OCT BASICS

UNDERSTANDING THE TECHNOLOGY

DR AMRIT SAHIL PANJWANI (MBBS, MS OPHTHALMOLOGY)

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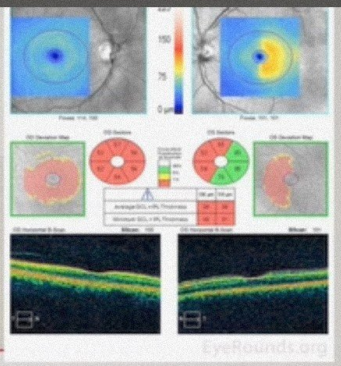
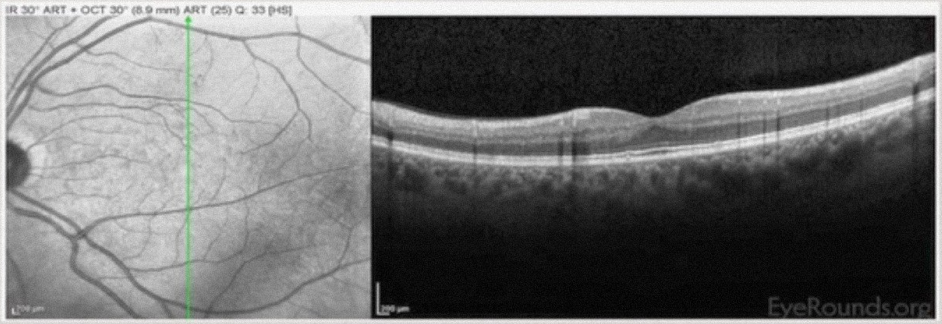
WHAT IS OCT?



- **Optical coherence tomography** is a non-invasive, noncontact imaging tool that allows for histology-like cross-sectional images of the human retina to be obtained.
- It makes use of Infra red light and measures the amount of optical reflectivity from a tissue.



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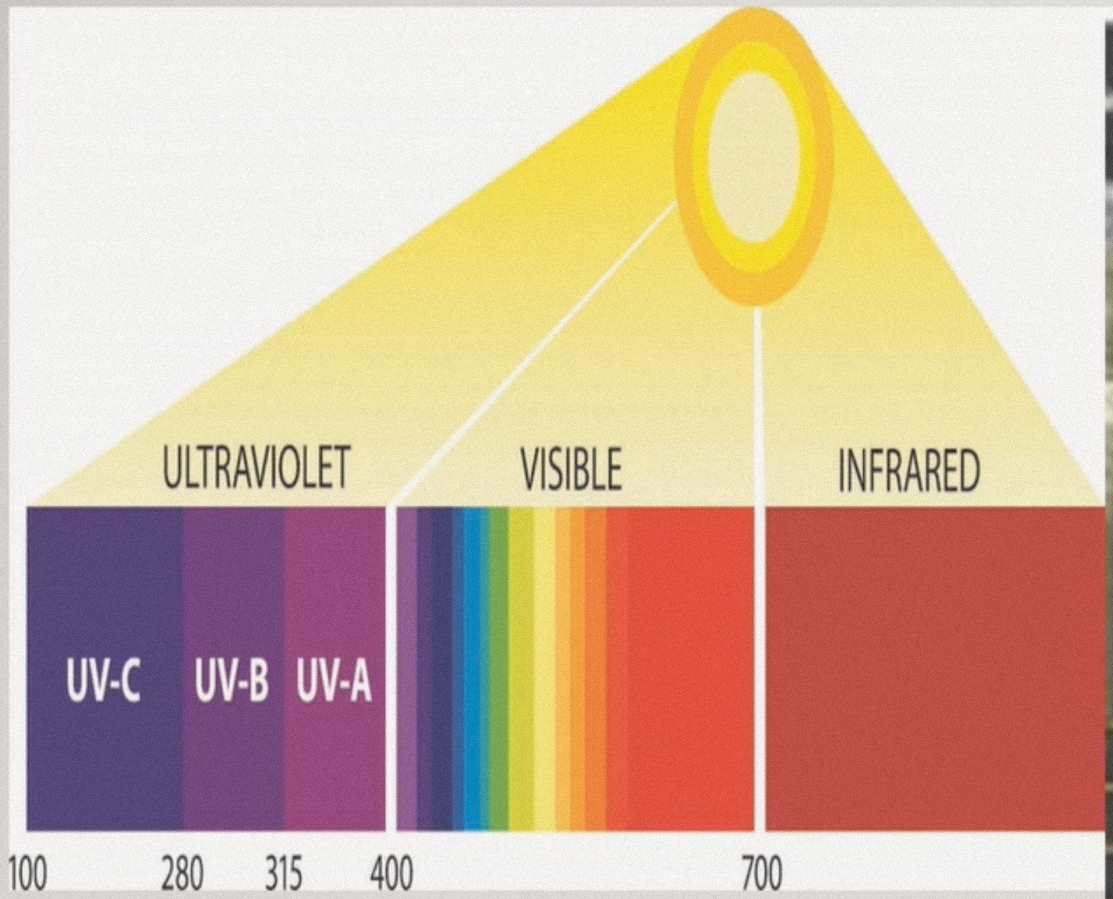

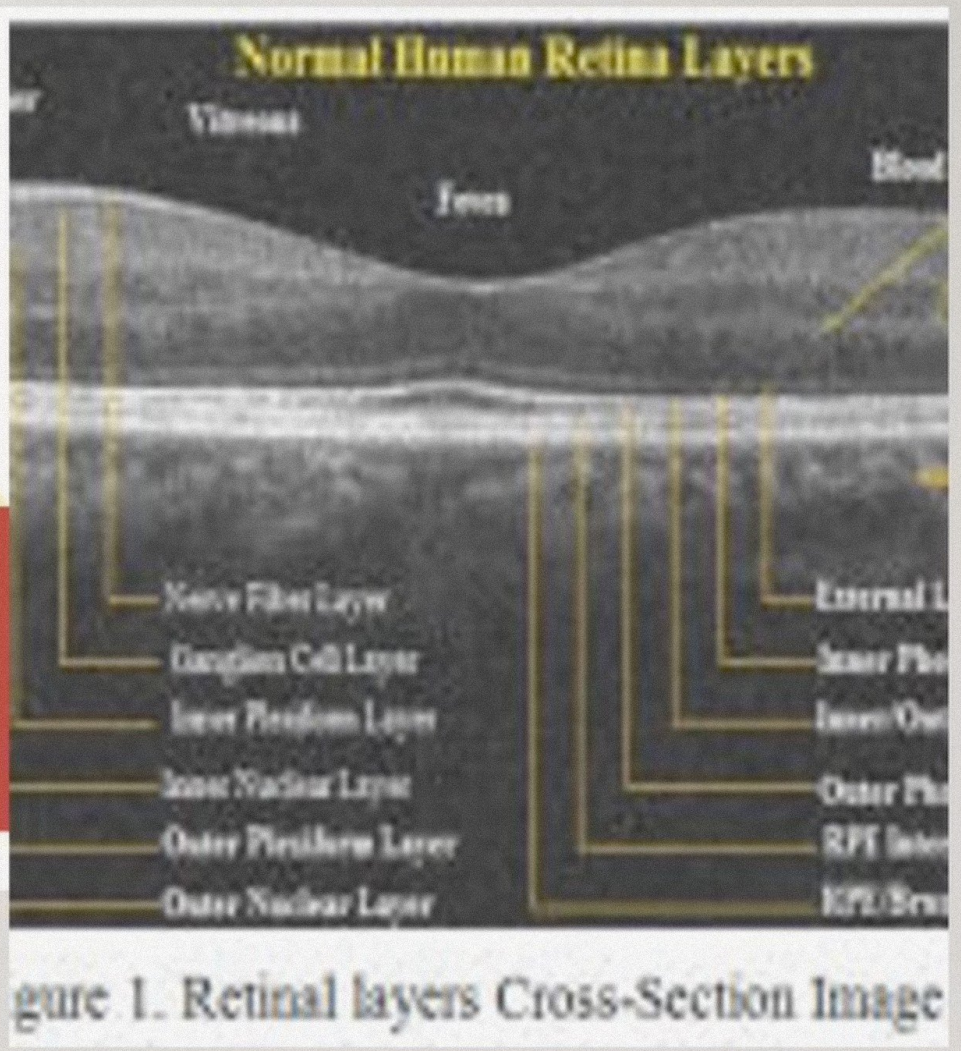

gure 1. Retinal layers Cross-Section Image

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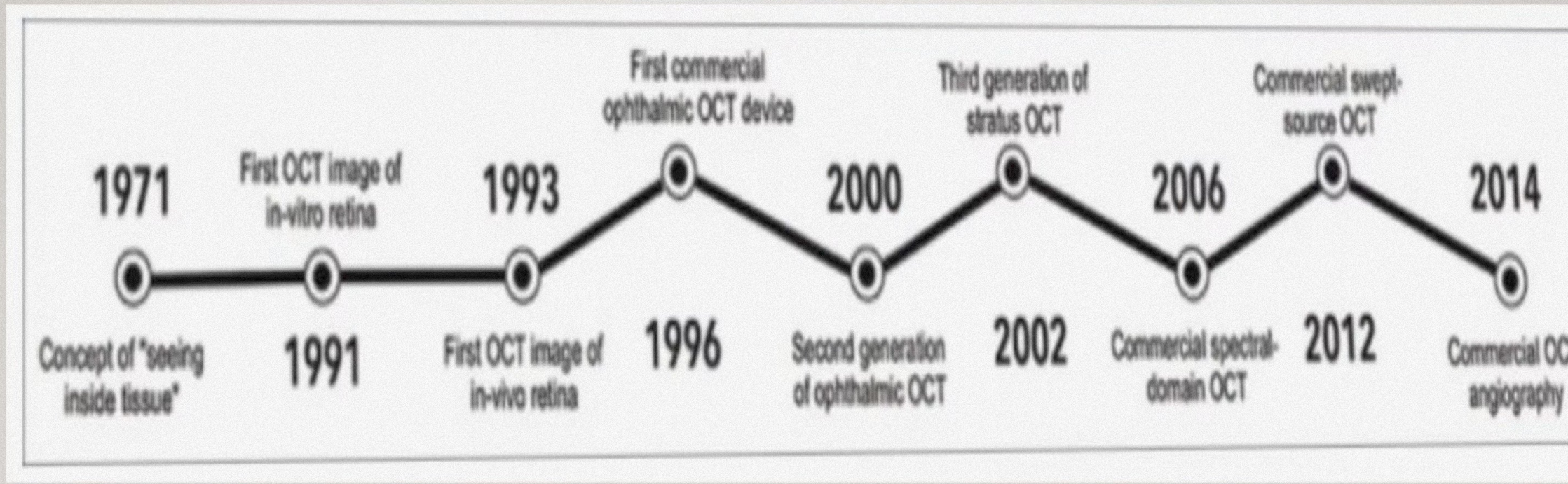
1971
Concept of "seeing inside tissue"
1991
First OCT image of in-vitro retina
1993
First OCT image of in-vivo retina
1996
First commercial ophthalmic OCT device
2000
Second generation of ophthalmic OCT
2002
Third generation of stratus OCT
2006
Commercial spectral-domain OCT
2012
Commercial swept-source OCT
2014
Commercial OC angiography

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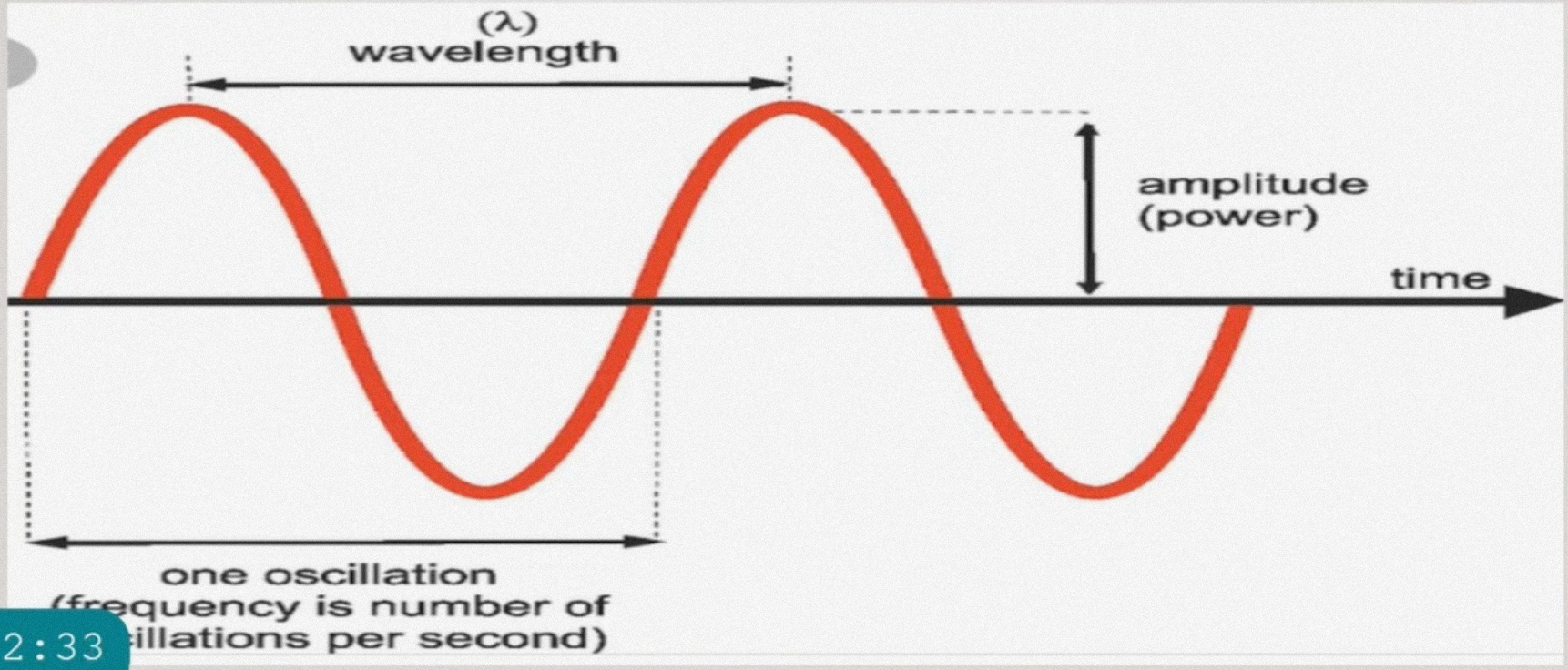
WAVE FORM

B scan → Acoustic waves



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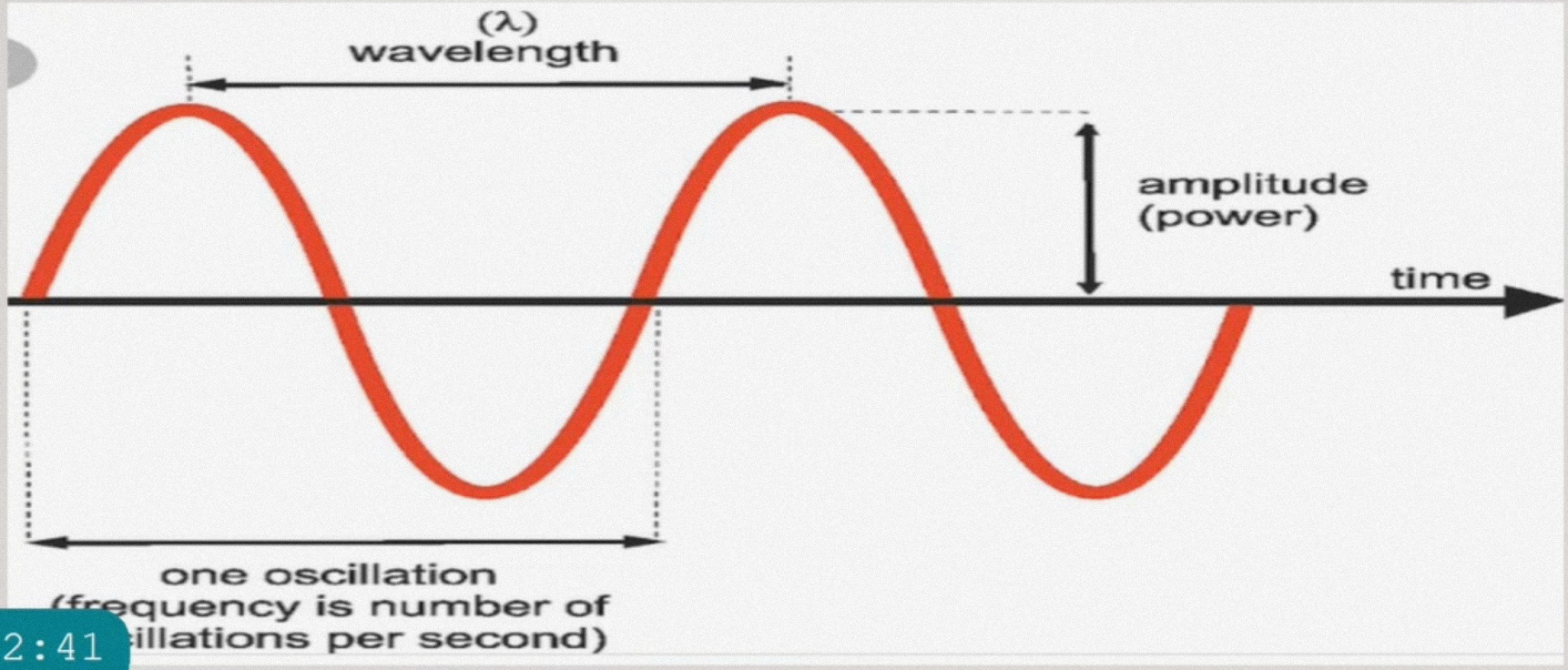
WAVE FORM

B scan → Acoustic waves

OCT → IR waves



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WHY DOES THE LIGHT REFLECT BACK ?

- **Because of the difference in the refractive index of the various layers of the retina .**

OCT is analogous to ultrasound measuring the intensity of the back reflected infrared light rather than the acoustic waves

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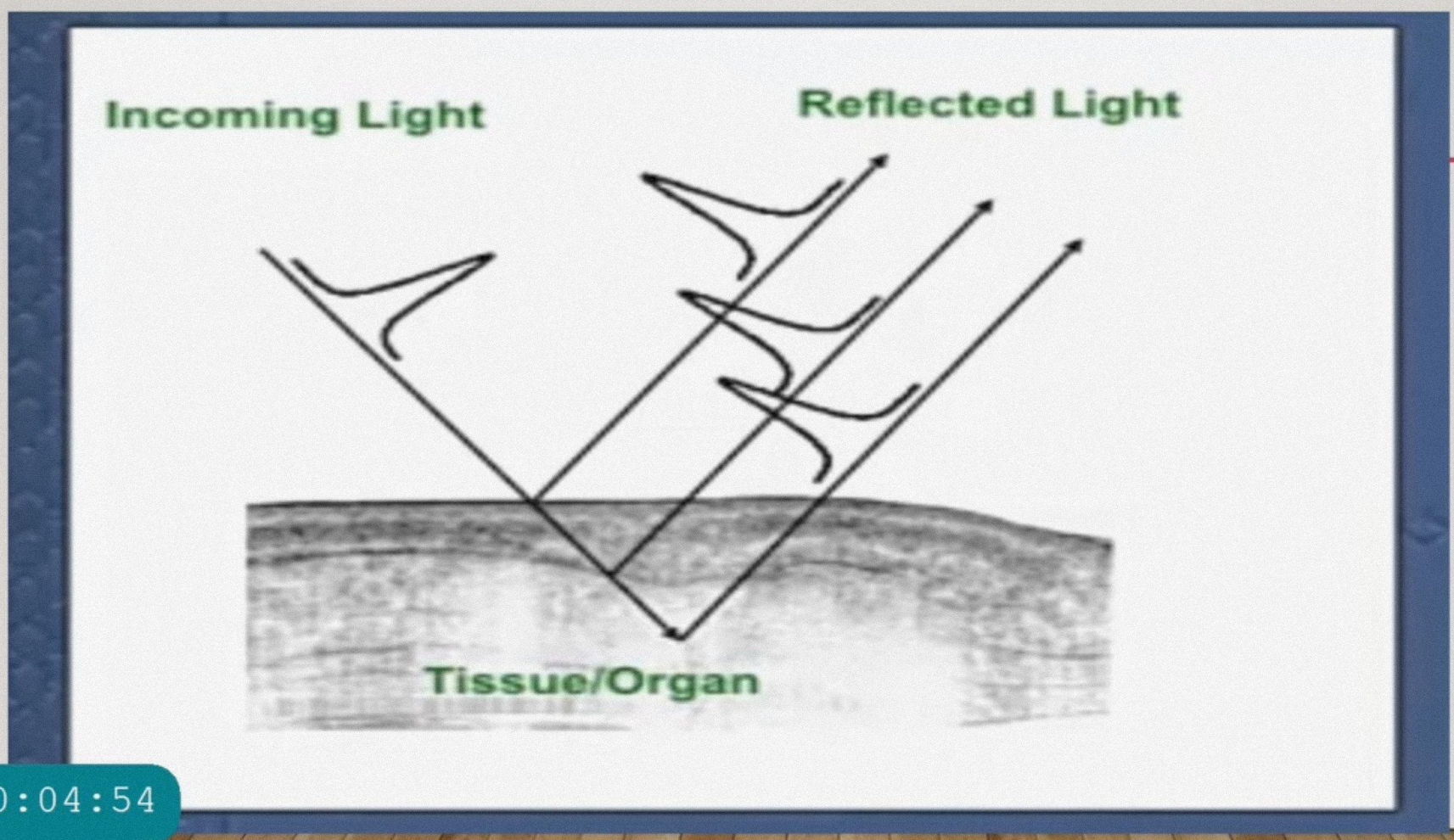

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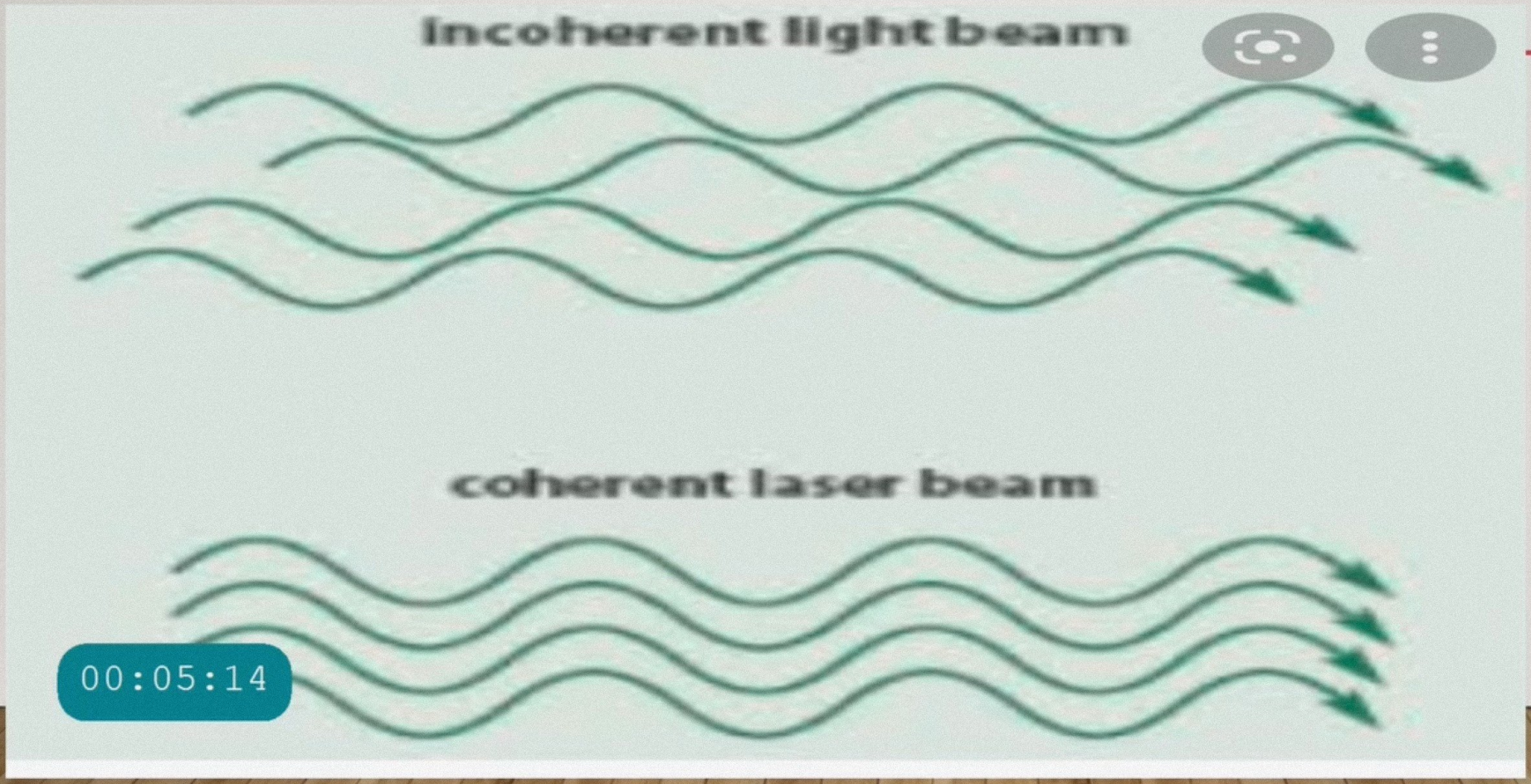
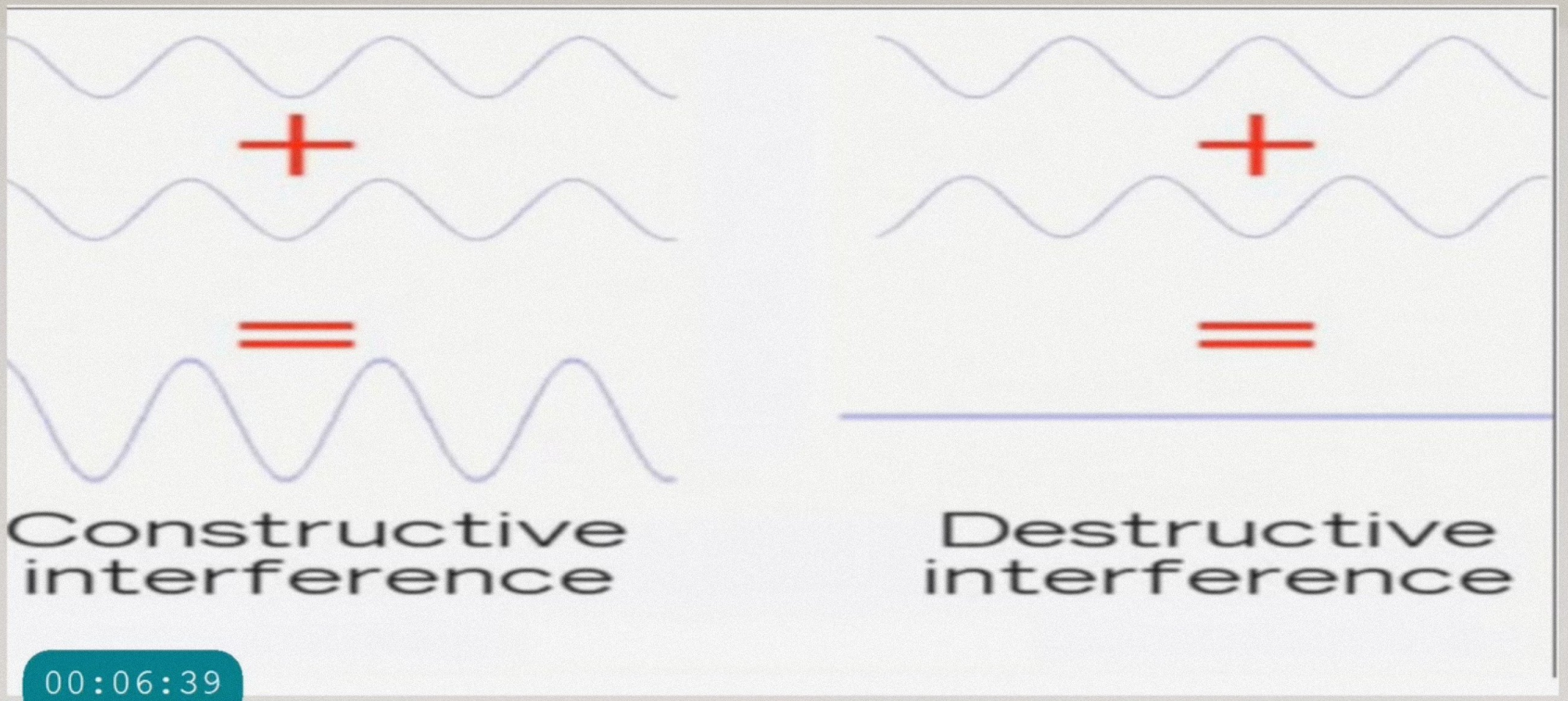
COHERENT V\S INCOHERENT



INTERFERENCE



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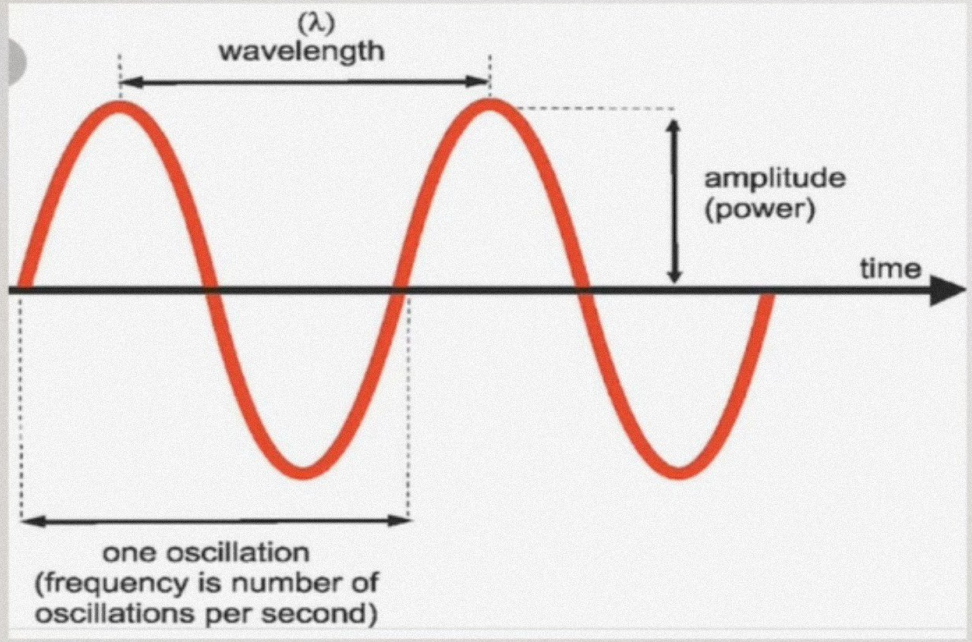
COHERENCE GATE \COHERENCE LENGTH



OCT
low coherence interferometry

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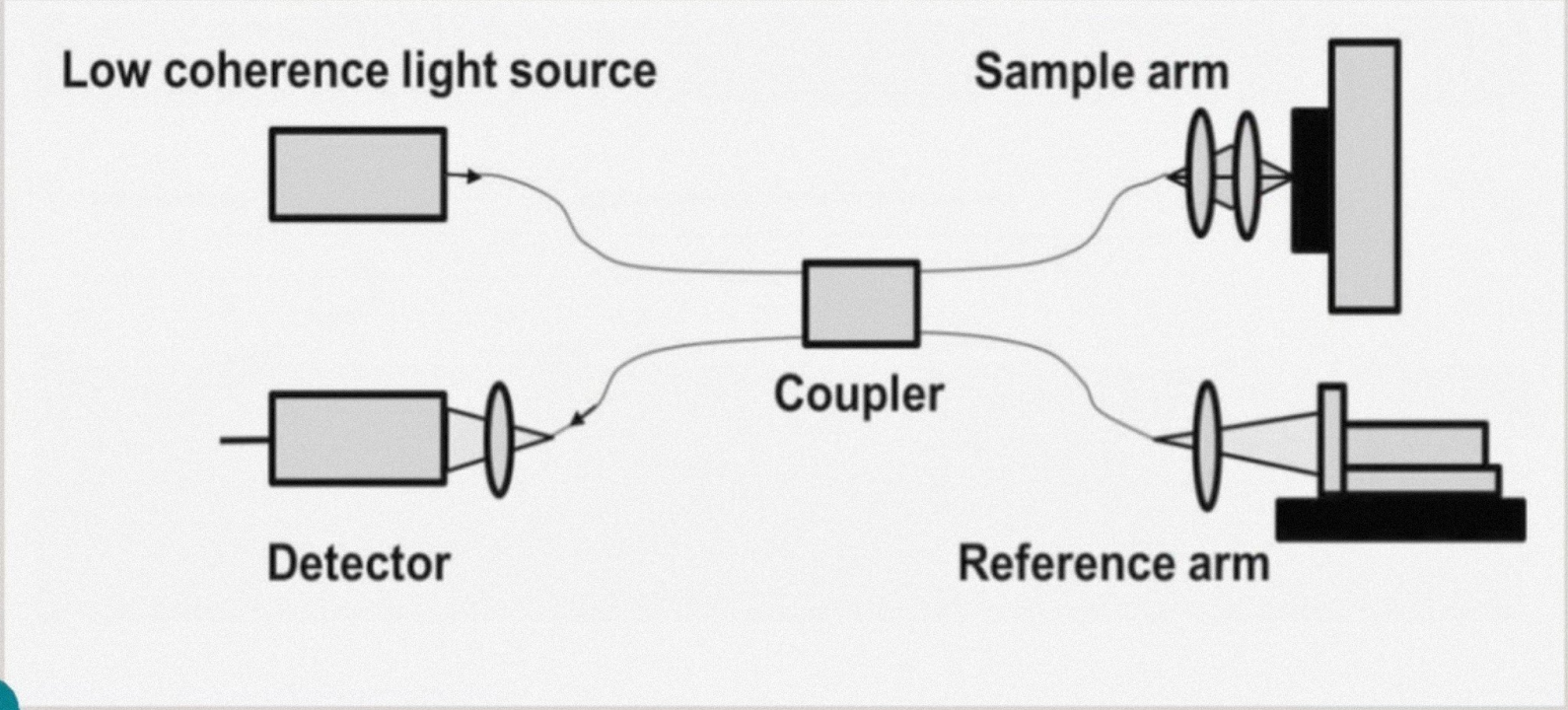
HOW IT WORKS? (MICHELSON'S INTERFEROMETRY PRINCIPLE)



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WHY DO WE NEED A REFERENCE ARM ?

- Light travels very fast
- Calculation of light delay using from the back scattered light is not possible, unlike the acoustic delay
- Therefore, a reference arm with a known optical pathlength is needed for indirect calculations.

00:11:27

HOW IT WORKS?

- Light from a low-coherence light source is split by a coupler into two paths, a sample and reference arm.
- In the **reference arm**, the light is reflected back by a reference mirror and returns into the interference system in the opposite direction that it came from.
- In the **sample arm**, the same process occurs except the beam is backscattered by the sample when materials of different indices of refraction are encountered.

00:13:25

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- In the **sample arm**, the same process occurs except the beam is backscattered by the sample when materials of different indices of refraction are encountered.
- The returning light from both arms are combined by the coupler and generate an **interference pattern**, which arrives at the detector and is recorded.

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Interference can occur only when the two arms are matched in length so that the returning pulses can arrive at the detector at the same time to interfere.

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TYPES / GENERATIONS

- **TIME DOMAIN** (TD-OCT)(first generation)

- **FOURIER DOMAIN**

1. Spectral domain (SD –OCT)(second generation)
2. Swept source oct (SS – OCT) (third generation)

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TIME DOMAIN OCT (STRATUS OCT)

- Uses a monochromatic light source
- Uses the physical movement of the mirror
- That is physical movement of the optical length to scan various depth or layers of the retina.
- Therefore , THERE IS TIME BASED MOVEMENT

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TIME DOMAIN OCT { T-D OCT)

400 A scans / seconds
AXIAL RESOLUTION :- 8-10 MICROMETER.

- **Does not** permit visualization of finer retinal structures or pathology, particularly the outer photoreceptor layers, retinal pigment epithelium (RPE), or choroid. It also suffers from lower interscan repeatability compared to SD-OCT.

- MOTION ARTIFACTS
- LESS SHARP AND SLOW

00:19:06

FOURIER DOMAIN (SPECTRAL DOMAIN)

CIRRHUS – HD
RT Vue OCT
TOPCON

- utilizes a **fixed reference arm**
- **broadband light source** (840-850nm)to produce a spectrum of wavelengths of backscattered light
- which is measured by a **high-speed spectrometer** in the detection arm of the interferometer.
- **Fourier transformation** to provide multiple A-scans with a single exposure

00:20:07

FOURIER DOMAIN (SPECTRAL DOMAIN)

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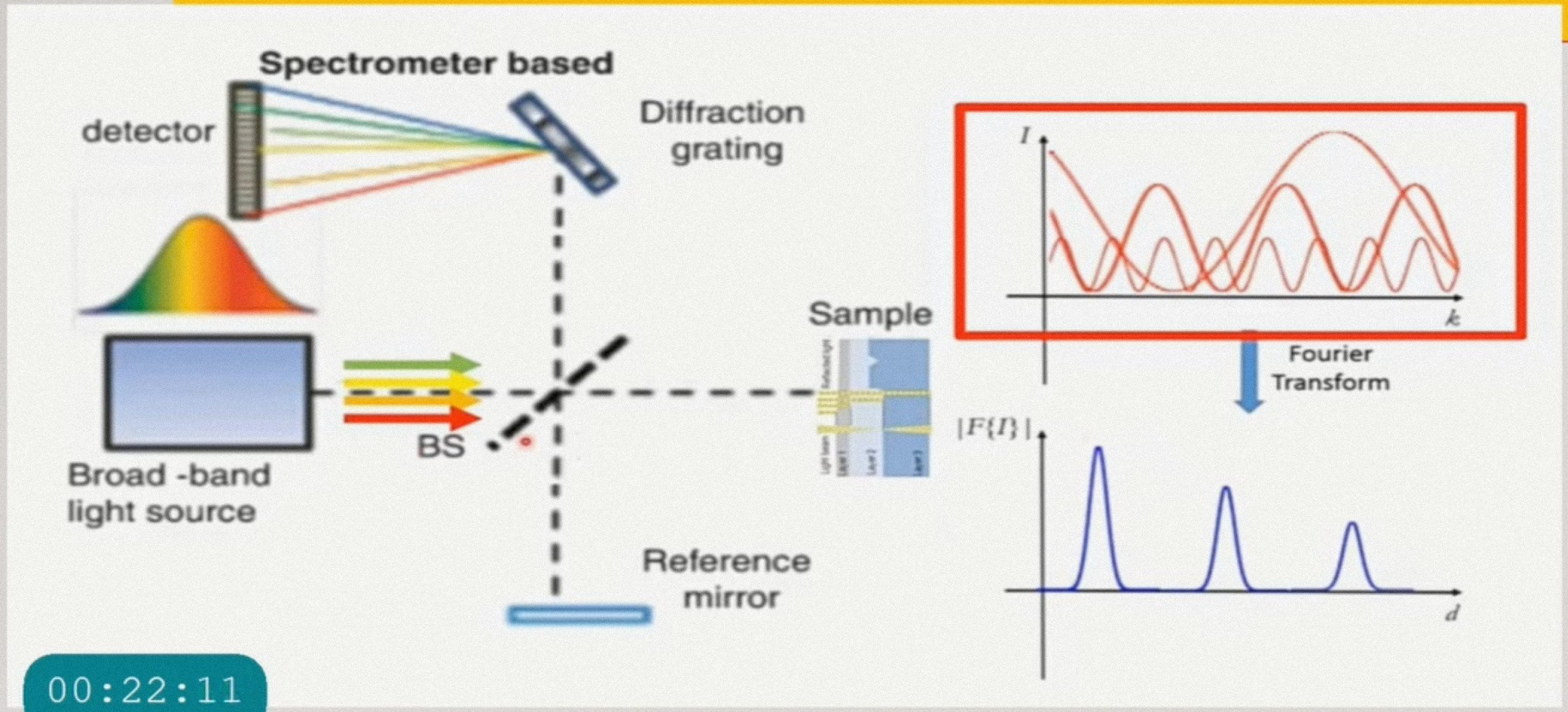
SPECTRAL DOMAIN (FOURIER DOMAIN)



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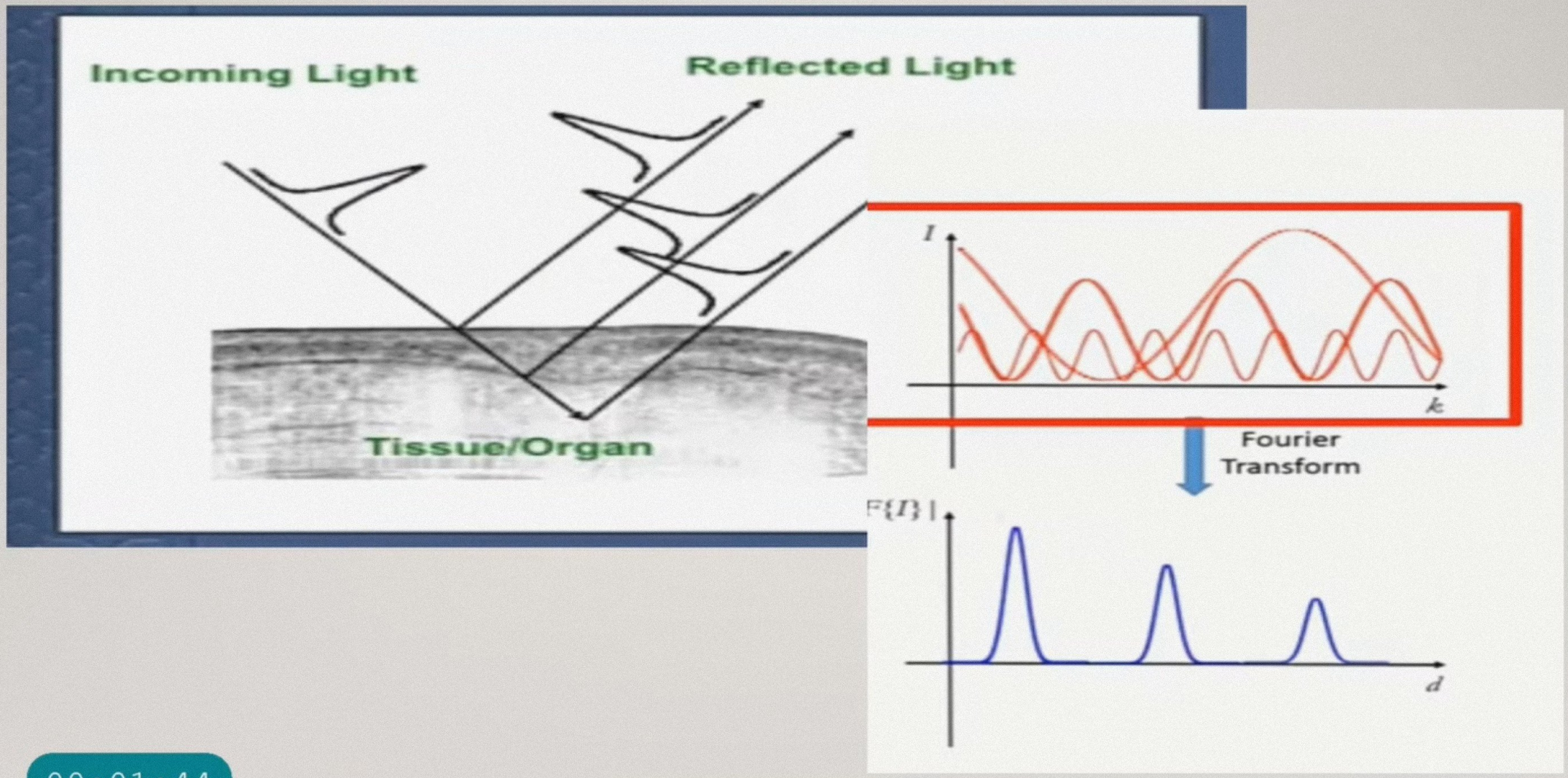
Incoming Light
Reflected Light
Tissue/Organ
I
k
Fourier
Transform
F{I}
d

00:01:44

18000-70000 A scans / seconds

AXIAL RESOLUTION :- 5-7 MICROMETER.

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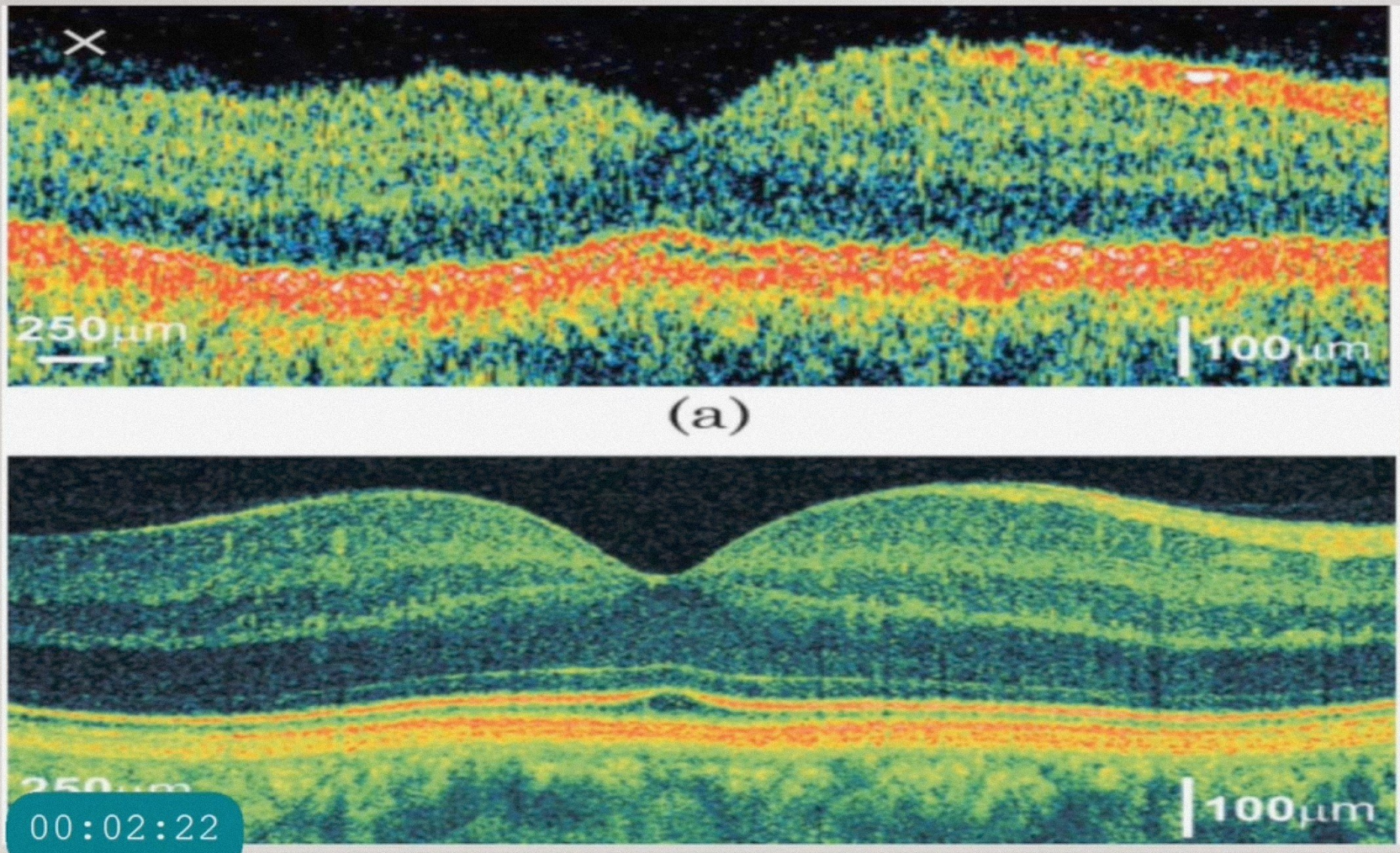

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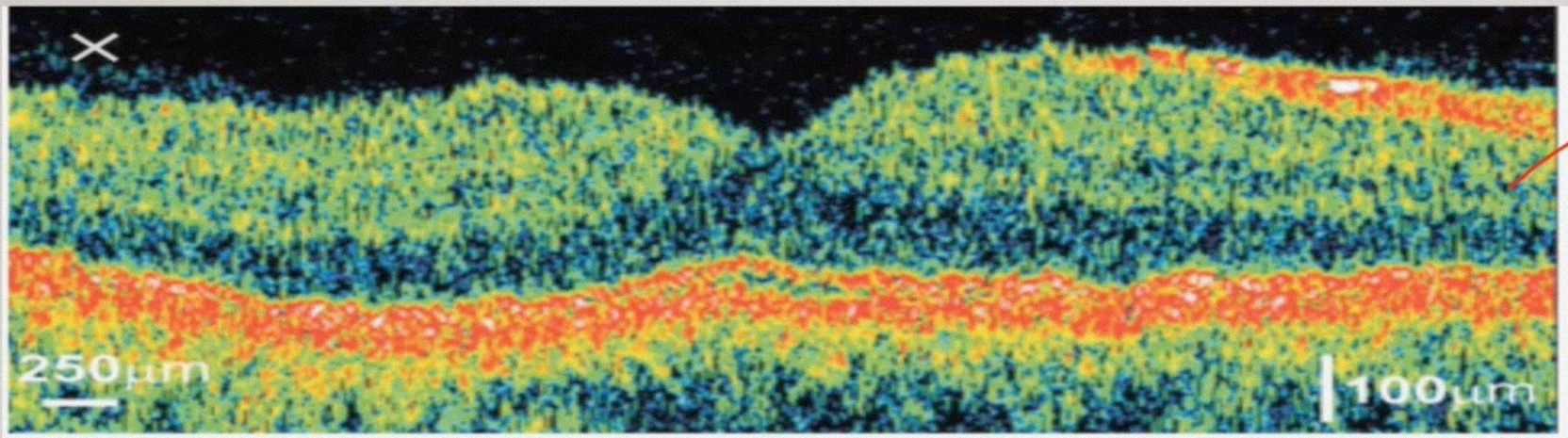
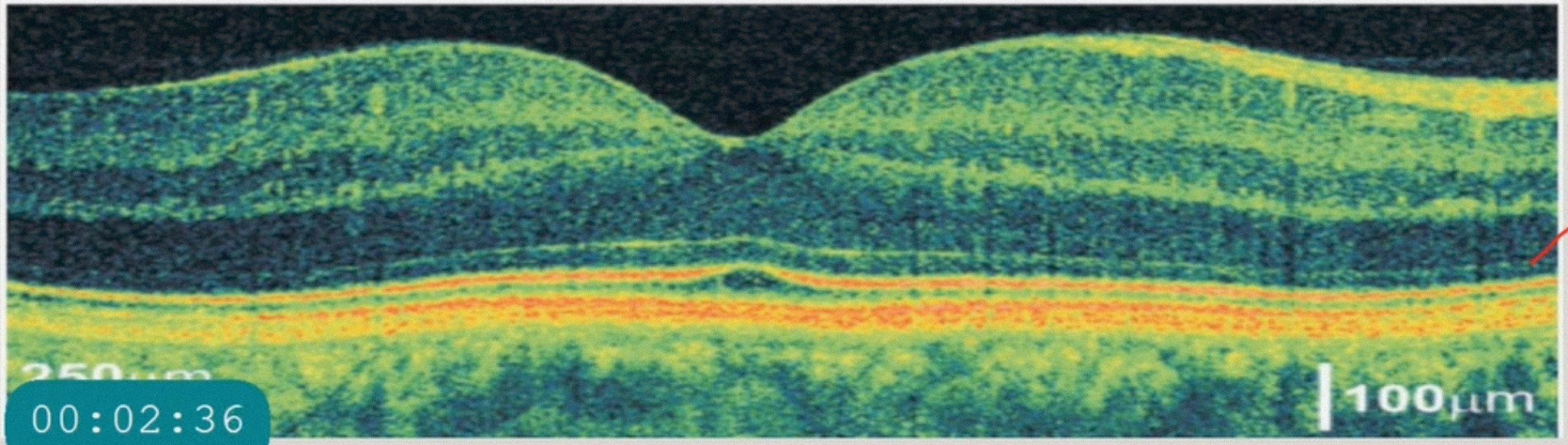


(a)



1D

3D

00:02:36

SWEPT SOURCE OCT (TIME ENCODED FREQUENCY DOMAIN OCT)

TOPCON's DEEP RANGE OCT (ATLANTIS)

- **Tunable frequency swept laser light** source (**1050 nm**)
- Instead of a reference mirror to sweep through a **broad range of frequencies.**
- The interferometric signals are detected on a single or small number of receivers as a function of time and
- undergo **inverse Fourier transformation** to generate A-scan information.

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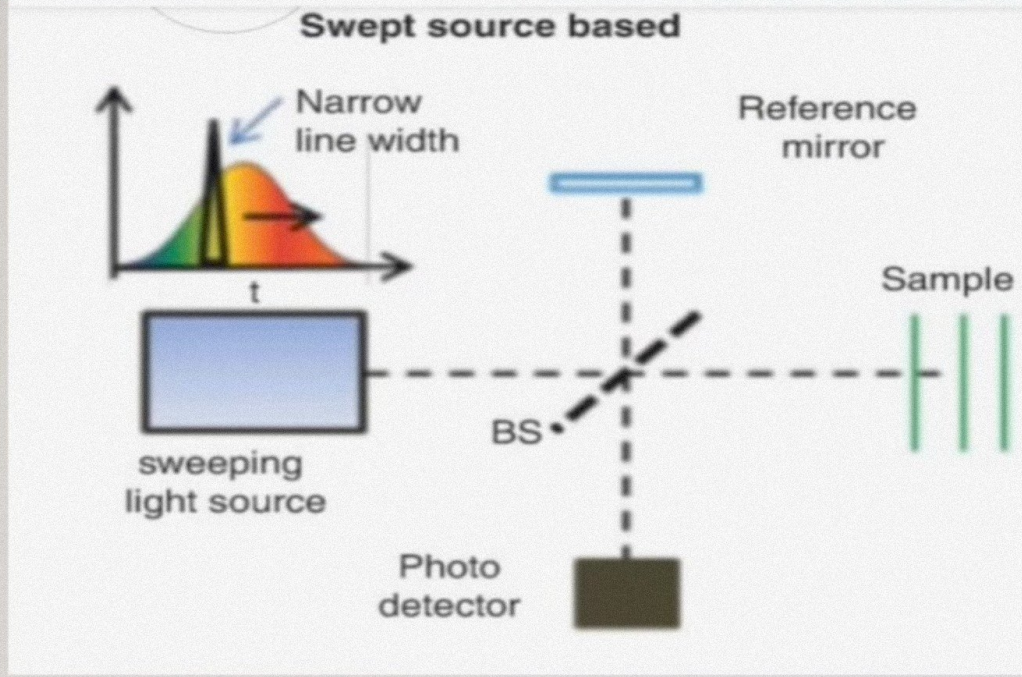
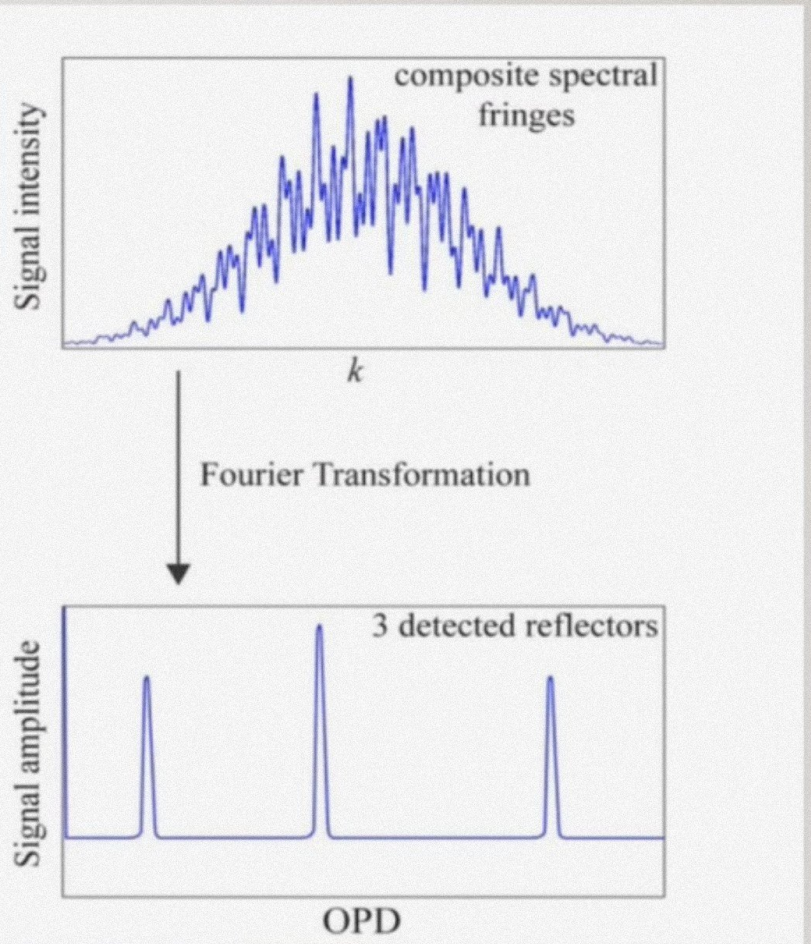
SWEPT SOURCE OCT





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400,000 A scans / seconds

AXIAL RESOLUTION :- 5-7 MICROMETER.

5-10x faster

Better signal to noise ratio

deep structures (i.e., choroid) and the vitreoretinal interface._

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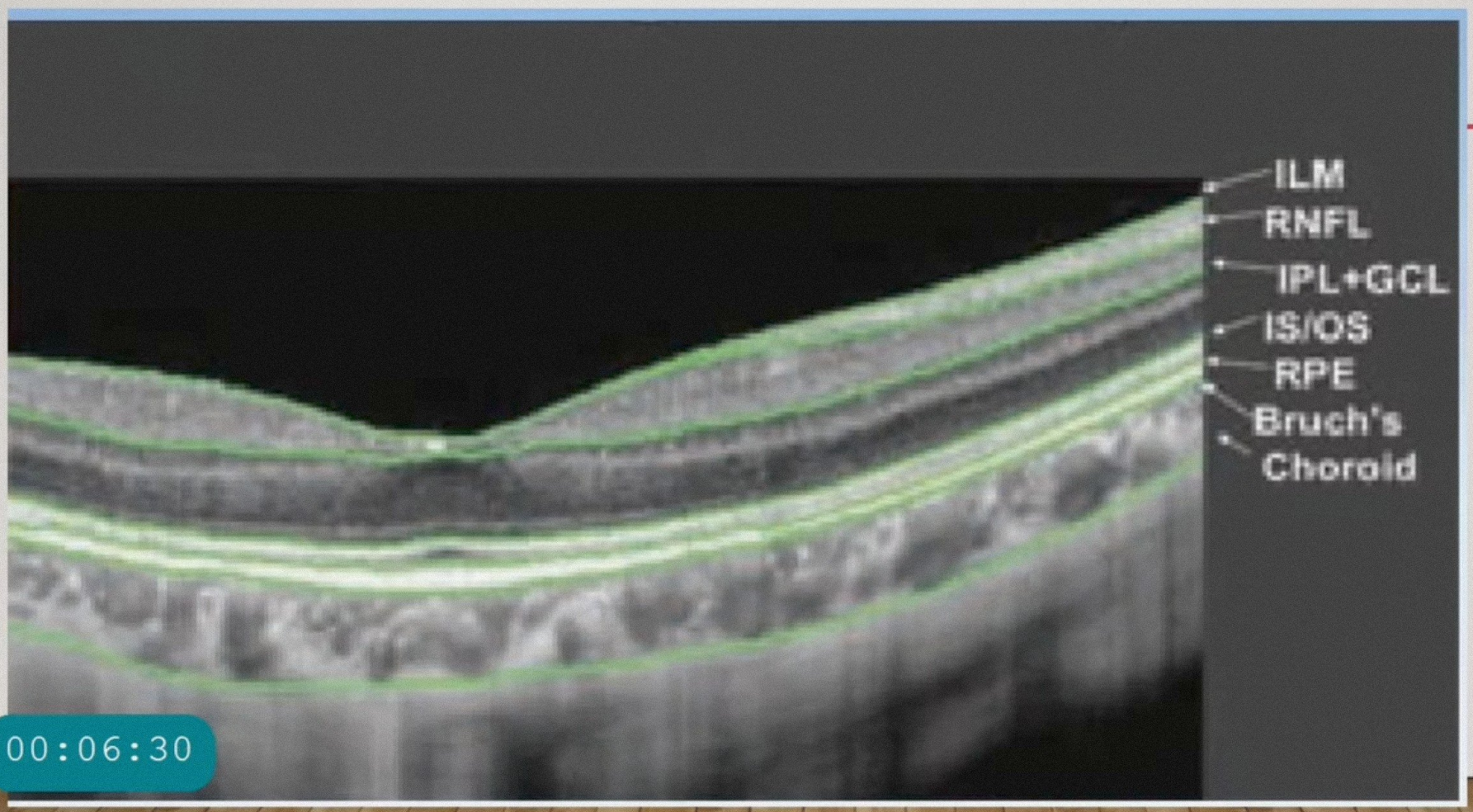
ILM
RNFL
IPL+GCL
IS/OS
RPE
Bruch's
Choroid
00:06:30

DIFFERENCES

	TD- OCT	SD- OCT	SS- OCT
Features	Movable reference mirror	Fixed reference mirror Spectrometer	Swept source laser
Wave length	810 nm	840 nm	1052 nm
A Scan Speed / Sec	512 scans/ sec	50000 scans/sec	100000 scans/ sec
Axial resolution	10 µ	8 µ	6 µ
Lateral resolution	20 µ	20 µ	20 µ
Artifacts	More	Less	Less
h of line	6mm	Up to 9mm	Up to 12 mm

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TYPES OF SCANNING

- Macular scans (cube, raster, star patterns)
- Line scans
- Additional scans

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