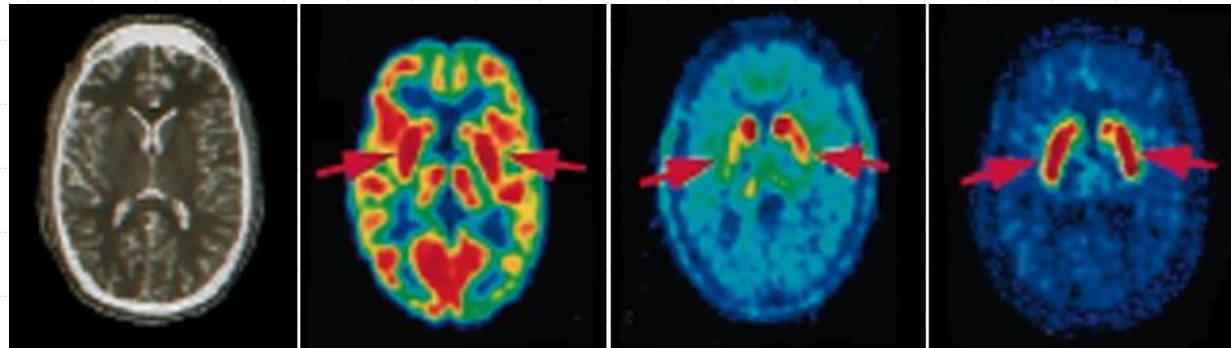


FORMATION TIC (Phymed, Télécom) ANALYSE D'IMAGES MEDICALES

QUELQUES SOLUTIONS LOGICIELLES INNOVANTES APPLIQUEES
EN IMAGERIE ISOTOPIQUE DE ROUTINE



Fayçal Ben Bouallègue - faybenb@hotmail.com

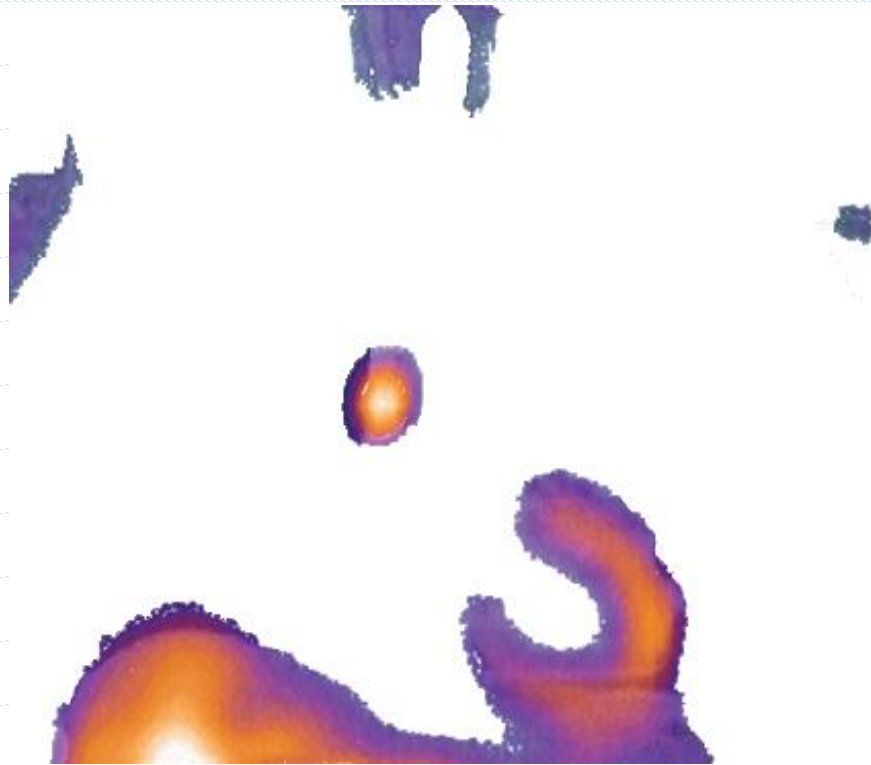
<http://scinti.etud.univ-montp1.fr>

Plan

1. Recalage d'images multimodales
2. Filtrage par AFC
3. Cinétique et épaisseur myocardique
4. Débruitage de Courbes temps-activité
5. Segmentation morphologique

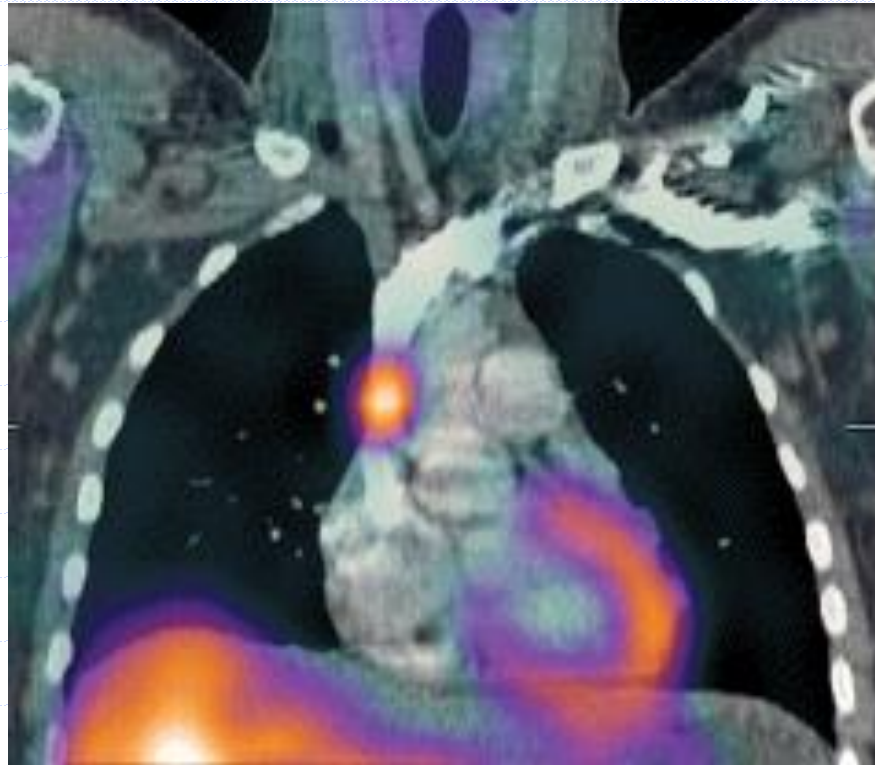
Recalage d'images multimodales

- ✓ pour localiser anatomiquement une anomalie fonctionnelle



Recalage d'images multimodales

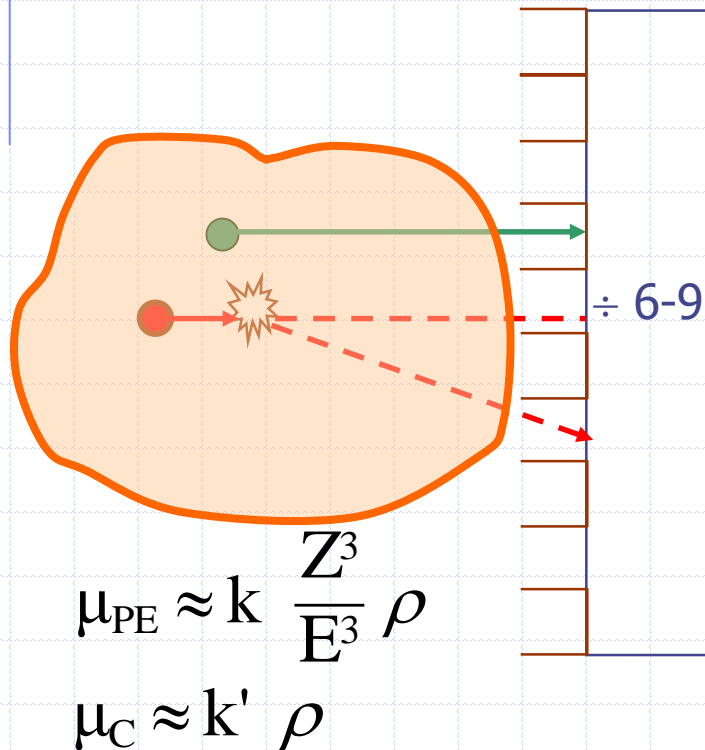
- ✓ pour localiser anatomiquement une anomalie fonctionnelle



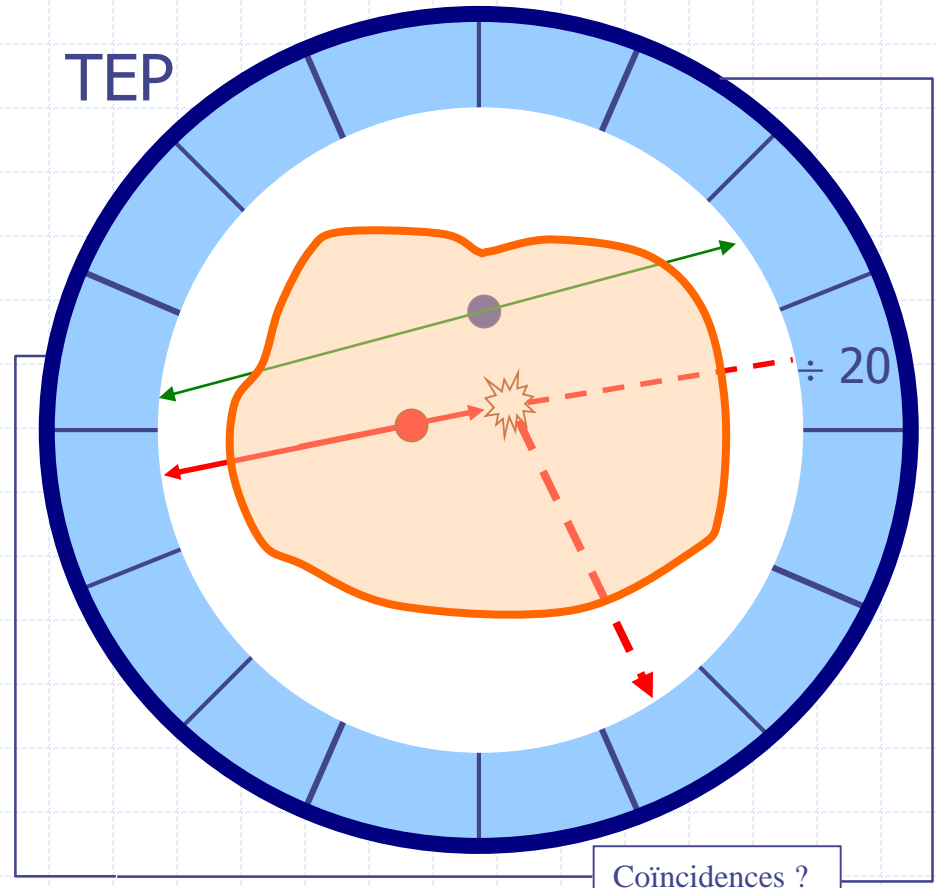
Recalage d'images multimodales

- ✓ Pour localiser anatomiquement
- ✓ Pour corriger des artefacts d'atténuation

TEMP



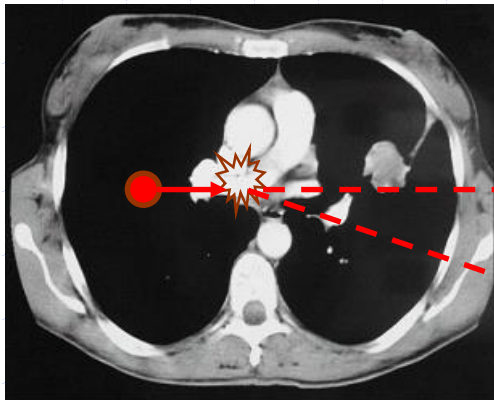
TEP



Recalage d'images multimodales

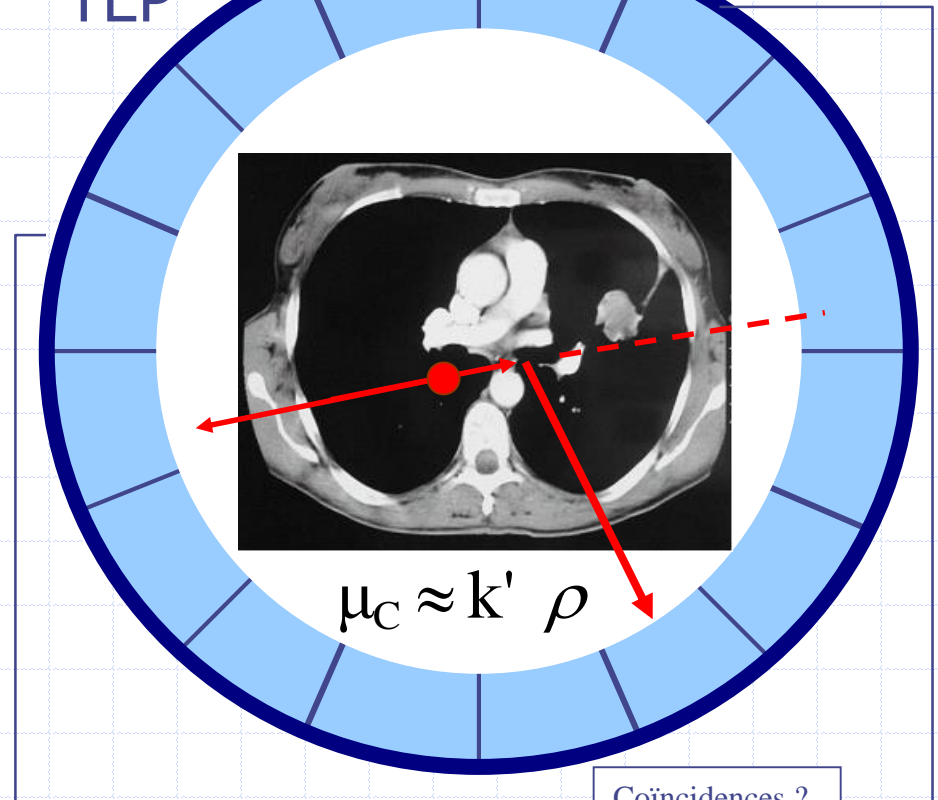
- ✓ Pour localiser anatomiquement
- ✓ Pour corriger des artefacts d'atténuation

TEMP



$$\mu_{PE} \approx k \frac{Z^3}{E^3} \rho$$

TEP

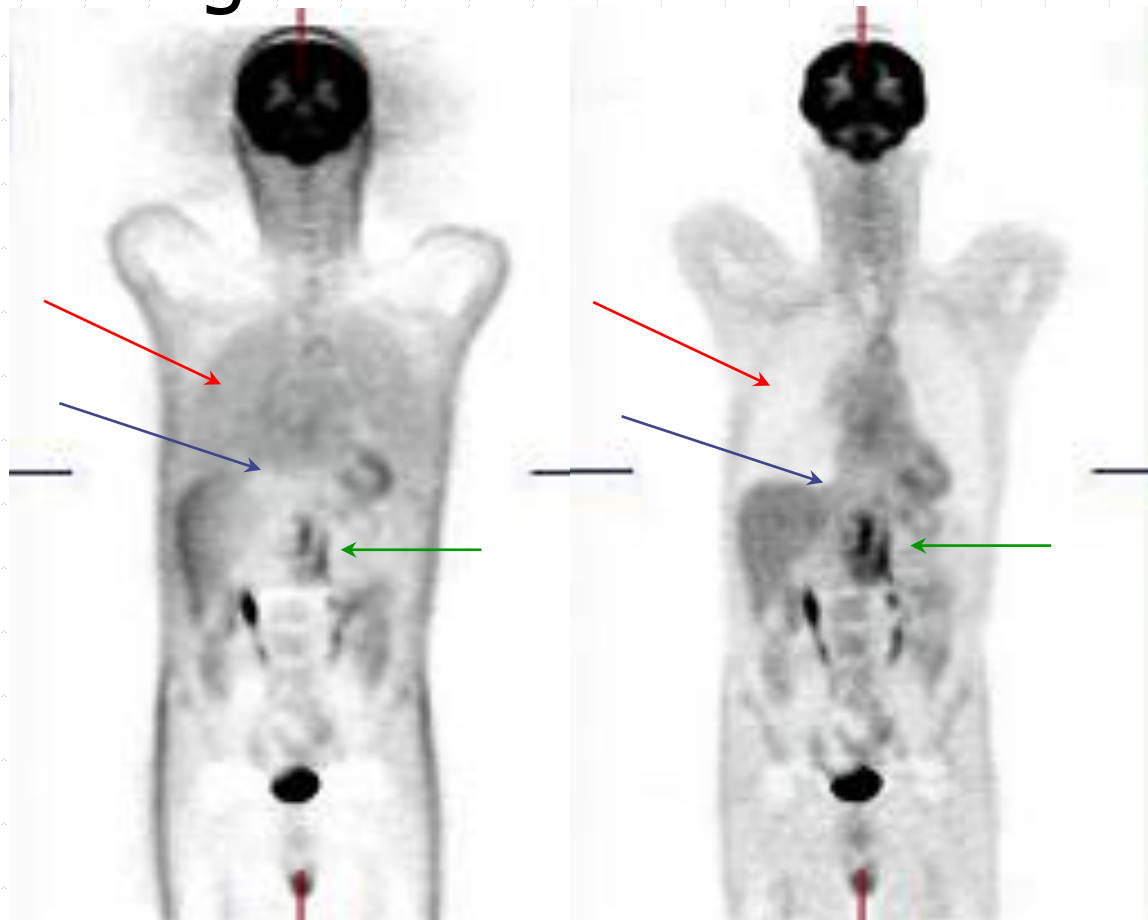


$$\mu_c \approx k' \rho$$

Coïncidences ?

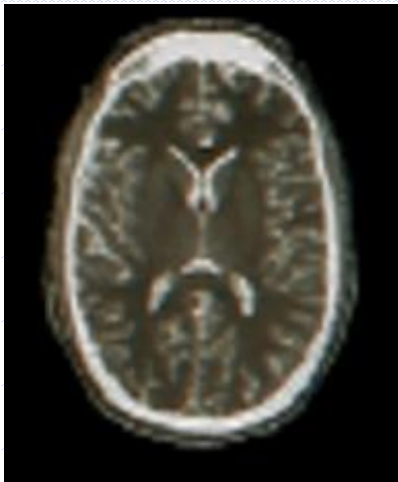
Recalage d'images multimodales

- ✓ Pour localiser anatomiquement
- ✓ Pour corriger des artefacts d'atténuation

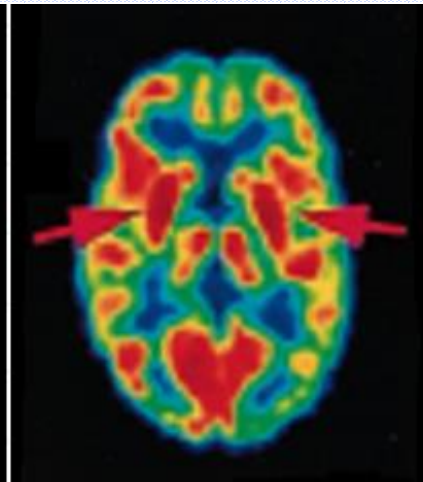


Recalage d'images multimodales

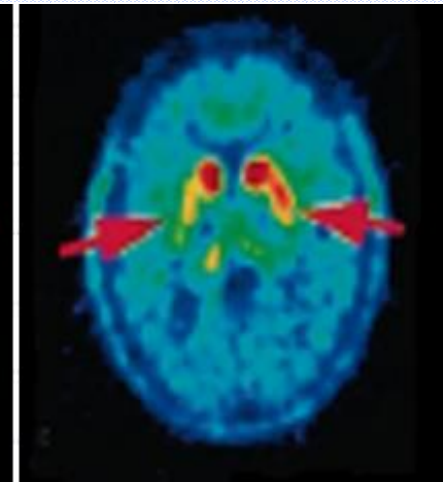
- ✓ Pour localiser anatomiquement
- ✓ Pour corriger des artefacts d'atténuation
- ✓ Pour une interprétation multimodale



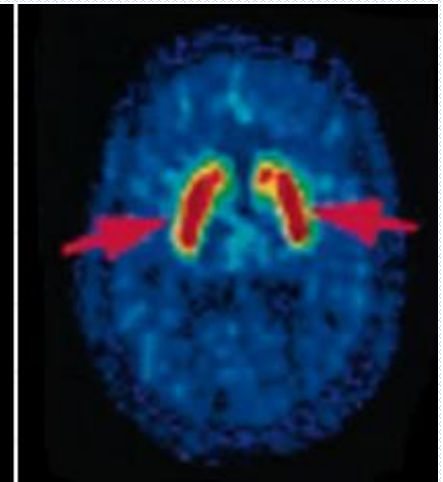
IRM



FDG



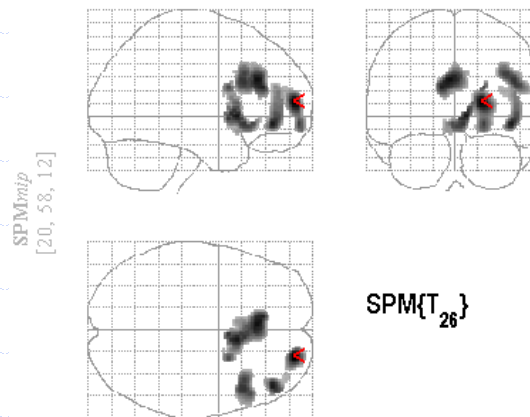
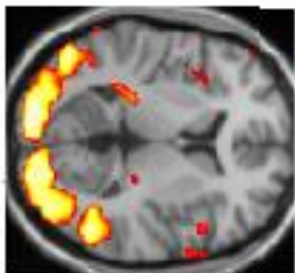
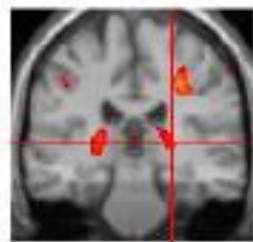
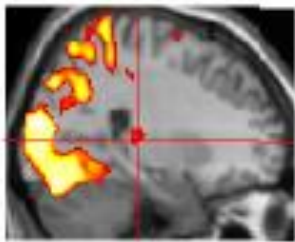
F-DOPA



F-Ethyl-
Spiperone

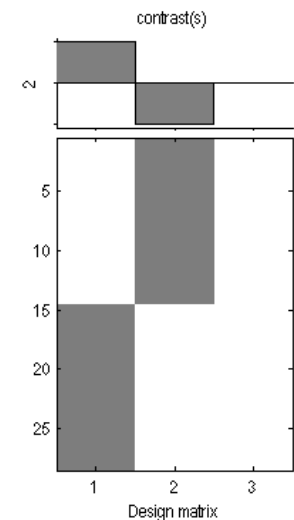
Recalage d'images multimodales

- ✓ Pour localiser anatomiquement
- ✓ Pour corriger des artefacts d'atténuation
- ✓ Pour une interprétation multimodale
- ✓ Pour des tests statistiques sur des VOI

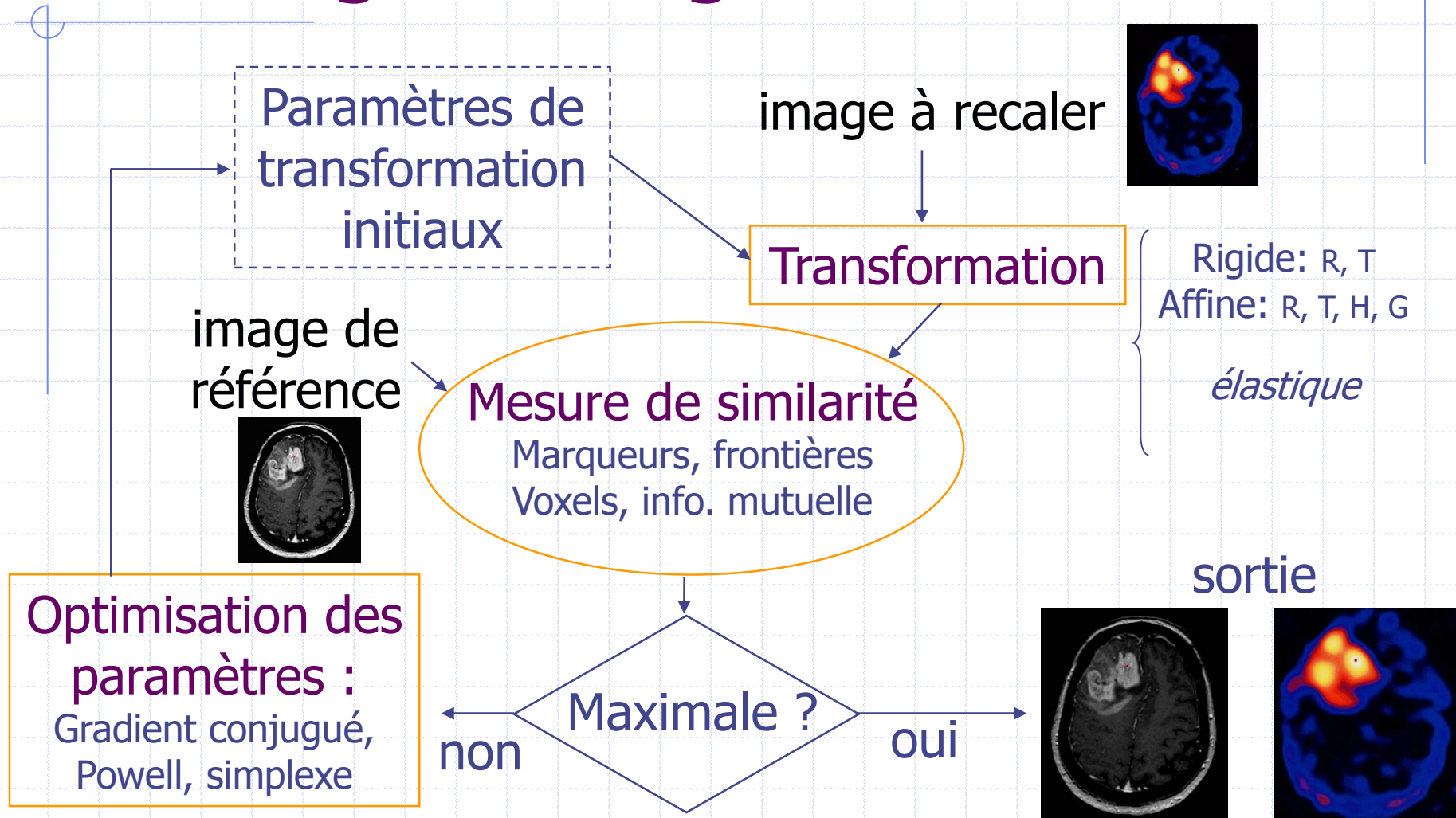


SPM{ t_{26} }

SPM (Gnu)



Recalage d'images multimodales

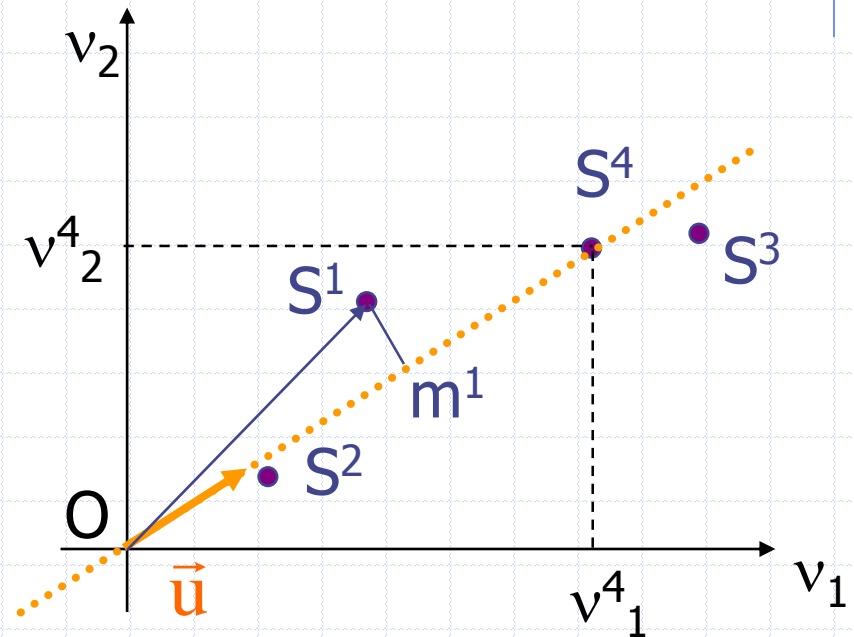


Analyse Factorielle des Correspondances

Analyse de 2 variables v_n (ex: taille et poids) sur 4 sujets S^p

$$M = \begin{bmatrix} v_1^1 & v_2^1 \\ v_1^2 & v_2^2 \\ v_1^3 & v_2^3 \\ v_1^4 & v_2^4 \end{bmatrix} \rightarrow \text{sujet } S^2$$

\downarrow variable v_1 \downarrow variable v_2



Idée : isoler les caractéristiques principales de chaque sujet S^i en ne le décrivant que par le point m^i (ex: « costaud » ou pas)

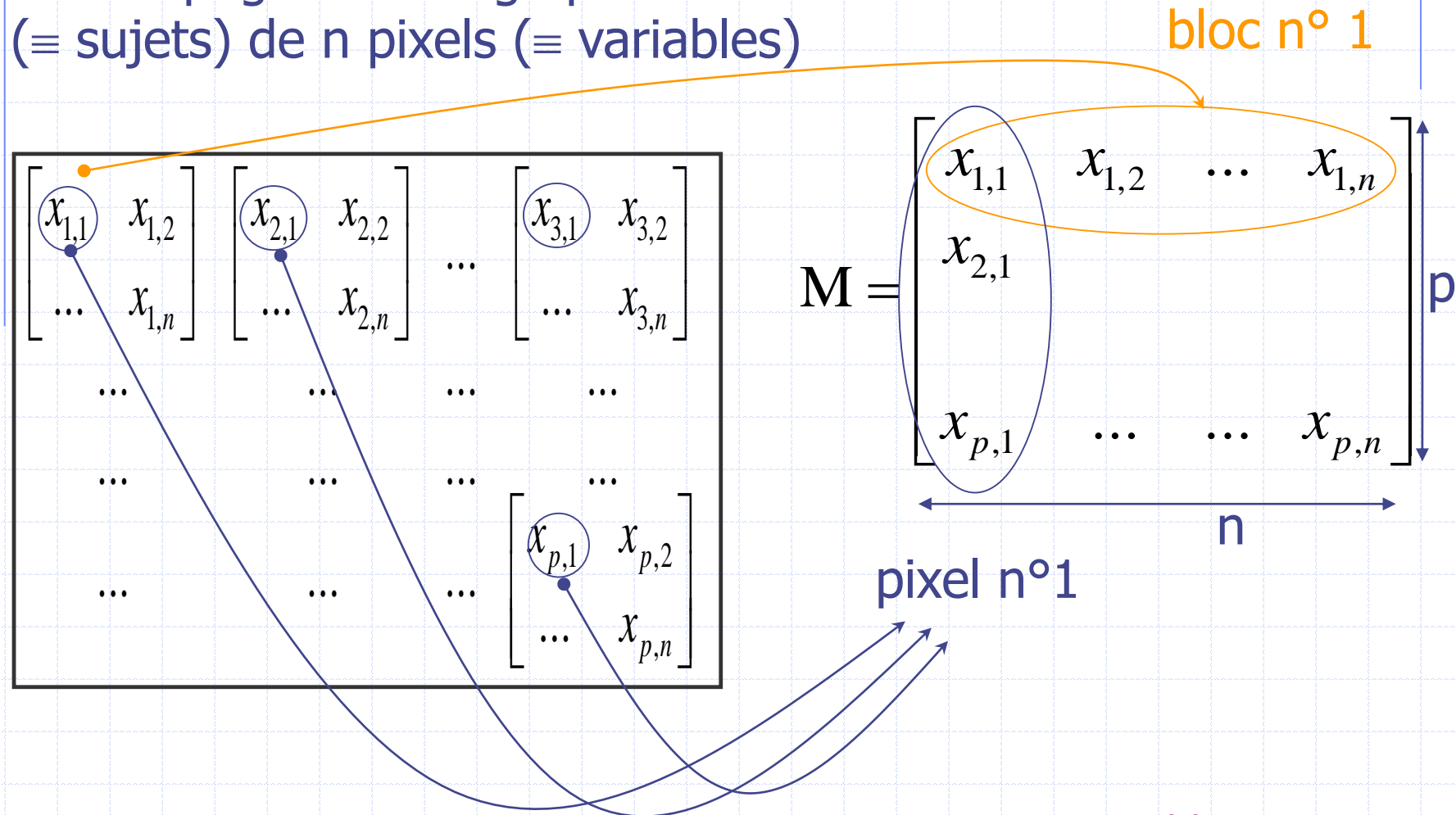
AFC: aspects techniques

$$\text{Max} (\text{Om}^p)^2 \Leftrightarrow C \vec{u} = \lambda \cdot \vec{u} \quad \text{où} \quad C_{i,j} = \sum_{k=1}^n v_k^i \cdot v_k^j$$

- ◆ \vec{u} est un vecteur propre de la matrice de covariance C , associé à la valeur propre λ (quantité d'information non corrélée).
- ◆ AFC = représenter M dans une base de vecteurs propres associés aux plus grandes valeurs propres

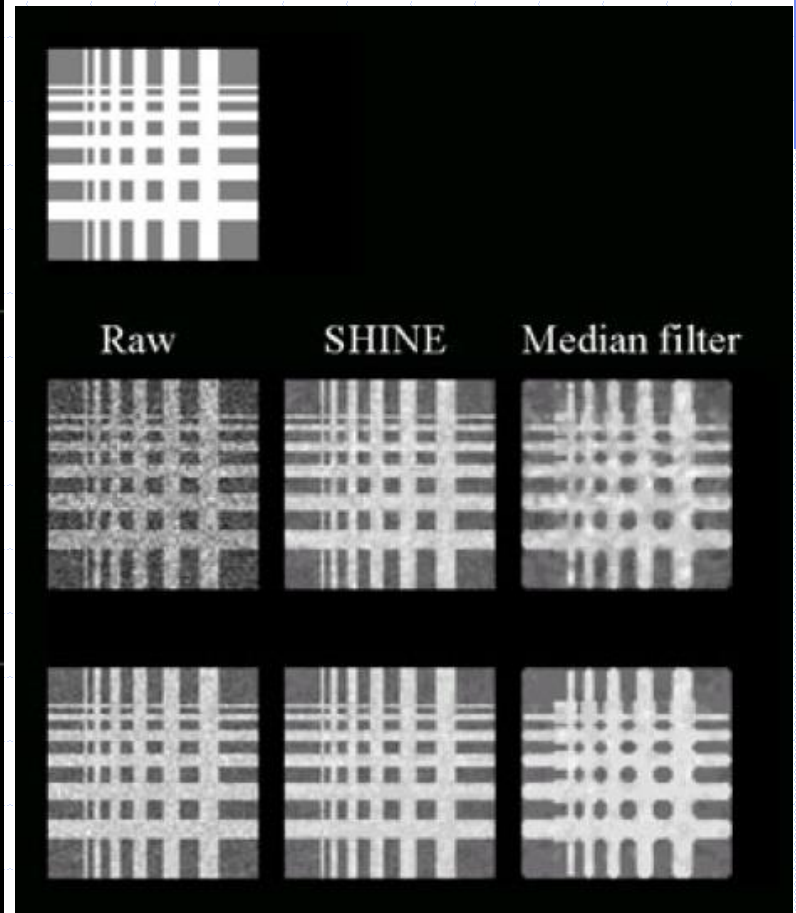
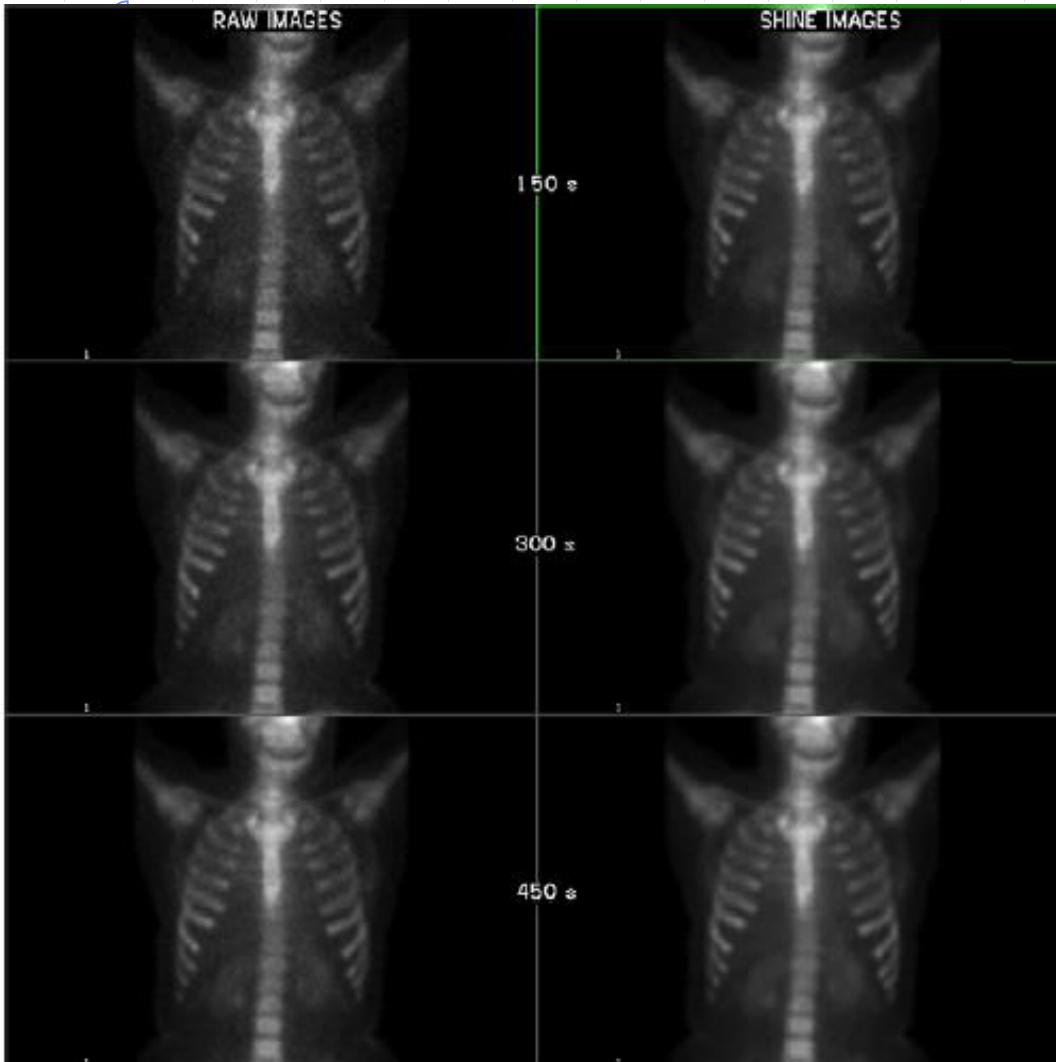
Construction de la matrice des données

Découpage de l'image par blocs
(\equiv sujets) de n pixels (\equiv variables)



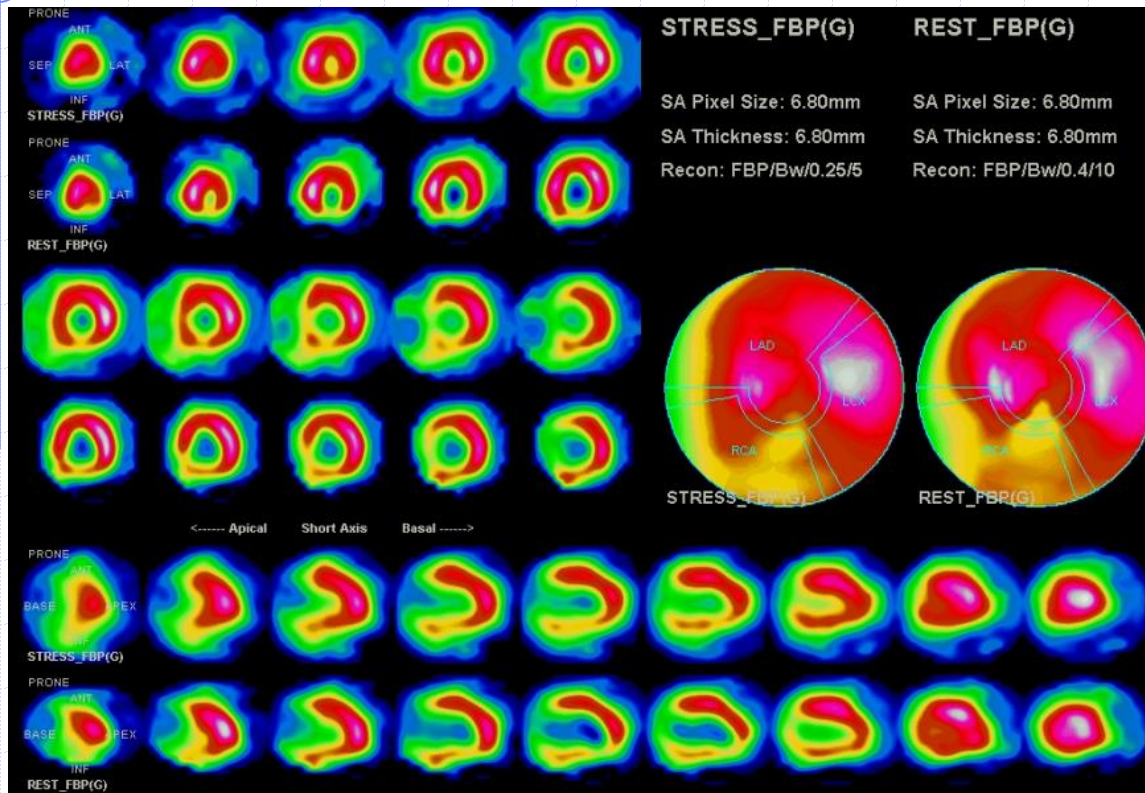
AFC appliquée au filtrage du bruit

Statistical Heuristic Image Noise Extraction



SHINE[®] (SEGAMI[®])

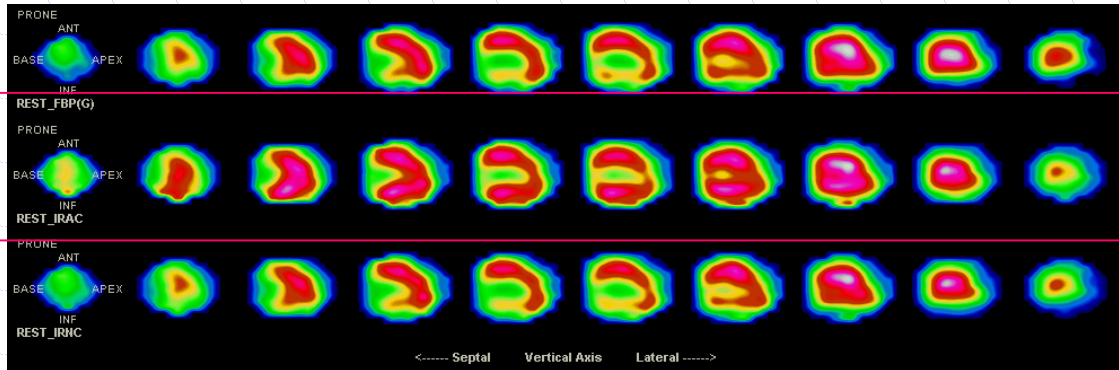
Scintigraphie myocardique



Problème médical :

Différencier
nécrose et artefact
en scintigraphie
Myocardique

1° idée : couplage à un scanner X



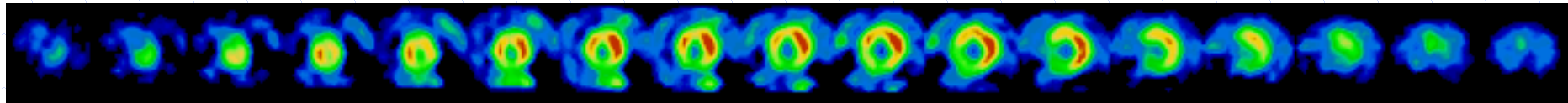
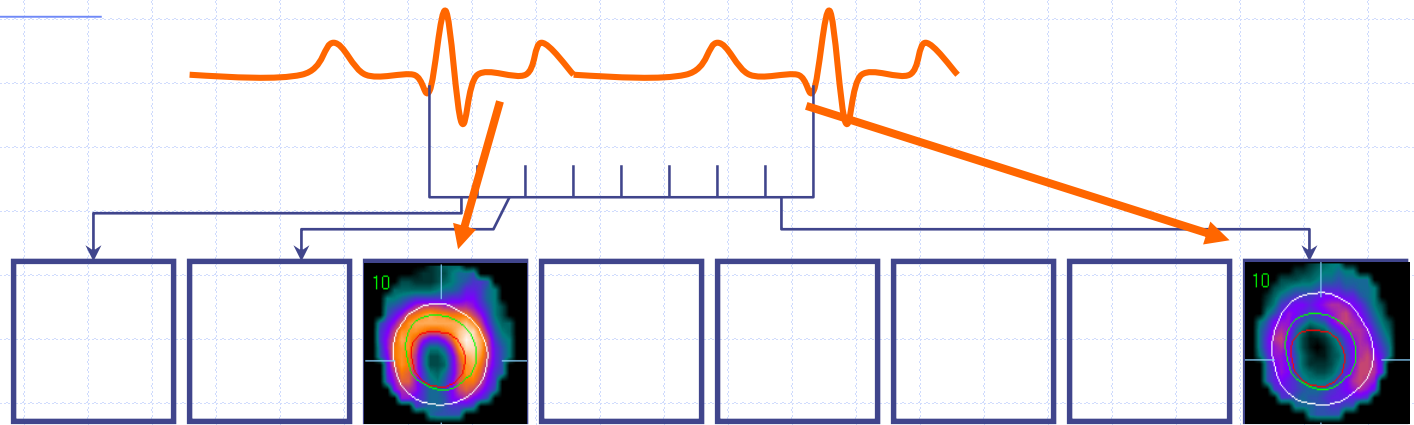
Sans correction

+ scanner X

Sans correction

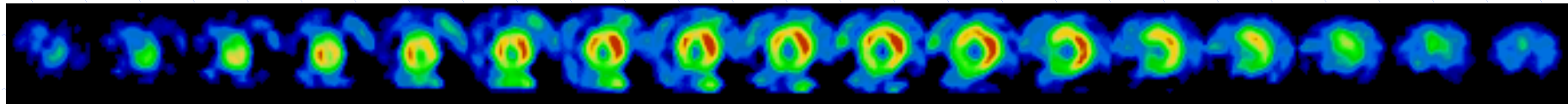
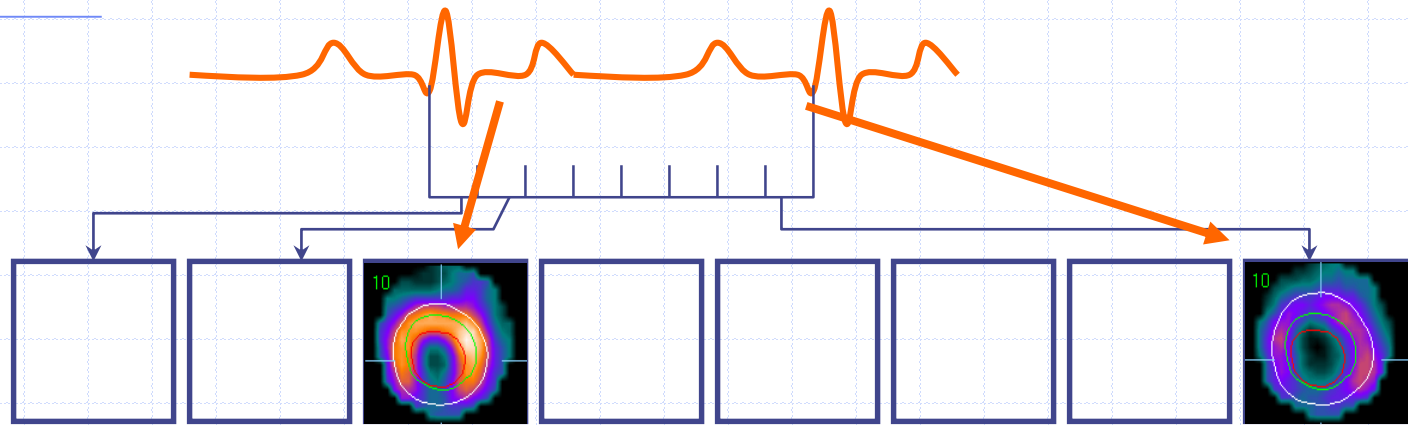
Mais la solution est coûteuse en temps d'acquisition, irradiation du patient et appareillage...

2° idée : mouvement pariétal ?



mais FWHM ≈ 15 mm \approx mouvement
qui est donc peu ou pas visible.

3° idée : Effet de volume partiel

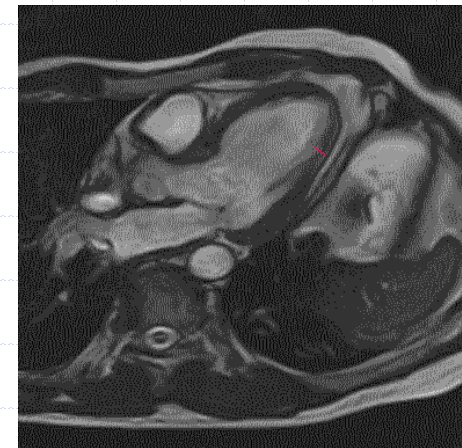


Epaississement systolique ≈ 30 mm

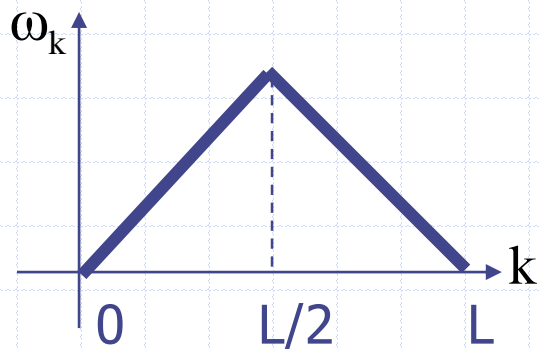
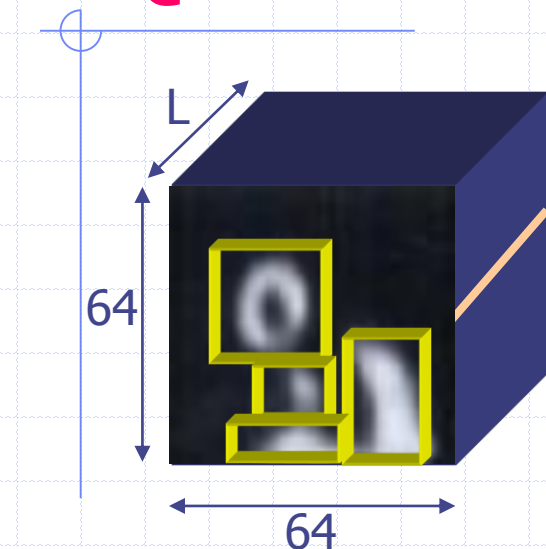
↳ 100 % de l'activité mesurée

Pour une épaisseur diastolique de 15 mm

↳ 75 % de l'activité mesurée



QPS[®] : Identification



Essai d'identification :
seuil → 1 amas cubique [50 mL, 1L]

S+5% ⇒ fragmentation

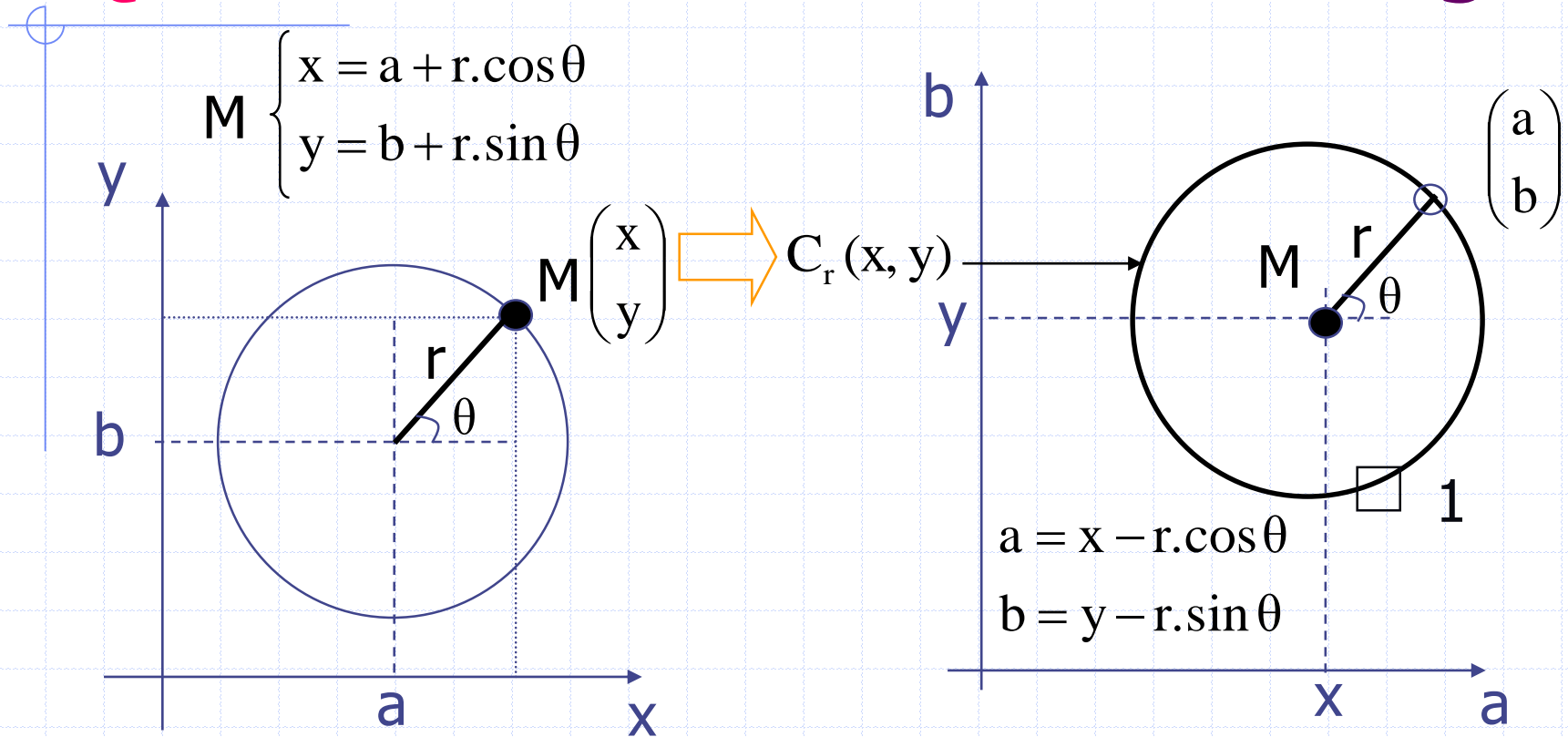
① Somme pondérée des coupes SA

$$S(i, j) = \sum_{k=1}^L \omega_k \cdot SA(i, j, k)$$

② Transformée de Hough

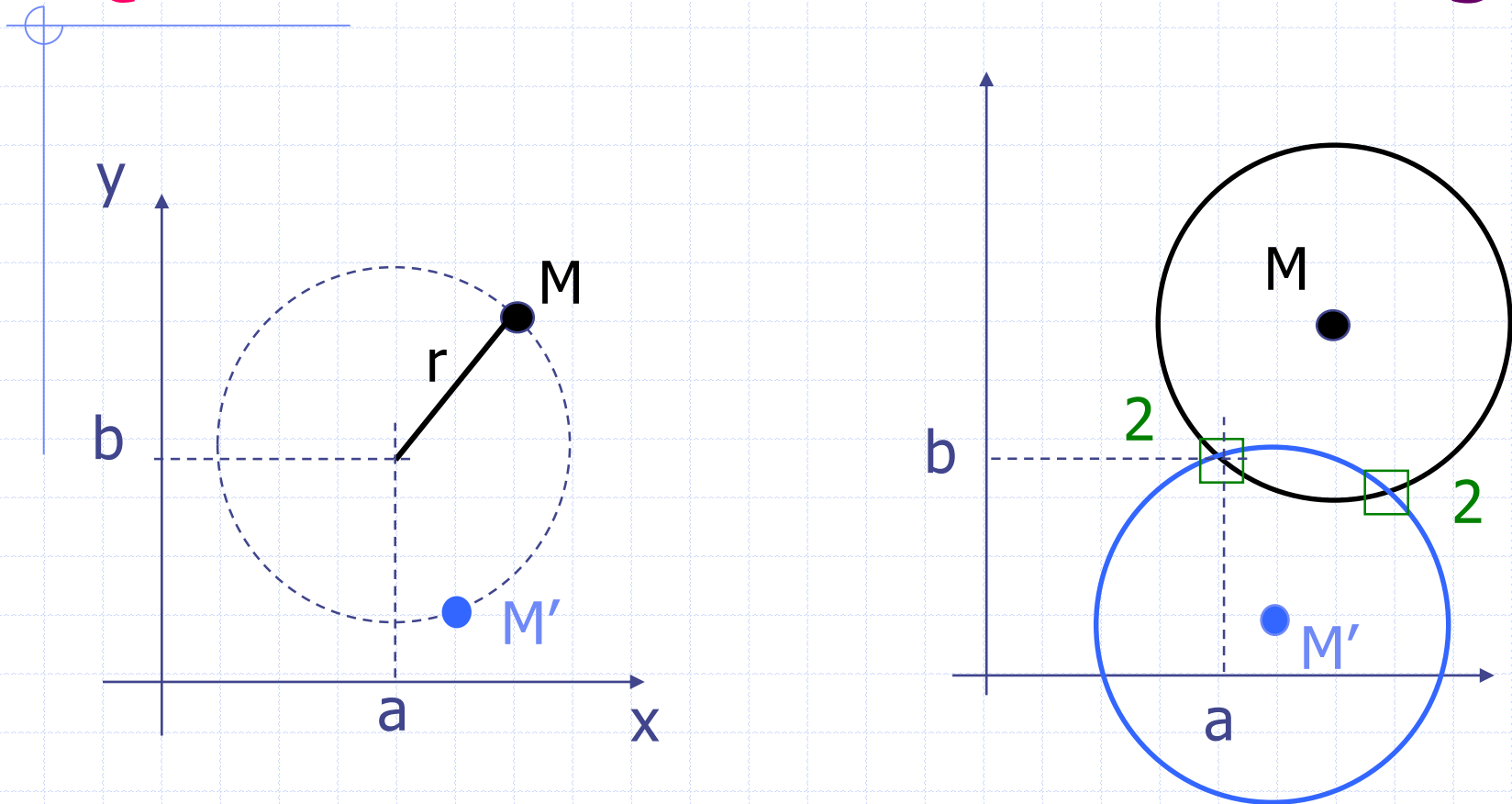
- ? cercles dans un nuage de points

QPS[®] : transformation de Hough



à tout **point** M du cercle (O, r) on associe un **cercle** (M, r)

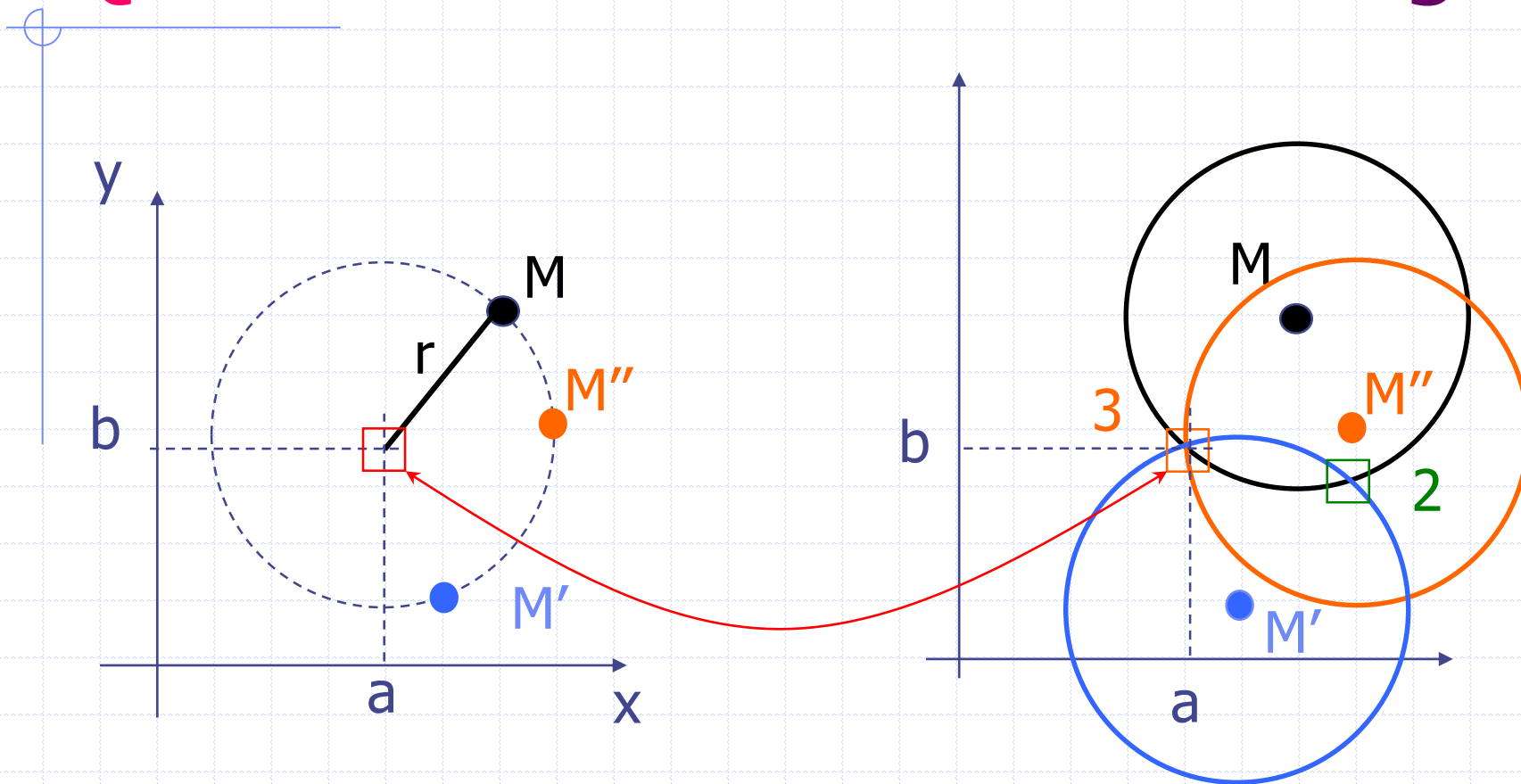
QPS[®] : transformation de Hough



D. Ballard, C. Brown. Computer vision. Englewood Cliffs, NJ: Prentice-Hall; 1982.

<http://homepages.inf.ed.ac.uk/rbf/BOOKS/BANDB/bandb.htm>

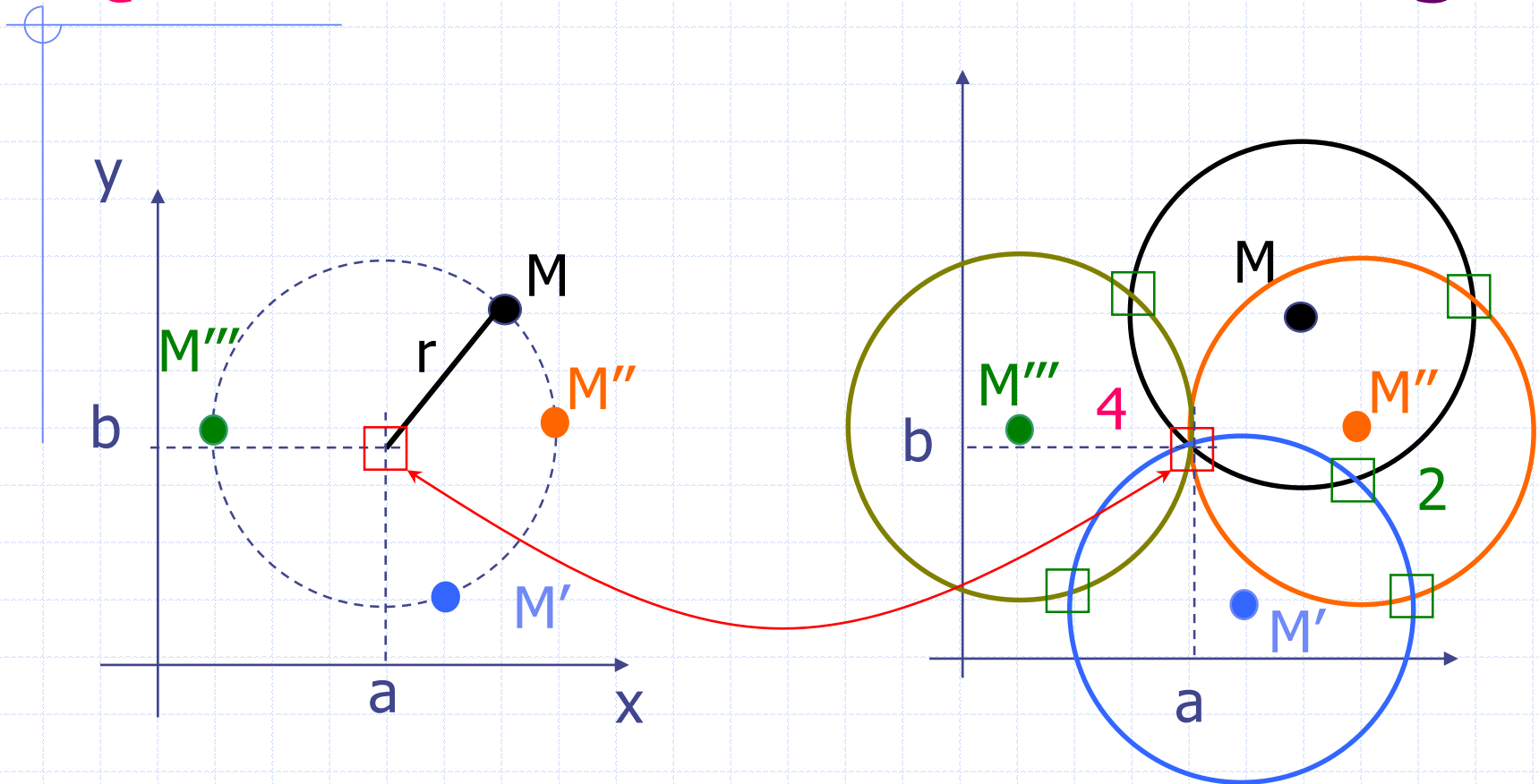
QPS[®] : transformation de Hough



D. Ballard, C. Brown. Computer vision. Englewood Cliffs, NJ: Prentice-Hall; 1982.

<http://homepages.inf.ed.ac.uk/rbf/BOOKS/BANDB/bandb.htm>

QPS[®] : transformation de Hough

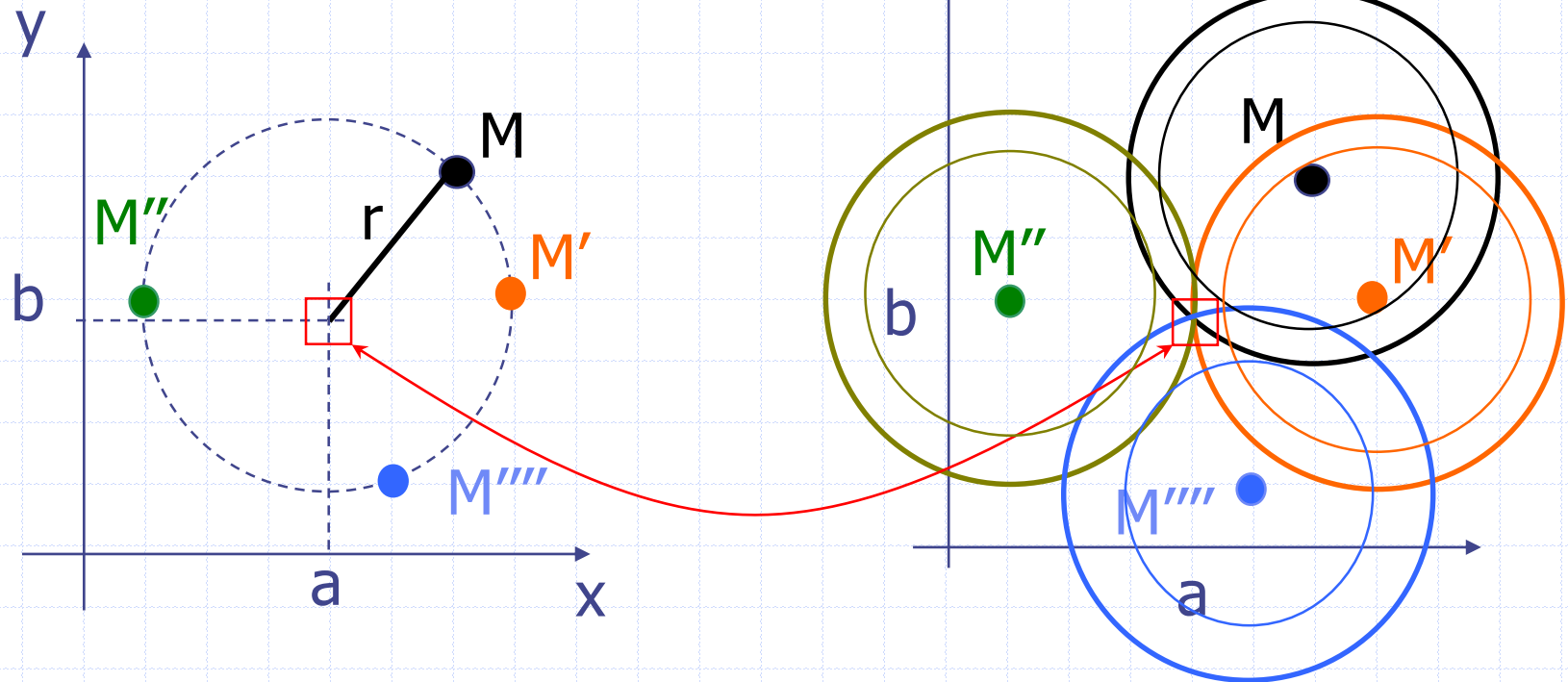


D. Ballard, C. Brown. Computer vision. Englewood Cliffs, NJ: Prentice-Hall; 1982.

<http://homepages.inf.ed.ac.uk/rbf/BOOKS/BANDB/bandb.htm>

QPS[®] : transformation de Hough

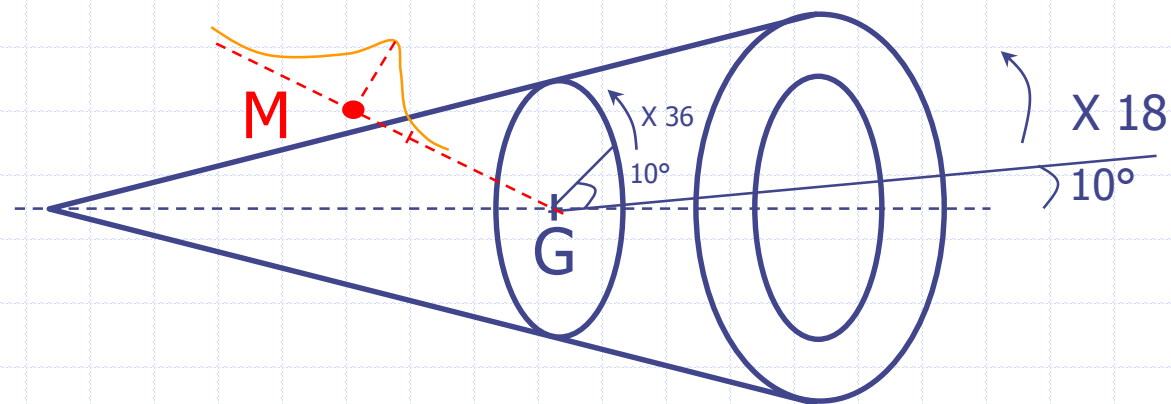
Si r est inconnu : cônes



Extremum dans l'espace des paramètres 3D: (a, b, r)

QPS[®] : surface myocardique médiane

- ① G : Centre de Gravité
- ② Extraction de 18x36 profils d'activité
- ④ Surface médio VG = maxima des profils M
- ⑤ Fit ellipse 3D → axe VG → G ← proj.(G)/axe



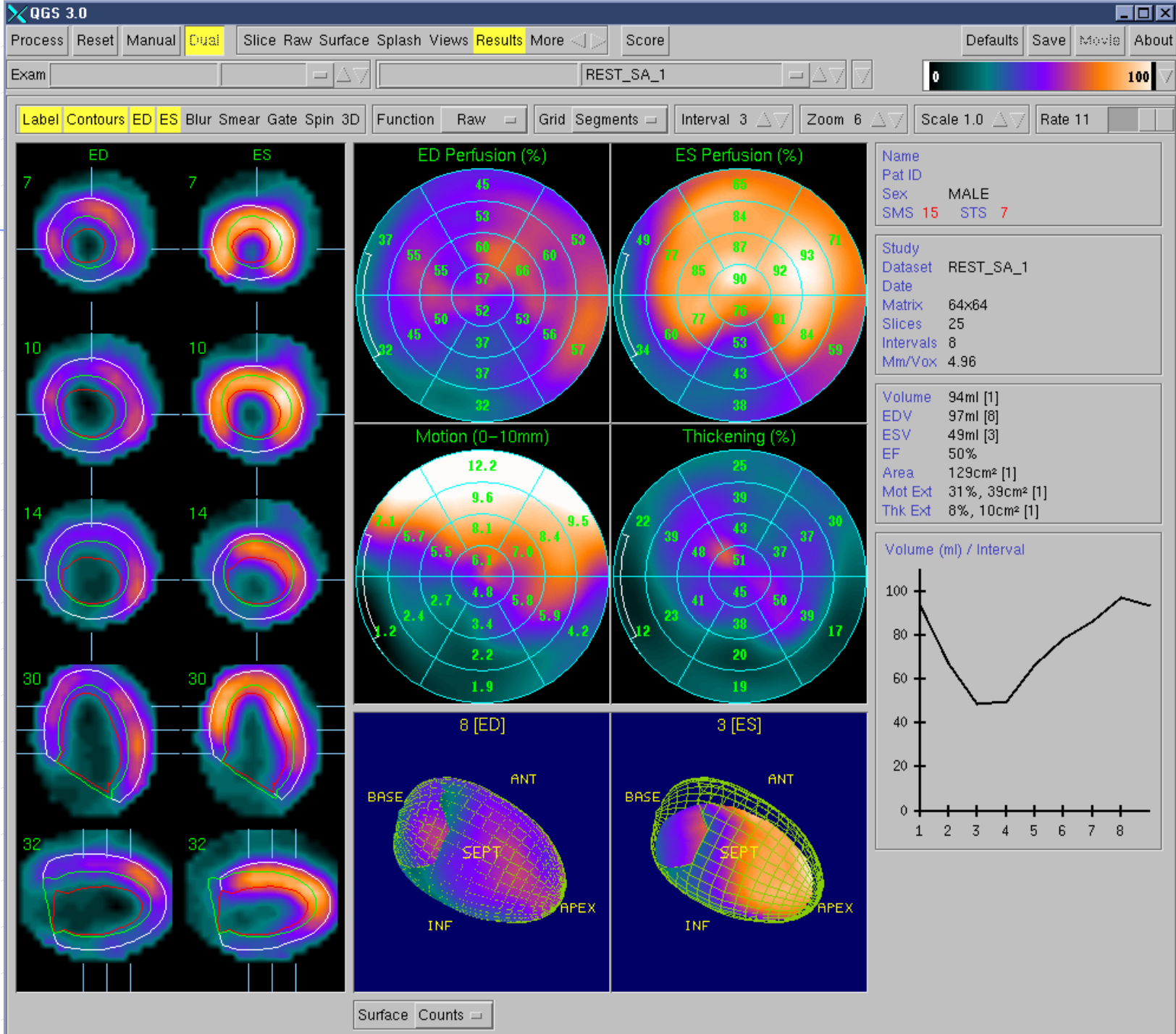
JC Cauvin et al. Eur J Nucl med 1992;19:1032-1037

G. Germano et al. JNM 1995;36:1107-14 ; 1995;36:2138-47 et JNM 2000;41:712-19

QPS®

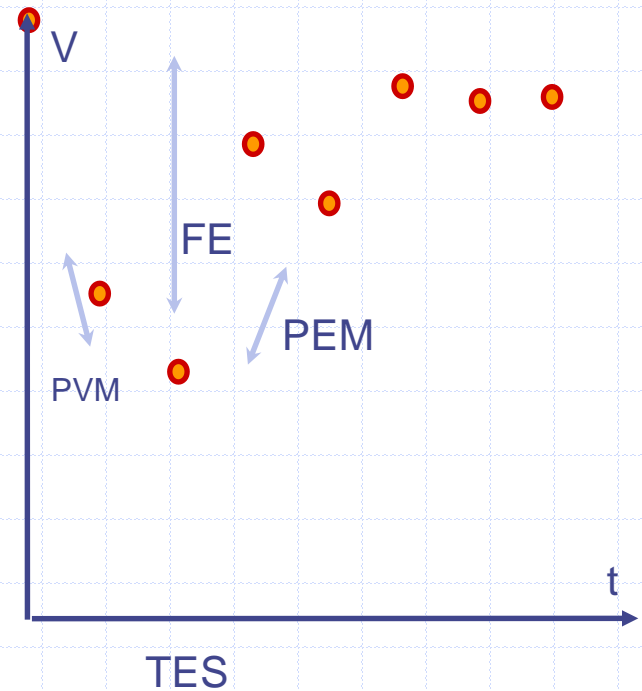
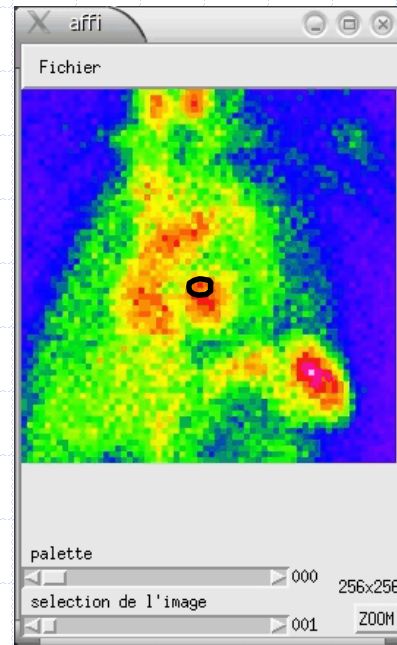
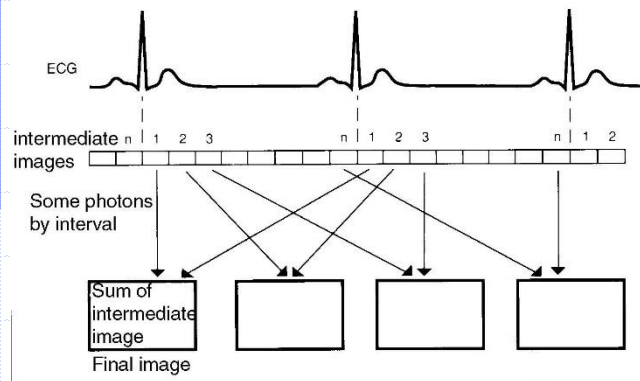
et

QGS®



Ventriculographie isotopique

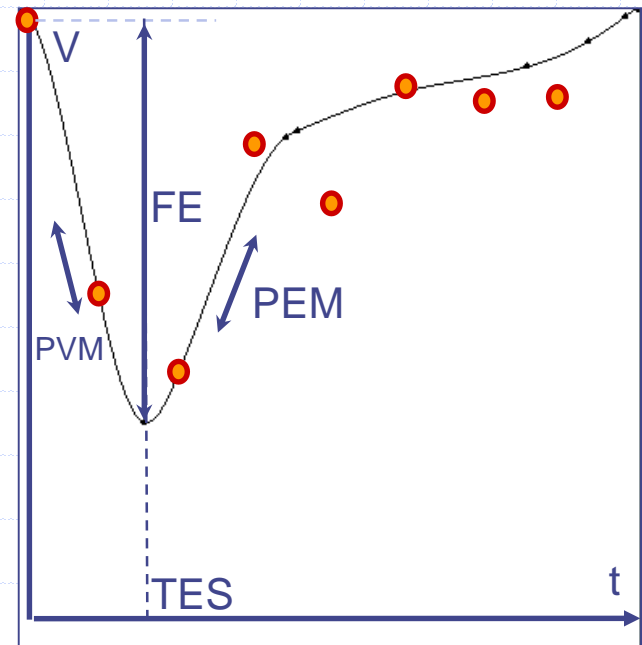
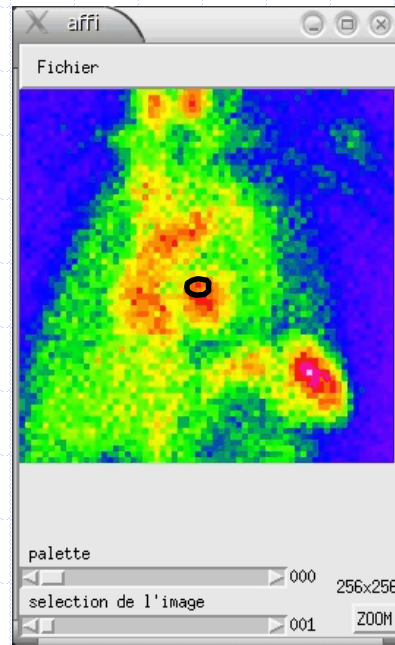
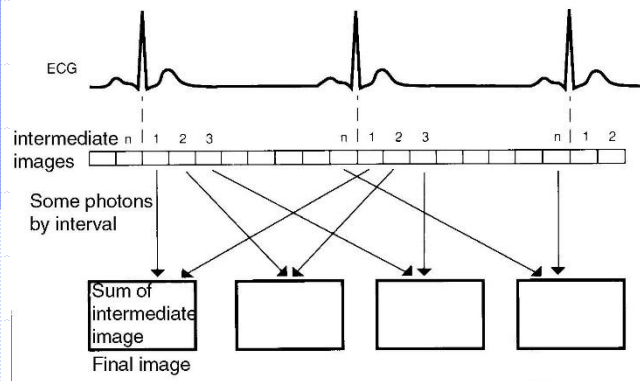
- ◆ Marquage des GR au ^{99m}Tc : Contraste
- ◆ Synchronisation ECG



- ◆ Analyse de CTA
 - Activité \propto Volume
 - Globale ou locale

Ventriculographie isotopique

- ◆ Marquage des GR au ^{99m}Tc : Contraste
- ◆ Synchronisation ECG



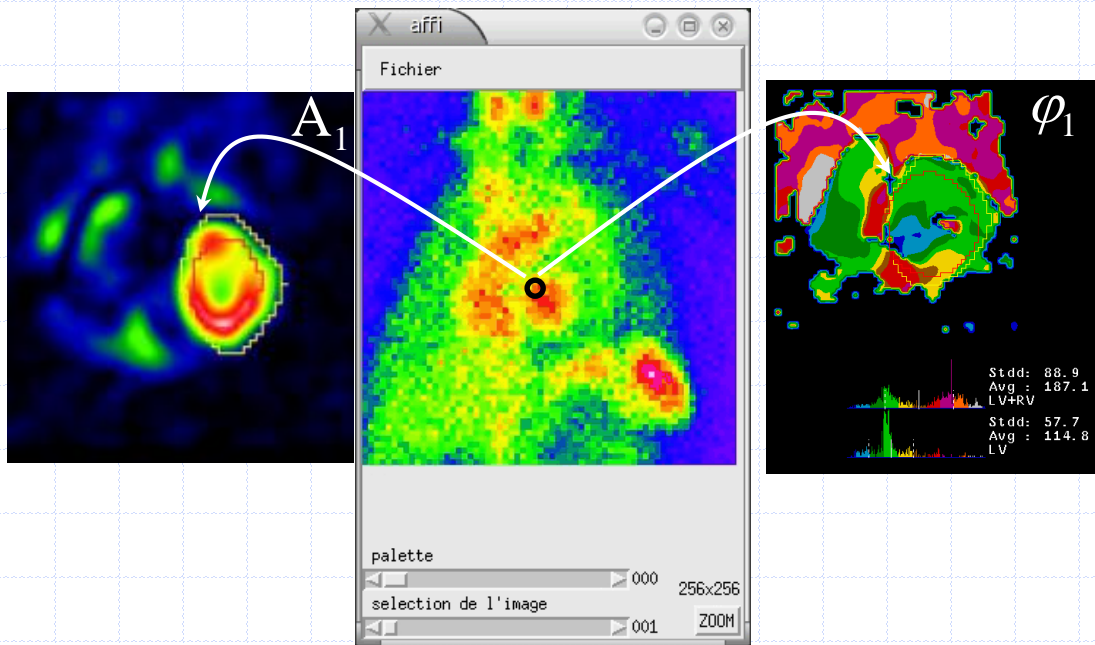
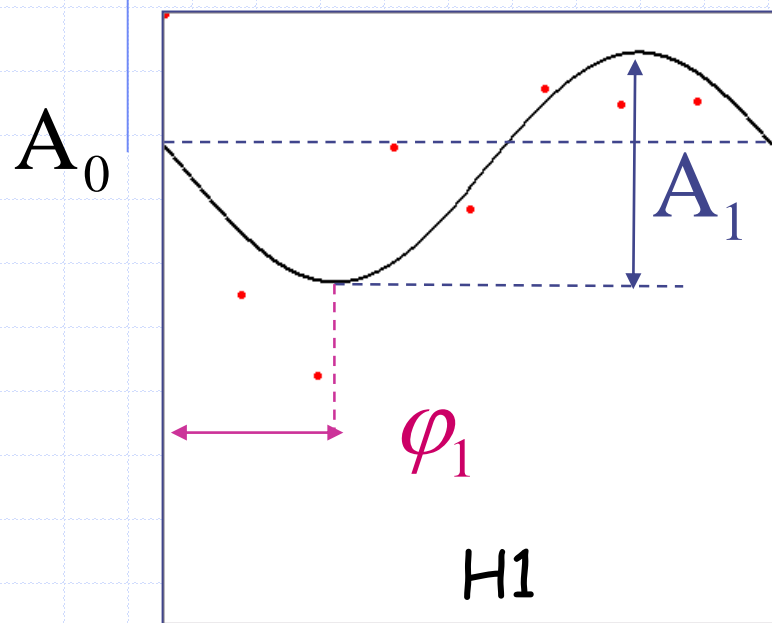
- ◆ Analyse de CTA
 - Activité \propto Volume
 - Globale ou locale

Fit harmonique

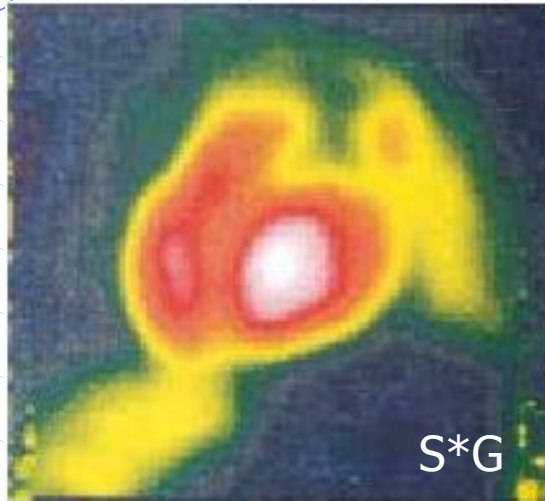
$$s(t) = \frac{1}{N} \sum_{k=0}^{N-1} \hat{s}(k) \cdot e^{j \cdot (k \cdot \omega_0) t} = \sum_{k=0}^{N-1} A_k \cdot e^{j \cdot \varphi_k} \cdot e^{j \cdot (k \cdot \omega_0) t} \approx A_0 + A_1 e^{j \cdot (\omega_0 t + \varphi_1)}$$

Ampitude
 ↙ hypokinésies ?

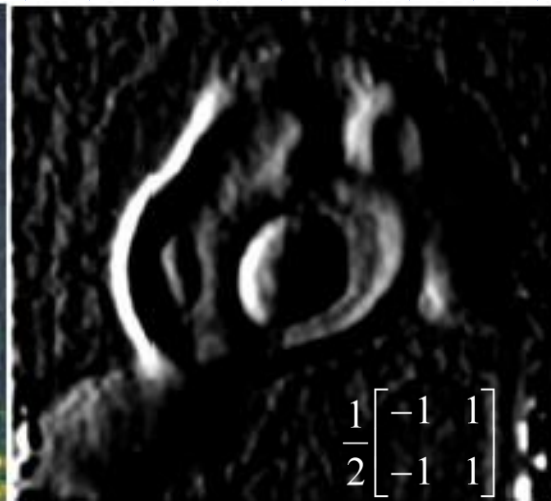
Phase
 ↘ dyskinésies ?



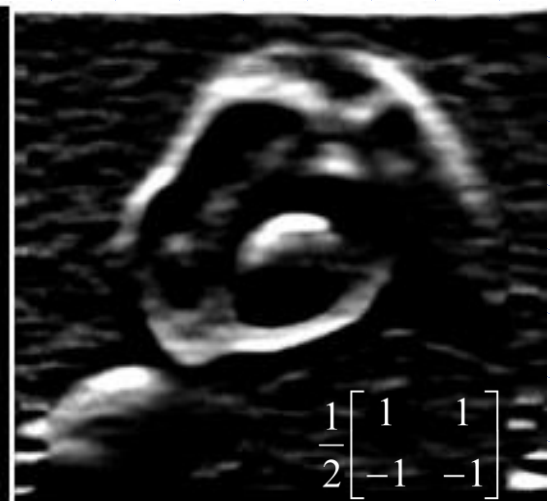
Segmentation par gradient



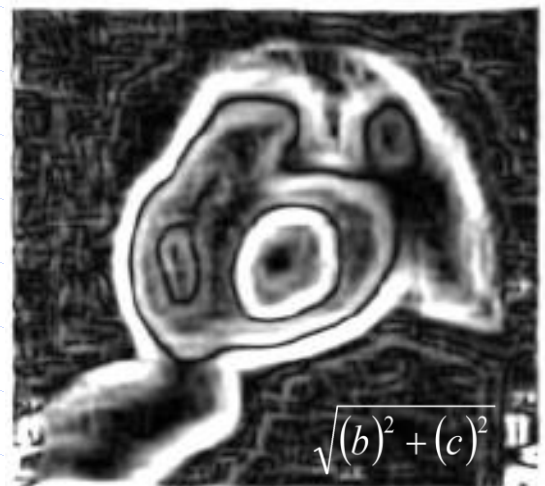
(a)



(b)



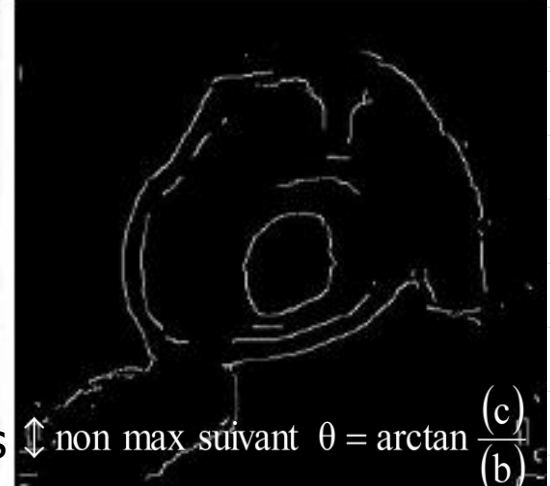
(c)



(d)

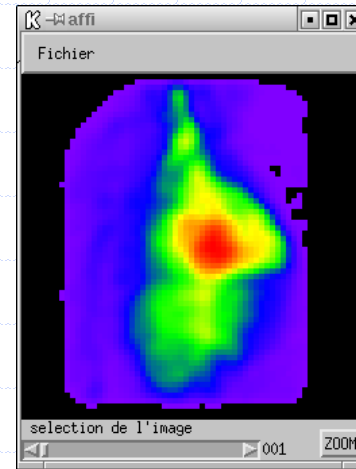
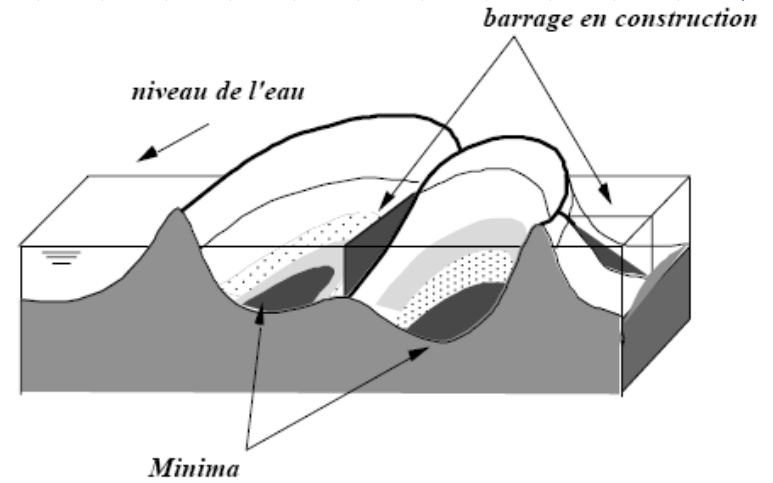


(e)

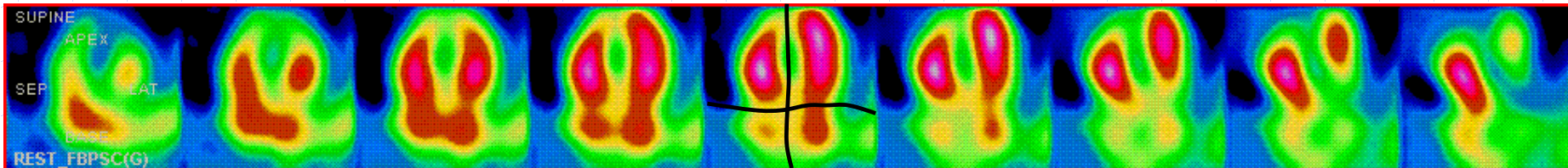


(f)

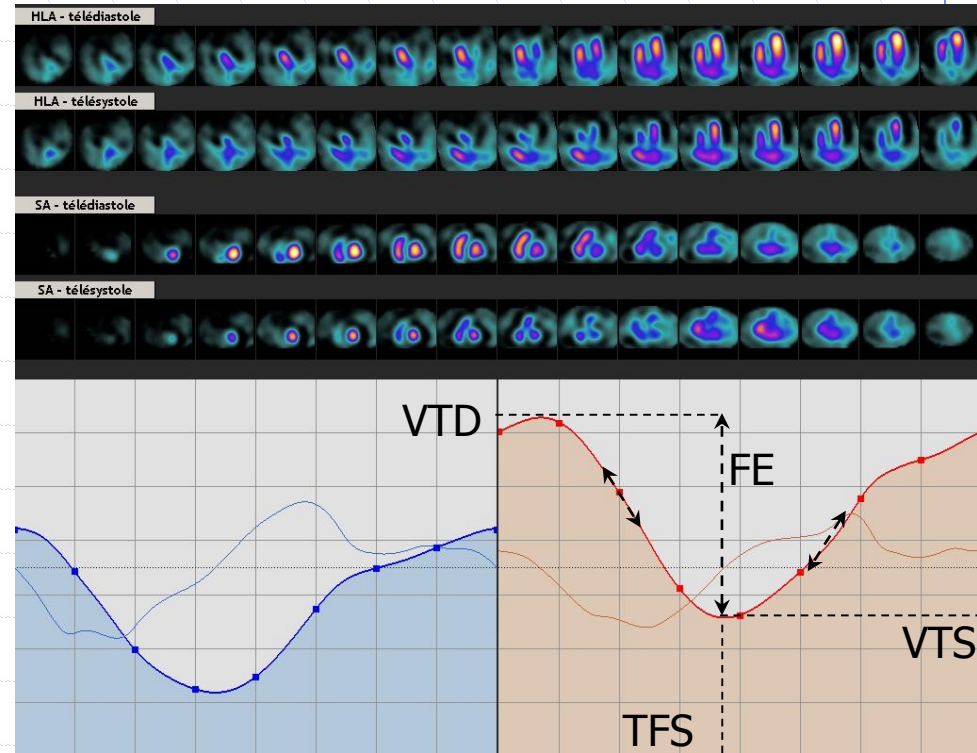
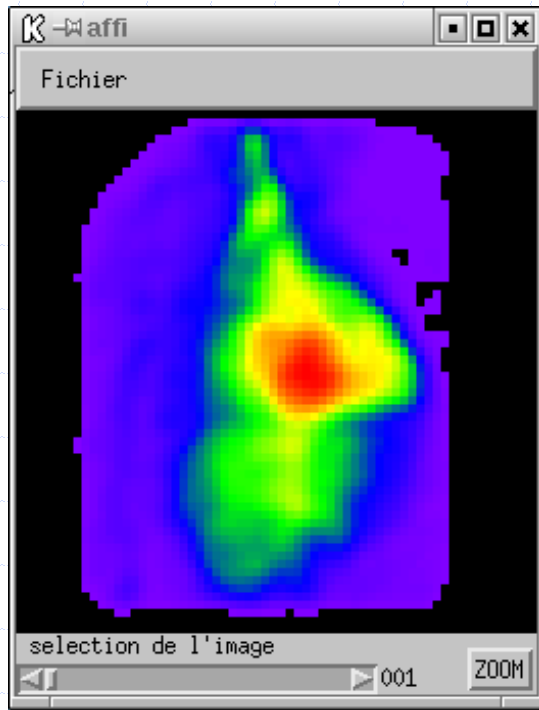
Tomo ventriculographie



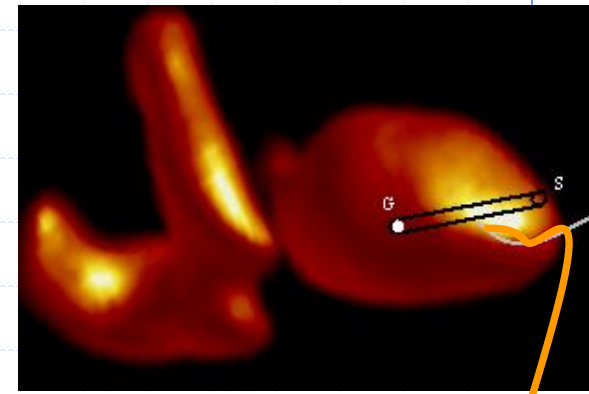
Segmentation par ligne de partage des eaux



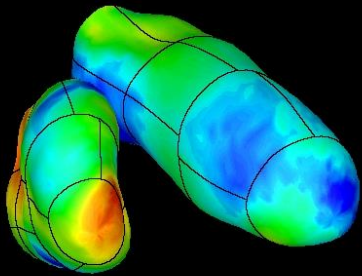
Paramètres globaux



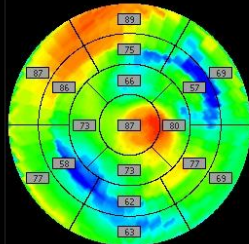
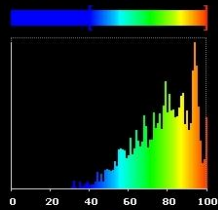
Paramètres locaux



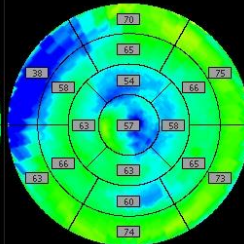
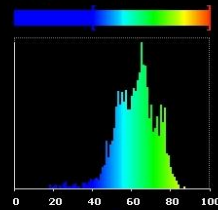
Fraction d'éjection systolique (%)



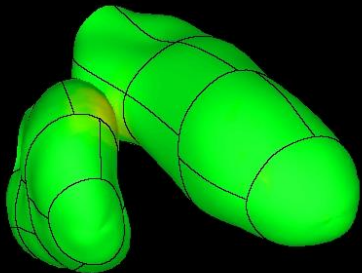
FES (%) : 78 +/- 15



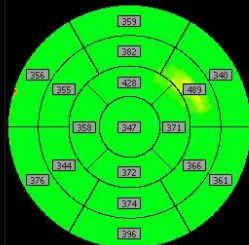
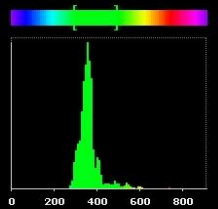
FES (%) : 62 +/- 11



Temps de fin de systole (ms)



TFS (ms) : 358 +/- 50



TFS (ms) : 434 +/- 42

