

DIU - Imagerie et Pathologie Rétiniennes

Technique de réalisation de l'OCT et l'OCTA

A. Erginay, B. Haouchine



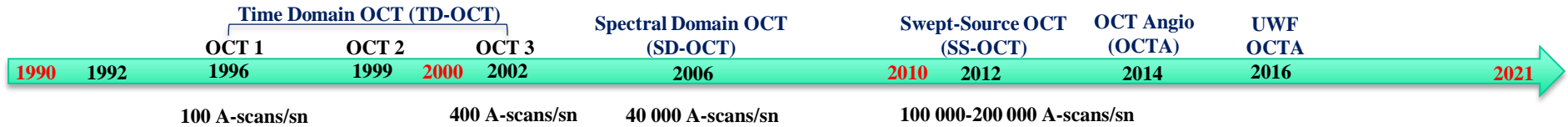
Service d'Ophtalmologie
Hôpital Lariboisière

Conflits d'intérêts

- Allergan
- Bayer
- Canon
- Novartis

sans rapport avec cette communication

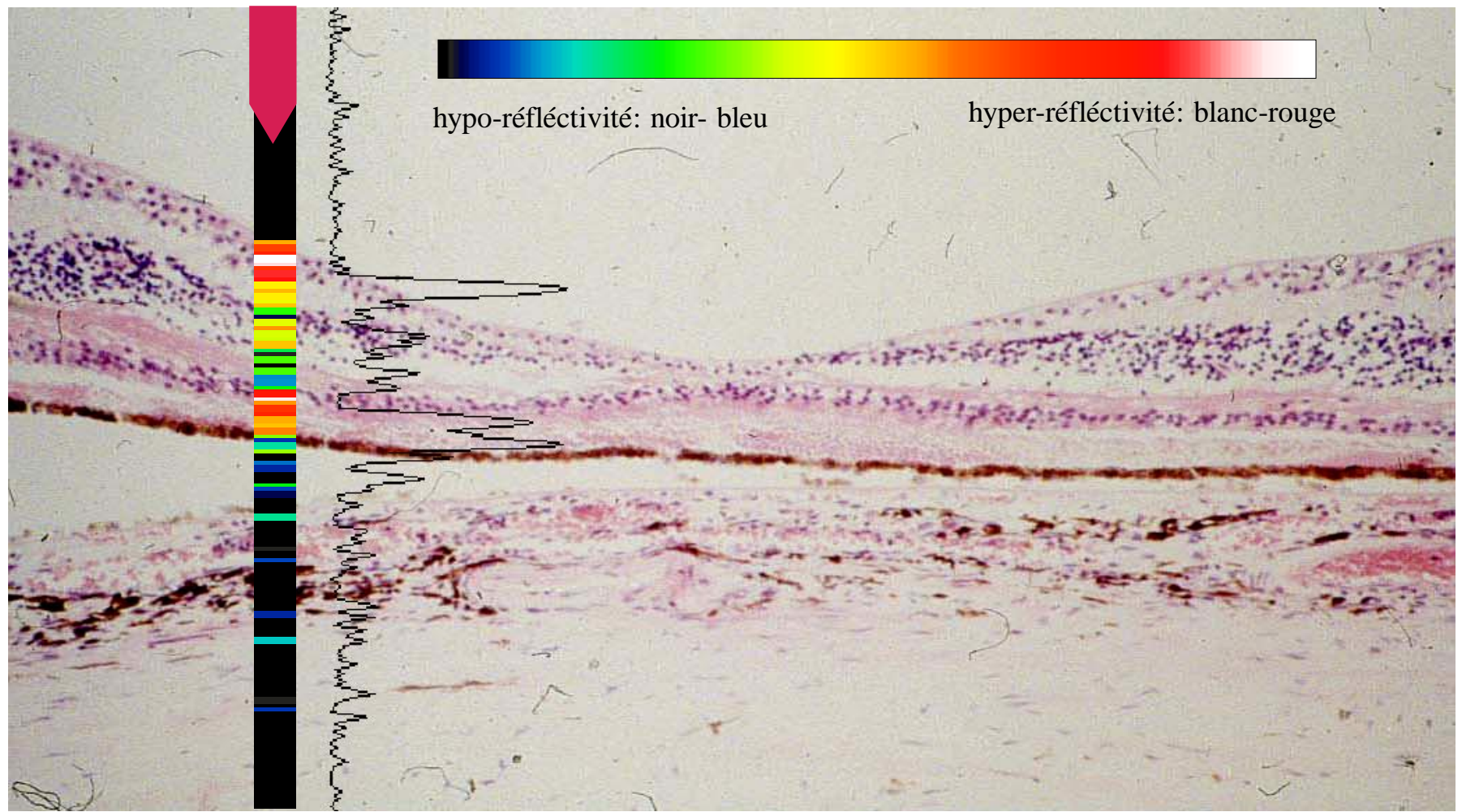
26^e Anniversaire de l' OCT



Vitesse de scan (*A-scans per second*): 100 A-scans/sn ➡ 200,000 A-scans/sn

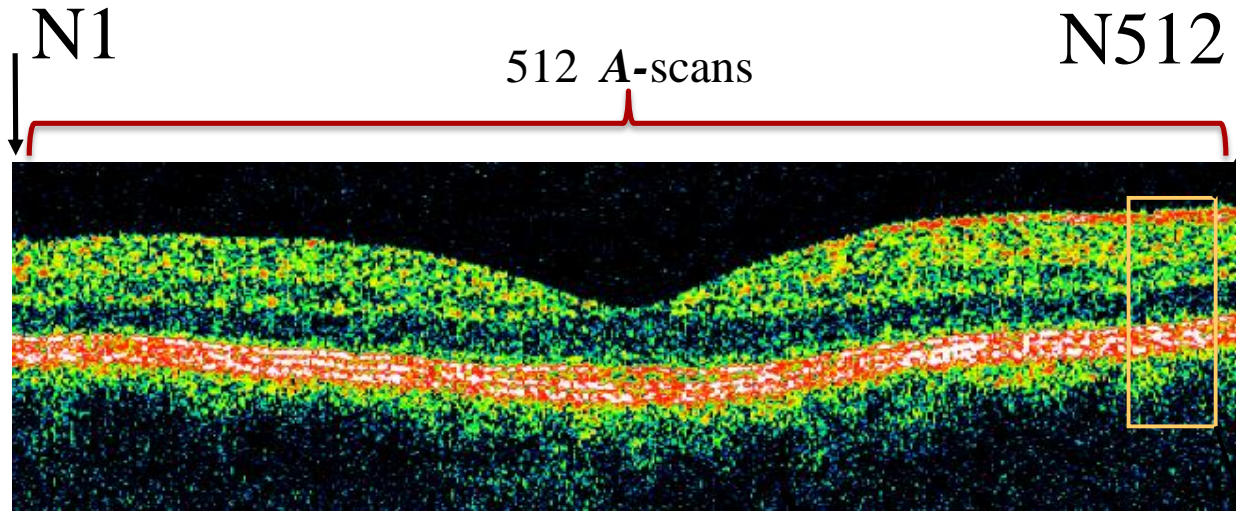
Résolution axiale: 12 μm ➡ 4-5 μm

Résolution longitudinale (*A scan / B scan*): 128 ➡ 4096

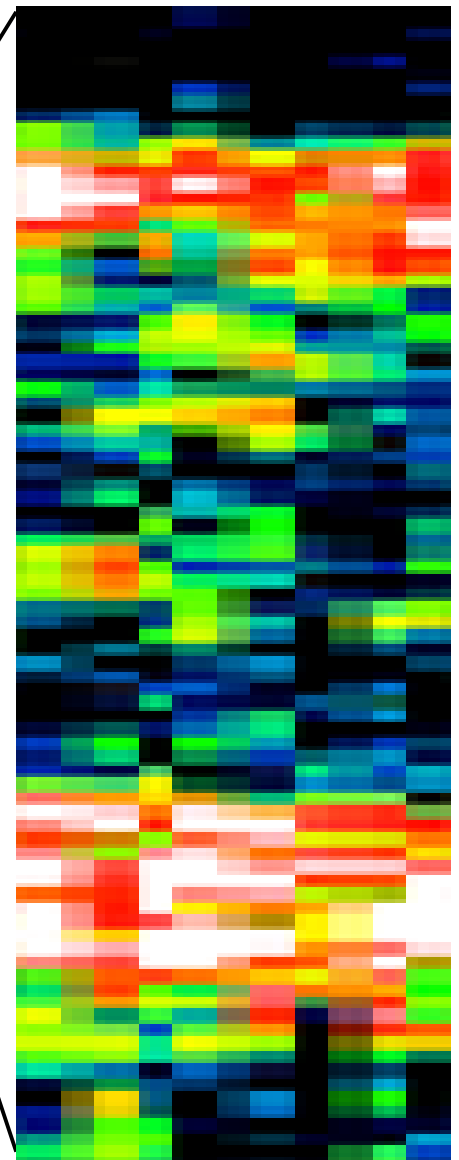


Enregistrement du signal de réflexion sous forme de pics d'amplitude variable comparable à un « **écho A** » (on utilise la lumière et non les Ultrasons) ➡ **A-Scan**

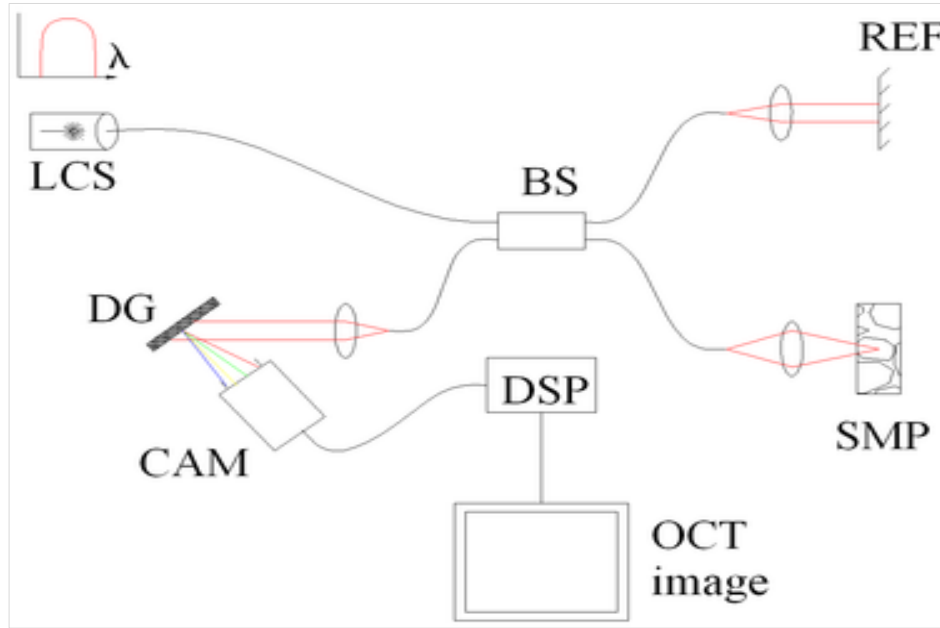
OCT 3



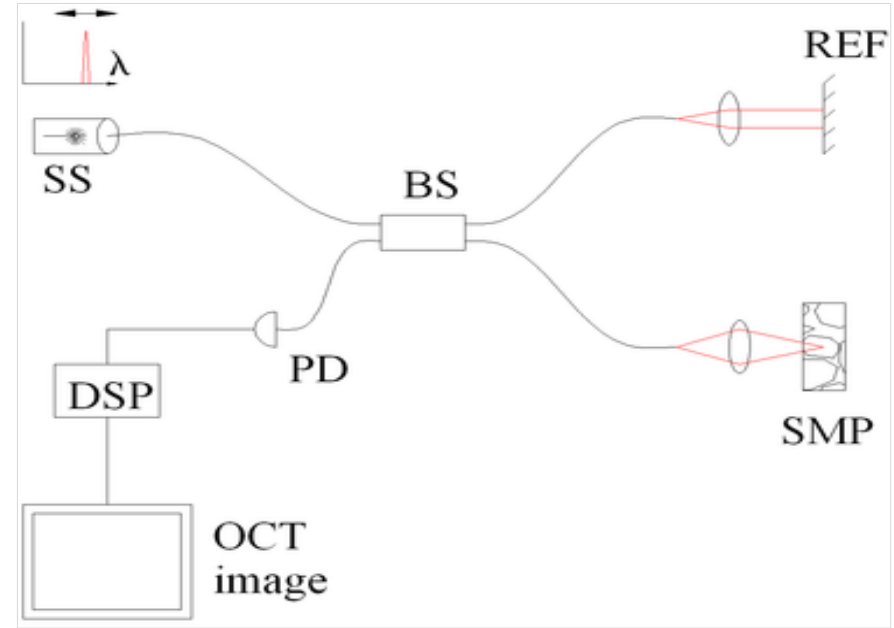
- L'image en OCT3 est composée de 512 (résolutions à 128 & 256 possibles) A-scans successifs en 1,28 sec
- Résolution longitudinale d'environ 8-10 μ m



Swept Source OCT (SS-OCT)



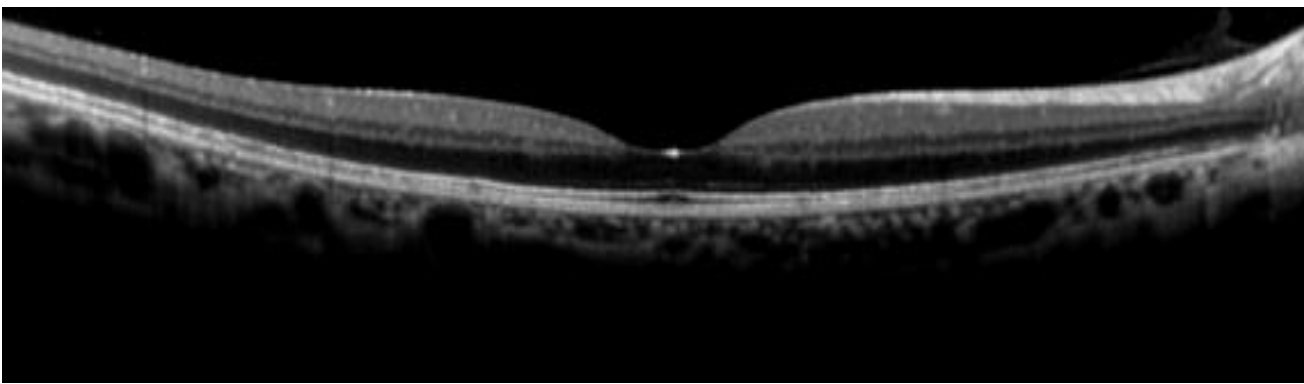
Spectral discrimination by fourier-domain OCT. Components include: low coherence source (LCS), beamsplitter (BS), reference mirror (REF), sample (SMP), diffraction grating (DG) and full-field detector (CAM) acting as a spectrometer, and digital signal processing (DSP)



Spectral discrimination by swept-source OCT. Components include: swept source or tunable laser (SS), beamsplitter (BS), reference mirror (REF), sample (SMP), photodetector (PD), digital signal processing (DSP)

SD-OCT & SS-OCT

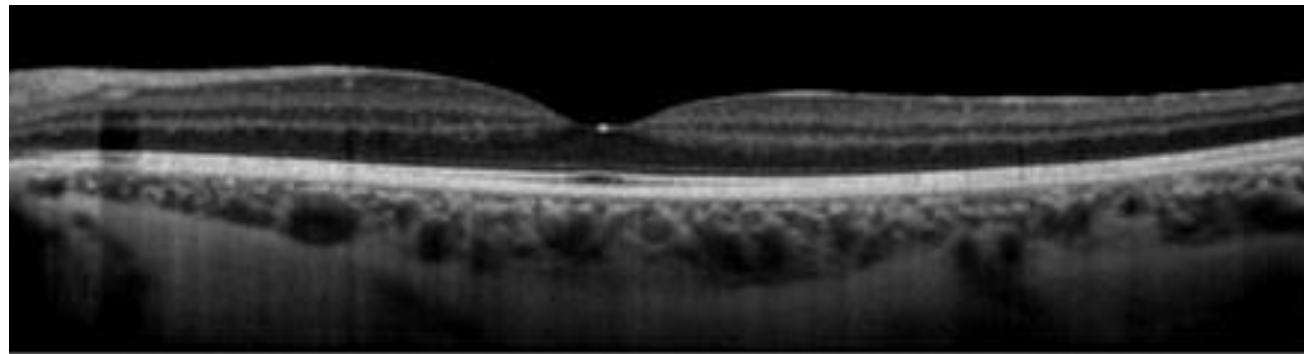
- Vitesse d'acquisition
 - 80 000 à 100 000 A-scans/sec
 - 100 000 à 200 000 pour le SS-OCT
- Résolution axiale
 - 5-7 μm
 - 6,3 μm le SS-OCT (Cirrus)
- Meilleure résolution longitudinale (A scan / B scan)
 - 128 lignes x 512 pts (Cirrus)
 - 400 lignes x 400 pts (Optovue)



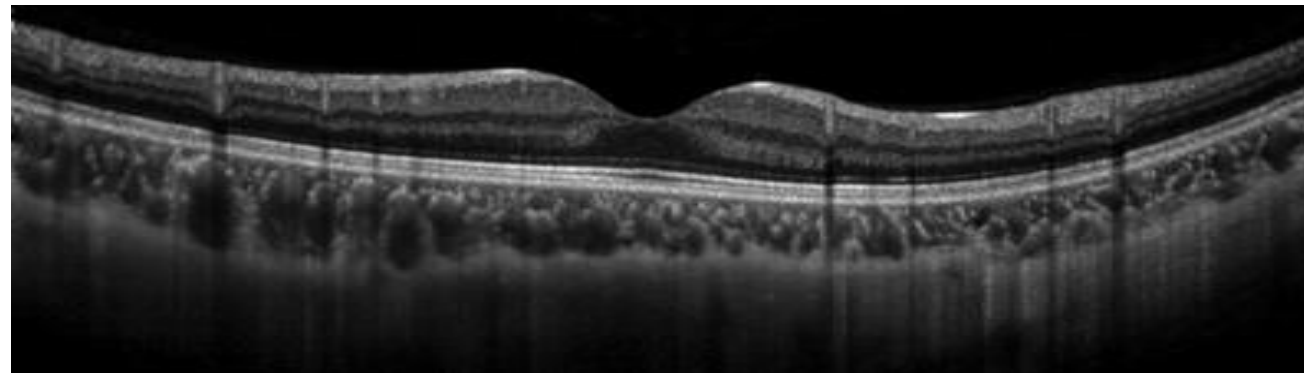
OCT Spectral

820 -880 nm

50.000 scans/s



OCT spectral- MODE EDI

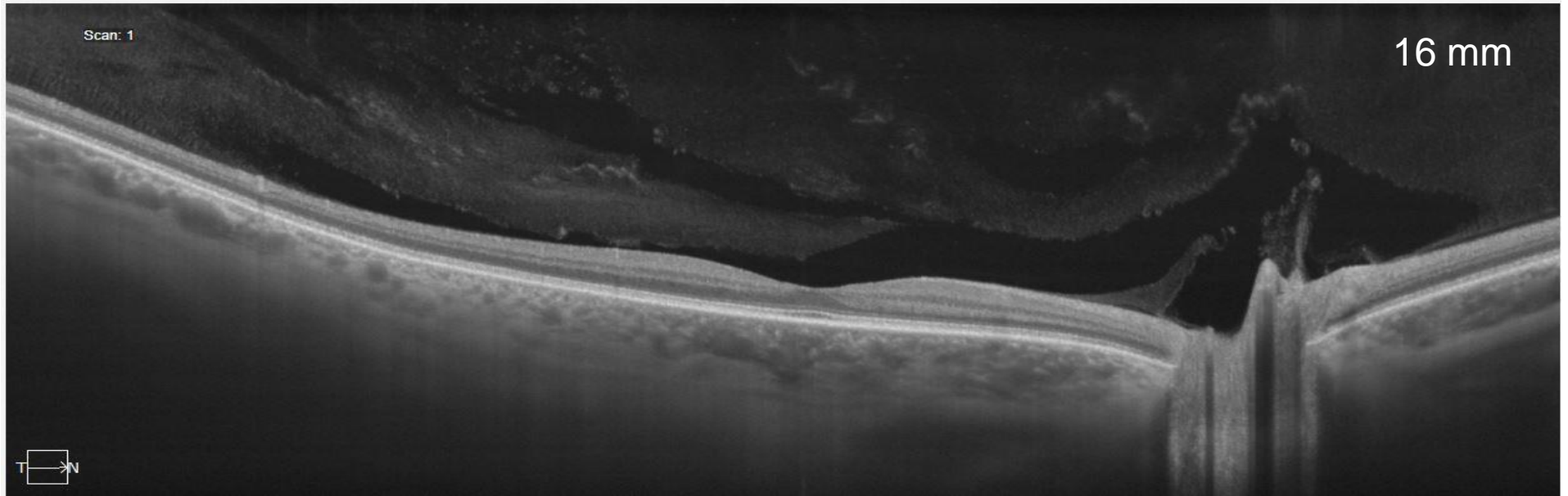
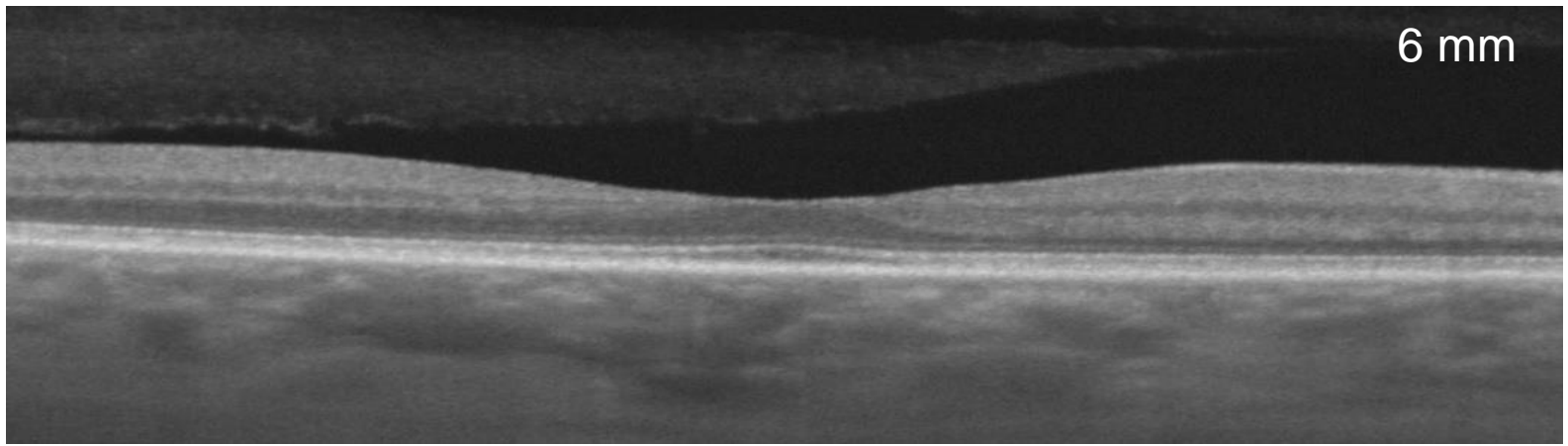


Swept Source OCT

1050 nm

100.000 scans/s

Topcon



OCT / OCTA

CANON

- OCT-HS 100 + the Angio Expert AX
- Xephilio OCT-S1, **SS OCT**

OPTOPOL

- Flux
- REVO NX
- SOCT Copernicus REVO

NIDEK

- OCT SPECTRAL RS-3000 ADVANCE + ANGIOSCAN
- OCT SPECTRAL + RNM RS-330 RETINSCAN DUO
- MIRANTE

OPTOVUE

- Angiovue
- Avanti
- iVue80 & iFusion80
- iScan80

TOPCON

- 3D OCT-2000
- 3D OCT-1 Maestro
- DRI OCT Triton, **SS OCT**

ZEISS

- Cirrus 500
- Cirrus 5000, 6000
- PlexElite 9000, **SS OCT**
- Primus 200

OPTOS

- Monaco
- Silverstone, **SS OCT**

HEIDELBERG

- Spectralis OCT-2

Critères pour obtenir une bonne qualité des examens (1)

Avant de capturer une image, suivez ces directives afin d'optimiser la qualité des images.

1. L'image de l'iris :

- Centrez l'image de l'iris à l'intérieur de la pupille (celle-ci peut être légèrement déplacée en fonction de l'inclinaison de la rétine ou afin d'éviter l'opacité).
- Centrée sur le détail de l'iris.

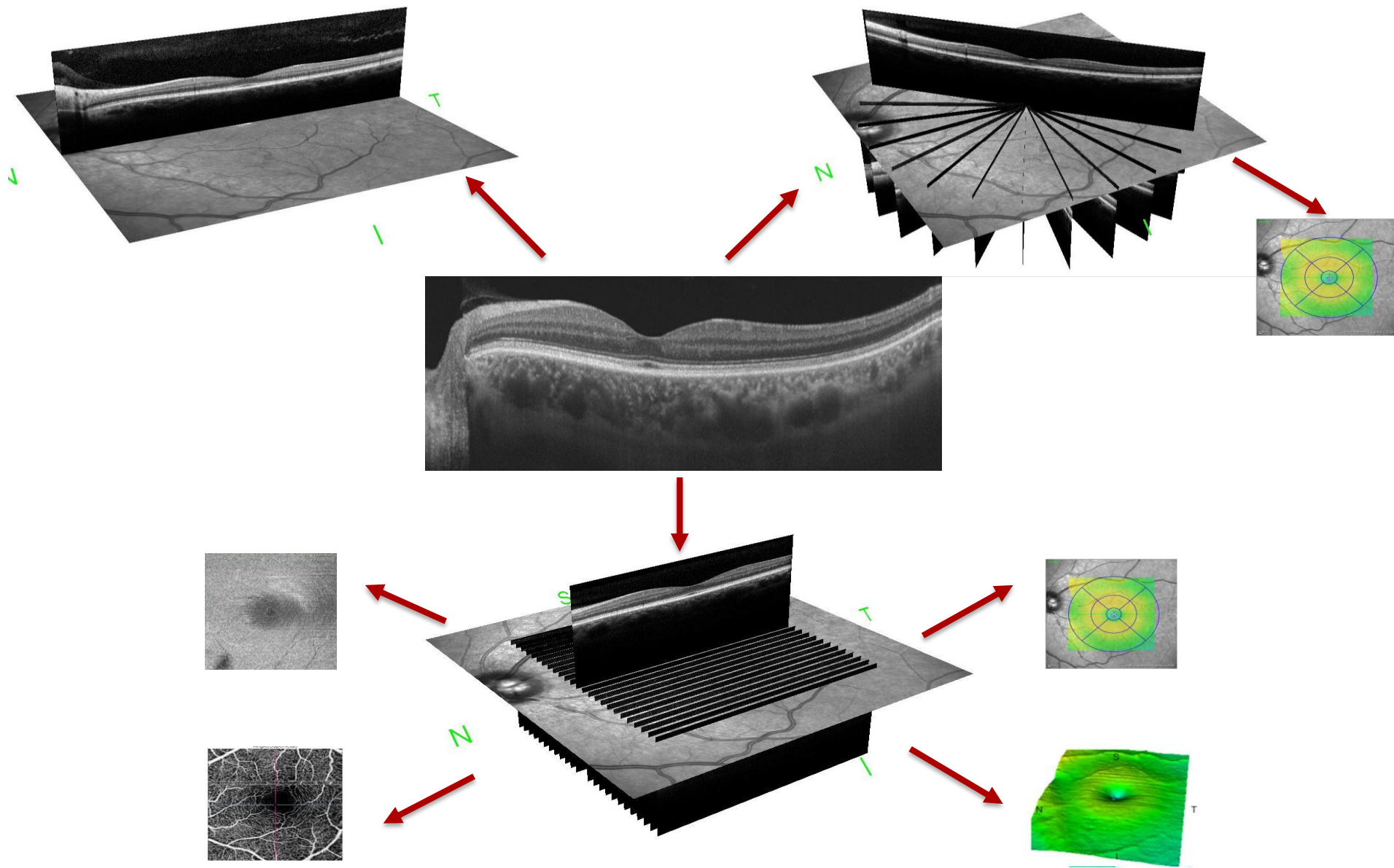
2. L'image du fond d'oeil :

- La focalisation doit être forte et claire, de préférence avec une bonne visibilité de la ramification des vaisseaux sanguins.
- Centrez le calque d'examen sur la fovéa pour les examens maculaires et sur la tête du nerf optique pour les examens de disque optique.
- Assurez un éclairage uniforme sans les coins sombres.
- Il n'y devrait pas avoir d'artéfacts ou, le cas échéant, il y devrait en avoir peu, car ceux-ci peuvent jeter des ombres sur les examens OCT.
- L'image en-face OCT doit avoir un minimum de saccades et pas de saccades à travers la zone d'intérêt (macula, par exemple).
- Les corps flottants peuvent être souvent déplacés en demandant au patient de changer les yeux avant de la capture d'image.
- Les opacités cornéennes peuvent être minimisées par le réalignement de la Pupille

Critères pour obtenir une bonne qualité des examens (2)

3. L'examen OCT :

- Centrez l'examen OCT dans la partie moyenne vers supérieure de l'écran d'acquisition d'examen.
- L'examen OCT de type B doit être complet dans toutes les fenêtres, sans données manquantes.
- La densité des couleurs devrait être la même de bout en bout.
- La force du signal devrait être 6 ou supérieure.
- Une rétine inclinée peut être corrigée par le déplacement de la pupille hors du centre de l'alignement pour permettre un niveau plus grand de l'examen OCT.
- Ajustez le réglage d'amélioration pour obtenir le plus brillant et le plus clair examen.



CIRRUS HD-OCT (*Zeiss*)



Image FO: SLO

Source optique : superluminescent diode (SLD), 840 nm

Puissance optique: < 725 μ W à l'entrée

Vitesse d'examen: **100,000 A-scans per second**

Profondeur A-scan : 2.0 mm (dans les tissus), 1024 points

Résolution axiale : 5 μ m (dans les tissus)

Résolution transversale: 15 μ m (in tissue)

Champs de vision: 36 degrees W x 30 degrees H

FastTrac™ ++

- OCT 1 (*1996*)
- OCT2 (*1999*)
- OCT3 (*2002*)
- Cirrus (*2007*)
- PlexElite 9000 (*2016*)

Cirrus obtains up to 200 B-Scans along a 6 x 6 mm box in less than 2 seconds, creating a 3D cube with minimal data interpolation

test, test**Date de naissance: 16/09/1956****ID: CZMI402903878****Visit History****04/05/2021**

HD Raster (1 or 5 Line) OD

HD Raster (1 or 5 Line) OD

09/04/2021

Macular Cube 512x128 OD

17/06/2020

Macular Cube 512x128 OD

Optic Disc Cube 200x200 OD

Macular Cube 512x128 OS

Optic Disc Cube 200x200 OS

Optic Disc Cube 200x200 OS

26/02/2020

Anterior Segment Cube 512x128 OD

24/06/2019

Macular Cube 512x128 OD

Angiography 3x3 mm OD

19/11/2018

Macular Cube 512x128 OD

Optic Disc Cube 200x200 OD

16/08/2016

Macular Cube 512x128 OD

HD Raster (1 or 5 Line) OD

HD Raster (1 or 5 Line) OD

Optic Disc Cube 200x200 OD

Anterior Segment 5 Line Raster OD

ProtocolsRépéter la
dernière visite

Rétine

Glaucome

Segment
antérieur

Tous les examens

AngioPlex

Examen de l'état
physique**Protocol Details**

Macular Cube (200x200, 512x128)

HD Scans (Radial, Cross, 1, 5, 21 Line)

Optic Disc Cube 200x200

Anterior Segment Cube 512x128

Pachymetry

Angiography (3x3, 6x6, 8x8 mm)

Montage Angiography (6x6, 8x8 mm)

ONH Angiography

5 Line Raster

HD (Angle, Cornea)

Anterior Segment 5 Line Raster



Tous les examens

Répéter la dernière visite

Rétine

AngioPlex

Glaucome

Segment antérieur

Examen de l'état physique

Macular Cube 512x128

HD Raster (1 or 5 Line)

Optic Disc Cube 200x200

Angiography 6x6 mm

Angiography 8x8 mm

Angiography 3x3 mm

Anterior Segment 5 Line Raster

Macular Cube 200x200

HD 1 Line 100x

HD 21 Line

HD Radial

HD Cross

5 Line Raster

HD Angle

Anterior Segment Cube 512x128

Macular Cube 512x128

HD Raster (1 or 5 Line)

Angiography 3x3 mm

Angiography 6x6 mm

Angiography 8x8 mm

Améliorer



Centrer

Mise au point
automatique

-20 20

Mise au point

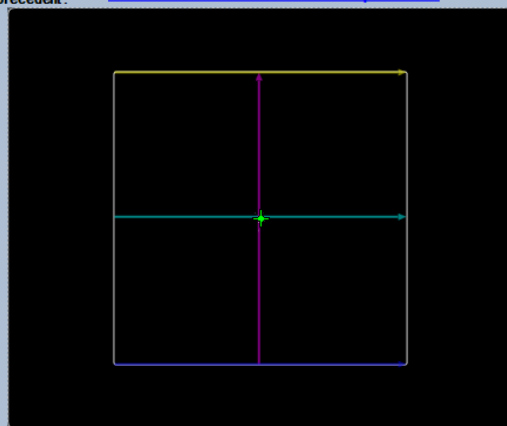
Transparence: 100%



Optimiser



Capturer

Examen
précédent: [Veuillez sélectionner un examen précédent](#)

État:



ID du patient

Protocoles

Acquérir

Analyser

Terminer

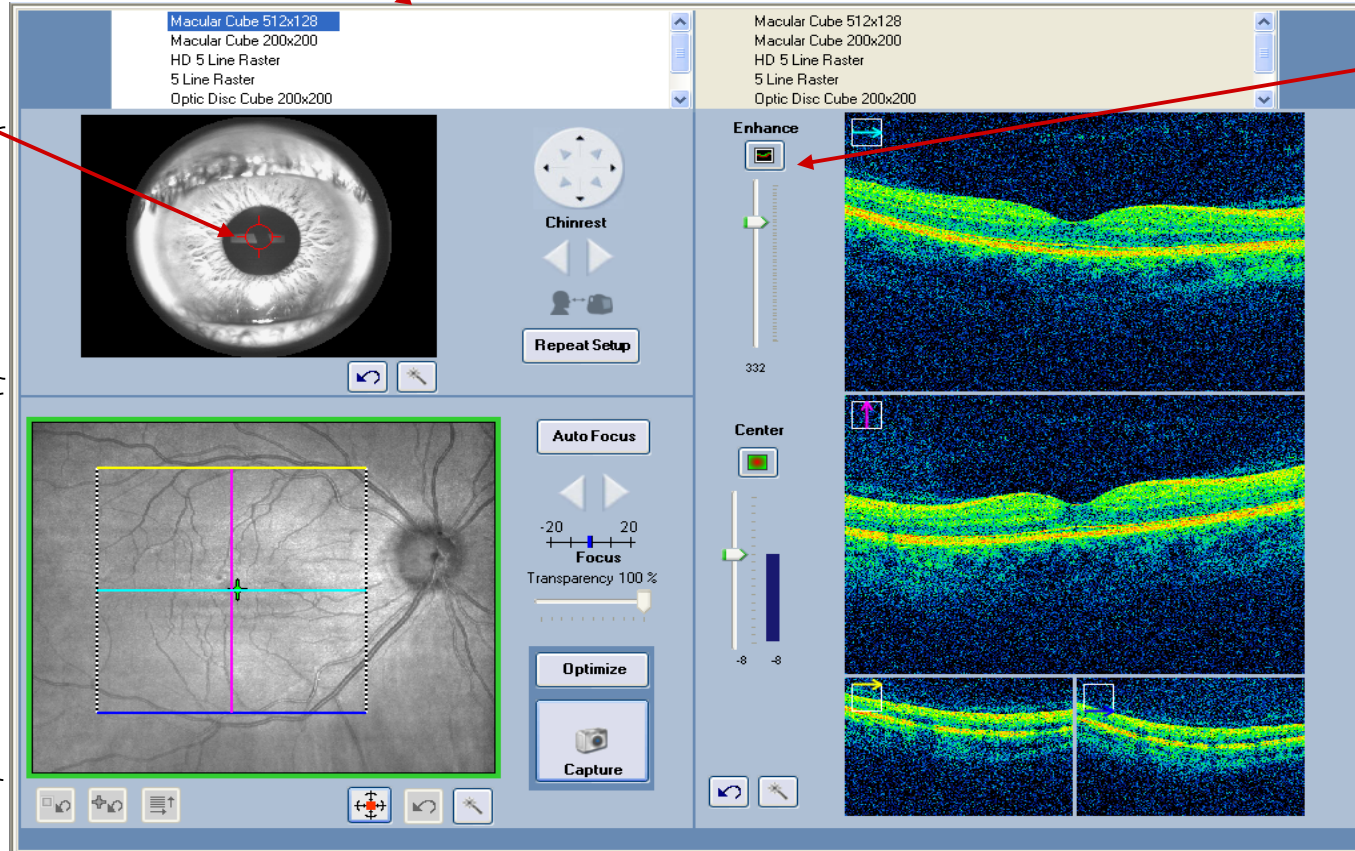
Fenêtre d'acquisition pour Macular Cube (CIRRUS 5000)

Liste d'examens OD et OG

Cliquer au centre de la pupille pour aligner l'oeil

Fenêtre de l'iris et commandes plus répétition du réglage

Fenêtre du fond d'oeil avec examen Calque et commandes



Polarization

Affichage de l'examen et commandes

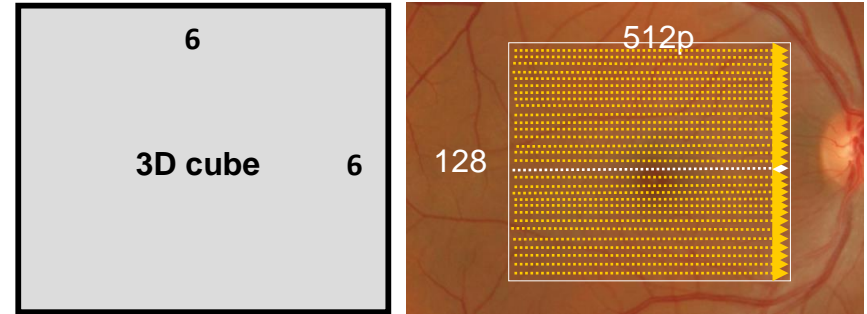
La taille minimale de pupille est 2mm

Protocole d'acquisition pour Cube Maculaire (*CIRRUS 5000*)

- **Macular Cube (3D-Scan)** – génère deux types de scans :

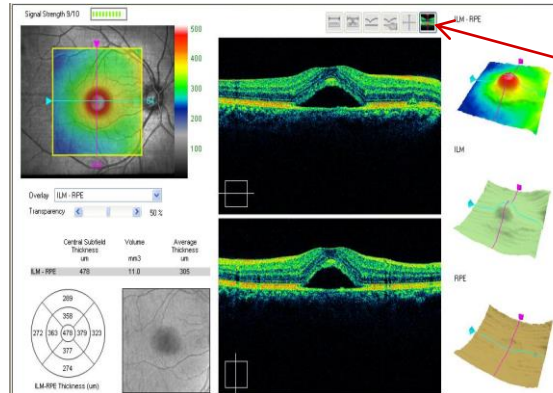
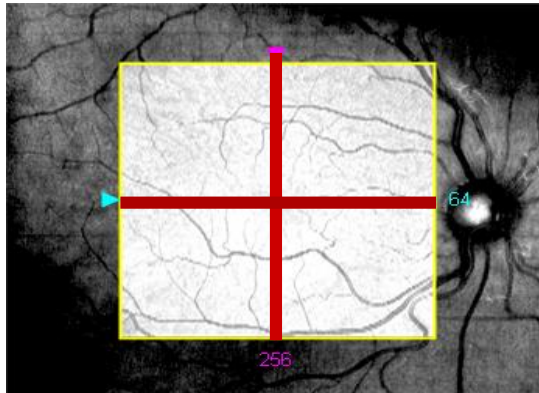
- **Cube Scan 6mm x 6 mm**

- 128 B-scans X 512 A-scans
- 200 B-scans X 200 A-scans



- **HD Cross Hair Scan**

- 2 B-scans of 1024 A-scans each (part of the cube package, acquired automatically with the Macula Cube – do not need to be acquired separately) for Macular Cube 512x128



Click on icon to toggle between HD-Cross hair and standard view

Fenêtre d'acquisition pour Line Raster (CIRRUS 5000)

Macular Cube 512x128
Macular Cube 200x200
HD 5 Line Raster
5 Line Raster
Optic Disc Cube 200x200

Macular Cube 512x128
Macular Cube 200x200
HD 5 Line Raster
5 Line Raster
Optic Disc Cube 200x200

Enhance

Center

Chinrest

Repeat Setup

Auto Focus

-20 20

Focus

Transparency:

Custom Scan Pattern

Rotation: 0 (0-90, 270-359, degrees)

Length: 6 (mm)

Spacing: 3 (mm)

Close

Custom Scan Pattern

Rotation: 65 (0-90, 270-359, degrees)

Length: 9 (mm)

Spacing: 0.25 (mm)

Close

Custom Scan Pattern

Rotation: 0 (0-90, 270-359, degrees)

Length: 6 (mm)

Spacing: 0.25 (mm)

Close

Valeur par défaut

Tous les examens

Répéter la dernière visite

Rétine

AngioPlex

Glaucome

Segment antérieur

Examen de l'état physique

ONH Angiography 4.5x4.5 mm

HD 1 Line 100x

HD 21 Line

HD Radial

HD Cross

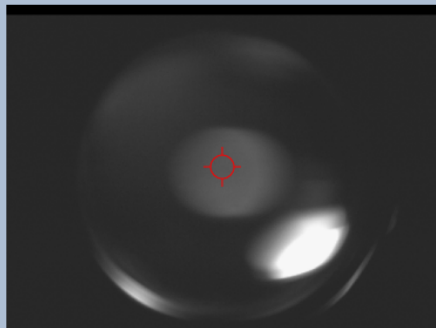
Anterior Segment Cube 512x128

Angiography 3x3 mm

Angiography 6x6 mm

Angiography 8x8 mm

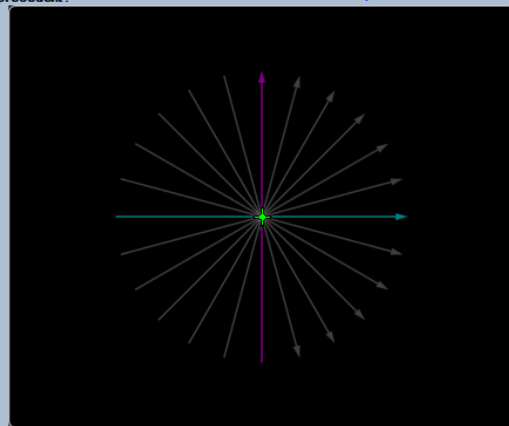
Montage Angio 6x6 mm



Mentonnière



Examen précédent: Veuillez sélectionner un examen précédent

☐ EDI

Mise au point automatique



-20 20

Mise au point

Transparence: 100%



Optimiser



Capturer



Améliorer



Centrer



T N

S T

État:



ID du patient

Protocoles

Acquérir

Analyser

Terminer

Protocole d'acquisition pour Line Raster

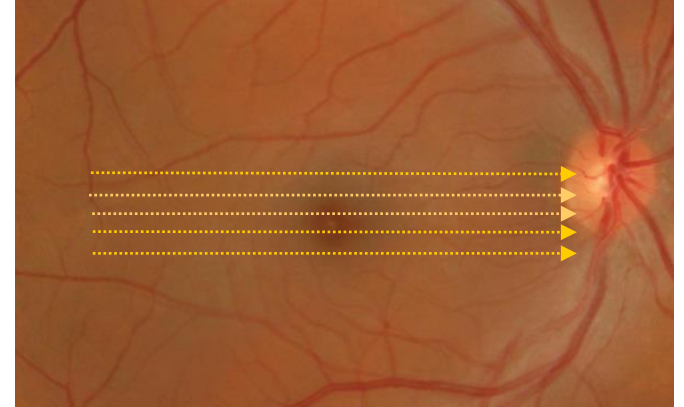
- **5 Line-Raster**

- **5 Line-Raster**

- Rotation : 0° - 360°
 - Longueur: 3.0 - 6.0 – 9.0 mm, 4096 A-scans
 - Espacement (mm) : 0.025, 0.05, 0.075, 0.125, 0.2, **0.25**, 0.5, 1.25

- **HD 5 Line-Raster** (5x1024 A-scans)

- **HD 1 Line-Raster 20x** (20x1024 A-scans)



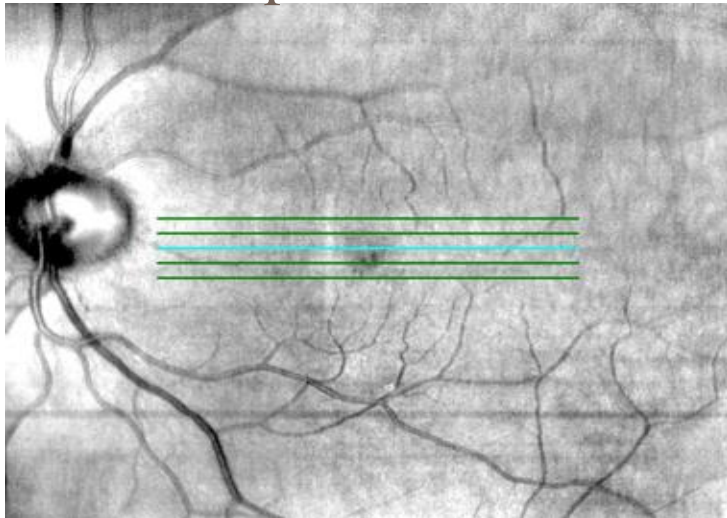
L'espacement des lignes

0.25 mm

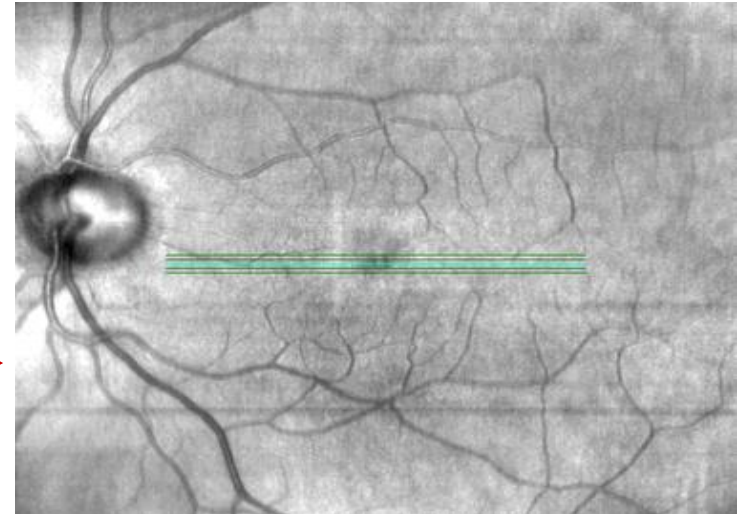
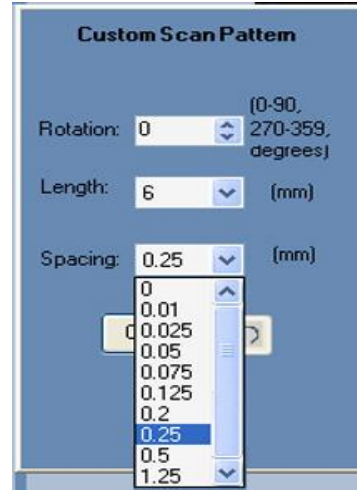


0.075 mm

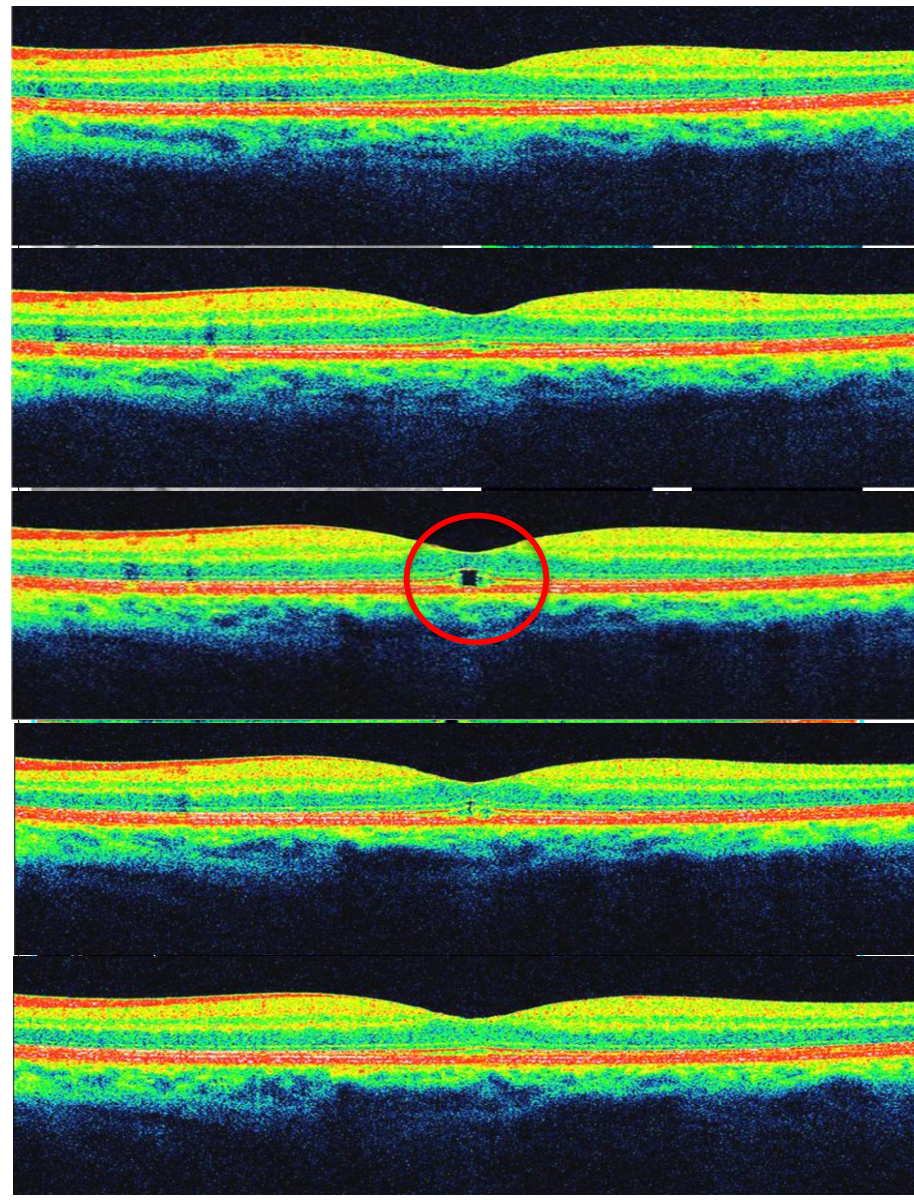
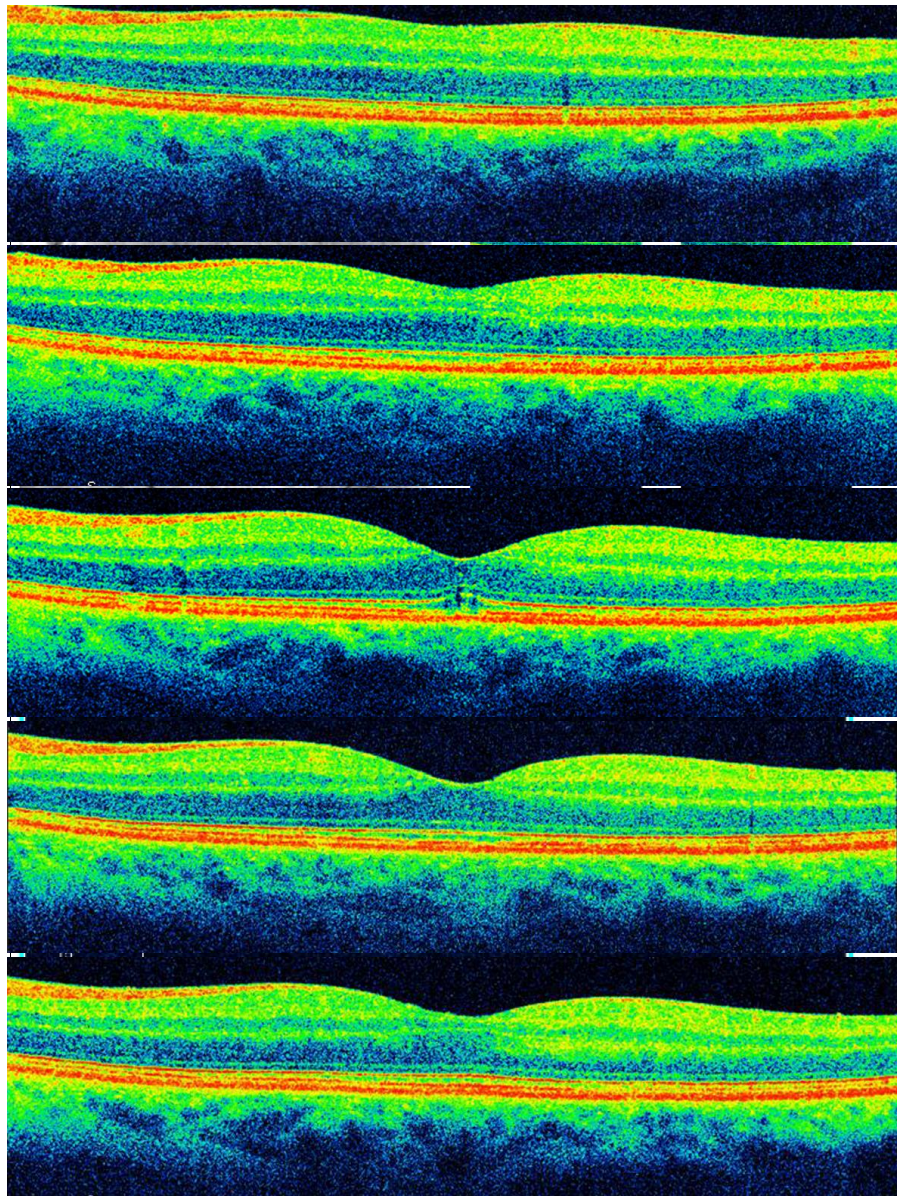
Valeur par défaut

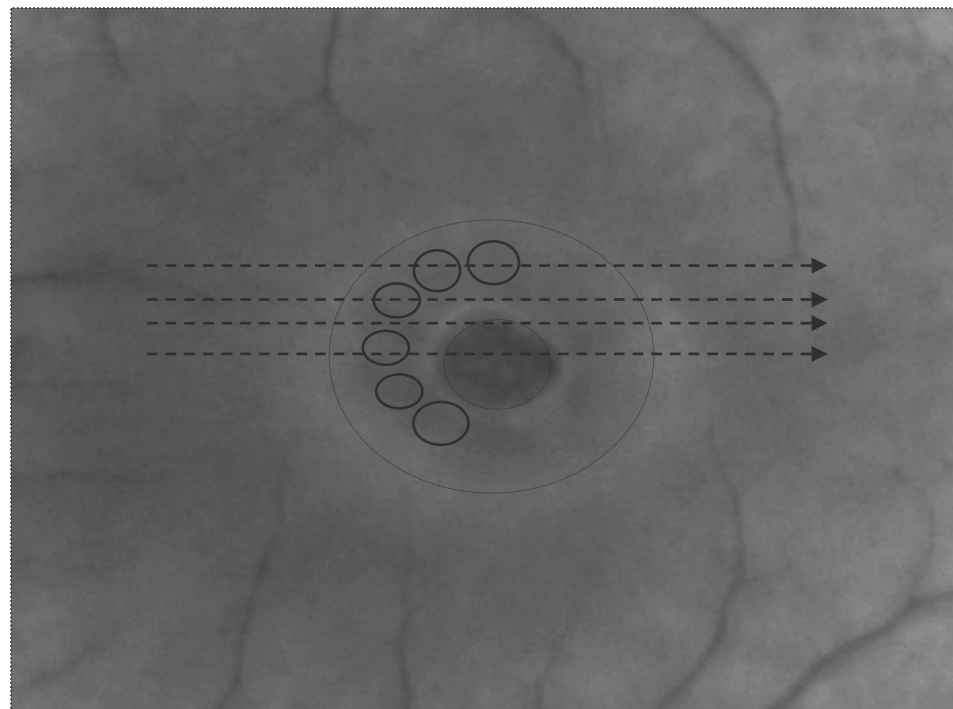
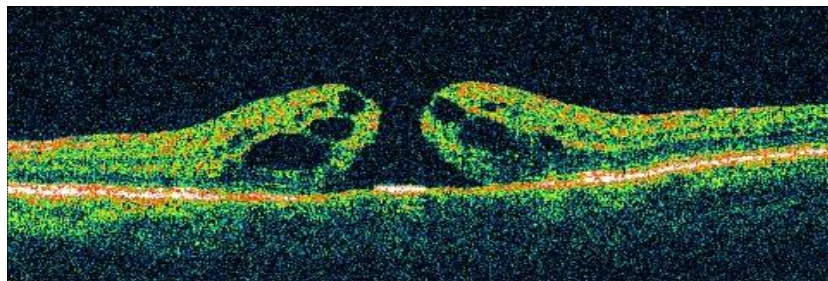
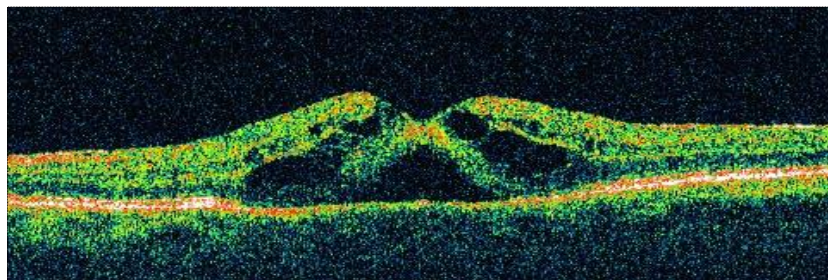
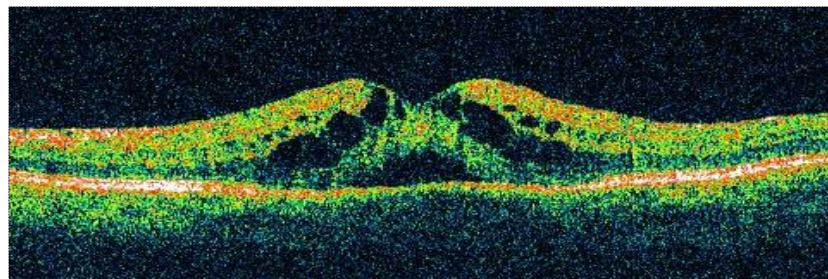
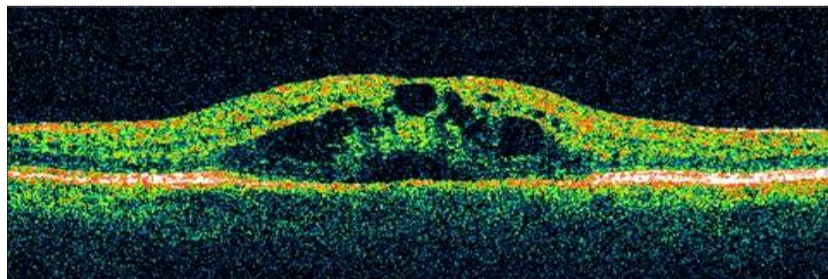


4 x 0.25 : 1 mm (**1000 μ**)



4 x 0.075 : 0.3 mm (**300 μ**)





Modes d'acquisition (SPECTRALIS-HEIDELBERG)

Possibilité d'extension avec l'angio confocal-SLO HRA2 afin de confronter différents types d'imagerie (6 modes) :

- Vitesse d'examen: 85,000 A-scans per second
- OCT
- angiographie à la fluorescéine
- angiographie au vert d'Infracyanine
- autofluorescence
- Red Free
- Infrarouge
- Multicolor
- OCT-A

Fonctionnalités particulières :

- L'ophtalmoscope à balayage laser confocal (cSLO)
- Technologie de réduction du bruit (Heidelberg Noise Reduction Technology™)
- Système de moyennage automatique en temps réel des images (ART ou Automatic Real Time, 1 à 100)
- Eye tracking** (TruTrack™ Technology) : suivi des mouvements oculaires, maintien de la position du scan sur la rétine durant l'examen
- Autorescan (Repositionnement automatique du scan sur l'emplacement de l'examen initial).
- C'est le seul système permettant de placer un scan OCT sur une image d'angiographie acquise simultanément.

Eye tracking + Repositionnement automatique du scan sur l'emplacement de l'examen initial



Bonne reproductibilité

Mode haute résolution (*High Resolution Mode*)

Résolution numérique (μm) : 3.8 axial x 6 latéral

Résolution optique (μm) : 7 axial x 14 latéral

Diamètre pupillaire minimum : 2.5 mm

Vitesse de balayage : 80 000 A scan / sec

Cibles de fixation : interne et externe

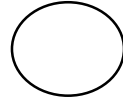
Model de scan linéaire :

- Taille de l'image (pixels) : (1536 x 496) / (1024 x 496) / (768 x 496)
- Temps d'acquisition mini (ms) : 39 / 26 / 19



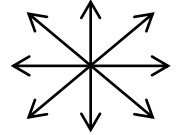
Model de scan circulaire :

- Taille de l'image (pixels) : (1535 x 496)
- Temps d'acquisition mini (ms) : 52



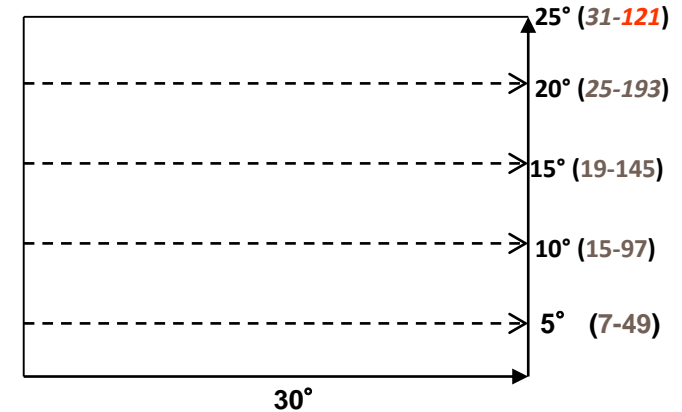
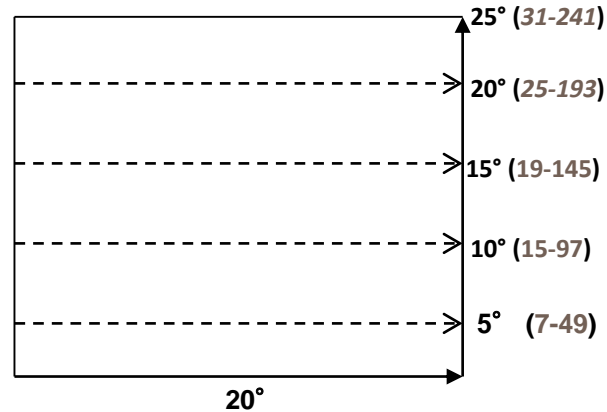
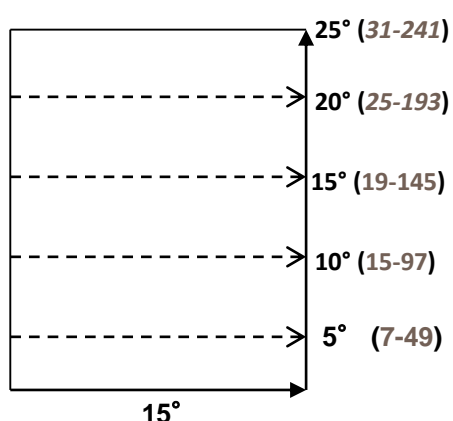
Model de scan en étoile :

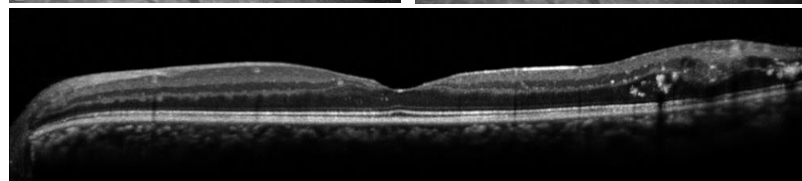
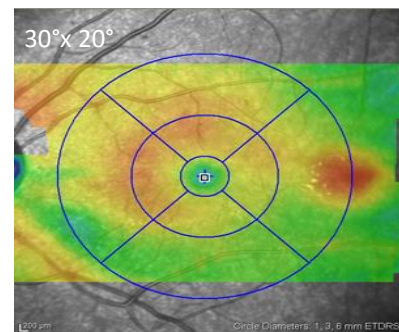
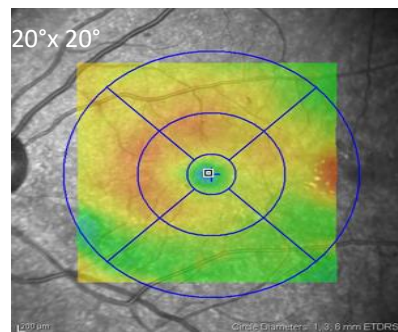
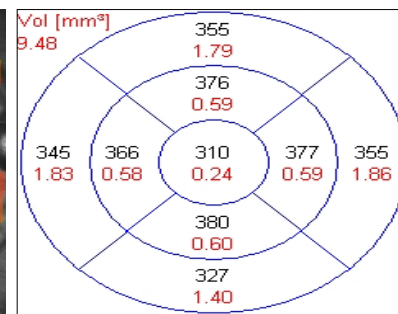
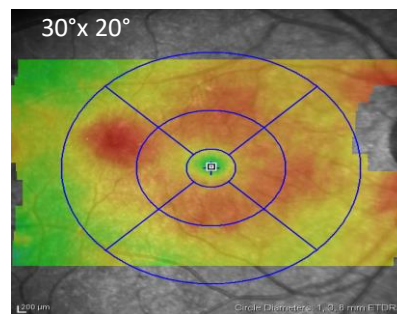
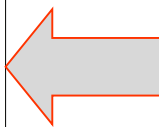
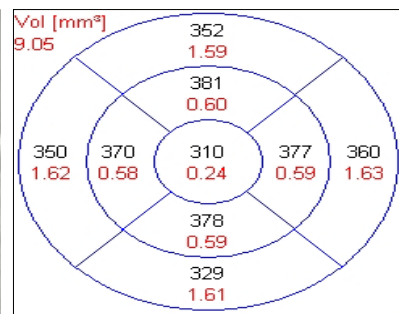
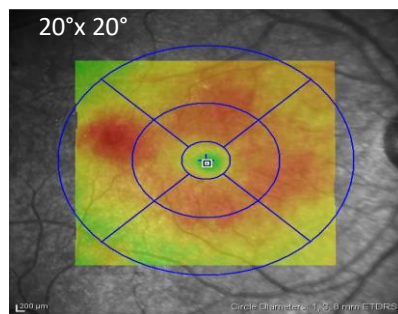
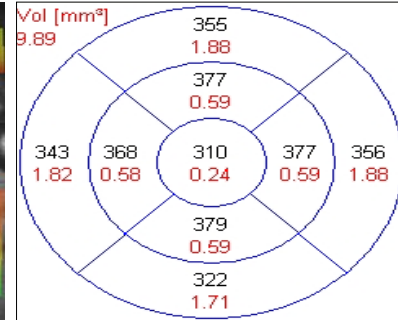
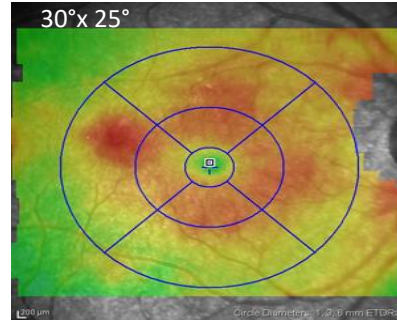
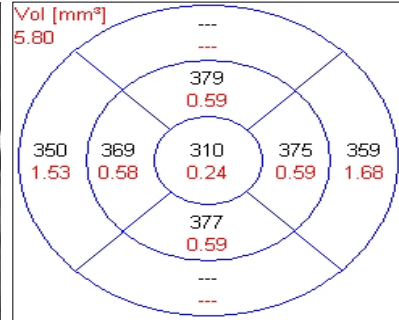
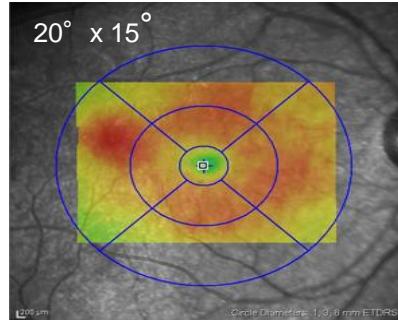
- Diamètre (°) : 30 / 20 / 15
- Nombre de coupes : 48 / 24 / 12 / 6 / 4 / 2



Model de scan en volume :

- Etendu horizontal (°) : 30 / 20 / 15
- Etendu vertical (°) : 25 / 20 / 15 / 10 / 5
- Nombre de coupes par scan de volume : 7 à 241 (\updownarrow 240 μm à 30 μm)





Volume Scan à 49 lignes

Save Images Setup Exit

IR Reflection Image

Settings

Eye:

Angle: 30°

Focus: 1.50 D

Sens.: 59

Power: IR 100%

Mode: OCT Volume

Rate: 8.8/sec

Res.: High Speed

Timers

ICGA: Not set!

FA: Not set!

Memory

Images: 0

Free: 999 MB

Application

Retina

Follow-Up

Preset

Fast Dense Detail P.Pole 7Lines

OCT Control

EDI

Scan

ART 10 frames

20° x 20°

49 sections

120 µm

512 A-scans

ART / Live

HS

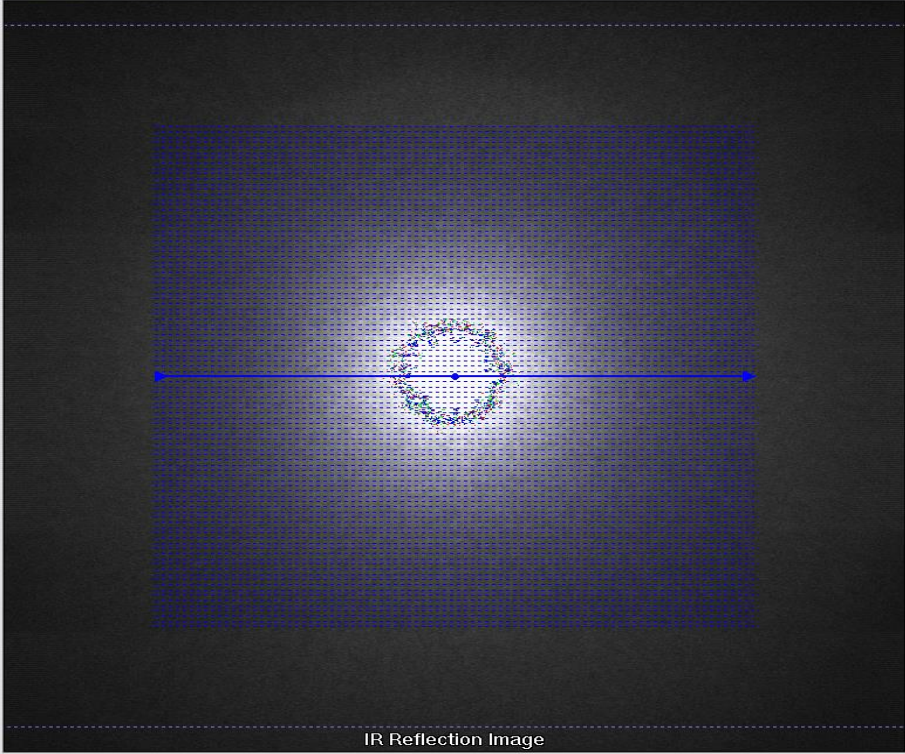
OCT

HEIDELBERG ENGINEERING

Use touch panel to operate the camera...

Volume Scan à 97 lignes

Save Images Setup Exit



IR Reflection Image

Settings

Eye: ☐ OD ☐ OS

Angle: 30°

Focus: 1.50 D

Sens.: 59

Power: IR 100%

Mode: OCT Volume

Rate: 8.8/sec

Res.: High Speed

Timers

ICGA: Not set!

FA: Not set!

Memory

Images: 0

Free: 999 MB

CIRRUS-Volume Scan

- 6mm x 6mm
- 128 lignes X 512 A-scans (46.9µm)



Quality: 0

Application

Retina

Follow-Up

Preset

Fast Dense Detail P.Pole 7Lines

OCT Control

EDI

Scan

ART 10 frames

0.0°

20° x 20°

97 sections

60 µm

512 A-scans

ART / Live

HS

OCT

HEIDELBERG ENGINEERING

Use touch panel to operate the camera...

Volume Scan à 193 lignes

The screenshot displays the Heidelberg Engineering HRA+OCT Spectralis software interface. The main window is divided into several sections:

- Top Left:** A large black area labeled "IR Reflection Image" showing a blue crosshair and a small white spot.
- Top Right:** A large black area showing a dense grid of white dots, representing the volume scan data.
- Bottom Left:** A "Settings" panel with fields for Eye (OD, OS), Angle (30°), Focus (2.75 D), Sens. (59), Power (IR 100%), Mode (OCT Volume), Rate (4.7/sec), and Res. (High Res.).
- Bottom Center-Left:** A "Timers" panel with fields for ICGA, FA, and Memory (Images: 0, Free: 999 MB).
- Bottom Center-Right:** A "CIRRUS-Volume Scan" panel with fields for "6mm x 6mm" and "128 lignes X 512 A-scans (46.9µm)".
- Bottom Right:** A "Scan" panel with fields for "ART 20 frames", "0.0°", "20° x 20°", "193 sections", "30 µm", and "1024 A-scans".
- Bottom Far Right:** A "HEIDELBERG ENGINEERING" logo and a "Use touch panel to operate the camera..." message.

The interface includes various control buttons and sliders, such as "Retina", "Follow-Up", "Preset", "OCT Control", "Scan", "ART / Live", "HR", "OCT", and "Quality: 1".

Raster Lignes Scan à 25 lignes

Save Images Setup Exit

IR Reflection Image

Settings

Eye: ☐ OD ☐ OS

Angle: 30°

Focus: 1.50 D

Sens.: 59

Power: IR 100%

Mode: OCT Volume

Rate: 4.7/sec

Res.: High Res.

Timers

ICGA: Not set!

FA: Not set!

Memory

Images: 0

Free: 999 MB

Application

Retina

Follow-Up

Preset

Fast Dense Detail P.Pole 7Lines

P-Map M-Mac P-EDI Custom

OCT Control

ED I

Scan

ART 20 frames

20° x 5°

25 sections

60 µm

1024 A-scans

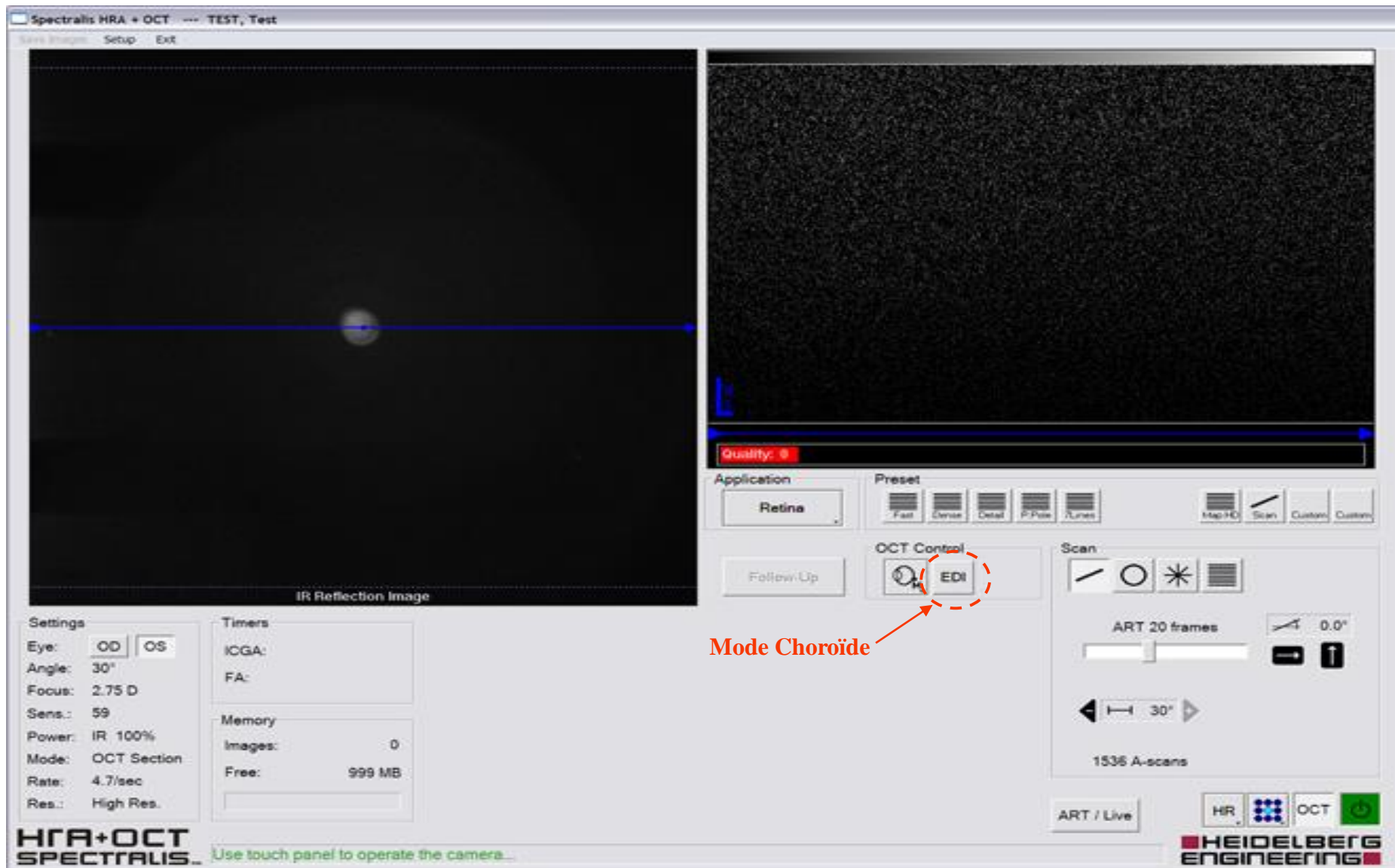
ART / Live

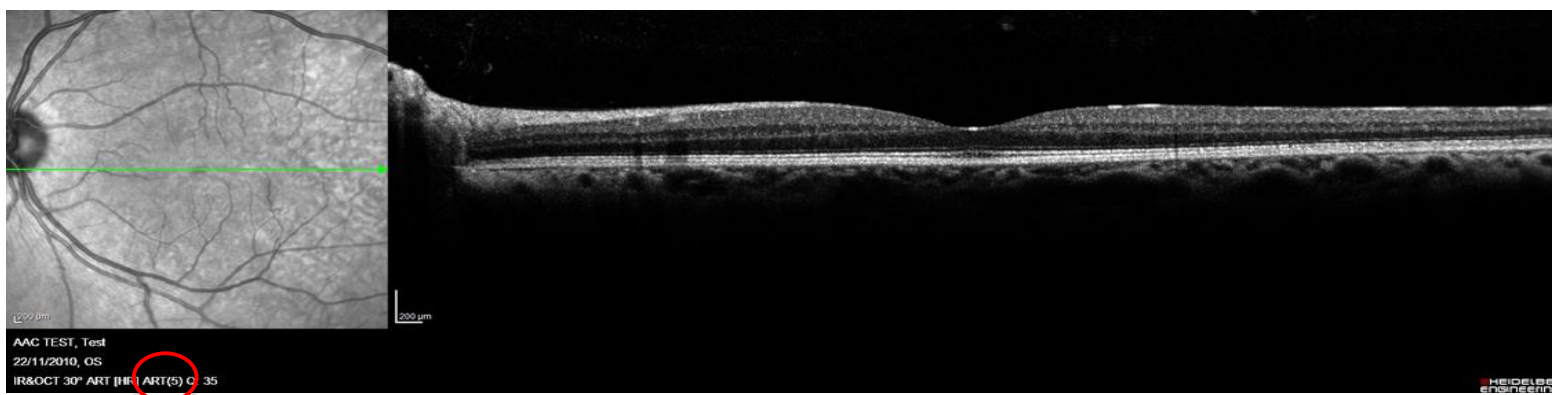
HR

OCT

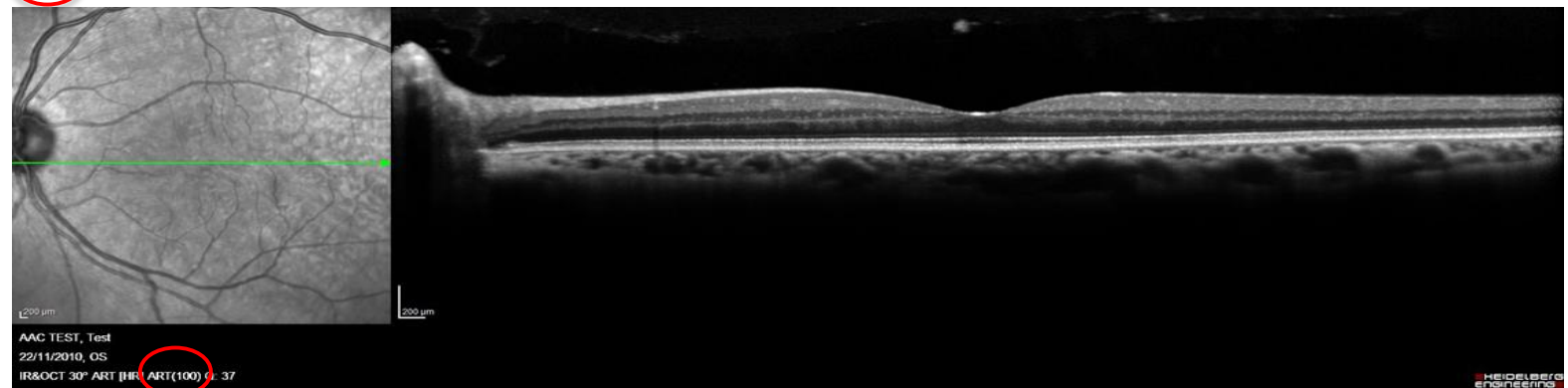
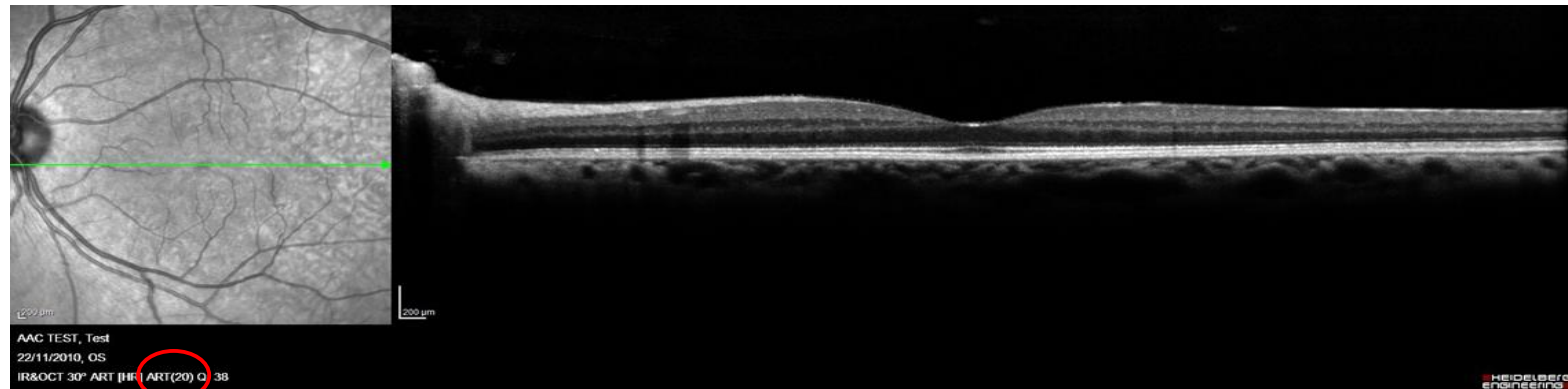
HEIDELBERG ENGINEERING

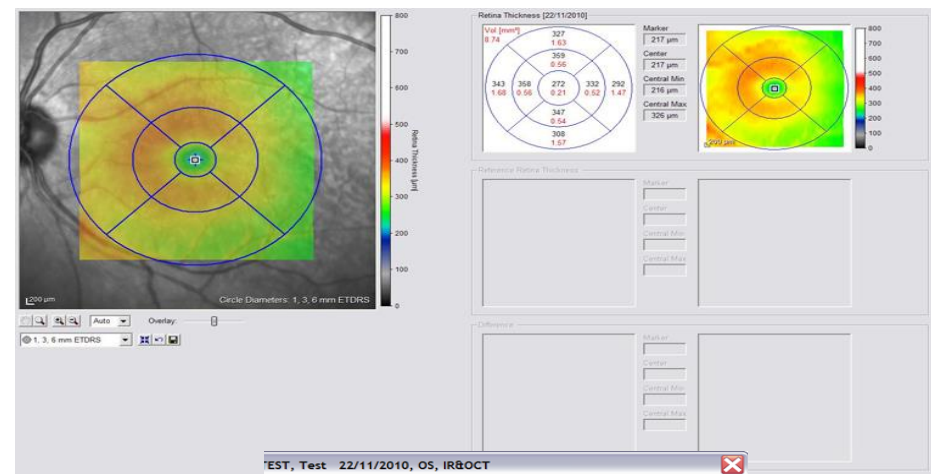
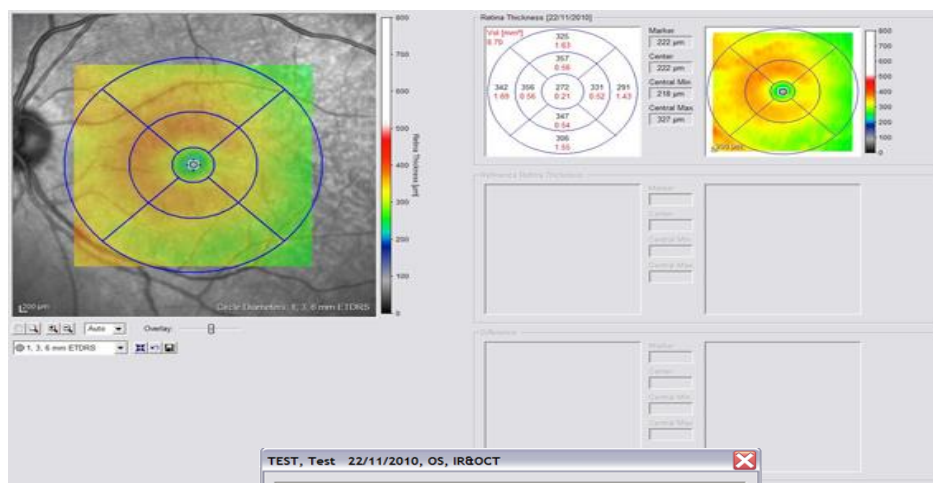
Use touch panel to operate the camera...





ART ?





TEST, Test 22/11/2010, OS, IR&OCT

Scan Parameters	
Resolution Mode	High Resolution
Scan Focus	2.74 D
Camera Objective	2
Internal Target	Middle
External Target	OFF
Examination Time	14.21.24 (UTC +1)
Examined Structure	Retina
IR Image	
Scan Angle	30°
Size X	1536 pixel (8.4 mm)
Size Y	1536 pixel (8.4 mm)
Scaling	5.49 µm/pixel
ART Mode	ON (66 images averaged)
ART Normalization	ON
Sensitivity (DC/DC)	90%
Total Sensitivity	59
IR Laser Power	25%
Filter State	FA Filter
Lookup Table	Linear
ERG Mode	OFF
Auto-Brightness State	OFF
OCT Image	
Scan Angle	20°
Size X	1024 pixel (5.6 mm)
Size Z	496 pixel (1.9 mm)
Scaling X	5.49 µm/pixel
Scaling Z	3.97 µm/pixel
ART Mode	ON (11 images averaged)
Eye Length	Medium
Quality	27 dB
EDI Mode	OFF
OCT Scan Pattern	
Number of B-Scans	25
Pattern Size	20° x 20° (5.6 x 5.6 mm)
Distance between B-Scans	234 µm
Device	
Camera Model	Spectralis HRA+OCT
Camera S/N	002014
Power Supply S/N	002004
Touch Panel S/N	001624
HRA Camera FW Version	1.6.0.0
Power Supply FW Version	1.4.2.0
Touch Panel FW Version	1.5.1.0
OCT Camera FW Version	1.47.0.0
OCT Controller FW Version	1.3.1.0
OCT Camera FPGA Version	1.37.0.0
Acquisition Software Version	5.2.4.0

OK

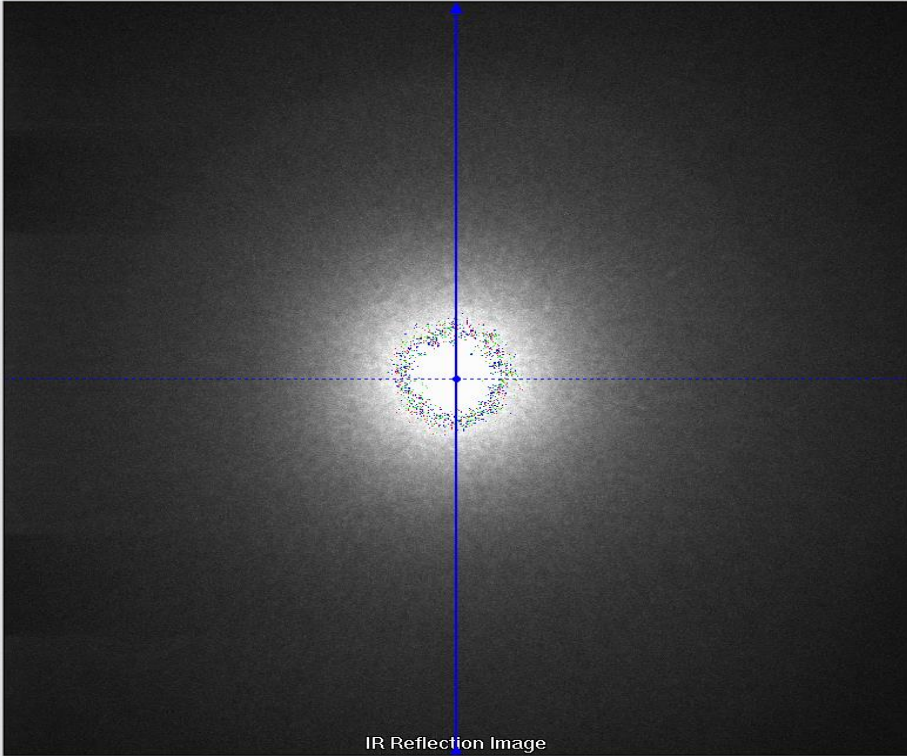
TEST, Test 22/11/2010, OS, IR&OCT

Scan Parameters	
Resolution Mode	High Resolution
Scan Focus	2.74 D
Camera Objective	2
Internal Target	Middle
External Target	OFF
Examination Time	14.21.51 (UTC +1)
Examined Structure	Retina
IR Image	
Scan Angle	30°
Size X	1536 pixel (8.4 mm)
Size Y	1536 pixel (8.4 mm)
Scaling	5.49 µm/pixel
ART Mode	ON (100 images averaged)
ART Normalization	ON
Sensitivity (DC/DC)	90%
Total Sensitivity	59
IR Laser Power	25%
Filter State	FA Filter
Lookup Table	Linear
ERG Mode	OFF
Auto-Brightness State	OFF
OCT Image	
Scan Angle	20°
Size X	1024 pixel (5.6 mm)
Size Z	496 pixel (1.9 mm)
Scaling X	5.49 µm/pixel
Scaling Z	3.97 µm/pixel
ART Mode	ON (100 images averaged)
Eye Length	Medium
Quality	21 dB
EDI Mode	OFF
OCT Scan Pattern	
Number of B-Scans	25
Pattern Size	20° x 20° (5.6 x 5.6 mm)
Distance between B-Scans	234 µm
Device	
Camera Model	Spectralis HRA+OCT
Camera S/N	002014
Power Supply S/N	002004
Touch Panel S/N	001624
HRA Camera FW Version	1.6.0.0
Power Supply FW Version	1.4.2.0
Touch Panel FW Version	1.5.1.0
OCT Camera FW Version	1.47.0.0
OCT Controller FW Version	1.3.1.0
OCT Camera FPGA Version	1.37.0.0
Acquisition Software Version	5.2.4.0

OK

Cross Scan à 2 lignes (H et V)

Save Images Setup Exit



IR Reflection Image

Settings

Eye: ☐ OD ☐ OS

Angle: 30°

Focus: 1.50 D

Sens.: 59

Power: IR 100%

Mode: OCT Star

Rate: 4.7/sec

Res.: High Res.

Timers

ICGA:

FA:

Memory

Images: 0

Free: 999 MB

Application

Retina

Preset

Fast Dense Detail P.Pole 7Lines

Custom Custom Custom Custom

OCT Control

Follow-Up

Q_M EDI

Scan

ART 100 frames

30°

2 sections

90.0°

1536 A-scans

ART / Live

HR

OCT

HEIDELBERG ENGINEERING

Use touch panel to operate the camera...

Protocole d'acquisition

toujours les deux yeux

L'examen standard OCT pour une première fois doit comporter

- cube 6x6
- 2 raster lignes 9 mm H + V séparées de 75 μ sur le *Cirrus* , ou 2 lignes simples 9x9 H+V sur *Spectralis* toujours EDI

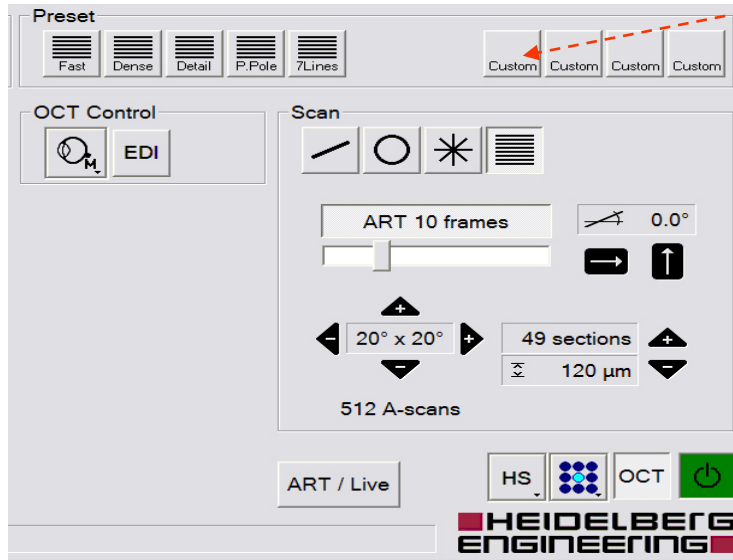
ou : radial lignes

- 1 ligne 12 mm papille macula
- RNFL + CG

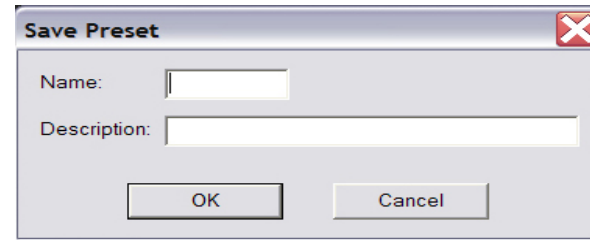
Coupes additionnelles selon pathologie

- Exploitation post acquisition (segmentation ILM , CC etc..) selon pathologie
- Suivi : toujours recommencer les coupes précédentes + coupes additionnelles si nécessaire

On peut créer les icône préréglés en « CUSTOM »

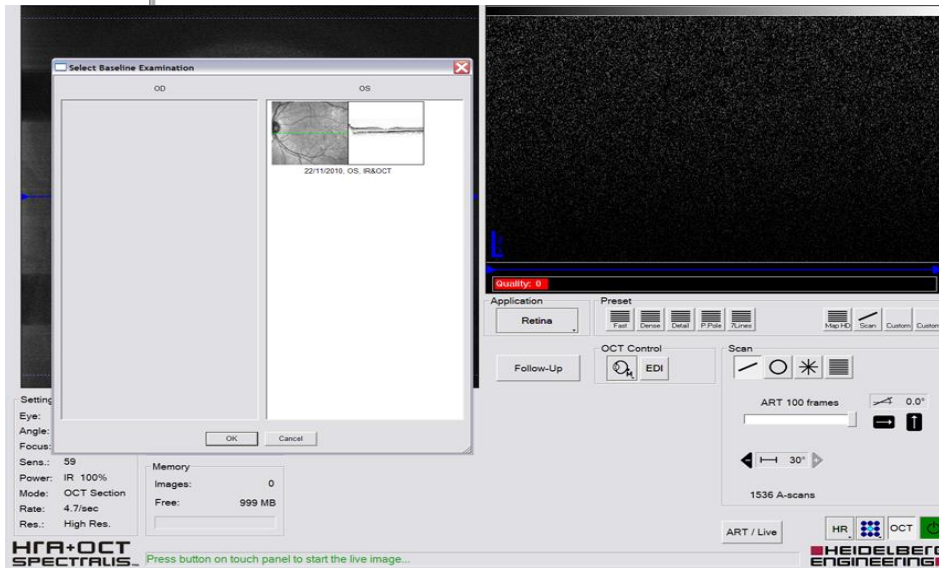
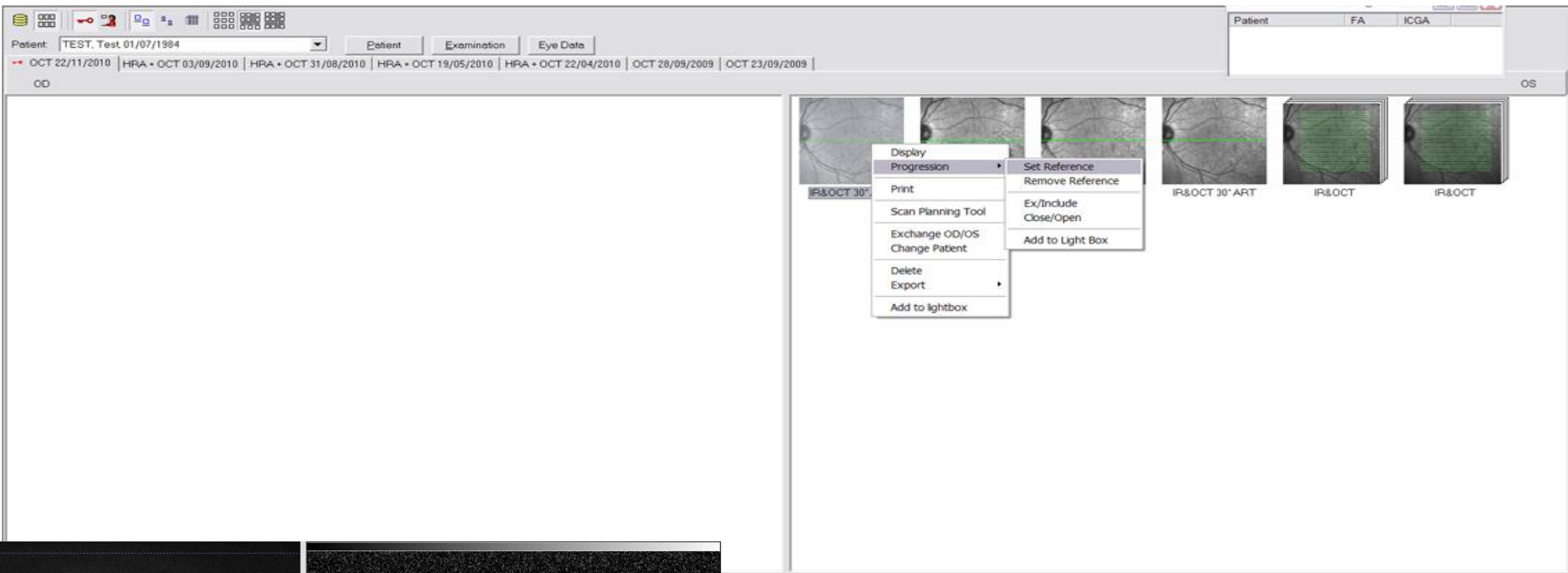


1. Après avoir entré les paramètres pour le 1er examen
2. Rester appuyé sur l'icône « Custom »
3. Puis renommer l'icône

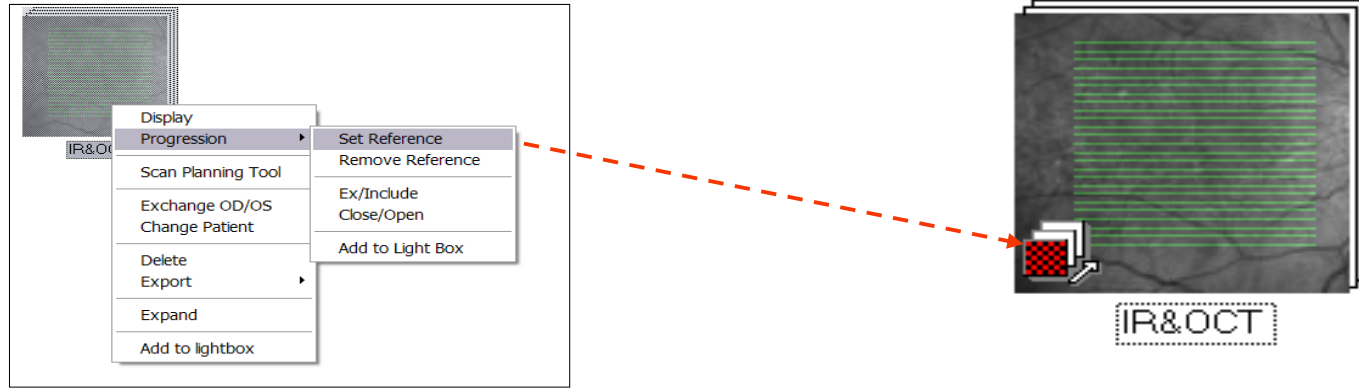


4. Faire la même chose pour chaque examen
5. A

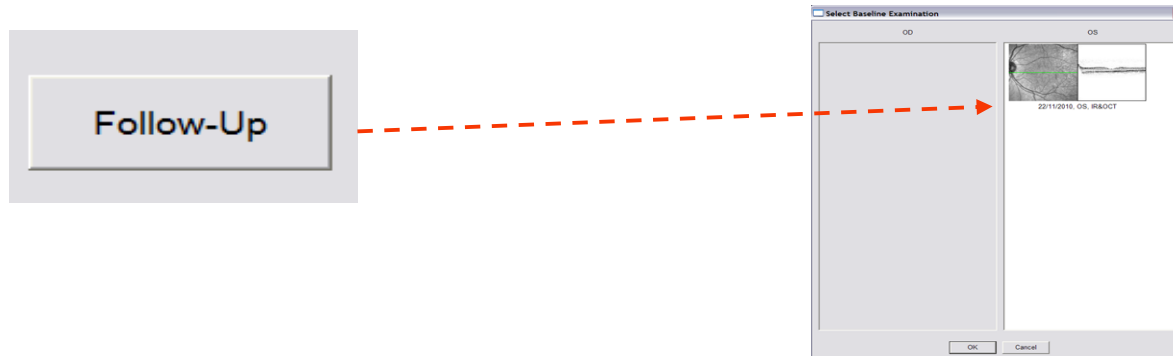




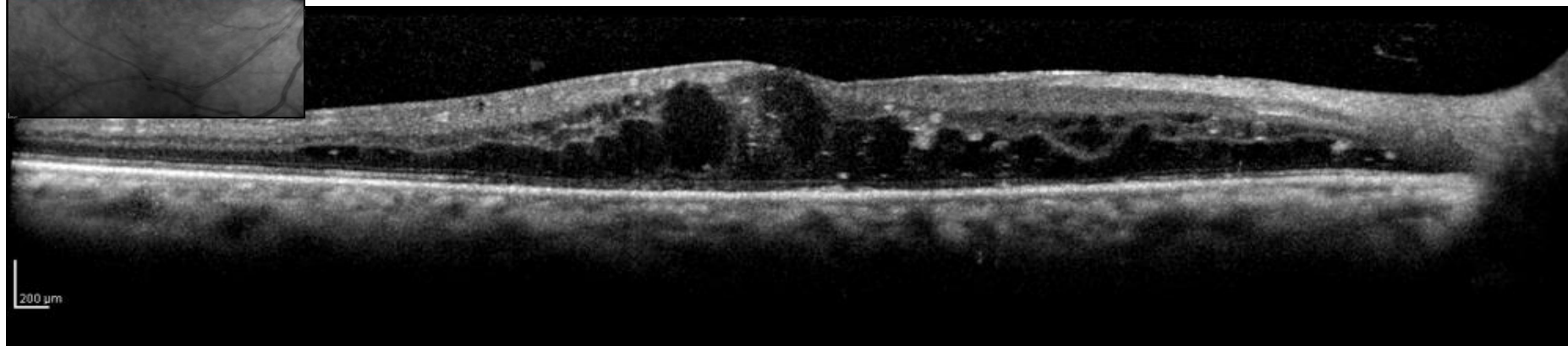
Dans tous les cas il faudra définir l'examen de référence pour 3 examens en OCT lors de la 1^{re} visite pour pouvoir réaliser les examens en mode « REPEAT »



Pour les examens de suivis, il faudra cliquer sur « Follow-Up » et choisir l'examen de référence de la 1^{re} visite

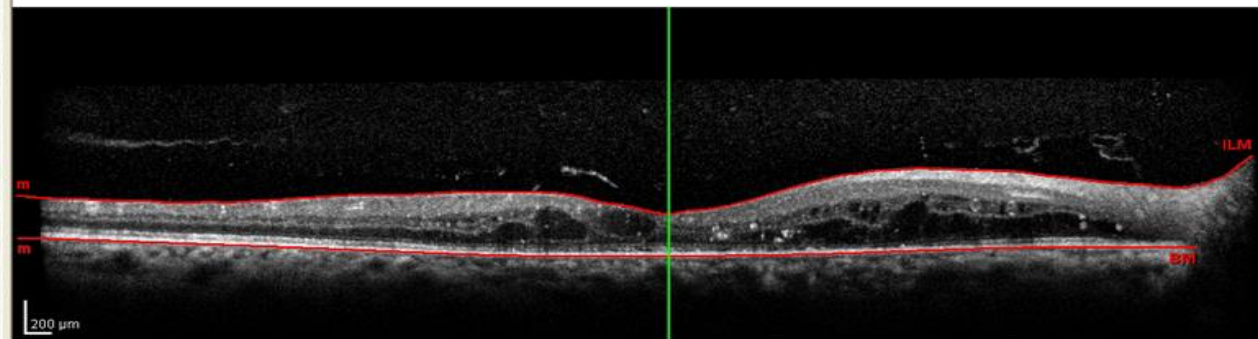
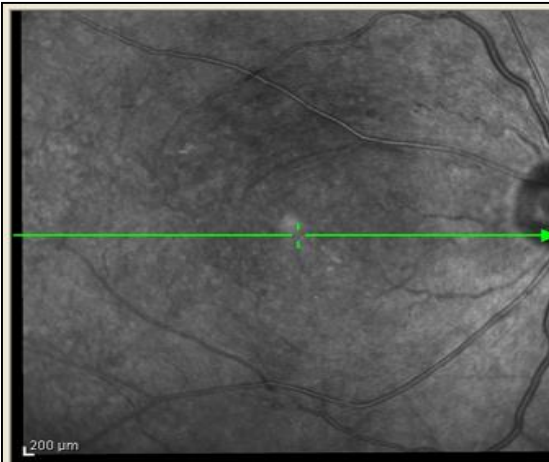


Permet de suivre l'évolution spontanée et traitée de l'OM



Anti-VEGF



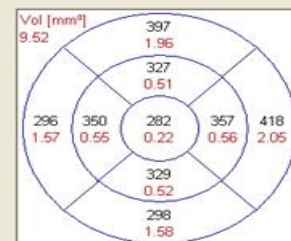




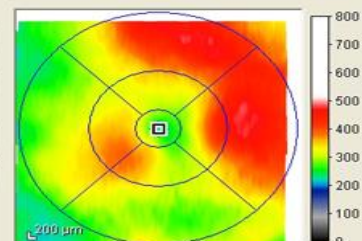
Auto Overlay:

1, 3, 6 mm ETDRS

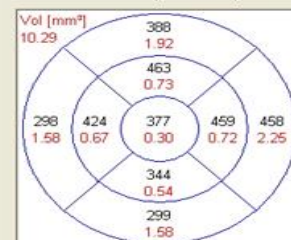
Thickness [04/03/2010]



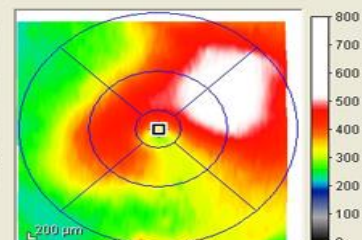
Marker
242 µm
Center
240 µm
Central Min
233 µm
Central Max
345 µm



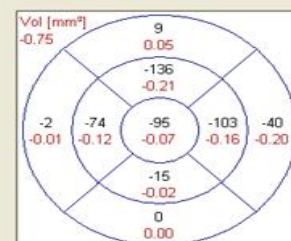
Reference Thickness [05/03/2009]



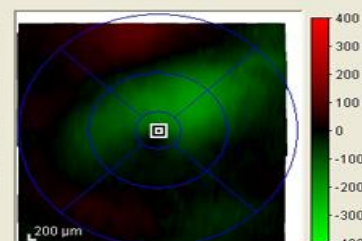
Marker
327 µm
Center
328 µm
Central Min
289 µm
Central Max
471 µm



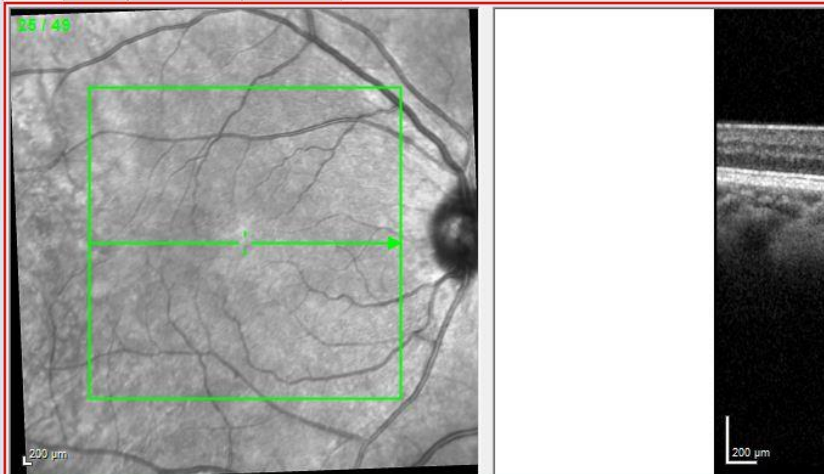
Difference



Marker
-86 µm
Center
-88 µm
Central Min
-176 µm
Central Max
4 µm



Display 3D View Thickness Profile Thickness Map



Auto 1:1 pixel



Brightness & Contrast

HRA

HRA Brightness & Contrast slider and color table controls.

OCT

OCT Brightness & Contrast slider and color table controls.

Color Table

Color Table options: Black on White, White on Black (selected), Color: Spectrum.

Sharpen

Sharpen options: None (selected), Low, Medium, High.

Noise Reduction

Noise Reduction options: None (selected), Low, Medium, High.

Save Custom Settings

Load Custom Settings

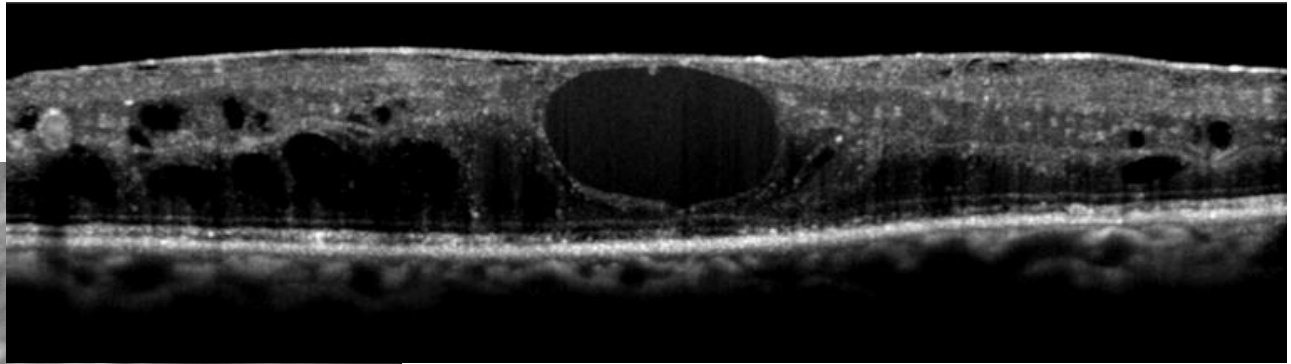
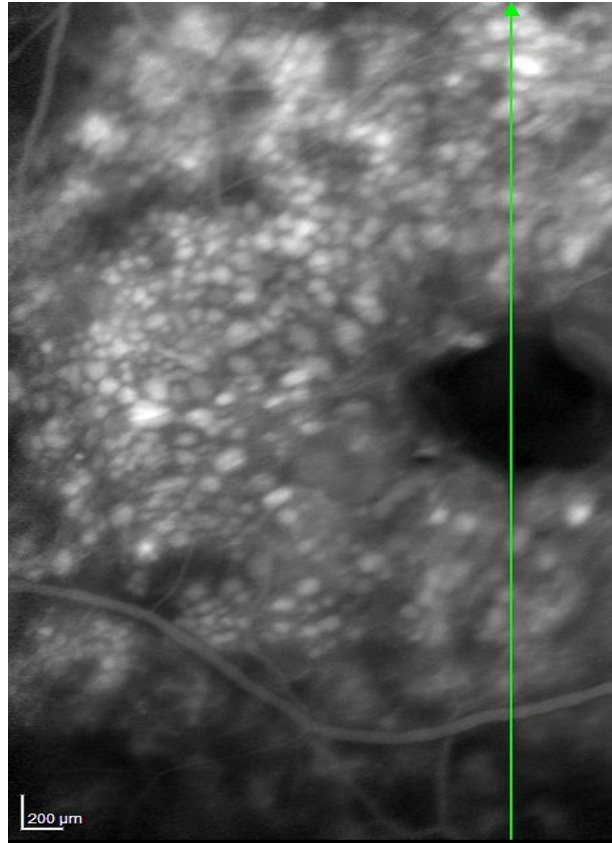
Reset

OK

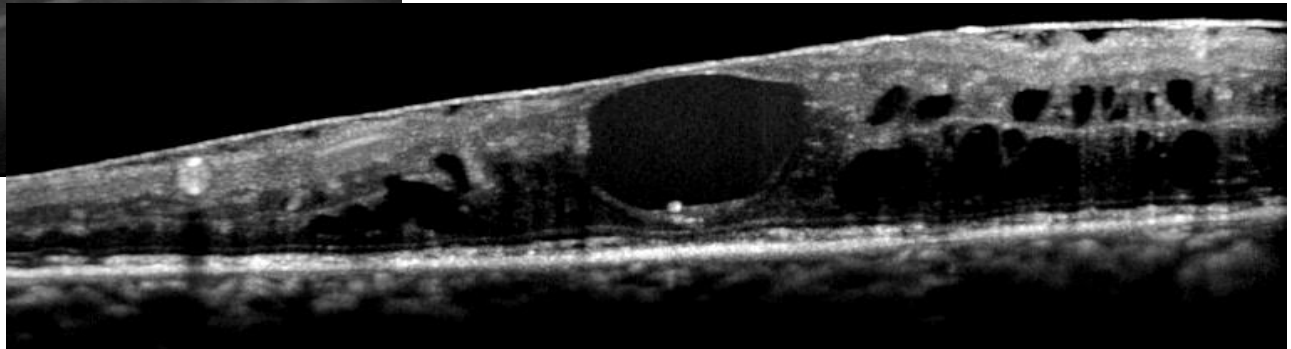
Cancel

406/2018

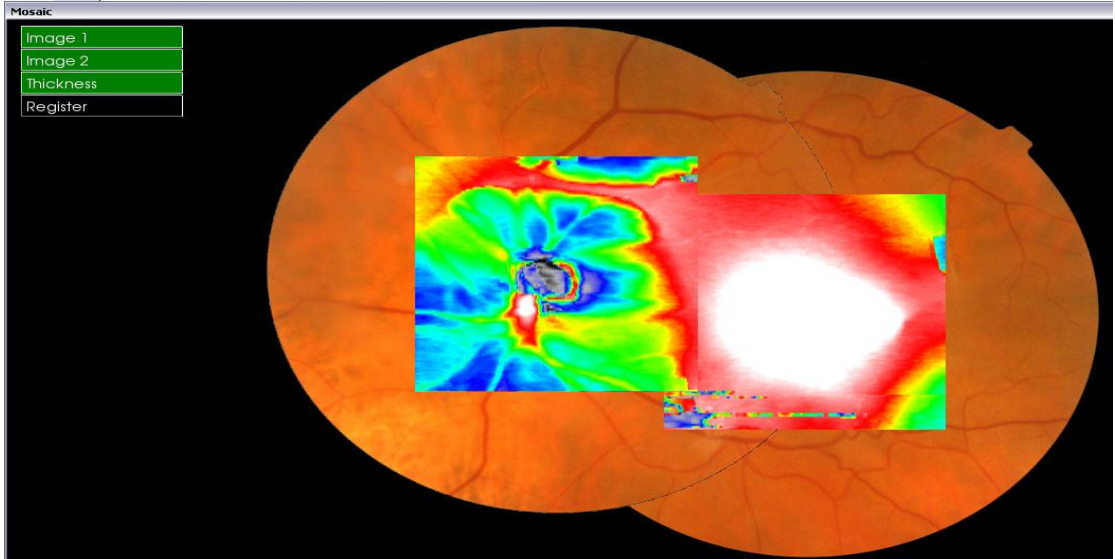
12/11/2018

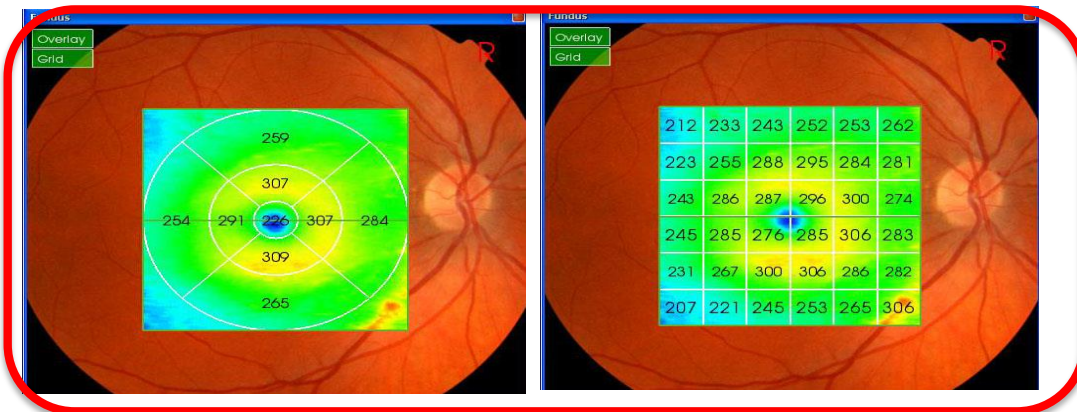
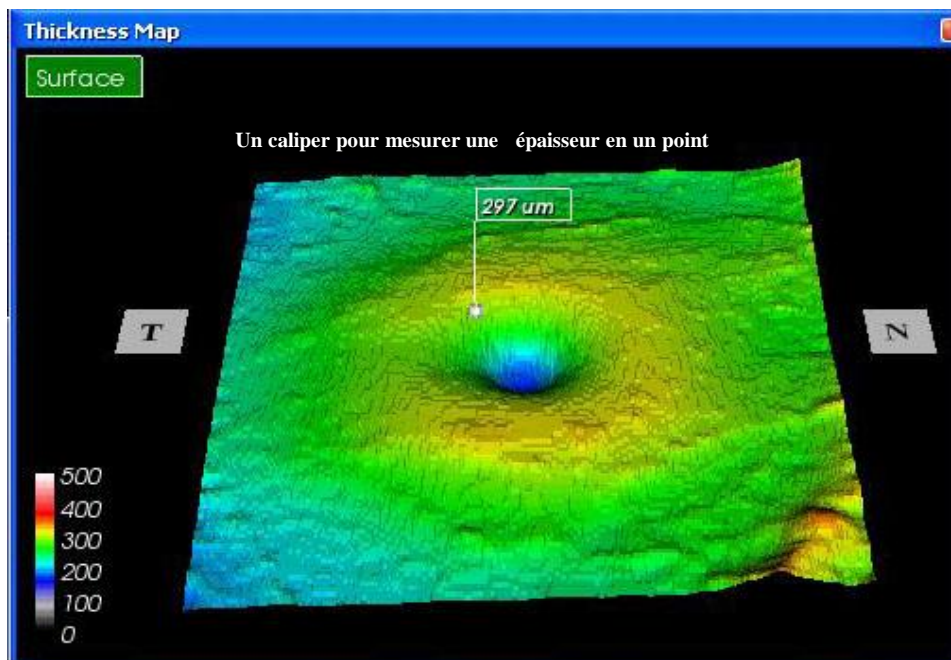
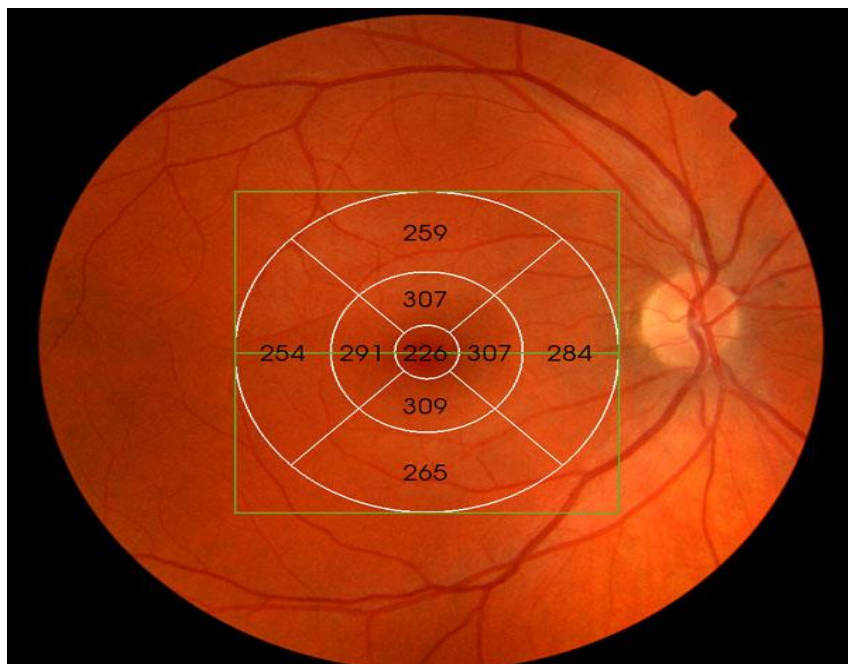


Le système permettant de placer un scan OCT
sur une image d'angiographie acquise
simultanément.



Basic Mosaic ID: 94779 Name: MEMBRANE EPI-MACULAIRE Andre





Mapping superposable

OCTA

Cirrus

5000

test, test

Date de naissance: 16/09/1956
ID: CZMI402903878

Visit History

04/05/2021
HD Raster (1 or 5 Line) OD
HD Raster (1 or 5 Line) OD

09/04/2021
Macular Cube 512x128 OD

17/06/2020
Macular Cube 512x128 OD
Optic Disc Cube 200x200 OD
Macular Cube 512x128 OS
Optic Disc Cube 200x200 OS
Optic Disc Cube 200x200 OS

26/02/2020
Anterior Segment Cube 512x128 OD

24/06/2019
Macular Cube 512x128 OD
Angiography 3x3 mm OD

19/11/2018
Macular Cube 512x128 OD
Optic Disc Cube 200x200 OD

16/08/2016
Macular Cube 512x128 OD
HD Raster (1 or 5 Line) OD
HD Raster (1 or 5 Line) OD
Optic Disc Cube 200x200 OD
Anterior Segment 5 Line Raster OD

Protocols

Répéter la
dernière visite

Rétine

Glaucome

Segment
antérieur

Tous les examens

AngioPlex

Examen de l'état
physique

Protocol Details

Angiography (3x3, 6x6, 8x8 mm)

Montage Angiography (6x6, 8x8 mm)

ONH Angiography



Tous les examens

Répéter la dernière visite

Rétine

AngioPlex

Glaucome

Segment antérieur

Examen de l'état physique

Montage Angio 6x6 mm

Montage Angio 8x8 mm

ONH Angiography 4.5x4.5 mm

HD 1 Line 100x

HD 21 Line

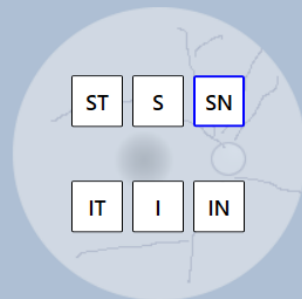
Anterior Segment Cube 512x128

Angiography 3x3 mm

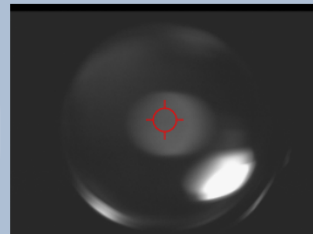
Angiography 6x6 mm

Angiography 8x8 mm

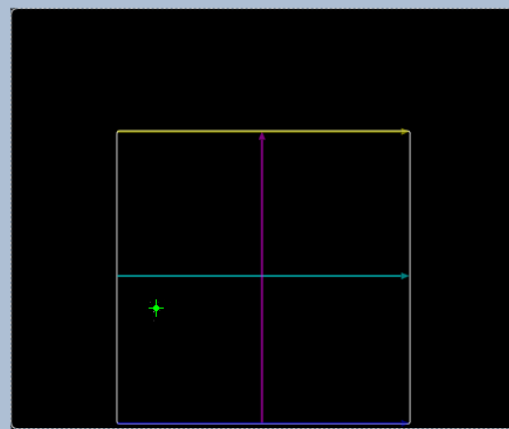
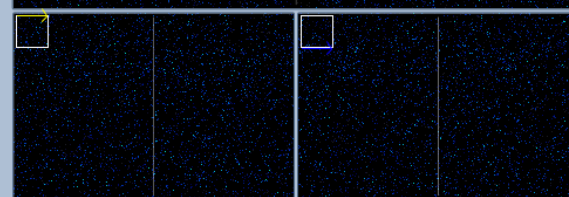
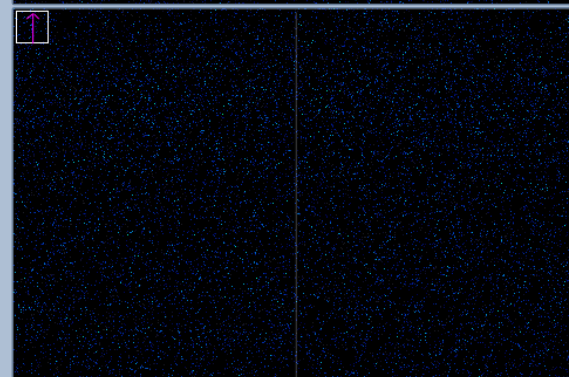
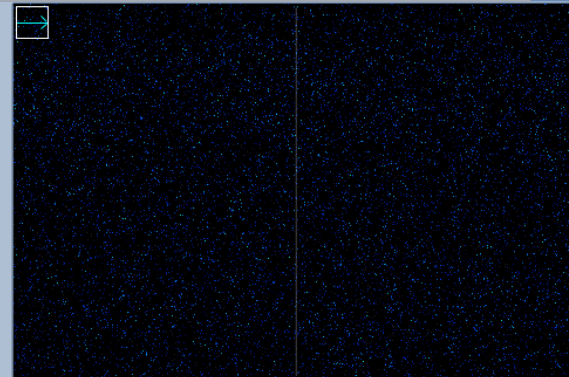
Montage Angio 6x6 mm



Terminé



Améliorer

Mise au point
automatique

-20 20

Mise au point

Transparence: 100%



Centrer



Optimiser



Capturer



État :



ID du patient

Protocoles

Acquérir

Analyser

Terminer

Tous les examens

Répéter la dernière visite

Rétine

AngioPlex

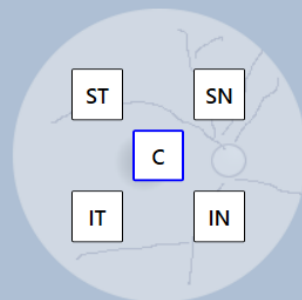
Glaucome

Segment antérieur

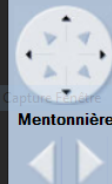
Examen de l'état physique

Montage Angio 6x6 mm
Montage Angio 8x8 mm
ONH Angiography 4.5x4.5 mm
HD 1 Line 100x
HD 21 Line

Anterior Segment Cube 512x128
Angiography 3x3 mm
Angiography 6x6 mm
Angiography 8x8 mm
Montage Angio 6x6 mm



Terminé



Améliorer



Centrer

Mise au point
automatique

-20 20

Mise au point

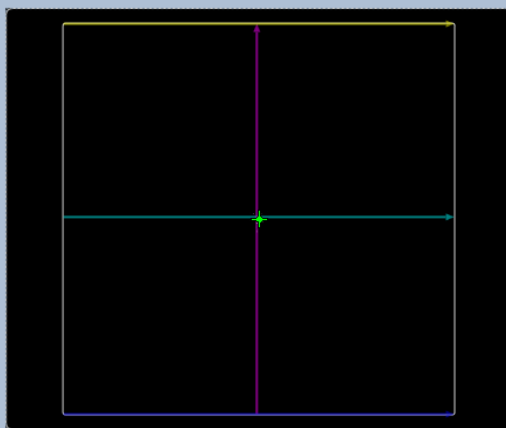
Transparence: 100%



Optimiser



Capturer



ED1



État :



ID du patient

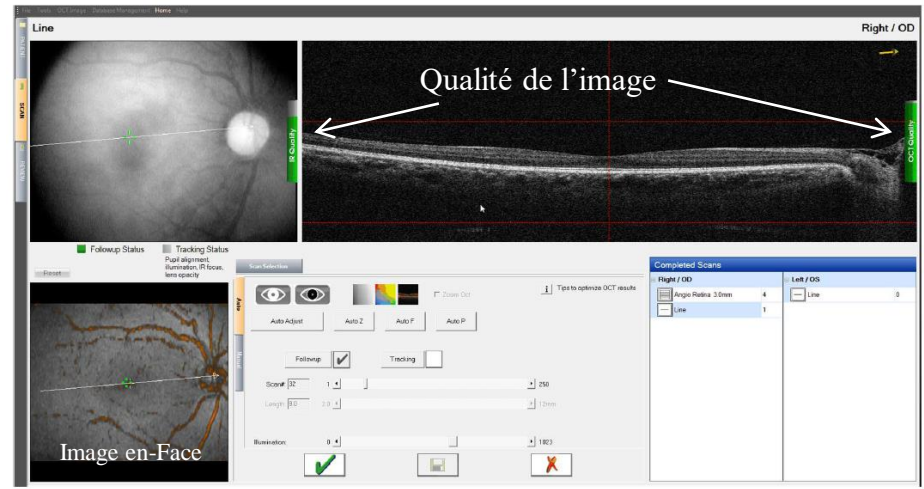
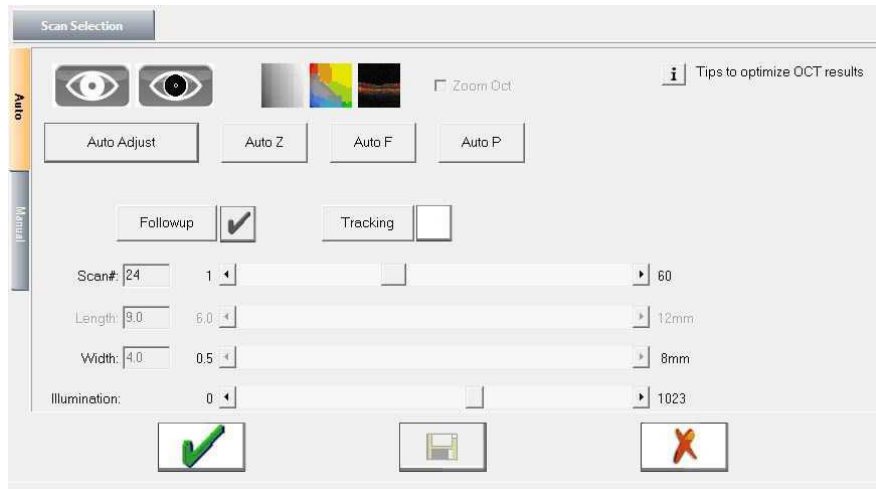
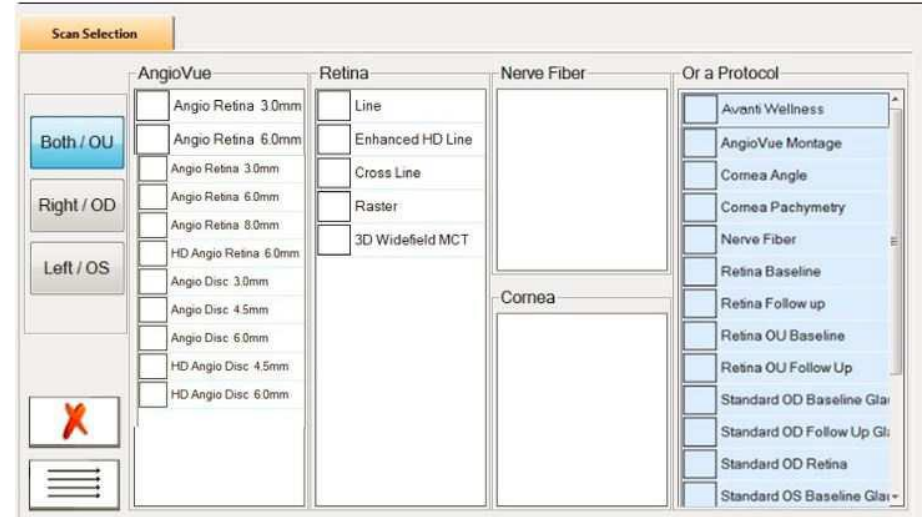
Protocoles

Acquérir

Analyser

Terminer

AVANTI RTVUE (OPTOVUE)



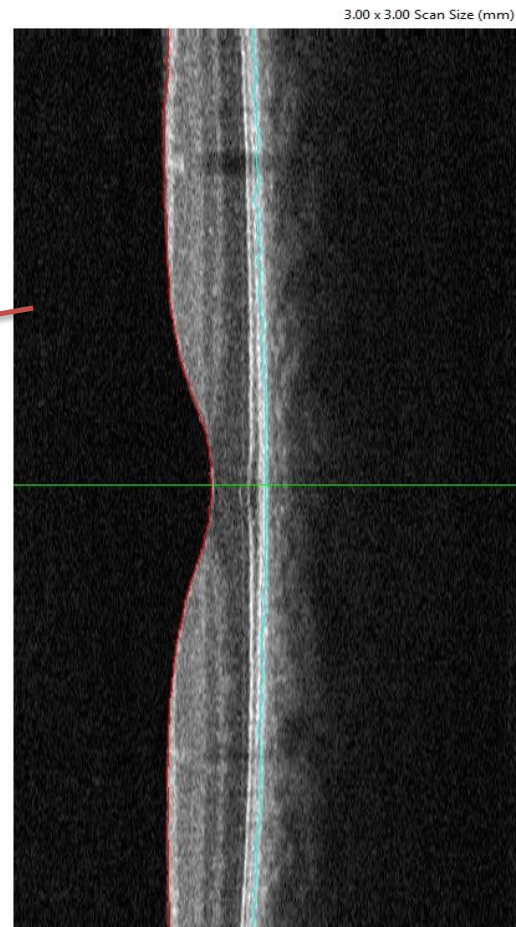
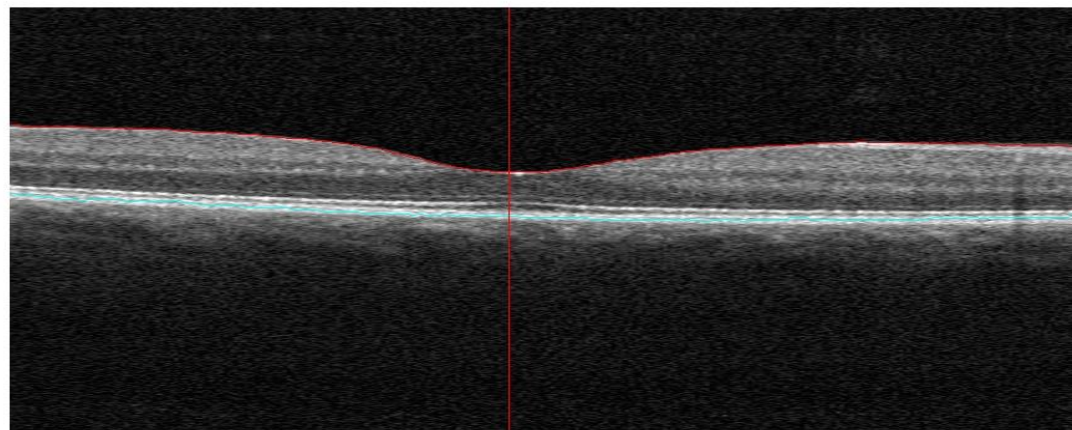
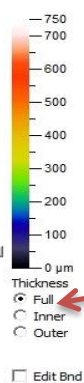
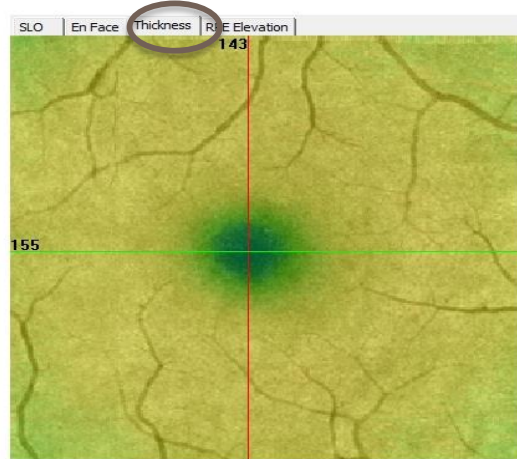
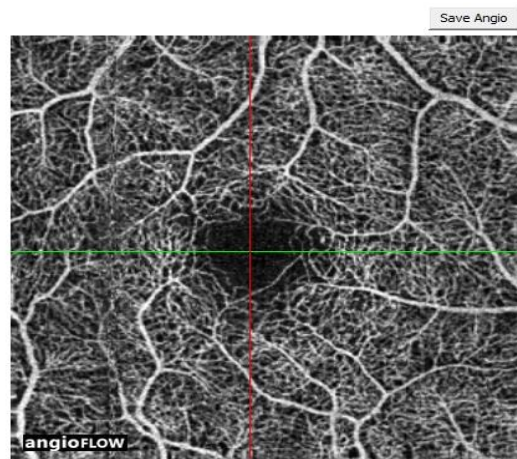
Full Thickness

Angio Retina

Signal Strength Index

84

Right / OD



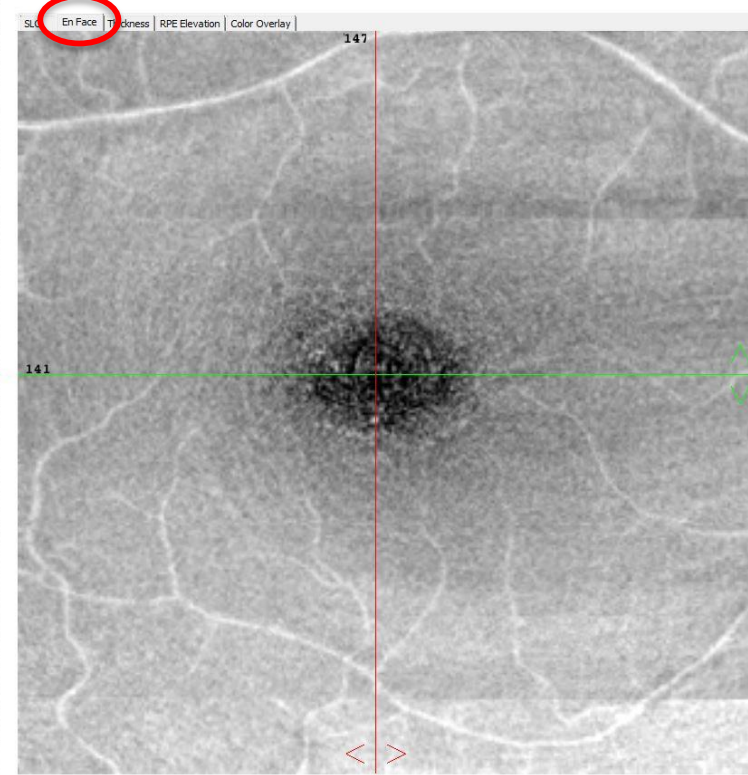
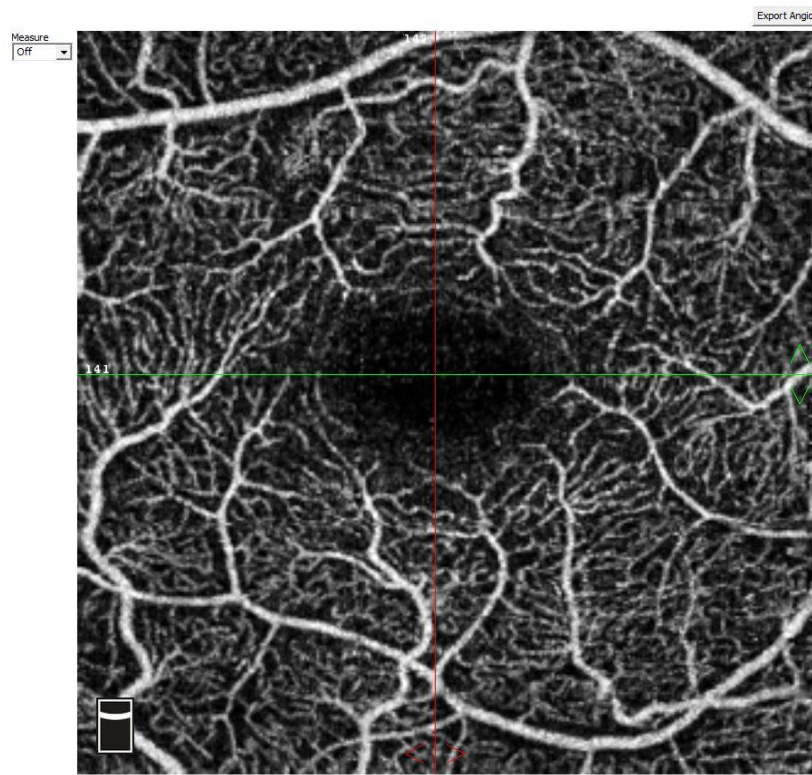
Print

Comment

optovue

Superficial capillary plexus

Scan Quality 9/10 SSI 81



Edit Bnd

Restore Settings

En Face Slab

- ☒ Superficial
- ☐ Deep
- ☐ Outer Retina
- ☐ Choriocapillaris
- ☐ Retina
- ☐ Custom

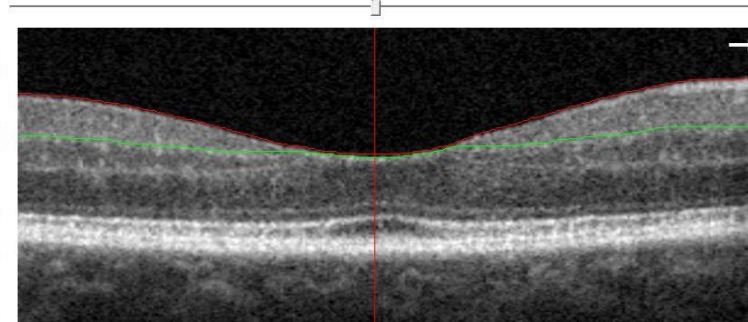
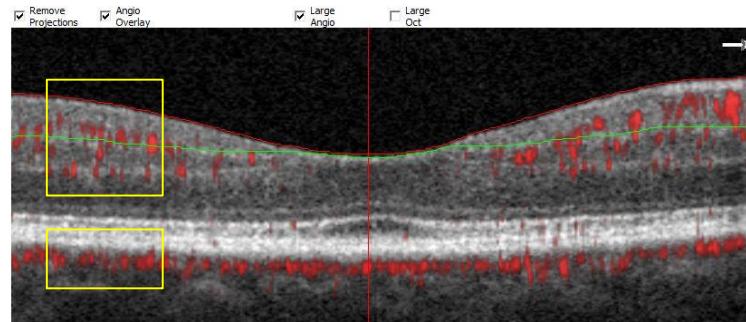
Upper - ILM
Offset(um)

0

Lower - IPL
Offset(um)

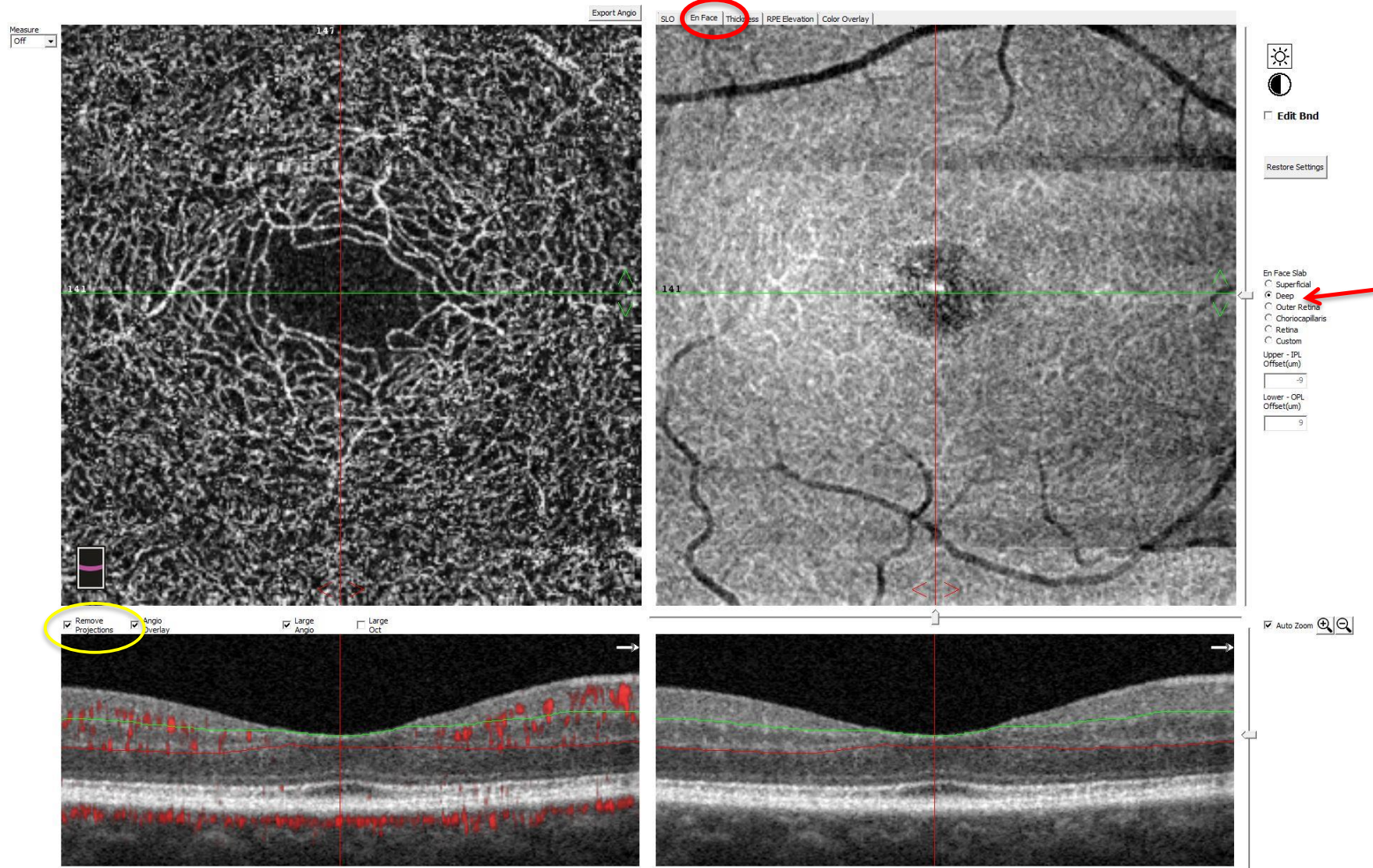
-9

Auto Zoom

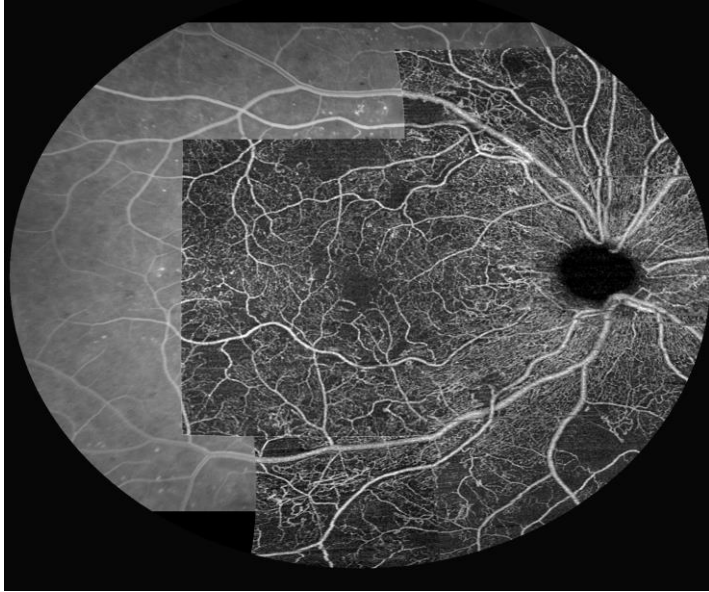


Deep Capillary plexus

Scan Quality 9/10 SSI 81



Swept-Source OCTA



- SS-OCTA
 - 100 à 200 000 A-scan/sec
 - λ :1060nm
 - permet
 - augmenter la densité de points
 - ou la surface des cartographies
 - des montages automatiques

Topcon Triton SS-OCT

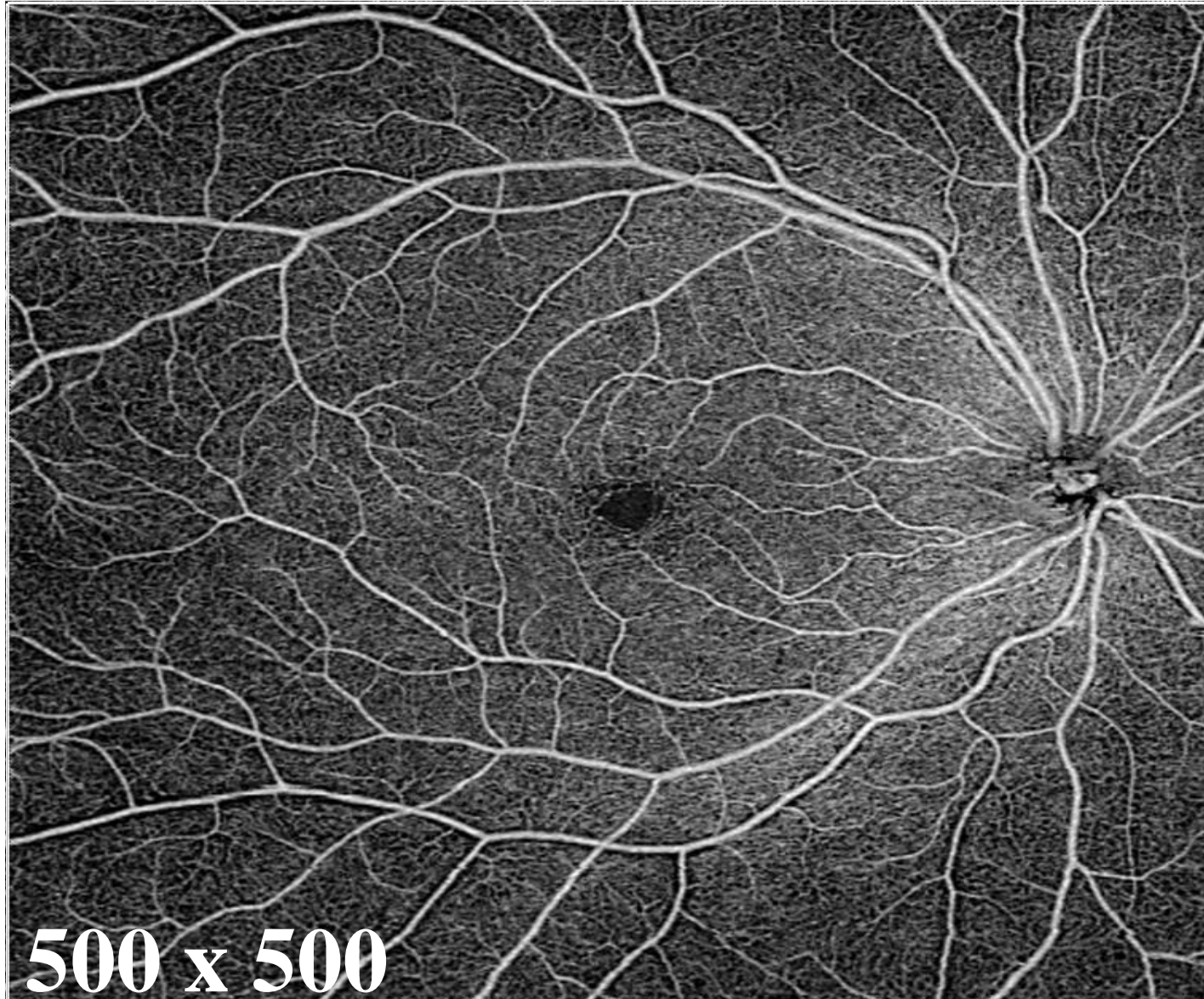
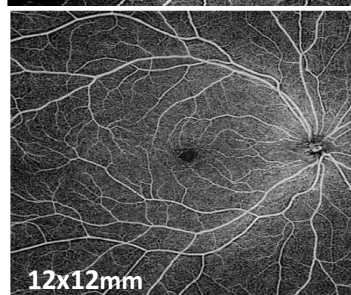
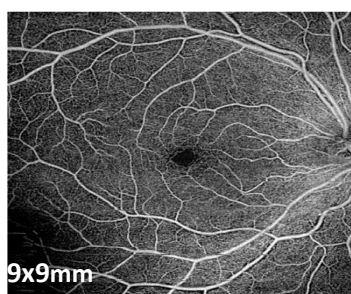
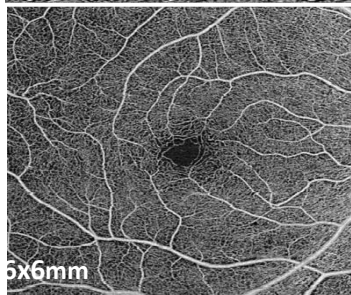
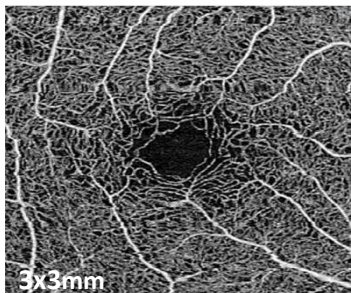


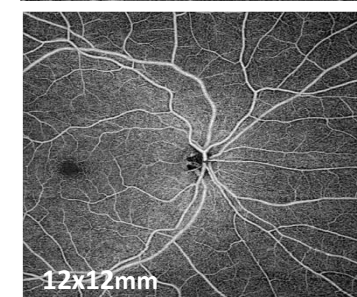
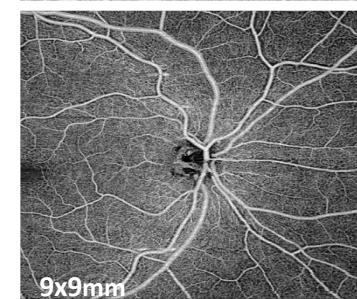
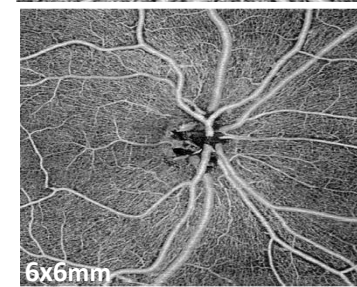
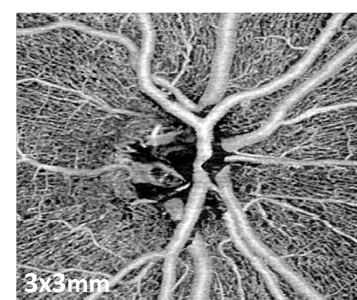
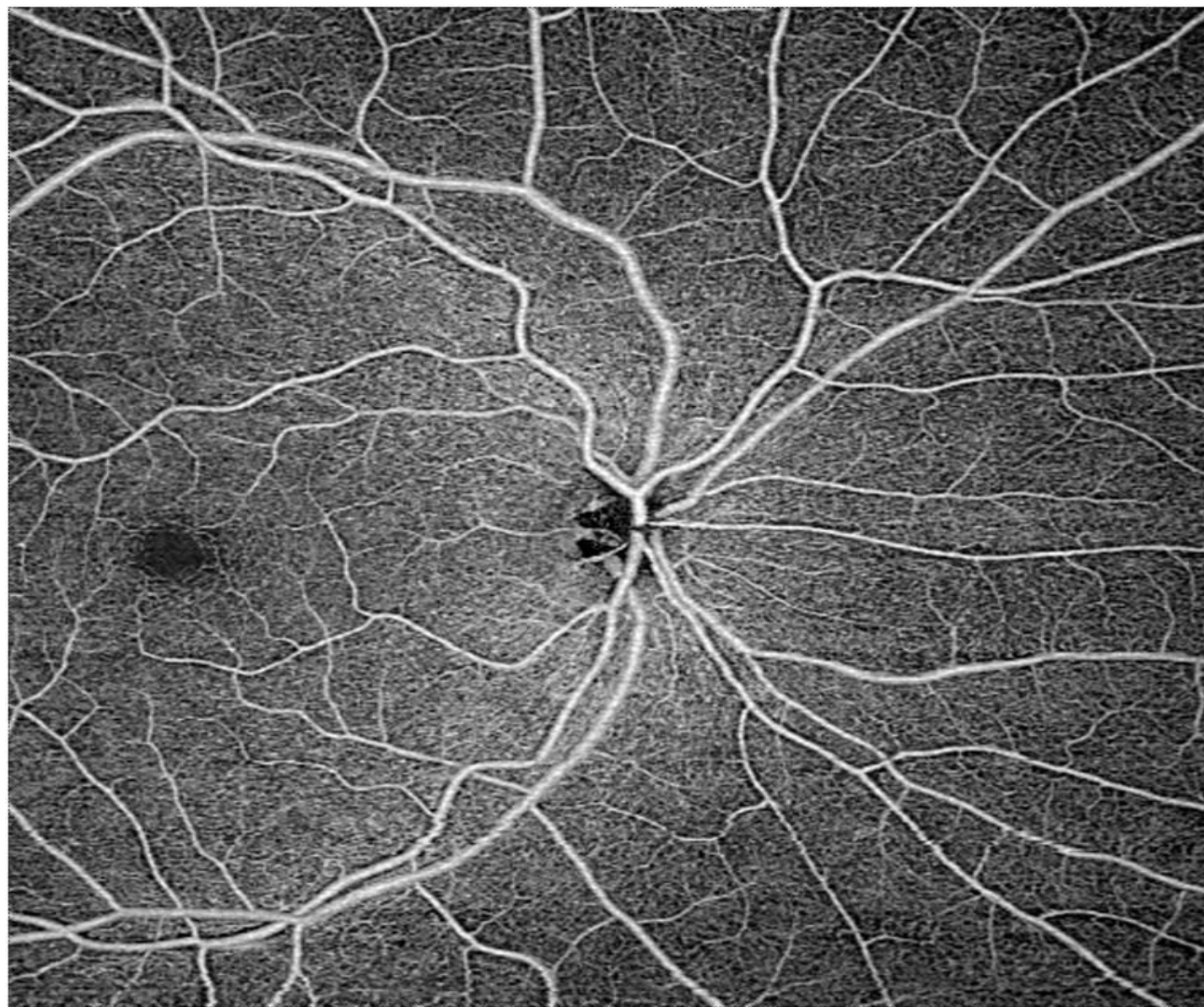
Zeiss PLEX™ Elite 9000



OPTOS Silverstone

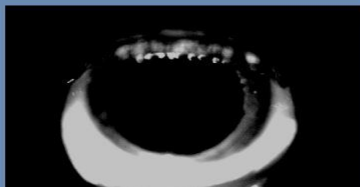






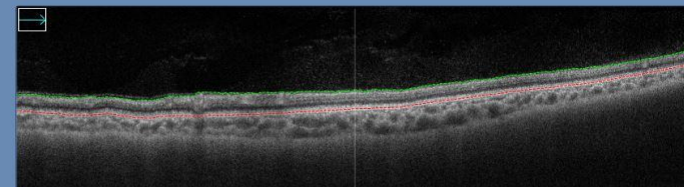
ALL SCANS

OS Angio (15mmx9mm)



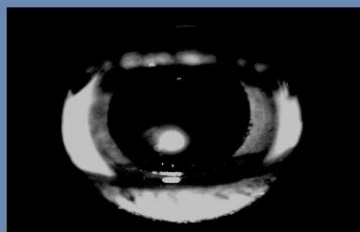
Signal Strength : 9/10

Fundus Image : 7/10

☒ Tracked during scan
☐ Tracked to prior

ALL SCANS

OS Angio (15mmx9mm)

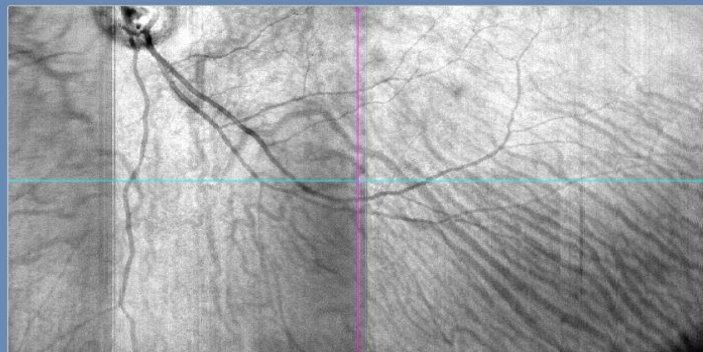
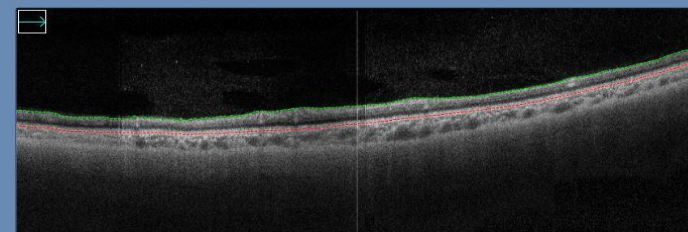


Signal Strength : 9/10

Fundus Image : 7/10

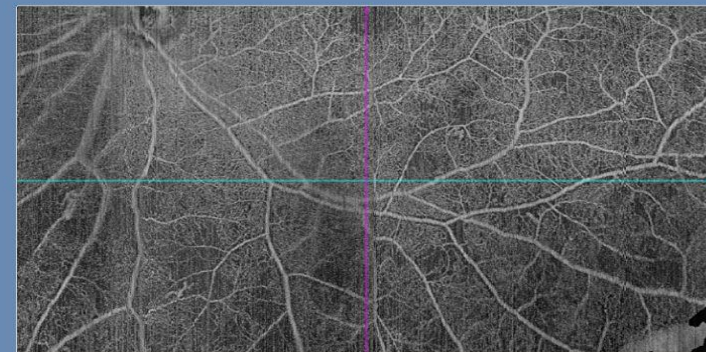
☒ Tracked during scan
☐ Tracked to prior

Transparency : 0%



Try Again

Save



Available Scans

Click to toggle selection

Angio (12mmx12mm-1) 9/6/2017 10:41:09 AM

Angio (12mmx12mm-2) 9/6/2017 10:42:02 AM

Angio (12mmx12mm-3) 9/6/2017 10:43:38 AM

Angio (12mmx12mm-4) 9/6/2017 10:44:31 AM

Angio (12mmx12mm-5) 9/6/2017 10:45:09 AM

Selected Scans

Angio (12mmx12mm-1) 9/6/2017 10:41:09 AM

Angio (12mmx12mm-2) 9/6/2017 10:42:02 AM

Angio (12mmx12mm-3) 9/6/2017 10:43:38 AM

Angio (12mmx12mm-4) 9/6/2017 10:44:31 AM

Angio (12mmx12mm-5) 9/6/2017 10:45:09 AM

Montage Options

Slabs

☒ Retina Depth Encoded

☒ Retina

☒ VRI

☒ Superficial

☒ Deep

☒ ORCC

☒ Avascular

☒ Choriocapillaris

☒ Choroid

☒ Remove Projections

Montage

Retina Depth Encoded

Retina

VRI

Superficial

Deep

ORCC

Avascular

Choriocapillaris

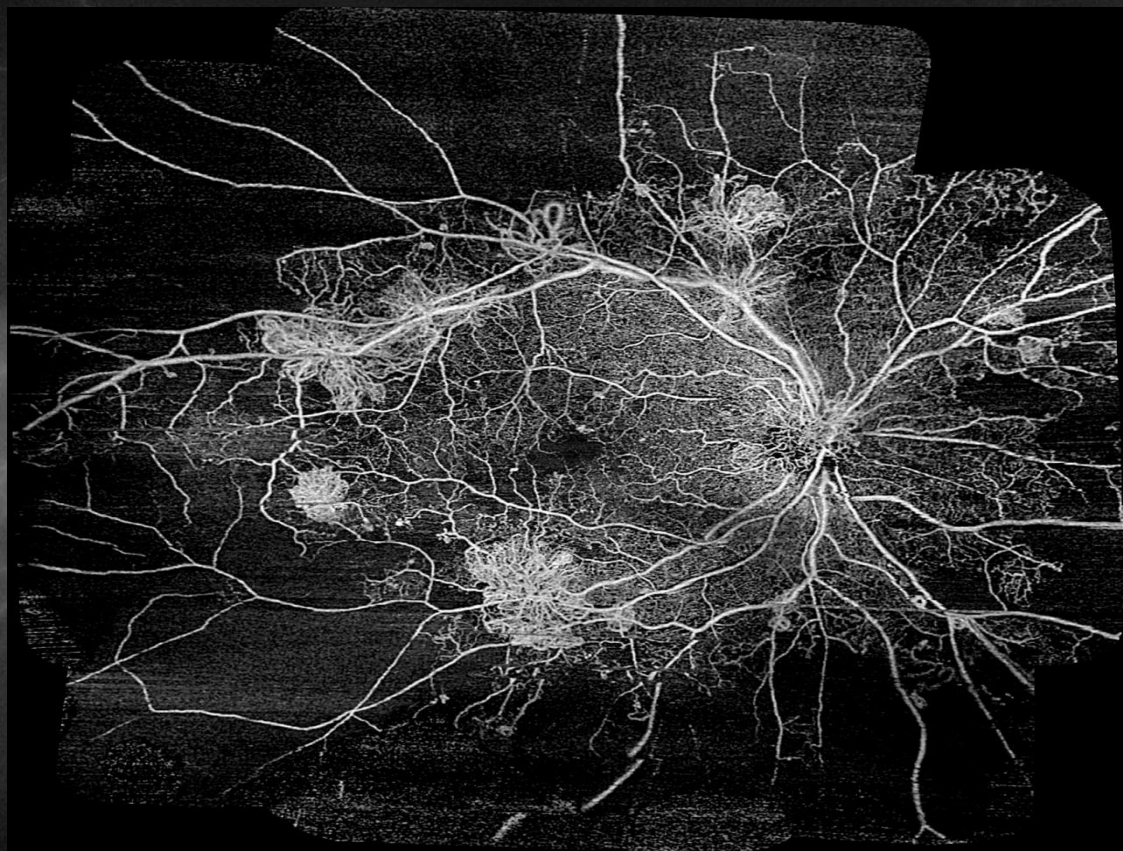
Choroid

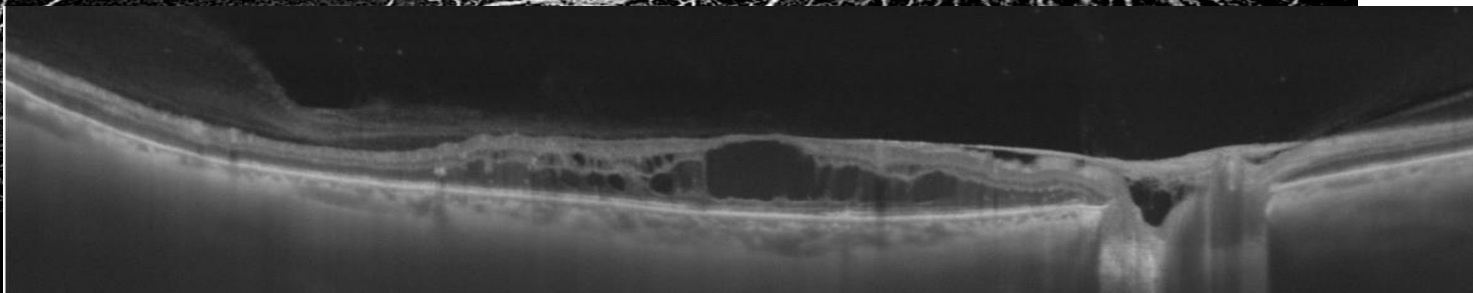
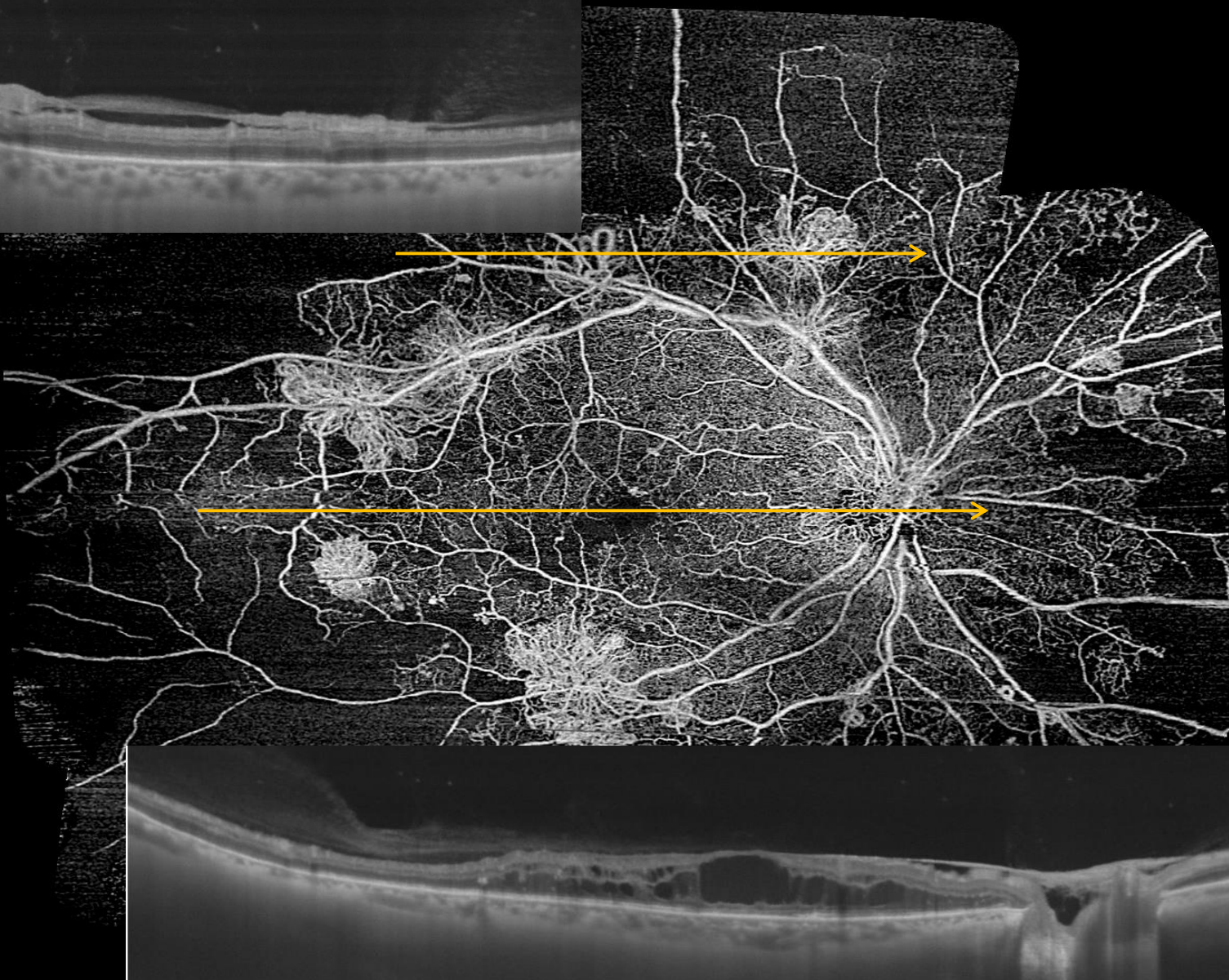
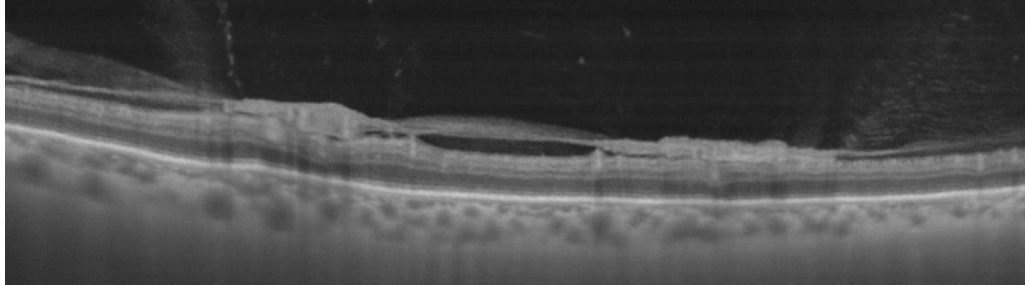
☐ Show Device Watermark

☐ Show Montage Watermark

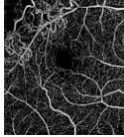
Export

Montage Preview





PLEX Elite 2.1 à 200 Mhz



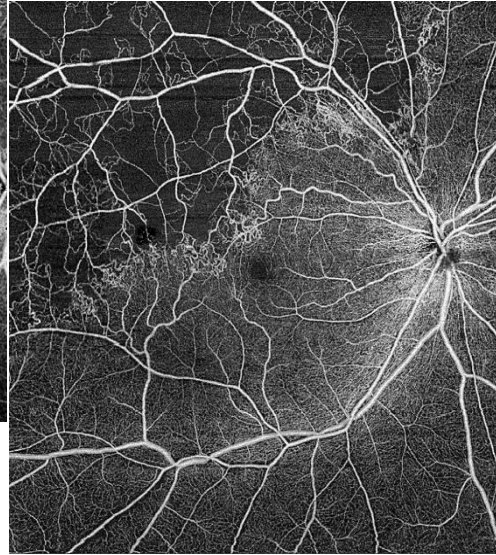
3mmx3mm



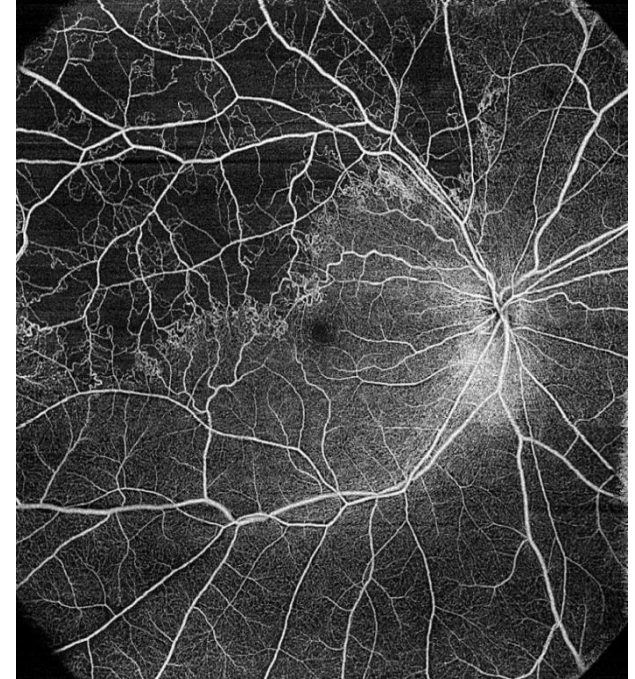
6mmx6mm



9mmx9mm

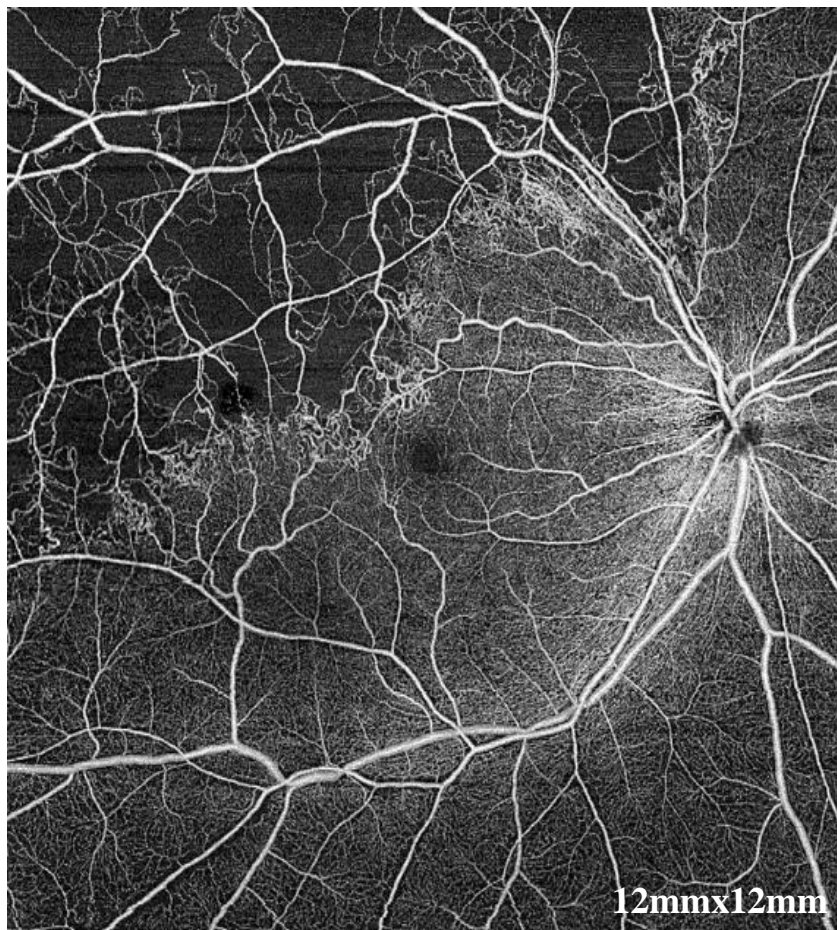


12mmx12mm

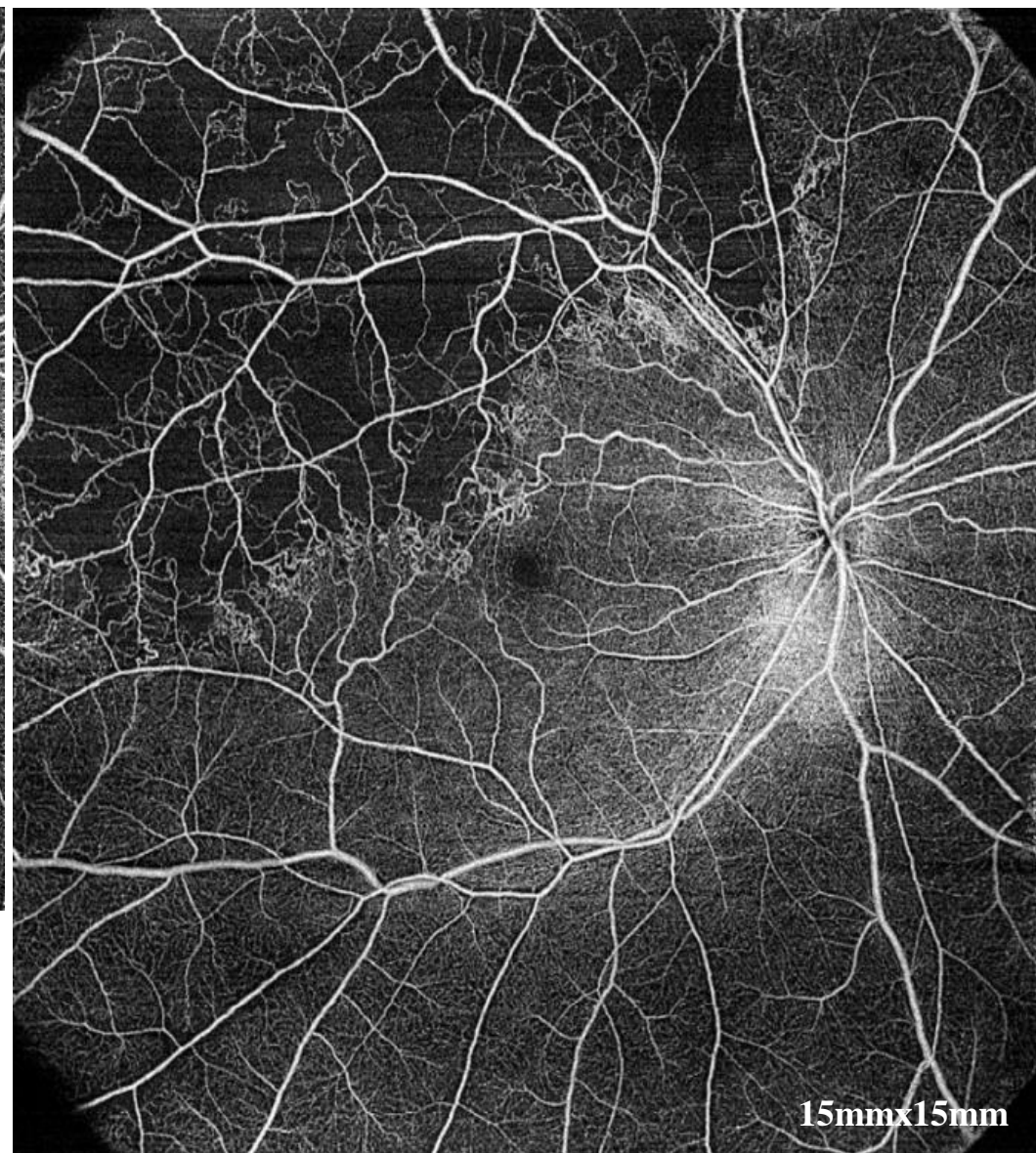


15mmx15mm

- Male
- 56 year-old
- BRVO in right eye



PLEX Elite 2.1 à 200 Mhz



OPTOS Silverstone (P200TxE)

SS-UWF OCT, 1050 nm

100 000A-scan/sec

Imaging Modalities

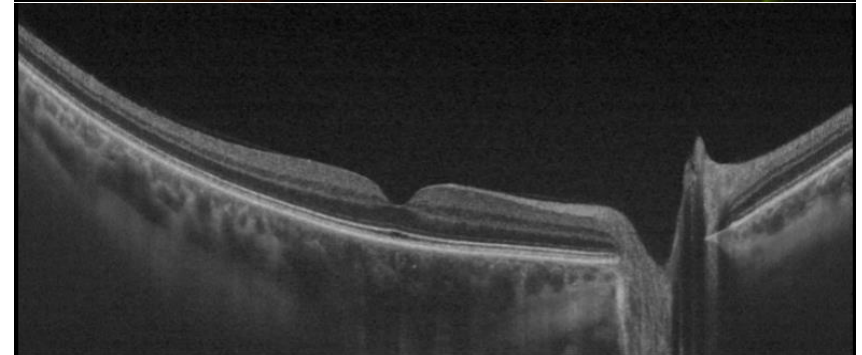
- Color
- Sensory (red-free)
- Choroidal
- Autofluorescence (AF)
- Fluorescein (FA)
- Indocyanine Green (ICG)

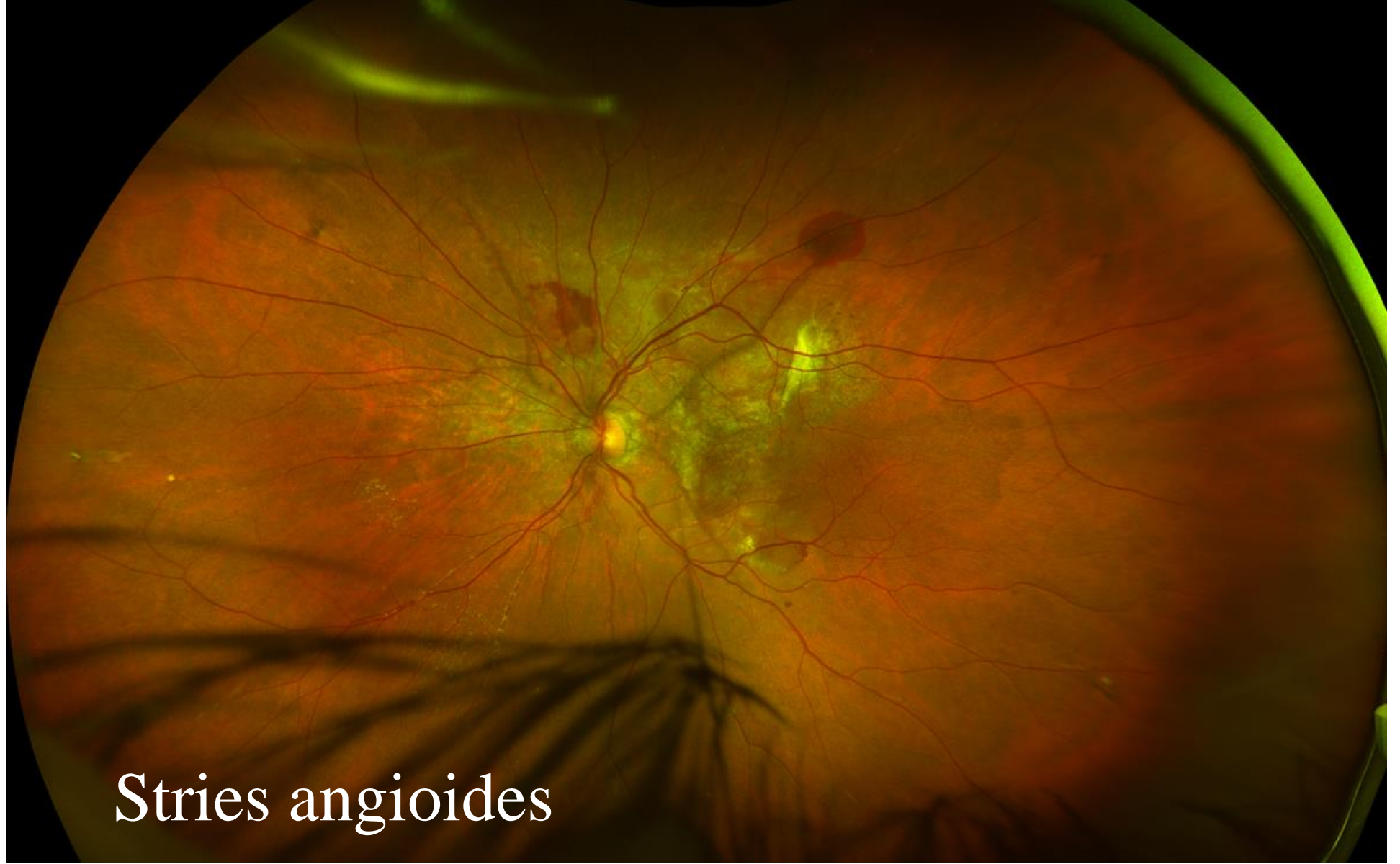
Laser Wavelengths

- Blue Laser: 488 nm (for FA)
- Red laser: 635 nm
- Green laser: 532 nm (for AF)
- Infra-red: 802 nm (for ICG)

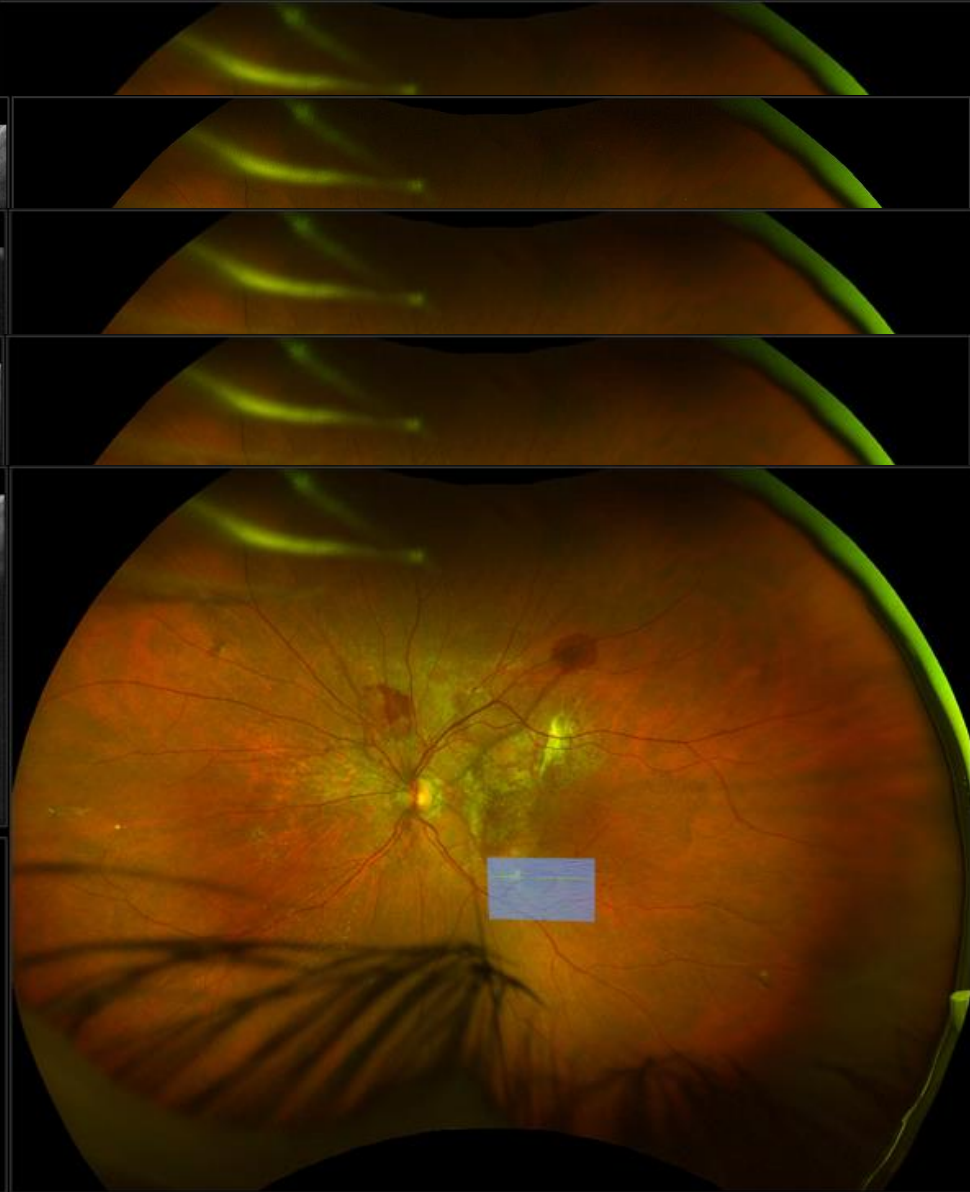
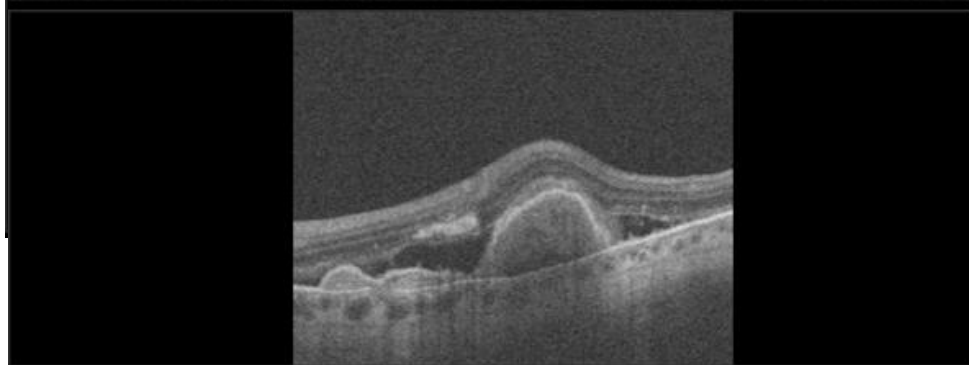
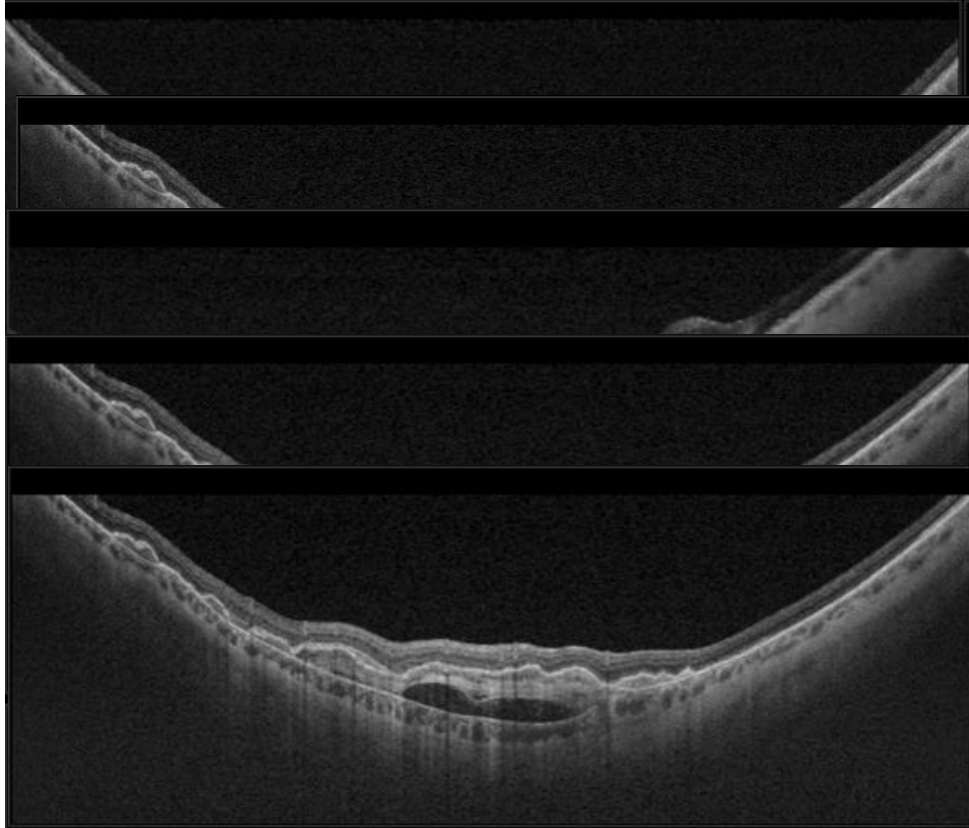
Scan Types

- Line Scans
 - Width: 6 mm, 14 mm, 23 mm
- Volume & High-Density Volume Scans
 - Height: Min 3.5 mm; Max 9 mm
 - Width: Min 6.0 mm; Max 14 mm





Stries angioides



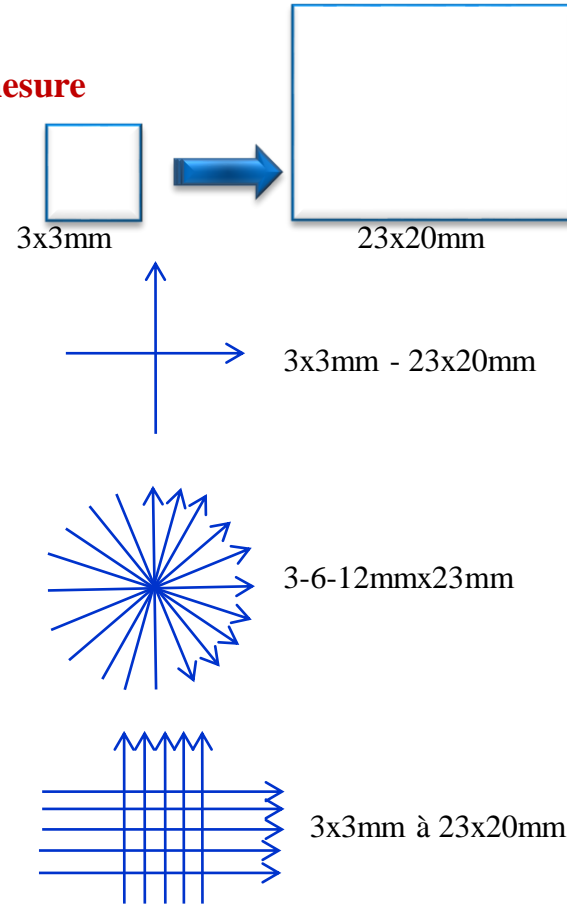
Canon Xephilio S1 (*SSOCT/SSOCTA*)

- **Swept Source 100 000A-scans/sn**
- **23 mm** of UWF B-scan images in a single acquisition (*80°viewing angle*)
- UWF OCT image up to **23 x 20 mm**, high density of **928 x 807 pixels**
- UWF Mosaic up to **31 x 27 mm**
- **5.3 mm** scan depth
- Deep Learning AI technology – **Denoise** (*reduced noise*)
- Auto alignment
- SLO/OCT auto focus
- Retinal Tracking



Canon Xephilio S1 (SSOCT/SSOCTA)

- Swept Source 100000A-scans/sn
- Ultra grand champ de **23 x 20 mm en une seule mesure**
- Mosaïque jusqu'à **31 x 27 mm**
- Profondeur de champ 5.3 mm
- Intelligent Denoise
- Alignement automatique
- Focalisation SLO/OCT automatique
- Positionnement de la coupe automatique
- Tracking rétinien



Macula Disease

- Multi Cross
- Radial
- Cross
- Custom 3D
- Macula 3D

Choroid (Inverse)

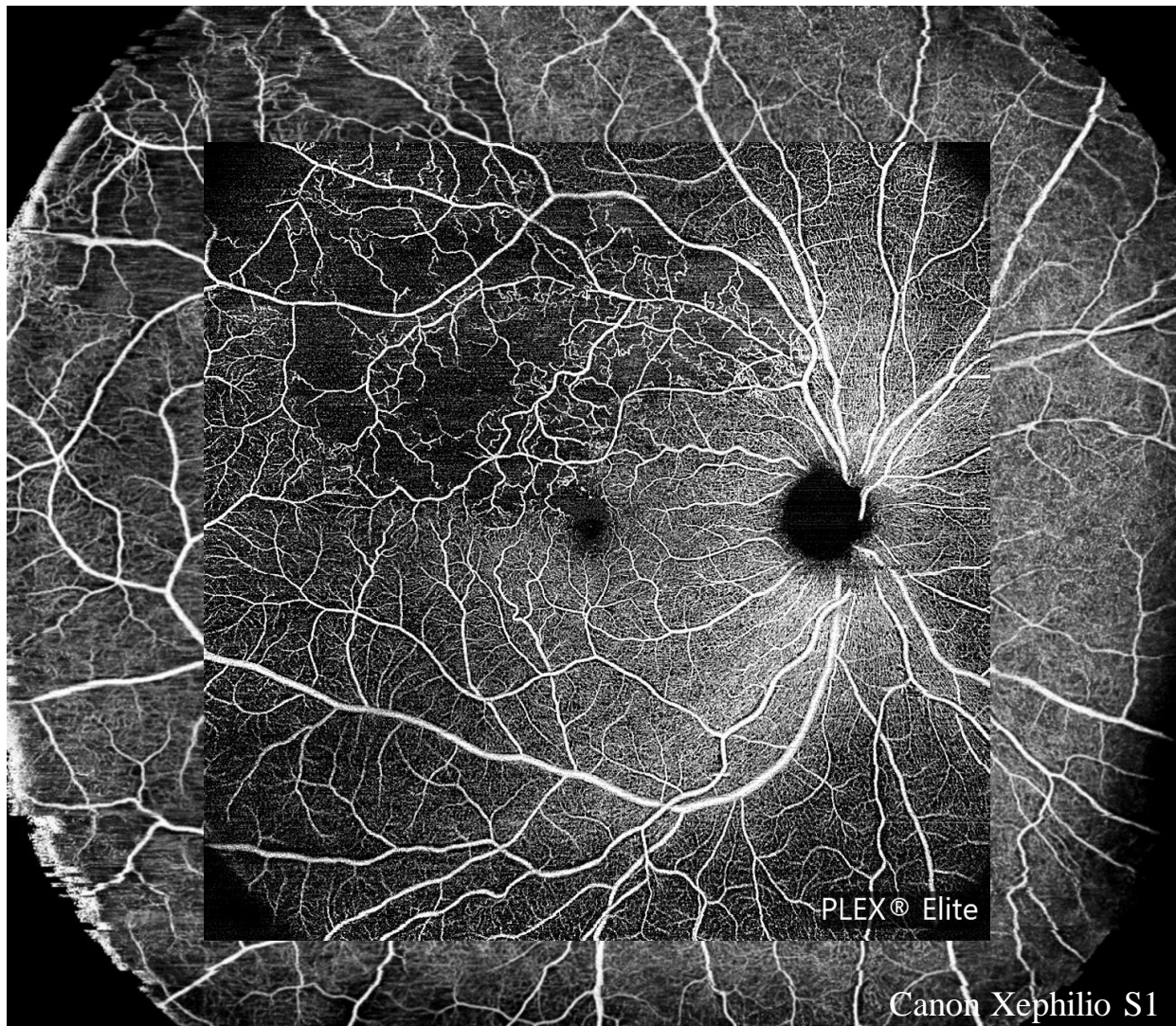
- Multi Cross
- Radial
- Cross
- Custom 3D

Glaucoma

- Glaucoma 3D
- Disc 3D
- Radial

Anterior (12x12mm)

- Cross
- Radial

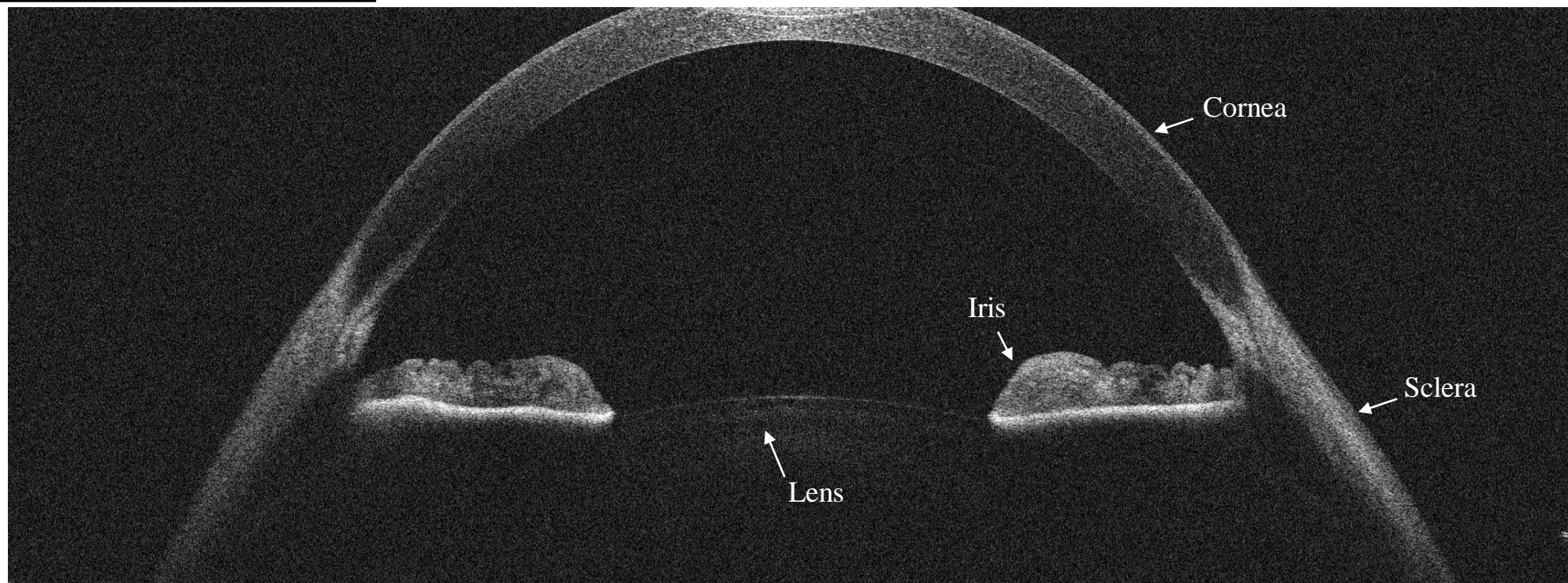
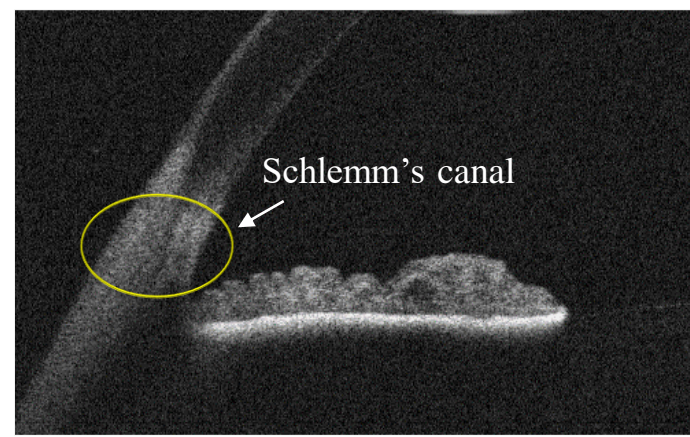
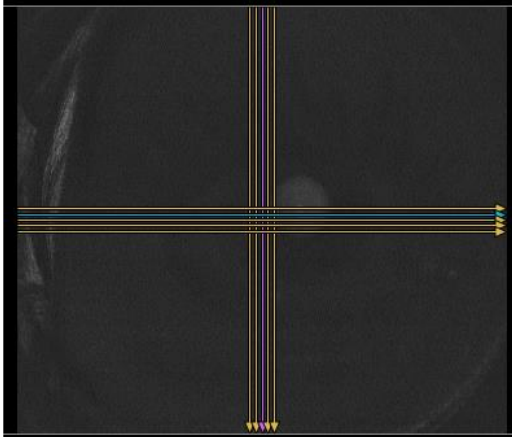


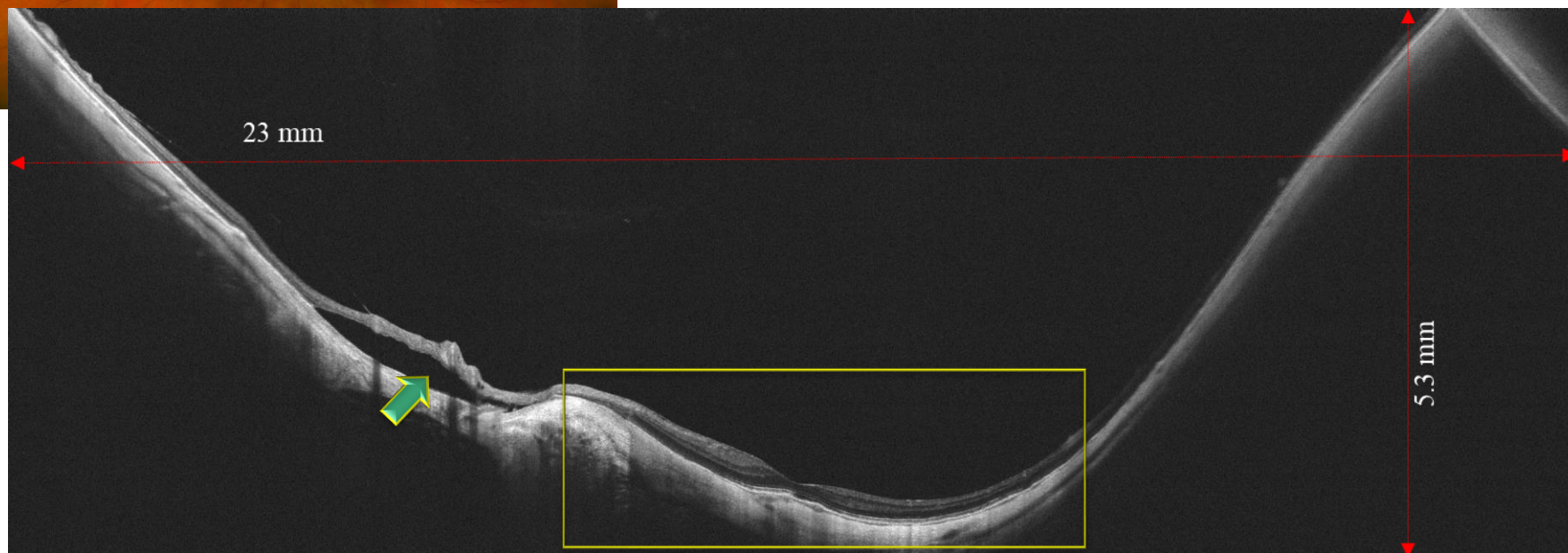
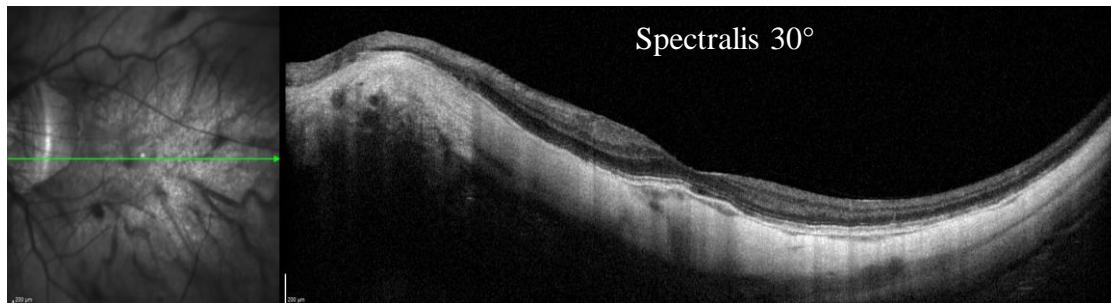
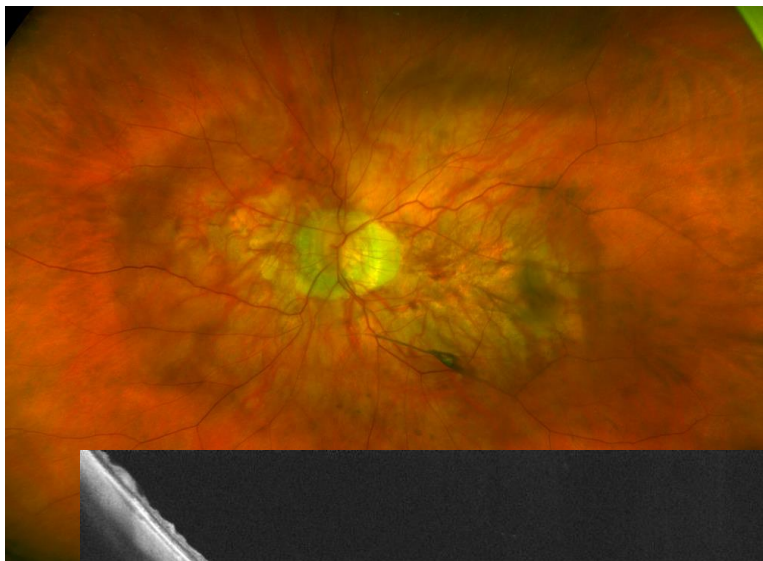
**Canon Xephilio S1
(23x20mm)**

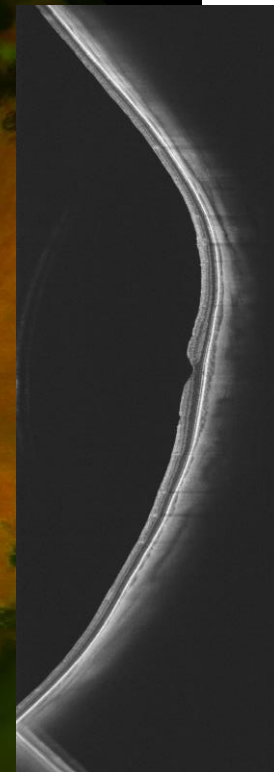
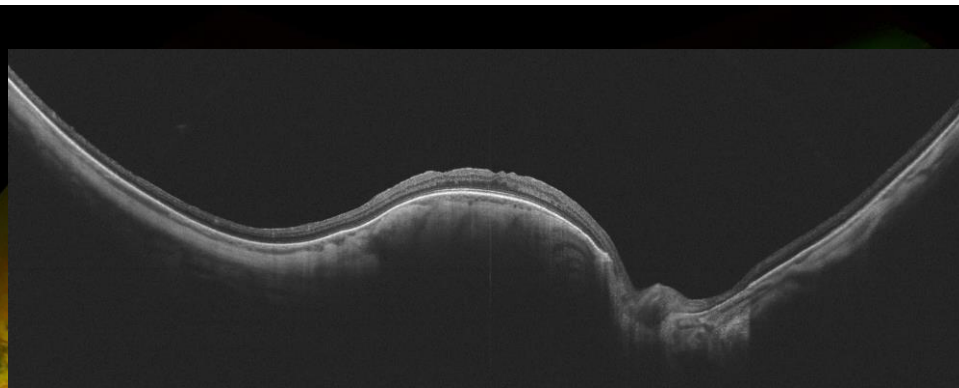
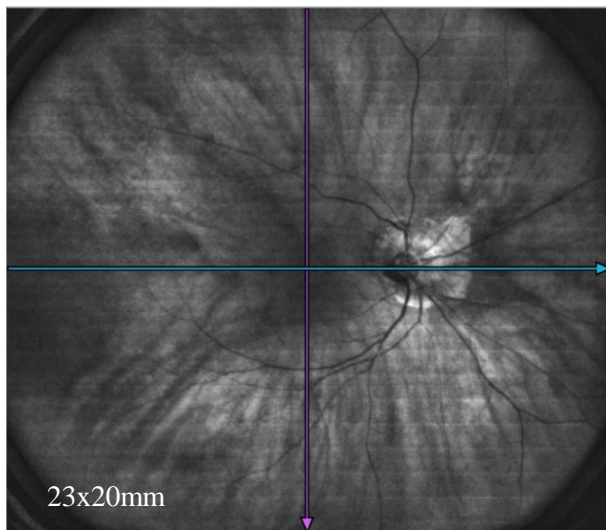
Vs

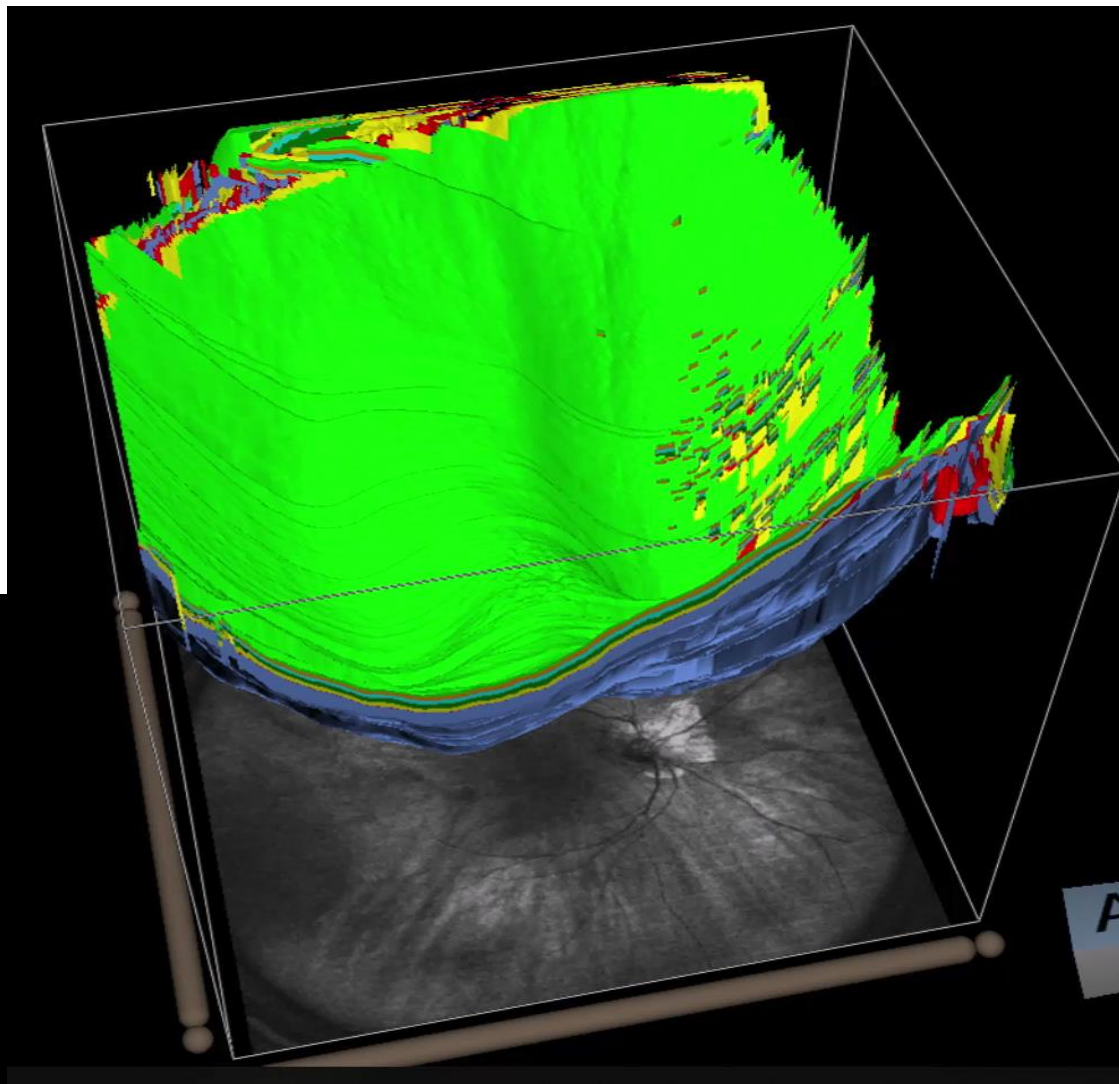
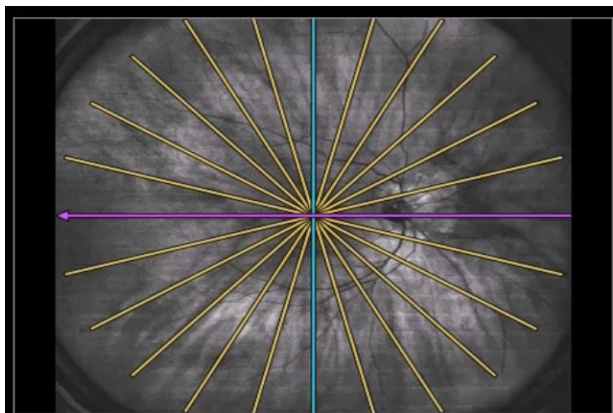
**Zeiss PlexElite
(15x15mm)**

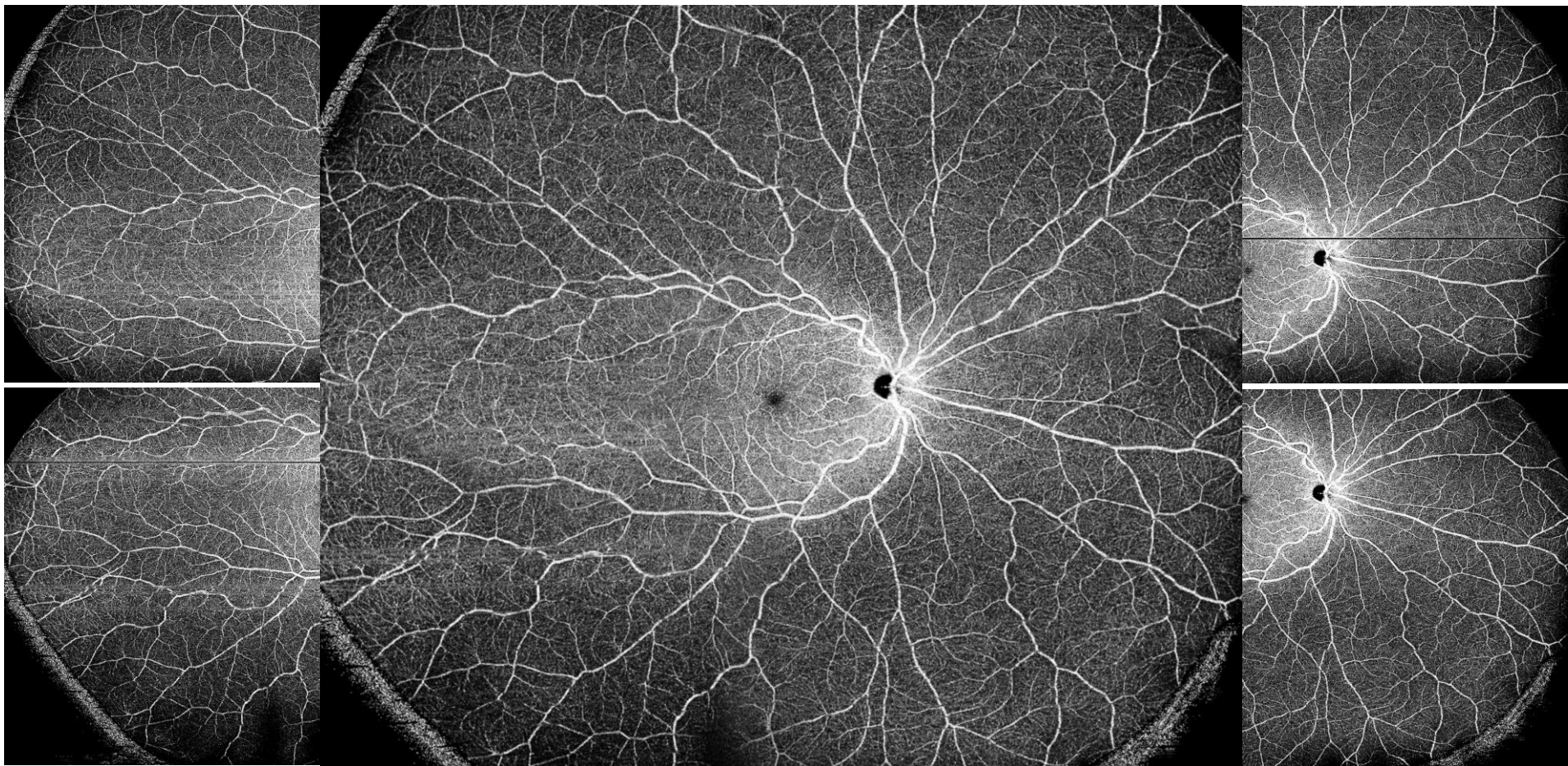


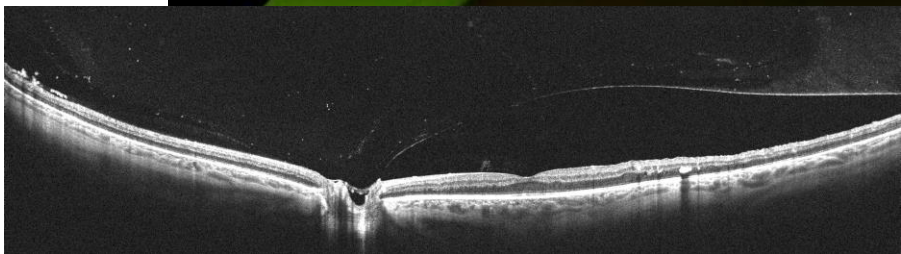


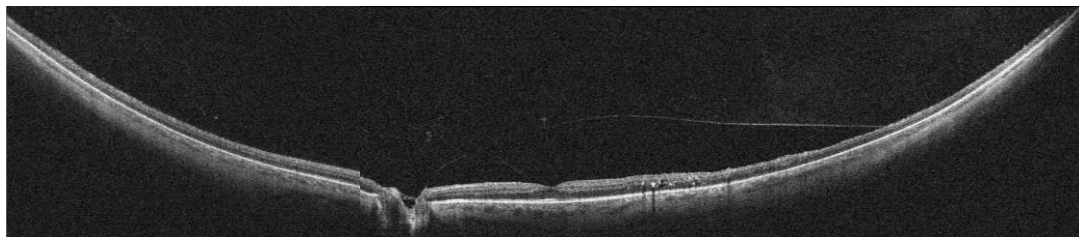
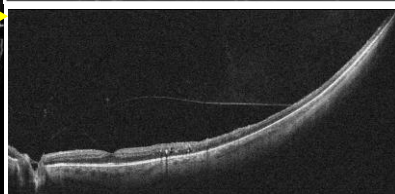
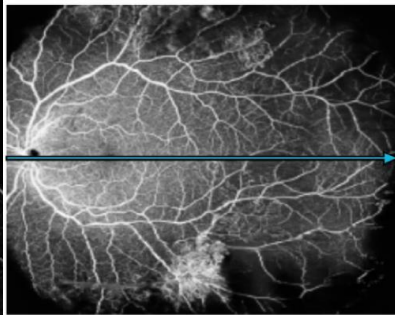
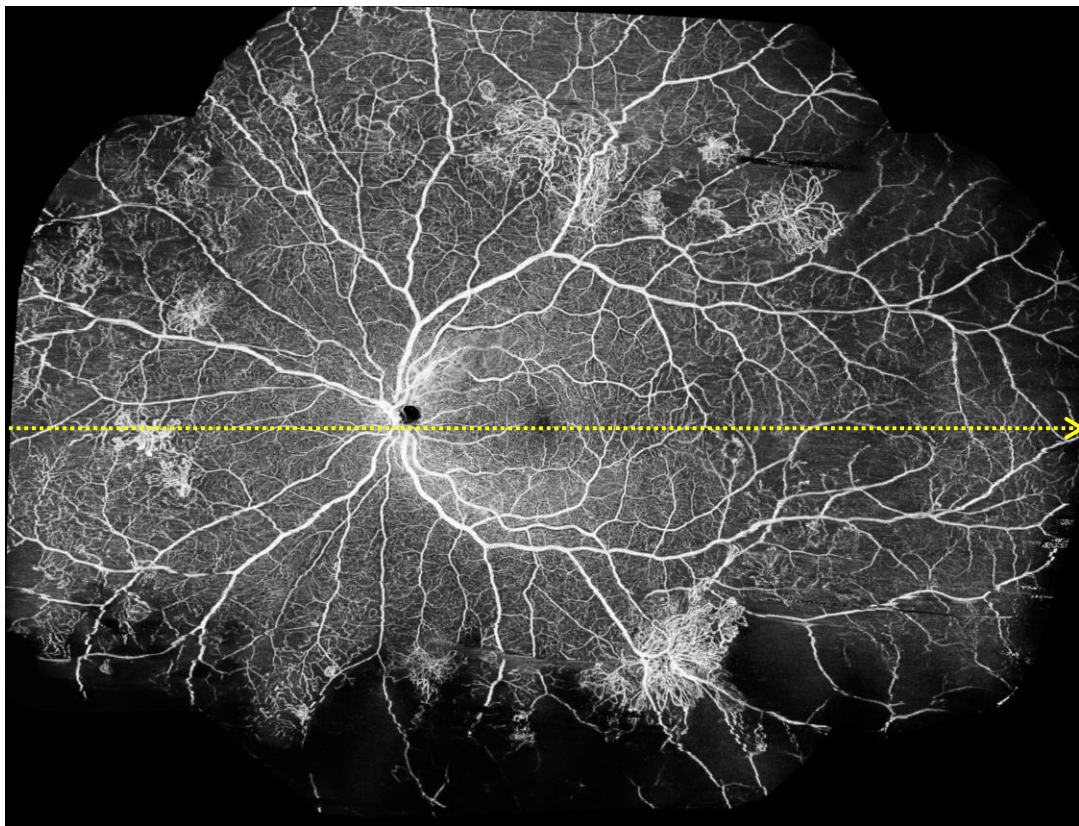
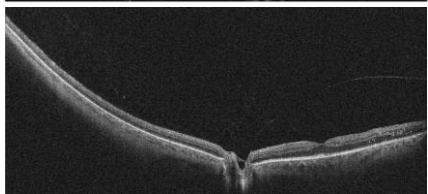
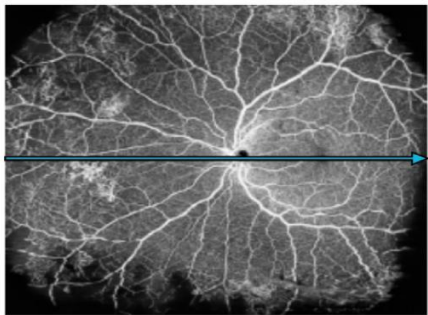


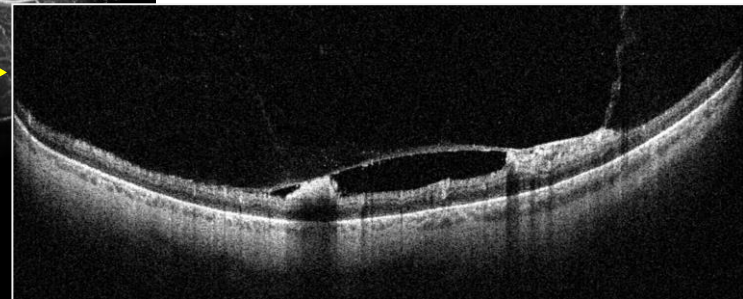
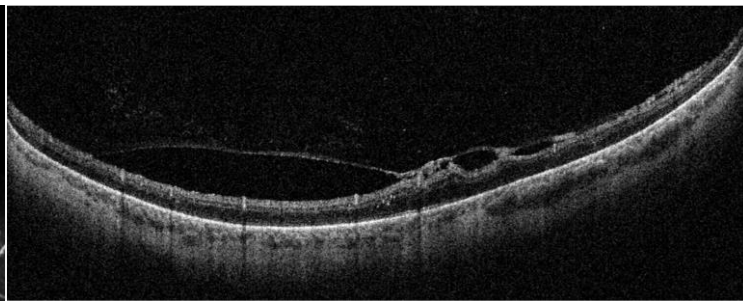
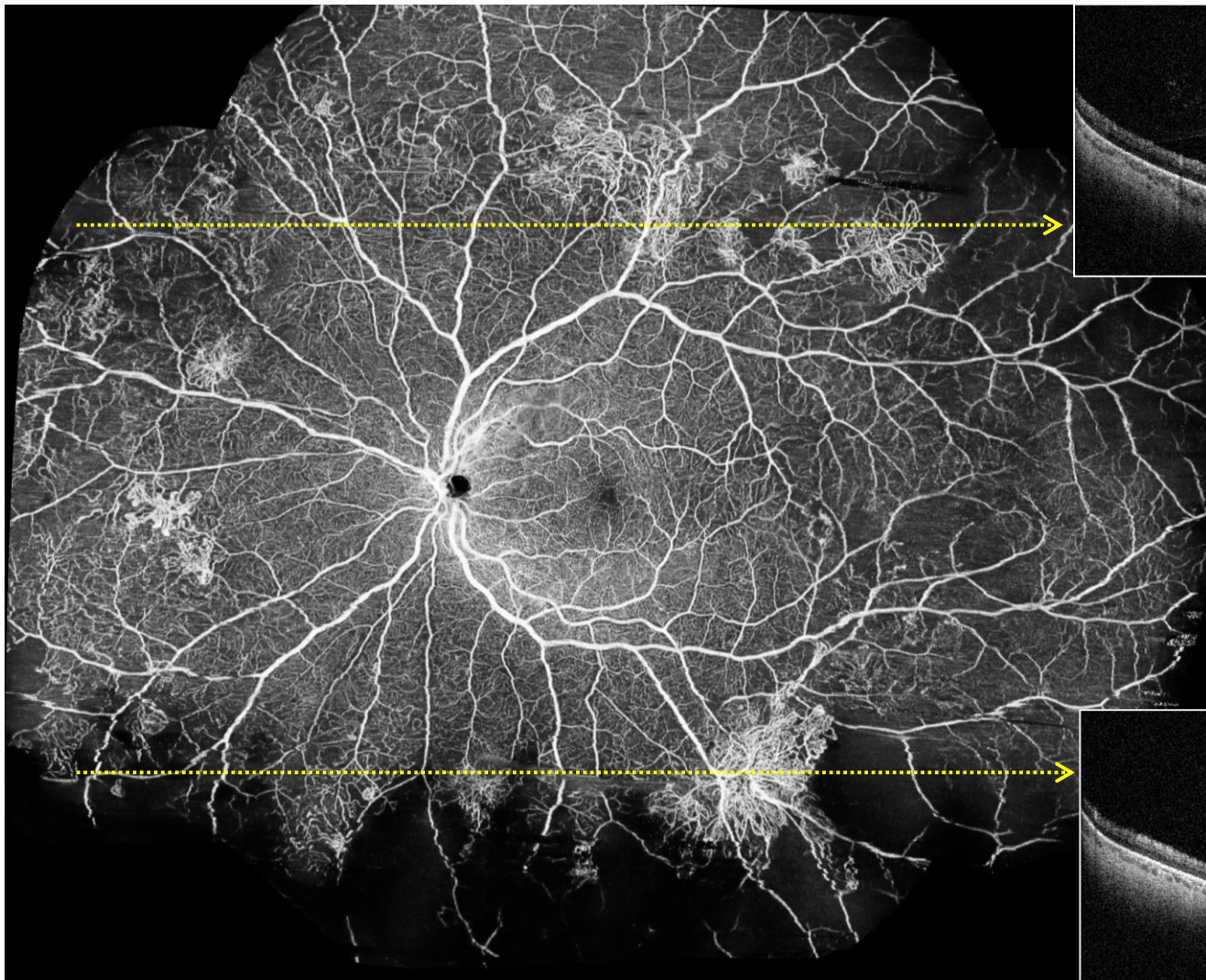


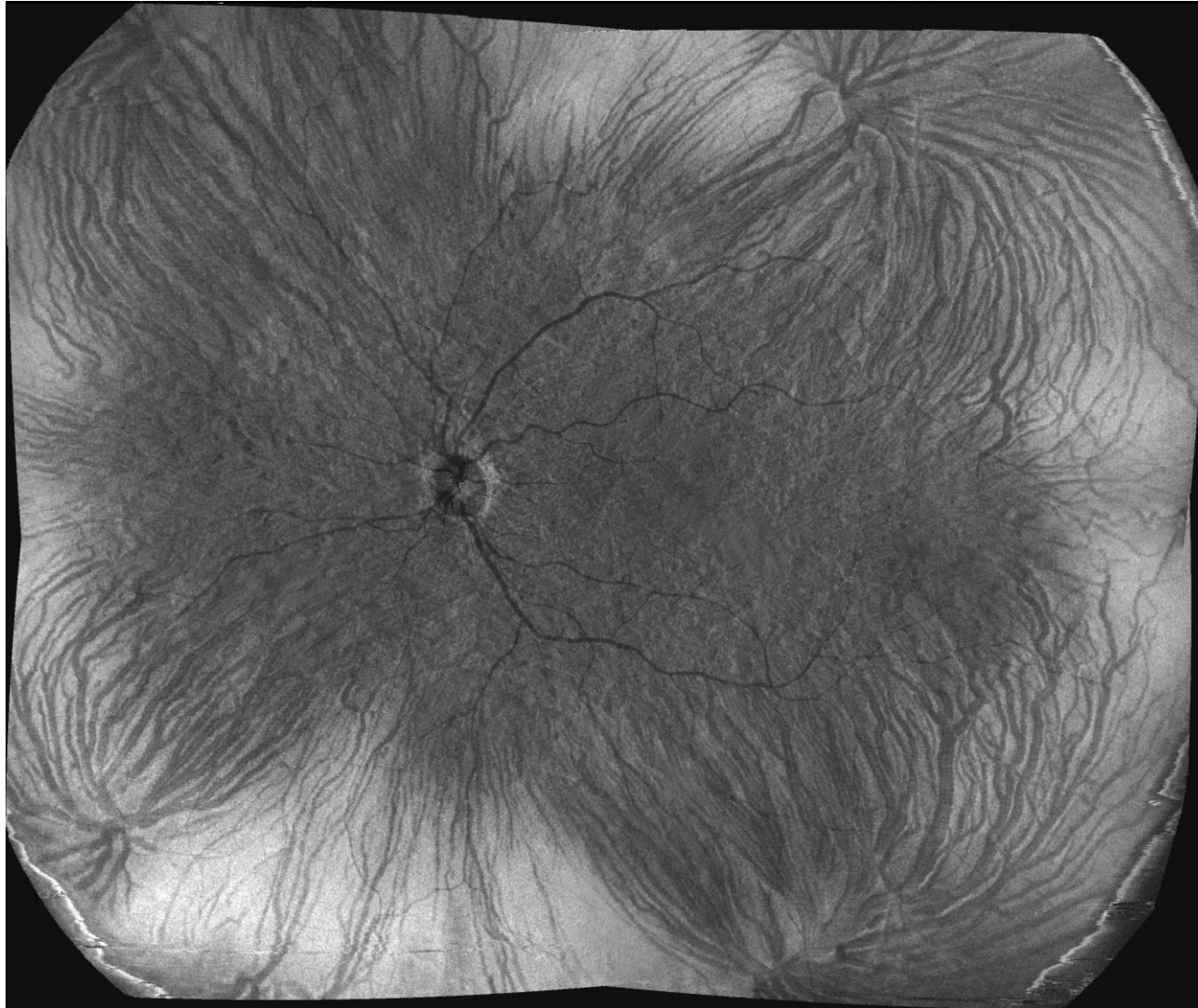












Canon Xephilio, « mosaïc »

**Mosaic en-face image showing
4 choroidal vortex veins.**

OCT/OCTA

Artéfacts

Les artefacts peuvent avoir une origine triple

✓ Liés au patient:

- trouble des milieux (cataractes, hémorragies intra vitréennes / sous rétiniennes, corps flottants)
- mouvements oculaires
- mauvaise fixation...

✓ Liés à l'opérateur (l'acquisition):

- mauvais positionnement du scan et/ou du choix de protocole d'examen

✓ Liés à l'appareil et au logiciel de traitement d'image:

- erreurs de mesure de l'épaisseur , sommations, eye tracking, segmentation ...

9/16/2008

5 Line Raster 3:31:32 PM

5 Line Raster 3:31:11 PM

5 Line Raster 3:30:28 PM

5 Line Raster 3:27:59 PM

Macular Cube 512x128 3:27:04 PM

Macular Cube 512x128 3:32:54 PM

5 Line Raster 3:32:02 PM

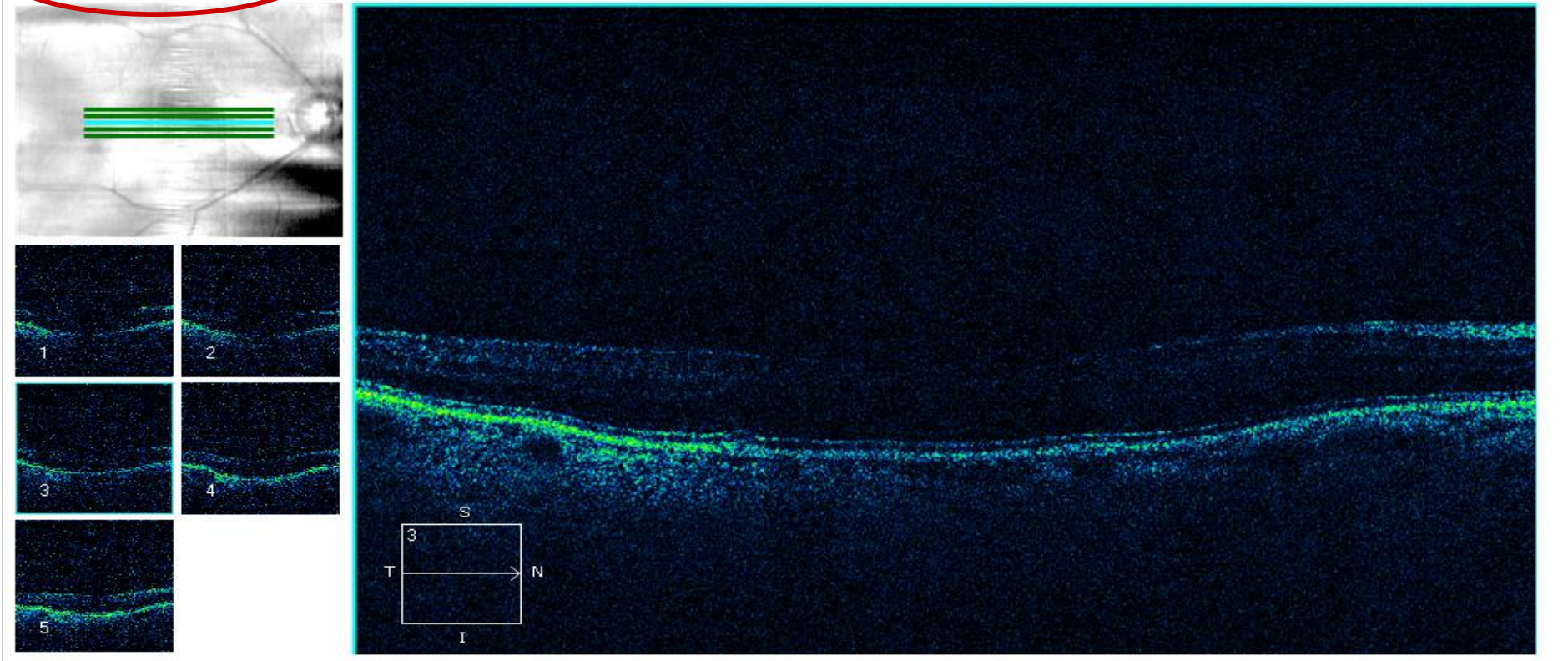
High Definition Images

Signal Strength 1/10

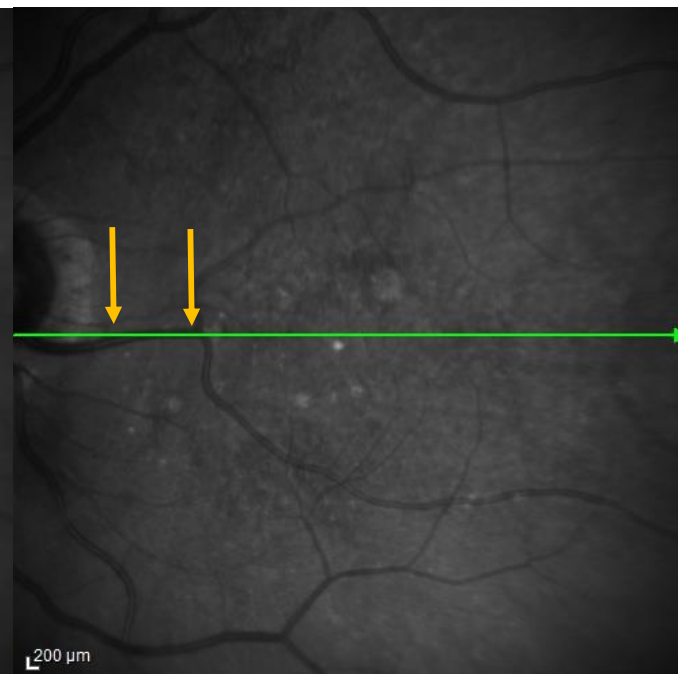
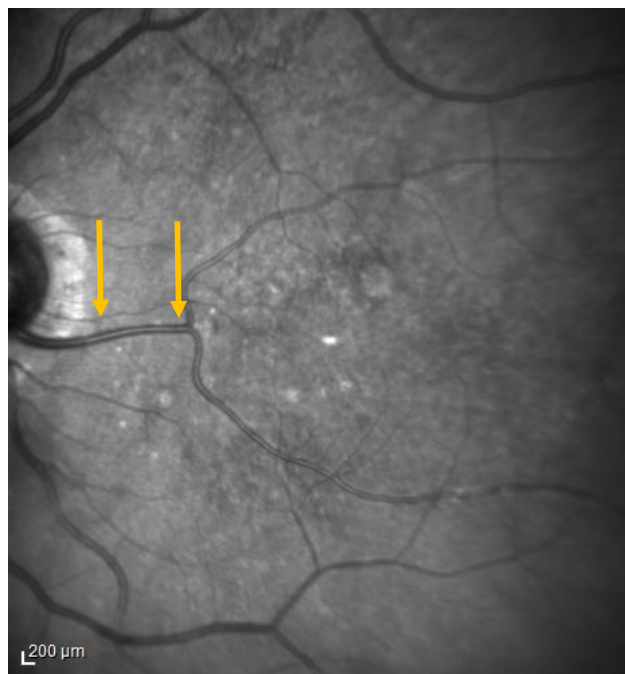
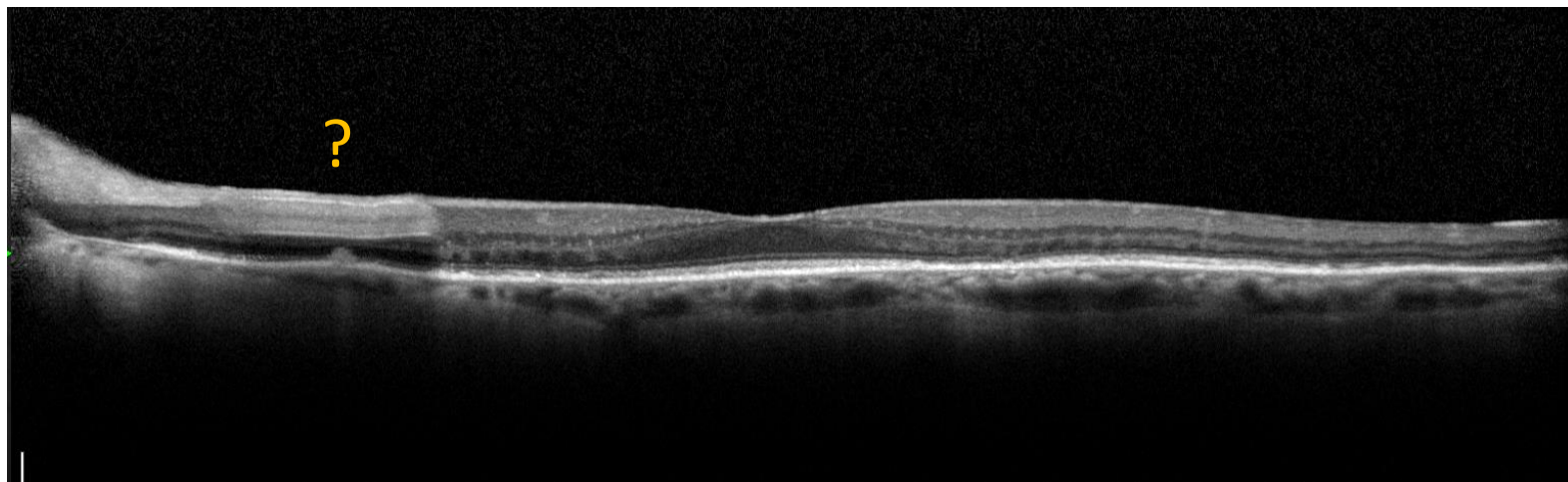
Scan angle: 0°

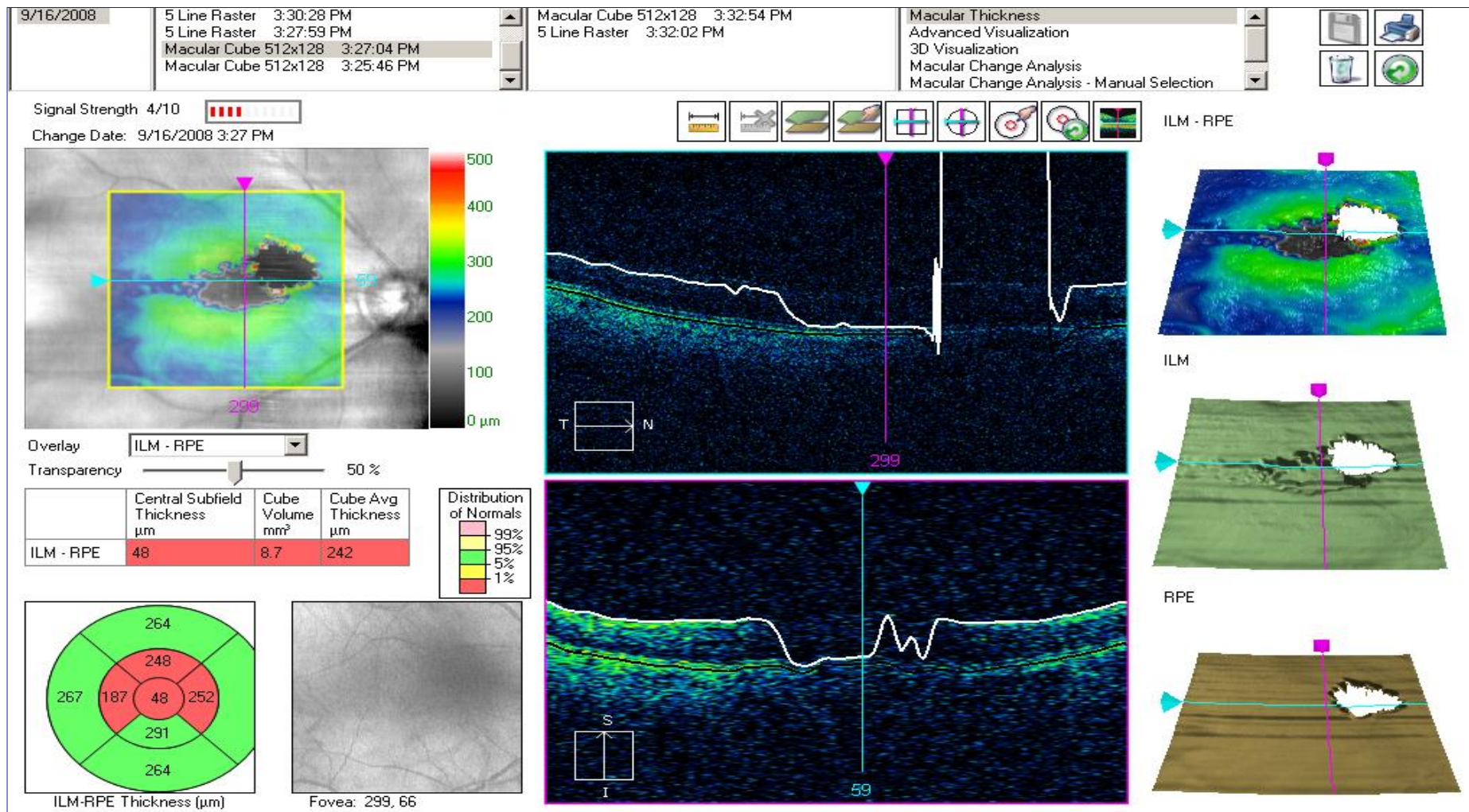
Spacing: 0.25 mm

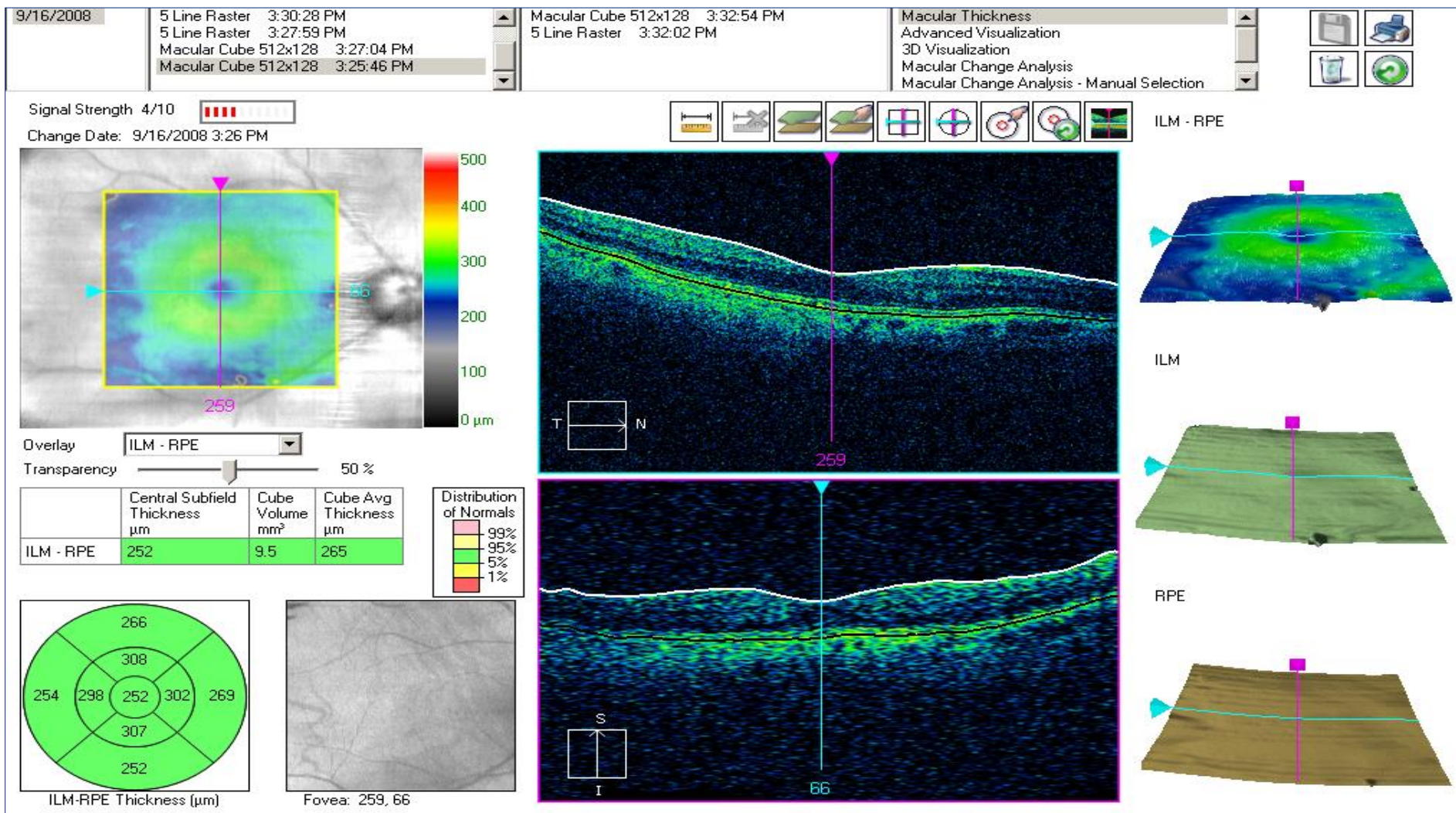
Length: 6 mm

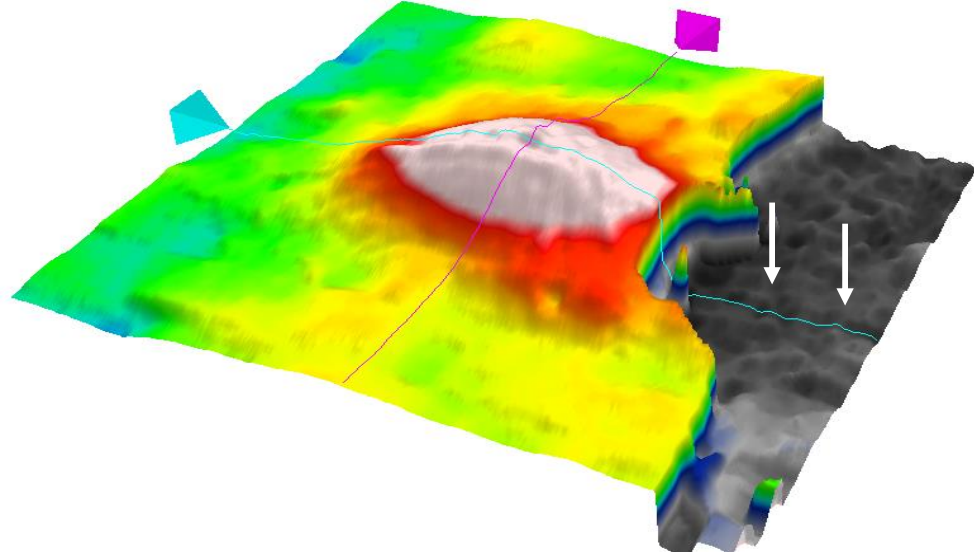




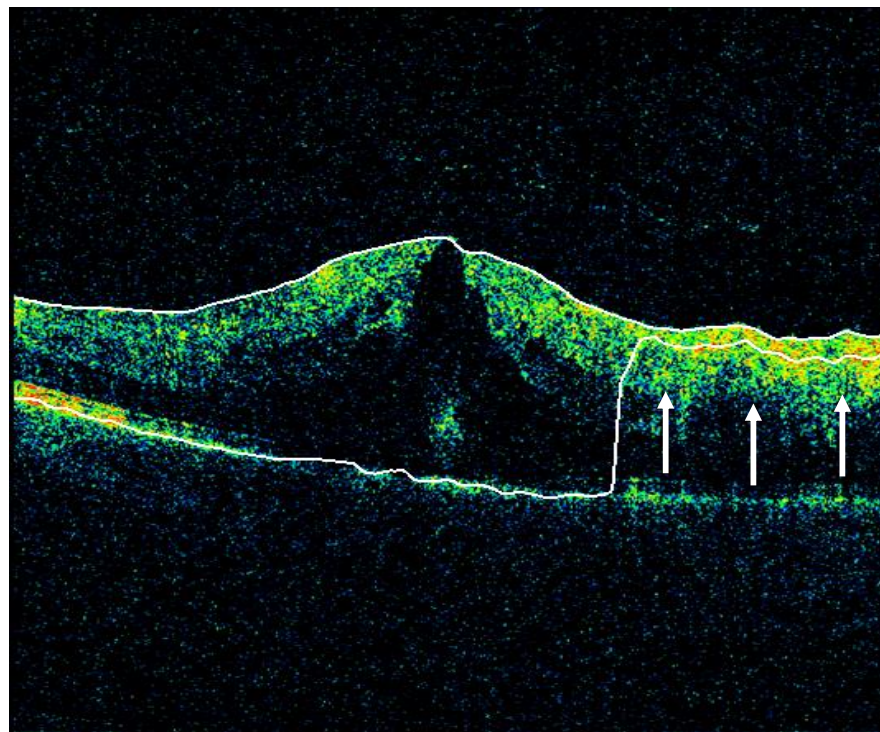


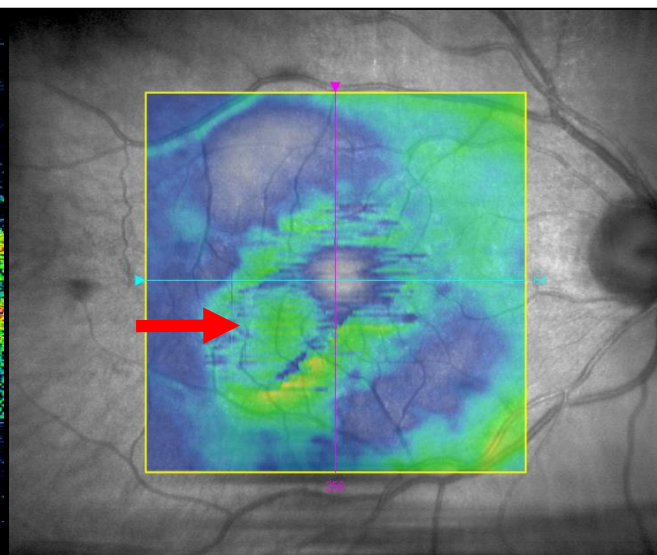
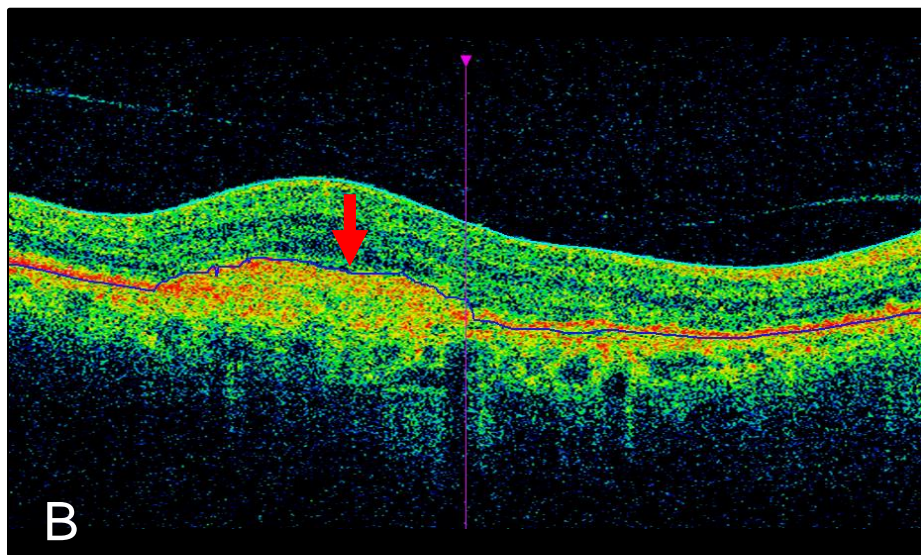
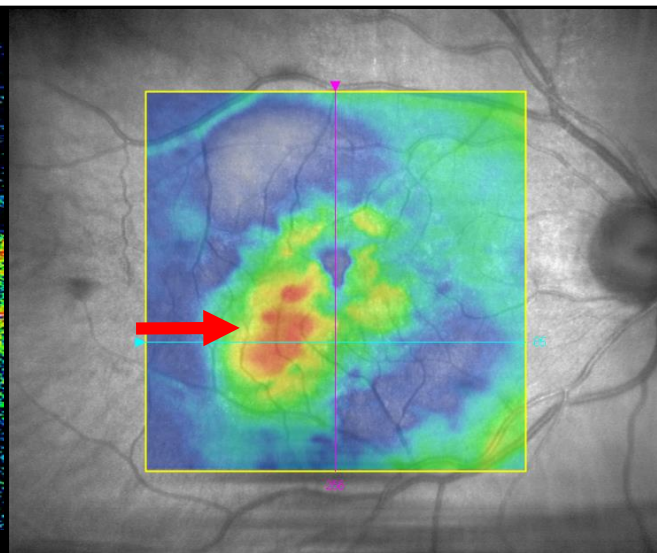
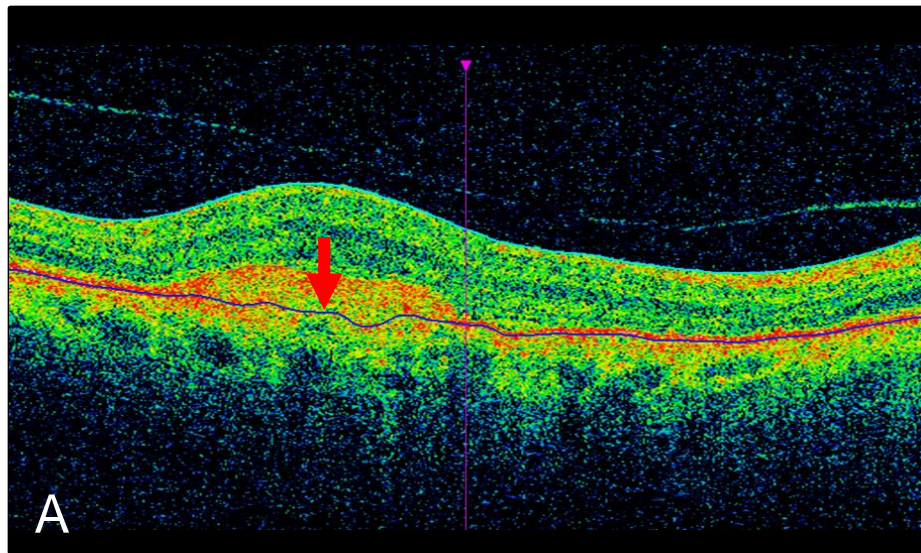


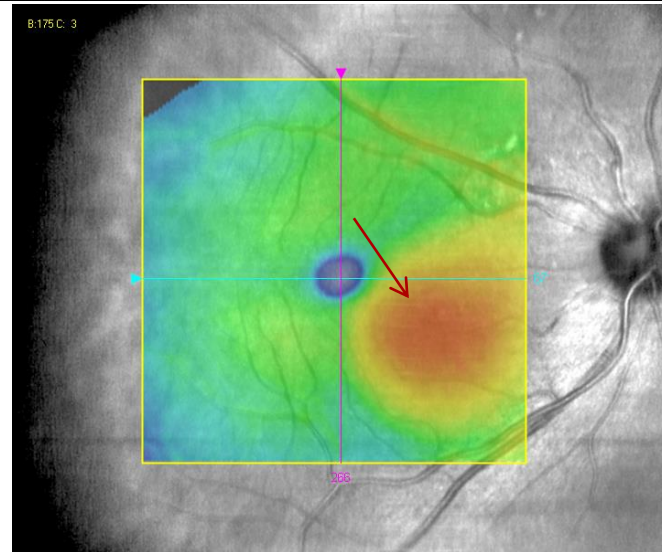
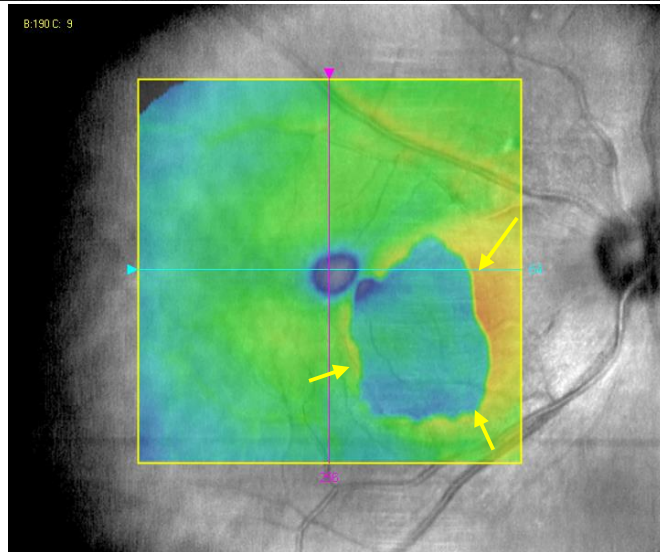
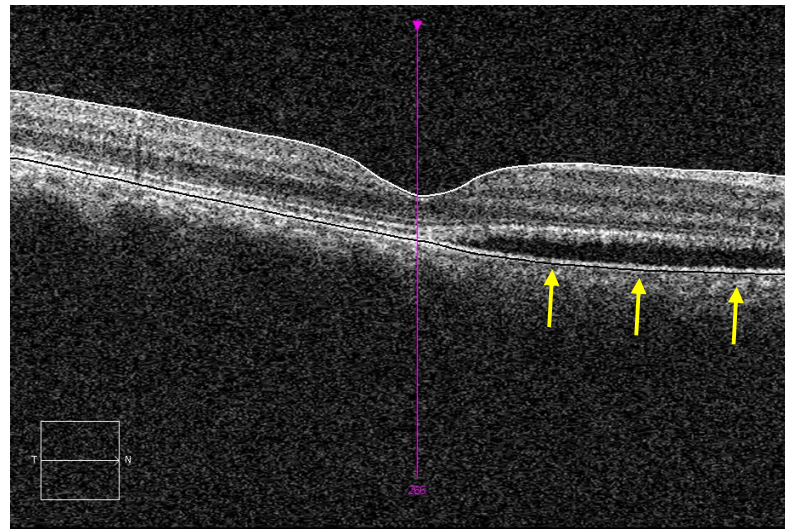
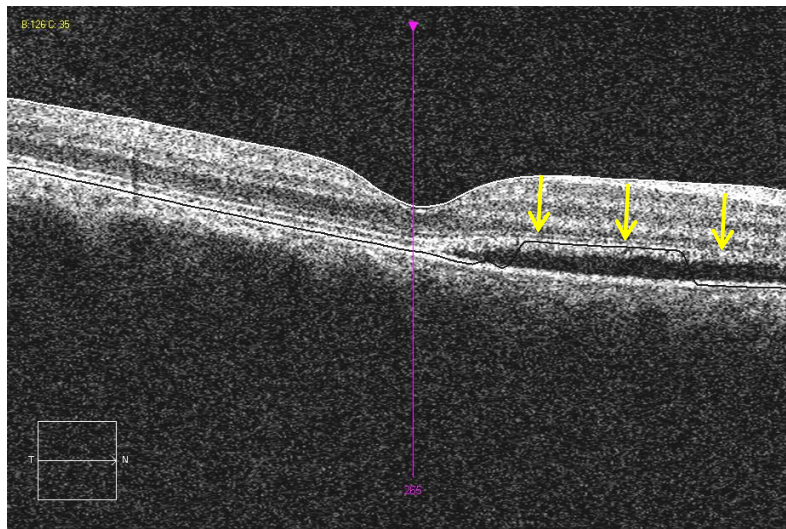




Artéfacts sur le mapping 3D







10/16/2007

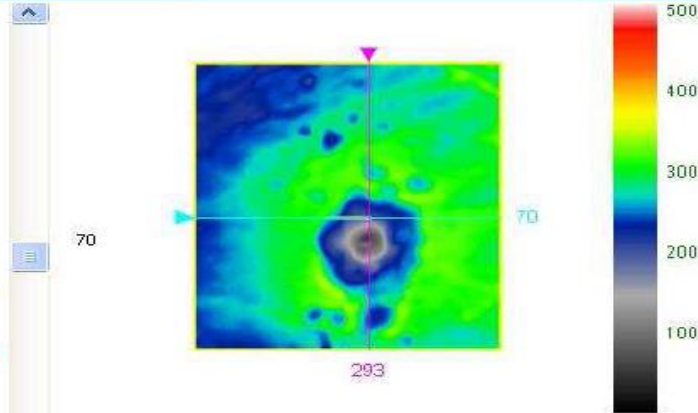
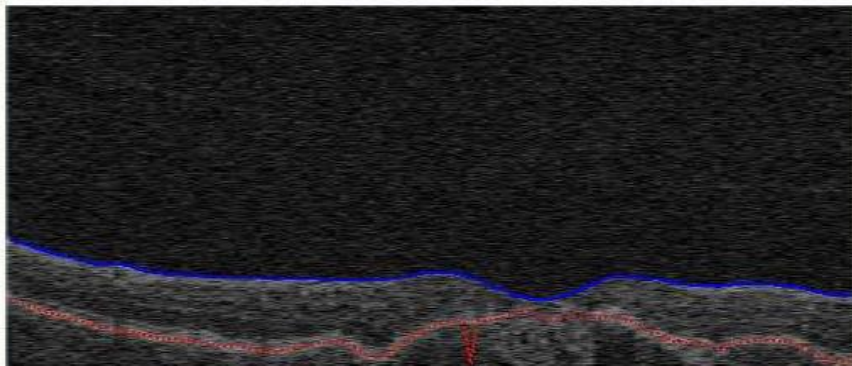
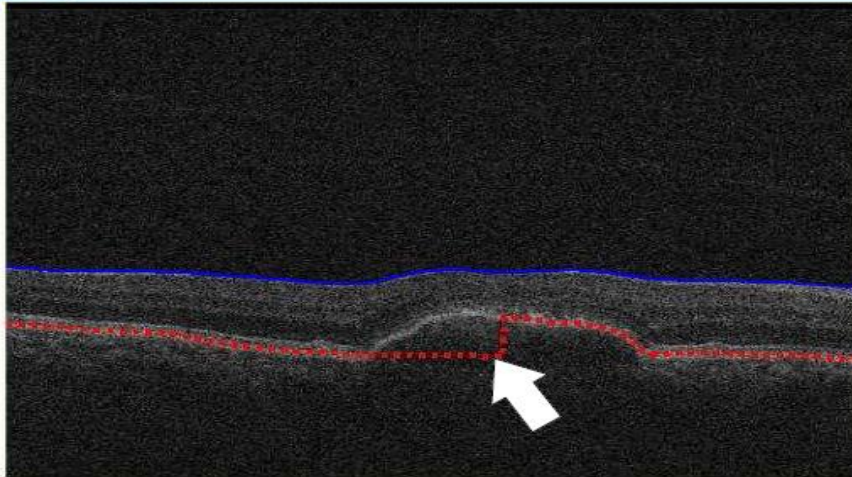
Optic Disc Cube 200x200 8:47:13 AM
Macular Cube 200x200 8:43:53 AM

Optic Disc Cube 200x200 8:51:44 AM
Optic Disc Cube 200x200 8:50:58 AM
Macular Cube 200x200 8:49:37 AM

Advanced Visualization
Glaucoma OU Analysis



Edit Segmentation



Segmentation Layer Editing Tool



✓ Allows for correcting segmentation errors

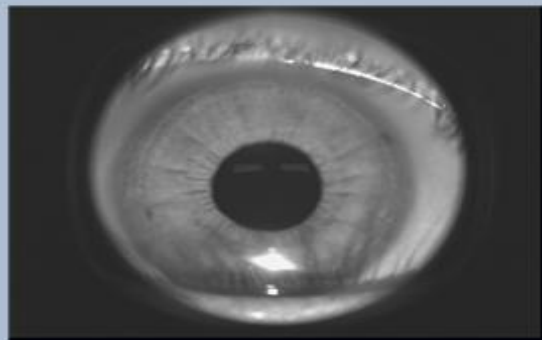
Macular Cube 200x200 7:59:18 AM
Macular Cube 200x200 7:58:51 AM



ILV

OD

Macular Cube 512x128



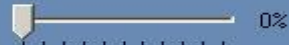
Signal Strength : 10/10



Overlay:

OCT

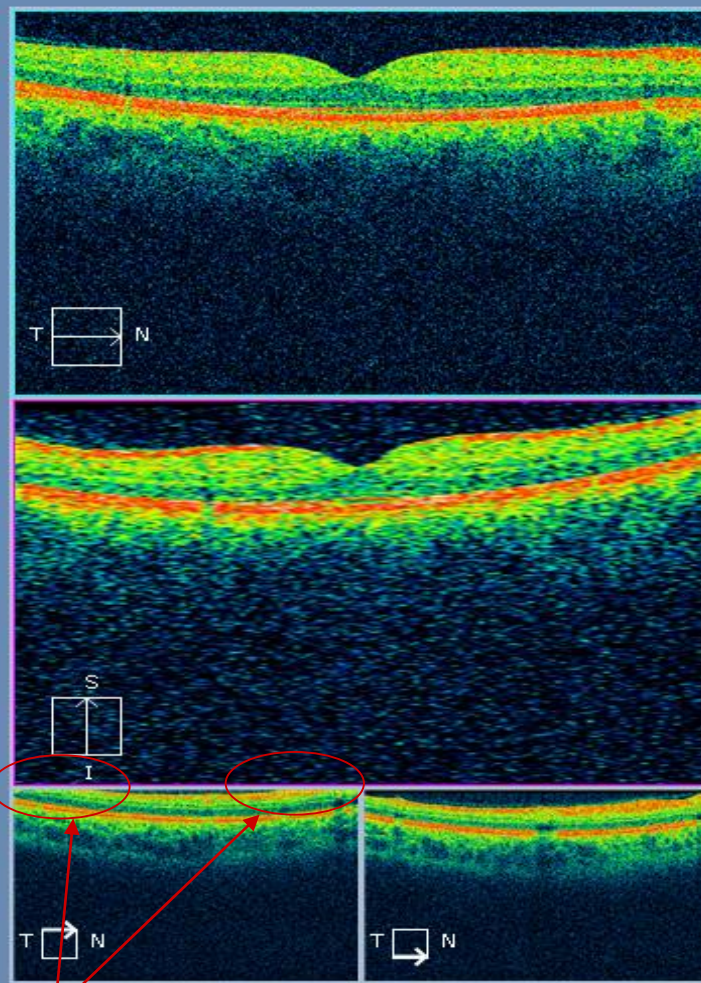
Transparency :



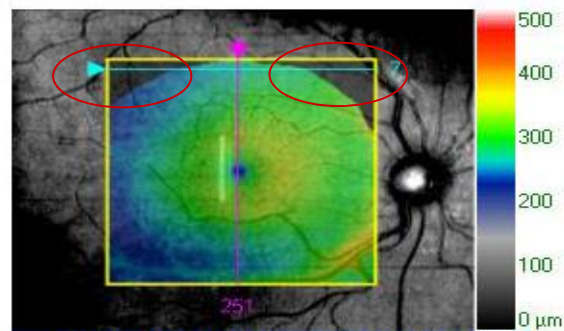
Snap To Center

Try Again

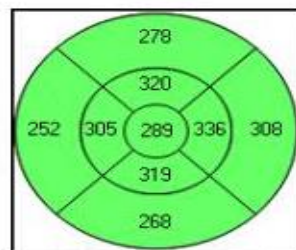
Save



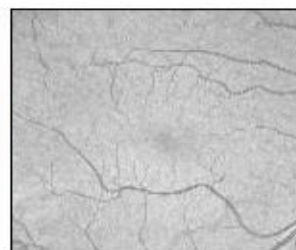
Missing data



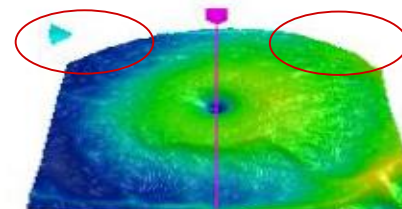
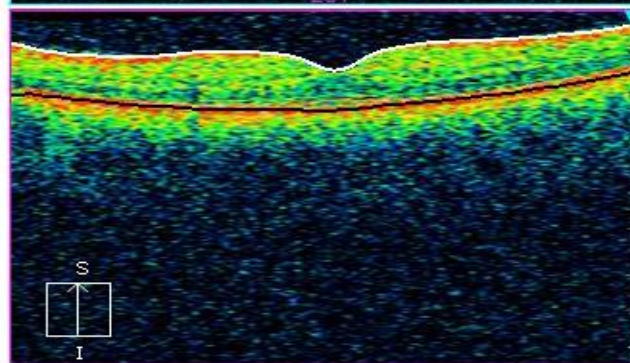
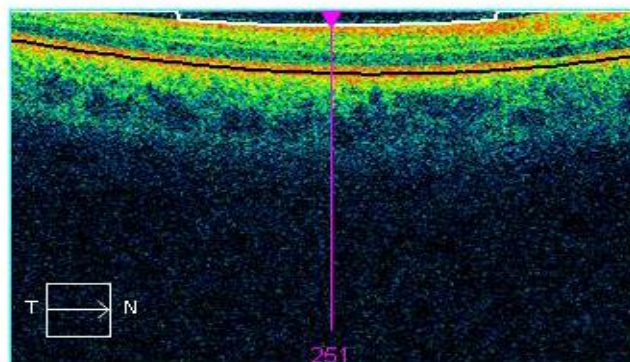
Overlay: ILM - RPE Transparency: 50 %



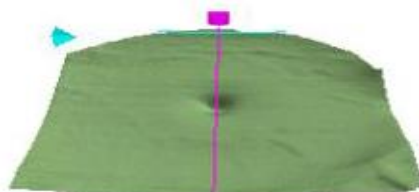
ILM-RPE Thickness (μm)



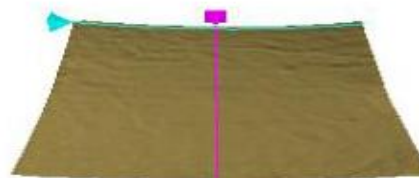
Fovea: 251, 65



ILM - RPE

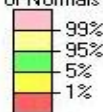


ILM



RPE

Distribution of Normals



	Central Subfield Thickness (μm)	Cube Volume (mm^3)	Cube Average Thickness (μm)
ILM - RPE	289	9.4	262

Cropping

5/3/2010
10/19/2009
8/21/2008

5 Line Raster 10:49:50 AM
5 Line Raster 10:48:51 AM
Macular Cube 512x128 10:48:20 AM

5 Line Raster 10:51:26 AM
Macular Cube 512x128 10:51:02 AM
Macular Cube 512x128 10:50:41 AM

Macular Thickness
Advanced Visualization
3D Visualization
Macular Change Analysis
Macular Change Analysis - Manual Selection



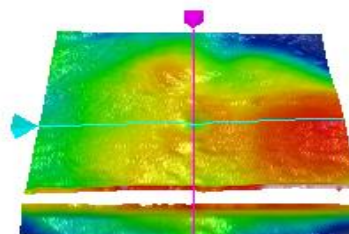
Signal Strength 6/10



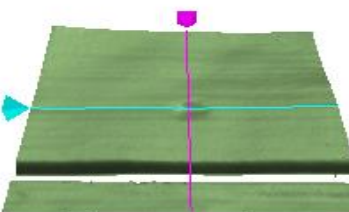
Change Date: 8/21/2008 10:51 AM



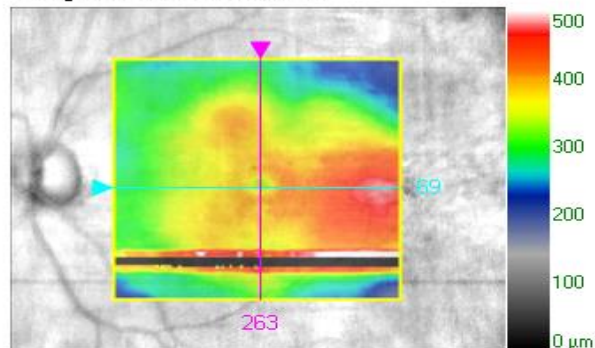
ILM - RPE



ILM



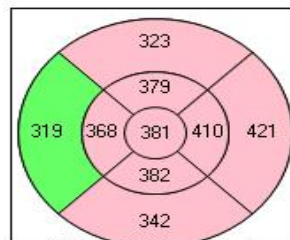
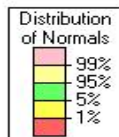
RPE



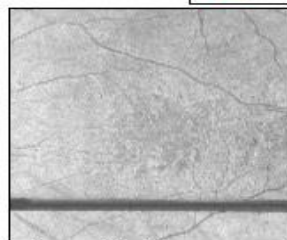
Overlay ILM - RPE

Transparency 30 %

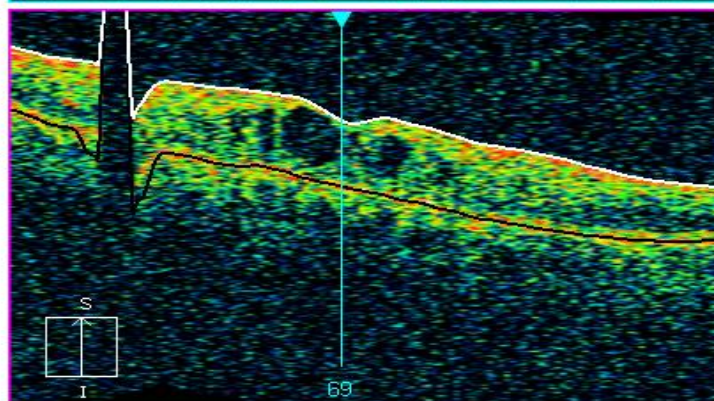
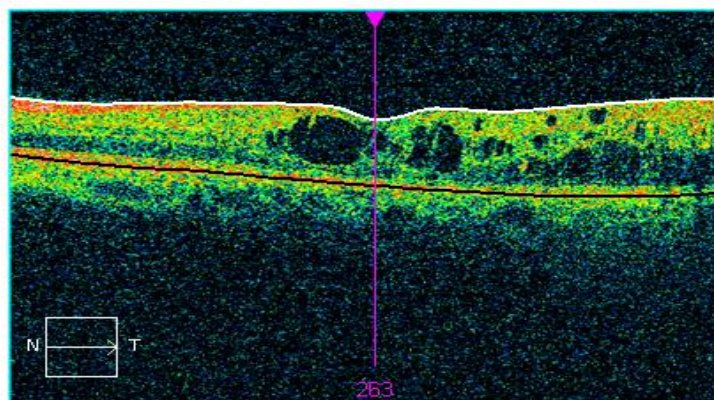
	Central Subfield Thickness μm	Cube Volume mm^3	Cube Avg Thickness μm
ILM - RPE	381	11.9	331



ILM-RPE Thickness (μm)



Fovea: 263, 69



5/3/2010
10/19/2009
8/21/2008

5 Line Raster 10:49:50 AM
5 Line Raster 10:48:51 AM
Macular Cube 512x128 10:48:20 AM

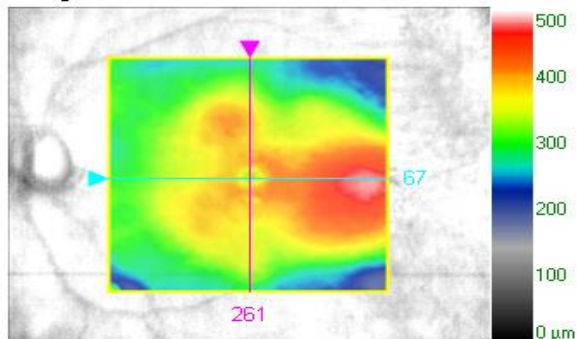
5 Line Raster 10:51:26 AM
Macular Cube 512x128 10:51:02 AM
Macular Cube 512x128 10:50:41 AM

Macular Thickness
Advanced Visualization
3D Visualization
Macular Change Analysis
Macular Change Analysis - Manual Selection



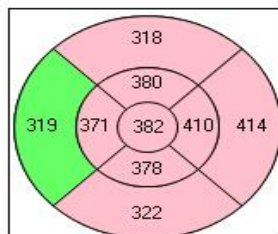
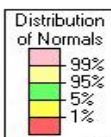
Signal Strength 6/10

Change Date: 8/21/2008 10:52 AM

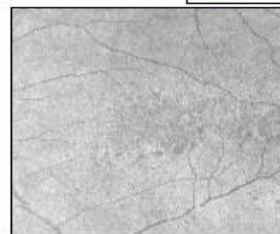


Overlay
Transparency 22 %

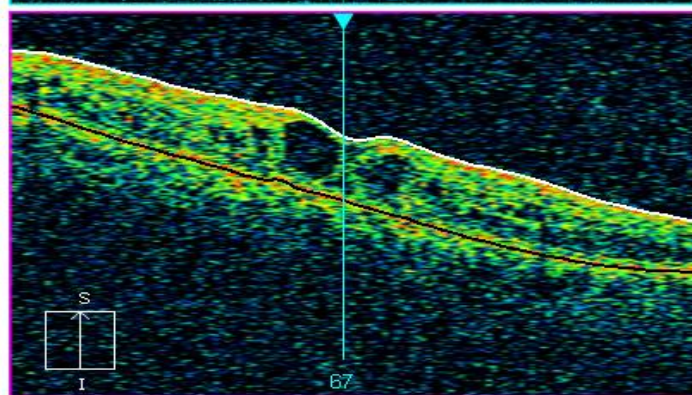
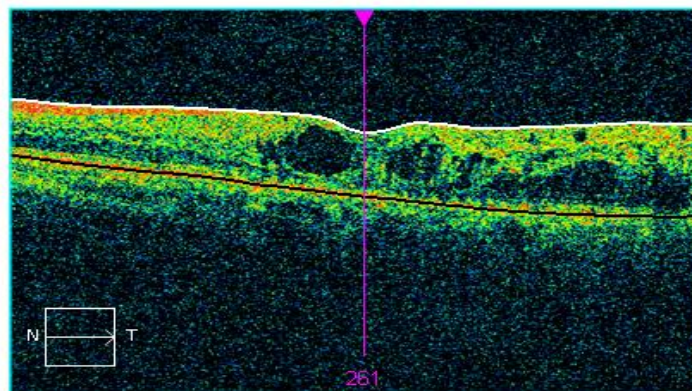
	Central Subfield Thickness μm	Cube Volume mm^3	Cube Avg Thickness μm
ILM - RPE	382	12.1	335



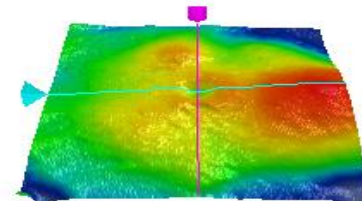
ILM-RPE Thickness (μm)



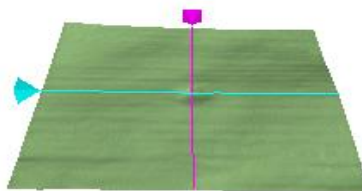
Fovea: 261, 67



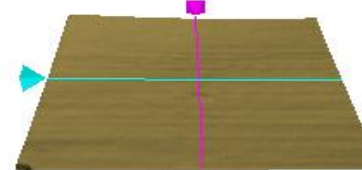
ILM - RPE



ILM



RPE



8/14/2008

5 Line Raster 11:26:37 AM
5 Line Raster 11:24:44 AM
Macular Cube 512x128 11:24:00 AM
Macular Cube 512x128 11:23:38 AM

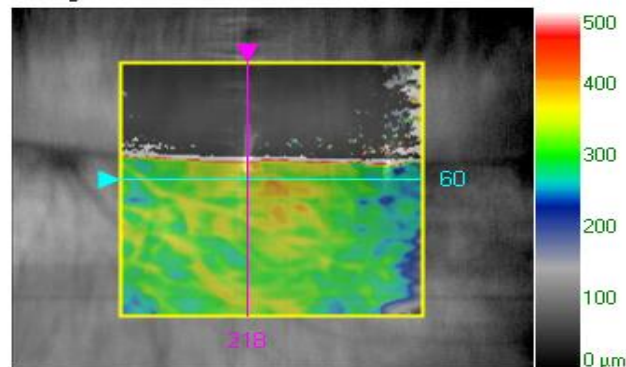
Macular Thickness
Advanced Visualization
3D Visualization
Macular Change Analysis
Macular Change Analysis - Manual Selection



Signal Strength 1/10



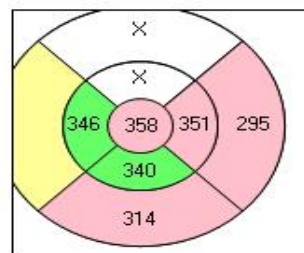
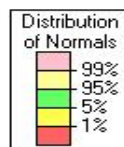
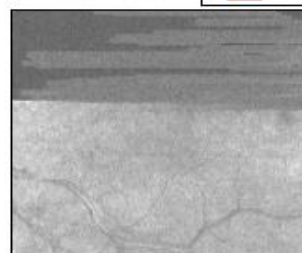
Change Date: 8/14/2008 11:25 AM



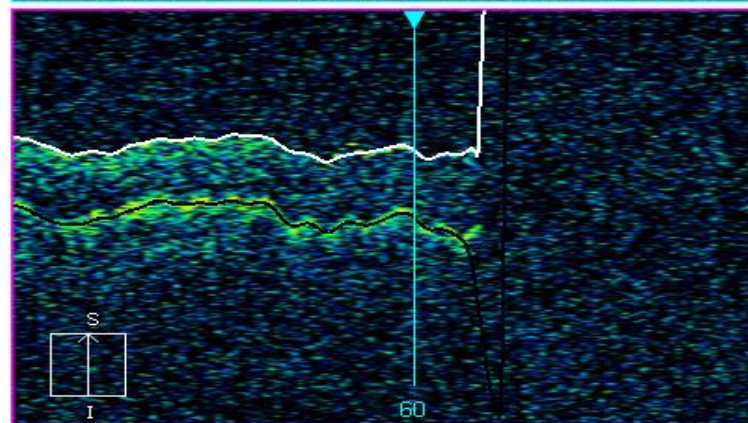
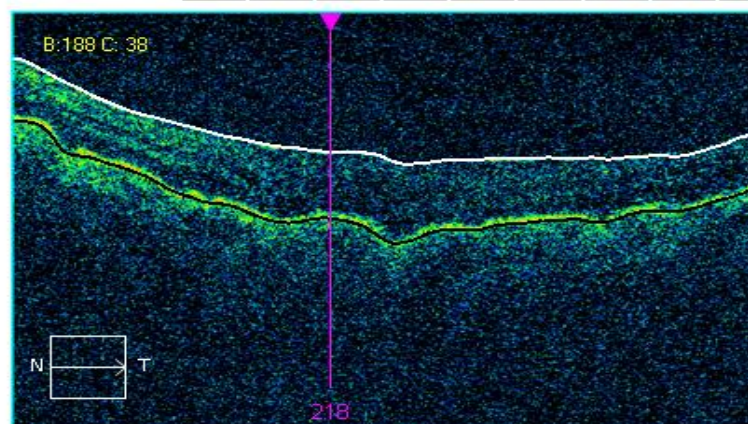
Overlay ILM - RPE

Transparency 46 %

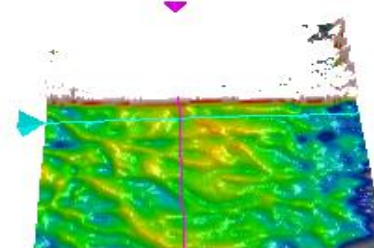
	Central Subfield Thickness μm	Cube Volume mm^3	Cube Avg Thickness μm
ILM - RPE	358	7.6	211

ILM-RPE Thickness (μm)

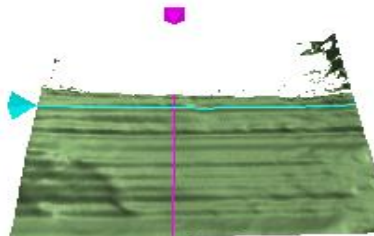
Fovea: 218, 60



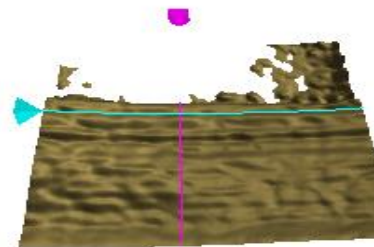
ILM - RPE

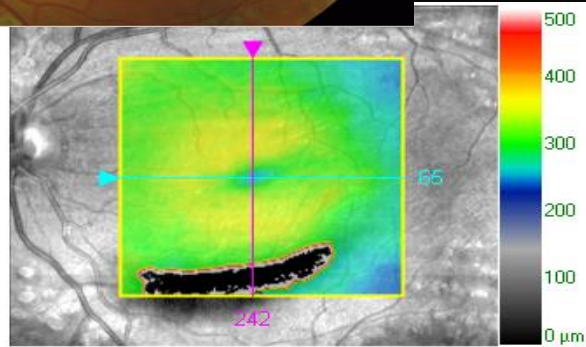
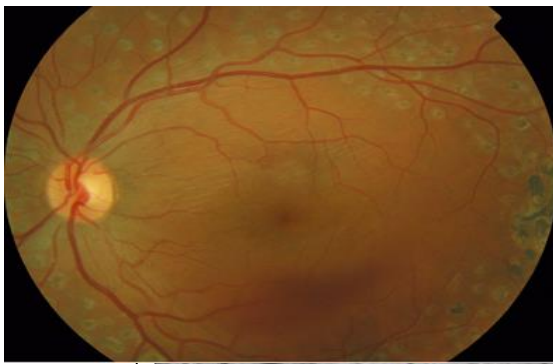


ILM



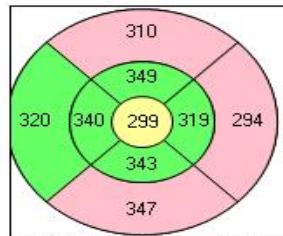
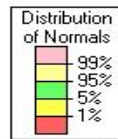
RPE



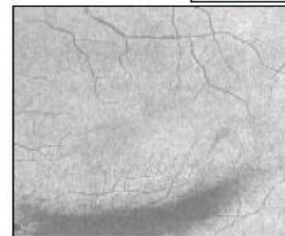


Overlay Transparency

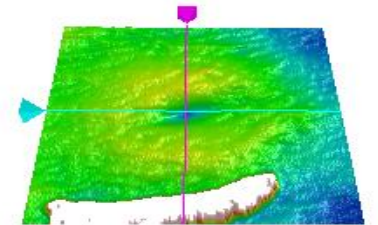
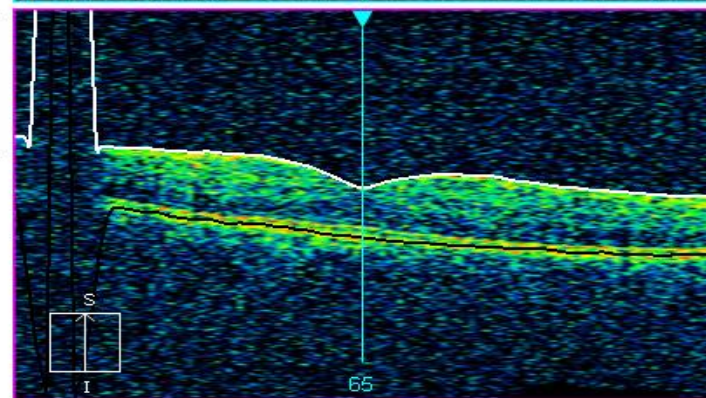
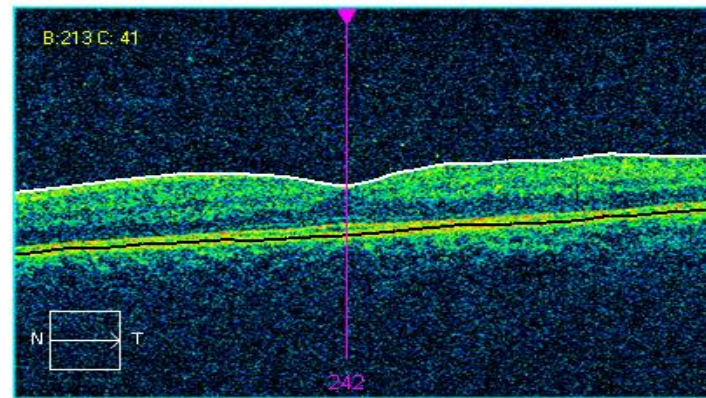
	Central Subfield Thickness μm	Cube Volume mm^3	Cube Avg Thickness μm
ILM - RPE	299	10.7	298



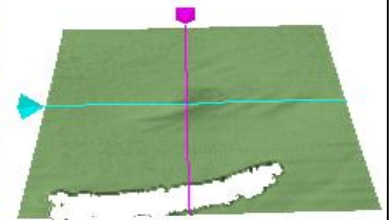
ILM-RPE Thickness (μm)



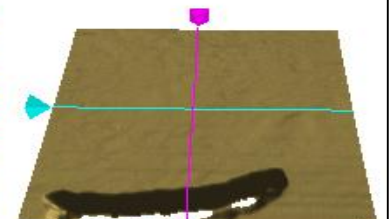
Fovea: 242, 65



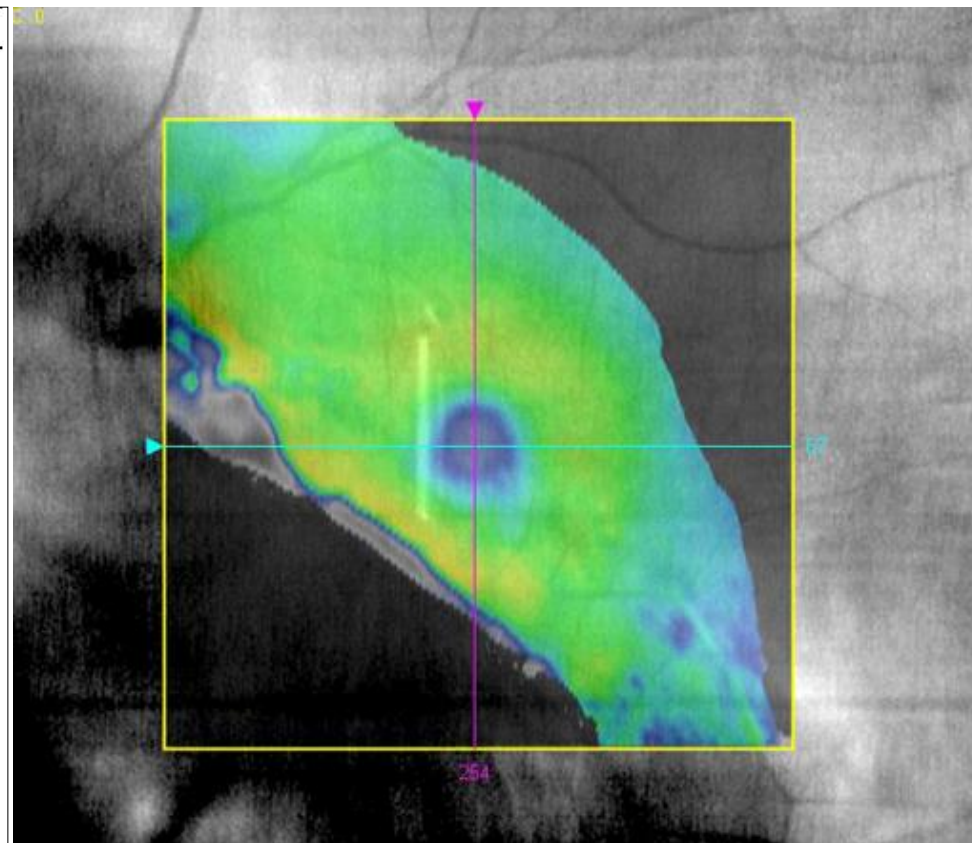
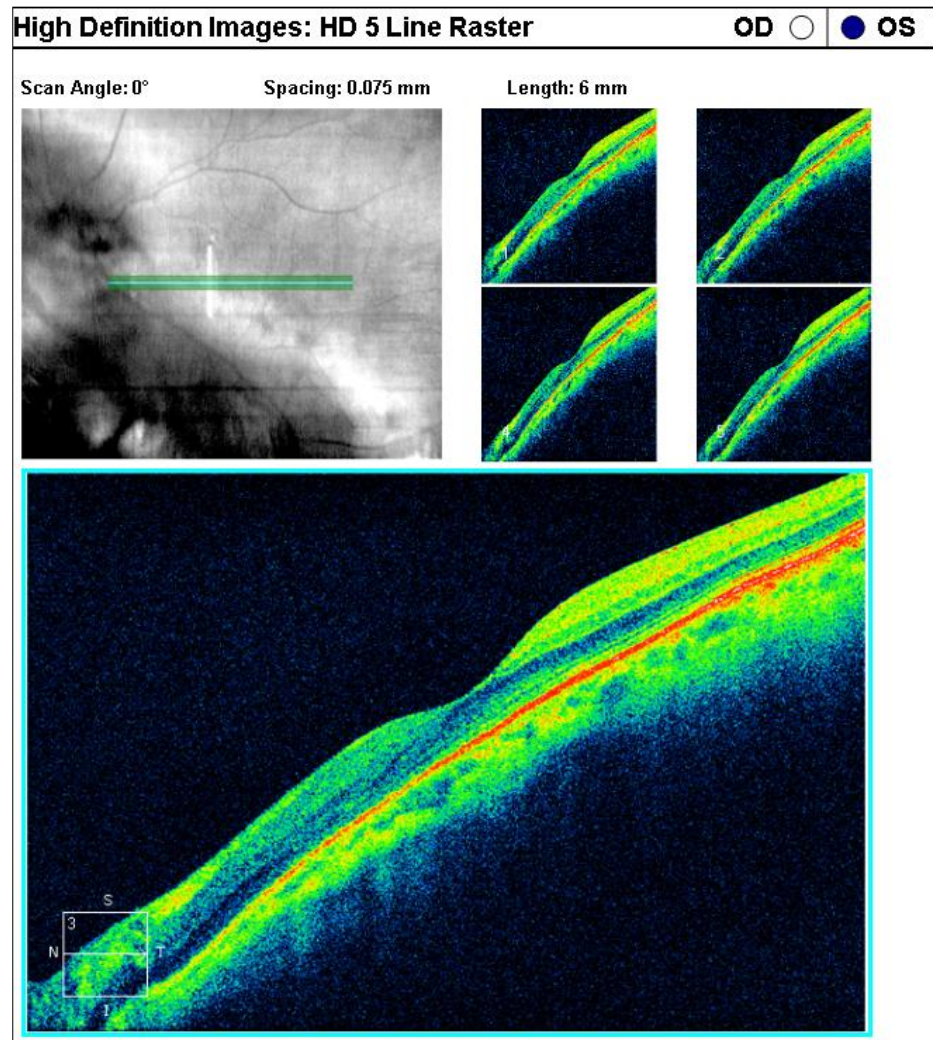
ILM

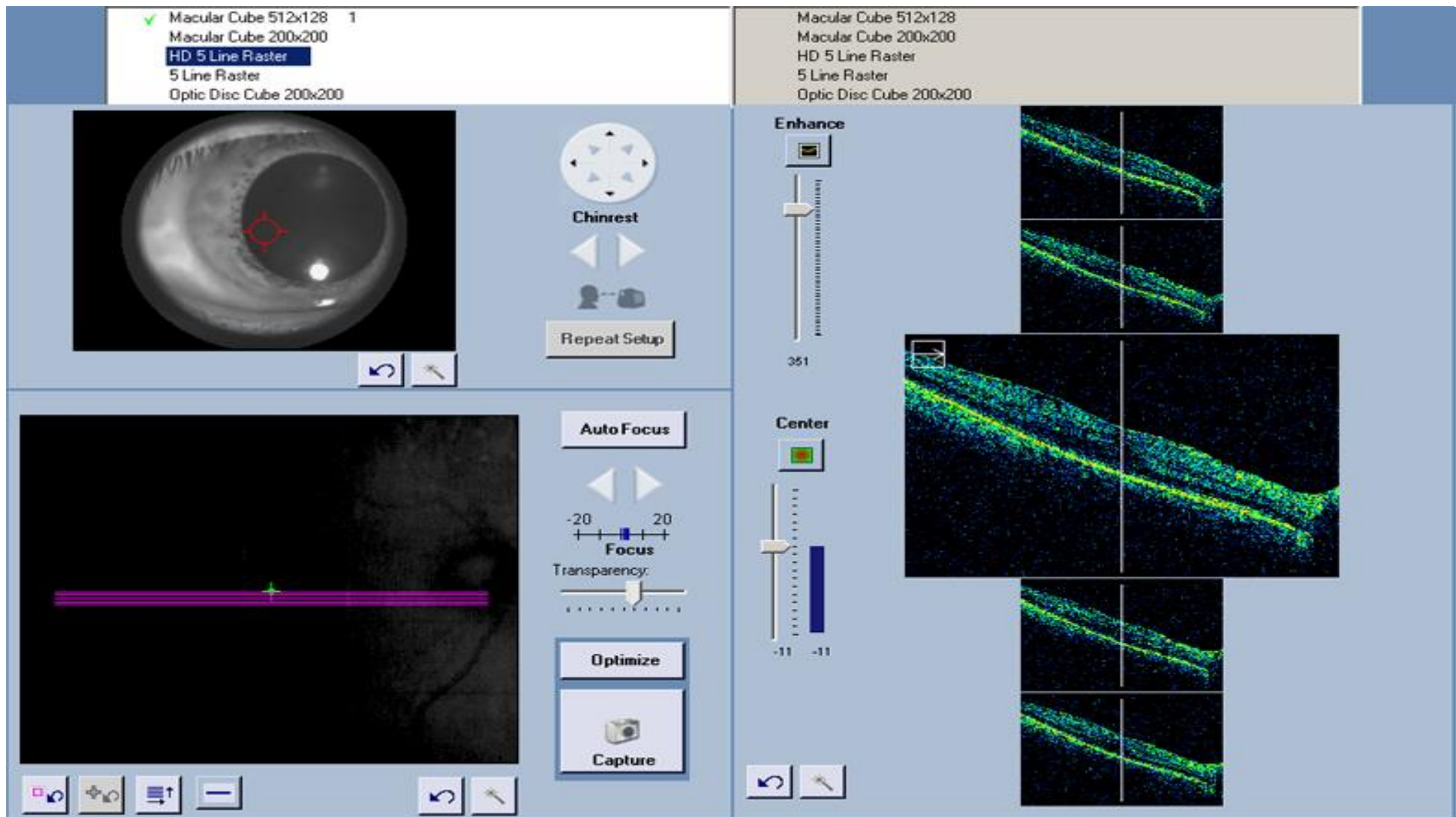


RPE



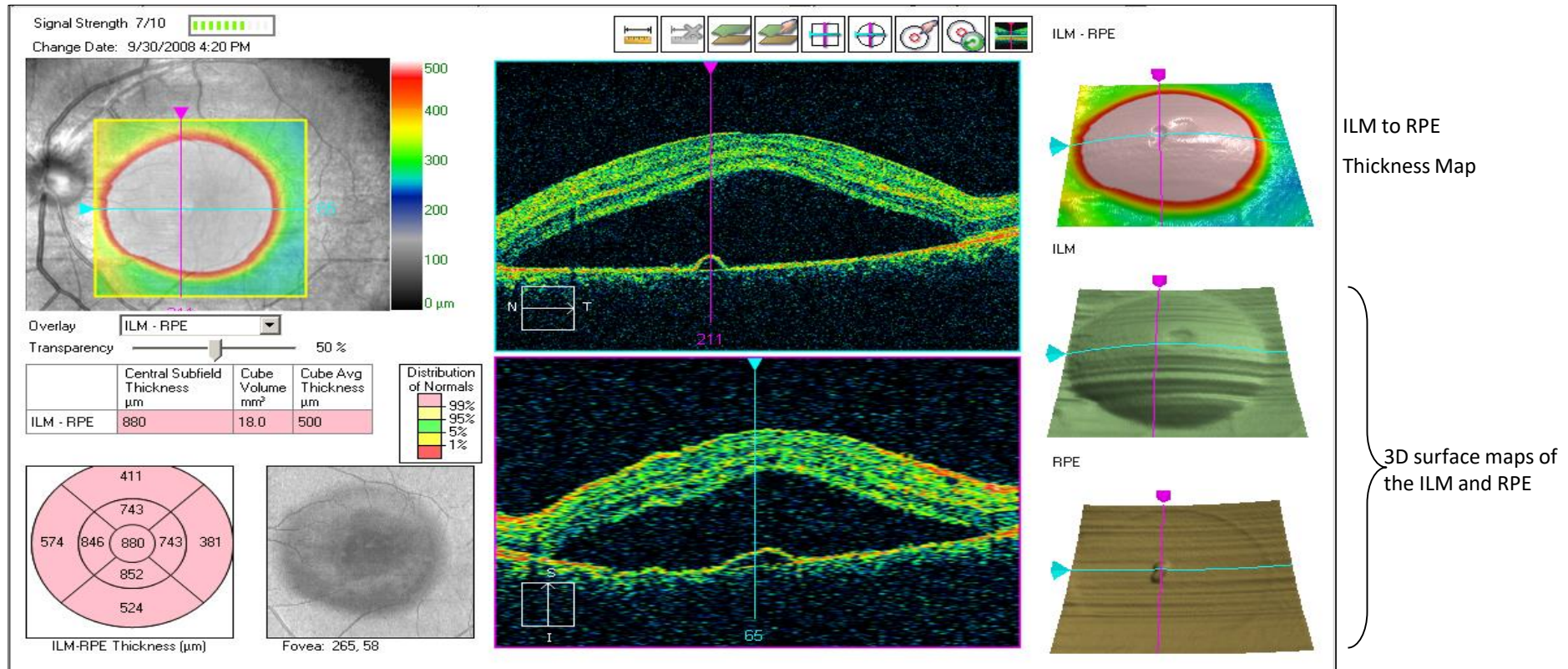
Myopie forte et dysversion papillaire

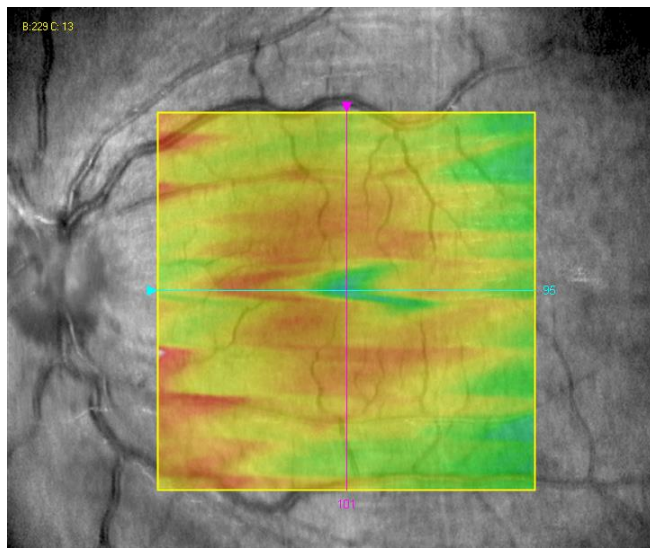




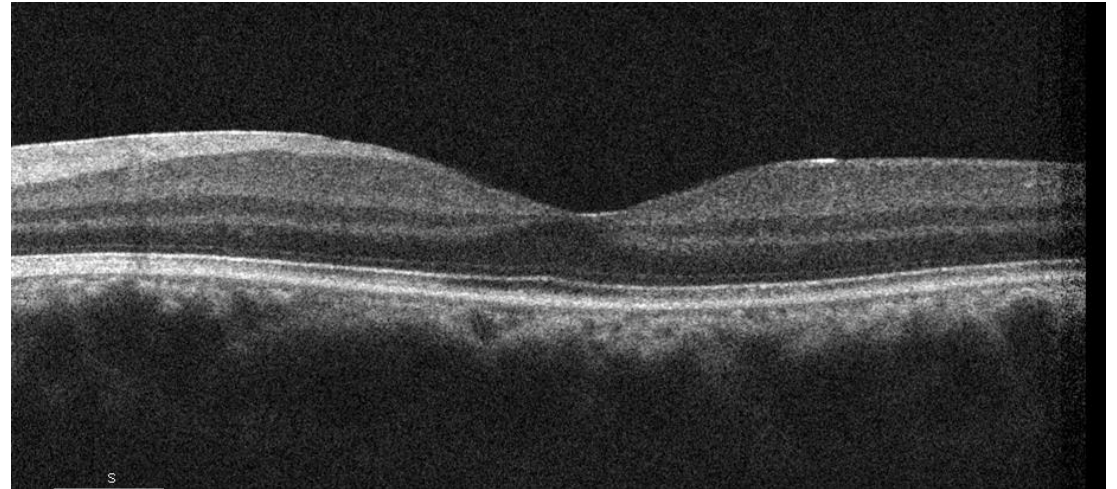
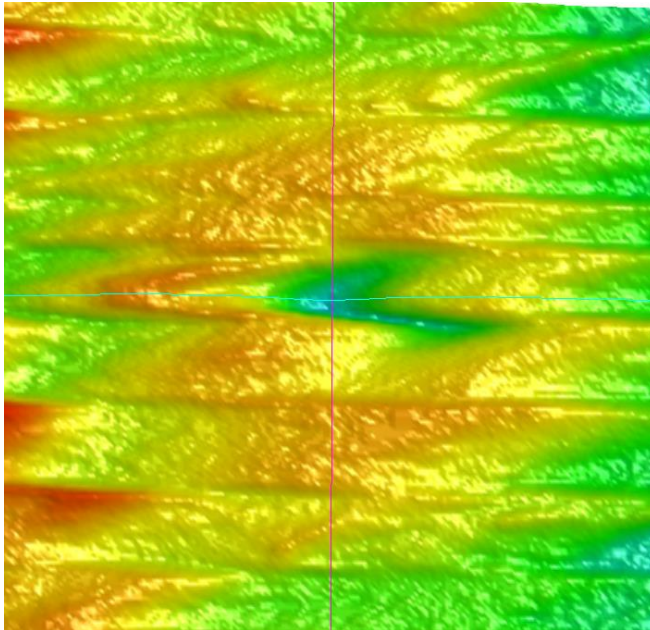
Tilted retina may be corrected for by off-centering pupil alignment to allow for a more horizontal scan

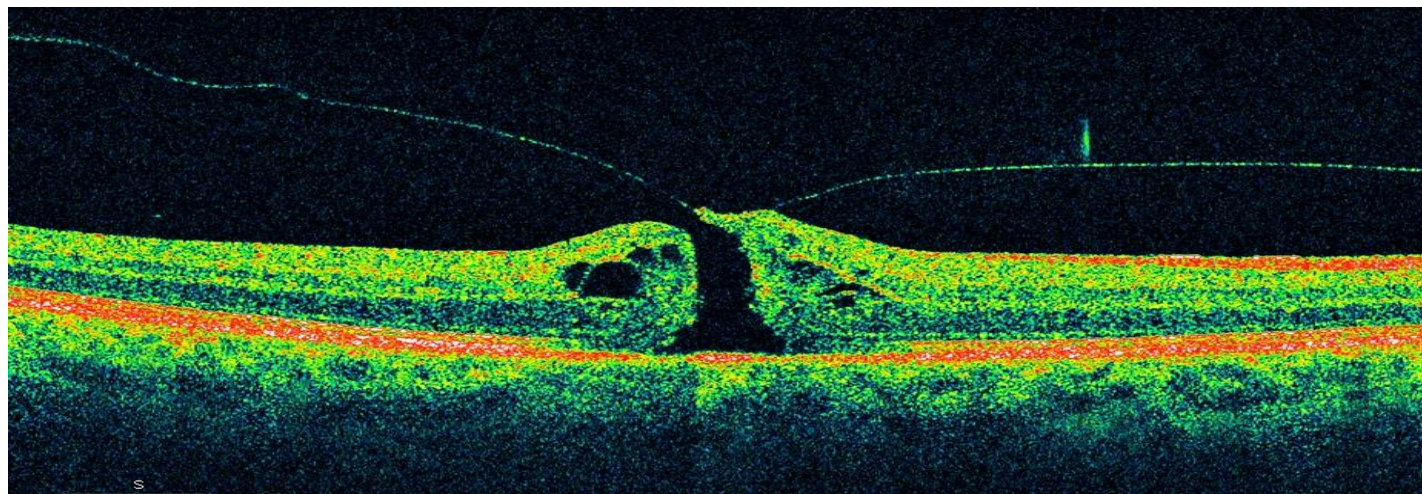
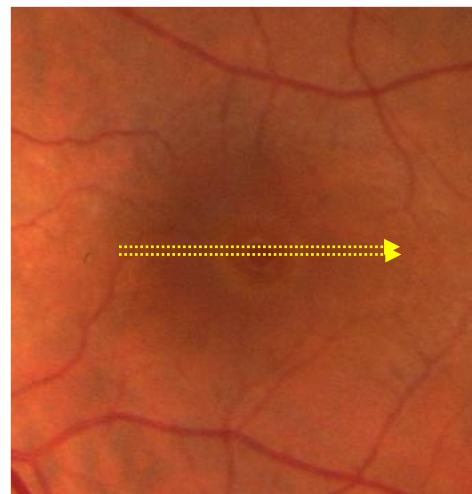
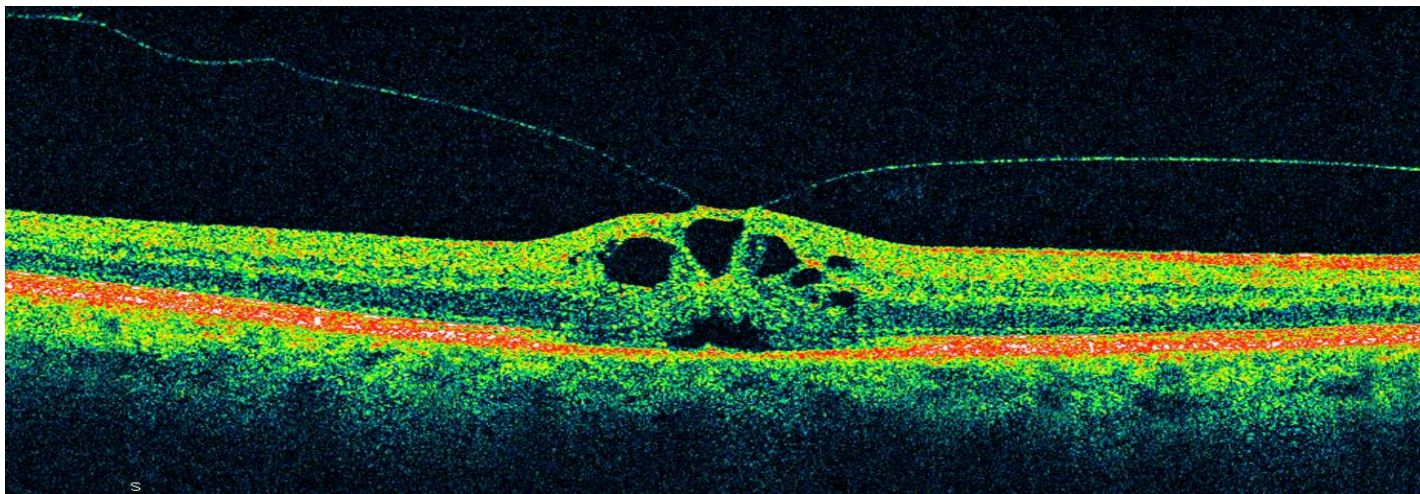
For Macular Cube Scan **PLAY** the **MOVIE** to insure that
no pathology is missed

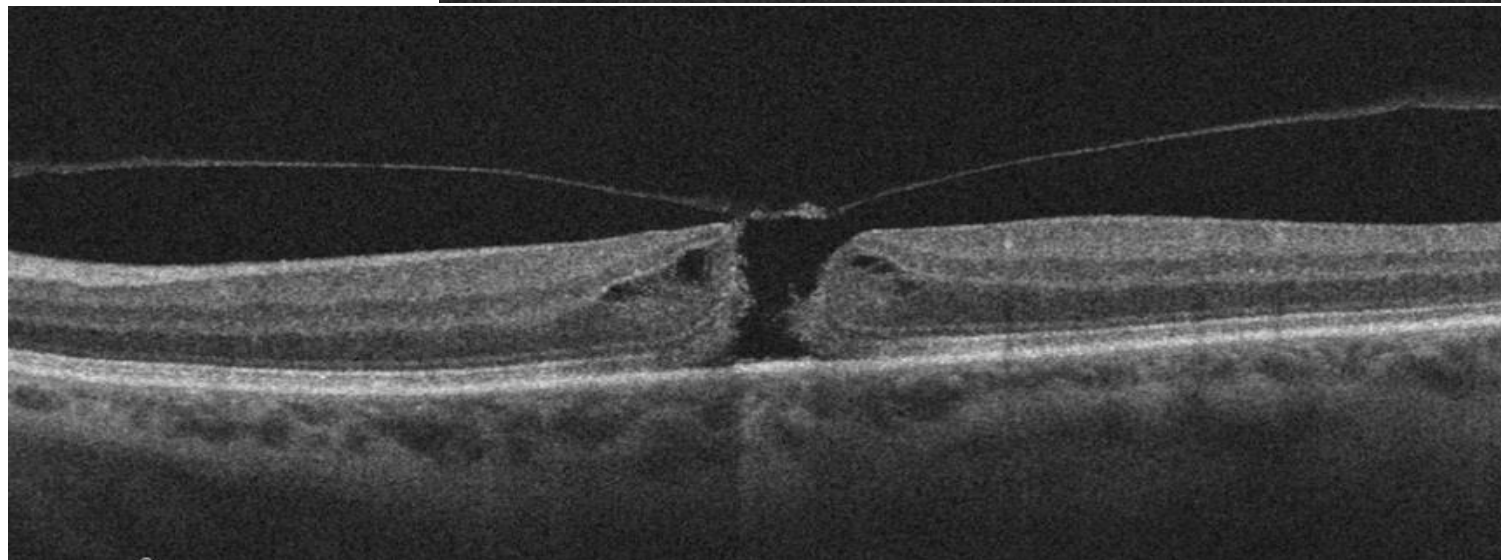
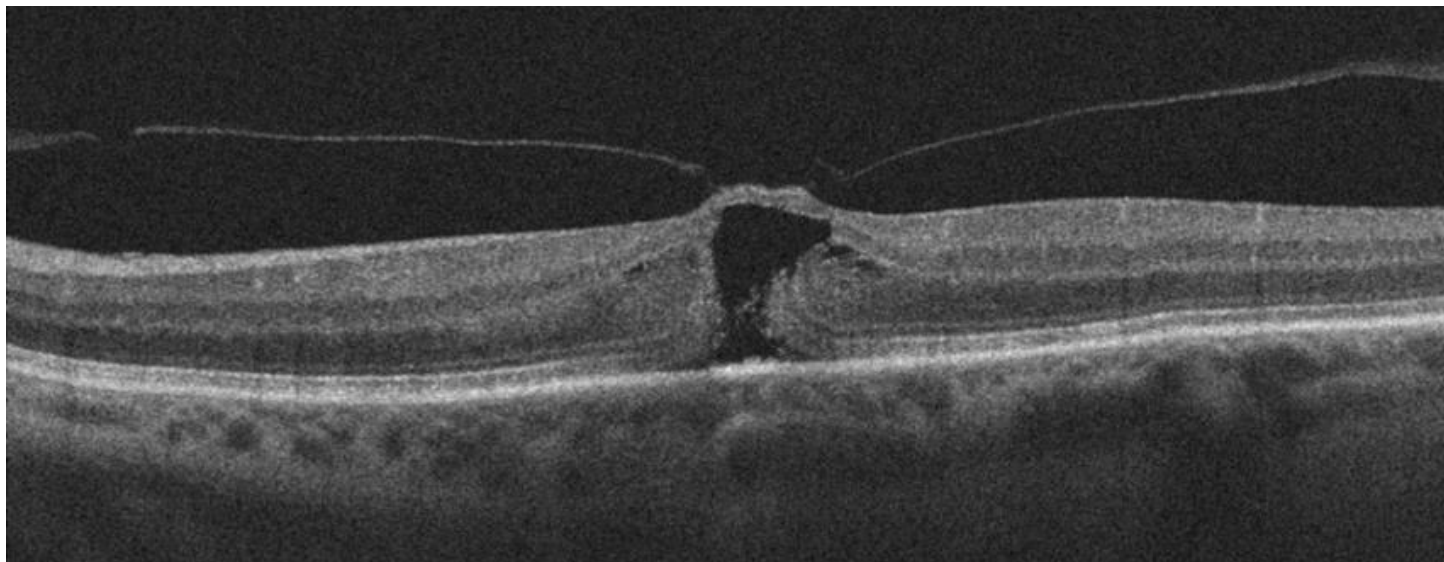
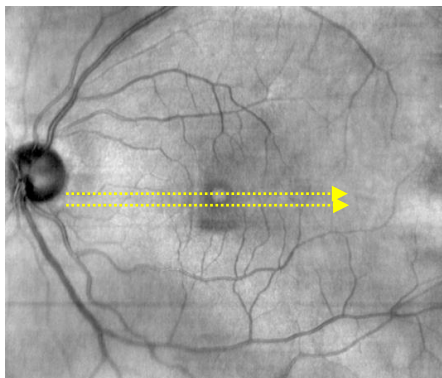


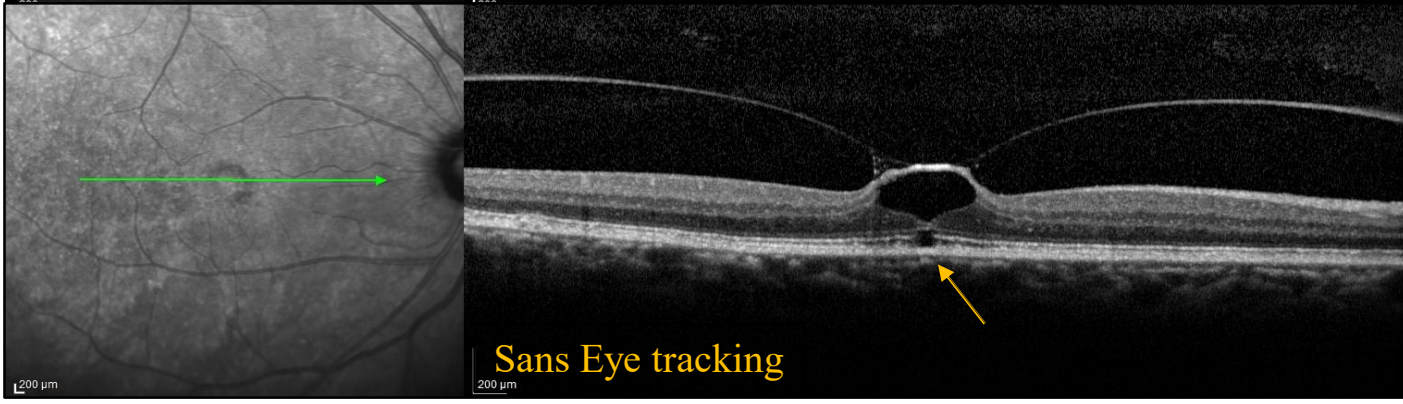
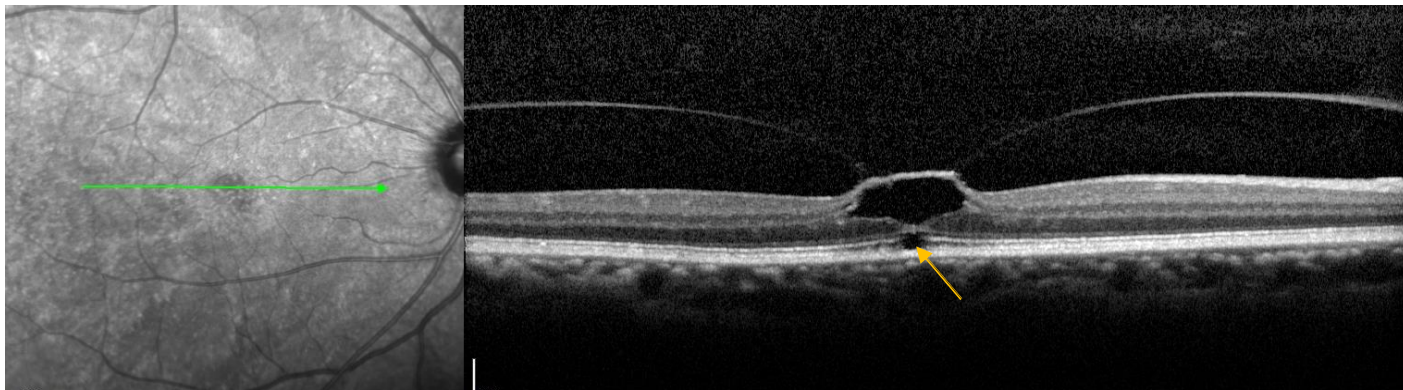


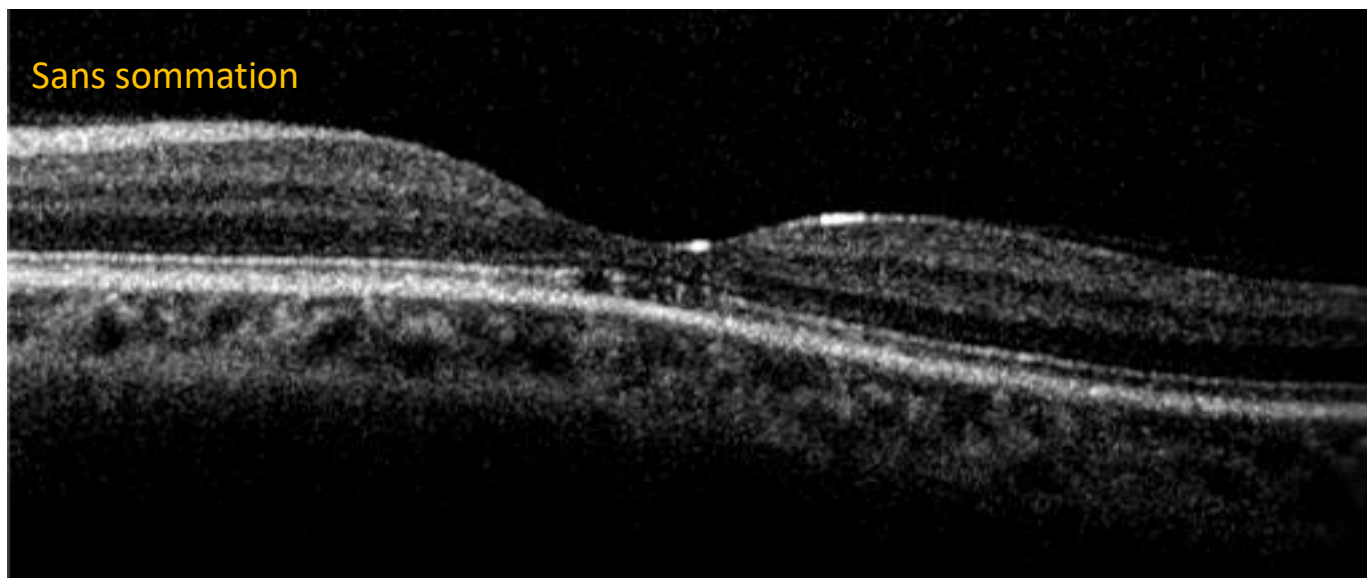
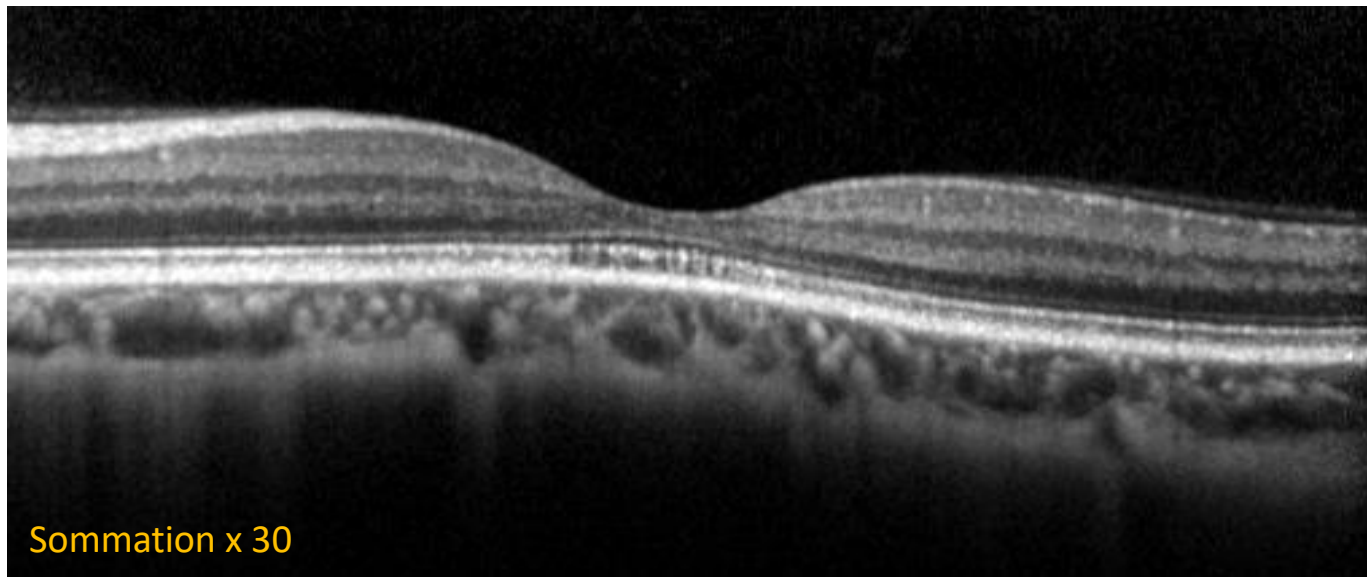
- Nystagmus
- Tremblements (Parkinson...)











OCTA & Artéfacts

Displacement artifact: artefact de déplacement

Provoqué par les mouvements oculaires pendant le scan. L'image en face semble discontinue le long de la direction du B-scan.

False-negative flow : fausse absence de flux

Les signaux OCTA avec une décorrélation basse suggèrent l'absence de flux, alors que le flux existe réellement. La décorrélation peut être trop faible au cours de l'intervalle mesurant le flux, pour mettre en évidence ce flux. Une atténuation du signal pouvant être liée à des opacités des milieux peut aussi entraîner des faux négatifs. (exemple : μanévrismes)

False positive flow : fausse présence de flux

Un signal OCTA avec une forte décorrélation suffit à montrer un flux dans des situations où il n'y en a pas, ou peu. Ceci peut être du bruit au niveau de l'image ou à des microsaccades oculaires. (exemple: exsudats)

Projection artifact : artefacts de projection

L'un des plus importants artefacts en OCTA. La lumière incidente sur un vaisseau sanguin peut être réfléchiée en arrière, ou dispersée, ou réfractée. La lumière qui passe à travers le vaisseau fluctue au cours du temps et n'importe quelle structure en arrière du vaisseau peut être « illuminée » par cette lumière fluctuante. Les techniques utilisant le contraste des mouvements détectent les fluctuations au cours du temps, donc des images artéfactuelles des vaisseaux peuvent être vues à des localisations plus profondes dans l'œil que leur réelle position.

Gap defect : lacunes

Une perte d'information au niveau d'une région de l'image, résultant d'un mouvement oculaire, peut exister dans les données de l'image brute, ou dans les images traitées par le logiciel (correction des mouvements oculaires).

Segmentation artifact : artefact de segmentation

Réduire risque d'erreurs
d'interprétation

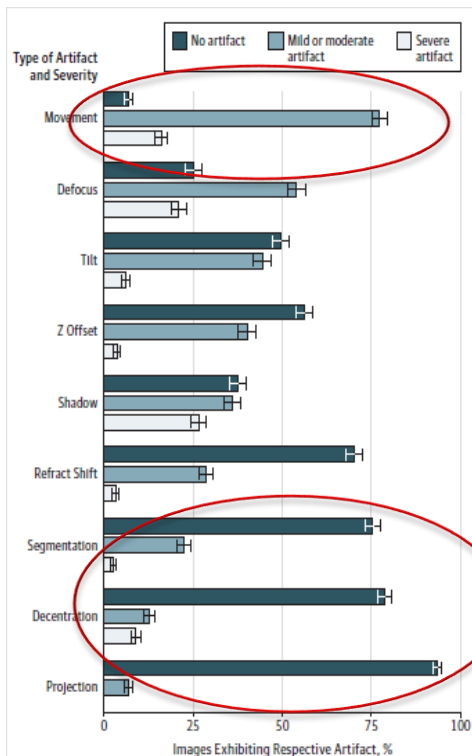


Corrélation avec l'imagerie multimodale
Visualisation combinée des B-scans et de l'OCT-A

Prevalence and Severity of Artifacts in Optical Coherence Tomographic Angiograms

Ian C. Holmen, MD; Sri Meghana Konda, MD; Jeong W. Pak, PhD; Kyle W. McDaniel, MS; Barbara Blodi, MD; Kimberly E. Stepien, MD; Amitha Domalpally, MD, PhD

JAMA Ophthalmology February 2020



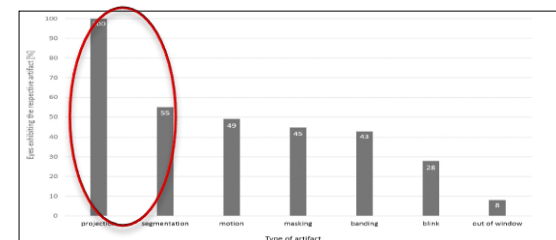
Percentage of No, Mild or Moderate, and Severe Artifacts in All Images (n = 406)

Quantity and quality of image artifacts in optical coherence tomography angiography

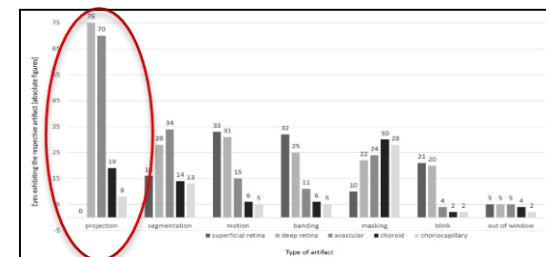
Christian Enders^{1*}, Gabriele E. Lang¹, Jens Dreyhaupt², Max Loidl¹, Gerhard K. Lang¹, Jens U. Werner¹

¹ Department of Ophthalmology, Ulm University, Ulm, Germany, ² Institute of Epidemiology and Medical Biometry, Ulm University, Ulm, Germany

PLOS ONE | January 25, 2019



Different types of identified artifacts and their relative frequencies per entire OCTA scan.



Frequencies of various artifacts in different segmentations of the OCTA scans.

Evaluation of artifact reduction in optical coherence tomography angiography with real-time tracking and motion correction technology

ACNER CAMINO,¹ MIAO ZHANG,^{1,2} SIMON S. GAO,¹ THOMAS S. HWANG,¹ UTKARSH SHARMA,² DAVID J. WILSON,¹ DAVID HUANG,¹ AND YALI JIA^{1,*}

¹Casey Eye Institute, Oregon Health & Science University, Portland, OR, USA

²Optovue, Inc. 2800 Bayview Dr., Fremont, CA 94538, USA

Image artefacts in swept-source optical coherence tomography angiography

Khalil Ghasemi Falavarjani,^{1,2} Mayss Al-Sheikh,¹ Handan Akil,¹ Srinivas R Sadda¹

Br J Ophthalmol 2017;101:564–568.

IMAGE ARTIFACTS IN OPTICAL COHERENCE TOMOGRAPHY ANGIOGRAPHY

RICHARD F. SPAIDE, MD,* JAMES G. FUJIMOTO, PhD,† NADIA K. WAHEED, MD‡

Purpose: To describe image artifacts of optical coherence tomography (OCT) angiography and their underlying causative mechanisms. To establish a common vocabulary for the artifacts observed.

Methods: The methods by which OCT angiography images are acquired, generated, and displayed are reviewed as are the mechanisms by which each or all of these methods can produce extraneous image information. A common set of terminology is proposed and used.

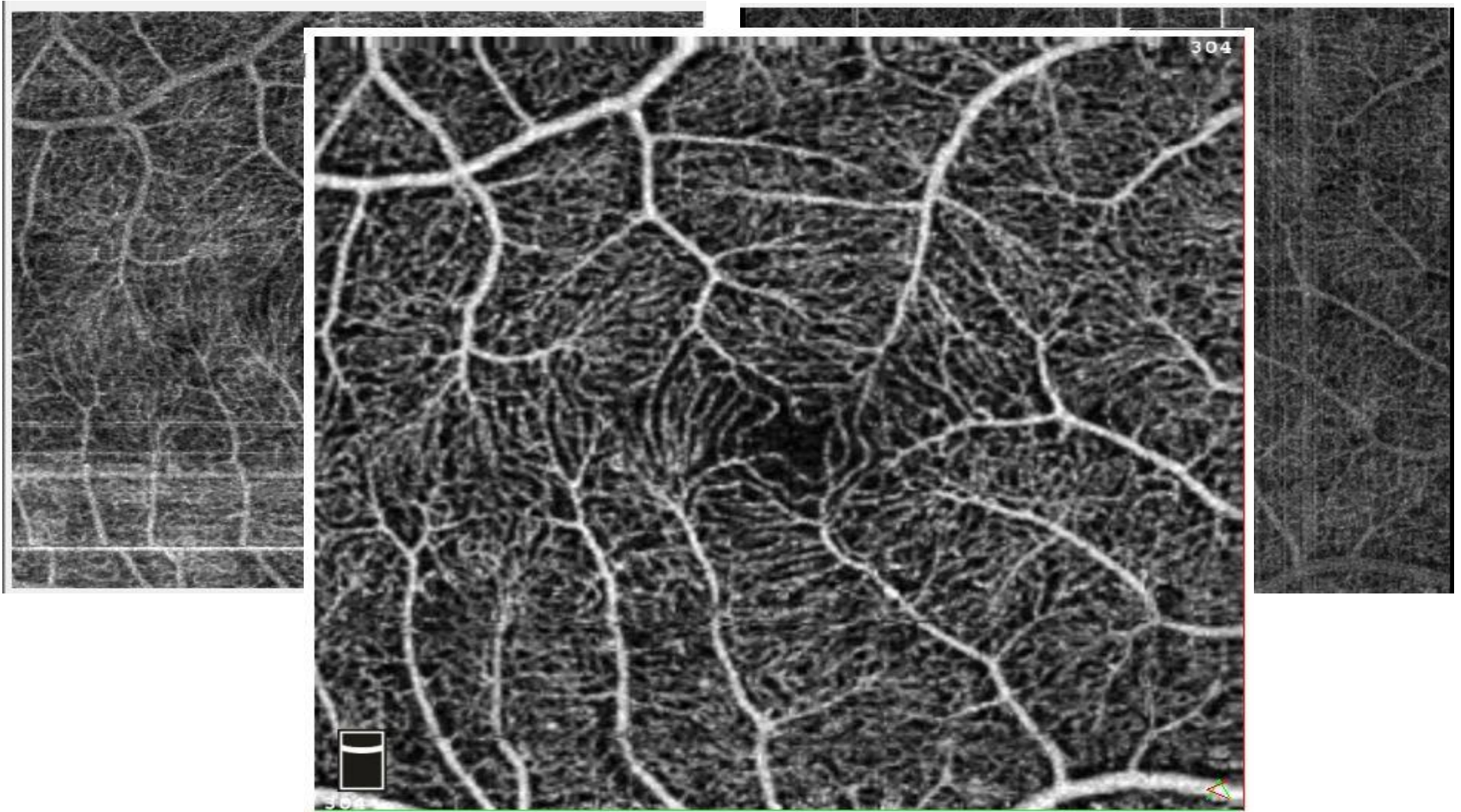
Results: Optical coherence tomography angiography uses motion contrast to image blood flow and thereby images the vasculature without the need for a contrast agent. Artifacts are very common and can arise from the OCT image acquisition, intrinsic characteristics of the eye, eye motion, image processing, and display strategies. Optical coherence tomography image acquisition for angiography takes more time than simple structural scans and necessitates trade-offs in flow resolution, scan quality, and speed. An important set of artifacts are projection artifacts in which images of blood vessels seem at erroneous locations. Image processing used for OCT angiography can alter vascular appearance through segmentation defects, and because of image display strategies can give false impressions of the density and location of vessels. Eye motion leads to discontinuities in displayed data. Optical coherence tomography angiography artifacts can be detected by interactive evaluation of the images.

Conclusion: Image artifacts are common and can lead to incorrect interpretations of OCT angiography images. Because of the quantity of data available and the potential for artifacts, physician interaction in viewing the image data will be required, much like what happens in modern radiology practice.

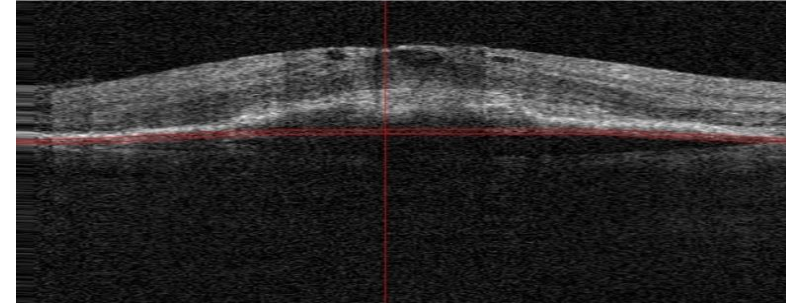
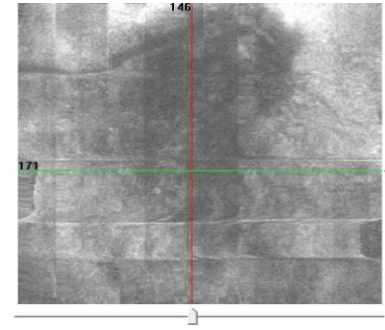
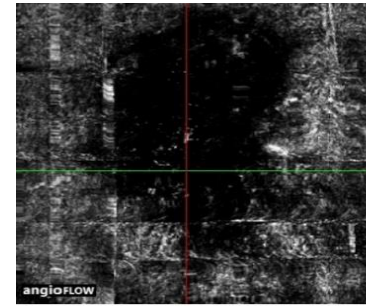
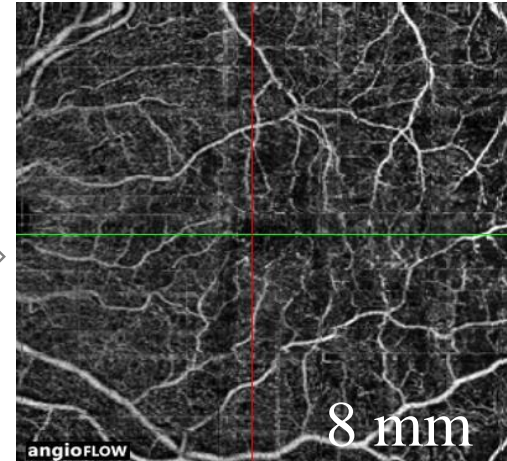
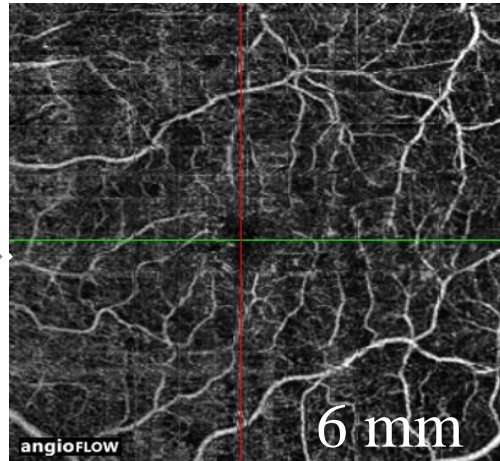
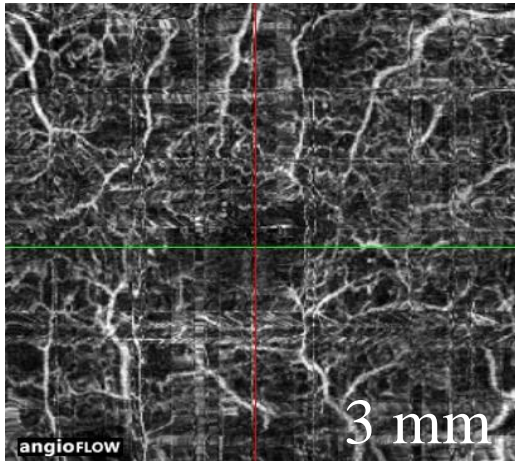
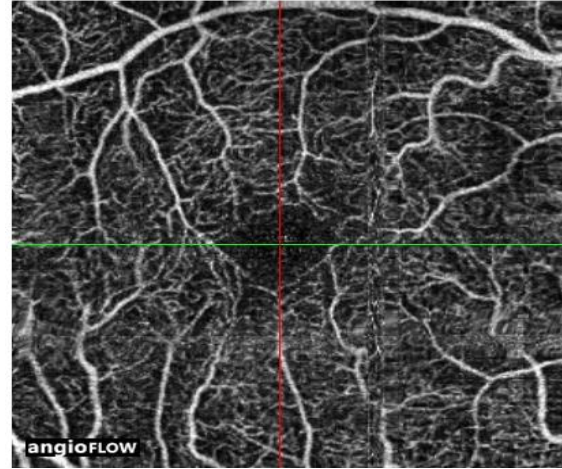
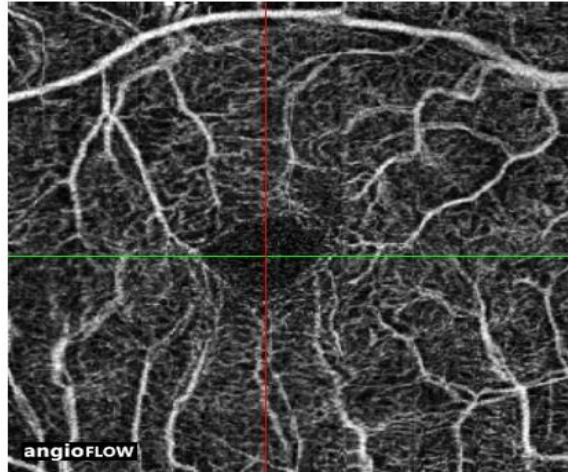
RETINA 35:2163–2180, 2015

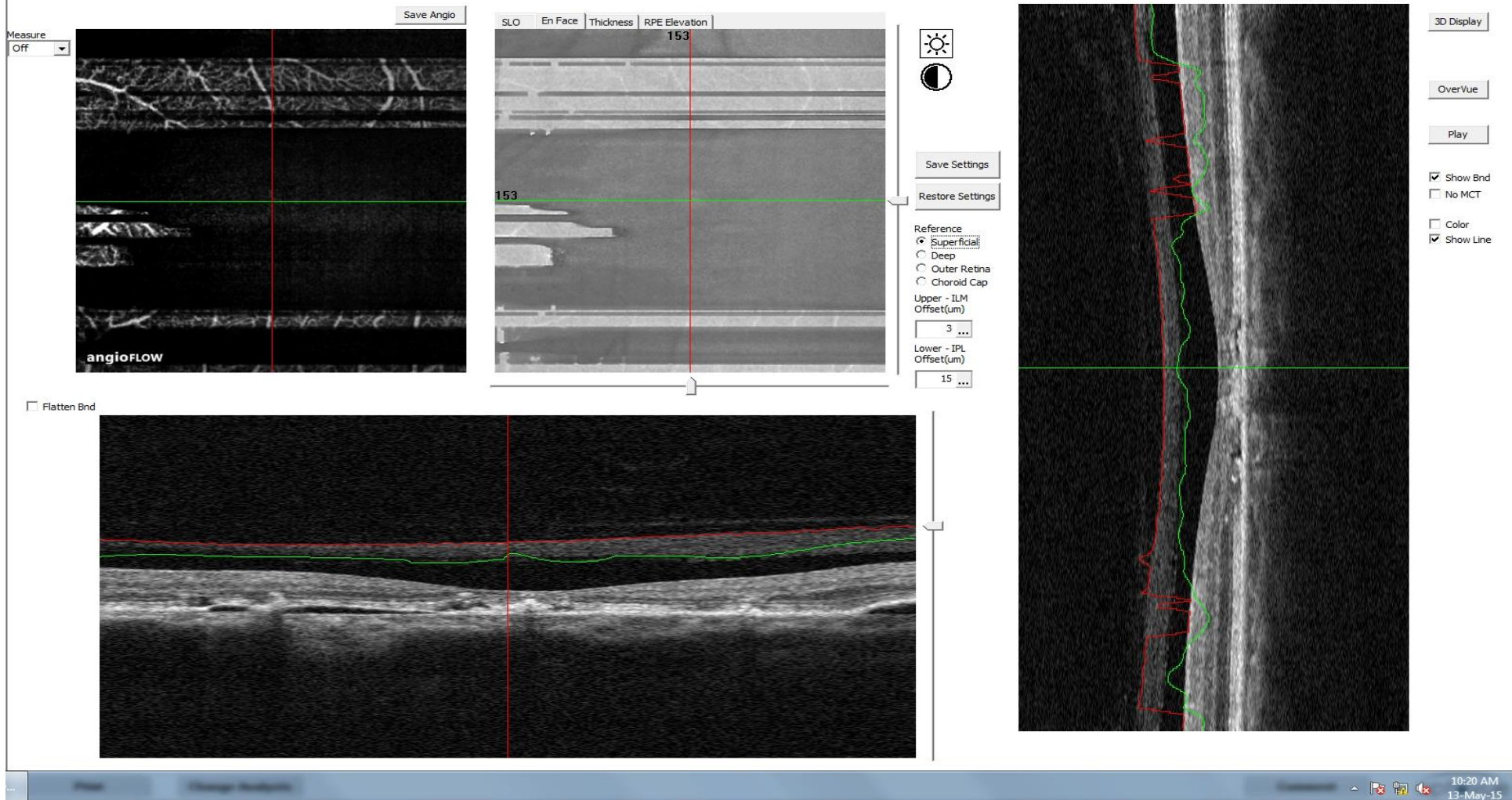
The artefacts are more frequent in eyes with pathology.
They should be known and avoided.

Motion Correction Technology (MCT)

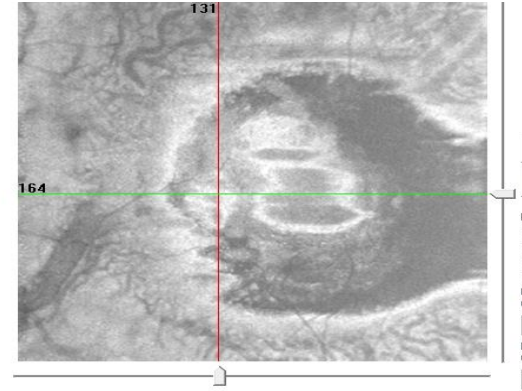
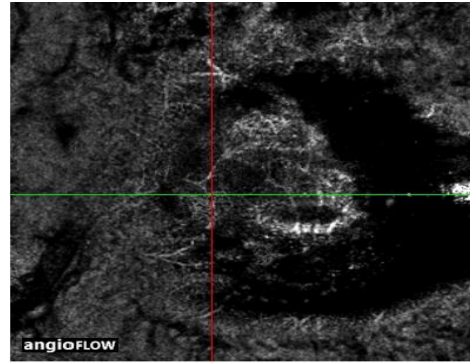
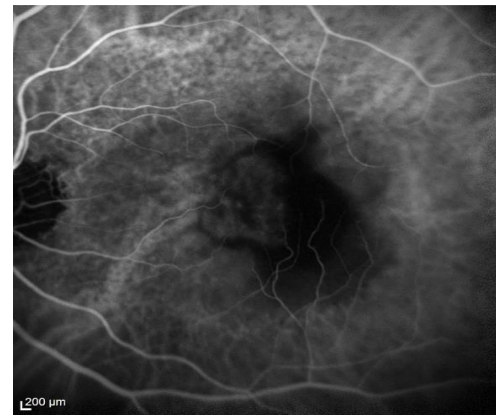
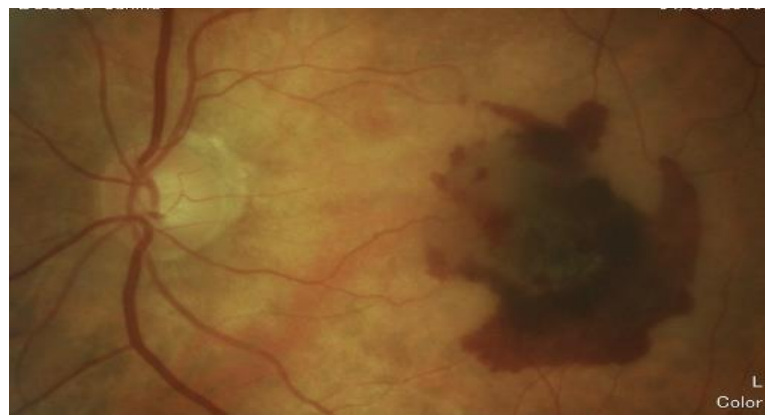


motion artifact, blinks, shadowgraphic flow projection, vessel duplication, and vessel discontinuity...etc

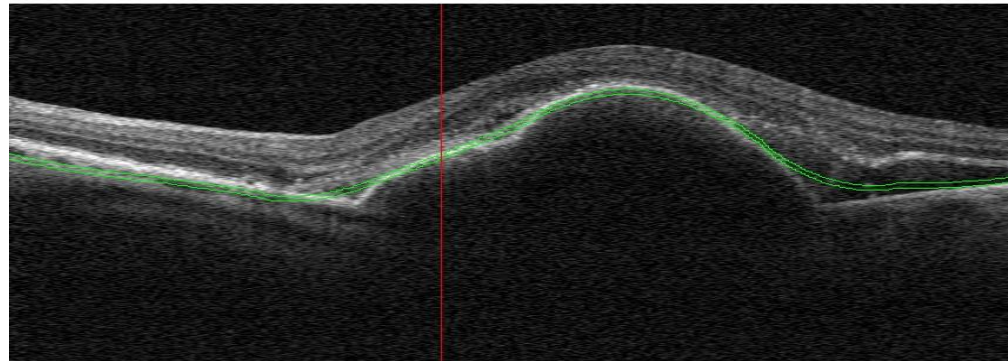


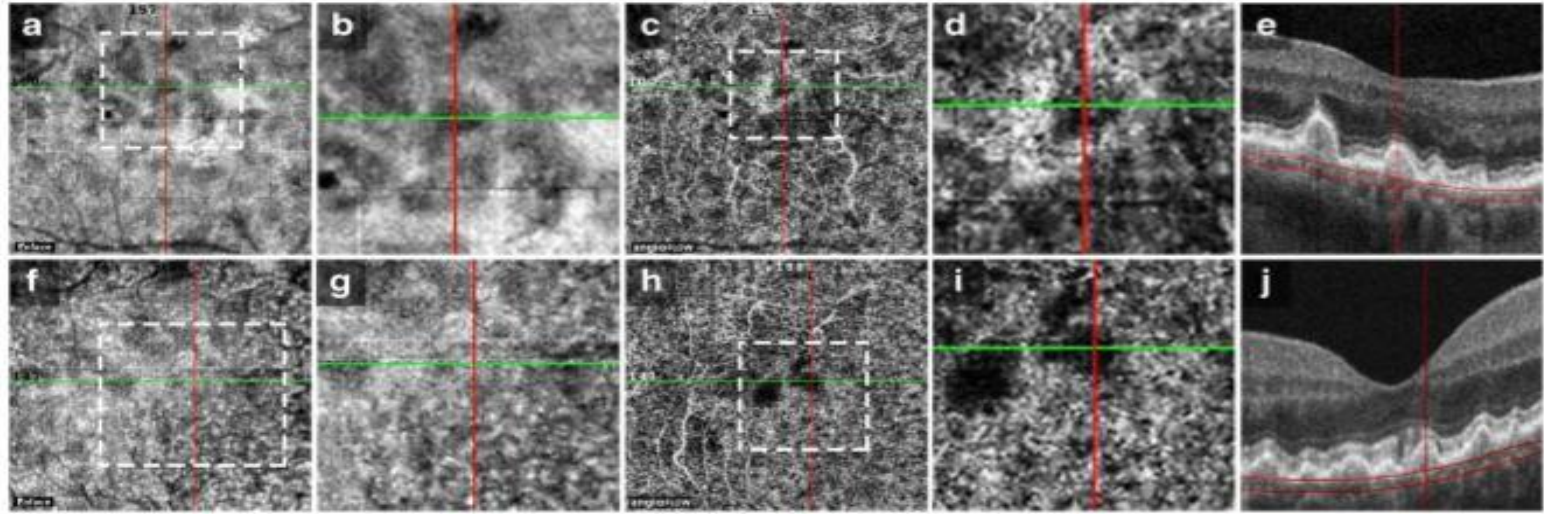
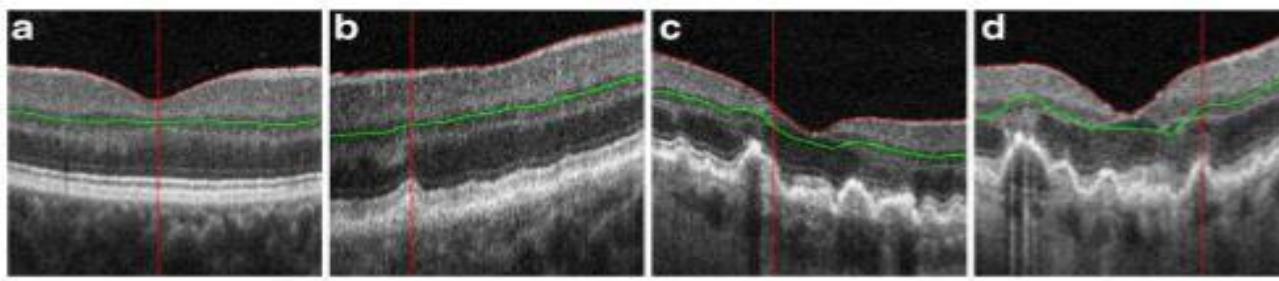


Condensation vitrénne



Hémorragies





The vast majority of soft drusen produce shadowing artifacts in the structural en-face OCT CC images that allow neither a qualitative nor a quantitative flow evaluation under drusen in SD OCT-A.

Signal reduction in choriocapillaris and segmentation errors in spectral domain OCT angiography caused by soft drusen

F. Alten¹ • J. L. Lauer¹ • C. R. Clemens¹ • P. Heiduschka¹ • N. Eter¹

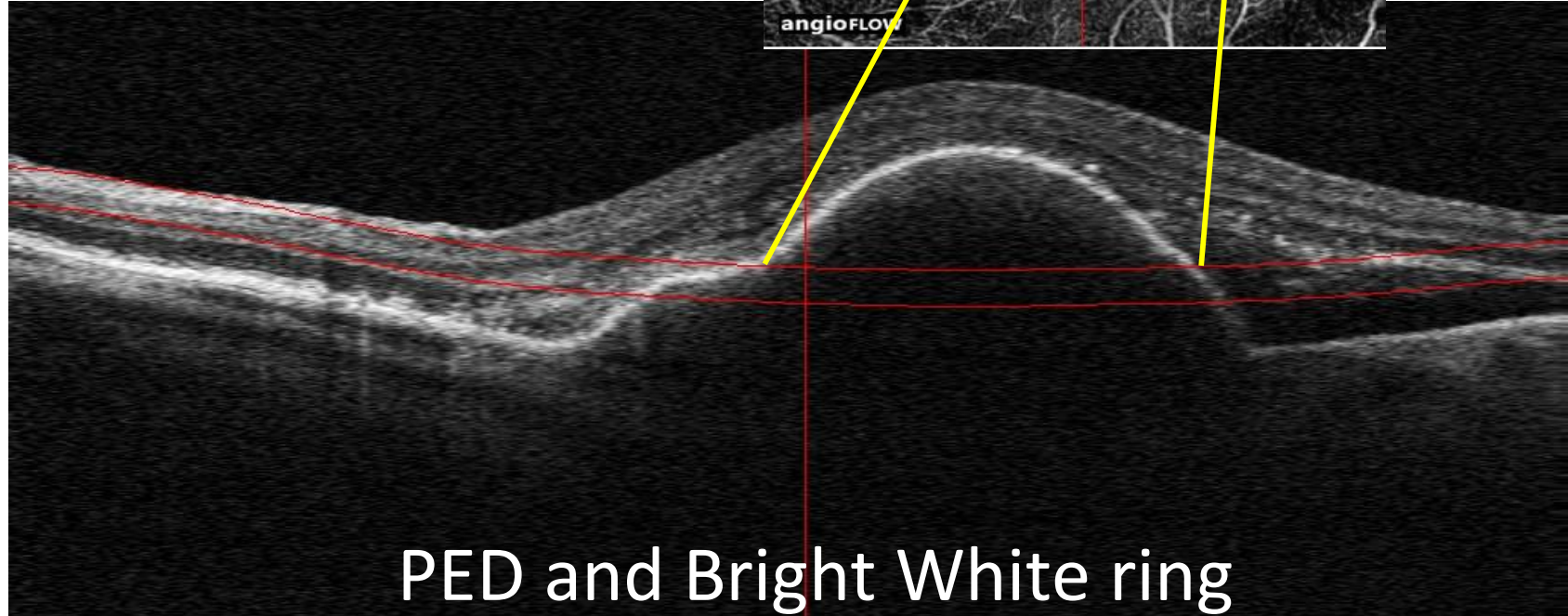
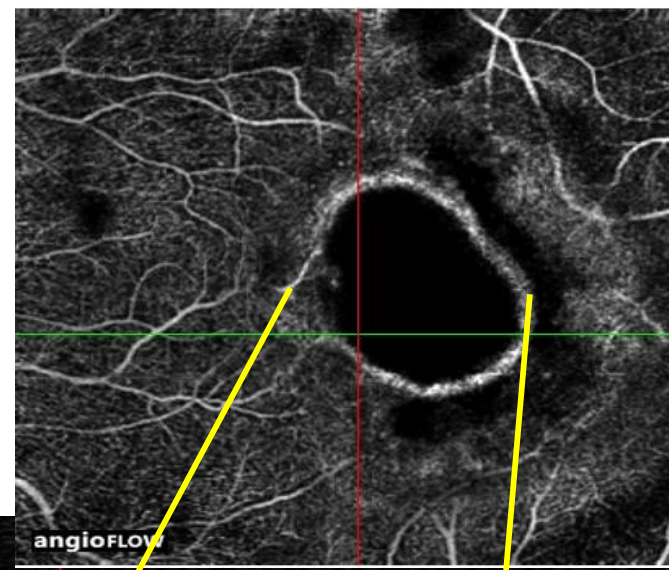
Graefes Arch Clin Exp Ophthalmol
DOI 10.1007/s00417-017-3813-8

Optical coherence tomography angiography artifacts in retinal pigment epithelial detachment

Ricardo N. Louzada, MD,^{*,†} Talisa E. de Carlo, MD,^{*,‡} Mehreen Adhi, MD,^{*,‡}
Eduardo A. Novais, MD,^{*,§} Mary K. Durbin, PhD,^{||} Emily Cole, MD,^{*,‡} Mark Lane, MD,^{*,||}
Omid Moghimi, MD,^{*} Malvika Arya, BS,^{*} Marco Bonini Filho, MD, PhD,^{*} Andre J. Witkin, MD,^{*}
Caroline R. Bauman, MD,^{*} Marcos Ávila, MD, PhD,[†] Jay S. Duker, MD,^{*}
Nadia K. Waheed, MD, MPH^{*}

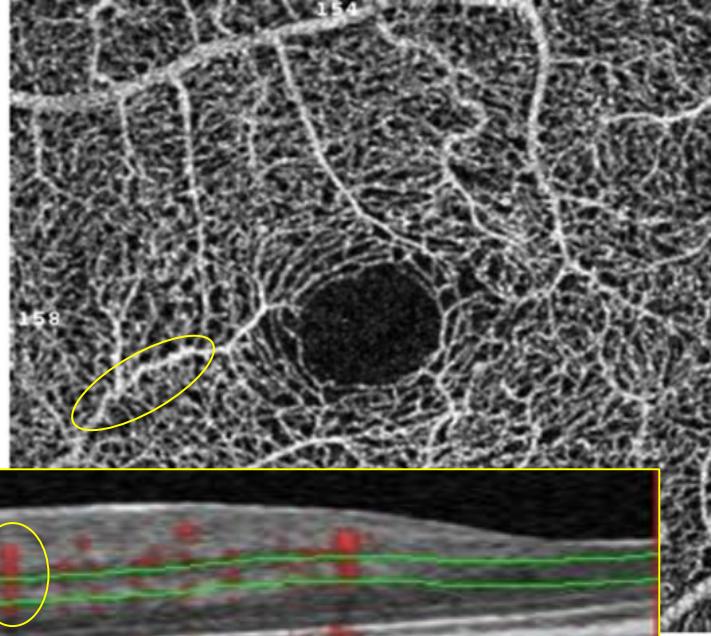
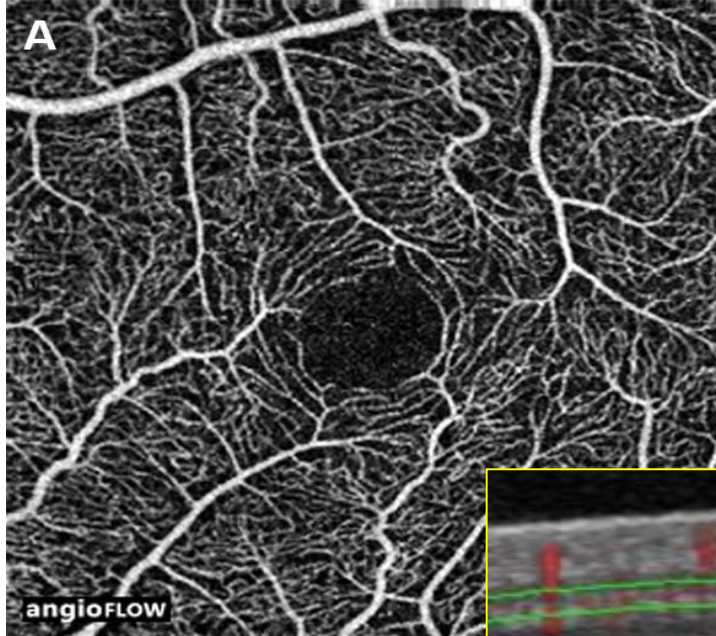
CAN J OPHTHALMOL—VOL. 52, NO. 4, AUGUST 2017

The RPED creates a flow signal that corresponds exactly with the edges of the RPED



Artefacts de projection

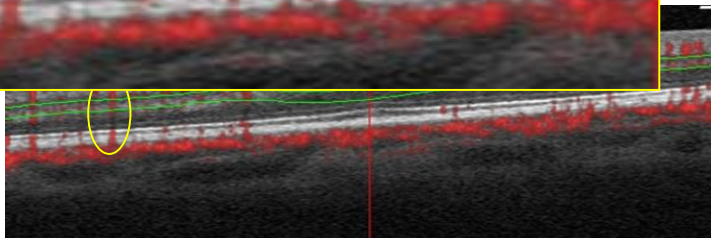
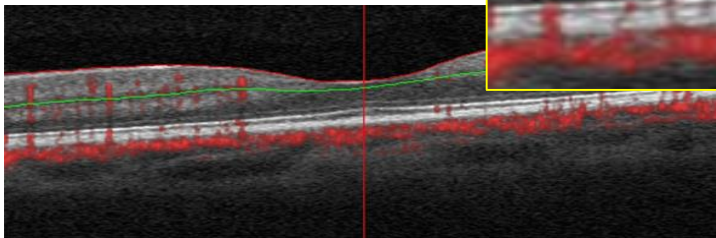
Dans plus de 2/3 des cas, les vaisseaux superficiels sont en partie visibles aussi dans le réseau profond.



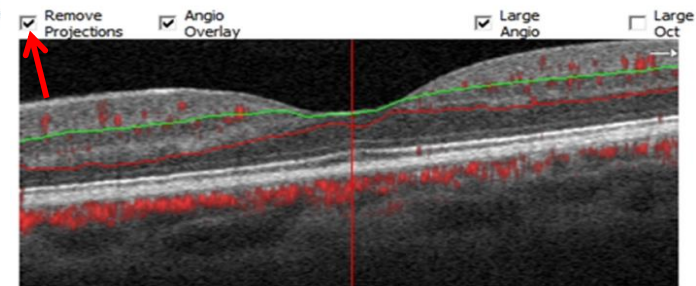
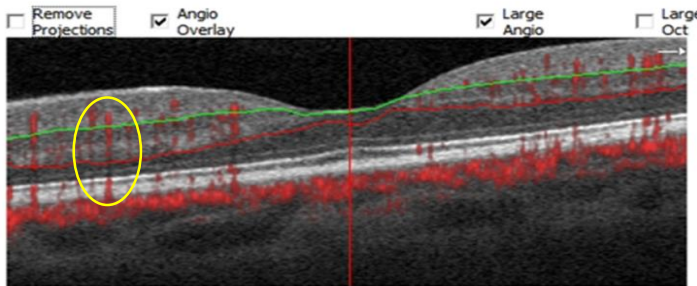
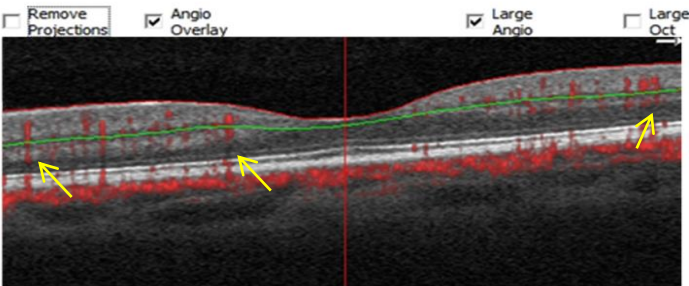
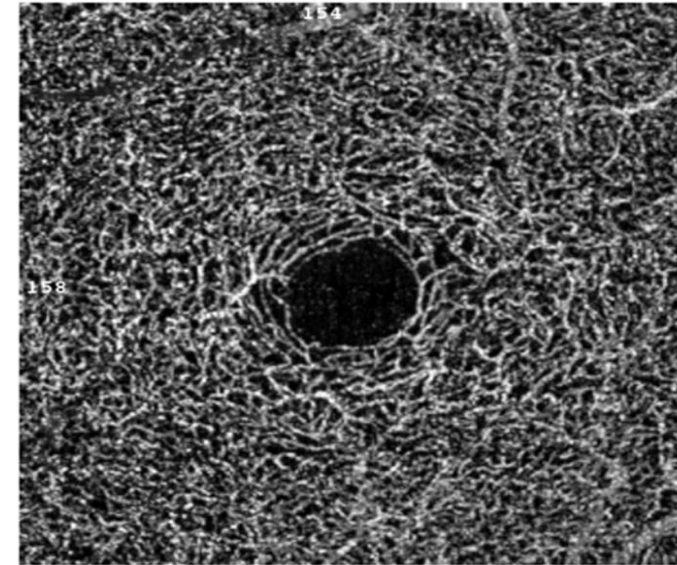
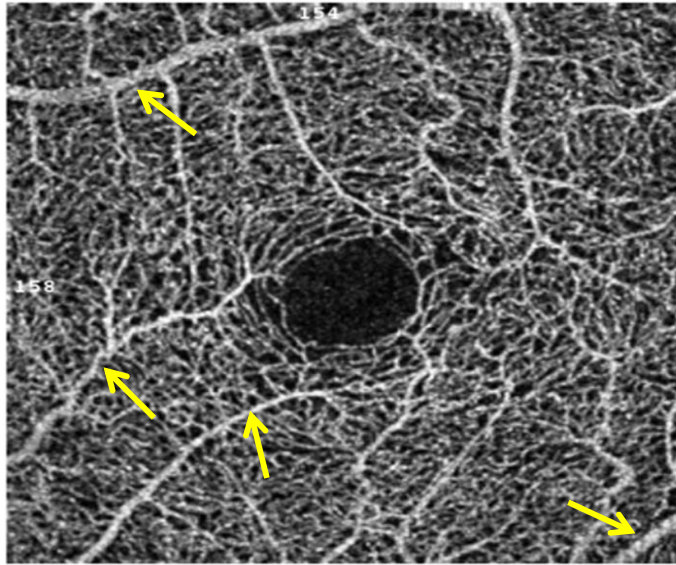
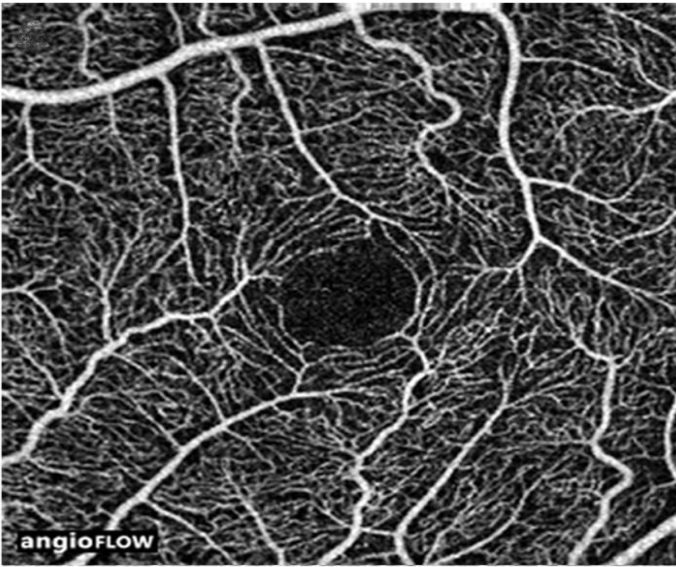
Réseau superficiel. le tracé des vaisseaux sur l'image en face a sa contrepartie dans le signal du flux (en rouge) sur la coupe OCT Angio

Les vaisseaux superficiels sont en partie visibles dans le réseau capillaire profond. Le rond jaune montre que le signal du vaisseau forme un trait vertical traversant plusieurs couches sur la coupe OCT Angio

Détail de la coupe OCT Angio montrant la projection du signal d'un vaisseau superficiel dans les couches profondes (ellipse)



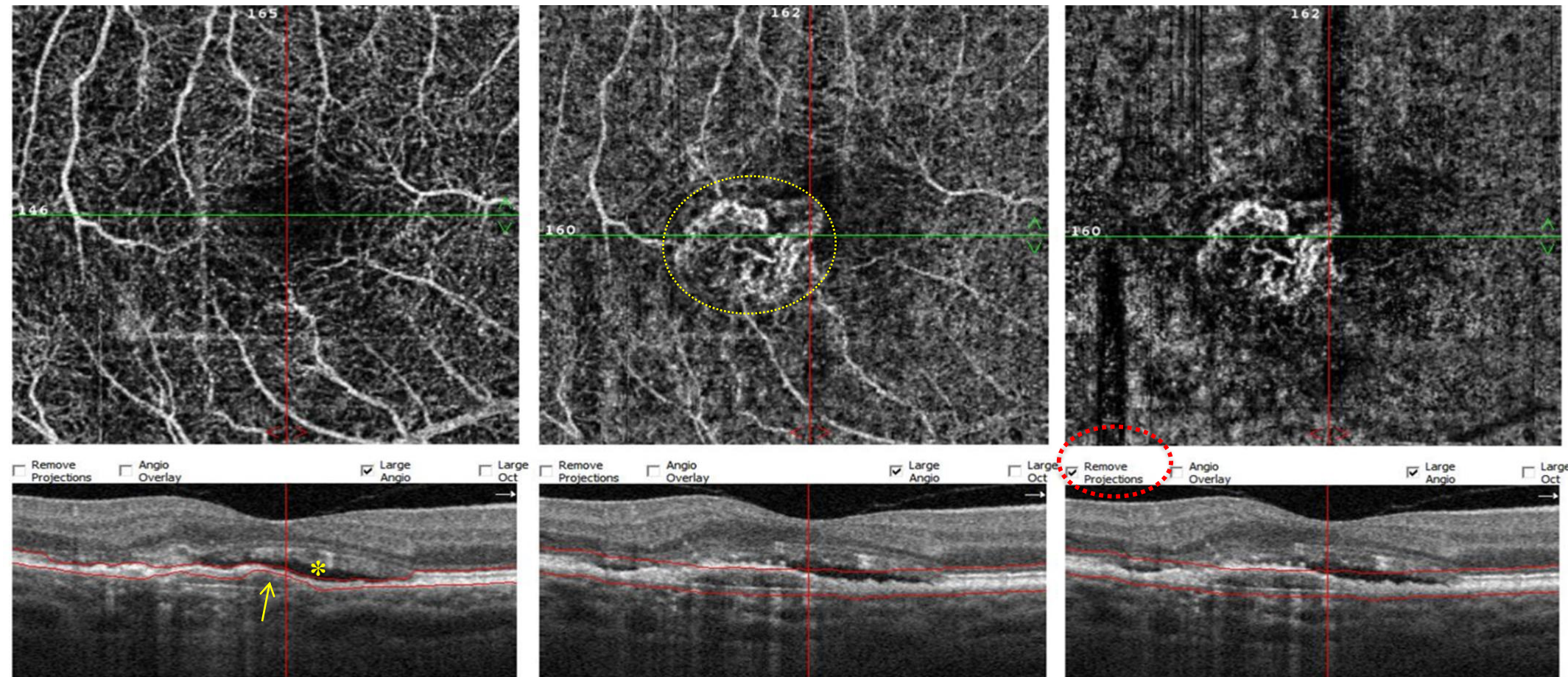
Artefacts de projection



Ici un scan au niveau de l'épithélium pigmentaire (flèches jaunes) montre les artefacts de projection paradoxale des vaisseaux superficiels.

Artefacts de projection corrigés

Correction of Segmentation artifact



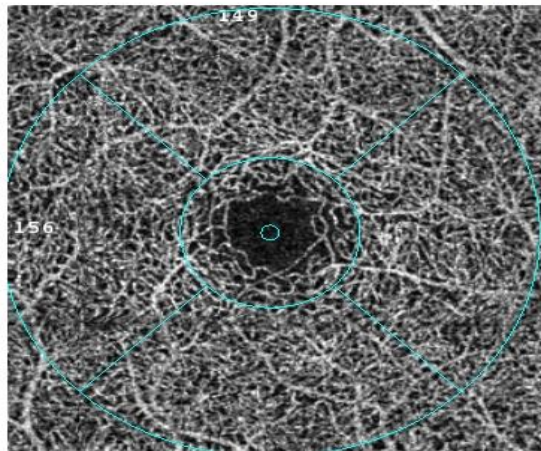
After manuel correction of segmentation artifact + Projection artifact removal

Angio Retina

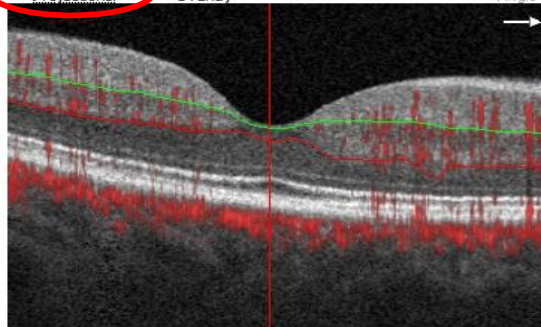
Ring Diameters (mm): 1.00, 3.00

Export Angio

Measure
Density



☐ Flatten Br ☒ Remove Projections ☒ Angio Overlay ☒ ETDRS Contour ☒ Large Angio

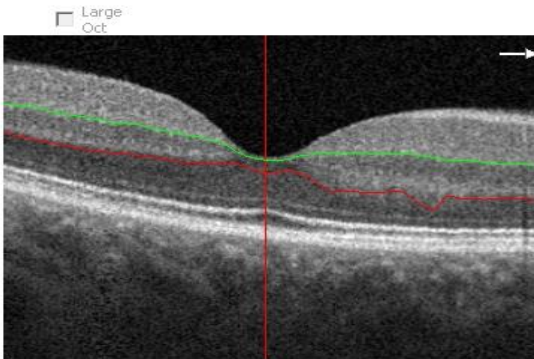
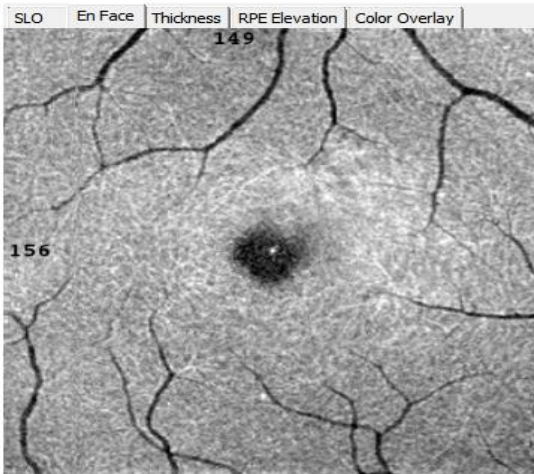


Print

Multi Scans View

Signal Strength Index

81



Right / OD

3.00 x 3.00 Scan Size (mm)

OCT Thickness ILM-IPL

Section	Thickness (μm)
ParaFovea	132
- Superior-Hemi	131
- Inferior-Hemi	133

OCT Thickness ILM-RPE & Vessel Density

Density ...	Section	Thickness ...
64.65	Whole Image	N/A
40.14	Fovea	285
67.27	ParaFovea	352
67.20	- Superior-He...	353
67.35	- Inferior-Hemi	351
65.30	- Tempo	344
68.66	- Superior	353
67.13	- Nasal	359
67.99	- Inferior	353

Grid-based Vessel Density (%)

66.92	68.34	68.11
64.73	45.03	67.54
66.13	67.27	67.07



Save
Analytic

Reference

- ☐ Superficial
- ☒ Deep
- ☐ Outer Retina
- ☐ Choroid Cap
- ☐ Retina
- ☐ Deep Custom

Upper - IPL
Offset(μm)

0 ...

Lower - OPL
Offset(μm)

16 ...

16 ...

3D Display

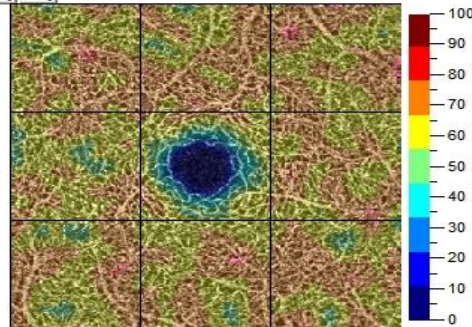
OverVue

Play

☒ Show Brd

☐ Color

☐ Show Line



Comment

optovue

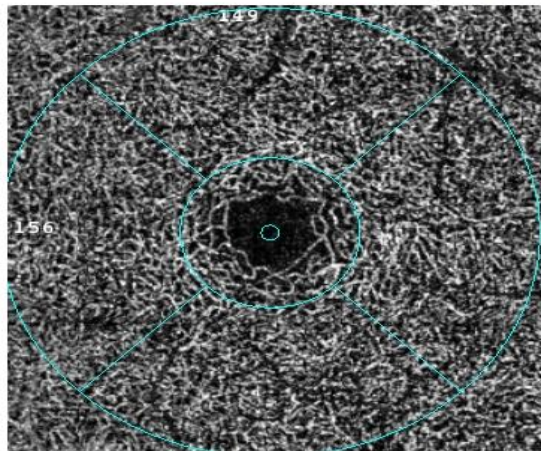
Angio Retina
Bing Dian

Ring Diameters (mm): 1.00, 3.00

Export Angio

Measure

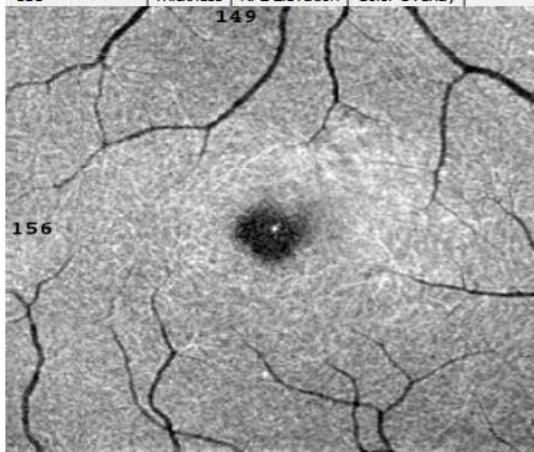
Density ▼



Signal Strength Index

81

SLO	En Face	Thickness	RPE Elevation	Color Overlay
-----	---------	-----------	---------------	---------------



Right / OD

3.00 x 3.00 Scan Size (mm)

OCT Thickness ILM-IPL

Section	Thickness (μm)
ParaFovea	132
- Superior-Hemi	131
- Inferior-Hemi	133

3D Display

Save OCT Thickness ILM-RPE & Vessel Density

Density ...	Section	Thickness ...
58.43	Whole Image	N/A
41.21	Fovea	285
60.02	ParaFovea	352
60.34	- Superior-He...	353
59.70	- Inferior-Hemi...	351
63.26	- Tempo	344
59.04	- Superior	353
59.93	- Nasal	359
57.85	- Inferior	353

OverVue

Play

Reference

- ☐ Superficial
☒ Deep
☐ Outer Retina
☐ Choroid Cap
☐ Retina
☐ Deep Custom

Upper - IPL
Offset(um)

0

Lower - OP
Offset(um)

16

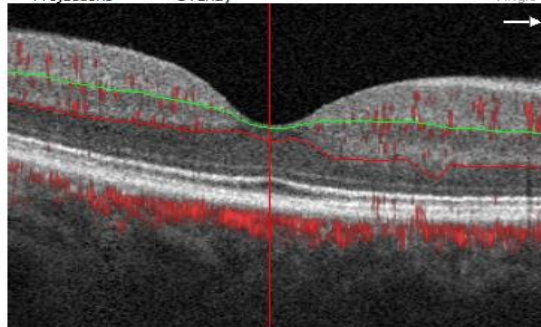
16 ...m

Grid-based Vessel Density (%)

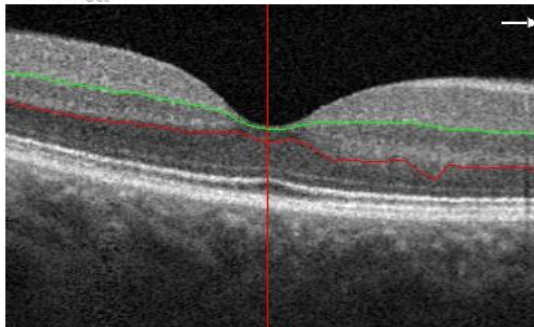
64.33	57.26	57.46
63.71	45.48	60.16
61.68	58.46	56.85

☒ Show Bnd☐ Color☐ Show Line☐ Flatten Bnd☒ Remove Projections☒ Angio Overlay☒ ETDRS Contour

☒ Large Angio



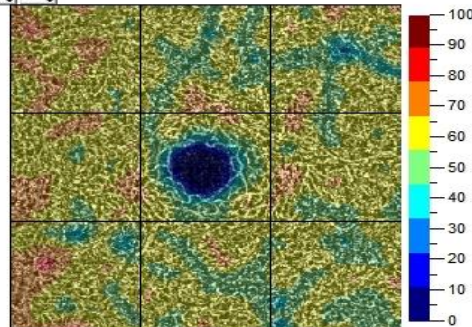
☐ Large Oct



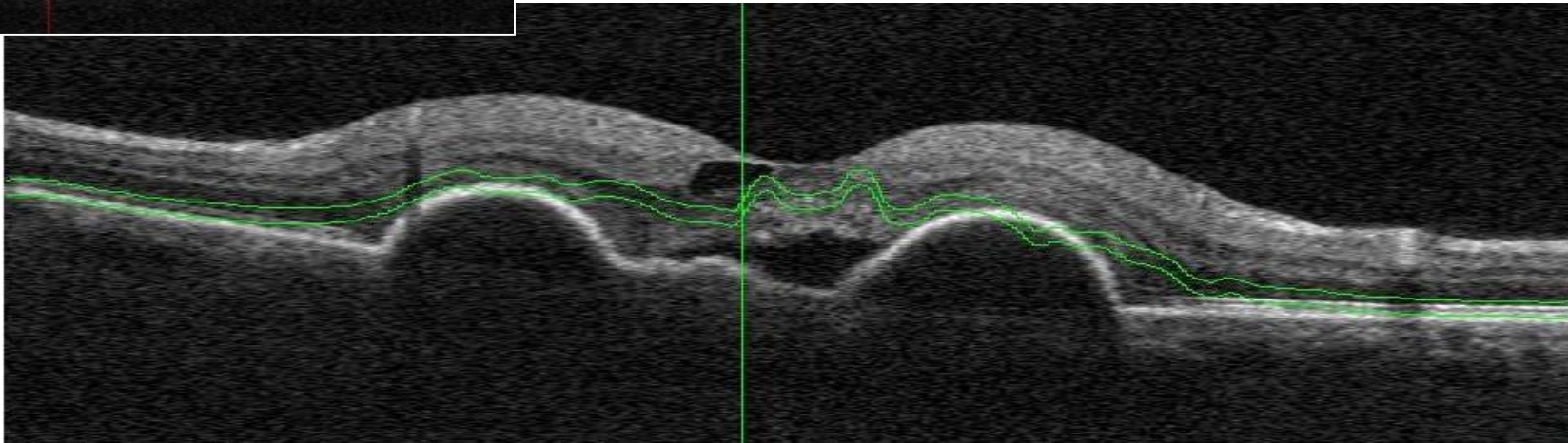
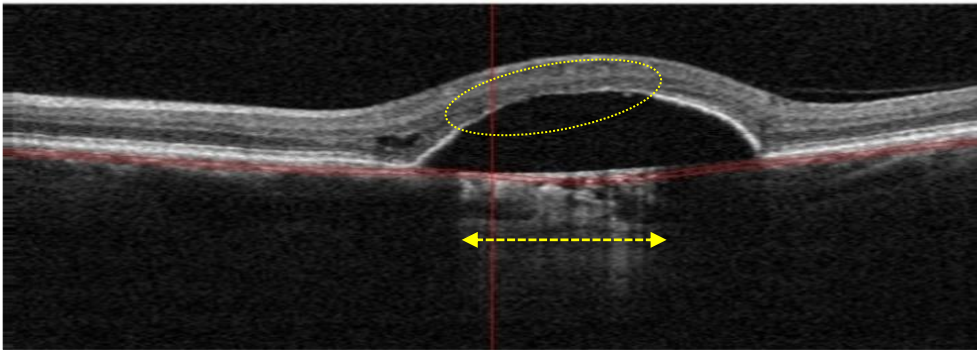
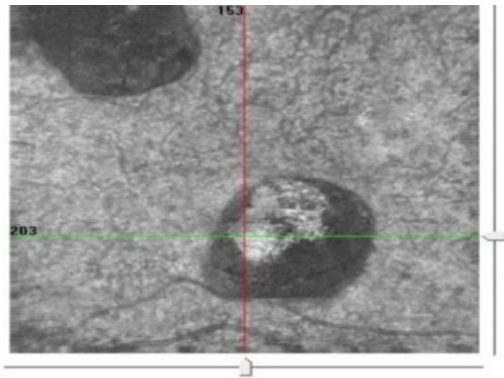
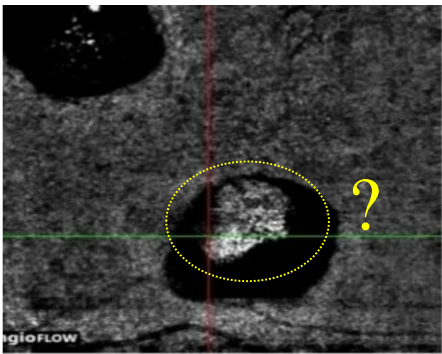
Print

Multi Scans View

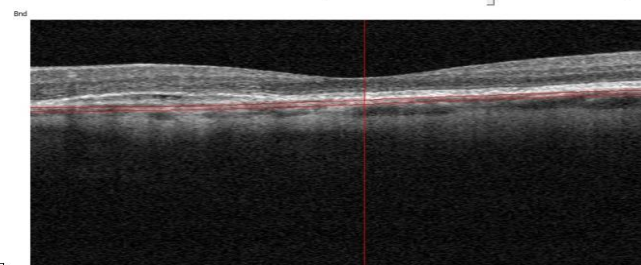
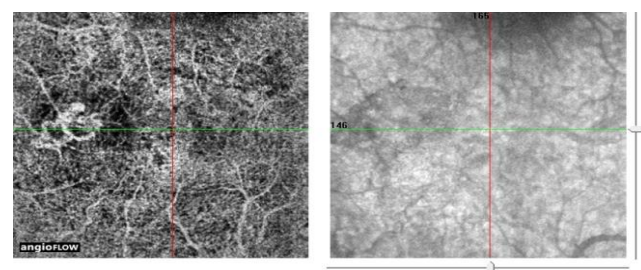
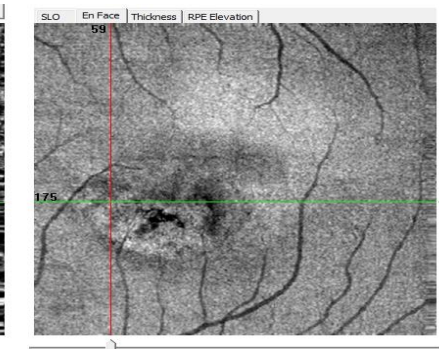
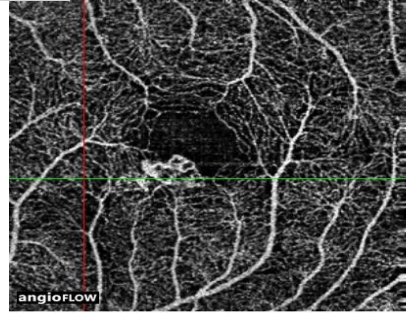
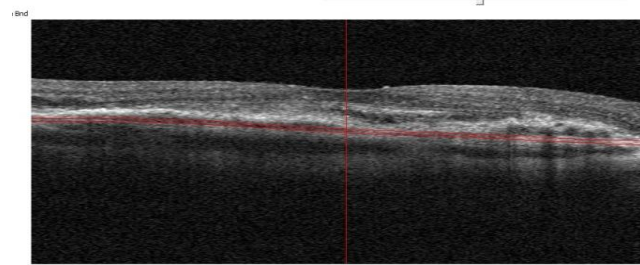
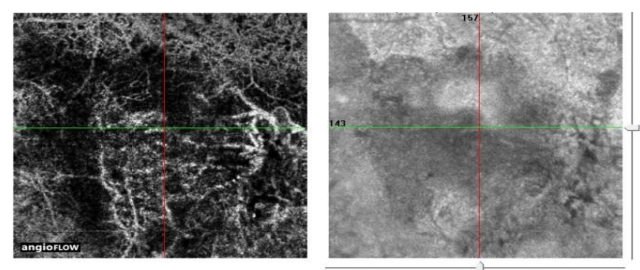
Comment



Segmentation Erreurs



Type et placement de Slab



Save Settings

Restore Settings

Reference

☐ Superficial

☐ Deep

☐ Outer Retina

☒ Choroid Cap

Upper - RPE Ref

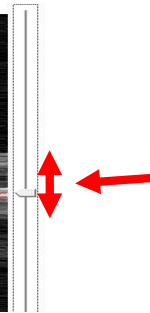
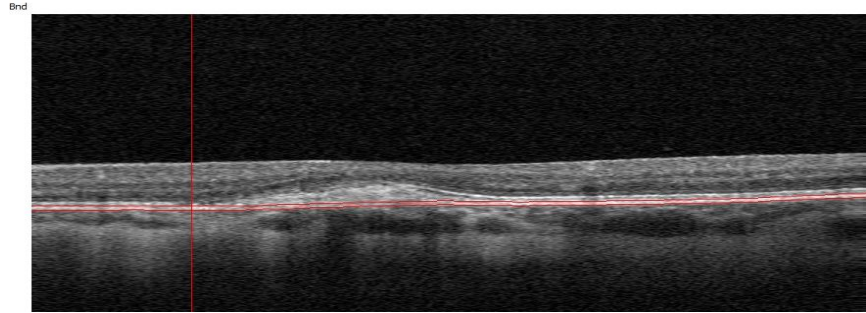
Offset(um)

-6 ...

Lower - RPE Ref

Offset(um)

17 ...



Soft drusen and segmentation errors

False positive
flow

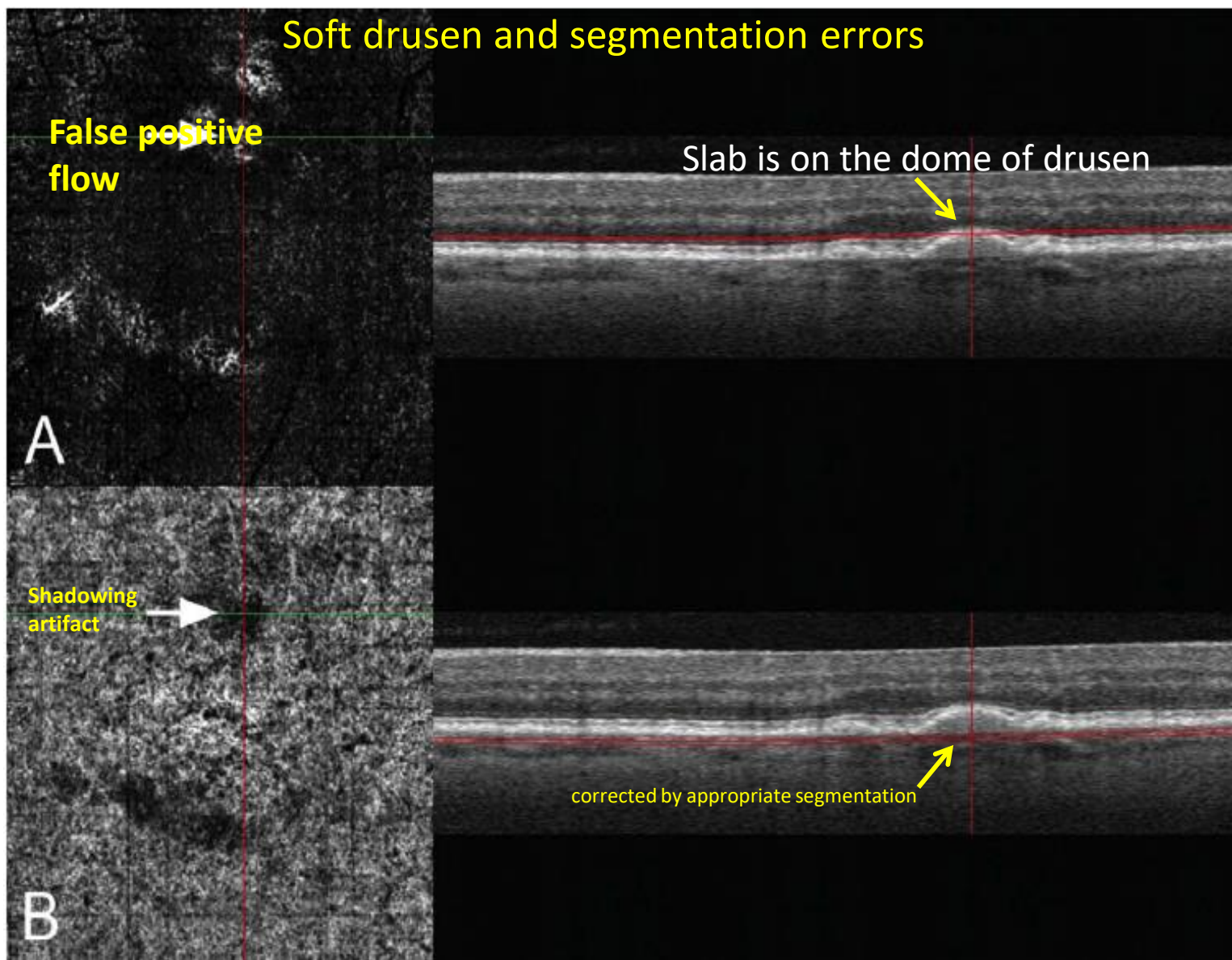
A

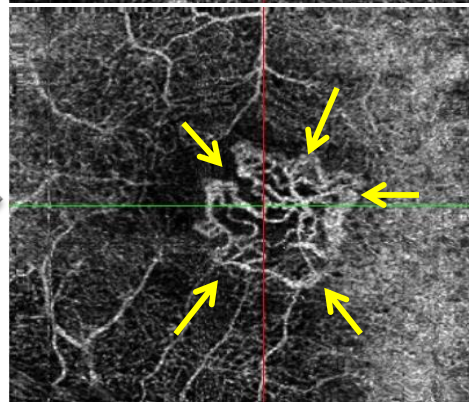
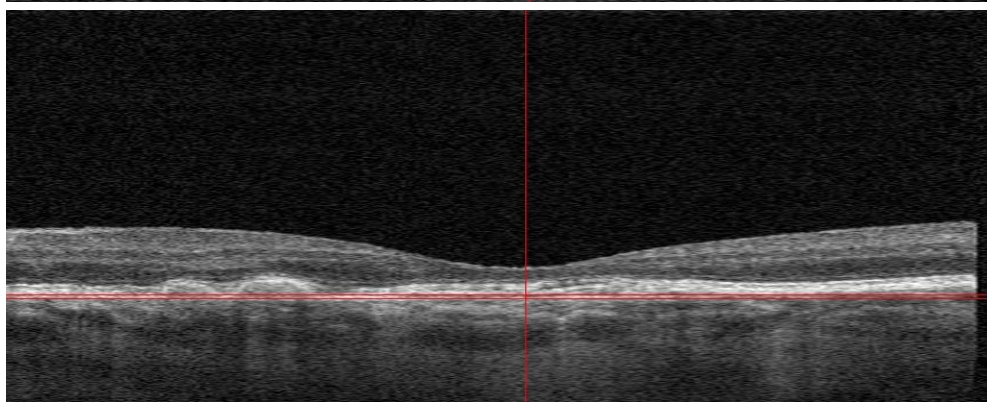
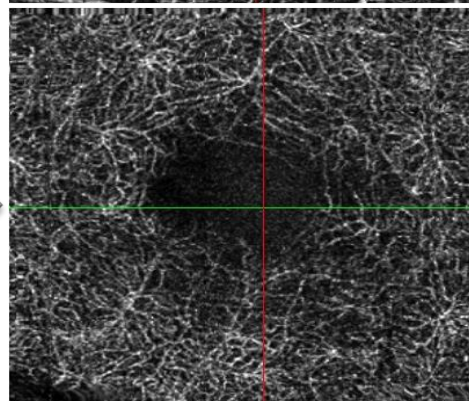
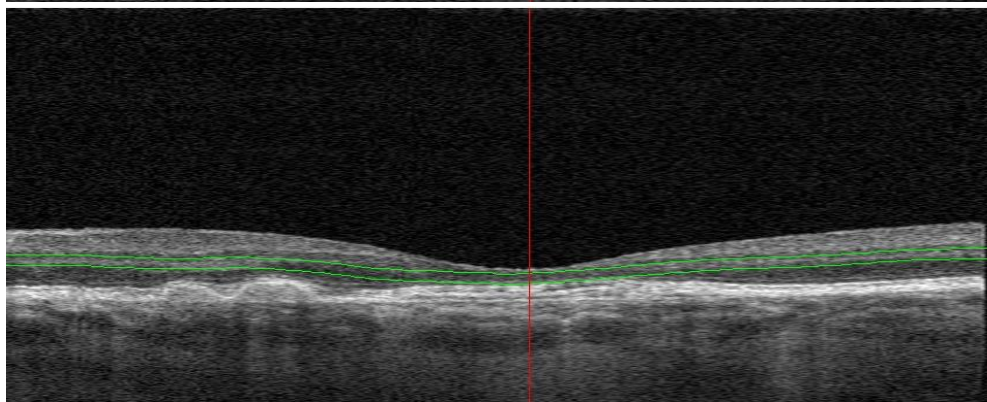
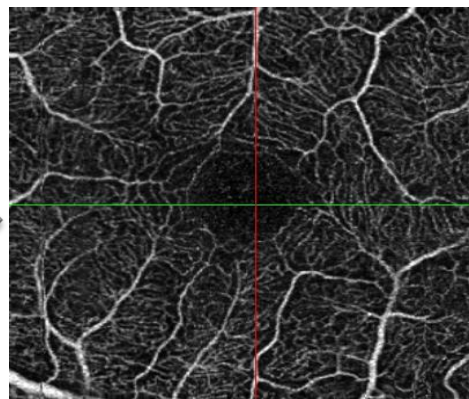
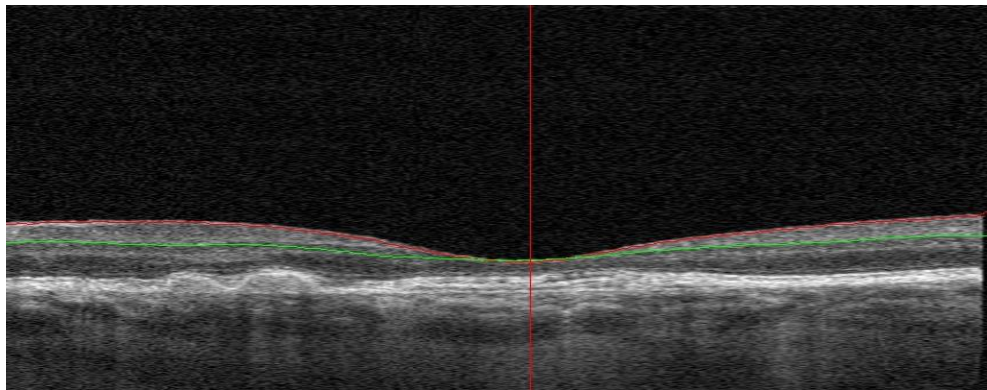
Slab is on the dome of drusen

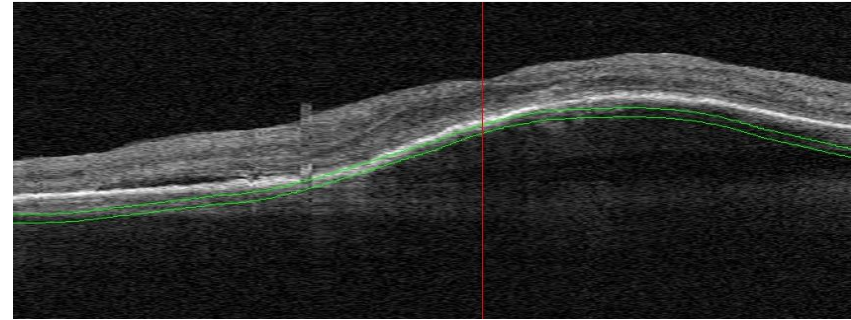
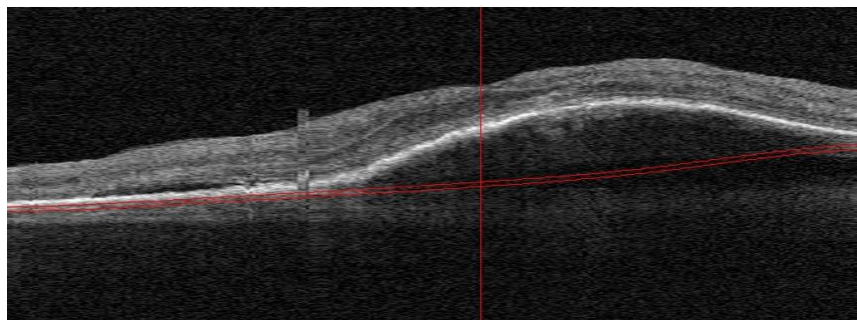
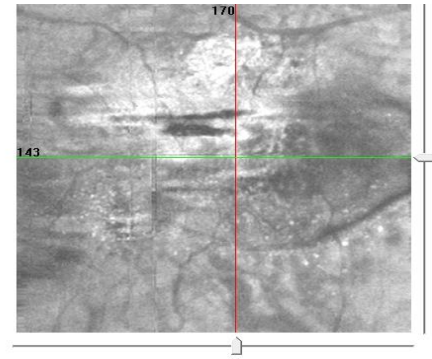
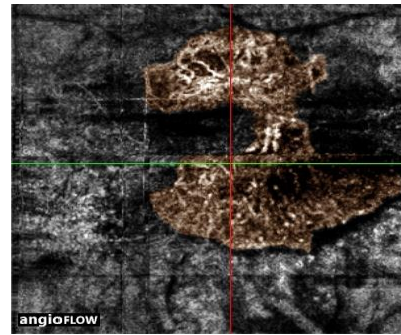
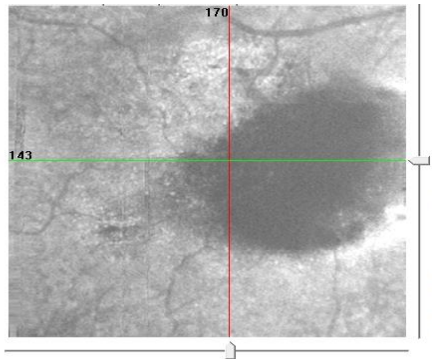
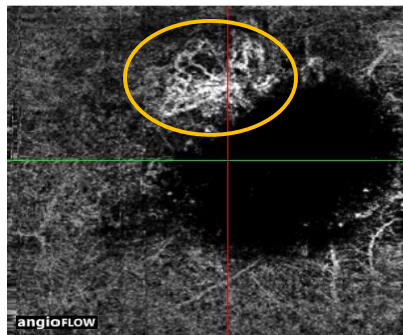
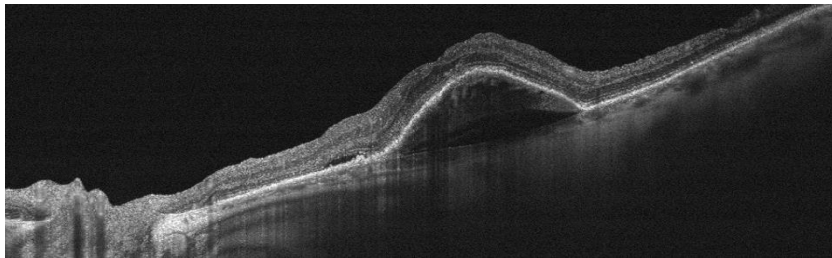
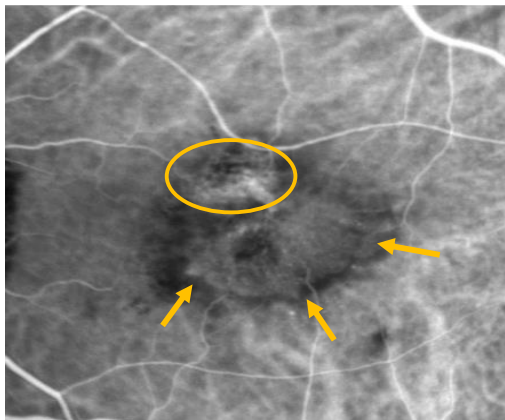
Shadowing
artifact

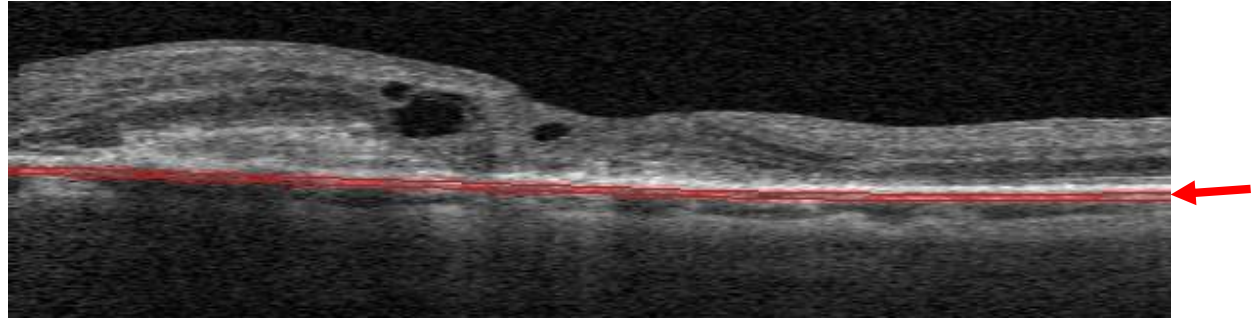
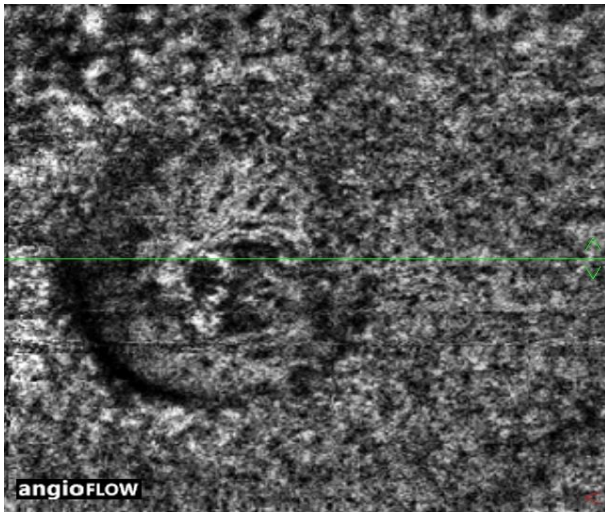
B

corrected by appropriate segmentation

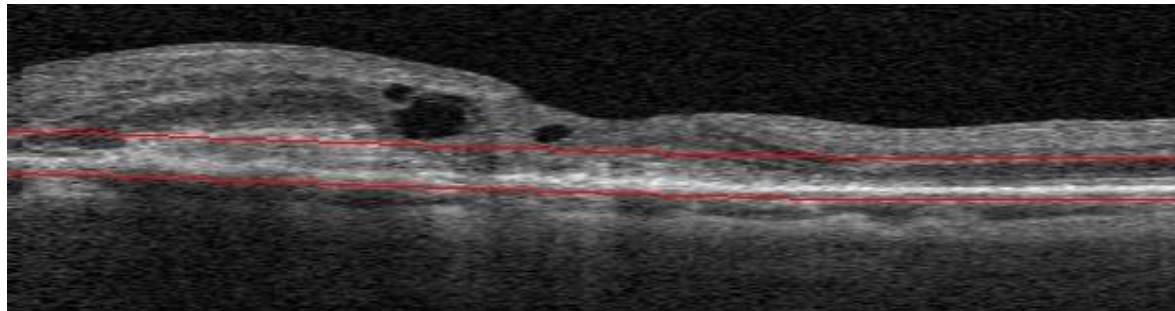
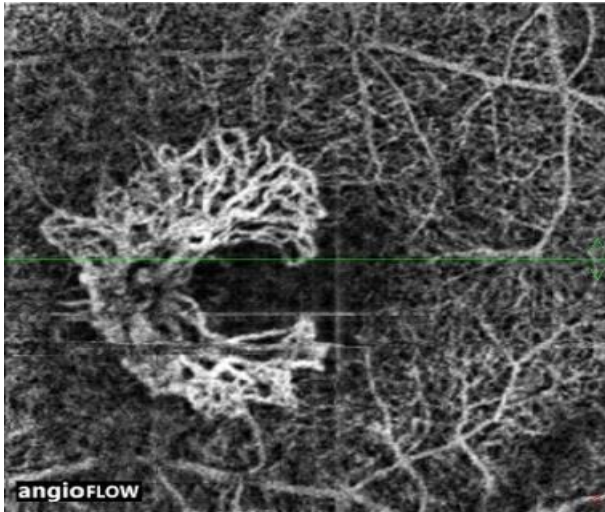


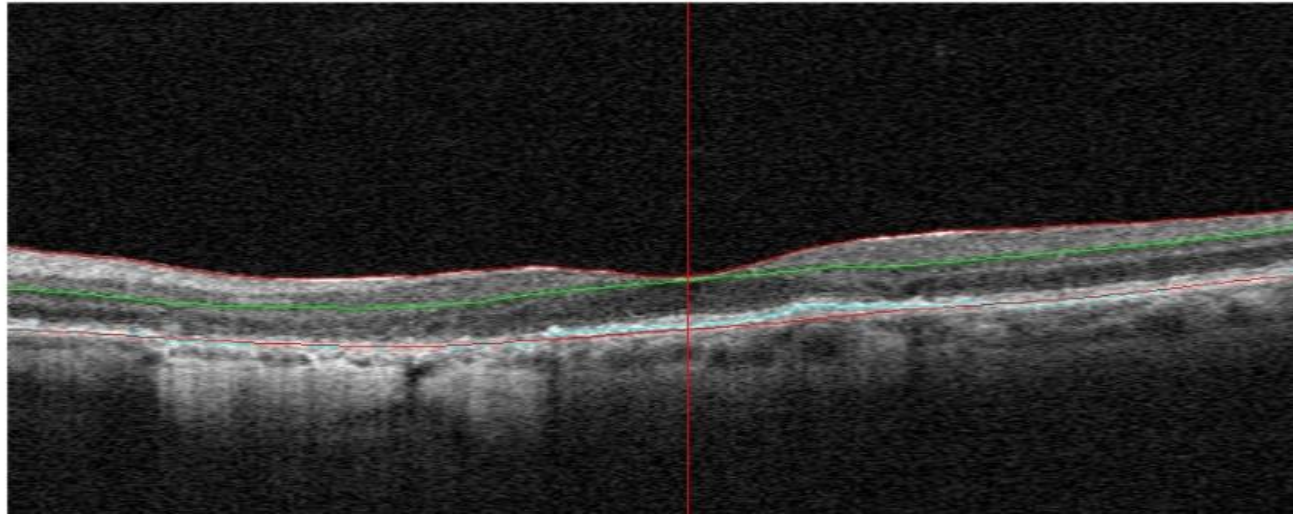
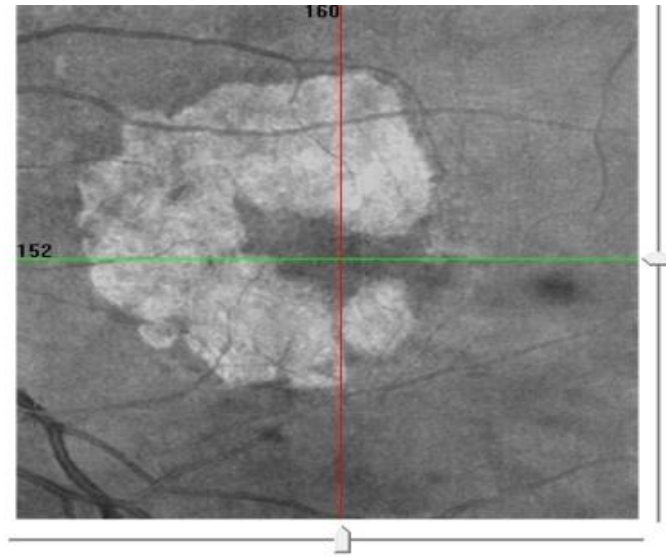
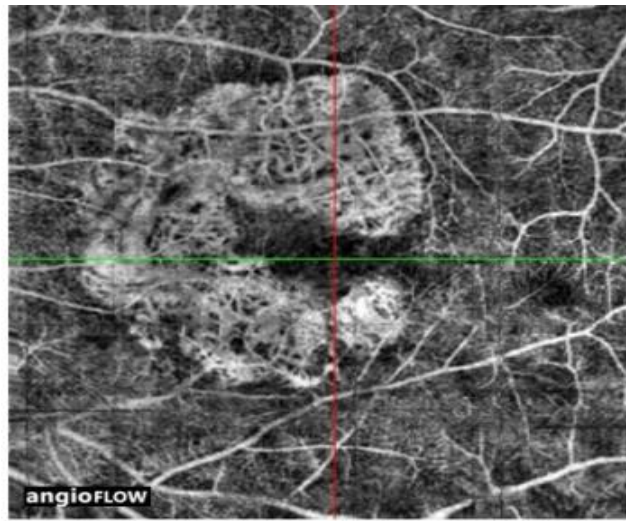




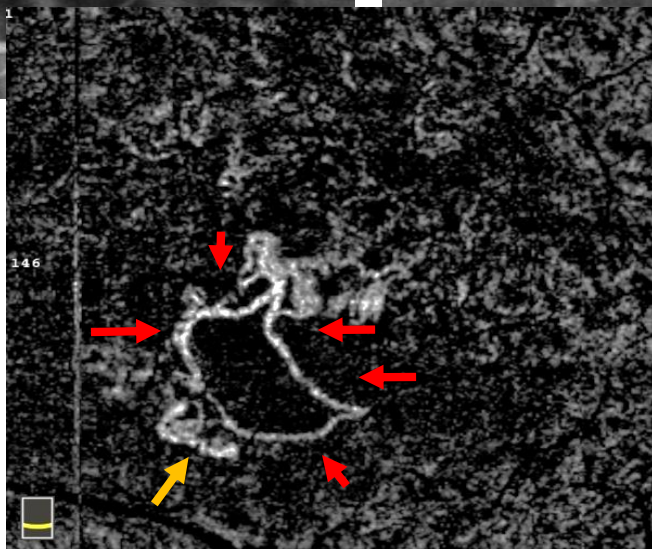
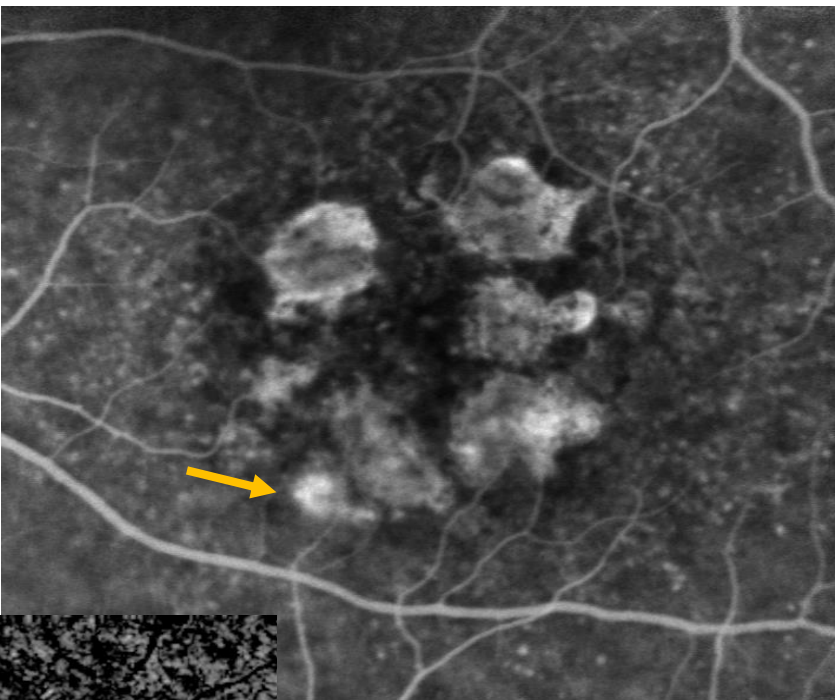
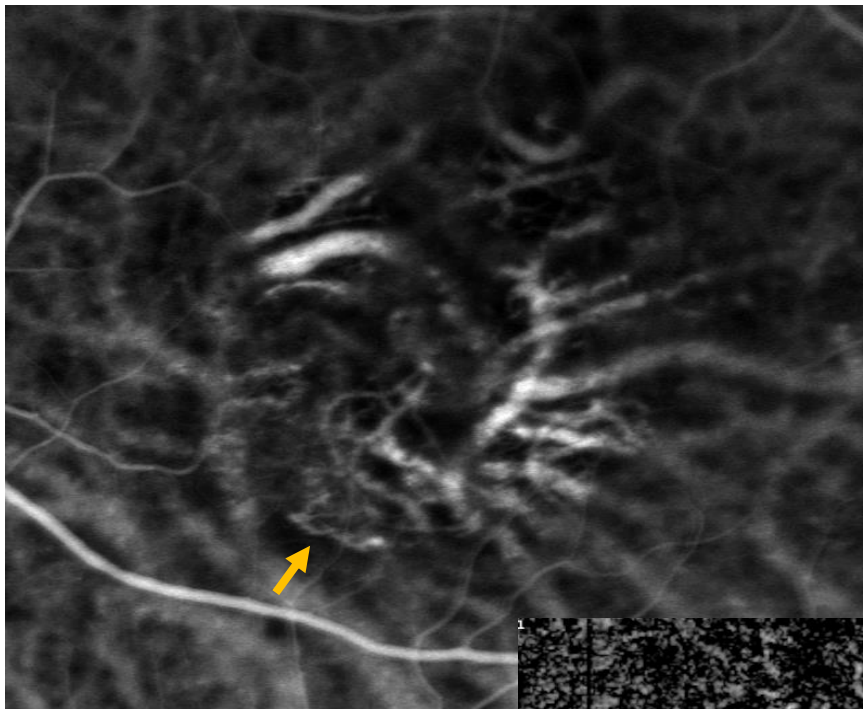


adjustment of slab boundaries





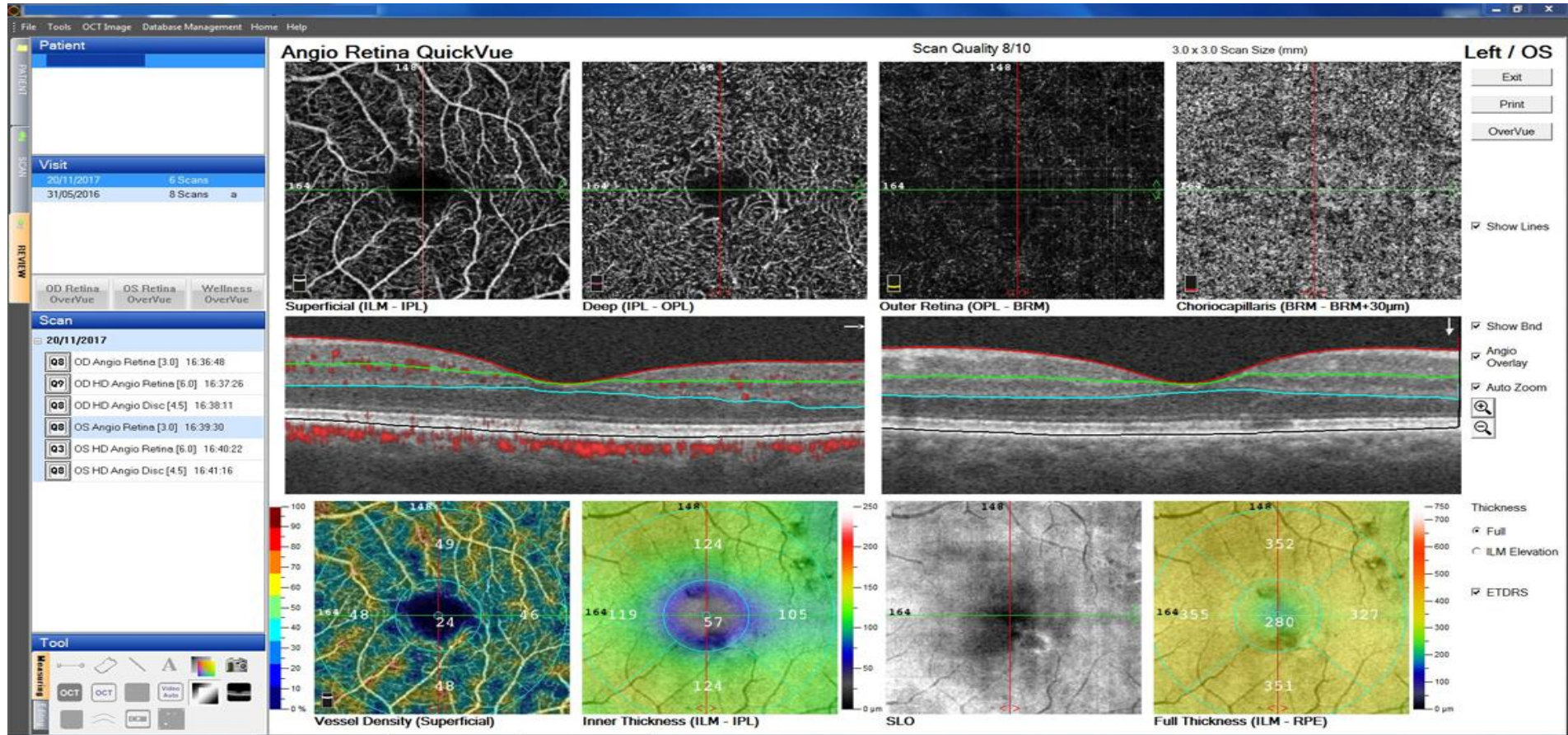
Unmasking artefact in choriocapillaris slab may resemble a choroidal neovascularisation



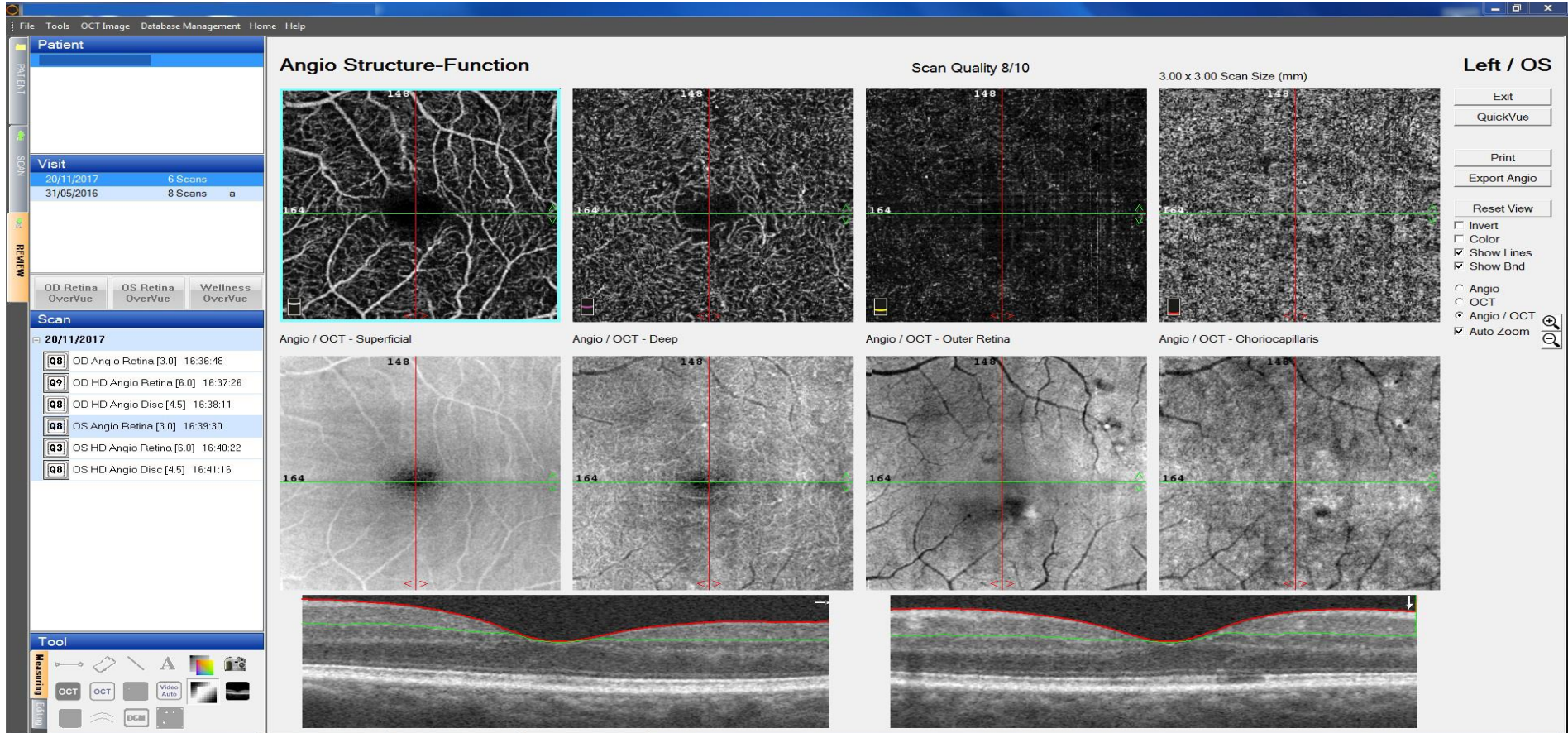
Multi-imaging

- ✓ **OCT (B-scan ++)**
- ✓ **OCT en -Face**
- ✓ **OCT-Angio**
- ✓ **Angiographie ...**

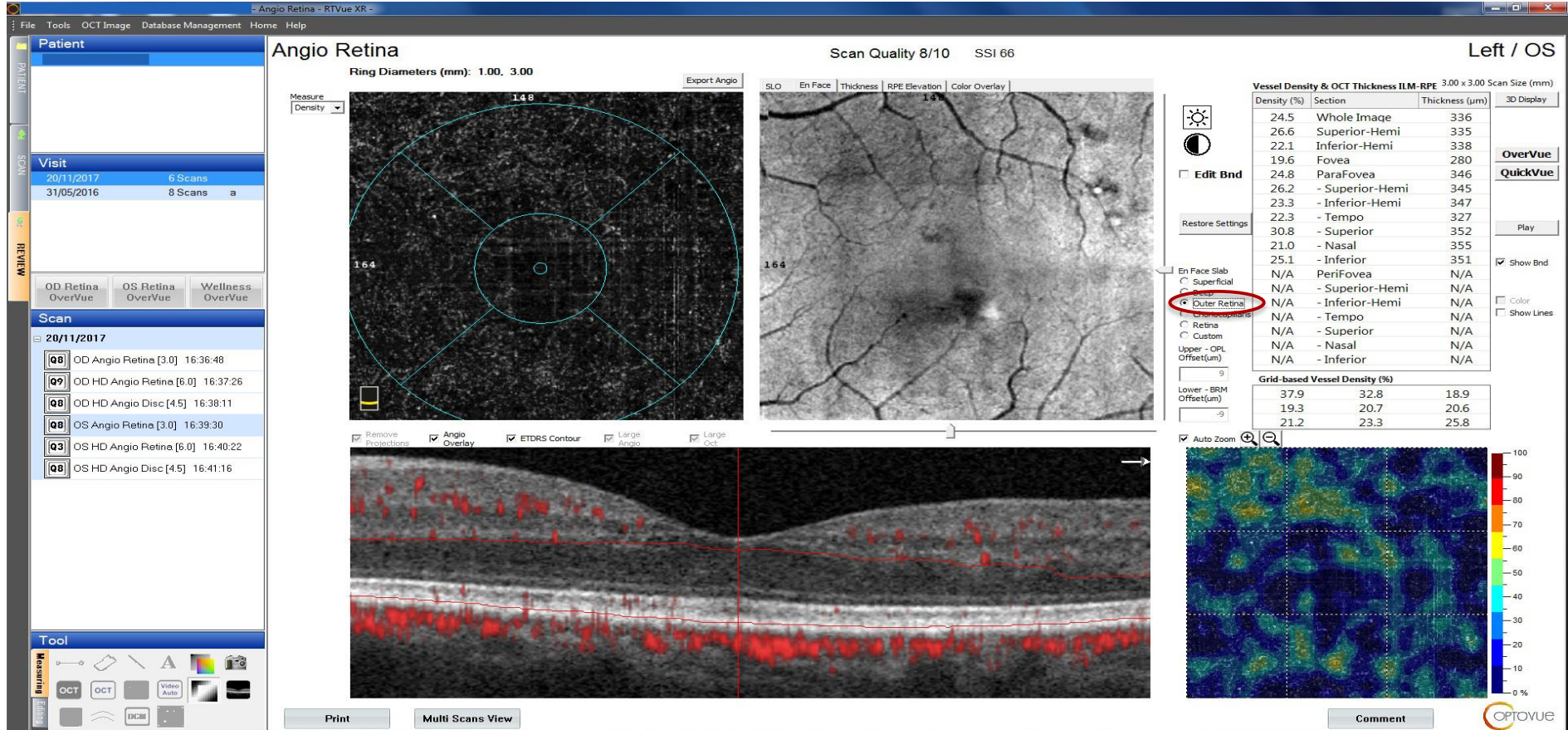
Analyse Optovue: OCT-A, B-Scan, densité capillaire, épaisseur rétinienne

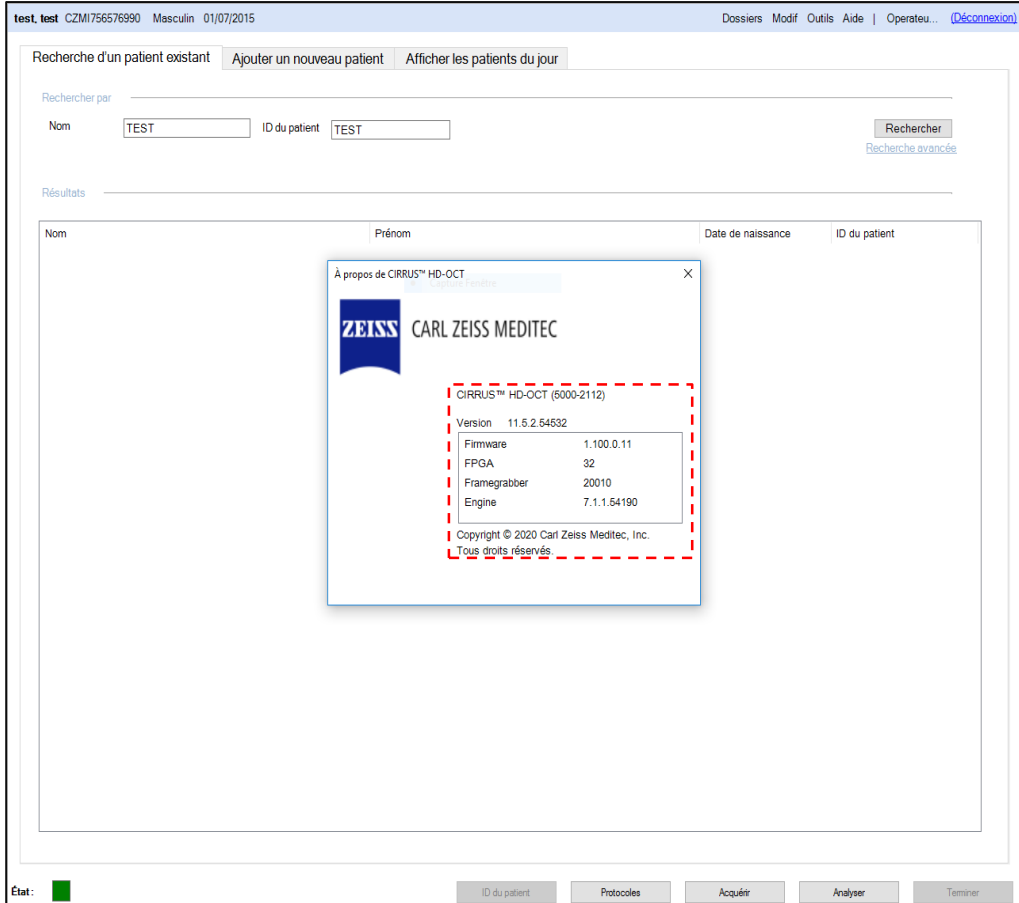


Analyse Optovue: OCT-A, OCT en-Face, B-Scan

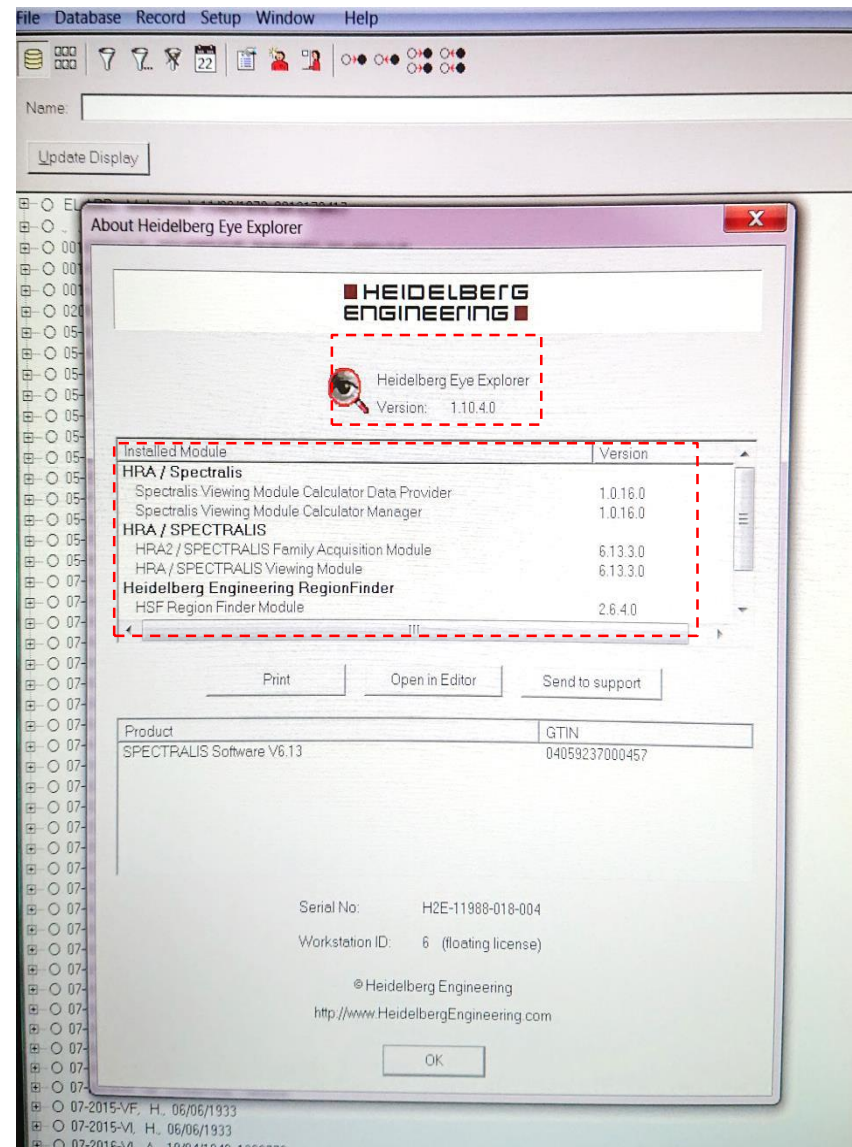


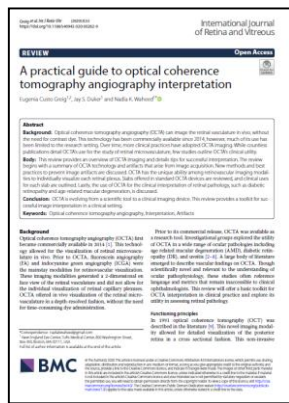
Analyse Optovue: OCT-A, OCT en –Face, B-Scan, densité capillaire (*rétilne externe*)



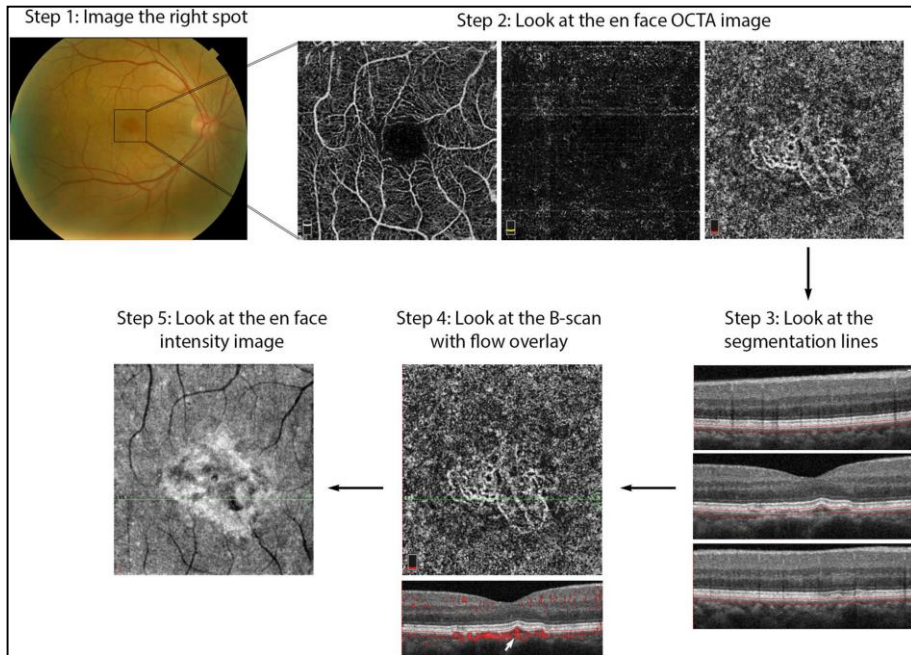


- ✓ Version du logiciel
- ✓ Outils en option
- ✓ Mise à jour +++





*A practical guide to optical coherence tomography angiography interpretation
Greig et al. International Journal of Retina and Vitreous, 2020*



OCTA Interpretation Toolkit. How to apply step-by-step OCTA interpretation toolkit in a patient with AMD.

Step 1: Image the right spot. Color fundus photograph of a patient with known AMD, the macula was selected as the area of interest and imaged.

Step 2: Look at the en face OCTA images. 3×3 mm en face projections of each the full retinal depth, the avascular slab and the choriocapillaris (from left to right). The avascular and choriocapillaris slabs should be assessed in this AMD patient to check for presence of MNV. Note clearly defined vascular structures in the choriocapillaris slab (right most image), this is concerning for a type 1 MNV.

Step 3: Look at the segmentation lines. Segmentation is assessed at multiple points throughout the slab to ensure accuracy.

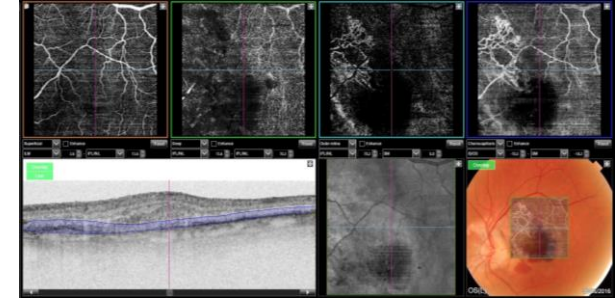
Step 4: Look at the B-scan with flow overlay. B-scan through lesion shows clear flow below the RPE (white arrow) and no projection artifact from overlying vasculature, suggesting this is in fact an MNV.

Step 5: Look at the en face intensity image. En face intensity image for the choriocapillaris slab shows strong signal, shadowing artifact is not expected to disrupt image interpretation.

Summary: Methodical OCTA image analysis uncovered a type 1 MNV that was not visible on fundus examination or on full depth retinal projection

Conclusion

- **Bonne compréhension des artefacts existants**
- **En corrélation avec l'imagerie multimodale**
- **La visualisation combinée des images OCTA et OCT (B-scans, en-face, lignes de segmentation) devrait réduire considérablement le risque de mauvaise interprétation tout en fournissant des informations plus complètes sur les pathologies rétiniennes.**
- **Les améliorations apportées aux logiciels informatiques automatisés pour la segmentation anatomique, la détection pathologique et la quantification rendront OCTA plus facile à utiliser**



Merci de votre attention

ali.erginay@aphp.fr



Service d'Ophtalmologie
Hôpital Lariboisière