High Resolution IVUS: What's New and What's Different

Gary S. Mintz, MD

Cardiovascular Research Foundation

- **IVUS technology has been clinically available for over 20 years. *Yet. . .***
  - **Image quality has not improved in the last 10 years.**
  - **Poor spatial resolution and catheter-to-catheter imaging inconsistency are problematic.**
  - **Current IVUS systems are not capable of resolving structures <100 µm (and maybe <150µm) in size.**
  - **Poor image quality often requires expert interpretation, inhibits confidence in new users, and is a primary obstacle to maximizing growth and adoption of IVUS technology.**

But what if. . . .

- What if we could start from scratch to design an IVUS system – transducer, catheter, catheter interface, console, etc – using current technology as well as 15 years of knowledge. . . What would this system look like?
- However, building a high-definition image requires optimizing the entire system. Improvements to any one system component (e.g., transducer) may enhance performance, but not optimizing each component of the imaging chain will not yield the targeted improvements.

Four Companies Are Working on Next Generation IVUS Systems

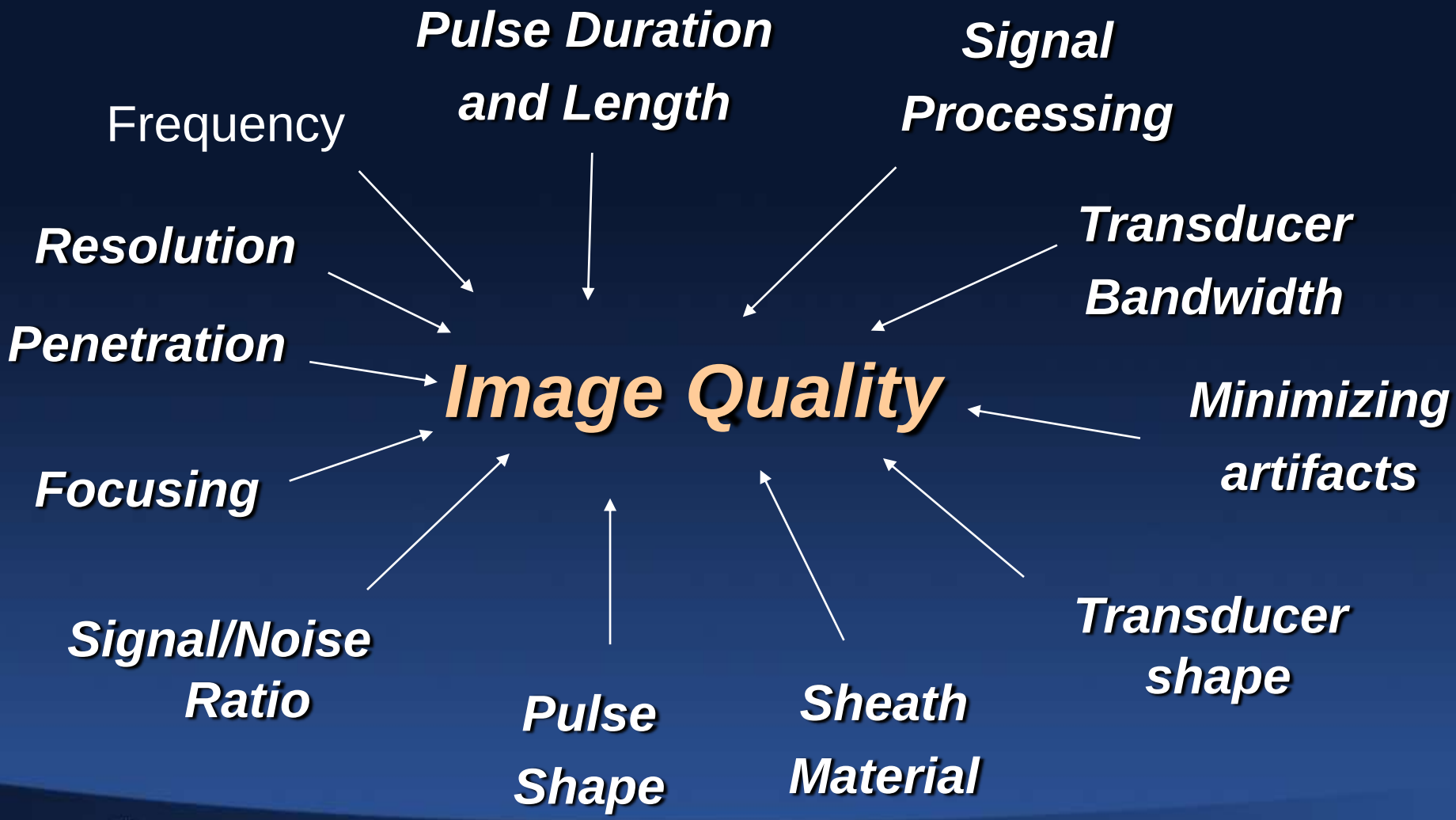
- ACIST (purchased SVMI - has been working on next generation IVUS since 2007)
- BostonScientific
- Volcano
- InfraReDx

Available

Under development

Each is taking a very different approach

What determines image quality?

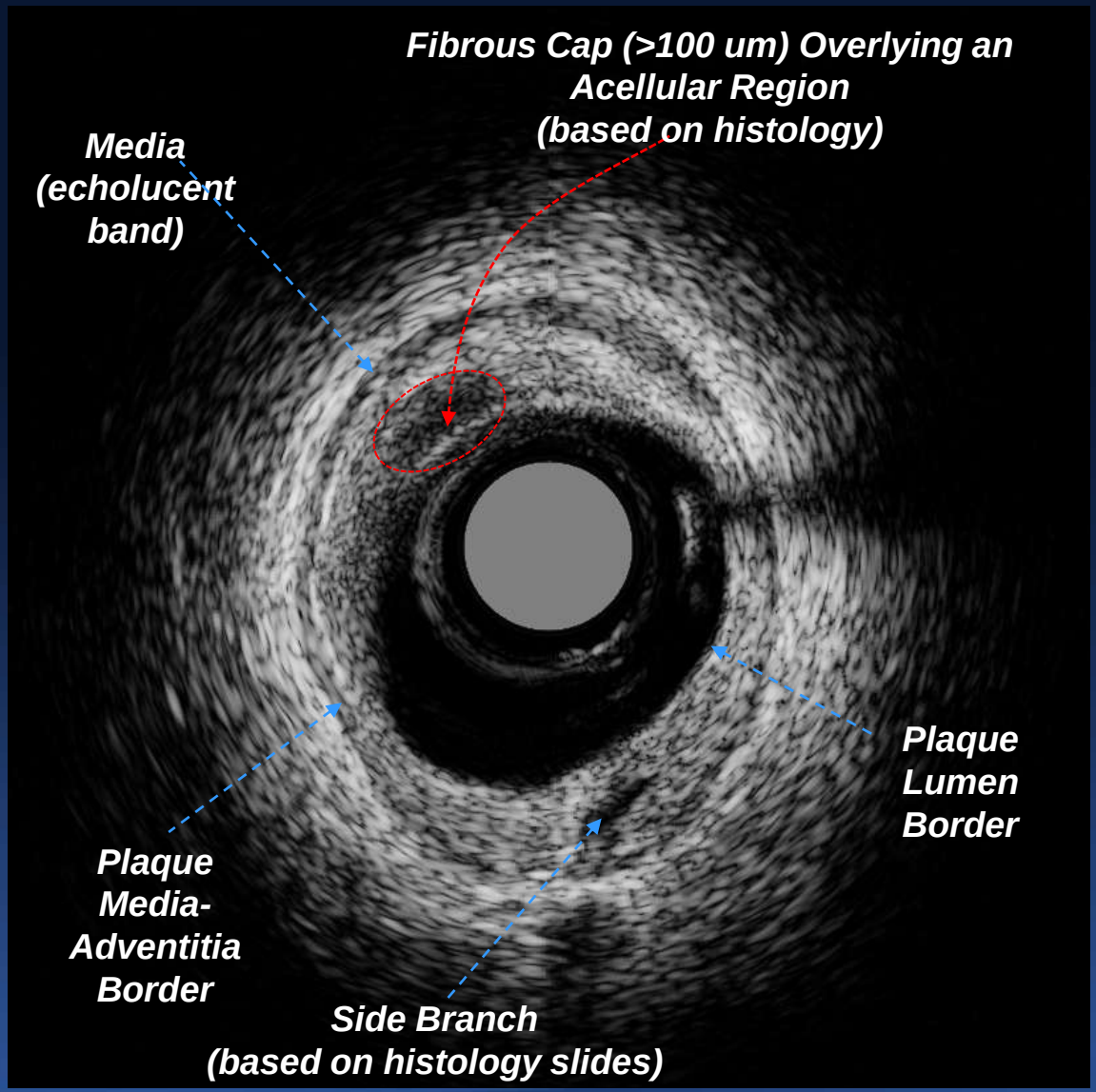


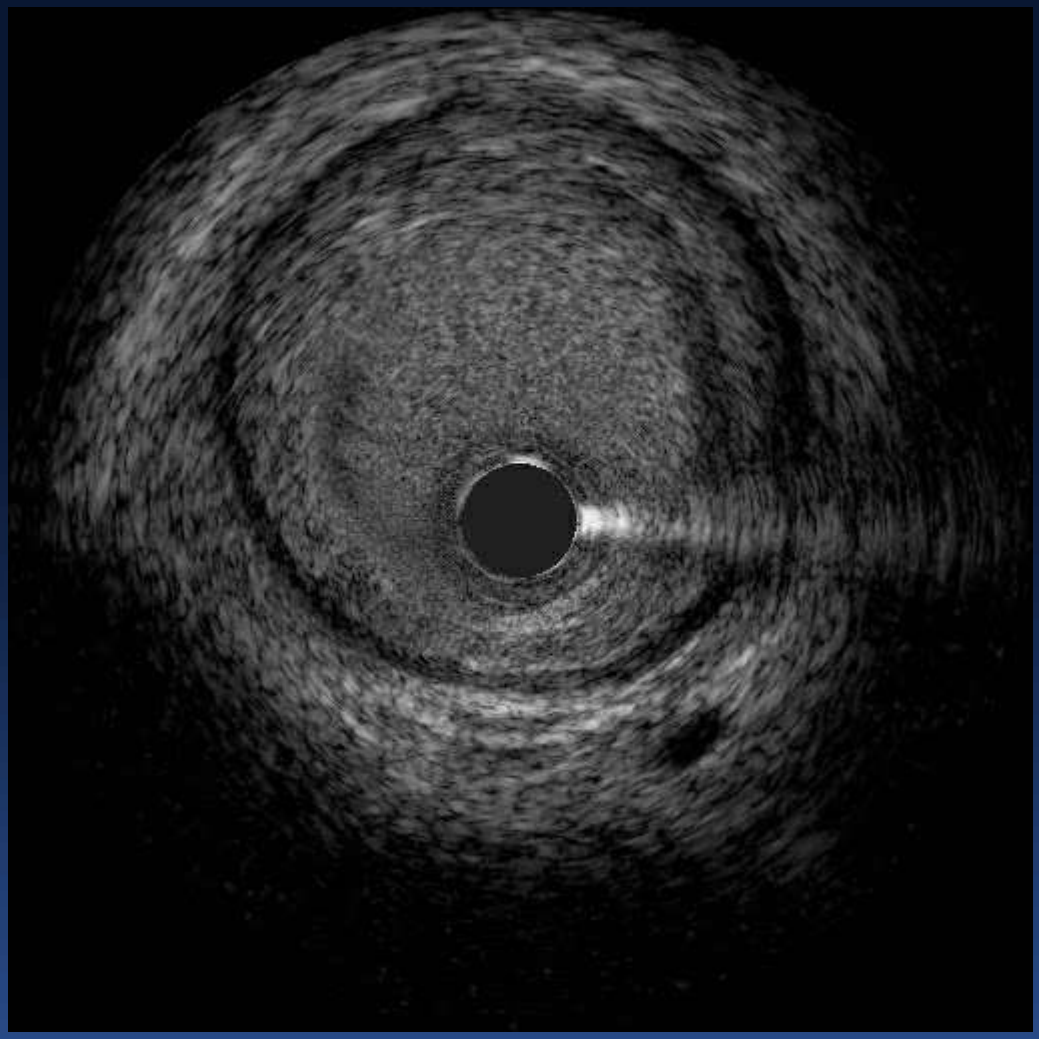
- Catheter improvements
  - Improved handling performance
  - Resolved flushing issues
  - Improved transducer connections
- Improved catheter/system interface
- Reduced image acquisition time
- High performance digital signal processing
- Increase the densities of the number of vectors/frame and image samples/vector.
- Increased frame rates should provide sharp, quick longitudinal views.
- Dual transmit/receive channels

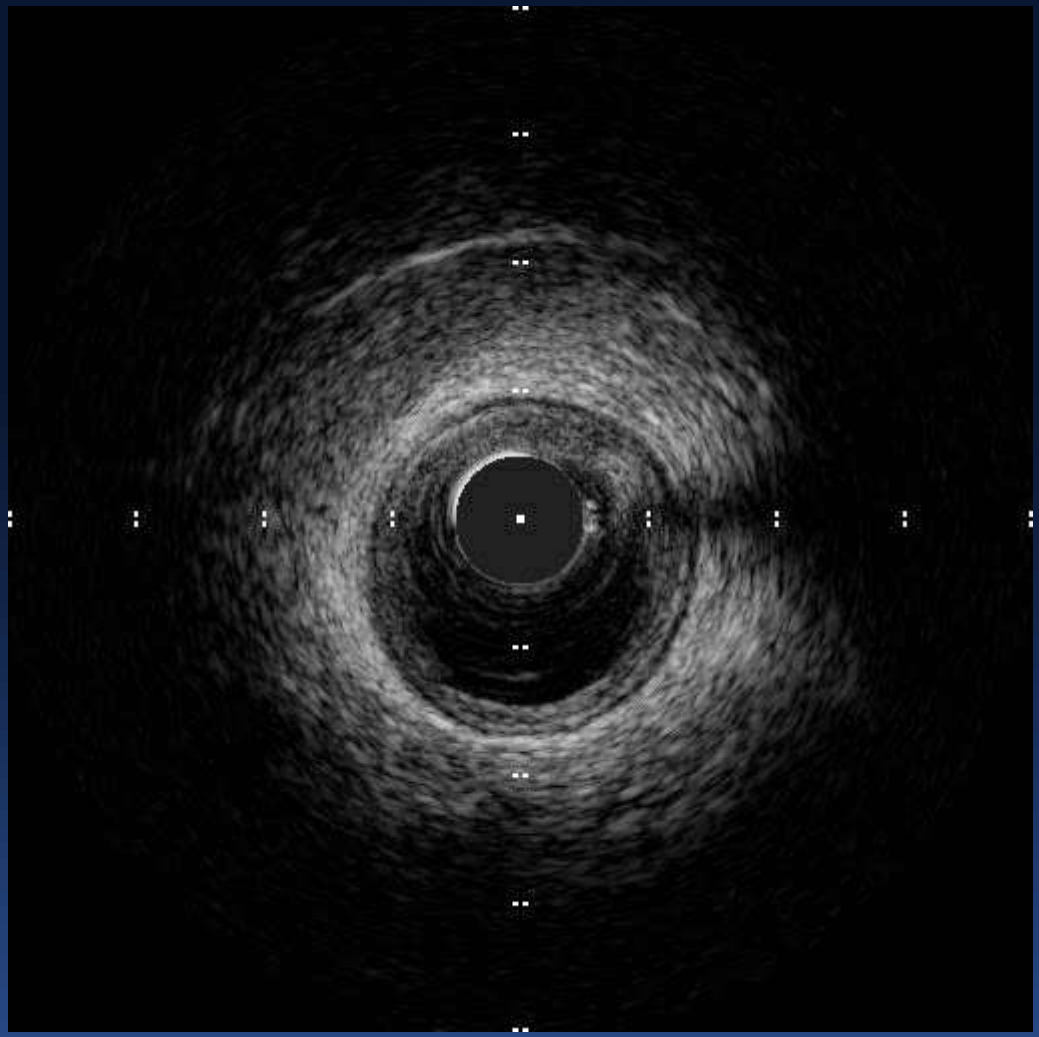
ACIST: HD-IVUS

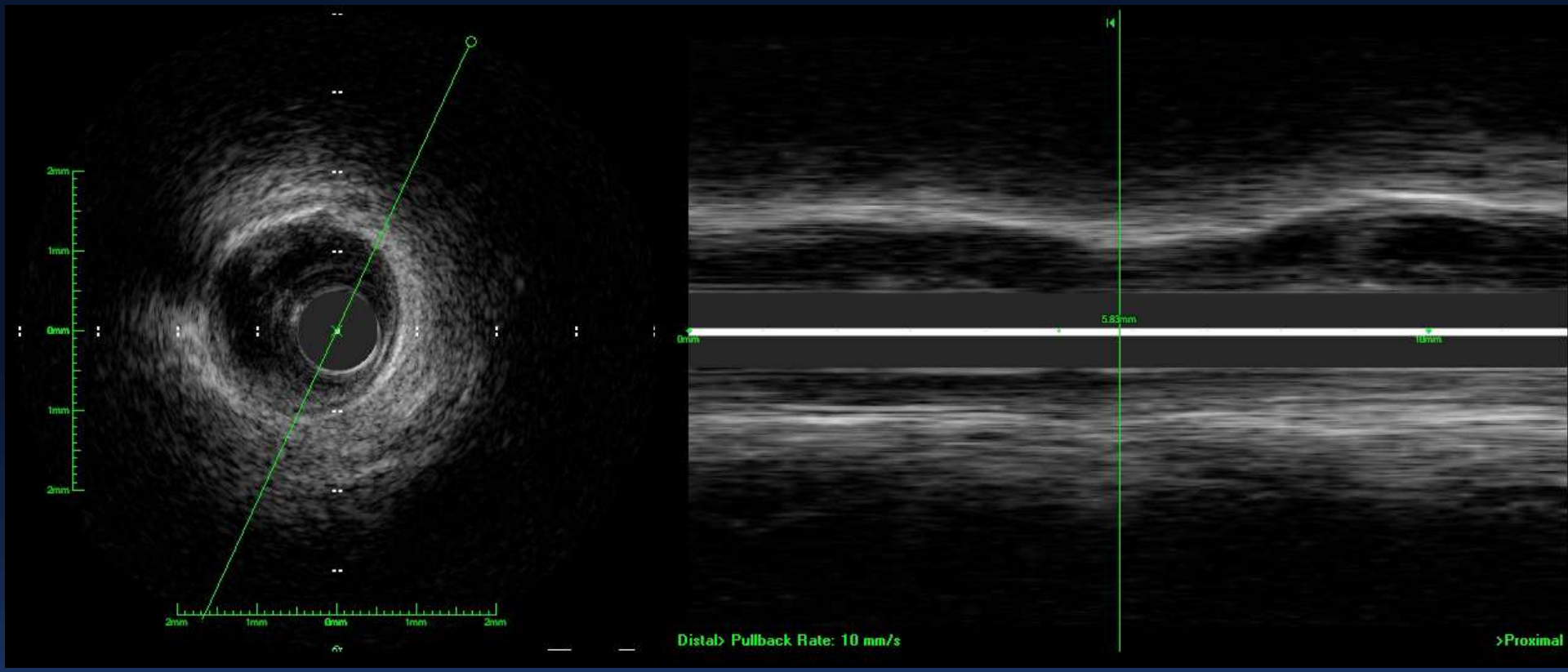
ACIST: HD-IVUS

Axial Resolution	<50 µm
Lateral Resolution	~200 µm
Max. Frame Rate	60 fps
Max. Pullback Speed	10 mm/sec
Frame Spacing	5-167 µm
Pullback length	120 mm
Tissue Penetration	~3 mm @ 60 Mhz
Imaging in Blood	Yes









60MHz @ 60 frame/sec *Acquisition time: 10 sec*

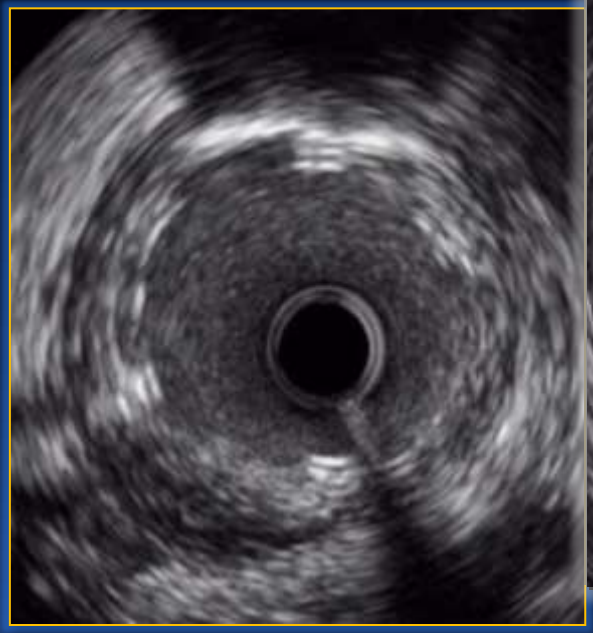
Pullback speed: 10.0 mm/sec *Pullback length: 96mm*

567 Frames acquired (200 viewed) *Frame spacing: 167 µm*

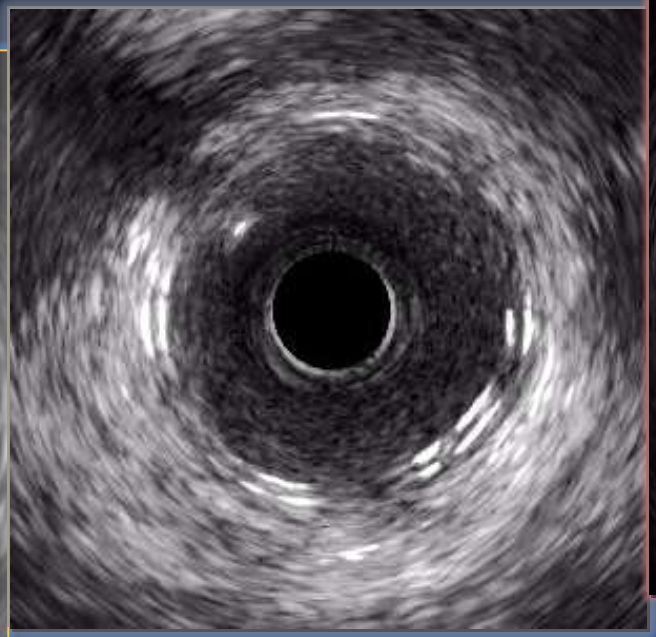
File size: 149 MB (10MB WMV viewed)

BostonScientific: HD-IVUS and Bioresorbable Vascular Scaffolds

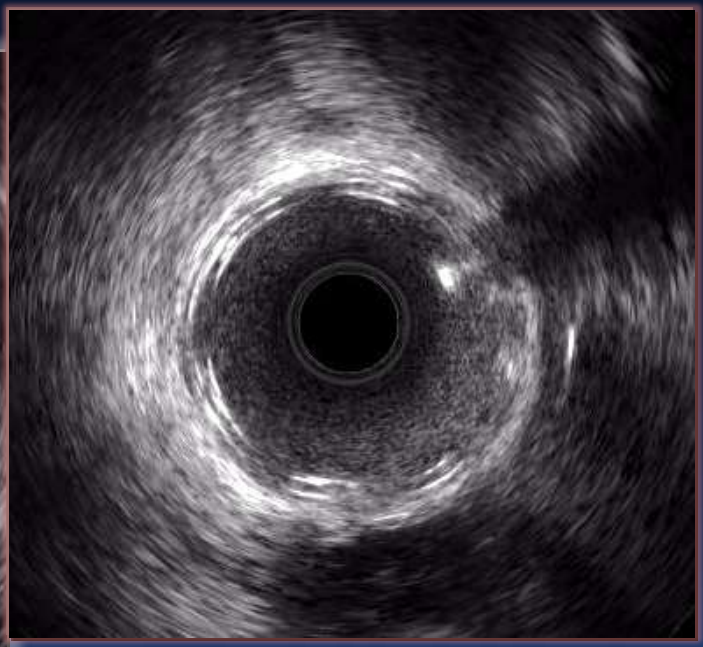
Pro/iCross 40 MHz
43 micron axial



OptiCross 40 MHz
38 micron axial

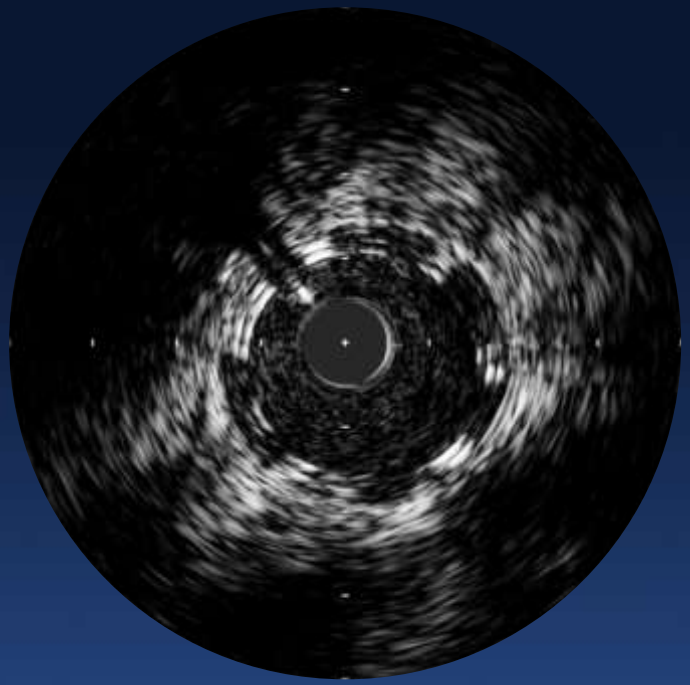


Next Gen IVUS 55 MHz
22 micron axial



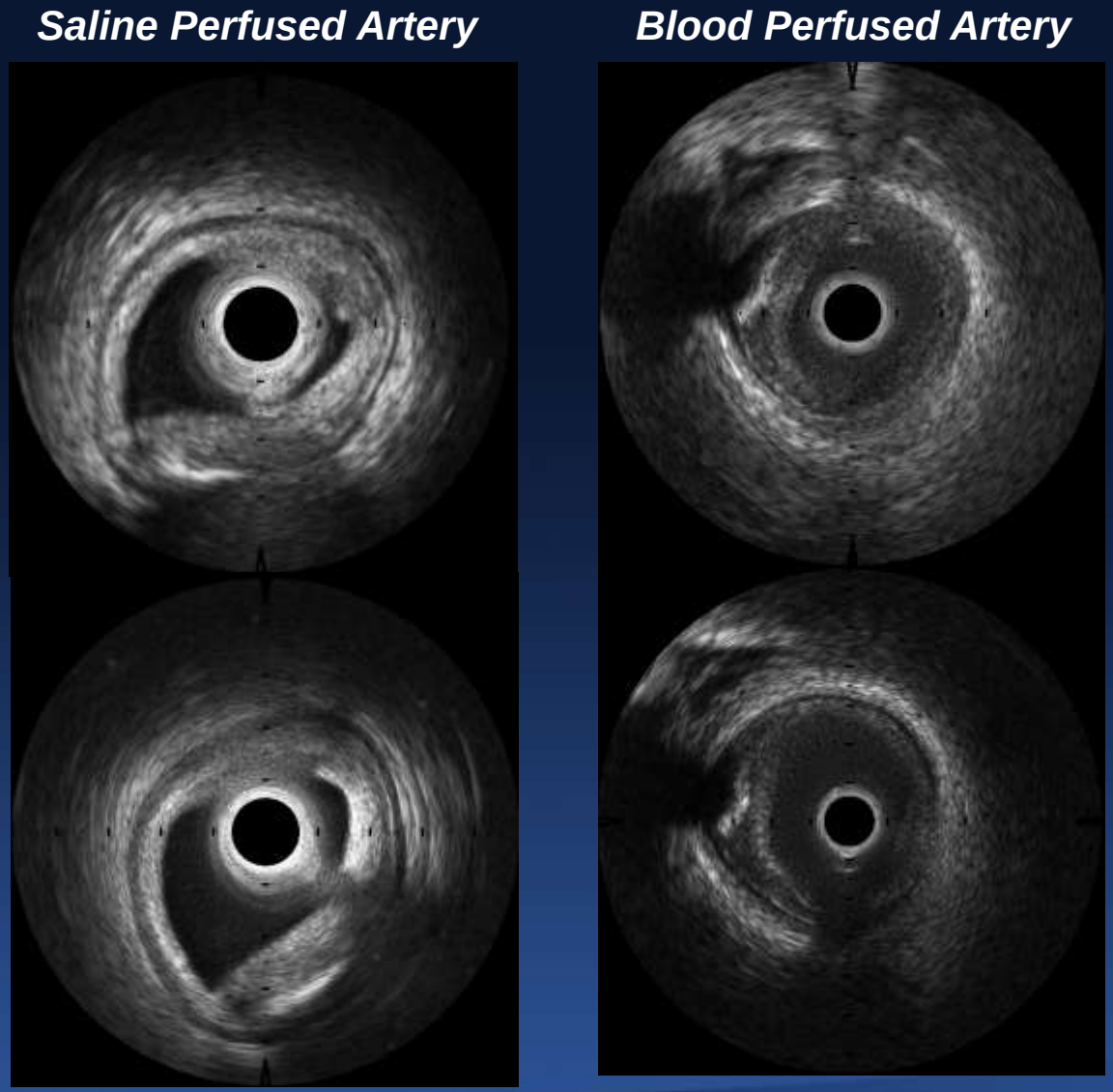
Improving IVUS Resolution without Compromising Penetration

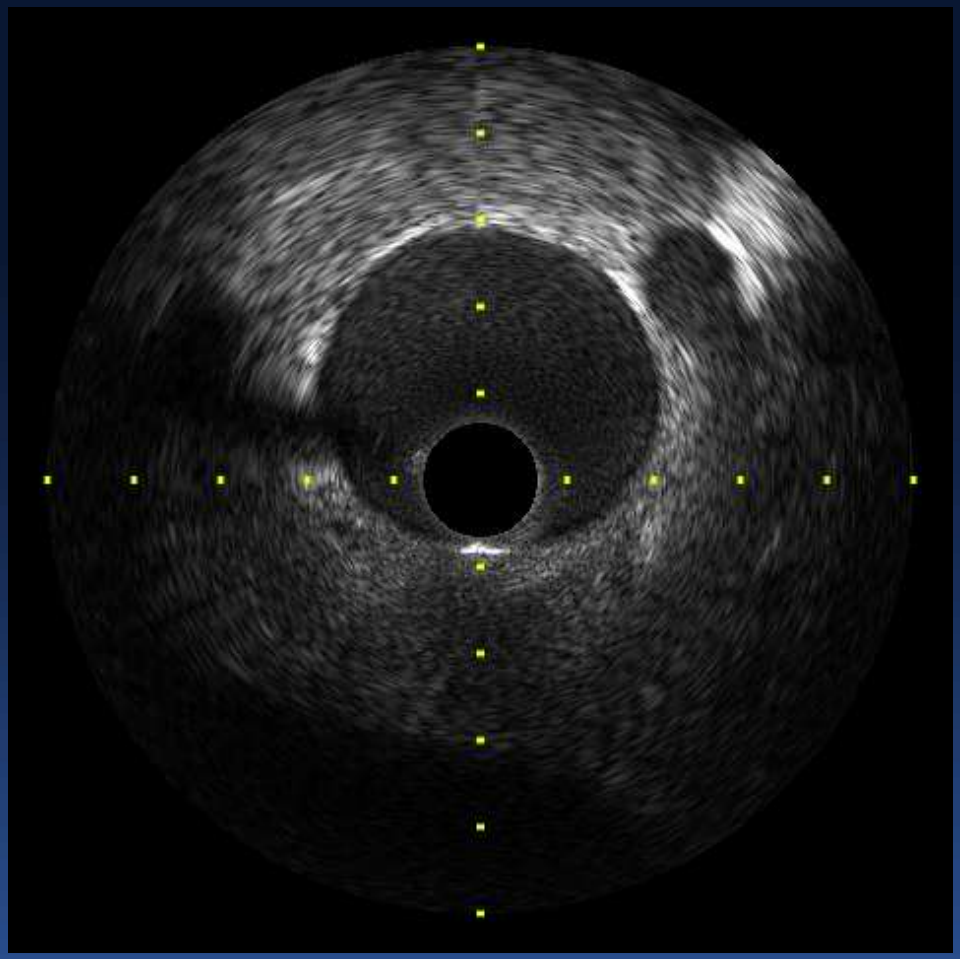
Volcano: FACT (Focused Acoustic Computed Tomography) and Bioresorbable Vascular Scaffolds



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

InfraReDx


Saline Perfused Artery
Blood Perfused Artery
Today
Next Generation



What is new and different?

- **Just about everything except the use of ultrasound**
  - **Better resolution without sacrificing penetration**
  - **Improved system design and user-interface**
  - **More rapid image acquisition**
  - **More accurate longitudinal (L-Mode) reconstruction**