ECHOGRAPHIE DE L'APPAREIL GENITAL DE LA VACHE

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Introduction

- Echographie: technique d'imagerie médicale, US
- Visualisation non invasive des organes génitaux
- Historique: Premières tentatives examen tissus biologiques (1952), première image échographique transrectale organes génitaux de la jument (1980)
- Réalisations possibles en physiologie de la reproduction
- Palpation rectale et échographie
- Echographie: technique exigeante sur le plan intellectuel
- Sécurité de l'échographie (énergie US: 1-10 mWatt/cm²)

Plan de l'exposé

- Principes de l'échographie et principaux artéfacts lors de l'examen de l'appareil génital
- Application de l'échographie à l'examen de l'utérus et au diagnostic de gestation
- Application de l'échographie à l'identification des organites ovariens et au suivi ovarien

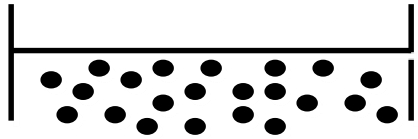
Principes de l'échographie

- Nature physique des ultrasons
  - Vibration mécanique, même nature que le ondes sonores
  - Fréquence sons audibles: 20- 20 000 Hz (1Hz=1cycle/s)
  - Fréquence ultrasons > 20 000 Hz
  - Fréquence US imagerie médicale : 2-10 MHz (1MHz= 1 million de cycles/s)

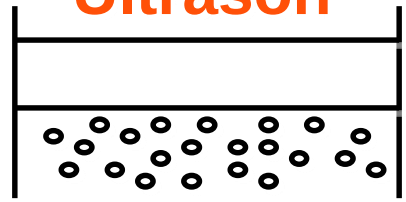
Genèse d'un son et d'un ultrason

tambour

Son audible

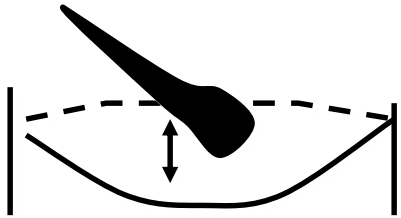


Ultrason

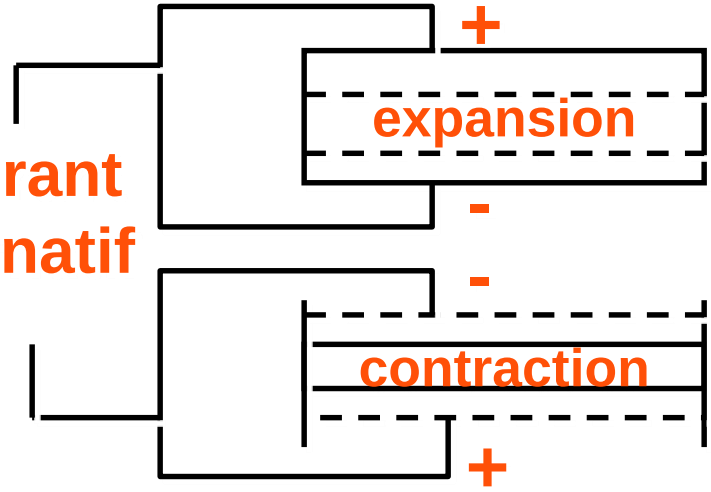


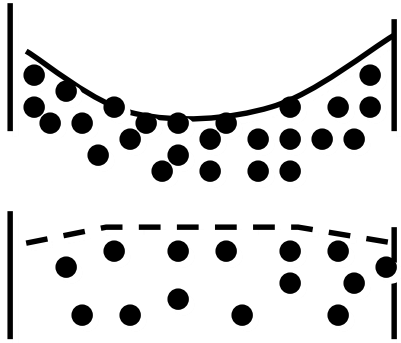
Cristal piézo-électrique

Activation



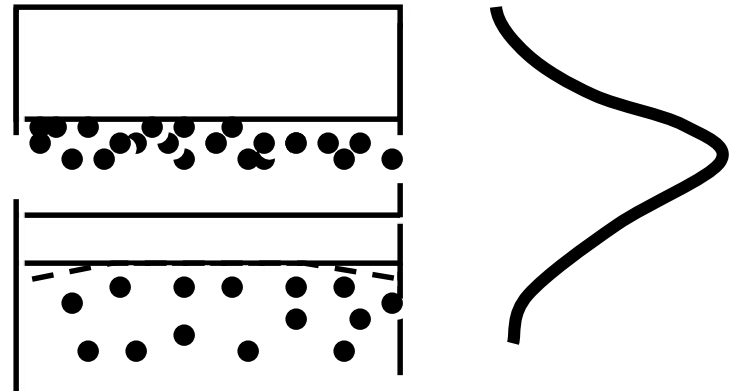
Courant alternatif



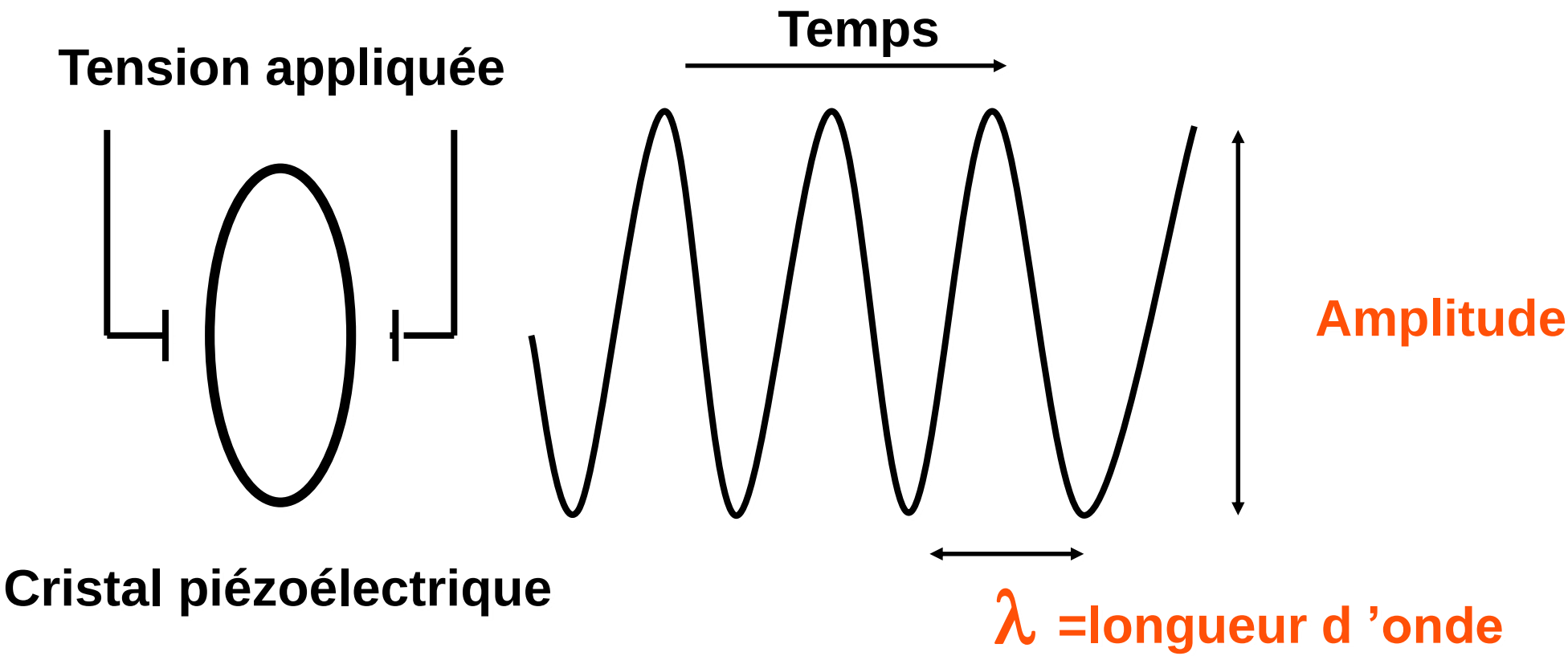


Compression

Décompression



Propriétés physiques des US



Fréquence: nombre de cycles par unité de temps

Propriétés physiques des US

$\lambda = C/f$

f = fréquence
C = célérité ou vitesse de l ’onde
λ = longueur d ’onde

C = 1540 m/s = constante dans les tissus mous

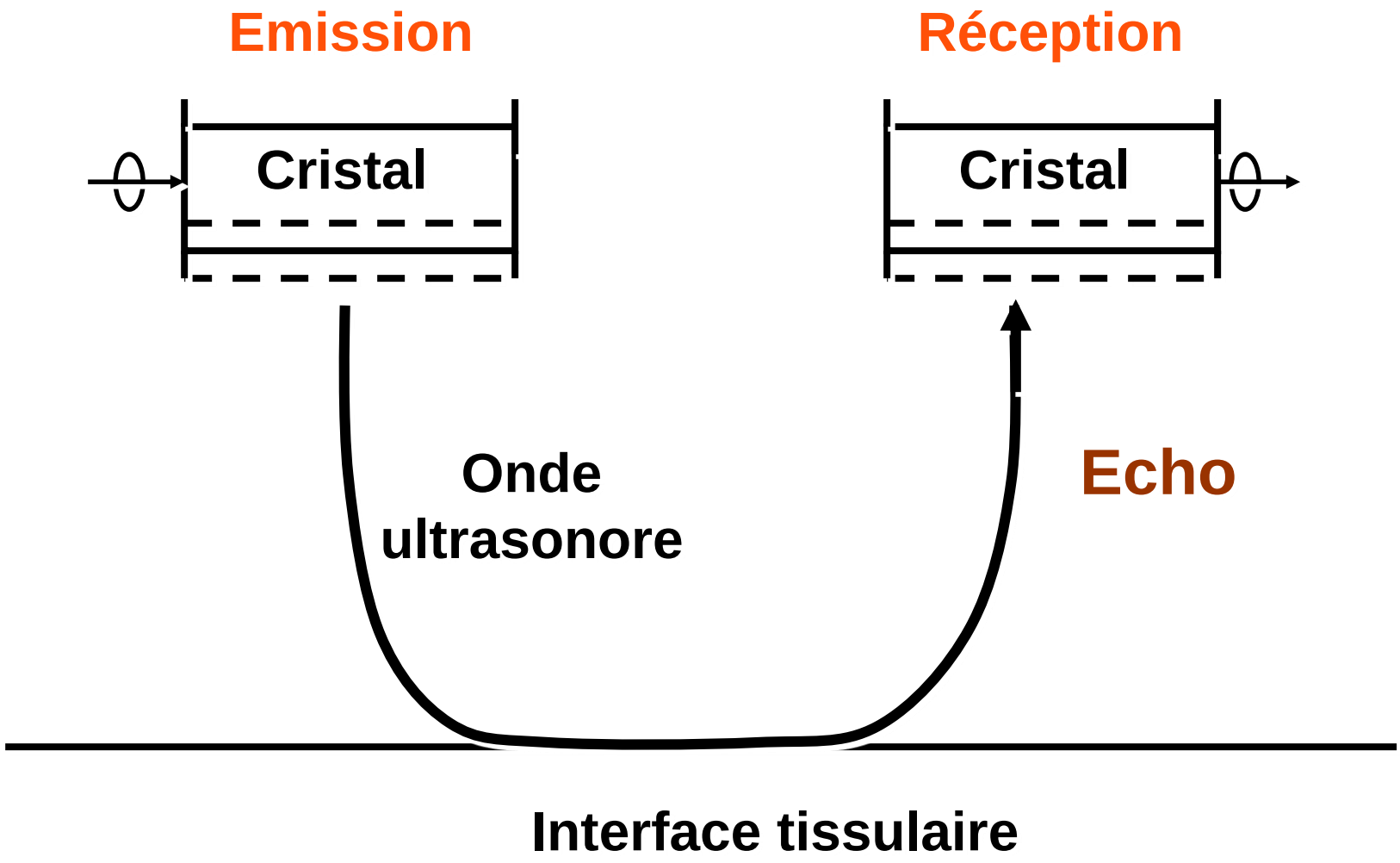
$\uparrow f \quad \Rightarrow \quad \downarrow \lambda$

1 MHz	1.5 mm
10 MHz	0.15 mm

Propriétés physiques des US

Tissus	Vitesse de propagation des US (m/s)
Poumons	650
Graisse	1460
Eau	1482
Foie	1535
Rein	1500
Collagène	1680
Os	2700-4000
Air	330
Lait	1540
Muscle	1545-1630

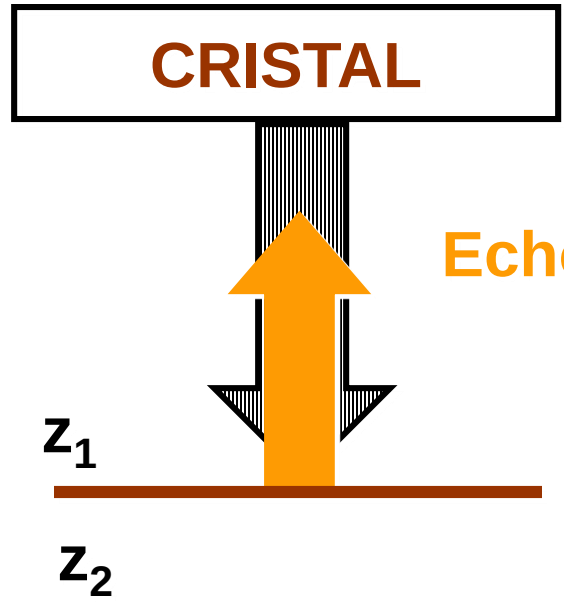
Genèse des échos



Réflexion

Z=Impédance acoustique=

vitesse propagation US x densité



Interface tissulaire

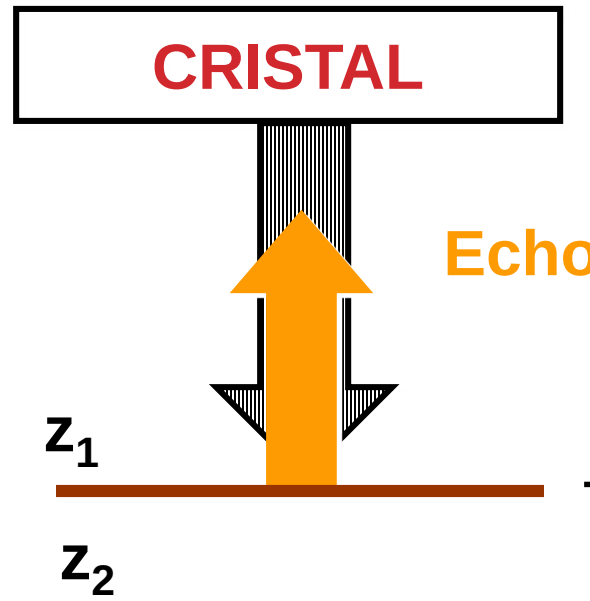
$$\frac{I}{I_0} = \frac{(z_1 - z_2)^2}{(z_1 + z_2)^2}$$

Ex: Interface graisse ($z=1.33\ 10^6$)-muscle ($z=1.7\ 10^6$): 1.5% énergie incidente réfléchie

Réflexion

Z=Impédance acoustique=

vitesse propagation US x densité

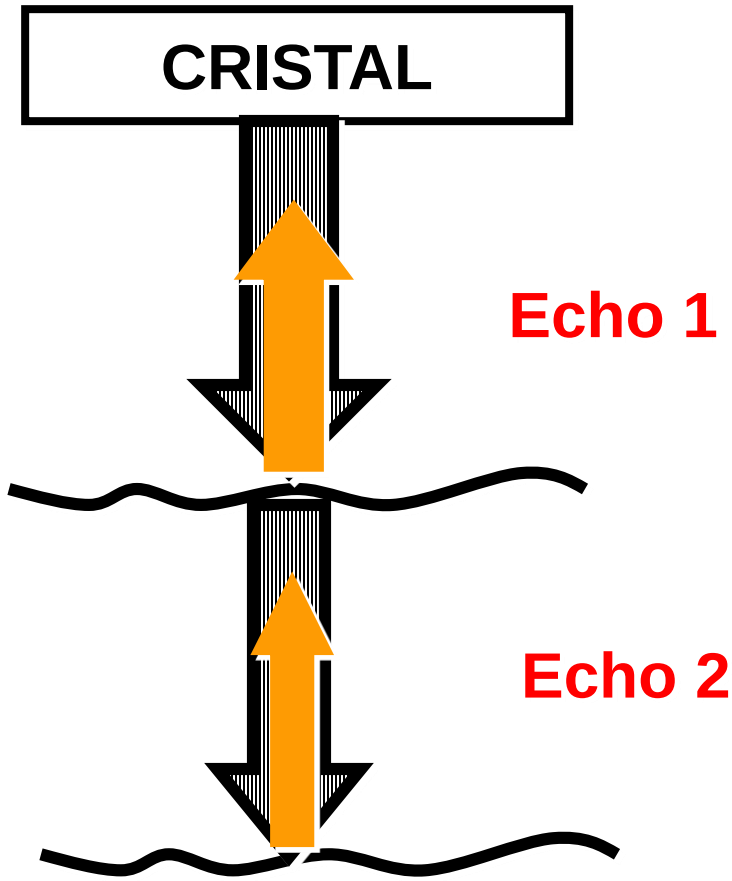


Interface tissulaire

$$\frac{I}{I_0} = \frac{(z_1 - z_2)^2}{(z_1 + z_2)^2}$$

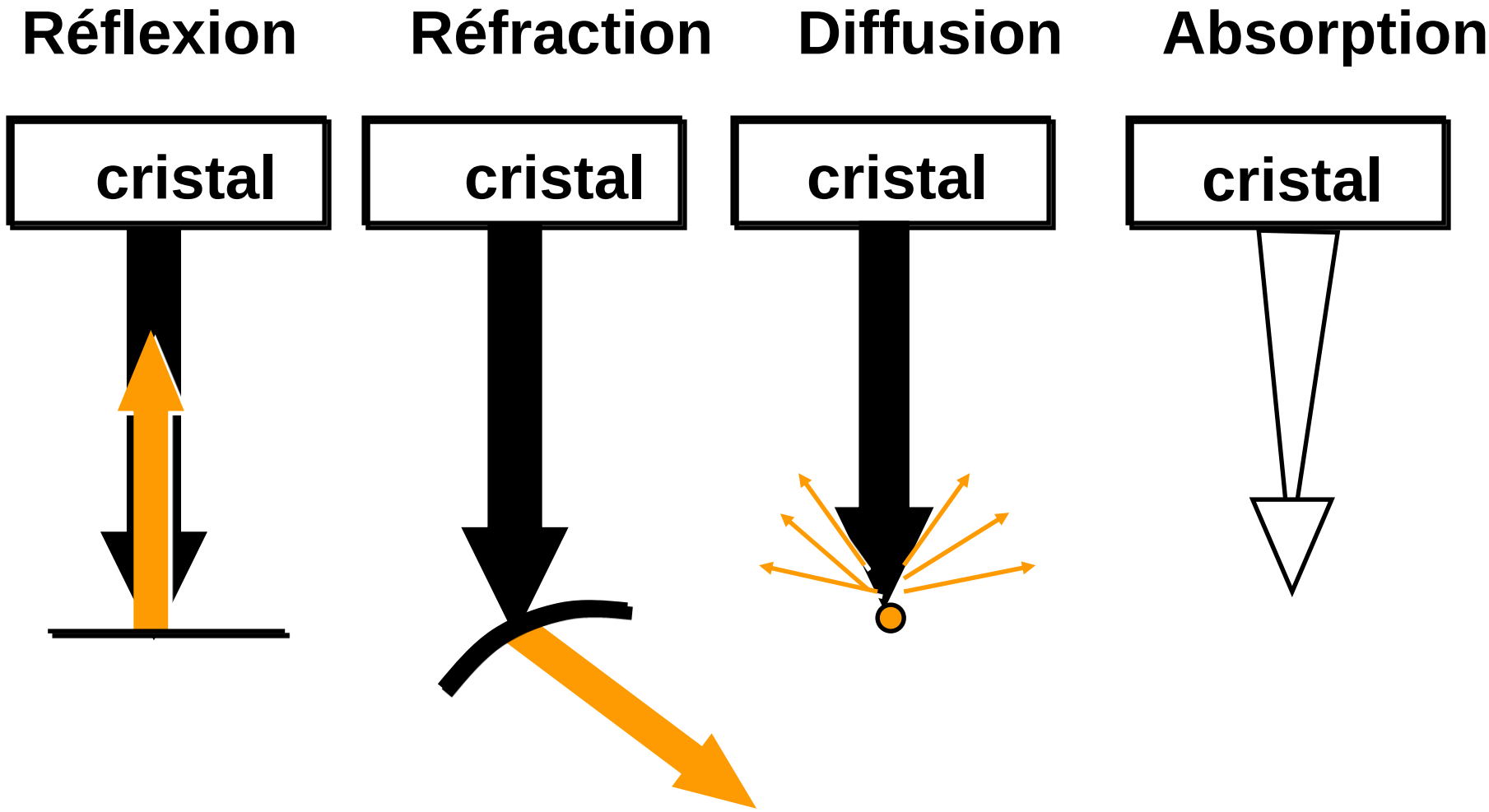
Ex: Interface tissu mou-os, tissu mou-gaz: 99% énergie incidente réfléchie

Atténuation

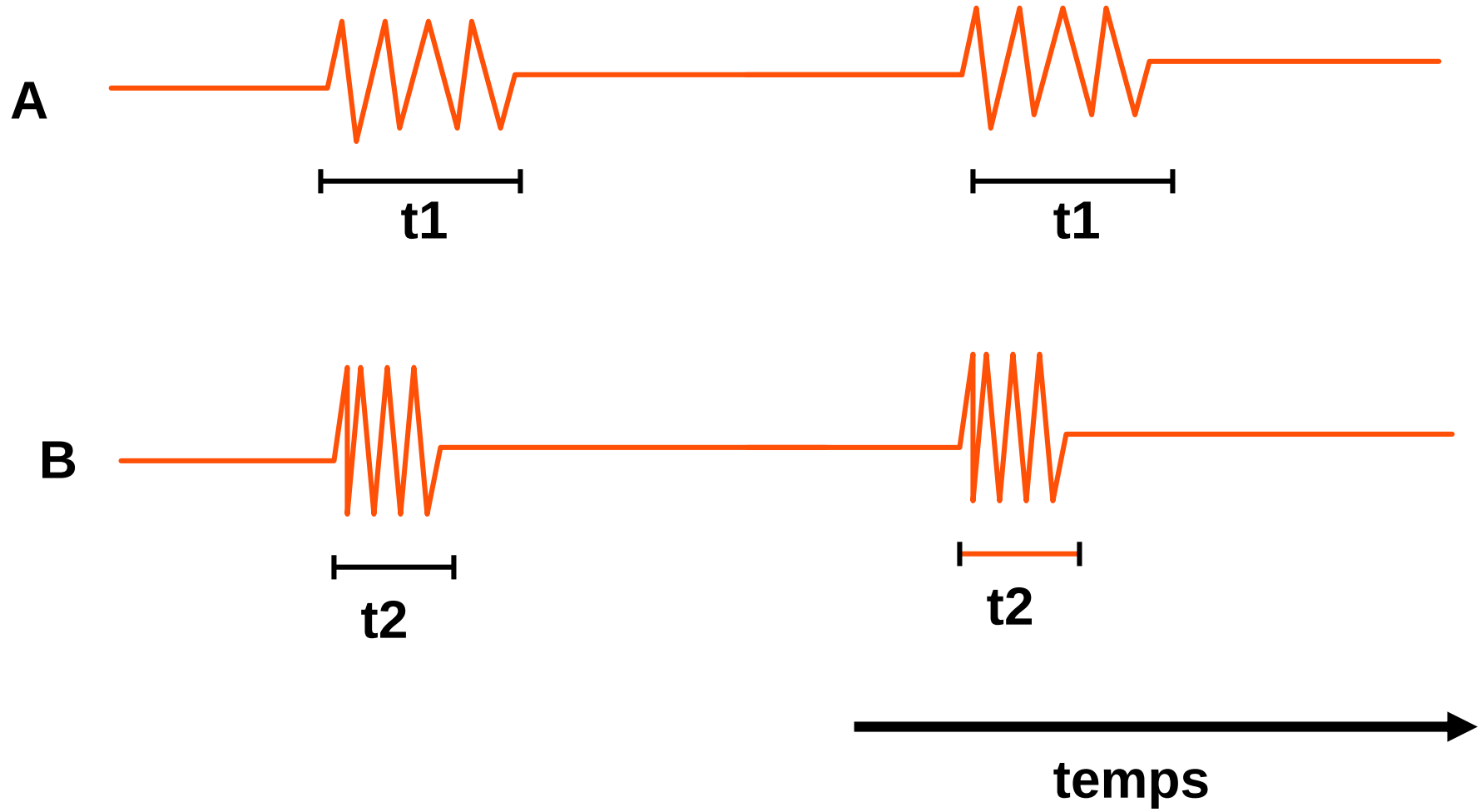


Capacité d ’atténuation (dB par MHz par cm)	
Eau	0.002
Air	10
Tissu mou	0.3-1.5
Os	10
Poumon	40

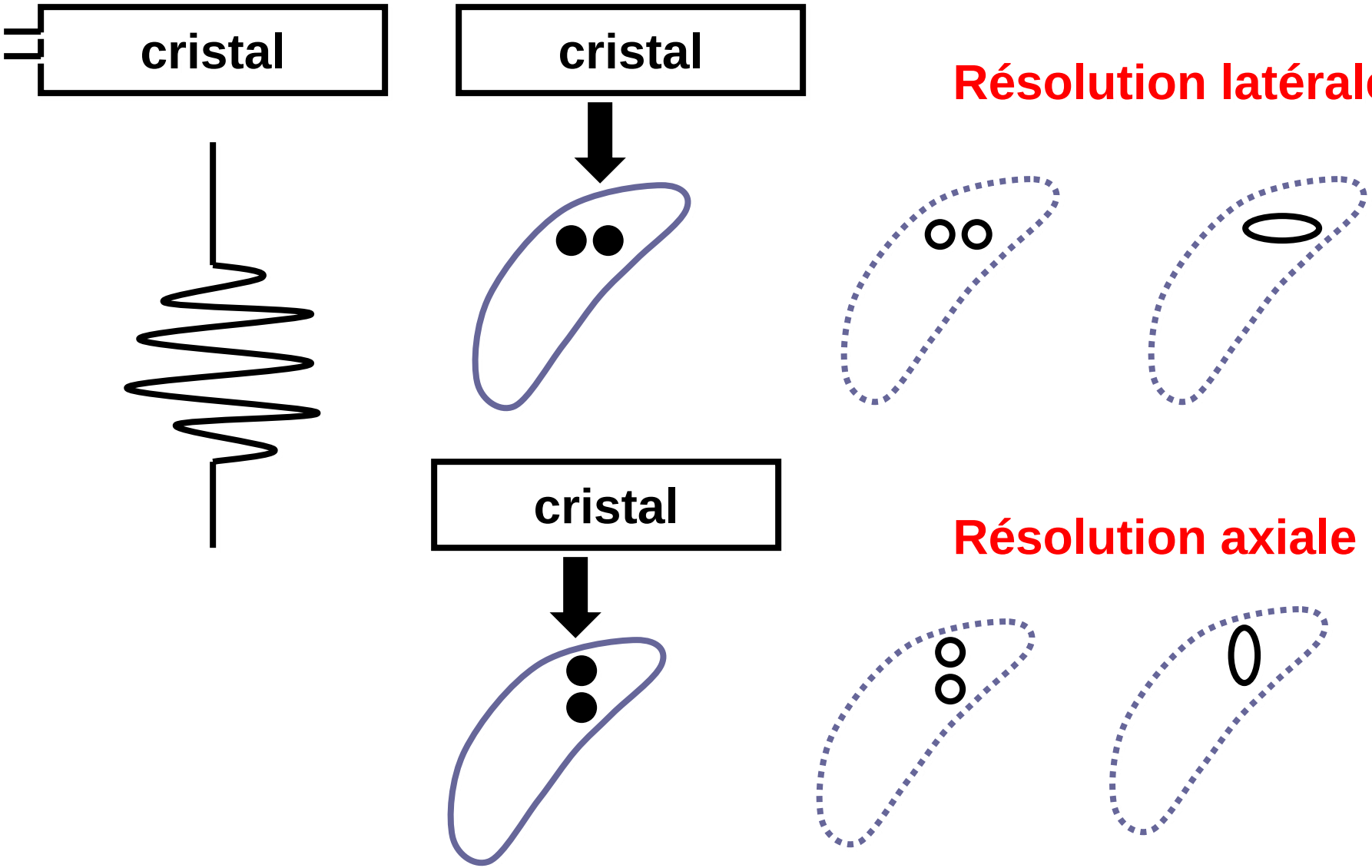
Interaction US-tissu



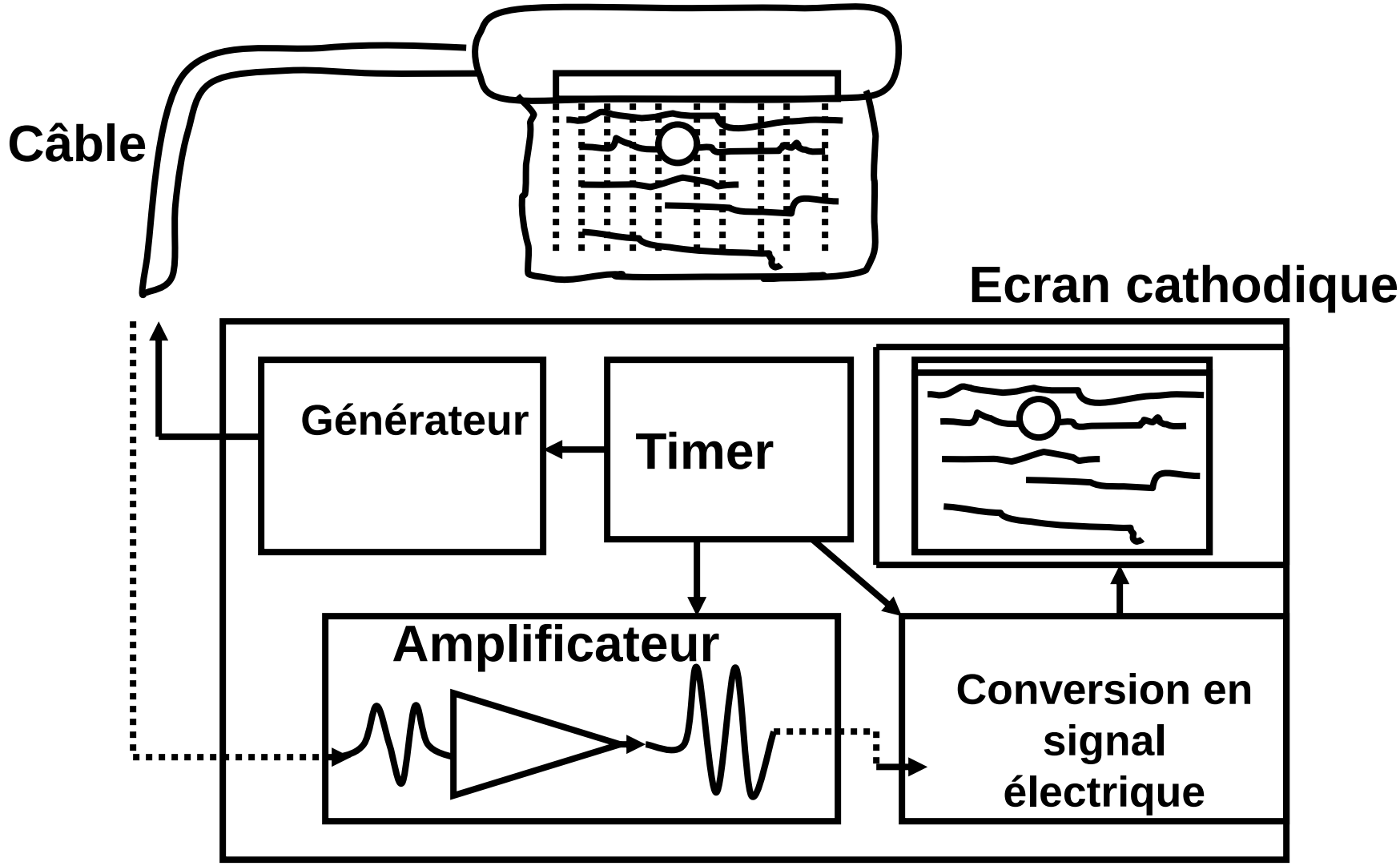
Génération de salves d'ultrason



Résolution axiale - Résolution latérale

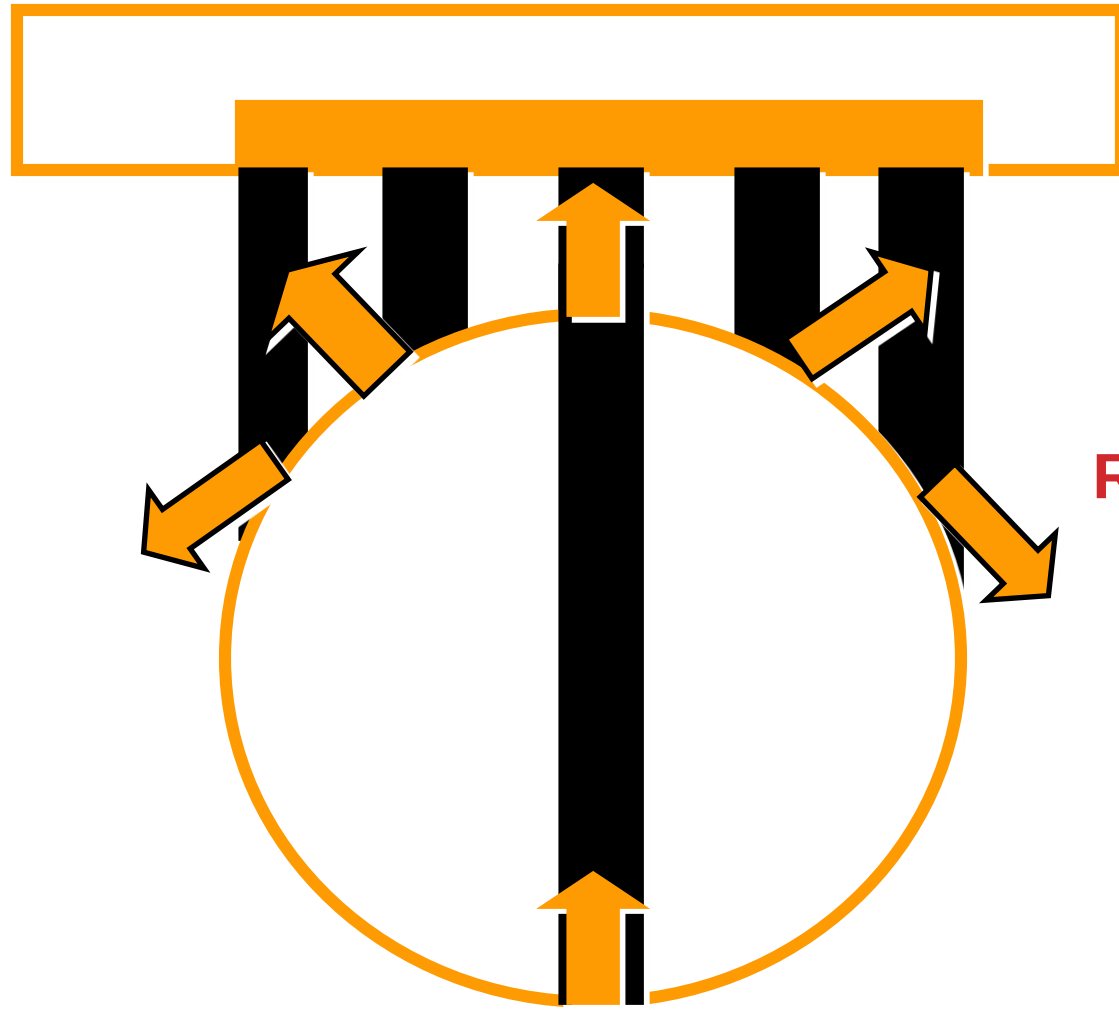


Formation des images

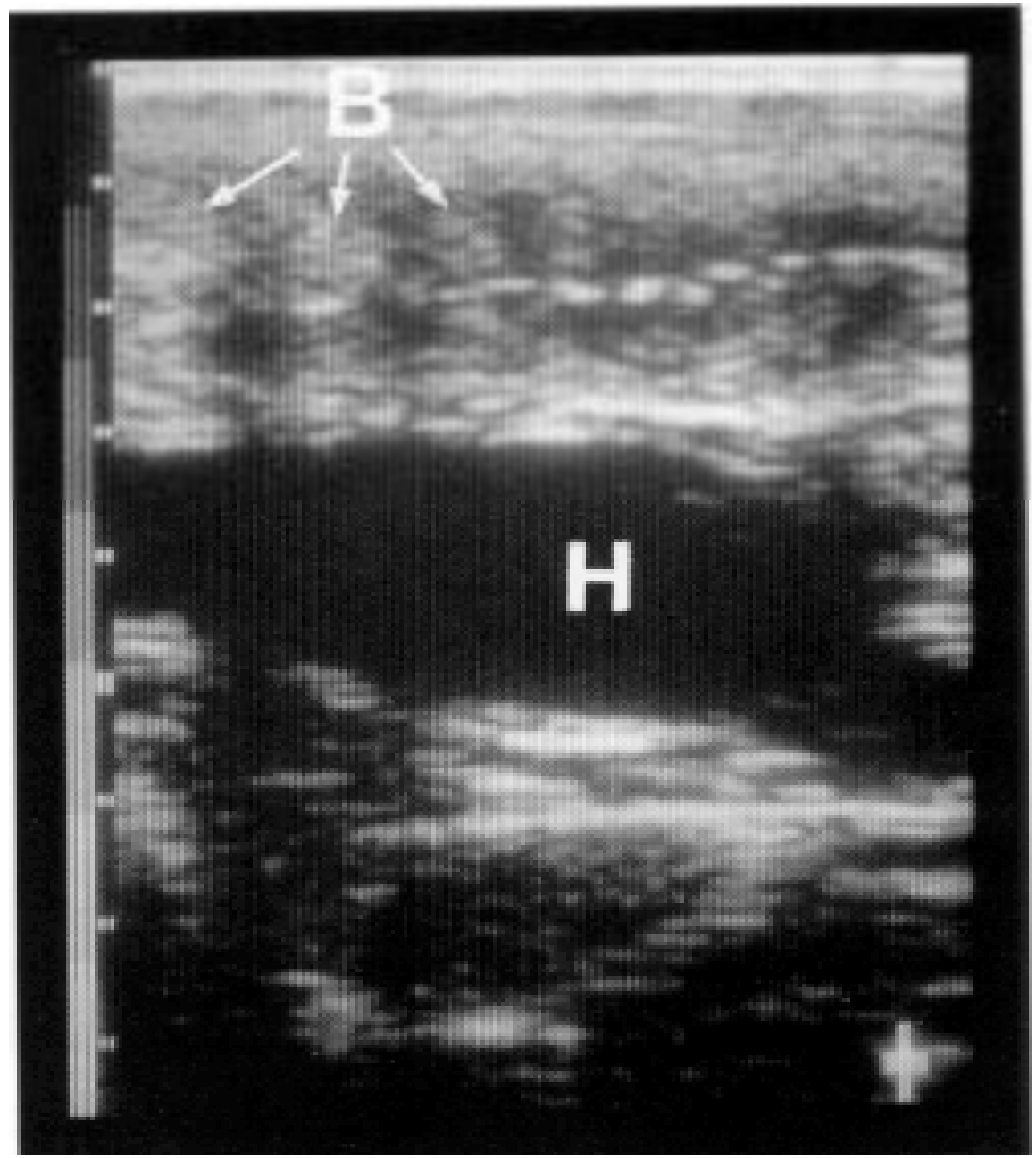



esaote piemedical MyLab
Pathologie de la reproduction, ENVT
1913, 58j , N:No, , ID: 2012-11-28-00,
28 NOV 2012 14:39
F 10.0 MHz G 78%
D 7 cm
PRC 7/1/H PRS 5
PST 1/2
4
13
SV3513
443 / 500

Image spéculaire



Réflexion


B
H


14/02/08
11:07:30
L 8.0 MHz
fab
G
R→
17 Ips
Memoire 1
Standard
Attendez s.v.p.
Id patient :
HOSPIMEDI FRANCE

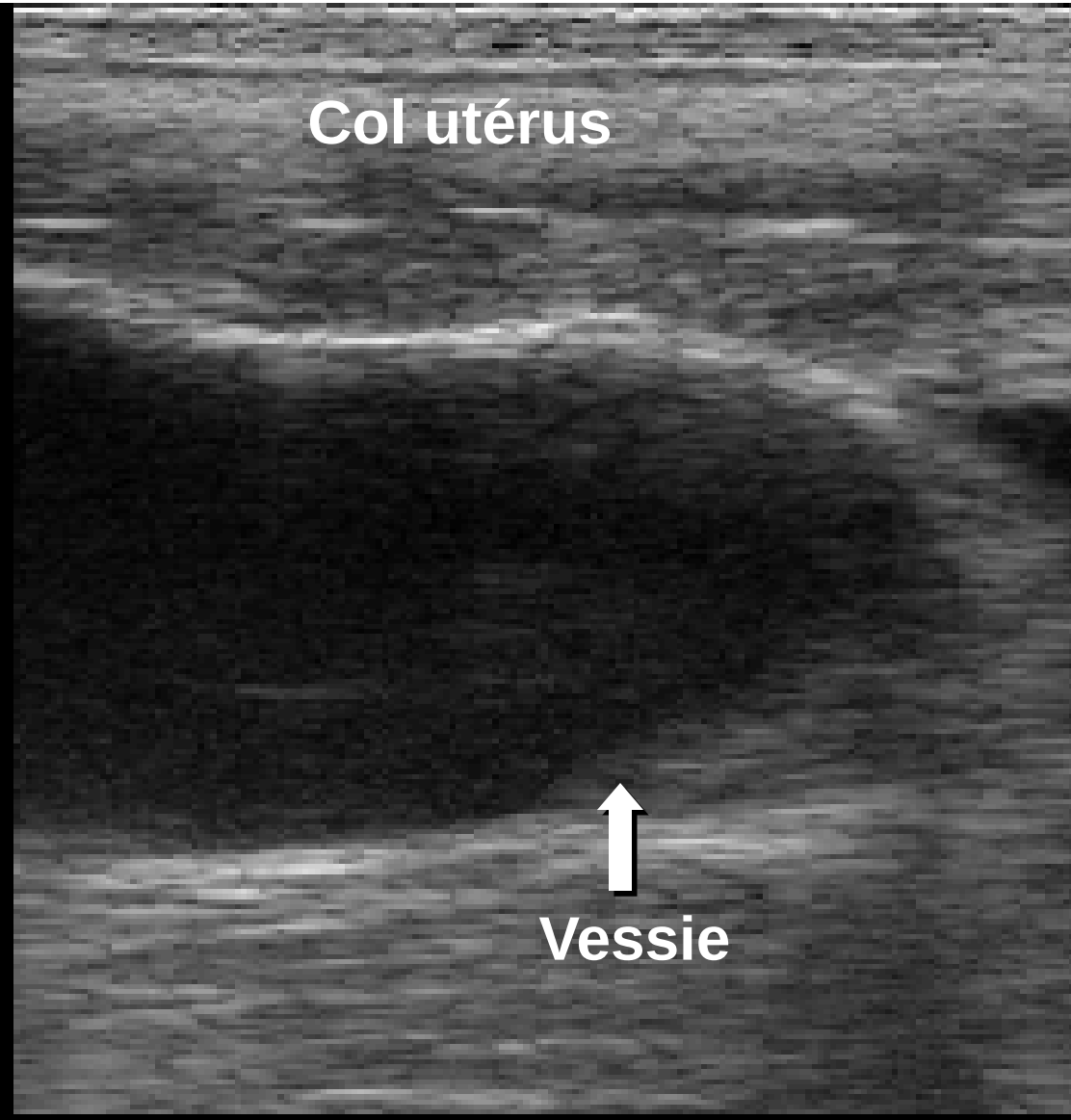
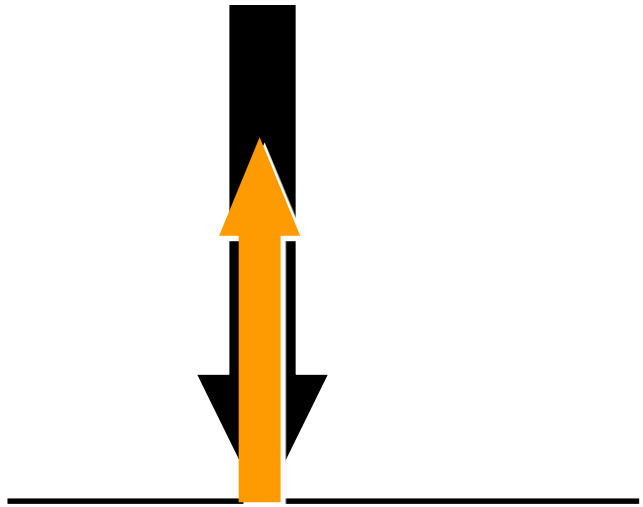

Col utérus
Vessie

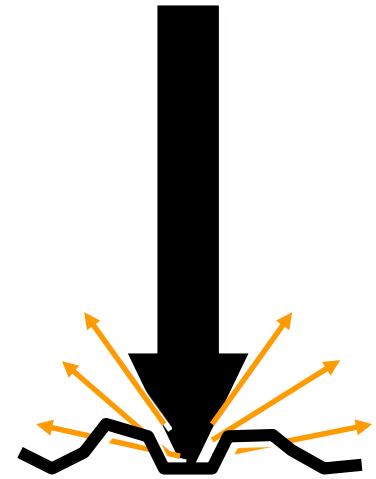
Image non spéculaire

Réflecteur spéculaire

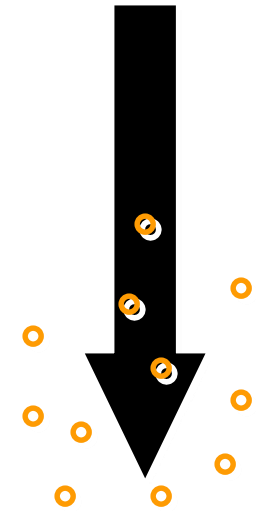


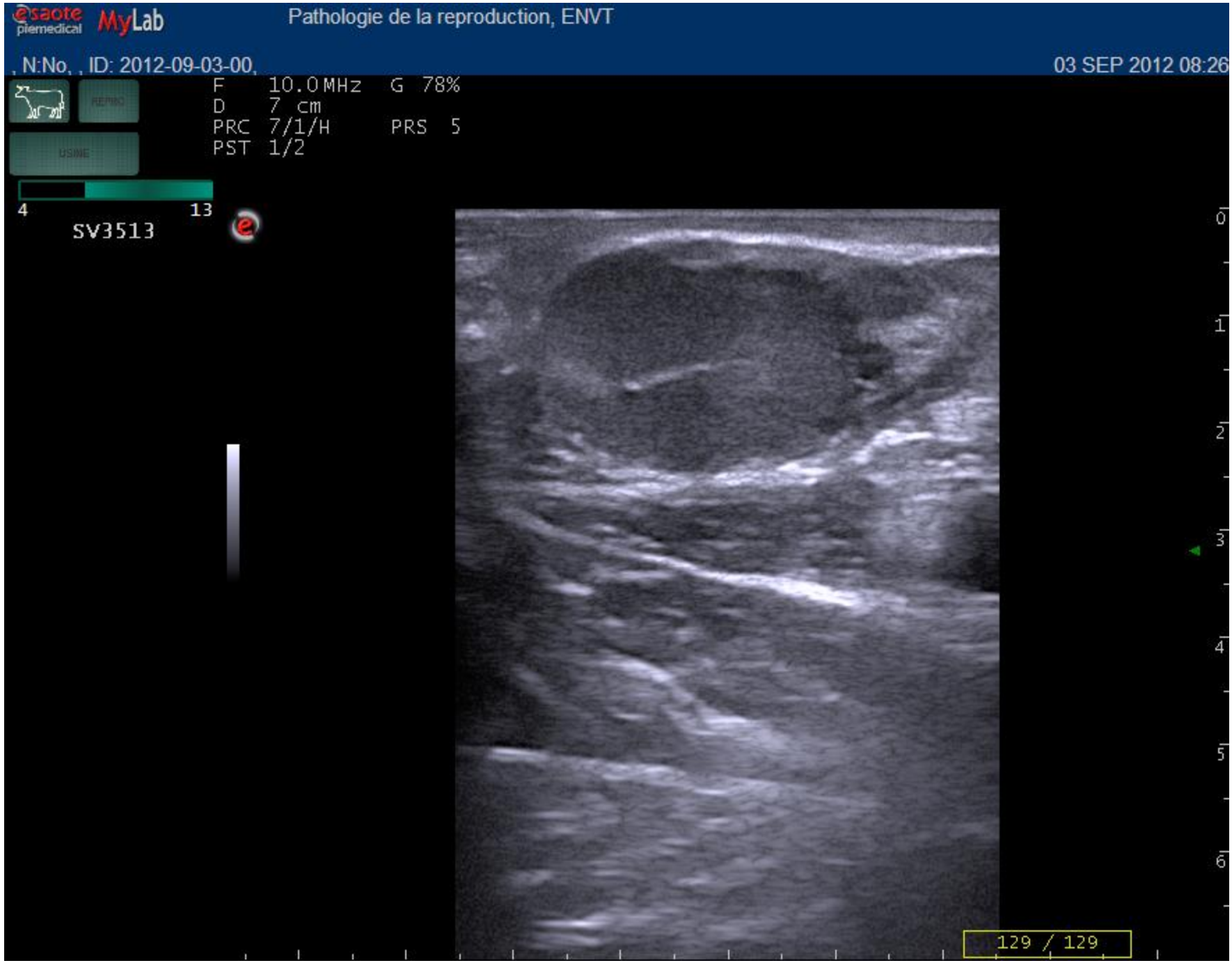
Réflecteurs non spéculaires

Surface non lisse



Petites interfaces

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Pathologie de la reproduction, ENVT
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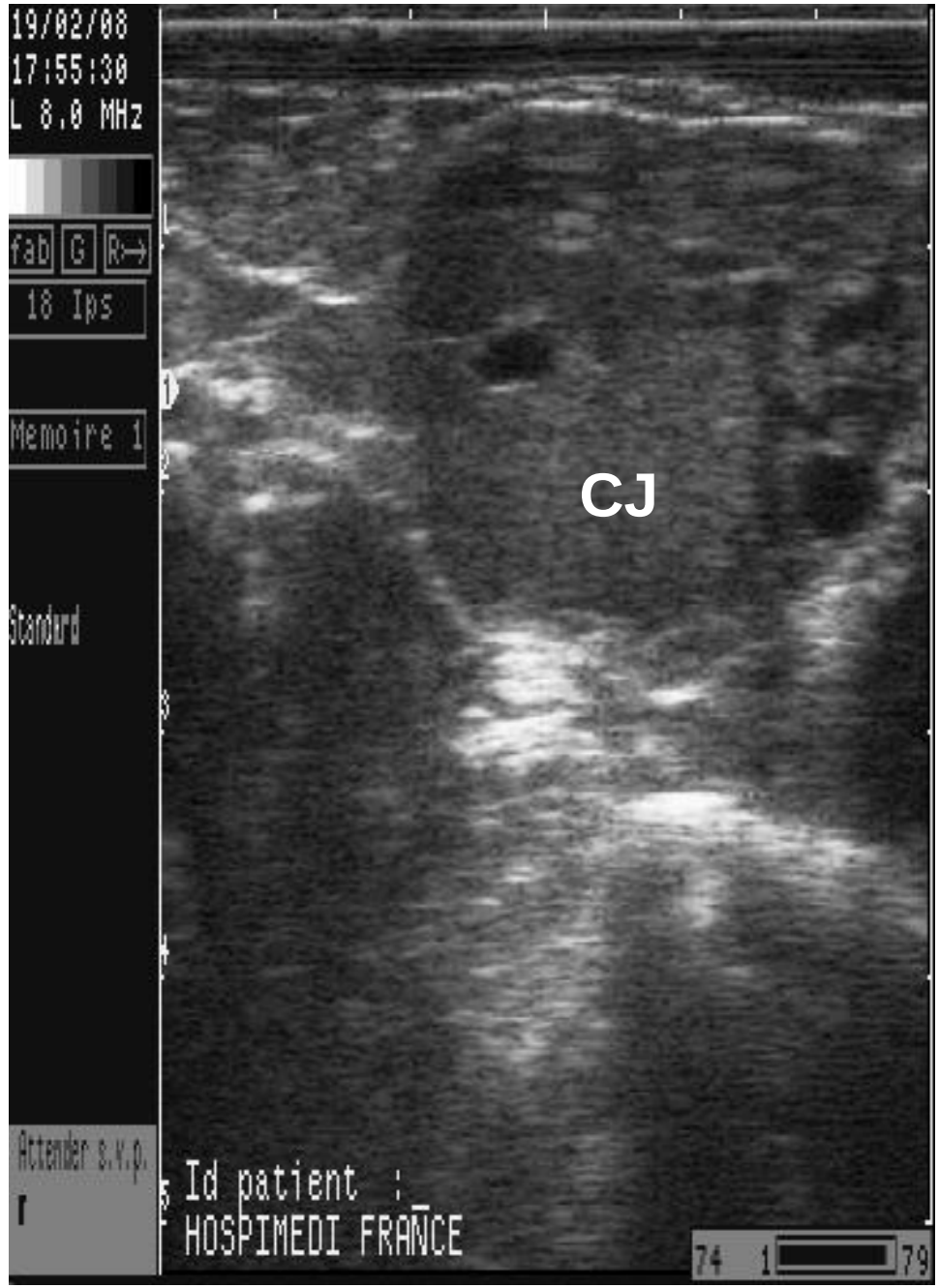
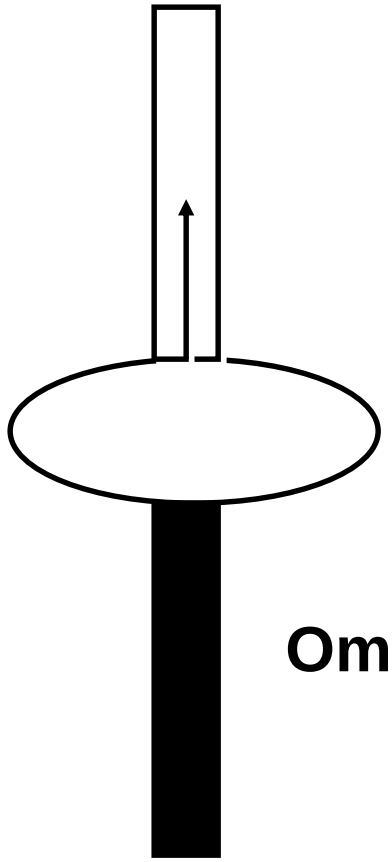
D 7 cm
PRC 7/1/H PRS 5
PST 1/2
4
13
SV3513
129 / 129


19/02/08
17:55:30
L 8.0 MHz
fab
G
R
18 Ips
Memoire 1
Standard
Attendez s.v.p.
CJ
Id patient :
HOSPIMEDI FRANCE
74
79

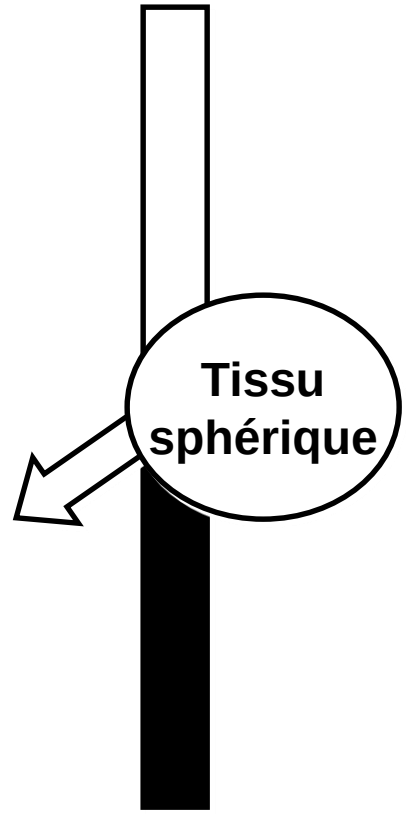
Ombres artefactuelles

Objet dense

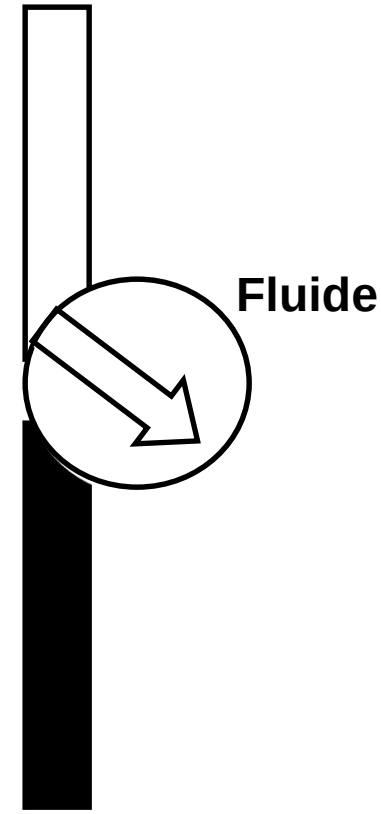


Ombre

Réflexion



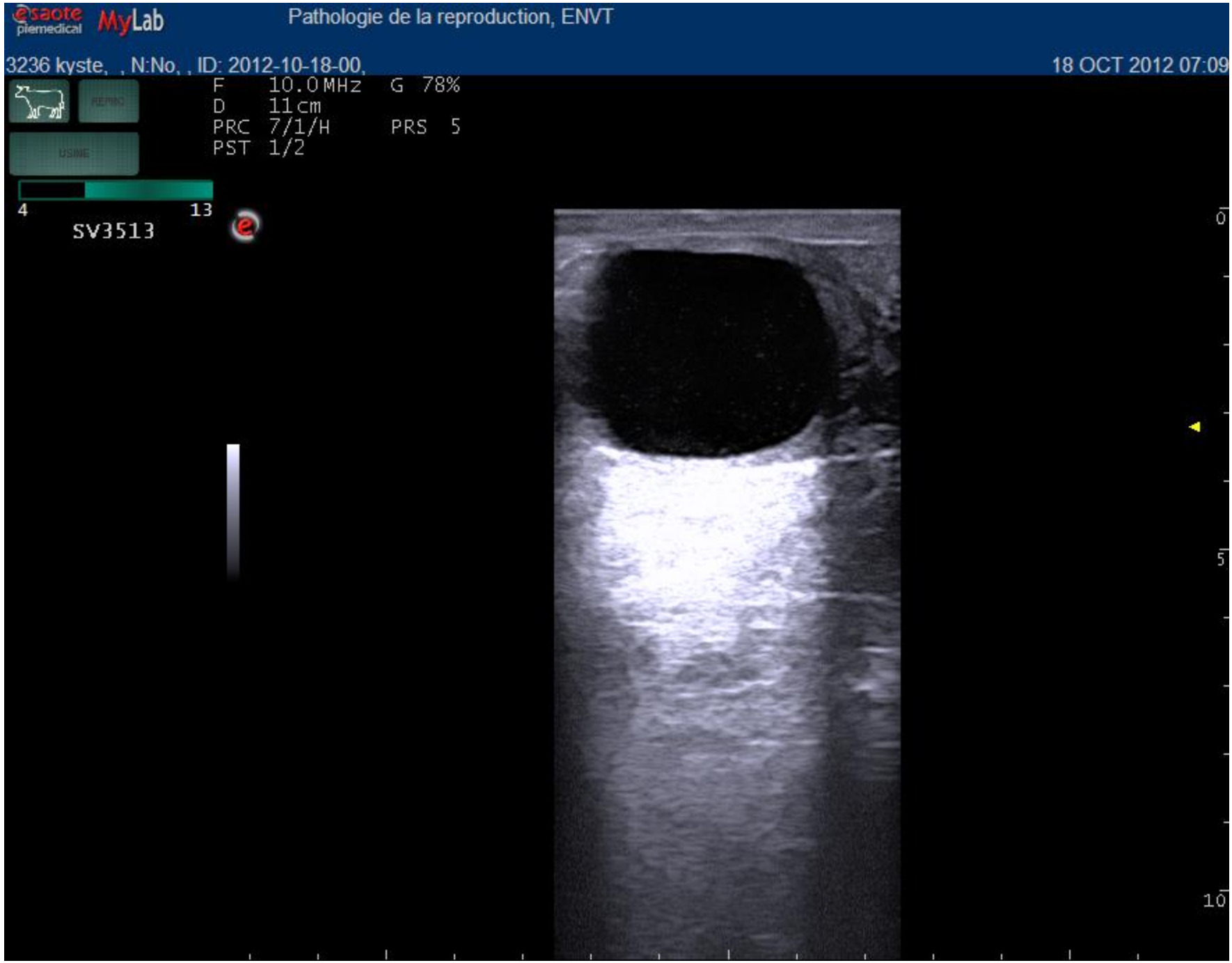
Réfraction




14/02/08
10:46:55
L 8.0 MHz
fab
G
R→
17 Ips
Memoire 1
Standard
Attendre s.v.p.
Id patient :


15/02/08
16:38:25
L 8.0 MHz
fab
G
17 Ips
Memoire 1
Standard
Attendez s.v.p.
Id patient :
HOSPIMEDI FRANCE
102 1
102


17/12/07
10:36:55
L 10. MHz
fab
G
R→
18 Ips
Memoire 1
Standard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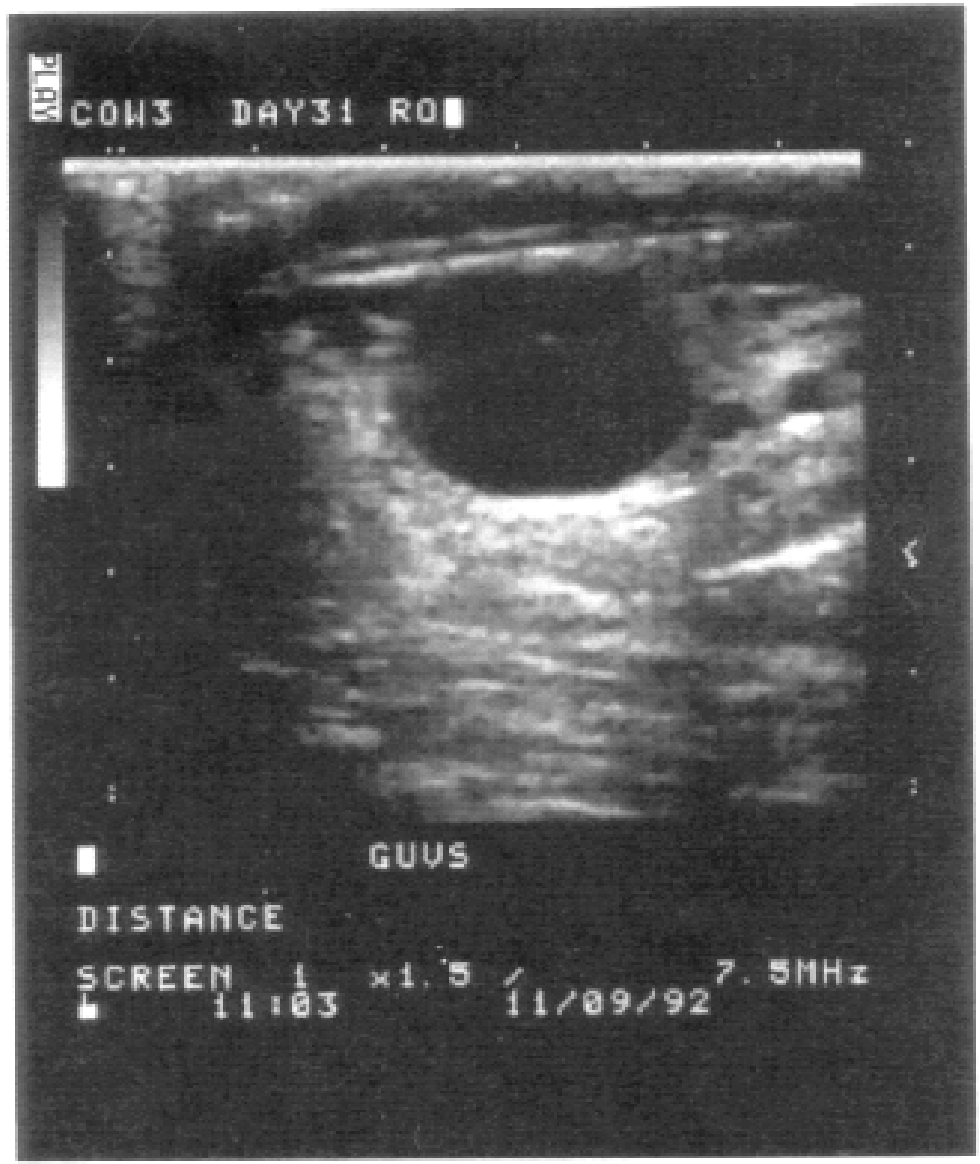
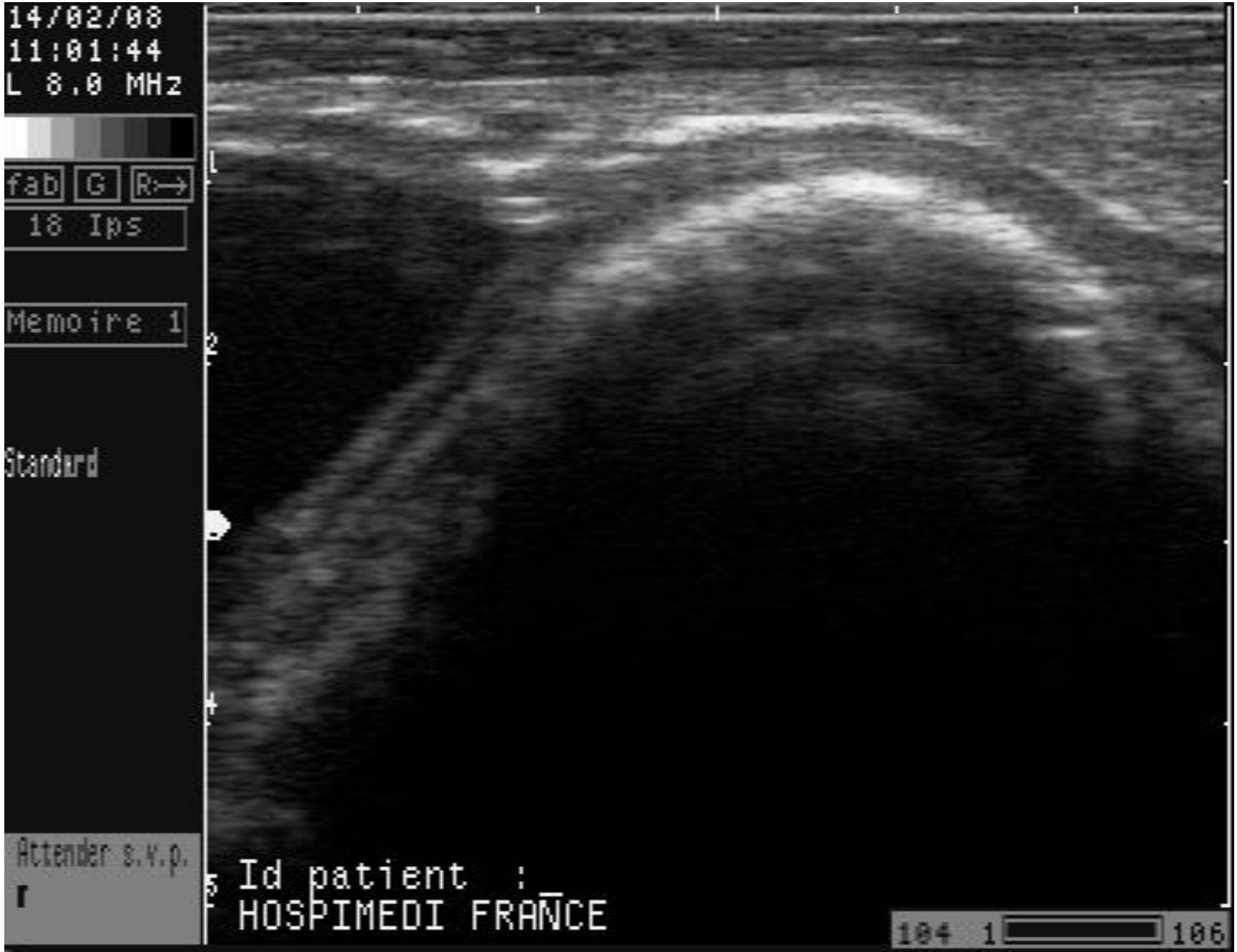
Pathologie de la reproduction, ENVT
3236 kyste, , N:No, , ID: 2012-10-18-00,
18 OCT 2012 07:09
F 10.0 MHz G 78%
D 11 cm
PRC 7/1/H PRS 5
PST 1/2
4
13
SV3513
0
5
10

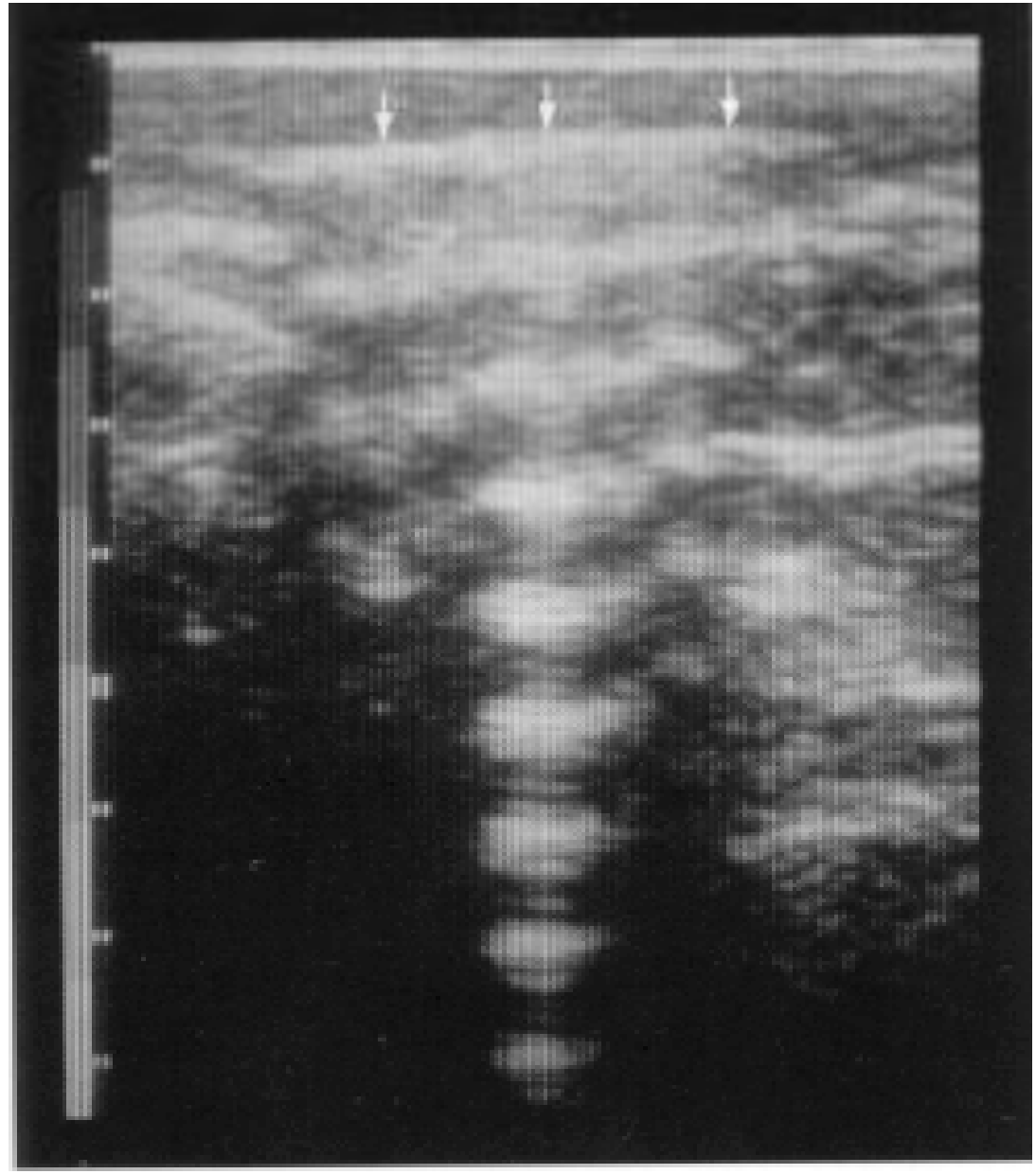
Artéfact par augmentation

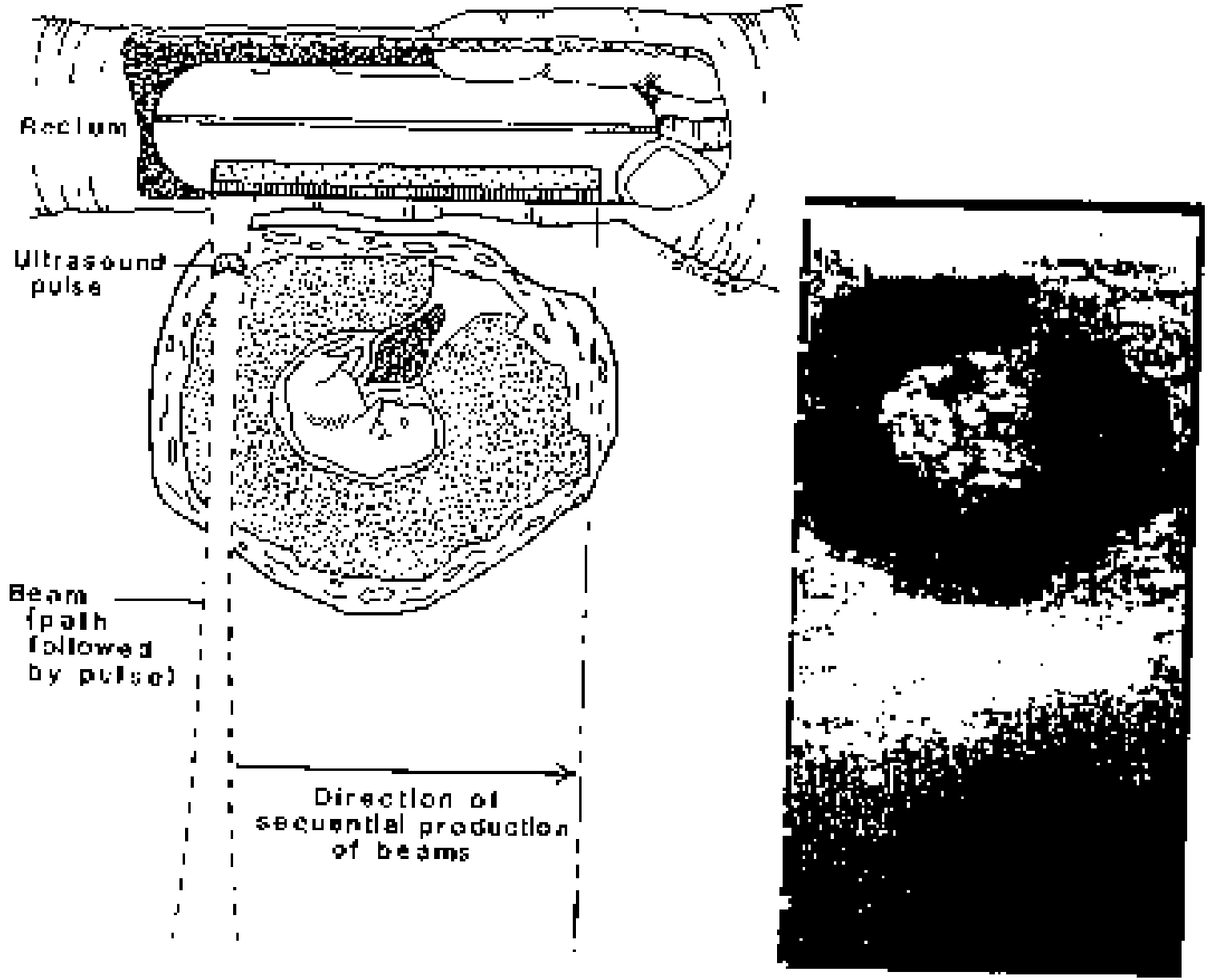


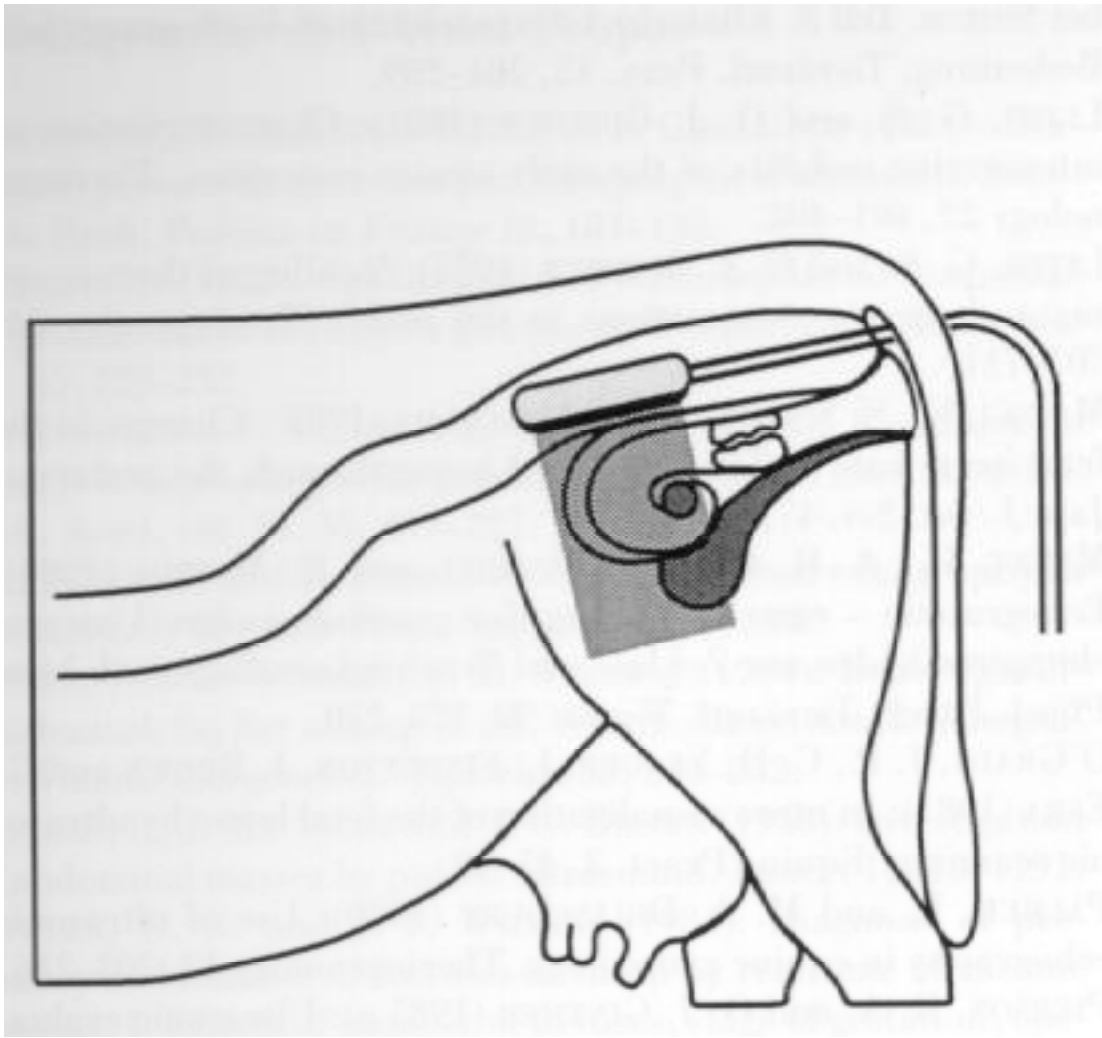
a

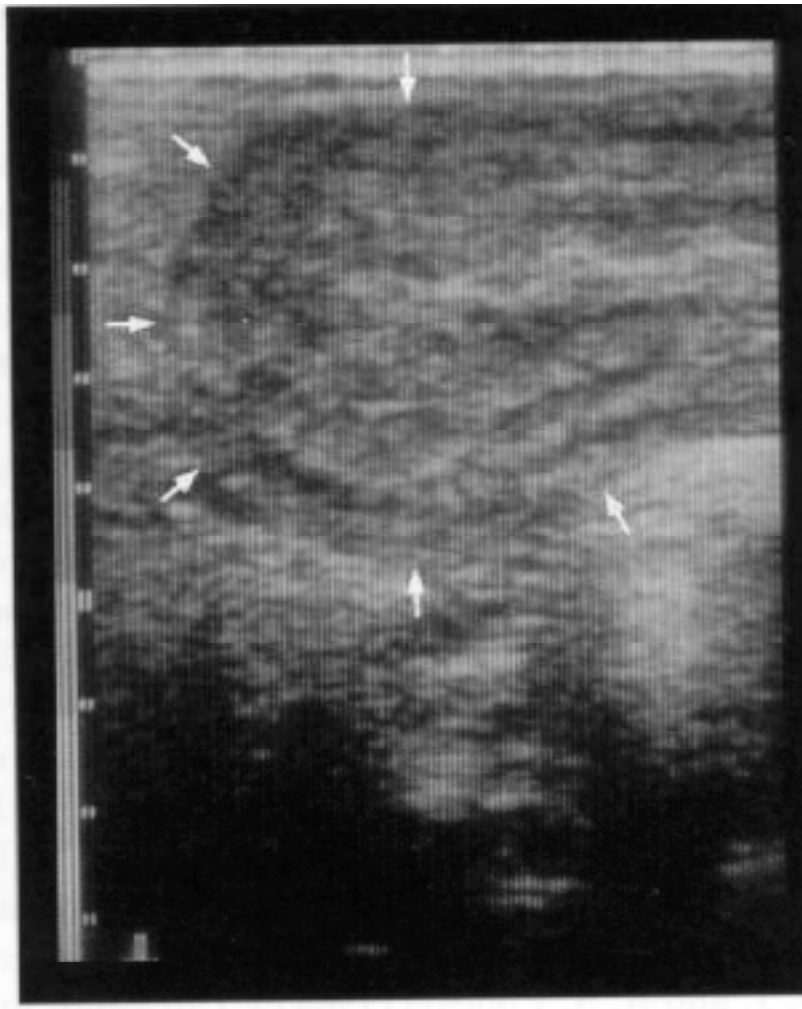

14/02/08
11:01:44
L 8.0 MHz
fab
G
R
18 Ips
Memoire 1
Standard
Attender s.v.p.
Id patient :
HOSPIMEDI FRANCE
104 1 106

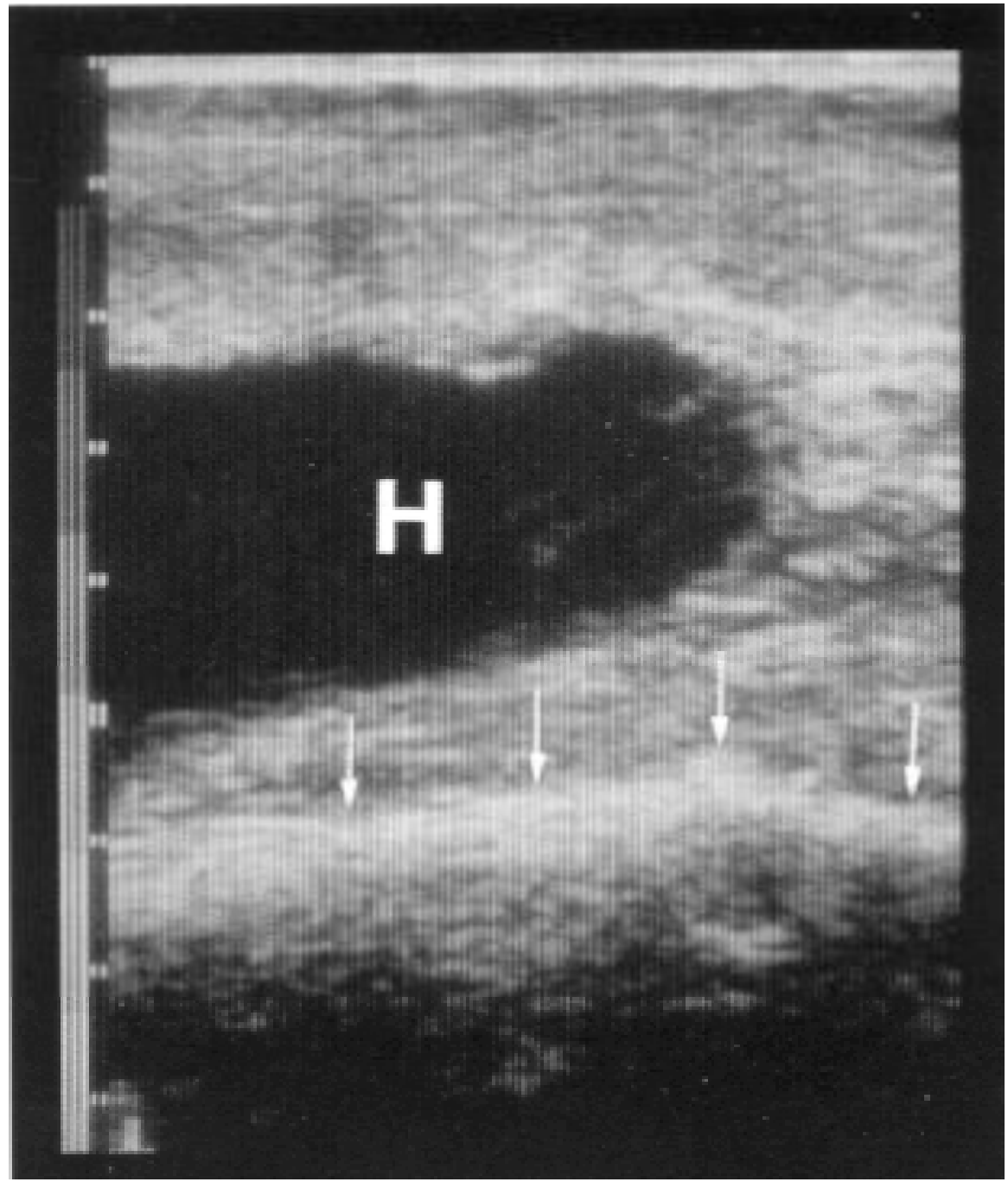
Artéfact de réverbération

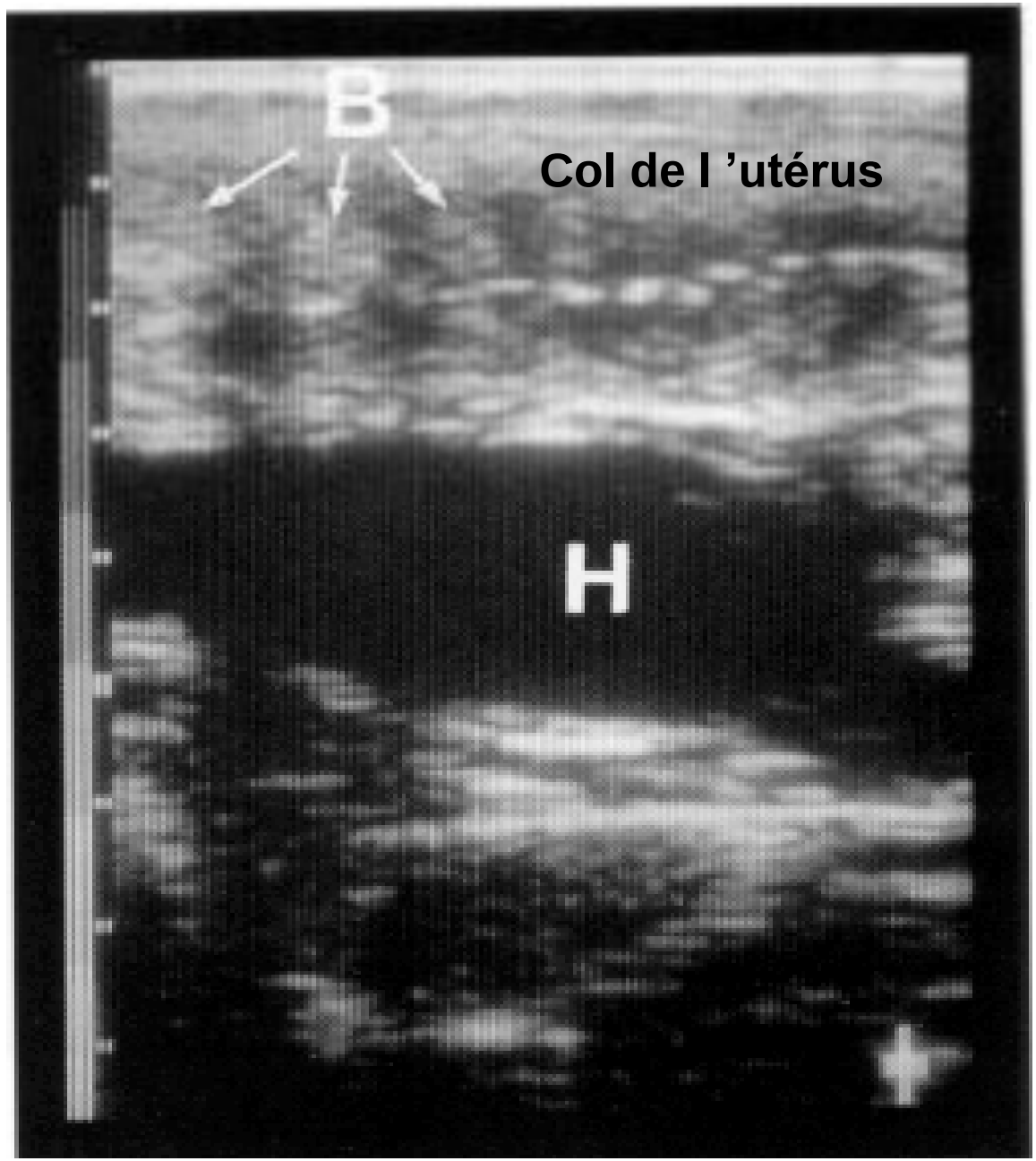


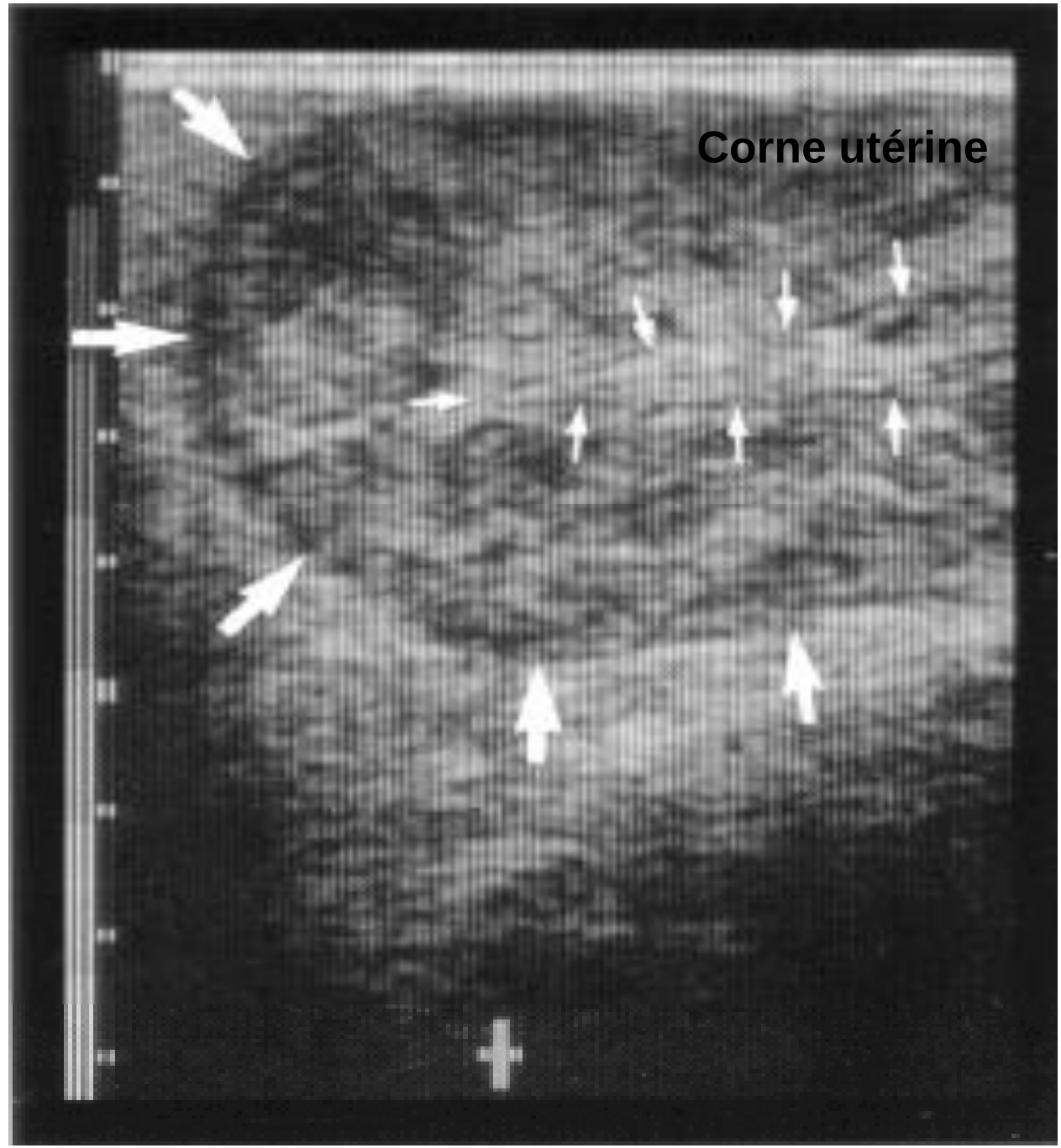

Rectum
Ultrasound pulse
Beam (path followed by pulse)
Direction of sequential production of beams






H

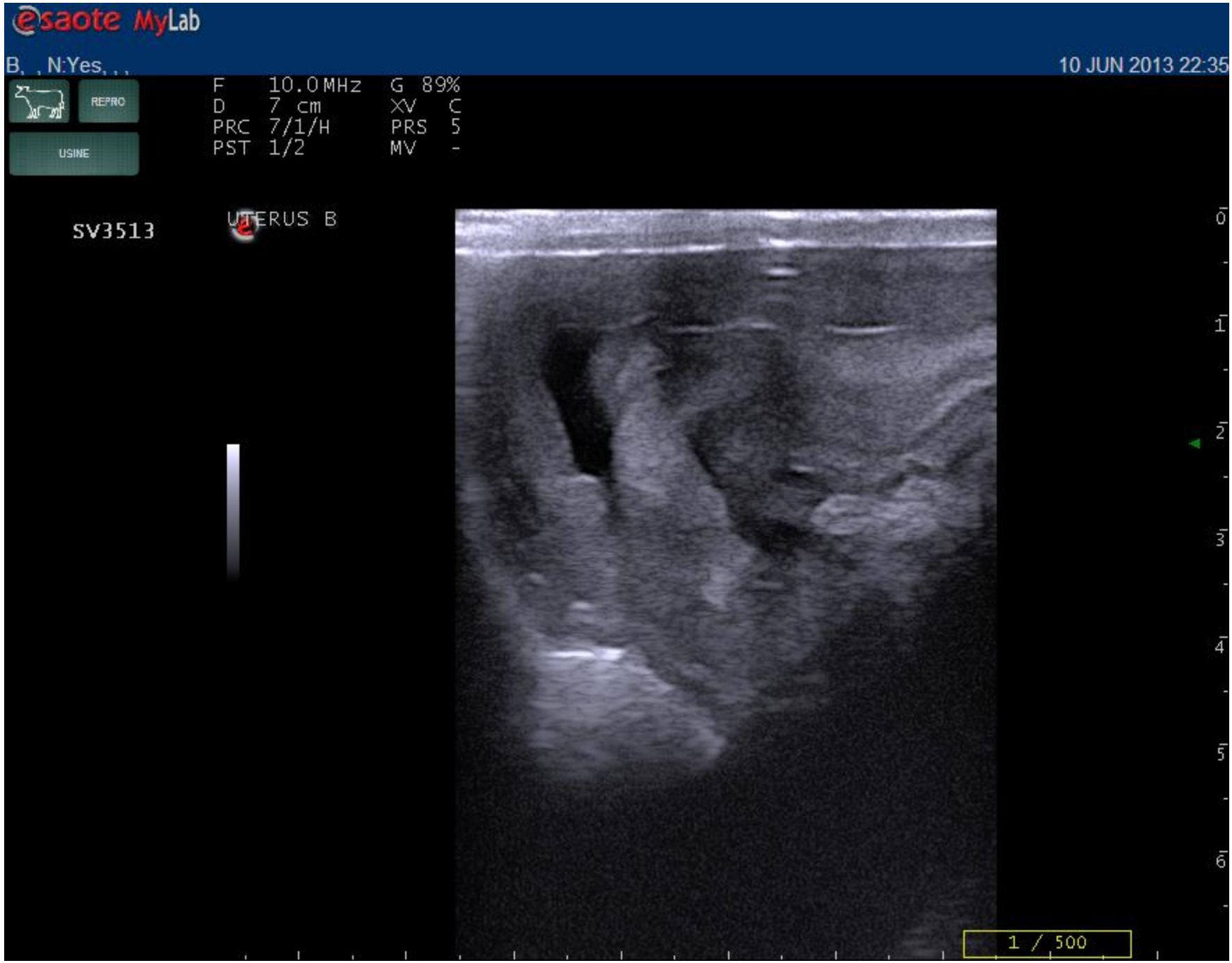

B
Col de l ’utérus
H

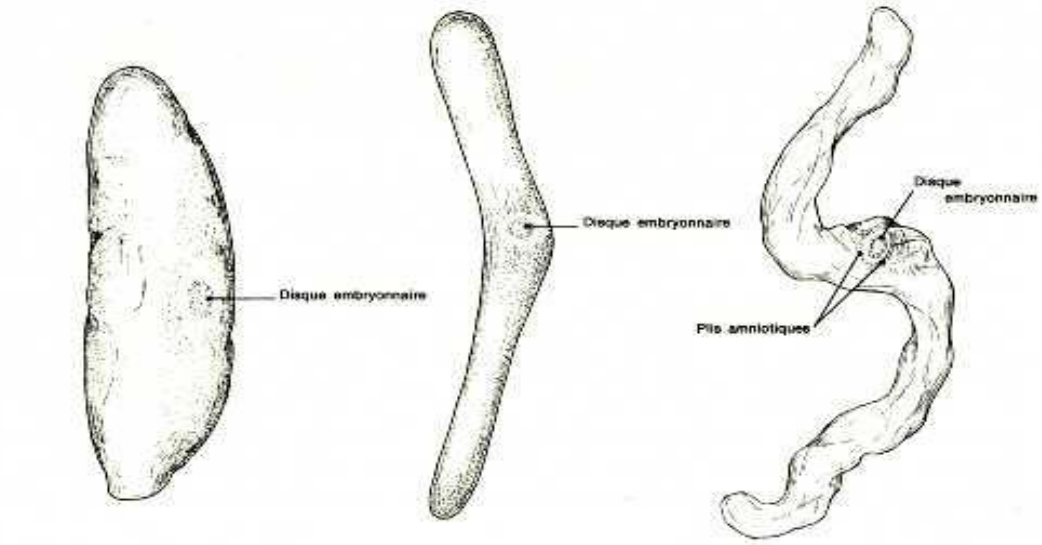

Corne utérine


22/02/08
10:17:36
L 8.0 MHz
fab
G
R
17 Ips
Memoire 1
Standard
Attender s.v.p.
Id patient :
HOSPIMEDI FRANCE
102 1
102


22/02/08
09:47:44
L 8.0 MHz
fab
G
R→
17 Ips
Memoire 1
Standard
Attender s.v.p.
Id patient :
HOSPIMEDI FRANCE
101
1
102


esaote piemedical MyLab
Pathologie de la reproduction, ENVT
, N:No, , ID: 2011-09-22-00,
22 SEP 2011 11:00
F 10.0 MHz G 78%
D 7 cm
PRC 7/1/H PRS 5
PST 1/2
4
13
SV3513
424 / 424

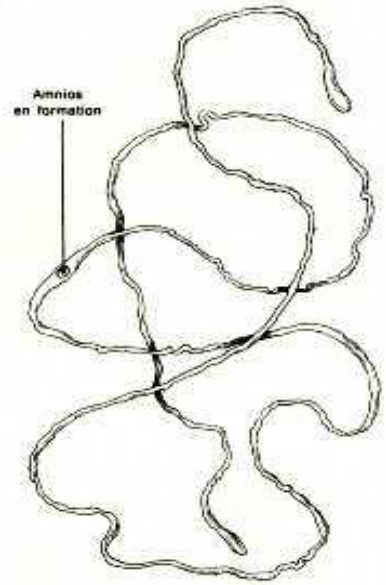

esaote MyLab
B, , N:Yes, , ,
10 JUN 2013 22:35
REPRO
USINE
F 10.0 MHz G 89%
D 7 cm XV C
PRC 7/1/H PRS 5
PST 1/2 MV -
SV3513
UTERUS B
0
1
2
3
4
5
6
1 / 500



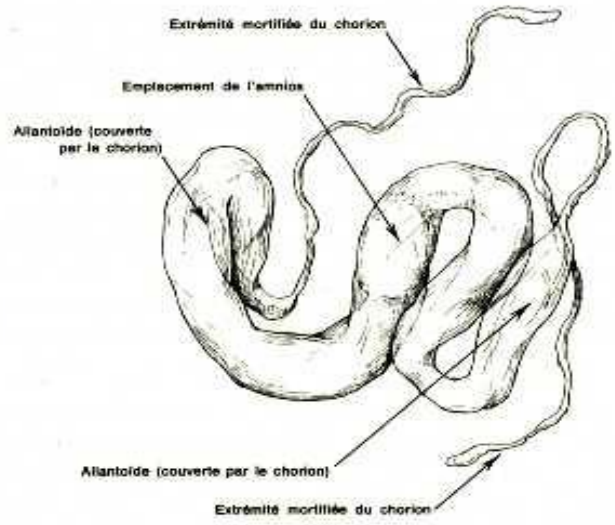
BLASTOCYSTE DE 12 JOURS (Gr. x 5)

BLASTOCYSTE DE 14 JOURS (Gr. x 4)

BLASTOCYSTE DE 16 JOURS (Gr. x 4)



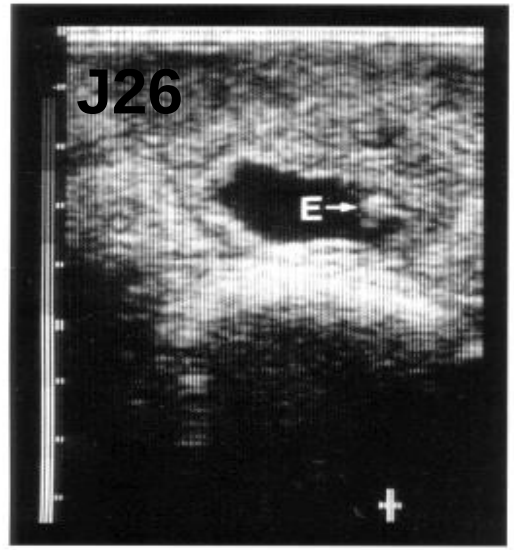
BLASTOCYSTE DE 18 JOURS (Gr. naturel)

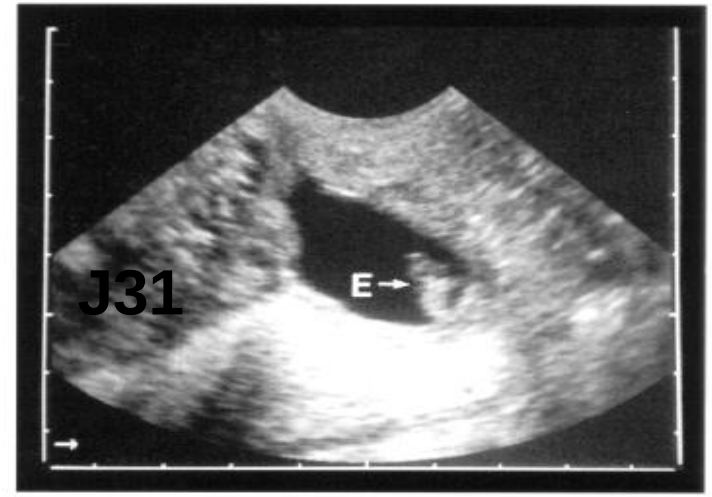


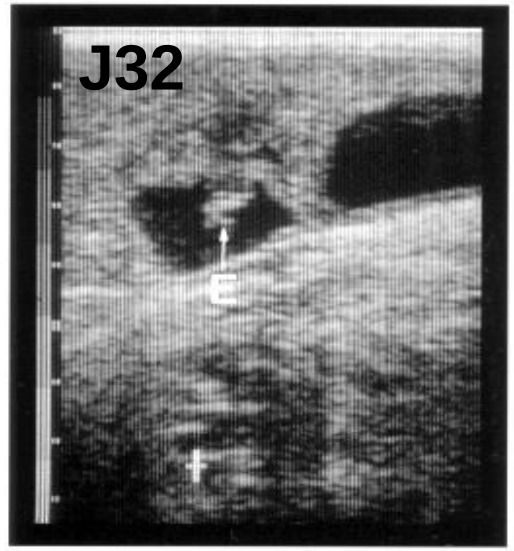
CONCEPTUS DE 30 JOURS (Gr. x 0,5)

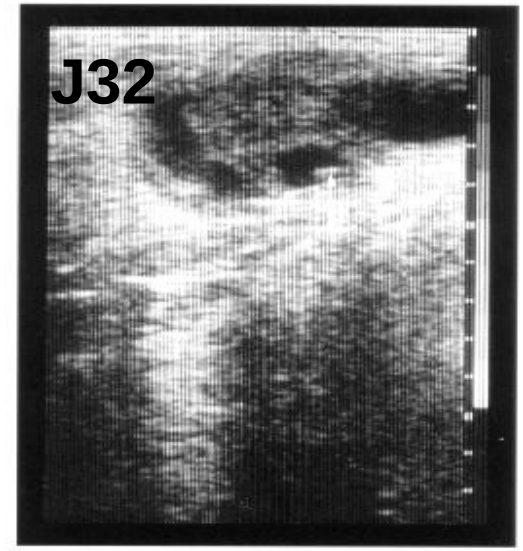
Développement du blastocyste bovin

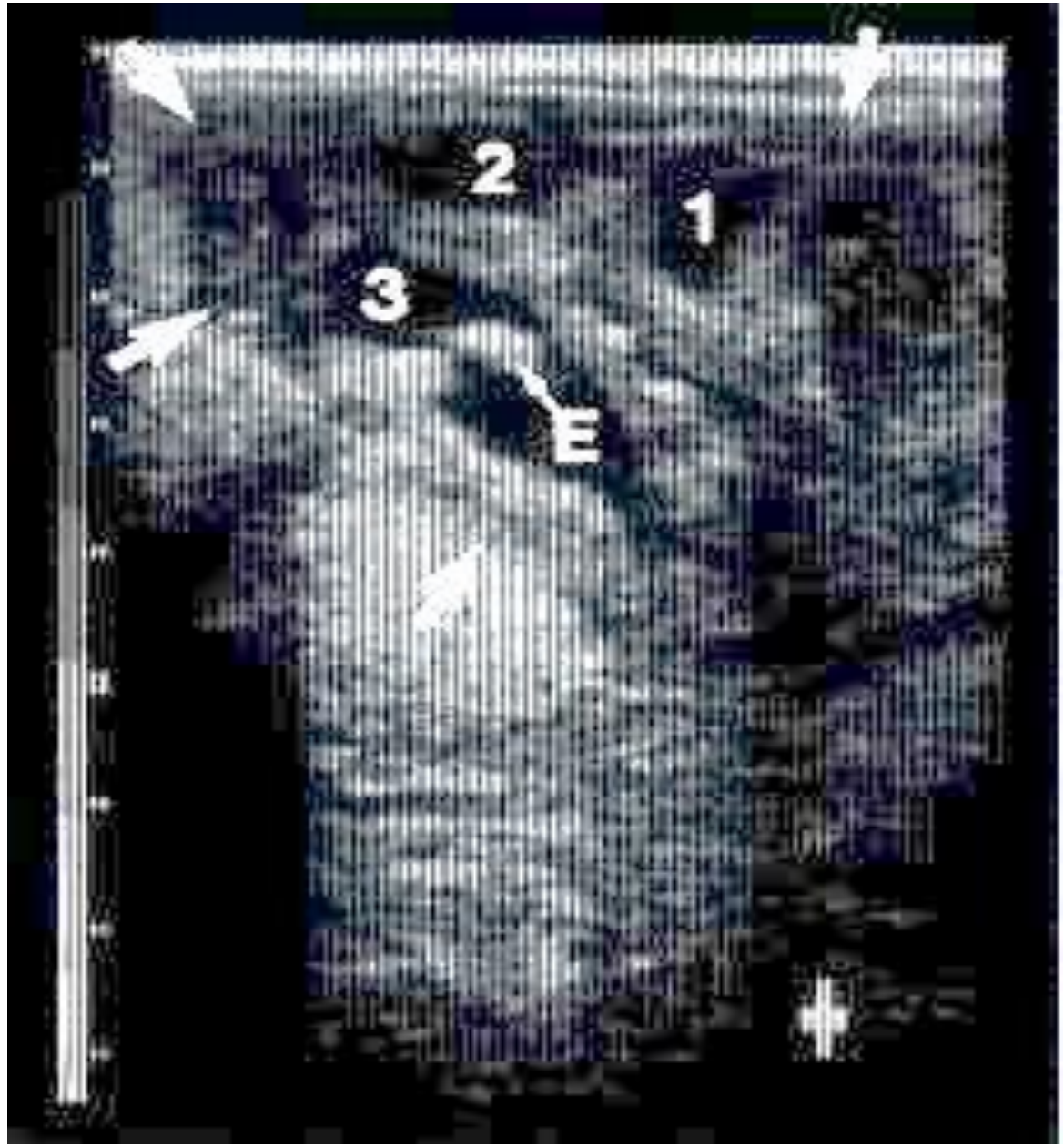
Stade (jours de gestation)	Diamètre VE (mm)	Longueur embyon (mm)
20	2-3	3
22	3-5	5
25	10	8-9
30	18-20	12
40	25	22
50	35-40	32
60	50-60	69


J26
E

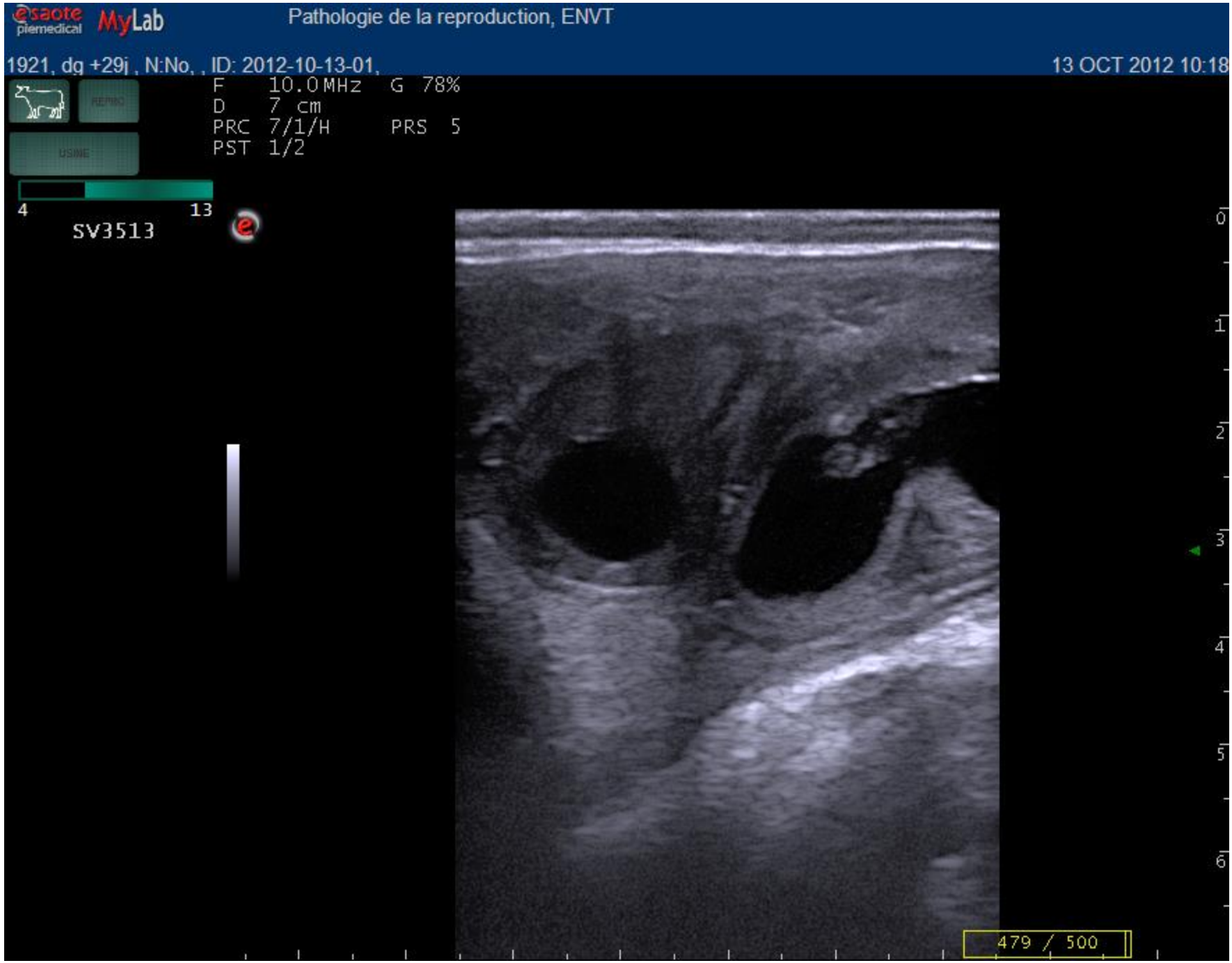

J31
E

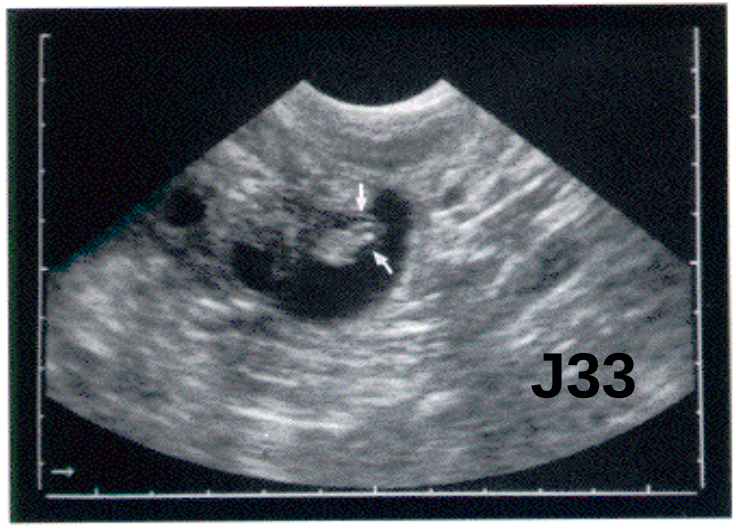

J32
E

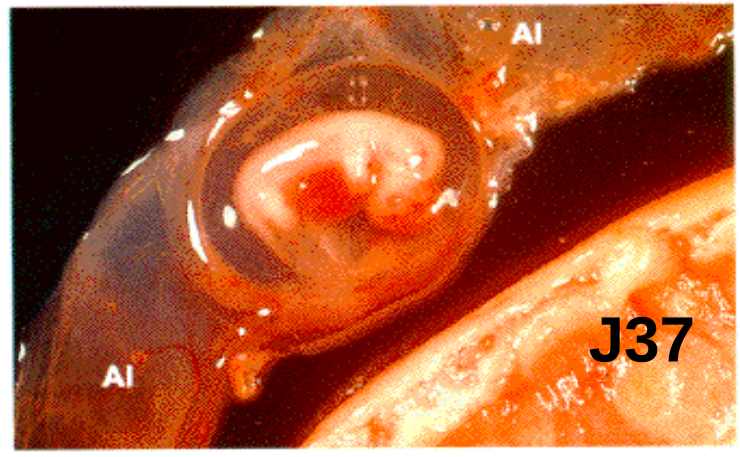

J32

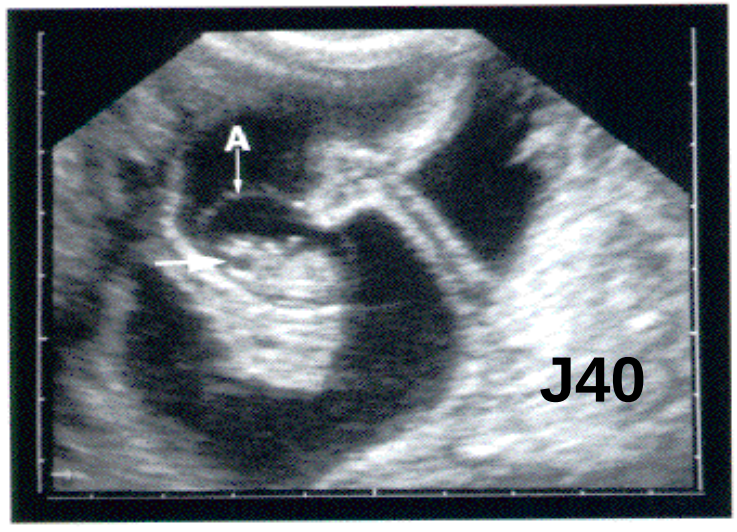


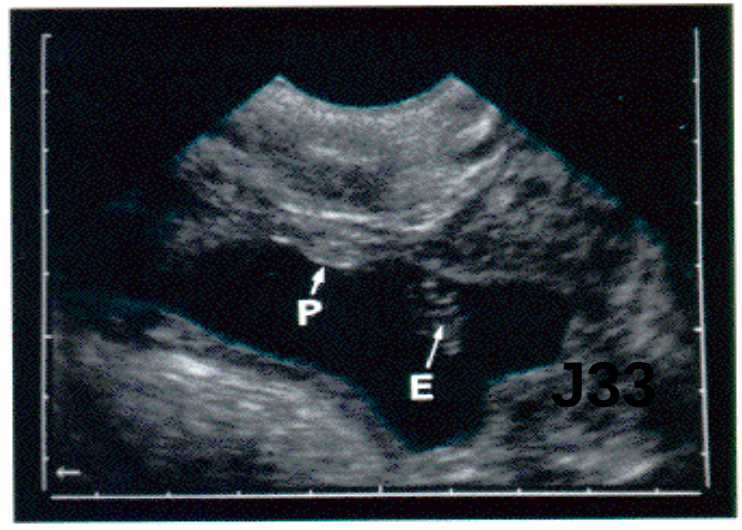
Embryon bovin: stade 29 jours

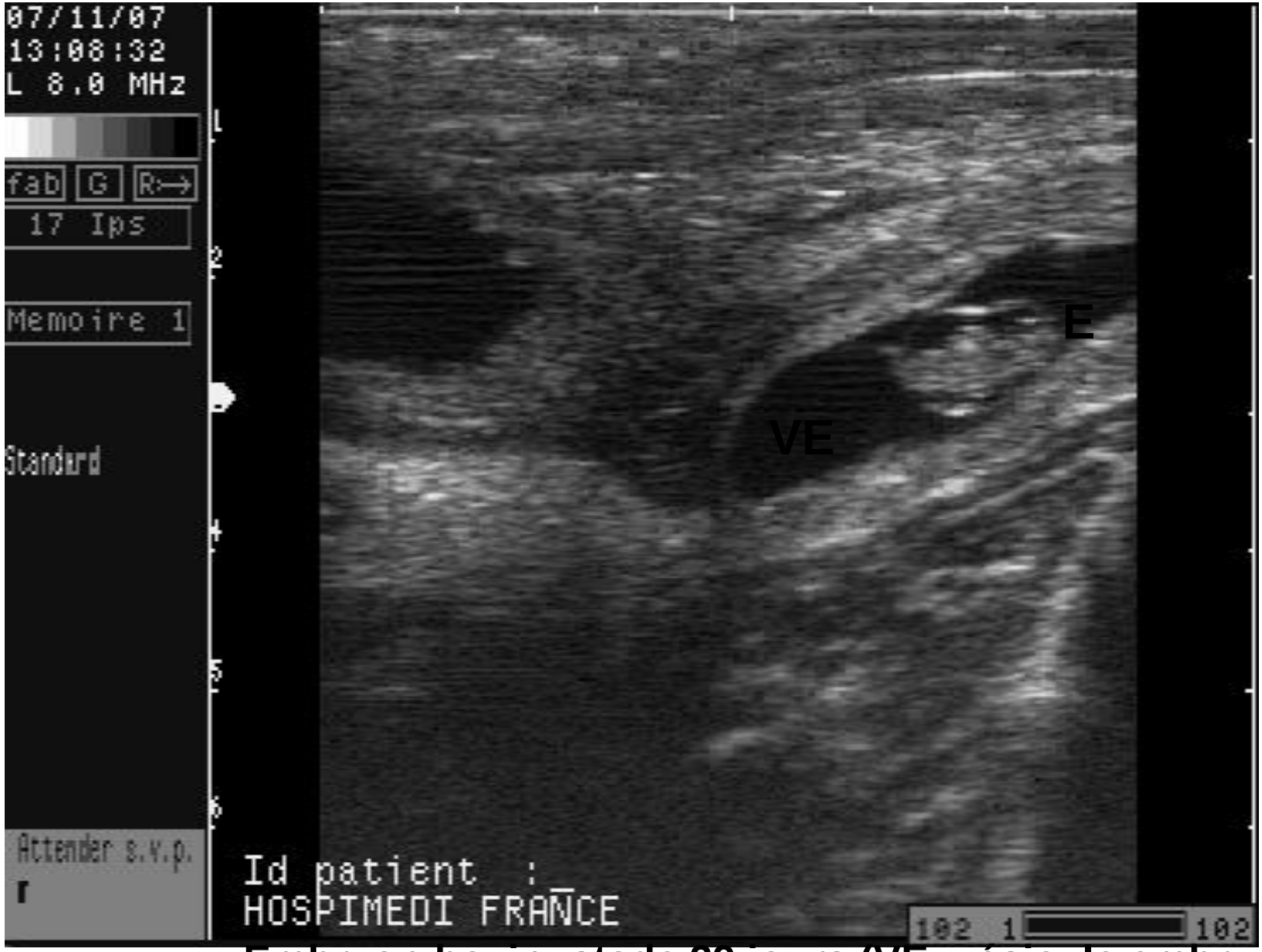

esaote piemedical MyLab
Pathologie de la reproduction, ENVT
1921, dg +29j , N:No, , ID: 2012-10-13-01,
13 OCT 2012 10:18
F 10.0 MHz G 78%
D 7 cm
PRC 7/1/H PRS 5
PST 1/2
4
13
SV3513
479 / 500


J33


AI
AI
J37


A
J40


P
E
J33



Embryon bovin: stade 29 jours (VE: vésicule embryonnaire, E: embryon)

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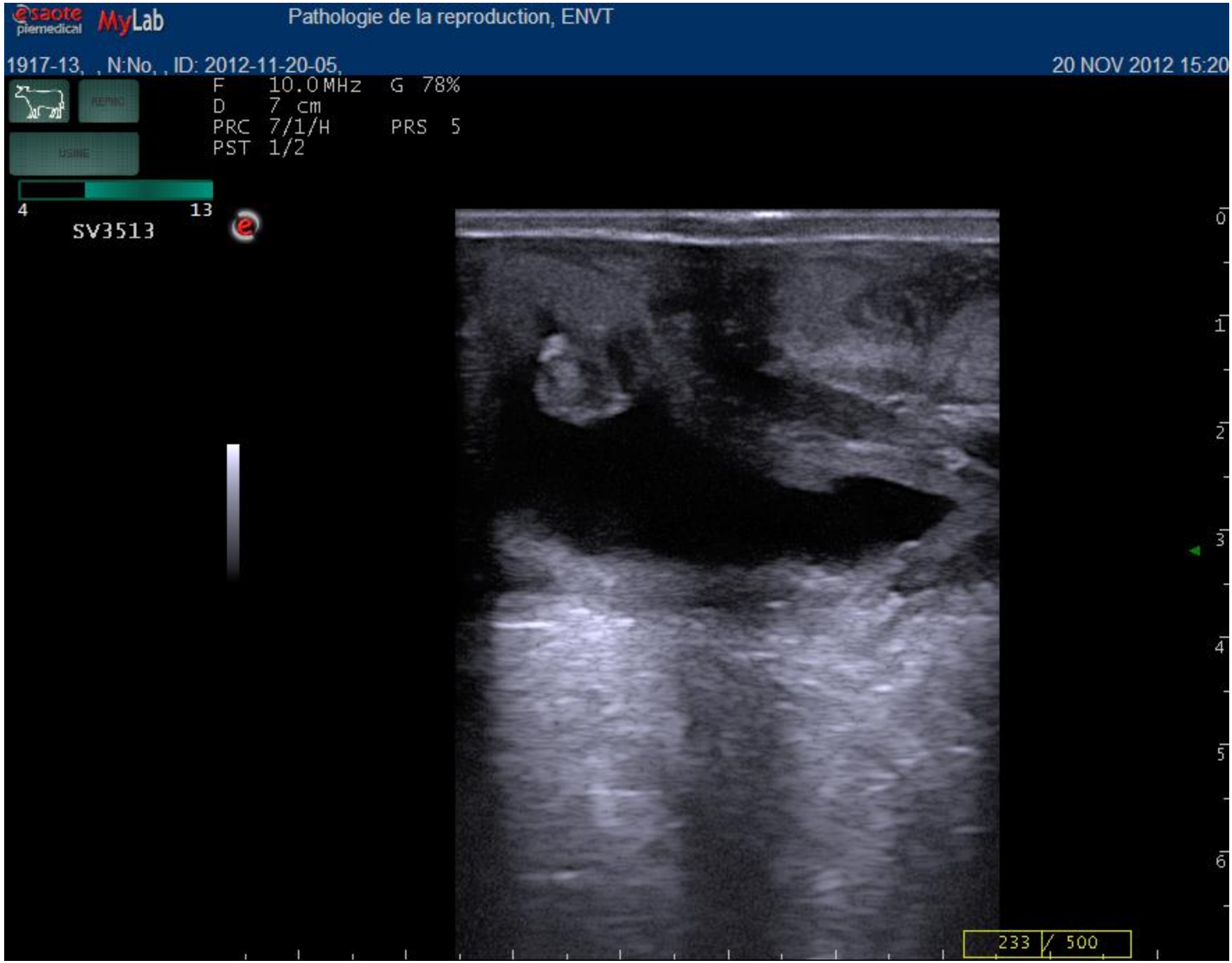
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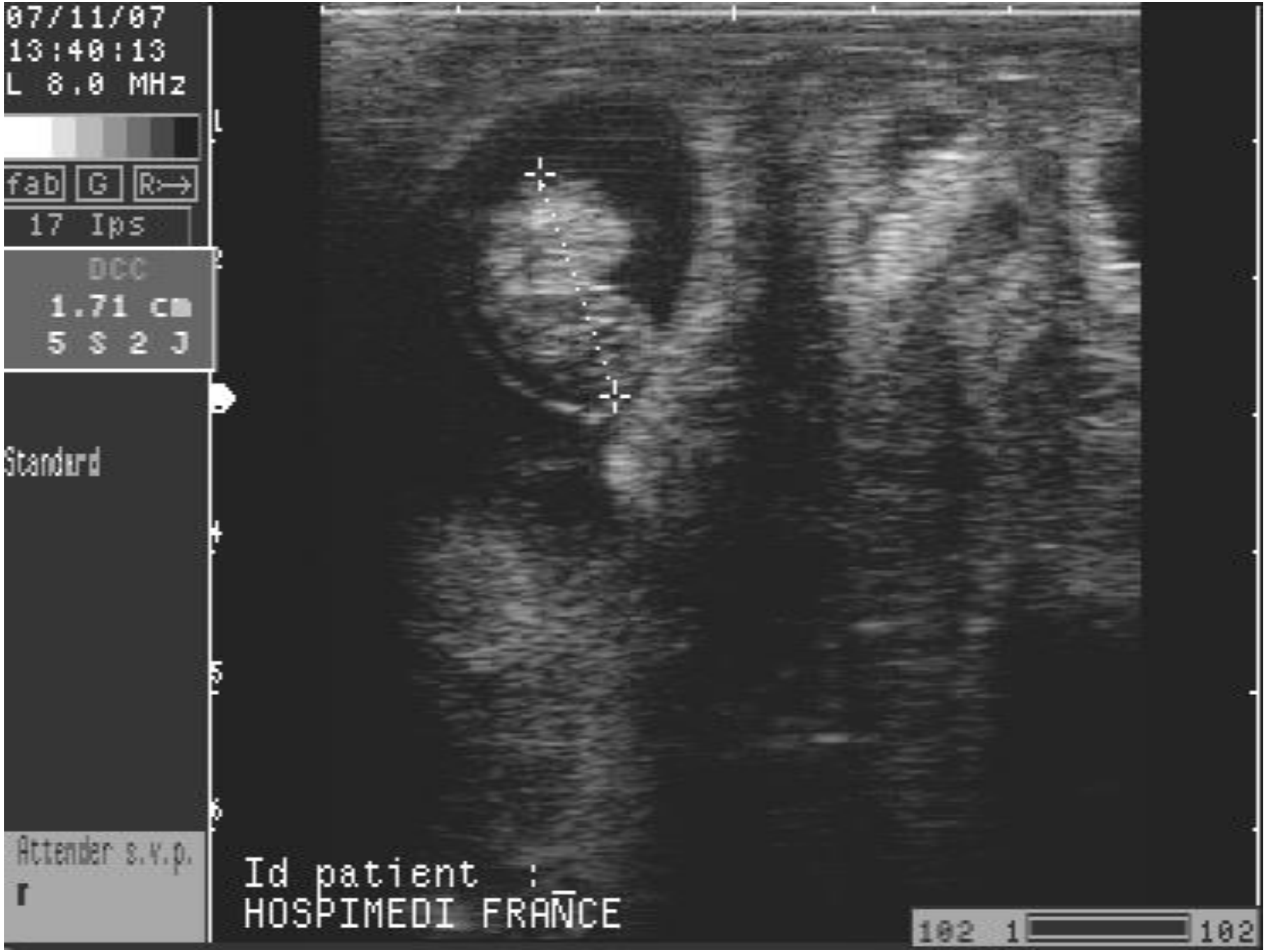
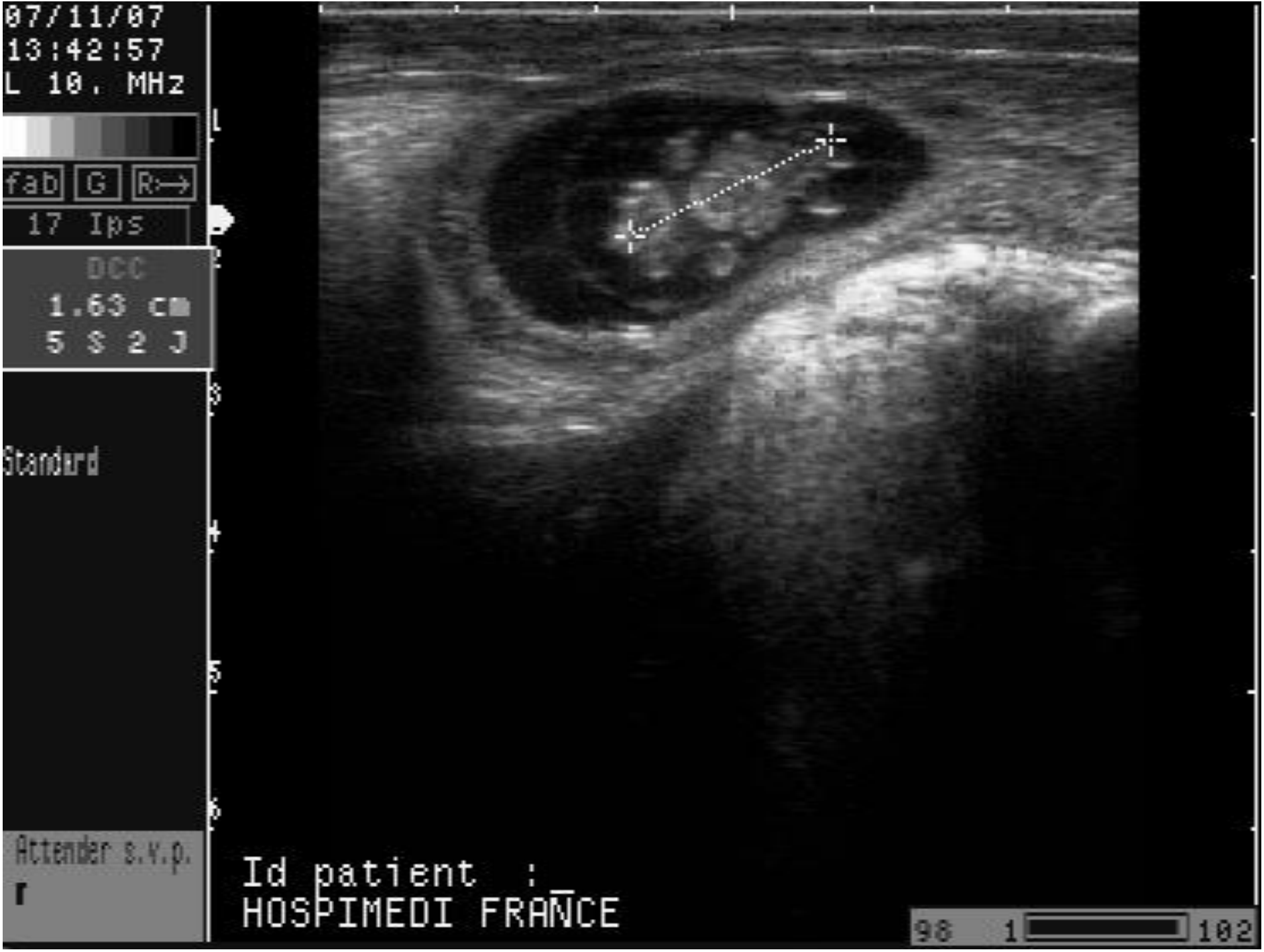
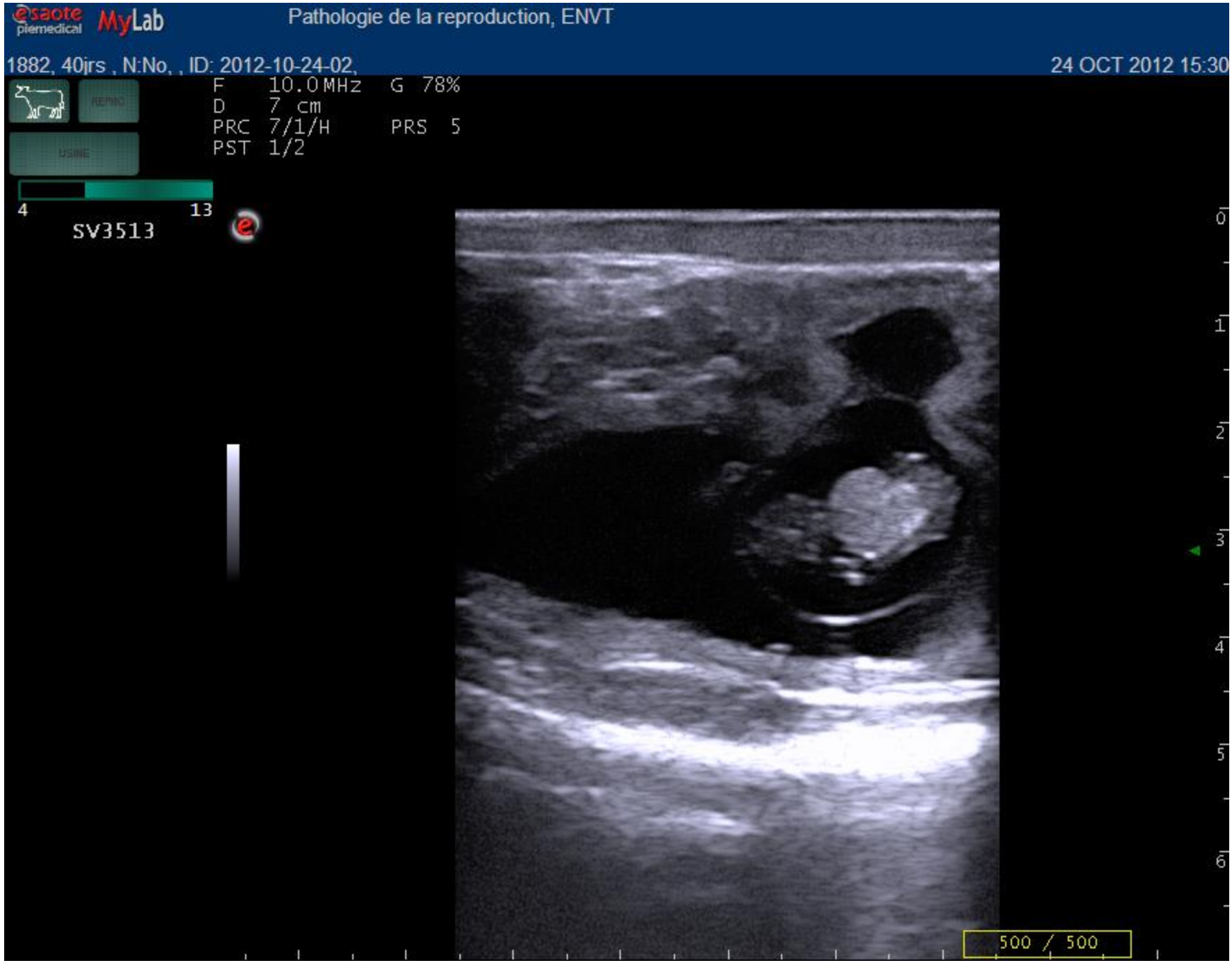
Pathologie de la reproduction, ENVT
1917-13, , N:No, , ID: 2012-11-20-05,
20 NOV 2012 15:20
F 10.0 MHz G 78%
D 7 cm
PRC 7/1/H PRS 5
PST 1/2
4
13
SV3513
233 / 500

Conceptus bovin de 45 jours


07/11/07
13:40:13
L 8.0 MHz
fab
G
R
17 Ips
DCC
1.71 cm
5 S 2 J
Standard
Attender s.v.p.
Id patient :
HOSPIMEDI FRANCE
102 1 102


07/11/07
13:42:57
L 10. MHz
fab
G
R
17 Ips
DCC
1.63 cm
5 S 2 J
Standard
Attendez s.v.p.
Id patient :
HOSPIMEDI FRANCE
98
1
102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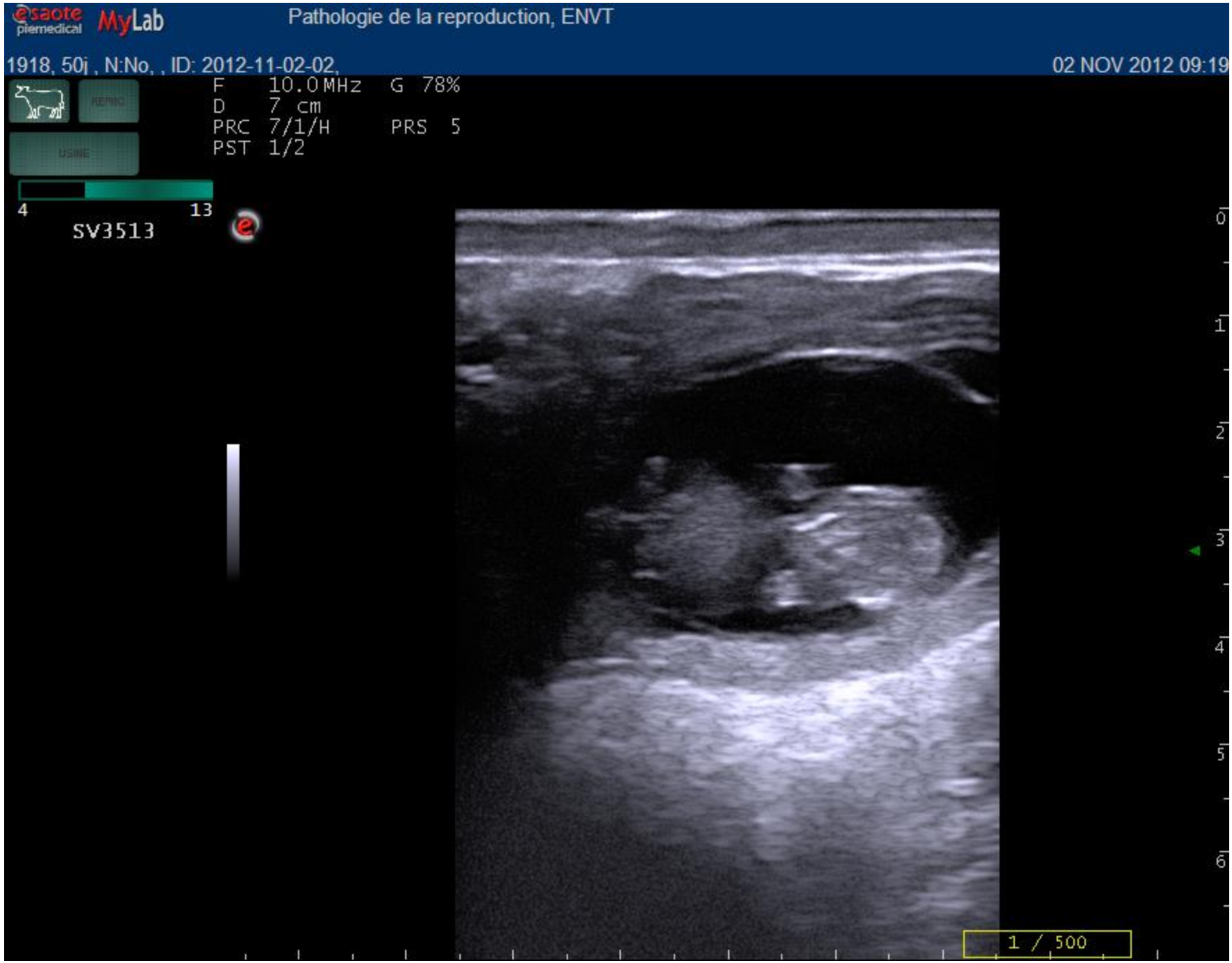
Pathologie de la reproduction, ENVT
1882, 40jrs , N:No, , ID: 2012-10-24-02,
24 OCT 2012 15:30
F 10.0 MHz G 78%
D 7 cm
PRC 7/1/H PRS 5
PST 1/2
4
13
SV3513
0
1
2
3
4
5
6
500 / 500

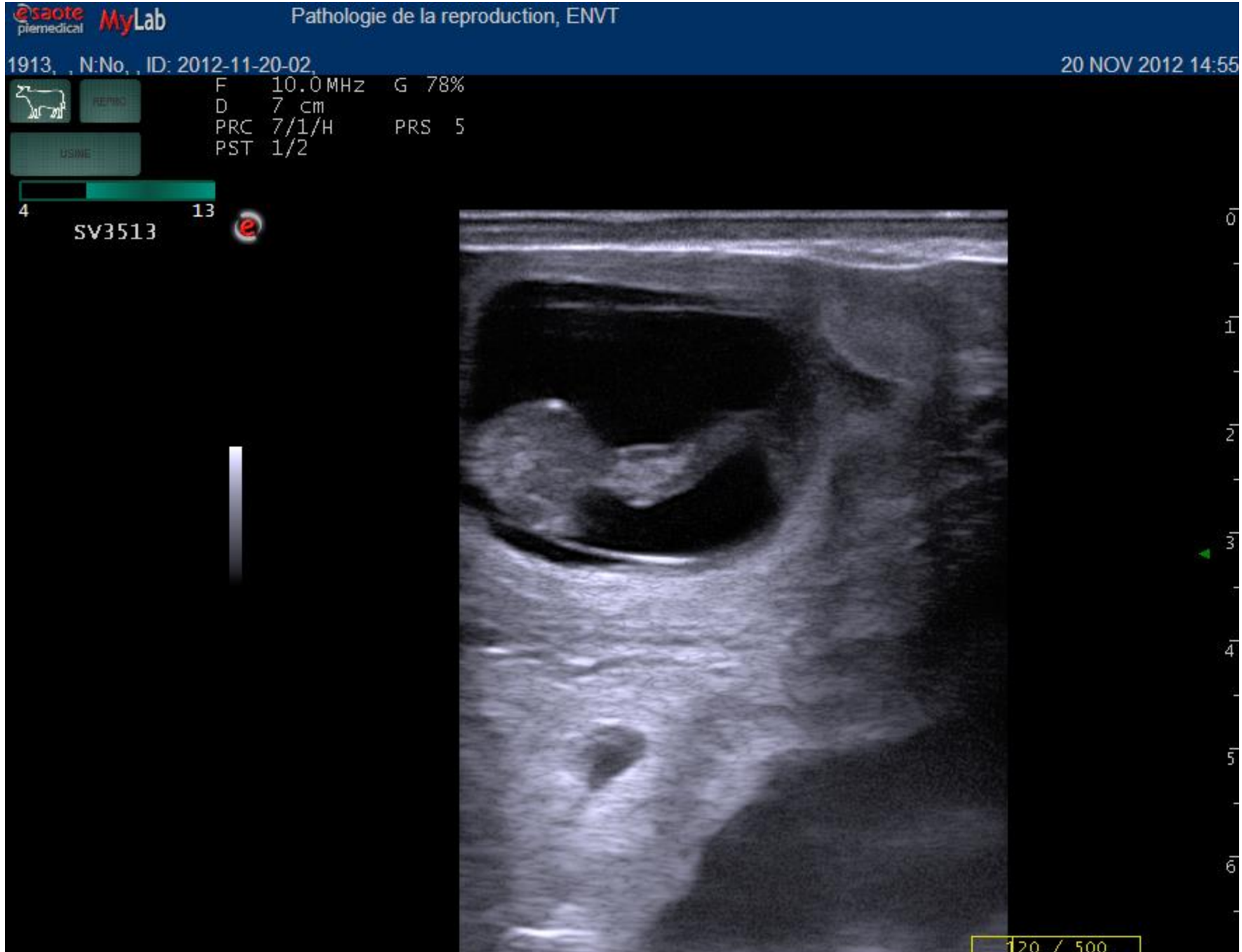

esaote piemedical MyLab
Pathologie de la reproduction, ENVT
1918, 50j , N:No, , ID: 2012-11-02-02,
02 NOV 2012 09:19
F 10.0 MHz G 78%
D 7 cm
PRC 7/1/H PRS 5
PST 1/2
4
13
SV3513
1 / 500

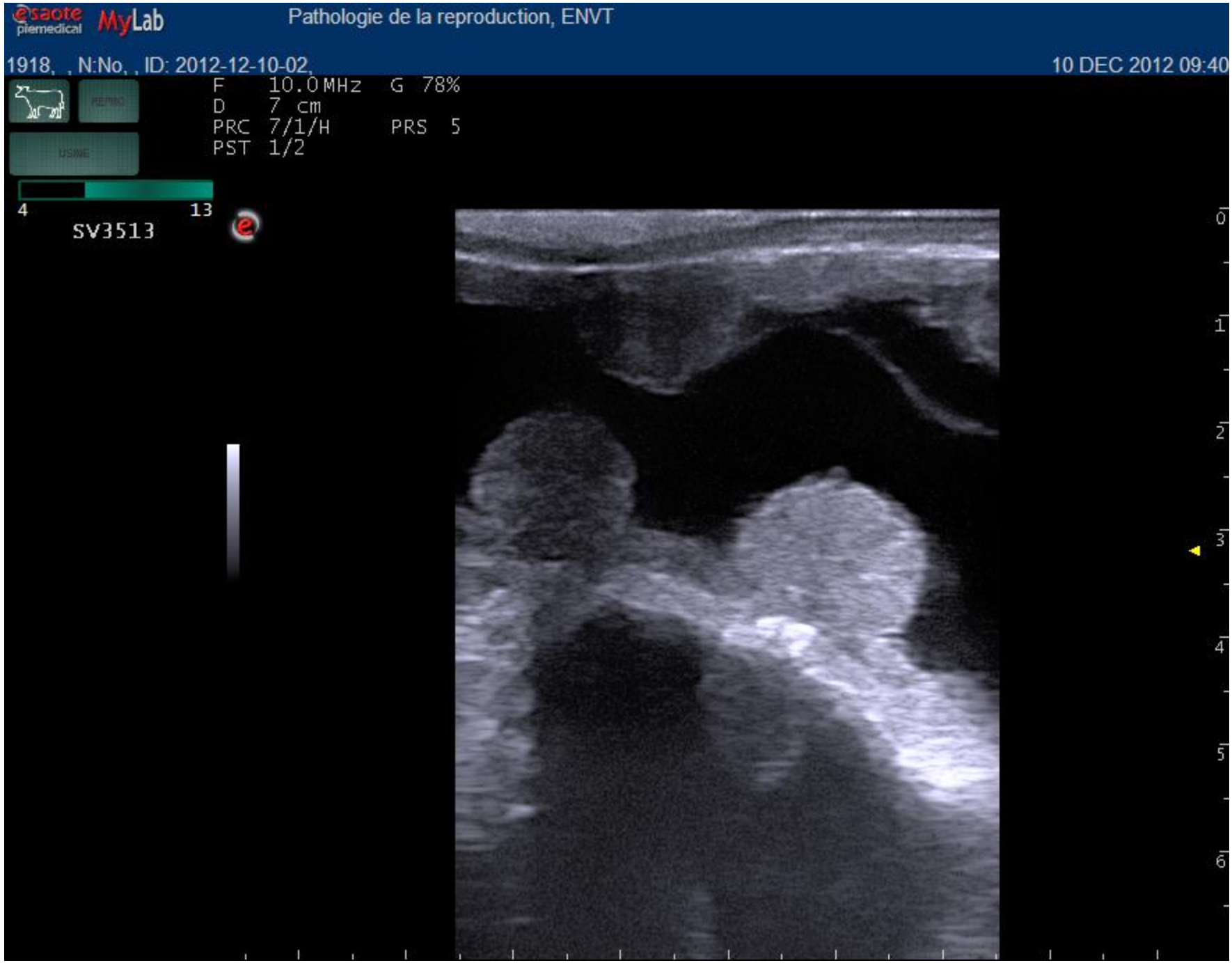
Fœtus bovin: stade 50 jours
Ecole Nationale Vétérinaire de Toulouse


esaote piemedical MyLab
Pathologie de la reproduction, ENVT
1882, 52j , N:No, , ID: 2012-11-05-00,
05 NOV 2012 14:43
F 10.0 MHz G 78%
D 7 cm
PRC 7/1/H PRS 5
PST 1/2
4
13
SV3513
485 / 500

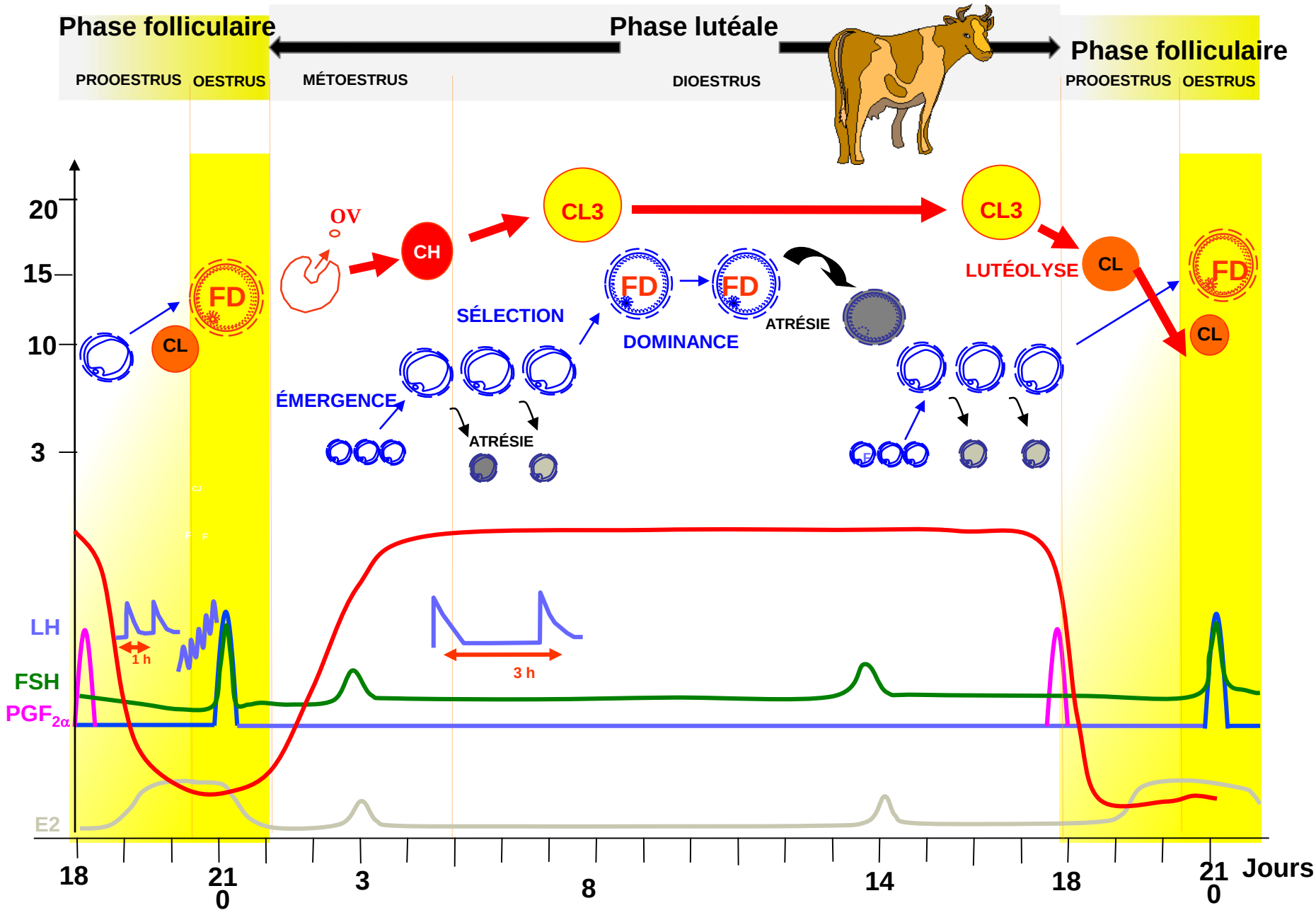

esaote piemedical MyLab
Pathologie de la reproduction, ENVT
1913, 58j , N:No, , ID: 2012-11-28-00,
28 NOV 2012 14:39
F 10.0 MHz G 78%
D 7 cm
PRC 7/1/H PRS 5
PST 1/2
4
13
SV3513
443 / 500

Fœtus bovin: stade 90 jours
Ecole Nationale Vétérinaire de Toulouse


esaote piemedical MyLab
Pathologie de la reproduction, ENVT
1913, , N:No, , ID: 2012-11-20-02,
20 NOV 2012 14:55
F 10.0 MHz G 78%
D 7 cm
PRC 7/1/H PRS 5
PST 1/2
4
13
SV3513
120 / 500

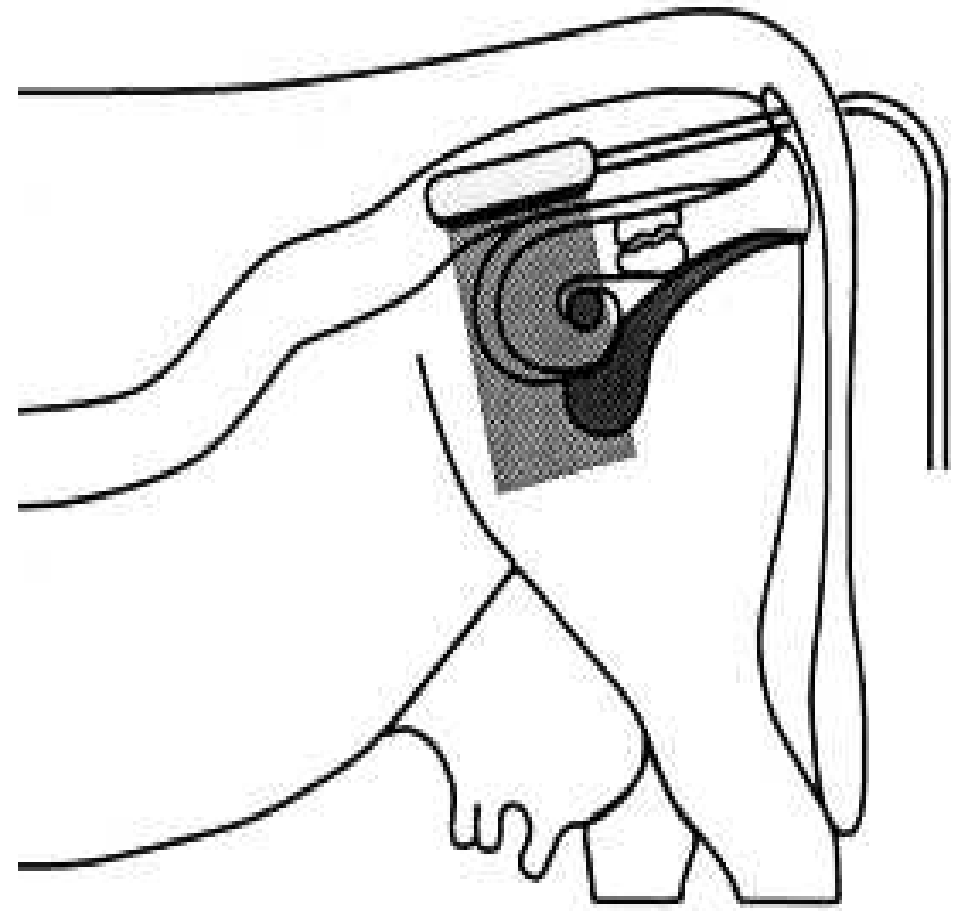

esaote piemedical MyLab
Pathologie de la reproduction, ENVT
1918, , N:No, , ID: 2012-12-10-02,
10 DEC 2012 09:40
F 10.0 MHz G 78%
D 7 cm
PRC 7/1/H PRS 5
PST 1/2
4
13
SV3513


esaote piemedical MyLab
Pathologie de la reproduction, ENVT
1921, 80j , N:No, , ID: 2012-12-03-00,
03 DEC 2012 16:27
F 10.0 MHz G 78%
D 7 cm
PRC 7/1/H PRS 5
PST 1/2
4
13
SV3513
362 / 500


Phase folliculaire
Phase lutéale
Phase folliculaire
PROOESTRUS
OESTRUS
MÉTOESTRUS
DIOESTRUS
PROOESTRUS
OESTRUS
20
15
10
3
OV
CH
CL3
CL3
LUTÉOLYSE
CL
FD
CL
SÉLECTION
DOMINANCE
FD
FD
ATRÉSIE
ÉMERGENCE
ATRÉSIE
LH
FSH
PGF2α
E2
1 h
3 h
18
21
0
3
8
14
18
21
0
Jours

Echographie des ovaires

- voie rectale
- inclinaison de la sonde ou échographie de l'ovaire dans la main
- Fréquence 5 à 10 MHz
- Exploration dynamique



Images échographiques des organites ovariens

- **stroma** — **échostructure hétérogène**
  médulla échogène

- **follicule** — **structure liquidienne**
  anéchogène
  sphérique
  paroi fine
  ≠ vaisseau sanguin

- **corps jaune** — **structure échogène**
  parfois cavitaire
  2-3 cm de diamètre

Image échographique du follicule

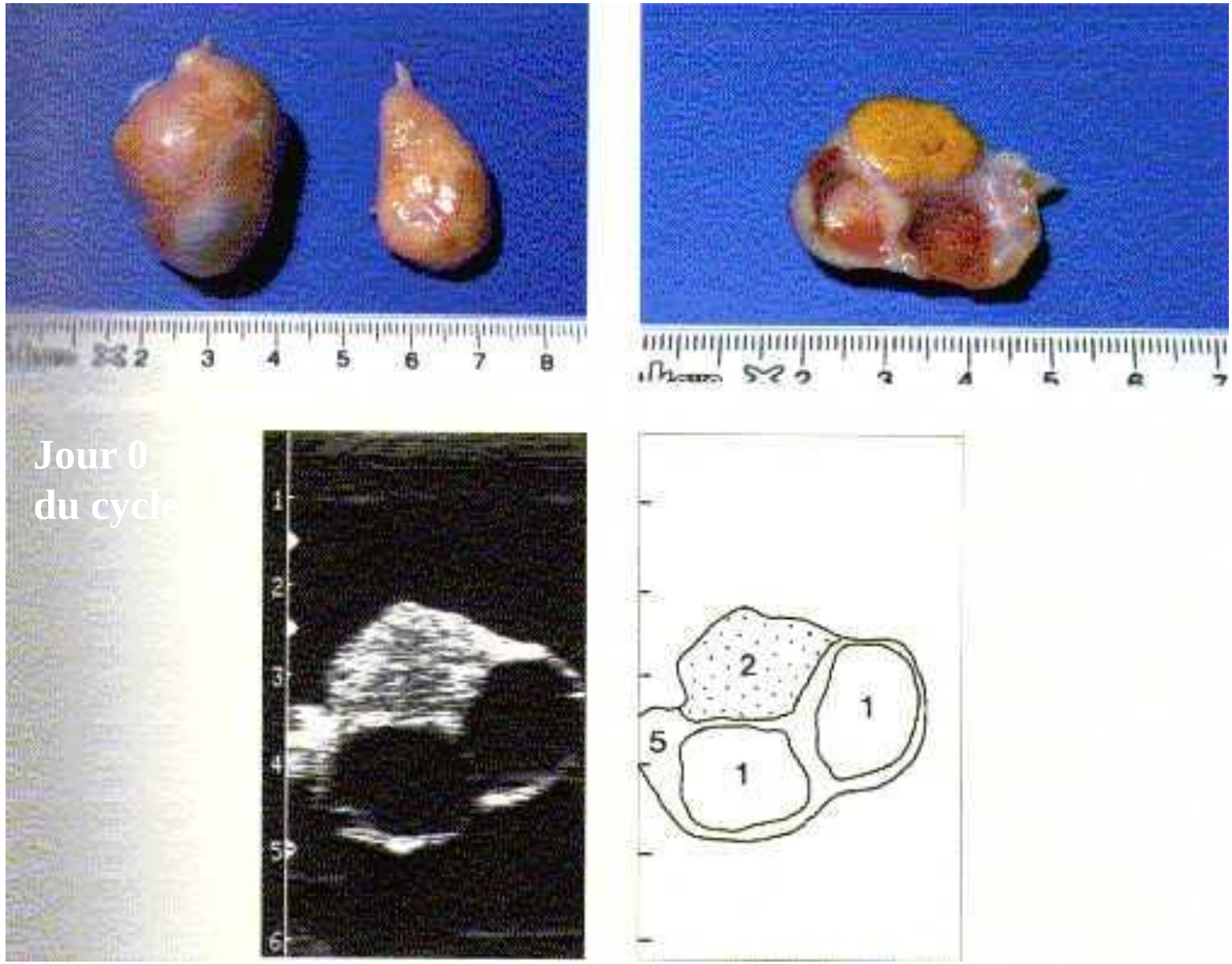


Image échographique du corps jaune

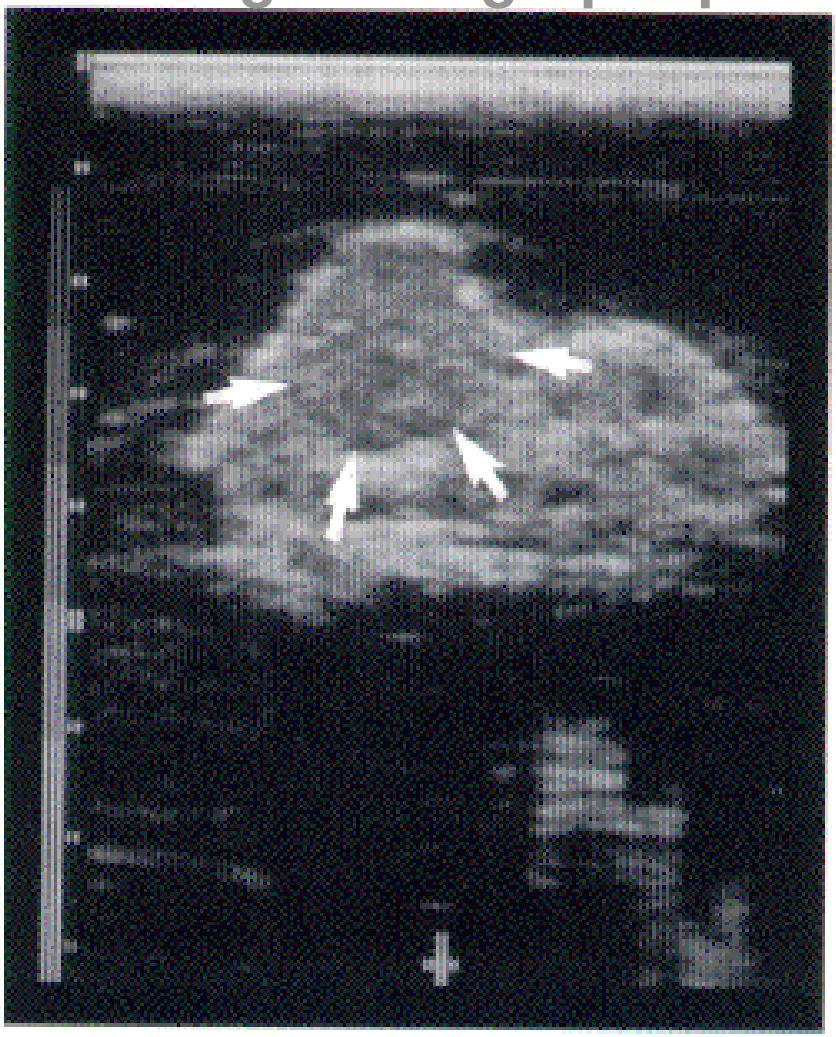
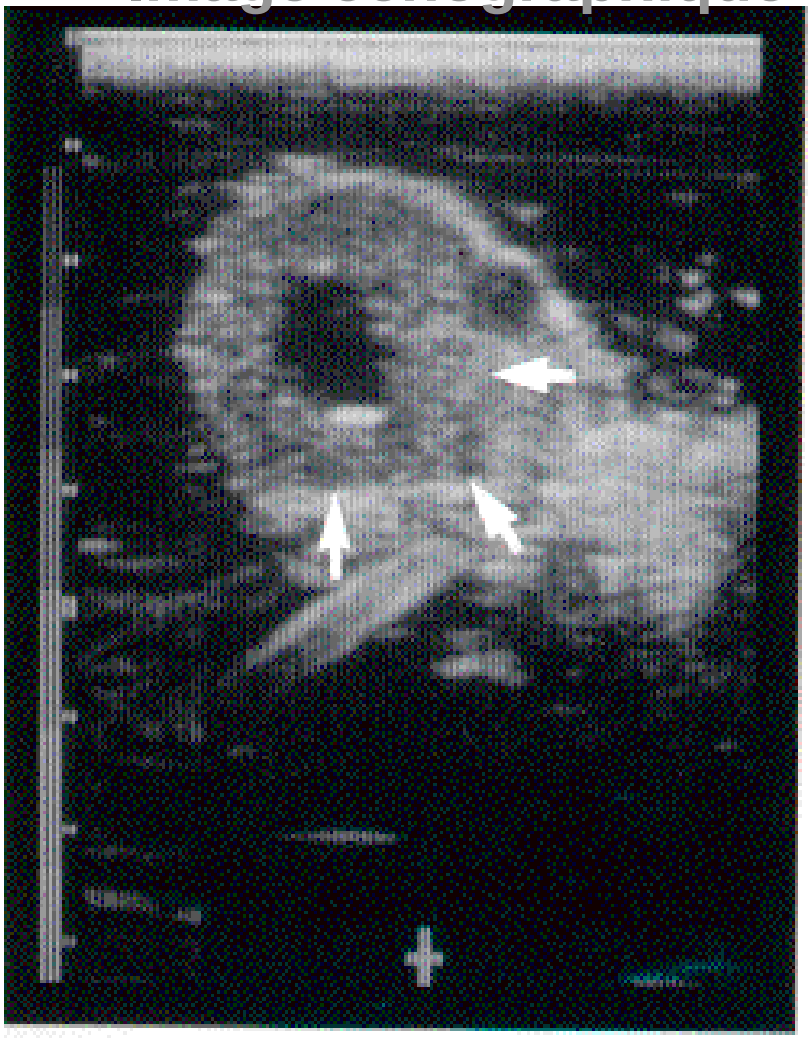


Image échographique du corps jaune



Evolution des organites ovariens au cours du cycle oestral

- **Le follicule**
  - **nécessité d'un suivi ovarien**
  - **follicule dominant et préovulatoire identique**
  - **diamètre moyen du follicule préovulatoire (Quirk et al, 1986)**
    - **J-3 : 8.5 mm**
    - **J-2 : 9.9 mm**
    - **J-1 : 12.0 mm**
    - **J0 : 13.7 mm**
- **Le corps jaune**
  - **à partir du 3ème jour du cycle**
  - **corps jaune en formation moins échogène : 14-20 mm**
  - **corps jaune mature (J6-J16) : 2-3 cm de diamètre**
  - **corps jaune en régression visible jusqu'à J3 : 12-20 mm**

Conclusion

- Cycle oestral
- Vagues de croissance folliculaire
- Développement du fœtus
- Applications de l’échographie