Clinical Utility of
HD-IVUS (High Definition IVUS)

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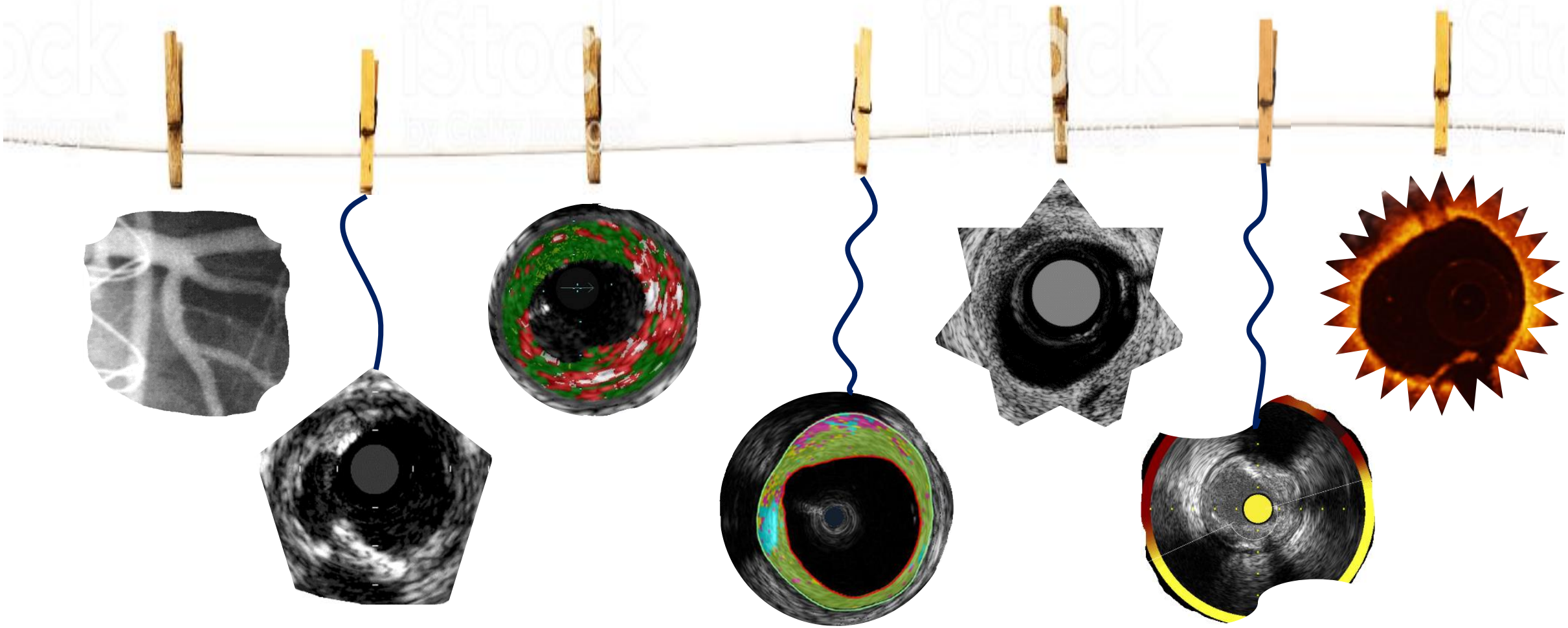

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IVUS has been clinically available for over 20 yrs.

However…

★ Image quality has not improved in the last 10 years.

★ Lower spatial resolution and catheter-to-catheter imaging inconsistency are problematic.

★ Hard to interpretation due to the limited image quality

Clinical Utility of High Definition IVUS

★ Physics

★ Available HD-IVUS System

★ Comparing 40 MHz vs 60 MHz

★ Cases compared to OCT

★ Summary

Heart Research Institute
Chung-Ang University Hospital, SEOUL

60 MHz Transducer Technology

Boston Scientific
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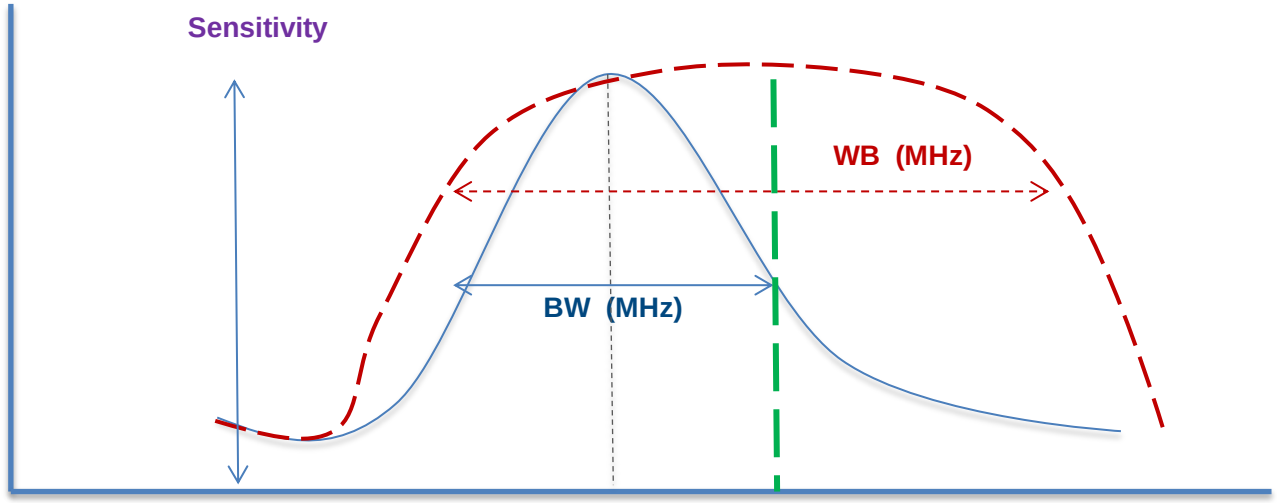
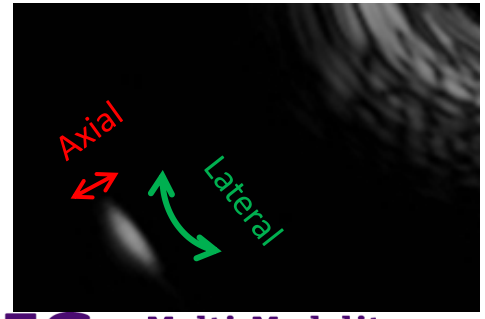
Transducer Spectrum



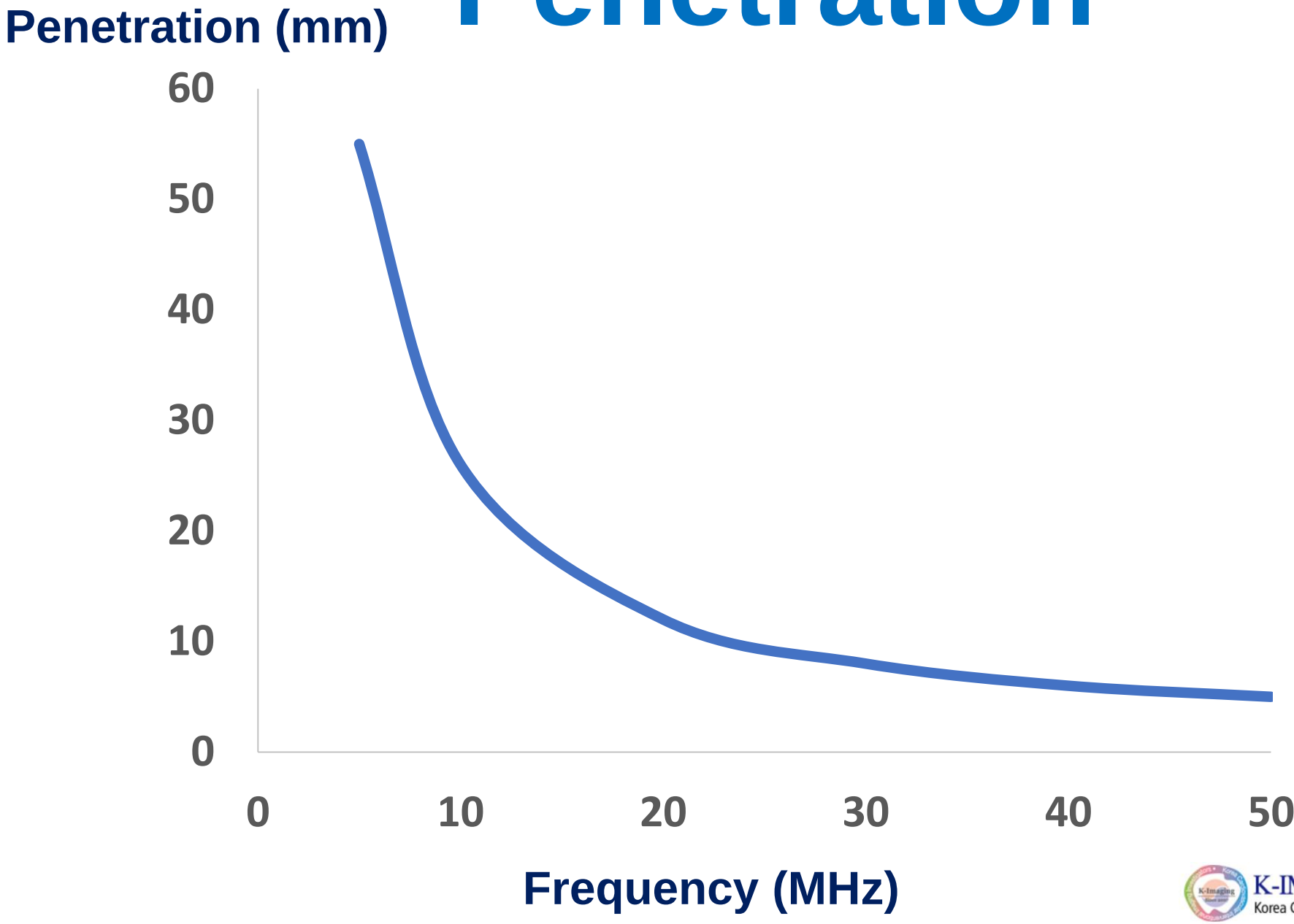
40 MHz **60 MHz**



Wide bandwidth → better axial resolution
High frequency → better lateral resolution
High sensitivity → deeper penetration

POLARIS Multi-Modality Guidance System

Penetration



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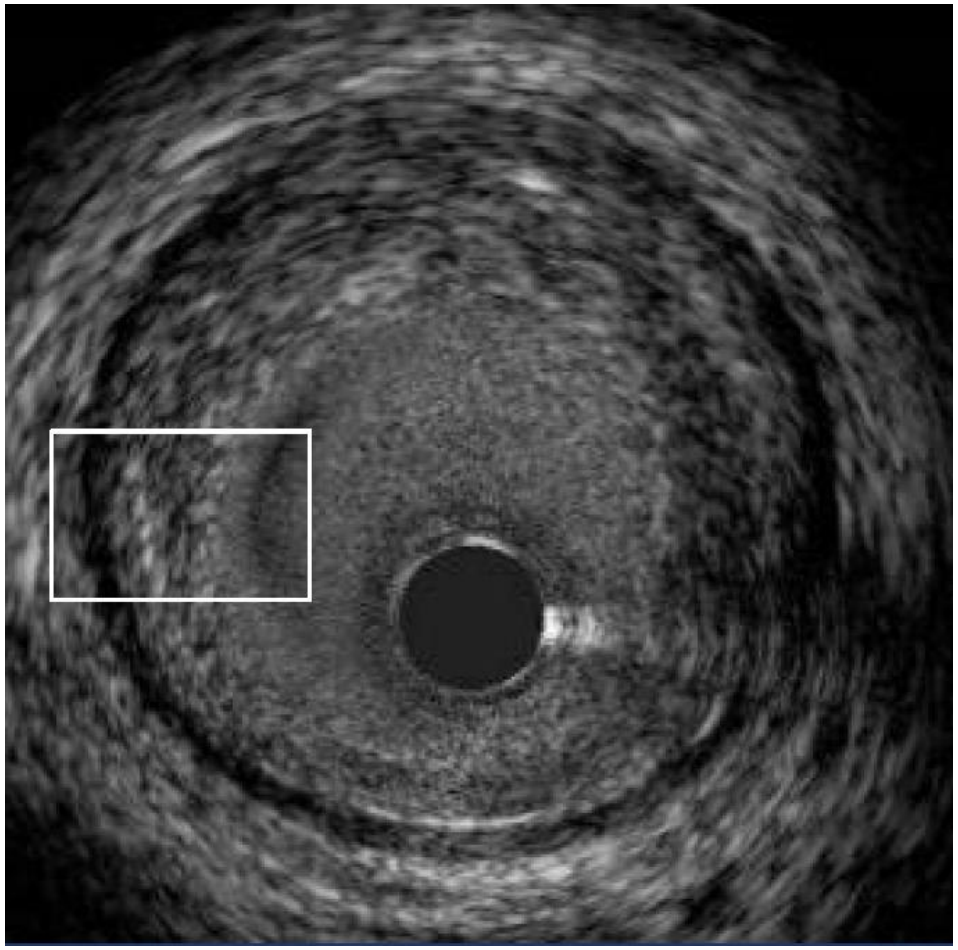
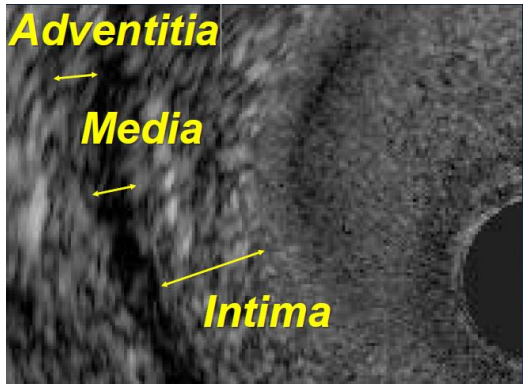
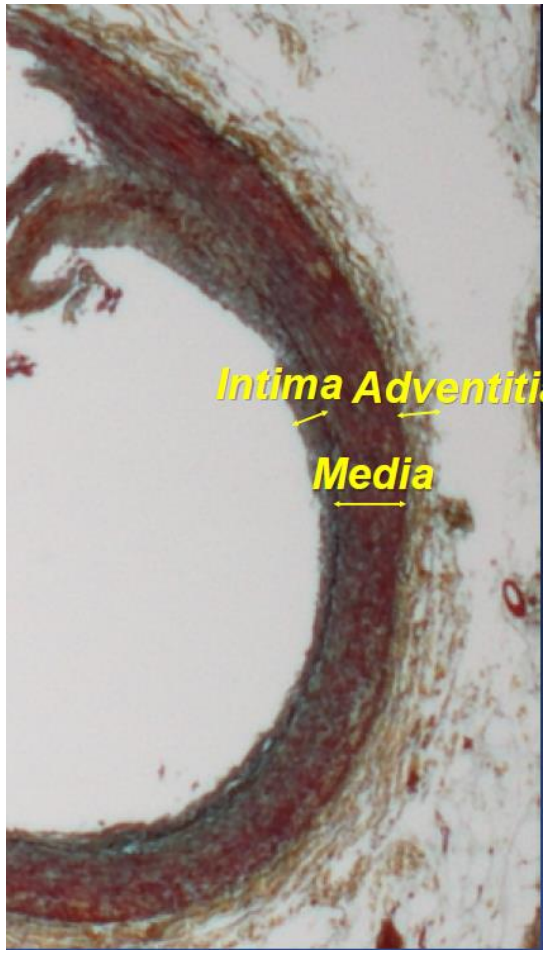
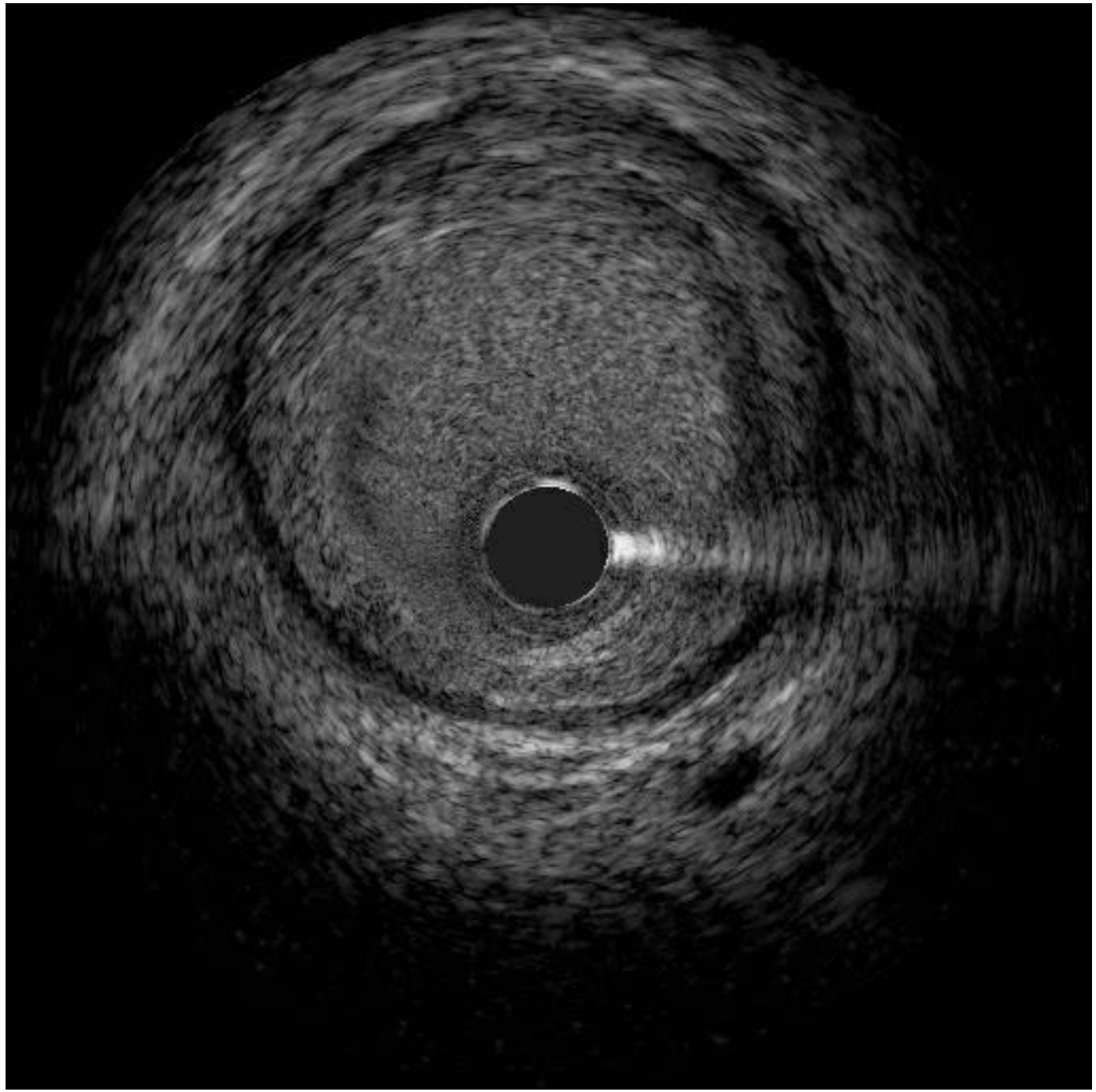
Three Layers Appearance







ACIST
60MHz IVUS



HD-IVUS Systems

- **ACIST** (purchased SVMI - has been working on next generation IVUS since 2007)

} Available

- **Boston Scientific** --- Available soon
- **Volcano**
- **Terumo HD**

} Under development

HD-IVUS Imaging System Comparison

	ACIST HDi / Kodama	Boston Scientific	Volcano FACT	InfraReDx	St. Jude OCT
Frequency or Wavelength	60 MHz	60 MHz	Not available	50 MHz	1.3 um
Nature of the Energy	Ultrasound				Optical
Axial Resolution	40 μm	22 μm	<50 μm	20 μm	15 μm
Lateral Resolution	90 μm	50-140 μm	100-200 μm	<200 μm	40 μm
Soft Tissue Penetration	>2.5 mm	>3.5 mm			0.8-1.2 mm
Blood Penetration	>3.4 mm	>4.0 mm			≤1.2 mm
Pullback Speed (mm/s)	0.5, 1.0, 2.5, 5.0, 10	0.5, 1.0		0.5	20
Pullback Length (mm)	130	100		150	75

High Definition IVUS catheter

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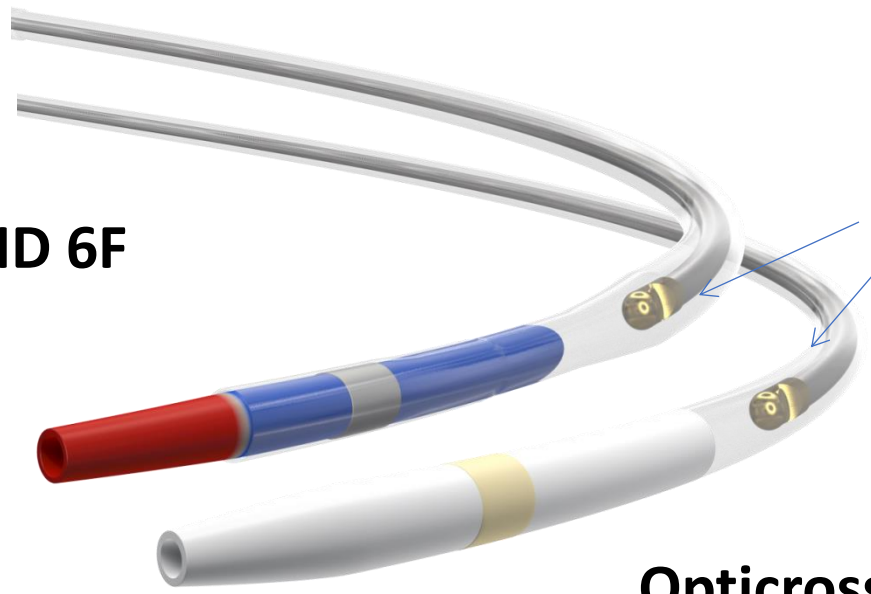
Opticross™ 6 HD 6F



Opticross™ HD 5F

	Opticross HD	Opticross 6 HD
Transducer Type	Next Gen Wide Bandwidth Transducer	
Transducer frequency	60 MHz	
Axial resolution	22 um	
Vessel penetration	Visualizes 6 mm vessels	
Guide catheter copatibility	5F *(ID > 0.058”)	6F *(ID > 0.064”)

POLARIS Multi-Modality Guidance System

Opticross HD vs OCT - Thrombus

Boston Scientific
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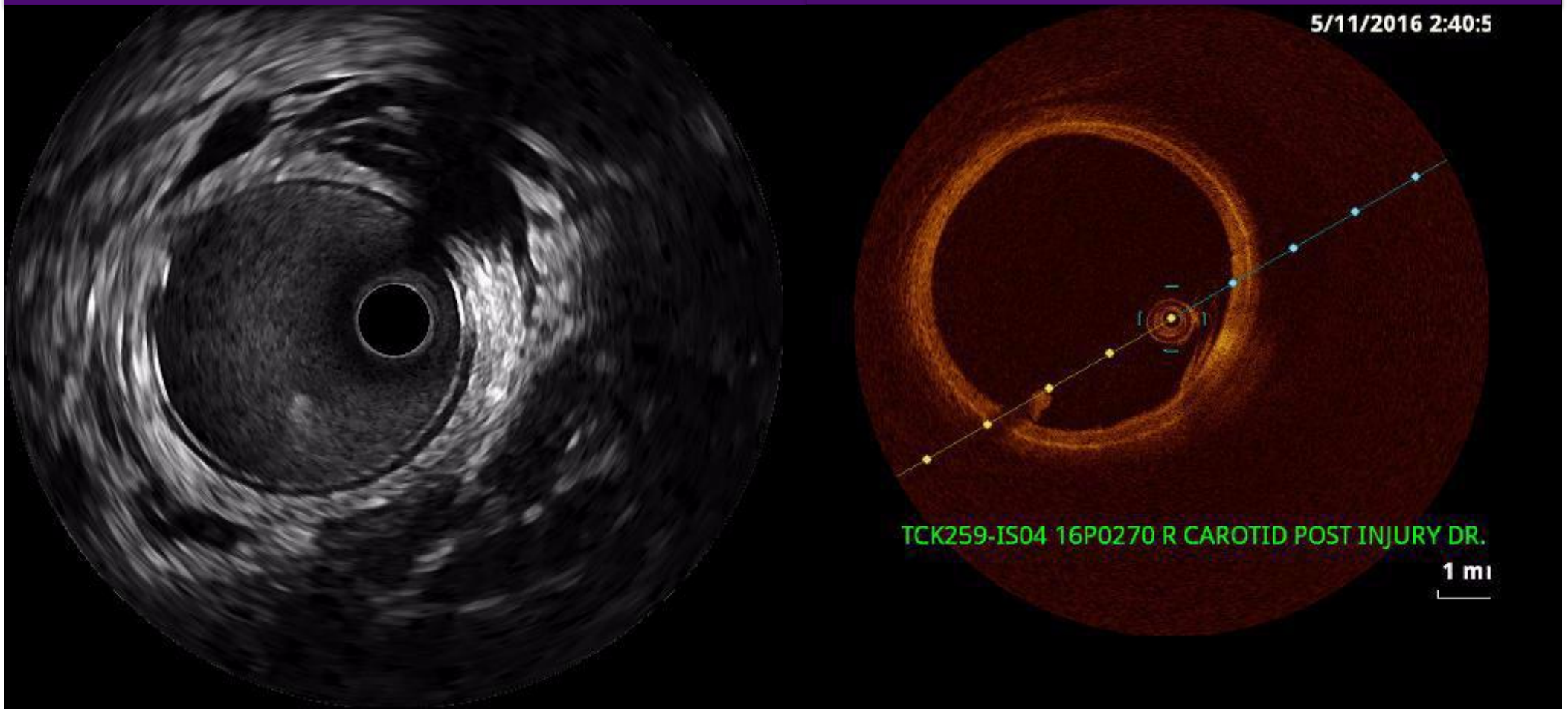
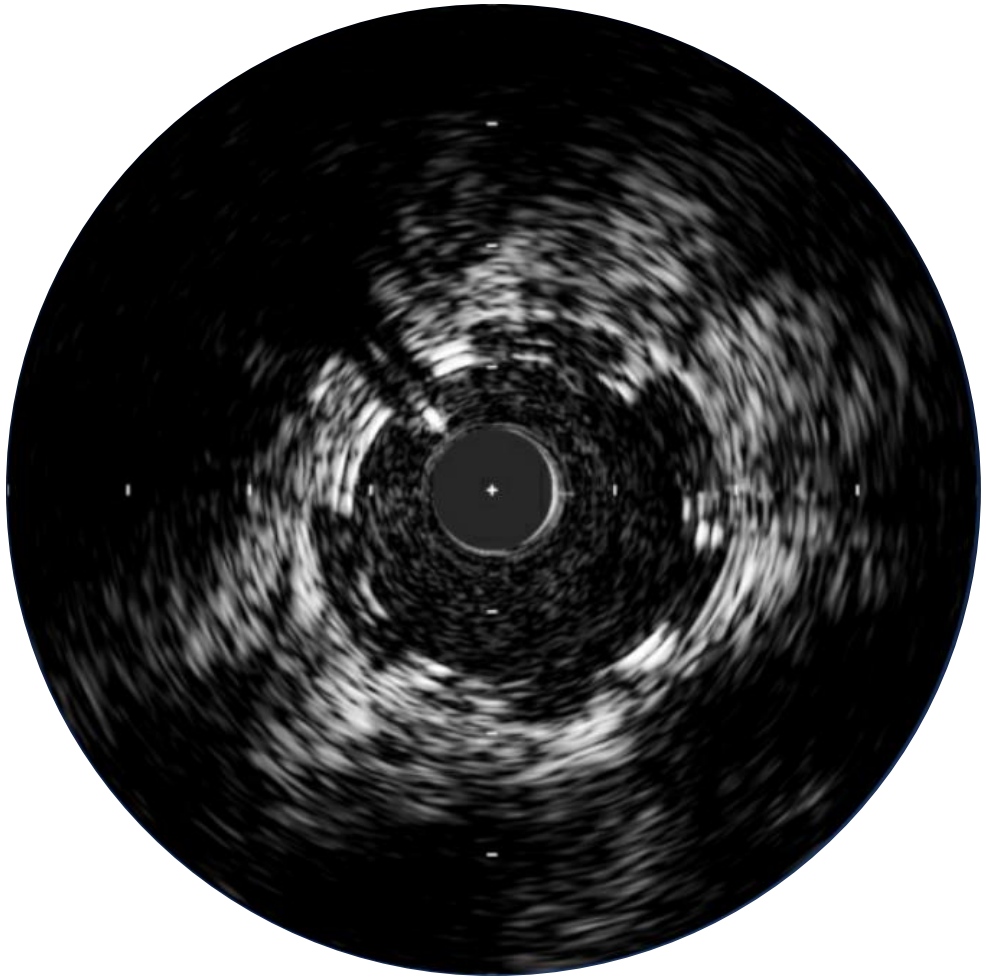
Next Gen IVUS HD*	OCT



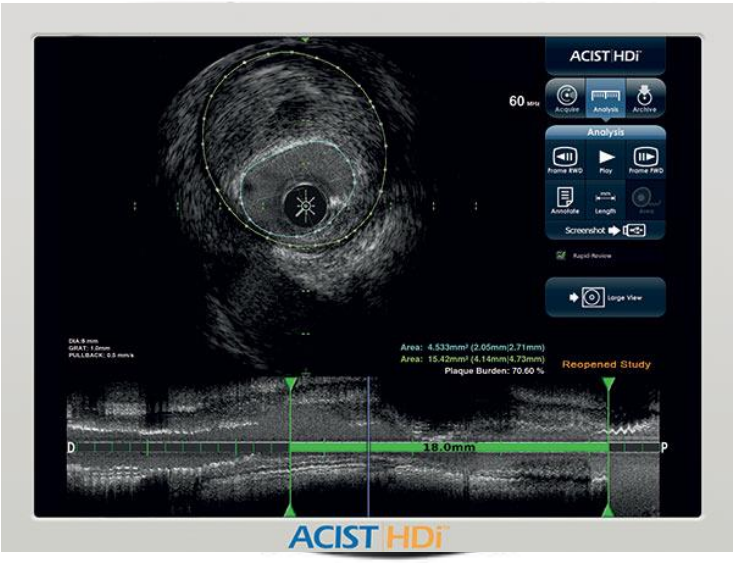
* Caution: Investigational Devices: Limited by Federal (or US) Law for Investigational Use Only. Under Development. Not for Sale.

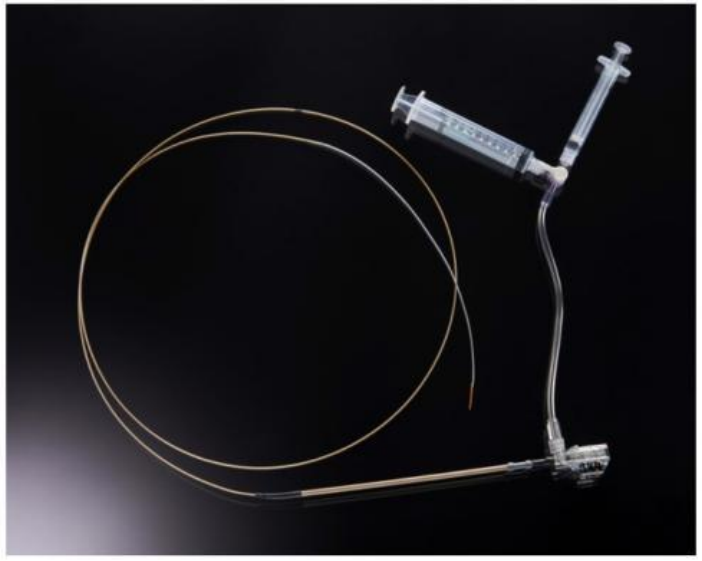
Volcano: FACT (Focused Acoustic Computed Tomography) and Bioresorbable Vascular Scaffolds

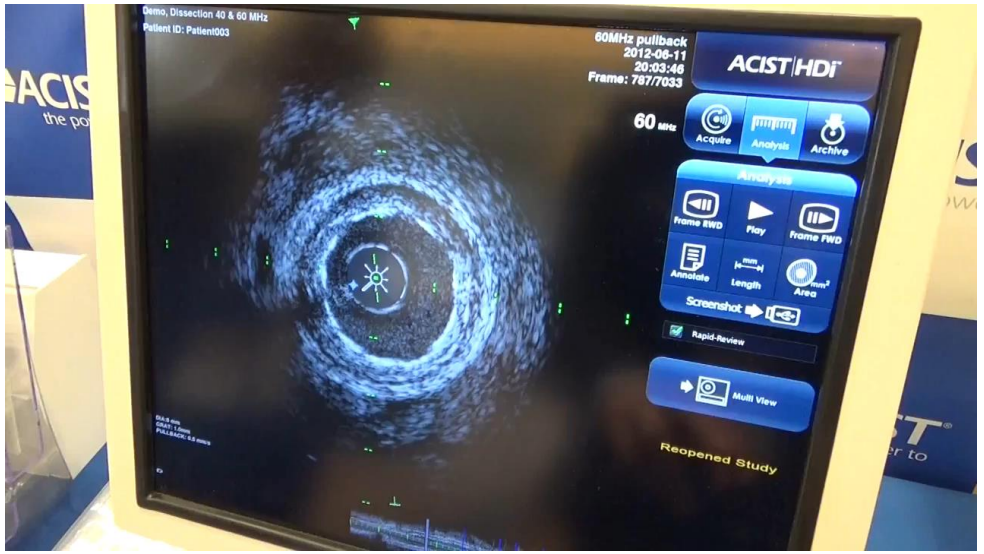


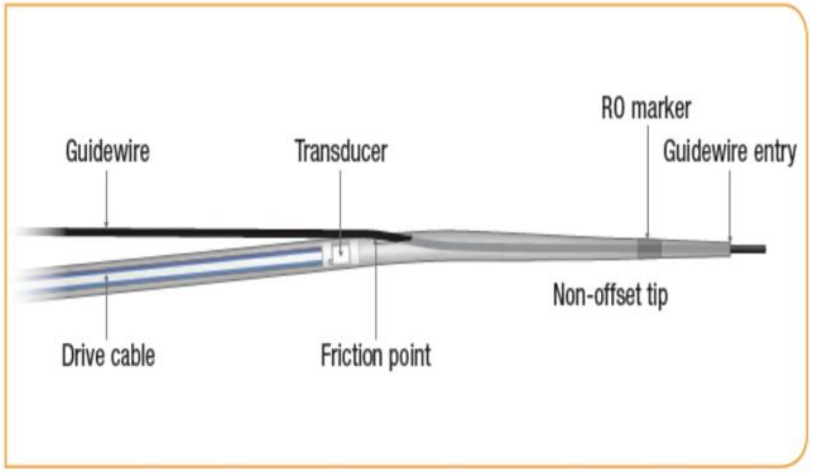
FACT ultrasound transducer intented to generate a “cleaner” signal than traditional PZT, near field resolution close to OCT, visibility of the entire plaque and vessel wall, and without the need for a blood clearing flush

ACIST HDi

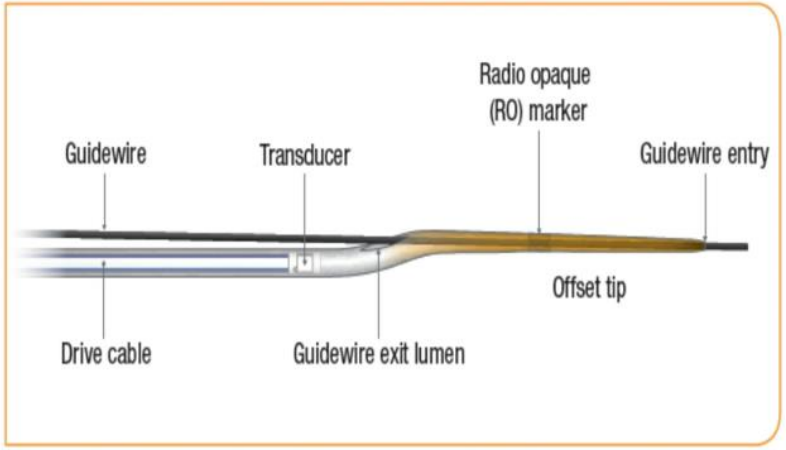








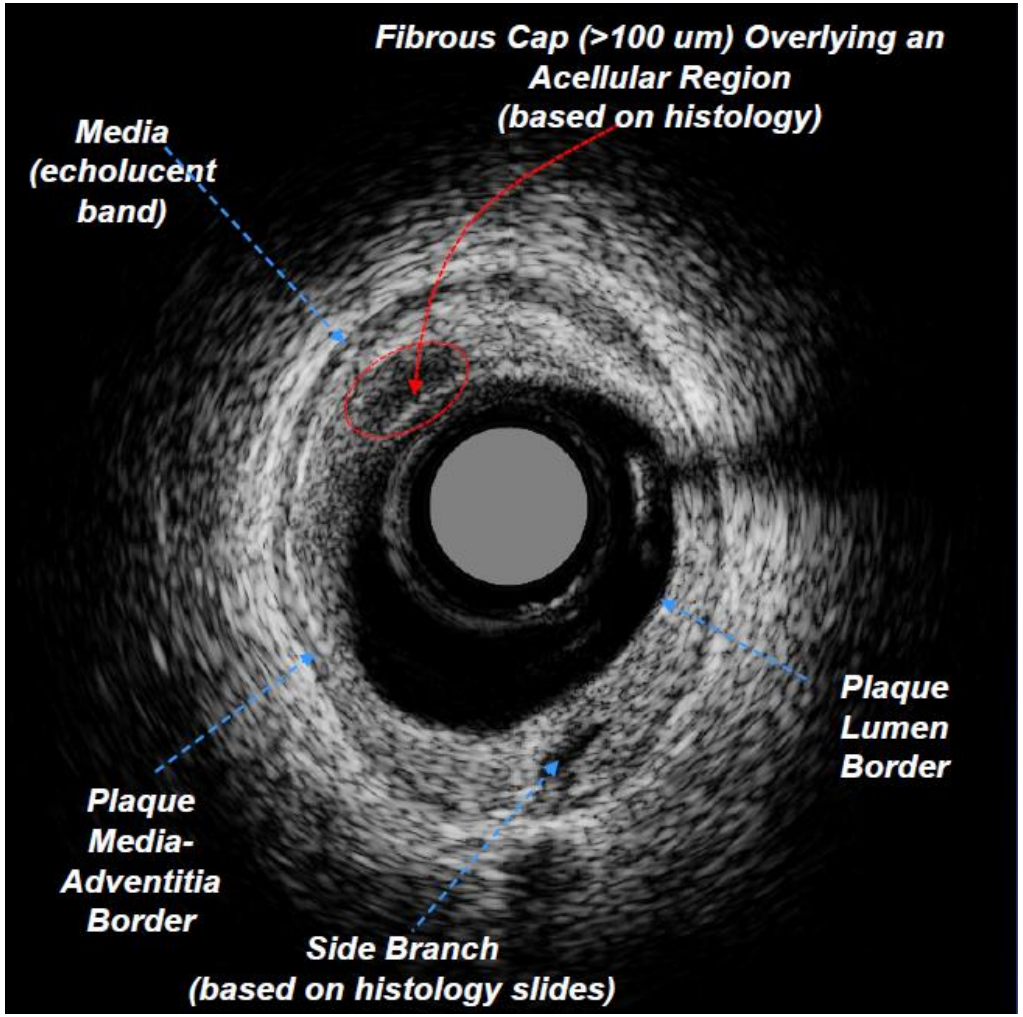
Standard IVUS catheter tip design.

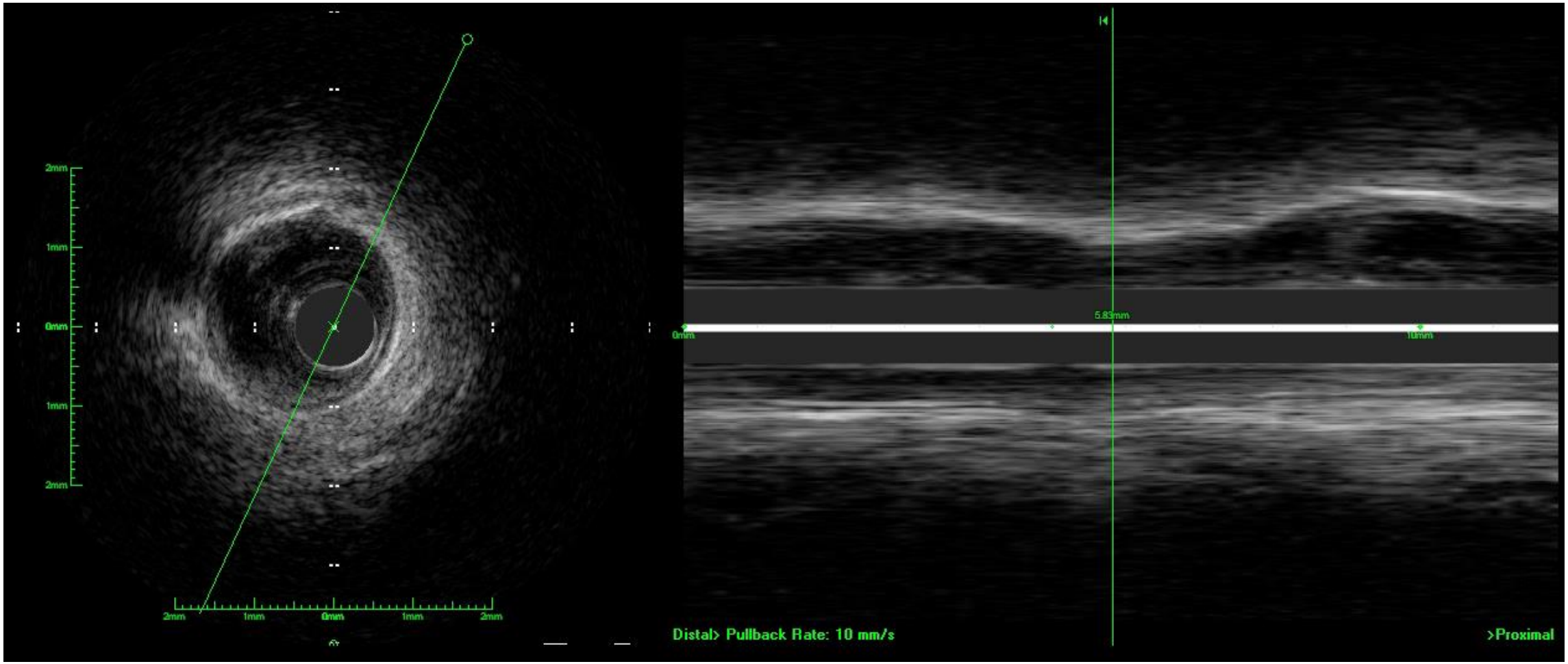


Novel offset tip design of Kodama.

ACIST: HD-IVUS

Axial Resolution*	~40 µm
Lateral Resolution*	~90 µm
Frame Rate	
60 fps	0.5mm/s
30 fps	1.0mm/s
24 fps	2.5mm/s
12 fps	5.0mm/s
6 fps	10mm/s
Maximum Pullback Speed	10 mm/sec
Frame Spacing	17 - 167 µm
Pullback length	120 mm
Tissue Penetration	~3 mm
Imaging in Blood	Yes





60MHz @ 60 frame/sec
Pullback speed: 10.0 mm/sec
567 Frames acquired (200 viewed)

Acquisition time: 10 sec
Pullback length: 96mm
Frame spacing: 167 µm

File size: 149 MB (10MB WMV viewed)

ACIST HDi

BSC HD vs ACIST HD

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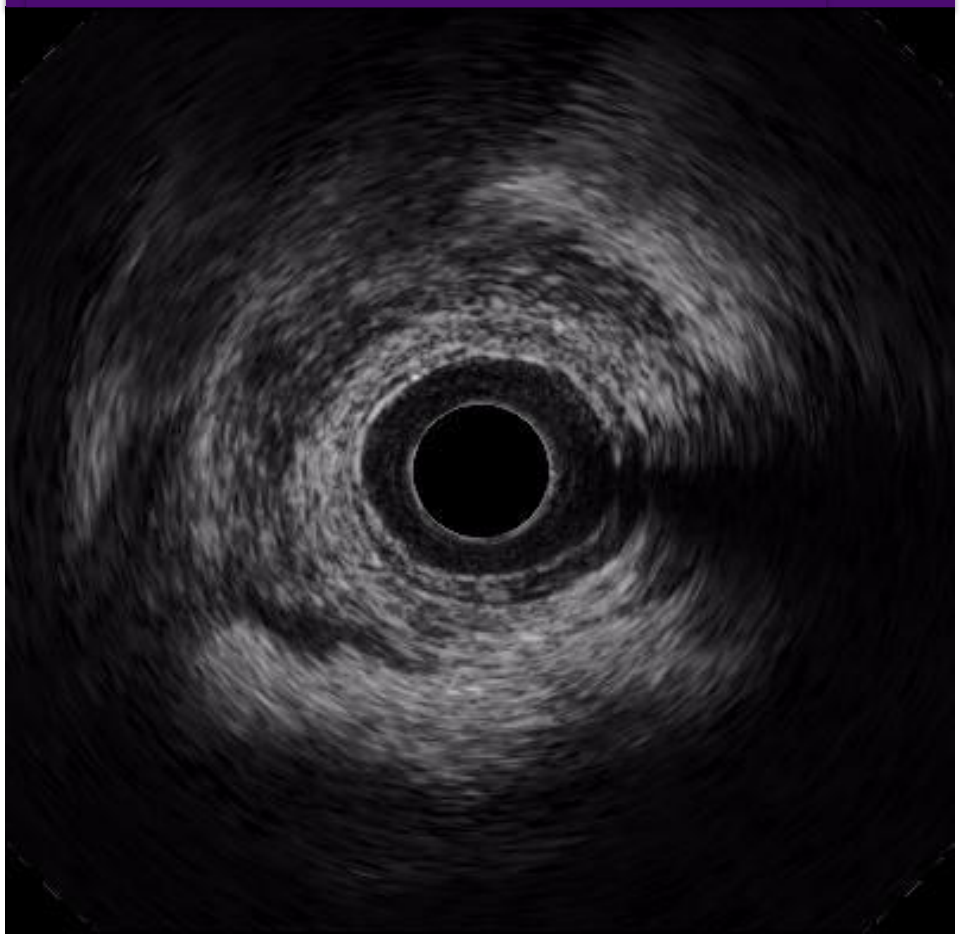
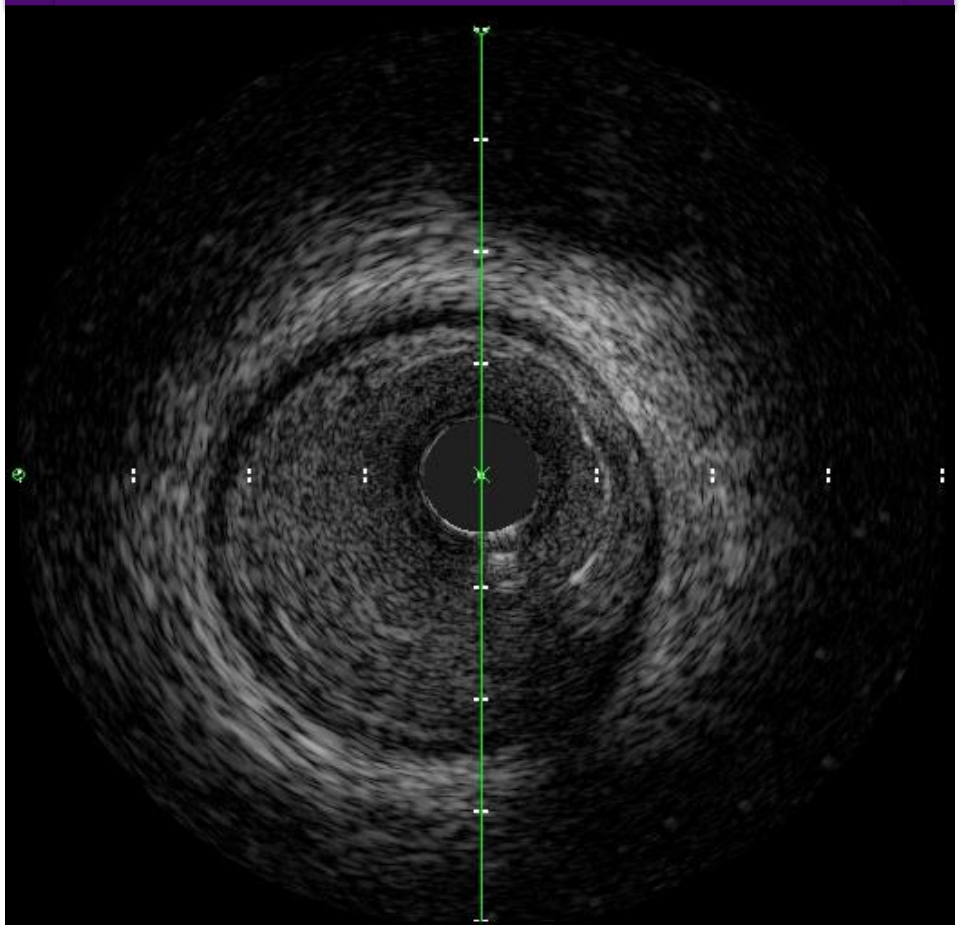
Next Gen IVUS HD*



Acist HD



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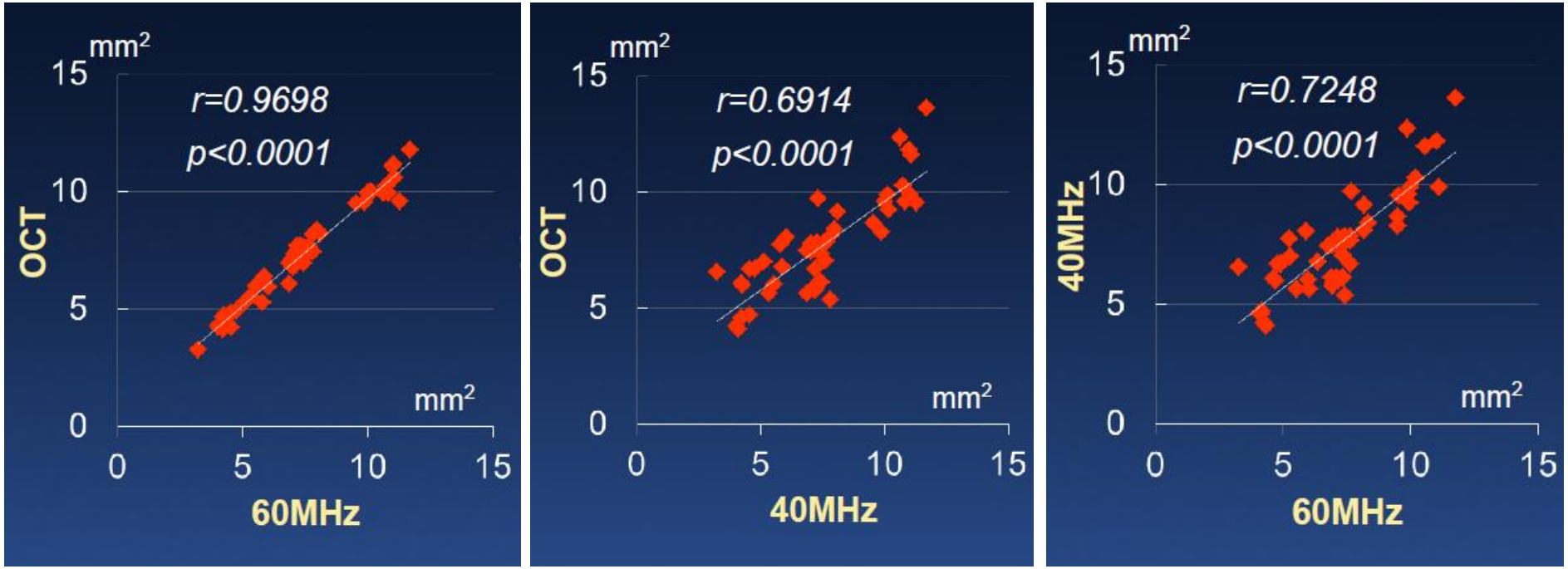
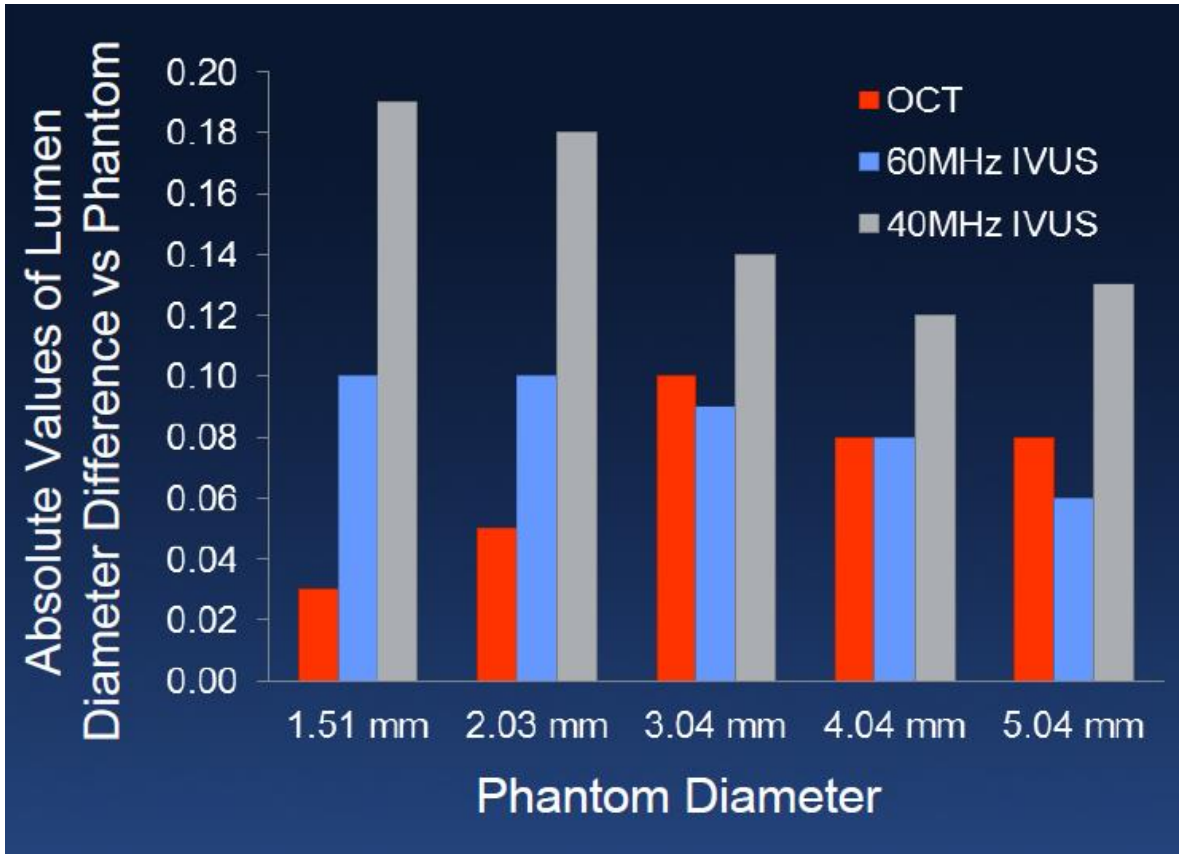
In Vitro Correlation of Lumen Area Among 40 MHz and 60 MHz IVUS and OCT

(50 matched x-sections from 9 arteries)

60MHz vs OCT ***40MHz vs OCT*** ***60MHz vs 40MHz***

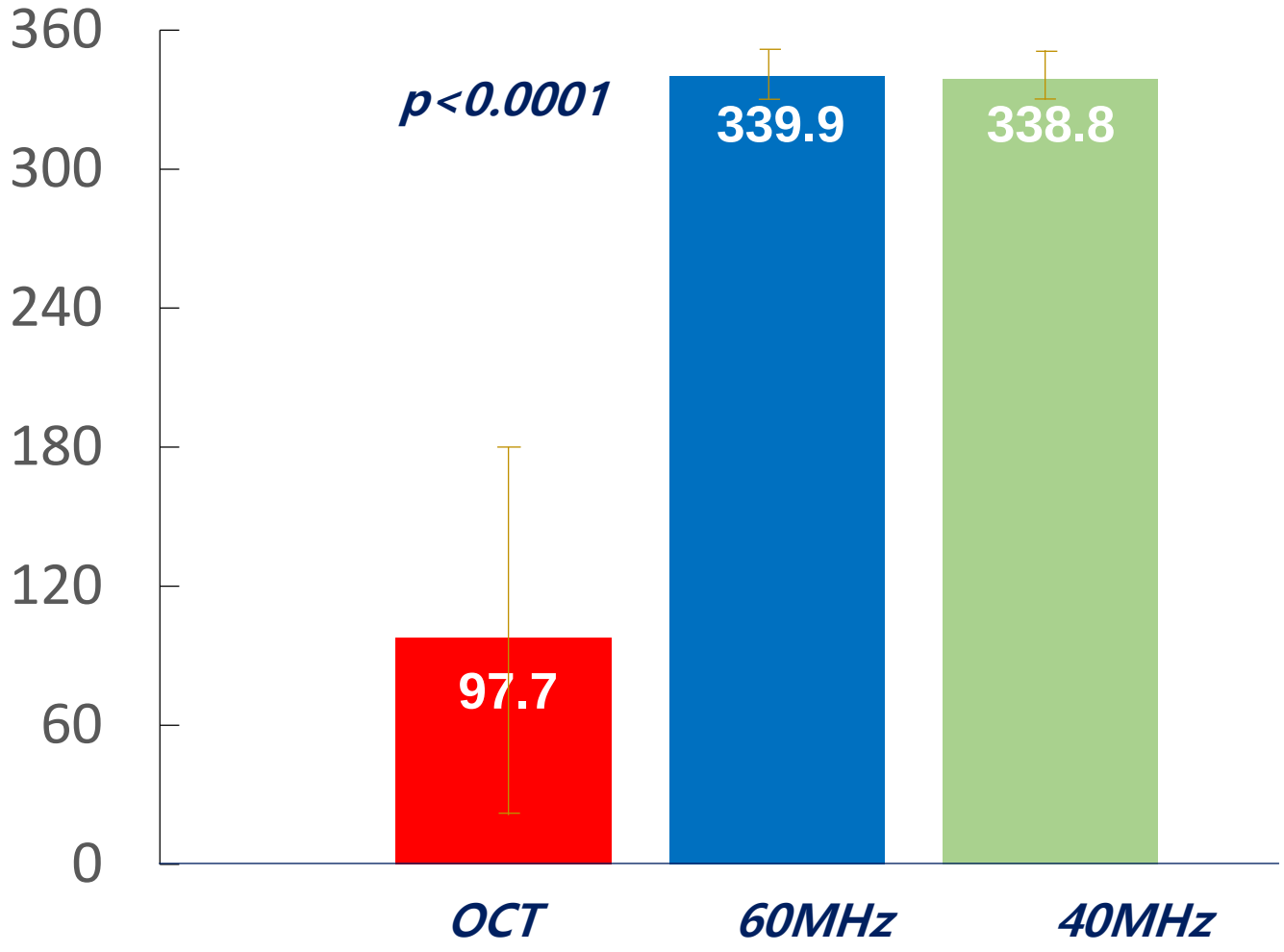


Five coronary phantoms with known lumen diameters of 1.51, 2.03, 3.04, 4.04, and 5.04 mm were imaged in a saline-filled tank at 37℃.



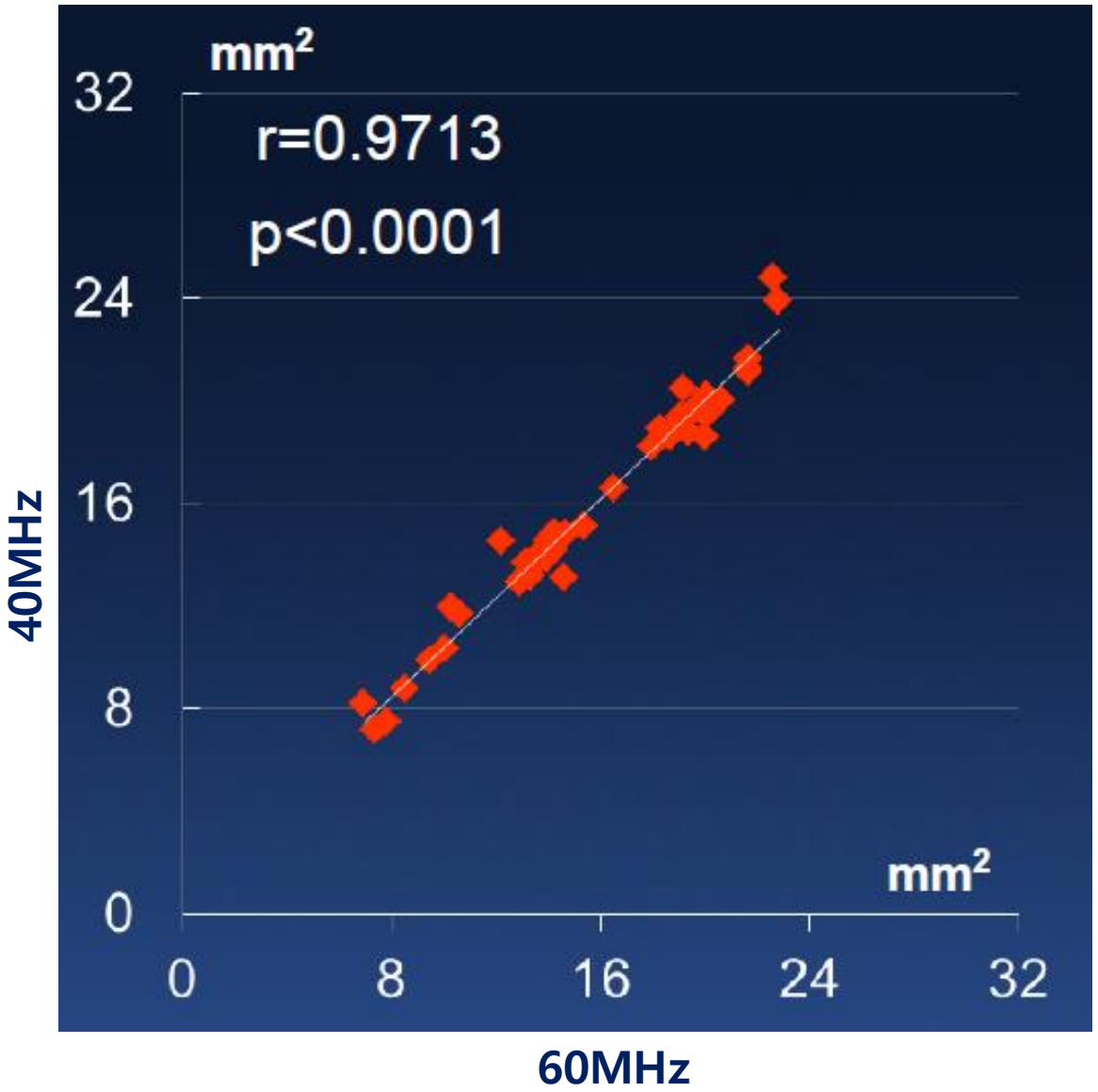
Modality	Mean Lumen Diameter Difference vs Phantom
OCT	0.07 ± 0.03 mm
60MHz IVUS	-0.08 ± 0.03 mm
40MHz IVUS	0.15 ± 0.03 mm

Visibility of EEM

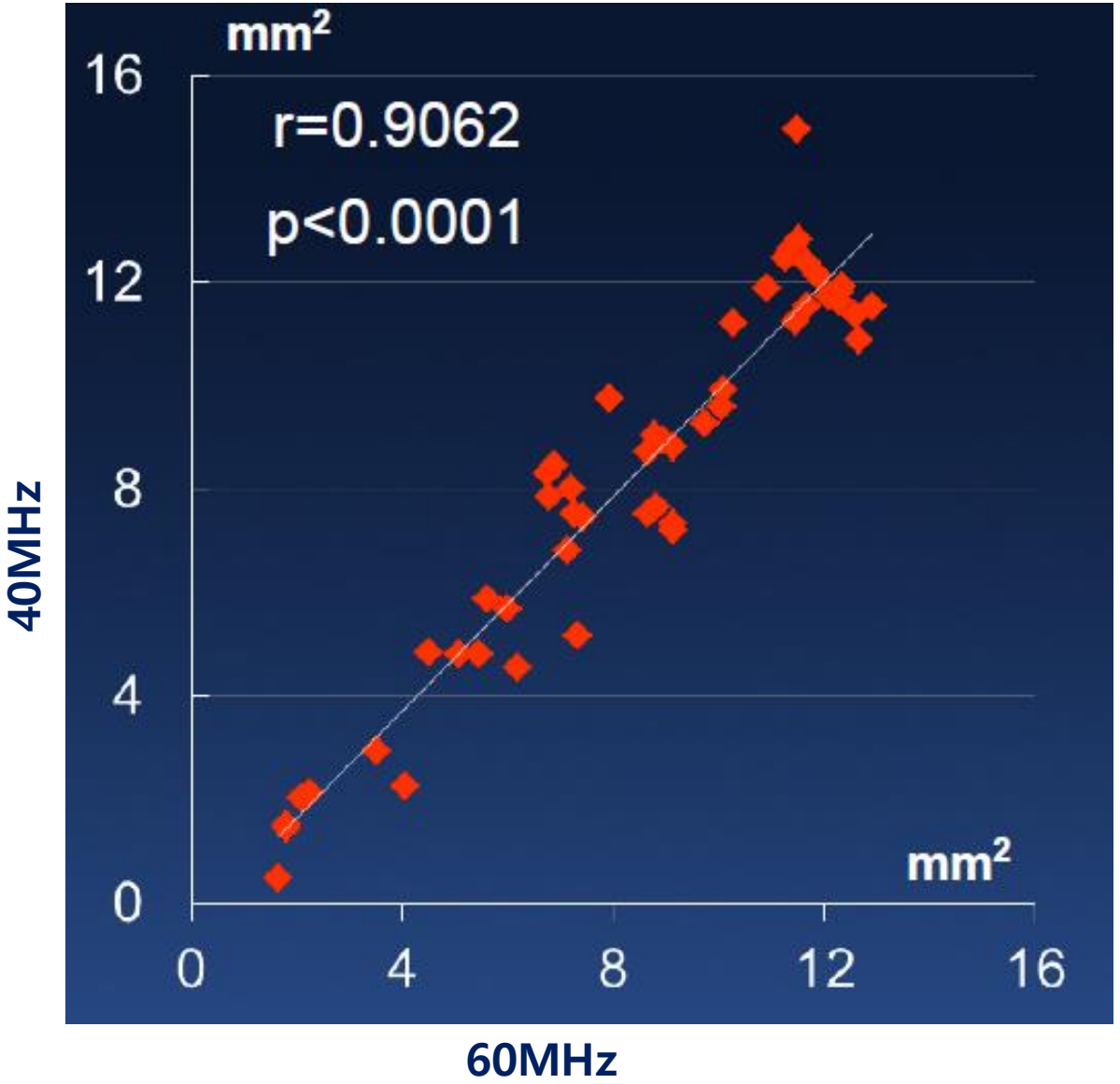


Honda et al. ACC 2013

EEM Area

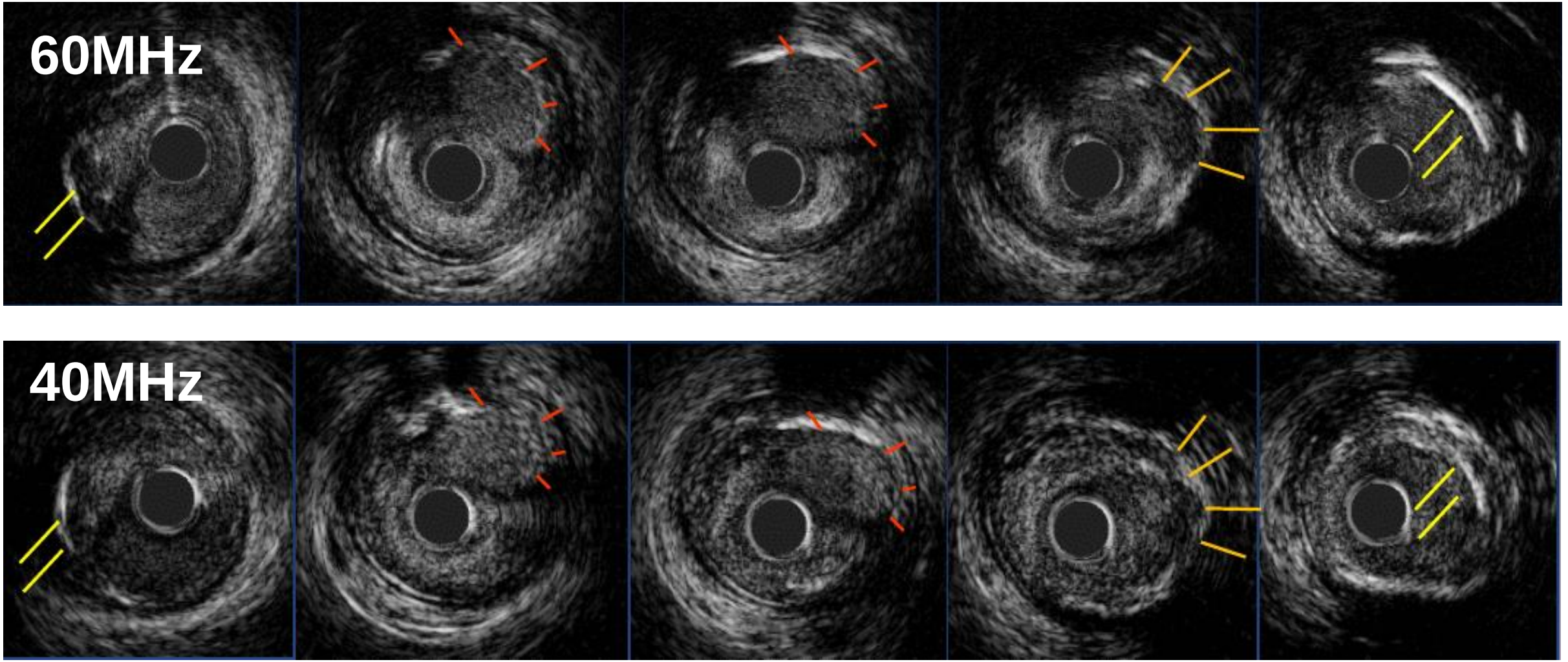


Plaque Area

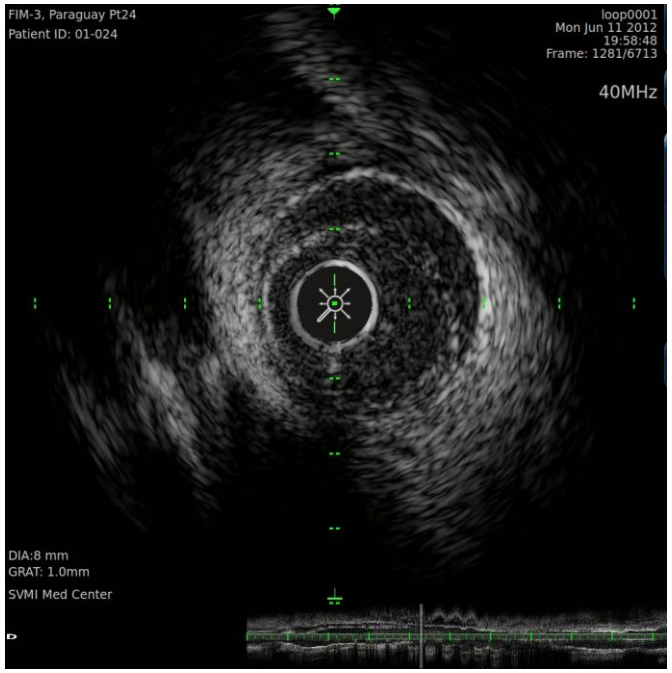


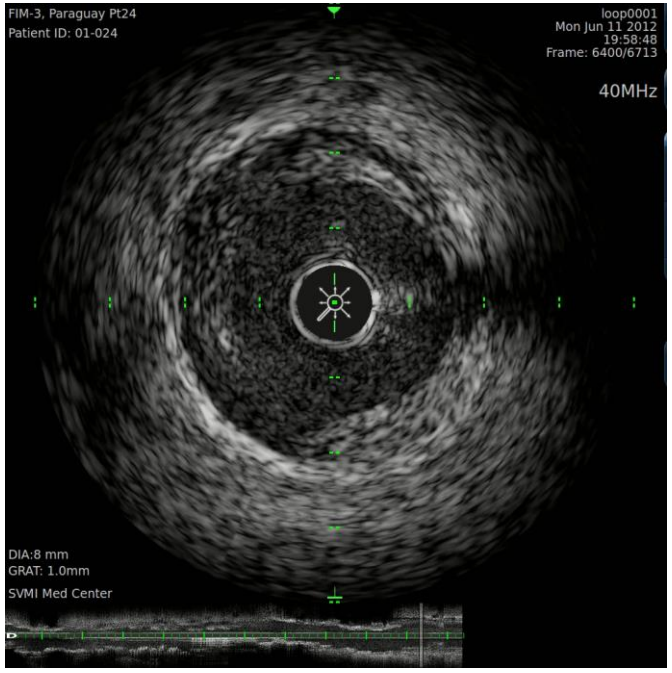
Honda et al. ACC 2013

Difference between 60 and 40 MHz

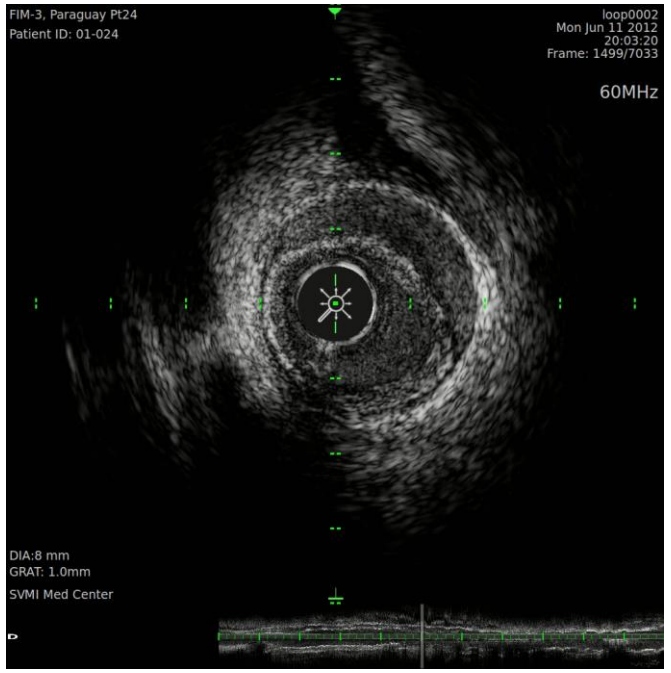


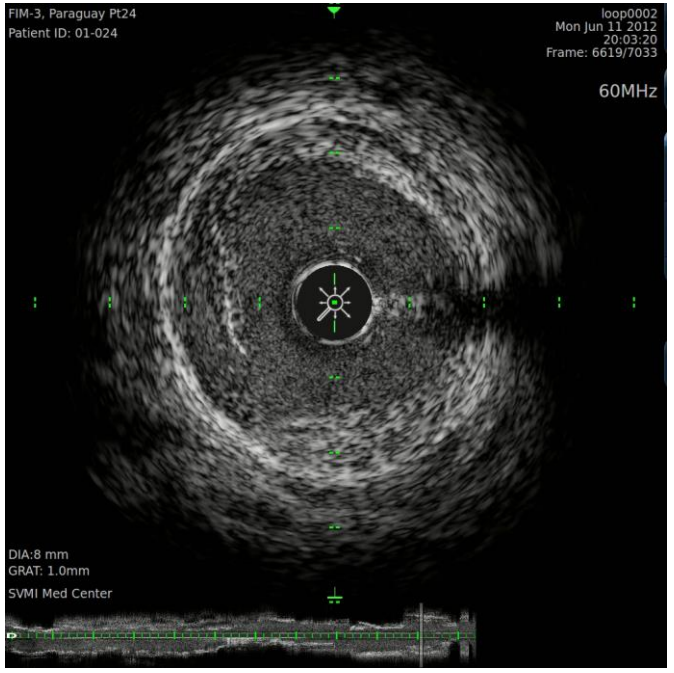
40MHz


FIM-3, Paraguay Pt24
Patient ID: 01-024
loop0001
Mon Jun 11 2012
19:58:48
Frame: 1281/6713
40MHz
DIA:8 mm
GRAT: 1.0mm
SVMI Med Center

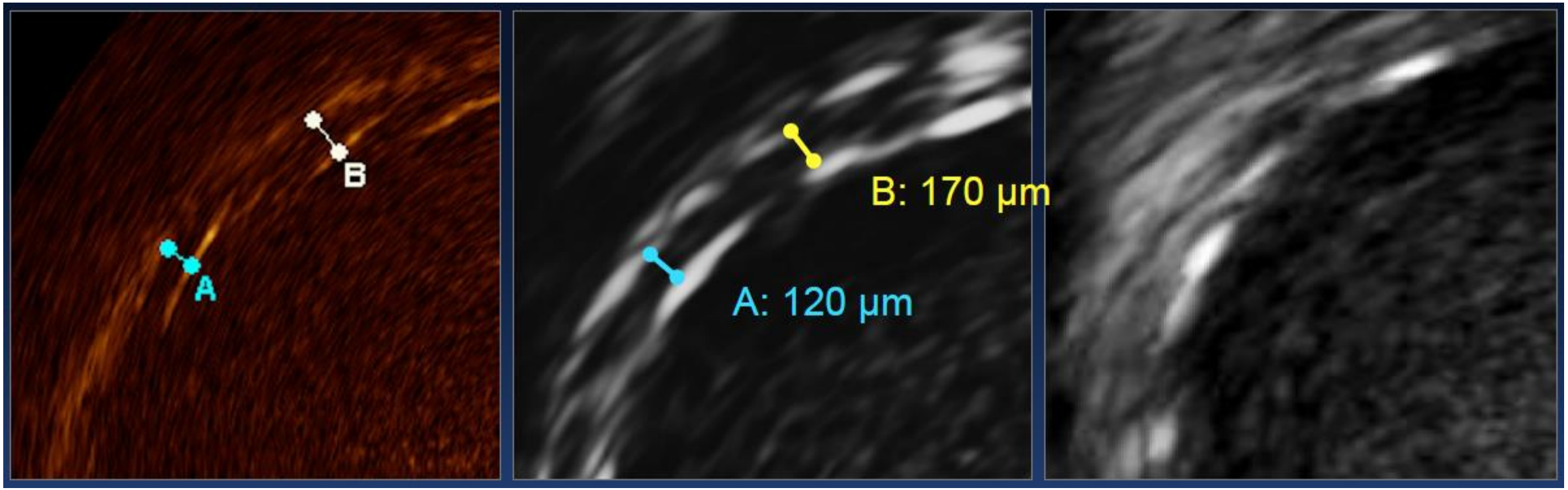

FIM-3, Paraguay Pt24
Patient ID: 01-024
loop0001
Mon Jun 11 2012
19:58:48
Frame: 6400/6713
40MHz
DIA:8 mm
GRAT: 1.0mm
SVMI Med Center

60MHz


FIM-3, Paraguay Pt24
Patient ID: 01-024
loop0002
Mon Jun 11 2012
20:03:20
Frame: 1499/7033
60MHz
DIA:8 mm
GRAT: 1.0mm
SVMI Med Center


FIM-3, Paraguay Pt24
Patient ID: 01-024
loop0002
Mon Jun 11 2012
20:03:20
Frame: 6619/7033
60MHz
DIA:8 mm
GRAT: 1.0mm
SVMI Med Center

Stent Apposition: In Vivo Comparison



OCT
(with flush)

HD-IVUS 50 MHz
(in blood)

IVUS 40MHz
(in blood)

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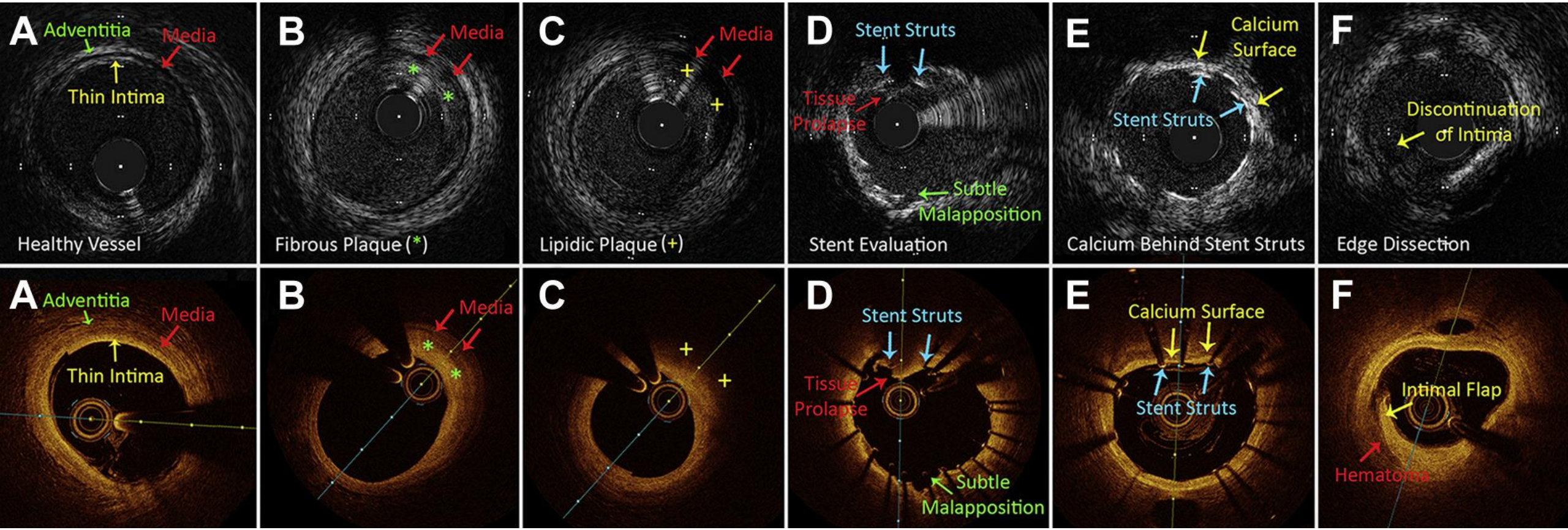
Imaging Comparisons of Coregistered Native and Stented Coronary Segments by High-Definition 60-MHz IVUS & OCT



Images in Intervention

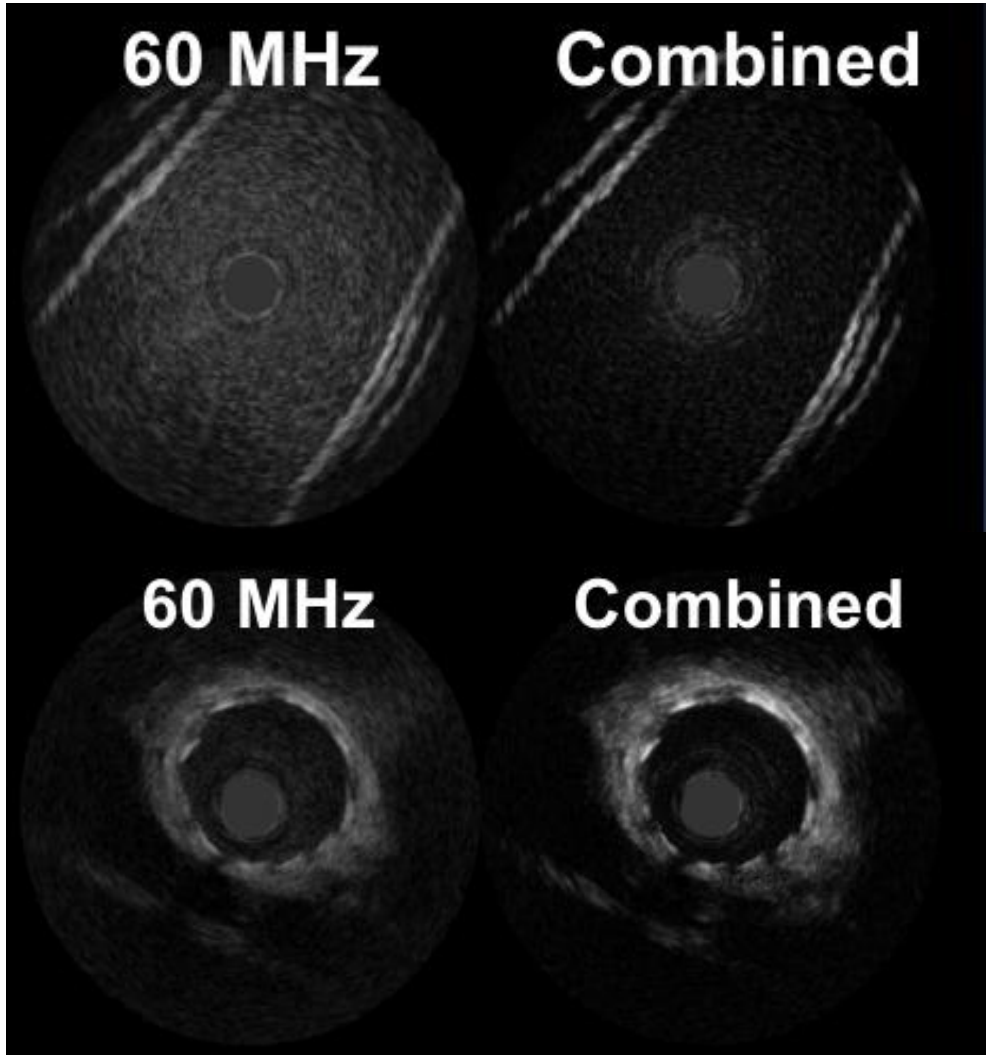
Chin et al, JACC Cardiovasc Interv. 2016;9:1305-1306

Combining Ultrasound Frequencies

Combining high and low frequency ultrasound imaging provides
a high resolution image of the vessel wall, combined with a dark lumen

Blood-Mimicking Fluid Phantom

Porcine Model with Stent



ARiA 2017

Alliance for Revolution and Interventional Cardiology Advancement

2017/11/24 16:20—18:20: ARiA imaging session

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Korea Cardiovascular Interventional Imaging Forum

ARiA 2017

Alliance for Revolution and Interventional Cardiology Advancement

2017/11/24 16:20—18:20: ARiA imaging session

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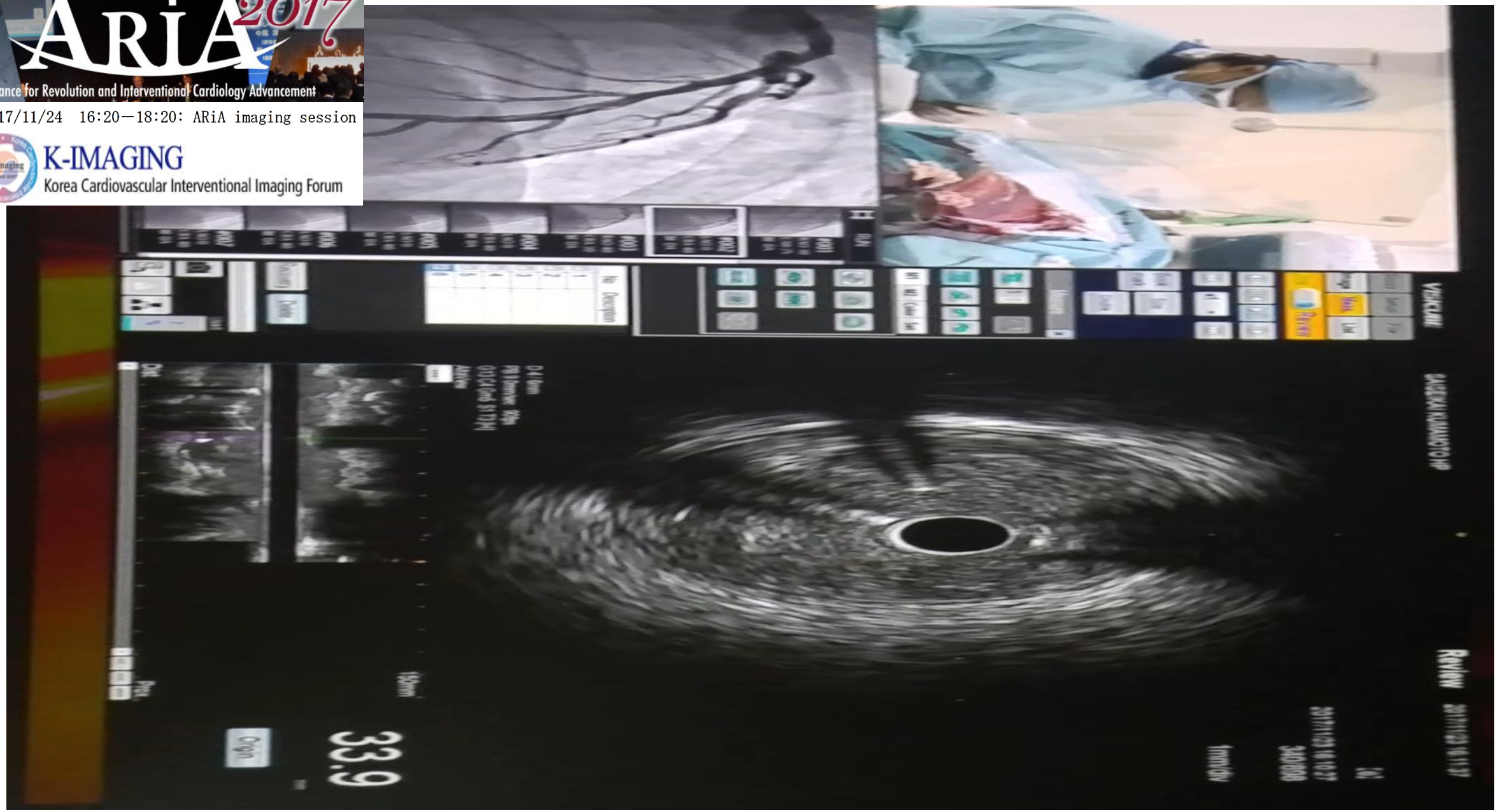

6 Ways to be Happier at PCI

① **Practice looking for the good**
keep a daily "gratitude list"

② **Have some fun [IVUS]**
think more clearly and creatively

③**Brighten your office space**
surround your desk with pictures and objects toward positive thoughts

④**Keep a Journal**
simple act of putting emotions into words immediately

⑤**Invest in People**
small start by reaching out to just one person a day

⑥**Think of work as a series of sprints, not a marathon**
short sprints of 90-120 minutes each, with a 5-minute break
jump in your concentration and productivity

Fisher, A. (2009) 6 ways to be happier at work, *Fortune*

EURO CHORUS 14-16 MARCH 2018
Hôtel du département STRASBOURG France

Summary

High-definition 60-MHz IVUS offers **superior spatial resolution**, **faster catheter pull-back** speeds up to 10 mm/s, and **rapid image acquisition** at 60 frames/sec

And HD-IVUS maintains the potential benefits of IVUS over OCT, especially**, greater tissue penetration without the need for luminal blood clearance**.

It's time to level up the use of IVUS.

K-Imaging CHORUS Seoul EURO CHORUS 14-16 MARCH 2018

Heart Research Institute
Chung-Ang University Hospital