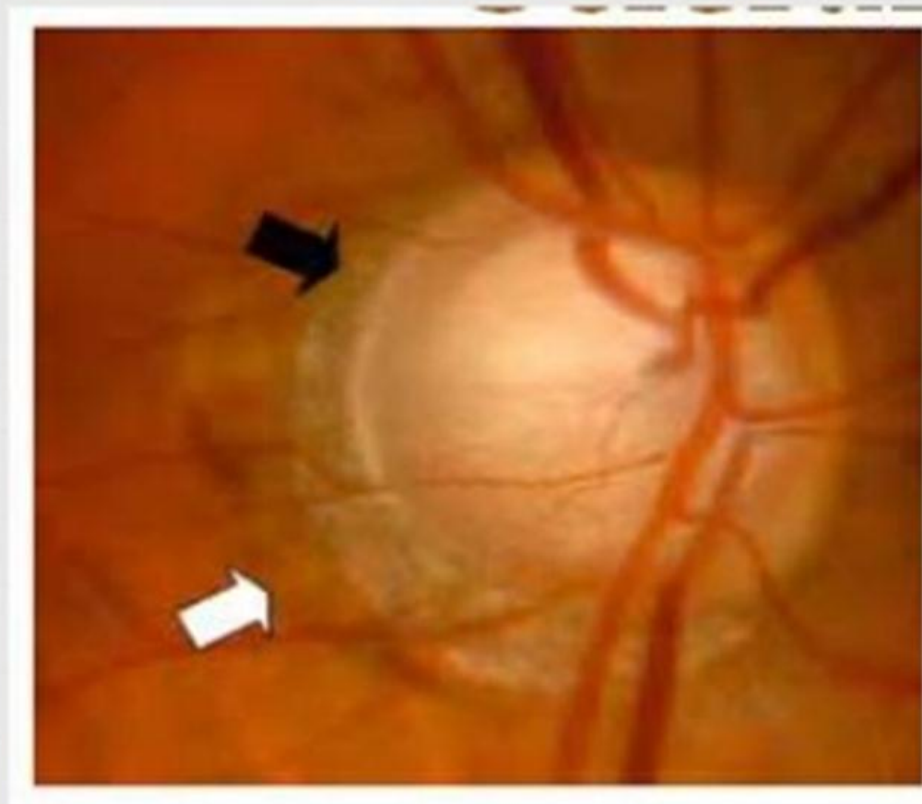


Oct in glaucoma

Zone beta atrophy (black arrow)
zone alpha atrophy (white arrow)



Disc recording



Careful detailed drawing of the optic disc should be done on every visit.

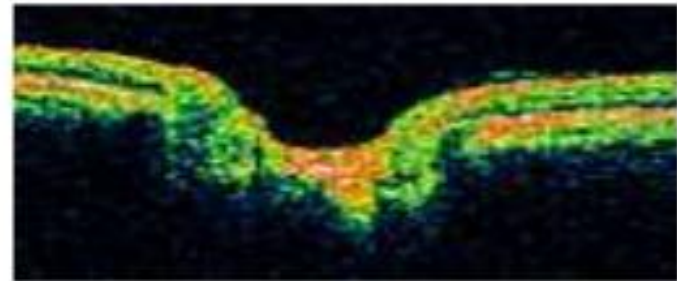
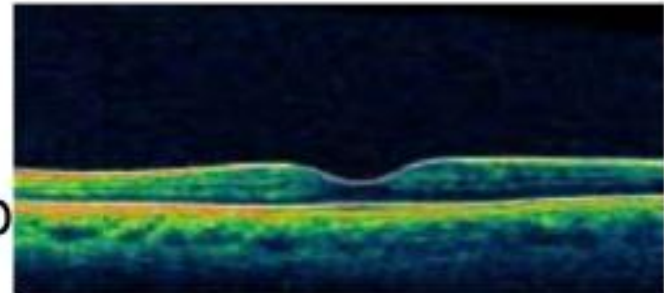
Following structures should be always documented

1. Size and shape of the optic nerve head.
2. Size and shape of the cup.
3. Neuroretinal rim thinning at the vertical cup
4. Disc hemorrhages
5. Position of blood vessel as they cross the cup margin.
6. Scleral crescent
7. Peripapillary atrophy
8. Nerve fiber layer defects
9. Tortuosity of blood vessel
10. Arteriolar narrowing

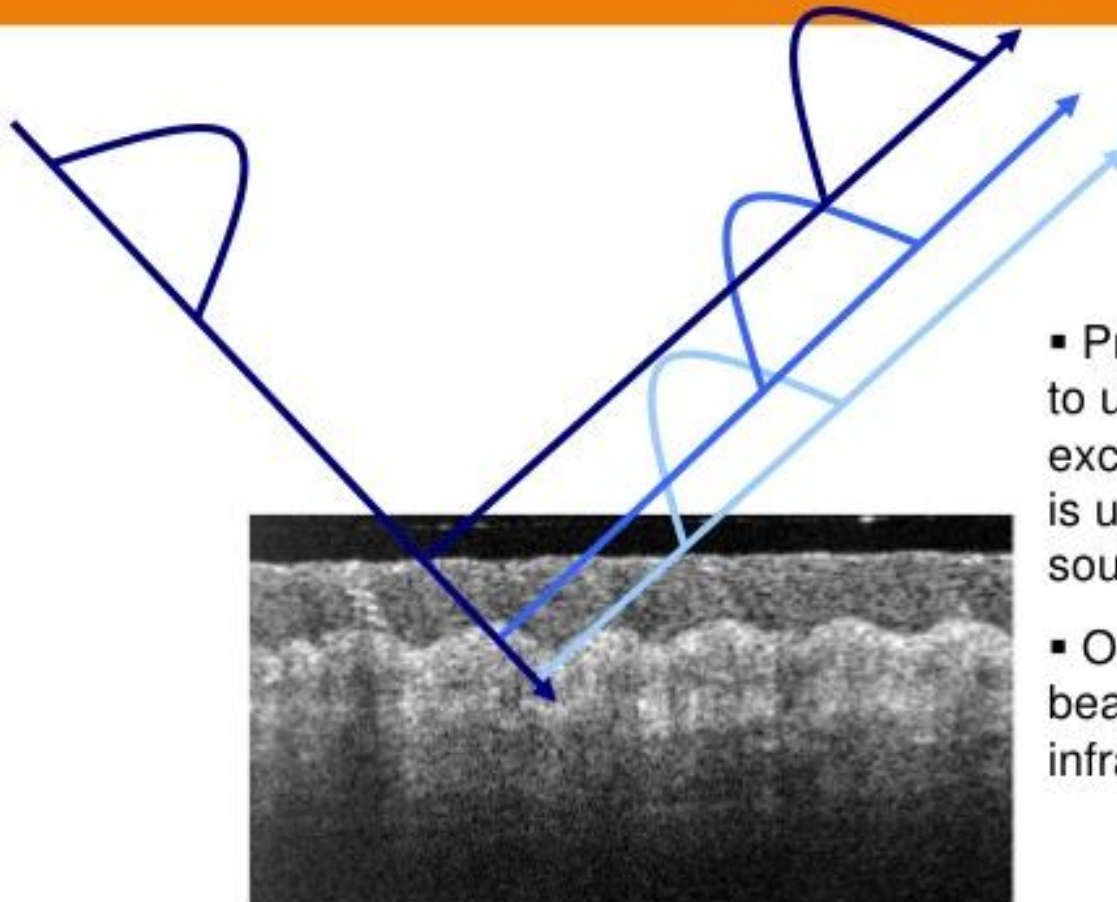
Optical coherence tomography

- Optical Coherence Tomography (OCT) is a noncontact, noninvasive imaging technique used to obtain high resolution cross-sectional images of the:
 - retina (macula)
 - ONH including RNFL and
 - anterior segment.

- **James G. Fujimoto, 1991**



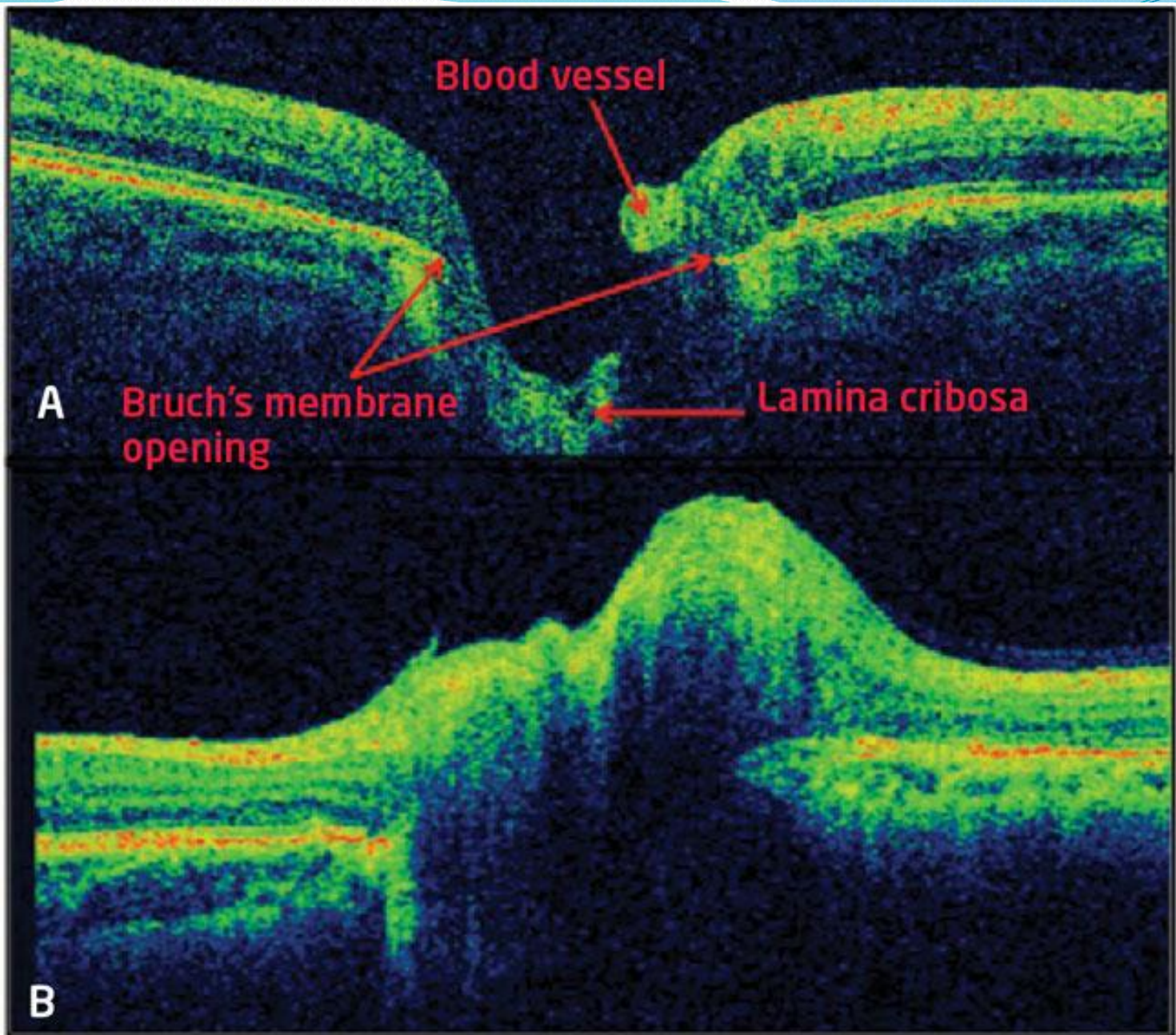
OCT analogous to B-scan



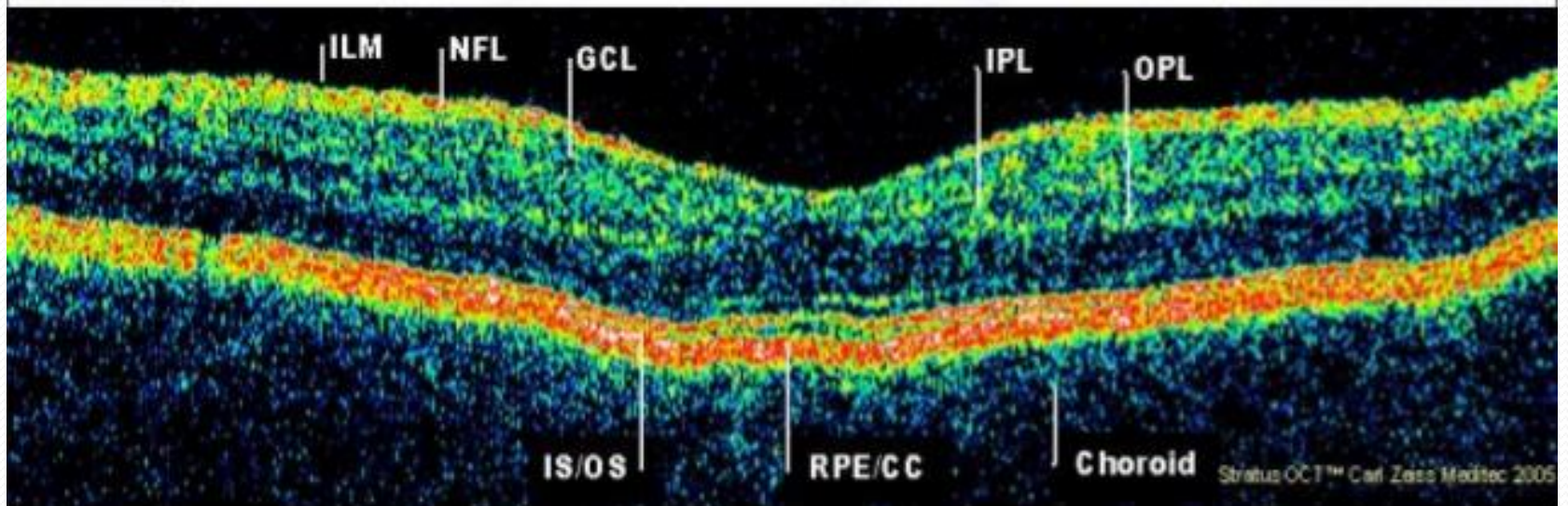
- Process similar to ultrasound except that light is used instead of sound waves.

- OCT probe beam- Near infrared (800nm)

Measures reflected light from tissue discontinuities



Optical Coherence Tomography (OCT)



Contd...

- When all of the A-scans are combined into one image, the image has axial (vertical) resolution of < 10 microns and transverse (horizontal) resolution of 20 microns.
- Compare that to the resolution of a good medical ultrasound at 100 microns, or 1/10th of a millimeter.



Represents the resolution of ultrasound

OCT image has 10 times more the pixels per inch than the image with ultrasound



Represents the resolution of OCT

EVOLUTION:

- OCT first described : HUANG (1991)
- 2002 – Time domain OCT became popular
- 2006- Spectral Domain OCT.
- Future:

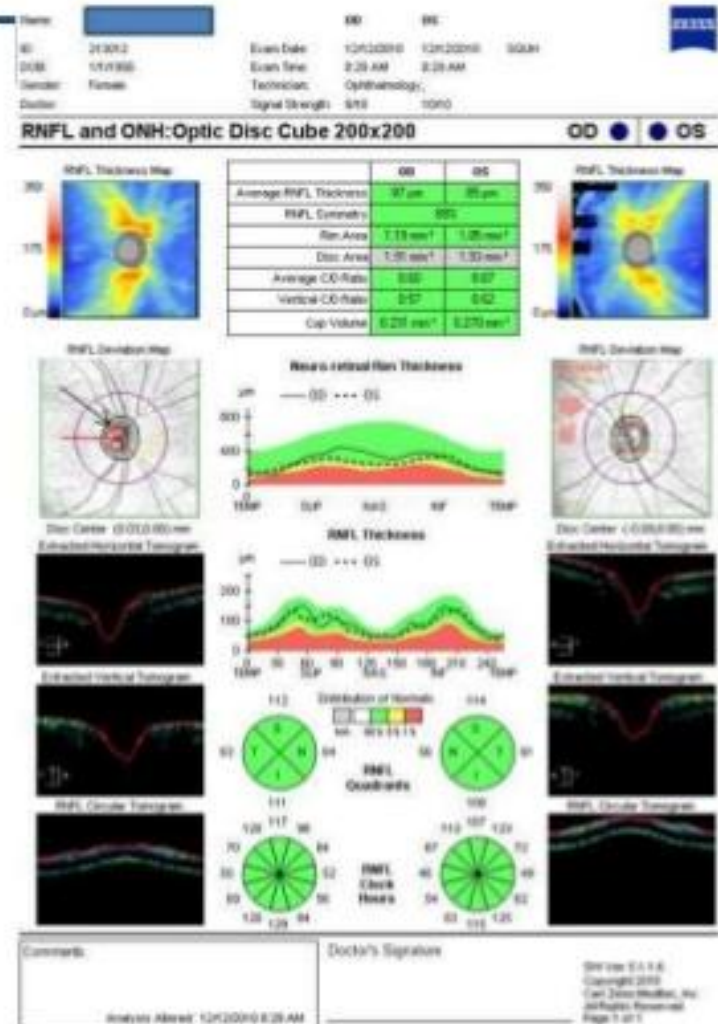
SPEED SWEEP SOURCE OCT

ULTRA HIGH RESOLUTION OCT

POLARIZATION SENSITIVE OCT

OCT PRINT OUT

- PATIENT DATA
- RETINAL NERVE FIBER LAYER ANALYSIS
- OPTIC NERVE HEAD ANALYSIS
- GANGLION CELL COMPLEX ANALYSIS.



OCT in Glaucoma

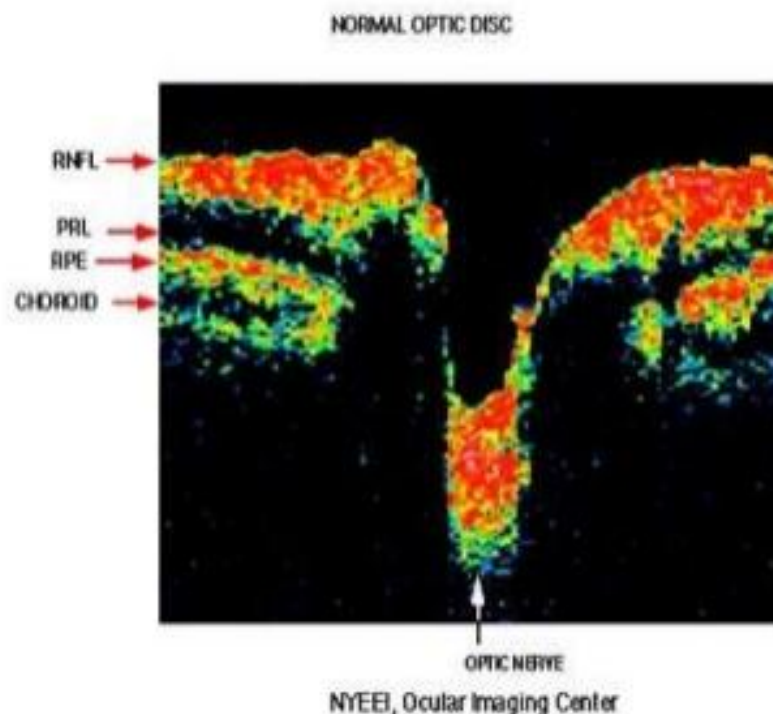
- Glaucoma-related neural losses result in characteristic structural changes to the optic nerve head (ONH) and peripapillary retinal nerve fiber layer (RNFL) such as a loss of the neuroretinal rim and diffuse or localized RNFL defects.

- The clinician's recognition of ONH topographical changes is therefore important for diagnosing glaucoma and detecting progression, particularly because structural changes often precede observable defects on perimetry.

- In Glaucoma, OCT helps in evaluation of:
 - Optic Nerve Head
 - RNFL
 - Peri-papillary Region

OCT imaging of normal ONH

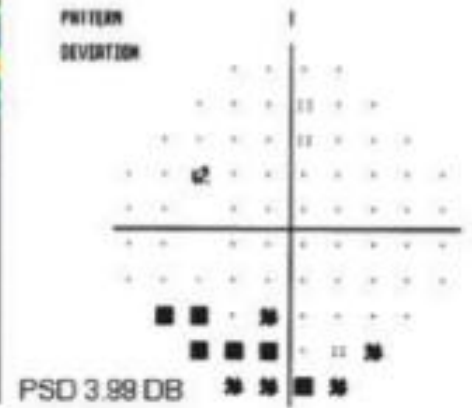
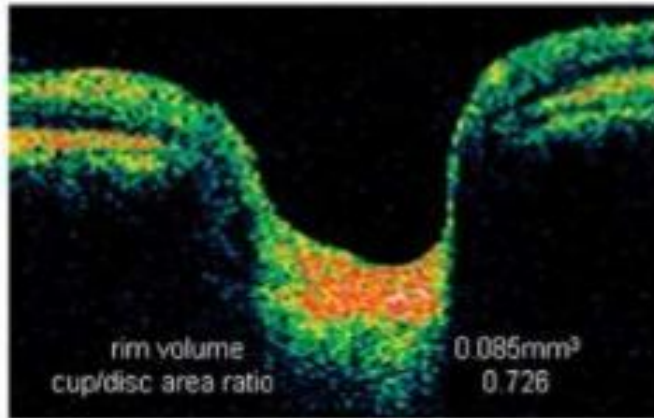
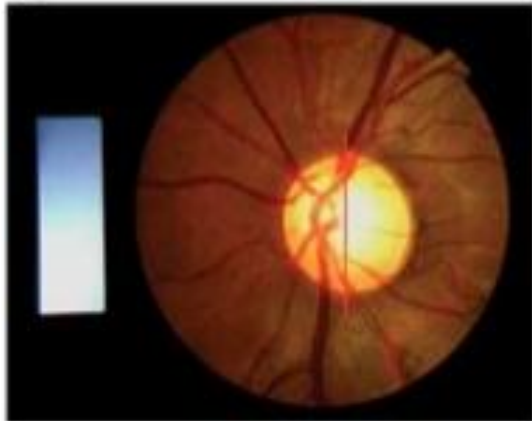
- ONH can be identified on the basis of its contour:
 - Central depression of cup and the stalk behind the anterior part of the nerve.
- Anterior dark space: Vitreous
- Contrast between non-reflective vitreous and back scattering surface of retina: Vitreo-retinal interface
- Bright back scattering (red layer) :RNFL



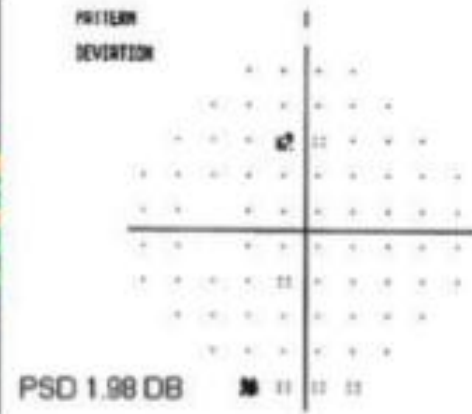
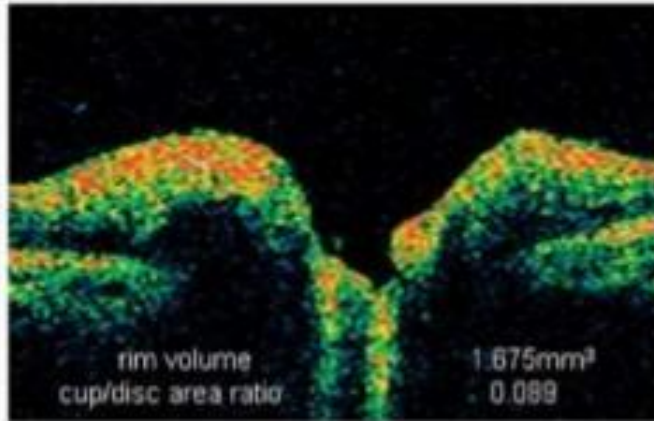
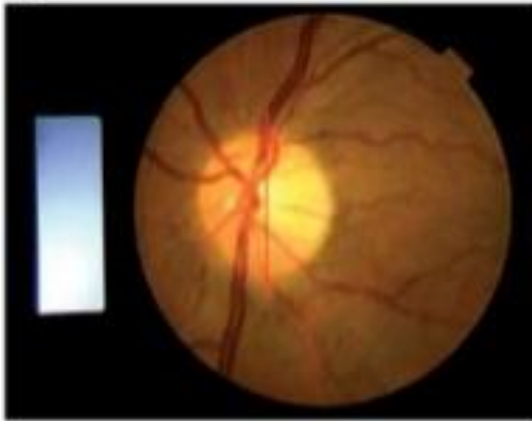
Average RNFL thickness

1. Normal	95.9 ± 11.4
2. Early glaucoma	80.3 ± 18.4
3. Advanced glaucoma	50.7 ± 13.6

a

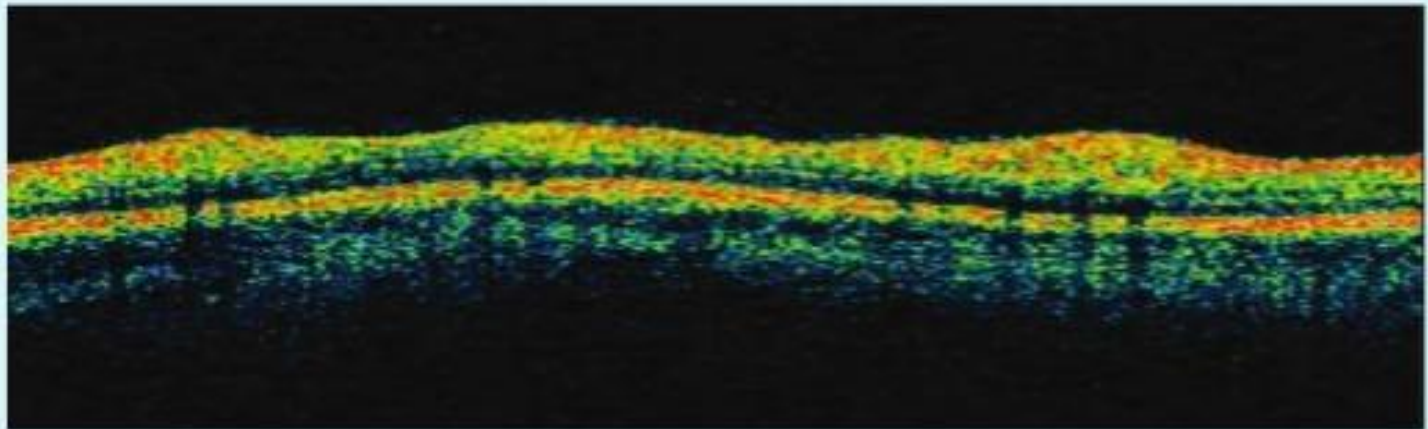
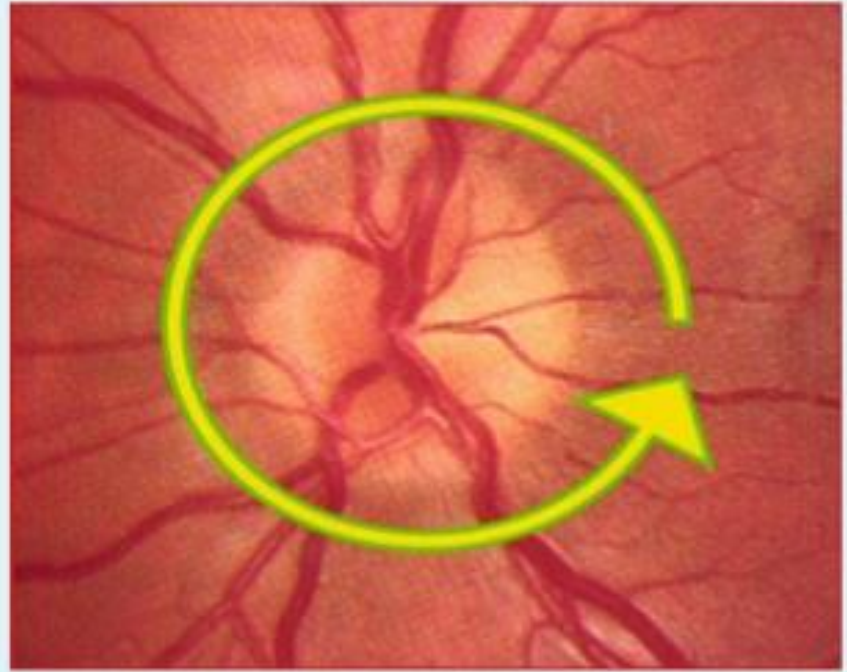


b



RNFL analysis

- Circular scanning around ONH at a radius of 1.73mm
- Three scans are acquired and data is averaged and compared with normative data base of age matched subjects
- Scan begins temporally

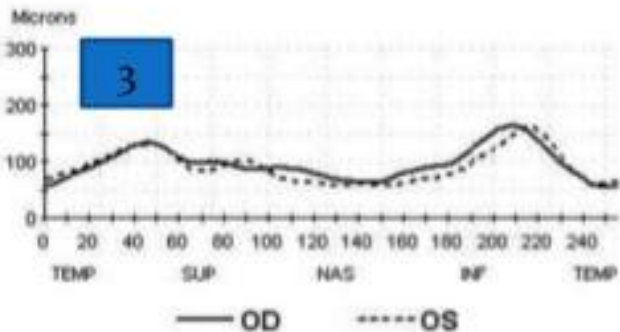
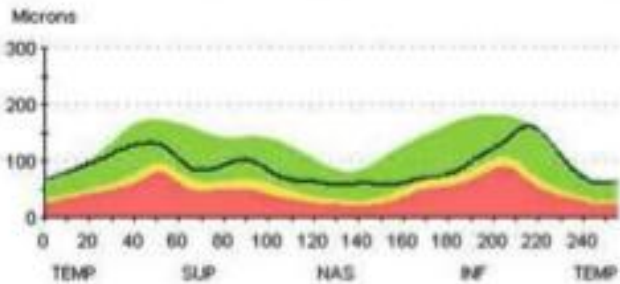
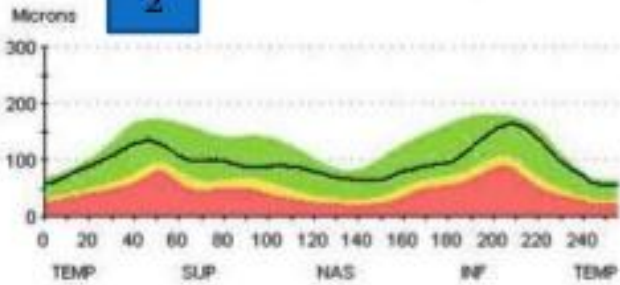


RNFL thickness average analysis printout -7 zones

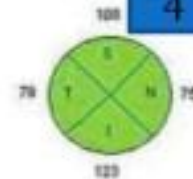
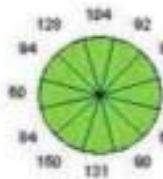
- Zone -1-Pt. I.D
- Zone -2-TSNIT with age matched normative data base
- Zone-3-TSNIT overlap of two eyes
- Zone -4-circular scan-quadrant/clockwise
- Zone-5-DATA TABLE-ratio/average
- Zone-6-RED FREE PHOTOGRAPH-position
- Zone-7-PERCENTILE COLOR CODING



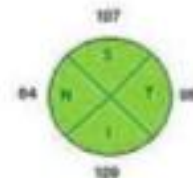
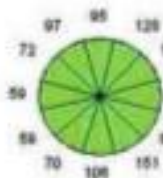
RNFL THICKNESS AVERAGE ANALYSIS



OD

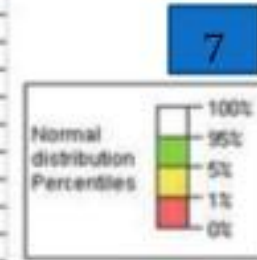
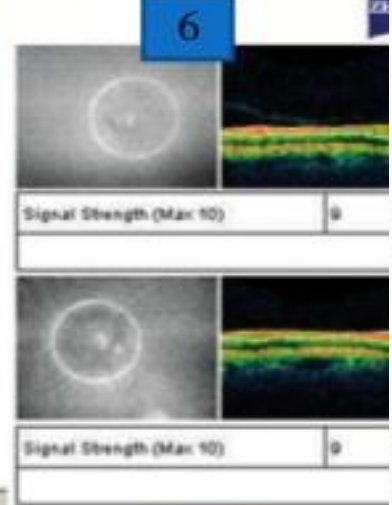


OS



5

	OD (N=3)	OS (N=3)	OD-OS
max/Grmax	1.21	1.22	0.00
Smax/Grmax	0.82	0.82	0.00
Smax/Tavg	1.89	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



6

1

1

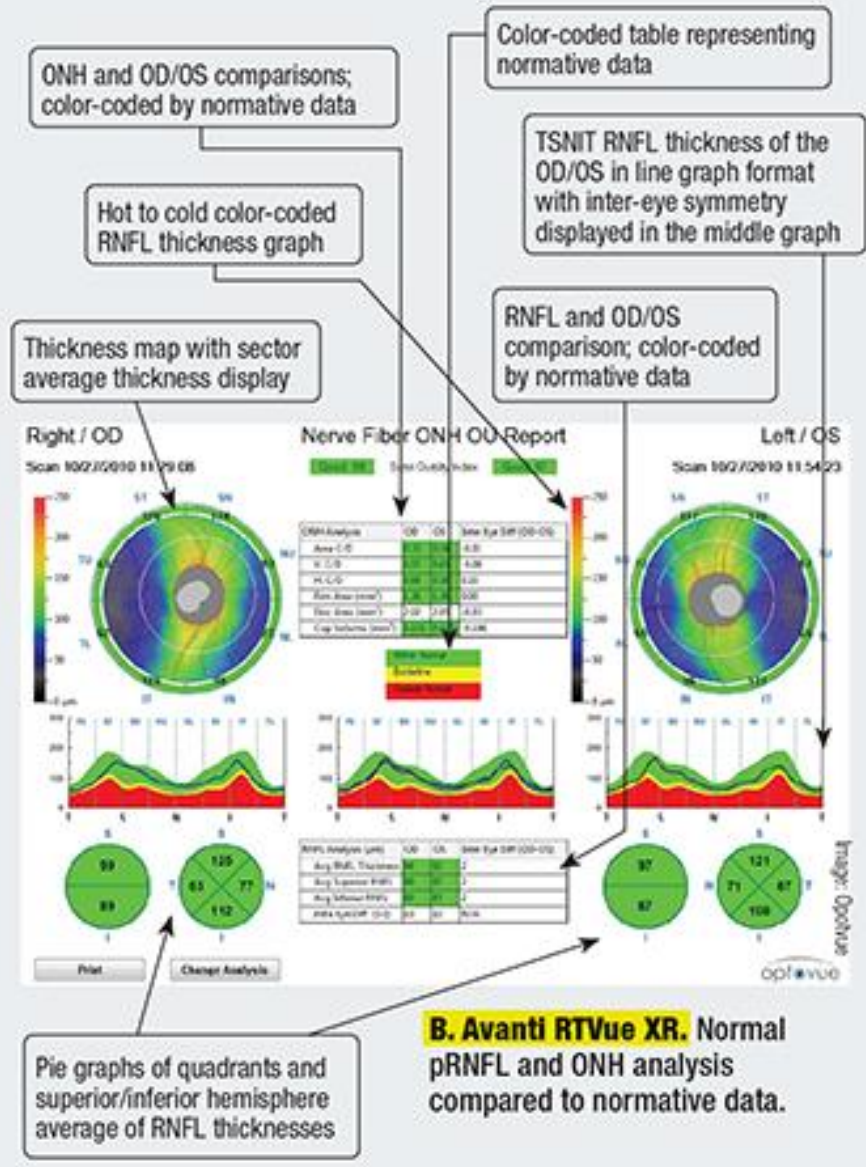
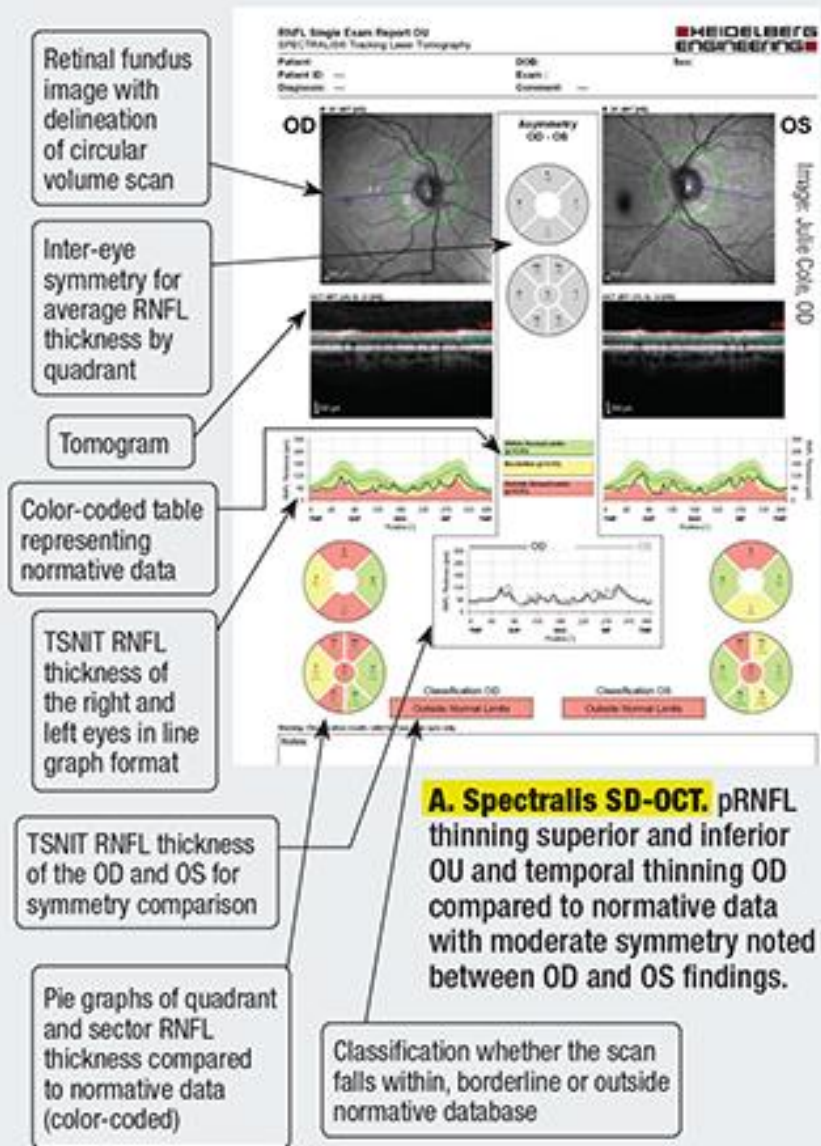
DOB: 2/18/1936, ID: NA, Female

Scan Type: Fast RNFL Thickness (3.4)

Scan Date: 5/12/2005

Scan Length: 10.87 mm

Figures A-D. RNFL Thickness Analysis By Manufacturer



Optic nerve head analysis

Optic nerve head scans are composed of six linear scans in a spoke pattern separated by 30-degree intervals centered on the ONH



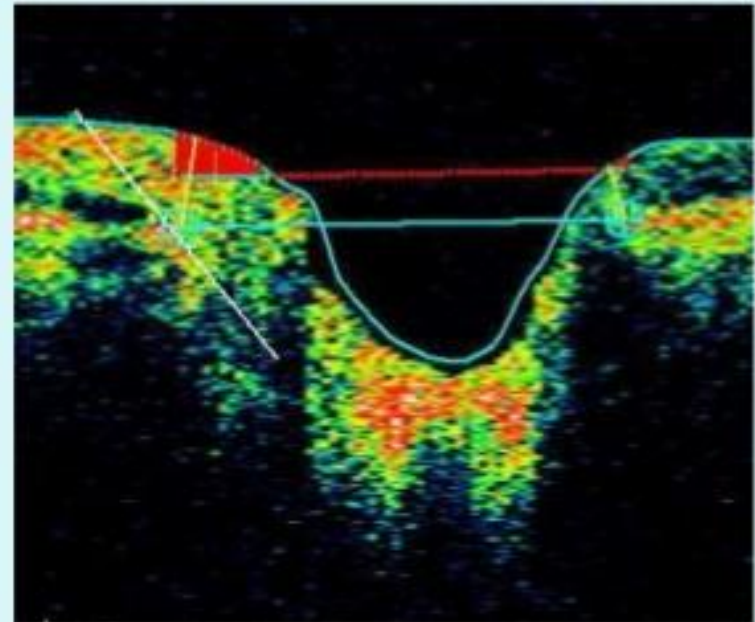
Cup/disk ratios and cup Volumes

Disc size:

- by measuring the distance between the terminal ends of the choroid at the level of the pigment epithelium (green line)

Cup:

- determined by drawing a line b/w both sides of the cup at a point 140um above the green line.
- Area below the line is cup and above is neuroretinal rim*

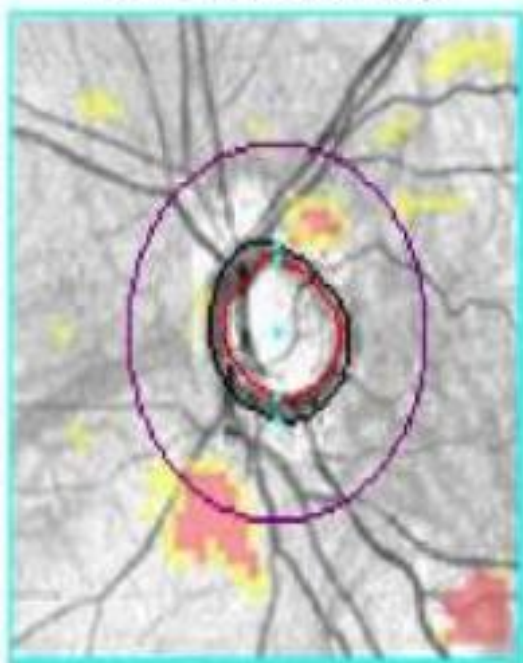


Optic Nerve Head Analysis Results

Vert. Integrated Rim Area (Vol.)	083 mm ²
Horiz. Integrated Rim Width (Area)	1.229 mm ²
Disk Area	2.467 mm ²
Cup Area	1.489 mm ²
Rim Area	978 mm ²
Cup/Disk Area Ratio	0.604
Cup/Disk Horiz. Ratio	0.529
Cup/Disk Vert. Ratio	0.752



RNFL Deviation Map



Disc Center (0.09,0.09) mm


	OD	OS
Average RNFL Thickness	77 μm	80 μm
RNFL Symmetry	58%	
Rim Area	0.88 mm^2	0.77 mm^2
Disc Area	1.97 mm^2	2.01 mm^2
Average C/D Ratio	0.75	0.80
Vertical C/D Ratio	0.80	0.78
Cup Volume	0.472 mm^3	0.616 mm^3

Figure 2: Optic Nerve Head Analysis

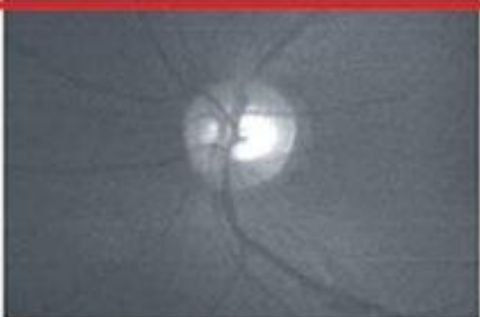
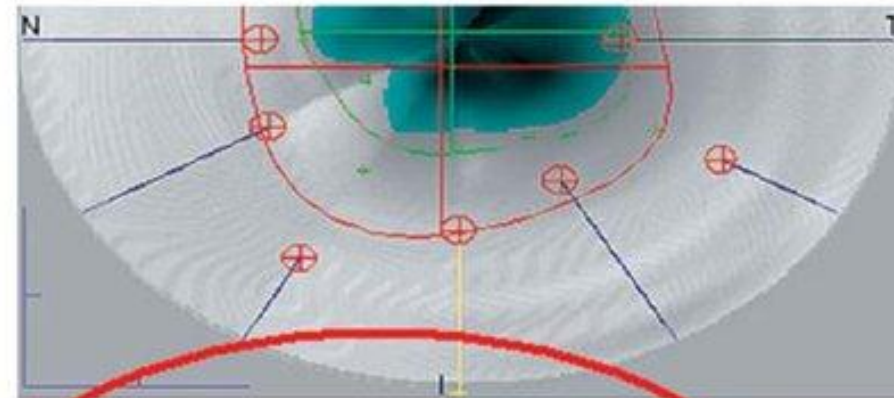
Individual Radial Scan Analysis

ReAnalyze Adj

Rim Area (Vert. Cross Section):	.107 mm ²	Surface Sensitivity:
Avg Nerve Width @ Disk	.33 mm	<input type="text"/> <input type="text"/>
Disk Diameter:	2.16 mm	
Cup Diameter:	1.31 mm	
Rim Length (Horiz.):	.84 mm	

Use This Scan Data

Name
BirthDate
ScanType
ScanDate
ScanLeng

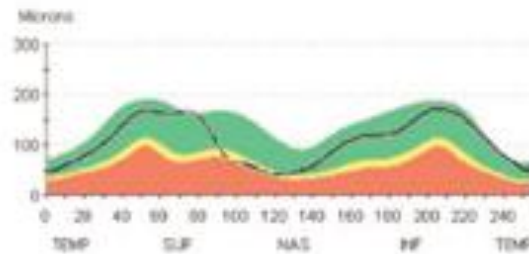
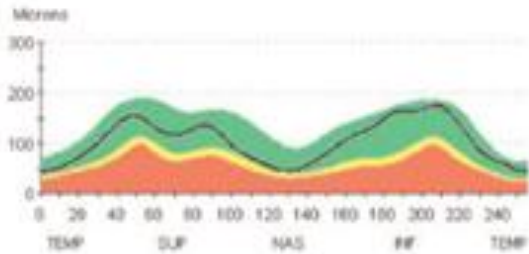
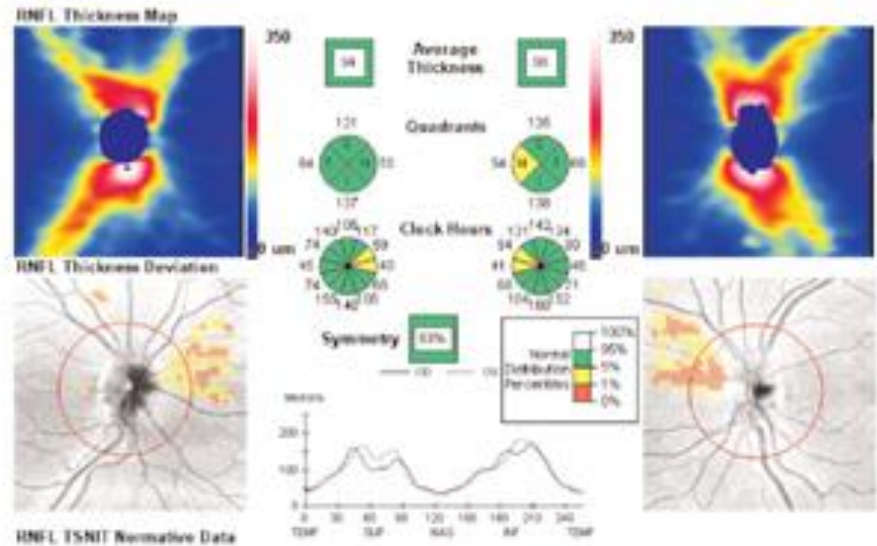
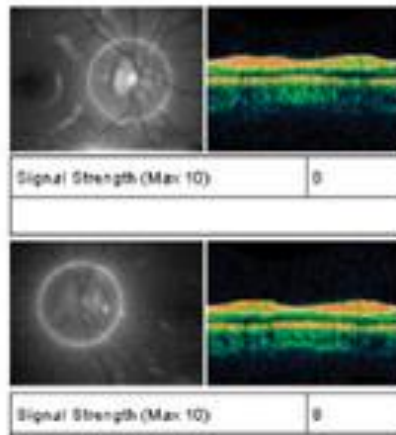
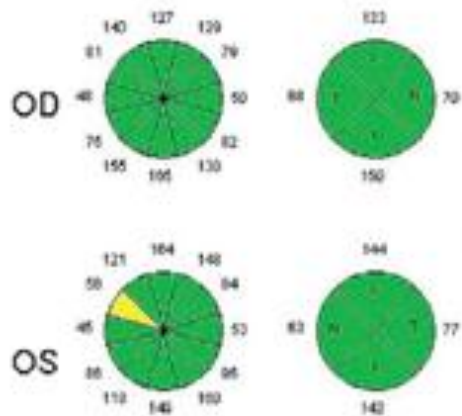



Optic Nerve Head Analysis Results

Vert. Integrated Rim Area (Vol.)	.217 mm ²
Horiz. Integrated Rim Width (Area)	1.767 mm ²
Disk Area	3.332 mm ²
Cup Area	1.637 mm ²
Rim Area	1.695 mm ²
Cup/Disk Area Ratio	0.491
Cup/Disk Horiz. Ratio	0.779
Cup/Disk Vert. Ratio	0.634

Z In Z Out Clear Points

Case 1: The Normal Patient



	OD (n=3)	OS (n=3)	OD-OS
max/min	113	100	0.11
StdevMax	0.09	0.90	-0.09
StdevAvg	2.26	2.16	0.10
max/avg	2.56	2.21	0.34
Stdev/avg	2.19	2.00	-0.49
Max-Min	120.00	132.00	-4.00
Stdev	184.00	160.00	-14.00
max	174.00	171.00	3.00
Stdev	130.00	144.00	-11.00
avg	150.00	142.00	8.00
Avg Thickness	105.20	105.58	-1.48

Case 2 (early glaucoma)

- 59 year old male with suspicious optic nerve
- Normal perimetry
- Normal IOP
- No positive family history
- Thinning of NRR clinically
- Nasal step in SWAP
- RNFL thinning in OCT



FIXATION MONITOR: BLIND SPOT

FIXATION TARGET: CENTRAL

FIXATION LOSSES: 3/10

FALSE POS ERRORS: 0 %

FALSE NEG ERRORS: 0 %

TEST DURATION: 03:43

FOVER: 26 DB

STIMULUS: V. BLUE

BACKGROUND: YELLOW

STRATEGY: SITA-SWAP

PUPIL DIAMETER:

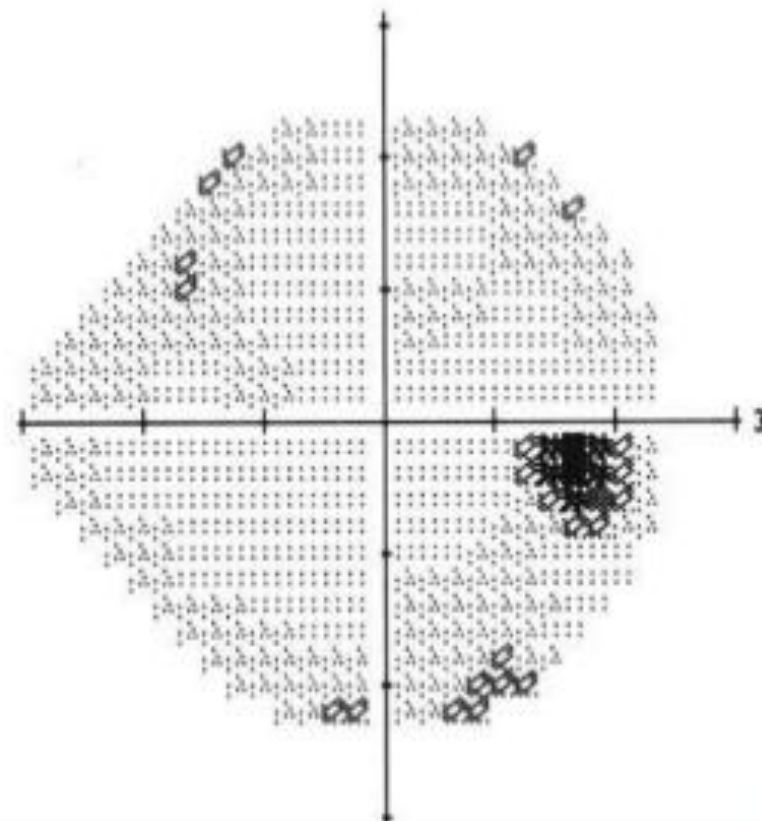
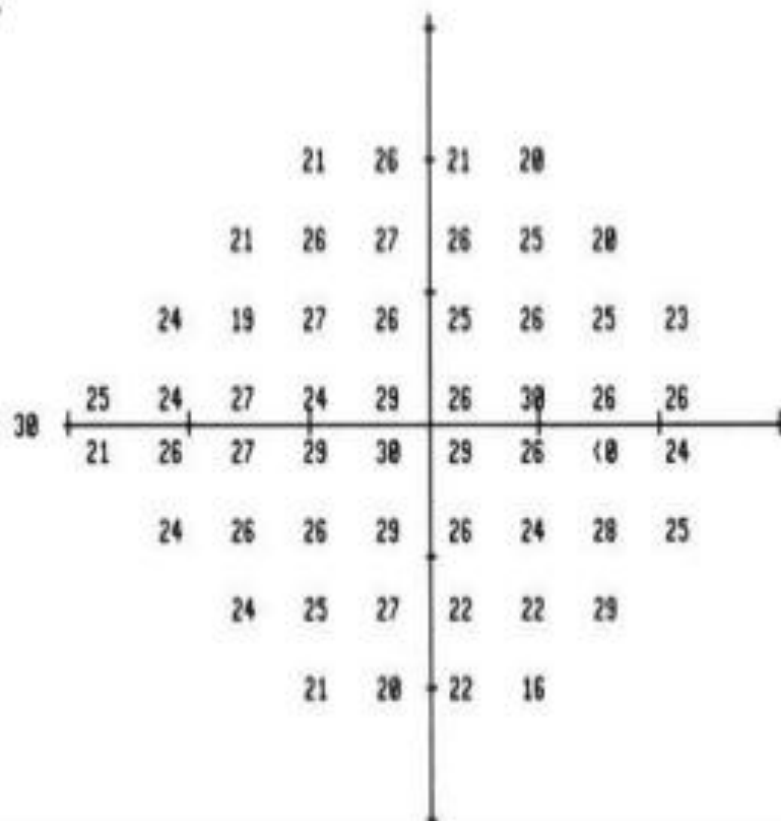
VISUAL ACUITY: 20/20

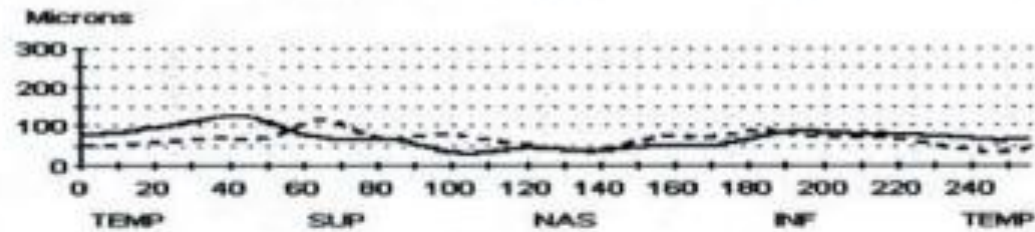
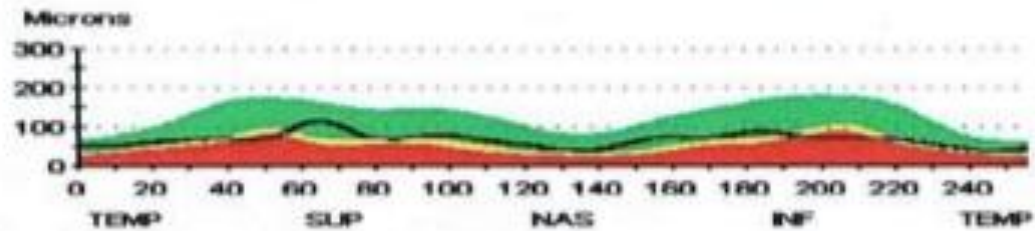
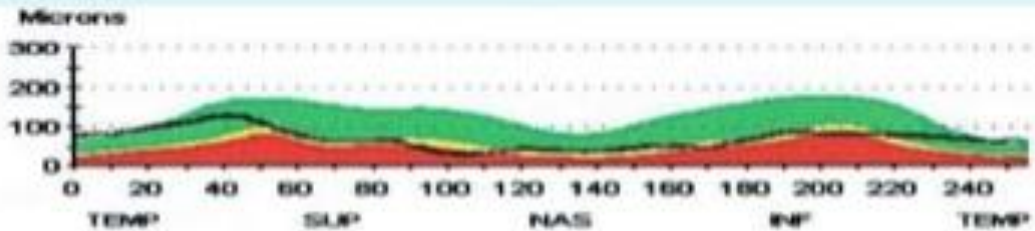
RX: +2.00 DS +1.50 DC X 15

DATE: 09-18-2006

TIME: 7:54 AM

AGE: 59





— OD - - - - OS

OD	Scans used	1, 2, 3
OS	Scans used	1, 2, 3



OD



Signal Strength (Max 10)	6
--------------------------	---



OS

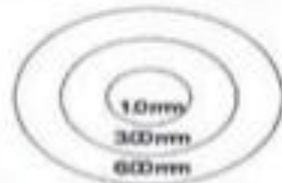
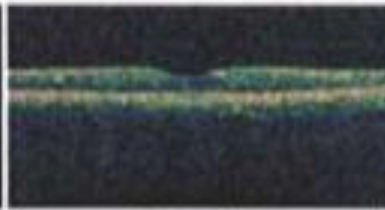
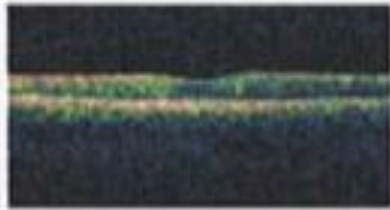


Signal Strength (Max 10)	7
--------------------------	---

	OD (N=3)	OS (N=3)	OD-OS
lmax/Smax	0.68	0.77	-0.09
Smax/lmax	1.47	1.30	0.17
Smax/Tavg	1.58	2.32	-0.74
lmax/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
lmax	87.00	88.00	-1.00
Savg	84.00	82.00	2.00
lavg	73.00	74.00	-1.00
Avg.Thick	69.41	65.44	3.97

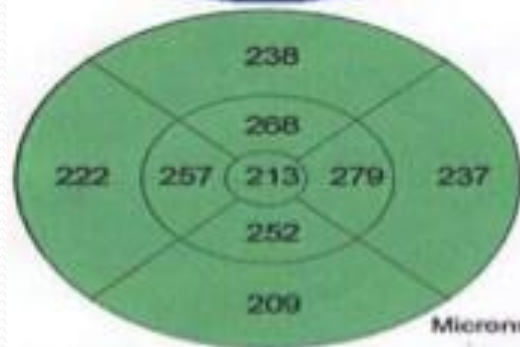
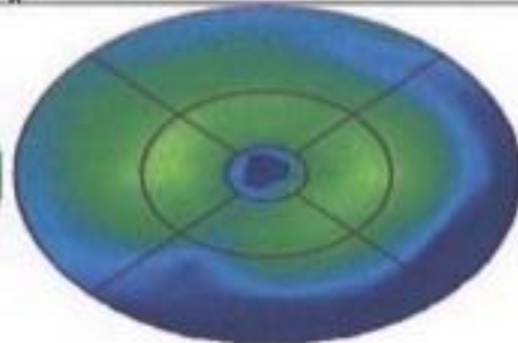
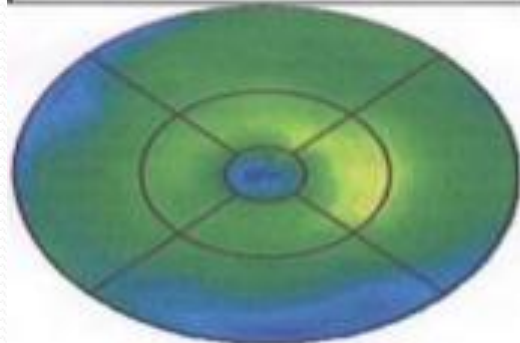
OD

OS



Map Diameters

Signal Strength (Max 10)	8	Signal Strength (Max 10)	8
--------------------------	---	--------------------------	---



	Parameter	OD	OS	Diff (OD-OS)
Thickness	Foveal minimum	188	151	38
	Fovea	213	195	18
	Temporal inner macula	257	259	-2
	Superior inner macula	268	248	20
	Nasal inner macula	279	254	25
	Inferior inner macula	252	232	20
	Temporal outer macula	222	198	24
	Superior outer macula	238	213	25
	Nasal outer macula	237	221	16
	Inferior outer macula	209	184	25
	Superior/Inferior outer	1.139	1.158	-0.019
	Temporal/Nasal inner	0.921	1.020	-0.099
	Temporal/Nasal outer	0.037	0.006	0.041
Volume (cubic mm)	Fovea	0.167	0.153	0.014
	Temporal inner macula	0.404	0.407	-0.003
	Superior inner macula	0.422	0.29	0.032
	Nasal inner macula	0.438	0.399	0.039
	Inferior inner macula	0.397	0.384	0.033
	Temporal outer macula	1.179	1.049	0.130
	Superior outer macula	1.363	1.131	0.131
	Nasal outer macula	1.255	1.171	0.085
	Inferior outer macula	1.109	0.979	0.131
	Total macula volume	6.038	6.040	0.591

OD	Scans used	1, 2, 3, 4, 5, 6	OS	Scans used	1, 2, 3, 4, 5, 6
----	------------	------------------	----	------------	------------------





A



B

Case 3-(Unilateral Open Angle Glaucoma)

- 54 year old female
- Unilateral exfoliative glaucoma
- IOP- 33 mmHg
- Thinning of NRR in sup, inf and temporal
- Inferior arcuate defect in perimetry
- RNFL thinning in sup and inf pole in OCT

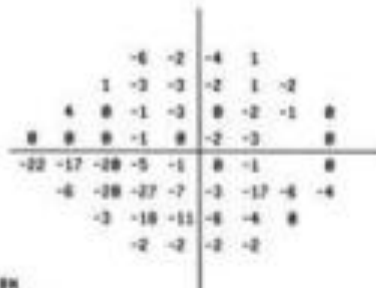
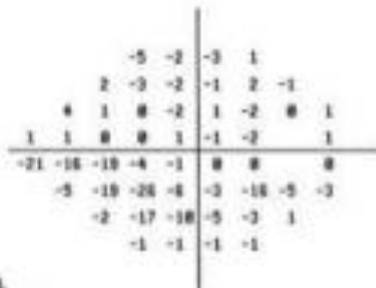
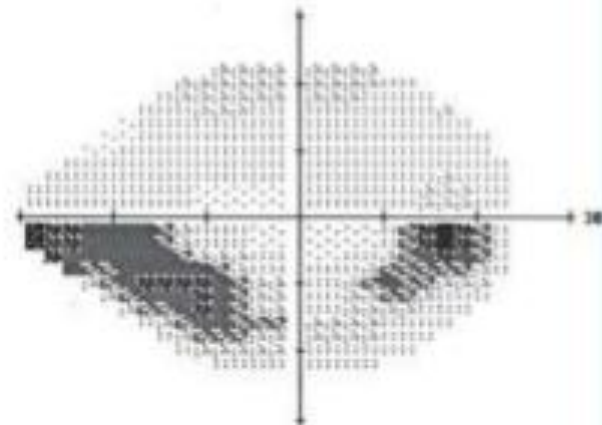
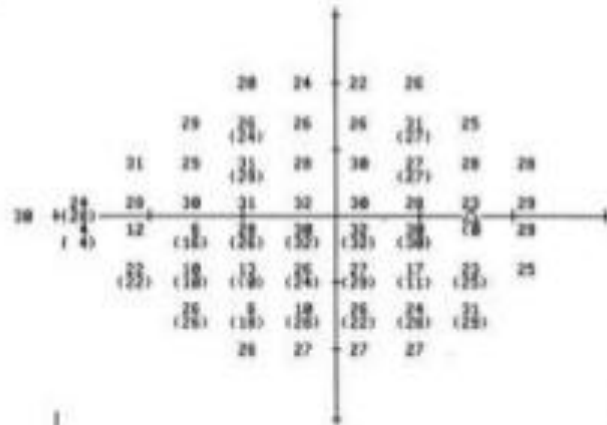
FIXATION MONITOR: GAZE/BLINDSPOT
 FIXATION TARGET: CENTRAL
 FIXATION LOSSES: 1/25
 FALSE POS ERRORS: 0/17
 FALSE NEG ERRORS: 0/16
 TEST DURATION: 14:20

POWER: 34.00

STIMULUS: III, WHITE
 BACKGROUND: 31.5 NIB
 STRATEGY: FULL THRESHOLD

PUPIL DIAMETER: 5.0 MM
 VISUAL ACUITY: 20/15
 RX: +2.50 DS DC X

DATE: 05-28-2002
 TIME: 7:53 AM
 AGE: 64

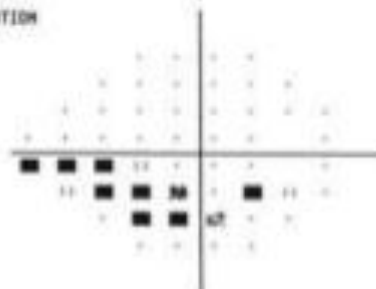
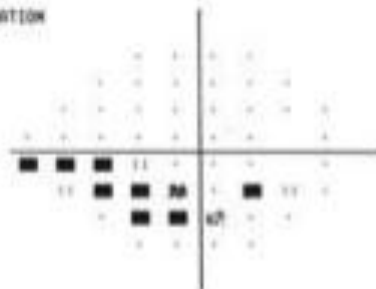


GWT
 OUTSIDE NORMAL LIMITS

MD -4.25 DS P < .25
 PSD 7.00 DS P < 0.50
 SF 1.00 DS
 CPSD 7.42 DS P < 0.50

TOTAL DEVIATION

PATTERN DEVIATION



11 < 50
 12 < 25
 13 < 15
 14 < 10

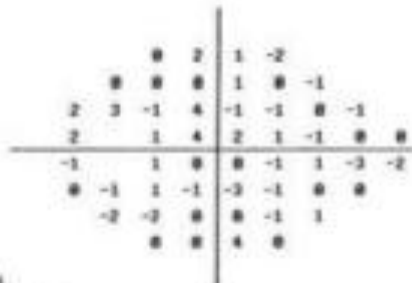
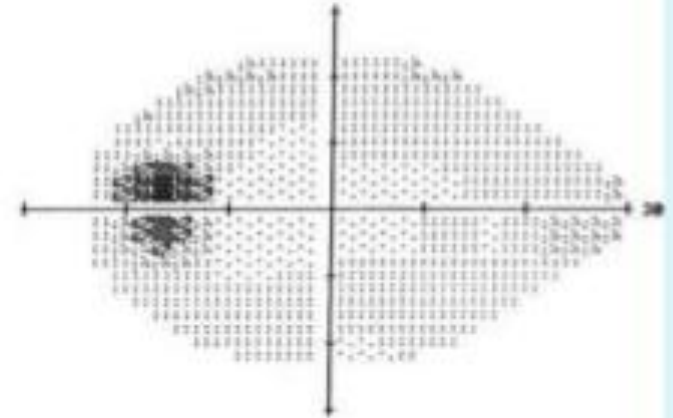
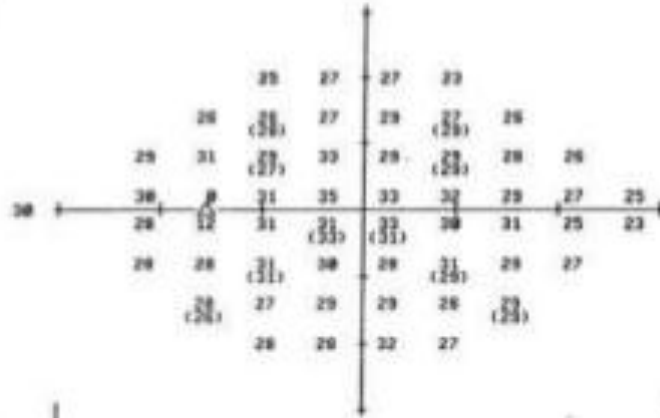
FIXATION MONITOR: BLINDSPOT
 FIXATION TARGET: CENTRAL
 FIXATION LOSSES: 2/18
 FALSE POS ERRORS: 0/18
 FALSE NEG ERRORS: 0/9
 TEST DURATION: 00:00

STIMULUS: III, WHITE
 BACKGROUND: 21.5 OSB
 STRATEGY: FULL THRESHOLD

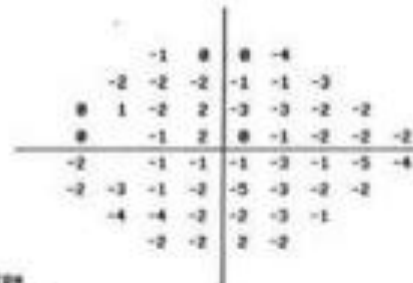
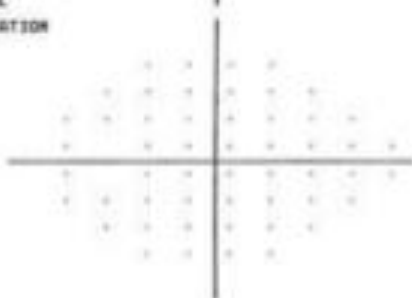
PUPIL DIAMETER: 6.0 MM
 VISUAL ACUITY: 20/20
 ENI +2.25 DS DC X

DATE: 11-19-2002
 TIME: 0:00 AM
 AGE: 64

FOVER: 27 DB



TOTAL DEVIATION



PATTERN DEVIATION



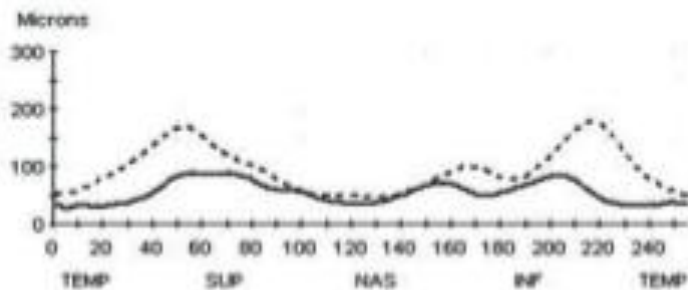
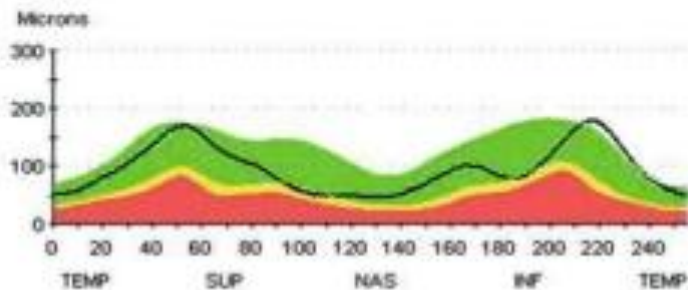
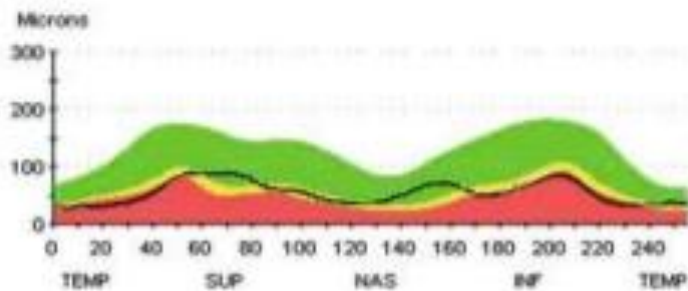
GHT
 WITHIN NORMAL LIMITS

MD +0.00 DB
 PSD 1.75 DB
 SP 1.15 DB
 CPD 1.28 DB

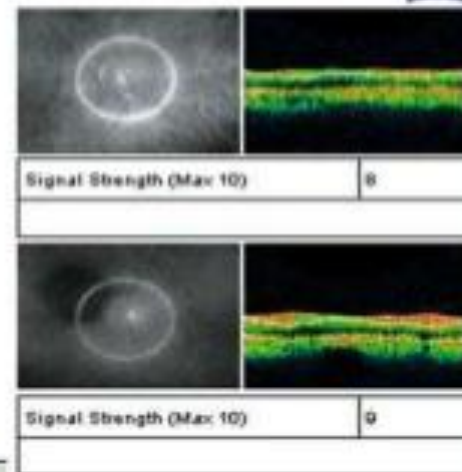
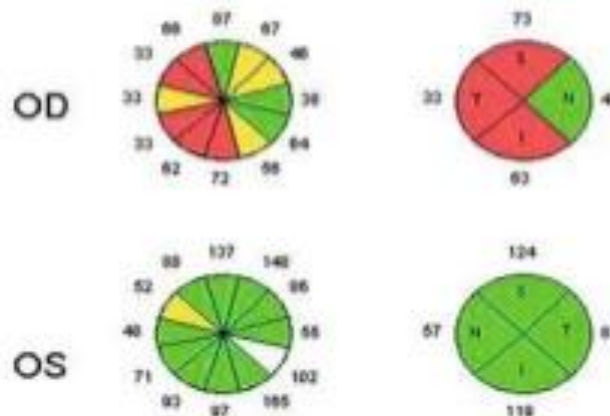
I: 4 DB
 N: 4 DB
 M: 1 DB
 S: 0.25



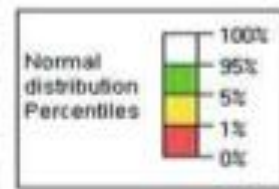
RNFL THICKNESS AVERAGE ANALYSIS



— OD - - - - OS

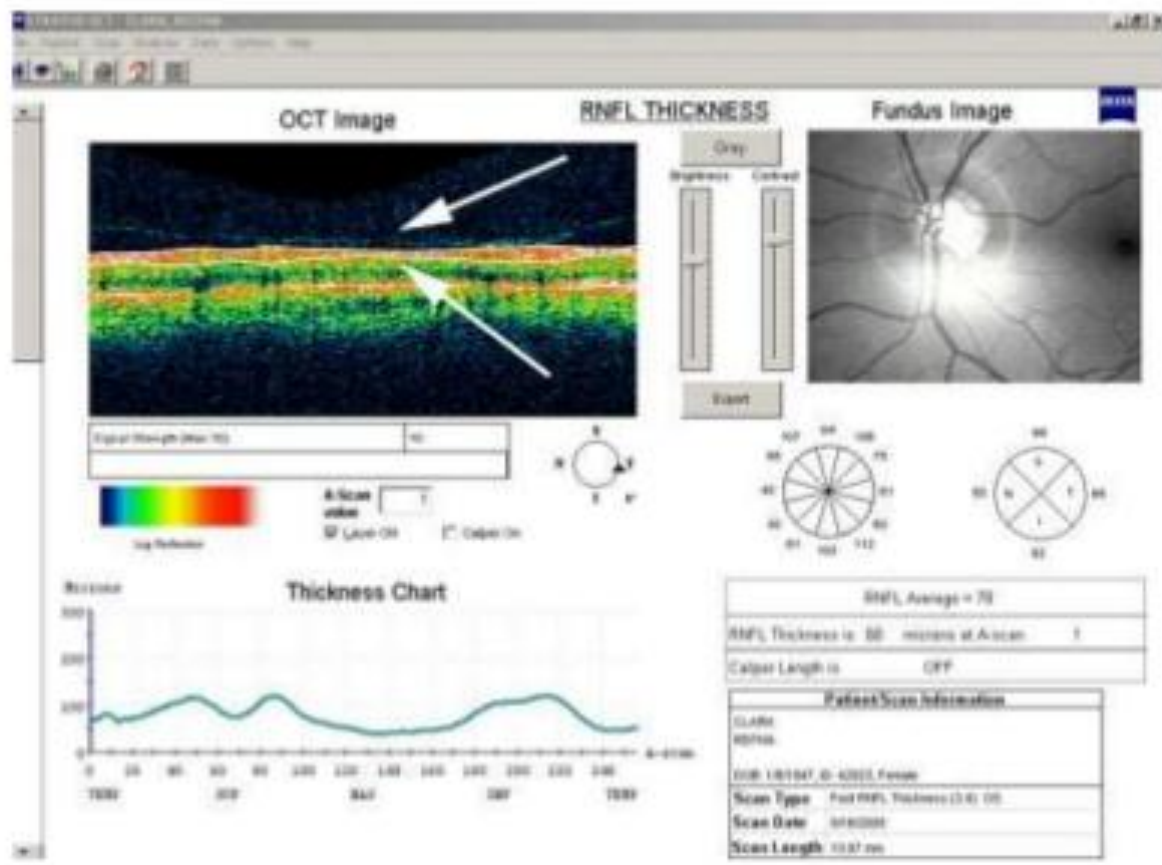


	OD (N=3)	OS (N=3)	OD-OS
lmax/Smax	0.95	1.05	-0.10
Smax/Amx	1.05	0.95	0.10
Smax/Tavg	2.70	2.10	0.60
lmax/Tavg	2.58	2.20	0.38
Smax/Navg	1.81	2.96	-1.16
Max-Min	60.00	131.00	-71.00
Smax	89.00	169.00	-80.00
lmax	84.00	178.00	-94.00
Savg	73.00	124.00	-51.00
lavg	63.00	119.00	-56.00
Avg.Thickness	54.71	95.20	-40.49



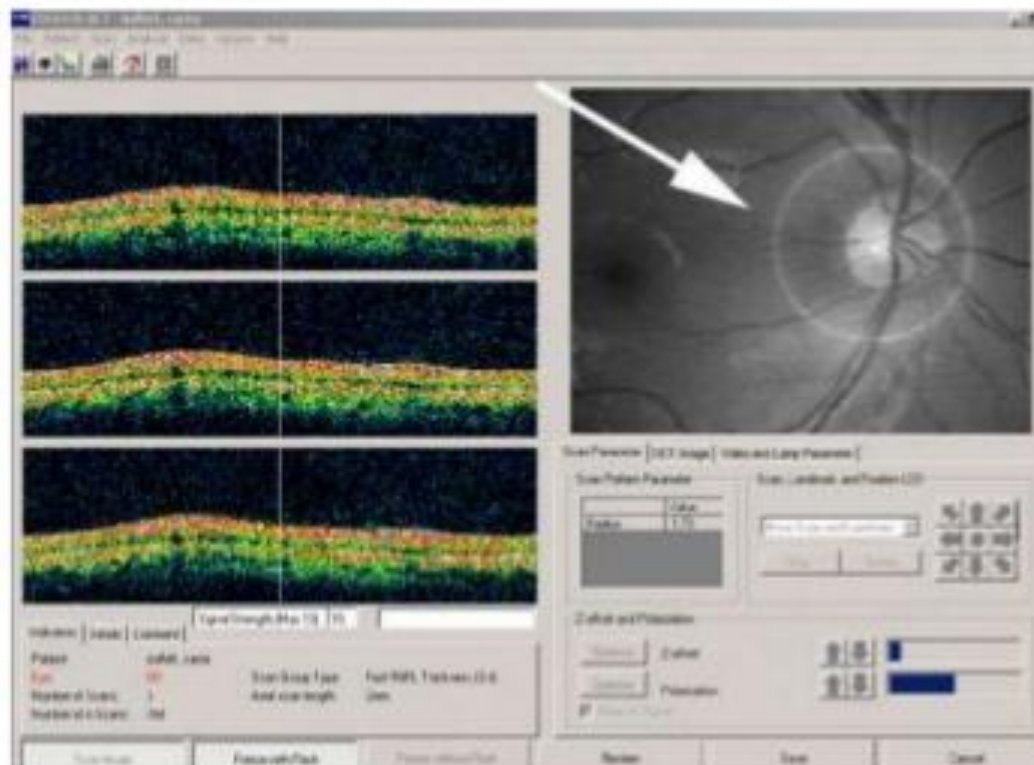
Patient/Scan Information	
DOB	6/26/1942, ID: HT03, Female
Scan Type	Fast RNFL Thickness (3.4)
Scan Date	2/25/2005
Scan Length	10.87 mm

The analysis software places lines on the top and bottom of the nerve fiber layer and the distance between the two lines is interpreted to be the thickness of the nerve fiber layer

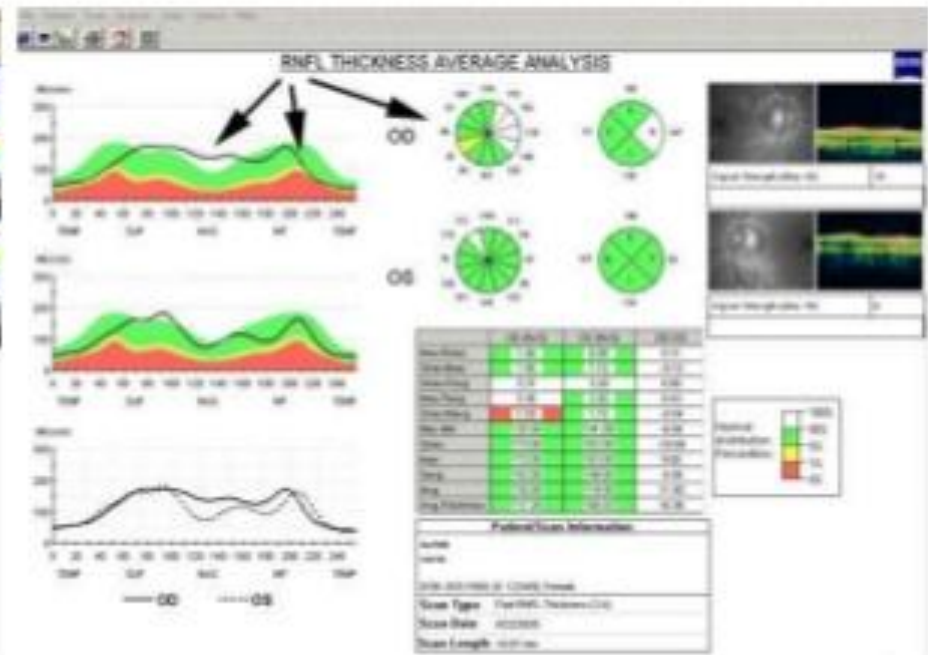
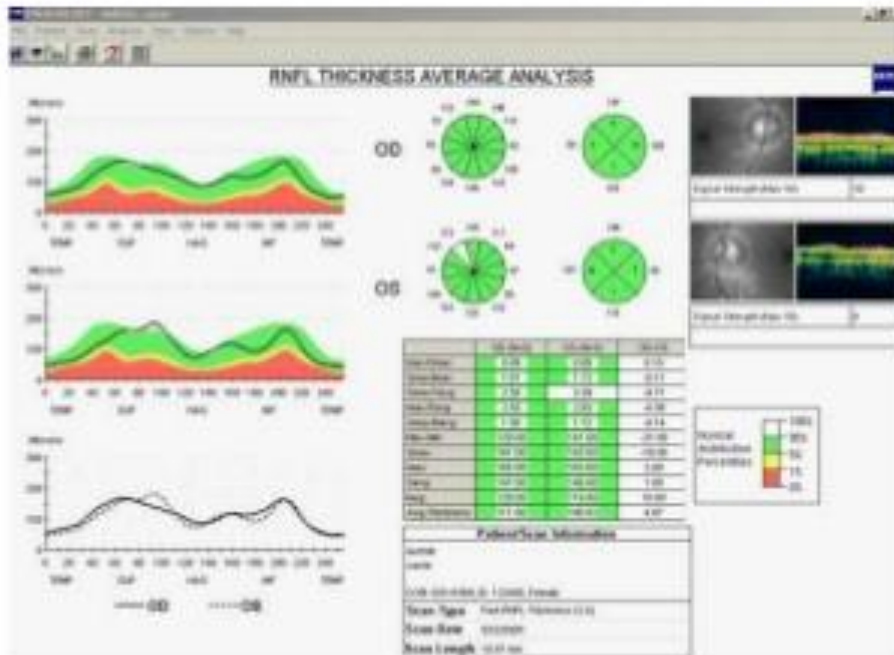


Care must be taken to make sure that the image is captured with the circle centered on the optic nerve

The placement of the circle can make a big difference in the analysis of the nerve fiber layer thickness



These two scans (OD) are of a normal eye. The scan in the first analysis is well centered and the RNFL thickness falls within the normal range. The scan in the second analysis is of the same eye (OD), but the scan is not well centered. The analysis is abnormal (black arrows).





THANK YOU