



OCT: Recent Development and Next generation

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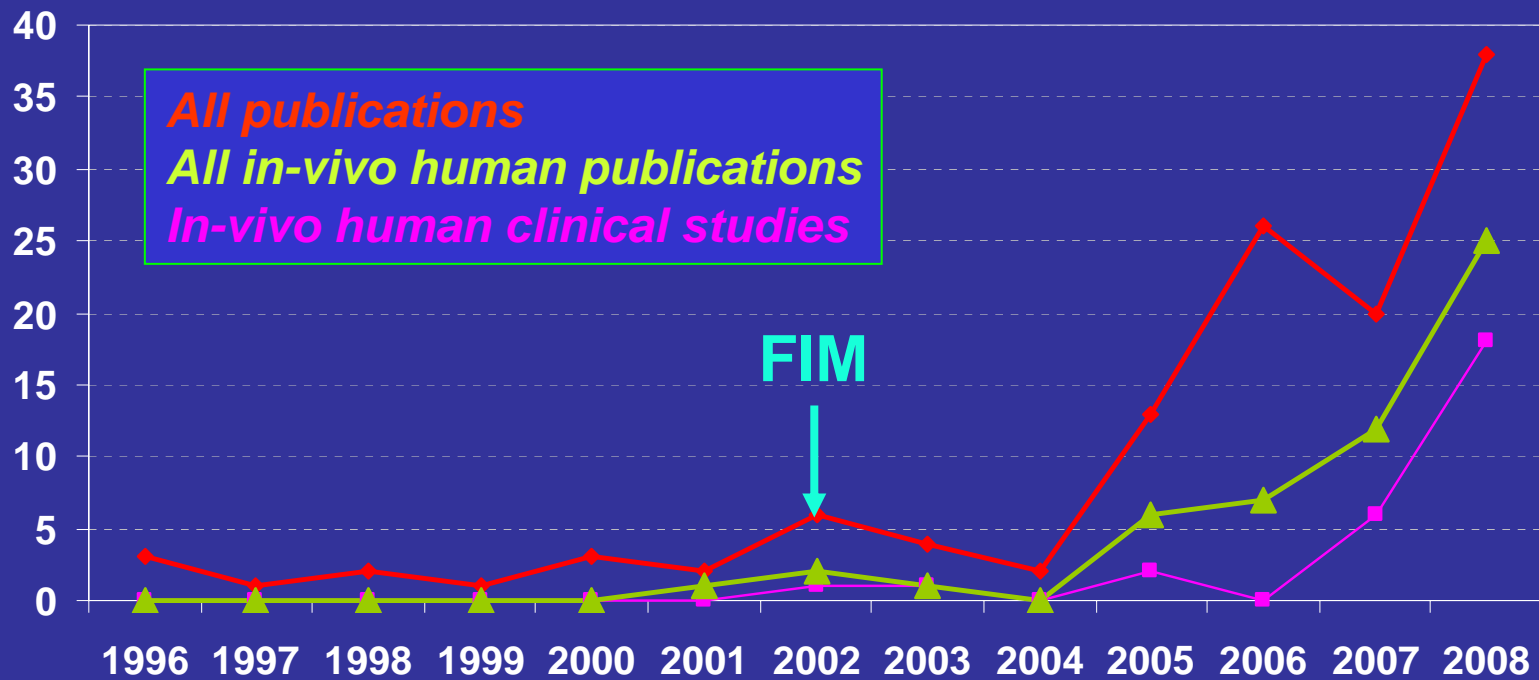


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Publications



Intravascular OCT



Intravascular Diagnostics for VP

Modality	Resolution	Penetration	Cap	Lipid	Inflam	Ca
IVUS	100 um	good	+	+	-	+++
Angioscopy	100 um	poor	+	++	-	-
OCT	10 um	poor	+++	++	+	+++
Thermography	500 um	poor	-	-	++	-
Spectroscopy	-	poor	+	++	++	++
IV MR	160 um	good	+	++	+	++



Limitations of the Current OCT

1. Low sensitivity for detecting collagen
2. No functional (physiologic) information
3. Need to create blood free zone
4. Shallow penetration depth



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Ex Vivo Study Results

Fibrous	Sensitivity	.87
	Specificity	.97
Calcific	Sensitivity	.95
	Specificity	1.0
Lipid pool	Sensitivity	.92
	Specificity	.94

Interobserver k = **0.88**, Intraobserver k = **0.91**

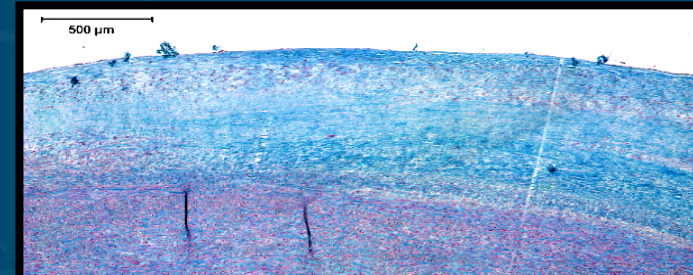




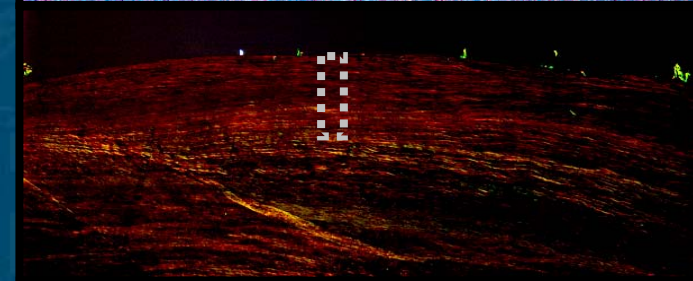
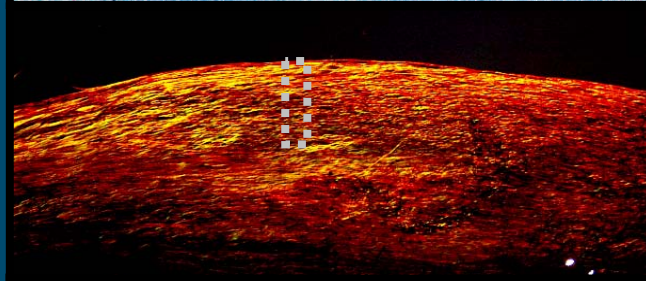
Polarization Sensitive OCT

Collagen Content by PS-OCT

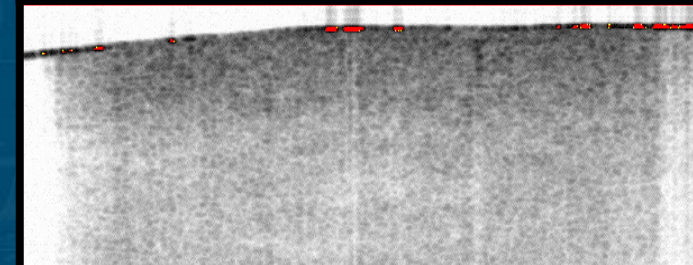
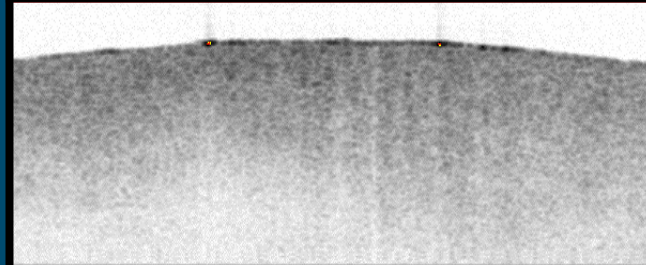
Trichrome



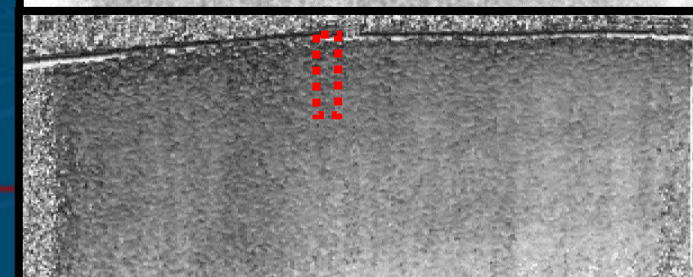
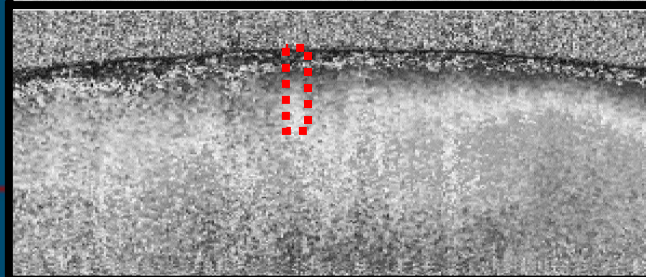
Picrosirius
Red



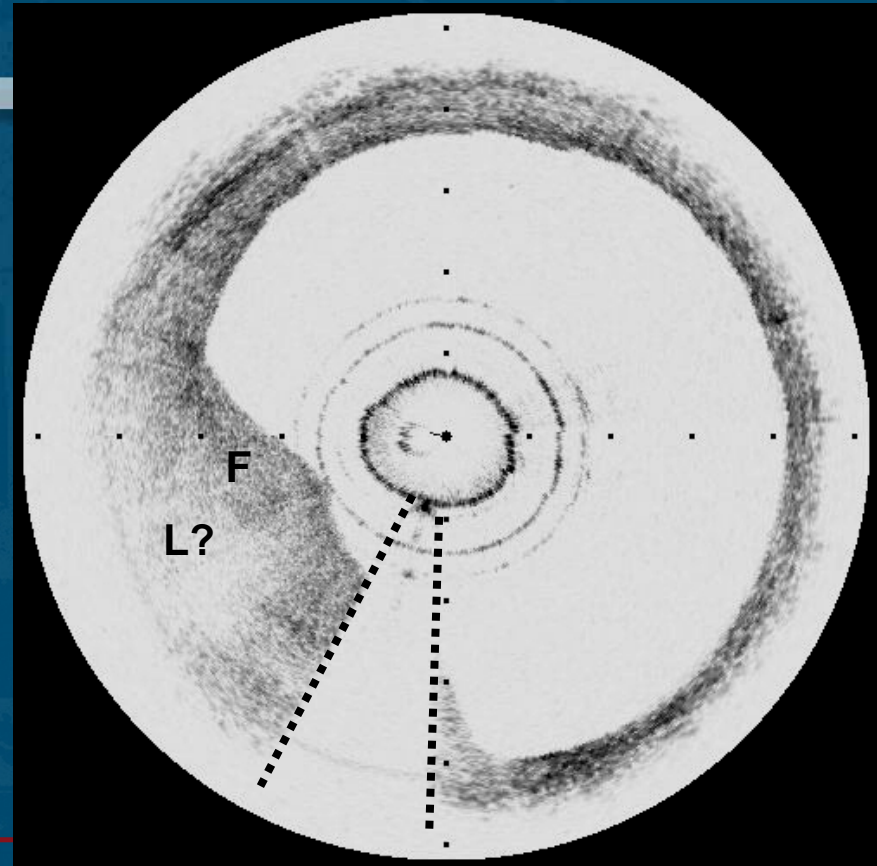
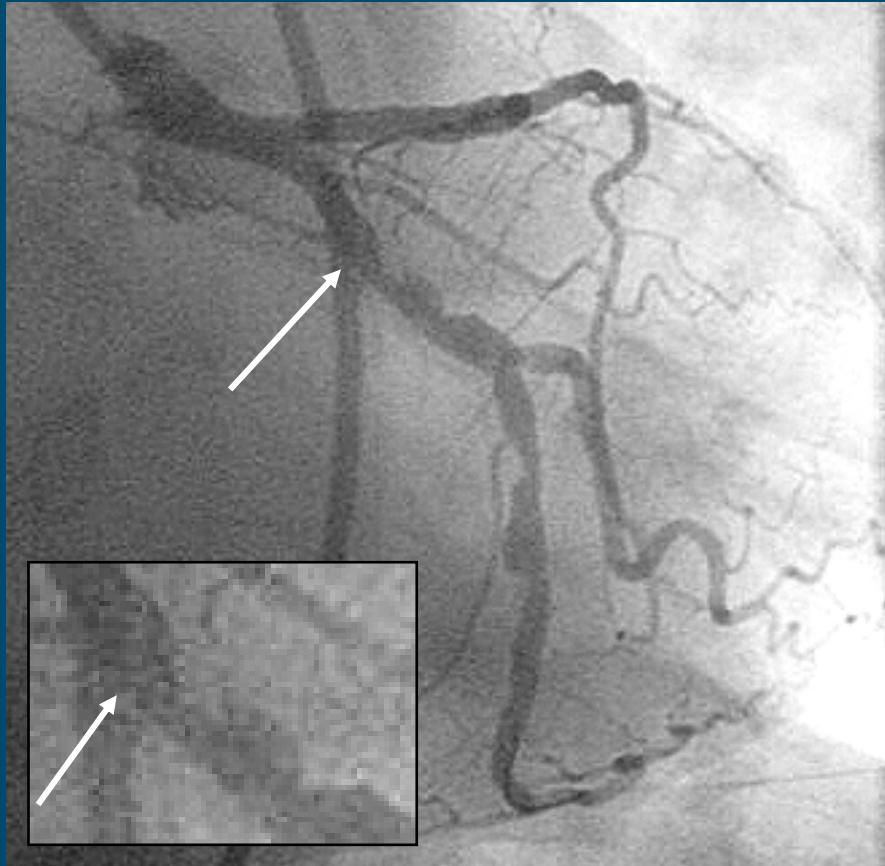
OCT



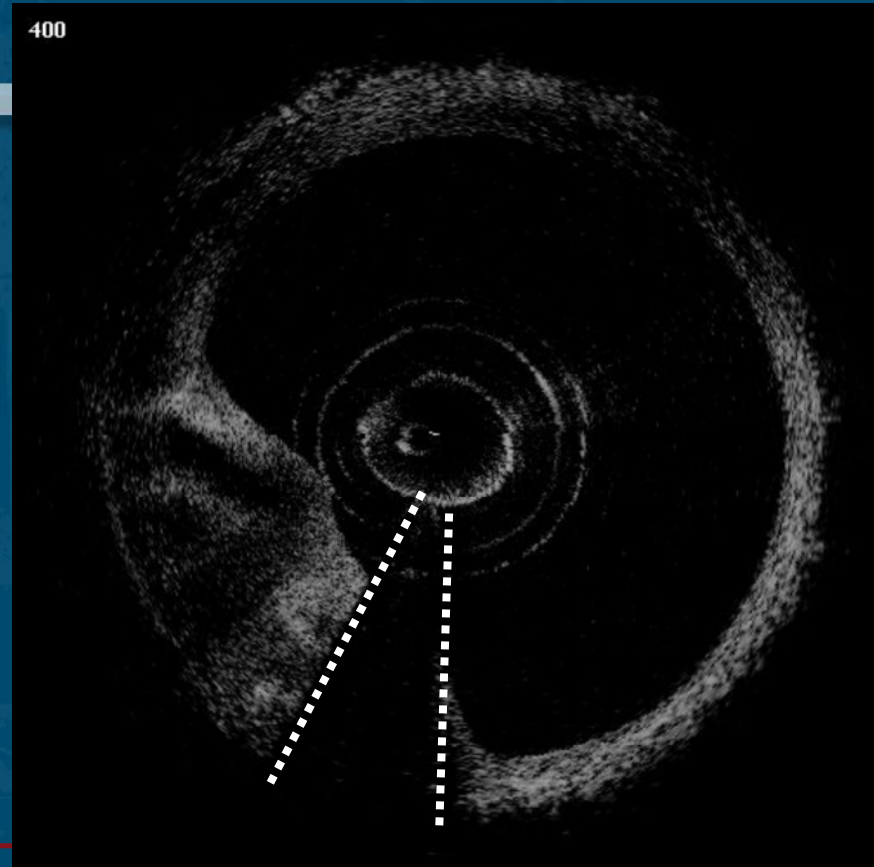
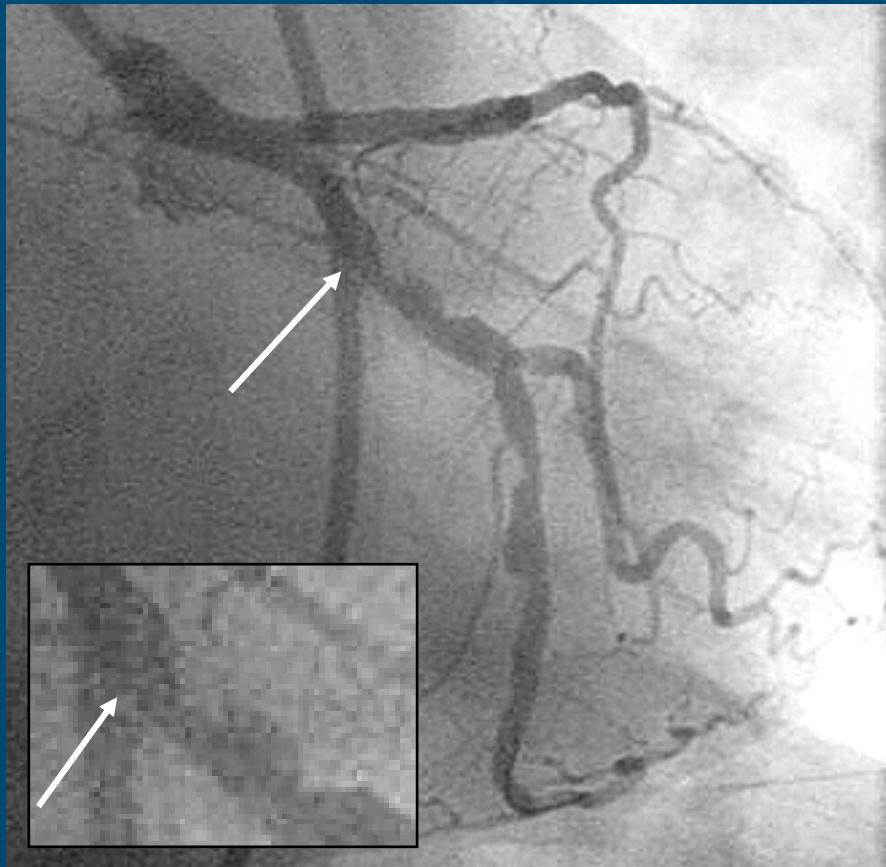
PS-OCT



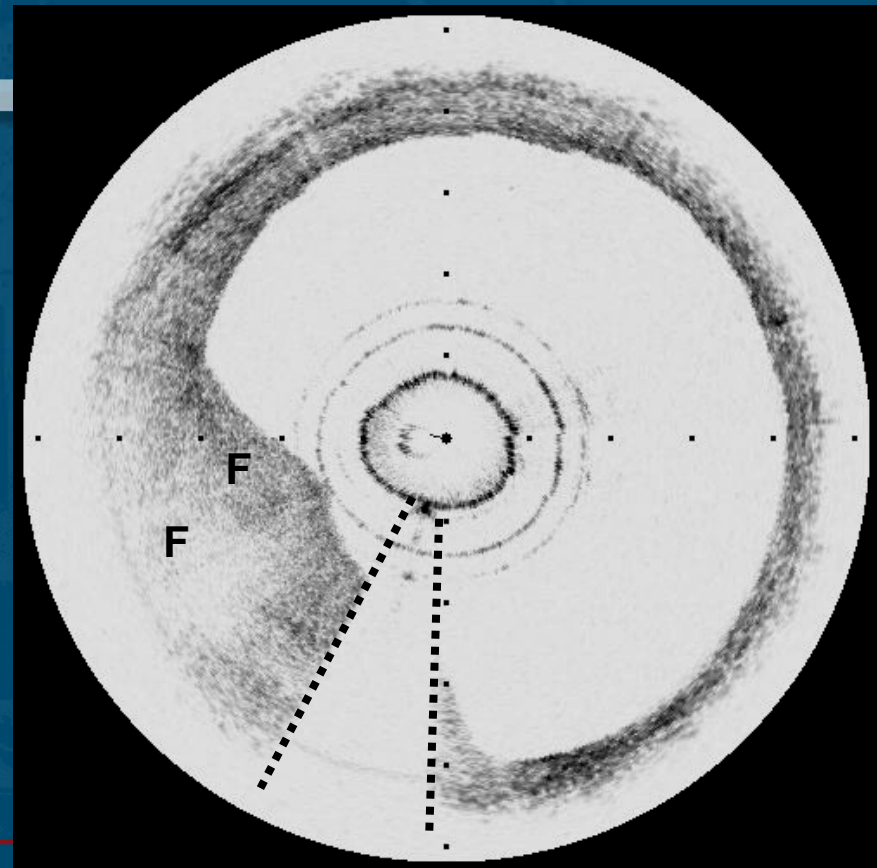
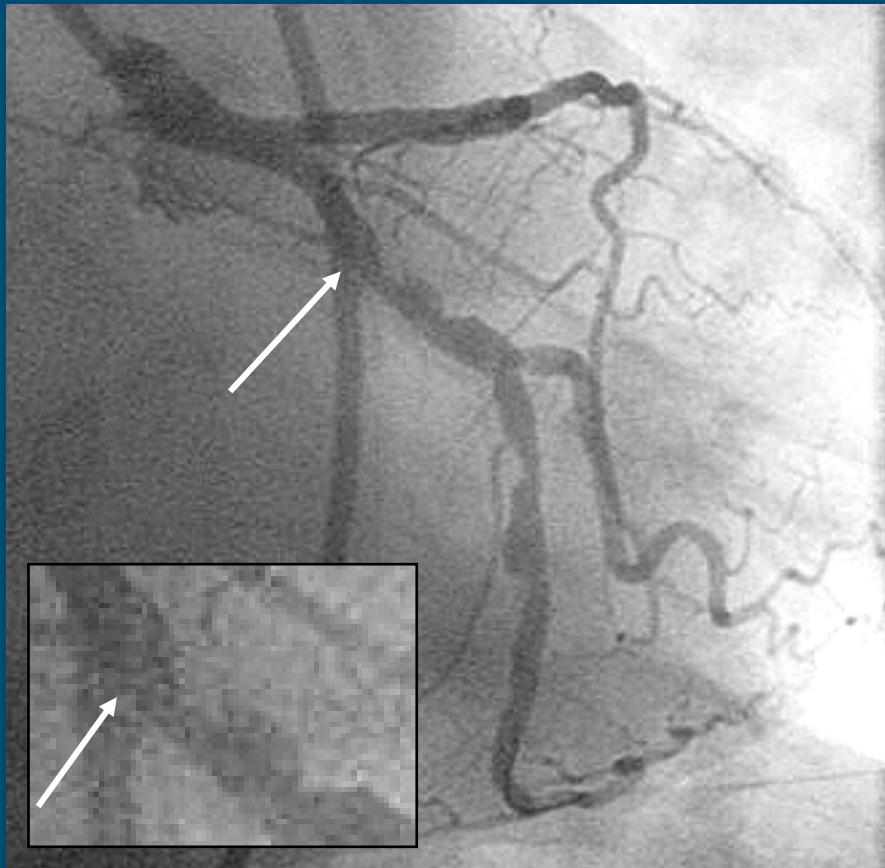
Deep Lipid ?



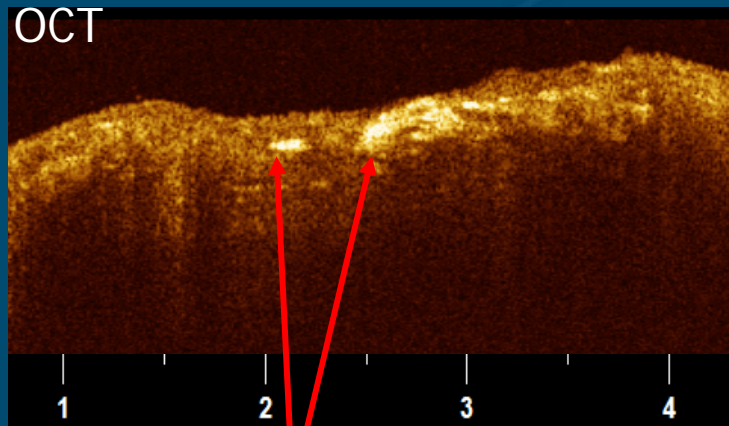
Birefringence Image



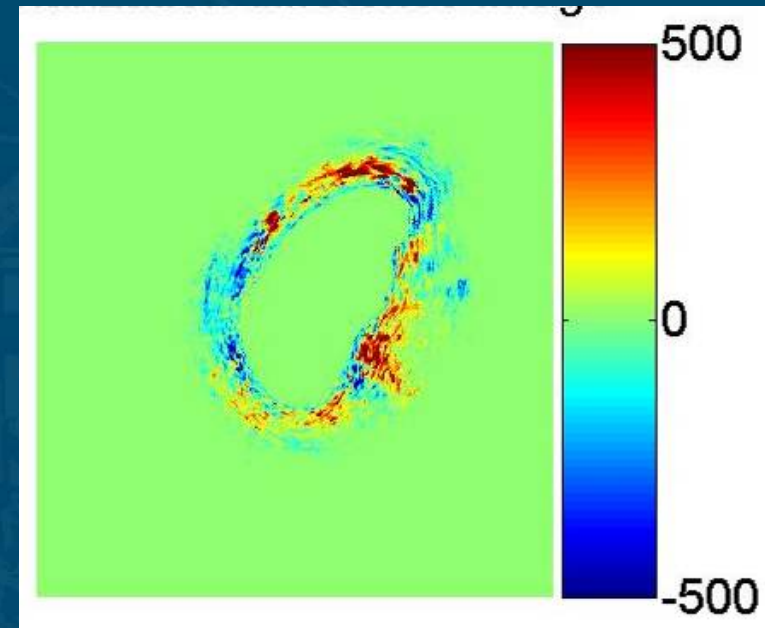
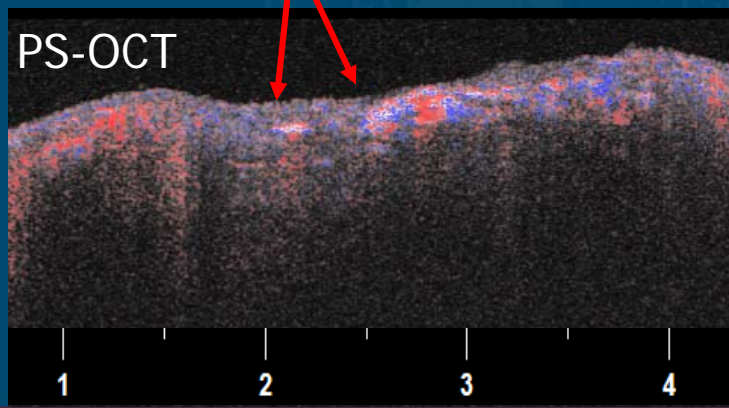
Dense Fibrous Plaque with attenuation



PS OCT



Cholesterol crystals



PS OCT with imaging wires



PS OCT using microscope

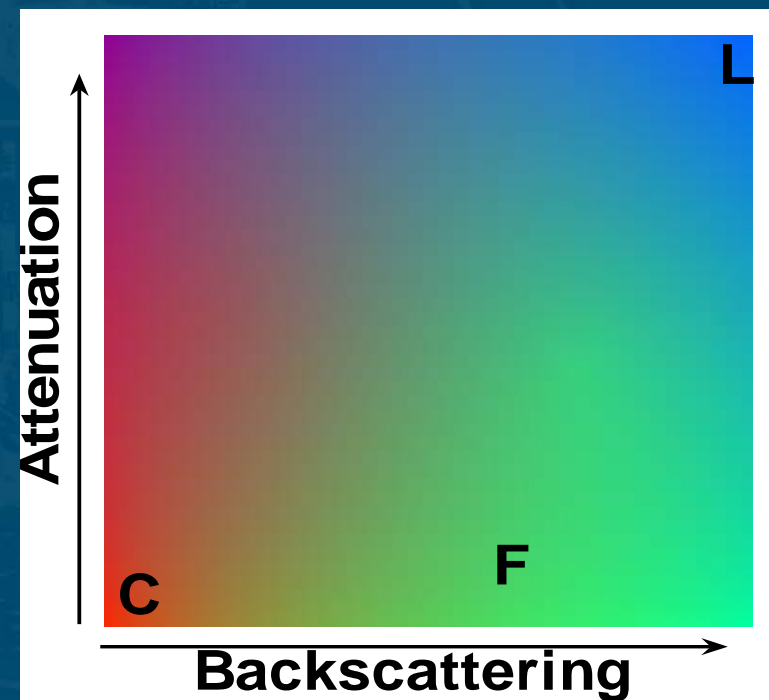
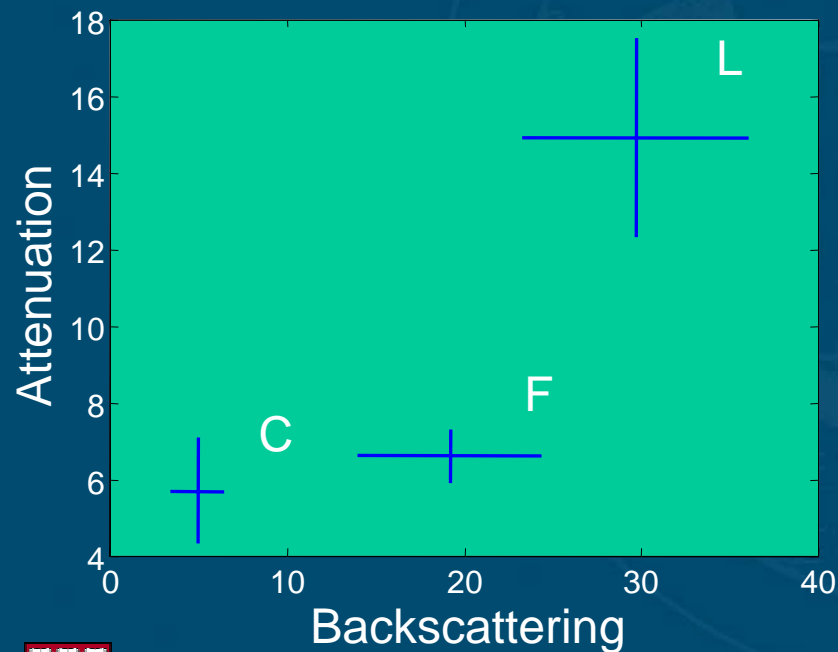
Quantitative color mapping

Use RGB color scale

Red: Geometrical distance from prototype calcification

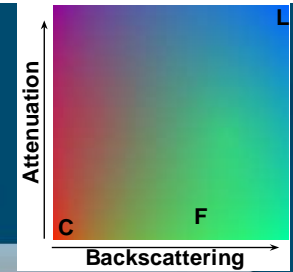
Green: Geometrical distance from prototype fibrous tissue

Blue: Geometrical distance from prototype lipid tissue



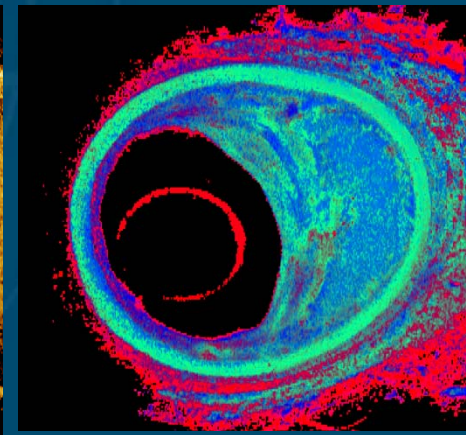
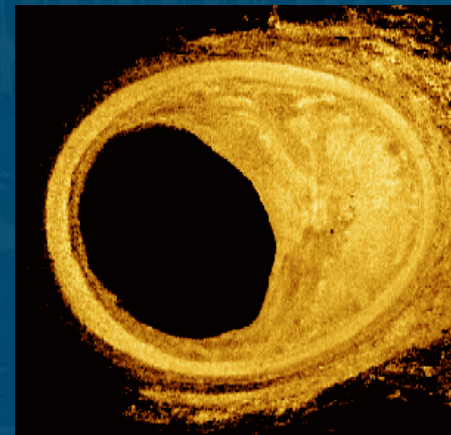
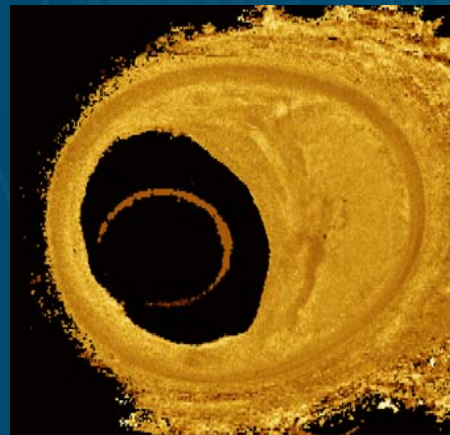
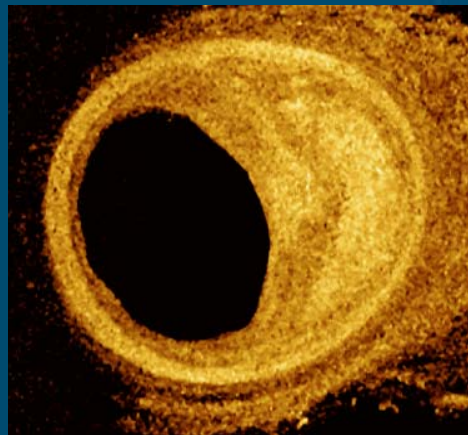
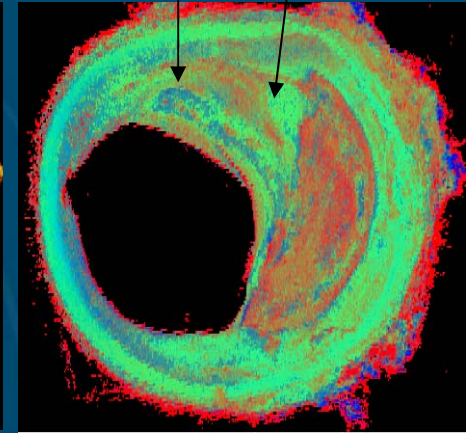
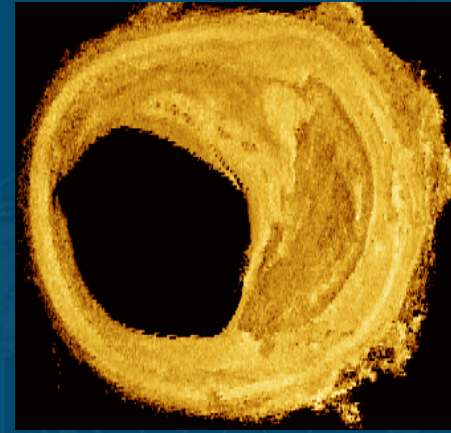
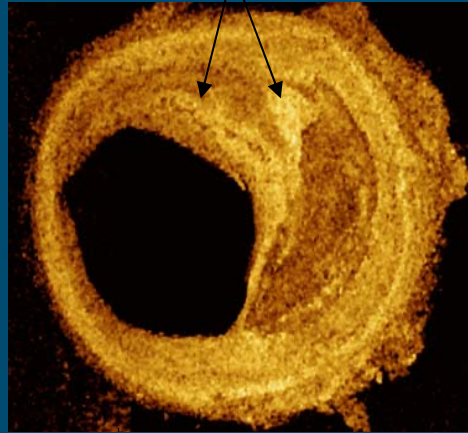
C: calcification; F: fiber; L: lipid

Quantitative color mapping applied to OCT images



Similar brightness

Different attenuation



en face OCT

Attenuation

Back scattering

Combination

Limitations of the Current OCT

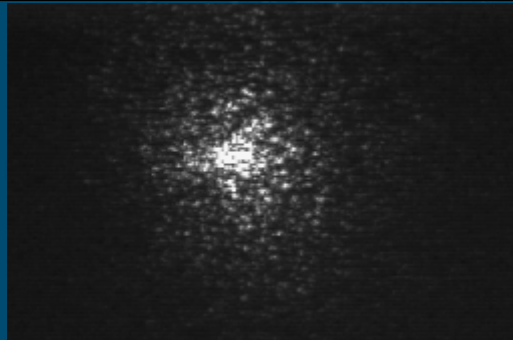
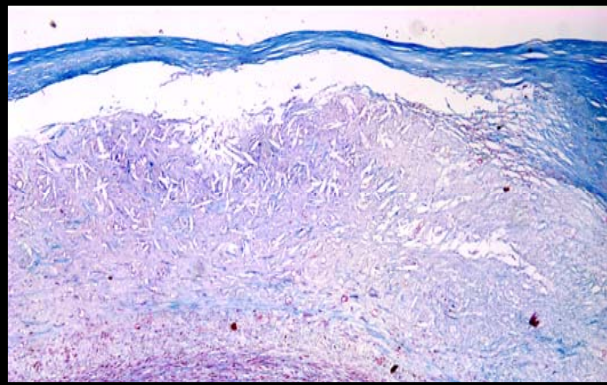
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Laser Speckle Imaging (LSI)

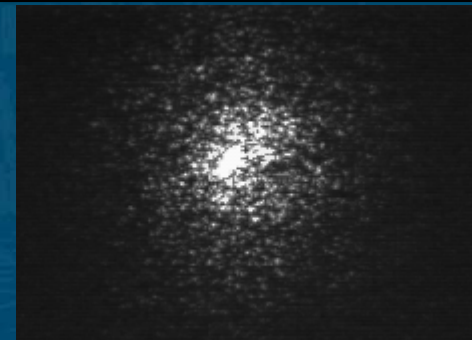
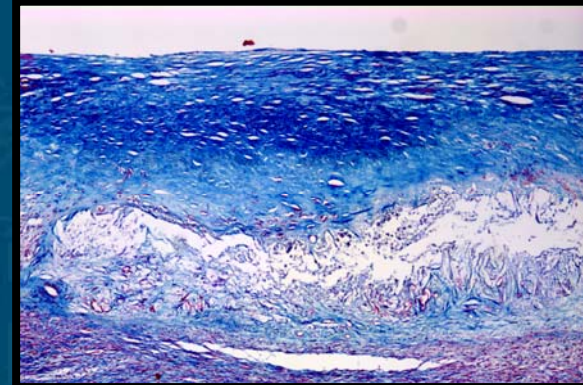
Laser speckle imaging (LSI)

Thin – cap Fibroatheroma:
Cap thickness = 64 μm



$\tau = 43 \text{ ms}$

Thick – cap Fibroatheroma:
Cap thickness = 426 μm

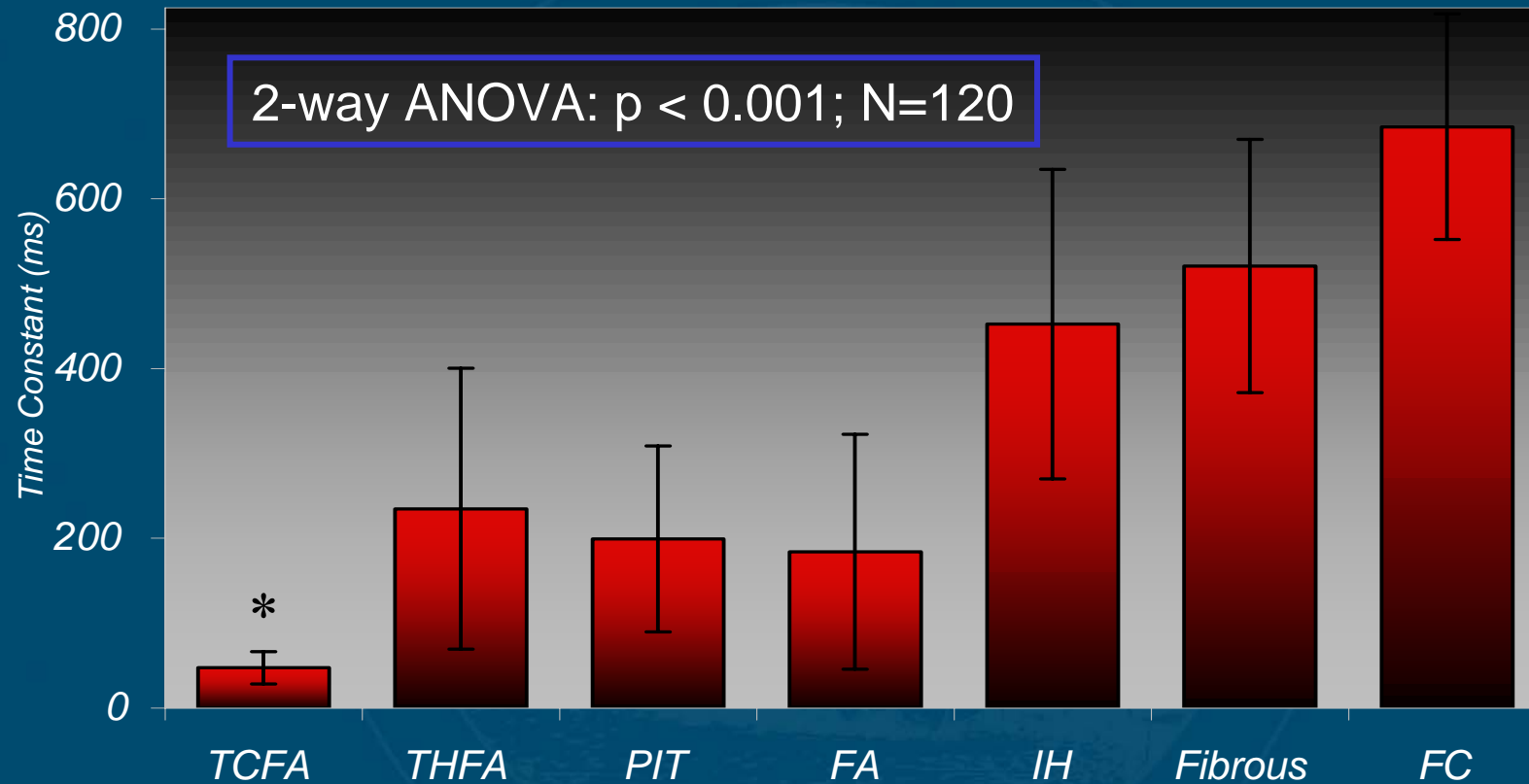


$\tau = 571 \text{ ms}$



LSI measures index of viscoelasticity by fluctuation of speckle pattern

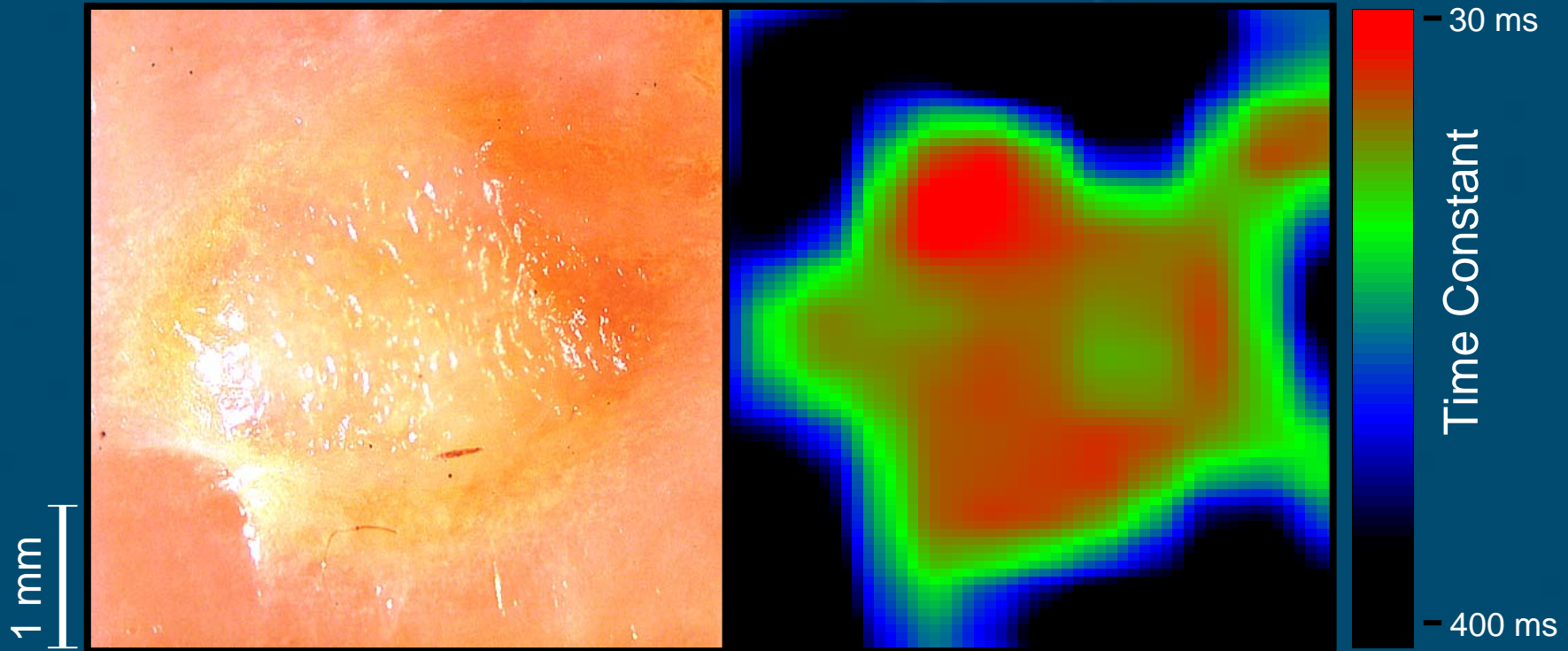
LSI - Characterization



Identification of TCFA: Sensitivity > 90%
 (Diagnostic threshold = 76 ms) **Specificity > 90%**



LSI - Images



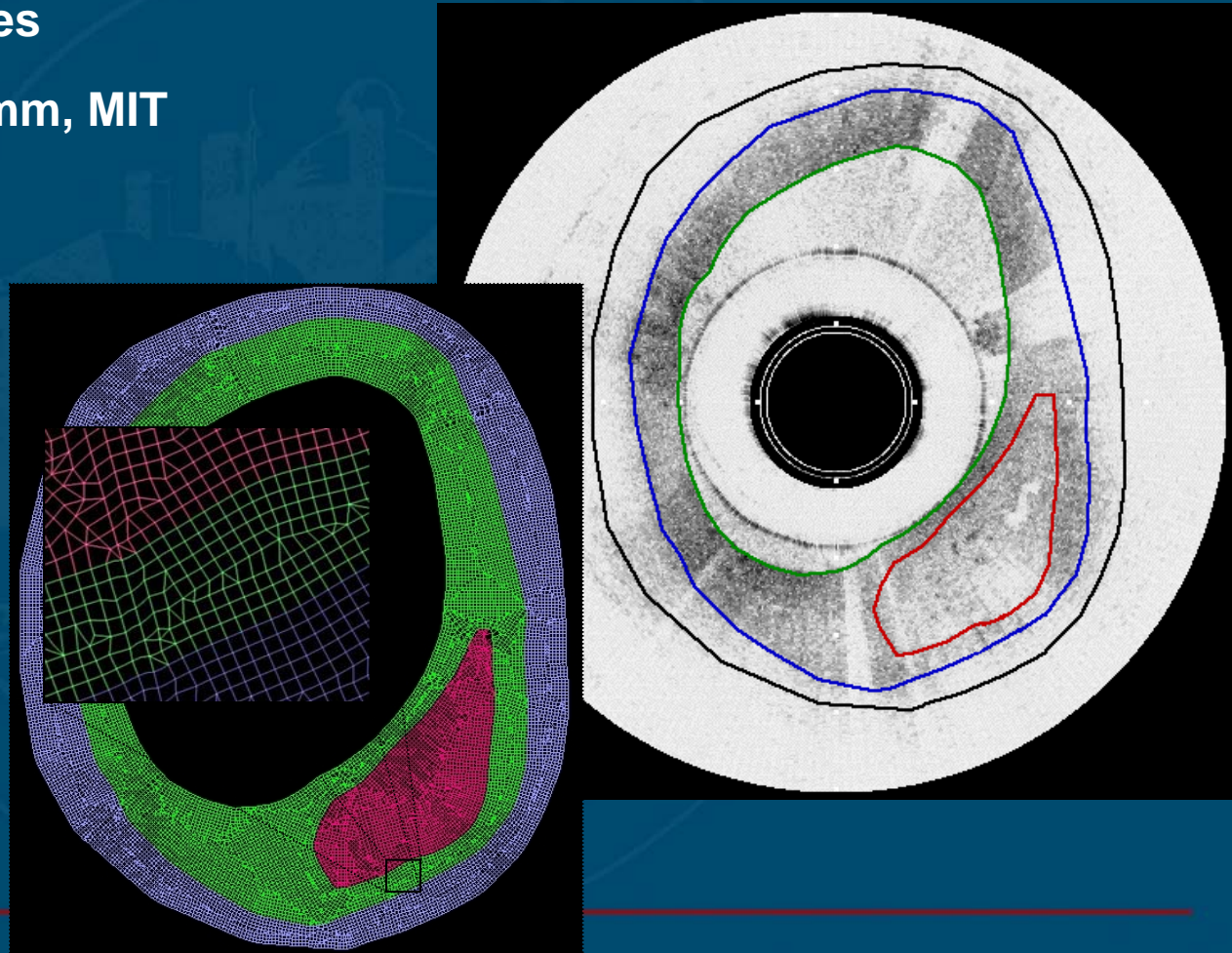
Photograph of Fibroatheroma

Time constant colormap of
Fibroatheroma

OCT Elastography (OCE)

OCT-High Resolution Elastography

- Biomechanical Properties
- B. Bouma, MGH, R. Kamm, MIT
- Combine OCT and FEA
- Visualization of Stress/Strain
- Determination of Elastic Modulus



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Second-Generation OCT

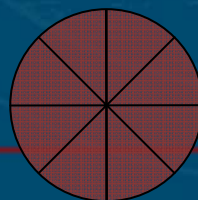
**FD OCT
(Frequency Domain)**

M3 vs C7 (XR)

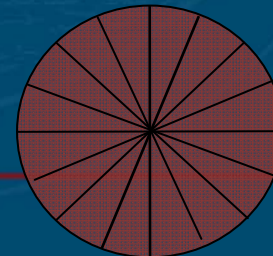
	M3	C7
Max. Frame Rate	20 fps	100+ fps
Max. Pullback Speed	3 mm/s	20+ mm/s
# Lines/frame	200	500
Scan diameter (in contrast)	6.8 mm	8+ mm
Lateral Resolution		
@ Z = 1 mm	30 μ m	30 μ m
@ Z = 3 mm	90 μ m	40 μ m
Axial Resolution	18 μ m	12 μ m



160,000
pixels/frame



500,000
pixels/frame



FD OCT

Injection of contrast initiates the acquisition of a rapid OCT image sequence with fast pullback. The recorded images are reviewed in a slow playback loop.

Example:

Flush @ 4 ml/s

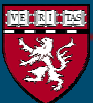
Infusion time = ~ 3 s

Pullback speed = 20 mm/s

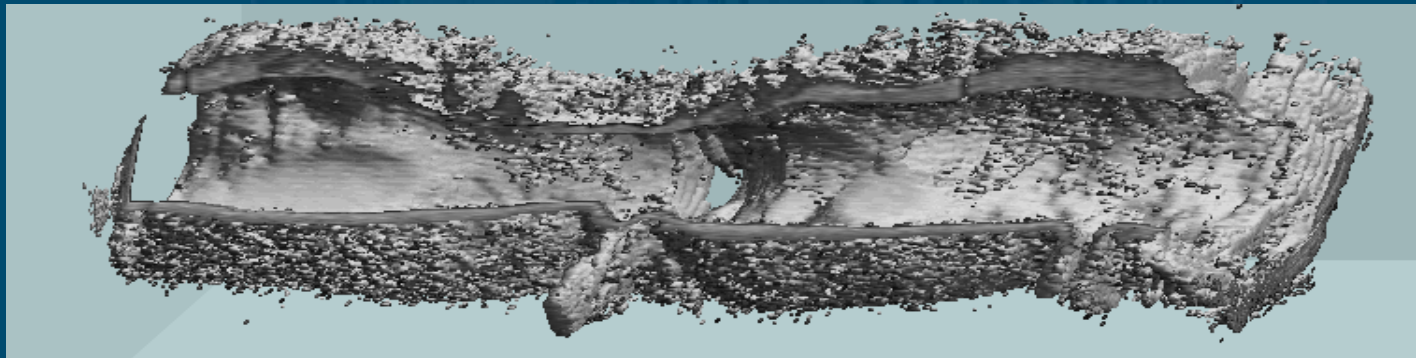
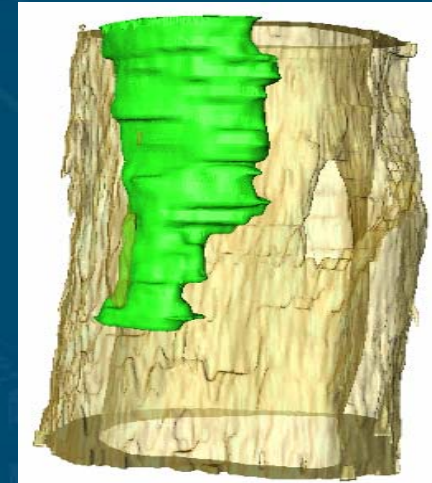
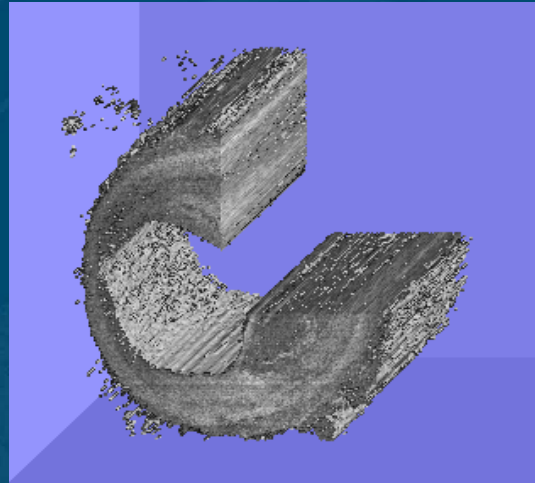
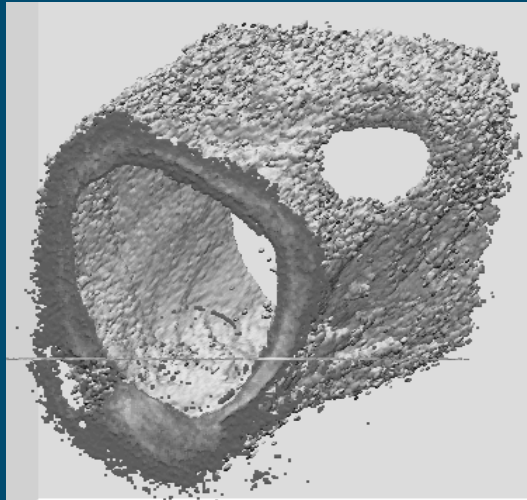
50mm vessel segment

2.5 second pullback

12 ml flush



3D Reconstruction



OCT Research Group



- 20 Investigators from Australia, China, Hong Kong, Japan, Korea, USA
- Establishing Clinical Research Network
- Unify terminology, Standardize analysis methods, Registry, Multi center studies
- Establish OCT fellowship
- Harvard Continuing Education: OCT Research Group Symposium: May 2010, Boston.

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