



The Next Generation Plaque Imaging: C7 FD-OCT

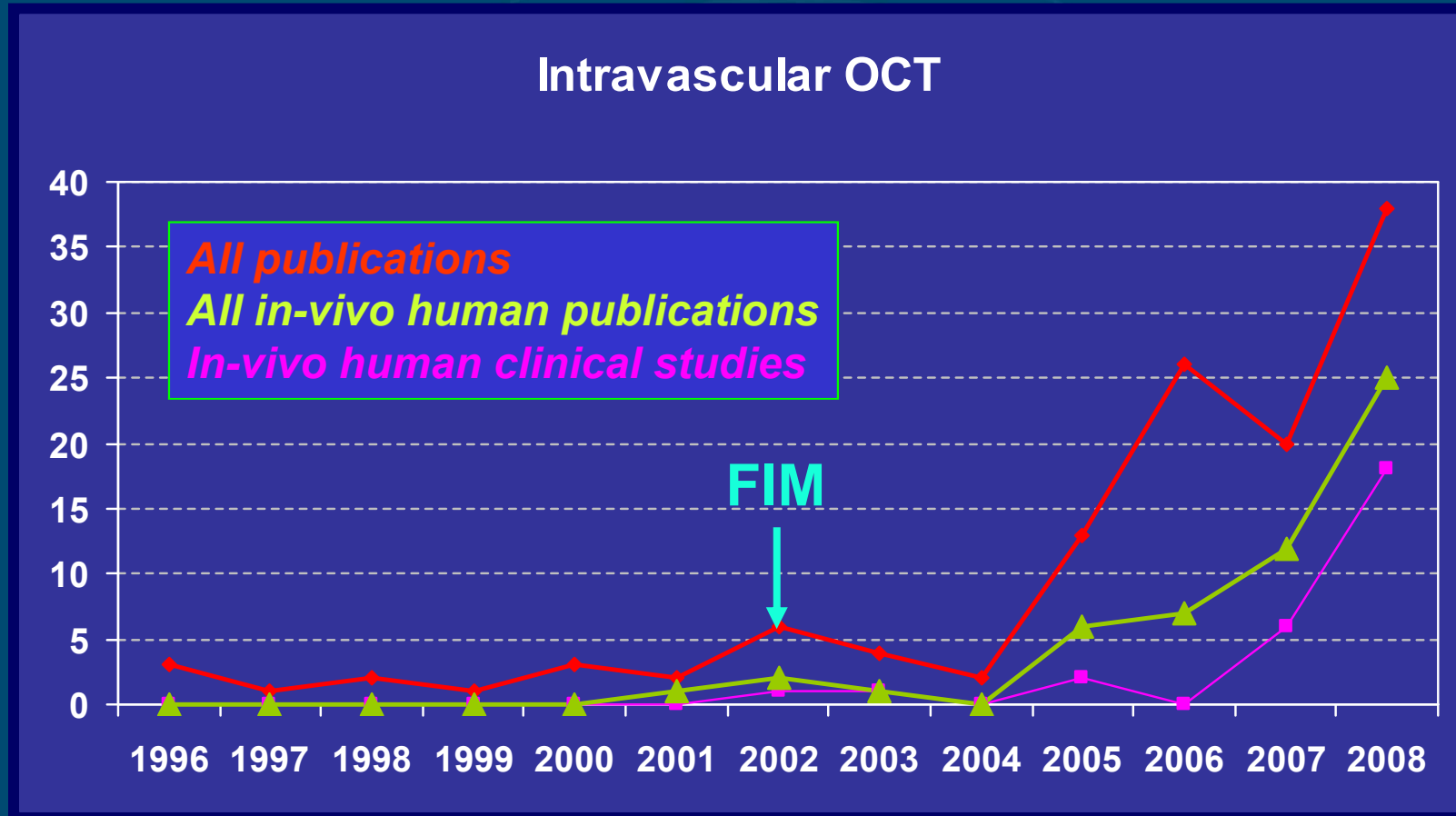
Ik-Kyung Jang, MD

Professor of Medicine
Harvard Medical School



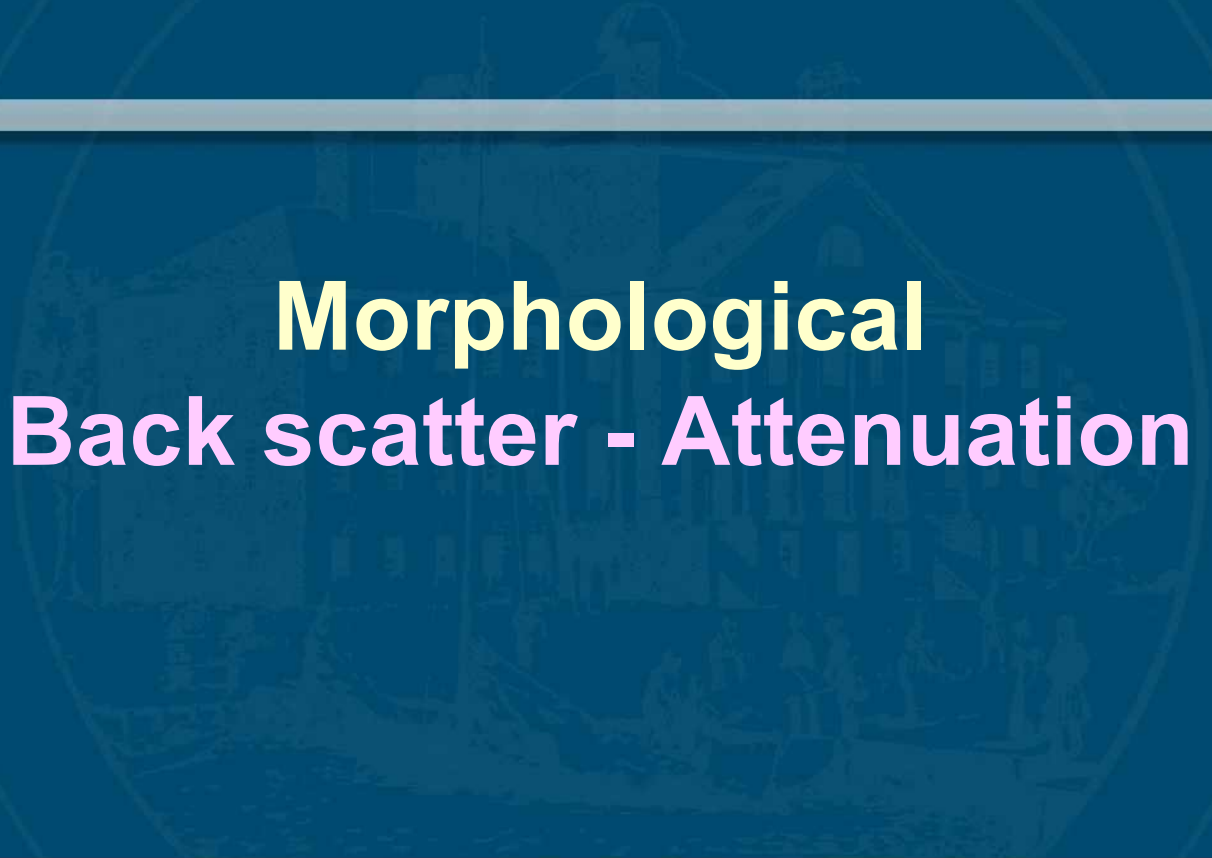
April 29, 2010

Publications



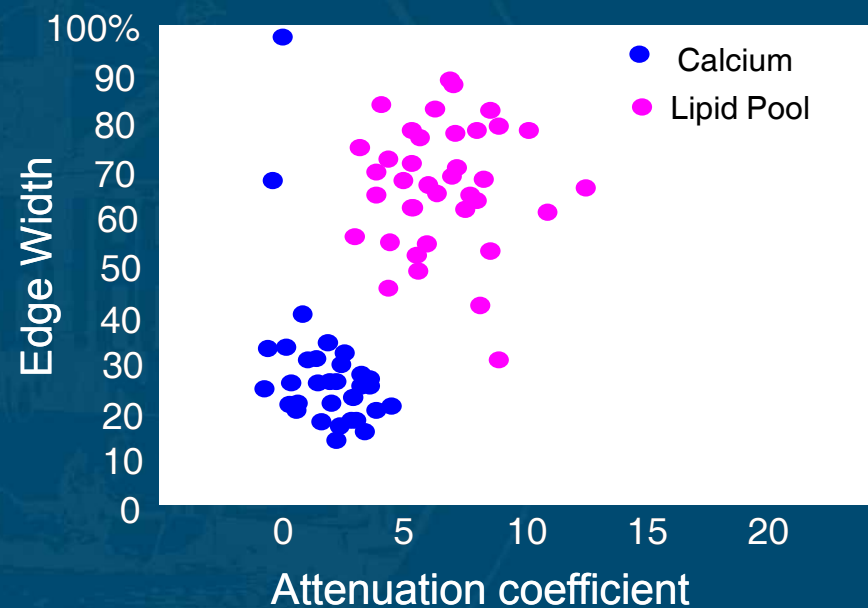
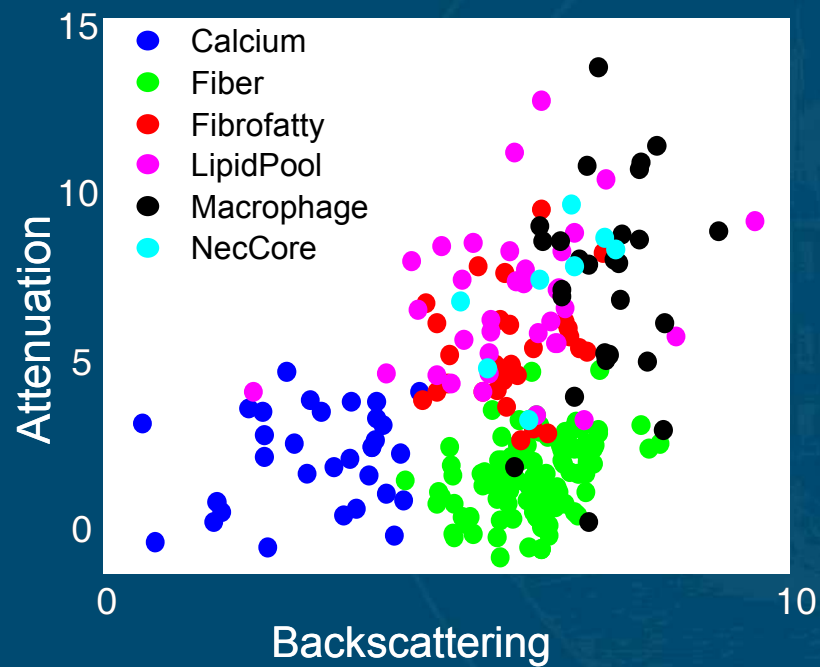
Expanded imaging capabilities

| | | |
|--------------------------------|--------------------------------------------------------------------------|-----------------------------------------------------|
| Morphological | Lesion size & shape % Stenosis Cap thickness Macrophage density | Backscatter Intensity Variance |
| Biochemical composition | Lipid, collagen, proteoglycans, calcium | Polarization Spectroscopy |
| Physiological | Flow disturbances CFR, FFR | Doppler |
| Mechanical | Plaque stiffness | Speckle Elastography |



Morphological Back scatter - Attenuation

Classification of OCT-selected Regions of Interest (ROIs)



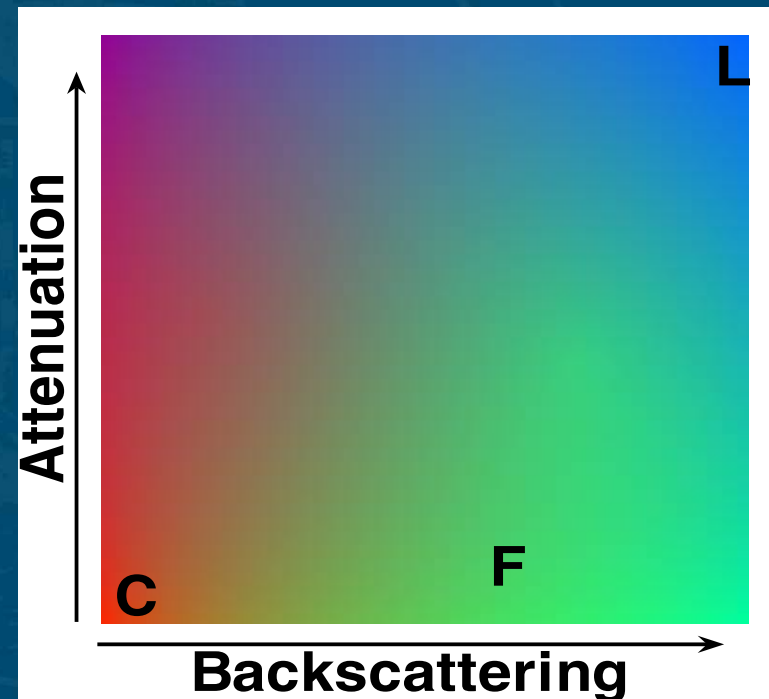
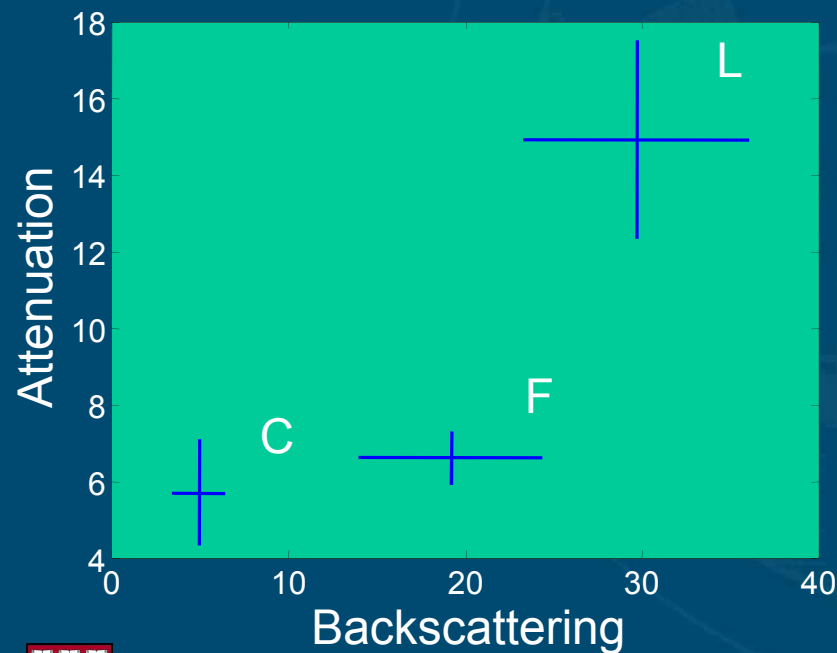
Quantitative color mapping

Use RGB color scale

Red: Geometrical distance from prototype calcification

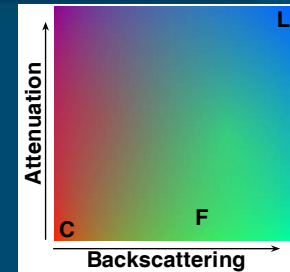
Green: Geometrical distance from prototype fibrous tissue

Blue: Geometrical distance from prototype lipid tissue



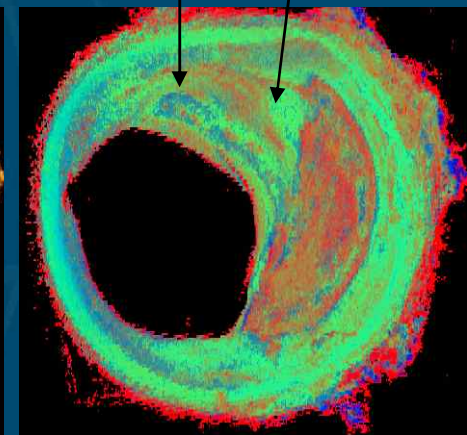
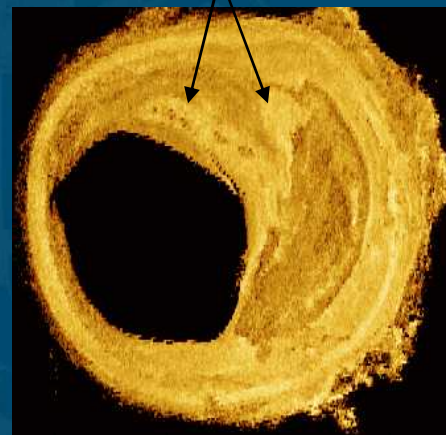
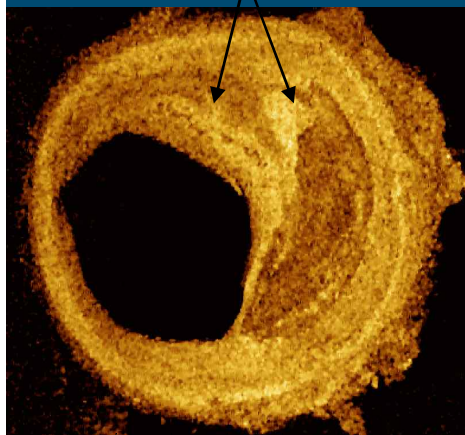
C: calcification; F: fiber; L: lipid

Quantitative color mapping applied to OCT images



Similar brightness

Different attenuation Similar back scatter



en face OCT

Attenuation

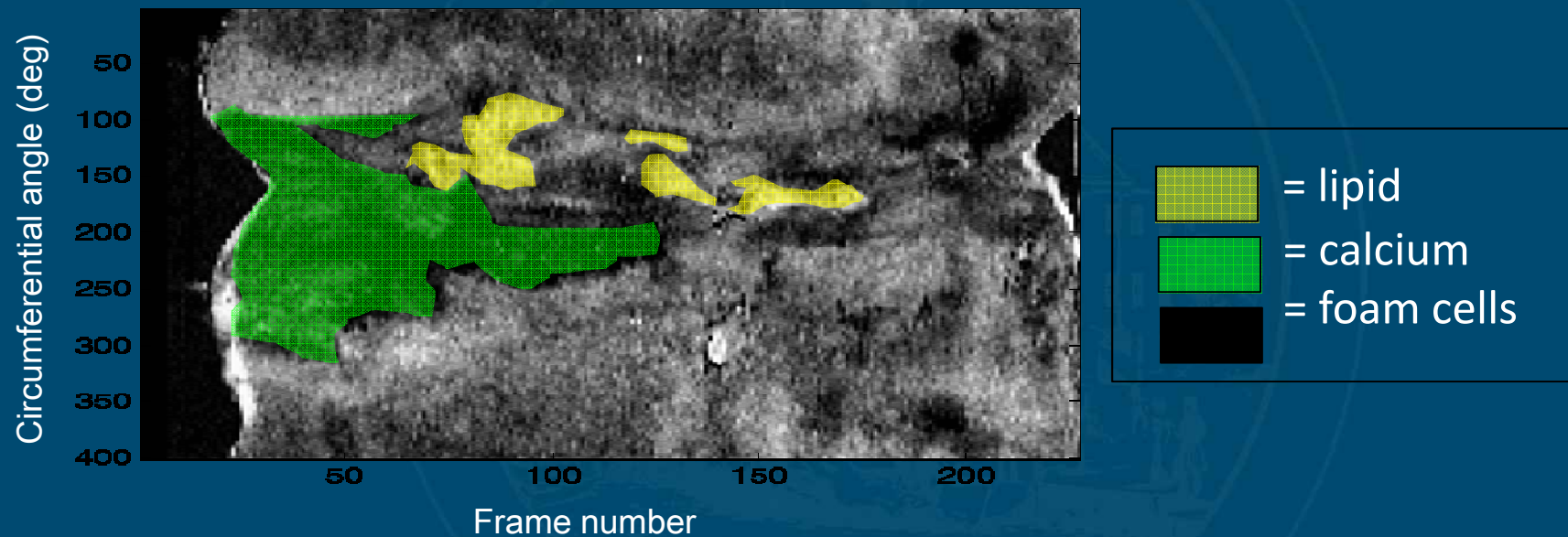
Back scattering

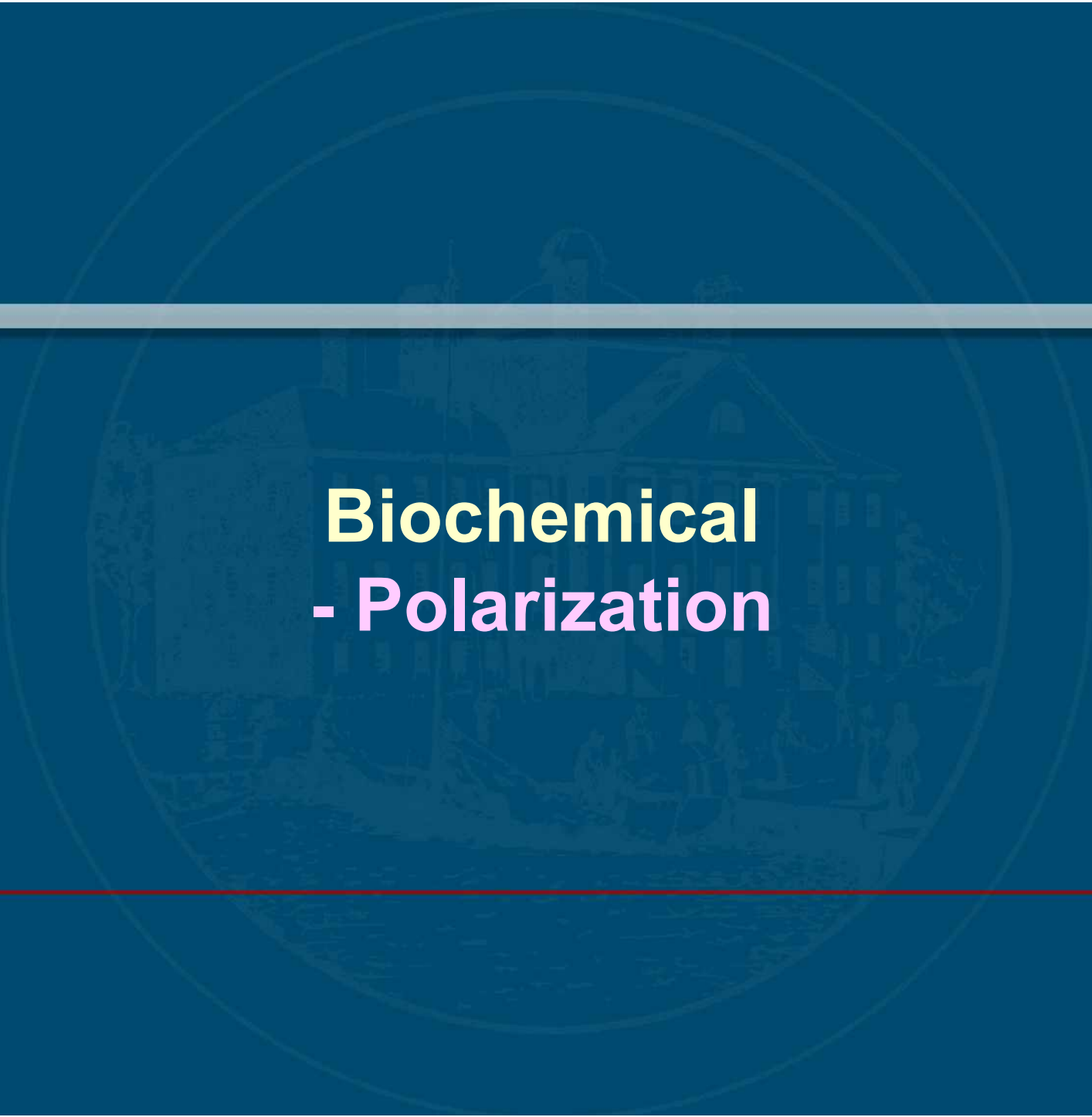
Combination



Surface images of plaque composition

>>Displays information from entire pullback image sequence

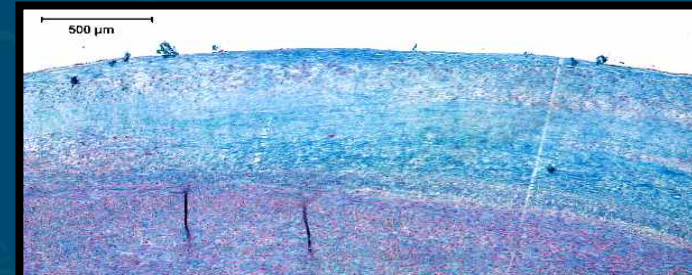




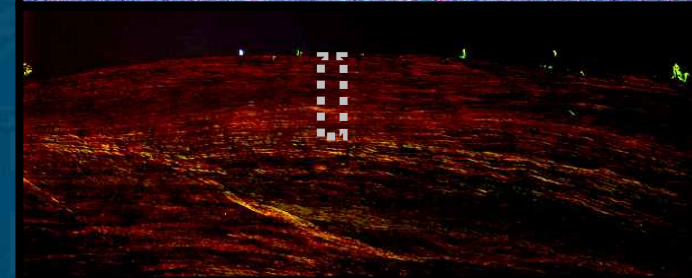
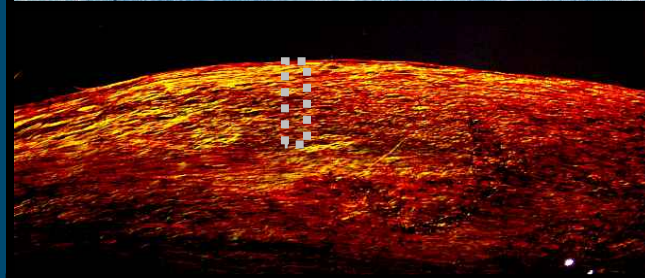
Biochemical - Polarization

Collagen Content by PS-OCT

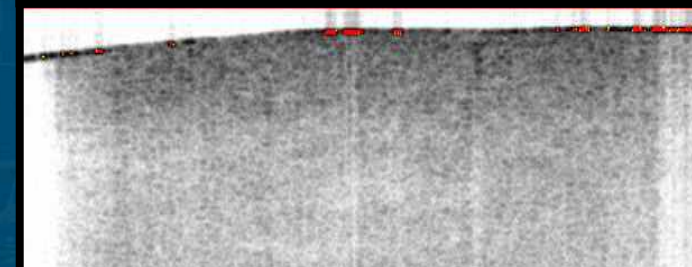
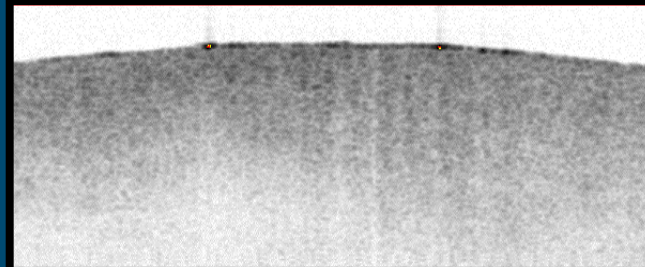
Trichrome



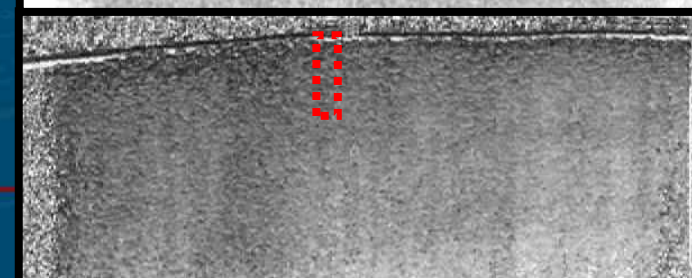
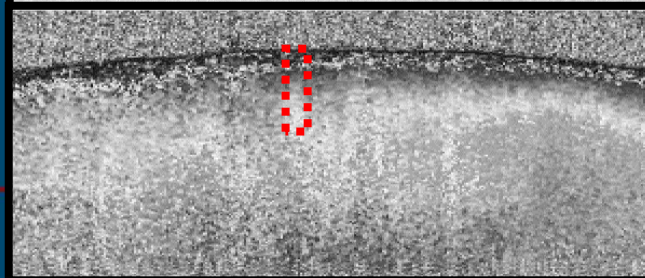
Picrosirius
Red



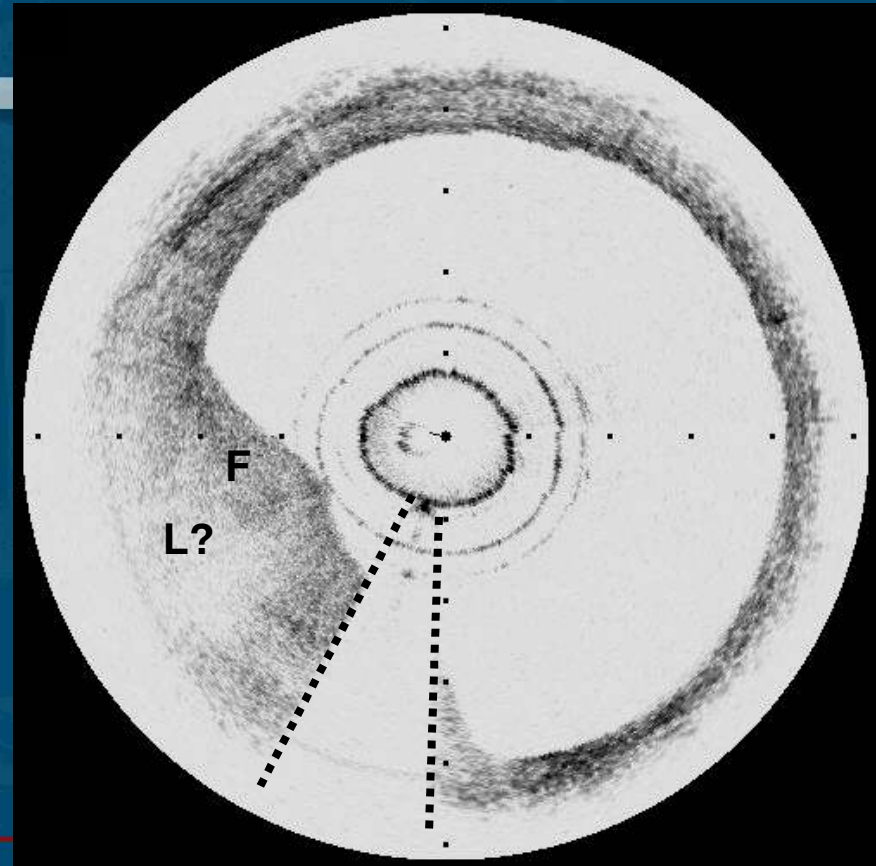
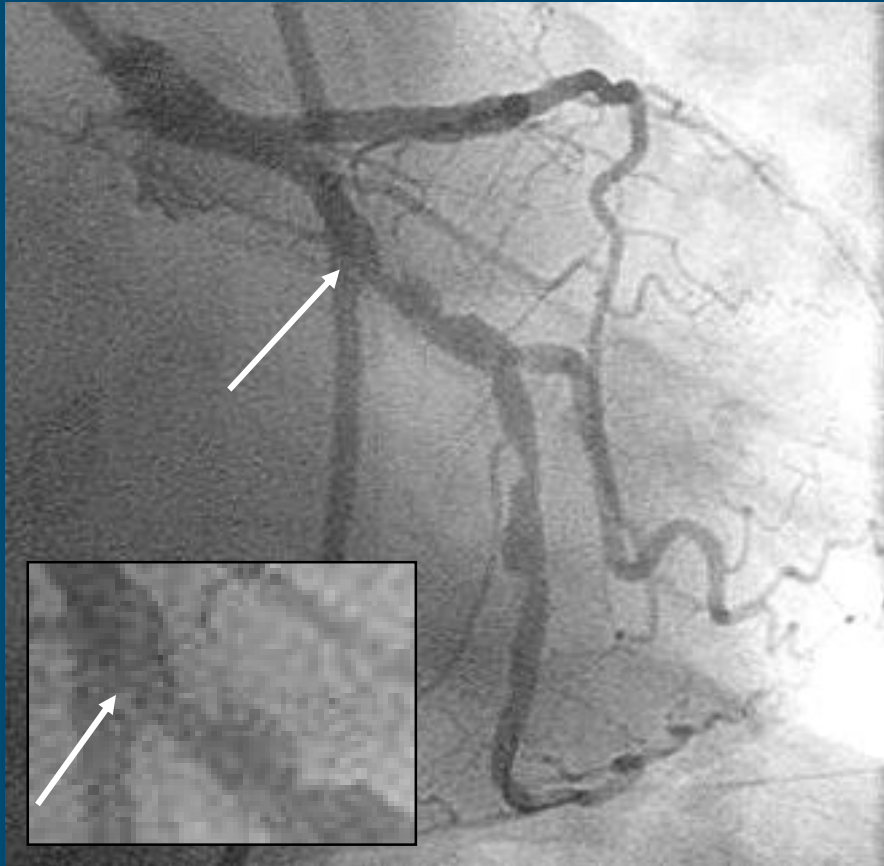
OCT



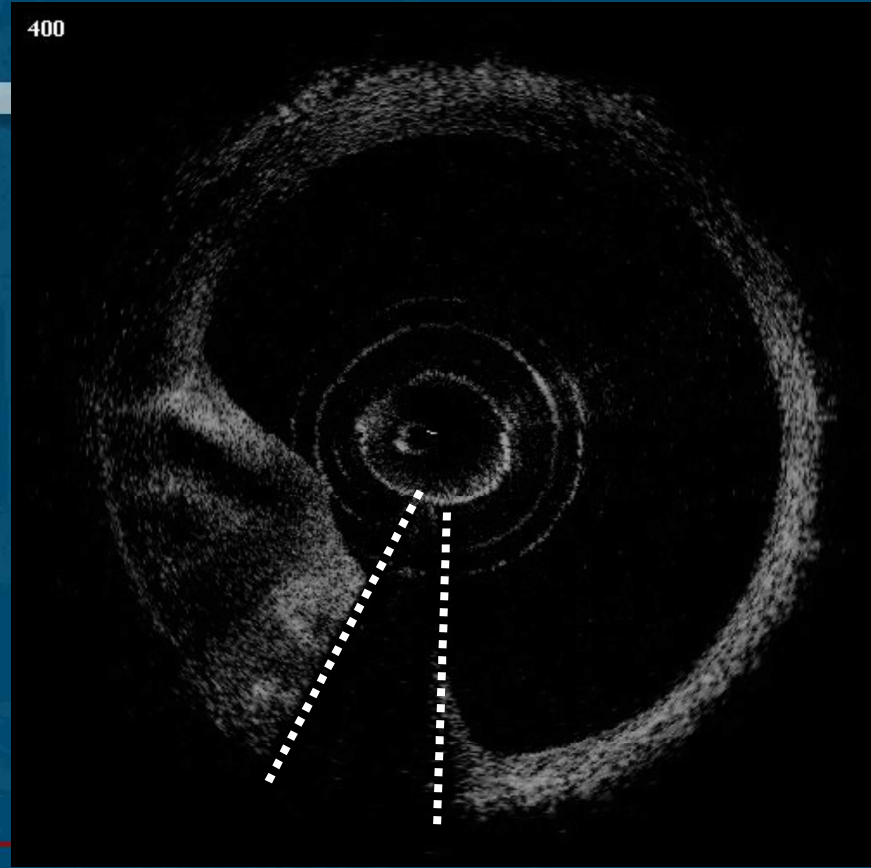
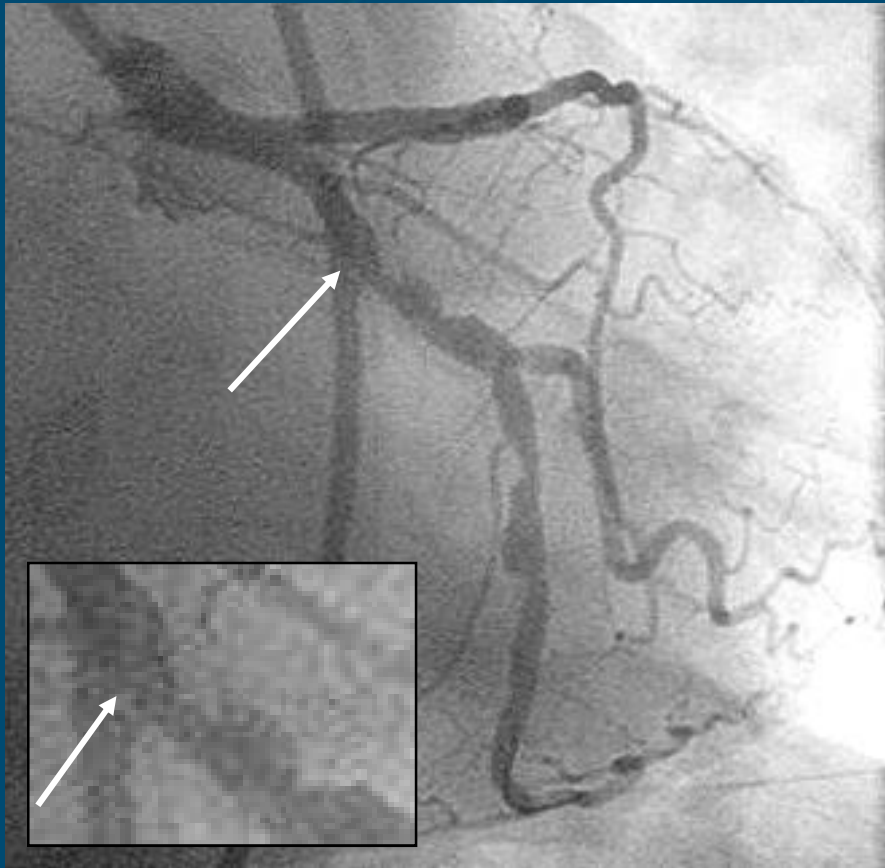
PS-OCT



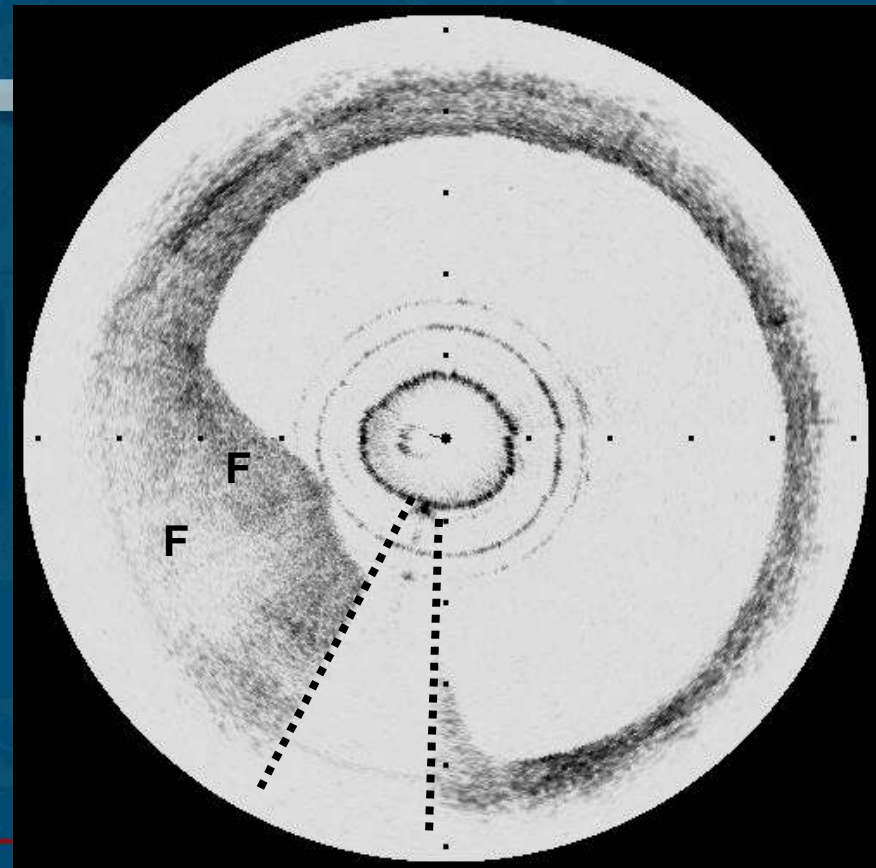
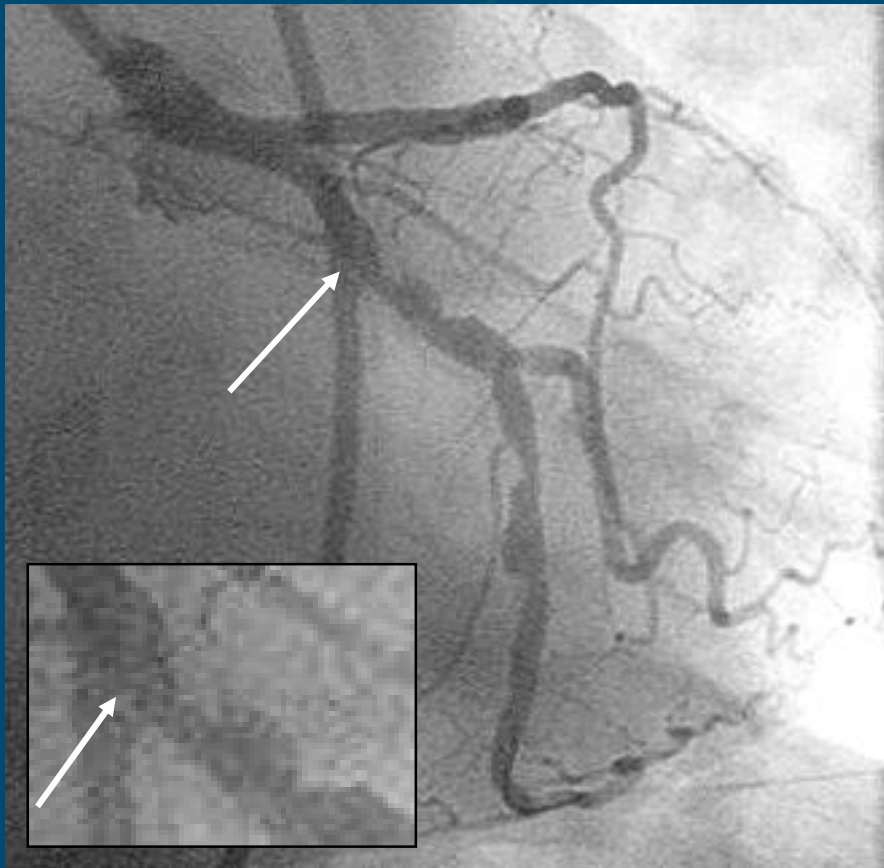
Deep Lipid ?



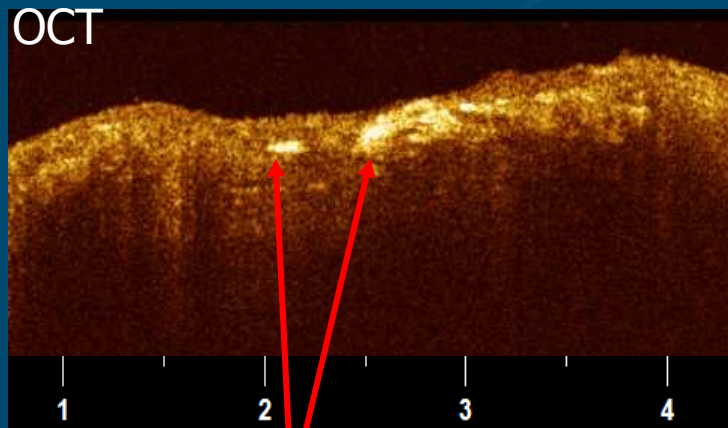
Birefringence Image



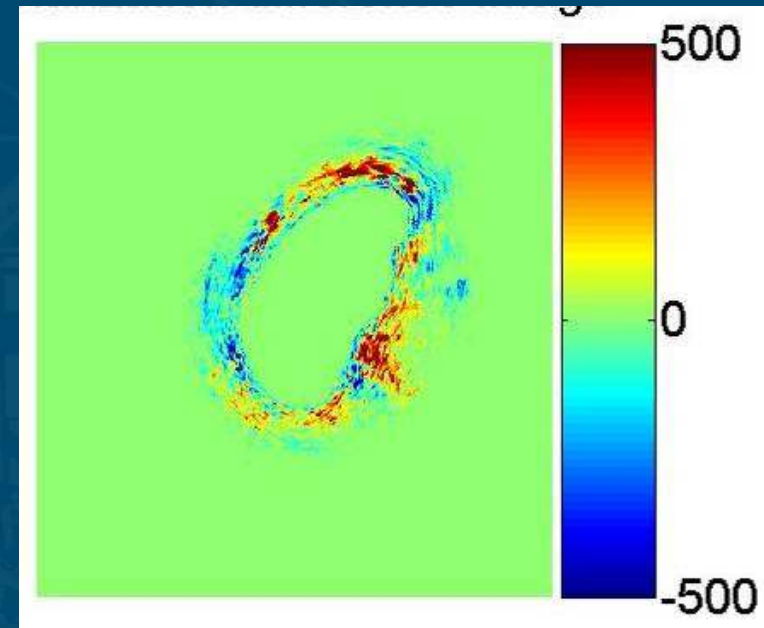
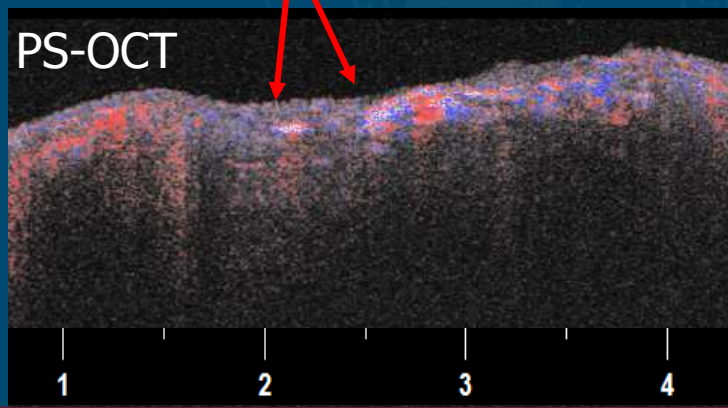
Dense Fibrous Plaque with attenuation



PS OCT



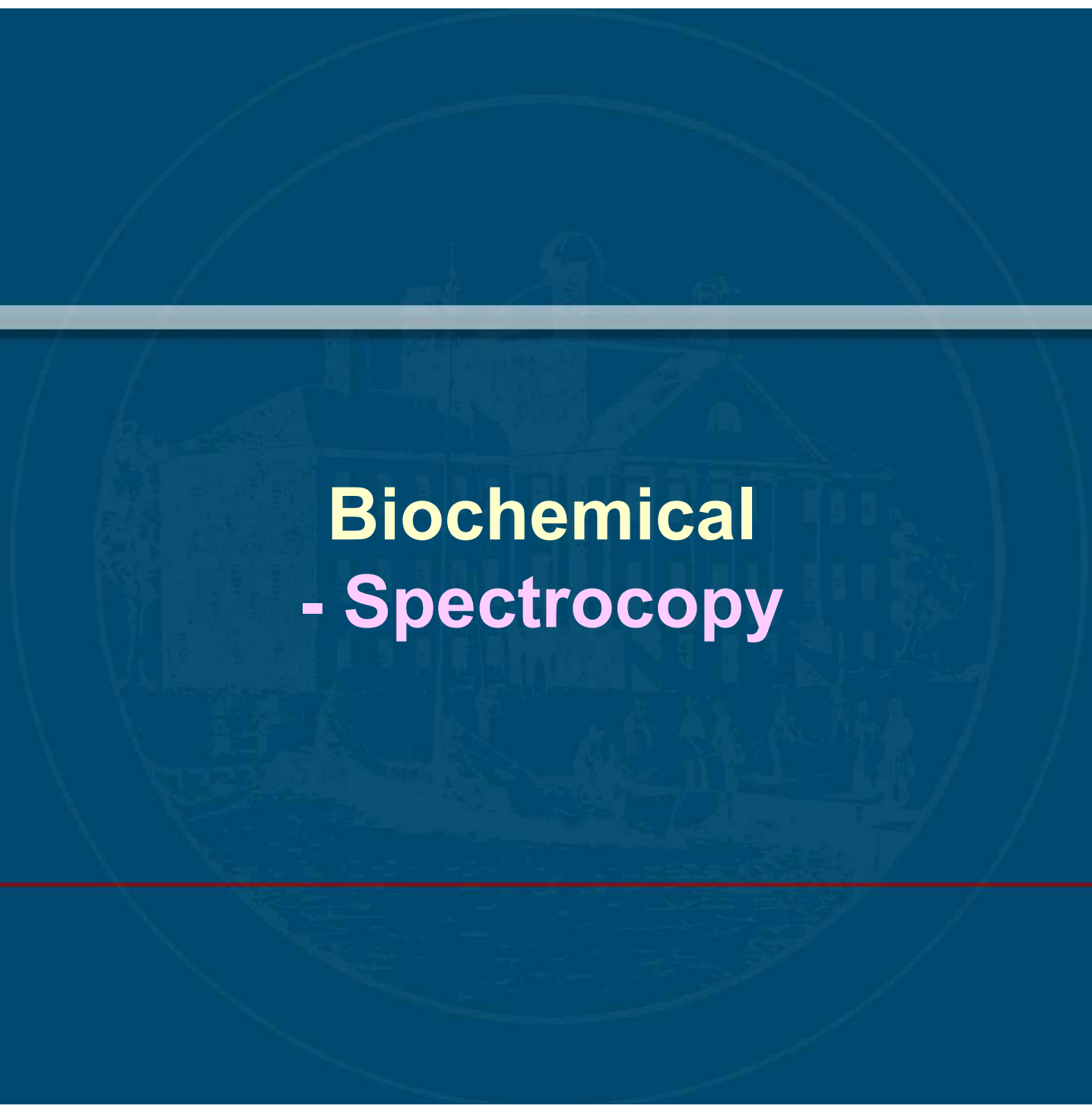
Cholesterol crystals



PS OCT with imaging wires

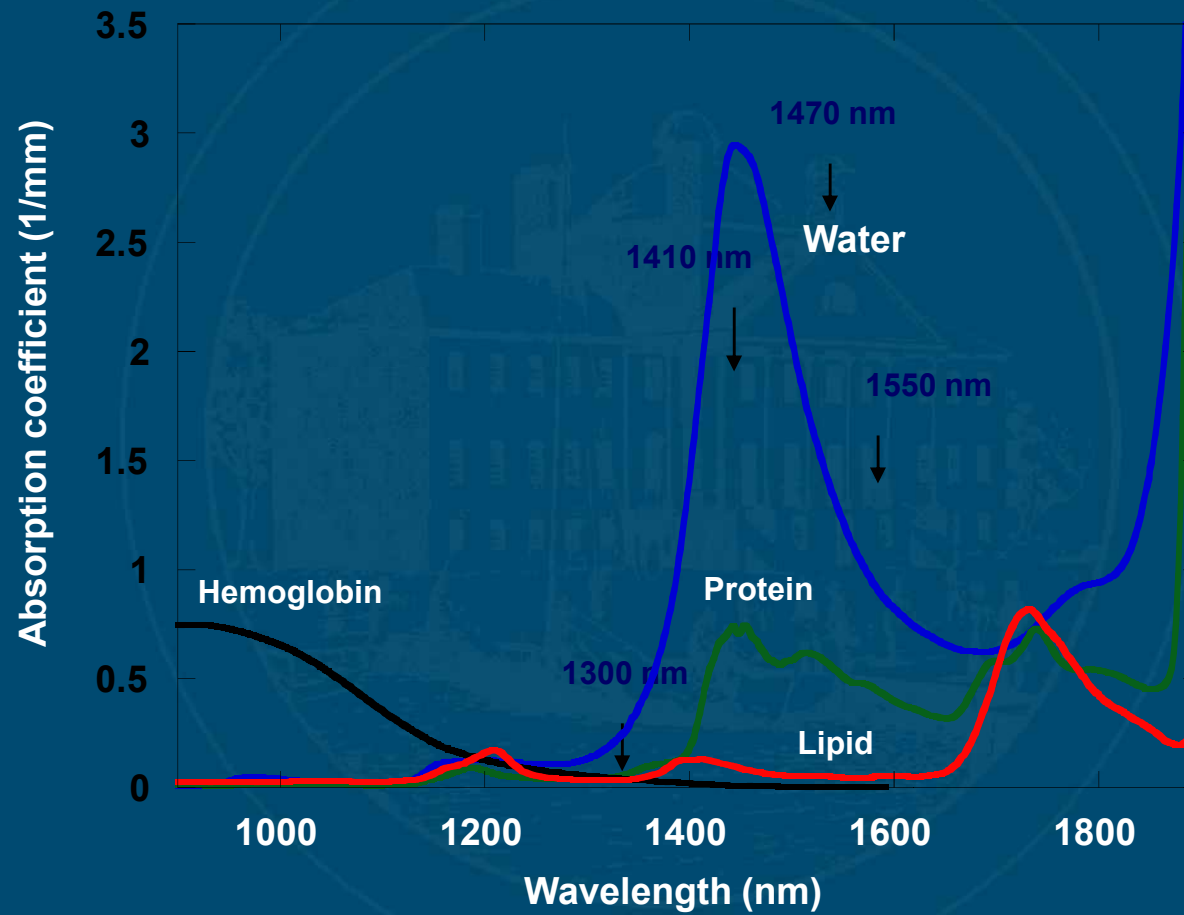


PS OCT using microscope



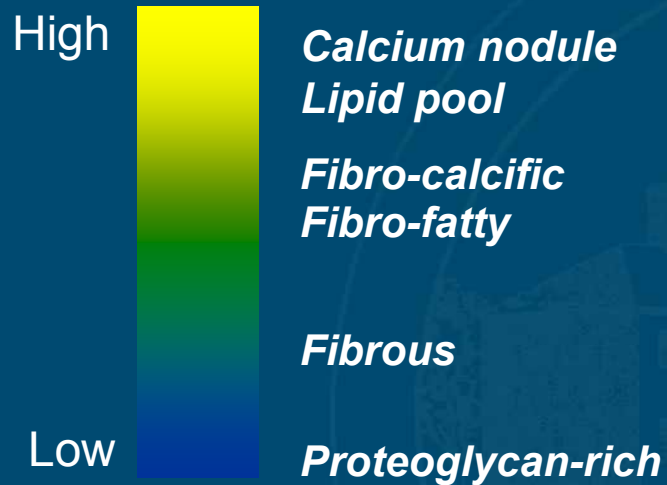
Biochemical - Spectroscopy

OCT Spectroscopy

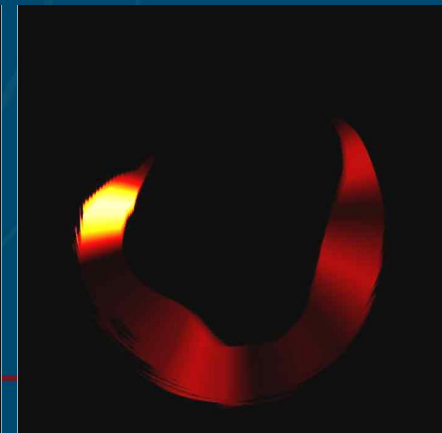
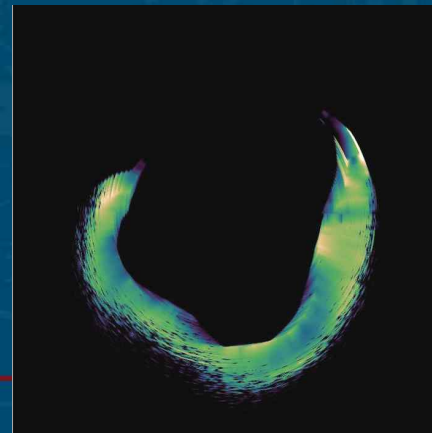
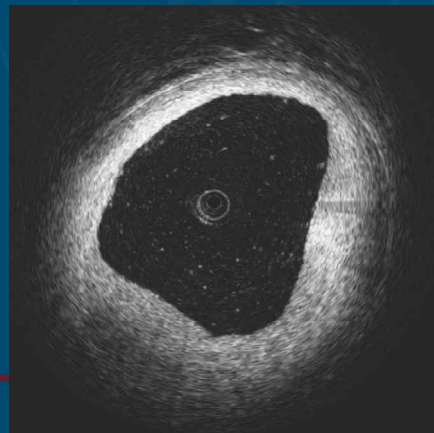
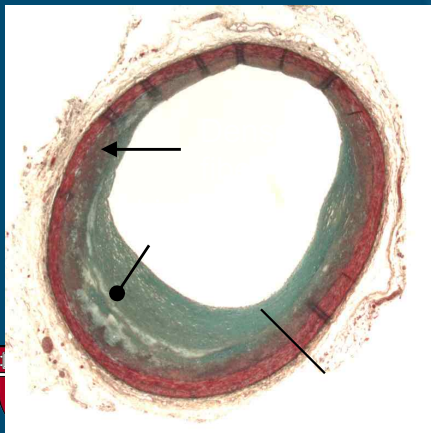


Spectroscopy and Polarization

Spectroscopy



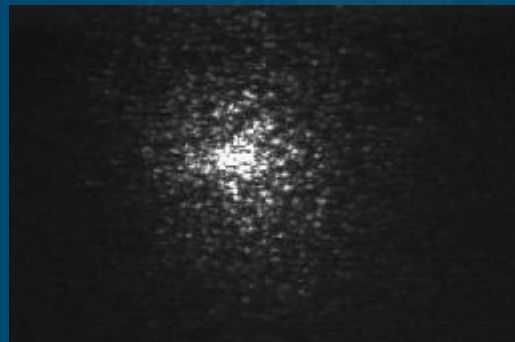
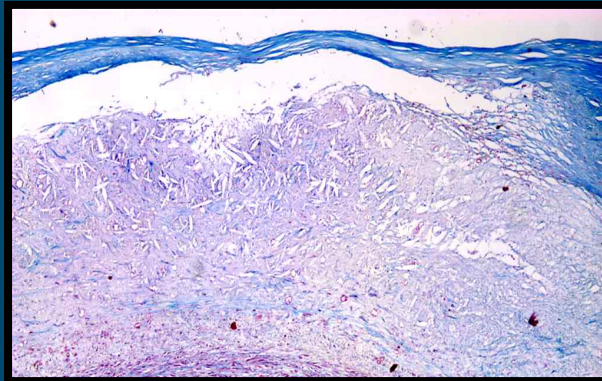
Birefringence



Mechanical - Speckle

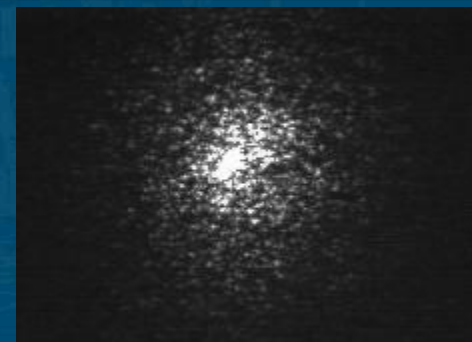
Laser speckle imaging (LSI)

Thin – cap Fibroatheroma:
Cap thickness = 64 μm



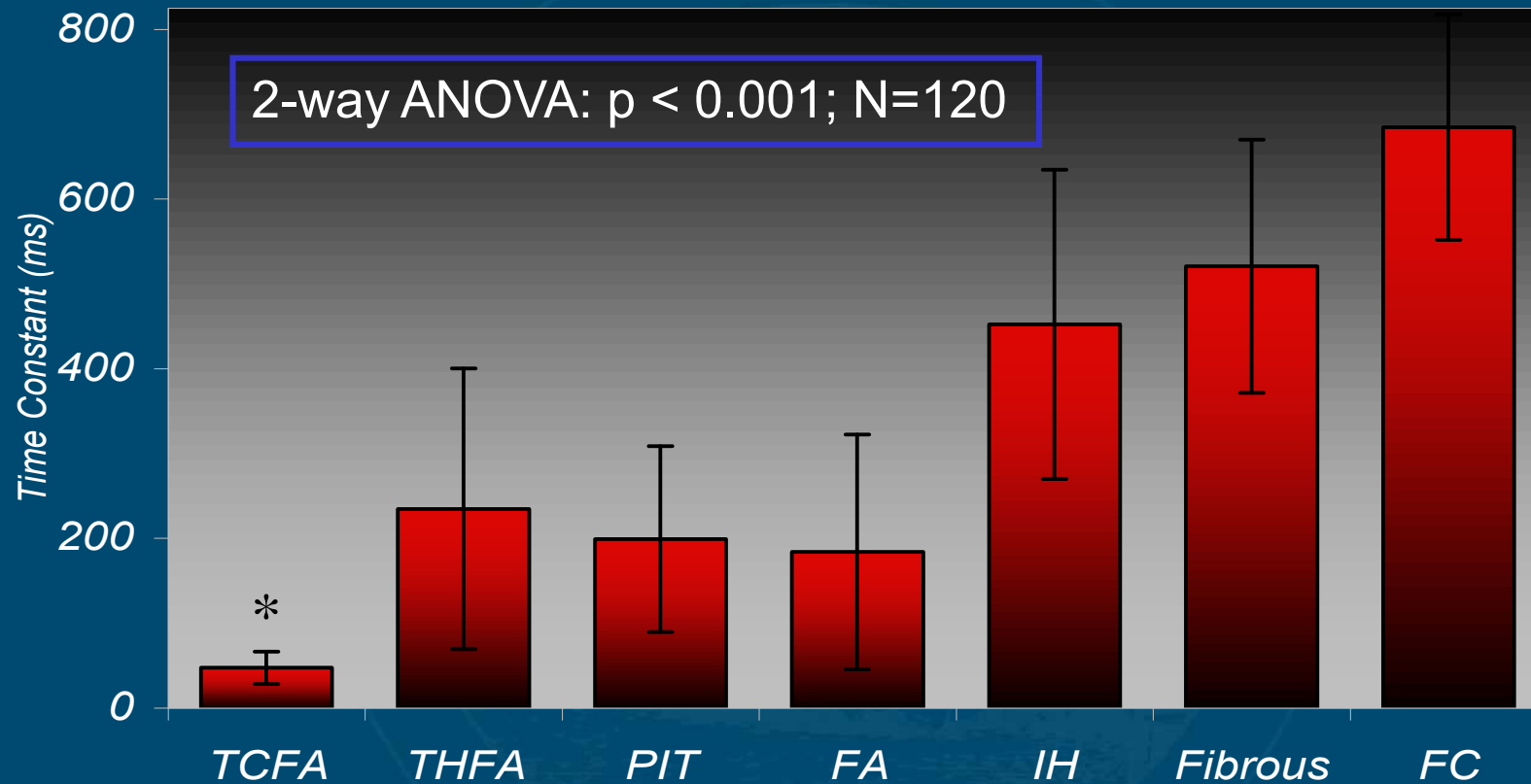
$\tau = 43 \text{ ms}$

Thick – cap Fibroatheroma:
Cap thickness = 426 μm



$\tau = 571 \text{ ms}$

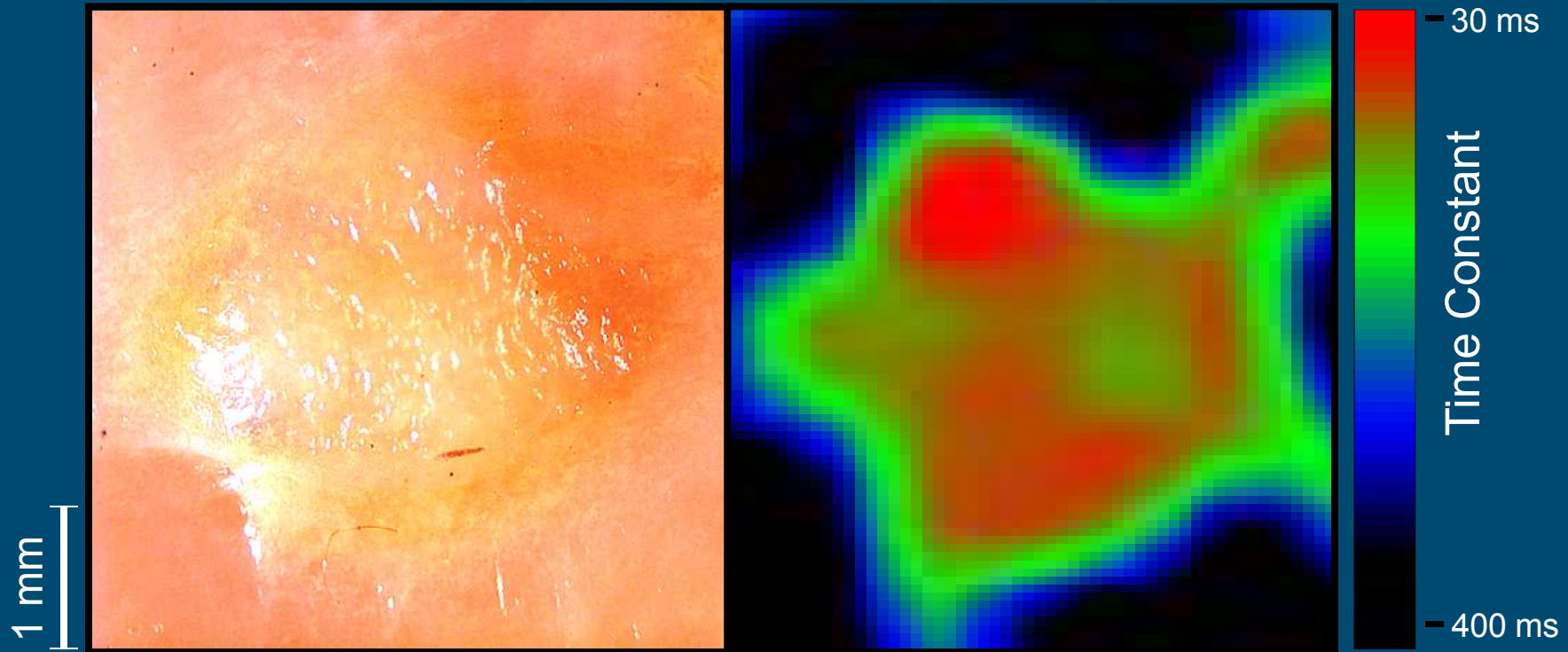
LSI - Characterization



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



LSI - Images



Photograph of Fibroatheroma

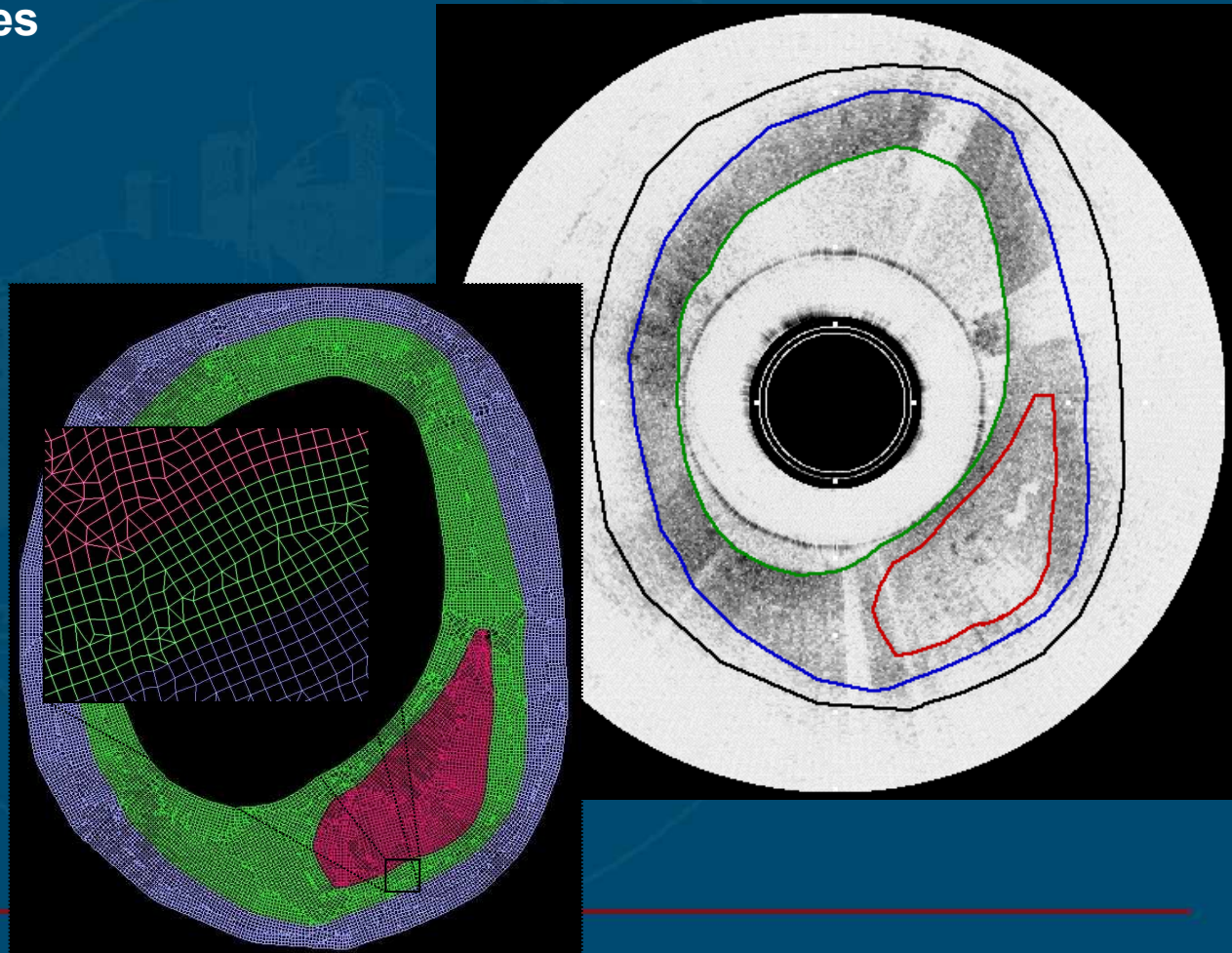
Time constant colormap of
Fibroatheroma

A faint, circular watermark image is centered in the background. It depicts a large, multi-story building with a prominent central tower and a person standing in front of it. The image is rendered in a light blue color that blends with the dark blue background.

Elastography

OCT Elastography

- Biomechanical Properties
- Combine OCT and FEA
- Visualization of Stress/Strain
- Determination of Elastic Modulus



Second-Generation OCT

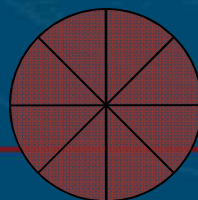
**FD OCT
(Frequency Domain)**

M3 vs C7

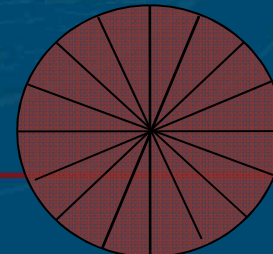
| | <i>M3</i> | <i>C7</i> |
|----------------------------------------|------------|------------|
| <i>Max. Frame Rate</i> | 20 fps | 100+ fps |
| <i>Max. Pullback Speed</i> | 3 mm/s | 20+ mm/s |
| <i># Lines/frame</i> | 200 | 500 |
| <i>Scan diameter (in contrast)</i> | 6.8 mm | 8+ mm |
| <i>Lateral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



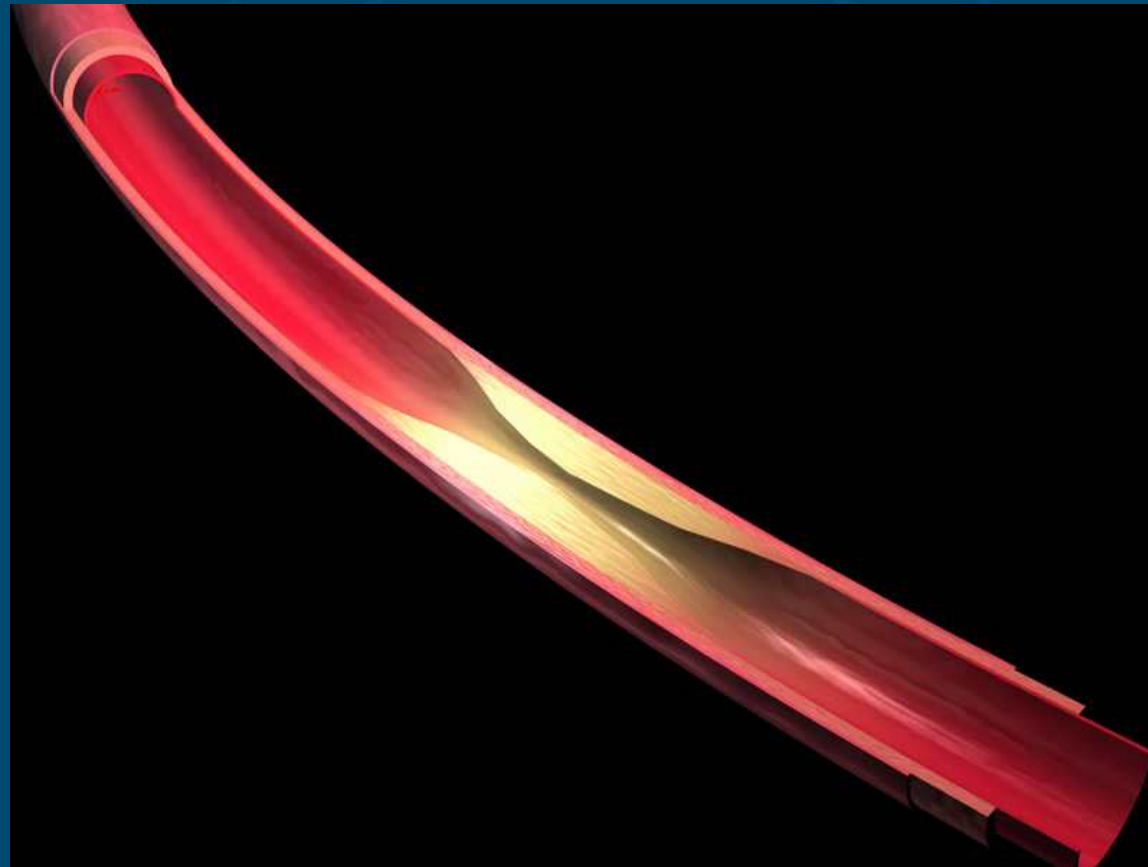
160,000
pixels/frame



500,000
pixels/frame



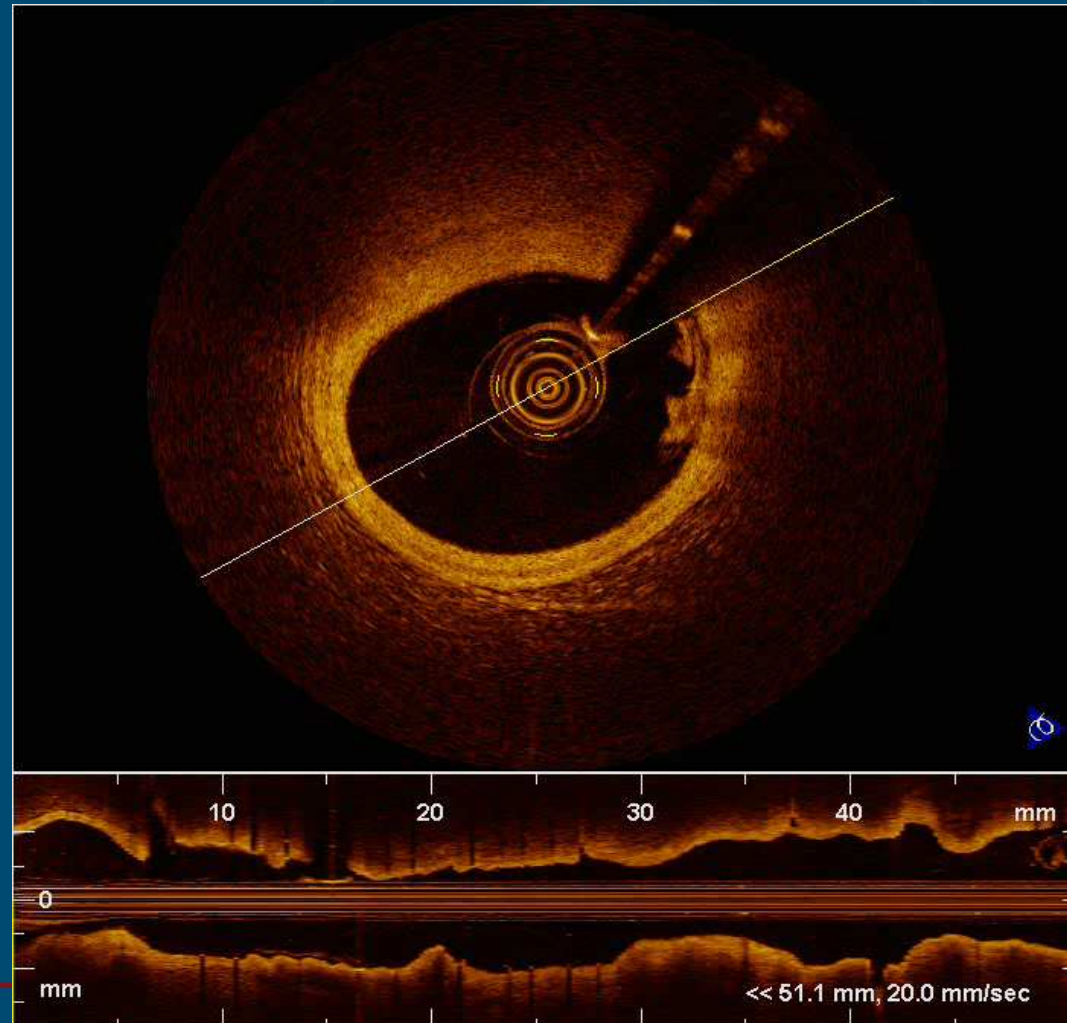
TD OCT with proximal balloon occlusion



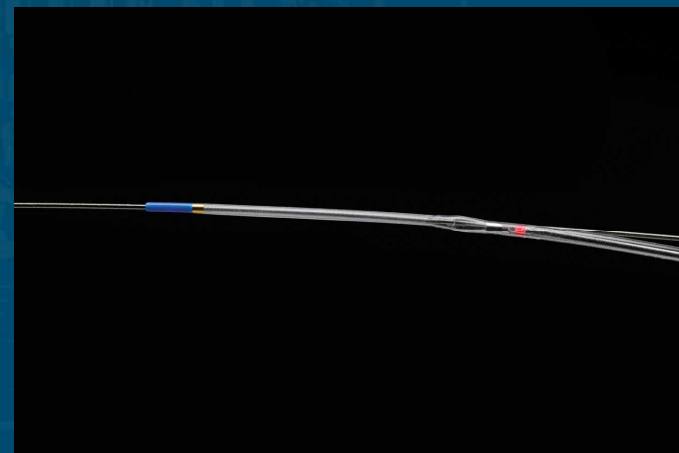
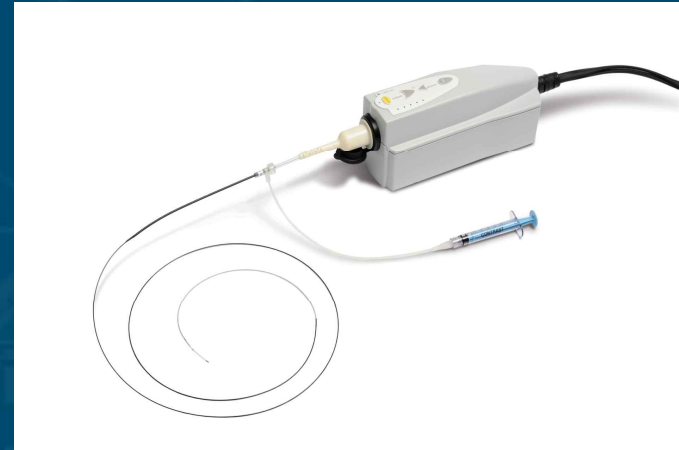
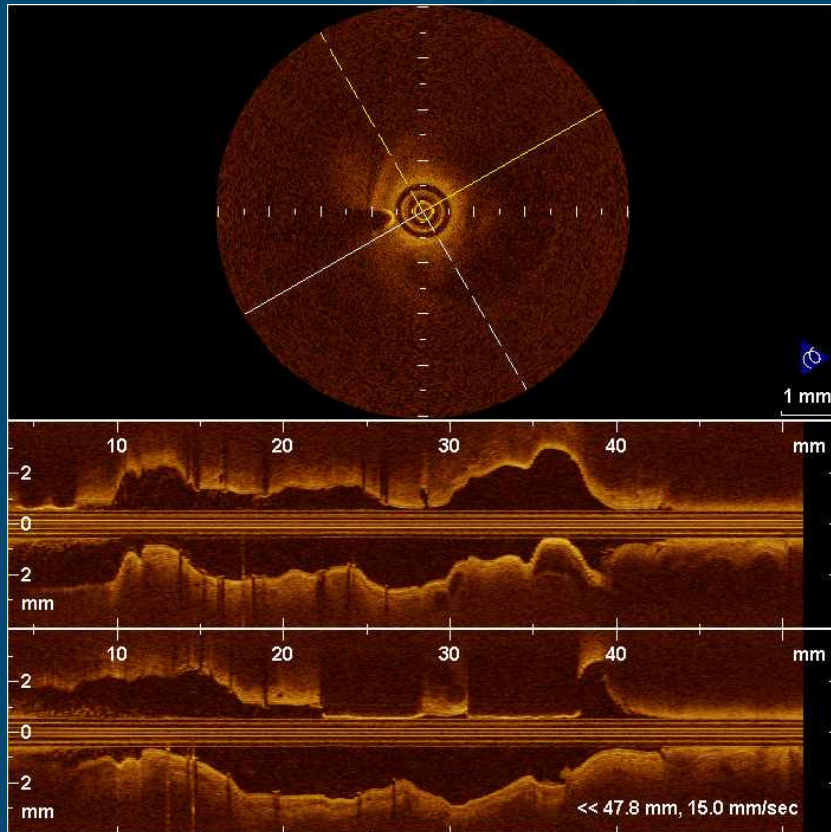
FD OCT



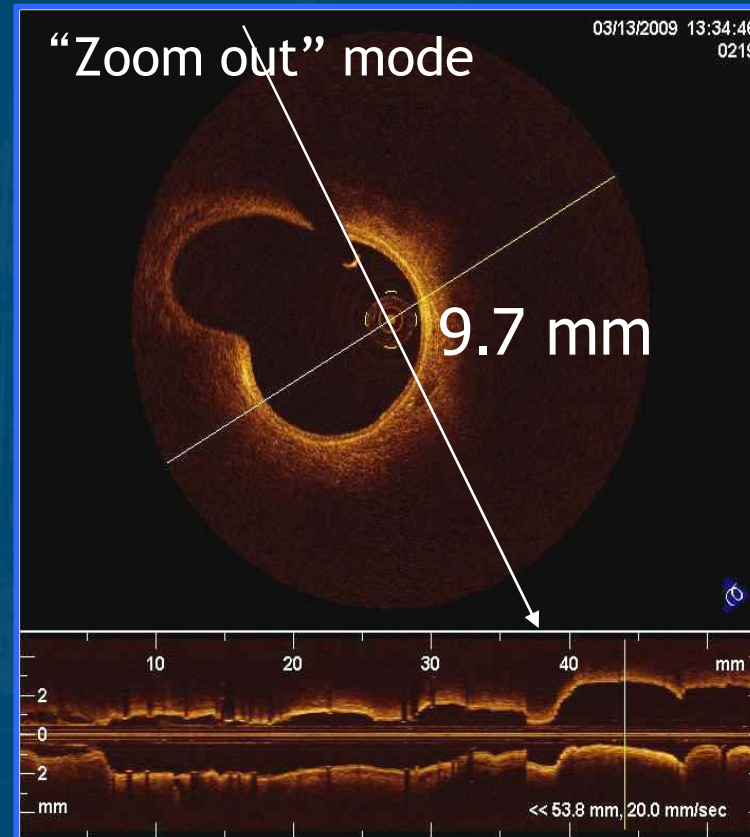
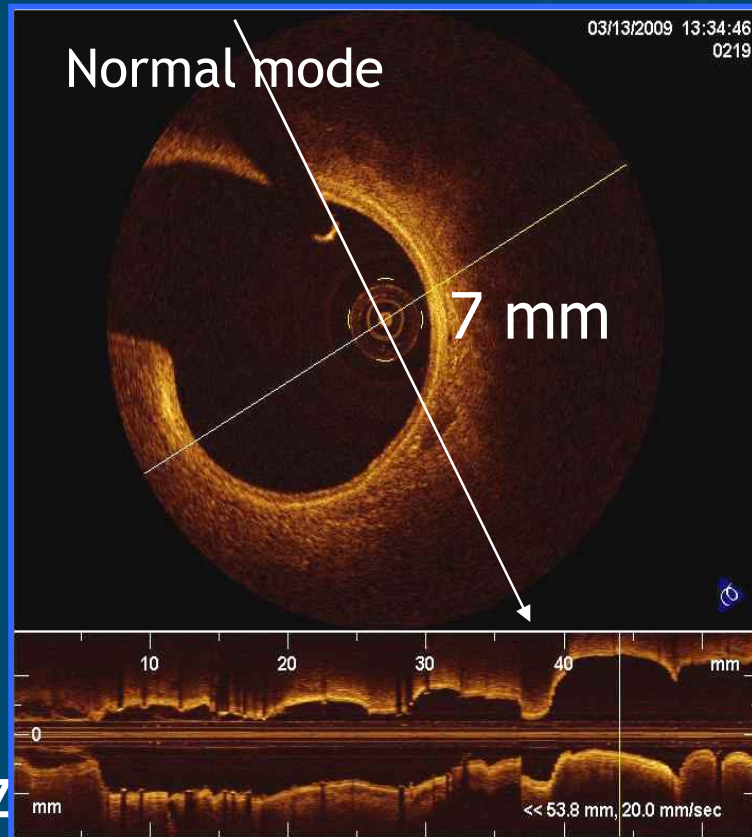
FD OCT (pressure triggered)



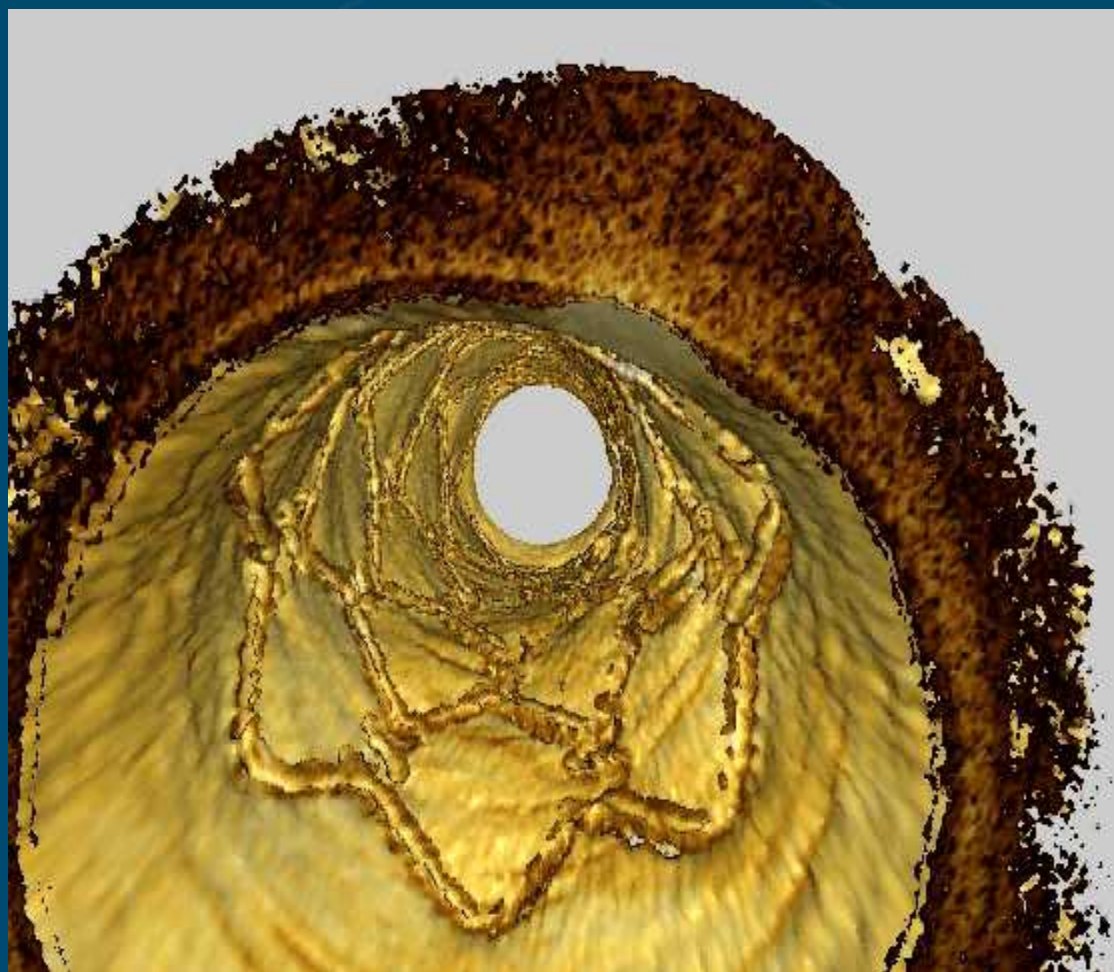
FD OCT (software triggered – C7)



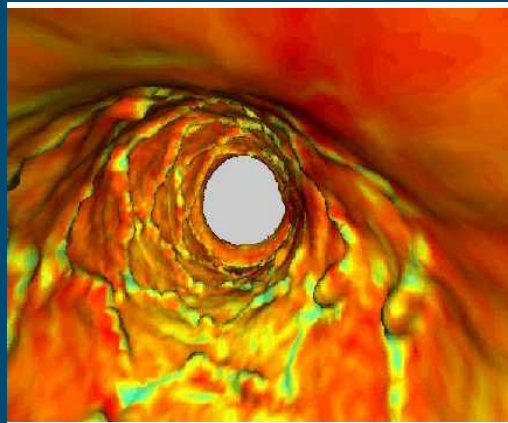
Zoom Feature



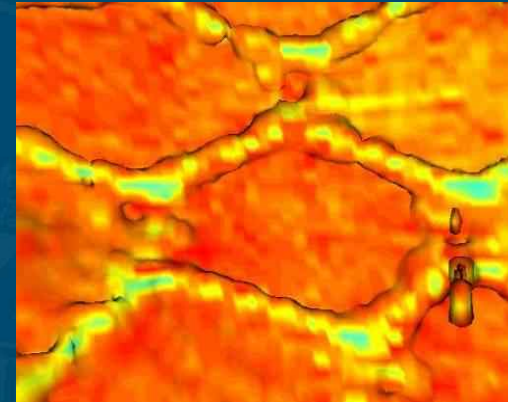
Fly through



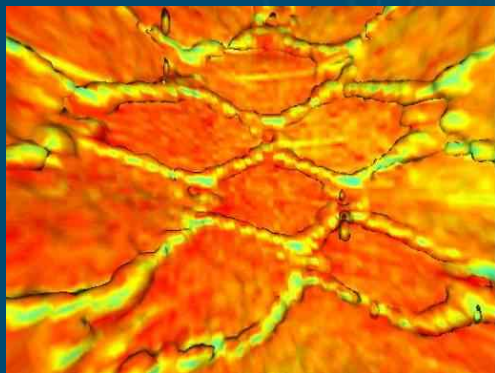
Angioscopic Views



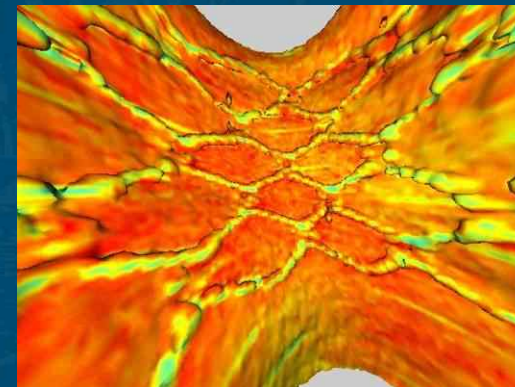
Perpendicular viewing axis



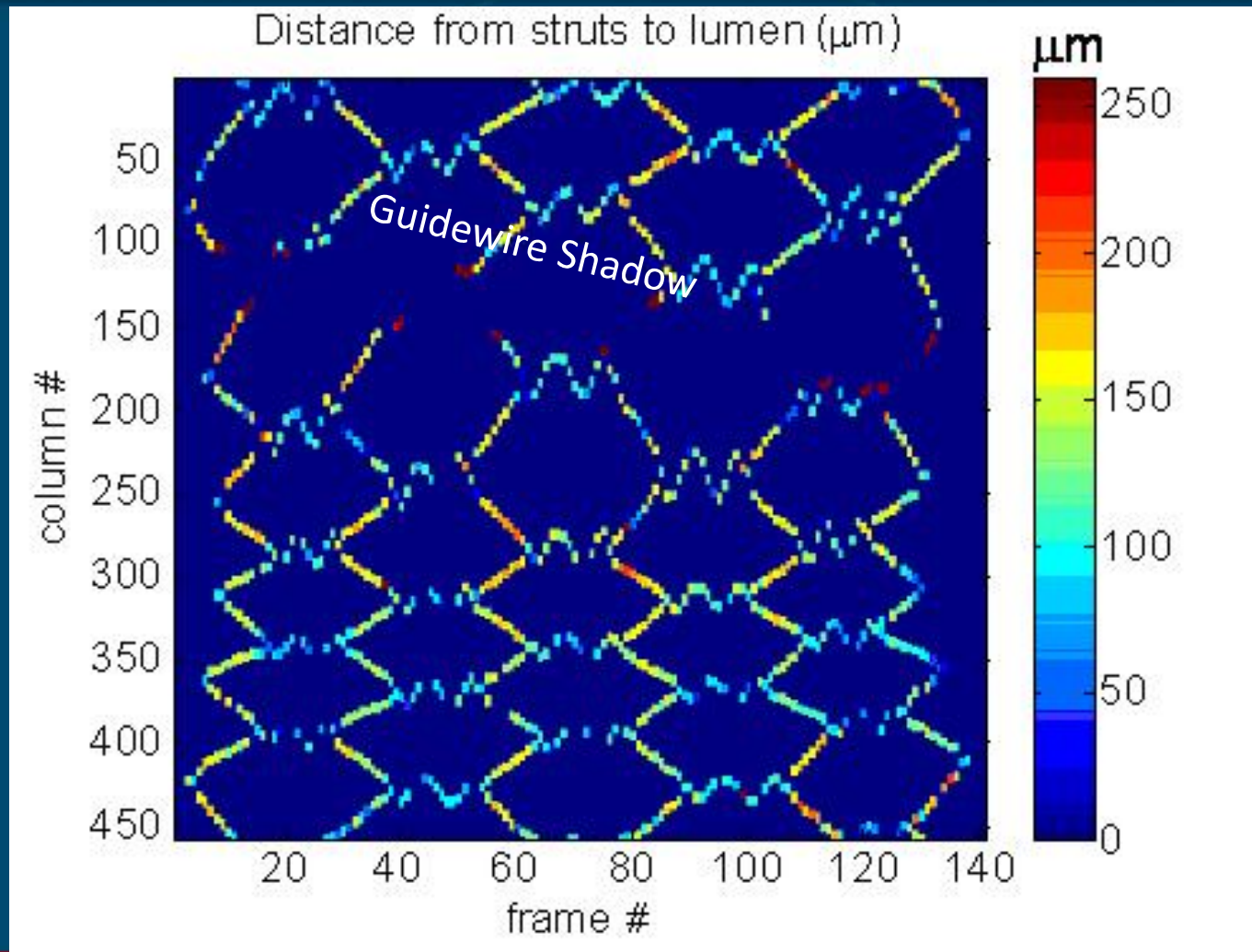
Zoom in



Zoom out
(wide-angle lens)

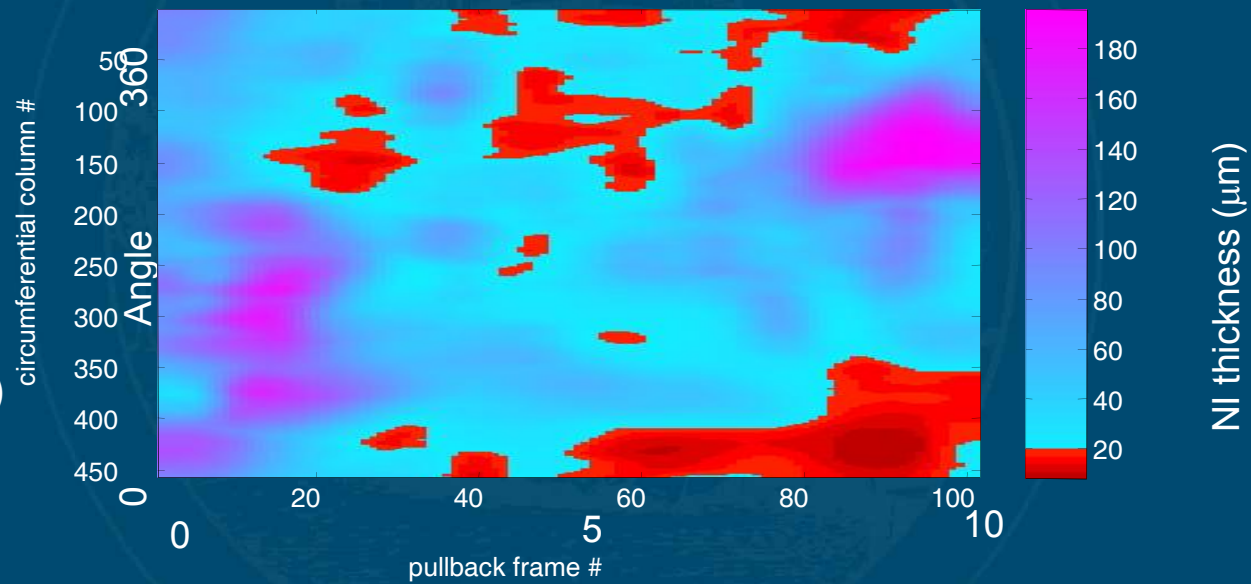


Stent Malapposition Mapping : *in-vivo* imaging

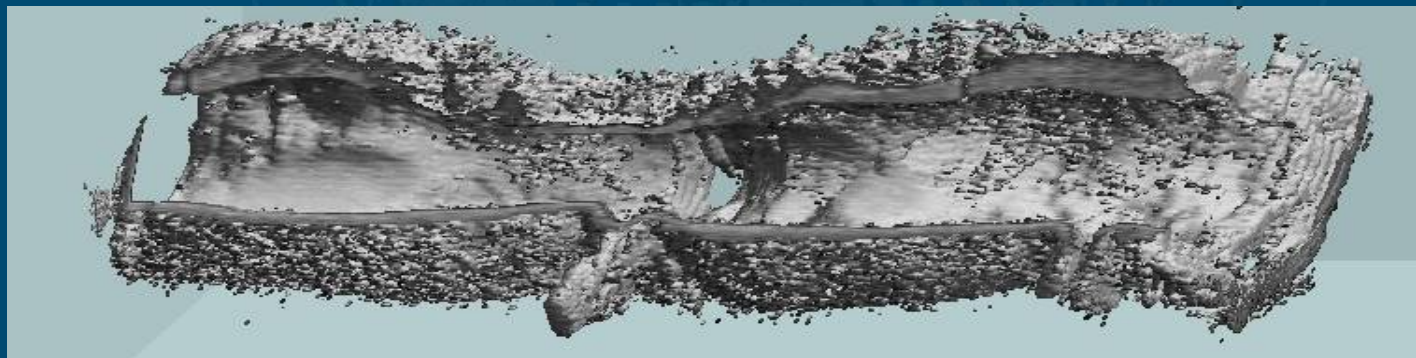
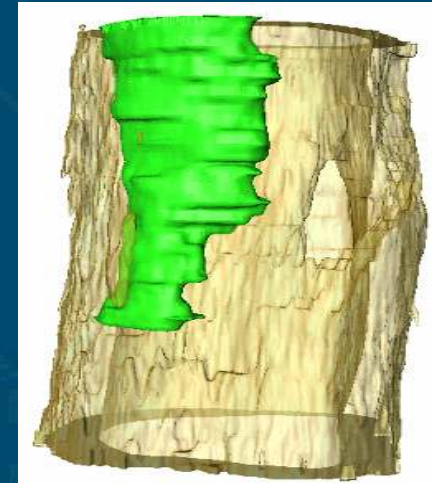
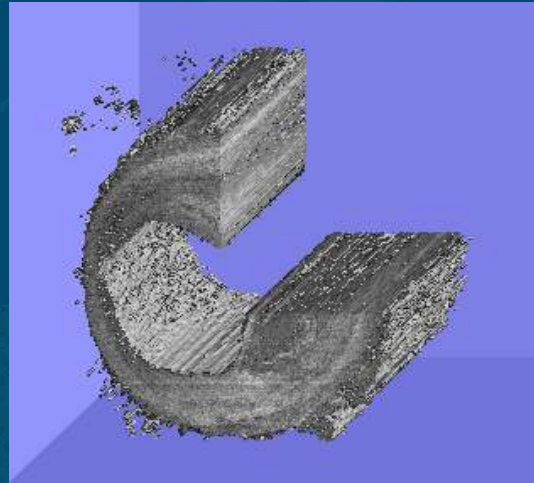
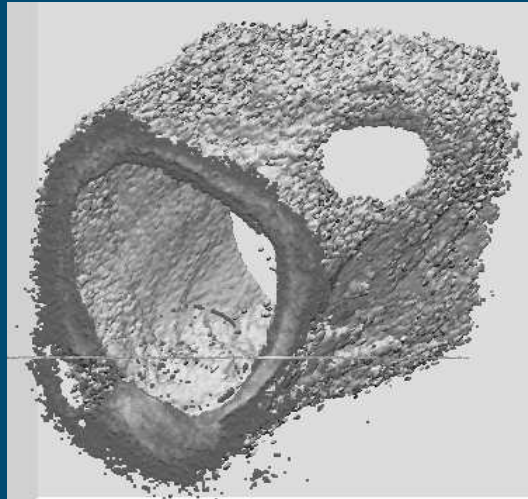


Computer-assisted volumetric stent analysis

Strut
coverage
map
(DES stent follow-up)



3D Reconstruction



MGH OCT Registry

- 20 sites from Australia, China, Japan, Korea, (USA, Europe)
- Establishing Clinical Research Network
- 1st Symposium: March 13, 2010 at MGH
- Start data collection in 6/1/2010
- Establish OCT fellowship

ijang@partners.org

Data Collection

- eCRF
- OCT, Angio, IVUS
- Blood sample (proteomics, metabolomics, and genomics)



UAT

- 11-0005
- Index Procedure
- Follow Up Month 6
- Follow Up Year 1
- Follow Up Year 2
- Follow Up Year 3
- Follow Up Year 4
- Follow Up Year 5
- Completion/Withdrawal

Subject Characteristics

Grid View

| Visit | Date |
|-------------------|-------------|
| Index Procedure | 12 Jan 2009 |
| Follow Up Month 6 | 15 Jul 2009 |
| Follow Up Year 1 | 15 Aug 2009 |
| Follow Up Year 2 | 12 Jan 2011 |
| Follow Up Year 3 | 12 Jan 2012 |
| Follow Up Year 4 | 11 Jan 2013 |
| Follow Up Year 5 | 11 Jan 2014 |

Task Summary: Subject

Pages

| | |
|---------------------|---|
| Requiring Signature | 5 |
| NonConformant Data | 0 |
| Open Queries | 1 |
| Sticky Notes | 0 |
| Overdue Data | 3 |

Add Event Add

[Icon Key](#)

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- Index Procedure
- Presentation
- Demographics
- Medical History
- Outpatient Medication
- Pre-Procedure Labs
- Cardiac Markers
- Procedure Details
- Peri/Intra-Procedure Medications
- Vessel Imaging and Procedures
- Vessel Runs
- Stent Details
- Intra-Procedure Complications
- Post-Procedural Complications
- Discharge Medications

Subject: 11-0005
Page: Presentation - Index Procedure

Date of contact [] [] [] [] [] [] [] [] [] []

Presentation [] [] [] [] [] [] [] [] [] []

Location of ischemia or infarct

| | | |
|-----------------|--------------------------|-----------------|
| None | <input type="checkbox"/> | [] [] [] [] |
| Anterior/septal | <input type="checkbox"/> | [] [] [] [] |
| Inferior | <input type="checkbox"/> | [] [] [] [] |
| Lateral | <input type="checkbox"/> | [] [] [] [] |
| Posterior | <input type="checkbox"/> | [] [] [] [] |
| Unknown: | <input type="checkbox"/> | [] [] [] [] |

- CRF History
- 11-0005 - Presentation



- Follow Up Year 1
- Presentation
- Follow-up

- CRF History
- 11-0005 - Presentation
 - 11-0005 - Completion/Withdrawal
 - 11-0005 - Presentation
 - 11-0005 - Presentation
 - 11-0005 - Presentation

Data Saved
Next Page - "Follow Up Year 1 - Follow-up"

Subject: 11-0005
Page: Presentation - Follow Up Year 1

Date of contact

? The date of contact for the Follow Up Year 1 visit is not 365 days (+/- 30 days) after the 'Index Procedure'. Please amend the date or explain the reason why the patient is outside the visit window. Thank you
Opened To Site from System (11 Mar 2010)

Entry Error 15 Aug 2009

Presentation Stable angina

CCS Classification of Angina

Location of ischemia or infarct

| | | |
|-----------------|-------------------------------------|-------------------------------------|
| None | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| Anterior/septal | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Inferior | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| Lateral | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| Posterior | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| Unknown: | <input type="checkbox"/> | <input checked="" type="checkbox"/> |

Printable Version View PDF Icon Key
CRF Version 63 - Page Generated: 11 Mar 2010 15:18:18 Greenwich Standard Time

Save Cancel



Click Here for Customer Support Information

Participating PIs and Institutions

Australia

- OC Raffel: Prince Charles

China

- BX Chen: Qinghua Univ.
- YD Chen: 301 Hospital
- H Fang: Peking Union Univ.
- G Fu: Zhejiang Univ.
- RL Gao: Fu Wai
- Y Han: Shenyang Military Hosp.
- S Lv: Anzhen
- H Wang: Nanjing City Hosp.
- B Yu: Harbin Med Univ.

Japan

- Ito: Iwate
- K Mizuno: Tokyo
- J Shite: Kobe
- T Suzuki: Toyohashi
- S Uemura: Nara
- Kakuta: Tsutiura Kyodo

Korea

- JM Cho: Kyung Hee
- SY Choi: Ajou
- YS Jang: Yonsei
- SJ Kim: Kyung Hee



Future Symposia

1st: 3/13/2010 - Boston

2nd: 2011 – Seoul, Korea

3rd: 2012 - Boston

4th: 2013 – Yokohama, Japan

5th: 2014 – Boston

6th: 2015 - China





1st Massachusetts General Hospital OCT Registry Symposium

March 13, 2010 // 9:00 am - 1:30 pm

SPEAKERS

Opening Remarks: IK-KYUNG JANG, MD, PHD // MASSACHUSETTS GENERAL HOSPITAL
G. WILLIAM DEC, MD // MASSACHUSETTS GENERAL HOSPITAL
DAVID W. KOLSTAD // LIGHTLAB IMAGING, INC

JAMES G. FUJIMOTO, PHD // MASSACHUSETTS INSTITUTE OF TECHNOLOGY

KYOICHI MIZUNO, MD, PHD // NIPPON MEDICAL SCHOOL

YUEJIN YANG, MD, PHD // FUWAI HOSPITAL

CARLO DI MARIO, MD, PHD // ROYAL BROMPTON HOSPITAL

MYEONG-KI HONG, MD, PHD // YONSEI UNIVERSITY HOSPITAL

GREG KOSKI, PHD, MD, CPI (HONORARY) // MASSACHUSETTS GENERAL HOSPITAL

IK-KYUNG JANG, MD, PHD // MASSACHUSETTS GENERAL HOSPITAL

LOCATION

Massachusetts General Hospital
Simches Research Center
185 Cambridge Street Room #3110
Charles River Plaza
Boston, MA 02115

CONTACT INFORMATION

Iris McNulty, RN
imcnulty@partners.org
617-726-2612

REGISTRATION

<http://oct2010.kintera.org/>
Registration ends March 1, 2010



MASSACHUSETTS
GENERAL HOSPITAL

HEART CENTER

Thank You

