



2012 :15th SESSION of ESMP

Lecture presented in Archamps (Salève Building) by :

Piero TORTOLI (Florence)



Erasmus MC
University Medical Center Rotterdam



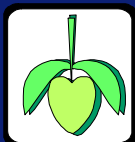
“History of Echocardiography and the use of sound”.

Nico de Jong

Presented by **Piero Tortoli**

University degli Studi di Firenze

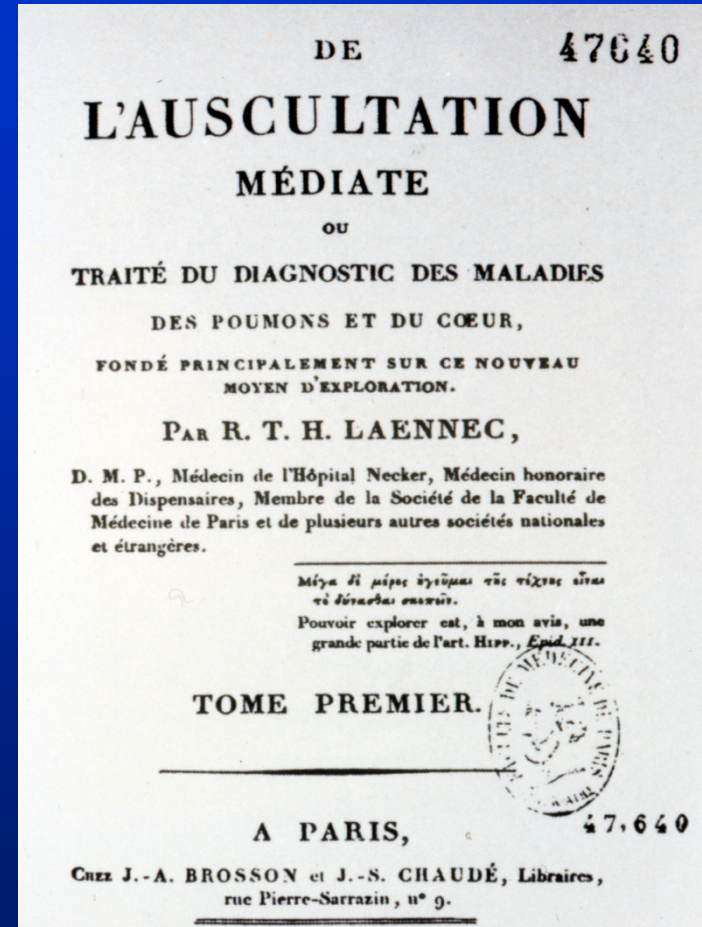
Electronics and telecommunications Department



The stethoscope



R.T.H. Laennec (1781-1826)



1819

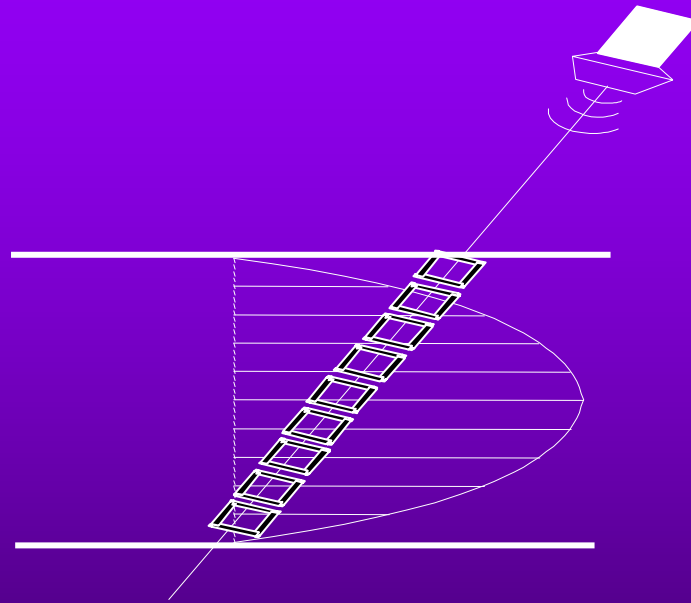
slide number







Doppler



J.V.



C.C.A.



slide number

5

**“seeing with sound started by
using echo”**

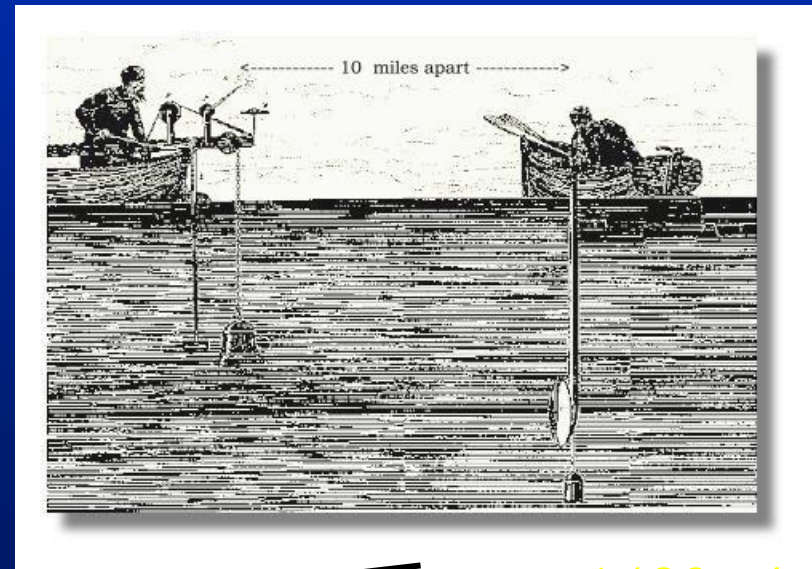
Echo

- Ultrasound
- Propagation in water
- Resolution in water

Speed of Sound

- **1826** Jean-Daniel Colladon and Charles-Francois Sterm used an underwater bell to determine speed of sound in Lake Geneva

An underwater bell was struck simultaneously with ignition of gunpowder. The flash from the ignition was observed **10 miles away** and compared with the arrival of the sound from the bell underwater heard through a trumpet-like device in the water.



~~$c=1435\text{m/s}$~~

$c=1480\text{m/s}$

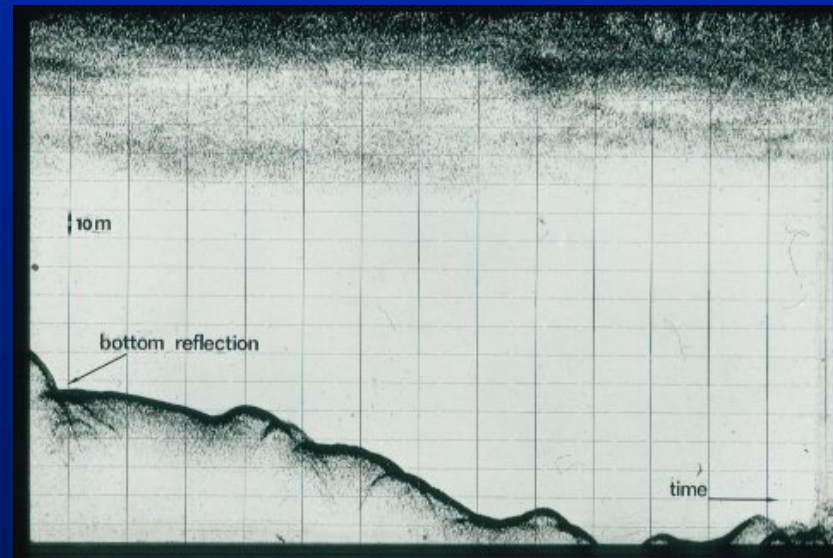
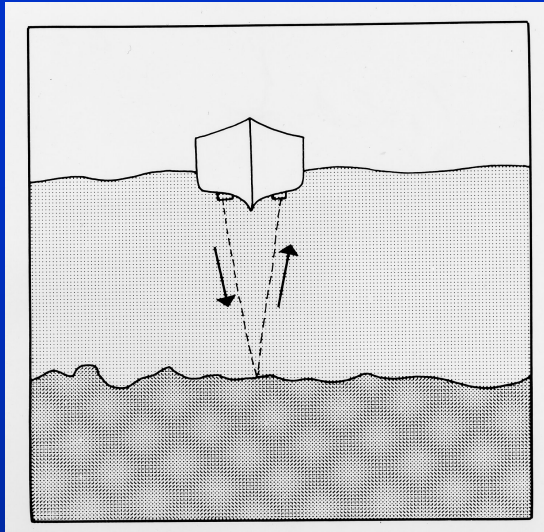
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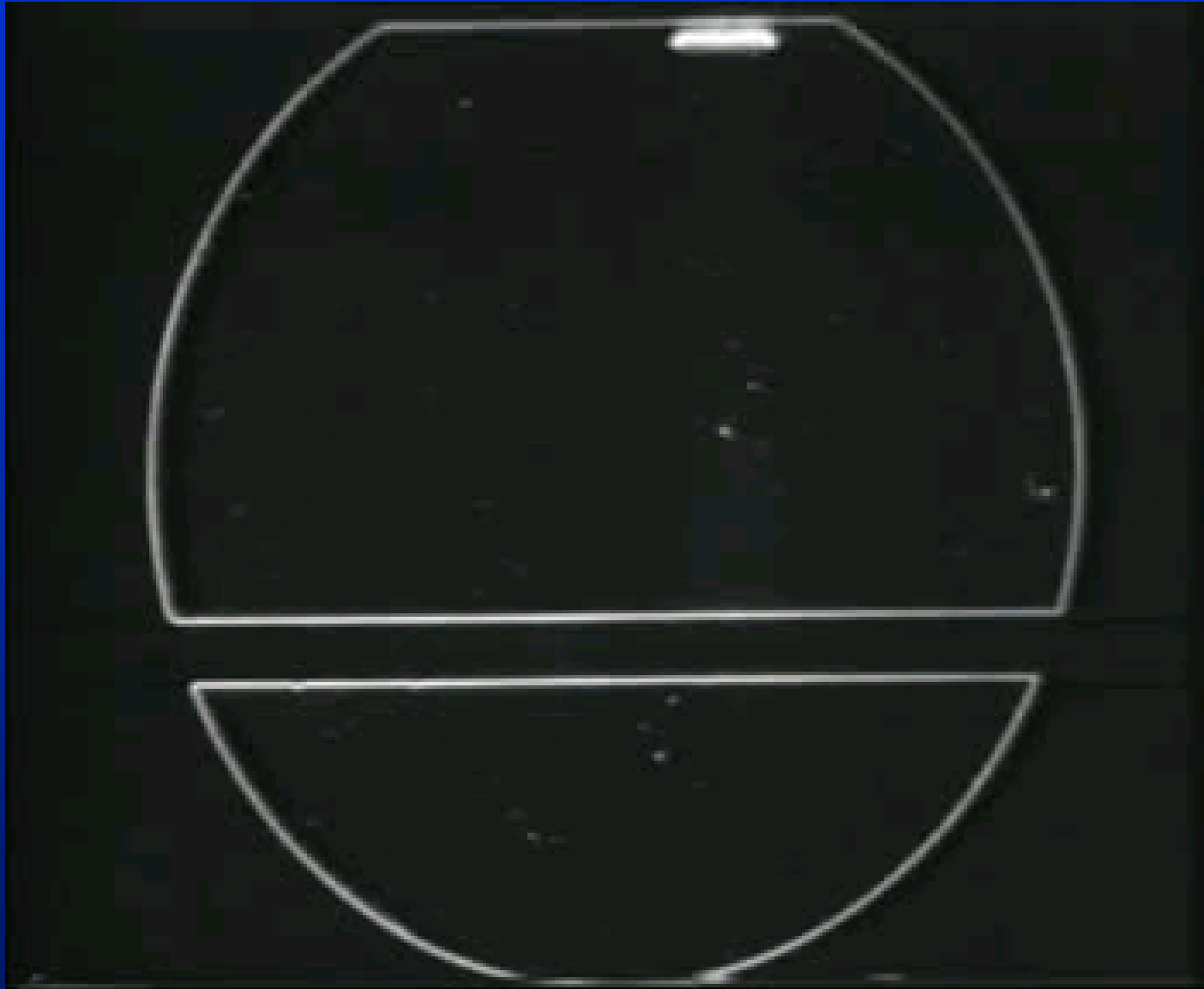
8

Ultrasound

- **1794** Lazzaro Spallanzani discovered high frequency 'ultra' sound by demonstrating ability of bats to navigate by echo reflection
- **1876** Francis Galton invented a whistle that generated sound above the limit of human hearing
- **1880** Pierre Currie discovered the piezo-electric effect in certain crystals.

It was then possible for the generation
and reception of ultrasound





Courtesy J. Somer



Lazzaro Spallanzani

Spallanzani

1794

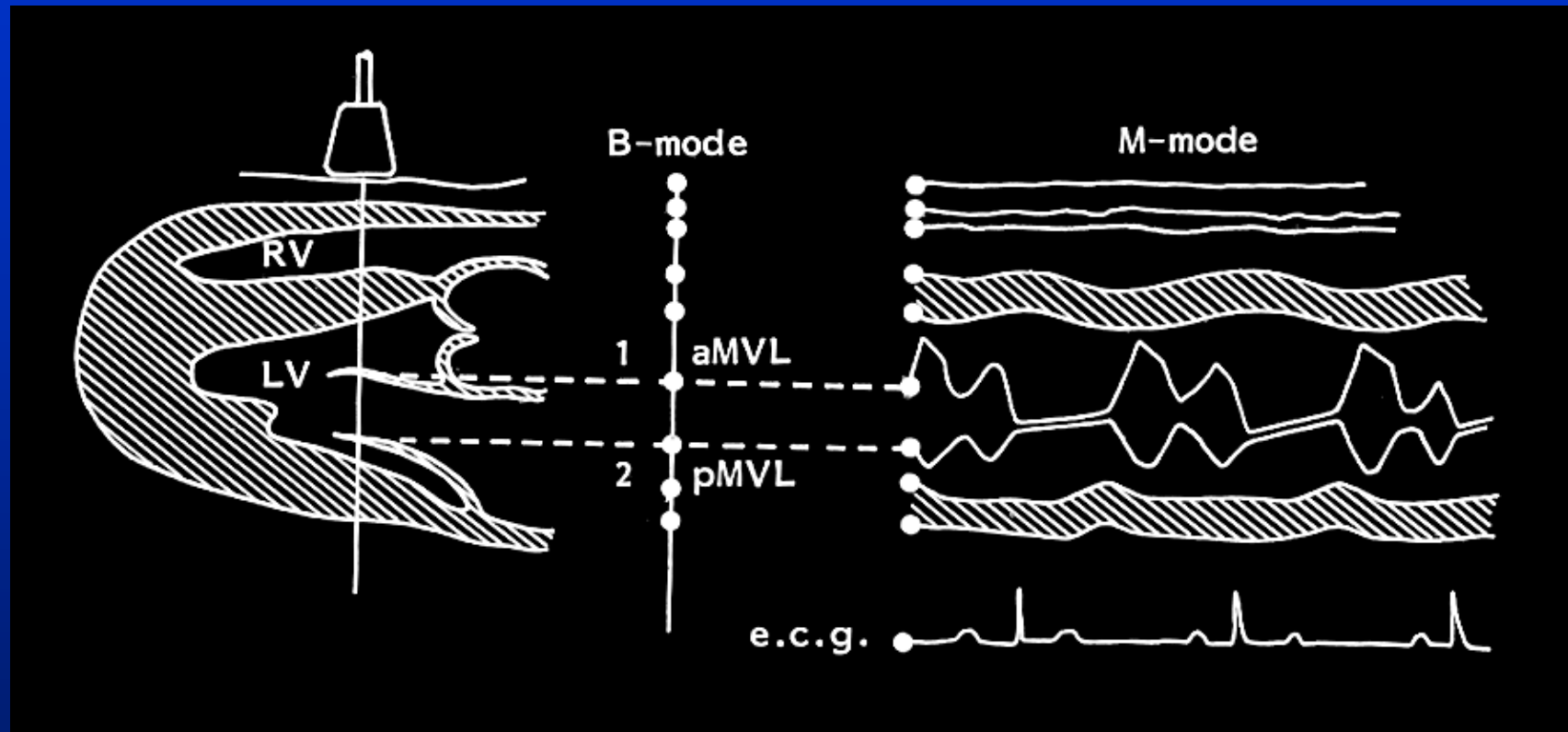


SONAR



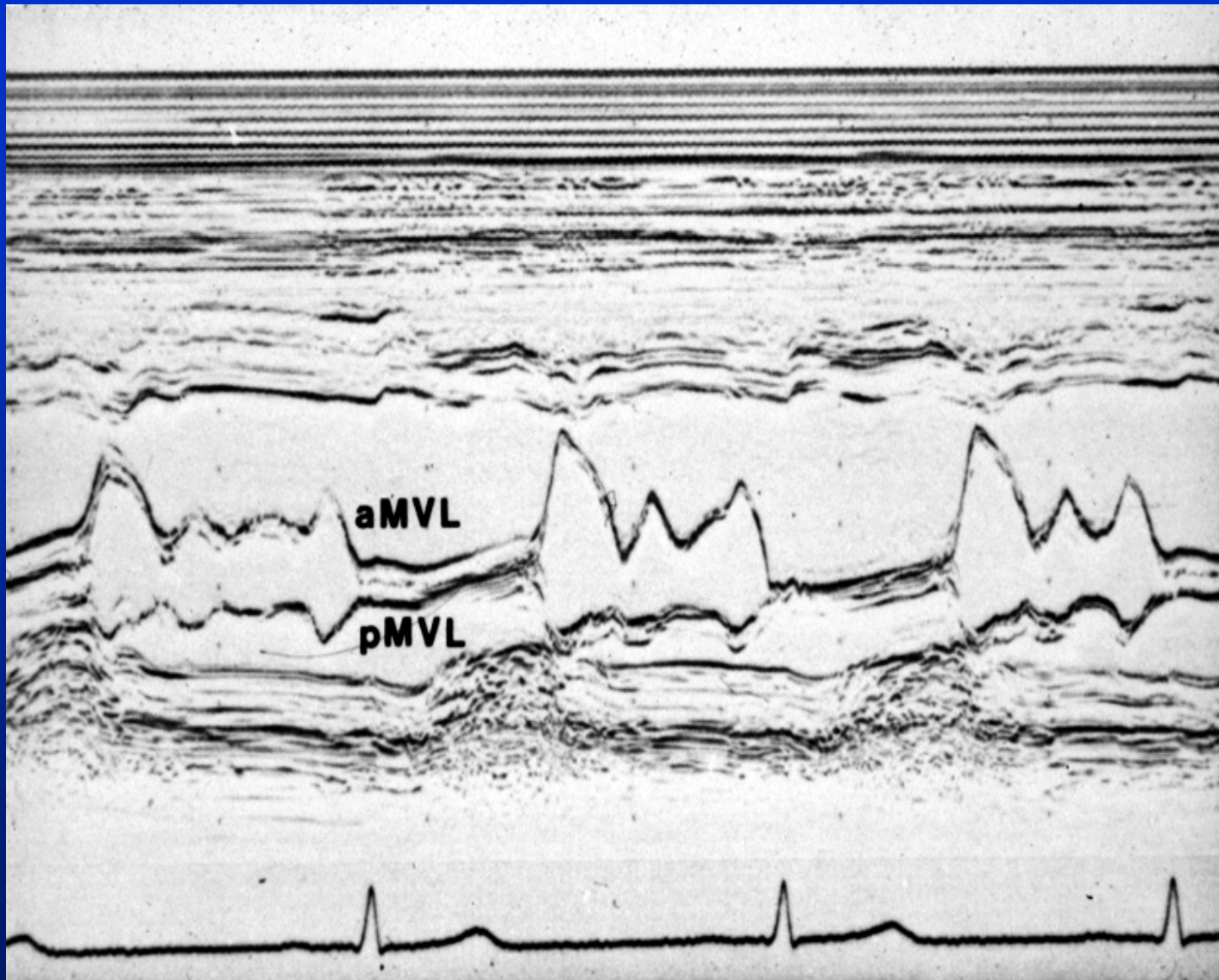
Courtesy TNO-FEL

Principle of M(otion)-mode registration

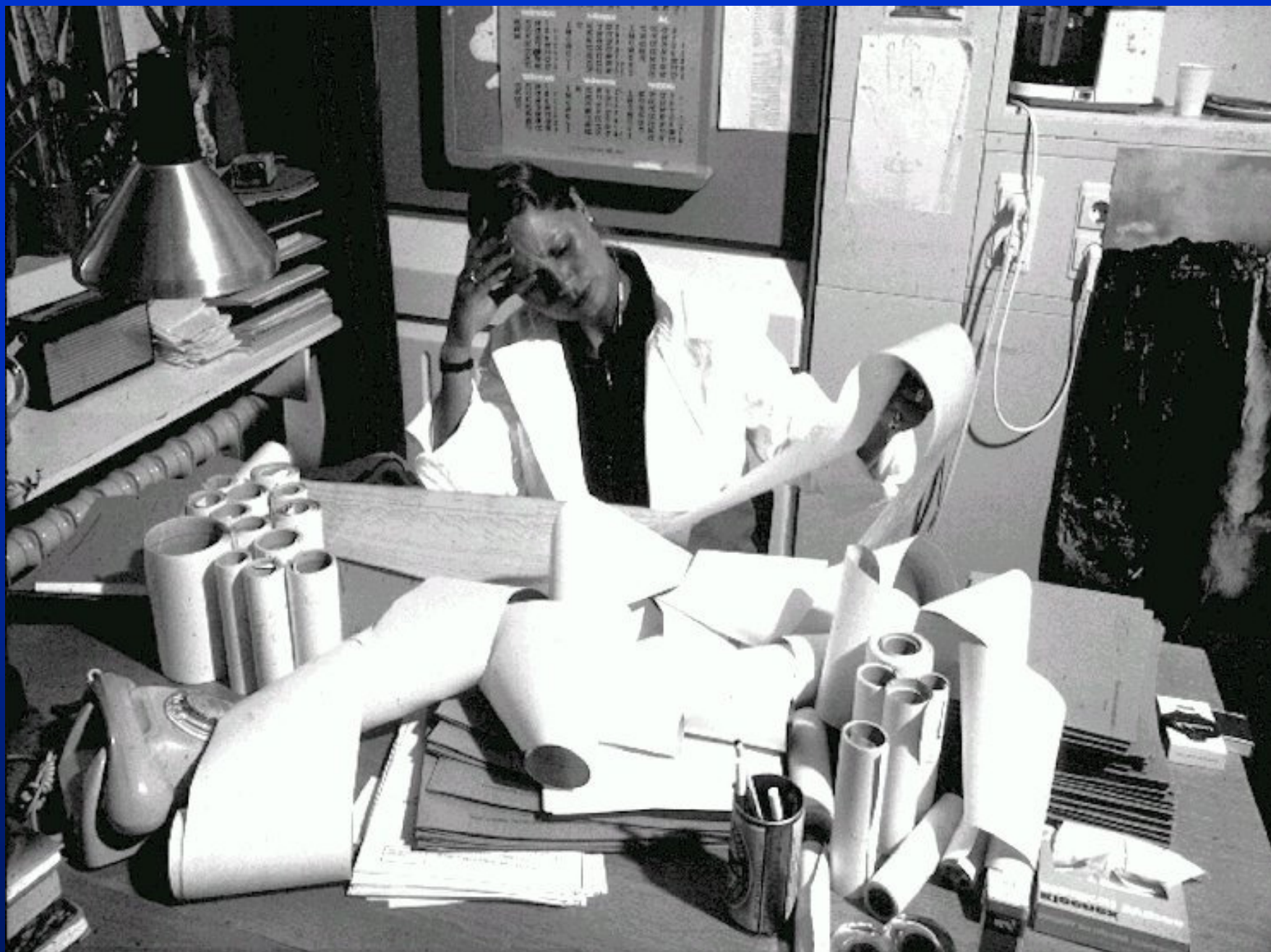




European School of Medical Physics - Archamps



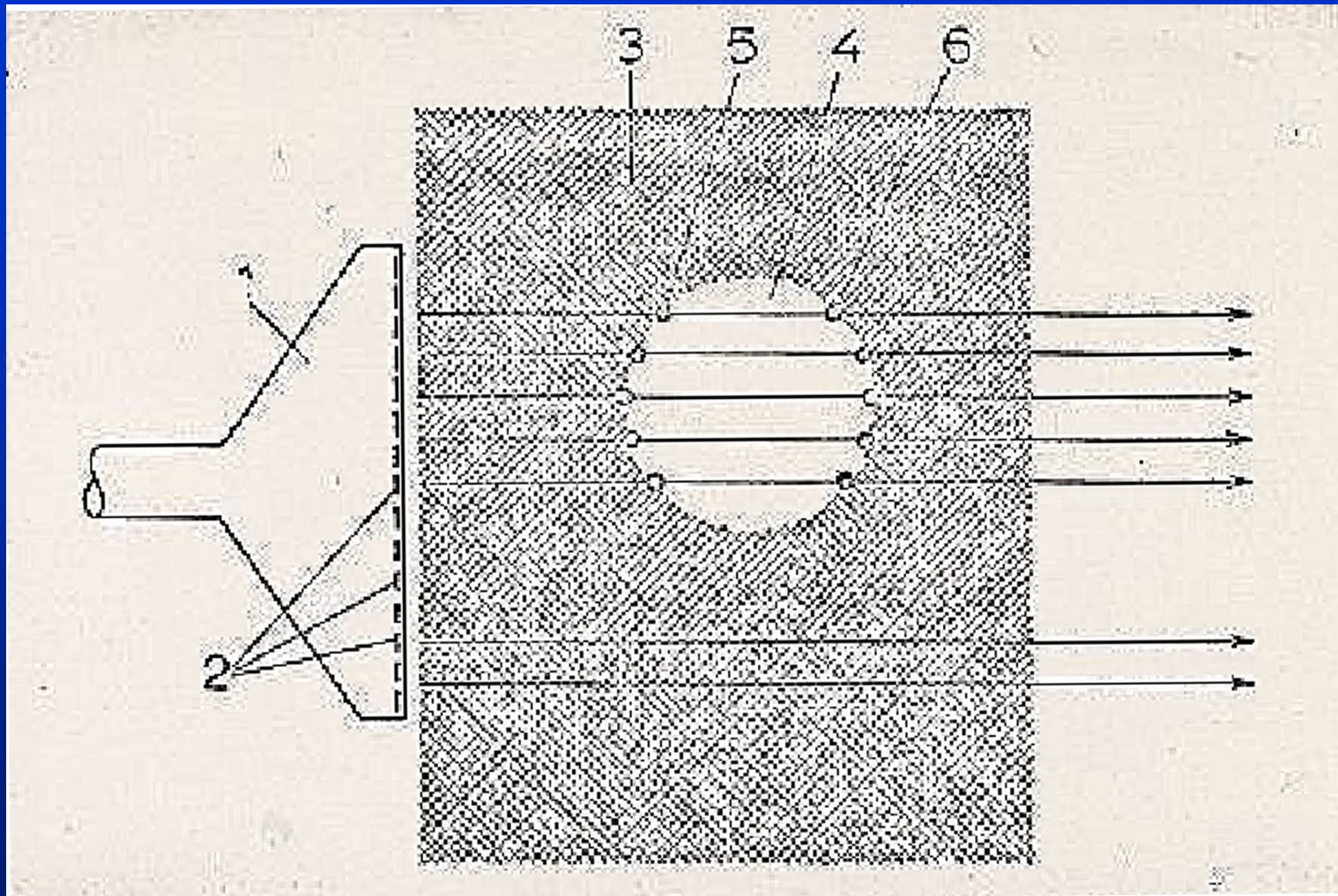




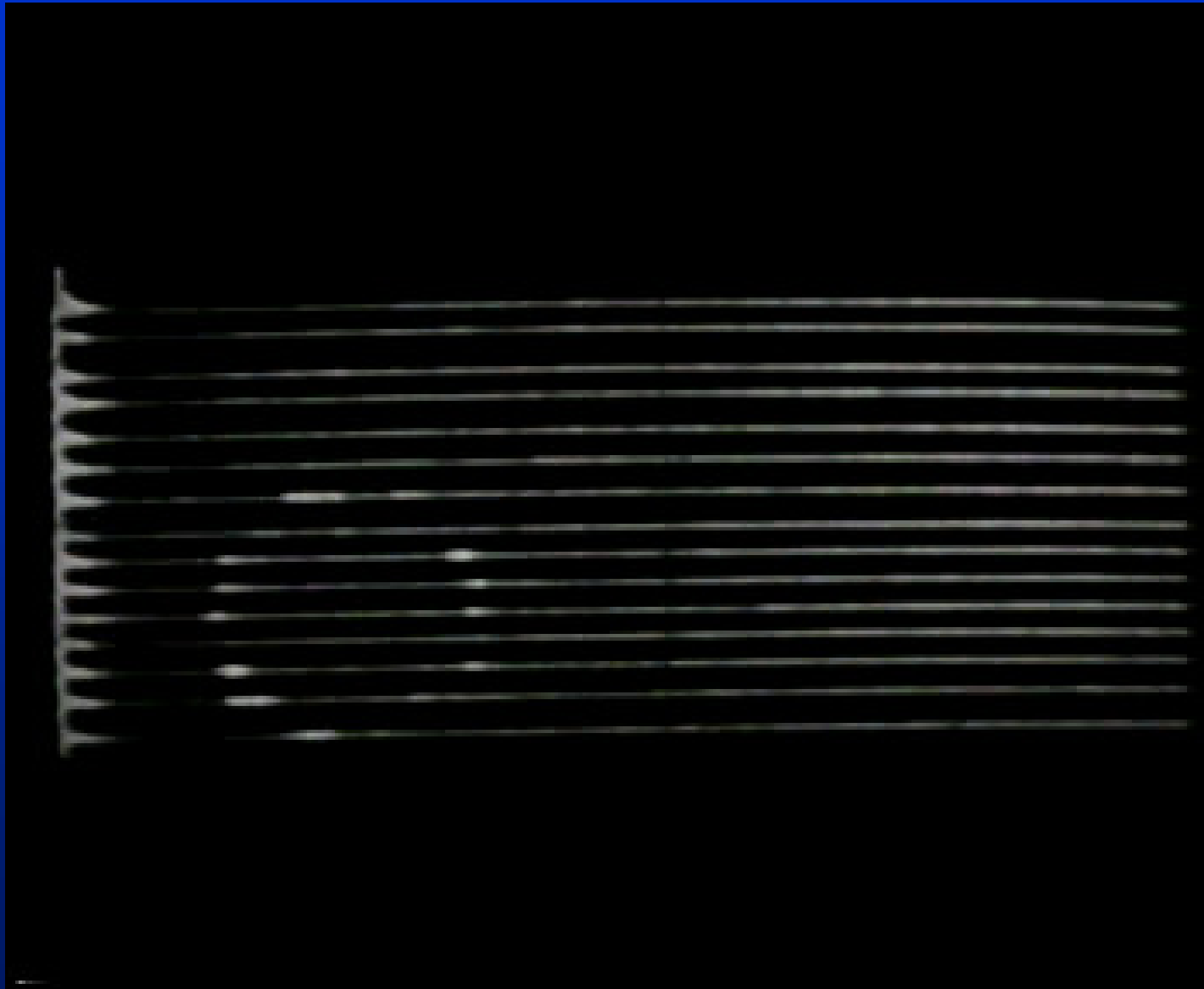
European School of Medical Physics - Archamps

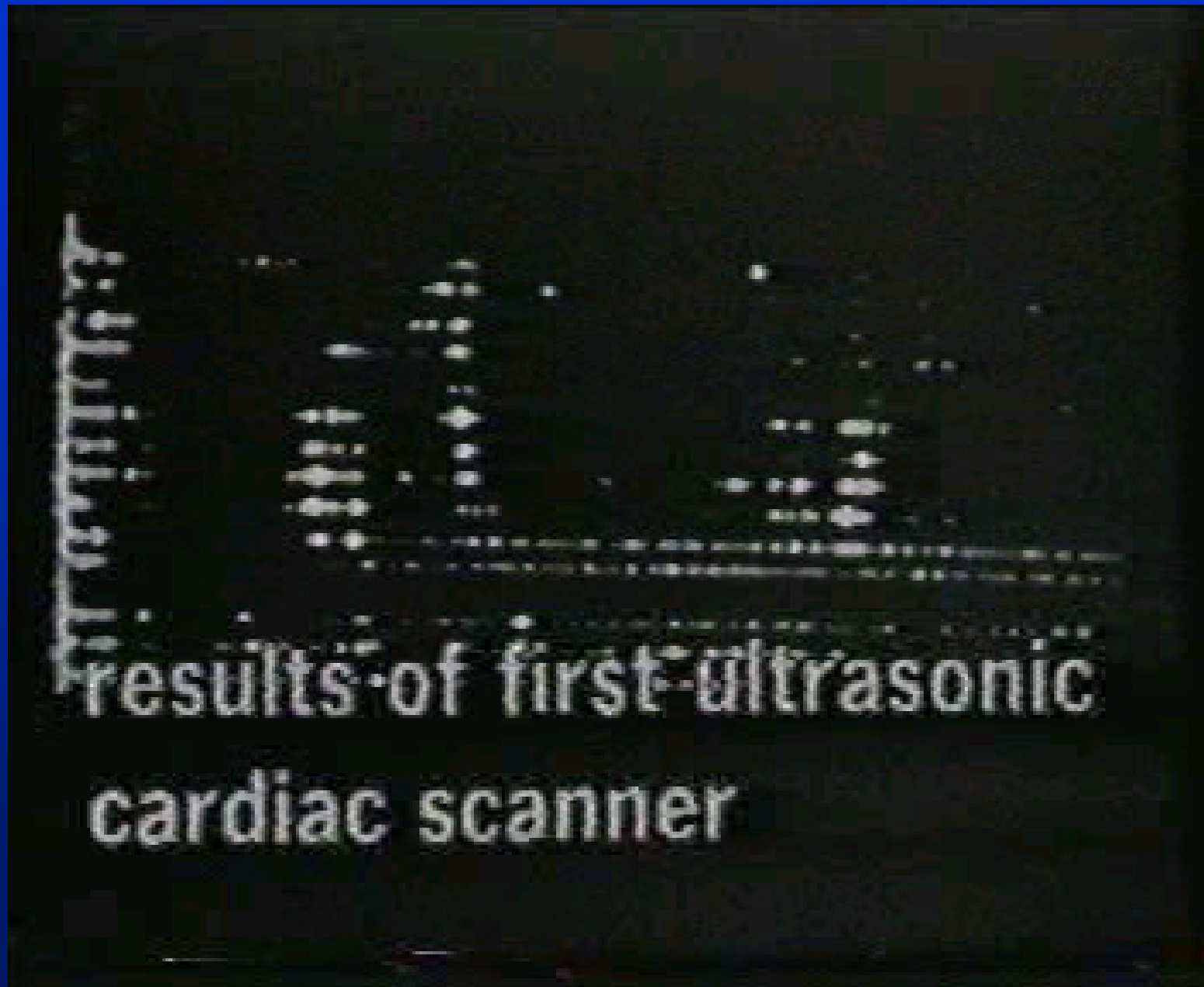
Real time medical imaging:
Starts in 1969

Linear array



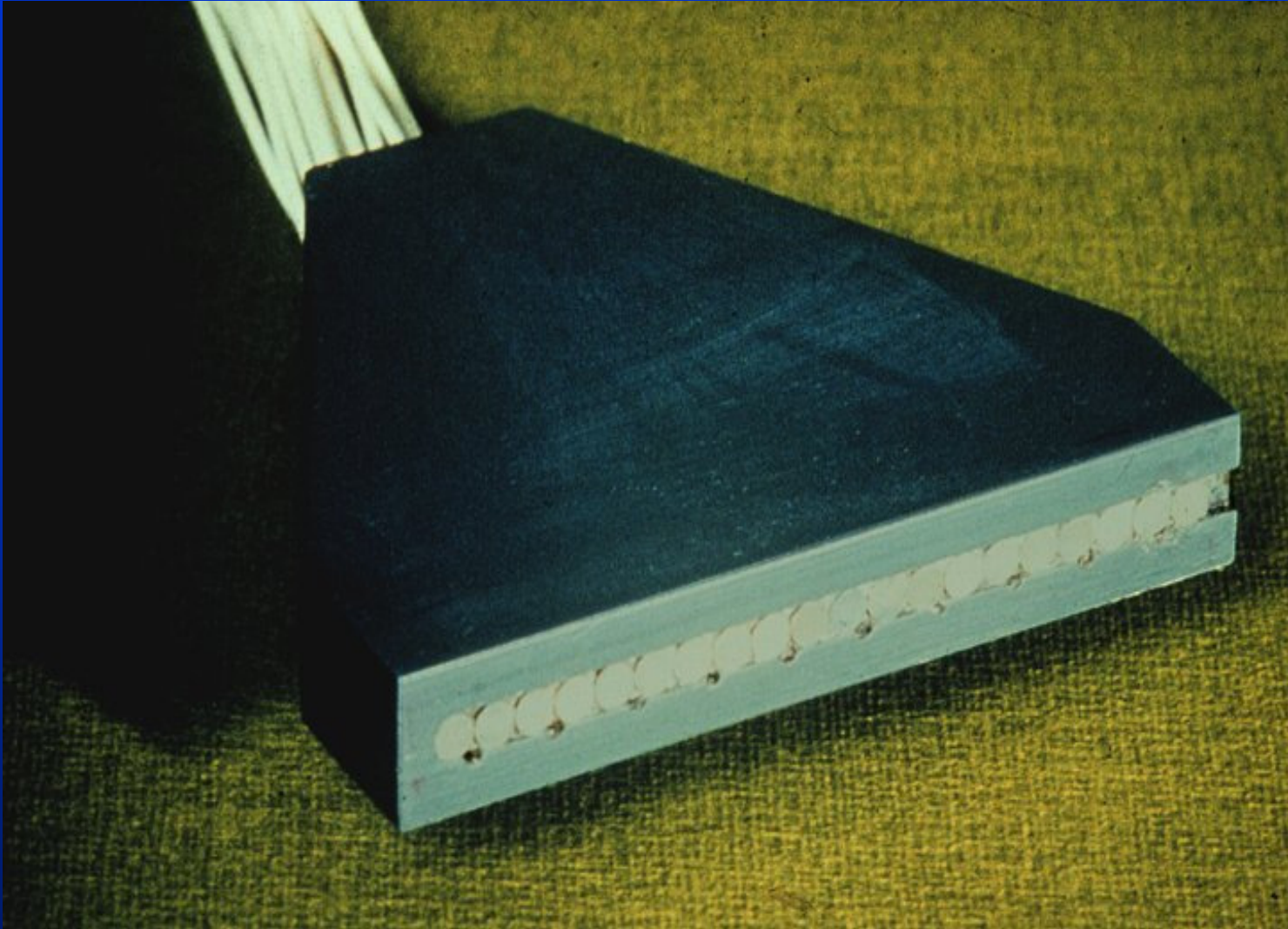
Rotterdam 1971

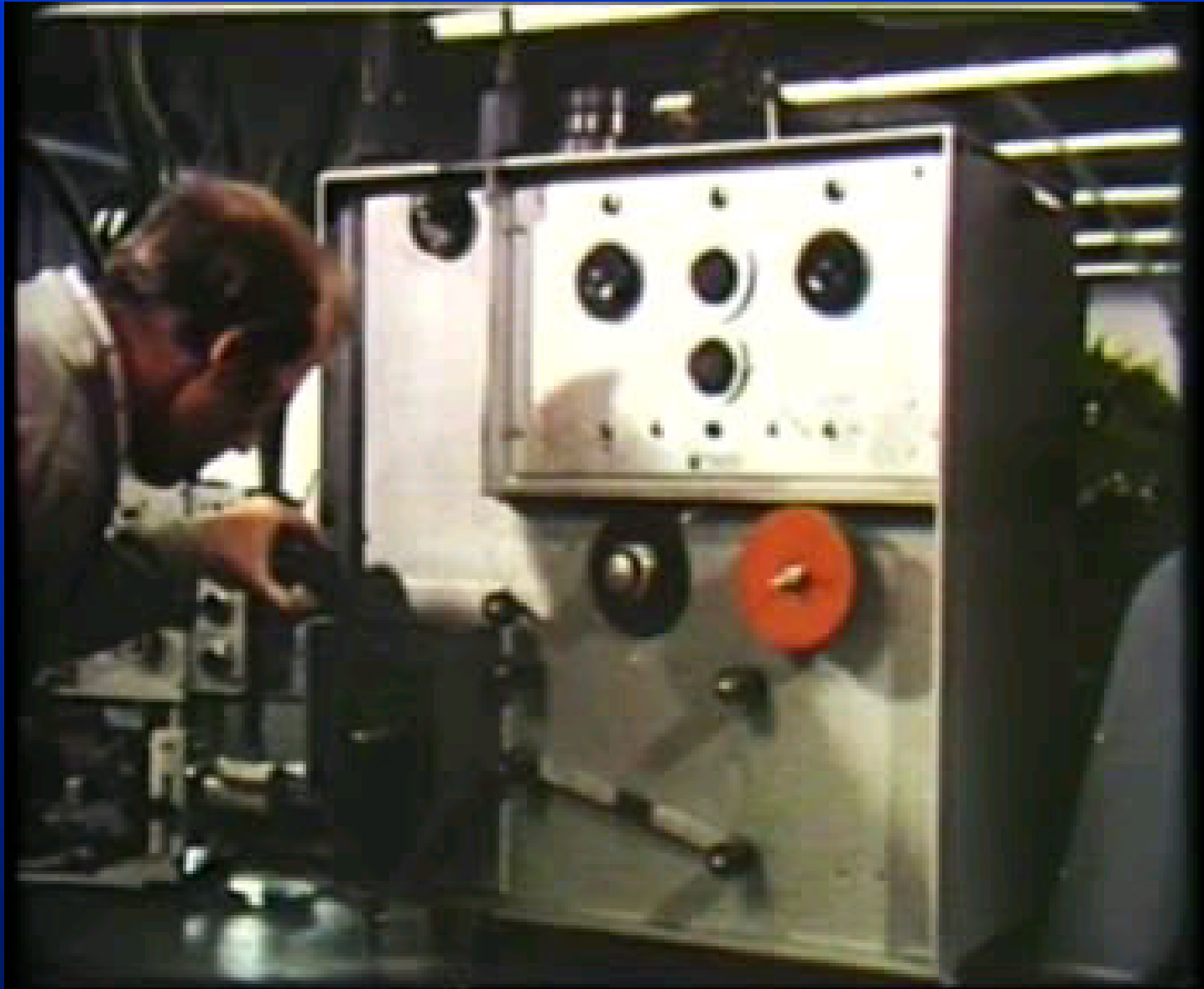




2.5.11.1957

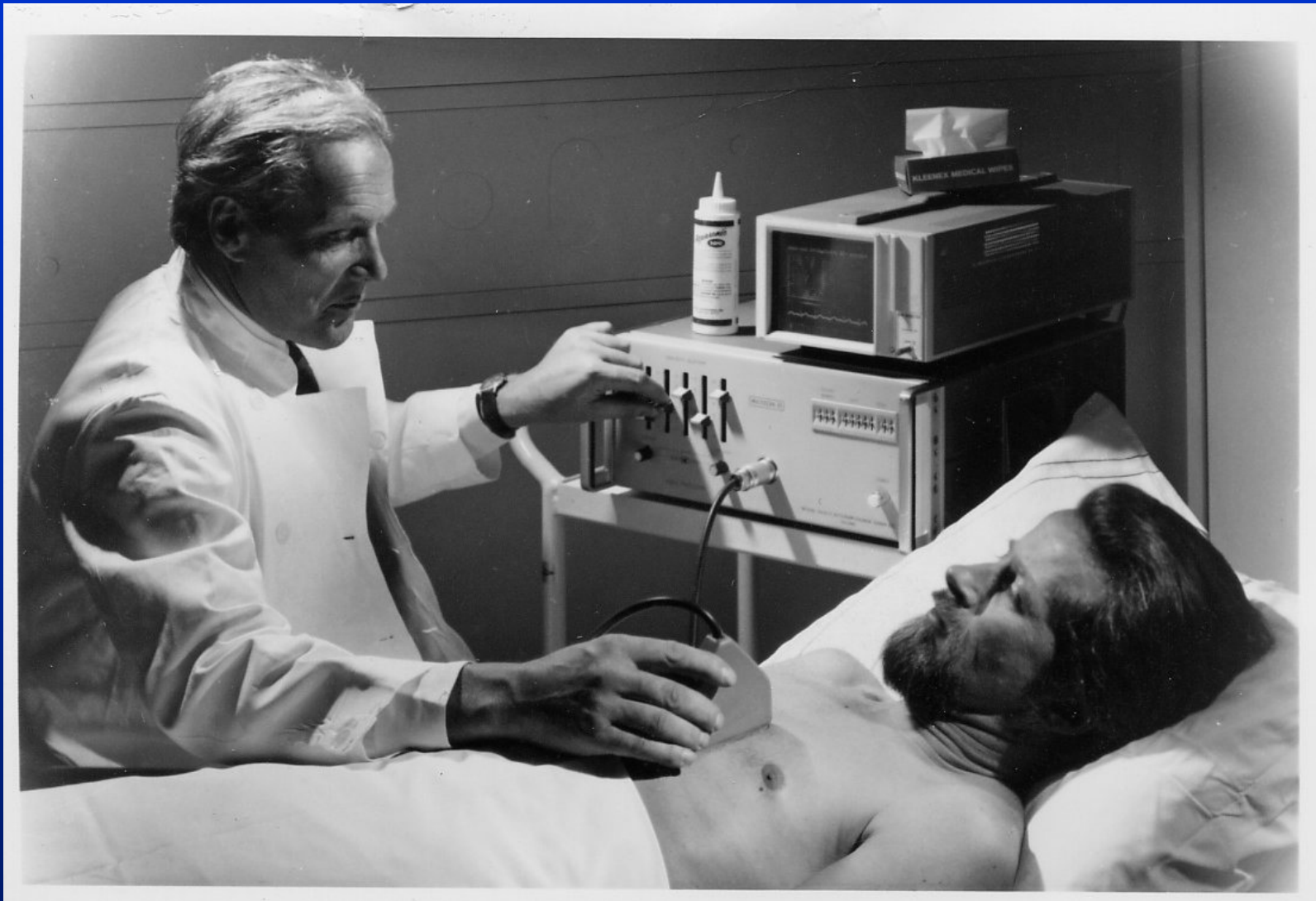
results of first ultrasonic
cardiac scanner





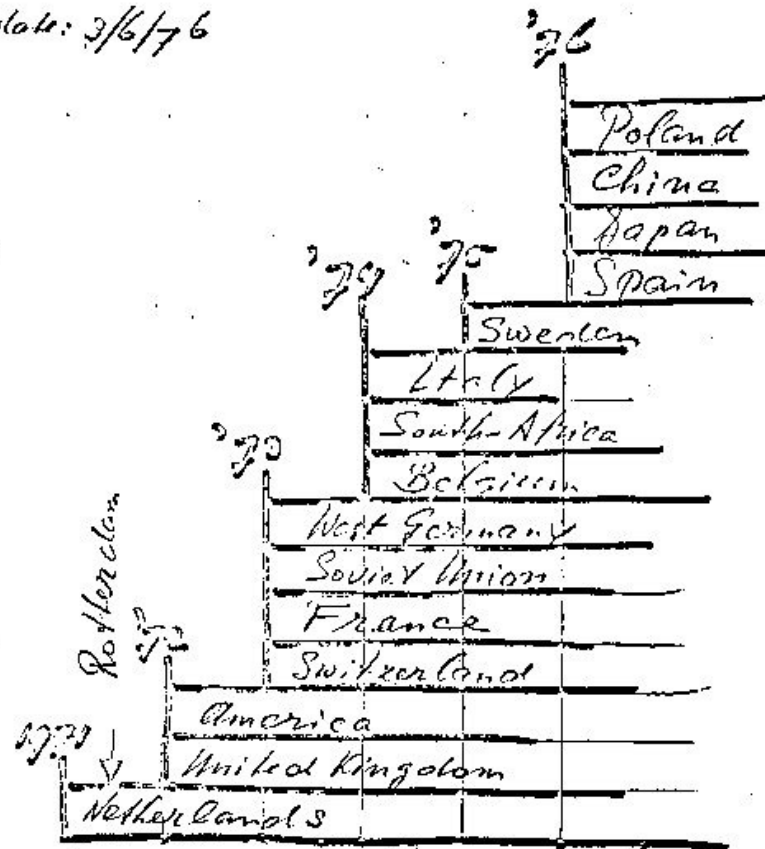
slide number

24

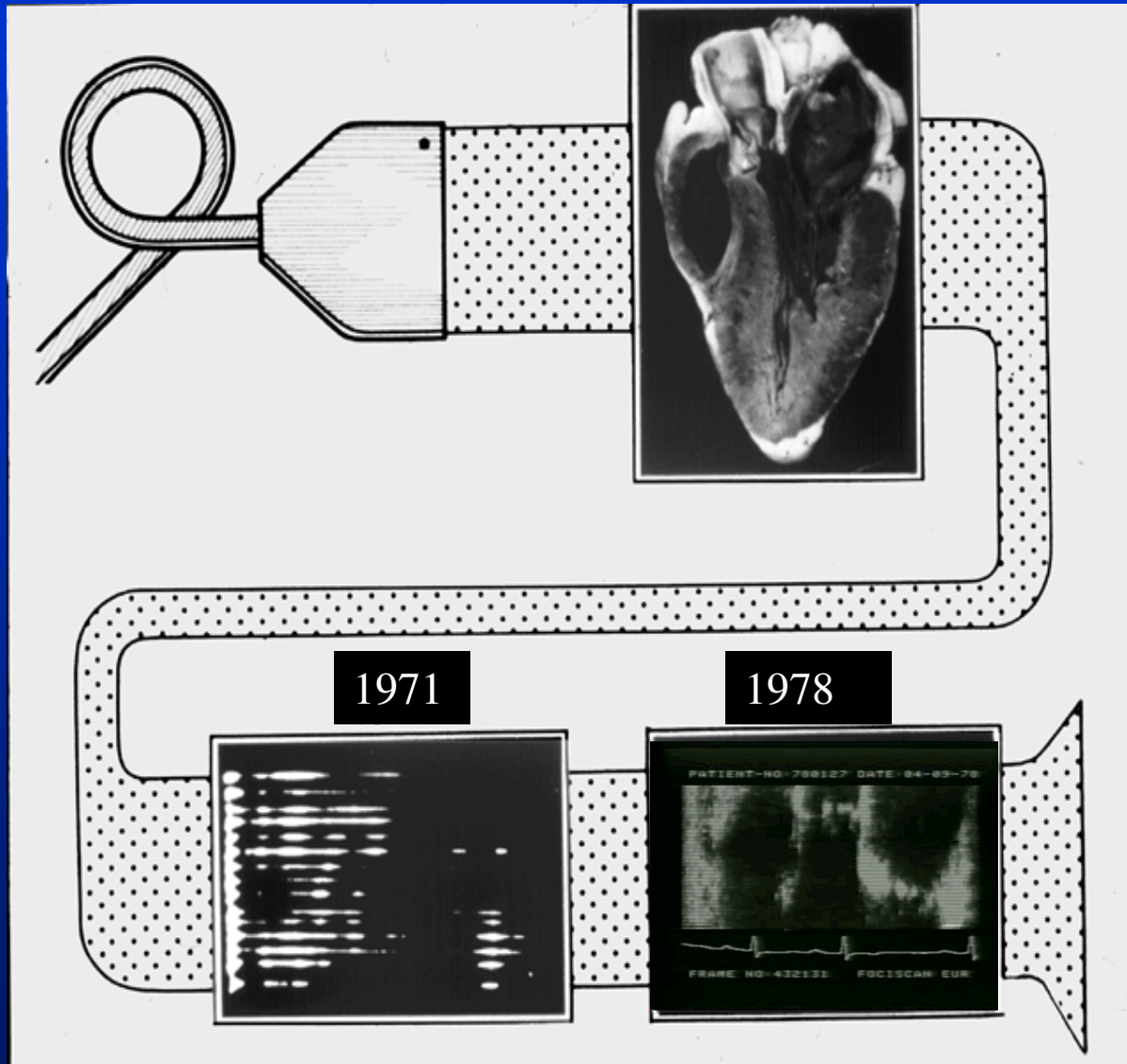


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date: 3/6/76



Introduction of the Multiholant method
into clinical practise in various countries
since its first application.

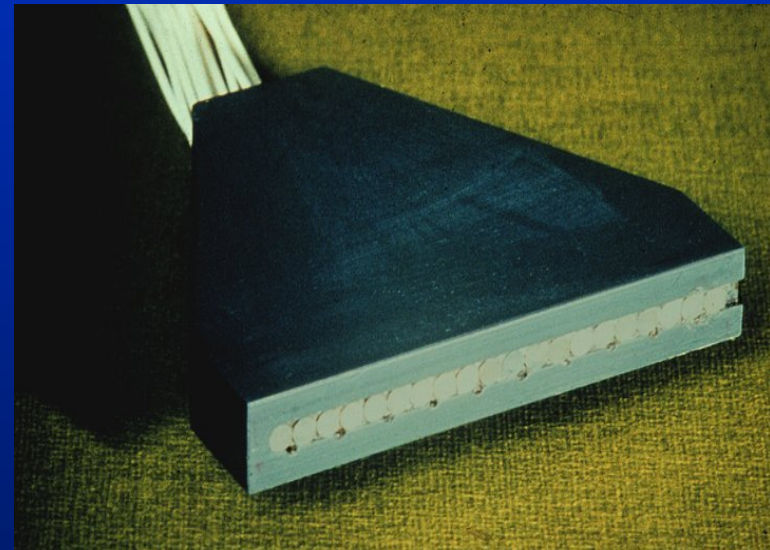


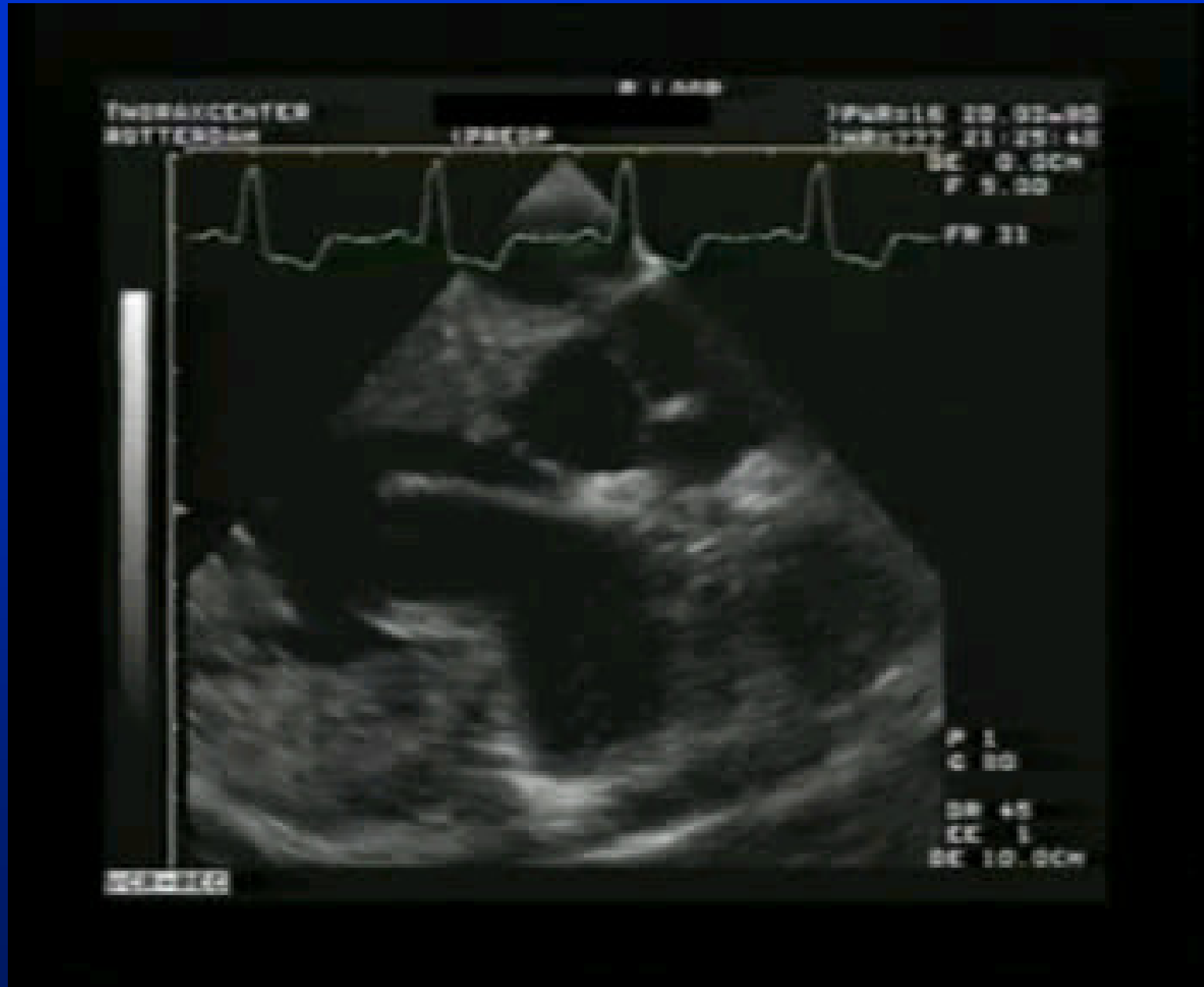


Phased array

Introduced by Jan Somer

Linear array

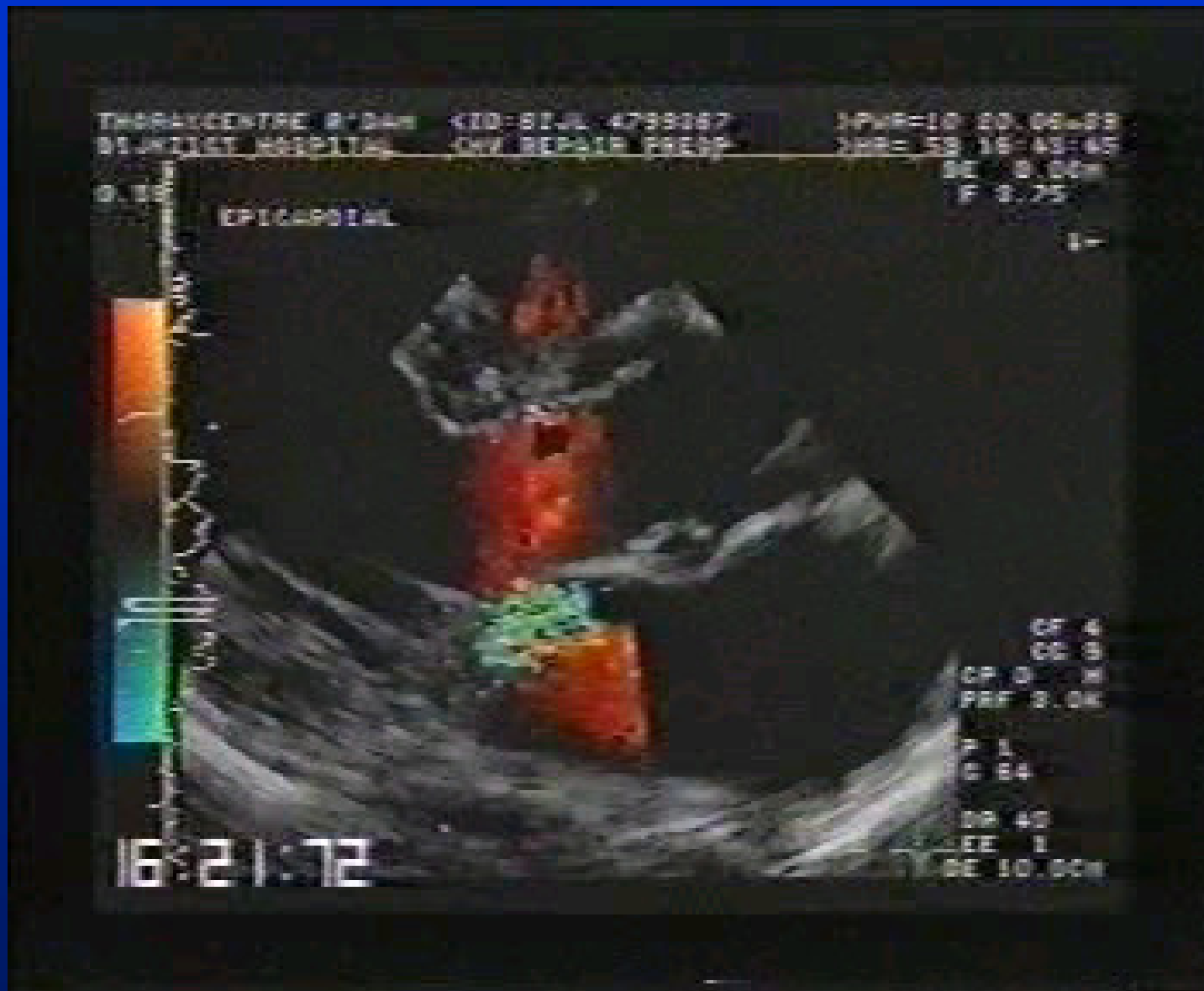




Doppler

Doppler effect





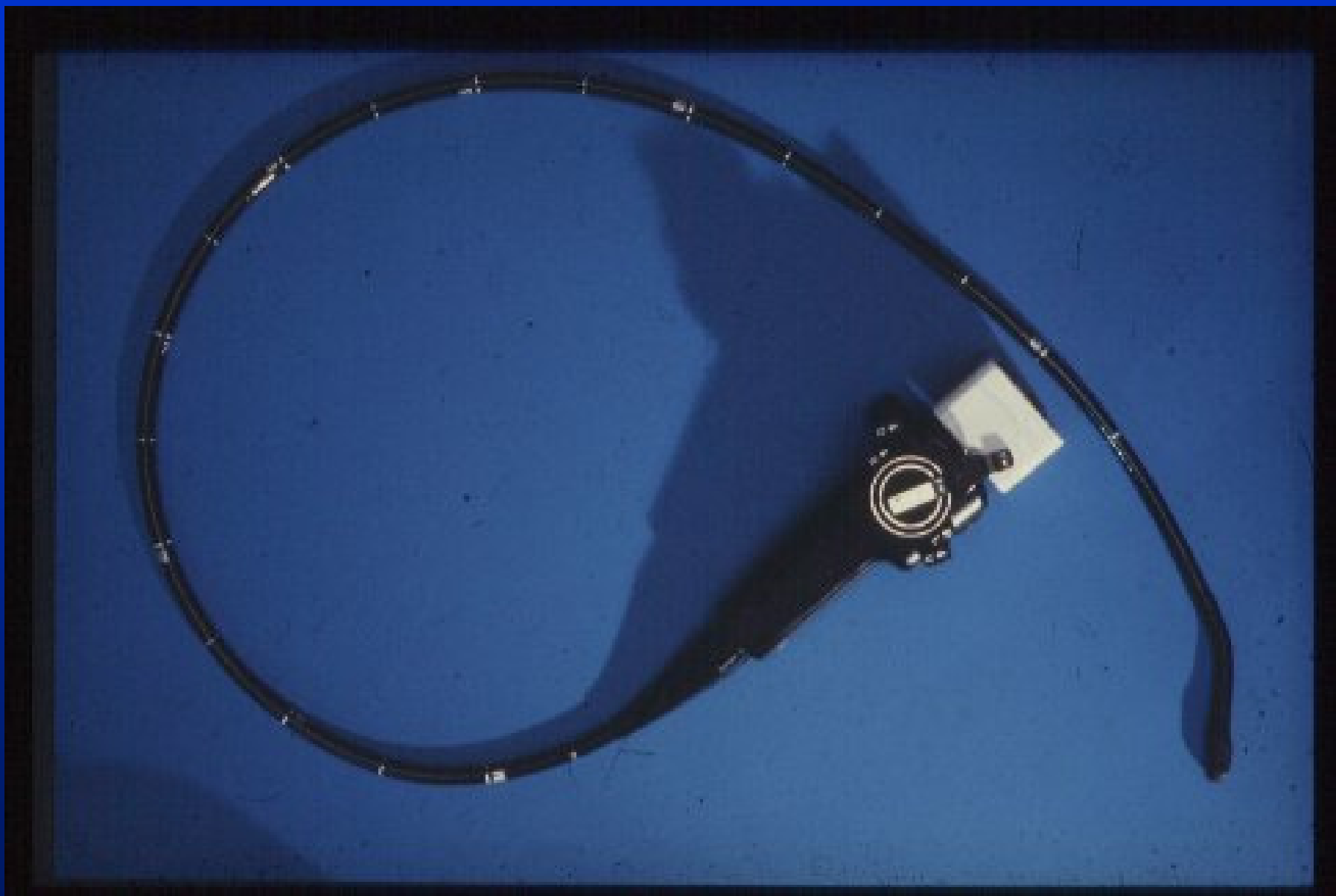


Y. Wladimiroff

Color Doppler introduced in 1982

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Trans-Esophageal-Echography



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4

1 multiplane

2 mini-multi

3 micro-multi

4 Baby probe

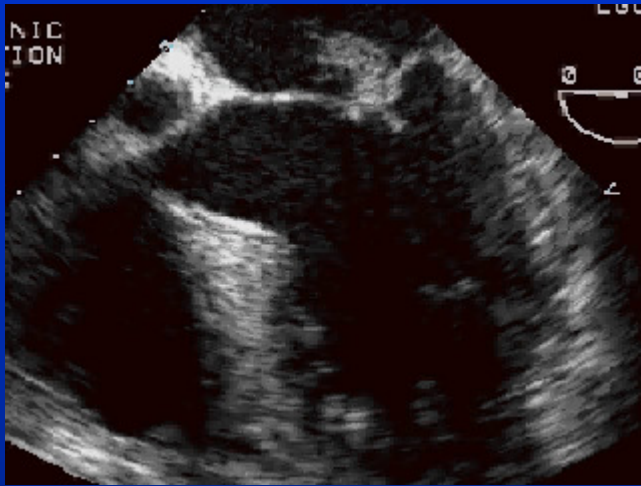
Oldelft/EUR TEE starts in 1978 with a follow up in 1983

Non invasive !!!

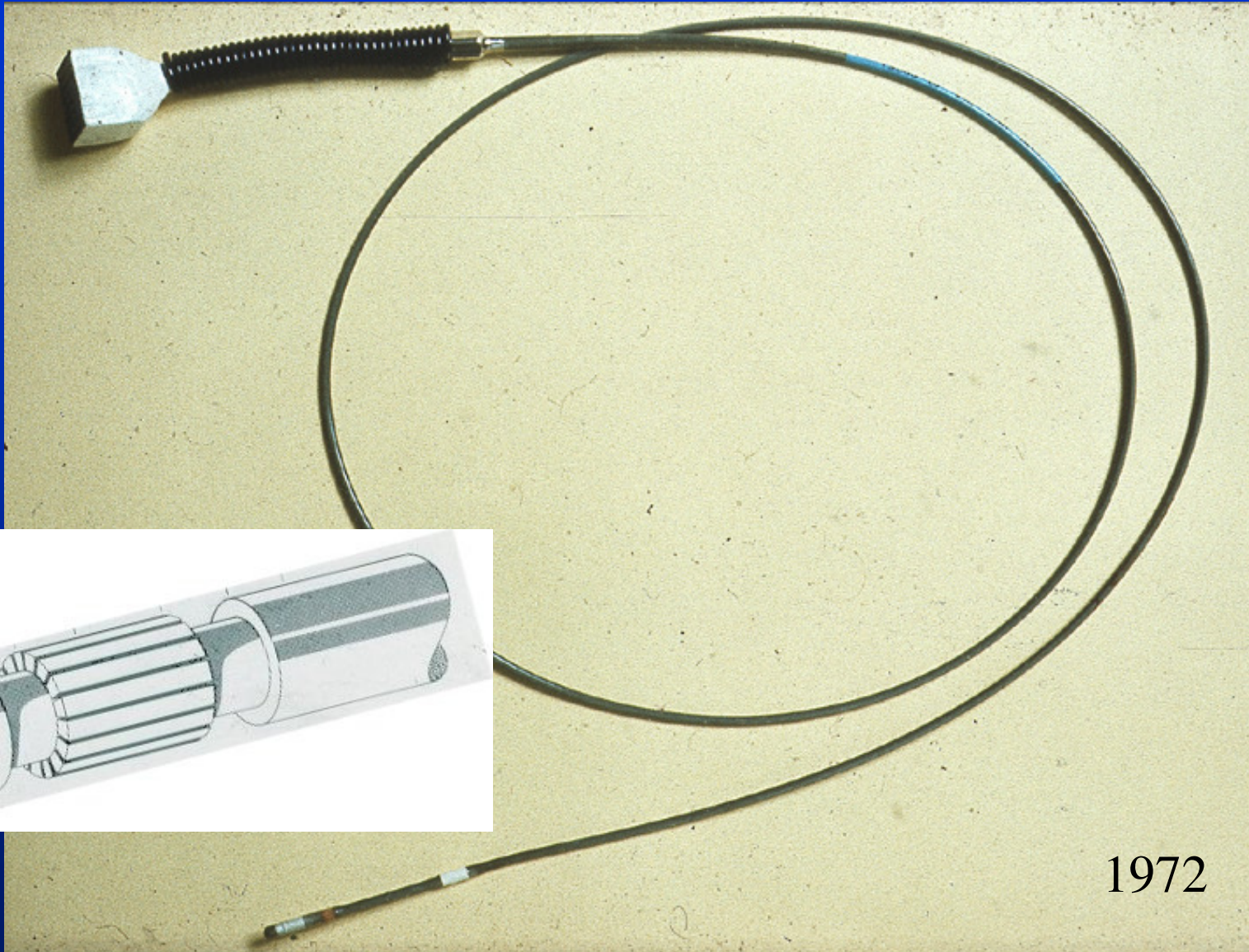


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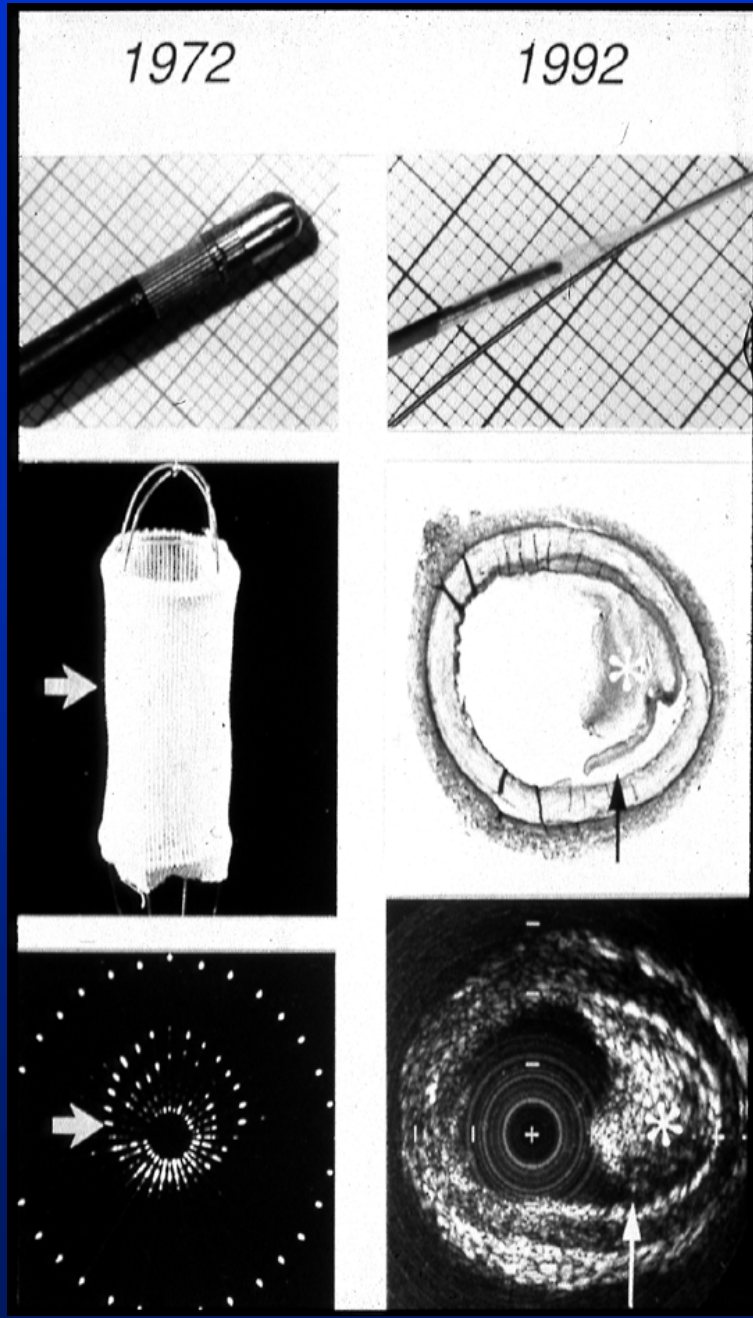
Examples of TEE



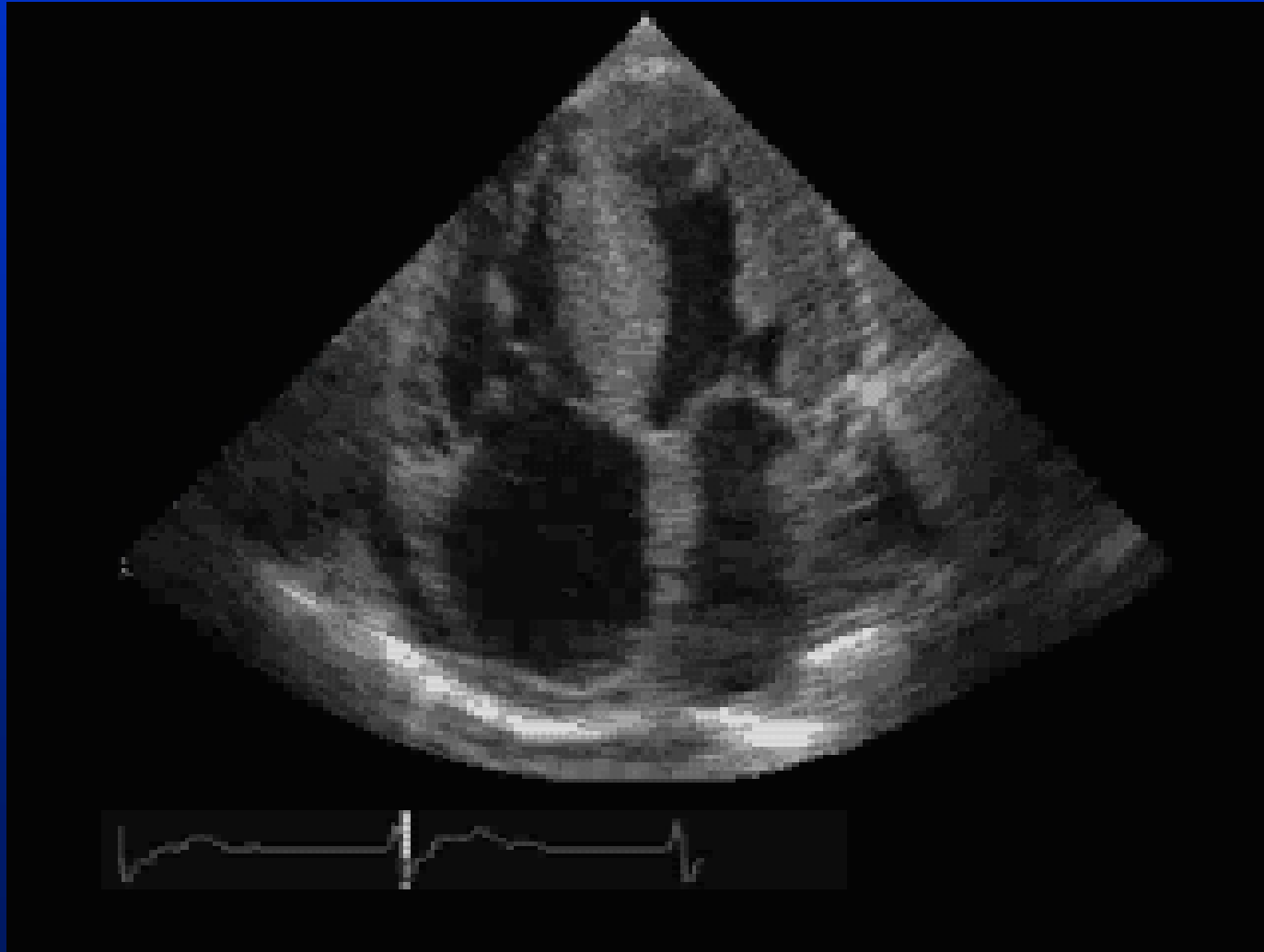
Echo catheters. Start 1969.



1972



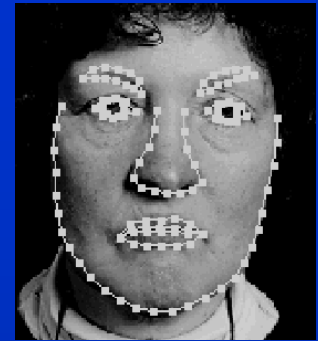
How could we quantify automatically?



42

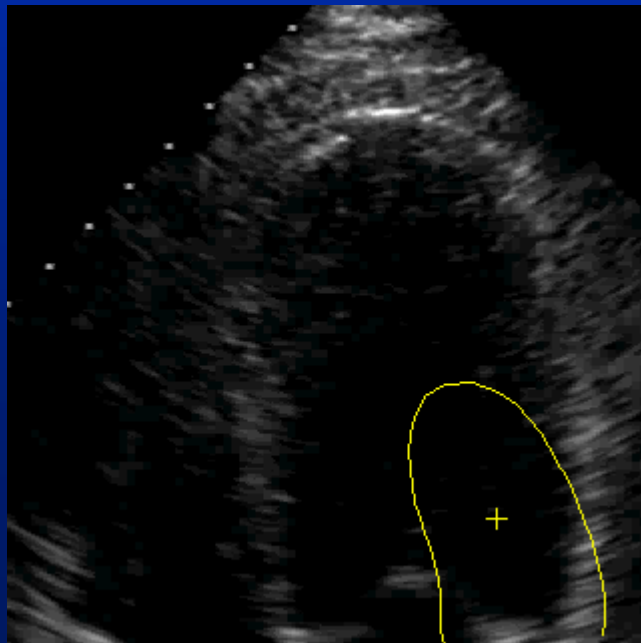
Active Appearance Models

- Introduced by Cootes, Taylor et al. (Univ. of Manchester) for facial recognition and medical image segmentation
- Trained from large sets of example images with expert-drawn contours
- Statistical models of typical variations in object shape and appearance (pixel values)
- Can (re)generate any likely shape / appearance
- Can locate a similar object in a new image

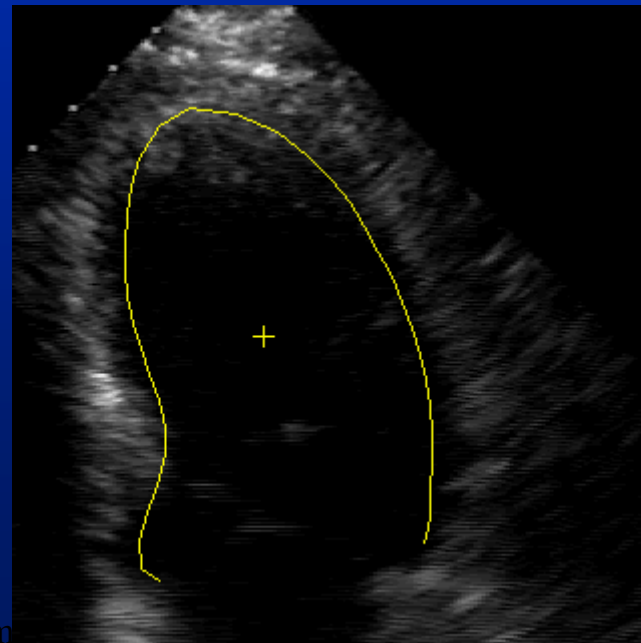


Matching: iterations on test set images

- Iterations on ED image of non-trained example
- Results of AAM match (ED, ES)
- Comparison to expert-drawn contours (ED, ES)

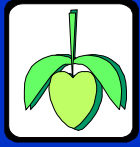


slide num



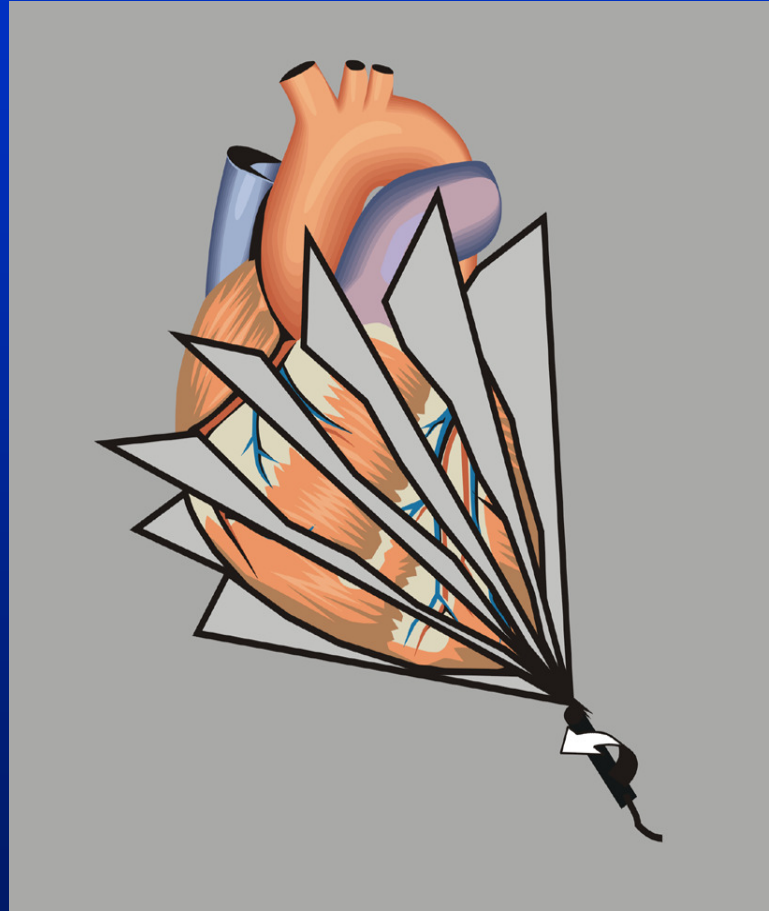
44

3D Echography

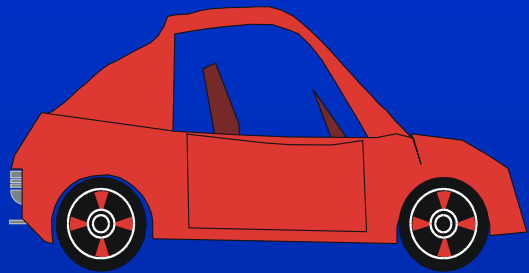


Thoraxcentr
e
Rotterdam

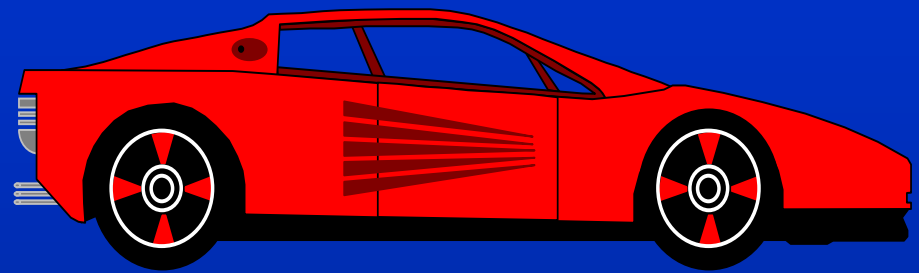
Rotational probe



NB



**Abdominal
echo**

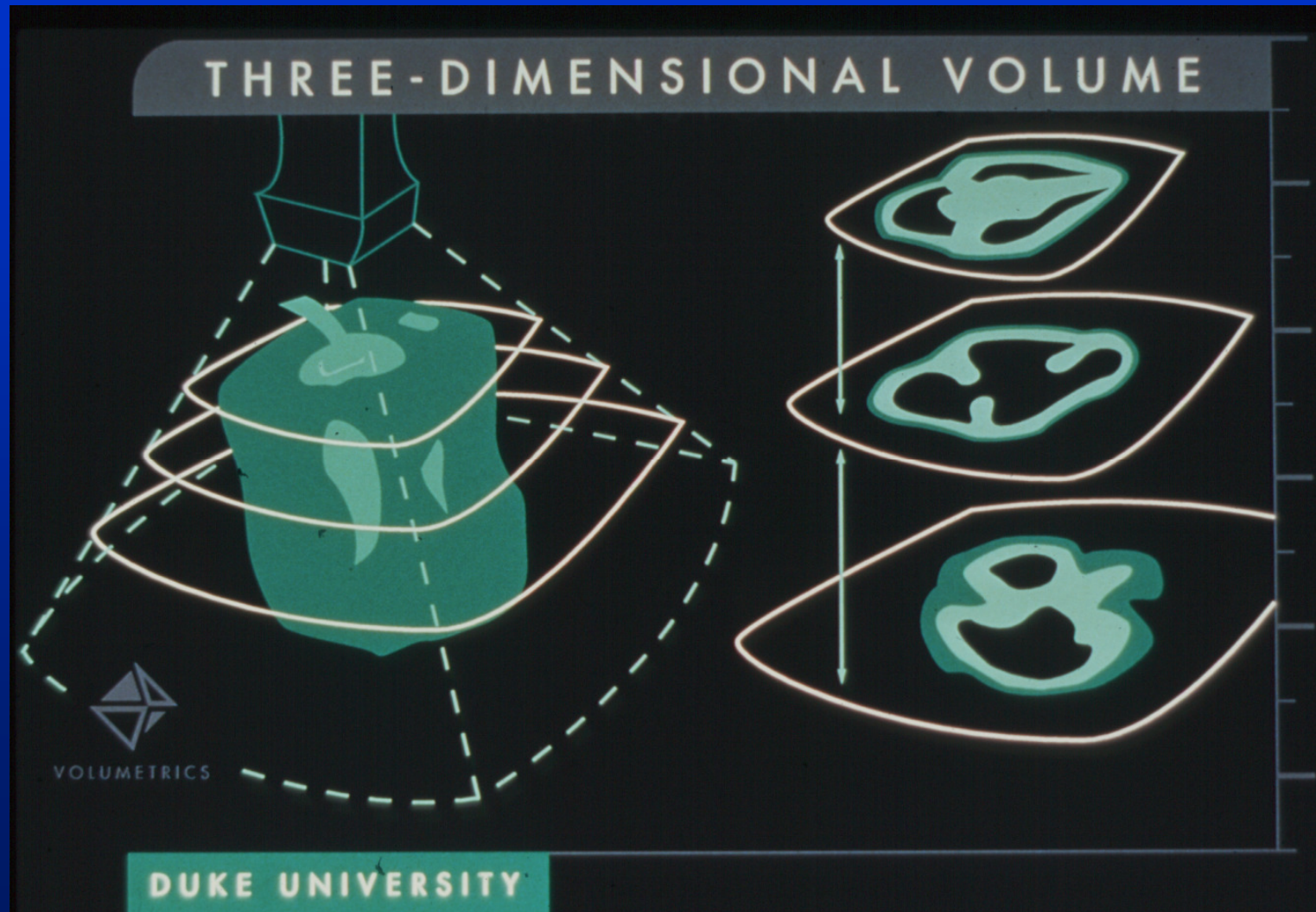


**Cardiology
echo**

Three-dimensional echocardiography

1. ECG triggered, respiration gated rotation stepping
2. Electronic 3-D beam forming
3. Fast rotating sector scanner
4. Free hand scanning with transducer orientation sensing

Real-time 3-D echocardiography

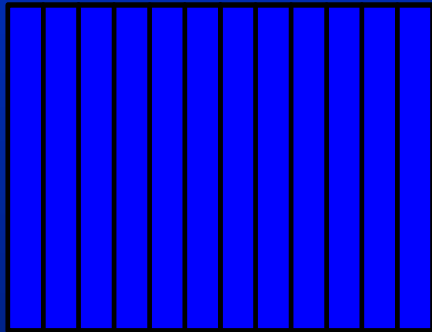


slide number

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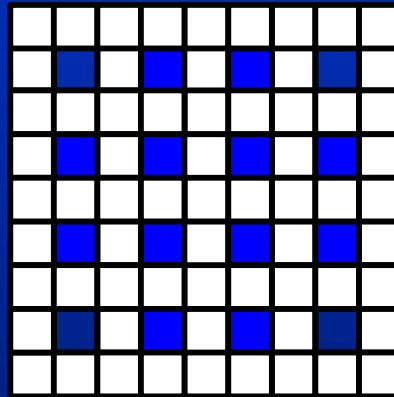
Comparison of Transducers

Sector Array
64 to 128 elements



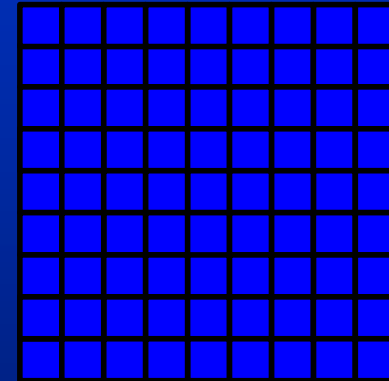
- Good for 2D Scanning
- Can be used for Slow 3-D Gated Acquisitions

Sparse Array
250 to 500 elements



- Real-time 3D Acquisitions
- Poor 3D Image Quality
- Poor Sensitivity
- Poor Harmonics
- Poor 2D Clinical Utility

The MATRIX
3000 elements



- Real-time 3D Acquisitions
- Excellent 3D Image Quality
- Excellent Sensitivity
- Excellent Harmonics
- Excellent 2D Clinical Utility



slide number

51



slide number

52

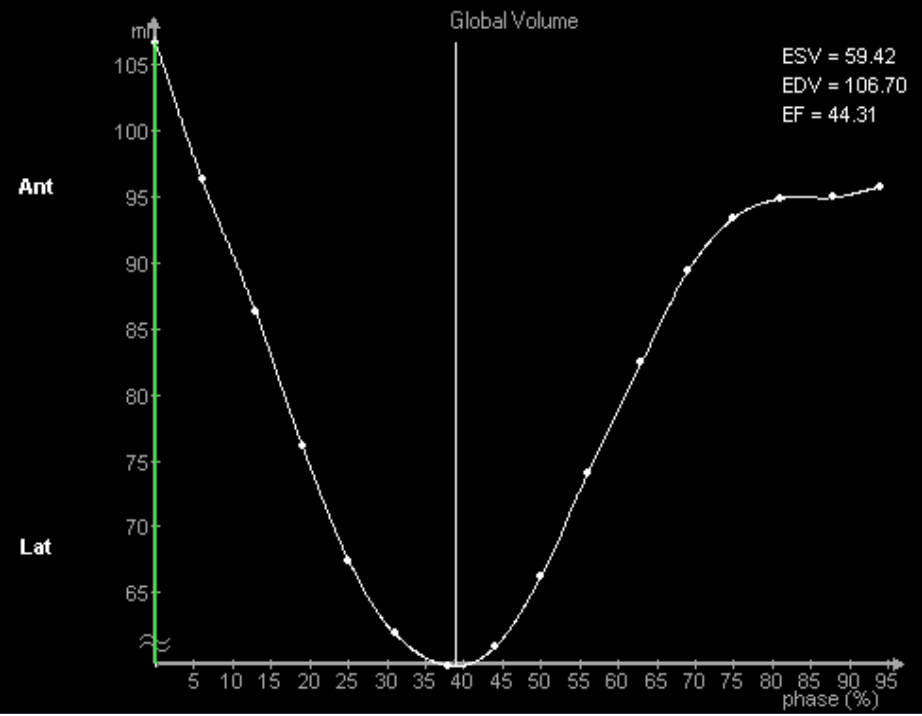
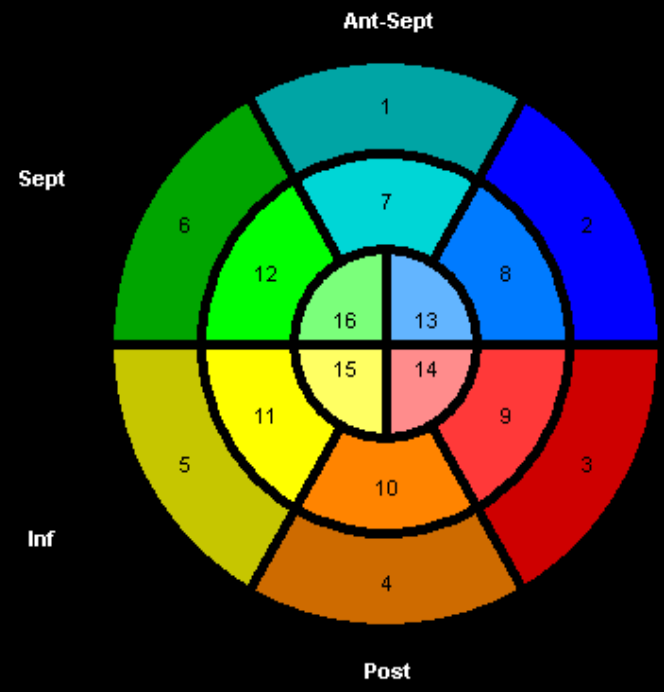
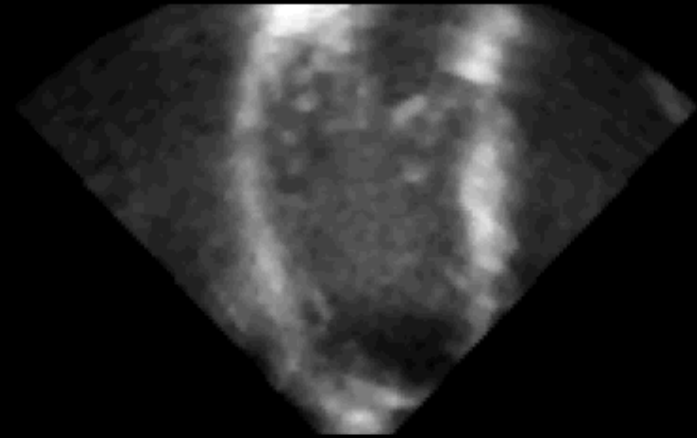
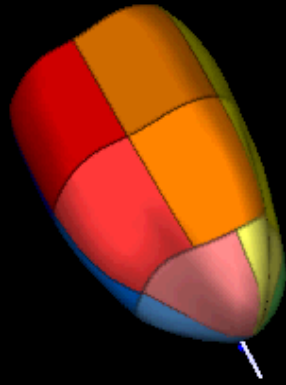
Fast Rotating Ultrasound probe

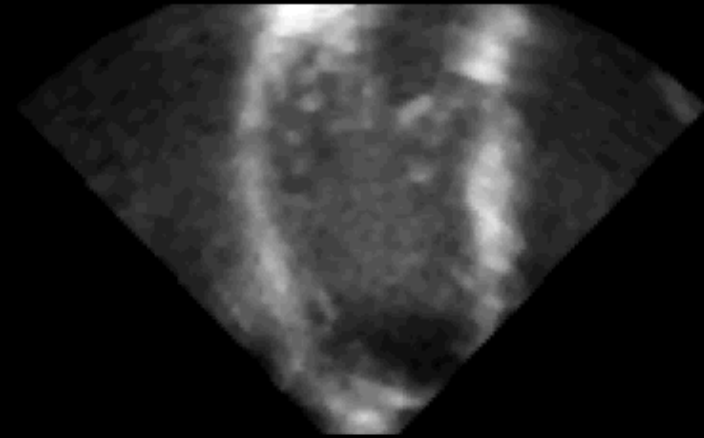
prototype I (July 1998)

prototype II (October 2000)

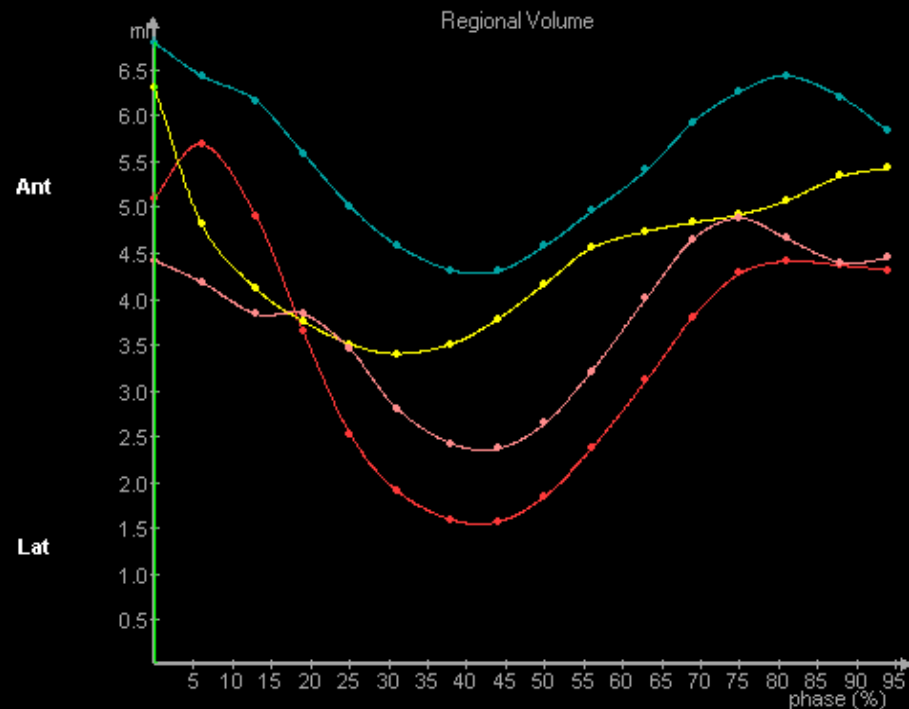
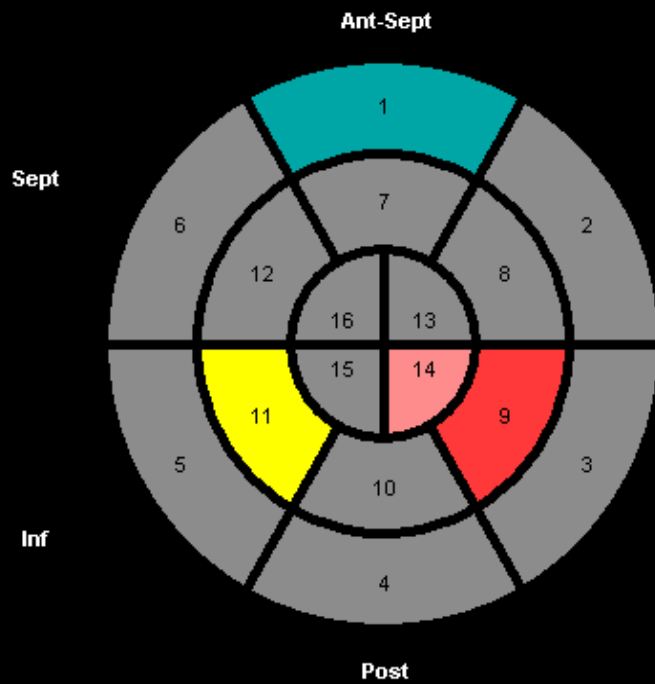
prototype III (April 2002)

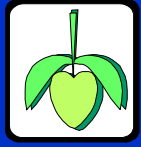






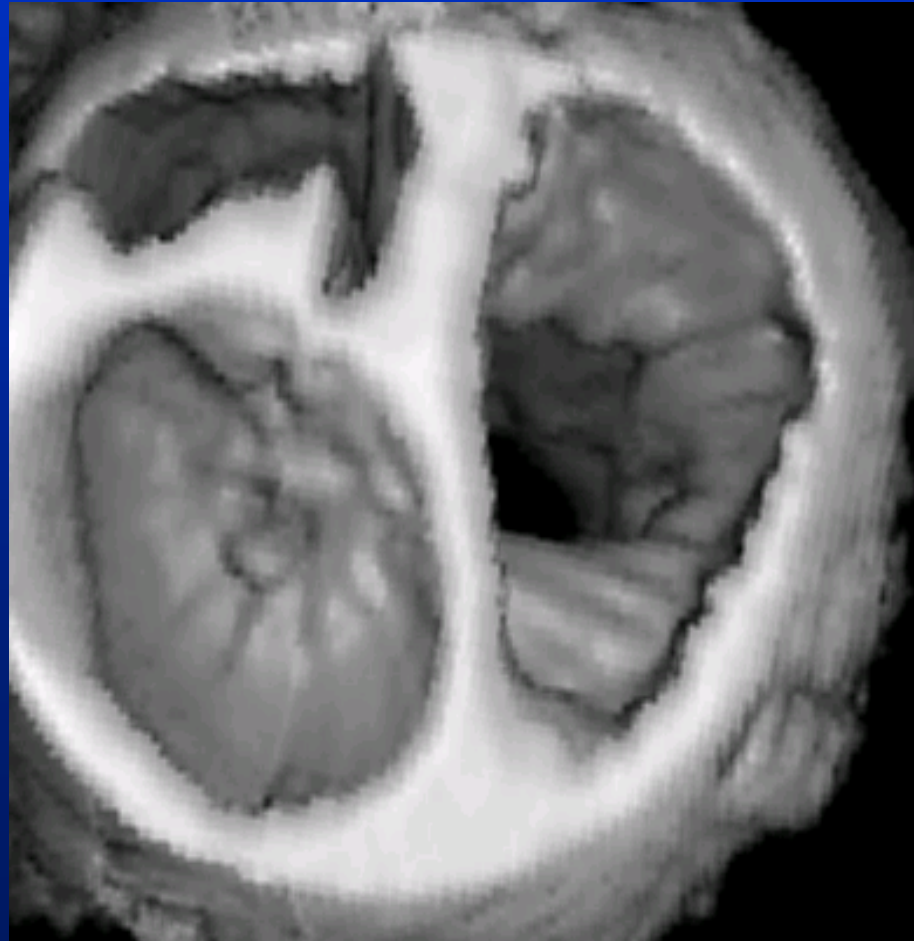
01 of 16





Thoraxcentre
Rotterdam

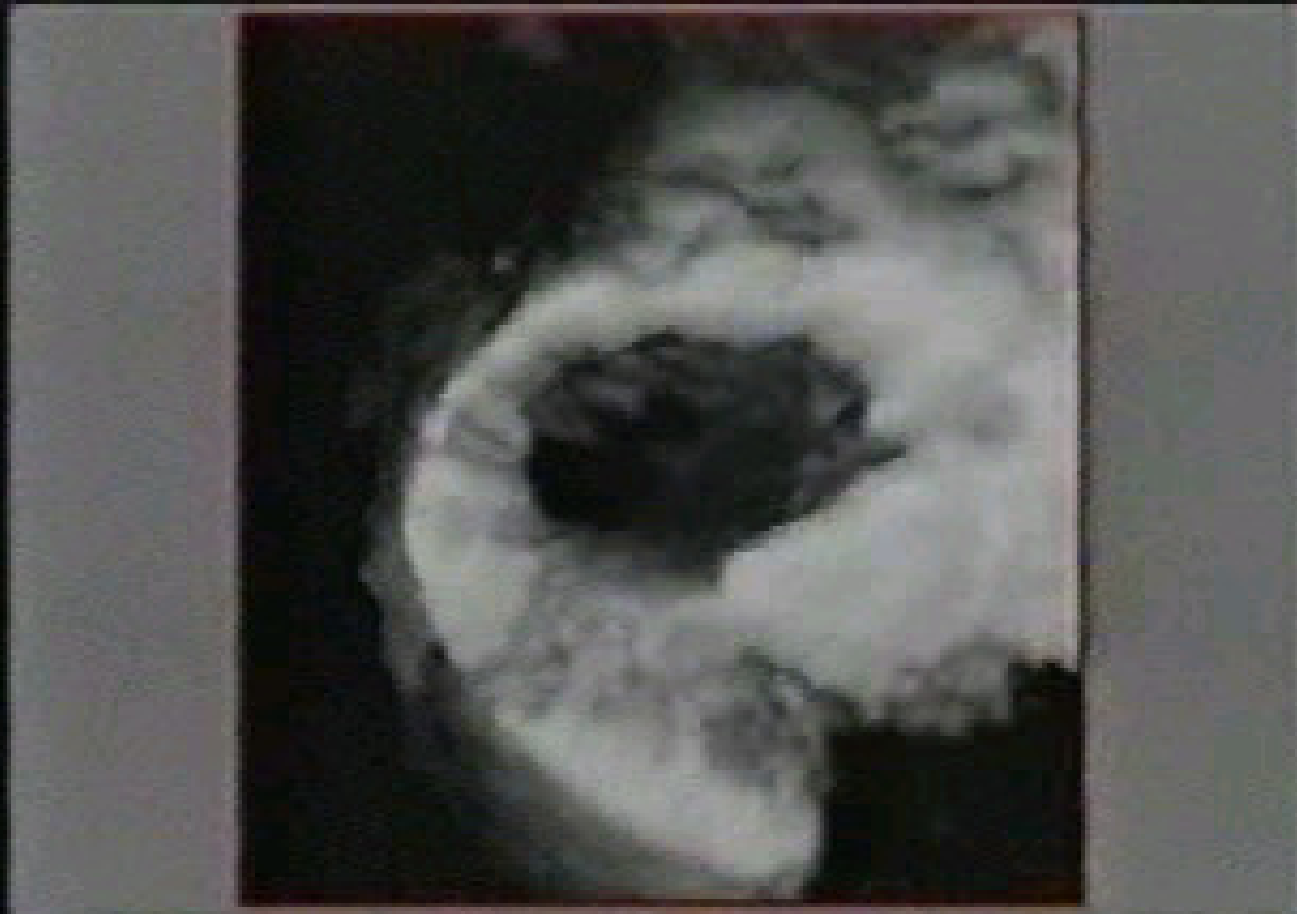
Top view atria



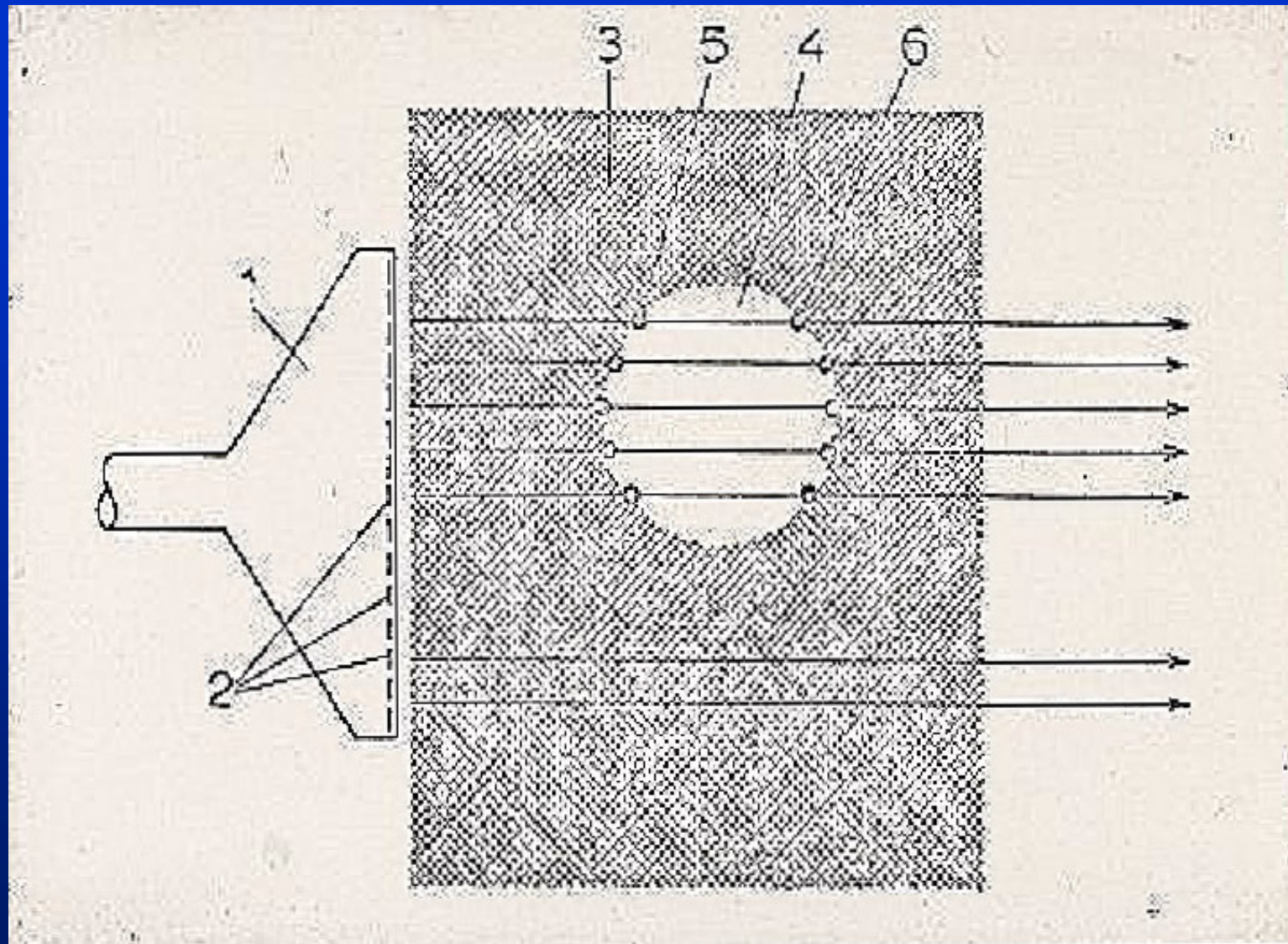
N. Bruining

MITRAL VALVE

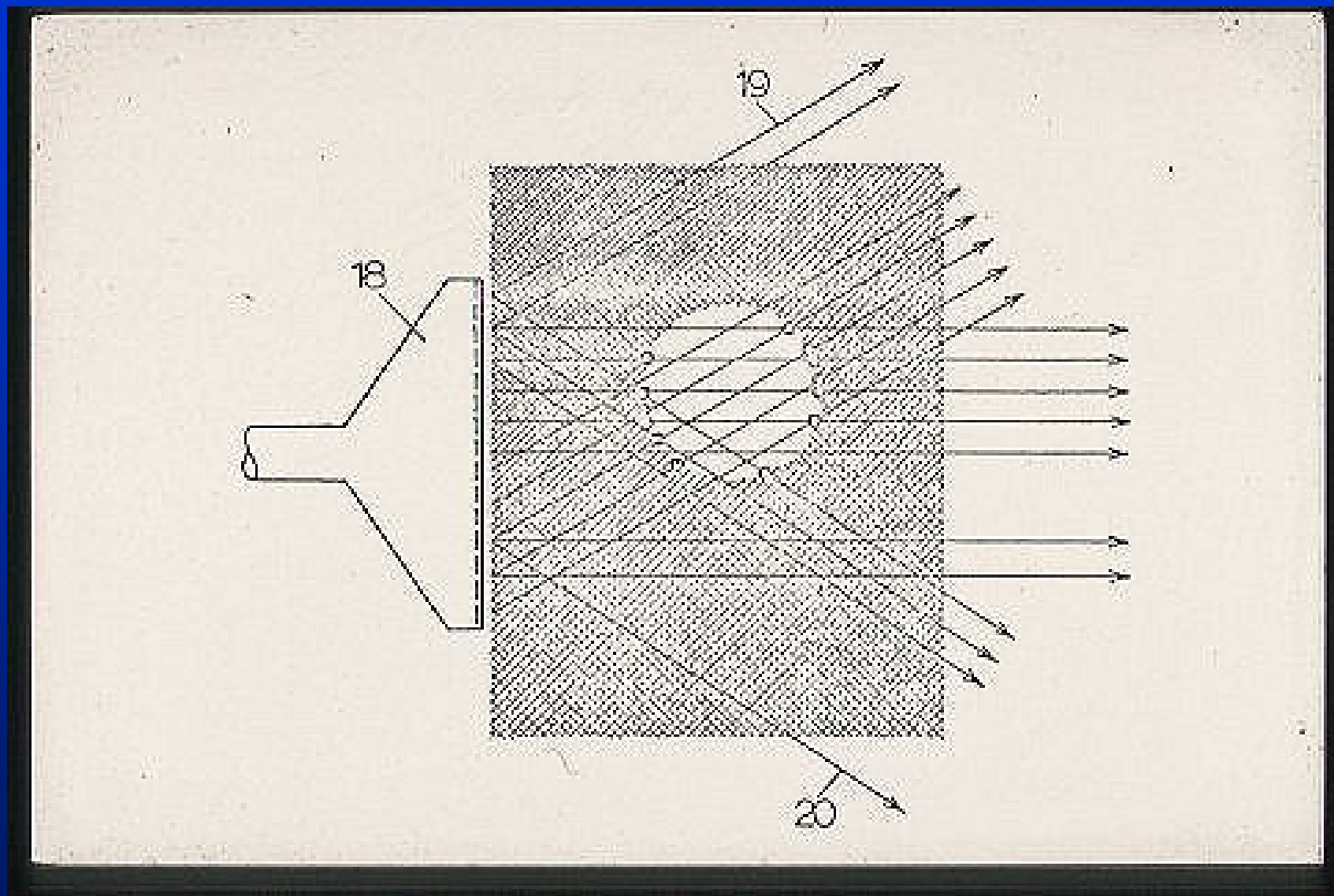
LA VIEW



Real-time compound scanning

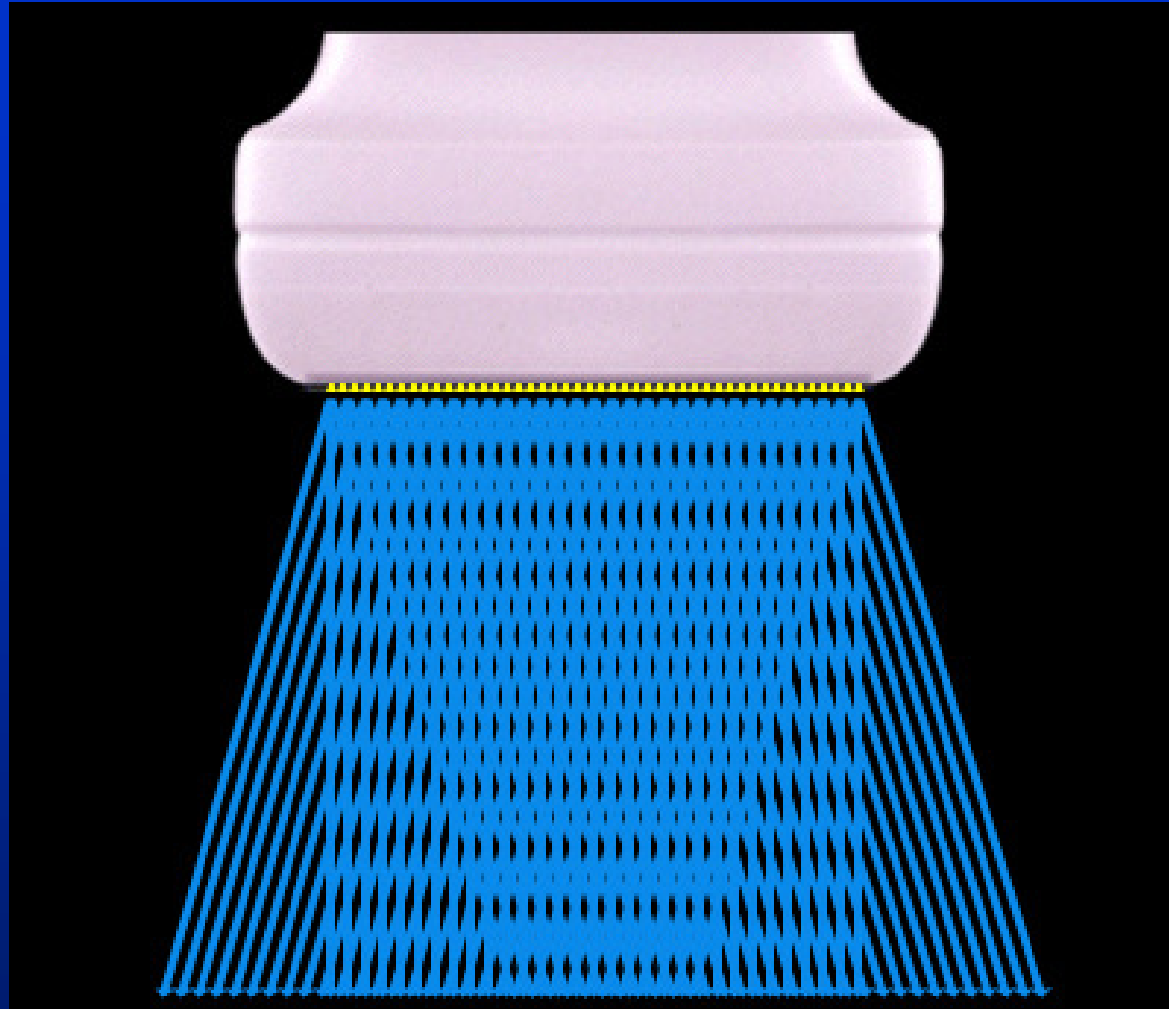


Rotterdam 1971

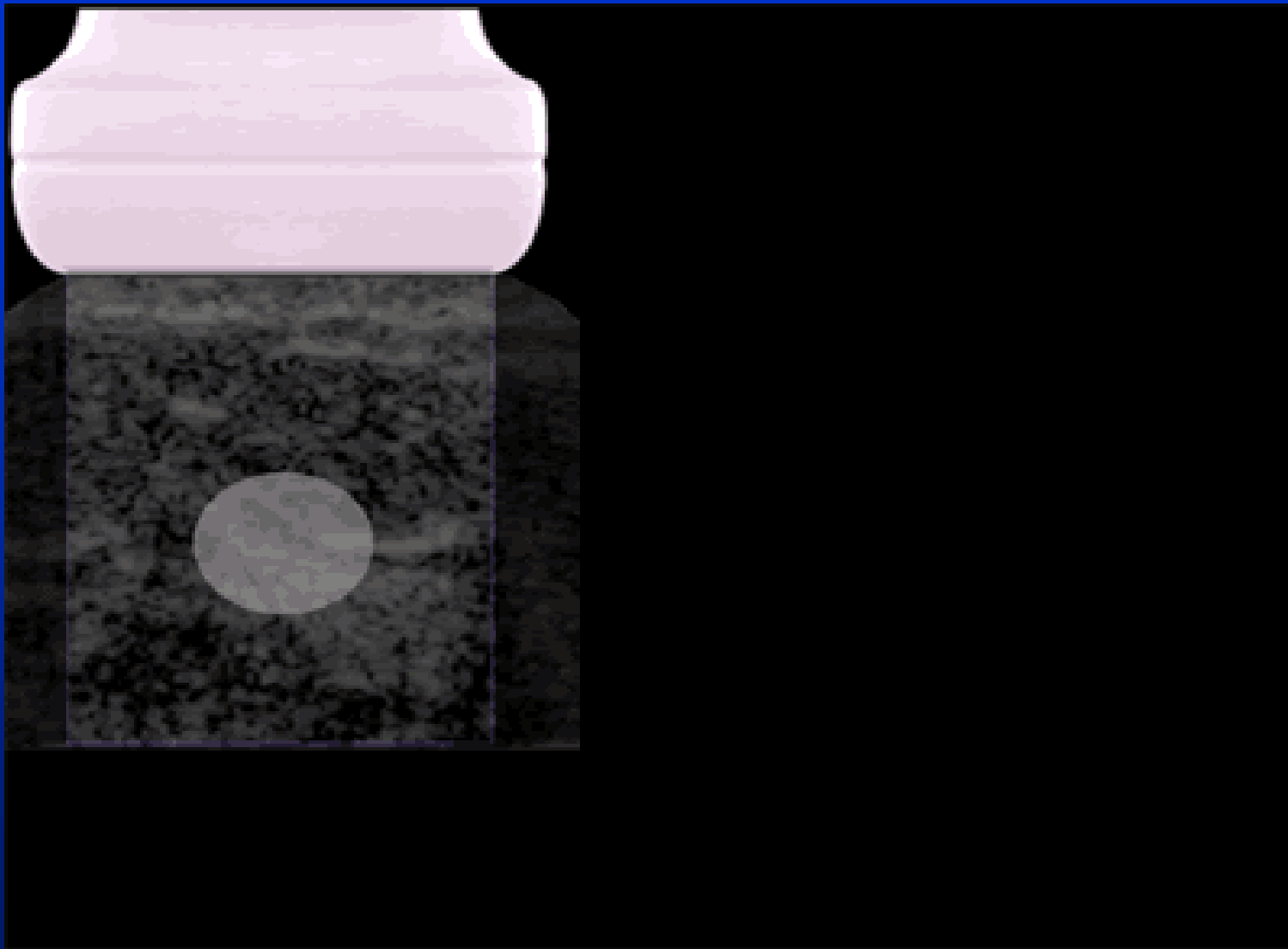


Rotterdam 1971

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courtesy ATL/Philips

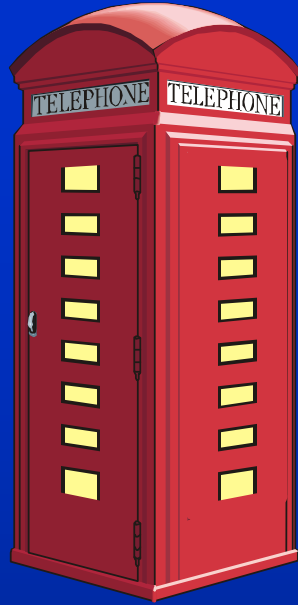


courtesy ATL/Philips

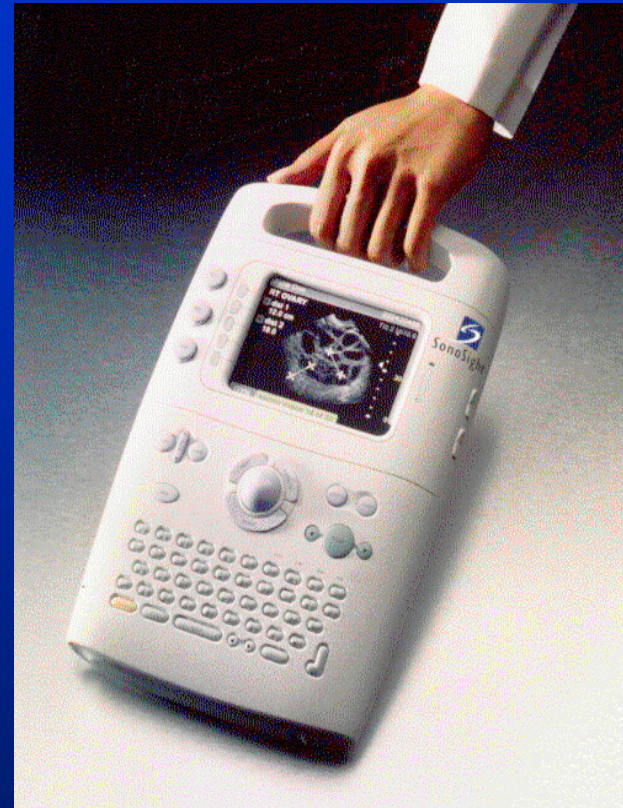


courtesy ATL/Philips

Portable apparatus



Portable apparatus



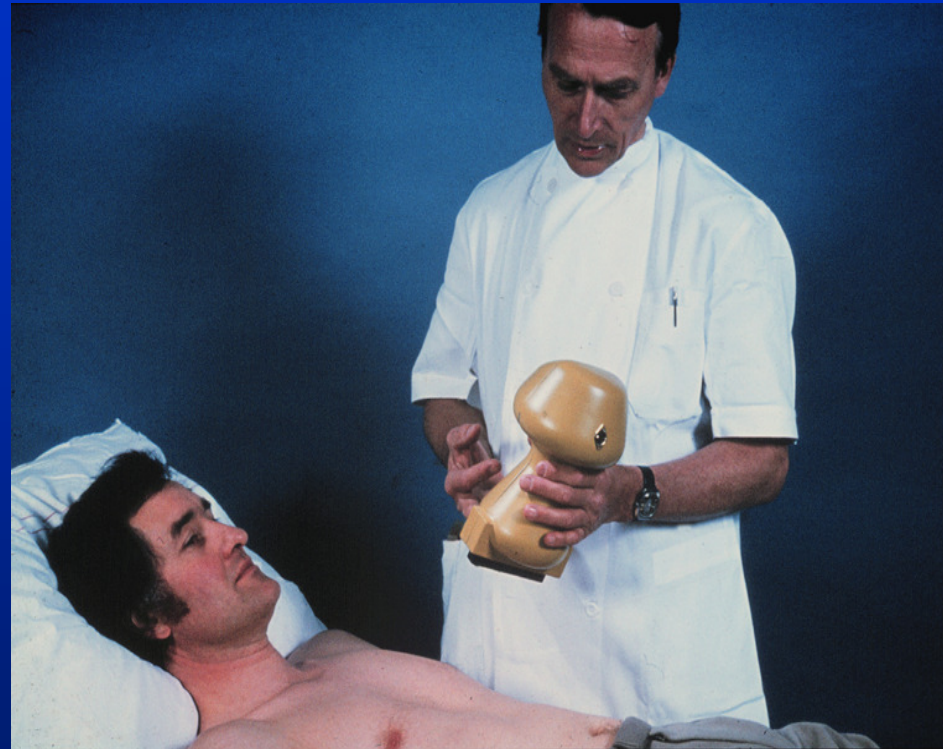
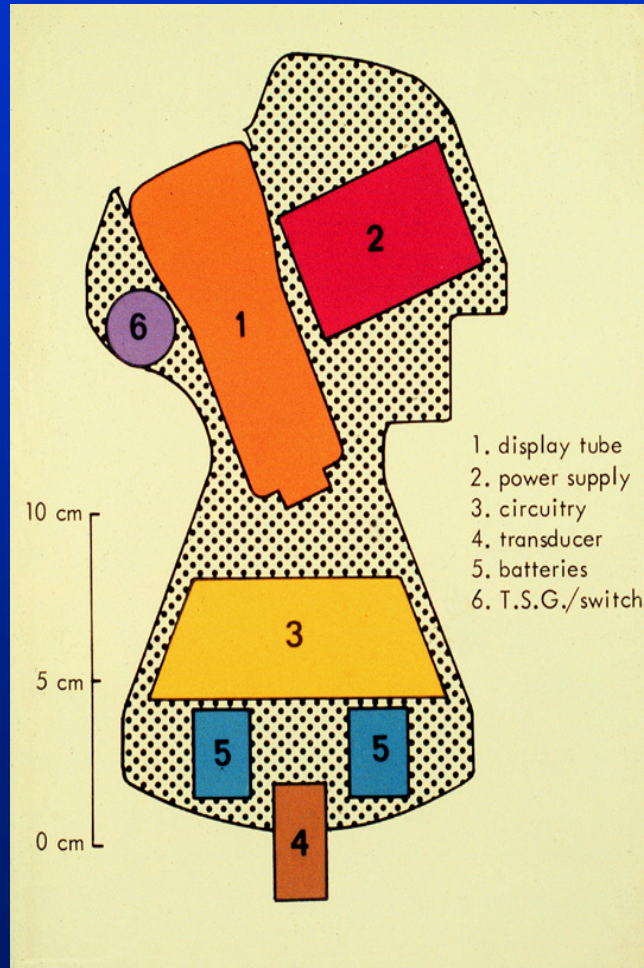


*Rotterdam
1976*

European School of Medical Physics - Archamps



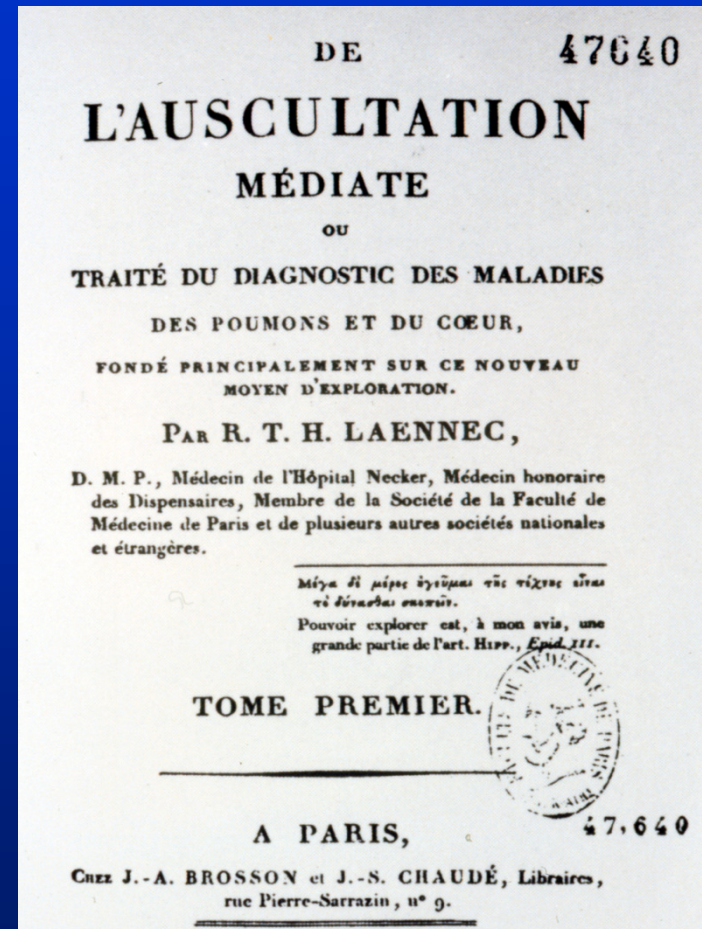
Minivisor 1975



The stetho-what?



R.T.H. Laennec (1781-1826)



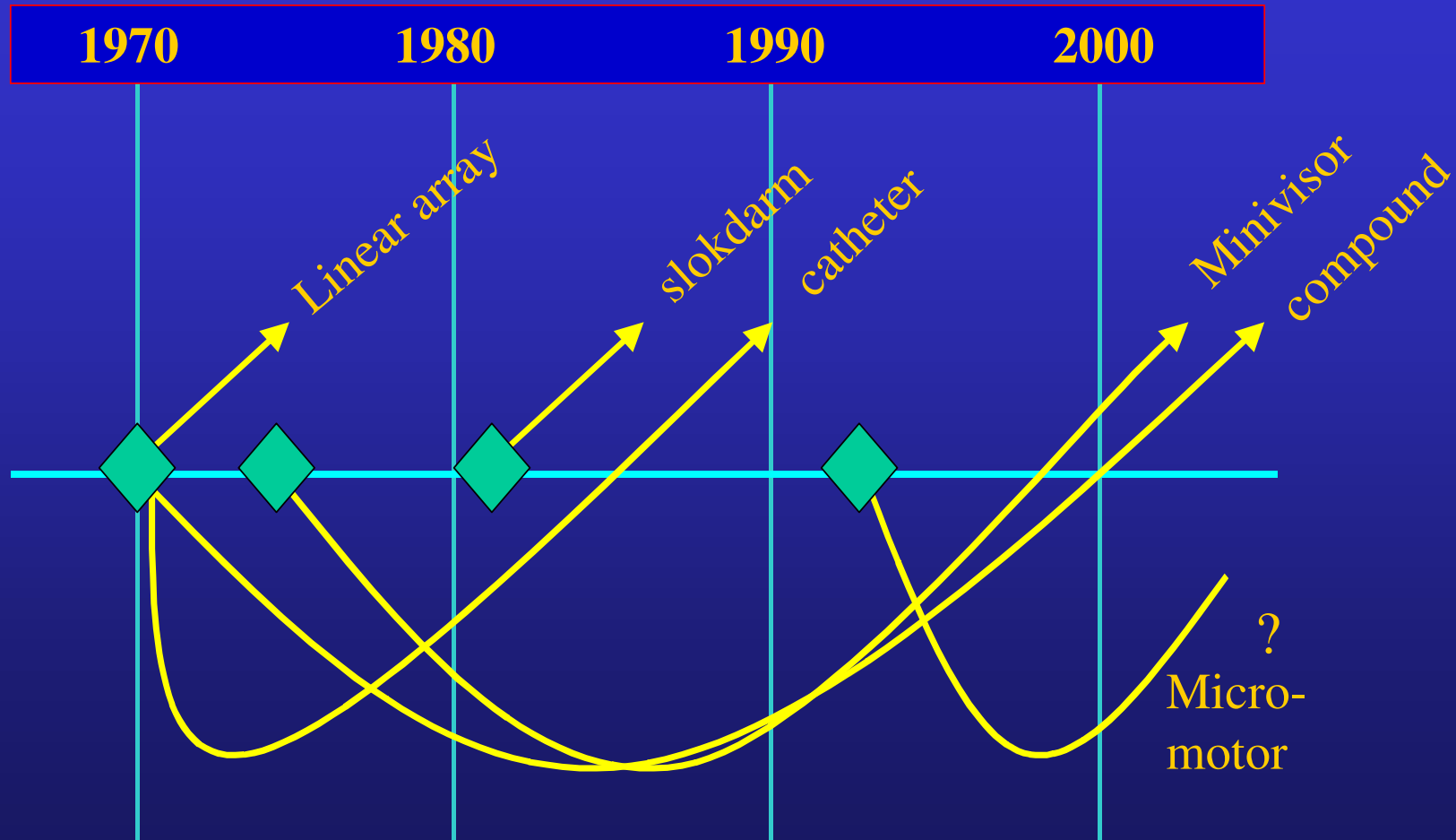
1819

slide number



The Stethophone
has become
Stethoscope

“Incubation time”



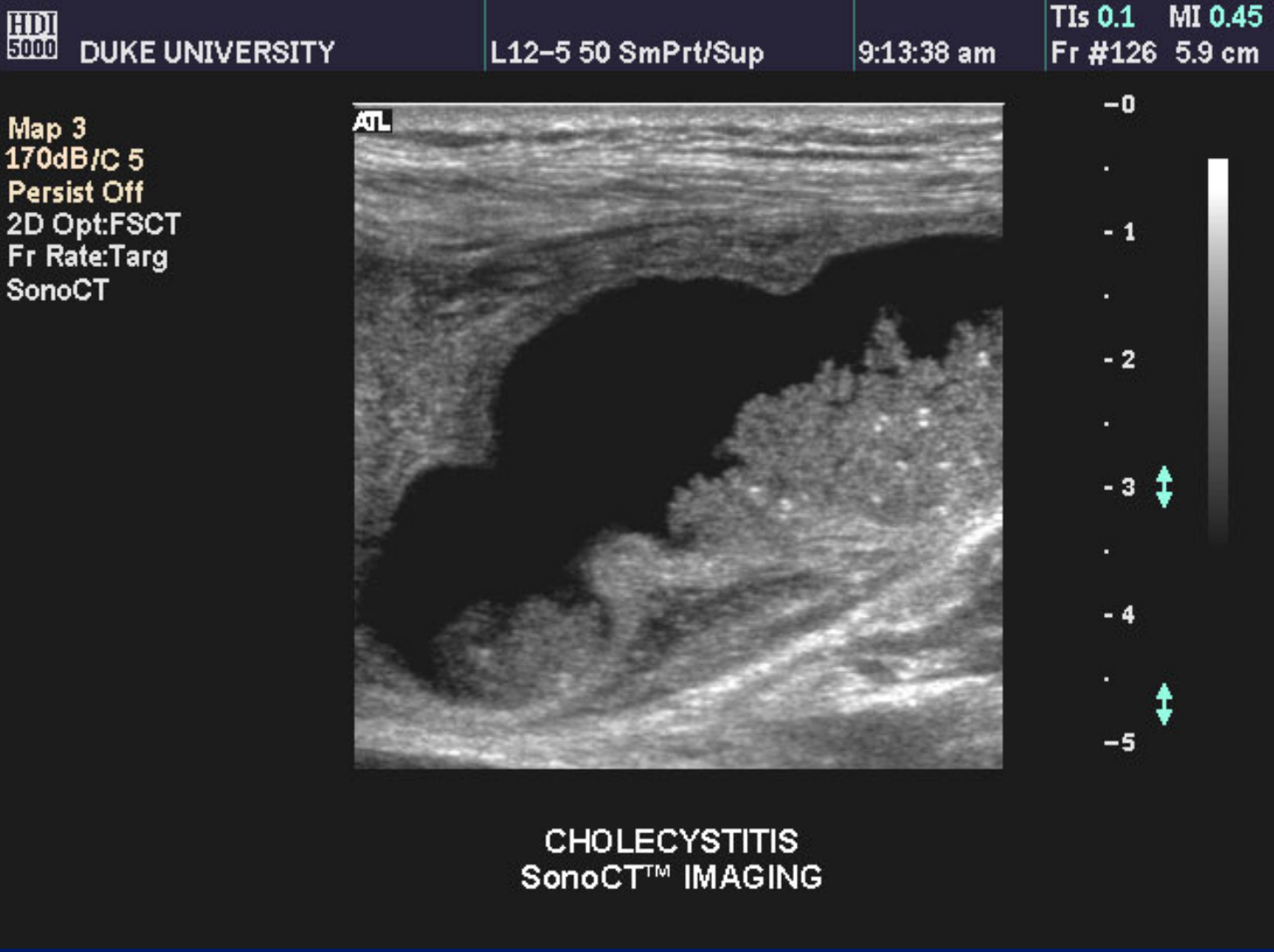
Micromotor



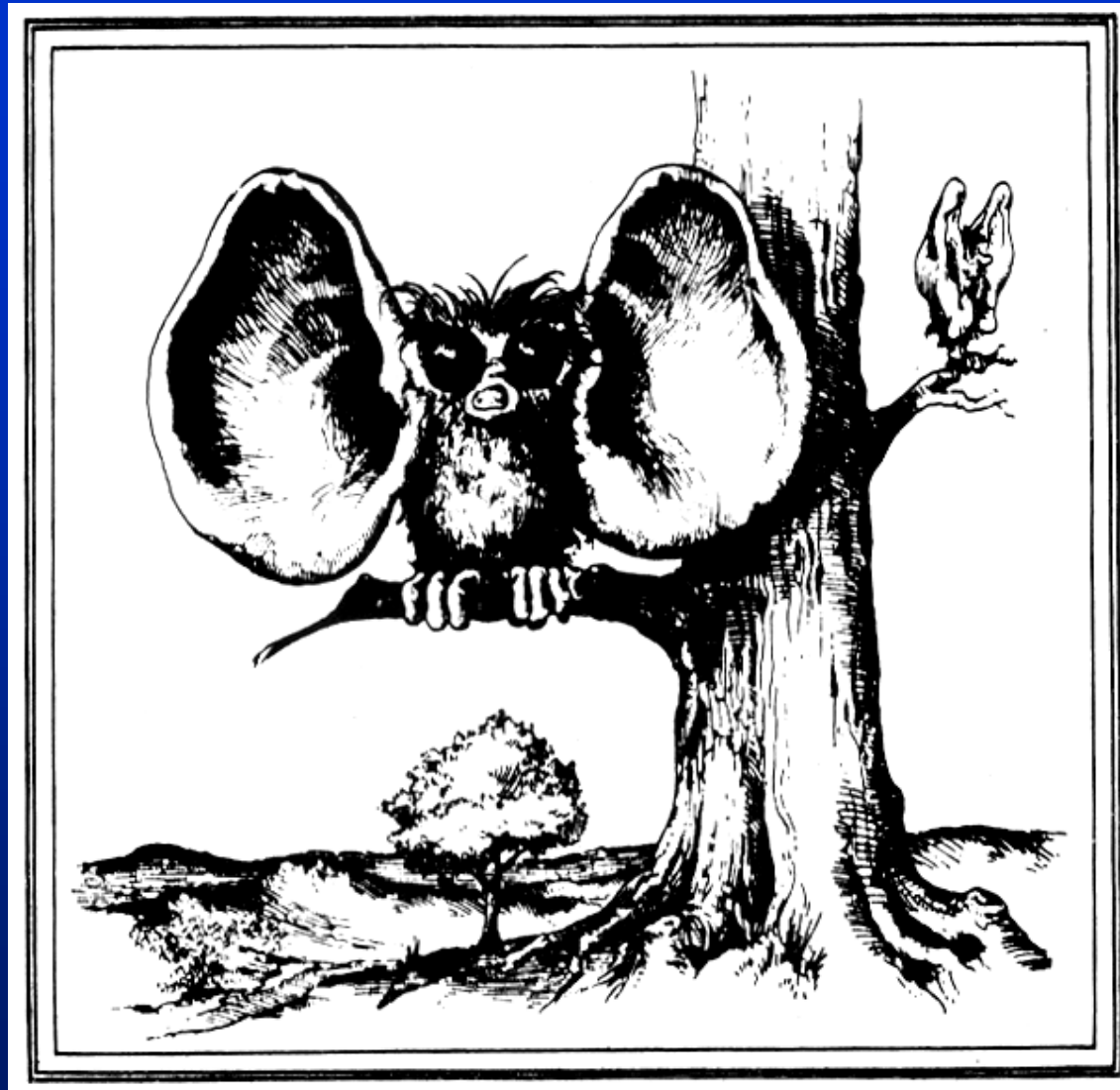
The end

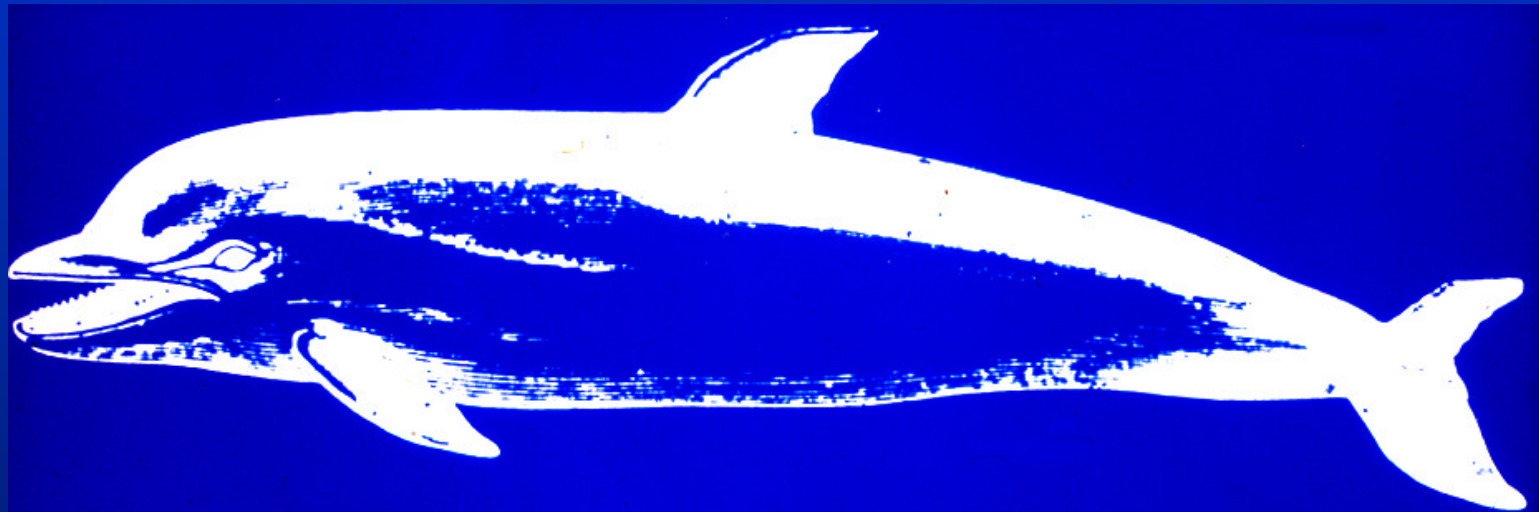


2001



courtesy ATL/Philips

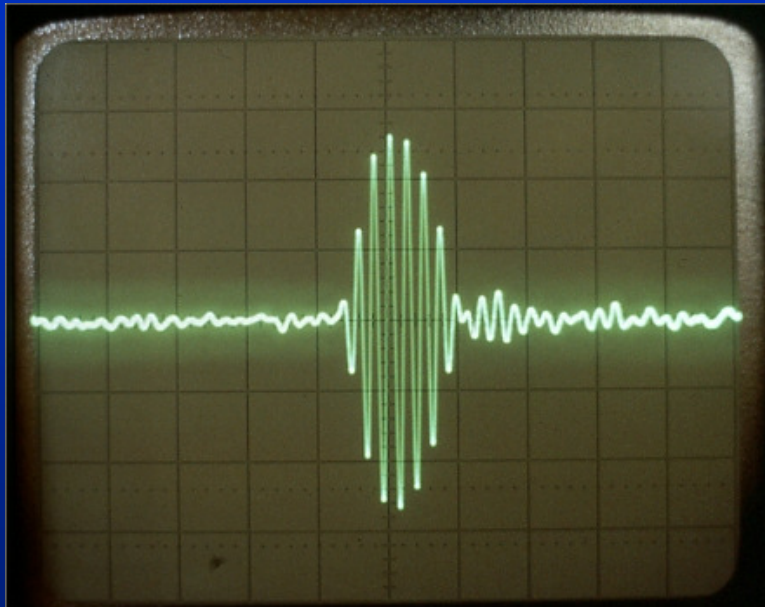




Delphinus delphis (aus règne animal).

soundpulses

purpoise (kHz)

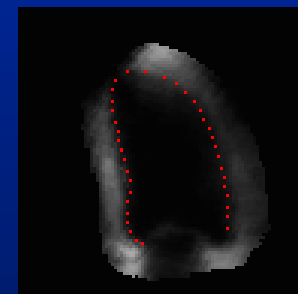
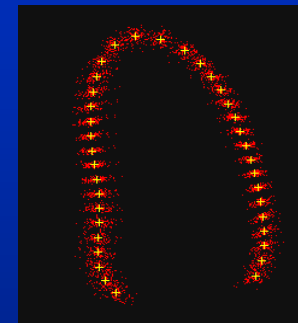


Echo apparaat (MHz)



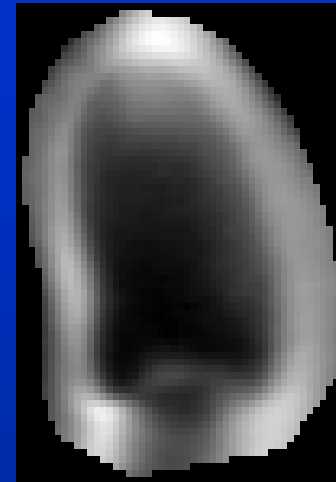
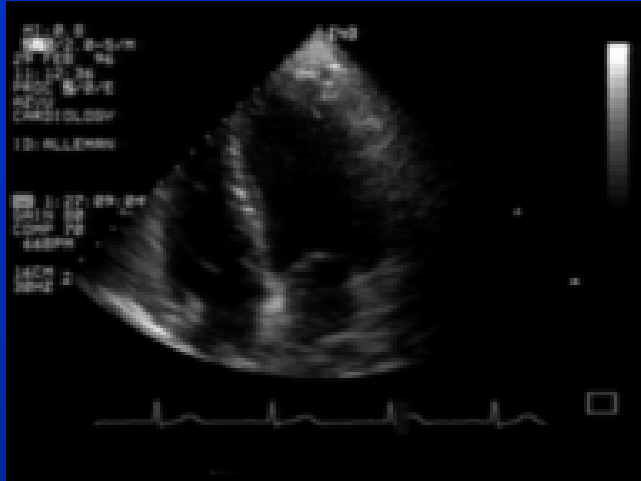
Active Appearance Model (AAM)

- ‘Learns’ properties from a population of example images + contours by Principal Component Analysis
- Describes the shape of an organ as
 - an average shape +
 - a small set of eigenvariations
- Describes overall object appearance
 - an average image +
 - set of gray value eigenvariations
- Detection of the object by eigenvector optimization



AAM Model Generation

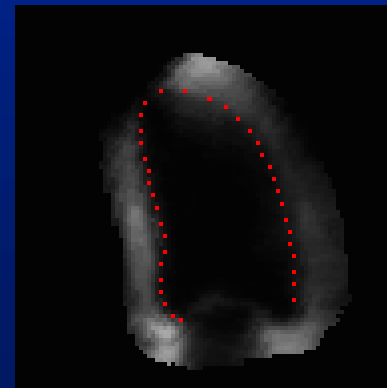
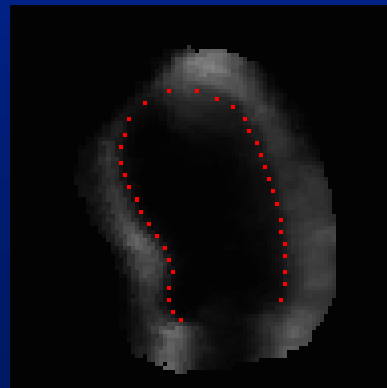
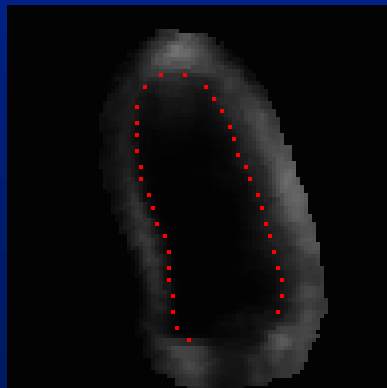
Set of examples



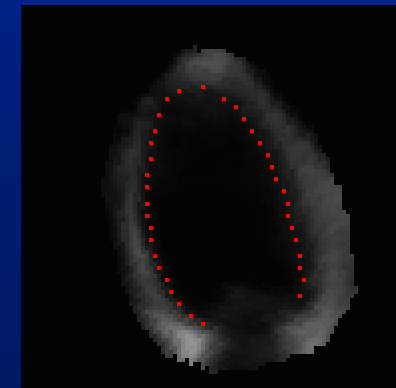
Average
patch



Appearance
eigenvariation 1

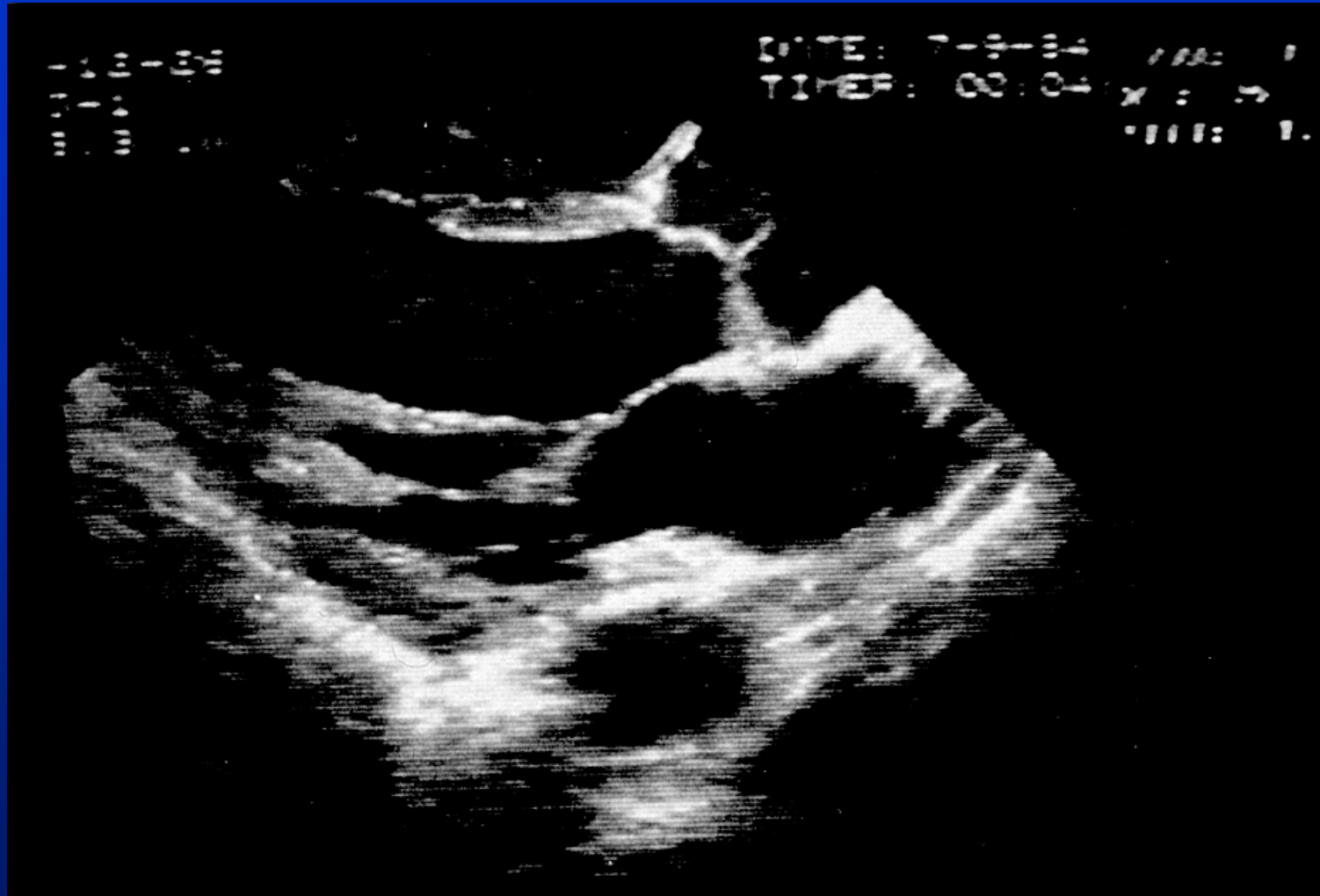


Appearance
eigenvariation 4



slide number

81



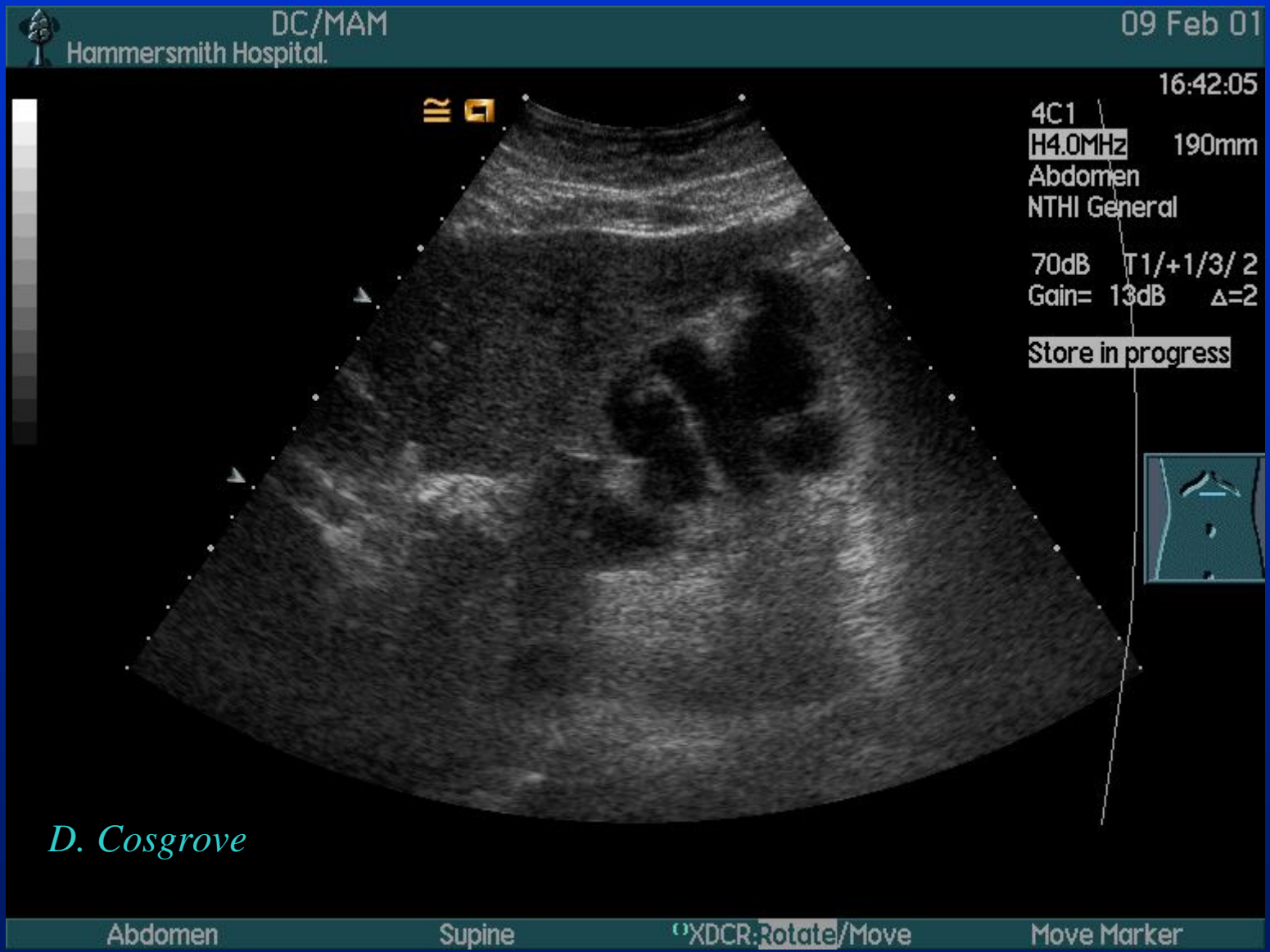
DC/MAM
Hammersmith Hospital. 09 Feb 01

16:42:05

4C1
4.0MHz 190mm
Abdomen
NTHI General

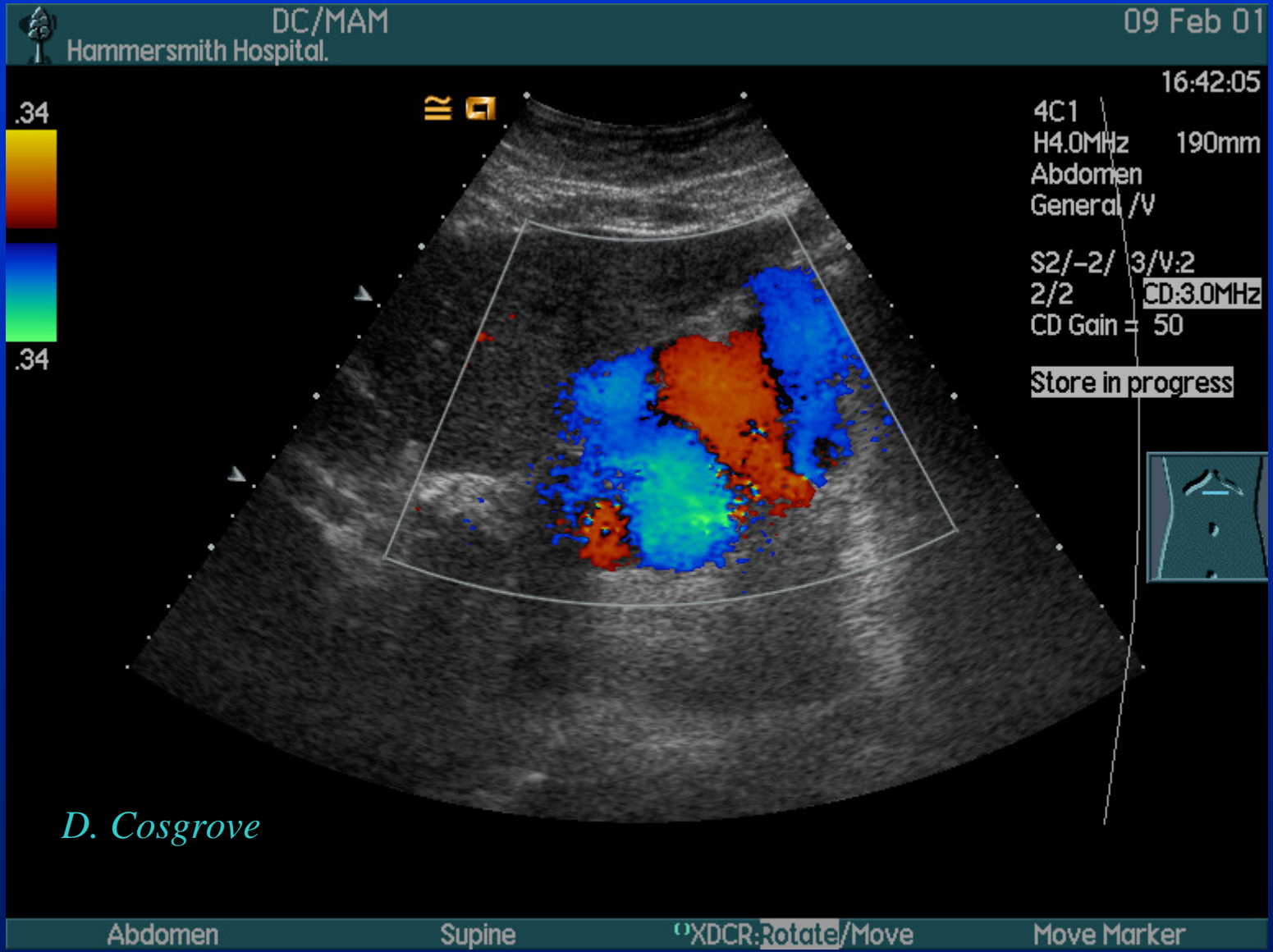
70dB T1/+1/3/2
Gain= 13dB Δ=2

Store in progress



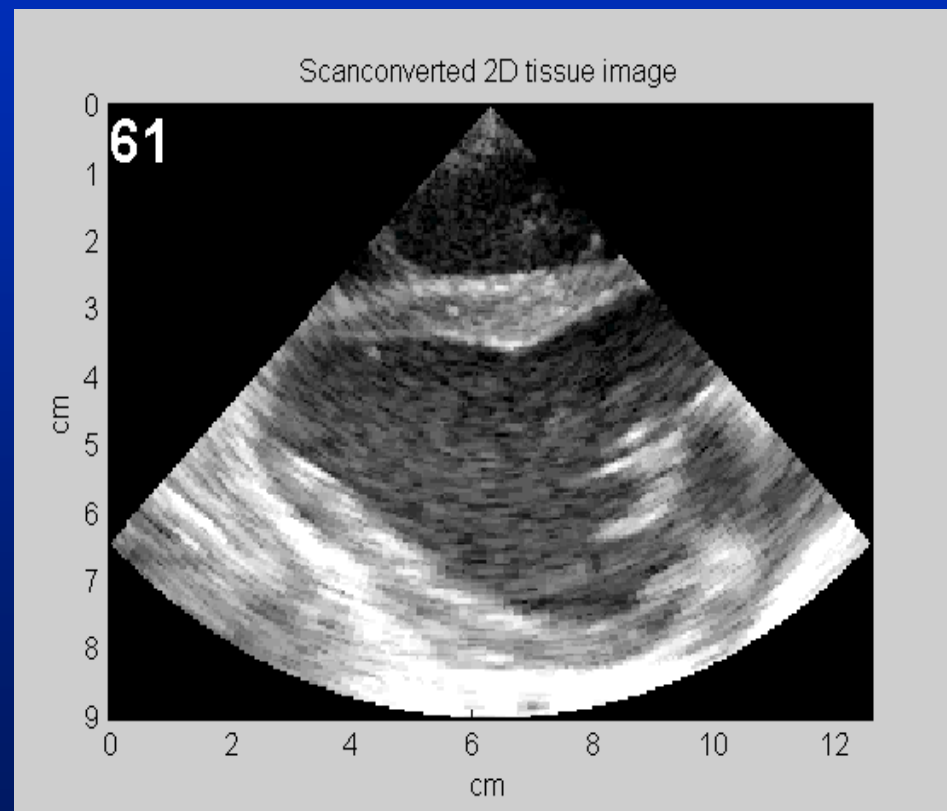
D. Cosgrove

Abdomen Supine XDCR: Rotate/Move Move Marker



Real-time 3-D echocardiography

Fast rotating probe



slide number

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