Medical ultrasound: examples of applications

Fetal imaging
“Needle imaging”
3D Ultrasound

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CREATIS

Fetal imaging
“Needle imaging”
3D Ultrasound
IVUS

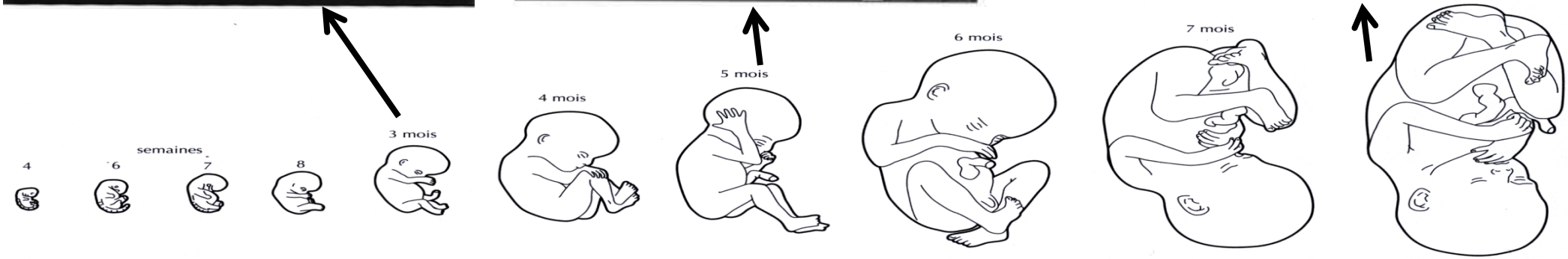
Medical application: fetal growth monitoring

- In France: 3 exams during pregnancy
- between 9 and 14 weeks
- between 20 and 22 weeks
- between 32 and 34 weeks

11 weeks

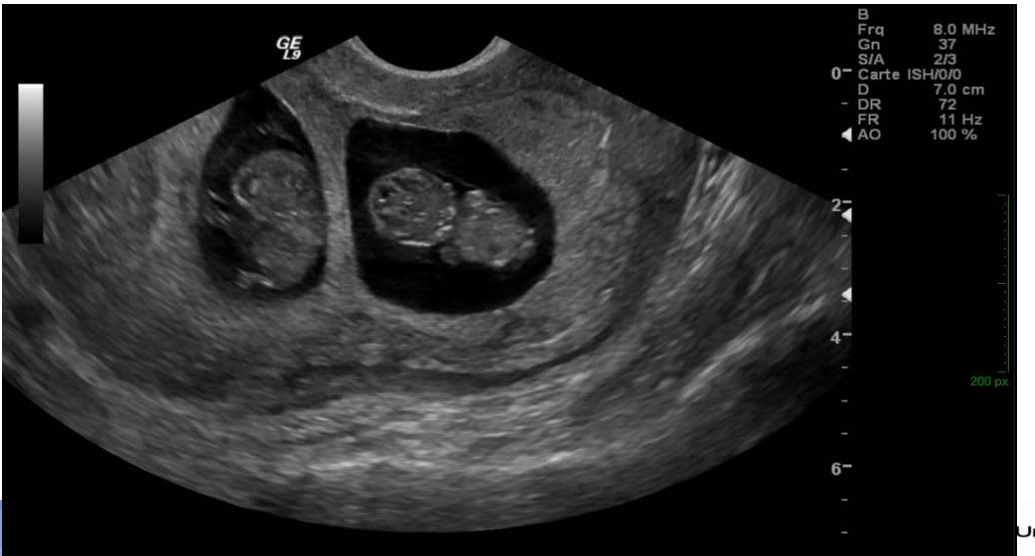
20 weeks

31 weeks



Medical application: fetal growth monitoring

- **Echo 1: Goal**
  - determine age of the pregnancy
  - establish the normal ongoing of the pregnancy and growing of the baby
  - determine if there is a multiple pregnancy
- **The type of the probe: depends if the exam is done intra vaginal or externally (depends on the size of the fetus)**

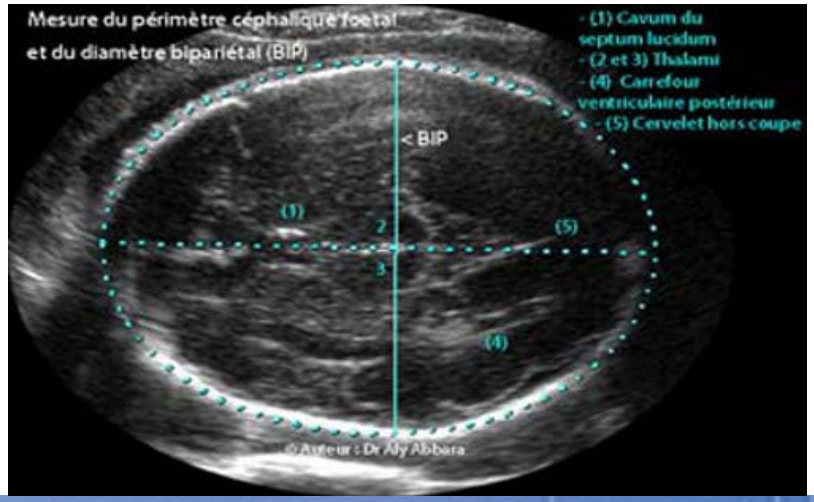


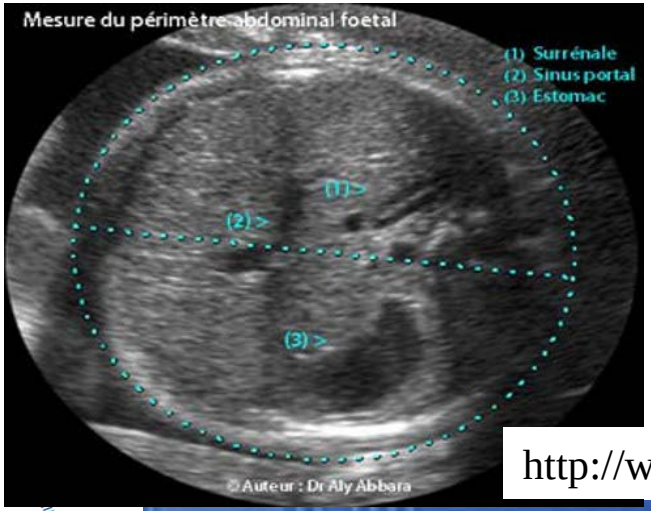
Surprise we are two ☺

www.mamo.fr

Measurement of the neck clarity
Thickness of the skin at the neck
Marker of the risk of trisomy
Markers are positioned in the image and the distance is calculated automatically

Measurement of the abdomen and cranium size ➔ age of pregnancy
Manual positioning of markers and automatic size calculation





http://www.futura-sciences.com

Medical application: fetal growth monitoring

- **Echo 2: Goal**
  - Complete morphological exam. All organs are checked and measured. The exam necessitated a high concentration by the practitioner
  - The vitality of the fetus is evaluated (cardiac activity and motion of the fetus)
  - Evaluation of the placenta
  - Evaluation of the quantity of amniotic liquid

- **Important (or not) for parents : gender of the future baby**

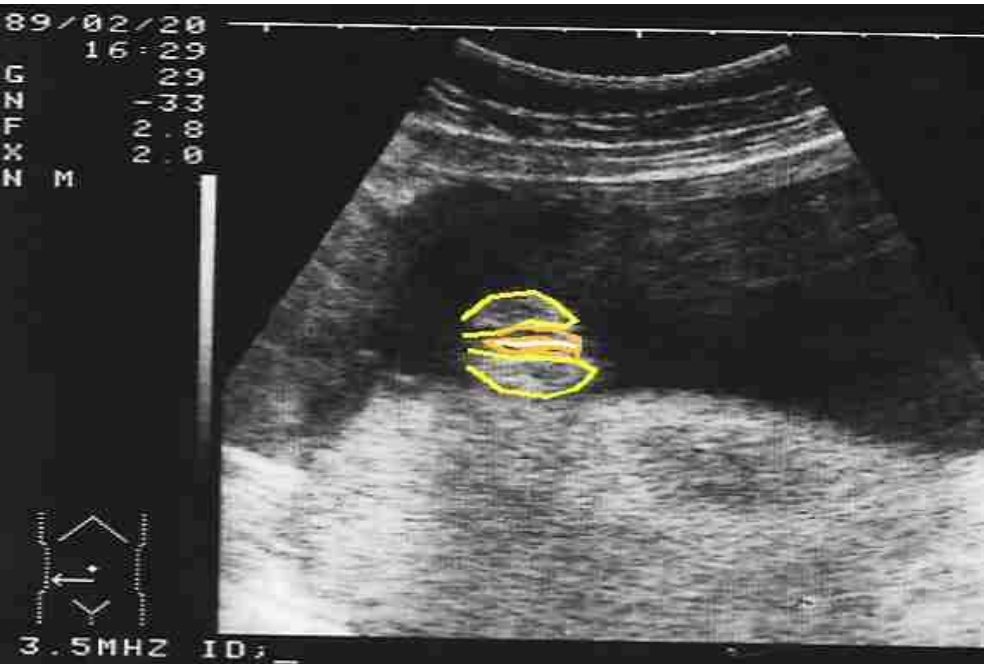
Girl or boy?

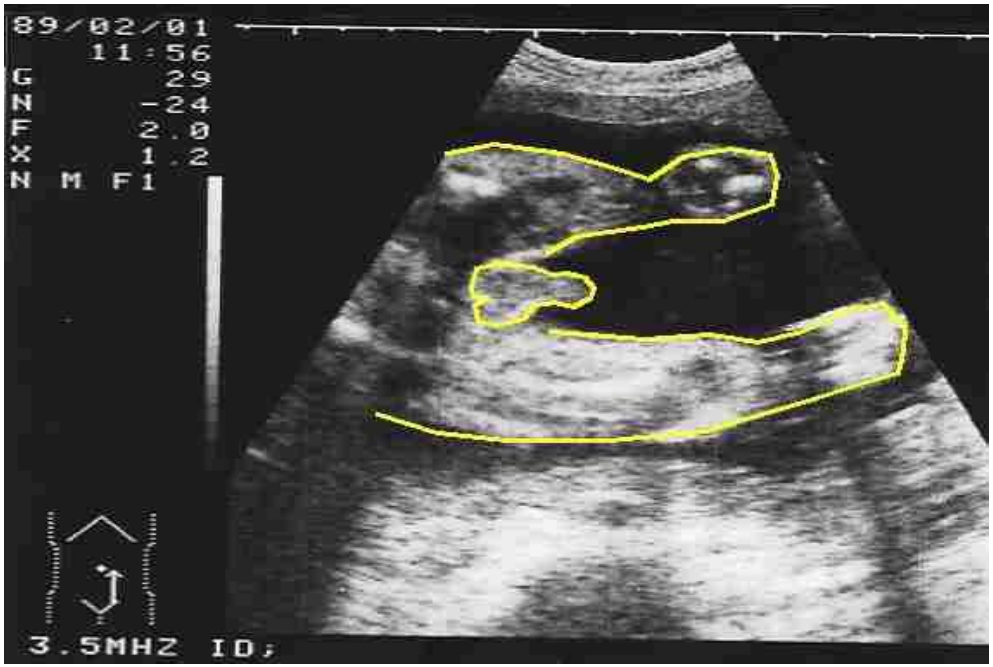

TOSHIBA
ME VANIET HELENE:- -
CENTRE JULES VERNE
F
- -
Fetal Heart 3
SA 25s0j
07/03/2011
09:58:04
MI(1.5)
2DG
80
DR
60
6C1
diff5.0
41 fps
DICOM PRT :
#299
A 2 IP1
Storing
HDD:95% Free
CINE REVIEW
ABC


Voluson
E8
Lefevre, Catherine 22.05.1984
VP7180 GA=22s2d
RAB4-8-D/OB
8.3cm / 1.0 / 16Hz
MI 1.2
TIs 0.1
Dr. Jean Michel Faure
17.05.2010 8:56:12 AM
Trimestre 1
Har-Élevée
Puiss. 100 %
Gn -4
C5 / M4
P1 / E0
SRI II 5


www.mamo.fr

Is it easier with some help!





http://www.ac-grenoble.fr/

Medical application: fetal growth monitoring

- **Echo 3: Goal**
- **Ensure everything is OK**
- **Again some measurements (for instance one verifies that abdomen and cranium increase proportionally)**
- **The overall situation is evaluated (amniotic liquid, position of the fetus)**

Last souvenir in 3D

Medical application: needle imaging

Creatis

Case 1 : biopsy

a biopsy consists in the collection of tissue sample(s) in order to proceed to an exam, most of the time using a microscope or sometimes biochemical exam, genetic etc…

Operating mode: the sample is collected using a needle that cuts a small cylinder of tissue

Goal: collect the sample at the right place and avoid to injure the patient (especially avoid hemorrhagic risks)

➔ performed under ultrasound supervision

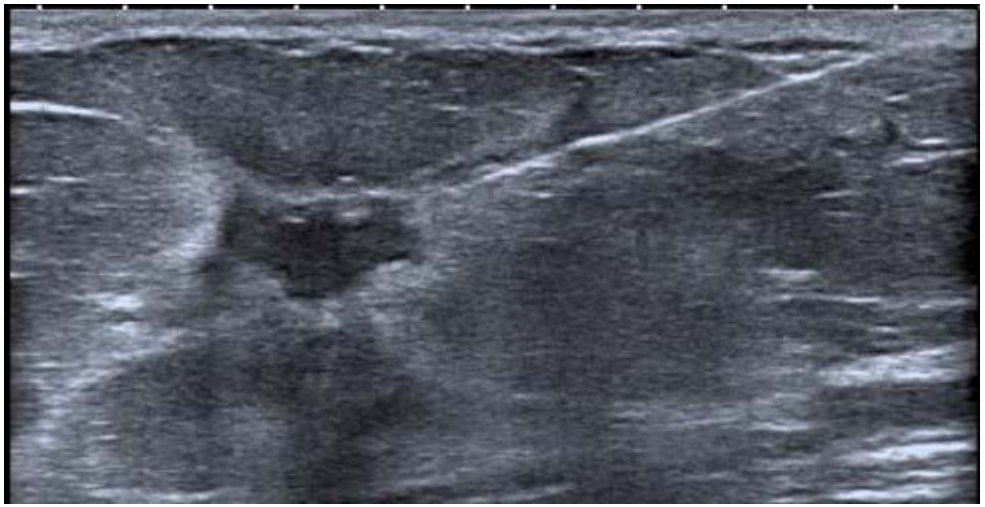
Breast biopsy

Medical application: needle imaging

Case 1 : biopsy

Example of targeted organs and pathologies

- **Cancer: prostate, breast**
- **Kidney diseases: only the kidney is imaged not the needle**
- **Hepatic, cirrhosis: liver**



Breast biopsy

http://radiologie-la-defense.fr

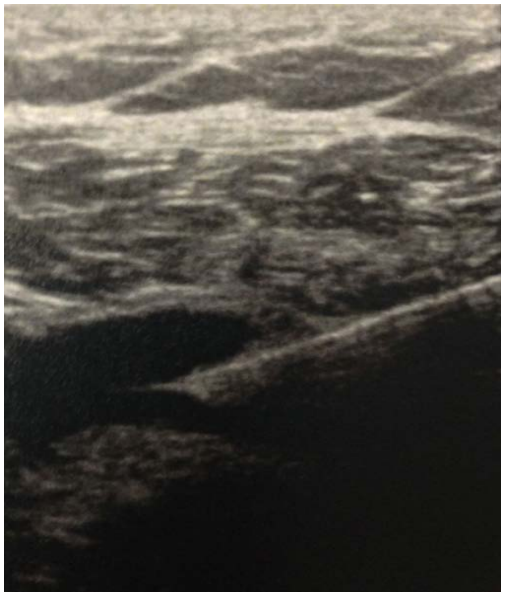
Goal: inject at the right place ➔ performed under ultrasound supervision

Injection under ultrasound supervision of a « De Quervain ténosynovite ». Tendon affection in the wrist.

http://www.irm-94.fr

Injection under ultrasound supervision in the shoulder

http://www.rimc.ca/



http://www.centre-epaule-lesprit.fr

3D Ultrasound

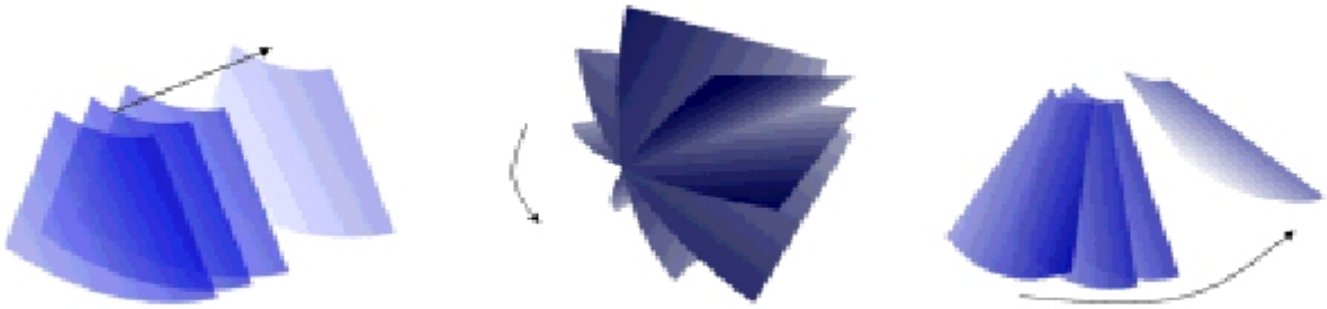
3D Ultrasound consists in constructing a **3D volume** instead of a 2D slice like in conventional ultrasound

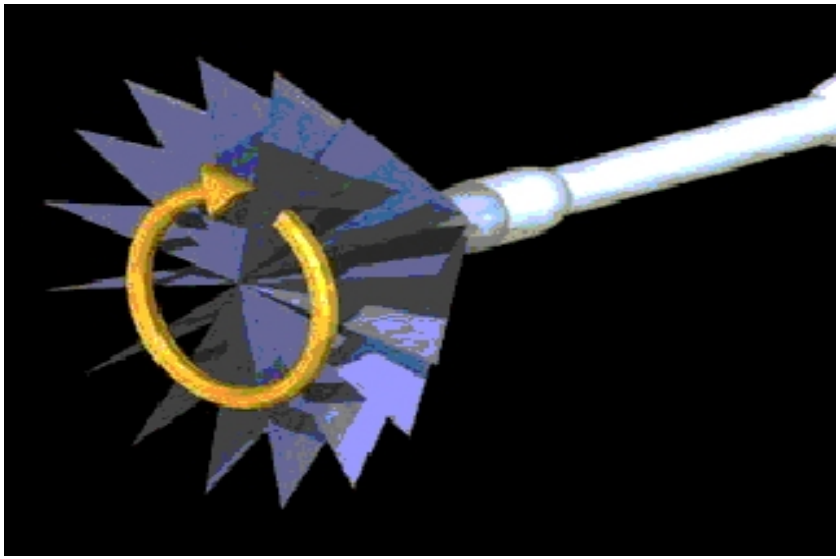
The Volume is obtained by **sweeping the elevation** direction with the US beam

mechanically: long acquisition time

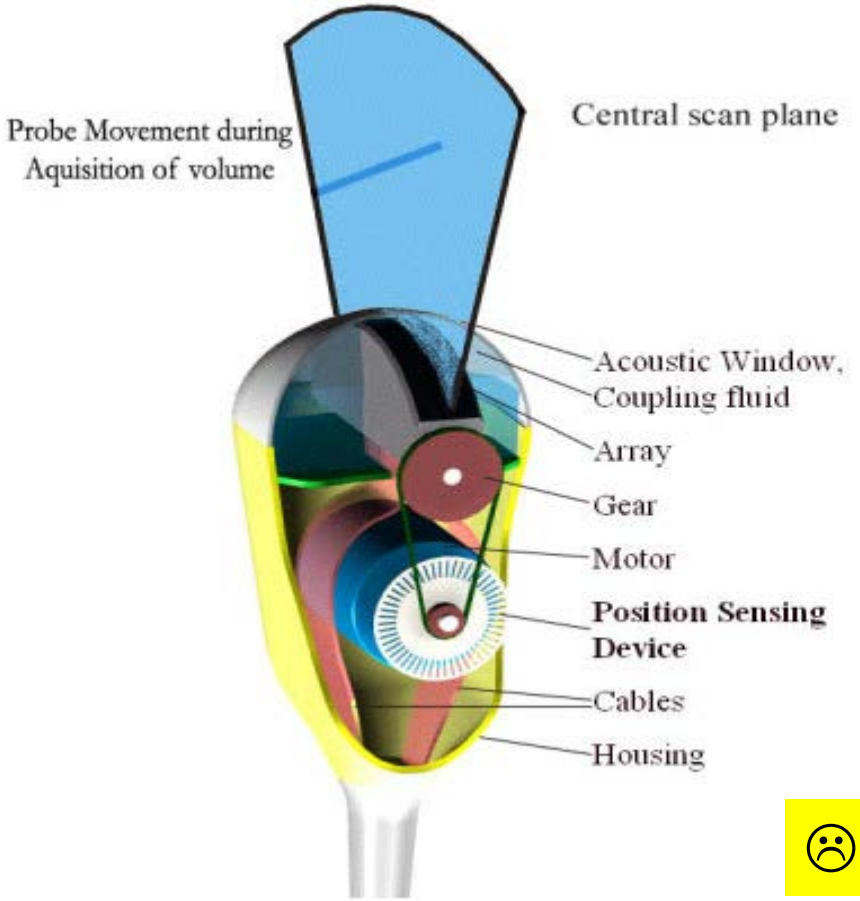
electronically: technological difficulties to construct and drive the probe

Mechanical sweeping





Mechanical sweeping : “the wobbler”



☹ Disadvantage: acquisition is slow

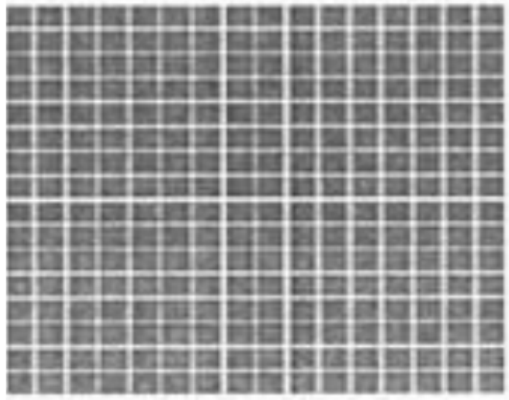
http://www.gehealthcare.com

Electronic sweeping

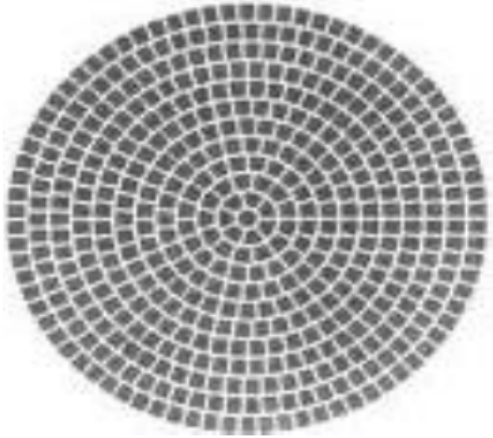
2D “matrix” array

- Control of the beam direction
- Fabrication is difficult
  + inter-element spacing
  + cabling (64x64=4096 elements)
  + electrical and acoustic coupling

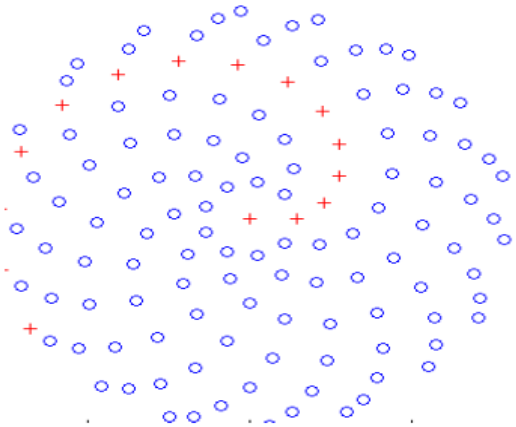
Different arrangements



Rectangular



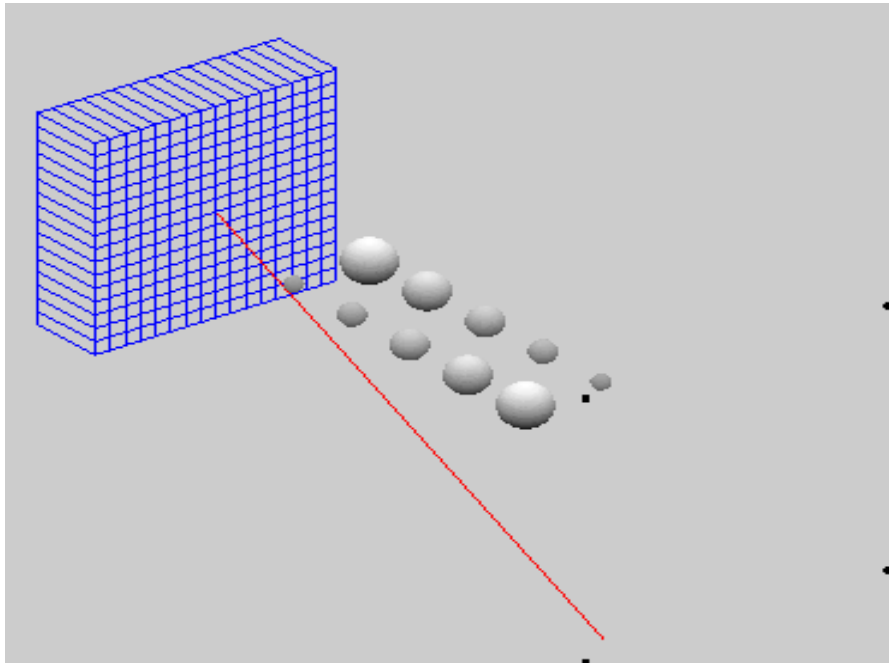
Circular

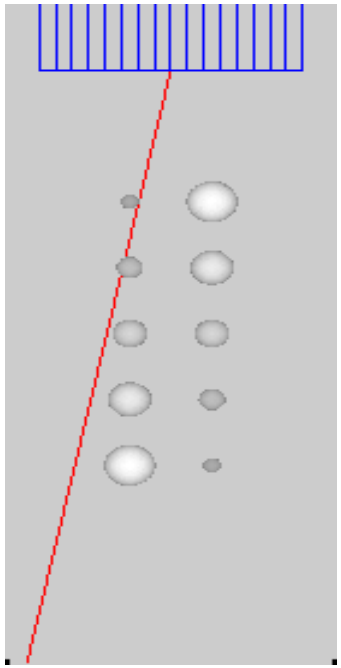


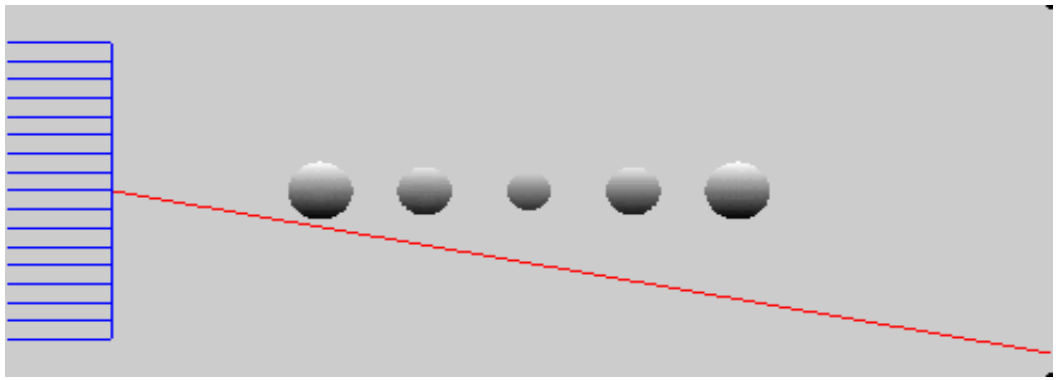
Spiral

Electronic sweeping

Visualization of the sweeping. Delays are adjusted to steer and focalize the beam in 3D

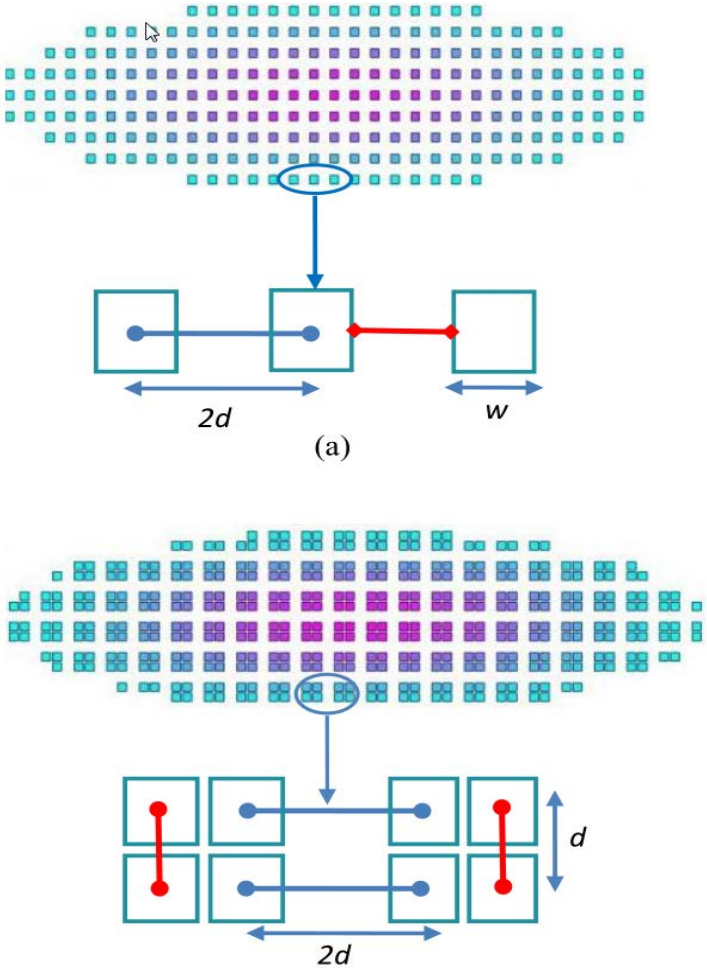




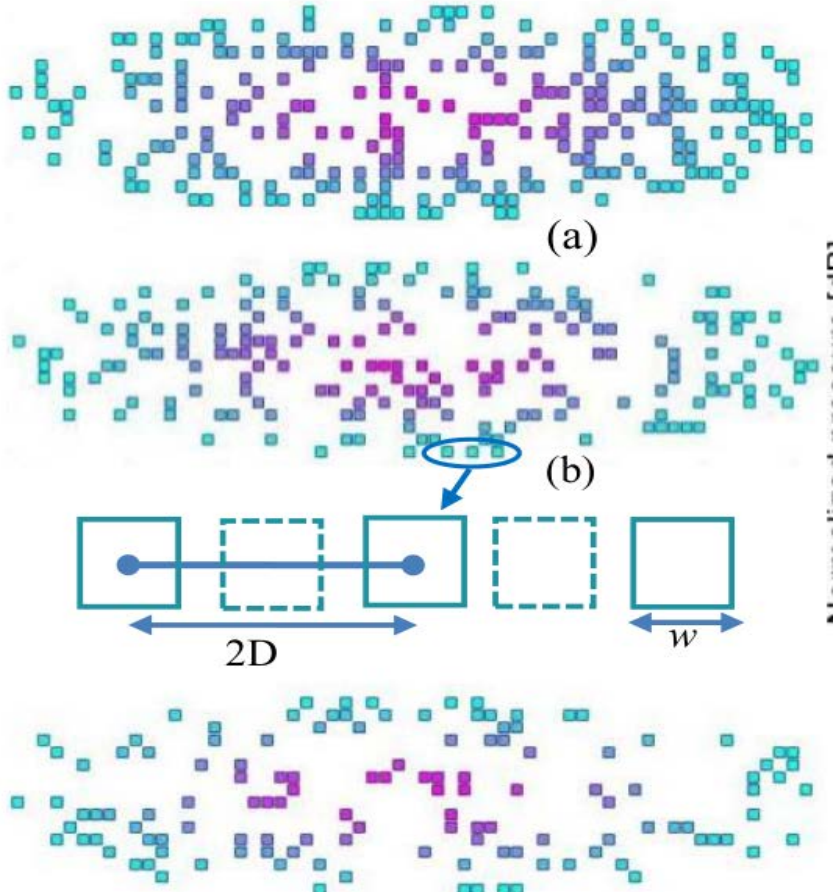


“**sparse array**” **:** connection of a fraction of elements
+ reduction of the coupling between elements

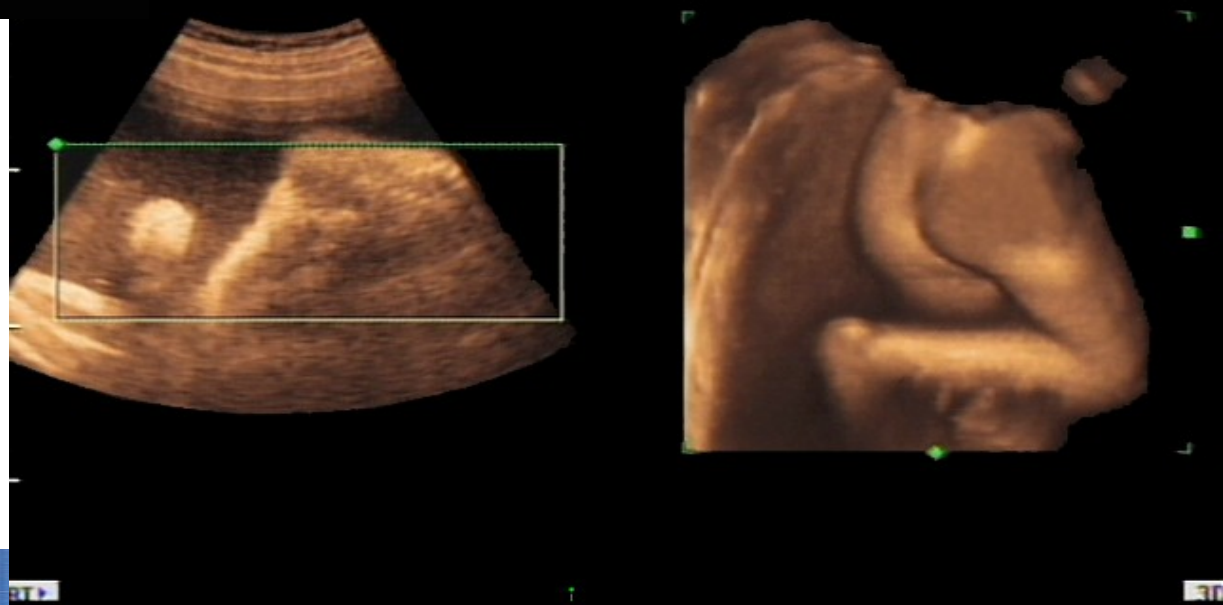
Regular configuration → increased grating lobes



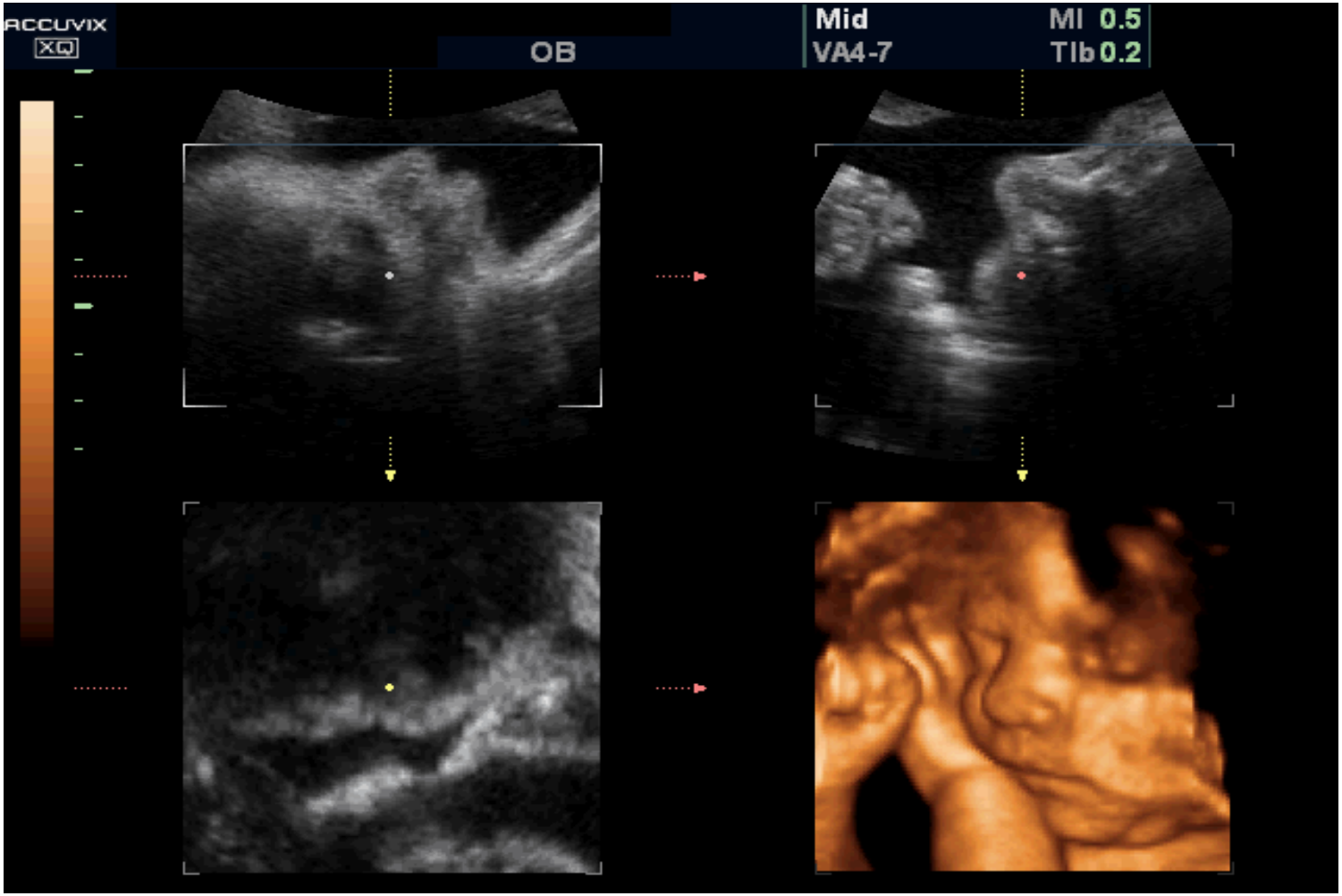
Non regular → decreased grating lobes



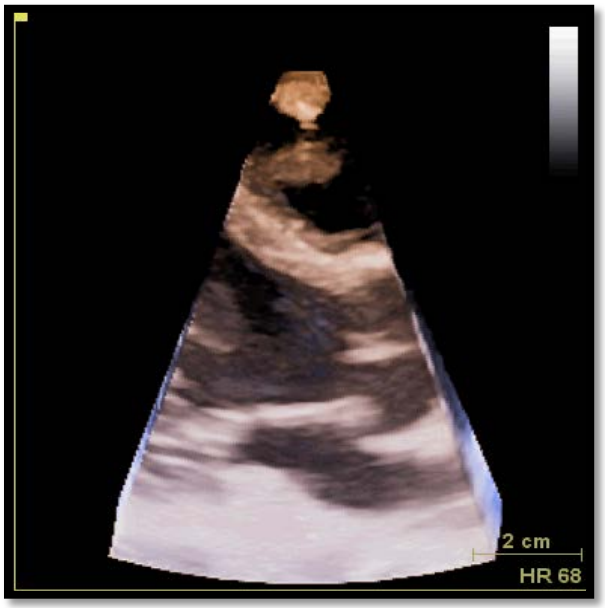
Example 3D: fetus



Example 3D: fetus (movie)

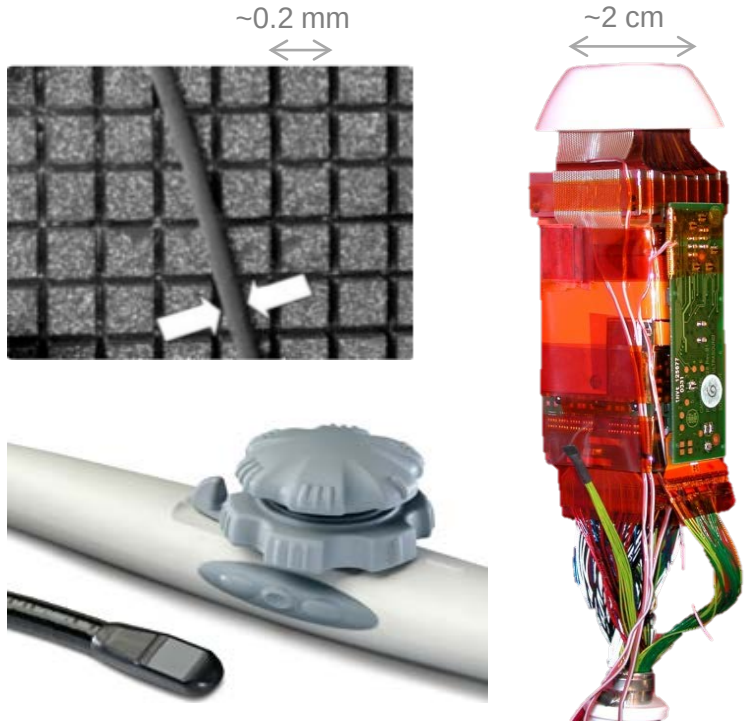


Real-time 3D imaging



Transthoracic imaging

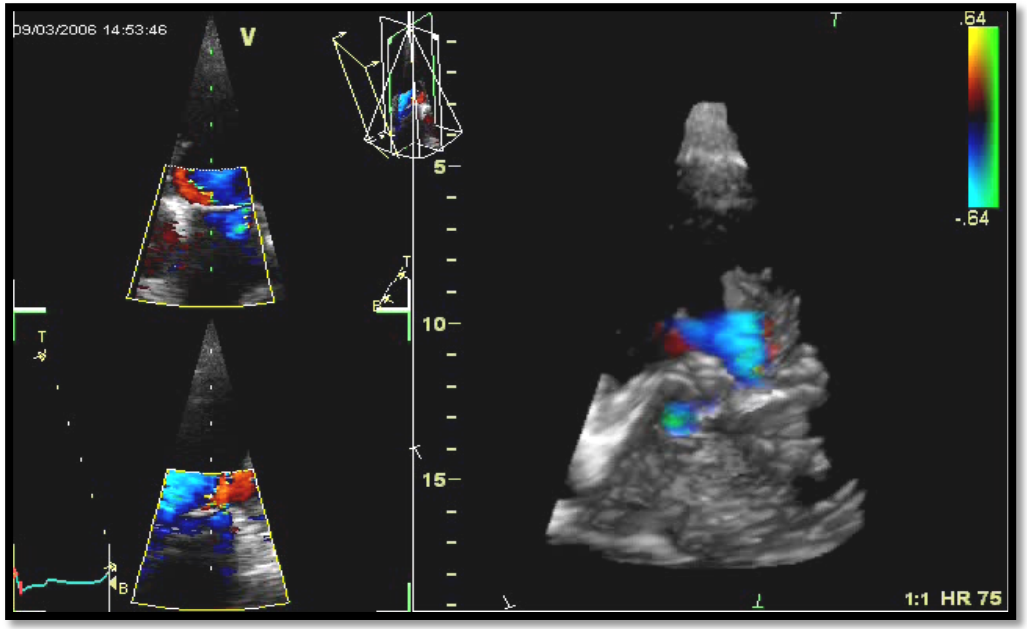
Transesophageal imaging



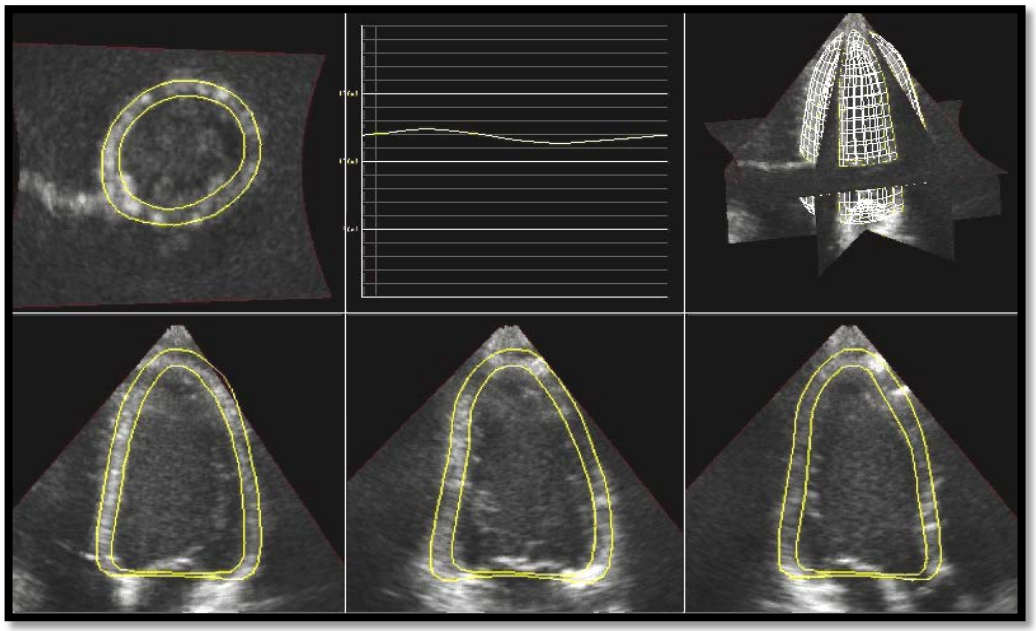
Courtesy of Lasse Lovstakken (NTNU Trondheim)

2D/3D quantification of blood and tissue properties

Quantification blood velocities and myocardial deformation



Real-time 3D color-Doppler imaging



Real-time 3D deformation imaging

Courtesy of Lasse Lovstakken (NTNU Trondheim)