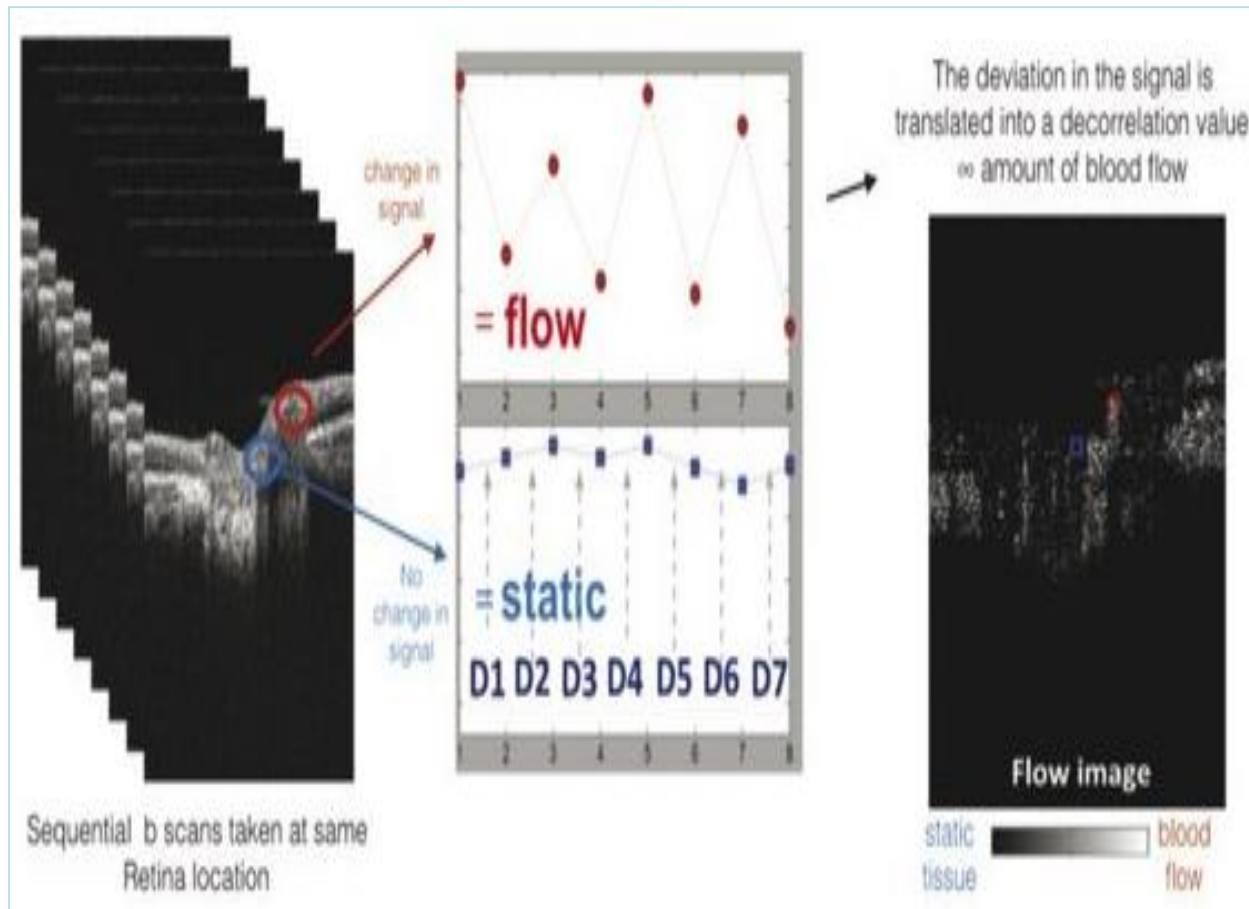
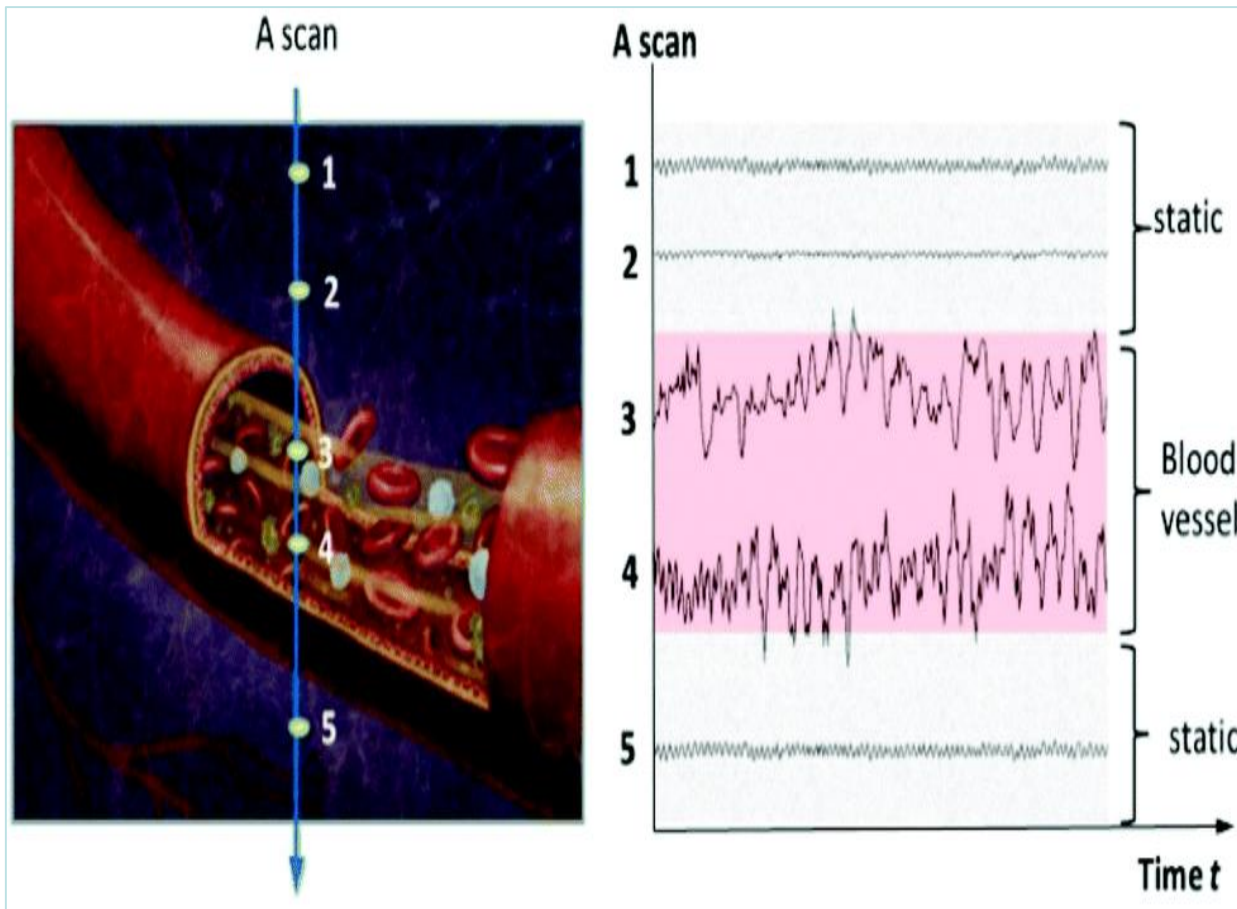

Angiography in HOCT

Jan. 2020
Ophthalmology Group
HUVITZ

Contents

- Background Knowledge
- Measurement & Analysis
- Field Test
- Evaluation



- If a big brother is watching 1,2,3,4,5 points for a while
- The variance of a vessel is much bigger than others
- That's why a Hemoglobin reflect a light much
- After there is no hemoglobin at the previous scan, then if there is a hemoglobin at this scan

- HOCT scans multiple A-scan at the same location
- Then it calculates the difference among them,
- Flow like a vessel make the big differences
- Static like a tissue, a network plexiform make little differences

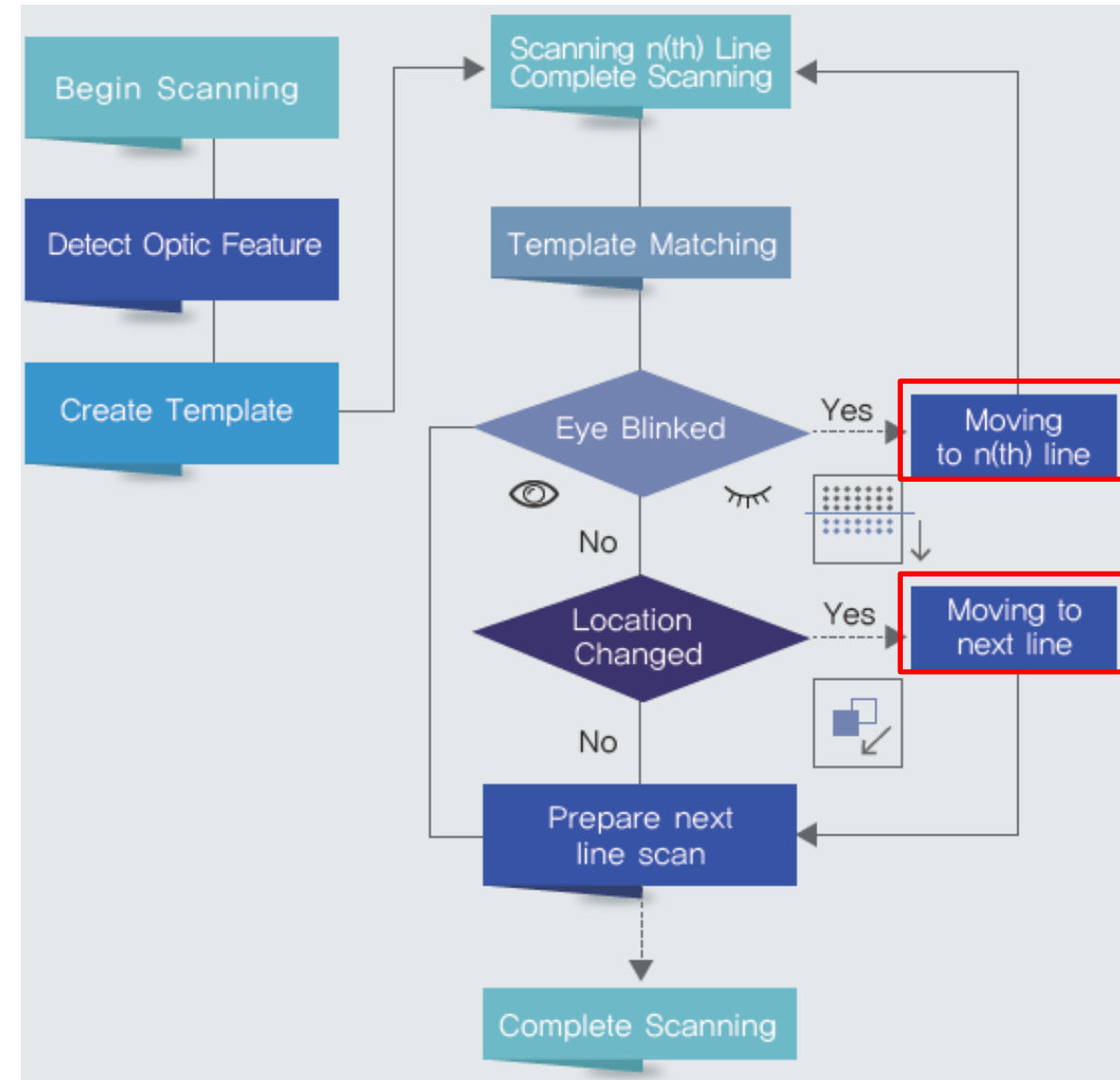
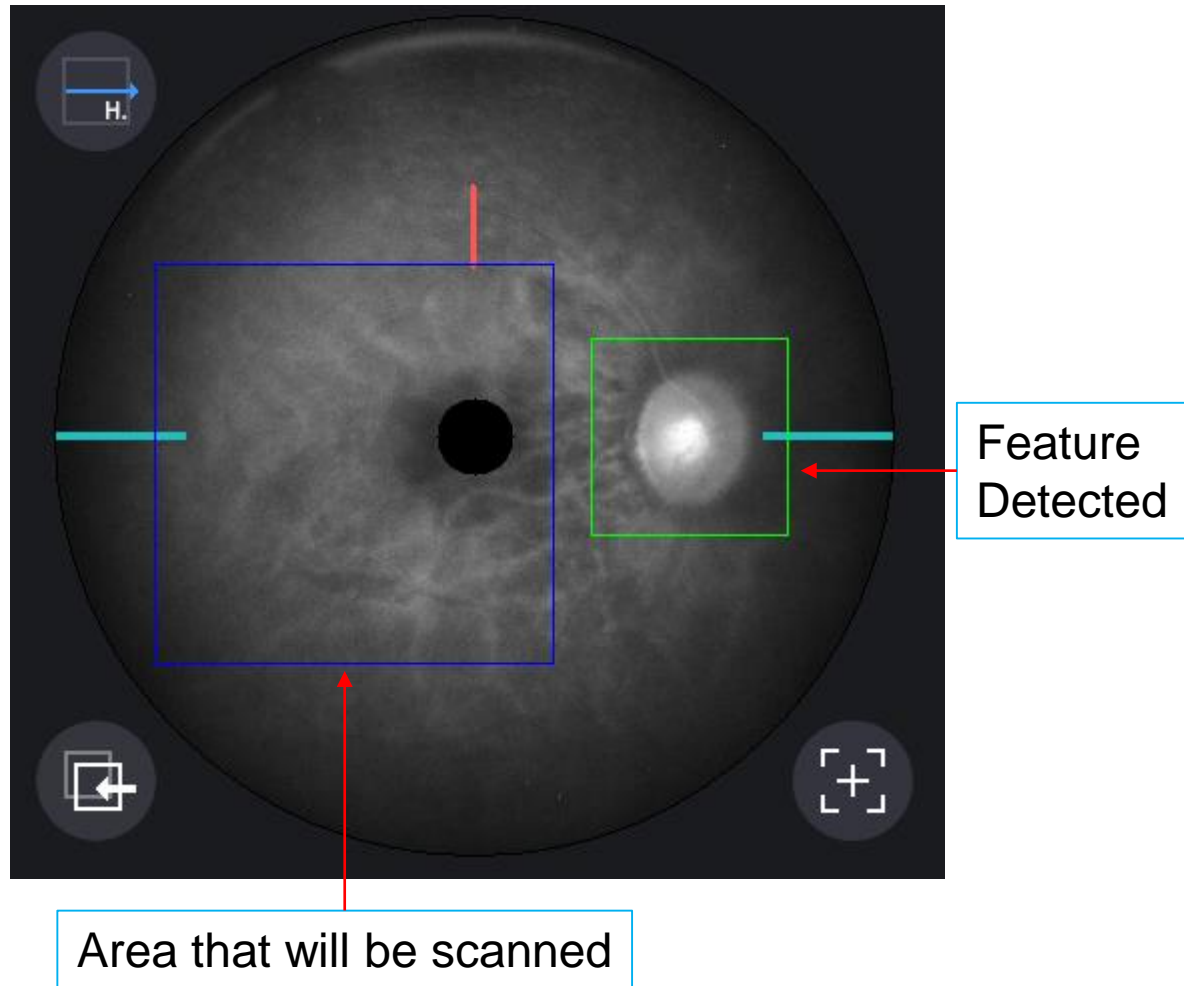
- .- Voluntary movement
- .- Involuntary movement

- .- Spontaneous blink
- .- Reflex blink
- .- Voluntary blink

- .- spatial vibration
- .- temporal vibration

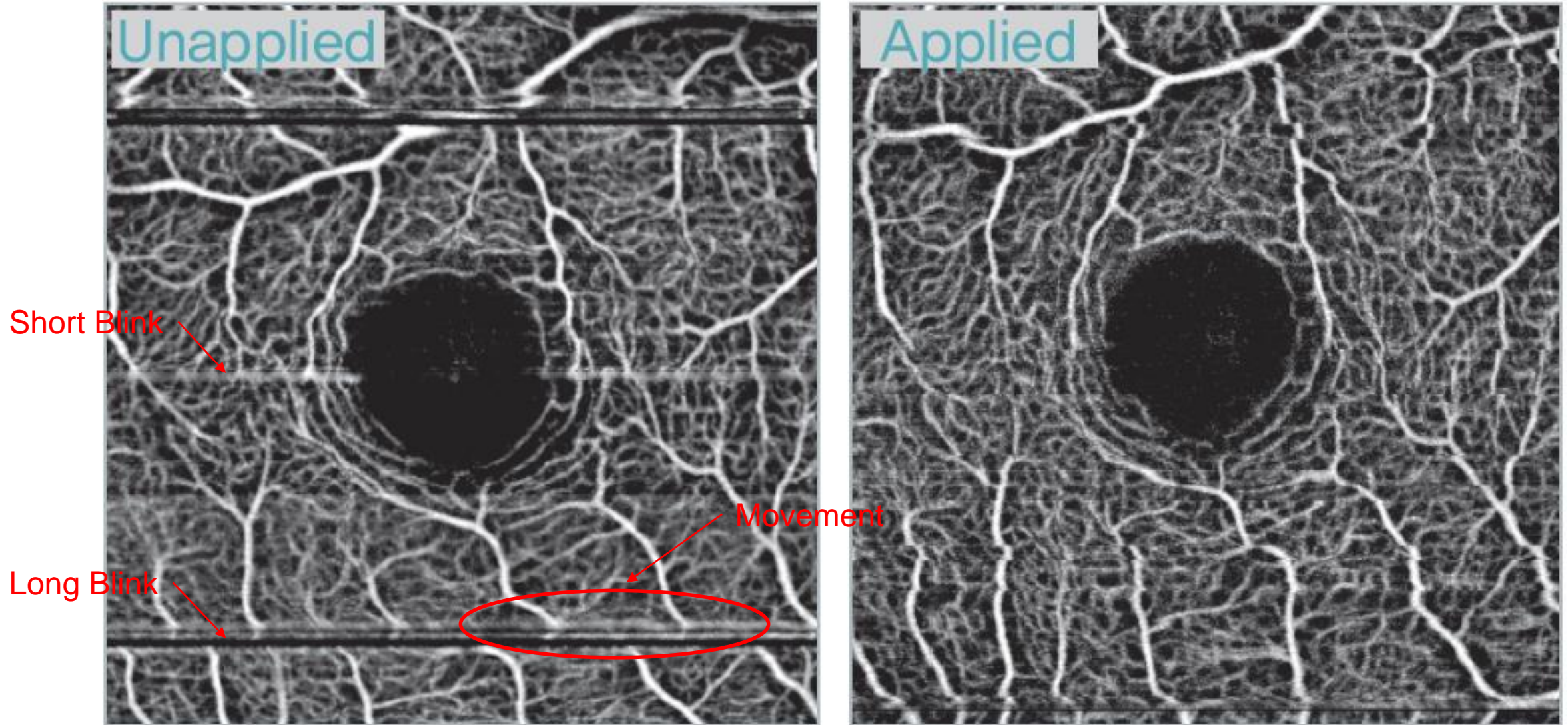


- .- How can we guarantee the same location for multiple B-scans ?
- .- People are moving their eyes continuously and even blink intentionally or unintentionally.
- .- How can we perform a motion correction in a full scanning range?



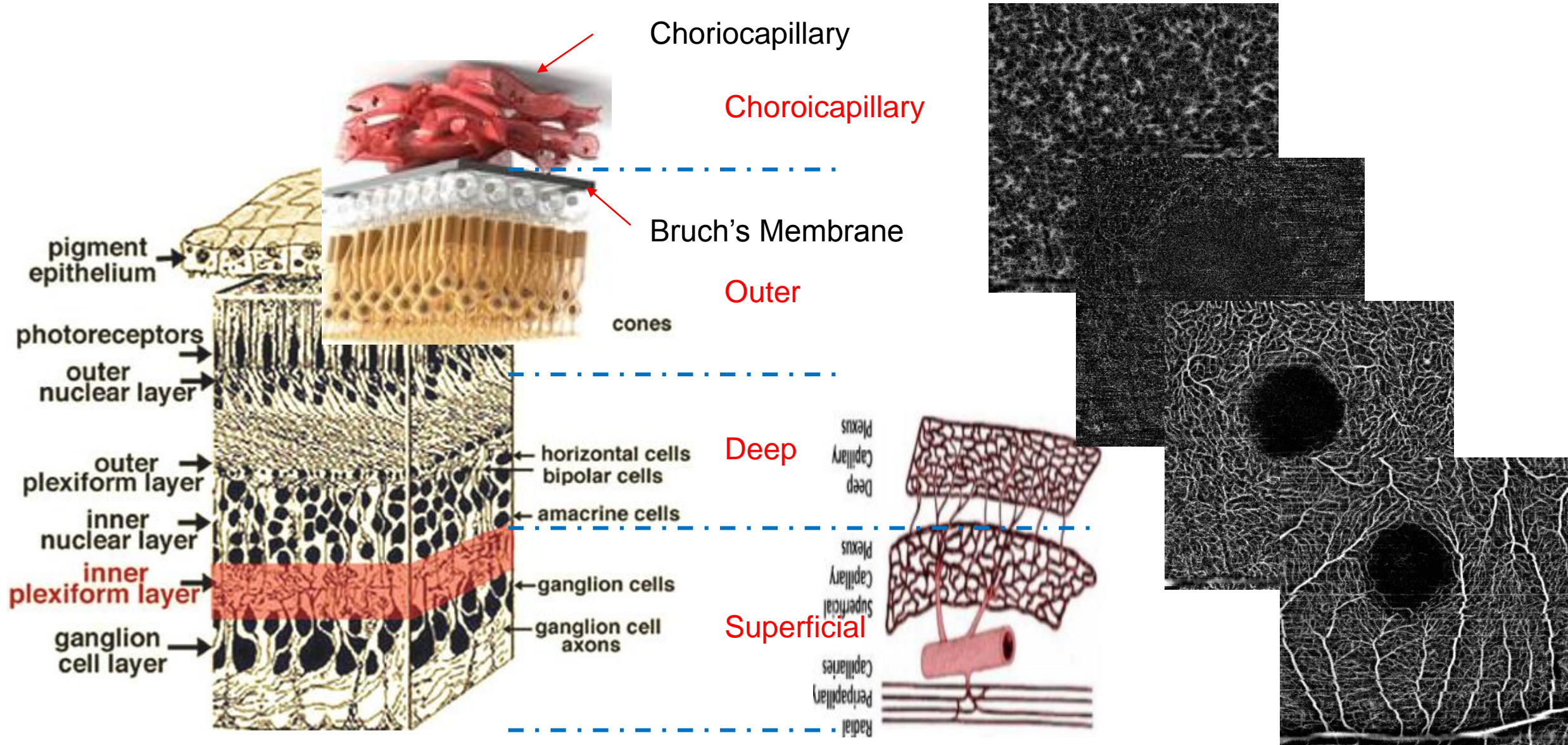
- Take a feature, store it as a template, and trace it whenever a patient blinks or moves an eye.

- Adjust a scanning position and rescan at the previous position.

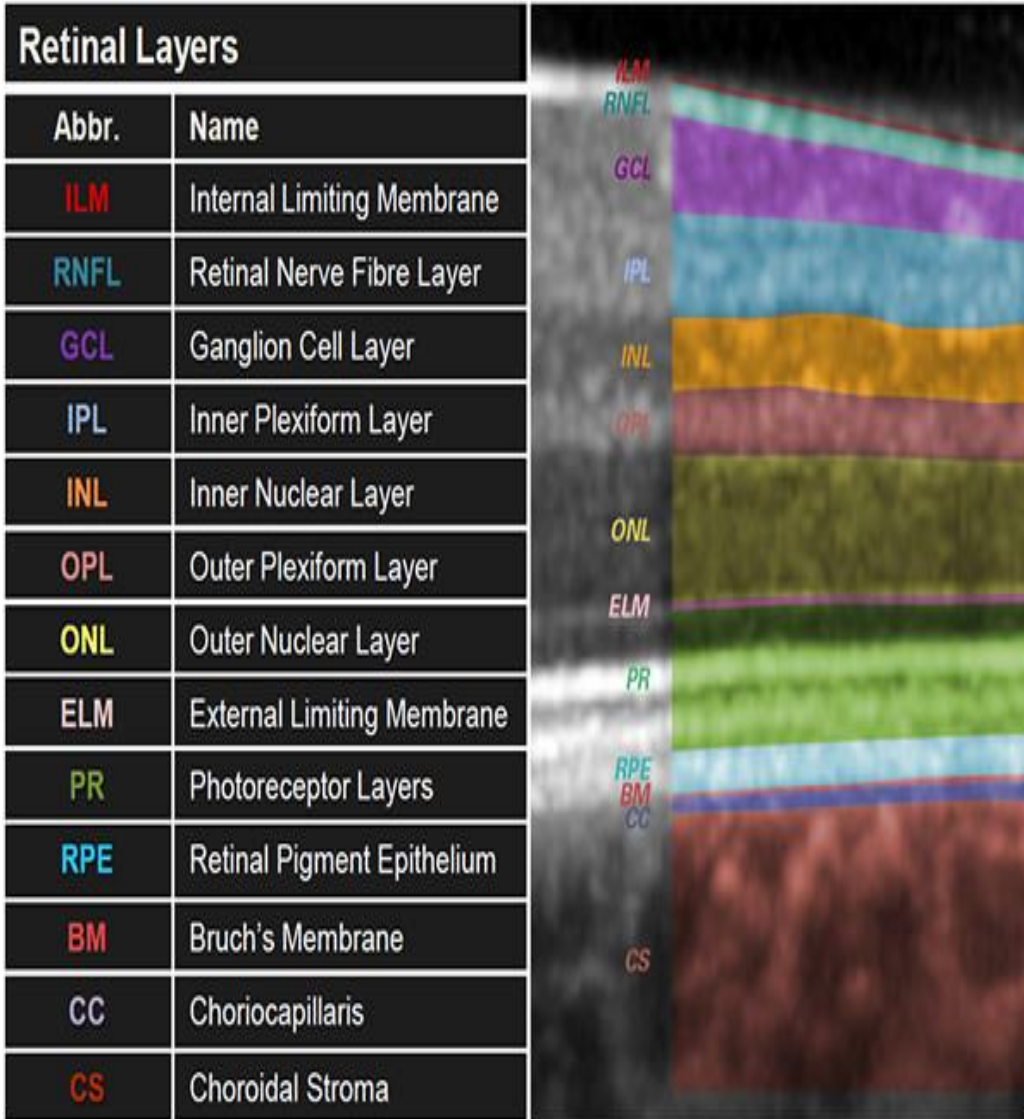


.- How can we guarantee the same location for multiple B-scans ?

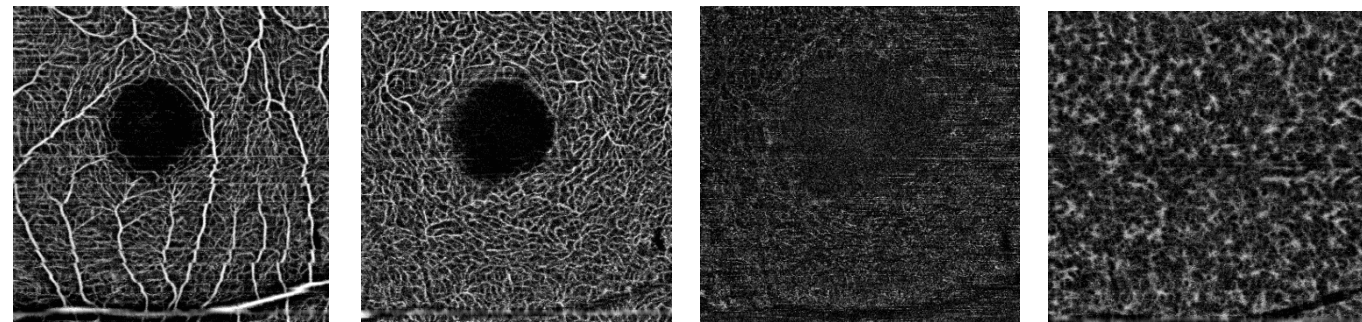
Typical Angiography Map(I)



.- Superficial, Deep, Outer, Choriocapillary

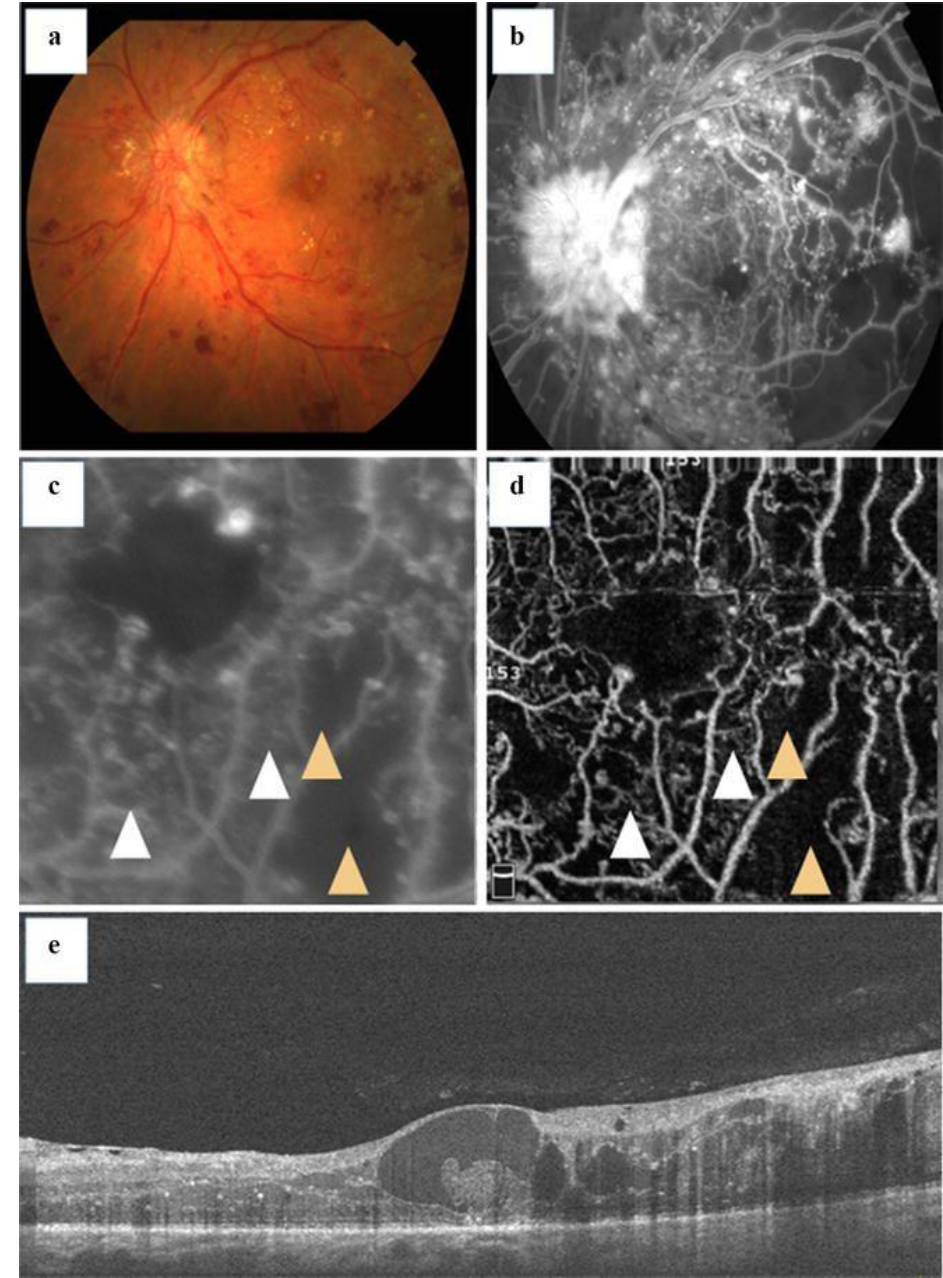
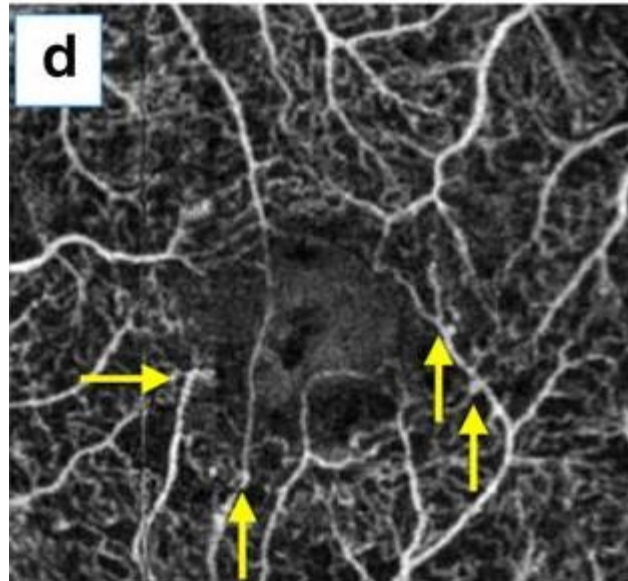
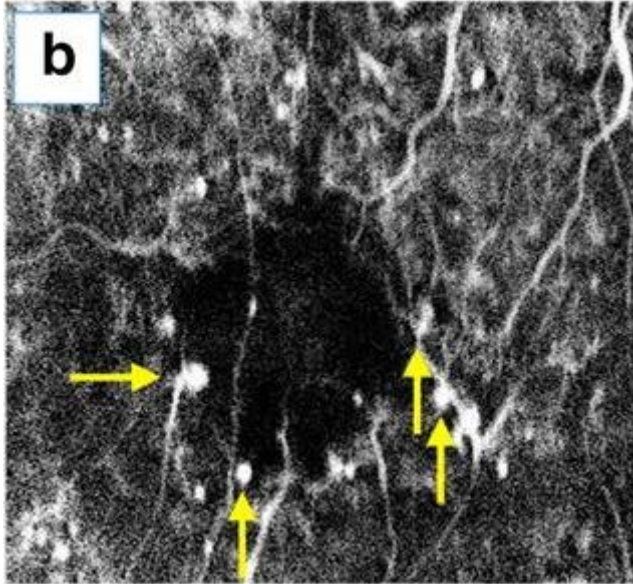


	Range	Symptom in OCTA
Superficial	ILM ~ posterior border ~ IPL	<ul style="list-style-type: none"> - Drop out of superficial vessels - Capillary remodeling - Lower vessel density
Deep	Posterior border of IPL ~ Posterior border of OPL	- Pattern associated with cystoid macular edema
Outer	Posterior border of OPL ~ Bruch's membrane	<ul style="list-style-type: none"> - Basically no vascular - Detected odd vascular
Choriocapillary	Bruch's membrane + 15um ~ +45um	<ul style="list-style-type: none"> - Choroidal flow reduction - Choroidal flow ischemia



Diabetics retinopathy in OCTA

- .- affect superficial capillary plexus.
- .- Vascular anomalies such as microaneurysms, capillary dropout, enlarge/distortion of FAZ, vascular loop, neovascularization.



RVO in OCTA

- .- CRVO
- .- BRVO

Retina OverVue 3.00 x 3.00 Scan Size (mm) **Left / OS**

Angio - Superficial Angio - Deep Angio - Outer Retina Angio - Choroid Capillary

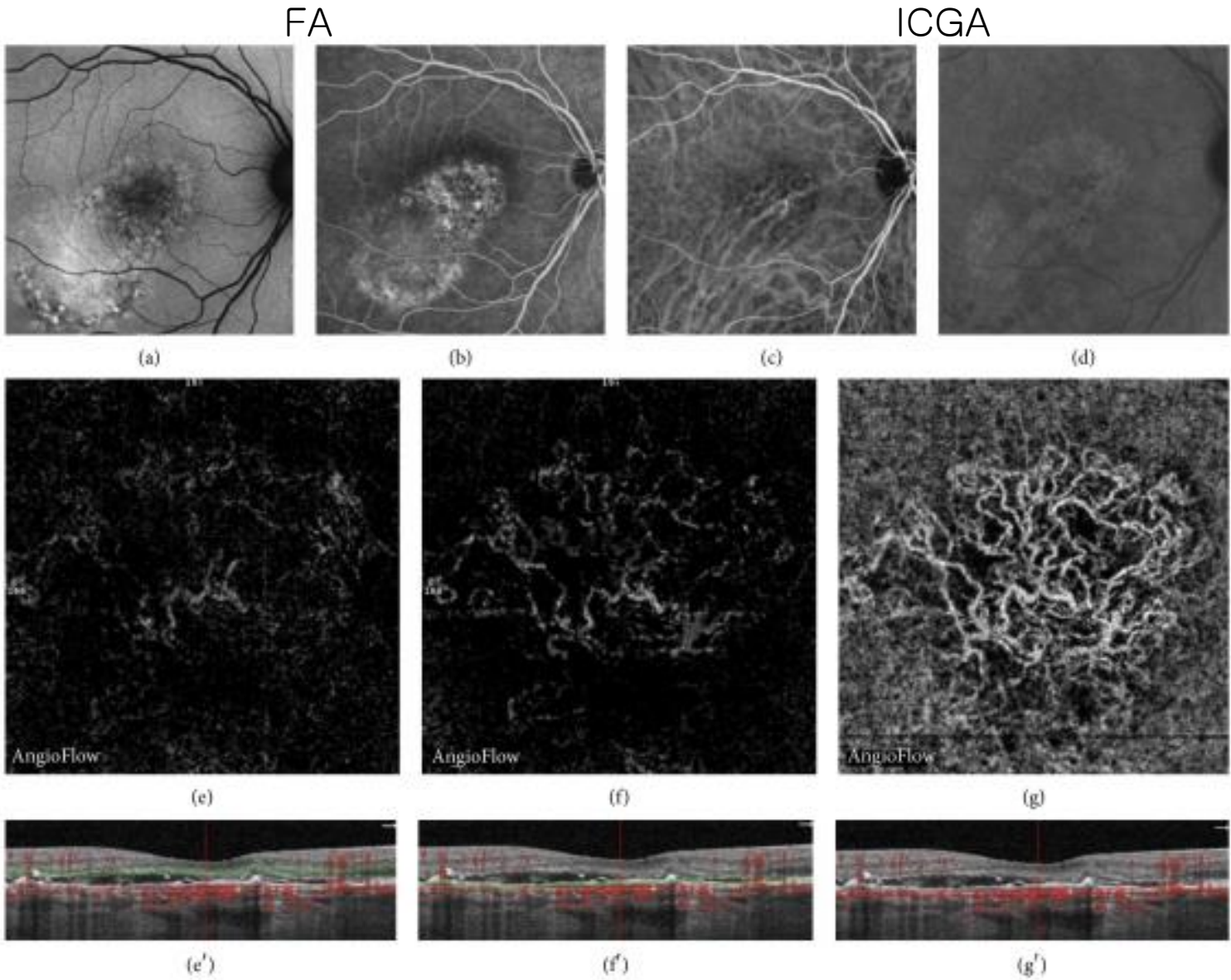
Exit
Print
Export Angio
Reset View
 Invert
 Color
 Show Lines
 Show Bnd
 Angio
 OCT
 Angio / OCT
 Auto Zoom

The interface displays four angiogram views: Superficial, Deep, Outer Retina, and Choroid Capillary. Below these are two OCT cross-sections showing retinal layers and vessel locations. A large fundus image is shown on the right side of the interface.

CSC in OCTA

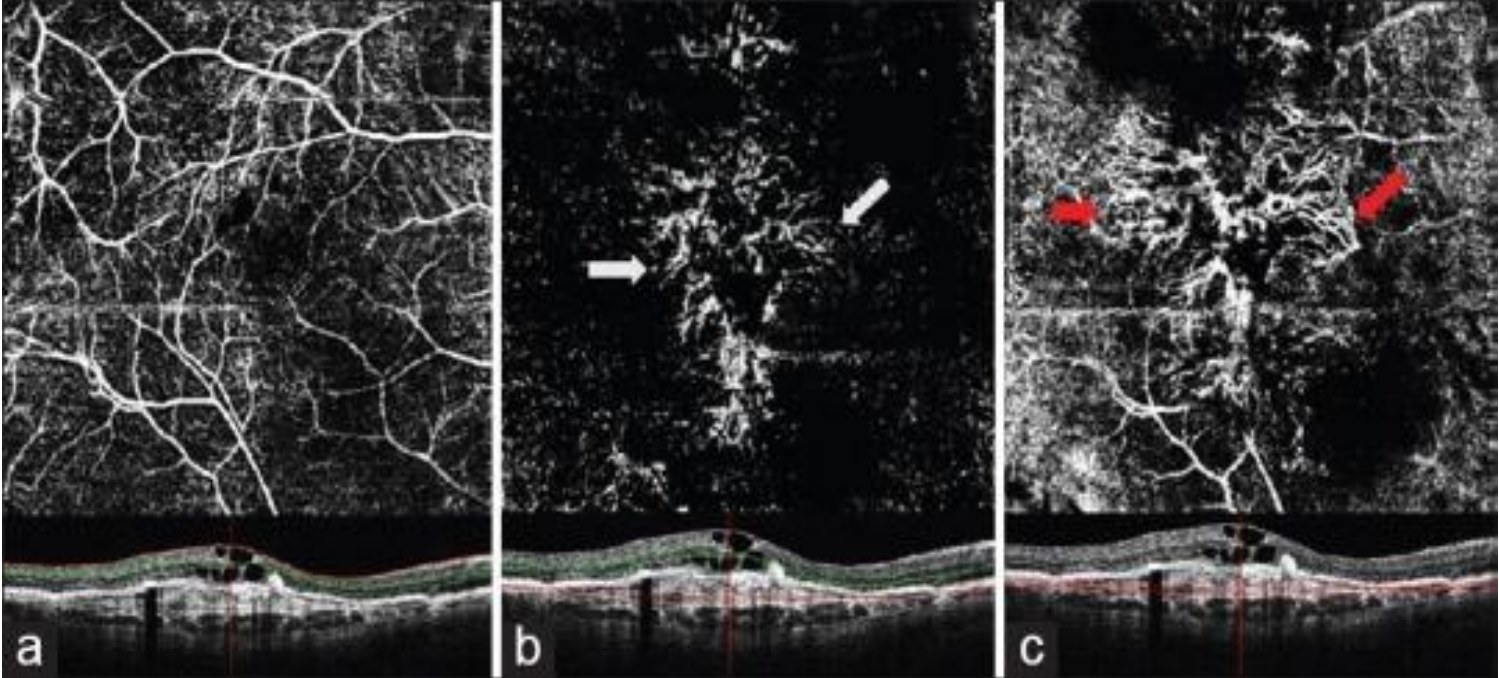
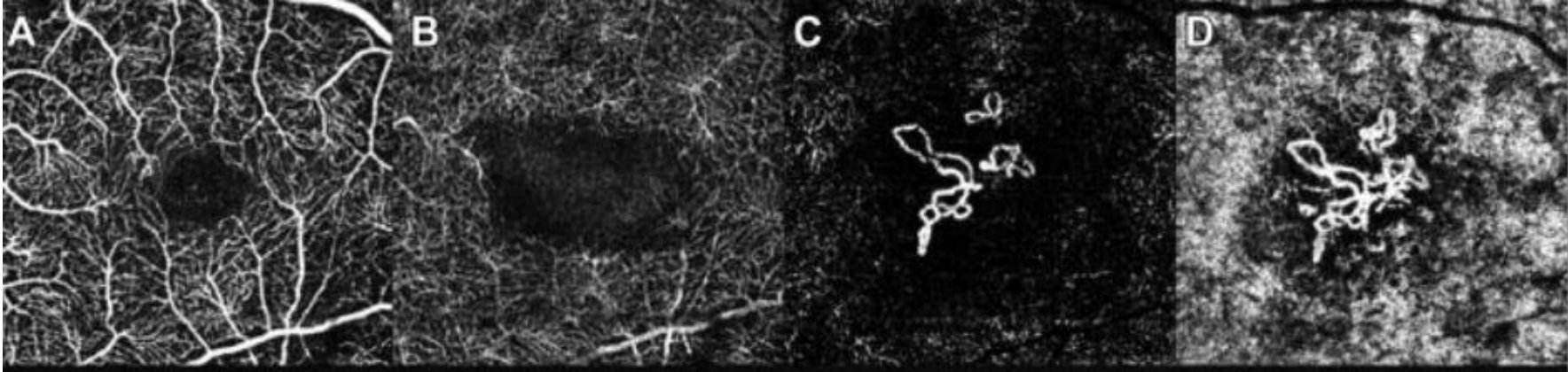
.- Chronic Central Serous Chorioretinopathy

.-



AMD in OCTA

.- Choroidal neovascularization in avascular layer or choriocapillaris.

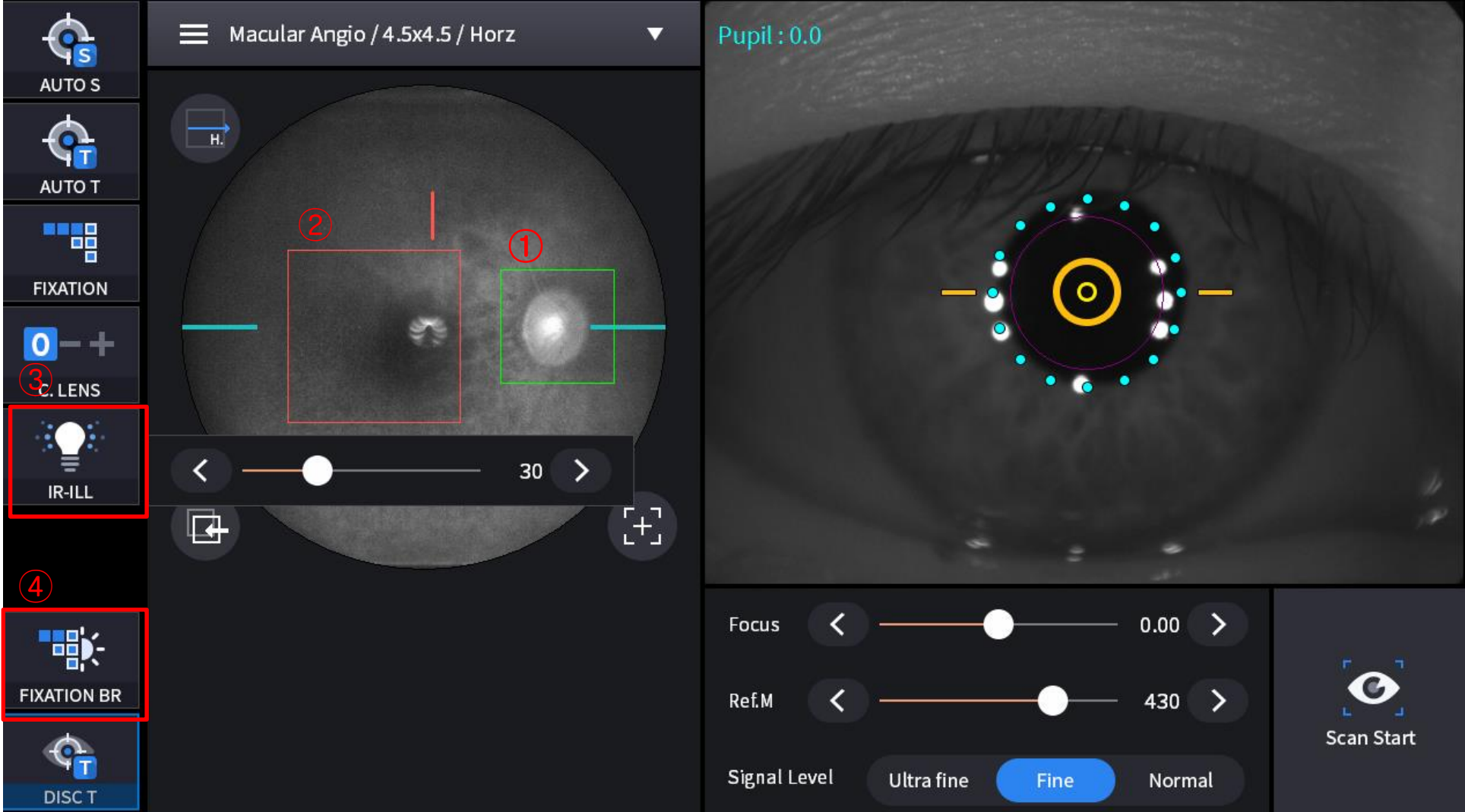


Contents

- Background Knowledge
- Measurement & Analysis
- Field Test
- Evaluation

Measurement: Alignment

- ① Green Box
Tracking Feature
- ② Red Box
Scanned Area
- ③ IR-ILL
IR illumination
- ④ FIXATION DR
Adjust a fixation
- ④ Tracking
Turn On/Off
a realtime tracking



Measurement : Preview Display

- ① Signal Level
Strength of Normal
- ② SSI
more than level 4.
- ③ Arrow
current scan position
- ④ Anterior view
check pupil's position

- ※ Put a chin on a chinrest
- ※ Lean a brow on its supporter
- ※ Open both eyes,
Look the center of
a green circle
- ※ Keep looking at the
center of a green circle
& don't follow
a red signal.

Macular Angio / 4.5x4.5 / Horz

80 / 384

① SSI(6/10)

Focus < —●— 4.00 >

Ref.M < —●— 412 >

Signal Level Ultra fine Fine Normal

Cancel

Measurement(I): StandBy -> Fixation

Step 1. Posture

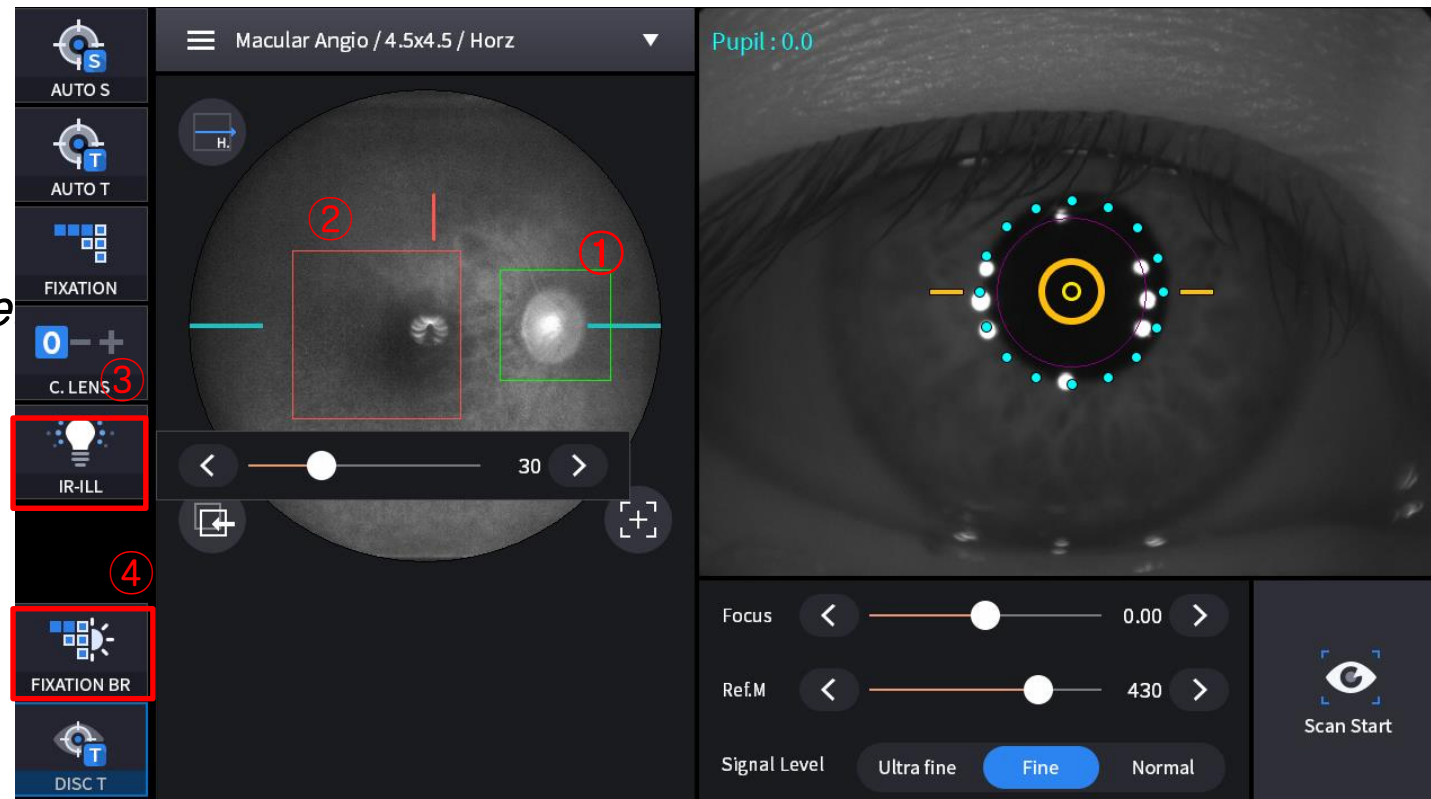
Put a chin on a chinrest, stick to its forehead on a headrest and open both eyes.

- . – *Angiography measurement takes more than 10 seconds generally, so a proper posture is critical.*
- . – *In case that a patient doesn't put on its chin on the chinrest, its eyes moves too much to upside or downside.*
- . – *If a patient's forehead detaches from the headrest, the signal of B-scan becomes weak.*
- . – *With a improper posture, HOCT lost the tracking feature, SSI of a scanning signal falls down dramatically during a measurement.*
- . – *A operator should check the posture of a patient not only before pressing a joystick but also during a measurement.*

Step 2. Fixation

Ask a patient to look at the center of a green circular target(=①), don't follow a red light or don't be distracted by a red light.

- . – *In case that a patient can't see a green target increase its intensity using the button 4.*
- . – *If a patient with a heavy cataract can't see a green target, please use the external fixation LED.*



Measurement(2): Optimize -> Measurement

Step 3. Start measuring

Press a joystick in case that the tracking feature is clear and the level SSI is enough to measure.

- . - Make sure that the SSI signal is higher than level 4 (=①).
- . - If an operator moves a B-scan upward, then the level of B-scan is increased, but check not to be out of range.
- . - An operator can check the current eye position at Box ②.

Step 4. During a measurement

Using a joystick or device's body, keep the tracking feature to stay around its original position.

- . - If the tracking feature disappeared, watch a live retina view, move a joystick, or a body to restore the tracking feature.
- . - In case that B-scan goes up too much, is out of window, scroll down a B-scan by wheeling a mouse.
- . - An operator stop a measurement by pressing button ④.



Measurement : Menu

.- Scan Type: Angio

.- Scan Range
3, 4.5, 6, 9mm

.- A/B Scan Point
512, 384, 304

.- Scan Overlap
2, 3, 4

.- Panorama
up to 4 x 3

Scan Pattern

Macular
Disc
Anterior

Macular Line
Macular Cross
Macular Radial
Macular Raster
Macular 3D
Macular Angio

Scan Direction
Horz
Vert

Scan Range
3mm
4.5mm
6mm
9mm

AScan Points
512
384
304

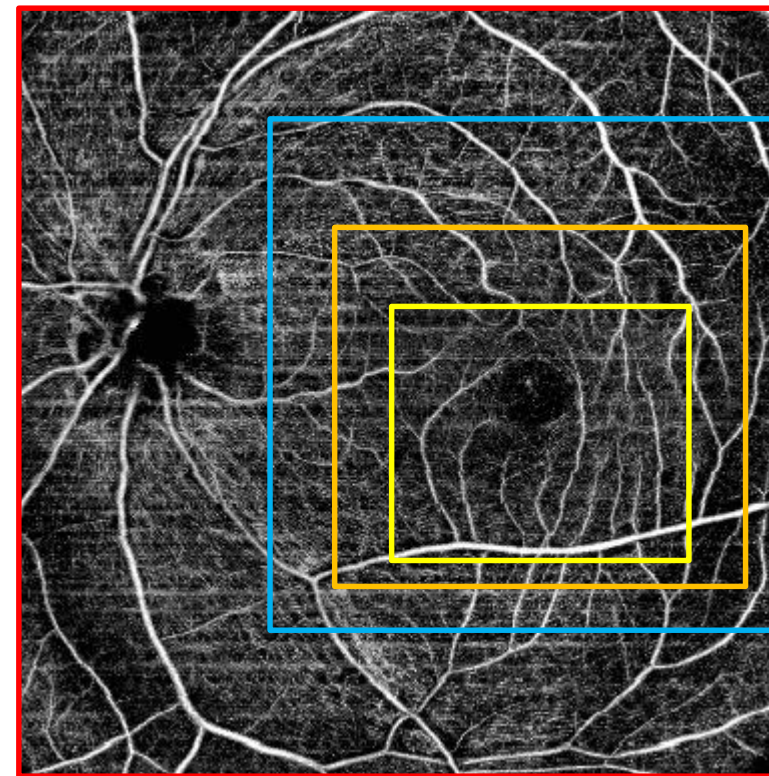
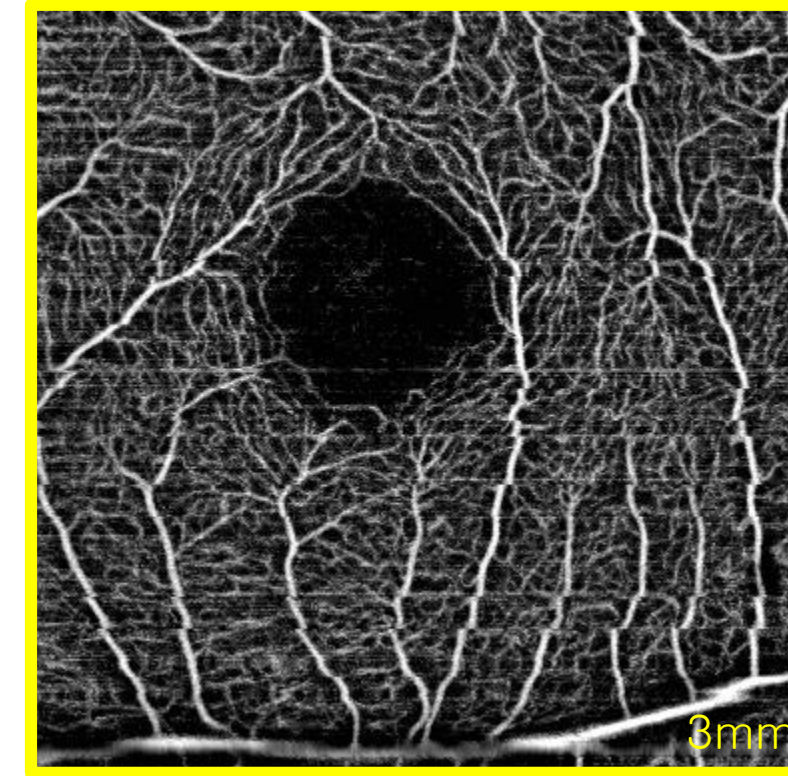
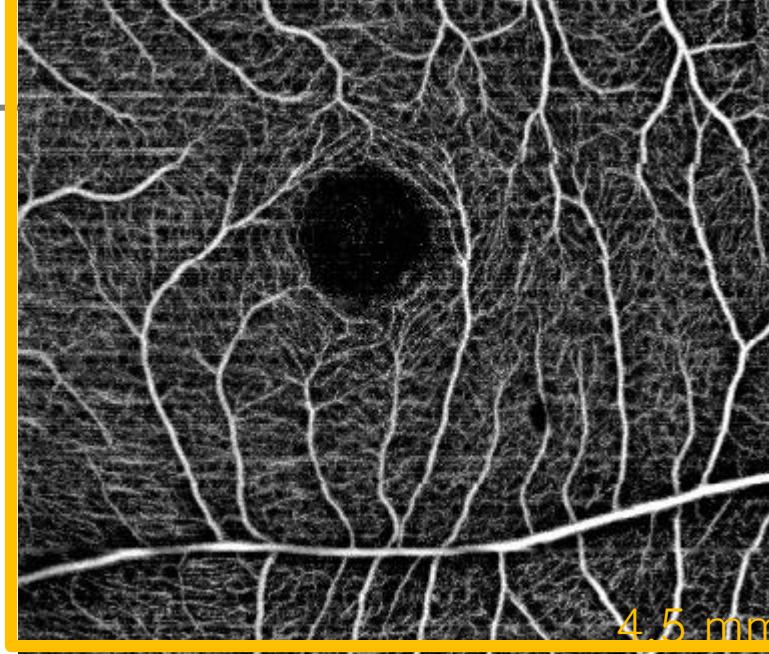
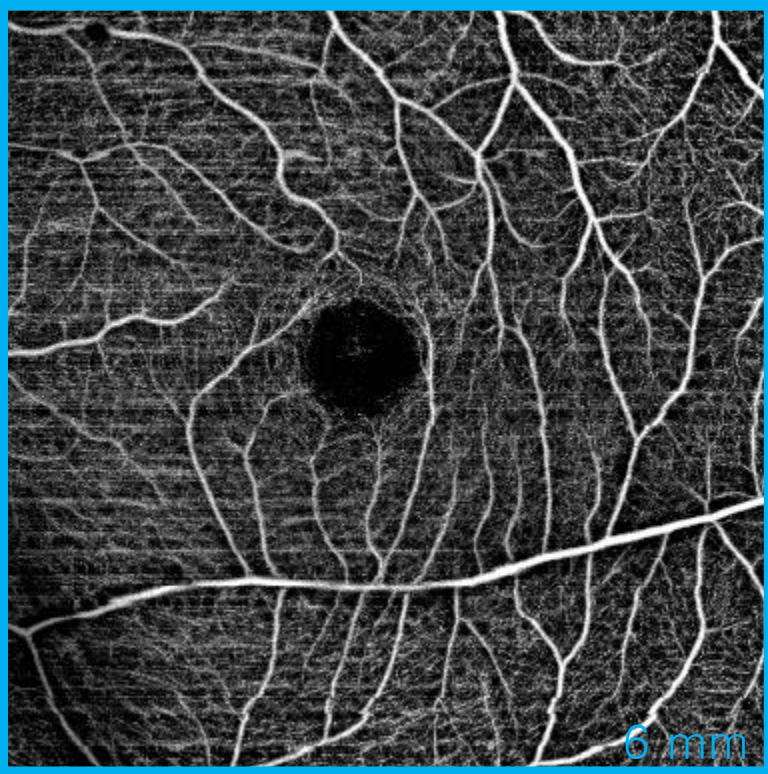
BScan Lines
512
384
304

Scan Overlap
2
3
4

Panorama
Single
2x2
3x2
4x3

save config
reset
cancel
ok

Measurement: Range

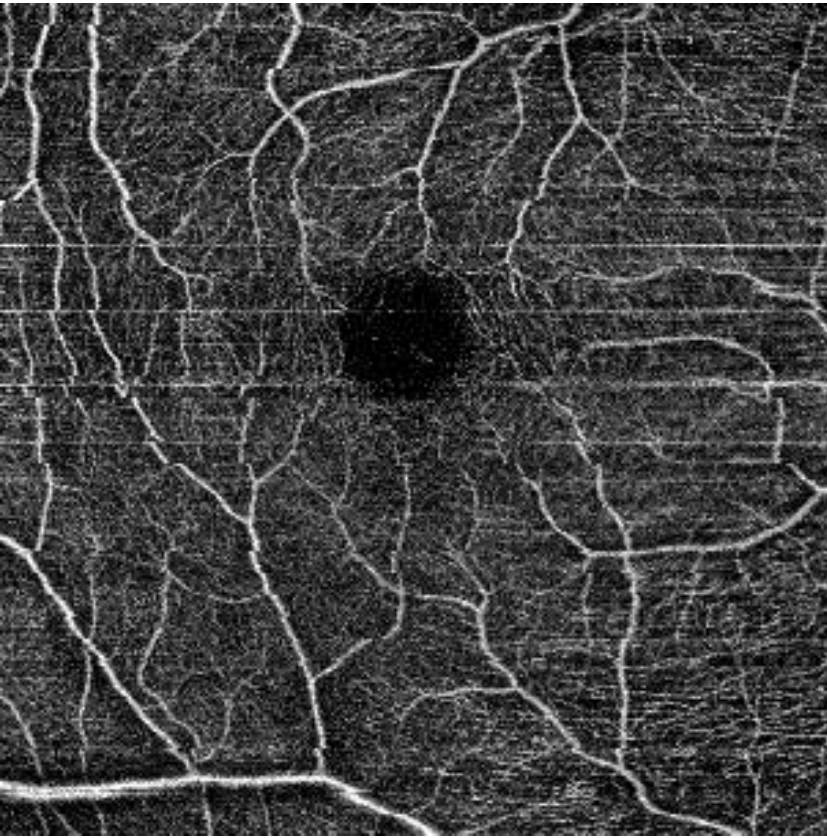


- 3.0mm x 3.0mm
- 4.5mm x 4.5mm
- 6.0mm x 6.0mm
- 9.0mm x 9.0mm
- 12mm x 9.0mm

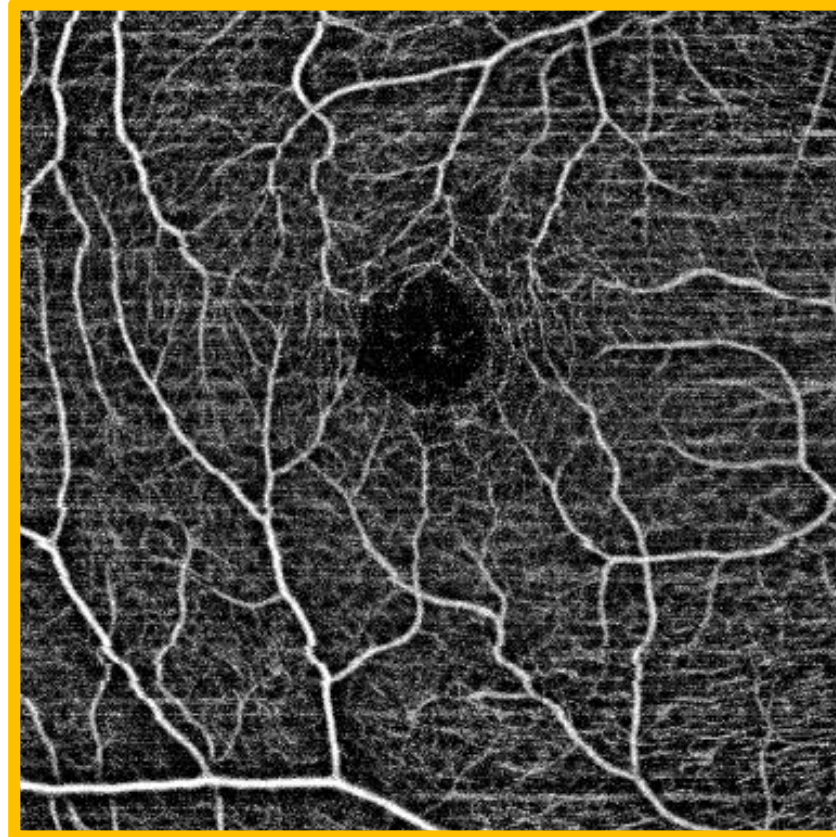
9mm

Measurement: Resolution & Overlaps

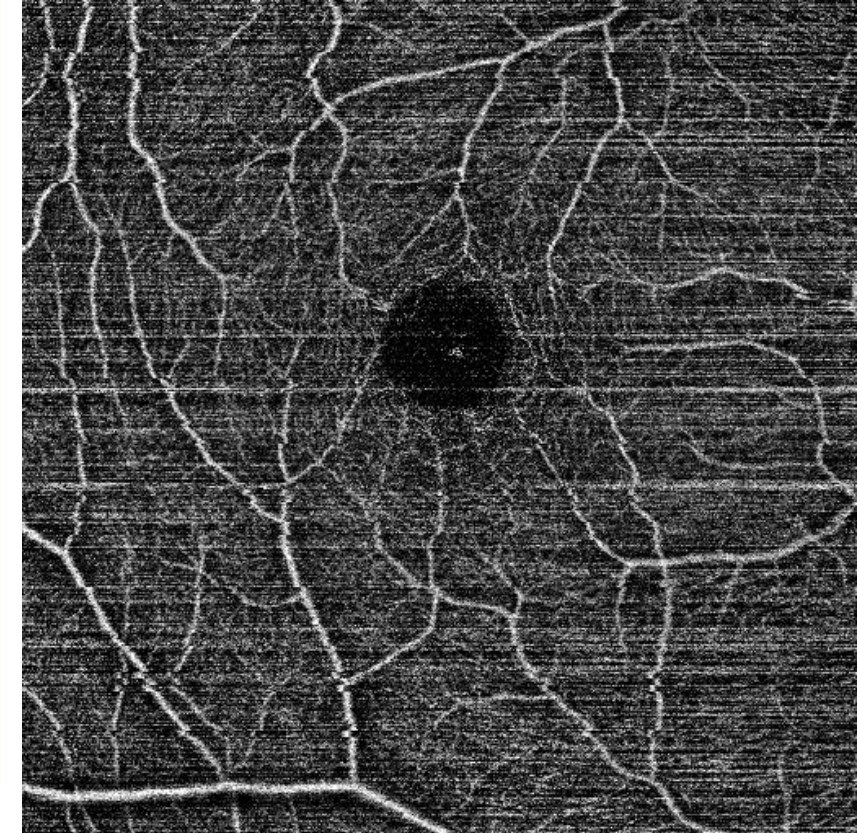
Resolution:304x304
Overlaps: 5times



Resolution:384x384
Overlaps: 3times



Resolution:512x128
Overlaps: 2times



Resolution

- Number of A-scan/B-scan
- 304, 384, 512

Overlaps

- Number of B-scan at the same location

Measurement : Panorama

- .- Predefined Fixation
- .- Select it sequentially

Macular Angio / 4.5x4.5 / Horz

Pupil : 0.0

AUTO S

AUTO T

FIXATION

0 - +

C. LENS

IR-ILL

FIXATION BR

DISC T

Focus < 0.00 >

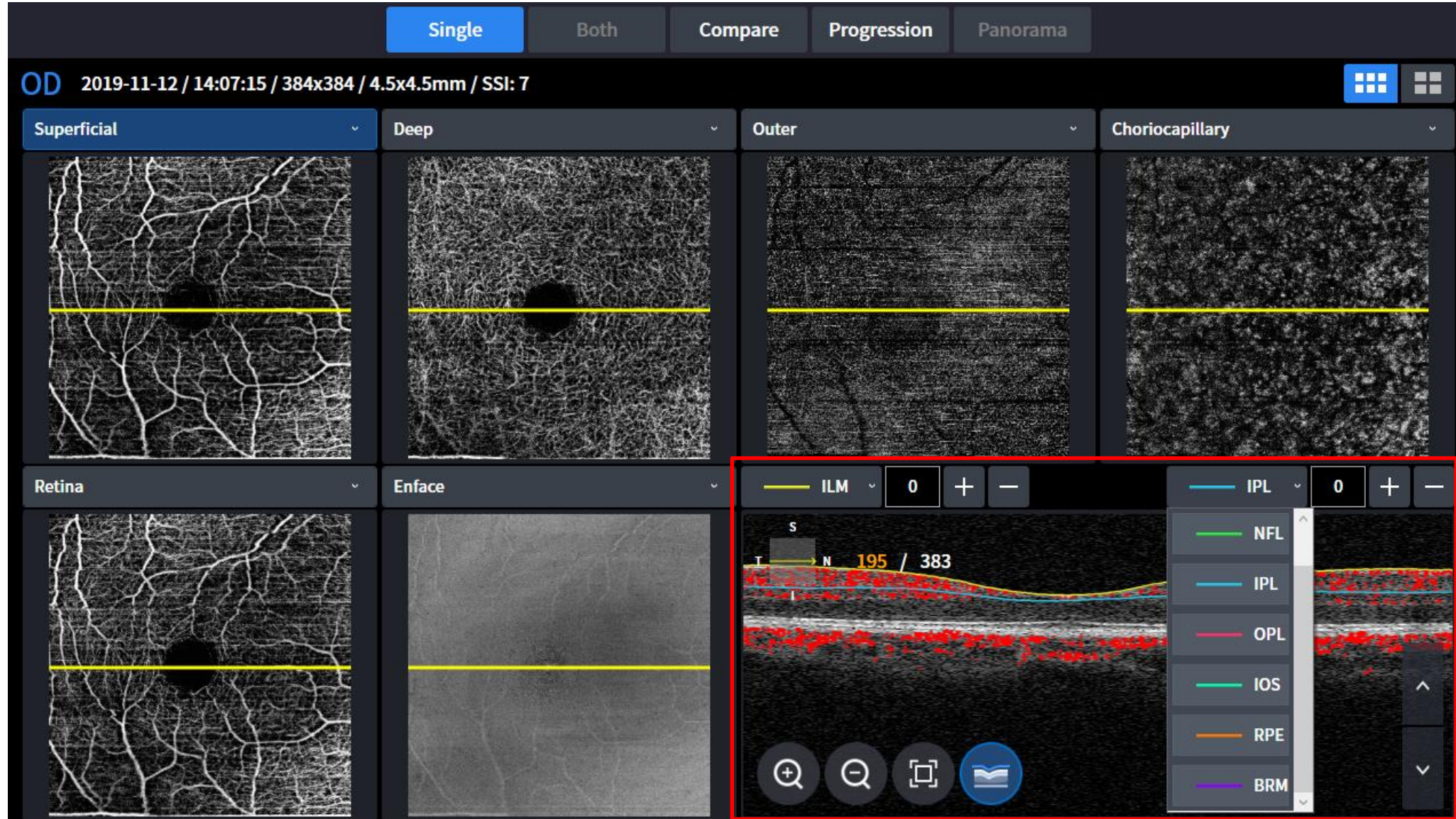
Ref.M < 430 >

Signal Level Ultra fine Fine Normal

Scan Start

Analysis : Basic

- .- Set Segment & Depth
- .- Turn on/off a decorrelation



Analysis : Detail

- .- Depth Code Map
Merged with
from superficial
to BRM
- .- Vessel Density
Unit: %
- .- Vessel Adjuster

OS 2019-08-19 / 10:02:35 / 304x304 / 4.5x4.5mm / SSI: 6

Retina | Depth coded map

Region	Vessel Density (%)	Area (µm²)
Top	36.29	(112.31)
Left	39.95	(131.29)
Center	20.81	(36.43)
Right	35.76	(127.17)
Bottom	42.53	(152.03)

Vessel Adjuster: Vessel (slider), FAZ (slider)

ILM: 0 | OPL: 0

131 / 303

Analysis : Detail

.- Thickness Map

.- FAZ
Area
Perimeter
Circularity

.- Vessel Adjuster

.- Difference of
two exams

※ Fovea might be
smaller than
the size of disc.

Single Both Compare Progression Panorama

OD 2019-11-12 / 14:07:15 / 384x384 / 4.5x4.5mm / SSI: 7

2019-11-26 / 10:55:55 / 384x384 / 4.5x4.5mm / SSI: 6 / Horizontal / Overlap: 3

Retina Thickness (ILM-RPE) Retina Thickness (ILM-RPE)

Area: 0.36 Perimeter: 2.56 Circularity: 0.70

Area: 0.29 Perimeter: 2.39 Circularity: 0.64

ILM OPL Vessel FAZ

	Right	Left	Difference
Area	0.36	0.29	0.07
Perimeter	2.56	2.39	0.16
Circularity	0.70	0.64	0.06

0 0

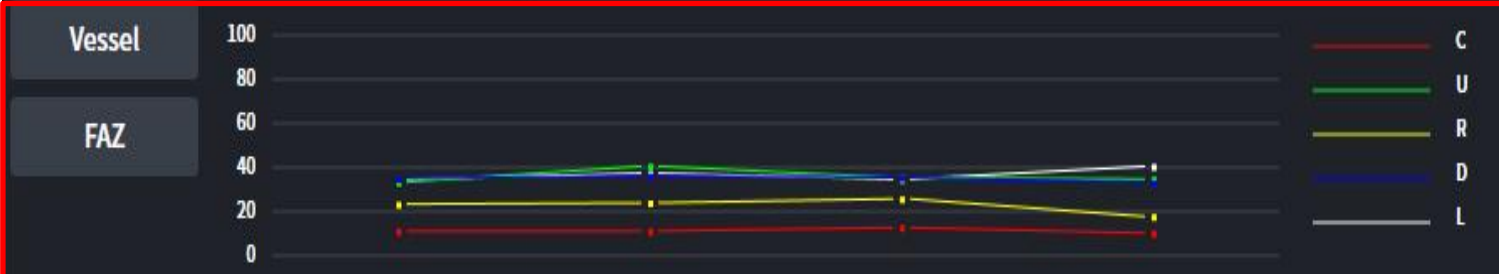
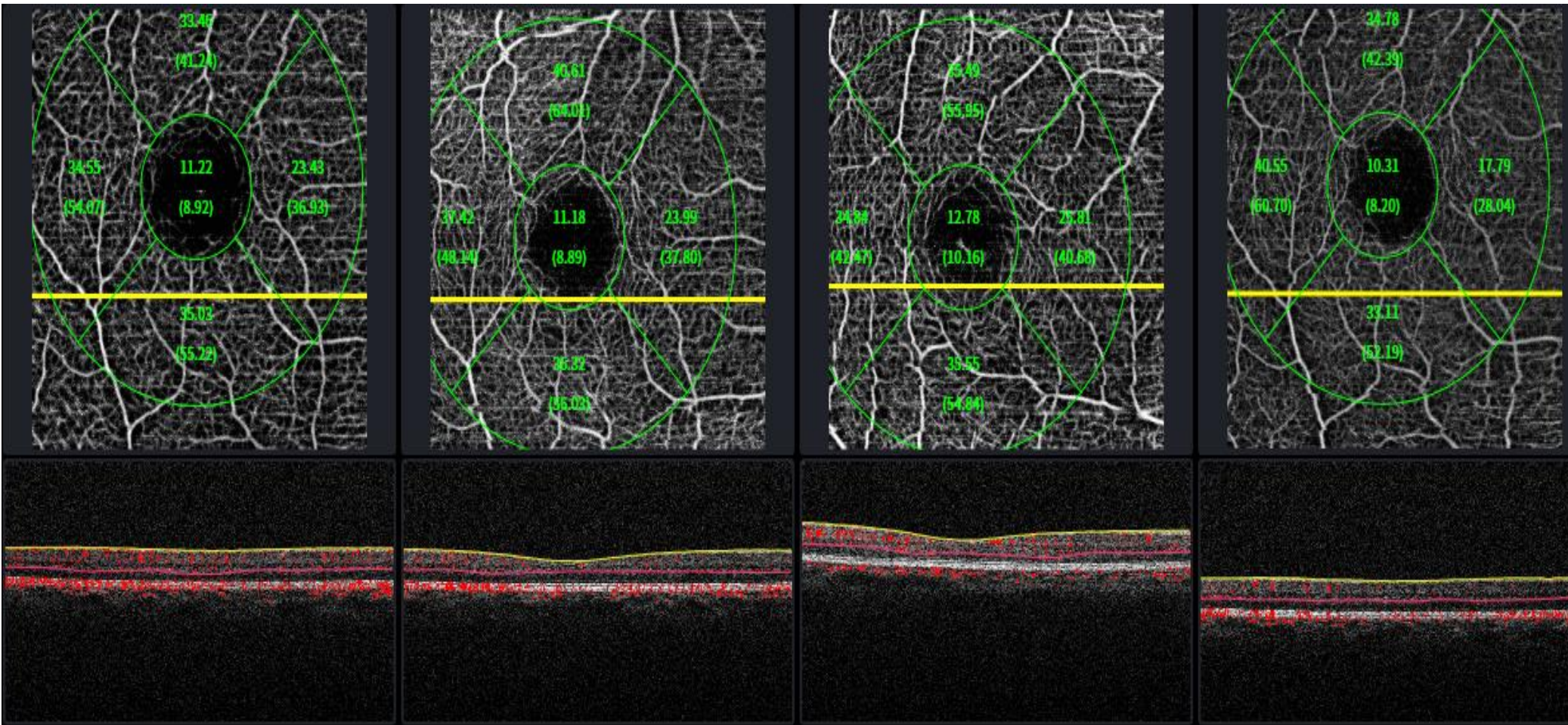
T → N 268 / 383

T → N 272 / 383

Huvitz © 2009, All rights reserved.

Analysis : Progression

- Vessel density of 5 regions
- Trend Graph
- One of Vessel or FAZ



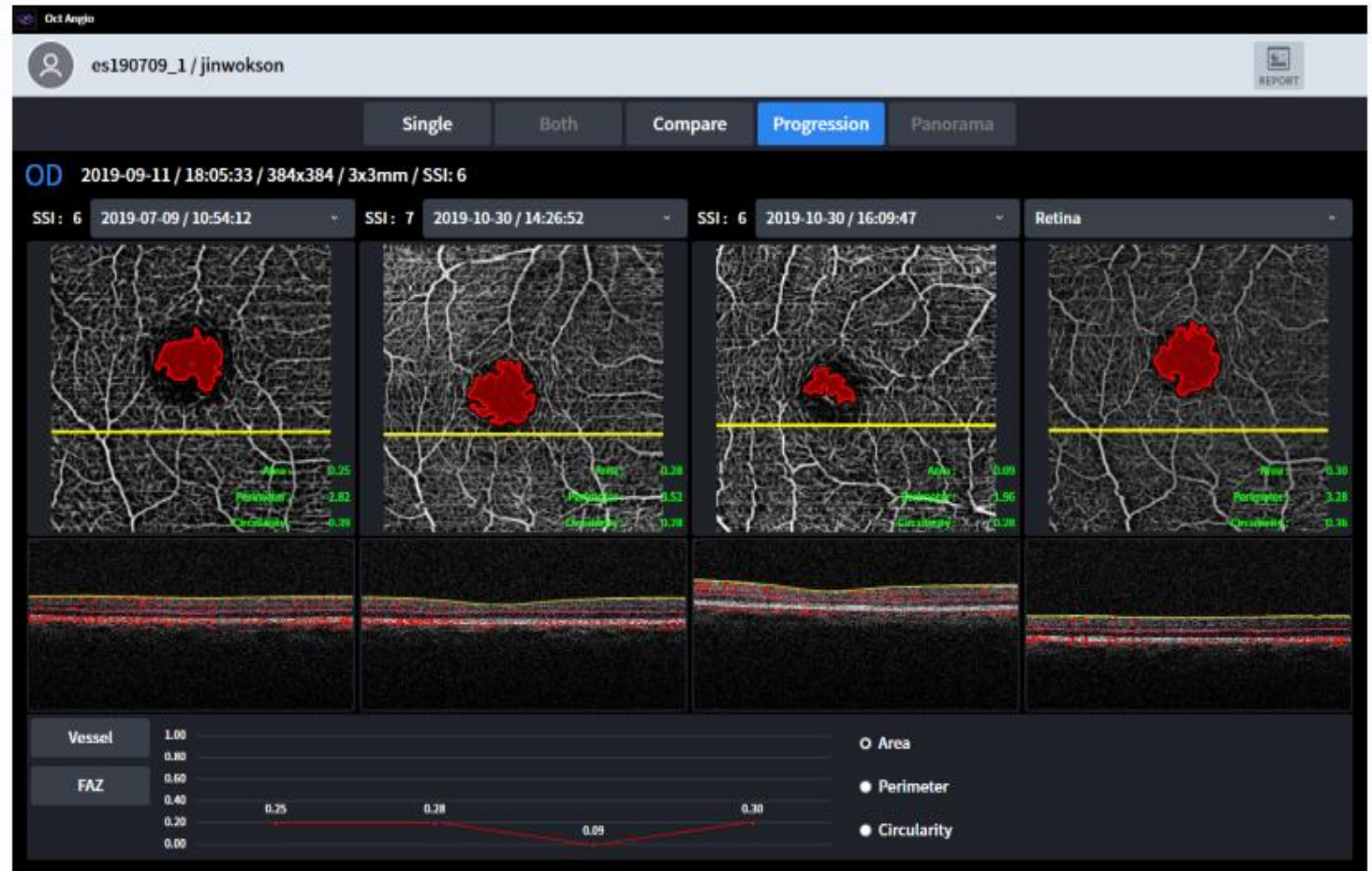
Analysis : Report

.- For all pages

.- Save as PDF



Huvitz Macular Angio [OD] 3x3mm / A384xB384 (H) Name : jinwokson Gender : Physician : Exam date : 2019-09-11
Id : es_190709_1 DOB : 1969-01-01 Gender : Operator : Exam time : 18:05:33



Comments

Signature

Info.

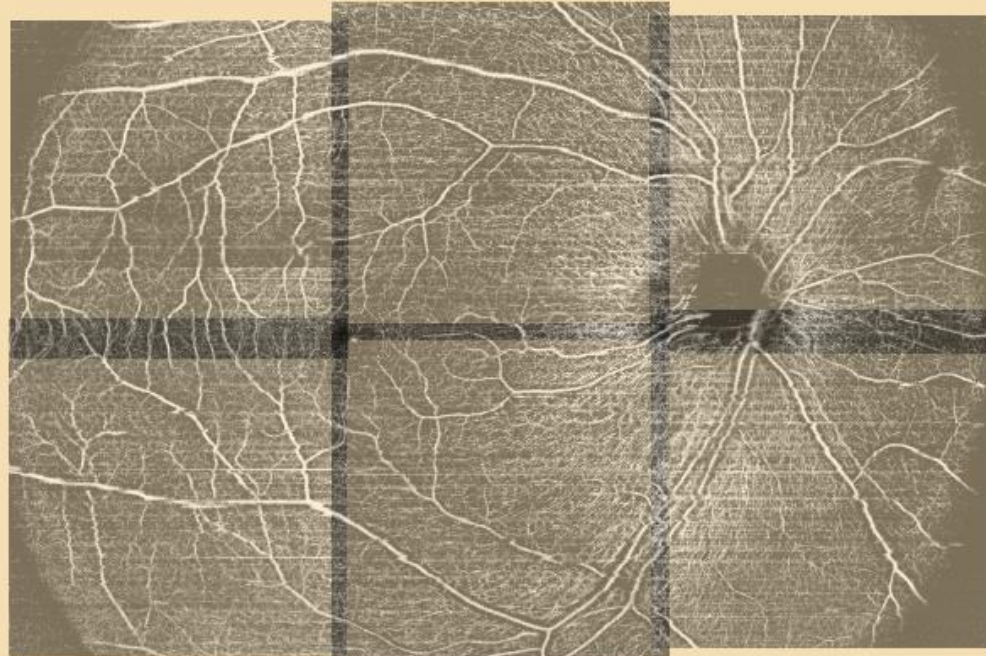
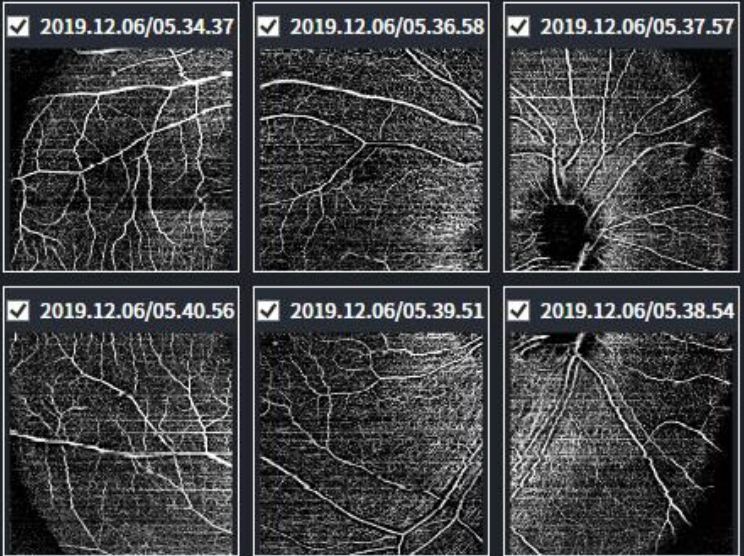
Analysis : Stitching(I)

.- Select Exams

.- Adjust them manually

.- Make a stitched image by 'Stitching'

Single Both Compare Progression **Panorama**

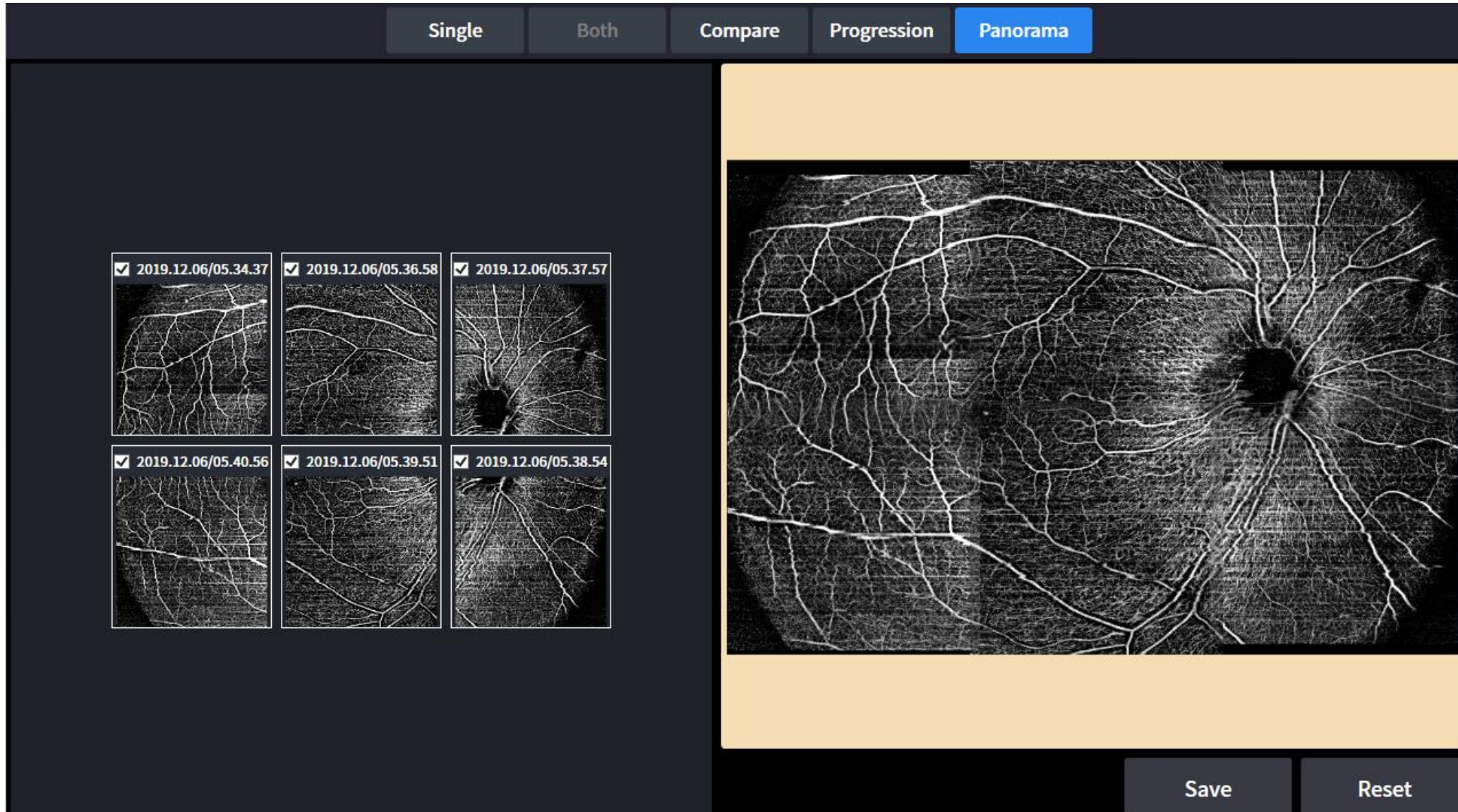


Stitch Reset

Analysis : Stitching(II)

.- Save it
as PDF file.

Single Both Compare Progression **Panorama**



2019.12.06/05.34.37 2019.12.06/05.36.58 2019.12.06/05.37.57

2019.12.06/05.40.56 2019.12.06/05.39.51 2019.12.06/05.38.54

Save Reset

OCT Angiography in Webviewer

PATIENT LIST

es_190709_1 / jinwok son
2019-08-19 / 10:02:35 / OS / Macular Angio / 304x304 / 4x4mm / SSI:6

URL EXPORT COMMENT REPORT SCREEN DUMP RECALC

Summary OU Progression Compare

2019-11-08
2019-08-19

2019-08-19

OD No data available in table

OS Macular Angio 304x304

Superficial Deep Outer Choriocapillary

Retina Depth coded map

— ILM / 0 μ m — IPL / 0 μ m

S N T 152/304 I

Contents

- Background Knowledge
- Measurement
- **Field Test**
- Evaluation

Field Test at KY University Hospital

- Nov 3rd ~ Nov 4th

	person	eyes
AMD	19	
DR	4	8
RVO	5	5
CSC	1	1
Hypertension	1	2

- Dec 16rd ~ Dec 17th

	person	eyes
AMD	23	31
DR	5	10
RVO	5	6
CSC	1	1

- Spectralis Images which were taken at the previous visit, about several months ago.

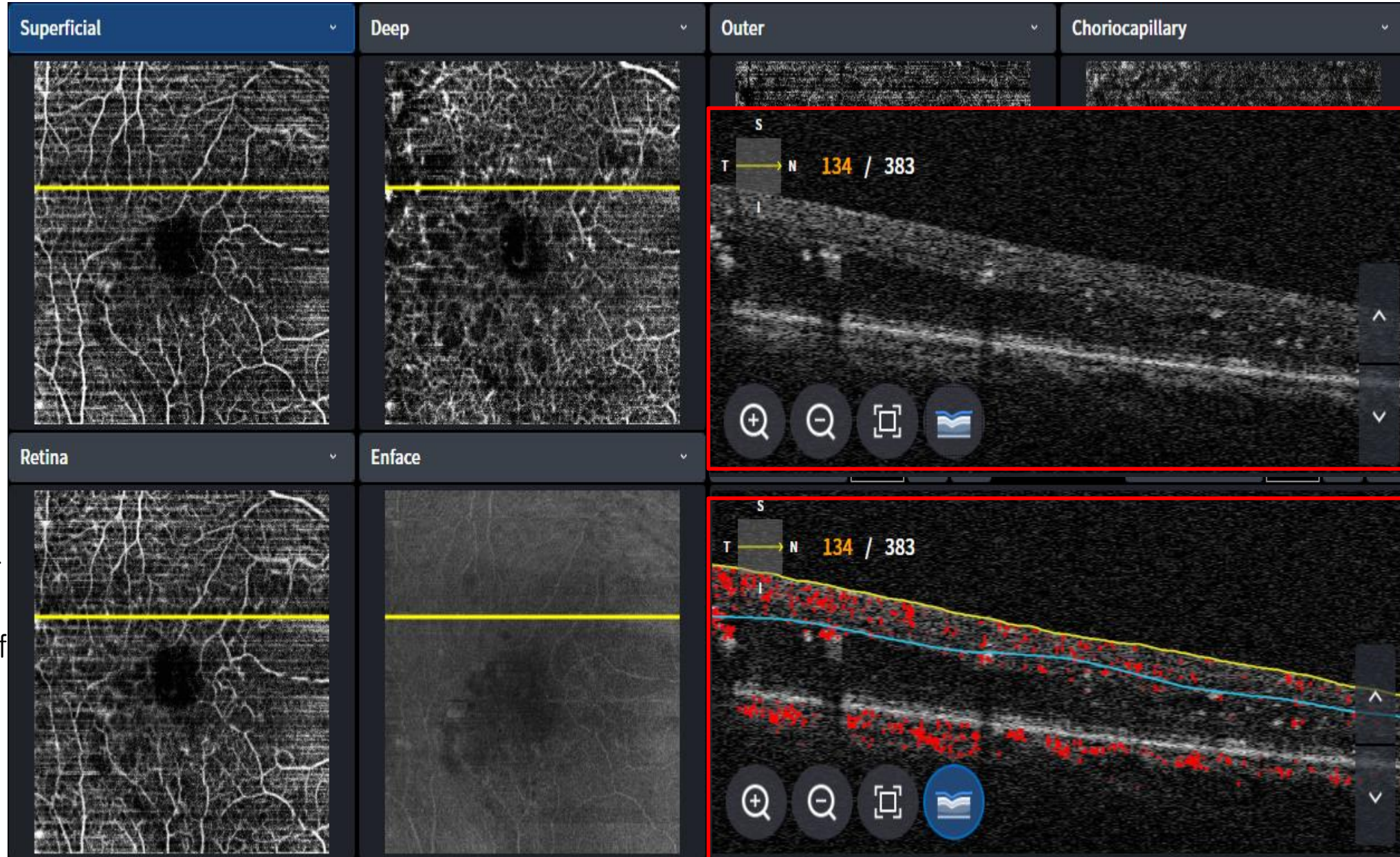
Field Test : Diabetic Macular Retinopathy

.- Microaneurysm



.- Nonperfusion area

.- Icon for B-scan
make Bigger/Smaller
back to its origin
turn on/off an info of
segmentation,
decorrelation.



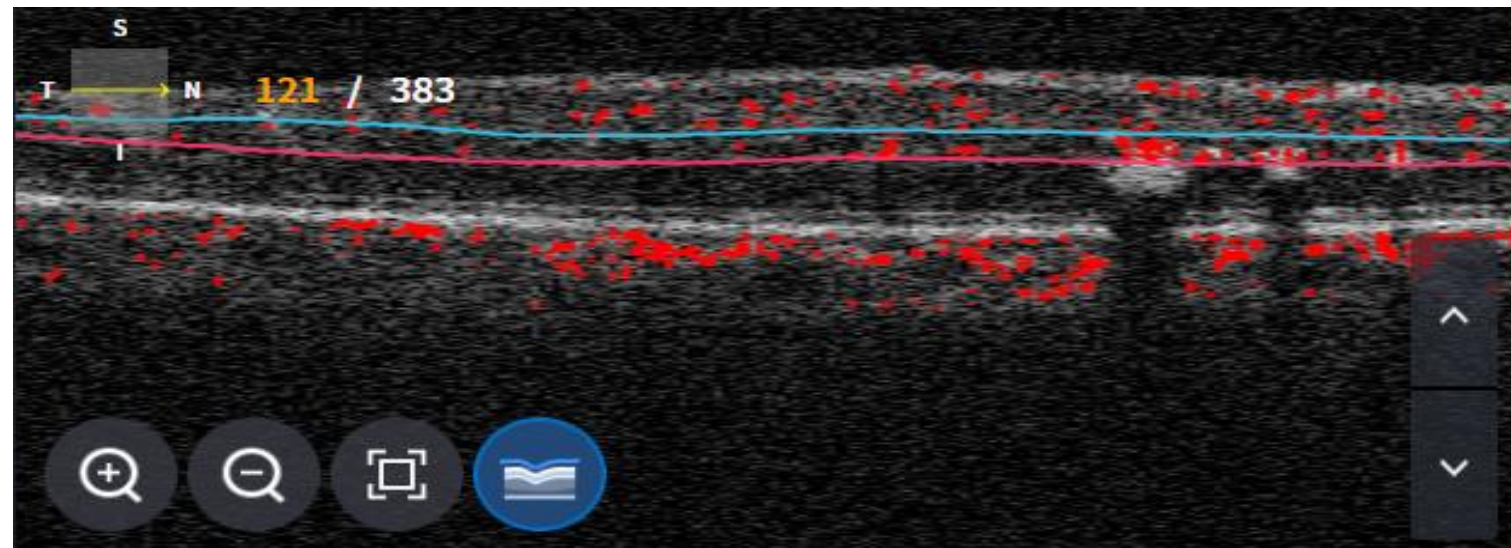
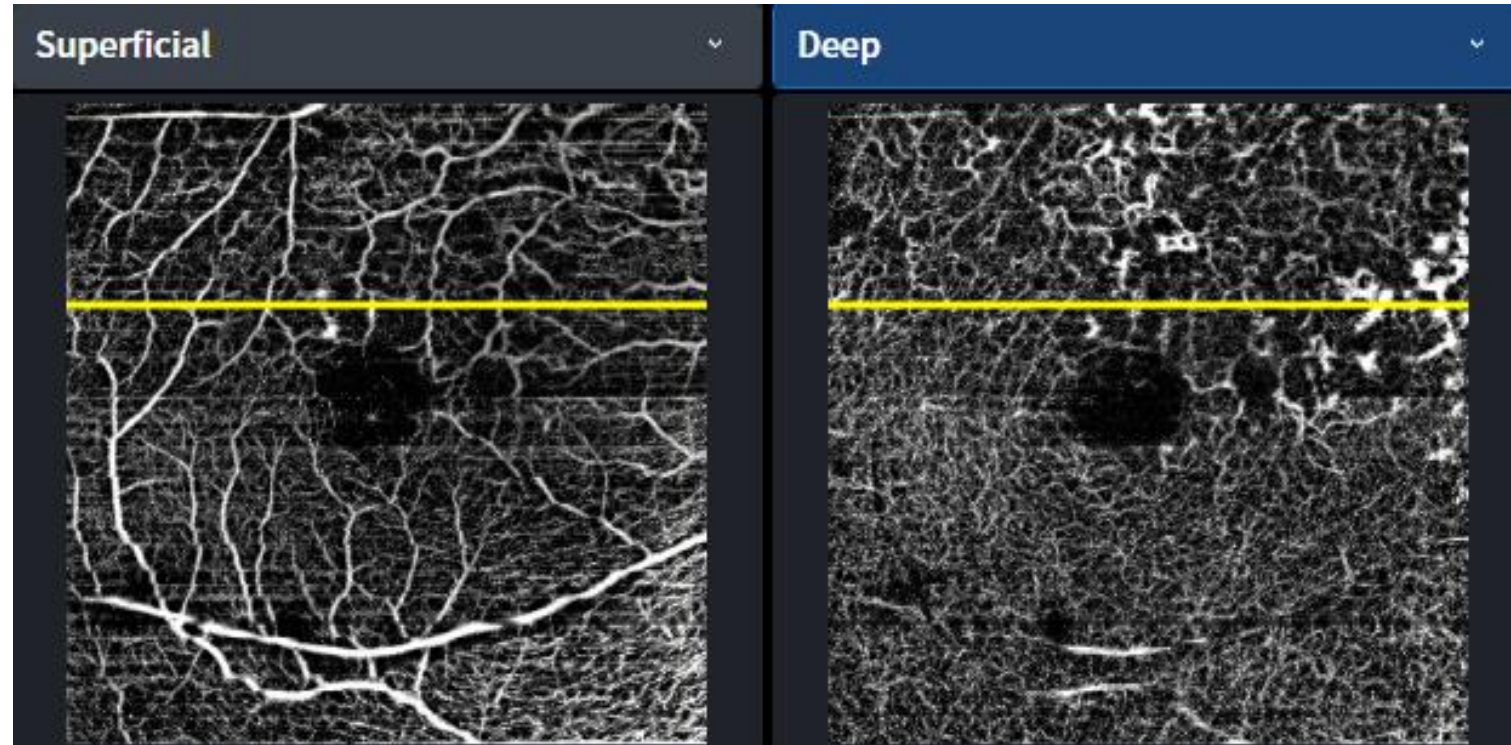
Field Test : Branch Retina Vein Occlusion

.- Pathology

Arterial compression onto veins causes turbulence which may lead to endothelial cell damage and thrombus formation

.- Risk Factors

Hypertension, cardiovascular disease, open angle glaucoma, and high body mass index (not diabetes mellitus)



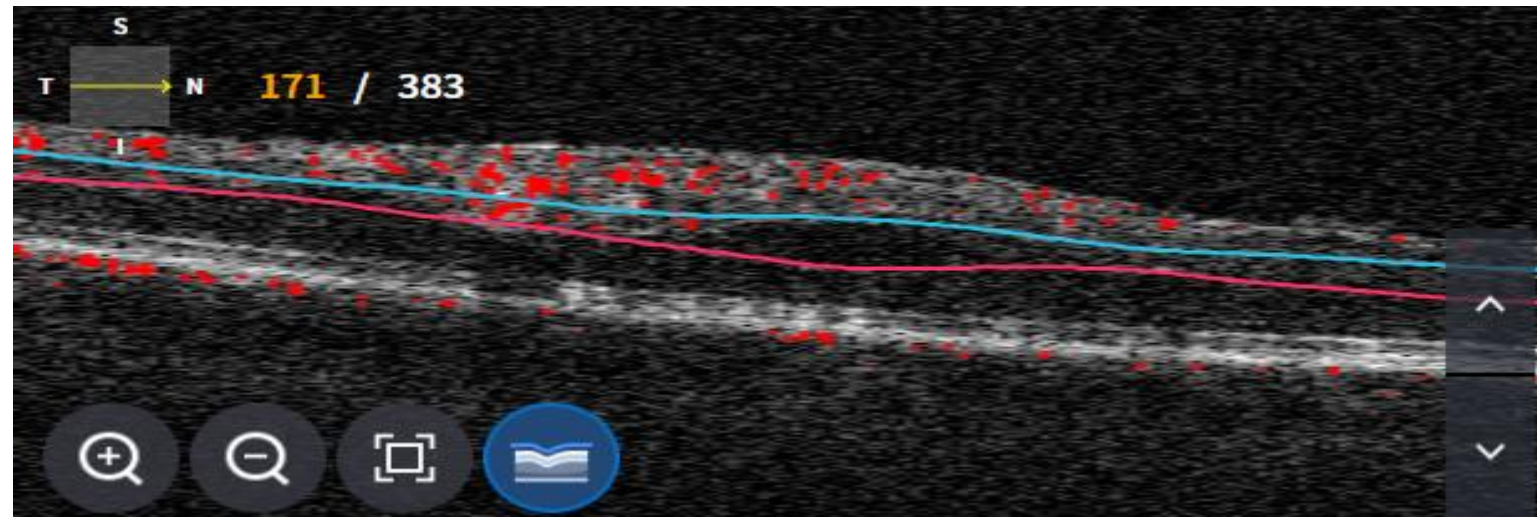
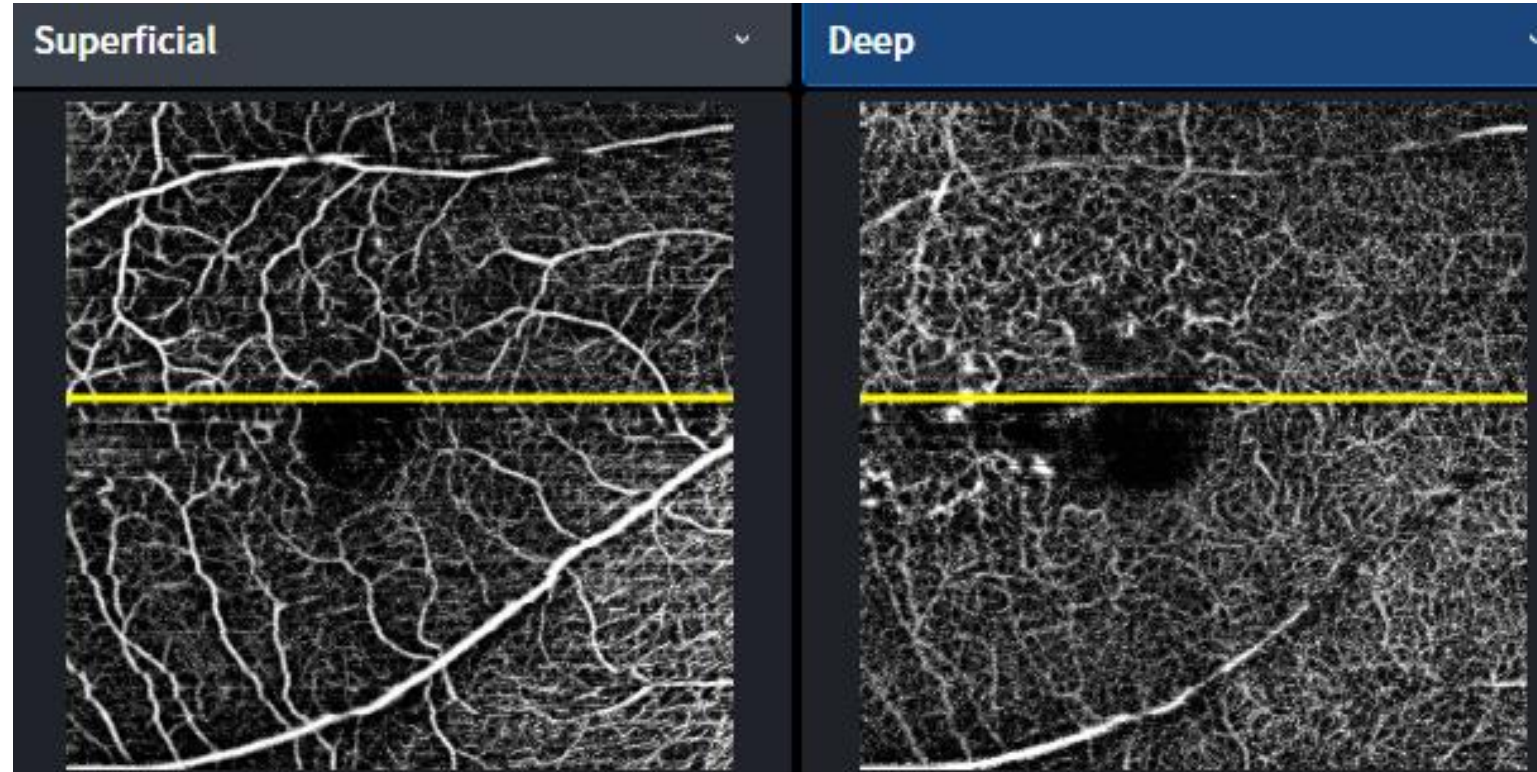
Field Test : Central Retina Vein Occlusion

.- Pathology

A thrombus forms at the central retinal vein near the lamina cribrosa

.- Risk Factors

Hypertension, open angle glaucoma, diabetes mellitus

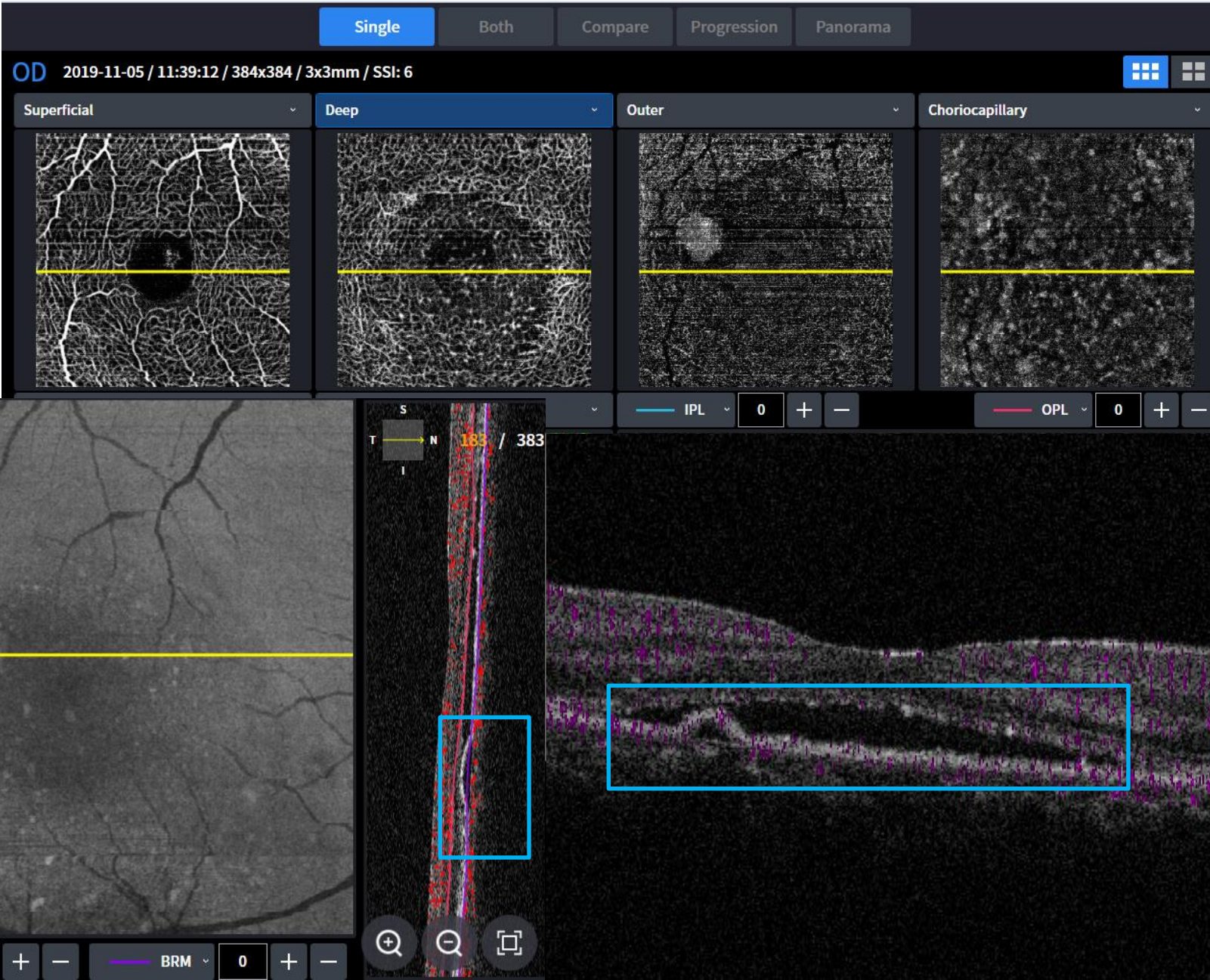


Field Test : Central Serous chorioretinopathy

.- Pathology

a condition in which fluid accumulates under the retina, causing a serous (fluid-filled) detachment and vision loss

.- Macular Degeneration



Field Test : Cystoid macular Edema

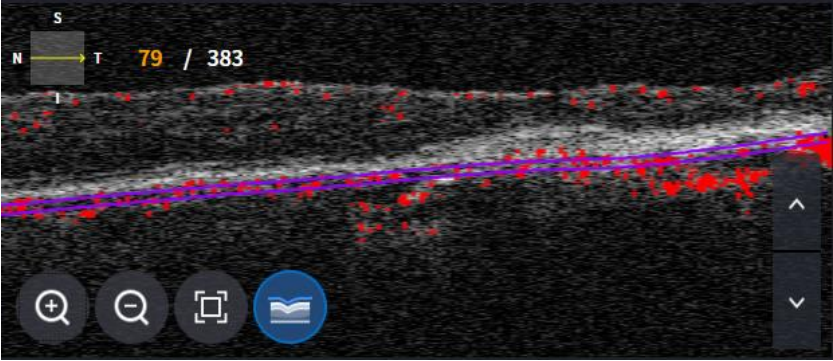
.- Pathology

retinal thickening of the macula
due to a disruption of the
normal blood-retinal barrier

decrease in visual acuity that
is associated with retinal edema

.- Risk Factors

diabetes, vein occlusion, surgery



Superficial	Deep	Outer	Choriocapillary
Retina	Depth coded map	ILM 0 + - IPL 0 + -	

Field Test : Aged Macular Degeneration(I)

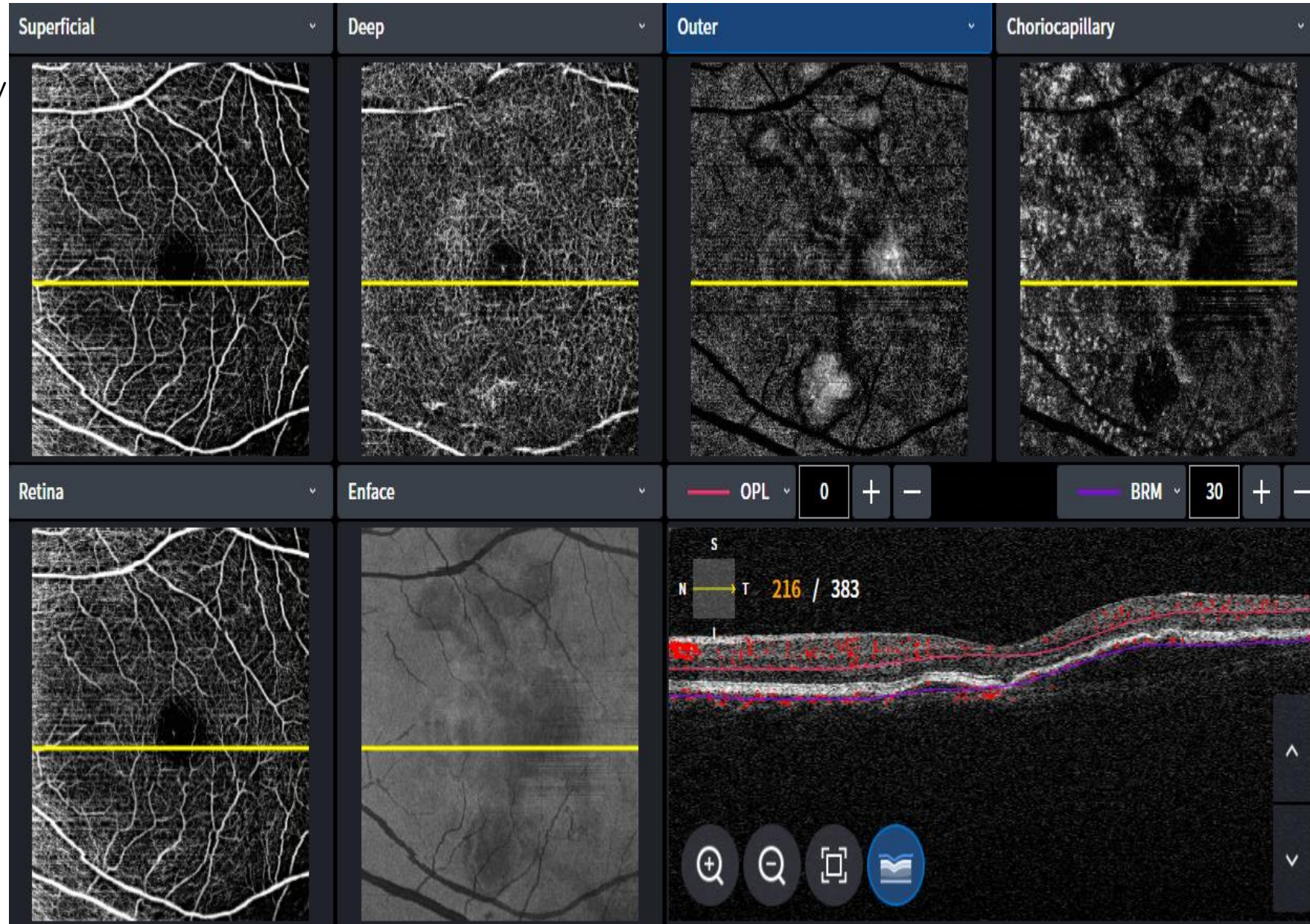
.- Pathology

thinning or depigmentation that precede geographic atrophy in the early stages of AMD

atrophy of the RPE (geographic atrophy) and/or development of new blood vessels (neovascularization)

.- Risk Factors

Smoking, Hypertension, High cholestrol



Field Test : Aged Macular Degeneration(II)

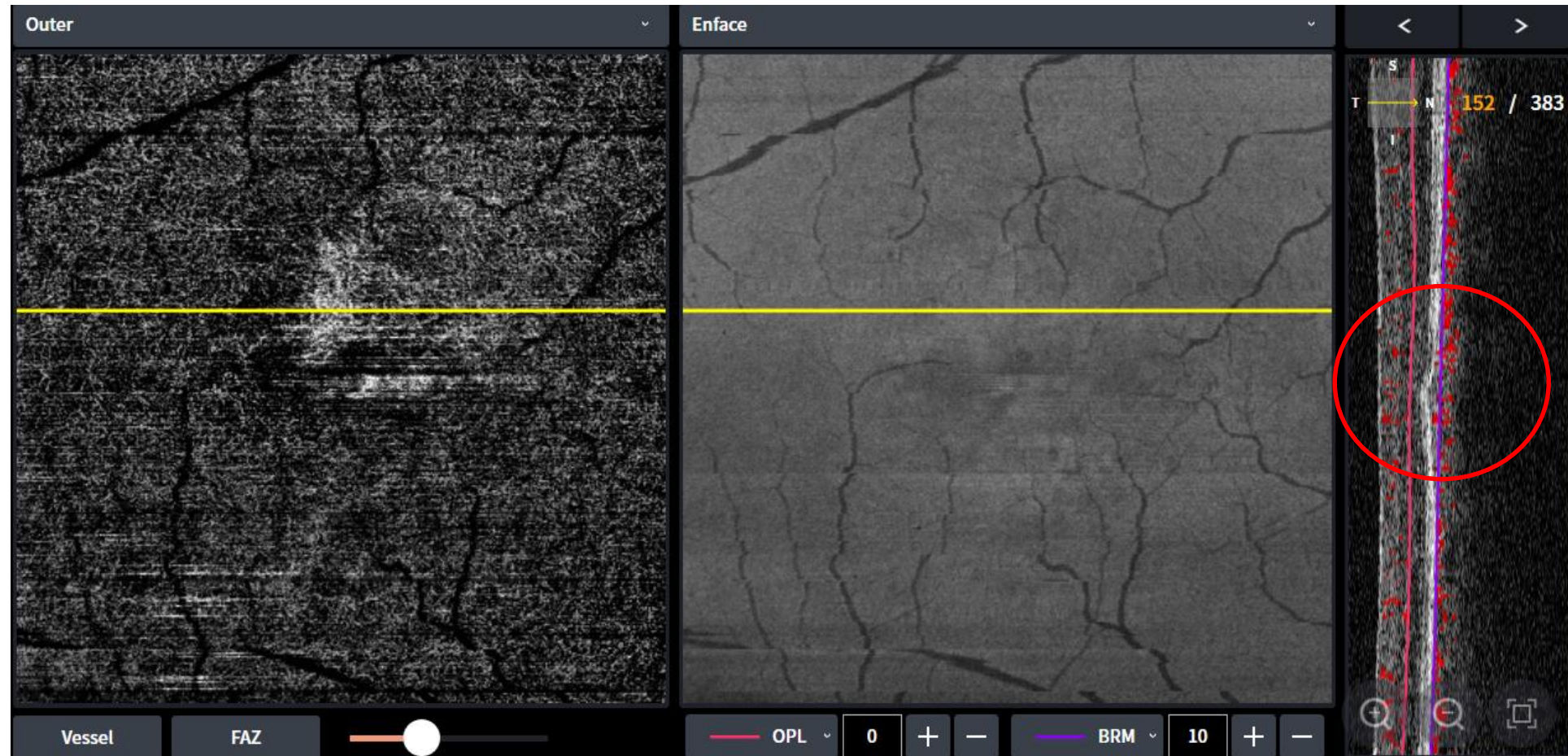
.- Pathology

thinning or depigmentation
that precede geographic atrophy
in the early stages of AMD

atrophy of the RPE
(geographic atrophy)
and/or development of
new blood vessels
(neovascularization)

.- Risk Factors

Smoking, Hypertension,
High cholestrol



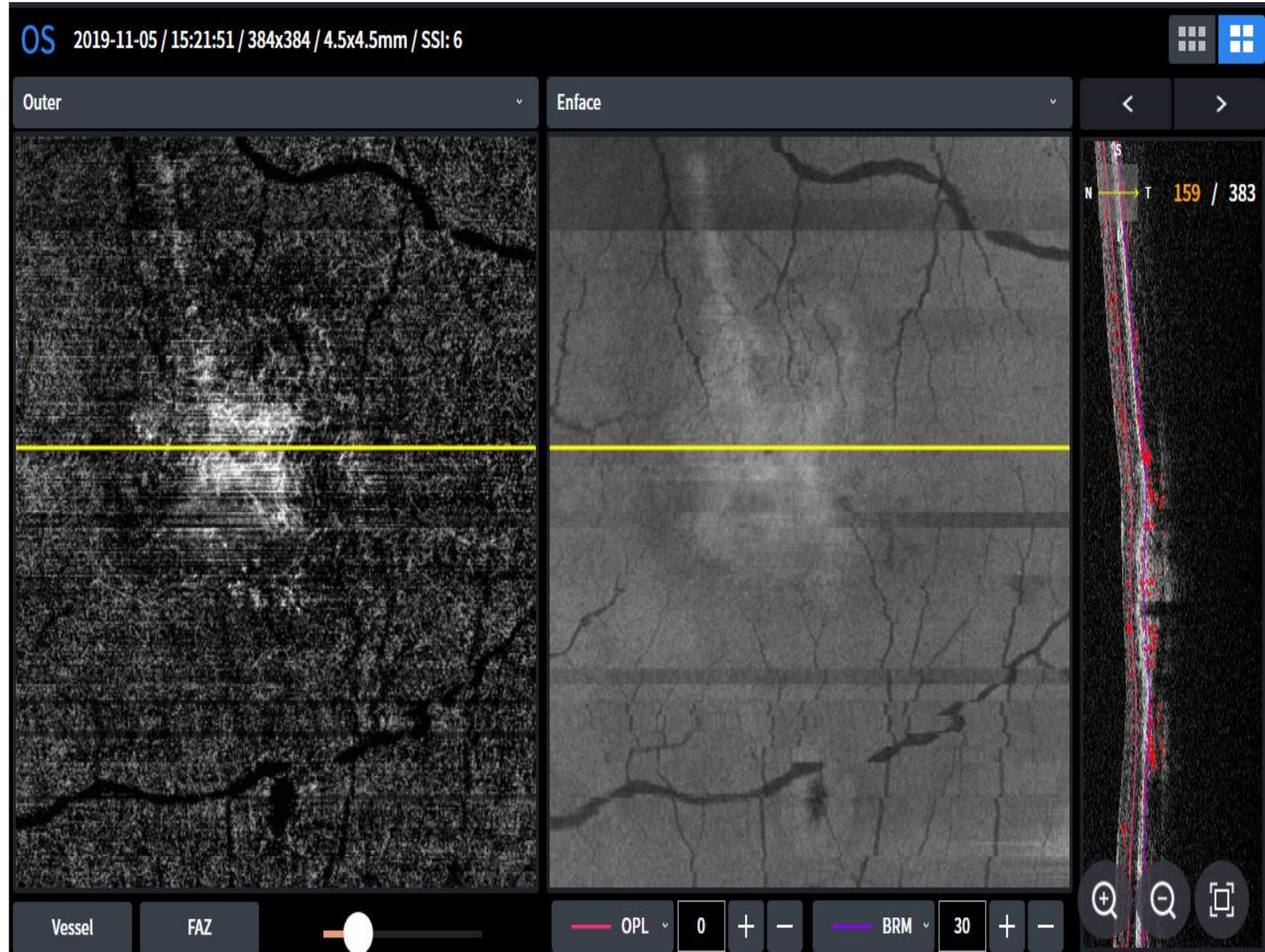
Field Test : Choroidal Neovascularization

.- Pathology

an abnormal growth of vessels from the choroidal vasculature to the neurosensory retina through the Bruch's membrane

.- Risk Factors

AMD, Aging.

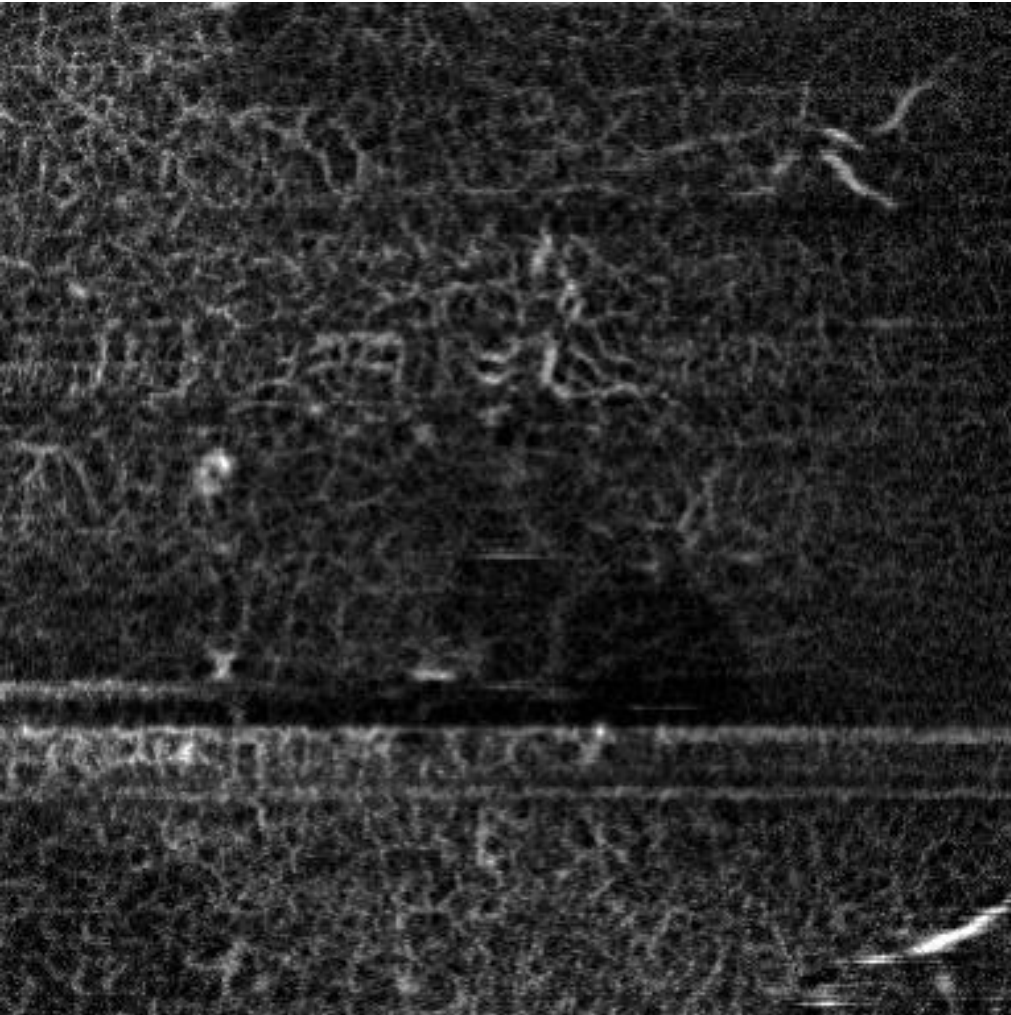


Field Test : Comparison with Spectralis

DMR

HOCT

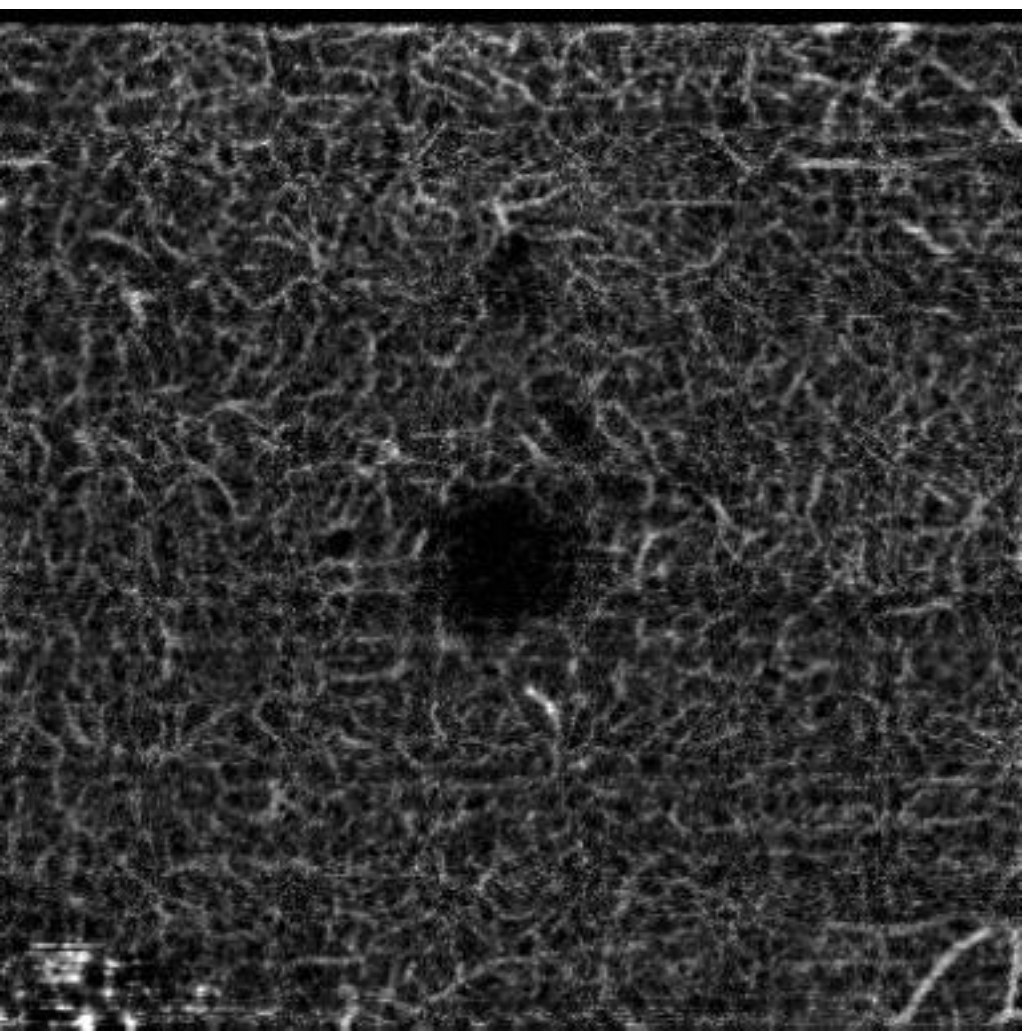
Spectralis



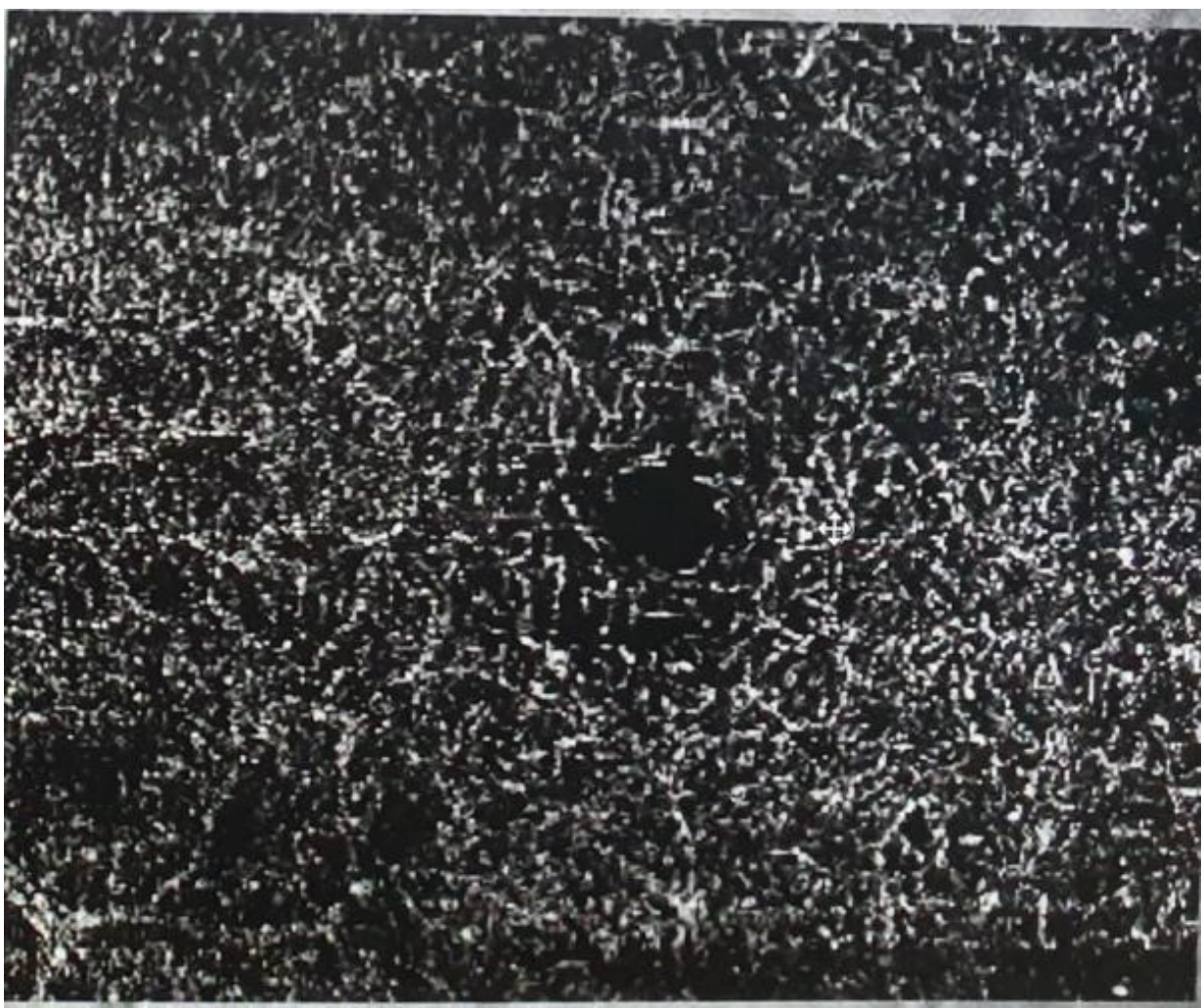
Field Test : Comparison with Spectralis

DMR (= Non-Proliferative Diabetic Retinopathy)

HOCT



Spectralis

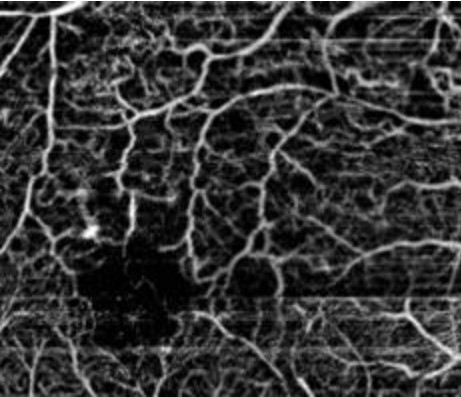
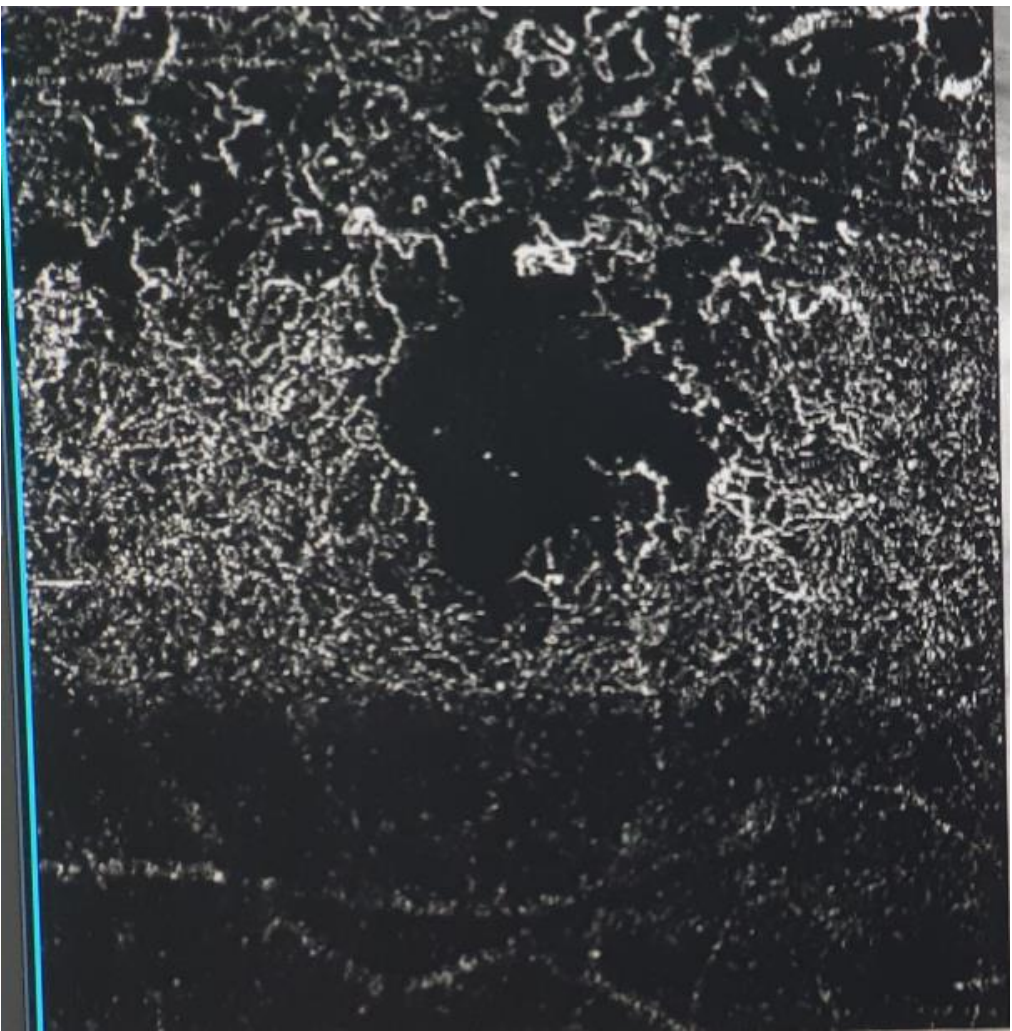
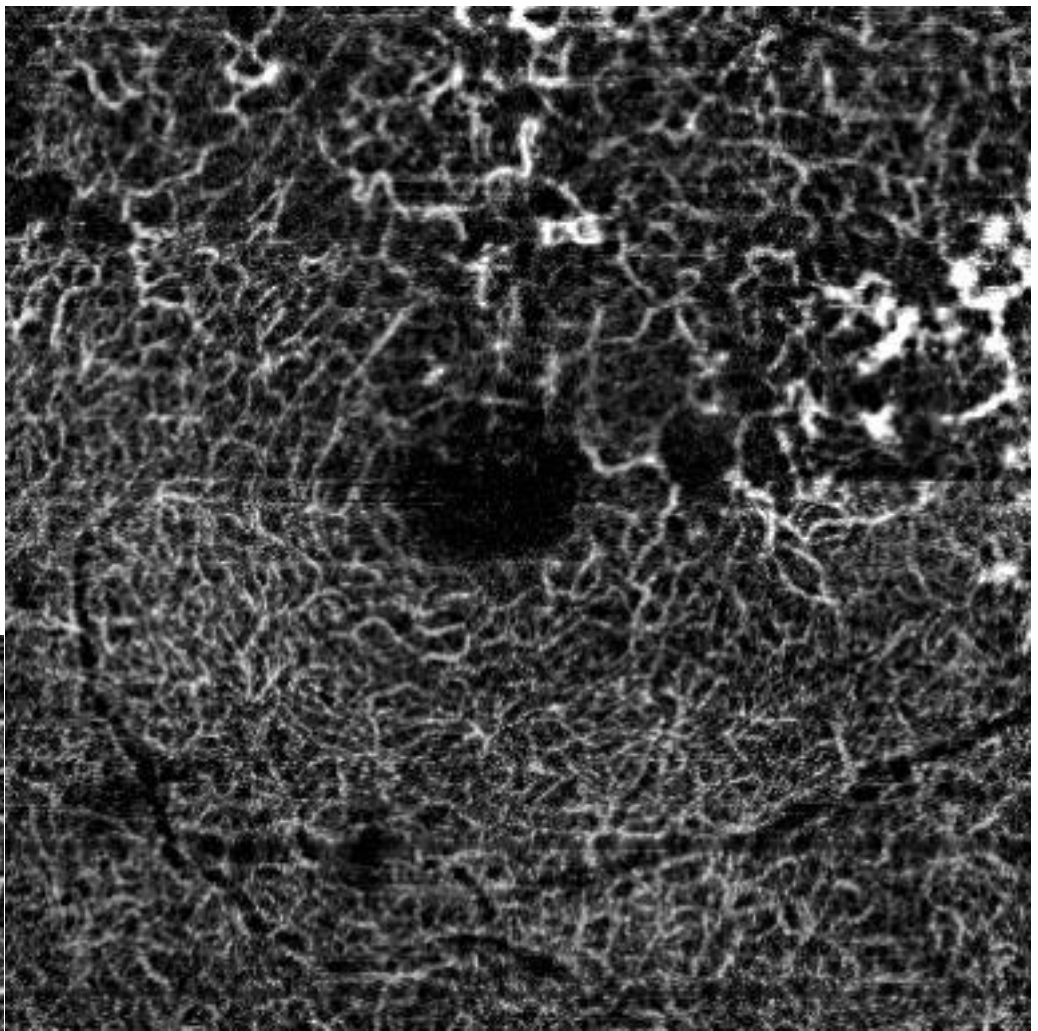


Field Test : Comparison with Spectralis

RVO

HOCT

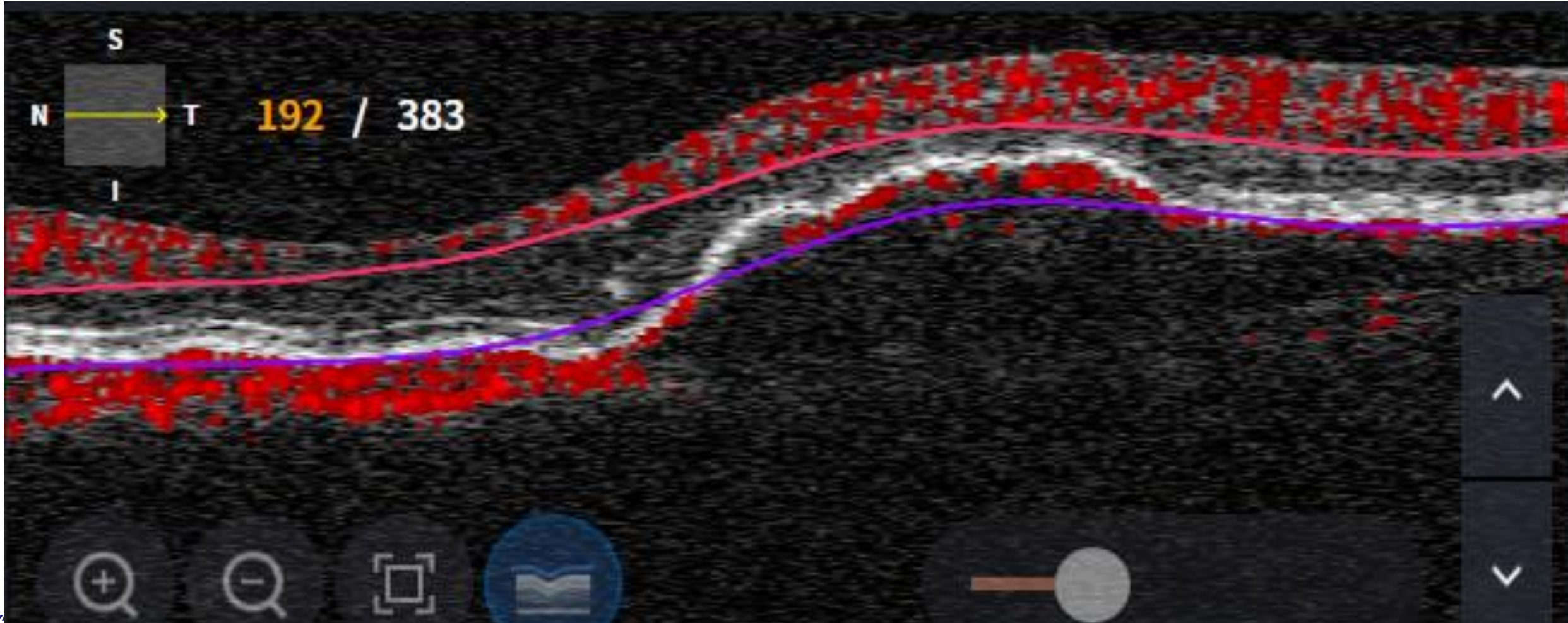
Spectralis



Field Test : Comparison with Spectralis

AMD/CNV :

B-scan

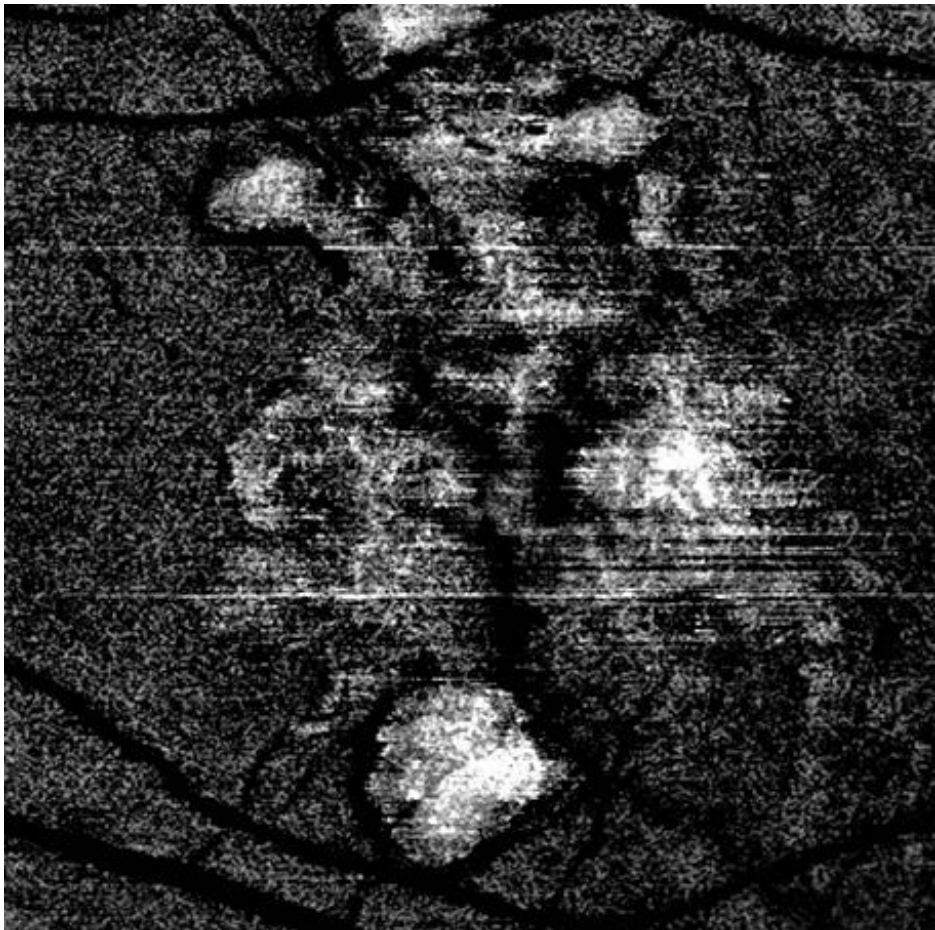
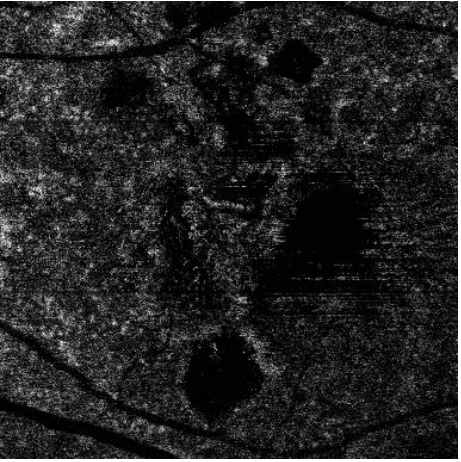
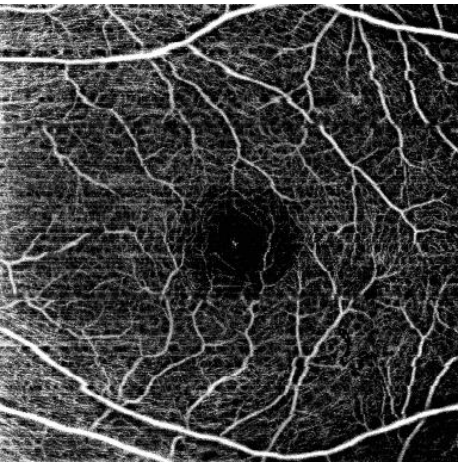


Field Test : Comparison with Spectralis

AMD/CNV :

HOCT

Spectralis



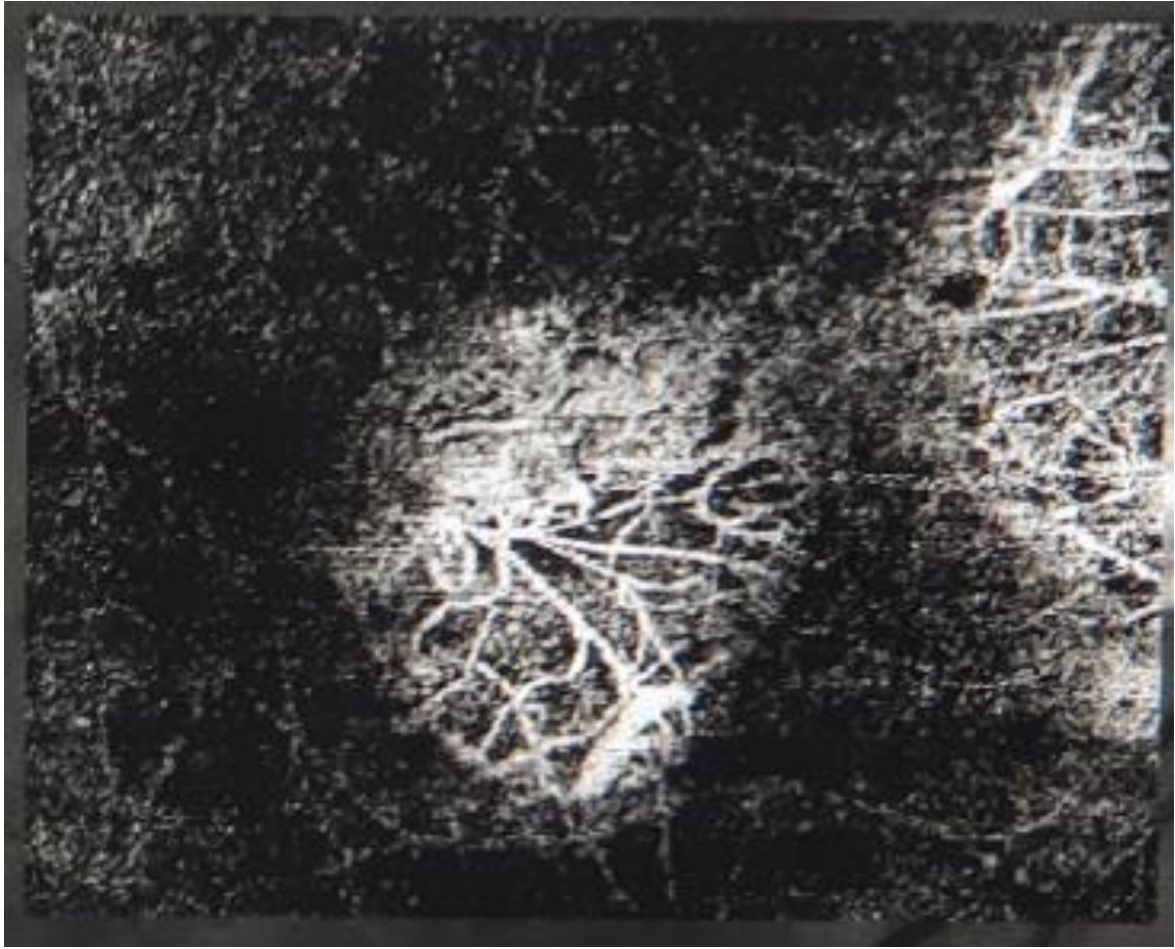
Field Test : Comparison with Spectralis

AMD/CNV :

HOCT



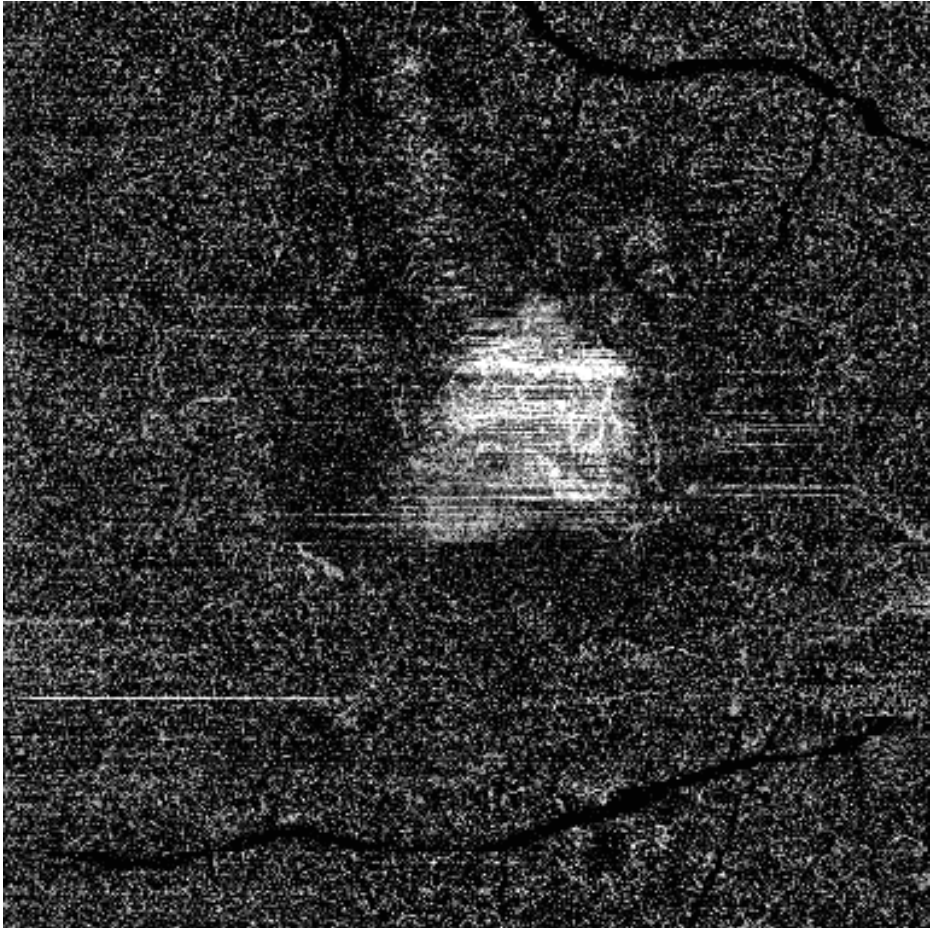
Spectralis



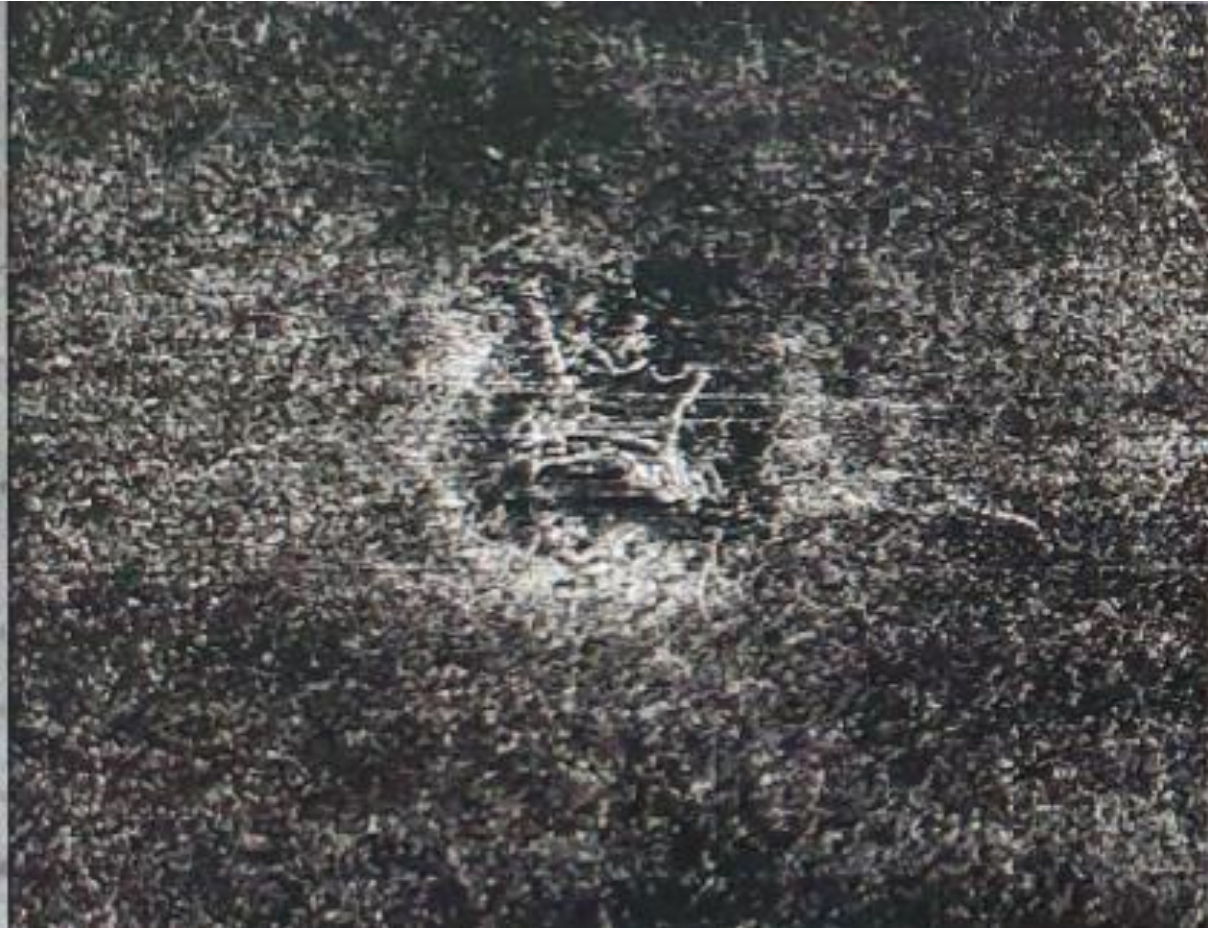
Field Test : Comparison with Spectralis

AMD/CNV :

HOCT



Spectralis

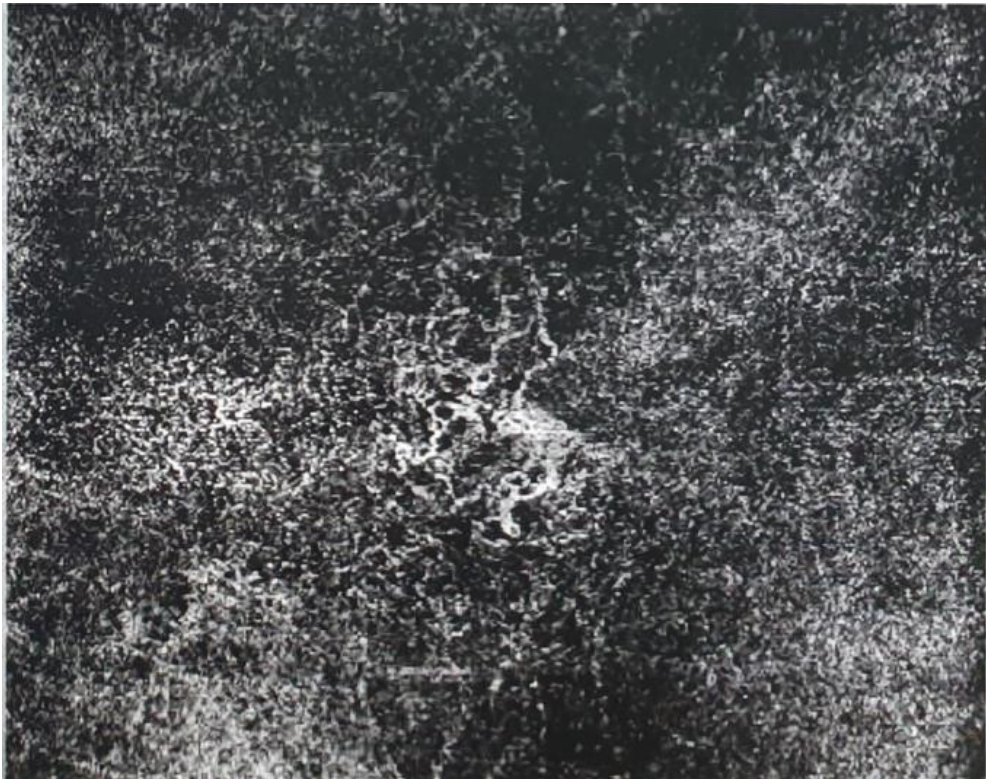
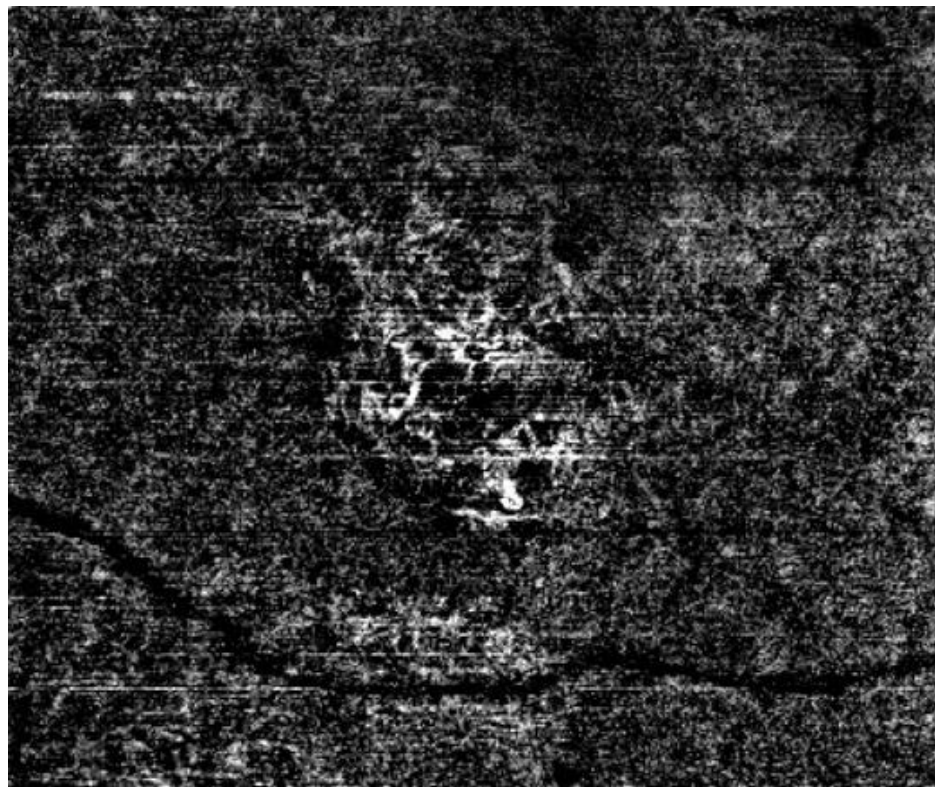


Field Test : Comparison with Spectralis

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Field Test : Comparison with Spectralis

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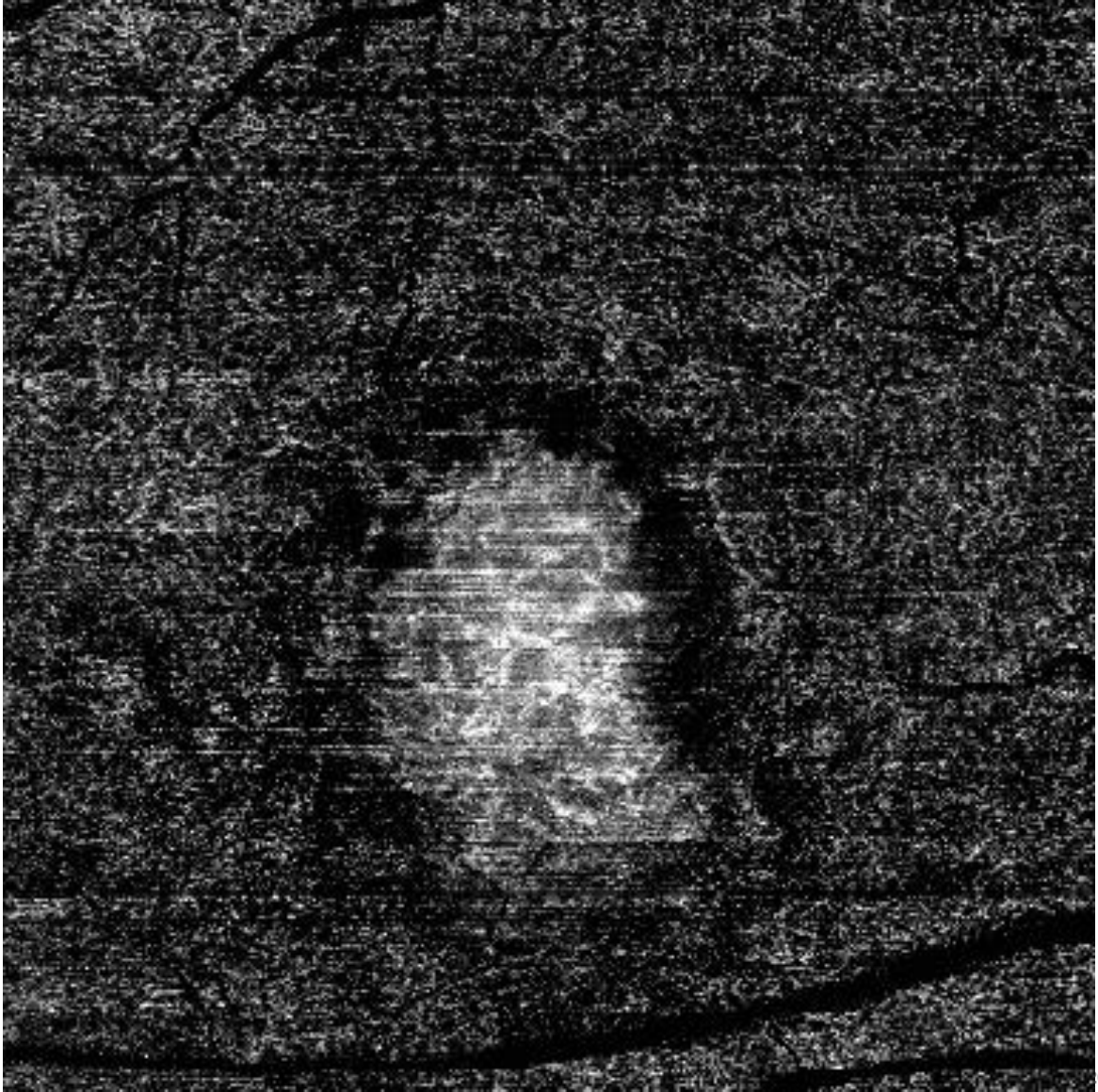
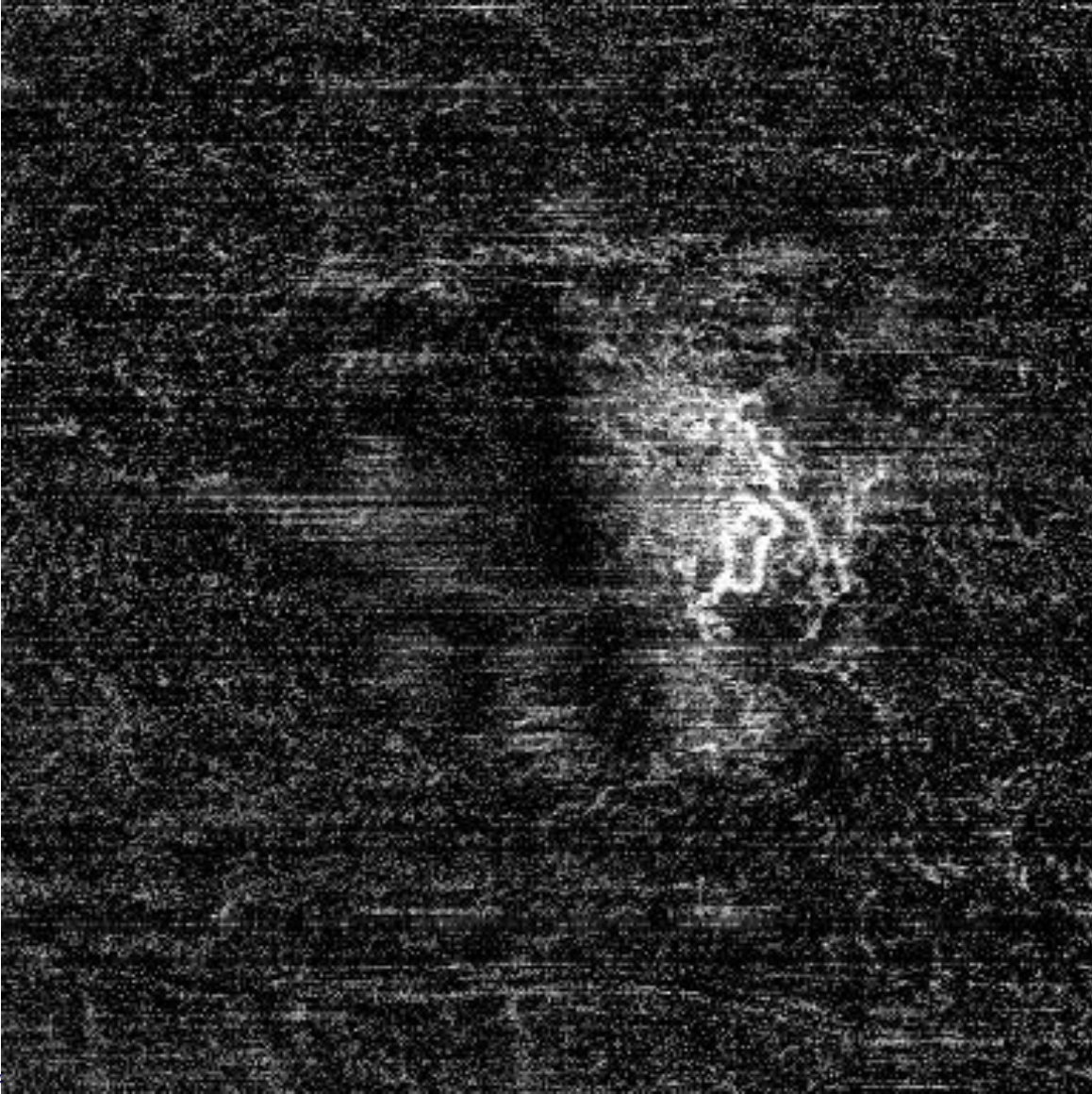


Spectralis



Samples of AMD/CNV

AMD/CNV:



Contents

- Background Knowledge
- Measurement
- Field Test
- Evaluation

Computing Time

	HOCT-Angio (SD)	HOCT-Angio (HD)	HOCT-Angio (HD)	OptoVue HD (MCT)
Points x Lines	304 x 304	384 x 384	384 x 384	304 x 304 403 x 403
Overlaps	2	2	3	2 (per 1 time)
Data Acquisition (without tracking)	5 sec	7.5 sec	12 sec	over 7.5x2 sec (camera spec)
Segmentation	1 sec	2 sec	2 sec	Processing SD : 7 sec HD : 10 sec
Registration	4 sec	5 sec	6 sec	
Projection & Correction	~ 1 sec	~ 1 sec	~ 1 sec	
Total	10 sec	15 sec	20 sec	14.5 ~ 17.5 sec

384 (A points) x 384 (B lines), 6mm x 6mm 스캔
PC Spec : Intel I-7 CPU, 32G RAM

Feature : Avanti vs HOCT

	항목	Optovue Avanti	HOCT	Eval.
Spec.	Resolution	304x304,400x400	304x304,384x384,512x512	+
	Range for Macular	3x3,6x6,8x8mm	3x3, 4.5x4.5, 6x6, 9x9	=
	Range for Optic Disc	4.5x4.5, 6x6mm	3x3, 4.5x4.5, 6x6, 9x9	=
	Stitching	X	4x3	+
	Voice Guide	X	O	+
	Anterior solution with a normal & a wide lens	O	O	=
Performance	Scan Overlaps: 2	2, Dual	2,3,4,5	=
	Min Scan Time : < 3 seconds	3, (7.5)	5.4	-
	Default Scan Time:	7.5 sec	12 sec	-
	Layer별 컬러	O	O	=
	FAZ 인식	O	O	=