3D OCT: Will It Change CathLab's Landscape ?

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Disclosure Statement of Financial Interest

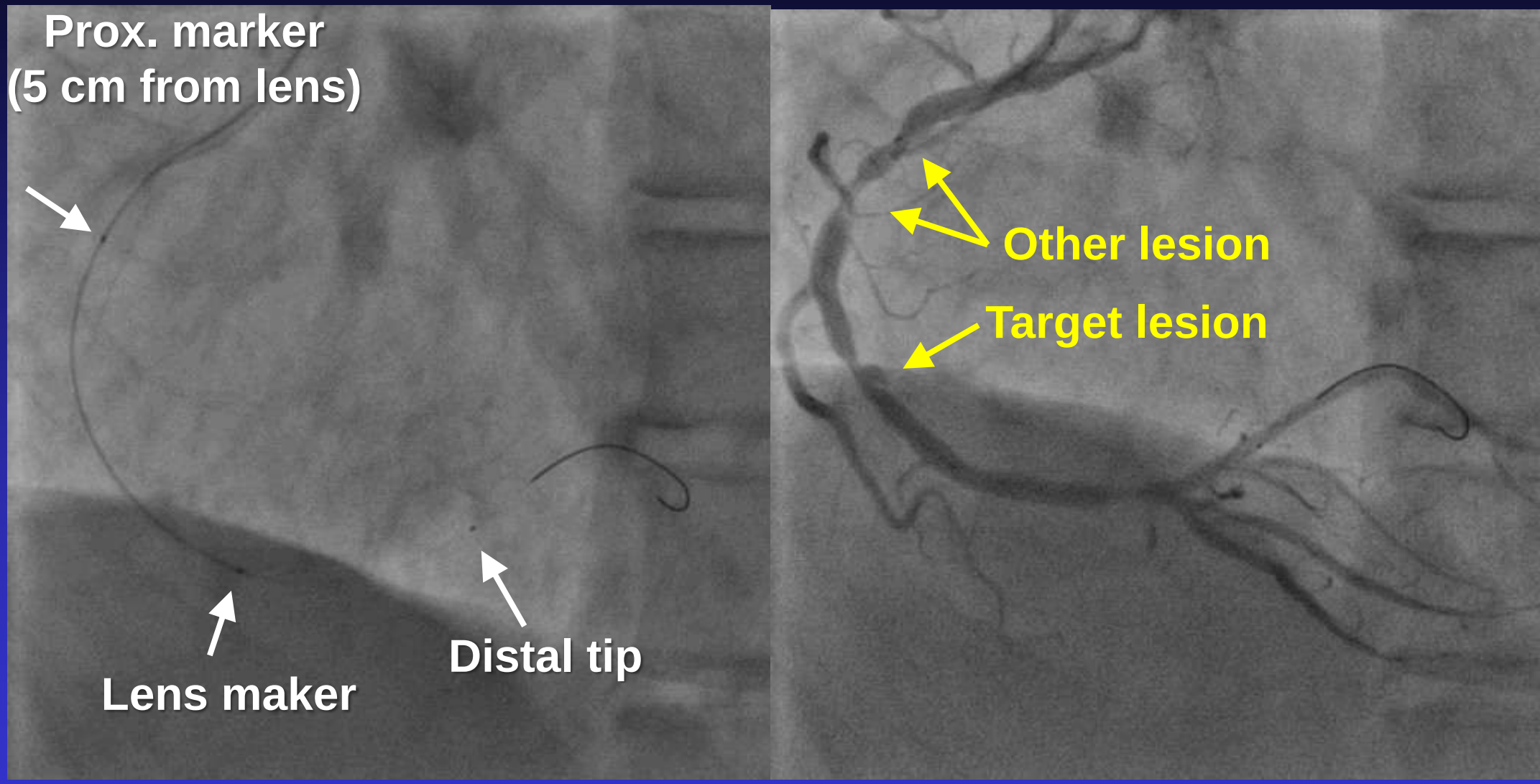
Within the past 12 months, I or my spouse/partner have had a financial interest/arrangement or affiliation with the organization(s) listed below.

Affiliation/Financial Relationship

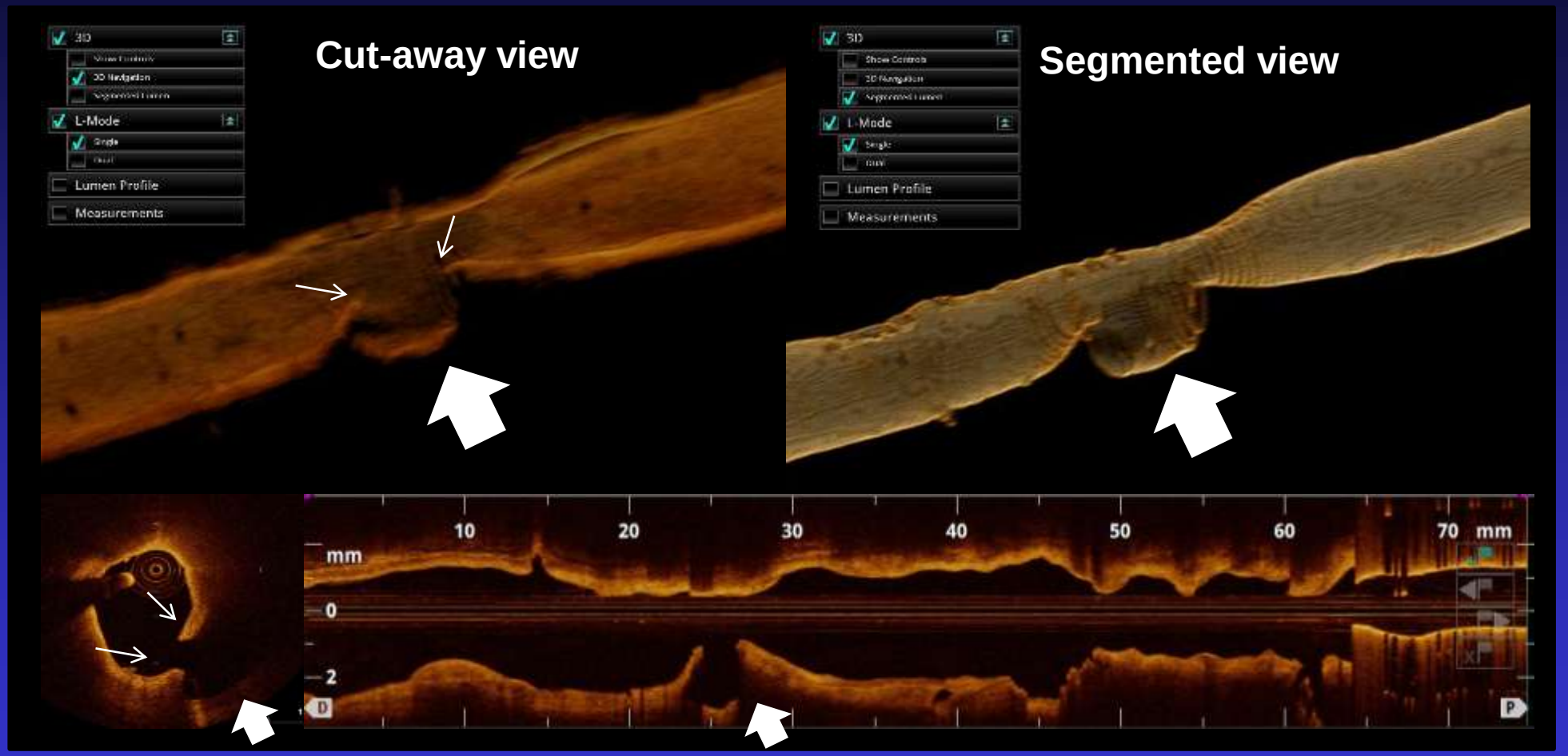
- **Grant/Research Support** : **Abbott Vascular Japan**
  Boston Scientific Japan
  Goodman Inc.
  Sent Jude Medical Japan
  Terumo Inc.

- **Consulting Fees/Honoraria** : **Astellas Pharmaceutical Inc.**
  Daiichi-Sankyo Pharmaceutical Inc.
  Goodman Inc.
  Sent Jude Medical Japan
  Terumo Inc.

Positioning of OCT Catheter



Advantages of FD-OCT system for 3D reconstruction (ILUMIEN OPTIS ®)



Kubo, Akasaka et al. RC 2013

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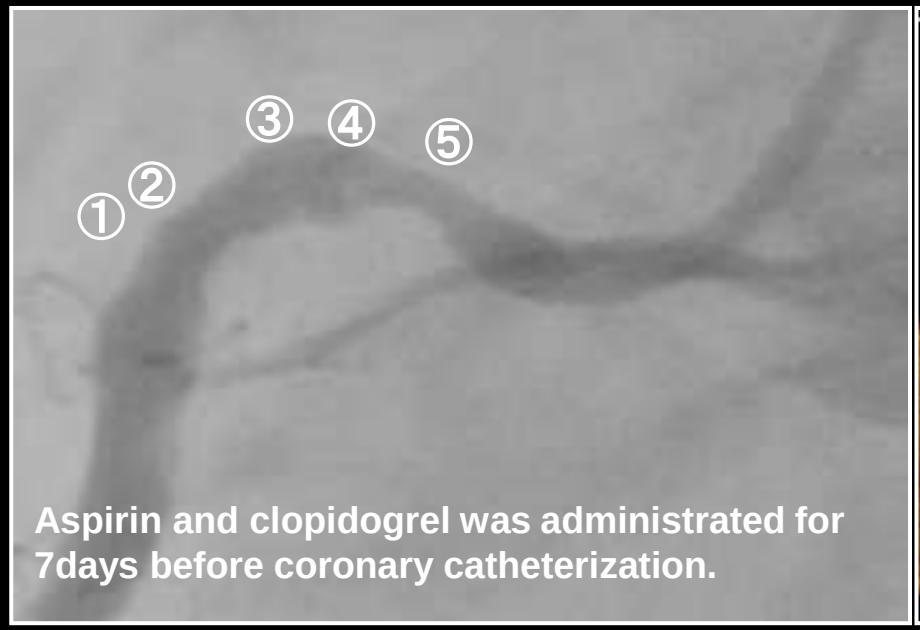
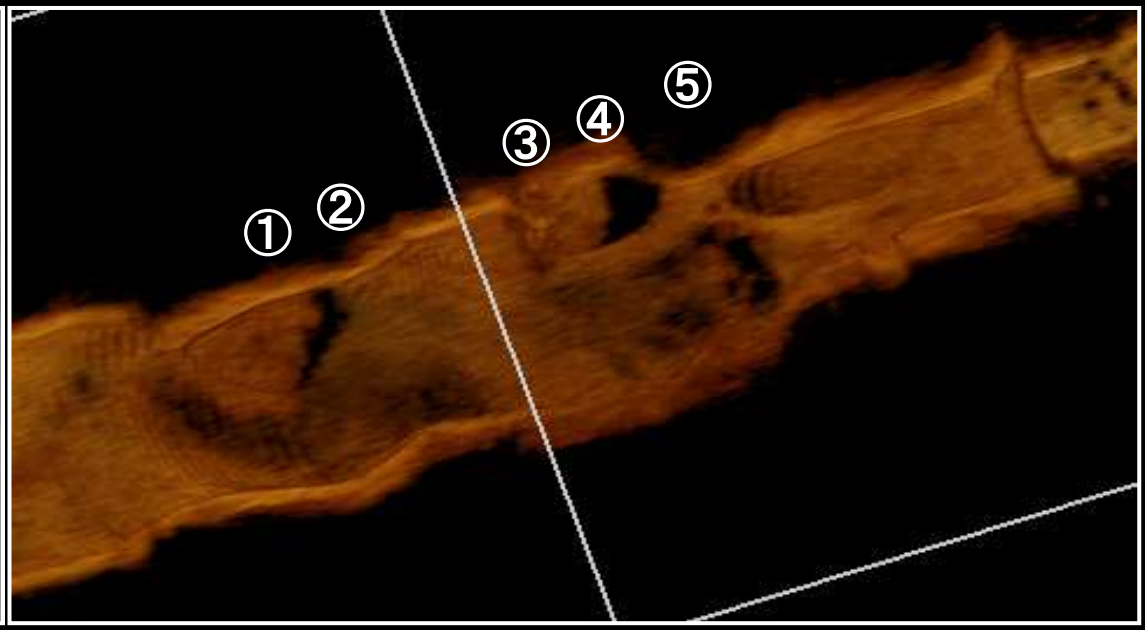
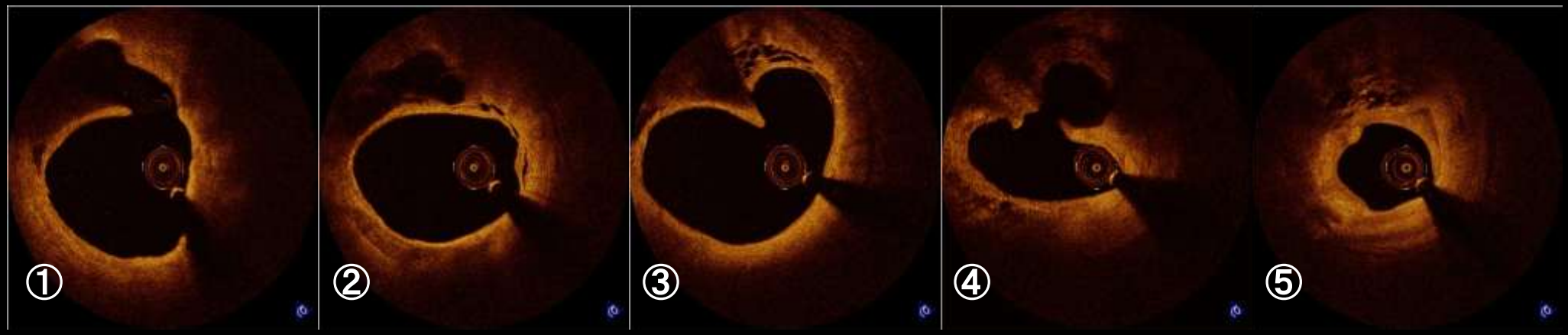
Complex morphology of coronary plaque rupture in patient with UAP

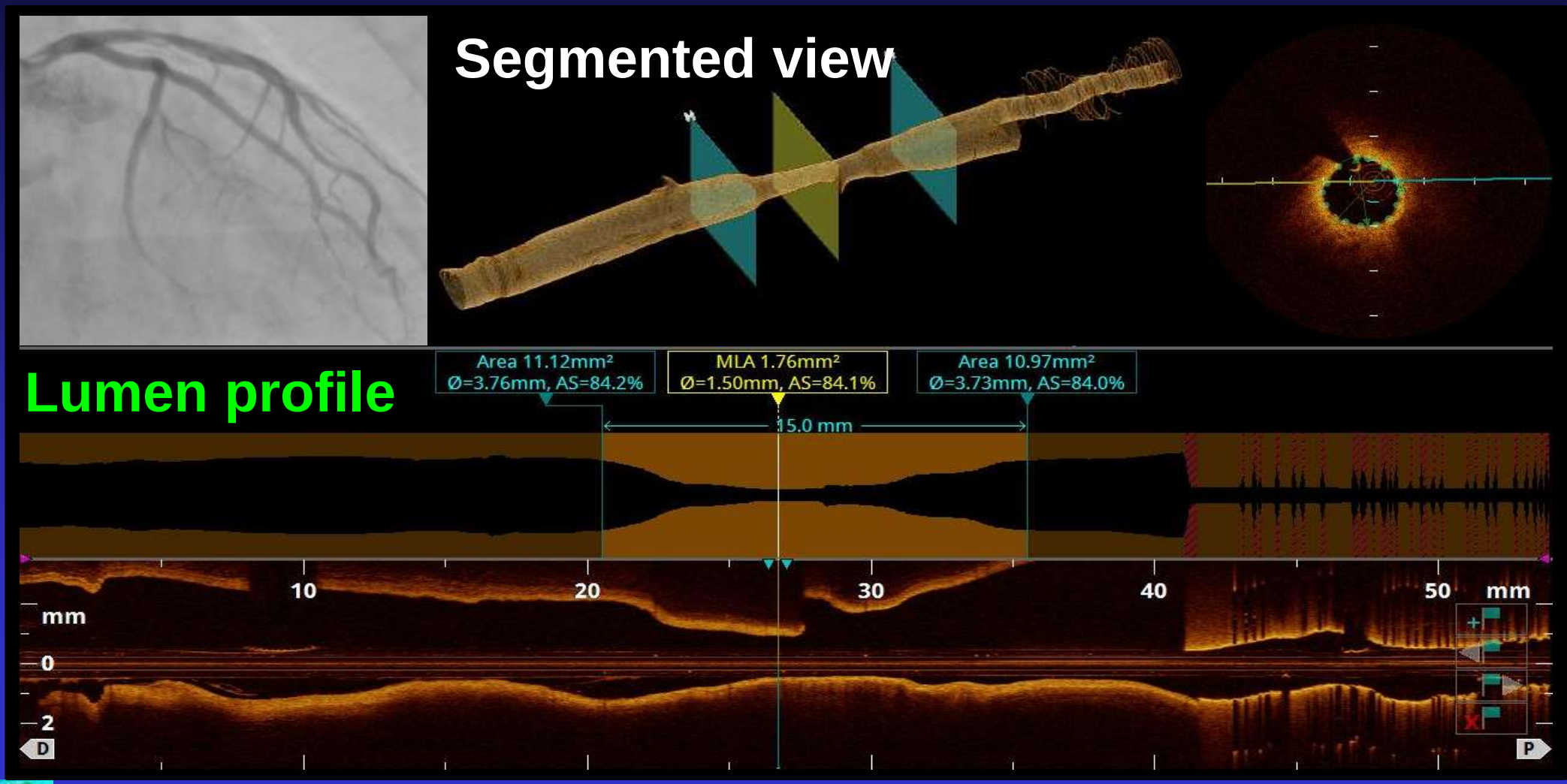




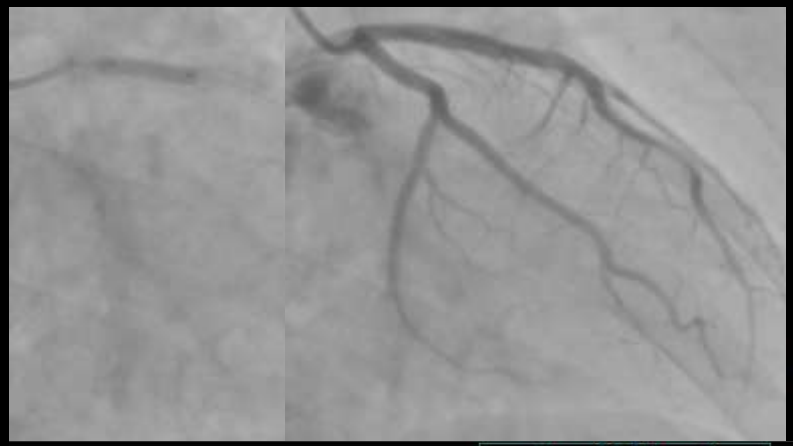


Kubo T, et al. J Am Coll Cardiol Img. 1:475-478, 2008

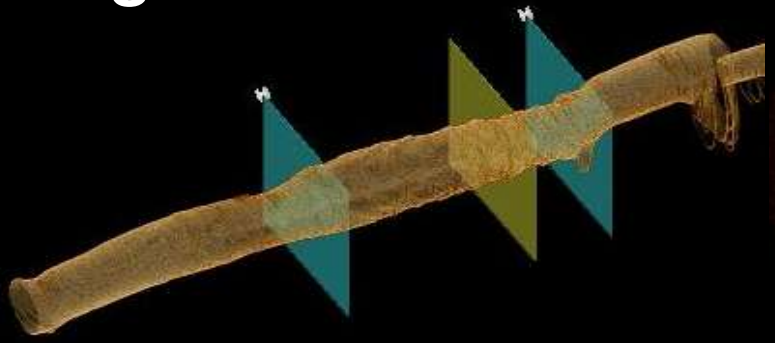
Pre-PCI assessment, #6 90%, (MultiLink 4.0×15mm)

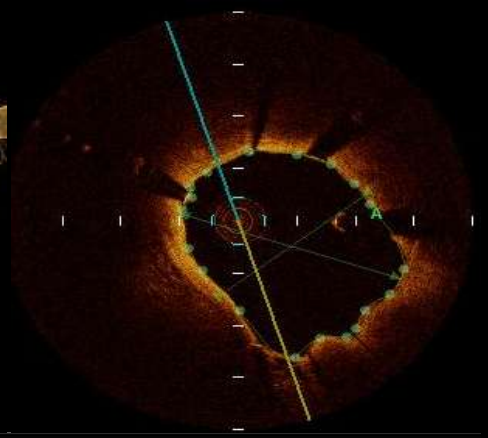


Post-PCI assessment, #6 90%, (MultiLink 4.0×15mm)

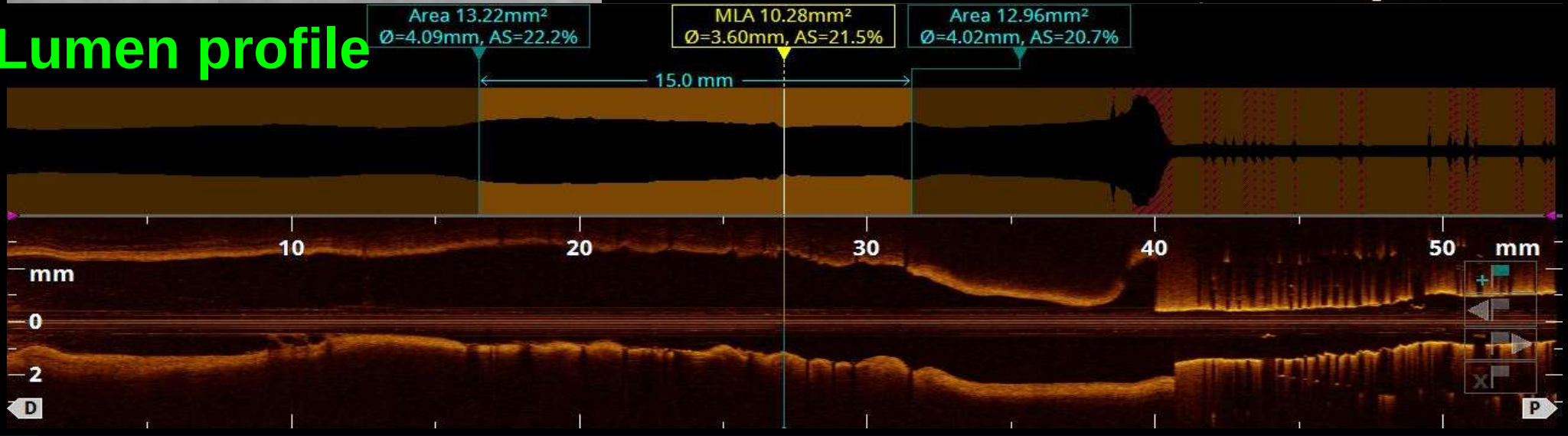


Segmented view

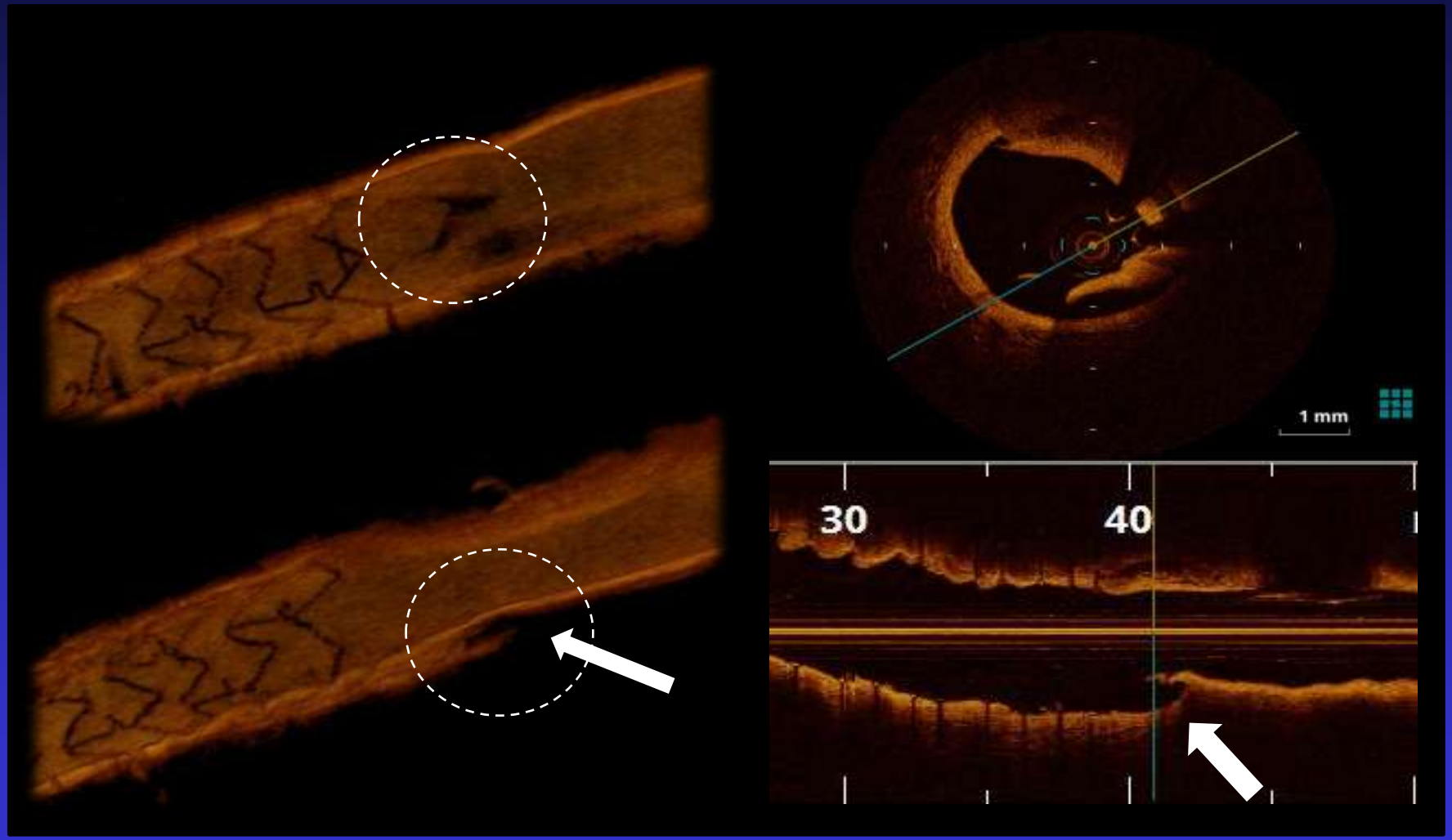




Lumen profile



SAP, #6 99% Xience 2.75x18, Dissection

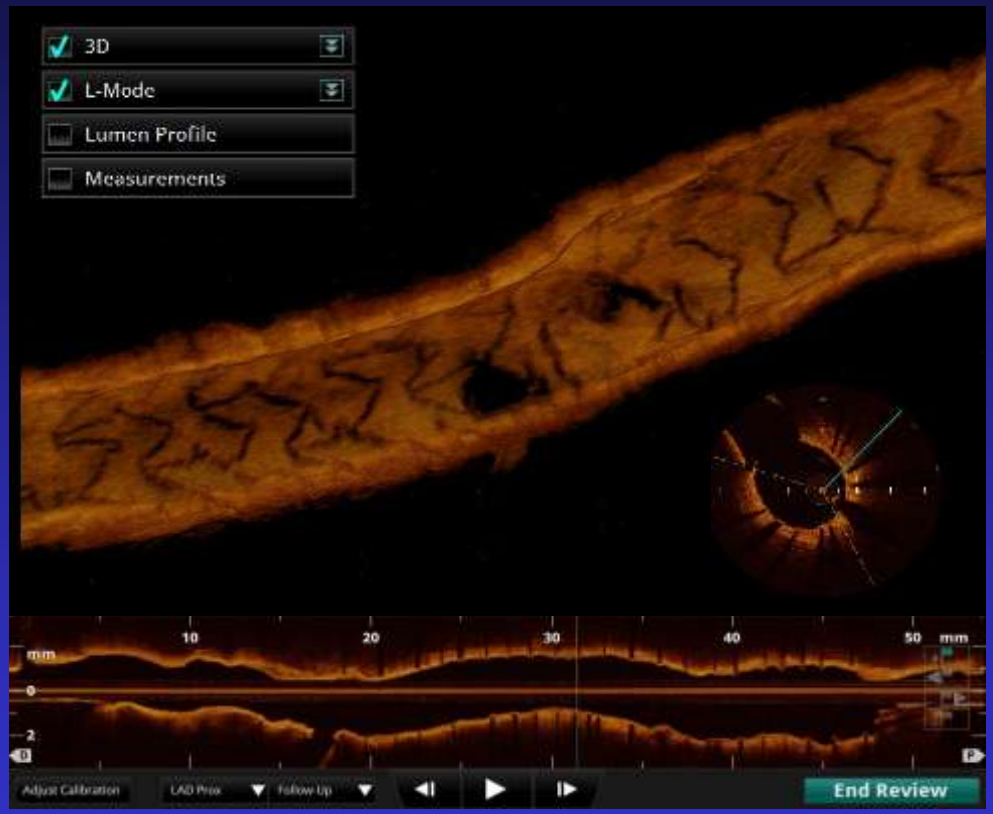


Advantages of 3D-OCT in Clinical Practice

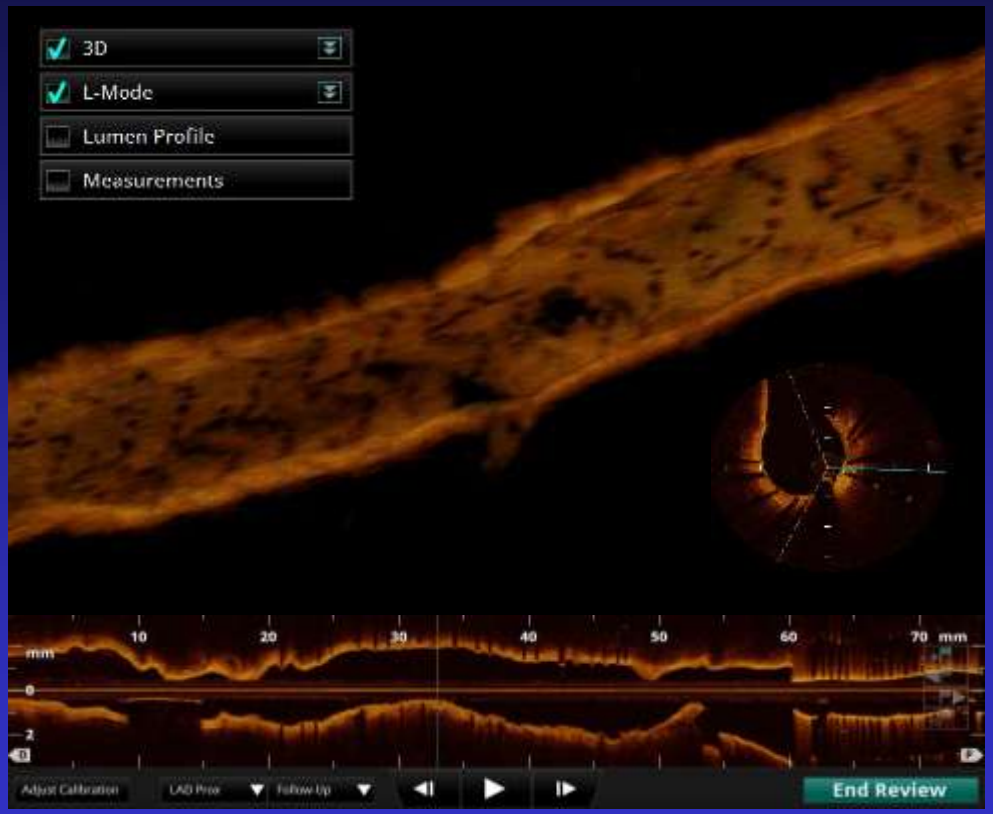
- Pre PCI
  - Image acquisition & 3-D reconstruction are very fast and easy.
  - 3-D OCT may be useful in precise automatic measurements.
  - 3-D OCT may allow us to assess lesion morphology in detail.

3D-OCT by high-resolution & long pullback
Cut-away view

High-resolution pullback



Long pullback

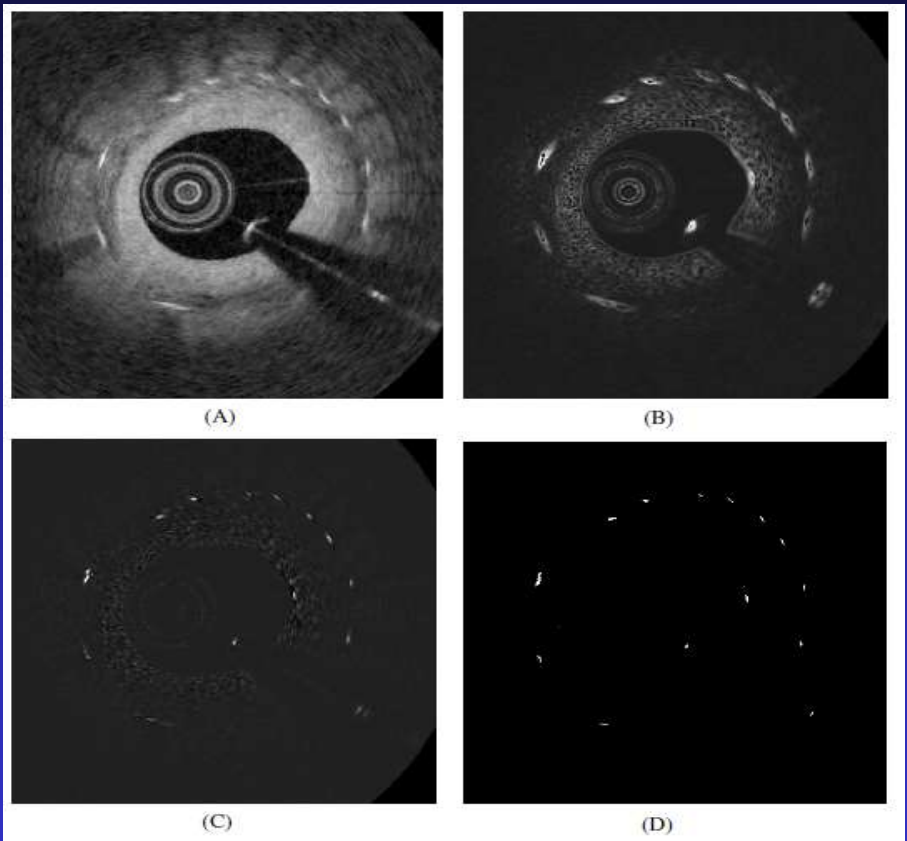


Speed = 18mm/sec, Length = 54mm

Speed = 36mm/sec, Length = 74mm

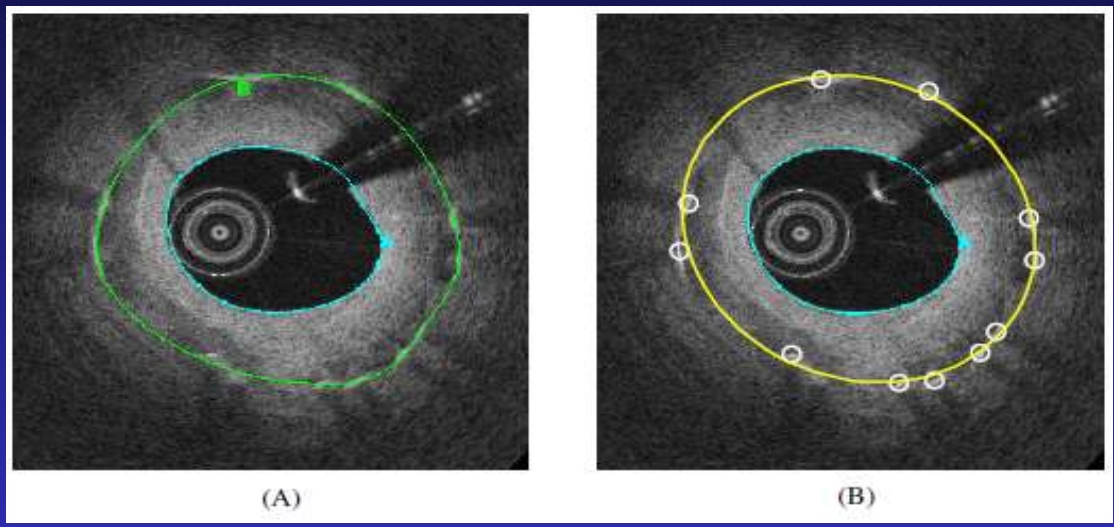
By high-resolution mode, stent struts can be identified clearly.

Automatic detection of stent struts



The steerable ridge detector applies to a single OCT frame. (A) An example of OCT image of a restenotic blood vessel. (B) The calculated λ1. (C) The calculated λ2. (D) Detection of struts after applying a threshold.

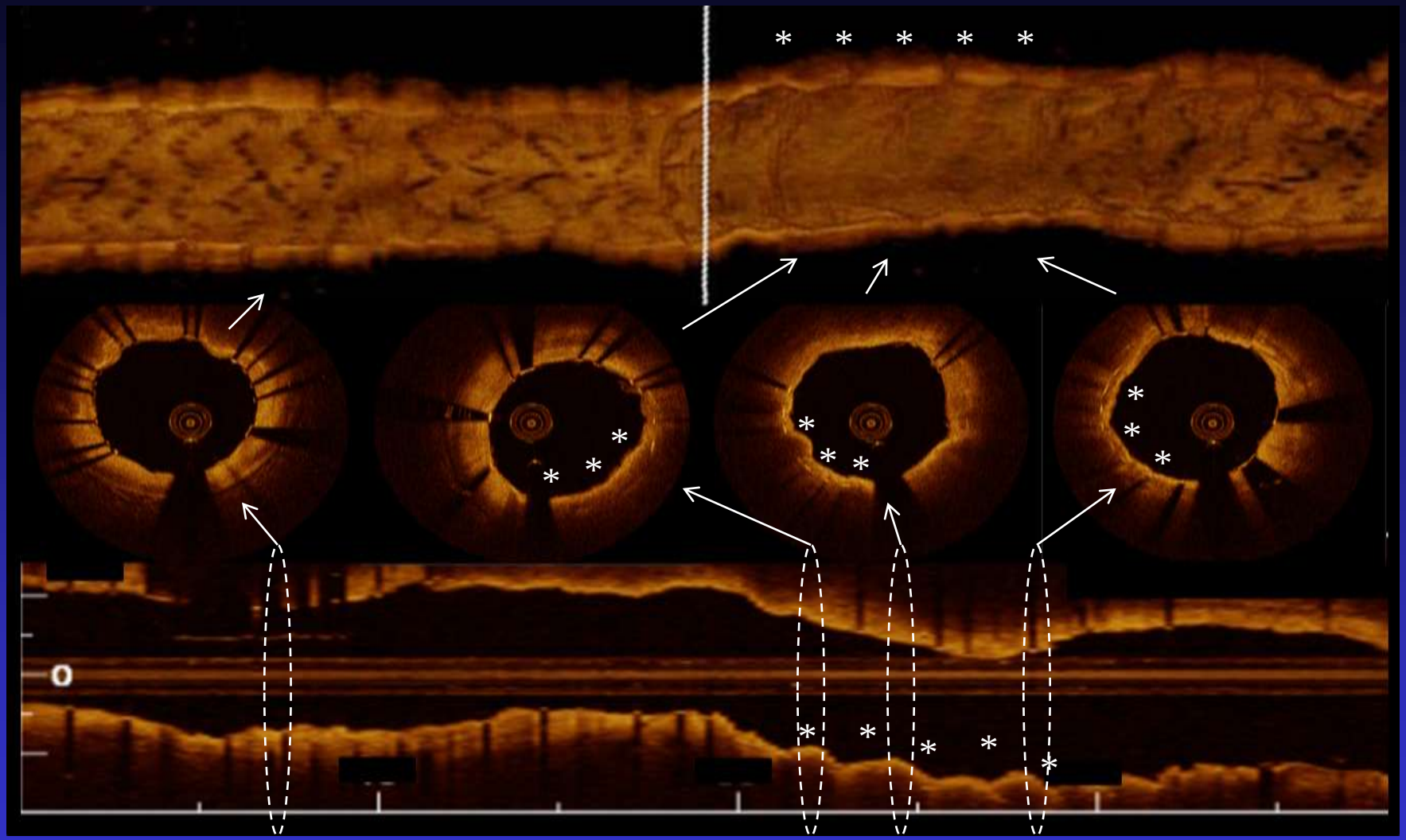
Human observers **Automatic algorism**



The example of restenotic burden measurement based on human observers (A) and automatic algorism (B). The circle shows the location of detected struts.

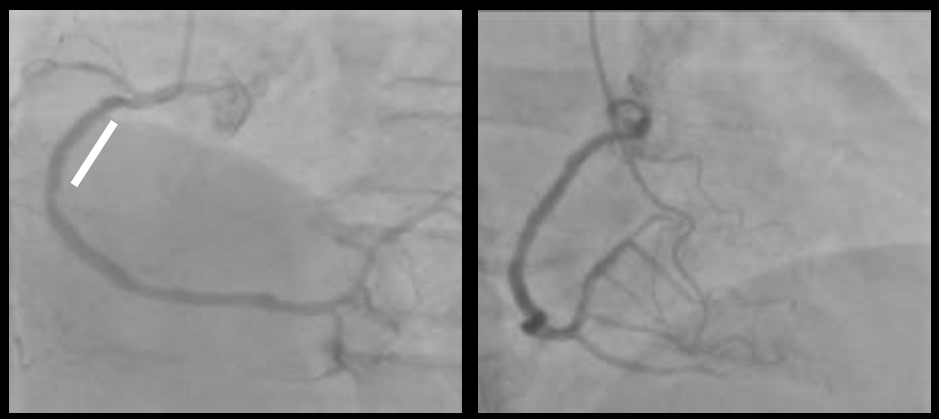
Xu C, Kubo T, Akasaka T, et al. Phys Med Biol. 2011;56:6665-6675.

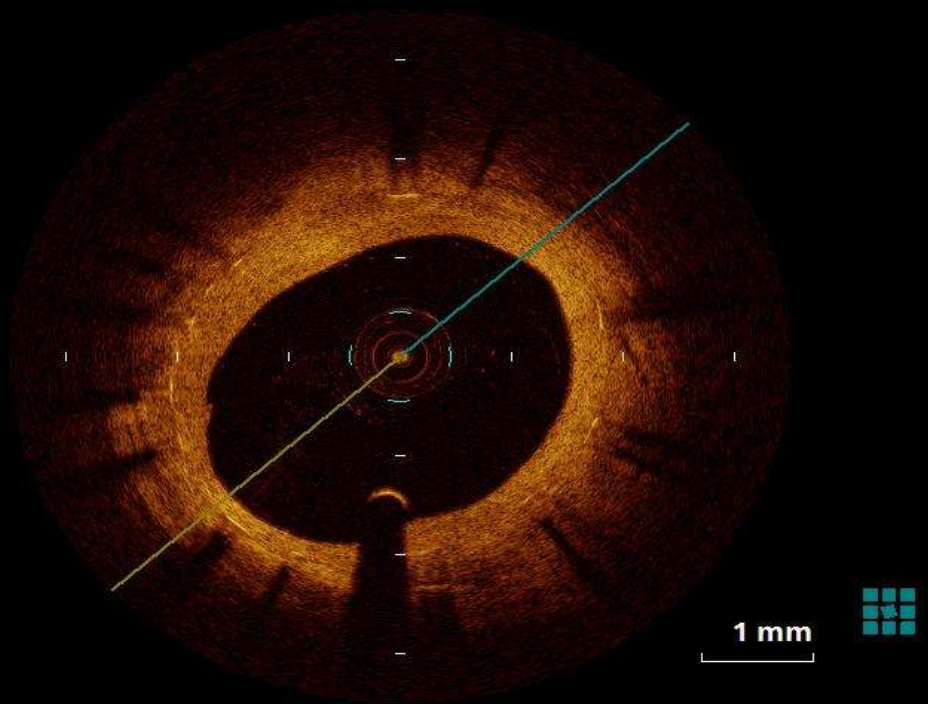
SAP, #3, Xience 3x23, tissue protrusion

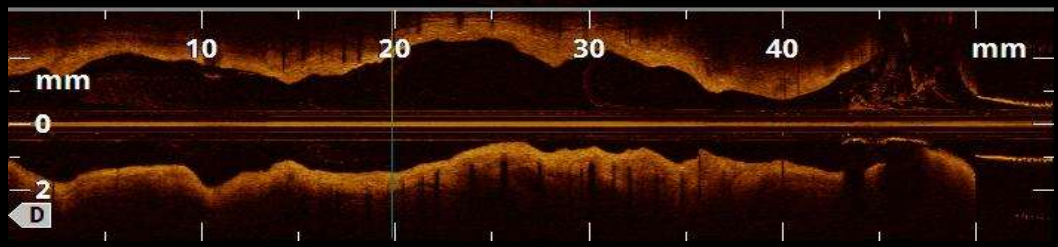


Visual assessment of neo-intima coverage would be very easy by 3-D OCT. This would be more useful if volumetric data could be demonstrated instantaneously.

F/U #1 (SAP, 2012/5/2) Vision 4x23

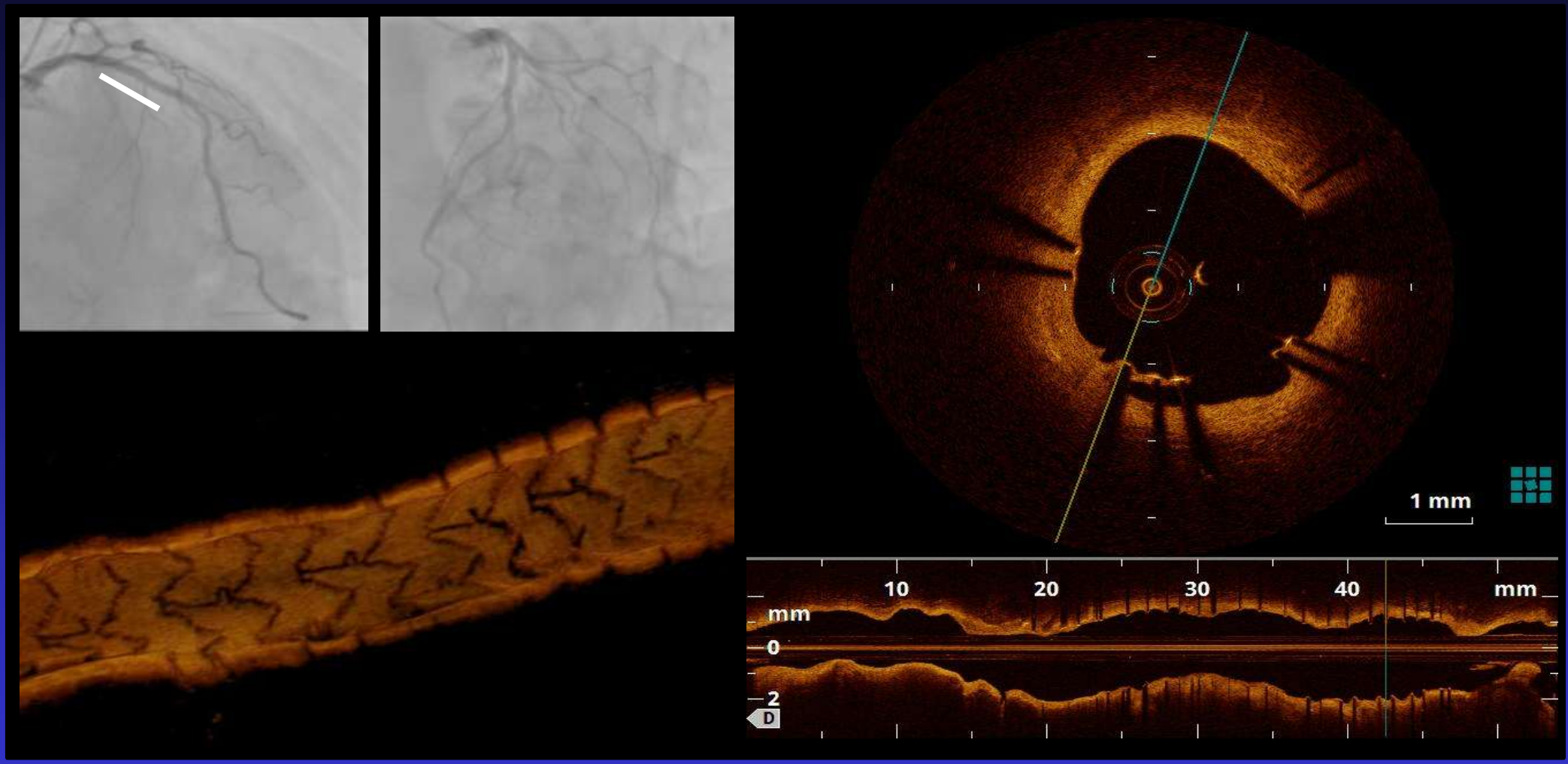






Full coverage by neo-intima could be identified easily if there is no stent strut images in the stented lesion.

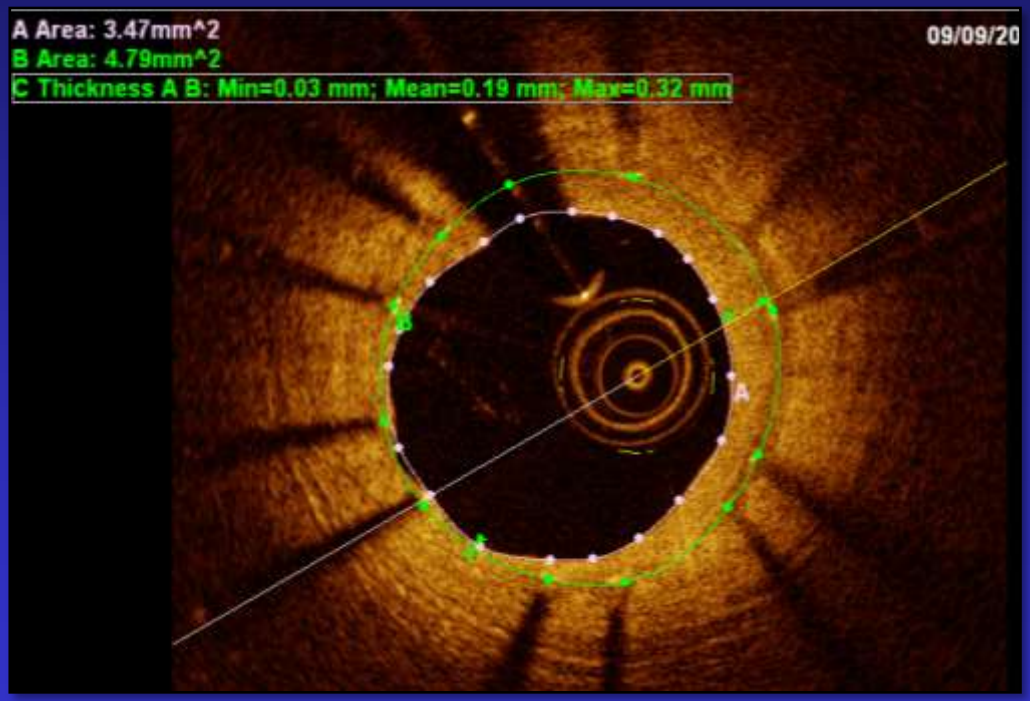
F/U #6 (SAP, 2012/5/2) Xience 3x28

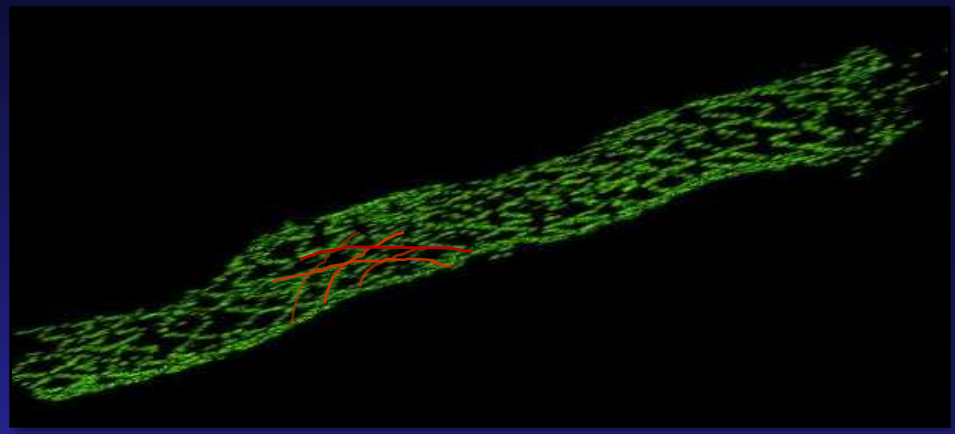


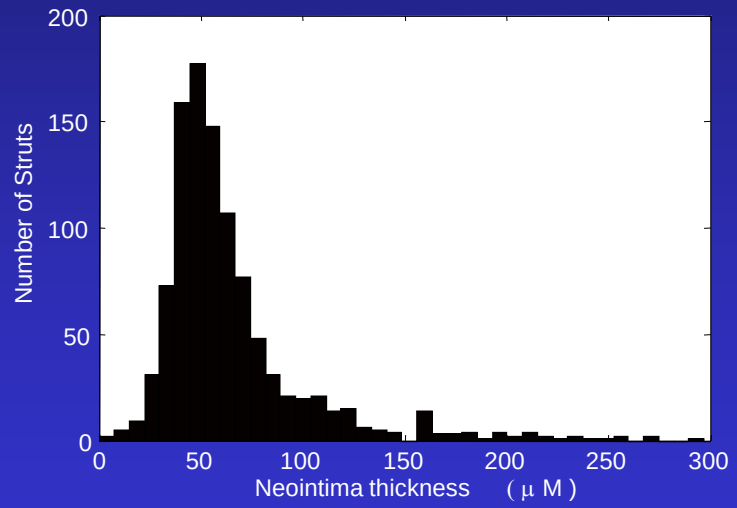
Presentation of incomplete stent apposition and mal-apposition should be difficult by 3D-OCT.

Automated 3-D Display of Stent Coverage

Automated segmentation of buried struts and measurement of coverage for follow-up assessment

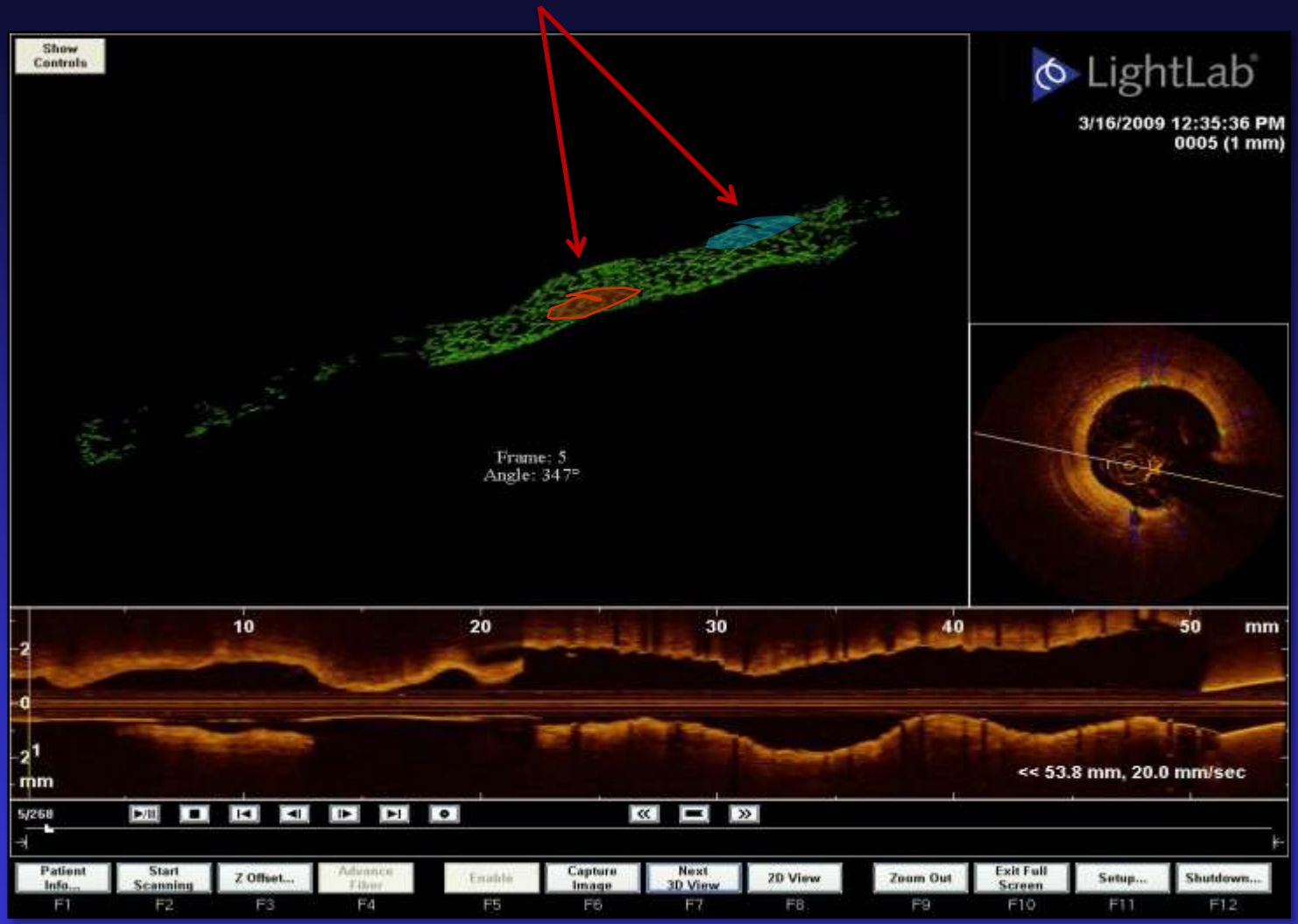






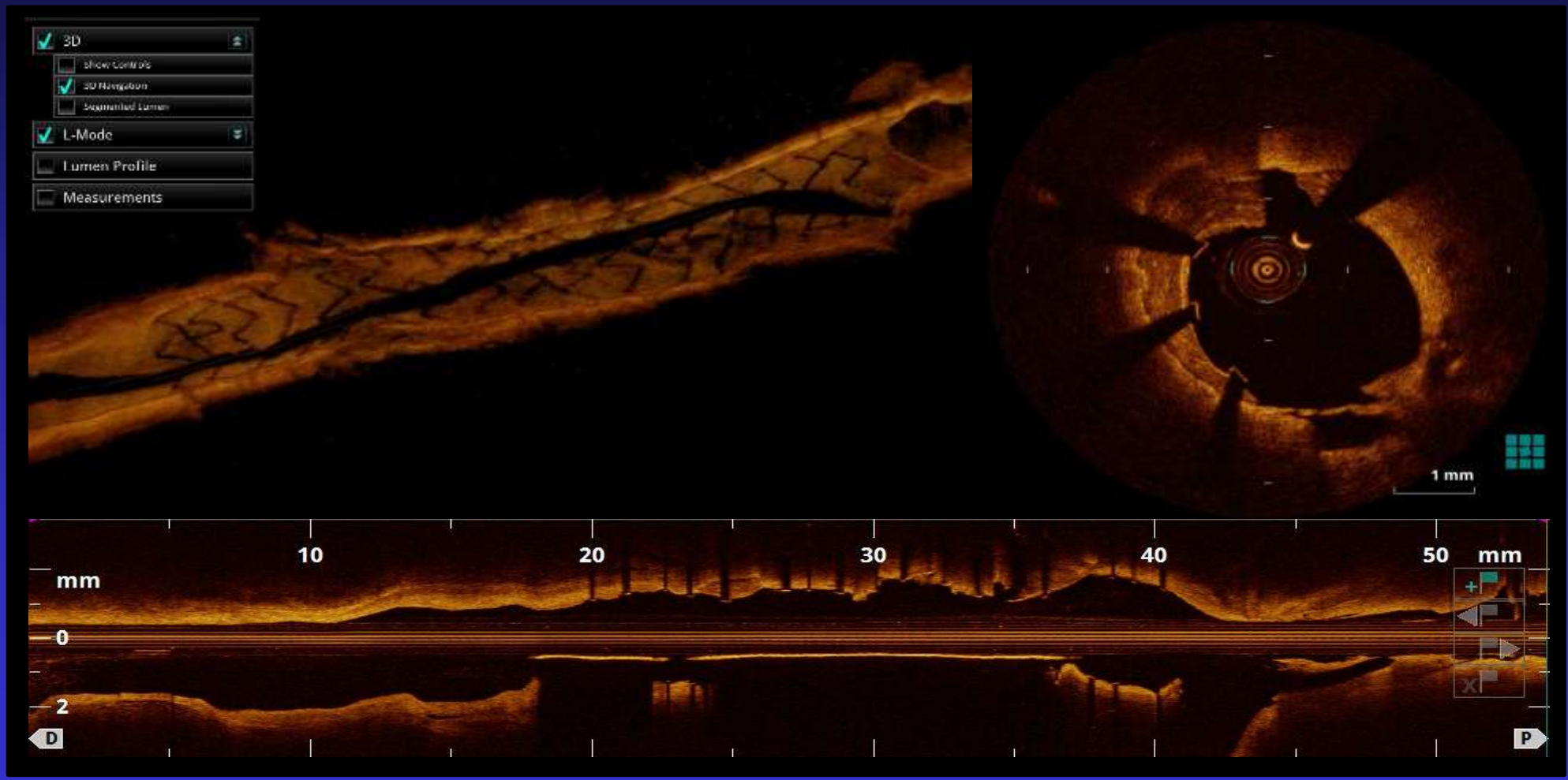
Automated 3-D Display of Stent Malapposition

Location and degree of malapposition appear as color-encoded volumes.



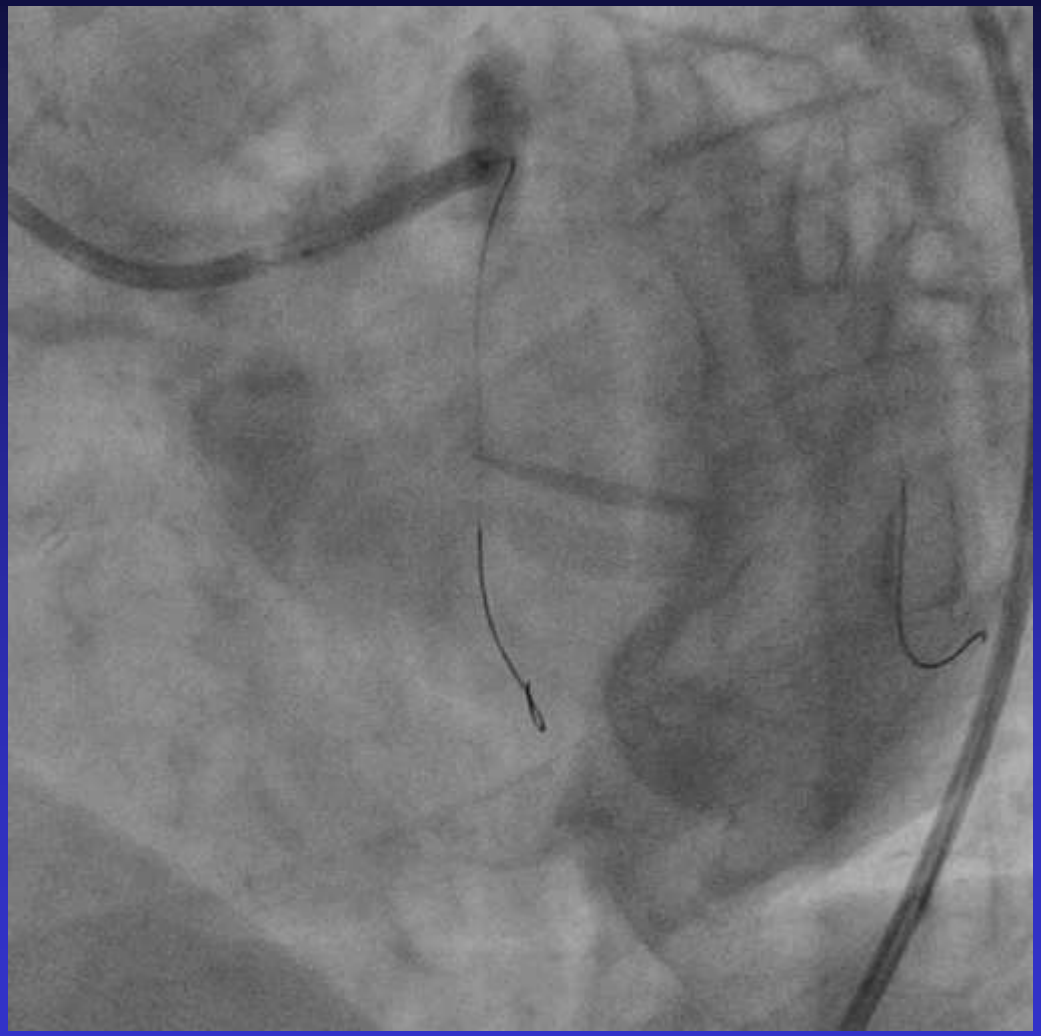
This would be much more useful if volumetric data could be obtained instantaneously.

SAP, #6 90%, P 3.0x20, wire artifact

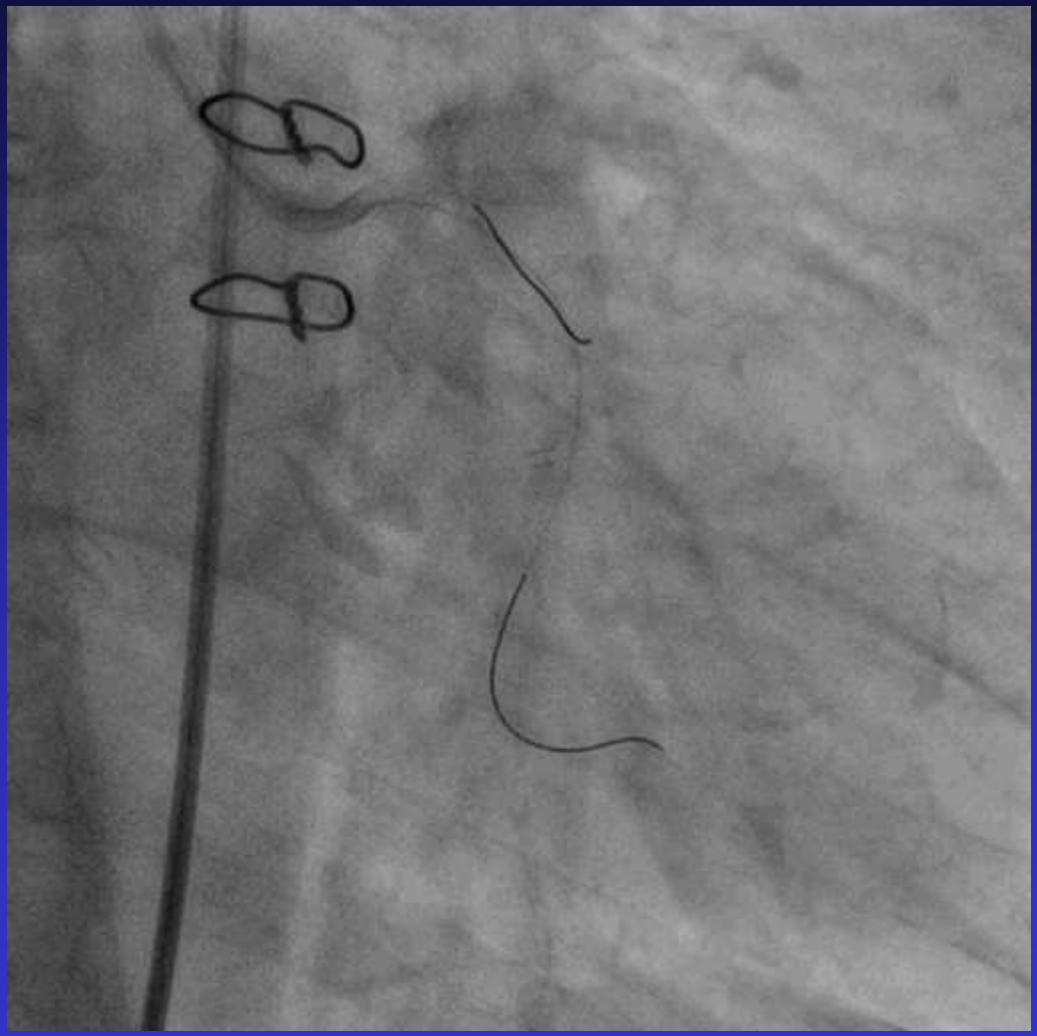


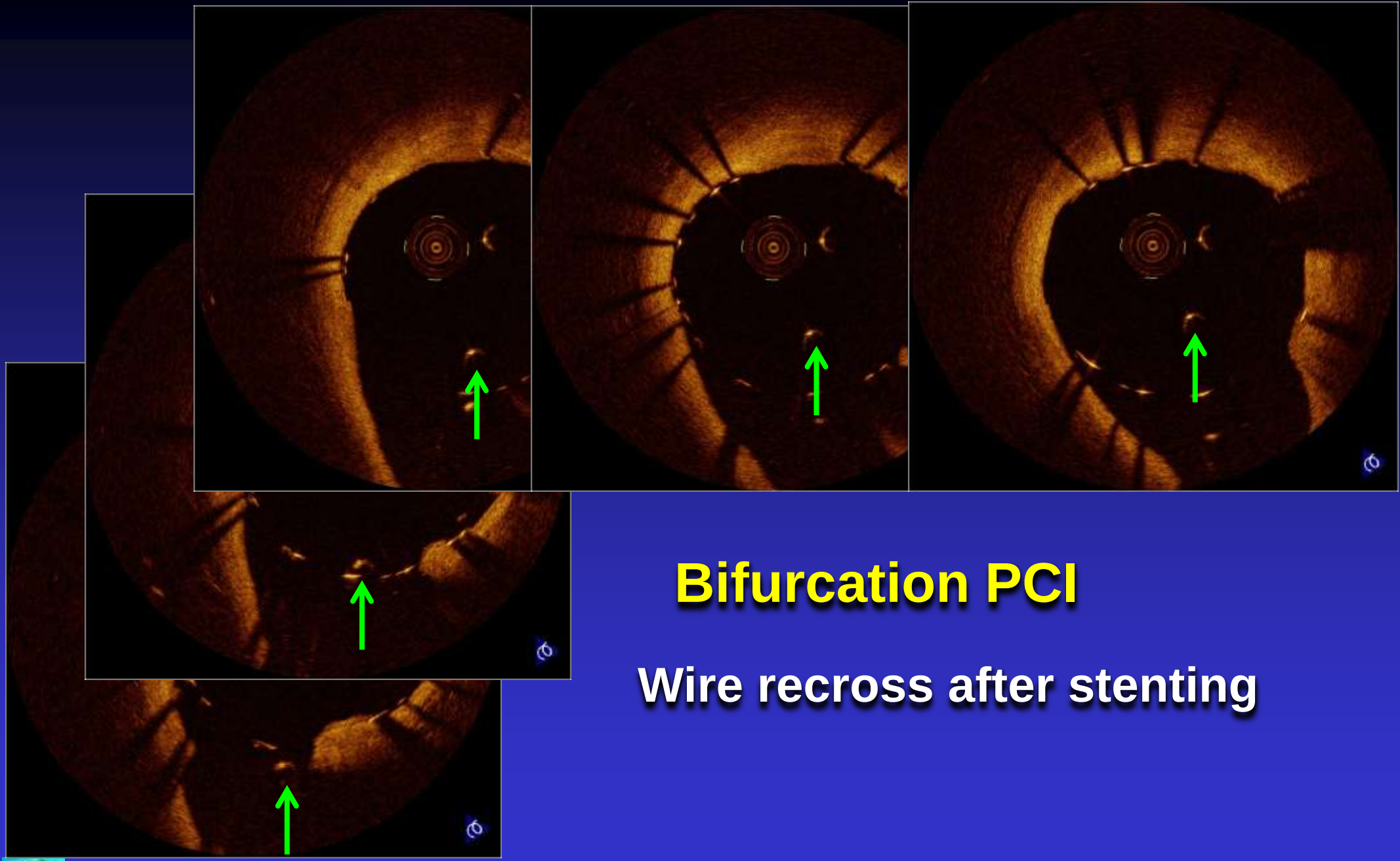
Bifurcation PCI

Post stenting



Recross after stenting

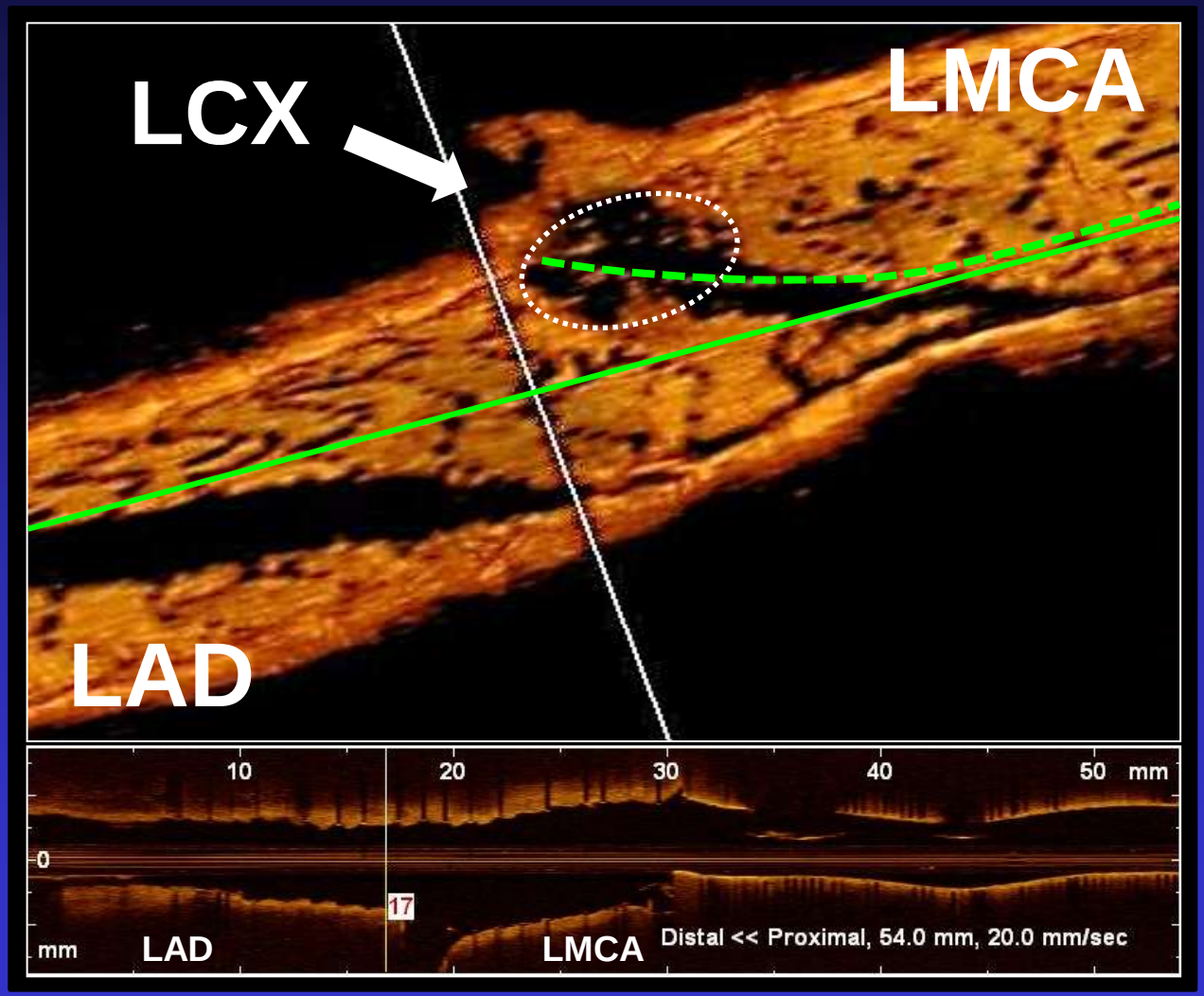




Bifurcation PCI

Wire recross after stenting

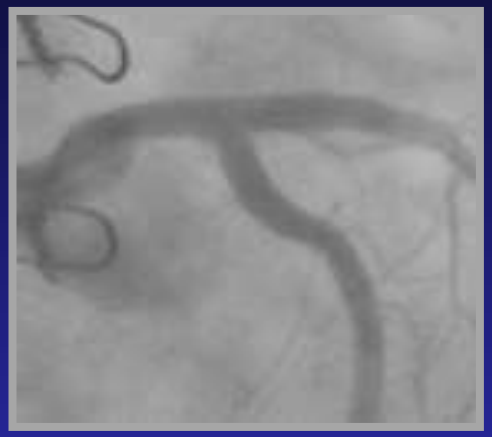
Re-wiring through stent struts into jailed LCX



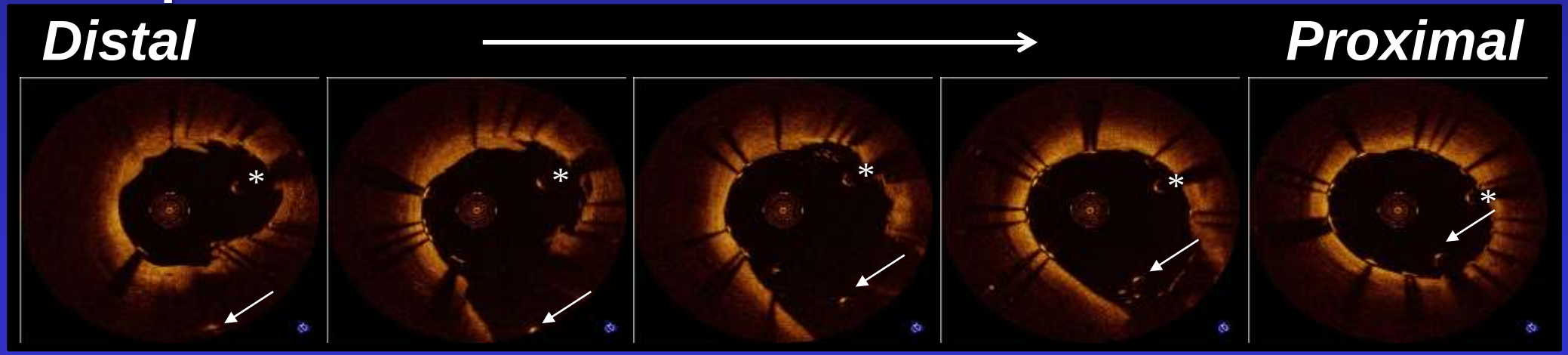
OCT pullback from LAD to LMCA after KBT

Kissing balloon angioplasty

Final angiography

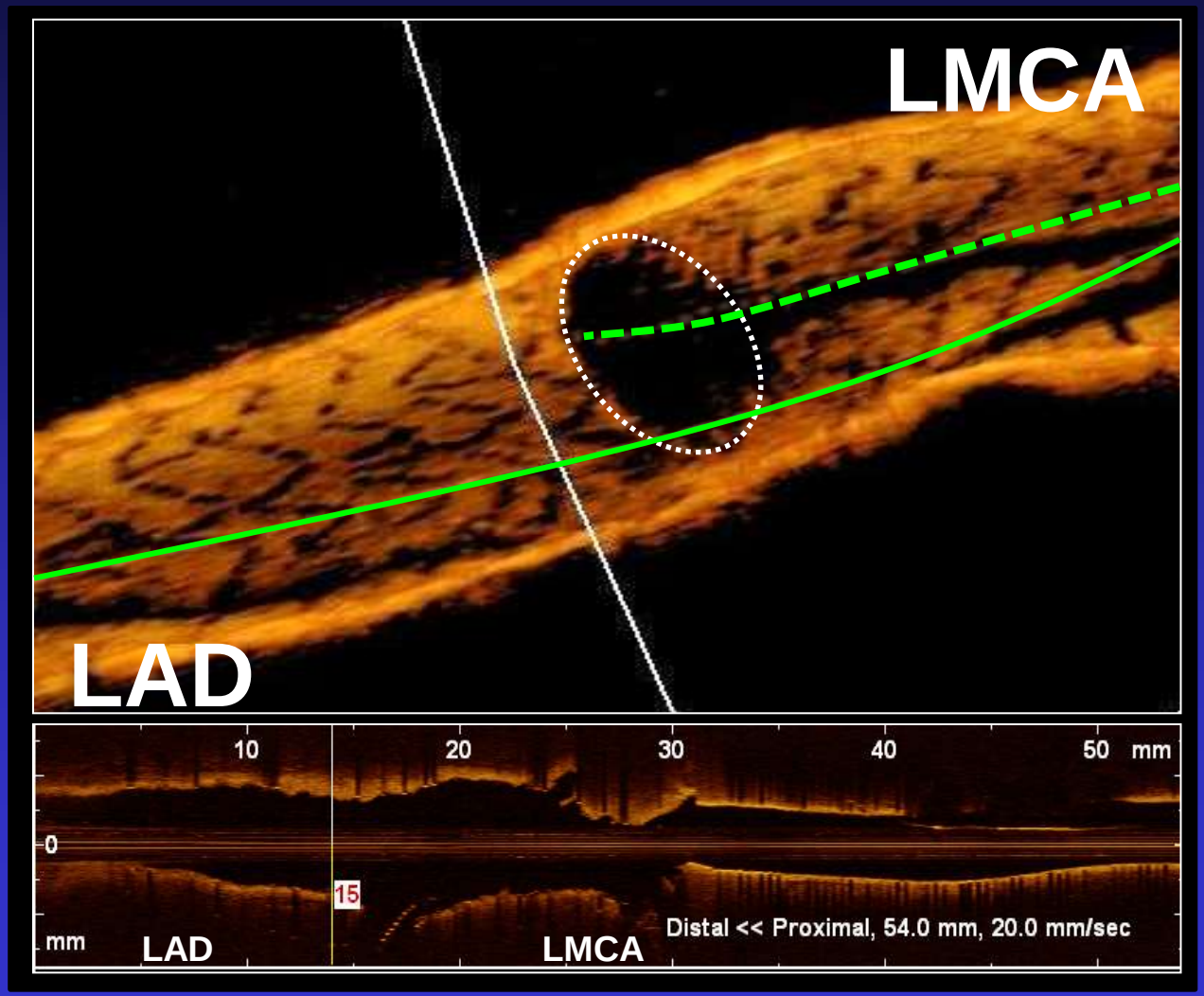


OCT pullback from LAD to LMCA

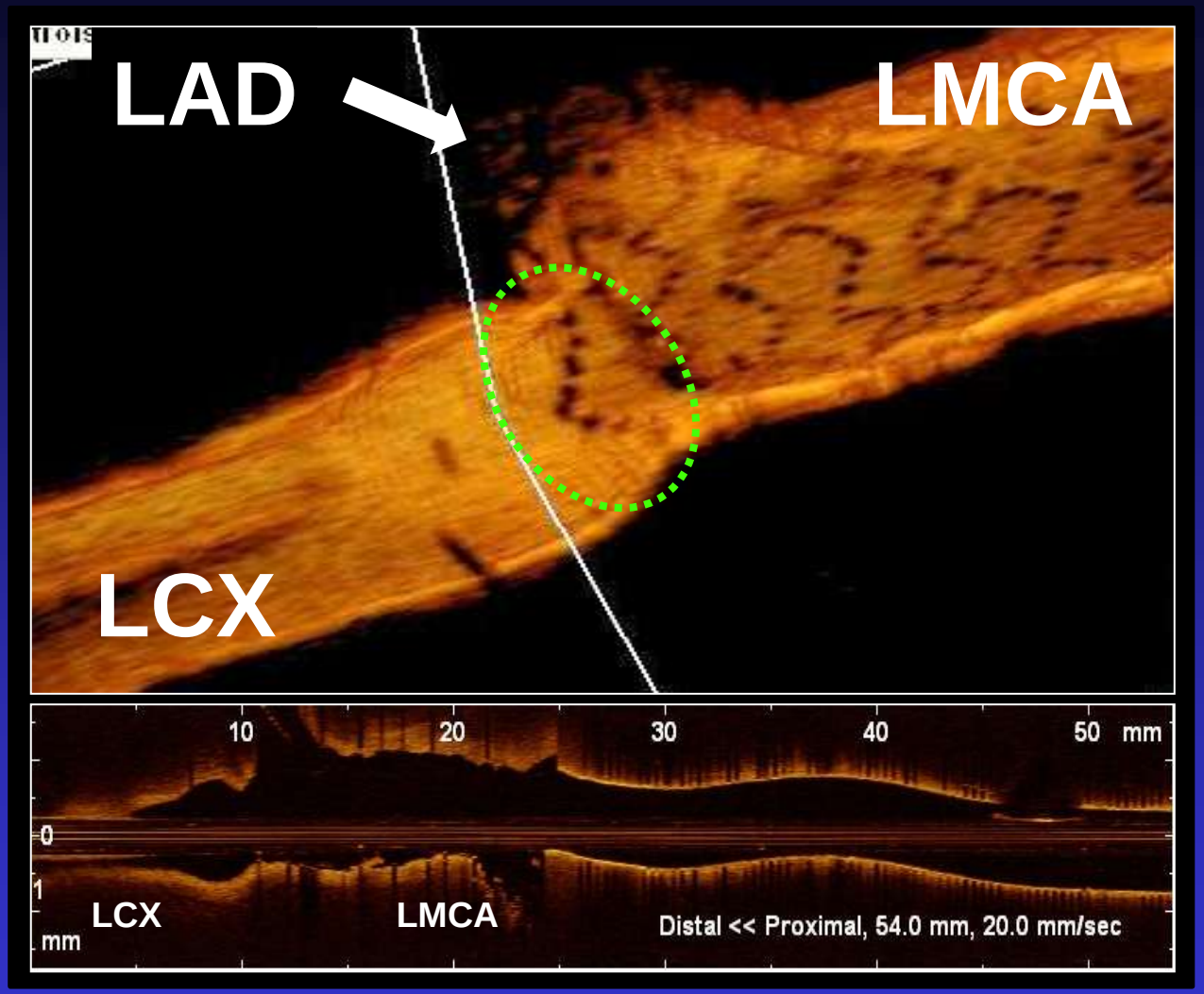


∗ = guidewire in LAD; Arrow = guidewire in LCX

OCT pullback from LAD to LMCA after KBT



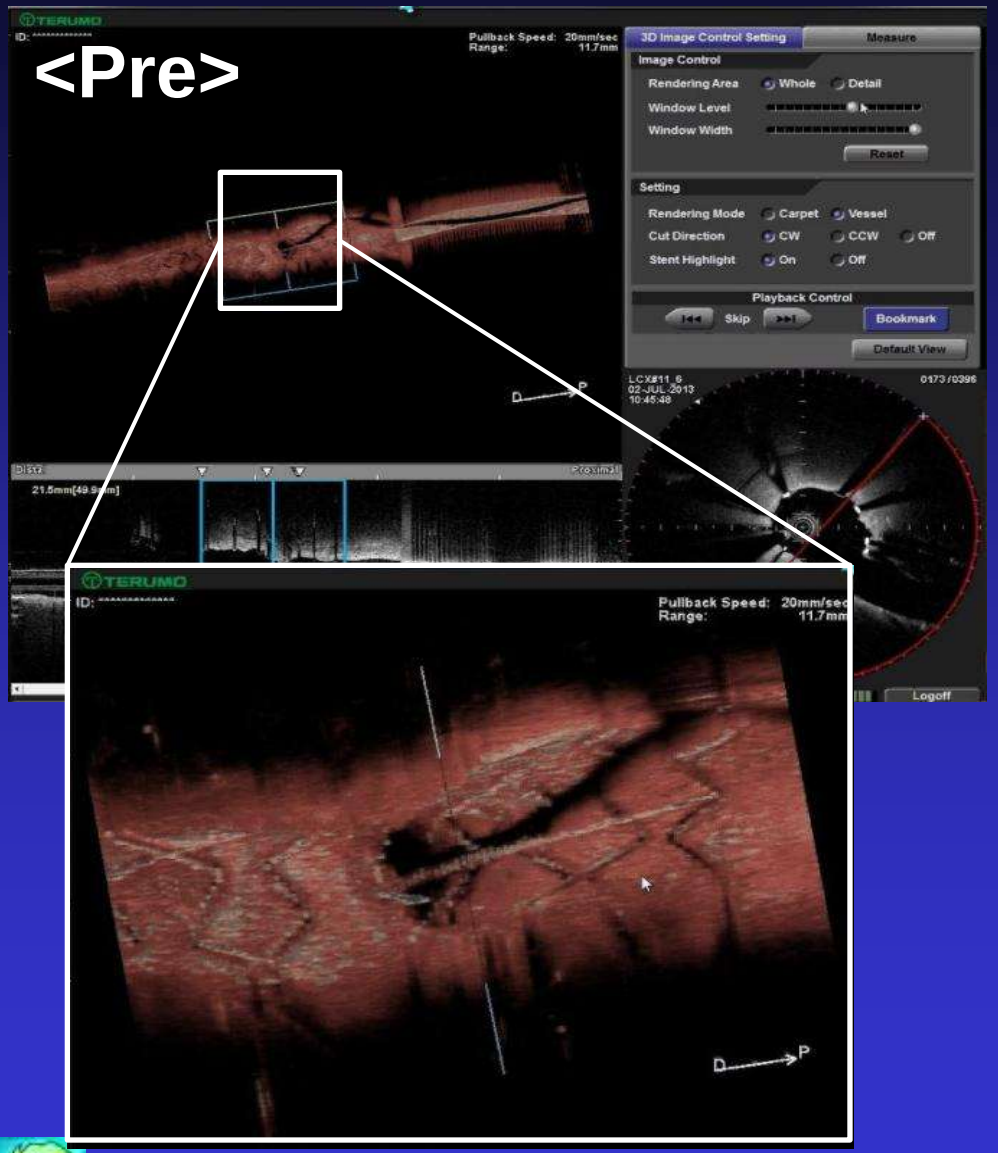
OCT pullback from LCX to LMCA after KBT

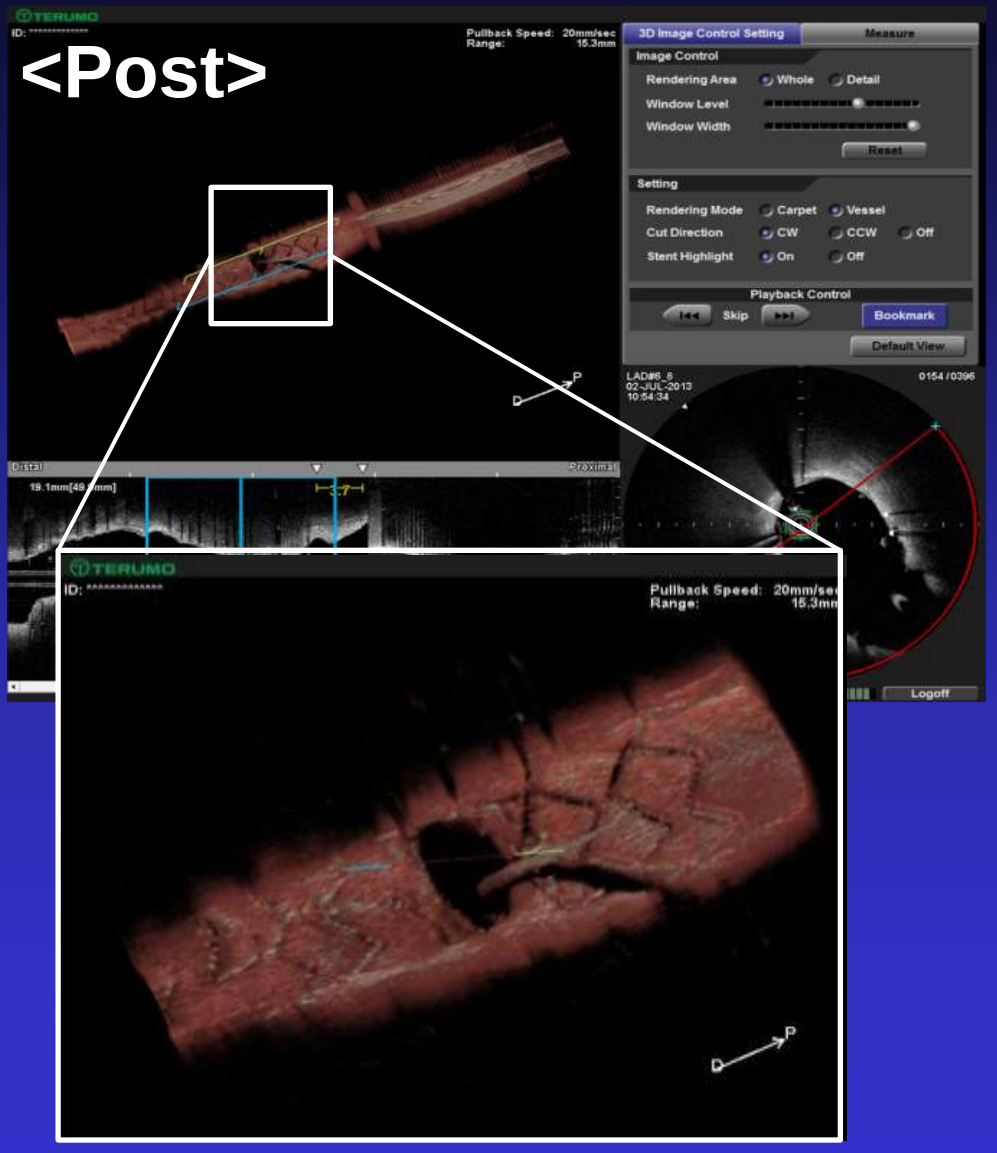


Mechanism of SAT and the restenosis could be demonstrated in bifurcation site by 3-D OCT analysis.

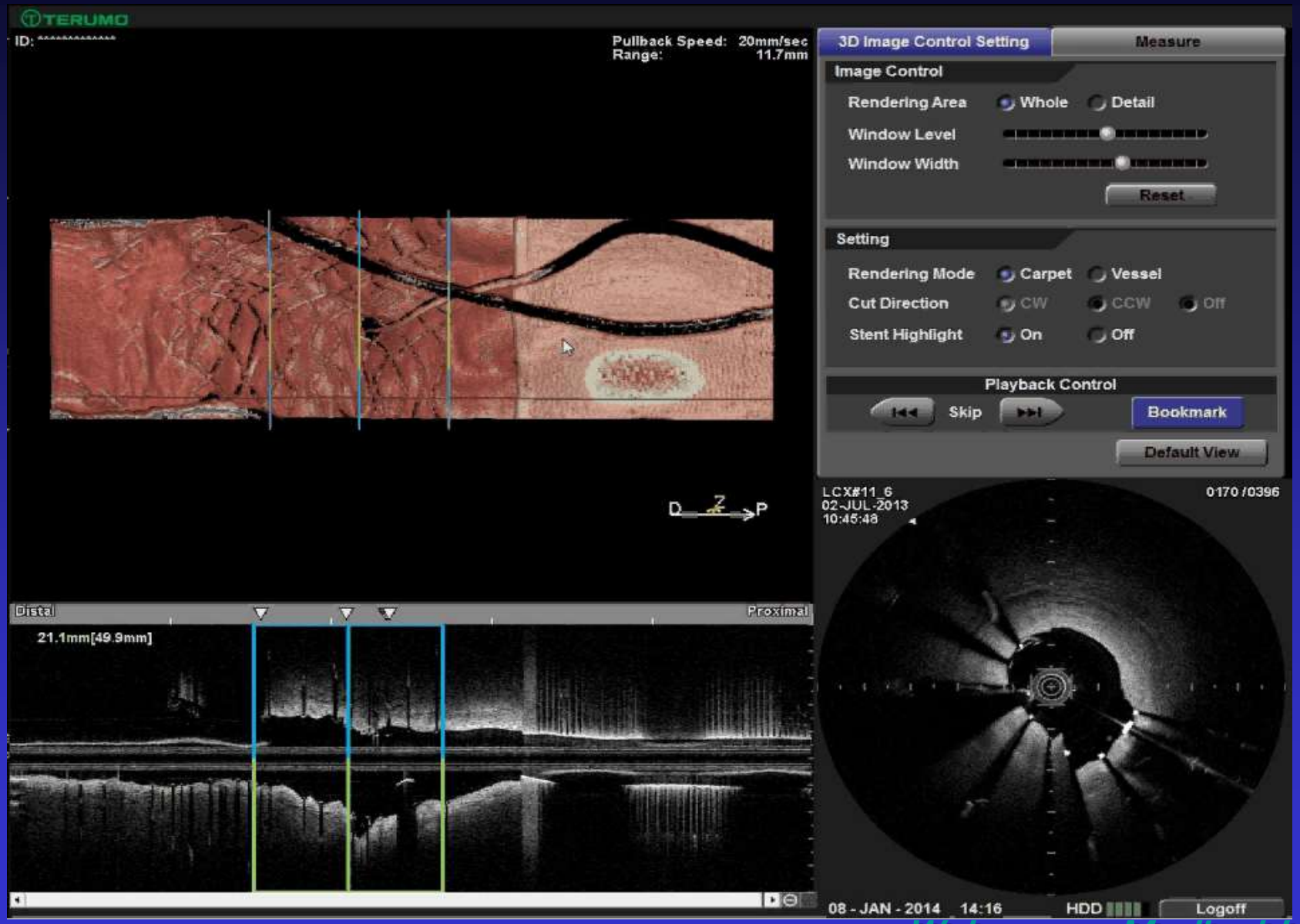
OFDI 3D Vessel view (Cut away view)

OFDI 3D Vessel view (Pre/Post KBT)





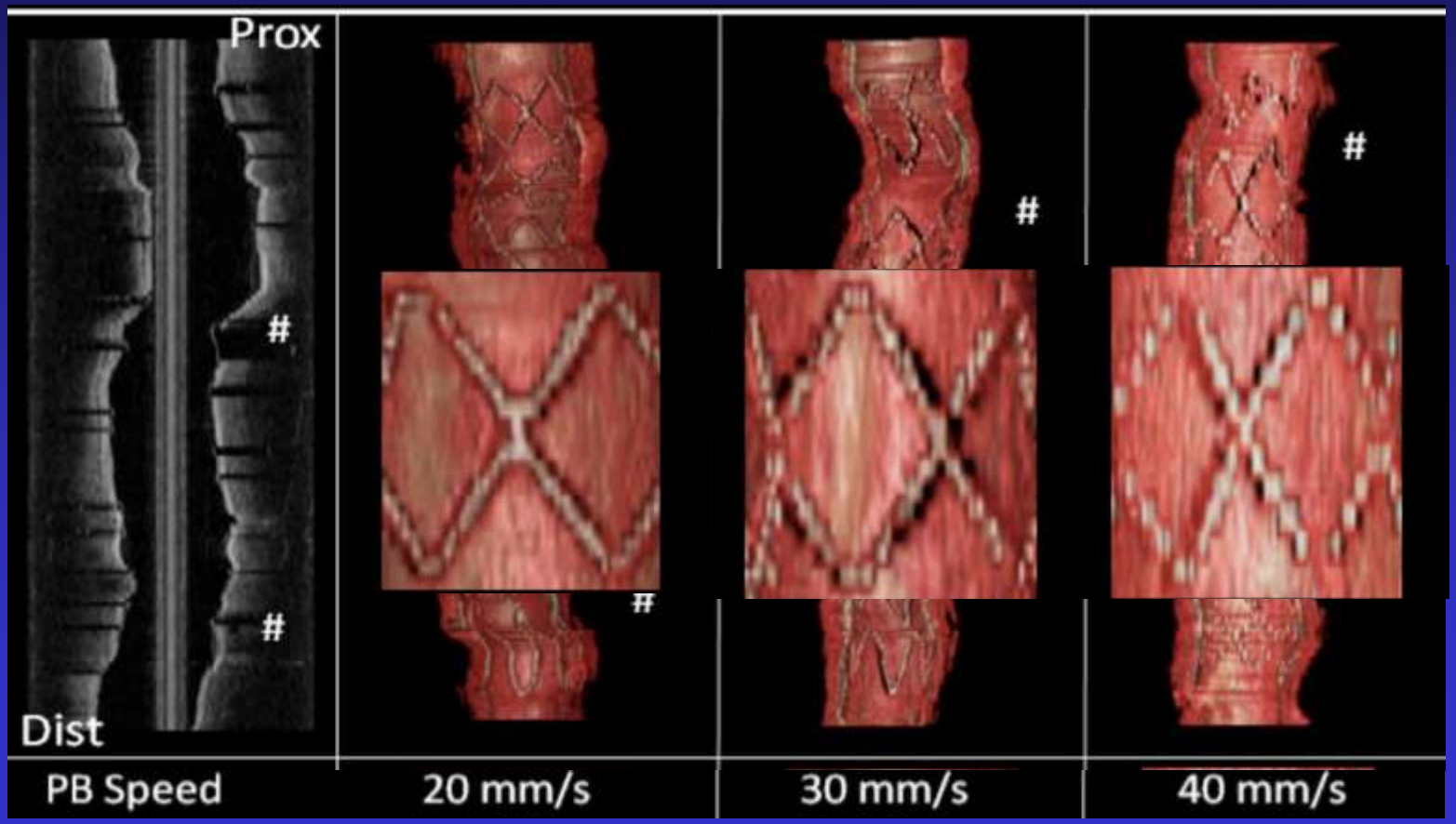
OFDI 3D Open Carpet View (Pre KBT)



High speed pullback with high frame rate

High frame density.

Less motion artifact
Less contrast media.



Dr.Okamura et al, EuroIntervention 2012;7:1216-1226

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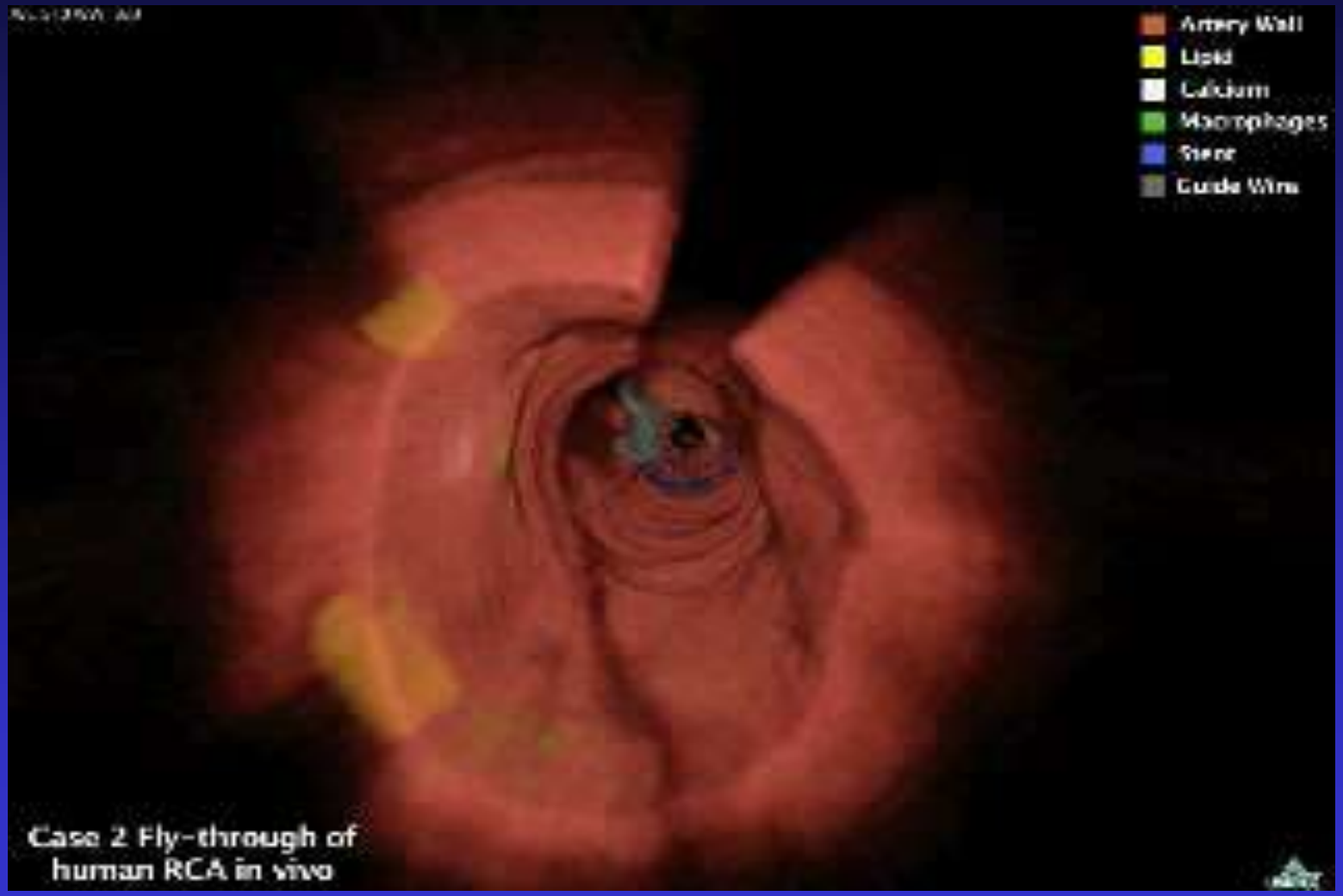
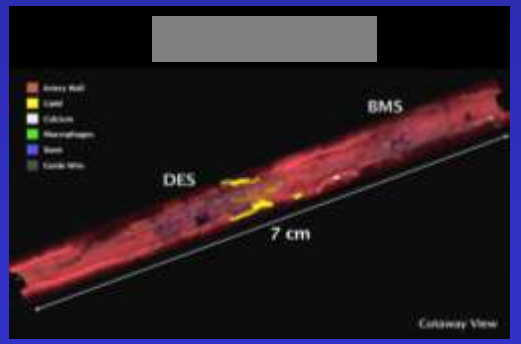
OCT 3-D reconstruction



- The 3D-OCT images allows us easy identification of the stent struts, calcium and lipid distribution.
- When FD-OCT is fully exploited, it has the potential to dramatically change the diagnostic strategy for coronary artery disease.



Tearney et al. JACC img 2008;1:752–61

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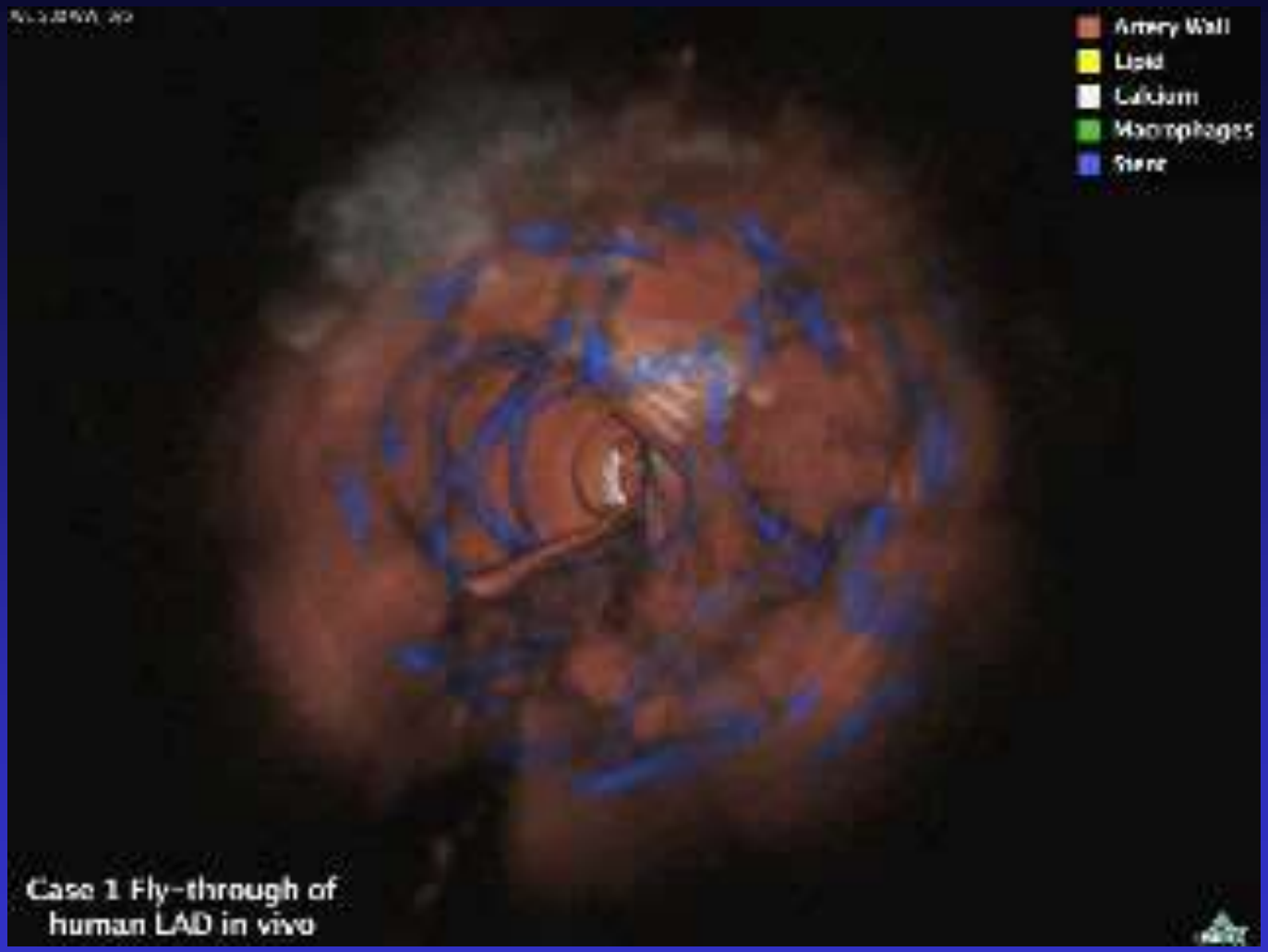
OCT 3-D reconstruction



Tearney et al. JACC img 2008;1:752–61

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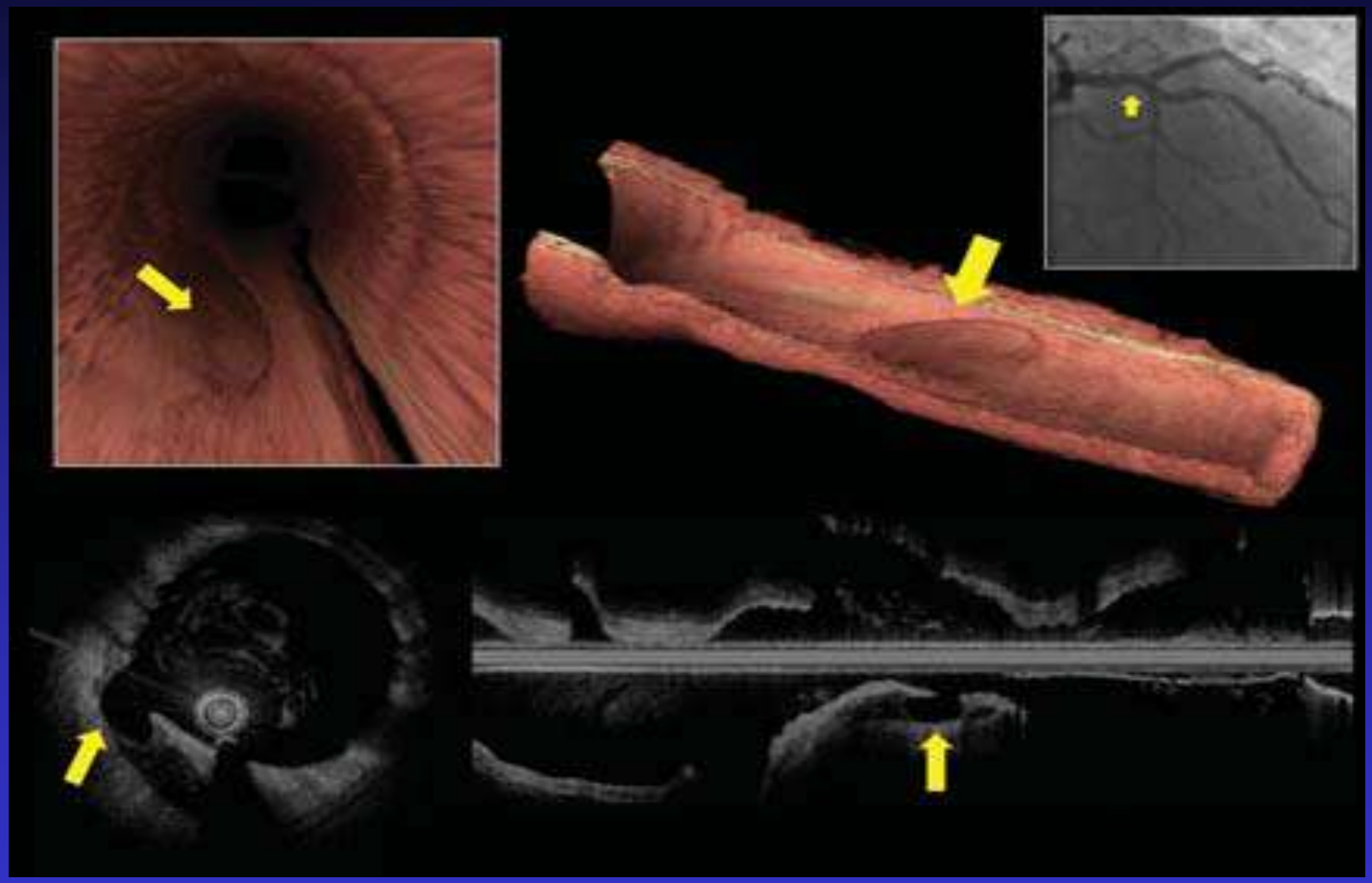
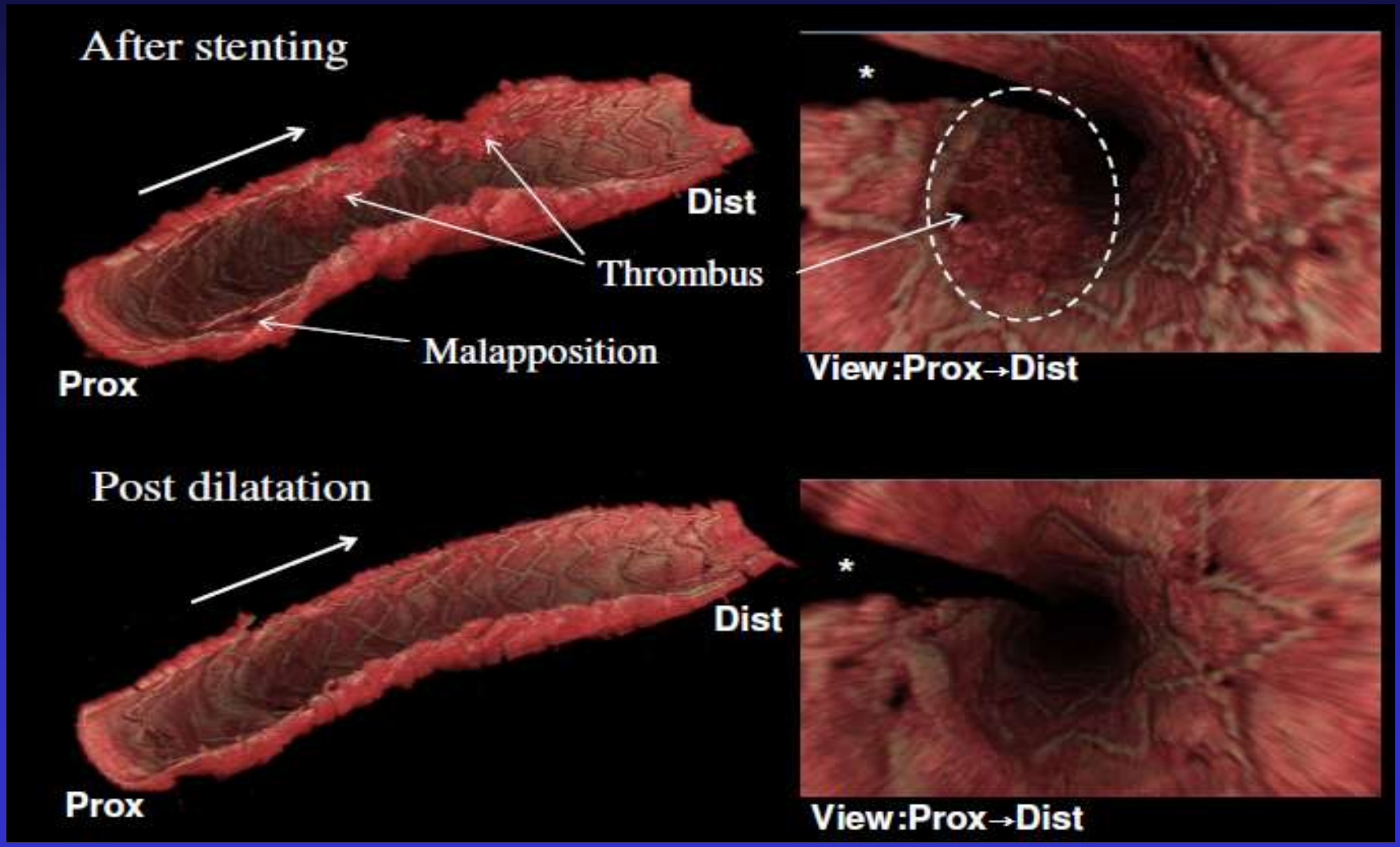
Fly-through 3D OCT images of plaque rupture



Plaque rupture is demonstrated on 3D longitudinal and downstream fly-through views with corresponding 2D FD-OCT images and Coronary angiogram.

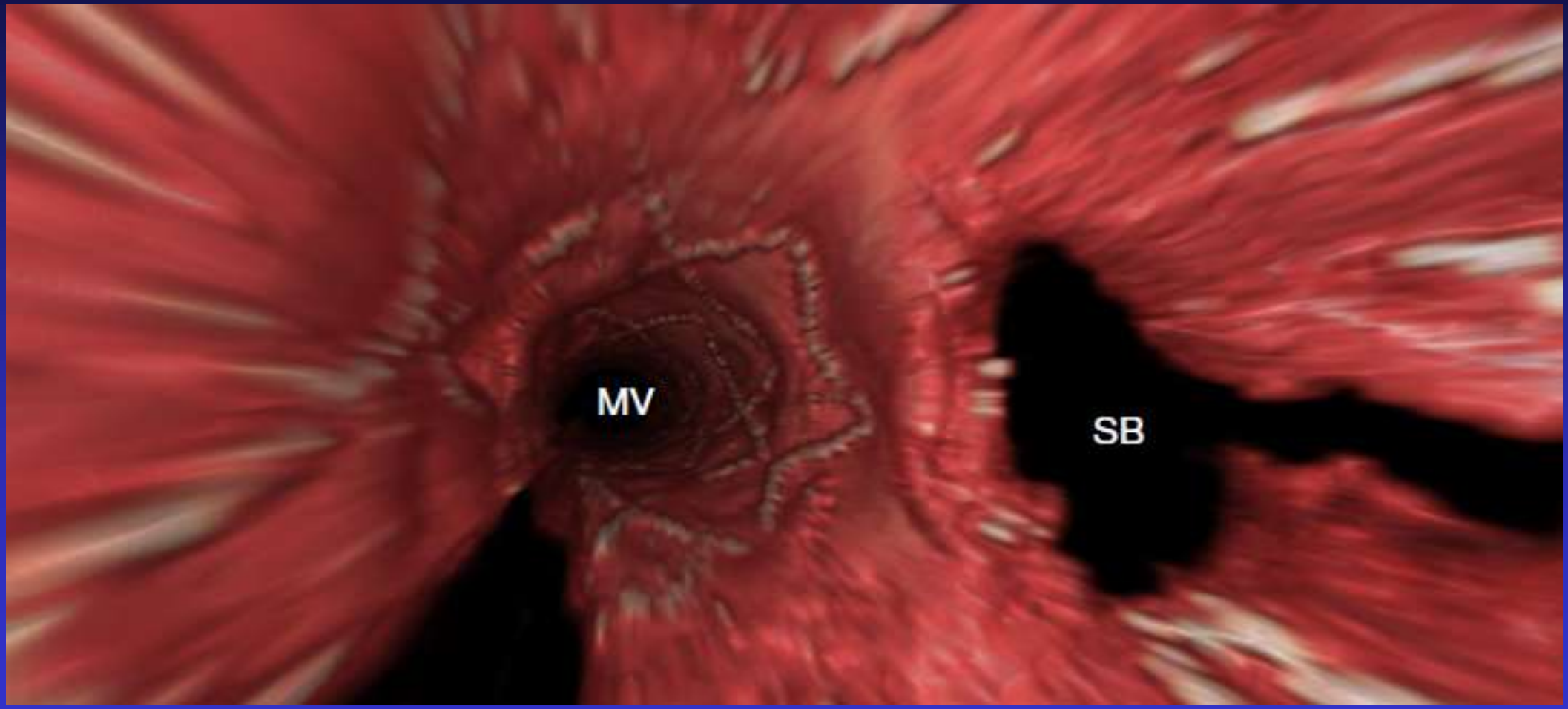
Farooq et al. Eur Heart J. 2012

Thrombus protrusion by 3D-OCT



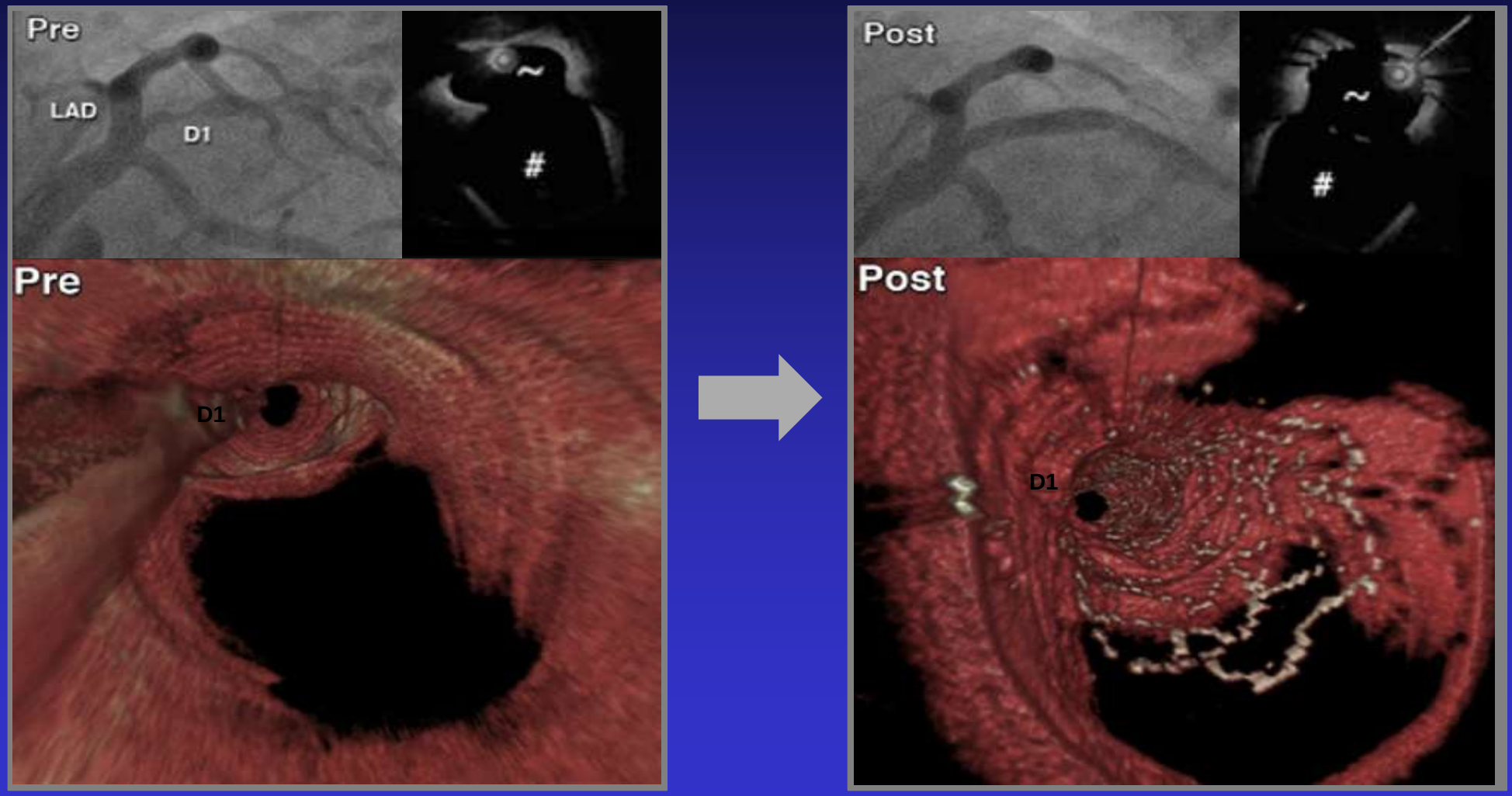
Courtesy of Prof Serruys

3-D assessment of SB opening

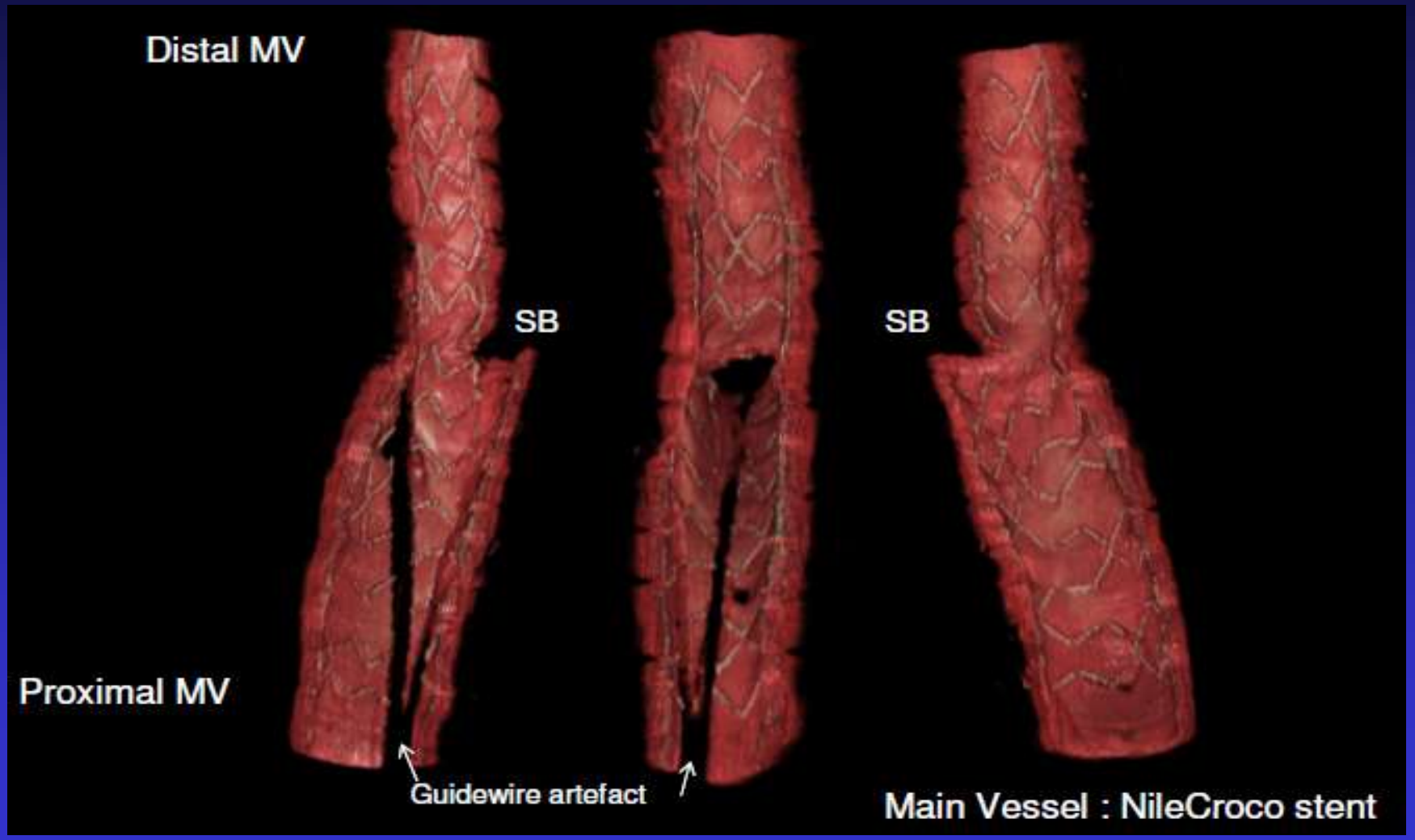


Farooq et al. Eur Heart J. 2011

“Overhanging” struts of the D1 stent into the LAD orifice



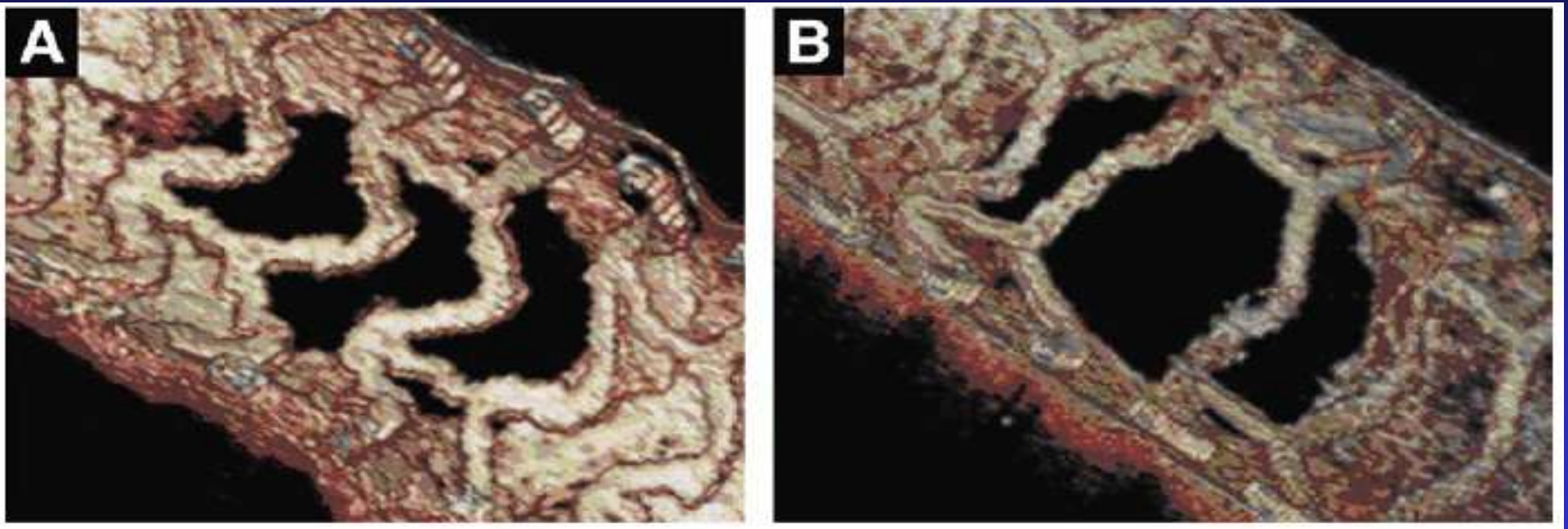
3-D assessment of SB opening



Impact of dilatation for SB Jailed by stent

Before SB dilatation

After SB dilatation



(A,B) Three-dimensional reconstruction of optical coherence tomography pullback. **(A)** Bioresorbable vascular scaffold was deployed in the main vessel crossing over a 2.5-mm SB orifice in silicon model. The SB was compartmentalized into 6 (Type V + double H). **(B)** After SB dilation, a configuration of jailed SB orifice by the bioresorbable vascular scaffold strut was modified. **(C)** Photo of the bioresorbable vascular scaffold in the silicon phantom model having the 2.5-mm SB. Abbreviations as in Figures 1 and 2.

Okamura et al. JACC int. 2010:3;836-844

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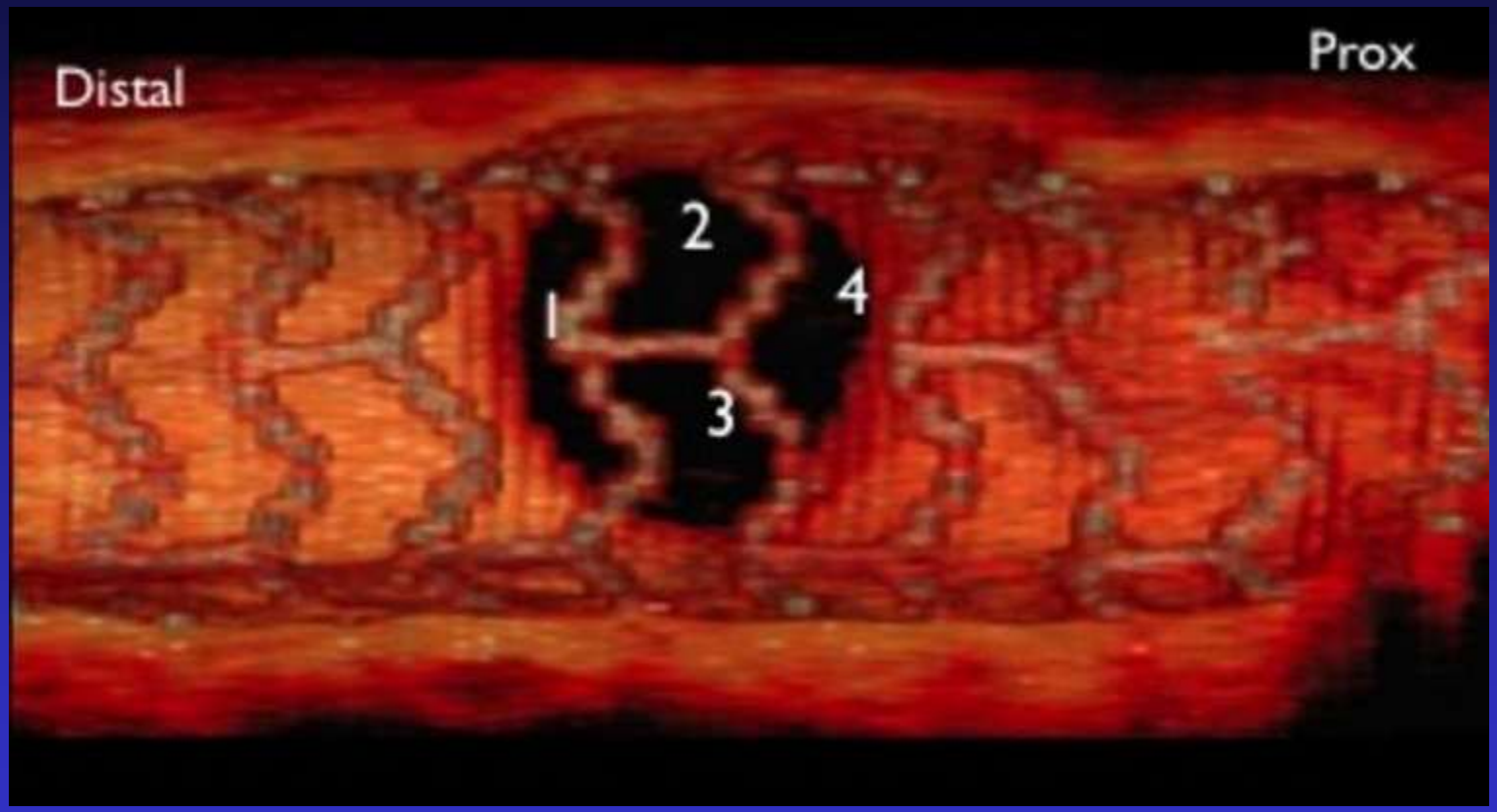
Re-wiring through stent struts into jailed LCX



Not only selection of re-wiring portion but also stent cell type should be very important to obtain enough lumen area in jailed side branch and to avoid stent deformity in main vessel.

Advantages of 3D-OCT in Clinical Practice

- Pre PCI
  - Image acquisition & 3-D reconstruction are very fast and easy.
  - 3-D images may useful in precise automatic measurements.
  - 3-D OCT may allow us to assess lesion morphology in detail.
- During and after PCI.
  - Neointimal coverage after stenting can be identified semi-quantitative way, and incomplete apposition or mal-apposition can be demonstrated using different presentation.
  - Much more delicate treatment may be expected to bifurcation lesion stenting.
  - Proportion of different plaque components and the condition of stent can be assessed precisely using fly-through images.

Summary

3-D OCT: Will It Change CathLab's Landscape

- Various type of real time 3D OCT images can be demonstrated very easily, and much more delicate measurement and treatment can be expected during PCI including bifurcation lesion stenting.
- 3D-OCT may allow us to assess complex lesion morphology in detail visually.
- Incomplete apposition or mal-apposition of stents can be demonstrated using different presentation automatically, and neointimal coverage after stenting can be identified semi-quantitatively.
- 3-D OCT may have potentials to change our diagnostic and therapeutic procedures much more in catheterization laboratory if volumetric data could be obtained at the same time.

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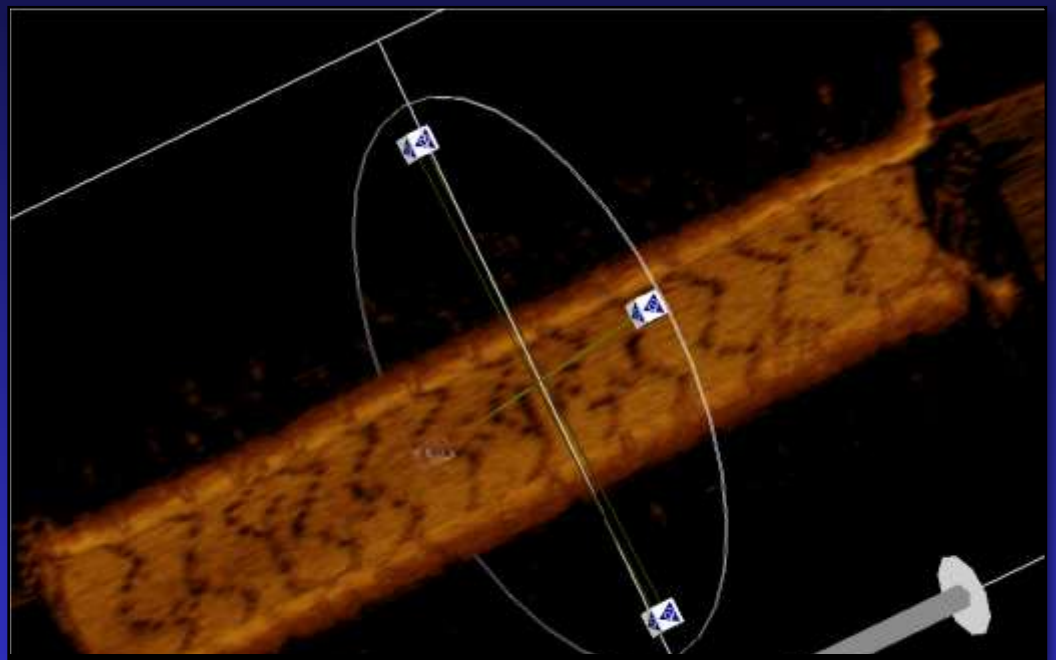
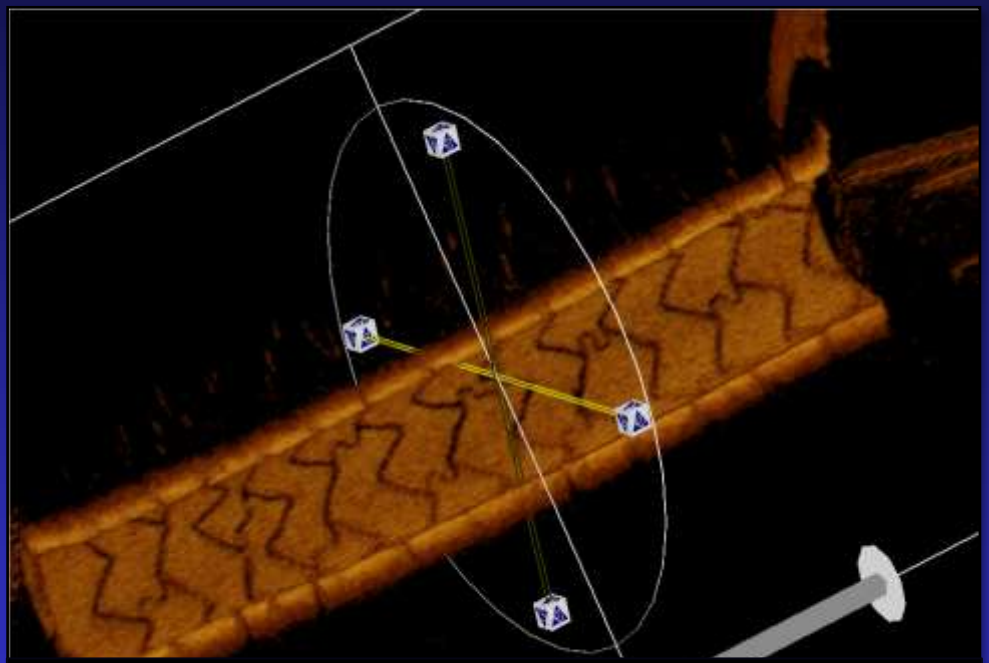
Comparison of OCT imaging between C7 & C8



5 frames/mm - ILUMIEN



10 frames/mm – ILUMIEN OPTIS