Optical Coherence Tomography in Glaucoma

OCT

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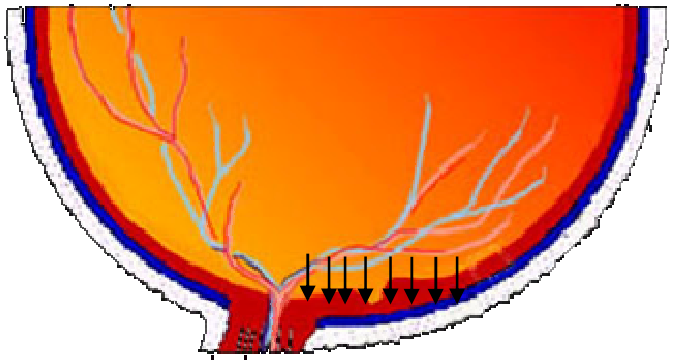
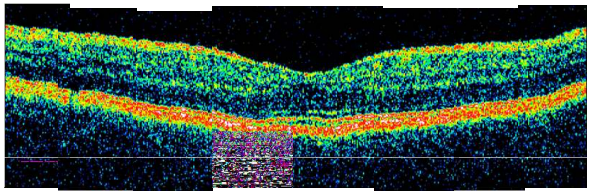
Optical coherence tomography

- Introduced in 1991, provides high-resolution direct measurements and cross-sectional imaging of the retina and the NFL. (OCT; Zeiss)

Is analogous to ultrasound B-scan imaging





OCT

B-Scan

- A short coherence length superluminescent diode source (850 nm)

- The operation of OCT is based on the principle of low coherence interferometry

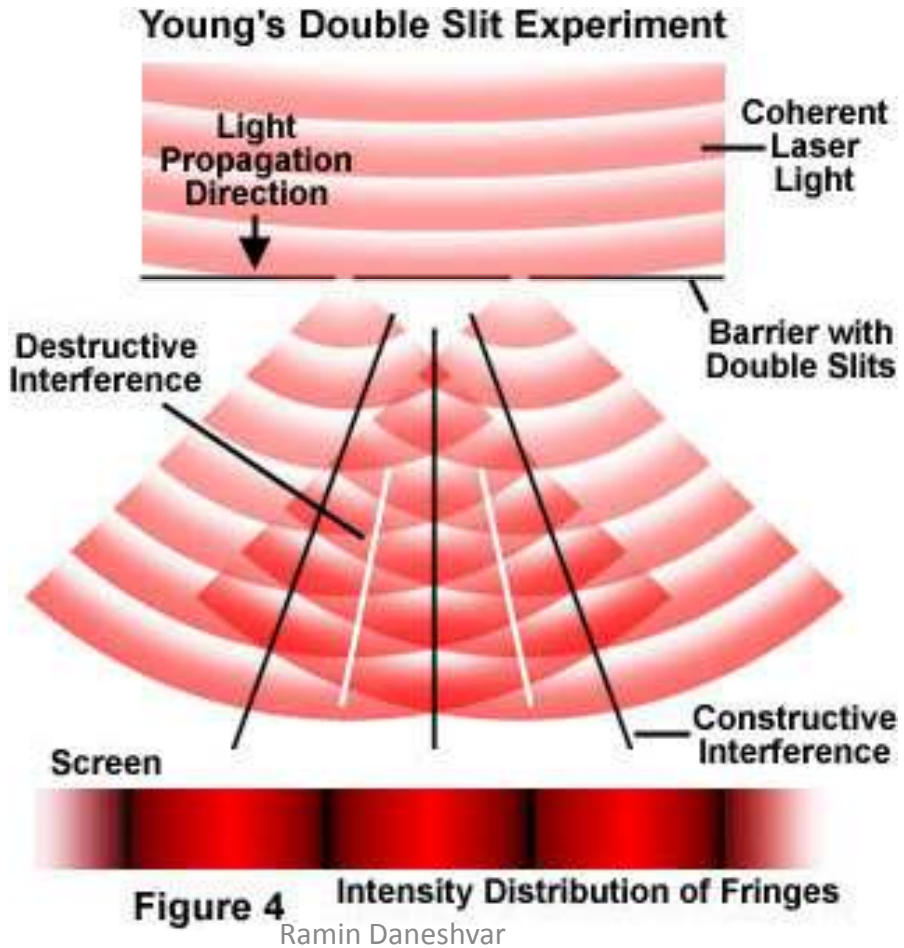
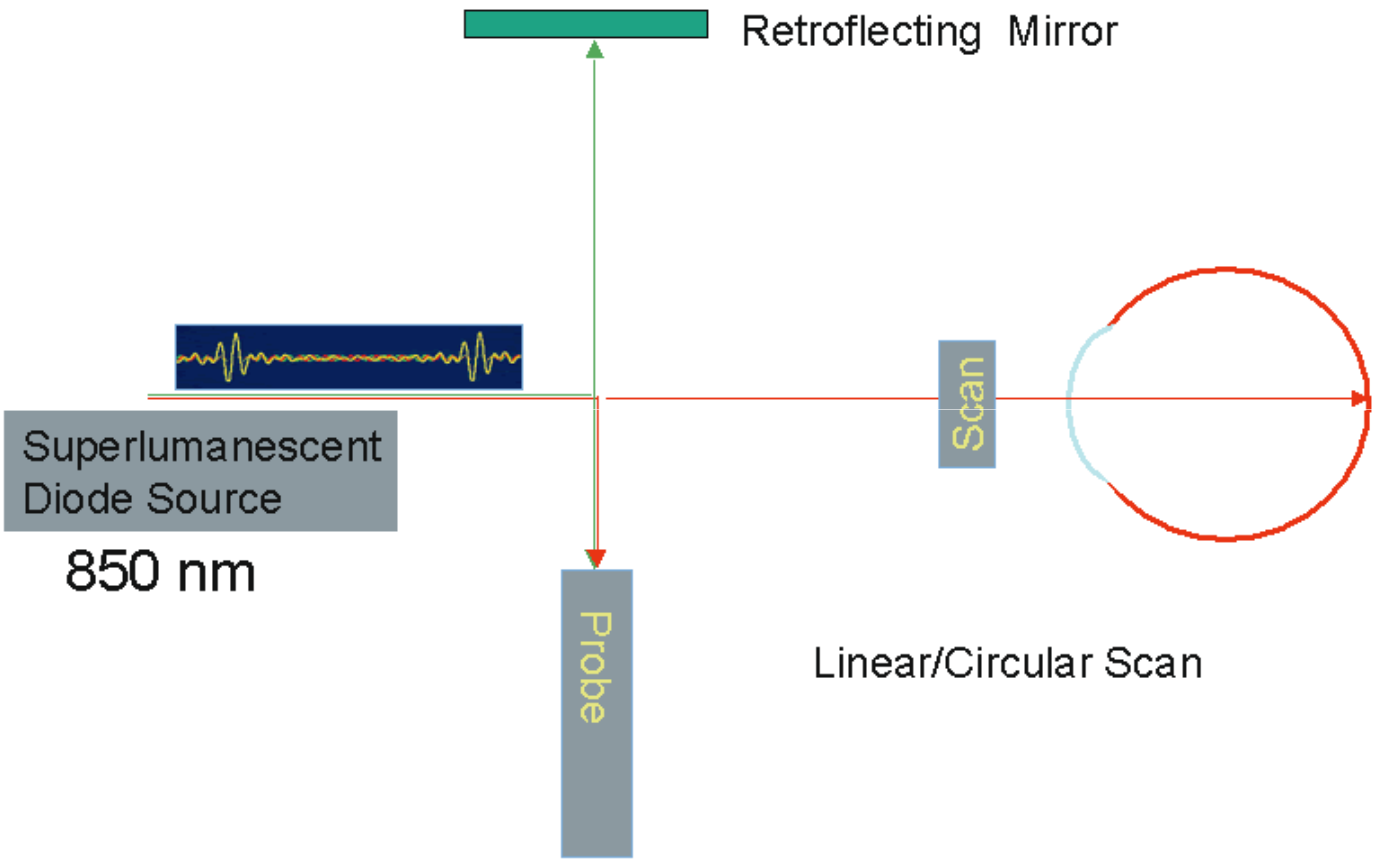


Figure 4

Michelson Interferometer



Reference Beam distance is known based on light velocity and time measurement

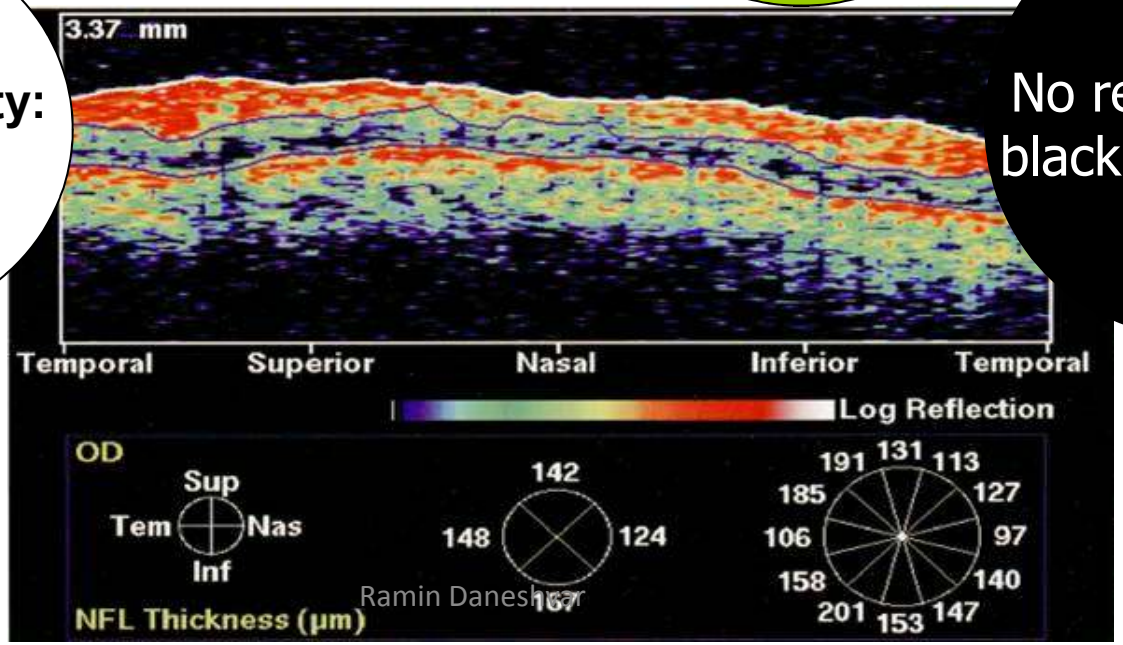
Pseudo-chromatic scale

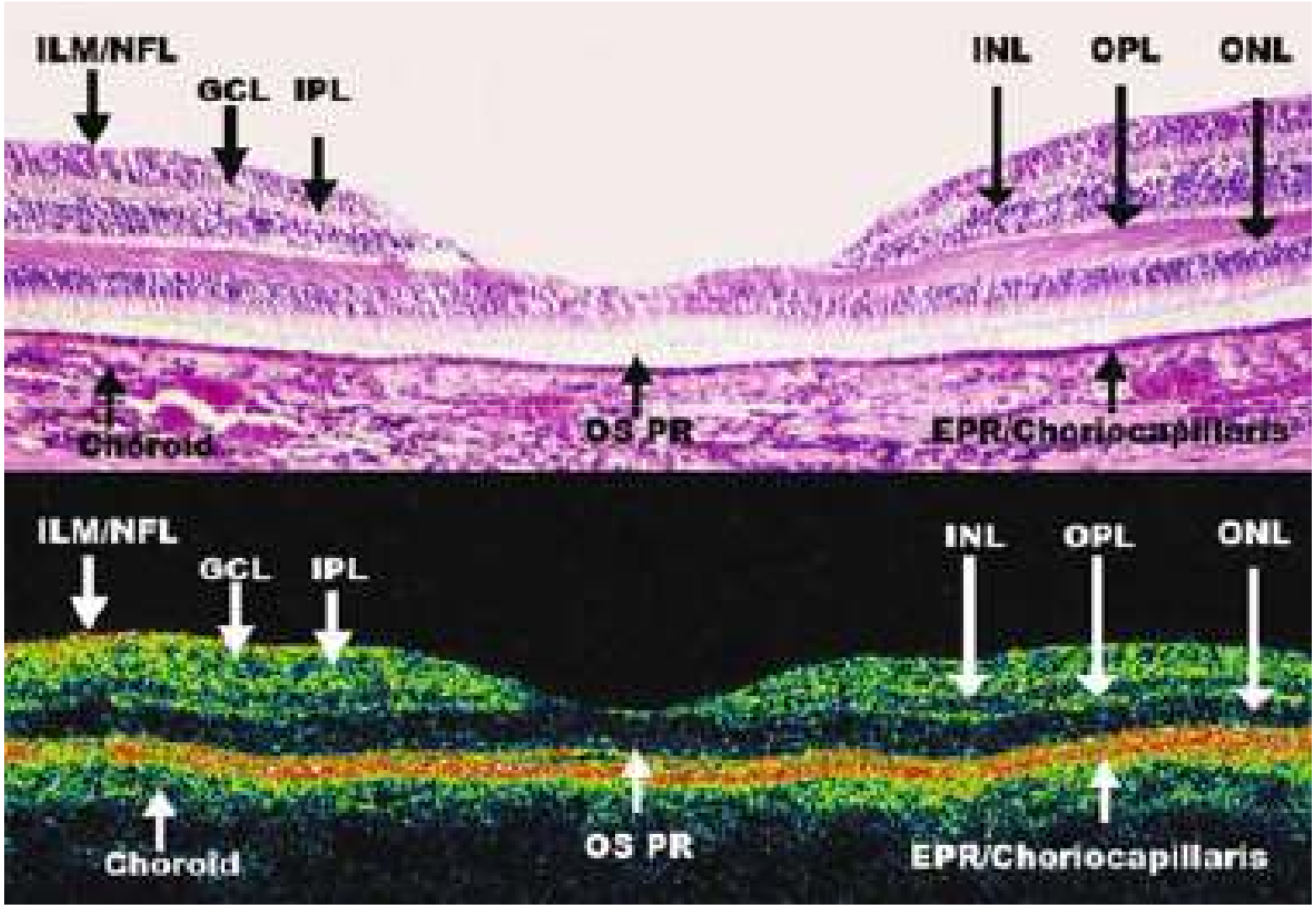
high reflectivity: red (RPE, NFL)

low reflectivity: blue or green (choroid, photoreceptors)

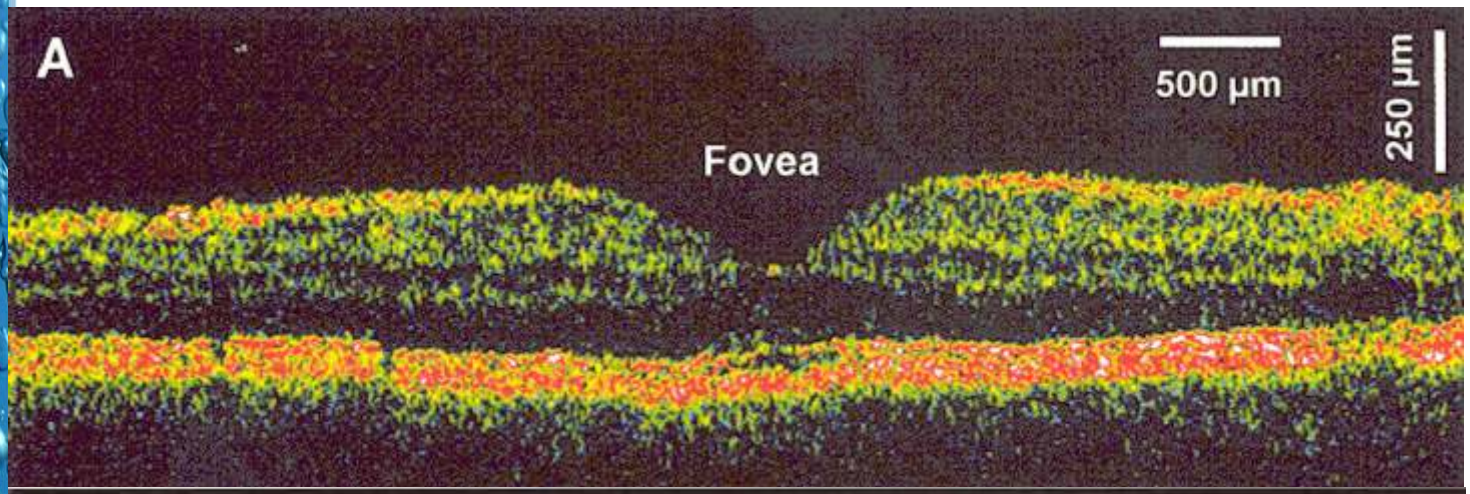
Max reflectivity: White

No reflectivity: black (vitreous)

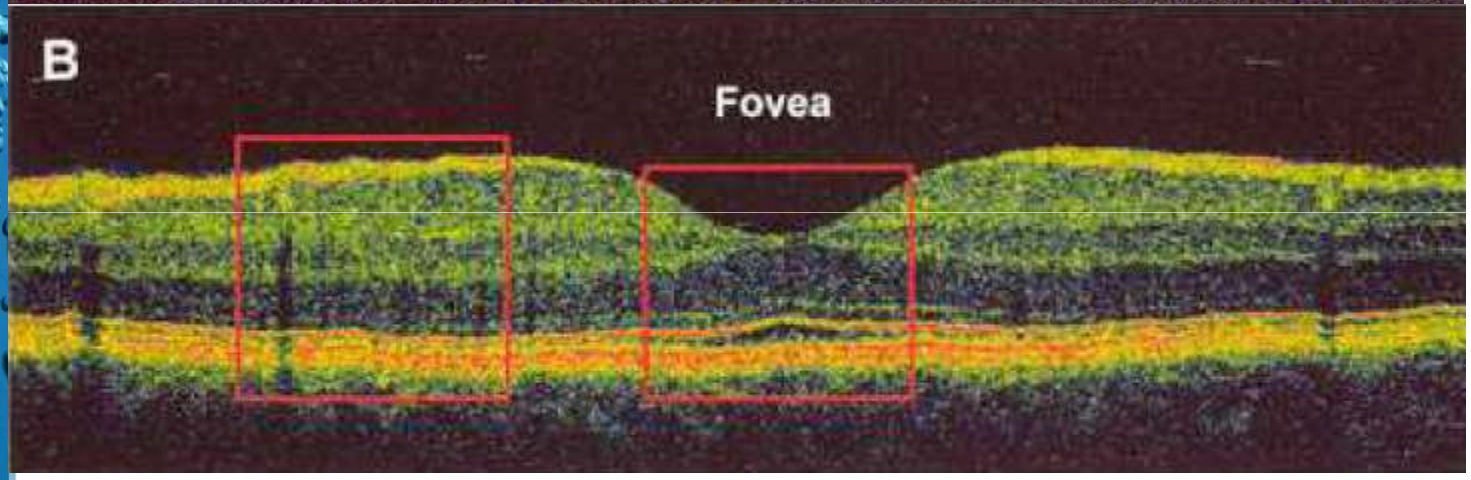



ILM/NFL
GCL
IPL
INL
OPL
ONL
Choroid
OS PR
EPR/Choriocapillaris
ILM/NFL
GCL
IPL
INL
OPL
ONL
Choroid
OS PR
EPR/Choriocapillaris

- Increased speed:
  - minimizes eye motion artifacts
  - Transverse and axial scan↑
  - 3D image

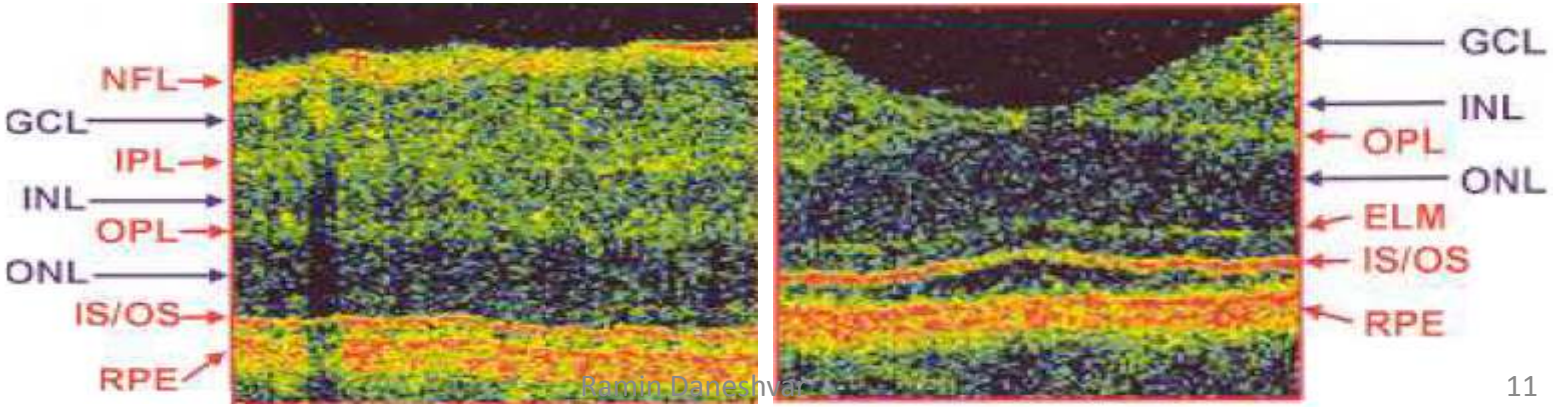

A
500 µm
250 µm
Fovea

10 µm

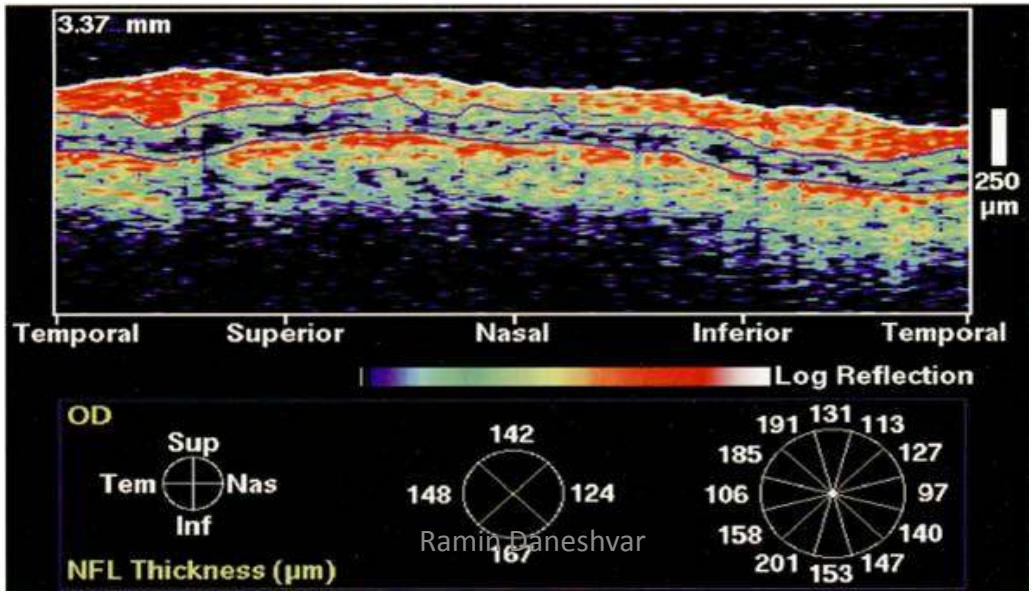

B
Fovea

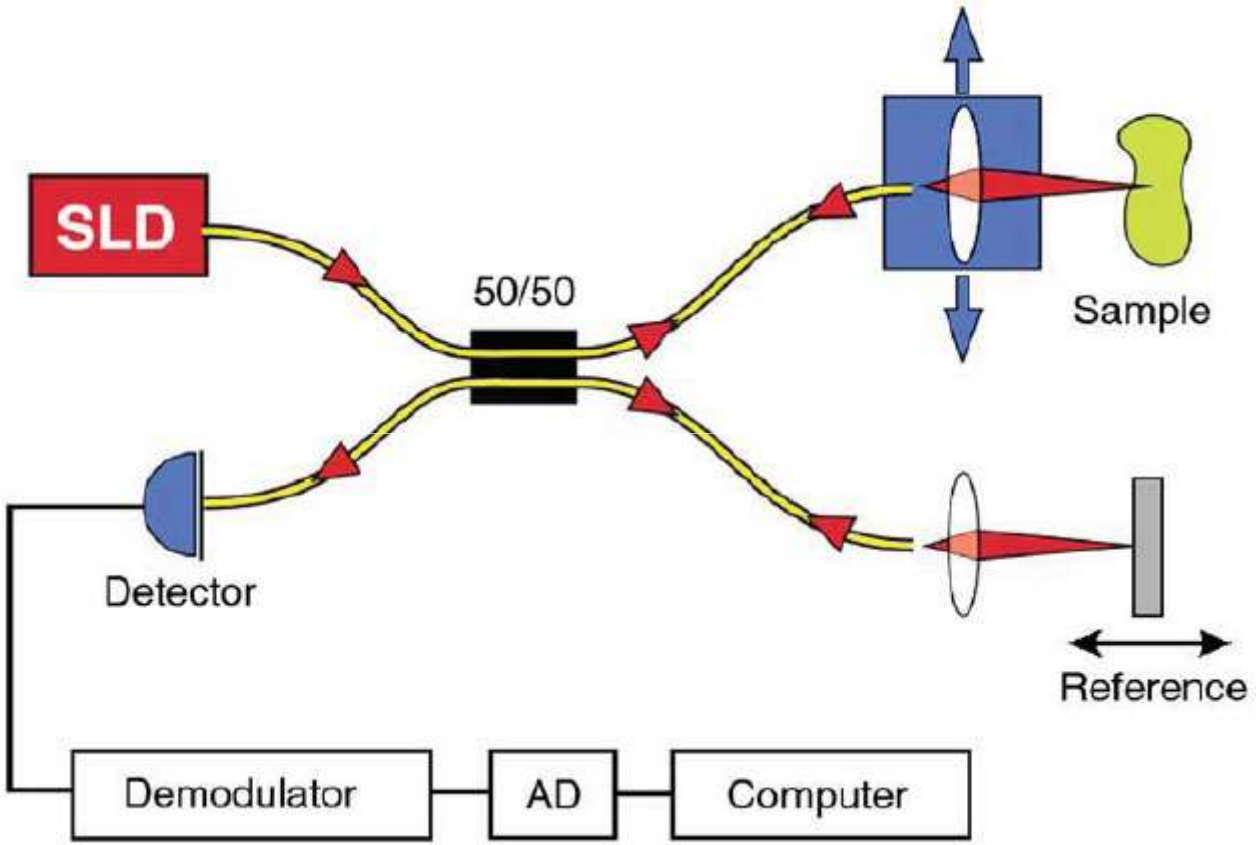
UHR

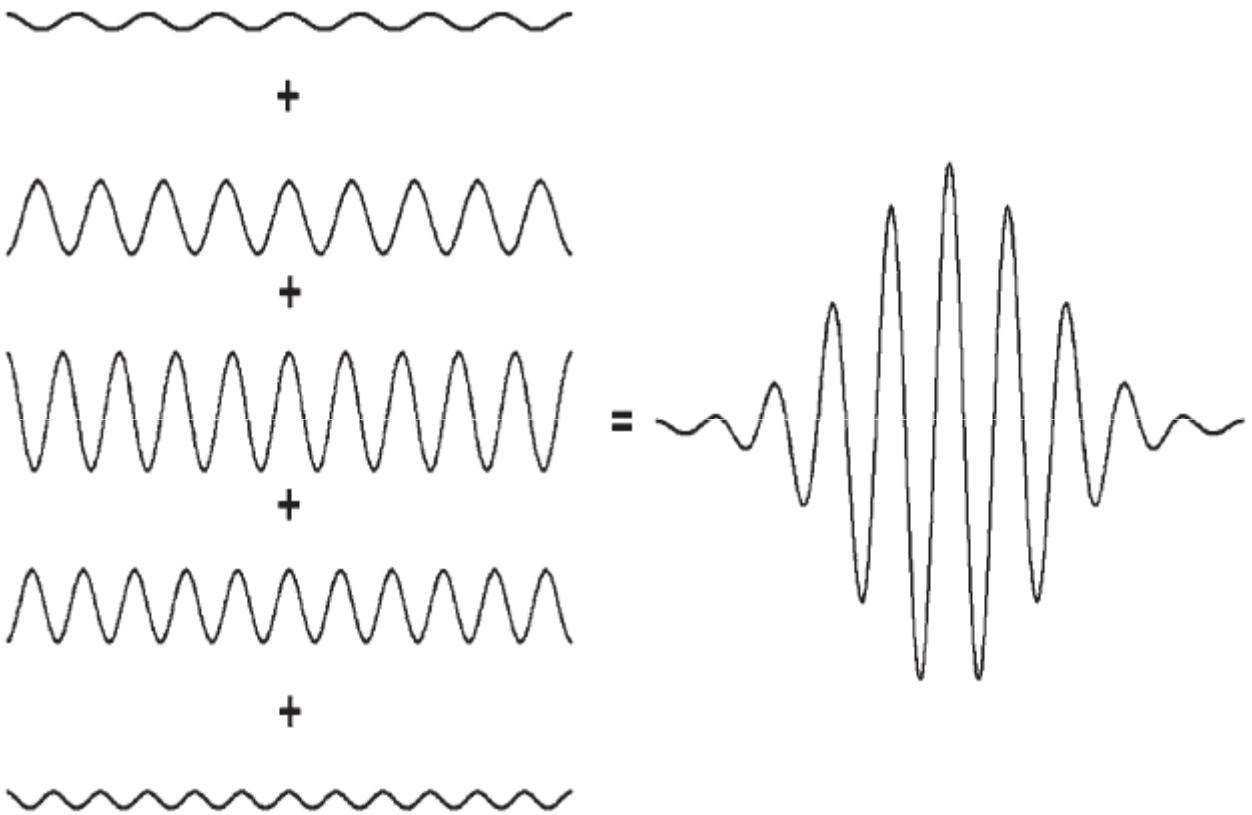
3 µm

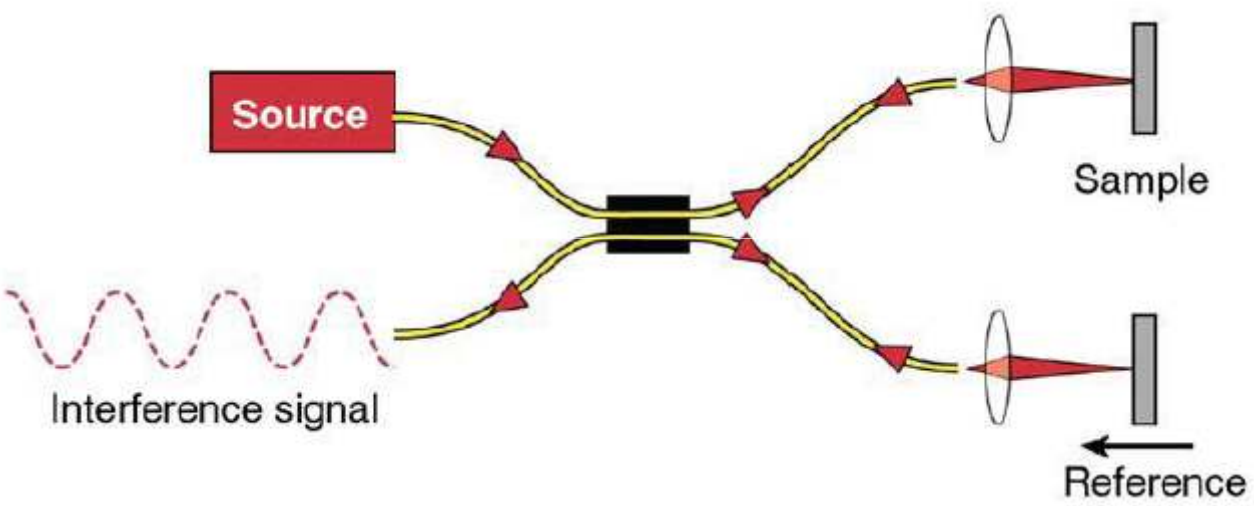

NFL
GCL
IPL
INL
OPL
ONL
IS/OS
RPE
GCL
INL
OPL
ONL
ELM
IS/OS
RPE

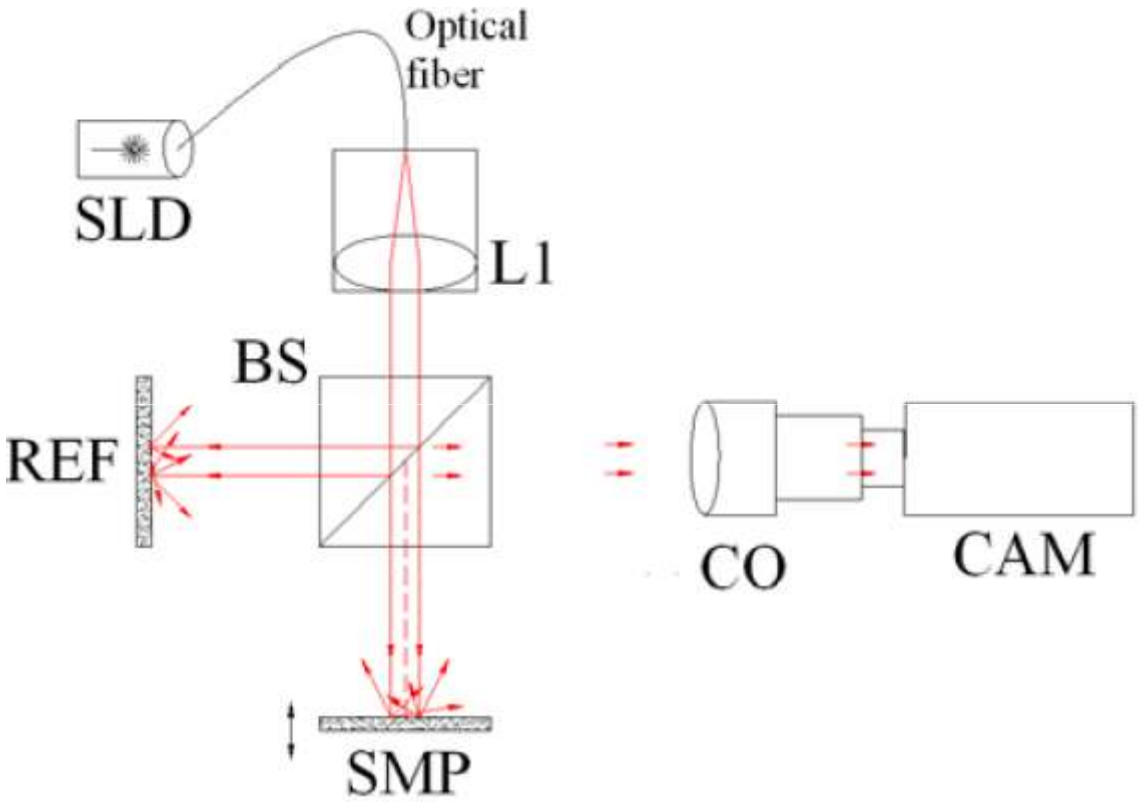
- The first reflection is the vitreoretinal interface
- The inner margin of the retina shows another bright area of backscattering corresponds to the RNFL.
- The highly reflective layer delineates the posterior boundary corresponding to the RPE

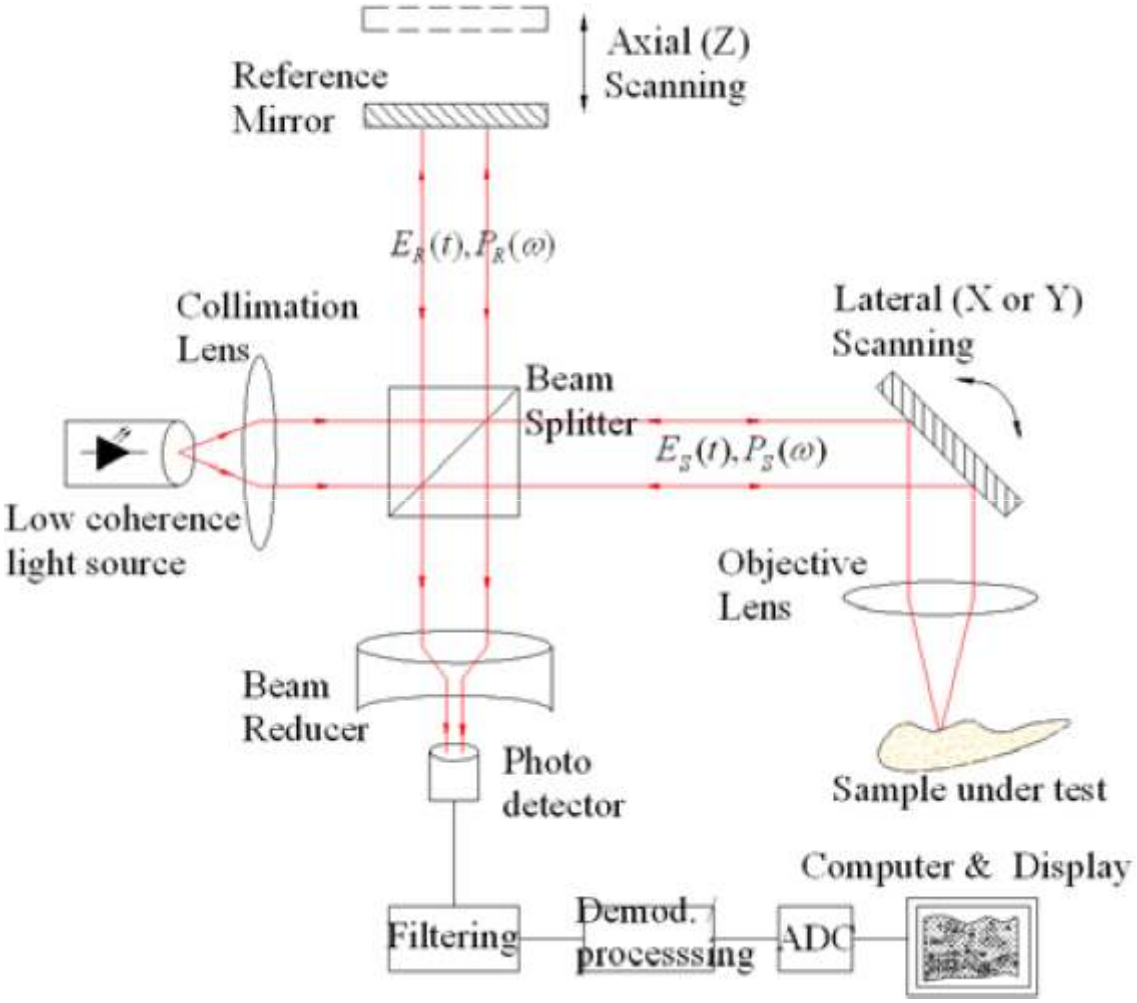


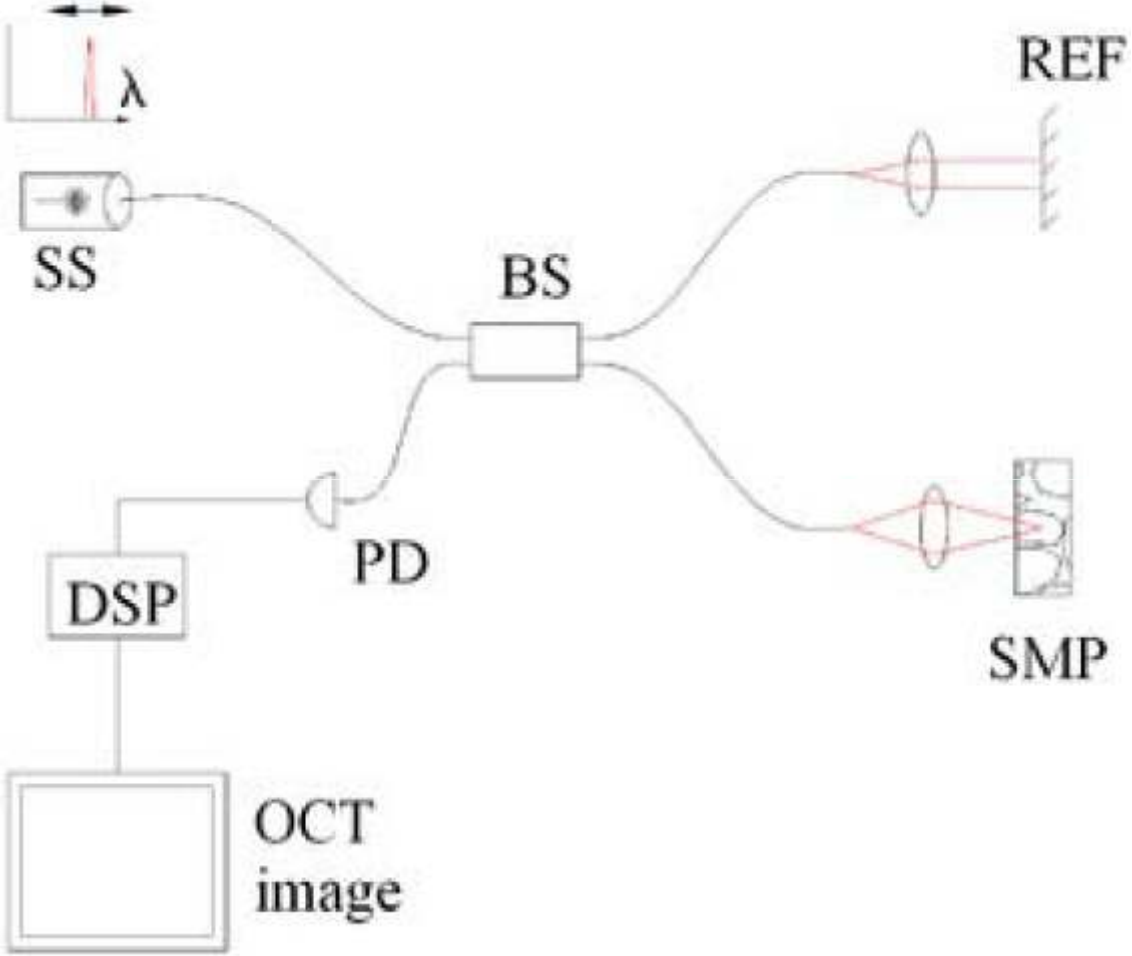

SLD
50/50
Sample
Detector
Reference
Demodulator
AD
Computer

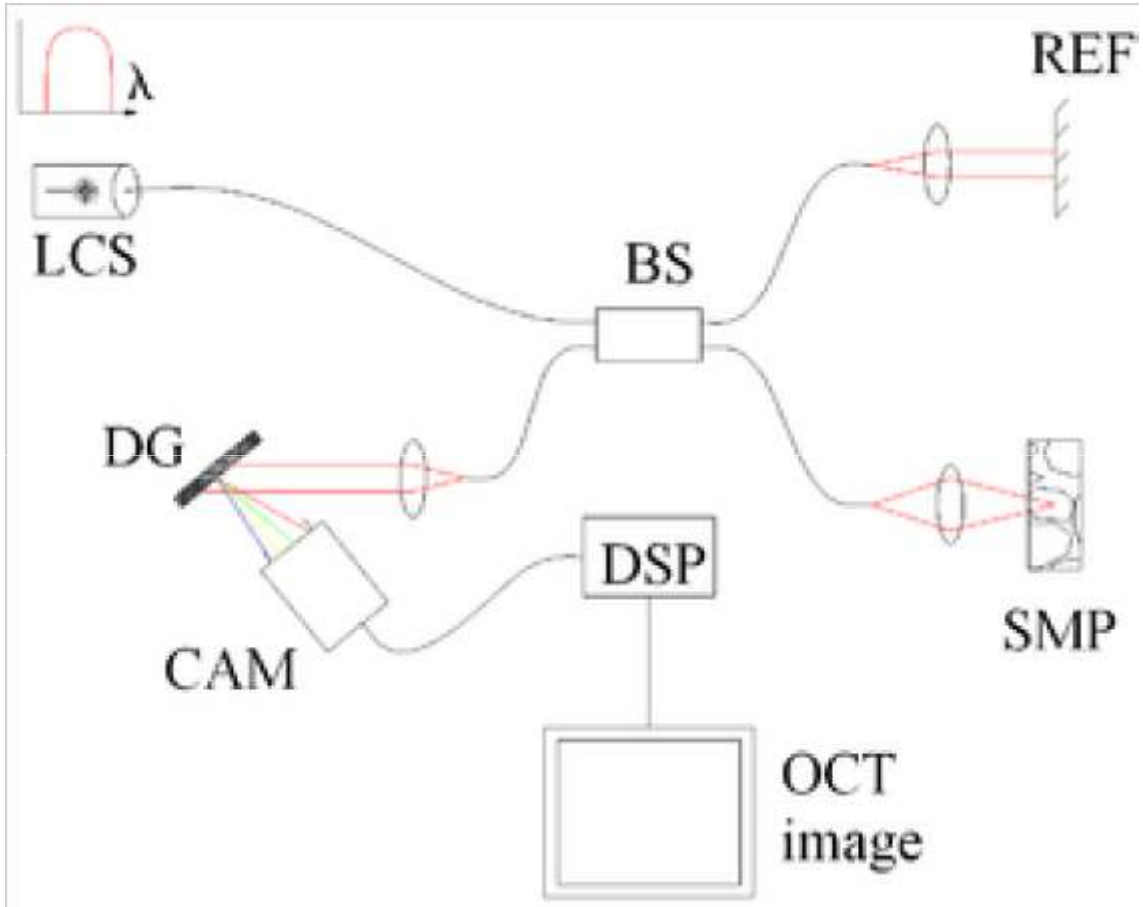


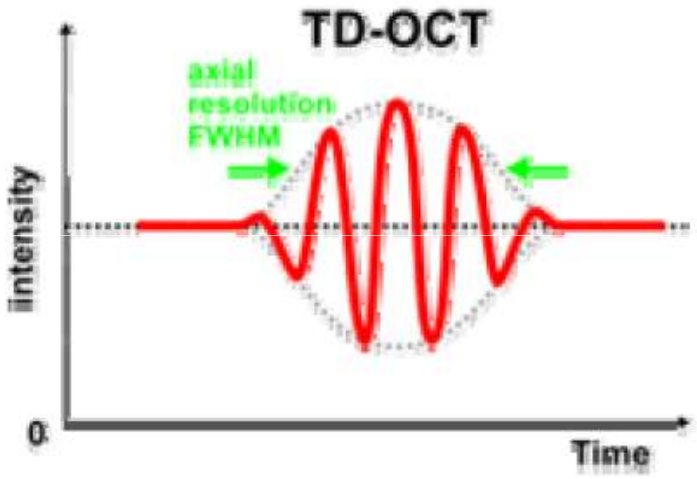

Source
Sample
Interference signal
Reference

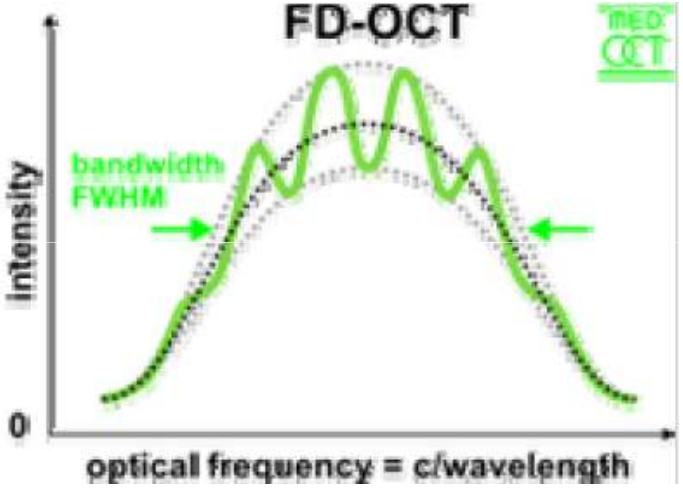

Optical
fiber
SLD
L1
BS
REF
CO
CAM
SMP

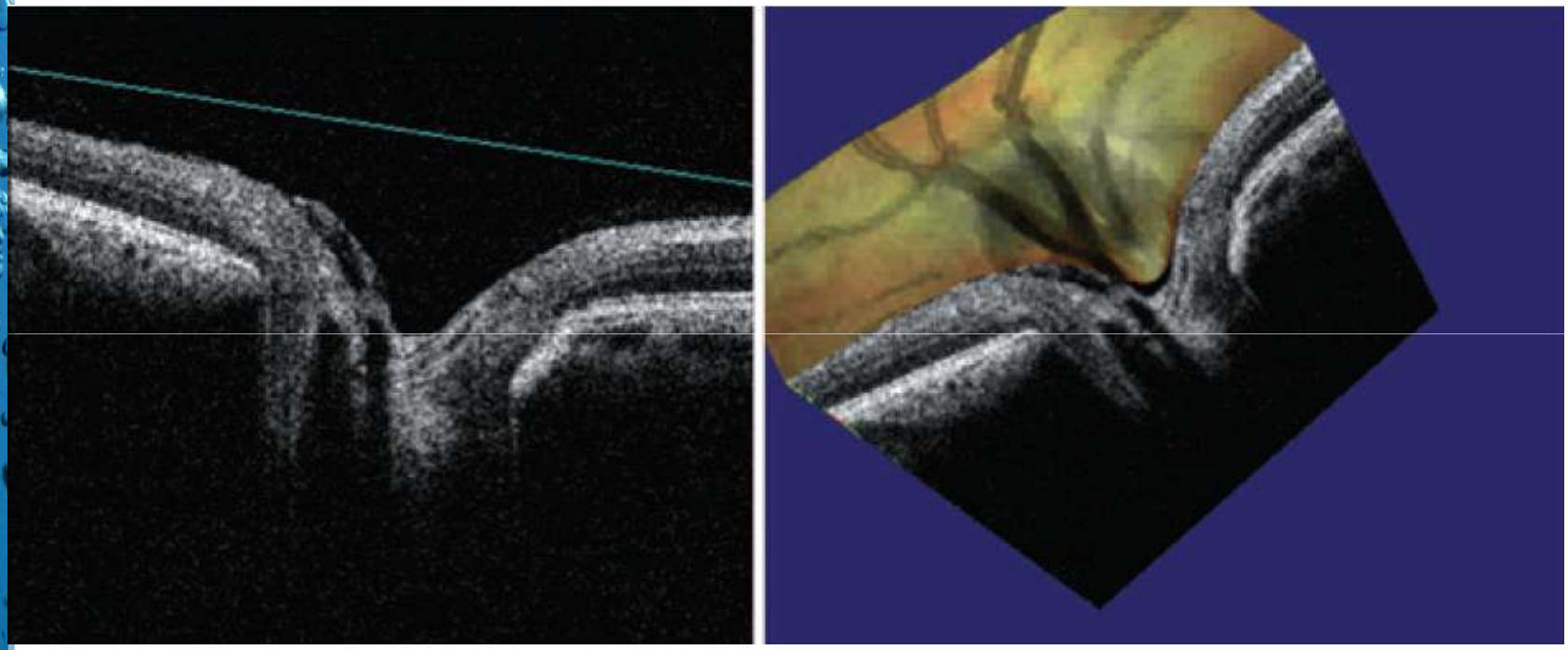

Axial (Z)
Scanning
Reference
Mirror
$E_R(t), P_R(\omega)$
Collimation
Lens
Lateral (X or Y)
Scanning
Beam
Splitter
$E_S(t), P_S(\omega)$
Low coherence
light source
Objective
Lens
Beam
Reducer
Photo
detector
Sample under test
Computer & Display
Filtering
Demod.
processsing
ADC

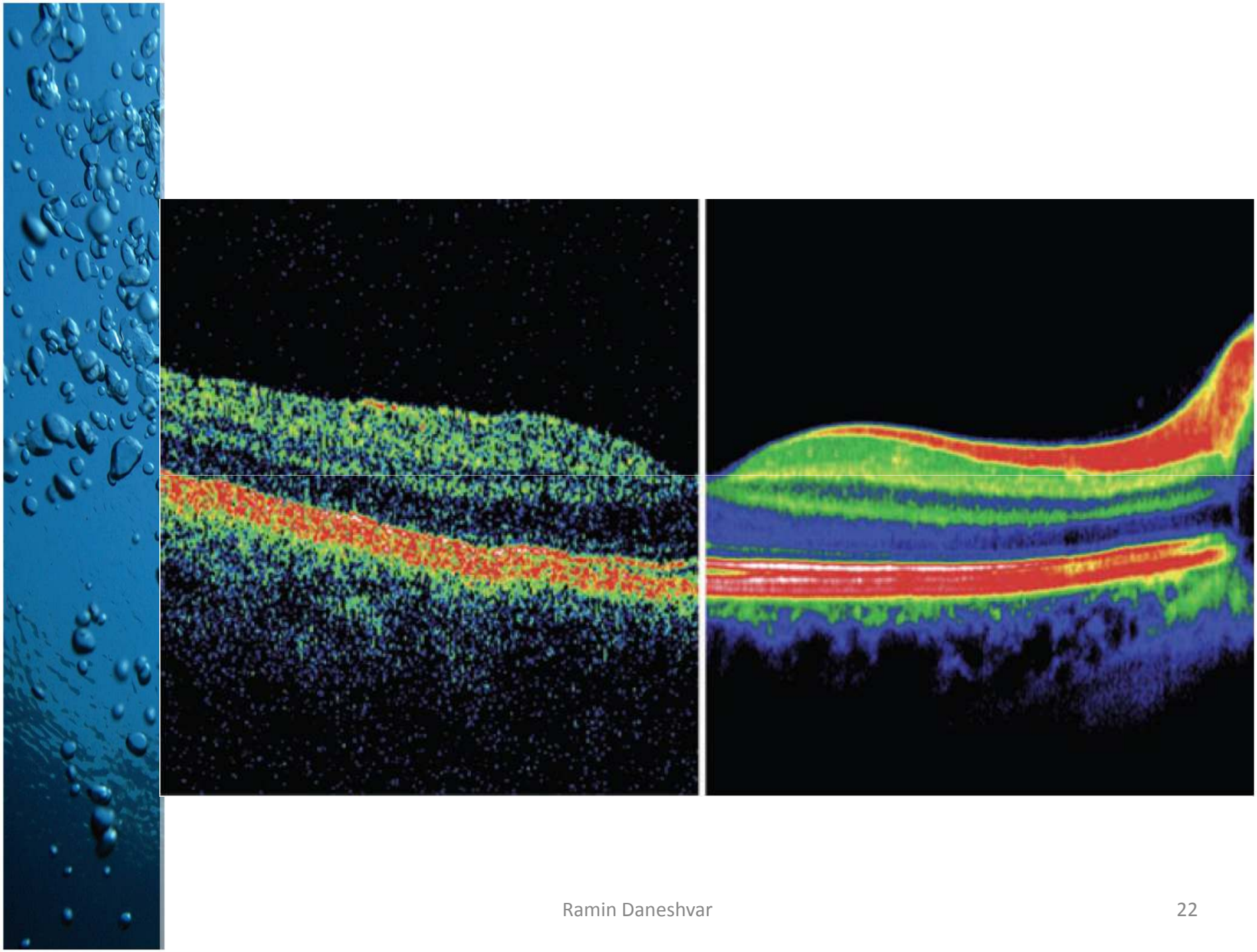

λ
SS
BS
REF
PD
DSP
SMP
OCT
image


λ
REF
LCS
BS
DG
DSP
SMP
CAM
OCT
image


TD-OCT
axial
resolution
FWHM
intensity
0
Time


FD-OCT
bandwidth
FWHM
intensity
0
optical frequency = c/wavelength

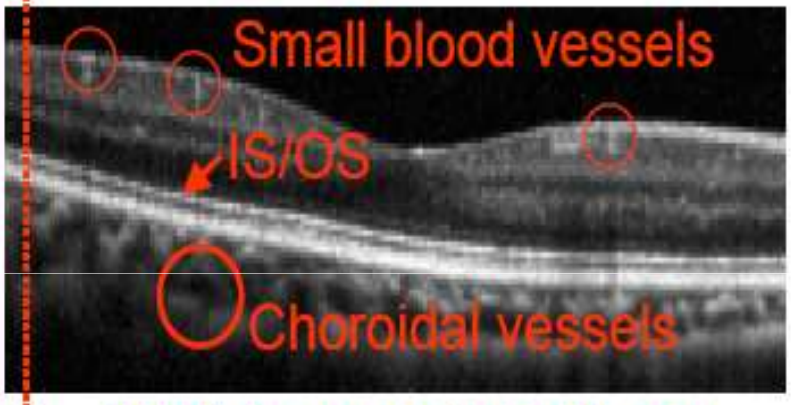




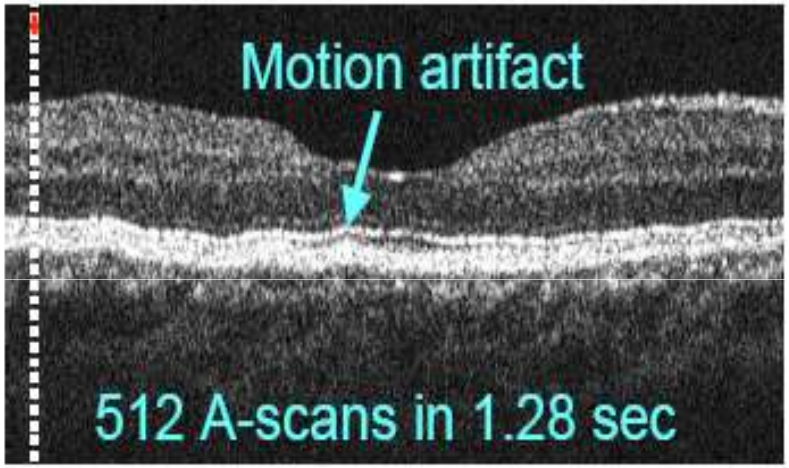
Instrument	Manufacturer	Axial resolution (μm)	Transverse resolution (μm)	Scan speed	Additional features
RTVue OCT	OptoVue	5	15	26 000 A-scan/s	Segmentation of multiple retinal layers, anterior segment OCT module
Cirrus HD-OCT	Carl Zeiss Meditec	5	25	27 000 A-scan/s	Segmentation of the ILM and RPE
Spectralis OCT	Heidelberg Engineering	3.5	14	40 000 A-scan/s	Eye tracking, automatic rescan, infrared imaging
Spectralis OCT + HRA	Heidelberg Engineering	3.5	14	40 000 A-scan/s	Same as above + red-free imaging, autofluo-rescence, fluorecein, and ICG angiography
SOCT Compernicus HR	Optopol Technology SA	3	12–18	55 000 A-scan/s	Detect RAPD, Doppler analysis of retinal blood flow
Spectal OCT SLO	OPKO Instruments/OTI OPKO Health	5–6	15	27 000 A-scan/s	Registration with SLO, Microperimetry
3D OCT-1000	Topocon Medical Imaing Systems	6	20	18 000 A-scan/s	Combined OCT with fundud camera
Bioptigen SDOCT	Bioptigen	4.5	10	20 000 A-scan/s	Handheld

FD OCT(RTVue)

- Fourier domain instead of time domain
- Decreases image acquisition time and improves resolution
- Permits 3-D imaging
- Compare to Stratus
  - 2x resolution
  - 65x faster



1024 A-scans in 0.04 sec



Higher speed, higher definition and higher signal.

- The pupil should be pharmacologically dilated
- Pupilary dilatation :
  - OCT I and II : 5 mm,
  - OCT III : 3 mm
  - Cirrus, fourier domain: optional
- Need fixation
- Measurements are not affected by:
  - refractive status
  - moderate NS

- SENSITIVITY: 76-82%
- SPECIFICITY: 84-92%

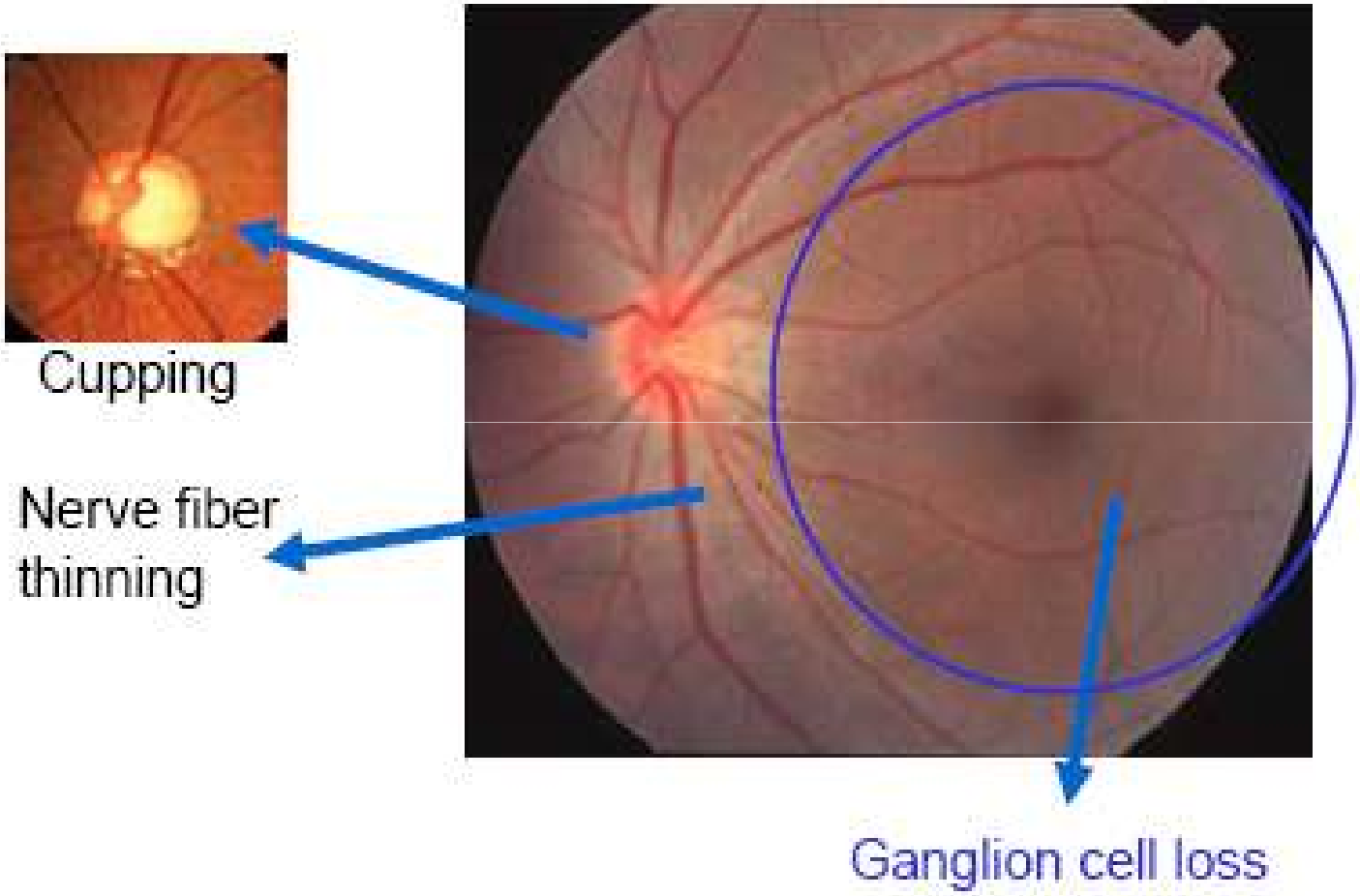
- Correlation with
  - SLP, HRT
  - SAP, SWAP

Comparison of imaging device resolutions

- CT and MRI: hundreds of microns
- Conventional ultrasound: 150 µ
- UBM 20 µ (penetration: 4 mm)
- OCT I, II : 12-15 µ
- OCT III : 8-10 µ
- Ultra-high resolution (UHR) OCT : 2-3µ

IMAGES FOR GLAUCOMA

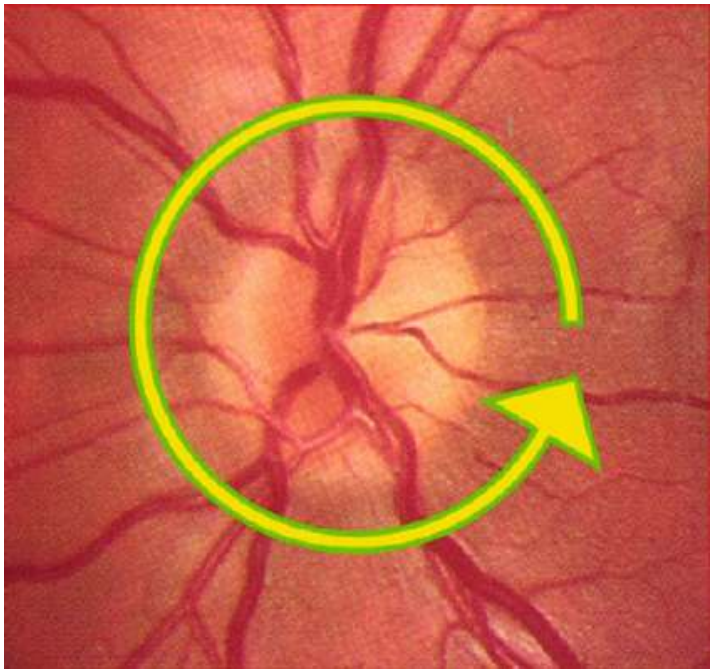
Glaucoma affects 3 areas in the posterior segment of the eye



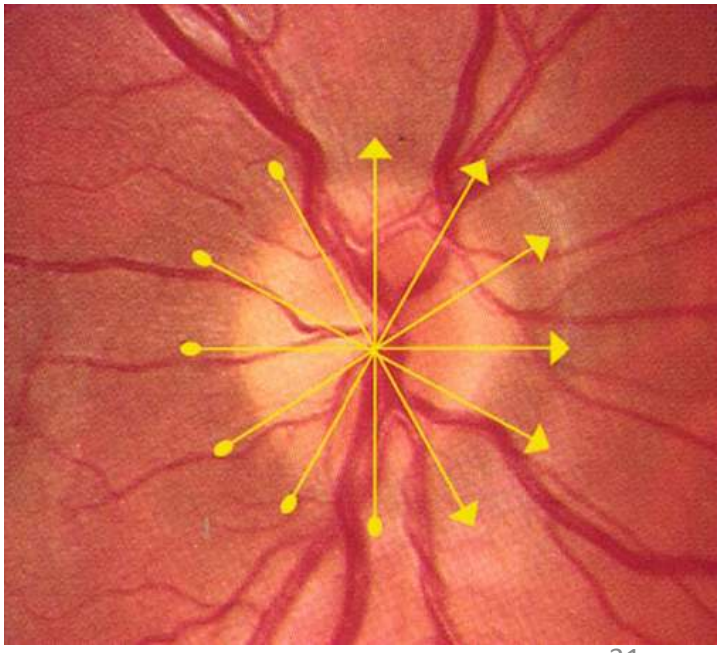
Macular volume
(has a reverse correlation with glaucoma damage)

- NFL thickness in the peripapillary region

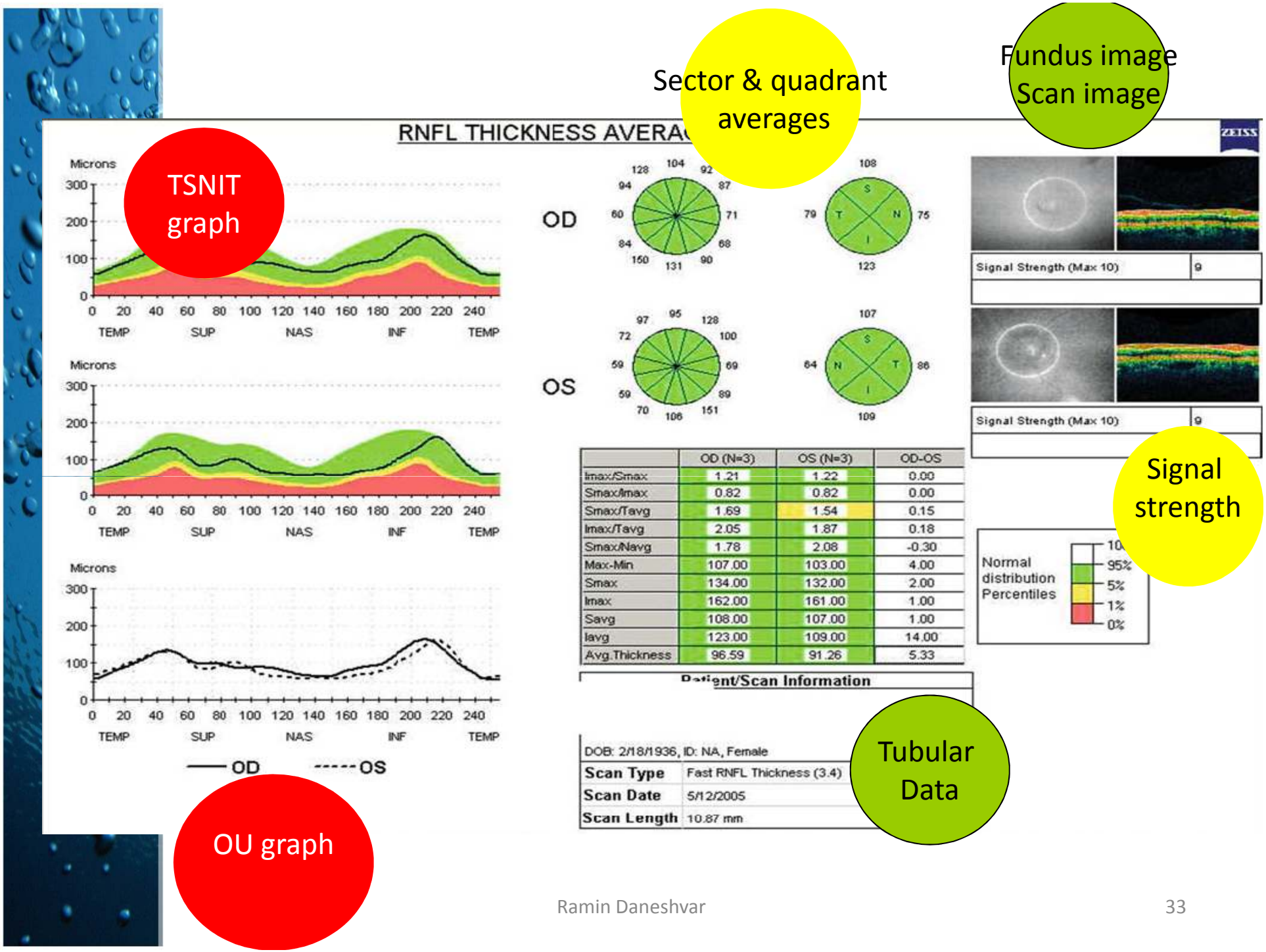
  circular (3.4mm)

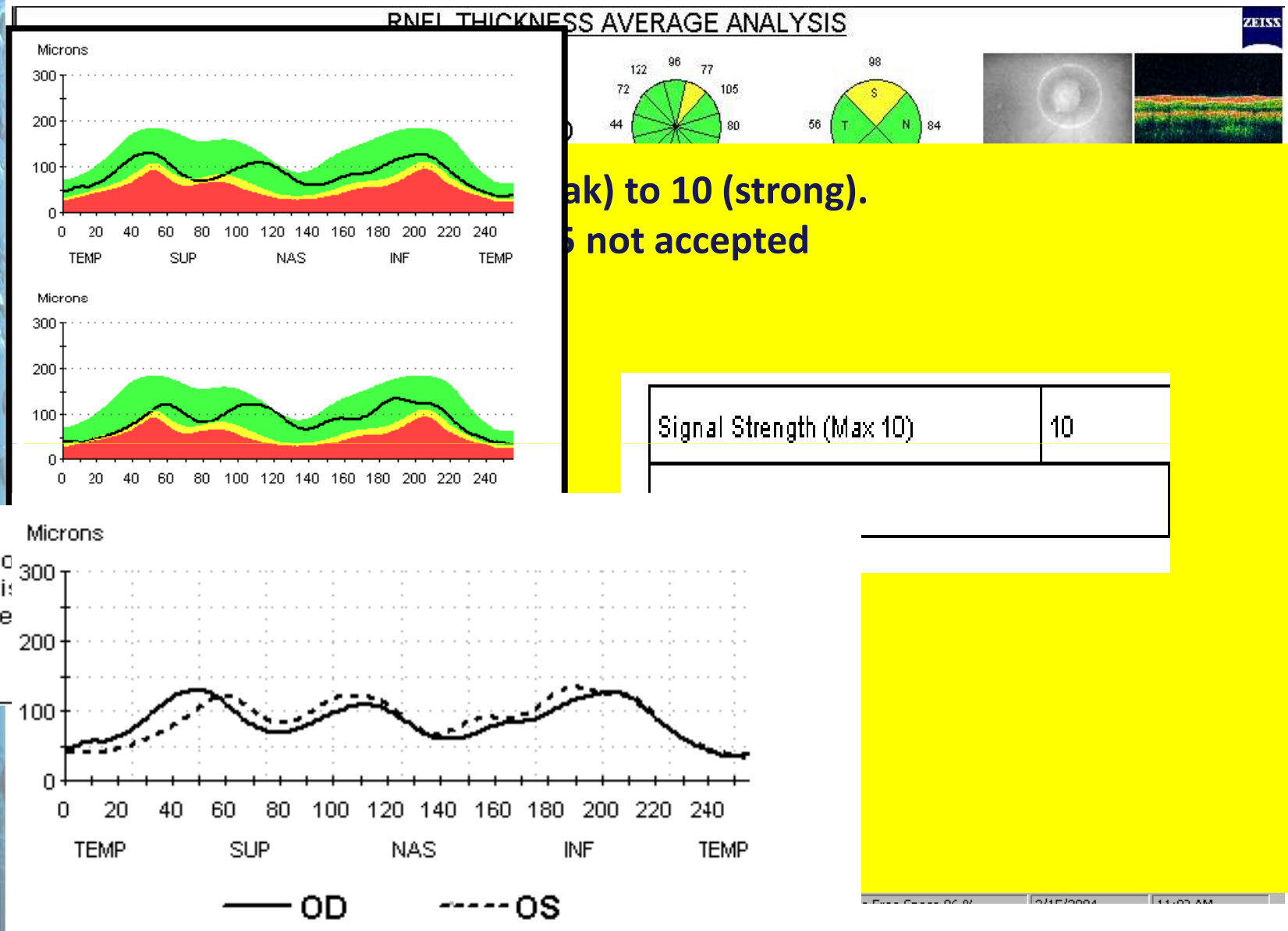


- Optic nerve head profile

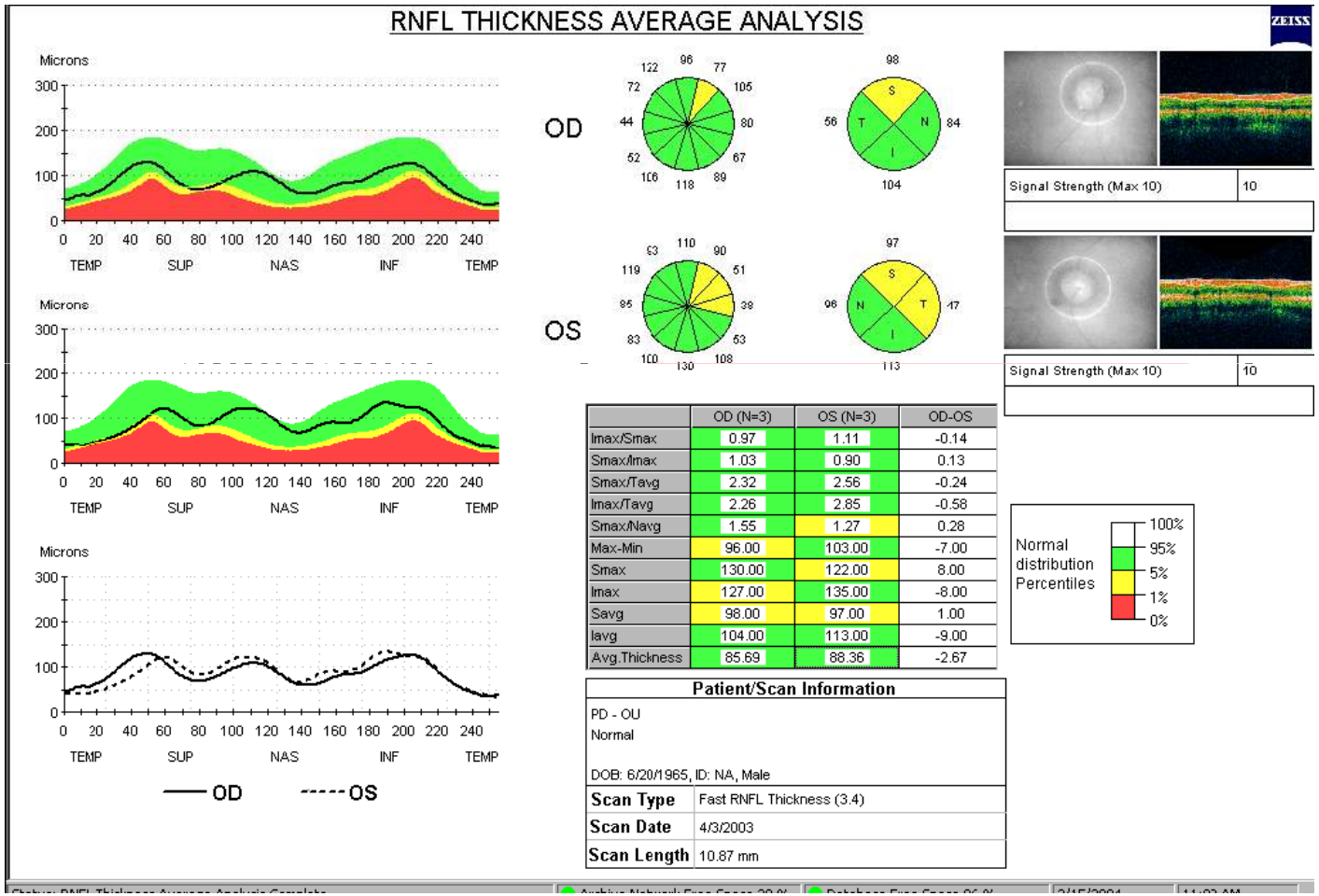


Stratus OCT

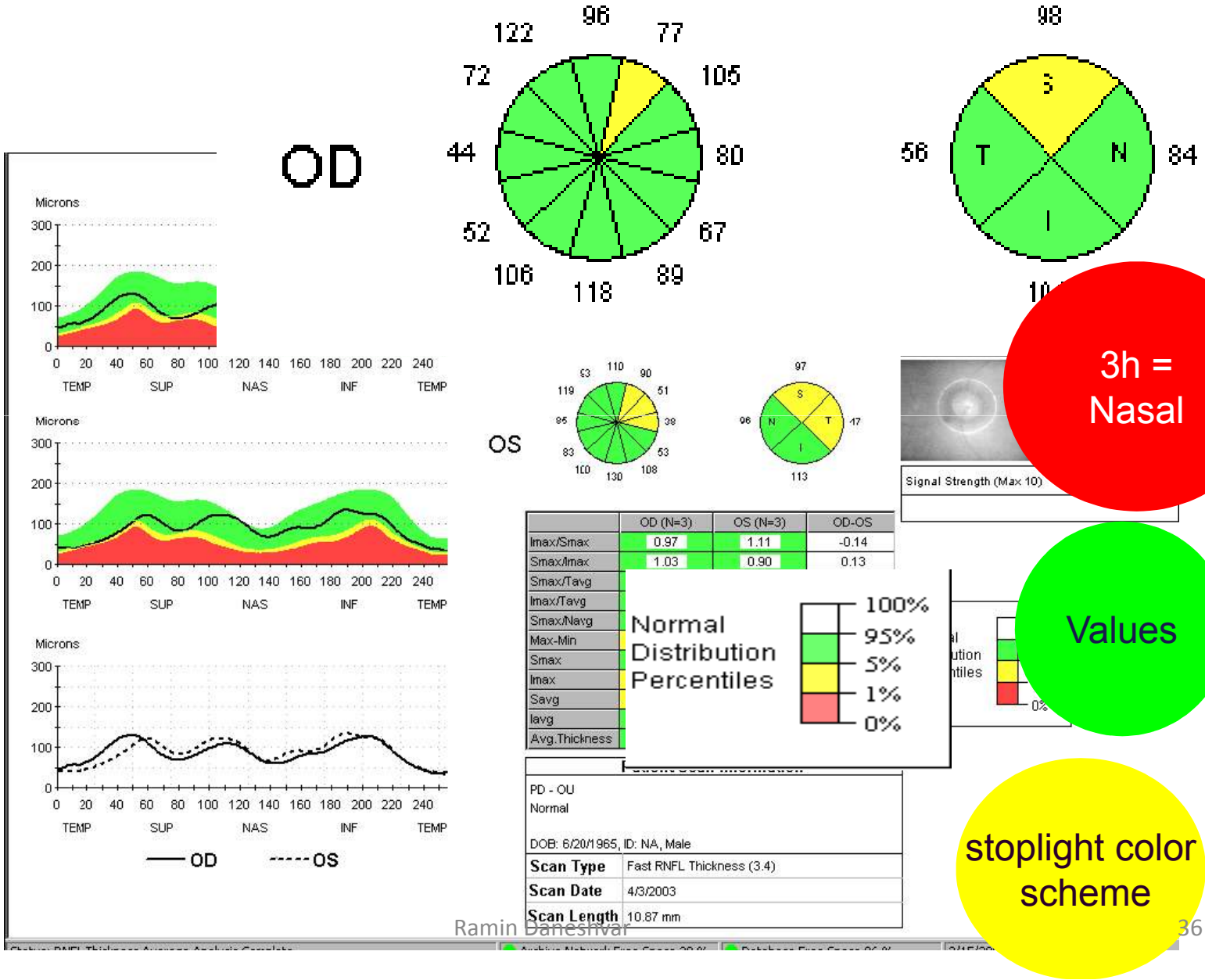

RNFL THICKNESS AVERA
ZEISS
Microns
300
200
100
0
0 20 40 60 80 100 120 140 160 180 200 220 240
TEMP SUP NAS INF TEMP
OD
OS
128 104 92 94 87 60 71 84 68 150 131 90
108 S T N 79 75 I 123
97 95 128 72 100 59 69 59 89 70 106 151
107 S N T 64 86 I 109
Signal Strength (Max 10) 9
Signal Strength (Max 10) 9
OD (N=3) OS (N=3) OD-OS
Imax/Smax 1.21 1.22 0.00
Smax/Imax 0.82 0.82 0.00
Smax/Tavg 1.69 1.54 0.15
Imax/Tavg 2.05 1.87 0.18
Smax/Navg 1.78 2.08 -0.30
Max-Min 107.00 103.00 4.00
Smax 134.00 132.00 2.00
Imax 162.00 161.00 1.00
Savg 108.00 107.00 1.00
Iavg 123.00 109.00 14.00
Avg.Thickness 96.59 91.26 5.33
Normal distribution Percentiles
10
95%
5%
1%
0%
Patient/Scan Information
DOB: 2/18/1936, ID: NA, Female
Scan Type Fast RNFL Thickness (3.4)
Scan Date 5/12/2005
Scan Length 10.87 mm
OD
OS
TSNIT graph
Sector & quadrant averages
Fundus image
Scan image
Signal strength
Tubular Data
OU graph


RNFL THICKNESS AVERAGE ANALYSIS
ZEISS
Microns
300
200
100
0
0 20 40 60 80 100 120 140 160 180 200 220 240
TEMP SUP NAS INF TEMP
122 96 77 72 105 44 80
98 S 56 T N 84
ak) to 10 (strong).
5 not accepted
Signal Strength (Max 10) 10
OD
OS

RNFL thickness (TSNIT) chart



Sector and Quadrant Averages Legend

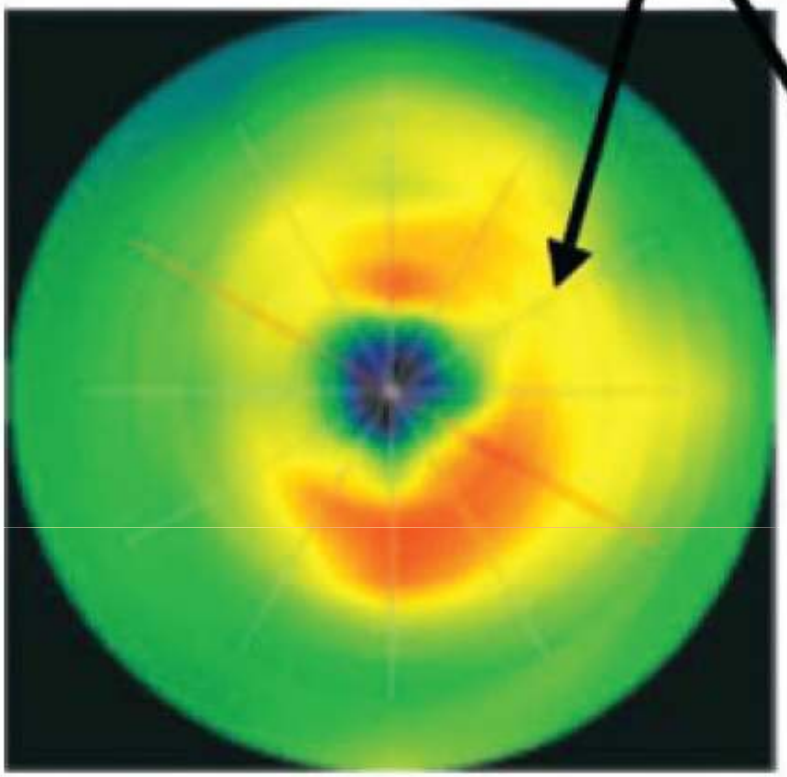


Tubular data

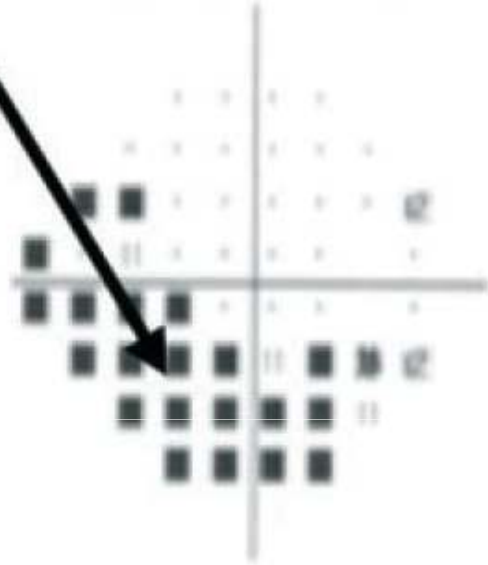
Is there any smart parameter like NFI?

	OD (N=3)	OS (N=3)	OD-OS
Imax/Smax	0.97	1.11	-0.14
Smax/Imax	1.03	0.90	0.13
Smax/Tavg	2.32	2.56	-0.24
Imax/Tavg	2.26	2.85	-0.58
Smax/Navg	1.55	1.27	0.28
Max-Min	96.00	103.00	-7.00
Smax	130.00	122.00	8.00
Imax	127.00	135.00	-8.00
Savg	98.00	97.00	1.00
Iavg	104.00	113.00	-9.00
Avg.Thickness	85.69	88.36	-2.67

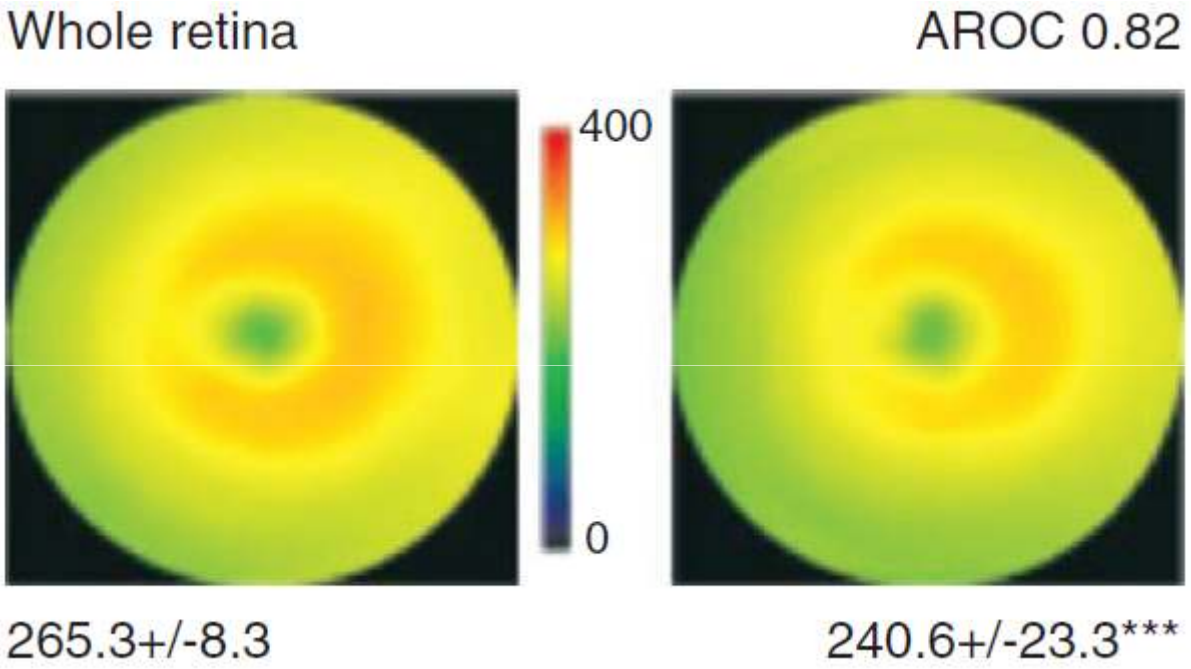
Correspondence of thinning and field defect

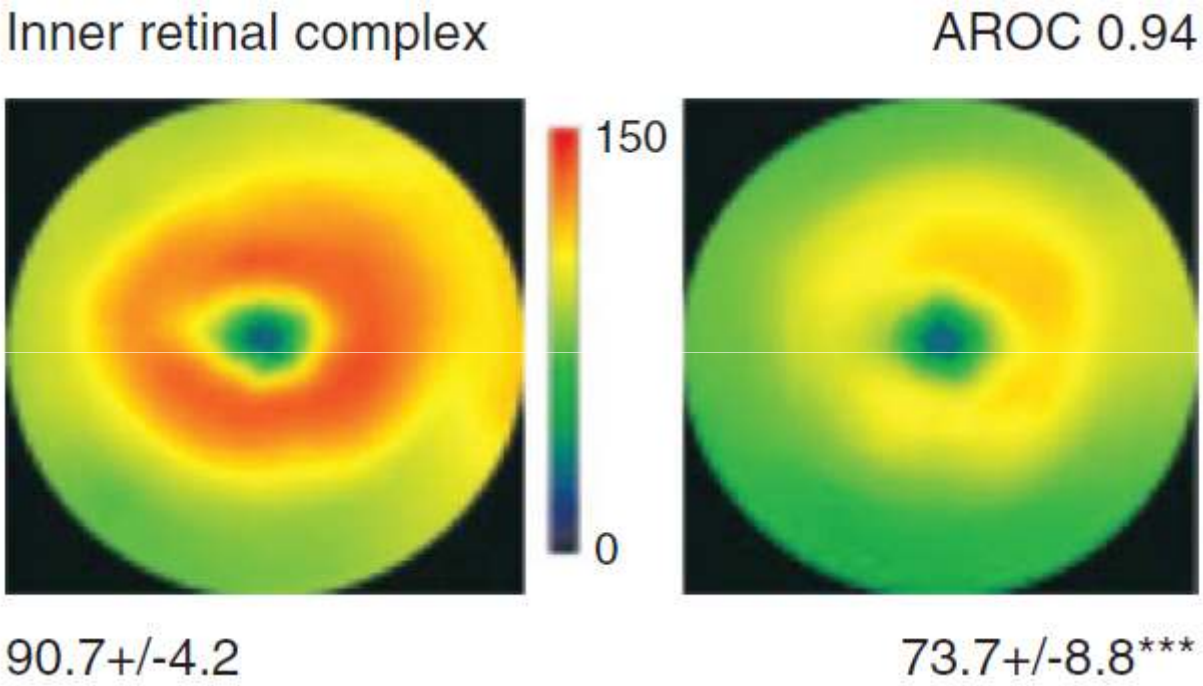


0 µm 200



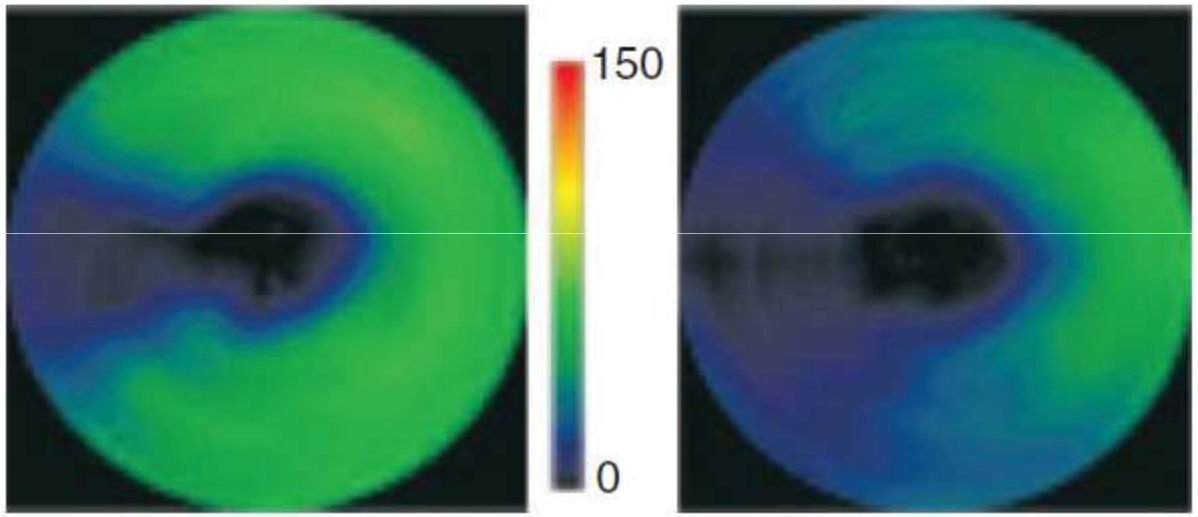
Glaucomatous Eye with NFL loss in maculopapillary bundle


Whole retina
AROC 0.82
400
0
265.3+/-8.3
240.6+/-23.3***
Normal
Glaucoma


Inner retinal complex
AROC 0.94
150
0
90.7+/-4.2
73.7+/-8.8***
Normal
Glaucoma

Macular nerve fibre layer thickness

AROC 0.95



28.4+/-4.7

15.6+/-6.3***

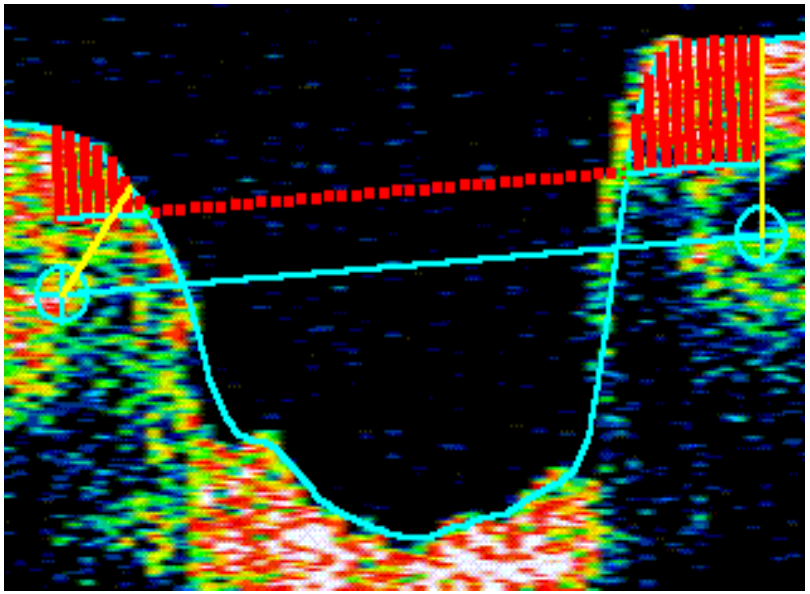
Normal

Glaucoma

Optic Nerve Head Analysis

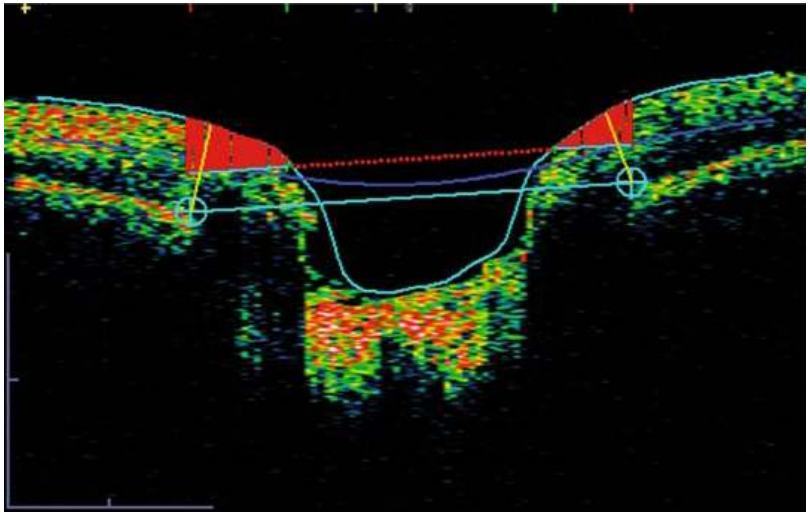
Optic Nerve Head Analysis

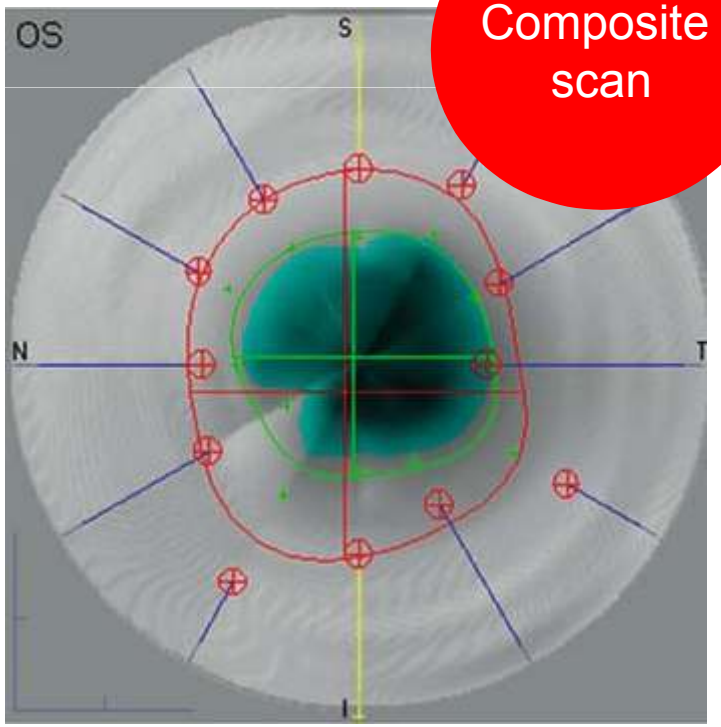
- Disk margin is selected from the end of RPE reflection.
- Does not require reference plane.



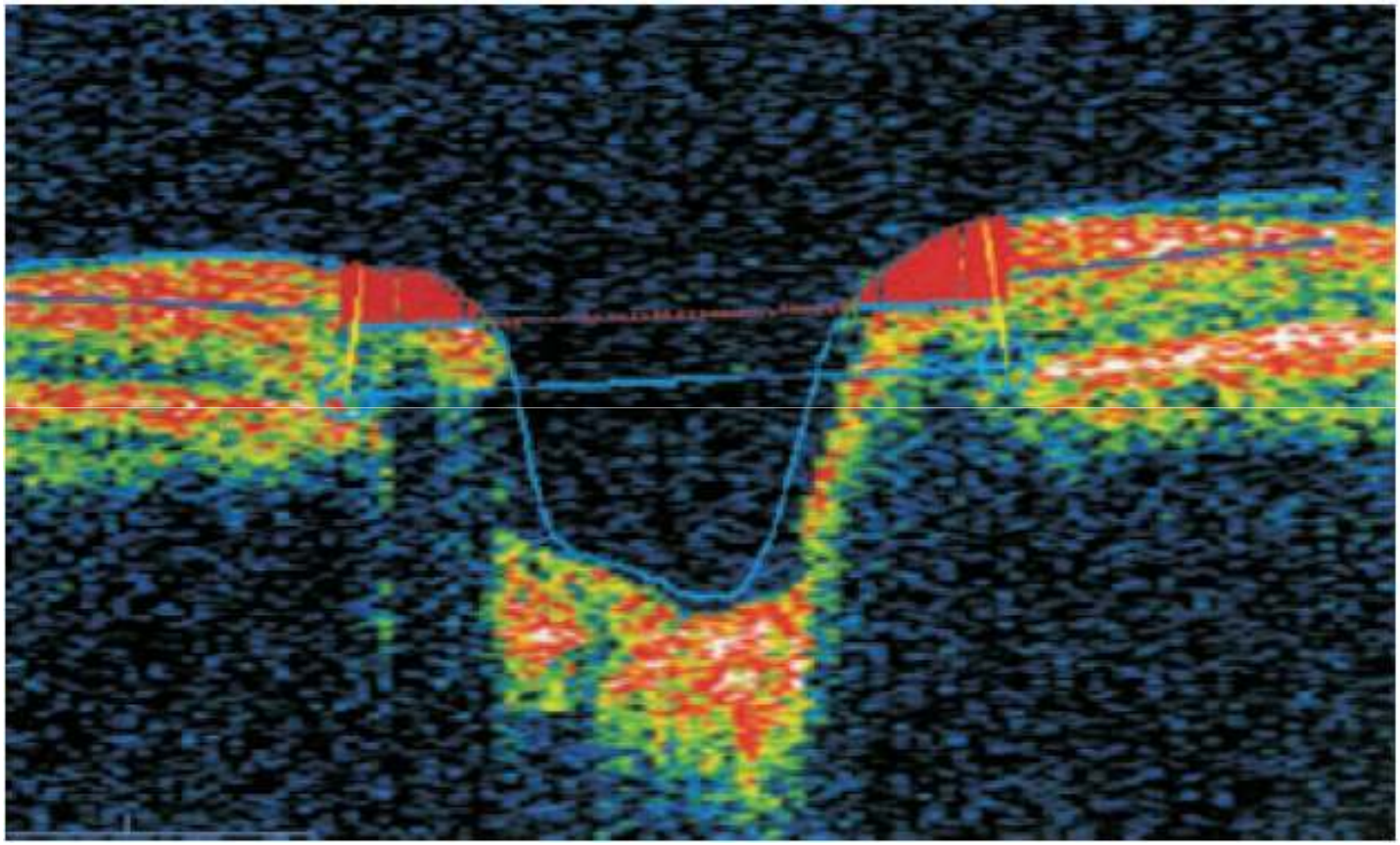
Optic Nerve Head Analysis

- **A parallel line 150 µm anterior to it is used to define the cup (area below) and the neuroretinal rim (area above)**





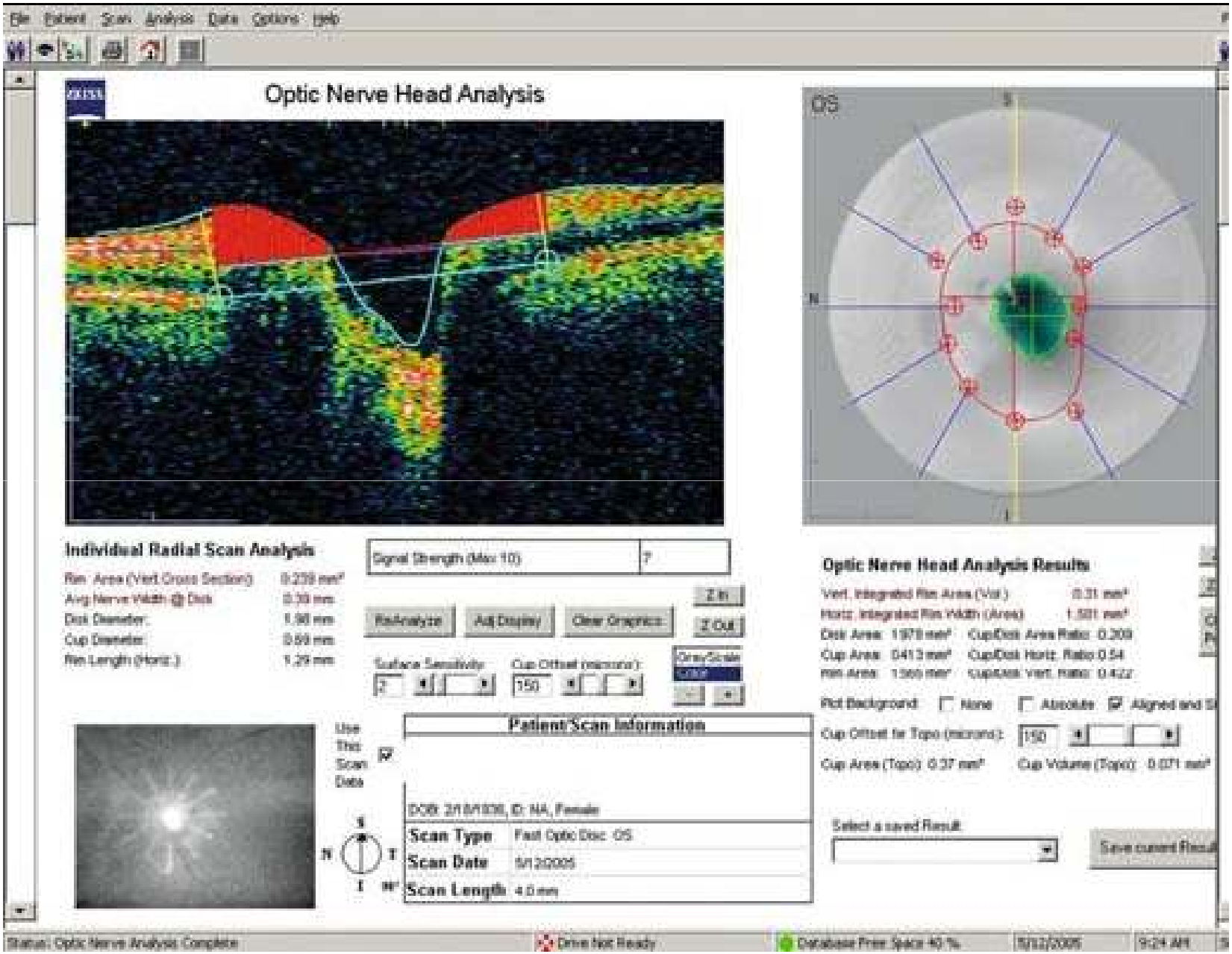
Composite scan



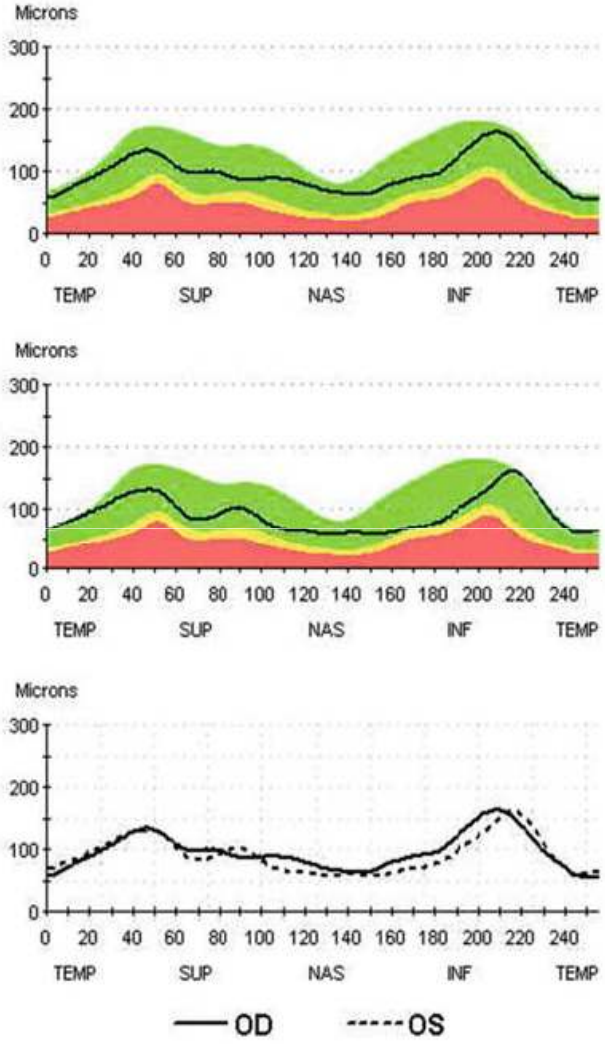
Rim Area (Vert.Cross Section):	.122 mm²
Avg Nerve Width @ Disk	.34 mm
Disk Diameter:	2.06 mm
Cup Diameter:	1.43 mm
Rim Length (Horiz.):	.63 mm

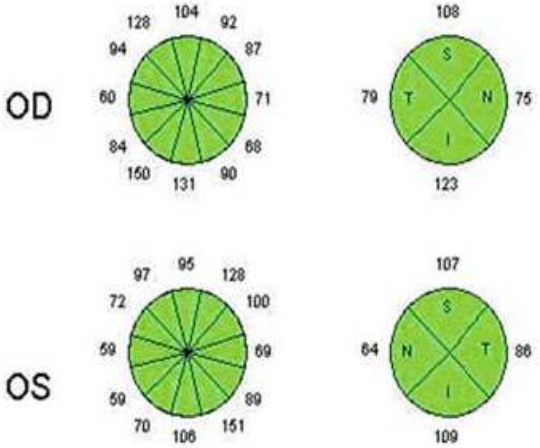
Vert. Integrated Rim Area (Vol.)	.202 mm³
Horiz. Integrated Rim Width (Area)	1.586 mm²
Disk Area	3.061 mm²
Cup Area	1.731 mm²
Rim Area	1.33 mm²
Cup/Disk Area Ratio	0.566
Cup/Disk Horiz. Ratio	0.79
Cup/Disk Vert. Ratio	0.727

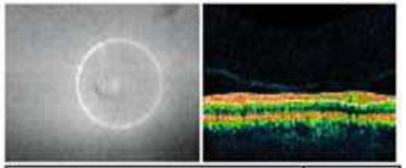
- The edge of the cup:
  - green dot on the scan image
  - Green x on the composite diagram.
- The end of RPE:
  - blue on scan image
  - Red on composite diagram


Optic Nerve Head Analysis
OS
Individual Radial Scan Analysis
Signal Strength (Max 10)
7
ReAnalyze
Adj Display
Clear Graphics
Z In
Z Out
Surface Sensitivity
Cup Offset (microns):
150
Optic Nerve Head Analysis Results
Patient/Scan Information
Use This Scan Data
Scan Type
Fast Optic Disc OS
Scan Date
Scan Length
4.0 mm
Select a saved Result
Save current Result
Status: Optic Nerve Analysis Complete
Drive Not Ready
Database Free Space 40 %

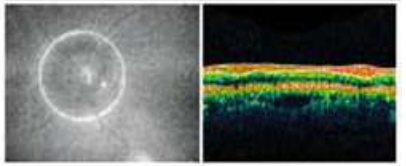
RNFL THICKNESS AVERAGE ANALYSIS





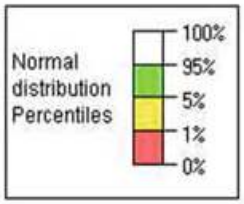


Signal Strength (Max 10)	9



Signal Strength (Max 10)	9

	OD (N=3)	OS (N=3)	OD-OS
Imax/Smax	1.21	1.22	0.00
Smax/Imax	0.82	0.82	0.00
Smax/Tavg	1.69	1.54	0.15
Imax/Tavg	2.05	1.87	0.18
Smax/Navg	1.78	2.08	-0.30
Max-Min	107.00	103.00	4.00
Smax	134.00	132.00	2.00
Imax	162.00	161.00	1.00
Savg	108.00	107.00	1.00
Iavg	123.00	109.00	14.00
Avg.Thickness	96.59	91.26	5.33

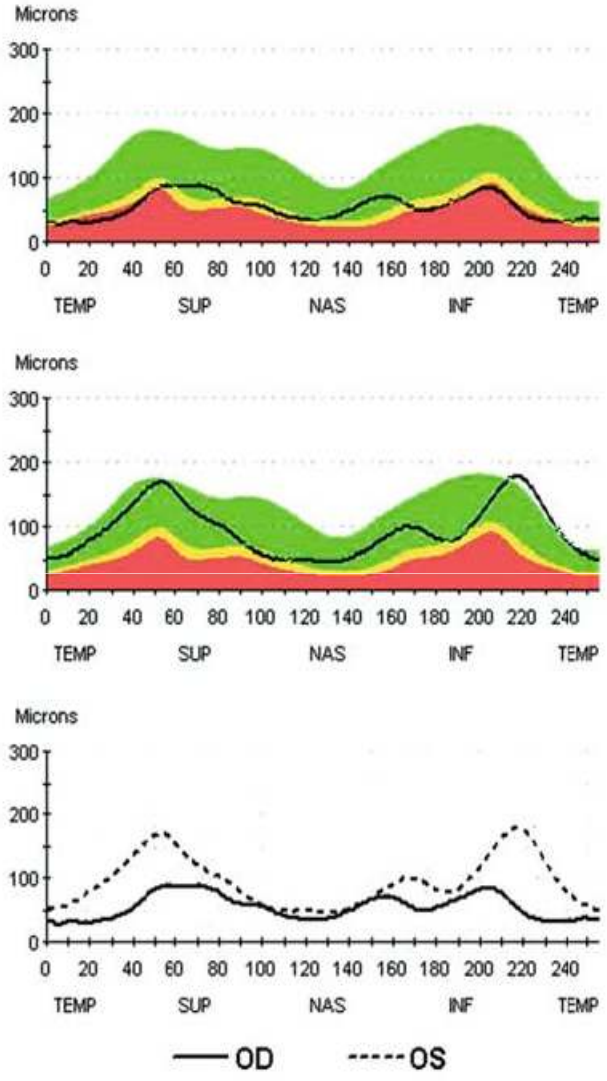


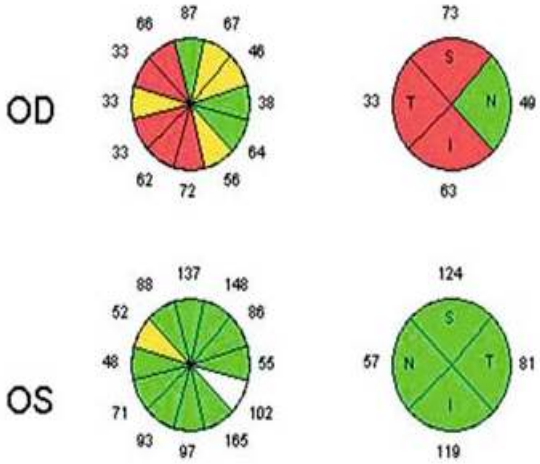
Patient/Scan Information

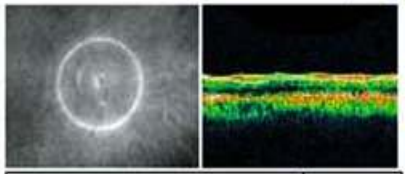
DOB: 2/18/1936, ID: NA, Female

Scan Type	Fast RNFL Thickness (3.4)
Scan Date	5/12/2005
Scan Length	10.87 mm

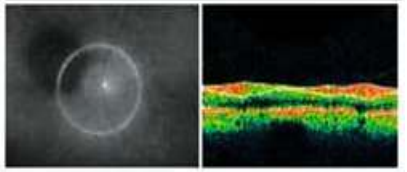
RNFL THICKNESS AVERAGE ANALYSIS





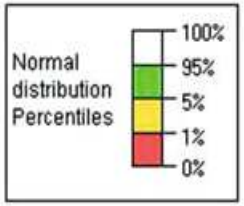


Signal Strength (Max 10)	8



Signal Strength (Max 10)	9

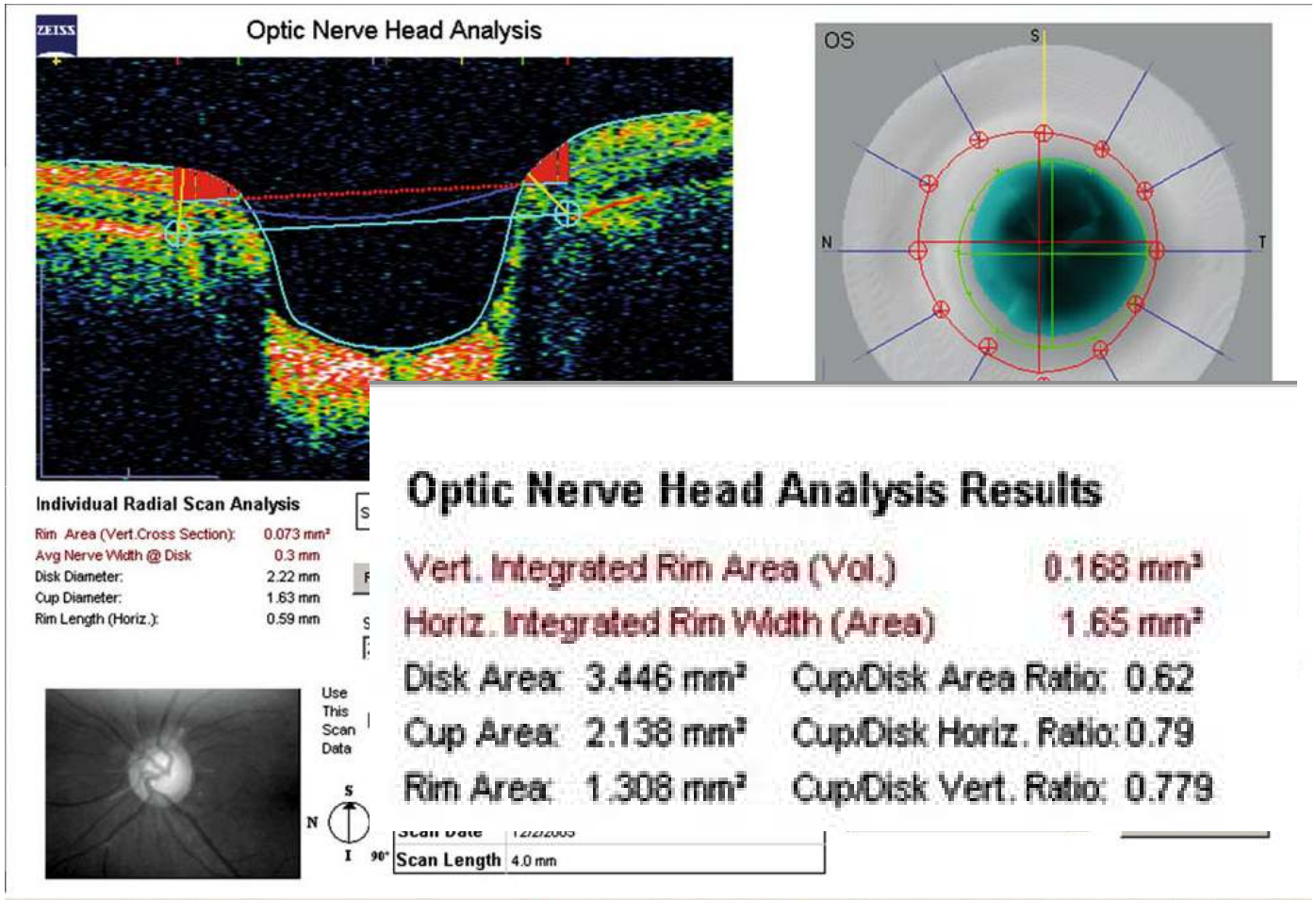
	OD (N=3)	OS (N=3)	OD-OS
Imax/Smax	0.95	1.05	-0.10
Smax/Imax	1.05	0.95	0.10
Smax/Tavg	2.70	2.10	0.60
Imax/Tavg	2.56	2.20	0.36
Smax/Navg	1.81	2.96	-1.16
Max-Min	60.00	131.00	-71.00
Smax	89.00	169.00	-80.00
Imax	84.00	178.00	-94.00
Savg	73.00	124.00	-51.00
Iavg	63.00	119.00	-56.00
Avg.Thickness	54.71	95.20	-40.49

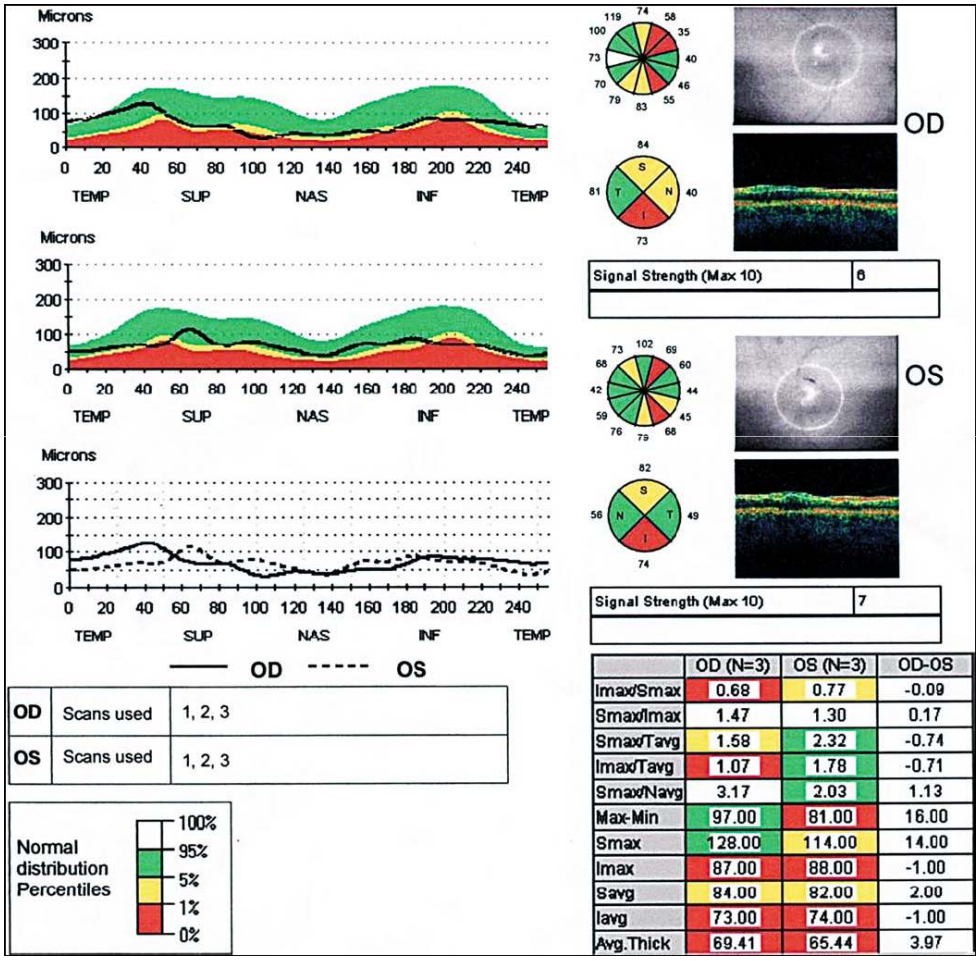


Patient/Scan Information

DOB: 6/26/1942, ID: HTG2, Female

Scan Type	Fast RNFL Thickness (3.4)
Scan Date	2/25/2005
Scan Length	10.87 mm

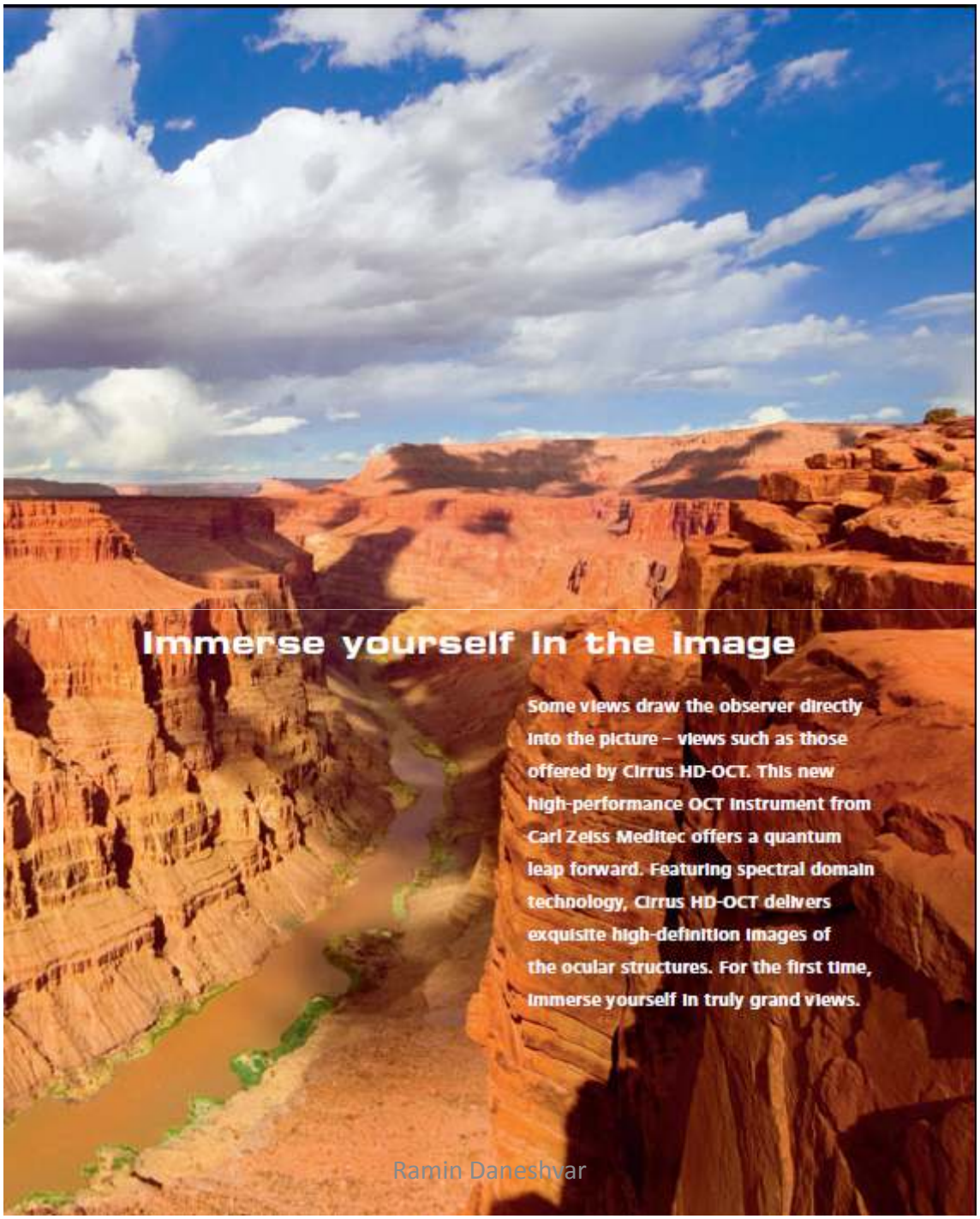

Optic Nerve Head Analysis
OS
S
N
T
Individual Radial Scan Analysis
Rim Area (Vert.Cross Section): 0.073 mm²
Avg Nerve Width @ Disk 0.3 mm
Disk Diameter: 2.22 mm
Cup Diameter: 1.63 mm
Rim Length (Horiz.): 0.59 mm
Use This Scan Data
S
N
I
90°
Scan Length 4.0 mm
Optic Nerve Head Analysis Results
Vert. Integrated Rim Area (Vol.) 0.168 mm³
Horiz. Integrated Rim Width (Area) 1.65 mm²
Disk Area: 3.446 mm² Cup/Disk Area Ratio: 0.62
Cup Area: 2.138 mm² Cup/Disk Horiz. Ratio: 0.79
Rim Area: 1.308 mm² Cup/Disk Vert. Ratio: 0.779

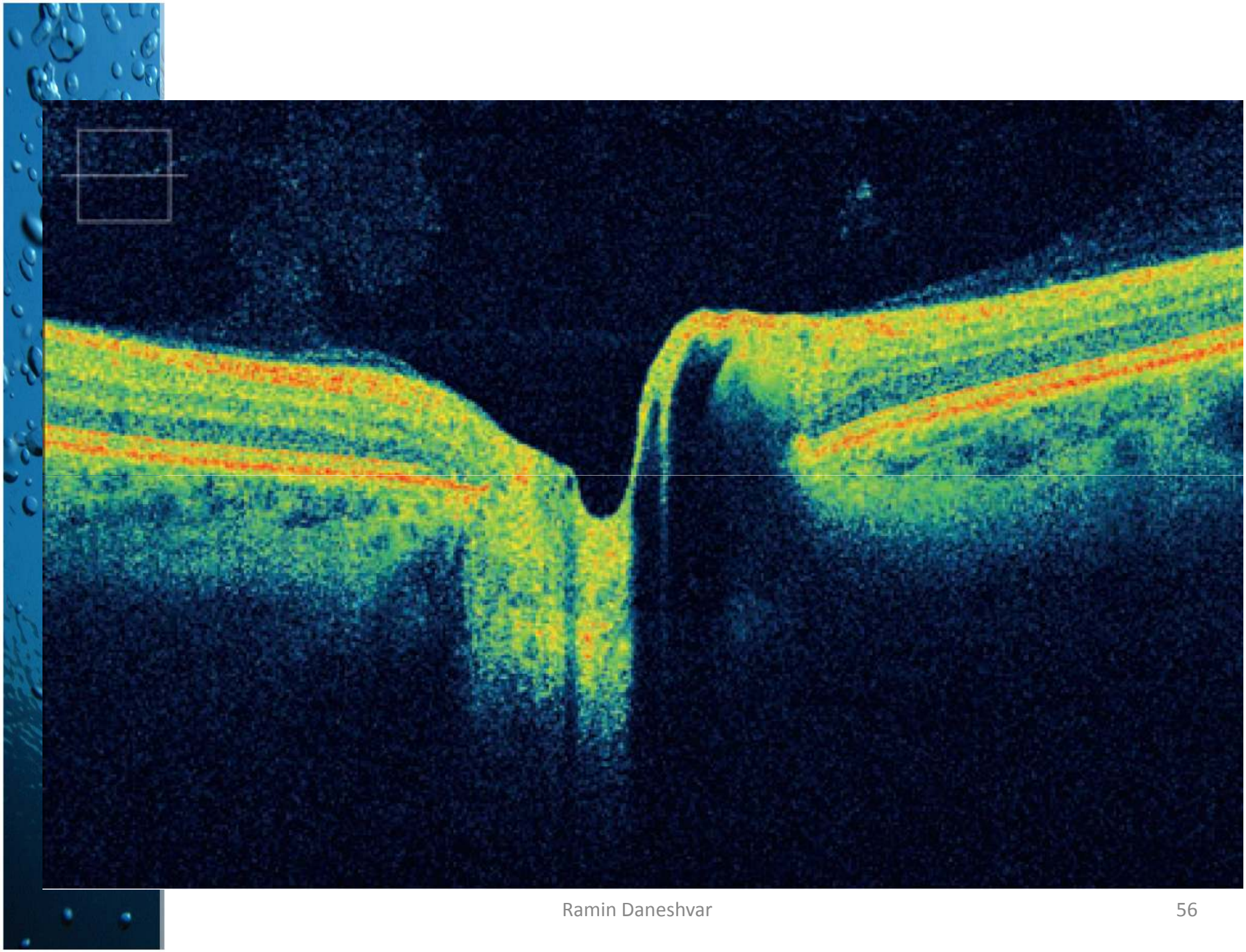


	OD (N=3)	OS (N=3)	OD-OS
Imax/Smax	0.68	0.77	-0.09
Smax/Imax	1.47	1.30	0.17
Smax/Tavg	1.58	2.32	-0.74
Imax/Tavg	1.07	1.78	-0.71
Smax/Navg	3.17	2.03	1.13
Max-Min	97.00	81.00	16.00
Smax	128.00	114.00	14.00
Imax	87.00	88.00	-1.00
Savg	84.00	82.00	2.00
Iavg	73.00	74.00	-1.00
Avg.Thick	69.41	65.44	3.97

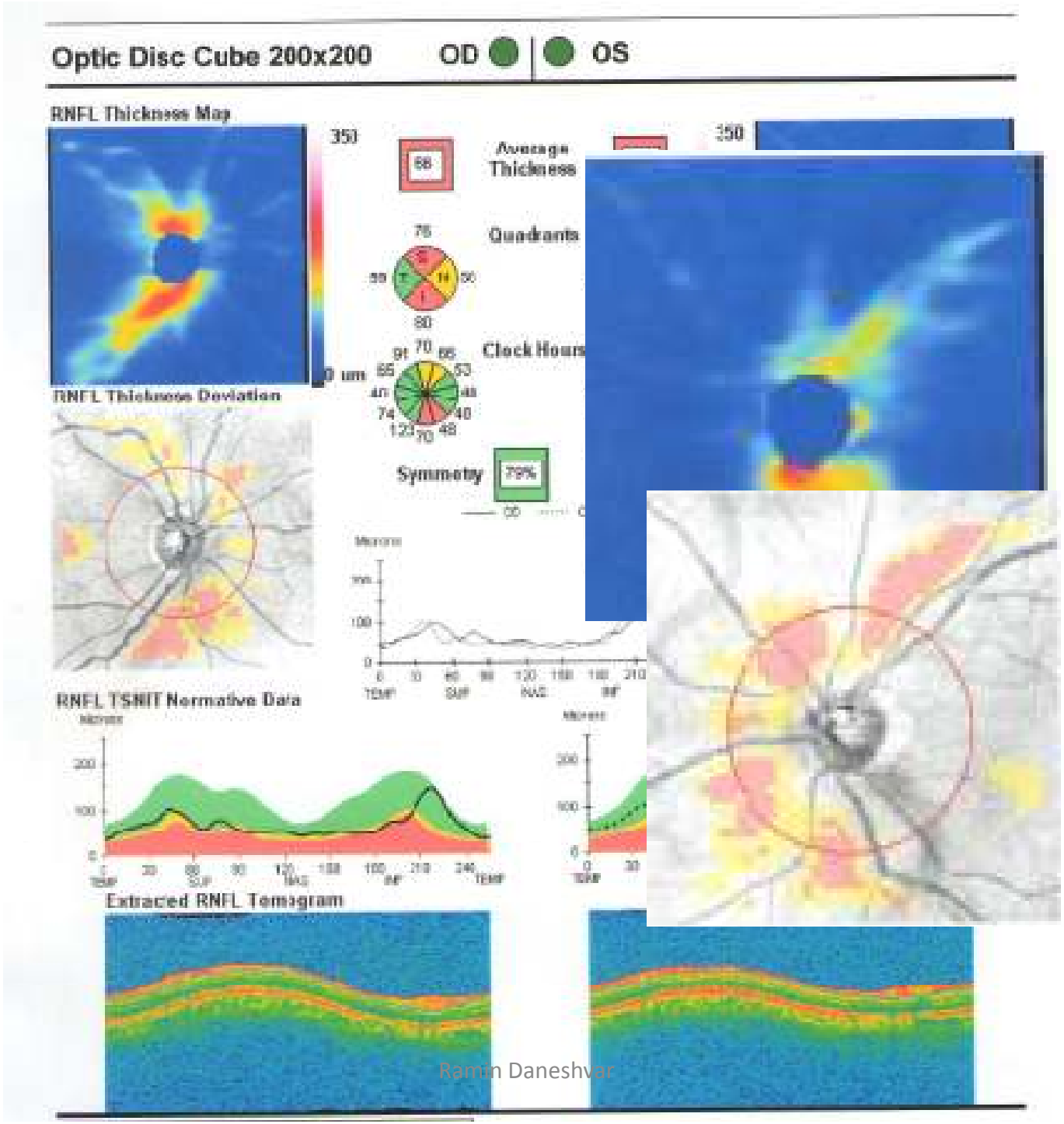
Cirrus HD OCT

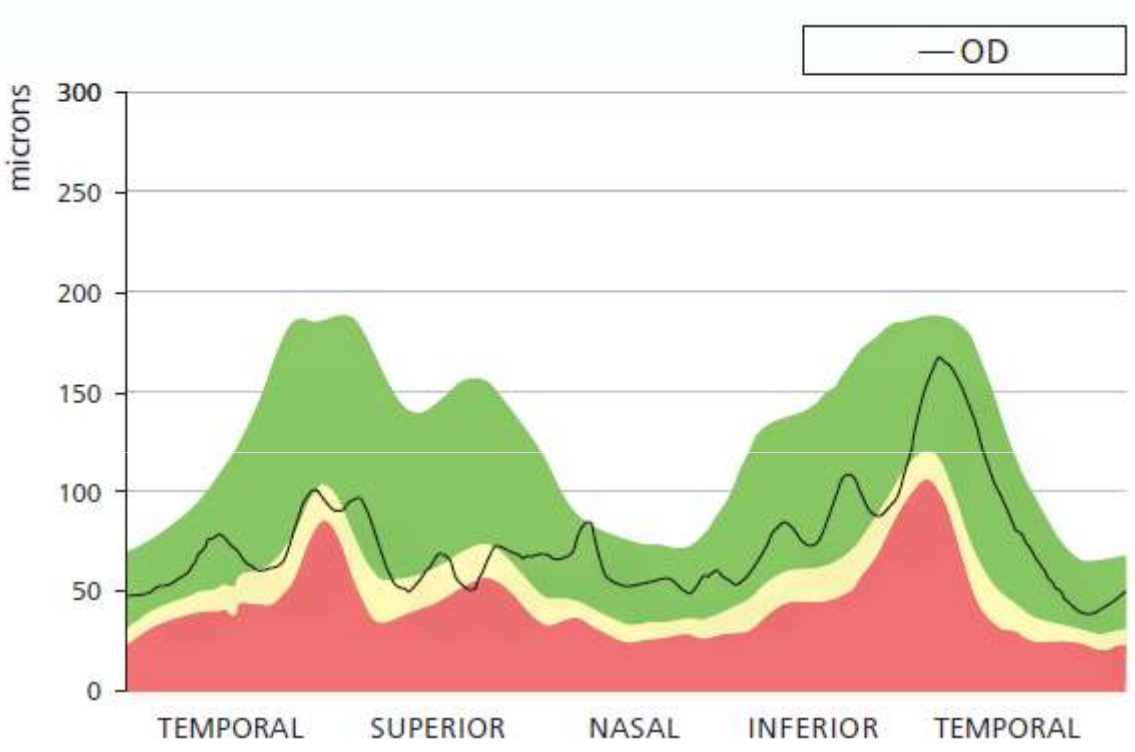

Cirrus HD-OCT
STRATUS OCT


Immerse yourself in the image
Some views draw the observer directly into the picture – views such as those offered by Cirrus HD-OCT. This new high-performance OCT instrument from Carl Zeiss Meditec offers a quantum leap forward. Featuring spectral domain technology, Cirrus HD-OCT delivers exquisite high-definition images of the ocular structures. For the first time, immerse yourself in truly grand views.



- RNFL Thickness Analysis
- Faster: 3D Volume
- Precise registration
- Printout like GDx
- Deviation MAP


Optic Disc Cube 200x200
OD
OS
RNFL Thickness Map
350
Average Thickness
Quadrants
Clock Hours
RNFL Thickness Deviation
Symmetry
RNFL TSNIT Normative Data
Extracted RNFL Tomogram



TSNIT graph plots RNFL thickness and compares it to a normative database

1. Fundus Image

- Well focused
- Evenly illuminated
- Well centered

2. Thickness Map

- RNFL thinning Superior OS
- Wedge defects Inferior OU

3. Deviation Map

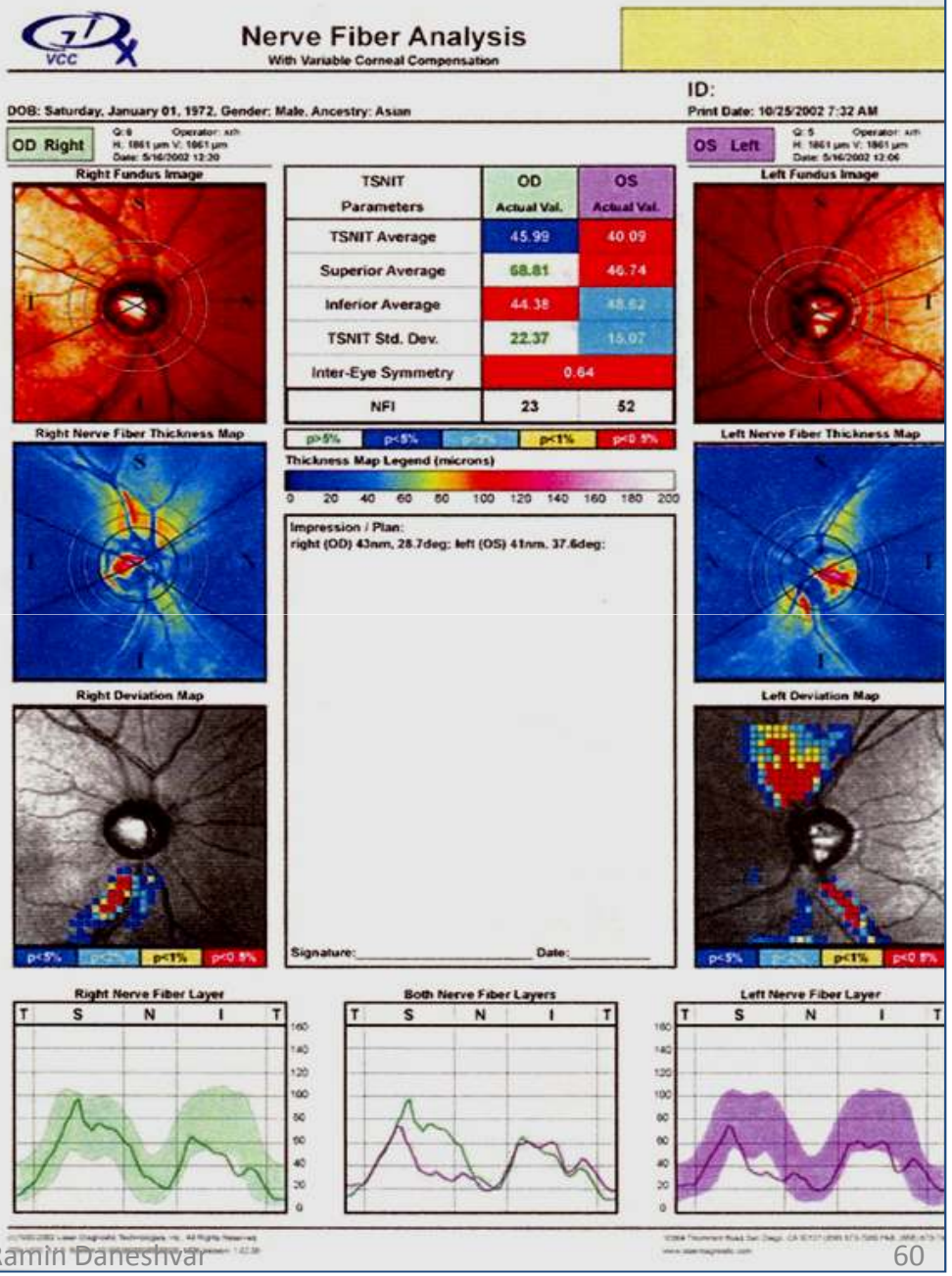
- Extensive RNFL loss Superior OS
- Wedge defects Inferior OU

4. TSNIT Graph

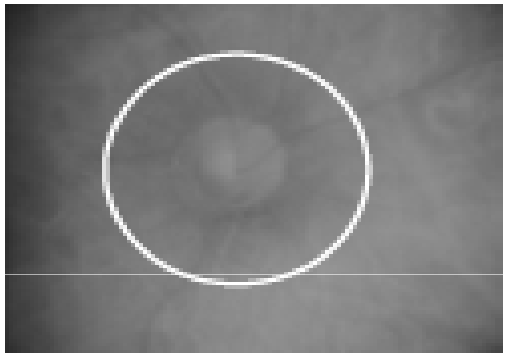
- Falls outside shaded area in Inferior region OU
- Falls below shaded area Superior OS

5. Parameter Table

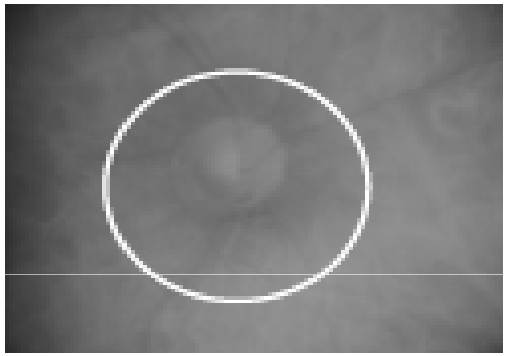
- Abnormal:
  - TSNIT Average and Inferior Average OU
  - Superior Average and TSNIT SD OS
  - IES value
  - NFI OS
  - NFI values abnormal OU



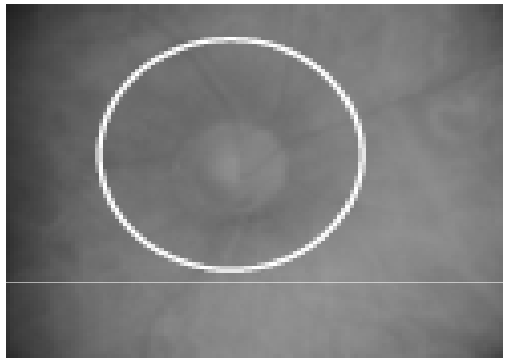
Scan location and eye movements affect results



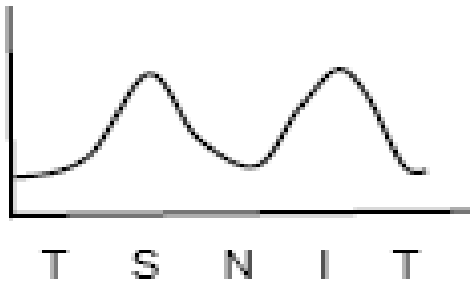
Properly centered



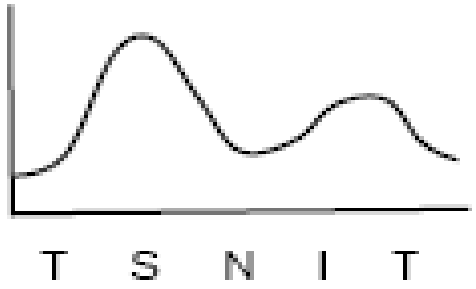
Poorly centered: too inferior



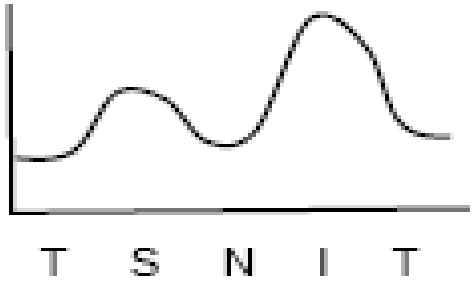
Poorly centered: too superior



Normal Double Hump

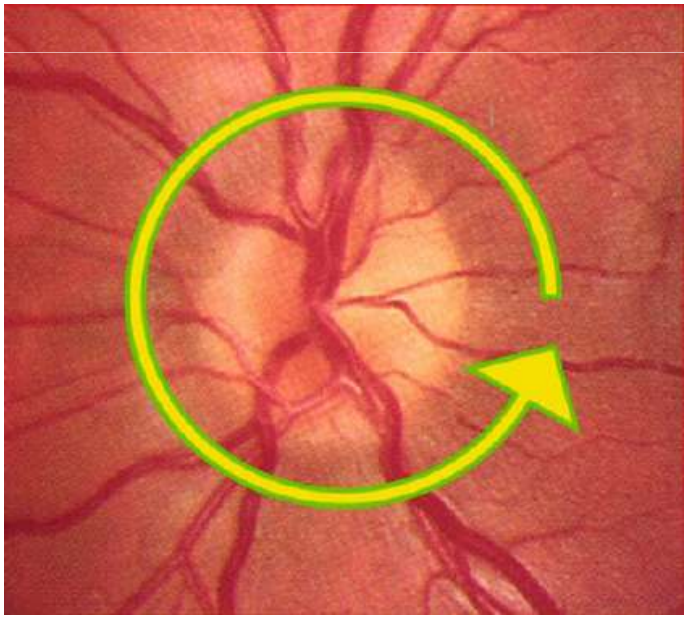


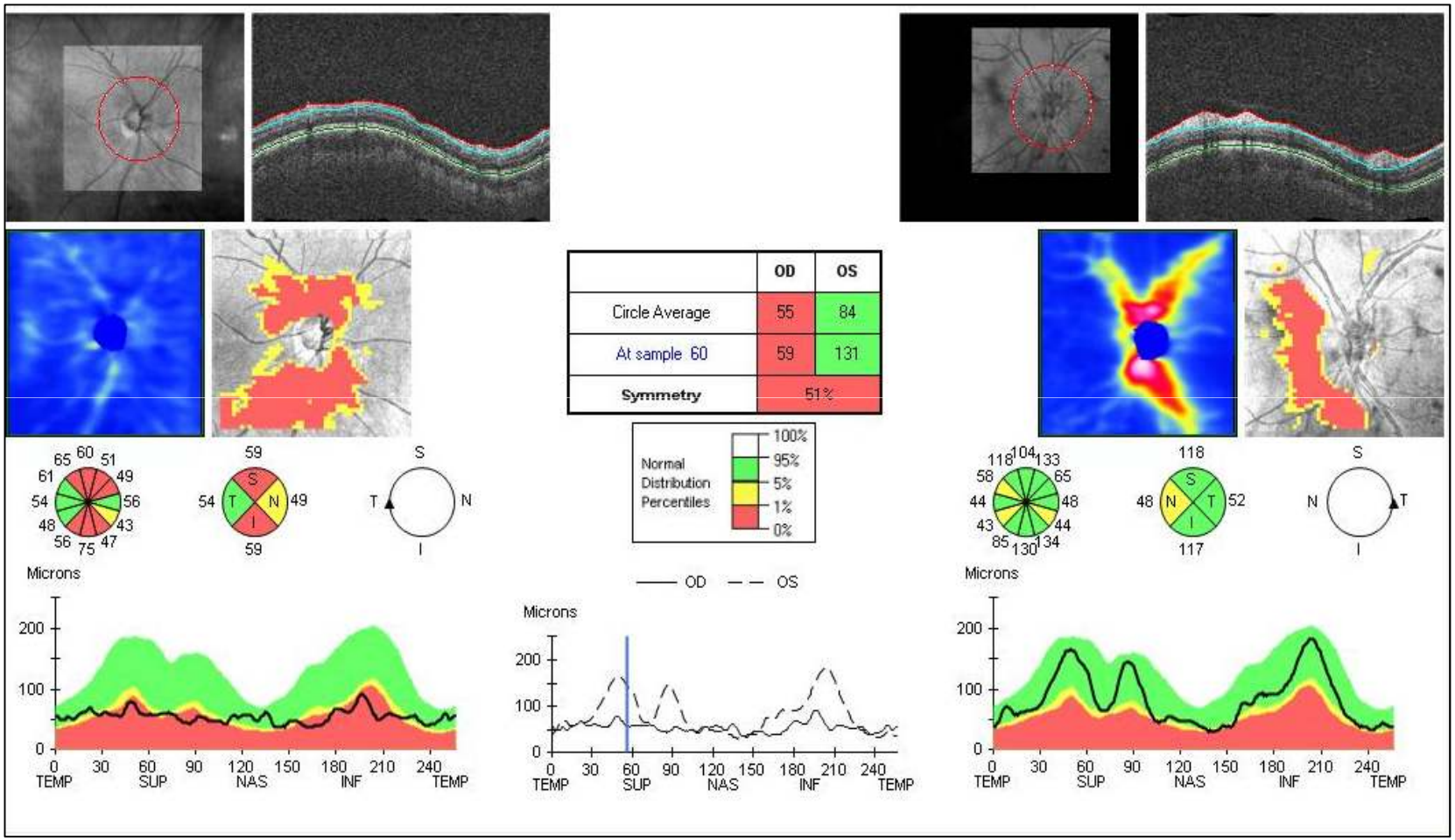
Inferior RNFL "Loss"

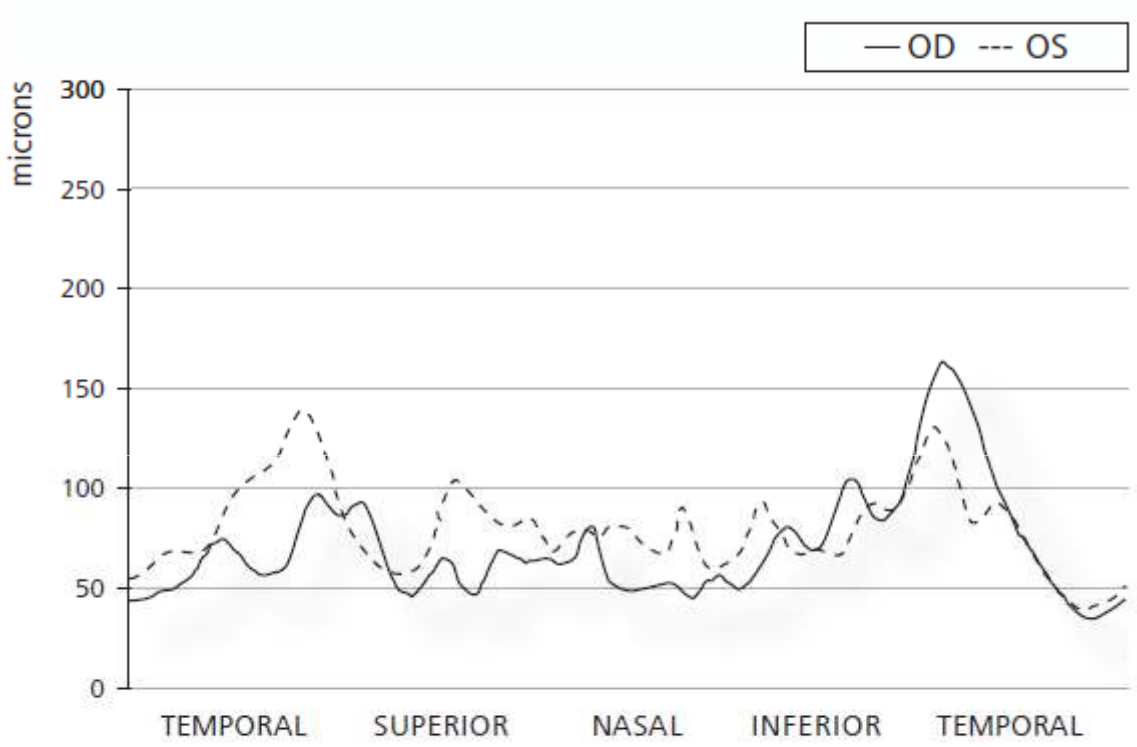


Superior RNFL "Loss"

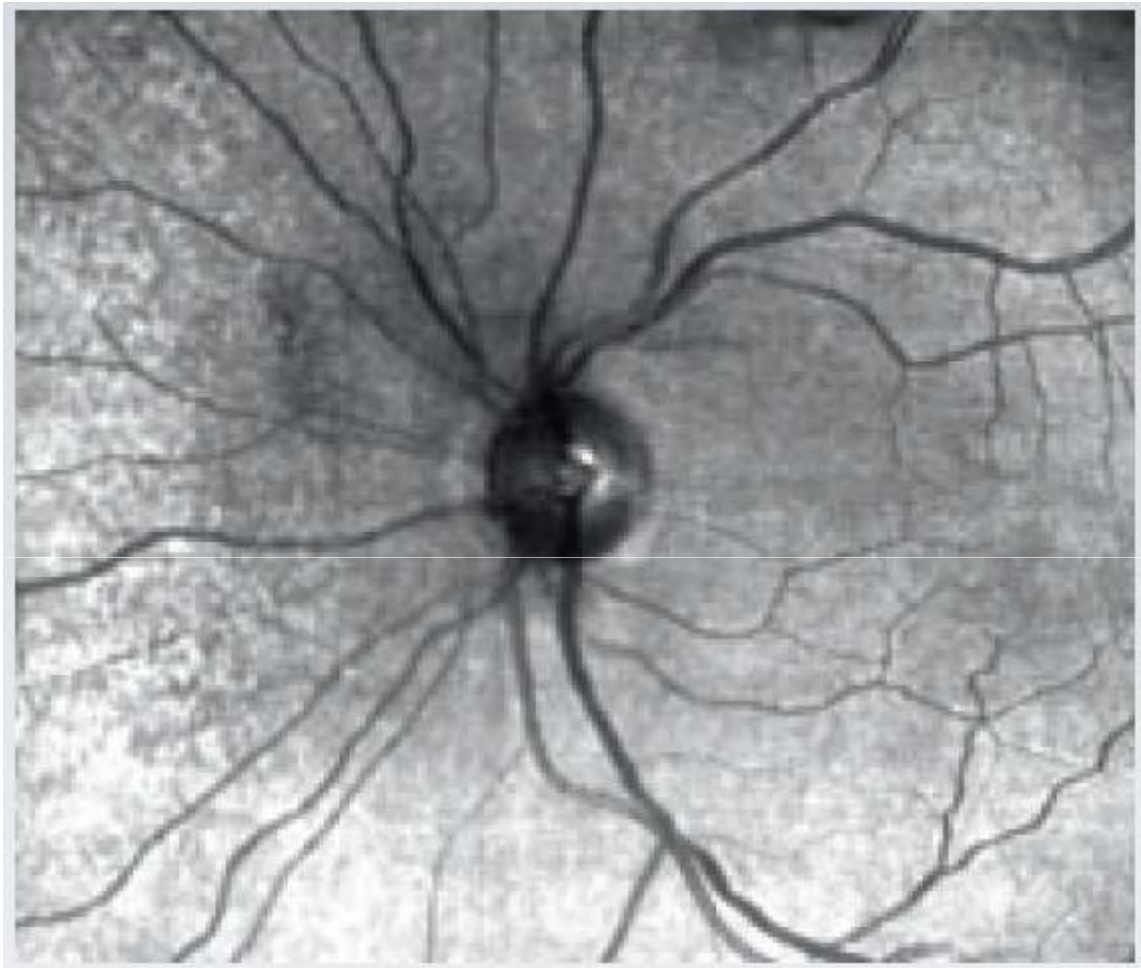
- **Center of disc is automatically identified**
- **F/U Software GPA**



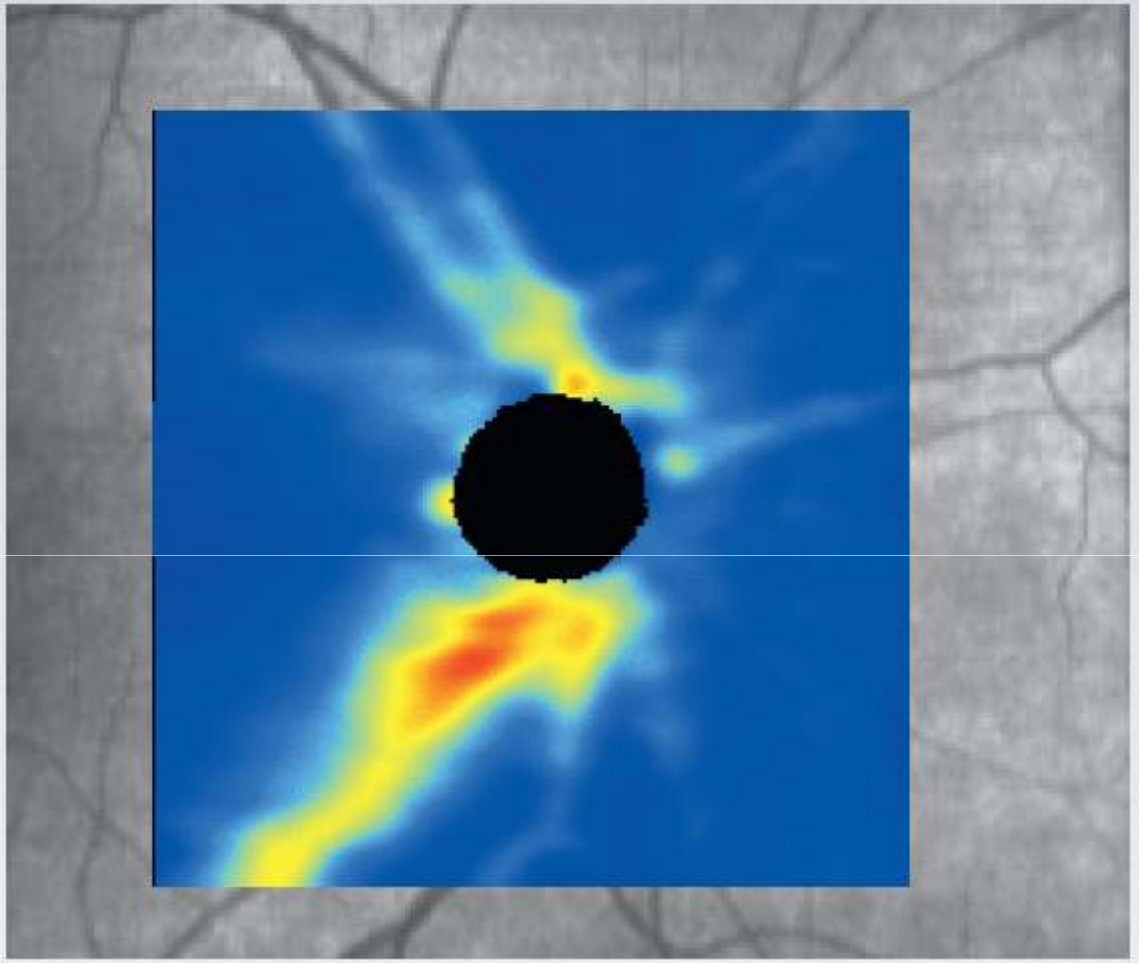

OD
OS
Circle Average
55
84
At sample 60
59
131
Symmetry
51%
Normal
Distribution
Percentiles
100%
95%
5%
1%
0%
Microns
TEMP
SUP
NAS
INF
TEMP



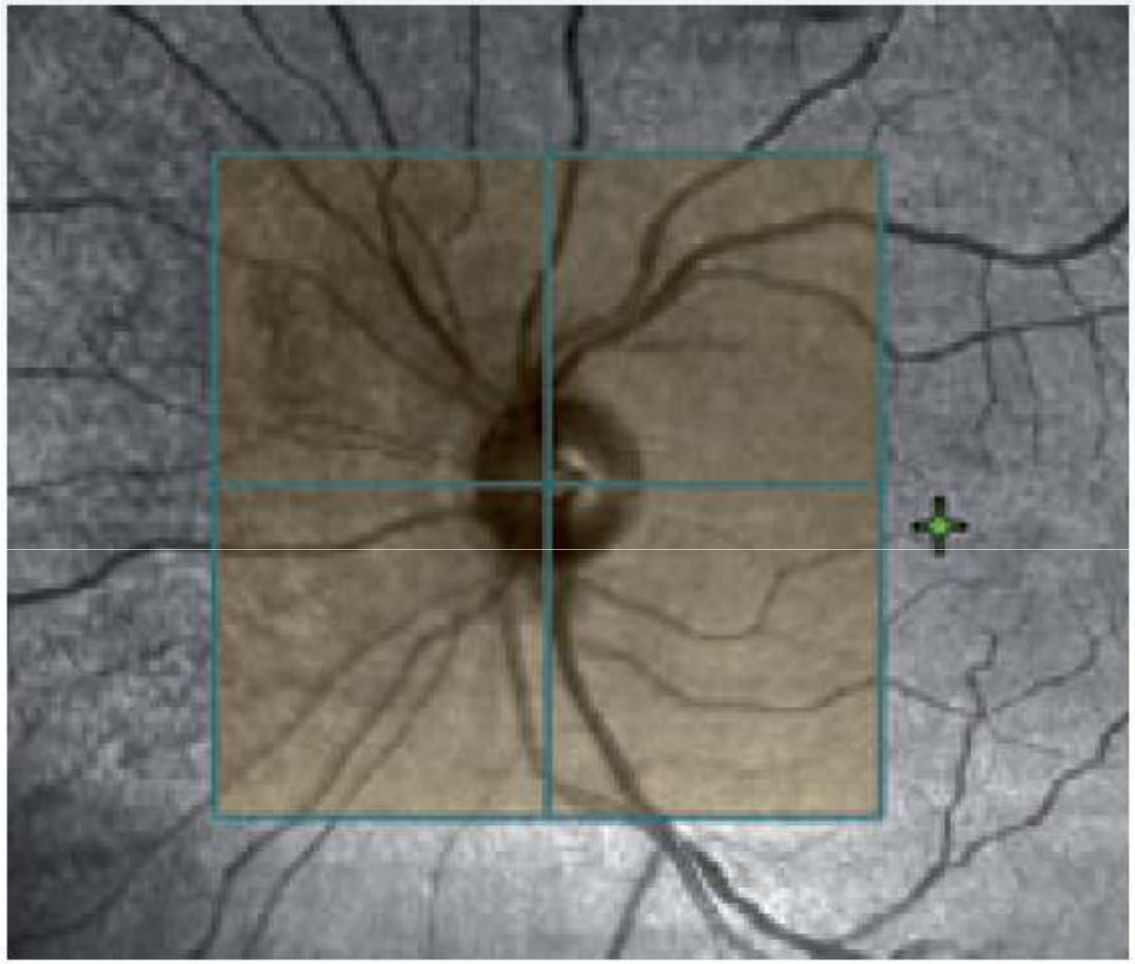
OU TSNIT graph displays RNFL thickness of both eyes for identification of asymmetry



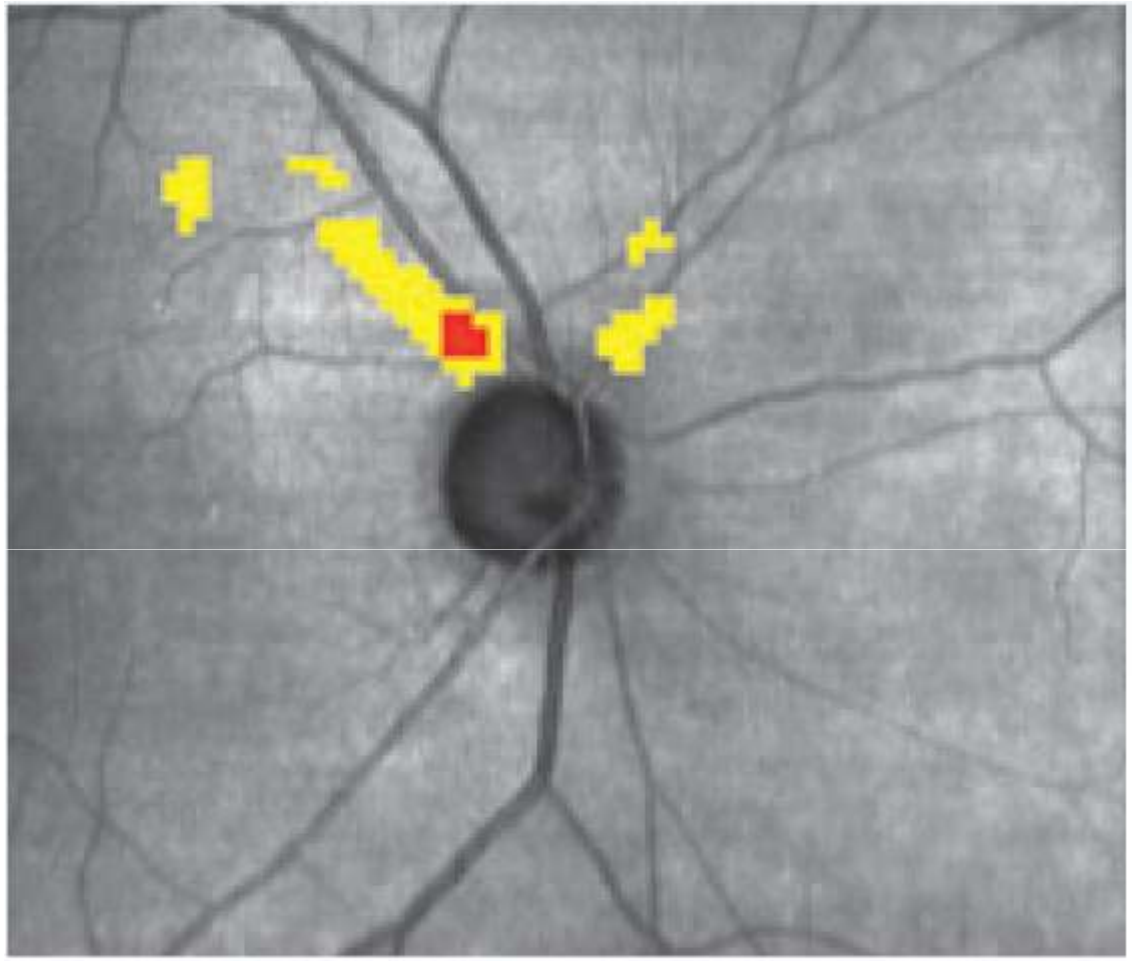
LSO provides an exquisite fundus image for visualization of the optic nerve head



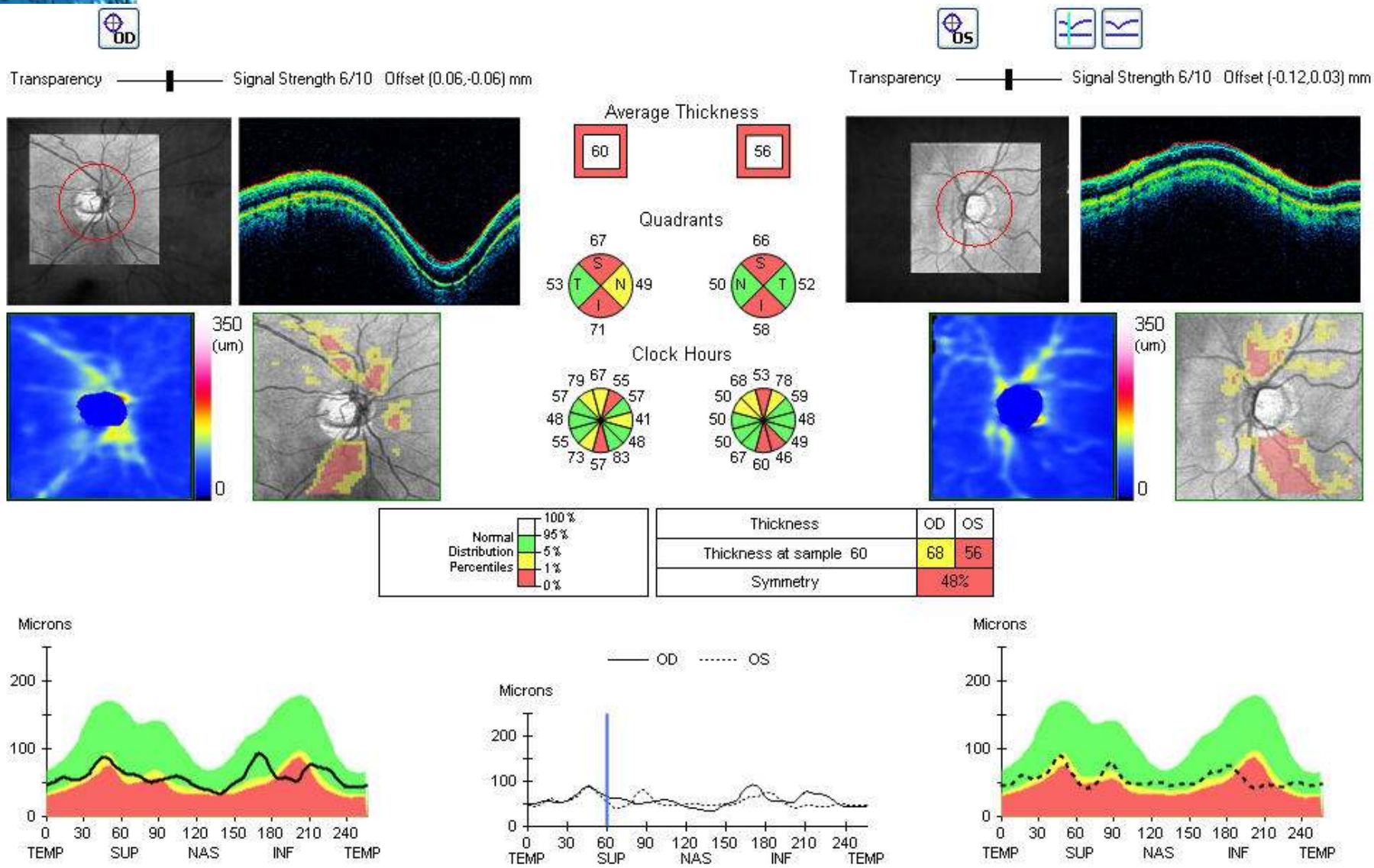
RNFL thickness map presents the pattern and thickness of the nerve fiber layer and aids in the detection of pattern defects

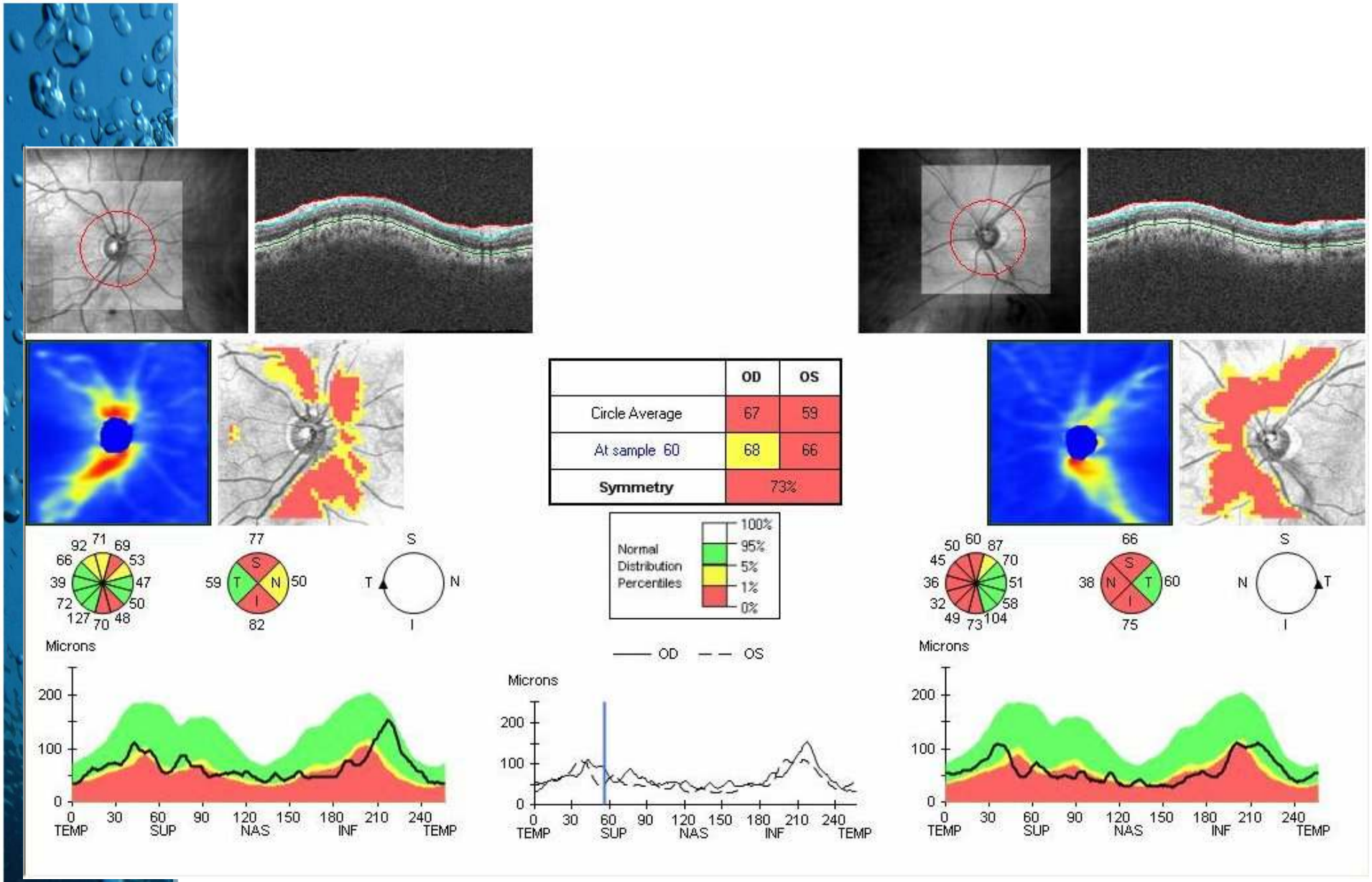


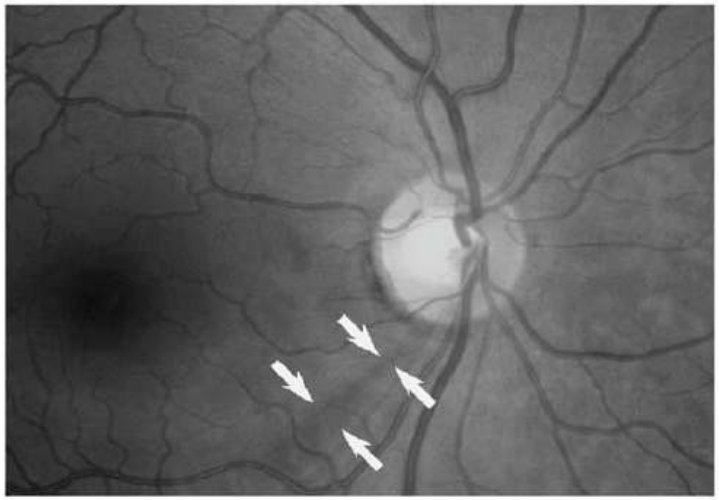
LSO with OCT fundus overlay from previous visit demonstrates visit-to-visit registration, assuring excellent reproducibility

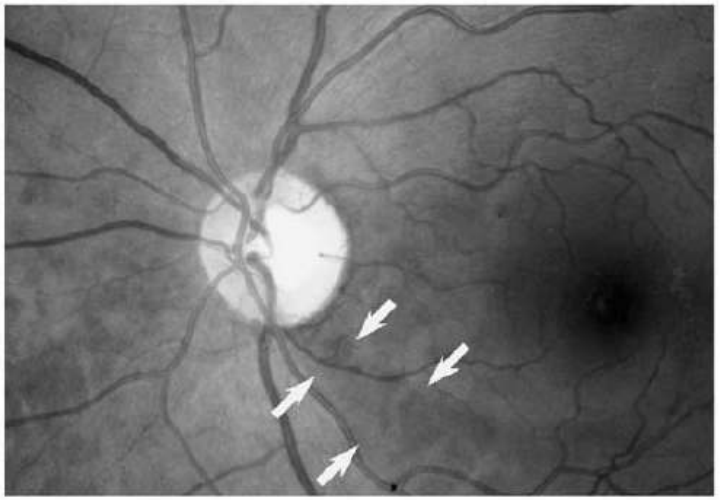


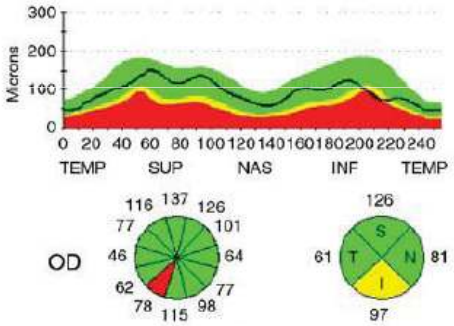
Deviation map, overlayed on OCT fundus image, illustrates where RNFL thickness deviates from a normal range

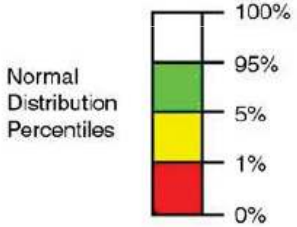

OD
OS
Transparency
Signal Strength 6/10 Offset (0.06,-0.06) mm
Transparency
Signal Strength 6/10 Offset (-0.12,0.03) mm
Average Thickness
60
56
Quadrants
67
S
53 T N 49
I
71
66
S
50 N T 52
I
58
Clock Hours
79 67 55
57 57
48 41
55 48
73 57 83
68 53 78
50 59
50 48
50 49
67 60 46
350
(um)
0
350
(um)
0
Normal Distribution Percentiles
100 %
95 %
5 %
1 %
0 %
Thickness OD OS
Thickness at sample 60 68 56
Symmetry 48%
Microns
200
100
0
0 30 60 90 120 150 180 210 240
TEMP SUP NAS INF TEMP
OD
OS
Microns
200
100
0
0 30 60 90 120 150 180 210 240
TEMP SUP NAS INF TEMP
Microns
200
100
0
0 30 60 90 120 150 180 210 240
TEMP SUP NAS INF TEMP

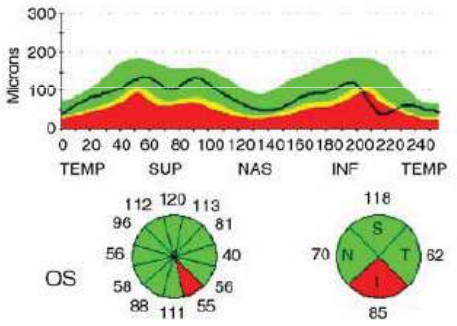

OD
OS
Circle Average
67
59
At sample 60
68
66
Symmetry
73%
Normal
Distribution
Percentiles
100%
95%
5%
1%
0%
Microns
TEMP
SUP
NAS
INF
TEMP

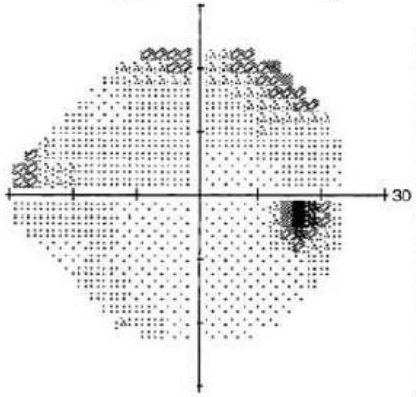




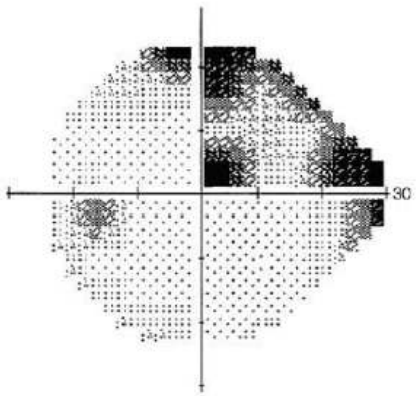






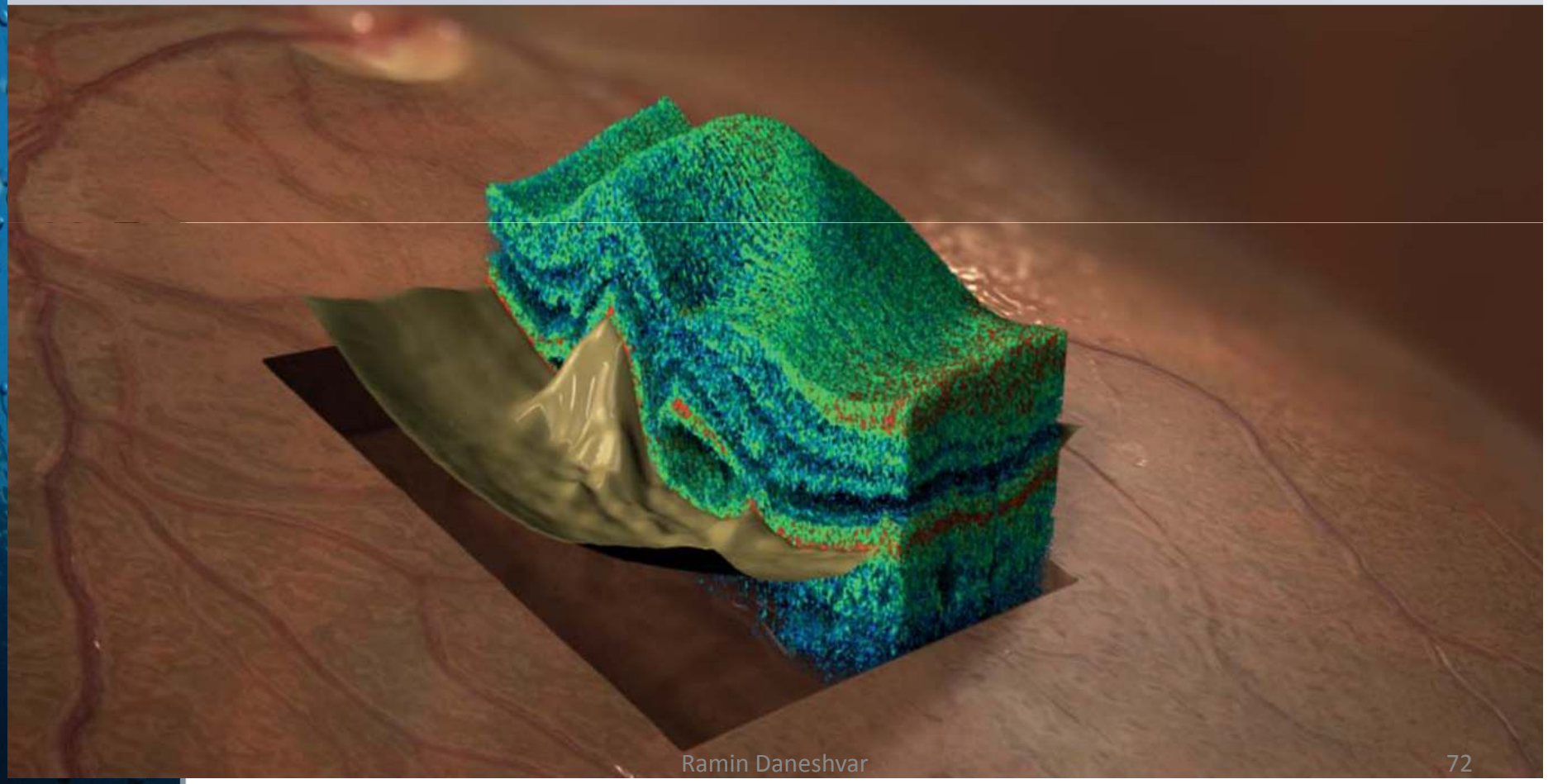


	OD (N=3)	OS (N=3)	OD-OS
Imax/Smax	0.82	0.88	-0.06
Smax/Imax	1.22	1.14	0.08
Smax/Tavg	2.43	2.20	0.24
Imax/Tavg	1.99	1.92	0.07
Smax/Navg	1.86	1.94	-0.09
Max-Min	105.00	98.00	7.00
Smax	150.00	136.00	14.00
Imax	122.00	119.00	3.00
Savg	126.00	118.00	8.00
Iavg	97.00	85.00	12.00
Avg.Thickness	91.00	83.74	7.65



It's not just spectral domain, it's High-Definition OCT.

Cirrus™ HD-OCT

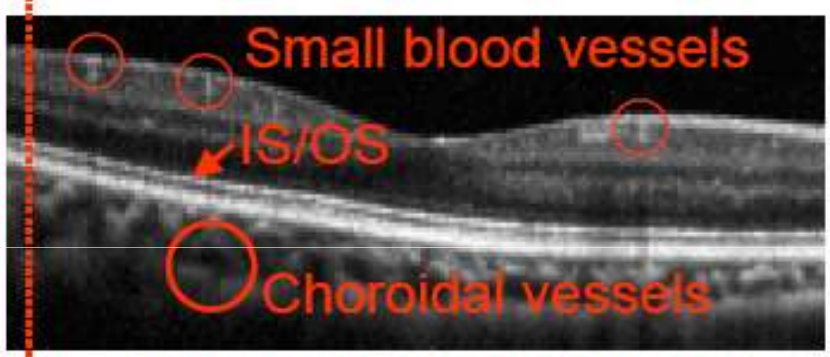


Technical data	
OCT Scanning	• Axial resolution: 5 µm (in tissue) • Transverse resolution: 15 µm (in tissue) • Scan speed: 27,000 A-scans per second • A-scan depth: 2.0 mm (in tissue), 1024 points • Optical source: superluminescent diode (SLD), 840 nm
Fundus Imaging	• Line scanning ophthalmoscope (LSO) • Live during scanning • Transverse resolution: 25 µm (in tissue) • Optical source: superluminescent diode (SLD), 750 nm • Field of view: 36° x 30°
Scan Patterns	• Macular Cube 200 x 200 Combo: 200 horizontal scan lines comprised of 200 A-scans • Macular Cube 512 x 128 Combo: 128 horizontal scan lines comprised of 512 A-scans • 5 Line Raster: 4096 A-scans per B-Scan (adjustable length, spacing and orientation)
Focus Adjustment Range	• –20D to +20D (diopters)
Fixation	• Internal and external
Computer	• Windows® XP Pro • High-performance multi-core processor • Internal storage: > 80,000 scans • CD-RW, DVD-ROM drive • Integrated 15” color flat panel display
Pupil Size Requirement	• ≤ 2.0 mm (≥ 3.0 mm optimal for LSO)
Dimensions/Weight (Instrument Only)	• 25.6 L x 17.3 W x 20.9 H (in); 65 L x 44 W x 53 H (cm) • 83 lbs; 37.6 kg
Electrical	100–120V~, 50/60Hz, 5A 220–240V~, 50/60Hz, 2.5A

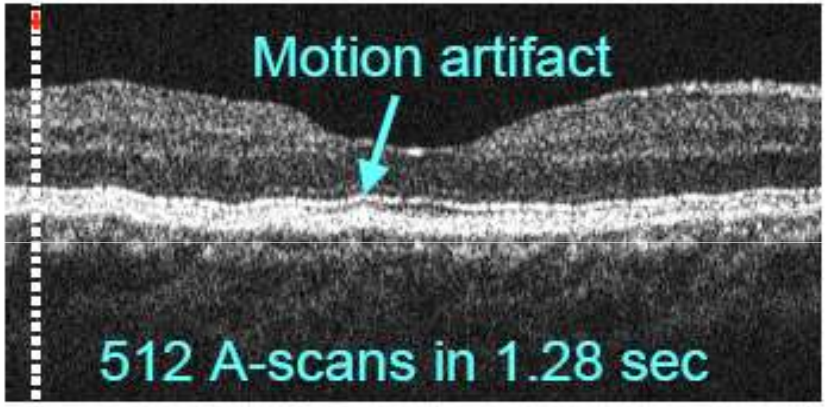
User Features	GDx	Stratus OCT	Cirrus HD-OCT
General			
Technology	Scanning Laser Polarimetry	Optical Coherence Tomography (OCT)	Spectral Domain OCT
Integrated design	•		•
Portable	•		
Acquisition			
Non-mydriatic	•		•
Joystick operation	•	•	
Point-and-click mouse driven operation			•
Fastest scan speed			•
Technician time for two eyes	< 3 min	< 5 min	< 3 min
Glaucoma screening mode	•		
Software Features			
Repeat scan function	•	•	•
Review Software	•	•	•
Correlation of scan to fundus image	•		•
Auto Patient Recall™			•
Bulk image export	•	•	
Images			
Cross-sectional OCT image		•	•
High-definition fundus image			•
3D volume rendering of macula and optic nerve head			•
3D fly-through video			•
Segmentation layer maps of ILM and RPE			•
Analyses			
Retinal thickness analysis		•	
RNFL thickness analysis	•	•	•
Optic nerve head analysis		•	
Automated optic nerve head registration	•		•
Macular thickness normative data		•	
RNFL normative data	•	•	•
Guided Progression Analysis™ (GPA)	•		
GPA Advanced Serial Analysis		•	
Technical Specifications			
Field of view	40 x 20 degrees	26 x 20.5 degrees	36 x 30 degrees
Scan speed	41 frames/sec	400 A-scans/sec	27,000 A-scans/sec
A-Scan depth	N/A	2.0 mm (in tissue)	2.0 mm (in tissue)
Axial resolution	N/A	10 µm (in tissue)	5 µm (in tissue)
Transverse resolution	45 µm	20 µm (in tissue)	15 µm (in tissue)
Minimum pupil diameter	2 mm	3.2 mm	2 mm
Dimensions (in inches)	14h x 10w x 24d	19.2h x 16.5w x 23.7d	20.9h x 17.3w x 25.6d
Weight	45 lbs (21 kg)	58 lbs (26.3 kg)	83 lbs (37.6 kg)

FD OCT(RTVue)

- **Decreases image acquisition time and improves resolution**
- **Permits 3-D imaging**
- **Compare to Stratus**
  - **2x resolution**
  - **65x faster**

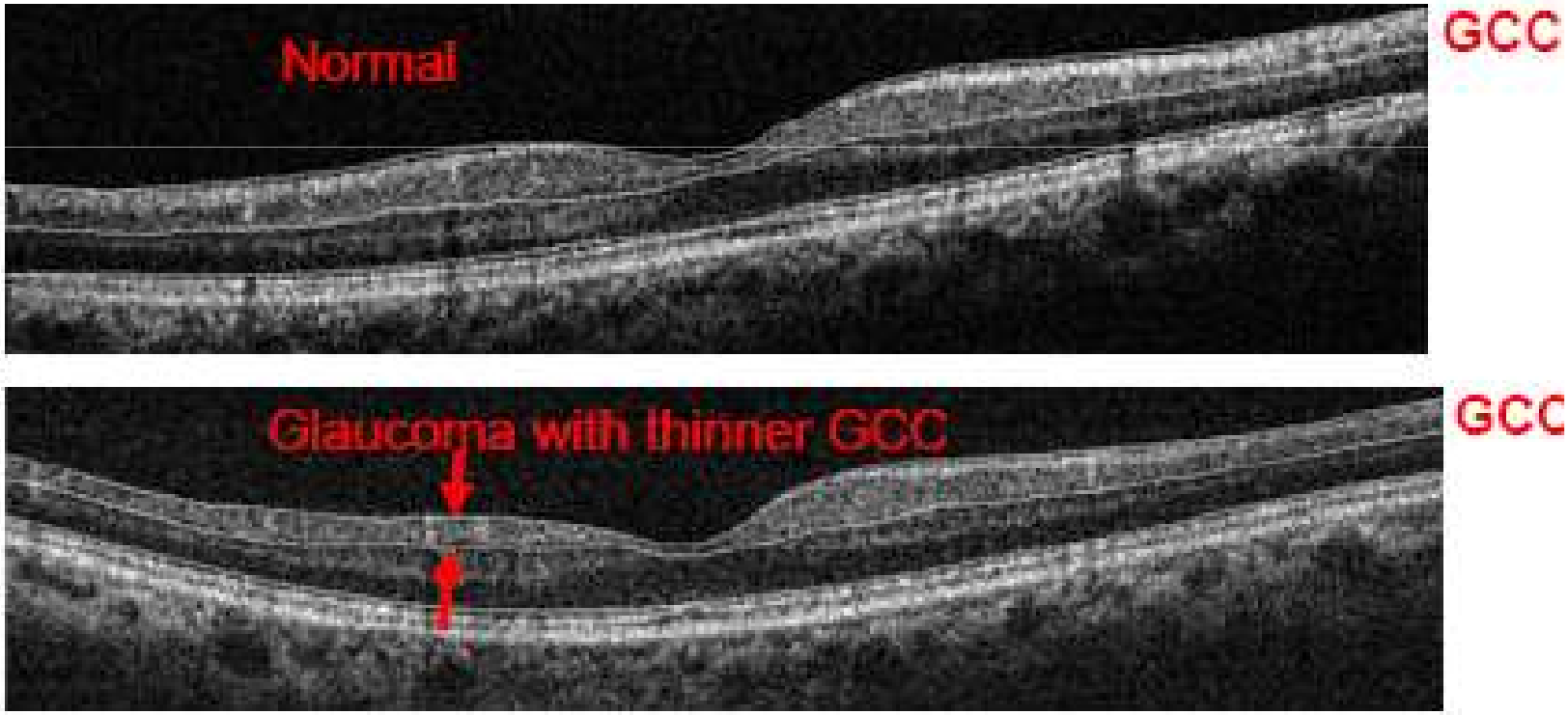


1024 A-scans in 0.04 sec

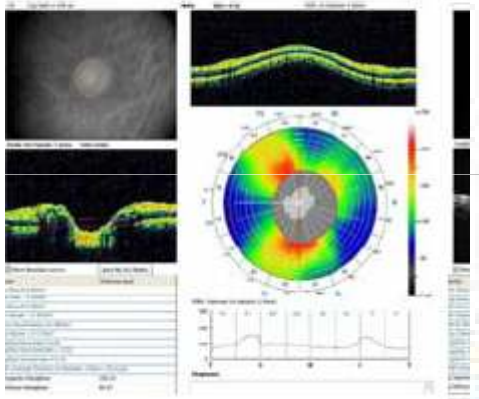


Higher speed, higher definition and higher signal.

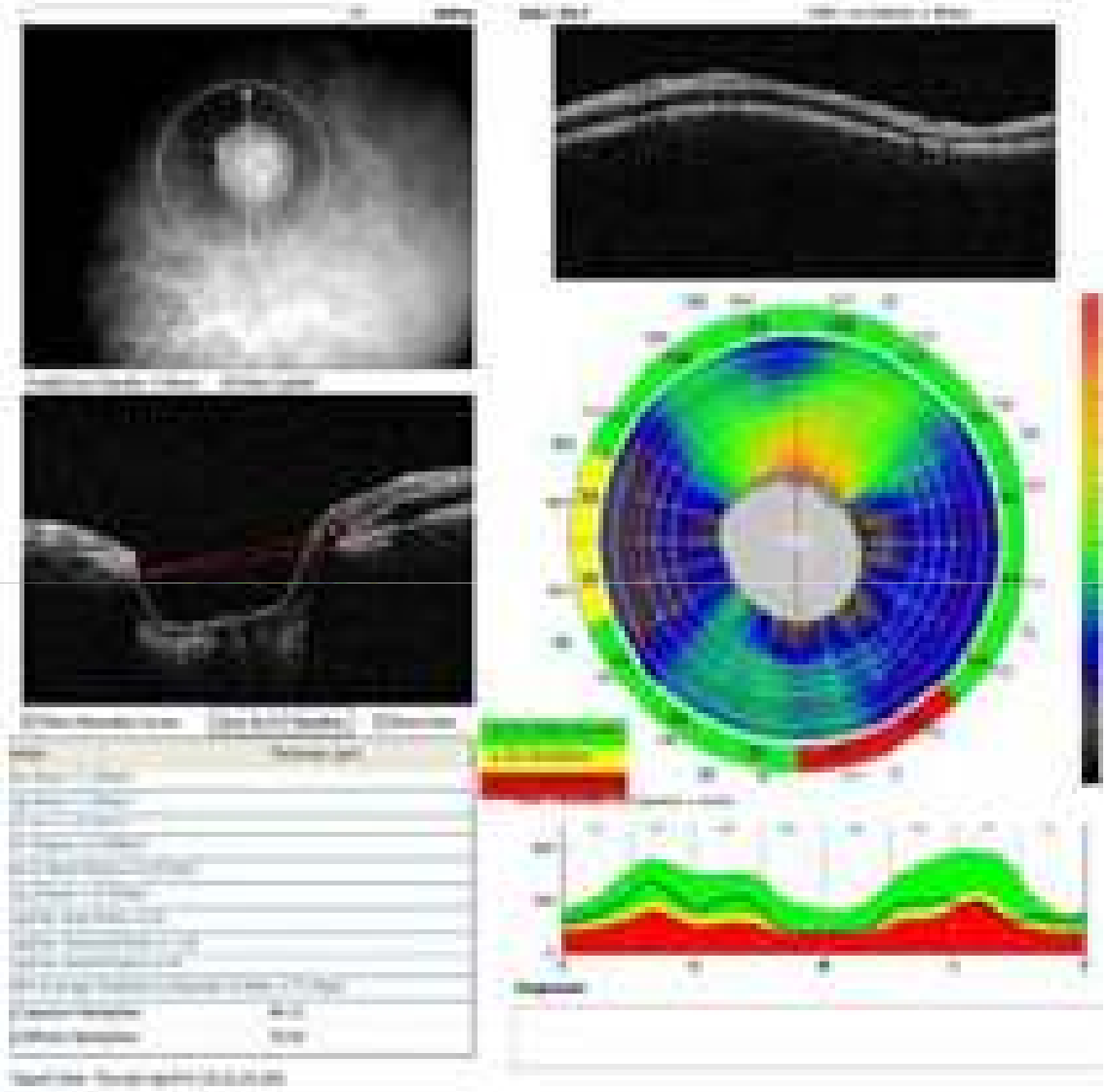
The Ganglion Cell Complex (GCC) becomes thinner in glaucomatous eyes



"NHM4" maps disc rim, cu
peripapillary nerve fiber la

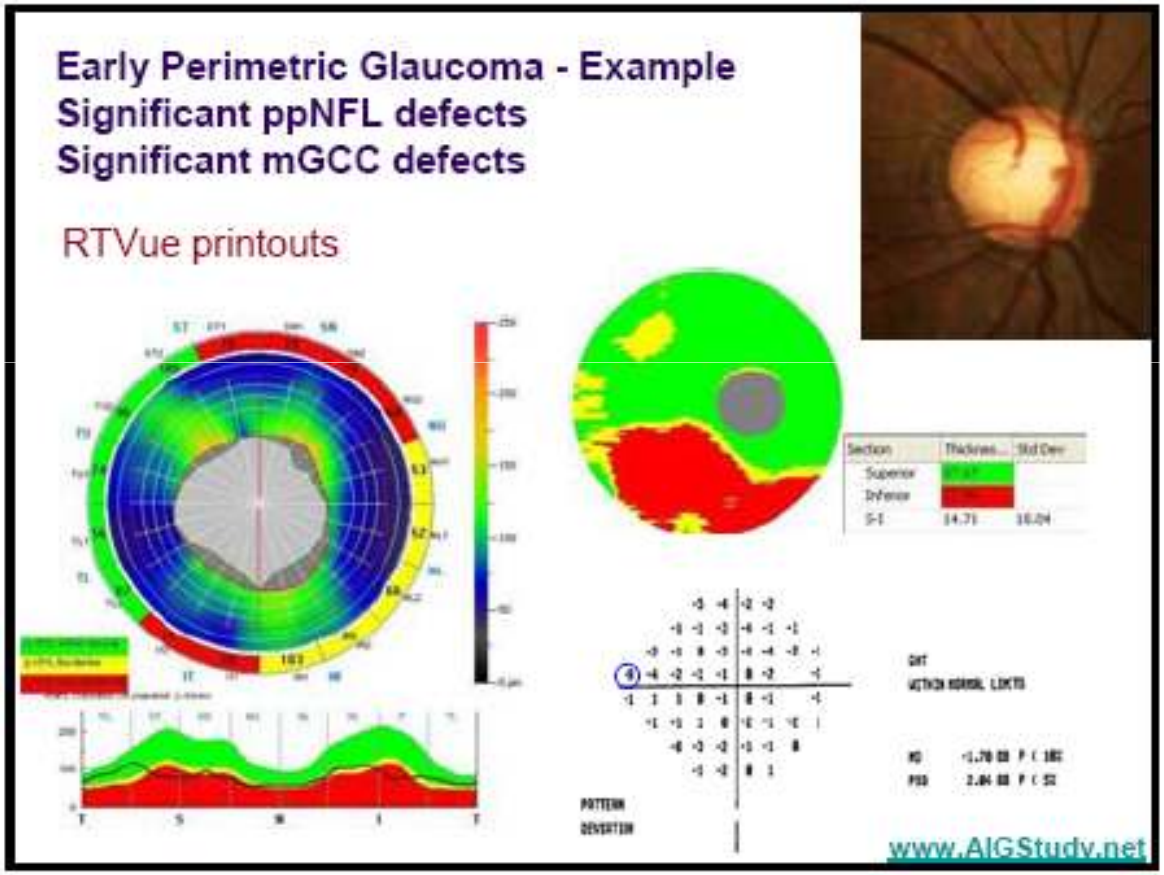


Normal



Early Perimetric Glaucoma - Example
Significant ppNFL defects
Significant mGCC defects

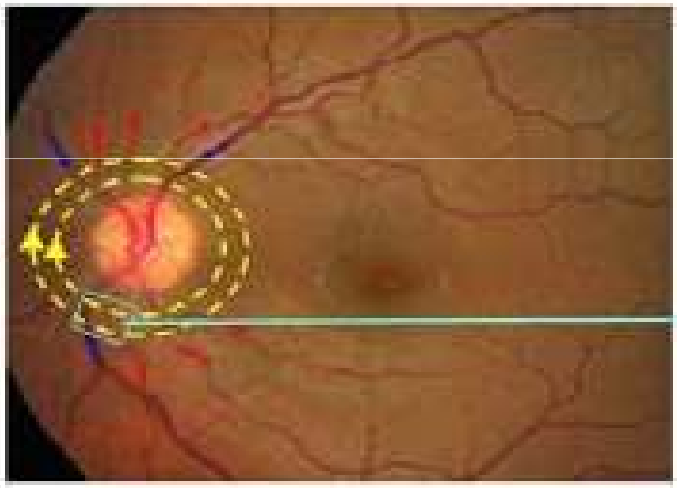
RTVue printouts



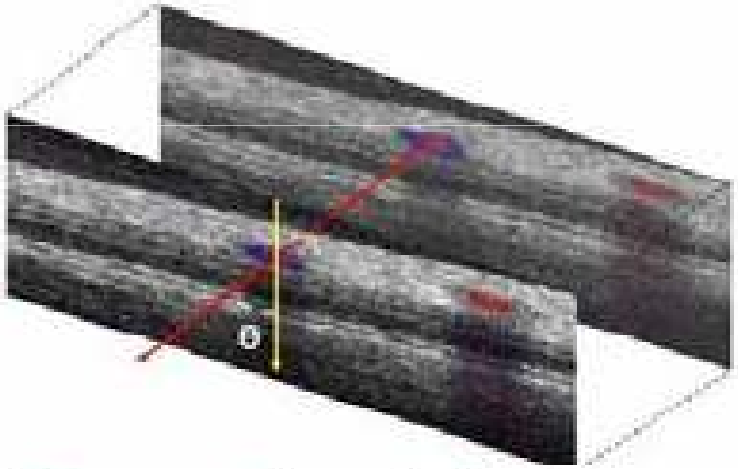
FD OCT can measure Blood flow

Measurement by comparing 2 parallel cross-section

Important Sp. in NTG



Double circular scan



Flow profile and direction determined on parallel sections

OCT Advantages

- Noninvasive
- Non-contact
- High resolution
- High sensitivity
- Topographical
- Reference plane not required
- Not affected by axial length and refraction

Disadvantages of OCT

- Requires pupil dilation:

  OCT I and II: 5mm, OCT III: 3mm, UHR/UHS: optional
- Needs fixation
- Impaired by media opacity sp. PSC
- Expensive technology
- Overlap among normal and abnormal values
- More variable in advanced glaucoma

	GDx	HRT	OCT
Principle	Birefringence	SLO	intreferometry
Pixel	65000	65000	50000
Pupil dialation	No	No	Yes
Normative data	1200 eyes	100 eyes	150 eyes
Parameter	Peripap RNFL	OD contour	Peripap RNFL
Reproducibility	5-10%	5-10%	5-10%
Sensitivity	70-80%	65-75%	70-80%
Specificity	60-80%	70-80%	75-85%
Change detection	Yes	Yes	Yes
Change probability	Yes	Yes	Yes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