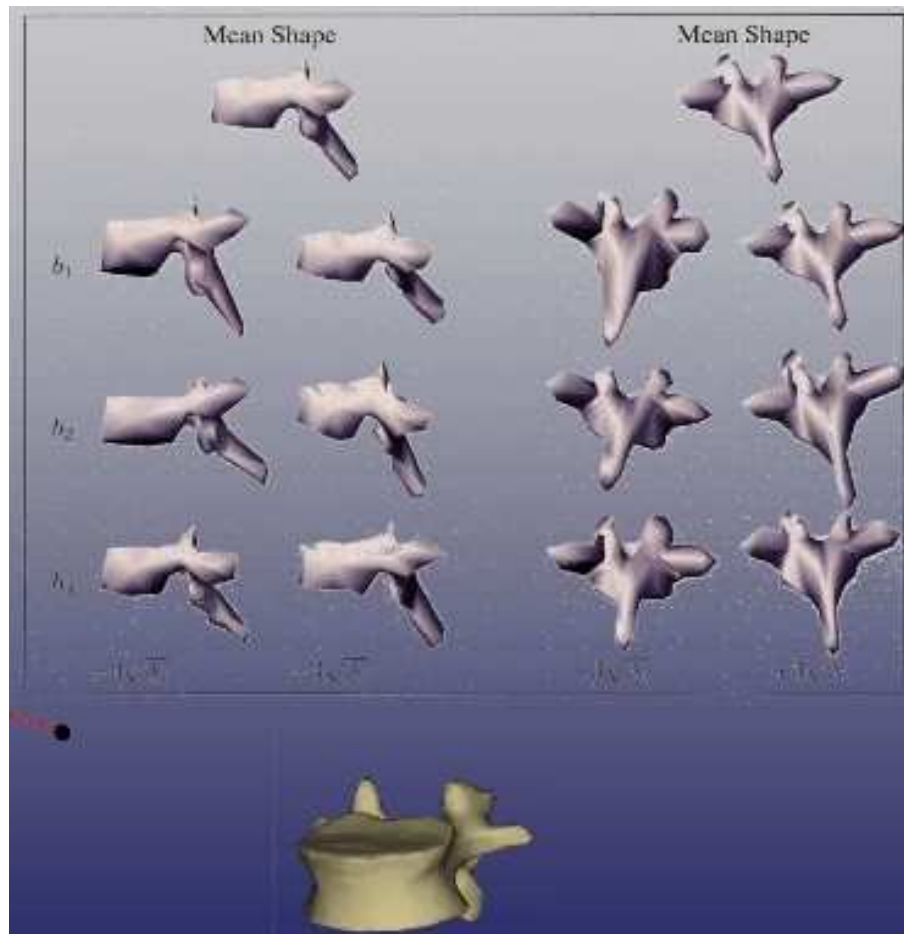
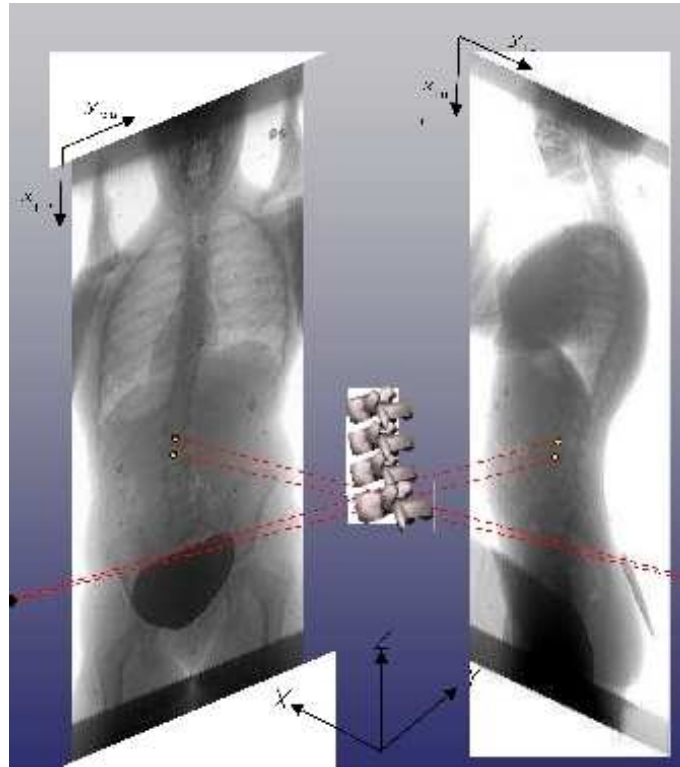


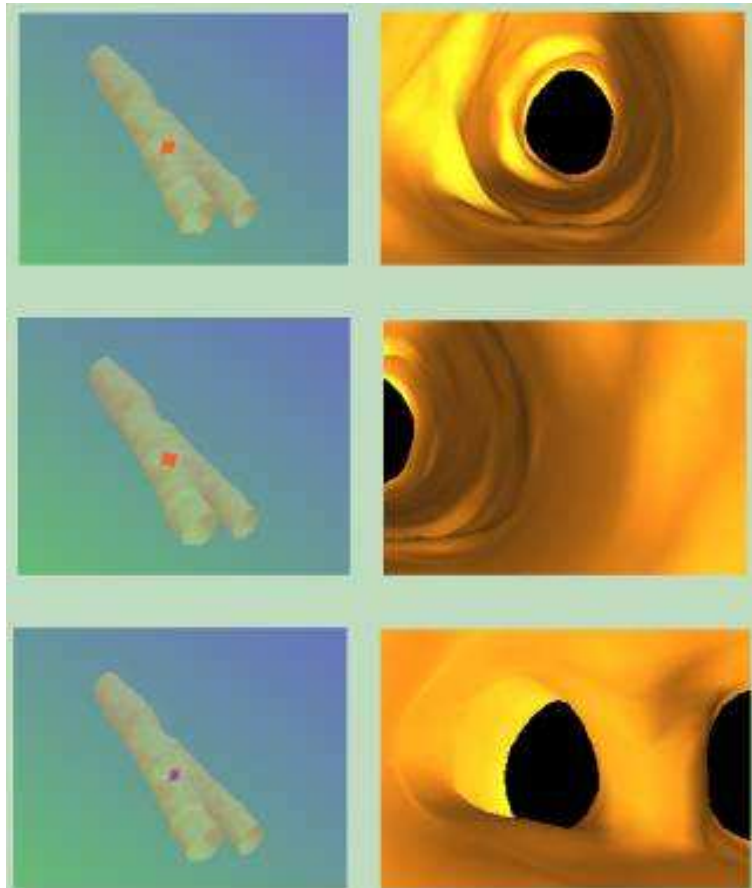
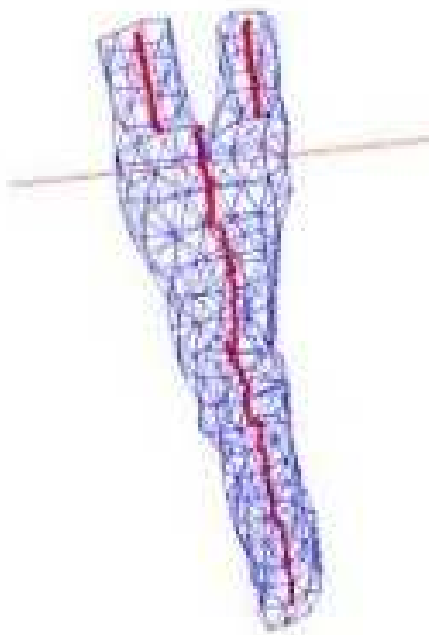
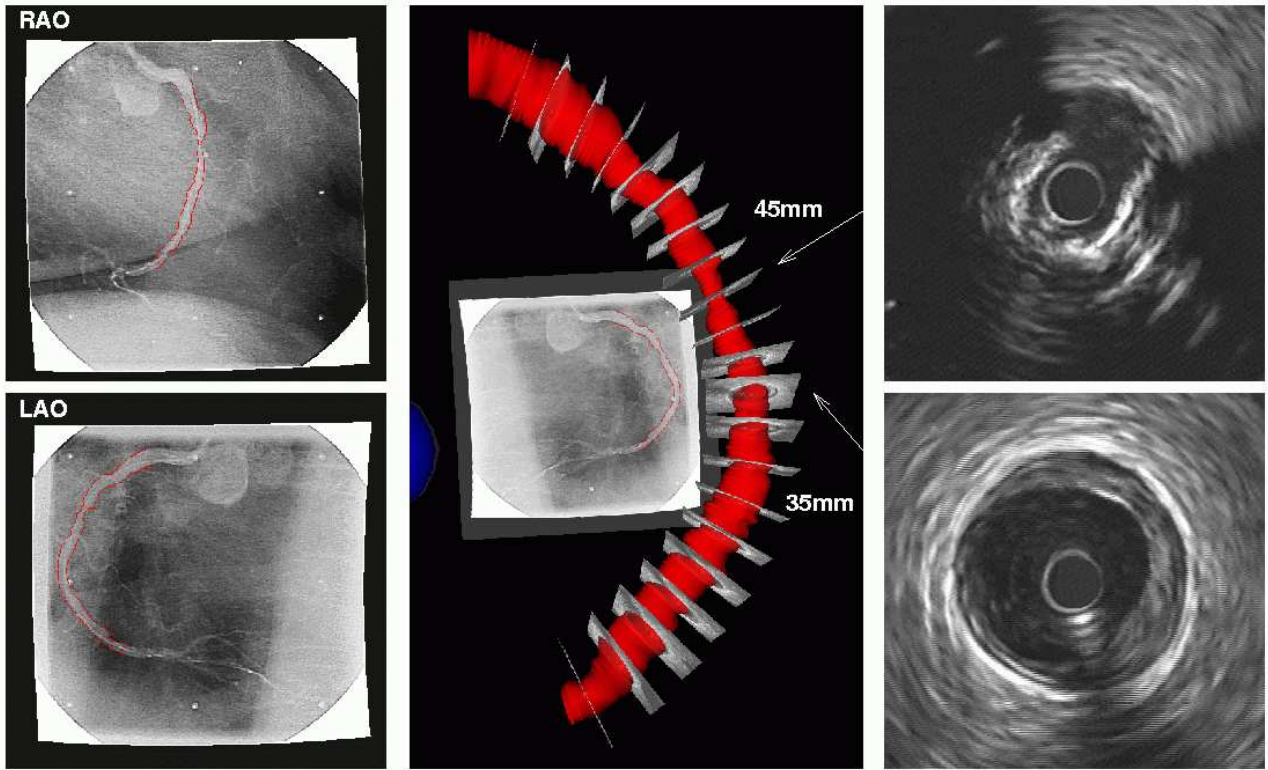
# INTRODUCTION

## Reconstruction 3D de la Colonne Vertébrale



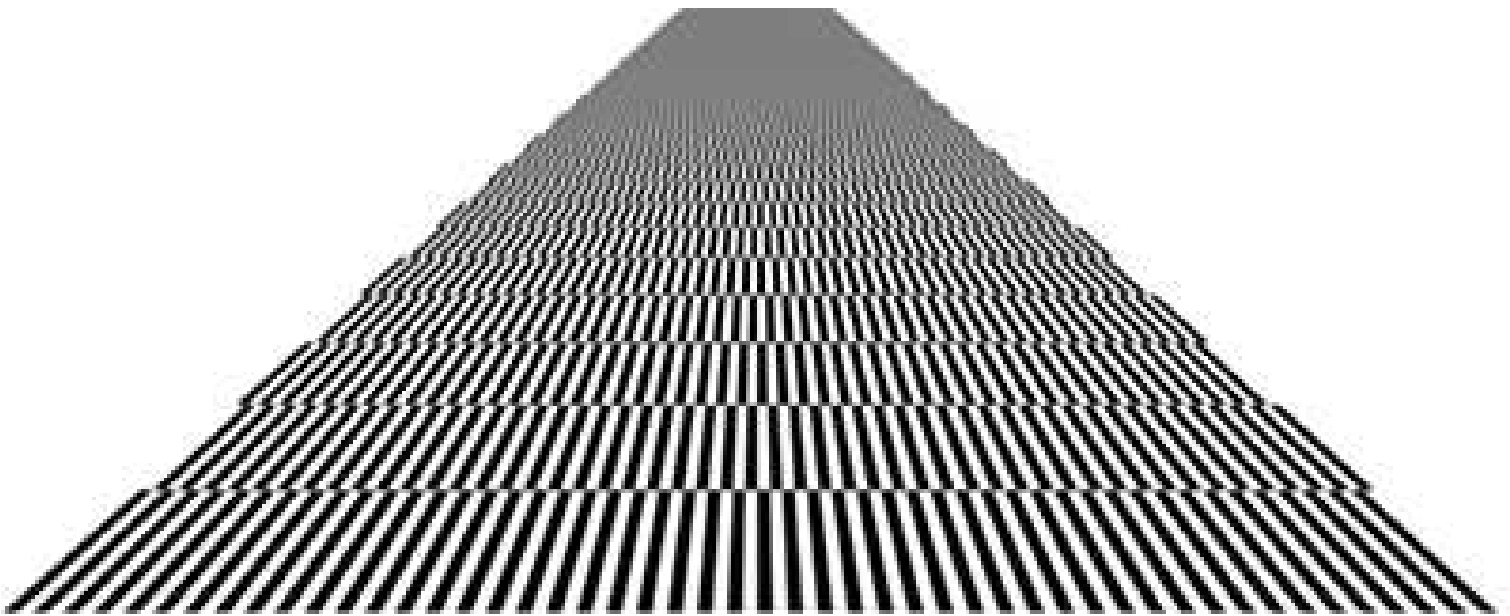
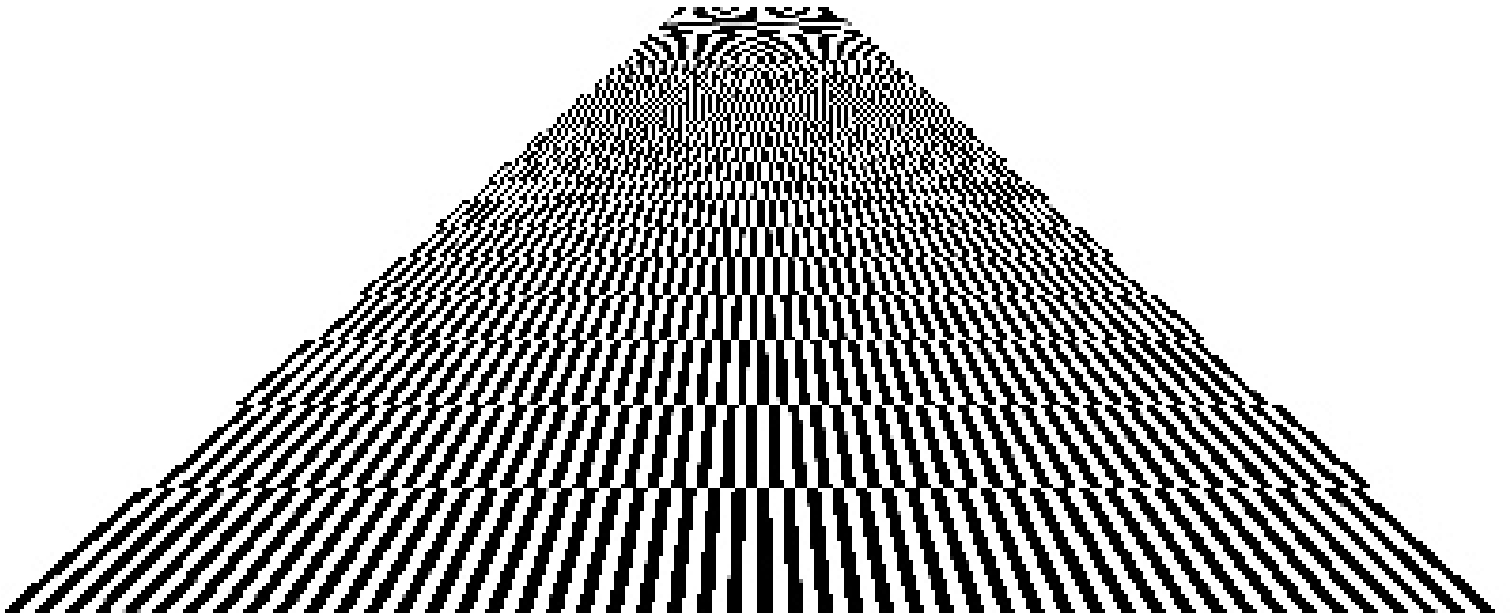
# INTRODUCTION

## Reconstruction Angiographique



# TRANSFORMÉ DE FOURIER

Aliasing & Antialiasing



# TFD

Périodisation Implicite de l'Image

$$\text{TFD} \left( \begin{array}{c} \text{Portrait of a man} \end{array} \right)$$

=

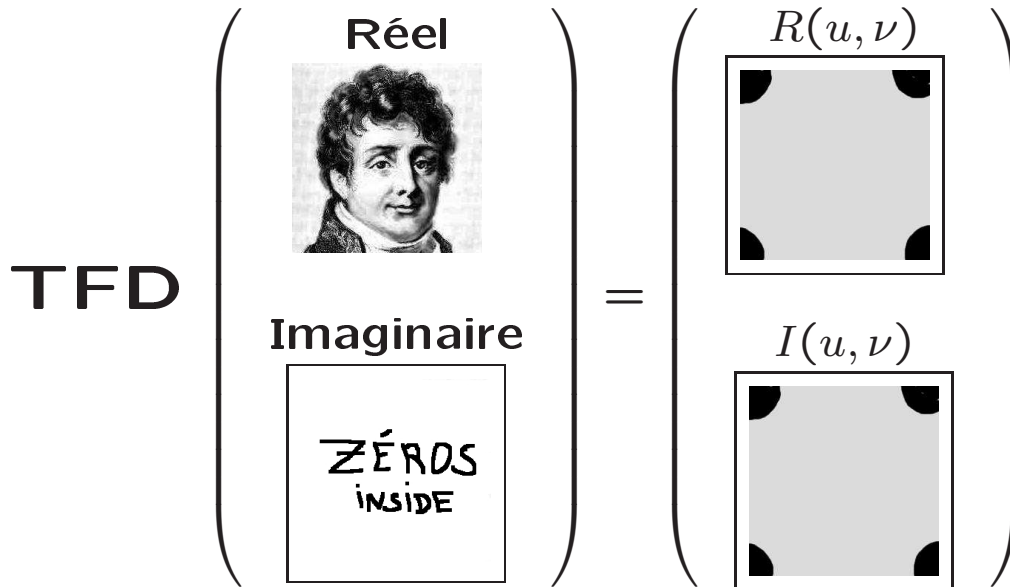
$$\text{TF} \left( \begin{array}{c} \vdots \\ \vdots \\ \text{Portrait grid} \\ \vdots \\ \vdots \end{array} \right)$$

The grid contains 12 portraits of a man, arranged in 3 rows and 4 columns. Ellipses indicate continuation in all directions.

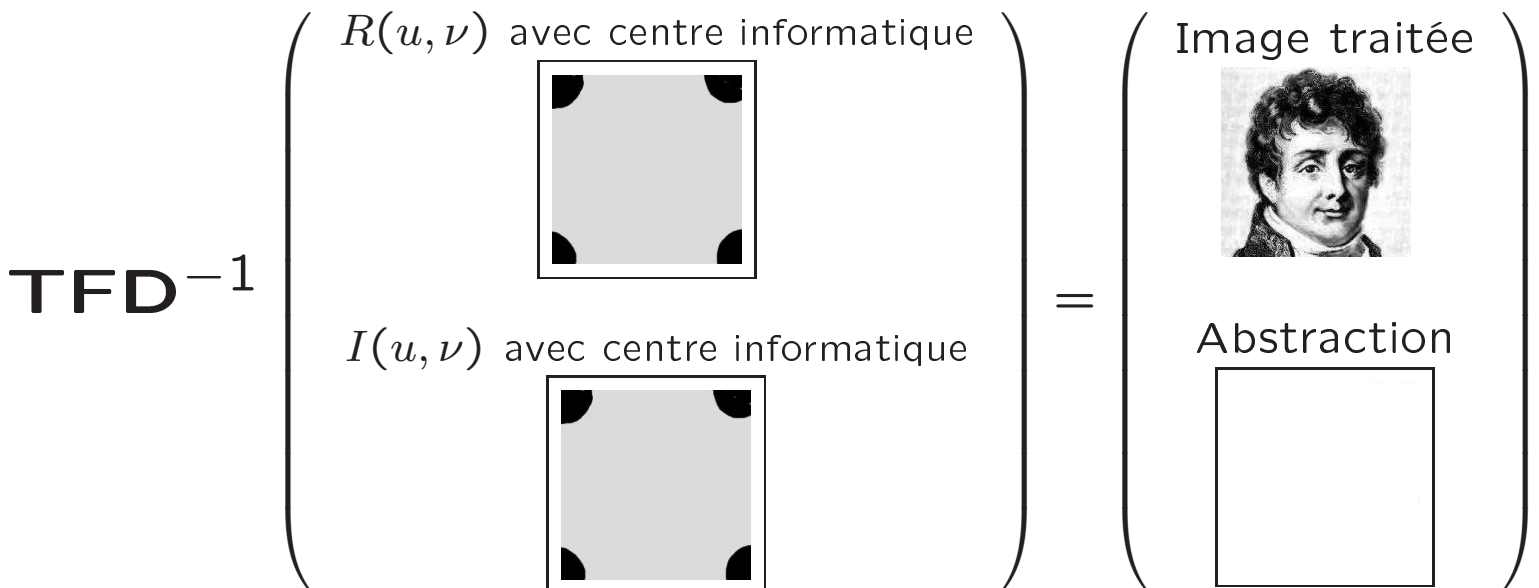
# TP1

## Algorithmiquement

$$f(x, y) \stackrel{\mathcal{F}}{\rightleftharpoons} F(u, \nu) = R(u, \nu) + jI(u, \nu)$$



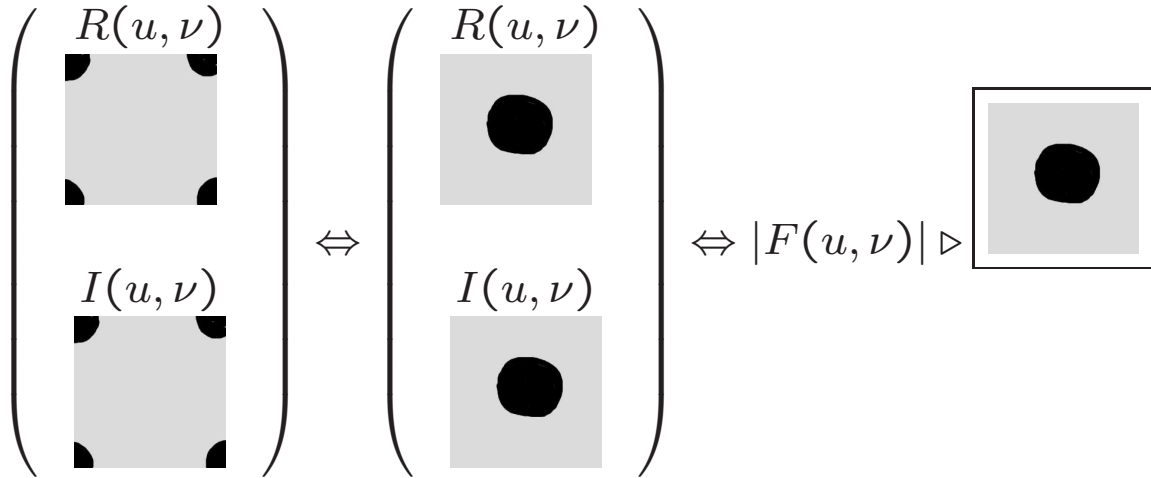
et



# TP1

## Modification et Visualisation du Module

$$|F(u, \nu)| = \sqrt{R^2(u, \nu) + I^2(u, \nu)}$$



### Exemples

$$|F(u = 3, \nu = 3)| = 0 \quad \Leftrightarrow \quad \begin{aligned} R(u = 3, \nu = 3) &= 0 \\ I(u = 3, \nu = 3) &= 0 \end{aligned}$$

$$|F(u = 3, \nu = 3)| \times 2 \quad \Leftrightarrow \quad \begin{aligned} R(u = 3, \nu = 3) &\times 2 \\ I(u = 3, \nu = 3) &\times 2 \end{aligned}$$

### Nota -1-

Mult et  $(1 + \log)$

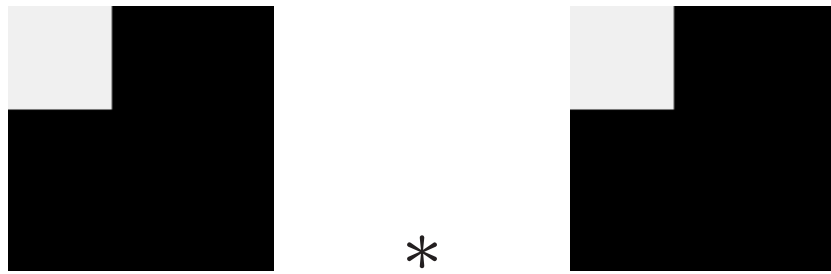
► seulement pour la visualisation d'un module de spectre !

### Nota -2-

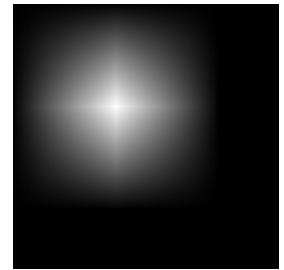
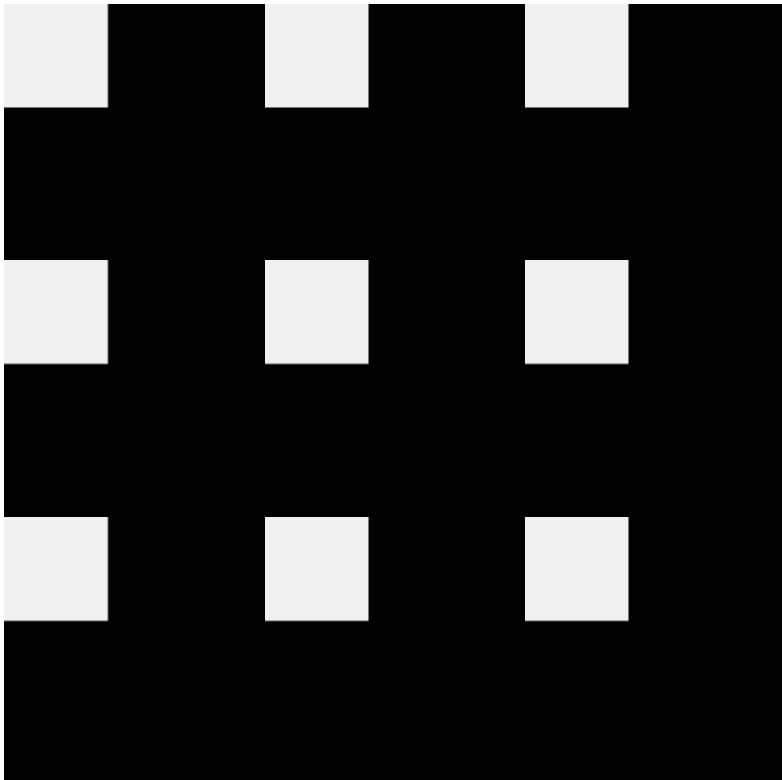
discontinuités horizontales  $\xLeftrightarrow{\mathcal{F}}$  discontinuités verticales

# TP1

## Recouvrement Spatial

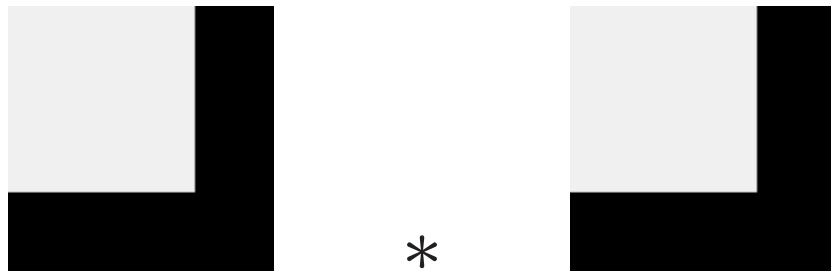


En utilisant la TFD

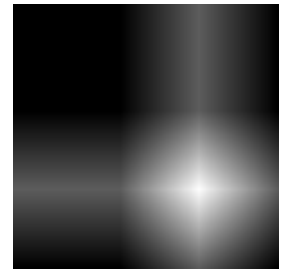
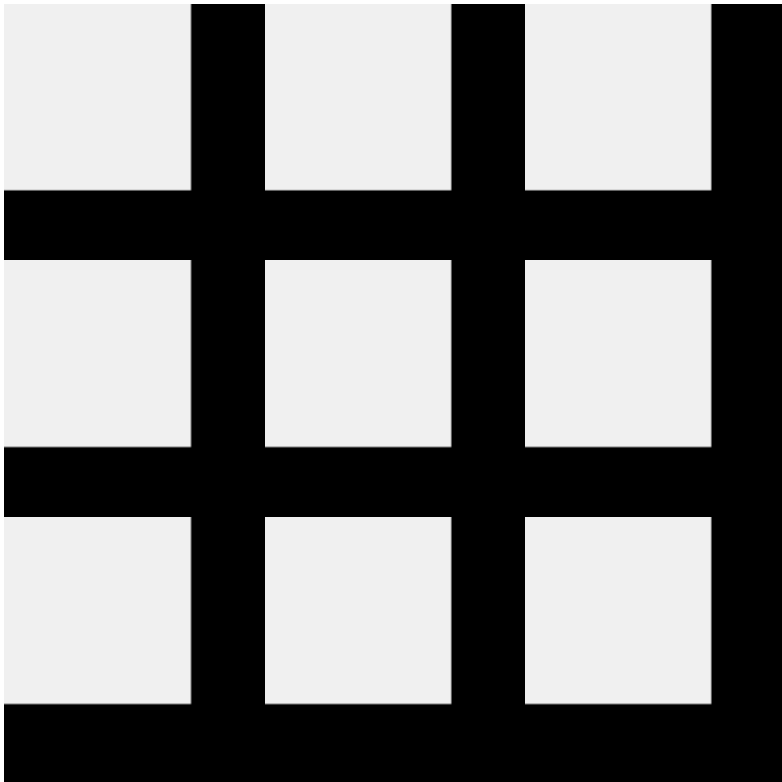


# TP1

## Recouvrement Spatial



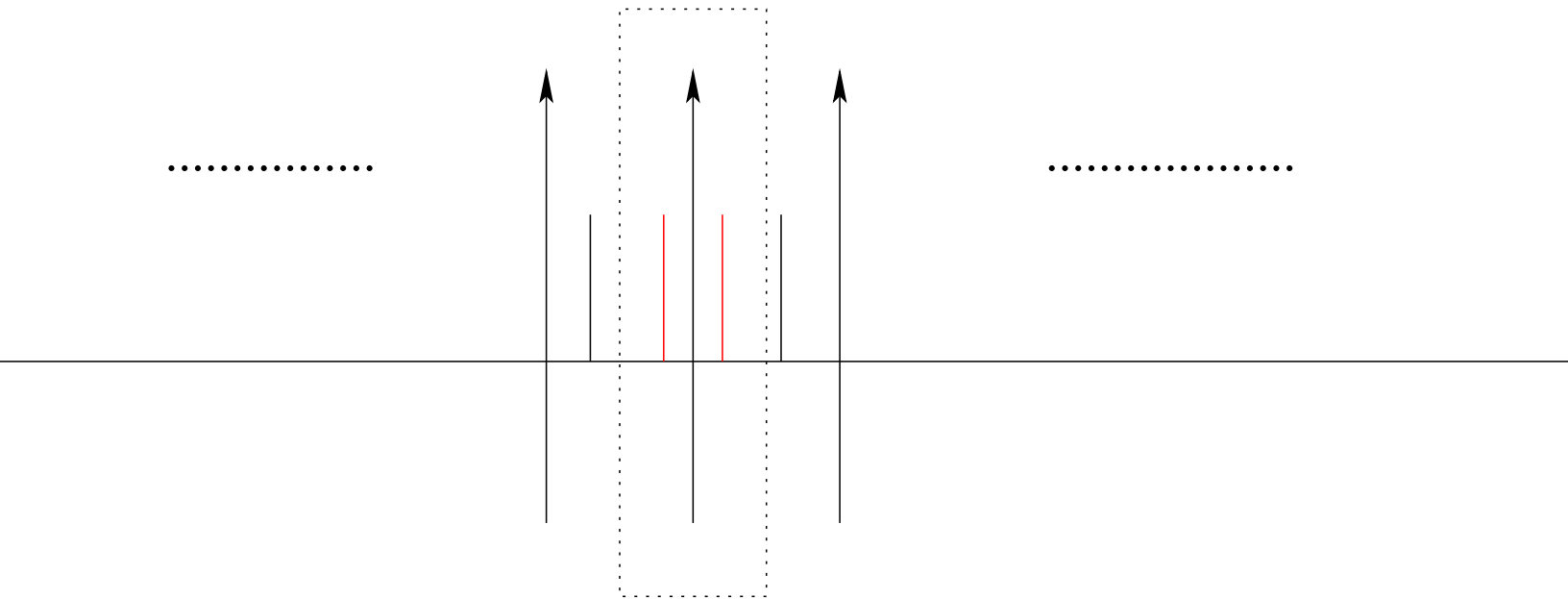
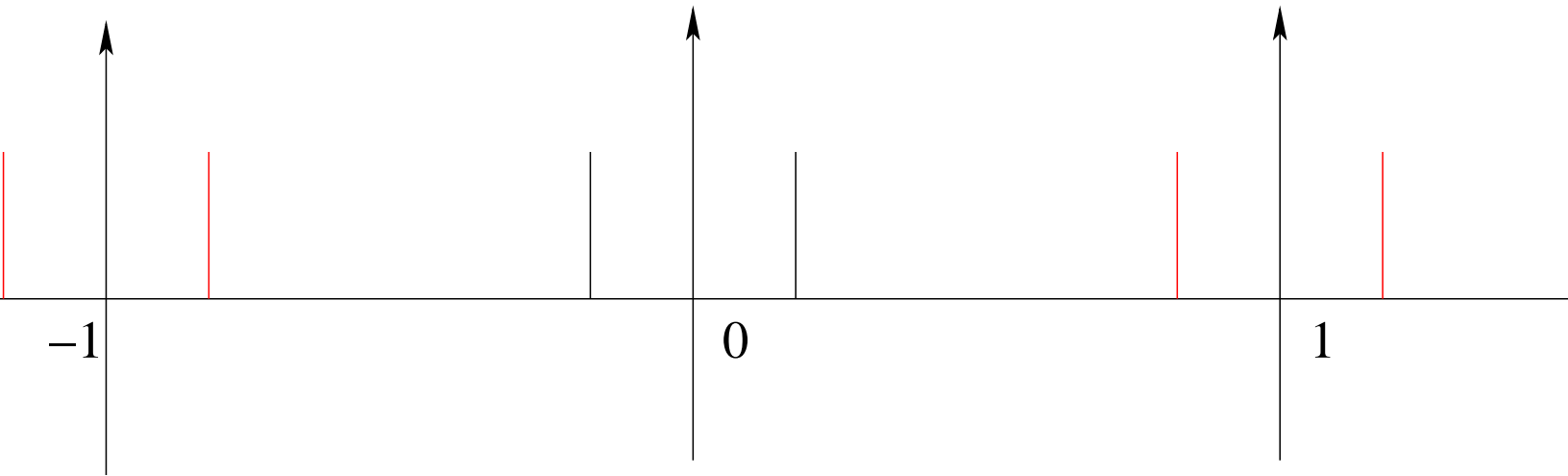
En utilisant la TFD





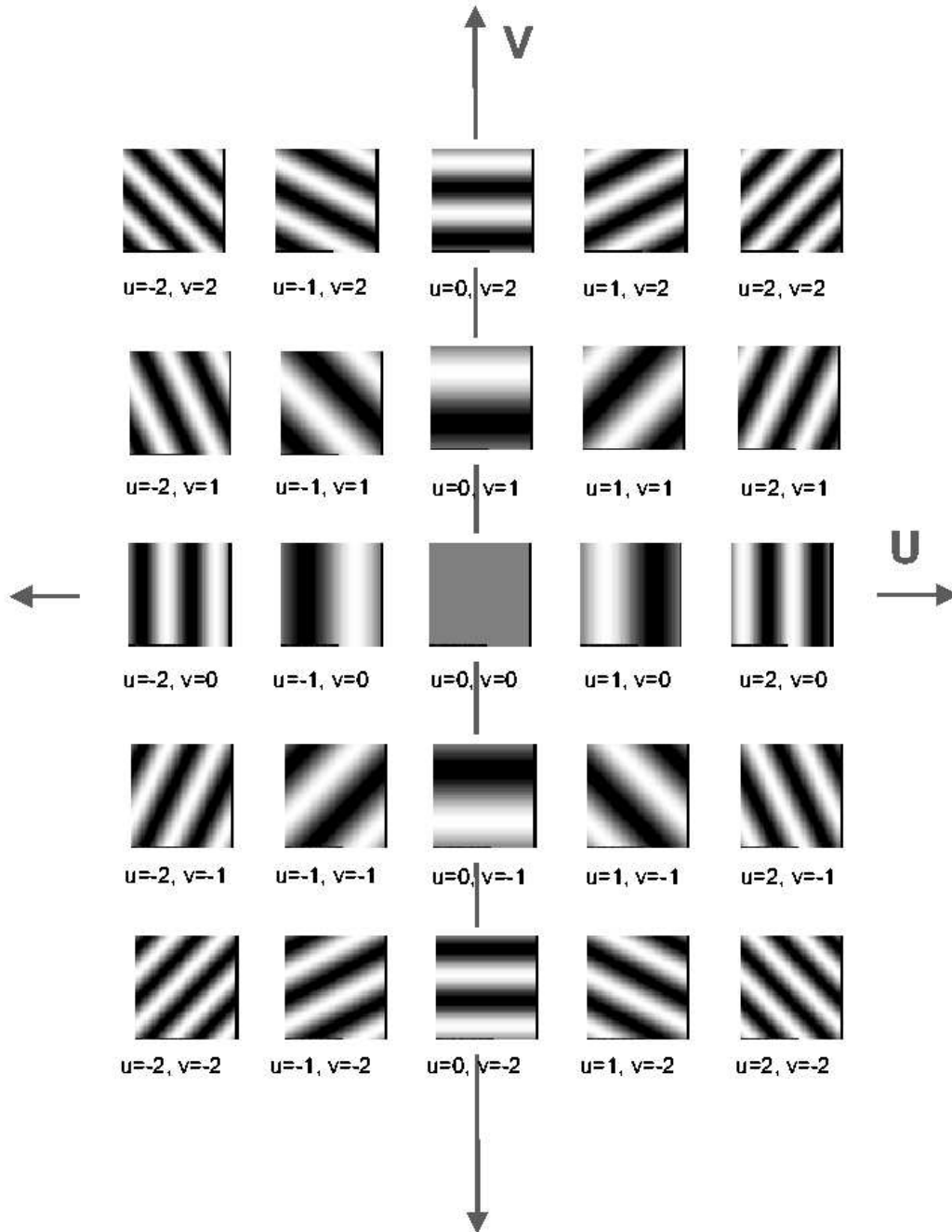
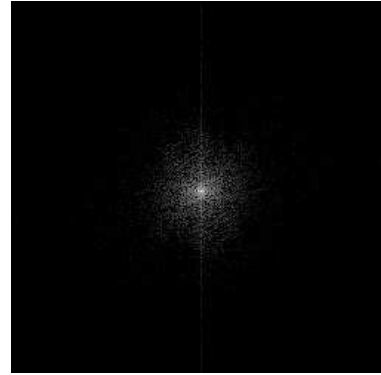
# TP1

## Sous-Échantillonnage



# TF DISCRÈTE

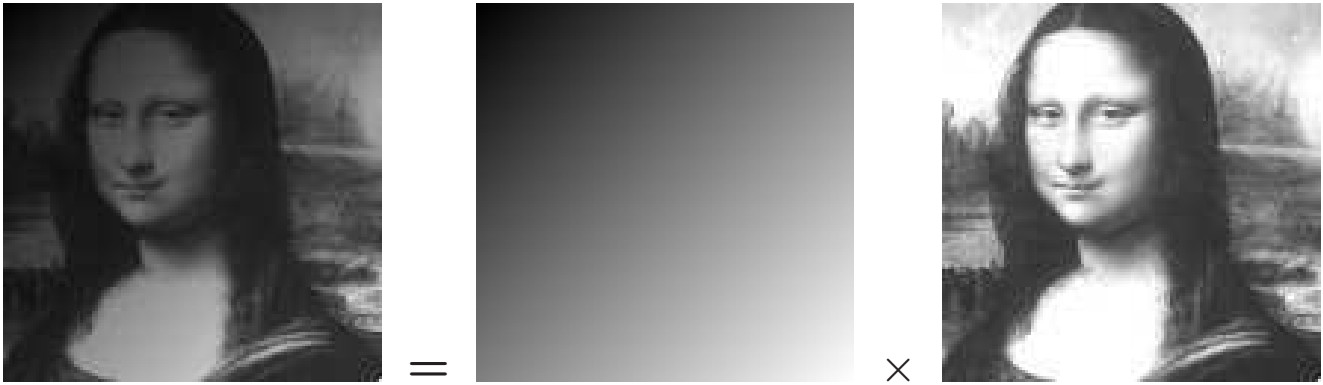
## TF discrète 2D (Interprétation)



# FILTRAGE FRÉQUENTIEL

## Filtrage Homomorphique

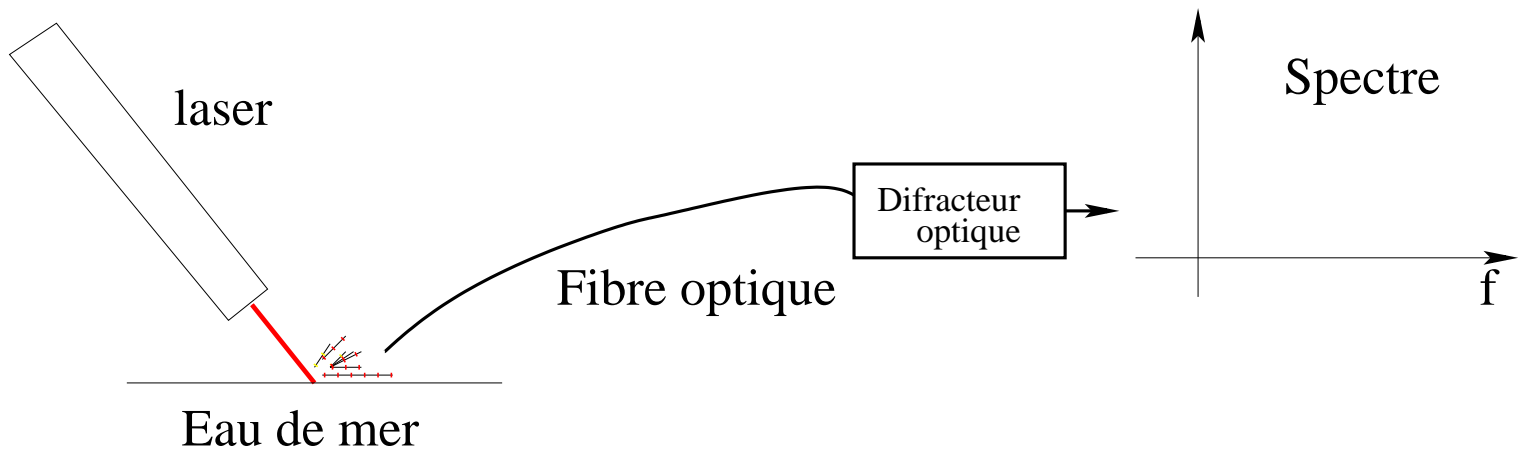
$$f(x, y) = i(x, y) \cdot r(x, y)$$



# RESTAURATION

## Déconvolution de Fonction d'Appareil

LOE (Ifremer)



# RESTAURATION

## Mars Curiosity

### TOOLS OF THE TRADE

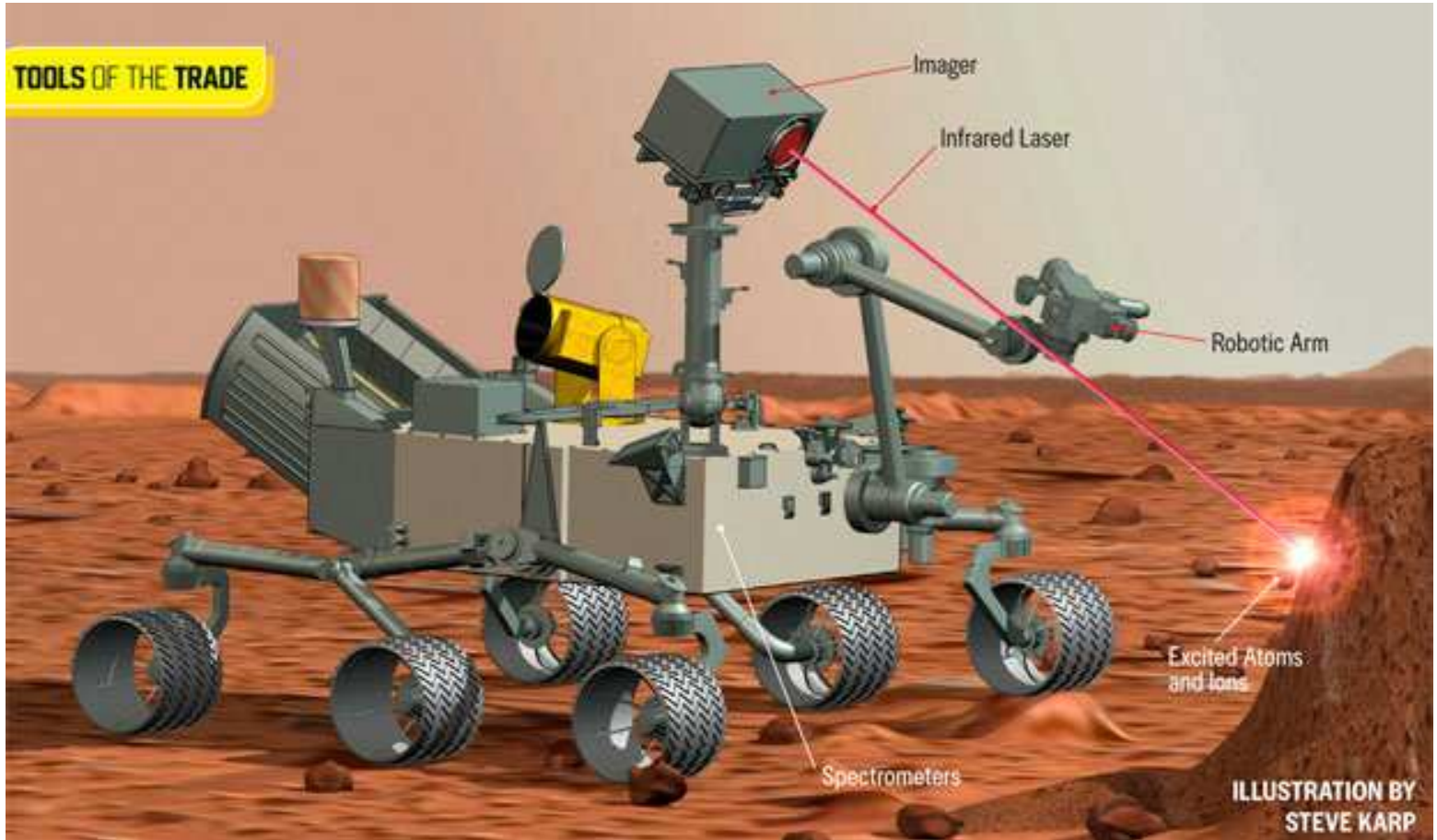


ILLUSTRATION BY  
STEVE KARP

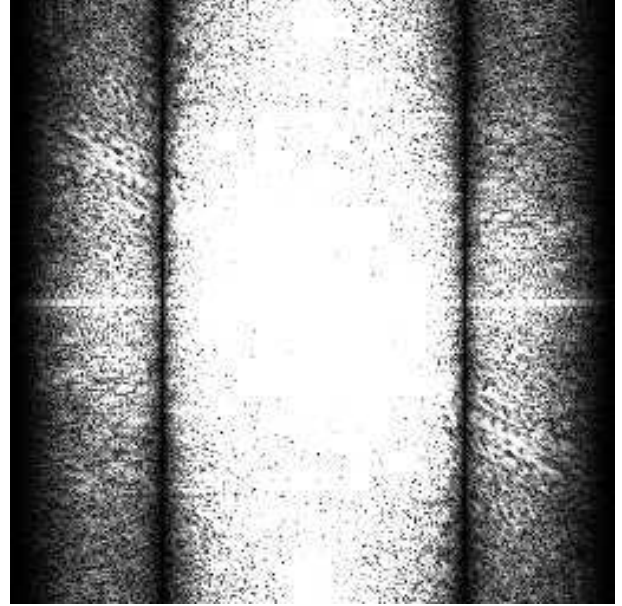
# RESTAURATION

Estimation de la PSF



# RESTAURATION

Estimation de la PSF





# RESTAURATION

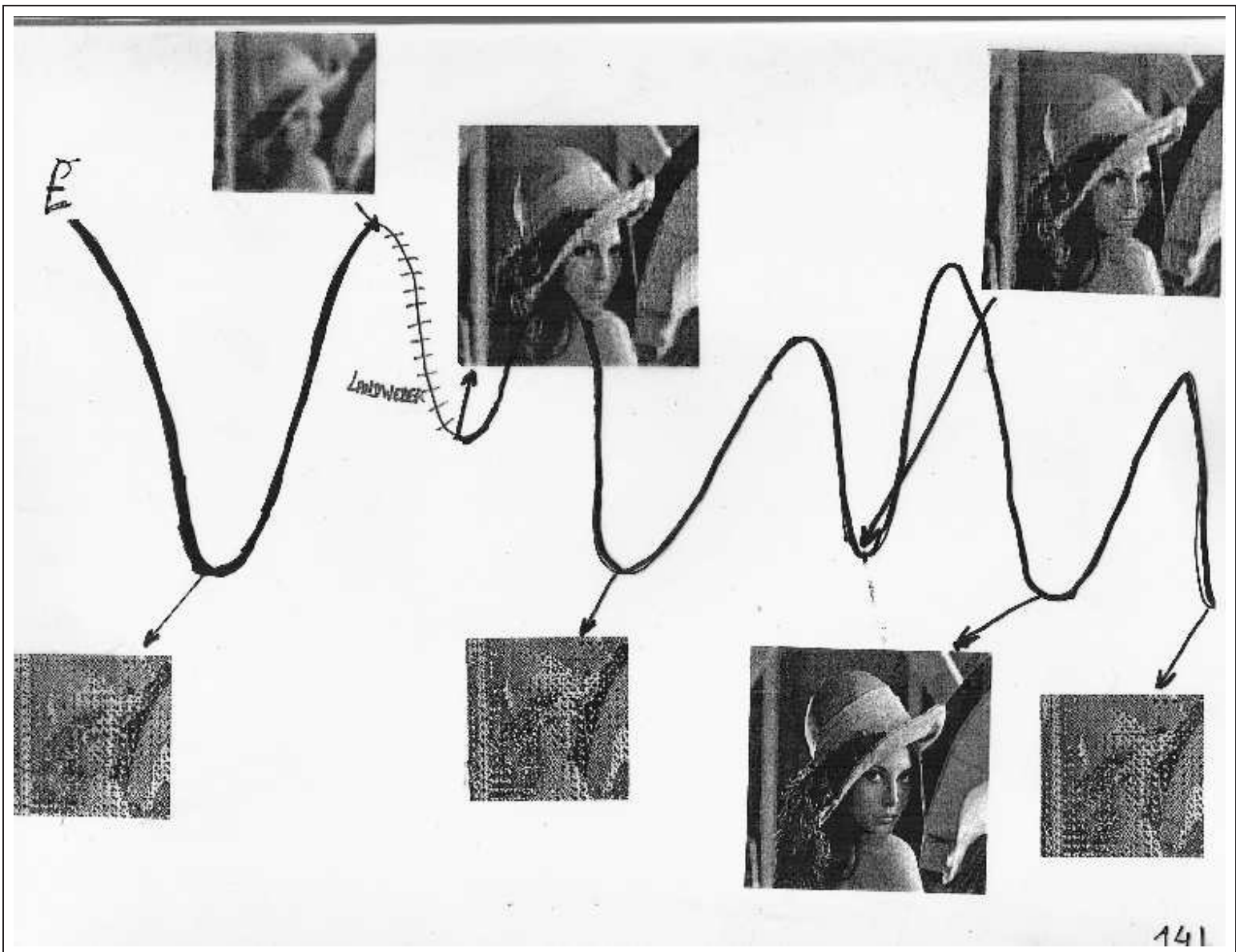
## Méthodes Itératives

### Méthodes Itératives & Problèmes Inverse Mal-Posés

Fonction de coût :

$$\hat{f}(x, y) = \arg \min_f \left\{ \|\hat{f}(x, y) - f(x, y)\|^2 \right\}$$

$$\hat{f}(x, y) = \arg \min_f \left\{ \|g(x, y) - h(x, y) * \hat{f}(x, y)\|^2 \right\}$$





# TOMOGRAPHIE

## Applications (1)

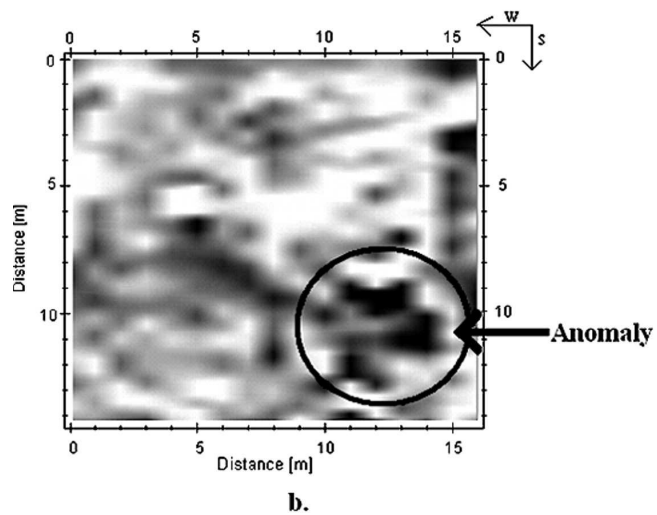
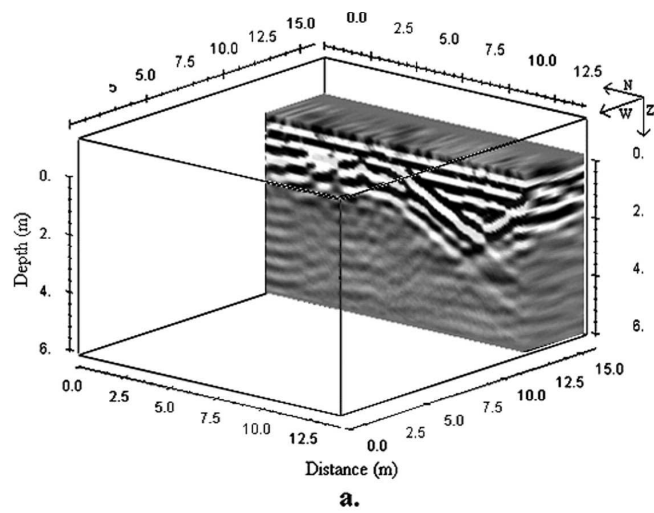
Reconstruction faciale de l'intérieur d'une momie



# TOMOGRAPHIE

## Applications (2)

### Detection de chambre mortuaires



# TOMOGRAPHIE

## Applications (3)

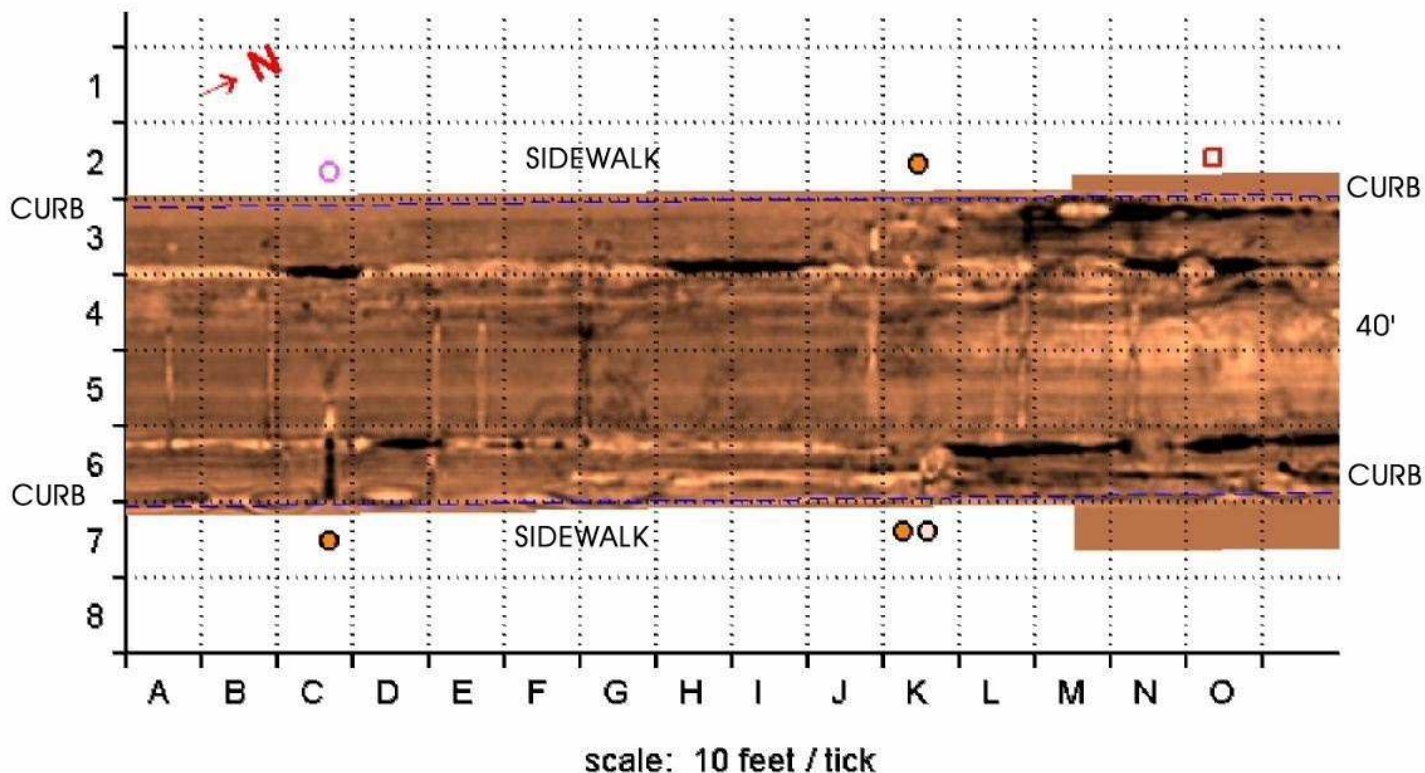
### Tomographie Radar des sols

WITTEN TECHNOLOGIES, INC

RADAR TOMOGRAPHY IMAGE OF UTILITIES AT 23" OF DEPTH

160' X 40'

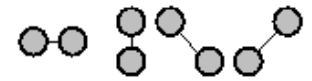
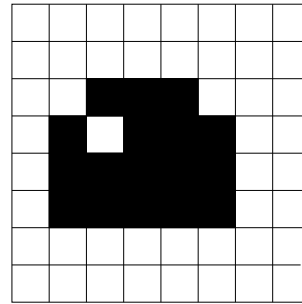
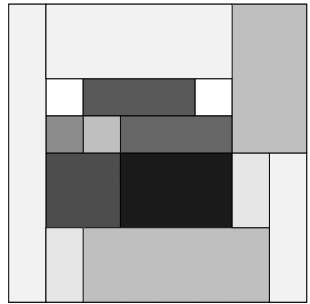
Jax - Courthouse Slice 23 Depth = 23 inches



# SEGMENTATION D'IMAGES

## ICM : Exemple de Calcul

$$\hat{x}_{MAP} = \arg \min_x \left\{ \underbrace{\sum_{s \in S} \left[ \ln(\sqrt{2\pi}\sigma_{x_s}) + \frac{(y_s - \mu_{x_s})^2}{2\sigma_{x_s}^2} \right]}_{V(x,y)} + \underbrace{\sum_{c \in C} \beta_c [1 - \delta(x_s, x_t)]}_{U(x)} \right\}$$



Voisinage du 2nd ordre avec cliques binaires

$$U(x) = \sum_{c \in C} V_c(x) \quad \text{avec} \quad V_c(x) = [1 - \delta(x_s, x_t)]$$

- A PRIORI**

$$P_{X_s}(x_s = \blacksquare) = \frac{1}{Z} \exp\left\{-\sum_{c \in C} V_c(x_s = \blacksquare)\right\} = \dots$$

$$P_{X_s}(x_s = \square) = \frac{1}{Z} \exp\left\{-\sum_{c \in C} V_c(x_s = \square)\right\} = \dots$$

- VRAISSEMBLANCE**

$$p_{Y_s/X_s}(y_s/x_s = \square) = \mathcal{N}(200, 10) \quad \& \quad p_{Y_s/X_s}(y_s/x_s = \blacksquare) = \mathcal{N}(100, 10)$$

- $y_s = 160 \triangleright$

- $y_s = 155 \triangleright$

# SEGMENTATION D'IMAGES

RS : Effet de la Température

$$P_{X_s/X_{v_s}, Y_s}(x_s/\eta_s, y_s) = \frac{1}{Z_s} \exp\left\{-\frac{1}{T_k}(U(.))\right\}$$

$$U_{\blacksquare} = 0.85$$

$$U_{\square} = 0.15$$

$$\mathbf{T=1} \triangleright$$

$$P(\blacksquare/y_s) = \frac{e^{-0.85}}{e^{-0.85} + e^{-0.15}} =$$

$$P(\square/y_s) = \frac{e^{-0.15}}{\mathcal{D}} =$$

$$\mathbf{T=10} \triangleright$$

$$P(\blacksquare/y_s) = \frac{e^{-0.85/10}}{e^{-0.85/10} + e^{-0.15/10}} =$$

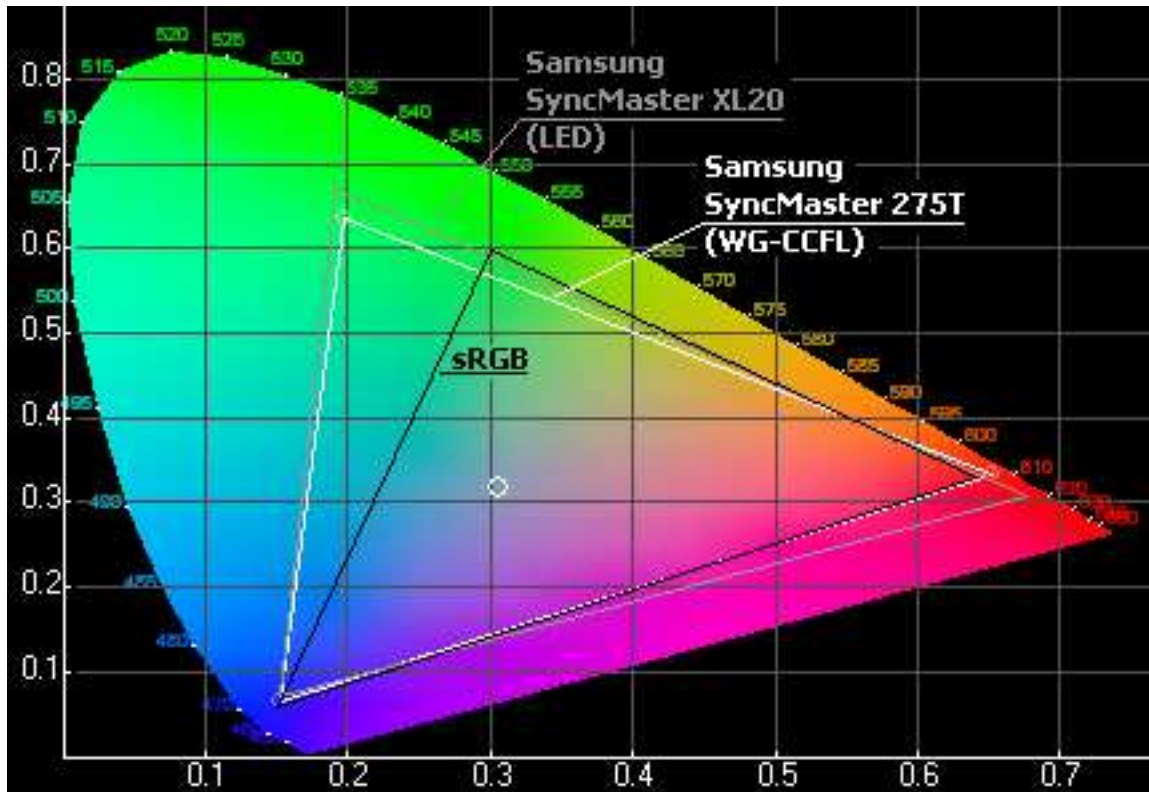
$$P(\square/y_s) = \frac{e^{-0.15/10}}{\mathcal{D}} =$$

$$\mathbf{T=0.1} \triangleright$$

$$P(\blacksquare/y_s) = \frac{e^{-0.85/0.1}}{e^{-0.85/0.1} + e^{-0.15/0.1}} =$$

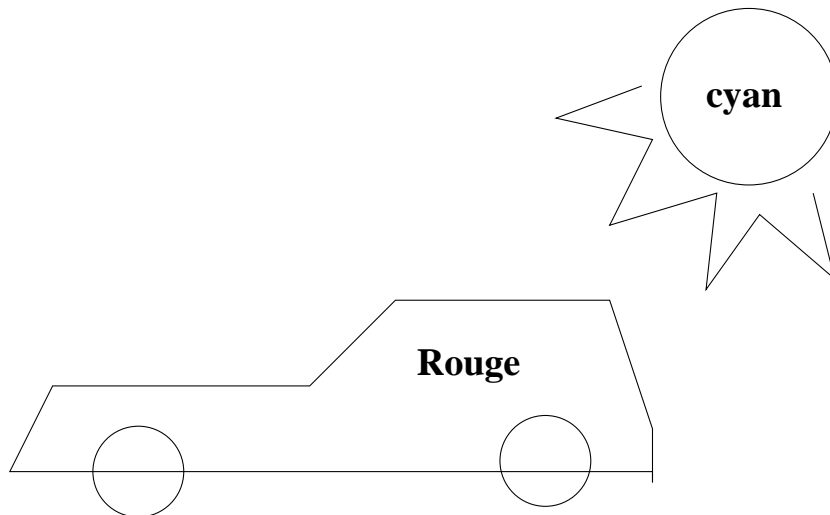
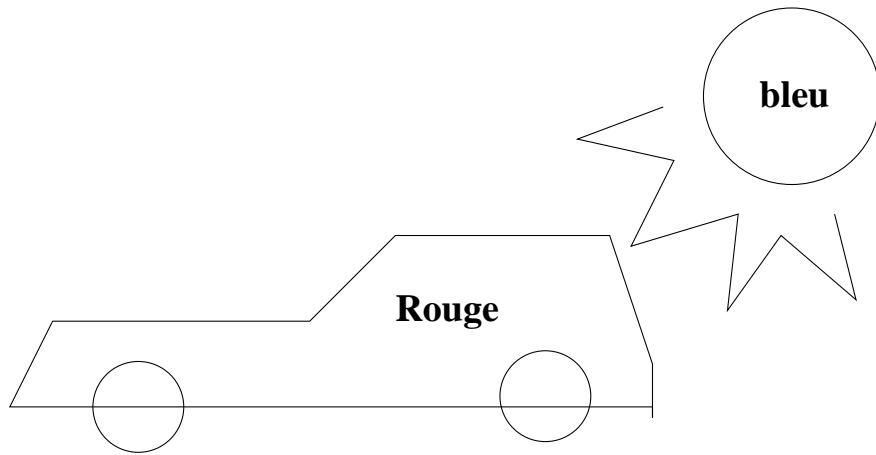
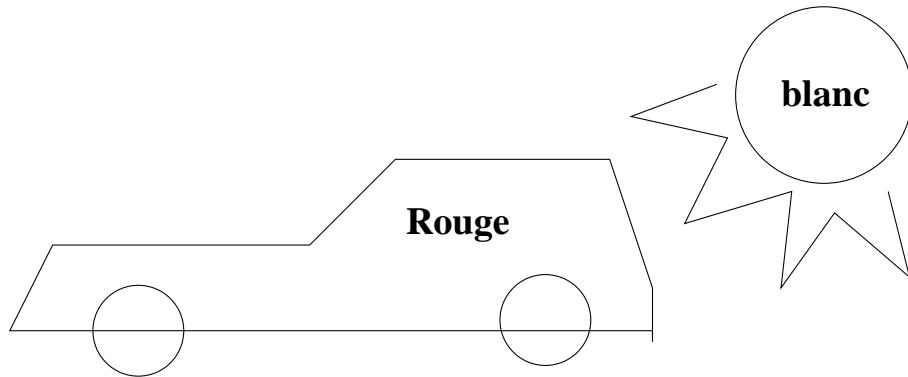
$$P(\square/y_s) = \frac{e^{-0.15/0.1}}{\mathcal{D}} =$$

# COULEURS GAMUT



# COULEURS

## CUBE RGB



# COMPRESSION

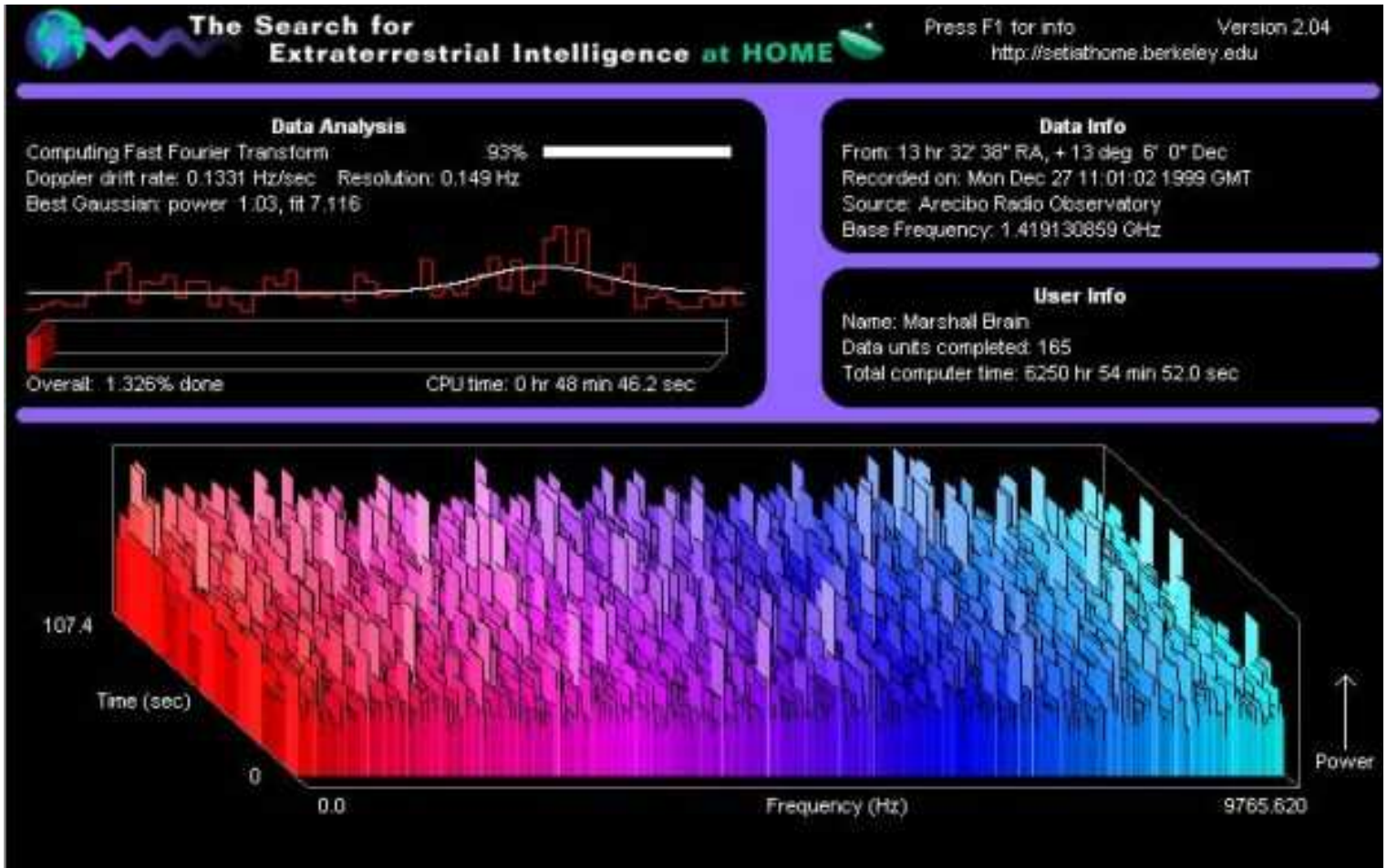
## DCT

$$\text{TCD} \left( \boxed{\text{😊}} \right) = \text{TFD} \left\{ \begin{array}{|c|c|} \triple \text{😊} & \text{😊} \\ \triple \text{😞} & \text{😞} \end{array} \right\}$$



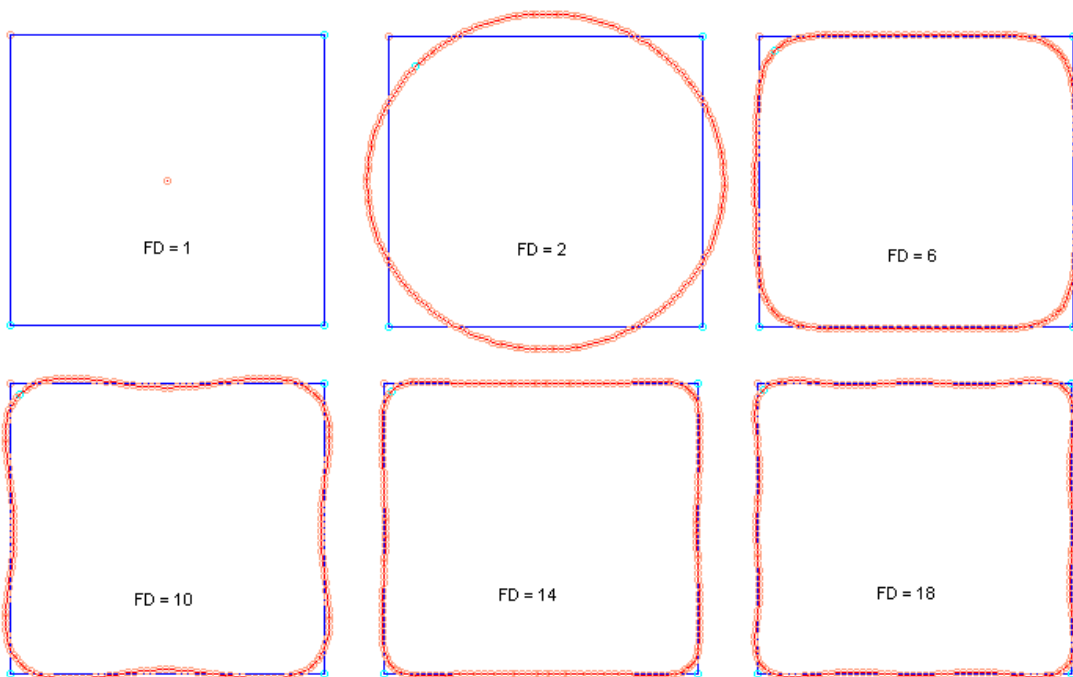
# RECONNAISSANCE DES FORMES

## PROJET SETI



# RECONNAISSANCE DES FORMES

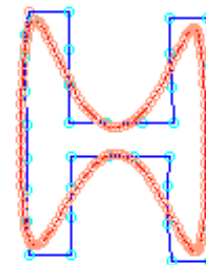
## DESCRIPTEUR DE FOURIER



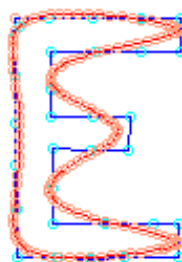
Number of FD: 6



Number of FD: 10



Number of FD: 8



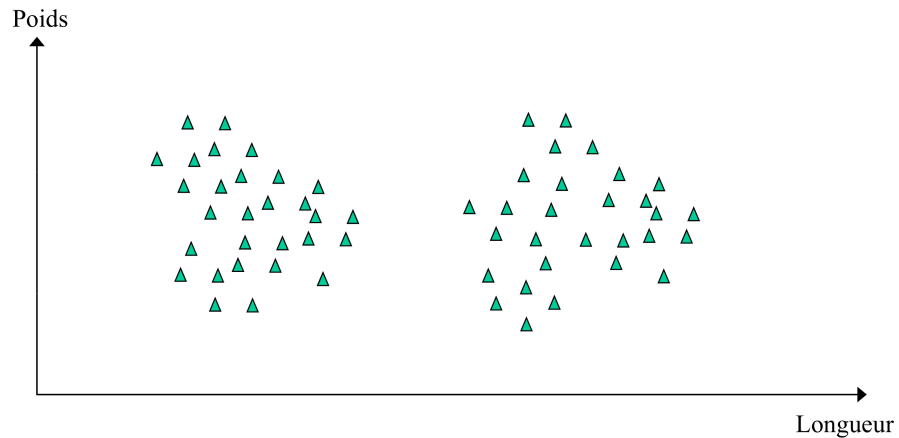
Number of FD: 8

# RECONNAISSANCE DES FORMES

## ALGORITHME DES K-MOYENNES (1)

### Algorithme des K-moyennes (*K-means*)

Exemple schématique de l'algorithme des K-moyennes

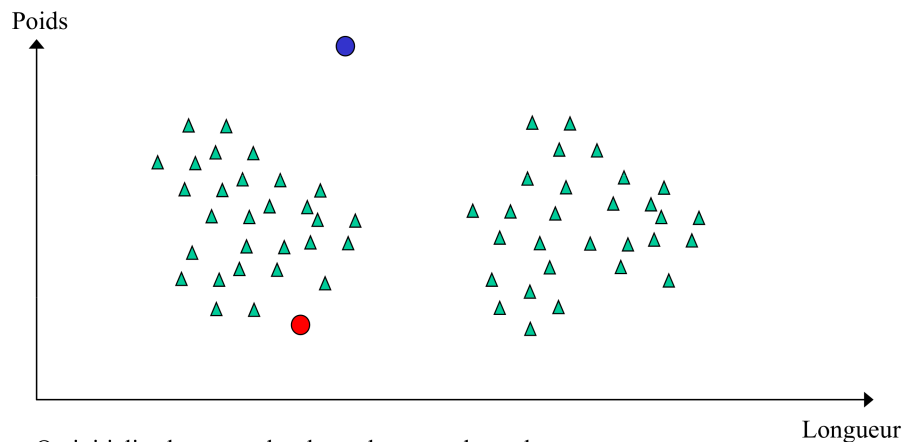


Voici 60 observations. Comment faire pour grouper ces données en deux classes et estimer la moyenne (ou le centre de masse) de ces classes ?

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### Algorithme des K-moyennes (*K-means*)

Exemple schématique de l'algorithme des K-moyennes



On initialise le centre des deux classes au hasard ● ●

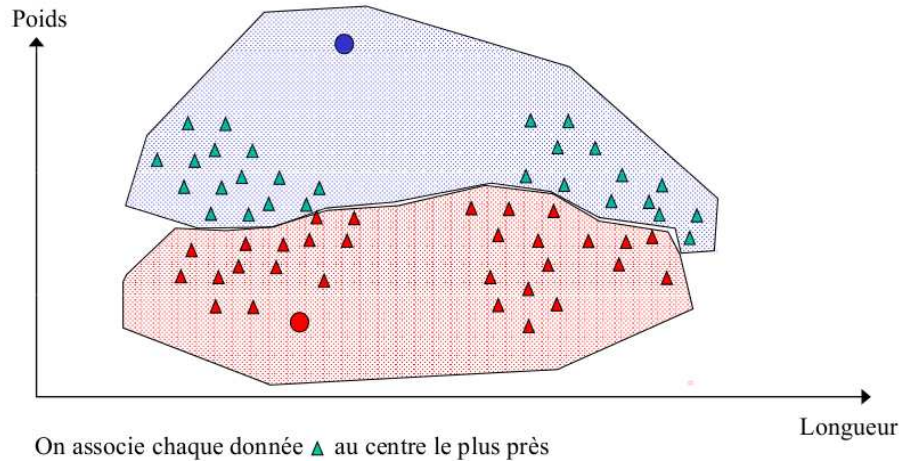
37

# RECONNAISSANCE DES FORMES

## ALGORITHME DES K-MOYENNES (2)

### Algorithme des K-moyennes (*K-means*)

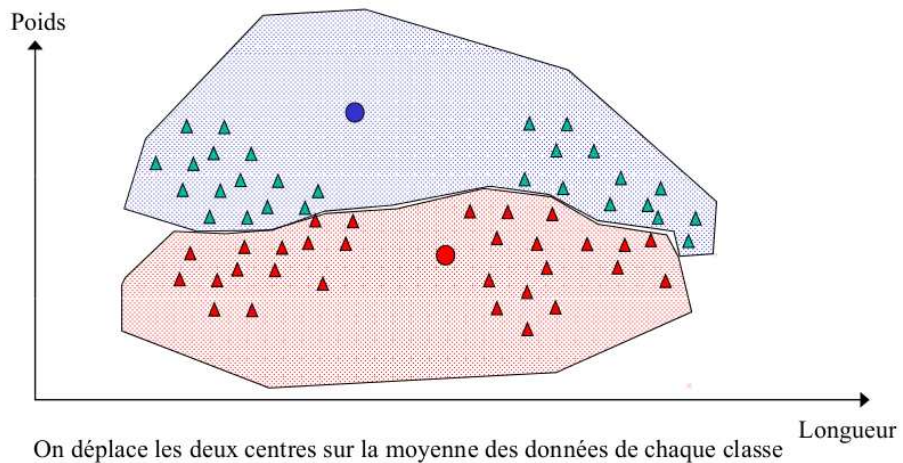
Exemple schématique de l'algorithme des K-moyennes



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### Algorithme des K-moyennes (*K-means*)

Exemple schématique de l'algorithme des K-moyennes



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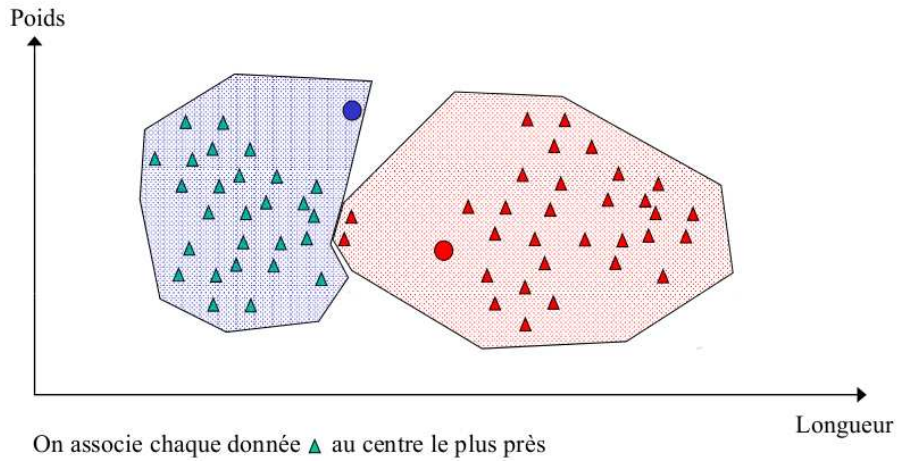


# RECONNAISSANCE DES FORMES

## ALGORITHME DES K-MOYENNES (3)

### Algorithme des K-moyennes (*K-means*)

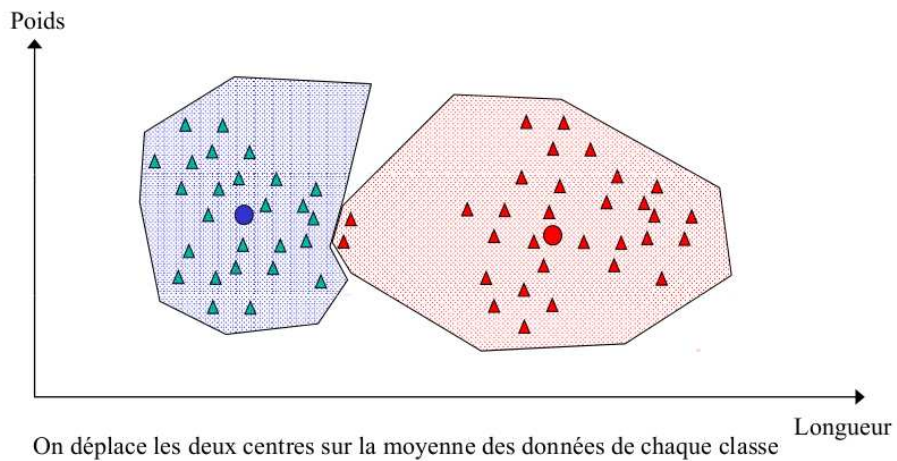
Exemple schématique de l'algorithme des K-moyennes



40

### Algorithme des K-moyennes (*K-means*)

Exemple schématique de l'algorithme des K-moyennes



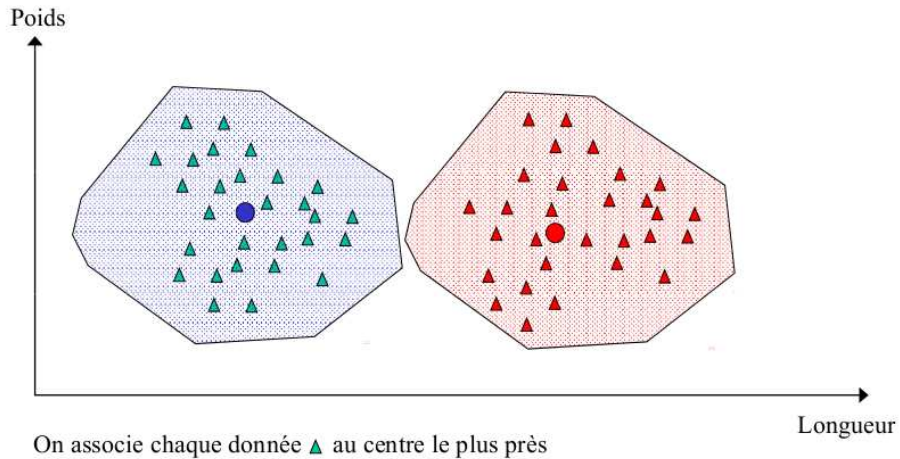
41

# RECONNAISSANCE DES FORMES

## ALGORITHME DES K-MOYENNES (4)

### Algorithme des K-moyennes (*K-means*)

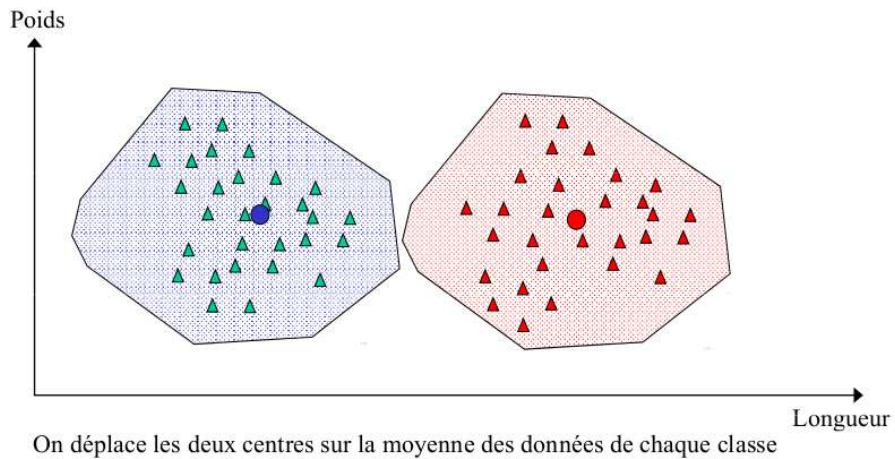
Exemple schématique de l'algorithme des K-moyennes



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### Algorithme des K-moyennes (*K-means*)

Exemple schématique de l'algorithme des K-moyennes



Lorsque l'algorithme converge, ● et ● correspondent à **la moyenne de chaque classe**

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