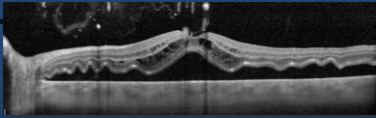


OCT - Anatomy of a Scan



Timothy J. Bennett, CRA, OCT-C, FOPS
Penn State Eye Center
Hershey, PA



OCT - Anatomy of a Scan

- A systematic approach to understanding what we see in retinal OCT images including descriptive features such as:
 - Retinal landmarks/layers
 - Contour/thickness
 - Reflectivity/shadowing
 - Artifacts
 - Common pathologic features

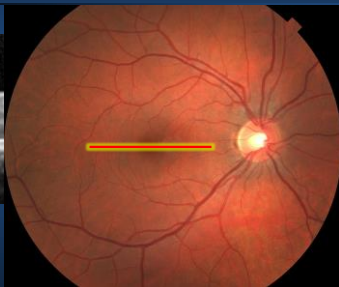
OCT Imaging

- Super luminescent diode light source
- Near-infrared wavelength: 820-850nm
- Analogous to ultrasound
- Time-of-flight delay (light echoes)
- Real time cross-sectional imaging
- Non-invasive

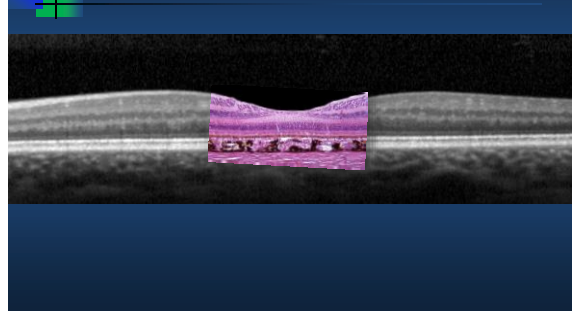
OCT Imaging

- SLD light source is directed into the eye
- OCT device records backscattered light
- Compares data with reference beam
- Generates an interference pattern
- Software converts that data into OCT image

Cross-Sectional Imaging

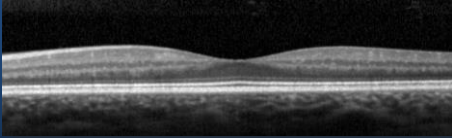


"Virtual Biopsy"

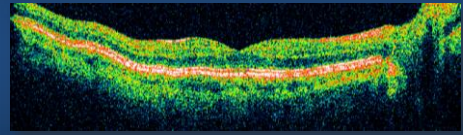


Cross-Sectional Imaging

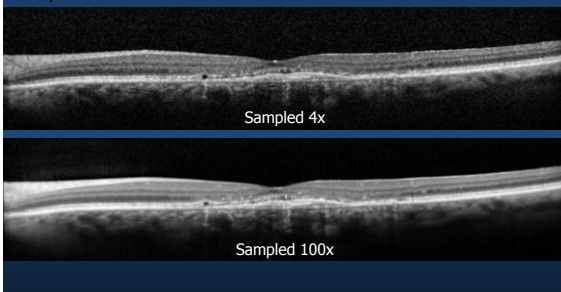
- Measures both depth/distance and intensity of reflectivity.



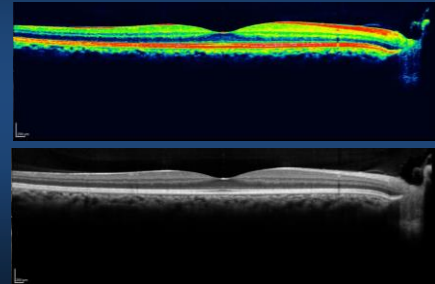
False Color vs. Grayscale



Eye Tracking/Sampling

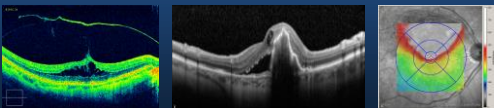


False Color vs. Grayscale



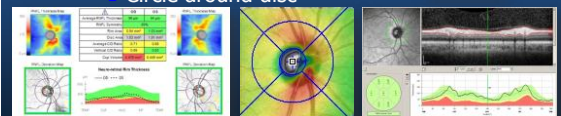
Common/Practical Use

- Line scans for structural changes
- Line scans for detection of subretinal or intraretinal fluid
- Volume scans for quantification of thickness or edema



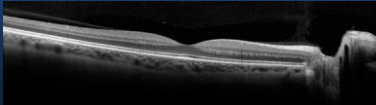
Common/Practical Use

- Optic nerve volume scan
 - Radial lines centered on cup
 - Cube Scan centered on disc
- RNFL scan
 - Circle around disc



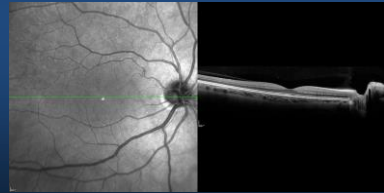
What Defines a Quality Scan?

- Centered on target anatomy/pathology.
- Good edge-to-edge reflectivity.
- Good saturation/signal strength.
- As horizontally level as possible.
- Free from artifacts.

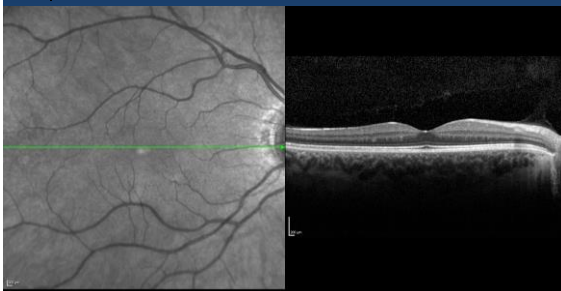


Anatomical Landmarks

- Fovea
- Optic Disc



Anatomical Landmarks

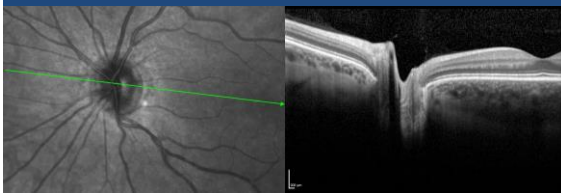


Anatomical Landmarks

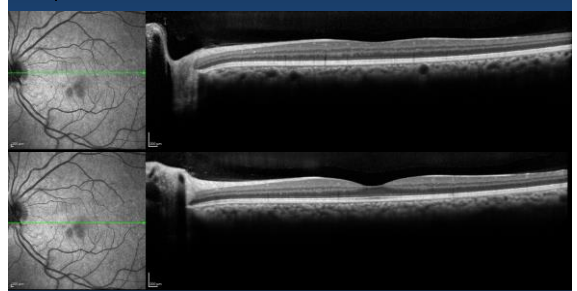


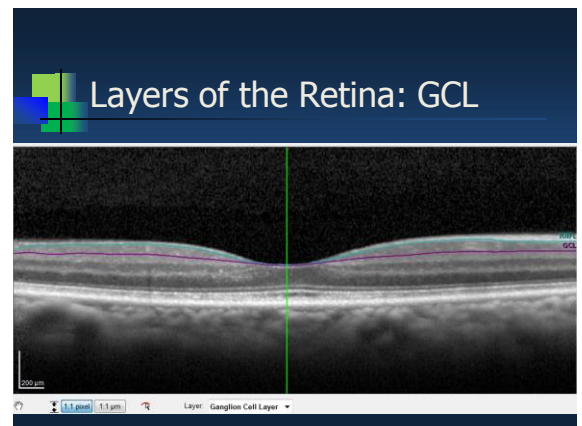
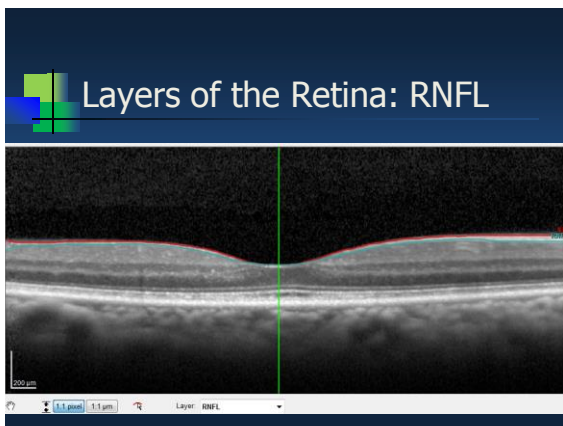
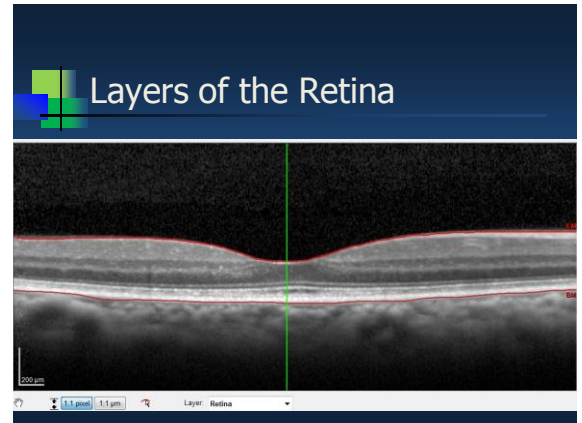
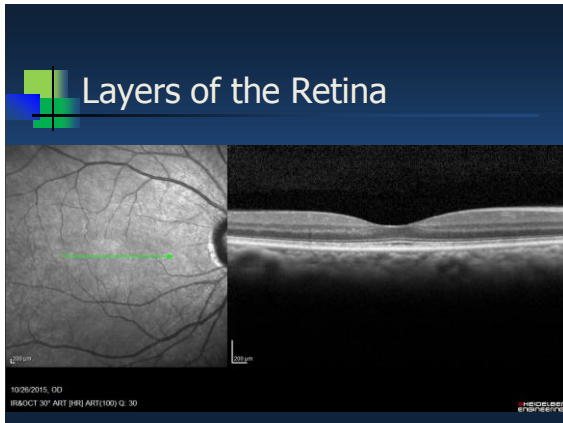
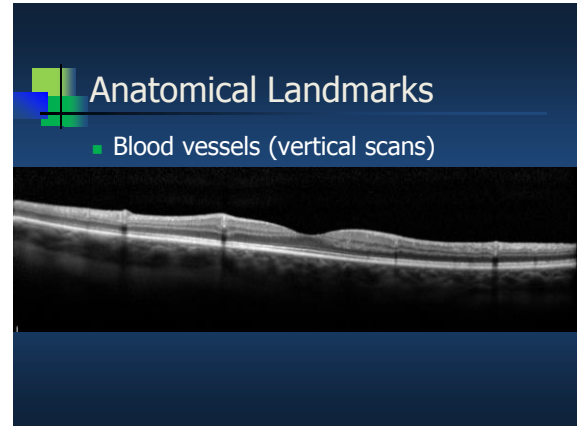
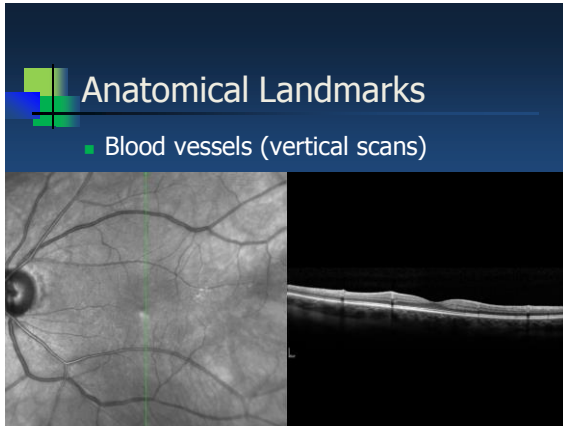
Anatomical Landmarks

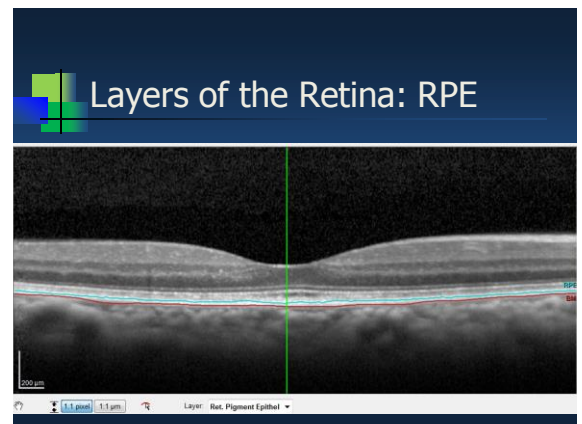
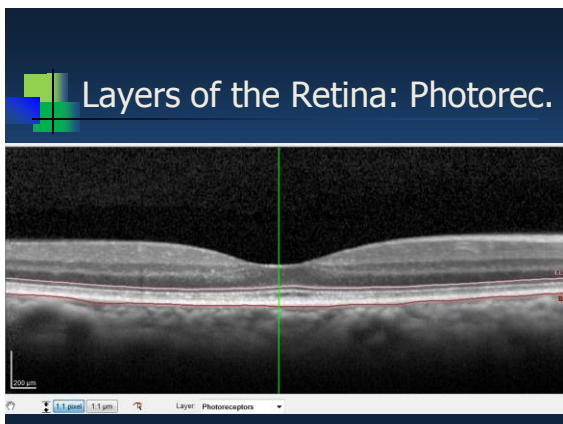
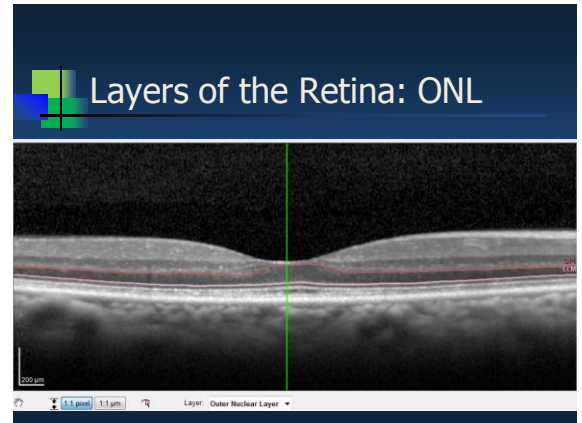
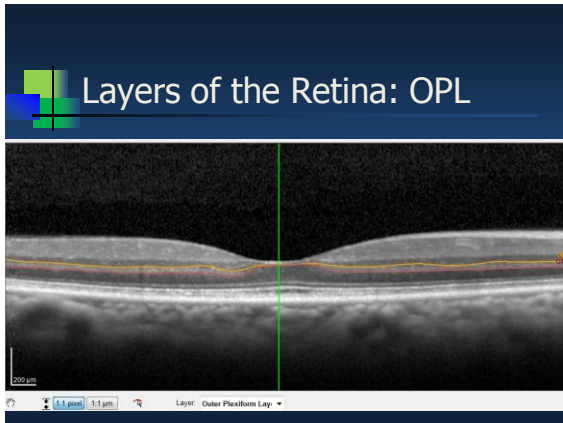
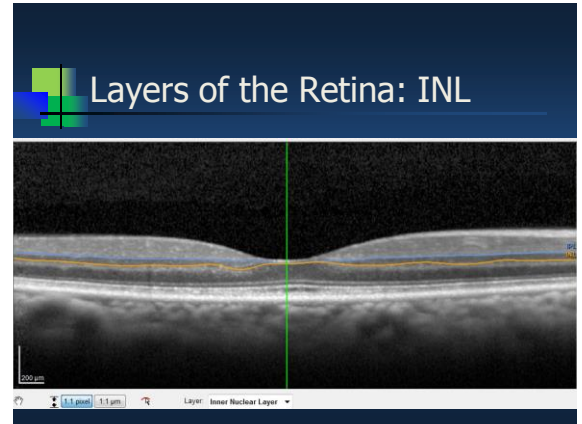
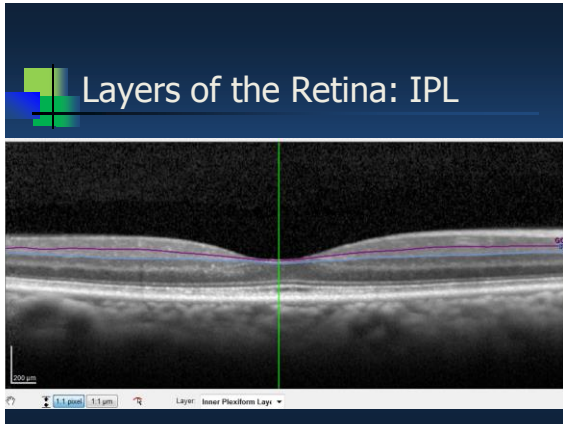
- Anatomically, the fovea sits 5-7 degrees below the midpoint of the disc.



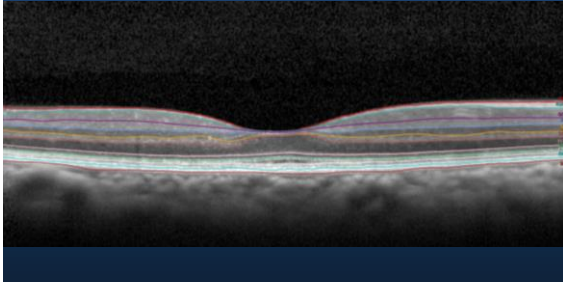
Anatomical Landmarks





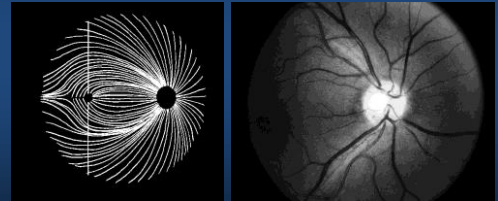


Layers of the Retina

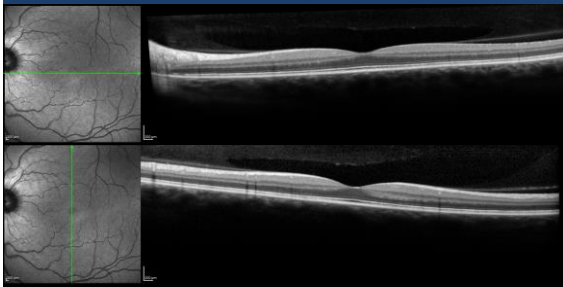
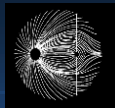


Anatomical Landmarks

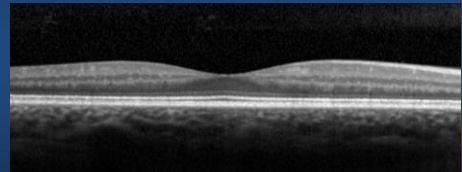
■ RNFL



RNFL Reflectivity



RNFL Reflectivity - Which Eye?

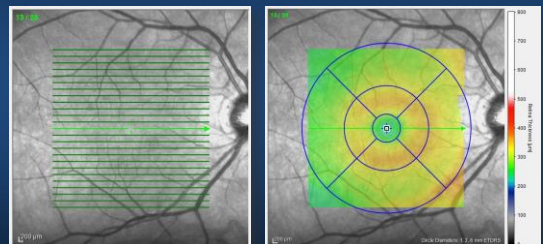


RNFL Reflectivity - Which Eye?

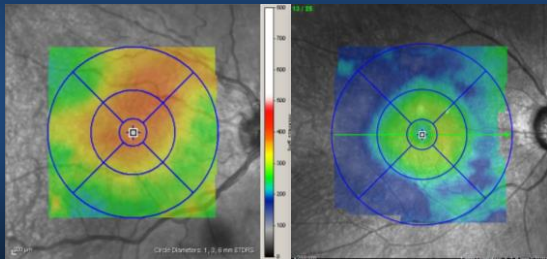


Right Eye

Topographic Anatomy



Topographic Anatomy



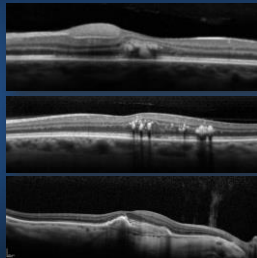
Relative Reflectivity: Normal

- Reflective/bright:
 - RNFL
 - RPE
 - Blood vessels
 - Optic Nerve



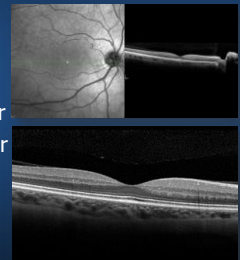
Relative Reflectivity: Abnormal

- Reflective/bright:
 - Hemorrhage
 - Exudate
 - Scar tissue
 - Drusen
 - Pigment
 - ERM



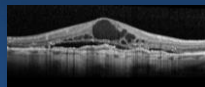
Relative Reflectivity: Normal

- Transparent/dark
 - Vitreous
 - Deep Choroid
 - Inner nuclear layer
 - Outer nuclear layer



Relative Reflectivity: Abnormal

- Transparent/dark
 - Fluid
 - Cysts
 - Shadowing from reflective structures, blood, or vitreous opacities



What to look for in Line Scans

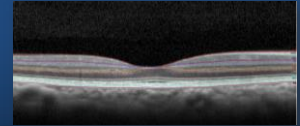
- Contour
 - Is the ILM smooth?
 - Is the foveal depression visible?
 - Is the RPE smooth/intact?
- Thickness
 - Does the retina seem thin or thick?

What to look for in Line Scans

- Brightness/reflectivity
 - Are there any unusual bright spots?
 - Are there any unusual dark spots?
- Shadowing
 - Are there reflective structures causing shadows in deeper layers?

What to look for in Line Scans

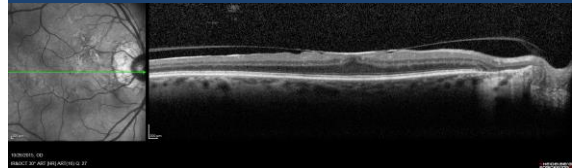
- At what level are the significant findings?
 - Vitreous
 - Pre-retinal
 - Intra-retinal
 - Subretinal
 - Sub RPE
 - Choroid



What to look for in Line Scans

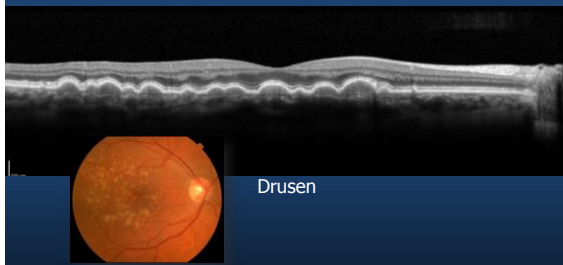
- Contour

Contour



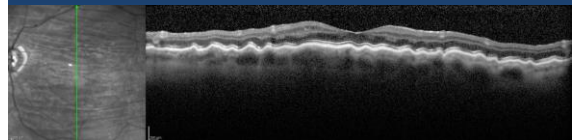
Epiretinal Membrane

Contour

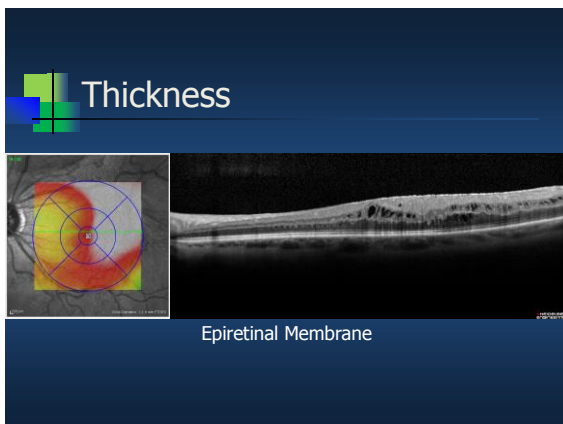
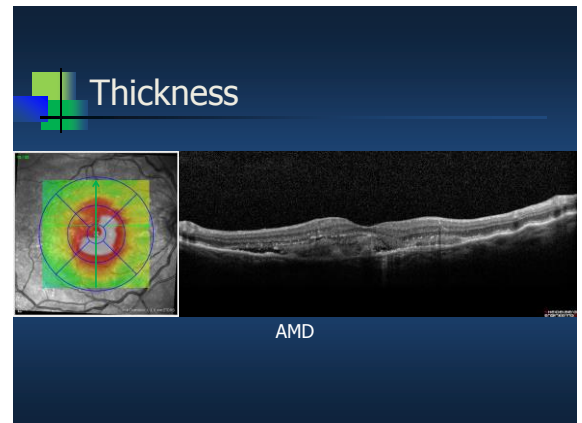
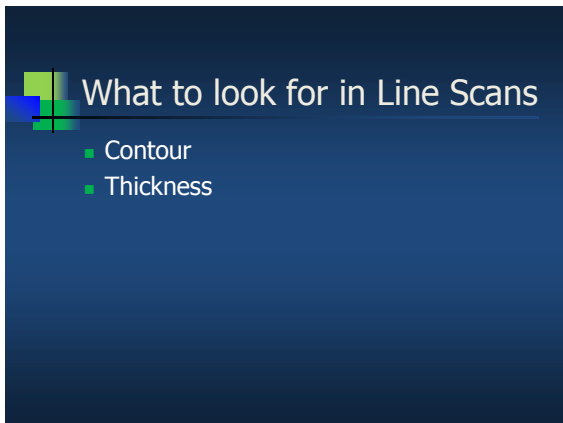
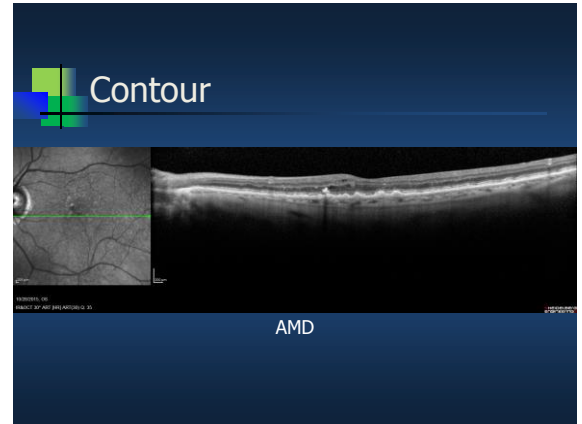
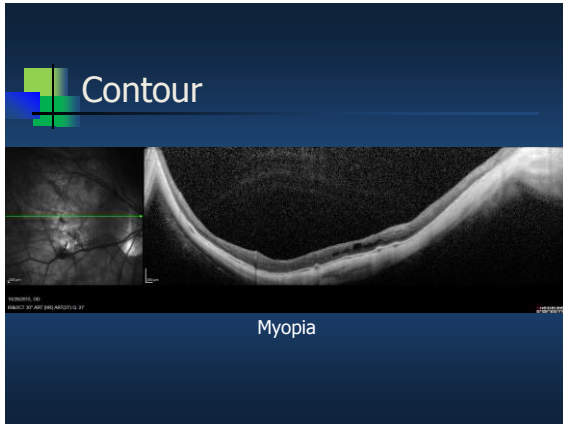


Drusen

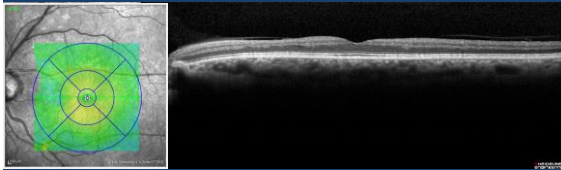
Contour



Choroidal Folds

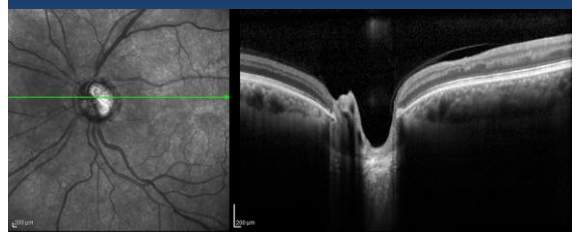


Thickness



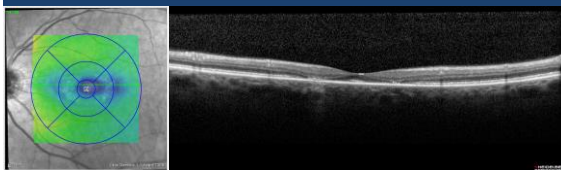
Glaucoma with loss of RNFL/GCC

Thickness



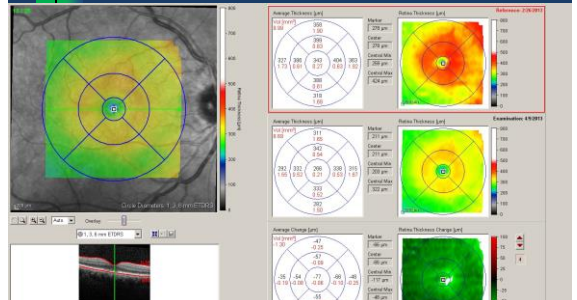
Glaucoma with loss of RNFL/GCC

Thickness



Retinitis Pigmentosa

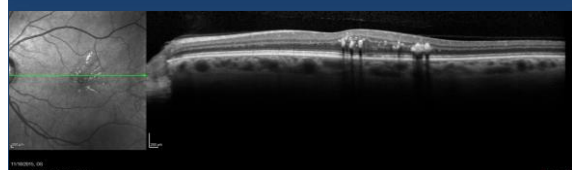
Thickness: Tracking Change



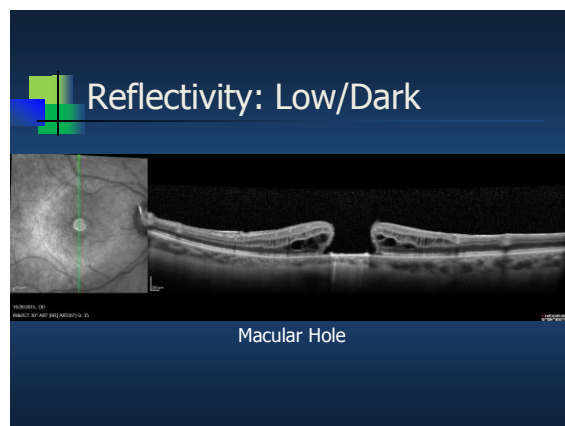
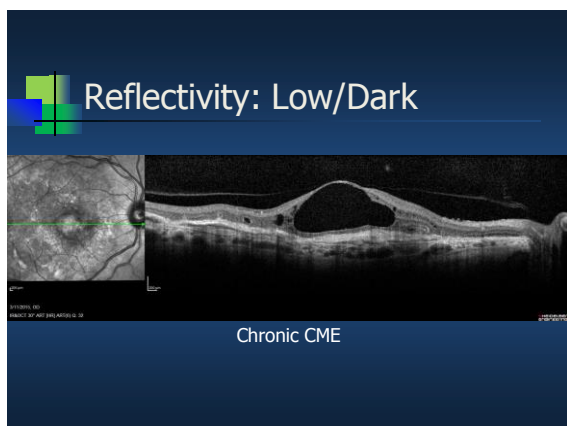
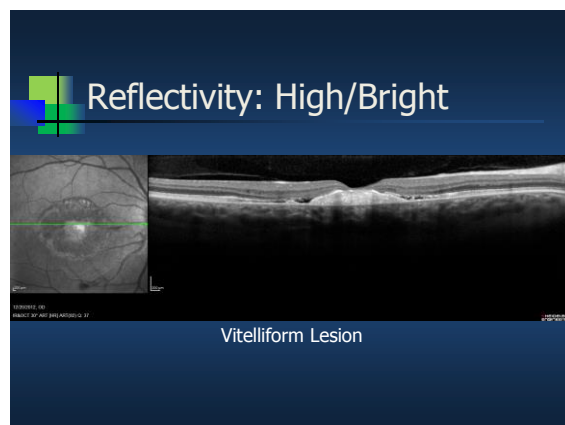
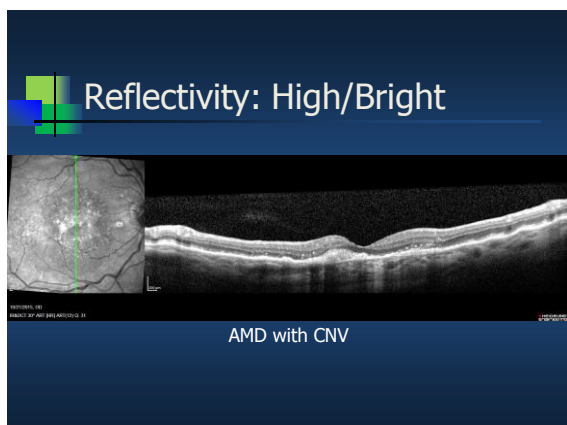
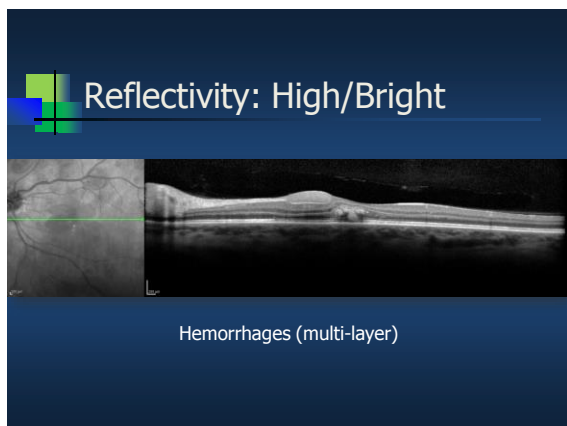
What to look for in Line Scans

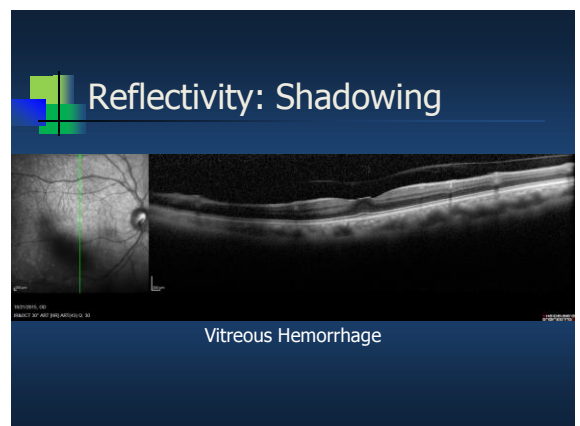
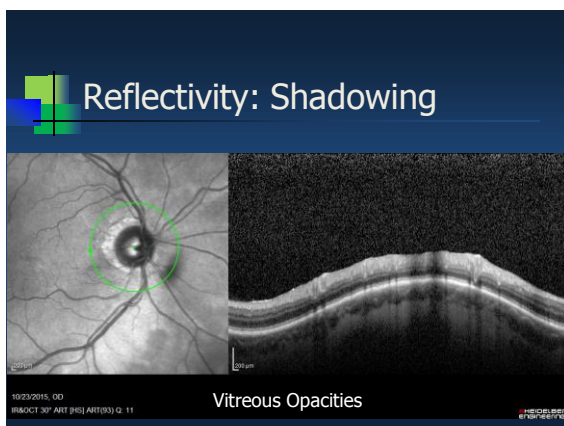
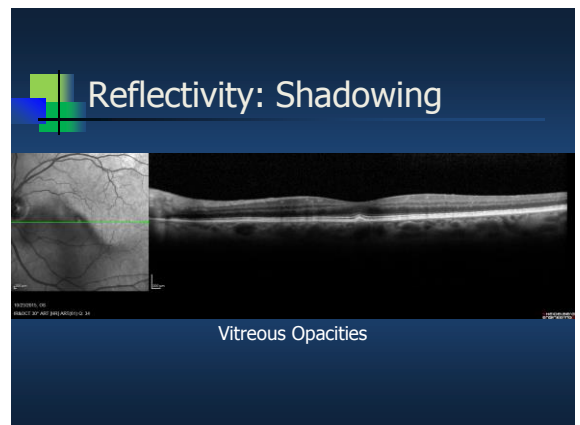
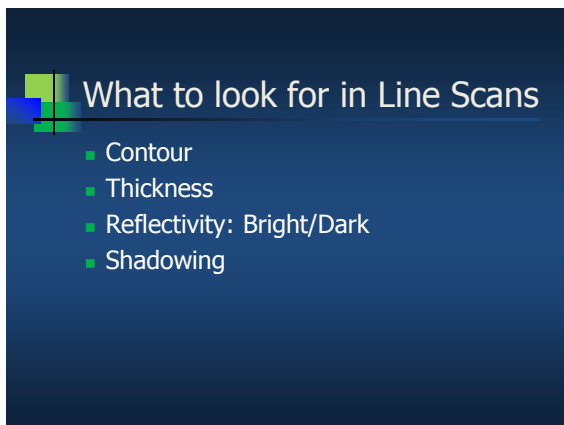
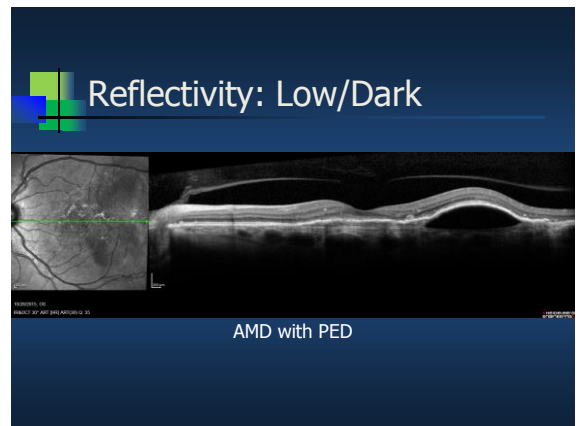
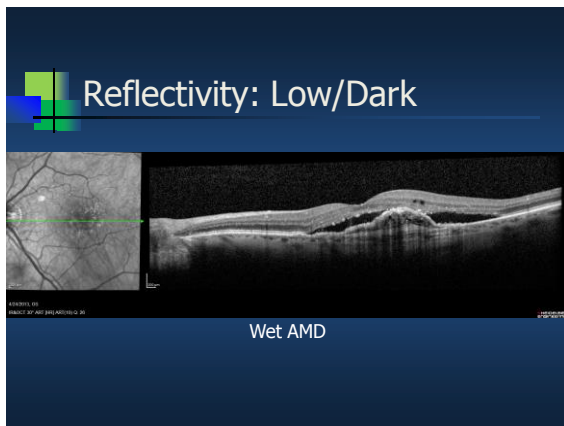
- Contour
- Thickness
- Reflectivity: Bright/Dark

Reflectivity: High/Bright

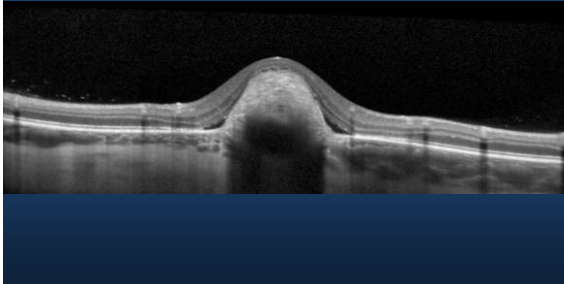


Exudates

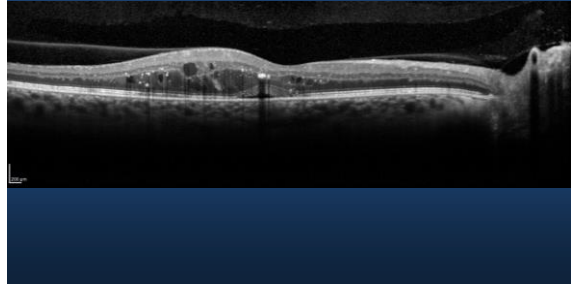




Reflectivity: Shadowing



Reflectivity: Shadowing



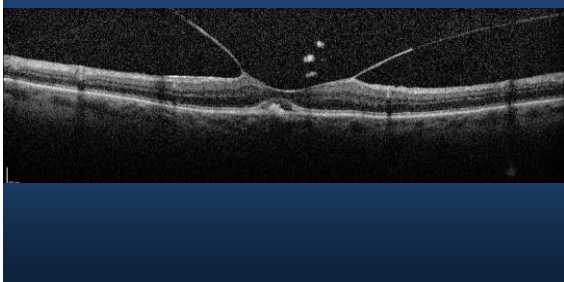
What to look for in Line Scans

- Contour
- Thickness
- Reflectivity: Bright/Dark
- Shadowing
- Layers/Location

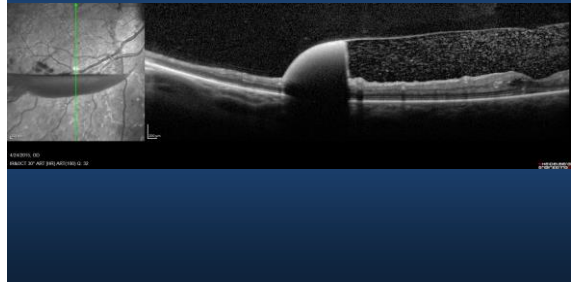
Location of Findings

- Vitreous
- Preretinal
- Intraretinal
- Subretinal
- Sub RPE
- Choroid

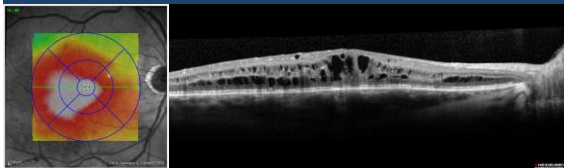
Location: Vitreous



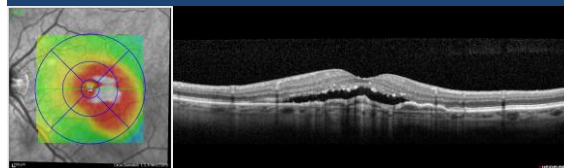
Location: Preretinal



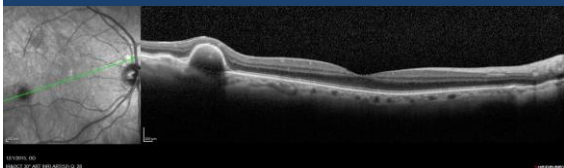
Location: Intraretinal



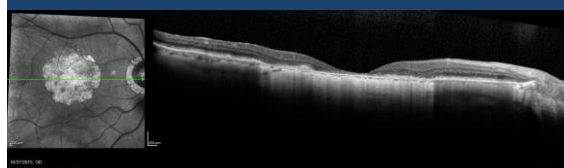
Location: Subretinal



Sub-RPE



Choroid

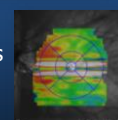
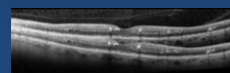


What to look for in Line Scans

- Contour
- Thickness
- Reflectivity: Bright/Dark
- Shadowing
- Layers/Location
- Artifacts

Identifying Artifacts

- Scan artifacts
 - Movement
 - Inversion
 - Sampling
- Analysis /algorithm artifacts
 - Misidentified tissue boundaries

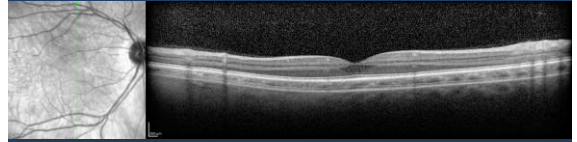


Identifying Artifacts

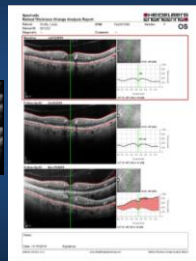
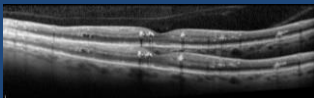
- Repetitive lines or shapes
- Mirrored images
- Upside down images
- Sharp lines on volume maps



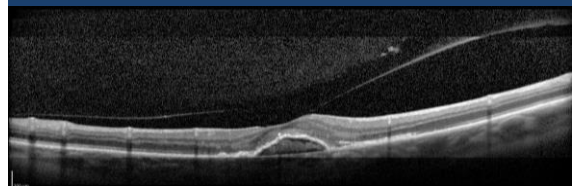
Movement Artifacts



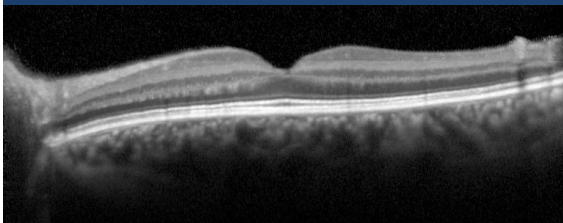
Movement Artifacts



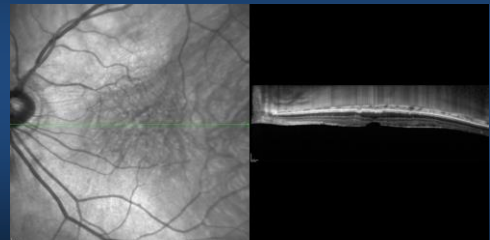
Sampling Artifacts



Sampling Artifacts

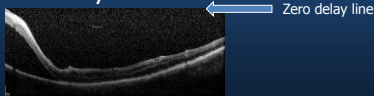


SD Inversion



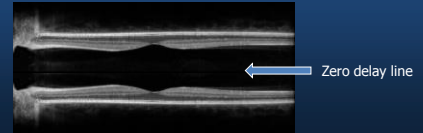
Zero-Delay Line

- OCT works on the principle of time-of-flight delay.
- Signal is strongest close to the zero time-delay line.
- Sensitivity falls off as image gets farther from zero-delay line.



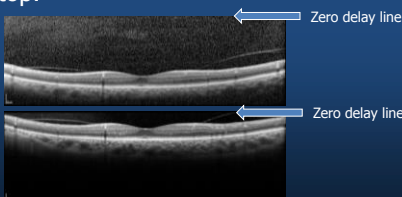
SD Inversion

- SD instruments cannot distinguish between positive and negative time delays.
- Produce mirror images near the 0-delay line.



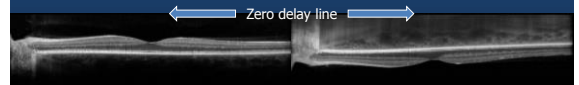
Zero-Delay Line

- The zero-delay is near the top of the window in SD-OCT, so we push close to the top.



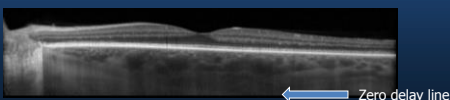
SD Inversion/EDI

- Moving the instrument forward moves the choroid of the inverted image closer to the zero-delay line and improves signal strength in choroid.



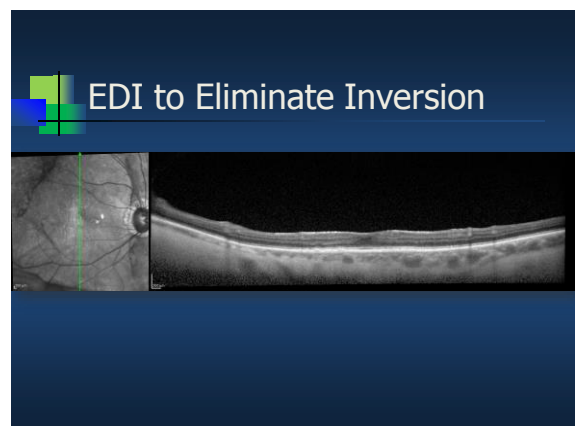
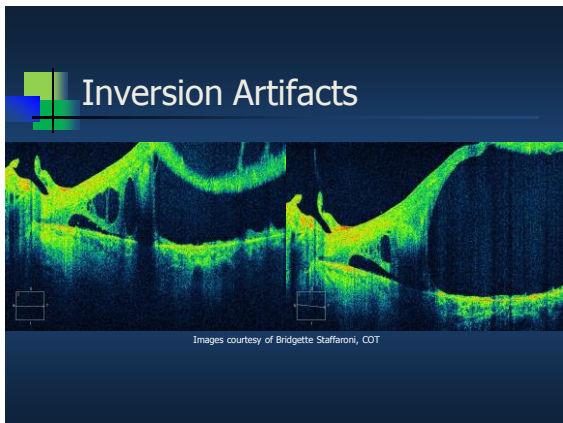
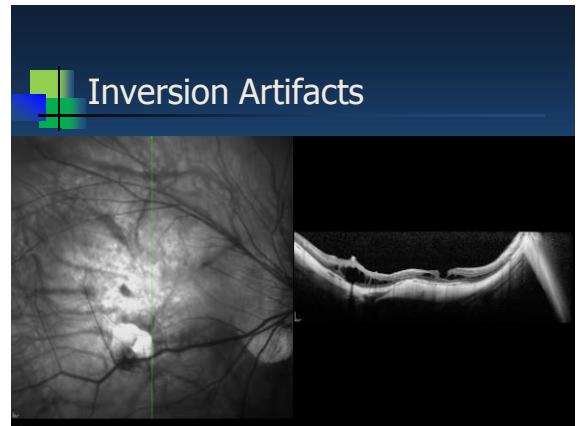
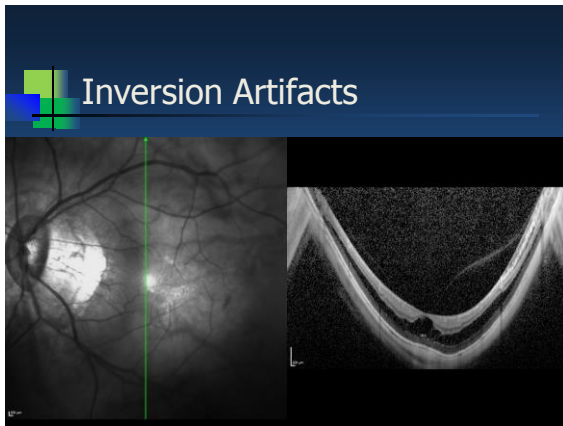
SD Inversion/EDI

- Moving the instrument forward moves the choroid of the inverted image closer to the zero-delay line and improves signal strength in choroid.
- The EDI feature places the zero point closer to the choroid without inversion.

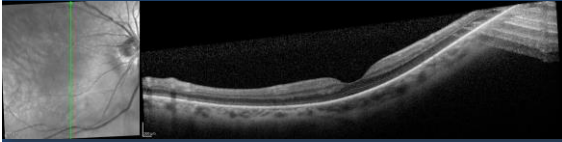


Inversion Artifacts

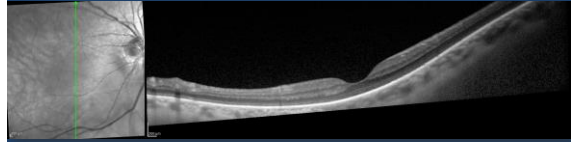
- Pathology is "too tall" for scan window
 - > 2mm
 - High myope, RD, traction, etc.
- Too close to eye/top of scan window.
- Only part of image inverts.
- Image may partially or completely flip for a few frames during sampling.



EDI to Eliminate Inversion

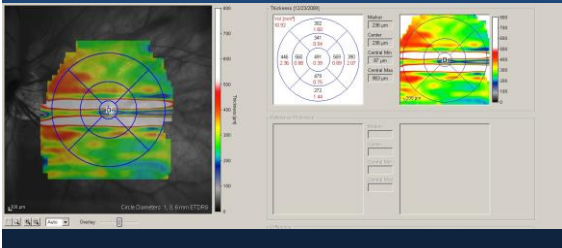


EDI to Eliminate Inversion

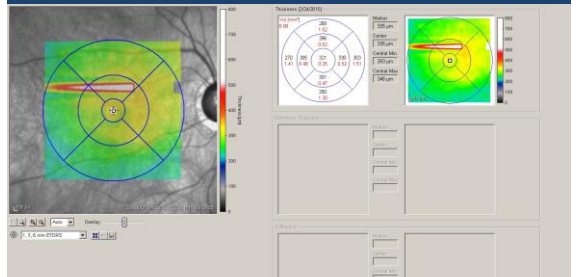


Analysis Artifacts

- Tissue boundary identification.



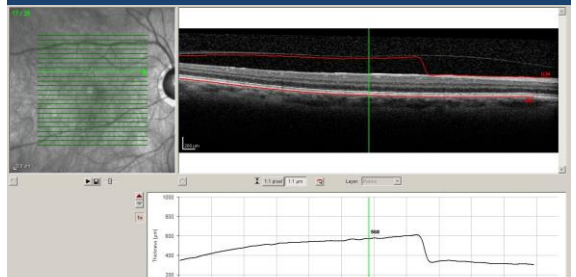
Boundary Line Artifacts



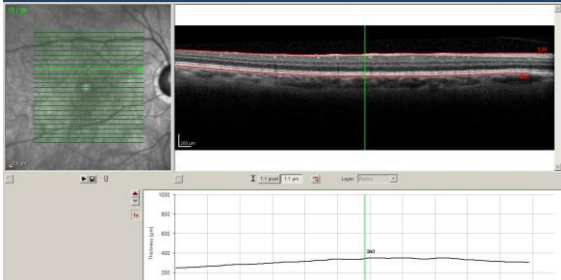
Boundary Line Artifacts

- Push scan higher in window (SD-OCT) to move anterior pathology out of view.
- Beware of inversion artifact.

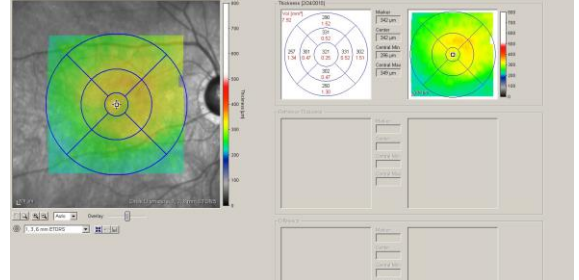
Boundary Line Artifacts



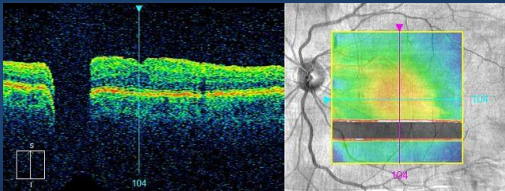
Boundary Line Artifacts



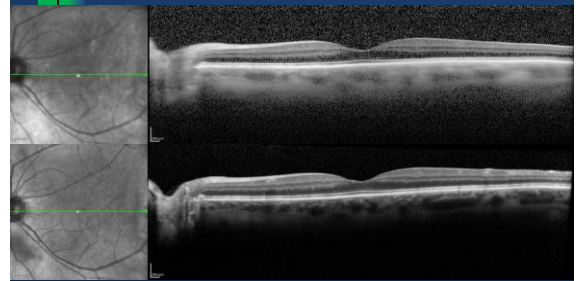
Boundary Line Artifacts



Artifact: Blinking



Artifact: Tear Film



Artifact: Oogies on My Lens

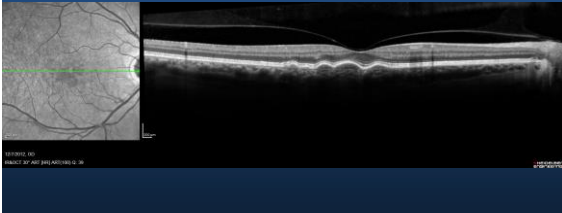


Putting it all Together

- Contour
- Thickness
- Brightness
- Shadowing
- Layers
- Artifacts

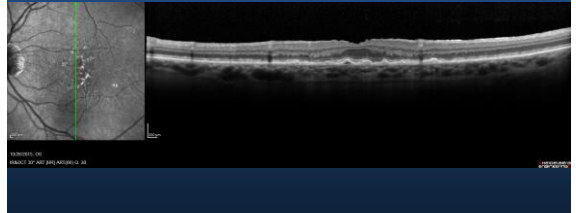
Descriptive Interpretation

- Resist the temptation to make a dx.
- Describe what you see:



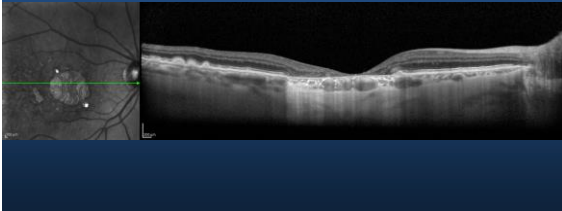
Descriptive Interpretation

- Resist the temptation to make a dx.
- Describe what you see:



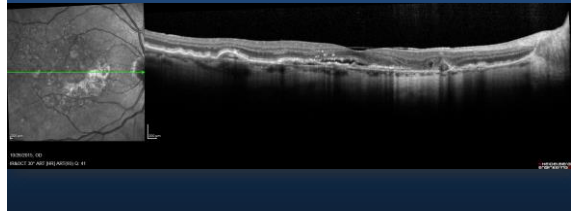
Descriptive Interpretation

- Resist the temptation to make a dx.
- Describe what you see:



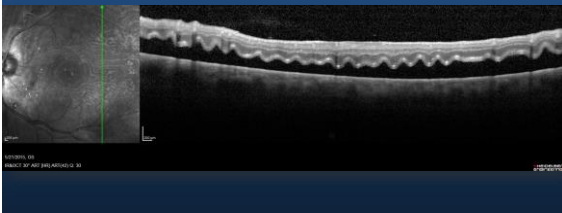
Descriptive Interpretation

- Resist the temptation to make a dx.
- Describe what you see:



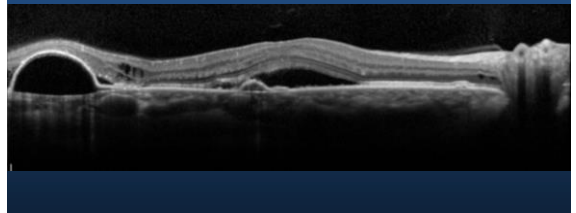
Descriptive Interpretation

- Resist the temptation to make a dx.
- Describe what you see:



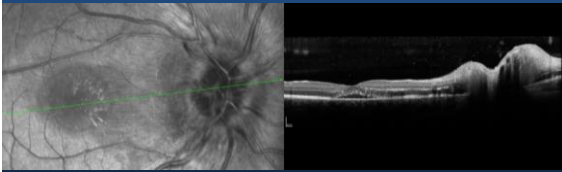
Descriptive Interpretation

- Resist the temptation to make a dx.
- Describe what you see:



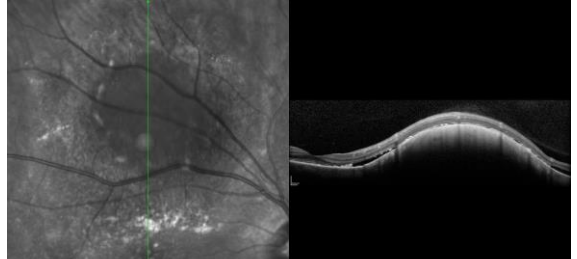
Descriptive Interpretation

- Resist the temptation to make a dx.
- Describe what you see:



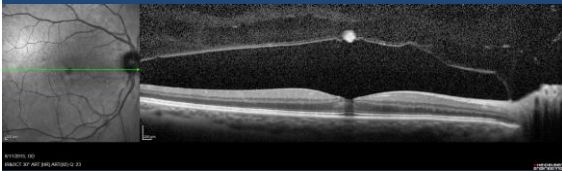
Descriptive Interpretation

- Resist the temptation to make a dx.



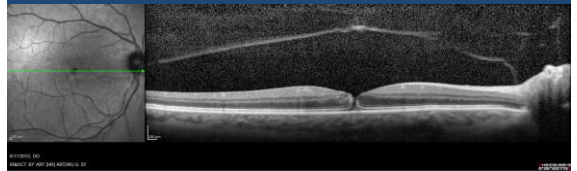
Descriptive Interpretation

- Resist the temptation to make a dx.
- Describe what you see:

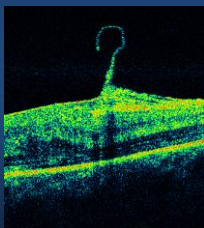


Descriptive Interpretation

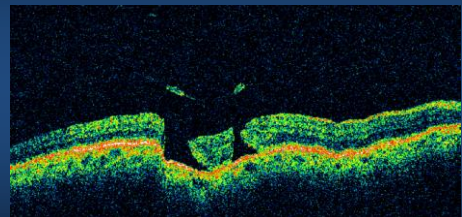
- Resist the temptation to make a dx.
- Describe what you see:



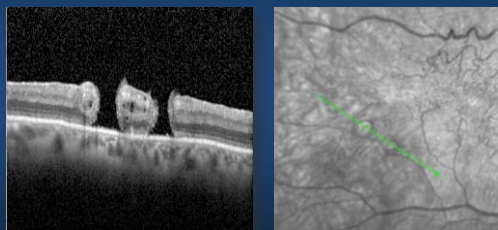
Art, Fact, or Artifact?



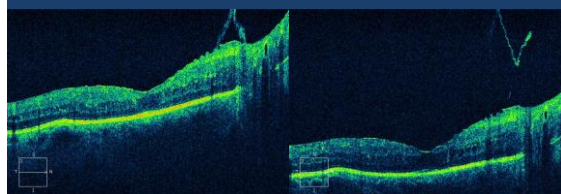
Art, Fact, or Artifact?



Art, Fact, or Artifact?

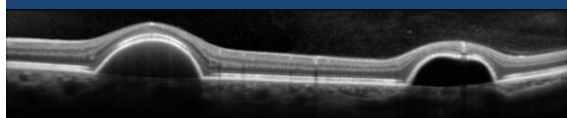


Art, Fact, or Artifact?



Images courtesy of Gary Miller, CRA, OCT-C

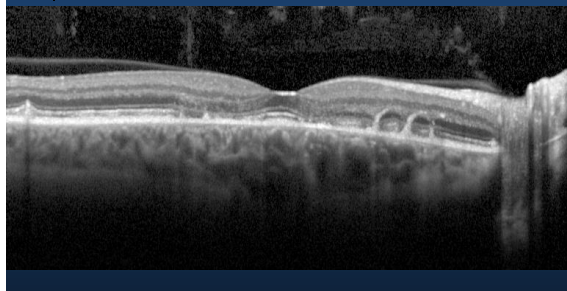
Art, Fact, or Artifact?



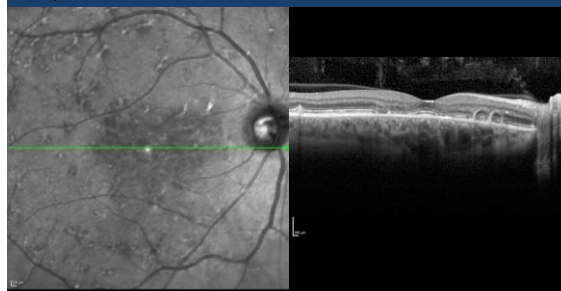
Art, Fact, or Artifact?

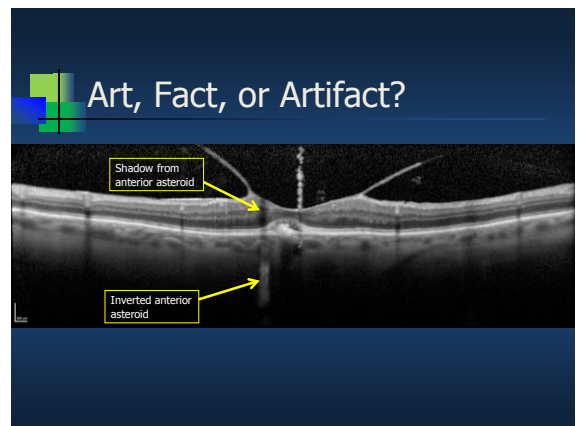
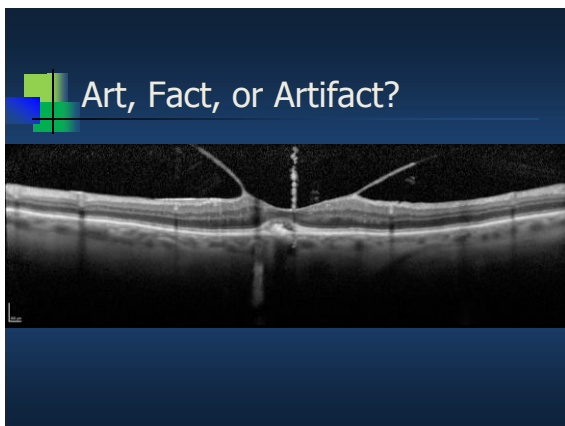
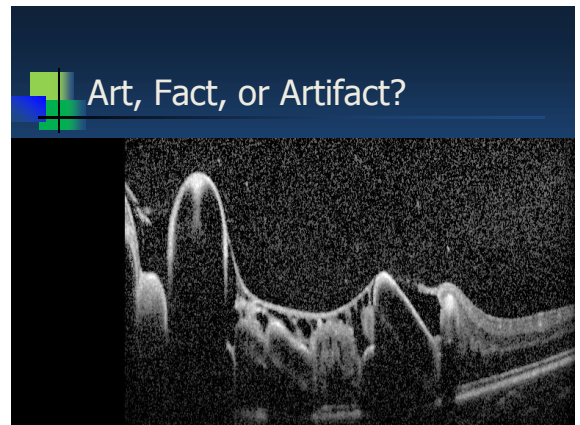
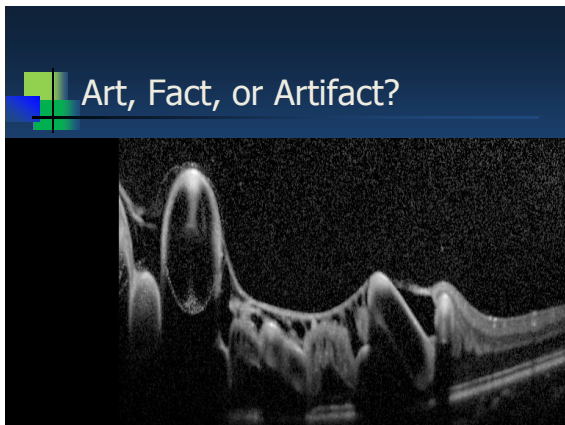
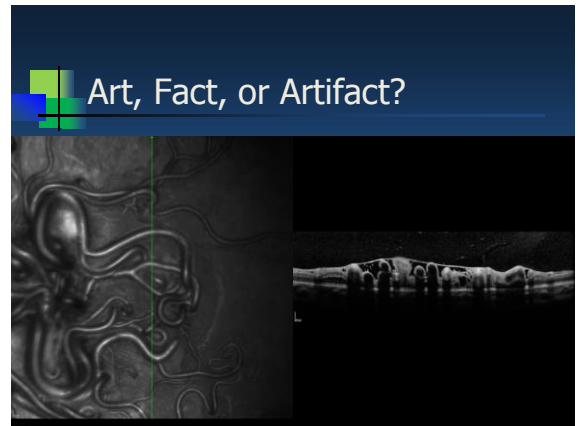
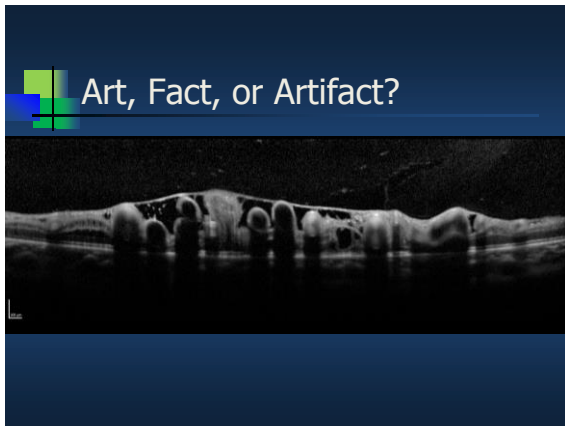


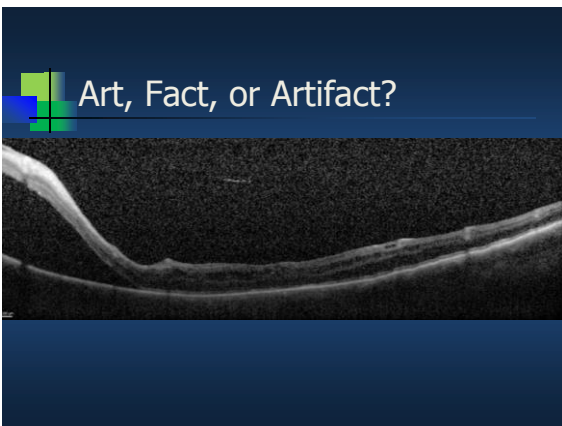
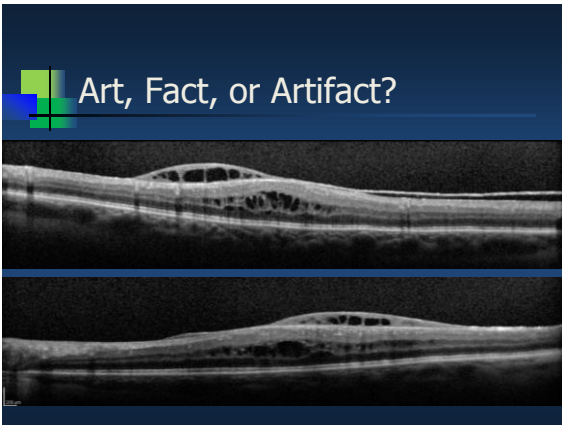
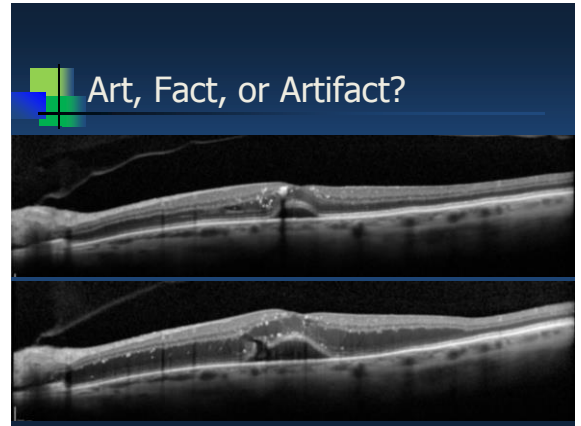
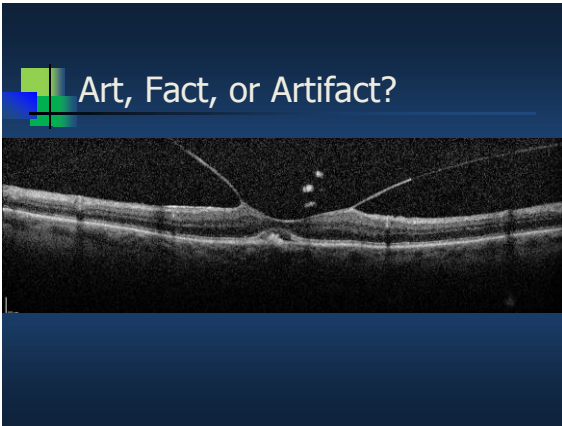
Art, Fact, or Artifact?



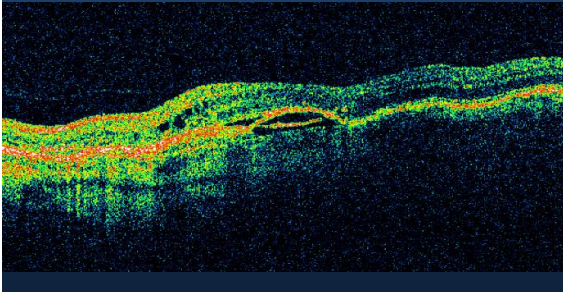
Art, Fact, or Artifact?







Art, Fact, or Artifact?



Questions?



<http://eye-pix.com/>
timbennett@eye-pix.com

