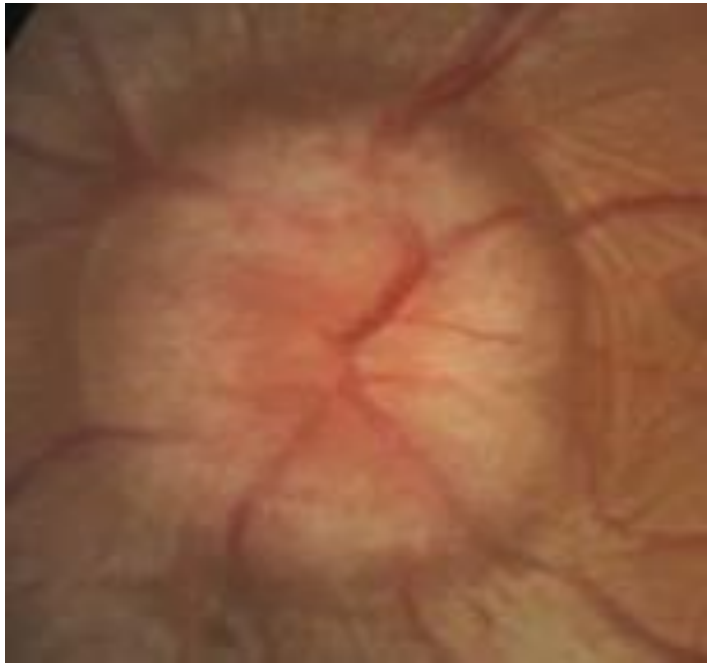
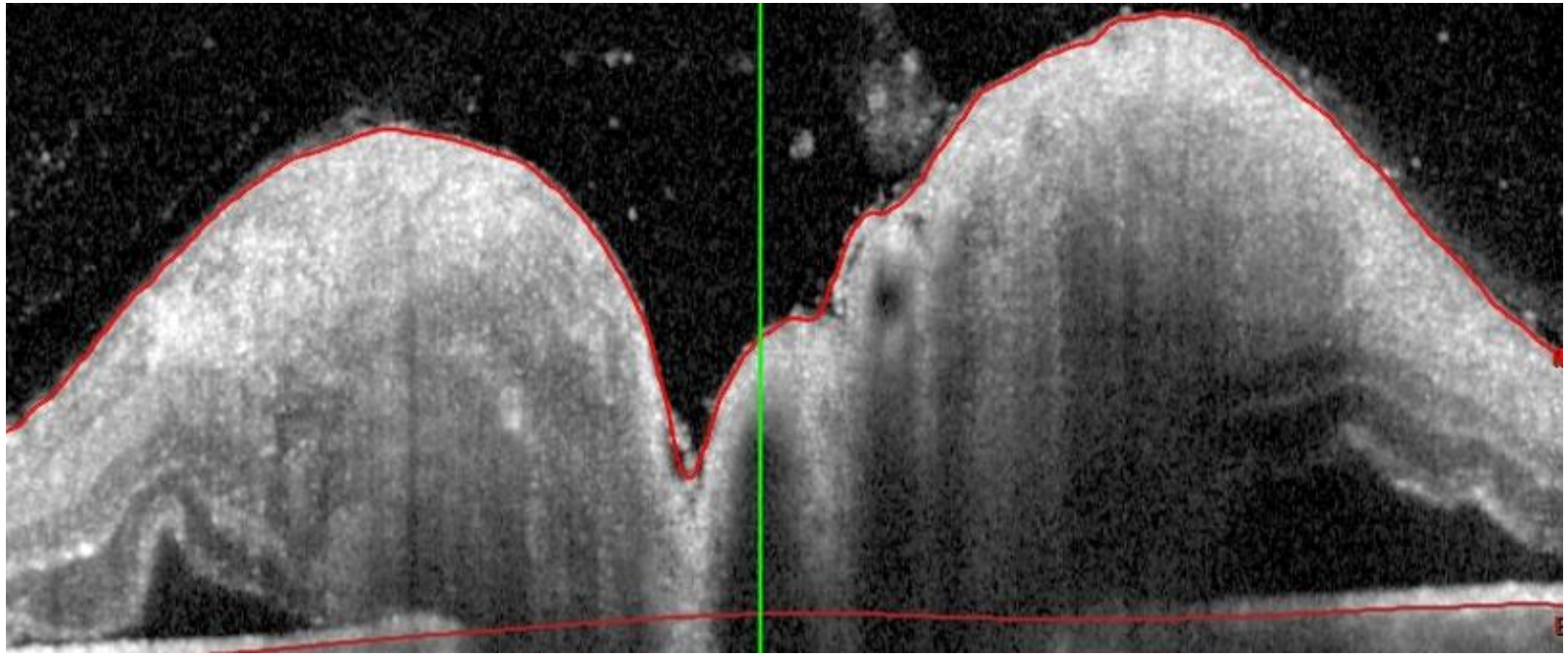




Papilloedema & OCT

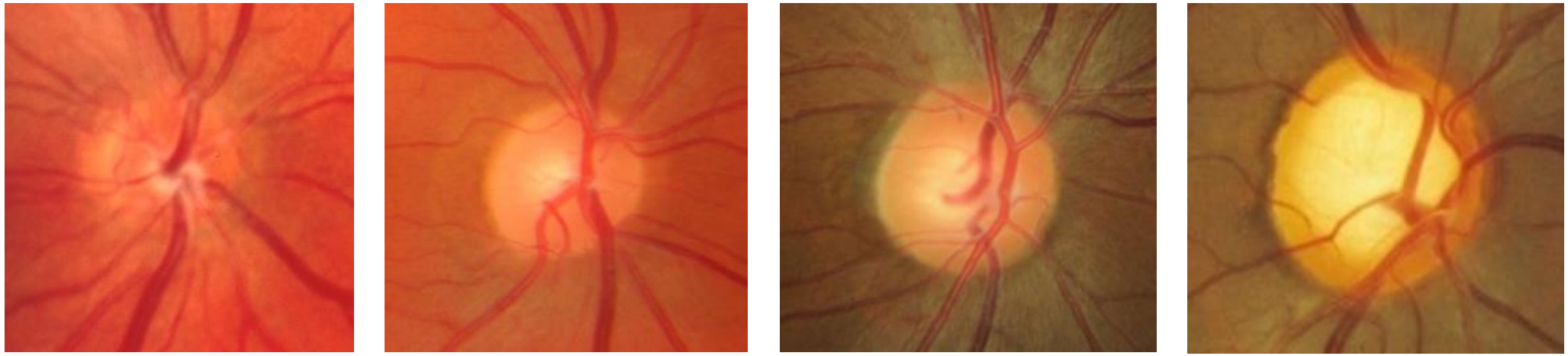
Jim McHugh

Consultant Neuro-Ophthalmologist

King’s College Hospital

Normal & abnormal discs

Range of disc normality



SMALL NORMAL DISCS

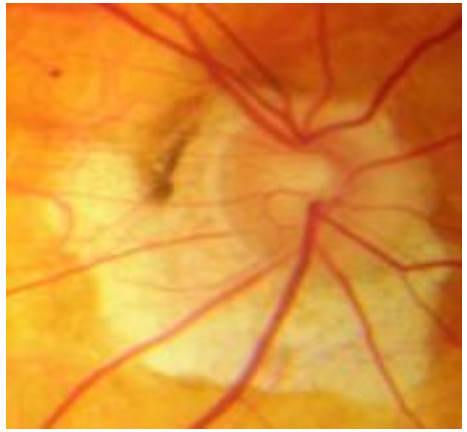
Nerve fibres crowded into a tight space
Look slightly swollen
Often referred as ?papilloedema
Greater tendency to swell
If they swell, greater risk of infarction

LARGE NORMAL DISCS

Prominent cup
Mild swelling easily missed
Resistant to swelling-related damage
Often mistaken for glaucoma
Increased risk of glaucoma ?

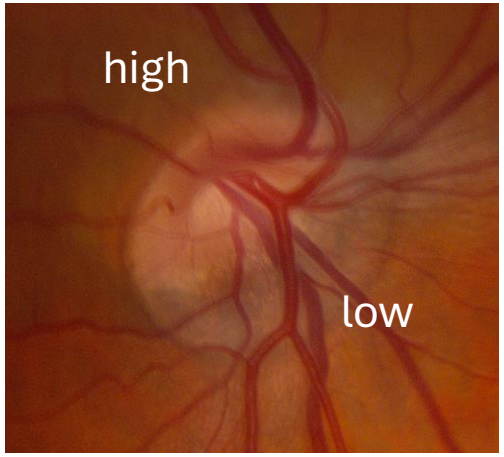
Common innocuous findings

Tilted disc

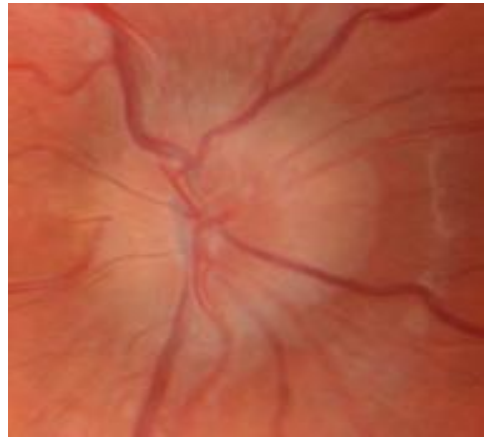


Myopic chorioretinal atrophy

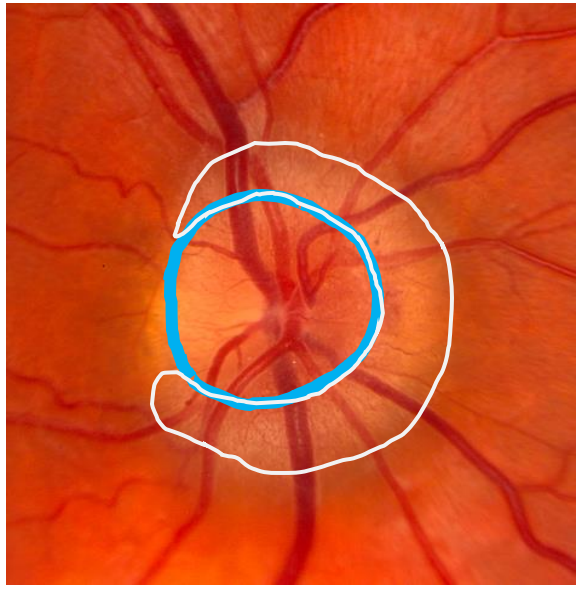
Superficial disc drusen

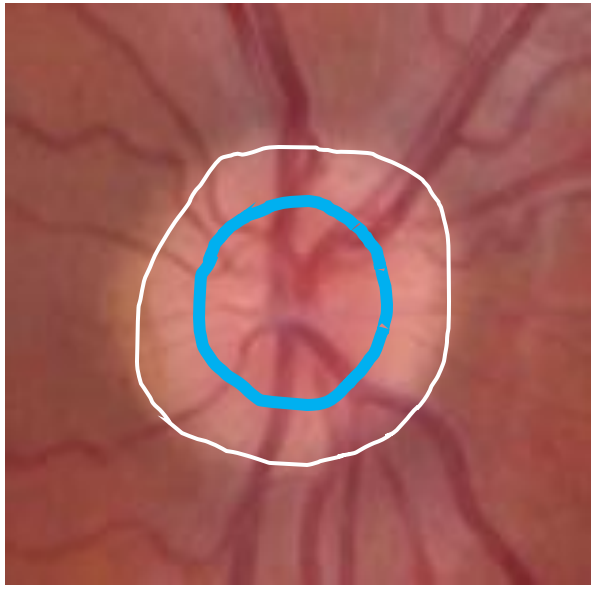


Reverse tilt

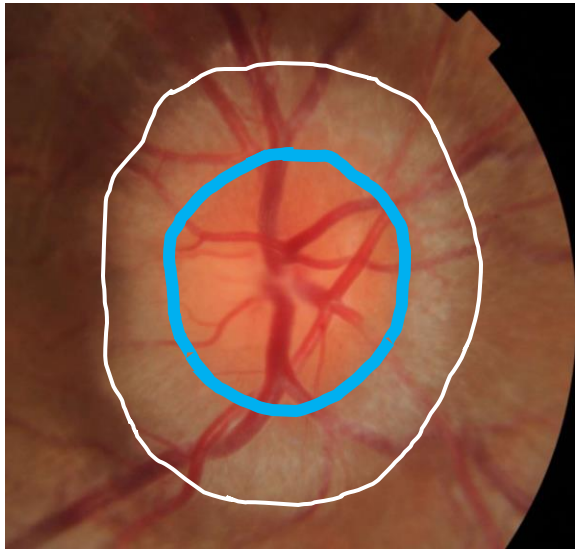


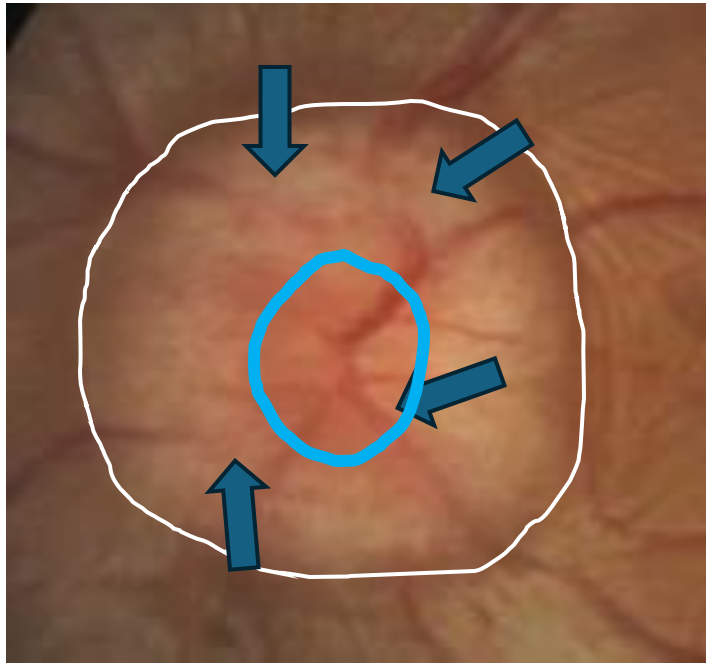
Buried disc drusen

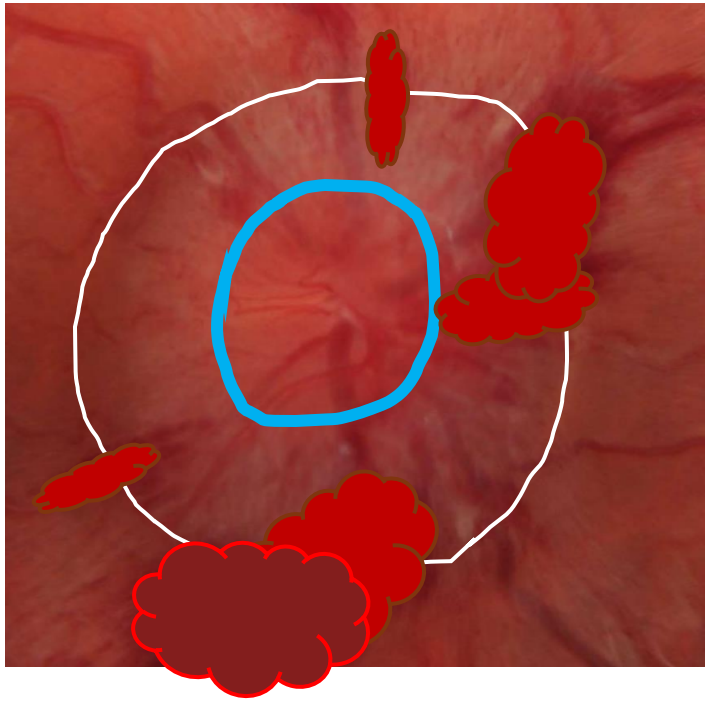


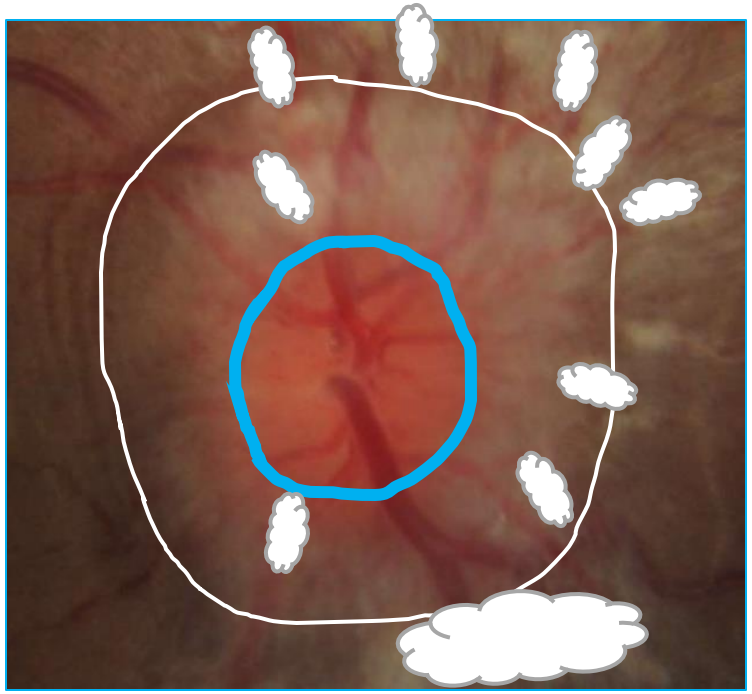


Note pallor





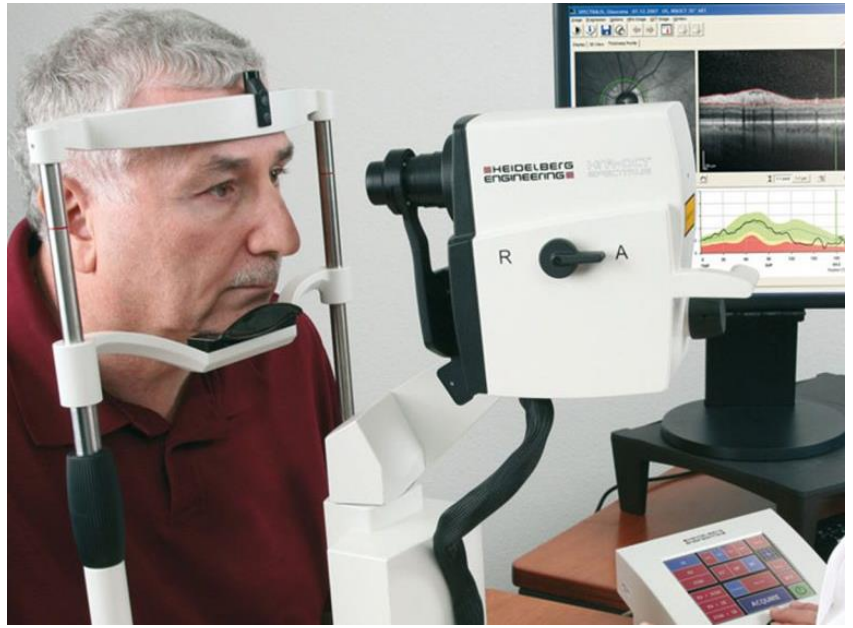


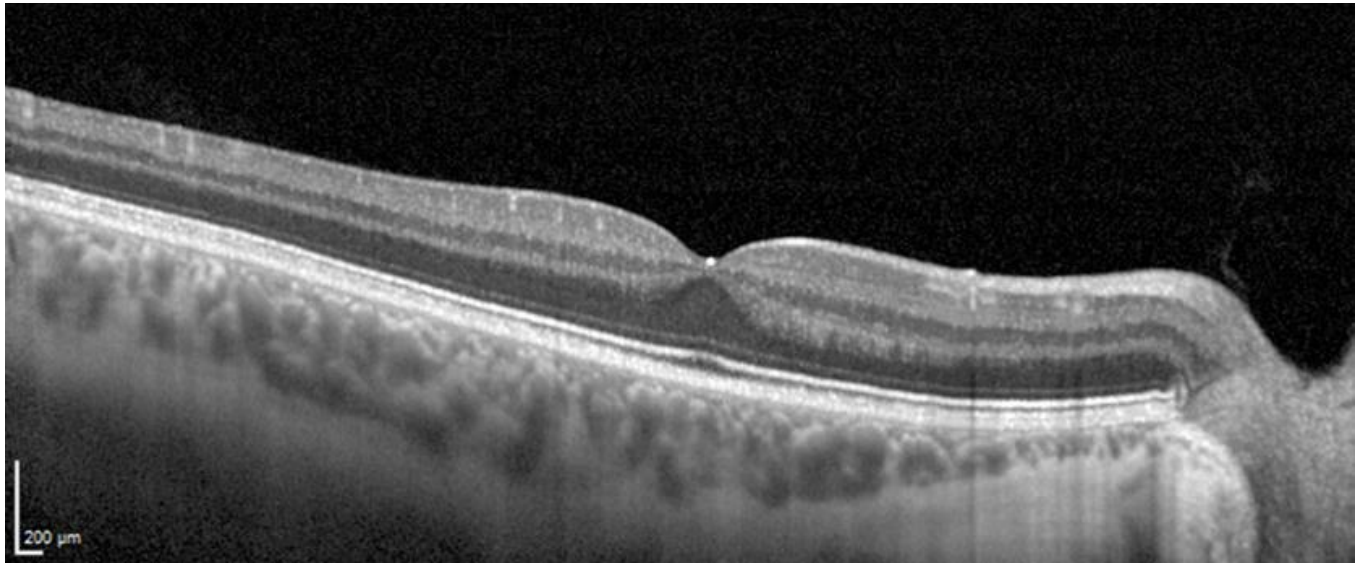


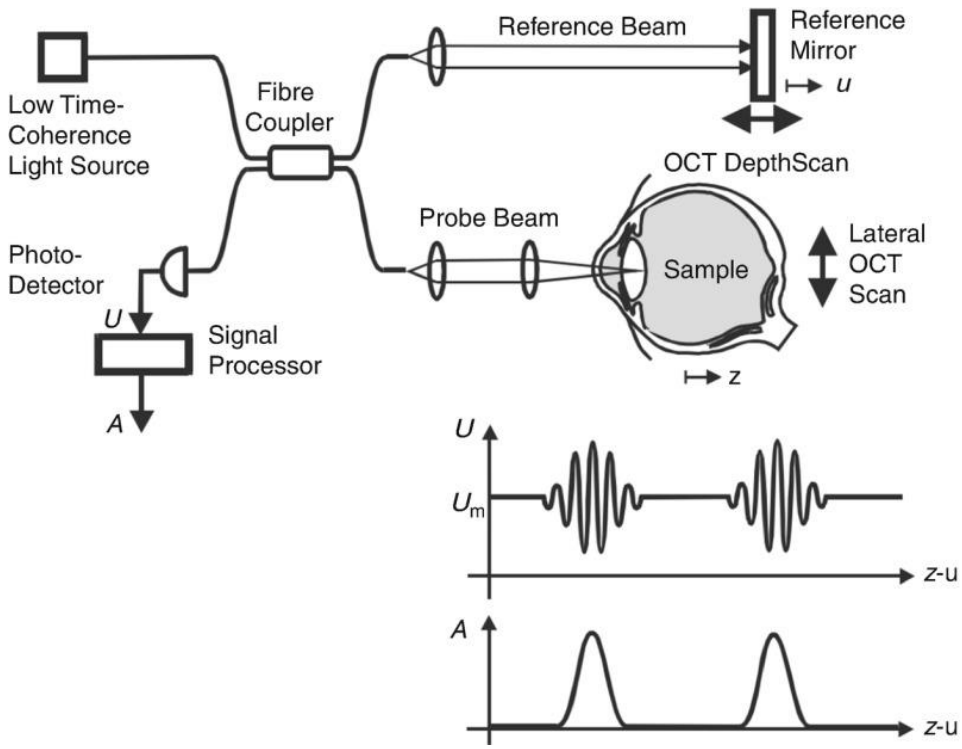
OCT

Optical Coherence Tomography (OCT)

- Near infrared laser beam (multiple wavelengths) is split
- A probe beam is projected onto retina & light reflects back depending on pigmentation & cell orientation (c.f. ultrasound).
- The interference pattern of the probe beam & a reference beam allows reflections from the retina to be read by the machine
- The beam is automatically moved around the retina in set patterns – up to 120,000 points scanned per second
- Resolution about 5µm: About 100x finer than MRI

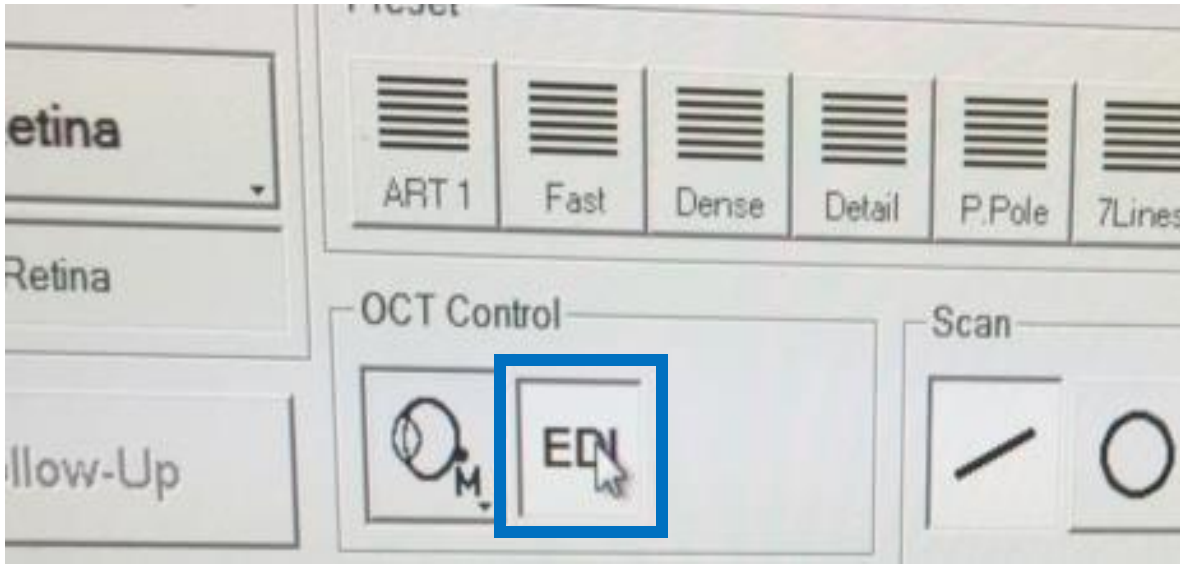


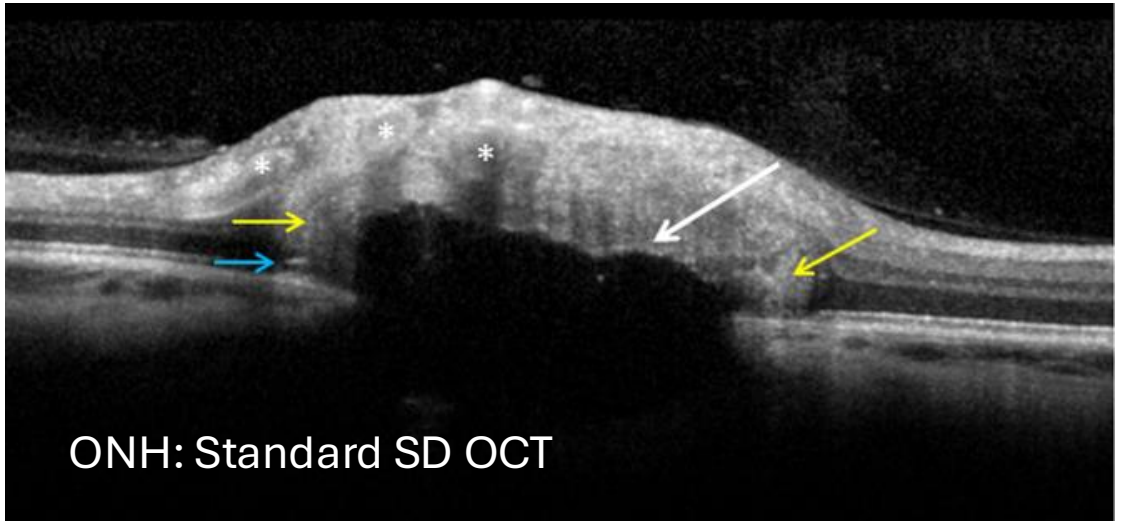


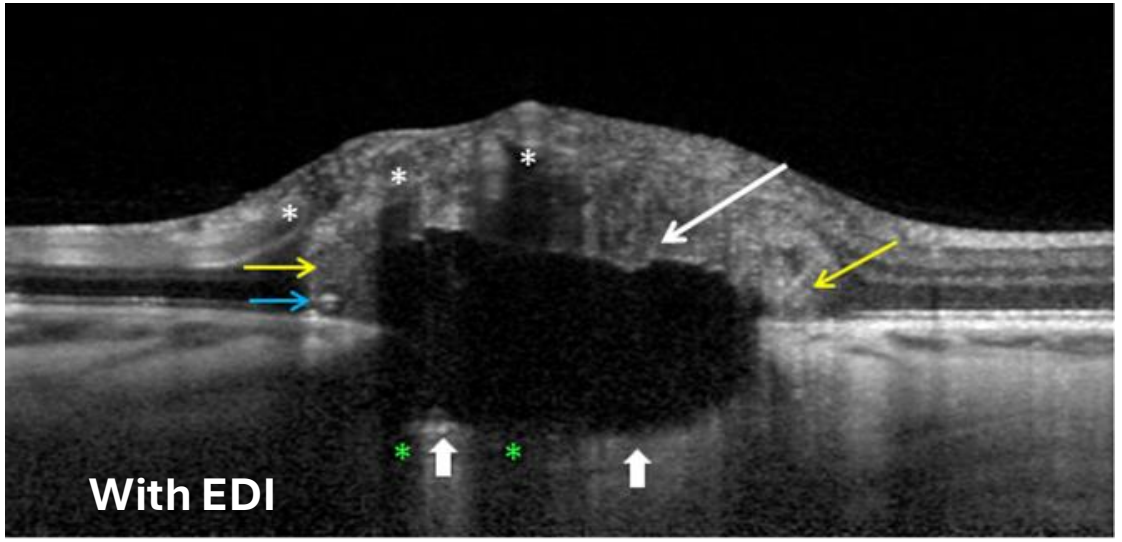


Enhanced Depth Imaging

- coherence gate set deeper than usual
- greater signal from deep structures
- less signal from superficial structures



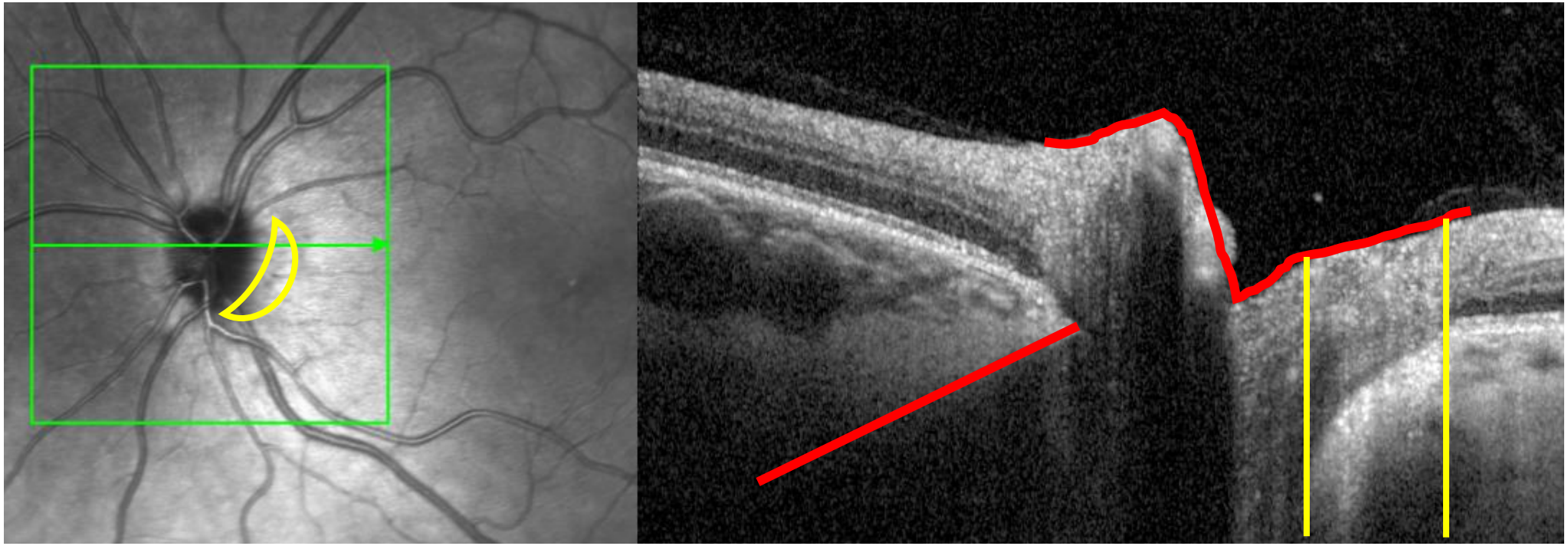




OCT scans used in IIH

1. Optic nerve head OCT with EDI
2. Peri-papillary RNFL circle OCT
3. Macular OCT
4. *(En face video)*

1. ONH profile

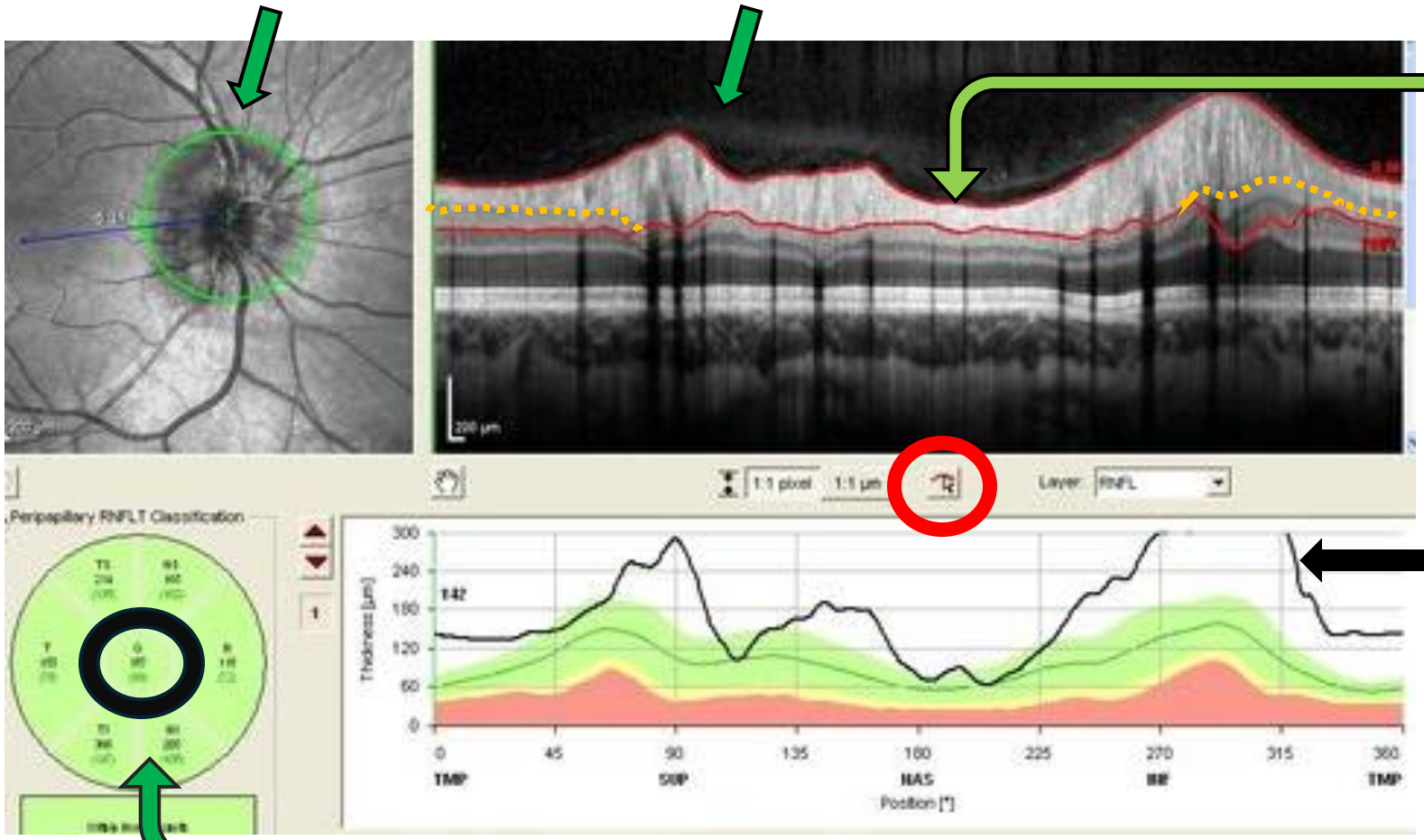


Tilted disc
with peri-papillary atrophy

2. Retinal nerve fibre layer circle scan

OCT scans circle around optic disc

Raw circle scan ‘unrolled’



NFL is pale top layer.

System has outlined NFL in red – note failures of segmentation

Black line: NFL thickness compared to normal range (green band) Includes segmentation failures

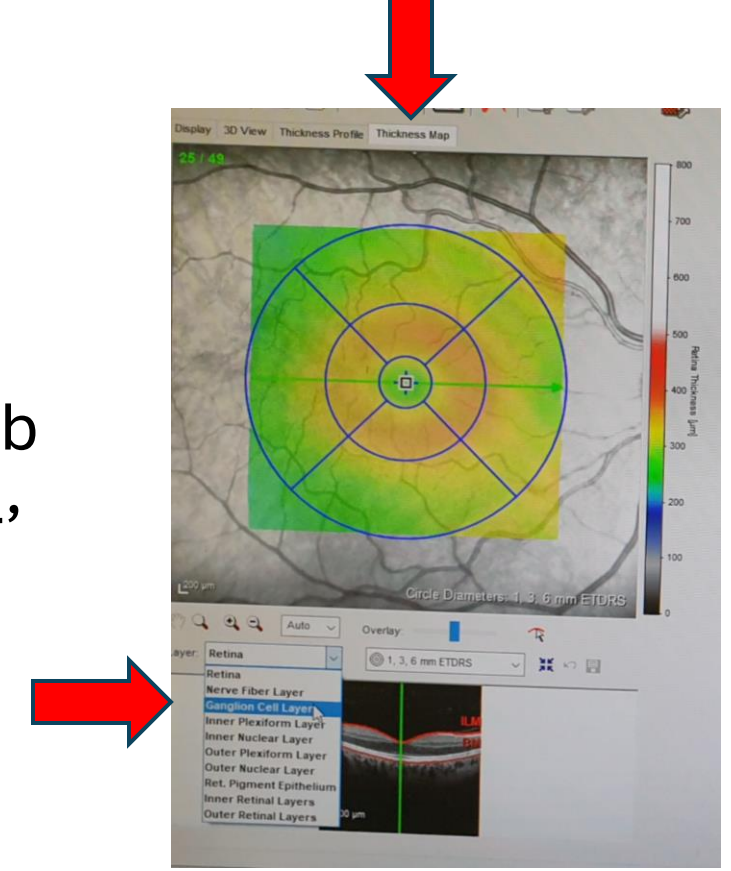
Summary ‘traffic light circle’. Red: thin. Amber: borderline thin. Green = not thin

~~Mea~~
~~RNFL ickness~~
~~>100 b derline~~
~~> 150 sw en~~
~~> 300 very vollen~~
??

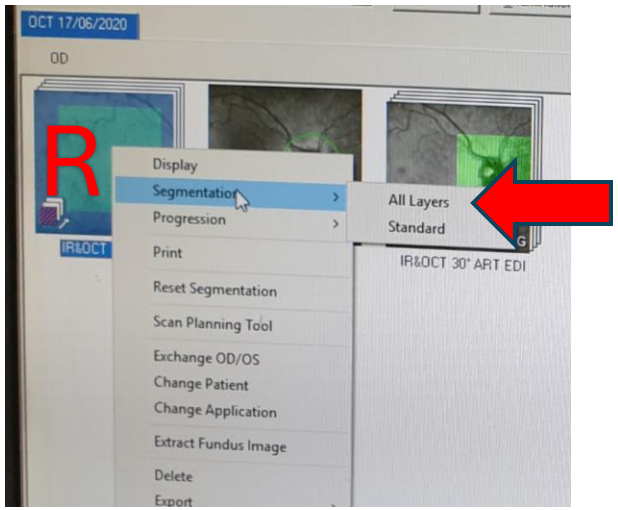
Do not use summary numbers unless segmentation is excellent

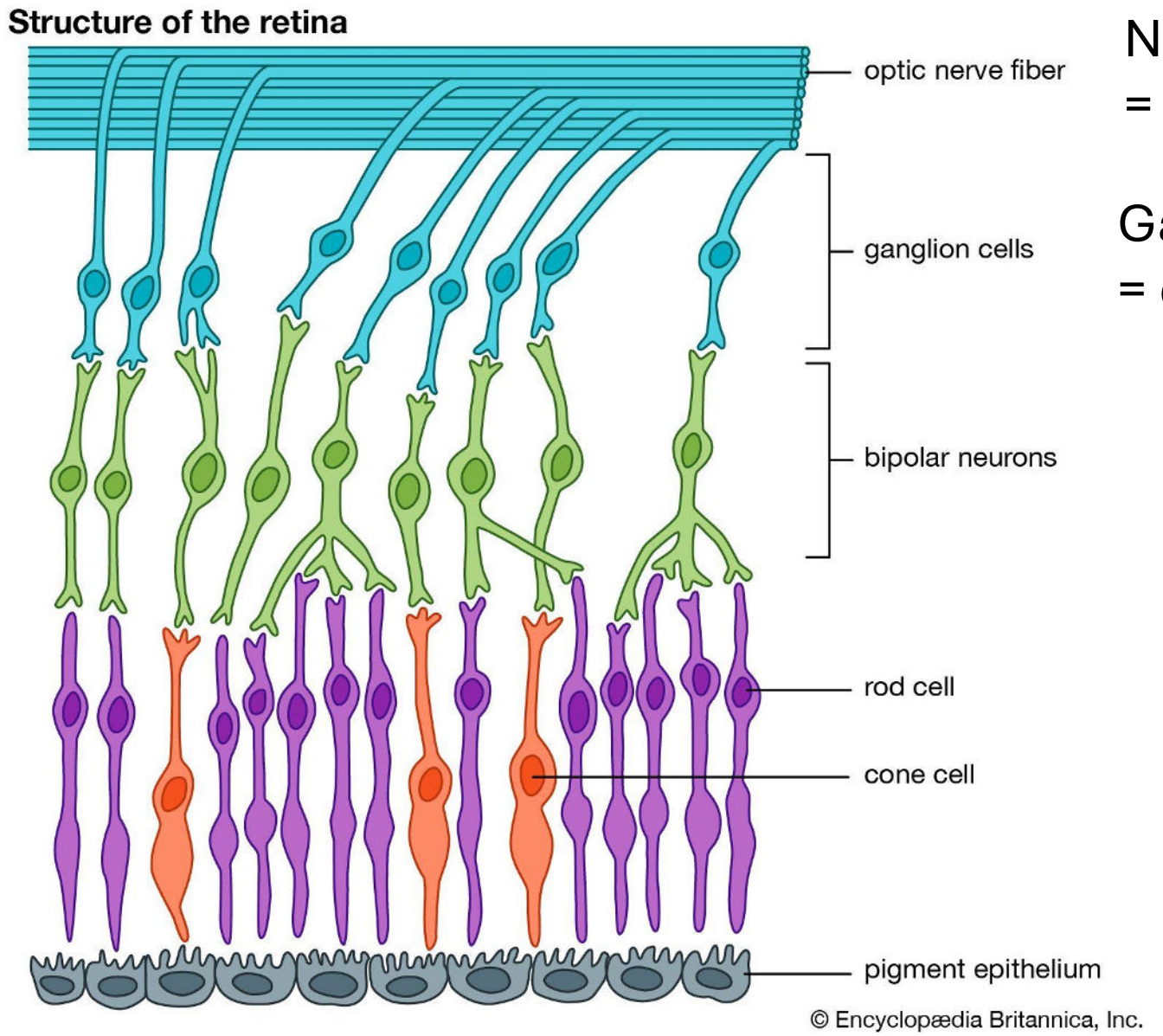
3. Macular OCT
How to view ganglion cell layer map
(with Heidelberg)

- Open a macular scan, then select ‘thickness map’ tab
- From the drop down menu, select ‘ganglion cell layer’



- If this does not show a colour map:
  - go back to the thumbnail view of all OCTs
  - Right click on macular OCT
  - Select ‘segmentation – all layers’
  - Open the macular scan & there should now be a colour map.





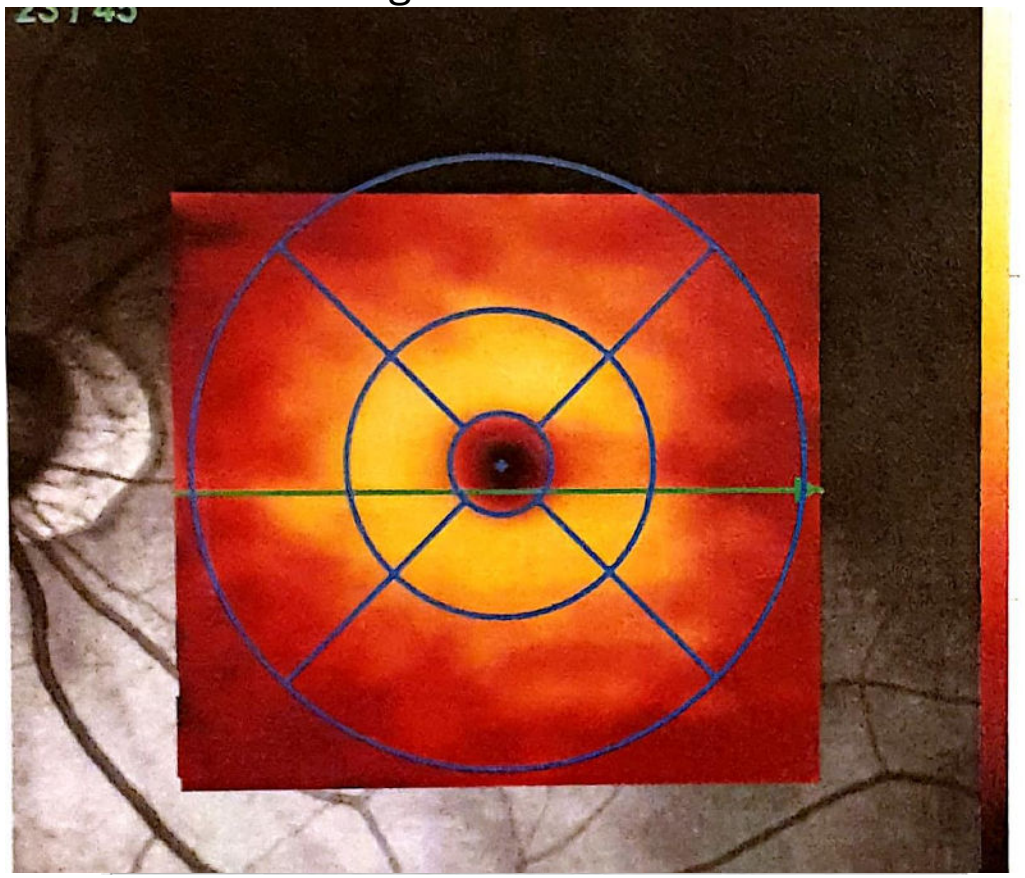
Nerve fibre layer
= optic nerve cell axons

Ganglion cell layer
= cell bodies of optic nerve cells

What is normal?

If using default 6mm circle, normal mGCL vol = approx 1.0
If using 3.45mm circle, normal vol = approx 0.4
Volumes are not reliable unless segmentation is good
Resegmenting mGCL is very time consuming compared to RNFL

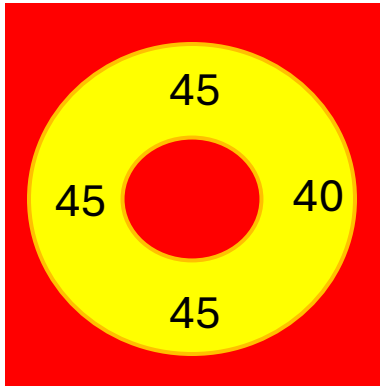
Default Heidelberg GCL colour scheme



Hotter colours = thicker MGCL

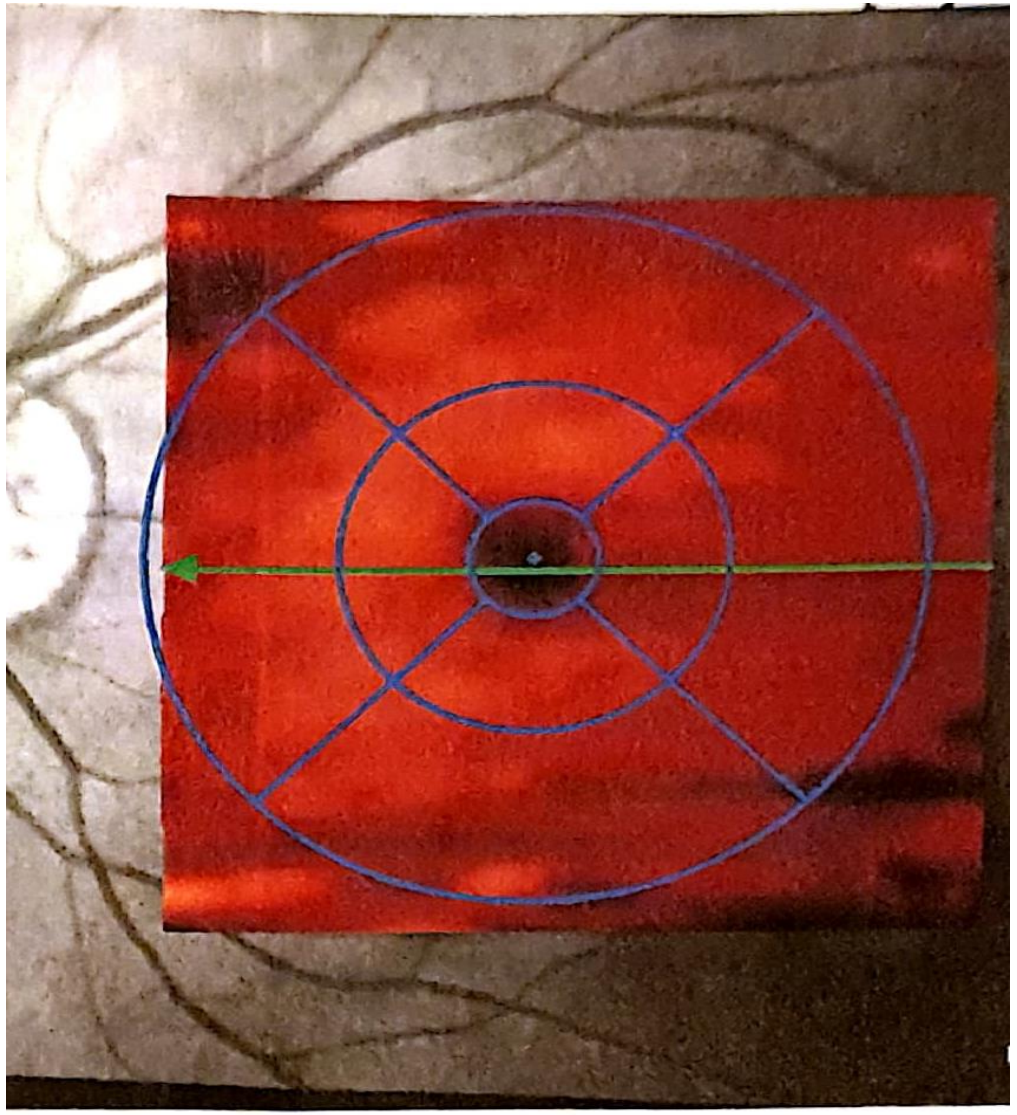
Normal MGCL:
ring doughnut on red plate

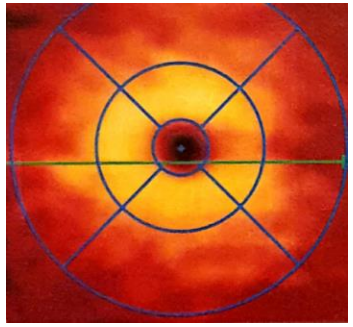
Using default ETDRS circle

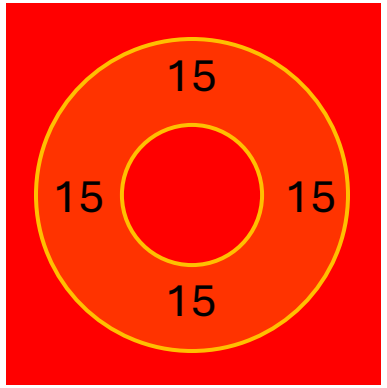


Approx LLN
(varies with age & refraction)

Thinned mGCL



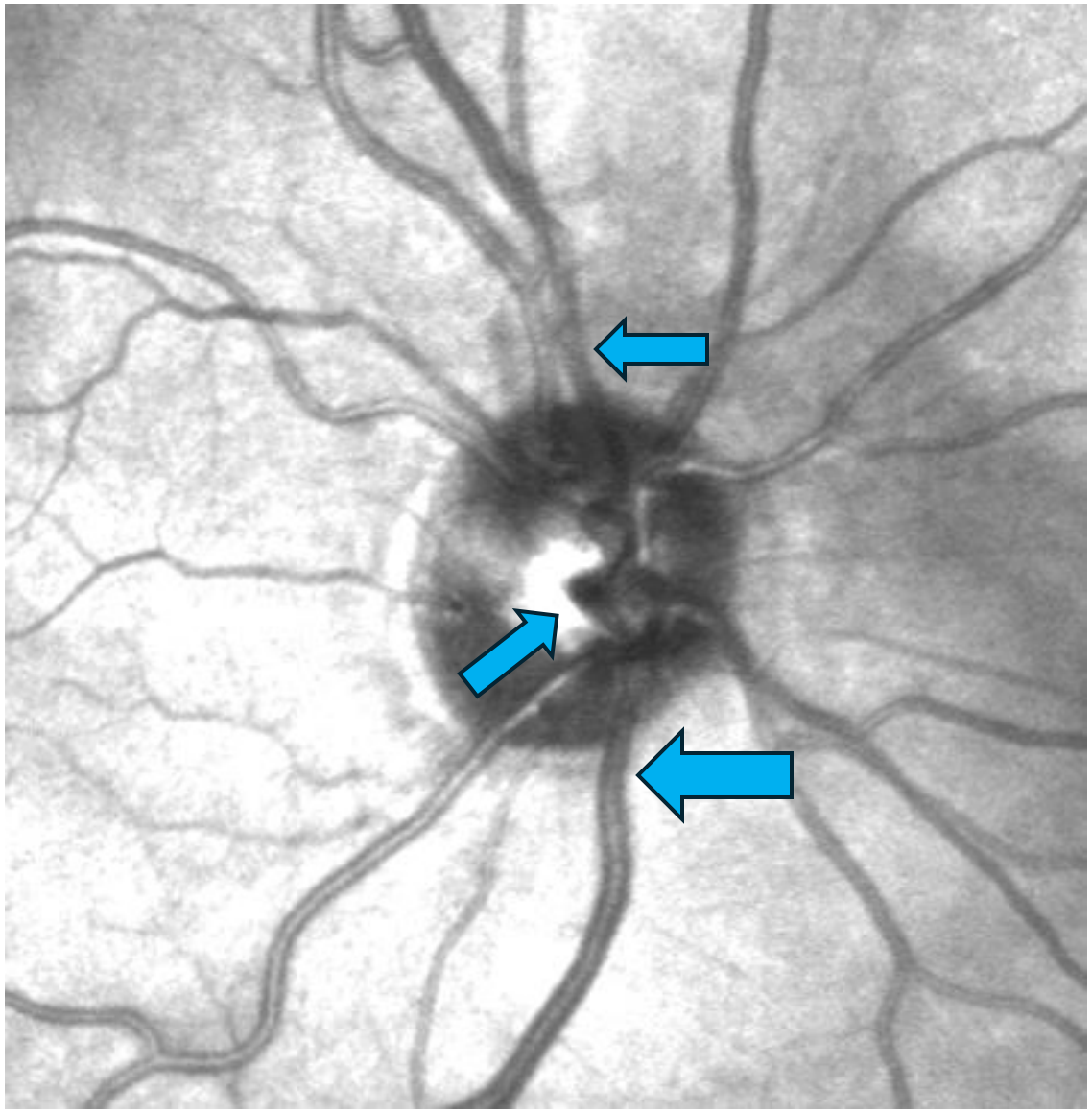




Approx ‘floor’ values

- Loss of mGCL indicates permanent destruction of cells of the optic nerve.
- Thinning takes several weeks to begin after severe optic nerve damage.
- The thinning process is not completed for several months.
- An intact mGCL means that the centre of the optic nerve was not significantly damaged *a month ago*.
- If the discs are severely swollen, **do not be falsely reassured that there is an intact mGCL**, <u>this does not rule out recent severe damage.</u>

4. SLO video



Spontaneous venous pulsations (captured with infrared SLO)

SVP are normal

SVP disappear in high ICP

Visible in about 75% of normal people with ophthalmoscope / slit lamp

98% of people with normal ICP have visible SVP on infrared video
provided media are clear & scan clearly focussed on disc vessels.

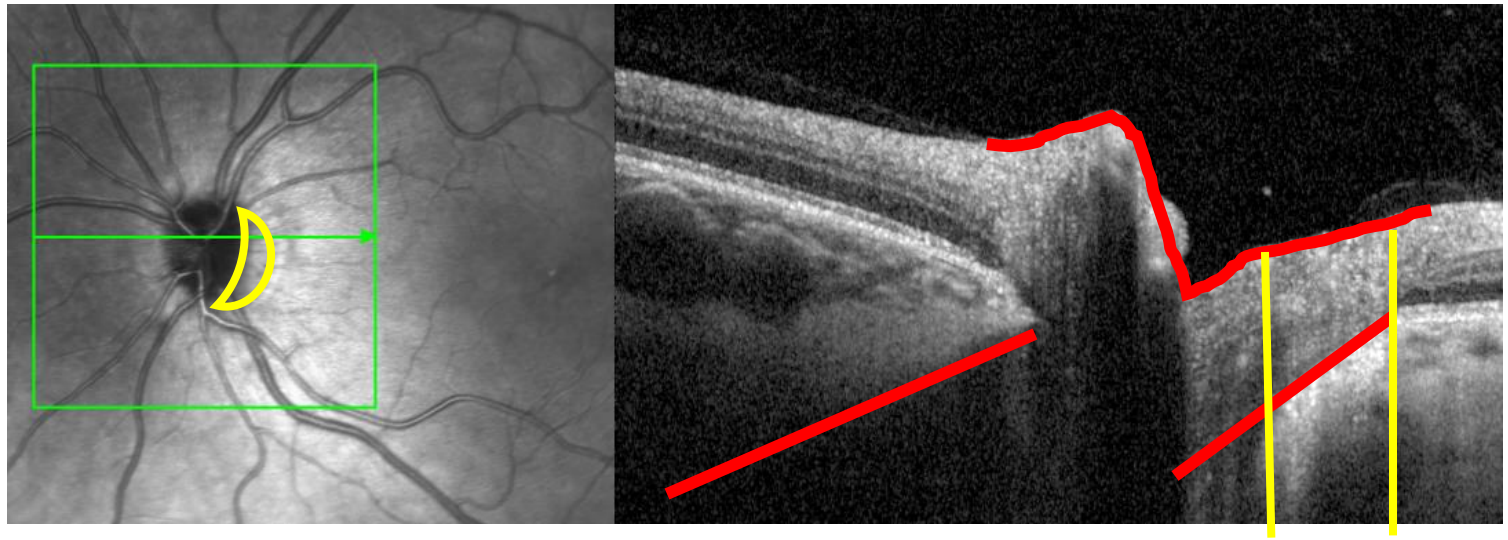
Applications

Applications of OCT in IIH

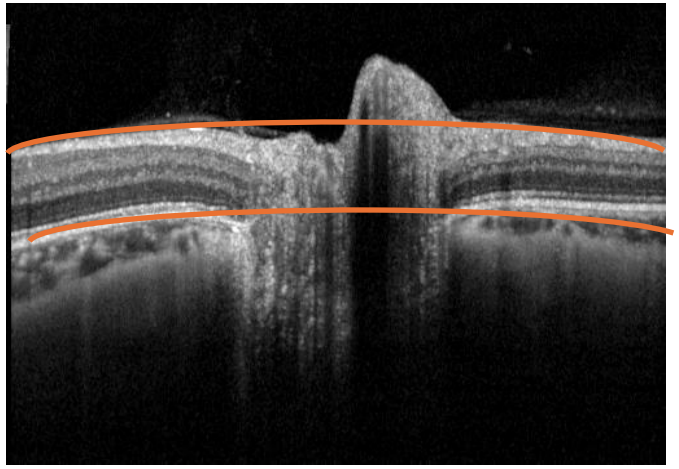
1. Determining whether there is disc swelling & assessing severity.
2. Monitoring disc swelling over time.
3. Detecting optic atrophy due to severe IIH.
4. Identifying re-swelling of atrophic discs.

1. Assessing disc swelling

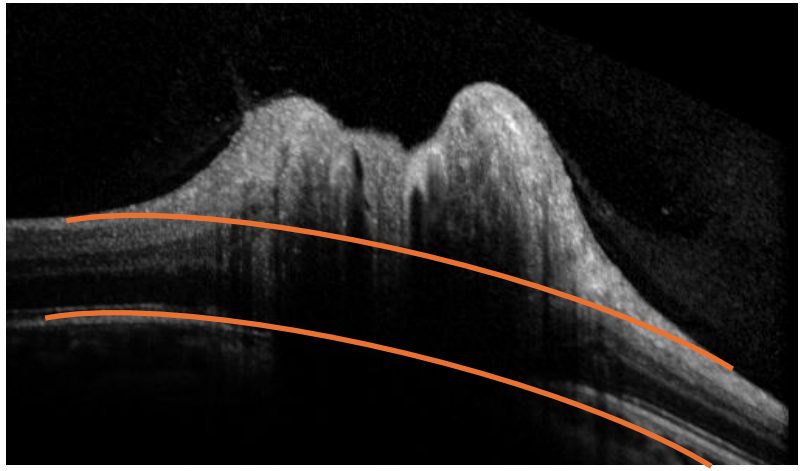
1. ONH profile



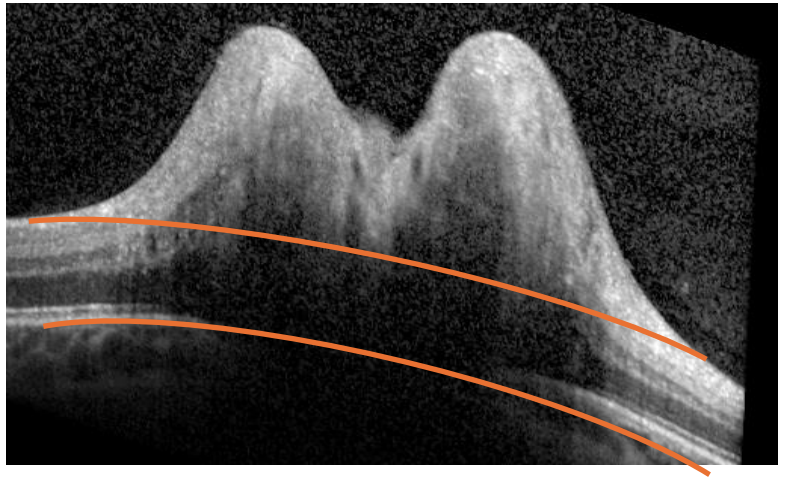
Tilted disc with peri-papillary atrophy



Crowded & tilted

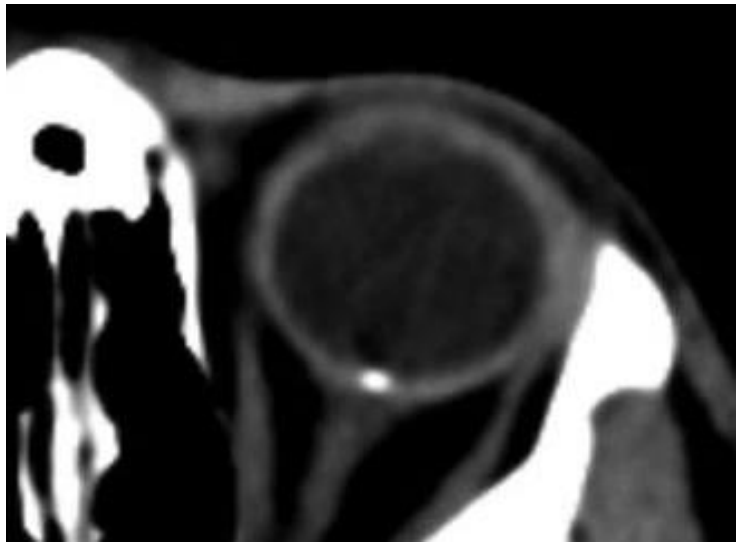


Swollen

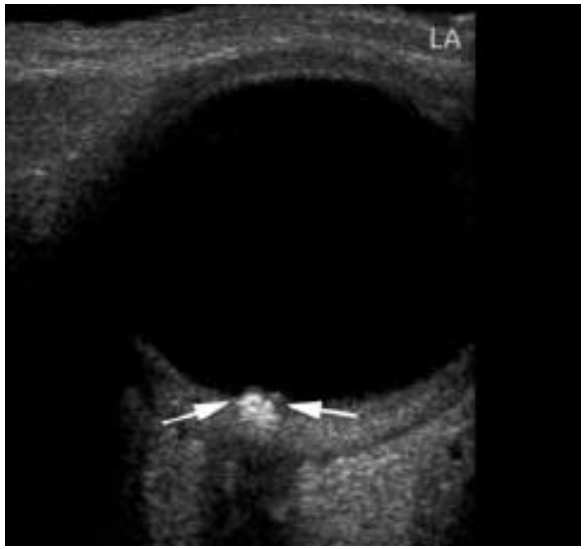


Very swollen

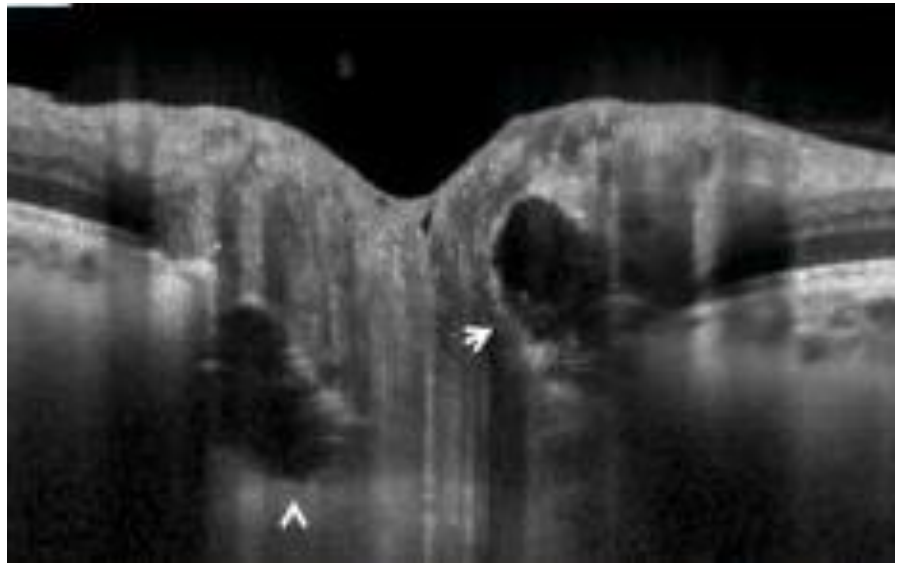
Looking for buried drusen



CT

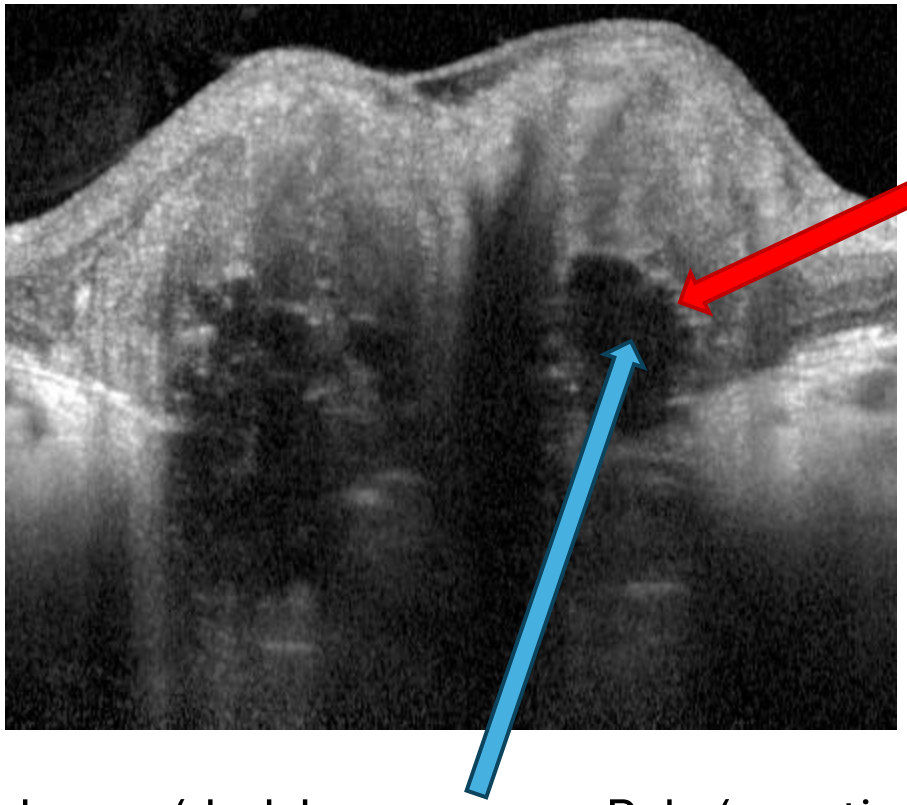


US



OCT with EDI

Disc drusen on ONH scan

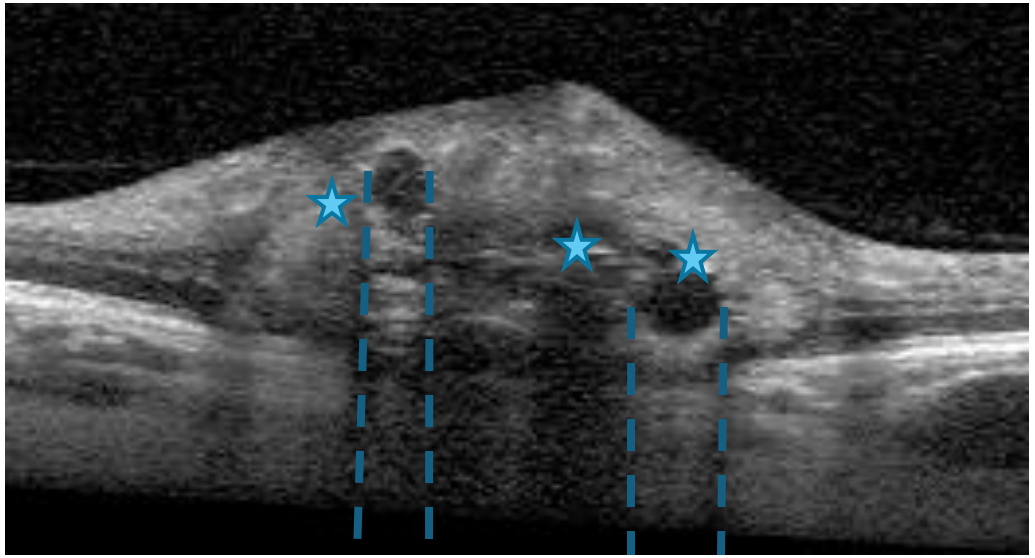


Bright rim:
calcification around druse

Dark core (dark because no internal reflection)

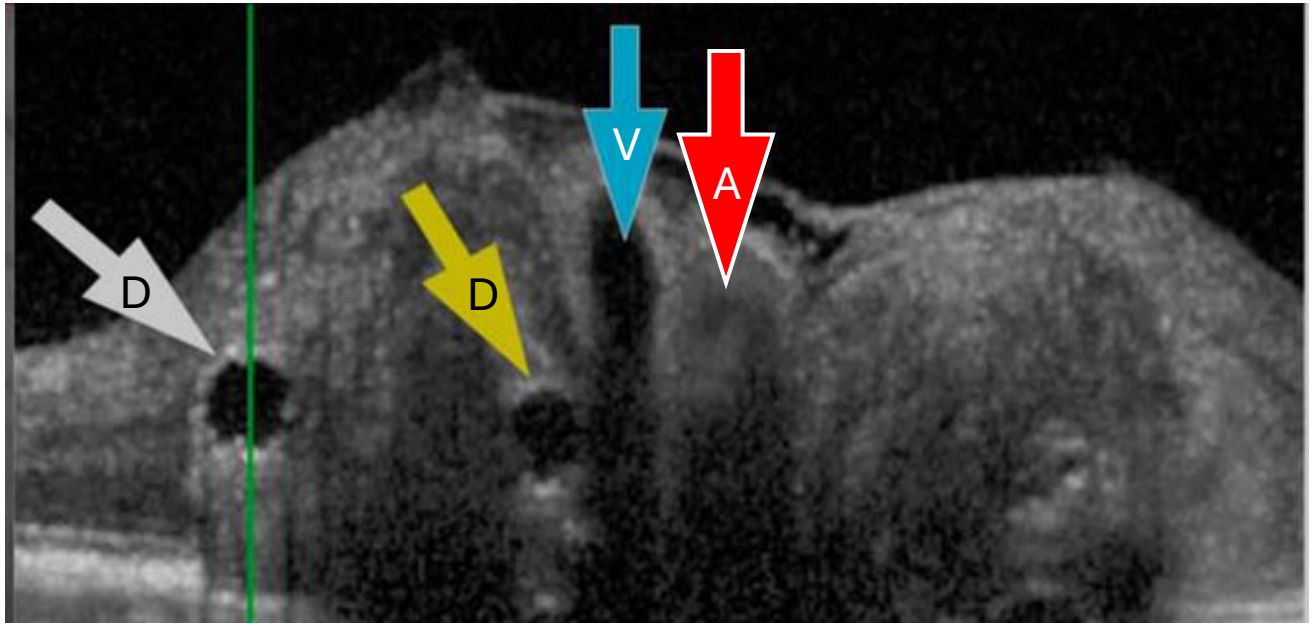
Pale (negative) shadow:
Drusen transmit more light than surrounding tissue

Tiny bright dots and horizontal streaks: baby (granular) drusen

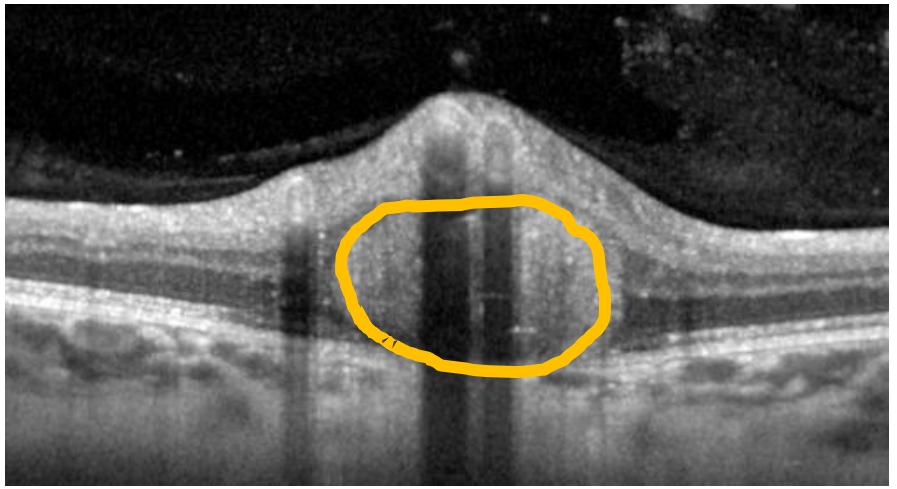


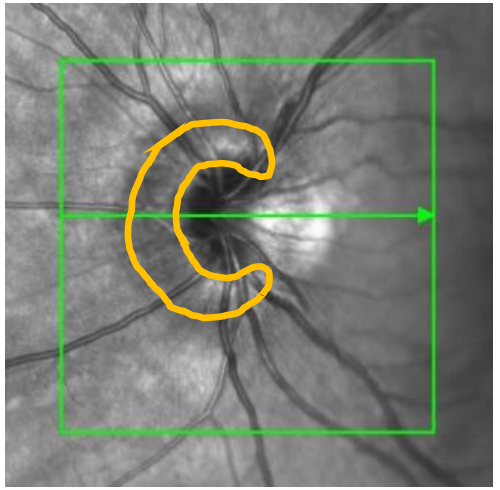
Drusen vs vessels

- Vessels: lumen either dark (haem absorbs light)
  or pale hourglass (artefact from shiny vessel wall)
- All vessels have a **dark shadow** extending to bottom of scan



- **PHOM**s (peripapillary hyperreflective ovoid masses)
- OCT: Grey bulges of nerve fibres under retina next to disc
- Correspond to the hazy pale halo visible around swollen discs
- NB PHOMS are also found in normal crowded discs, tilted discs (higher disc margin), & discs with drusen

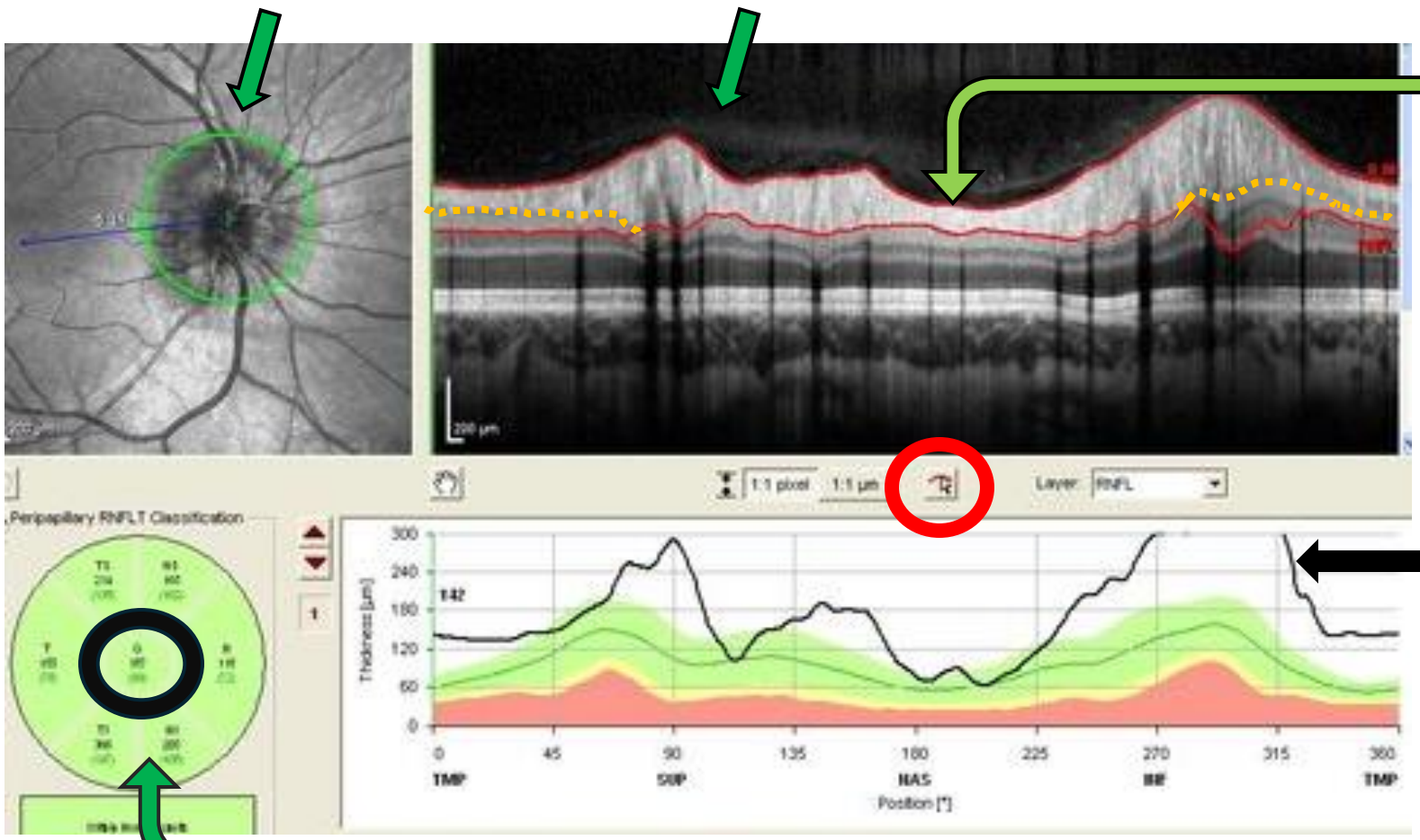




Retinal nerve fibre layer circle scan

OCT scans circle around optic disc

Raw circle scan 'unrolled'



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System has outlined NFL in red – note failures of segmentation

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~~Mea~~
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~~>100 b derline~~
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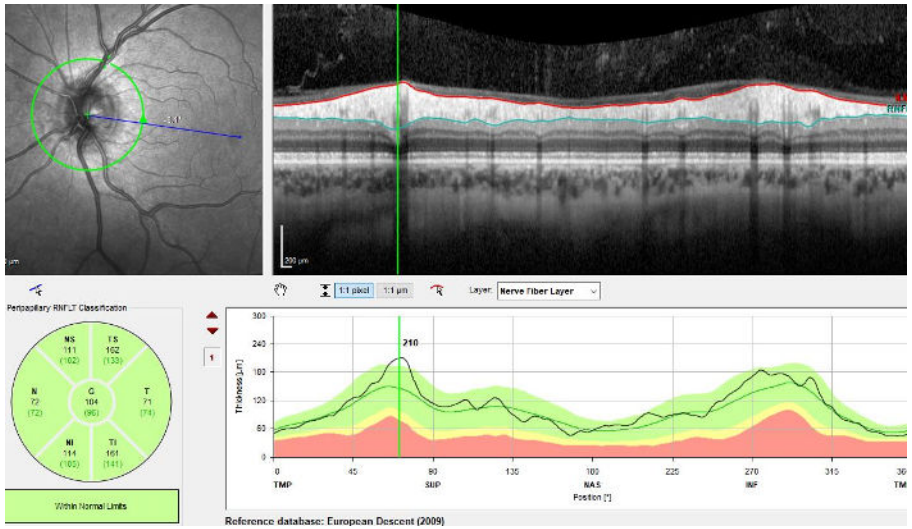
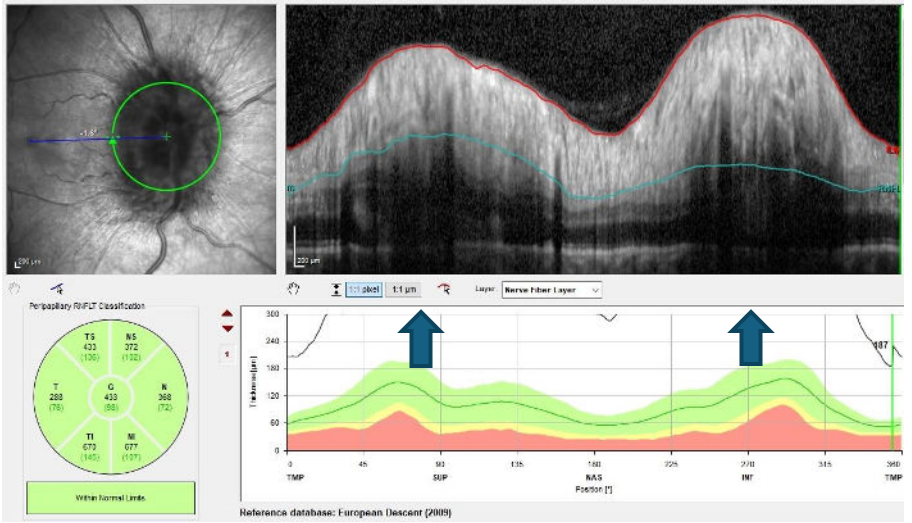
??

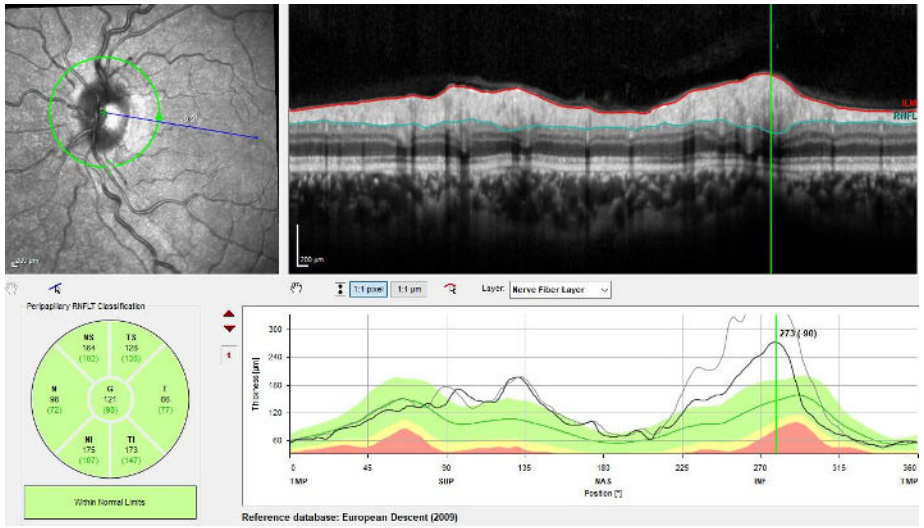
Summary 'traffic light circle'. Red: thin. Amber: borderline thin. Green = not thin

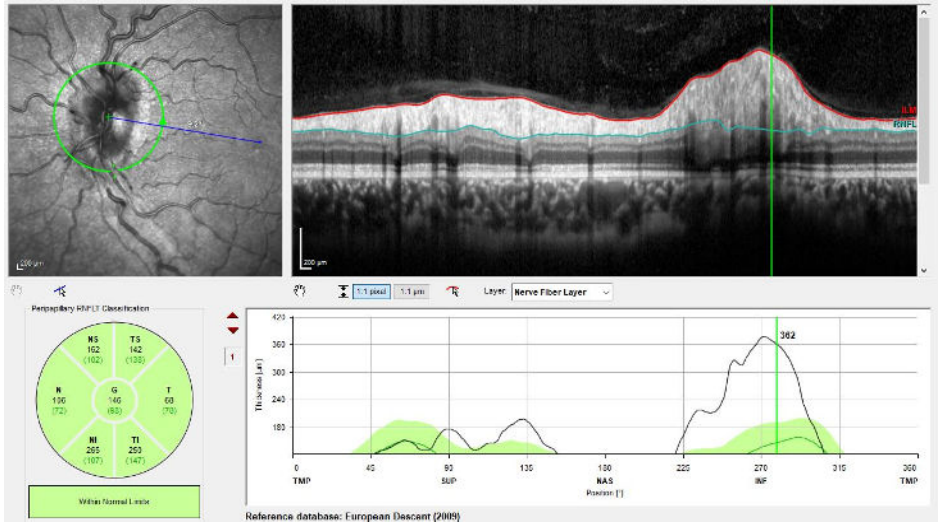
Do not use summary numbers unless segmentation is excellent

NFL scan examples







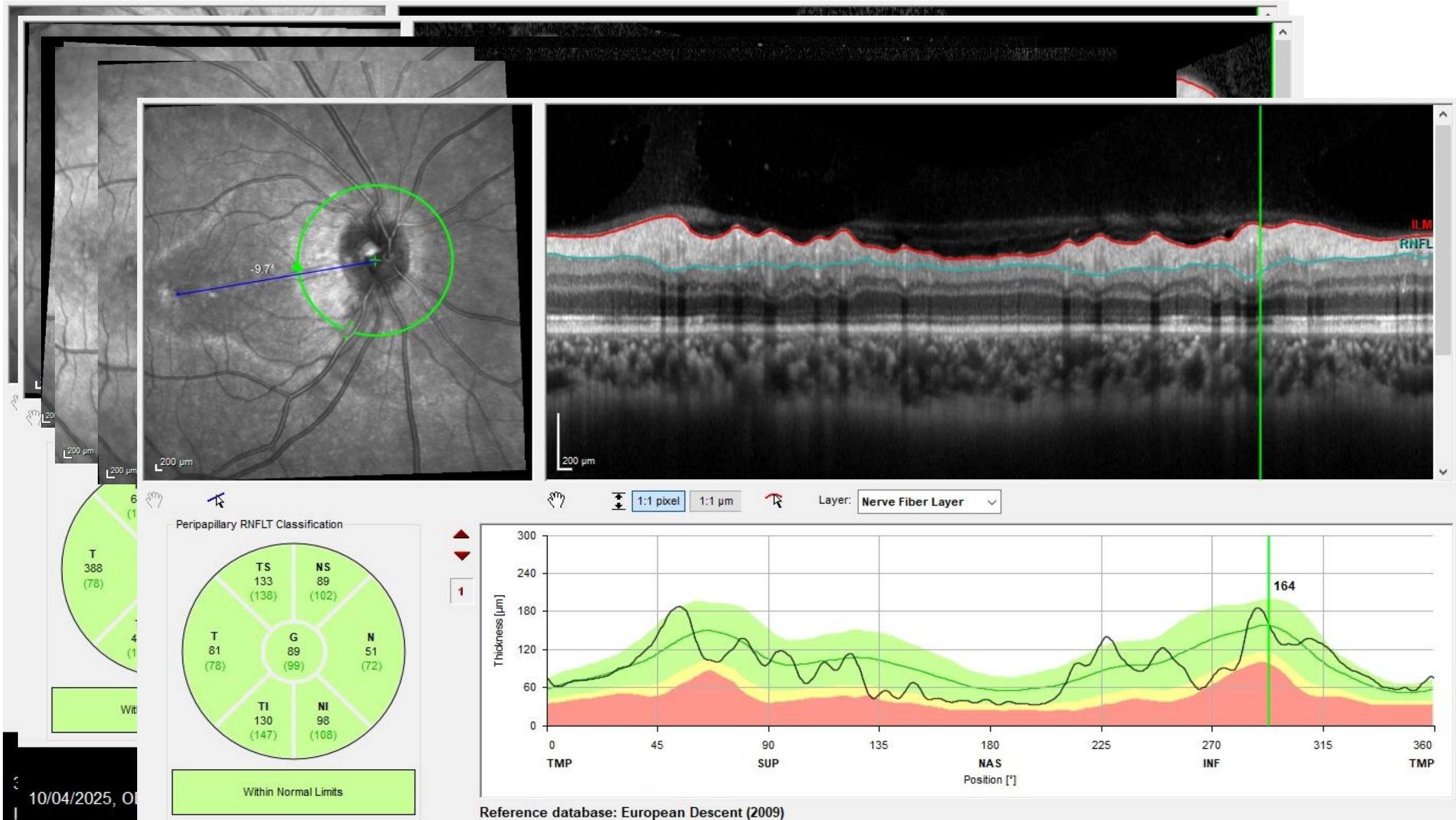


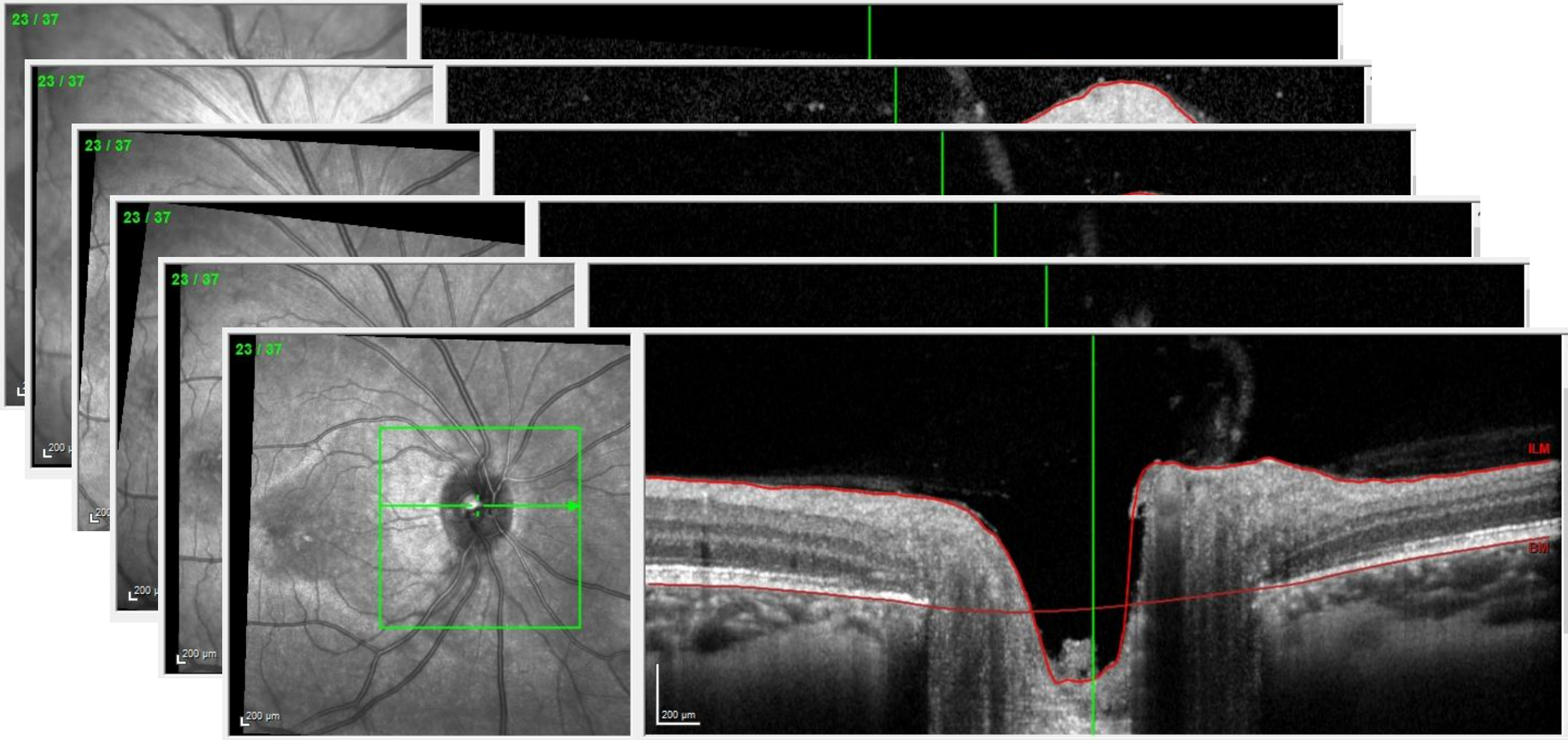
Note thickness line: off the page

Probably normal — Suspicious — Abnormal — Severely abnormal

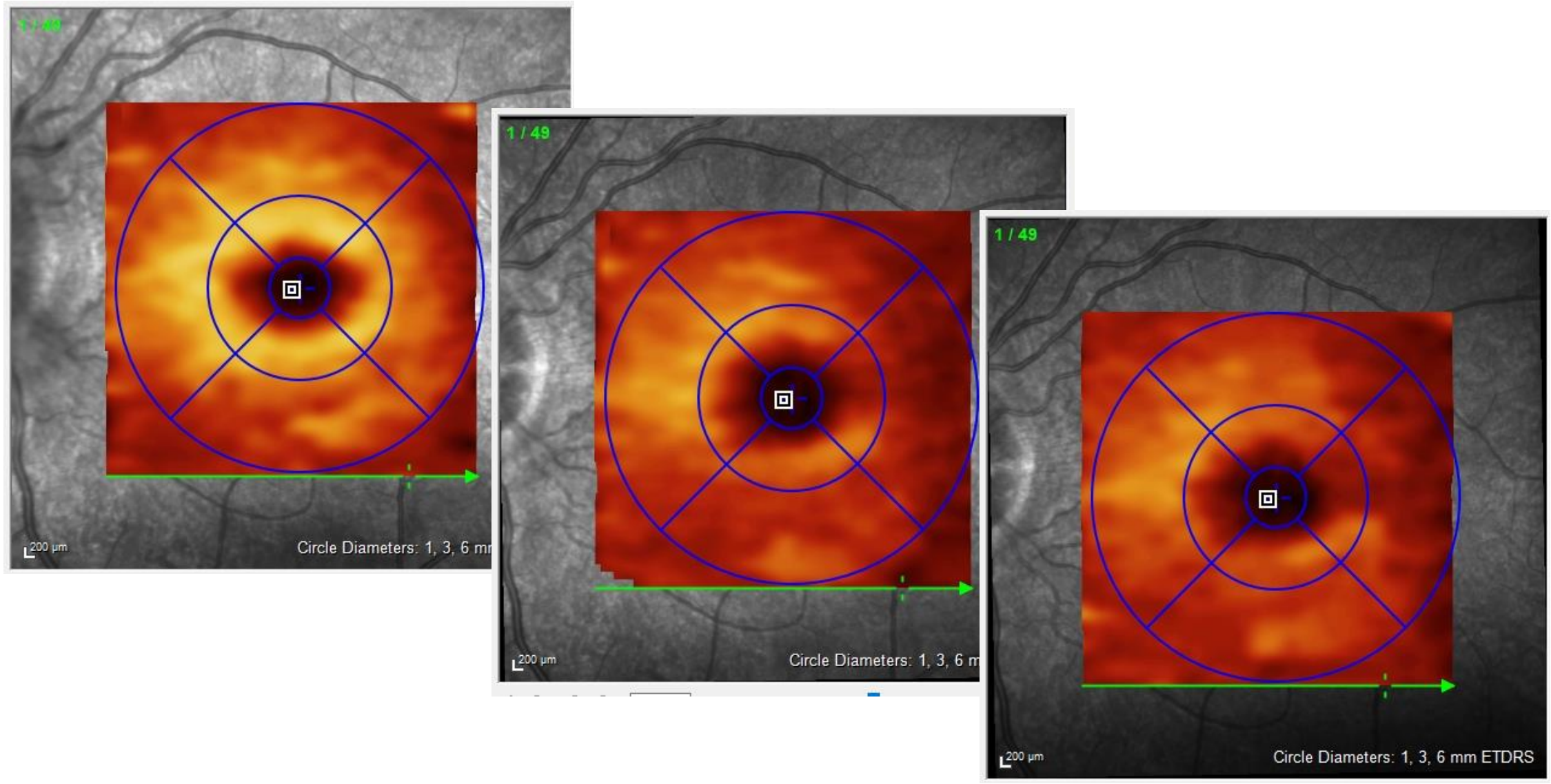
Normal discs do not change over time

2. Monitoring disc swelling over time.

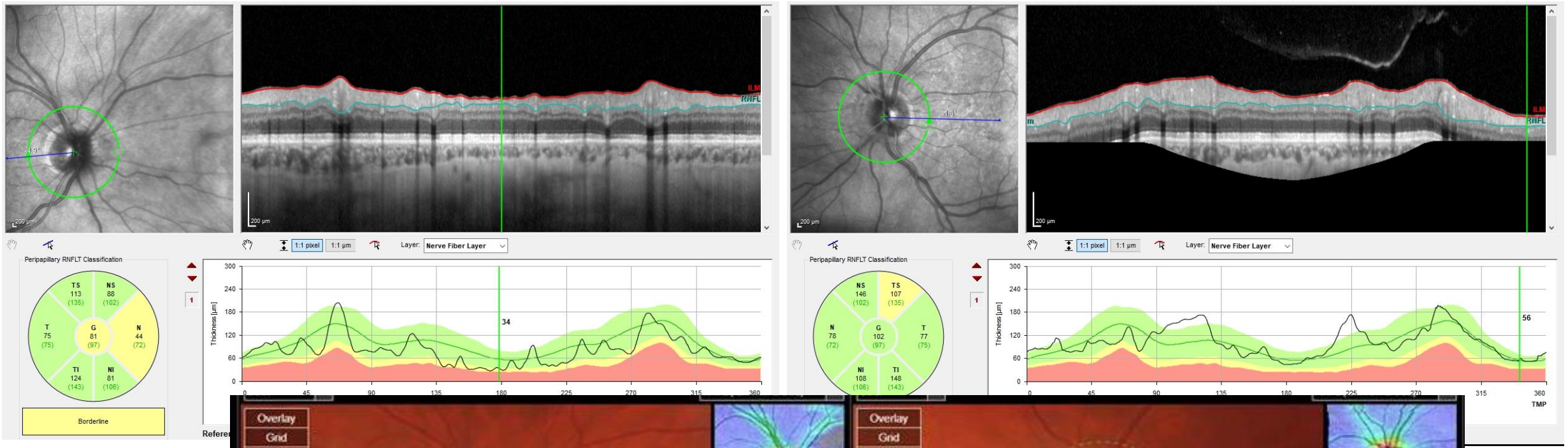

-9.7°
200 µm
ILM
RNFL
1:1 pixel
1:1 µm
Layer:
Nerve Fiber Layer
Peripapillary RNFLT Classification
TS 133 (138)
NS 89 (102)
T 81 (78)
G 89 (99)
N 51 (72)
TI 130 (147)
NI 98 (108)
Within Normal Limits
Thickness [µm]
300
240
180
120
60
0
164
0 TMP
45
90 SUP
135
180 NAS
225
270 INF
315
360 TMP
Position [°]
Reference database: European Descent (2009)


23 / 37
200 µm
ILM
BM

3. Detecting optic atrophy due to severe IIH

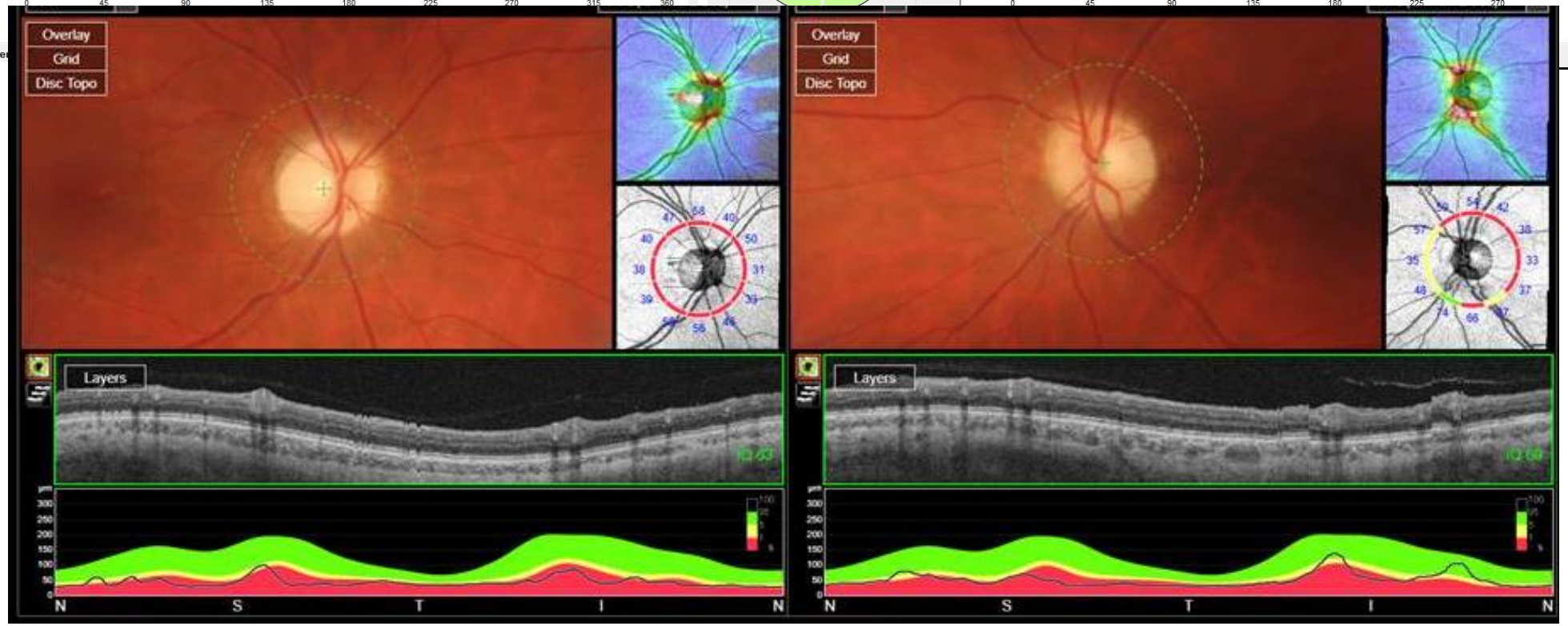

1 / 49
200 µm
Circle Diameters: 1, 3, 6 mm
1 / 49
200 µm
Circle Diameters: 1, 3, 6 m
1 / 49
200 µm
Circle Diameters: 1, 3, 6 mm ETDRS

4. Identifying re-swelling of atrophic discs



HM BE,
VF blacked out
No RAPD

External RNFL circle scan 6 months before:



- Any questions?

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