Université de Paris

Hôpital Lariboisière
Hôpital Saint Louis
AP-HP.Nord

HÔPITAL FONDATION
Adolphe de ROTHSCHILD
LA RÉFÉRENCE TÊTE ET COU

DIU - Imagerie et Pathologie Rétiniennes

Technique de réalisation de l'OCT et l'OCTA

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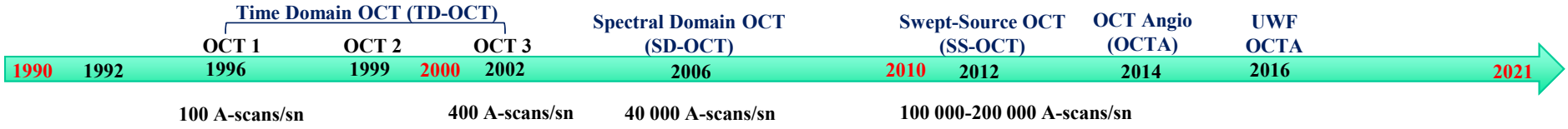
Service d'Ophtalmologie
Hôpital Lariboisière

Conflits d'intérêts

- Allergan
- Bayer
- Canon
- Novartis

sans rapport avec cette communication

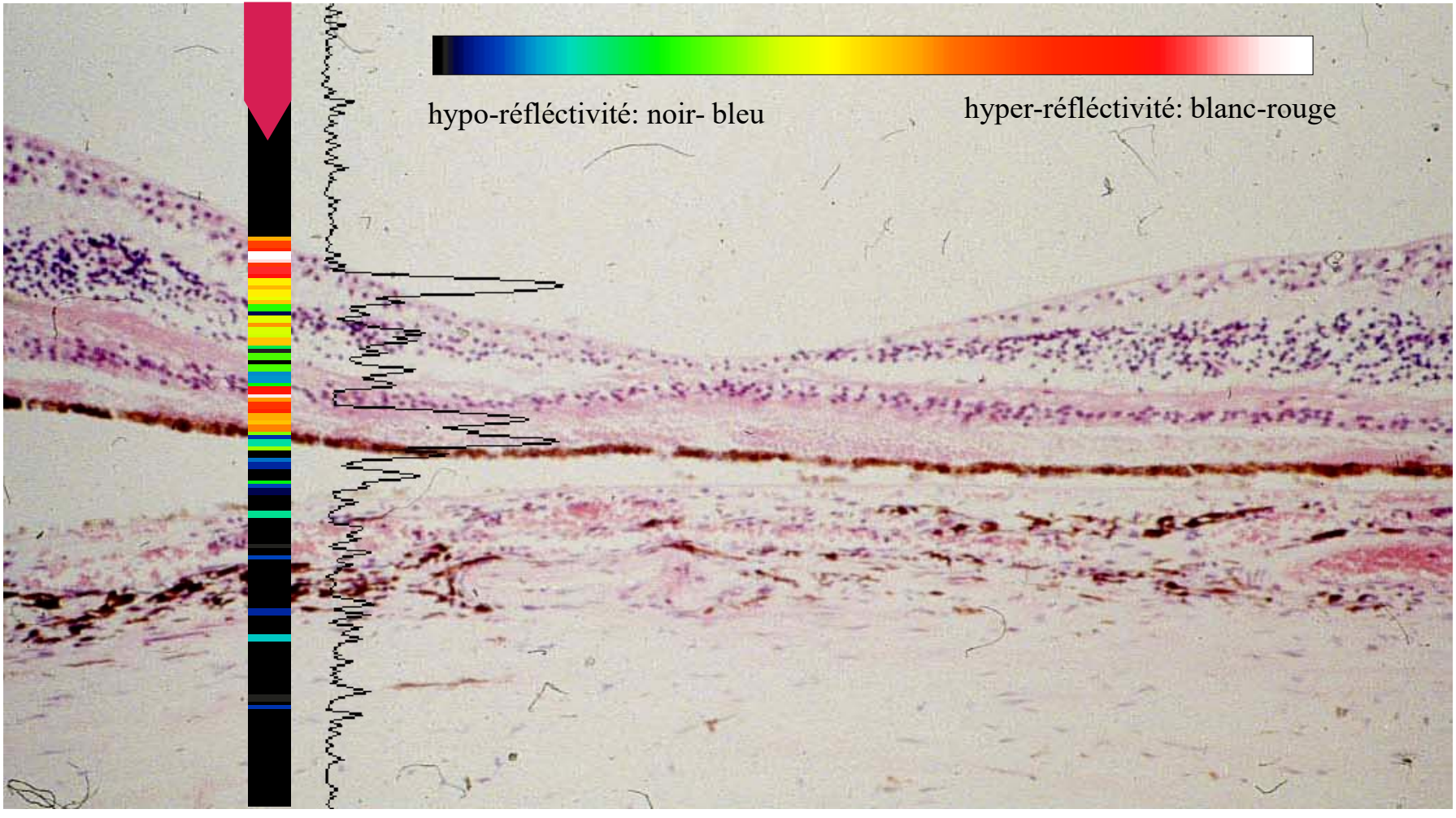
26e Anniversaire de l' OCT



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

Résolution axial*:* 12 µm → 4-5µm

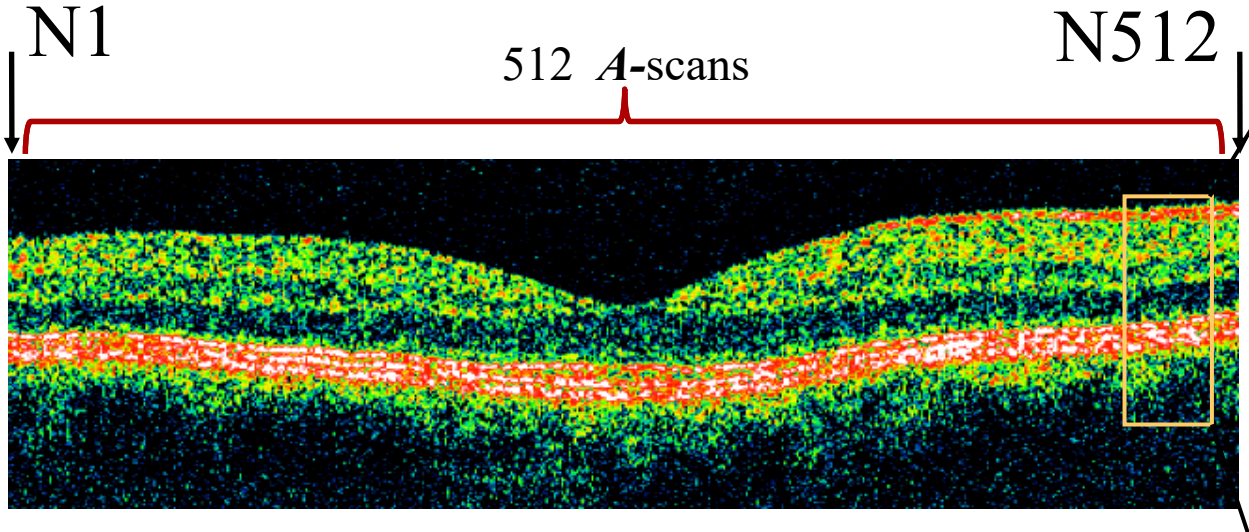
Résolution longitudinal *(A scan / B scan):* 128 → 4096

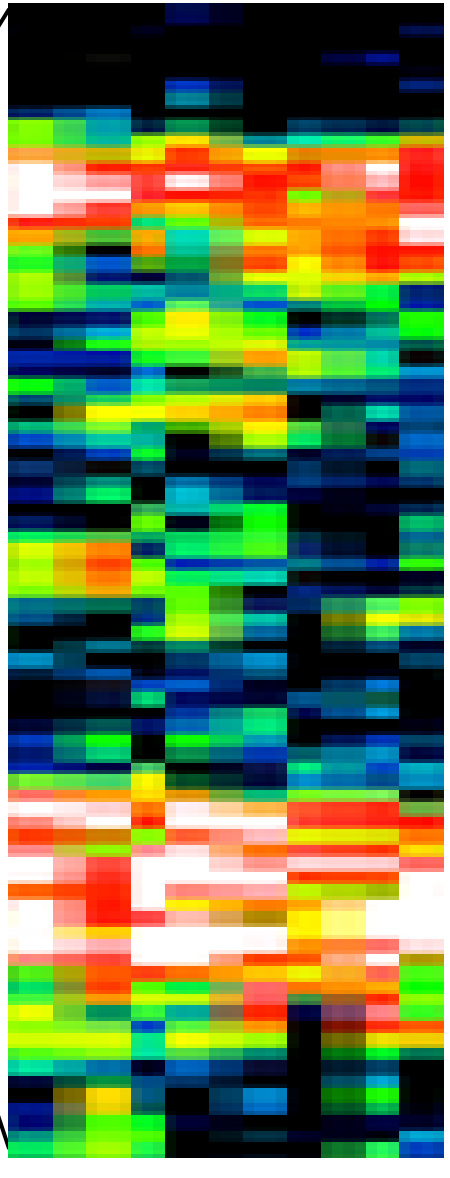


Enregistrement du signal de réfléxion sous forme de pics d'amplitude variable comparable à un

« écho A » (on utilise la lumière et non les Ultrasons) → **A-Scan**

OCT 3

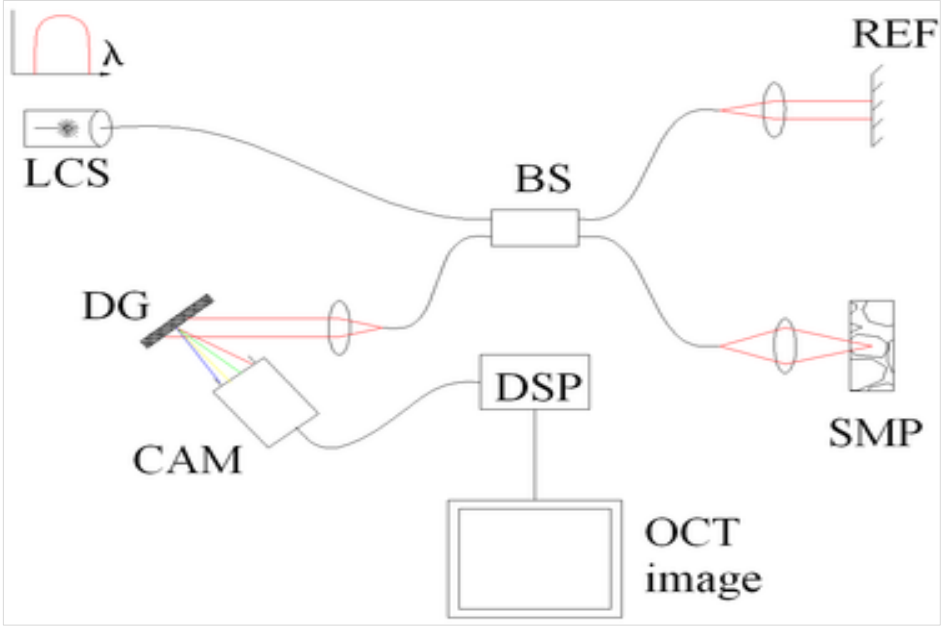


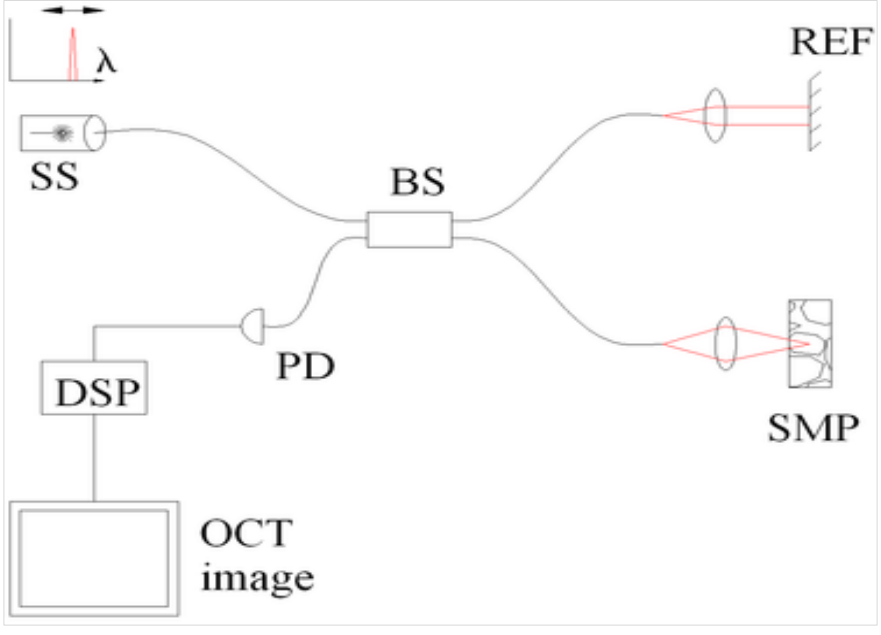


- L'image en OCT3 est composée de 512 (résolutions à 128 & 256 possibles) ***A***-scans successifs en 1,28 sec

- Résolution longitudinale d'environ 8-10µm

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)

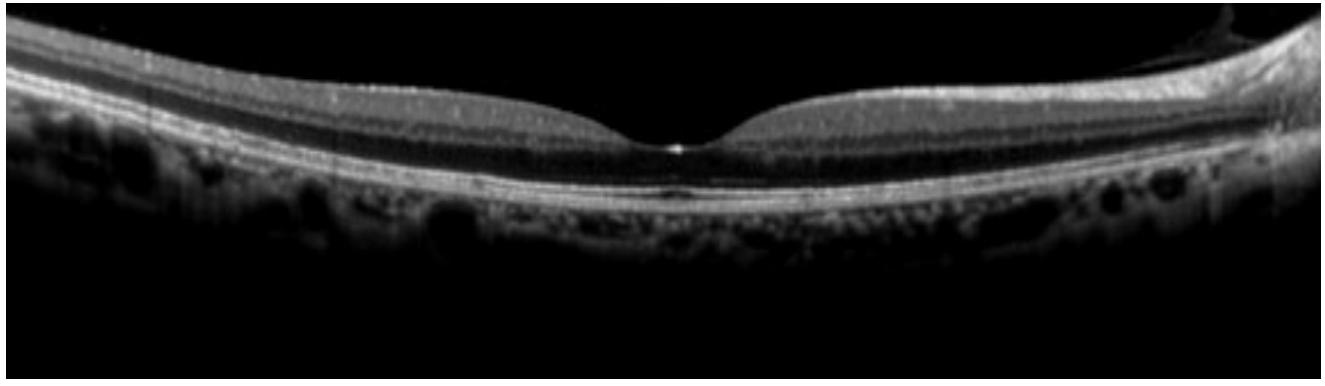
Spectral discrimination by swept-source OCT. Components include: swept source or tunable laser (SS), beamsplitter (BS), reference mirror (REF), sample (SMP), photodetector (PD), digital signal processing (DSP)

SD-OCT & SS-OCT

- Vitesse d'acquisition
  - 80 000 à 100 000 A-scans/sec
  - 100 000 à 200 000 pour le SS-OCT

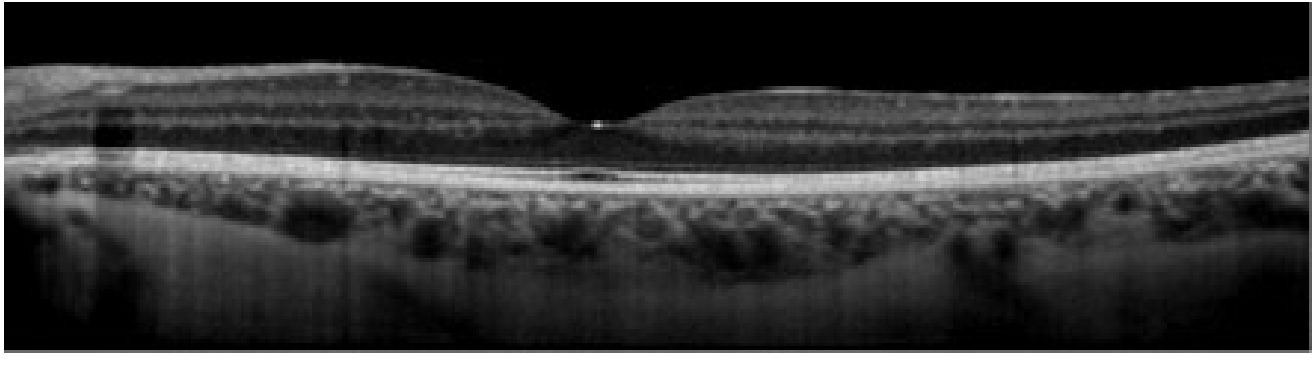
- Résolution axiale
  - 5-7 µm
  - 6,3 µm le SS-OCT (Cirrus)

- Meilleure résolution longitudinale (A scan / B scan)
  - 128 lignes x 512 pts (Cirrus)
  - 400 lignes x 400 pts (Optovue)

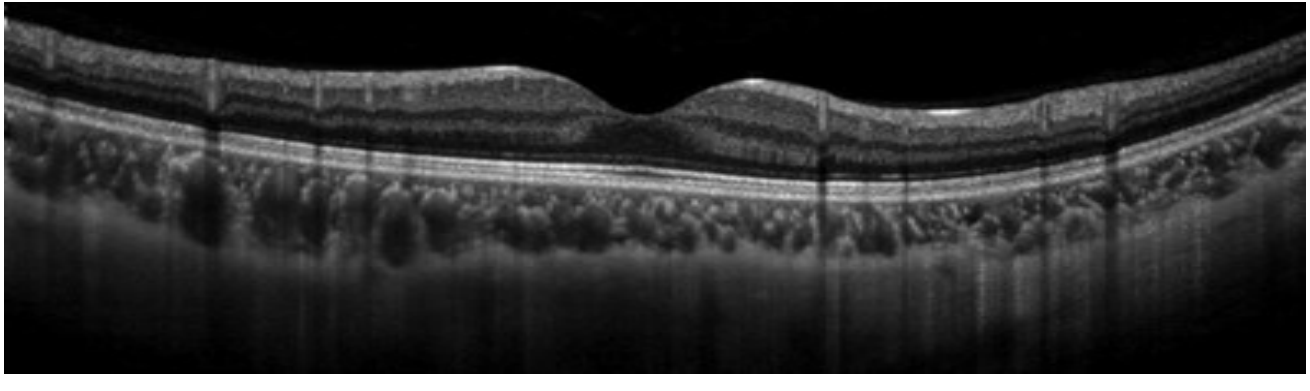


OCT Spectral

820 -880 nm
50.000 scans/s



OCT spectral- MODE EDI

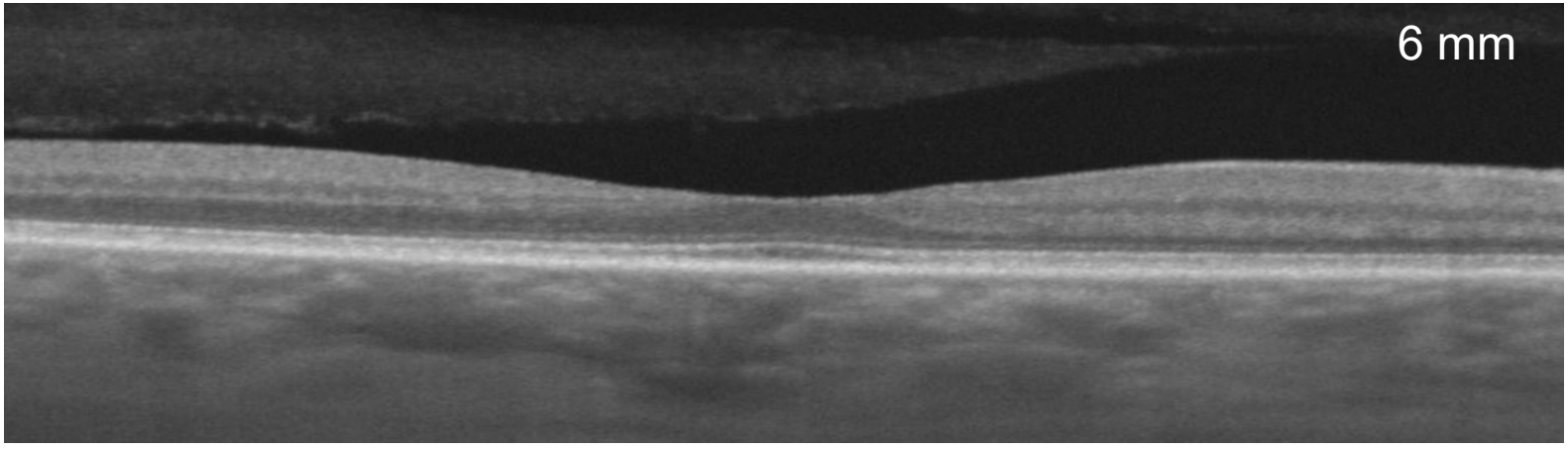


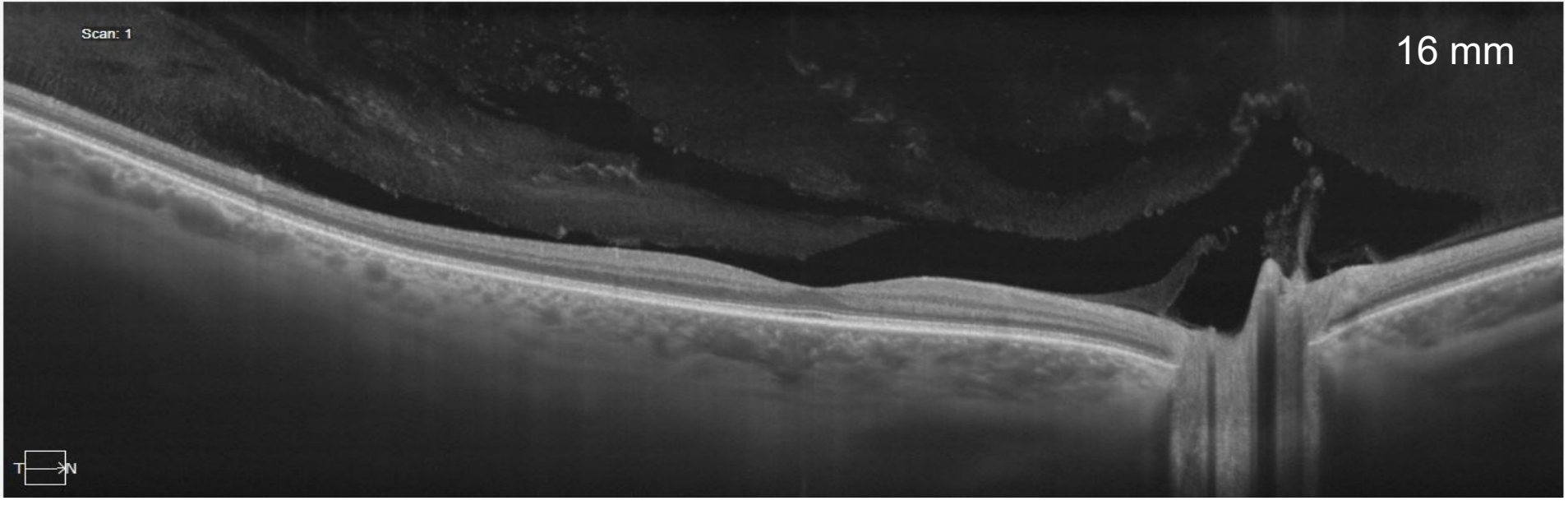
Swept Source OCT

1050 nm

100.000 scans/s

Topcon


6 mm


Scan: 1
16 mm
T
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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.

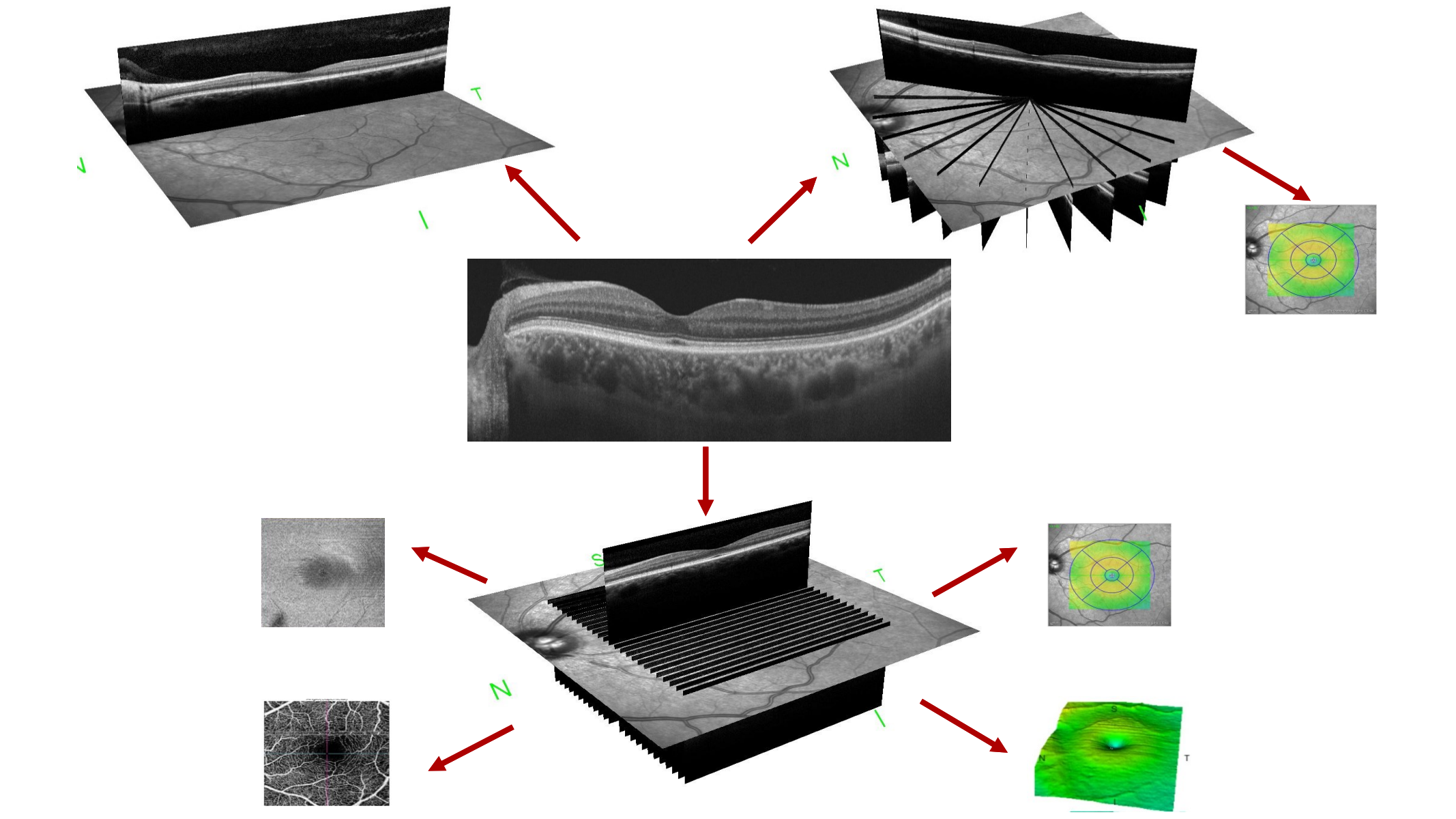
• L'examen OCT de type B doit être complet dans toutes les fenêtres, sans données manquantes.

• La densité des couleurs devrait être le 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.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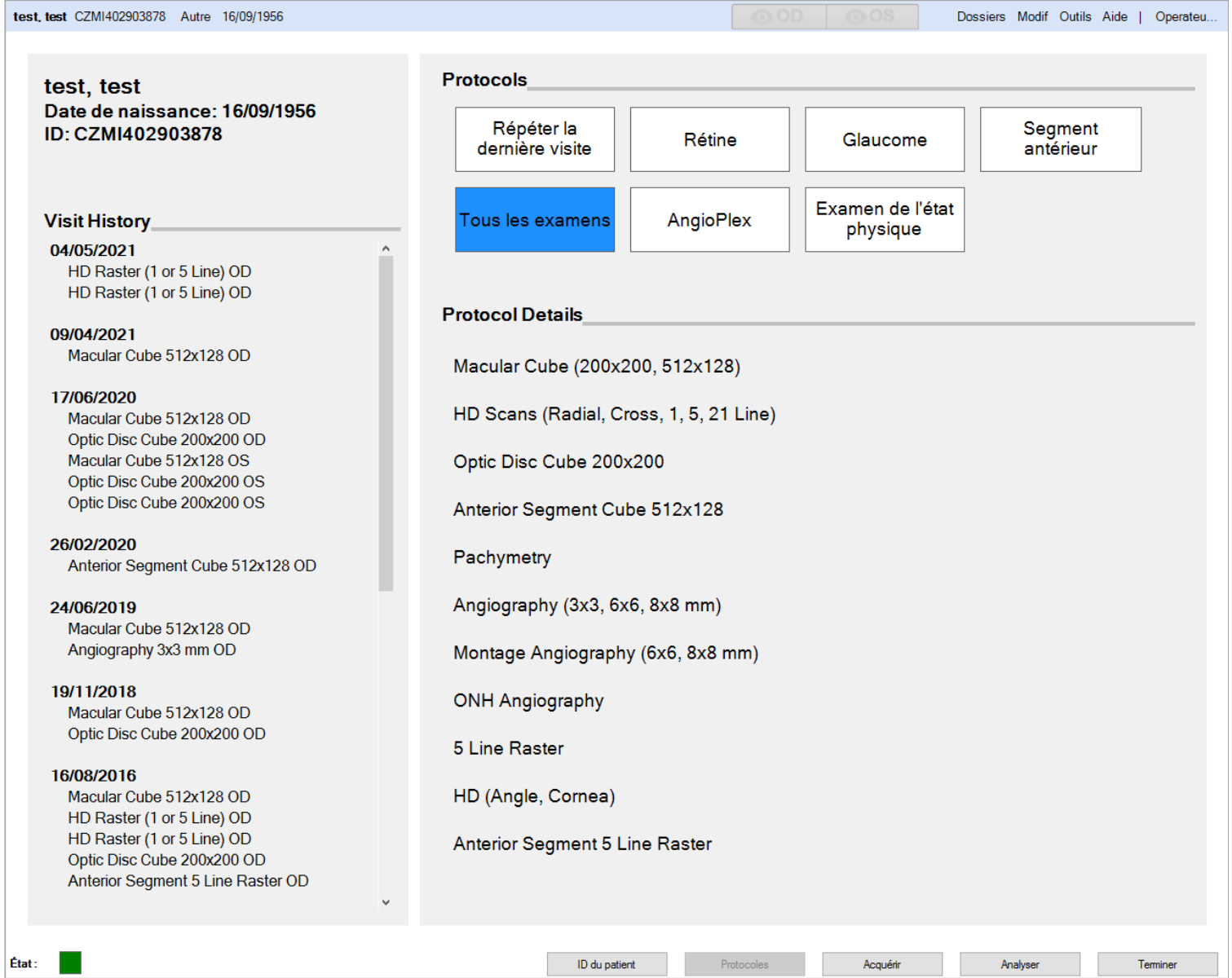
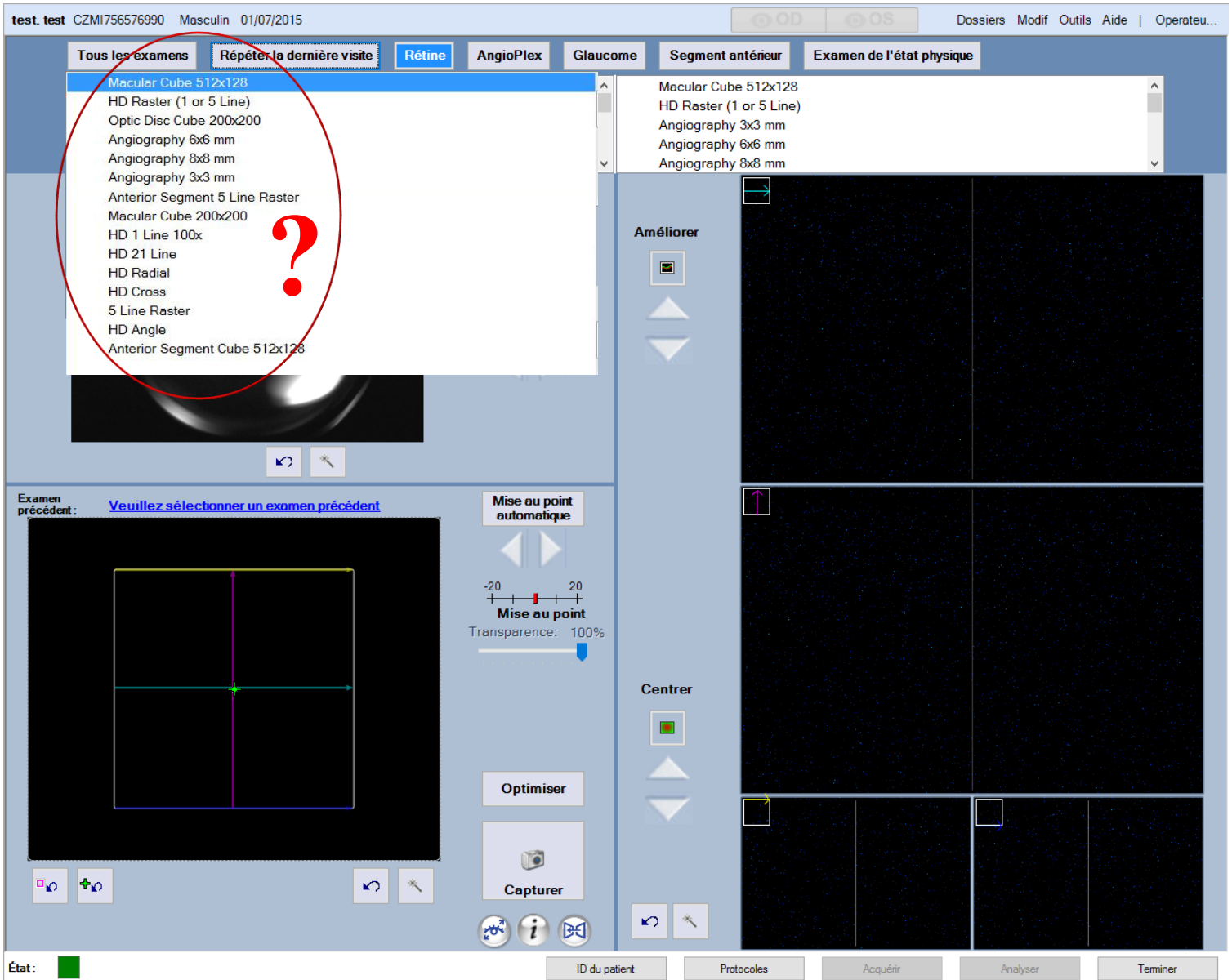
CIRRUS HD-OCT *(Zeiss)*

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

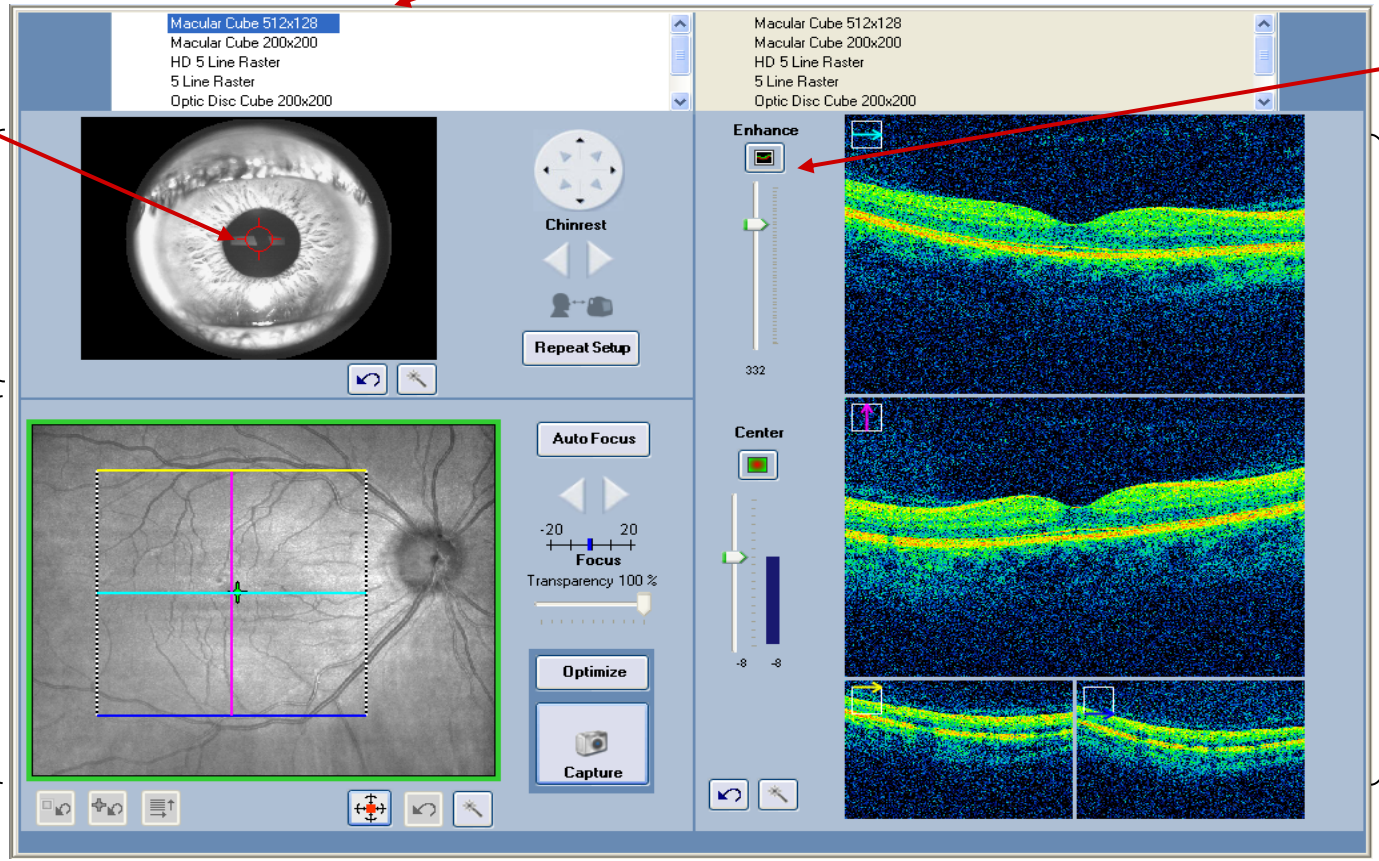
Image FO: SLO
Source optique : superluminescent diode (SLD), 840 nm
Puissance optique: < 725 µW à lacornée
Vitesse d'examen: 100,000 A-scans per second
Profondeur A-scan : 2.0 mm (dans les tissus), 1024 points
Résolution axiale : 5µm (dans les tissus)
Résolution transversale: 15 µm (in tissue)
Champs de vision: 36 degrees W x 30 degrees H
FastTrac™ ++

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 CZMI402903878 Autre 16/09/1956
OD OS
Dossiers Modif Outils Aide | Operateu...
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
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
État :
ID du patient
Protocoles
Acquérir
Analyser
Terminer


test, test CZMI756576990 Masculin 01/07/2015
OD OS
Dossiers Modif Outils Aide | Operateu...
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
Examen précédent :
Veuillez sélectionner un examen précédent
Mise au point automatique
-20
20
Mise au point
Transparence: 100%
Centrer
Optimiser
Capturer
État :
ID du patient
Protocoles
Acquérir
Analyser
Terminer

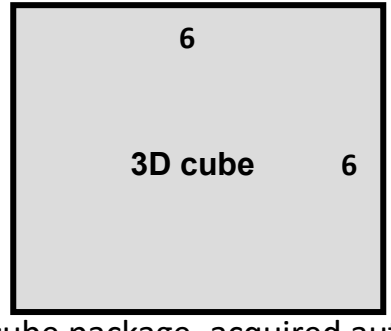
Fenêtre d'acquisition pour Macular Cube *(CIRRUS 5000)*

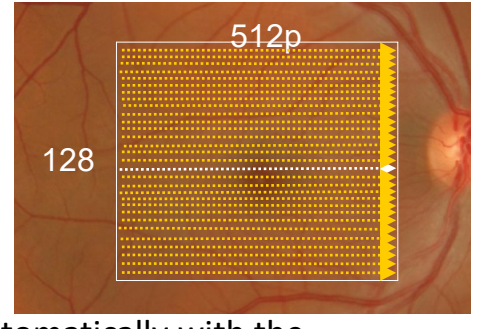


La taille minimale de pupille est 2mm

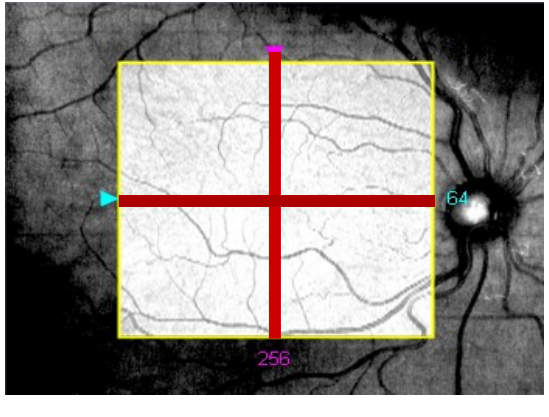
Protocole d'acquisition pour Cube Maculaire *(CIRRUS 5000)*

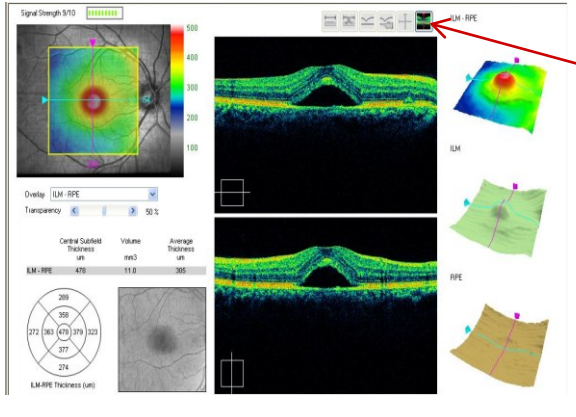
- **Macular Cube (*3D-Scan*)** – génère deux types de scans :
  - **Cube Scan 6mm x 6 mm**
    - 128 B-scans **X** 512 A-scans
    - 200 B-scans X 200 A-scans





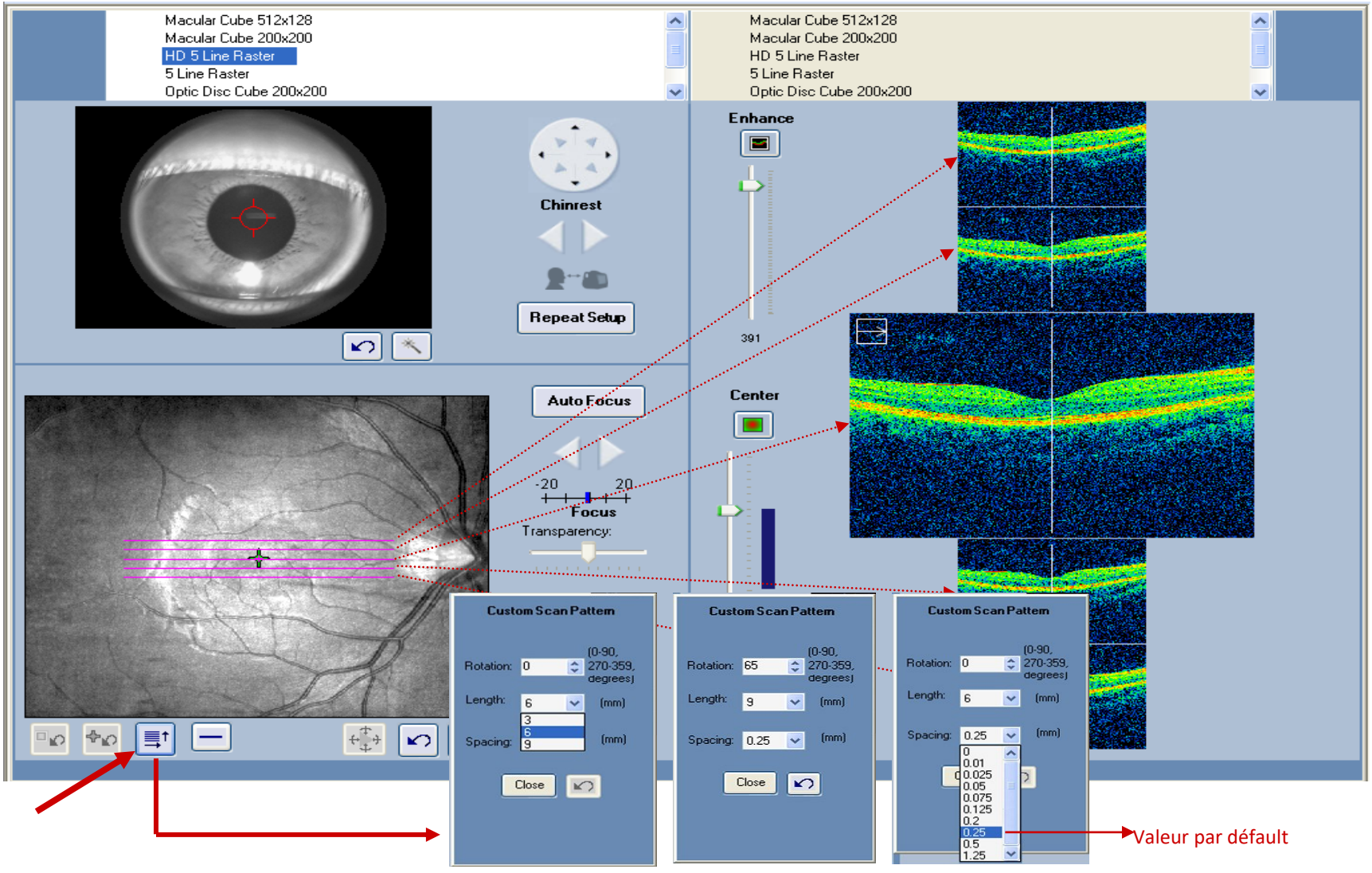
  - **HD Cross Hair Scan**
    - 2 B-scans of 1024 A-scans each (part of the cube package, acquired automatically with the Macula Cube – do not need to be acquired separately) for Macular Cube 512x128

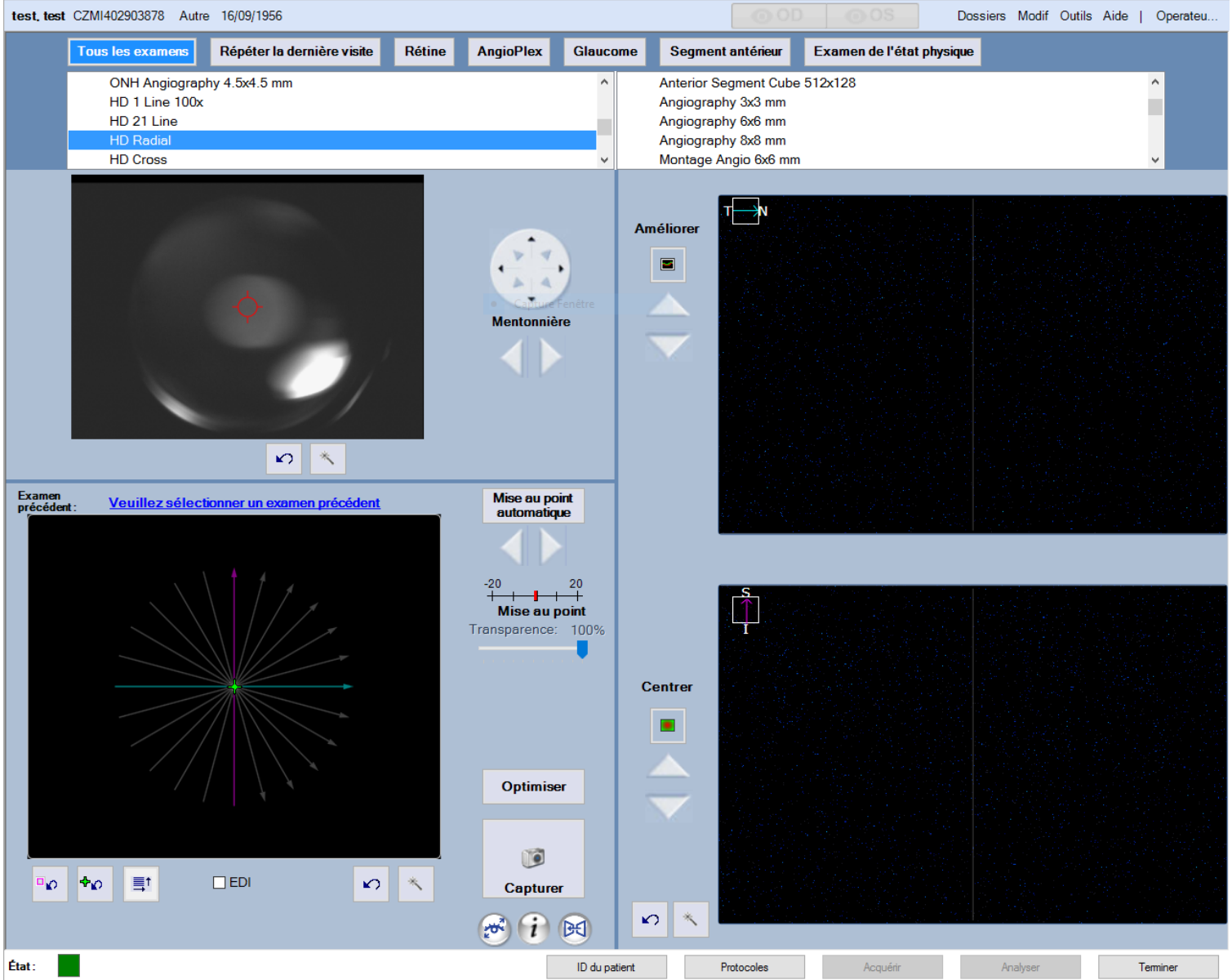




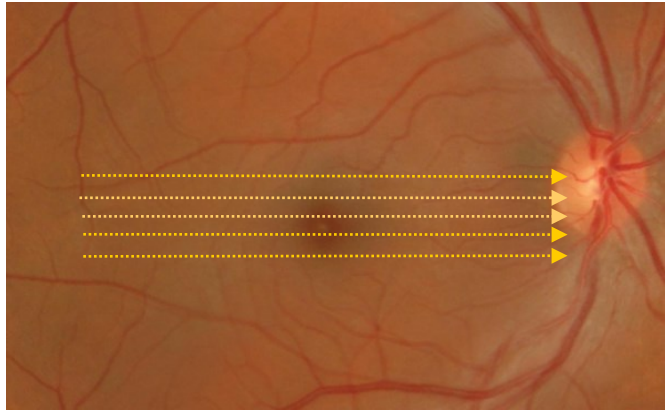
Click on icon to toggle between HD-Cross hair and standard view

Fenêtre d'acquisition pour Line Raster *(CIRRUS 5000)*




test, test CZMI402903878 Autre 16/09/1956
OD OS
Dossiers Modif Outils Aide | Operateu...
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
Améliorer
T
N
Examen précédent :
Veuillez sélectionner un examen précédent
Mise au point automatique
-20
20
Mise au point
Transparence: 100%
S
I
Centrer
EDI
Optimiser
Capturer
État :
ID du patient
Protocoles
Acquérir
Analyser
Terminer

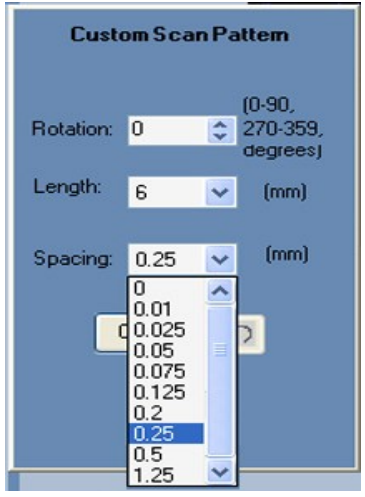
Protocole d’acquisition pour Line Raster



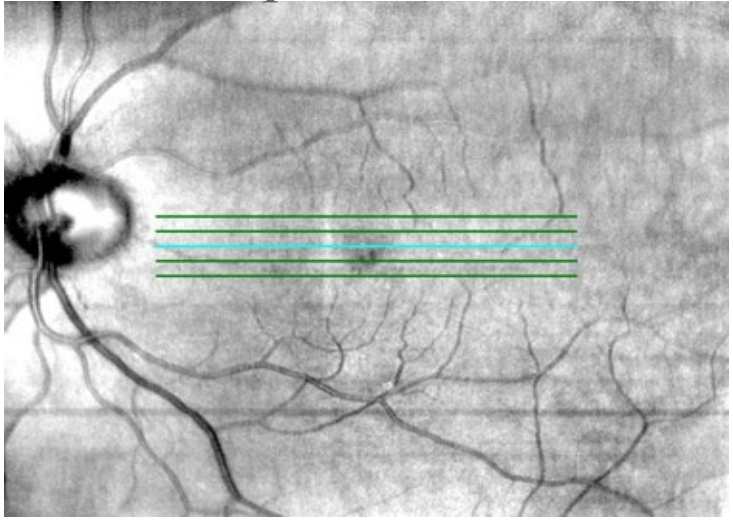
- **5 Line-Raster**
  - **5 Line-Raster**
    - Rotation : 0°- 360°
    - Longeur: 3.0 - 6.0 – 9.0 mm, 4096 A-scans
    - Espacement (mm) : 0.025, 0.05, 0.075, 0.125, 0.2, **0.25**, 0.5,1.25
  - **HD 5 Line-Raster** (5x1024 A-scans)
  - **HD 1 Line-Raster 20x** (20x1024 A-scans)

L’espacement des lignes

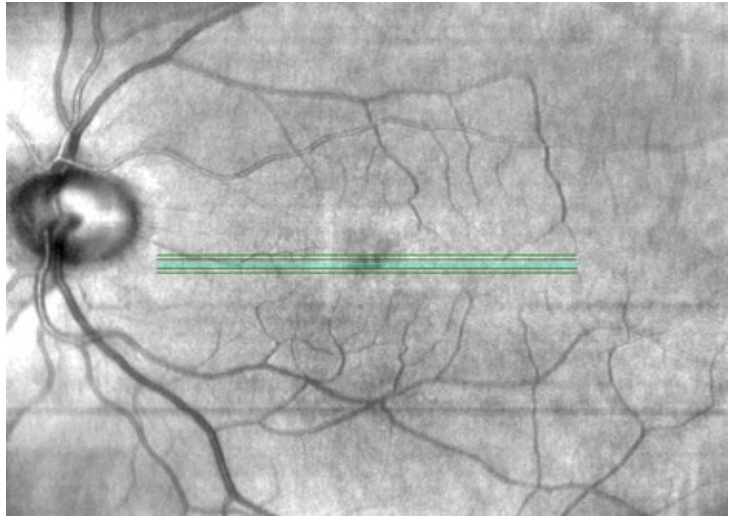
0.25 mm ? **0.075 mm**



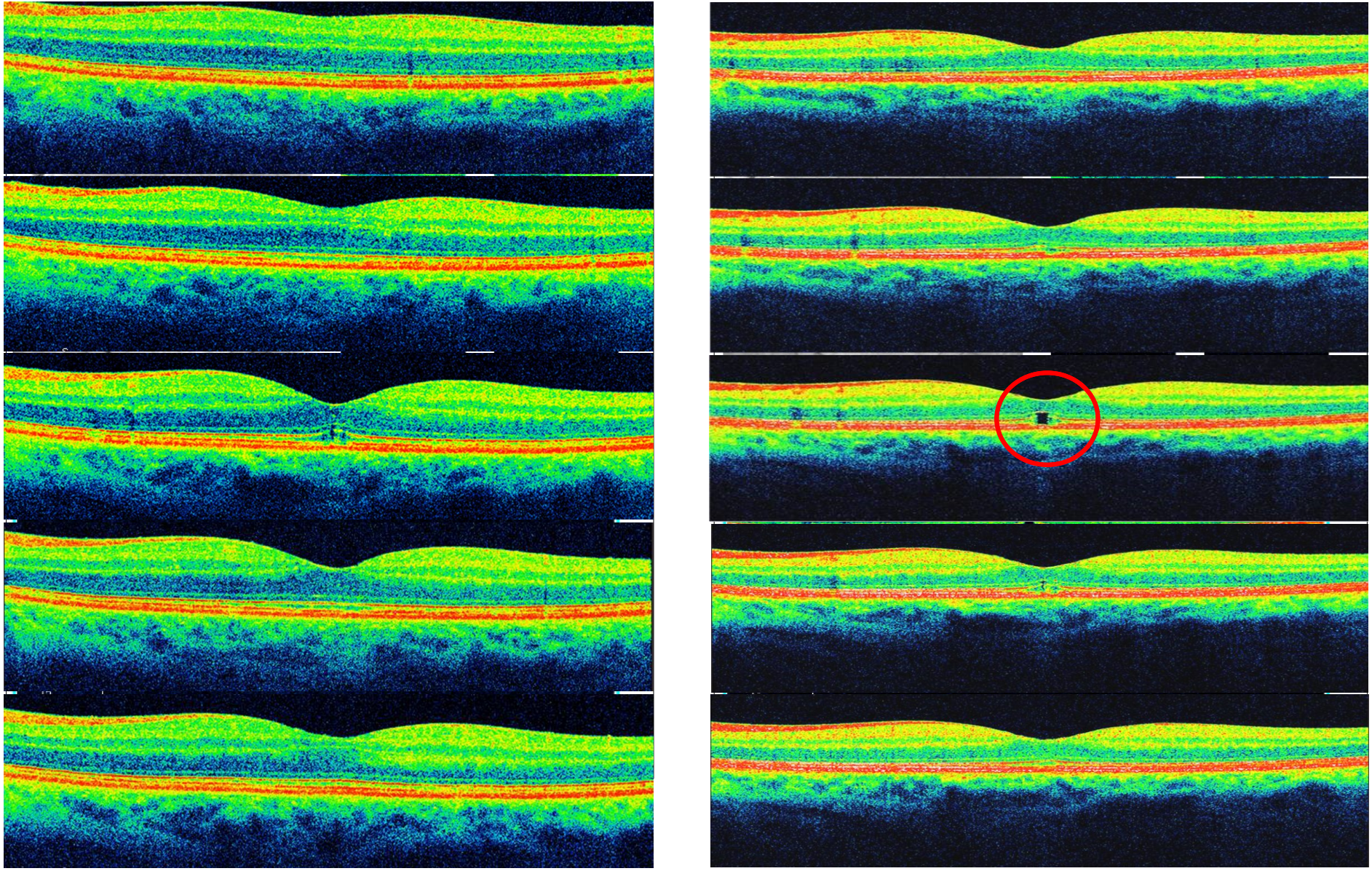
Valeur par défault

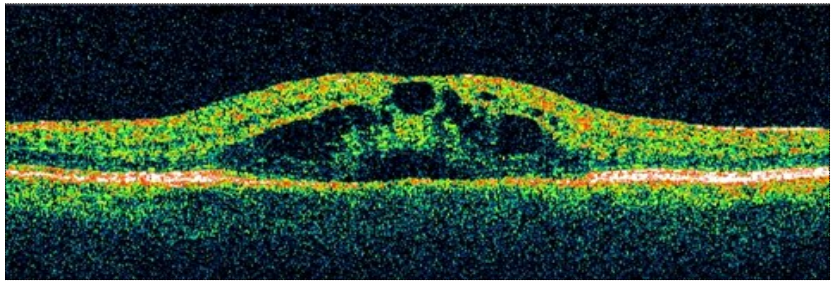


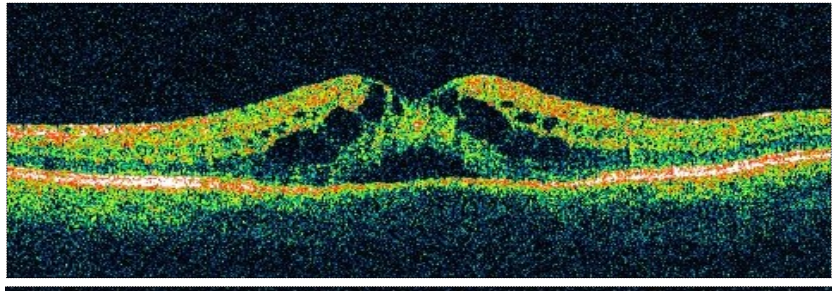
4 x 0.25 : 1 mm *(1000µ)*

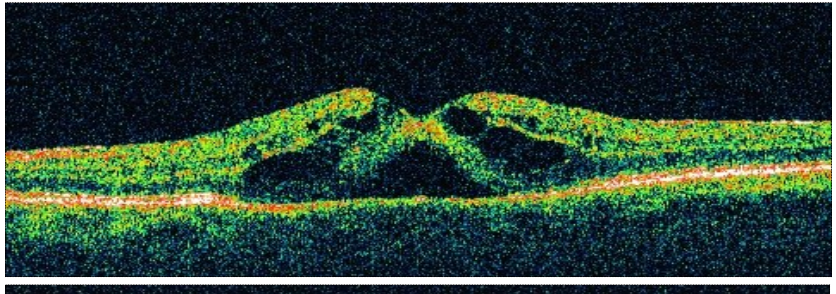


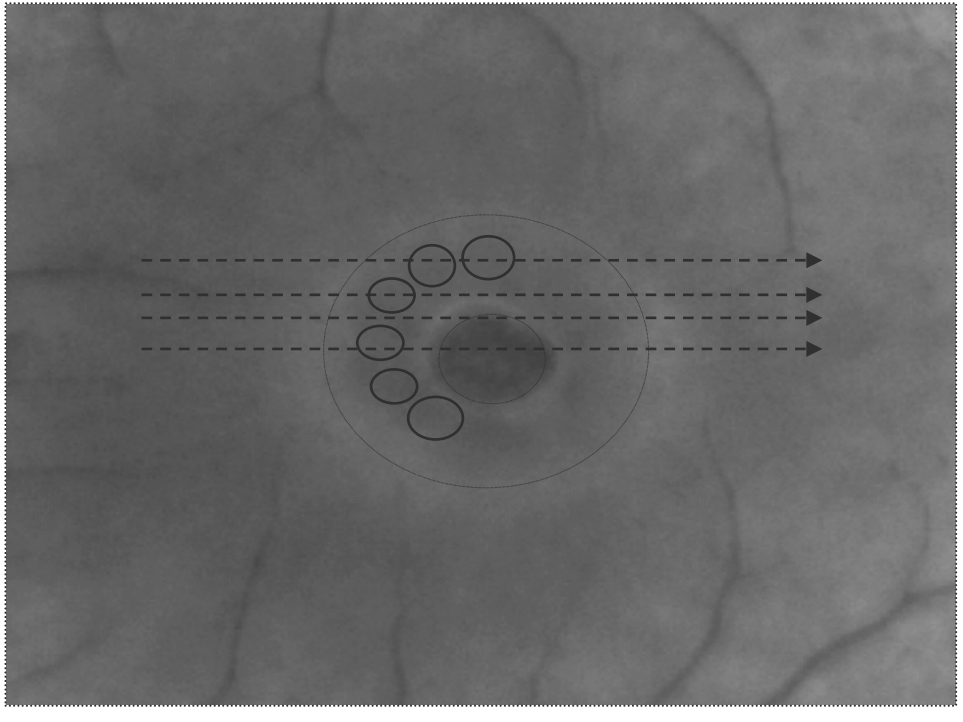
4 x 0.075 : 0.3 mm *(300µ)*











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*)

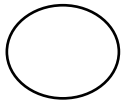
Résolution numérique (µm) : 3.8 axial x 6 latéral
Résolution optique (µm) : 7 axial x 14 latéral
Diamètre pupillaire minimum : *2.5 mm*

Vitesse de balayage : 80 000 A scan / sec

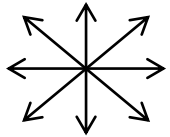
Cibles de fixation : interne et externe

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

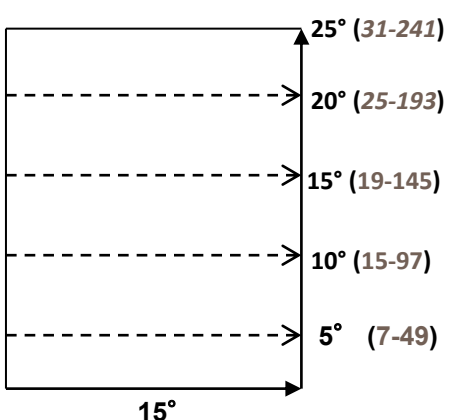
Model de scan circulaire :
•Taille de l'image (pixels) : (1535 x 496)
•Temps d'acquisition mini (ms): 52

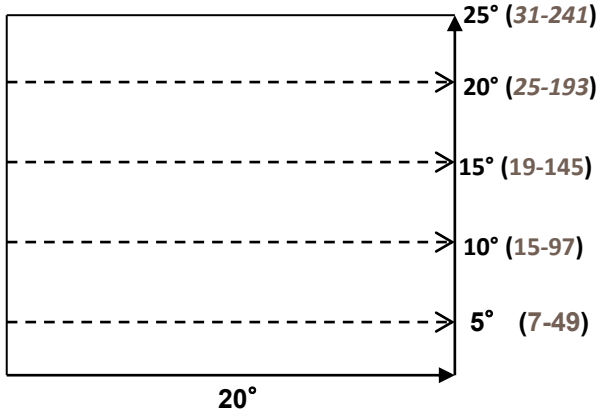


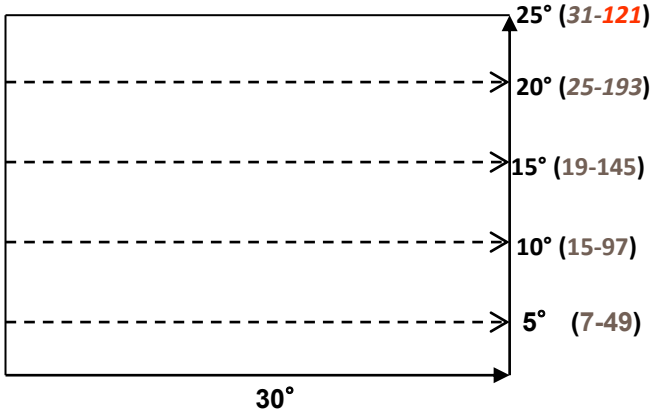
Model de scan en étoile :
•Diamèter (°) : 30/ 20/ 15
•Nombre de coupes : 48 / 24 / 12 / 6 / 4 / 2

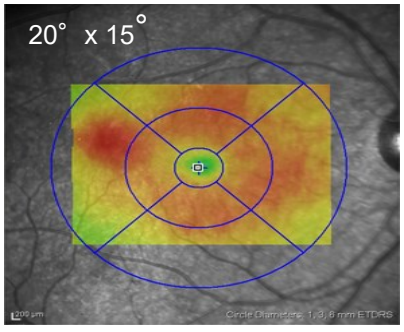


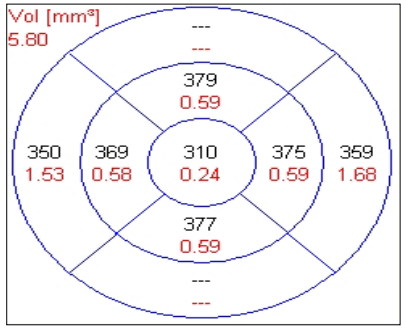
Model de scan en volume :
•Etendu horizontal (°) : 30 / 20 / 15
•Etendu vertical (°) : 25 / 20 / 15 / 10 / 5
•Nombre de coupes par scan de volume : 7 à 241 (240µm à 30µm)



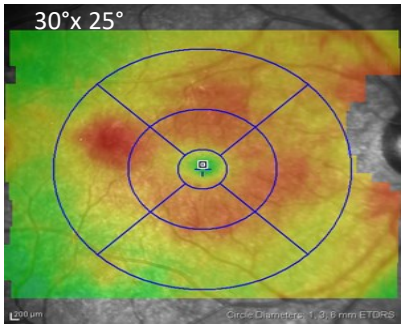


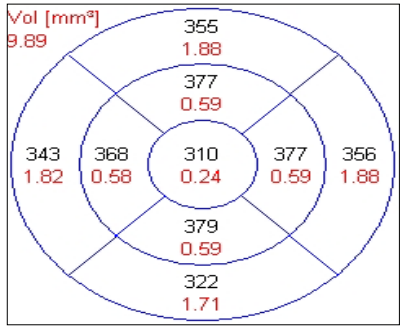


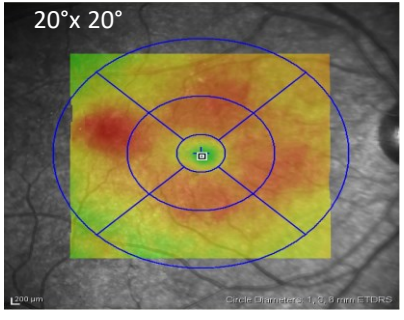

20° x 15°

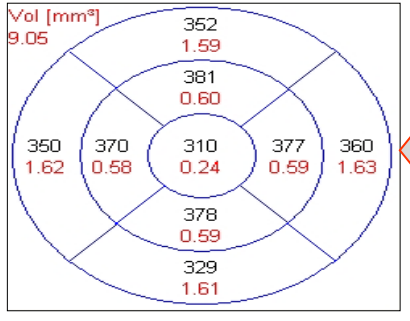

Vol [mm³]
5.80

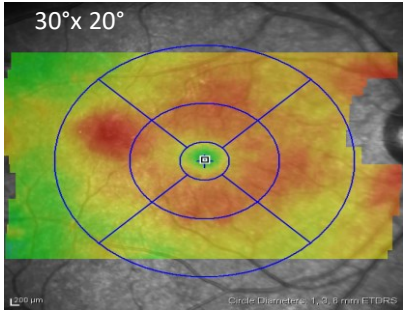
379
0.59
350
1.53
369
0.58
310
0.24
375
0.59
359
1.68
377
0.59

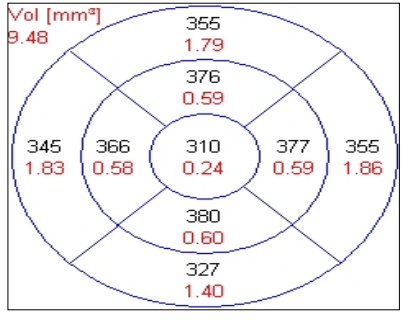

30°x 25°

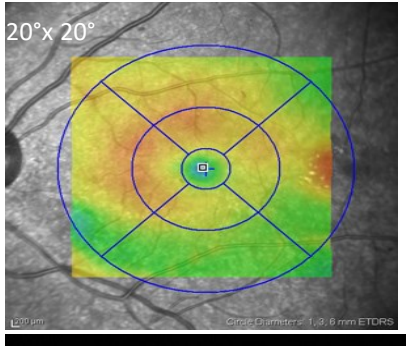

Vol [mm³]
9.89
355
1.88
377
0.59
343
1.82
368
0.58
310
0.24
377
0.59
356
1.88
379
0.59
322
1.71

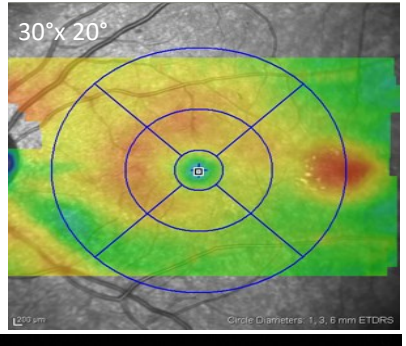

20°x 20°

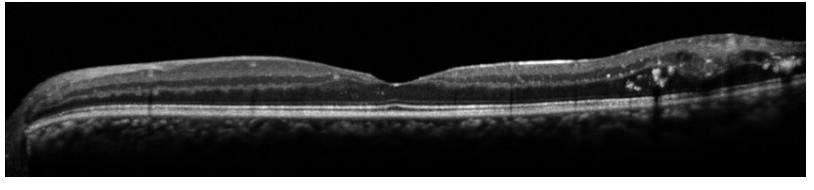

Vol [mm³]
9.05
352
1.59
381
0.60
350
1.62
370
0.58
310
0.24
377
0.59
360
1.63
378
0.59
329
1.61


30°x 20°

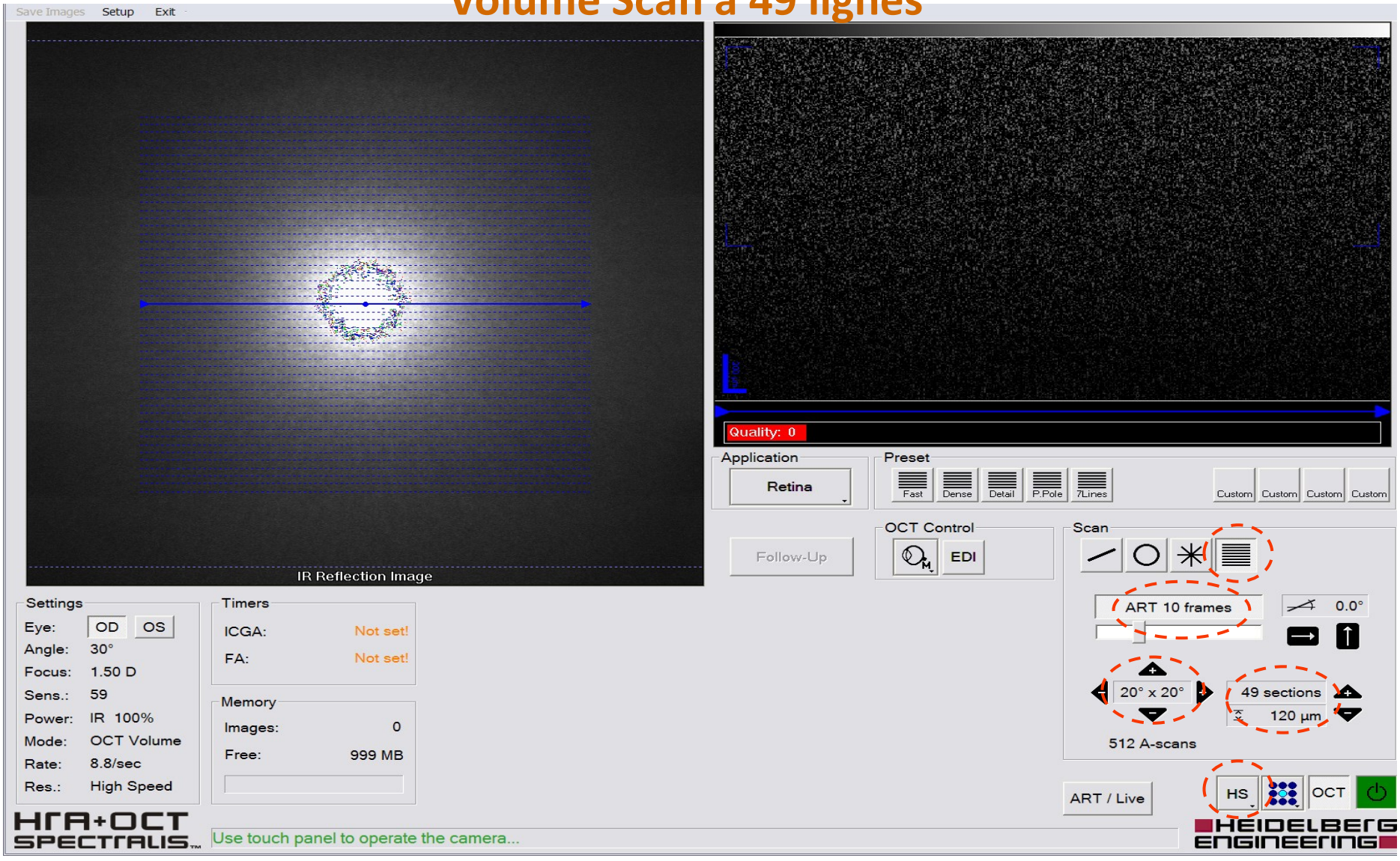

Vol [mm³]
9.48
355
1.79
376
0.59
345
1.83
366
0.58
310
0.24
377
0.59
355
1.86
380
0.60
327
1.40


20°x 20°

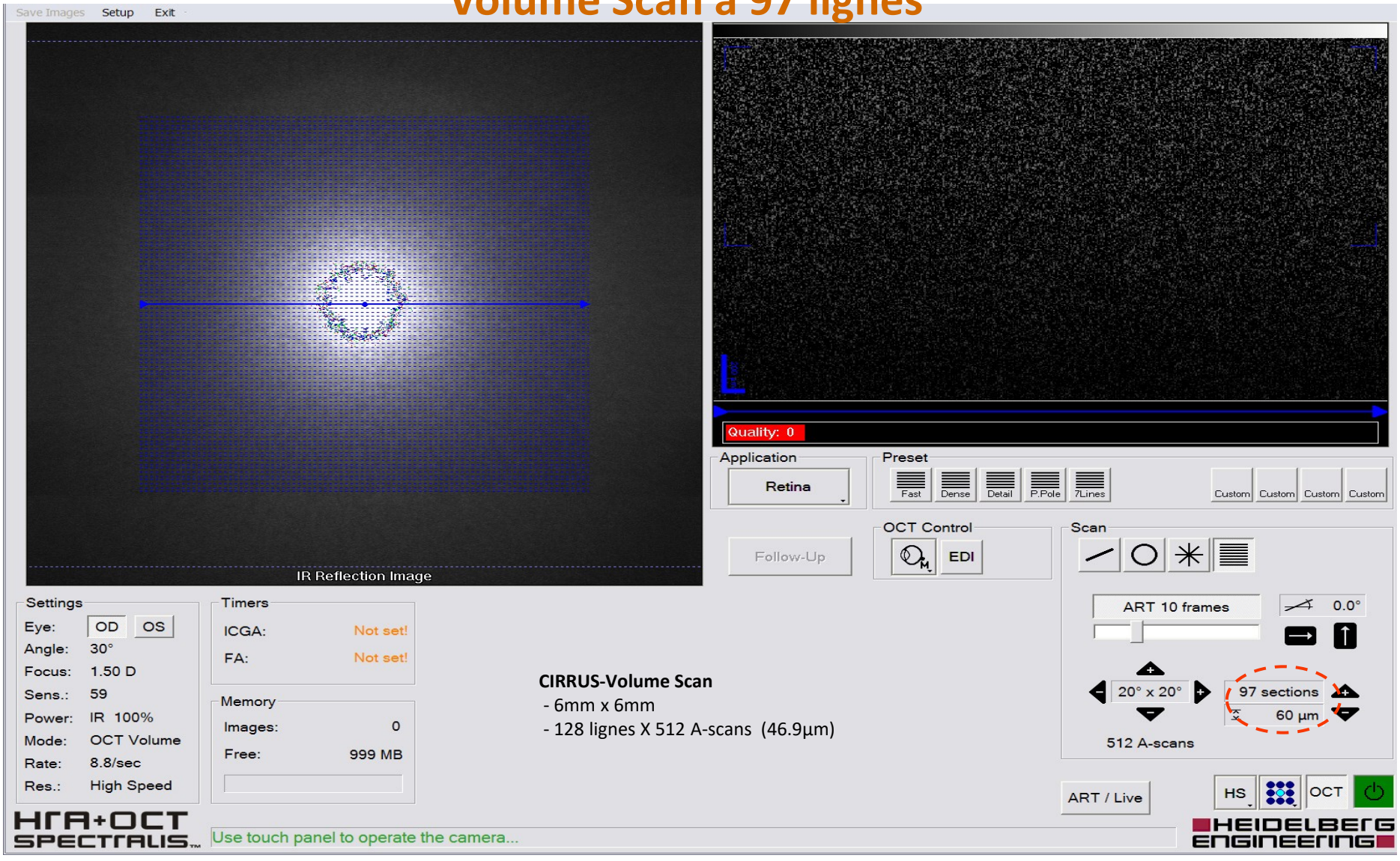

30°x 20°



Volume Scan à 49 lignes

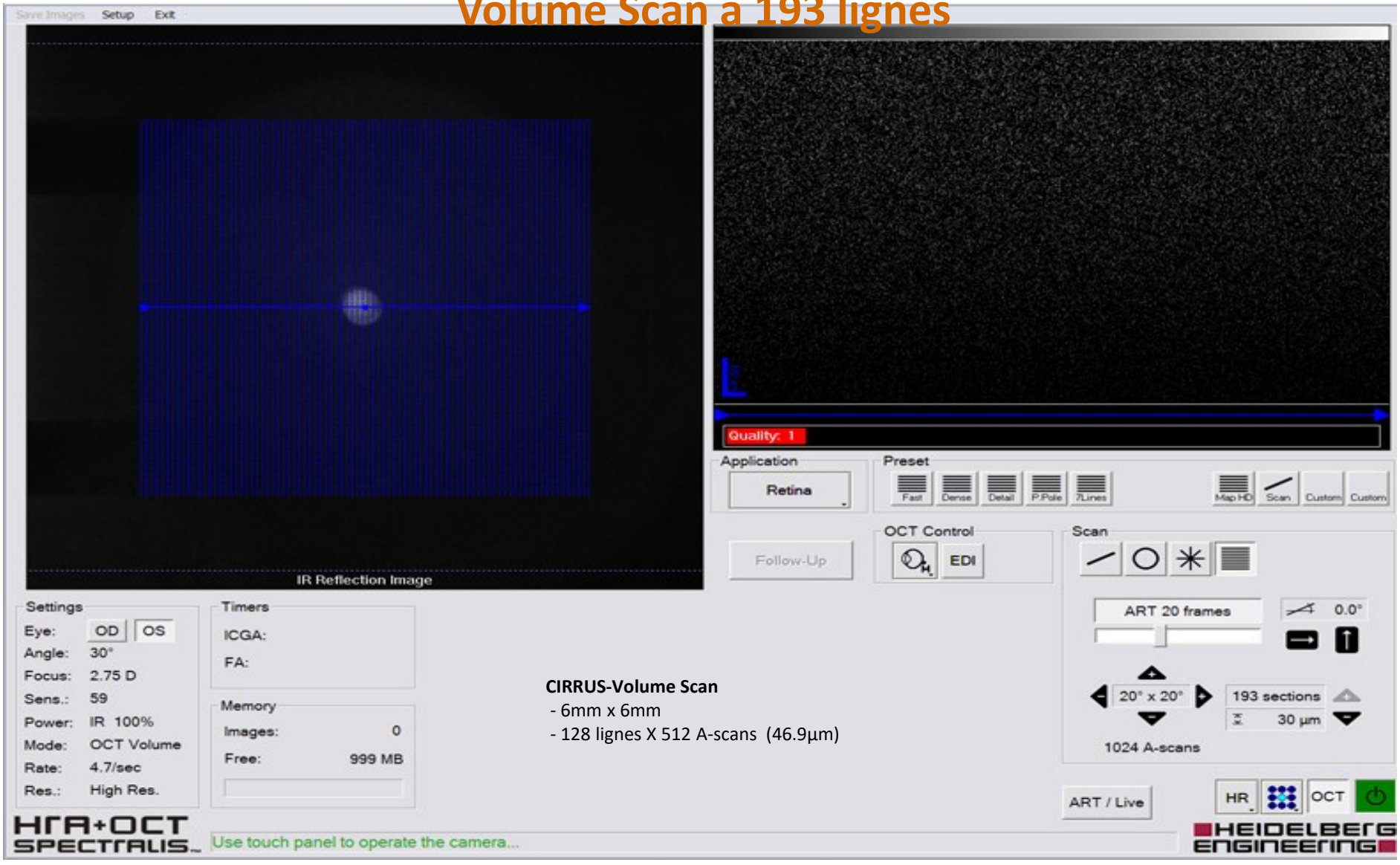


Volume Scan à 97 lignes

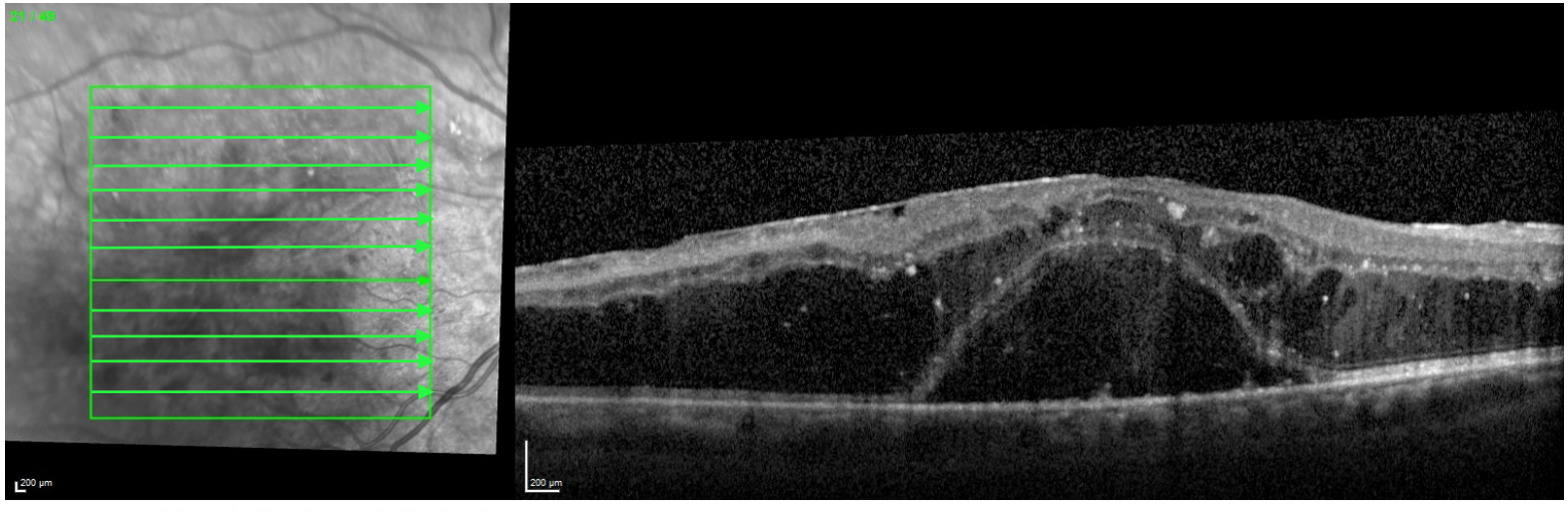


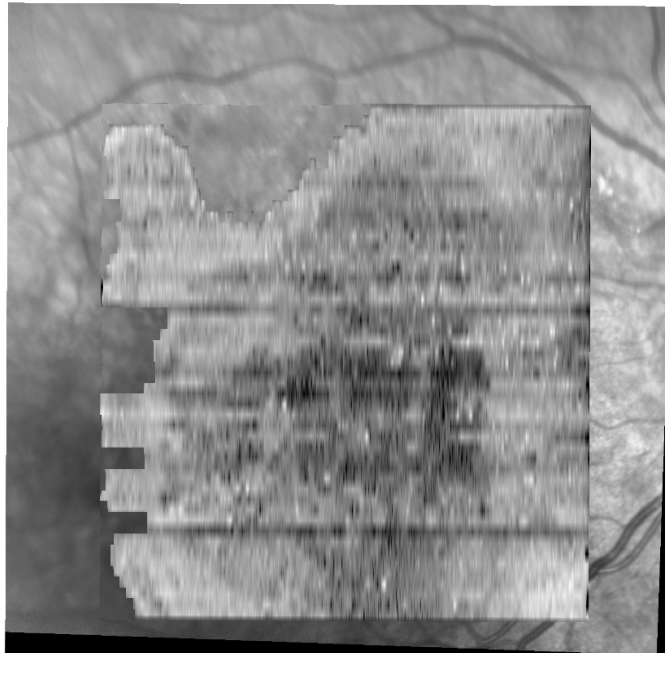
CIRRUS-Volume Scan
- 6mm x 6mm
- 128 lignes X 512 A-scans (46.9µm)

Volume Scan à 193 lignes

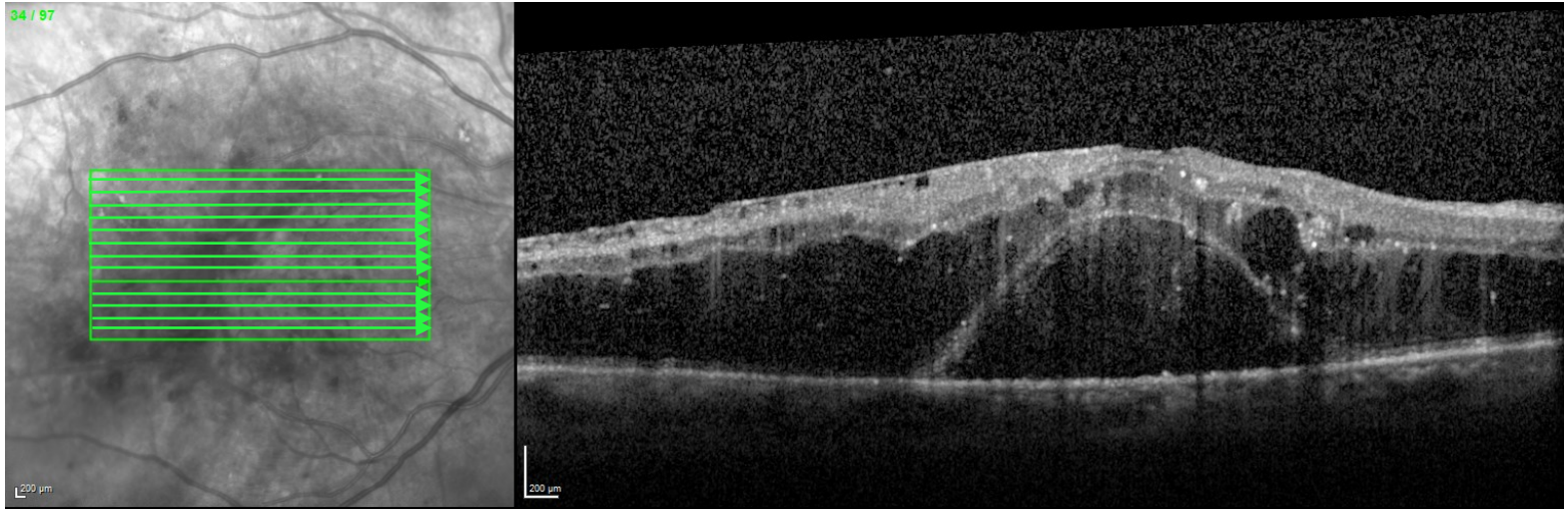


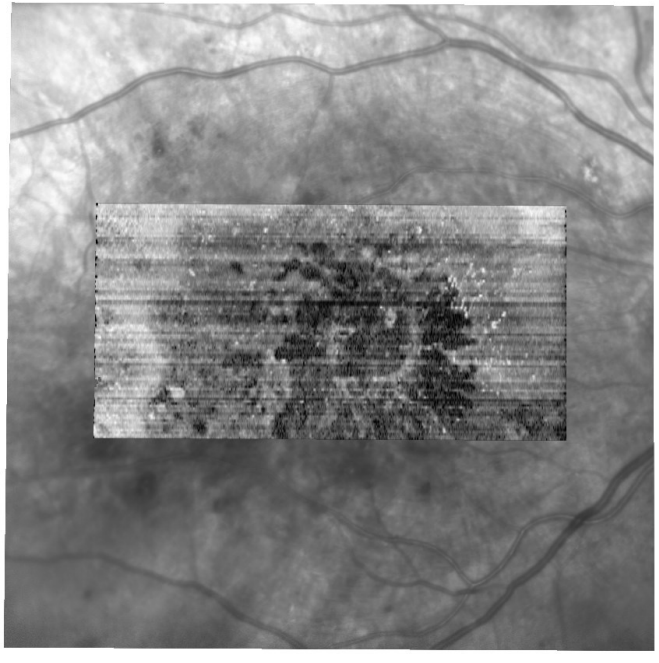
CIRRUS-Volume Scan
- 6mm x 6mm
- 128 lignes X 512 A-scans (46.9µm)



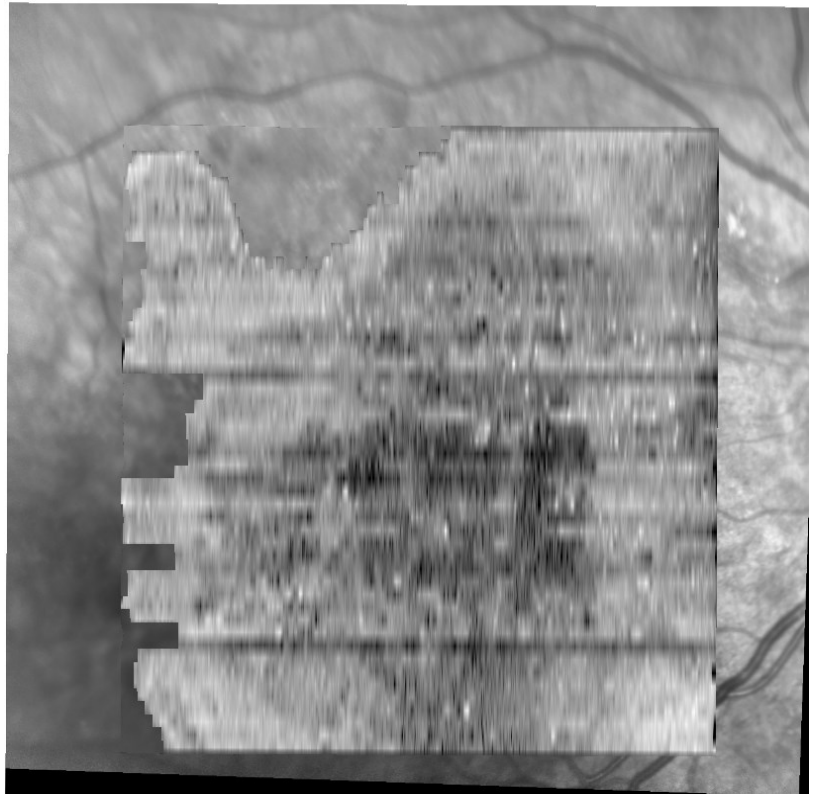


Number of B-scans : 49
Pattern Size : 20x20°(6,1 x 6,1 mm)
Distance between B-scans : 126 µm

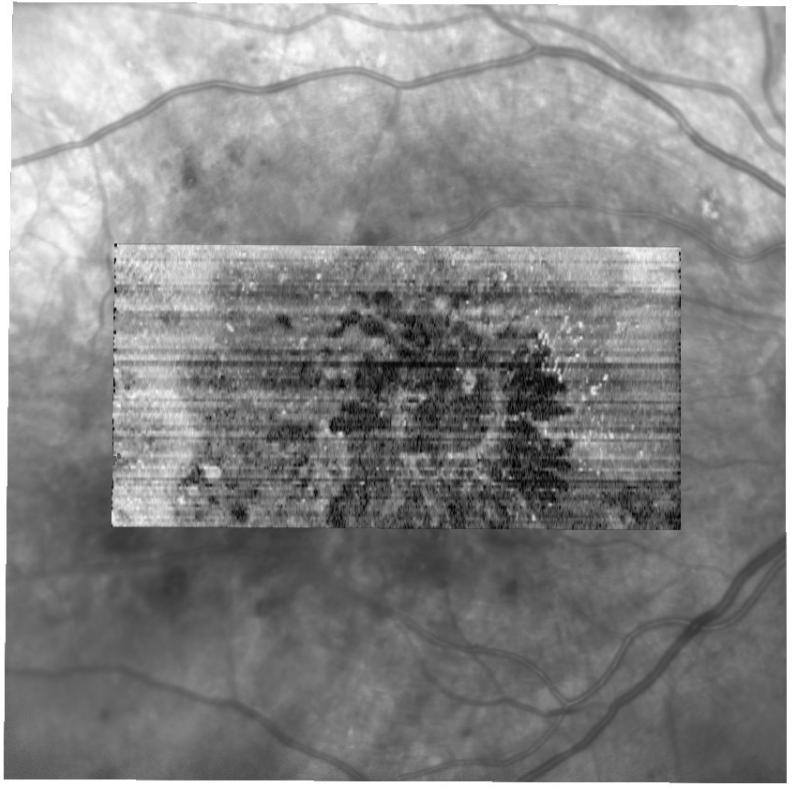




Number of B-scans : 97
Pattern Size : 20x1 0°(6,1 x 3,0 mm)
Distance between B-scans : 32 µm

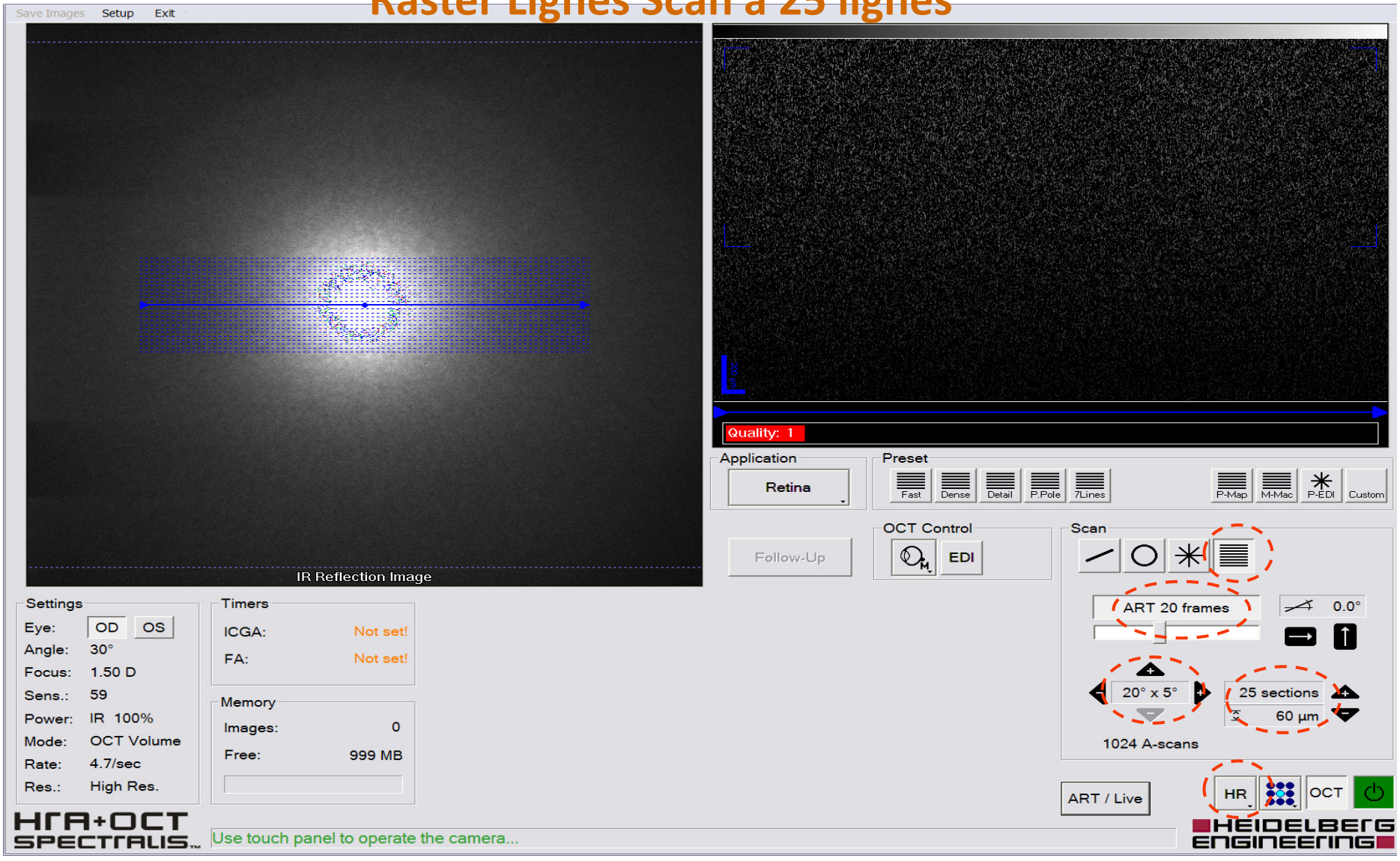


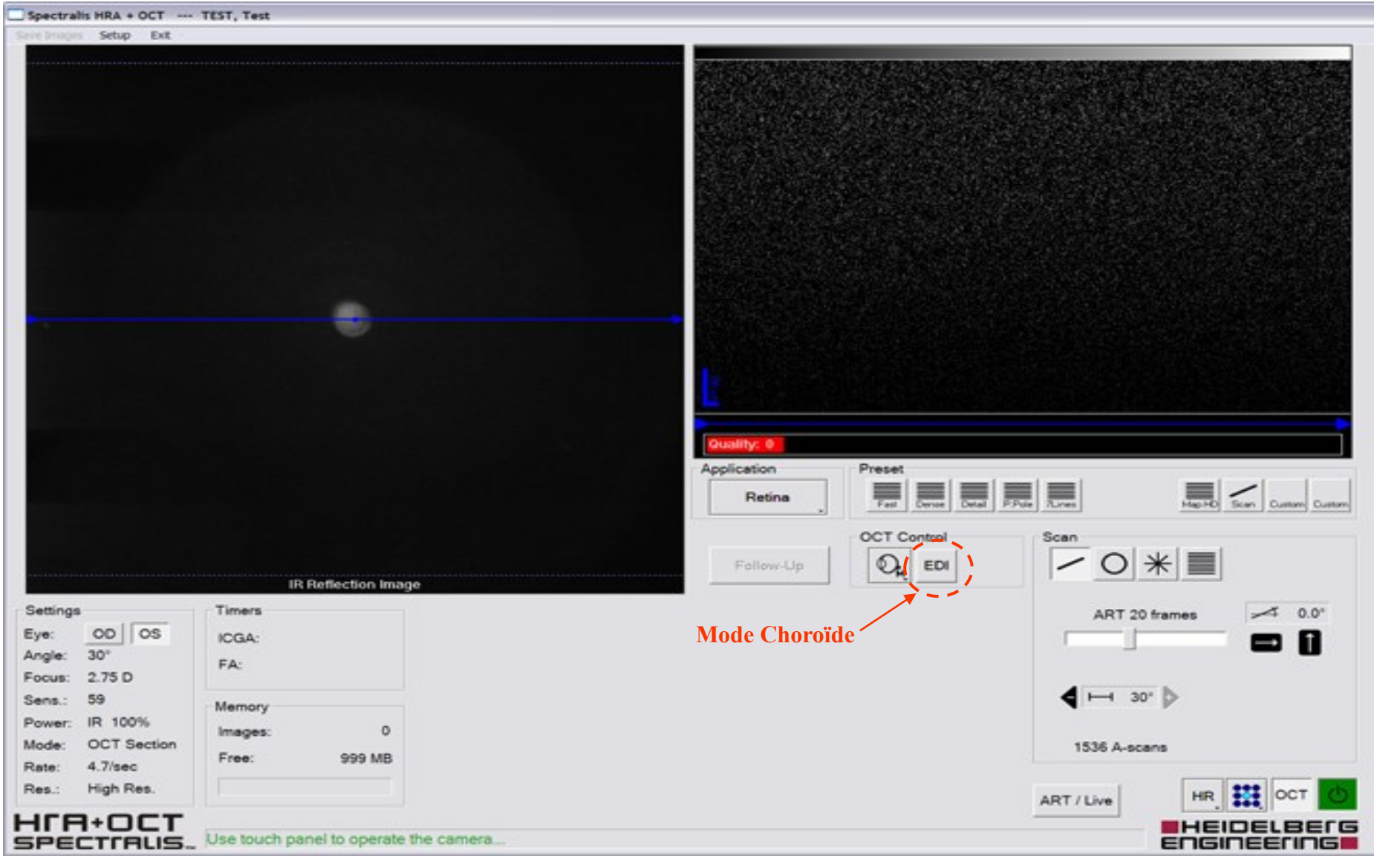
Number of B-scans : 49
Pattern Size : 20x20°(6,1 x 6,1 mm)
Distance between B-scans : 126 µm

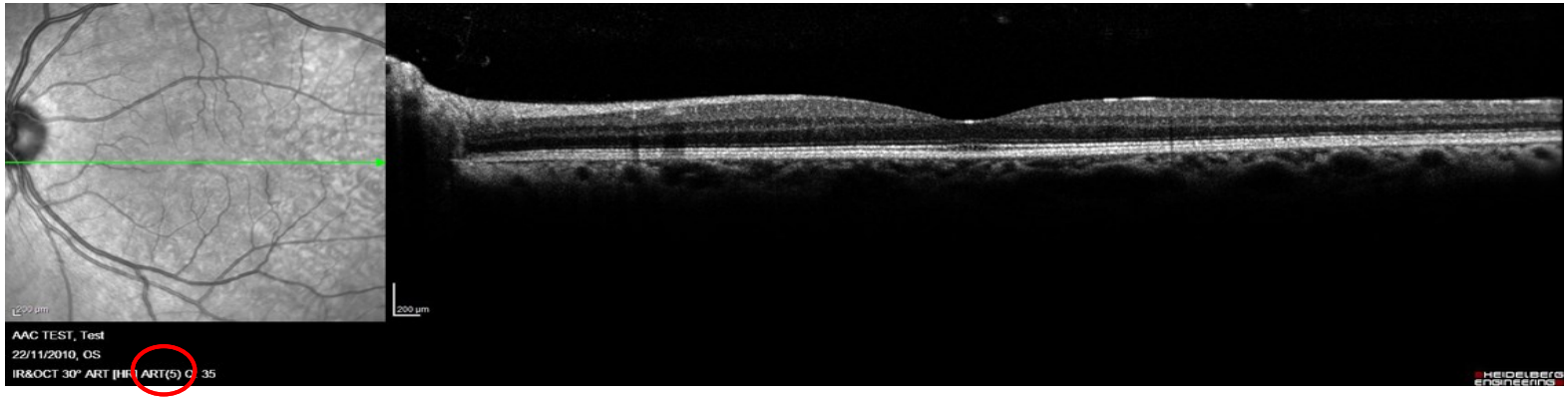


Number of B-scans : 97
Pattern Size : 20x1 0°(6,1 x 3,0 mm)
Distance between B-scans : 32 µm

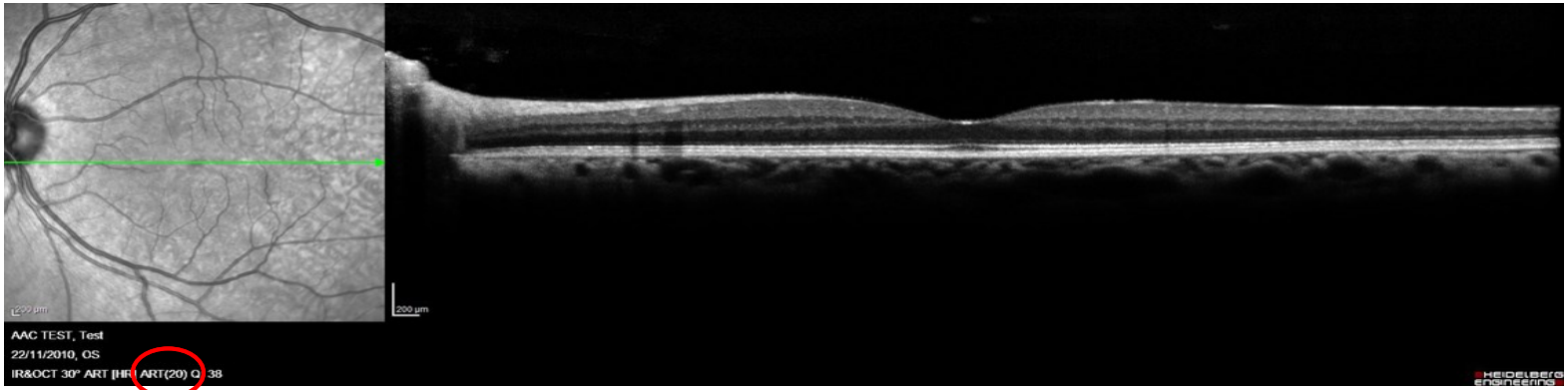
Raster Lignes Scan à 25 lignes

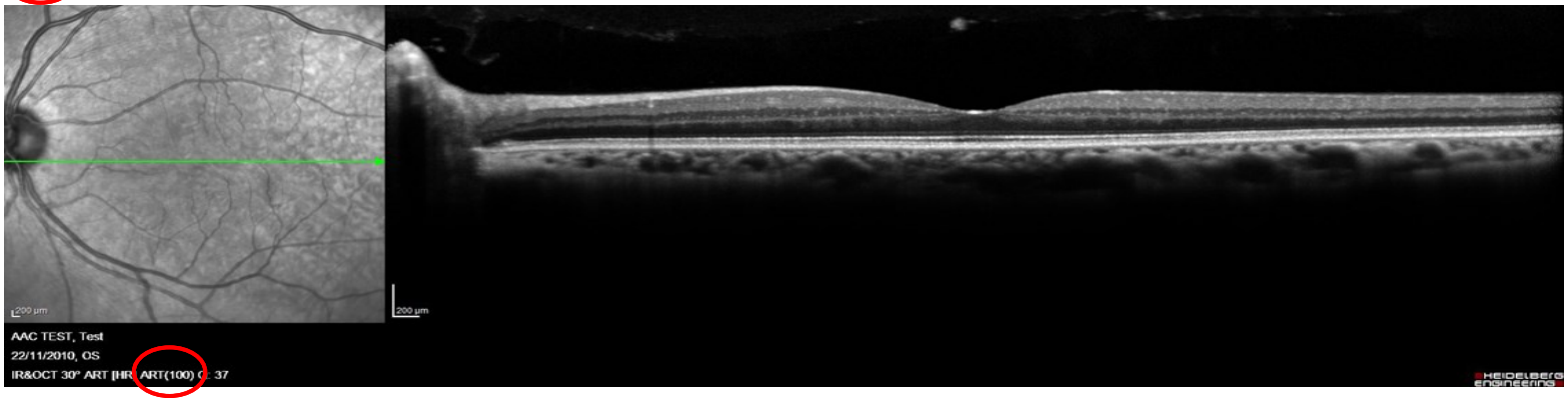


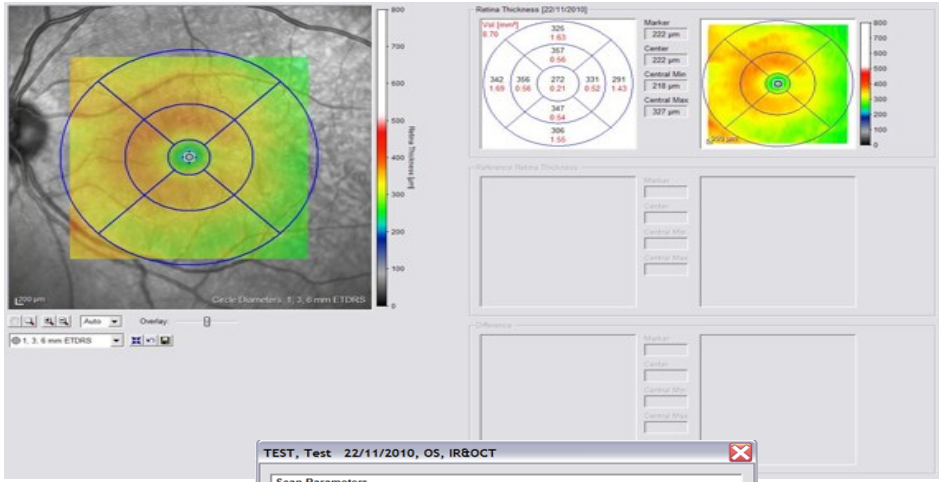

Spectralis HRA + OCT --- TEST, Test
Save Images
Setup
Exit
IR Reflection Image
Quality:
Application
Retina
Preset
Fast
Dense
Detail
P.Pole
7Lines
Map HD
Scan
Custom
Custom
Follow-Up
OCT Control
EDI
Scan
Mode Choroïde
ART 20 frames
0.0°
30°
1536 A-scans
Settings
Eye:
OD
OS
Angle:
30°
Focus:
2.75 D
Sens.:
59
Power:
IR 100%
Mode:
OCT Section
Rate:
4.7/sec
Res.:
High Res.
Timers
ICGA:
FA:
Memory
Images:
0
Free:
999 MB
ART / Live
HR
OCT
HRA+OCT
SPECTRALIS
Use touch panel to operate the camera...
HEIDELBERG
ENGINEERING


200 µm
AAC TEST, Test
22/11/2010, OS
IR&OCT 30° ART [HR] ART(5)

ART ?


200 µm
AAC TEST, Test
22/11/2010, OS
IR&OCT 30° ART [HR] ART(20)

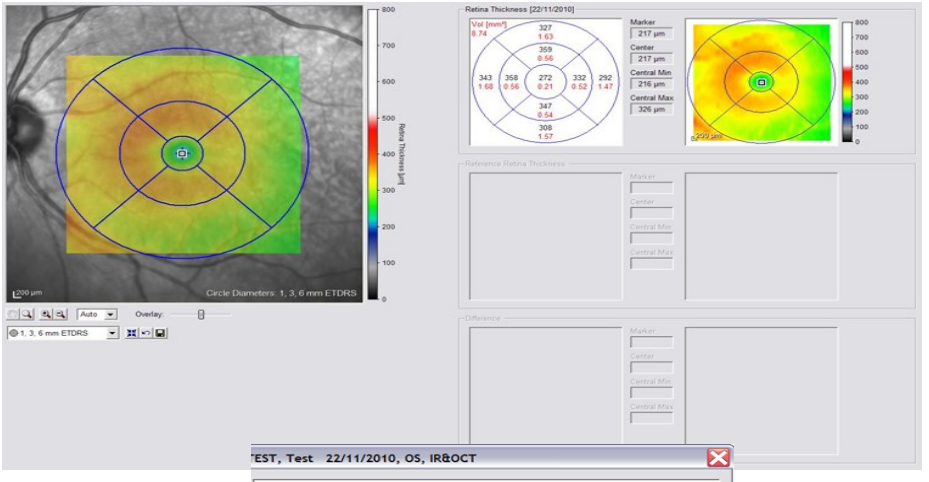

200 µm
AAC TEST, Test
22/11/2010, OS
IR&OCT 30° ART [HR] ART(100)



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	3.87 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

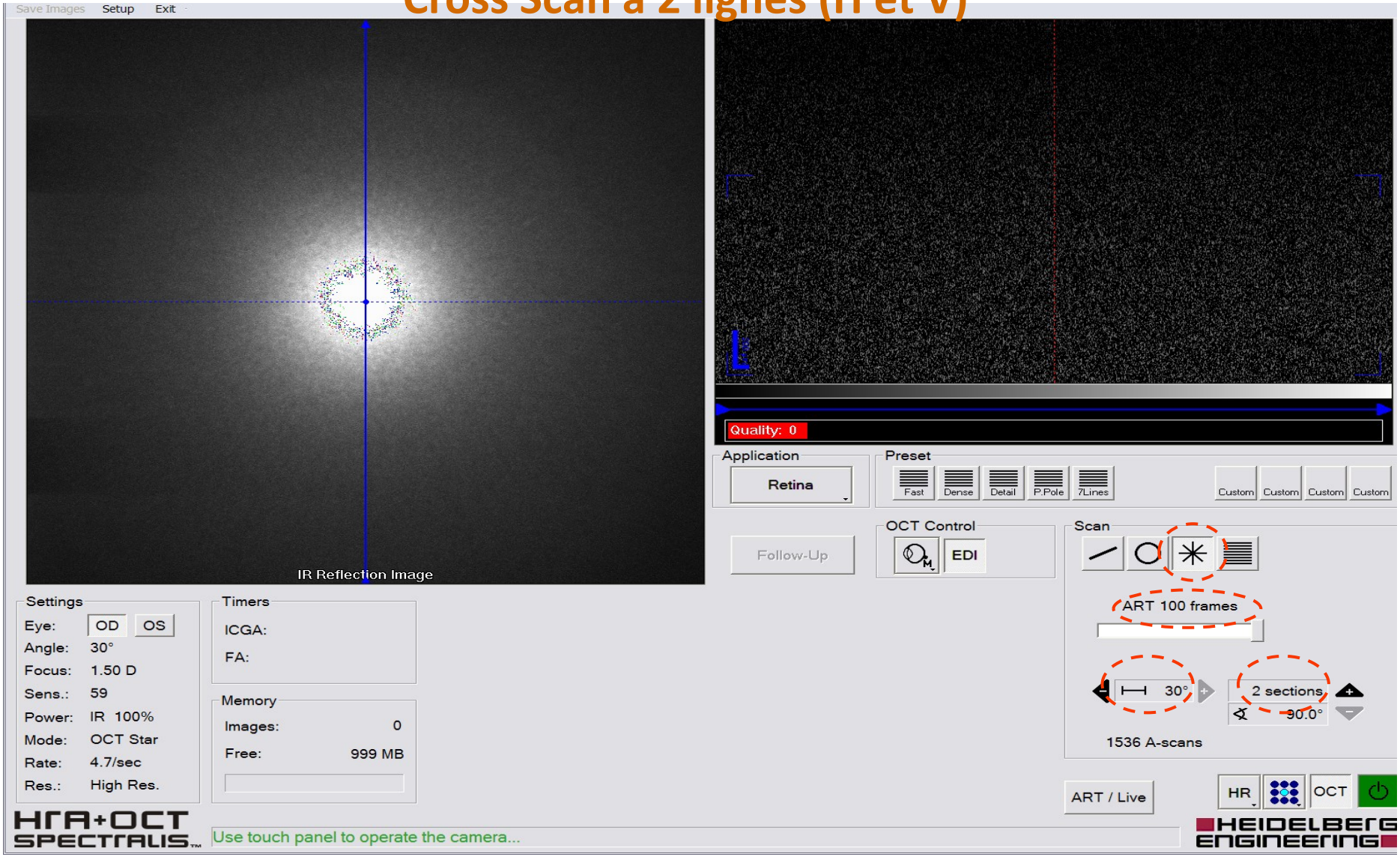


TEST, Test 22/11/2010, OS, IR&OCT

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	3.87 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)



Protocole d'acquisition

<u>toujours les deux yeux</u>

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

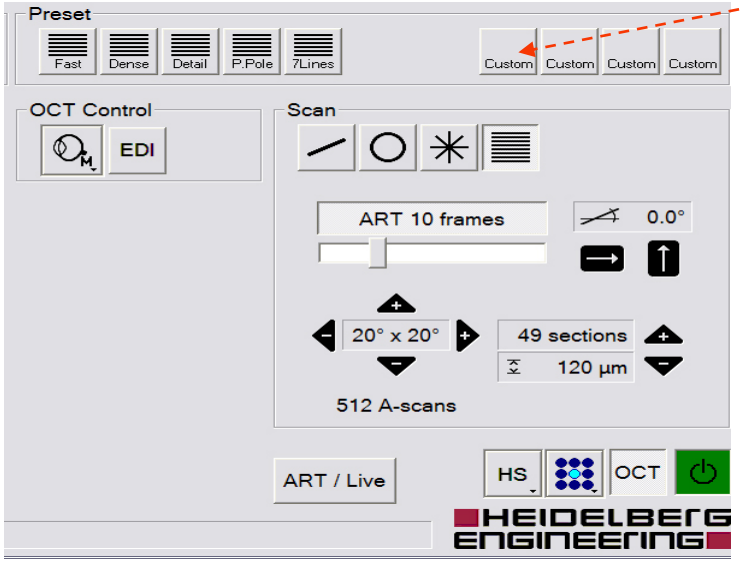
• 1 ligne 12 mm papille macula

• RNFL + CG

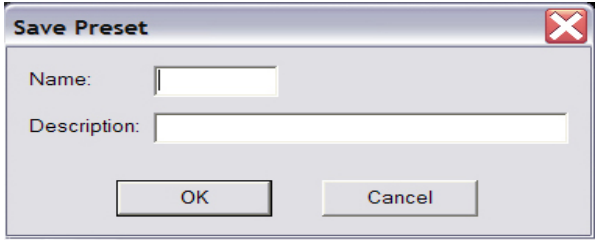
Coupes additionnelles selon pathologie

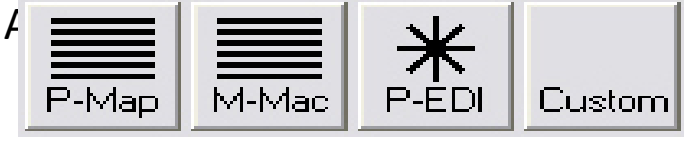
- Exploitation post acquisition (segmentation ILM , CC etc..) selon pathologie
- Suivi : toujours recommencer les coupes précédentes + coupes additionnelles si nécessaire

On peut créer les icône préréglés en « CUSTOM »

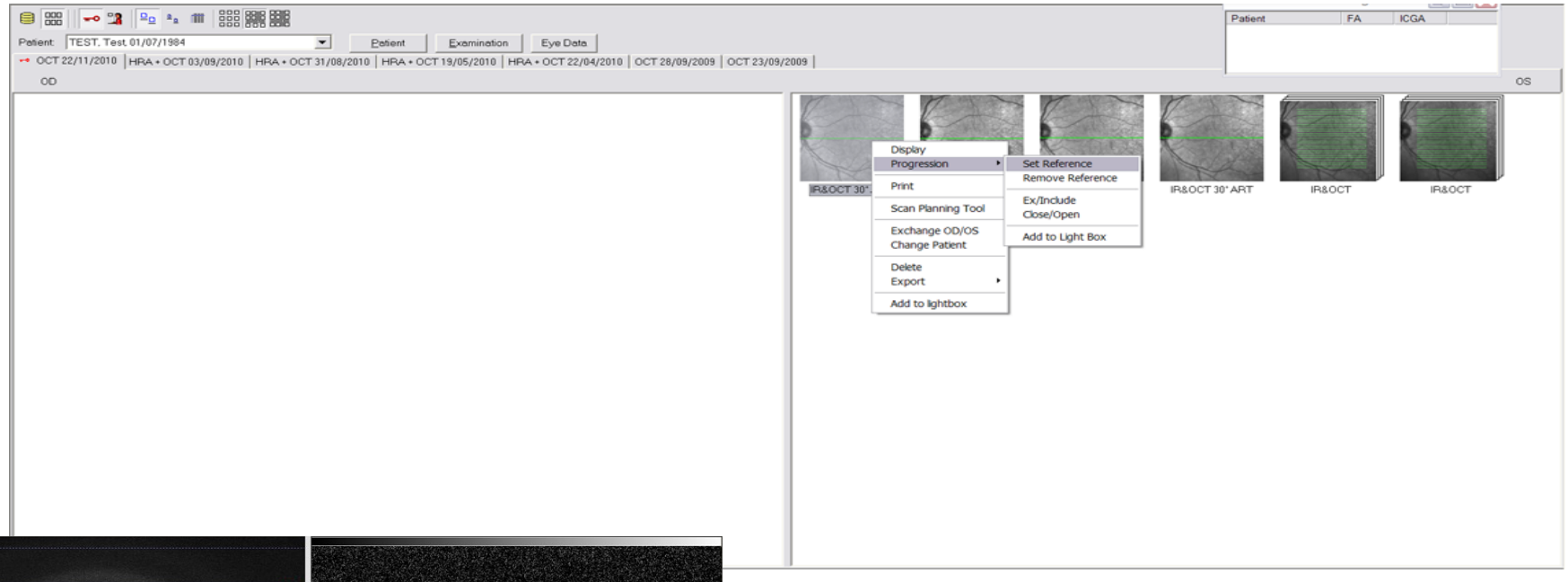


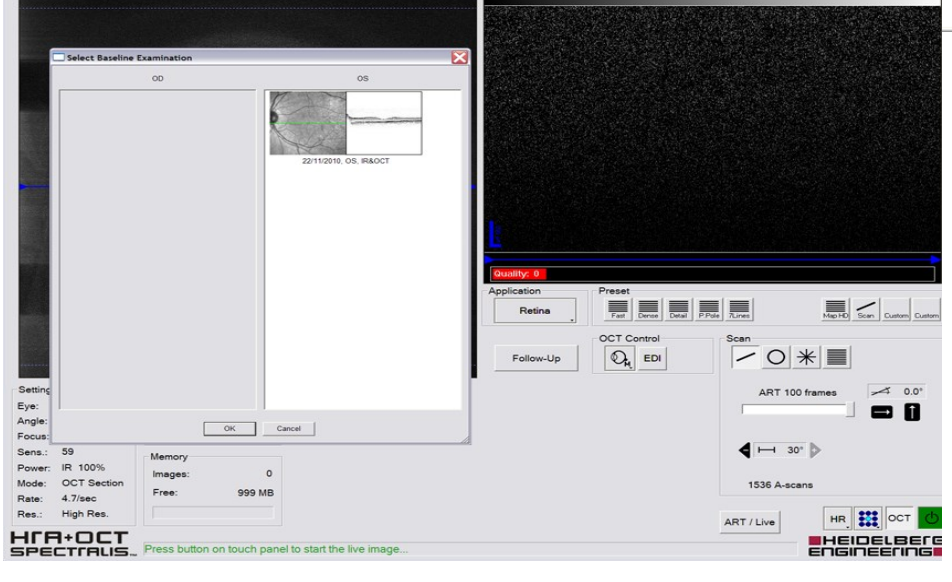
1. Après avoir entré les paramètres pour le 1er examen
2. Rester appuyé sur l'icône « Custom »
3. Puis renommer l'icône



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

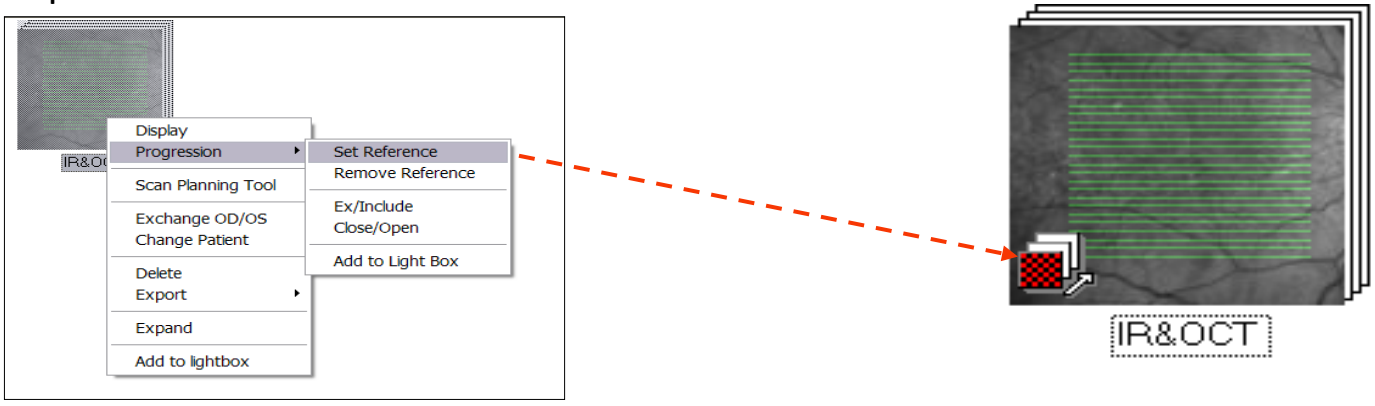
nnalisés


Patient: TEST, Test, 01/07/1984
Patient
Examination
Eye Data
OCT 22/11/2010
HRA • OCT 03/09/2010
HRA • OCT 31/08/2010
HRA • OCT 19/05/2010
HRA • OCT 22/04/2010
OCT 28/09/2009
OCT 23/09/2009
OD
OS
Patient
FA
ICGA
Display
Progression
Print
Scan Planning Tool
Exchange OD/OS
Change Patient
Delete
Export
Add to lightbox
Set Reference
Remove Reference
Ex/Include
Close/Open
Add to Light Box
IR&OCT 30° ART
IR&OCT

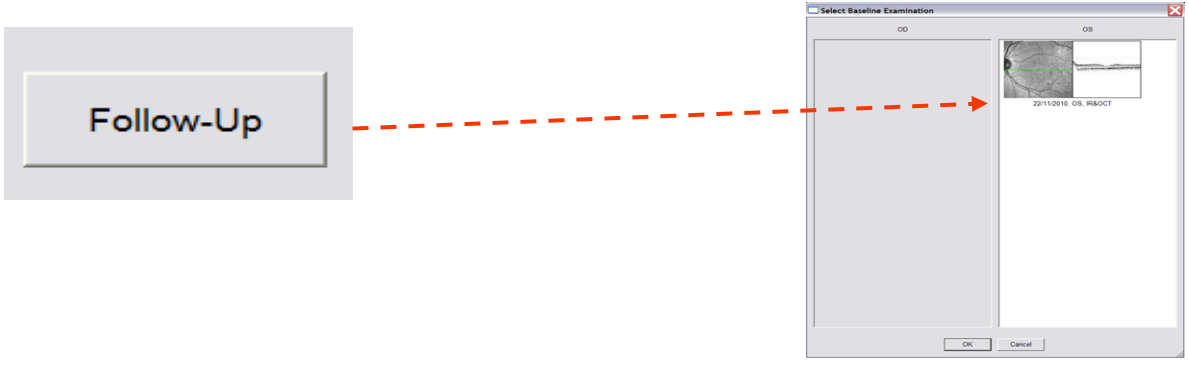

Select Baseline Examination
OD
OS
22/11/2010, OS, IR&OCT
OK
Cancel
Quality: 0
Application
Retina
Preset
Follow-Up
OCT Control
EDI
Scan
ART 100 frames
0.0°
30°
1536 A-scans
ART / Live
HR
OCT
Setting
Eye:
Angle:
Focus:
Sens.: 59
Power: IR 100%
Mode: OCT Section
Rate: 4.7/sec
Res.: High Res.
Memory
Images: 0
Free: 999 MB
HRA+OCT SPECTRALIS
Press button on touch panel to start the live image...
HEIDELBERG ENGINEERING


IR&OCT 30° ART
IR&OCT 30° ART
IR&OCT 30° ART
IR&OCT 30° ART
IR&OCT
IR&OCT

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

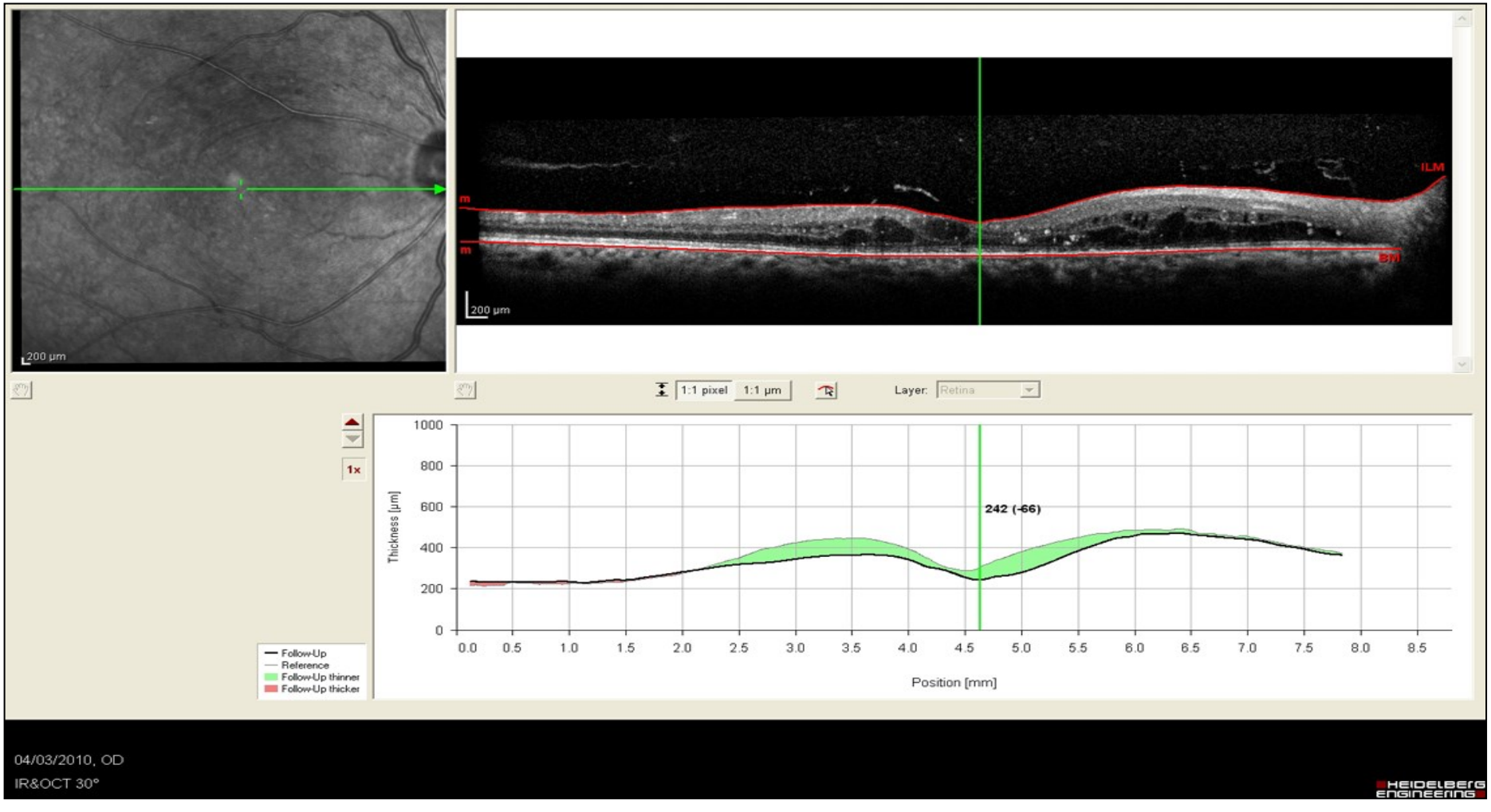


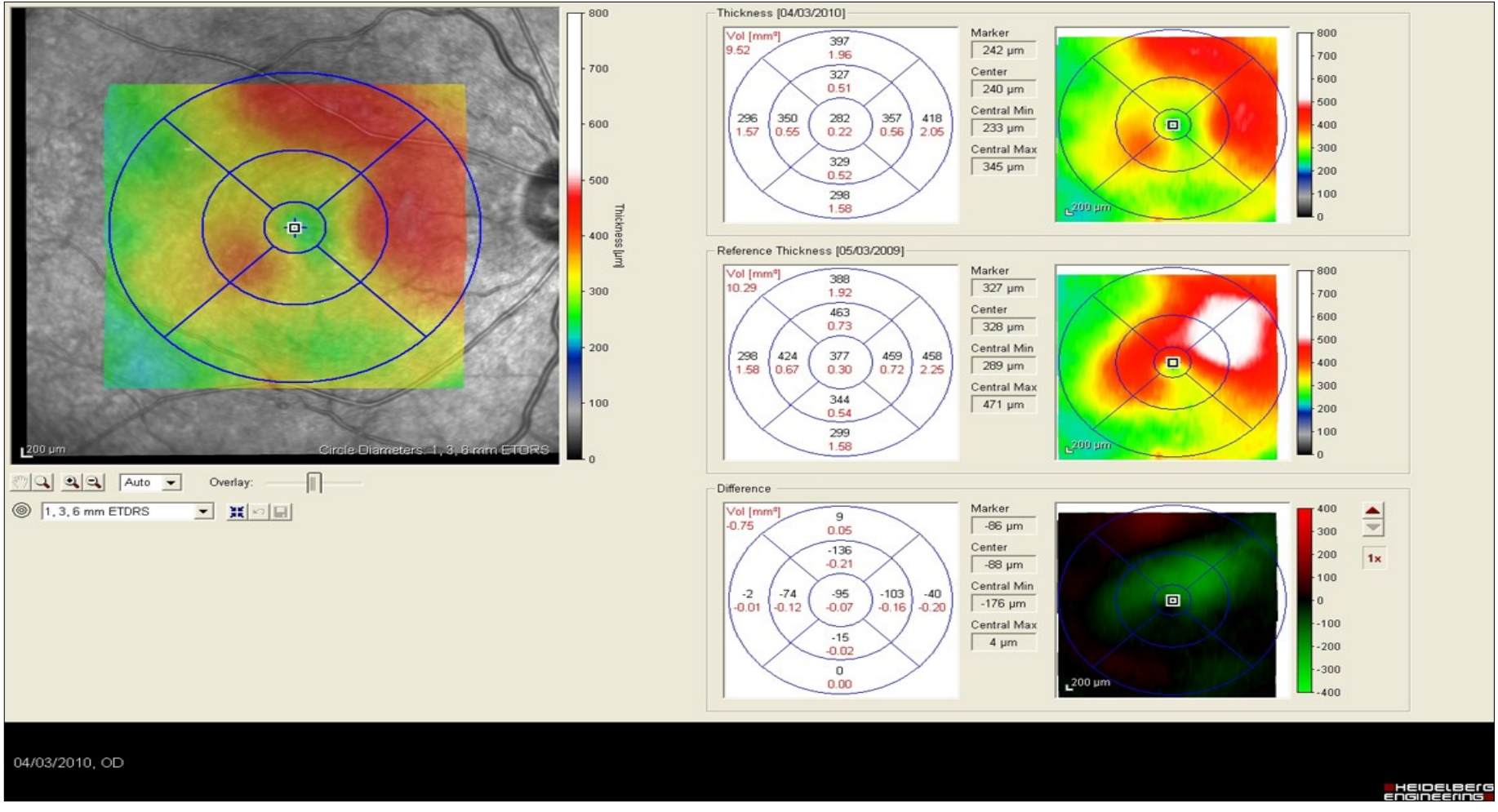
Pour les examens de suivis, il faudra cliquer sur « Follow-Up » et choisir l'examen de référence de la 1re visite



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

Anti-VEGF


200 µm
ILM
BM
200 µm
1:1 pixel
1:1 µm
Layer:
Retina
1x
Thickness [µm]
1000
800
600
400
200
0
242 (-66)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
Position [mm]
Follow-Up
Reference
Follow-Up thinner
Follow-Up thicker
04/03/2010, OD
IR&OCT 30°
HEIDELBERG ENGINEERING


200 µm
Circle Diameters: 1, 3, 6 mm ETDRS
800
700
600
500
400
300
200
100
0
Thickness [µm]
Auto
Overlay:
1, 3, 6 mm ETDRS
Thickness [04/03/2010]
Vol [mm³]
9.52
397
1.96
327
0.51
296
1.57
350
0.55
282
0.22
357
0.56
418
2.05
329
0.52
298
1.58
Marker
242 µm
Center
240 µm
Central Min
233 µm
Central Max
345 µm
Reference Thickness [05/03/2009]
Vol [mm³]
10.29
388
1.92
463
0.73
298
1.58
424
0.67
377
0.30
459
0.72
458
2.25
344
0.54
299
1.58
Marker
327 µm
Center
328 µm
Central Min
289 µm
Central Max
471 µm
Difference
Vol [mm³]
-0.75
9
0.05
-136
-0.21
-2
-0.01
-74
-0.12
-95
-0.07
-103
-0.16
-40
-0.20
-15
-0.02
0
0.00
Marker
-86 µm
Center
-88 µm
Central Min
-176 µm
Central Max
4 µm
400
300
200
100
0
-100
-200
-300
-400
1×
04/03/2010, OD
HEIDELBERG ENGINEERING

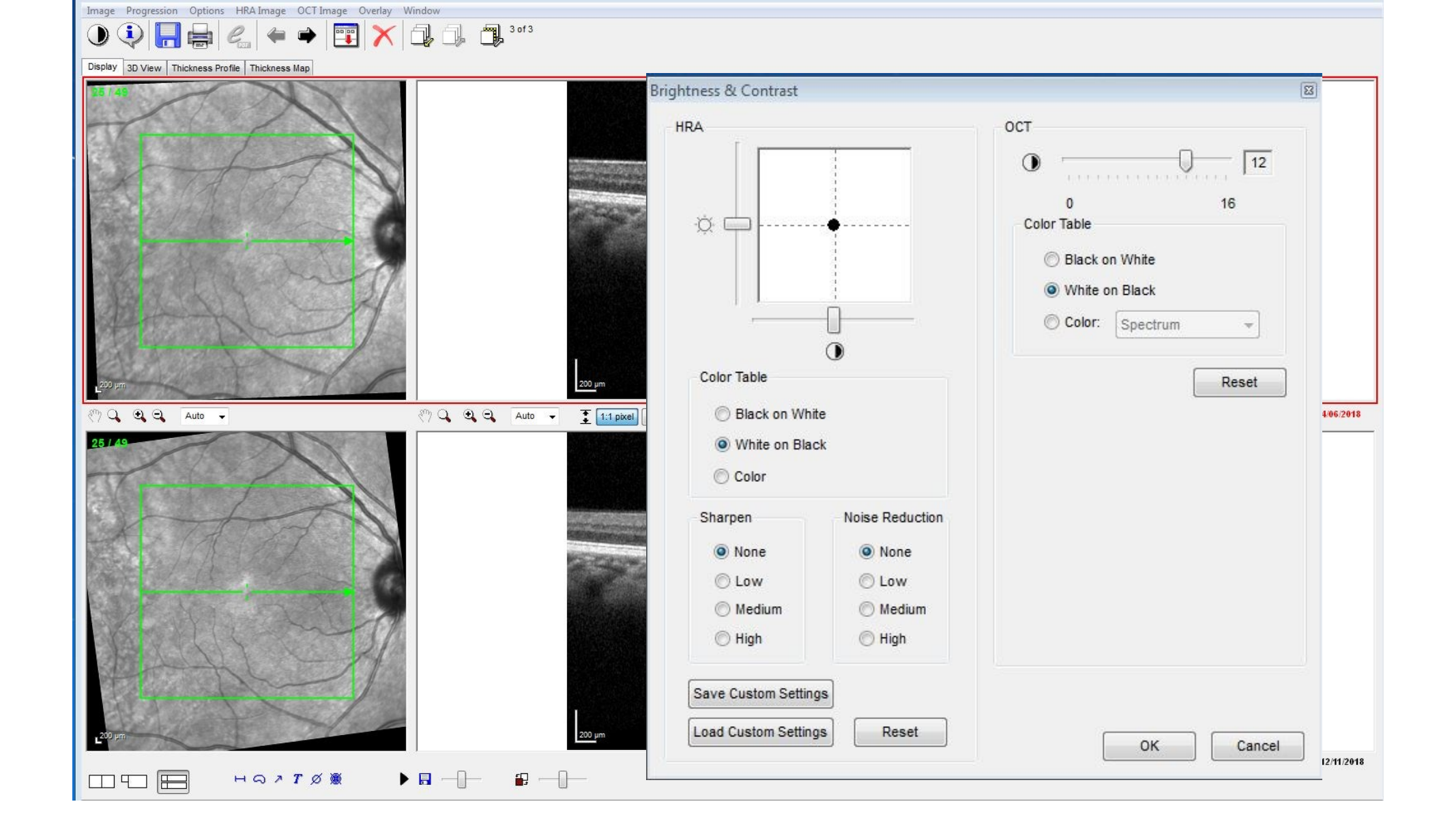
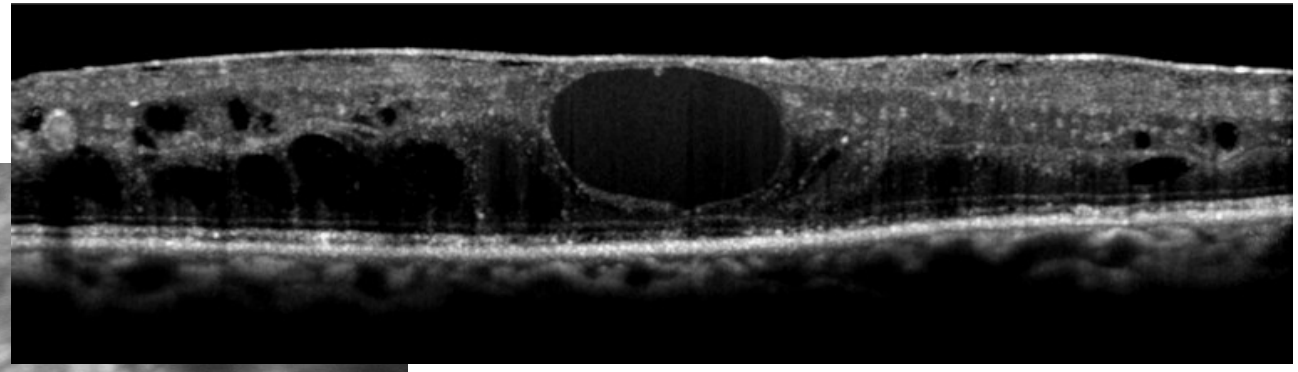
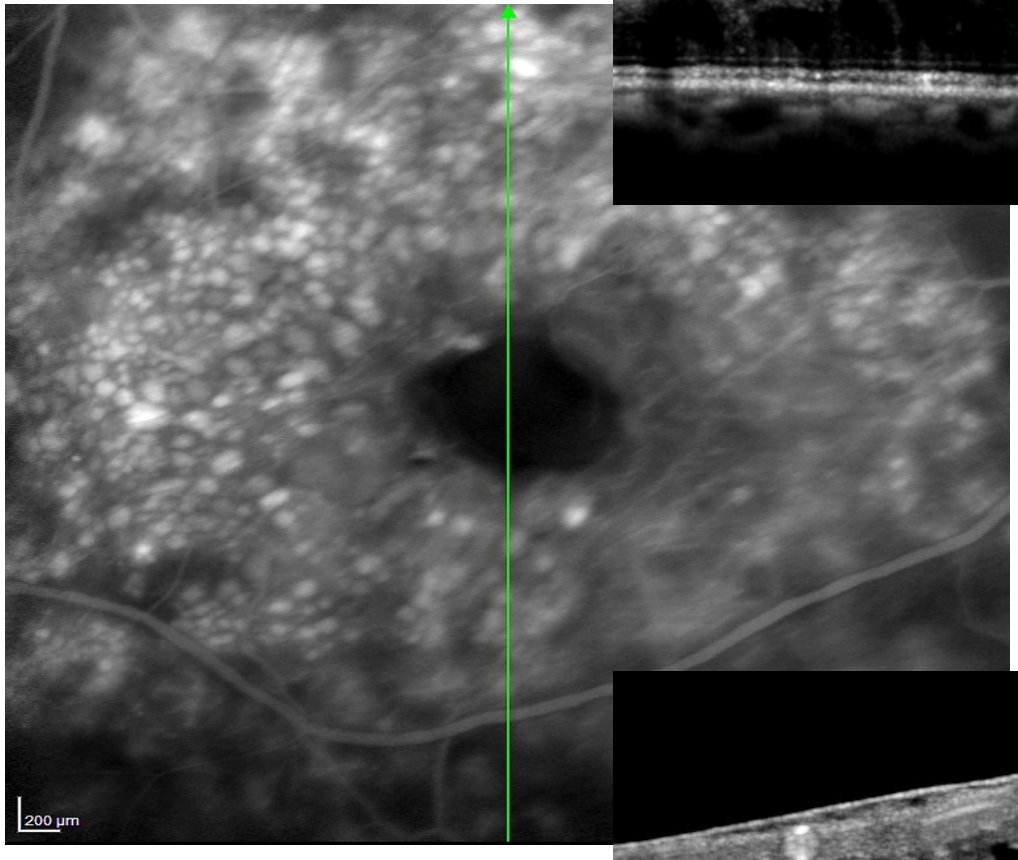
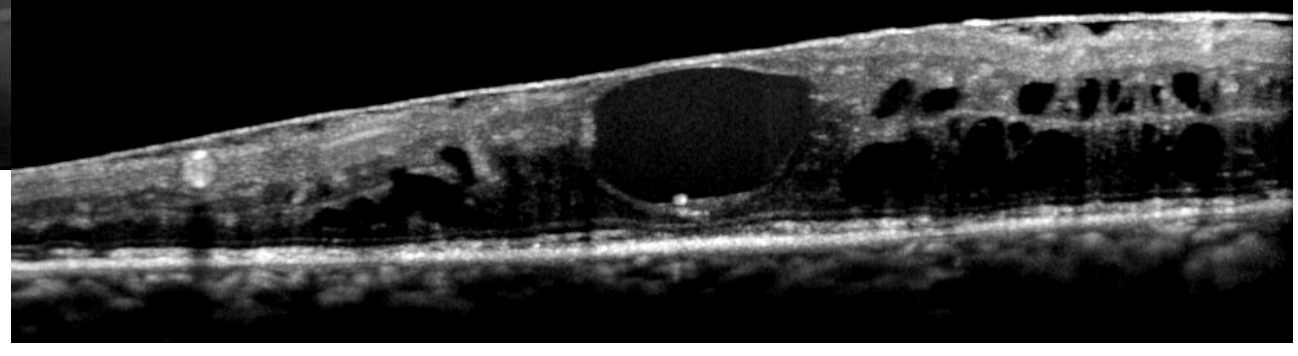


Image Progression Options HRA Image OCT Image Overlay Window
3 of 3
Display 3D View Thickness Profile Thickness Map
25 / 49
200 µm
Auto
1:1 pixel
Brightness & Contrast
HRA
Color Table
Black on White
White on Black
Color
Sharpen
None
Low
Medium
High
Noise Reduction
None
Low
Medium
High
Save Custom Settings
Load Custom Settings
Reset
OCT
12
0
16
Color Table
Black on White
White on Black
Color:
Spectrum
Reset
OK
Cancel

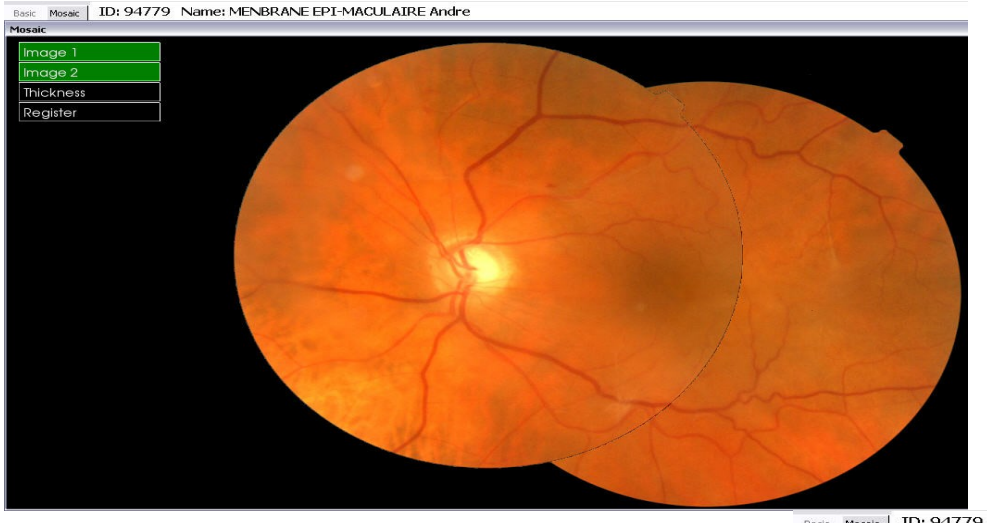




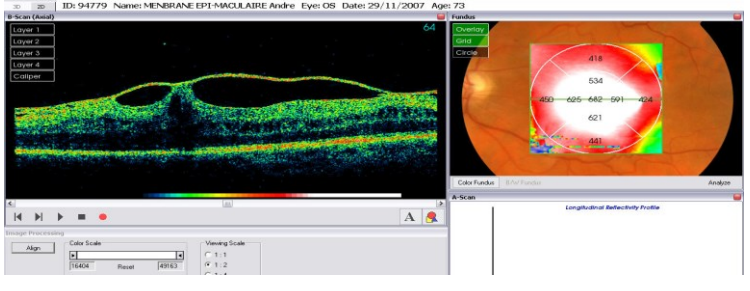
Le système permettant de placer un scan OCT sur une image d'angiographie acquise simultanément.

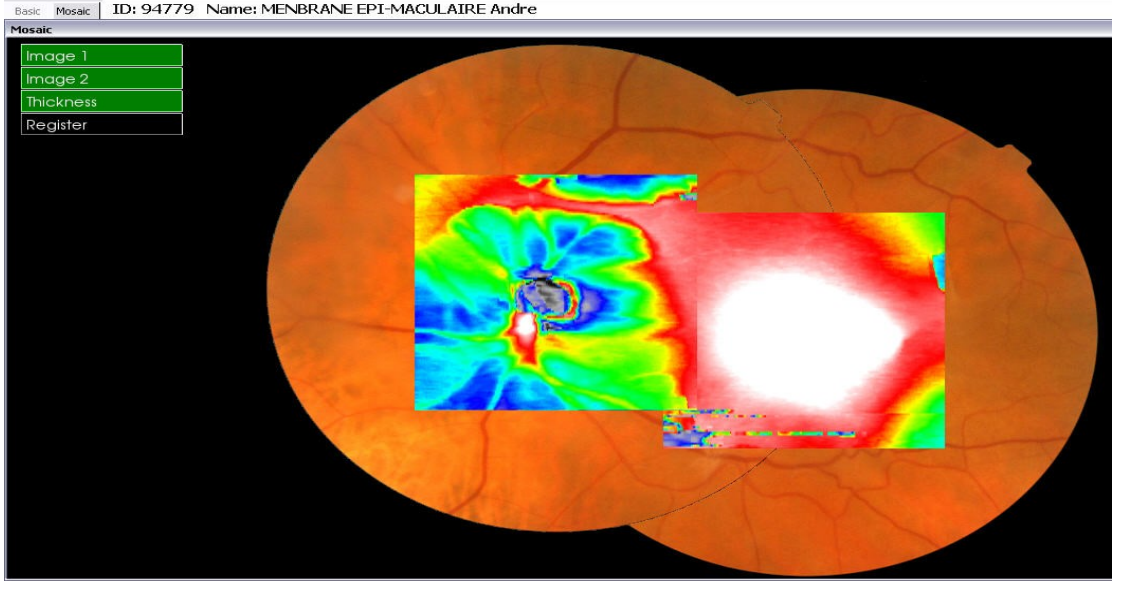


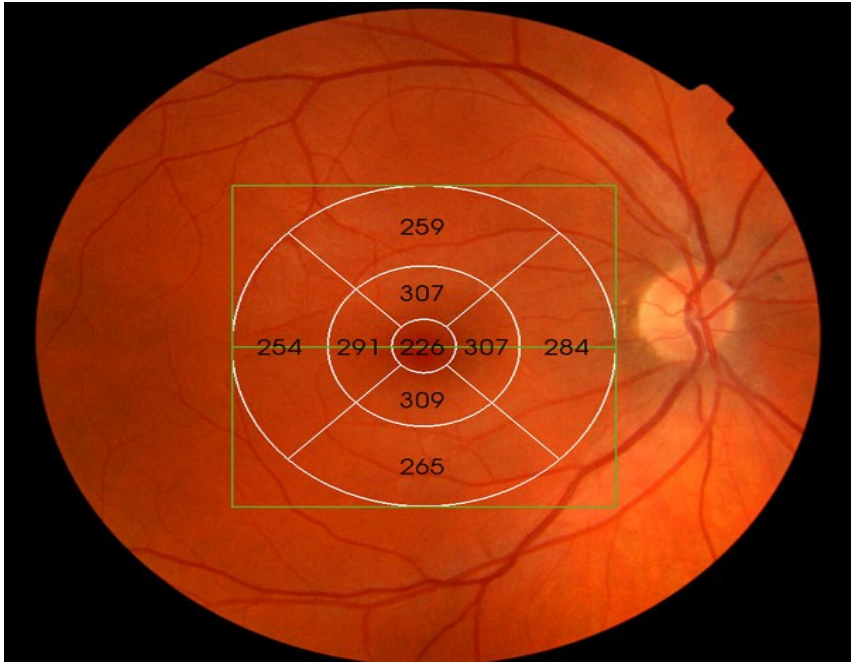
Topcon

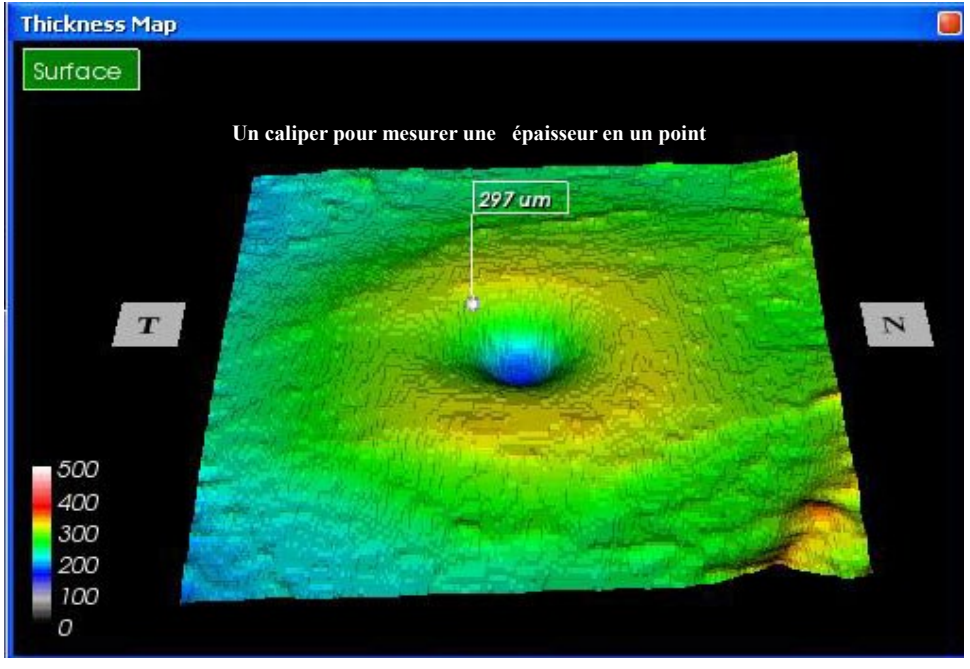


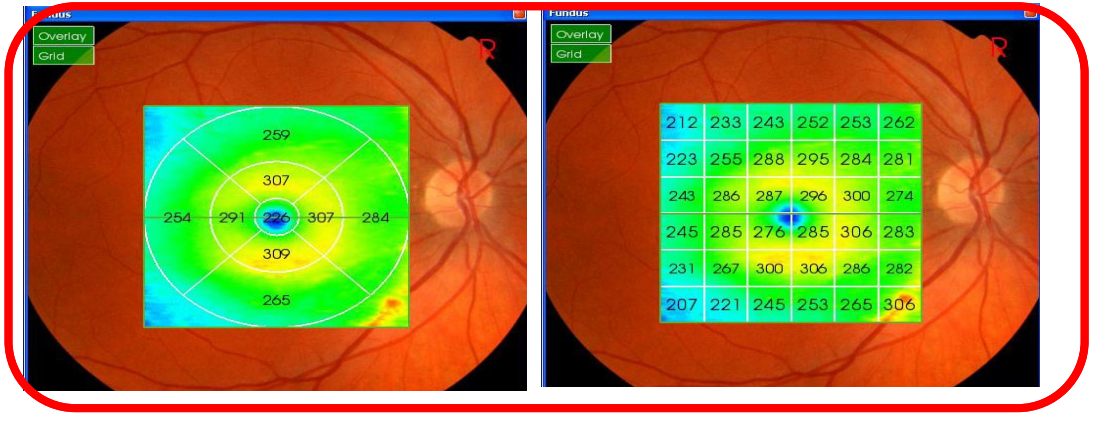
Mosaique Automatique







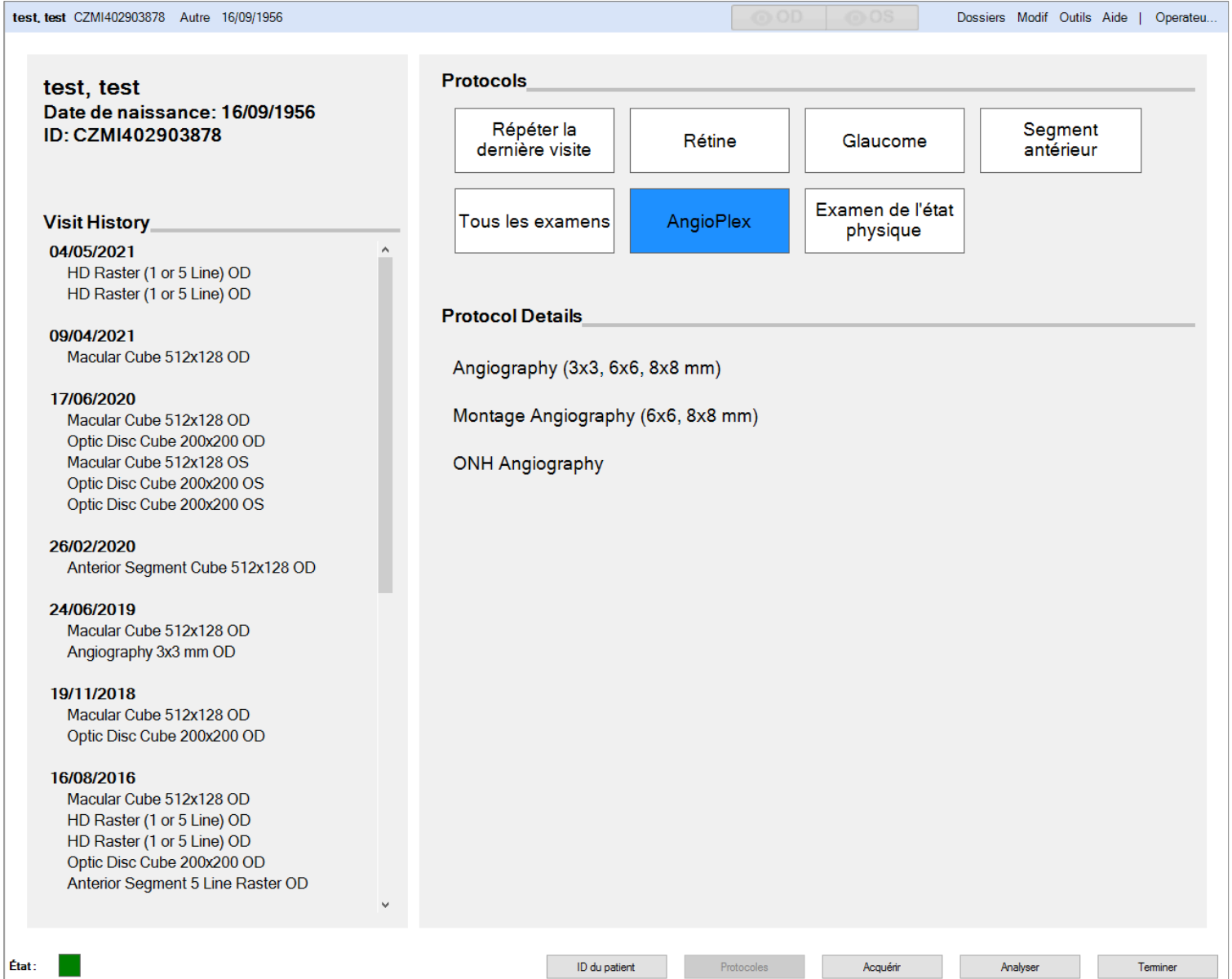


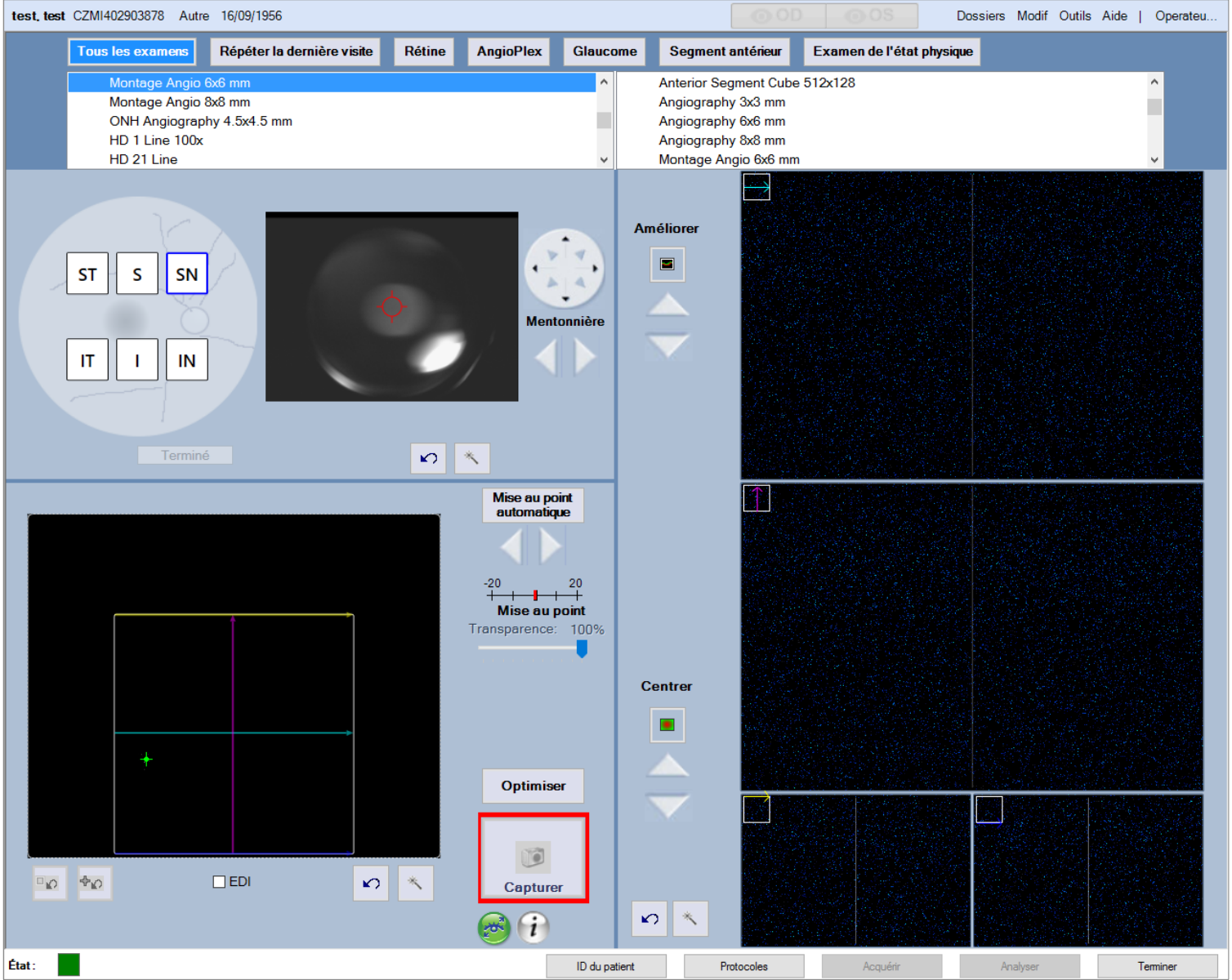


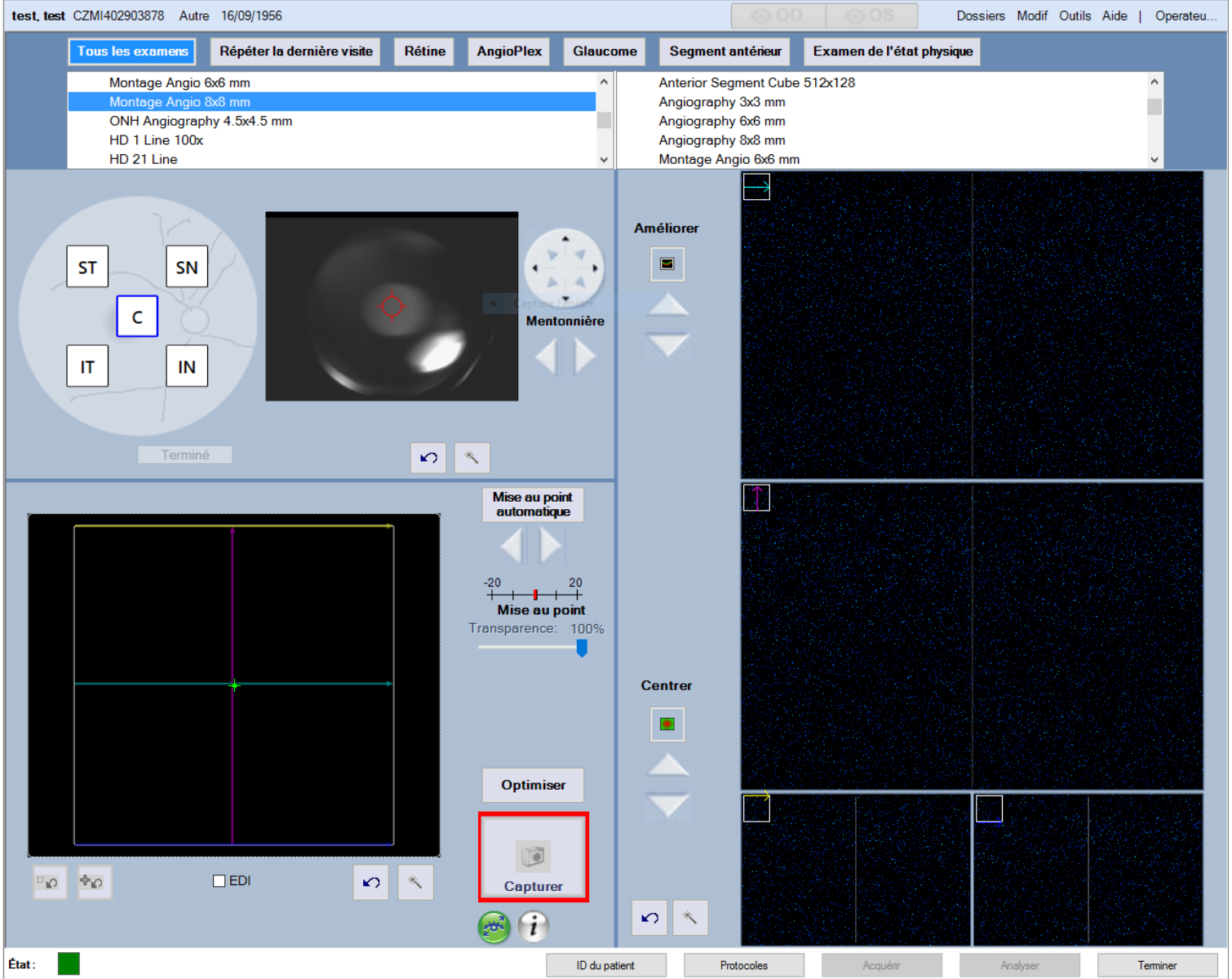
Mapping superposable

OCTA

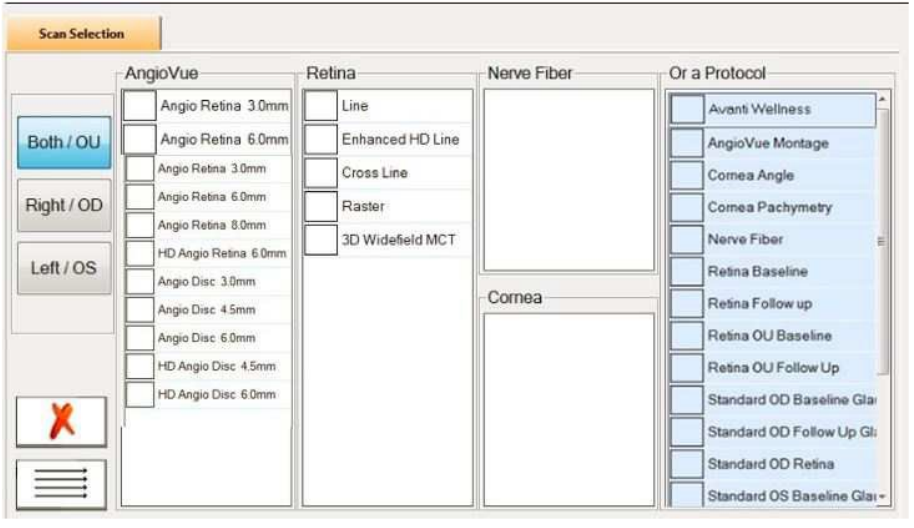
Cirrus 5000

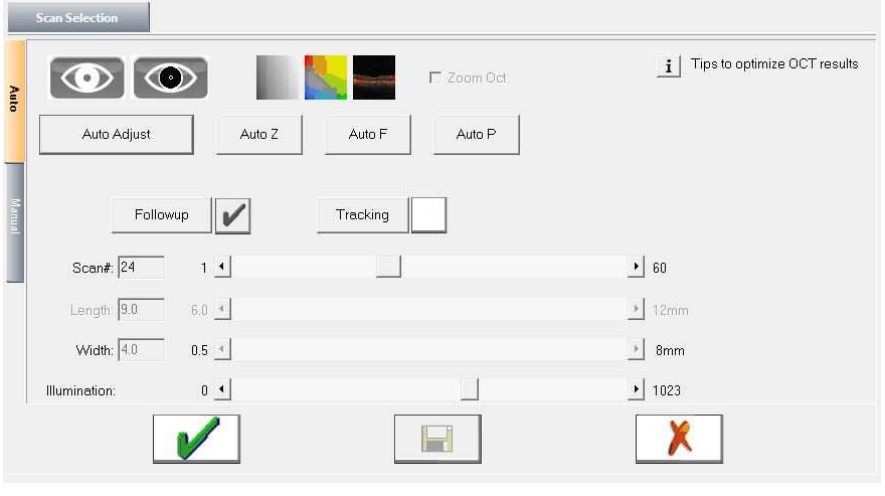

test, test CZMI402903878 Autre 16/09/1956
OD OS
Dossiers Modif Outils Aide | Operateu...
test, test
Date de naissance: 16/09/1956
ID: CZMI402903878
Visit History
04/05/2021
HD Raster (1 or 5 Line) OD
HD Raster (1 or 5 Line) OD
09/04/2021
Macular Cube 512x128 OD
17/06/2020
Macular Cube 512x128 OD
Optic 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
État :
ID du patient
Protocoles
Acquérir
Analyser
Terminer

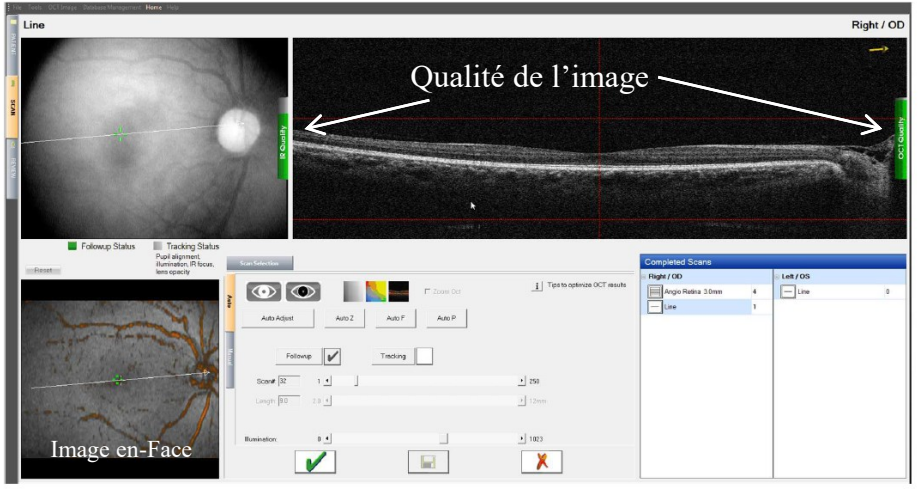

test, test CZMI402903878 Autre 16/09/1956
OD OS
Dossiers Modif Outils Aide | Operateu...
Tous les examens
Répéter la dernière visite
Rétine
AngioPlex
Glaucome
Segment antérieur
Examen de l'état physique
Montage Angio 6x6 mm
Montage Angio 8x8 mm
ONH Angiography 4.5x4.5 mm
HD 1 Line 100x
HD 21 Line
Anterior Segment Cube 512x128
Angiography 3x3 mm
Angiography 6x6 mm
Angiography 8x8 mm
Montage Angio 6x6 mm
ST
S
SN
IT
I
IN
Terminé
Mentonnière
Améliorer
Centrer
Mise au point automatique
-20
20
Mise au point
Transparence: 100%
EDI
Optimiser
Capturer
État :
ID du patient
Protocoles
Acquérir
Analyser
Terminer


test, test CZMI402903878 Autre 16/09/1956
OD OS
Dossiers Modif Outils Aide | Operateu...
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
ST
SN
C
IT
IN
Terminé
Mentonnière
Améliorer
Centrer
Mise au point automatique
-20
20
Mise au point
Transparence: 100%
EDI
Optimiser
Capturer
État :
ID du patient
Protocoles
Acquérir
Analyser
Terminer

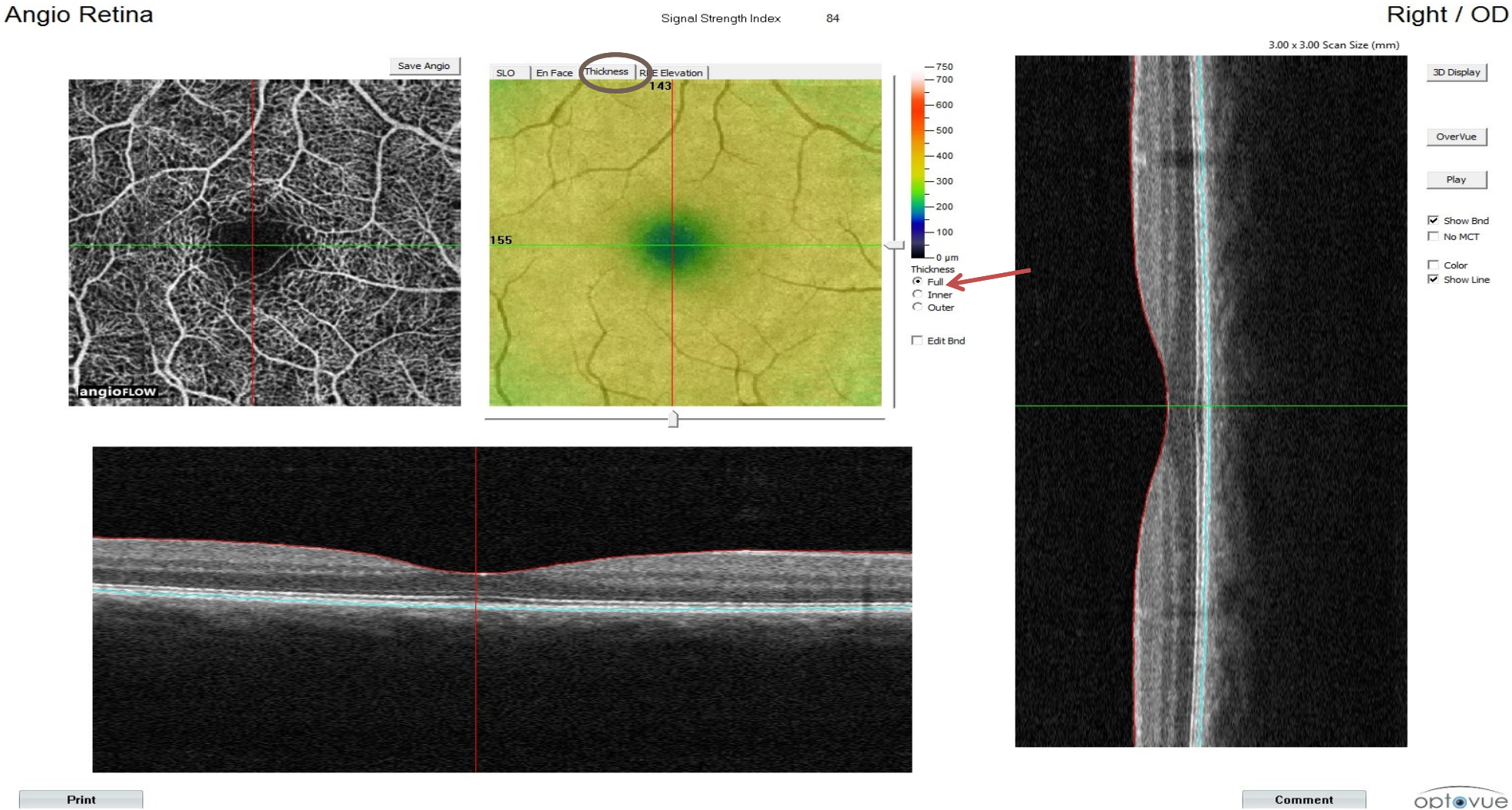
AVANTI RTVUE *(OPTOVUE)*







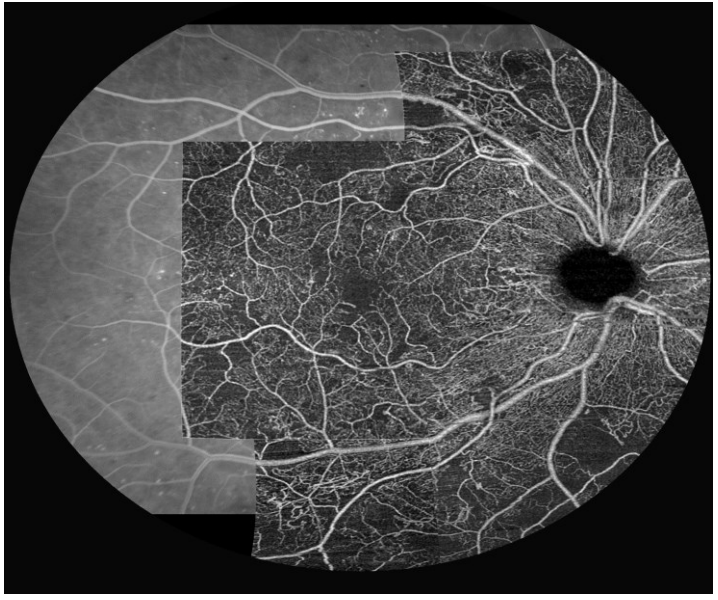
Full Thickness



Superficial capillary plexus

Deep Capillary plexus

Swept-Source OCTA

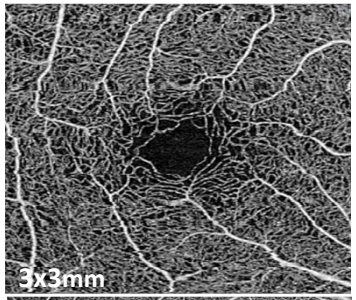


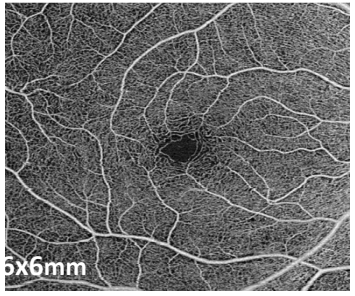
- SS-OCTA
  - 100 à 200 000 A-scan/sec
  - λ:1060nm
  - permet
    - augmenter la densité de points
    - ou la surface des cartographies
    - des montages automatiques

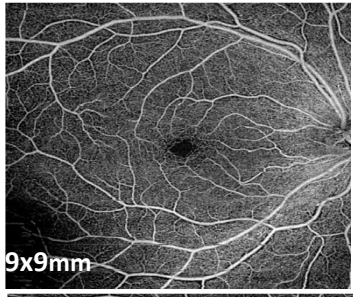
Topcon Triton SS-OCT

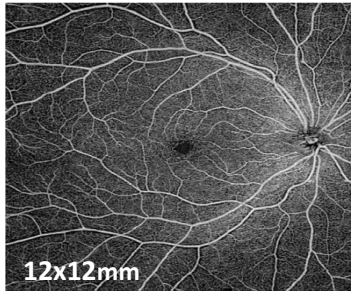
Zeiss PLEX™ Elite 9000

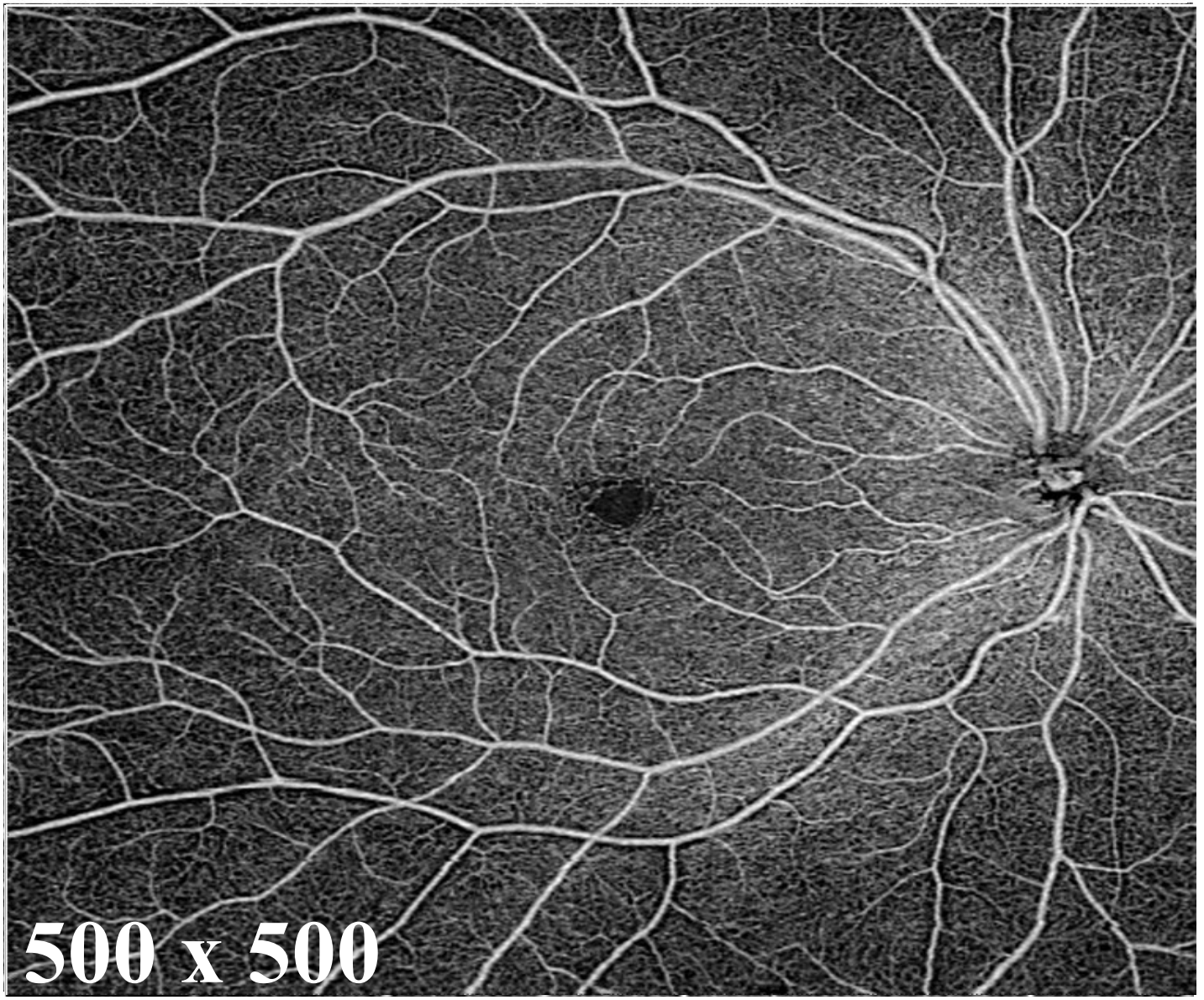
OPTOS Silverstone

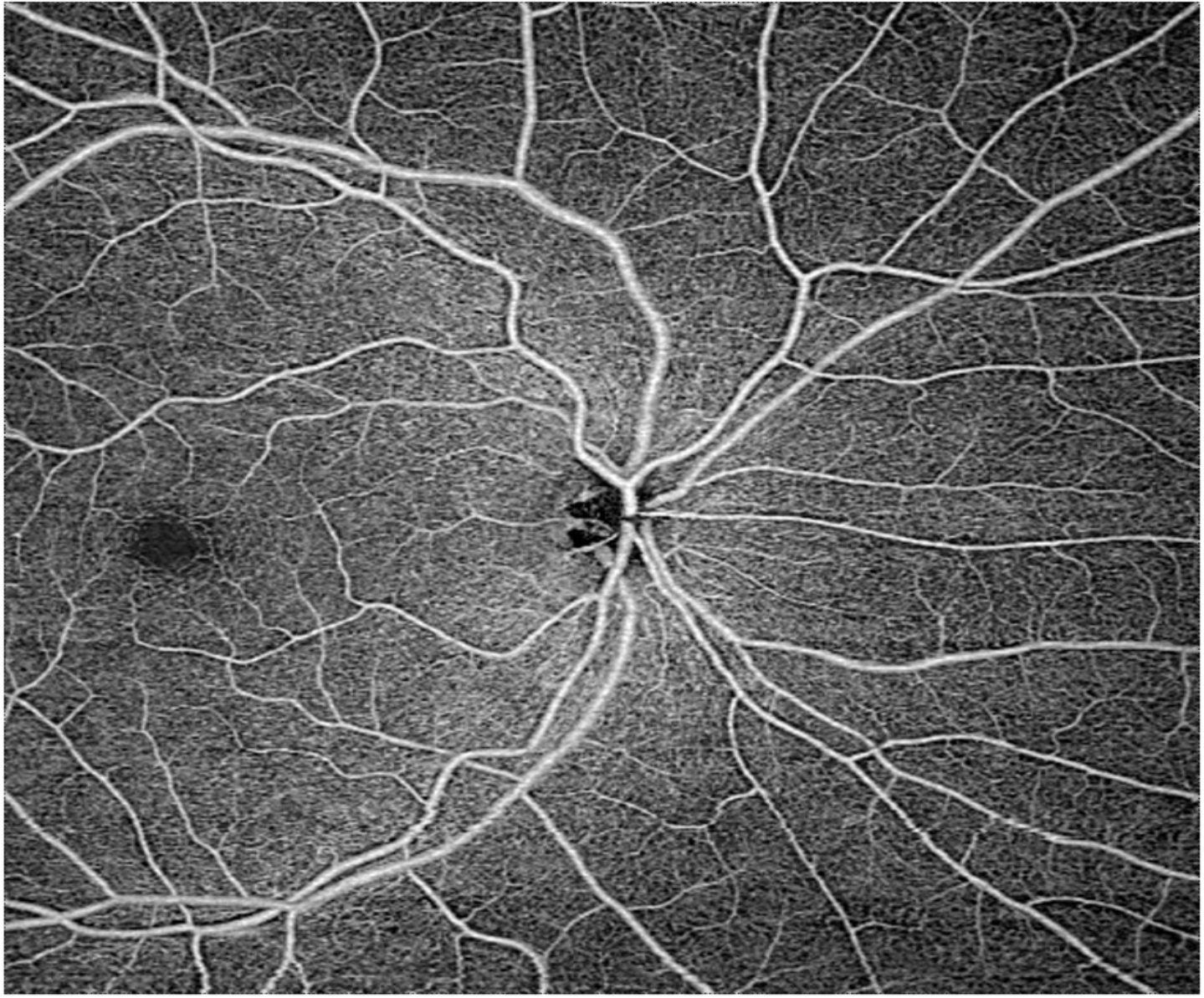

3x3mm

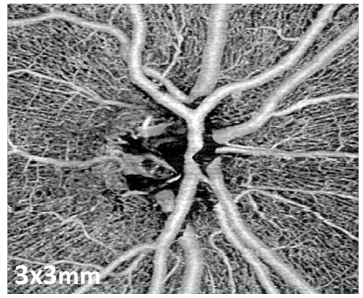

6x6mm

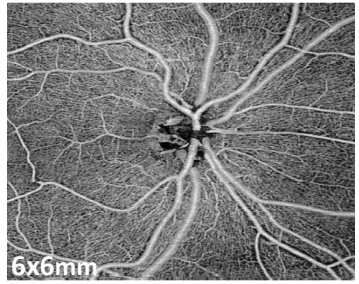

9x9mm

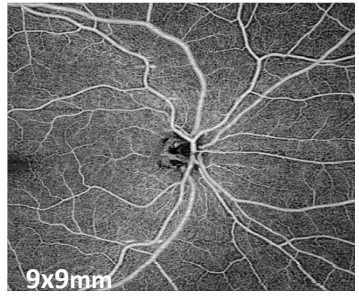

12x12mm

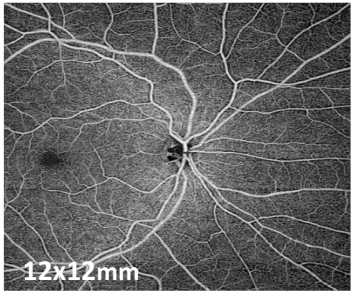

500 x 500




3x3mm


6x6mm

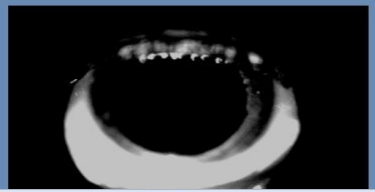

9x9mm


12x12mm

Female 10/18/1972 OD Right OS Left Records Edit Tools Help | PLEX OPER...

ALL SCANS

OS Angio (15mmx9mm)

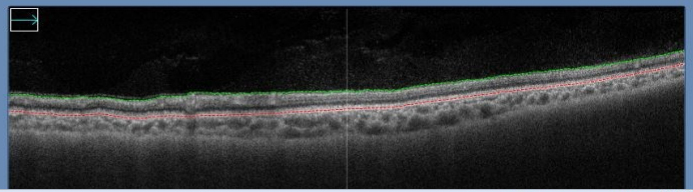


Signal Strength : 9/10

Fundus Image : 7/10

Tracked during scan

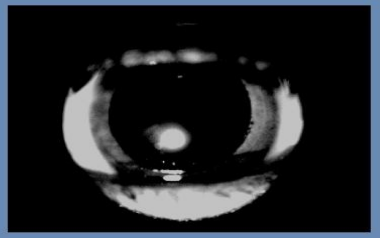
Tracked to prior



Female 10/18/1972 OD Right OS Left Records Edit Tools Help | PLEX OPER...

ALL SCANS

OS Angio (15mmx9mm)



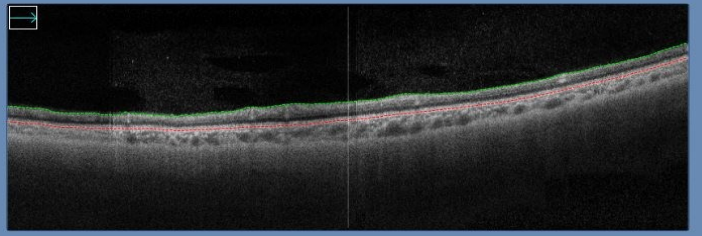
Signal Strength : 9/10

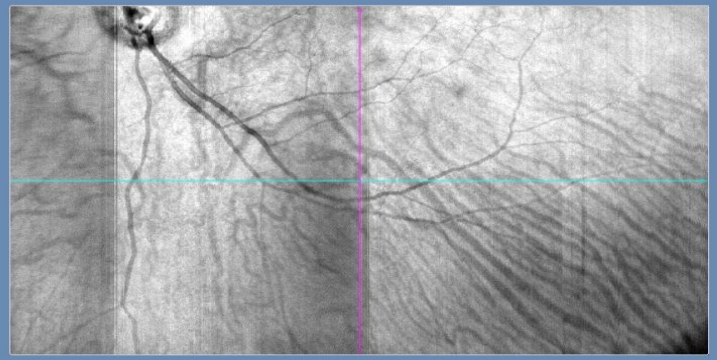
Fundus Image : 7/10

Tracked during scan

Tracked to prior

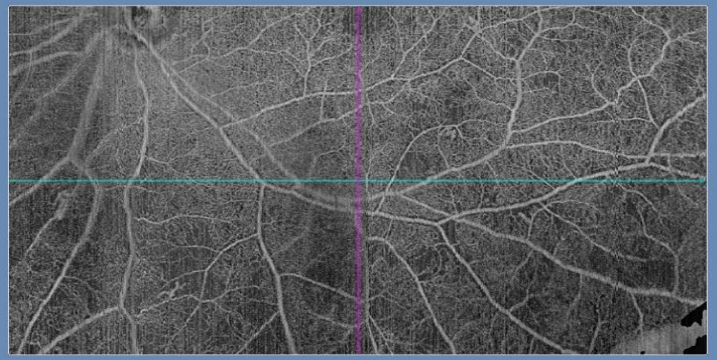
Transparency : 0%





Try Again

Save



ExportMontage

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

- [x] Retina Depth Encoded
- [x] Retina
- [x] VRI
- [x] Superficial
- [x] Deep
- [x] ORCC
- [x] Avascular
- [x] Choriocapillaris
- [x] Choroid

- [x] Remove Projections

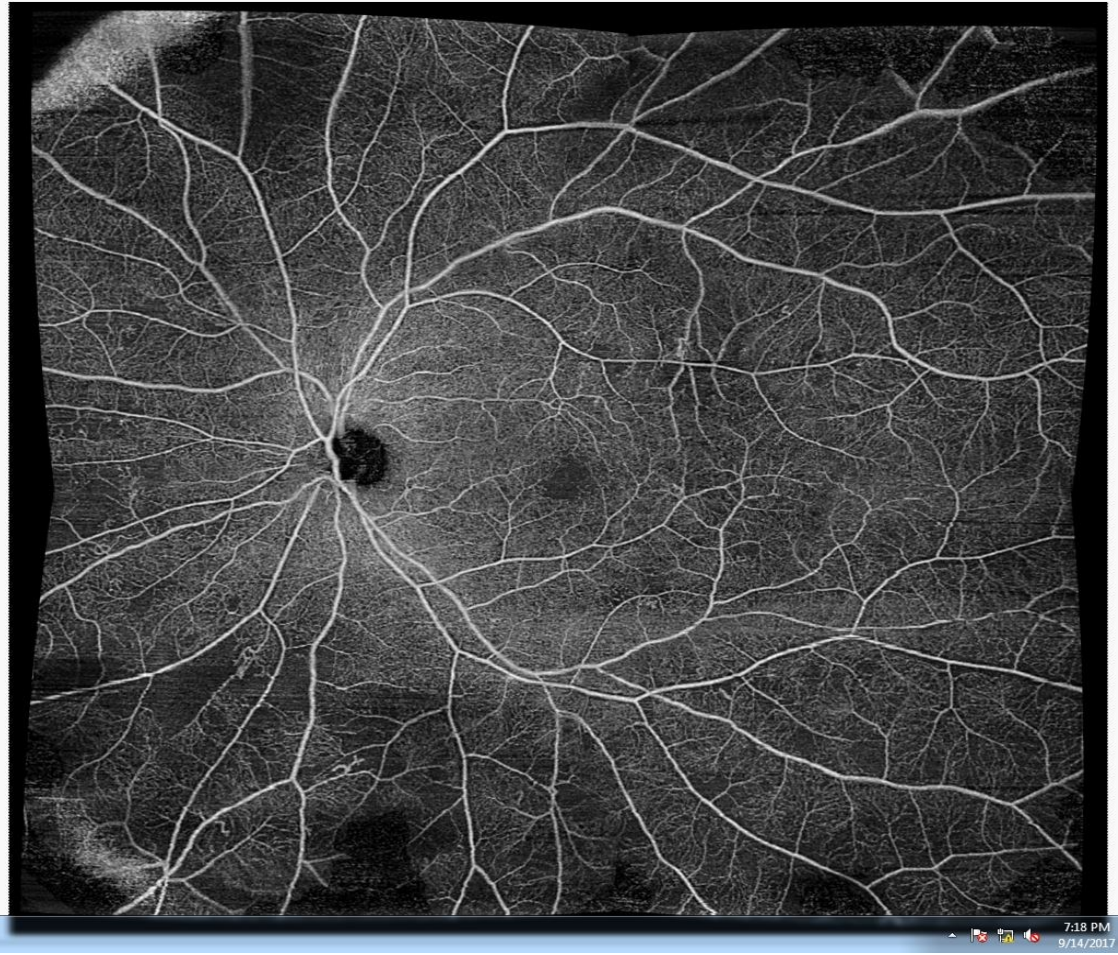
Montage

- Retina Depth Encoded
- Retina
- VRI
- Superficial
- Deep
- ORCC
- Avascular
- Choriocapillaris
- Choroid

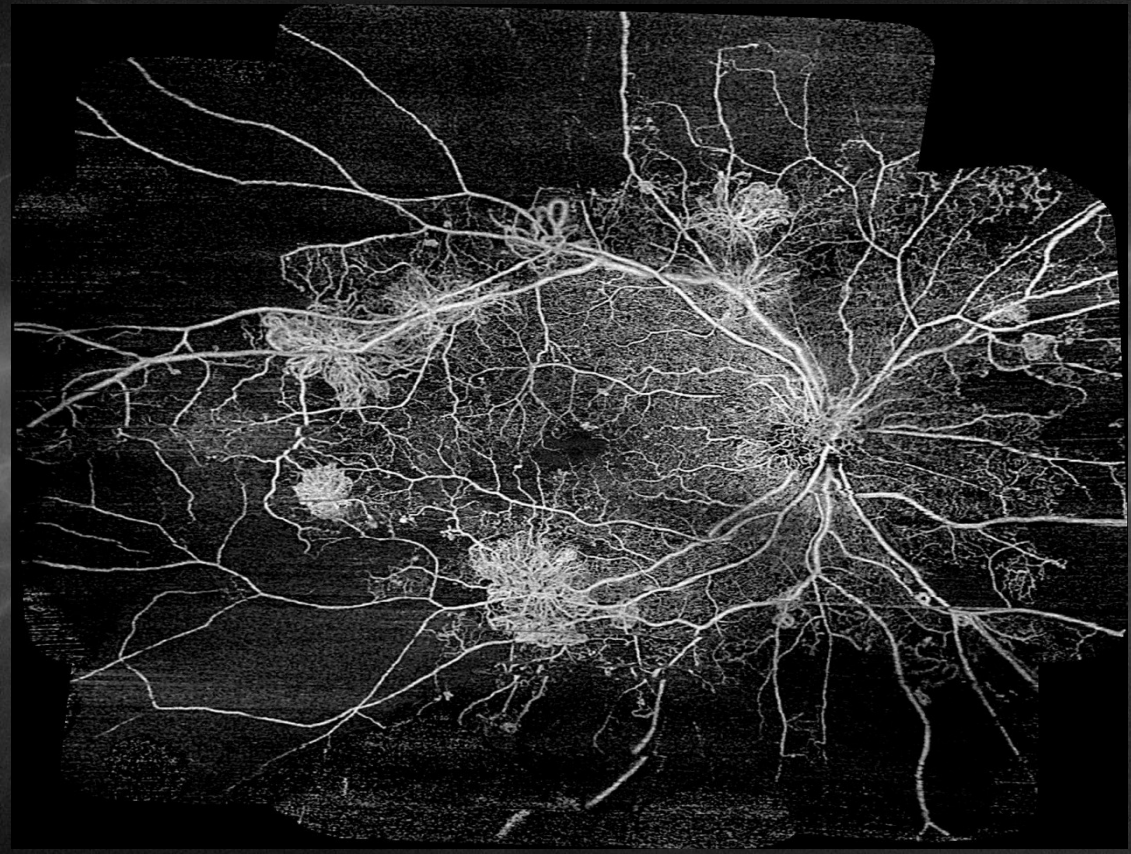
- [ ] Show Device Watermark
- [ ] Show Montage Watermark

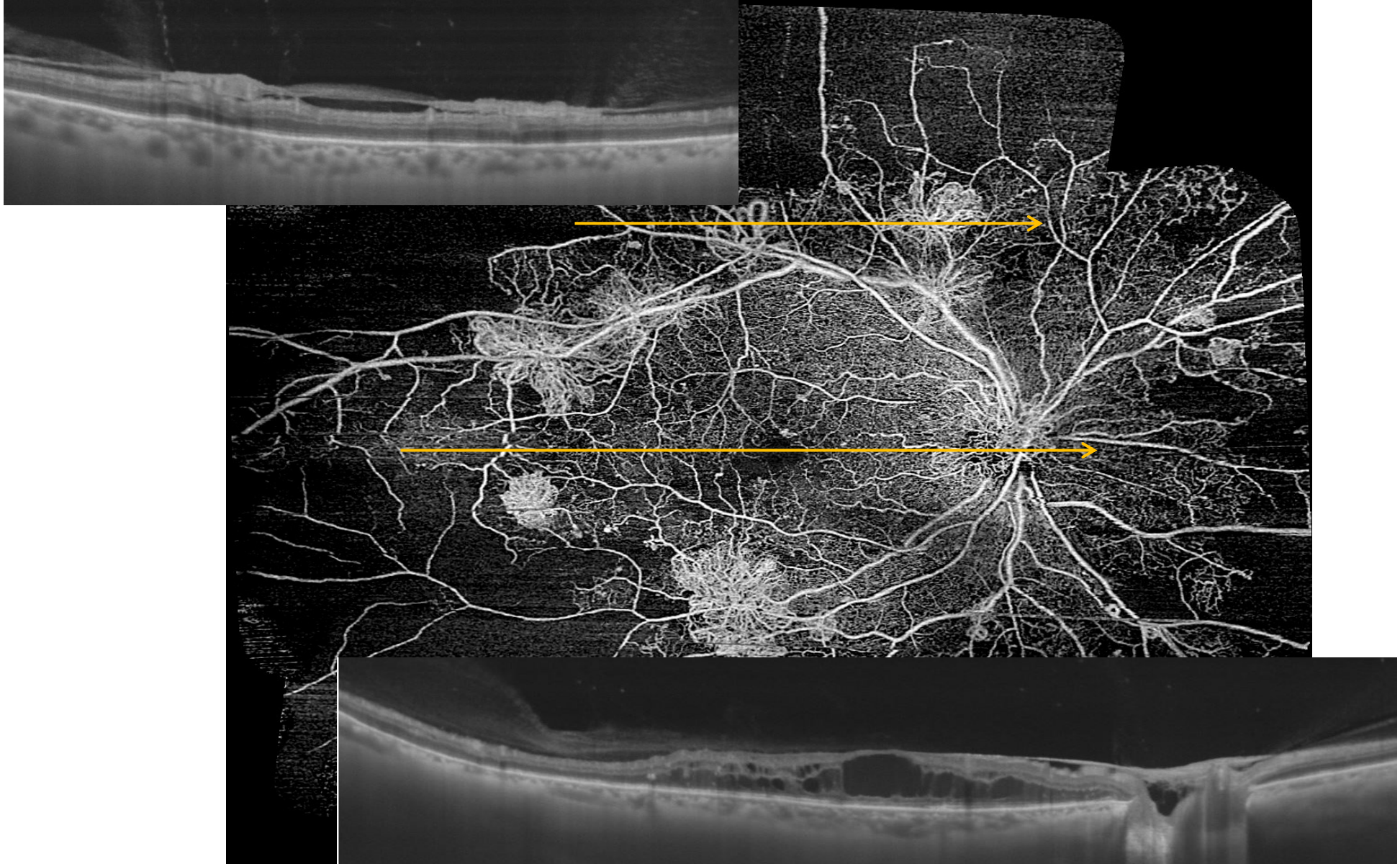
Export

Montage Preview

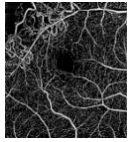


7:18 PM
9/14/2017

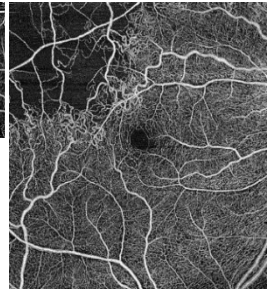




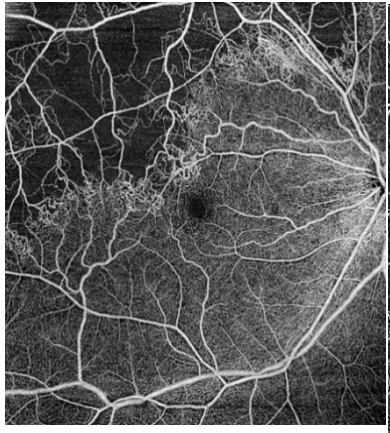
PLEX Elite 2.1 à 200 Mhz



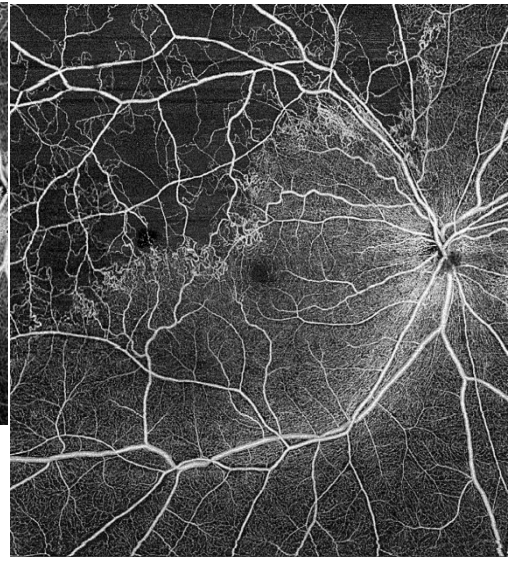
3mmx3mm



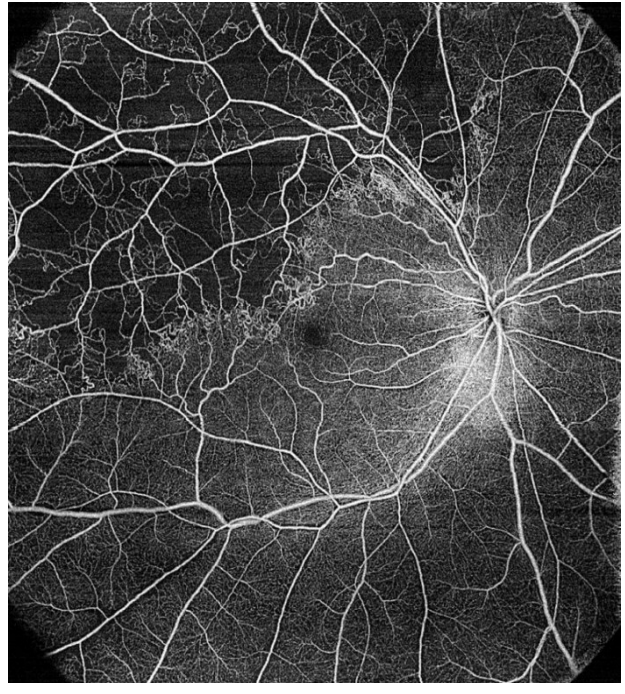
6mmx6mm



9mmx9mm

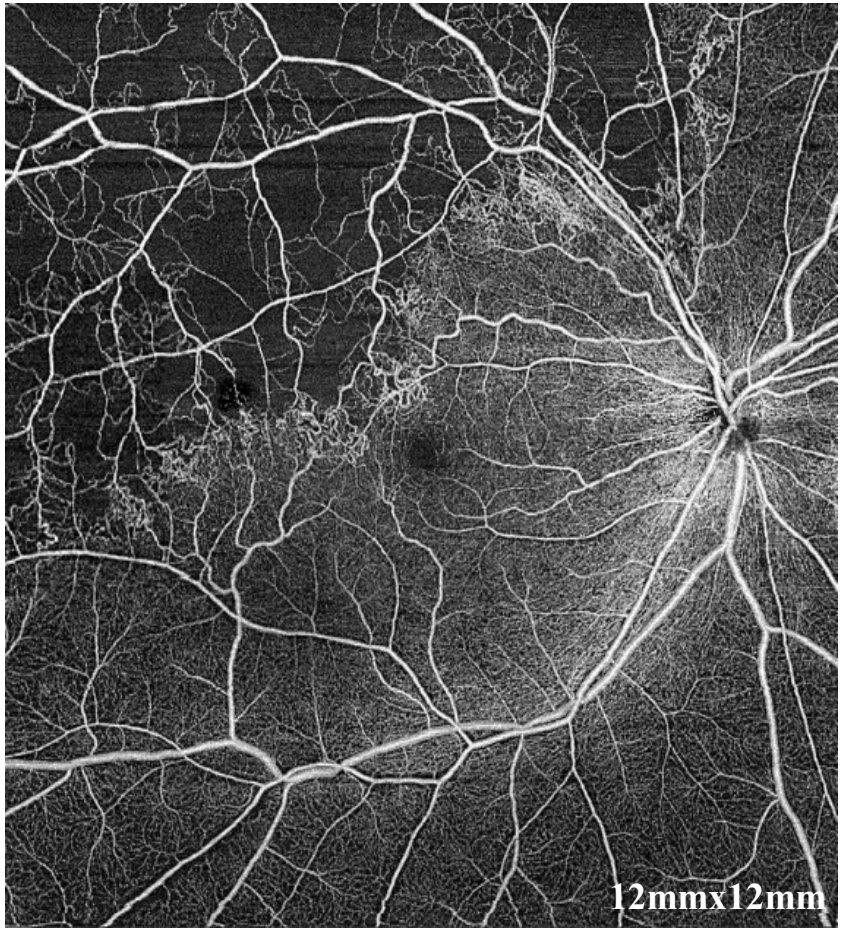


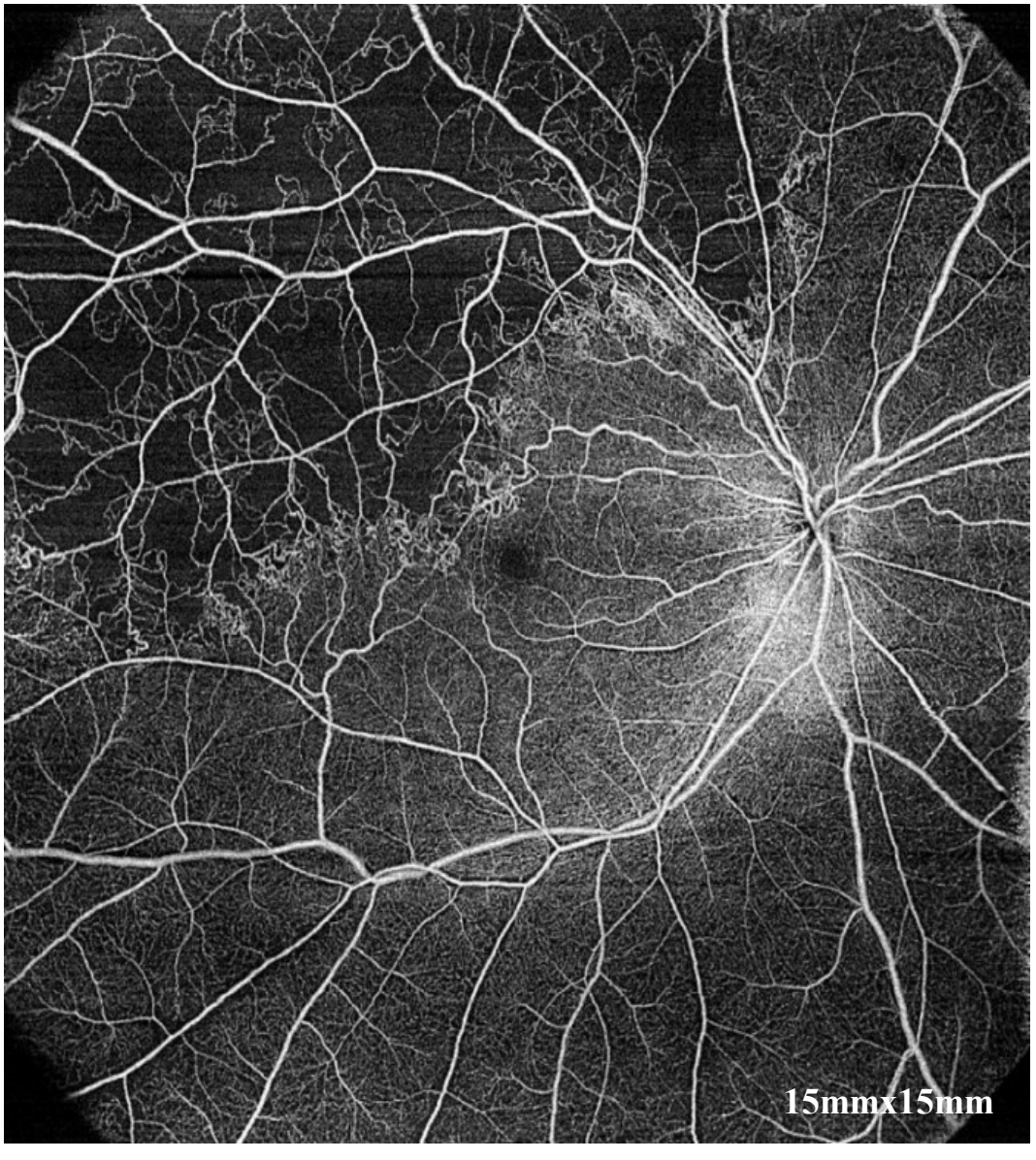
12mmx12mm



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

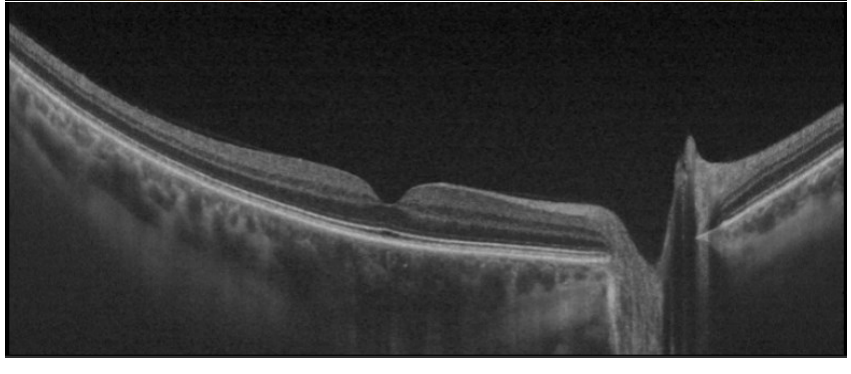
- Color
- Sensory (red-free)
- Choroidal
- Autofluorescence (AF)
- Fluorescein (FA)
- Indocyanine Green (ICG)

Laser Wavelengths

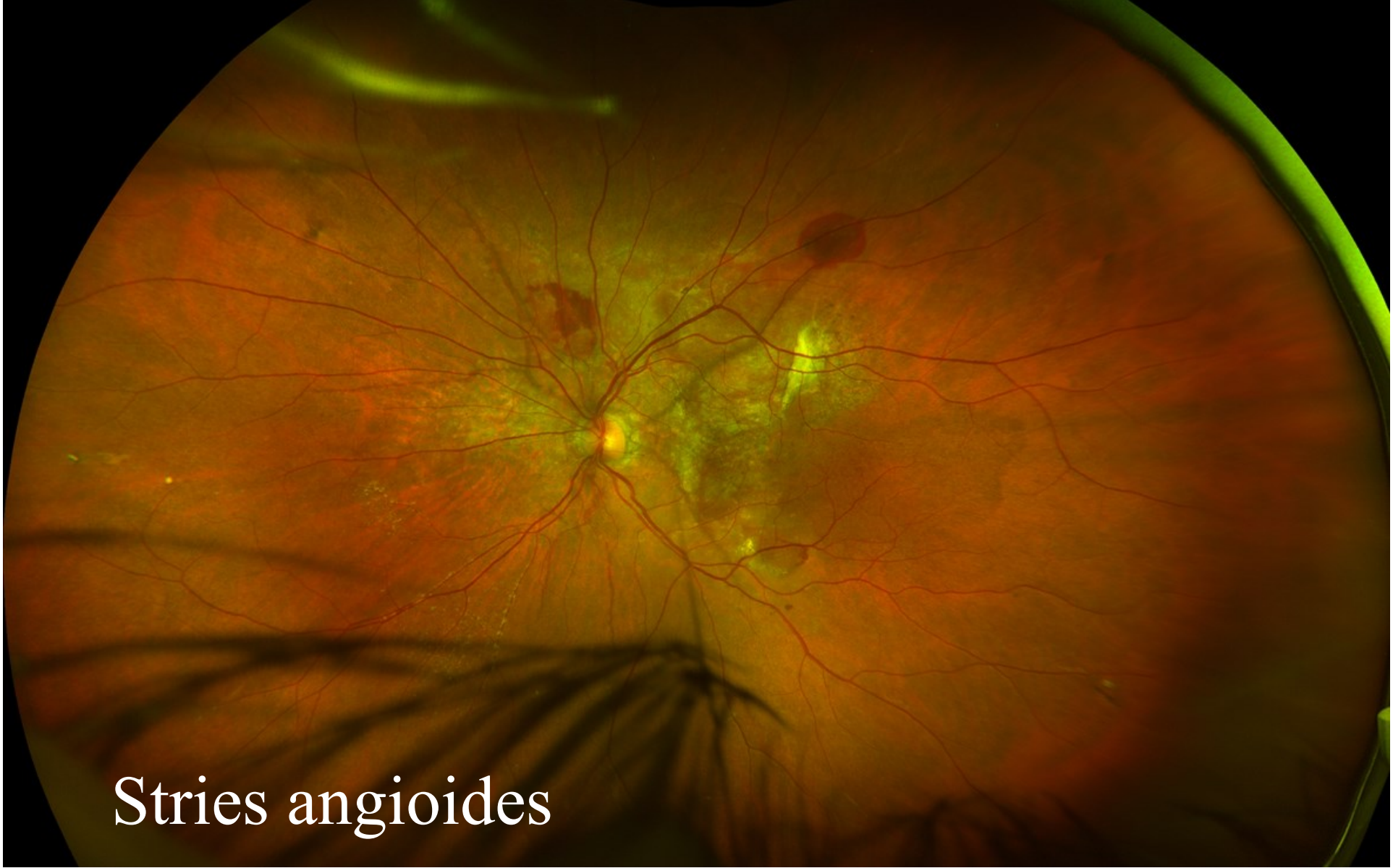
- Blue Laser: 488 nm (for FA)
- Red laser: 635 nm
- Green laser: 532 nm (for AF)
- Infra-red: 802 nm (for ICG)

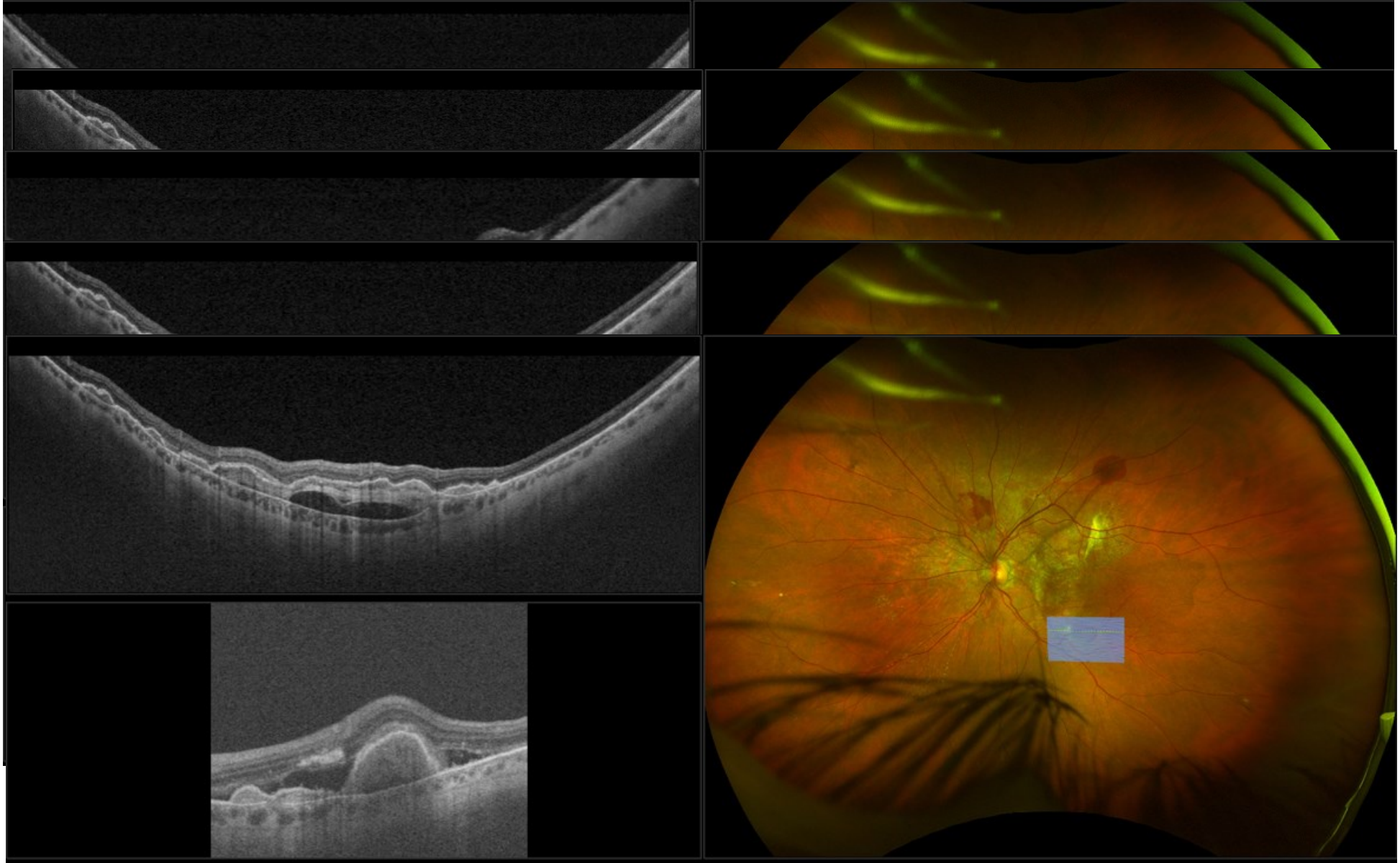
Scan Types

- 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



Nikon


Stries angioides

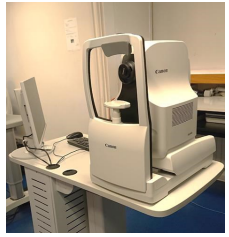


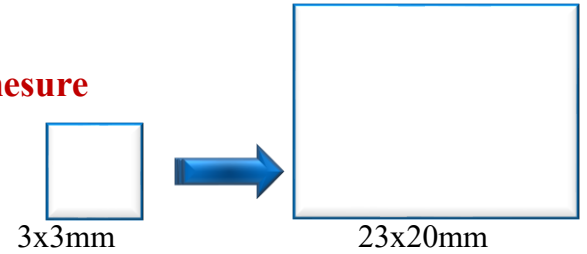
Canon Xephilio S1 *(SSOCT/SSOCTA)*

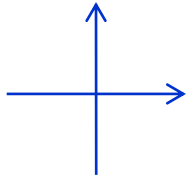
- **Swept Source 100 000A-scans/sn**
- **23 mm of UWF B-scan images in a single acquisition *(80°viewing angle)***
- **UWF OCT image up to 23 x 20 mm, high density of 928 x 807 pixels**
- **UWF Mosaic up to 31 x 27 mm**
- **5.3 mm scan depth**
- **Deep Learning AI technology – Denoise *(reduced noise)***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

Canon Xephilio S1 *(SSOCT/SSOCTA)*

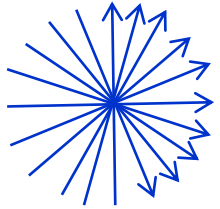
- **Swept Source 100000A-scans/sn**
- **Ultra grand champ de 23 x 20 mm en une seule mesure**
- **Mosaïque jusqu'à 31 x 27 mm**
- **Profondeur de champ 5.3 mm**
- **Intelligent Denoise**
- **Alignement automatique**
- **Focalisation SLO/OCT automatique**
- **Positionnement de la coupe automatique**
-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



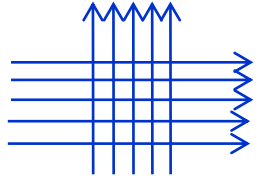




3x3mm - 23x20mm



3-6-12mmx23mm



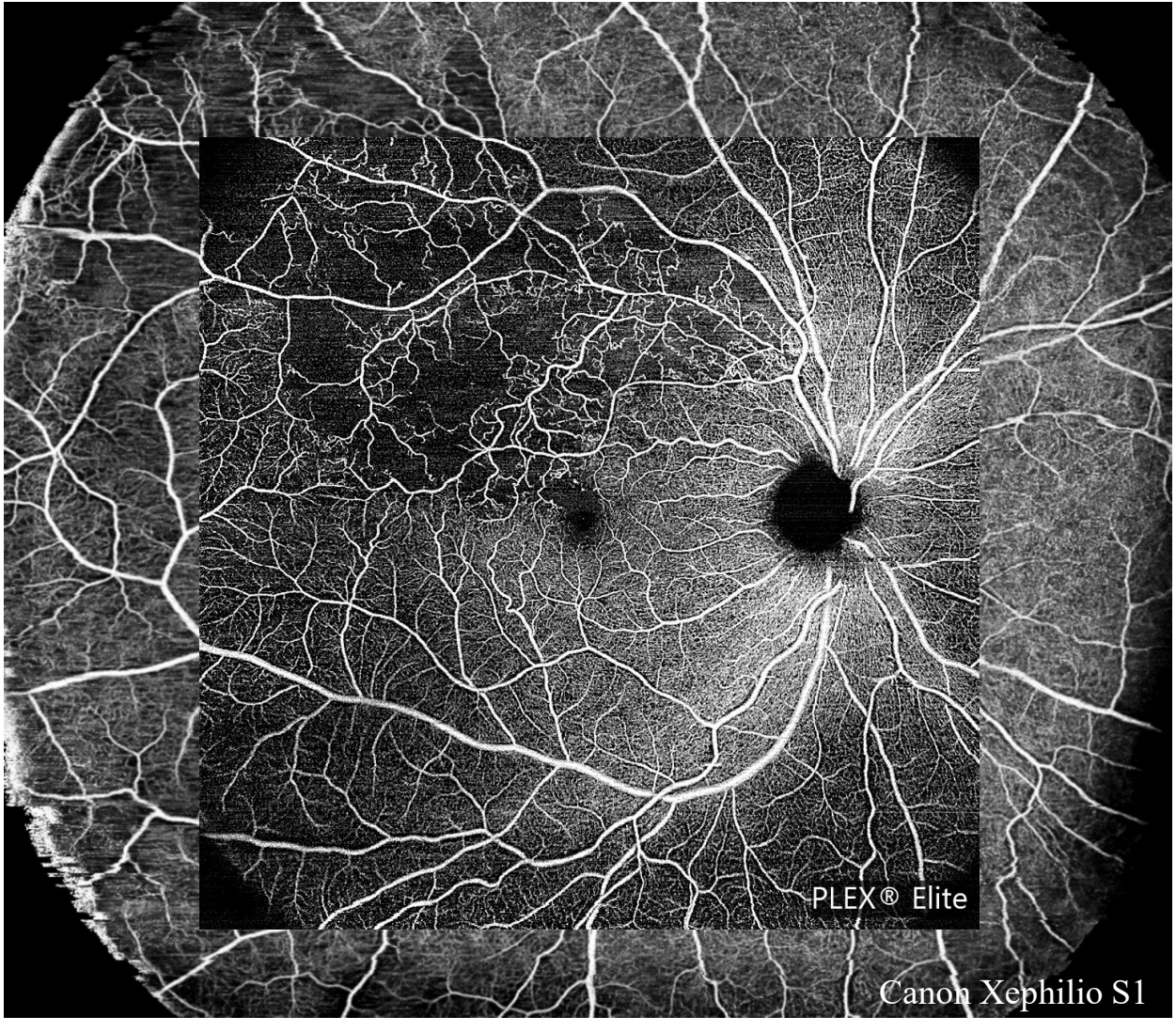
3x3mm à 23x20mm

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

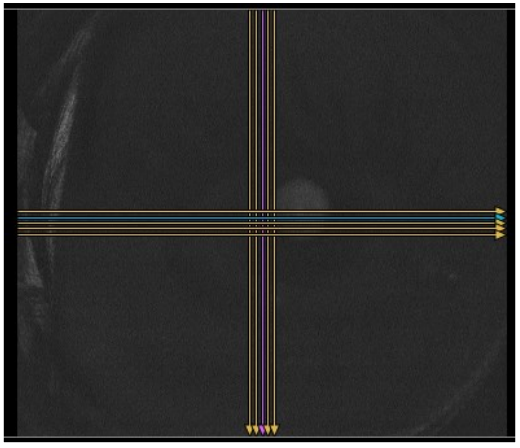
Choroid (Inverse)
- Multi Cross
- Radial
- Cross
- Custom 3D

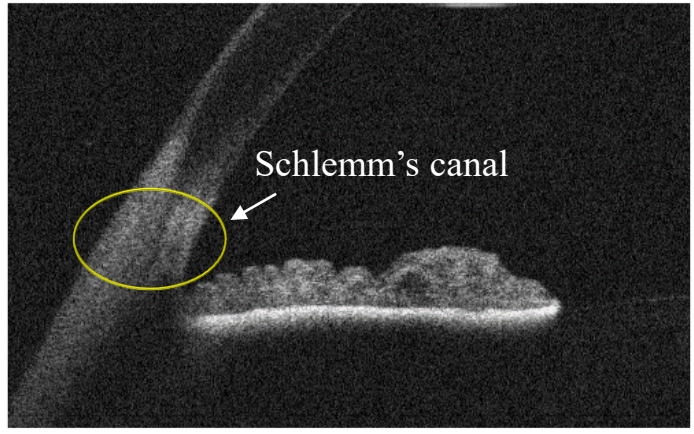
Glaucoma
- Glaucoma 3D
- Disc 3D
- Radial

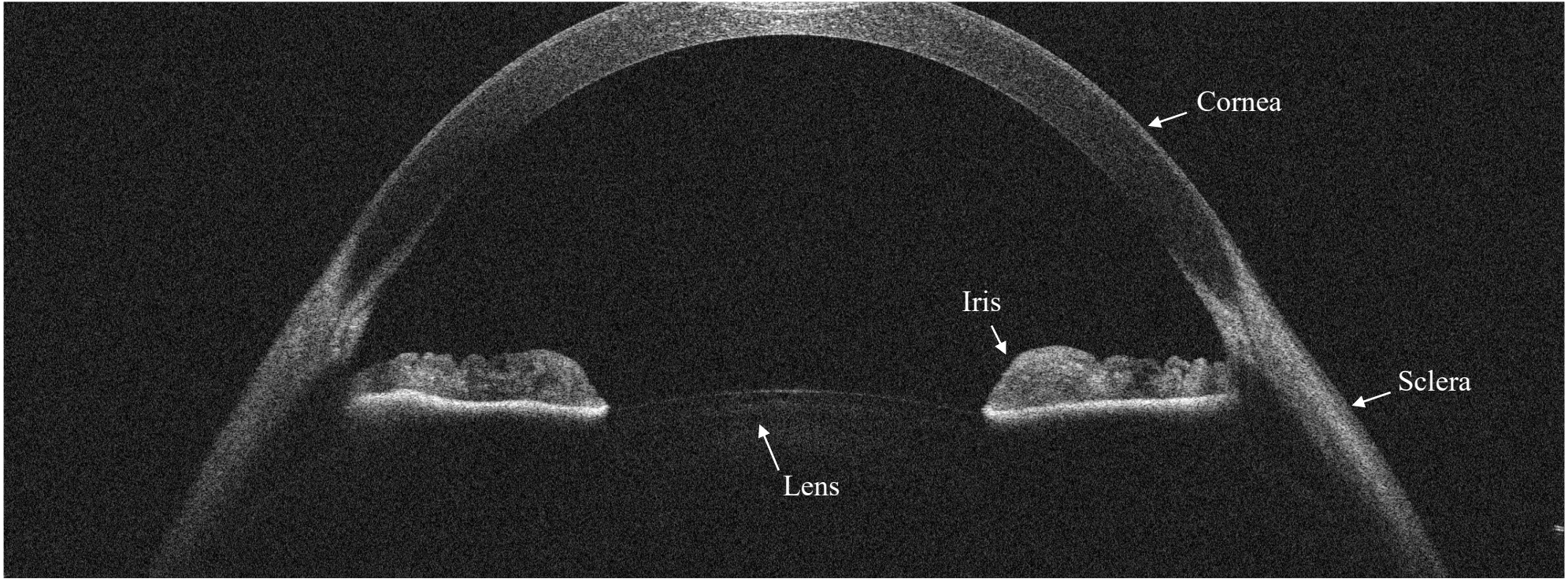
Anterior (12x12mm)
- Cross
- Radial

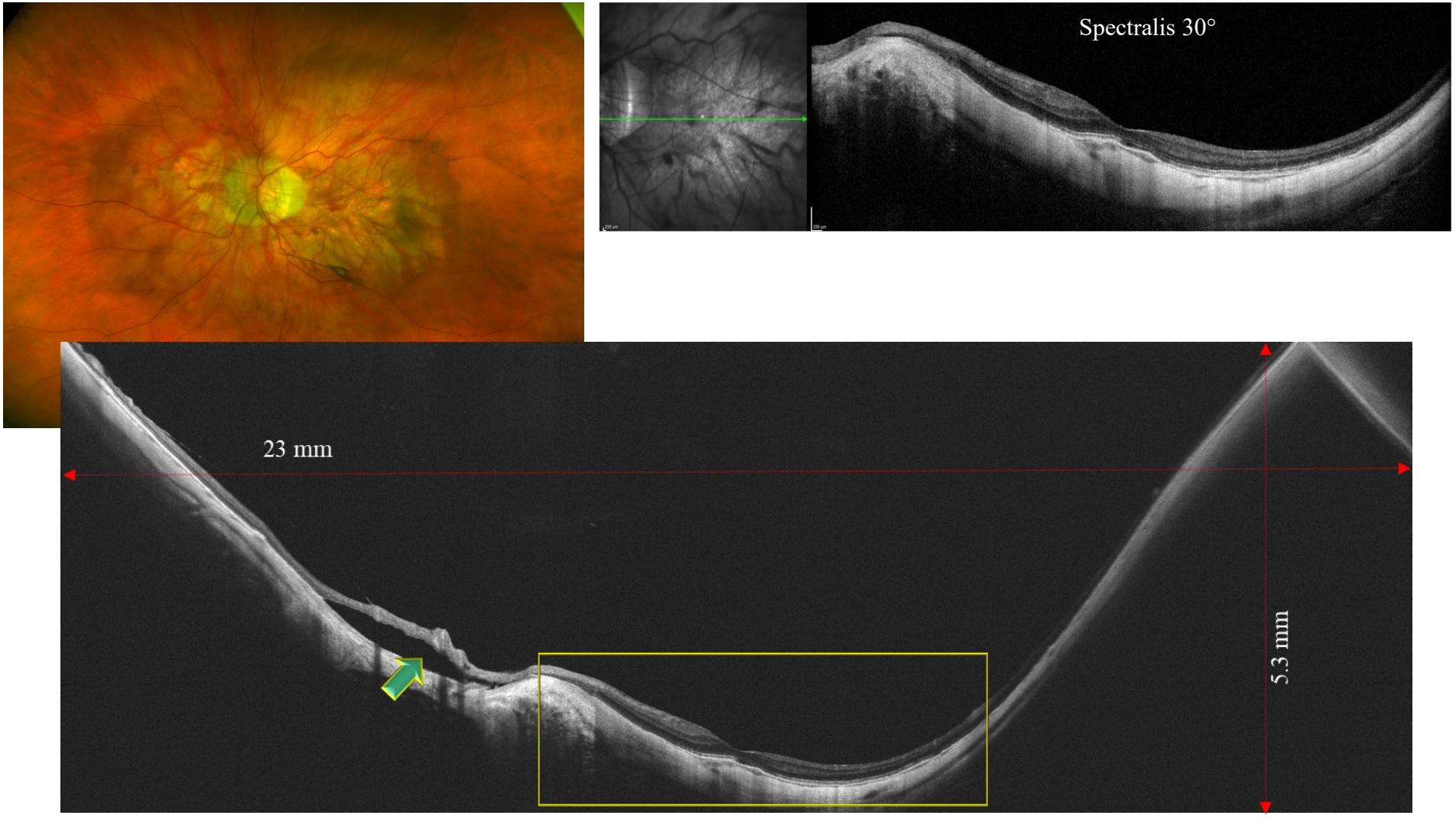


Canon Xephilio S1 (23x20mm)
Vs
Zeiss PlexElite (15x15mm)

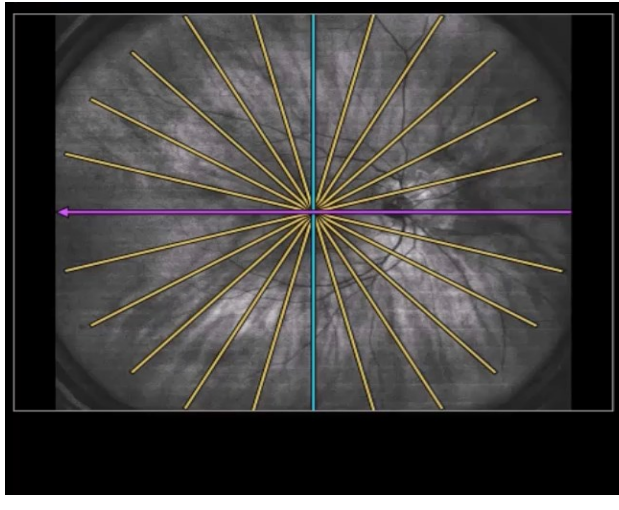


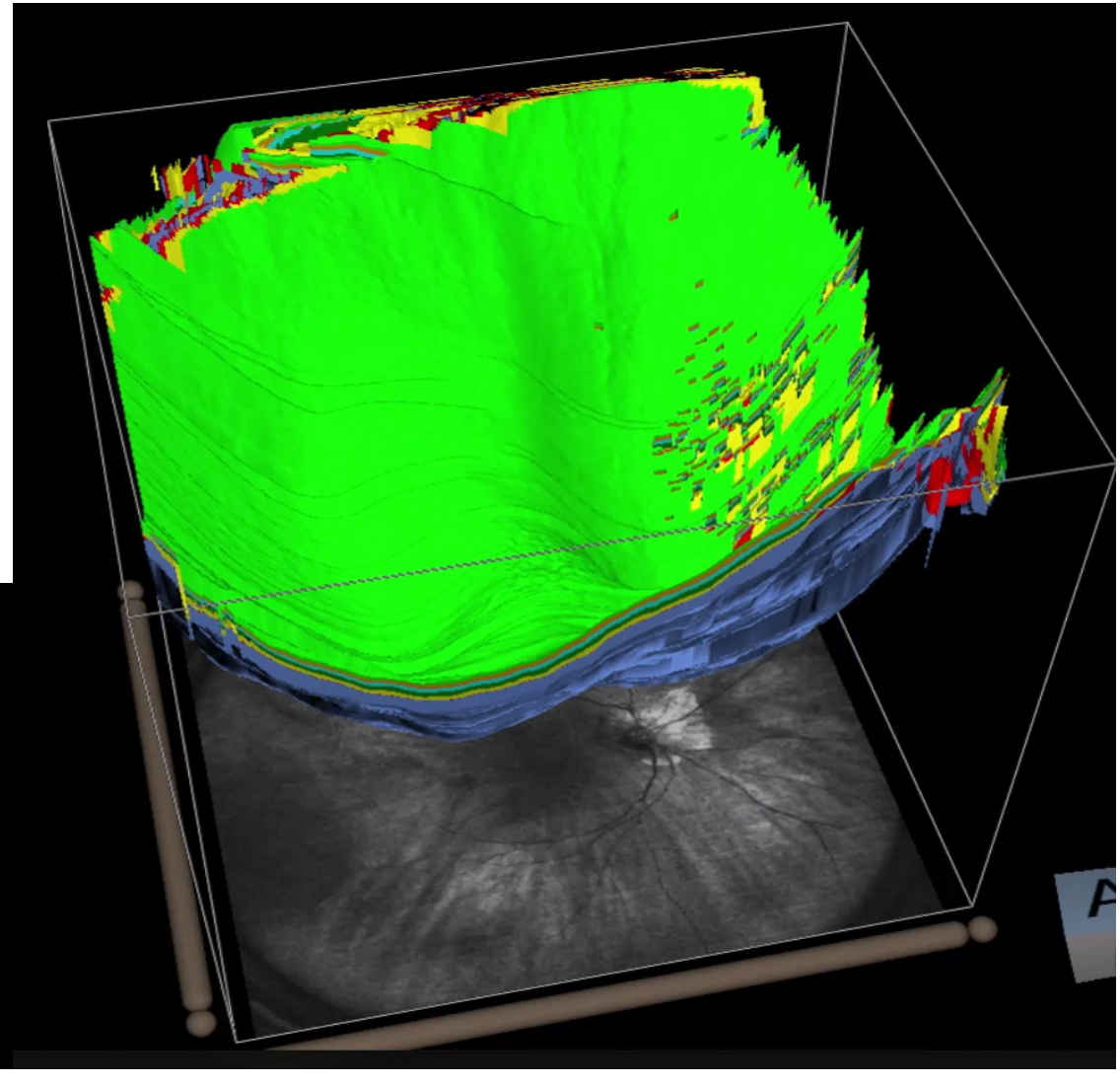

Schlemm’s canal

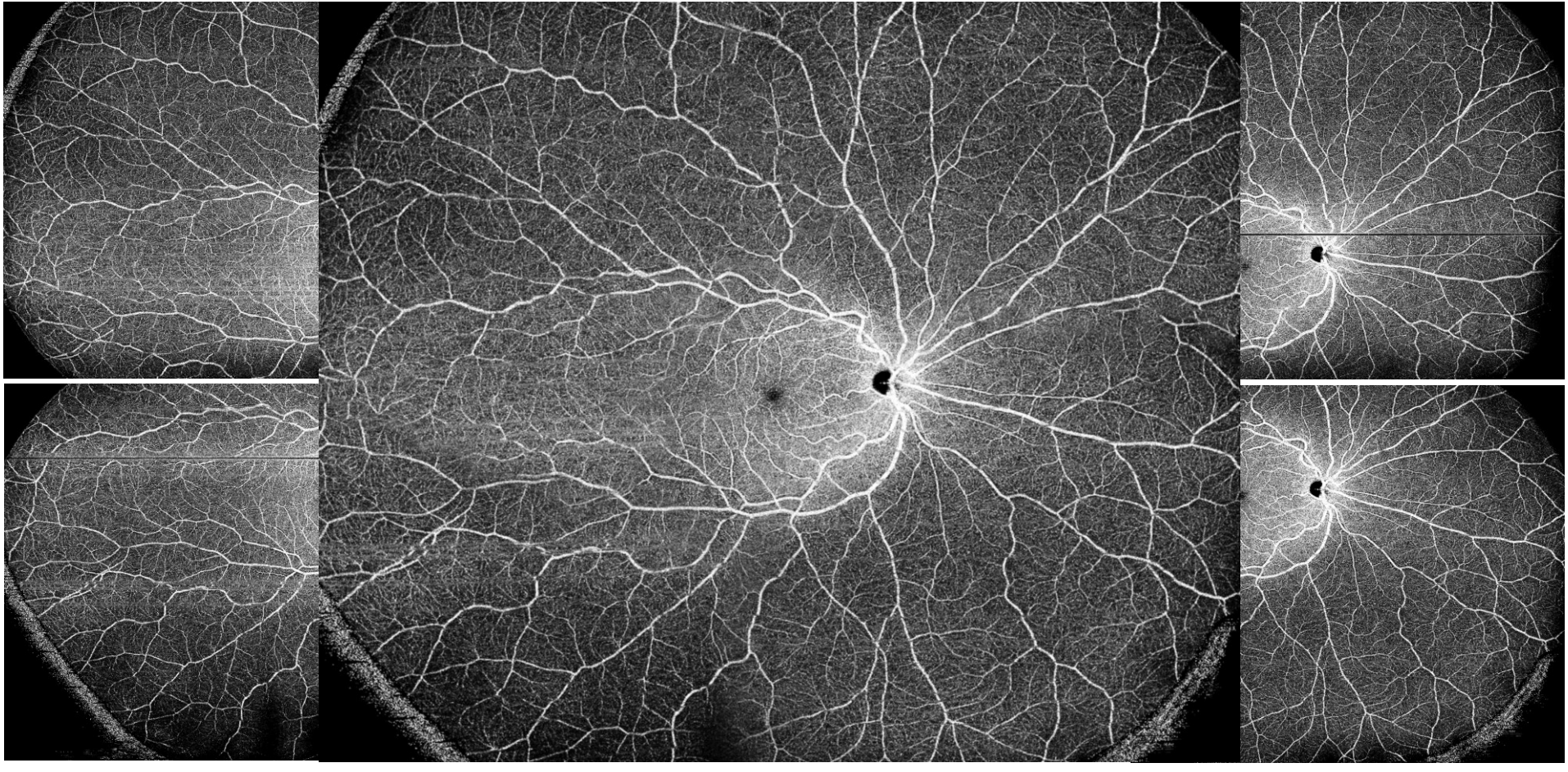

Cornea
Iris
Sclera
Lens

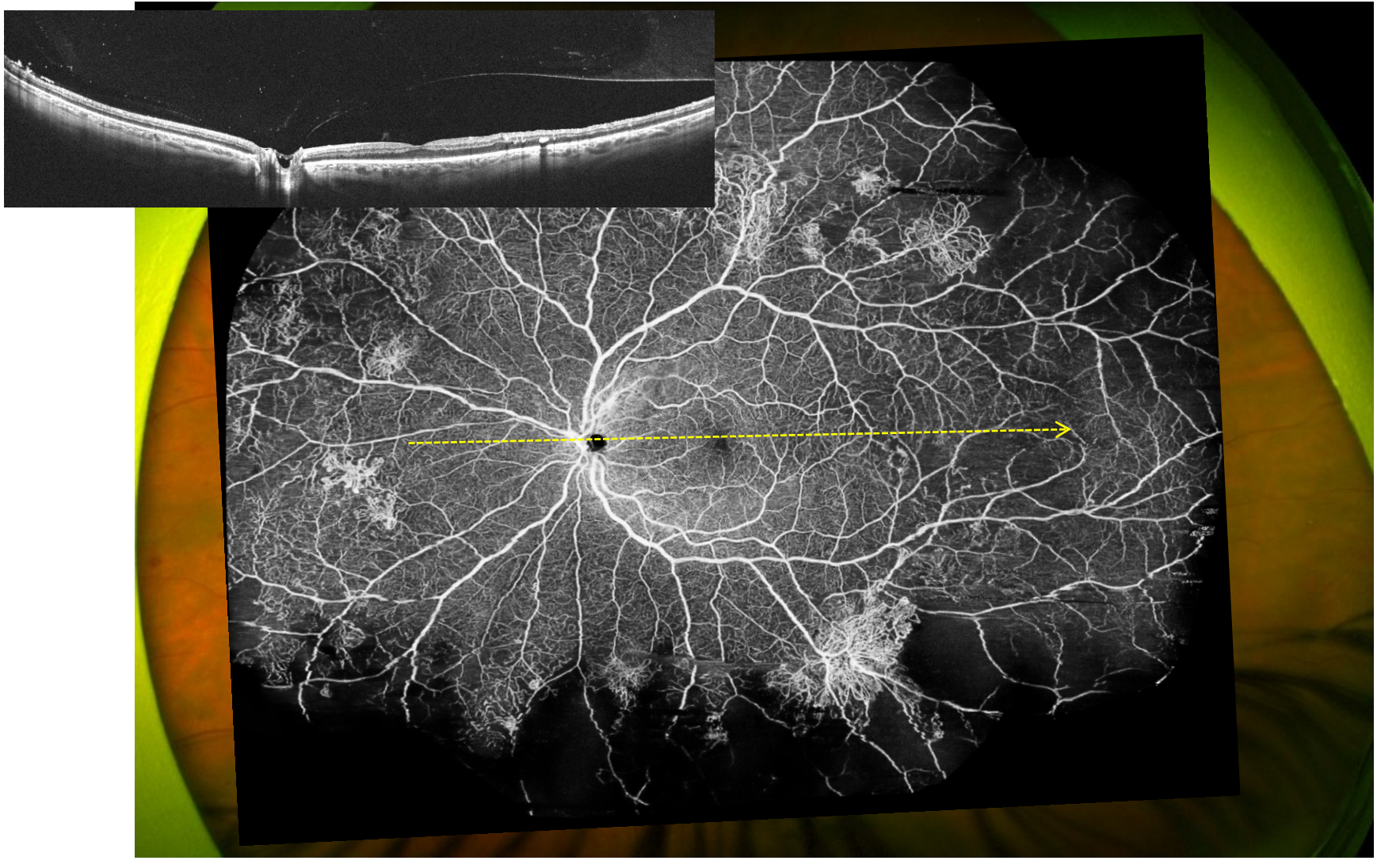

Spectralis 30°
23 mm
5.3 mm

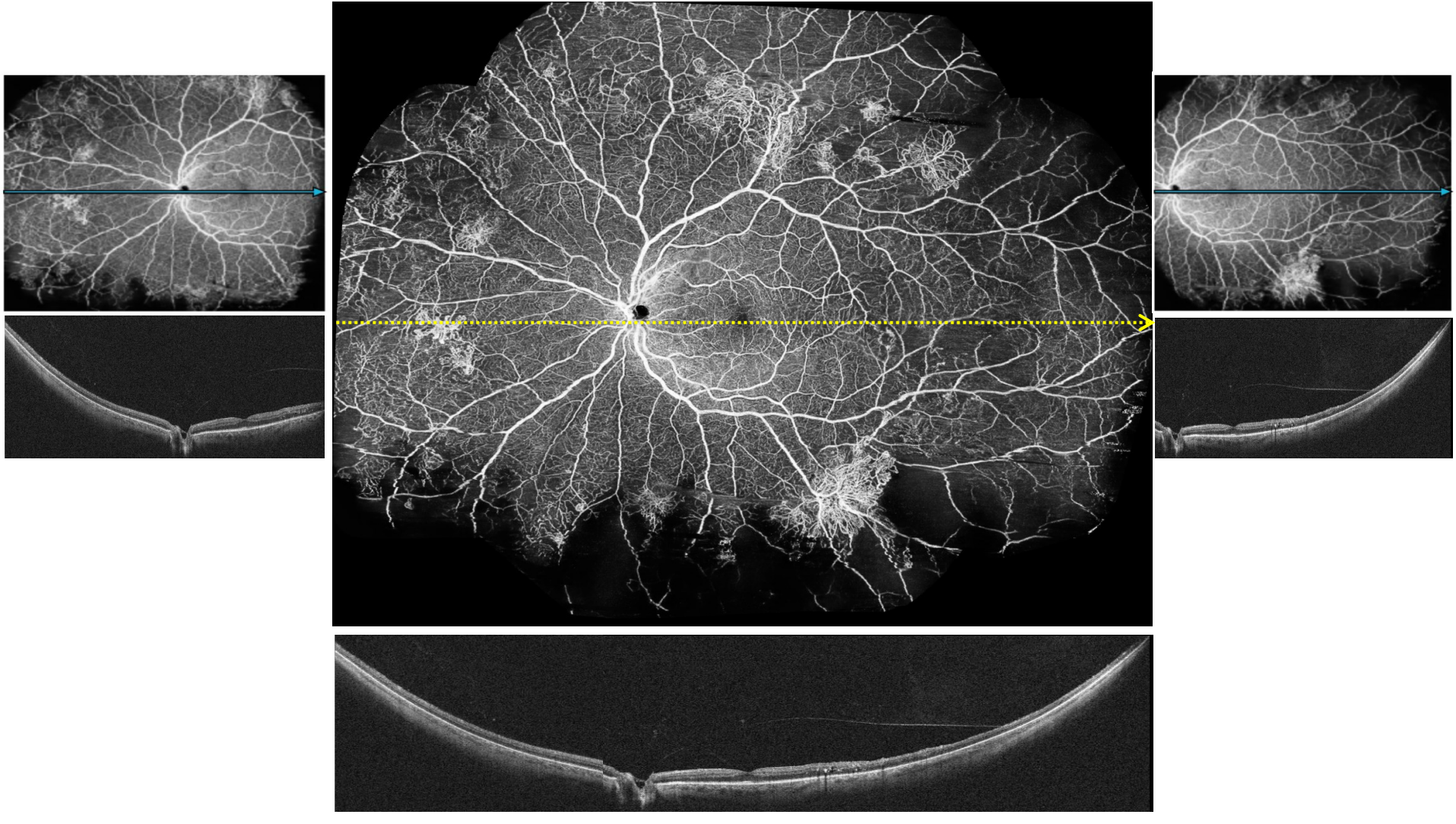

23x20mm

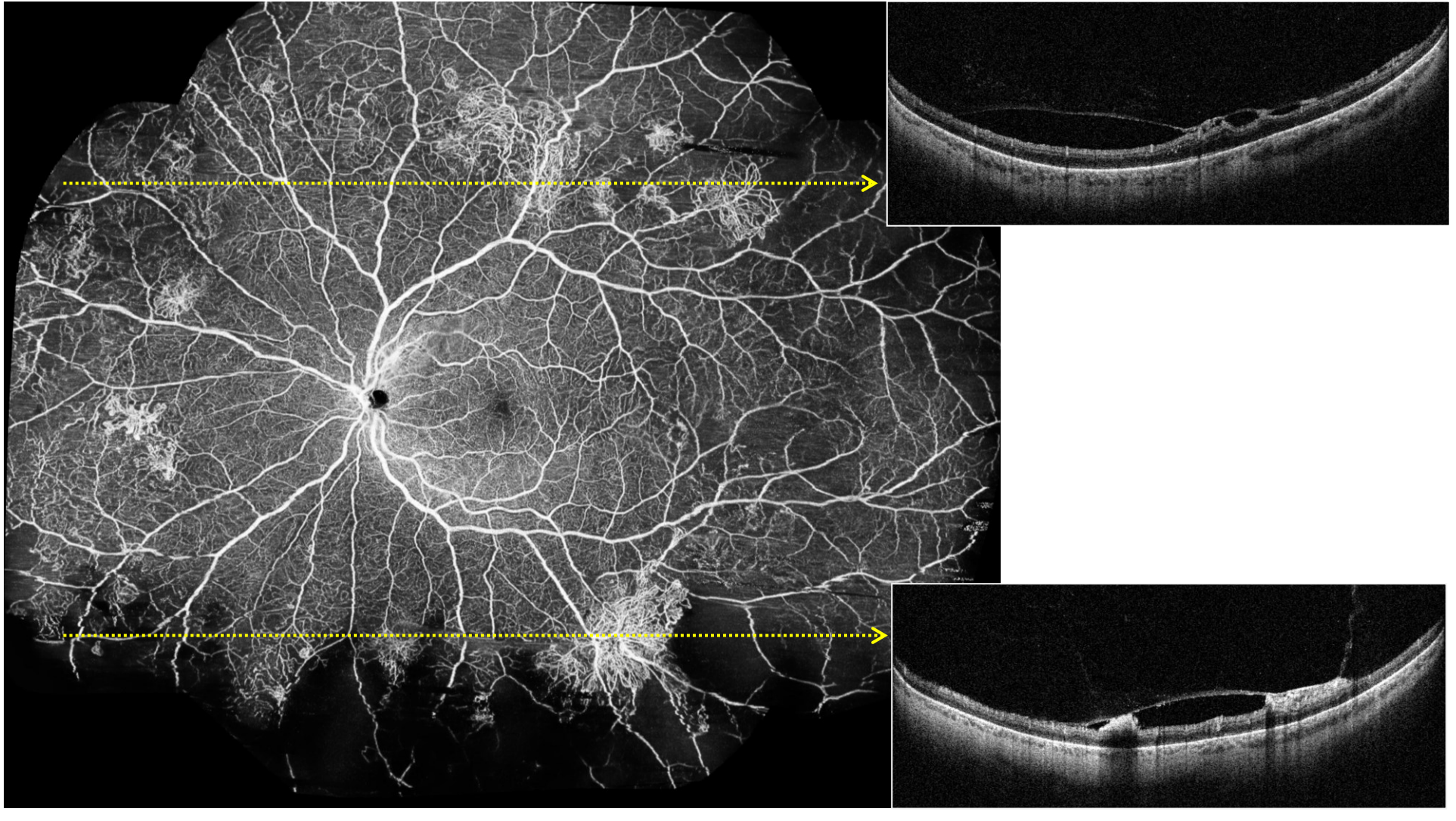


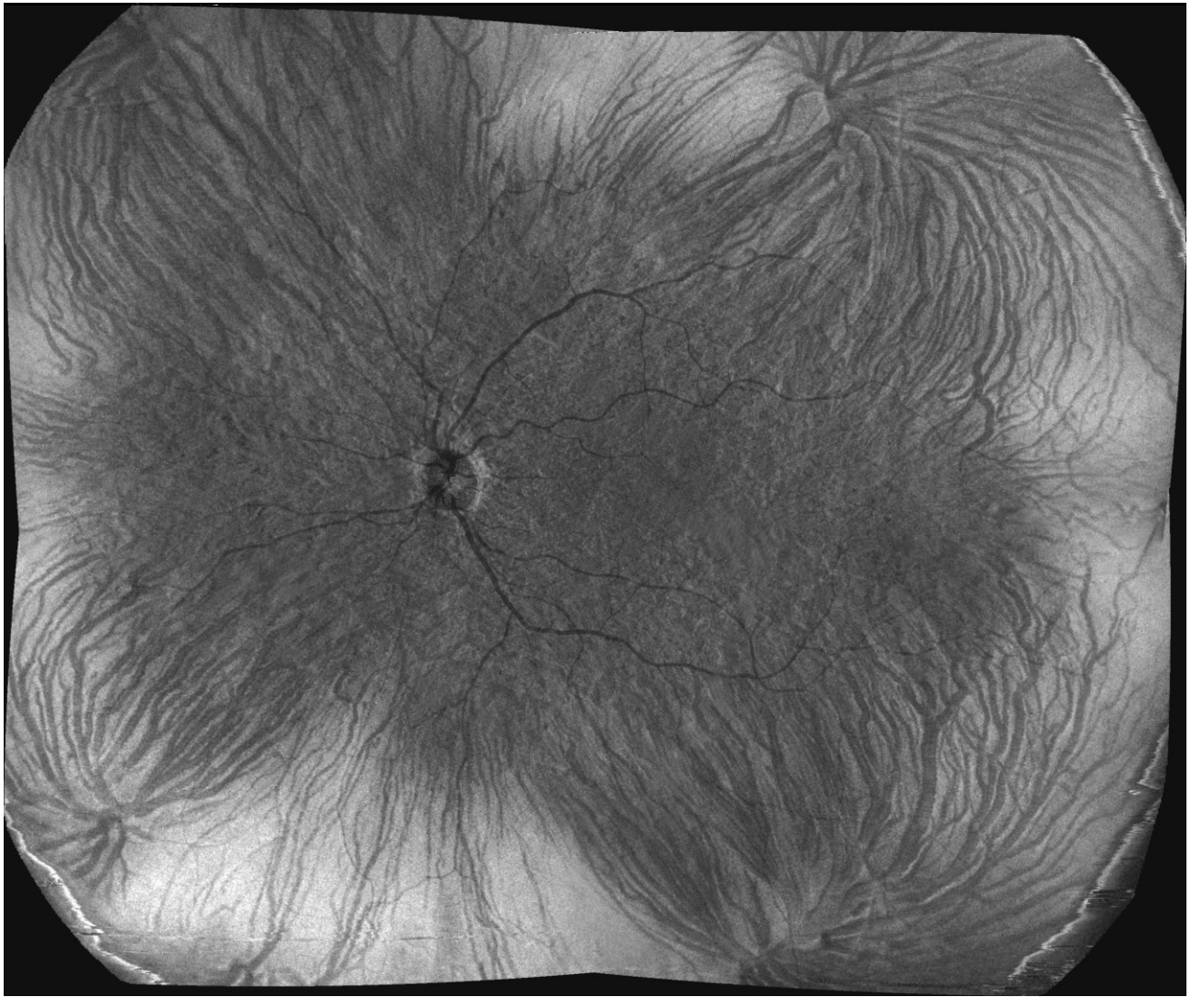












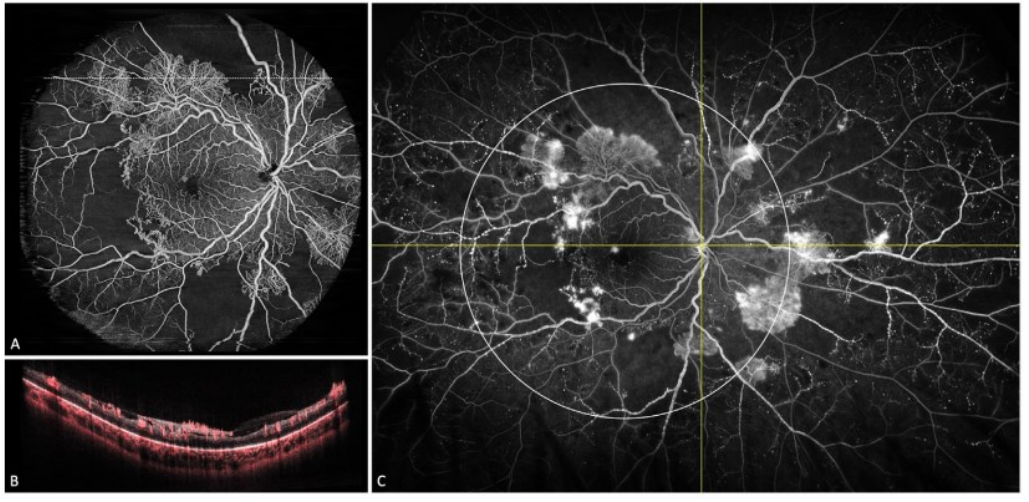
Canon Xephilio, « mosaïc »

Mosaic en-face image showing 4 choroidal vortex veins.

Detection of diabetic neovascularisation using single-capture 65°-widefield optical coherence tomography angiography

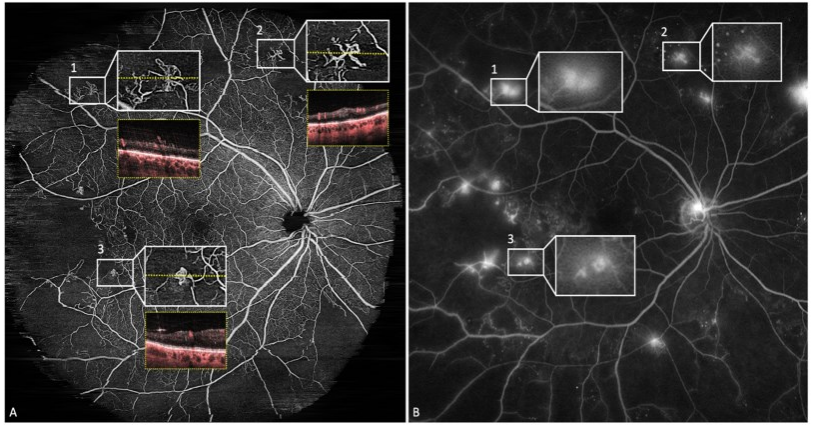
Heiko Stino ,[1] Michael Niederleithner,[2] Johannes Iby ,[1] Aleksandra Sedova,[1] Thomas Schlegl,[2] Irene Steiner,[3] Stefan Sacu,[1] Wolfgang Drexler,[2] Tilman Schmoll,[2,4] Rainer Leitgeb,[2] Ursula Margarethe Schmidt-Erfurth ,[1] Andreas Pollreisz [1]

Br J Ophthalmol 2022



Une image **(WF-SS-OCTA) à 65°** avec un diamètre de 18mm réalisée avec un système **PlexElite** modifié (développé par le Centre de physique médicale et d'ingénierie biomédicale de l'Université médicale de Vienne) est comparée à **l'angiographie à la fluorescéine à champ ultra-large (UWF-FA)**

Examen des scans B de l'OCTA à la recherche de NV, visibles comme des signaux de flux sanguin franchissant la membrane interne, a révélé une sensibilité de 0,95 de 0,95 pour le diagnostic du PDR.
Sur l'UWF-FA, la majorité des NV (63 %) étaient situés dans les quadrants dans les quadrants temporaux, 93 % d'entre eux étant détectés en utilisant la WF-OCTA à capture unique.

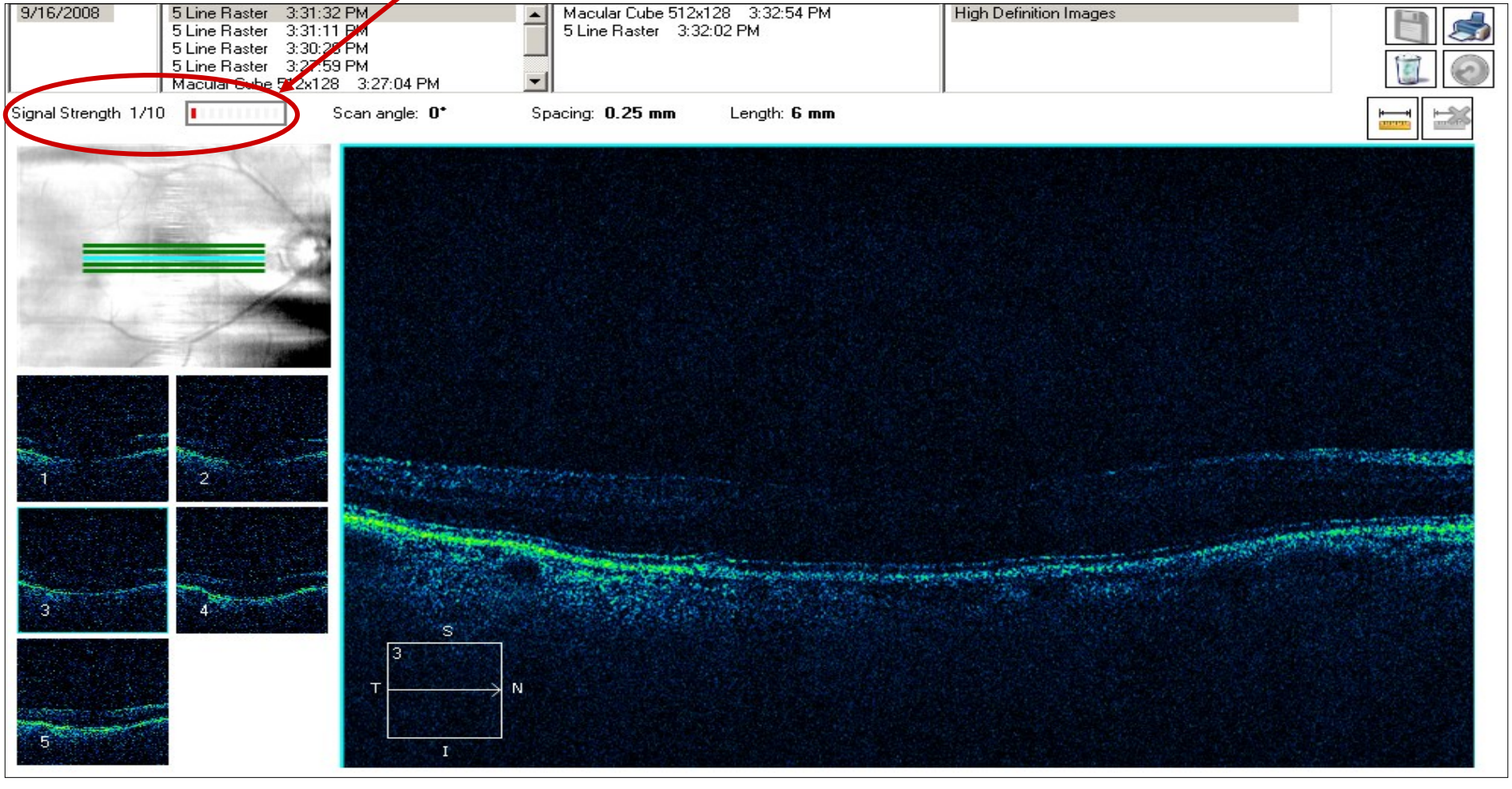


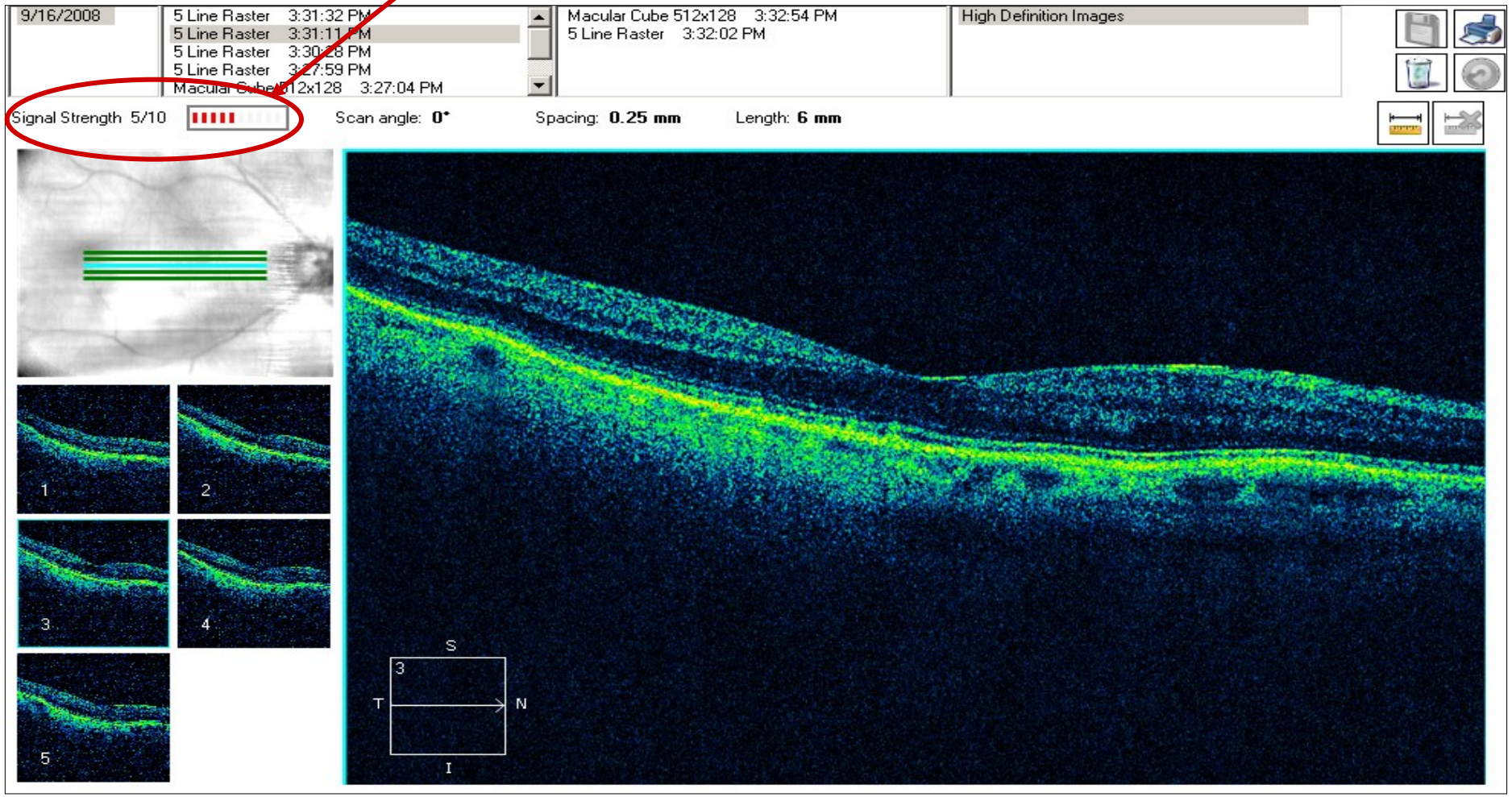
La sensibilité élevée de la WF-OCTA à capture unique dans le diagnostic de la RDP par rapport à l'UWF-FA peut améliorer la prise en charge clinique des patients patients atteints de diabète. La WF-OCTA 65° à capture unique, rapide et non invasive, a le potentiel de remplacer l'UWF-FA en tant qu'outil de diagnostic unique. remplacer l'UWF-FA en tant qu'outil de diagnostic unique.

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
1
2
3
4
5
S
3
T
N
I


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 5/10
Scan angle: 0°
Spacing: 0.25 mm
Length: 6 mm
1
2
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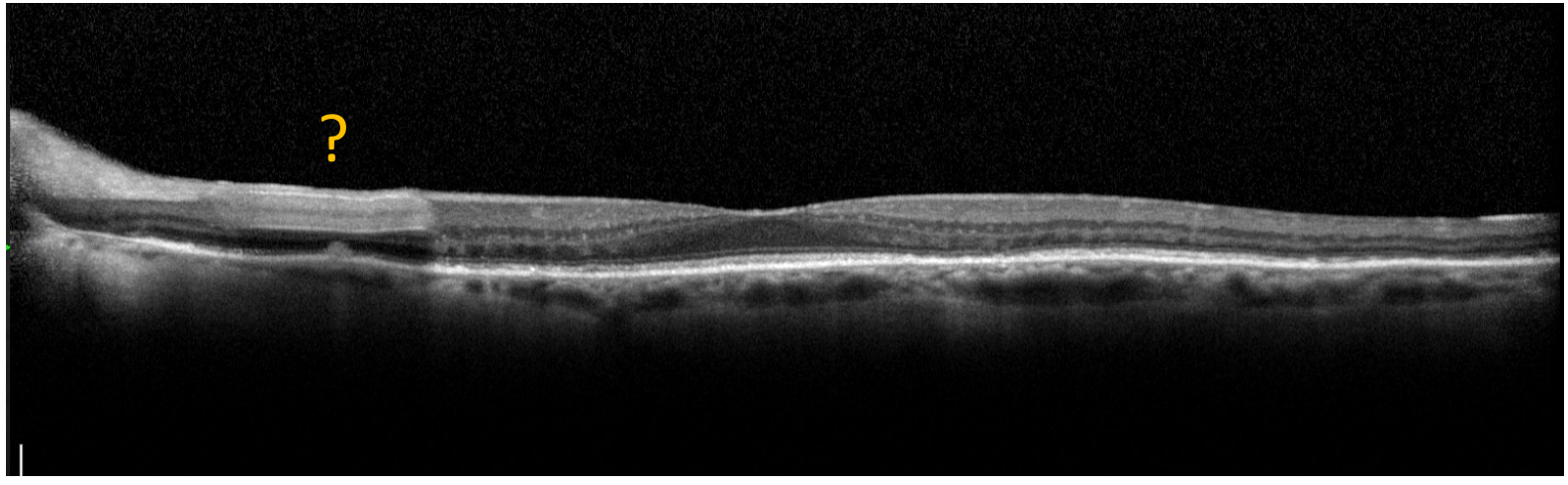
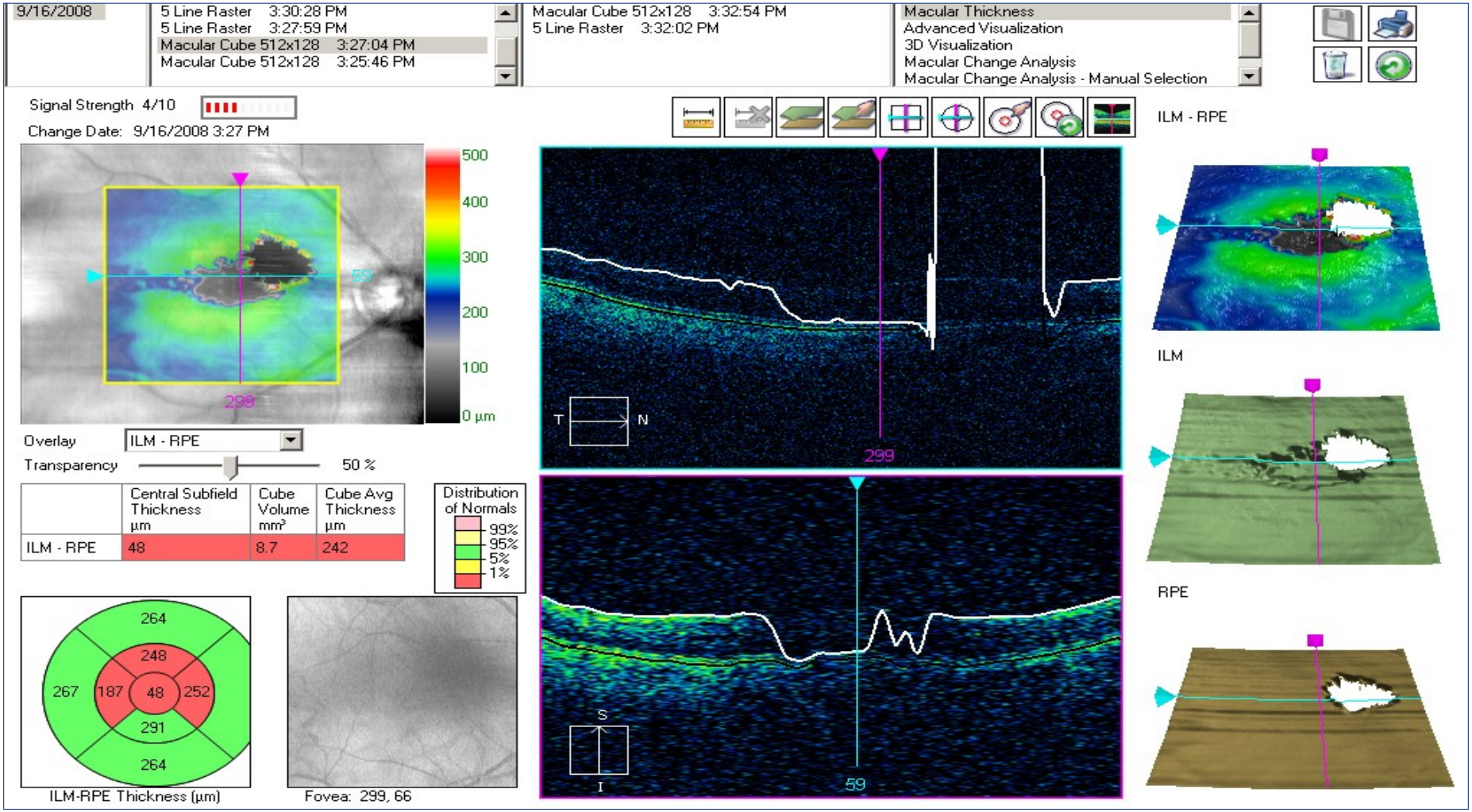
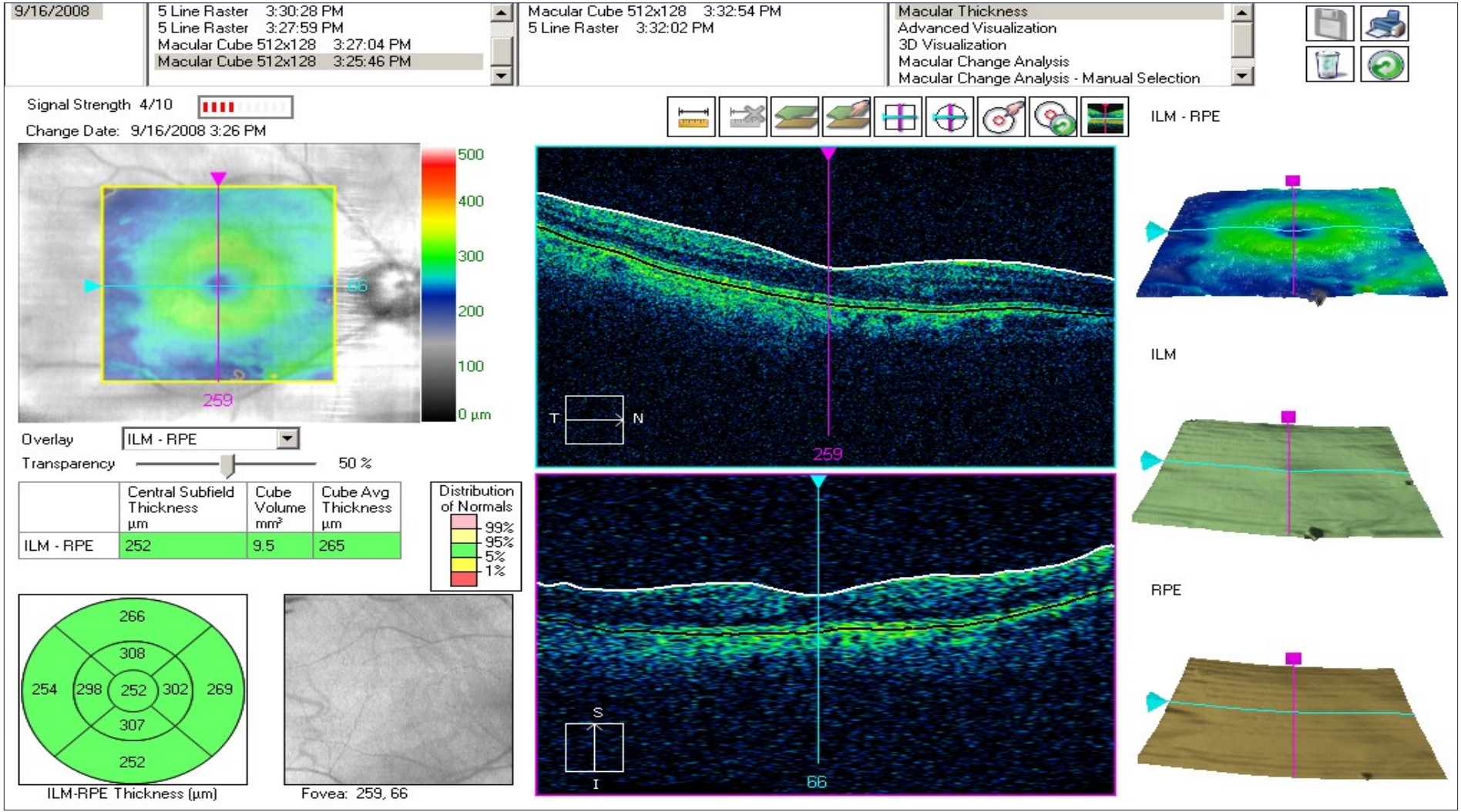
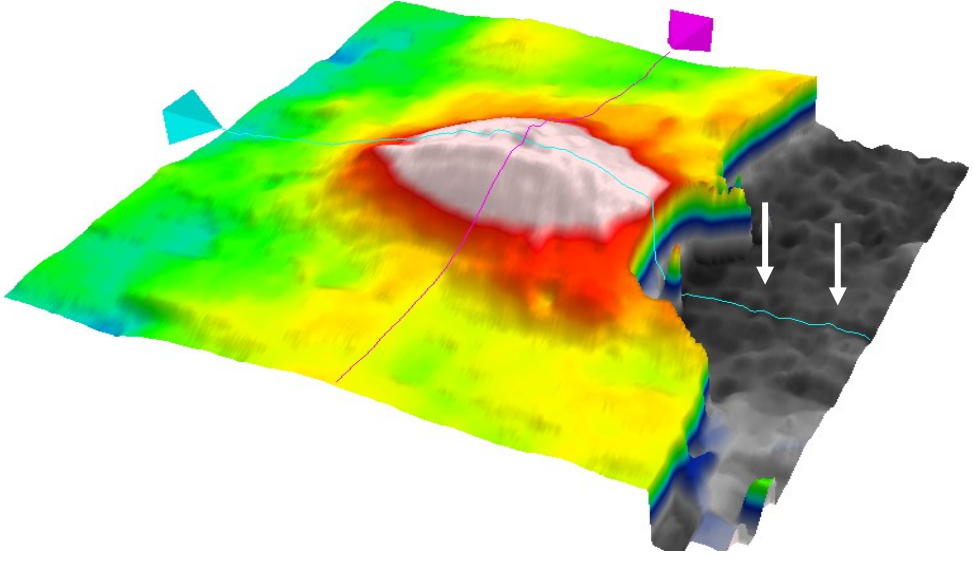

?


200 µm

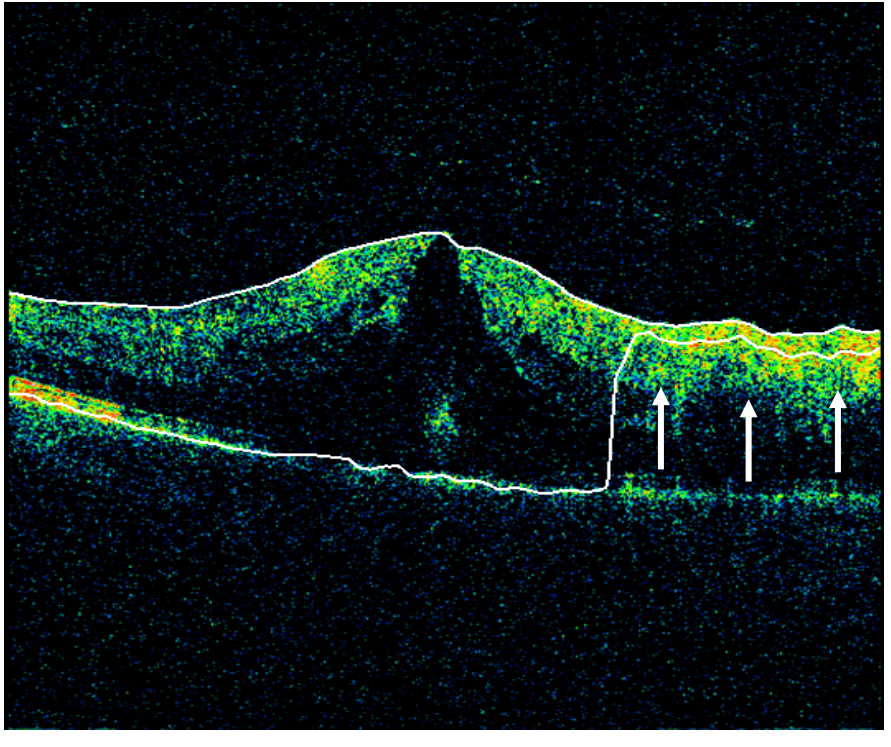

200 µm

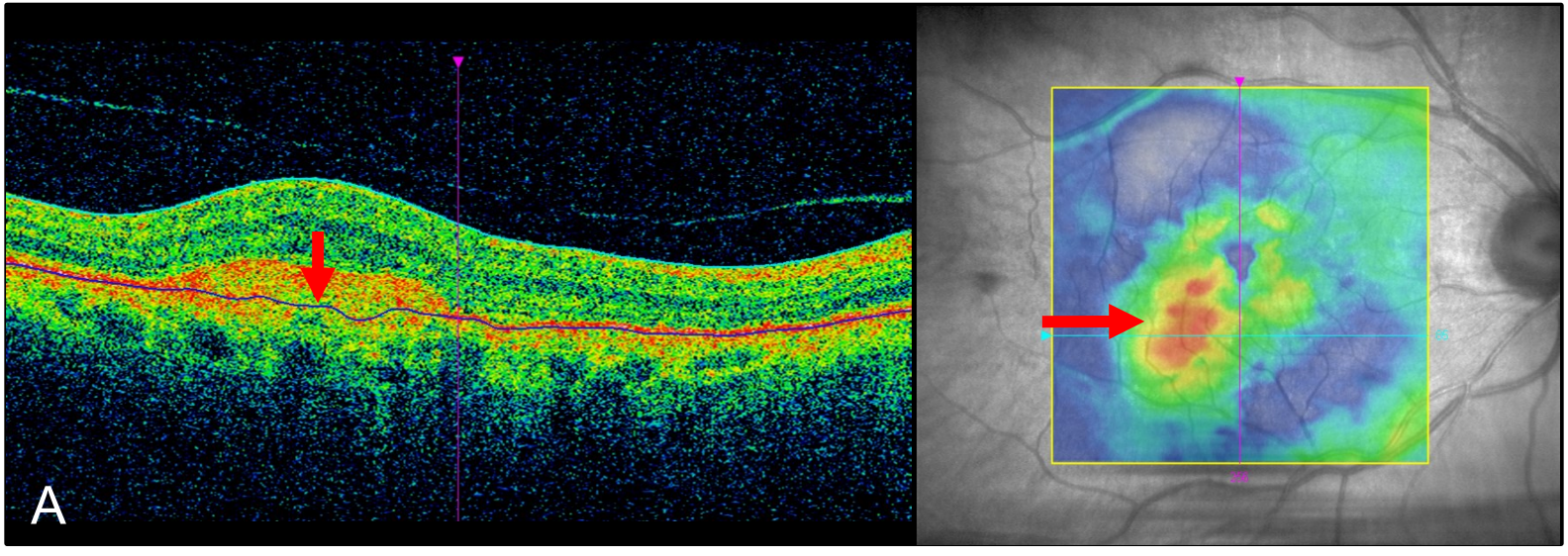

9/16/2008
5 Line Raster 3:30:28 PM
5 Line Raster 3:27:59 PM
Macular Cube 512x128 3:27:04 PM
Macular Cube 512x128 3:25:46 PM
Macular Cube 512x128 3:32:54 PM
5 Line Raster 3:32:02 PM
Macular Thickness
Advanced Visualization
3D Visualization
Macular Change Analysis
Macular Change Analysis - Manual Selection
Signal Strength 4/10
Change Date: 9/16/2008 3:27 PM
500
400
300
200
100
0 µm
59
299
Overlay
ILM - RPE
Transparency
50 %
Central Subfield Thickness µm
Cube Volume mm³
Cube Avg Thickness µm
ILM - RPE
48
8.7
242
Distribution of Normals
99%
95%
5%
1%
264
248
267
187
48
252
291
264
ILM-RPE Thickness (µm)
Fovea: 299, 66
T
N
299
S
I
59
ILM - RPE
ILM
RPE

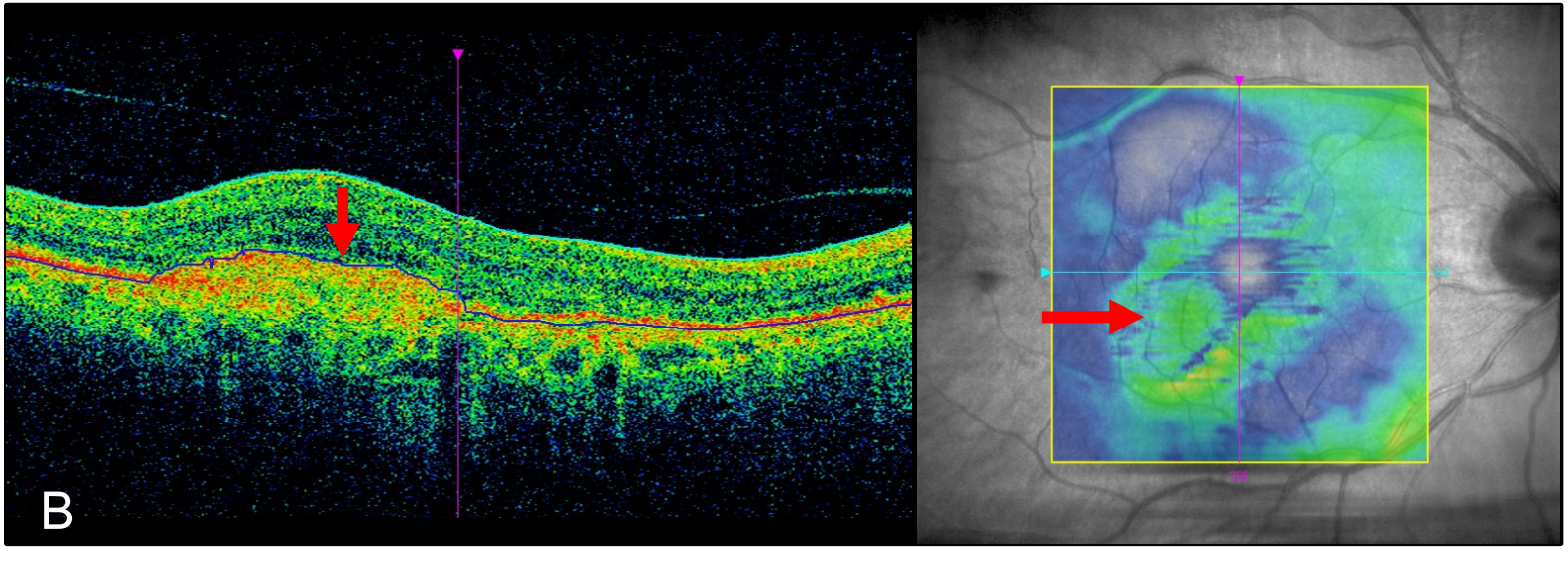

9/16/2008
5 Line Raster 3:30:28 PM
5 Line Raster 3:27:59 PM
Macular Cube 512x128 3:27:04 PM
Macular Cube 512x128 3:25:46 PM
Macular Cube 512x128 3:32:54 PM
5 Line Raster 3:32:02 PM
Macular Thickness
Advanced Visualization
3D Visualization
Macular Change Analysis
Macular Change Analysis - Manual Selection
Signal Strength 4/10
Change Date: 9/16/2008 3:26 PM
ILM - RPE
500
400
300
200
100
0 µm
66
259
T
N
259
Overlay
ILM - RPE
Transparency
50 %
ILM
RPE
Central Subfield Thickness µm
Cube Volume mm³
Cube Avg Thickness µm
ILM - RPE
252
9.5
265
Distribution of Normals
99%
95%
5%
1%
266
308
254
298
252
302
269
307
252
S
I
66
ILM-RPE Thickness (µm)
Fovea: 259, 66



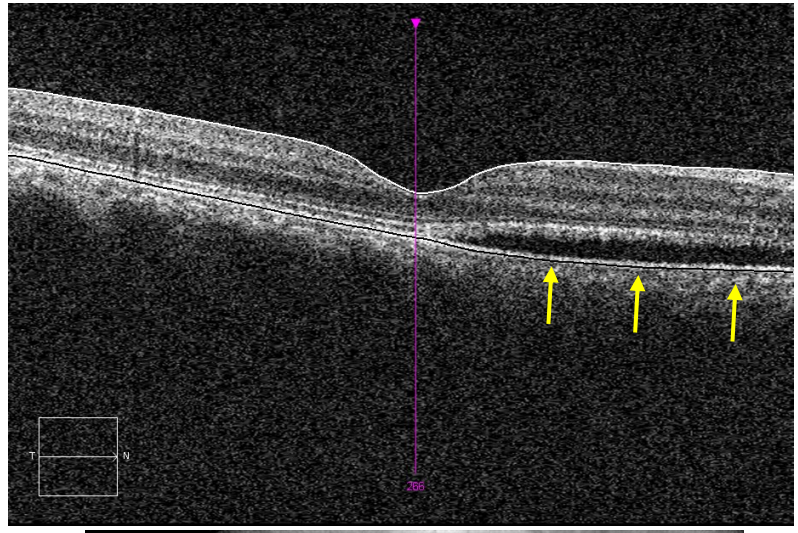
Artéfacts sur le mapping 3D

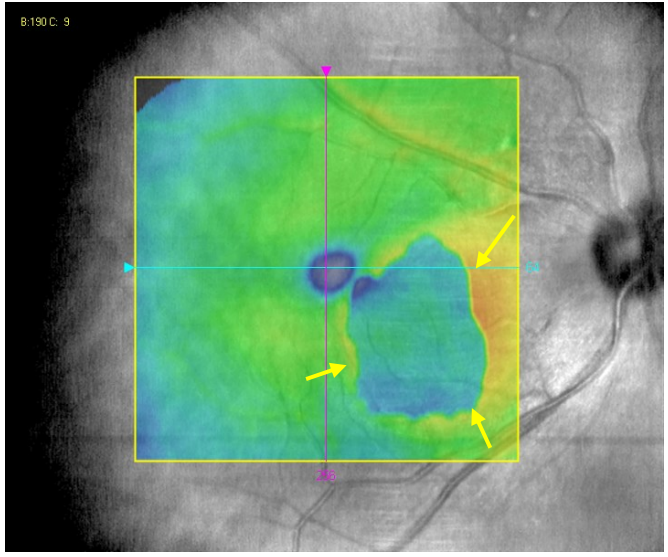


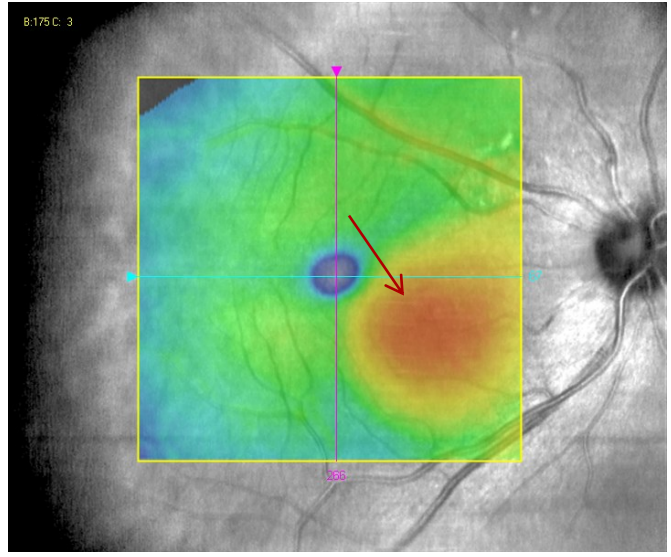

A

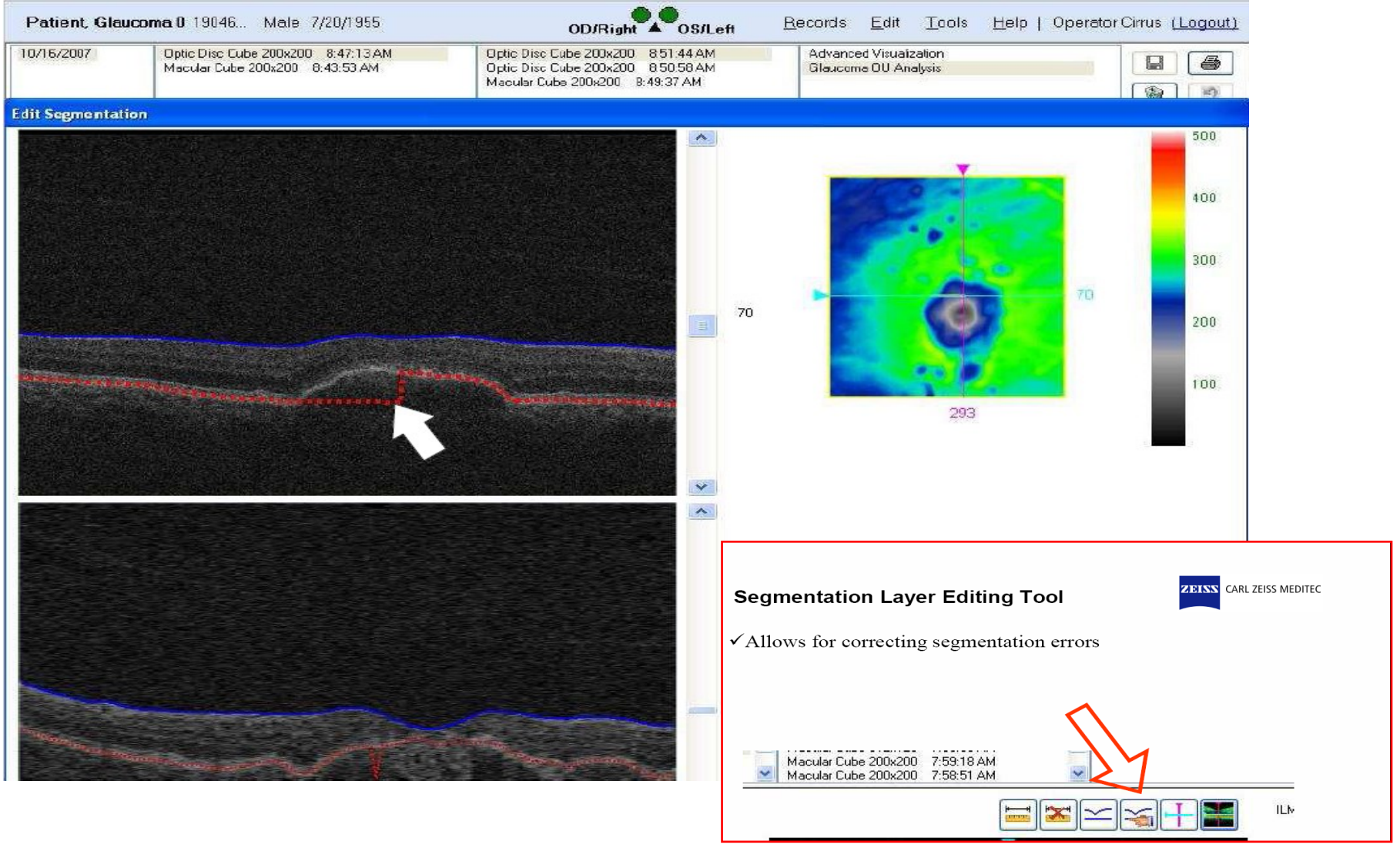

B

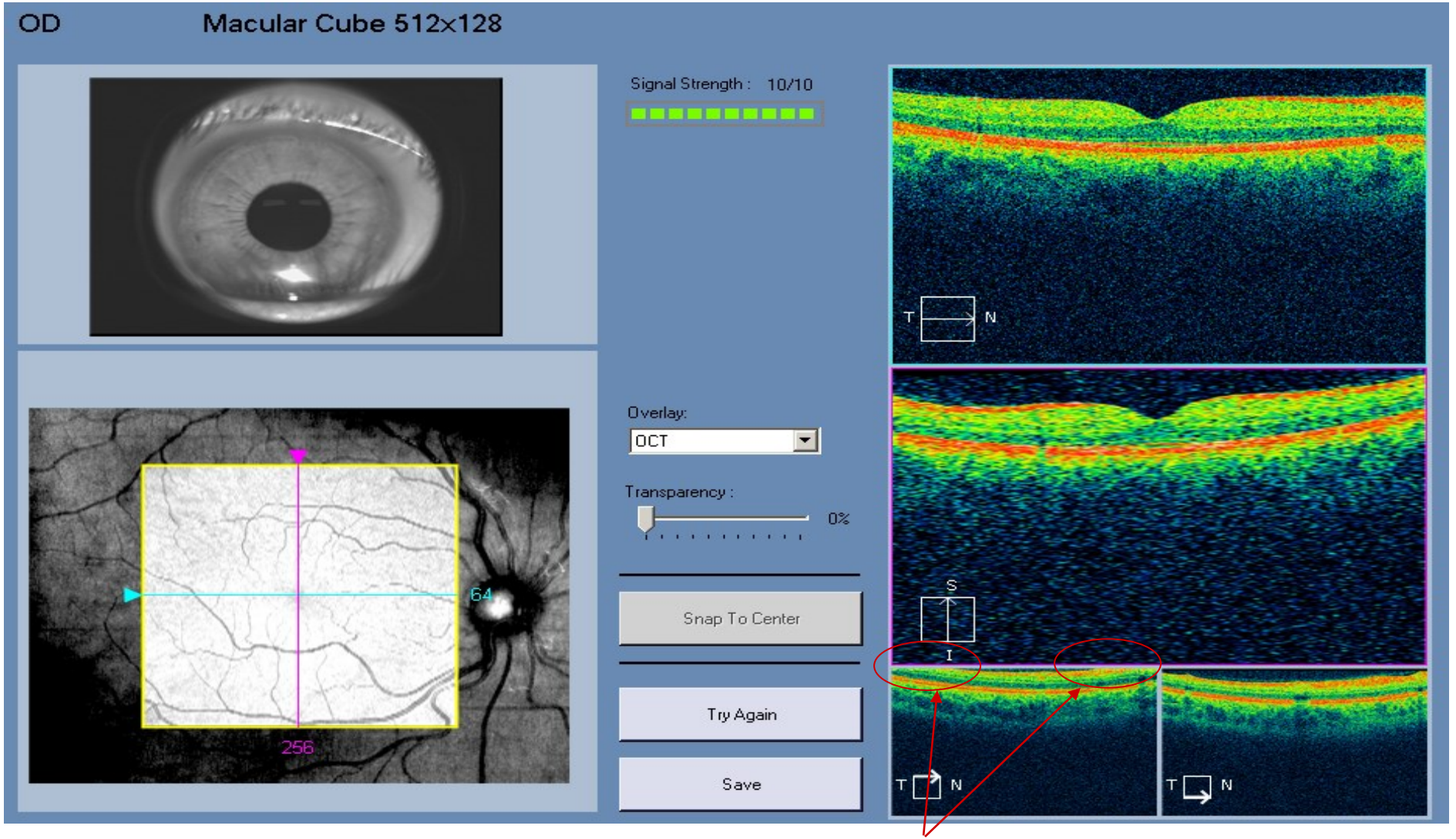

B:126 C: 35
T
N
265

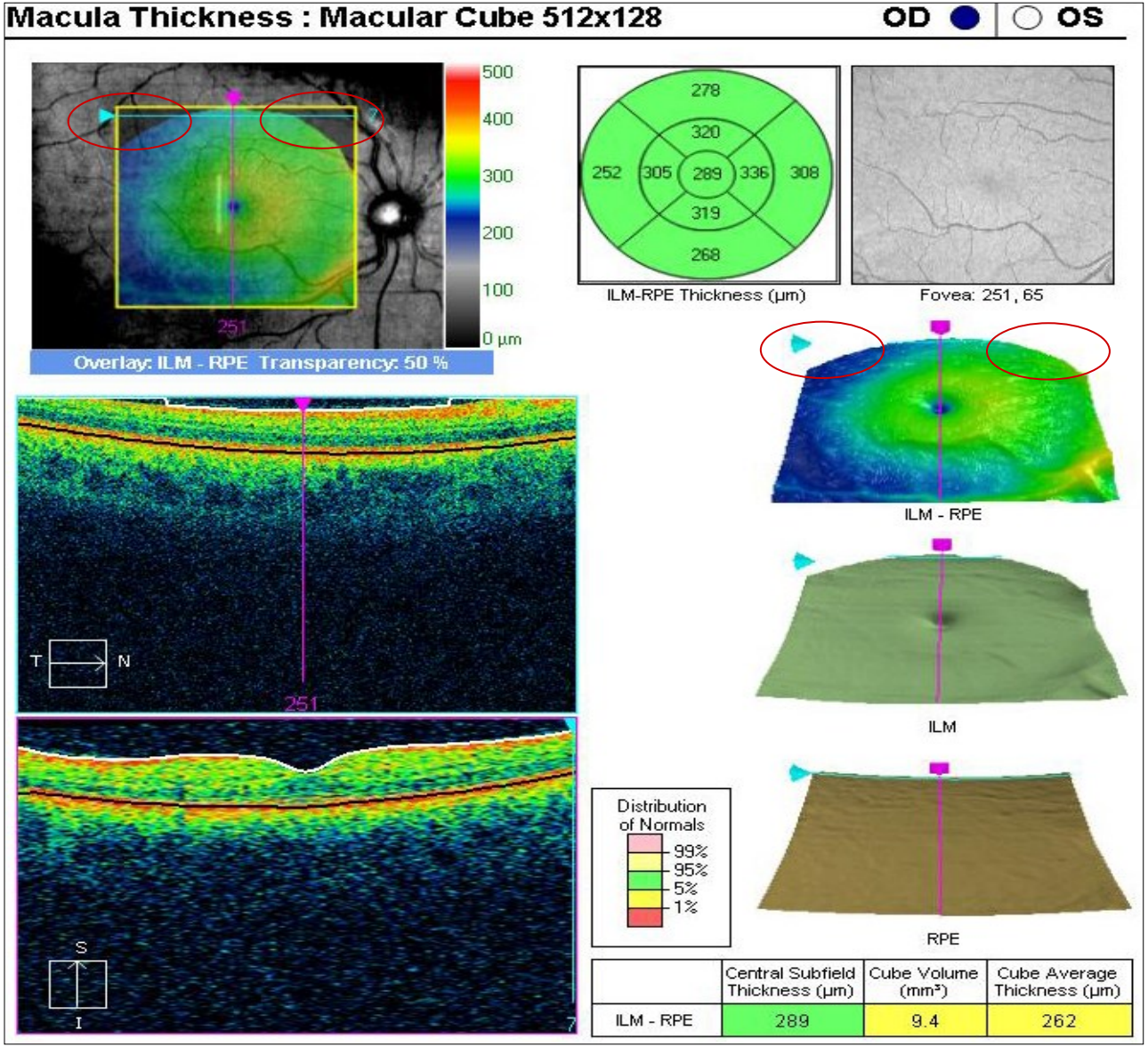

T
N
266


B:190 C: 9
265

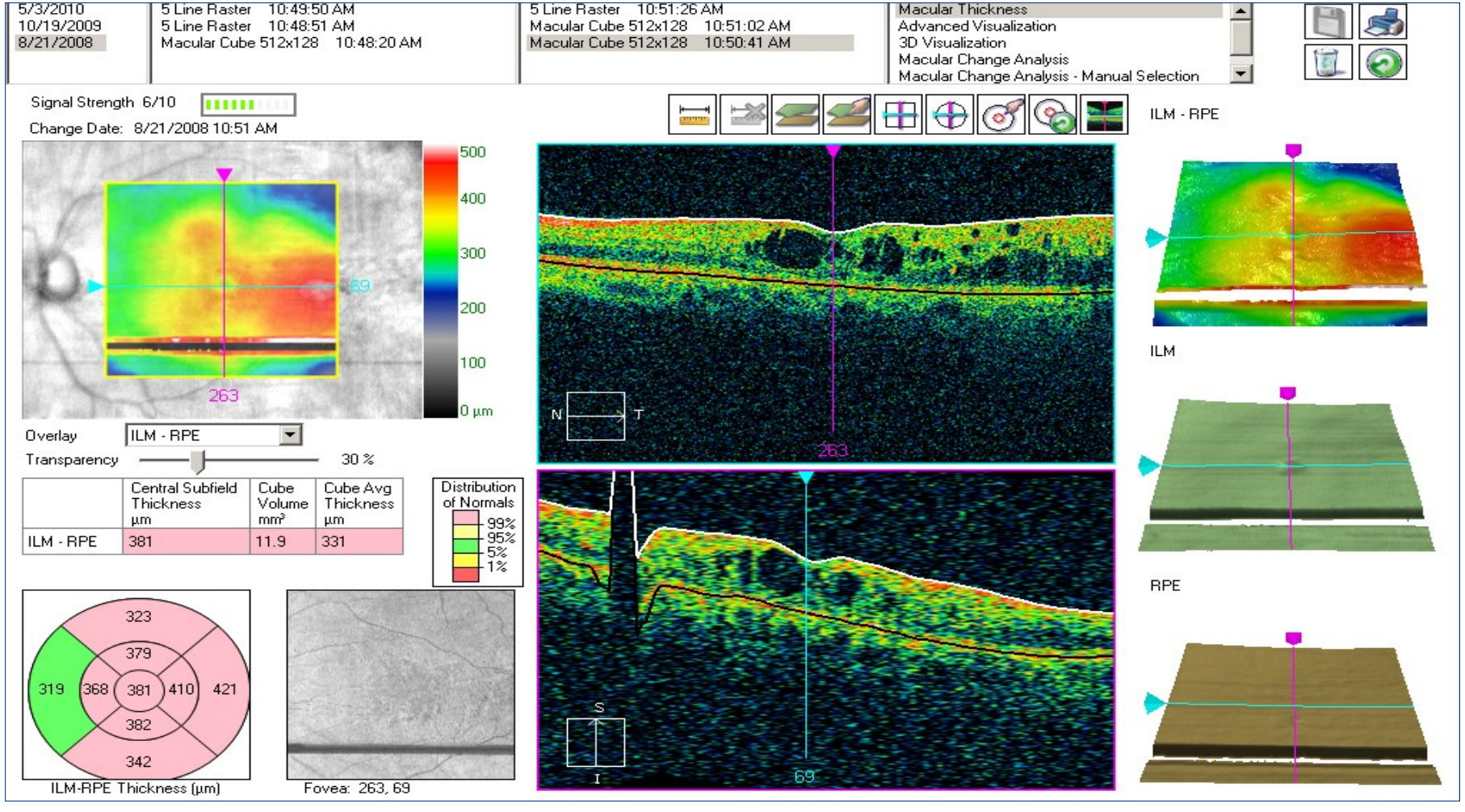

B:175 C: 3
266

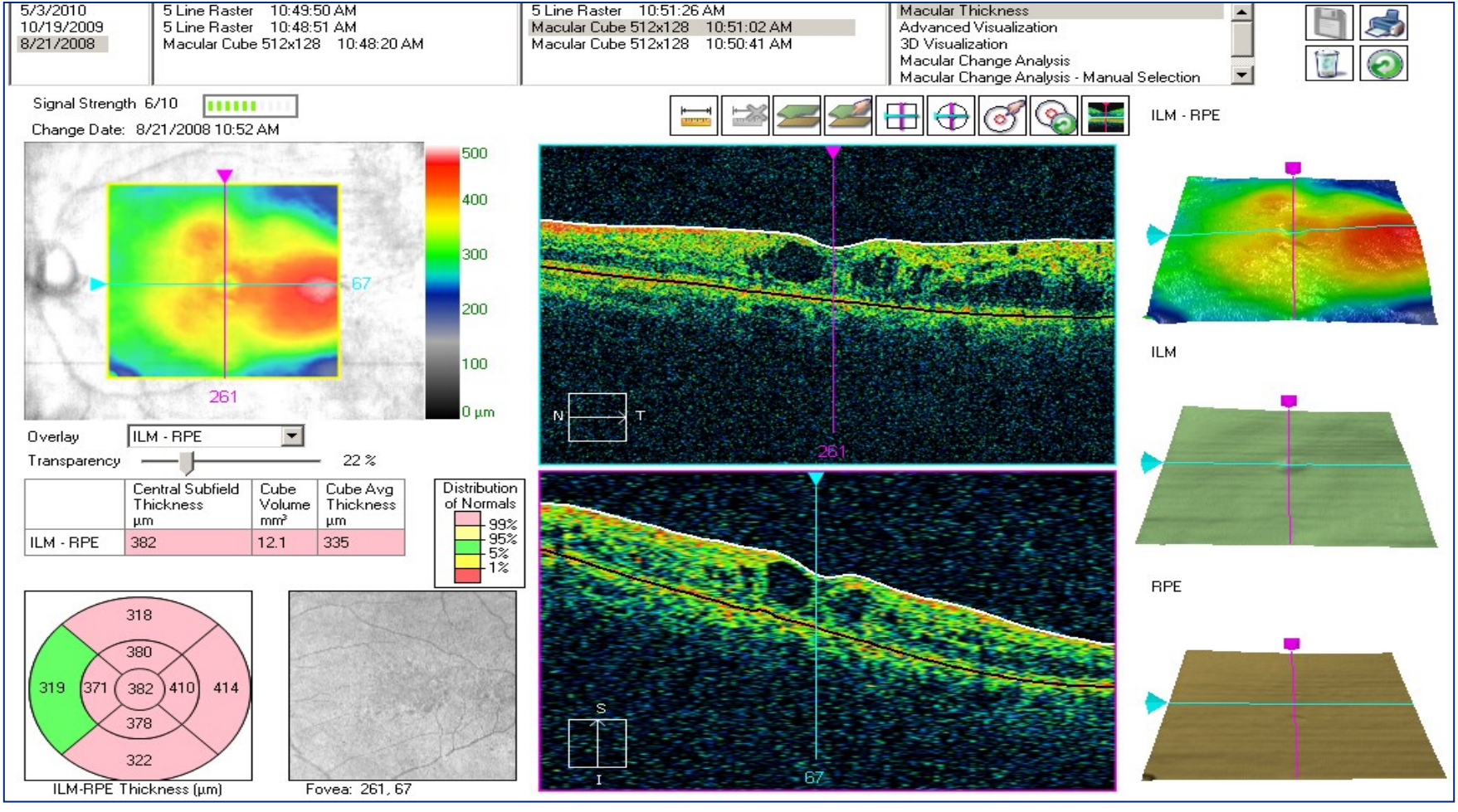

Patient, Glaucoma 0 19046... Male 7/20/1955
OD/Right OS/Left
Records Edit Tools Help | Operator Cirrus (Logout)
10/16/2007
Optic Disc Cube 200x200 8:47:13 AM
Macular Cube 200x200 8:43:53 AM
Optic Disc Cube 200x200 8:51:44 AM
Optic Disc Cube 200x200 8:50:58 AM
Macular Cube 200x200 8:49:37 AM
Advanced Visualization
Glaucoma OU Analysis
Edit Segmentation
500
400
300
200
100
70
70
293
Segmentation Layer Editing Tool
CARL ZEISS MEDITEC
✓Allows for correcting segmentation errors
Macular Cube 200x200 7:59:18 AM
Macular Cube 200x200 7:58:51 AM
ILM

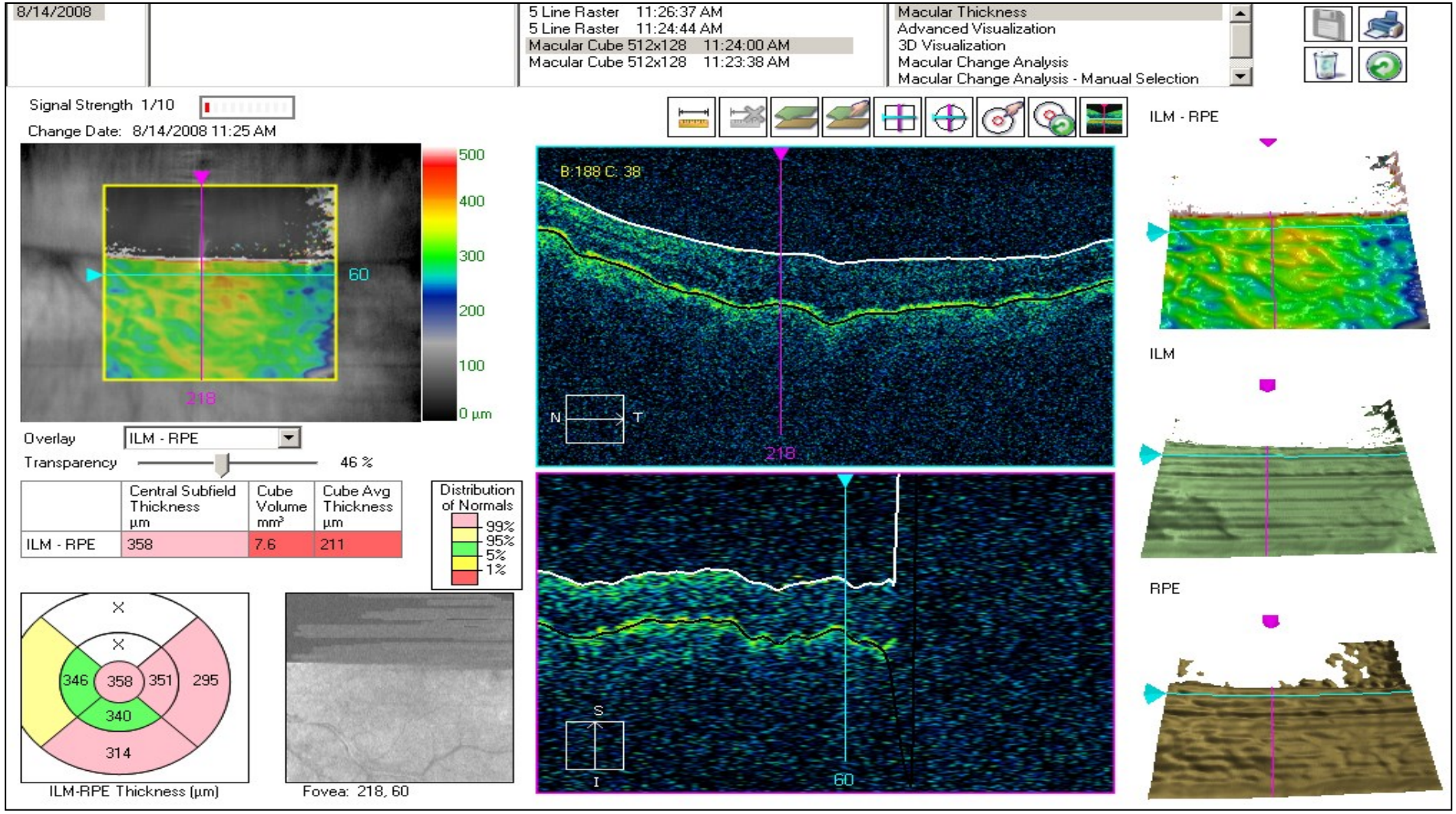

OD
Macular Cube 512x128
Signal Strength : 10/10
Overlay:
OCT
Transparency :
0%
64
256
Snap To Center
Try Again
Save
T
N
S
I
Missing data

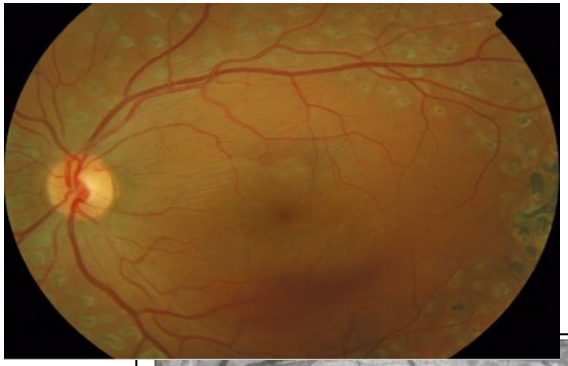

Macula Thickness : Macular Cube 512x128
OD
OS
500
400
300
200
100
0 µm
Overlay: ILM - RPE Transparency: 50 %
278
320
252
305
289
336
308
319
268
ILM-RPE Thickness (µm)
Fovea: 251, 65
T
N
251
ILM - RPE
ILM
Distribution of Normals
99%
95%
5%
1%
S
I
RPE
Central Subfield Thickness (µm)
Cube Volume (mm³)
Cube Average Thickness (µm)
ILM - RPE
289
9.4
262

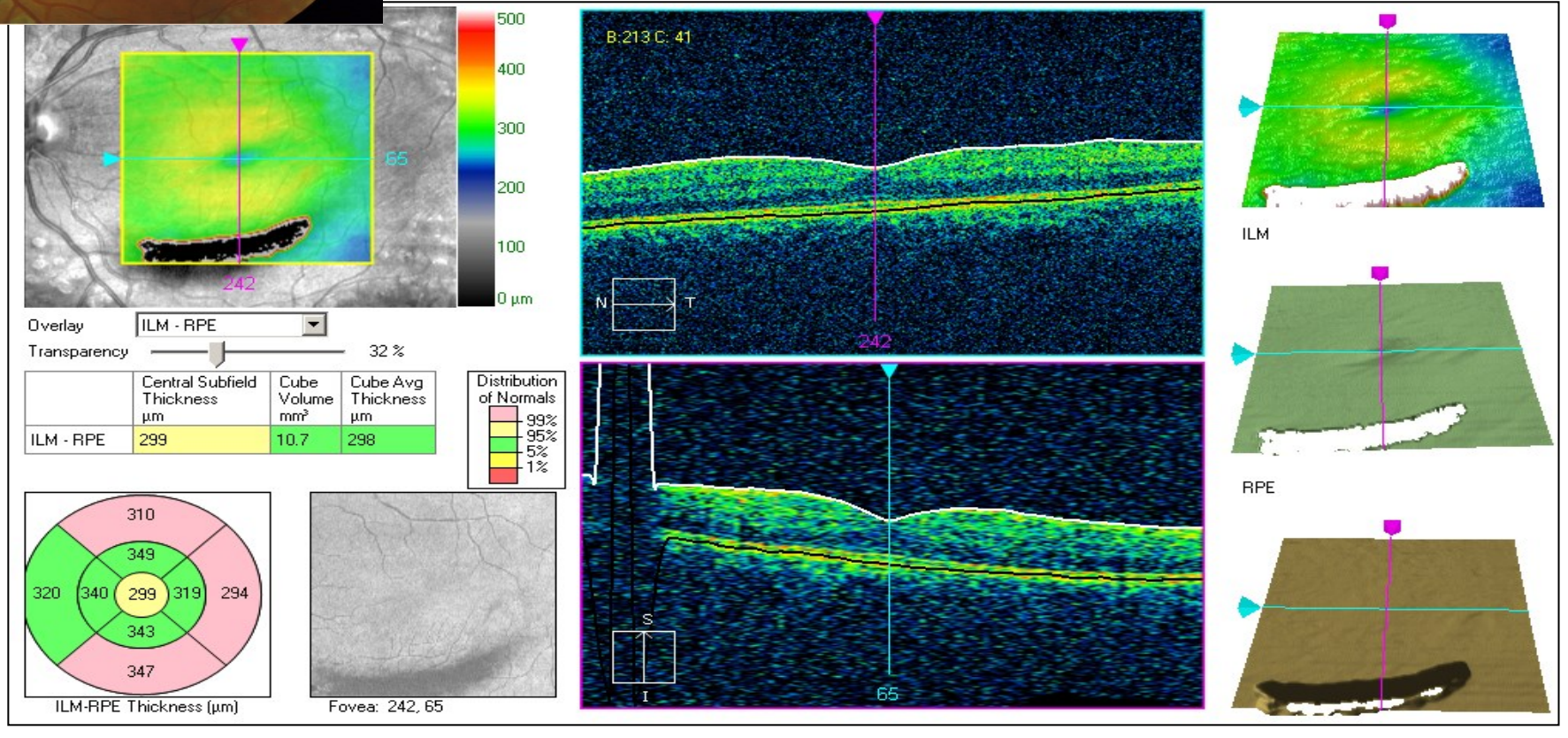
Cropping


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
500
400
300
200
100
0 µm
69
263
Overlay
ILM - RPE
Transparency
30 %
Central Subfield Thickness µm
Cube Volume mm³
Cube Avg Thickness µm
ILM - RPE
381
11.9
331
Distribution of Normals
99%
95%
5%
1%
N
T
263
S
I
69
ILM - RPE
ILM
RPE
323
379
319
368
381
410
421
382
342
ILM-RPE Thickness (µm)
Fovea: 263, 69

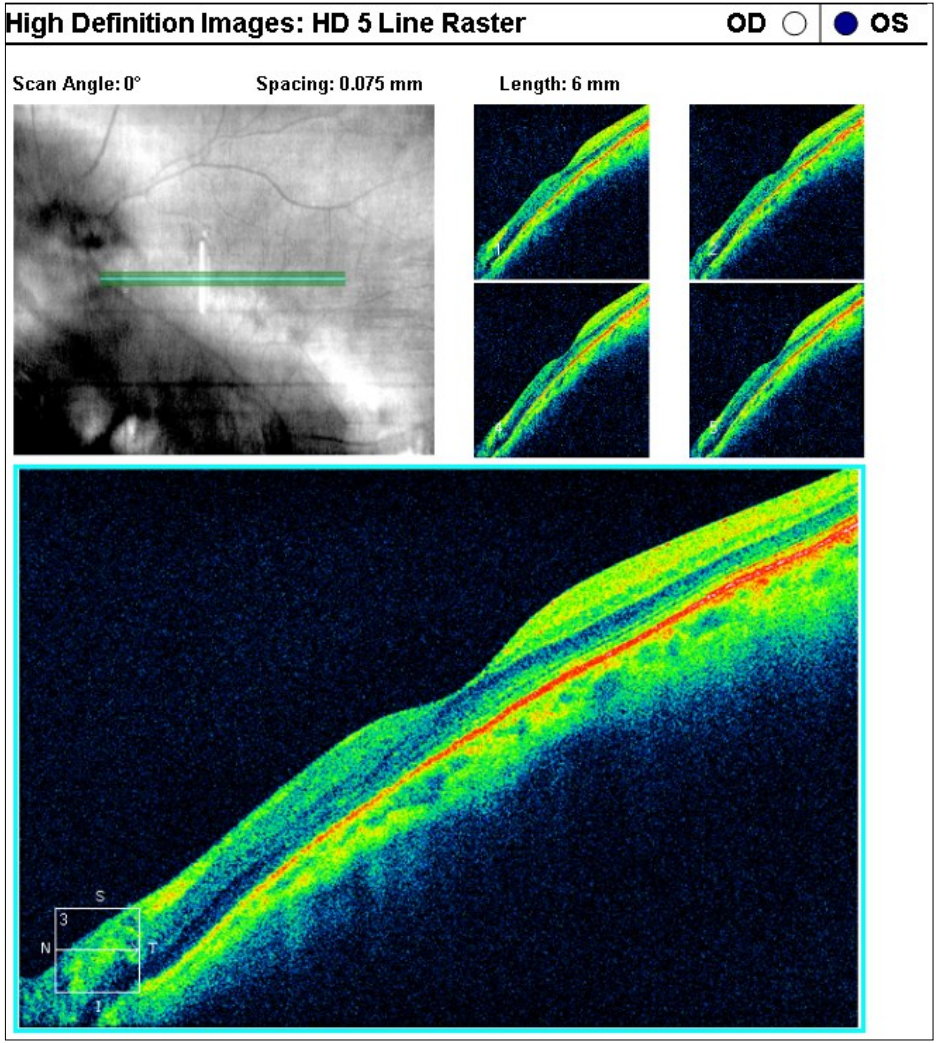

5/3/2010
10/19/2009
8/21/2008
5 Line Raster 10:49:50 AM
5 Line Raster 10:48:51 AM
Macular Cube 512x128 10:48:20 AM
5 Line Raster 10:51:26 AM
Macular Cube 512x128 10:51:02 AM
Macular Cube 512x128 10:50:41 AM
Macular Thickness
Advanced Visualization
3D Visualization
Macular Change Analysis
Macular Change Analysis - Manual Selection
Signal Strength 6/10
Change Date: 8/21/2008 10:52 AM
500
400
300
200
100
0 µm
67
261
Overlay
ILM - RPE
Transparency
22 %
Central Subfield Thickness µm
Cube Volume mm³
Cube Avg Thickness µm
ILM - RPE
382
12.1
335
Distribution of Normals
99%
95%
5%
1%
318
380
319
371
382
410
414
378
322
ILM-RPE Thickness (µm)
Fovea: 261, 67
N
T
261
S
I
67
ILM - RPE
ILM
RPE

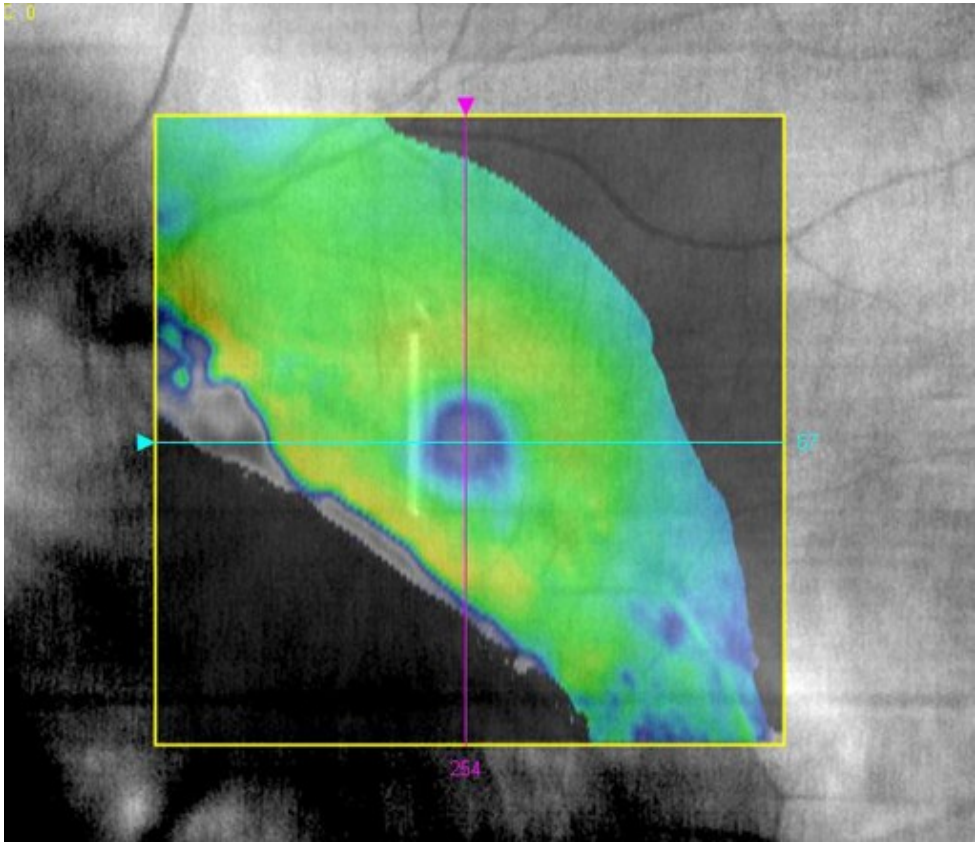

8/14/2008
5 Line Raster 11:26:37 AM
5 Line Raster 11:24:44 AM
Macular Cube 512x128 11:24:00 AM
Macular Cube 512x128 11:23:38 AM
Macular Thickness
Advanced Visualization
3D Visualization
Macular Change Analysis
Macular Change Analysis - Manual Selection
Signal Strength 1/10
Change Date: 8/14/2008 11:25 AM
500
400
300
200
100
0 µm
60
218
B:188 C: 38
N
T
218
ILM - RPE
ILM
RPE
Overlay
ILM - RPE
Transparency
46 %
Central Subfield Thickness µm
Cube Volume mm³
Cube Avg Thickness µm
ILM - RPE
358
7.6
211
Distribution of Normals
99%
95%
5%
1%
X
X
346
358
351
295
340
314
ILM-RPE Thickness (µm)
Fovea: 218, 60
S
I
60

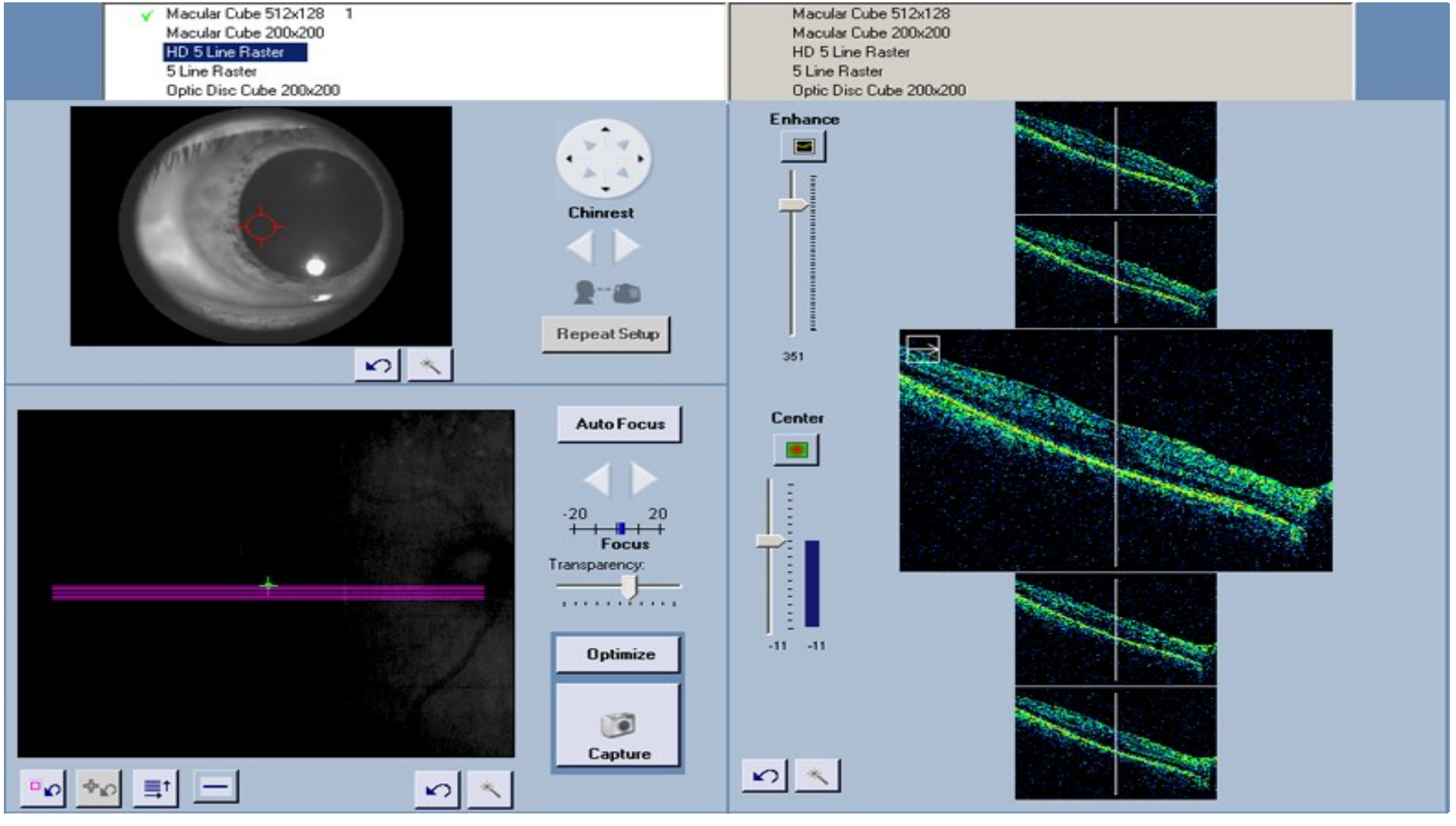



500
400
300
200
100
0 µm
65
242
Overlay
ILM - RPE
Transparency
32 %
Central Subfield Thickness µm
Cube Volume mm³
Cube Avg Thickness µm
ILM - RPE
299
10.7
298
Distribution of Normals
99%
95%
5%
1%
310
349
320
340
299
319
294
343
347
ILM-RPE Thickness (µm)
Fovea: 242, 65
B:213 C: 41
N
T
242
S
I
65
ILM
RPE

Myopie forte et dysversion papillaire

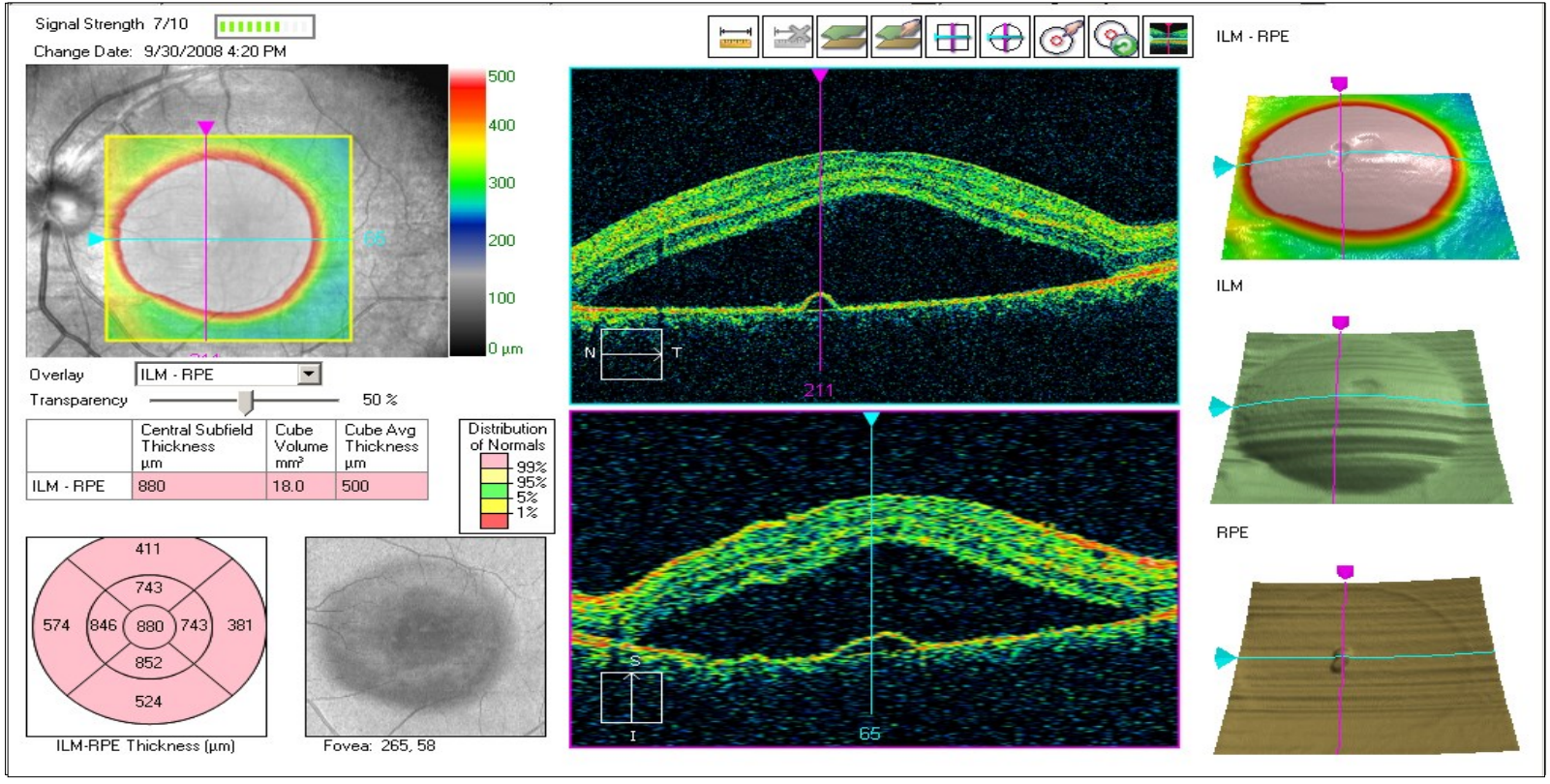






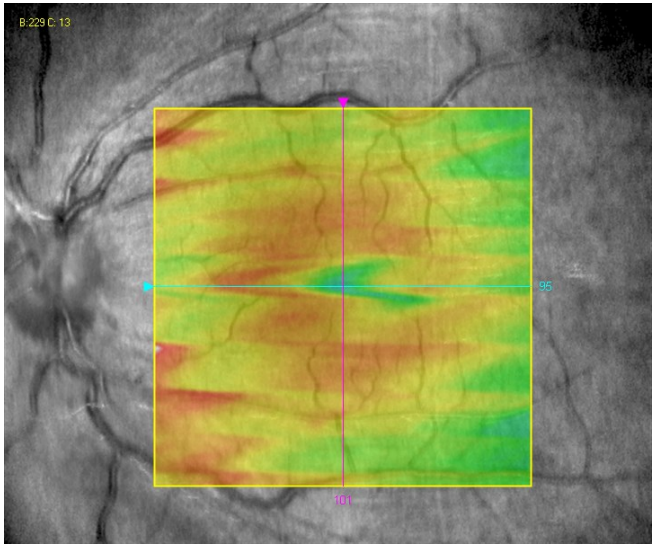
Tilted retina may be corrected for by off-centering pupil alignment to allow for a more horizontal scan

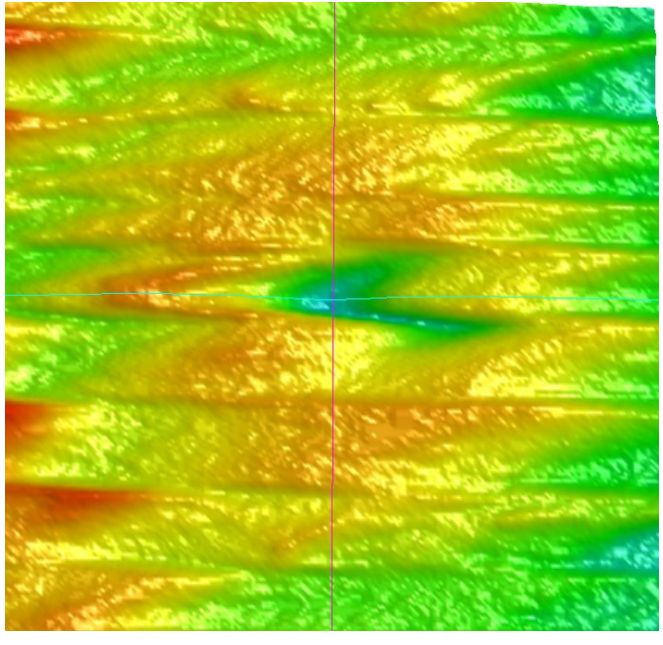
For Macular Cube Scan PLAY the MOVIE to insure that no pathology is missed



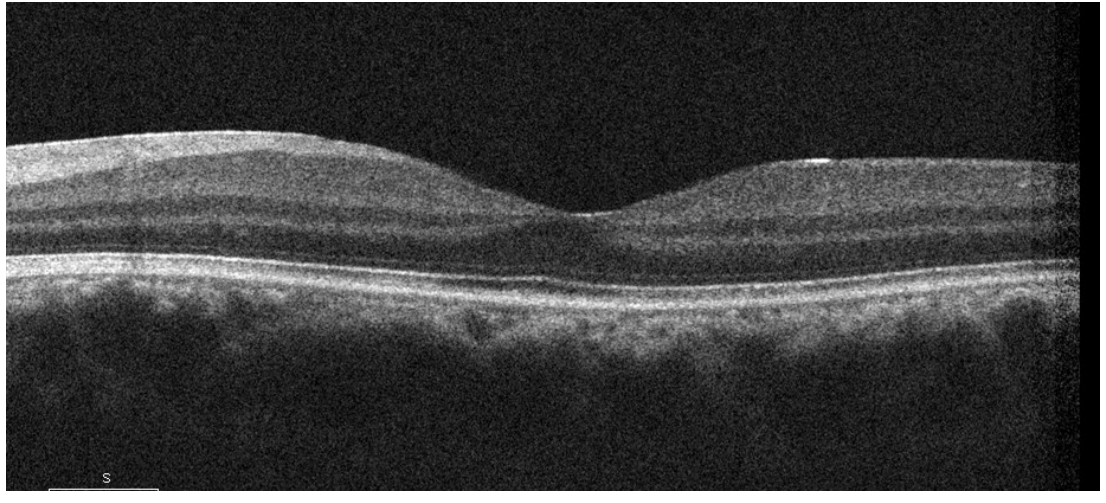
ILM to RPE Thickness Map

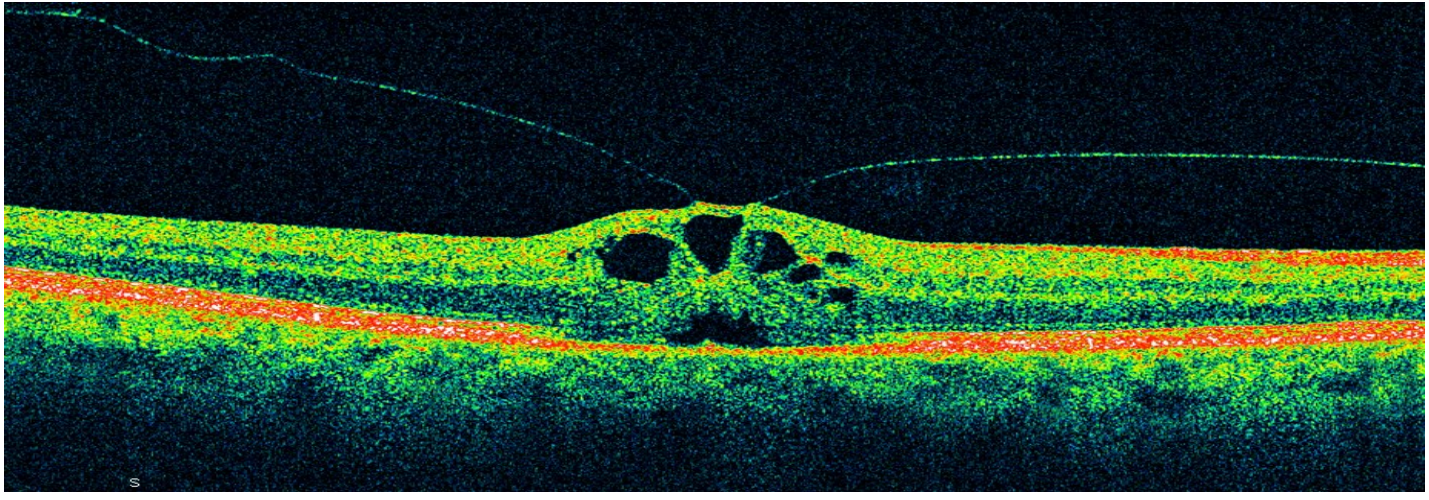
3D surface maps of the ILM and RPE

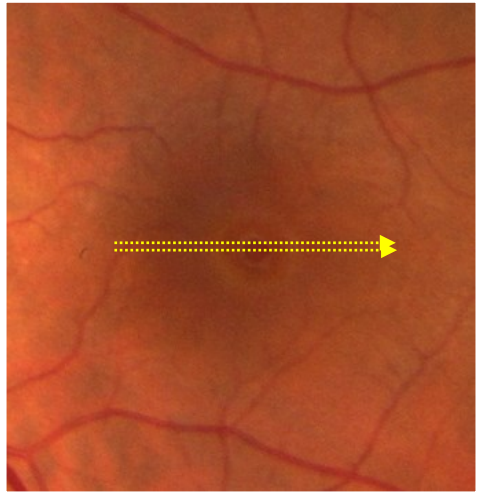


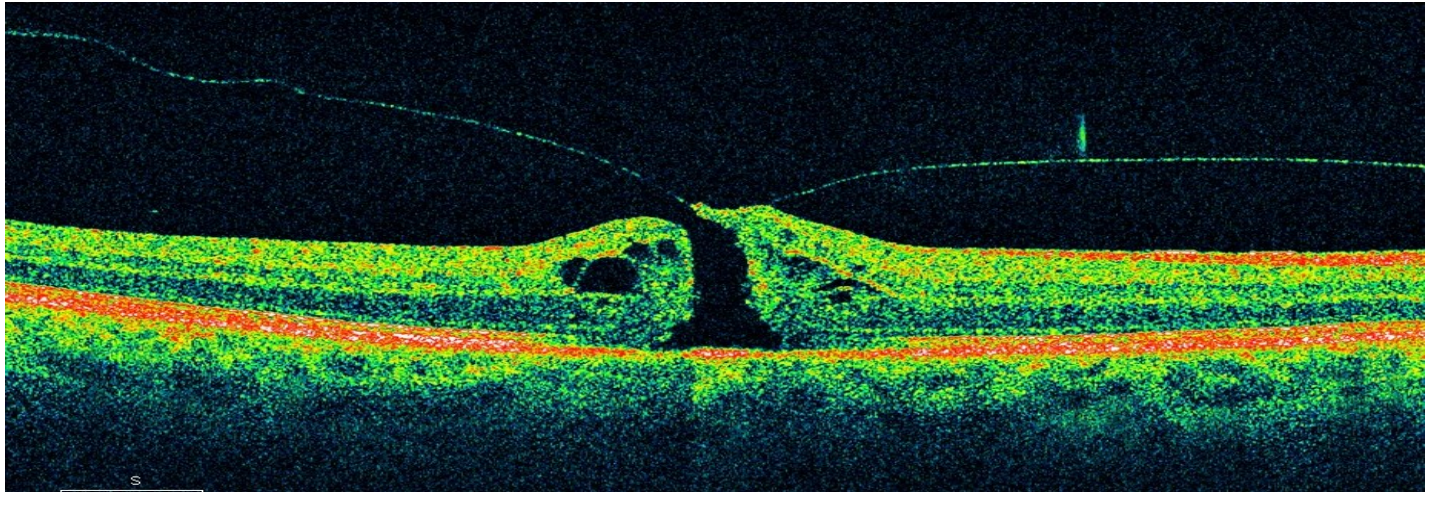


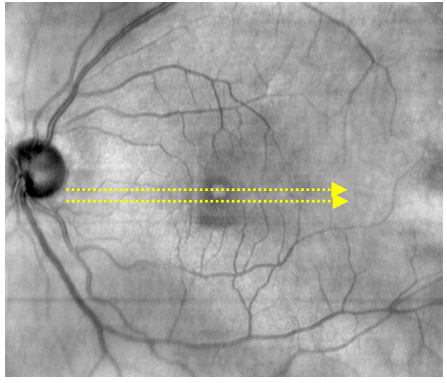
- Nystagmus
- Tremblements (Parkinson…)

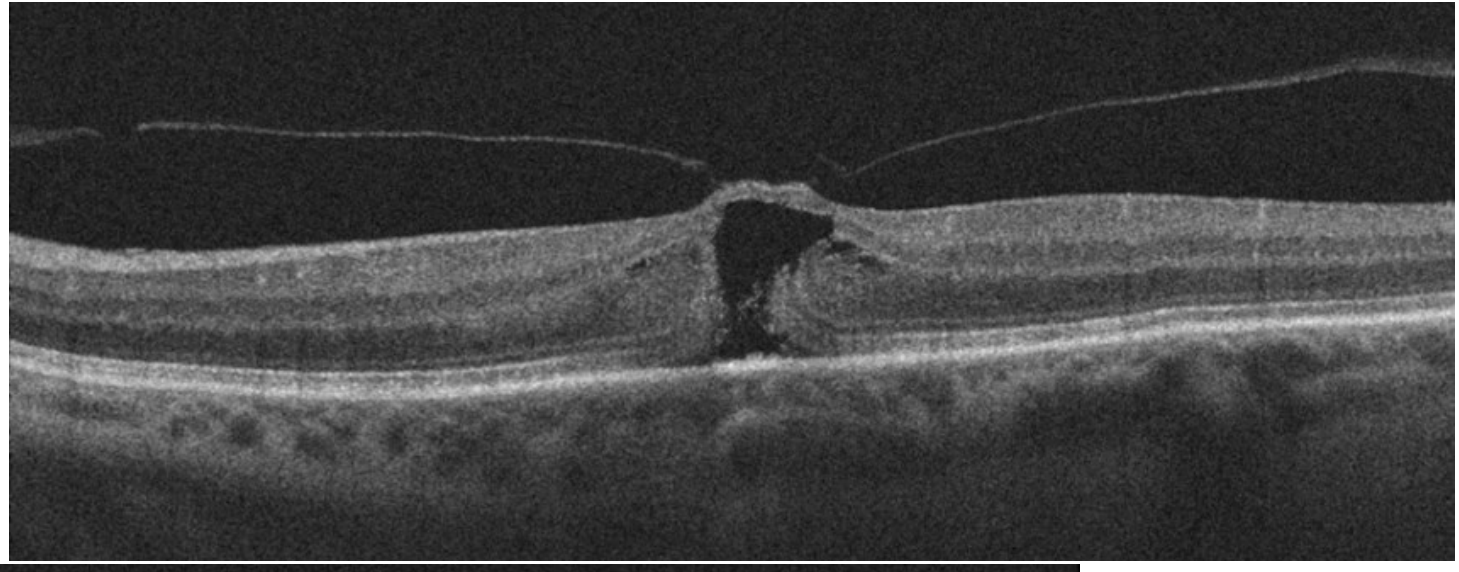


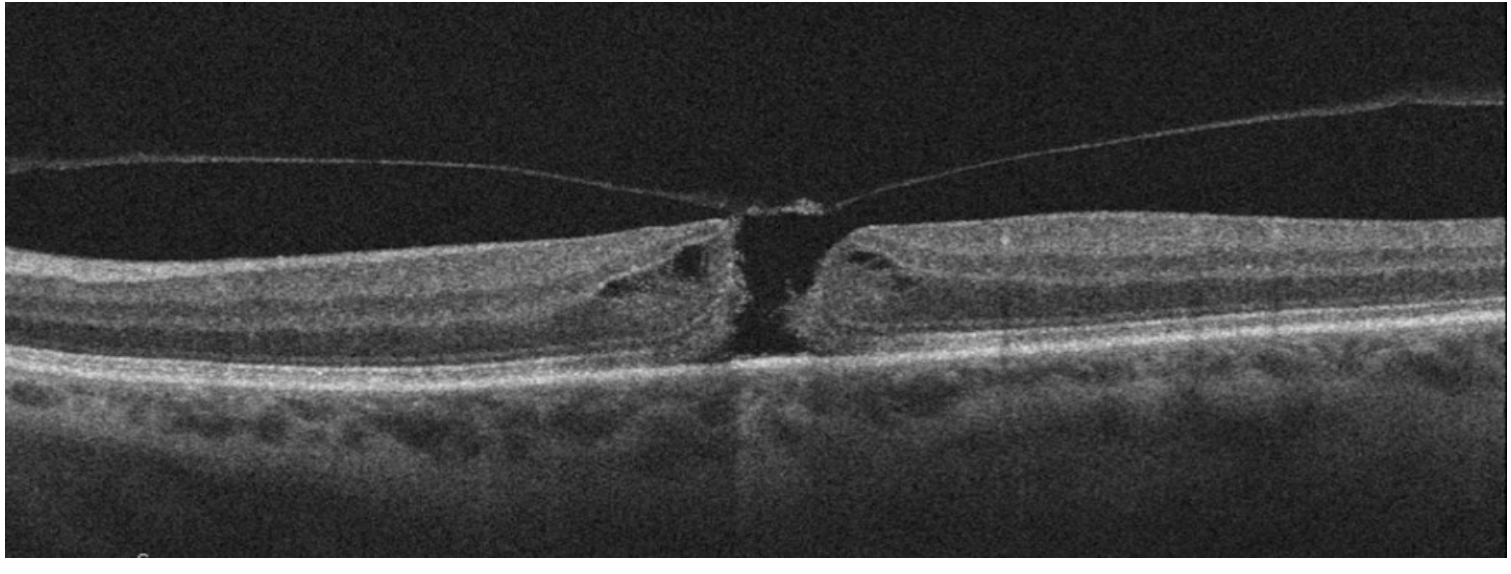


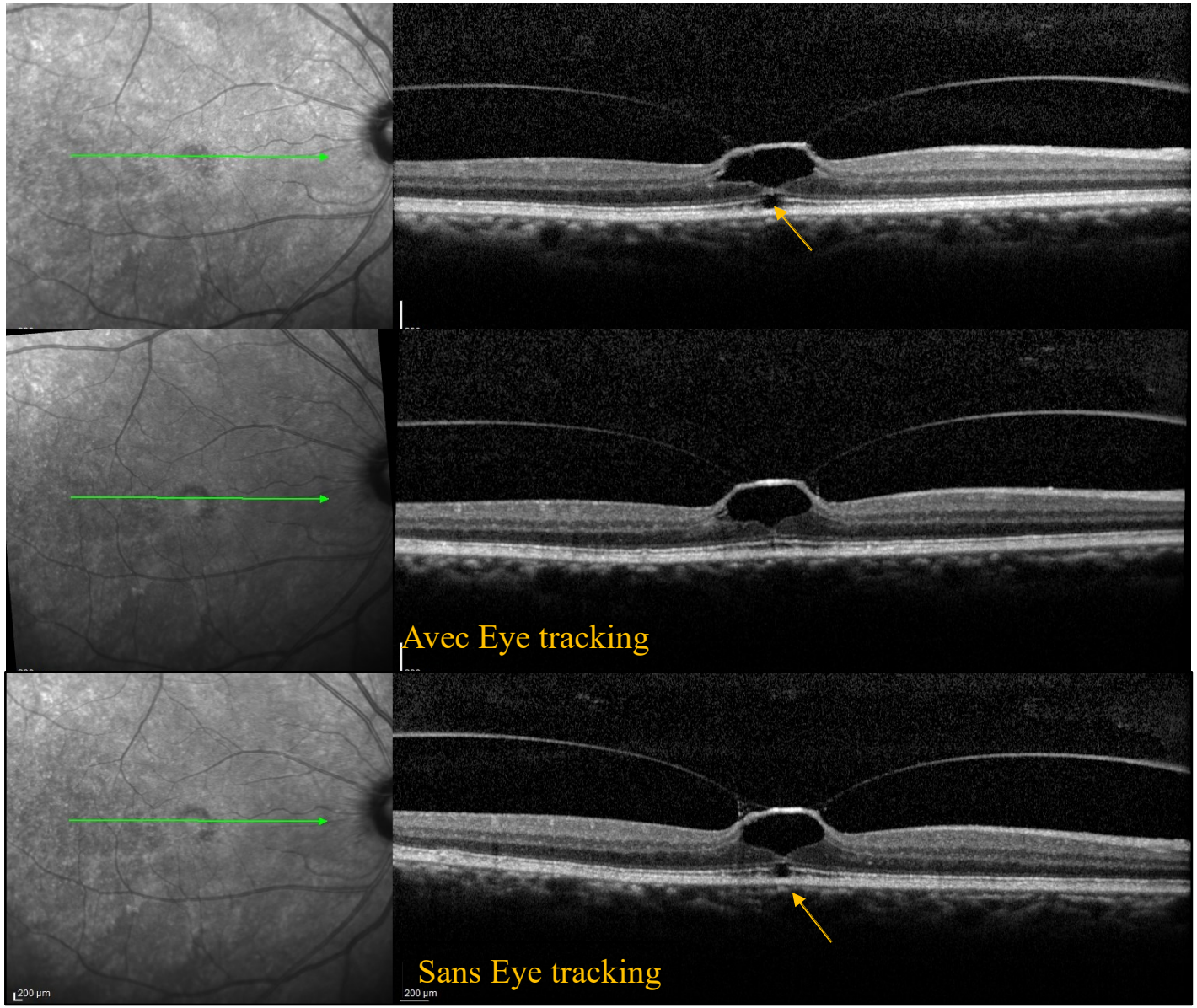


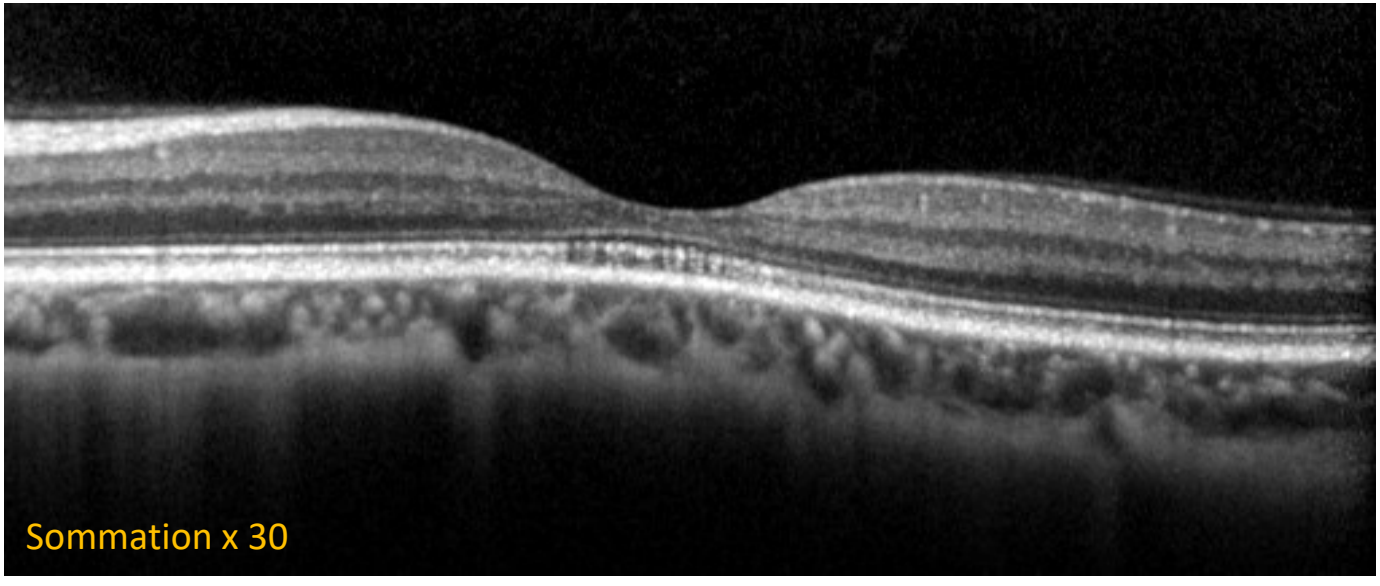


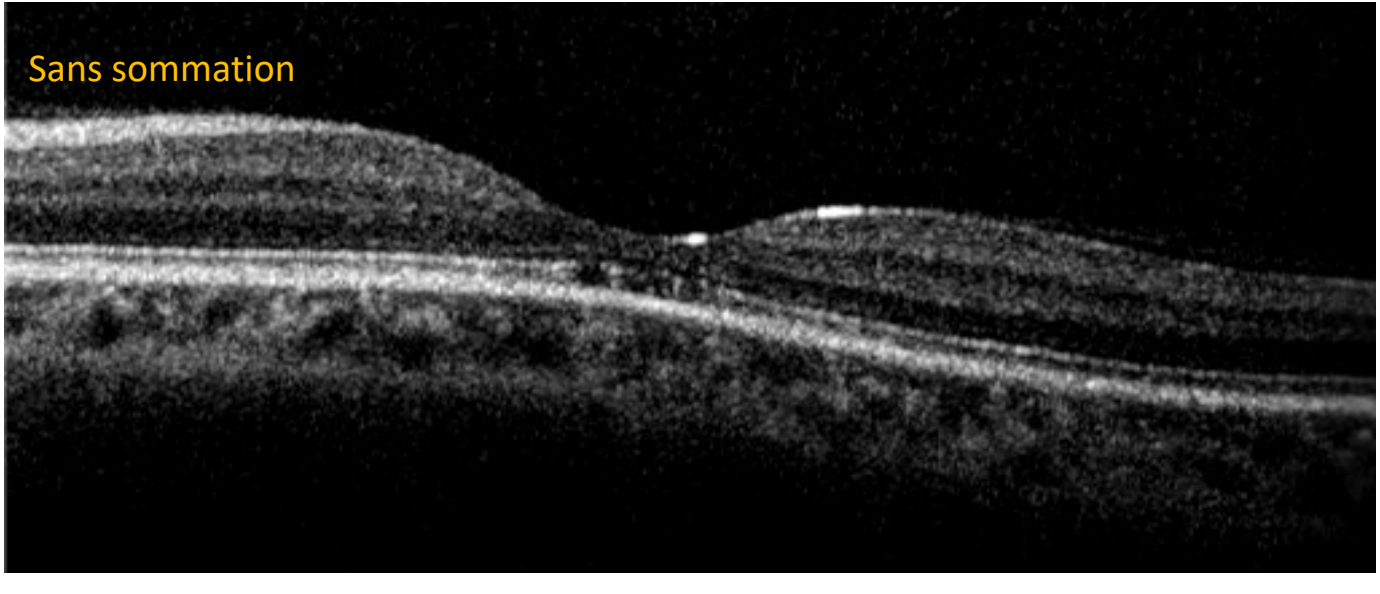







Avec Eye tracking
200 µm
Sans Eye tracking
200 µm


Sommation x 30


Sans sommation

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-negativ 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 lié 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 artéfacts en OCTA. La lumière incidente sur un vaisseau sanguin peut être réfléchie 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

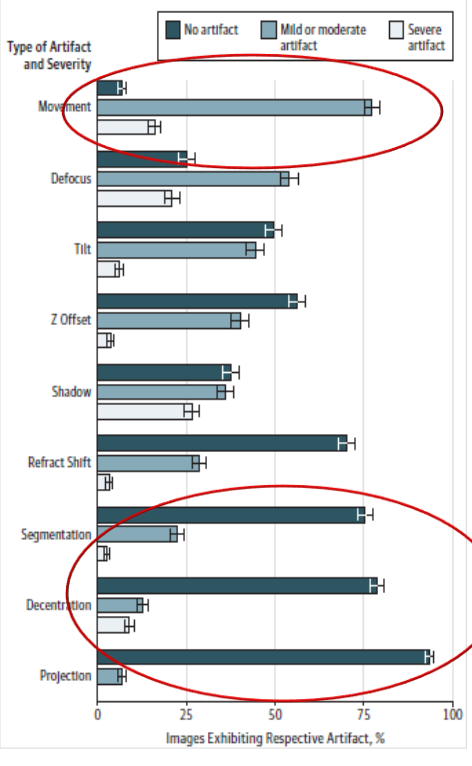
Réduire risque d'erreurs d'interprétation →
Corrélation avec l'imagerie multimodale
Visualisation combinée des B-scans et de l'OCT-A

JAMA Ophthalmology | Original Investigation

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)

Artifacts are common in OCTA images and can result in misinterpretation of images.

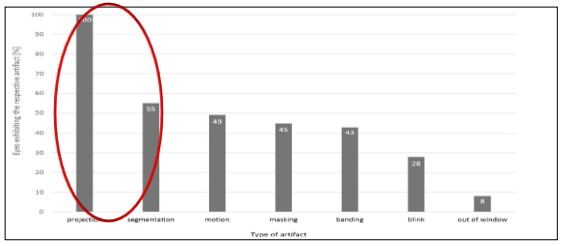
RESEARCH ARTICLE

Quantity and quality of image artifacts in optical coherence tomography angiography

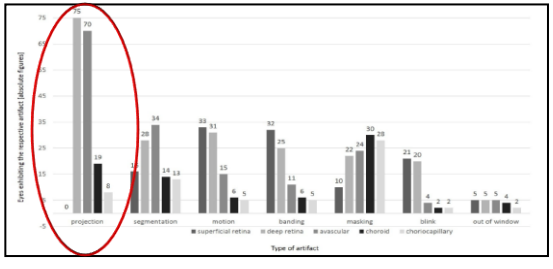
Christian Enders[1]*, Gabriele E. Lang[1], Jens Dreyhaupt[2], Max Loidl[1], Gerhard K. Lang[1], Jens U. Werner[1]

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

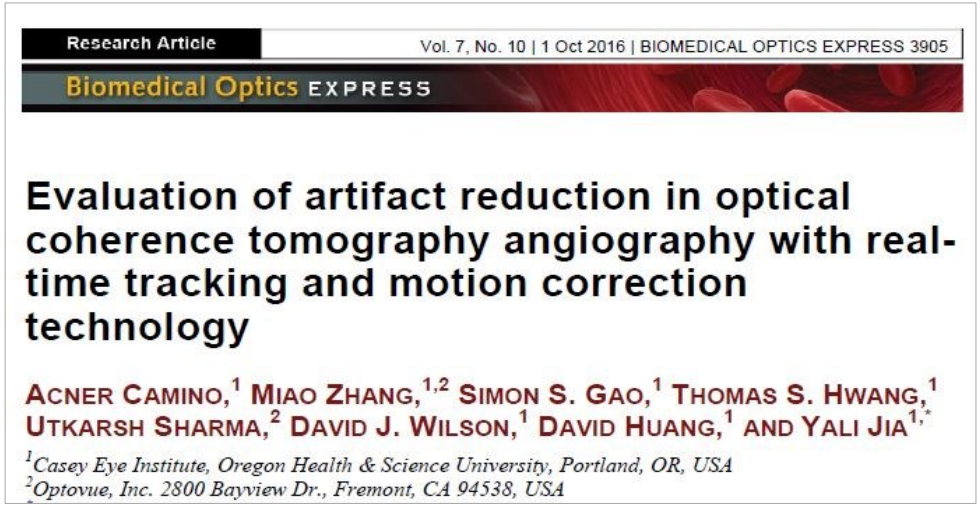
PLOS ONE | January 25, 2019



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



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



Research Article Vol. 7, No. 10 | 1 Oct 2016 | BIOMEDICAL OPTICS EXPRESS 3905

Biomedical Optics EXPRESS

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,*]

[1]*Casey Eye Institute, Oregon Health & Science University, Portland, OR, USA*
[2]*Optovue, 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 Sadda[1]

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.

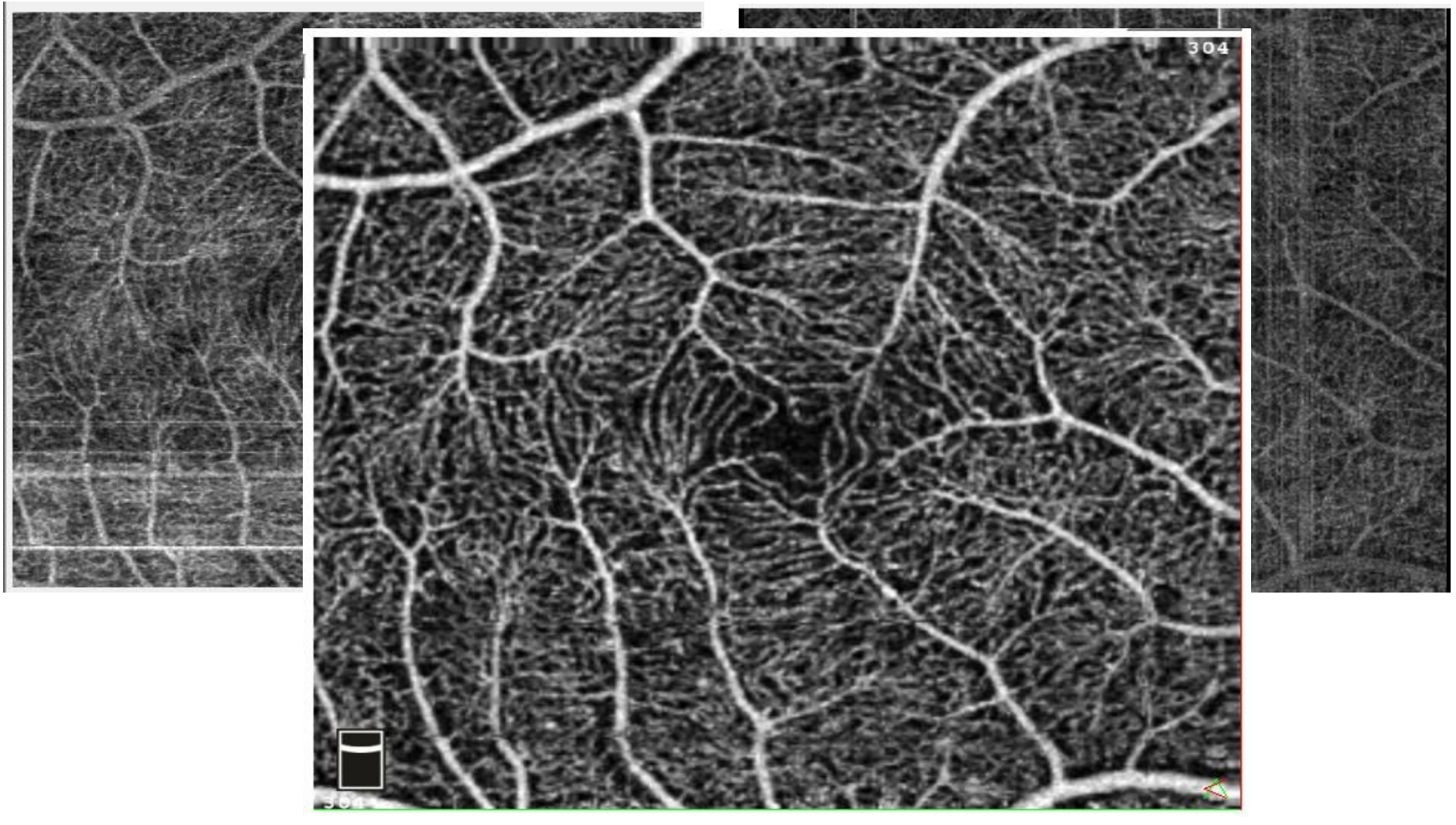
Results: Optical coherence tomography angiography uses motion contrast to image blood flow and thereby images the vasculature without the need for a contrast agent. Artifacts are very common and can arise from the OCT image acquisition, intrinsic characteristics of the eye, eye motion, image processing, 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.

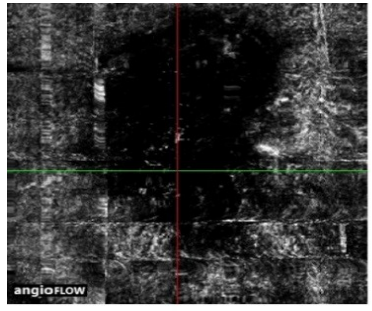
RETINA 35:2163–2180, 2015

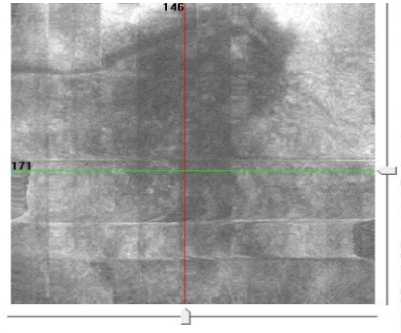
The artefacts are <u>more frequent</u> in eyes with pathology.
They should be known and avoided.

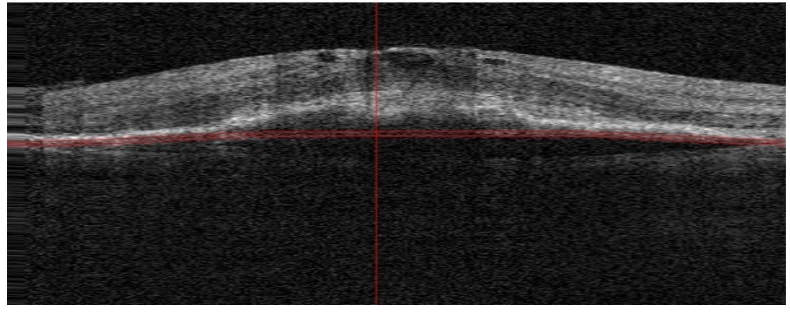
Motion Correction Technology (MCT)

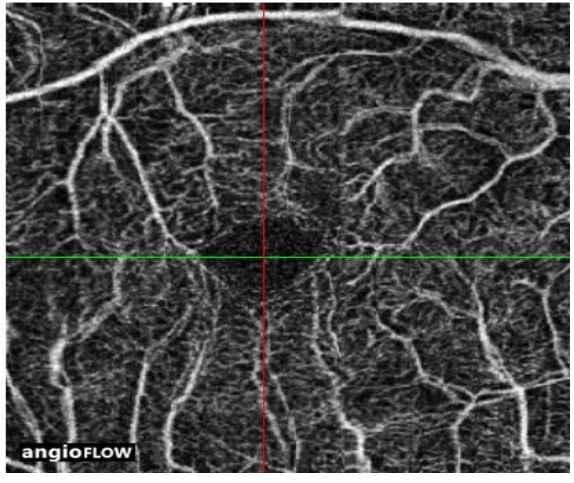


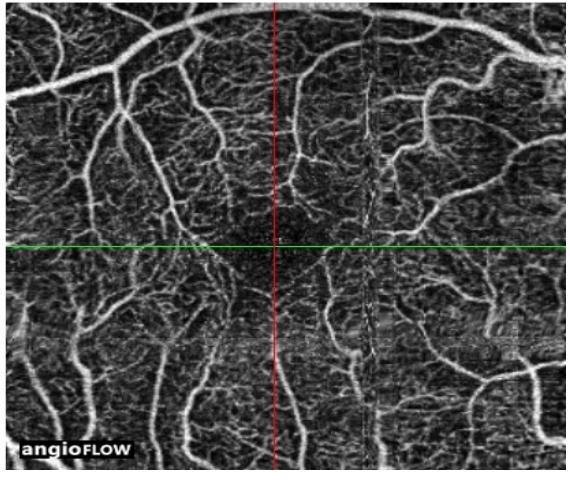
motion artifact, blinks, shadowgraphic flow projection, vessel duplication, and vessel discontinuity…etc

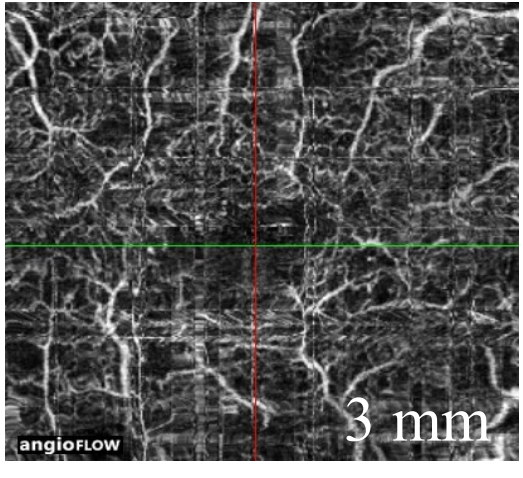


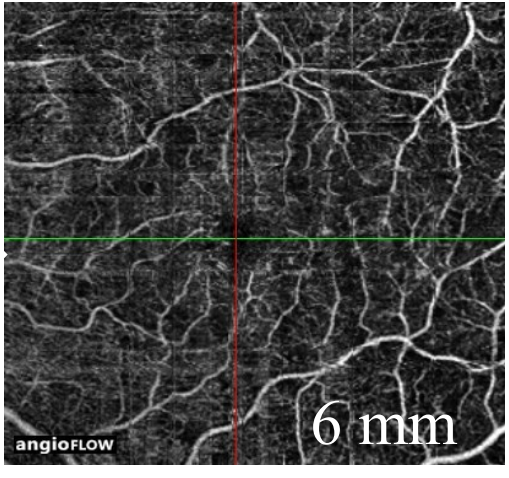


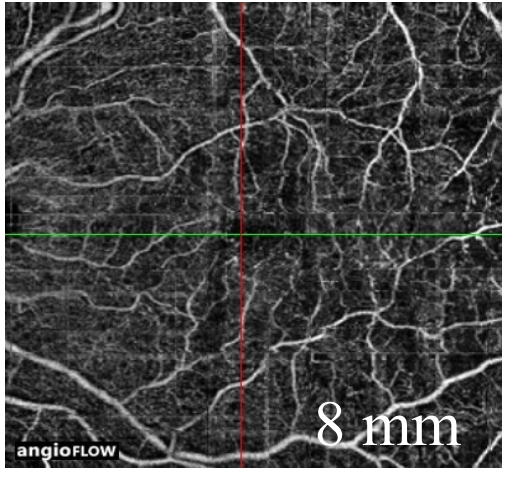


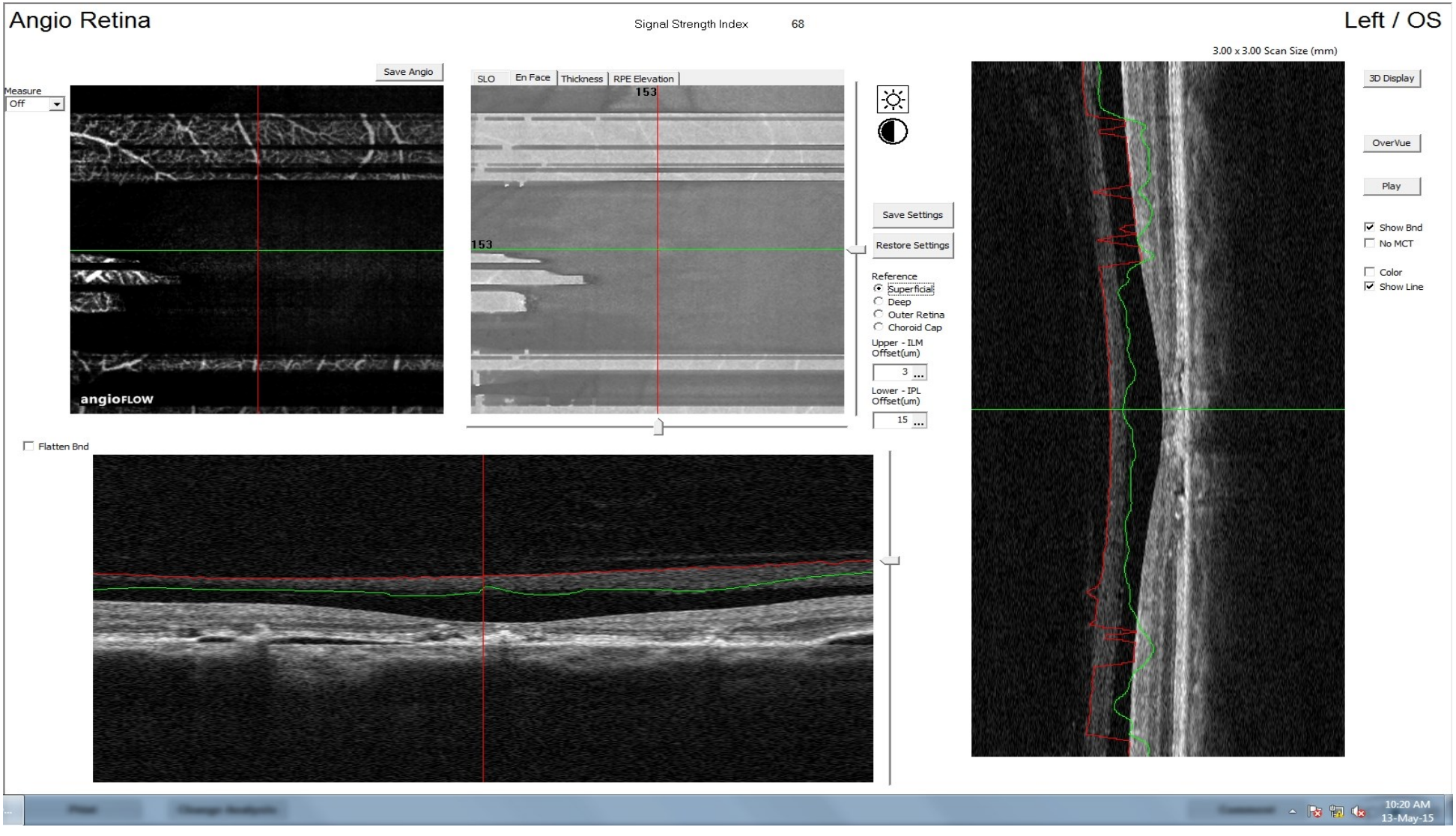




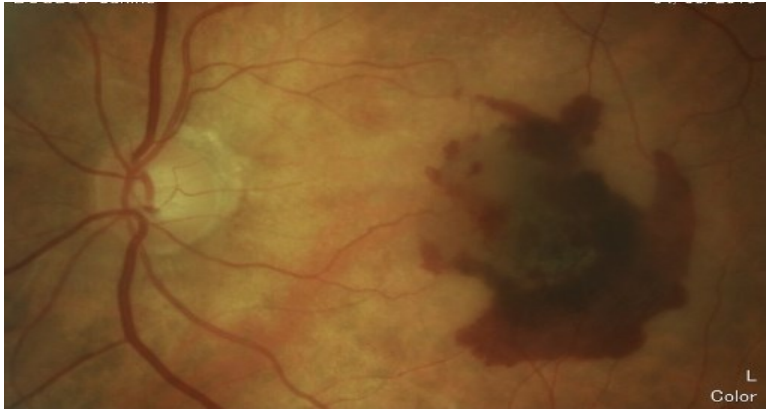


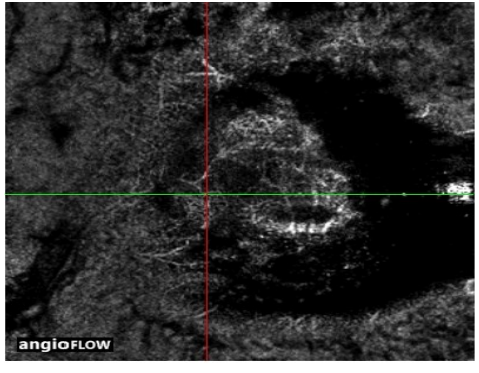


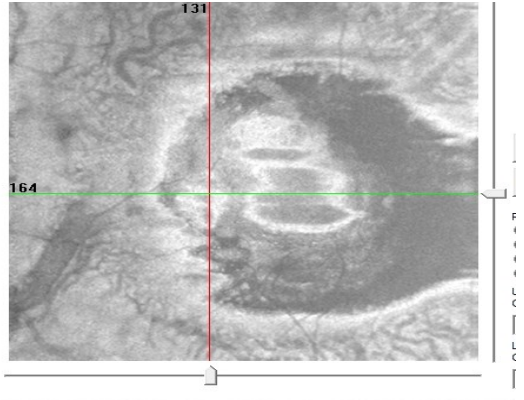




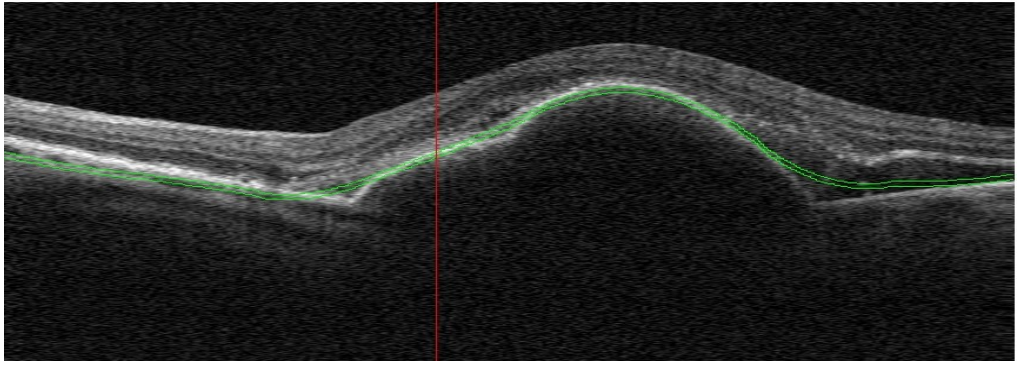
Condensation vitréenne

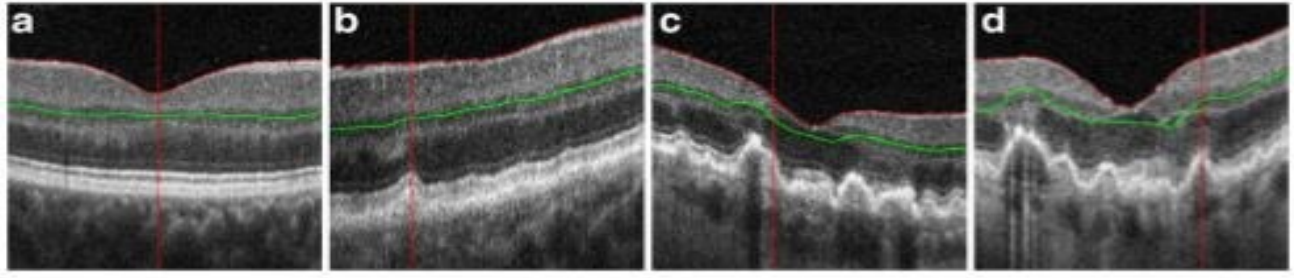


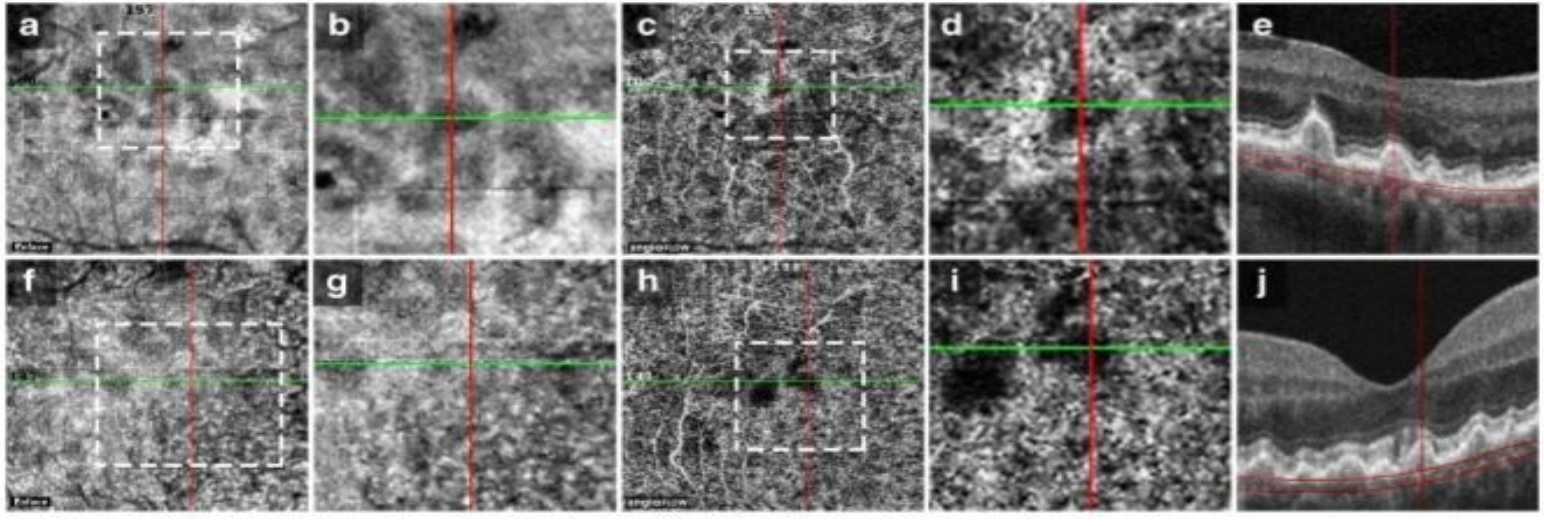




Hémorragies







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. Alten[1] · J. L. Lauermann[1] · C. R. Clemens[1] · P. Heiduschka[1] · N. Eter[1]

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

Optical coherence tomography angiography artifacts in retinal pigment epithelial detachment

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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. Baumal, MD,[*] Marcos Ávila, MD, PhD,[†] Jay S. Duker, MD,[*]
Nadia K. Waheed, MD, MPH[*]

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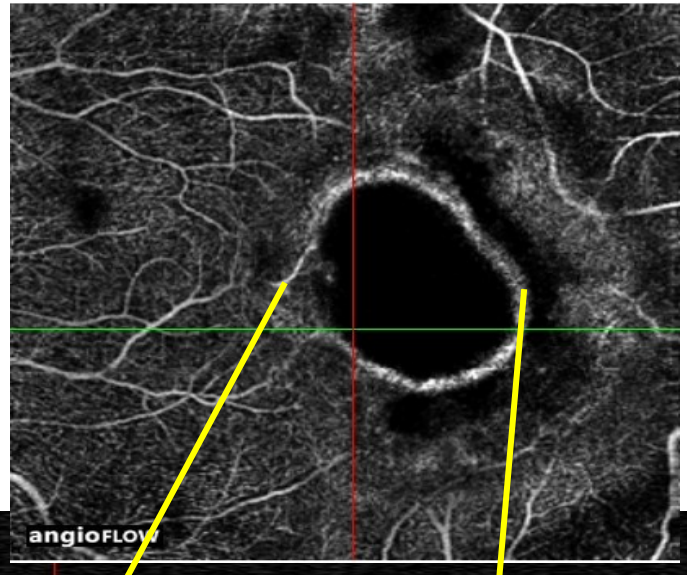
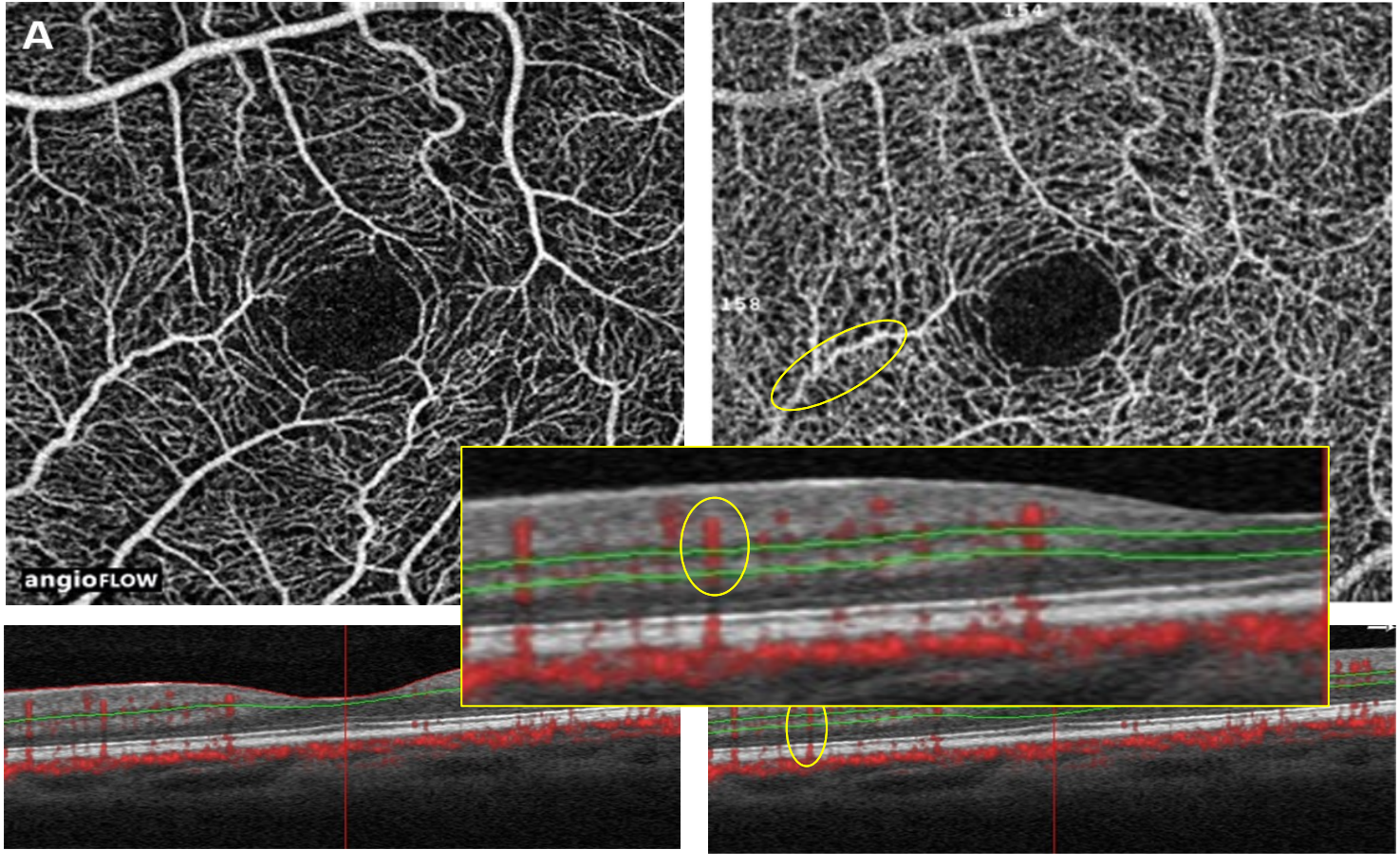
The RPED creates a flow signal that corresponds exactly with the edges of the RPED



PED and Bright White ring

Artefacts de projection

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

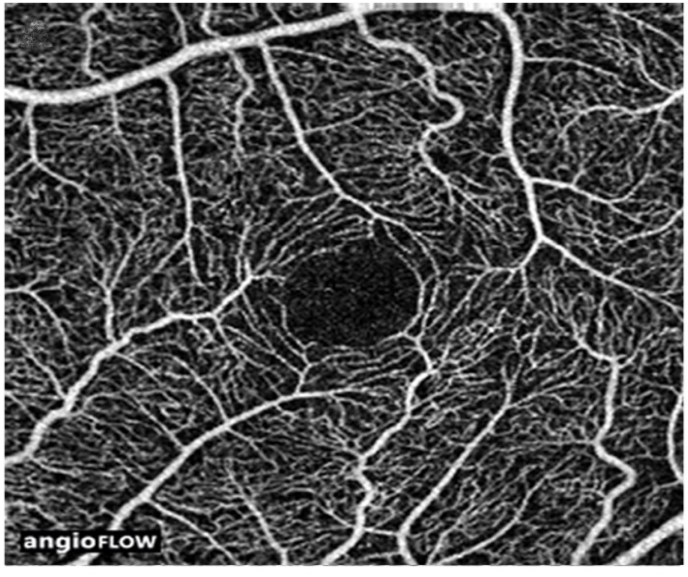


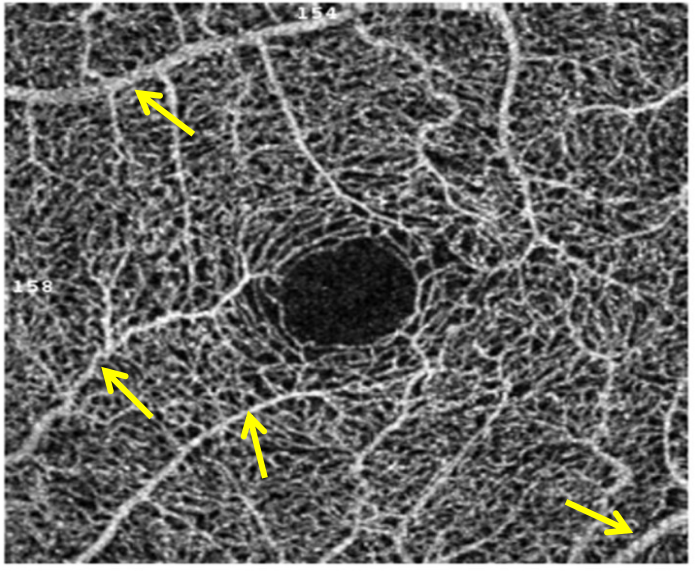
Réseau superficiel. le tracé des vaisseaux sur l'image en face a sa contrepartie dans le signal du flux (en rouge) sur la coupe OCT Angio

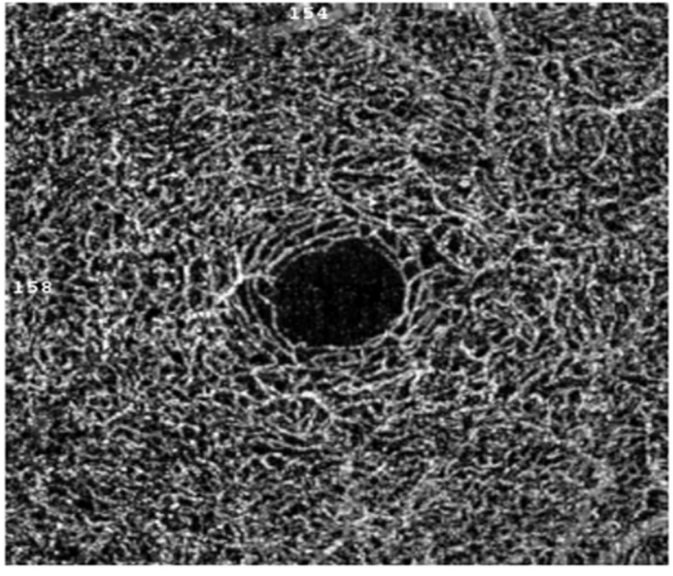
Les vaisseaux superficiels sont en partie visibles dans le réseau capillaire profond. Le rond jaune montre que le signal du vaisseau forme un trait vertical traversant plusieurs couches sur la coupe OCT Angio

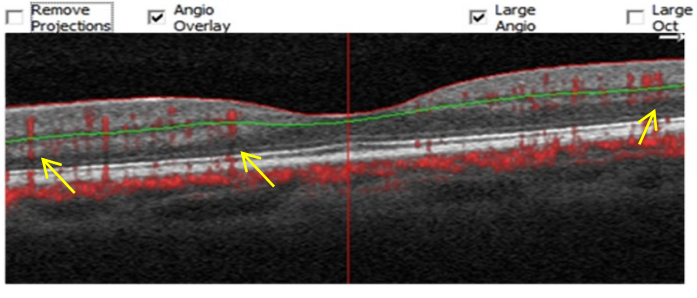
Détail de la coupe OCT Angio montrant la projection du signal d'un vaisseau superficiel dans les couches profondes (ellipse)

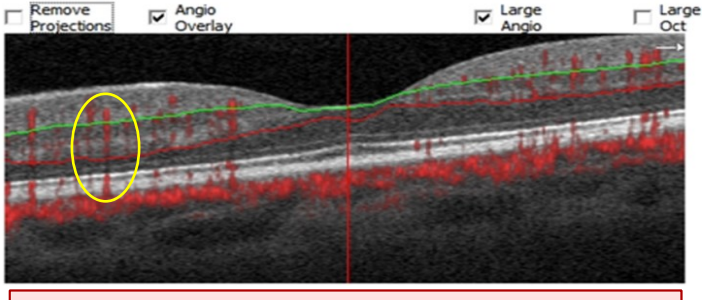
Artefacts de projection

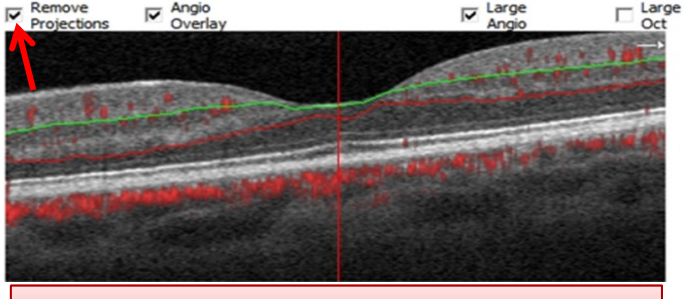








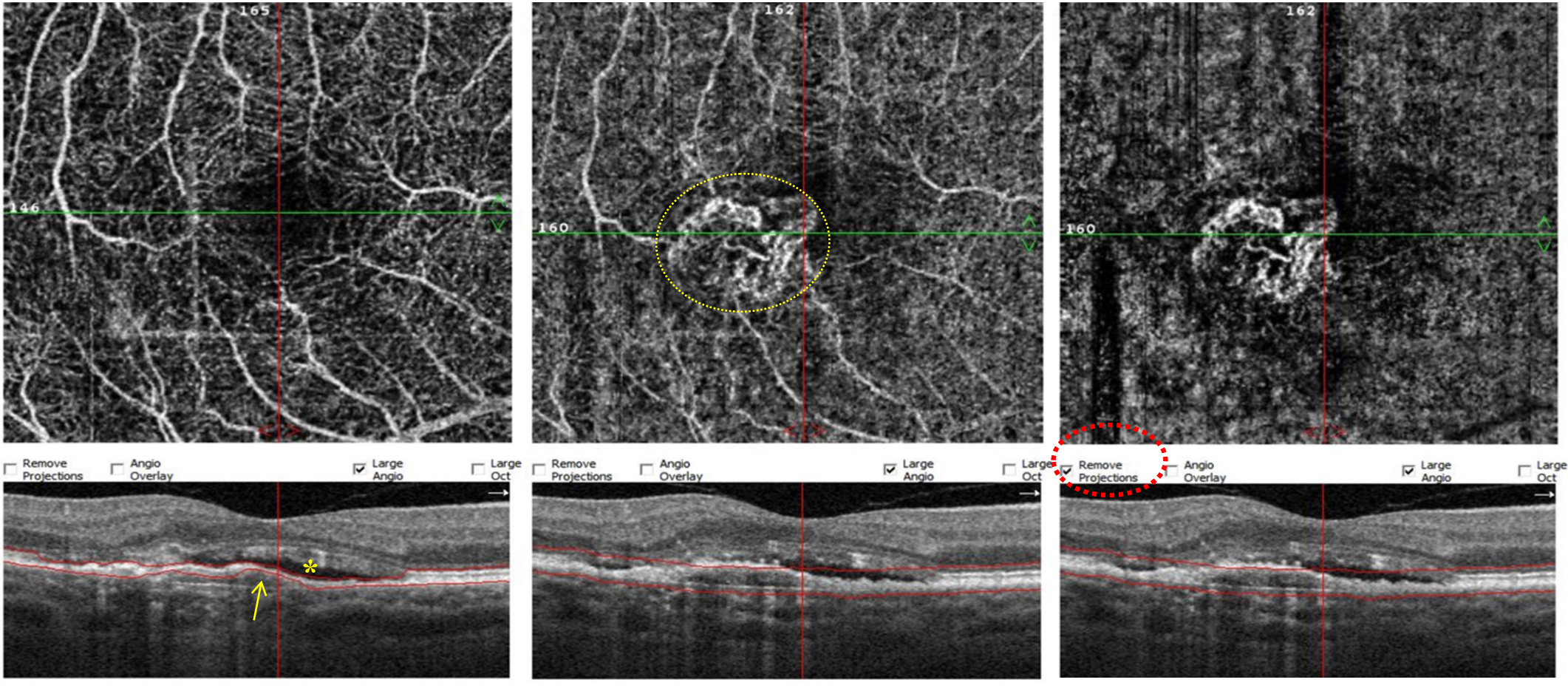




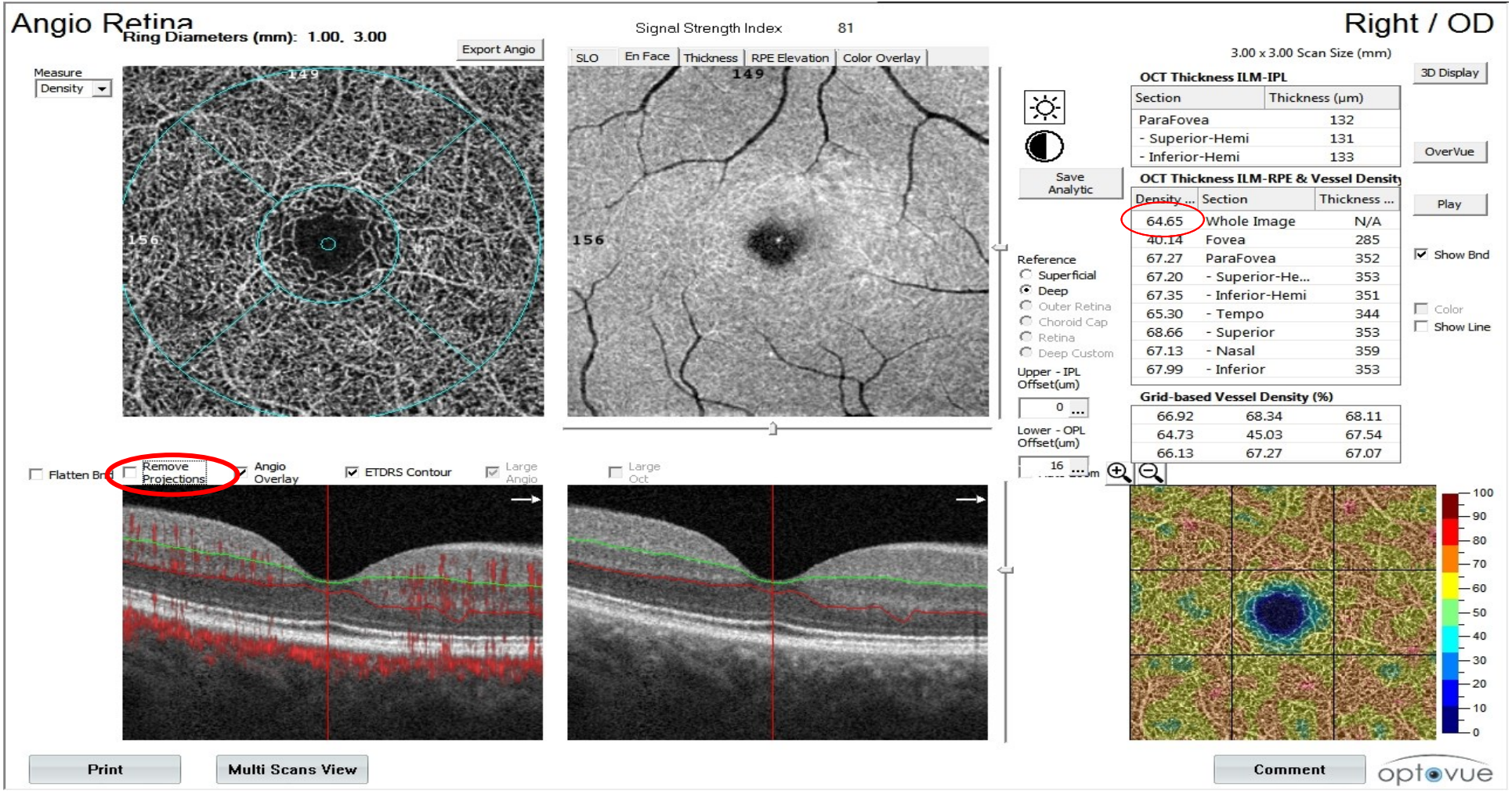
Ici un scan au niveau de l'épithélium pigmentaire (flèches jaunes) montre les artefacts de projection paradoxale des vaisseaux superficiels.

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
149
156
Signal Strength Index 81
SLO
En Face
Thickness
RPE Elevation
Color Overlay
Right / OD
3.00 x 3.00 Scan Size (mm)
3D Display
OCT Thickness ILM-IPL
Section
Thickness (µm)
ParaFovea 132
- Superior-Hemi 131
- Inferior-Hemi 133
OverVue
Save Analytic
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
Play
Show Bnd
Color
Show Line
Reference
Superficial
Deep
Outer Retina
Choroid Cap
Retina
Deep Custom
Upper - IPL Offset(um)
0
Lower - OPL Offset(um)
16
Grid-based Vessel Density (%)
66.92 68.34 68.11
64.73 45.03 67.54
66.13 67.27 67.07
Flatten Brd
Remove Projections
Angio Overlay
ETDRS Contour
Large Angio
Large Oct
100
90
80
70
60
50
40
30
20
10
0
Print
Multi Scans View
Comment
optovue

Angio Retina

Ring Diameters (mm): 1.00, 3.00

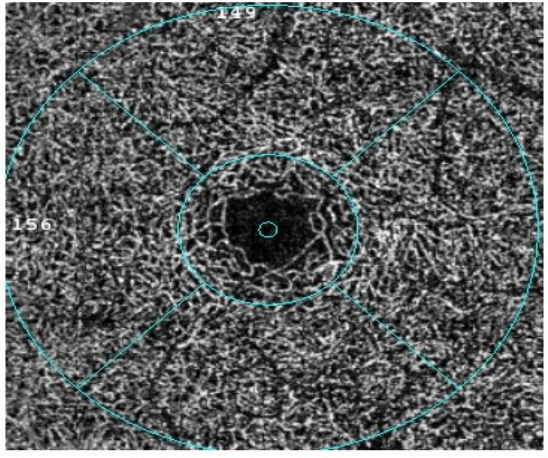
Export Angio

Signal Strength Index 81

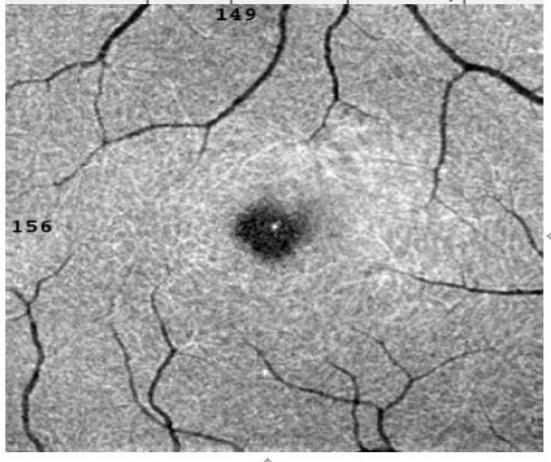
Right / OD

3.00 x 3.00 Scan Size (mm)

Measure: Density



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



OCT Thickness ILM-IPL

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

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

3D Display | OverVue | Play | Show Bnd | Color | Show Line

Save Analytic

Reference: Superficial / Deep / Outer Retina / Choroid Cap / Retina / Deep Custom

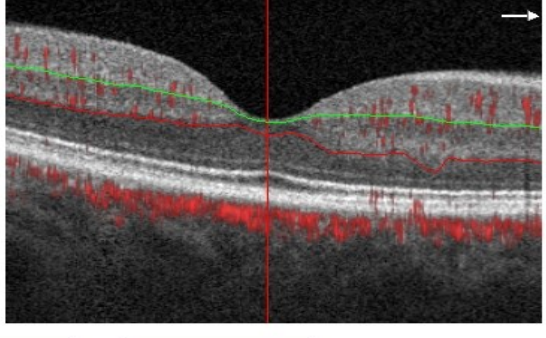
Upper - IPL Offset(um): 0

Lower - OPL Offset(um): 16

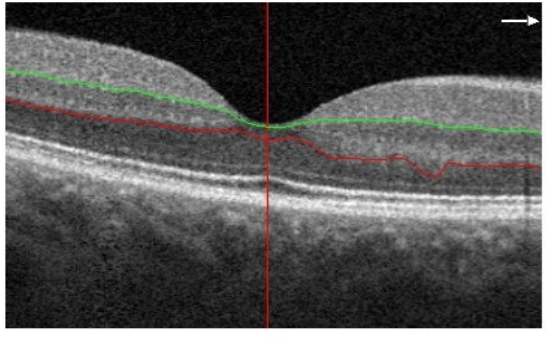
Grid-based Vessel Density (%)

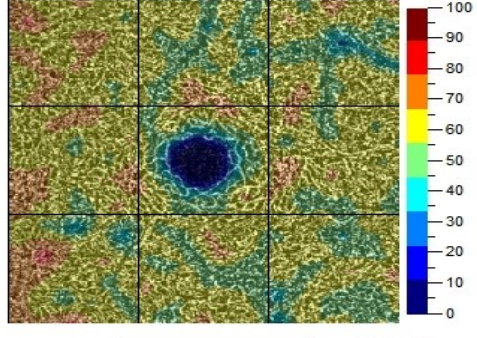
64.33	57.26	57.46
63.71	45.48	60.16
61.68	58.46	56.85

Flatten Bnd | Remove Projections | Angio Overlay | ETDRS Contour | Large Angio



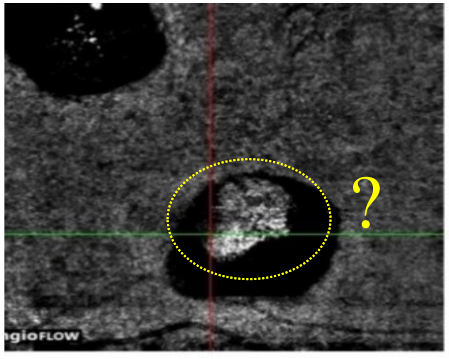
Large Oct

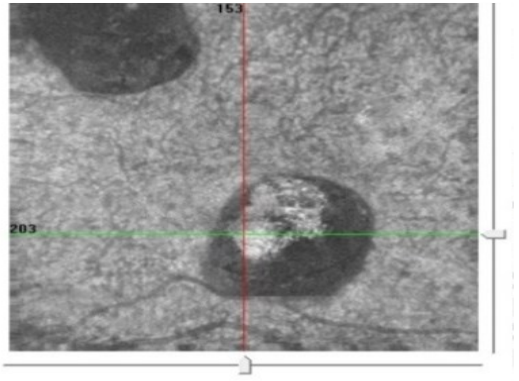




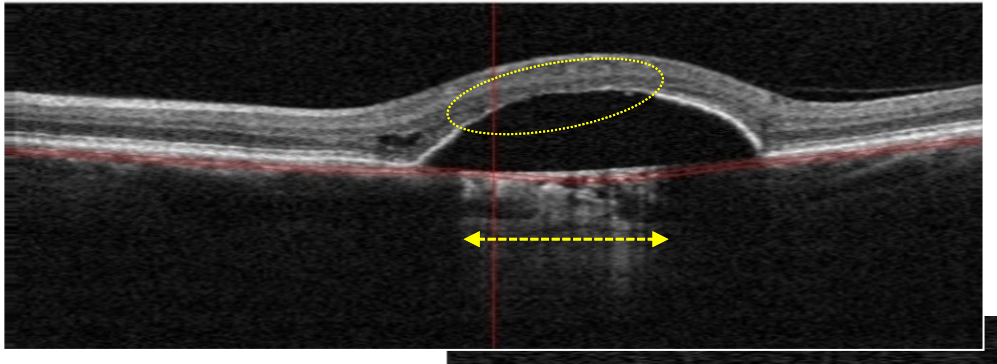
Print | Multi Scans View | Comment

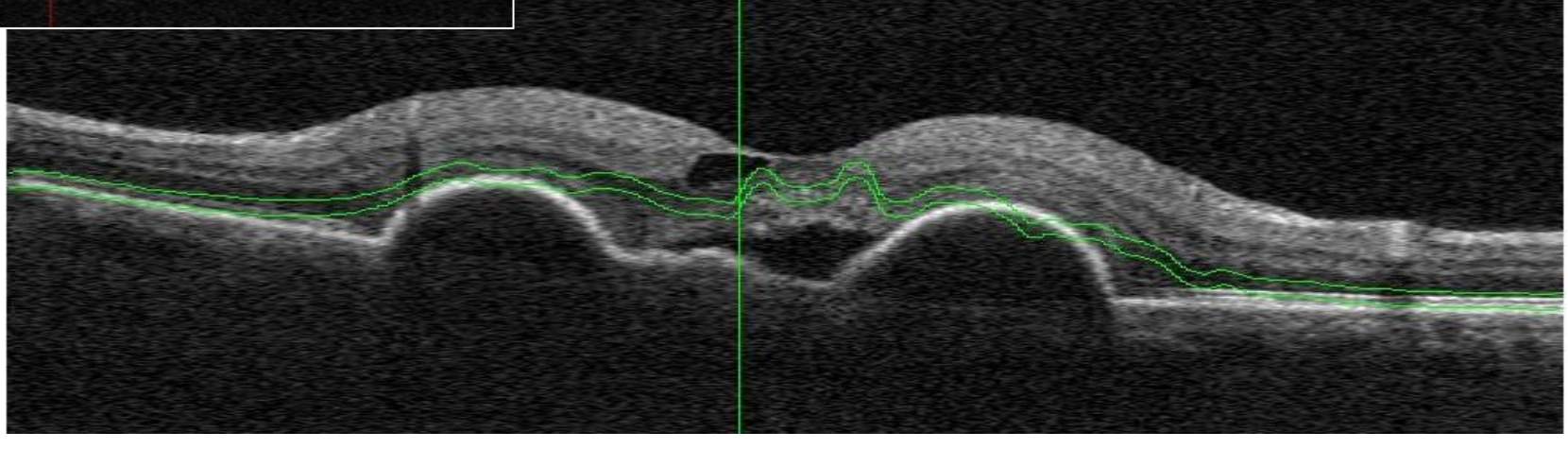
optovue



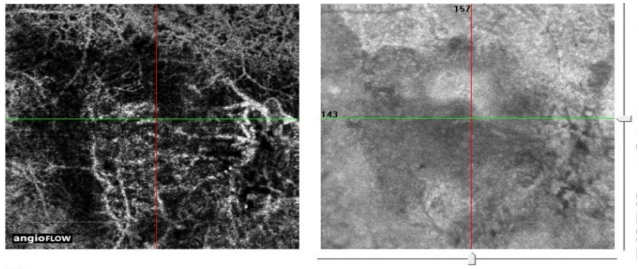


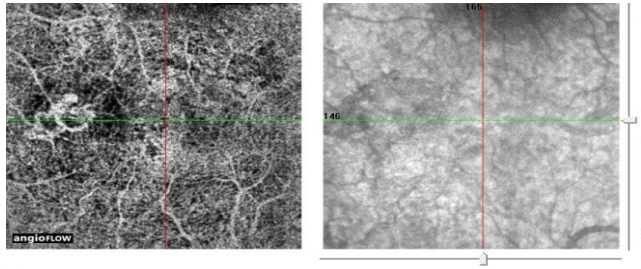
Segmentation
Erreurs

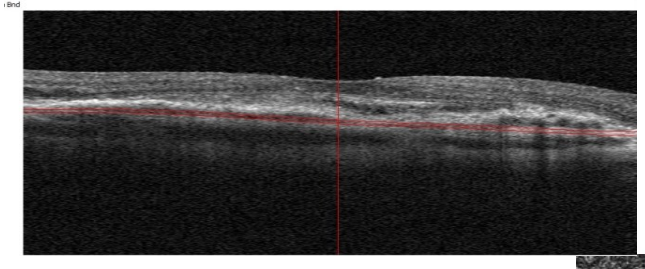


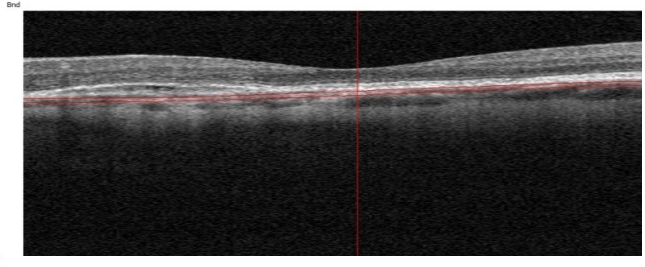


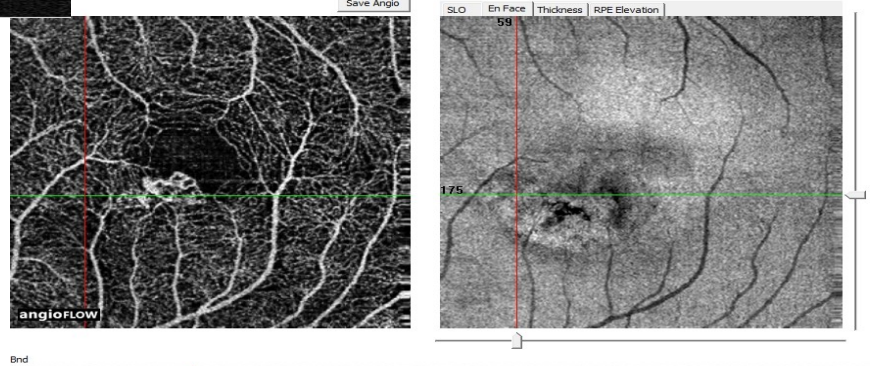
Type et placement de Slab

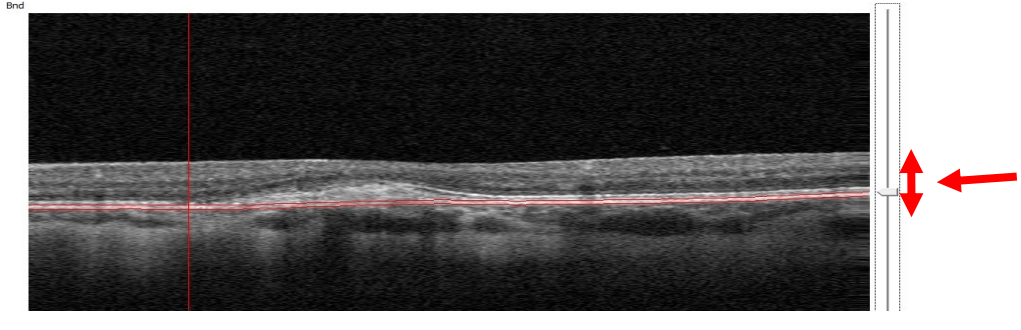

angioFLOW
157
143

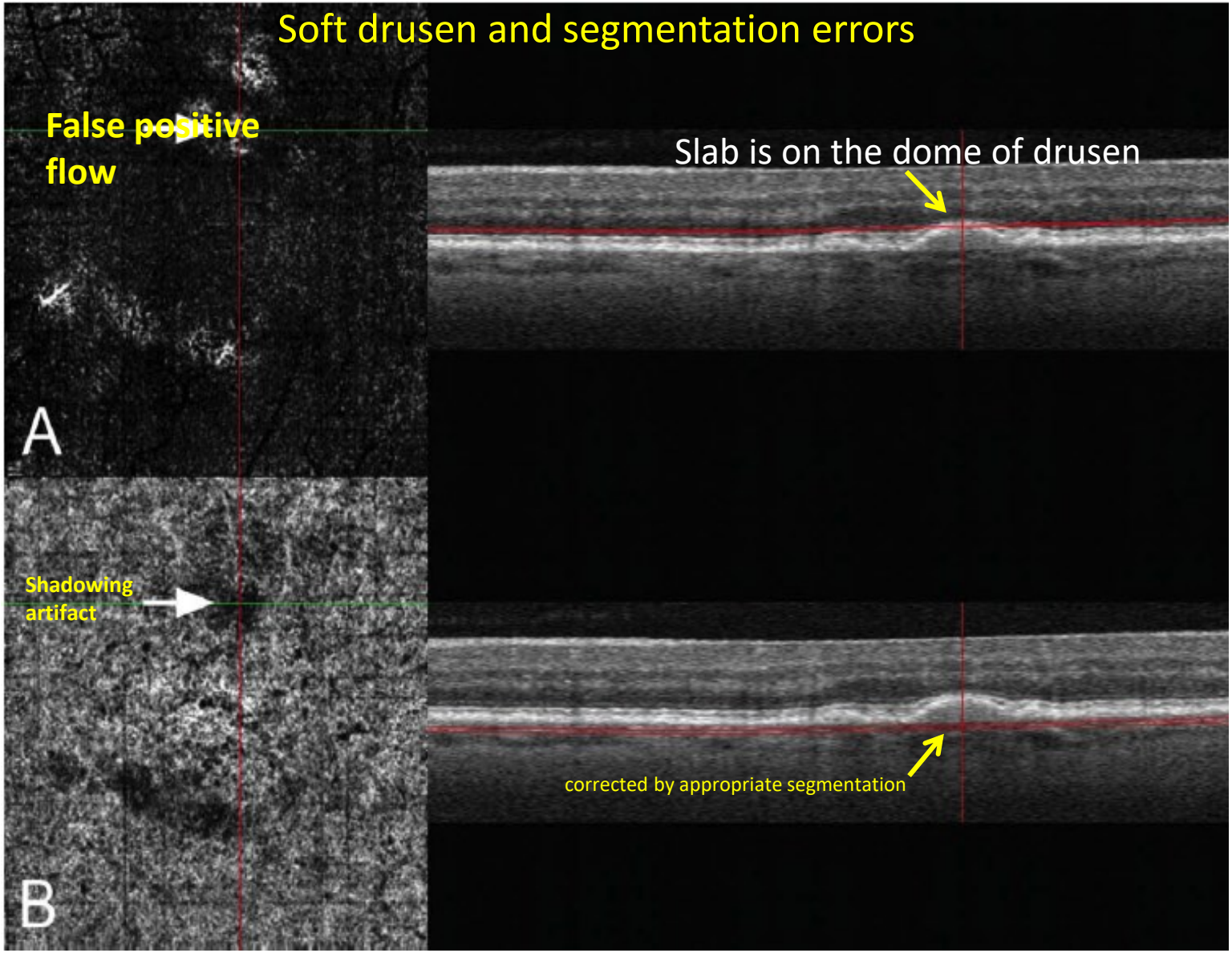

angioFLOW
165
146

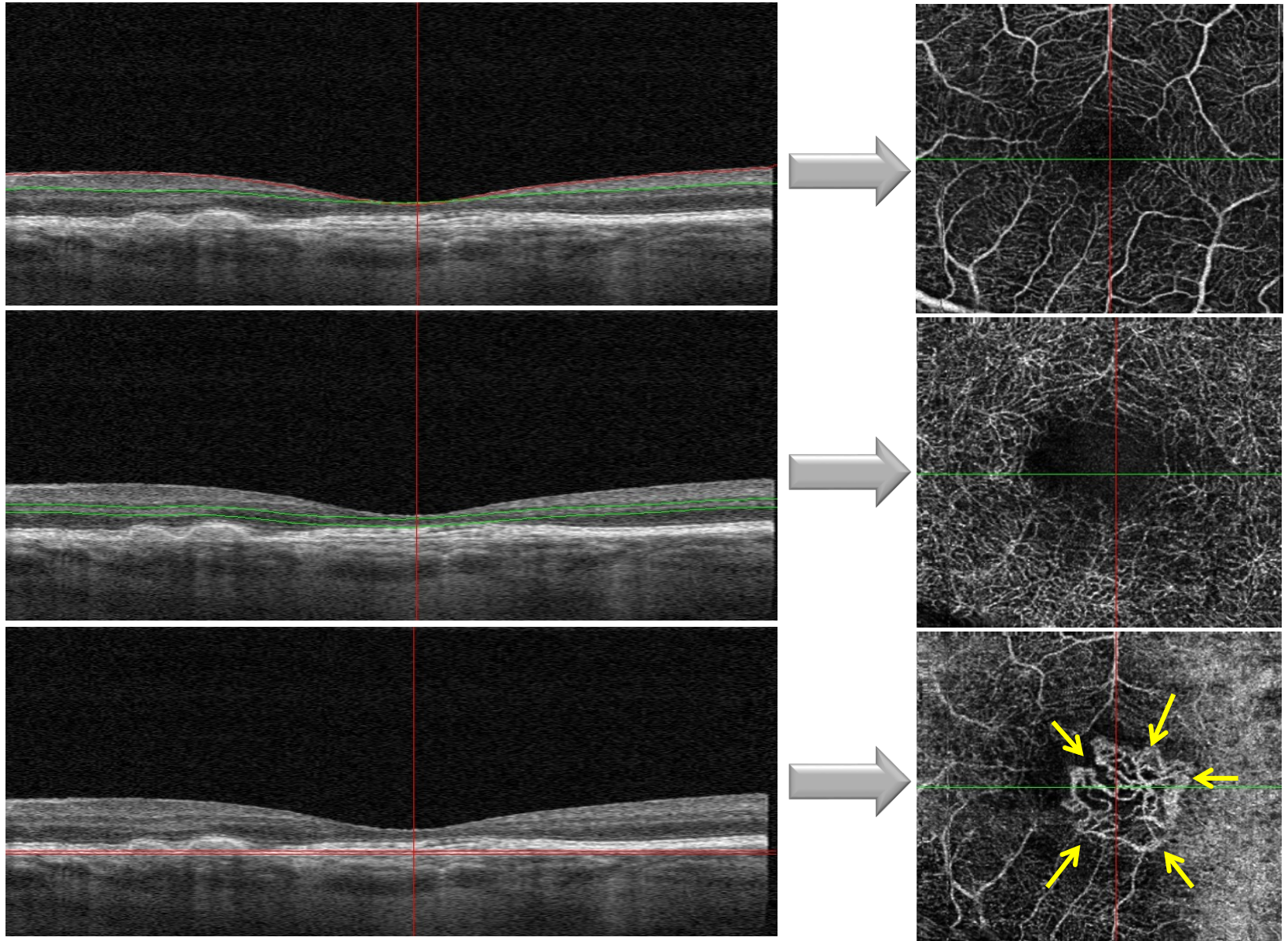

Bnd

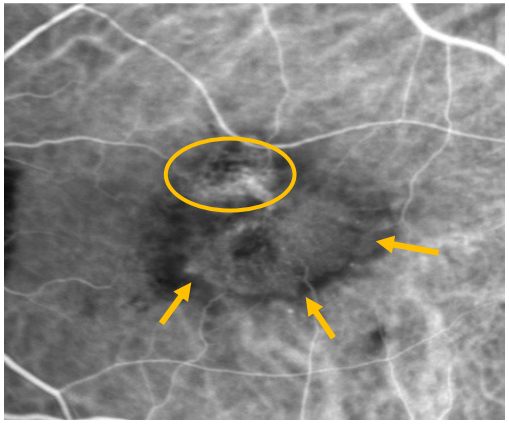

Bnd

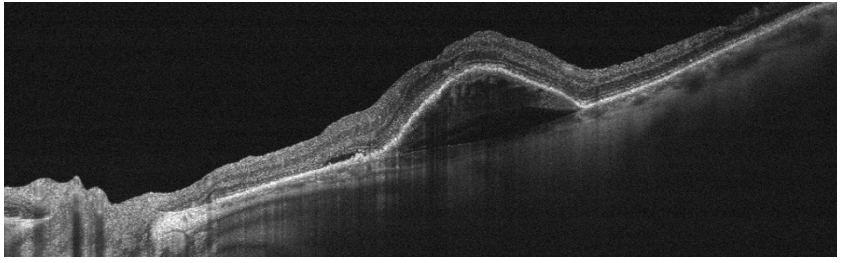

Save Angio
angioFLOW
SLO
En Face
Thickness
RPE Elevation
59
175
Save Settings
Restore Settings
Reference
Superficial
Deep
Outer Retina
Choroid Cap
Upper - RPE Ref Offset(um)
-6
Lower - RPE Ref Offset(um)
17

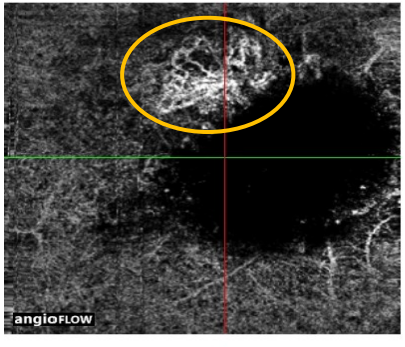

Bnd

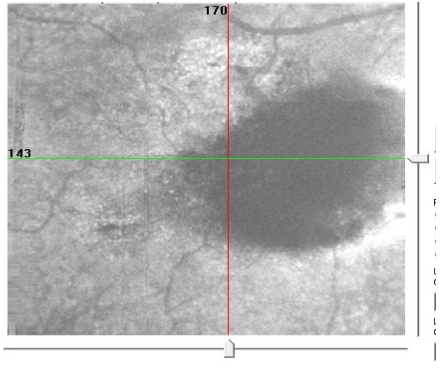

Soft drusen and segmentation errors
False positive flow
Slab is on the dome of drusen
A
Shadowing artifact
corrected by appropriate segmentation
B

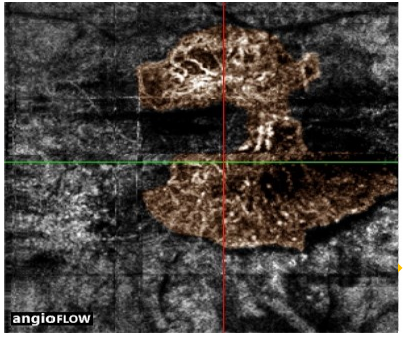


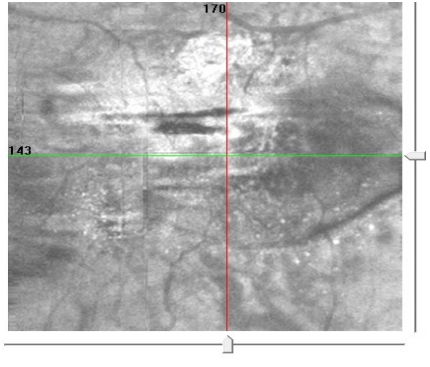


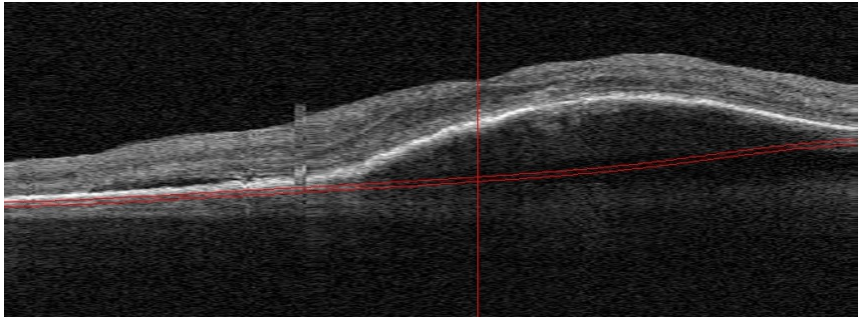


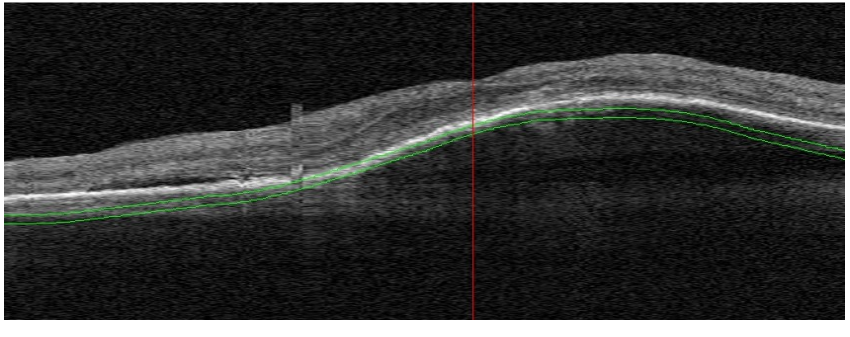

angioFLOW

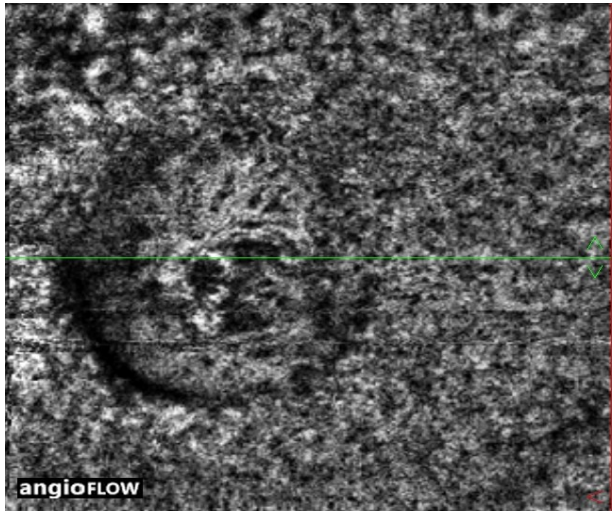

170
143

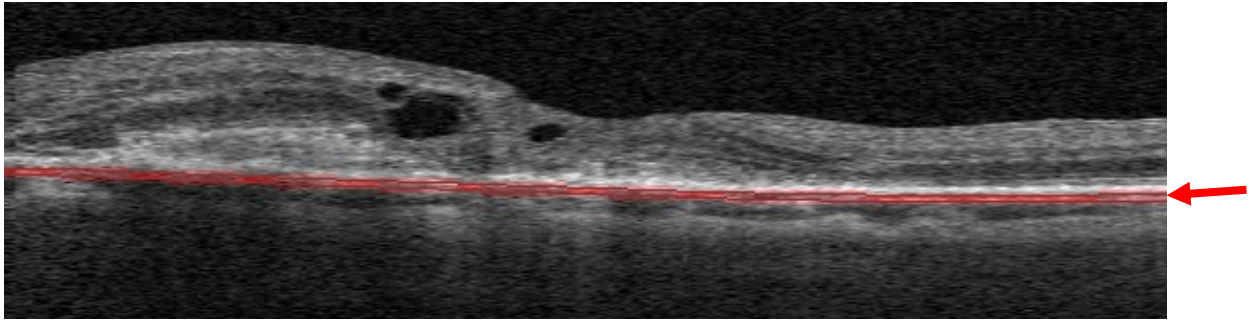

angioFLOW

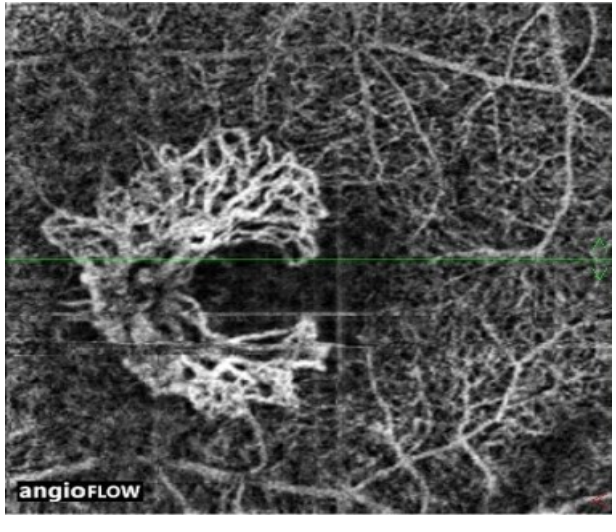

170
143



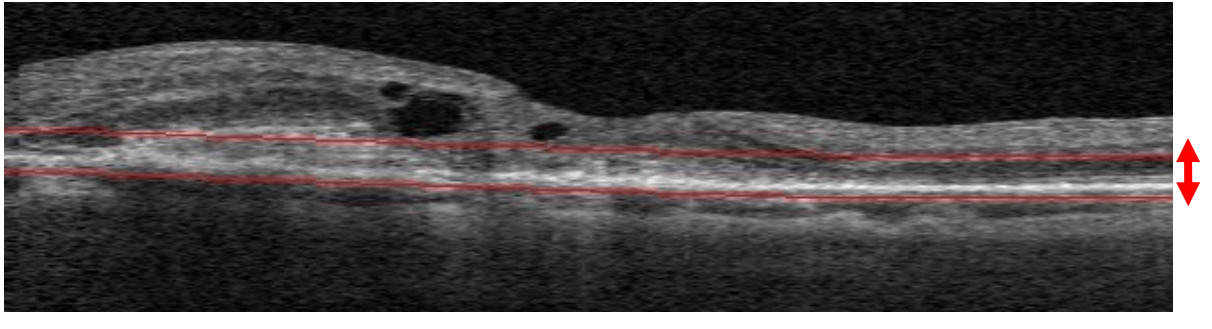


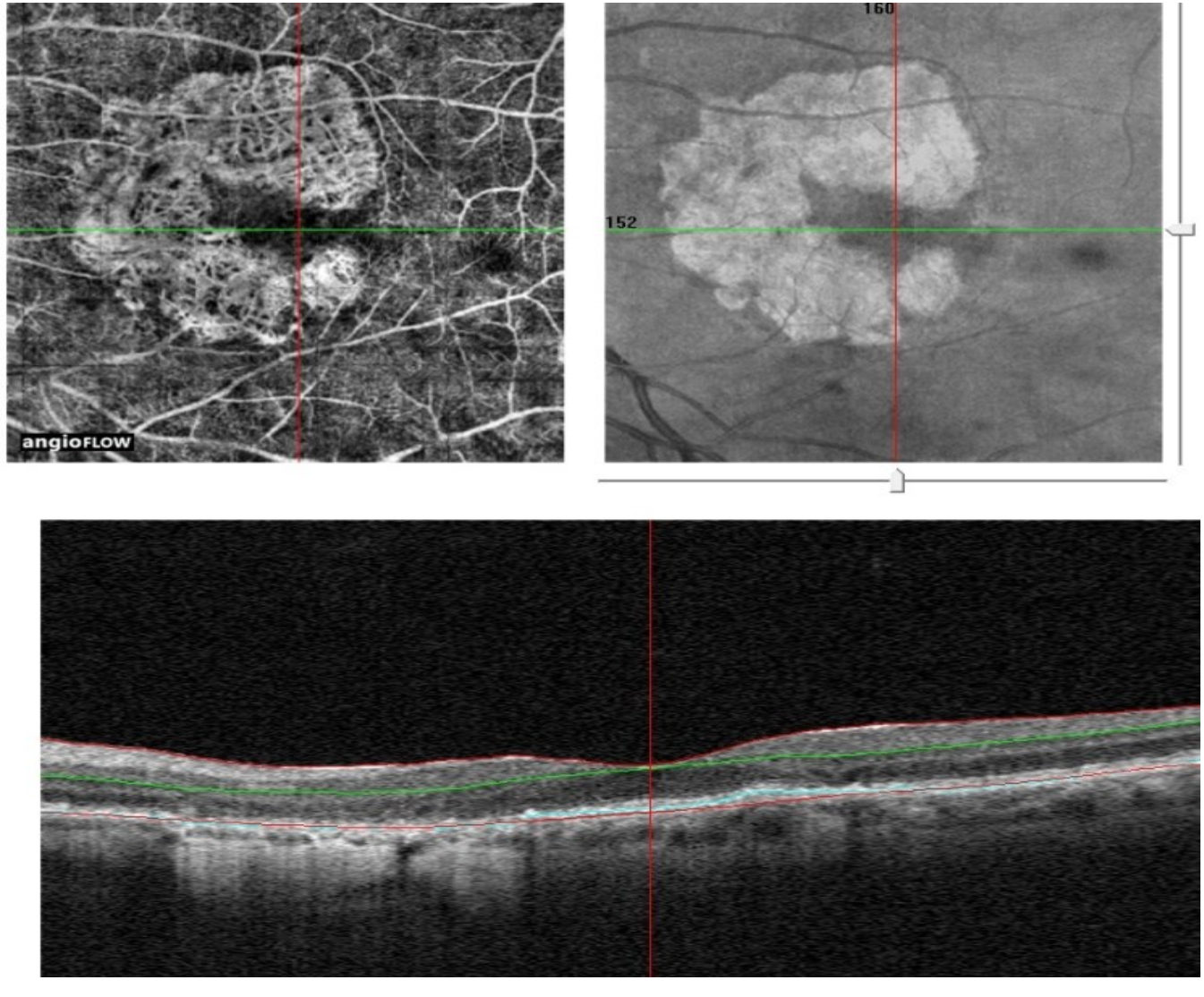




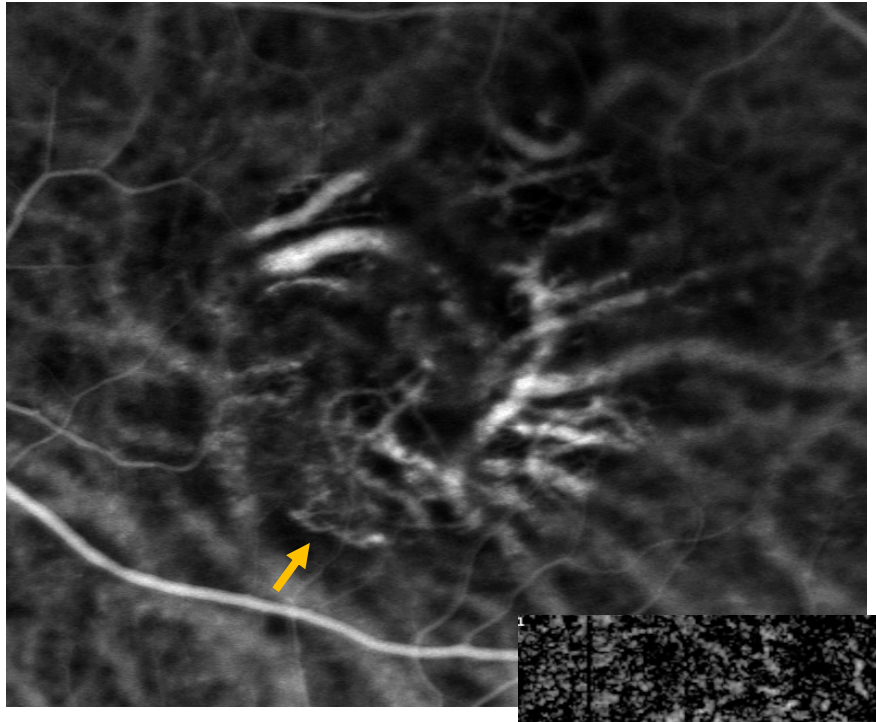


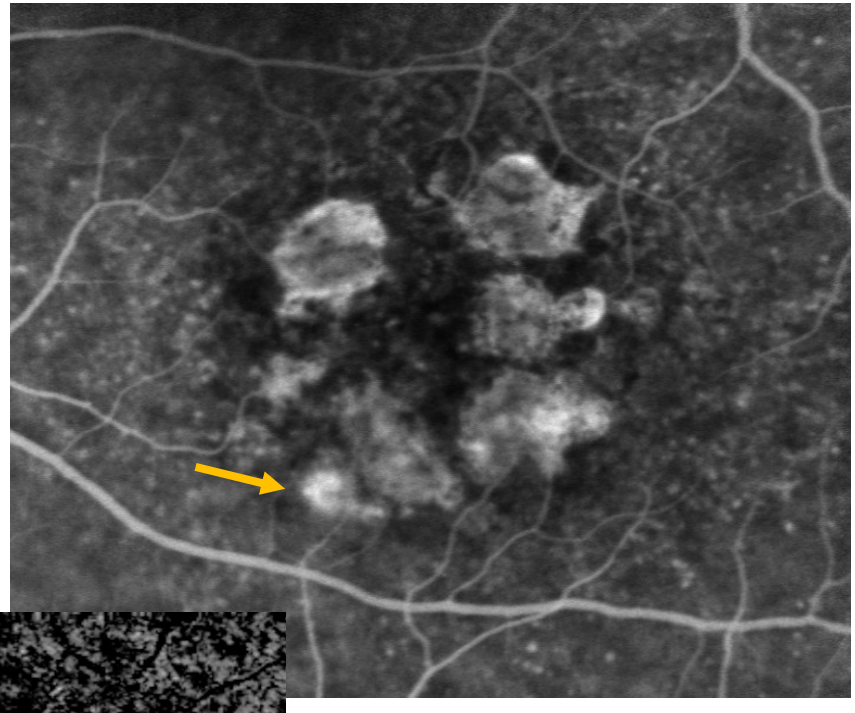
adjustment of slab boundaries

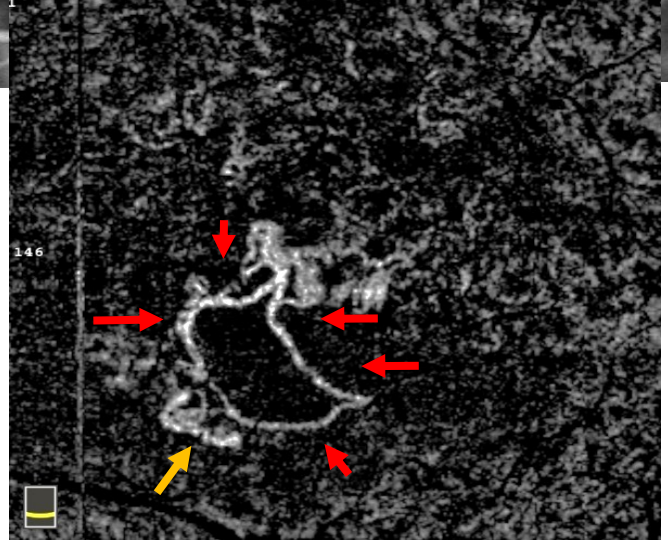




Unmasking artefact in choriocapillaris slab may resemble a choroidal neovascularisation





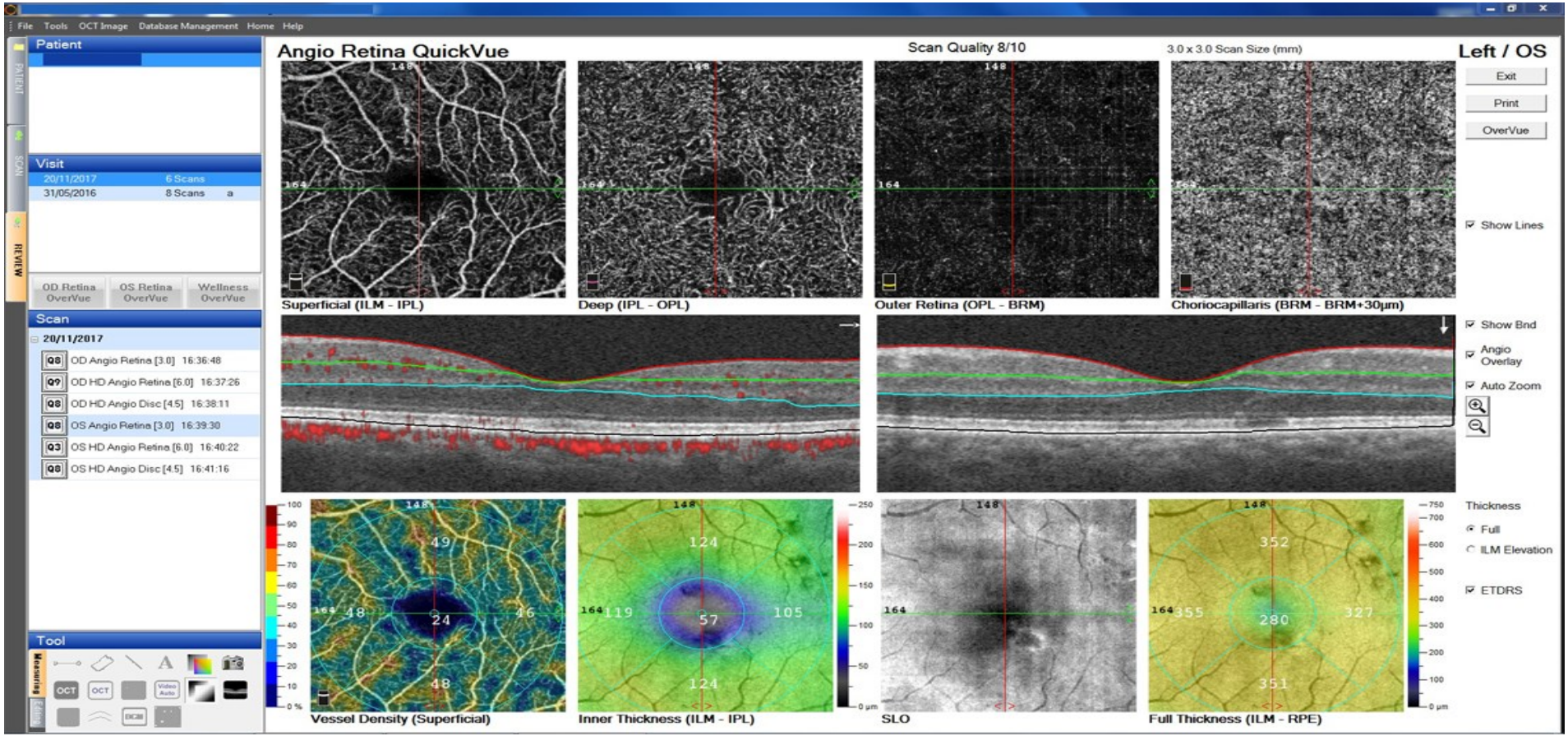

146

Multi-imaging

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

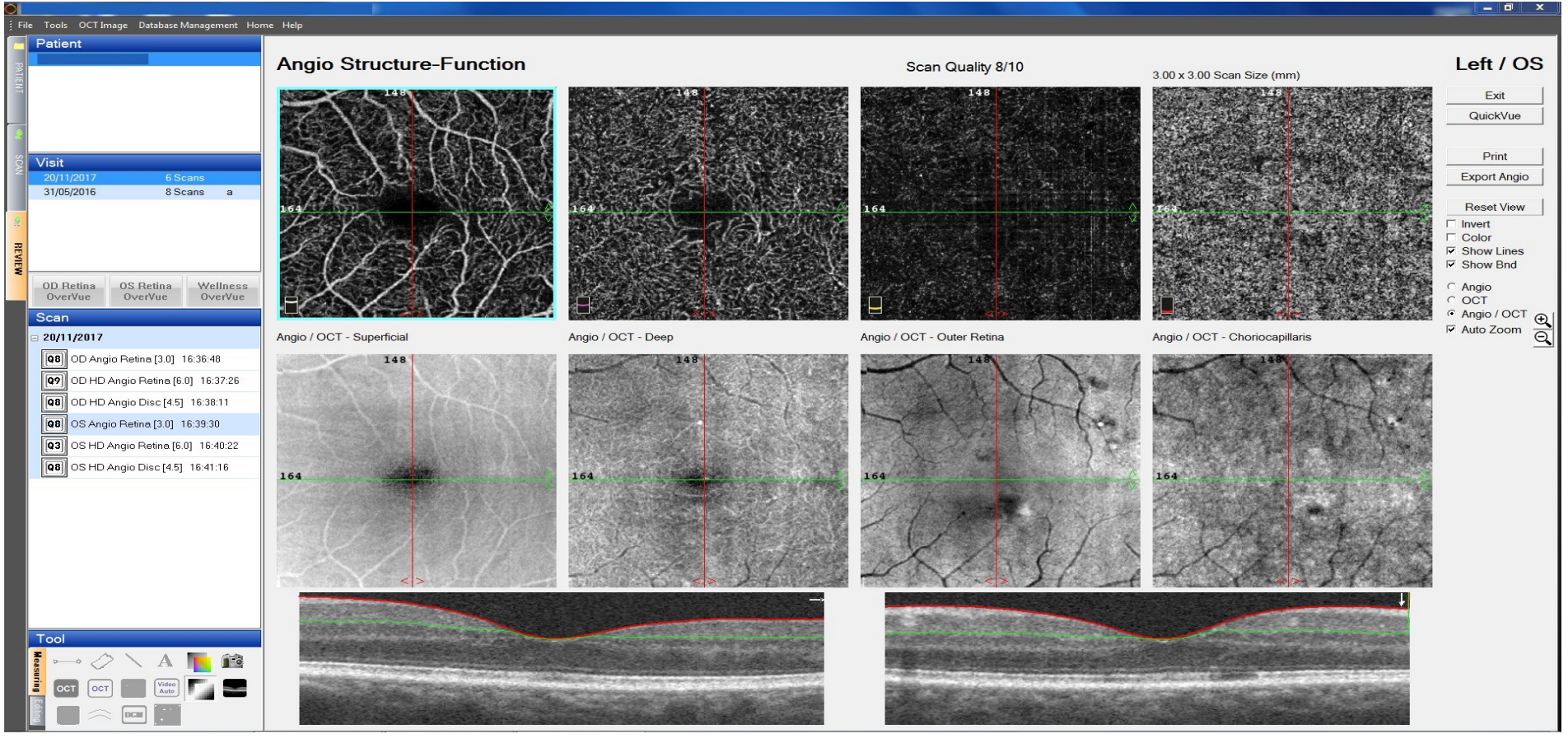
Analyse Optovue:

OCT-A, B-Scan, densité capillaire, épaisseur rétinien



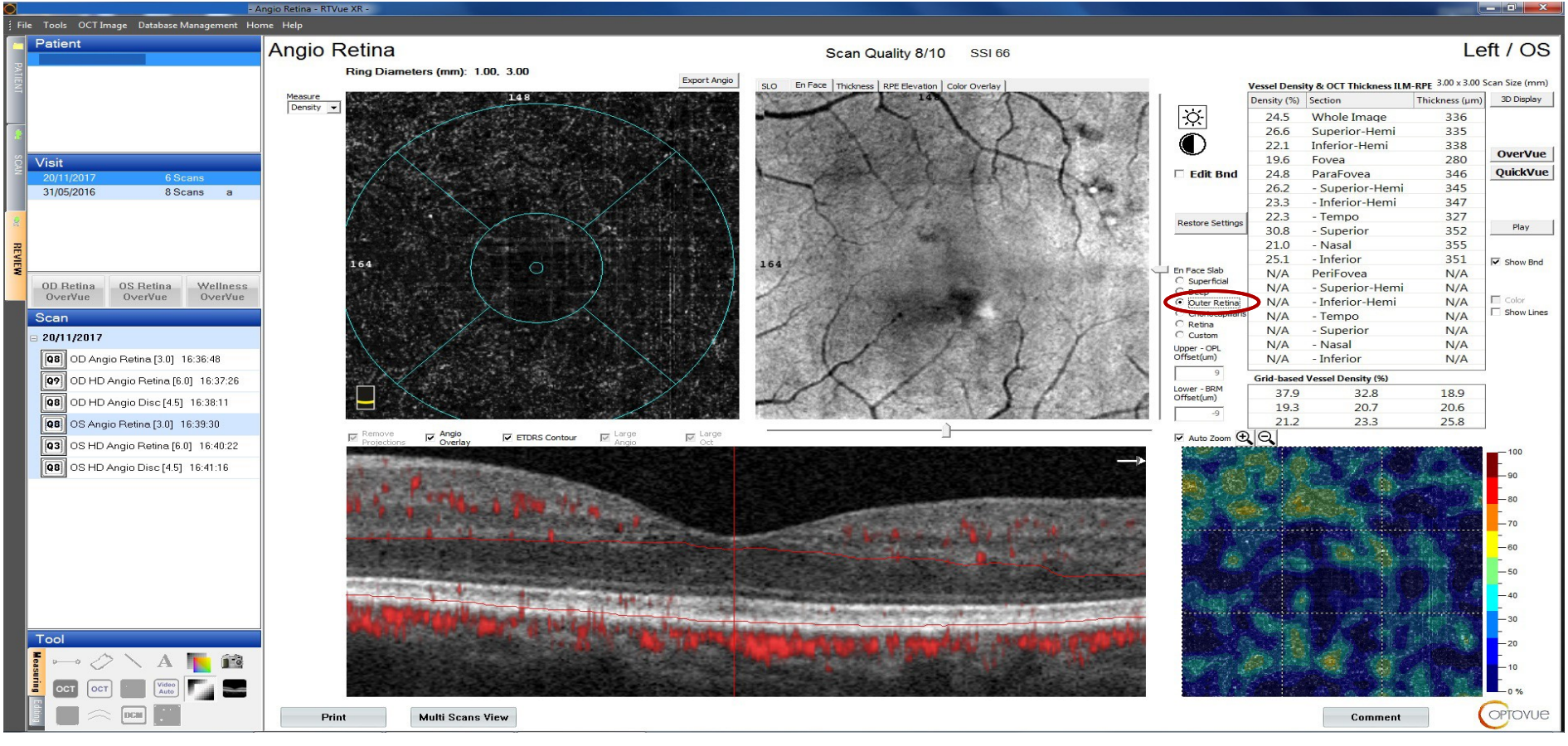
Analyse Optovue:

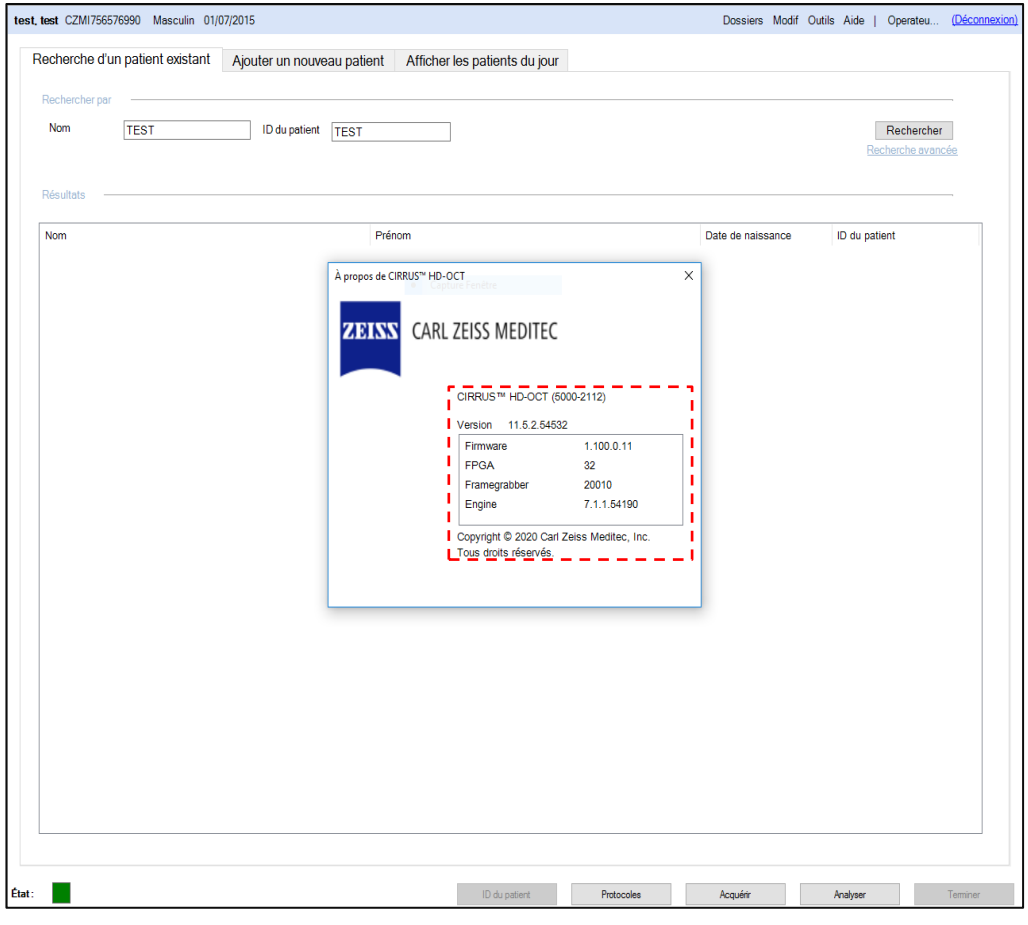
OCT-A, OCT en-Face, B-Scan

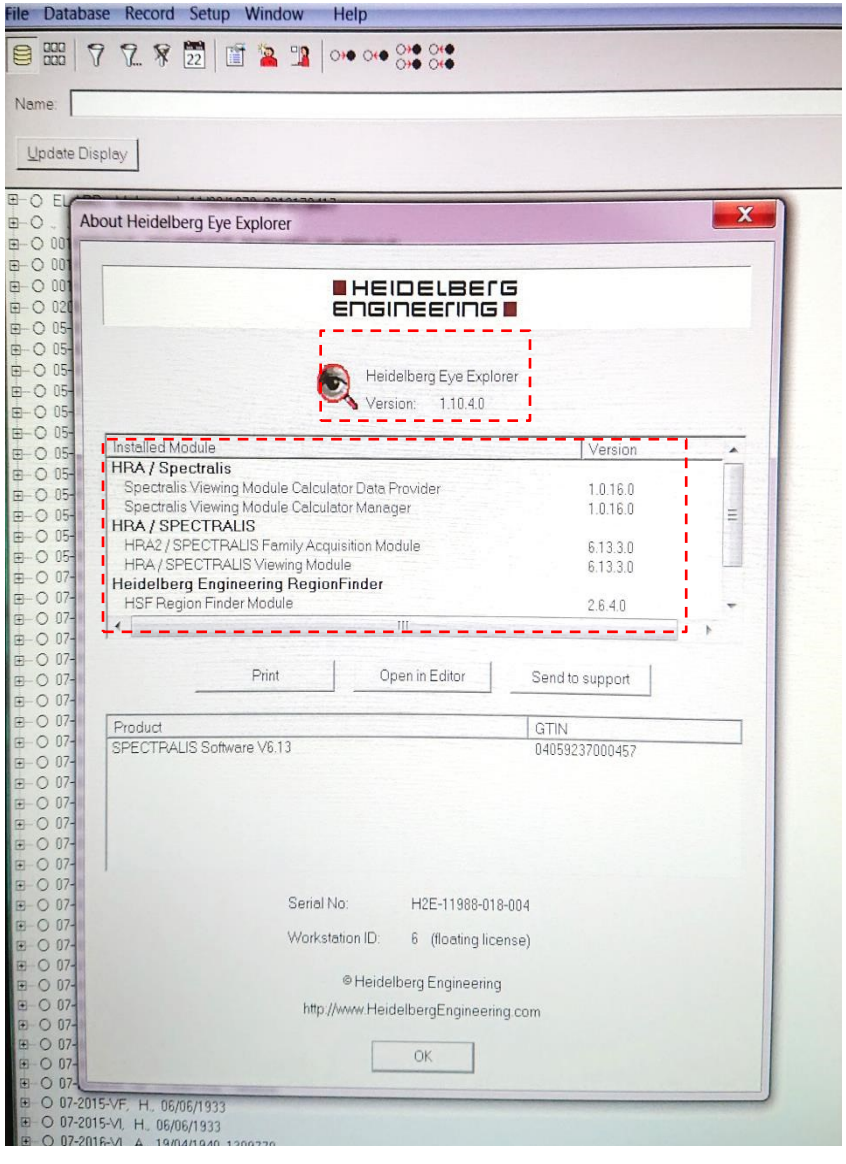


Analyse Optovue:

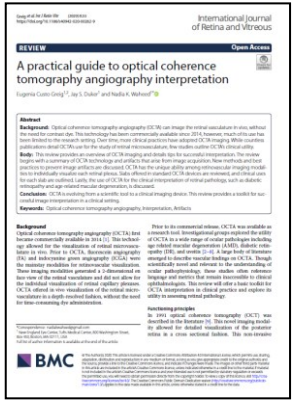
OCT-A, OCT en –Face, B-Scan, densité capillaire *(rétine externe)*



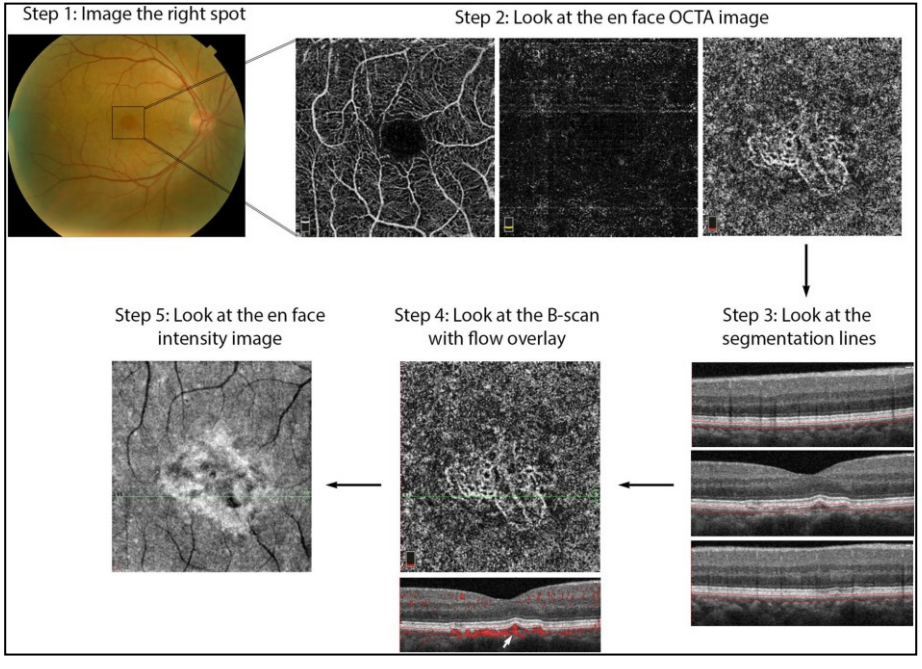




- ✓ Version du logiciel
- ✓ Outiles en option
- ✓ **Mise à jour** +++



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.

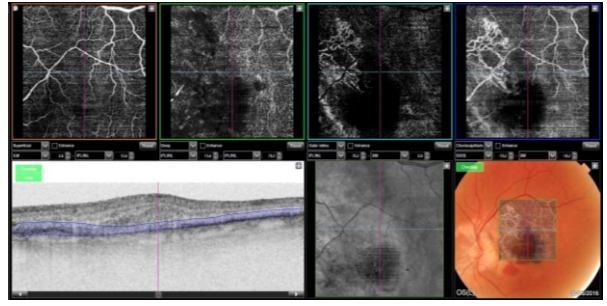
Step 3: Look at the segmentation lines. Segmentation is assessed at multiple points throughout the slab to ensure accuracy.

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**

Université de Paris

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Merci de votre attention

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