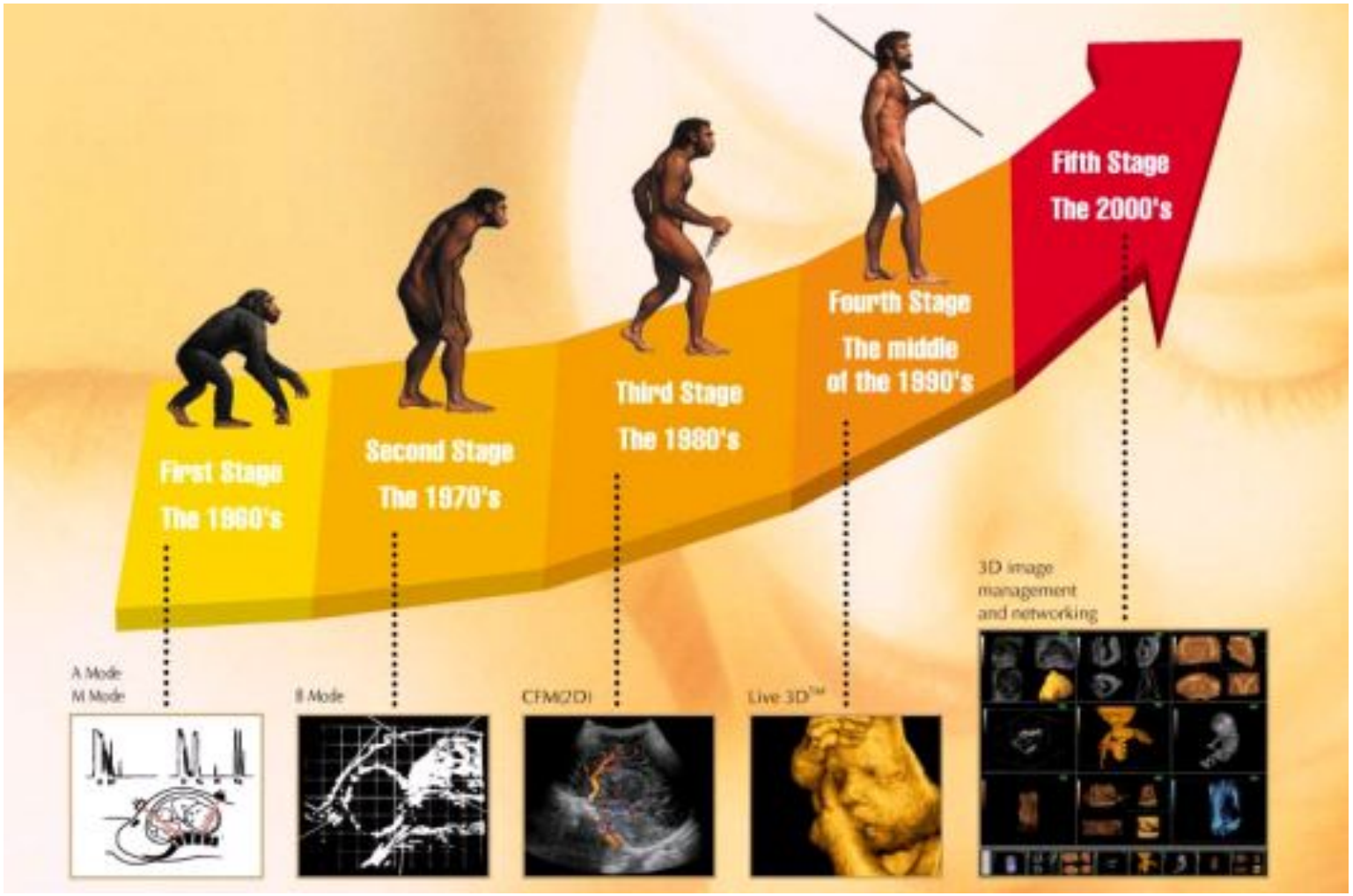
Atlas of 3D Ultrasound

Contents

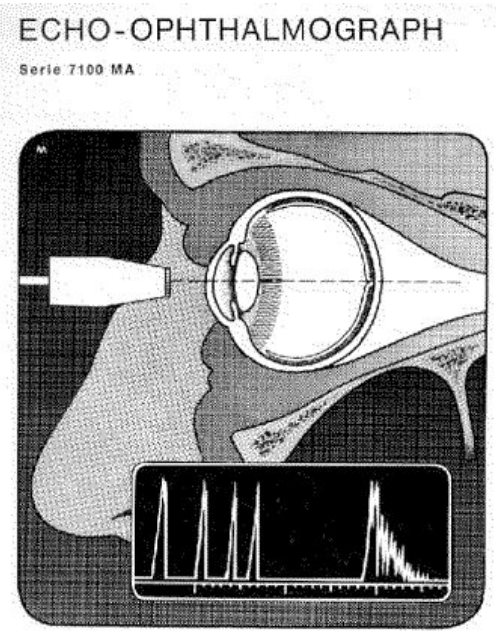
History of Ultrasound

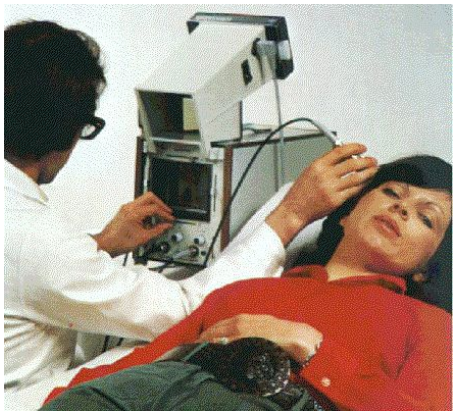
Technology development

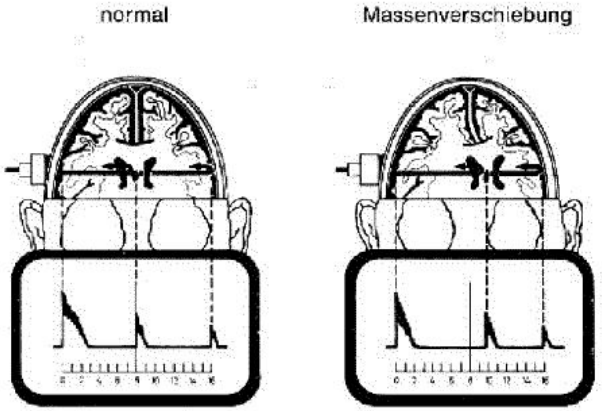


Diagnostic A mode

- **Examining brain lesions**: Lars Leksell & JC Turner, early 1950s
- **Applications**: Ophthalmology & neurology







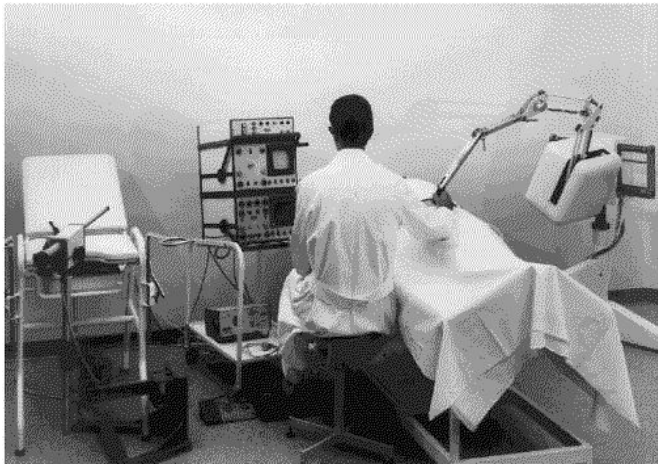
Static B mode

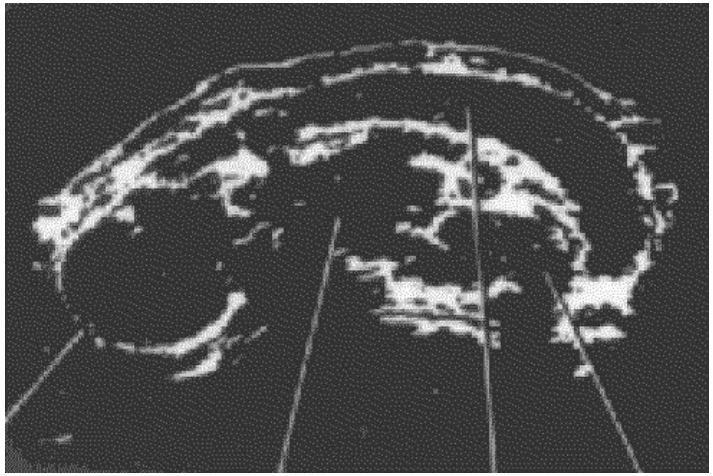
Threshold detection (Bi-stable tube)

: Echoes displayed as dots of constant intensity without information on echo amplitude.

> Good for representation of size, shapes, and position

> No information for depiction of the internal echoes





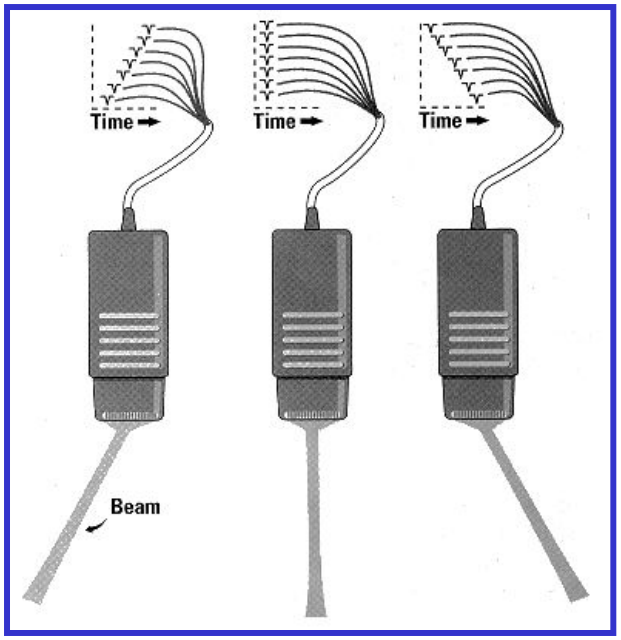
Real time B mode (Mechanical method)

The first use of Sector Probe : The element installed on the tip of the probe brings on a fan-shape injection rotation by motor

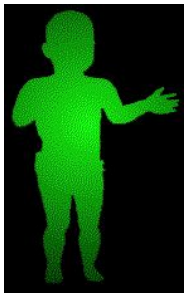
Real Time Image : 20~30 frame/s

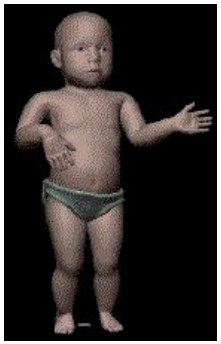
Real time B mode (Electronic method)

Electronic Probe : Obtain an image using each of a element with the front of Probe with many slender element which is in the shape of a rectangular and we can drive each of a element with electronical switch

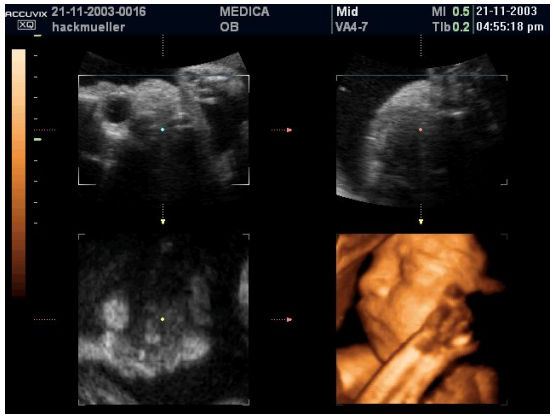


Concept of 3D



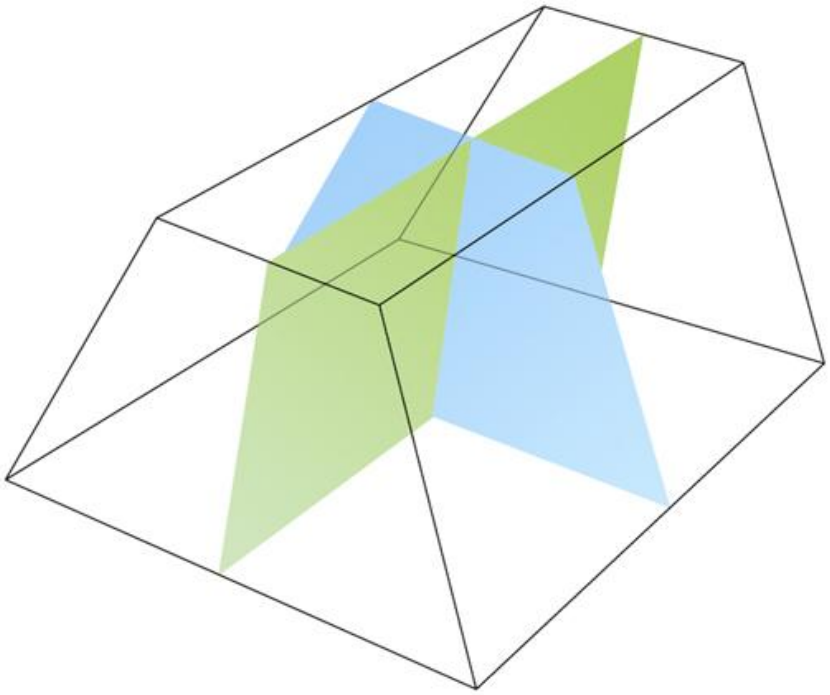


2D **3D** **4D**



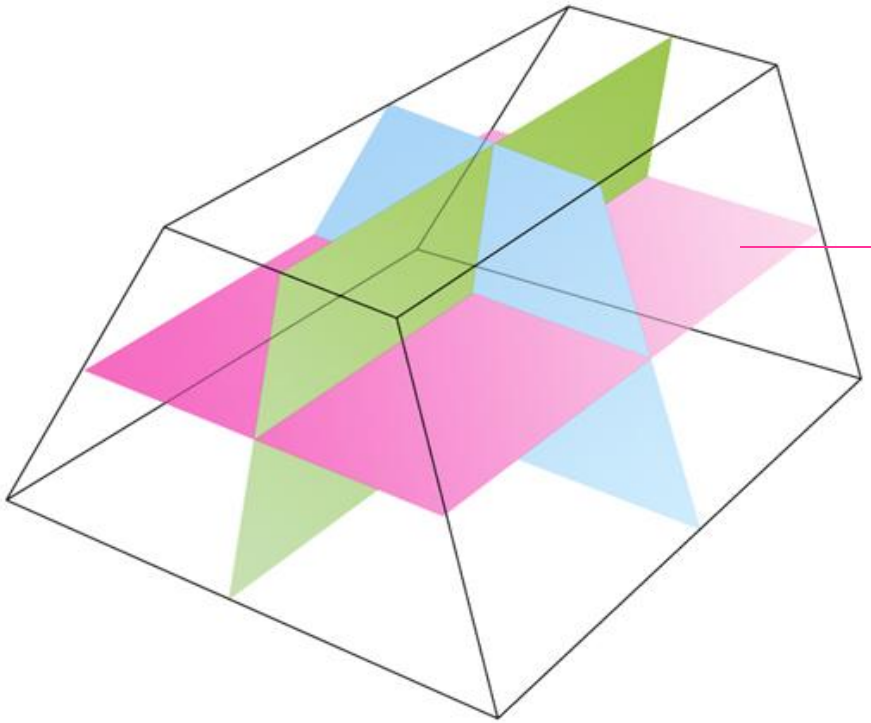
Comparison With 2D and 3D

Real Time 2D(B-Mode)
-NO Coronal Plane.
-Limitation of View Angle



Comparison With 2D and 3D

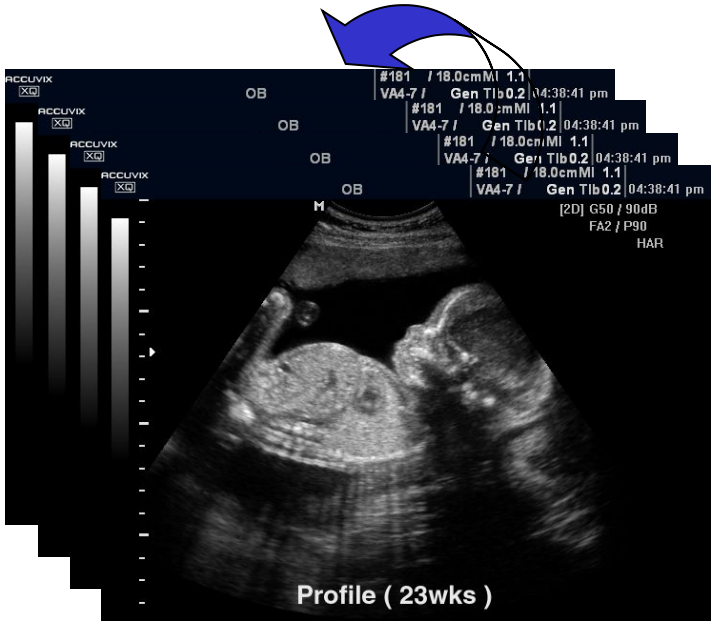
3D Scan
Freely Scan Arbitrary Plane



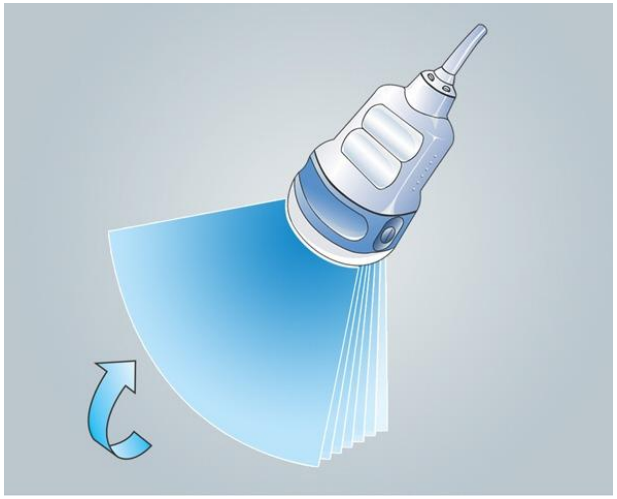
C
Plane(Coronal)

Comparison With 2D and 3D

2D	3D
Narrow View Angle	Wide View Angle
No Coronal Plane View	Coronal Plane View
Inaccuracy Volume Measurement	Accuracy Volume Measurement(VOCAL)

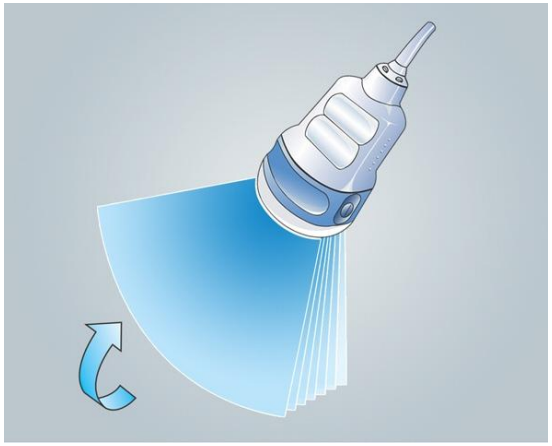


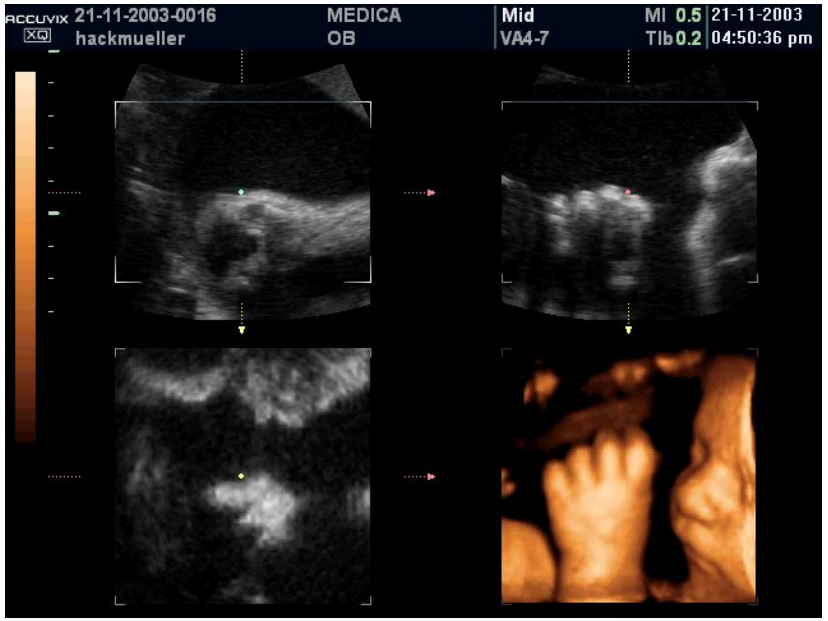
Static 3D




ACCUVIX
21-11-2003-0016
hackmueller
MEDICA
OB
Mid
VA4-7
MI 0.5
TIb 0.2
21-11-2003
04:55:43 pm

Live 3D




ACCUVIX 21-11-2003-0016
hackmueller
MEDICA
OB
Mid
VA4-7
MI 0.5
TIb 0.2
21-11-2003
04:50:36 pm

Classification of 3D US

- Workstation 3D
  - Post processing 3D with VHS output
  - Poor image resolution and non-dynamic 3D
- Freehand 3D
  - Post processing 3D with 2D image
  - Poor image resolution and non-dynamic 3D
- Integrated 3D (electrical 3D probe, Aloka)
  - Live 3D but poor image resolution
  - Poor multi-plane image
- Integrated 3D (mechanical 3D probe)
  - Genuine 3D
  - Good resolution
  - Dynamic 3D display (Live 3D)

Worst Performance

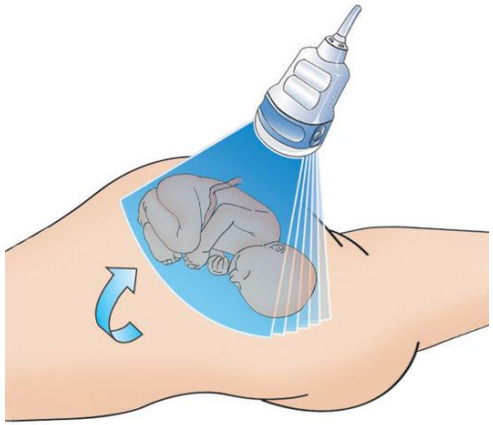
Best Performance

Principles of 3D Ultrasound

How 3D image is produced?

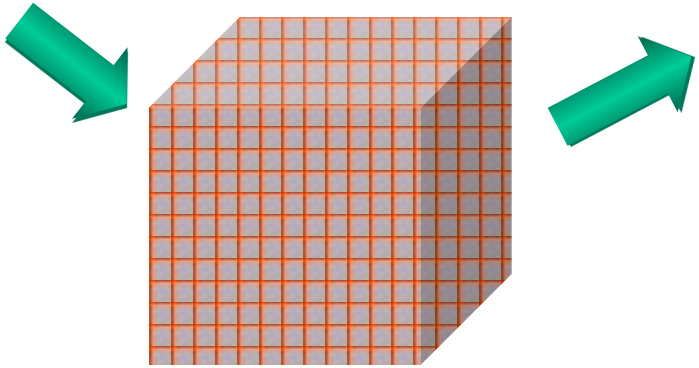
- Data acquisition
- Scan conversion
- Volume rendering

Data Process



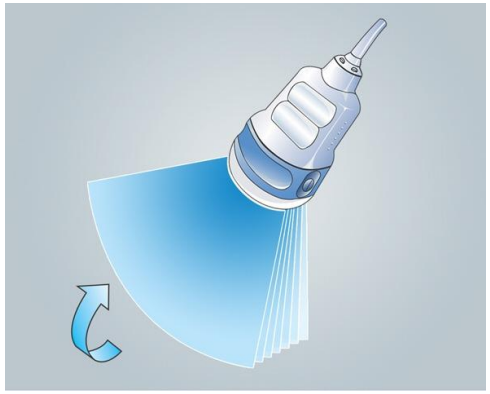
3D Image

3D Scan Conversion

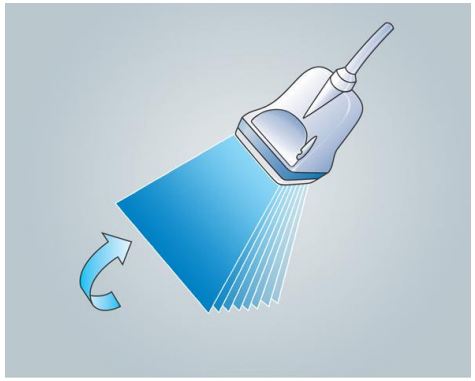


Data Acquisition I

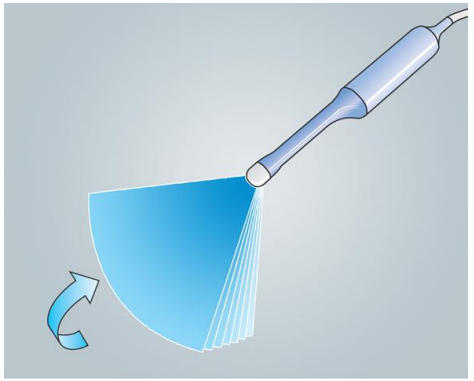
Step 1: Probe selection



3D convex Probe



3D Linear Probe

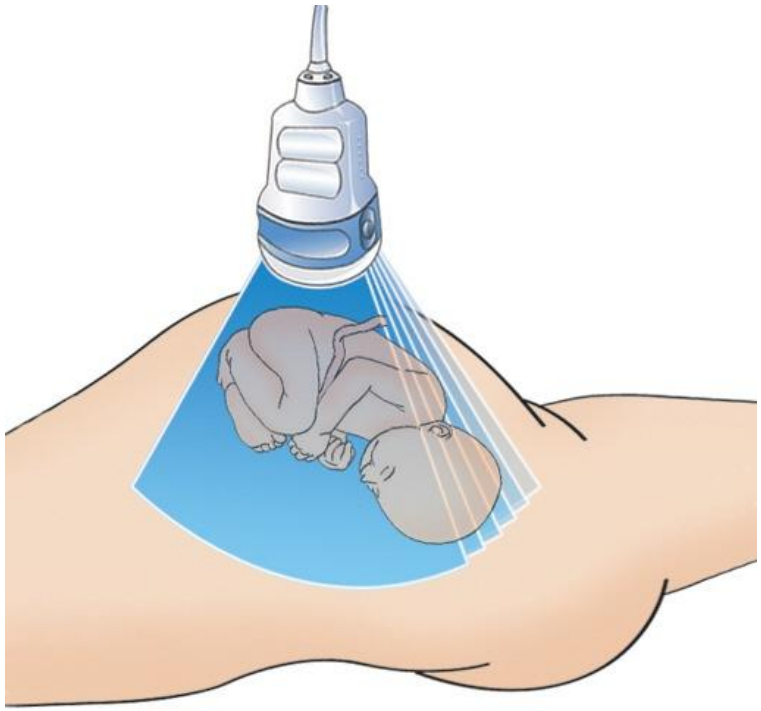


3D Vaginal Probe

Data Acquisition I

Step 2: Data scanning

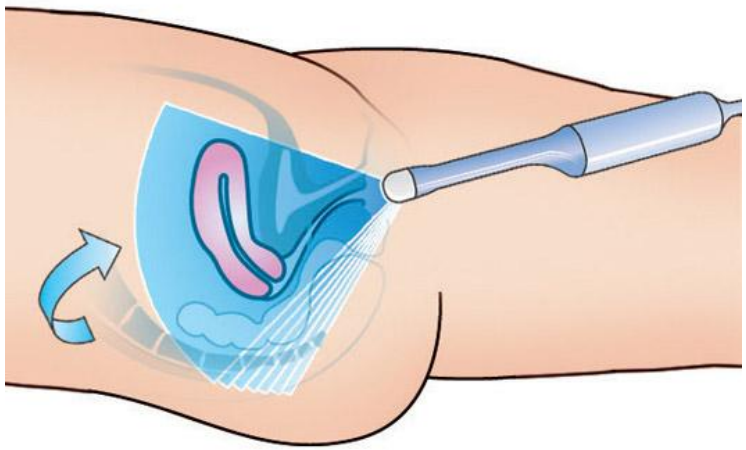
3D Convex Probe



Data Acquisition I

Step 2: Data scanning

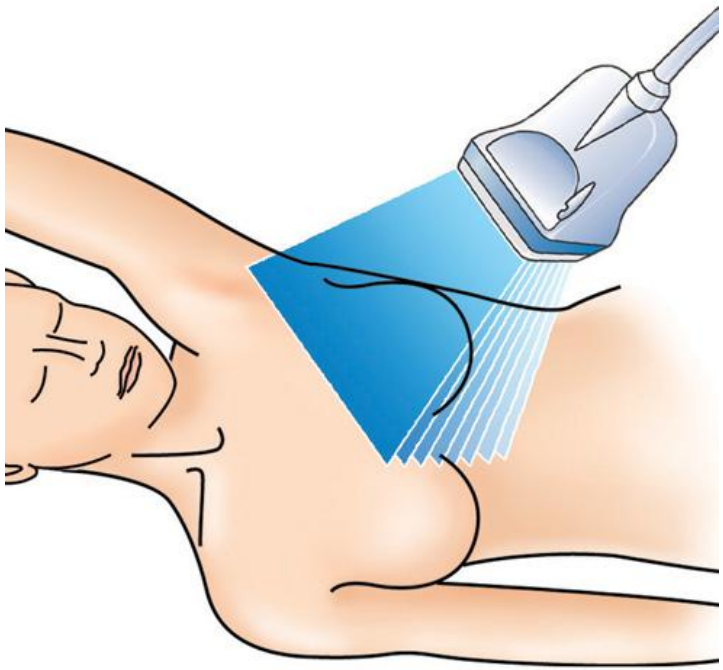
3D Vaginal Probe



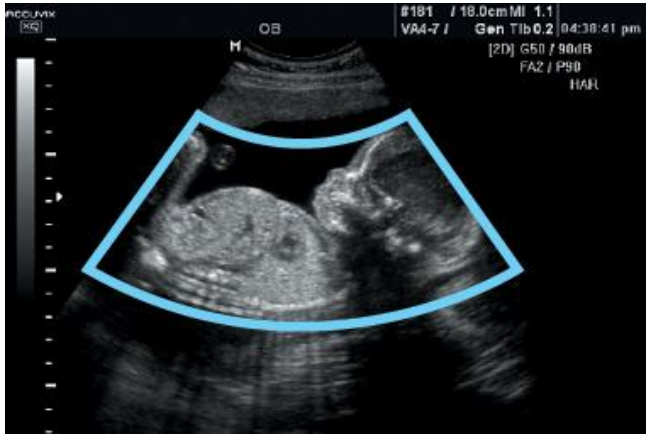
Data Acquisition I

Step 2: Data scanning

3D Linear Probe



ROI(Region of Interest)

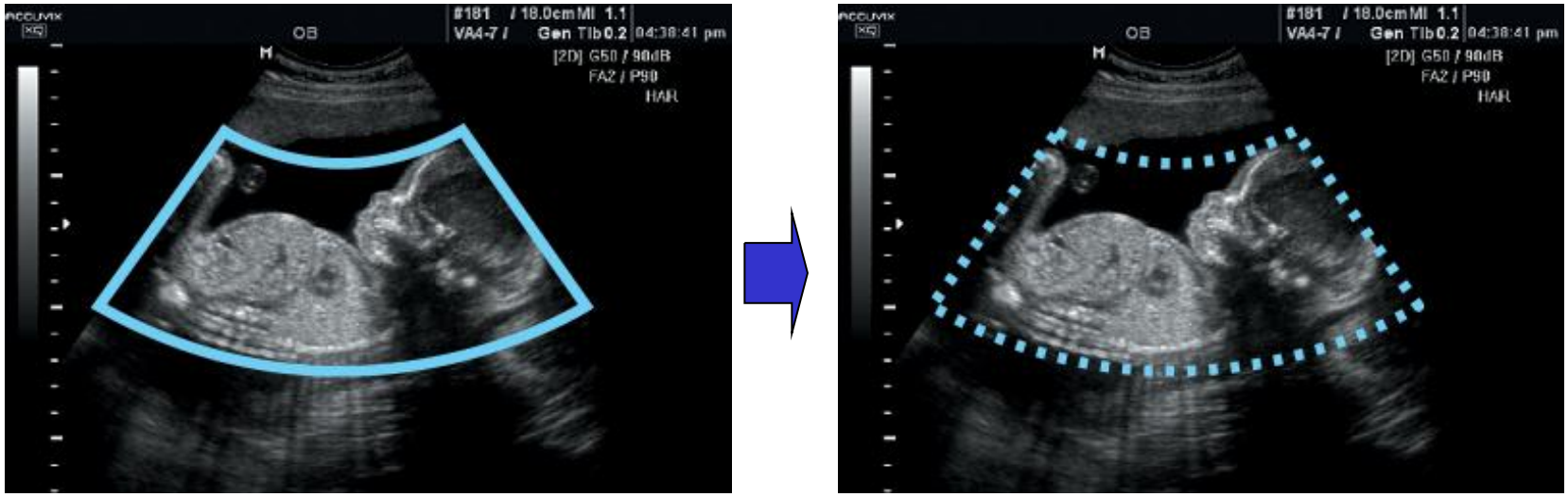


ROI in 2D mode

ROI(Region of Interest)

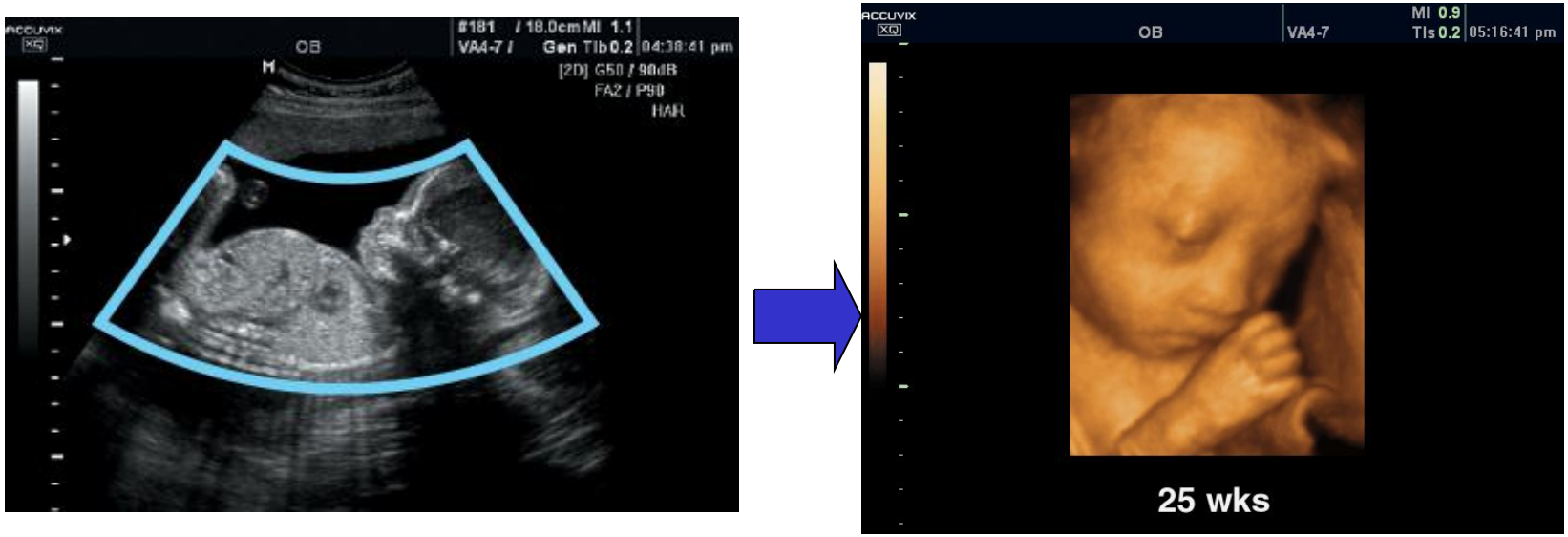
Step 3: Adjust ROI Size

Axial Depth, Lateral View Angle, Elevation Angle



ROI(Region of Interest)

- Auto ROI(Only ACCUIX XQ)

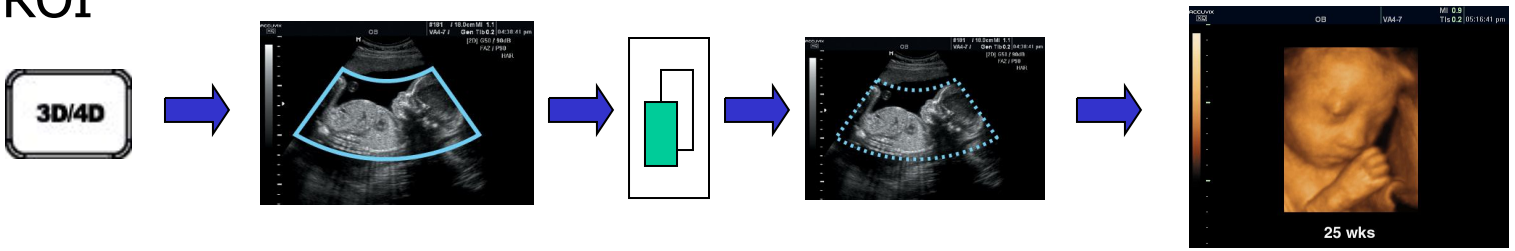


Data Acquisition

Data Acquisition

- Comparison of Sequence between adjustable ROI and Auto ROI

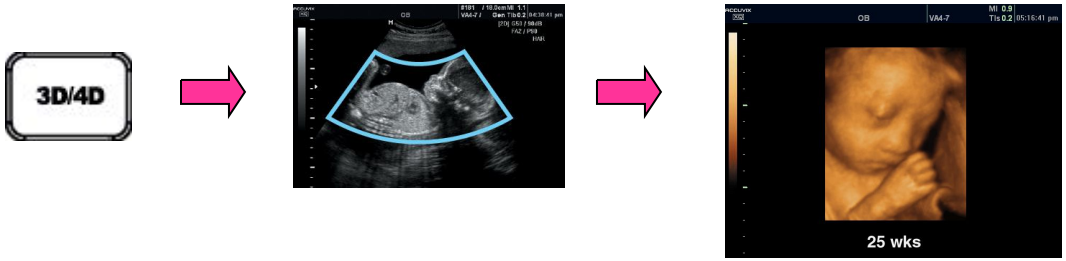
Adjustable ROI



Change button

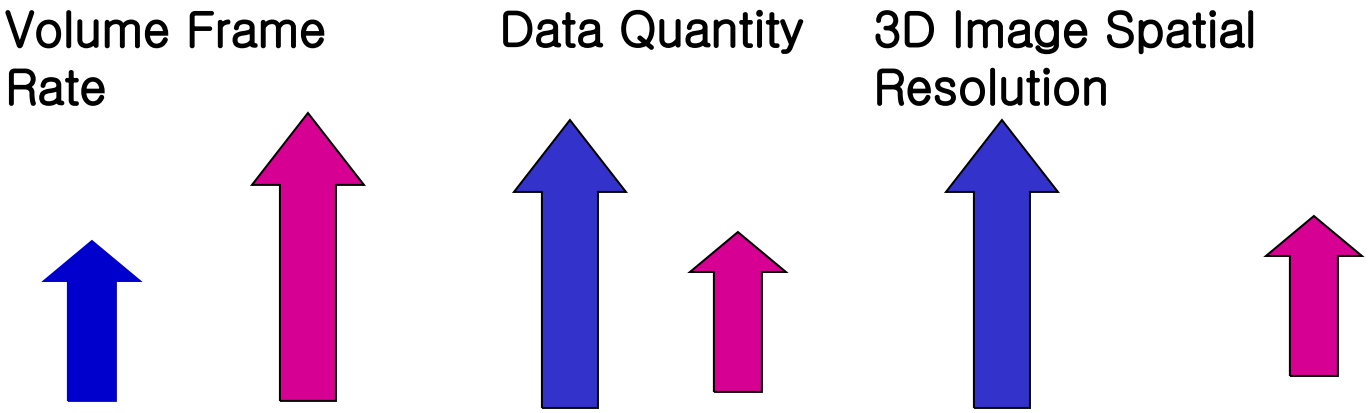
Adjustable ROI

Auto ROI(Quickly and Easy 3D)

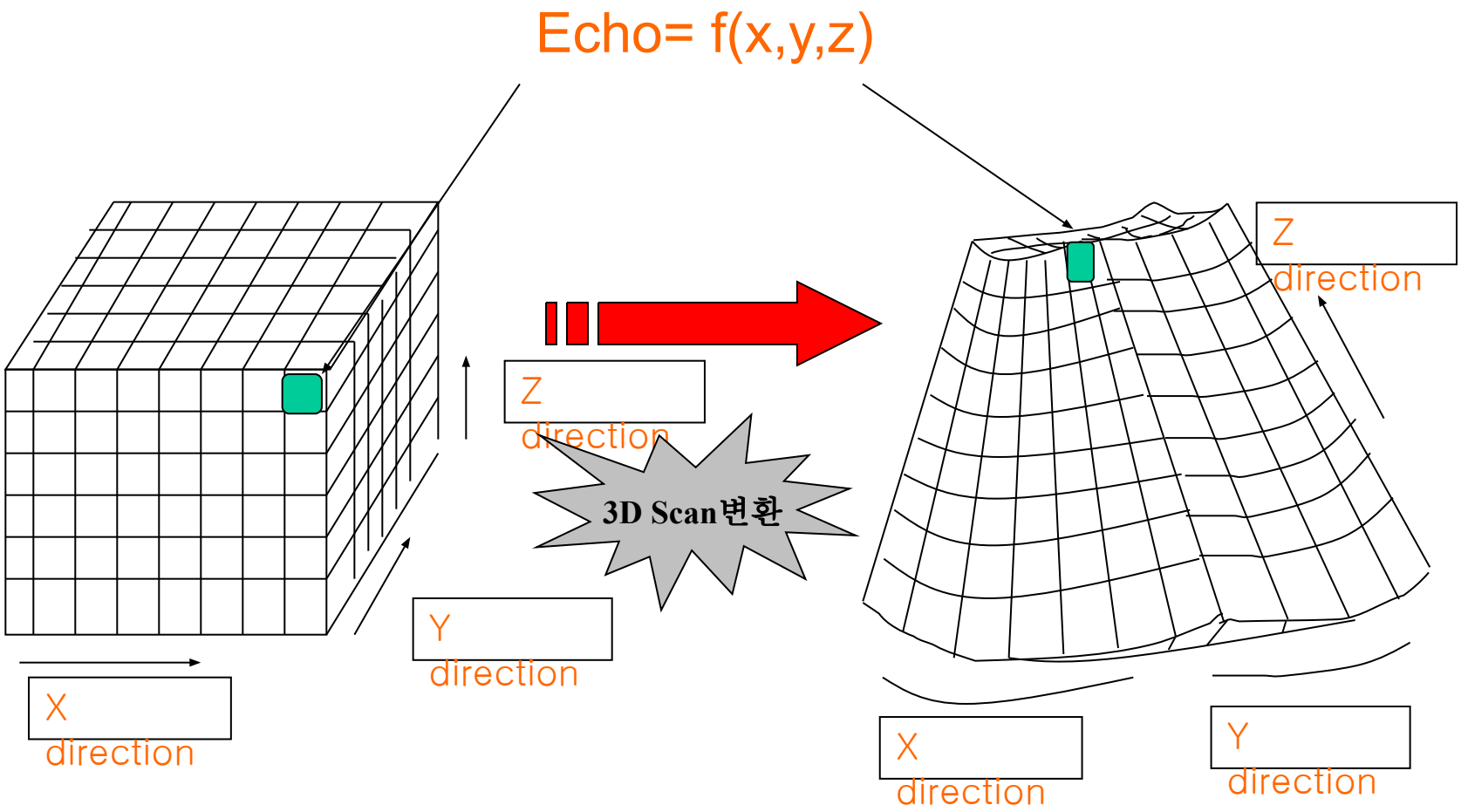


Data Acquisition

- Scan Quality Selection (ACCUVIX XQ 4 step, SA8000 3 step)
  - Low : FR is fast but spatial resolution is low quality
  - Mid
  - High
  - Extreme : slow but spatial resolution is excellent !!

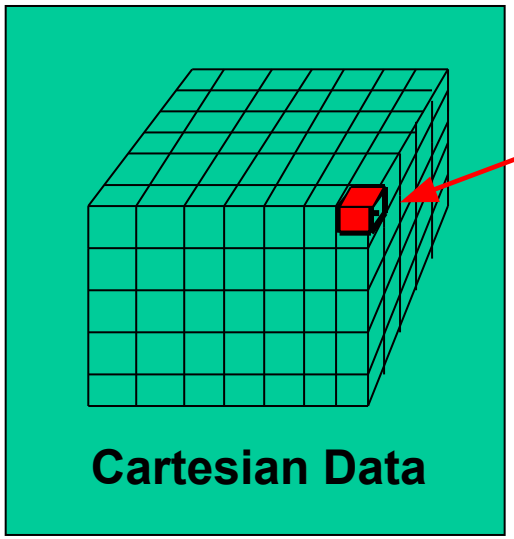


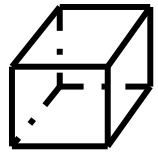
3D Scan conversion



3D Scan conversion

- Definition of Voxel



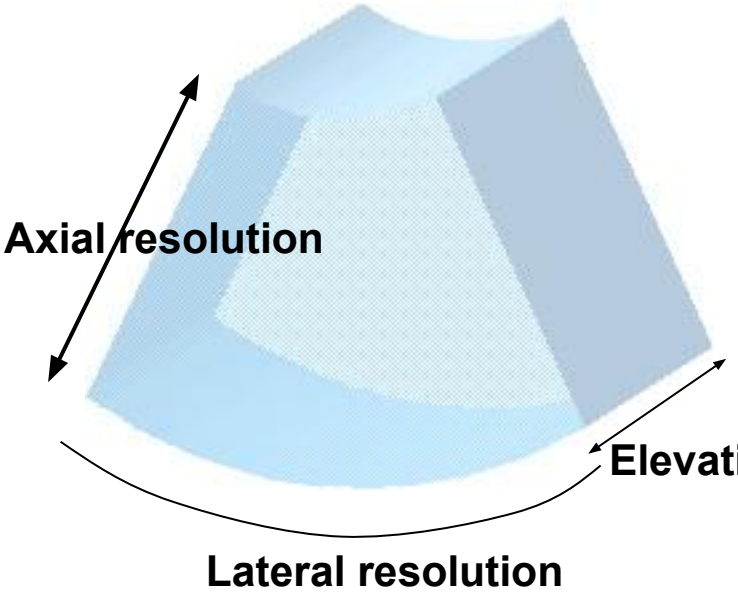


A voxel is a cubic cell, which has a single value cover the entire cubic region

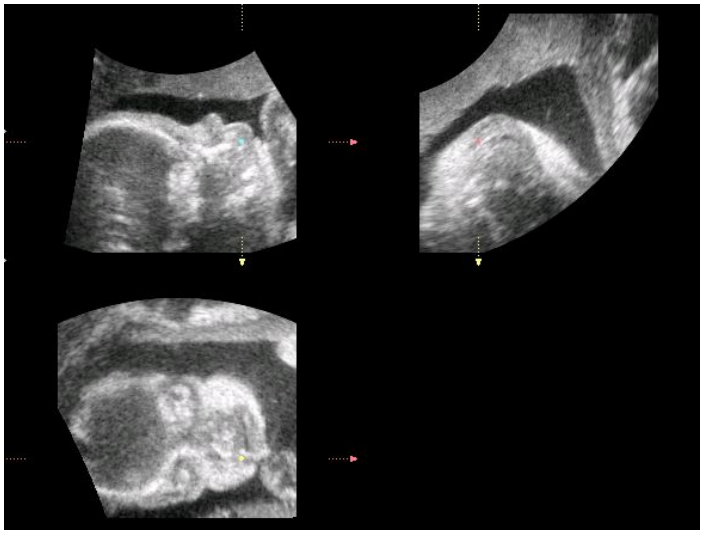
Voxel is the unique criteria of 3D image resolution including **Rendering image and Sliced View**

3D Scan conversion

3D volume resolution



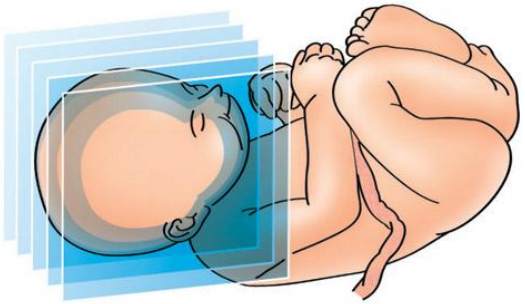
A-Plane B-Plane



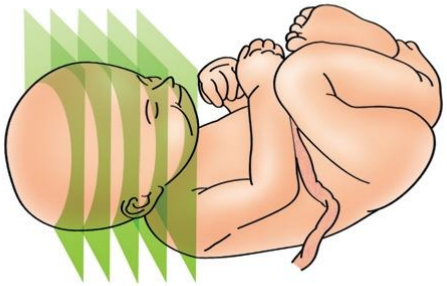
C-Plane

- A-Plane resolution: Axial resolution x Lateral resolution
- B-Plane resolution: Lateral resolution x Elevation resolution
- C-Plane resolution: Elevation resolution x Lateral resolution

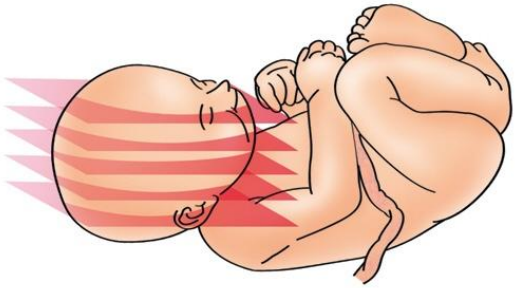
3D Data



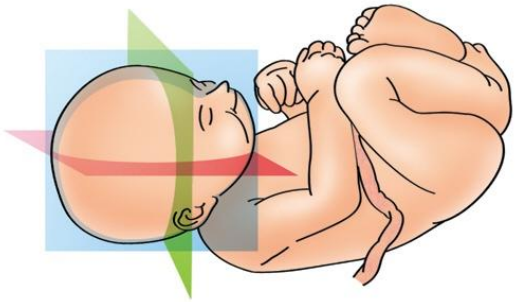
A Plane



B
Plane



C
Plane

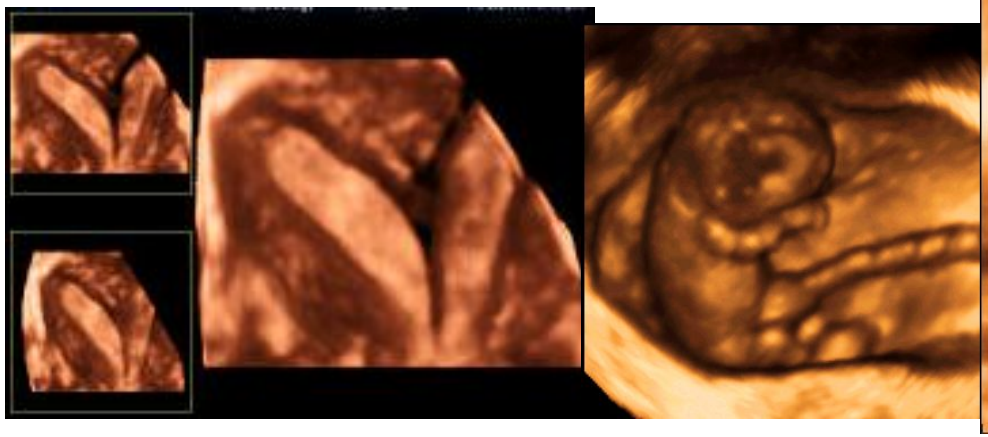


3D Image

Volume Rendering

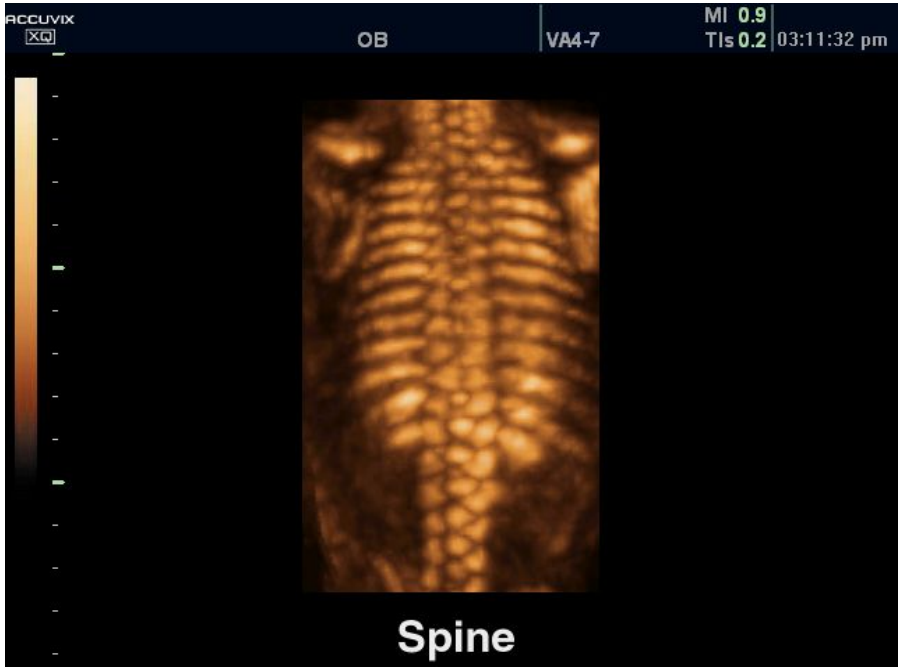
- Rendering mode
  - Surface mode
  - Transparent Mode
    - Maximum transparent mode
    - Minimum transparent mode
    - X-ray mode

Volume Rendering (Surface mode)



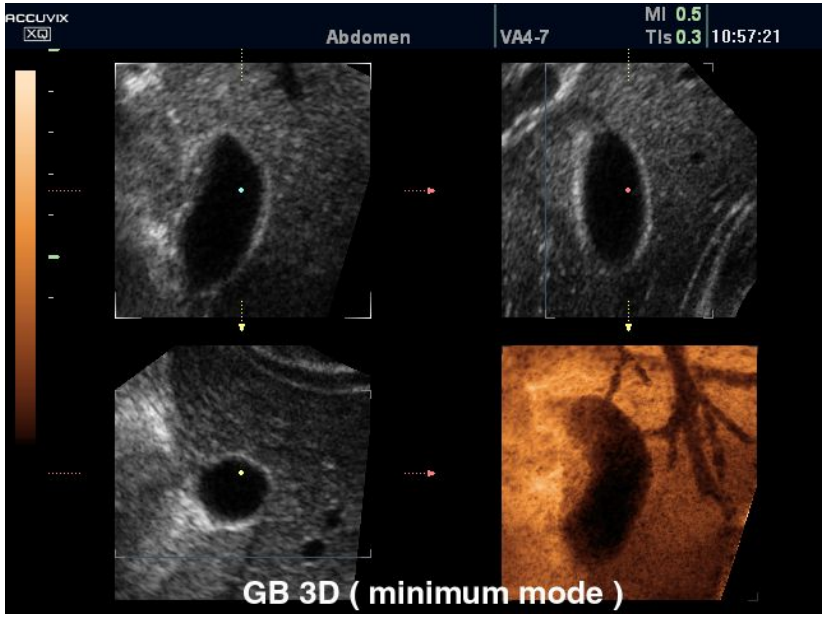
Volume Rendering (Transparent mode)

- Transparent mode
  - Maximum mode
    - The maximum gray values of the ROI characterization of hyper-echoic structures



Volume Rendering (Transparent mode)

- Transparent mode
  - Minimum mode
    - The minimum gray values of the ROI characterization of hypo-echoic structures



Volume Rendering (Transparent mode)

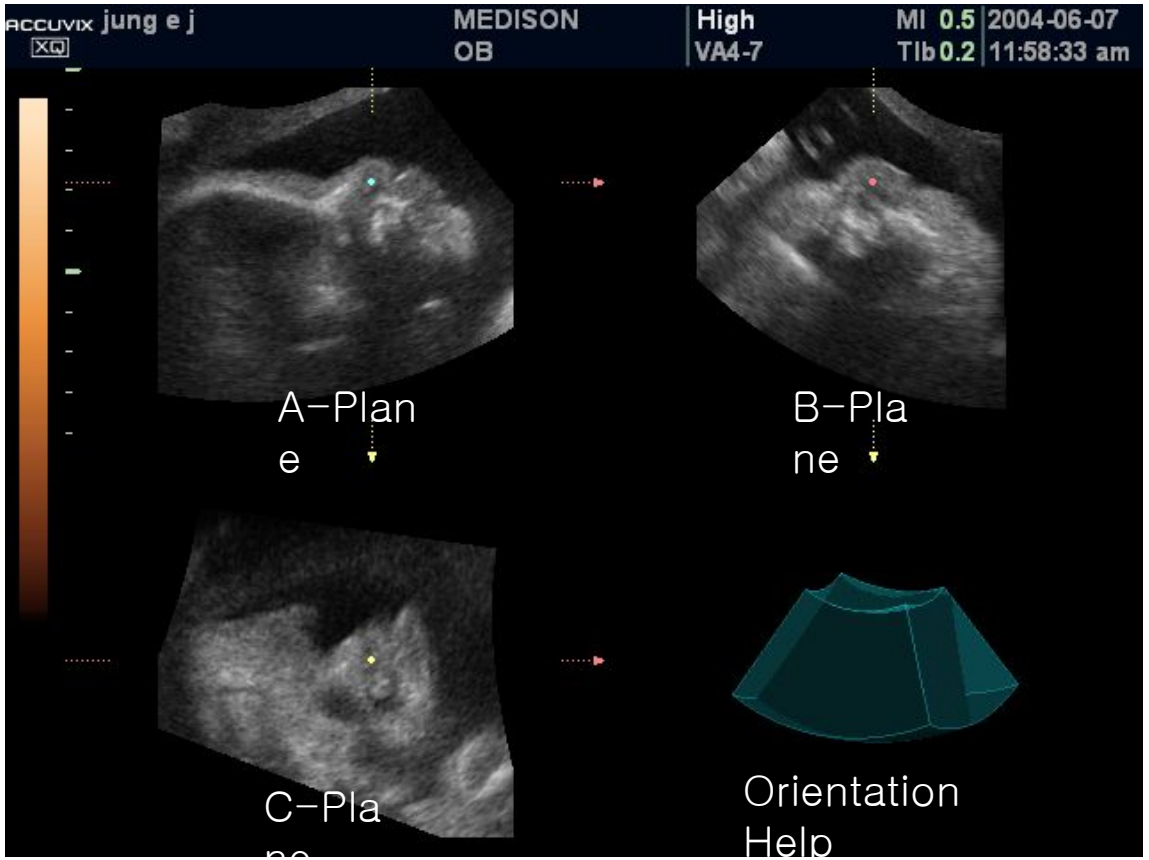
- Transparent mode
  - X-Ray mode
    - **Presentation of all gray values (mean values) within ROI can be combined with Maximum and Minimum modes Noninvasive study of fetal skeleton**

3D Utilities

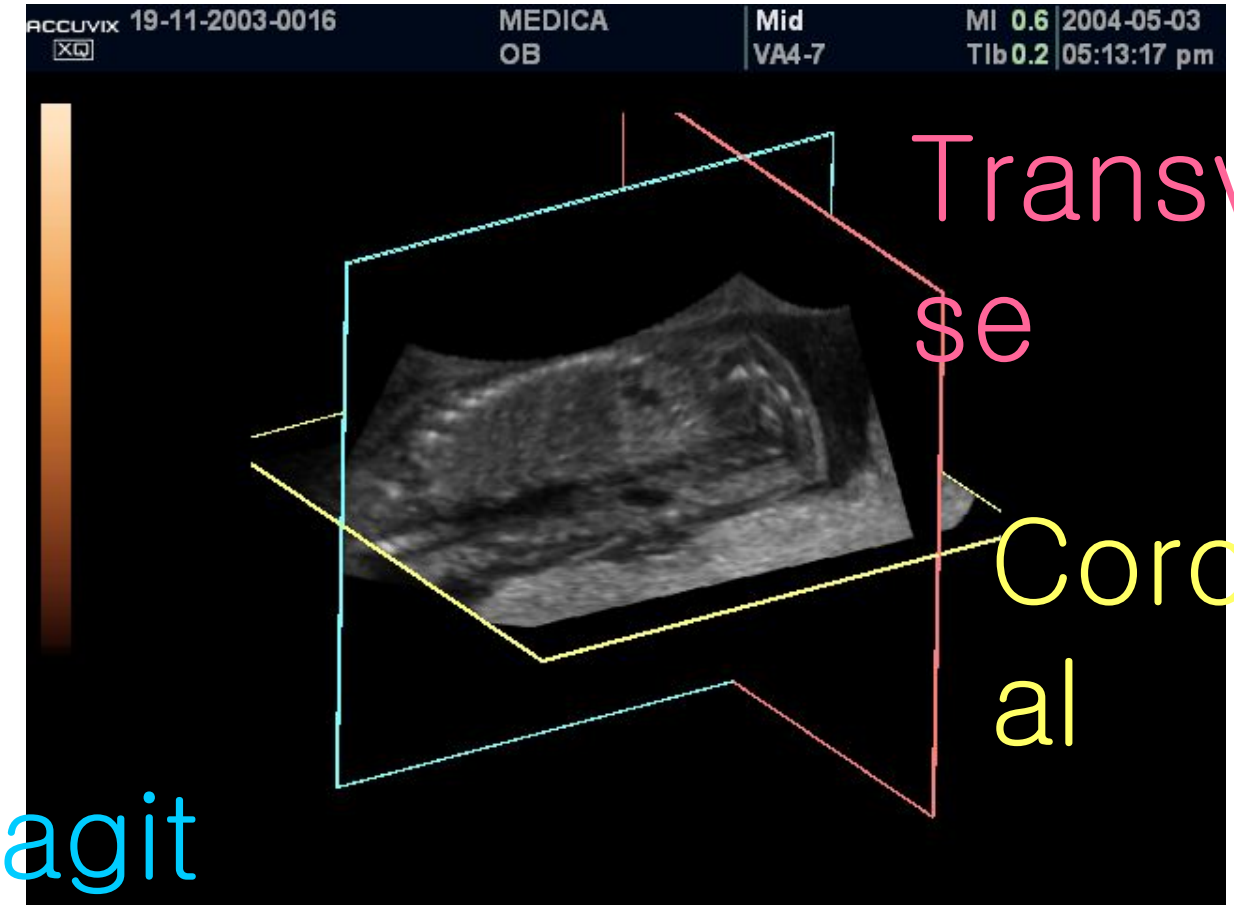
3D Utilities

- MULTI-PLANAR IMAGING
- VolumeCT mode
- VOCAL
- SHELL IMAGING
- SEE-THRU MODE

Multi-planar Imaging

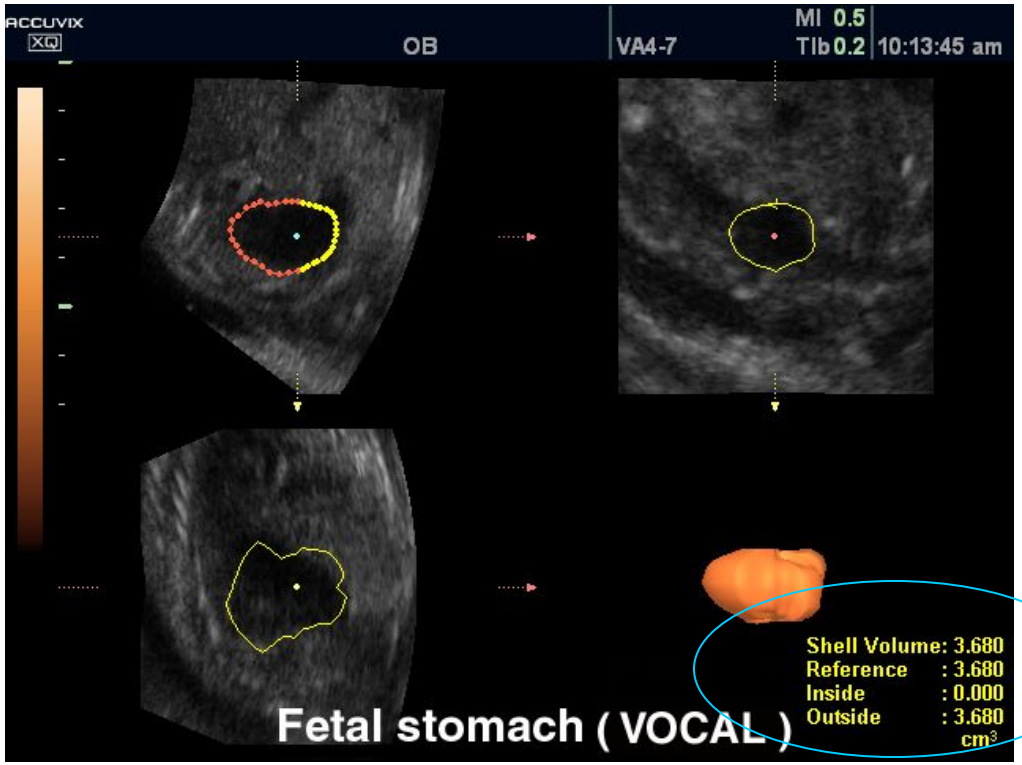


Volume CT mode



VOCAL

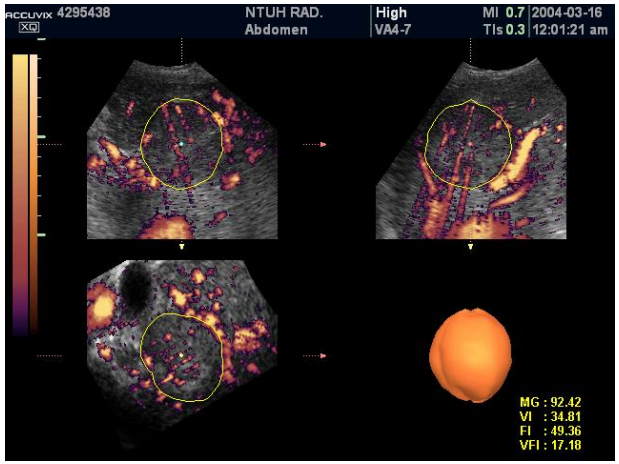
- Virtual Organ Computer Aided Analysis
  - Accurate volume measurement of mass by the automatically contour detected and rendered real mass



SHELL Imaging

- Result
  - Independent from Vascularization the “3D shell-values” are constant and give a measure how many blood flows through the “tumor”.
  - The Vascularization index applied to the full volume of “tumor” is a measure how the blood is distributed inside tumor.
  - The Flow index remains constant because this is not measure for volume-flow, it is a measure for mean velocity of flow only.
  - The VI, FI, VFI were obtained
  - The VI represents the vessels in the tissue, the FI represents the average intensity of flow, and the VFI represents both vascularization and flow.

SHELL Imaging



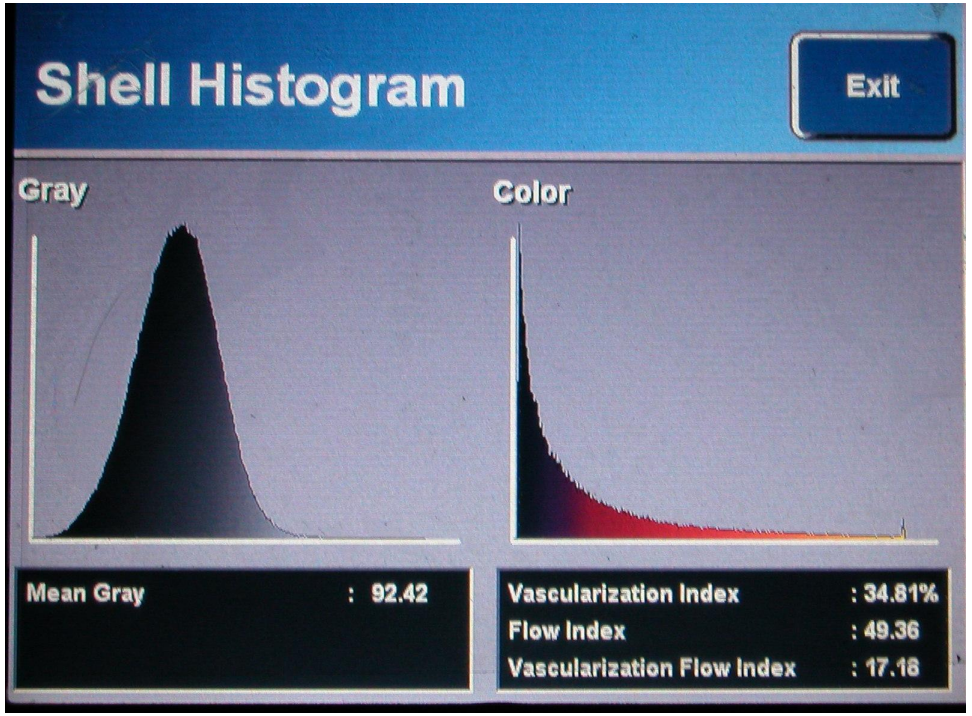
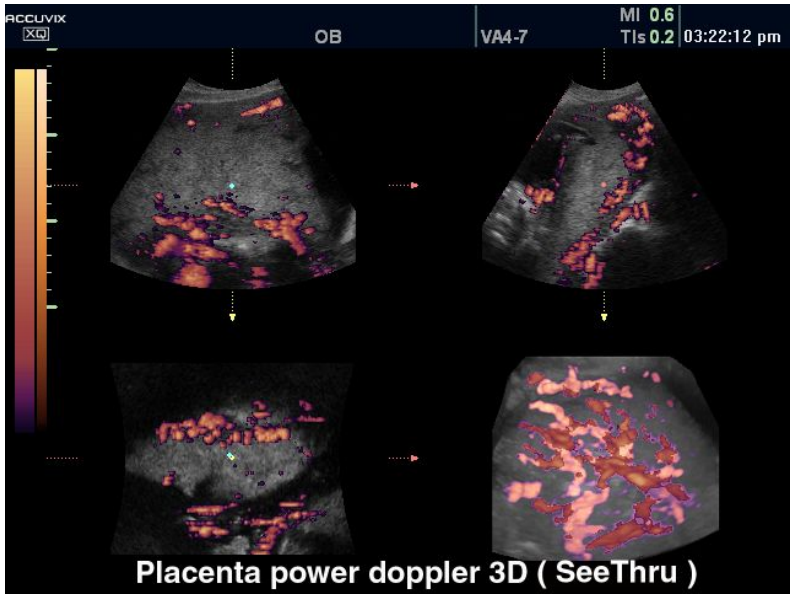


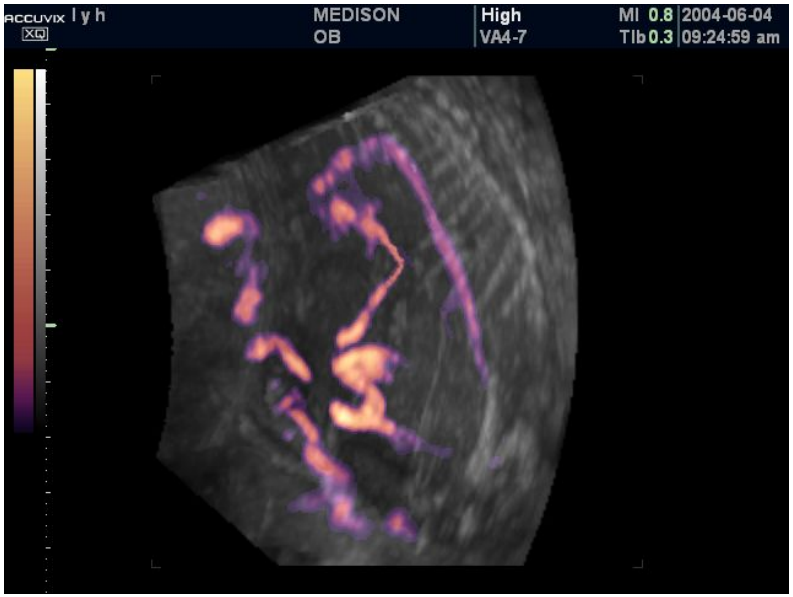
Image courtesy of Dr.YC. Chang, National Taiwan University Hospital

SEE-THRU MODE

- 3D imaging simultaneously for muscle tissue and blood vessels as well



Placenta power doppler 3D (SeeThru)

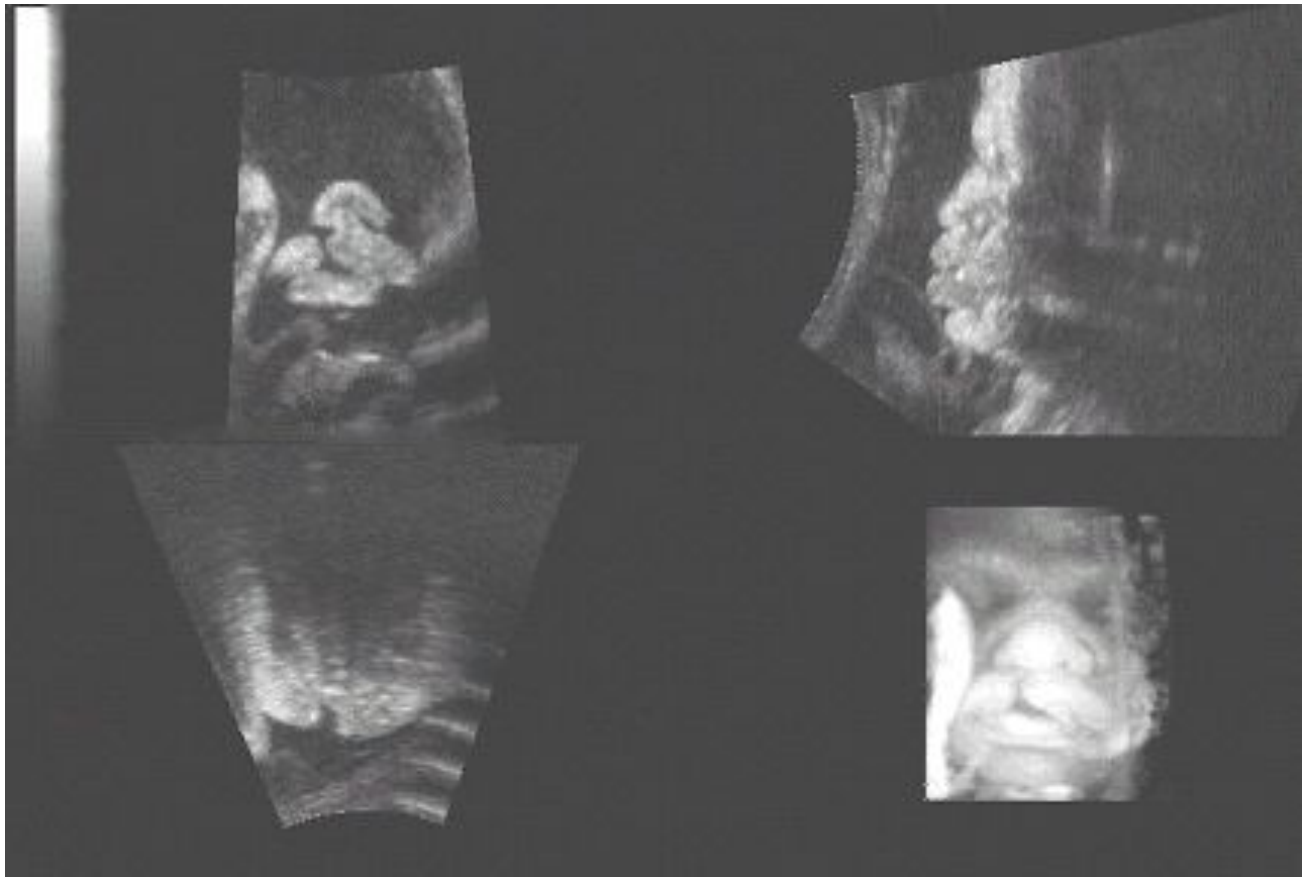


Clinical Advantages of 3D Ultrasound

Multi-Planar Imaging

- Congenital uterine abnormal(A,B,C Plane)
- Fetal cleft lip and palate detection
- Needle Position during breast biopsy
- Prostate Volume measurement
- NT measurement
- Intrauterine contraceptive device localization

Multi-Planar Imaging



Complete diagnosis of cleft lip on 3D multi-planar view

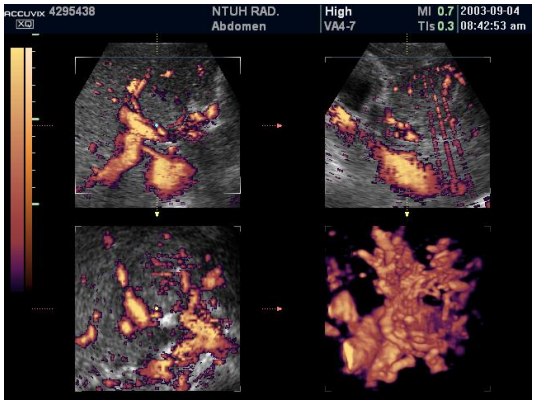
SHELL IMAGING

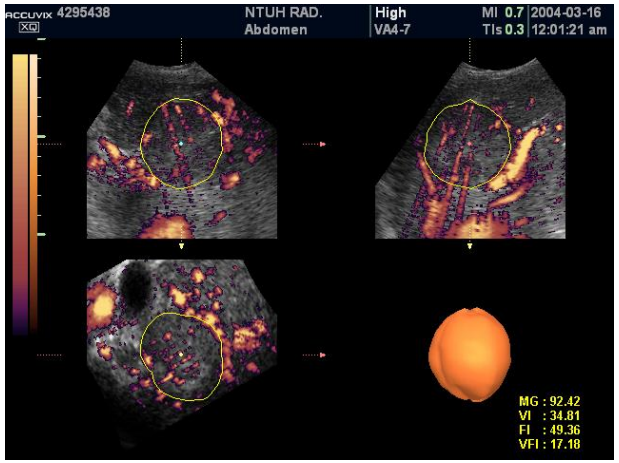
- Used to measure the Pre-and Post-TAE vascularity of Hepatocellular
- The tumor volume, Vascularization Index(VI), Flow Index(VFI) and mean grayness(MG) are Obtained

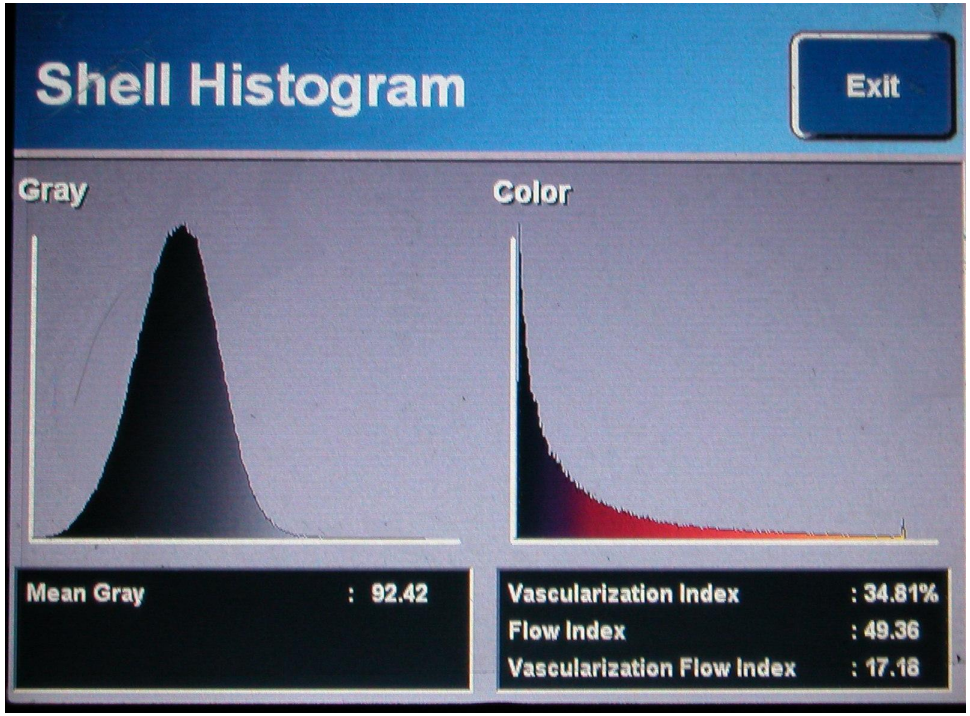
courtesy of Dr.YC. Chang, National Taiwan University Hospital

SHELL IMAGING

Pre Trans Arterial Embolization Vacularity of Hepatocellular



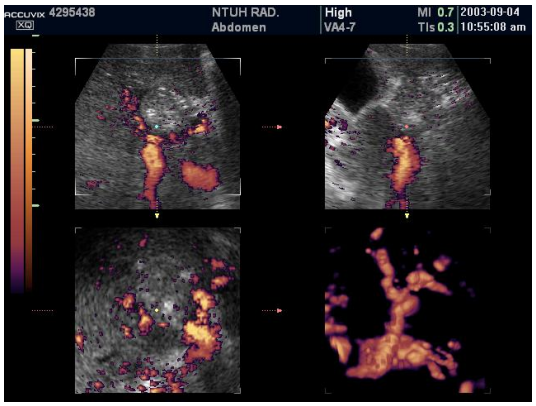


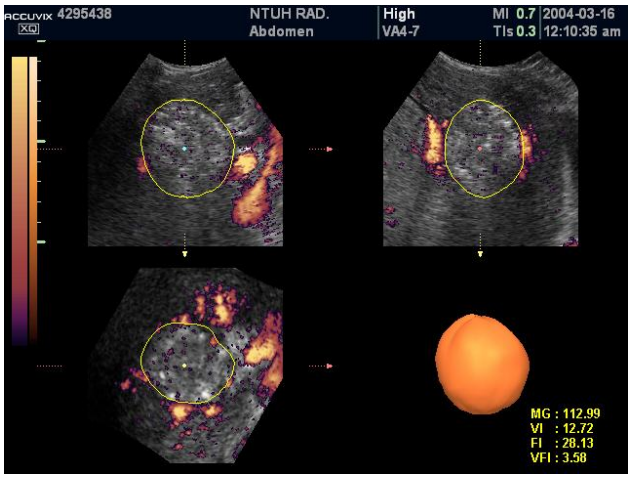


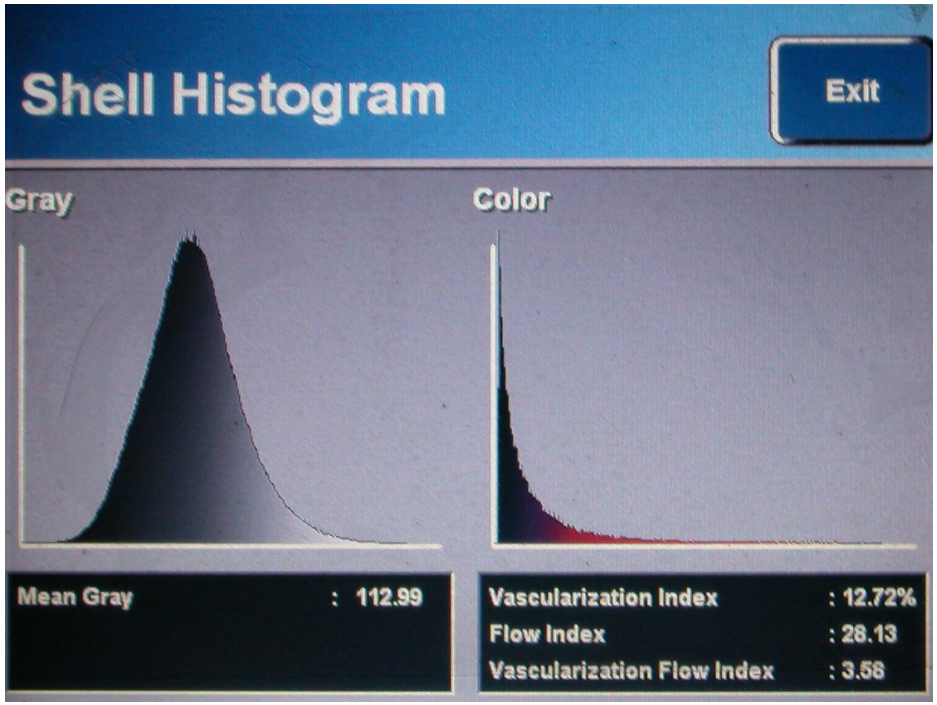
Images courtesy of Dr.YC. Chang, National Taiwan University Hospital

SHELL IMAGING

Post Trans Arterial Embolization Vacularity of Hepatocellular

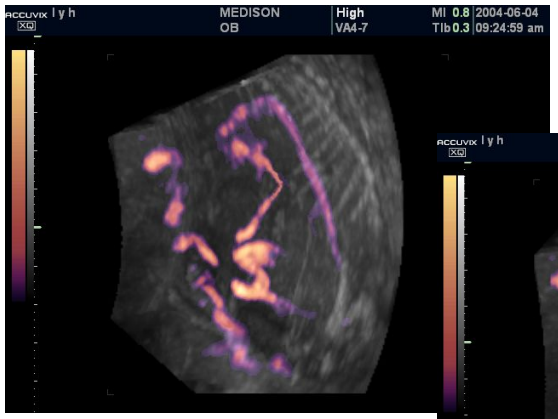




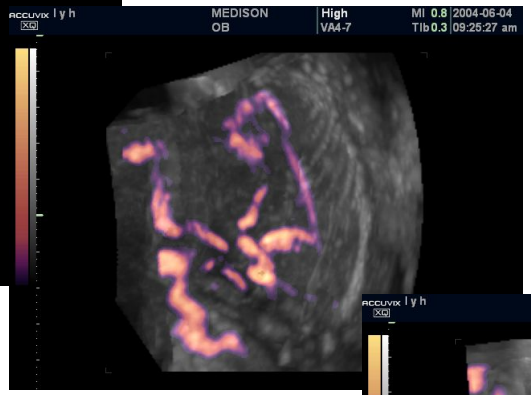


Images courtesy of Dr.YC. Chang, National Taiwan University Hospital

SEE-THRU MODE

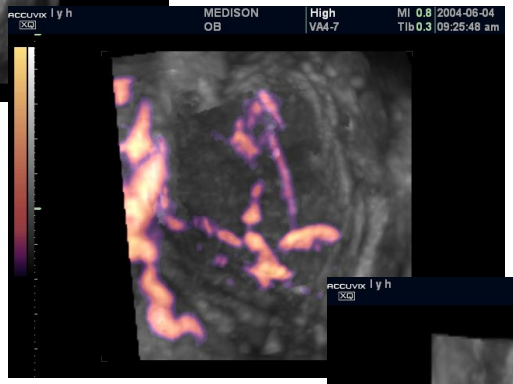


Lateral

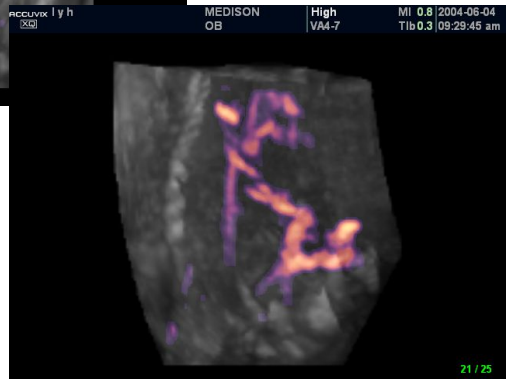


Oblique

Fetal Circulation



Frontage

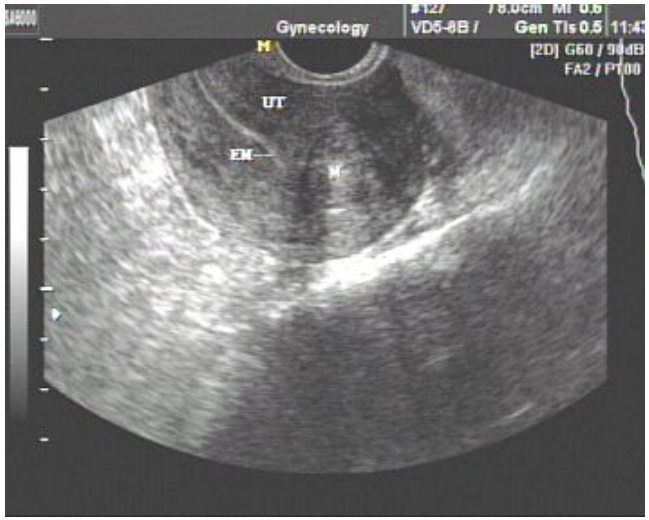


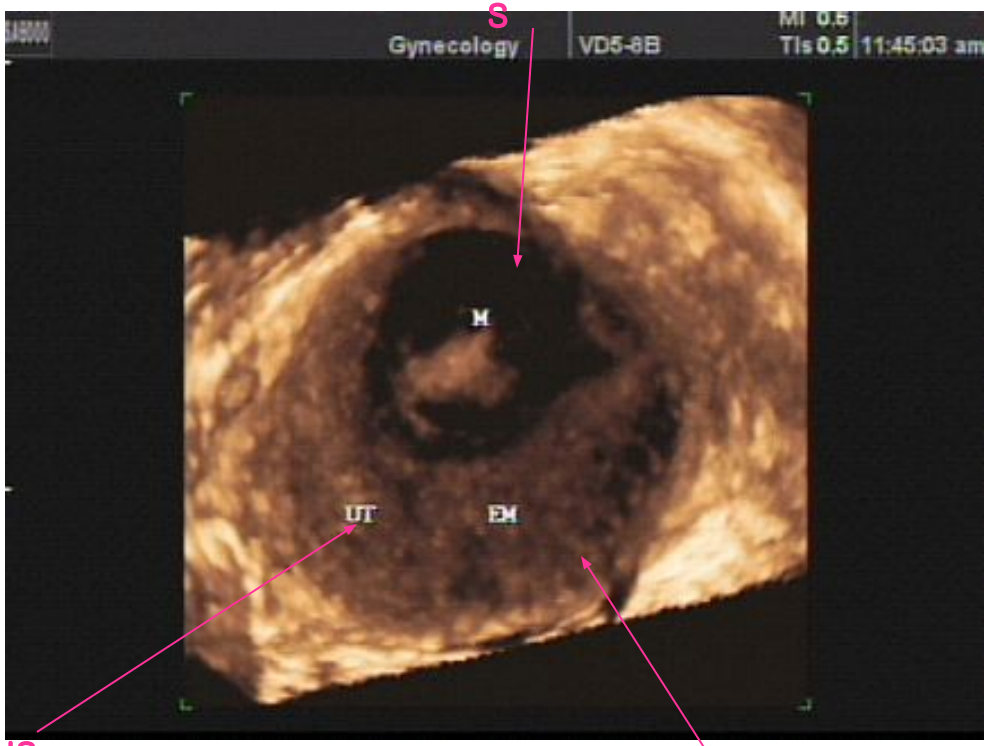
Oblique

Gynecology

Congenital uterine abnormal – Bicornuate uterus

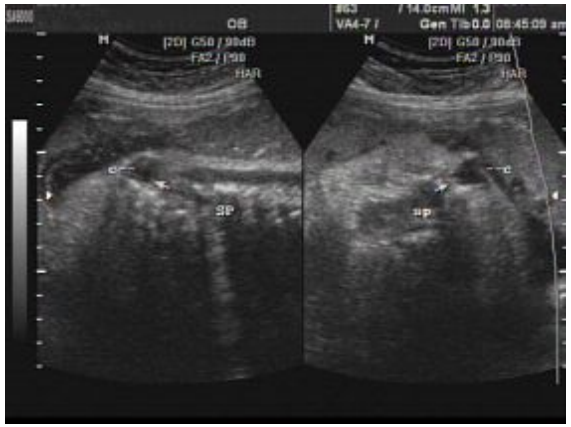
Gynecology





Uterus Mass in Surface Rendering

Obstetrics



Meningomyelocele

Obstetrics

Anecephaly

Obstetrics

Limbs with developmental defect and body edema

Obstetrics

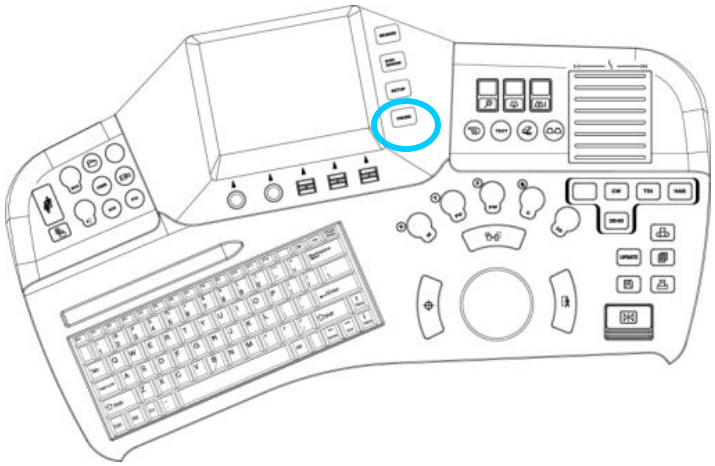
Cleft lip and palate

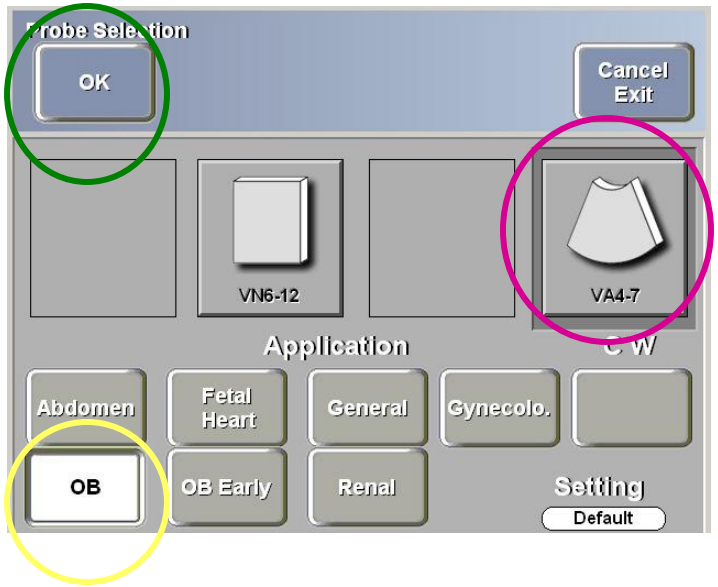
Obstetrics

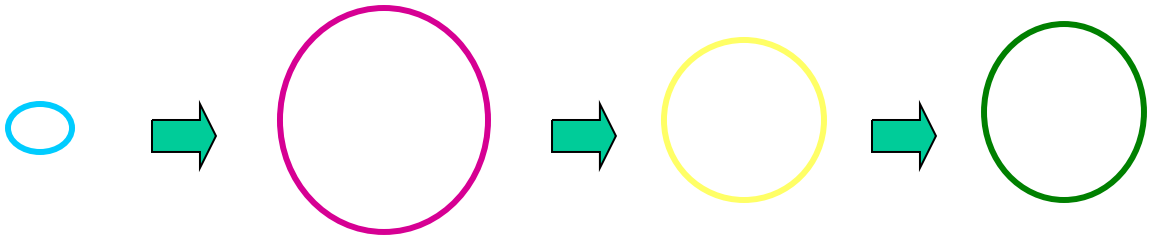
Limbs with developmental defect

Accuvix XQ 3D

Probe Selection





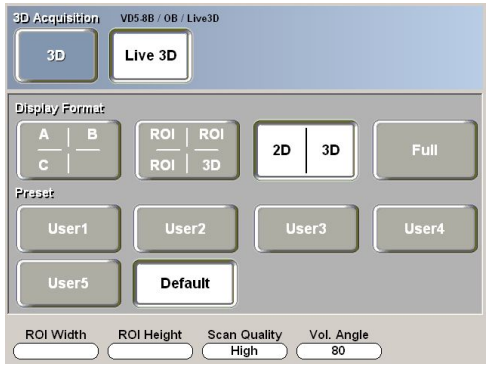


Live 3D

2D

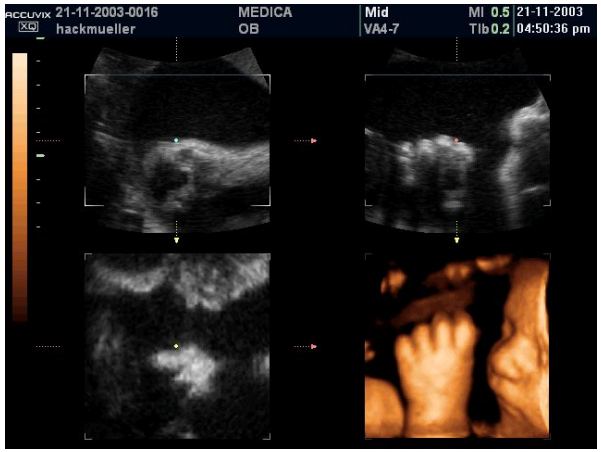
Press button

Adjustable ROI



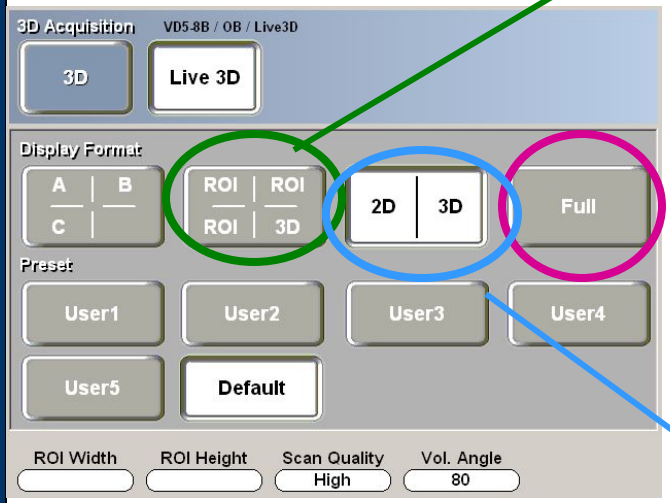
Live 3D Selection

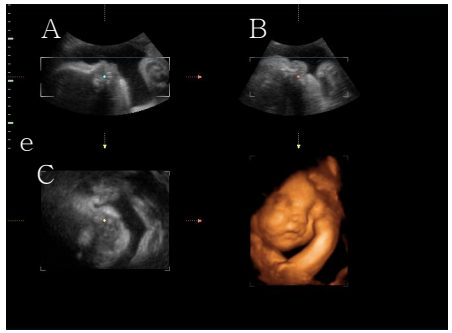
Press button



Live 3D

- Display image format select





Multi-planar image

Live 3D

Orientatio
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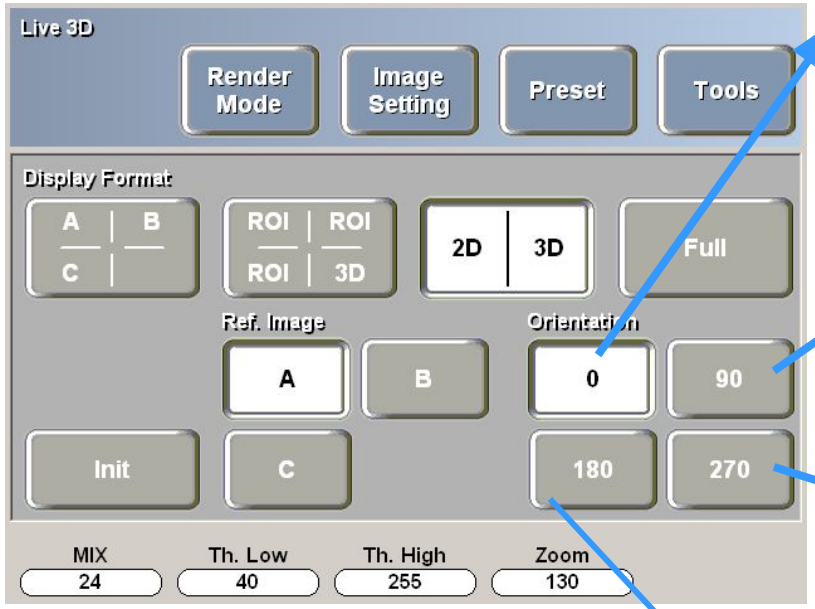
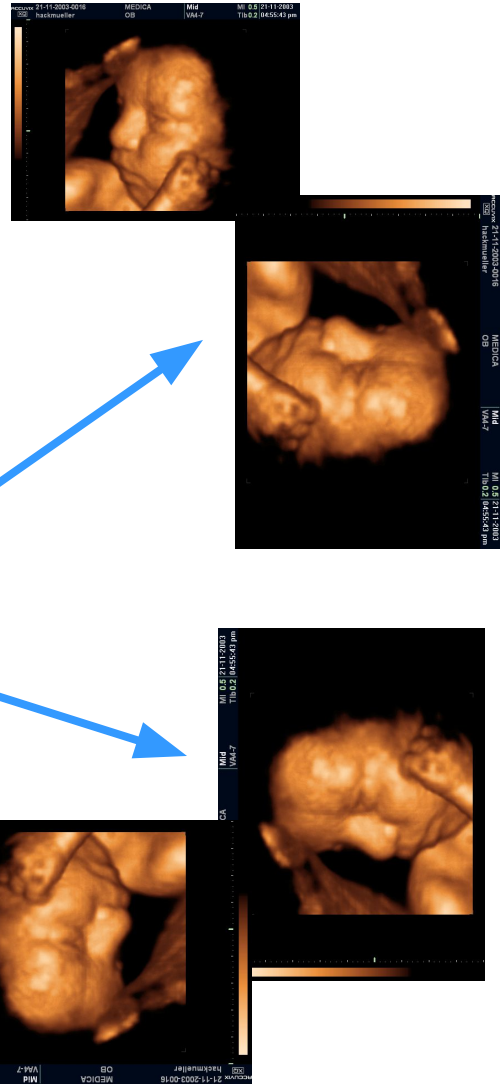


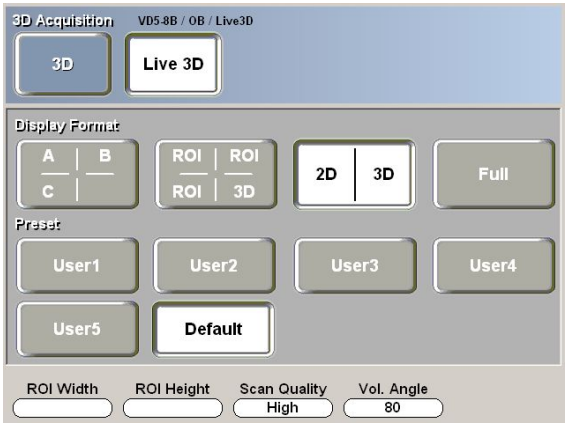


Live 3D

2D

Press button

Adjustable ROI

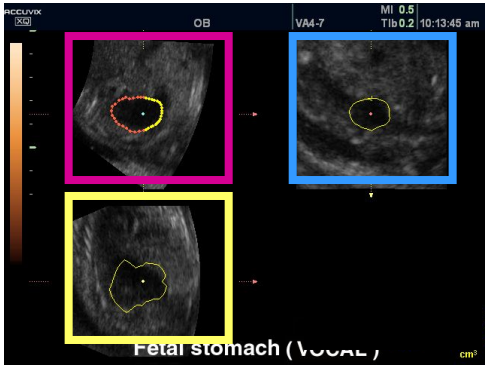


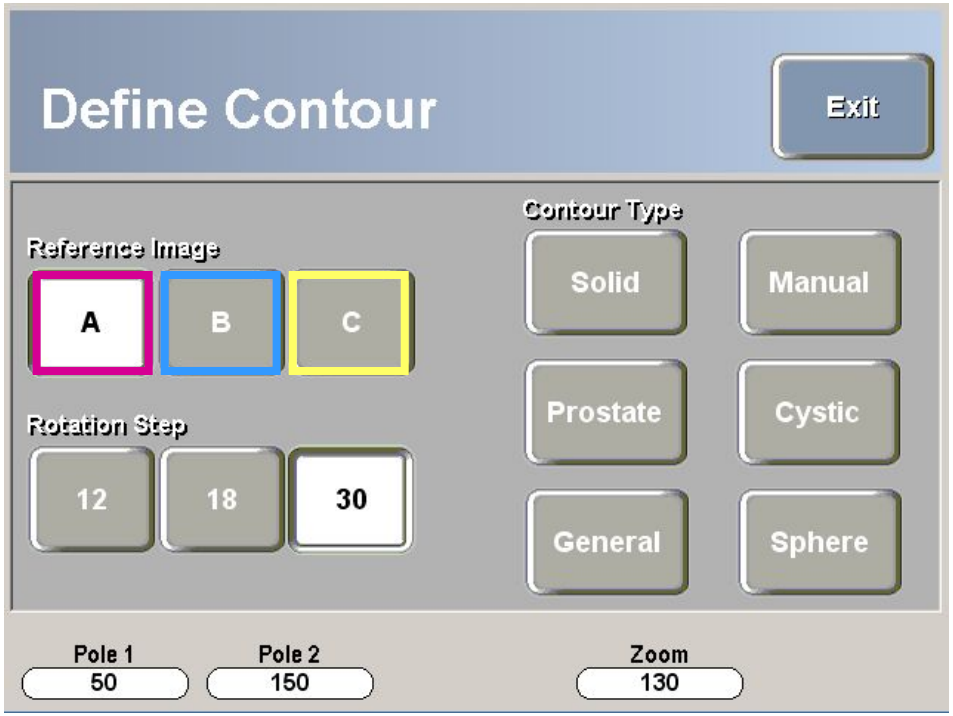
Live 3D Selection

Press button

VOCAL


VOCAL


OB
VA4-7
Fetal stomach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Exit
Reference Image
A
B
C
Contour Type
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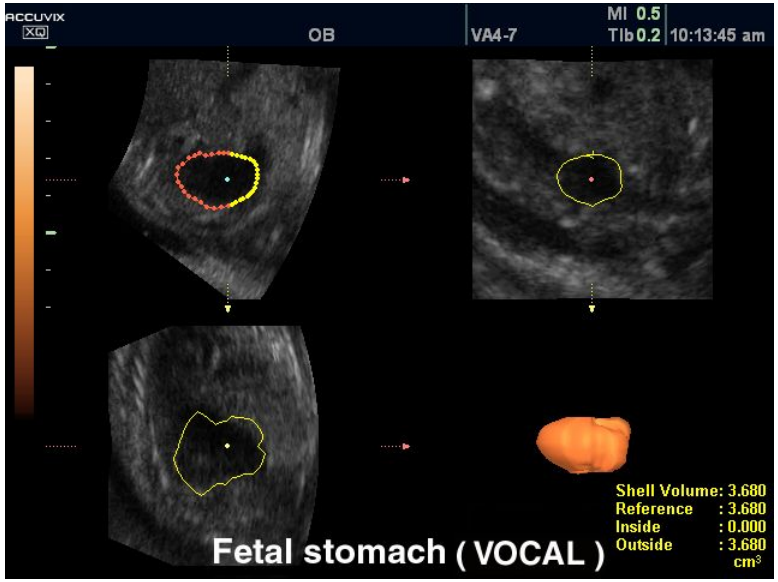
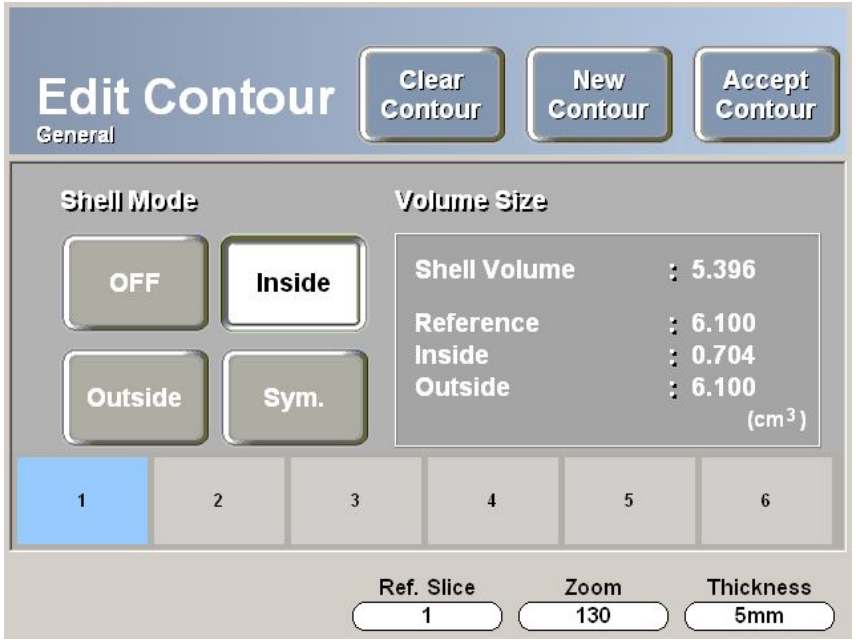
Pole 1
50
Pole 2
150
Zoom
130

VOCAL

Result

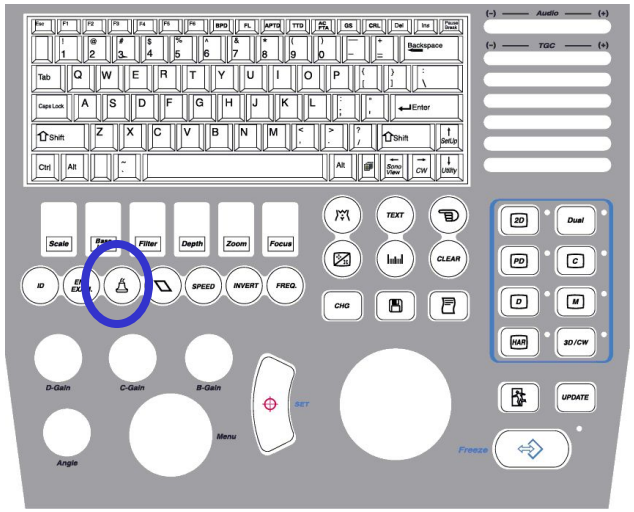




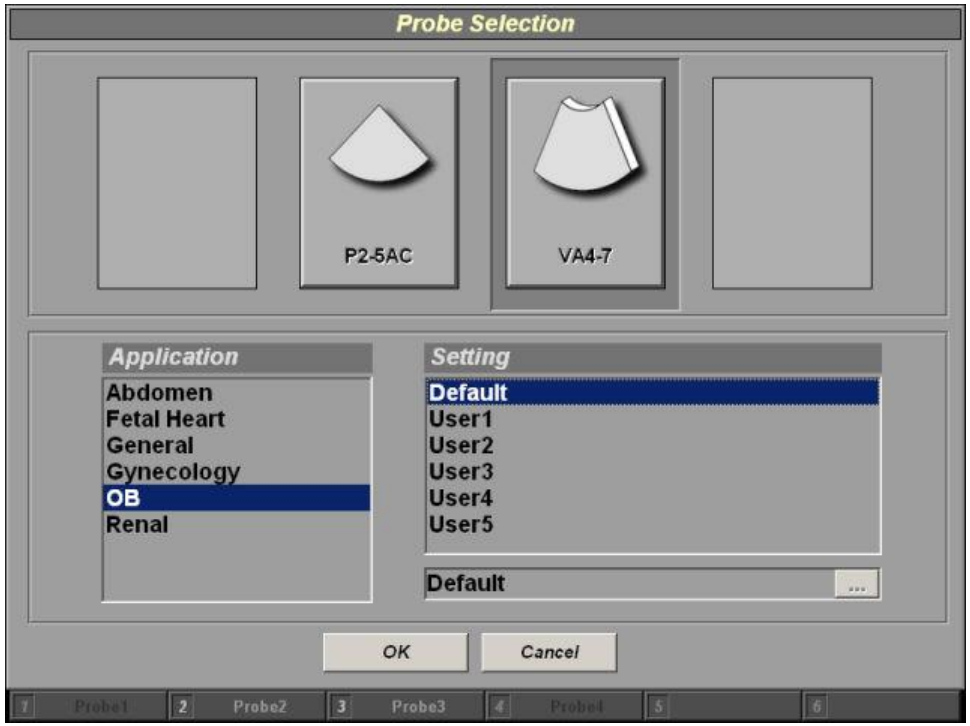
SA8000LV 3D

Live 3D

Probe Selection

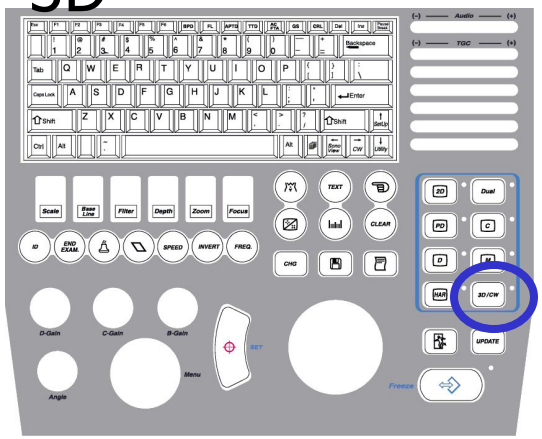


Press button

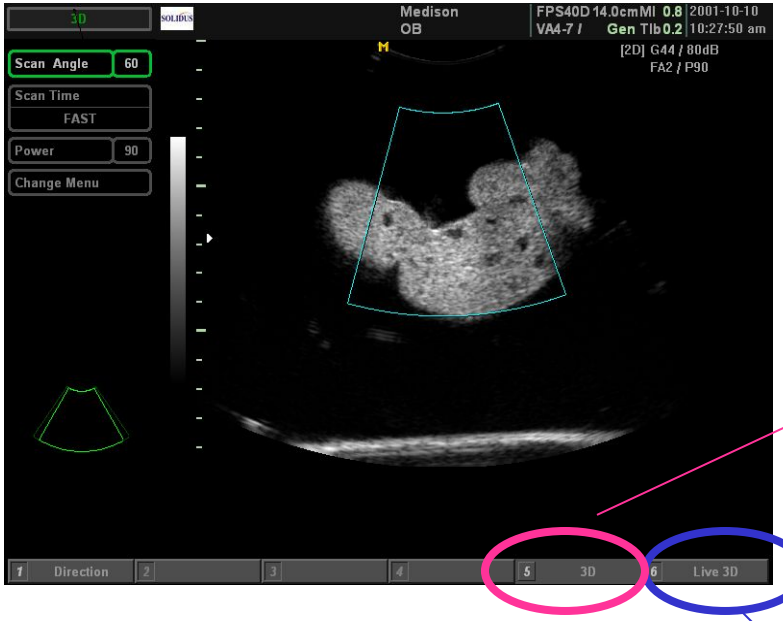


Live 3D

Live
3D

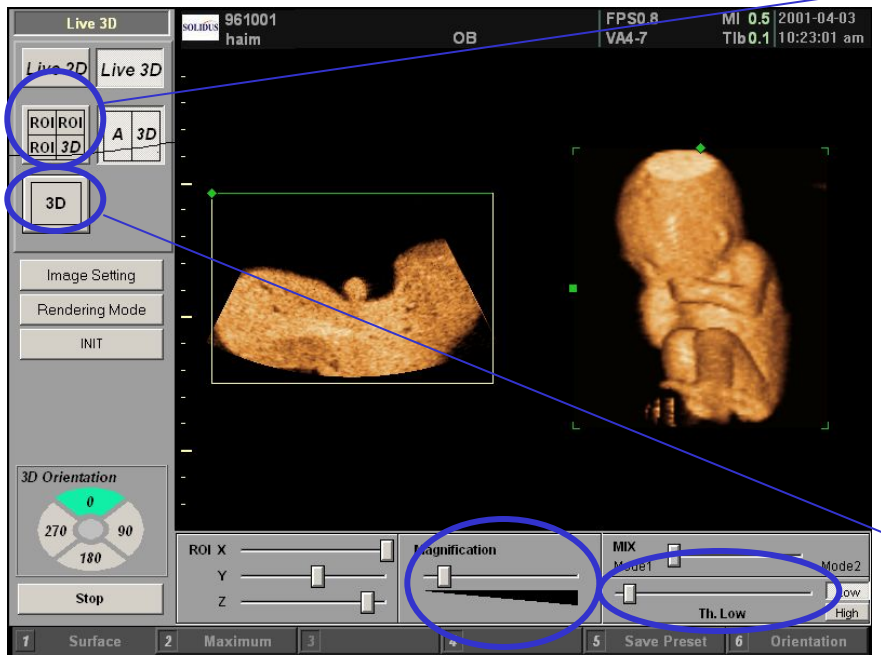


Press button



Press Keyboard

Live 3D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Live 3D
Live 3D
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ROI 3D
A 3D
3D
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Rendering Mode
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3D Orientation
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90
180
Stop
961001
haim
OB
FPS0.8
MI 0.5
VA4-7
TIb 0.1
2001-04-03
10:23:01 am
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MIX
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Mode2
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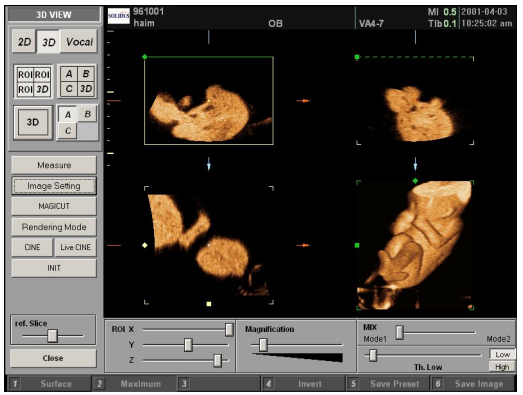
Low
High
1 Surface
2 Maximum
3
4
5 Save Preset
6 Orientation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2D
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C
Measure
Image Setting
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Magnification
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Mode2
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Th. Low
1 Surface
2 Maximum
3
4 Invert
5 Save Preset
6 Save Image


Lee Keon OB/GYN
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VA3-5
MI 0.6
TIb 0.1
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Live 3D

3
D


3D
Medison
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FPS40D 14.0cm MI 0.8 2001-10-10
VA4-7 / Gen TIb 0.2 10:27:50 am
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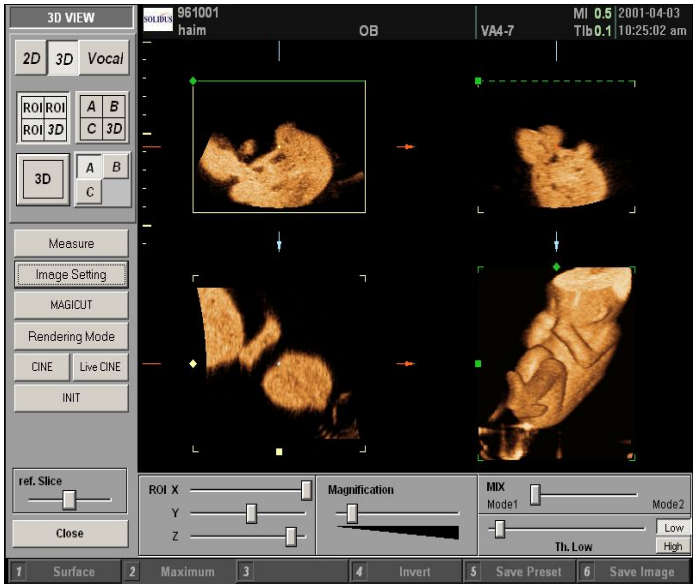
3D VIEW
961001
haim
OB
VA4-7
MI 0.5 2001-04-03
TIb 0.1 10:25:02 am
2D 3D Vocal
ROI ROI ROI 3D
A B C 3D
3D
A B C
Measure
Image Setting
MAGICUT
Rendering Mode
CINE Live CINE
INIT
ref. Slice
Close
ROI X
Y
Z
Magnification
MIX
Mode1 Mode2
Low
High
Th. Low
1 Surface
2 Maximum
3
4 Invert
5 Save Preset
6 Save Image