Clinical Utility of High-Resolution IVUS

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Conflict of Interest Disclosure

- Akiko Maehara
  - Personal: Consultant for ACIST, Boston Scientific Corporation, Speaker for St Jude Medical
  - Cardiovascular Research Foundation: Boston Scientific Corporation

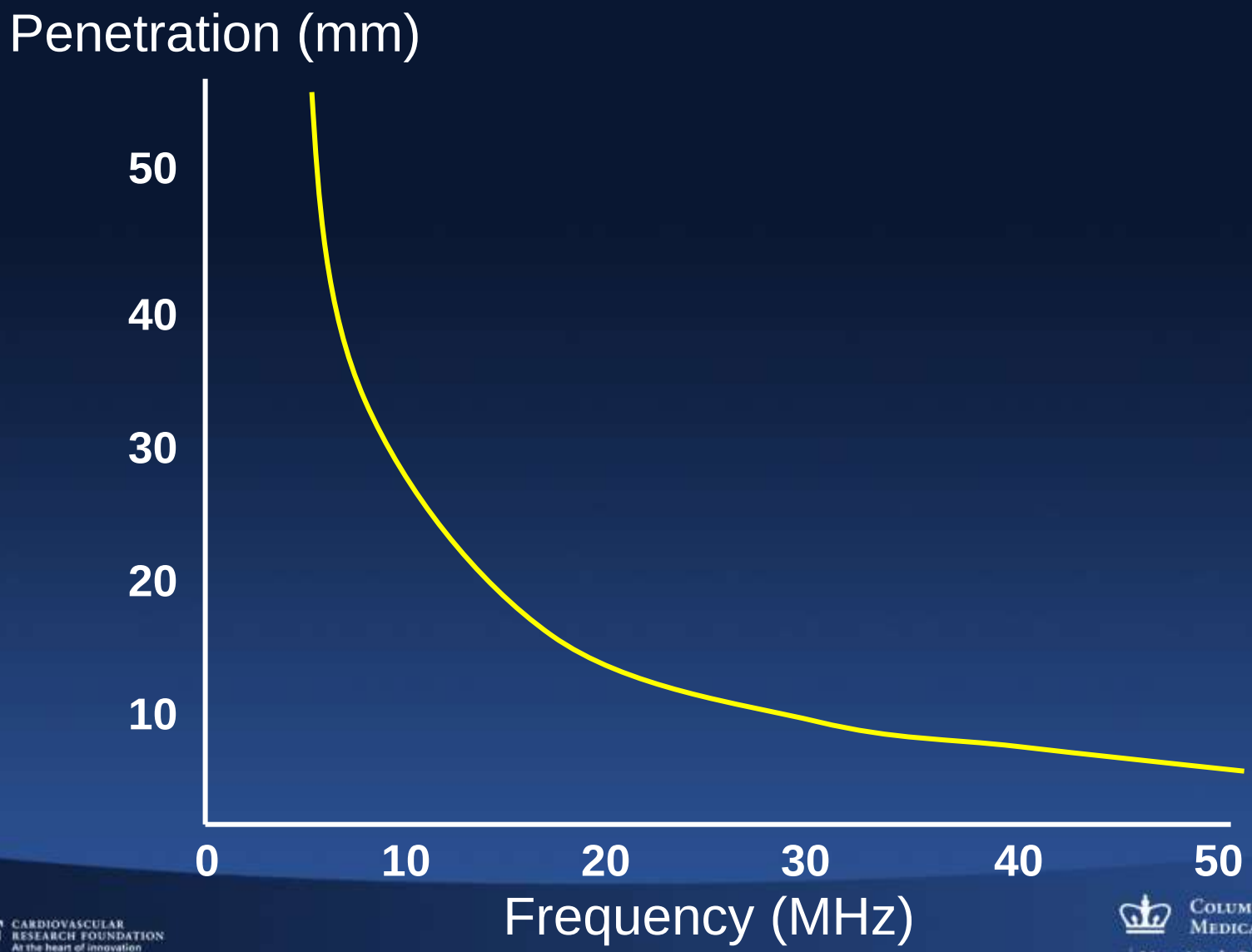
Intravascular Imaging System Comparison

- Angular resolution=1.22 × wave length/diameter of lens
- Frequency= speed of wave / wave length

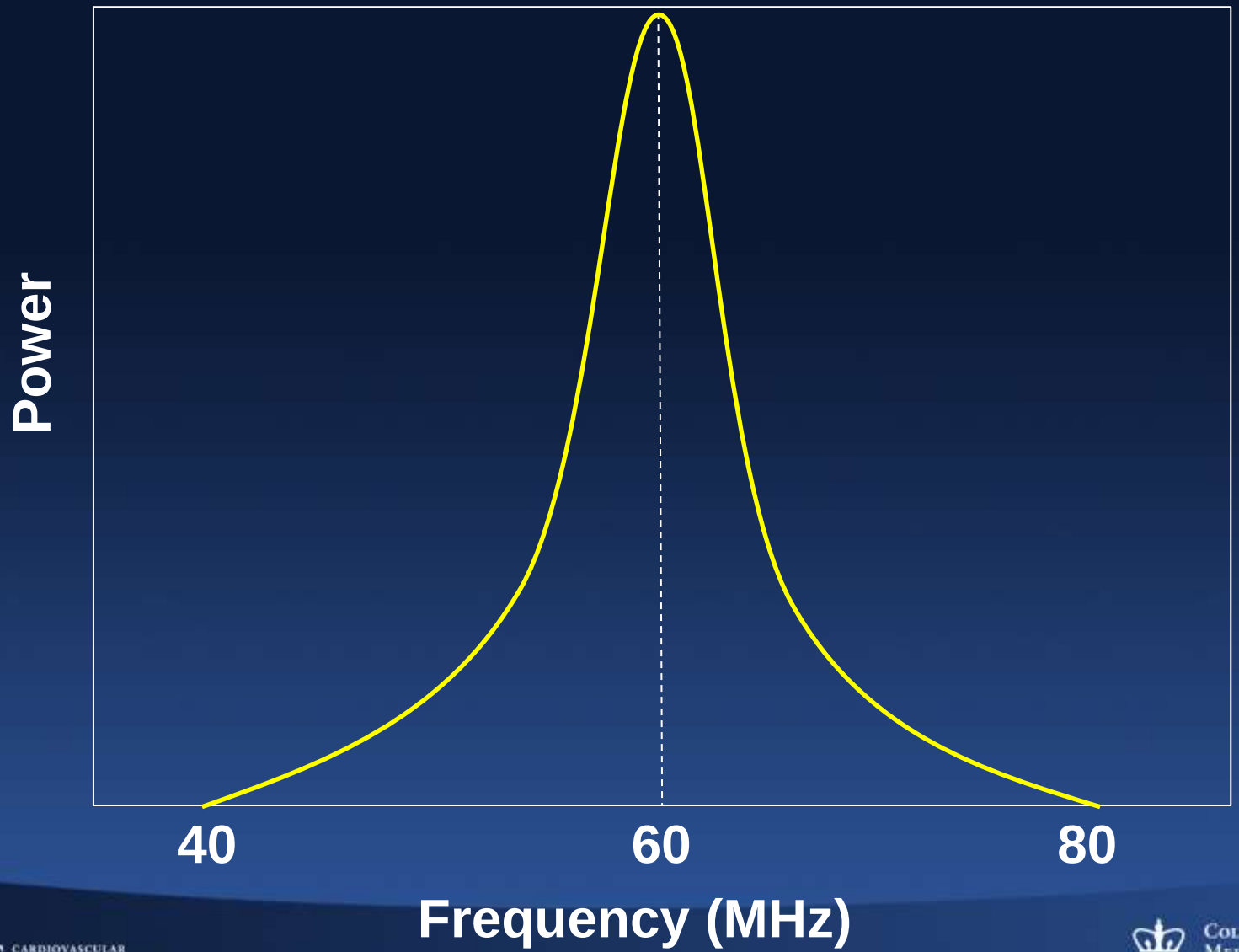
Feature	ACIST HDi / Kodama	Boston Scientific	Volcano FACT	InfraReDx	St Jude Medical OCT
Frequency or Wavelength	60 MHz	60 MHz	Not available	50 MHz	1.3 µm
Nature of the Energy	Ultrasound				Optical
Axial Resolution	40 µm	22 µm	<50 µm	20 µm	15 µm
Lateral Resolution	90 µm	50-140 µm	100-200 µm	<200 µm	40 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

* Soft Tissue Penetration with contrast injection to achieve blood clearing.

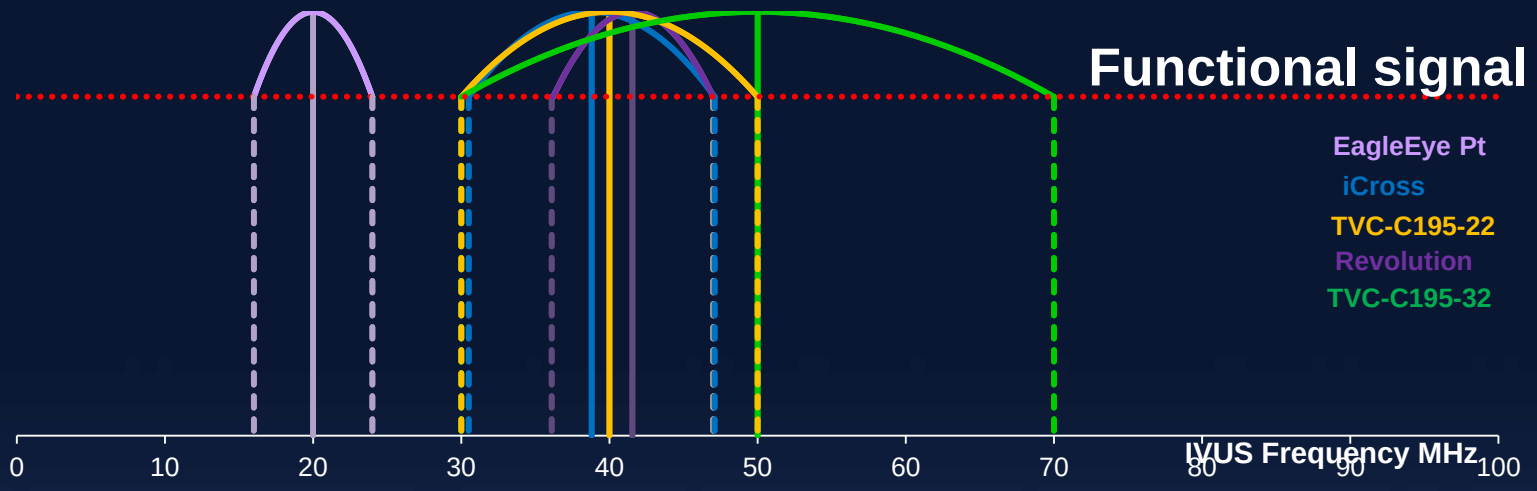
Frequency and Penetration



Power Spectrum of Wave



Center Frequency and Bandwidths



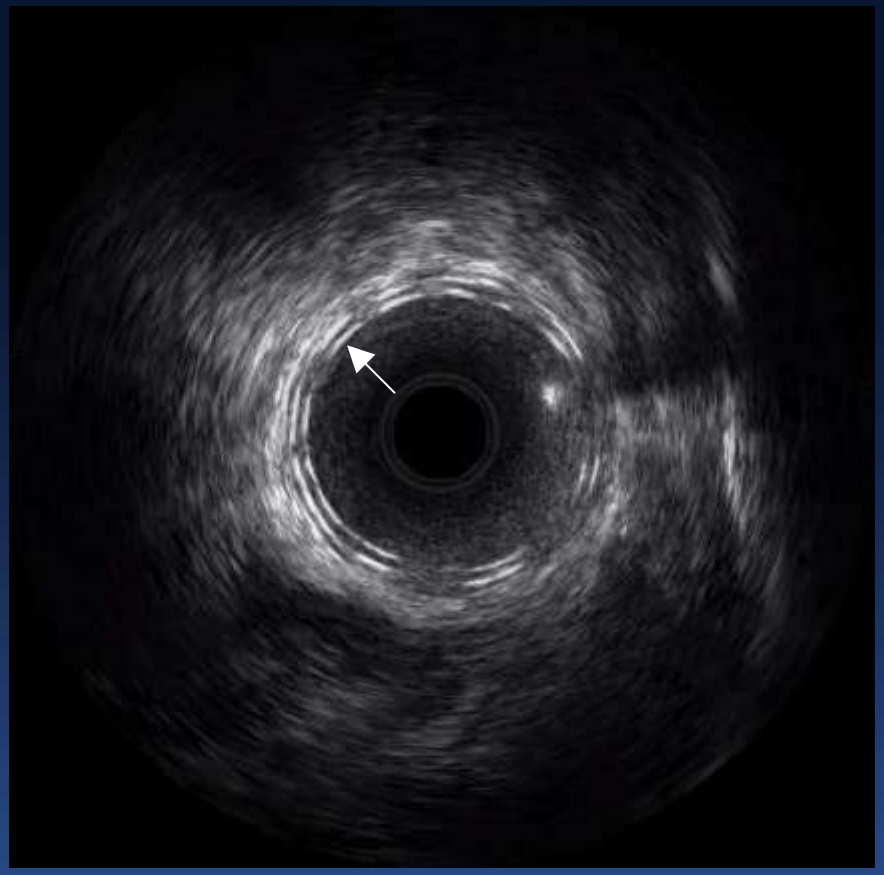
Catheter	Label Freq.	Center Frequency	Approx Functional Bandwidth	Approx. Functional IVUS Range	Calculated Axial Resolution*
VOLCANO Eagle Eye	20 MHz	20 MHz	40%	16-24 MHz	< 170 microns
VOLCANO Revolution	45 MHz	41.5 MHz	27%	36-47 MHz	50 microns
BSC iCross / Opticross	40 MHz	38.8 MHz	43%	30-47 MHz	43/38 microns
Infraredx Insight (TVC-C195-22)	40 MHz	39.5 MHz	50%	30-50 MHz	40 microns
Infraredx Muller (TVC-C195-32)	50 MHz	50.0 MHz	80%	30-70 MHz	20 microns

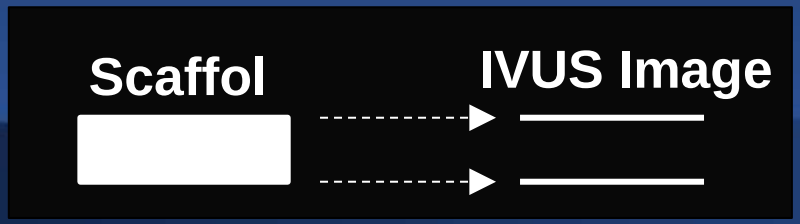
***Theoretical estimates based on design**:
http://users.tpg.com.au/mcgrath_/Calculators/Axial_Resolution_Calculator.htm

Boston Scientific: 60MHz IVUS

Metal Stent

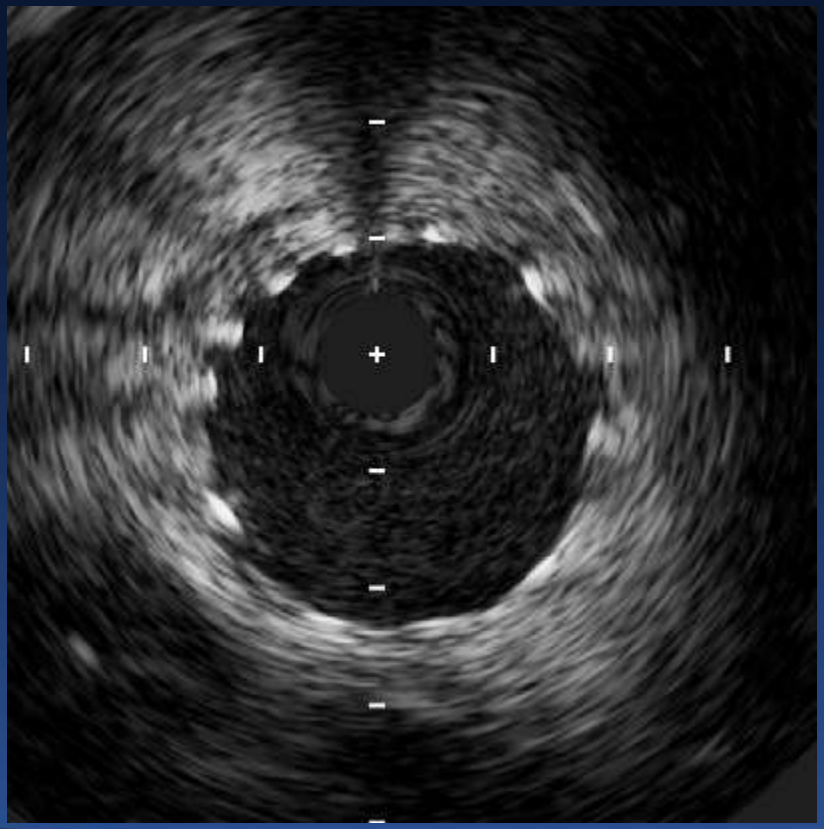
Scaffold





Volcano: Focused Acoustic Computed Tomography (FACT)

Metal Stent



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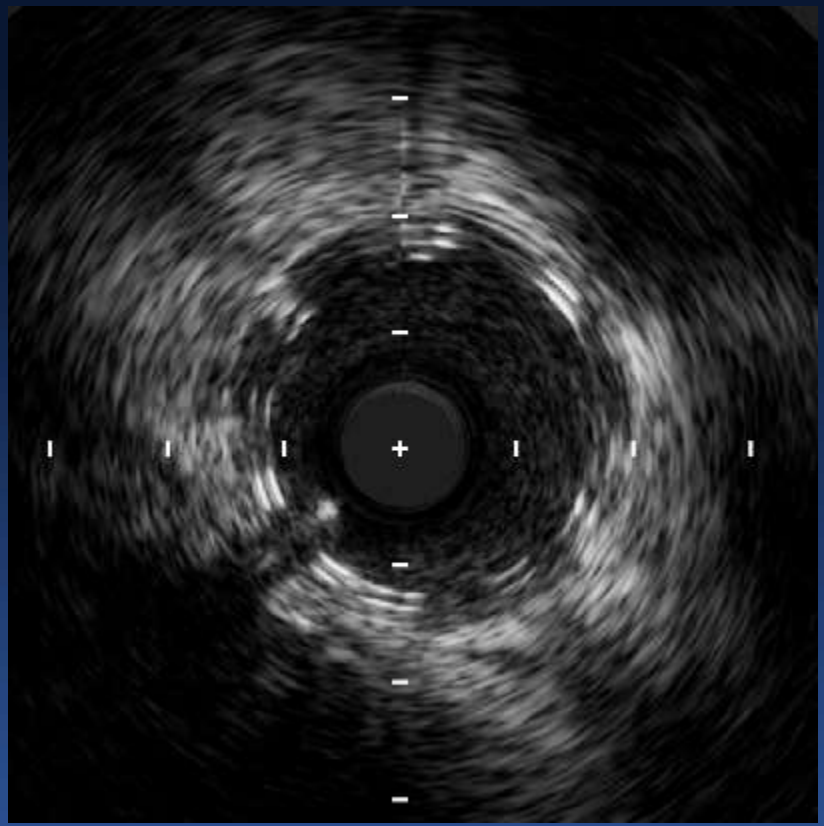
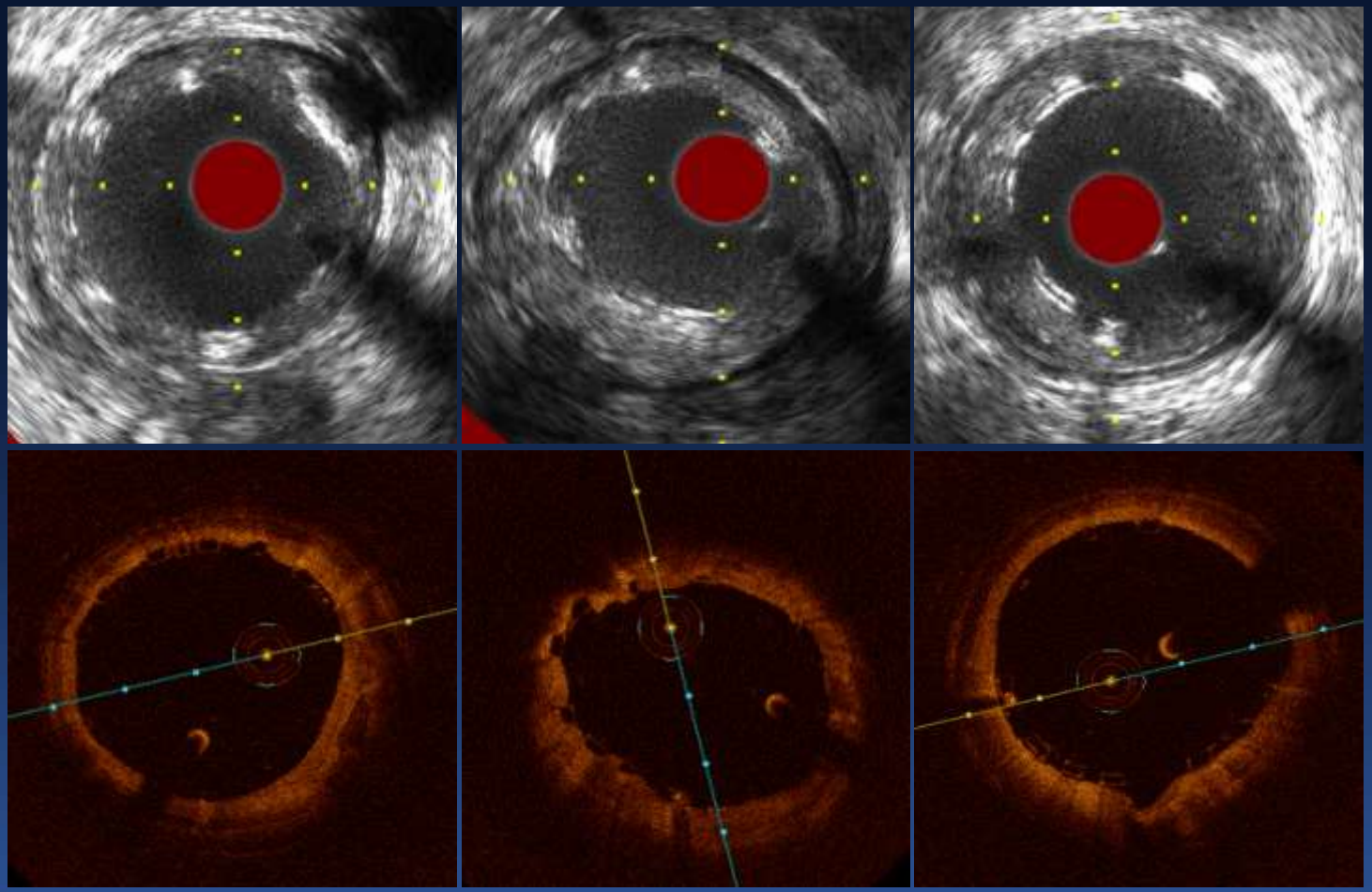
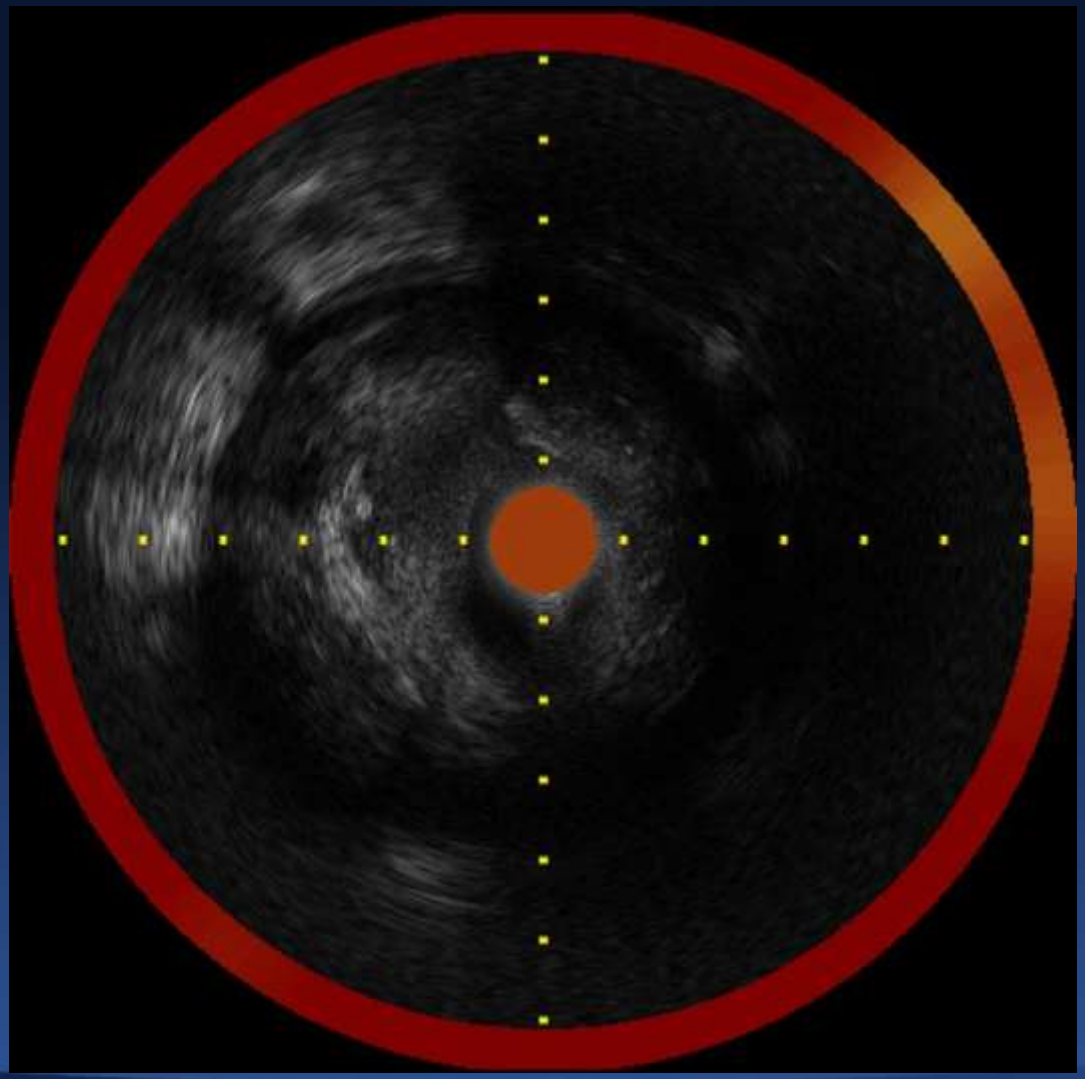


Under Development

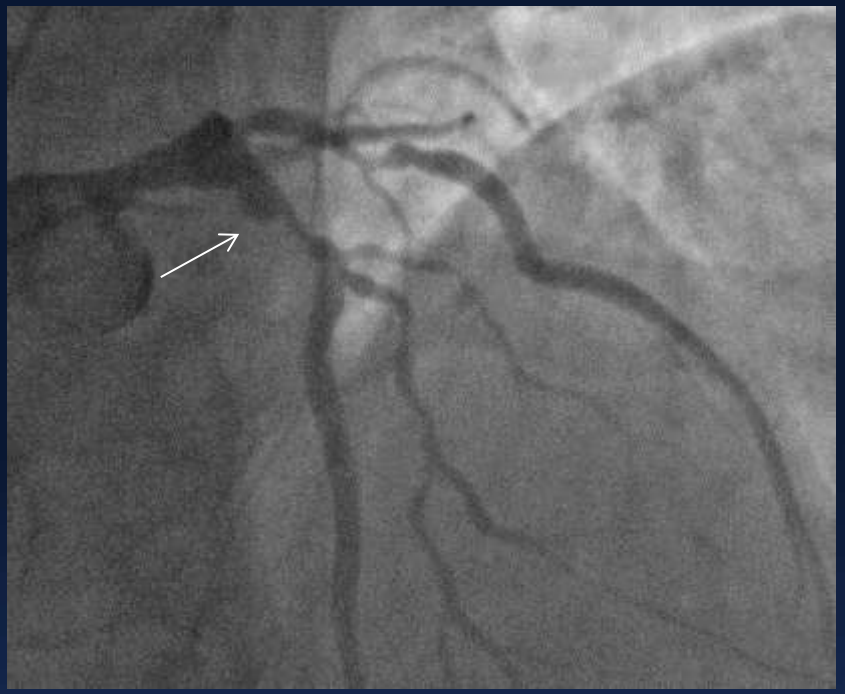
InfraReDx: HD IVUS vs OCT BRS



InfraReDx: 50MHz IVUS in Human



InfraReDx: 50MHz IVUS Plaque rupture



proximal

dista
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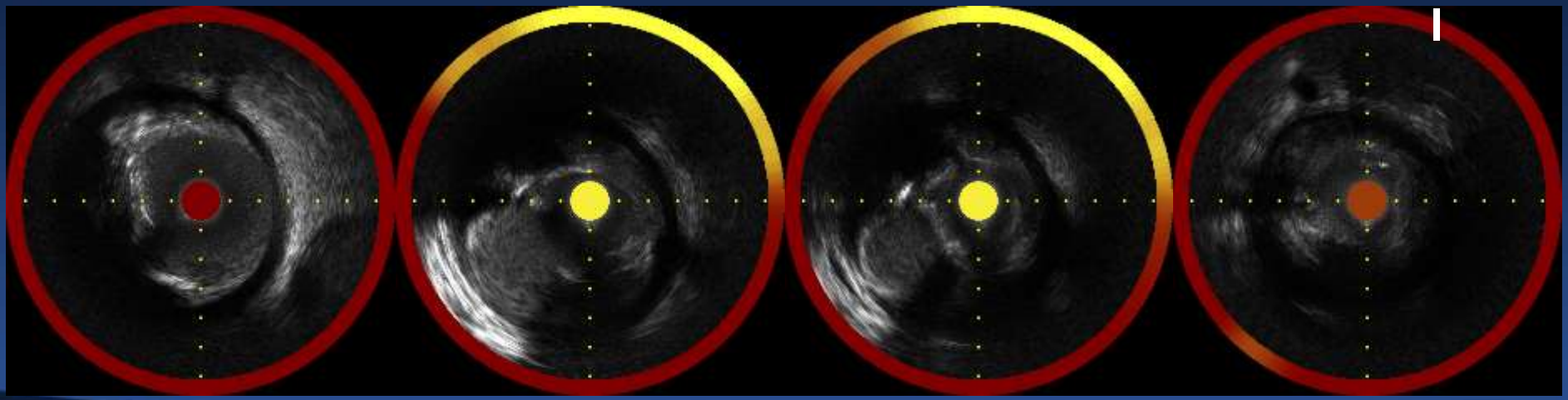
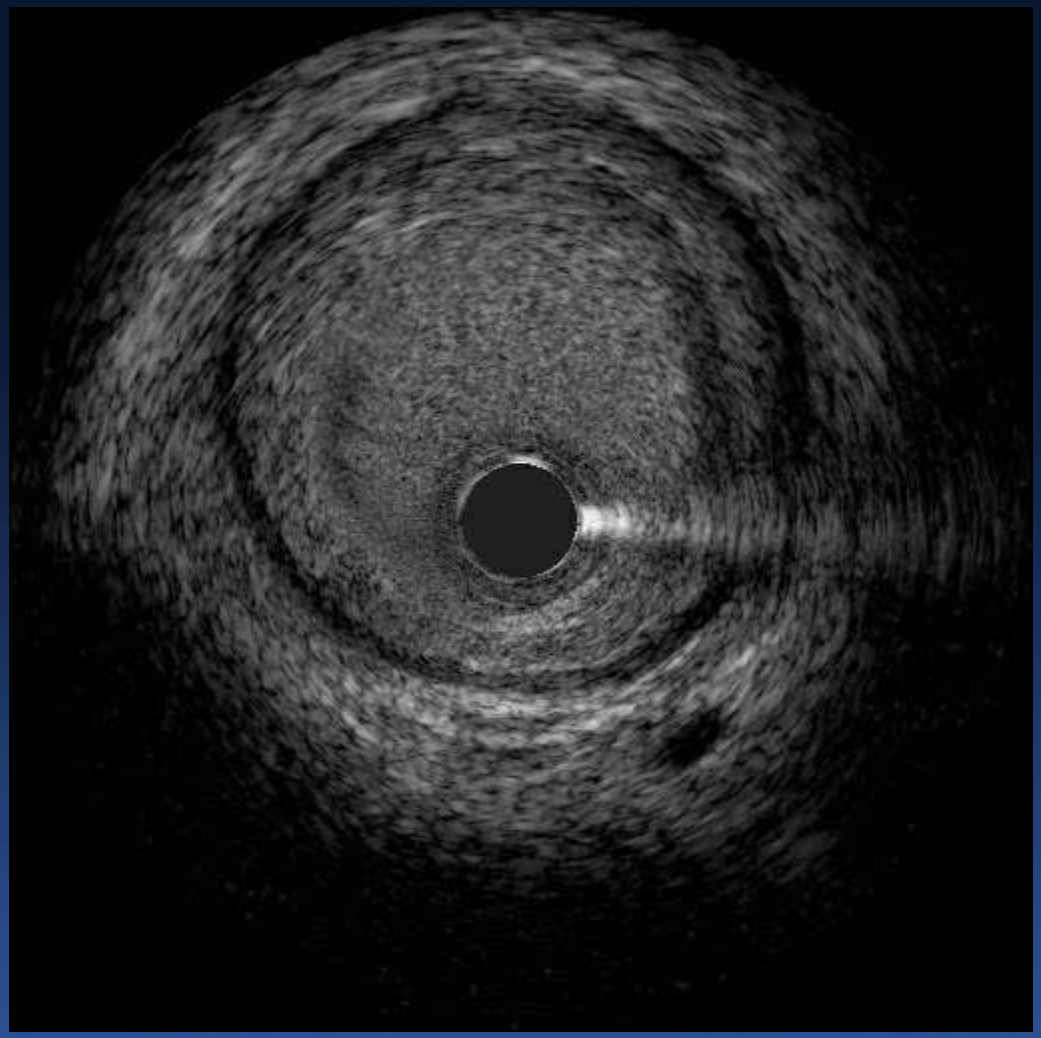
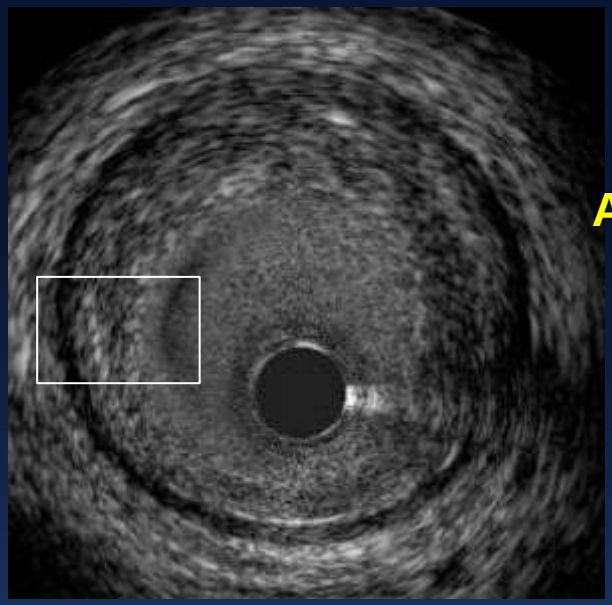
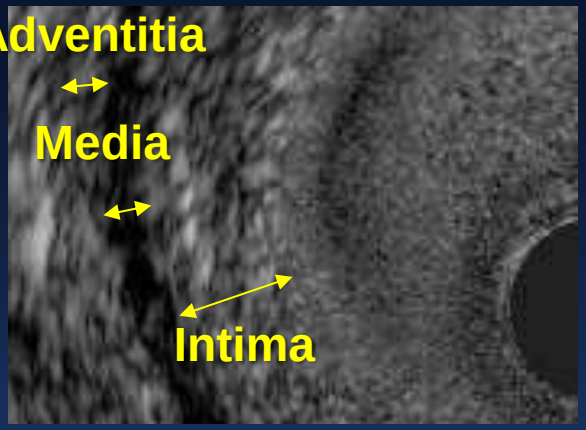


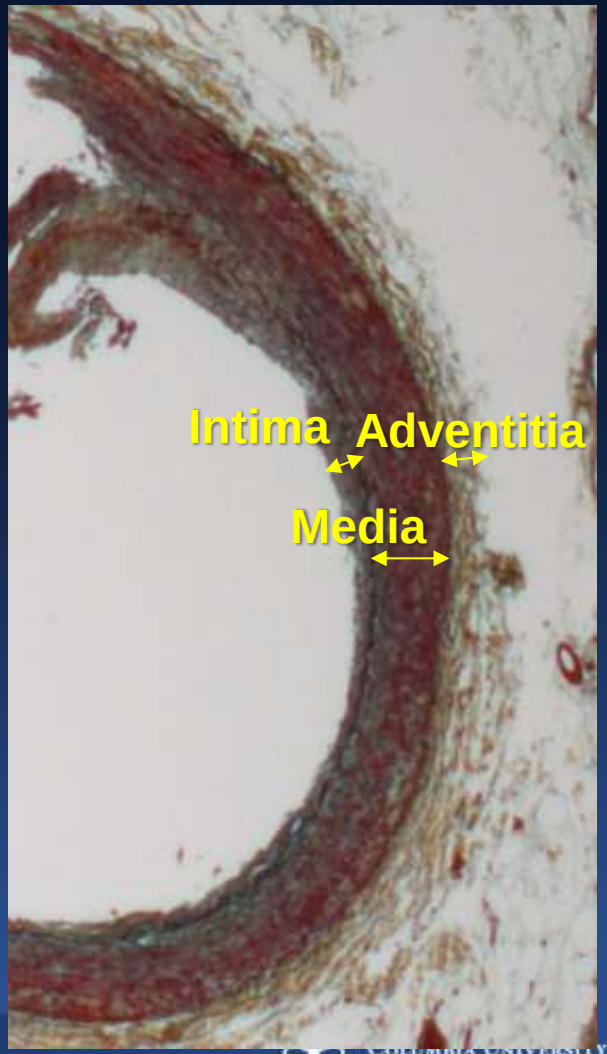
ACIST 60MHz IVUS



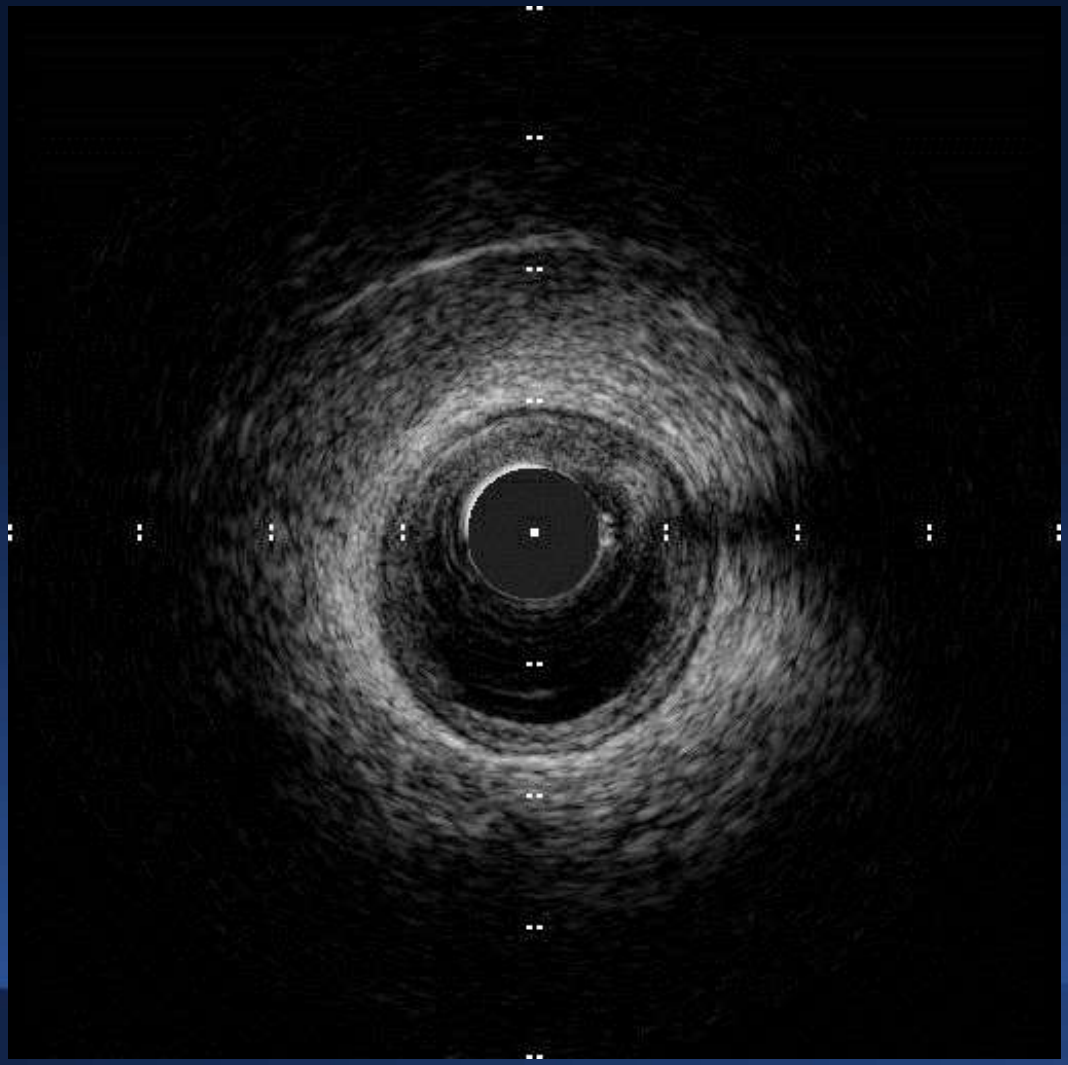
Three Layers Appearance

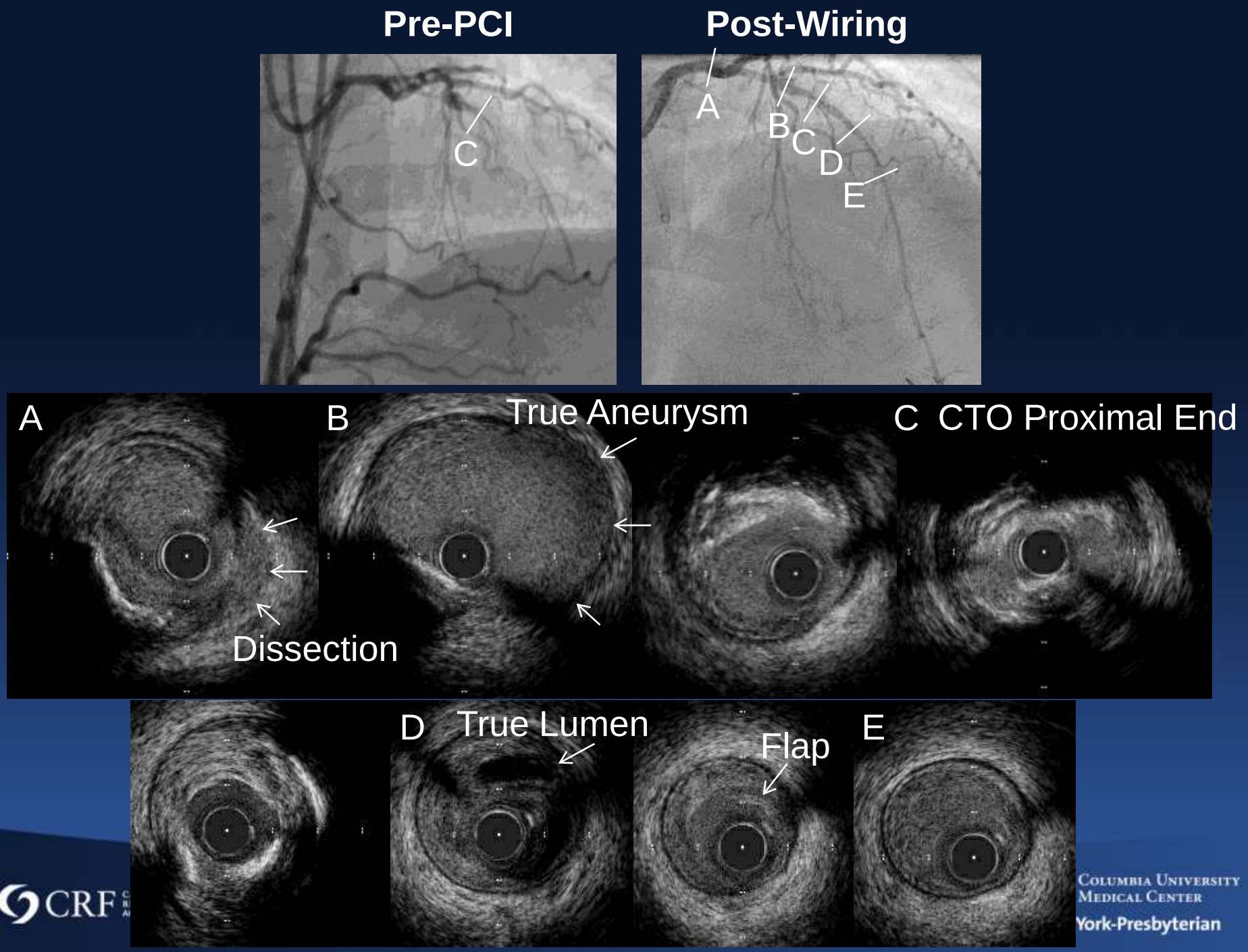






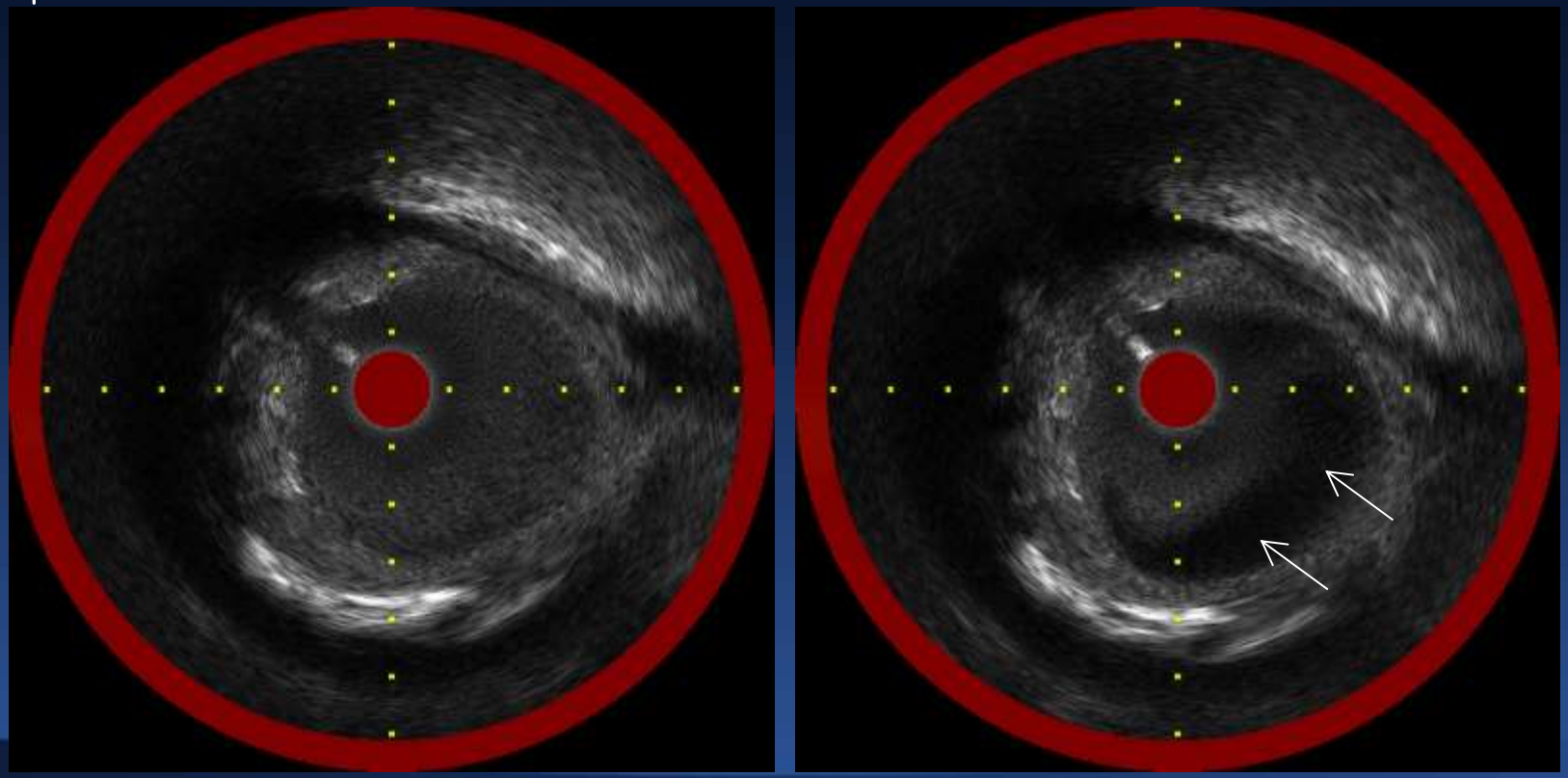
High Speed Pullback (10mm/sec) with Flushing



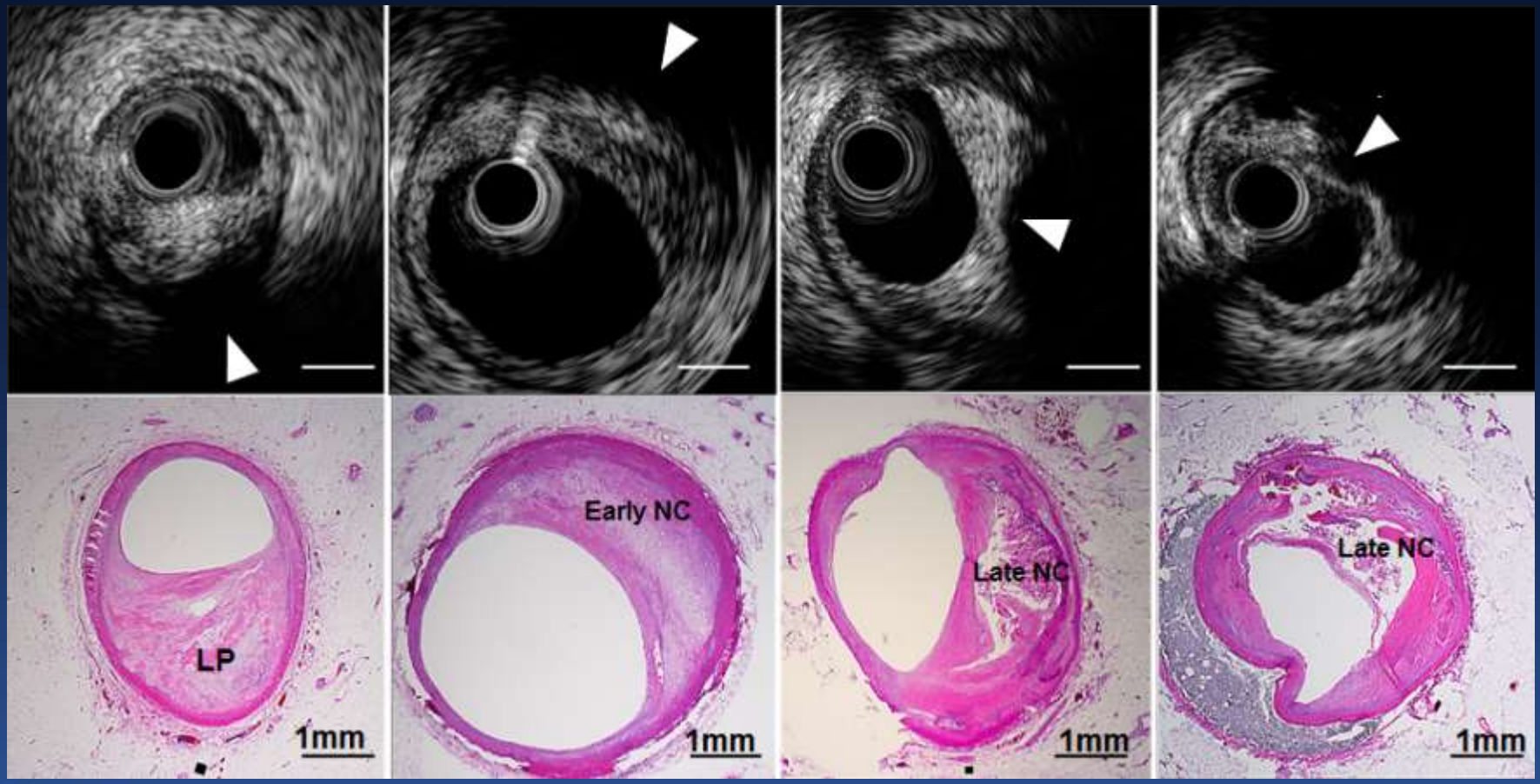


Phase Cancellation Signal Processing Artifact

RF averaging across multiple A-lines over a period of around 25 microseconds. If during this averaging period, the target moves slightly, this slight position change results in a 180 degree phase shift of the RF signal so that cancellation occurs and the black region is present.

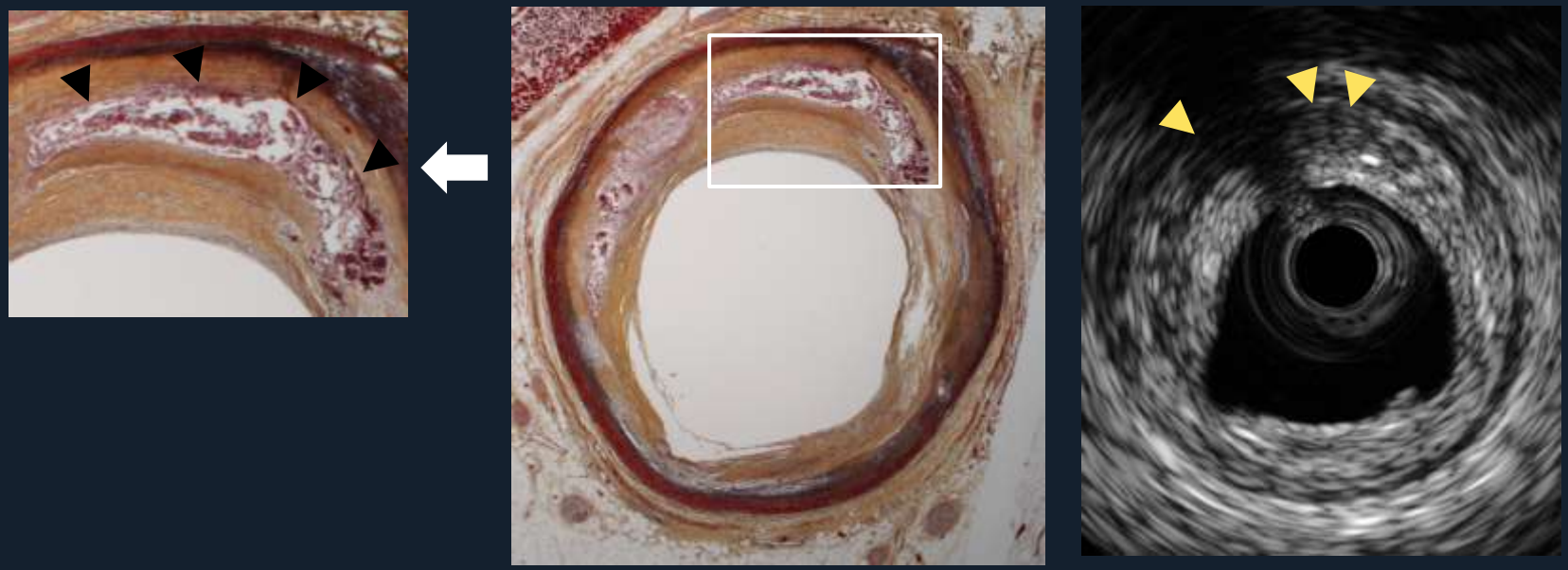


Attenuated Plaque (Superficial, Deep)



Pu J, et al. JACC 2014;63:2220-33.

Intraplaque hemorrhage



- Pathologic diagnosis : Late fibroatheroma
- IVUS diagnosis : Ecolucent plaque
- Plaque burden = 67.6 %
- Echolucent burden = 17.6 %

Matsumura M, et al. TCT 2014

Summary

1. New generation of high definition (frequency) of IVUS will provide better resolution (close to OCT) with clinically enough penetration (vessel size evaluation is possible).
2. Evaluation of scaffold is useful.
3. Understanding of plaque vulnerability (intraplaque hemorrhage, thin-cap fibroatheroma) would be promising.