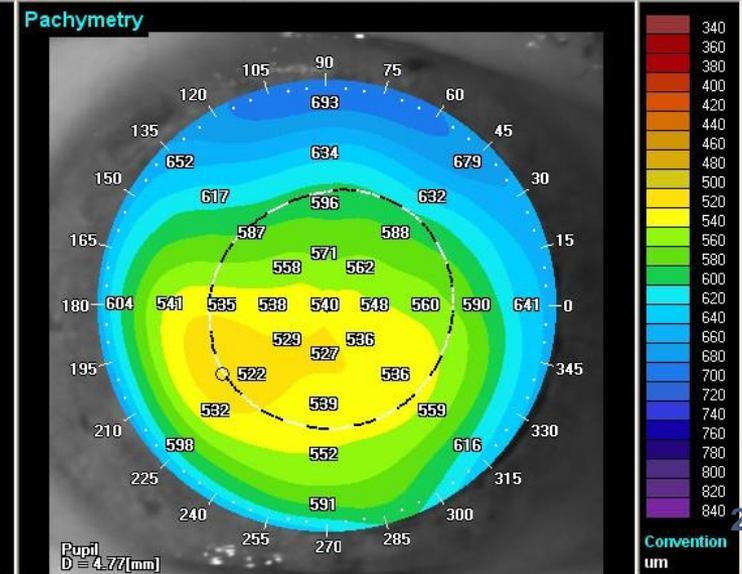
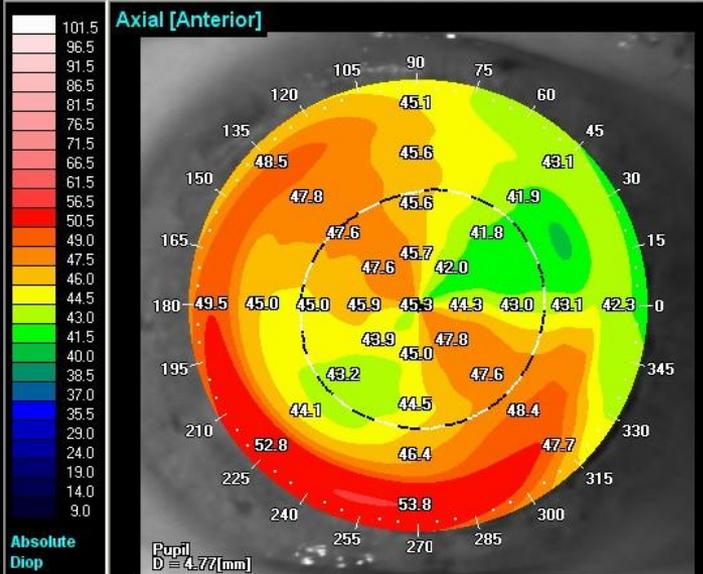
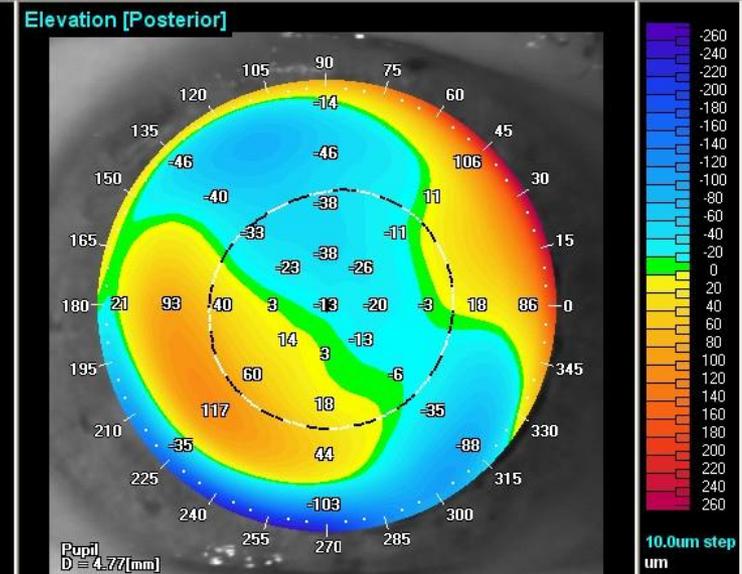
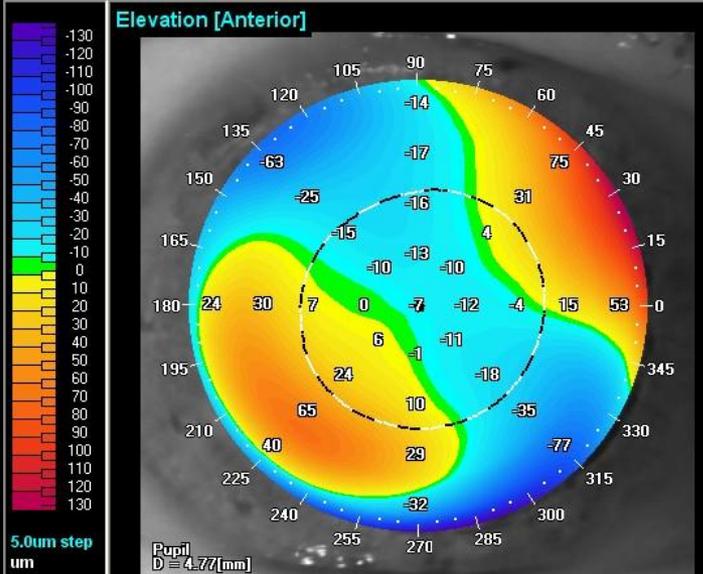
Date: 12/2/2009 Time: 9:42:59 AM

OD (Right)

Ks: 47.7 @ 132°
Kf: 42.8 @ 42°
CYL: 4.9
AvgK: 45.1

PachyApex: 540 [um]
Thinnest: 517 [um]
LocationX: -2.0 [mm]
LocationY: -1.4 [mm]

AA: 100.0 [%]



Graft diameter and CCT profile

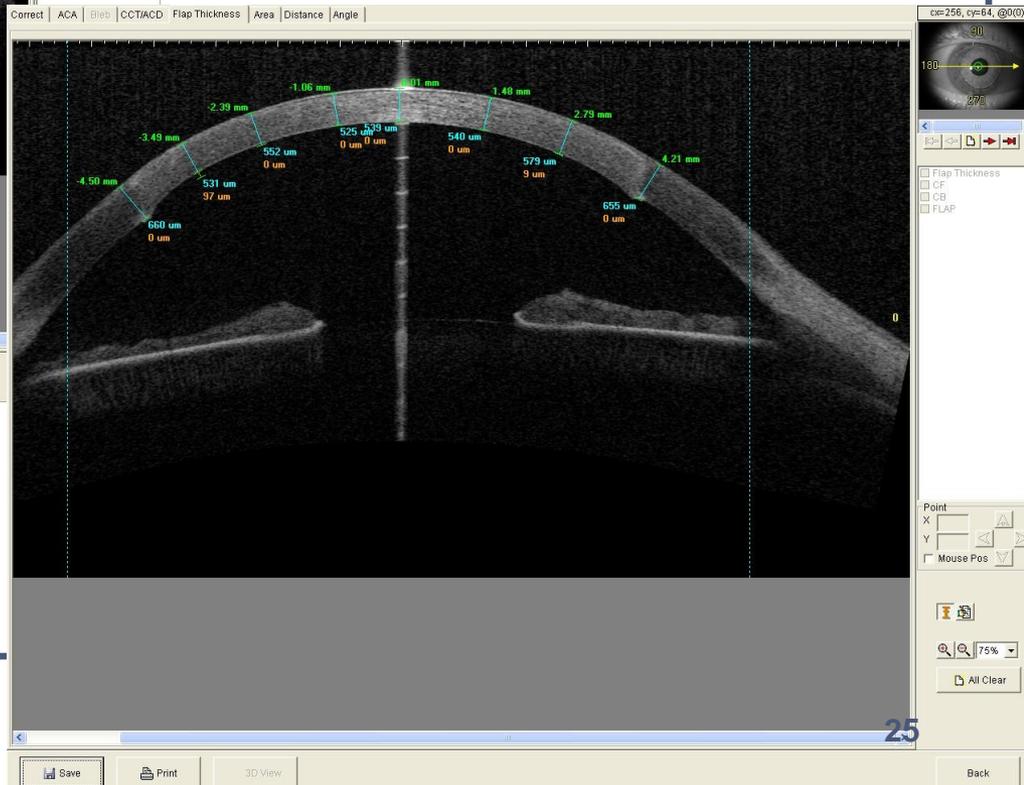


cx=256, cy=64, @0(0)

100
270

Auto Move Cursor

- L1_start
- L1_end
- L2_start
- L2_end
- L3_start
- L3_end
- L4_start
- L4_end
- L5_start
- L5_end



Automatic surface recognition following PK

Correct | ACA | Elevation | CCT/ACD | Flap Thickness | Area | Distance | Angle

Previous

12/4/2009
9:06:09 AM
OD (Right)

180 0

After

cx=256, cy=64, @0(0)

90
180 0
270

anterior cornea

Point
X
Y
 Mouse Pos

50%

Clear
Correct OK

Back

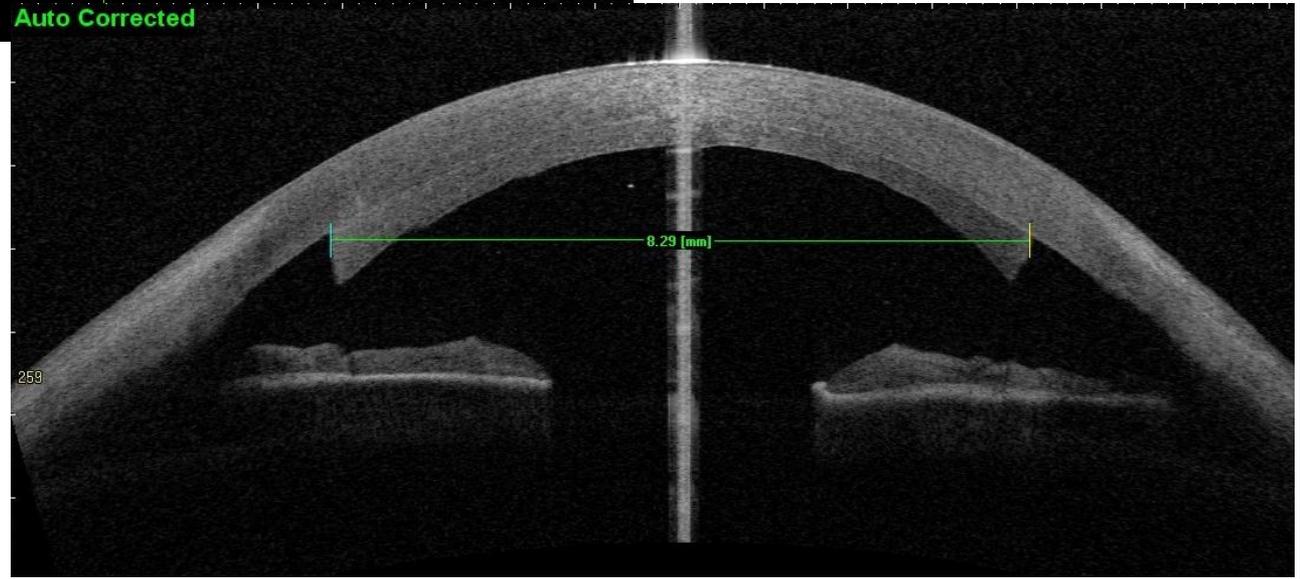
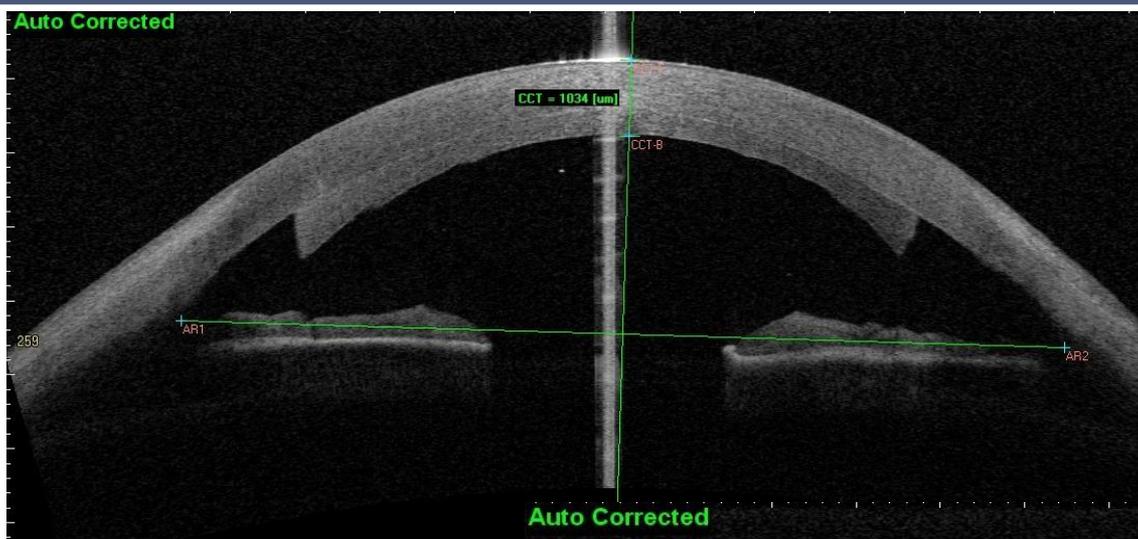
Pixel Ratio: 102.54 [pixel/mm]
Polynomial Order: 10
Function: Default

Save | Print | 3D View

Step formation and flat ACD



Measurement w-t-w and graft diameter

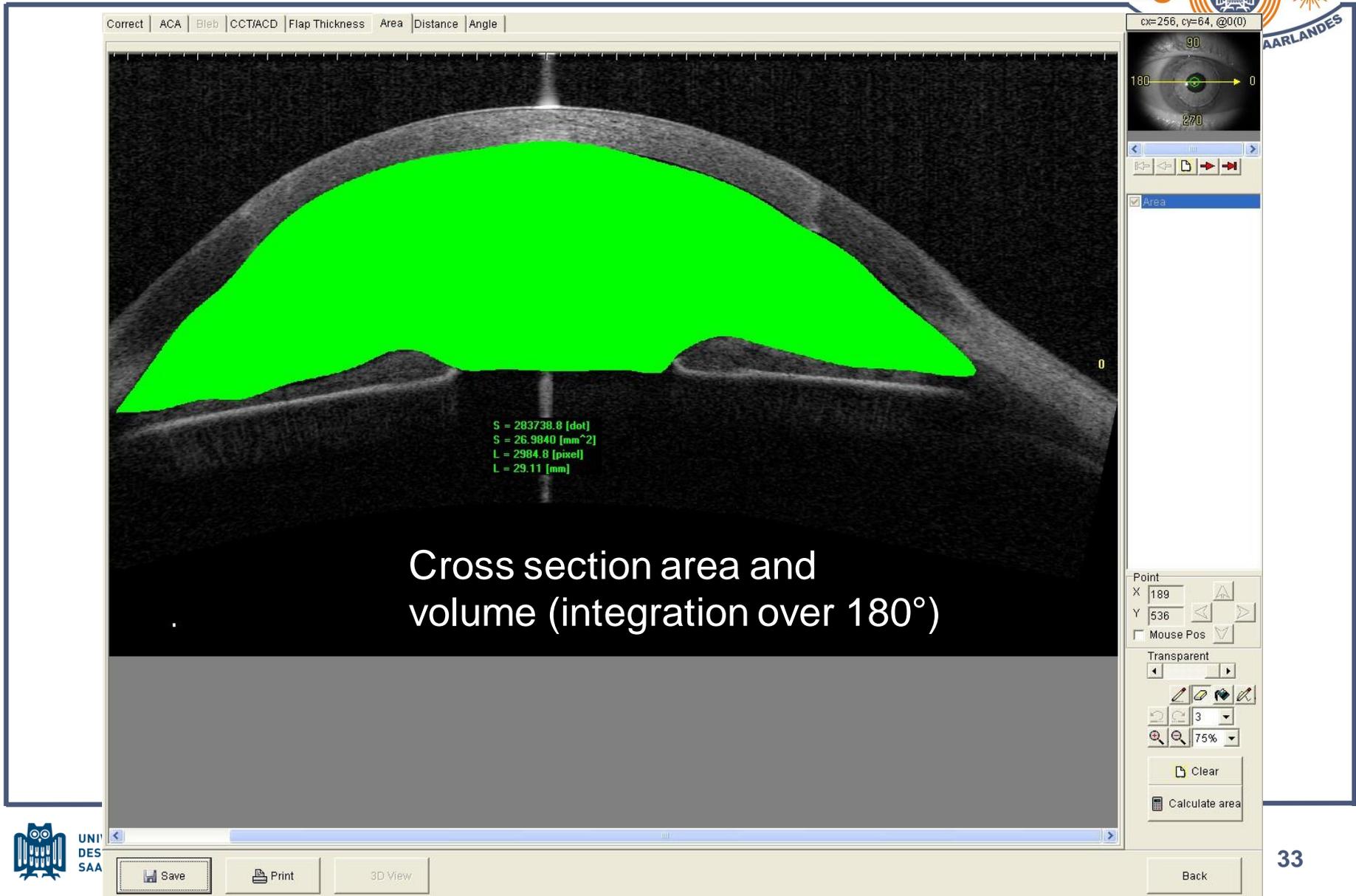


Measurement samples: Anterior segment analysis

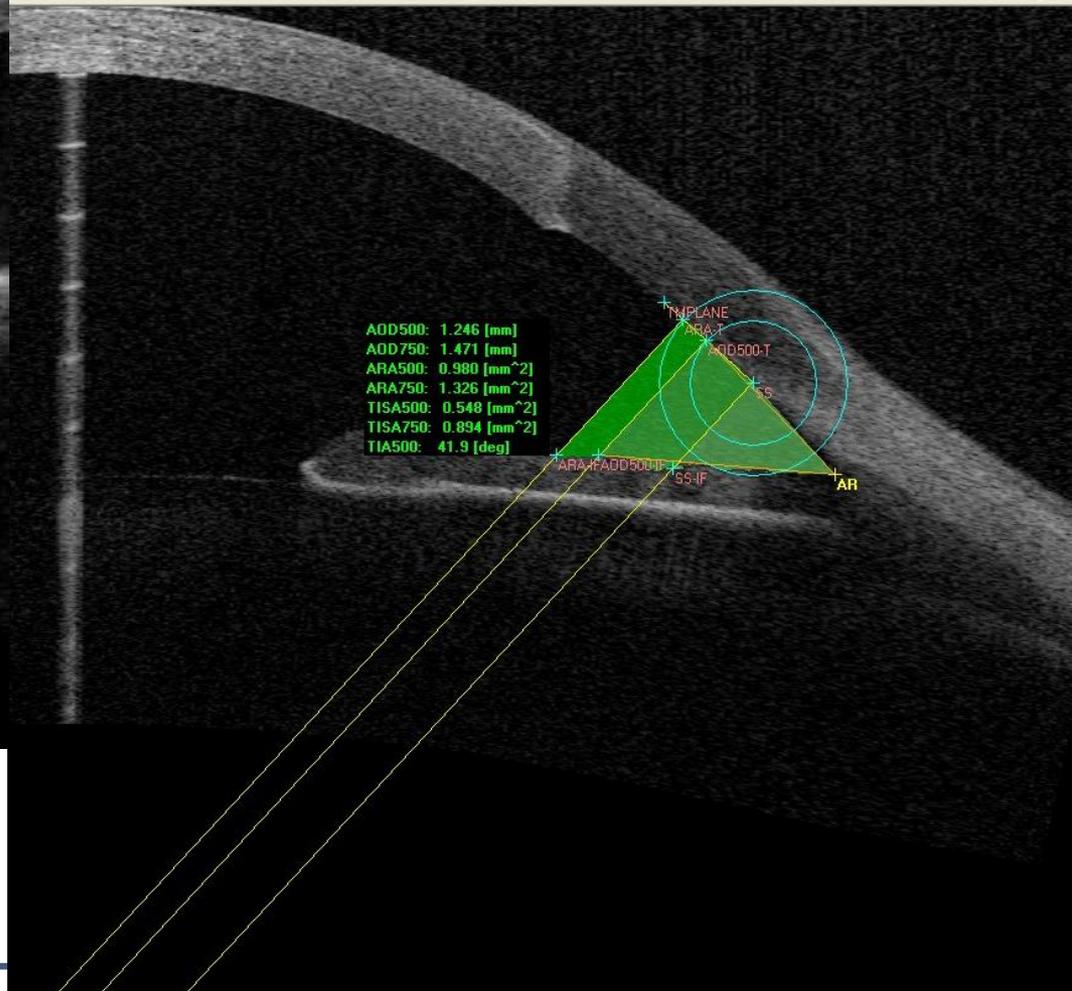
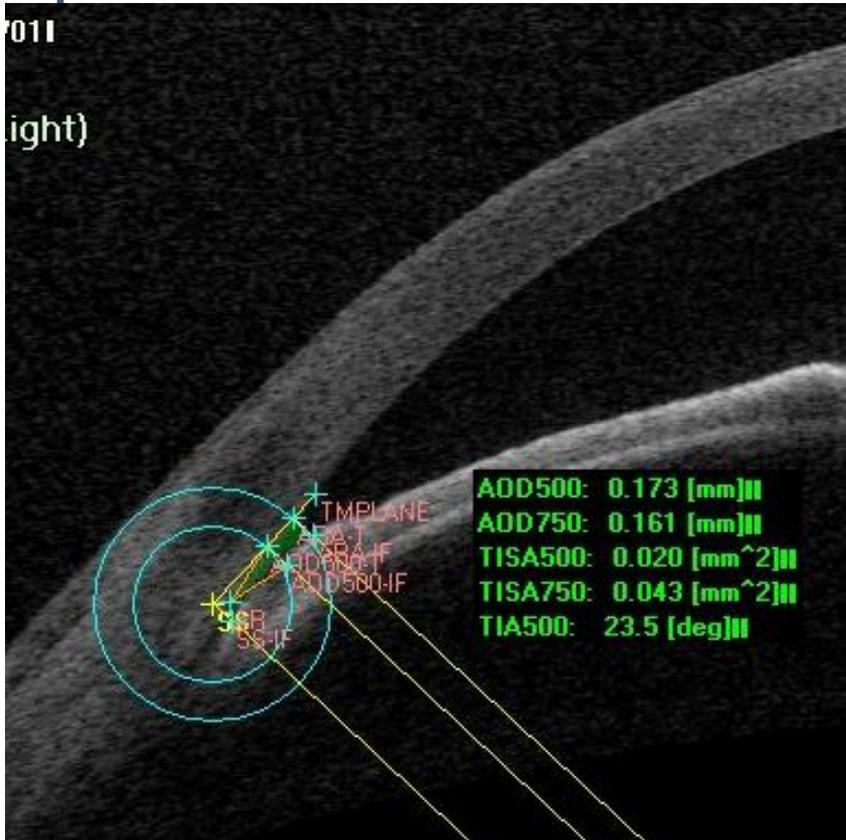
Anterior chamber depth measurement



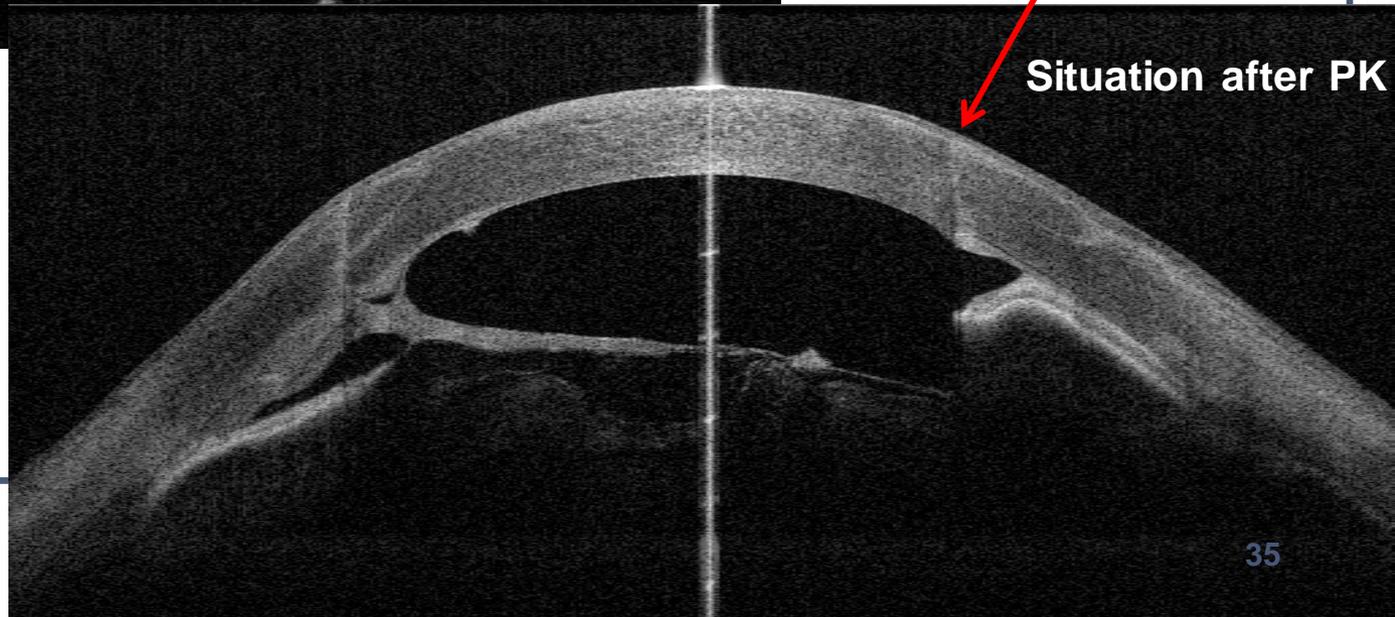
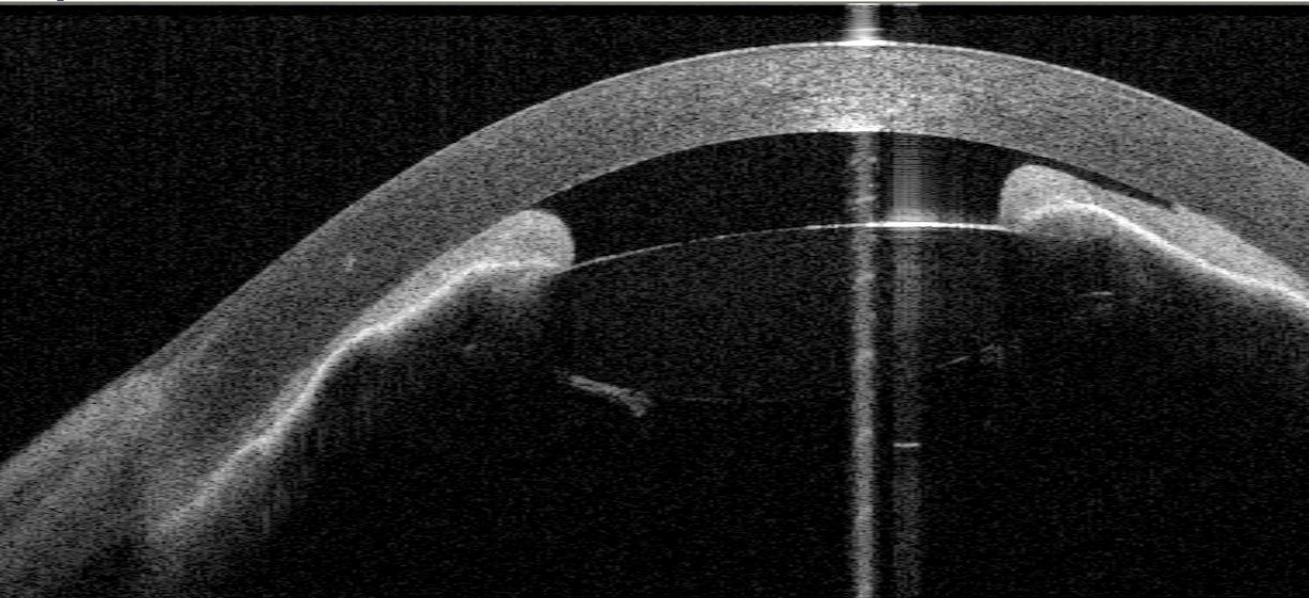
Anterior chamber analysis



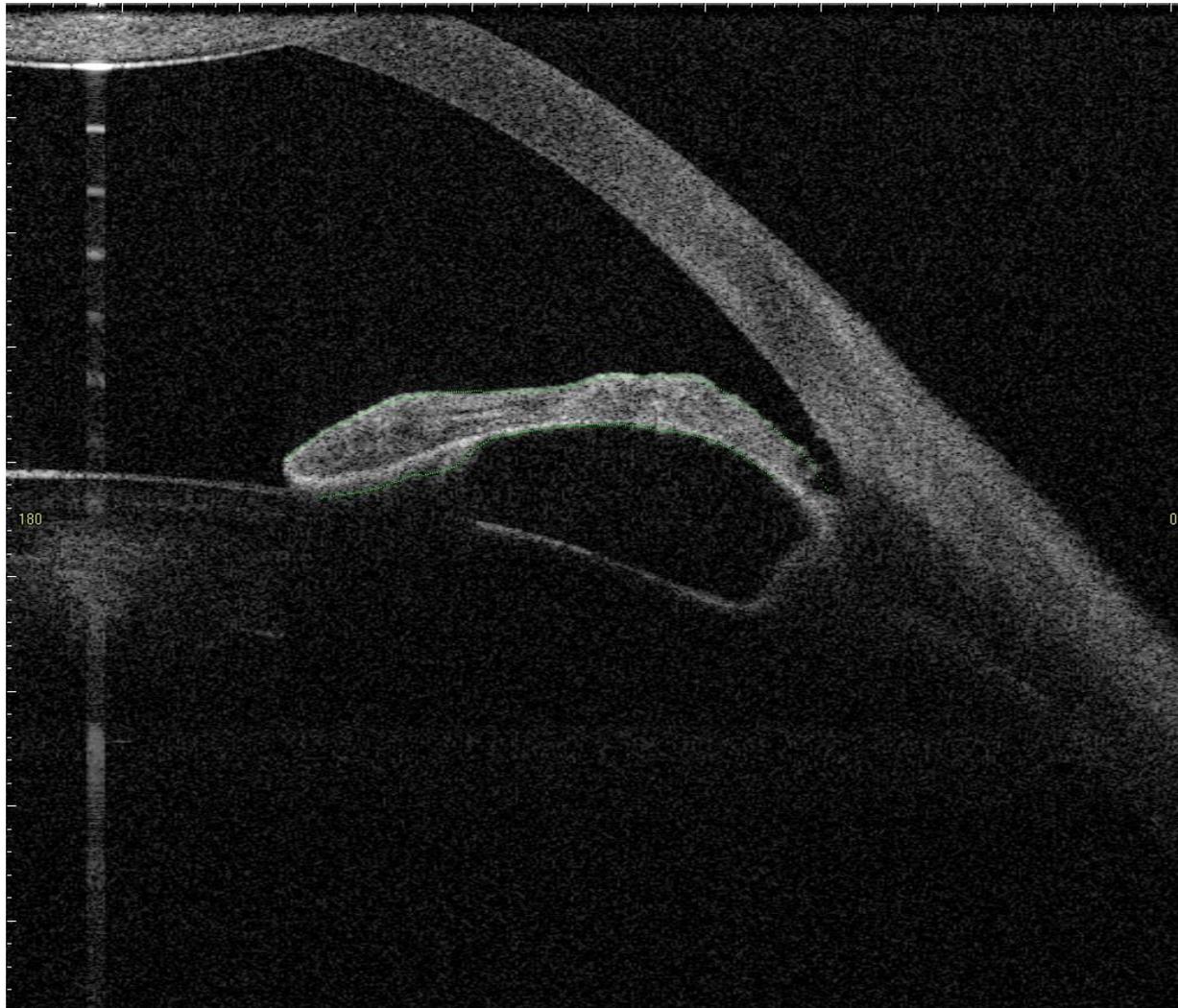
Angle measurement



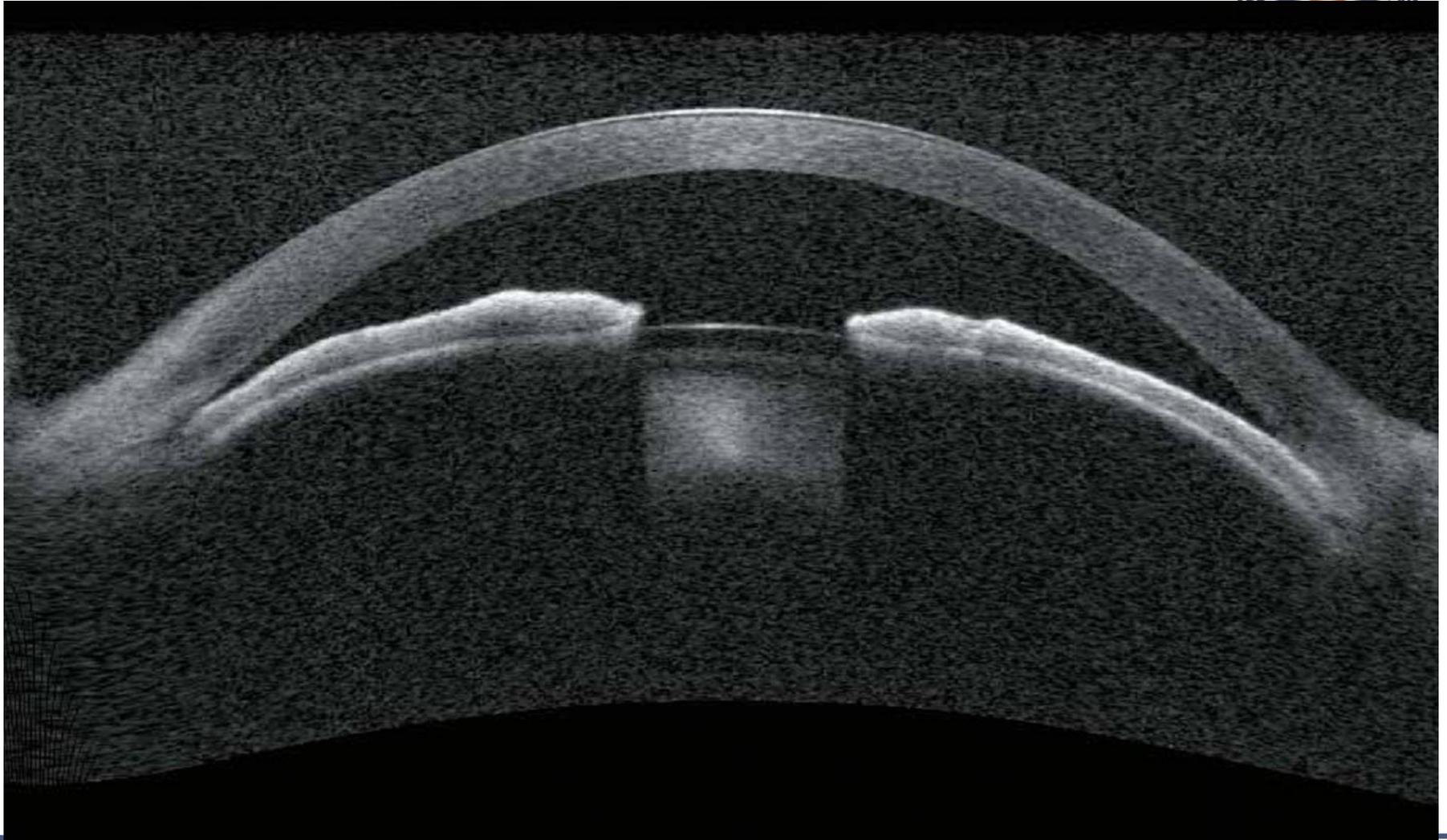
Complete and partial anterior synechiae



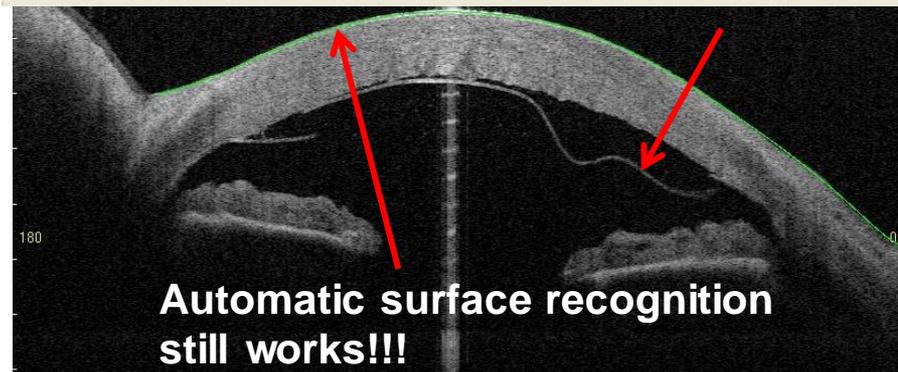
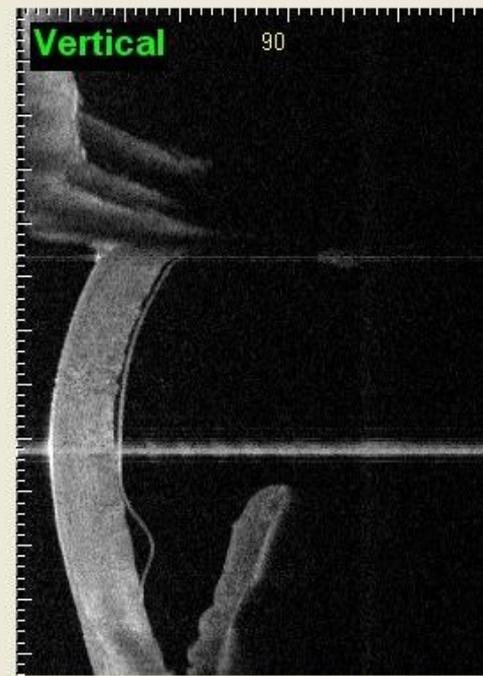
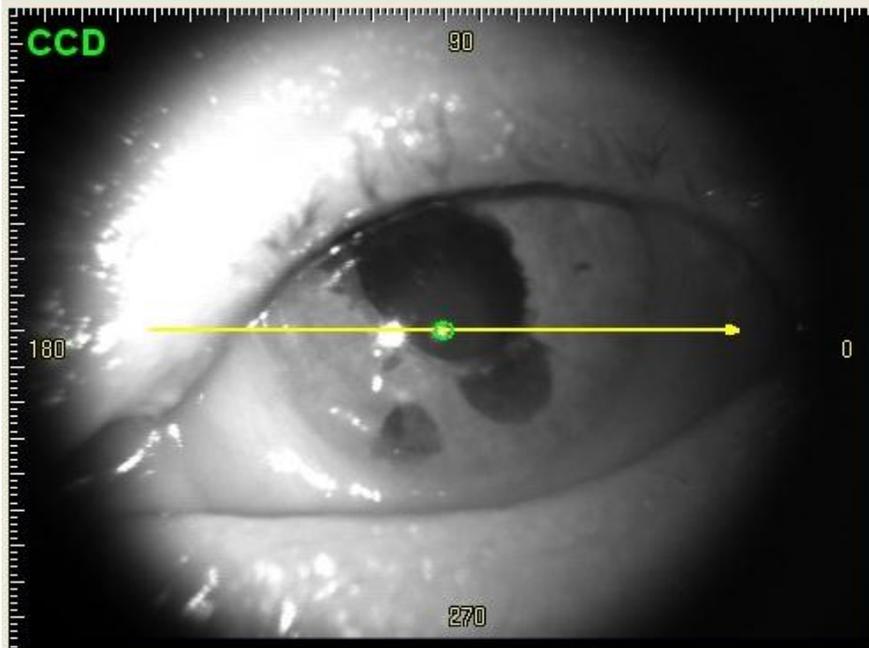
Posterior synechia with cyst



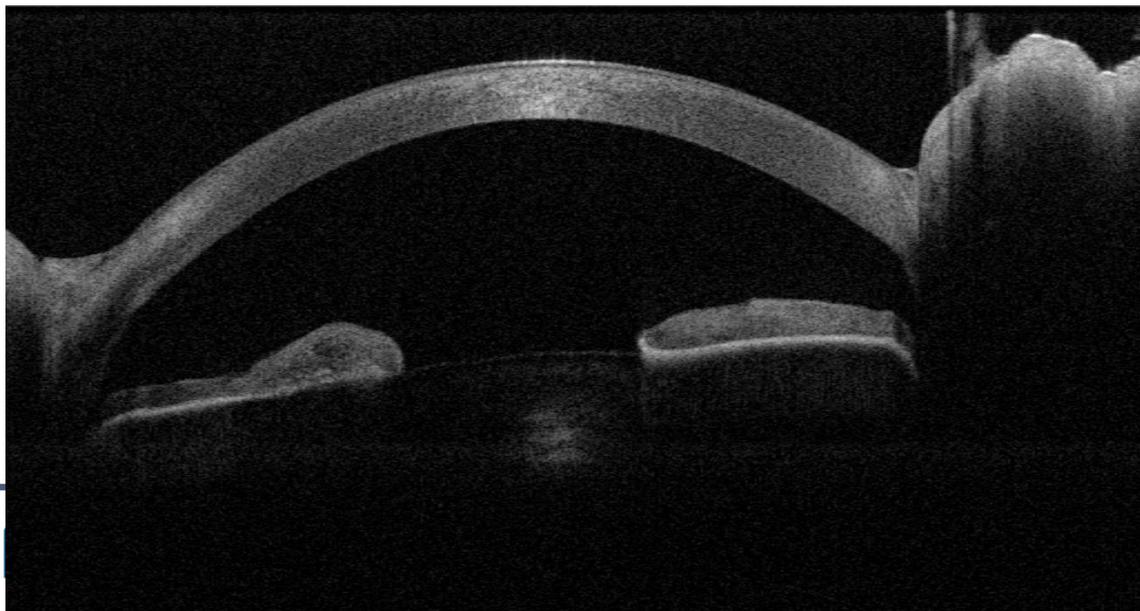
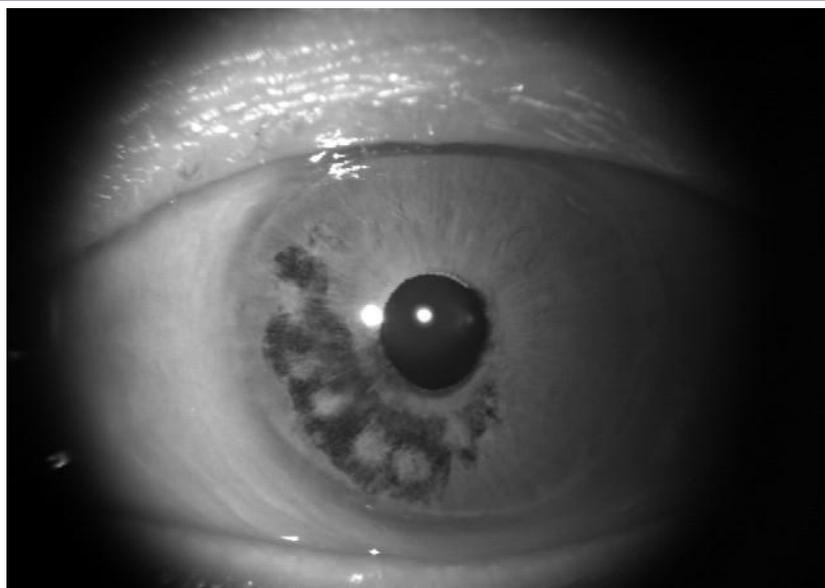
Angle closure glaucoma



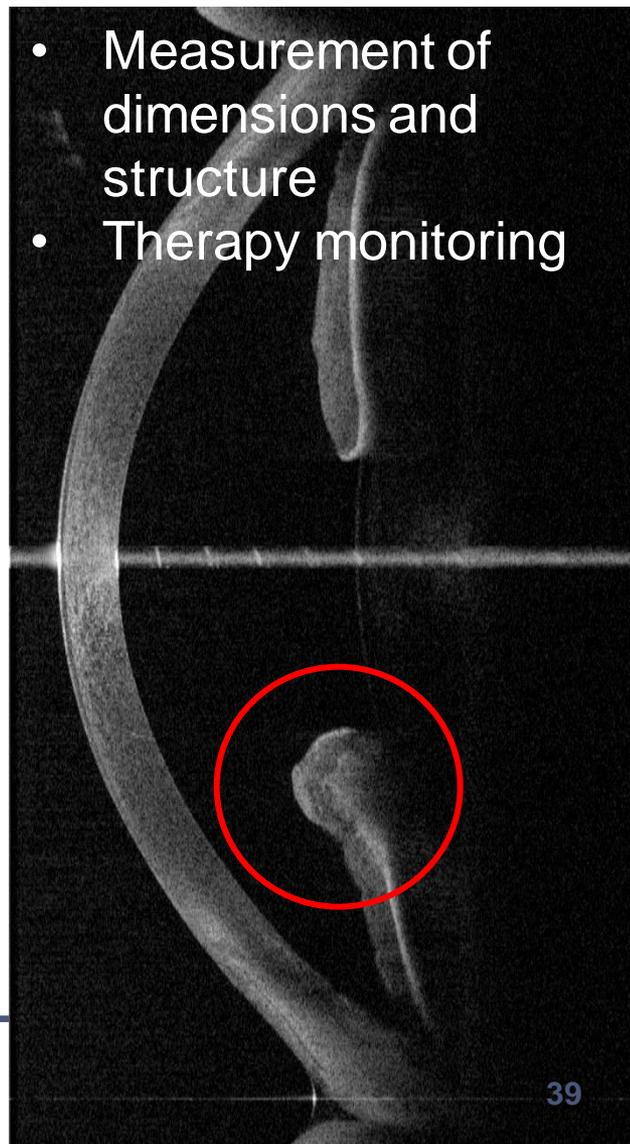
Severe iris defect and Descemet detachment after ocular trauma



Malignant iris tumor



- Measurement of dimensions and structure
- Therapy monitoring



Peripheral iris cyst

Print Save H+VScan Drag ZoomIn ZoomOut 30% 2D Analysis Play 3-D View Bleb

OS 3 D IRIS

Comment Save

CASIA Ver.5X

ScanParam Display

Color Type Gray

ShiftAverage 3

Grid Type Off

Data Window log Intensity

Max 100 Min 50

Max=100, Min=50

Max Min

En-face

Vertical

Horizontal

Cscan

Measurement samples: Refractive surgery and IOL implantation

Corneal topography following LASIK



Calibrated No. = 01

Date: 8/6/2010 Time: 3:19:19 PM

Comment:



Anterior

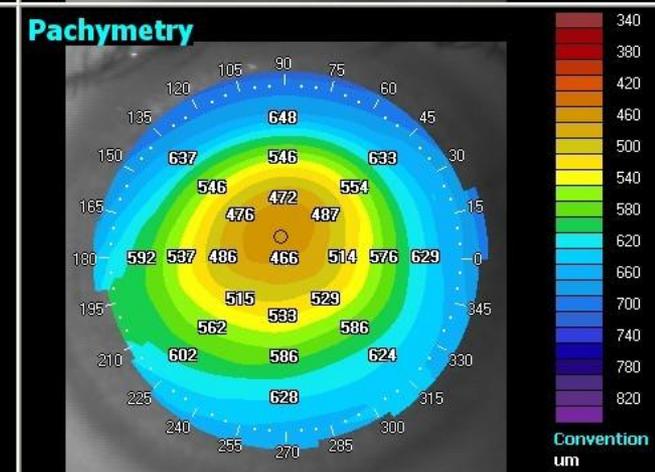
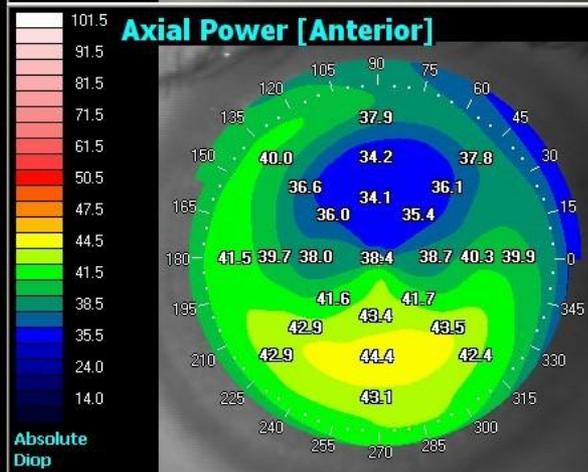
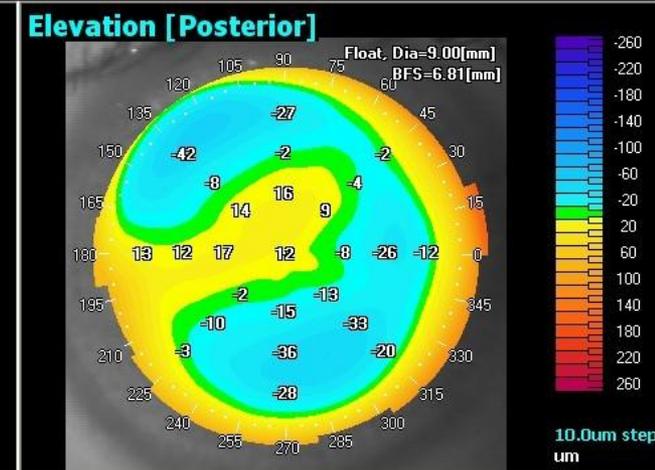
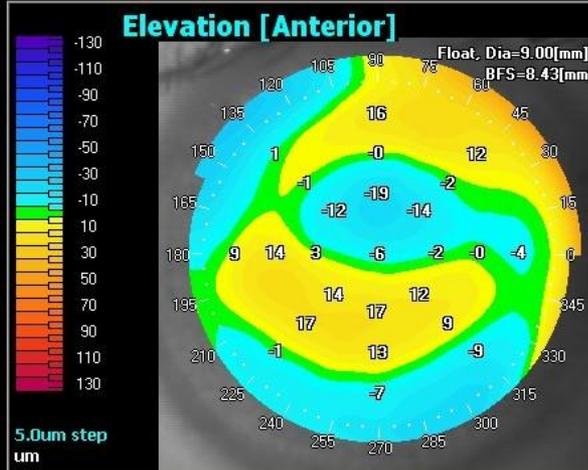
Ks: 38.9 @ 127°
Kf: 38.6 @ 37°
CYL: 0.3
AvaK: 38.7
AA: 97.6 I%|

Posterior

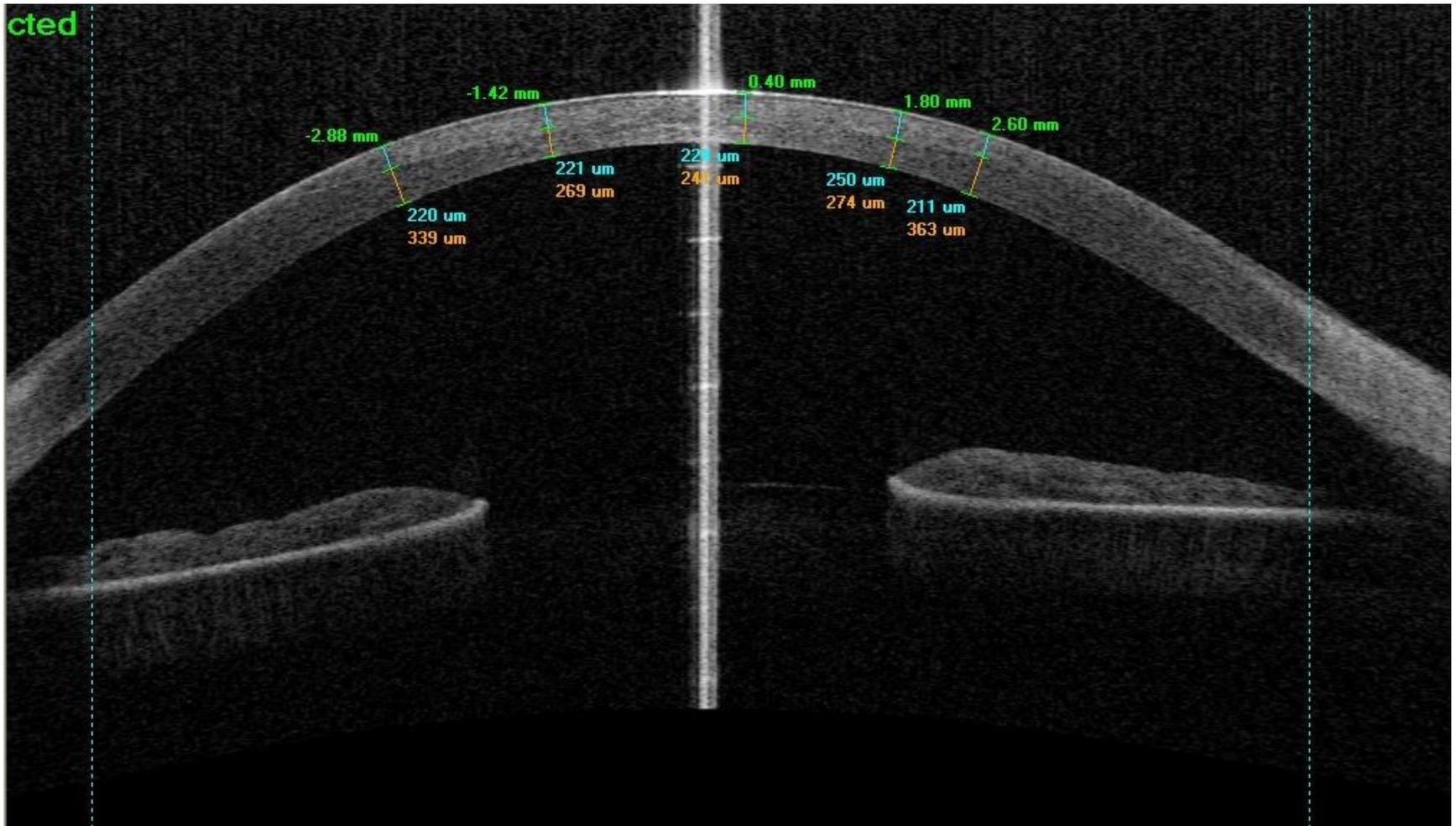
Ks: -6.4 @ 117°
Kf: -6.0 @ 27°
CYL: 0.3
AvaK: -6.2
AA: 93.9 I%|

Pachymetry

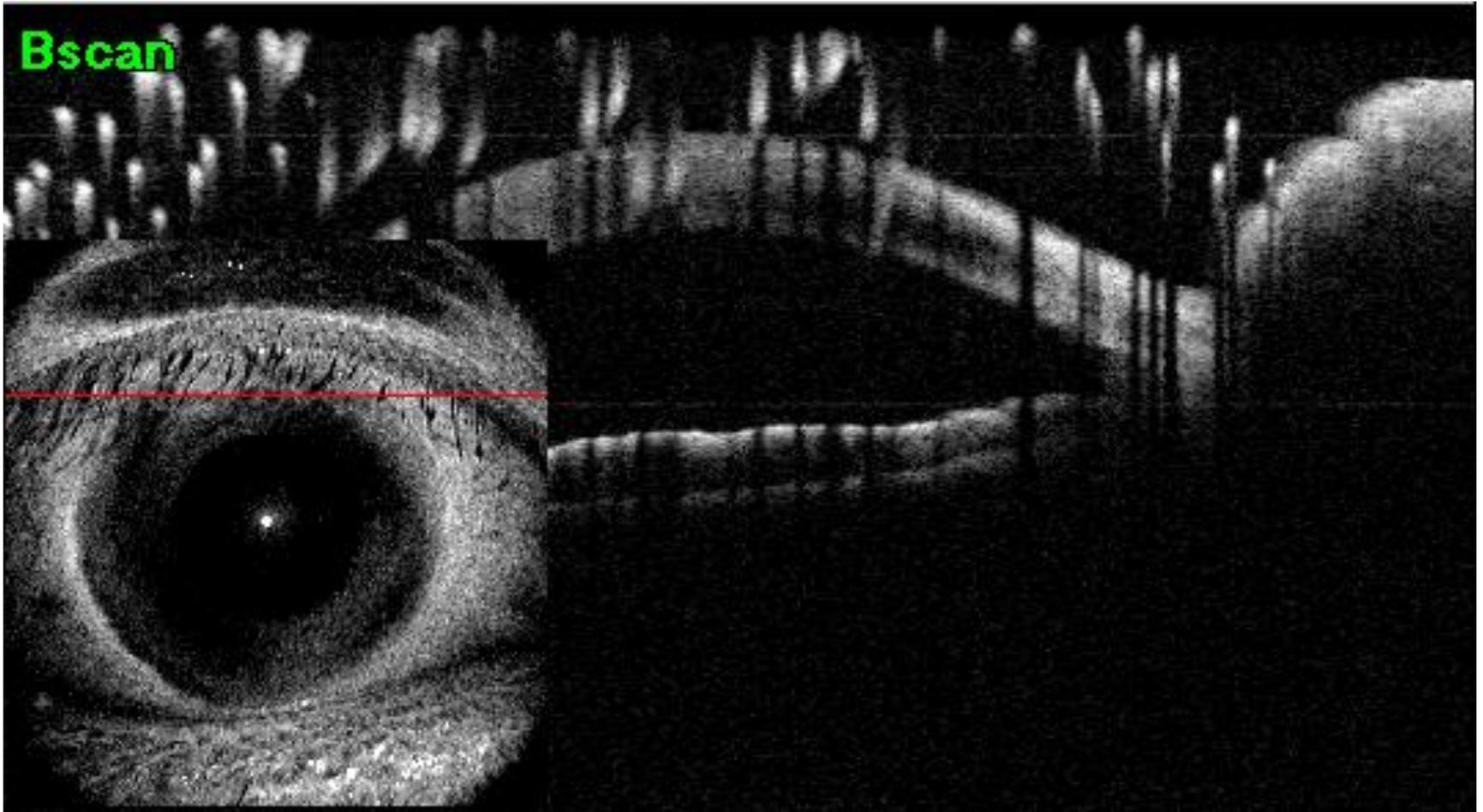
Apex: 466 μ m
X: 0.0 I μ m
Y: 0.0 I μ m
Thinnest: 452 μ m
X: -0.1 I μ m
Y: 0.5 I μ m



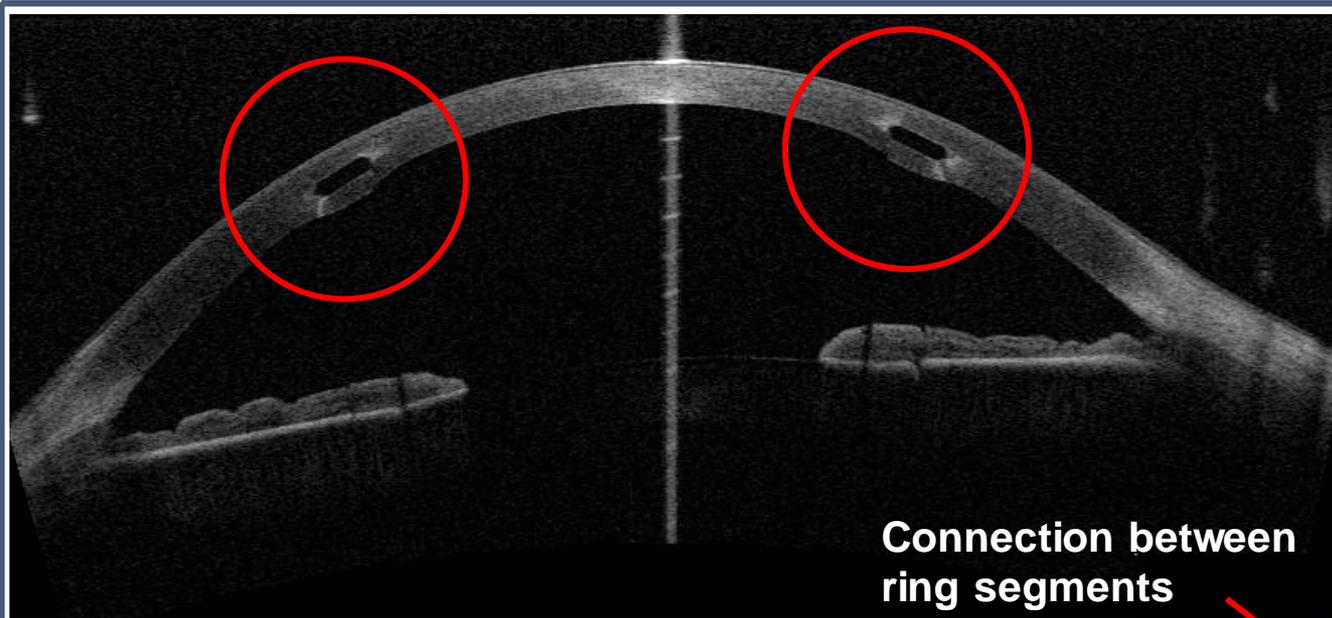
Evaluation of flap thickness after LASIK



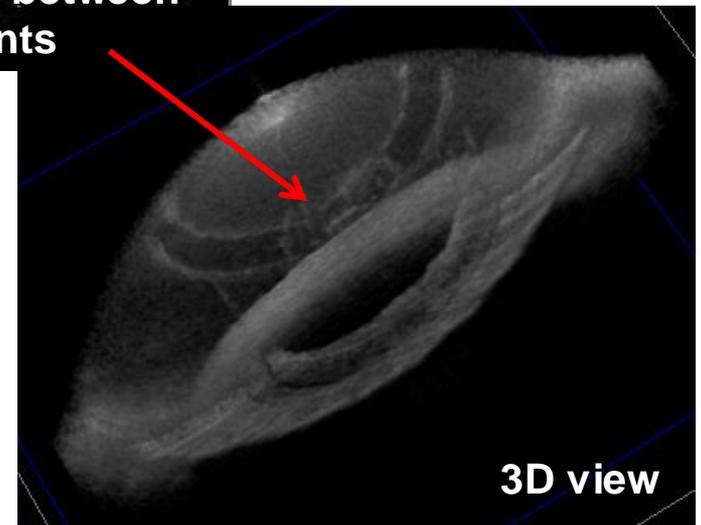
LASIK flap 3D video



Corneal Intacs

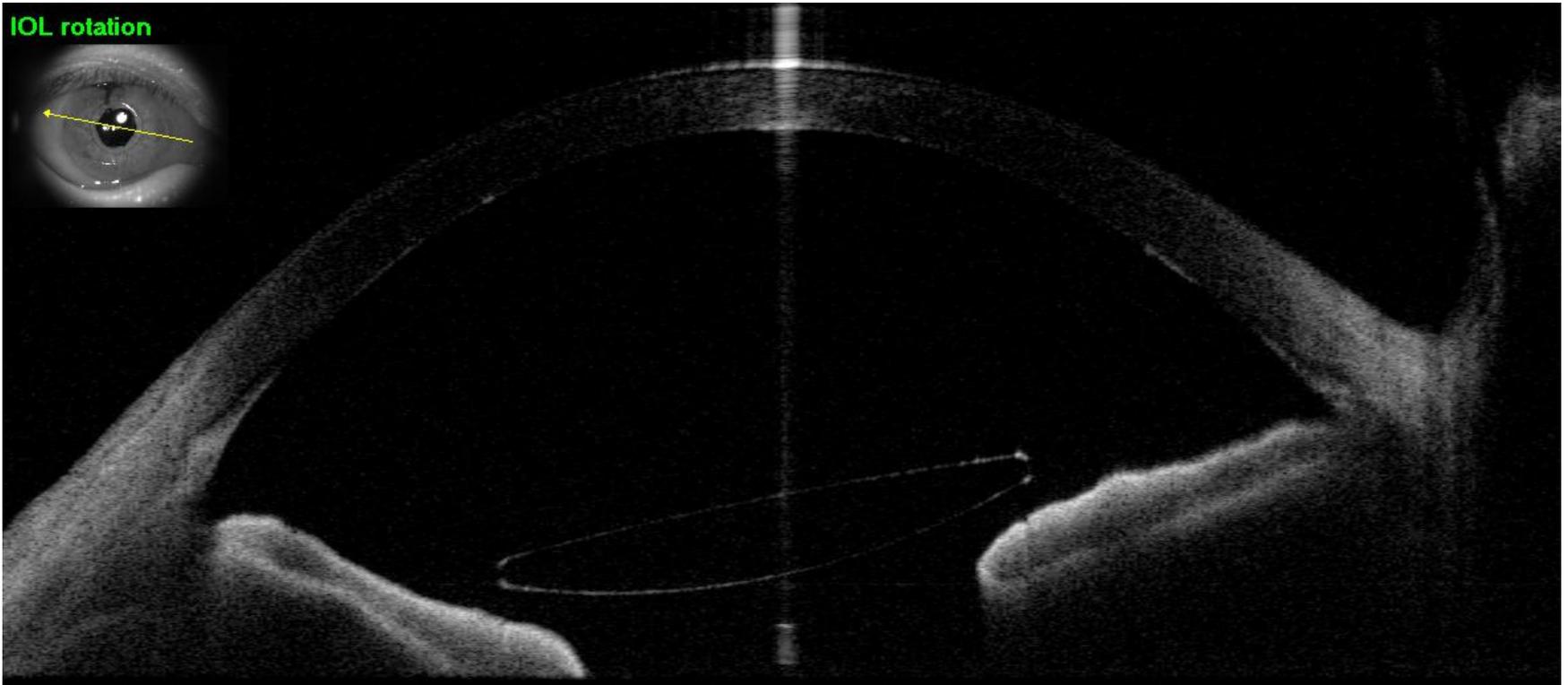


Connection between ring segments

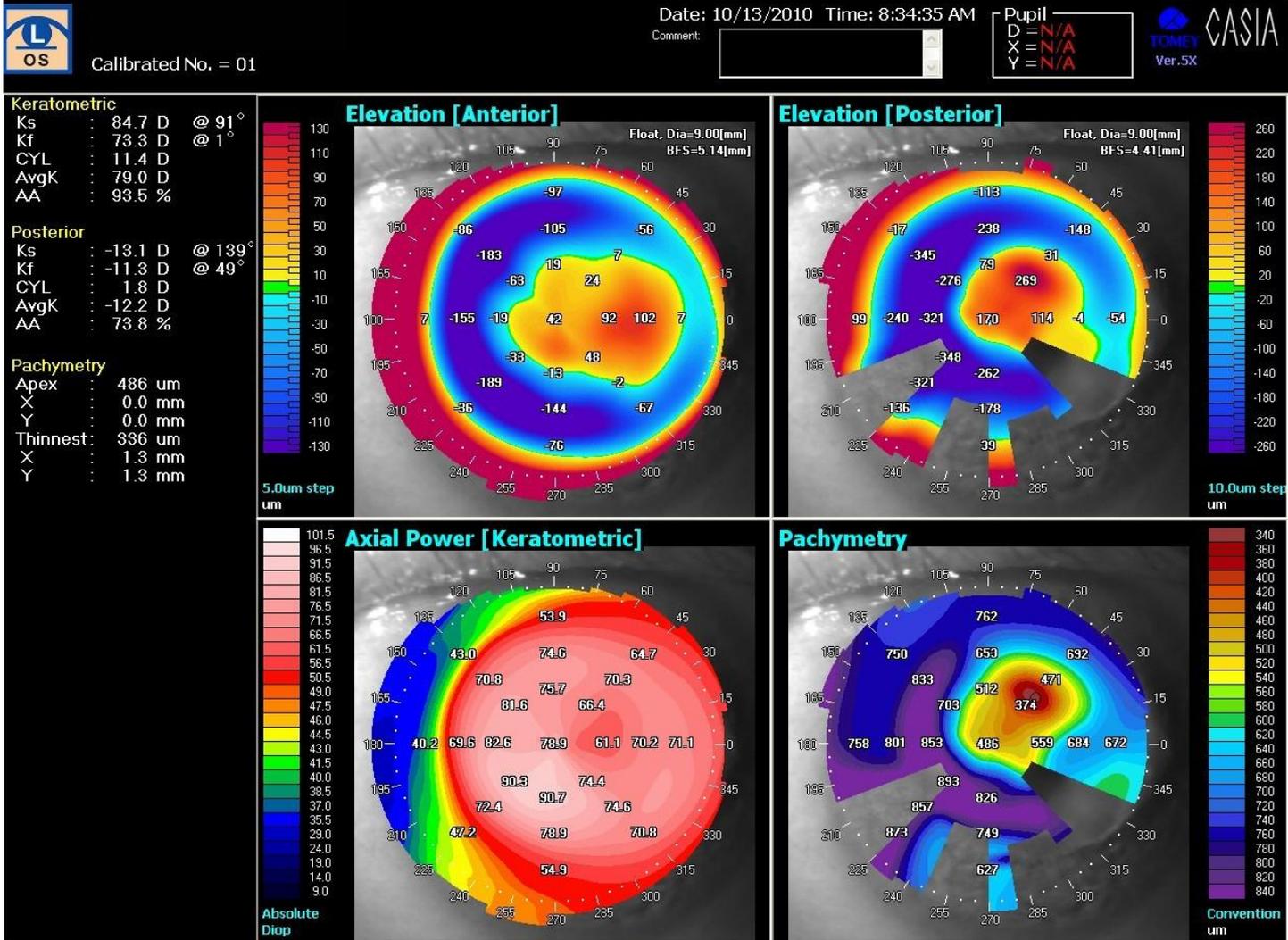


3D view

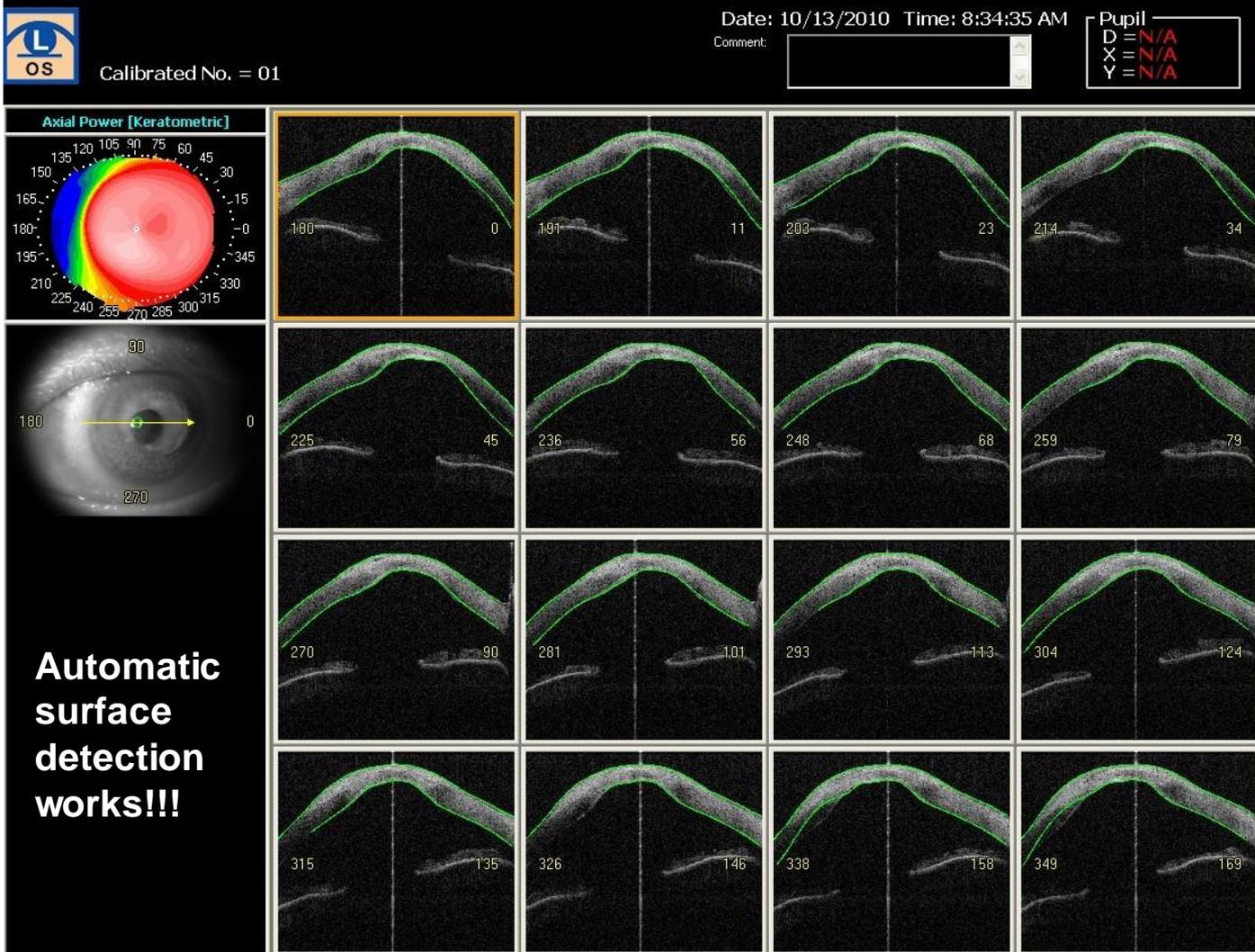
Tilted refractive anterior chamber IOL



Extreme keratectasia after LASIK – Corneal topography



Extreme keratectasia after LASIK – Meridional cross section



Conclusions

- The Casia 1000 is a powerful diagnostic tool which allows for high resolution 2D and 3D-measurements of
 - Cornea (.2-2.4 s image acquisition time)
 - Anterior eye segment (distances, chamber angles, areas,...; 1.2 s acquisition time)
 - Crystalline and artificial lens (mainly anterior segment, .5-1.2 s image acquisition time)
- Topography of the anterior and posterior corneal surface including precise full surface pachymetry (0.3 s acquisition time)
- True angles and distances **ONLY** if superficial surfaces are recognized and corrected properly
 - optical pathway correction with polynomials (n=10)
 - optional manual surface correction

Conclusions

- In measurement precision the Swept-Source-Technology is equivalent with SE-FD-OCT, but allows significantly shorter acquisition times
 - lower risk of movement artifacts (SS vs. TD-OCT: 30000 vs. 2000 scans/s)
- Raw data and processed data can be easily exported and postprocessed externally
- Dedicated keratoconus screening module is available with the new software version
- RGP CL fitting software in preparation (spherical, aspherical, multi-curved or toric CLs)

Experimental Ophthalmology

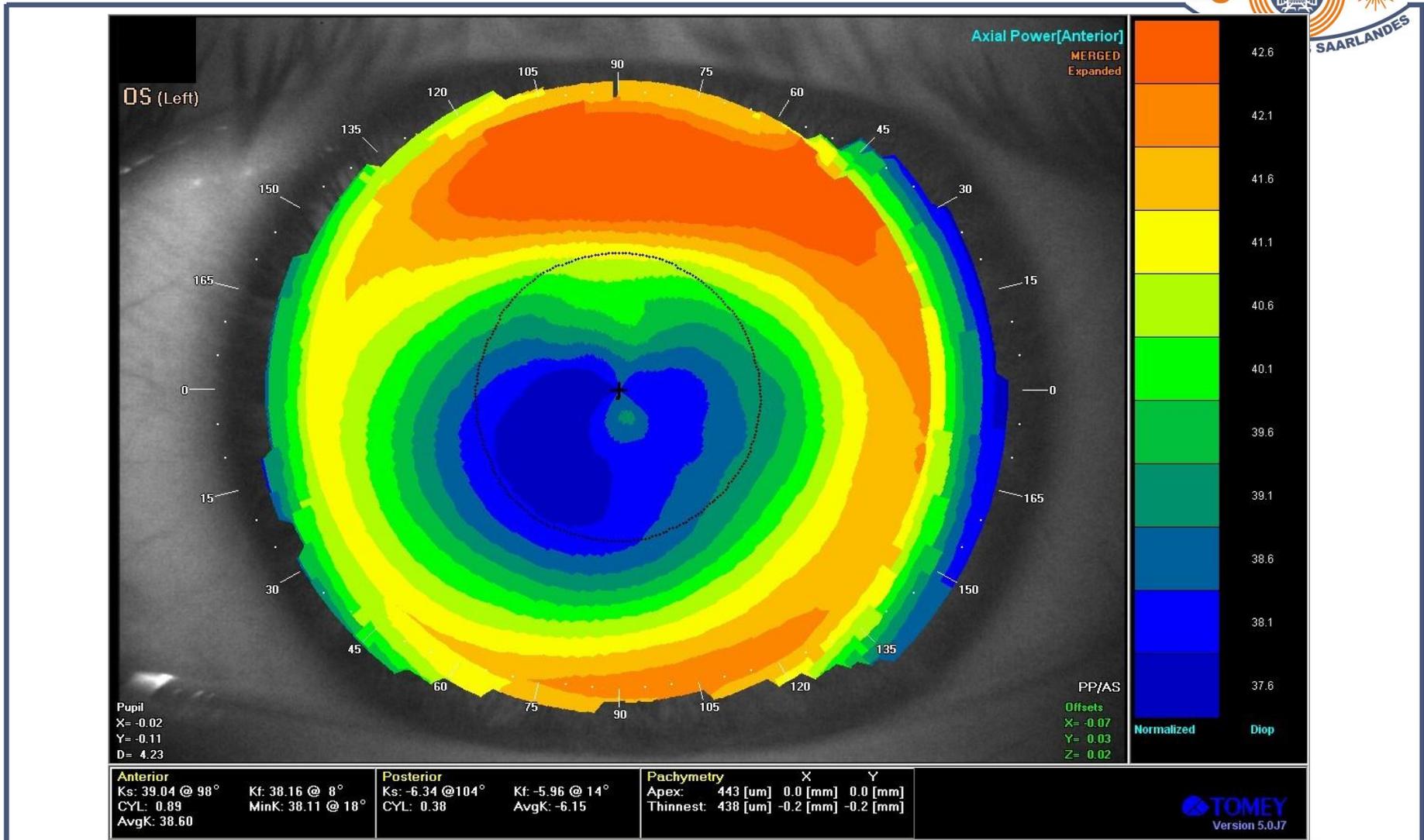
Saarland University

Thanks for your kind attention

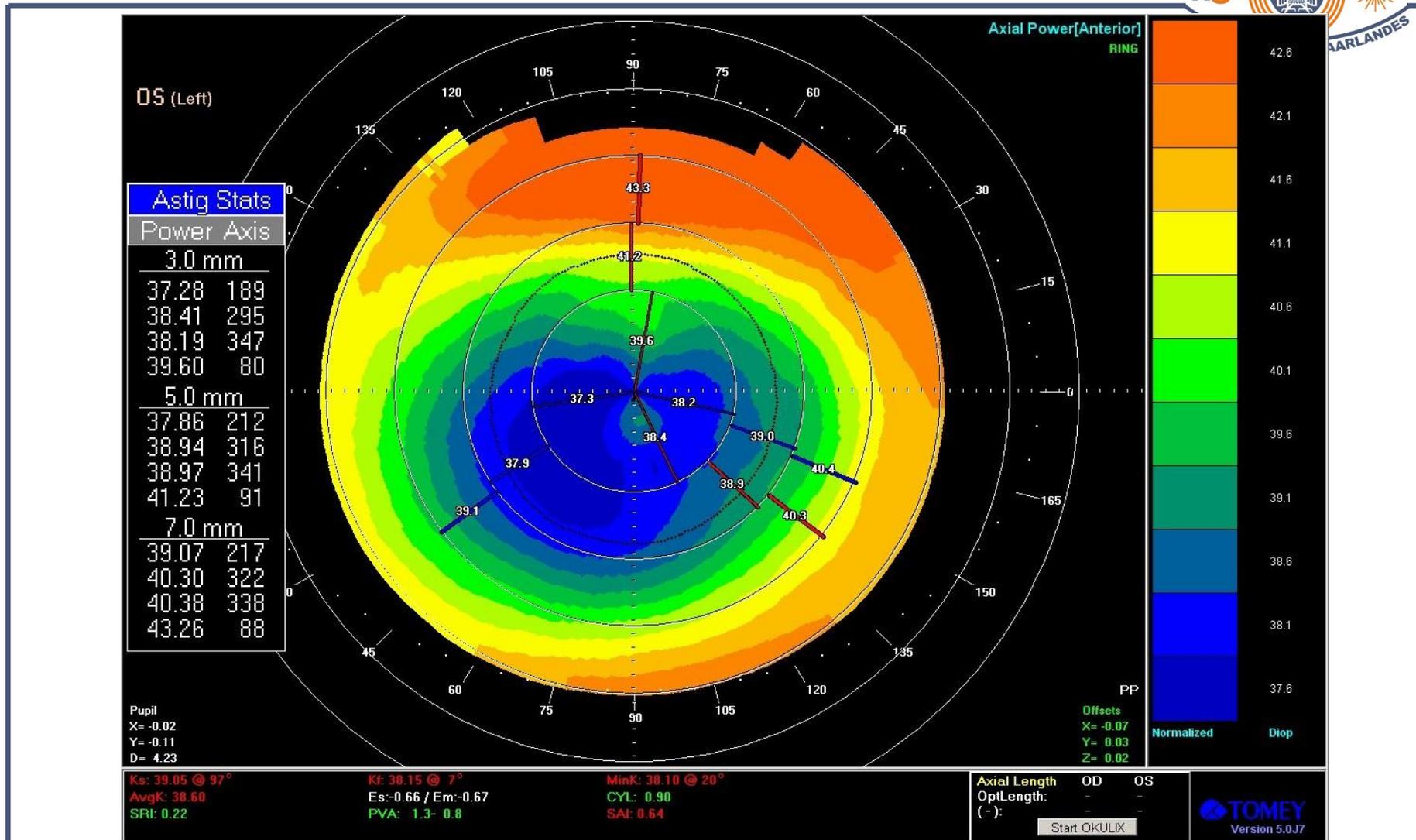
Kirrberger Strasse / Bldg. 22
66421 Homburg/Saar
Germany
Tel.: +49 (0) 6841 / 16-21218
Fax.: +49 (0) 6841 / 16-24400
achim.langenbucher@uks.eu

TMS-5 Anterior segment analyzer

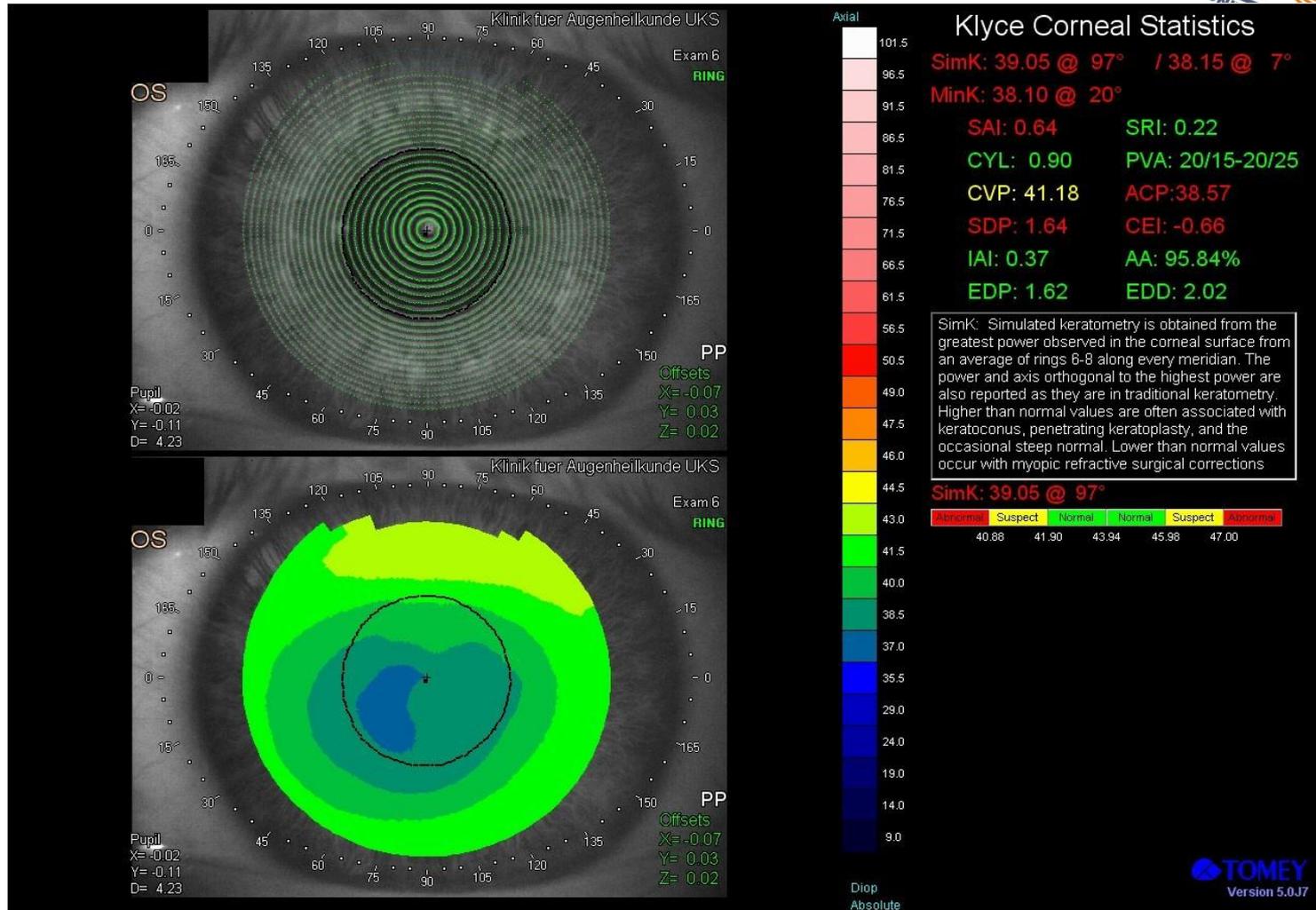
Classical topography map of the anterior corneal surface



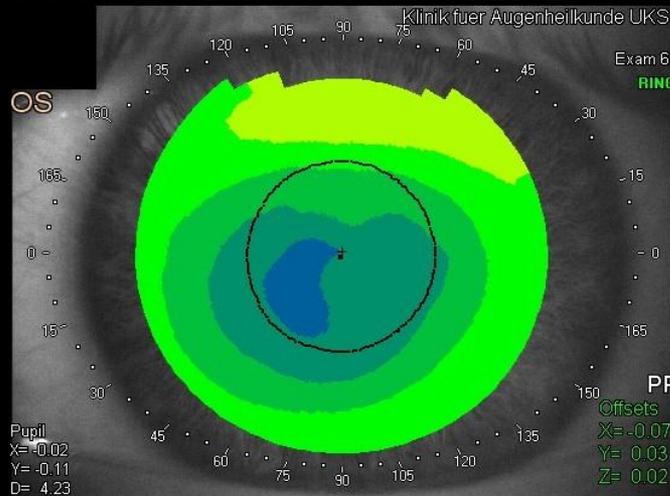
Corneal power evaluation of the anterior corneal surface (e.g. CL fitting)



Corneal statistics (qualitative and quantitative)



Keratoconus screening based on anterior corneal topography



Keratoconus Screening

Klyce/Maeda

Smolek/Klyce

KCI

KSI

0.0% Similarity
 Keratoconus
 Pattern not
 Detected

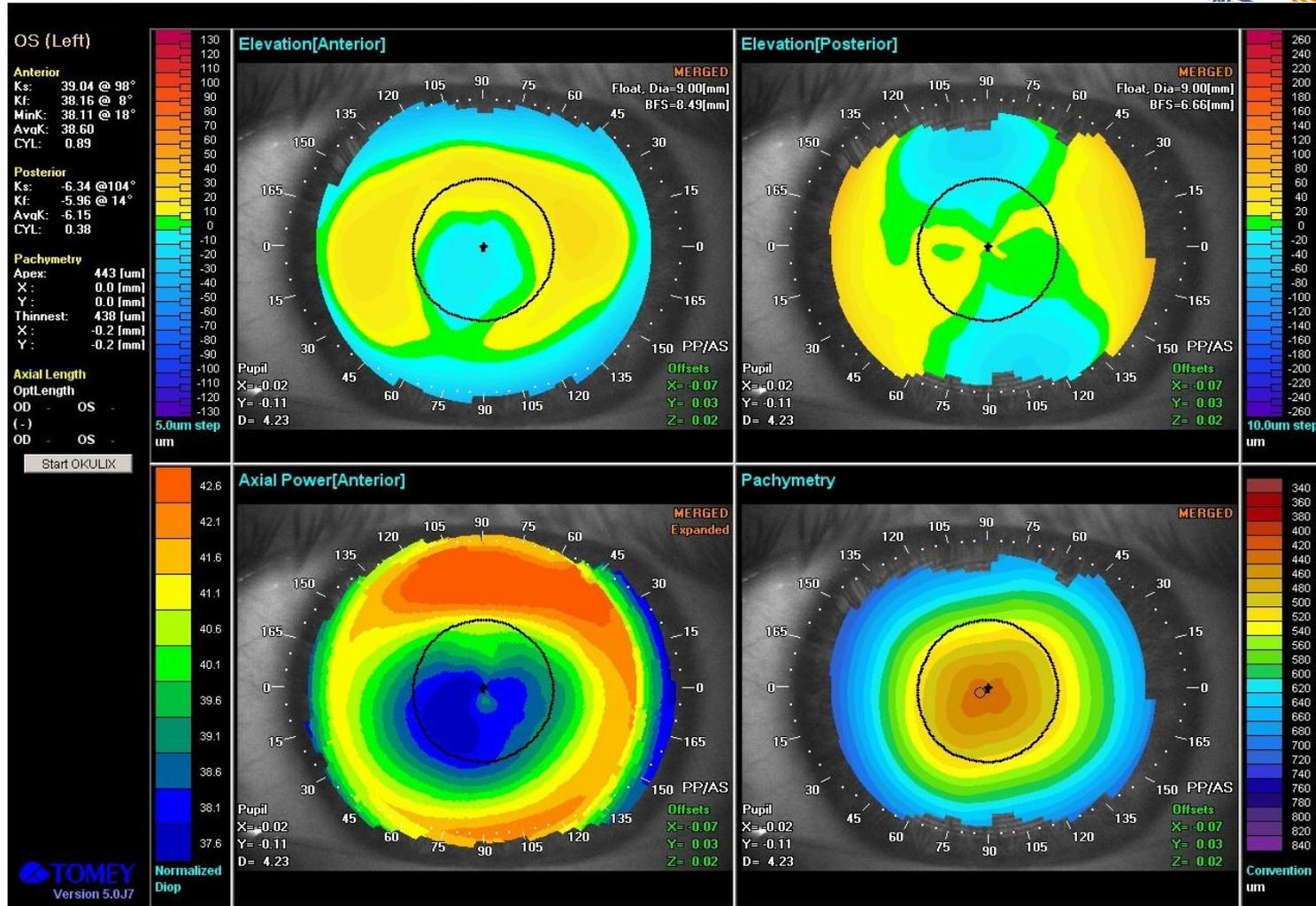
0.0% Severity
 Keratoconus
 Pattern not
 Detected

Related Indices

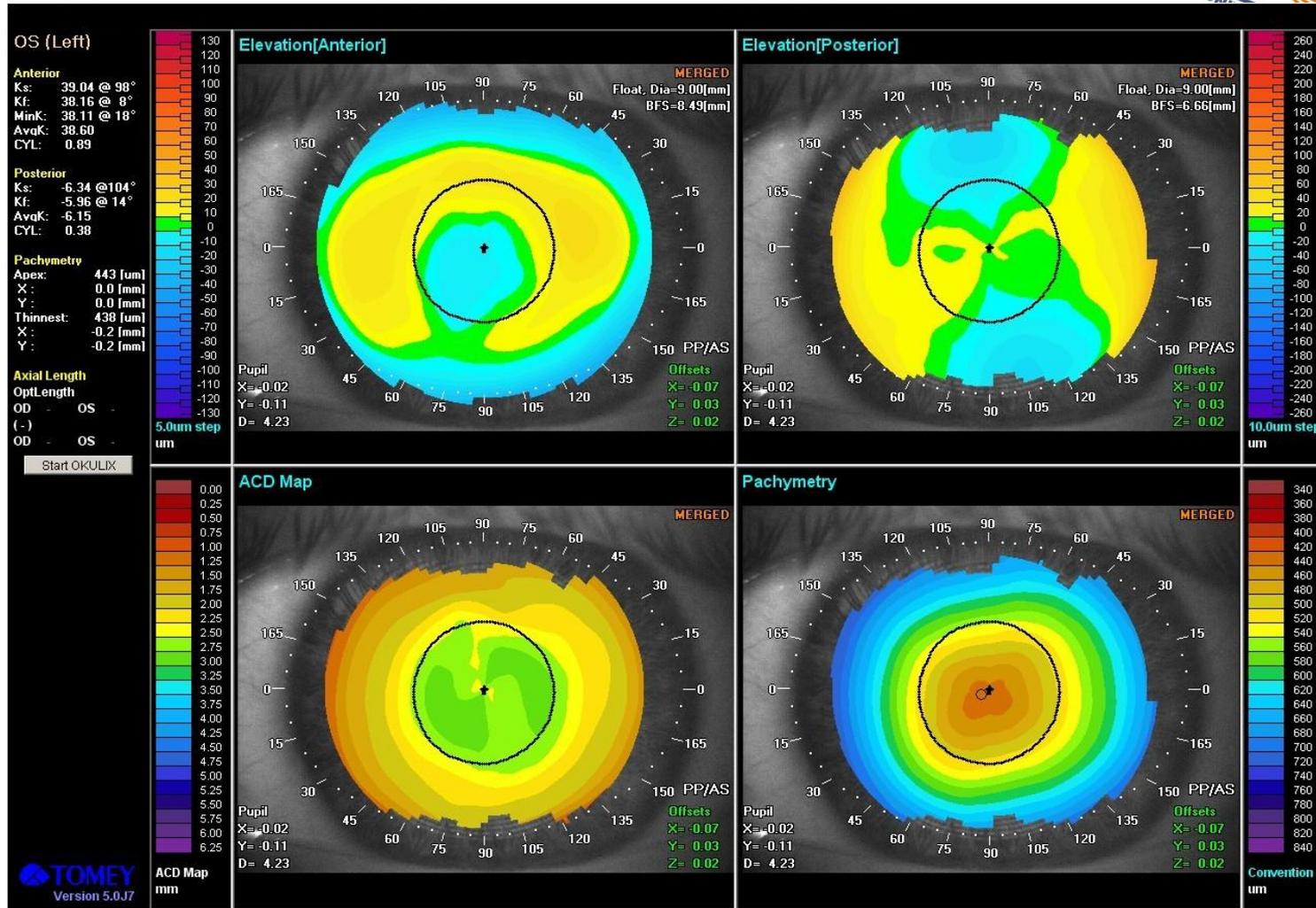
SK1: 39.05 SK2: 38.15 CYL: 0.90
 SAI: 0.64 DSI: 3.29 SRI: 0.22
 OSI: 2.17 CSI: -1.28 SDP: 1.64
 IAI: 0.37 KPI: 0.19 AA: 95.84%
 SK1: 39.05@97°



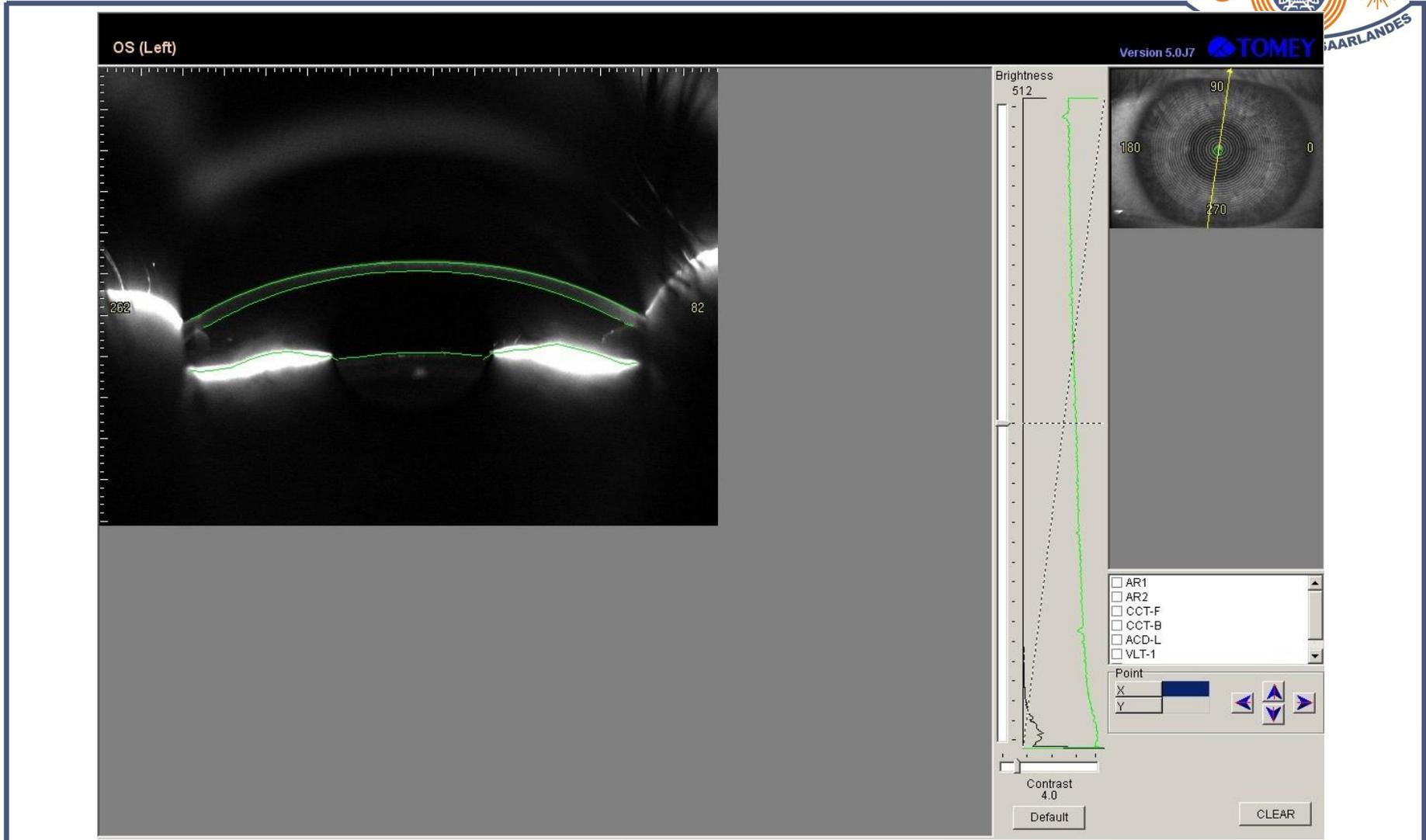
Corneal quad map



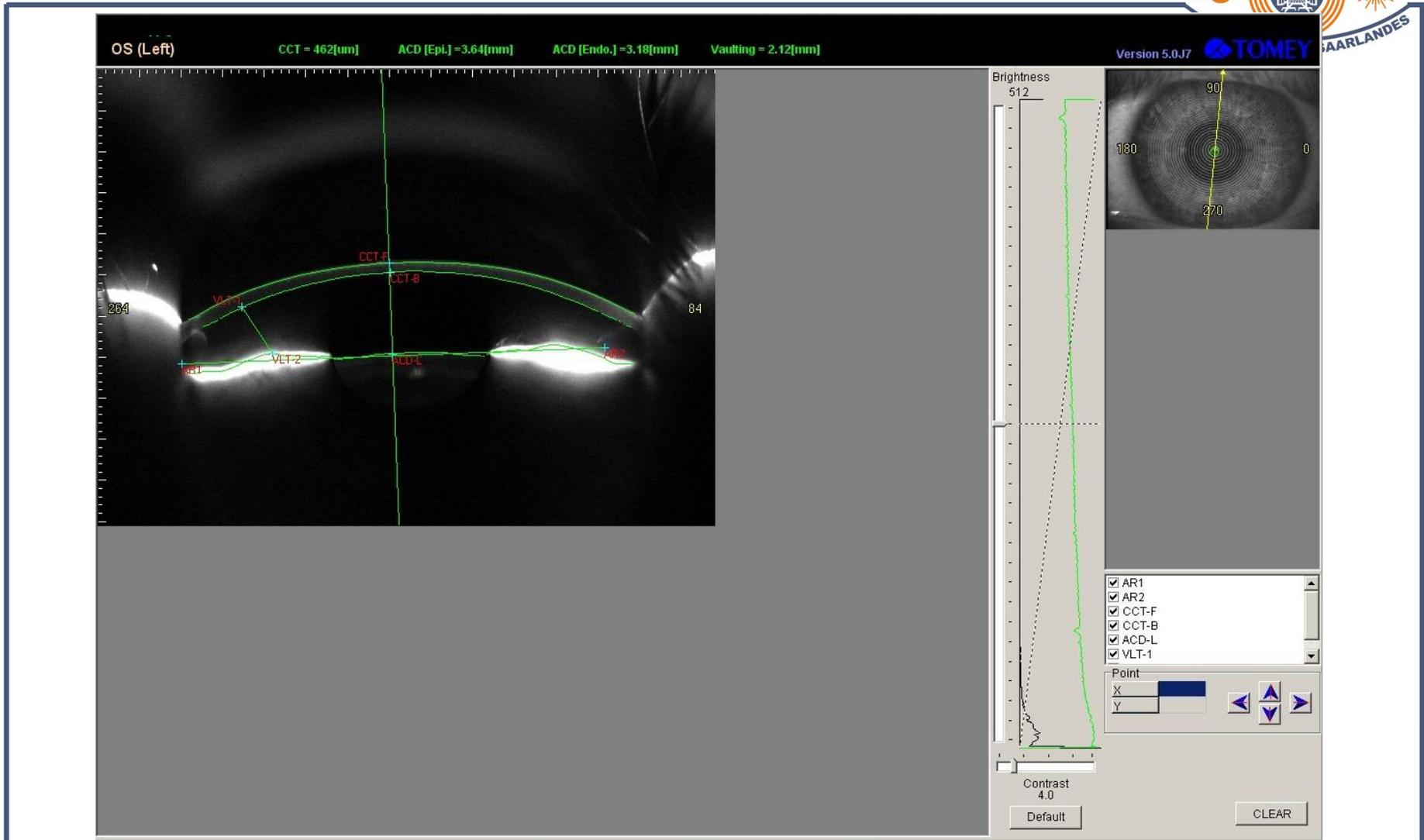
Alternatively with ACD instead of axial power (e.g. in glaucoma screening)



Surface detection with the Scheimpflug AC mode



Measurement of CCT, ACD and w-t-w



Case presentation: Comparison of different anterior segment imaging modalities

Extreme keratoconus with scarring – slit lamp overview



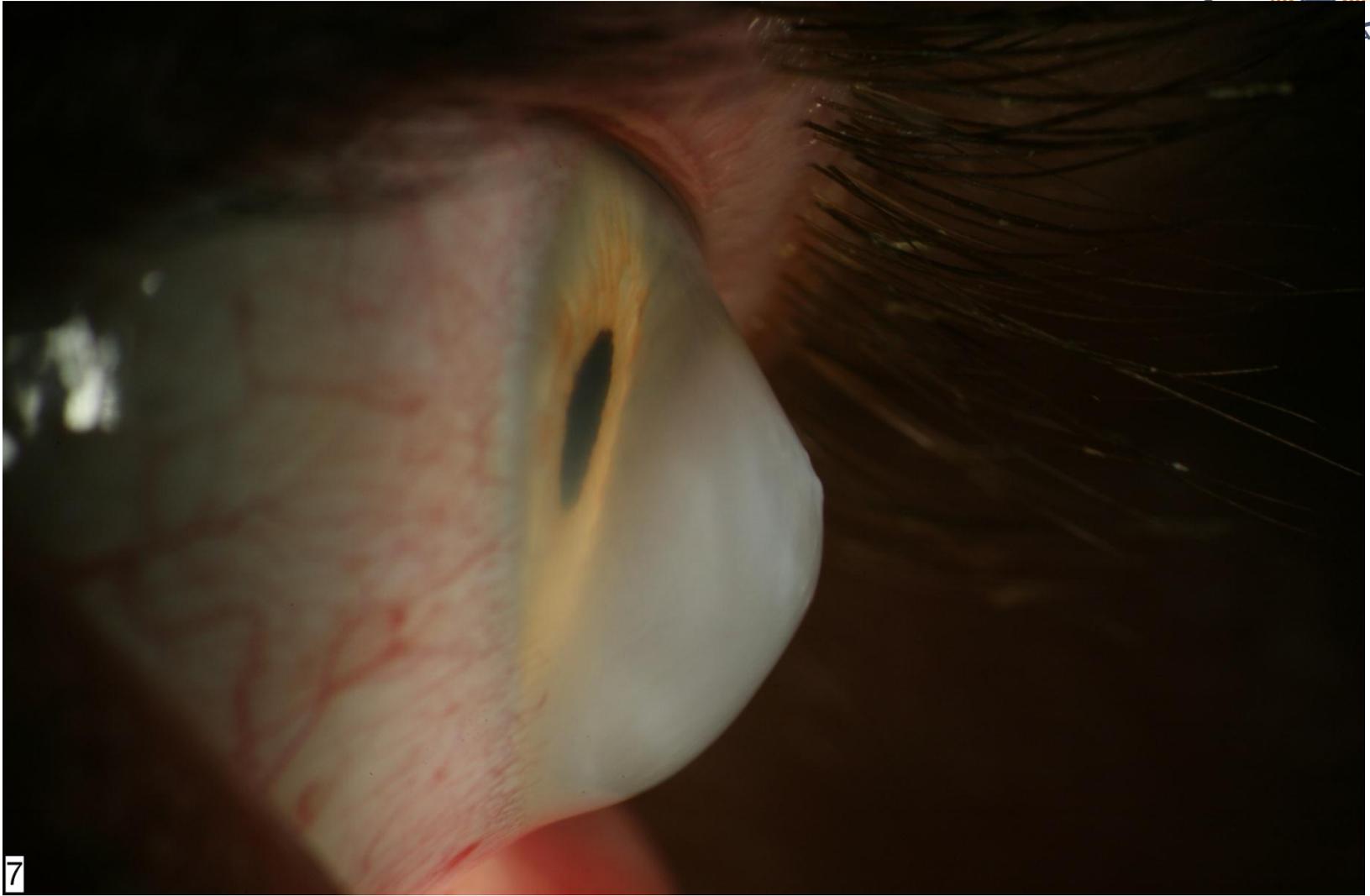
5

Slit lamp examination – cone profile

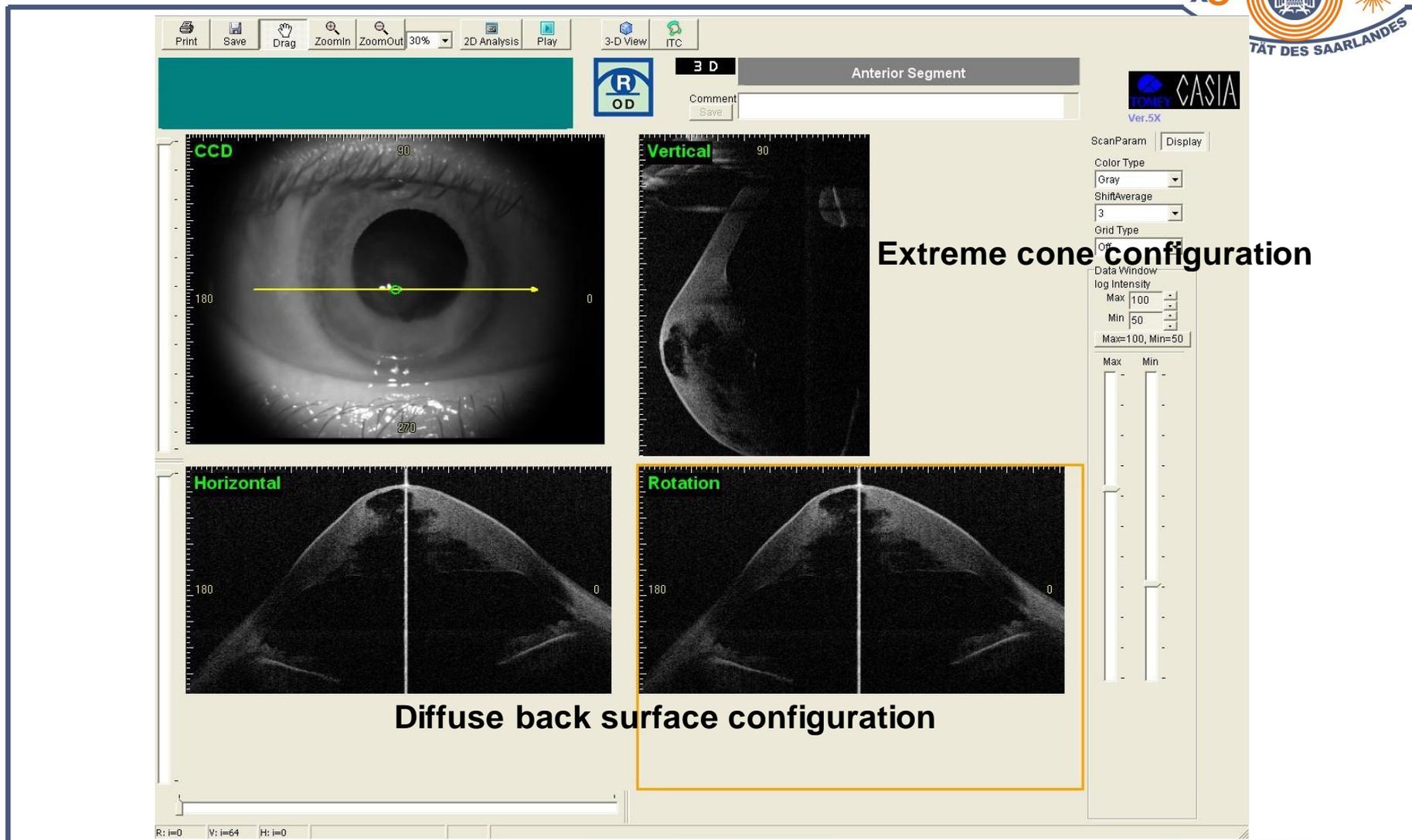


13

Munson sign – side view



Casia imaging – cross section



Comparison of different anterior segment imaging modalities

Print Save

3 D Anterior Segment

Comment

CASIA Ver. 5X

Correct ACA Bleb CCT/ACD Flap Thickness Area Manual

Previous

270 90

After

R(@90): I=64

180 0 270

anterior cornea

Point X Y Mouse Pos

50%

Clear

Correct OK

Casia imaging – 3D view

250
200
150
100
50
0

Color Type
Gray

Display Frame

Quality HIGH

Transparency(%) 70

Contrast(%) 15

Operation Object Plane

AngleStep(deg) 90

Move Plane

Speed(fps) 15

Gonio-scopic View

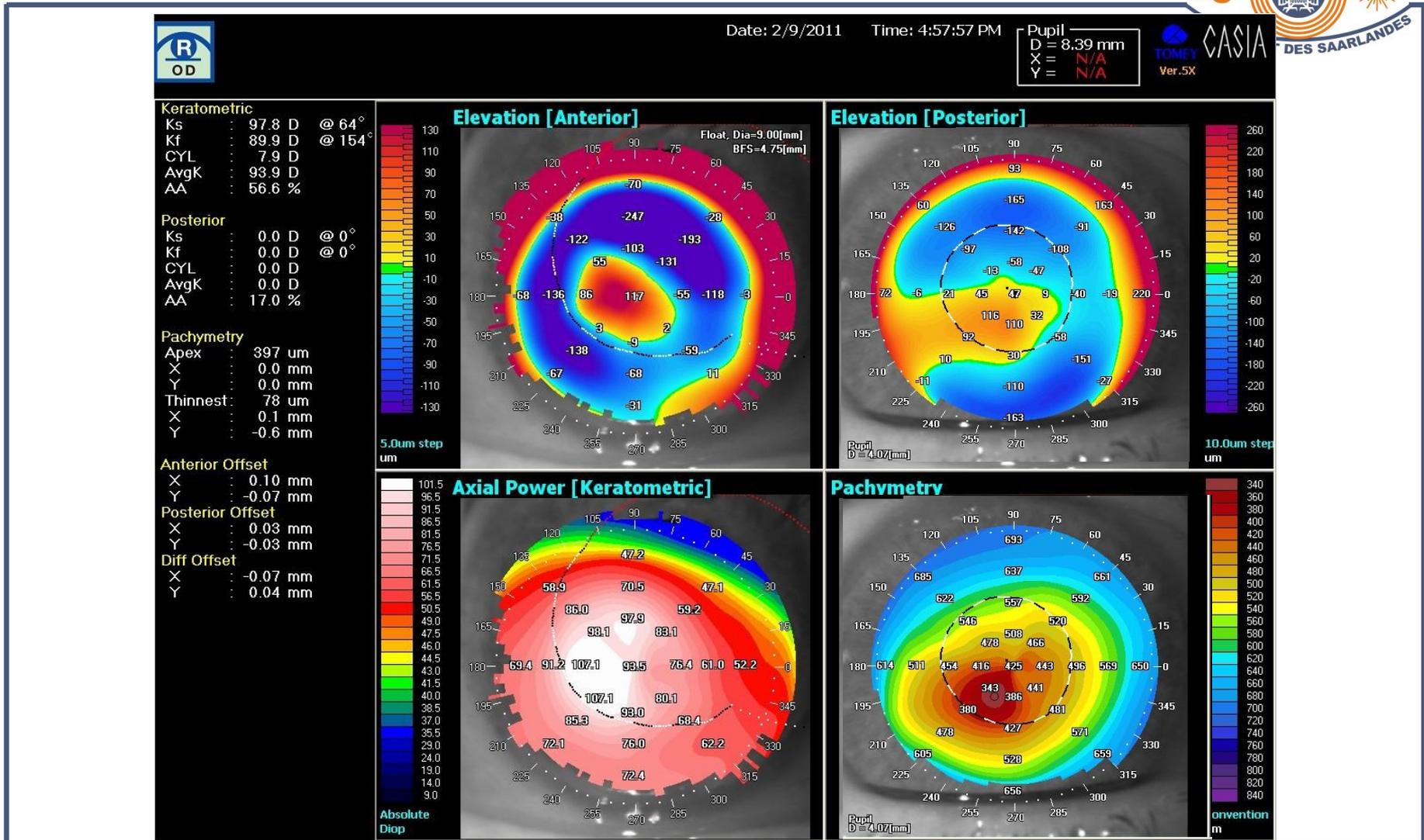
Rotation Speed

View Angle 20

Stop

TOMEY CASIA Ver.5X

Casia imaging – topography map



Pentacam HR imaging – topography map

OCULUS - PENTACAM

Name:
Vorname:
ID:
Geb. Dat.:
Unt. Dat.:
Unt. Info:

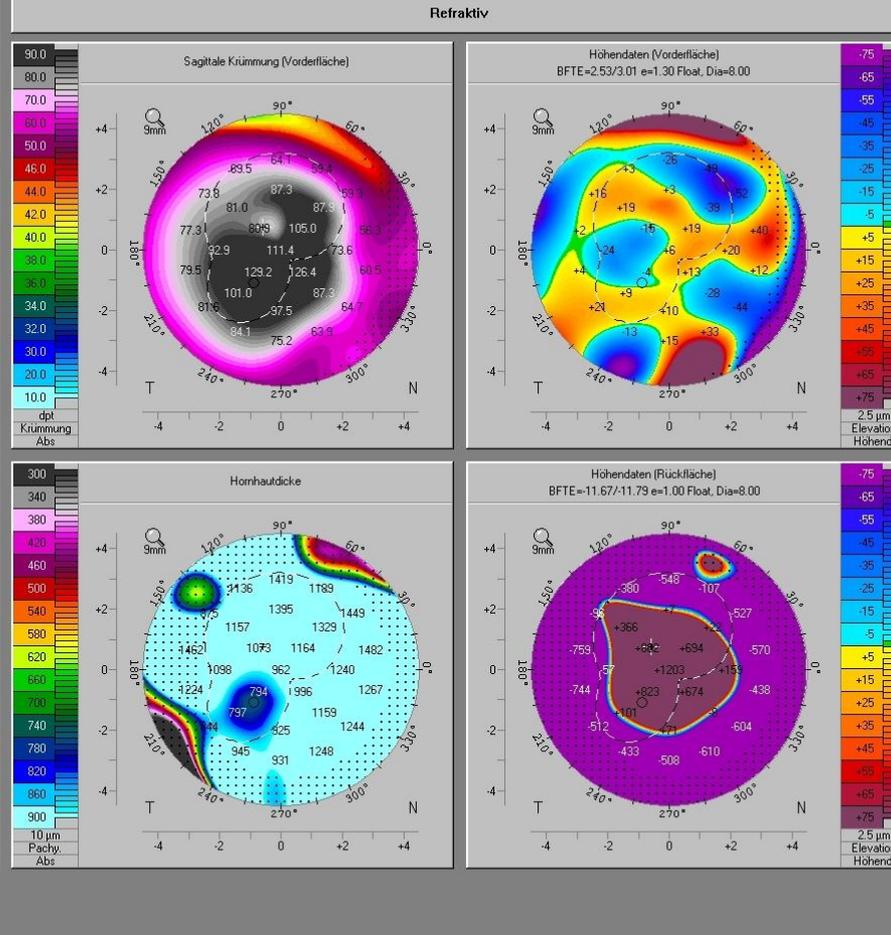
Cornea Vorderfläche

Rhc:	3.64 mm	K1:	92.8 dpt
Rvc:	3.18 mm	K2:	106.1 dpt
Rmc:	3.41 mm	Km:	99.0 dpt
QS:	Dalen	Ach: (flach)	142.5°
Q:	-1.66	Rper:	6.01 mm
		Rmin:	2.34 mm

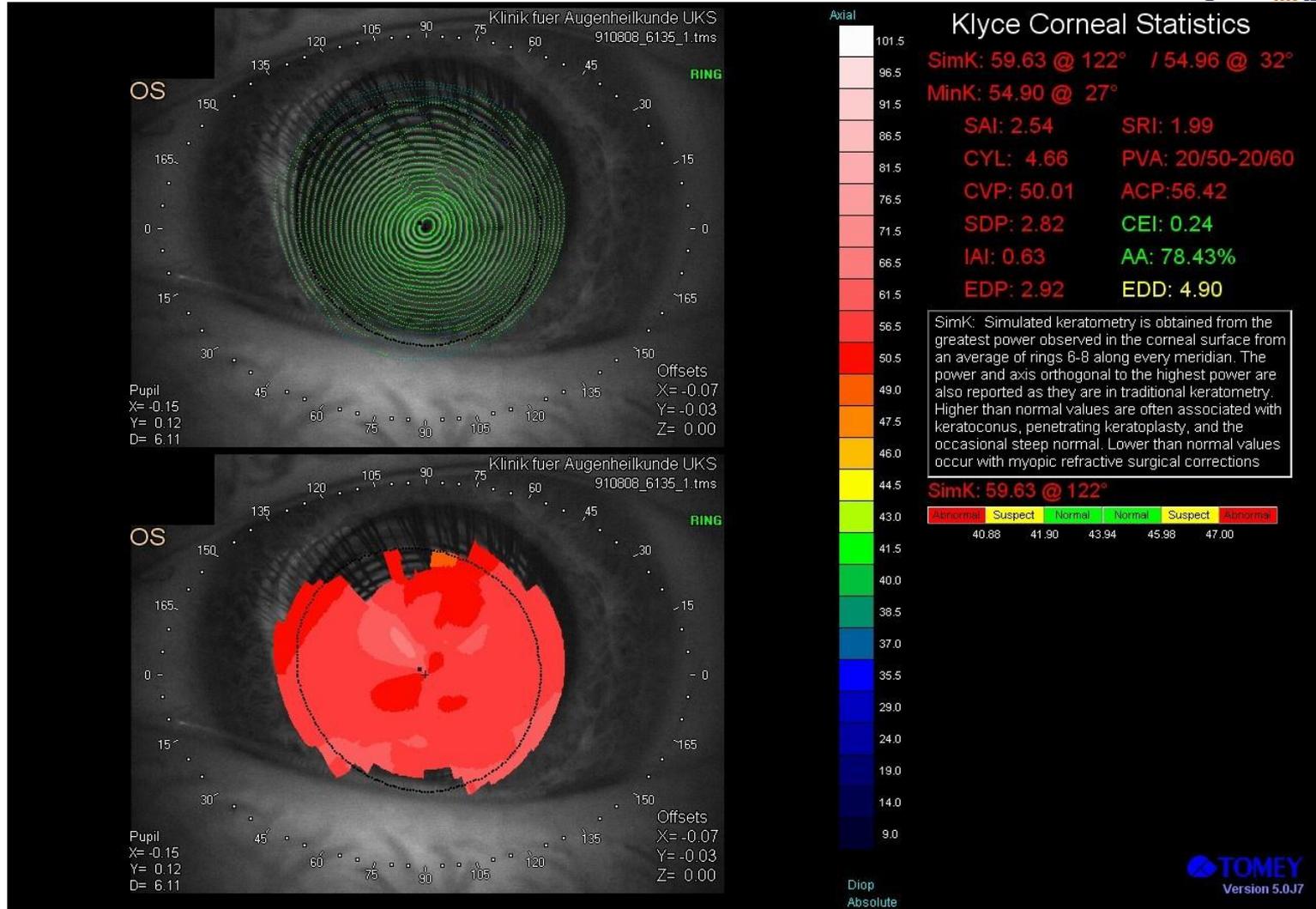
Cornea Rückfläche

Rhc:	2.64 mm	K1:	-15.2 dpt
Rvc:	2.53 mm	K2:	-15.8 dpt
Rmc:	2.58 mm	Km:	-15.5 dpt
QS:	Blinzeln	Ach: (flach)	1.1°
Q:	-5.87	Rper:	5.91 mm
		Rmin:	1.24 mm

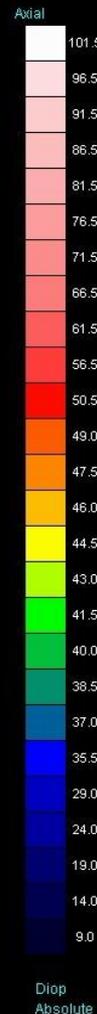
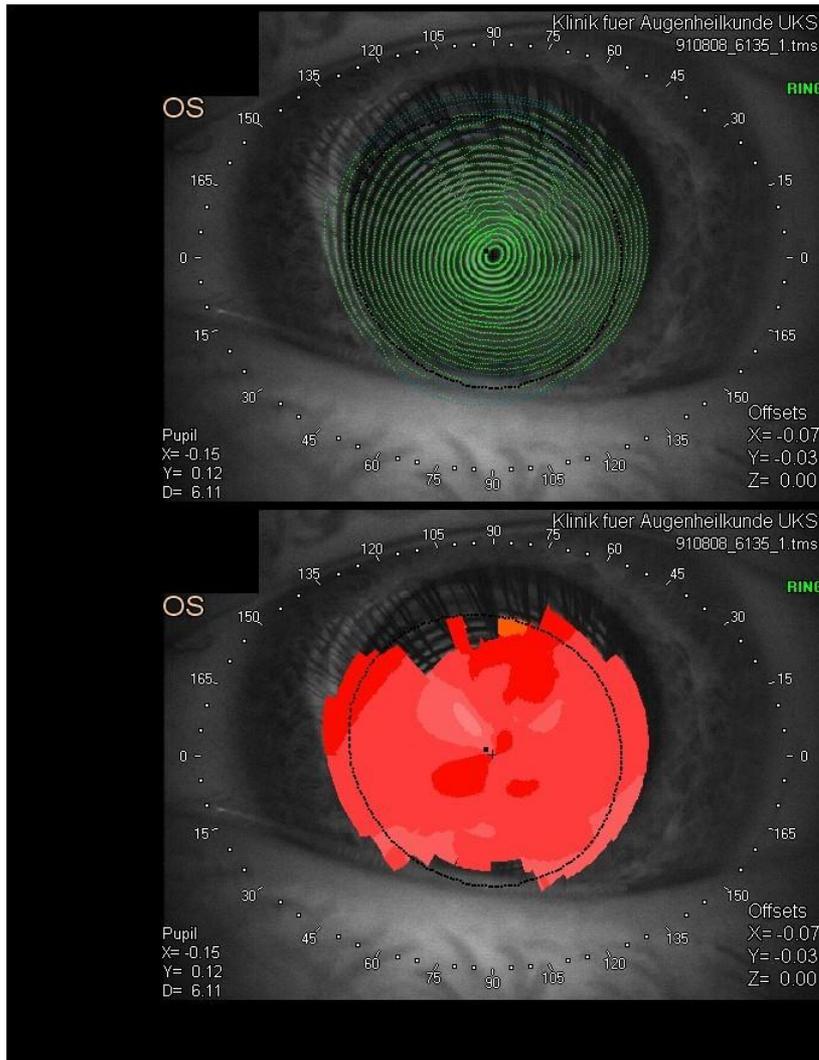
Pupillenzentrum:	+	1087 µm	x[mm]	-0.57	y[mm]	+0.74
Pachy Apex:	●	962 µm		0.00		0.00
Dünnstelle:	○	761 µm		-0.89		-1.07
K Max. (Vorderfl.):	◇	144.0 dpt		-0.06		-0.77
Cornea Volumen:		99.4 mm ³	KPD:			+10.8 dpt
Kammervolumen:		218 mm ³	Winkel:			48.5°
V. K. Tiefe (Int.):		1.87 mm	Pupille:			4.61 mm
Eing. IOD:		16.5 mmHg	IOD(Sum):			



TMS-5 imaging – corneal topography and Klyce statistics



TMS-5 imaging – corneal topography and Klyce keratoconus screening



Keratoconus Screening

Klyce/Maeda <u>KCI</u>	Smolek/Klyce <u>KSI</u>
72.9% Similarity	89.3% Severity
Clinical	Clinical
Keratoconus	Keratoconus
Interpreted	Interpreted

Related Indices

SK1: 59.63 SK2: 54.96 CYL: 4.66
 SAI: 2.54 DSI: 4.56 SRI: 1.99
 OSI: 3.99 CSI: -0.13 SDP: 2.82
 IAI: 0.63 KPI: 0.35 AA: 78.43%
 SK1: 59.63@122°

Abnormal	Suspect	Normal	Normal	Suspect	Abnormal
40.88	41.90	43.94	45.98	47.00	

TOMEY
 Version 5.0.J7