



# OCT: Recent Development

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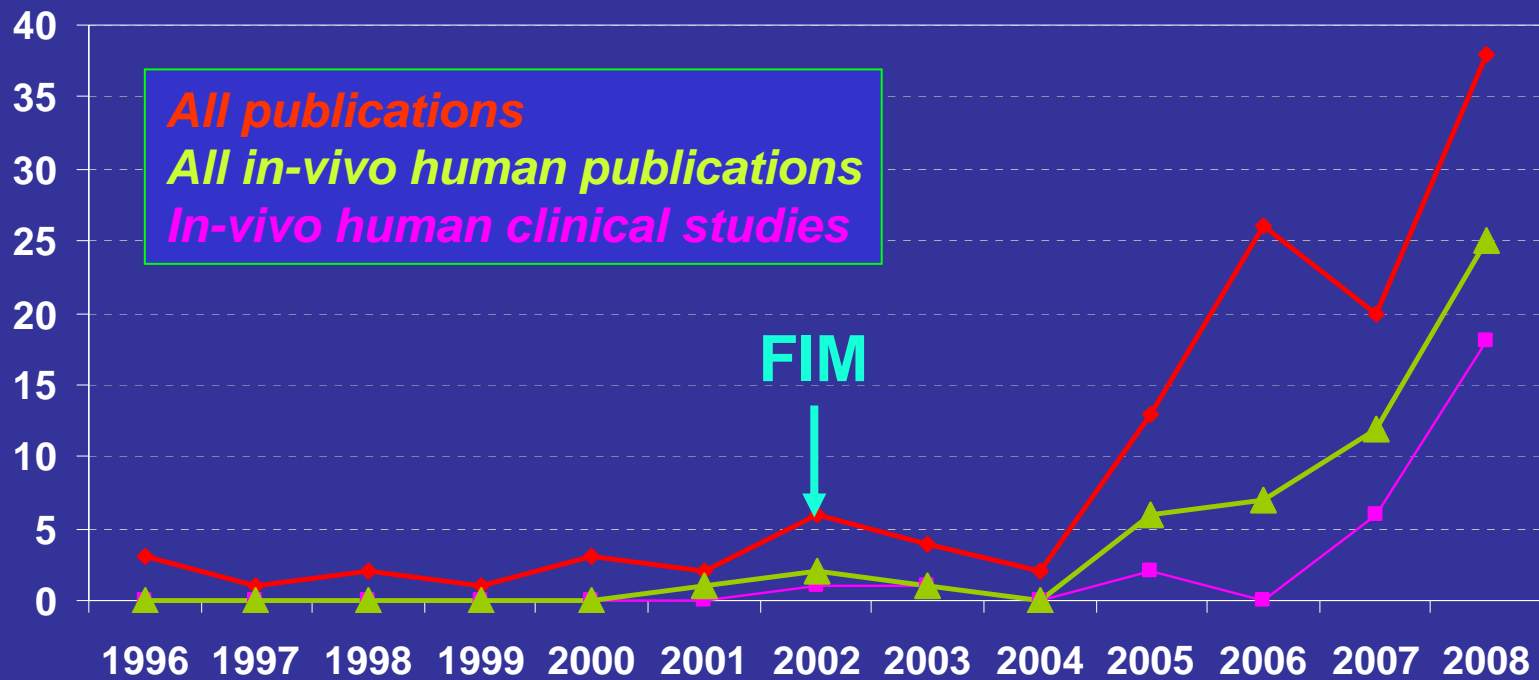


November 22, 2008

# Publications



## Intravascular OCT



# Intravascular Diagnostics for VP

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



# Limitations of the Current OCT

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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**



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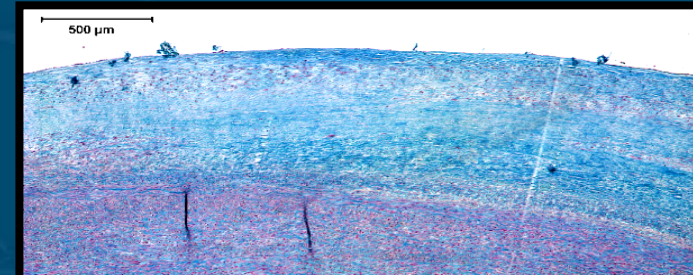
# Polarization Sensitive OCT

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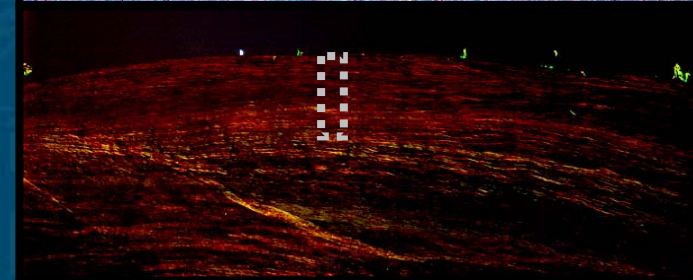
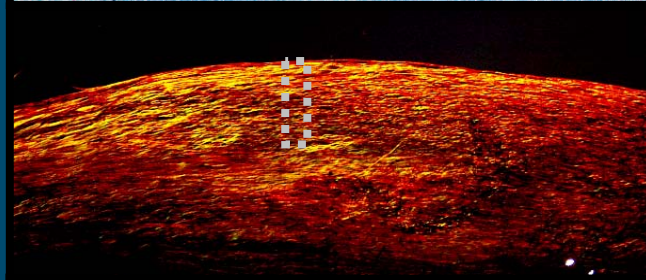


# Collagen Content by PS-OCT

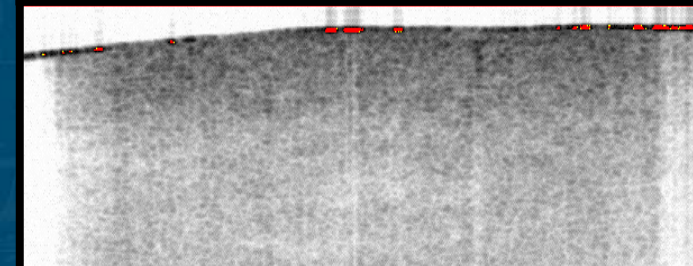
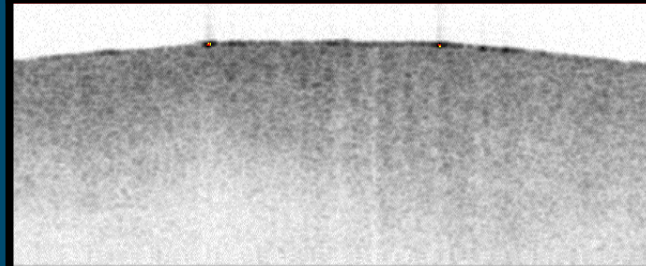
Trichrome



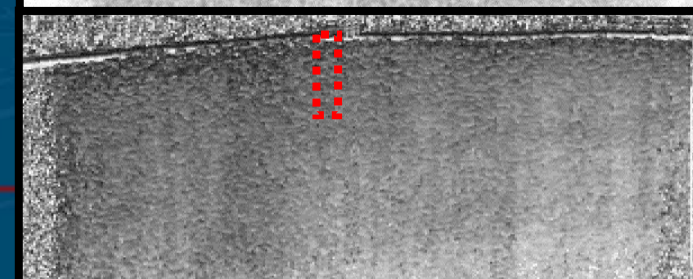
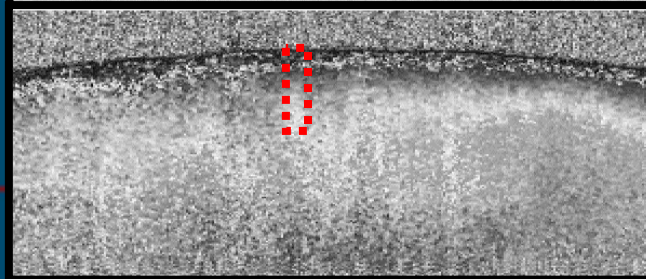
Picrosirius  
Red



OCT

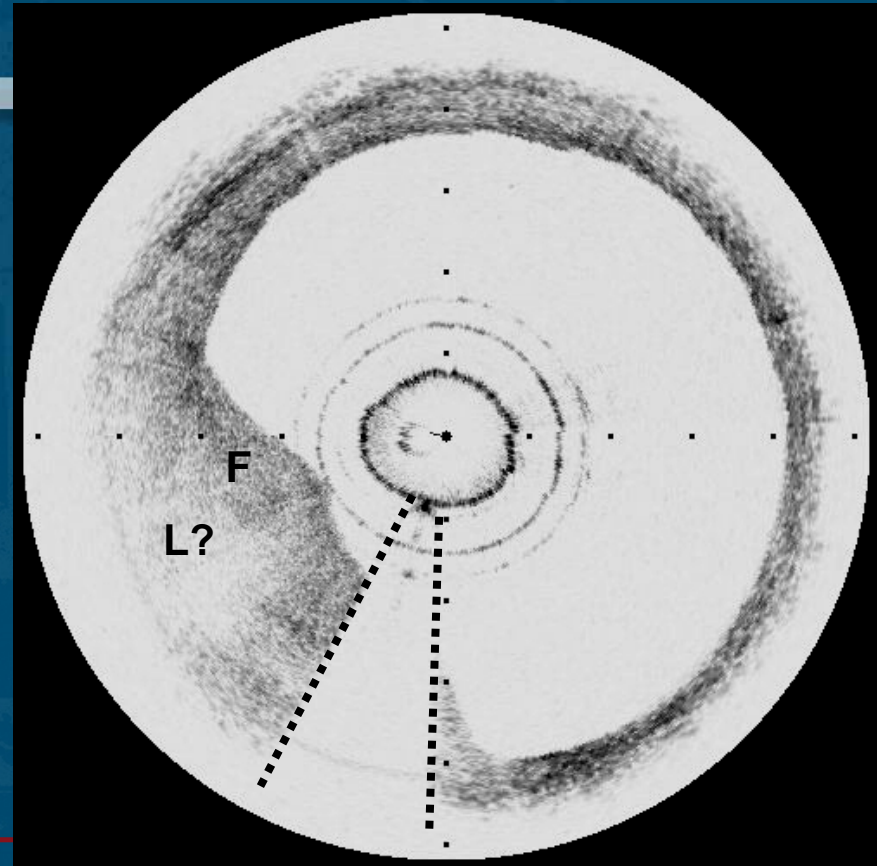
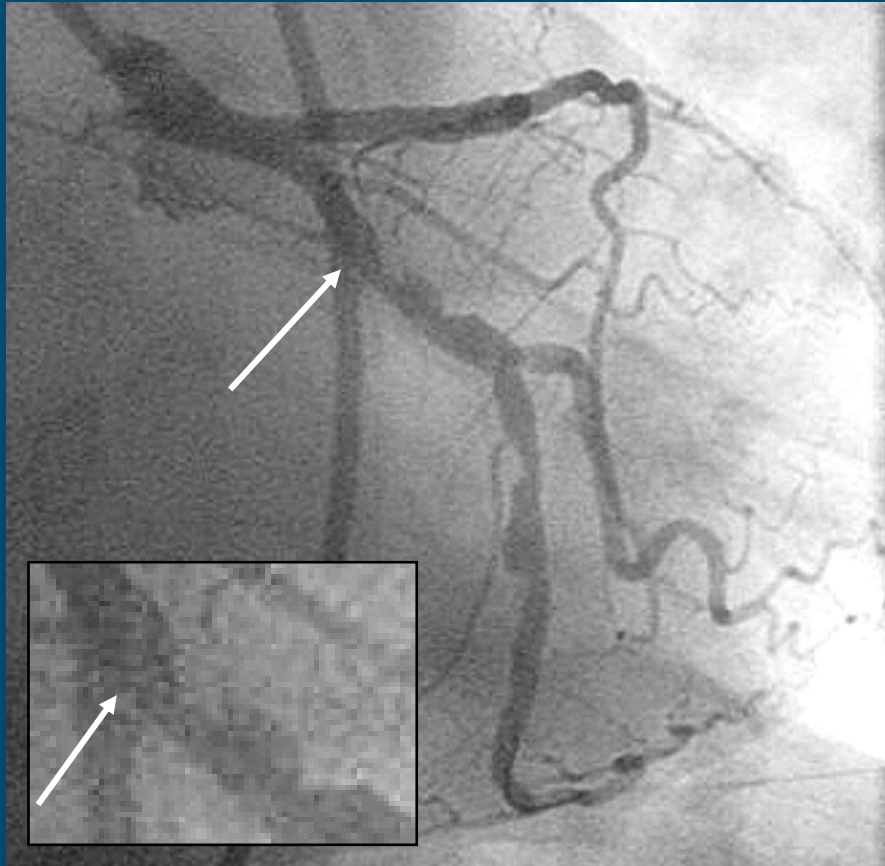


PS-OCT

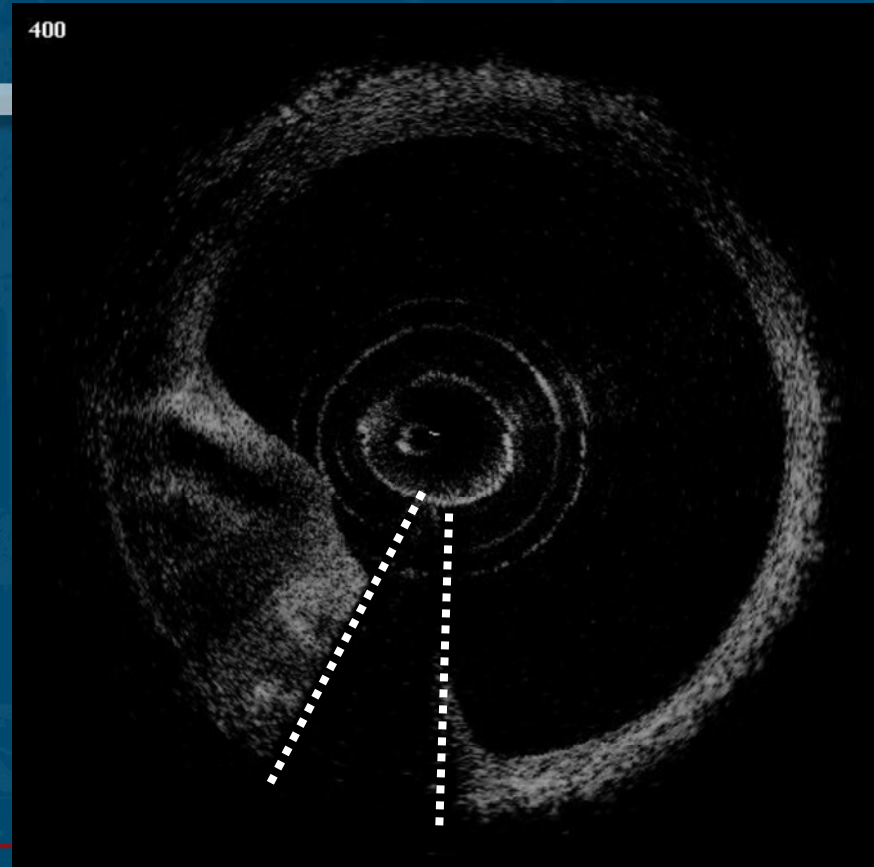
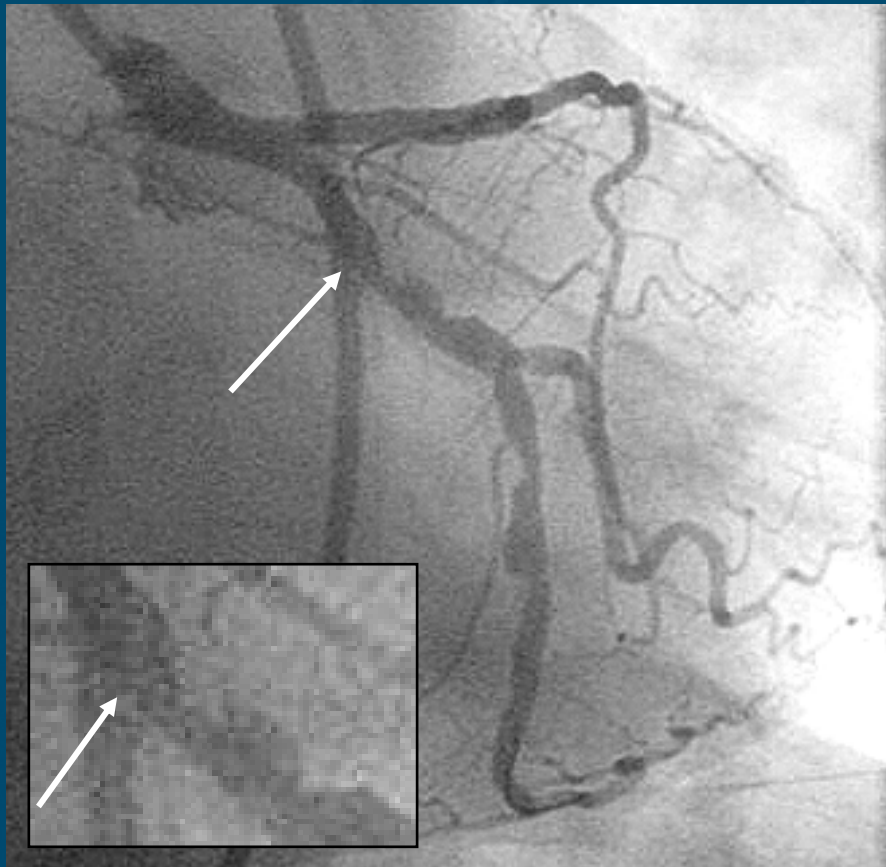




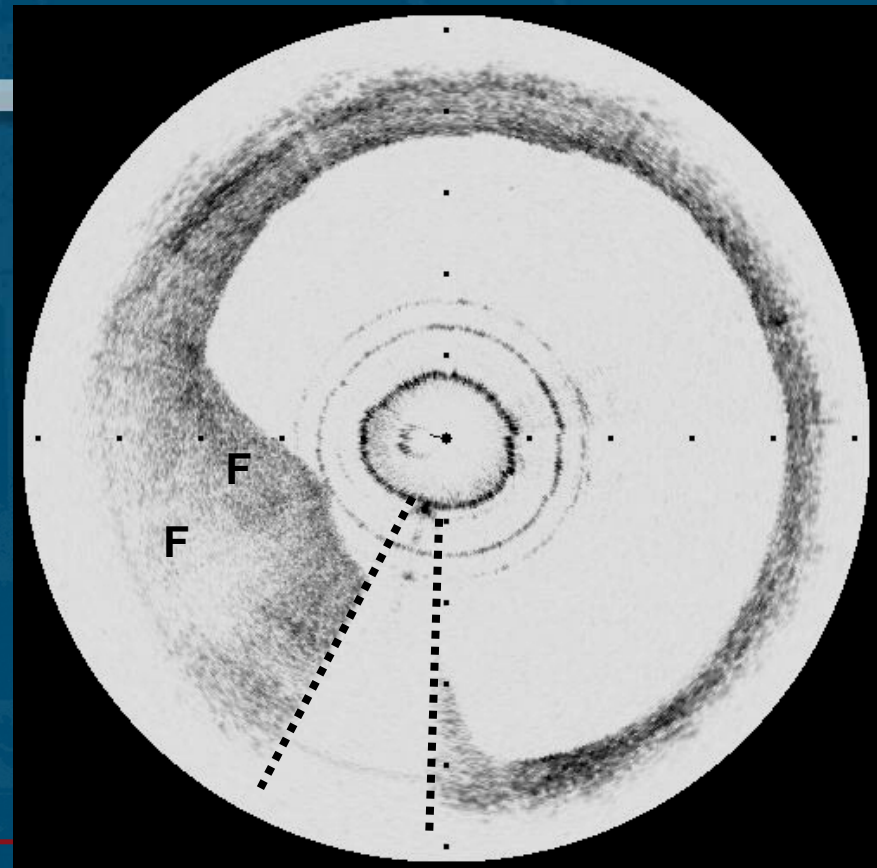
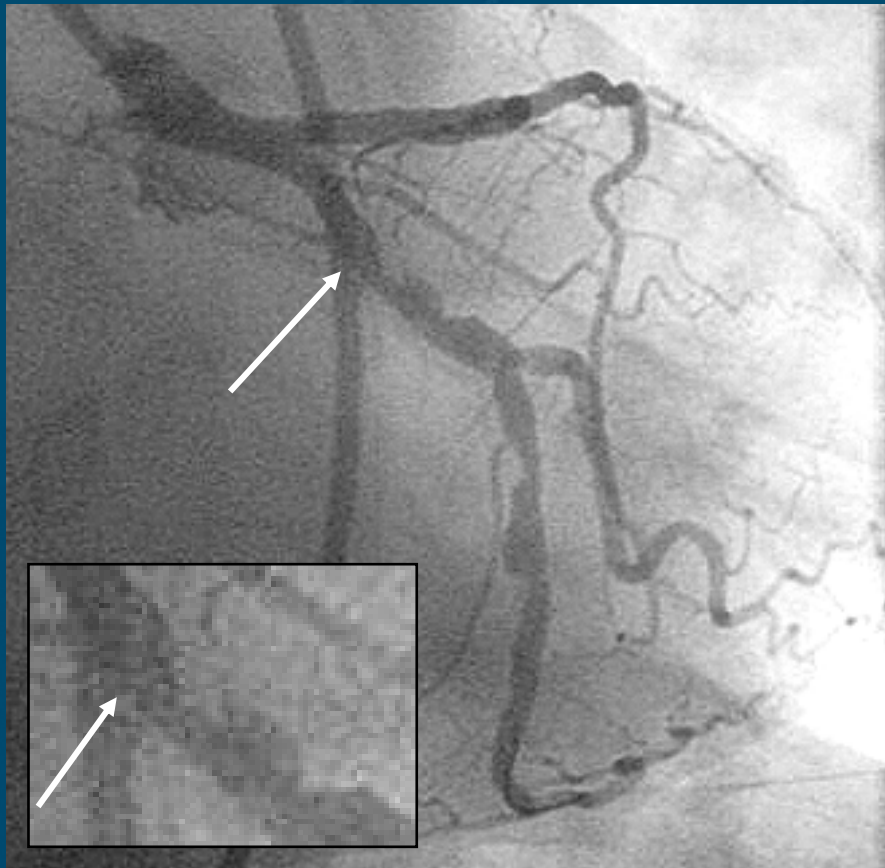
# Deep Lipid ?



# Birefringence Image

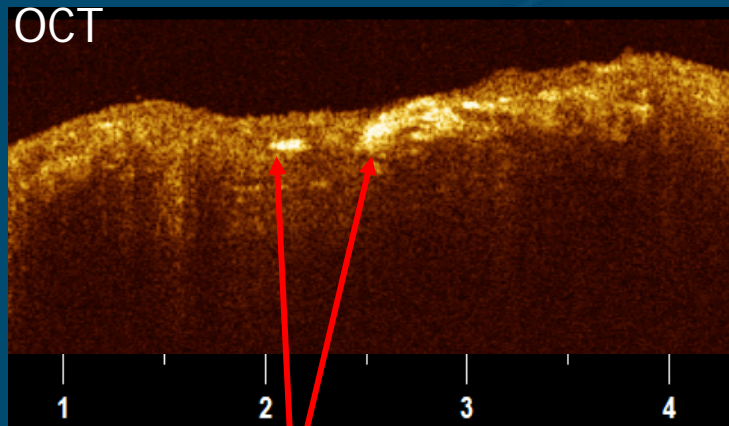


# Dense Fibrous Plaque with attenuation

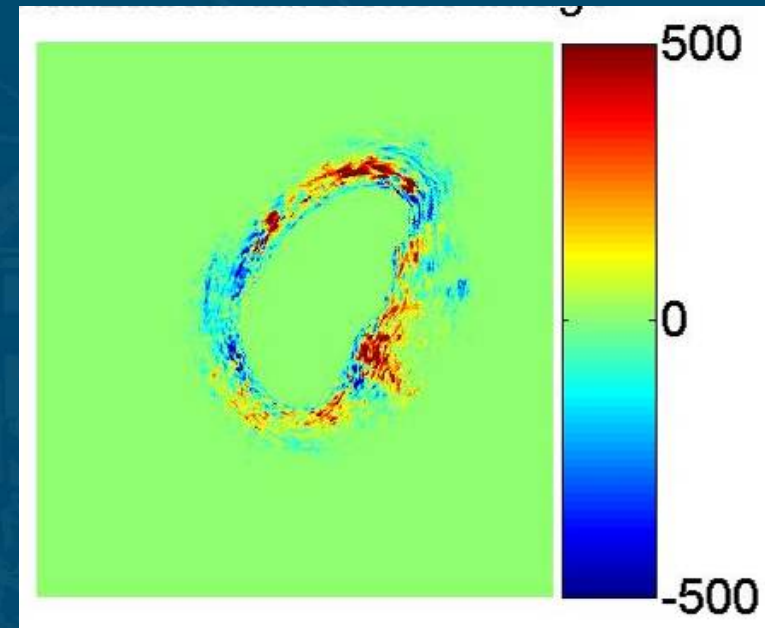
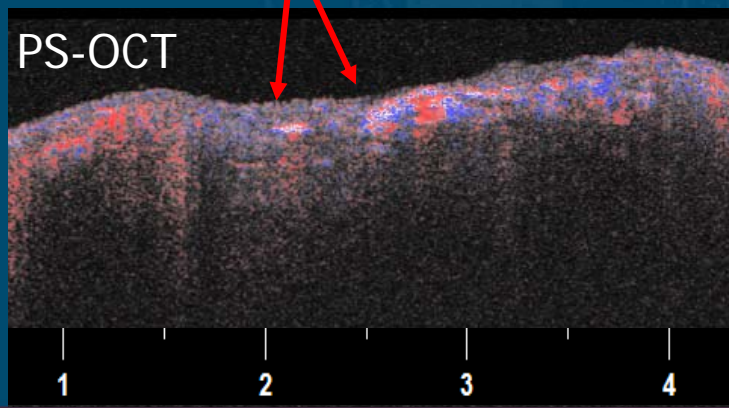




# PS OCT



Cholesterol crystals



PS OCT with imaging wires



PS OCT using microscope

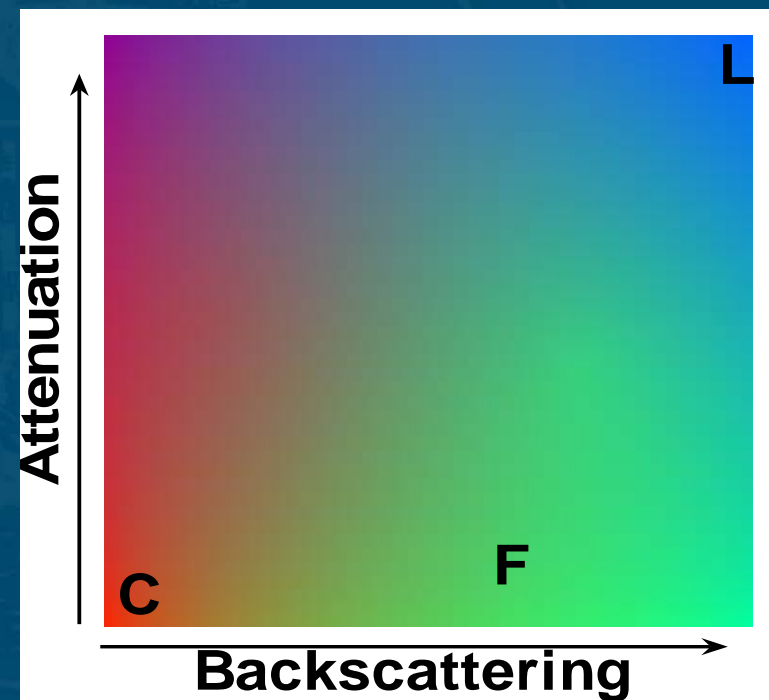
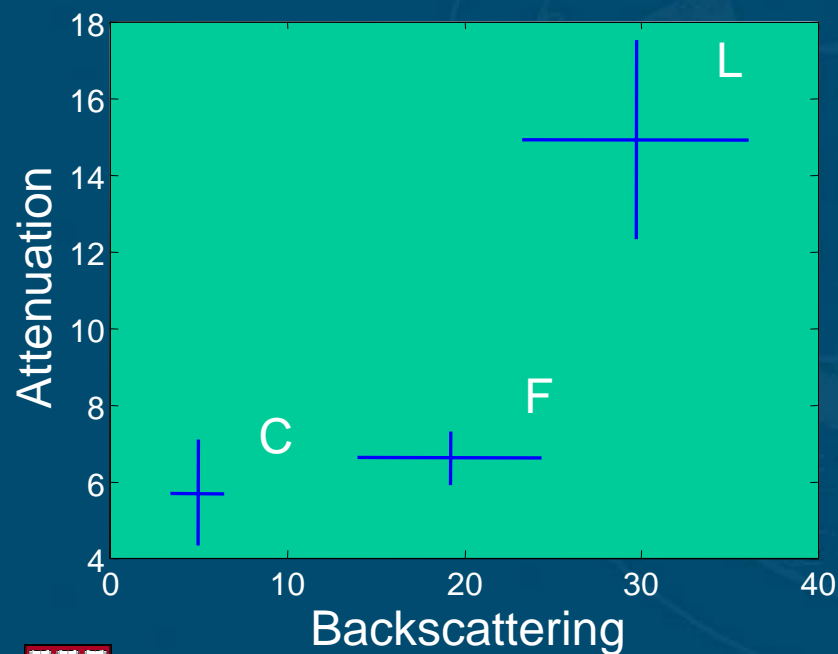
# Quantitative color mapping

Use RGB color scale

Red: Geometrical distance from prototype calcification

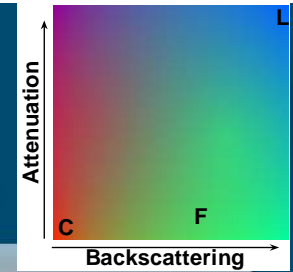
Green: Geometrical distance from prototype fibrous tissue

Blue: Geometrical distance from prototype lipid tissue



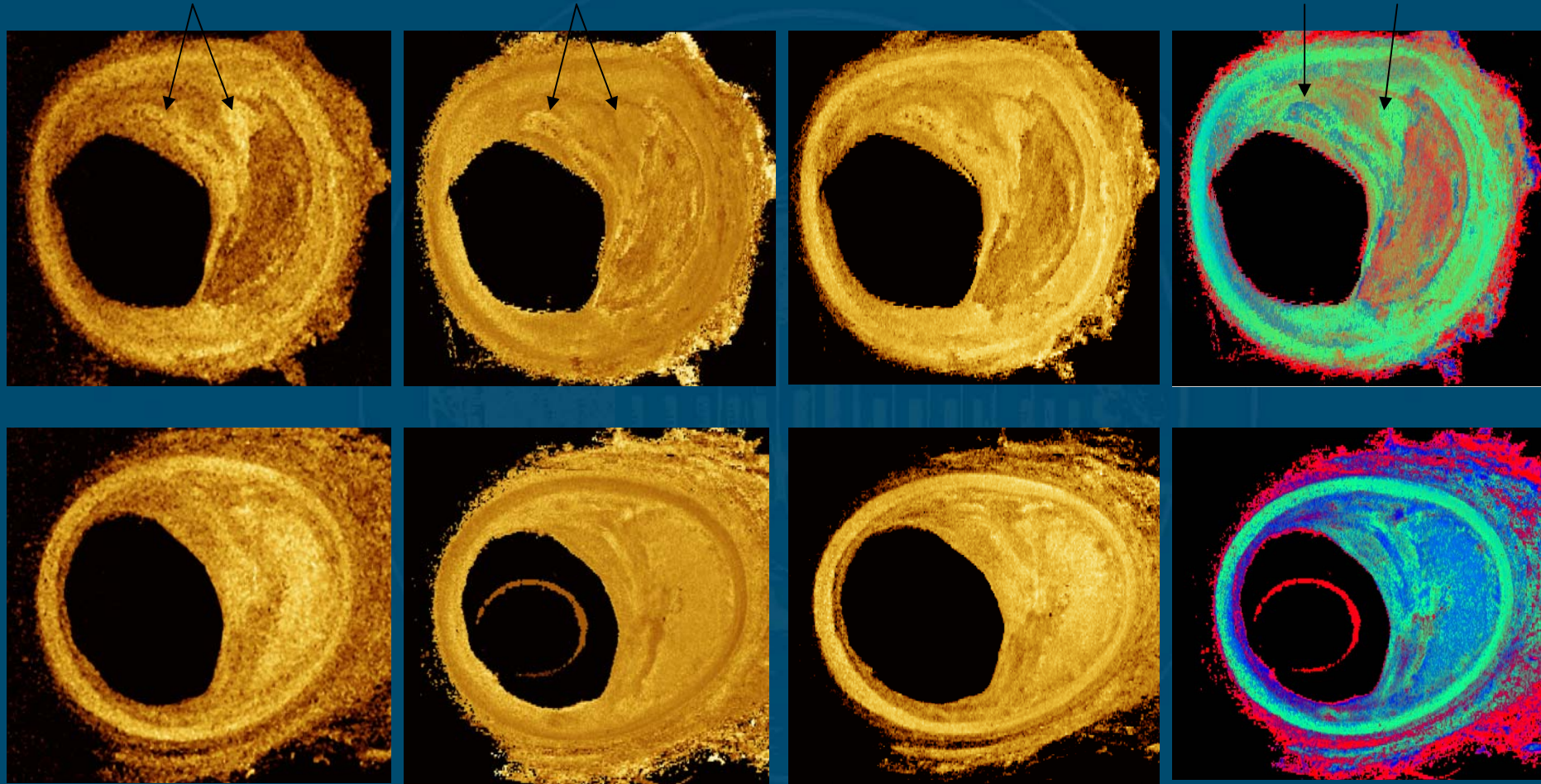
C: calcification; F: fiber; L: lipid

# Quantitative color mapping applied to OCT images



Similar brightness

Different attenuation



*en face* OCT

Attenuation

Back scattering

Combination



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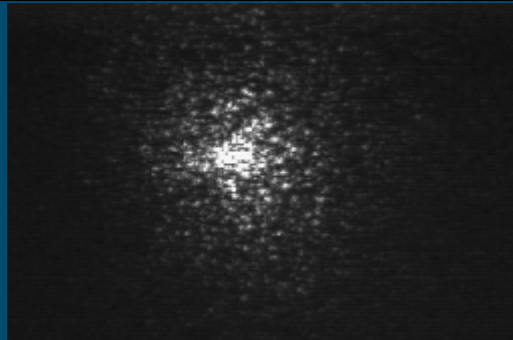
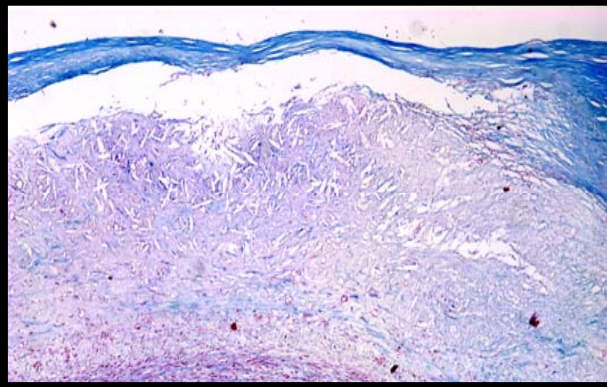
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# Laser Speckle Imaging (LSI)

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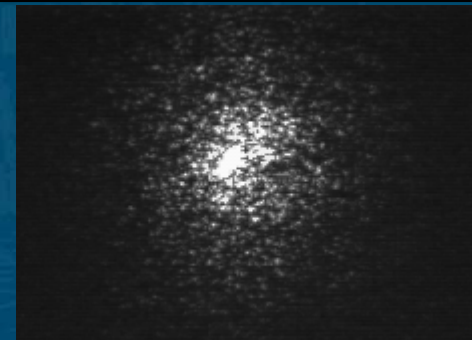
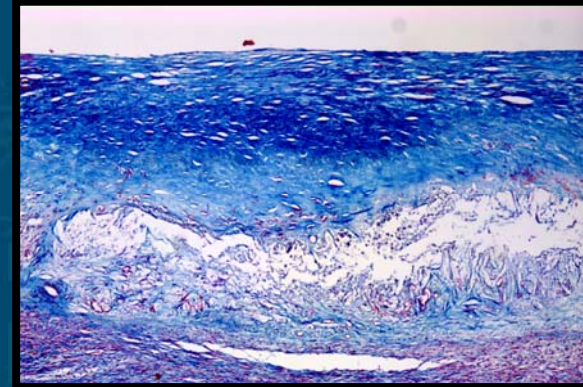
# Laser speckle imaging (LSI)

**Thin – cap Fibroatheroma:**  
Cap thickness = 64  $\mu\text{m}$

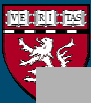


$\tau = 43 \text{ ms}$

**Thick – cap Fibroatheroma:**  
Cap thickness = 426  $\mu\text{m}$

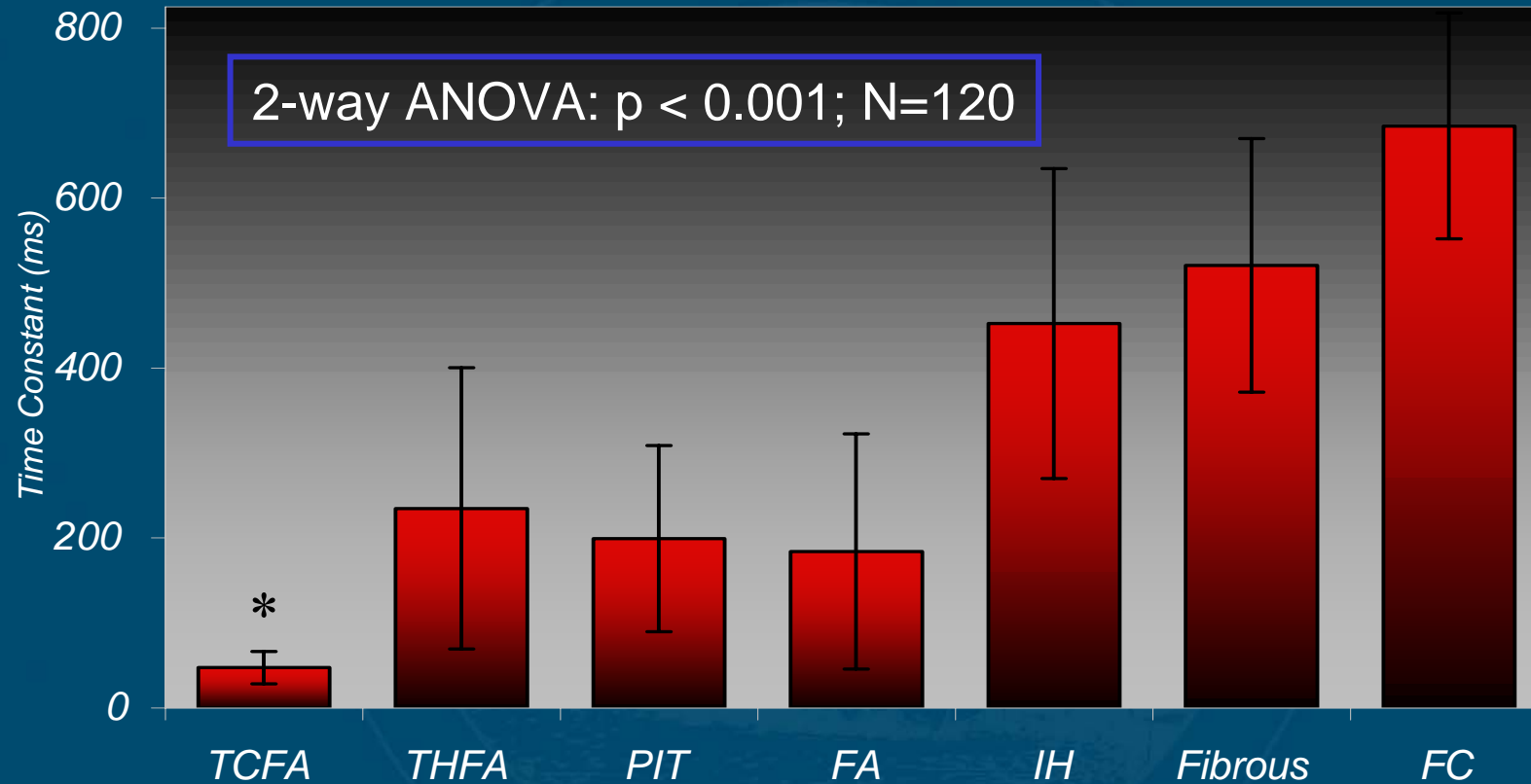


$\tau = 571 \text{ ms}$



*LSI measures index of viscoelasticity by fluctuation of speckle pattern*

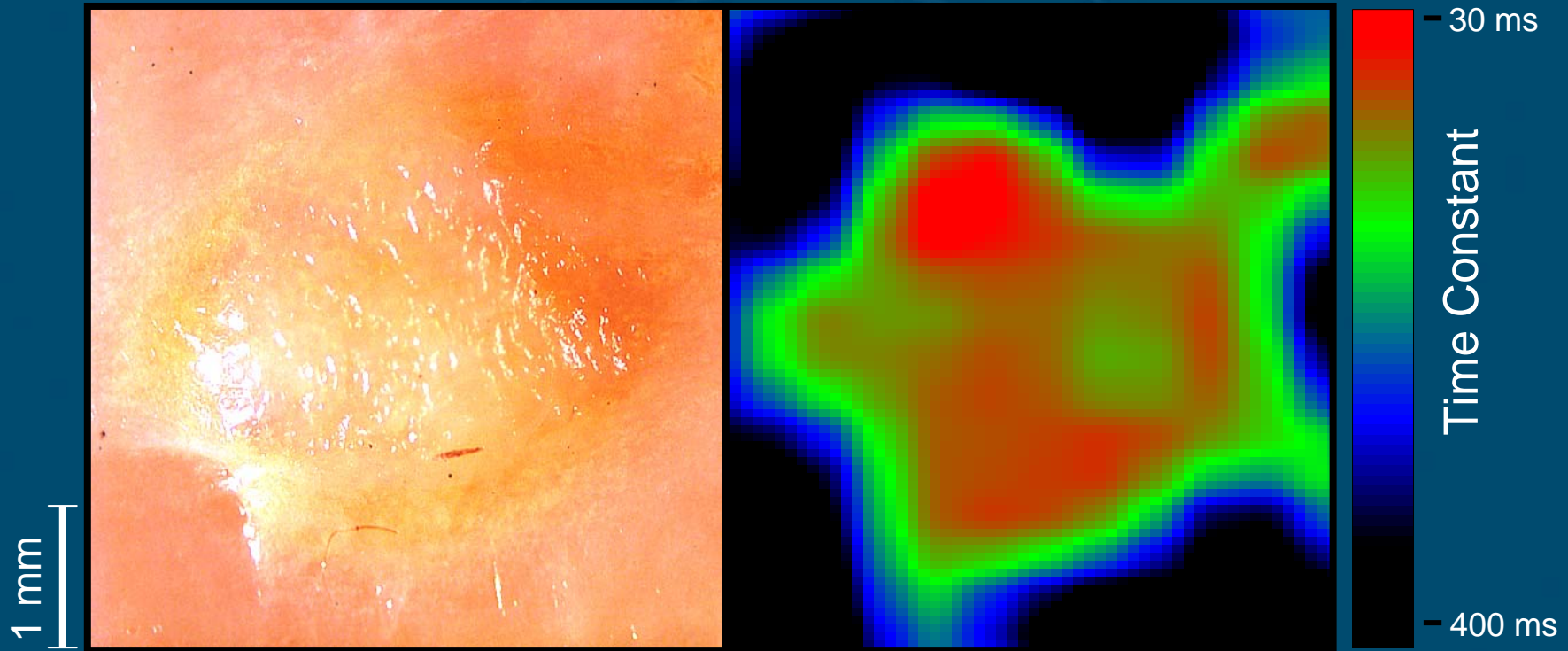
# LSI - Characterization



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



# LSI - Images



Photograph of Fibroatheroma

Time constant colormap of  
Fibroatheroma



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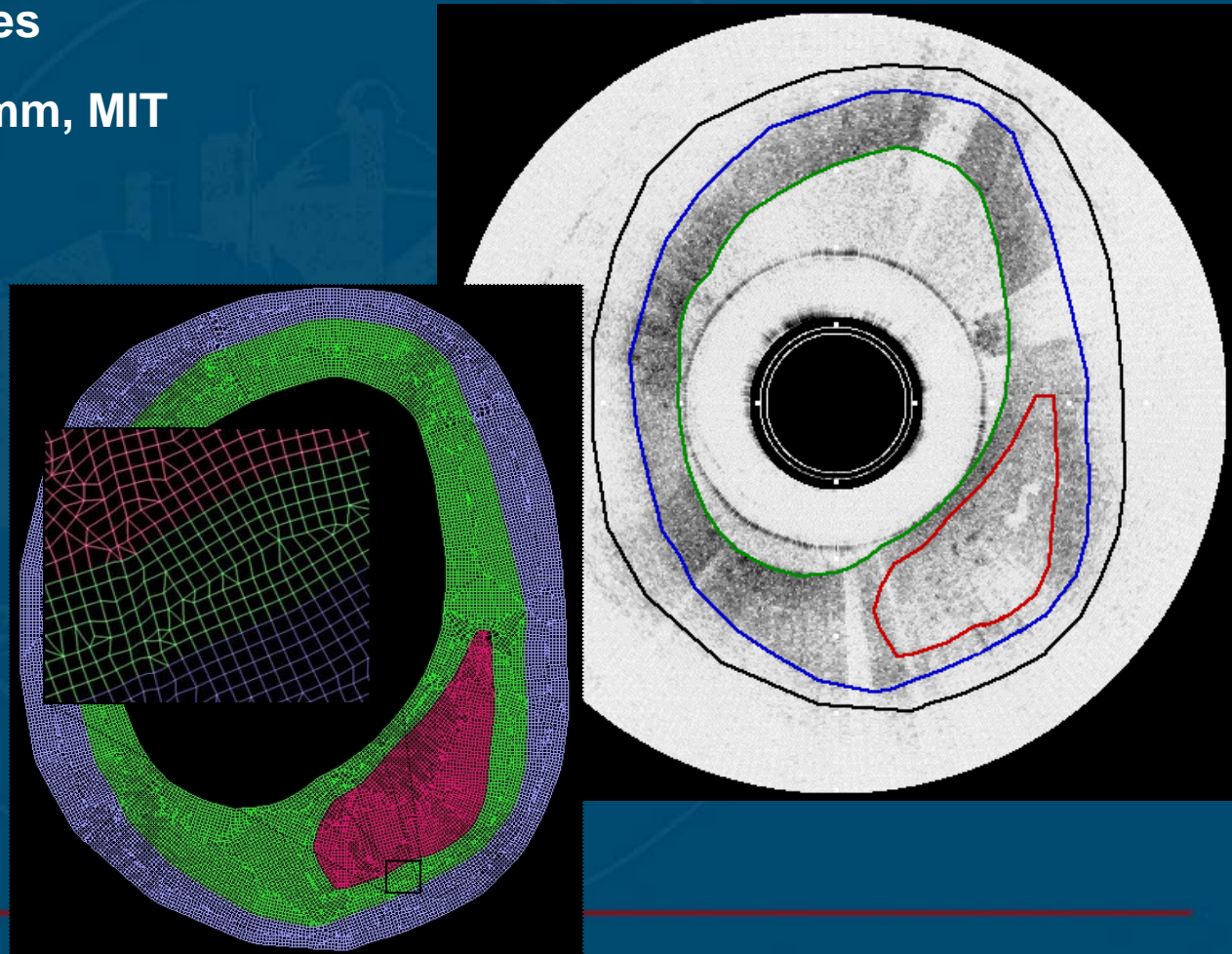
# OCT Elastography (OCE)

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# OCT-High Resolution Elastography

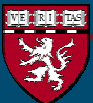
- Biomechanical Properties
- B. Bouma, MGH, R. Kamm, MIT
- Combine OCT and FEA
- Visualization of Stress/Strain
- Determination of Elastic Modulus



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# Second-Generation OCT

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**FD OCT**  
**(Frequency Domain)**

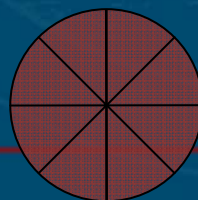
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# M3 vs M4

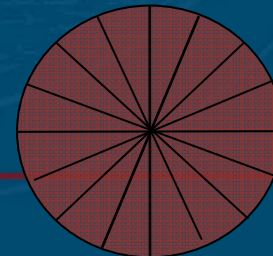
	<i>M3</i>	<i>M4</i>
<i>Max. Frame Rate</i>	20 fps	100+ fps
<i>Max. Pullback Speed</i>	3 mm/s	20+ mm/s
<i># Lines/frame</i>	200	500
<i>Scan diameter (in contrast)</i>	6.8 mm	8+ mm
<i>Lateral Resolution</i>		
@ Z = 1 mm	30 $\mu$ m	30 $\mu$ m
@ Z = 3 mm	90 $\mu$ m	40 $\mu$ m
<i>Axial Resolution</i>	18 $\mu$ m	12 $\mu$ m



160,000  
pixels/frame

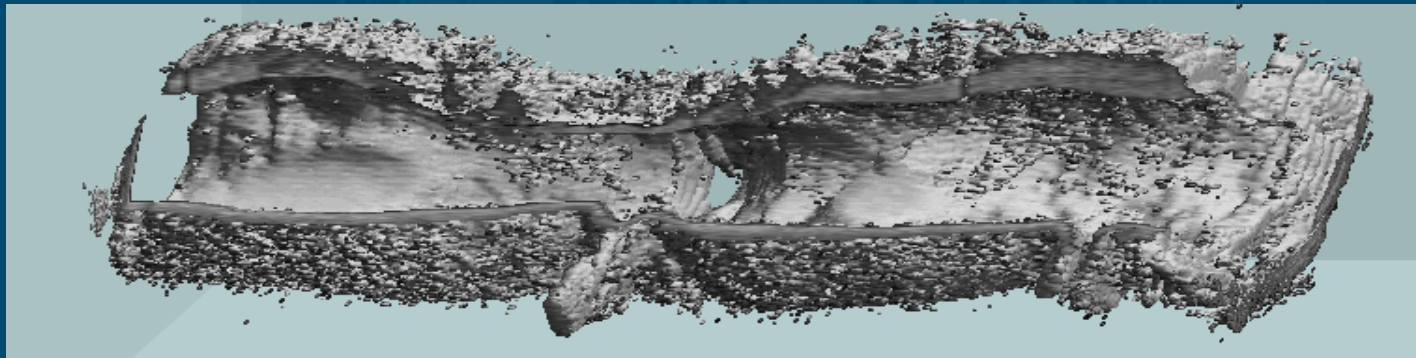
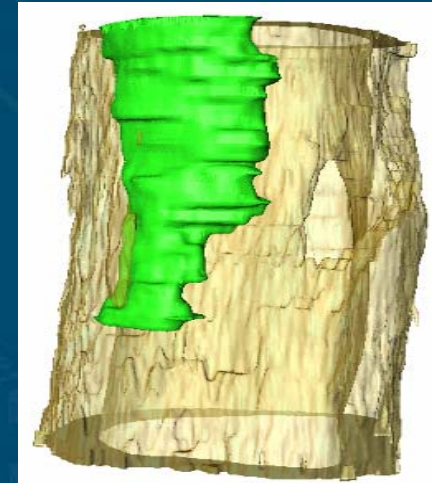
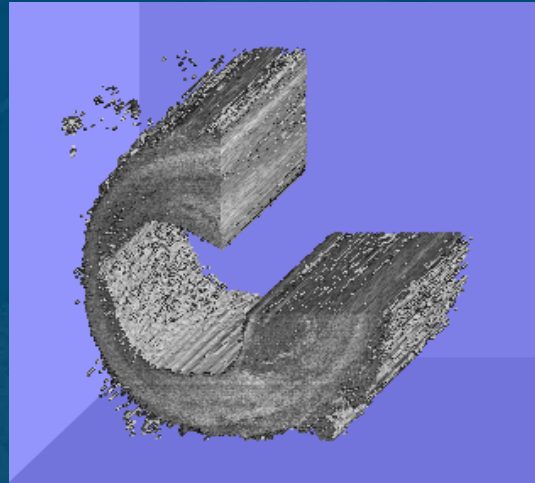
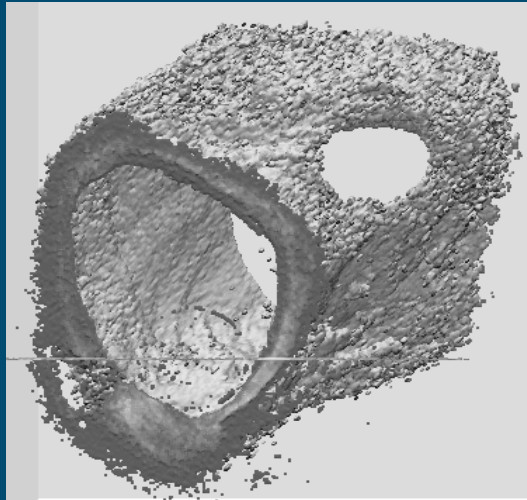


500,000  
pixels/frame





# 3D Reconstruction



# FD OCT Clinical Study

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- Multi center study in US
- MGH (PI)
- Started in November 2008





# Acknowledgements

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# Support

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**CIMIT**

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**Cardiology Division**

**Massachusetts General Hospital**

**LightLab Imaging**



# First OCT Research Group Conference

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- 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
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- Next meeting: June 2009 in Japan