# Ventricule droit (VD)
# et Artère pulmonaire (AP)

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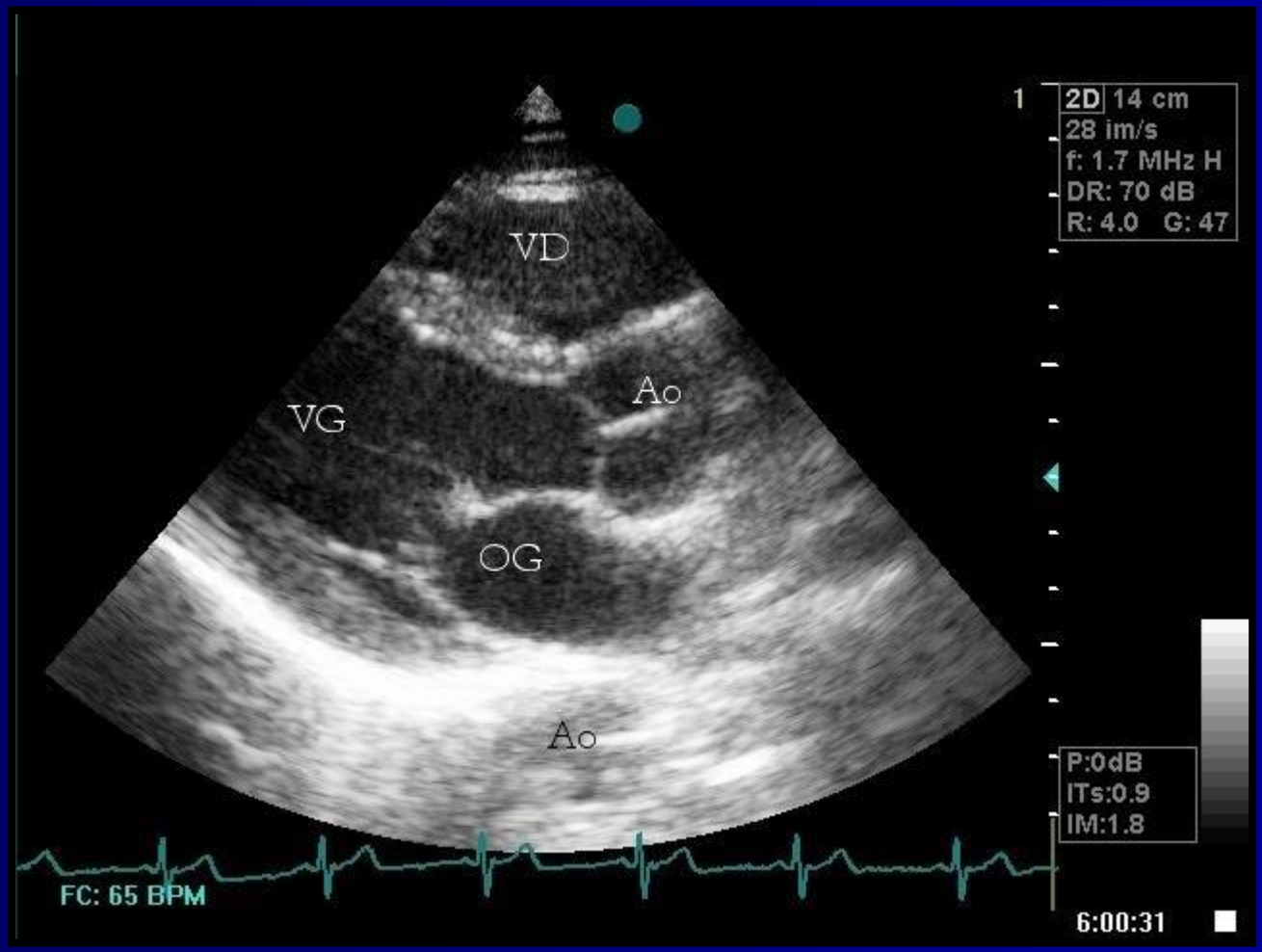
CHU Rennes

# Plan de la présentation

- Description des différentes coupes
  - Étude du VD ETT/ETO
  - Etude de l'AP ETT/ETO
- Analyse de la fonction systolique VD
  - FR, TAPSE, DTI
- Analyse de la fonction diastolique VD
  - Étude des flux
- Evaluation de la PAP
  - Méthode IT
  - Méthode IP

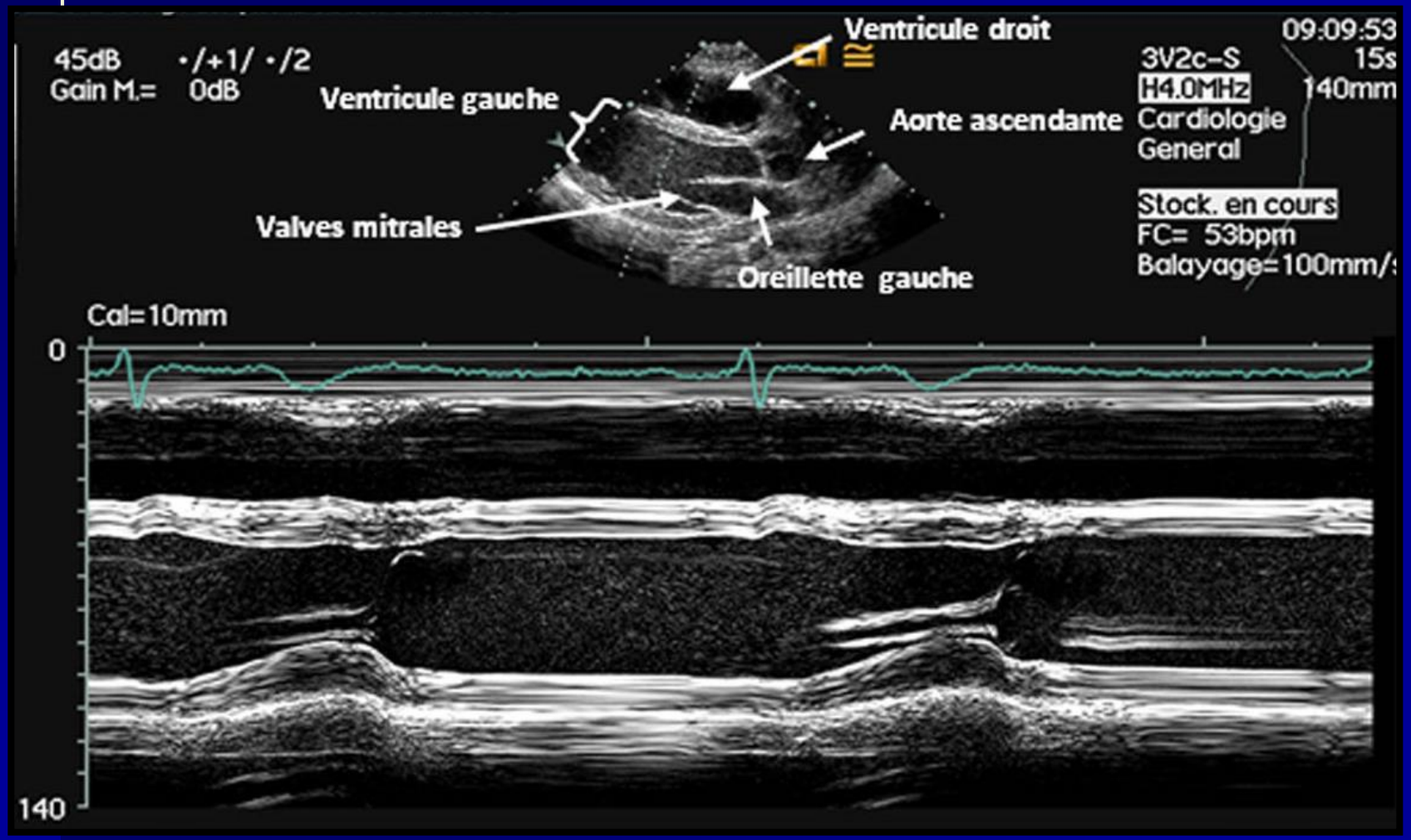
# Ventricule Droit en ETT

**Para sternale Gauche Grand Axe en 2D**



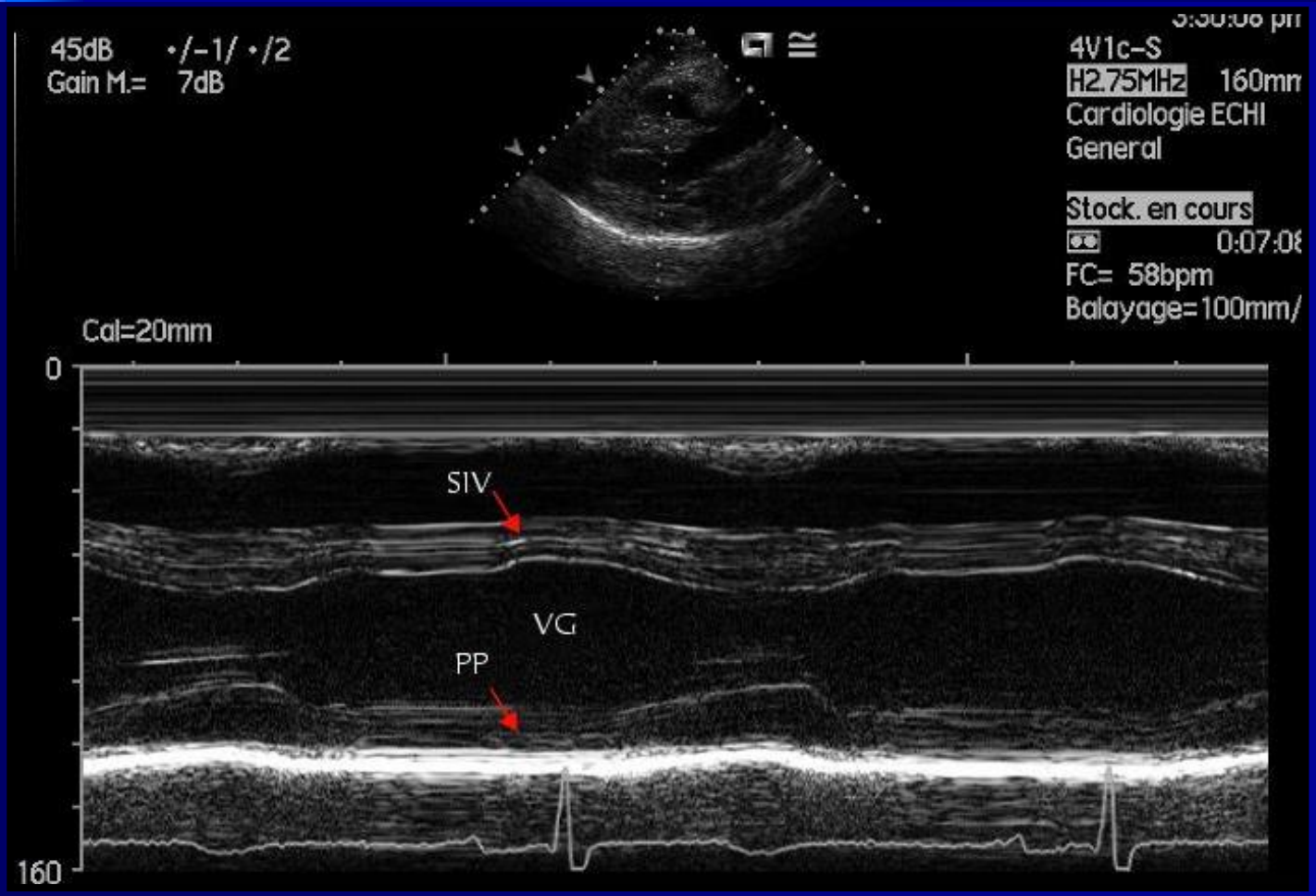
# Ventricule Droit en ETT

**Para sternale Gauche Grand Axe en TM**



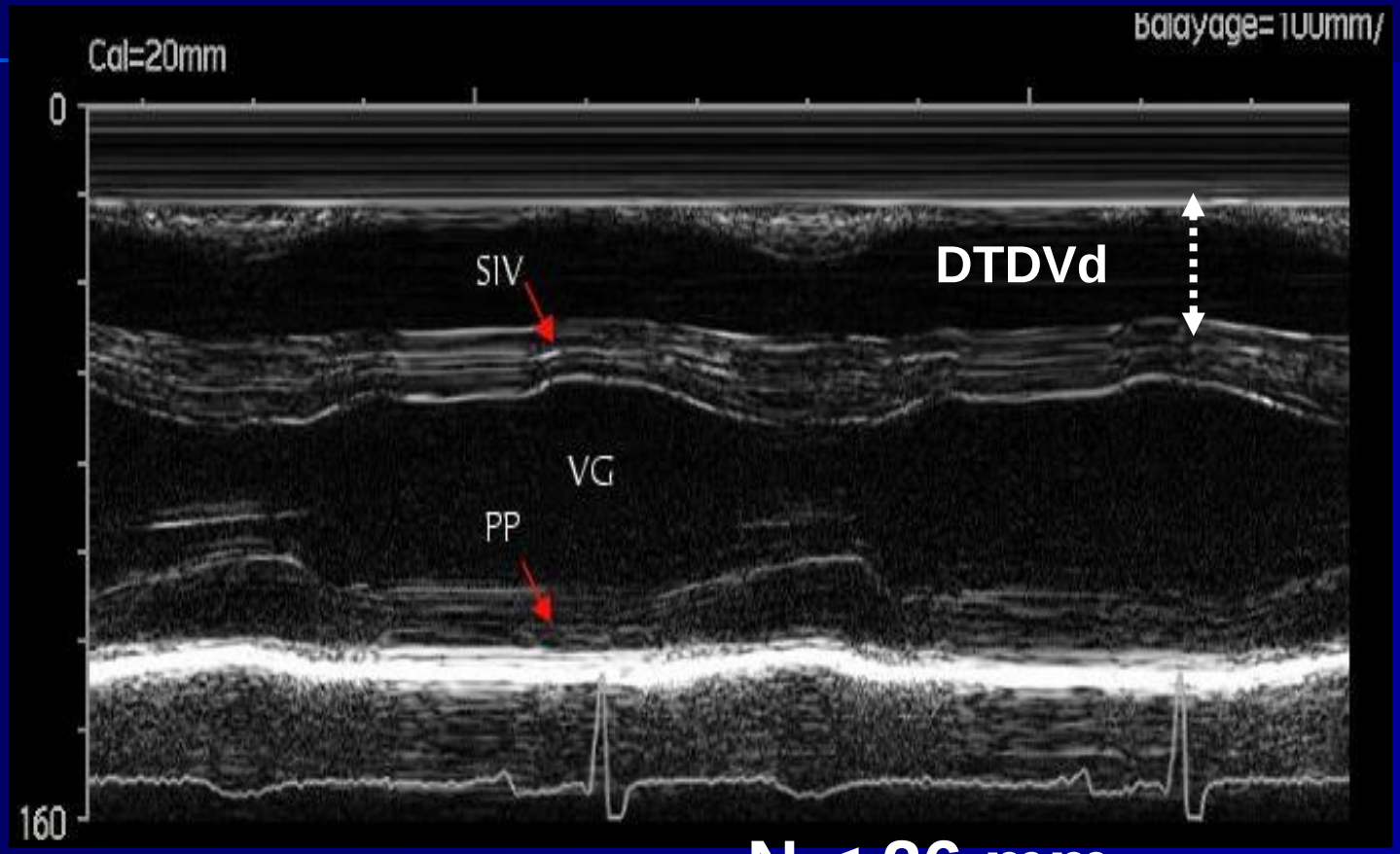
# Ventricule Droit en ETT

**Para sternale Gauche Grand Axe en TM**



# Ventricule Droit en ETT

**Para sternale Gauche Grand Axe en TM**

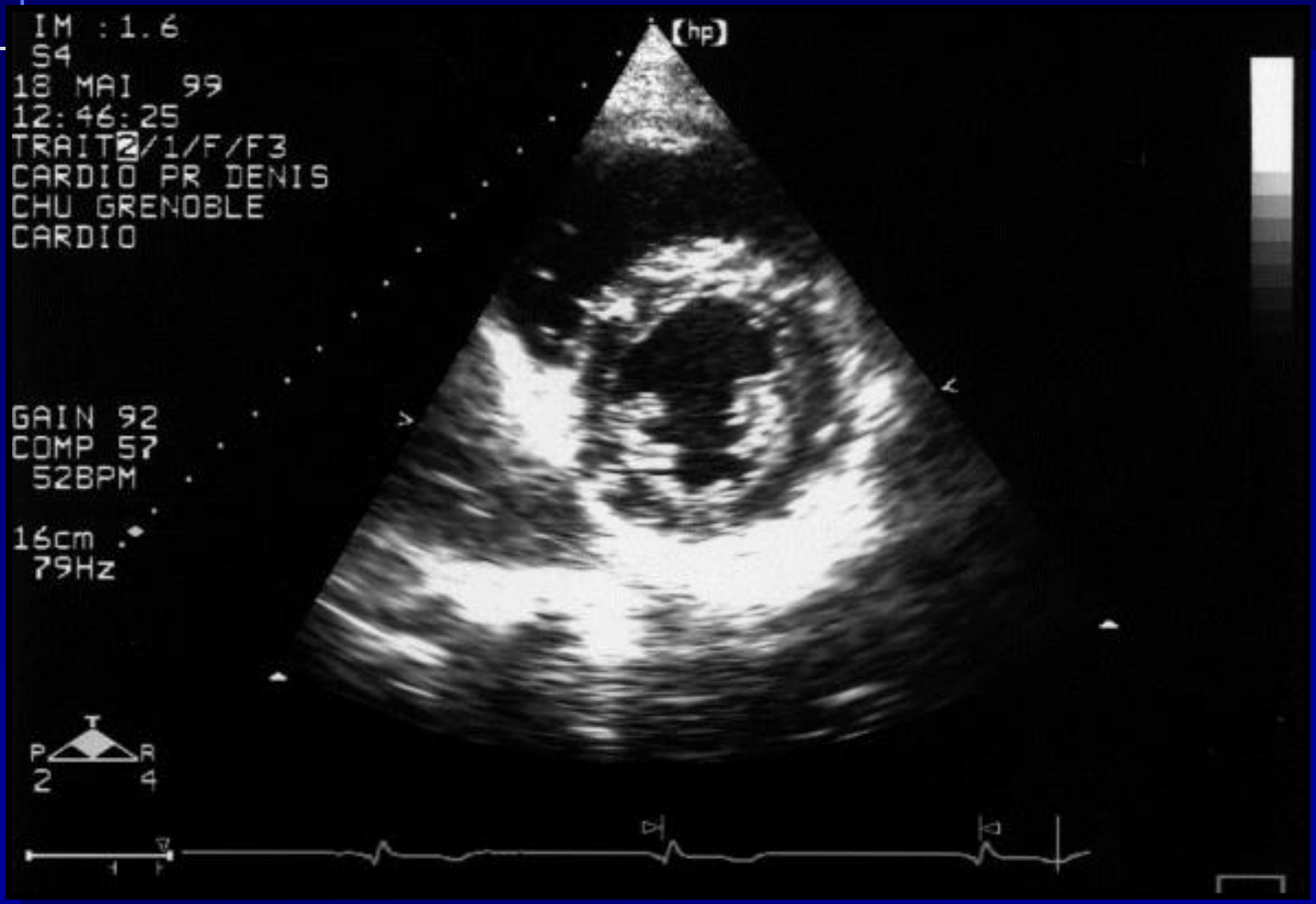



**N < 26 mm**

**ou < 14,4 ± 2,2 mm/m²**

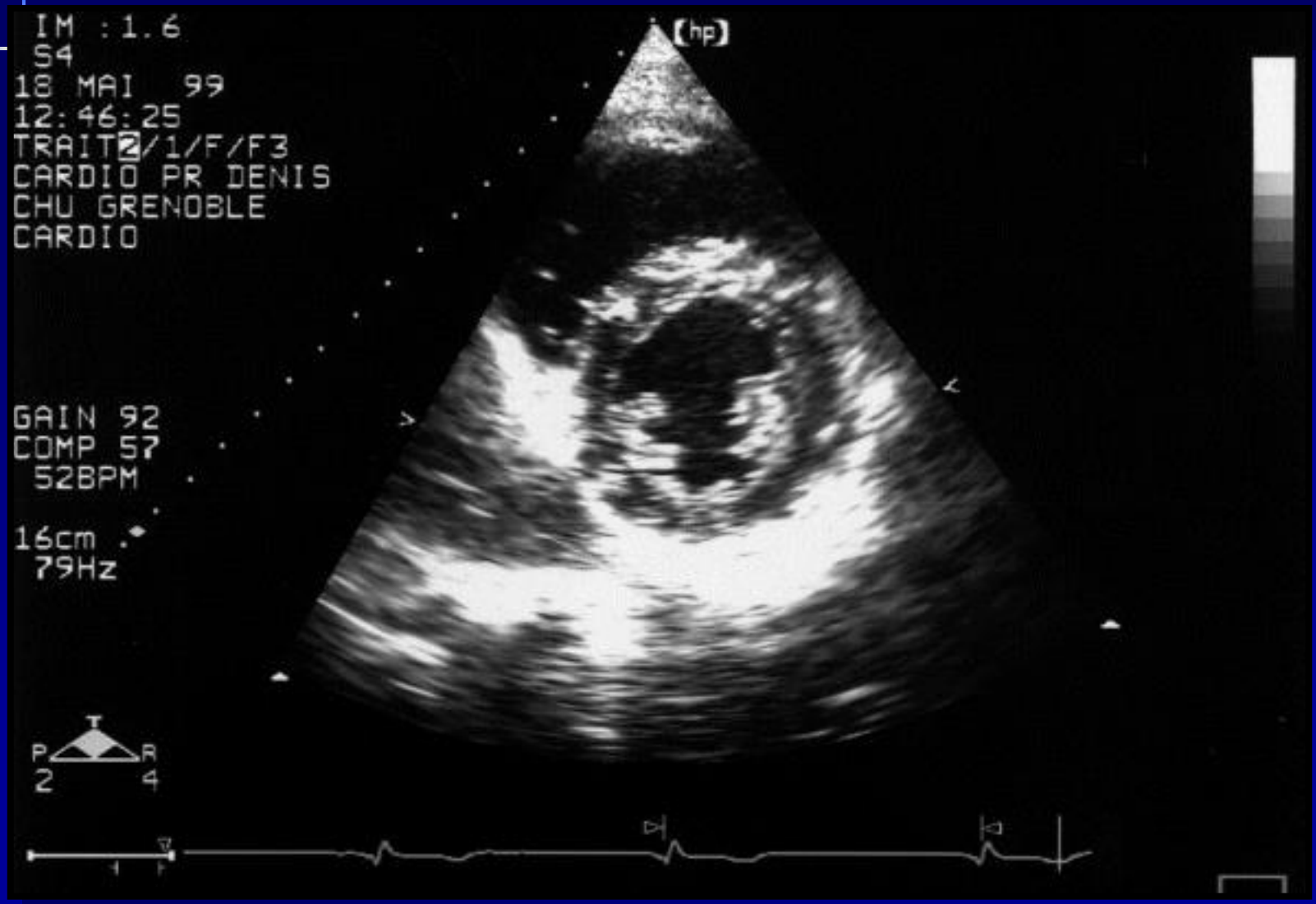
# Ventricule Droit en ETT

**Para sternale Gauche Petit Axe**



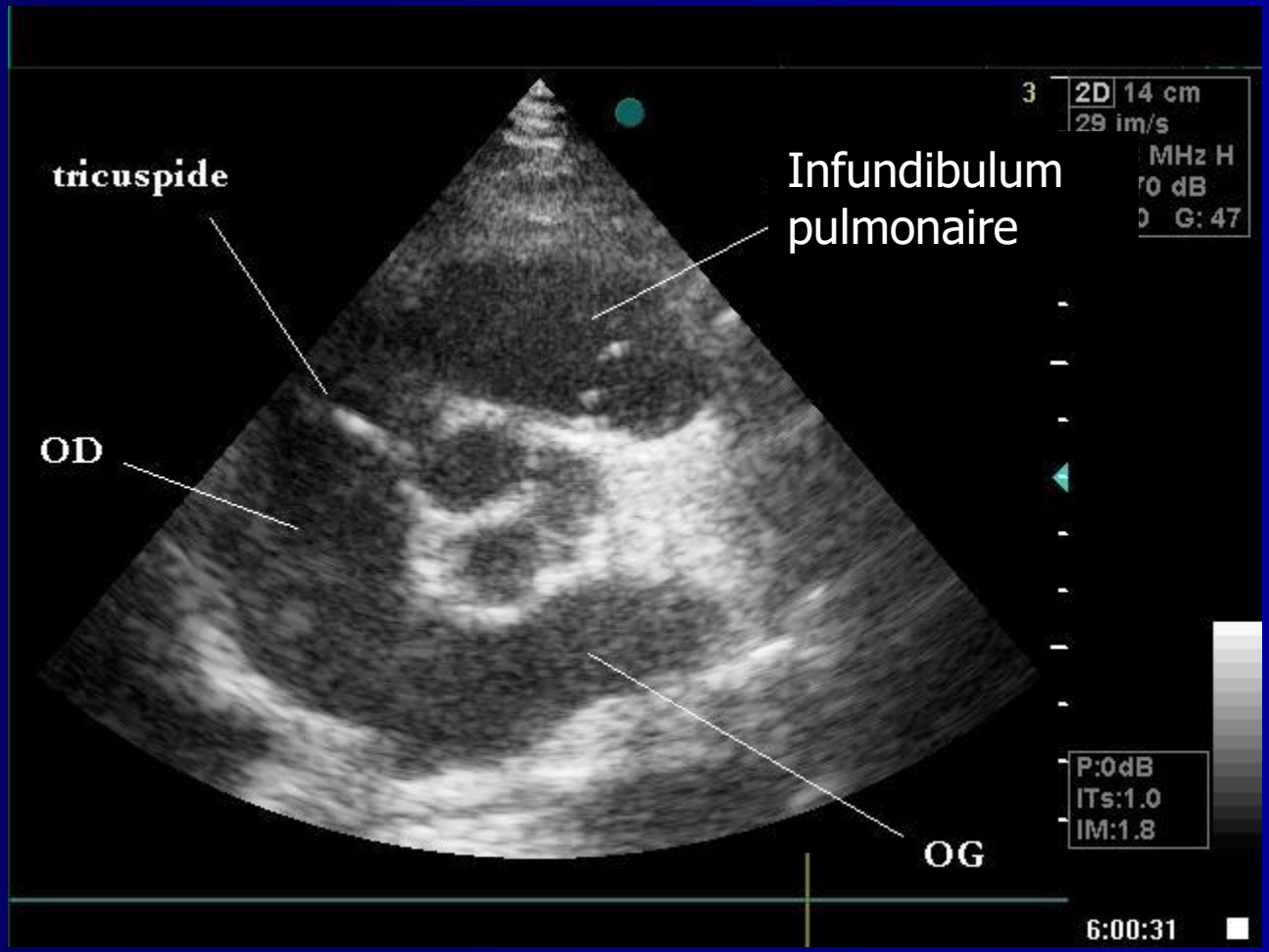
# Ventricule Droit en ETT

## Para sternale Gauche Petit Axe



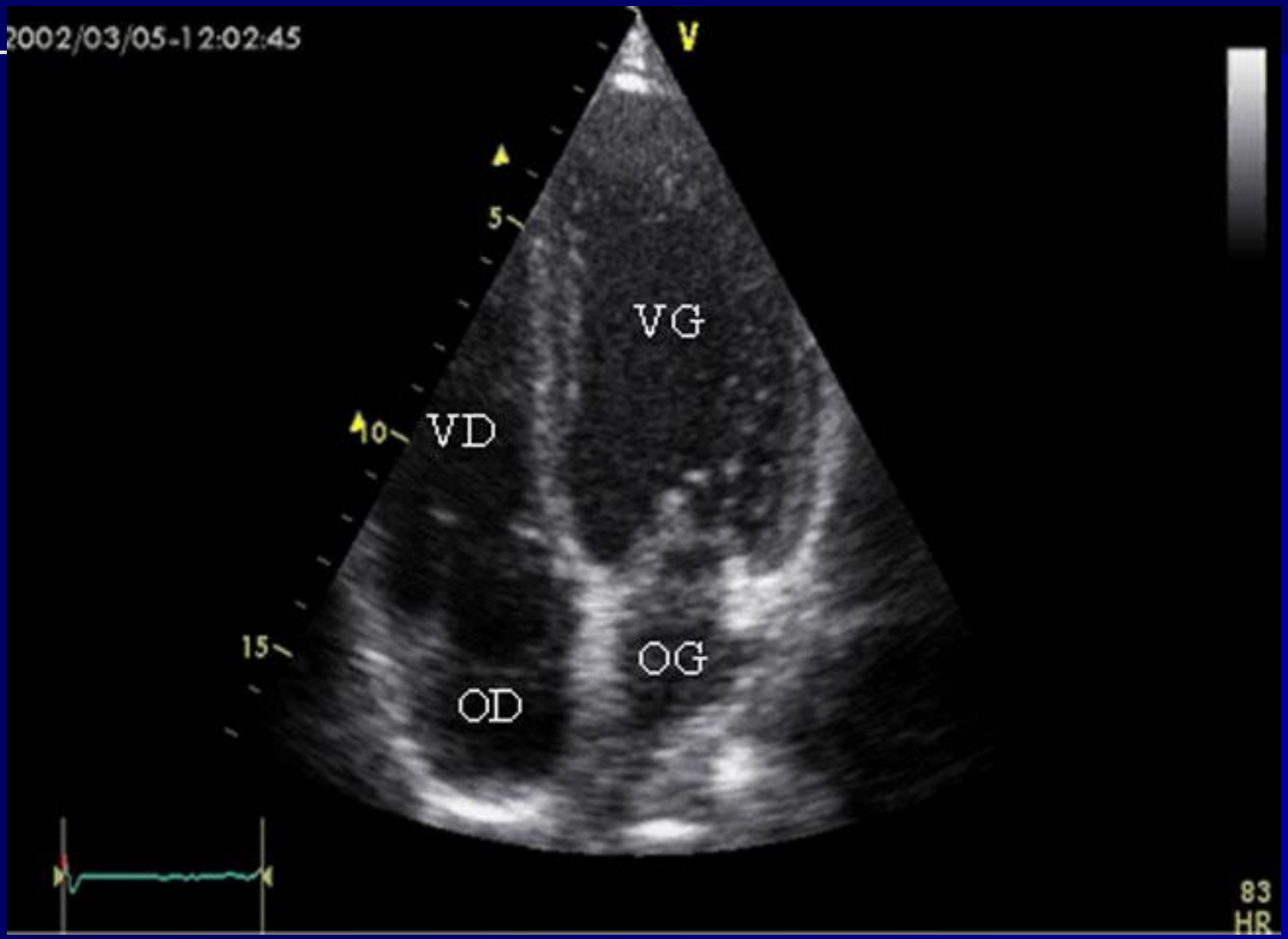
# Ventricule Droit en ETT

**Para sternale Gauche Petit Axe**



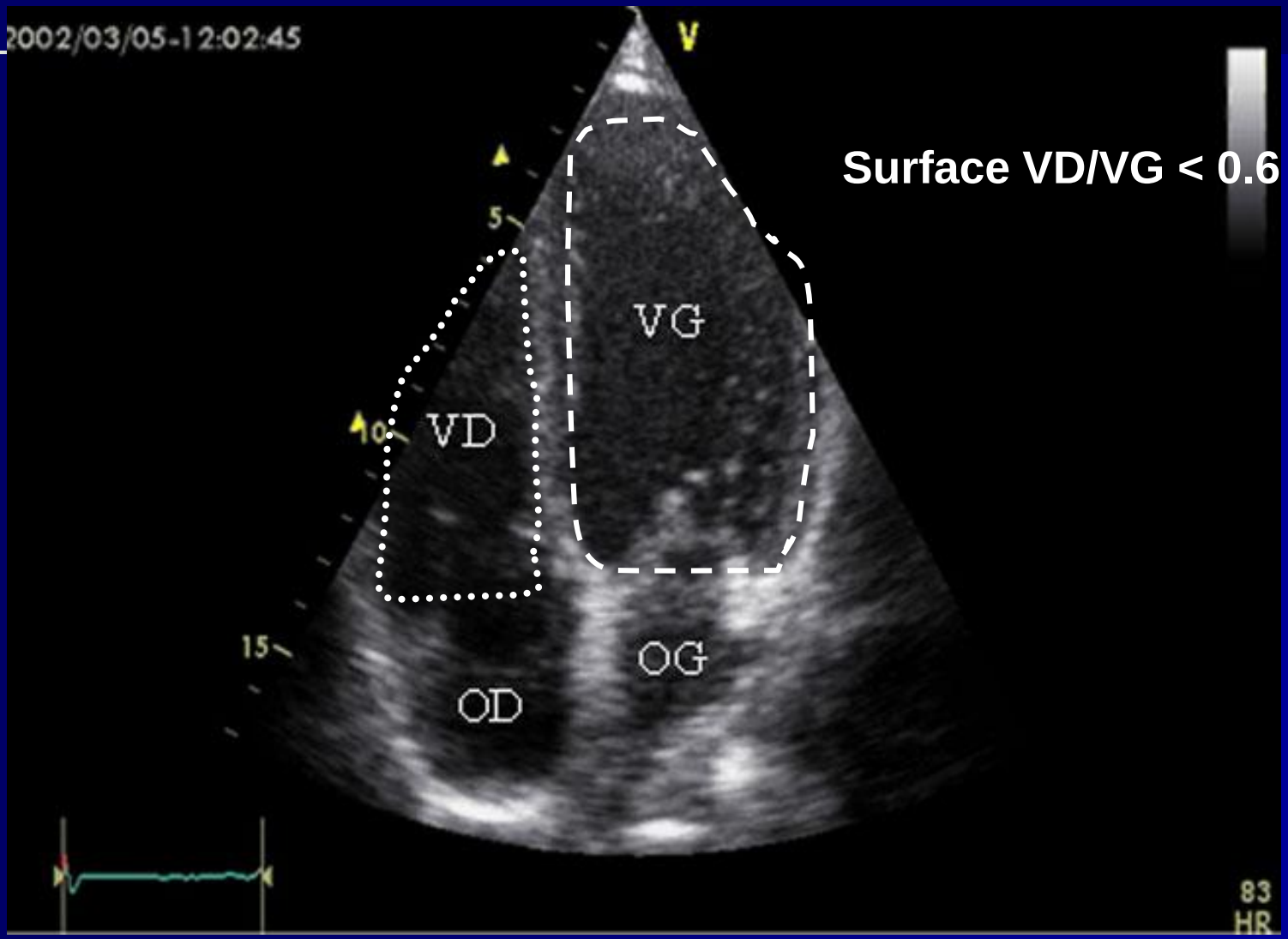
# Ventricule Droit en ETT

**Coupe Apicale 4 cavités**



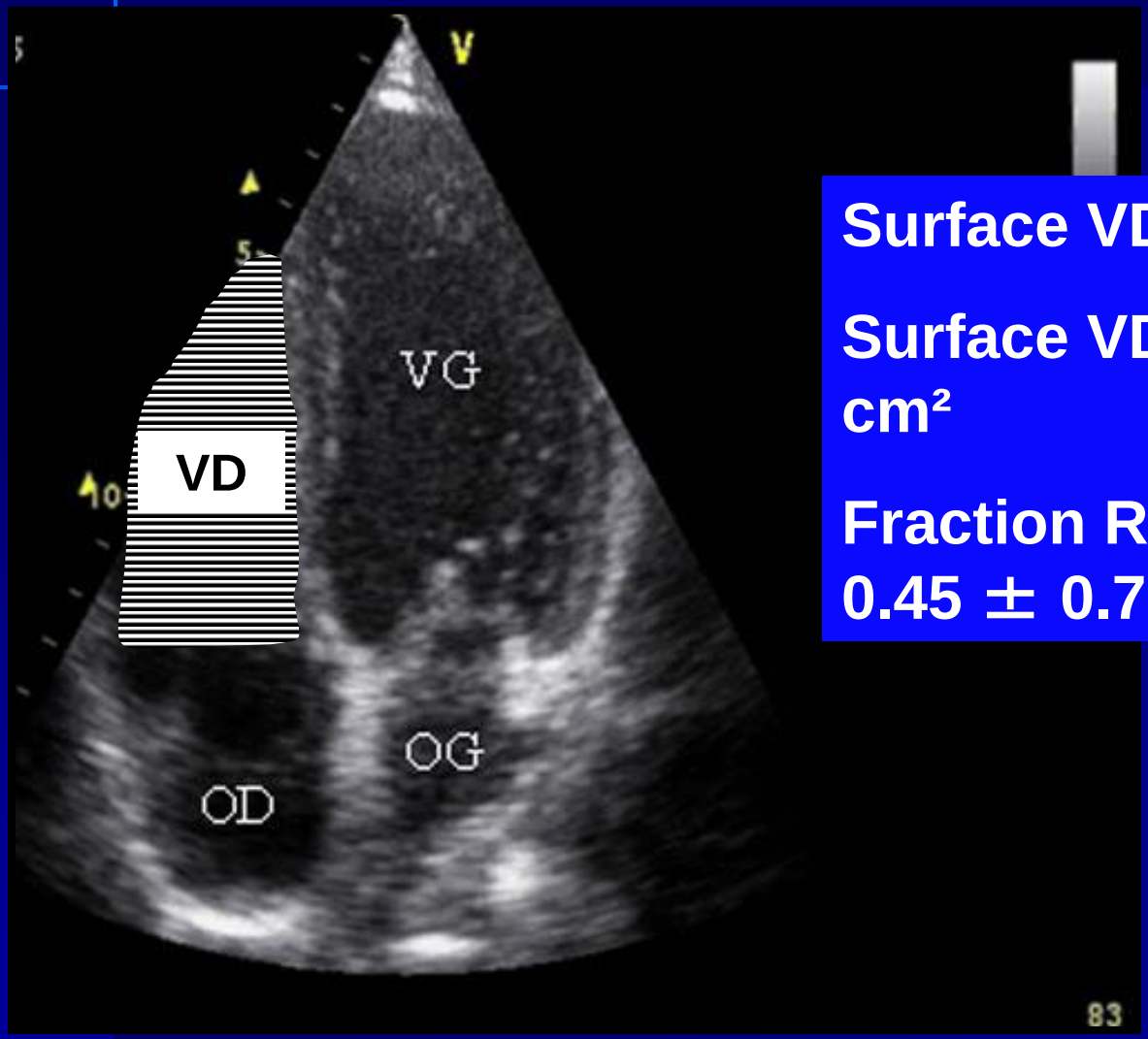
# Ventricule Droit en ETT

**Coupe Apicale 4 cavités**



# Ventricule Droit en ETT

**Coupe Apicale 4 cavités**

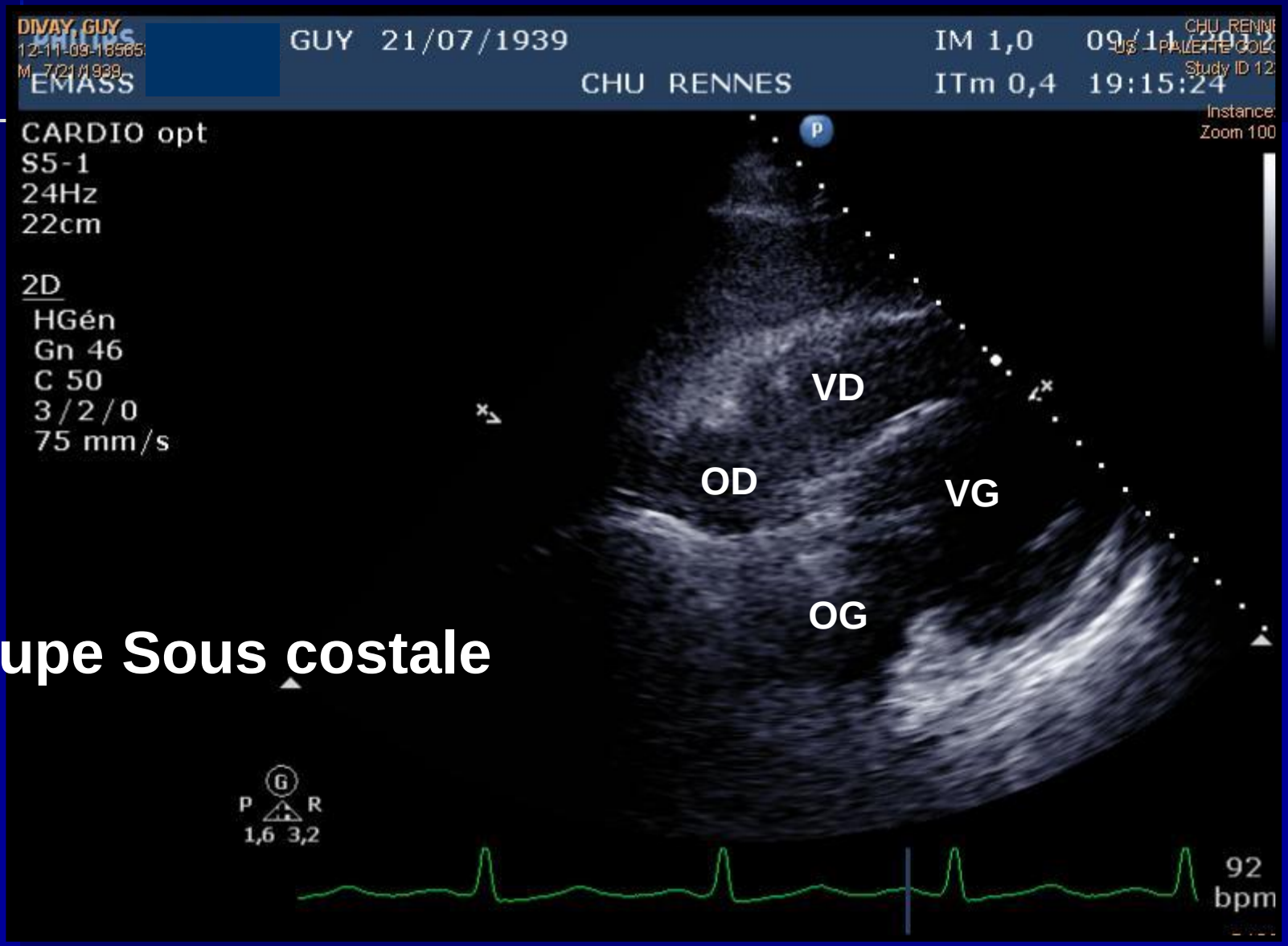



**Surface VDtd = 20,1± 4 cm²**

**Surface VDts = 10,9 ± 2,9 cm²**

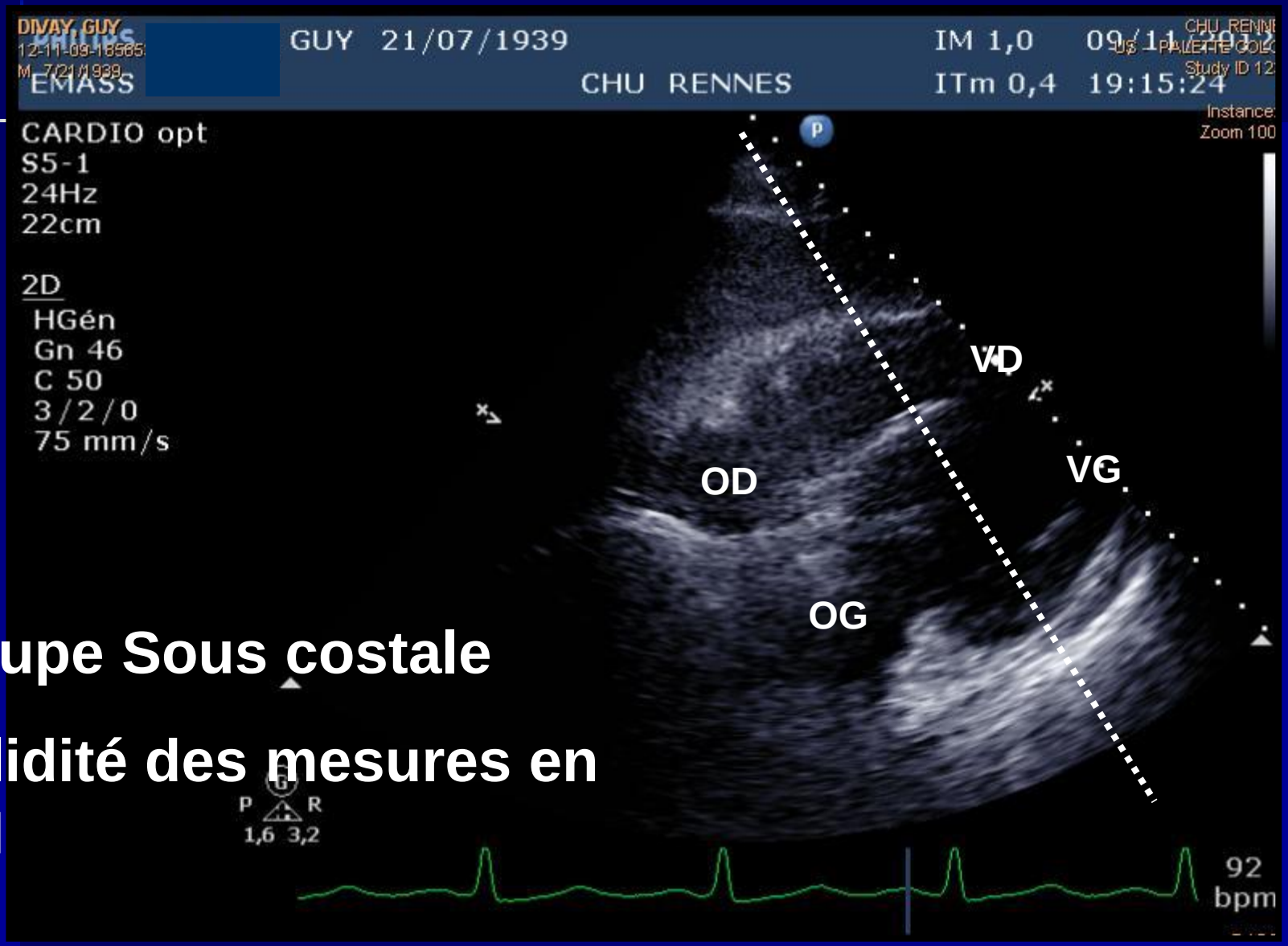
**Fraction Racourcissement = 0.45 ± 0.7**

# Ventricule Droit en ETT




**Coupe Sous costale**

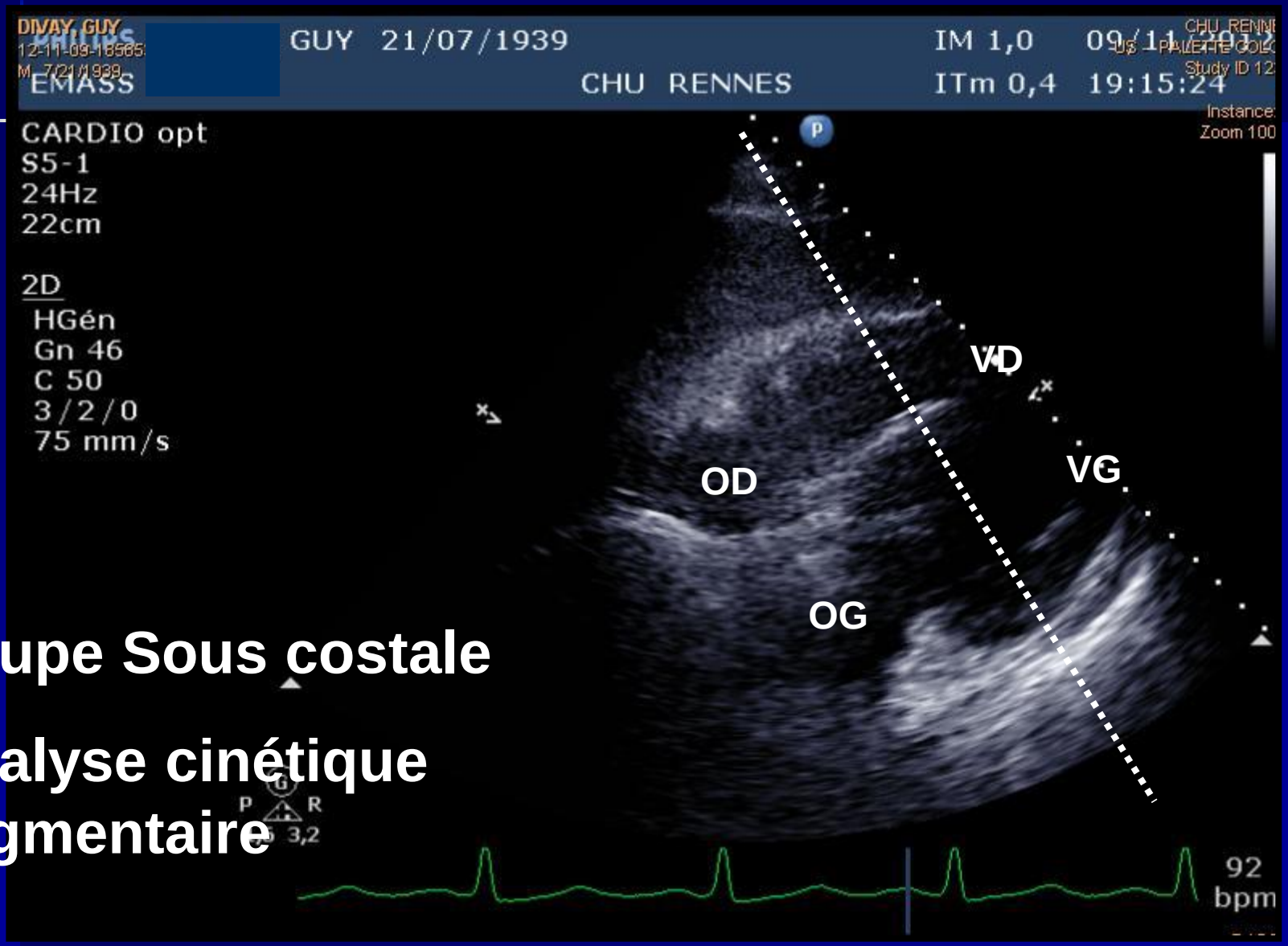
# Ventricule Droit en ETT




**Coupe Sous costale**

**Validité des mesures en TM**

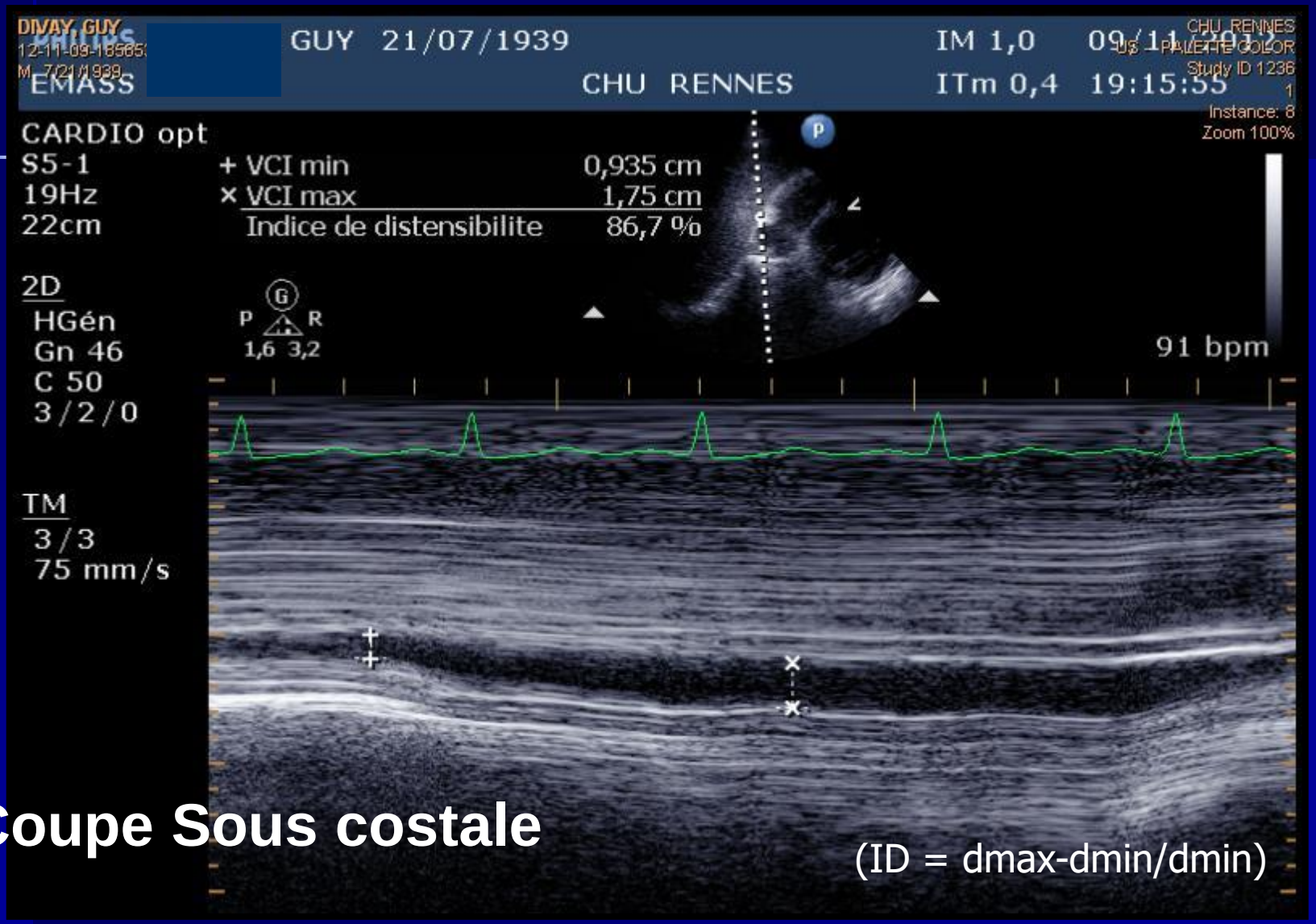
# Ventricule Droit en ETT




**Coupe Sous costale**

**Analyse cinétique segmentaire**

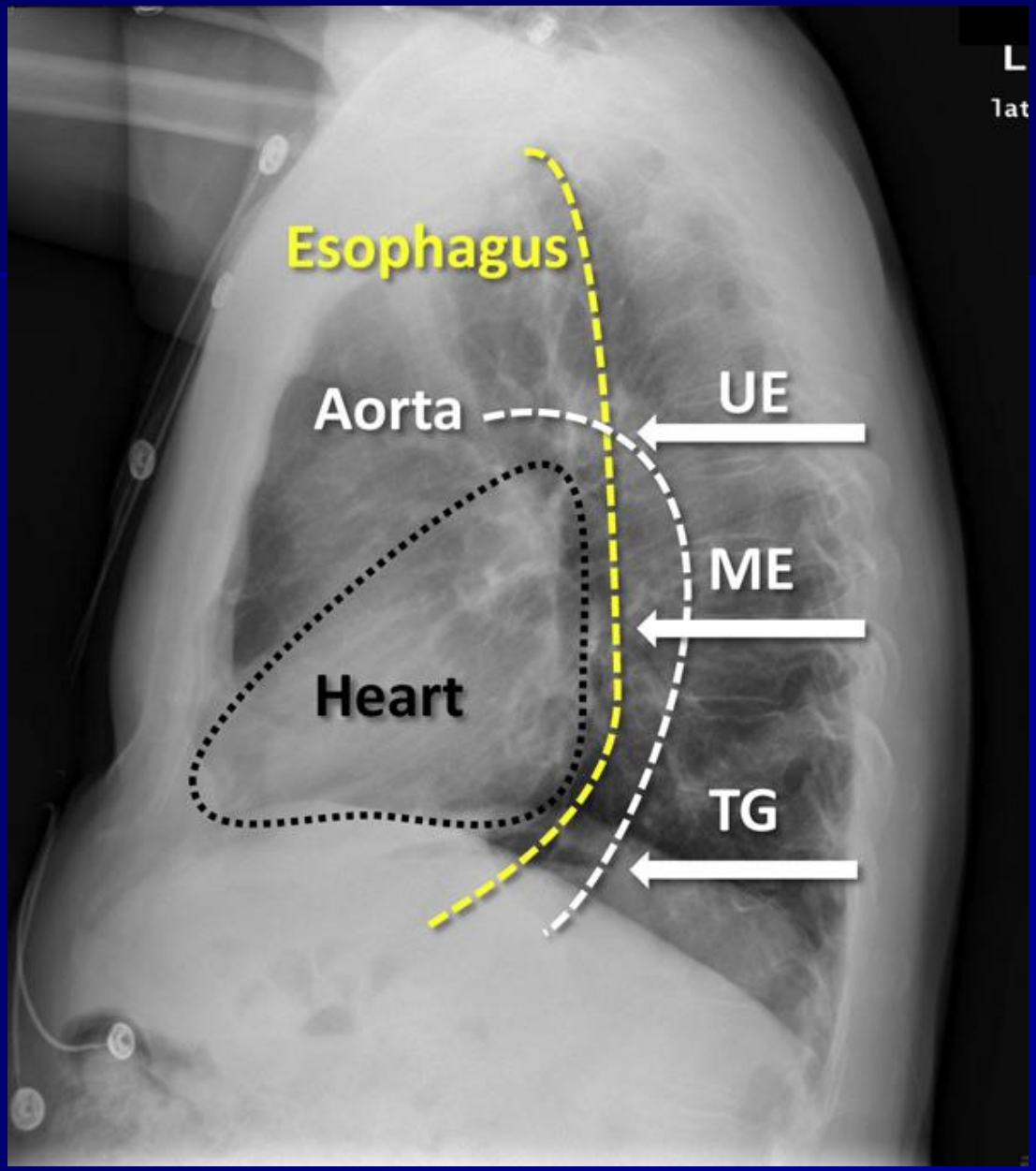
# Ventricule Droit en ETT

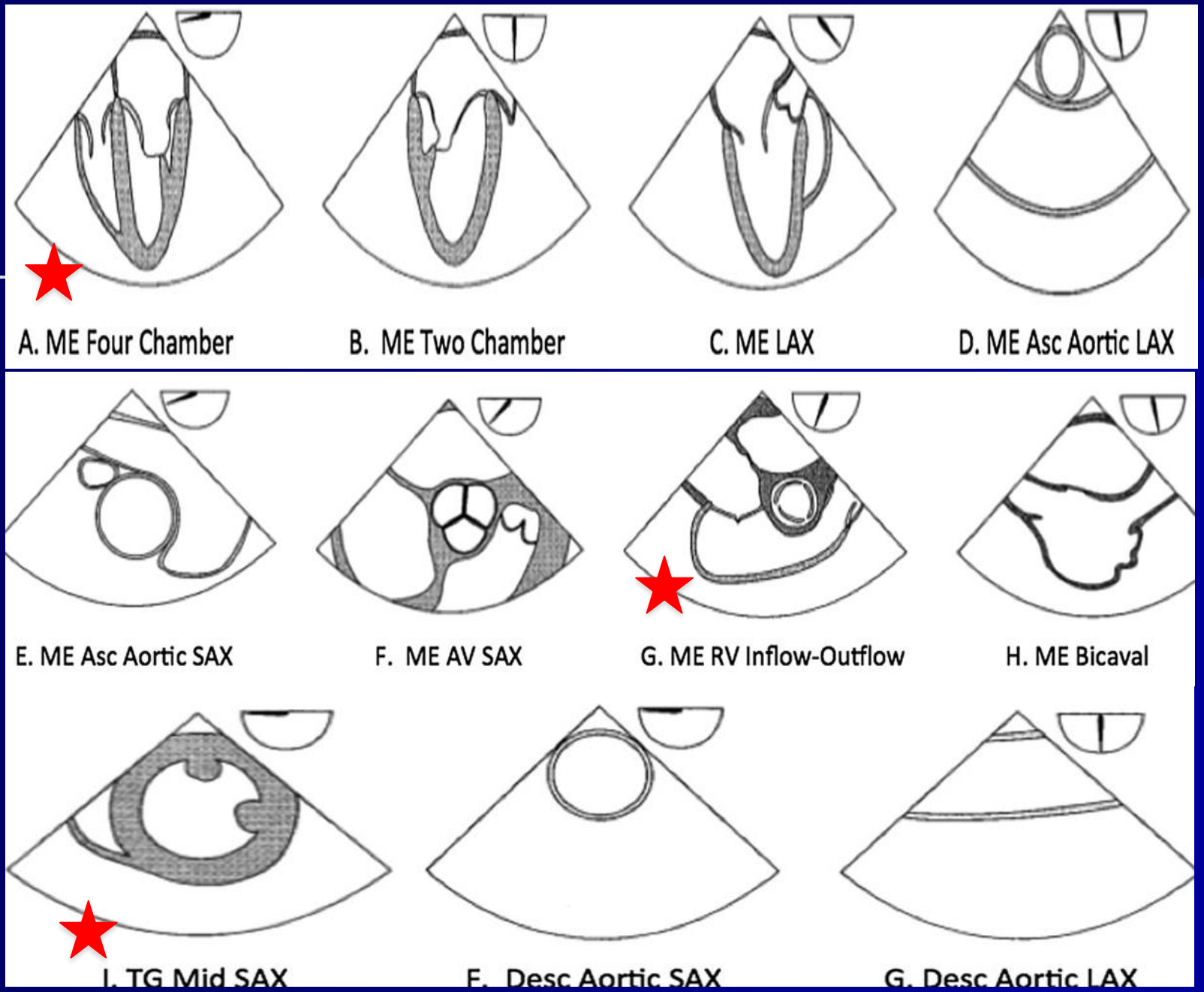



**Coupe Sous costale**

(ID = dmax-dmin/dmin)

# En ETO






Reeves et al, J Am Society of echocardiography, 2013

# Ventricule Droit en ETO (1)

- **Incidence 4 cavités**

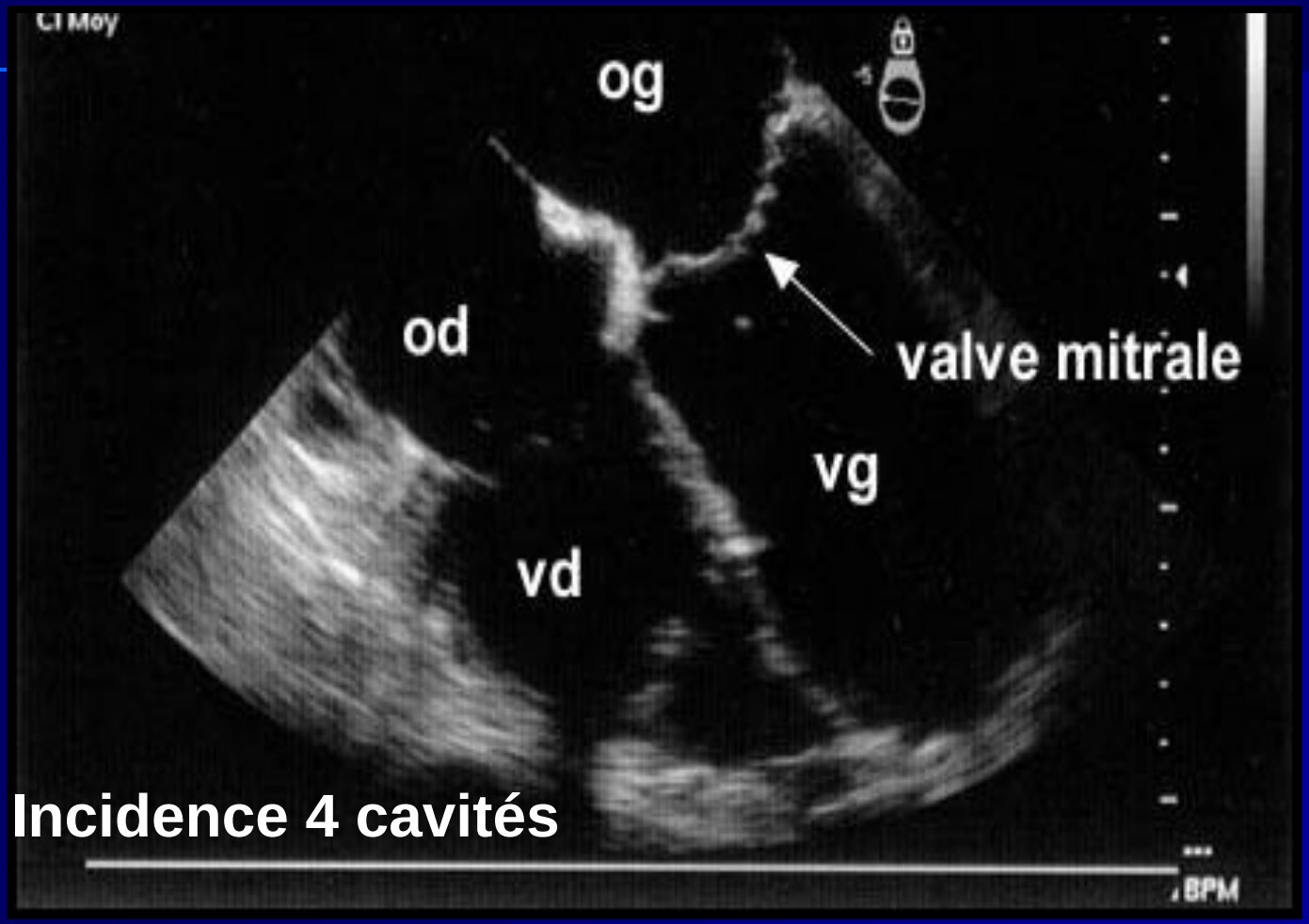
-**Partie basse œsophage *(ME)***

- **30-35 cm des arcades dentaires**

- **Angle = 0˚**

- **« 4 cavités-0˚ »**

# Ventricule Droit en ETO



# Ventricule Droit en ETO (2)

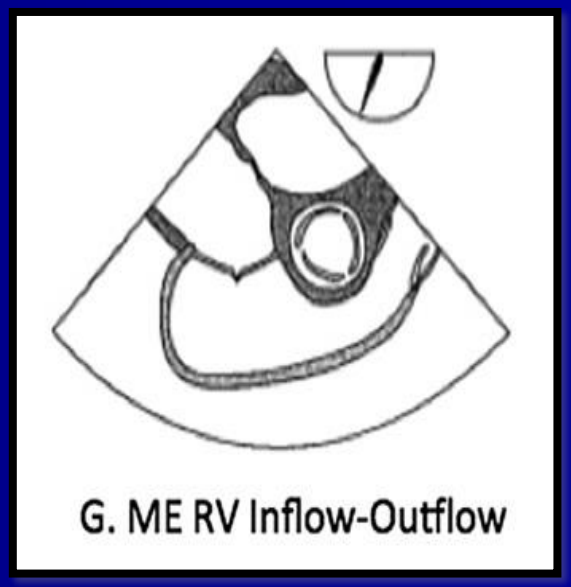
-**Partie Haute œsophage *(UE)***

**(15-20 cm des arcades dentaires)**

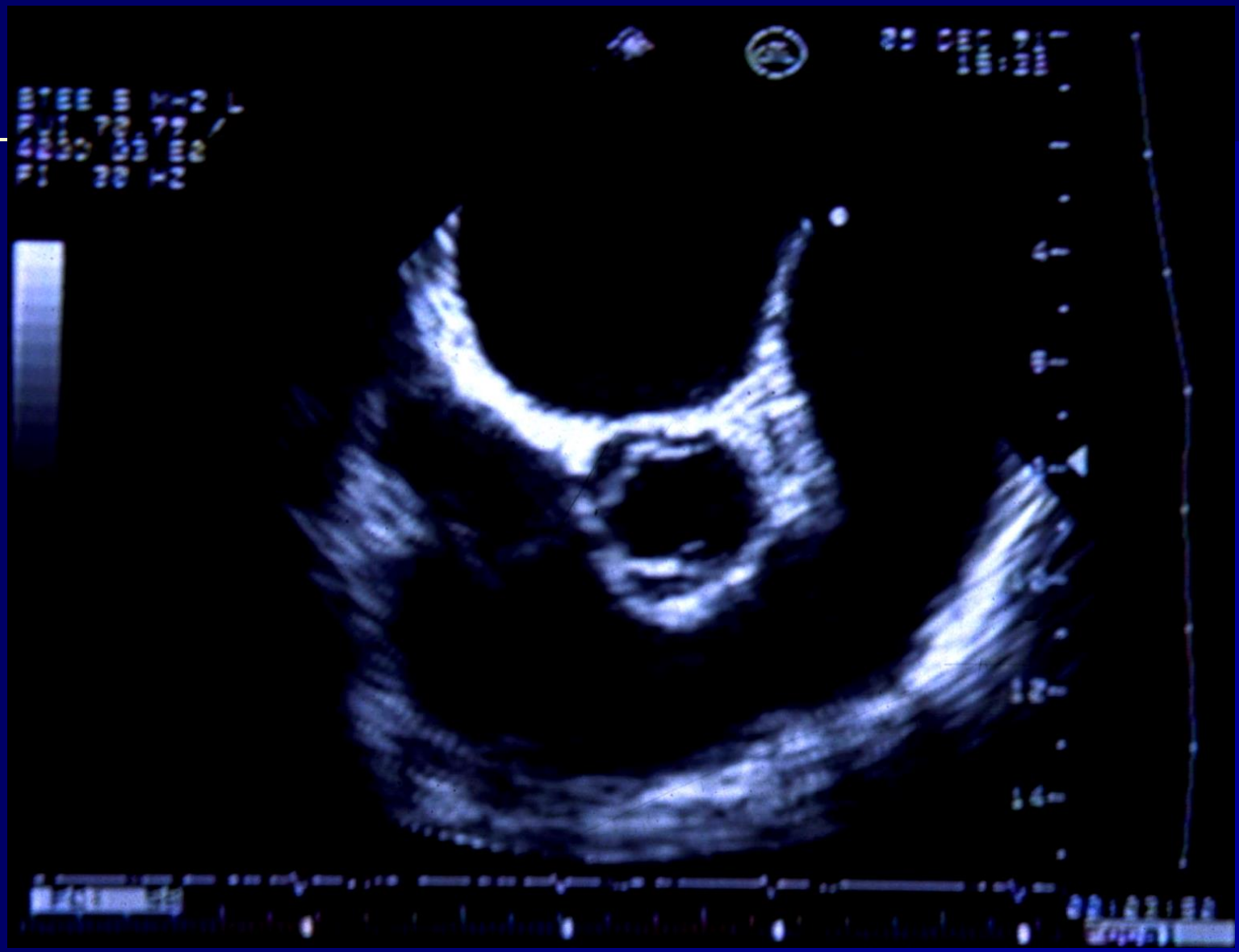
**- Centré sur la valve aortique**

**- 30° - 90°**

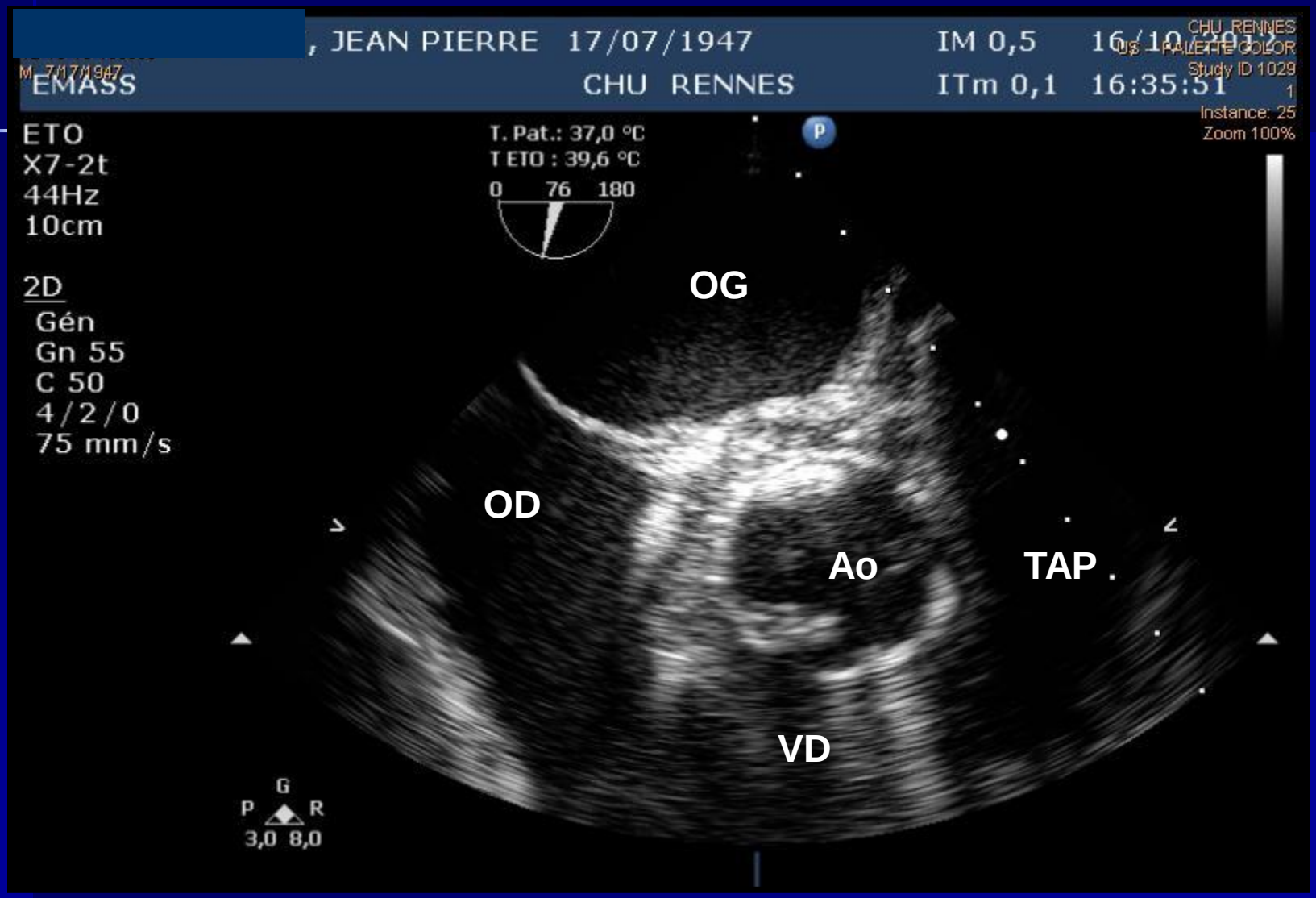
**- OD-VD-CC VD**



# Ventricule Droit en ETO



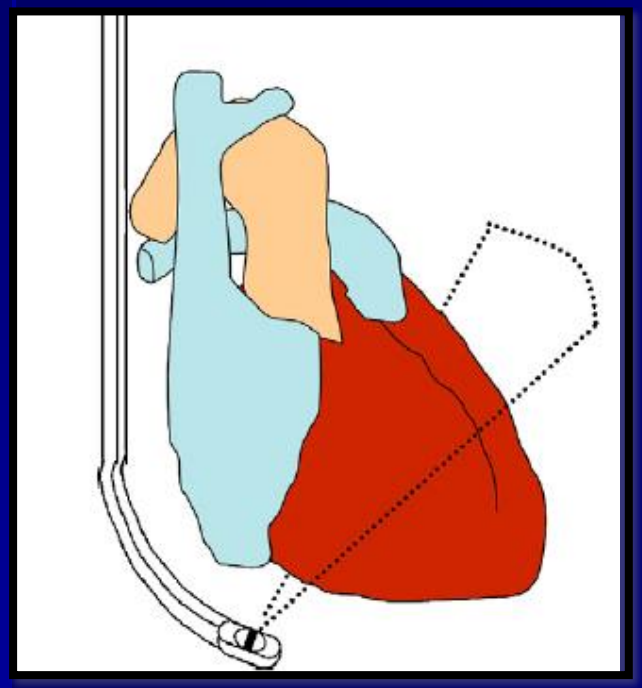
# Ventricule Droit en ETO

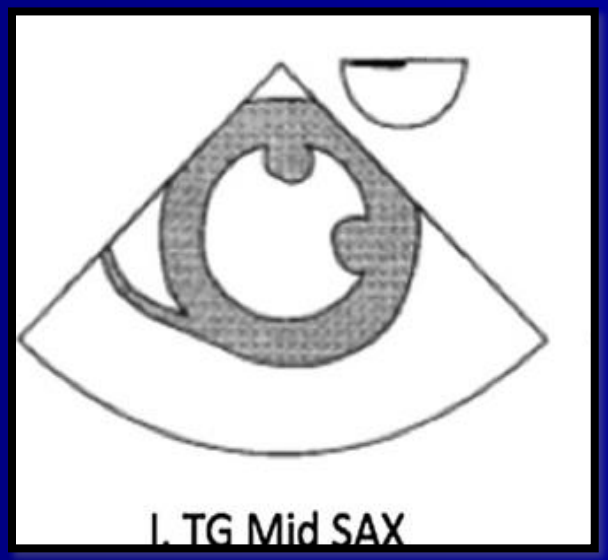


# Ventricule Droit

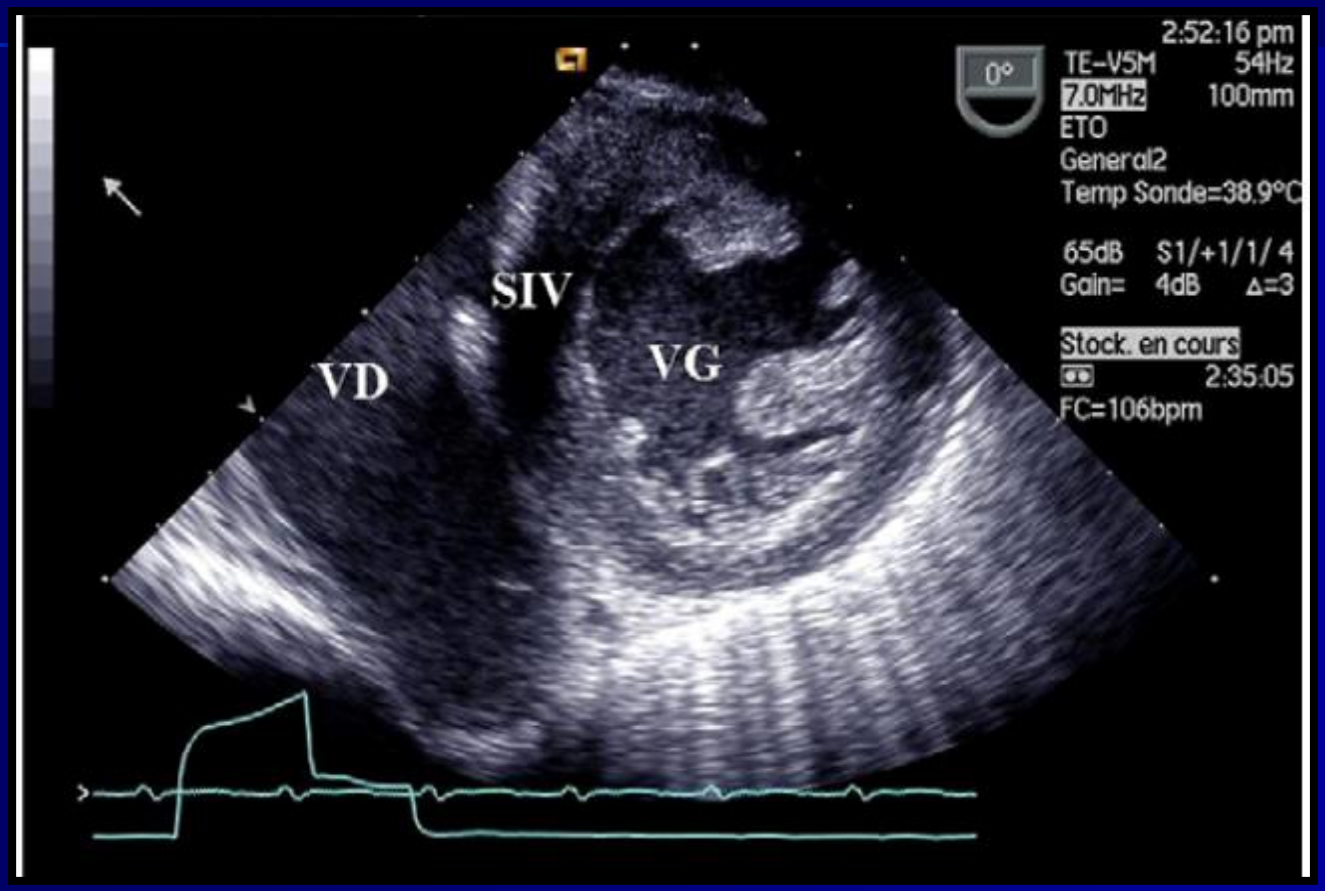
**-Voie transgastrique**

**-0° /30**



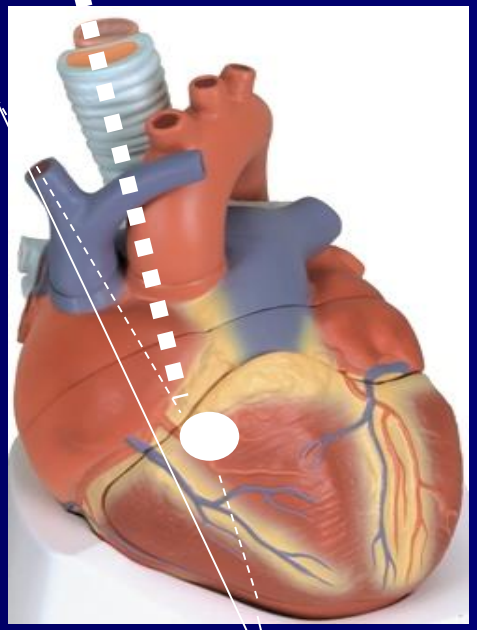


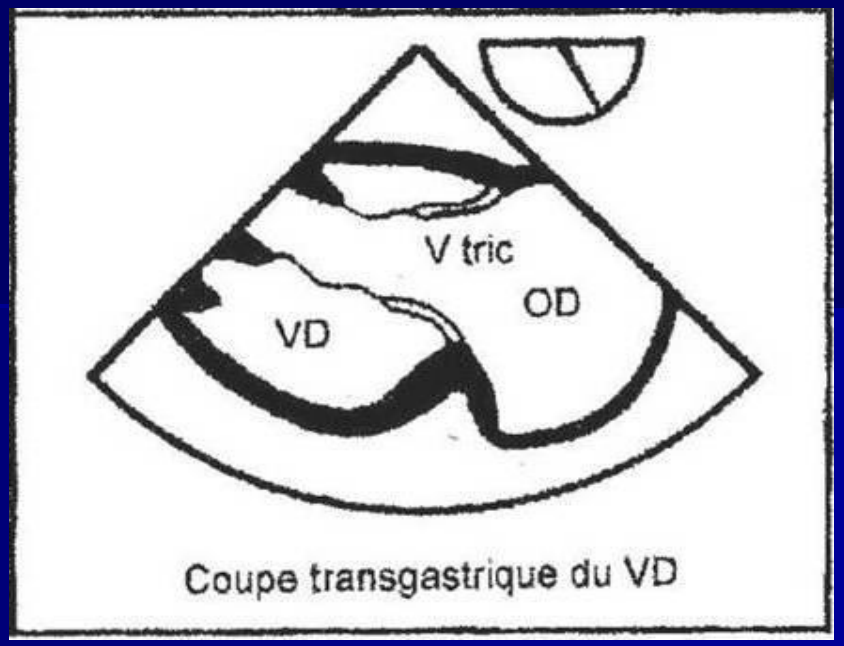
# Ventricule Droit en ETO



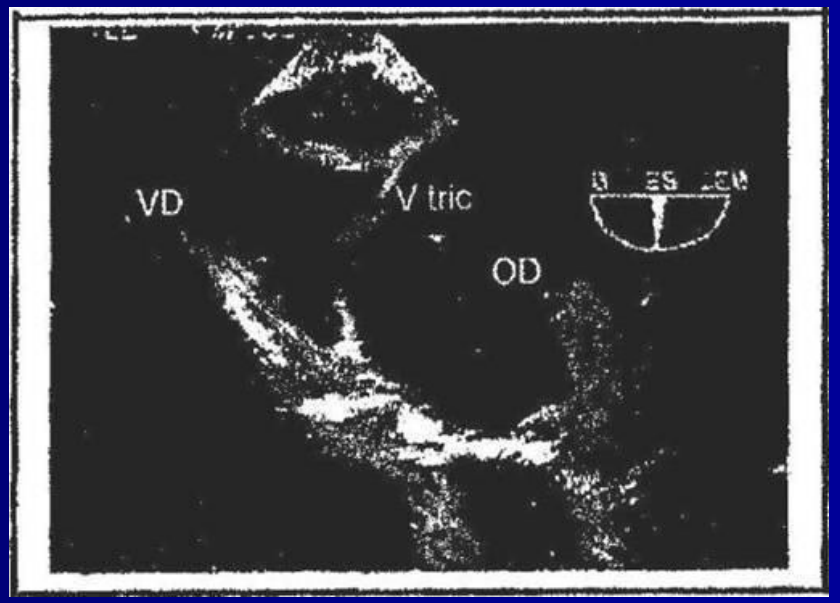
# Voie transgastrique

## 90° - 120°

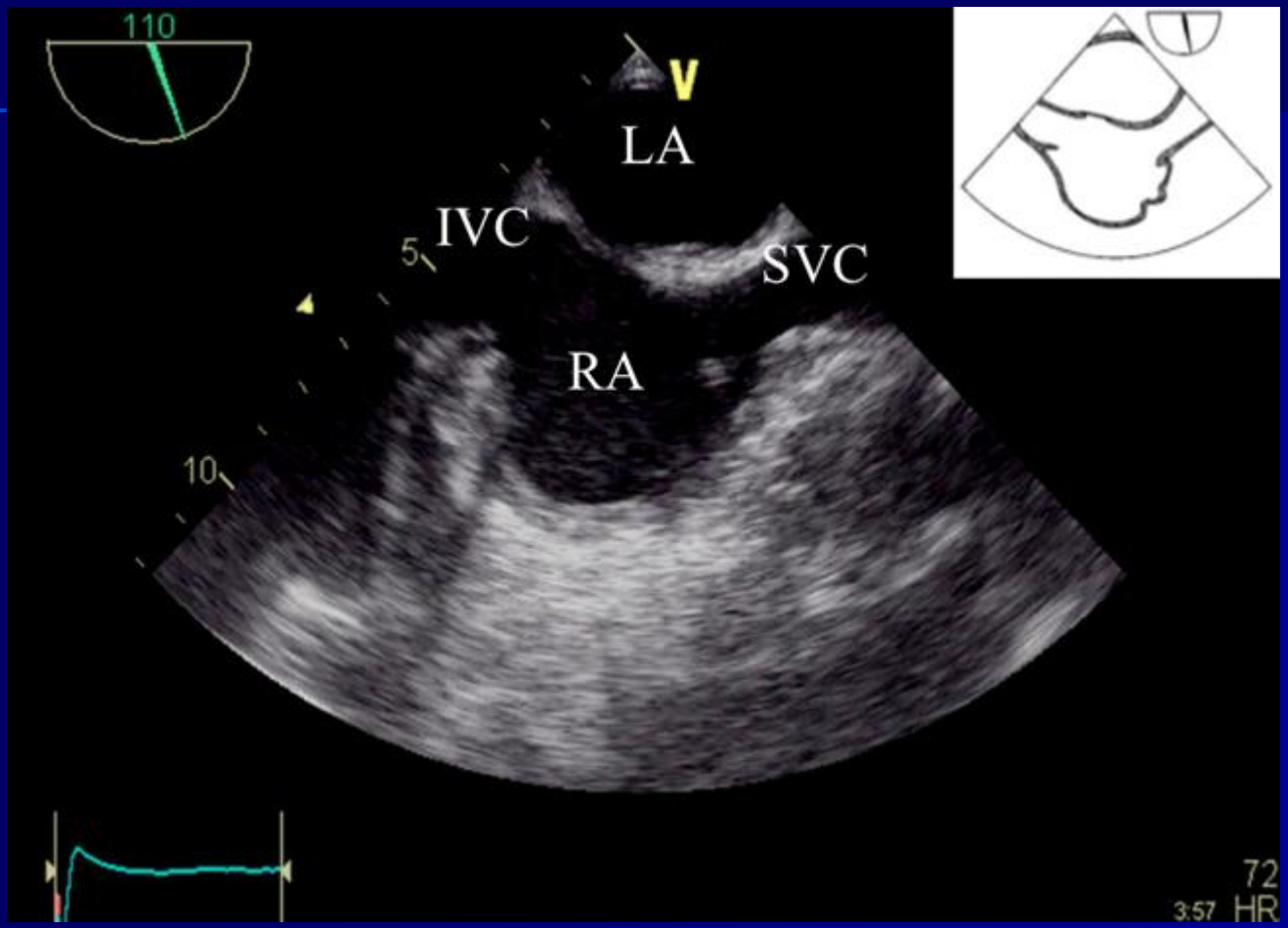





Coupe transgastrique du VD



# Coupe « Bicavale »




Œsophage Moyen, 90° rotation de 90° sens horaire

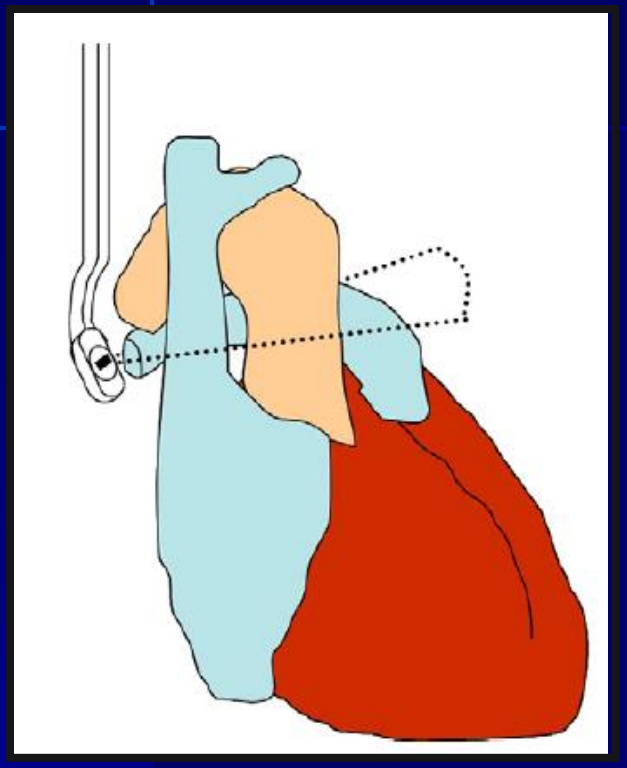
# Artère pulmonaire

**En ETT :**

**Coupe PSG petit axe**

**Coupe sous costale petit axe**

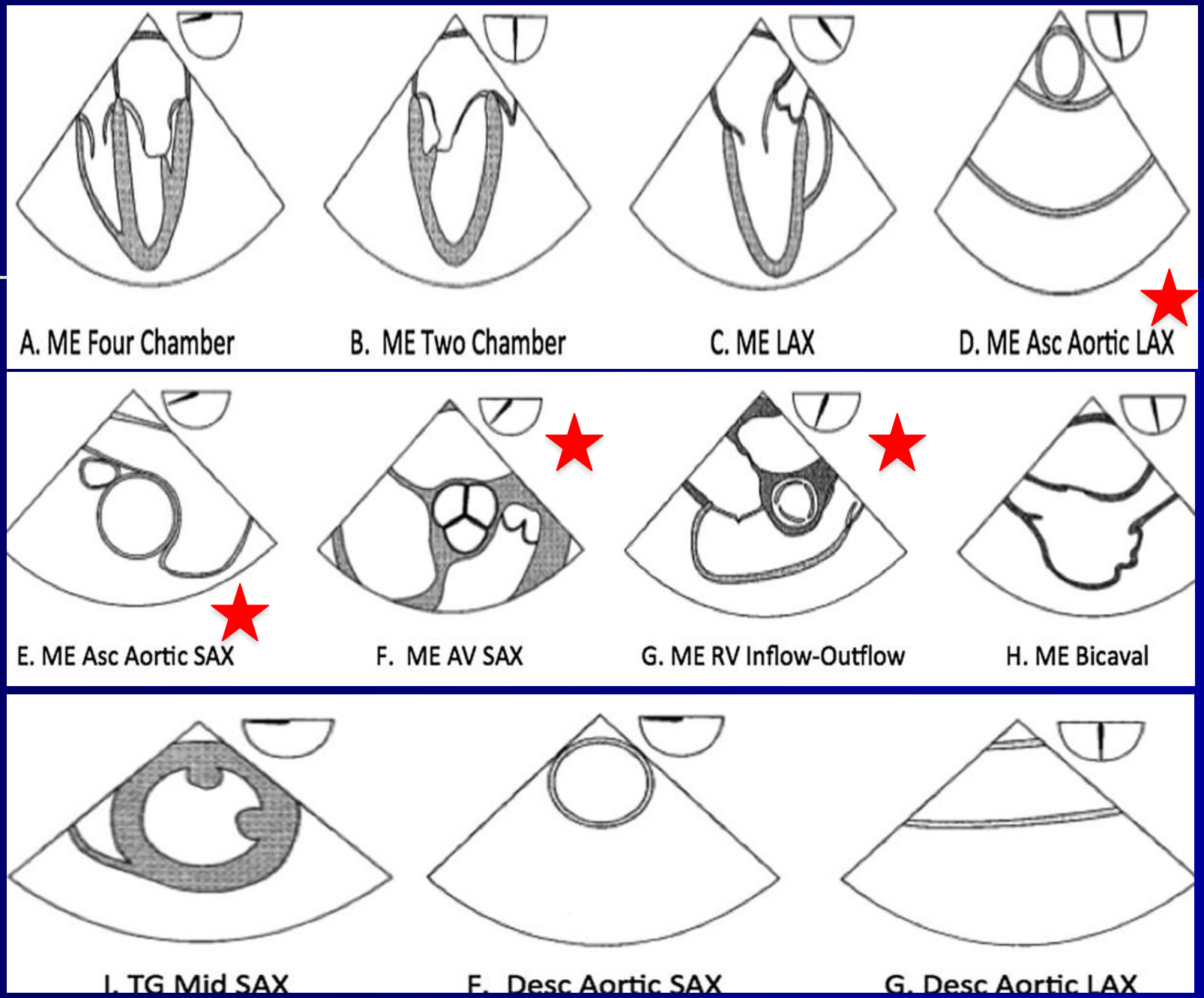
# Artère pulmonaire en ETO



**En ETO +++**

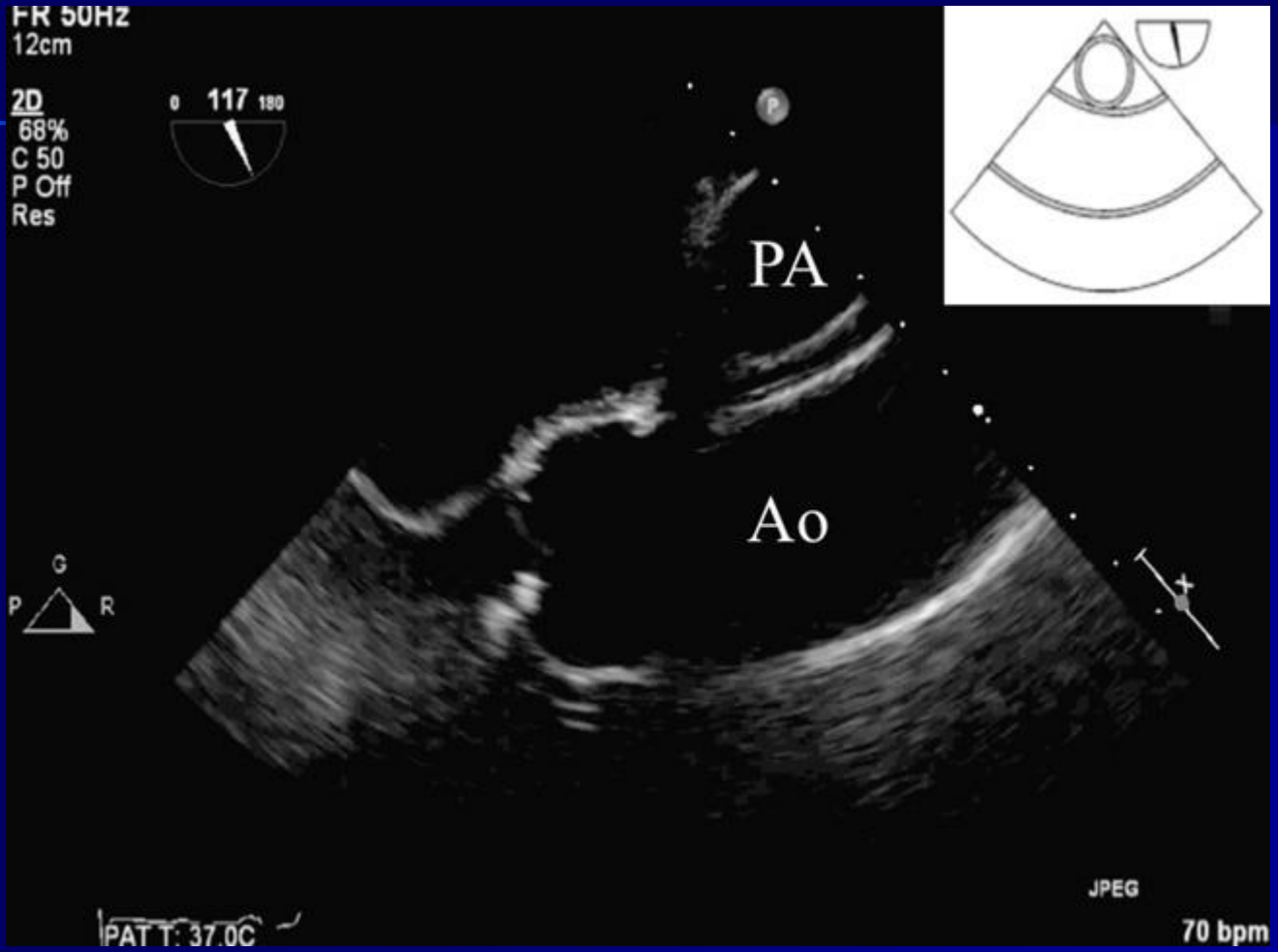
**- Partie haute de l’œsophage**

**- (15-20 cm des arcades dentaires)**



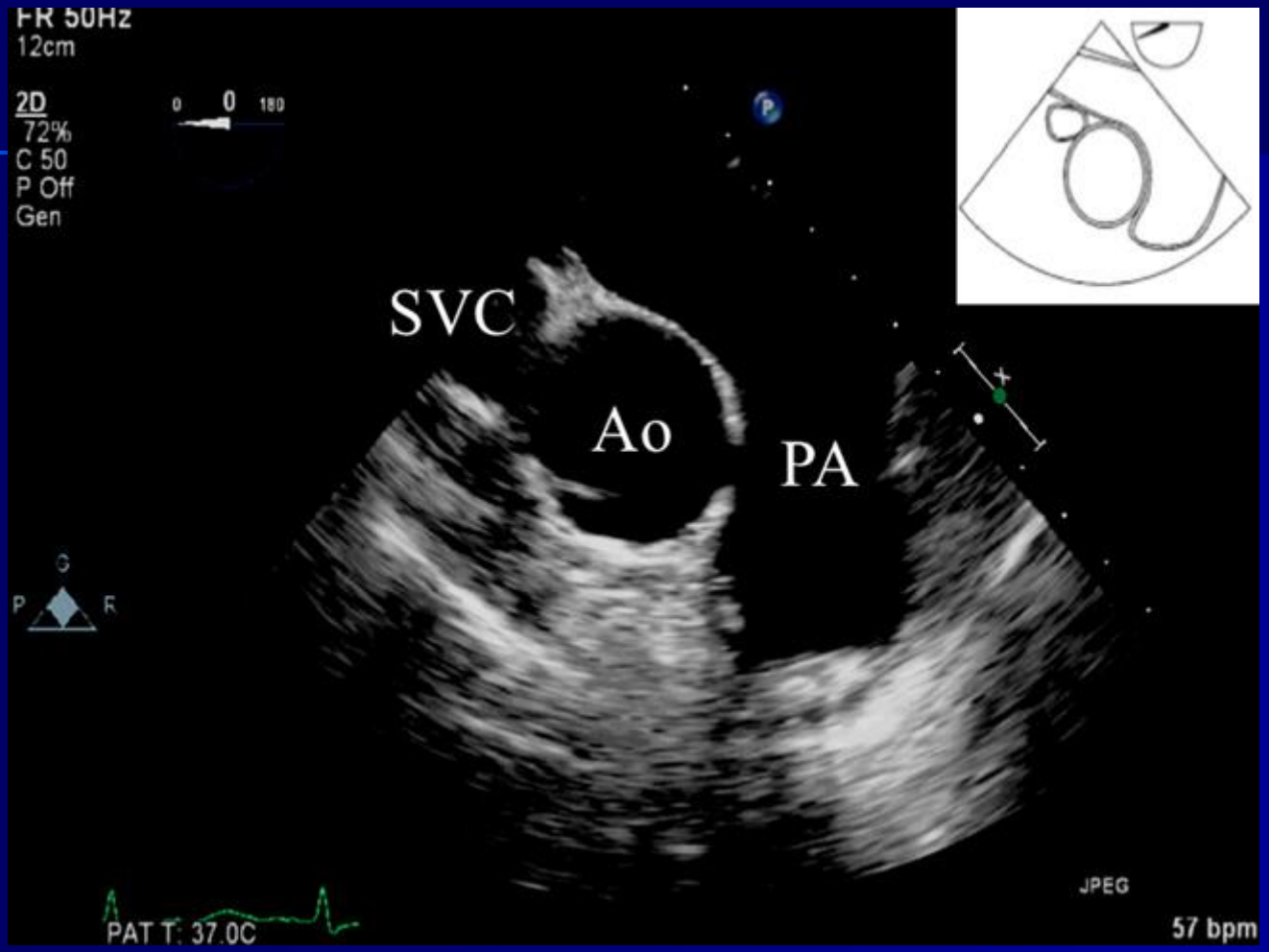

Reeves et al, J Am Society of echocardiography, 2013

# Artère pulmonaire



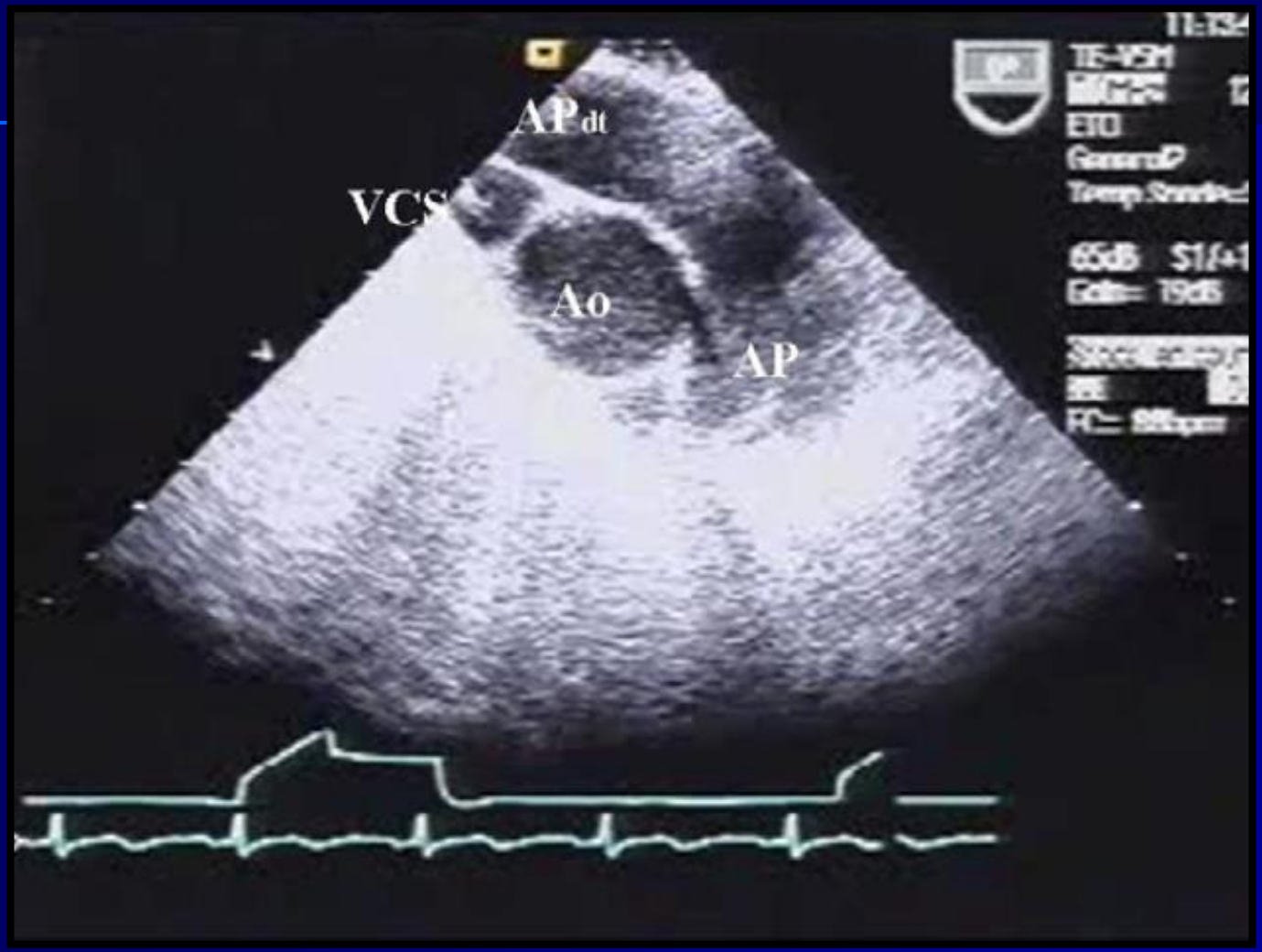

Œsophage Haut, Aorte ascendante, long axe à 120°

# Artère pulmonaire

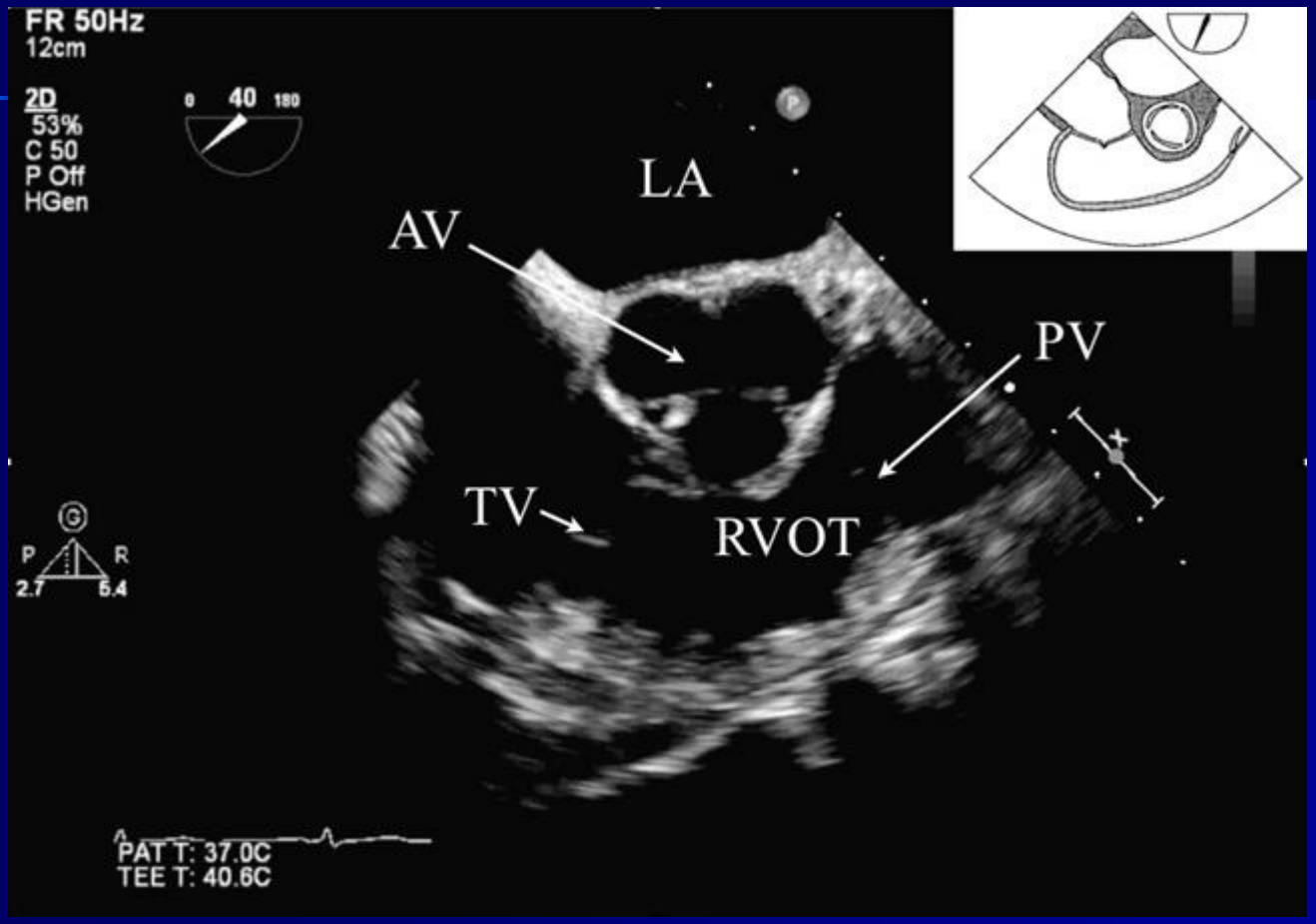



Œsophage haut, Aorte ascendante petit axe à 30°

# Artère pulmonaire

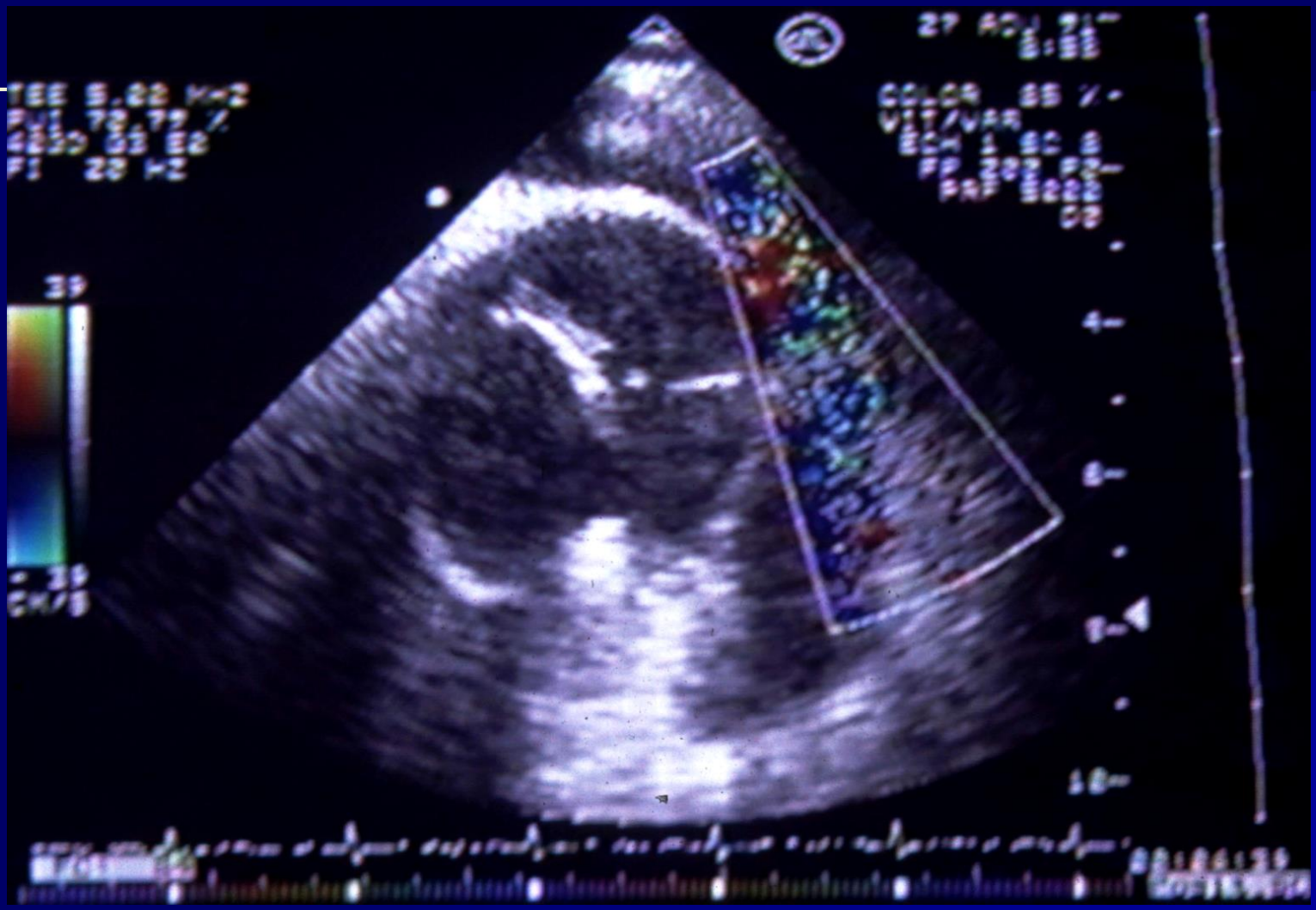


# Artère pulmonaire

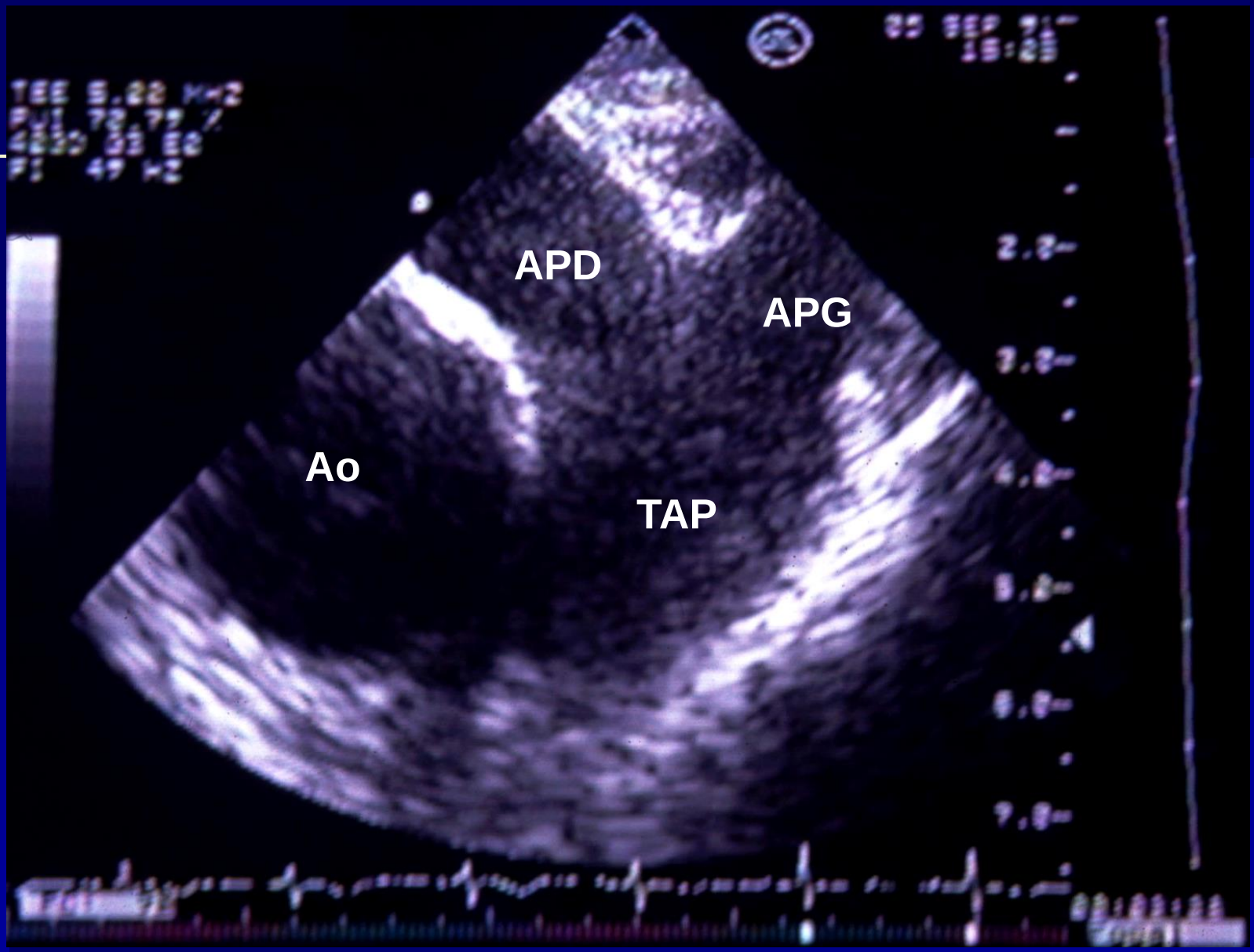



Œsophage moyen, valve aortique 30˚

# Artère pulmonaire



# Artère pulmonaire



# Fonction systolique VD

## Fraction d'éjection du VD (FEVD)

- **Méthode Simpson monoplan**
- **Méthode surface-longueur (4 cavités et sous costale pt axe)**

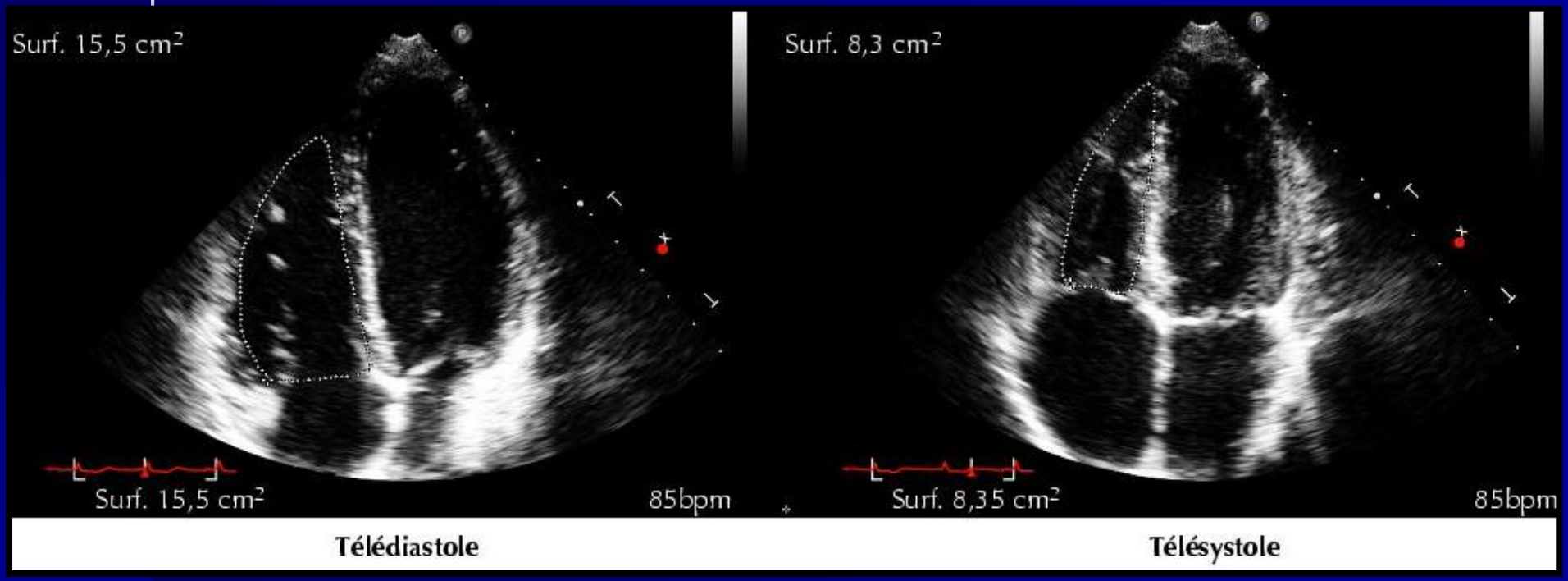
  **- Volume VD = 2/3 surface apicale x L**

## Equivalents de FEVD

- **Fraction de raccourcissement de surface**
- **Excursion systolique du plan de l'anneau tricuspide**
- **Doppler tissulaire à l'anneau tricuspide**

# Fonction systolique VD

## Fraction de raccourcissement de surface




**N = 9 ± 2,6 cm²/m²**

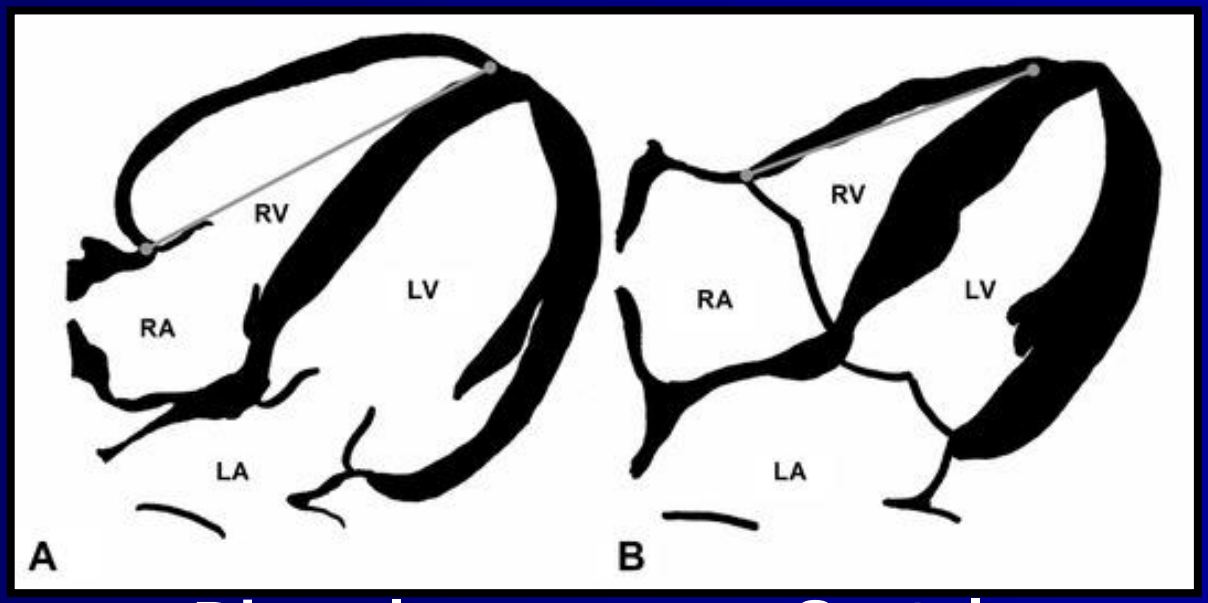
**N = 4,3 ± 1,6 cm²/m²**

**FR des surfaces apicales = 52,4 ± 11,2%**

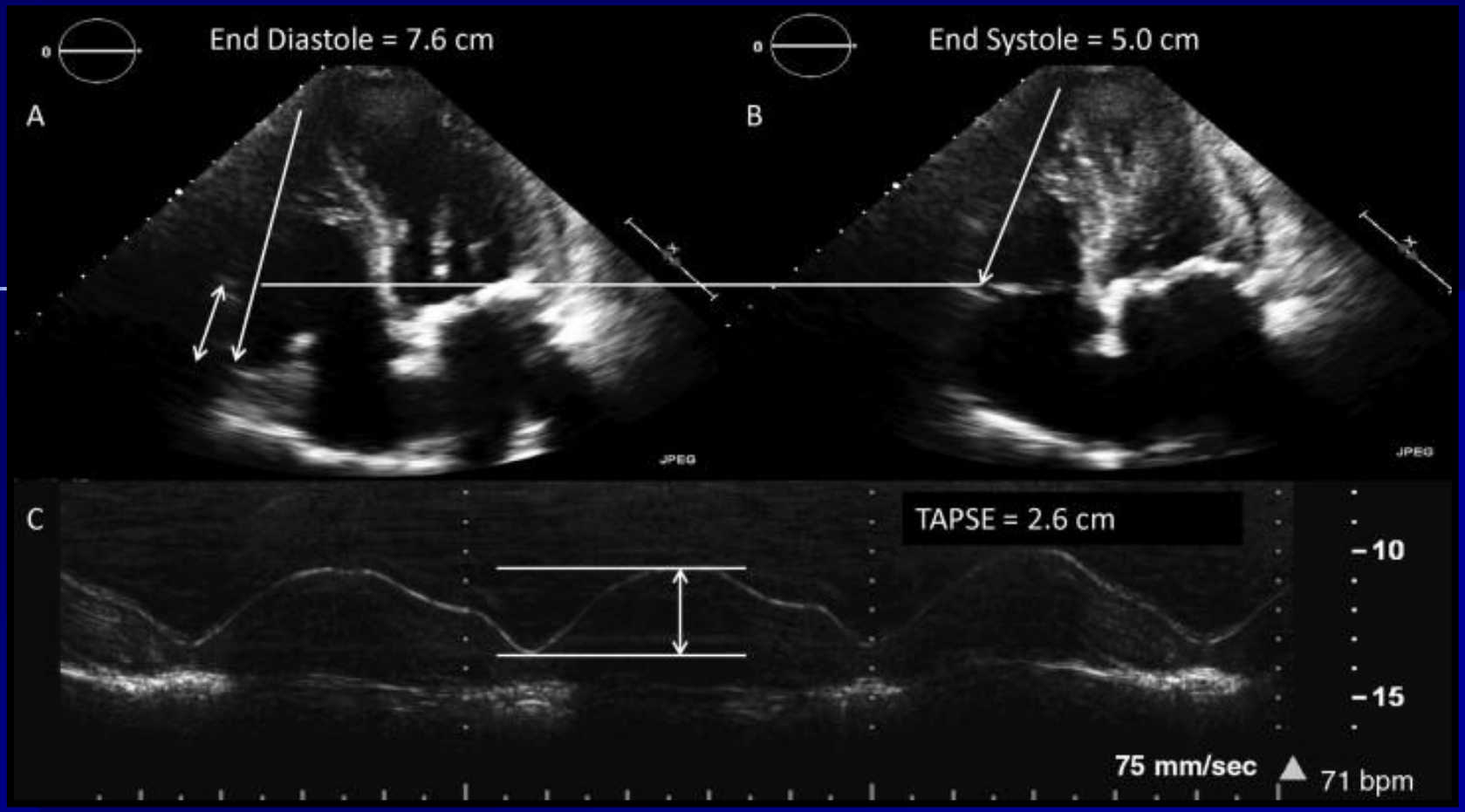
# Fonction systolique VD

**Excursion systolique du plan de l'anneau tricuspide ou TAPSE**

- ✓**Coupe apicale 4 cavités**
- ✓**Tir TM jonction anneau tricuspide-paroi libre du VD**




**Diastole** **Systole**

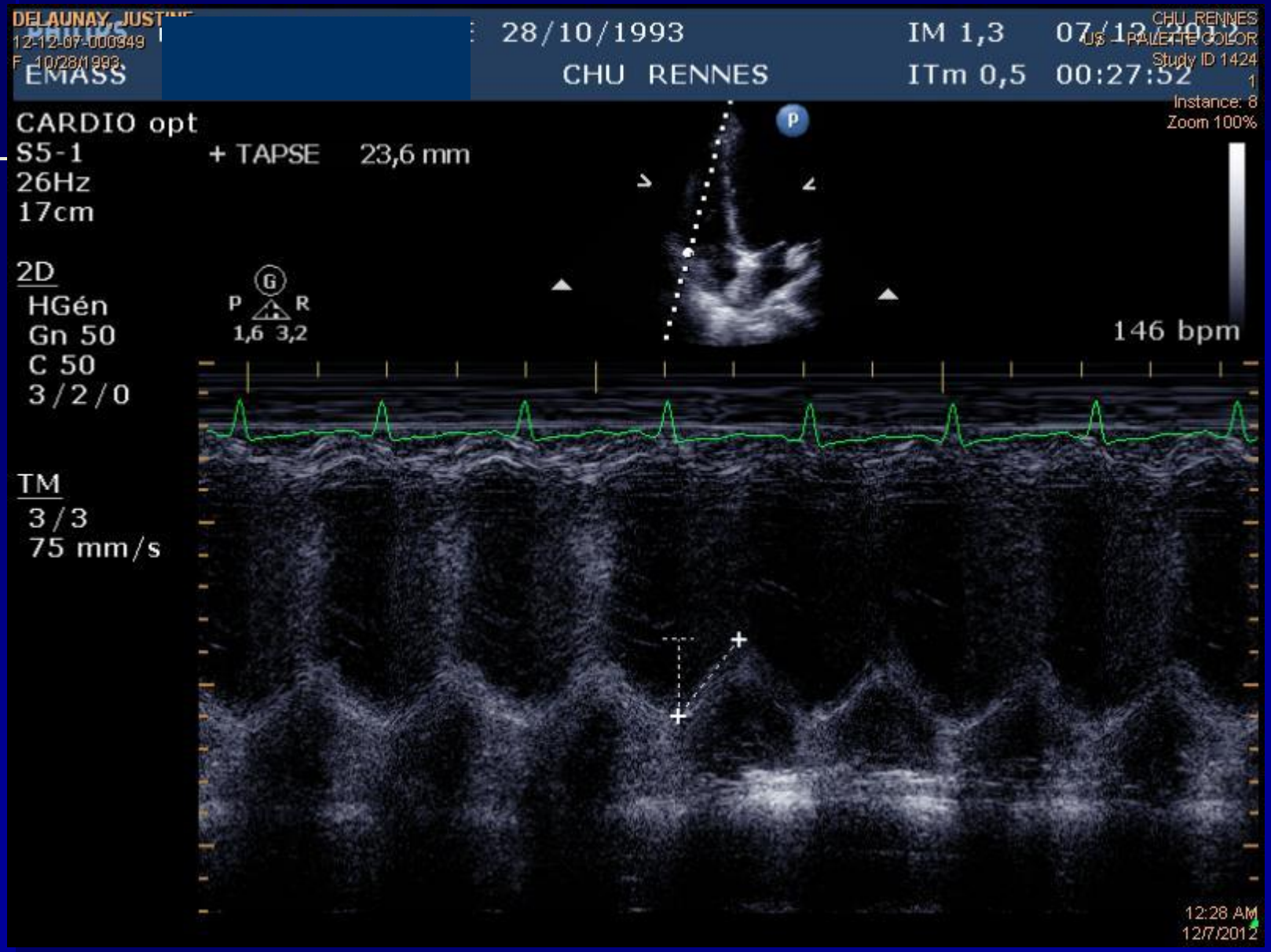



**N = 16,3 ± 0,6 mm**

**FEVD N si TAPSE > 15mm**

**Dysfonction VD si TAPSE < 12mm**

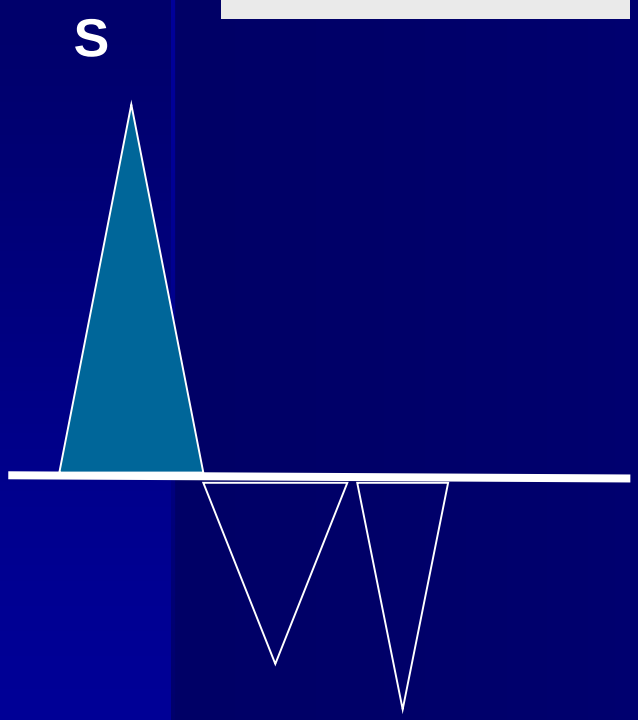
# Fonction systolique VD

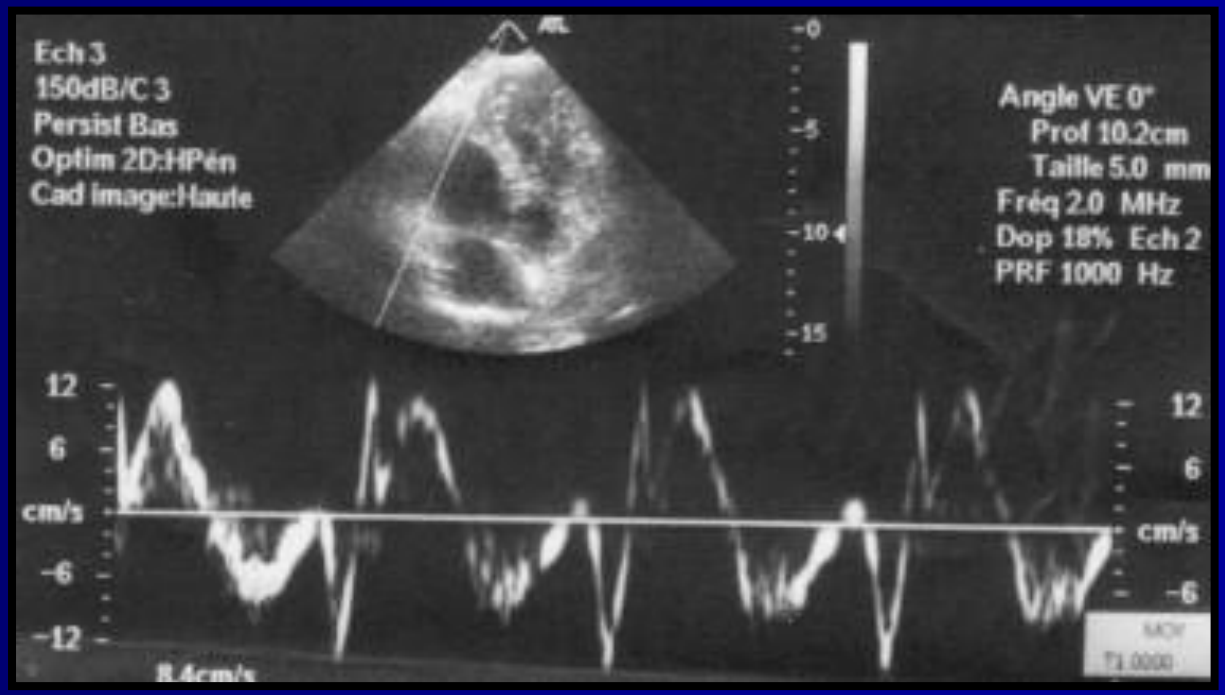


# Fonction systolique VD

## Doppler tissulaire à l'anneau tricuspide

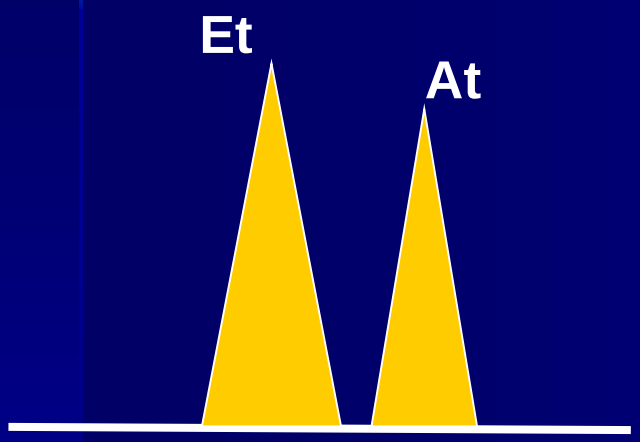
**N ≥ 12 cm/s**



# Fonction diastolique VD

## Flux Tricuspide




- Rapport Et/At > 2
- TDE t court

- Dysfonction diastolique VD
- Cardiopathie restrictive VD

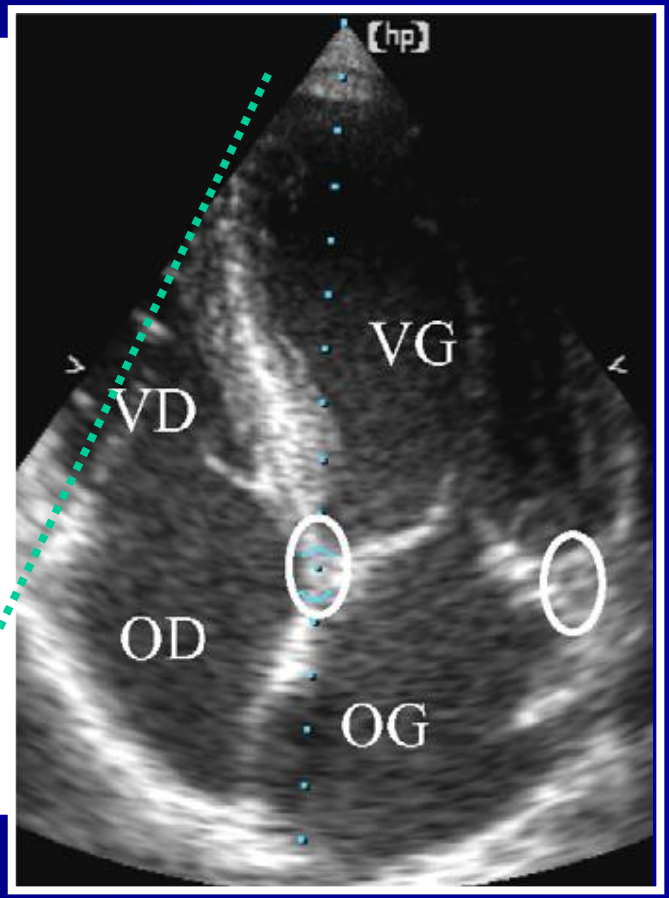
*Appleton, Am J Cardiology, 1998*

# Doppler pulsé tissulaire (DTI) à l'anneau tricuspide

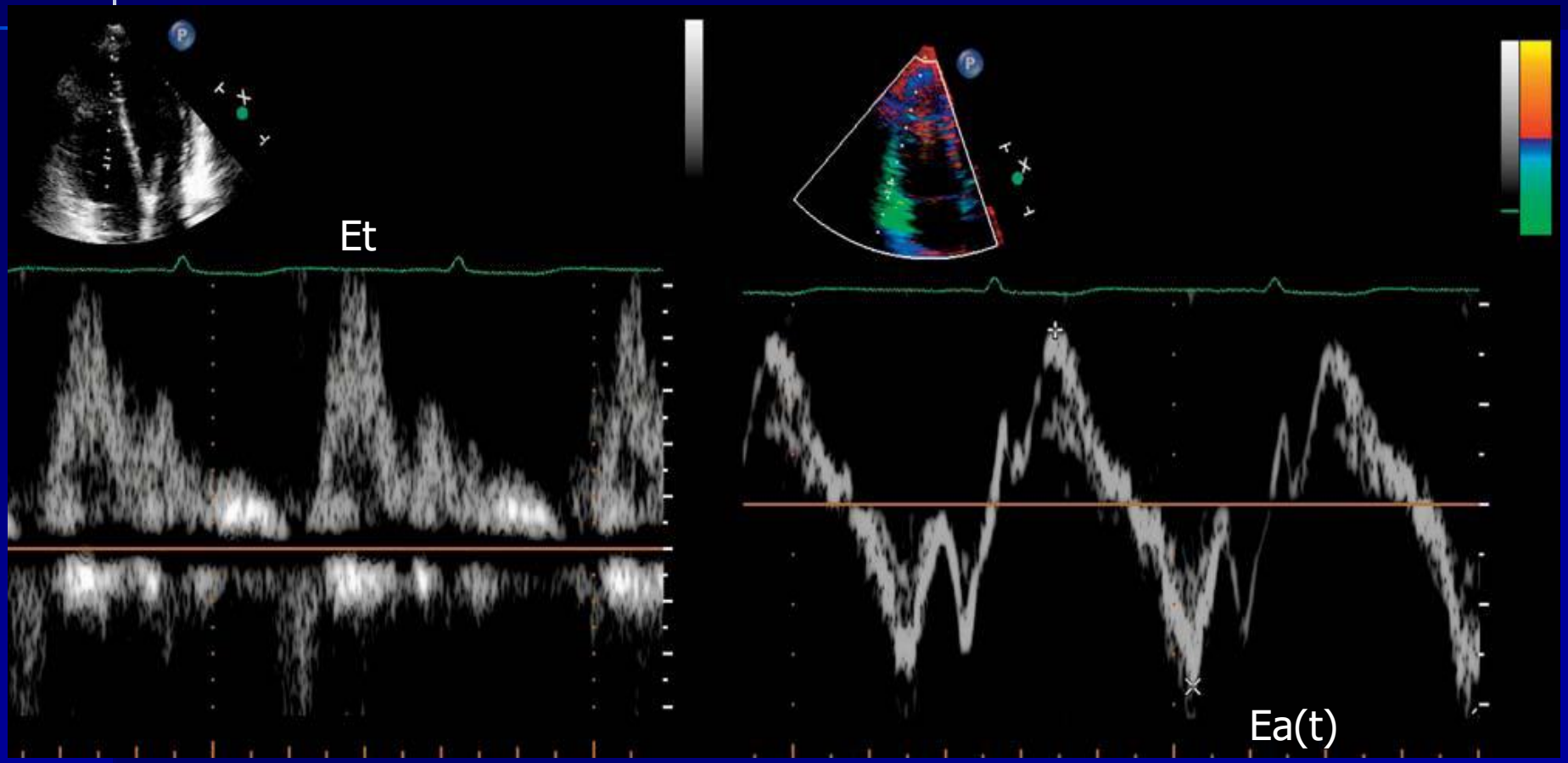
- Coupe apicale 4 cavités
- Doppler Pulsé Tissulaire
- Vitesse de déplacement

de l'anneau tricuspide

- Versant latéral

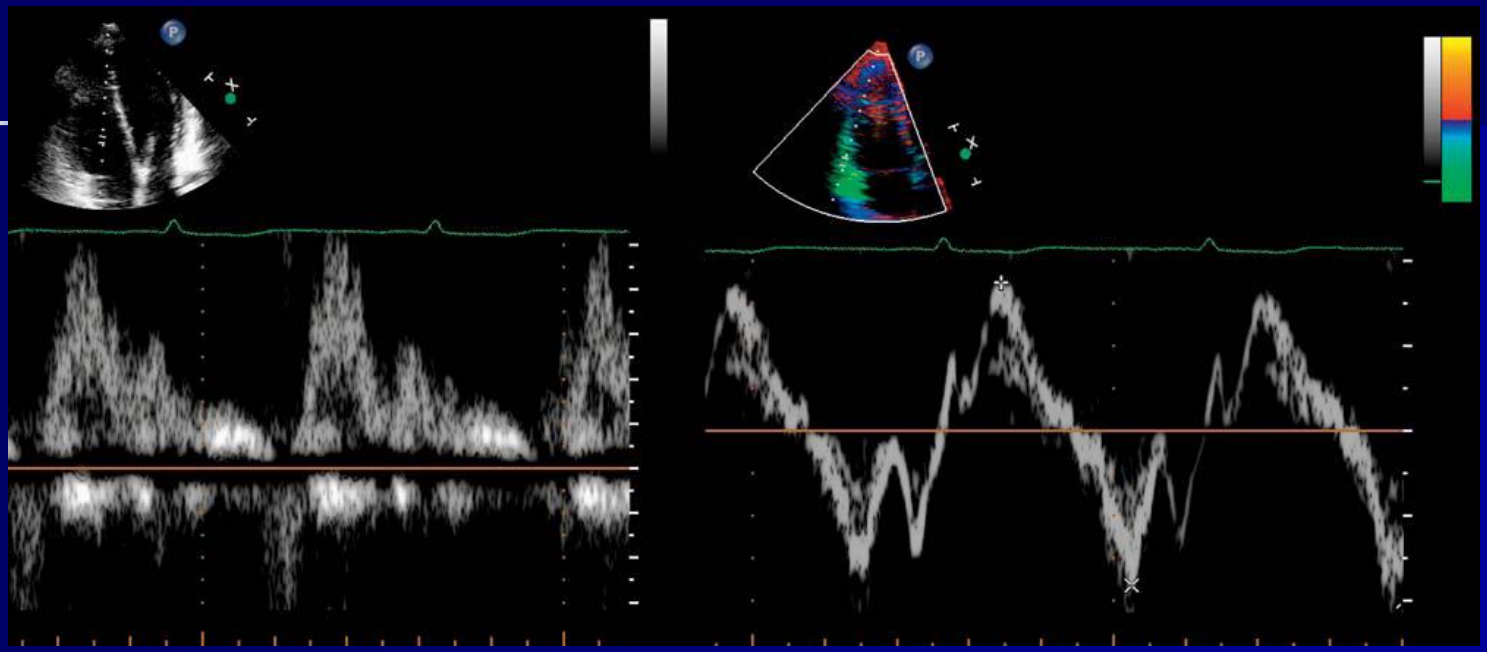


# DTI anneau tricuspide



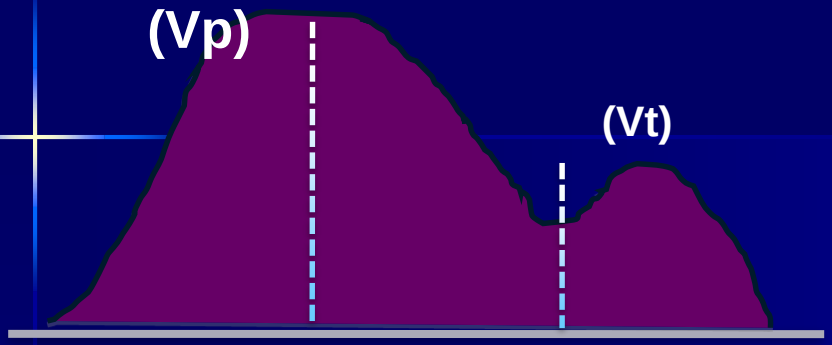

Et/Ea(t) =100/20<6 : pas d'augmentation des pressions de remplissage VD

# DTI anneau tricuspide

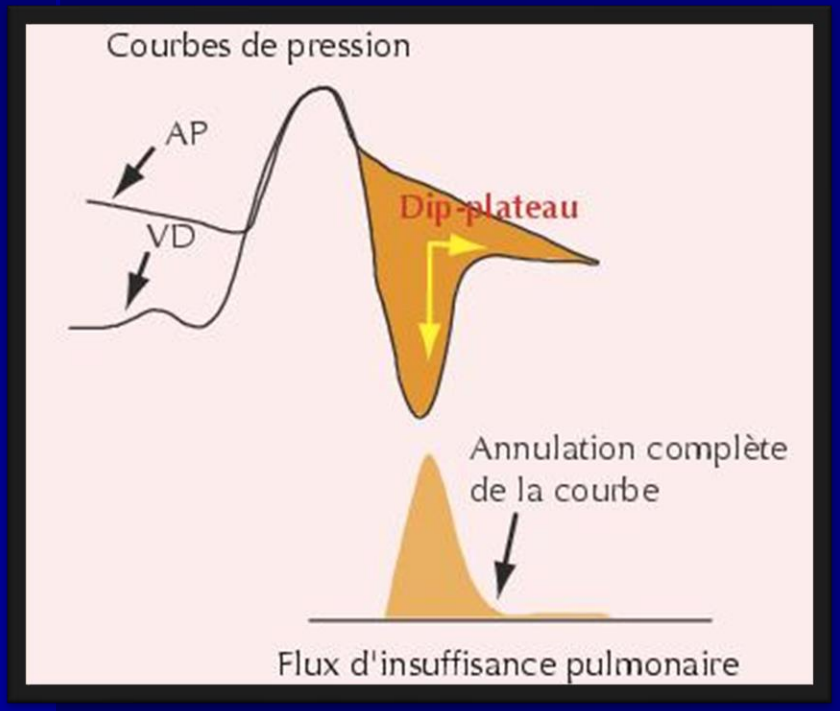


- Rapport Et/Ea > 6 → PR VD augmentées POD>10 mmHg
- Attention !
  - Mauvaise reproductibilité ++
  - Limites

# Fonction diastolique VD



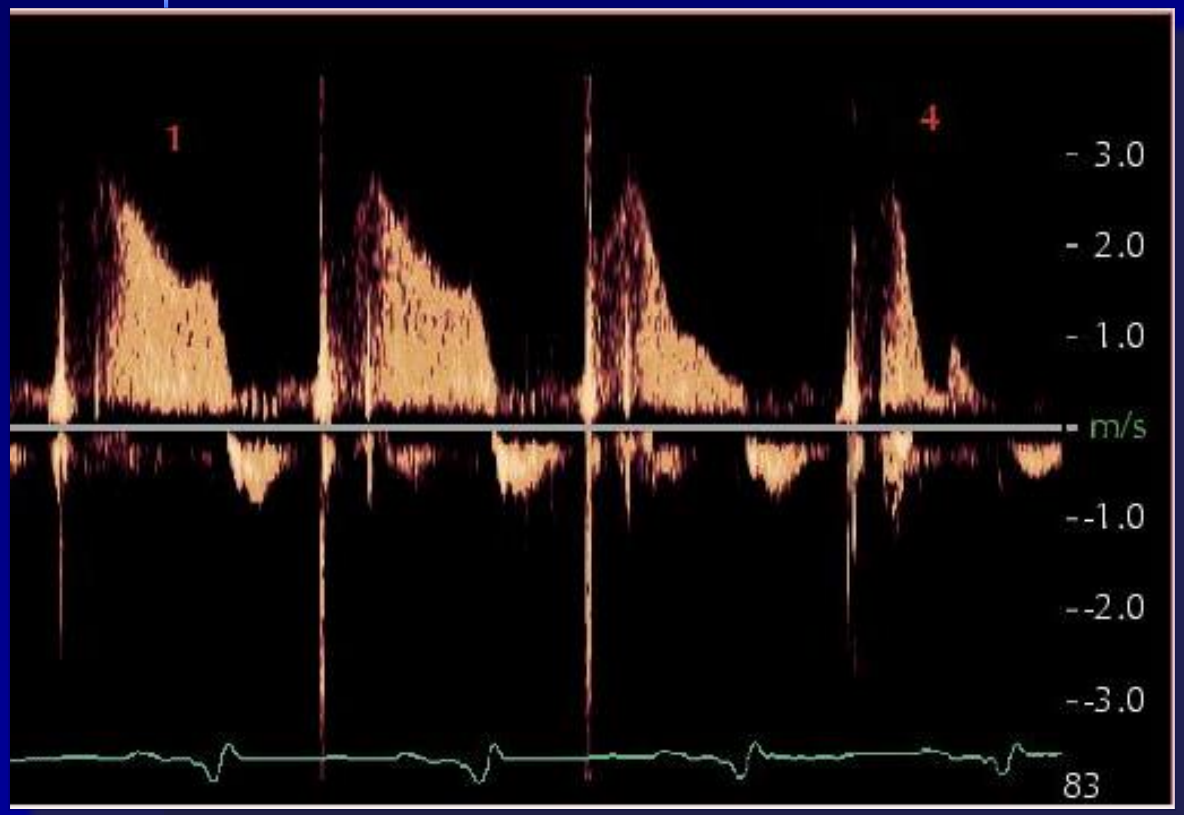

- Flux d'IP normal




- PSG Pt axe
- Doppler continu
- Aspect de dip plateau

# Fonction diastolique VD

**Flux d'insuffisance pulmonaire**




- PSG Pt axe
- Doppler continu
- Aspect de dip plateau

# Fonction diastolique VD

## Flux veineux cave

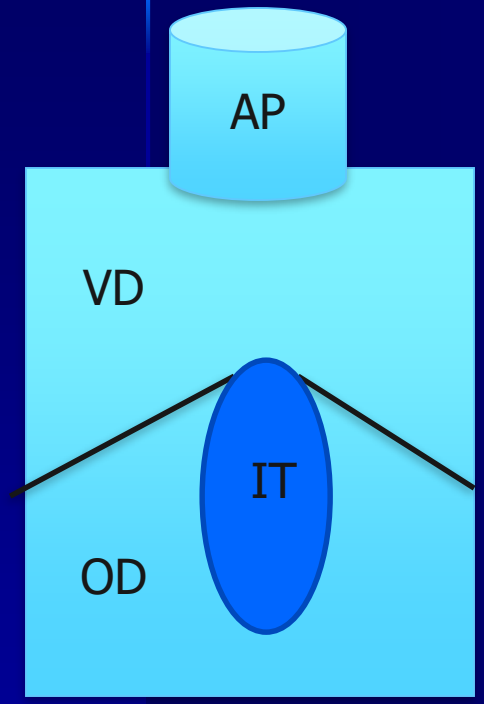
- Flux veineux Cave sup en sus-claviculaire droite en ETT ou coupe « bicavale » en ETO
- Doppler pulsé
- 3 types de flux

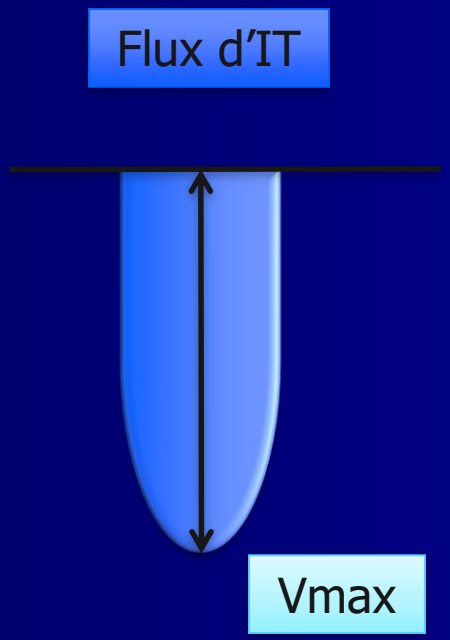
## Flux veineux sus-hépatique

- intérêt de la Fraction systolique du flux veineux sus-hépatique
- ITV S / ITV S ITV D < 0,55 → POD > 8 mmHg

# Evaluation de la PAP

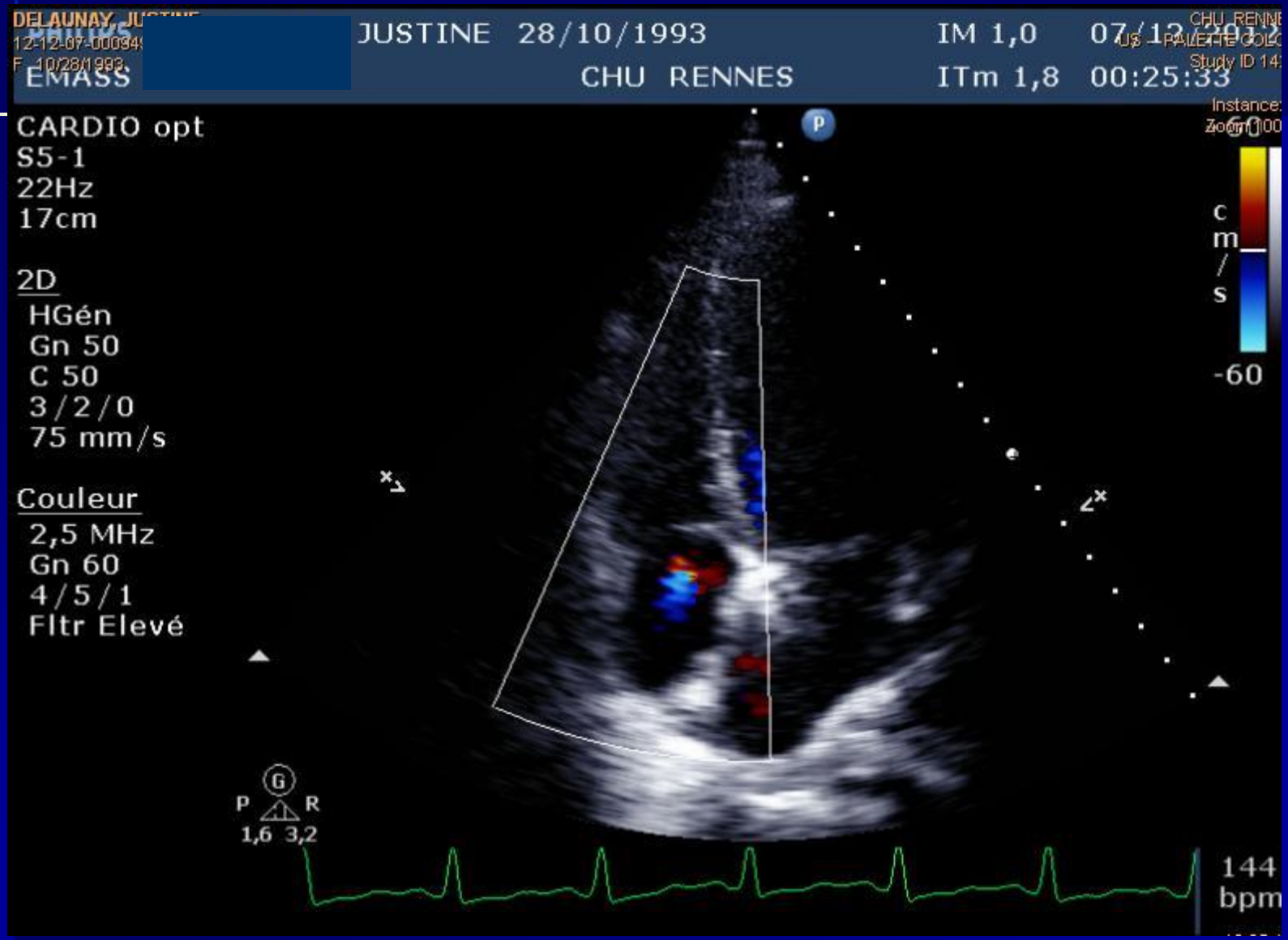
## Méthode de l'insuffisance tricuspide



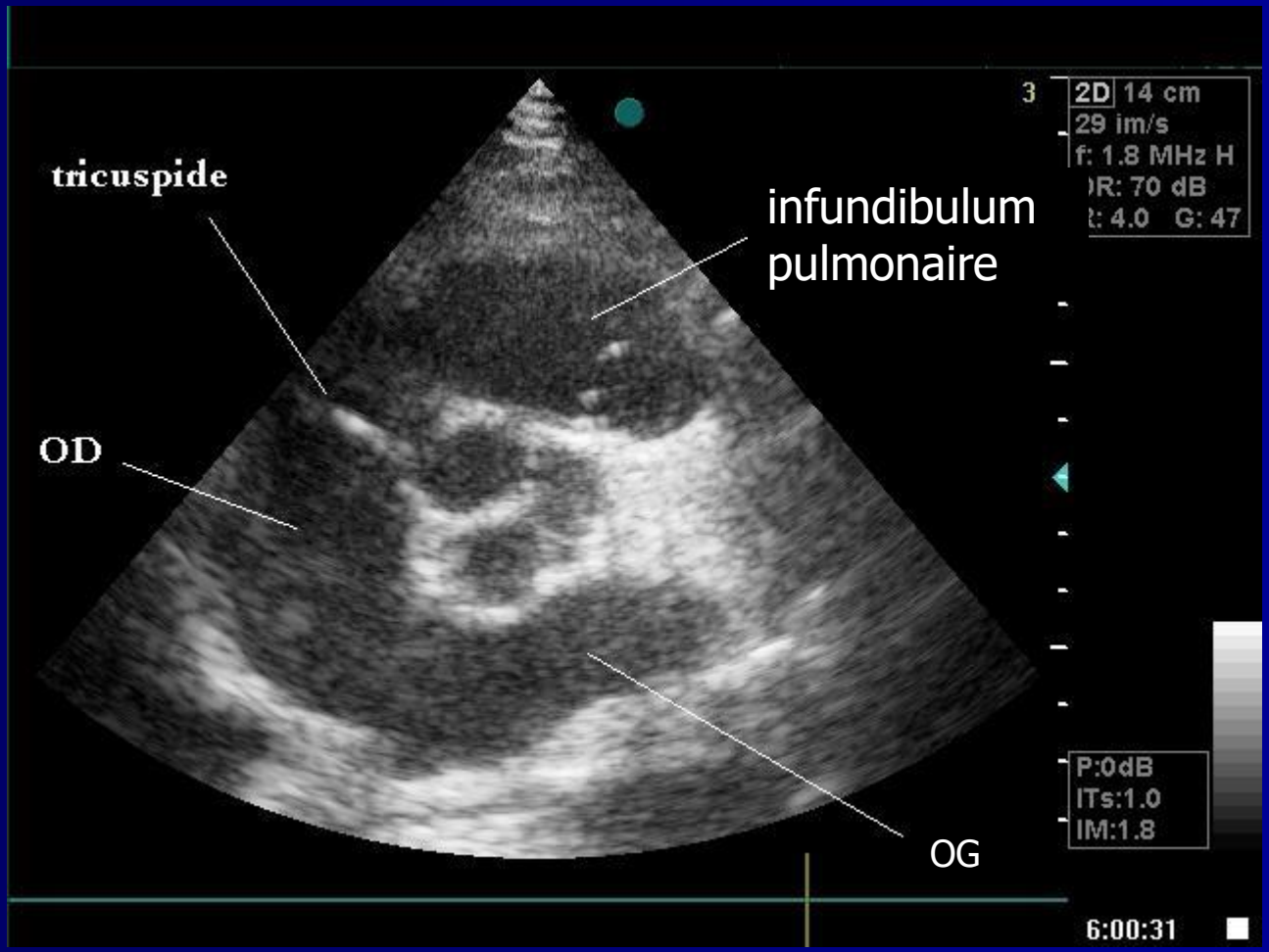




- Gradient VD-OD = $4V^2$
- PSVD = $4V^2$ + POD
- PAPS = $4V^2$ + POD

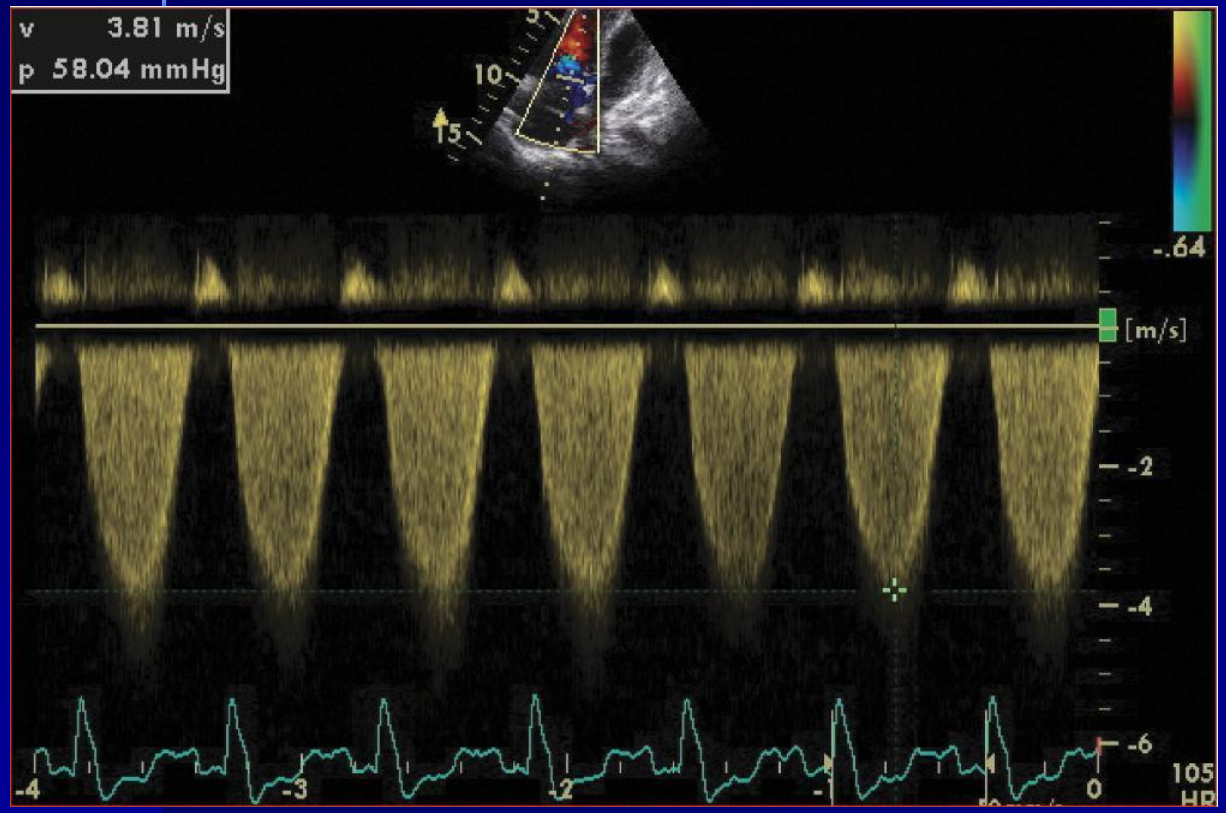
# Coupe Apicale 4 cavités



# Ou Coupe Para sternale Gauche Petit Axe



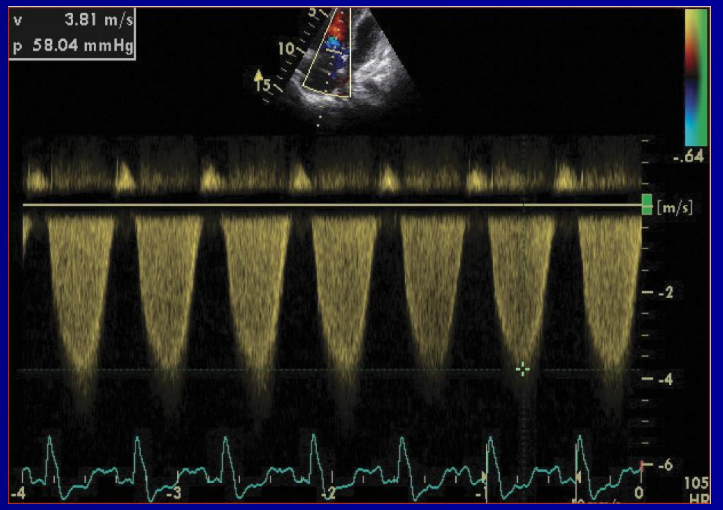
# Analyse du Flux d'insuffisance tricuspide




- Coupe Apicale 4 cavités +++
- Repérage doppler couleur d'une IT
- Doppler continu
- Filtres max
- Vitesse 100 mm/s

# Méthode de l'insuffisance tricuspide Limites et erreurs

- Confusion IT/autre flux
- Alignement imparfait flux d'IT/ faisceau US
- ACFA
- Variation respiratoires de la vitesse du flux d'IT
- Sténose valvulaire pulmonaire
- IT laminaire : estimation invalide!
- Pas d'IT
- Mauvaise estimation de la POD

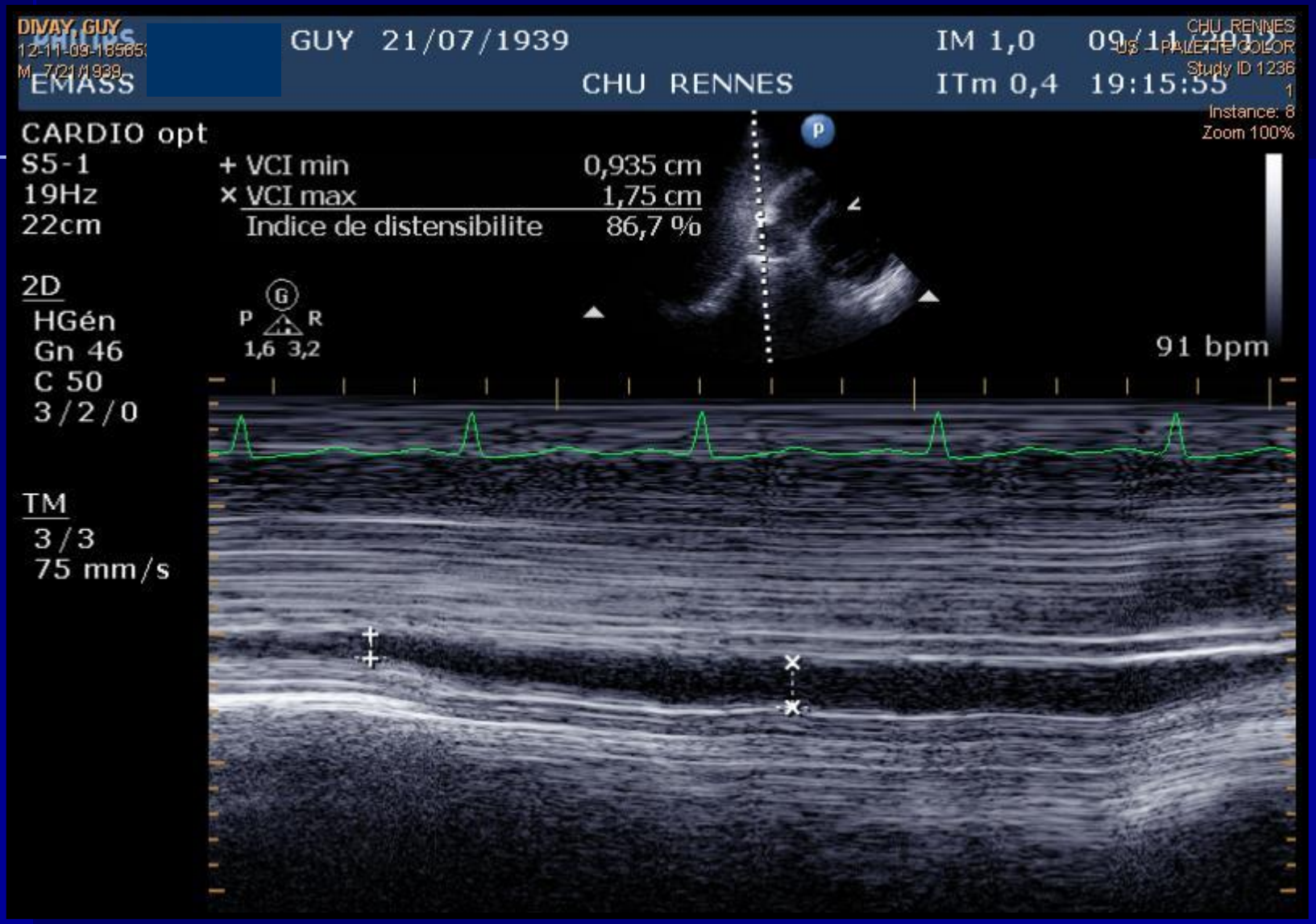


# Estimation de la POD

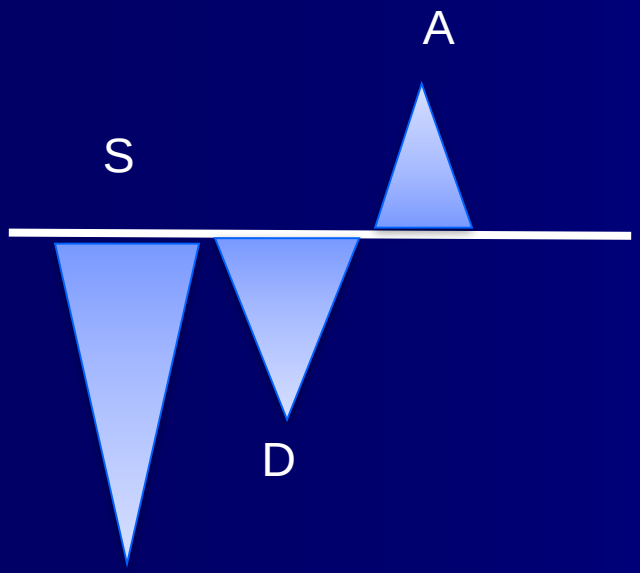
- Variations respiratoires de la VCI
- Flux veineux sus-hépatique
- Doppler tissulaire anneau tricuspide

# Avec la Veine Cave Inférieure (VCI)

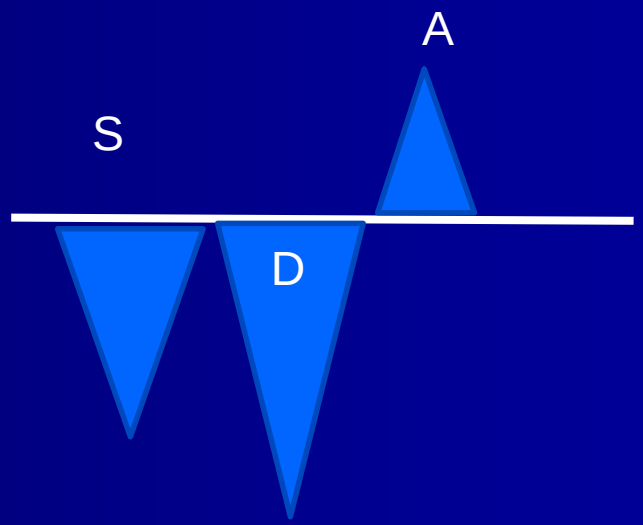
- Arbitrairement = 10 mmHg
- Collapsus inspiratoire en VS
  - < 50 % → 15 mmHg
  - > 50 % → 5 mmHg
- Diamètre VCI non fiable
- Influence de la position du patient
- Indice de distensibilité en Ventilation contrôlée (Dmax-Dmin/Dmin < 18%)


DIVAY, GUY
M 7/21/1939
EMASS
GUY 21/07/1939
CHU RENNES
IM 1,0
ITm 0,4
19:15:55
CHU RENNES
PALETTE COLOR
Study ID 1236
Instance: 8
Zoom 100%
CARDIO opt
S5-1
19Hz
22cm
+ VCI min 0,935 cm
× VCI max 1,75 cm
Indice de distensibilite 86,7 %
2D
HGén
Gn 46
C 50
3/2/0
P G R
1,6 3,2
91 bpm
TM
3/3
75 mm/s

# Avec le Flux veineux sus hépatique




**Flux veineux normal**




**Elévation de la POD**

**Fraction systolique =**
**(ITV onde S) / (ITV onde S + ITV onde D) x 100**
**FS < 55 → POD > 8mmHg**

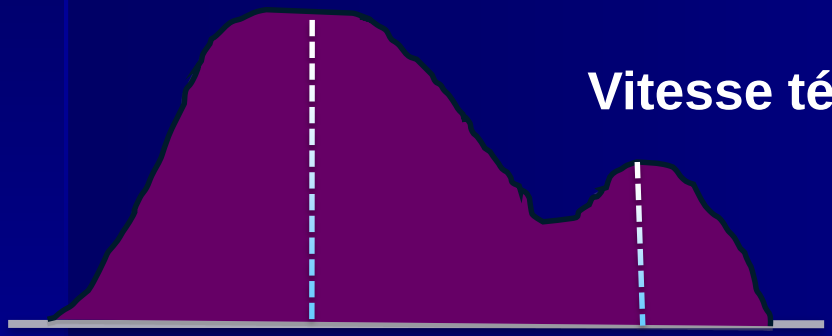
# Avec le Doppler tissulaire à l'anneau tricuspide

- E/Ea (tricuspide) > 6 → POD > 10 mmHg
  - Patient ventilé, absence de sous costale
  - 1 seule étude, manque de validité
  - ACFA?
  - PM?

# Evaluation de la PAP

## Méthode de l'insuffisance pulmonaire

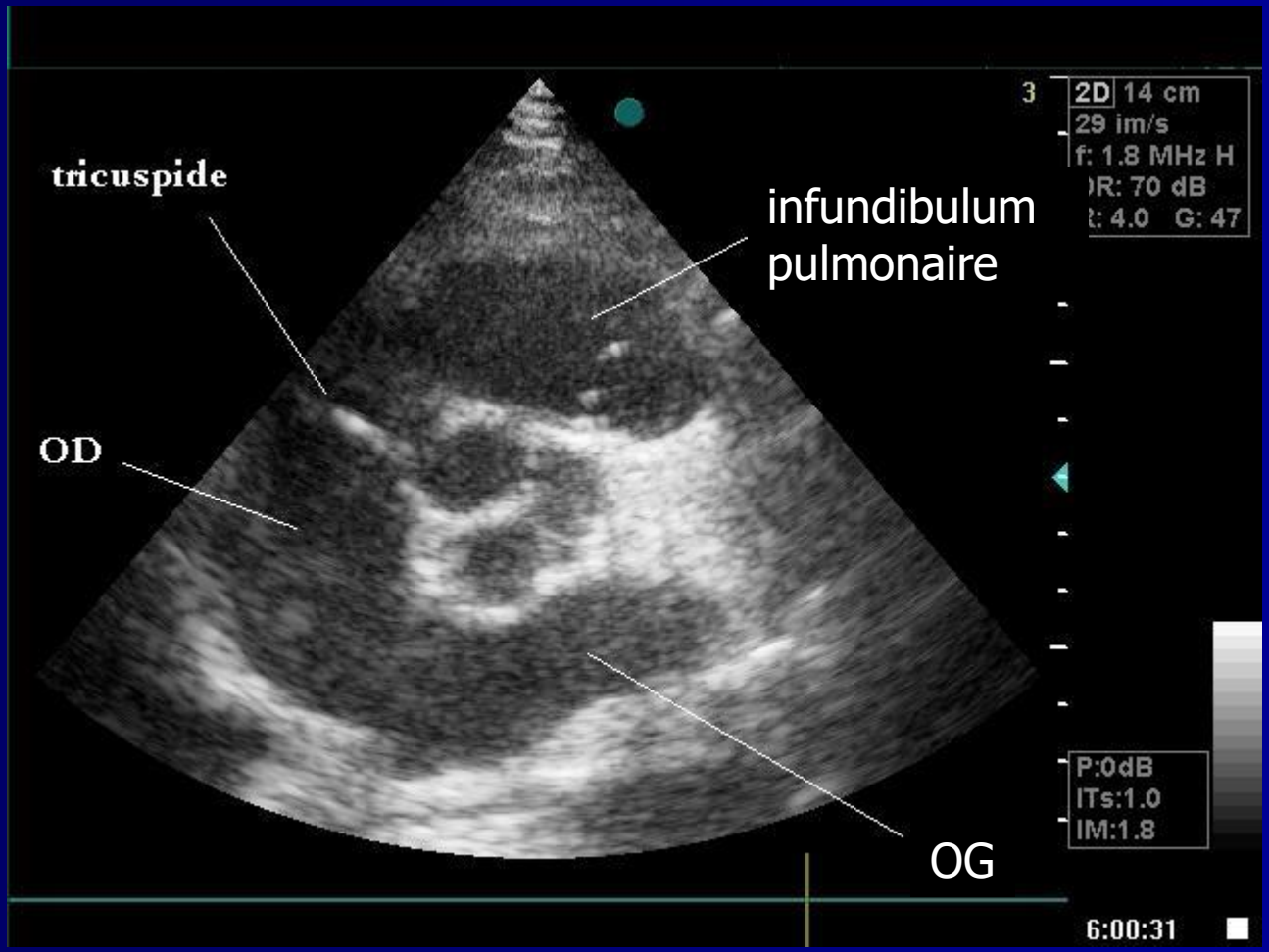
Vitesse protodiastolique (Vp)



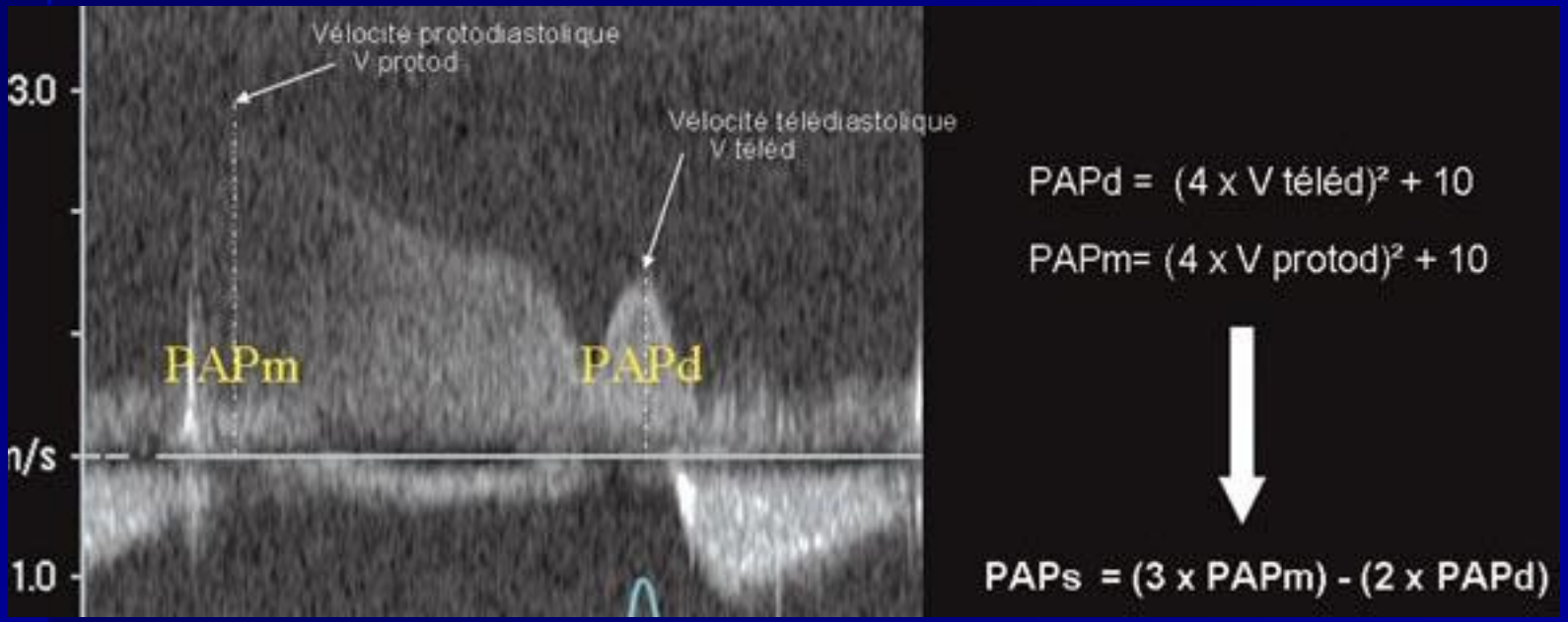
Vitesse télédiastolique (Vt)

- Coupe PSG PA
- Sous costale transversale
- Repérage en doppler couleur
- Doppler couleur
- N Vp < 1,2 m/s et Vt < 2 m/s

# Avec une coupe Para sternale Gauche Petit Axe



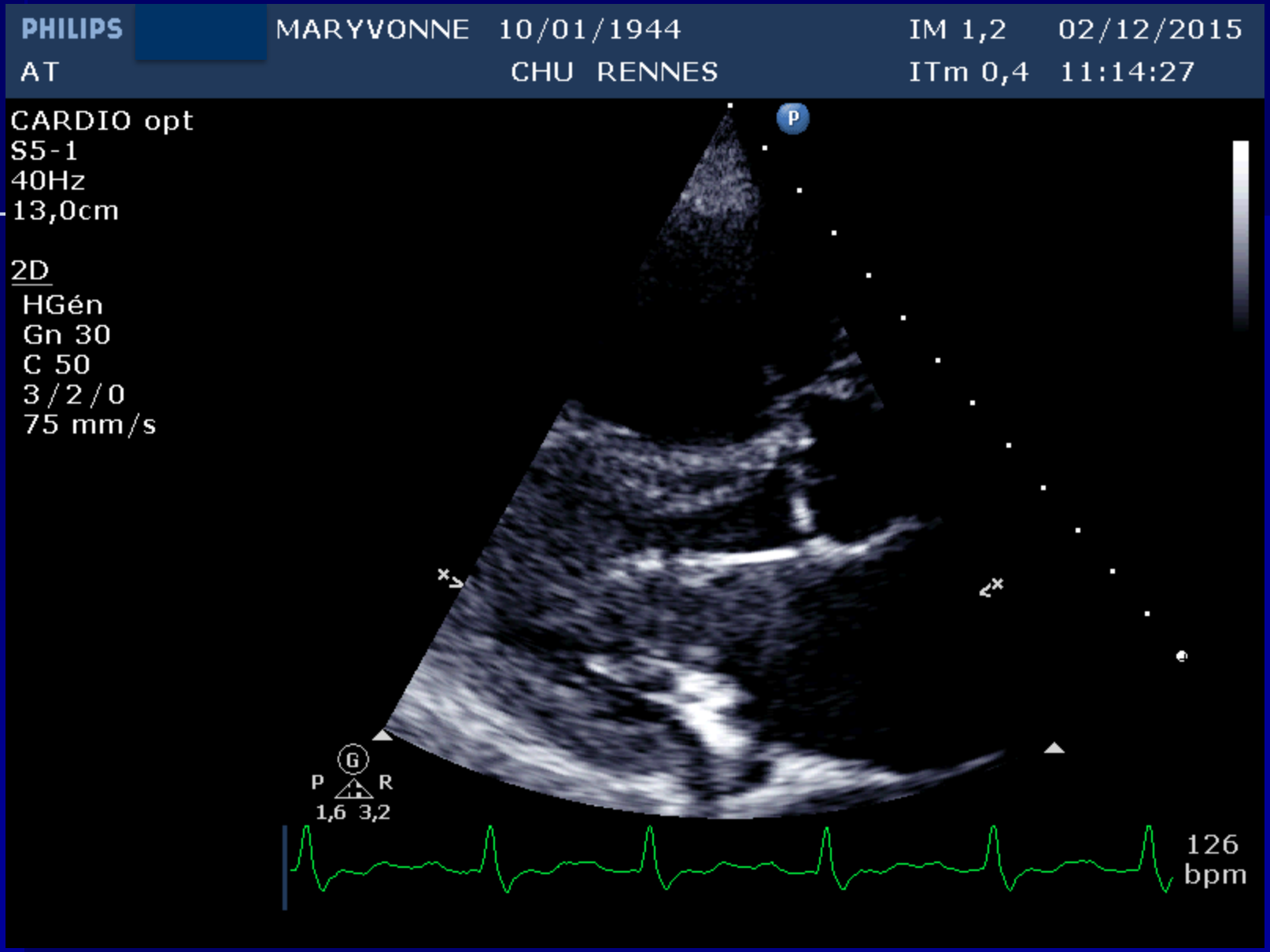
# Tir doppler continu sur le flux d'IP

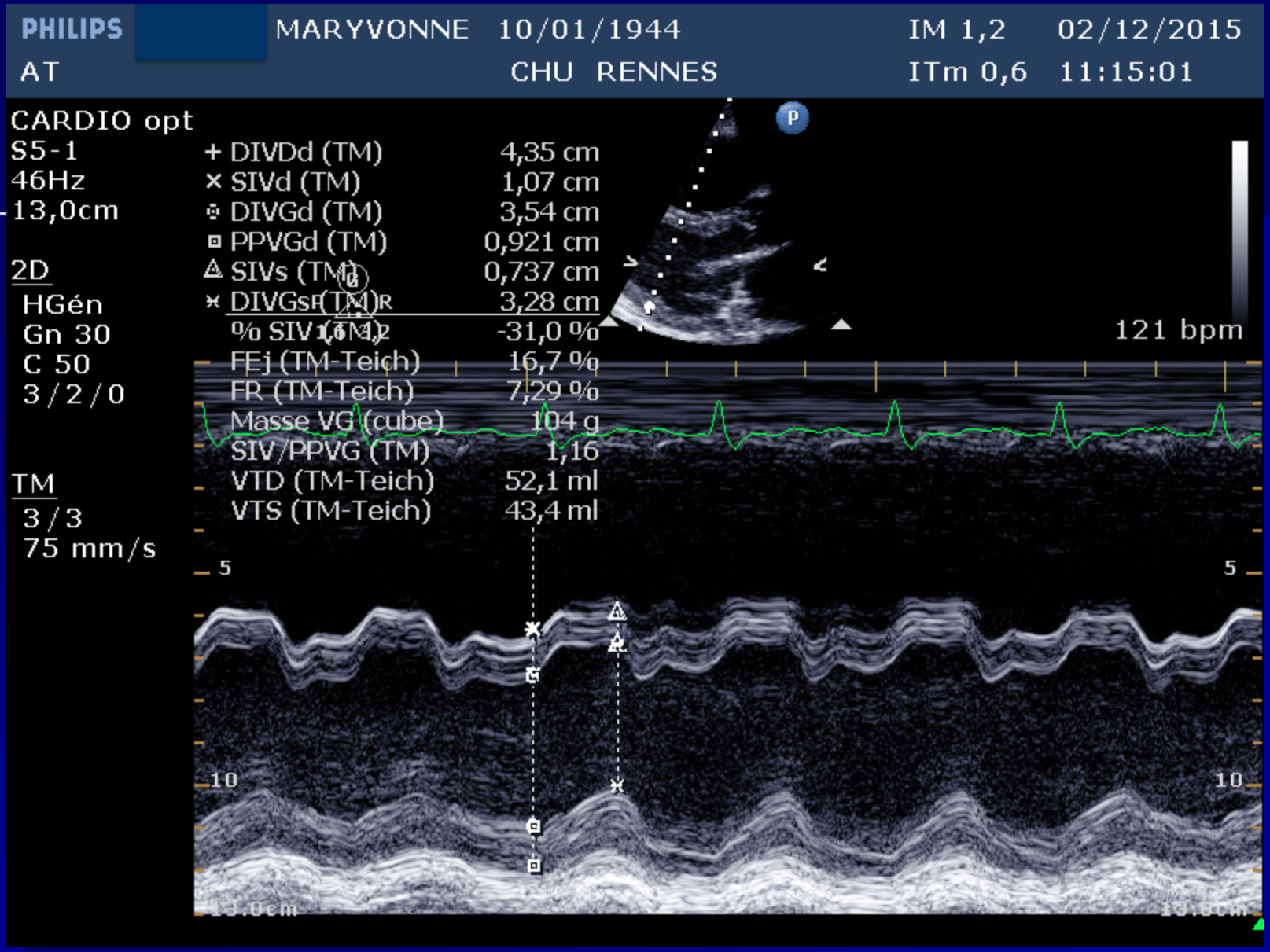


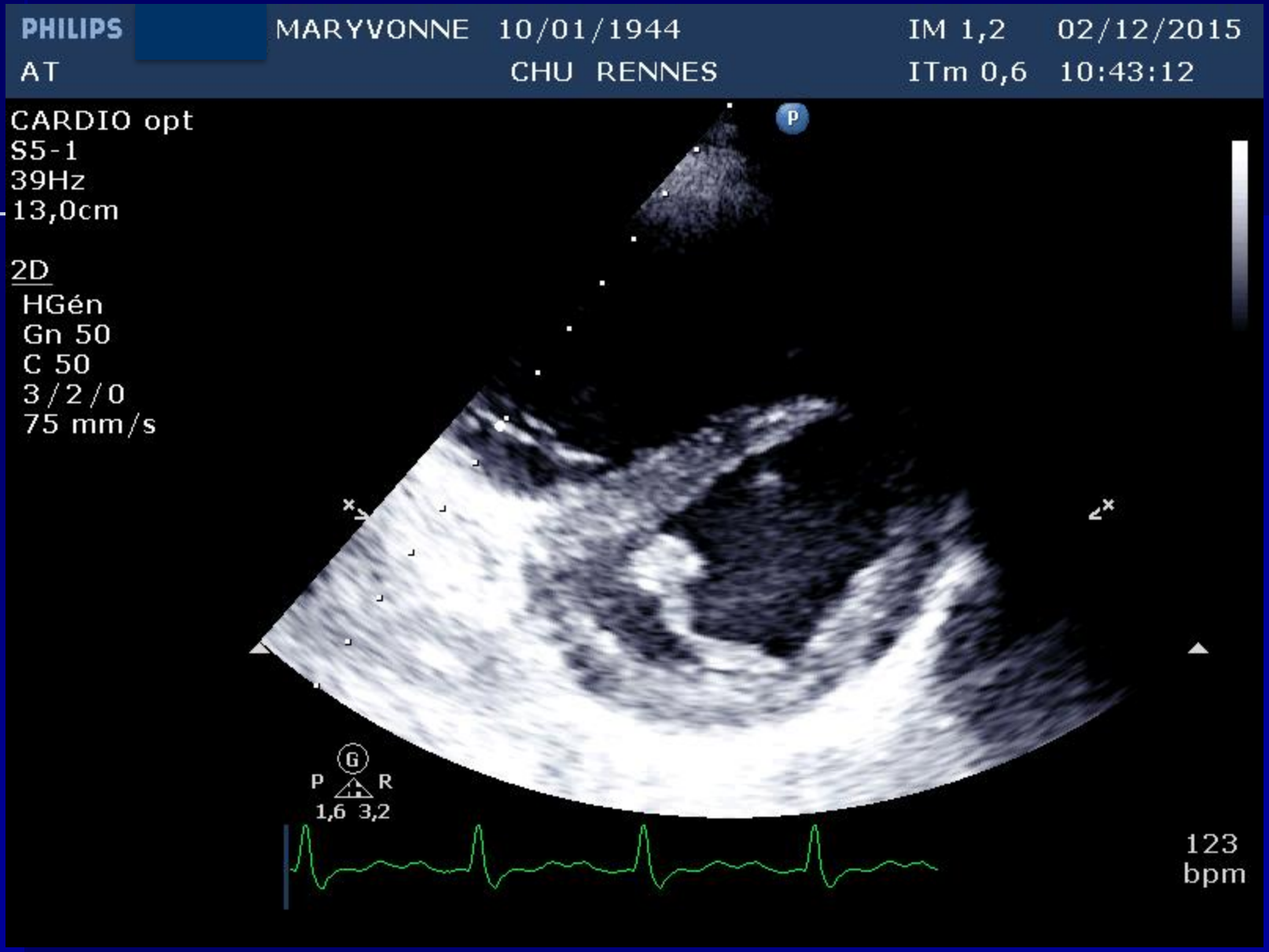
# Méthode de l’insuffisance pulmonaire

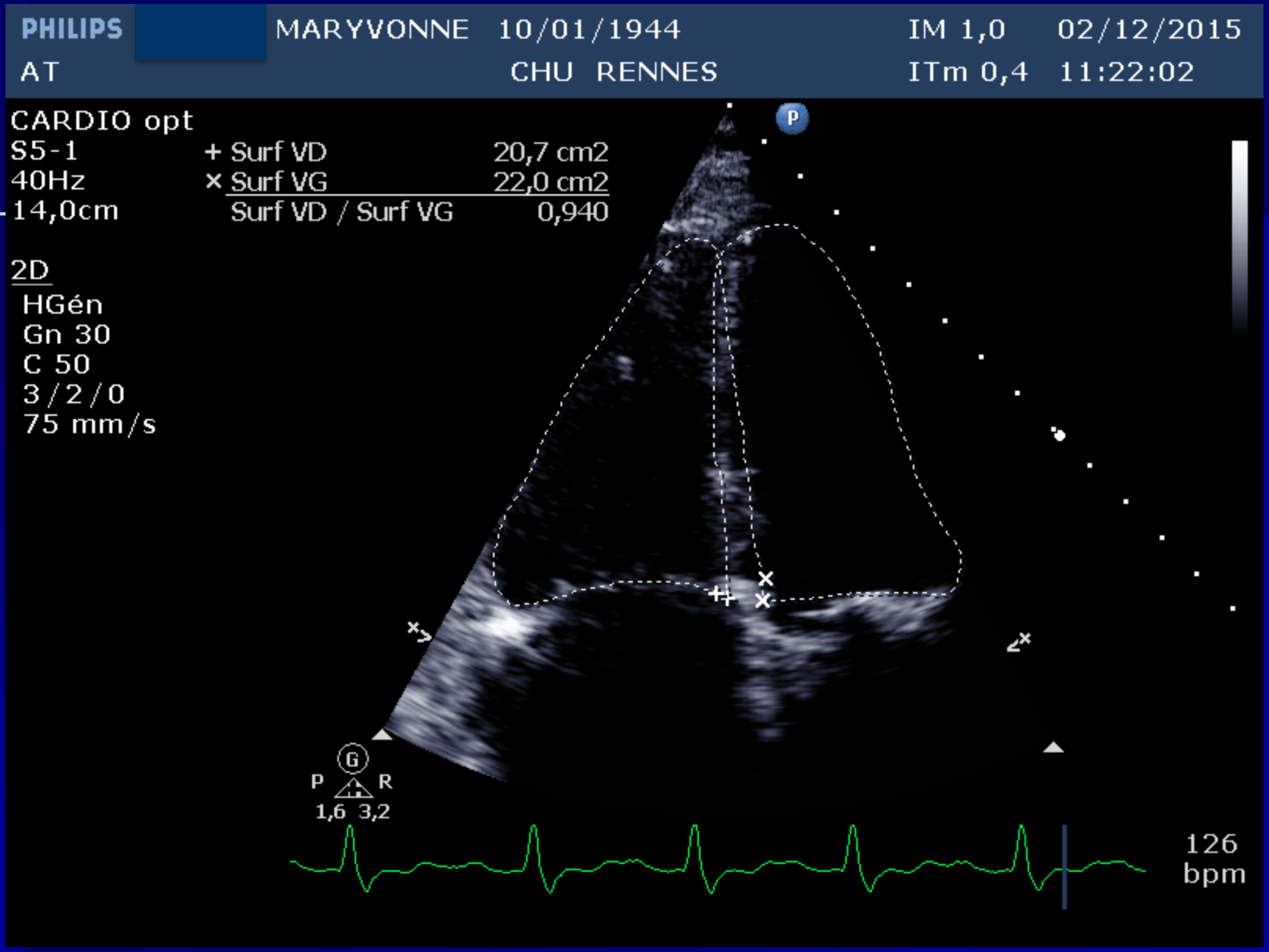
➢Limites

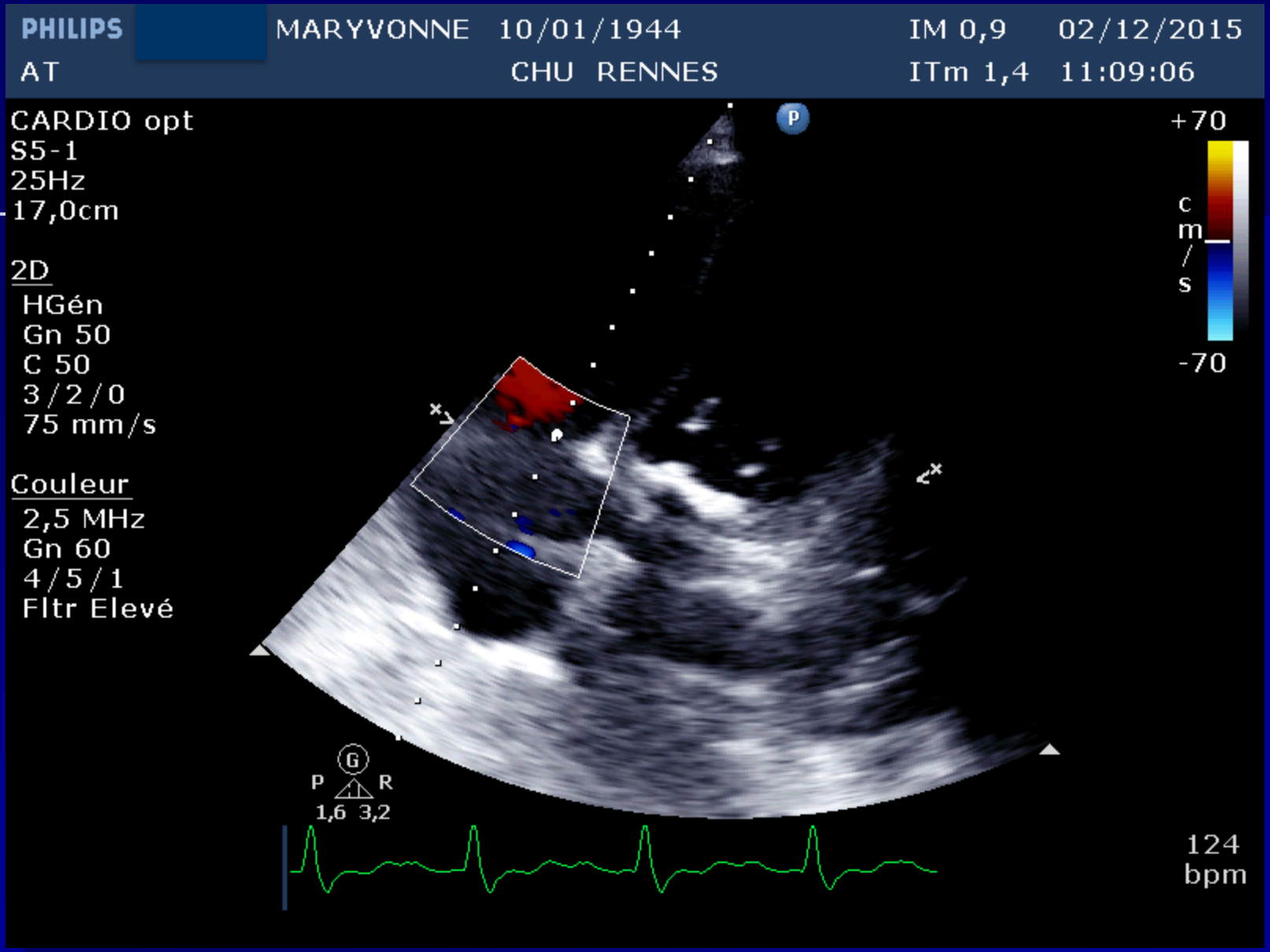
- Confusion entre le flux d’IP et un autre flux
- Alignement imparfait entre le faisceau US et le flux
- Variations de la vitesse (FA)
- Erreur dans l’estimation de la POD
- Morphologie particulière du flux

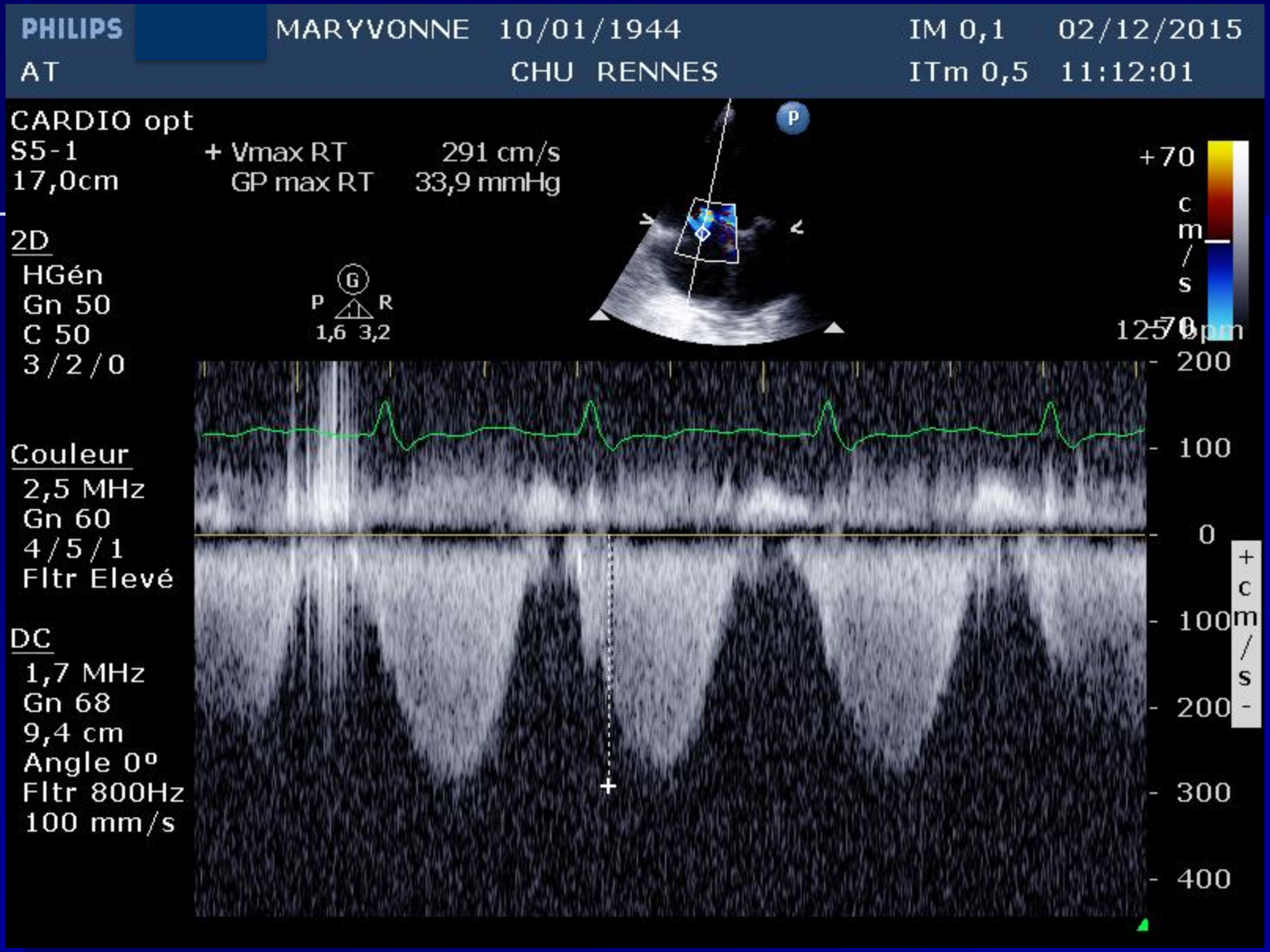

PHILIPS
MARYVONNE 10/01/1944
IM 1,2 02/12/2015
AT
CHU RENNES
ITm 0,4 11:14:27
CARDIO opt
S5-1
40Hz
13,0cm
2D
HGén
Gn 30
C 50
3/2/0
75 mm/s
P
G
P R
1,6 3,2
126
bpm

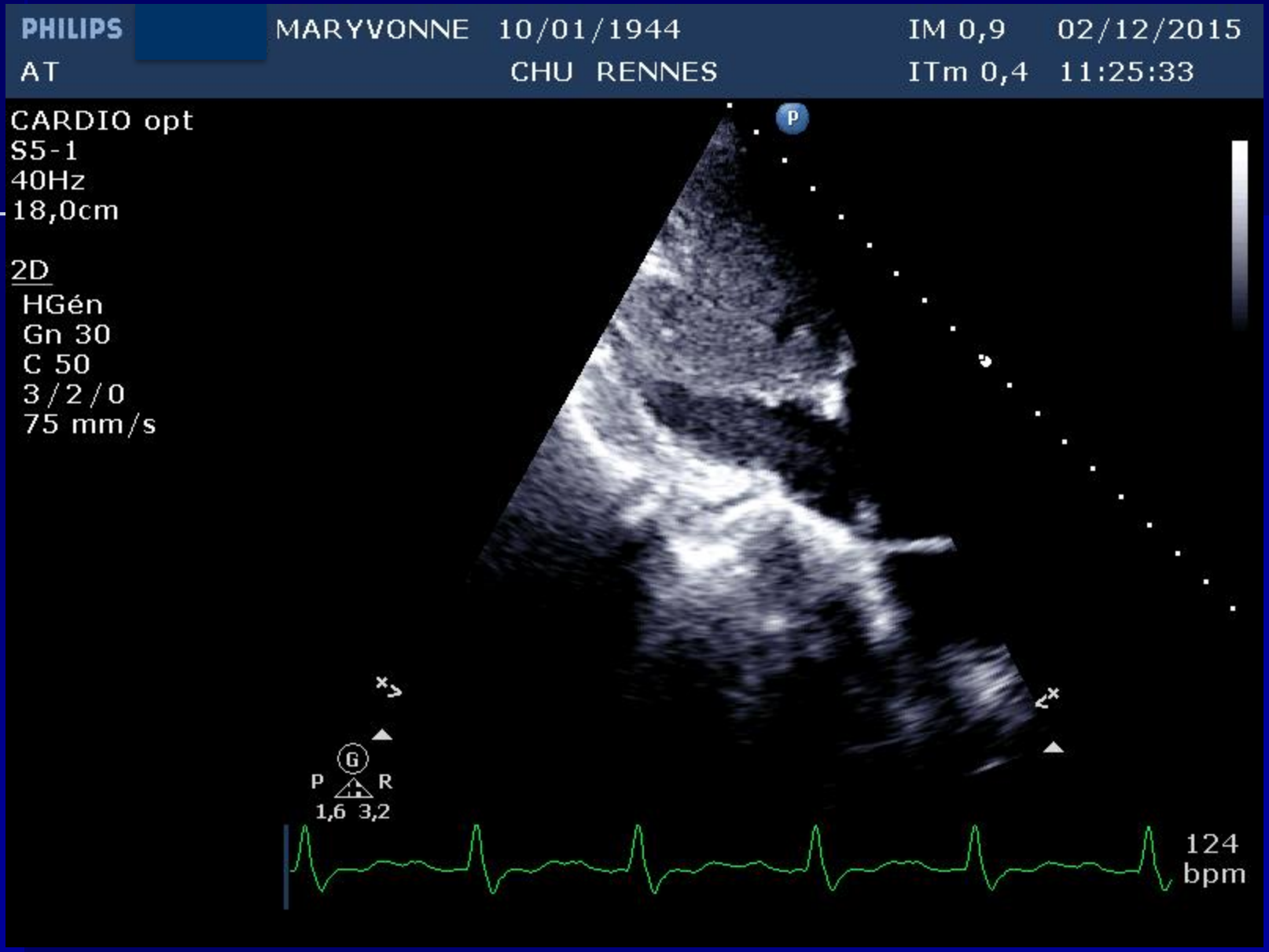

PHILIPS
MARYVONNE 10/01/1944
IM 1,2 02/12/2015
AT
CHU RENNES
ITm 0,6 11:15:01
CARDIO opt
S5-1
46Hz
13,0cm
2D
HGén
Gn 30
C 50
3/2/0
TM
3/3
75 mm/s
DIVDd (TM) 4,35 cm
SIVd (TM) 1,07 cm
DIVGd (TM) 3,54 cm
PPVGd (TM) 0,921 cm
SIVs (TM) 0,737 cm
DIVGs (TM) 3,28 cm
% SIV (TM) -31,0 %
FEj (TM-Teich) 16,7 %
FR (TM-Teich) 7,29 %
Masse VG (cube) 104 g
SIV/PPVG (TM) 1,16
VTD (TM-Teich) 52,1 ml
VTS (TM-Teich) 43,4 ml
121 bpm
5
5
10
10

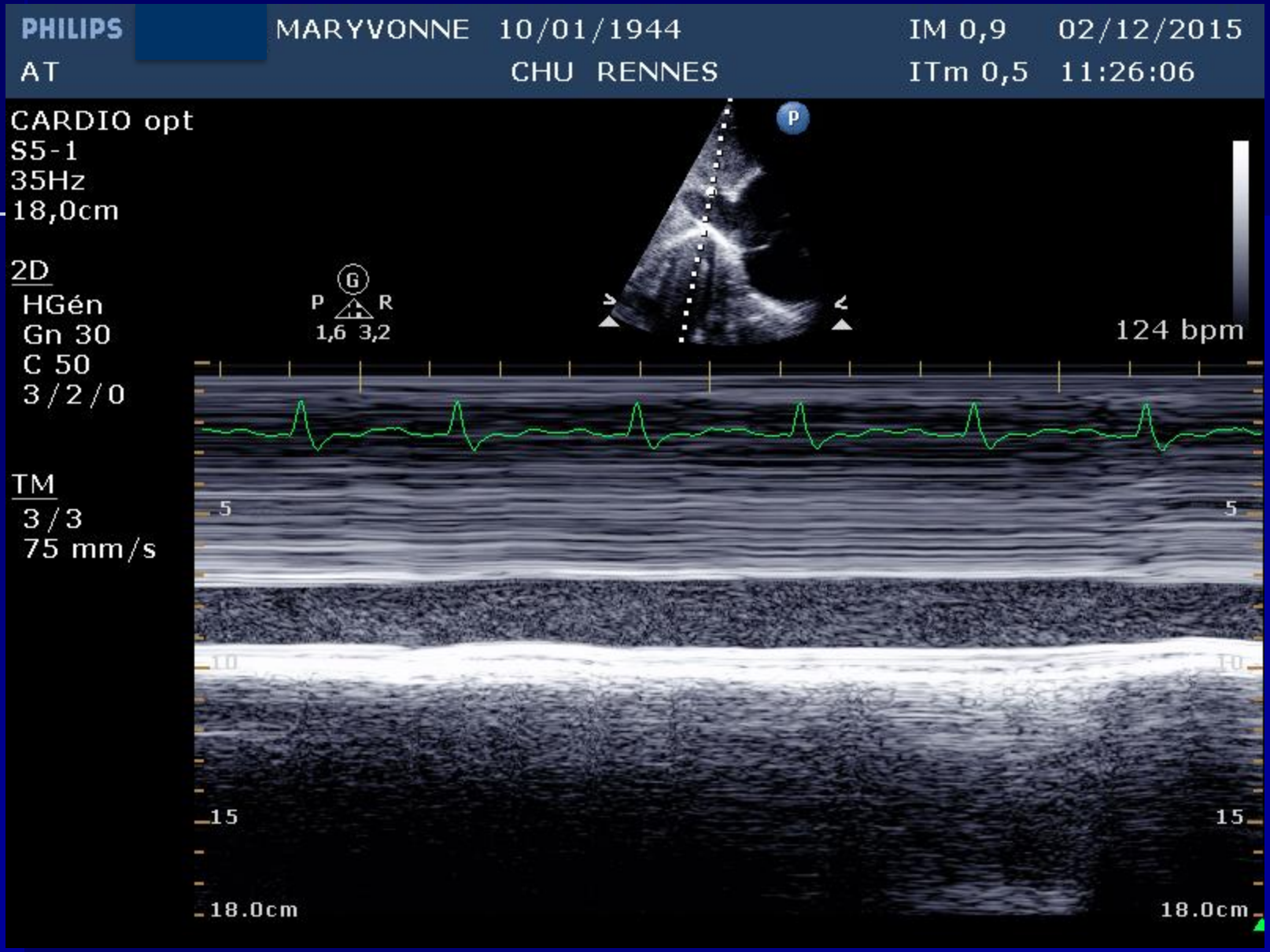

PHILIPS
MARYVONNE 10/01/1944
IM 1,2 02/12/2015
AT
CHU RENNES
ITm 0,6 10:43:12
CARDIO opt
S5-1
39Hz
13,0cm
2D
HGén
Gn 50
C 50
3/2/0
75 mm/s
P
G
P R
1,6 3,2
123
bpm

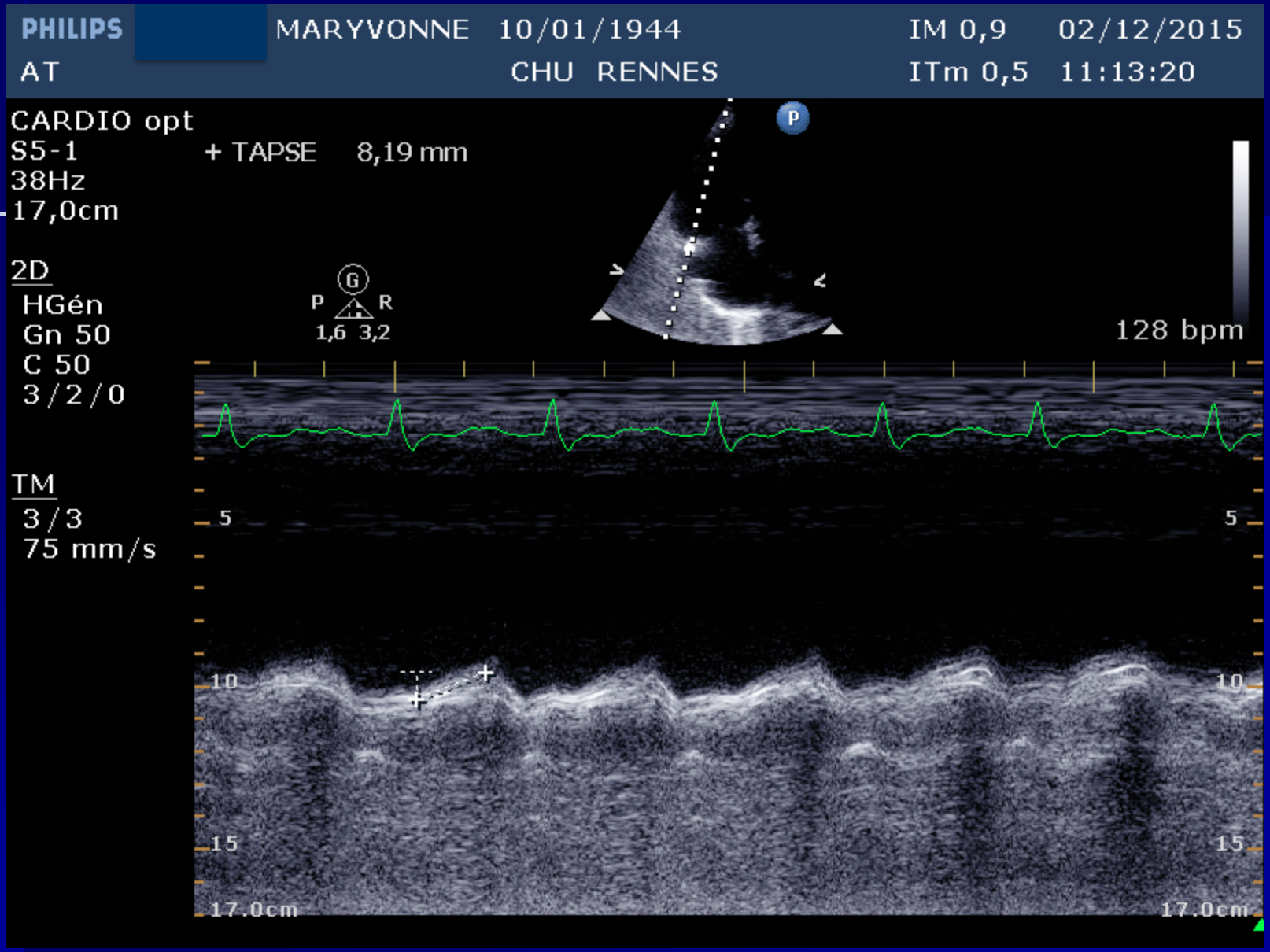

PHILIPS
MARYVONNE 10/01/1944
IM 1,0 02/12/2015
AT
CHU RENNES
ITm 0,4 11:22:02
CARDIO opt
S5-1
40Hz
14,0cm
+ Surf VD 20,7 cm2
× Surf VG 22,0 cm2
Surf VD / Surf VG 0,940
2D
HGén
Gn 30
C 50
3 / 2 / 0
75 mm/s
P
G
P R
1,6 3,2
126
bpm

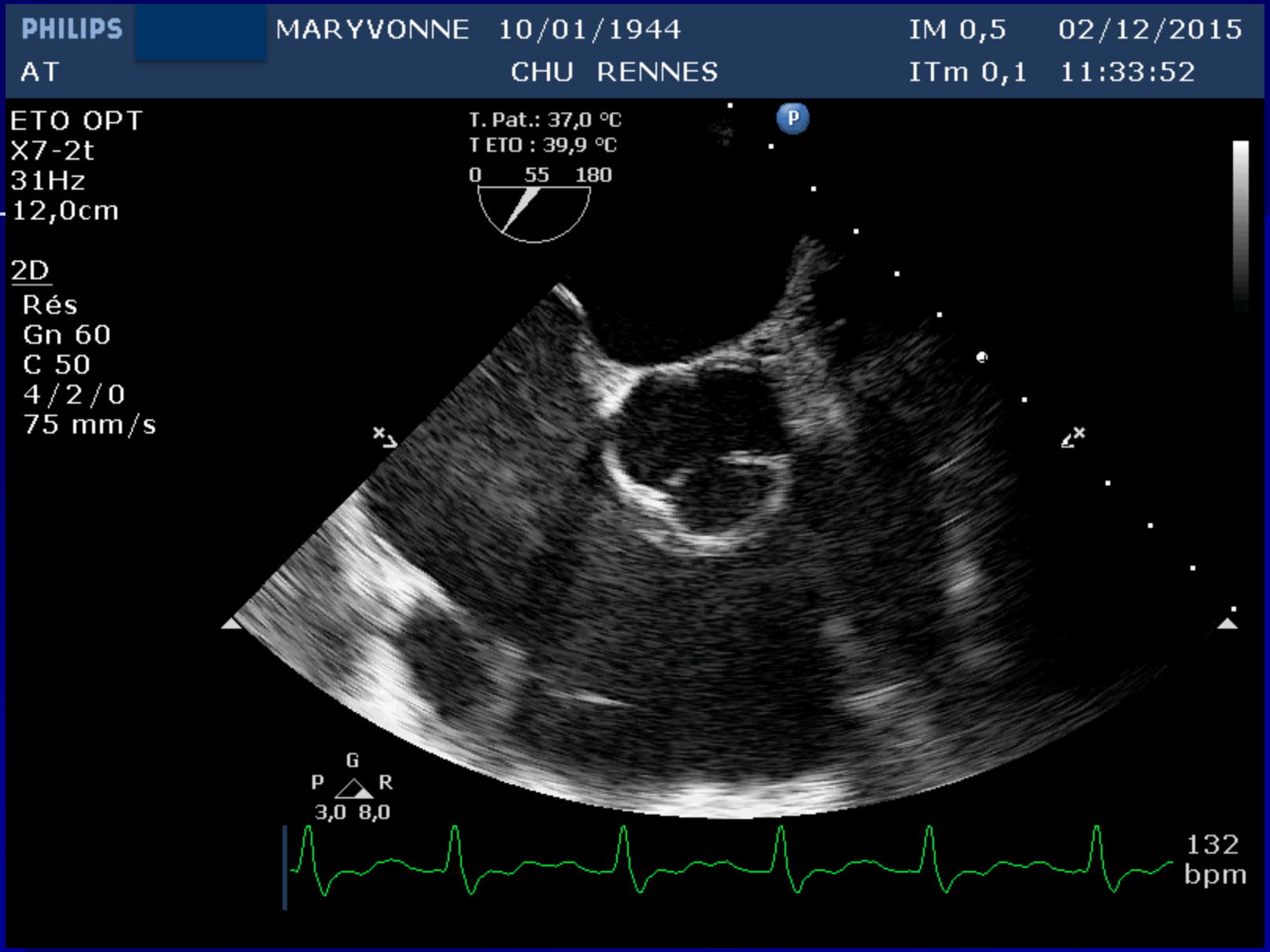

PHILIPS
MARYVONNE 10/01/1944
IM 0,9 02/12/2015
AT
CHU RENNES
ITm 1,4 11:09:06
CARDIO opt
S5-1
25Hz
17,0cm
2D
HGén
Gn 50
C 50
3/2/0
75 mm/s
Couleur
2,5 MHz
Gn 60
4/5/1
Fltr Elevé
+70
cm/s
-70
P
G
P R
1,6 3,2
124
bpm

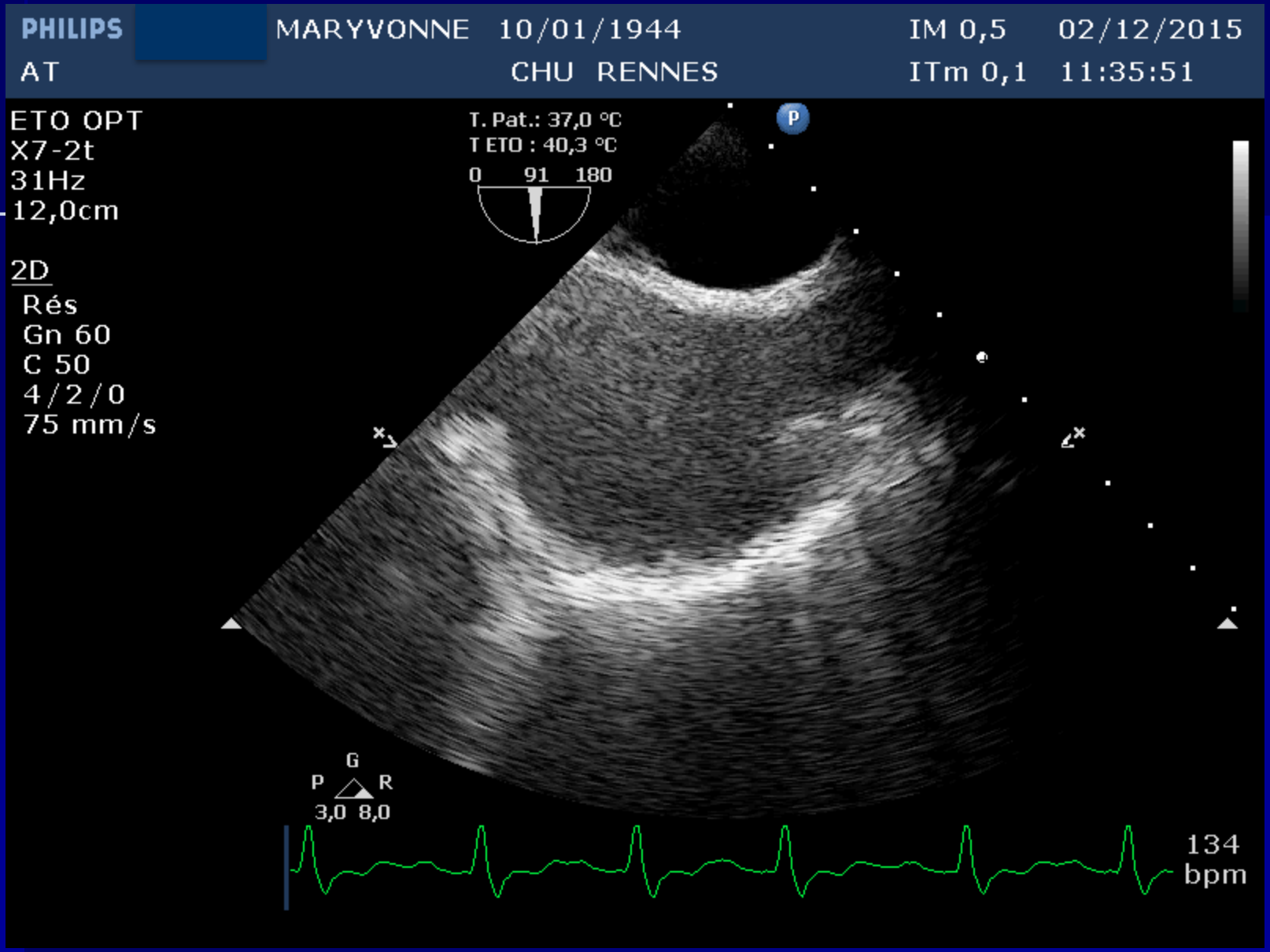

PHILIPS
MARYVONNE 10/01/1944
IM 0,1 02/12/2015
AT
CHU RENNES
ITm 0,5 11:12:01
CARDIO opt
S5-1
17,0cm
+ Vmax RT 291 cm/s
GP max RT 33,9 mmHg
2D
HGén
Gn 50
C 50
3/2/0
P
R
1,6 3,2
+70
cm/s
-70
125 bpm
Couleur
2,5 MHz
Gn 60
4/5/1
Fltr Elevé
DC
1,7 MHz
Gn 68
9,4 cm
Angle 0°
Fltr 800Hz
100 mm/s
200
100
0
100
200
300
400
+ cm/s -


PHILIPS
MARYVONNE 10/01/1944
IM 0,9 02/12/2015
AT
CHU RENNES
ITm 0,4 11:25:33
CARDIO opt
S5-1
40Hz
18,0cm
2D
HGén
Gn 30
C 50
3/2/0
75 mm/s
P
G
P R
1,6 3,2
124
bpm


PHILIPS
MARYVONNE 10/01/1944
IM 0,9 02/12/2015
AT
CHU RENNES
ITm 0,5 11:26:06
CARDIO opt
S5-1
35Hz
18,0cm
2D
HGén
Gn 30
C 50
3/2/0
TM
3/3
75 mm/s
G
P R
1,6 3,2
124 bpm
5
5
10
10
15
15
18.0cm
18.0cm


PHILIPS
MARYVONNE 10/01/1944
IM 0,9 02/12/2015
AT
CHU RENNES
ITm 0,5 11:13:20
CARDIO opt
S5-1
38Hz
17,0cm
+ TAPSE 8,19 mm
2D
HGén
Gn 50
C 50
3/2/0
P
G
P R
1,6 3,2
128 bpm
TM
3/3
75 mm/s
5
5
10
10
15
15
17.0cm
17.0cm


PHILIPS
MARYVONNE 10/01/1944
IM 0,5 02/12/2015
AT
CHU RENNES
ITm 0,1 11:33:52
ETO OPT
X7-2t
31Hz
12,0cm
2D
Rés
Gn 60
C 50
4/2/0
75 mm/s
T. Pat.: 37,0 °C
T ETO : 39,9 °C
0 55 180
P
G
P R
3,0 8,0
132
bpm


PHILIPS
MARYVONNE 10/01/1944
IM 0,5 02/12/2015
AT
CHU RENNES
ITm 0,1 11:35:51
ETO OPT
X7-2t
31Hz
12,0cm
2D
Rés
Gn 60
C 50
4/2/0
75 mm/s
T. Pat.: 37,0 °C
T ETO : 40,3 °C
0 91 180
P
G
P R
3,0 8,0
134
bpm

# Merci de votre attention