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Research at Center for Fast Ultrasound Imaging (CFU) Part 1: Vector Flow Imaging

Jørgen Arendt Jensen

Center for Fast Ultrasound Imaging
Department of Health Technology
Technical University of Denmark

$$f(x+\Delta x) = \sum_{i=0}^{\infty} \frac{(\Delta x)^i}{i!} f^{(i)}(x)$$

Center for Fast Ultrasound Imaging
Department of Electrical Engineering

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Front-line research in Ultrasound

- Part 1:
 - How can we measure the true blood velocity in the clinic?
 - Can we measure pressure non-invasively?
- Part 2:
 - Can we measure 3-D flow fast?
 - Can we break the speed-accuracy trade-off?
 - Can we see brain function and epileptic attack?
 - Can we resolve structures below the resolution limit?
- Part 1 now, Part 2 after the break

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Modern color flow mapping

SIEMENS

VF10-5

C-Vascular

0 dB

5.3 MHz

3906 Hz

Filter 2

Persist 2

R/S 3

Map A

Priority 4

Smooth 3

Flow M

10 fps

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Conventional velocity estimation system

- Low frame rate (approx. 20 Hz)
- Angle dependent velocity estimation

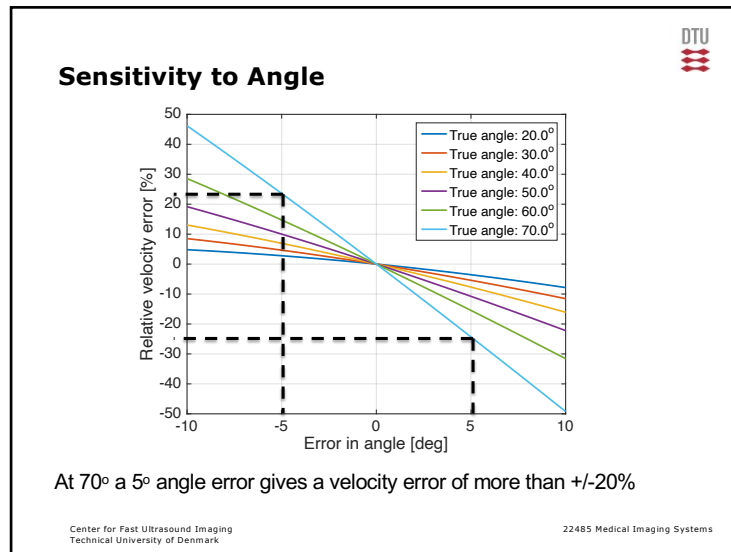
- Velocity changes direction in the image
- Determination is dependent on angle between beam and flow:

$$V_z = |v| \cos(\text{angle})$$
- At 45 degrees: 71% of velocity
- At 60 degrees: 50% of velocity
- At 80 degrees: 17% (!) of velocity
- At 90 degrees: 0%

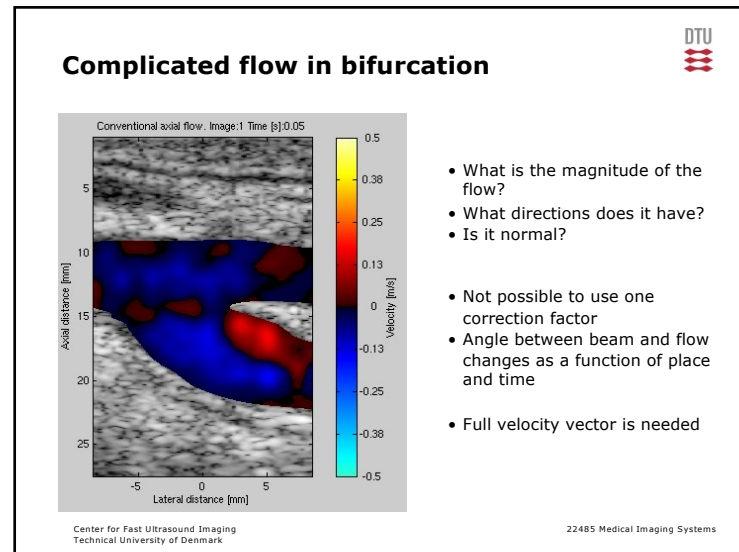
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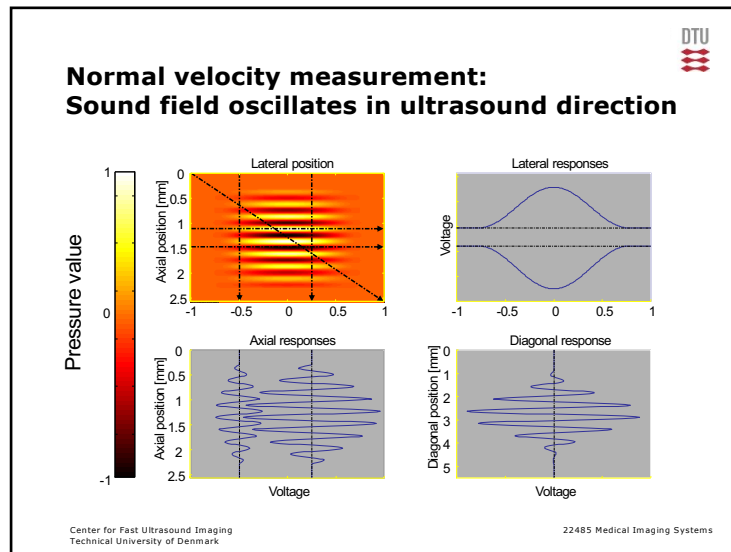
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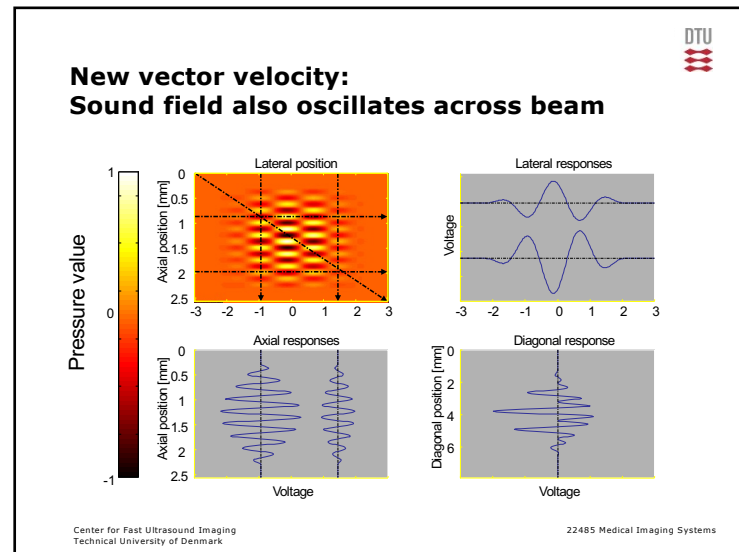
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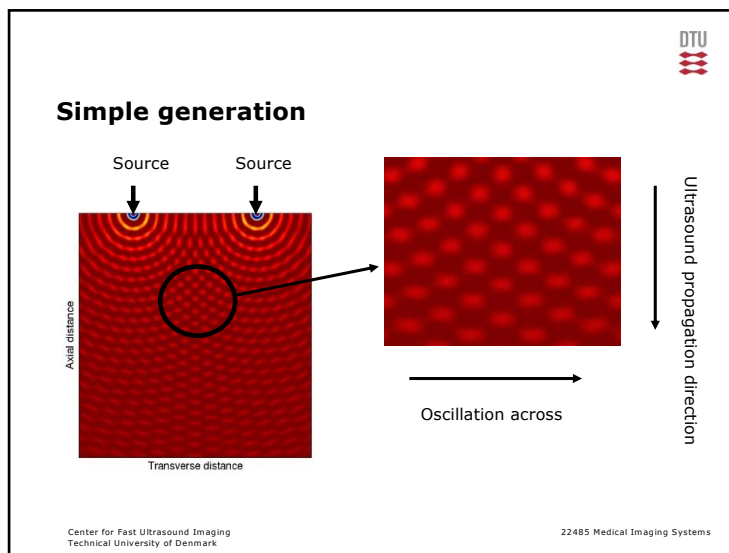
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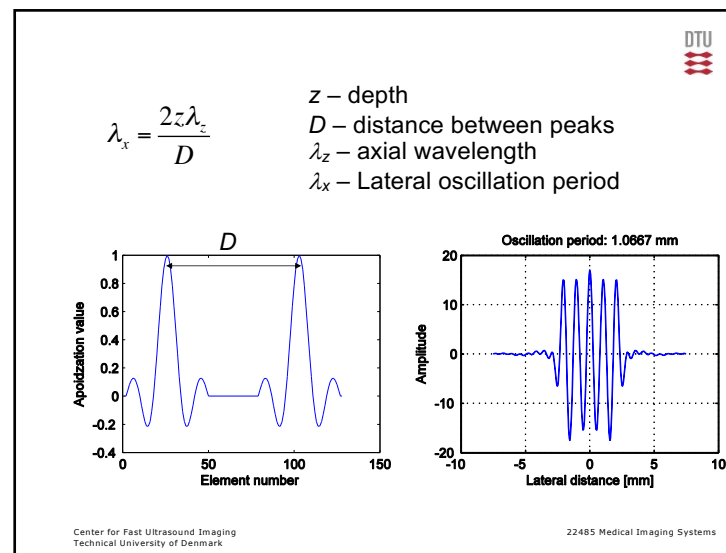
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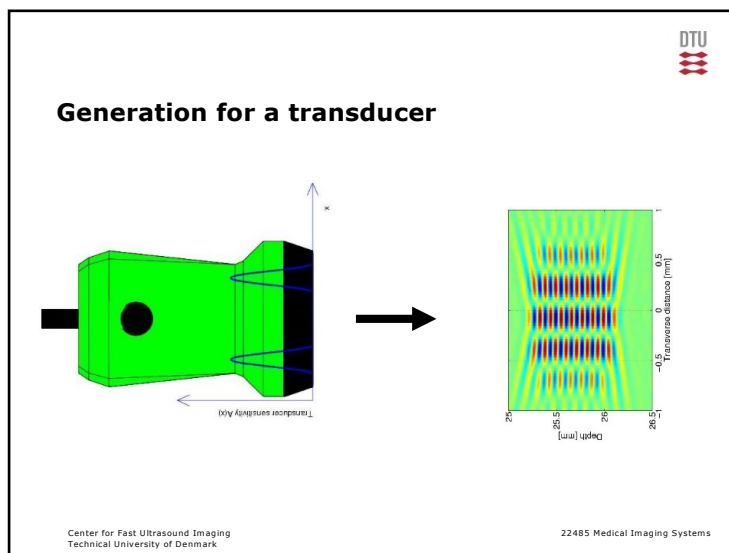
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RASMUS

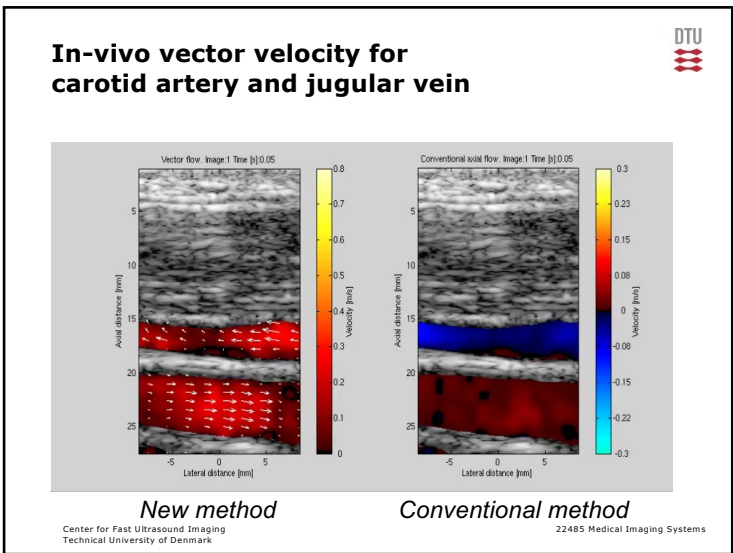
- Remotely Accessible Software programmable Multi-channel Ultrasound System
- Can be used for synthetic aperture, real-time, *in-vivo* data acquisition
- Made solely for research purposes

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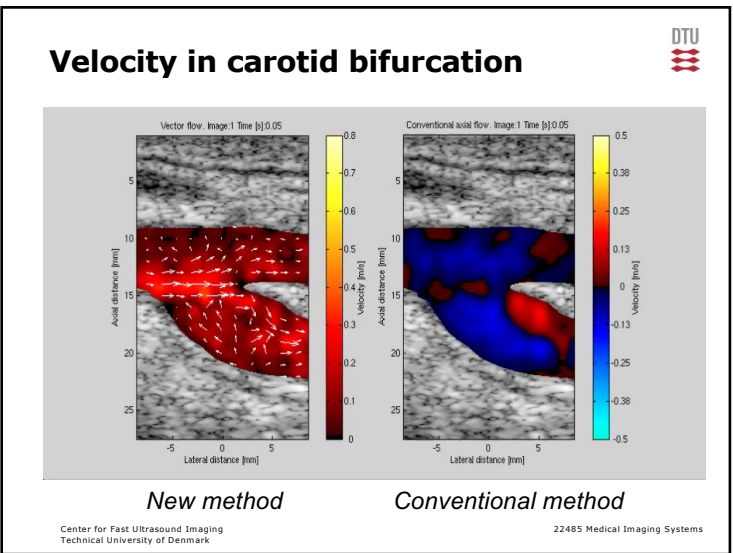
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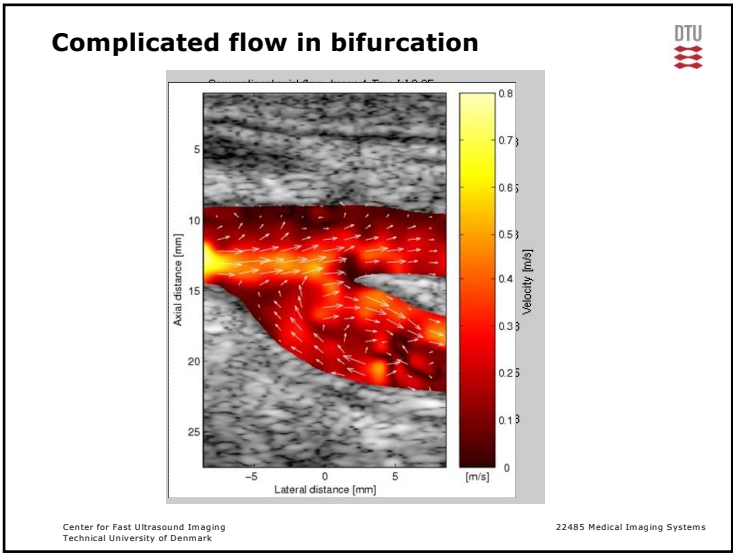
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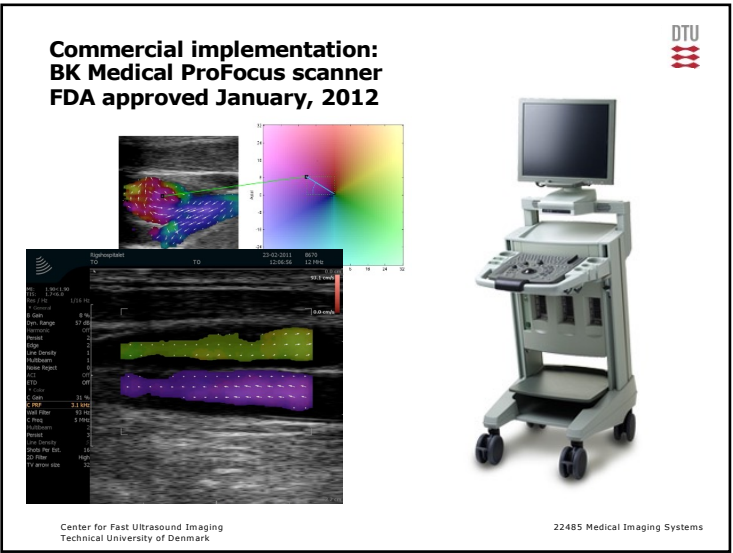
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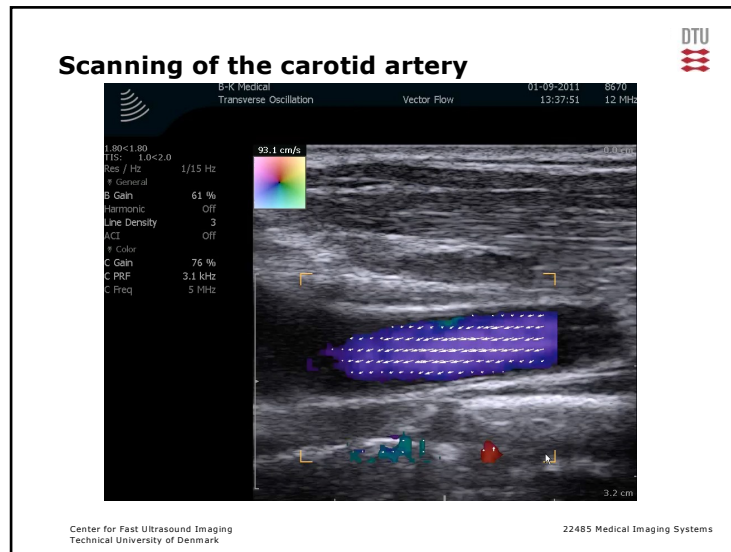
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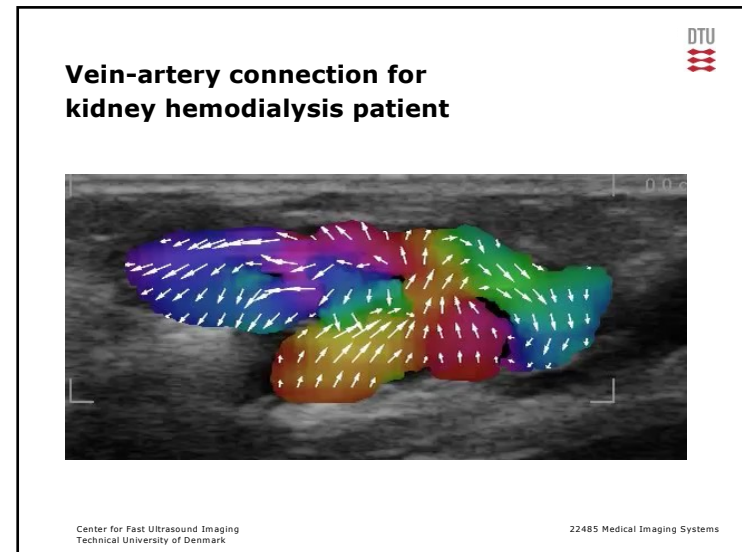
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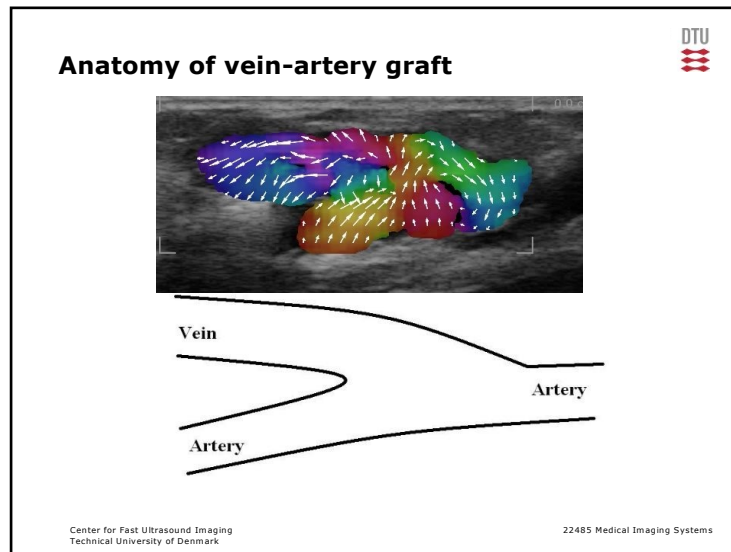
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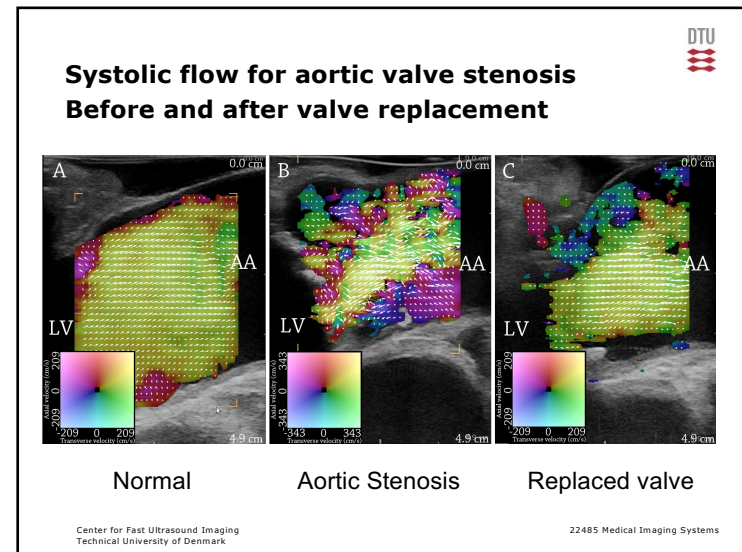
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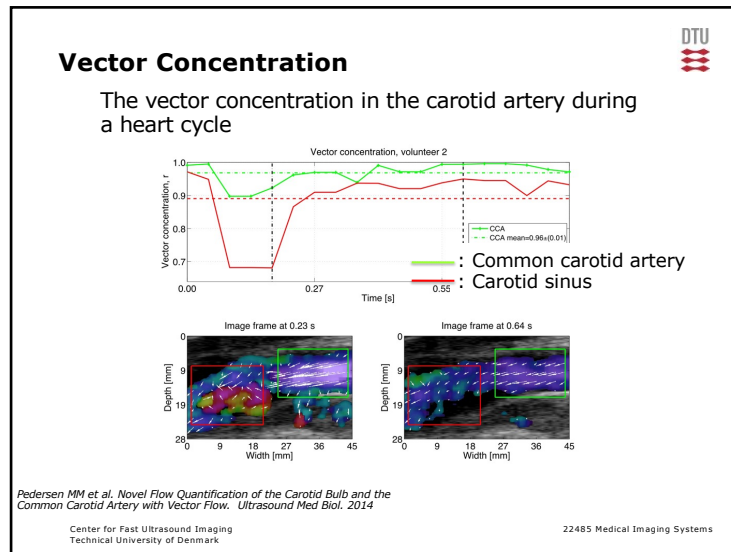
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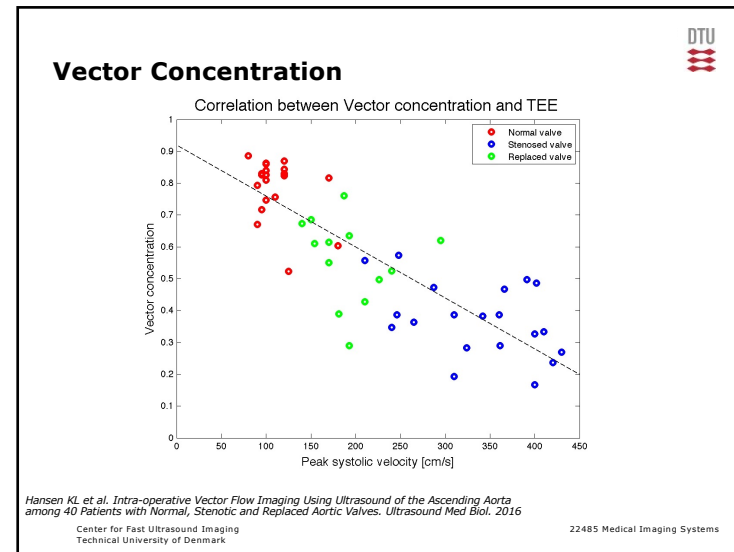
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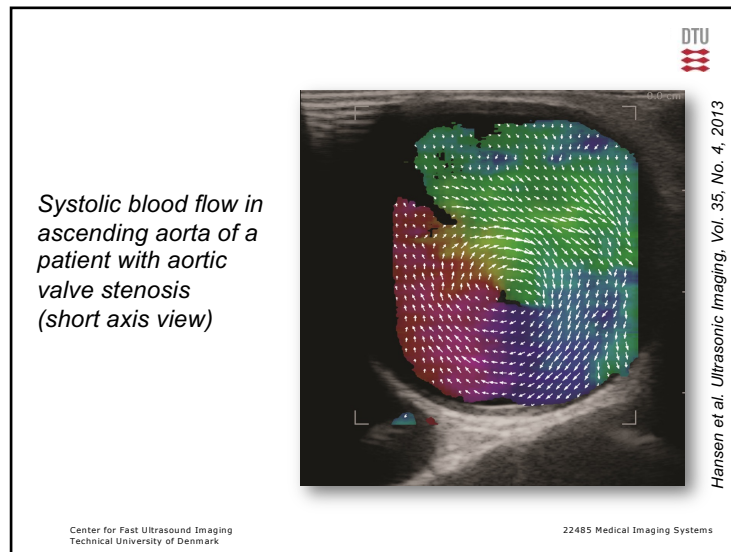
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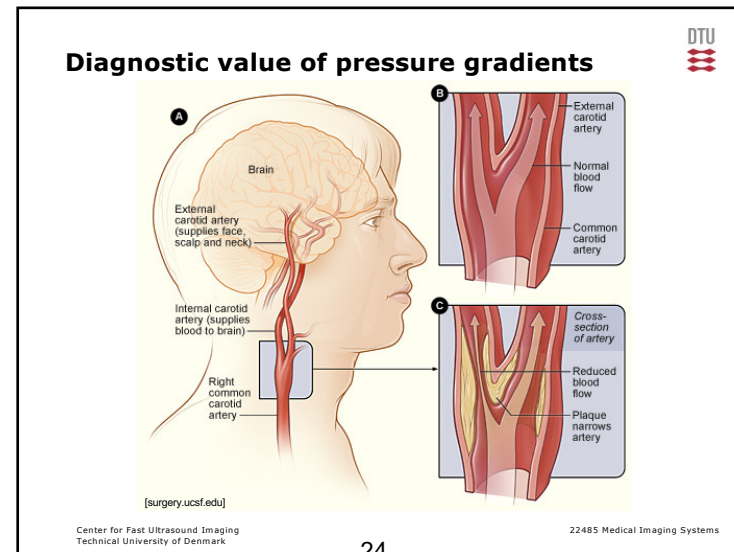
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Invasive vs. Non-invasive

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Foto by Jacob Bjerring Olesen

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Estimating pressure gradients from Navier-Stokes equation

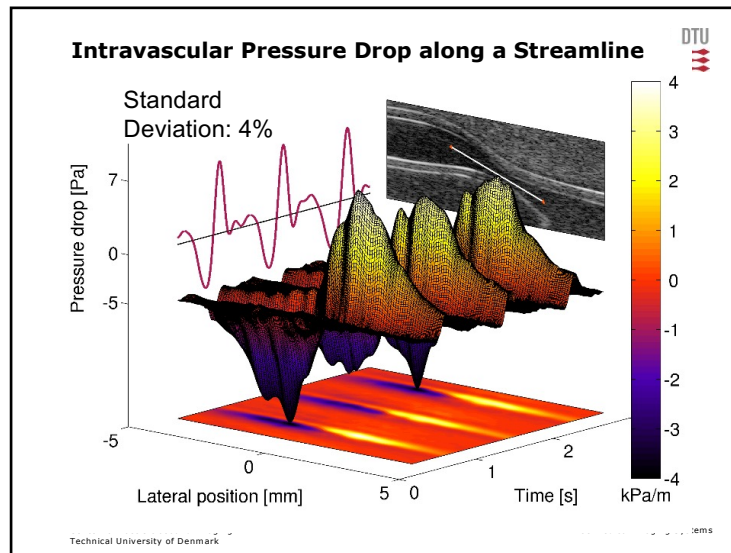
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The TO method can estimate both spatial and temporal acceleration

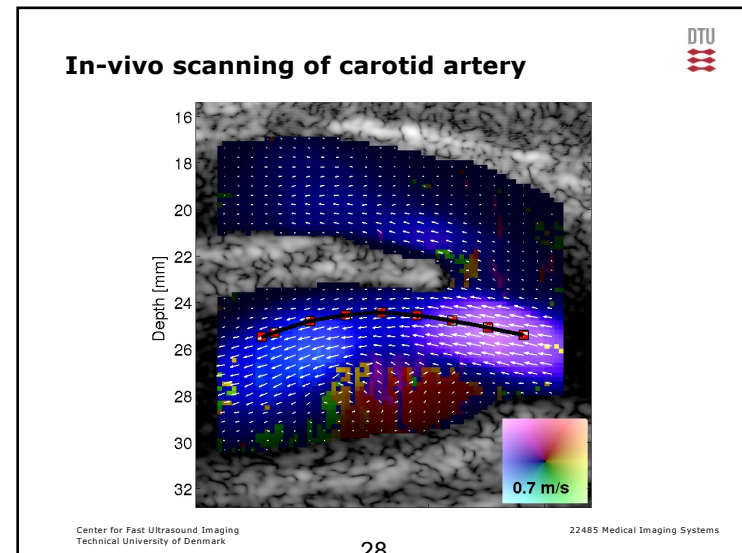
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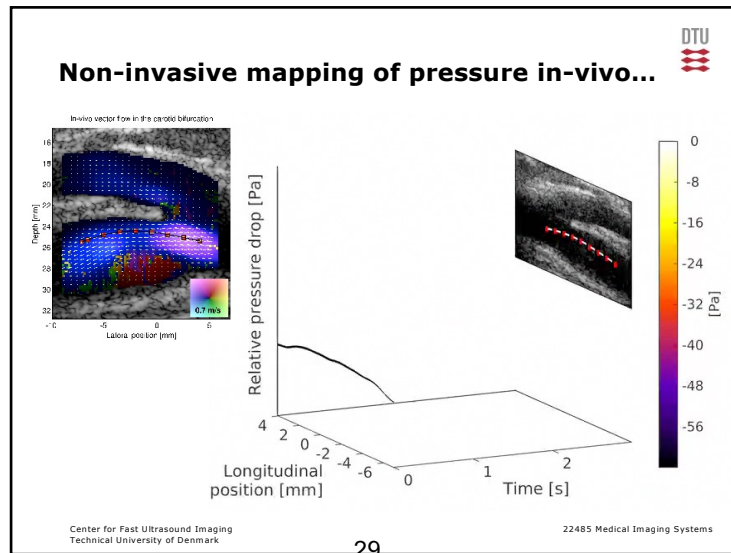
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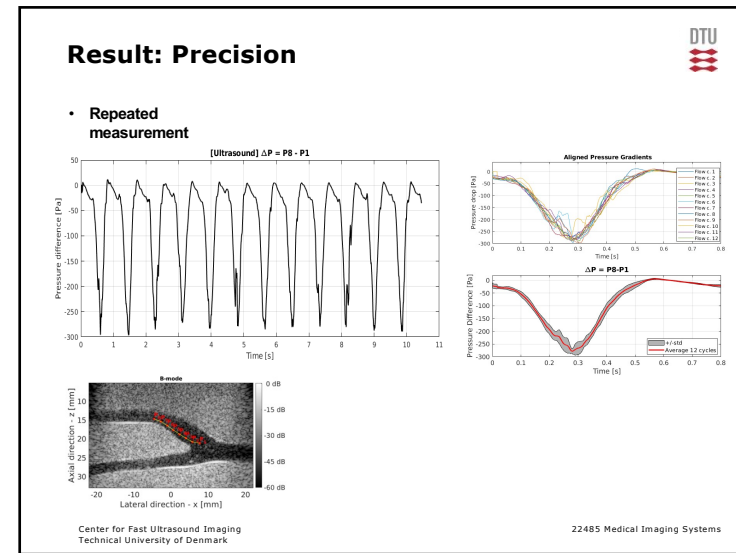
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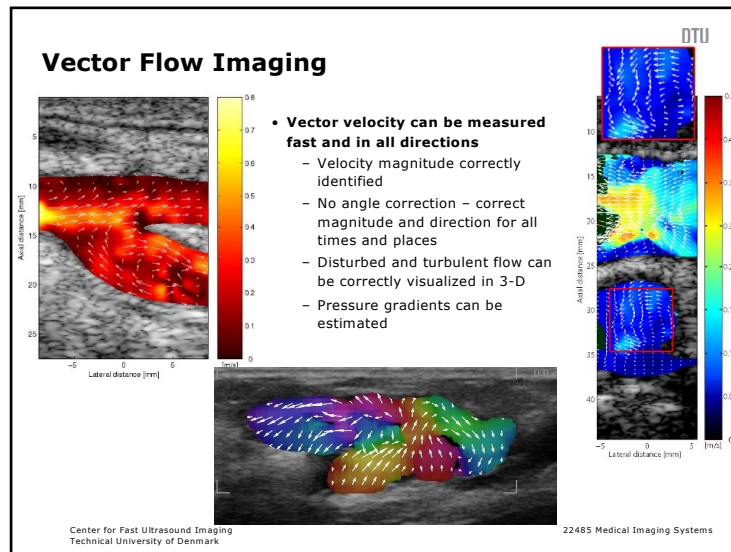
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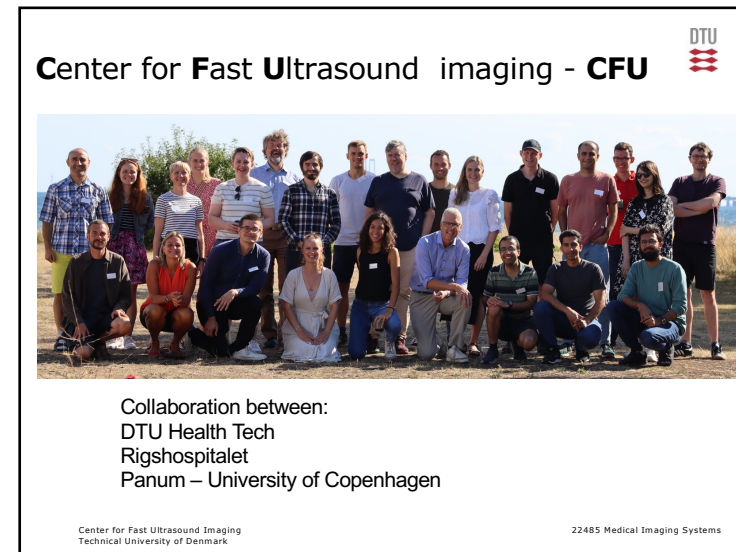
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