

**BMO Positioning and OCT
Interpretation in Glaucoma**

SPECTRALIS®

Glaucoma Module Premium Edition



**HEIDELBERG
ENGINEERING**



ACADEMY

This brochure is intended to provide an interpretation guideline for the Glaucoma Module Premium Edition of the SPECTRALIS® OCT. It is not a substitute for clinical experience and judgment. When diagnosing and treating patients, each clinician must analyze and interpret all available data and make individual clinical decisions based on his or her clinical judgment and experience. The diagnosis is the responsibility of the physician.

The Glaucoma Module Premium Edition provides an objective method of optic nerve head (ONH) examination combining the analysis of neuroretinal rim, retinal nerve fiber layer and ganglion cell layer thickness. The following How-to Guide supplies comprehensive explanations about the physiological and technical background, the correct Bruch's Membrane Opening (BMO) positioning, the available scan patterns and the interpretation of the obtained data.

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1 The Optic Nerve Head

1.1 The Optic Nerve Head in OCT

Fig. 1 shows the prelaminar portion of the optic nerve head extending from the retinal surface to the anterior lamina cribrosa. The unmyelinated axons coming from the retinal ganglion cells become segregated into bundles and are sheathed by astrocytes. Both structures, the retinal nerve fibers and the astrocytes, form the neuroretinal rim.

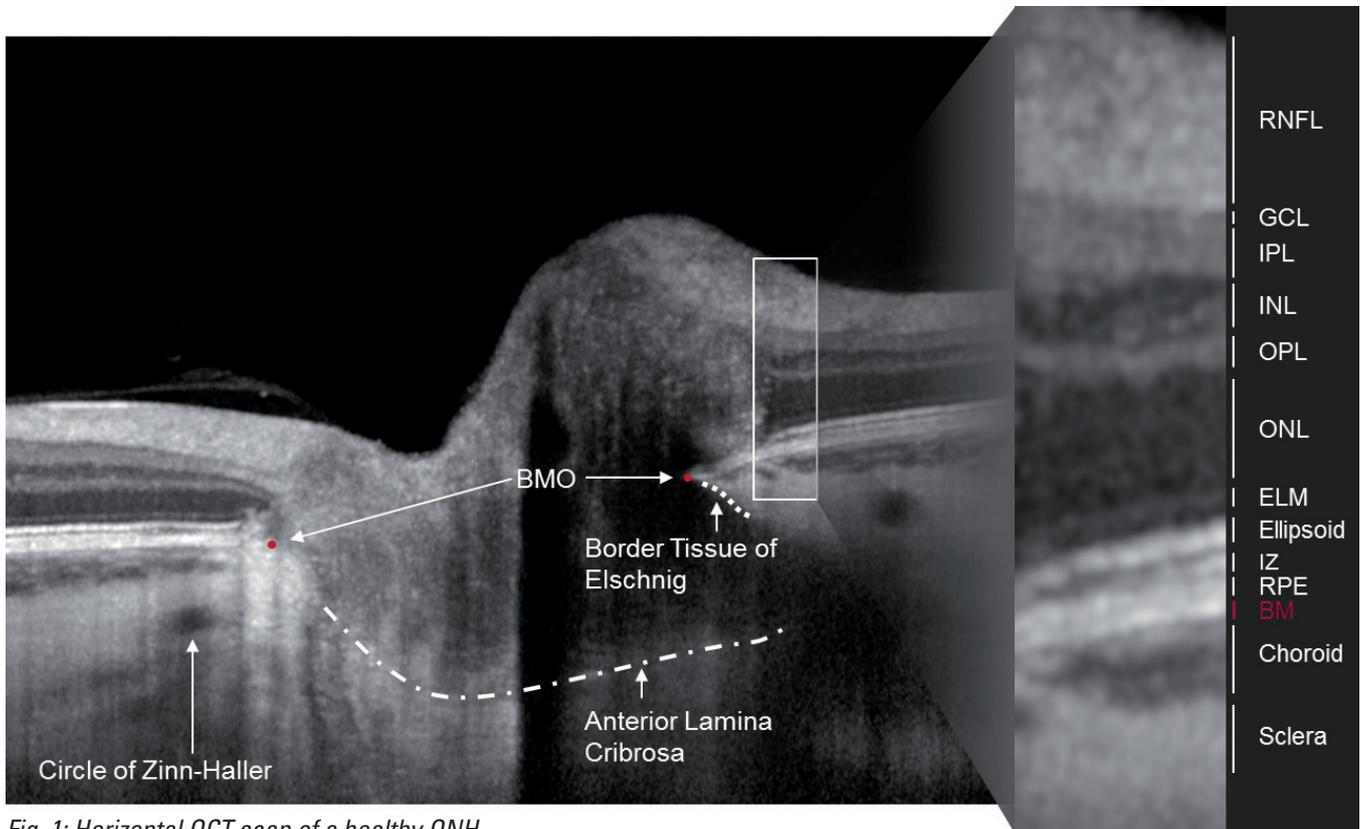


Fig. 1: Horizontal OCT scan of a healthy ONH

1.2 The Optic Disc Margin

The optic disc evaluation requires the identification of the disc margin. In ophthalmoscopy, optic disc photography and laser scanning tomography the disc margin is defined as the inner edge of the scleral ring known as peripapillary ring of Elschnig.

In OCT the termination of Bruch's membrane (BM) – known as Bruch's Membrane Opening (BMO) – is visible. It represents a stable opening through which all axons exit the eye. Since blood vessels and axons cannot pass through the BM, it is considered as the appropriate structural boundary of the optic disc.¹ The Bruch's membrane can extend beyond Elschnig border tissue (BT) or vice-versa (Fig. 3).² Fig. 2 shows a comparison between the BMO-based (red) and the clinical assessed (green) disc margin.¹

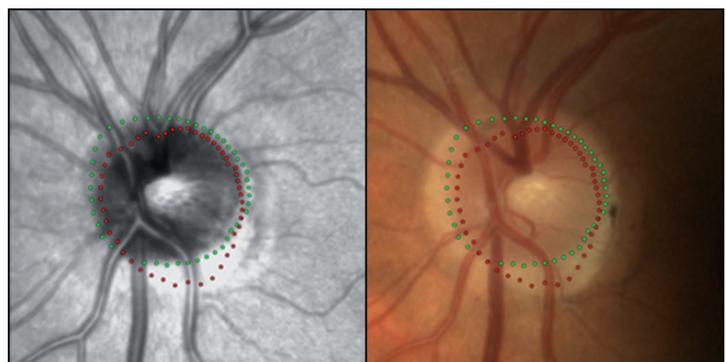


Fig. 2: BMO-based (red) and clinical assessed (green) disc margin in the IR image (left) and the optic disc photography (right)¹

1 CHAUHAN, BC et al.: From Clinical Examination of the Optic Disc to Clinical Assessment of the ONH: A Paradigm Change. Am J Ophthalmol. 2013; 156(2):218-227

2 REIS, AS et al.: Influence of Clinically Invisible, but Optical Coherence Tomography Detected, Optic Disc Margin Anatomy on Neuroretinal Rim Evaluation. Invest Ophthalmol Vis Sci. 2012; 53(4):1852-1860.

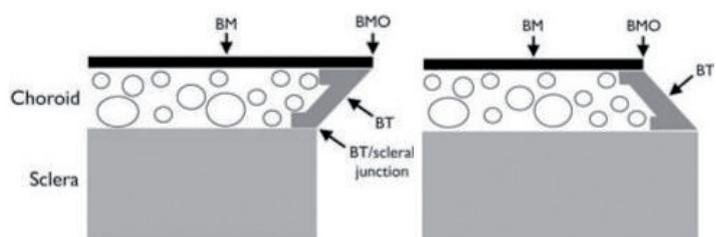


Fig. 3: Internally (left) and externally oblique (right) BM configuration²

1.3 Appearance of BM in Histology versus OCT

Comparisons between histology and OCT scans show that the displayed layer thickness in OCT does not necessarily correlate with the anatomical thickness.

While Bruch's membrane is known as a very thin anatomical structure (~2-5 microns)³ OCT shows a hyperreflective layer which seems as thick as the RPE (~14 microns)⁴. **Keep in mind that OCT detects the reflectance of bounding surfaces.** The perceived thickness can differ from the thickness as seen in histology: As Bruch's membrane consists of five single layers⁴ (Fig. 4) the high reflectivity of each boundary may cause the thick appearance in OCT.

Fig. 4: Electron microscopy of Bruch's membrane: (1) Basal membrane of choriocapillaris; (2) Collagen layer; (3) Elastic layer; (4) Collagen layer; (5) Basal membrane of RPE³

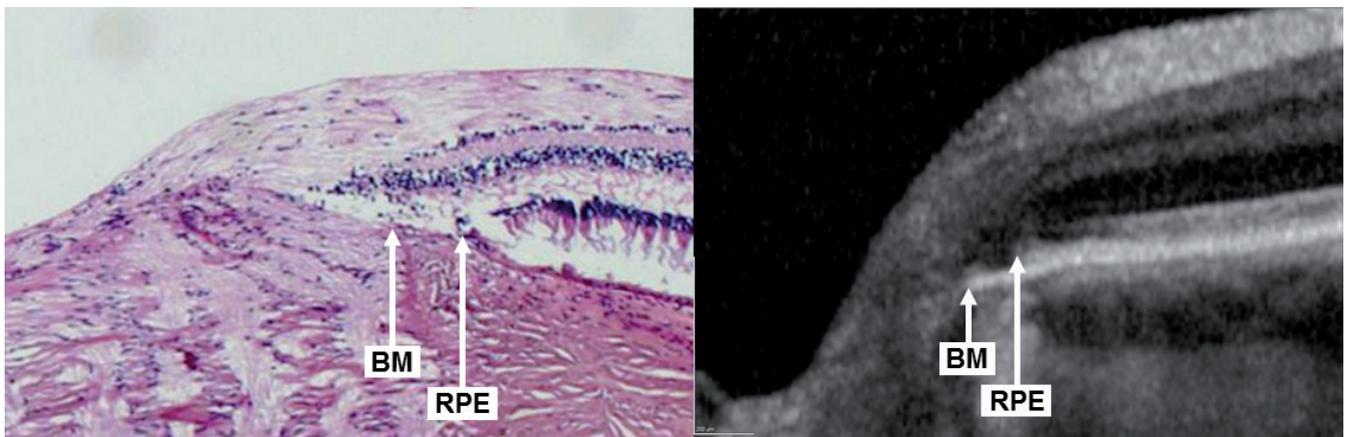
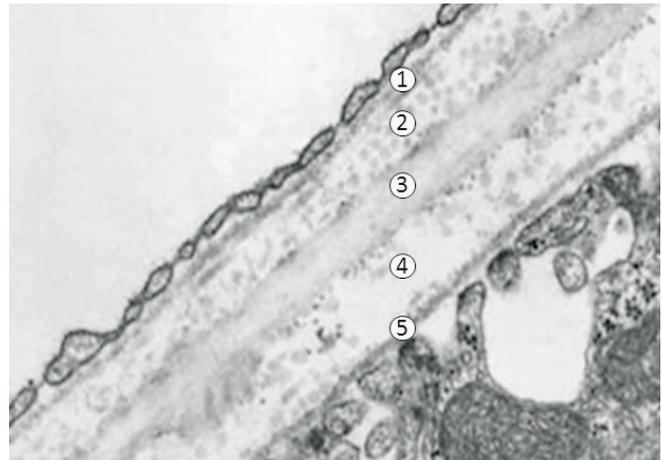


Fig. 5: Histology vs. OCT (By courtesy of Prof. Mardin, University Erlangen, Germany)

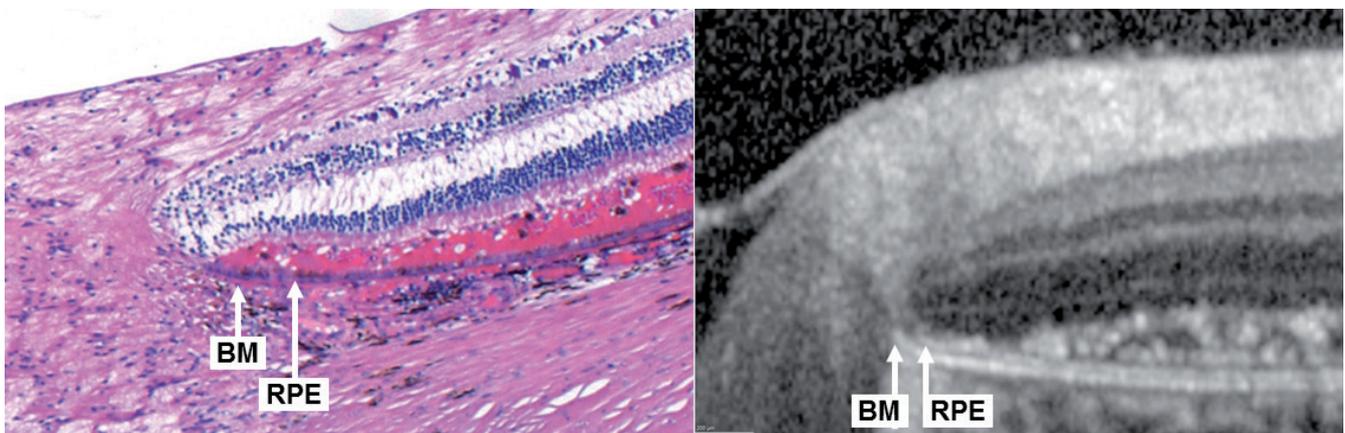


Fig. 6: Histology vs. OCT in Carcinoma (By courtesy of Prof. Mardin, University Erlangen, Germany)

Fig. 5 and 6 show a comparison of histology to an OCT of respectively the same eye. While the RPE appears violet in histology, the underlying BM is seen as a thin pink structure.

As visible in both, histology and OCT, Fig. 5 reveals a beta zone: the BM goes further while the RPE terminates earlier.

Furthermore Fig. 6 gives evidence that RPE and BM show a similar thickness in OCT contrary to their anatomical thickness. Furthermore, in this case RPE and BM are clearly distinguishable from each other due to the changed reflectivity properties caused by neurosensoric detachment in carcinoma.

3 RAMRATTAN, Raan S. et al.: Morphometric Analysis of Bruch's Membrane, the Choriocapillaris, and the Choroid in Aging. *Investigative Ophthalmology & Visual Science*, 1994, Vol. 35, No. 6

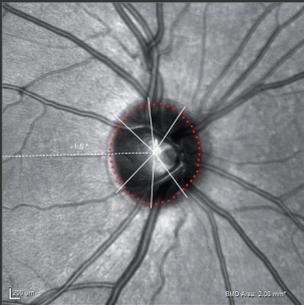
4 CURCIO, Christine A. et al.: Human Chorioretinal Layer Thicknesses Measured in Macula-wide, High-Resolution Histologic Sections. *Investigative Ophthalmology & Visual Science*, 2011, Vol. 52, No. 7

Checking Bruch's Membrane Opening in 60sec



Checking BMO in the cSLO Image

1 Categorize the ONH



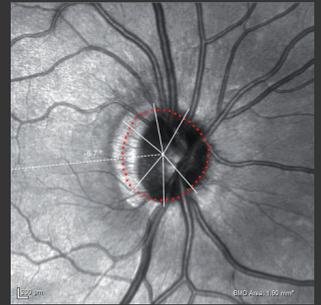
As BM, RPE and Elschnig border tissue end together, the BMO matches the clinical disc margin seen in funduscopy.



Peripapillary atrophy
The inner edge of the PPA appears sharp. The BMO matches the clinical disc margin.



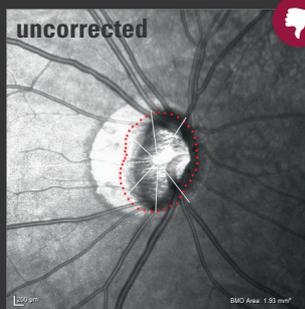
Conus temporalis
The inner edge of the hyper-reflective conus appears obscured. The BMO is located at the outer edge.



PPA and Conus temporalis
The BMO is placed within the hyperreflective zone, precisely at the inner edge of the PPA.

2 Check BMO Contour

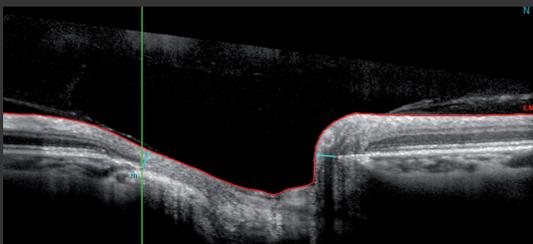
All BMO positions should form a smooth, typically round or elliptical, shape in the IR image. Abrupt kinks within the contour line may indicate an inaccurate BMO position. After detecting single outliers, check the BMO position in the corresponding OCT scan and correct if needed by paying attention to the neighboring scans.



Checking BMO in the OCT Image

3 Identify Distinctive BMO Points

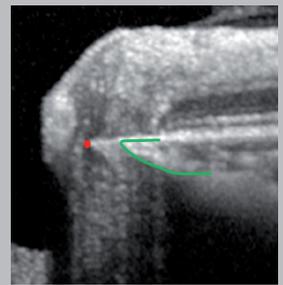
- 1 While scrolling through the OCT scans, check the ILM segmentation and look for clearly identifiable BMO points.
- 2 Place the green marker line at the distinctive BMO point and use it as a guide while checking the neighboring scans.



- 3 Correct the ILM and/or BMO if needed and press **Confirm**.

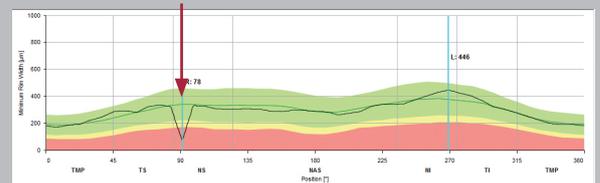


To find BMO in OCT, it may help to detect the wedge-shaped ending of the **choroid**. Since the choriocapillaris (CC) does not exist without Bruch's membrane, the **BM** never ends before the CC does, however, it can extend further.

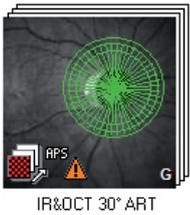


ALT + : Temporarily changing the contrast scale of the OCT from the standard setting of 12 to 16 may allow a better visibility of BMO points.

An irregular, jagged MRW diagram might indicate outlying BMO points.



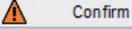
2 Checking Bruch's Membrane Opening



The ending of Bruch's membrane at the optic nerve head is defined as Bruch's Membrane Opening (BMO). Within 24 scan lines, the GMPE software automatically detects 48 BMO positions along the ONH to determine the BMO-based disc margin.

After having acquired an ONH-RC scan, the BMO segmentation needs to be checked and confirmed. As long as the images are *unconfirmed* the scan thumbnail contains a warning sign  (see picture on the left). The following steps provide tips on how to check and set the BMO points correctly.

2.1 General Workflow

-  To confirm the BMO position open the acquired scan, scroll through the OCT sections and mind the following steps:
-  Check the red segmentation line in each OCT section and make sure that it represents the ILM correctly. If not, correct it with <<Edit layer segmentations>> .
-  Check the position of the red dots in each OCT section, indicating the BMO points and correct them if necessary via <<Edit Bruch's membrane end points>> .
-  Click on  to confirm both, the BMO position and the ILM segmentation. The warning signs will disappear.

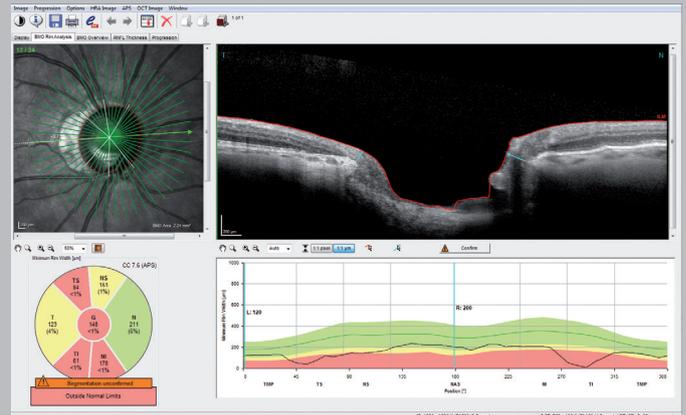


Fig. 7: BMO Rim Analysis tab

2.2 Pearls and Pitfalls in BMO Detection

The BMO can sometimes be hidden by e.g. an overlying blood vessel or cannot be distinguishable from neighboring tissues due to its similar reflectivity. In those cases the following steps may help to indicate the BMO location properly:

› Optimize the contrast

It might be useful to alter the image contrast of the OCT scans by pressing <<ALT+  >> or via <<Brightness & Contrast>> .

Changing the contrast from the standard settings of 12 to e.g. 16 may allow a better visibility of BMO points as seen in Fig. 8.

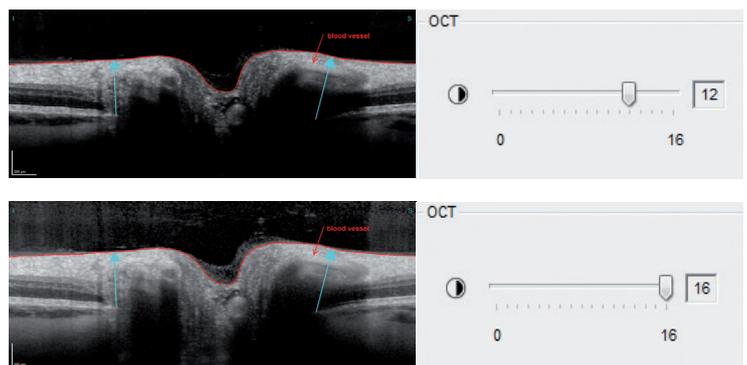


Fig. 8: BMO detectability after changing the contrast scale from 12 to 16

› Mind the choroid and the retinal layers

To find the BMO in OCT, it may help to detect the wedge-shaped ending of the choroid. Since the choriocapillaris does not exist without Bruch's membrane, the BMO never ends before the choriocapillaris does but it can extend further.

The blue arrow indicates the minimum rim width. Since the minimum rim width consists of retinal nerve fibers and astrocytes, the blue arrow should not cross retinal layers.

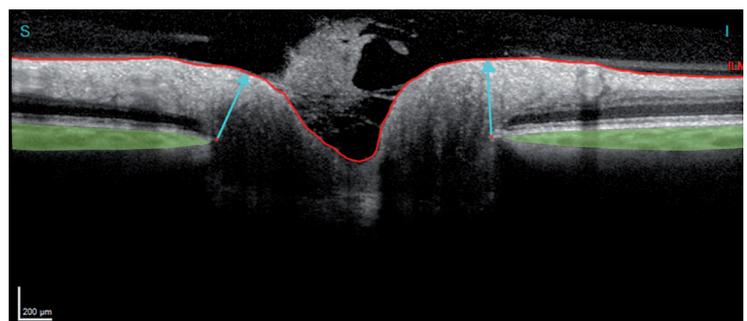
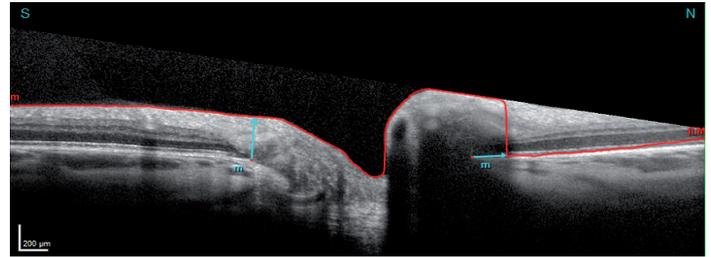
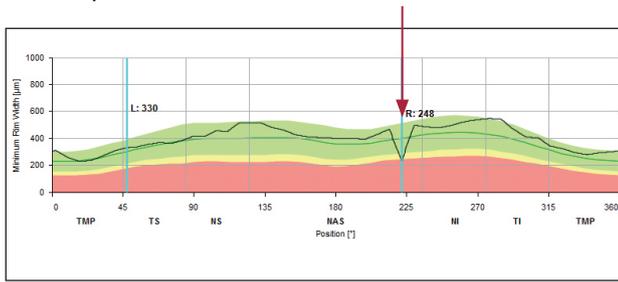


Fig. 9: Ending of the choroid (green) and MRW (blue arrow)

► Pay attention to an irregular height profile

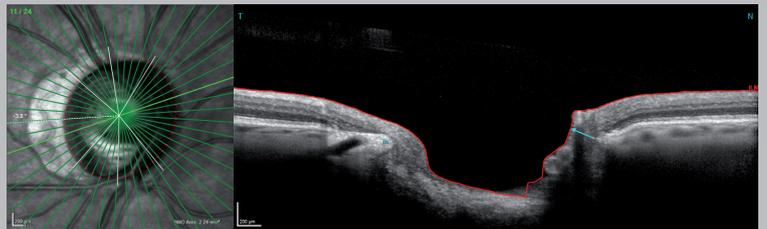
An irregular and jagged MRW profile might indicate outlying BMO points or a wrong ILM segmentation. By placing the blue vertical lines onto the peak in the height profile, the segmentation of the according OCT scan can be checked. In the following example the camera was too close to the patient's eye. Consequently, the OCT scan was not acquired properly. In this case a new acquisition is recommended.



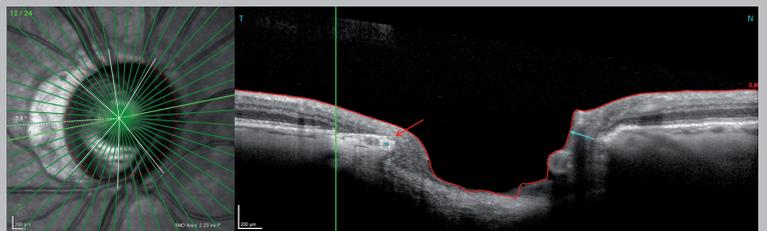
► Pay attention to the neighboring points



The figure on the right shows an OCT section (scan line 11) in which the BMO point is not distinguishable from the border tissue in the temporal area because of reflectivity similarities of the layers.



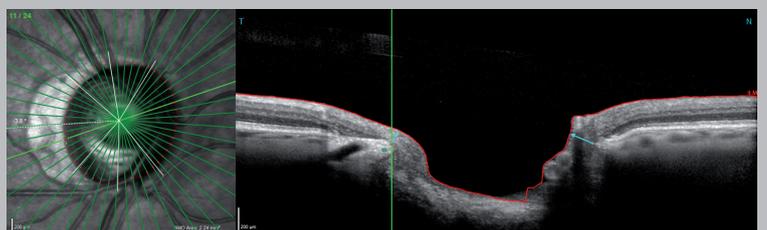
If it is not possible to detect the BMO point in one OCT scan, scroll through the neighboring scans until you can identify one BMO point clearly. In the image on the right (scan line 12), the green marker points to the RPE termination, the red arrow to the BMO.



Drag and drop the green marker (scan line 12) to the identified BMO point in the OCT.



Go back to the OCT scan in which the BMO was not detectable (scan line 11). The green marker gives a hint as to where the red point should be placed.



► Smooth BMO points in the IR image

The GMPE assumes a smooth, typically round or elliptical, shape of the BMO points in the IR image. Therefore, an irregular, jagged MRW profile might indicate outlying BMO points. However, outliers should not only be corrected based on the IR image. Instead corrections should be verified in the OCT scan by reconsidering all recommendations given above.



2.3 The BMO in PPA and Conus Temporalis

The optic nerve head can be surrounded by an area of hyper-reflectance in the IR image, commonly more visible in the temporal disc area. This hyper-reflectance can be caused e.g. by peripapillary atrophy (PPA) or conus temporalis in myopic eyes. While the HRT requests to set the contour line at the inner edge of the hyper-reflectance area, the OCT enables to visualize the BMO as the physiological disc margin. Fig. 10 provides an overview over the different peripapillary zones.

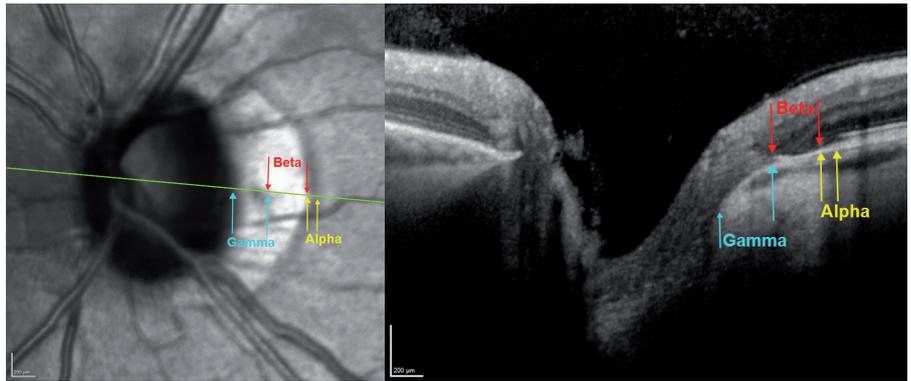


Fig. 10: Peripapillary zone alpha (BM present, irregular RPE), zone beta (BM present, no RPE) and zone gamma (no BM, no RPE)

> PPA

The clinical description of PPA should be distinguished from myopic crescents or conus. In contrast, the outer edge of the hyper-reflective area in PPA (Fig. 11) corresponds to the RPE ending (green marker), not to the BMO. Due to the temporal RPE-absence, more light can reach the underlying structures so that they appear hyper-reflective in the OCT. The BM ends together with the choroid and the sclera. The BMO is correctly located at the inner edge of the hyper-reflective zone.

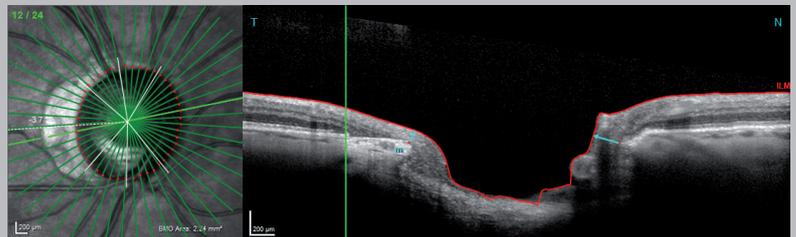


Fig. 11: Peripapillary atrophy

i The BMO is located at the inner edge of zone beta.

> Conus temporalis

Fig. 12 shows an optic nerve head with a temporal myopic crescent. As seen in the temporal OCT, the Bruch's membrane as well as the choroid terminate earlier than the border tissue of Elschnig. The absence of RPE and choroid enables a direct view onto the sclera and therefore leads to a white sharply demarcated zone in the IR image, known as zone gamma. The BMO is correctly detected at the outer edge of the hyper-reflectance area seen in the IR image.

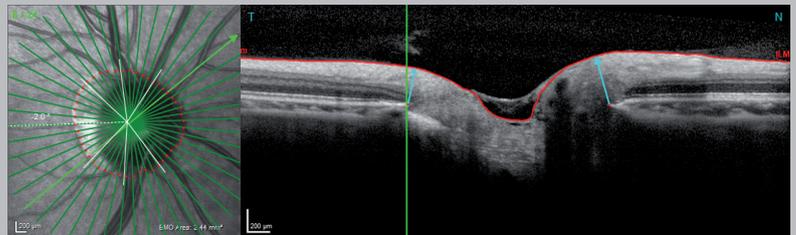


Fig. 12: Conus temporalis

i The BMO is located at the outer edge of zone gamma.

> PPA and Conus temporalis

Moreover, combinations of PPA and conus, e.g. in tilted myopic discs, are possible as seen in Fig. 13. The outer edge of the hyper-reflective area in the IR image corresponds to the RPE termination (green marker) while the inner edge correlates to the scleral ending. The BM goes further than the RPE does. Wherefore the BMO is found in between the hyper-reflective area at the outer edge of zone gamma or rather at the inner edge of zone beta.

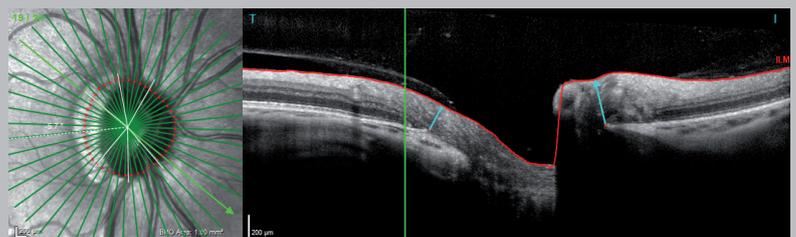


Fig. 13: Combination of PPA and Conus temporalis

i The BMO is located at the inner edge of zone beta = outer edge of zone gamma.

How to Interpret GMPE Parameters in 60sec



ONH-RC-Scan

1 BMO Rim Analysis

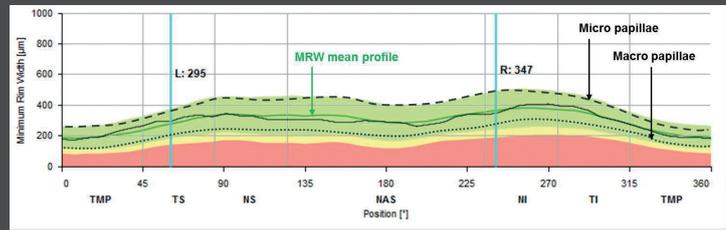
Check the disc size with the help of the stated BMO area size and be aware of the following:



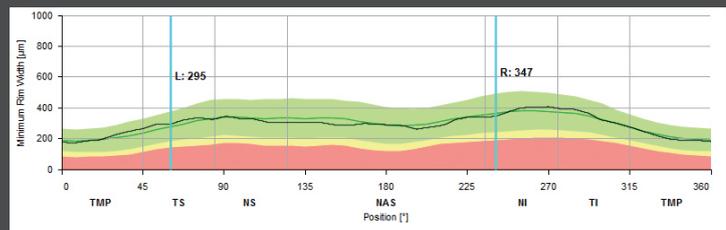
Micro papilla: MRW profile above the green mean profile



Macro papilla: MRW profile below the green mean profile



Compare the individual BMO-MRW height profile (black) with the BMO area- and age-adjusted reference database (green). The black graph should show a slight double hump which should not fall below the nasal height profile otherwise the ISNT rule is contravened. Notches occur in case of RNFL defects.



2 RNFL Thickness



Gradual increase from T to TS



RNFLT maximum at TS followed by a gradual decrease to NS

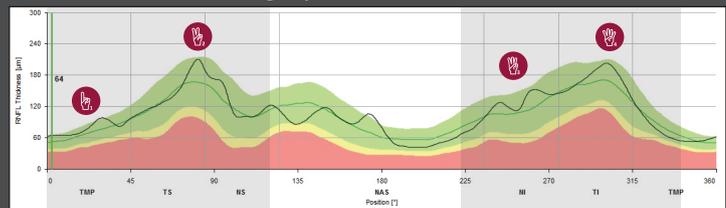


Gradual increase from NI to TI



RNFLT maximum at TI followed by an harmonic decline to T

Check the individual height profile:



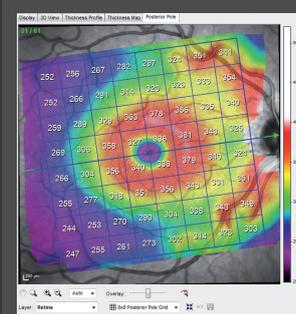
PPoleH-Scan

3 Posterior Pole Asymmetry Analysis

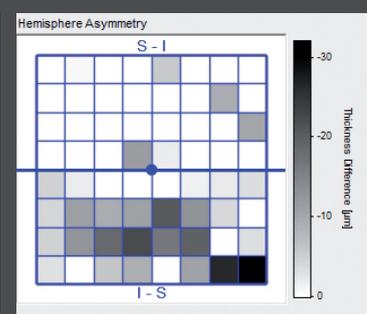
Check the PPole color map and grayscale chart for any asymmetries between the upper and the lower hemisphere.

The **thickness map** should appear red/orange along the TI and TS nerve fiber bundles as well as along the ganglion cell layer (red ring).

Gray squares in the **hemisphere asymmetry chart** represent areas thinner in the opposite hemisphere. Pay special attention to asymmetries presenting in arched and connecting patterns.



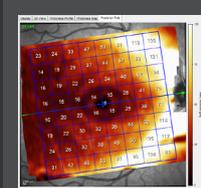
Thickness map



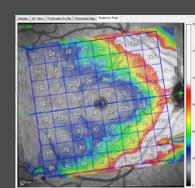
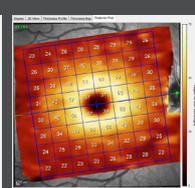
Hemisphere asymmetry

4 Layer Segmentation

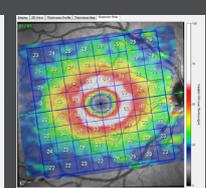
Pathologies within the outer retinal layers may confound the posterior pole thickness map of the retina. In those cases it may help to have a look at the individual RNFL and GCL maps.



Heat maps

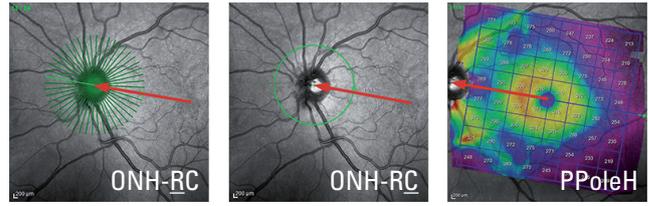


Color maps



3 Data Interpretation

Based on the Anatomic Positioning System (APS), all glaucoma scans are automatically aligned relative to the patient's individual Fovea-to-BMO-center (FoBMOC) axis. As a result, a more accurate comparison between the different analysis parameters of the ONH-RC scan and the PPoleH scan is made, independent of tilted head positions or cyclotorsions.



3.1 The BMO-MRW

The Bruch's Membrane Opening-based Minimum Rim Width (**BMO-MRW**) parameter is defined as the smallest distance between the Bruch's Membrane Opening (**BMO**) and the Internal Limiting Membrane (**ILM**).

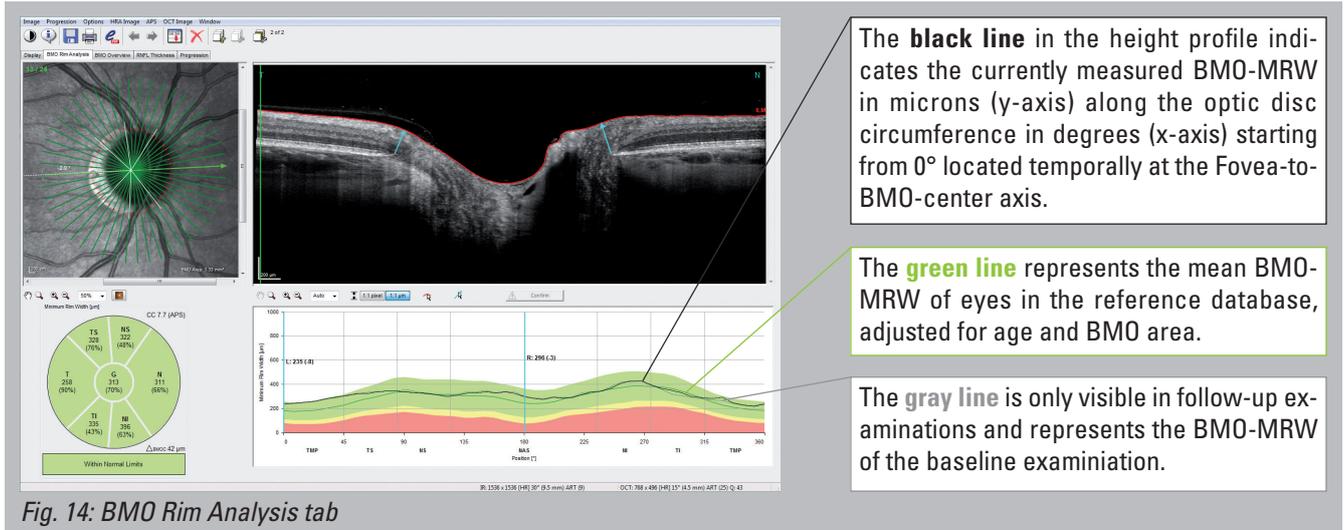


Fig. 14: BMO Rim Analysis tab

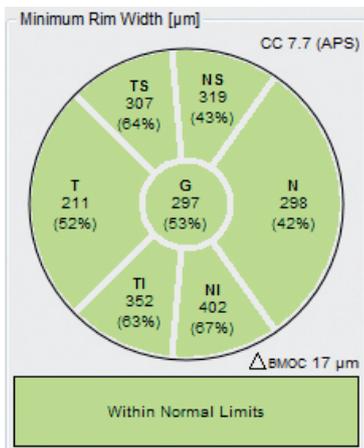


Fig. 15: Classification chart

3.1.1 The Classification Chart

The black numbers are the measured average BMO-MRW values in microns in each sector. The percentage numbers in parentheses are the corresponding percentiles of the normal distribution, adjusted for age and the BMO area of the examined eye. For example, a temporal inferior value of 63% (the 63rd percentile of the normal distribution) means that 63% of eyes in the reference database have BMO-MRW values this low or lower.

Furthermore, the classification chart is color-coded according to its percentile, to indicate the sector's classification as follows:

- "within normal limits" - above the 5th percentile of eyes in the reference database
- "borderline" - between 1st and 5th percentile of eyes in the reference database
- "outside normal limits" - below the 1st percentile of eyes in the reference database



Since averaging can hide focal axonal defects in the classification chart it is strongly recommended to have a detailed view on the height profile.

3.1.2 The Height Profile

According to the ISNT rule, the thickness profile of the BMO-MRW should show a slight double hump, as seen in Fig. 16. The inferior and superior section of the height profile should not run below the nasal height profile otherwise the ISNT rule is contravened.

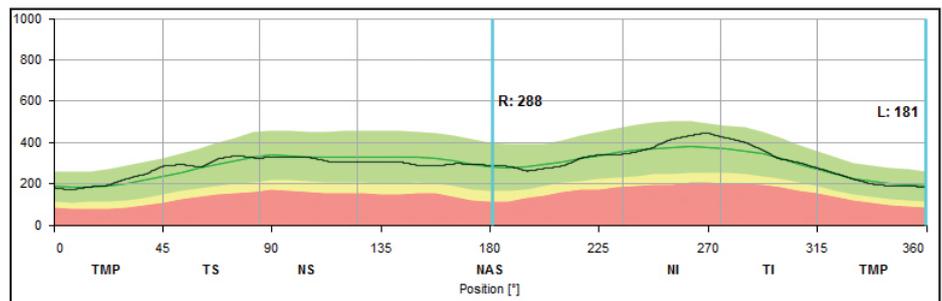
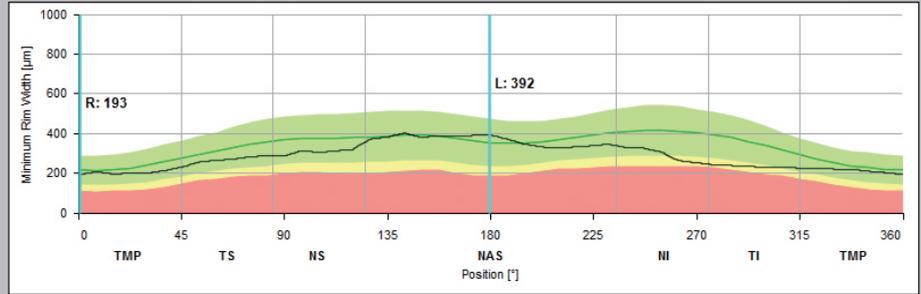


Fig. 16: Height profile

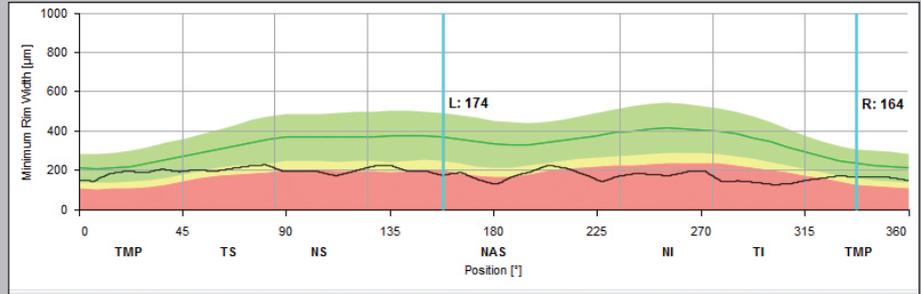
Moderate Defect

As shown in the diagram, the MRW profile does not show a temporal inferior and temporal superior hump. Instead, the black graph line is located below the nasal mean height profile in those sectors. Therefore, the ISNT rule is not fulfilled.



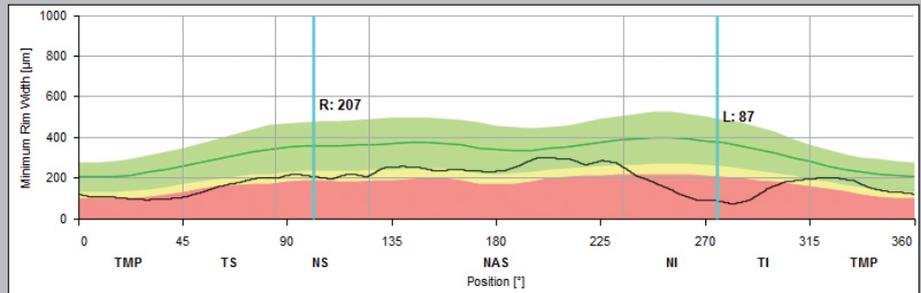
Severe Defect

The height profile is generally reduced across all sectors. The temporal inferior and temporal superior humps – representing the temporal inferior and temporal superior nerve fiber bundles – are missing.



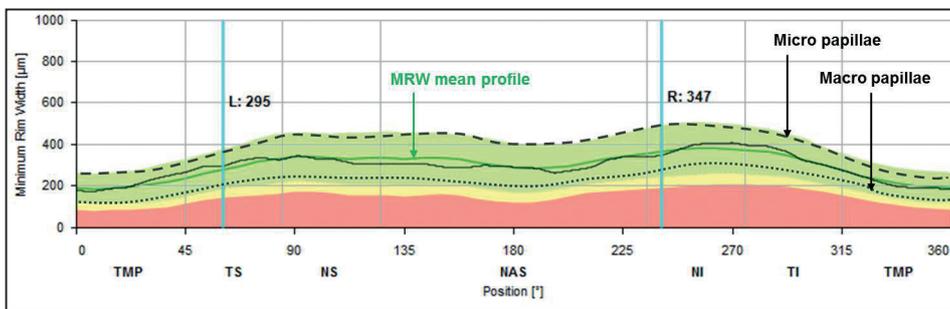
Localized Defect

Notches in the temporal inferior or temporal superior height profile correspond to focal nerve fiber losses or nerve fiber bundle defects, as displayed in the MRW diagram.

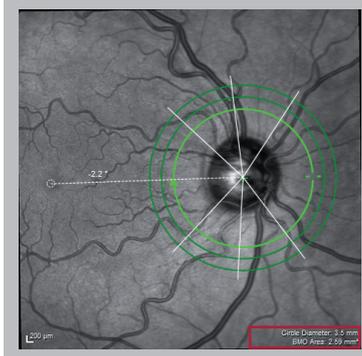
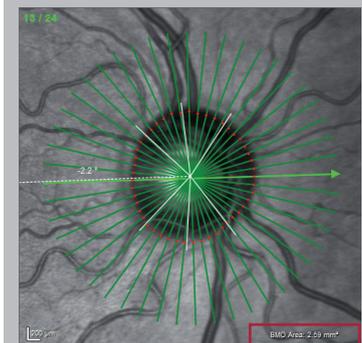


3.1.3 The Influence of the Disc Size on the BMO-MRW

The size of the optic nerve head affects the MRW profile: The reference data indicate that in small optic nerve heads (micro papillae) the MRW profile lies above the green mean profile. Vice versa, in macro papillae, the MRW profile is located below the green mean profile. In order to distinguish a macro papilla from a severe defect, the MRW profile in macro papillae shows slight humps temporal inferior and temporal superior.



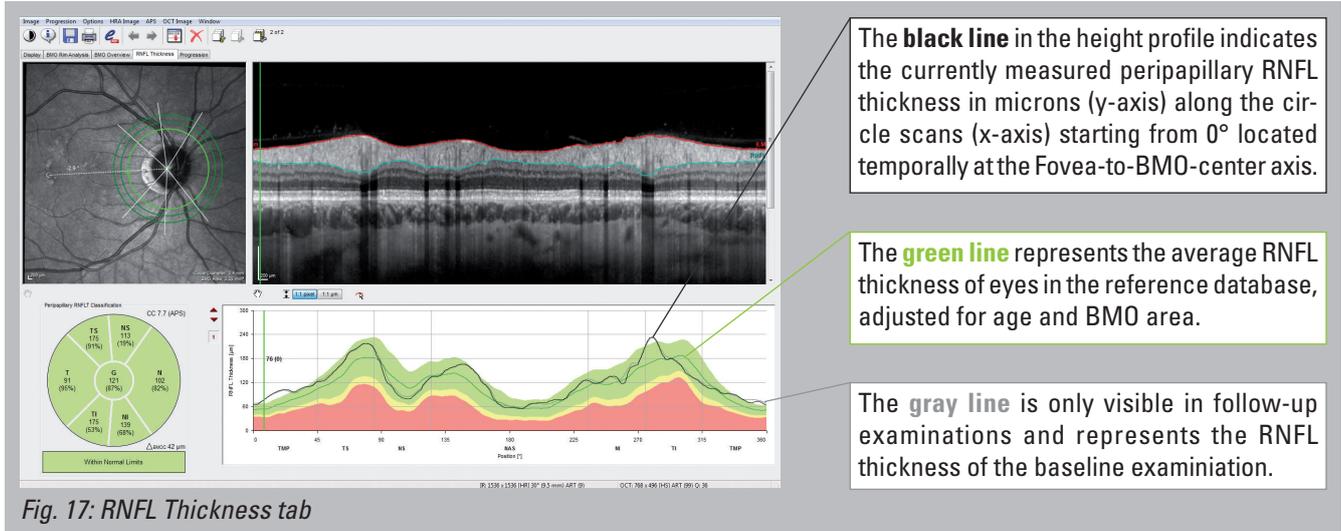
The size of the BMO area is displayed in the lower right corner of the IR images (highlighted in red).



A BMO-MRW profile lying above the mean profile of the reference database, while the RNFL is conforming to standards, can indicate a physiological micro papilla. Vice versa a BMO-MRW profile lying underneath the mean profile of the reference database, while the RNFL is conforming to standards, can indicate a physiological macro papilla.

3.2 The RNFLT

The retinal nerve fiber layer (RNFL) is the uppermost hyperreflective layer of the retina and represents the unmyelinated axons of the ganglion cells. For glaucoma diagnostics, the peripapillary retinal nerve fiber layer thickness (RNFLT) is measured and is compared to a reference database.



3.2.1 The Classification Chart

The black numbers are the measured averaged RNFLT thicknesses in microns in each sector. The percentage numbers in parentheses are the corresponding percentiles of the normal distribution, adjusted for age and the BMO area. For example, a temporal inferior value of 80% (the 80th percentile of the normal distribution) means that 80% of eyes in the reference database have RNFLT values this low or lower.

Furthermore, the classification chart is color-coded according to its percentile, to indicate the sector's classification as follows:

- “within normal limits” - above the 5th percentile of eyes in the reference database
- “borderline” - between 1st and 5th percentile of eyes in the reference database
- “outside normal limits” - below the 1st percentile of eyes in the reference database

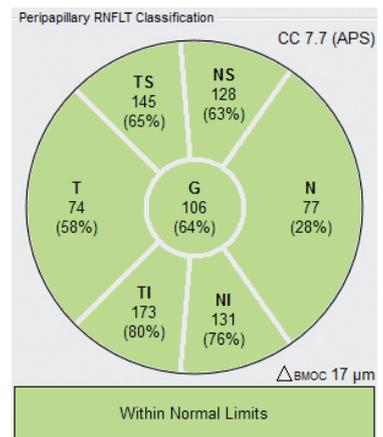
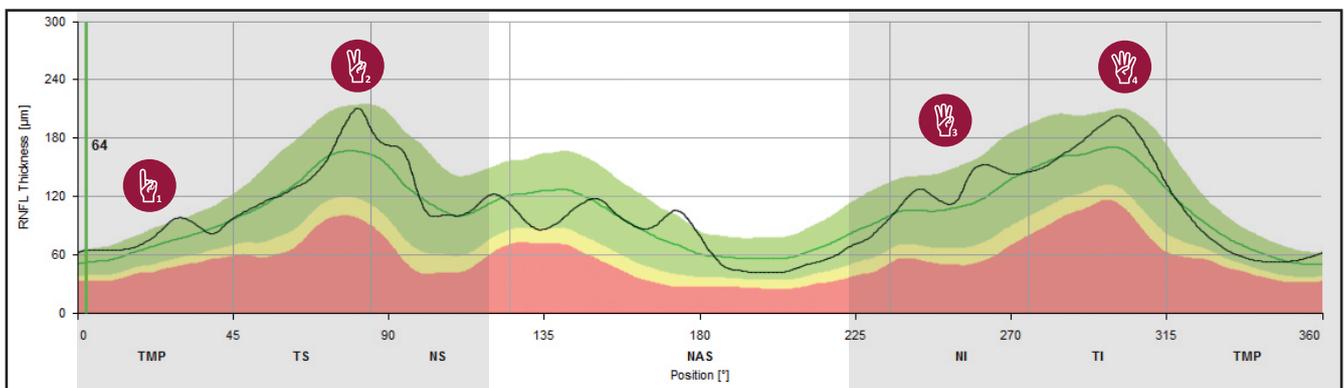


Fig. 18: Classification chart

i Since averaging can hide focal axonal defects in the classification chart it is strongly recommended to have a detailed view to the height profile.

3.2.2 The Height Profile

According to the anatomical properties of the retina, the thickness profile of the RNFL should be characterized by distinctive humps along the temporal superior and temporal inferior nerve fiber bundles and fall within the range of normal limits along all sectors.

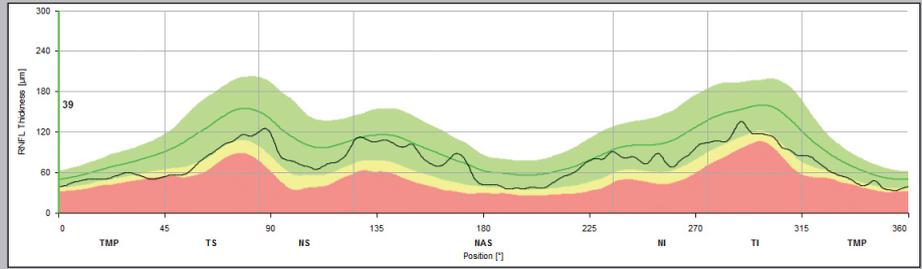


- i** Gradual slope from T to TS.
- i** RNFLT maximum at TS followed by a gradual decrease to NS.

- i** Gradual slope NI to TI.
- i** RNFLT maximum at TI followed by an harmonic decline to T.

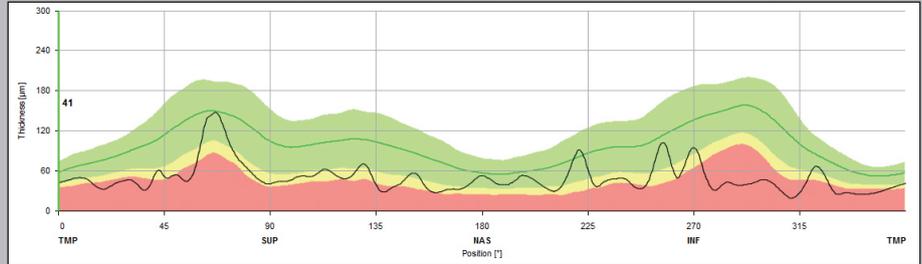
Moderate Defect

As shown in the diagram, the RNFL thickness profile is generally reduced in comparison to the mean height profile representing the averaged and age-adjusted RNFL thickness of healthy eyes.



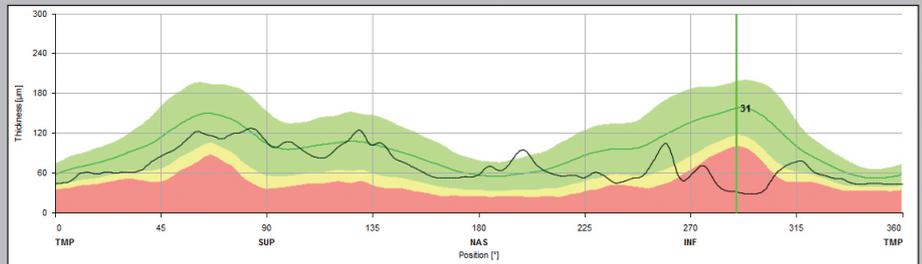
Severe Defect

The height profile is significantly reduced and hits the red area (outside normal limits) among all sectors. Single and well-defined peaks within the graph symbolize blood vessels which are no longer embedded in the RNFL due to a loss of nerve fibers.



Localized Defect

Notches in the temporal inferior or temporal superior height profile as seen in the RNFL diagram may correspond to focal nerve fiber loss or nerve fiber bundle defects.



3.2.3 The Relevance of the Three Circle Diameters

The GMPE software provides three peripapillary circle scans with diameters of:

- 3.5 mm
- 4.1 mm
- 4.7 mm

All circle scans are aligned to the individual Fovea-to-BMO-center axis. The alignment ensures an accurate definition of each single sector (T, TS, NS, N, NS, TI) independent of head positions and thereby enables a correct comparison to the reference database.

In size, the 3.5 mm circle diameter of the ONH-RC scan is comparable to the standard 12°-RNFL scan pattern.

The additional two larger circle scan diameters become more important as soon as the inner circle is not interpretable due to an influencing pathology.

The example on the right shows peripapillary myelinated nerve fibers. Due to the myelination the RNFL thickness is not measurable along the inner circle scans. The outer circle scan enables a better measurement of the RNFLT.

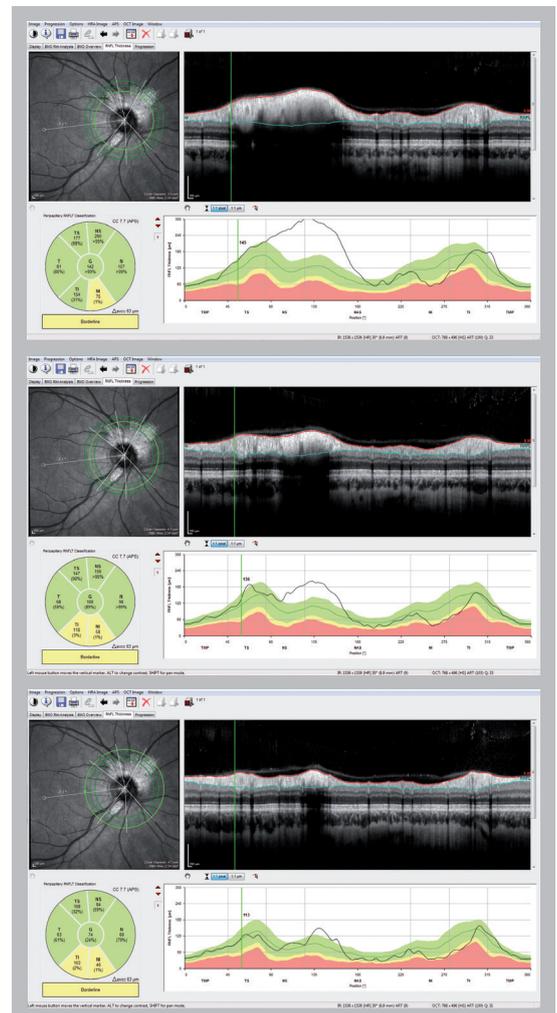


Fig. 20: Comparison of the three different circle scan diameters (3.5 mm, 4.1 mm and 4.7 mm) in a patient with myelinated retinal nerve fibers

3.3 The Posterior Pole Asymmetry Analysis

The Posterior Pole Asymmetry Analysis is only available after having acquired a PPoleH scan. The PPoleH scan is a volume scan which is placed on the posterior pole of the eye and which is aligned to the individual Fovea-to-BMO-center axis.



The Posterior Pole tab has to be chosen.

Posterior Pole Thickness Map

Changing the displayed layer

The OCT scan serves as a check for the layer segmentation.

Baseline examination

Follow-up examination

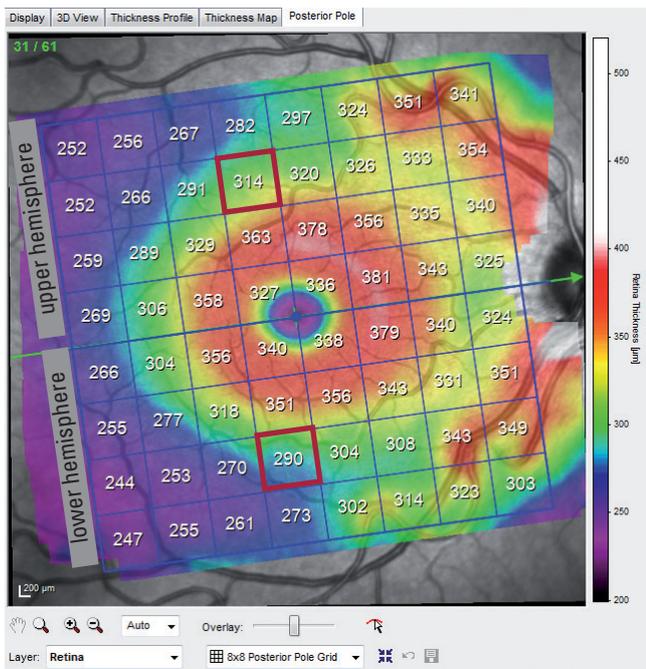
Retina Thickness Change
black: no changes between baseline and follow-up exam
red: follow-up is thinner than the baseline examination
green: follow-up is thicker than the baseline

Fig. 21: Posterior Pole Asymmetry Analysis tab

3.3.1 The Posterior Pole Thickness Map

The color scale of the Posterior Pole thickness map is finer than the standard retina thickness map and therefore more sensitive for the visualization of glaucomatous changes.

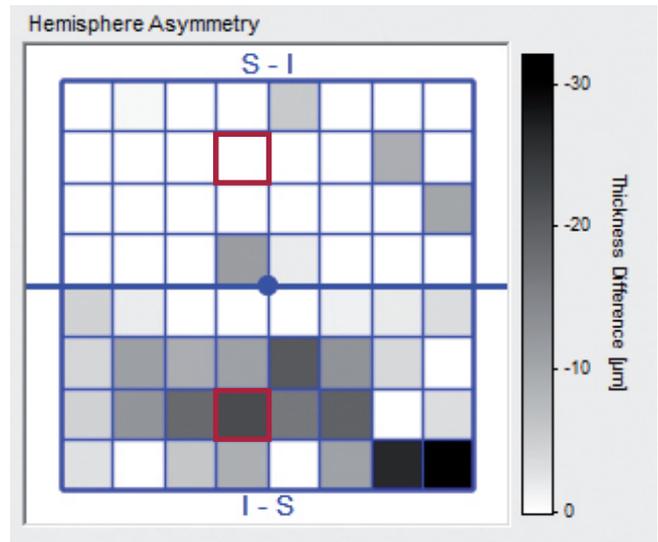
The warmer (the more red) the color of the thickness map, the thicker the measured retina area. The prominent arcuate inferior- and temporal-superior nerve fiber bundles appear red. The high concentration of ganglion cells within the foveal region are represented as a red ring around the fovea. The fovea itself as well as the peripheral retina appear violet caused by physiologically thinner values.



The blue grid is automatically aligned to the Fovea-to-BMO-center axis and consists of 64 squares. In each square the averaged retina thickness of all measured data points within the square is displayed.

3.3.2 The Posterior Pole Hemisphere Asymmetry Analysis

In the hemisphere asymmetry analysis, the averaged retina thicknesses of one hemisphere are compared to the corresponding thicknesses in the opposite hemisphere.



If squares appear gray in one hemisphere, the retina in these squares is thinner than those on the corresponding hemisphere. Thereby, the squares' gray value shows the amount of deviation between both hemispheres.

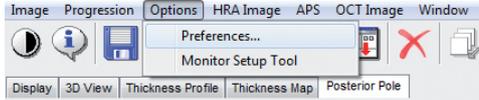
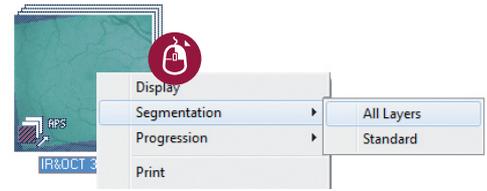
As an example, the red surrounded square in the lower hemisphere shows a thickness of 290 micrometers, which is 24 micrometers thinner than the red surrounded corresponding square in the upper hemisphere. Three dark squares next to each other can indicate a defect.

i Especially along the nasal most marginal squares, differences in thickness often appear. These differences are mostly caused by physiologically asymmetric distribution of arteries and veins.

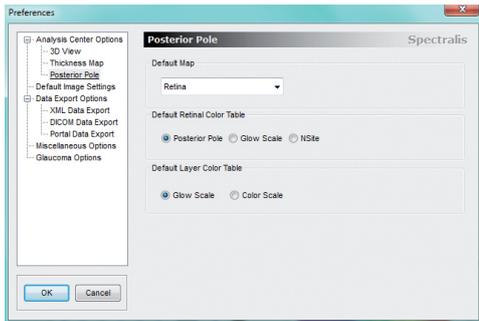
3.3.3 Thickness Map of RNFL and Ganglion Cell Layer (GCL)

Pathologies within the outer retinal layers can confound the Posterior Pole thickness map of the retina. In such cases it may help to review the single layer RNFL and GCL maps.

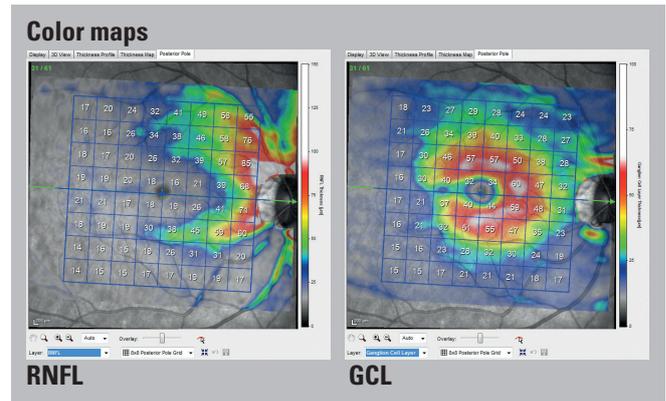
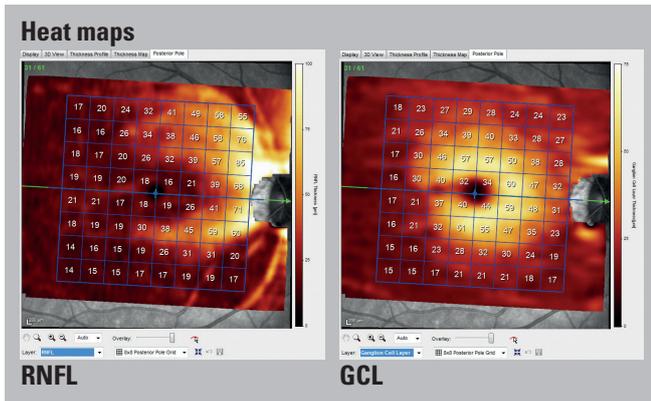
Before having access to the thickness maps of the individual layer, the segmentation of the OCT scan has to be calculated: Click with the right mouse button on the image thumbnail and select <<Segmentation>> <<All Layers>> from the context menu.



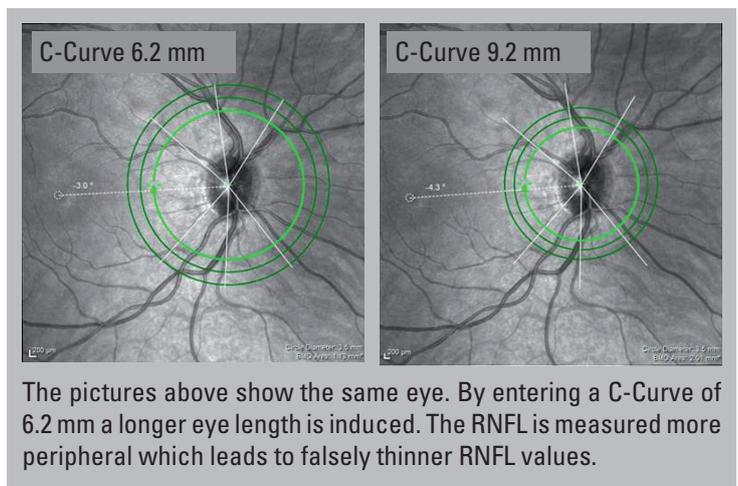
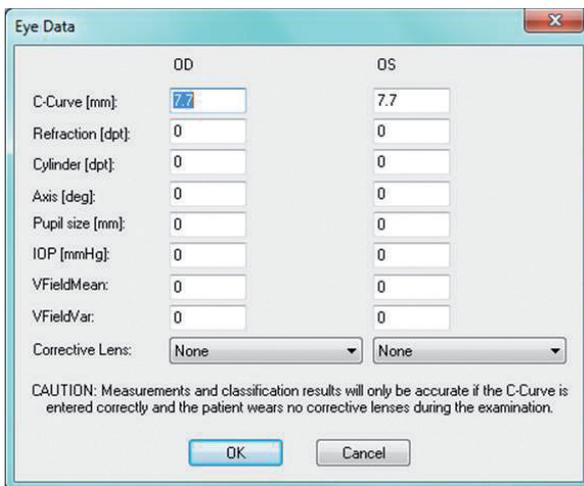
The thickness maps of the single layers can be displayed as standard heat maps (*Glow Scale*) or color maps (*Color Scale*). The standard settings can be changed in the Posterior Pole tab of the preference settings via <<Options>> <<Preferences>>.



i Since heat maps offer a more continuous spectrum of color-scales compared with color maps, it is strongly recommended to use the standard heat maps for the clinical assessment of individual layers. Color maps represent thickness values in a more discontinuous fashion, making the color transitions less representative of thickness changes than the more continuous heat maps. Subtle thickness changes – especially close to the color transition thresholds – may be misinterpreted as significant changes.



4 The Relevance of the C-Curve

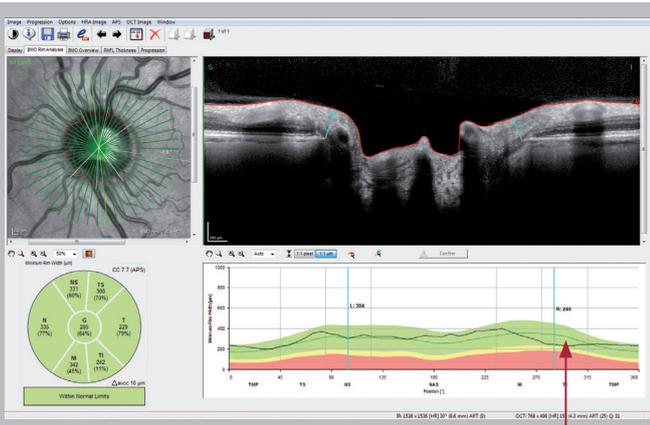
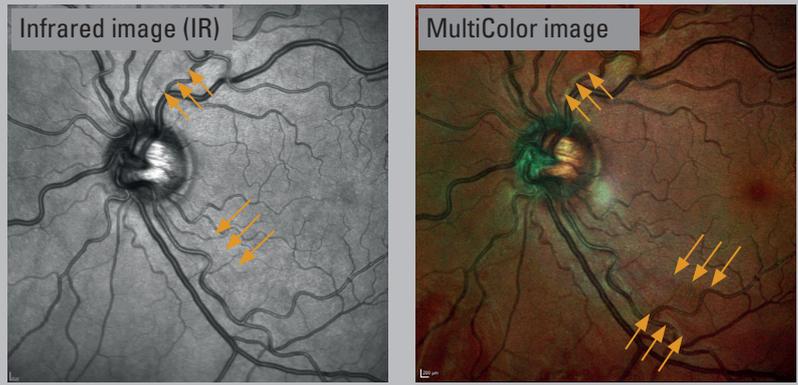


Before defining the APS, it is recommended to change the standard 7.7 mm and enter the corresponding eye's individual C-Curve. Subsequent changes are not possible. The C-Curve is the mean corneal radius of the horizontal and vertical corneal curvature. With the help of both – the C-Curve and the specific focus setting – the software can calculate the individual eye length. Thereby, exact circle diameters of 3.5 mm, 4.1 mm and 4.7 mm can be guaranteed independent of the eye length.

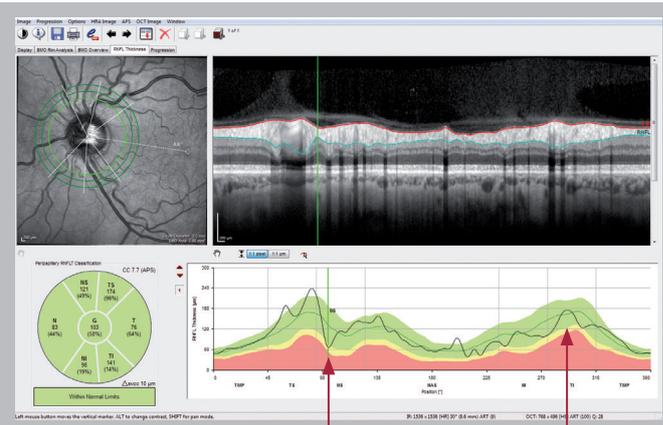
The C-Curve is especially important for the first examination and its comparison to the reference database. Entering an incorrect C-Curve causes a systemic error which has no influence on comparing the follow-up examinations with each other.

5 Case Study

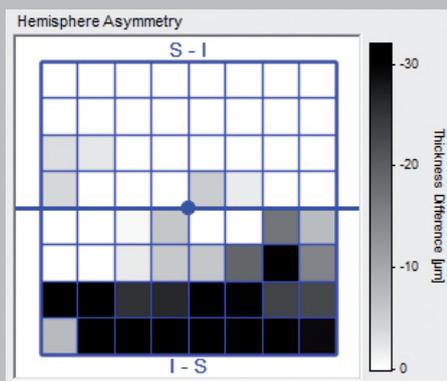
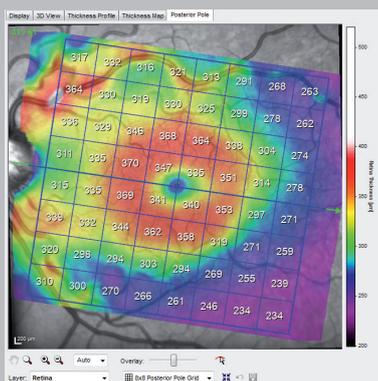
The following case study of a left eye illustrates a wide temporal inferior nerve fiber layer wedge defect as well as a more focal temporal-superior wedge defect. Nerve fiber axons highly reflect light, especially light of shorter wavelengths. When axons degenerate, the reflectivity of the nerve fiber layer decreases. For this reason, although nerve fiber layer defects can be visible in IR images, the shorter wavelengths of the green and blue laser accentuate the loss. This phenomenon leads to better visualization of such defects in blue/green or MultiColor images.



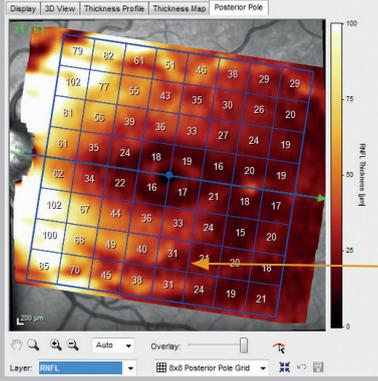
The BMO-MRW profile shows a depression of the black graph line in the TI sector. The TI MRW lies beneath the nasal mean height profile so the ISNT rule is not fulfilled. The classification diagram stays green and is classified as „within normal limits“. But the MRW of 242 microns falls on the 11th percentile range, meaning only 11% of the age-adjusted eyes in the reference database have a MRW that low or lower.



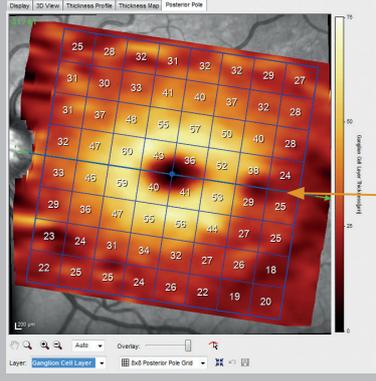
The RNFL profile shows a focal nerve fiber defect temporal-superior as well as an extended depression temporal-inferior which both correlate with the fundus image. The classification diagram stays green and is classified as „within normal limits“. But the RNFLT of 141 microns is triggered at the 14th percentile – meaning only 14% of the age-adjusted eyes in the reference database have RNFL values that low or lower.



The color map of the posterior pole scan shows a temporal-inferior thinning: The violet area extends further towards the optical nerve head than it does temporal-superiorly. The hemisphere asymmetry map confirms the defect already seen in the color map. The black squares of the inferior hemisphere represent thinner retina measures compared to their corresponding superior hemisphere squares.



Furthermore, the RNFL thickness map shows a notch in the temporal-inferior sector which is equivalent to the defect seen in the IR and MultiColor images as well as in all other analyses.



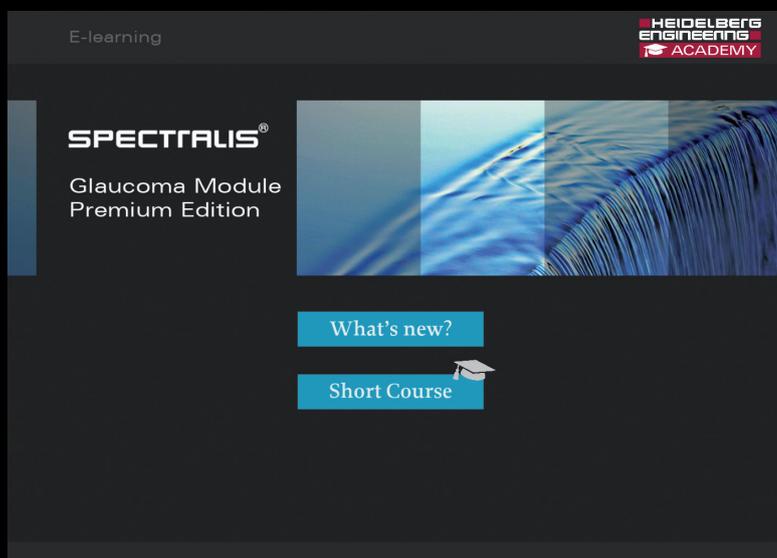
The red ring representing the GCL is intact and does not show signs of loss. Slight notches temporally are often seen in the GCL map and are caused by the raphe.

Table of Terms and Definitions

APS	Anatomic Positioning System
BM	Bruch's Membrane
BMO	Bruch's Membrane Opening
BMO-MRW	Bruch's Membrane Opening-based Minimum Rim Width
ELM	External Limiting Membrane
FoBMOc	Fovea-to-BMO-center axis; with APS, scans are automatically aligned relative to patient's individual Fovea-to-BMO-center axis.
GCL	Ganglion Cell Layer
GMPE	Glaucoma Module Premium Edition
ILM	Internal Limiting Membrane
INL	Inner Nuclear Layer
IPL	Inner Plexiform Layer
IZ	Interdigitation Zone
MRW	Minimum Rim Width
ONH	Optic Nerve Head
ONH-RC	Optic Nerve Head-Radial Circle: The ONH-RC scan pattern combines a radial scan and three concentric circle scans centered on the ONH with APS.
ONL	Outer Nuclear Layer
OPL	Outer Plexiform Layer
PPoleH	Posterior Pole (Horizontal-oriented scan lines)
RNFL	Retinal Nerve Fiber Layer
RNFLT	Retinal Nerve Fiber Layer Thickness
RPE	Retinal Pigment Epithelium

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The screenshot shows the Heidelberg Engineering Academy website interface. At the top right, the logo for Heidelberg Engineering Academy is visible. Below it, the text "E-learning" is displayed. The main content area features the "SPECTRALIS®" logo and the text "Glaucoma Module Premium Edition". To the right of this text is a large image showing a cross-section of the retina with various layers highlighted in blue. Below the image, there are two buttons: "What's new?" and "Short Course" with a graduation cap icon.

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