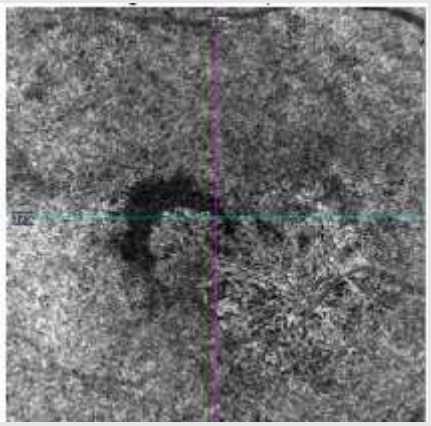


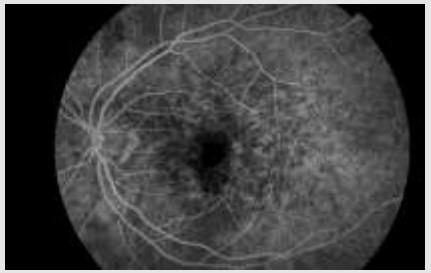
OCT Fundal Angiography Clinical Applications Initial experience

The new era in Medical Retina Imaging

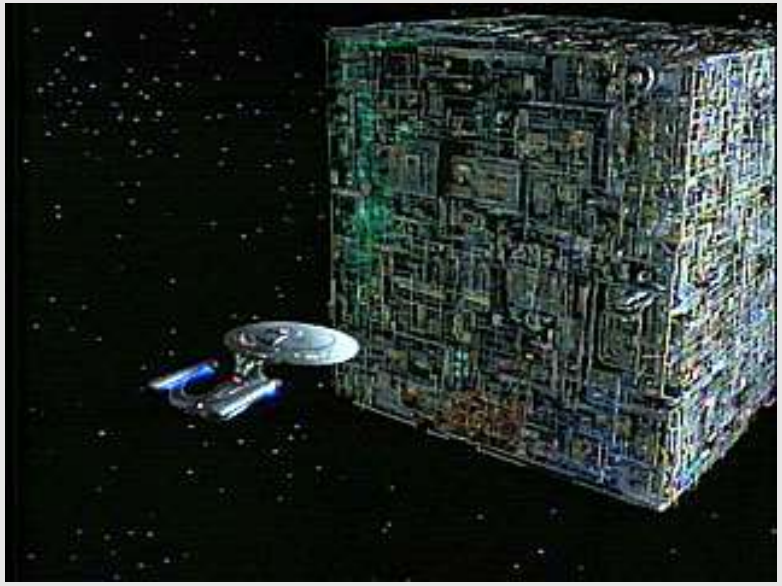
Based on Cirrus 5000 AngioPlex 2016 Model

Nicholas Lee

Consultants Ophthalmologist at The Hillingdon Hospital and The Western Eye Hospital in London UK



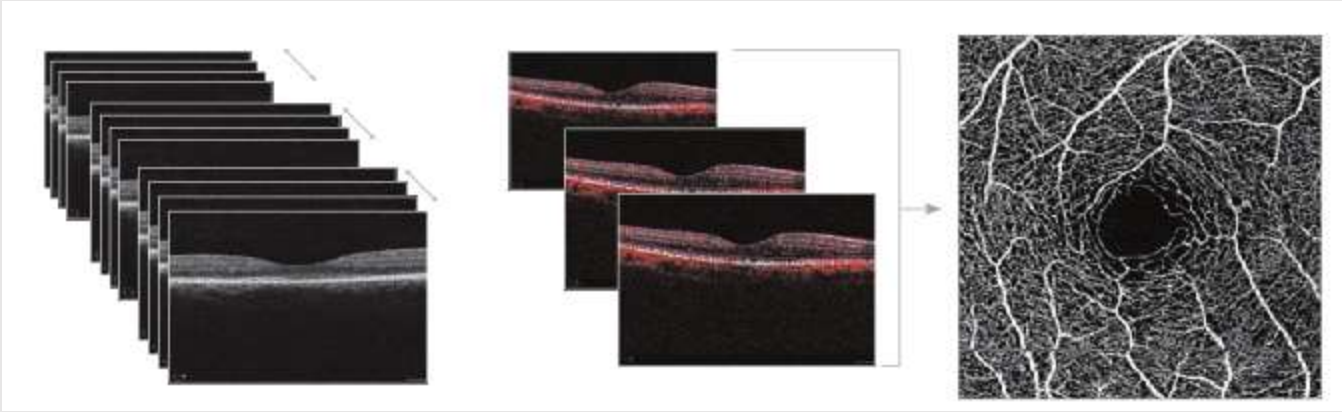
OCT – Angiography
New Era of Dye Less Angiography



- Key is OCT Laser scanners increased from 27,000 to 68,000+ Hz
    - Time to do scans is shorter
      2.6 for 512 image, 1.8 for 200 image and 0.8 for Raster
- 840um Wavelength for resolution
    - Shorter wavelength = higher resolution
    - Longer wavelength = greater depth penetration – eg swept Source
- 5um and 15um Axial/horizontal resolution
    - Limited by wavelength
- 36 x 30 degree view
    - Limited by optics designs
    - Typically 3 to 6 to 8mm squares
- >67 Million data cube points for Cube data analysis
    - Fast i7 chips allow for rapid processing – Near instant now.

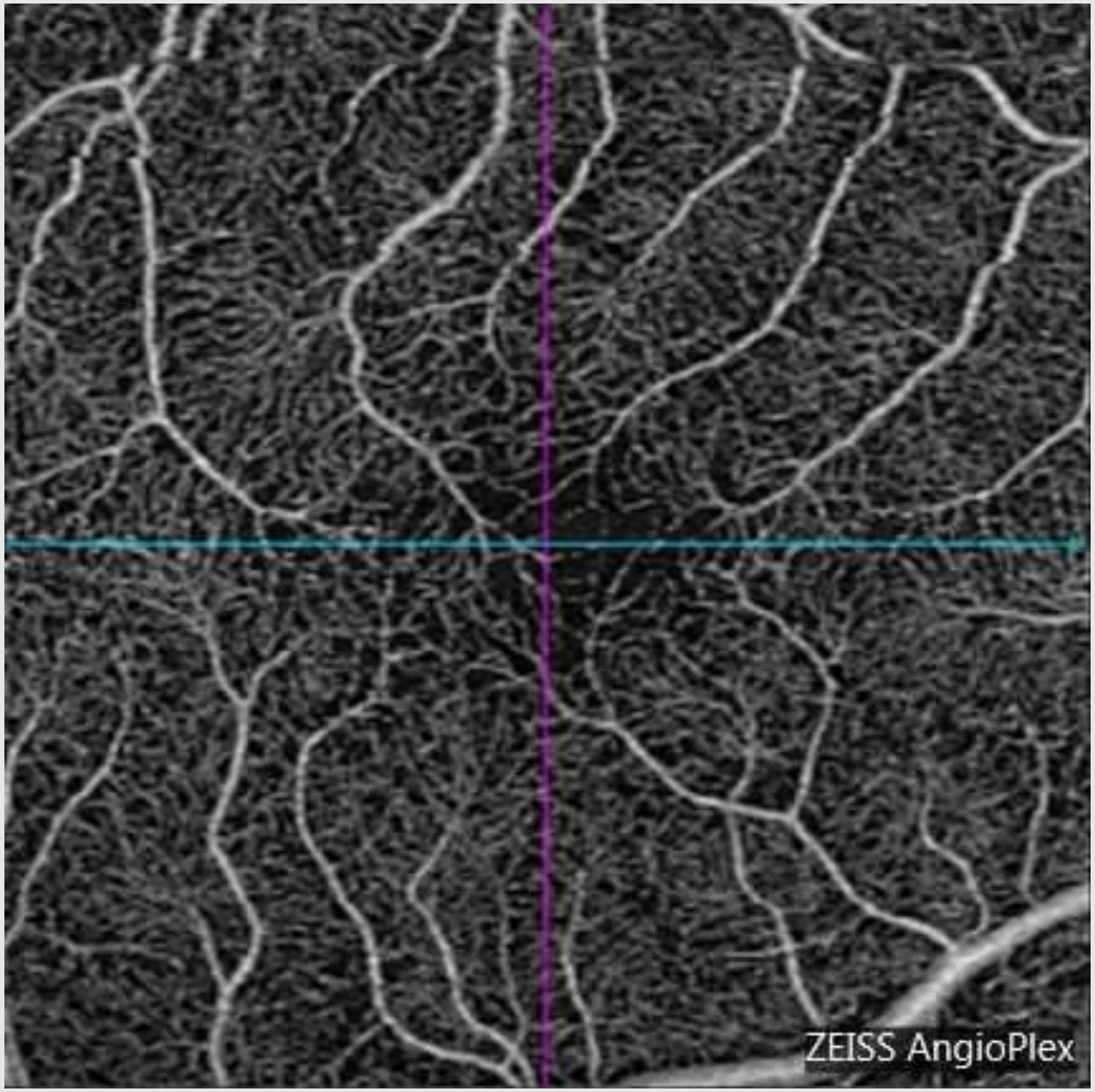
Blood Moves!

- Blood flows in veins and arteries
- Detect moving blood
- Imaging the vessels where blood moves
- Ultrafast scanners can look for changes = blood flow
- 3 scans taken per slice
- *Accurate Live eye tracking is key
- Computers calculate and render the data into images of the blood vessels



Normal OCT-A

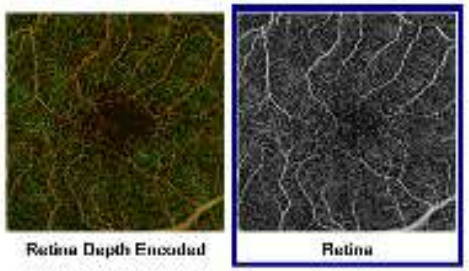
- As useful as abnormal
- Vitreous – New vessels
- Retinal circulation – Diabetes, Vein occlusions
  - Better resolution than FFA
- Mid retina – Aneurysm, RAP
- Choriocapillaris - AMD, PED
- Choroid – Naevi, Melanoma



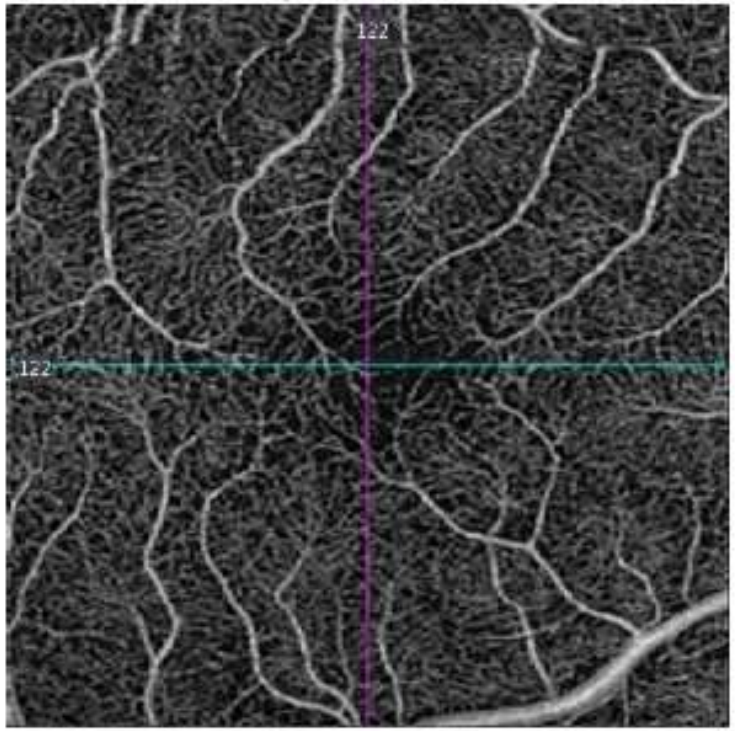
Zeiss OCT-A Standard Screen/Printed Report

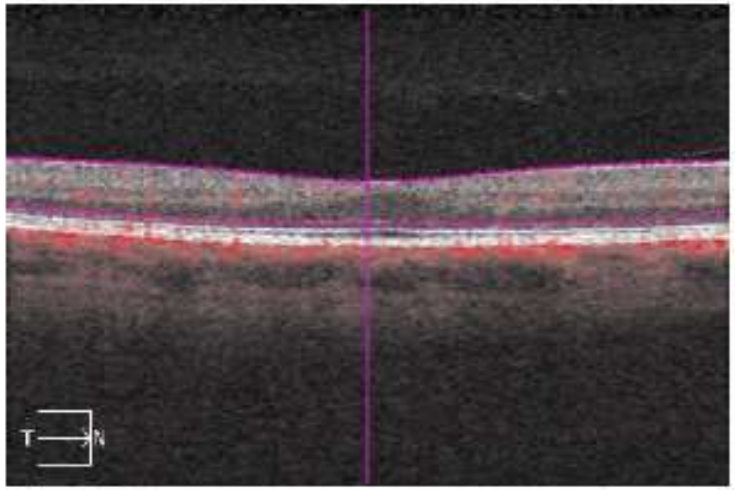
Angiography Analysis : Angiography 3x3 mm

OD ● | ○ OS

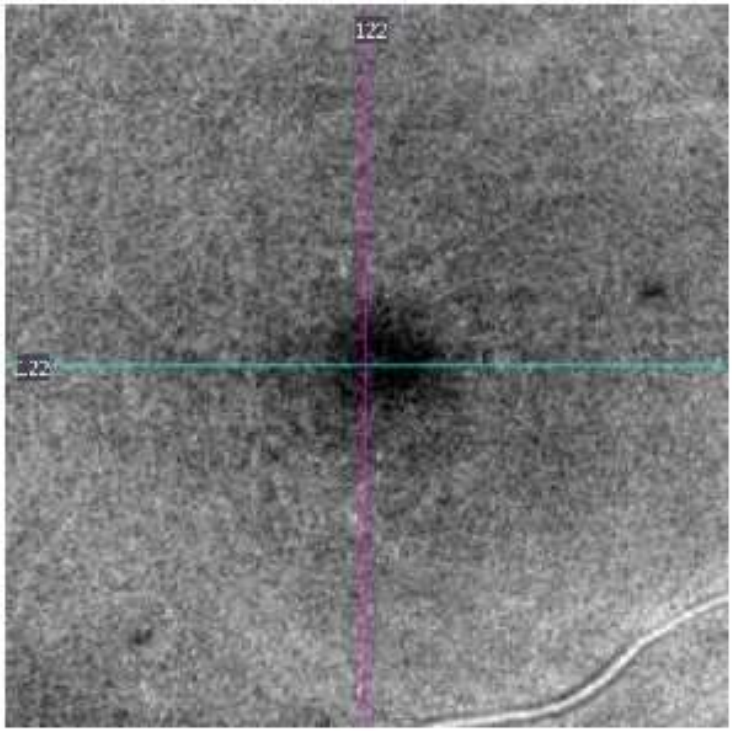


AngioPlex - Retina





Structure - Retina

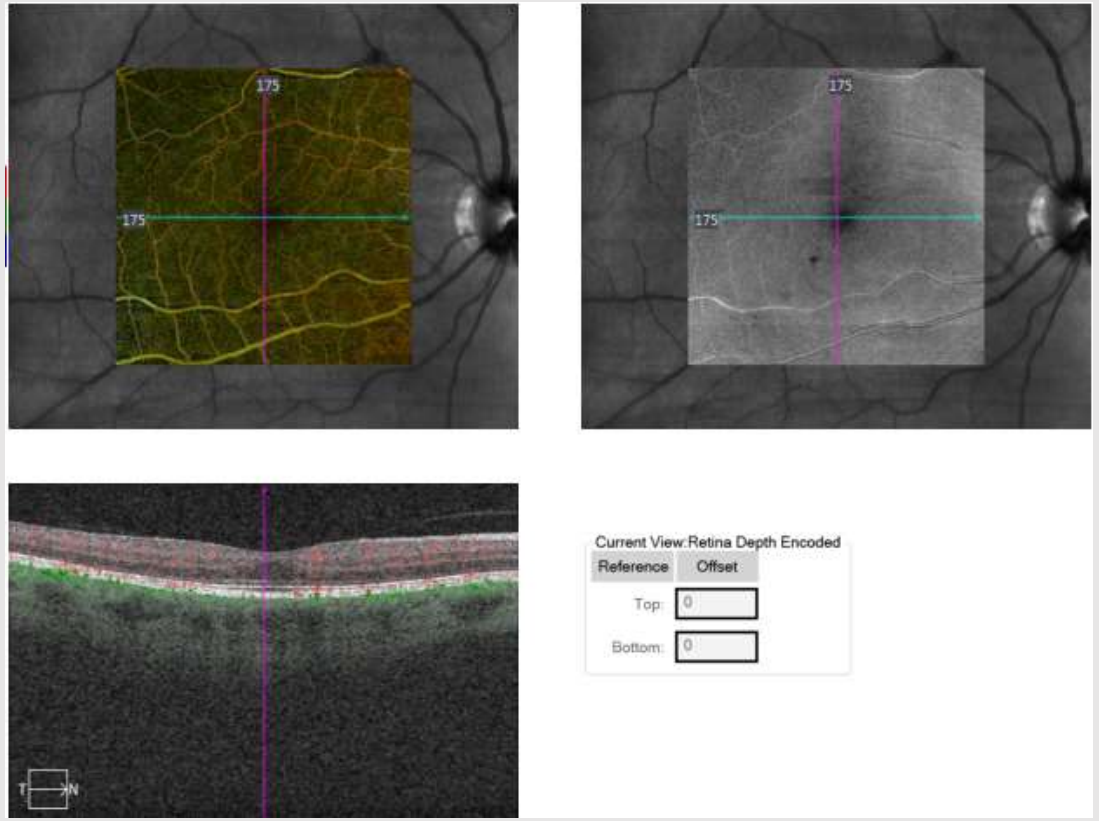


Current View:Retina

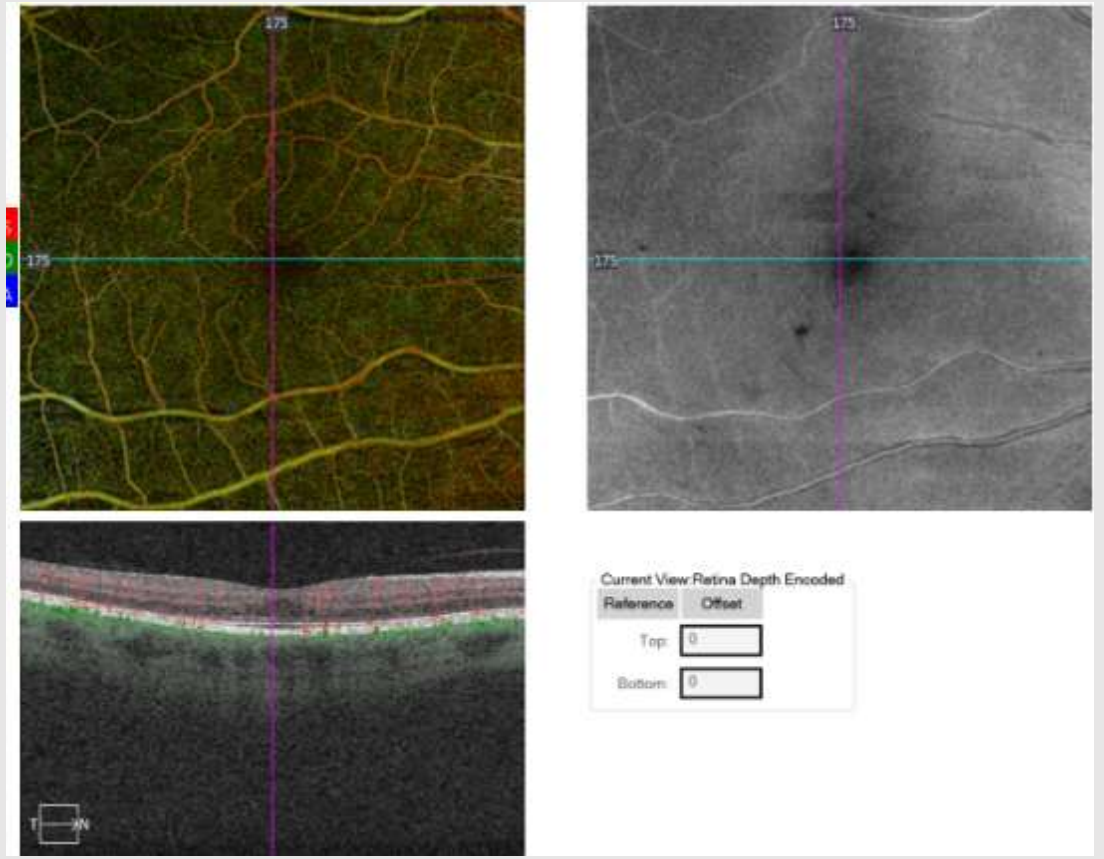
Reference	Offset
Top: ILM	0
Bottom: RPEFit	-70

Overview Options

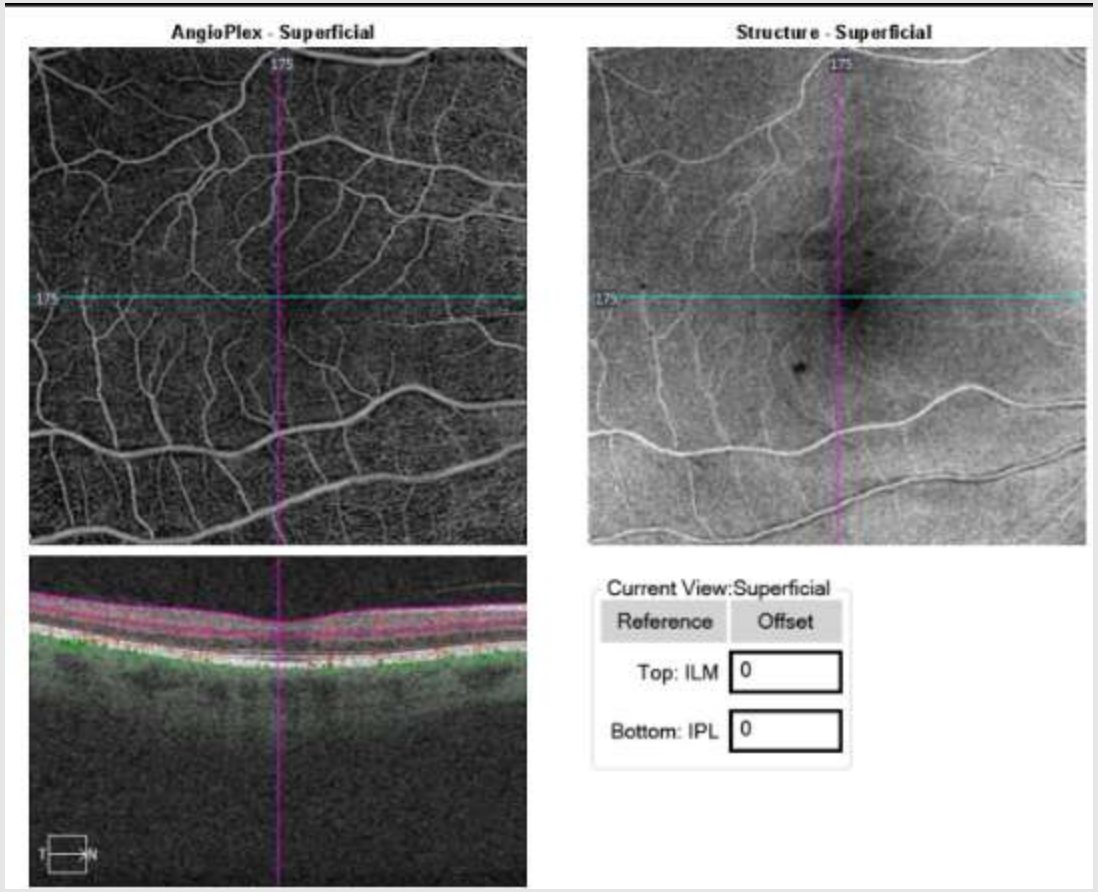
Fundal View



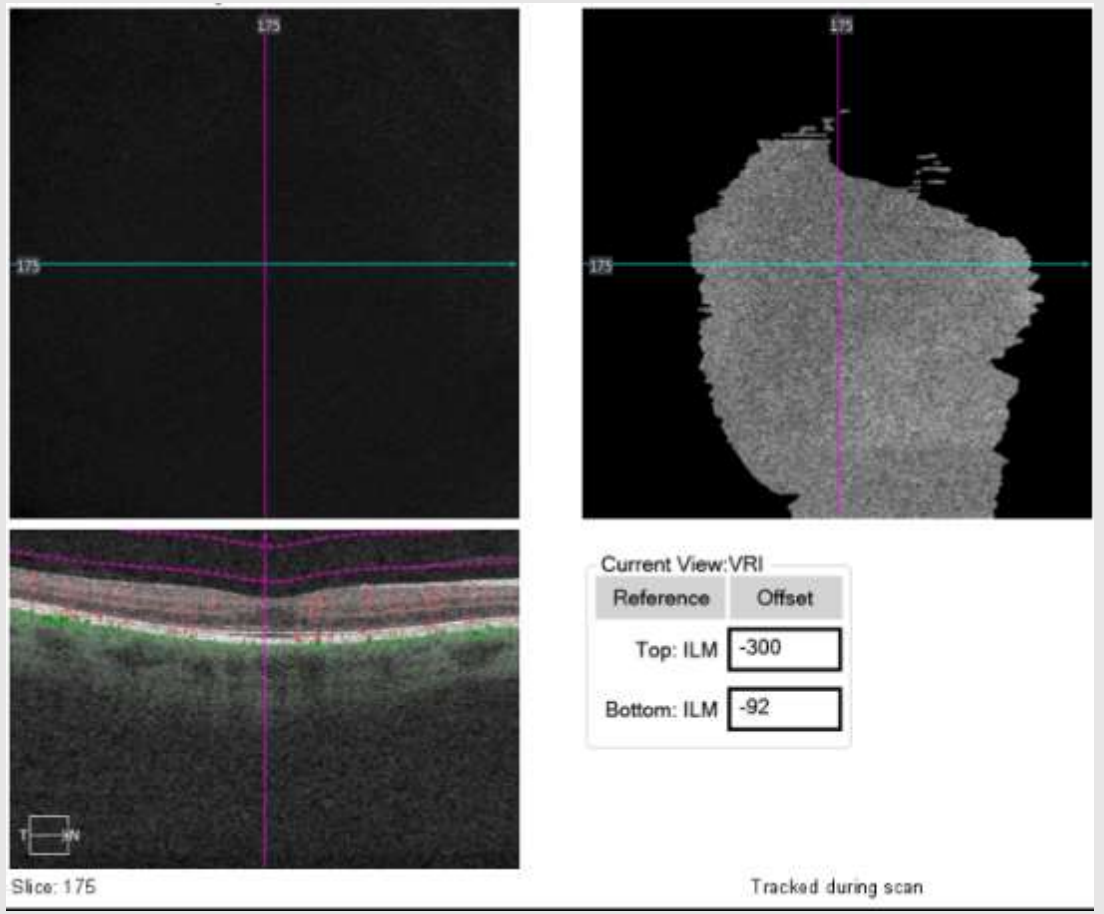
Doppler View



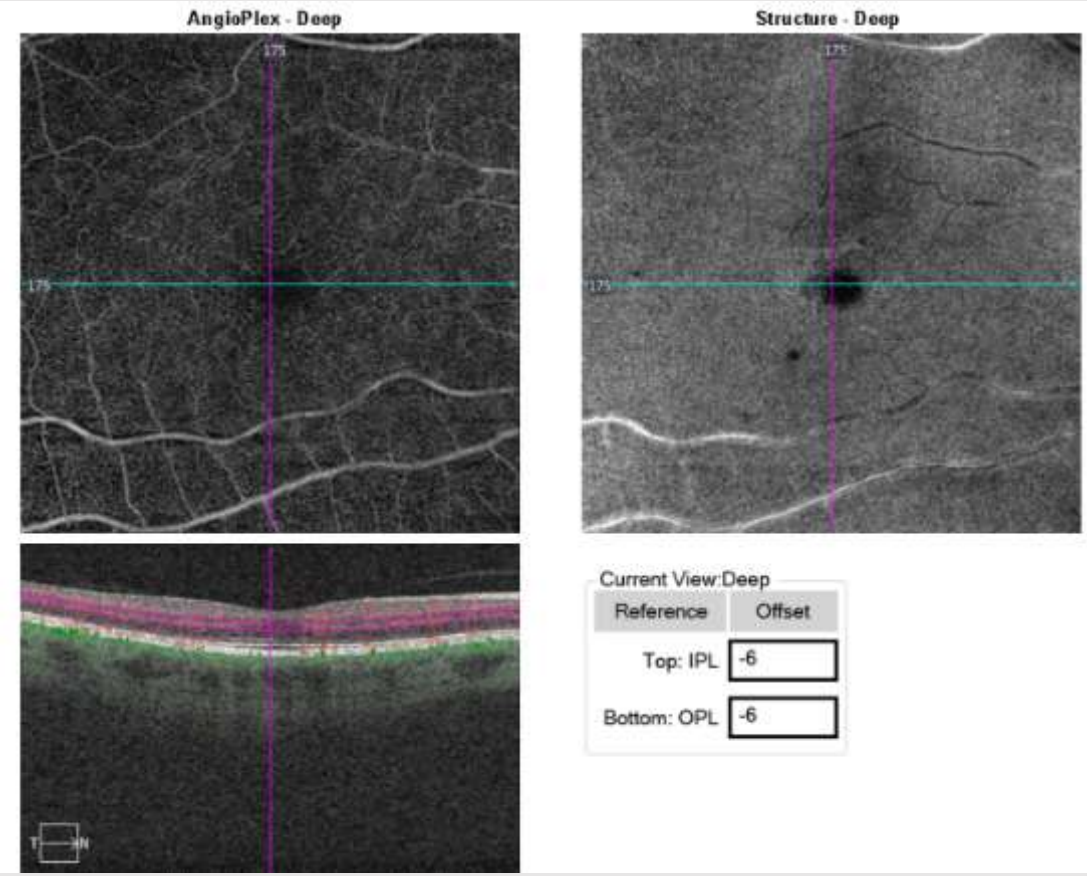
Superficial



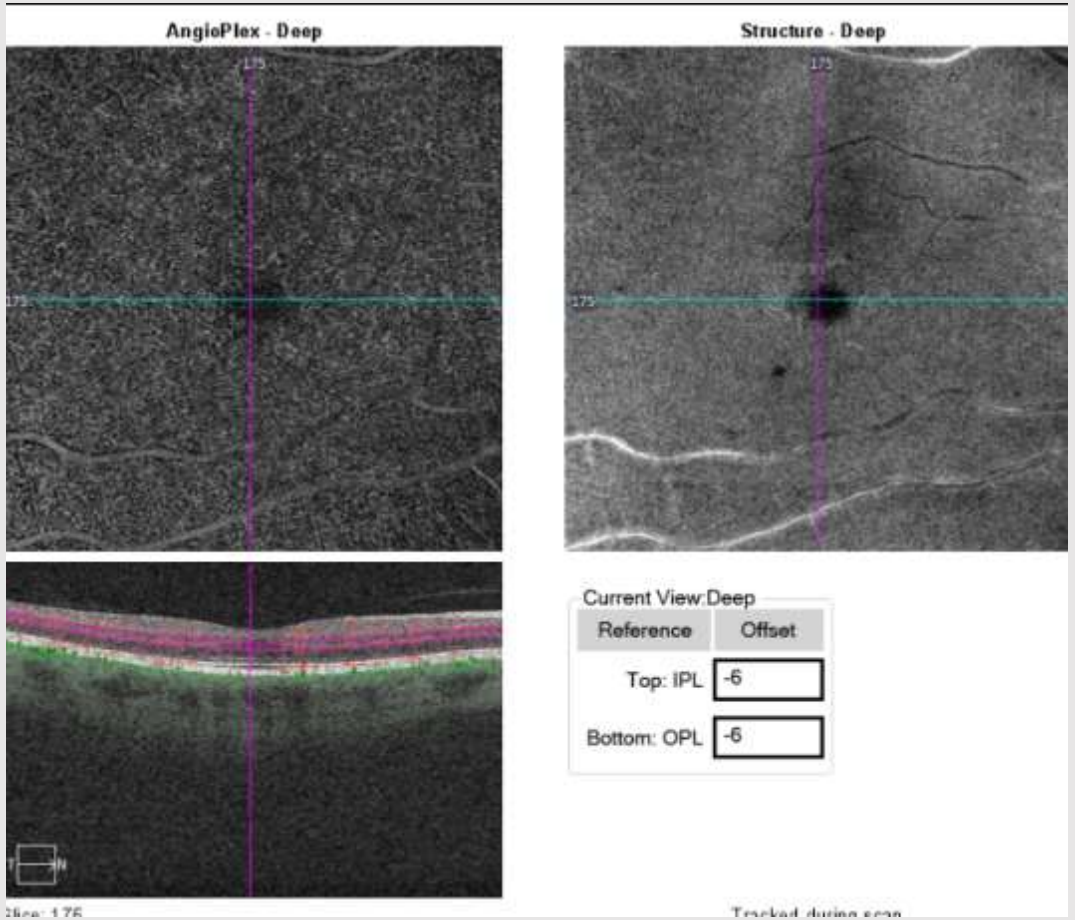
VRI



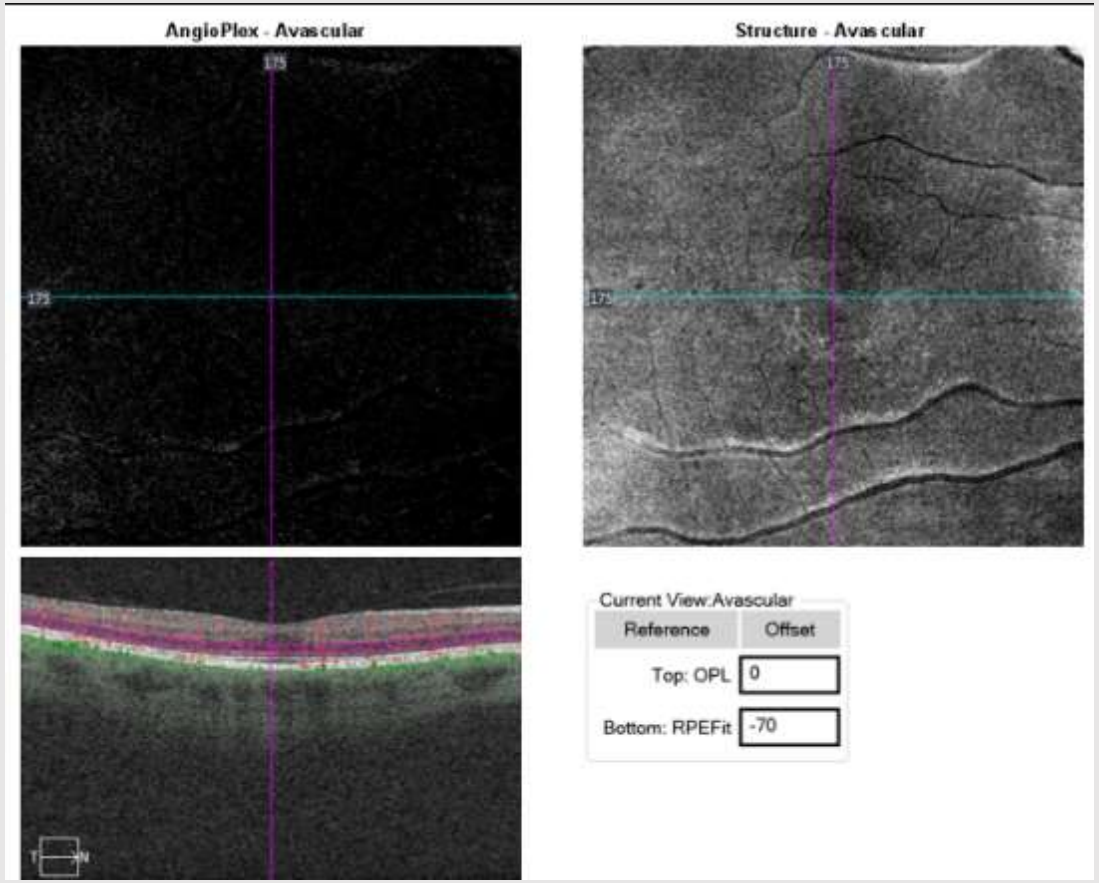
Deep layer



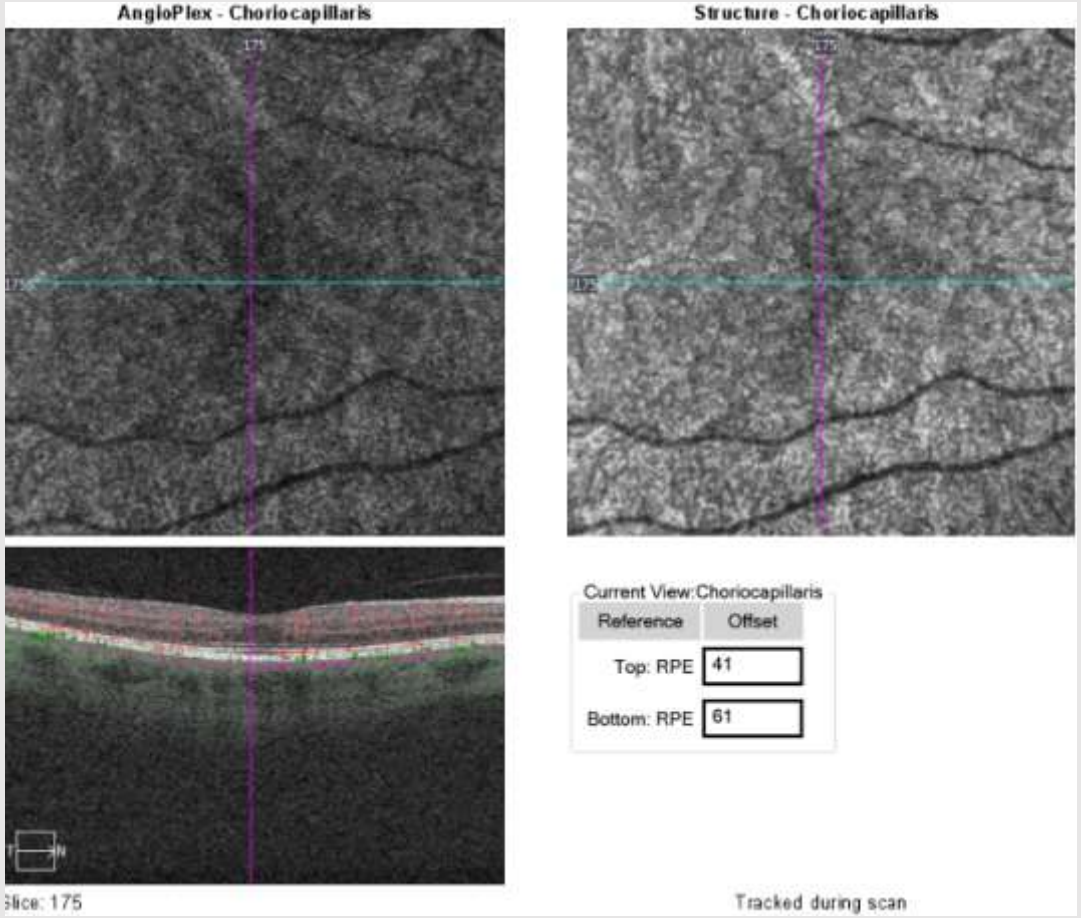
Removed Superficial retinal projections



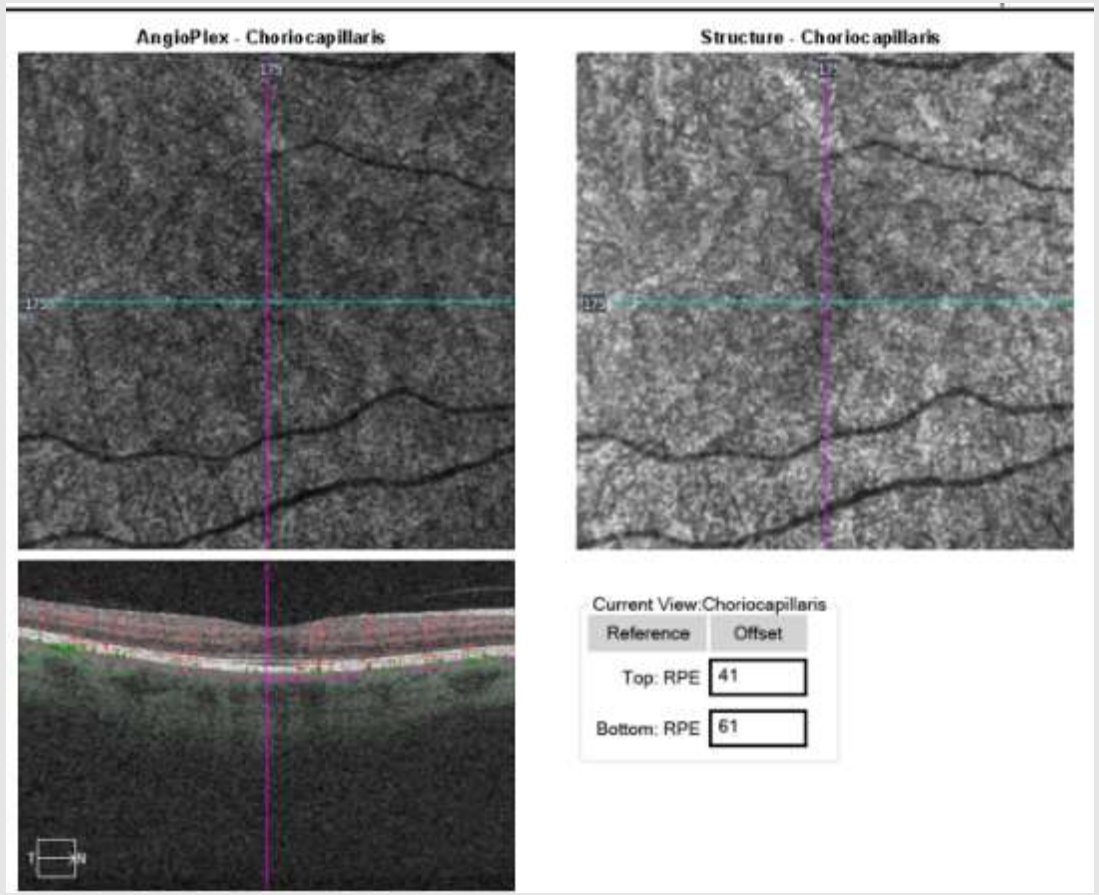
Avascular layer - Black



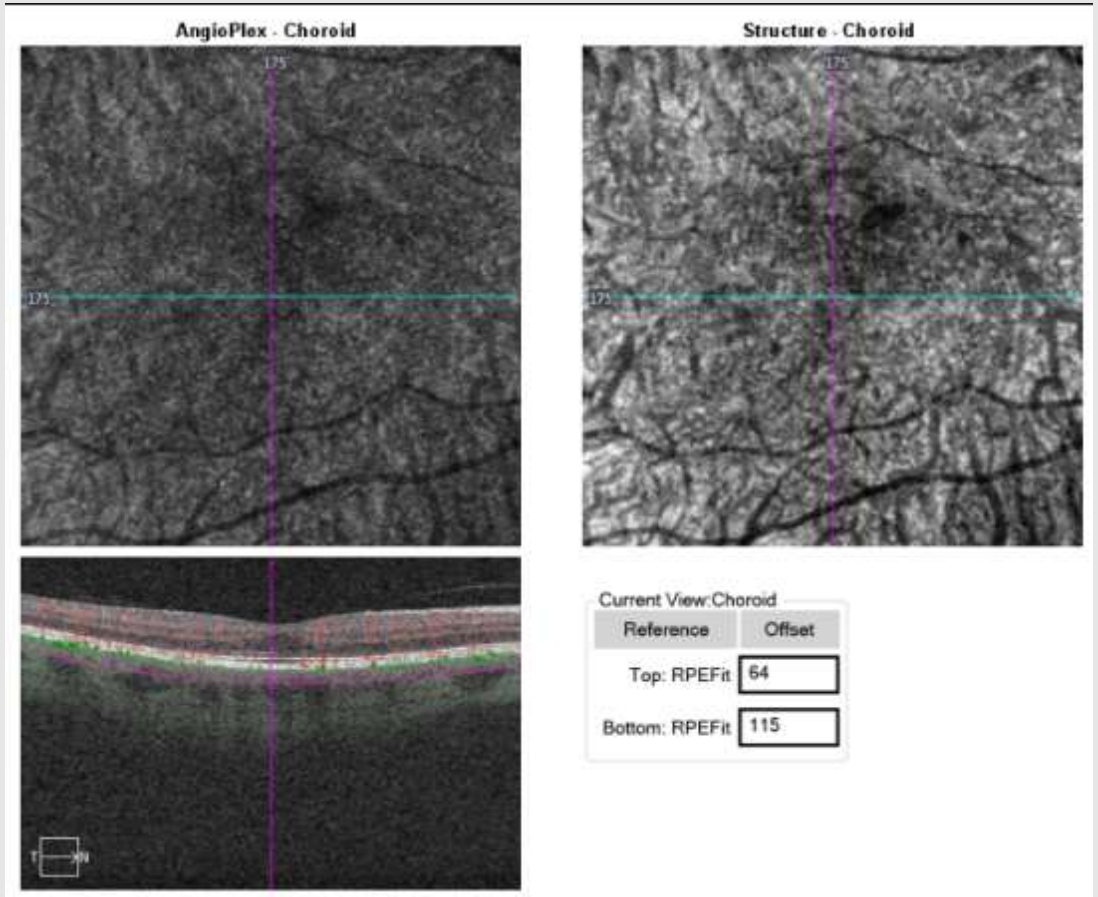
Choriocapillaris



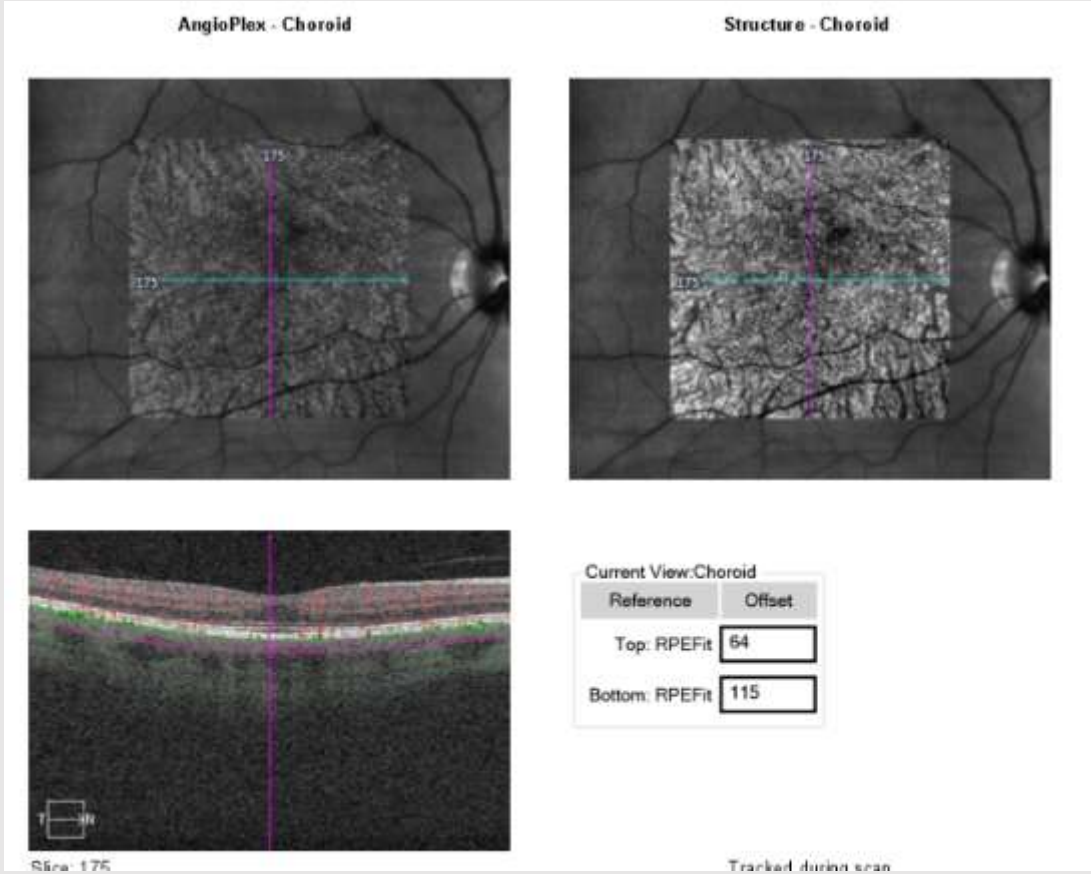
Removed Projections



Choroid

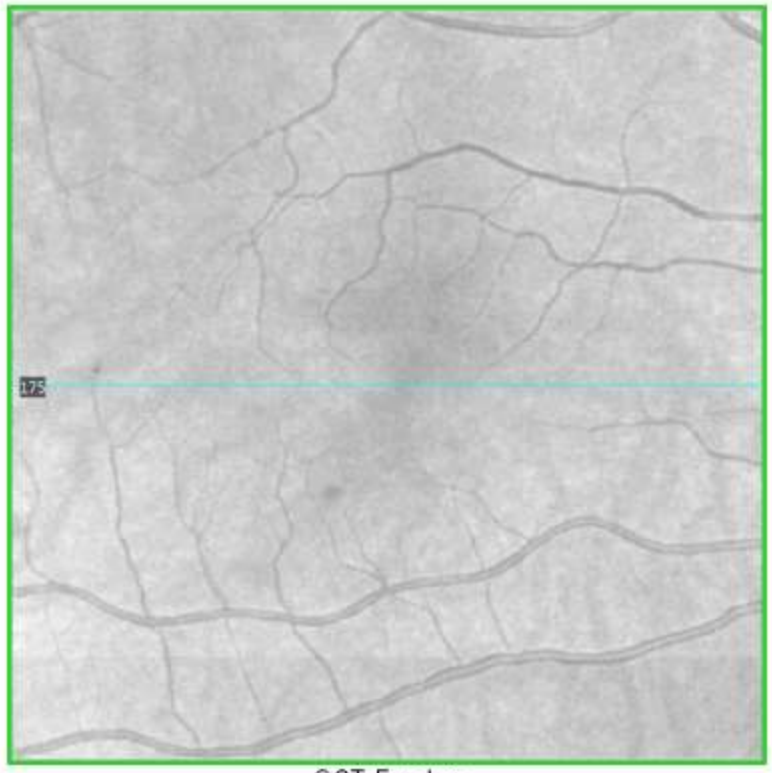


With Fundal Image

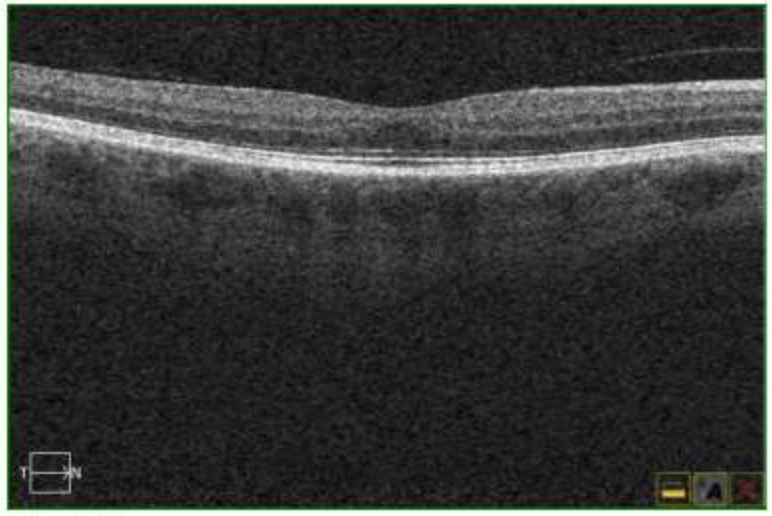


En Face Analysis : Angiography 6x6 mm

OD ● ○ OS

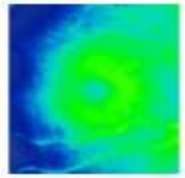


OCT Fundus

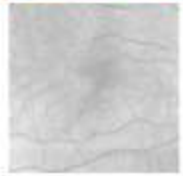


Slice: 175

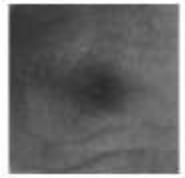
Thickness Map



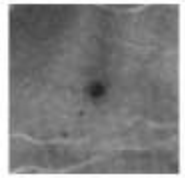
OCT Fundus



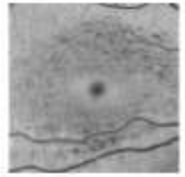
VRI



Mid-Retina

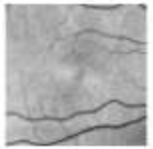


IS/OS-Ellipsoid



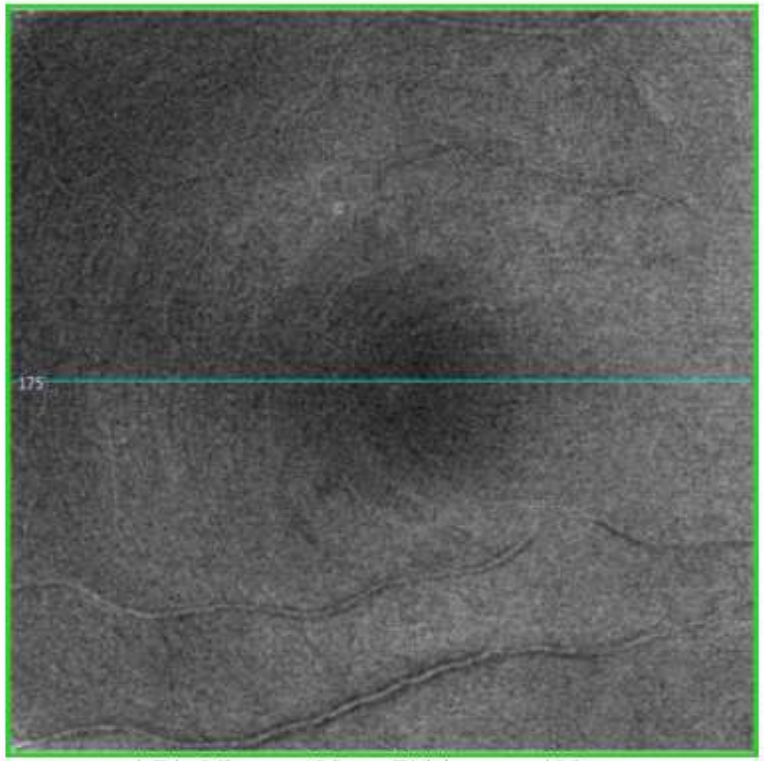
Choroid

Custom - (IS/OS-Ellipsoid)

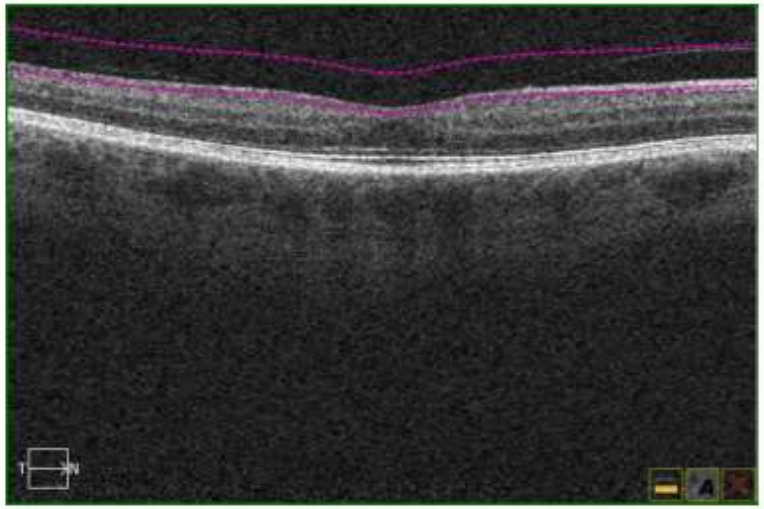


En Face Analysis : Angiography 6x6 mm

OD ● | ○ OS

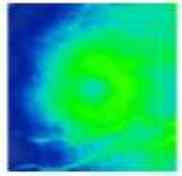


VRI: Offset = -133 µm Thickness = 166 µm



Slice: 175

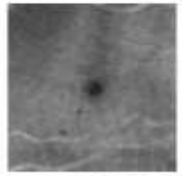
Thickness Map



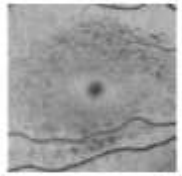
OCT Fundus

VRI

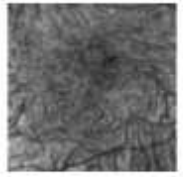
Mid-Retina



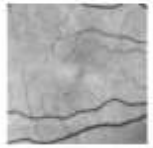
IS/OS-Ellipsoid



Choroid



Custom - (IS/OS-Ellipsoid)



What Machines are out there?

March 2016 Zeiss 5000 - Solely OCT 78K

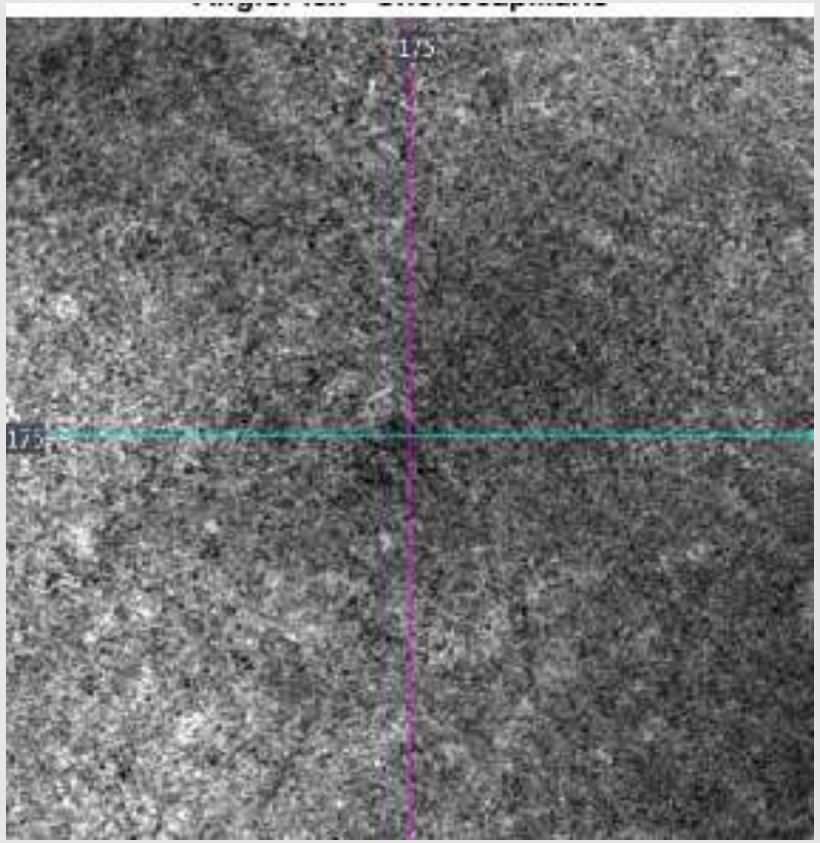
? 2017 Heidelberg Spectalis – Solely OCT 85K

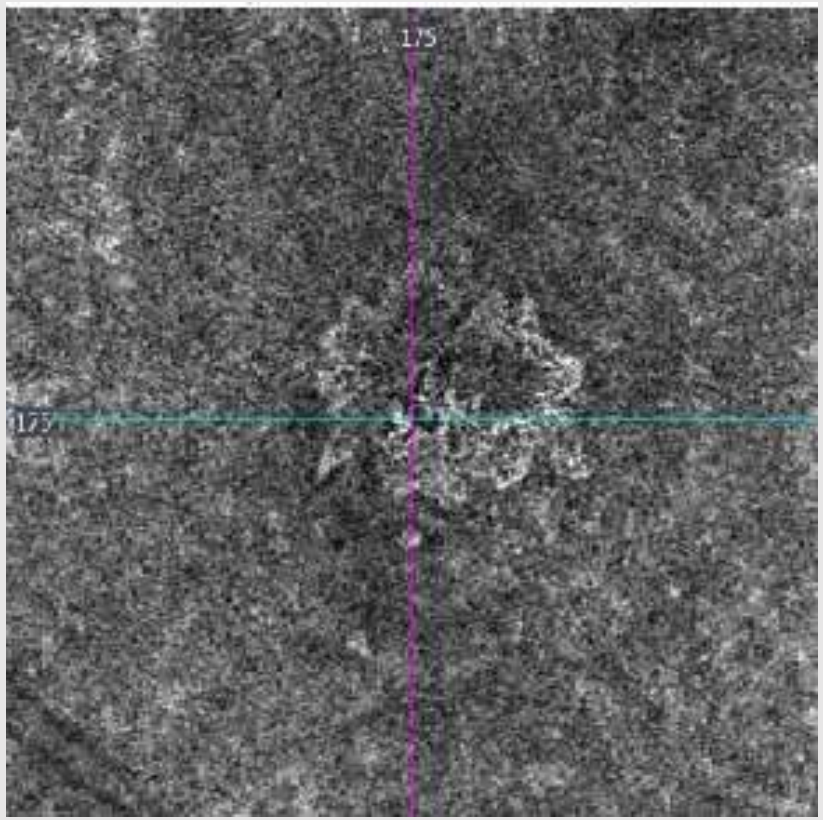
December 2015 Topcon Triton – Swept source 100K + Fundal Camera

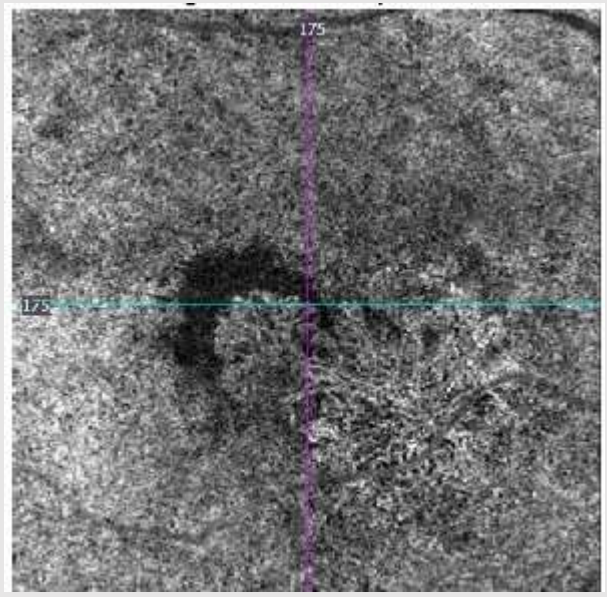
Nidek Rs-3000 Advance (53K)

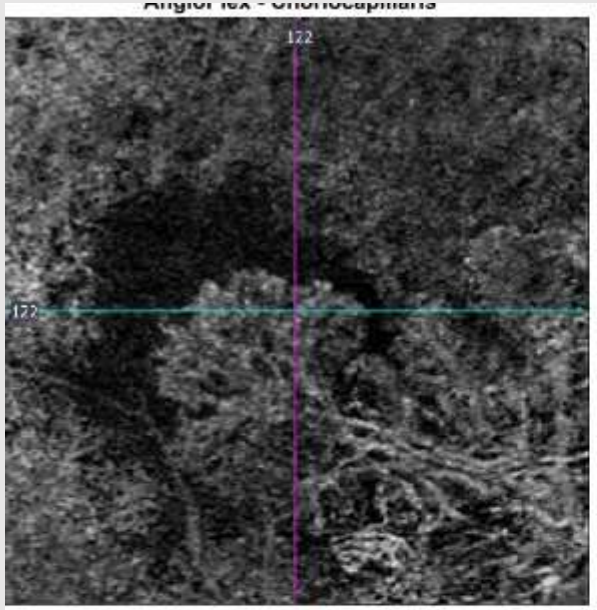
OptoVue – Haag-Streit, AngioMontage, Angio Anlaysis 70K

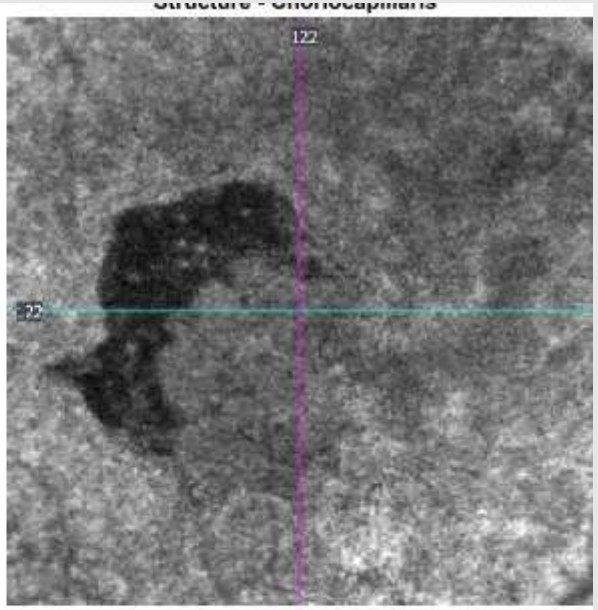
Normal Choriocapillaris vs abnormal inactive

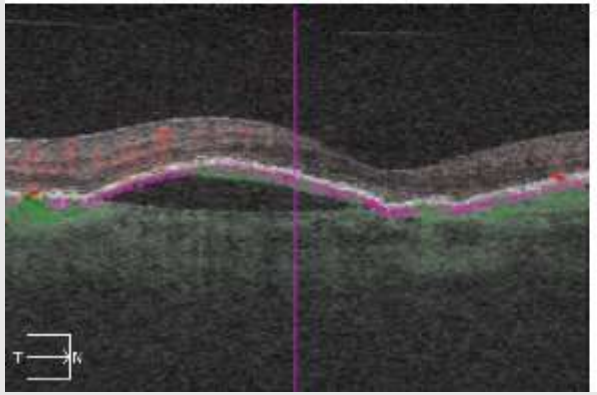


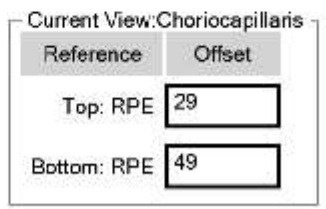






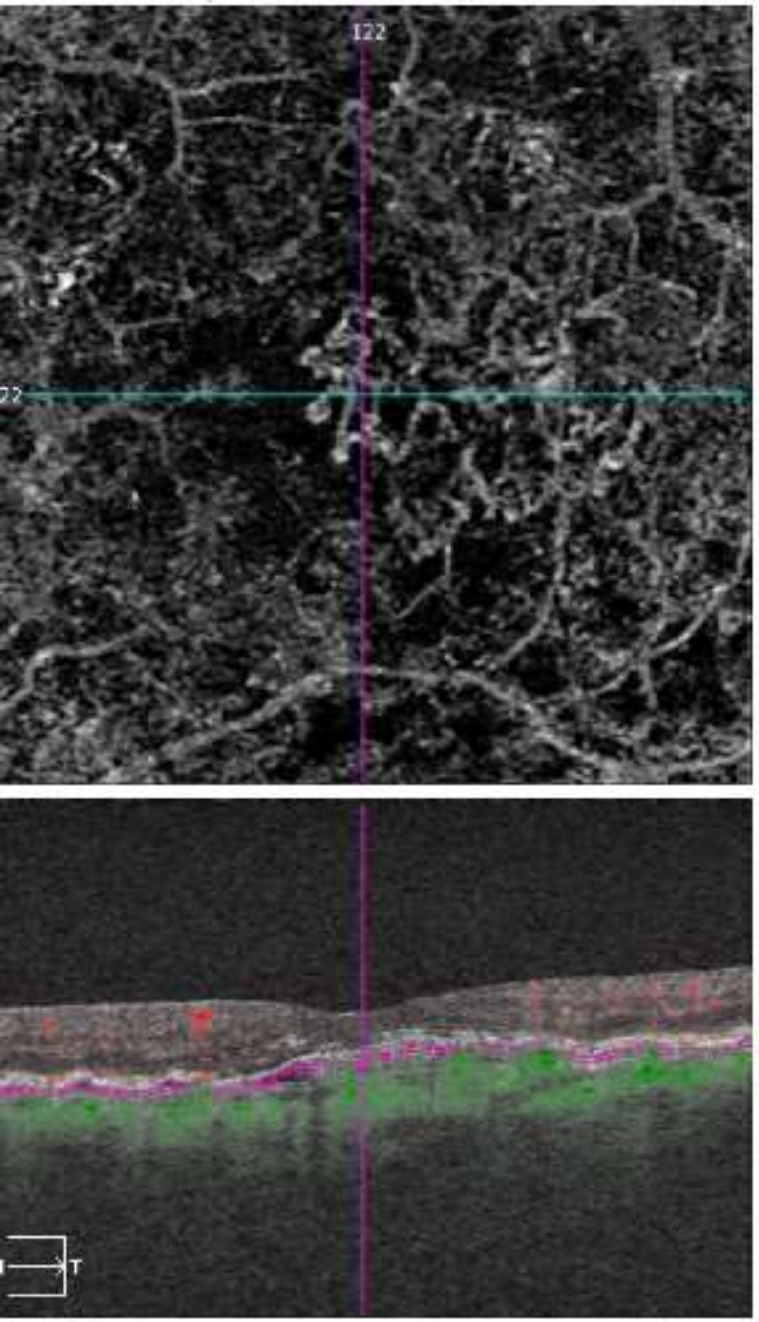


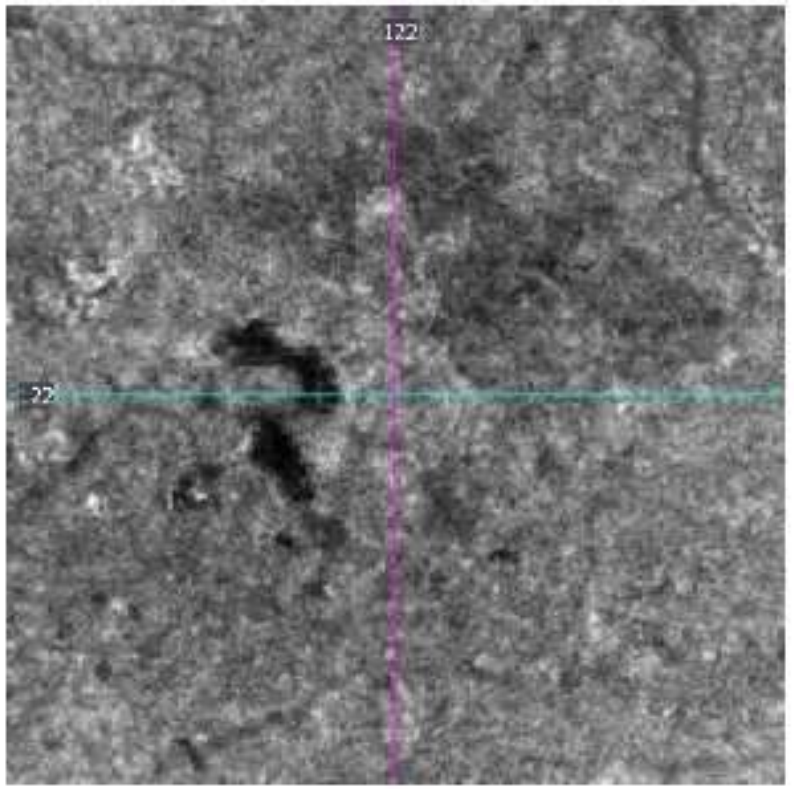




Classical SRNVM that has been treated and a new recurrence has fanned out from the edge of the old lesion

These originate from one central vessel growth and spread like petals of a flower





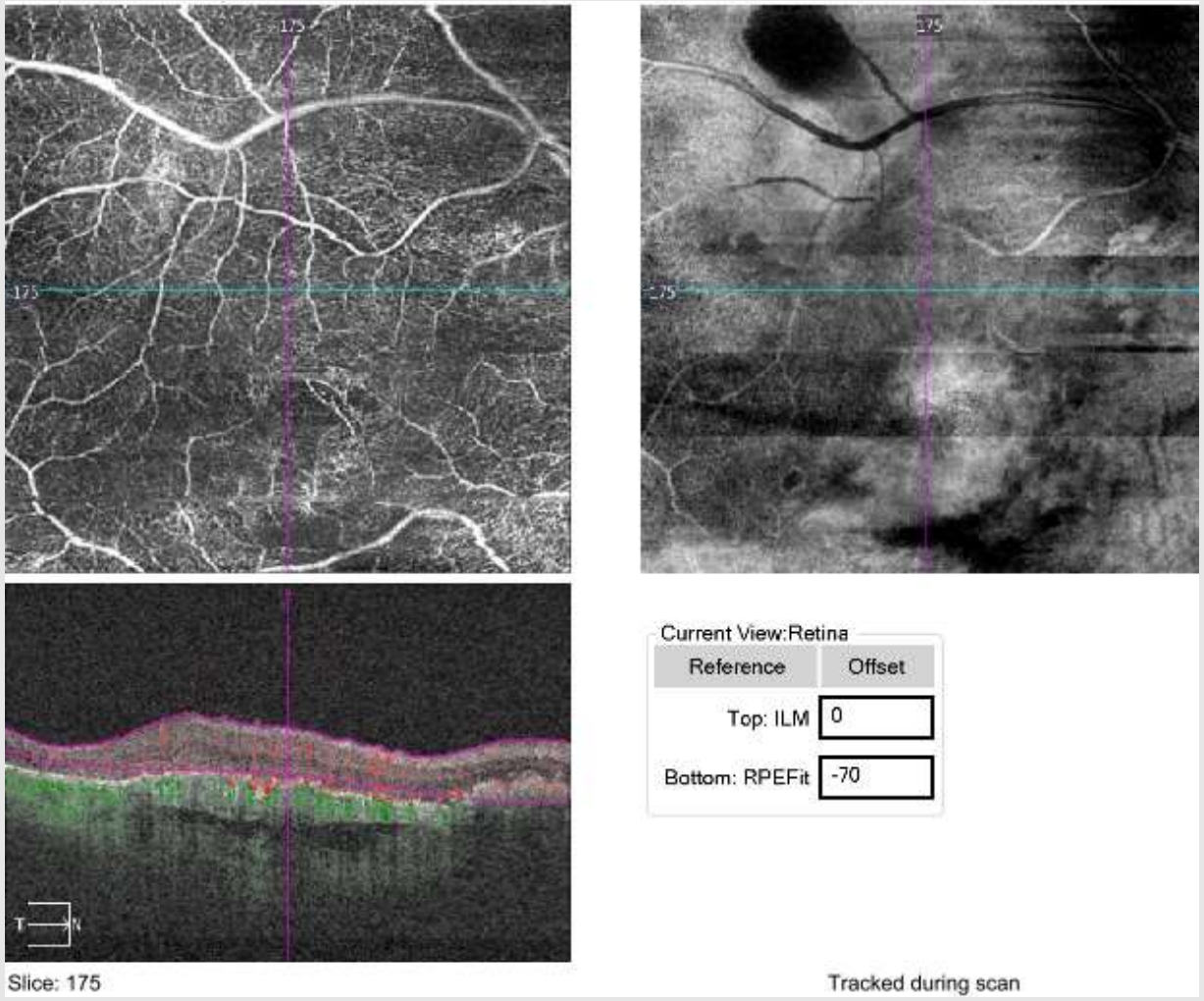
Current View:Choriocapillaris

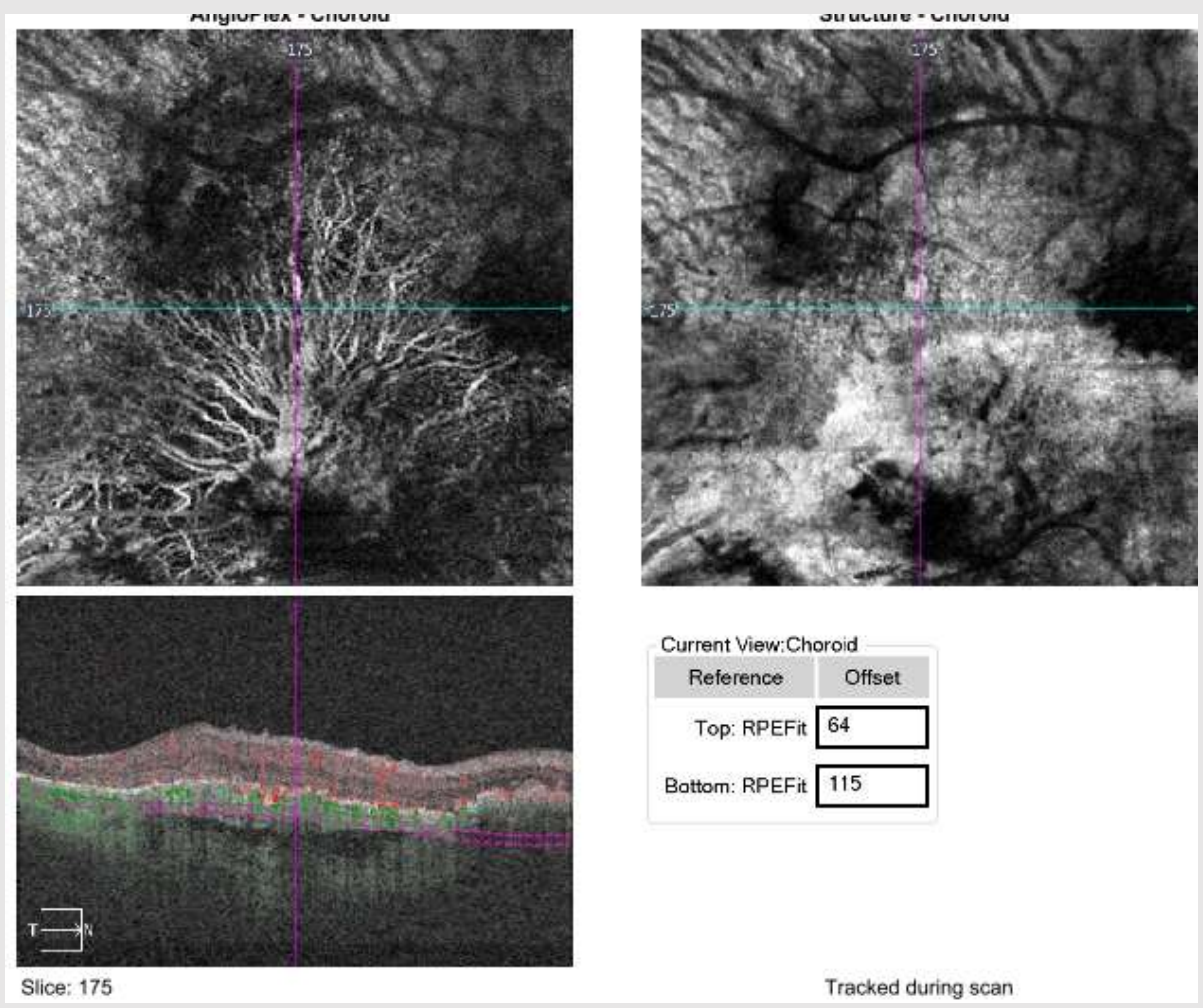
Reference	Offset
Top: RPE	29
Bottom: RPE	49

Tracked during scan

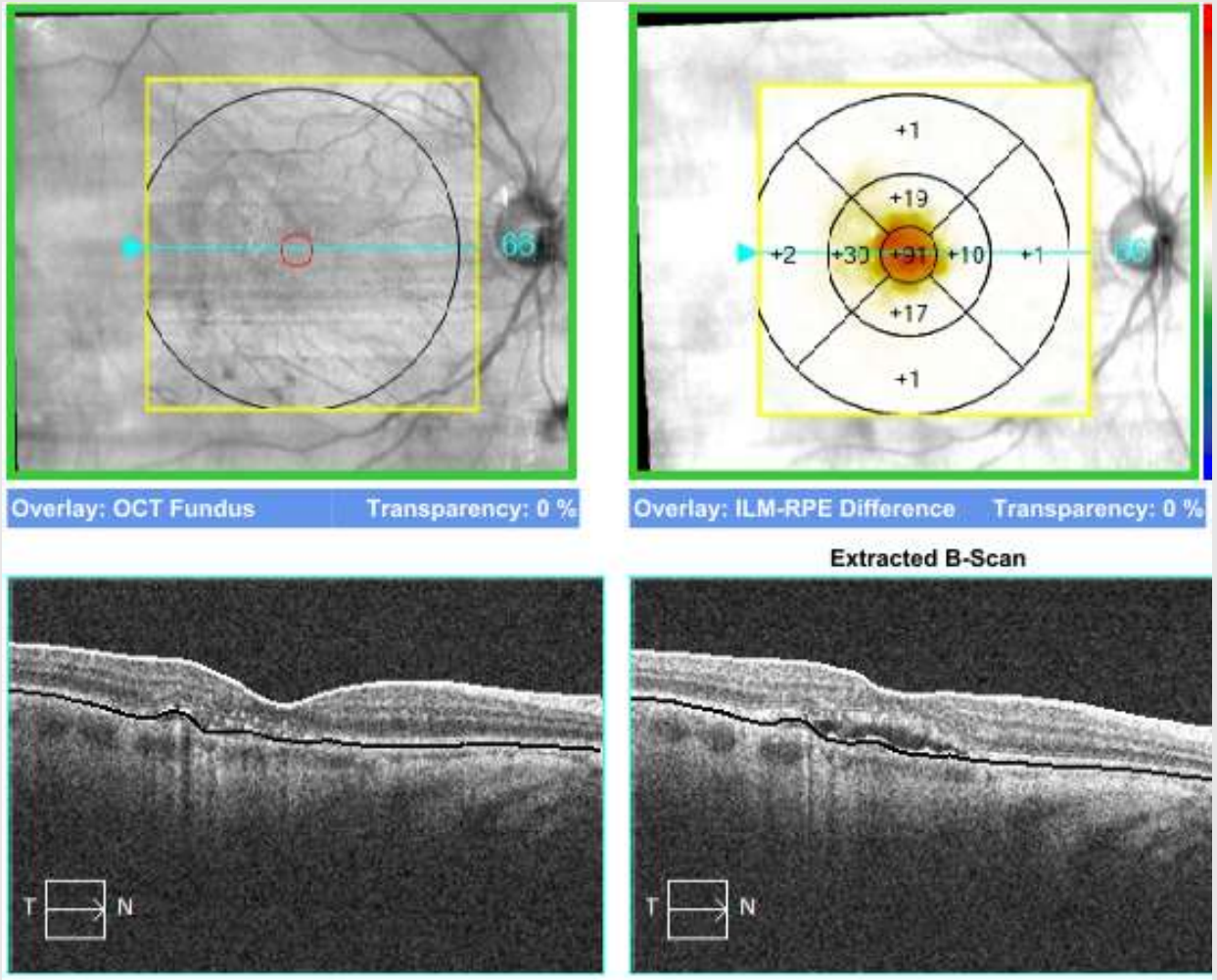
High quality Definition of SRNVM in AMD

Separation of Superficial vs Deep vessels

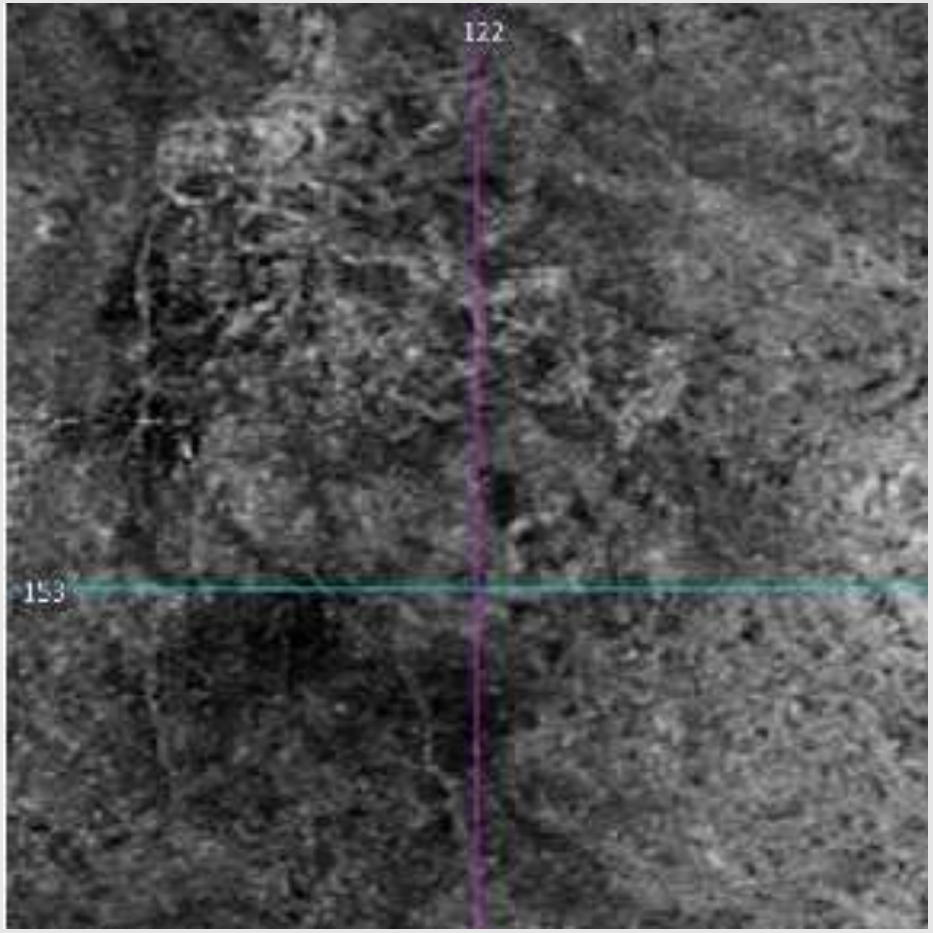


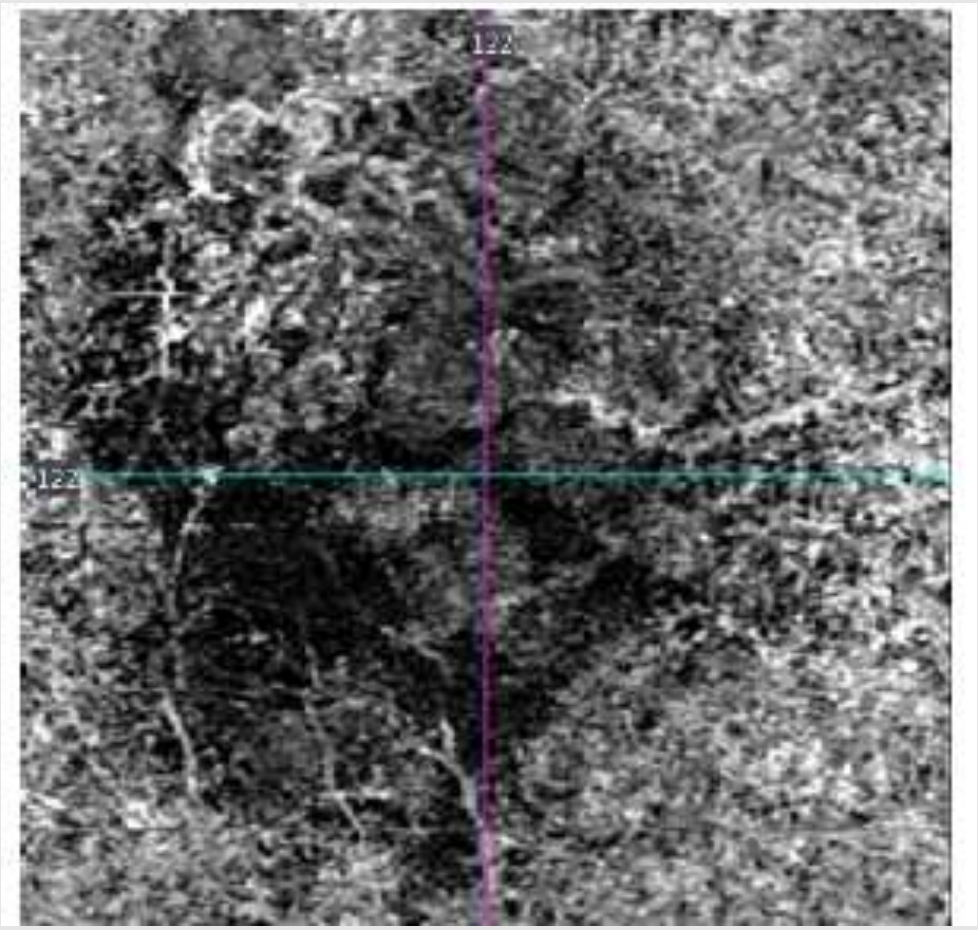


Change Analysis 6/6 to 6/9

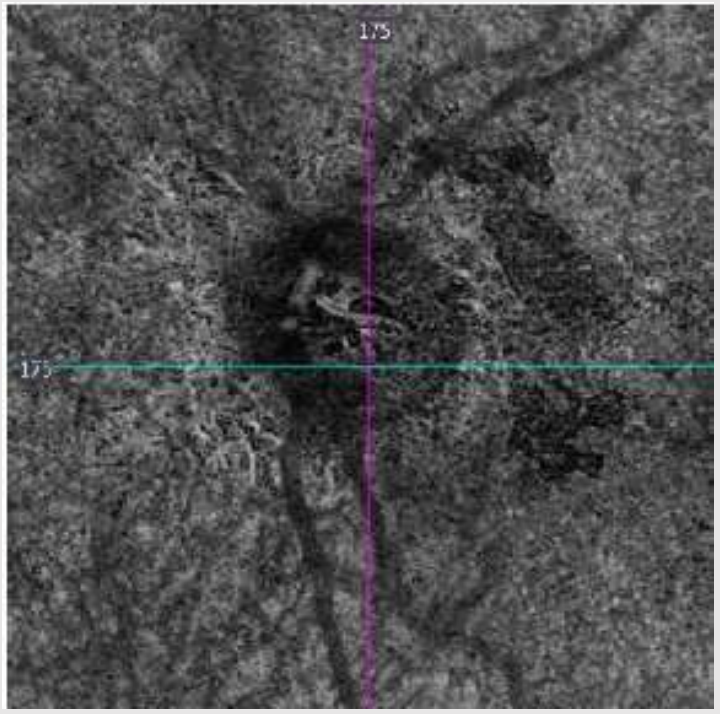


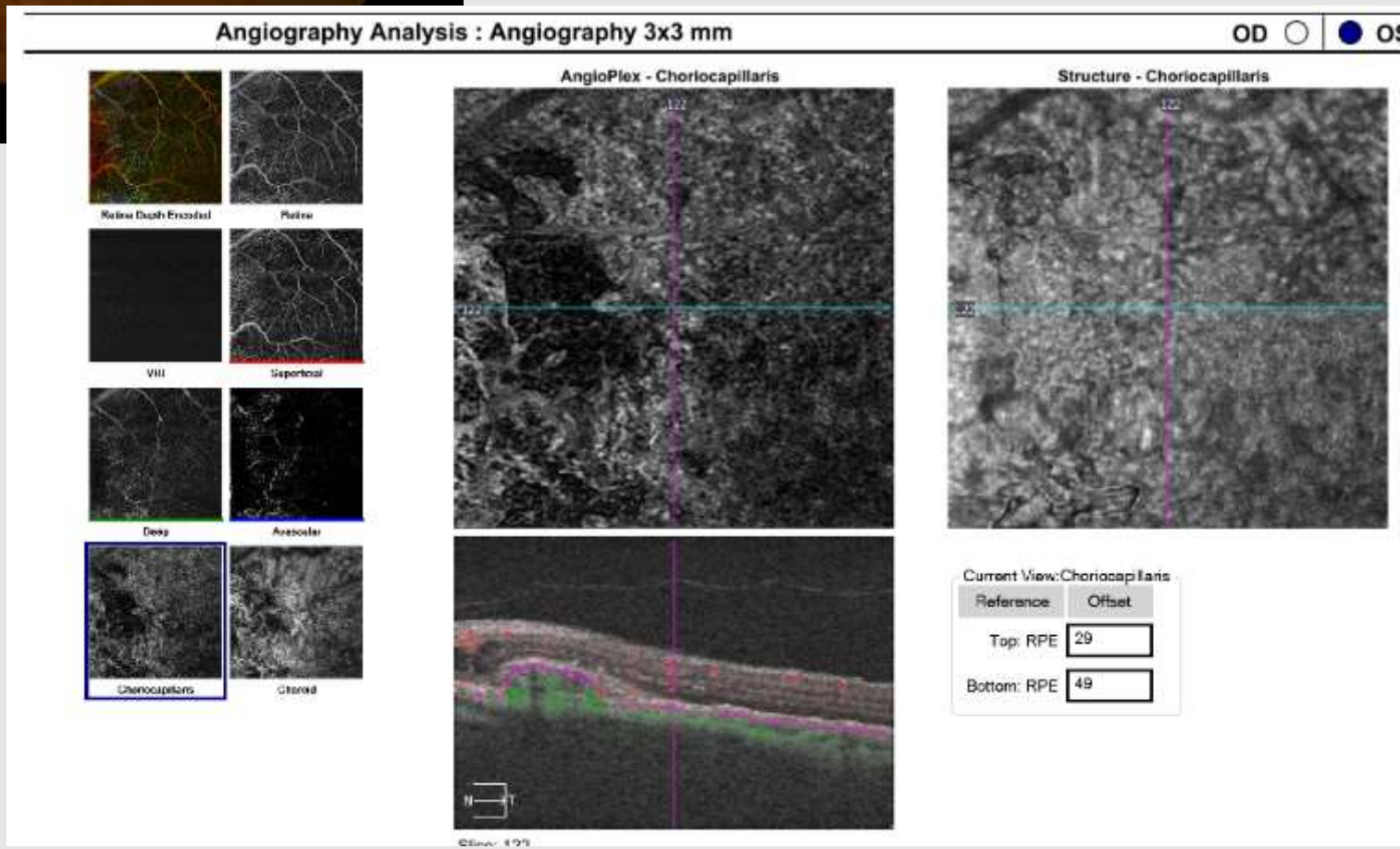
6 months apart NO change 6/9



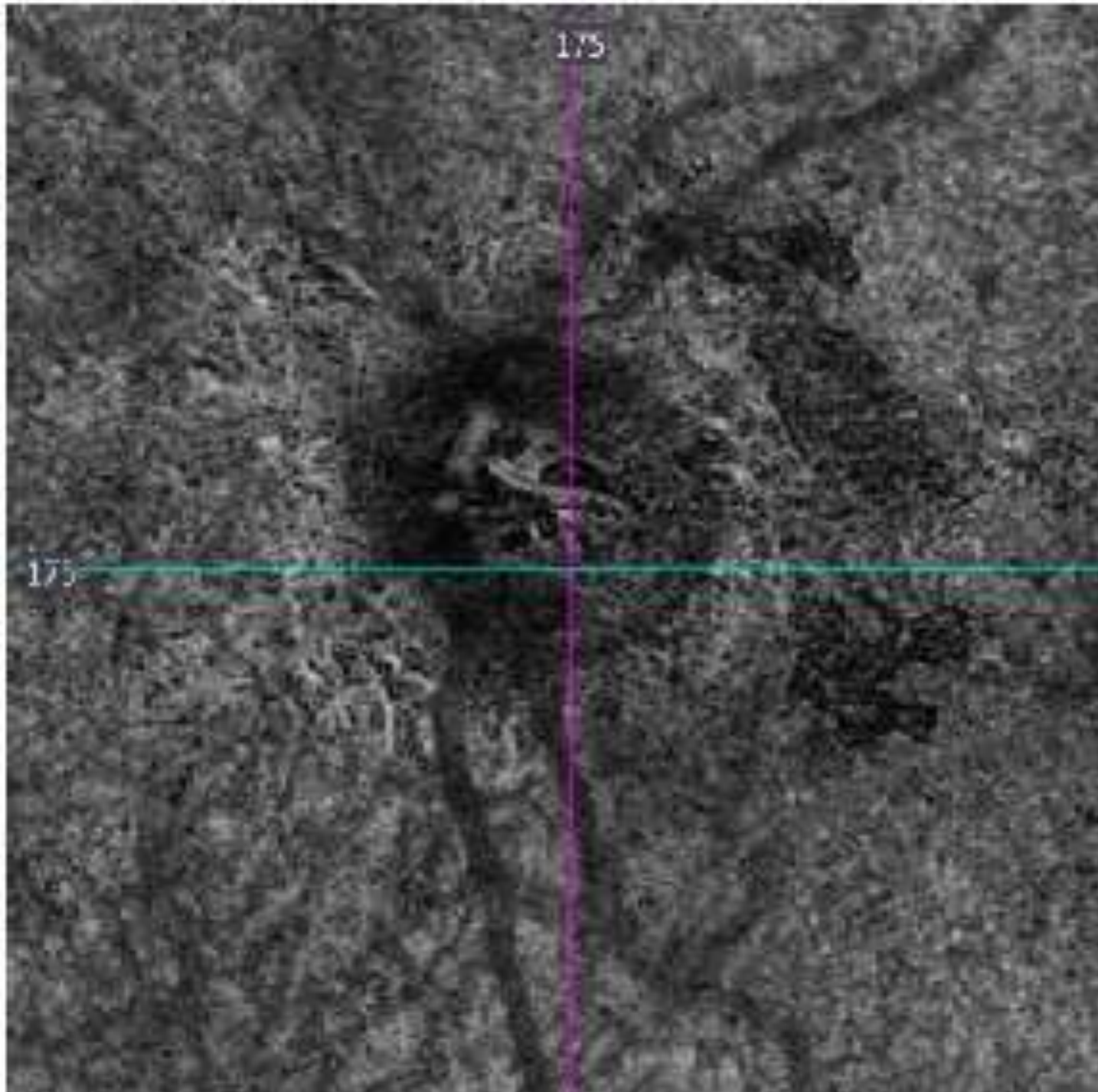


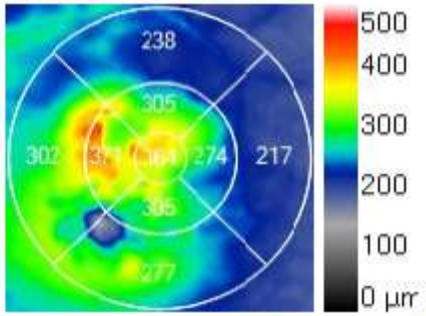
- PeriPapillary Disciform

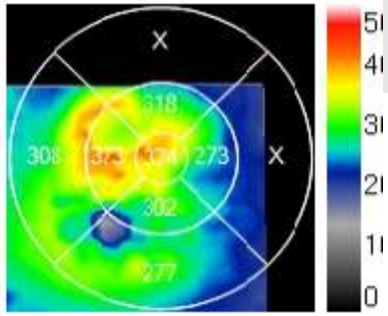


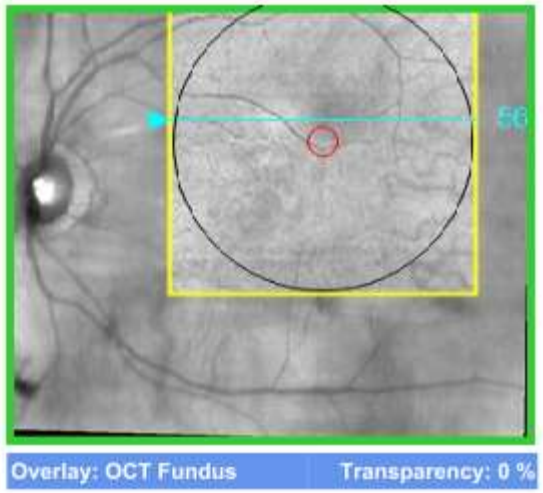


- Enhanced detail
- ConFocal Image
- Helpful to compare the two FFA and OCT-A at times
- Segmentation adjustments
- Still need Colour Photo

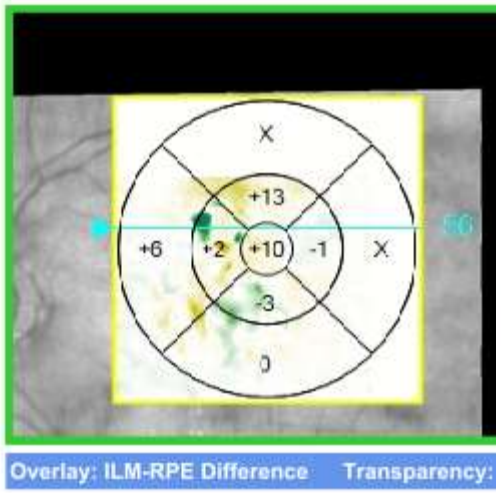






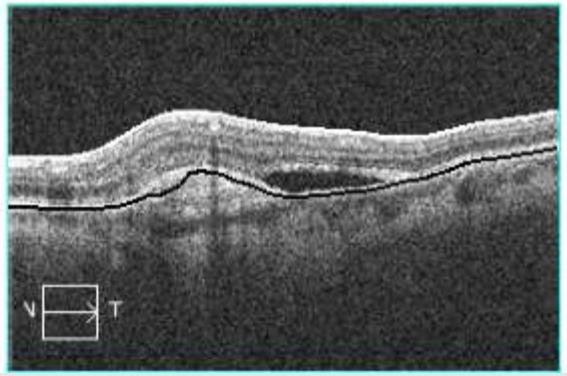


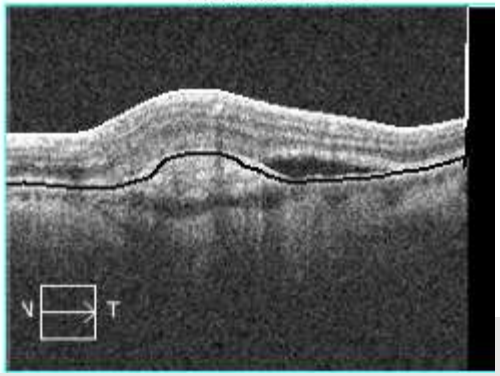
Overlay: OCT Fundus Transparency: 0 %

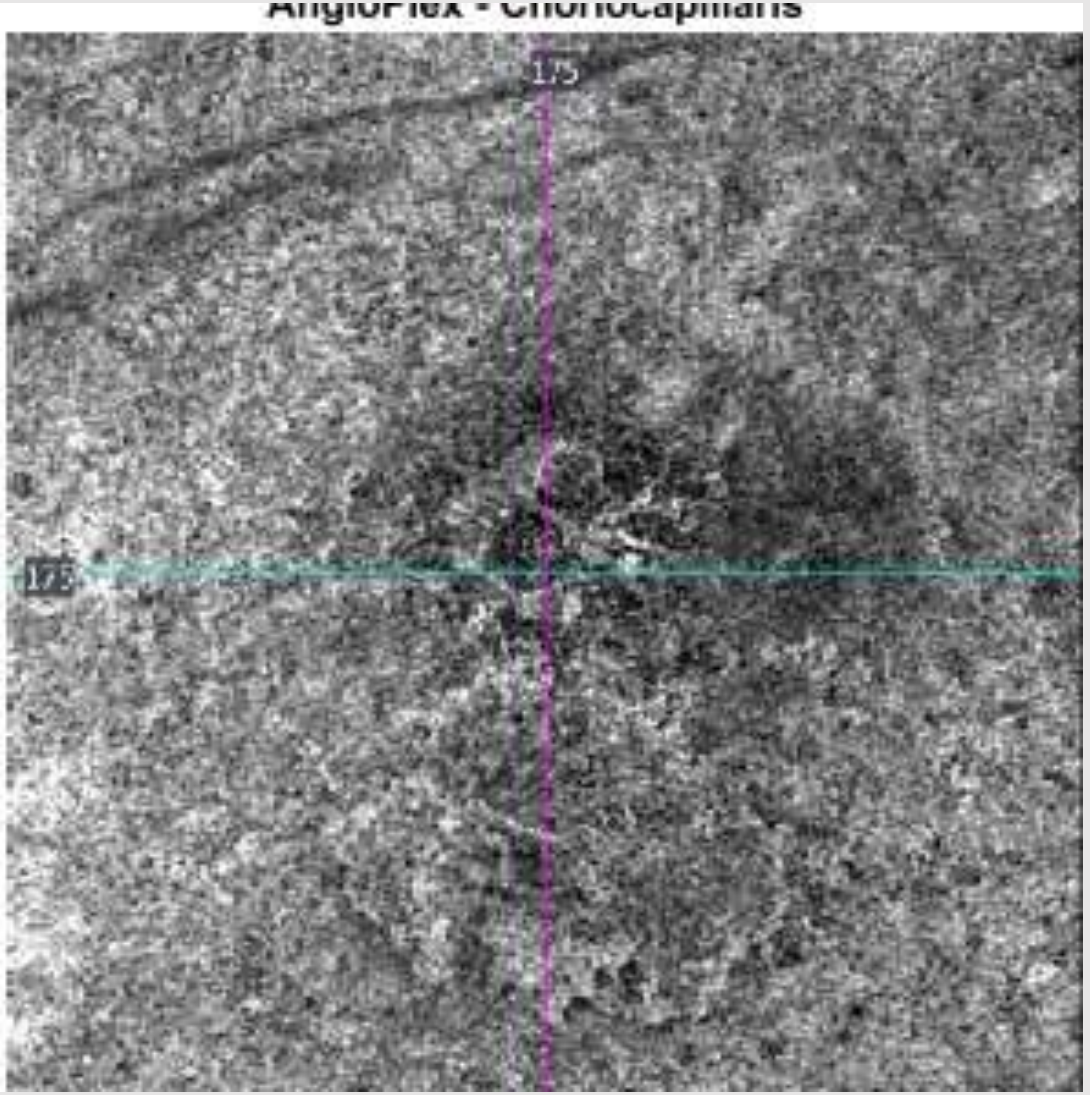


Overlay: ILM-RPE Difference Transparency:

Extracted B-Scan

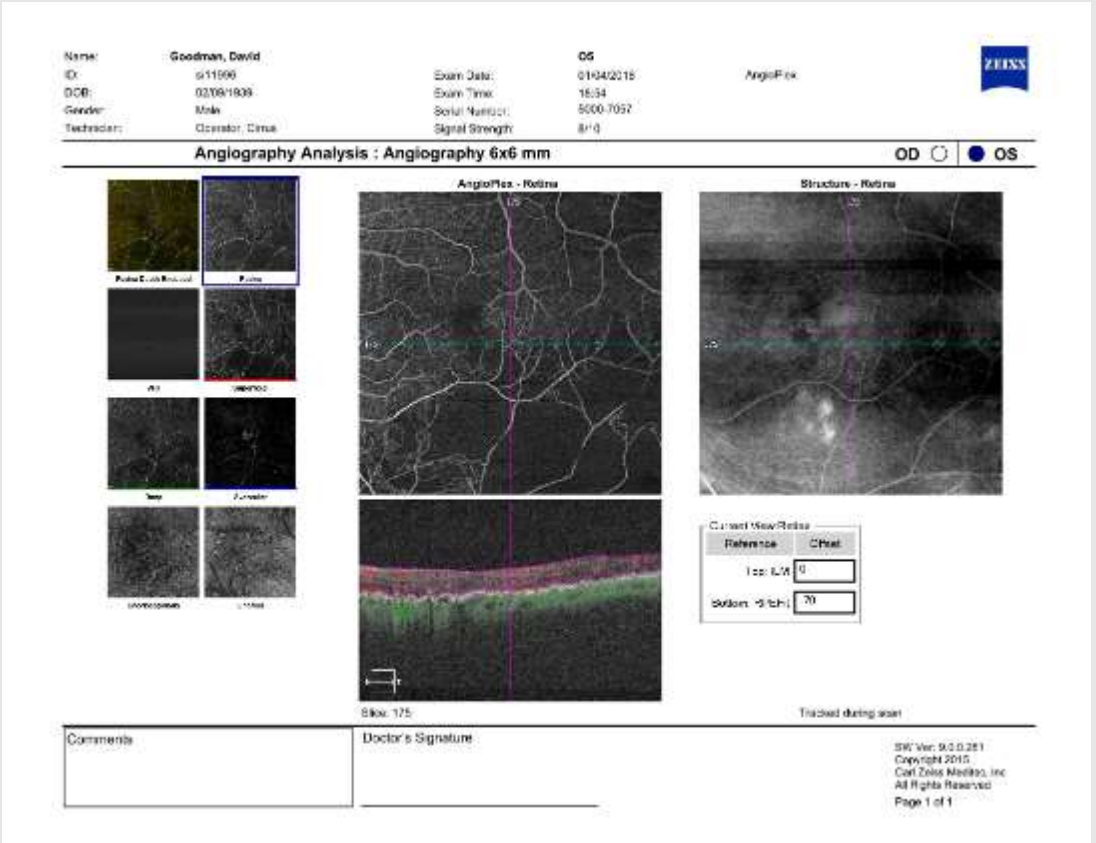


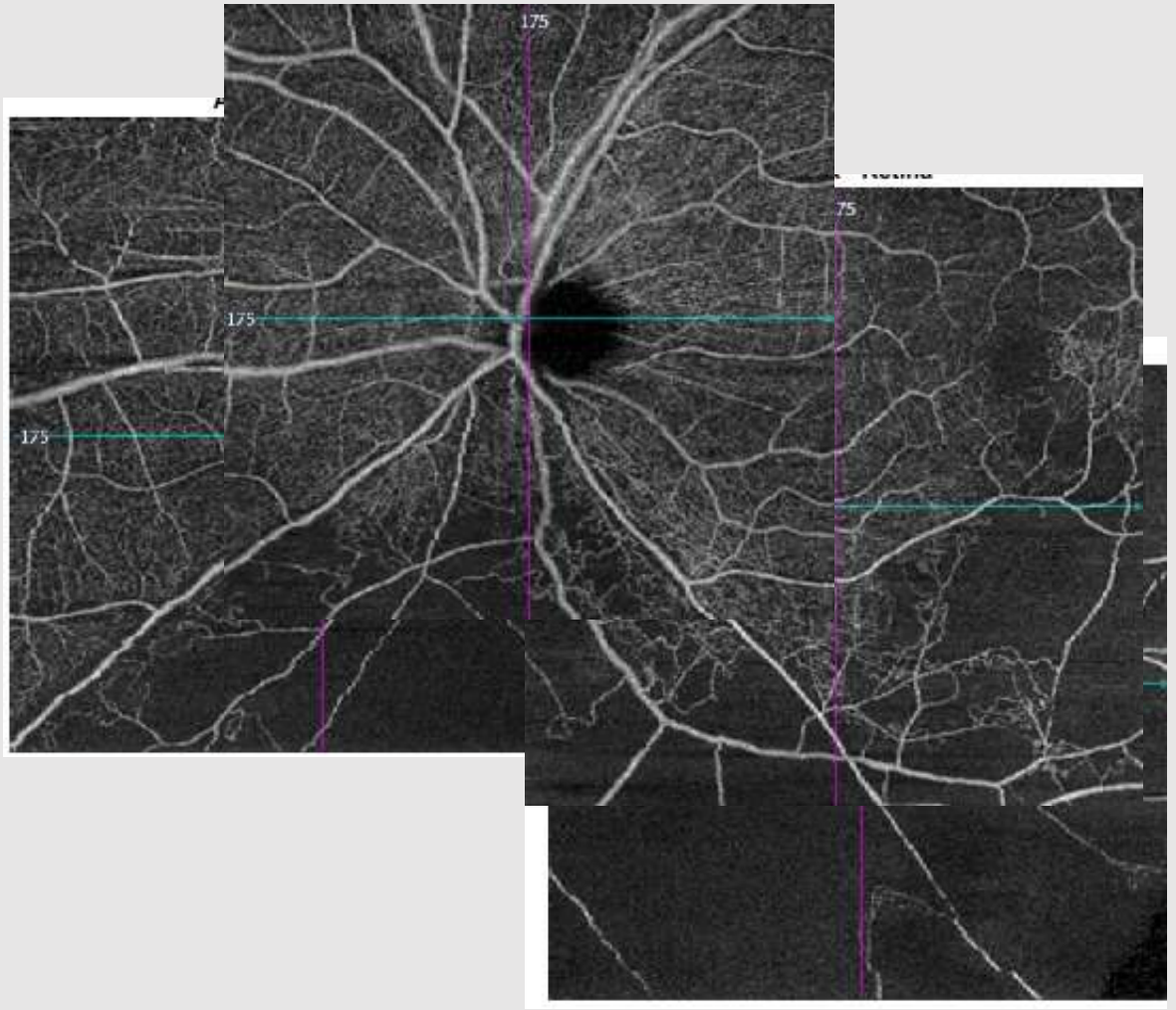




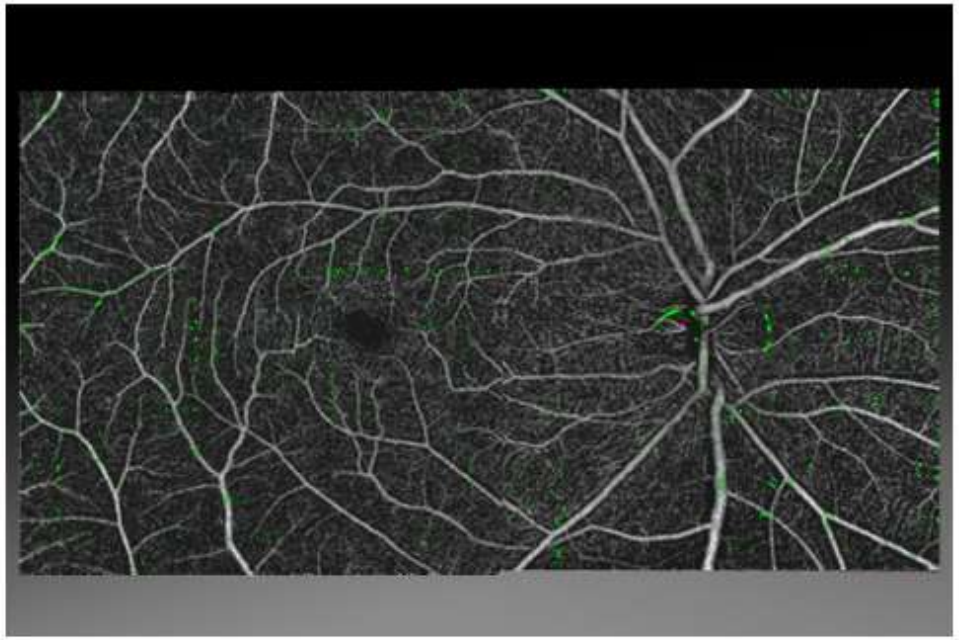
Making a Collage

- Capture Multiple images 6x6 or 3x3 or combination
- Use “Irfanview” Free image software to Crop image
- Use Power point to Collage the images
- Use Group function to lock all the images together





AngioVue



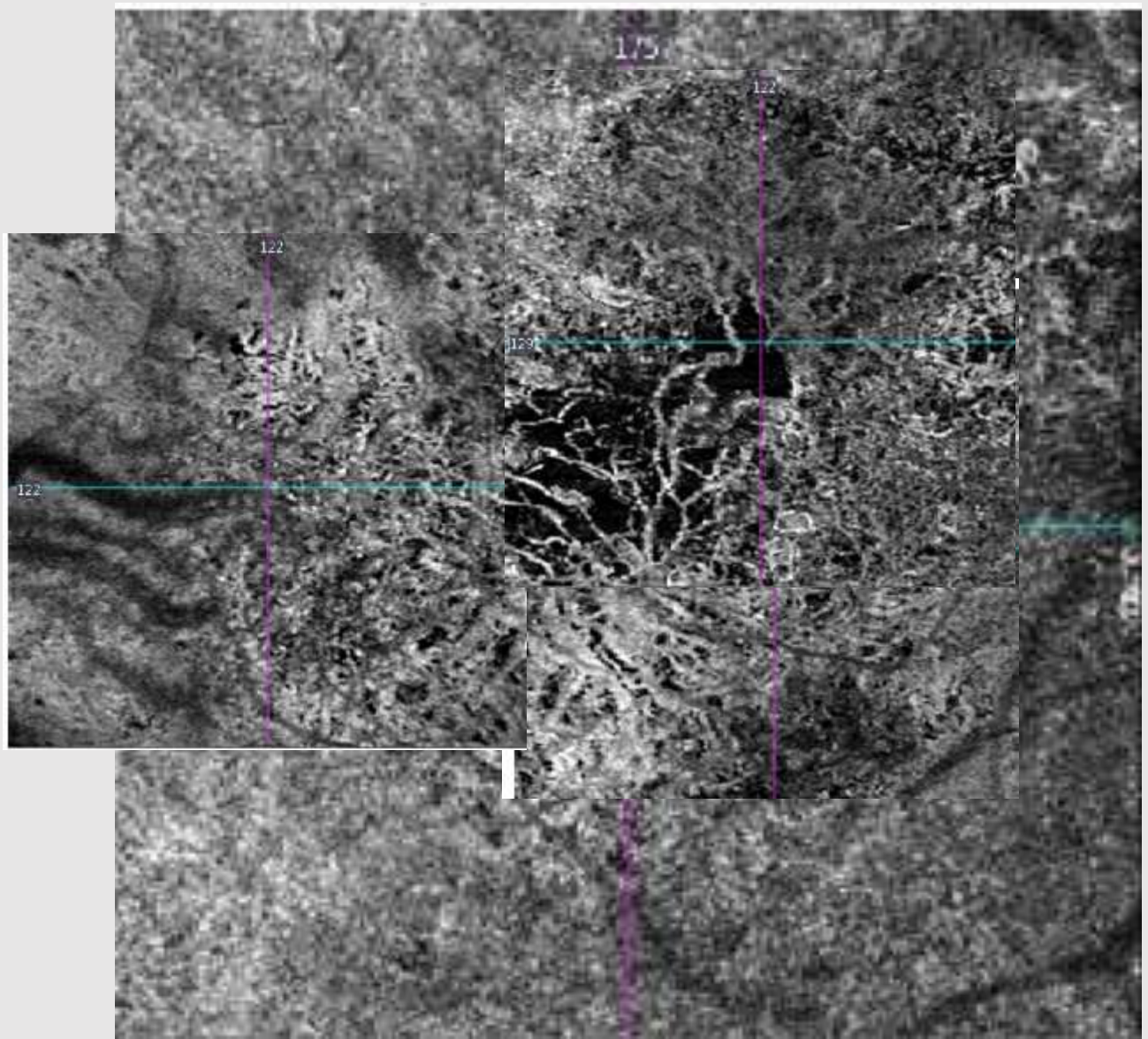
WIDER FIELD OF VIEW

Improves visualisation of abnormalities

AngioMontage combines two 6x6mm scan images to create a wider field of view that improves visualisation of abnormalities in the retinal vasculature. This unprecedented display of microvasculature enables assessment of the essential part of the retina to aid in the early diagnosis and management of sight-threatening diseases.

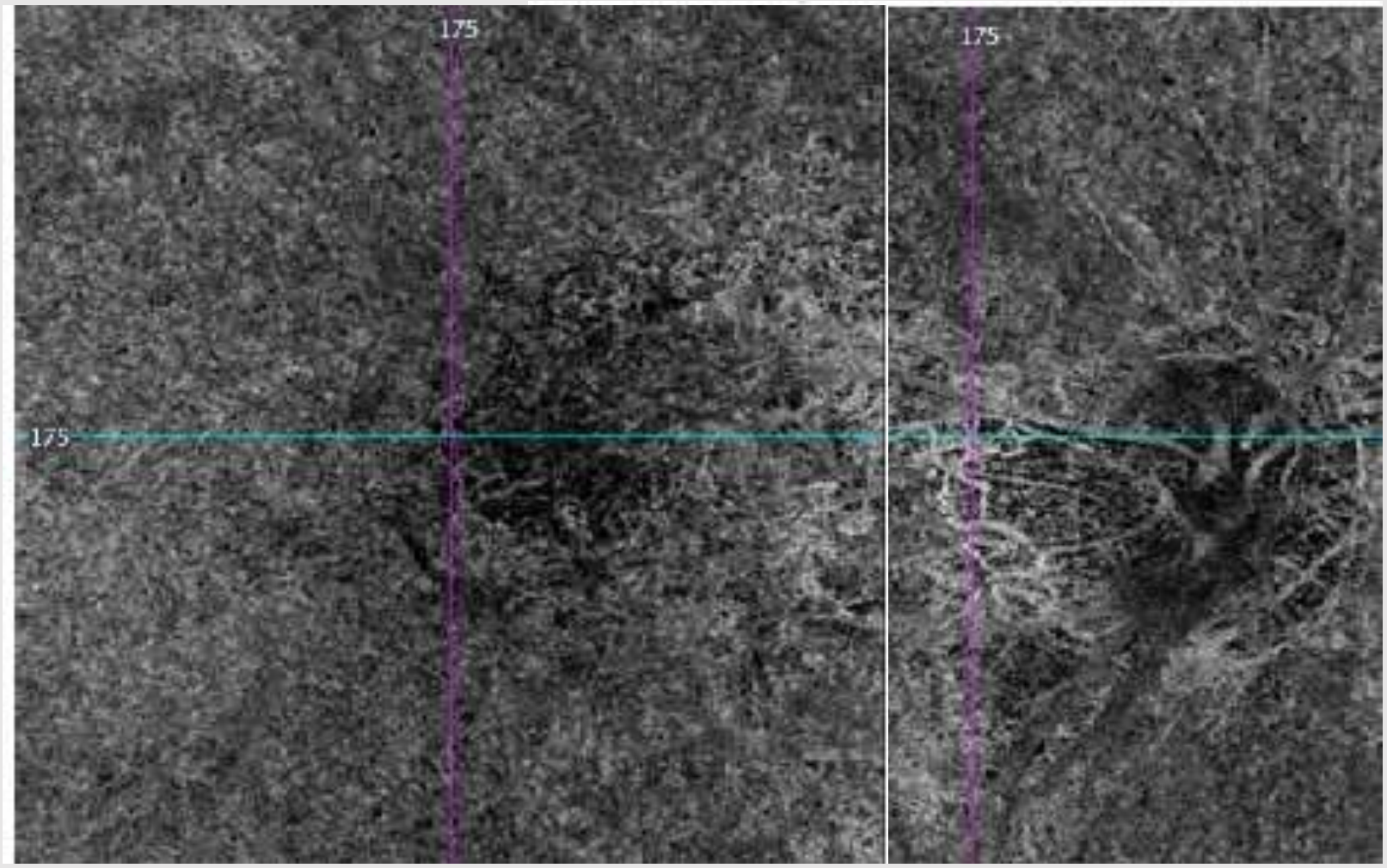
Collage images with Power point

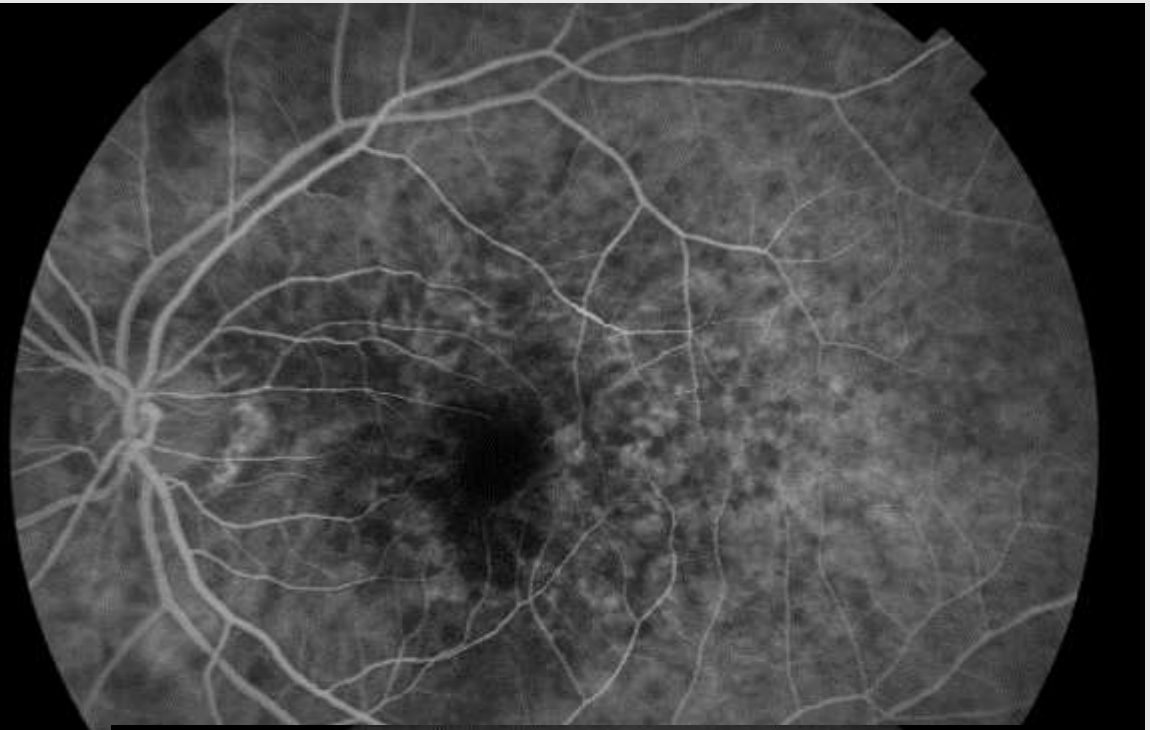
Overlay 3x3 on to 6x6 to enhance the detail

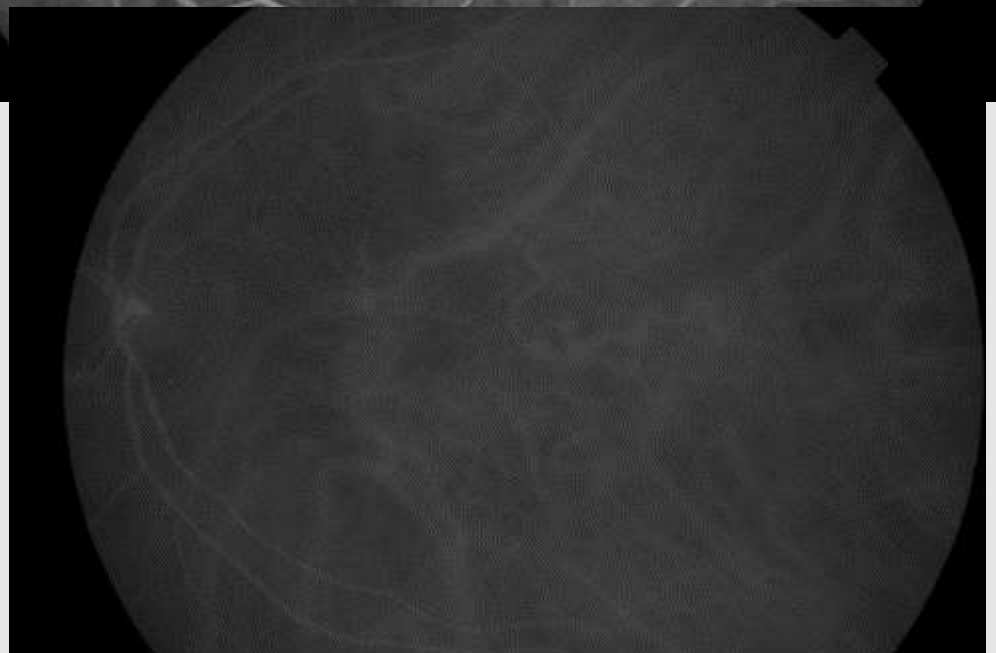


SRVM Spreading from the disc to

the macular







43 LUCENTIS (ranibizumab) to the Left eye,
Since 2011

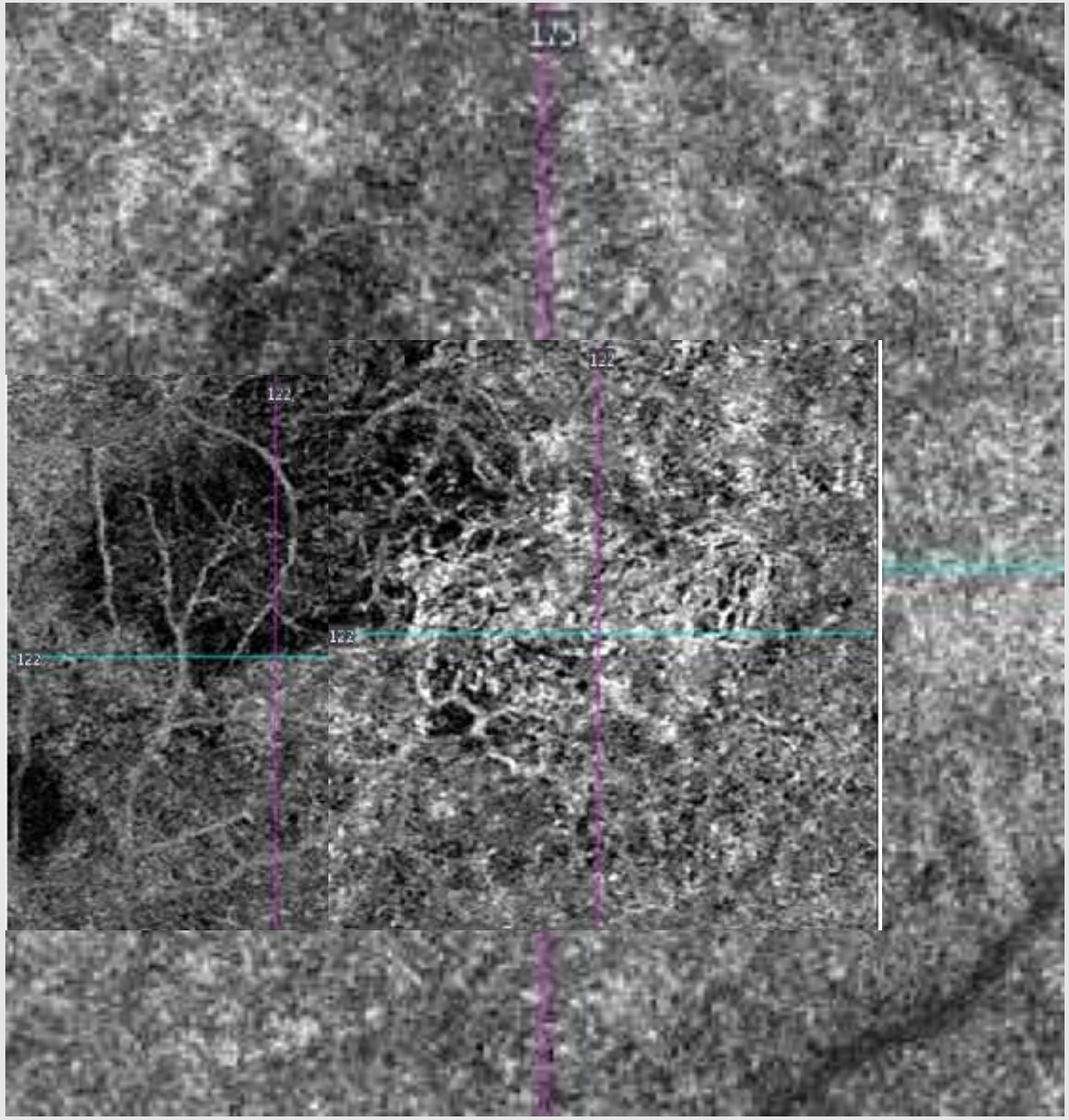
Undertook OCT-A

OCT-A shows good definition
This is 6x6 with inserted/over layered 3x3 images

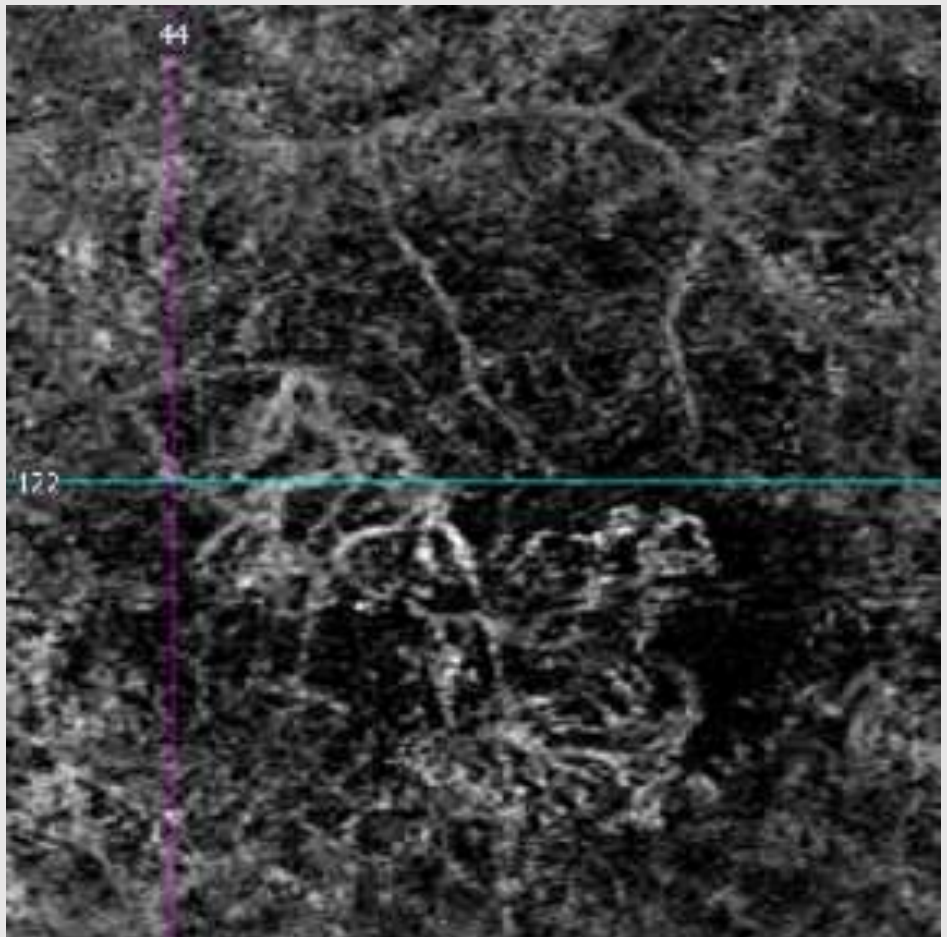
3x3 give higher definition than 6x6

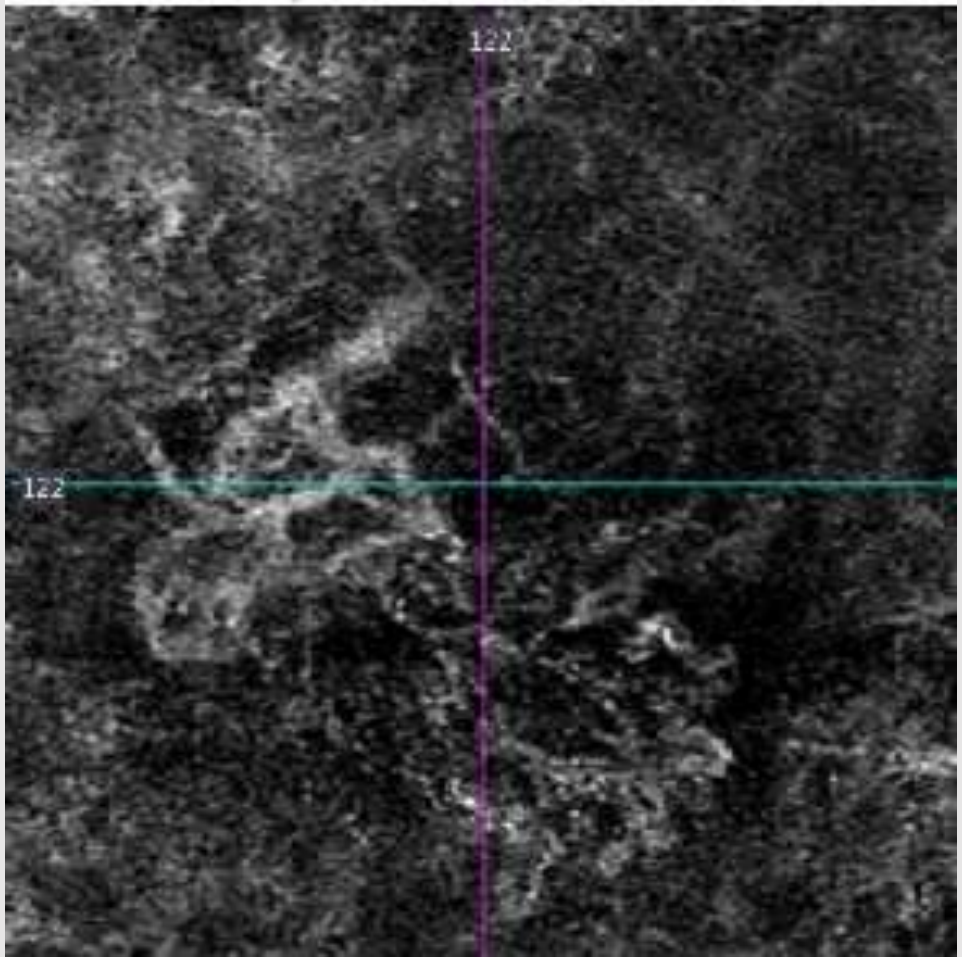
However by Collaging 3x3 or 6x6 wider fields of view can be achieved

Currently manually done using Power point - easy



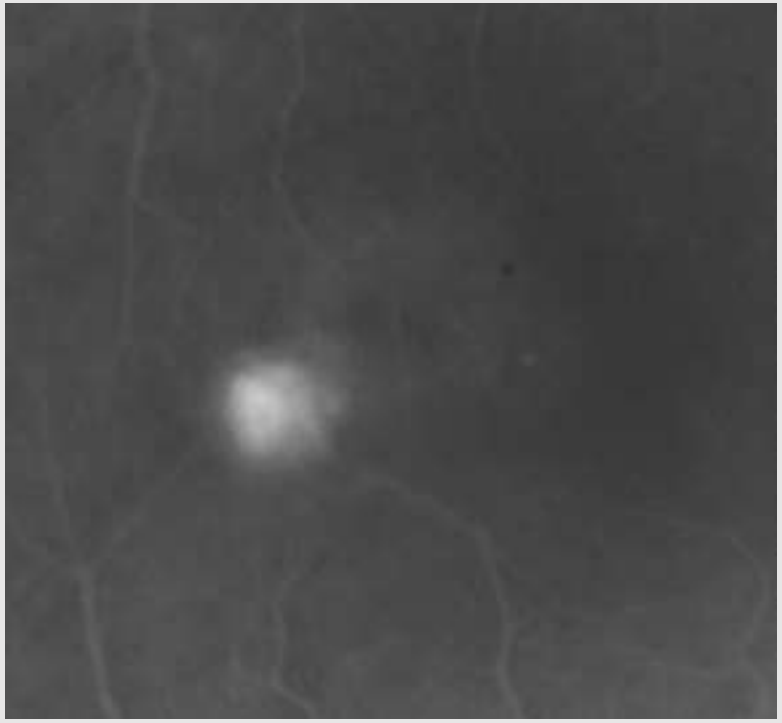
One Month apart – Dilation of the blood vessels
Possibility to monitor change/growth



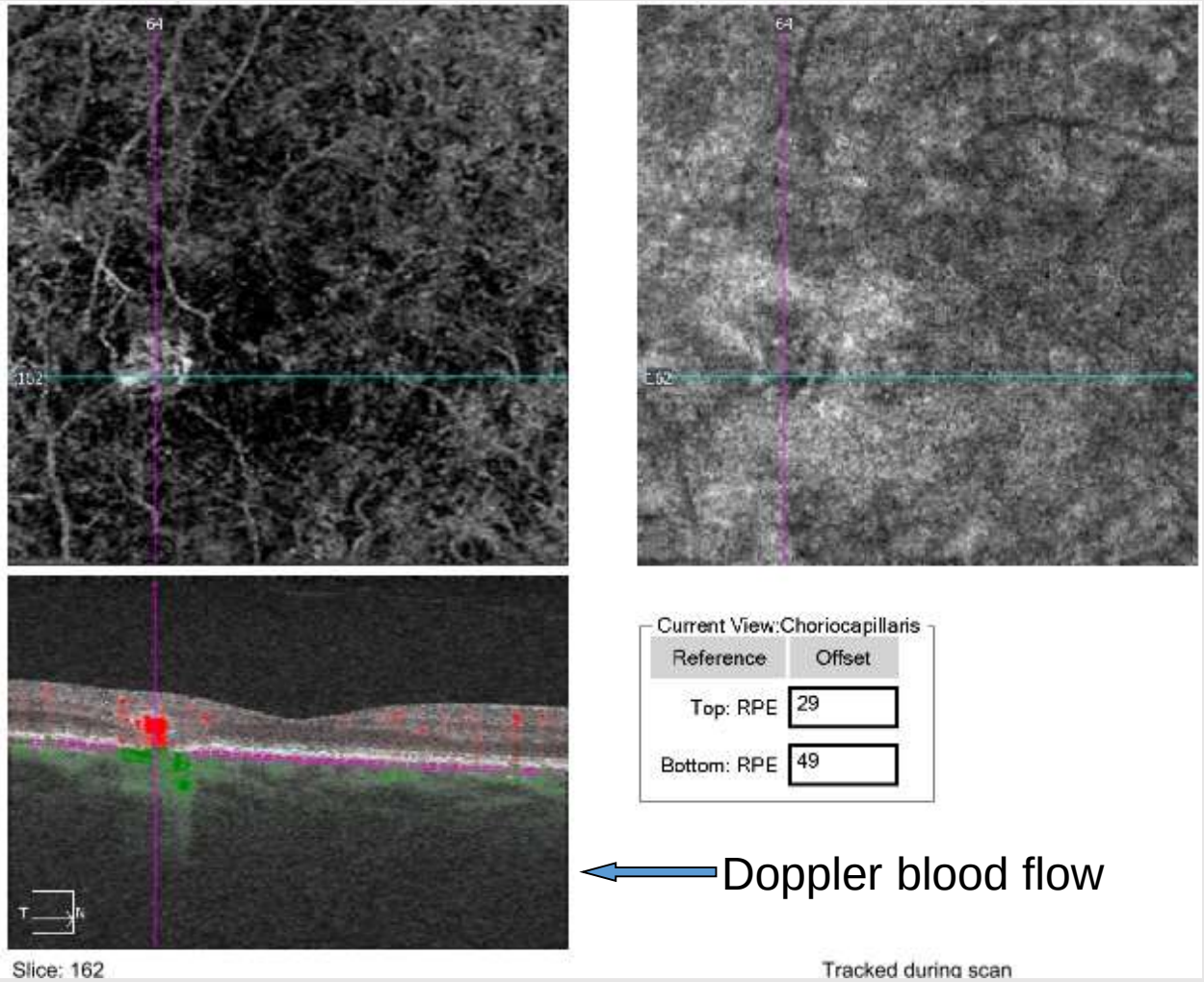


OCT-A shows this is Retinal to Choroidal Anastomosis - RAP

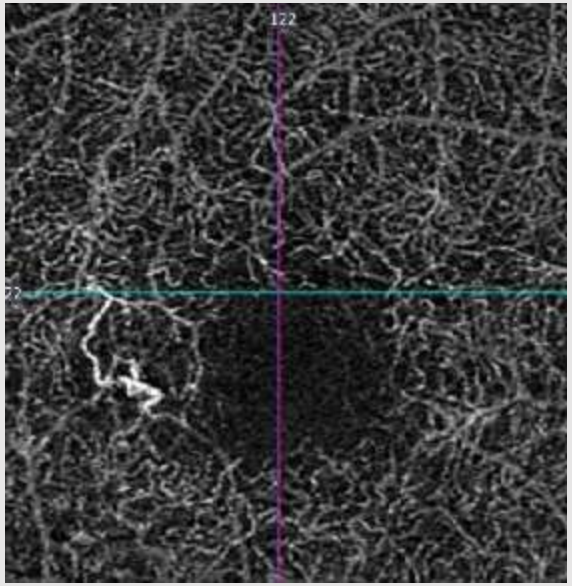
FFA

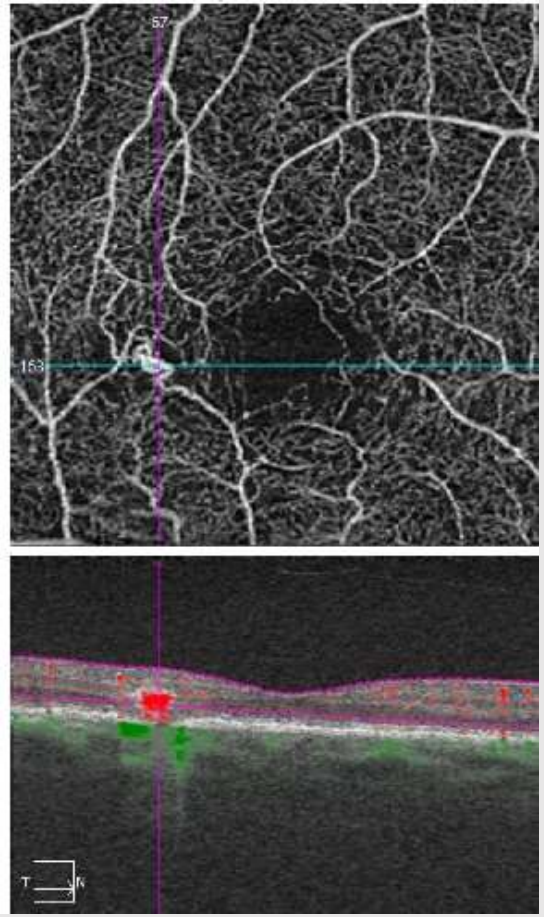


OCT-A

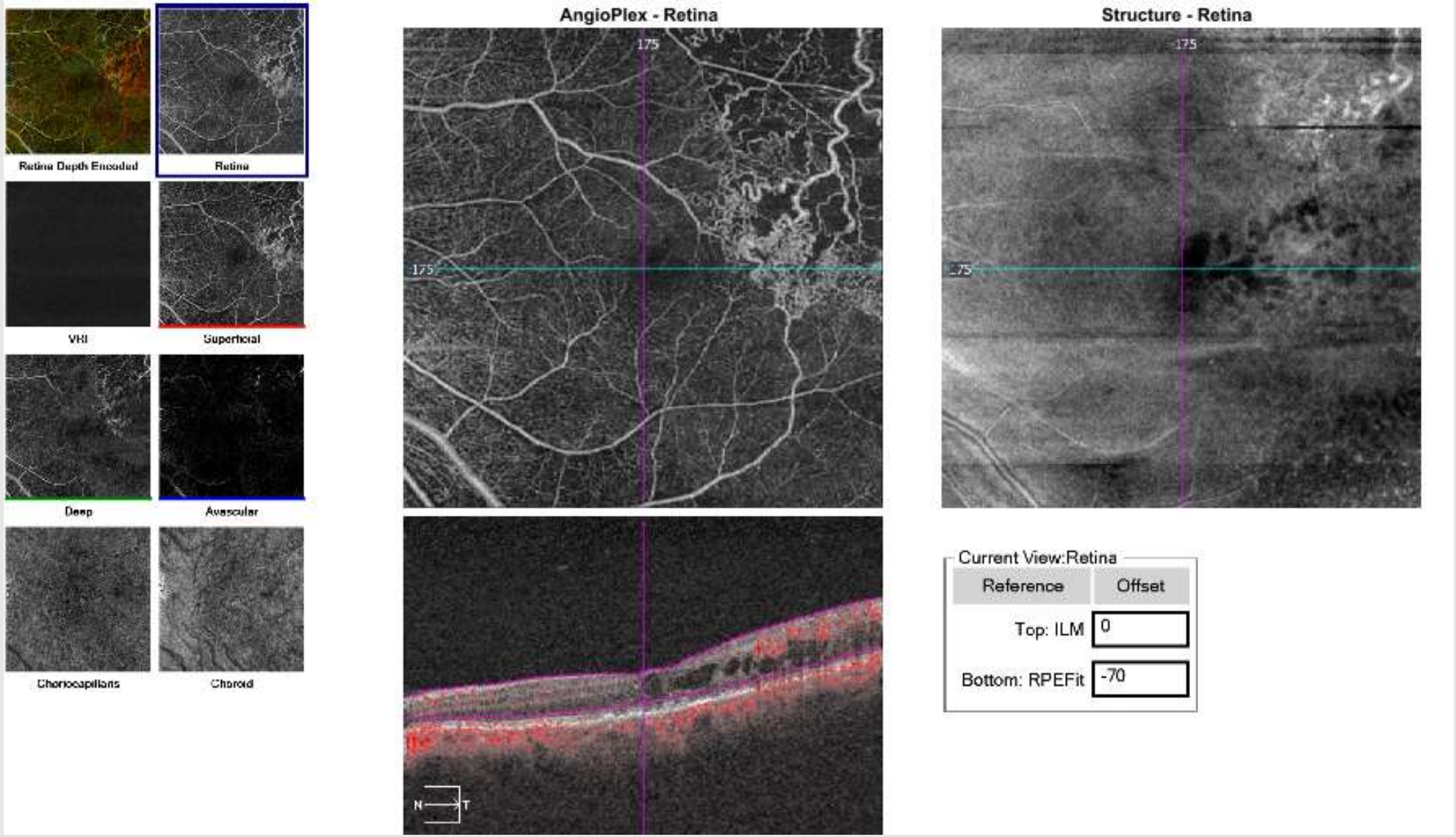


Move cursor to look at blood flow
Angiography – linked to OCT scan
Precise retinal alignment is essential in all OCT-A’s

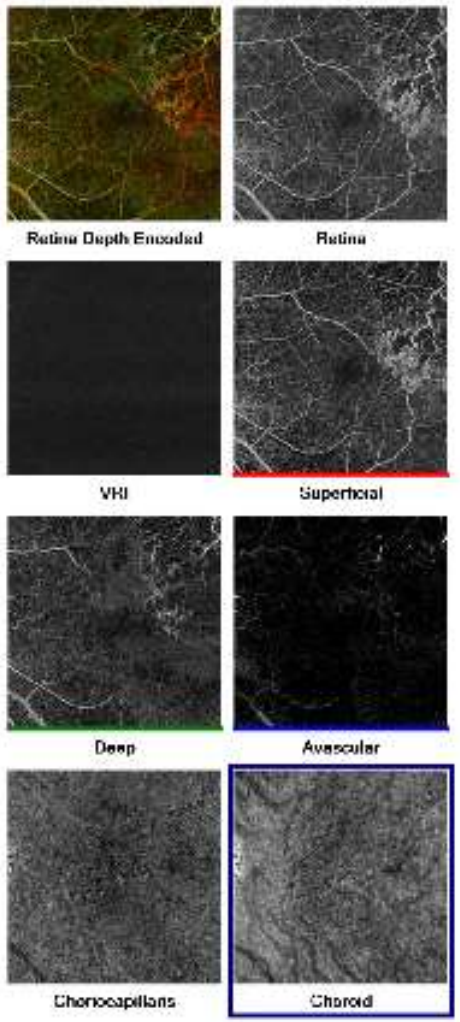


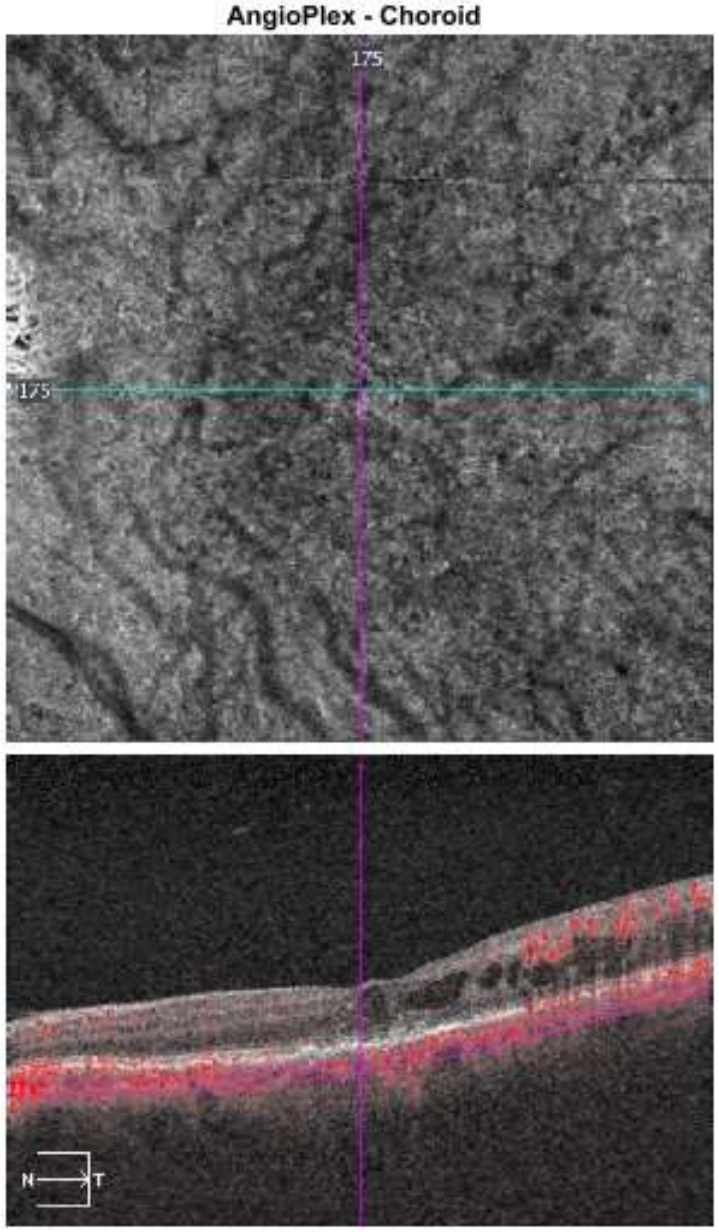


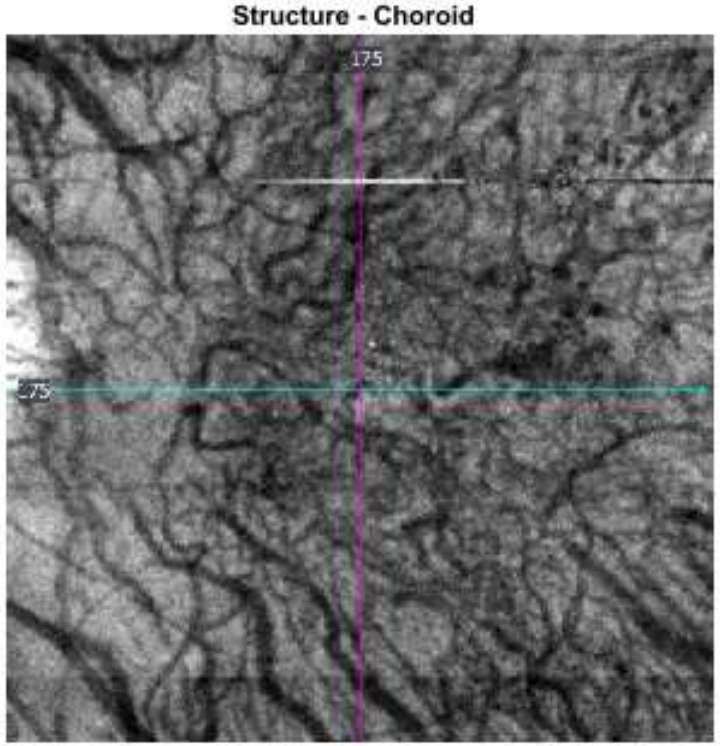
Branch retinal vein occlusion - Collaterals

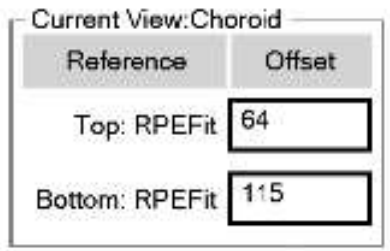


BRVO Choroidal views - Normal







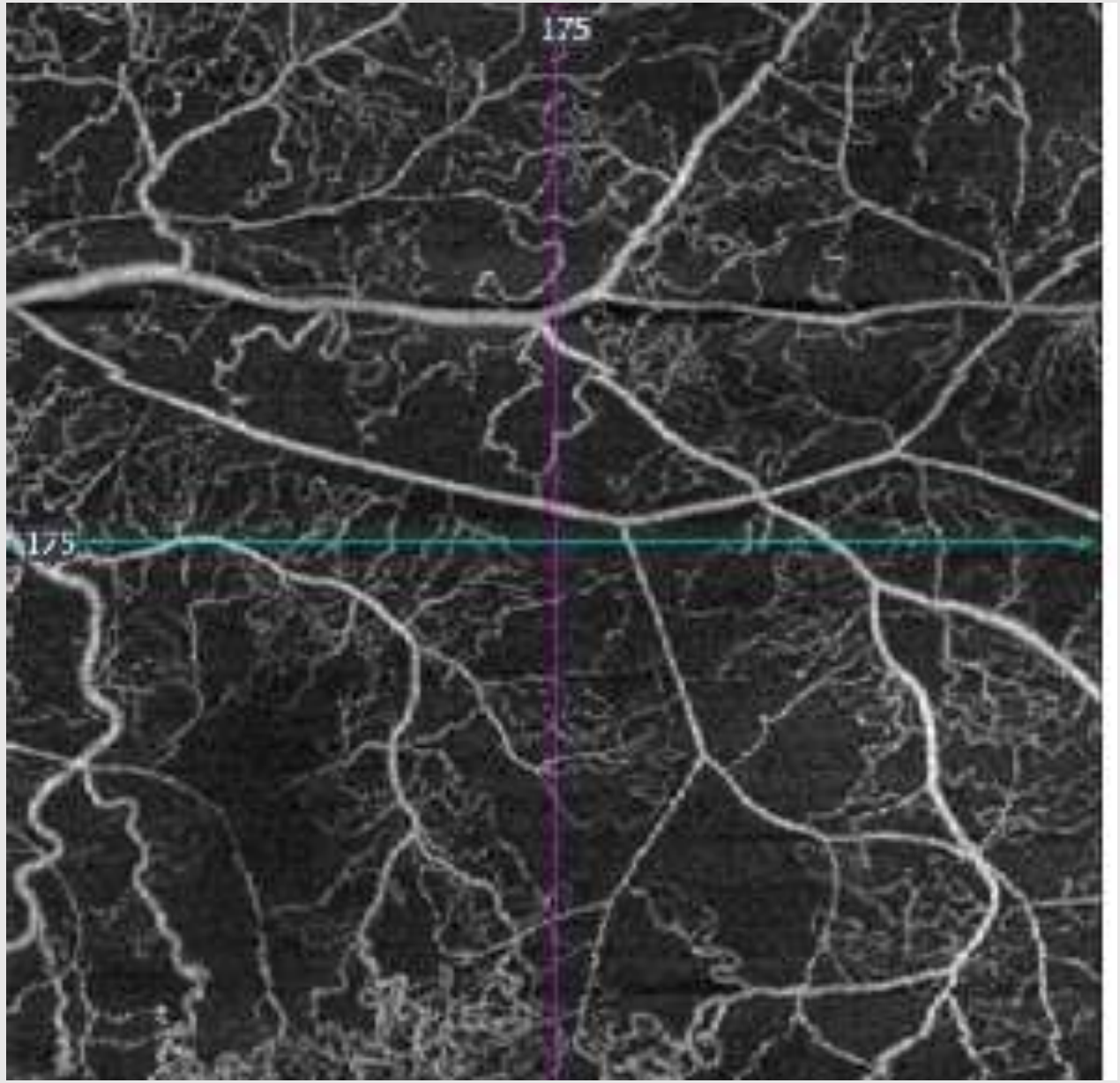


Instant differentiation of Choroidal vs Retinal disease

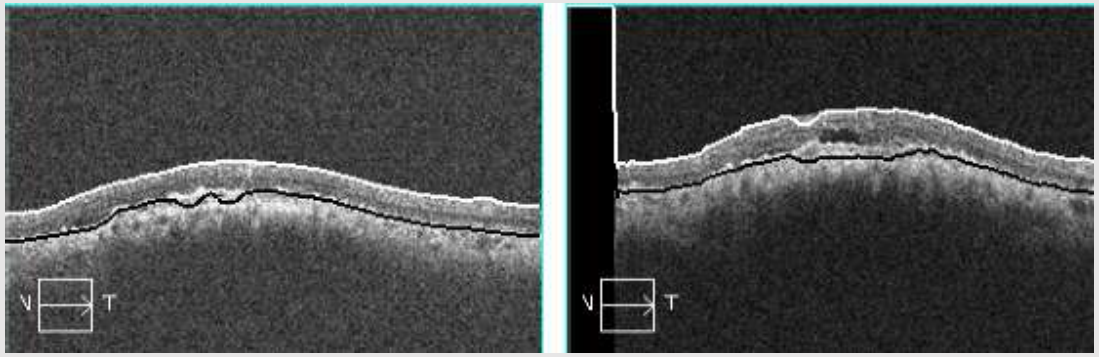
HD

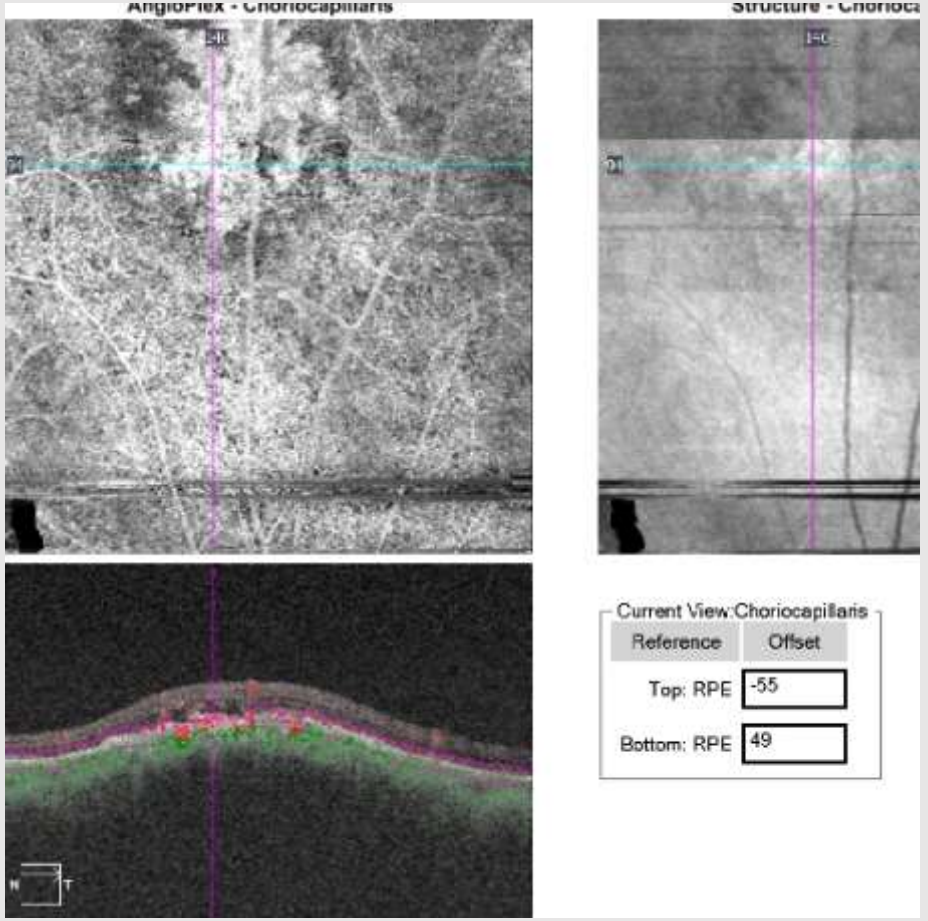
Detail Better than

Fundus fluorescein angiography

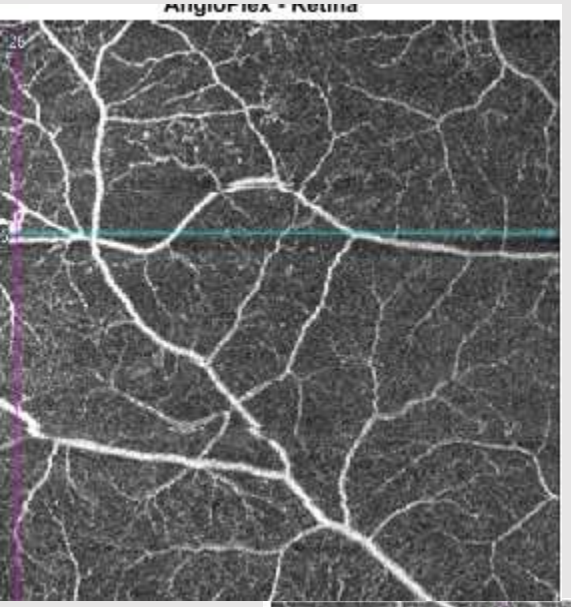


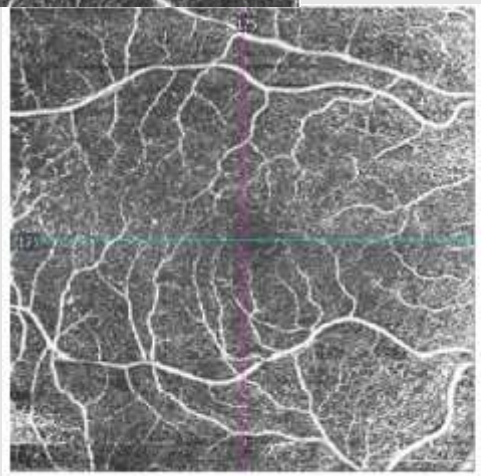
Naevus change to Melanoma
Change over one year Previously recommended observation
Now see Vascularisation present
For Plaque
Changed management

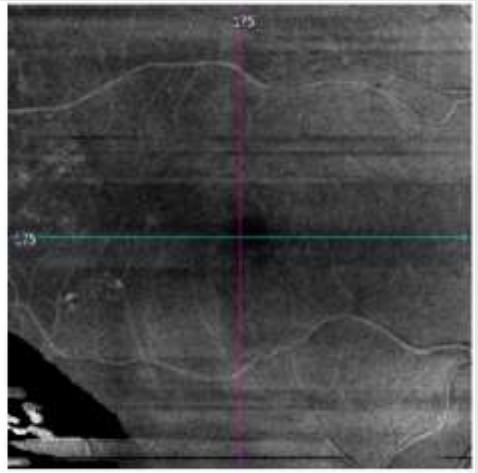


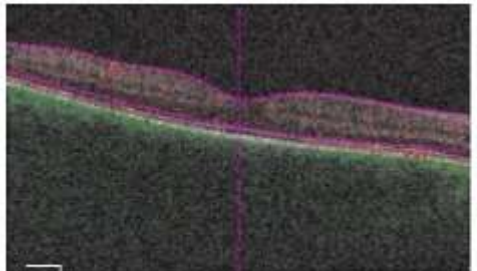


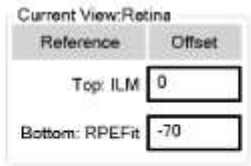
Diabetic

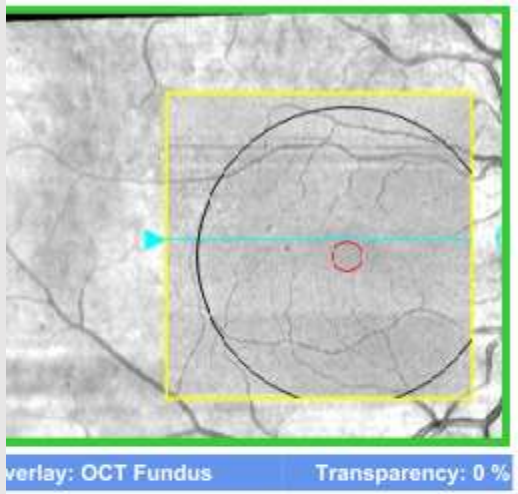


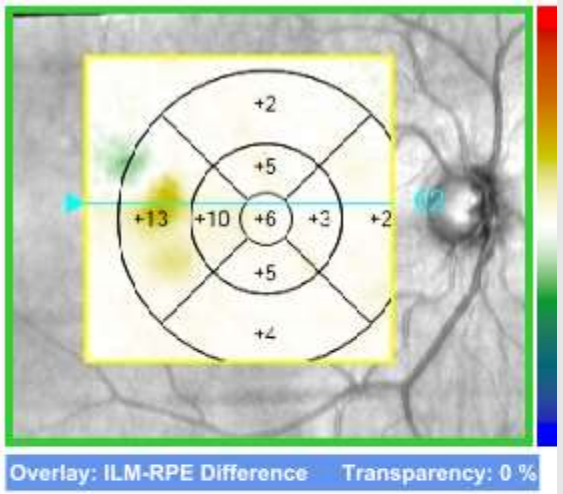


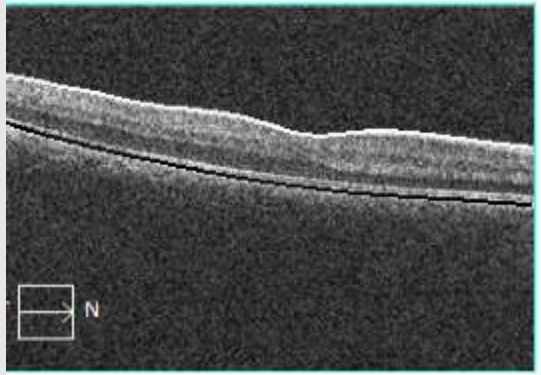





Current View:Retina
Reference
Offset
Top: ILM
0
Bottom: RPEFit
-70


verlay: OCT Fundus
Transparency: 0 %


+2
+5
+13
+10
+6
+2
+5
Overlay: ILM-RPE Difference
Transparency: 0 %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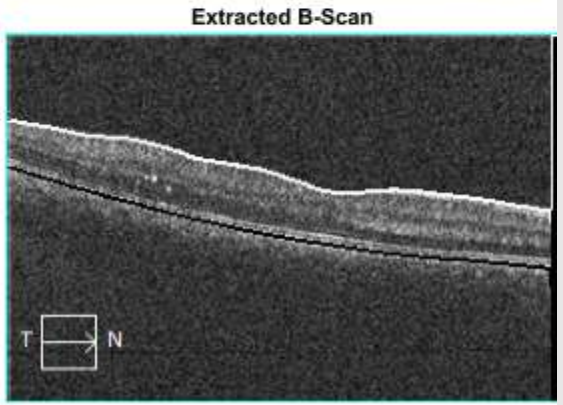
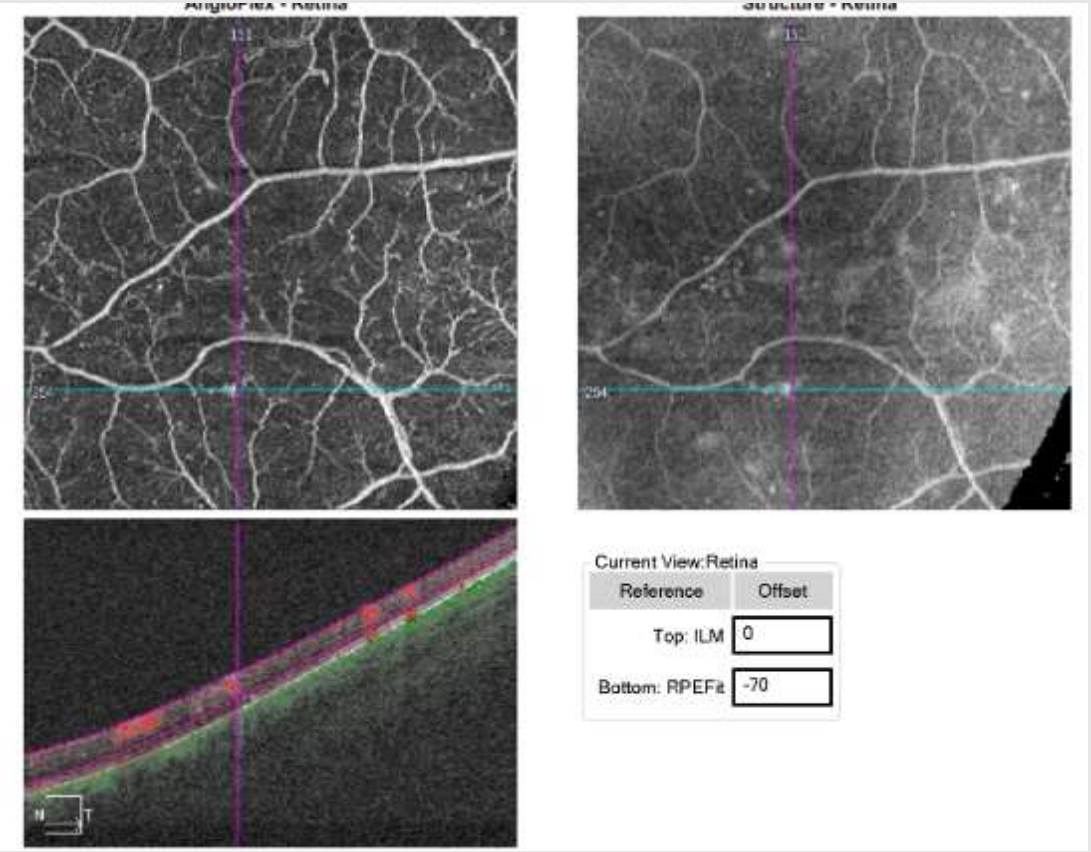
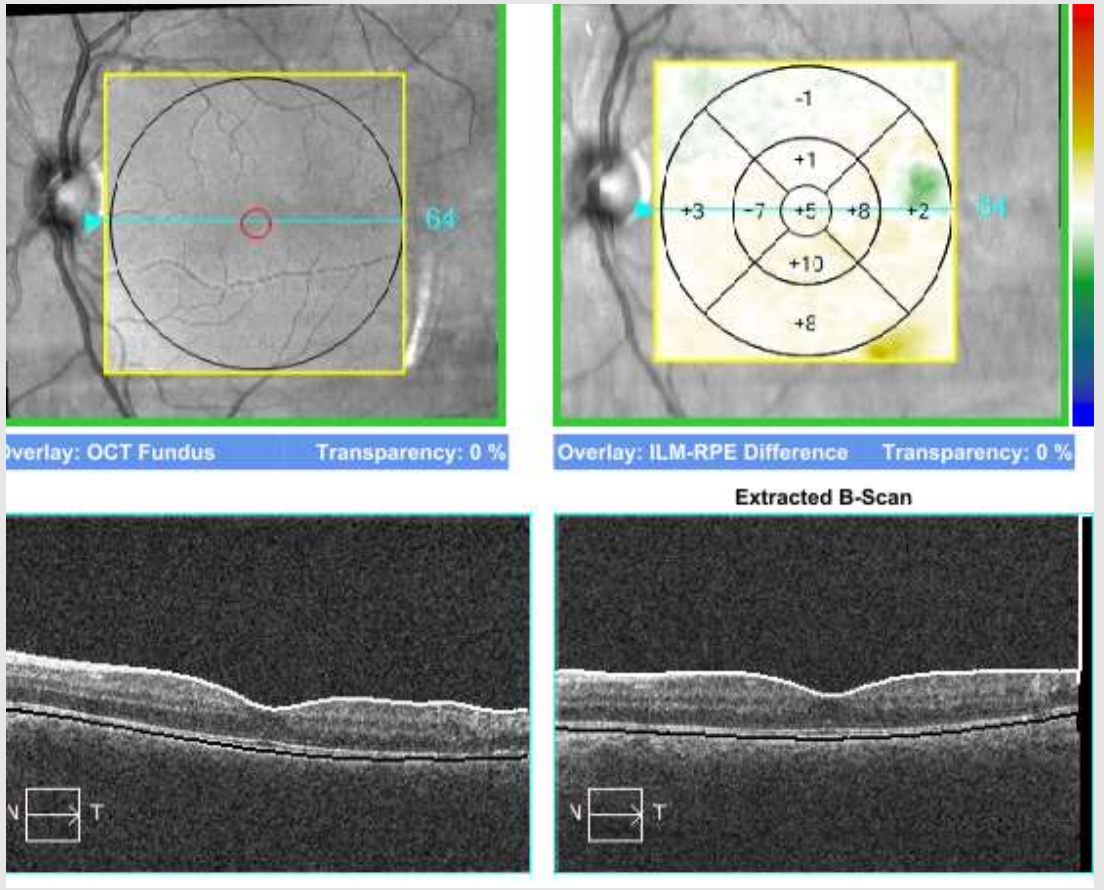
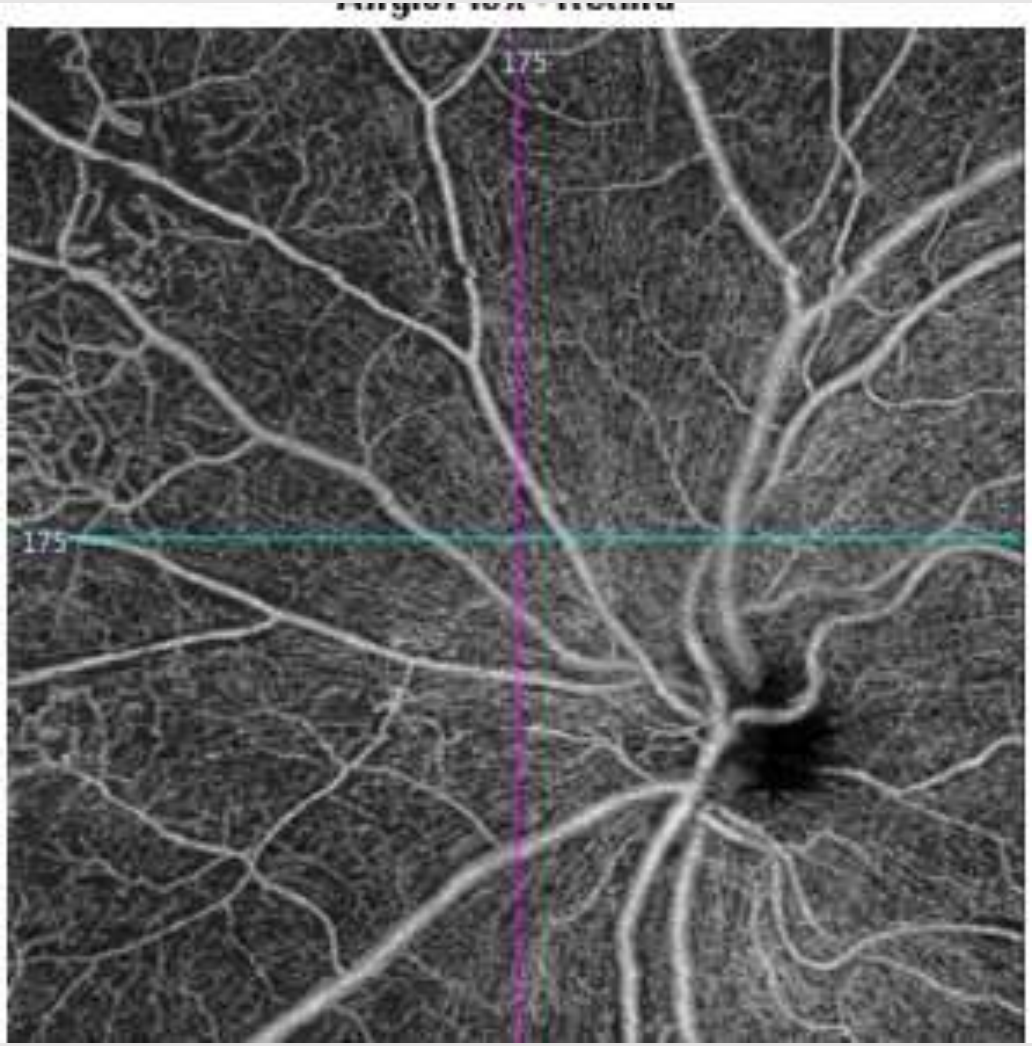

Extracted B-Scan
T
N

Diabetic

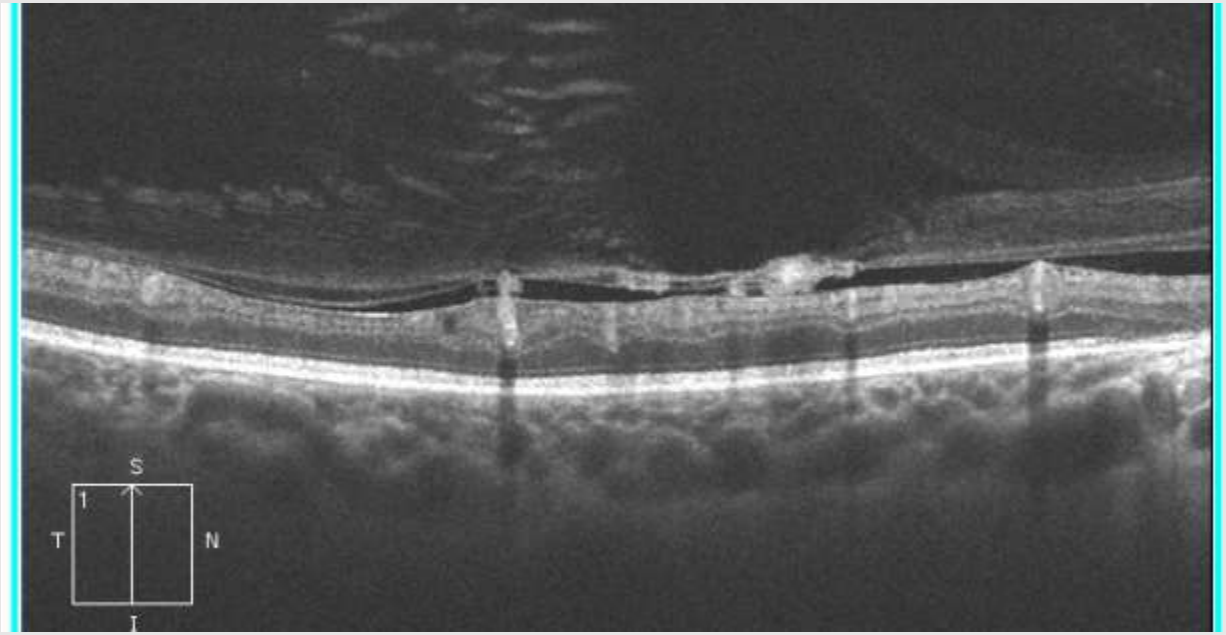

Current View:Retina
Reference
Offset
Top: ILM
0
Bottom: RPEFit
-70


Overlay: OCT Fundus
Transparency: 0 %
Overlay: ILM-RPE Difference
Transparency: 0 %
Extracted B-Scan

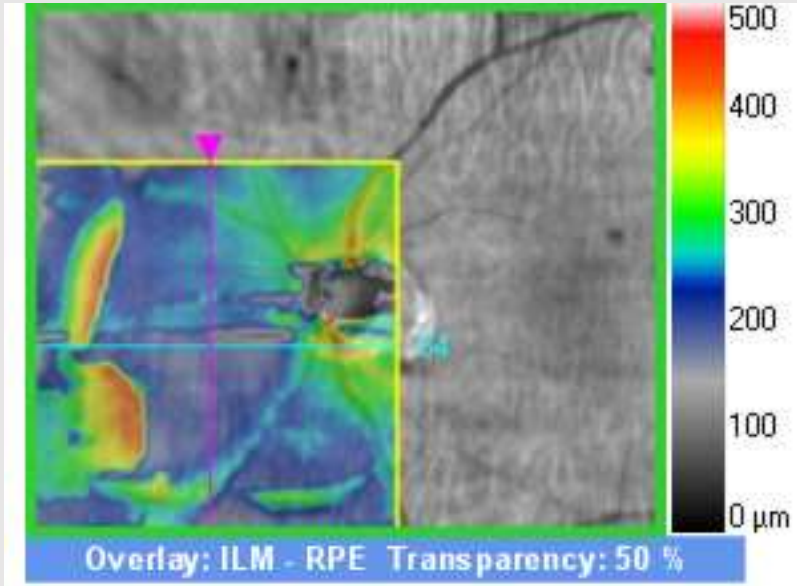
IRMA

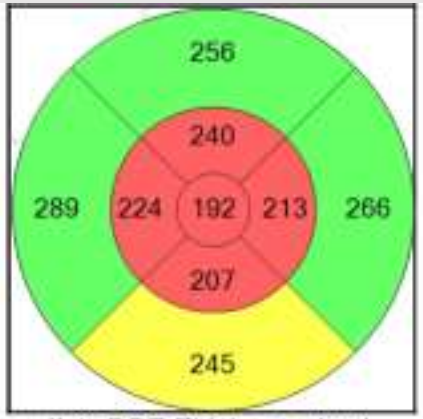


- NVE

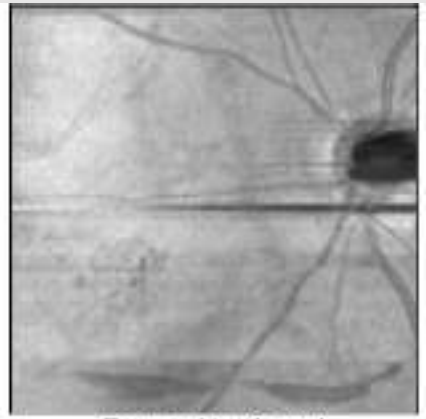


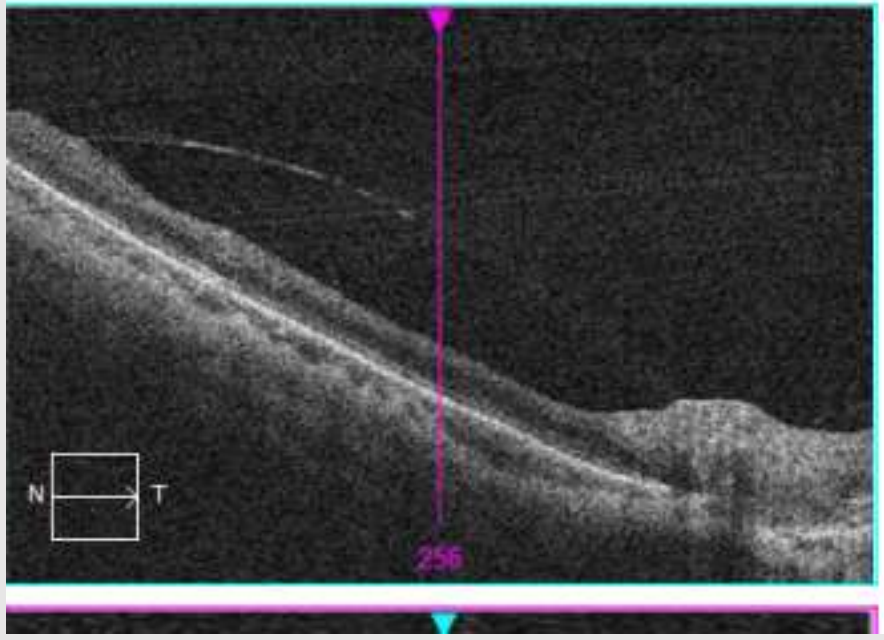
OCT NVE

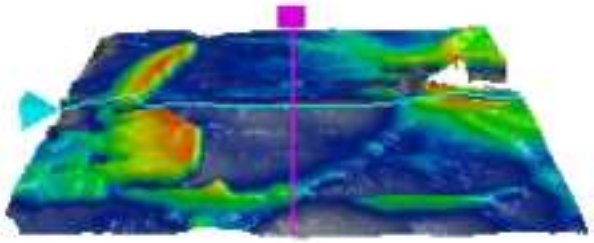


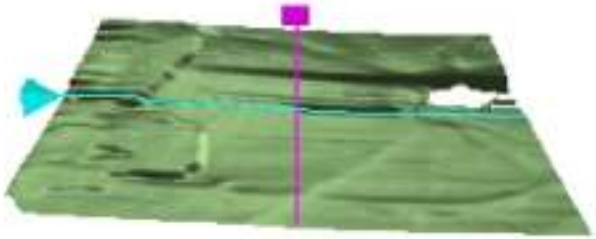


ILM-RPE Thickness (µm)

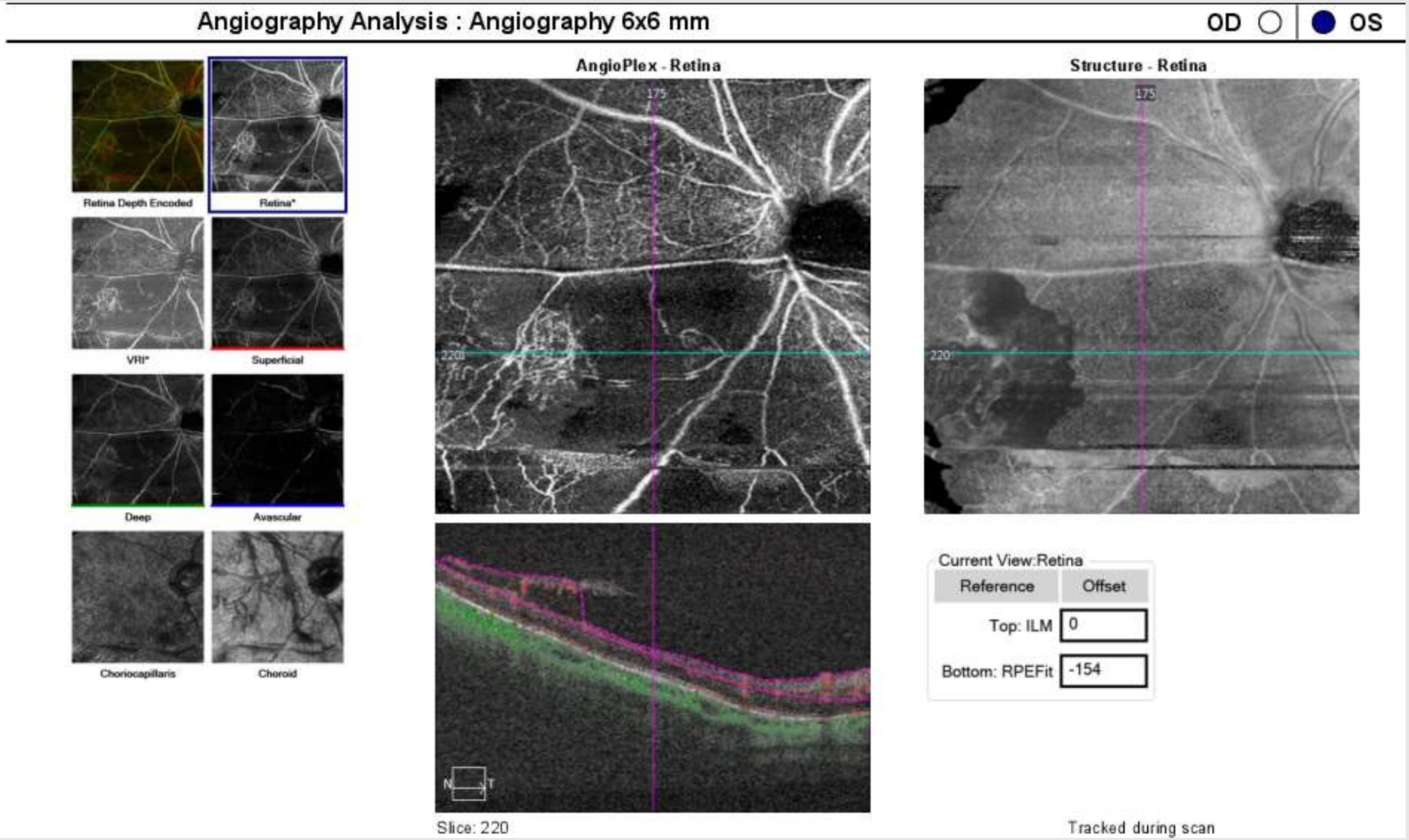

Fovea: Not found



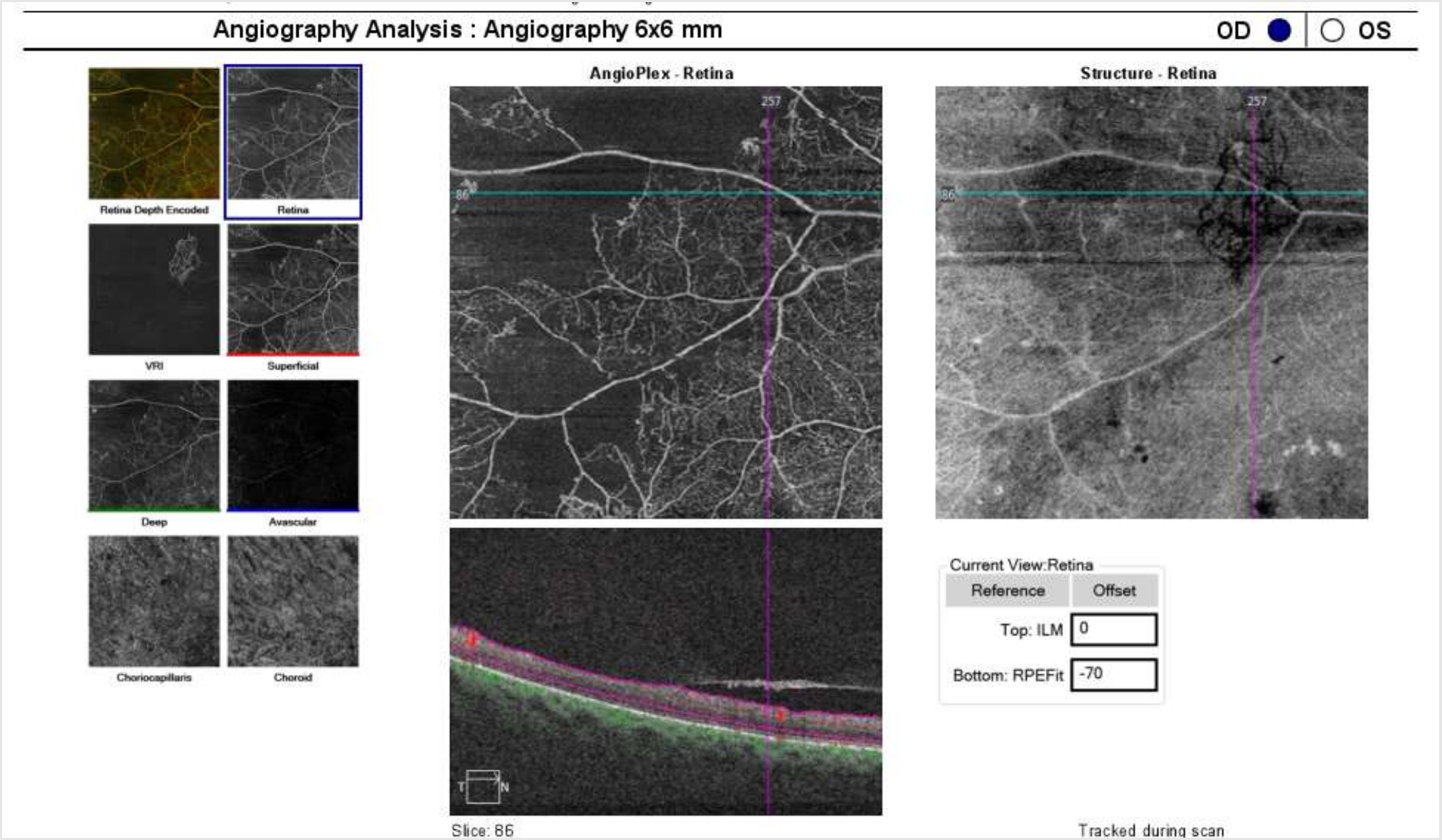

ILM - RPE


ILM

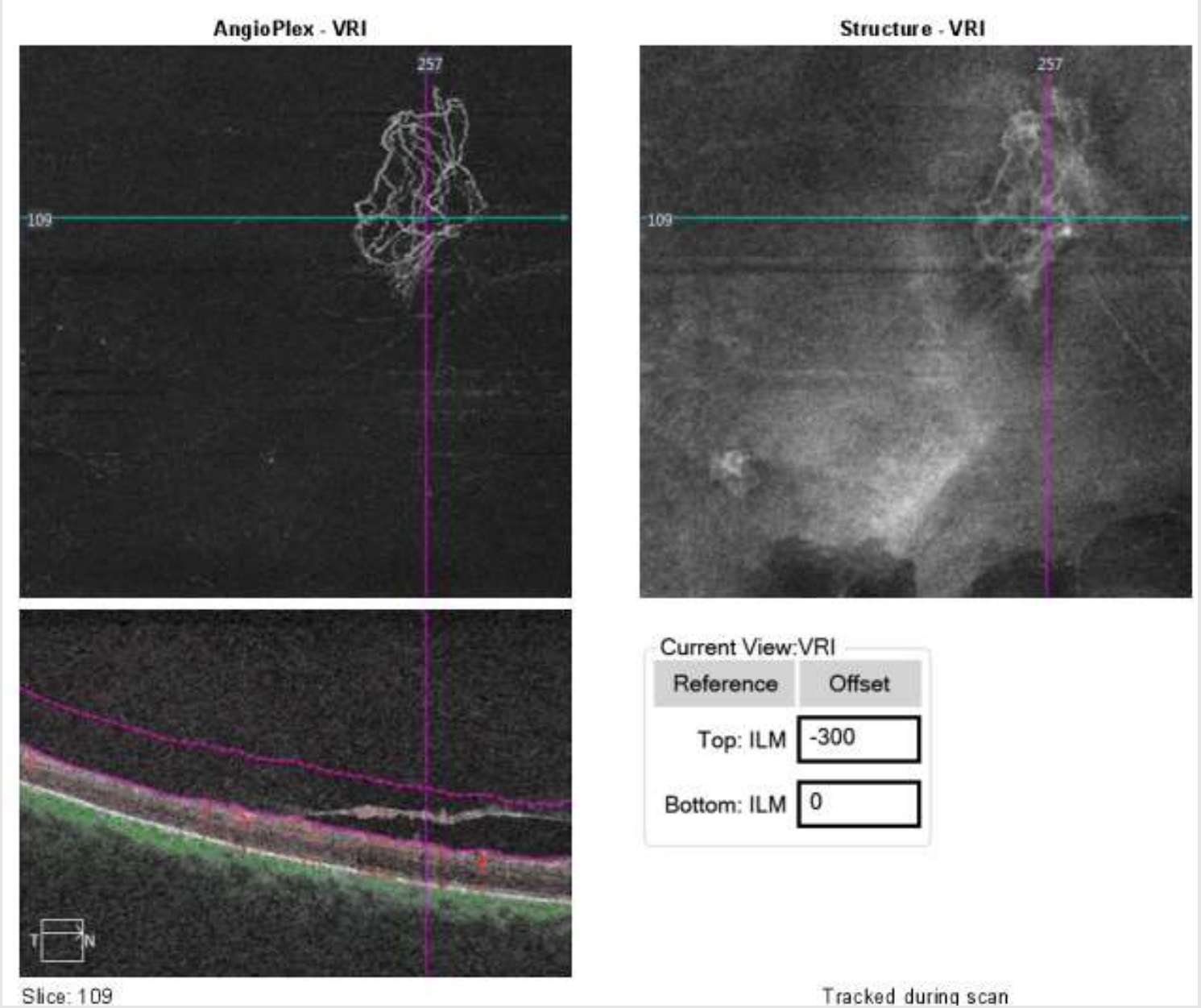
NVE

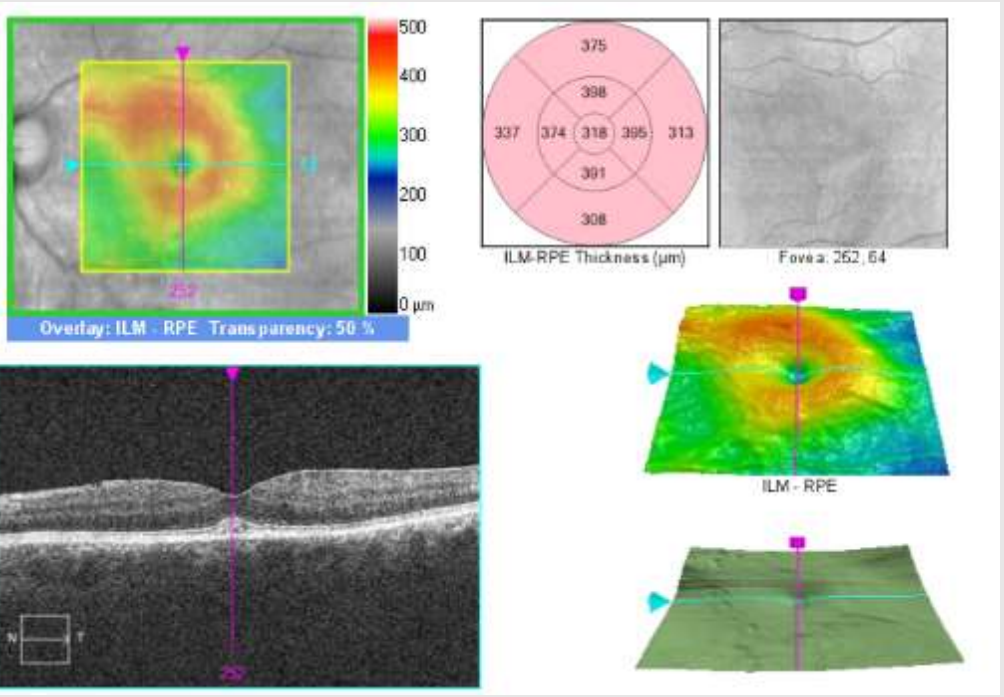

Angiography Analysis : Angiography 6x6 mm
OD
OS
Retina Depth Encoded
Retina*
VRI*
Superficial
Deep
Avascular
Choriocapillaris
Choroid
AngioPlex - Retina
Structure - Retina
175
220
Slice: 220
Current View:Retina
Reference
Offset
Top: ILM
0
Bottom: RPEFit
-154
Tracked during scan

NVE Ischemia

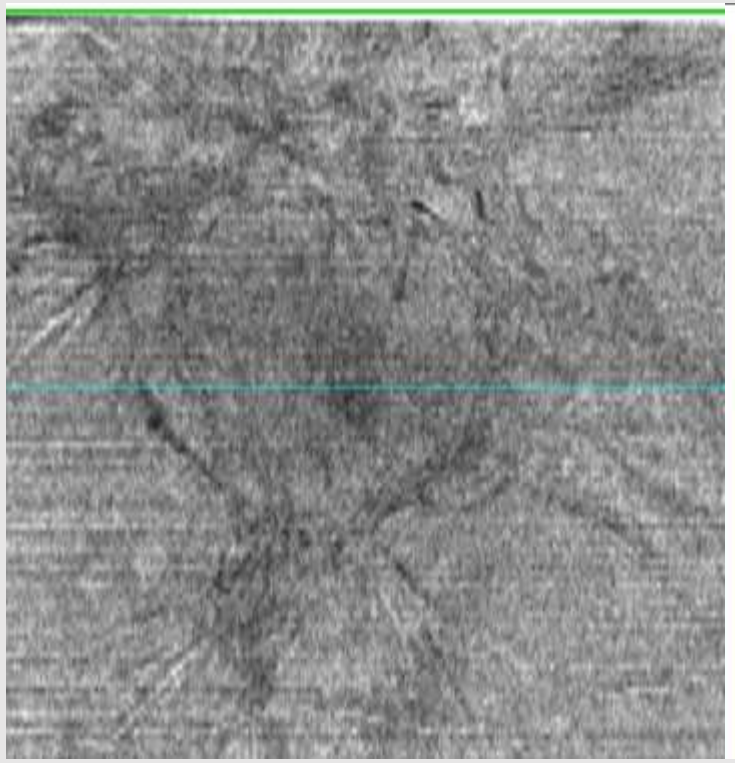


VRI
NVE

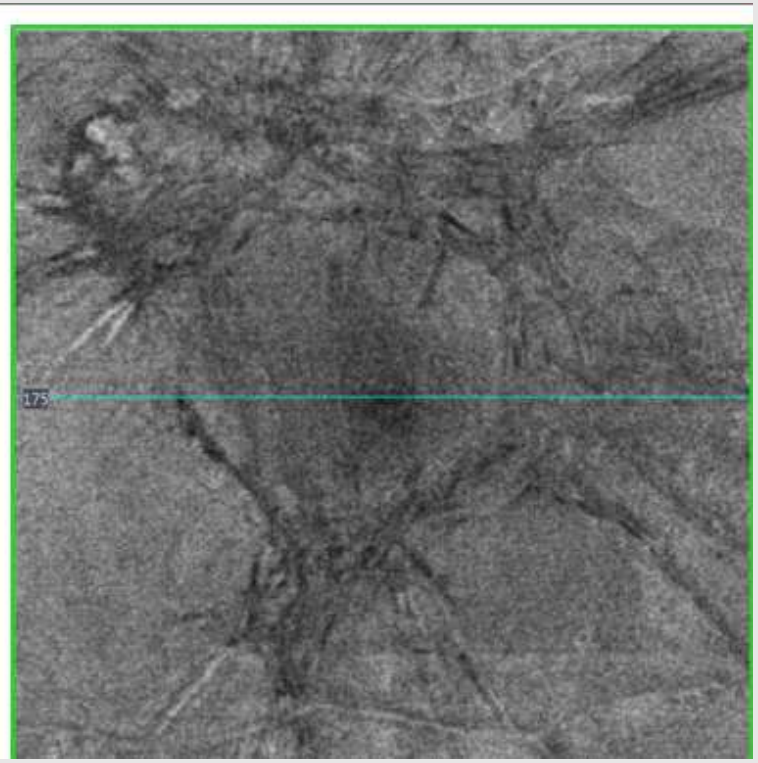

AngioPlex - VRI
Structure - VRI
257
109
257
109
T
N
Current View:VRI
Reference
Offset
Top: ILM
-300
Bottom: ILM
0
Slice: 109
Tracked during scan



Epiretinal membrane



Standard OCT 28Khz



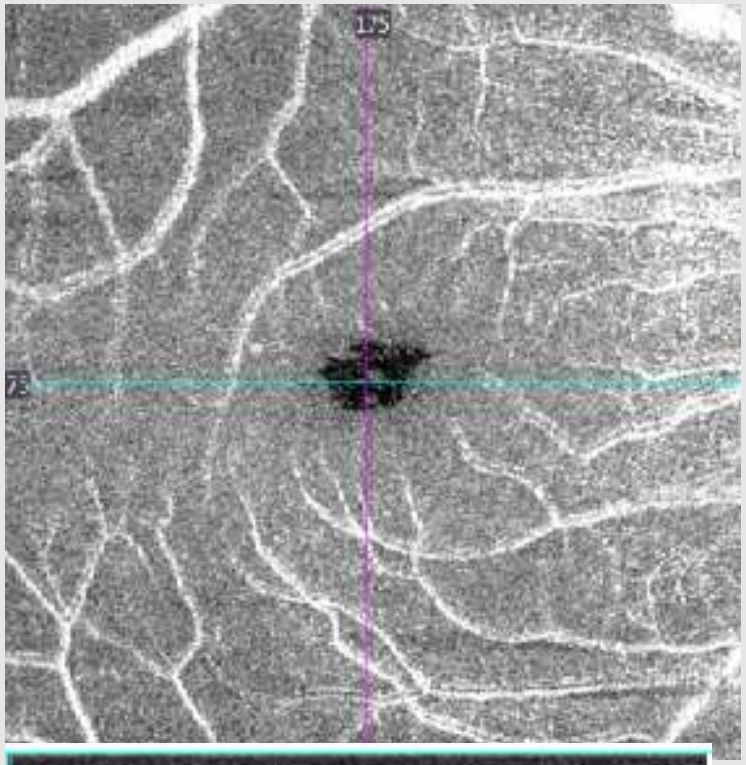
78KHz
Angio Analysis

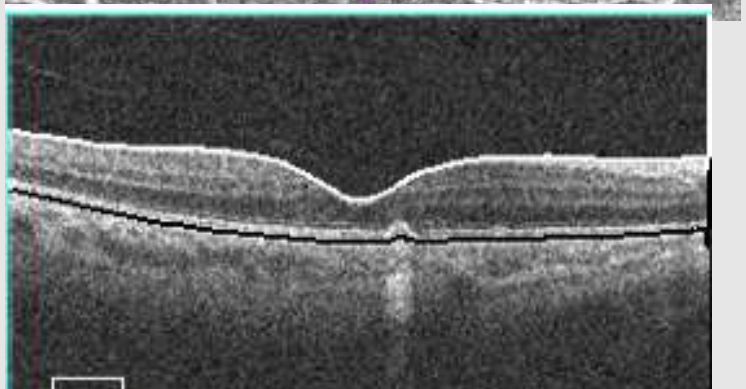
What can OCT-A DO and Not DO

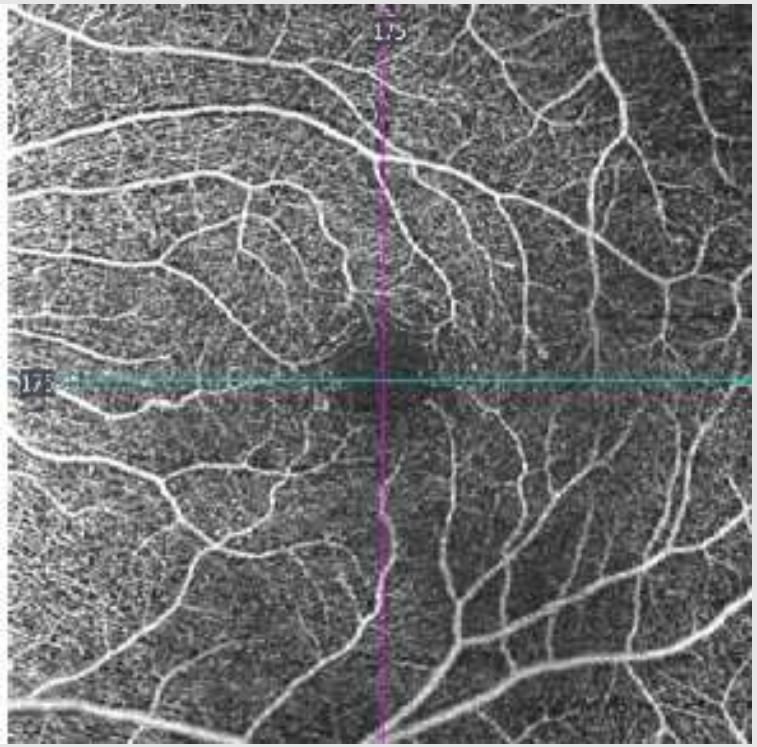
- High resolution of Retinal Circulation
  - Ischaemia, Collaterals, Aneurysms
- Identify NVE growing above Retina
  - Differentiating IRMA VS NVE
  - Epiretinal membranes
- Mid retina circulation - RAP
- Choriocapillaris
  - New Vs Abnormal
  - SRNVM type and Size
  - Vascularised vs non vascularised PED
- Choroid – large vessels
- Doppler Blood flow
  - Retinal & Choroid

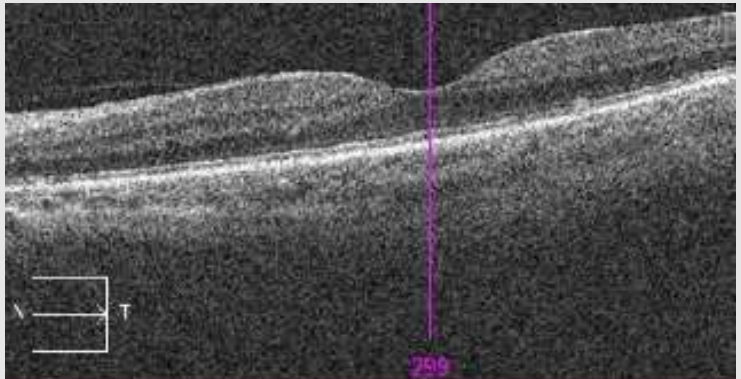
- Can not see Leak like FFA
  - No help for:
    - CSR, Irvine-Gass,
    - Optic disc leak
    - NVD / NVE leak - activity
- Narrow field
  - FFA wide field – Surveys
  - Spectral domain Vs Swept source
- Poor ocular Media clarity degrades image
  - ? FFA any better
- ? Sizing for PDT ?
- No colour photograph (Topcon dose Provide)
  - No Auto fluorescence
  - ICG vs OCT-A – not worked out
- Limited Experience of intrepreation
- Images degraded by Cataracts and media opacities

Image Degradation due to moderate Cataract









OCT-A VS FFA

- Non- Invasive – no side effects
- Limited Clinical experience - 2016
  - Limited availability
  - Currently Hot-topic for publications
- Rapid diagnosis
  - Same day Scans with normal OCT
  - Reduce diagnosis to treatment time
  - Colour print out summary or Computer
- Duration of test – 5 minutes
- Cost
  - Per test + (Operator only)
  - Low skill set to operate
    - Community / Optometrist practices
    - Mobile – K9
  - Capital – New equipment £80K
  - Situate OCT in any room/area

- Clinical Experience since 1960
- Side effects 5 – 10%
  - Yellow urine – 100%
  - Nausea – Common
  - Urticaria – 1 in 300, Bronchospasm, Hypotension, syncope
  - Anaphylaxis – 0.4%, MI/Cardiac arrest
  - Death 1 in 220,000 7 in 50 years reported
- Clinic to FFA appt can vary – often delays
  - Delay in clinic to diagnosis to treatment
  - Review usually on Computer only
- Duration of test – 1 Hour+
- Consent required
- Unlicensed drug
- Cost
  - Per Test +++
    - High Skill set - Photographer, nurse, doctor
  - Capital £40K & All units have one
  - Dark Photographic room

Dawn of a New Era in Imaging

- New Clinic Diagnostic pathway
  - Spectral Domain/Swept OCT
  - OCT-A
  - Colour Photograph / Auto fluorescence
  - FFA
  - ICG
- Patient safety issue
  - Informed consent about options
    - Medico-legal situation
- Developing Technology