26 septembre 2014

RTR IMAGE
RÉSEAU THÉMATIQUE DE RECHERCHE IMAGE
RÉGION CENTRE

Analyse quantitative d'images médicales

Clovis Tauber

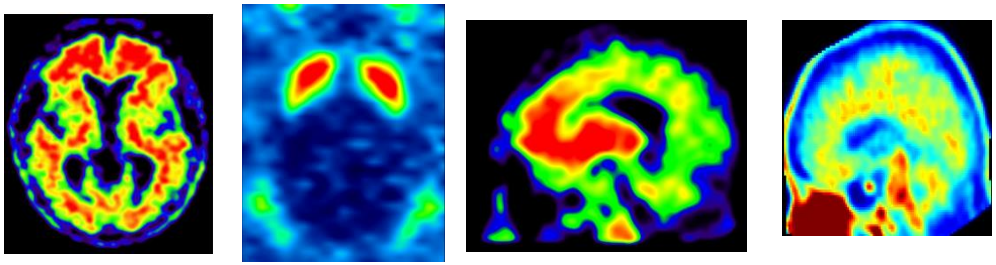
UMRS INSERM U930 – Université de Tours
Equipe 3 : Imagerie moléculaire du cerveau
UFR de Sciences Pharmaceutiques

Inserm
Institut national
de la santé et de la recherche médicale

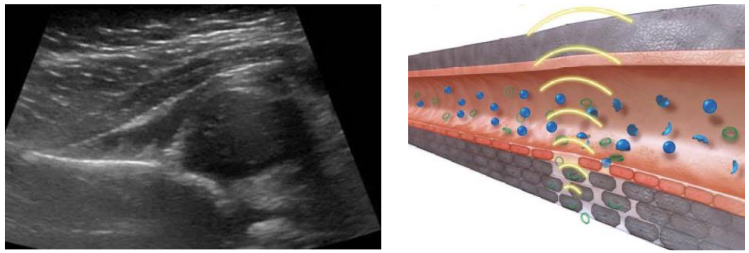
UNIVERSITÉ
FRANÇOIS - RABELAIS
TOURS

L'imagerie médicale à l'UMRS INSERM 930 – Tours
« Imagerie et cerveau »

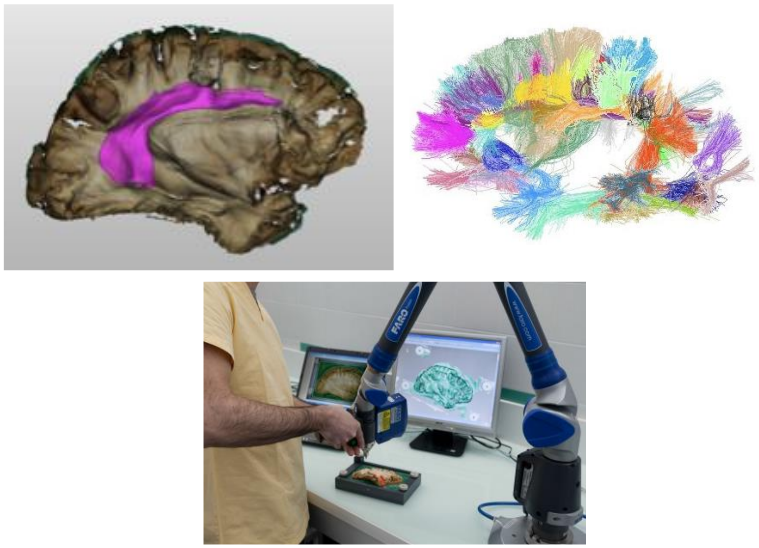
Imagerie TEP / MicroTEP



Imagerie Ultrasonore



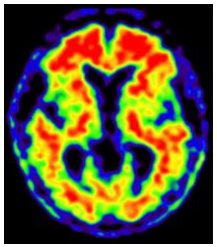
Imagerie IRM

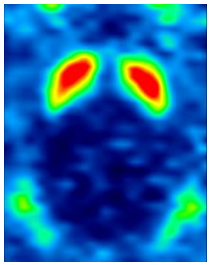


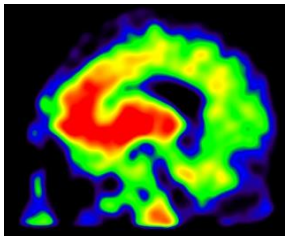
Traitement d'image TEP 4D

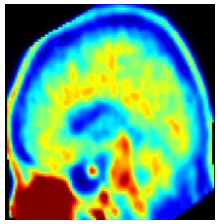
De l'acquisition à la quantification

Développement de l'imagerie TEP

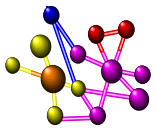

[18F]AV45

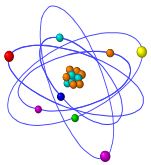

[18F]LBT999

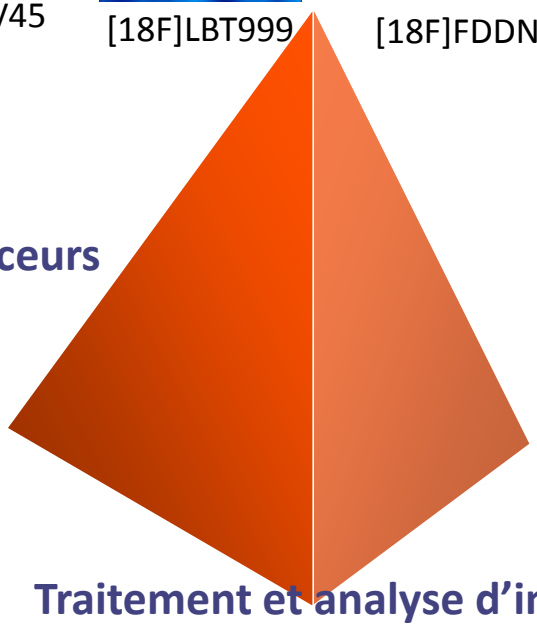

[18F]FDDNP


[18F]DPA714

Développement de radiotraceurs

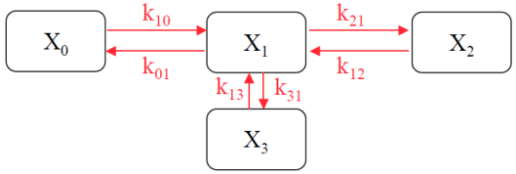






Caméra, détecteurs

Traitement et analyse d'image

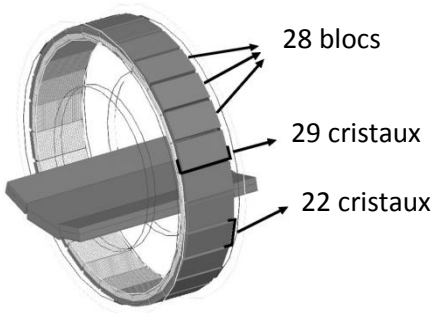


Validation des méthodes
Simulation d'images médicales réalistes

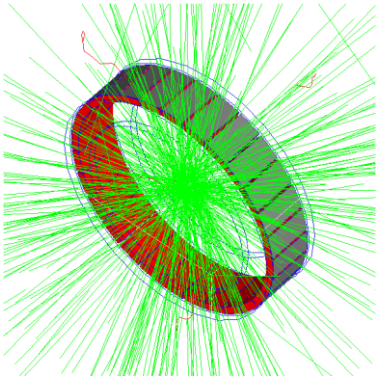
Simulations TEP : GATE Monte Carlo

Philips Gemini

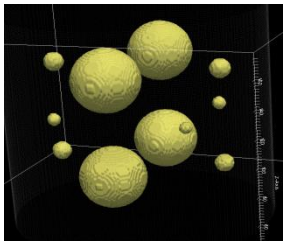
Caméra clinique réelle

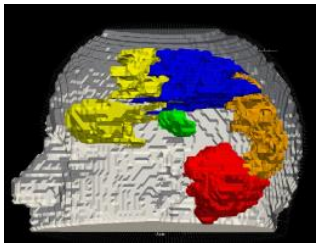


Modèle de caméra virtuel

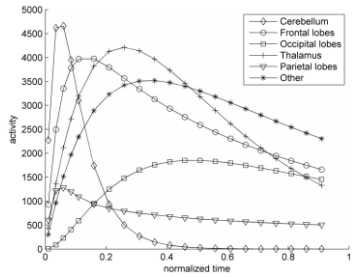


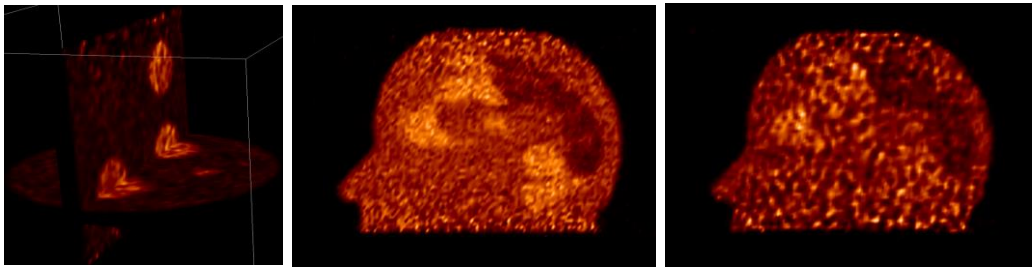
Acquisition





- Attenuation, diffusion, randoms
- OSEM reconstruction (OP, ANW …)
- Various param. (iter. , subsets…)





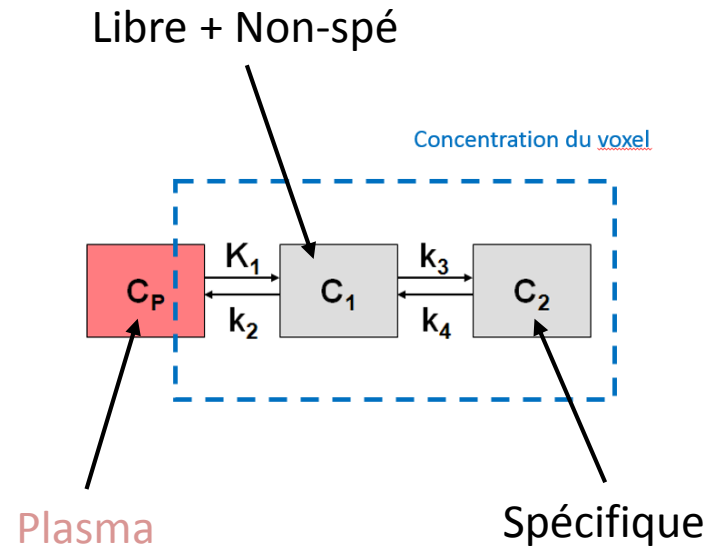
Enjeux de l'analyse quantitative d'images médicales

Source de problématiques infinie

A la croisée de nombreux domaines :

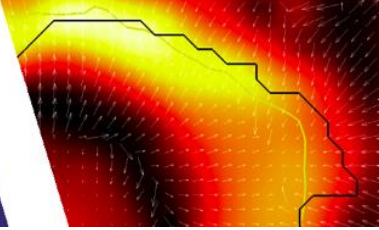
- **Modèles mathématiques (hyp. associées)**
- **Physique d'acquisition (bruit, EVP, …)**
- **Phénomènes physiologiques, anatomie (variabilité…)**
- **Contraintes applicatives (biais, estim. param., …)**
- **Informatique et Maths appli (parall., discrétisation …)**

Un voxel en TEP :



Cas concret : Traitement d'images TEP 4D

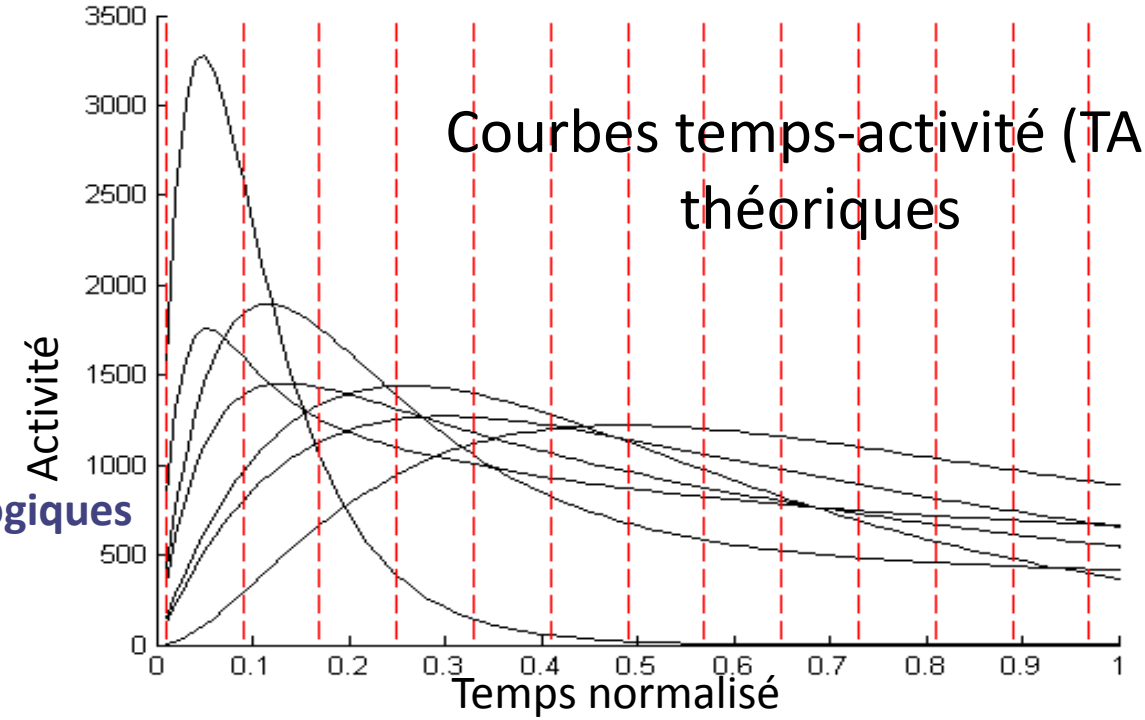
Imagerie TEP dynamique

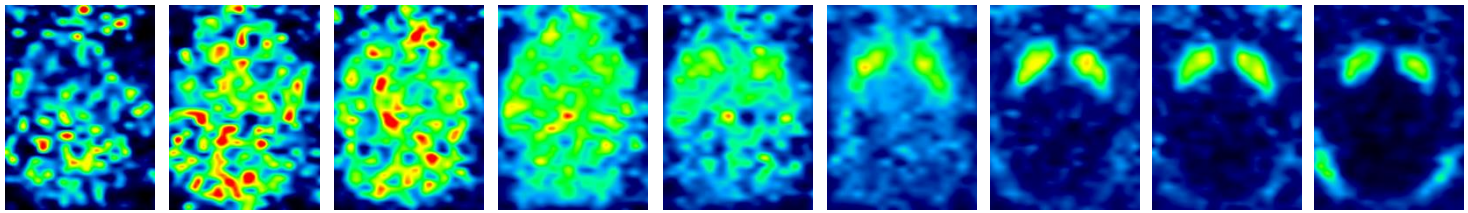


Imagerie dynamique
- **Information plus riche**
- **Evolution de la biodistribution**

Du radiopharmaceutique
- **Modélisation cinétique**

Pour quoi faire ? (dans l'U930)
- **Etude des processus neurophysiologiques**
- **Développement de radiotraceurs**
- **Modèles animaux**

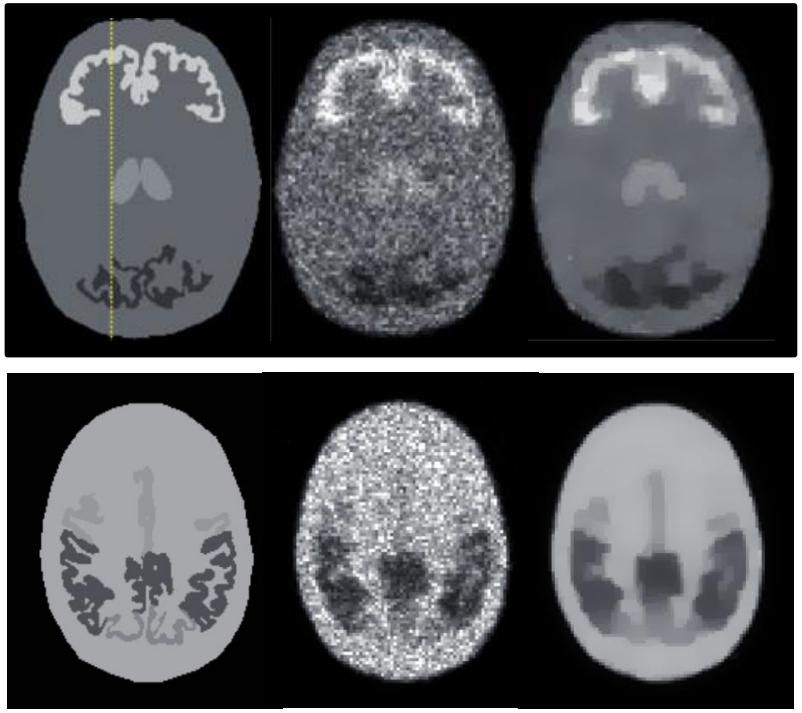


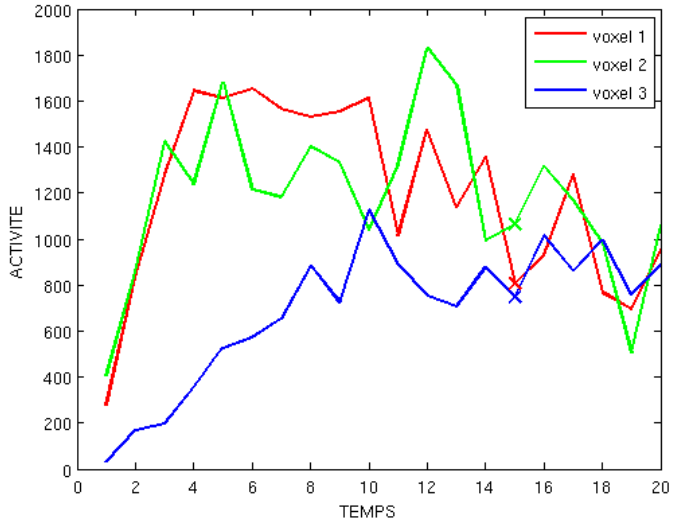


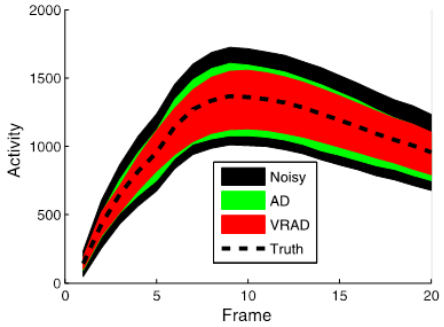
Traitement d'images TEP 4D

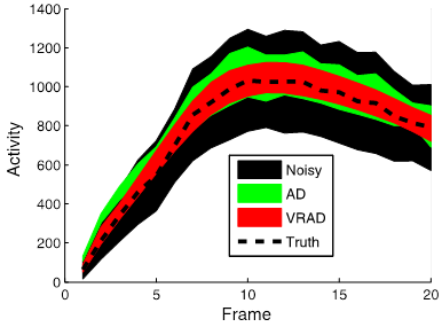
Diffusion anisotrope vectorielle robuste

VRAD : Vector-based robust anisotropic diffusion









Réduction de la variabilité

Traitement d'images TEP 4D

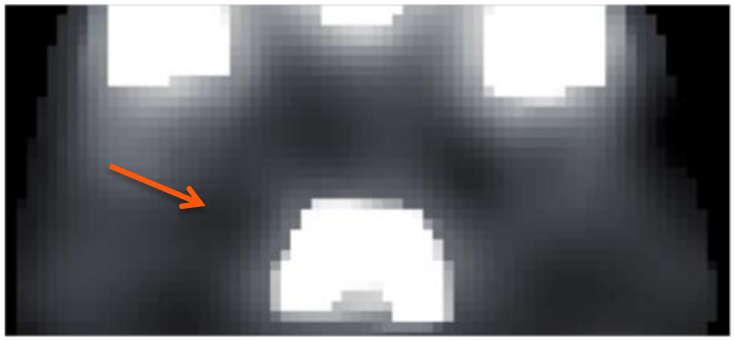
Analyse numérique et calcul parallèle

Schémas de discrétisation en espace et en temps

- Etudes de schémas explicites et semi-implicites
- Schémas itératifs parallèles, sous-domaines
- Dimensions des voxels hétérogènes

(Images saturées)

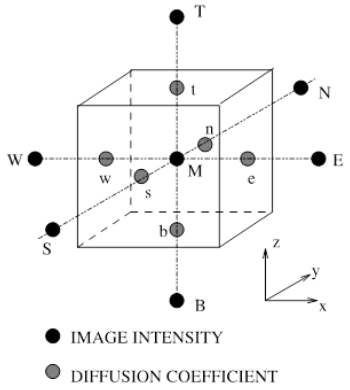
Evolution instable



Evolution stable

Enjeux

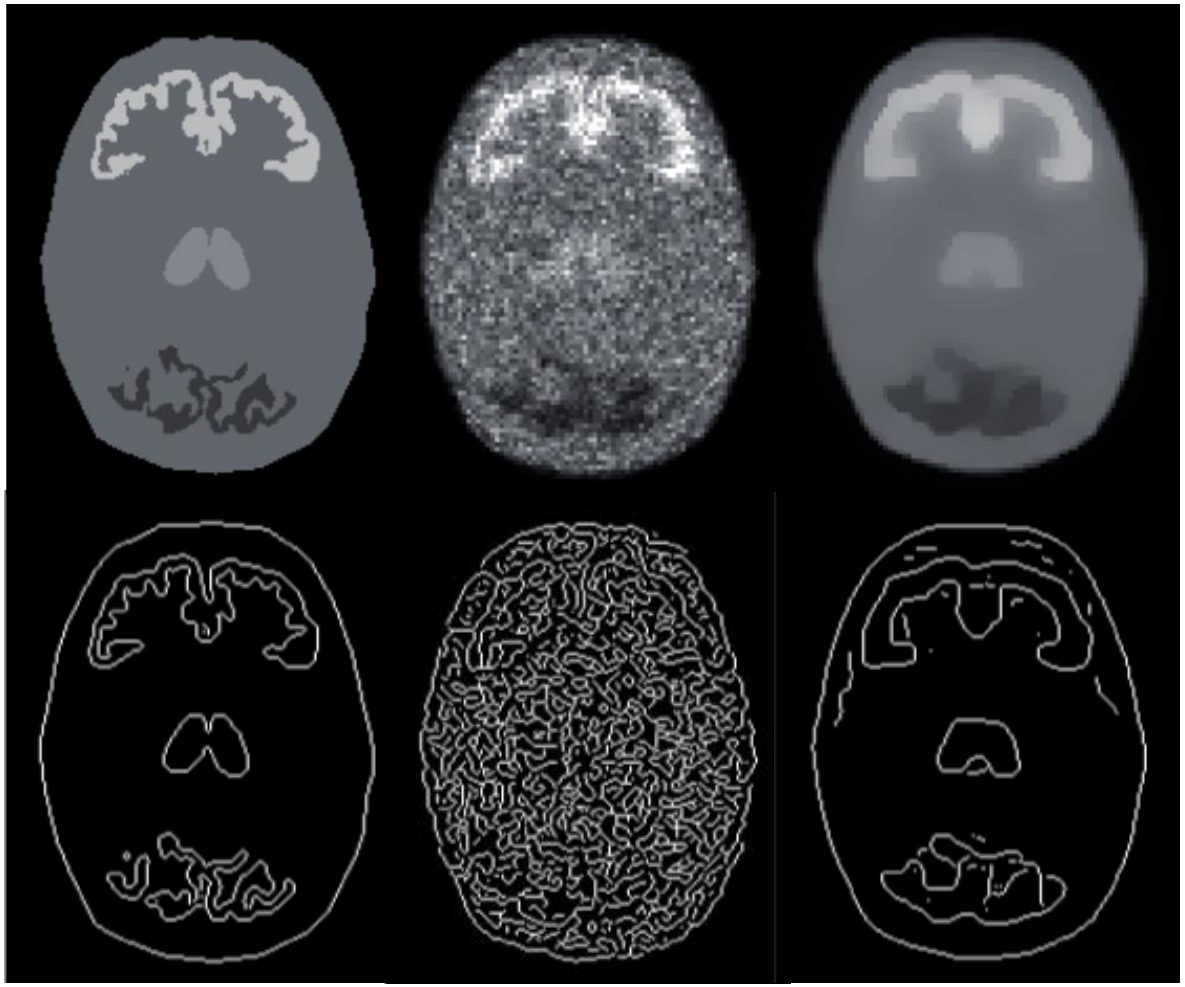
- Conditions de stabilité
- Amélioration de la convergence
- Accélaration des calculs sur HPC

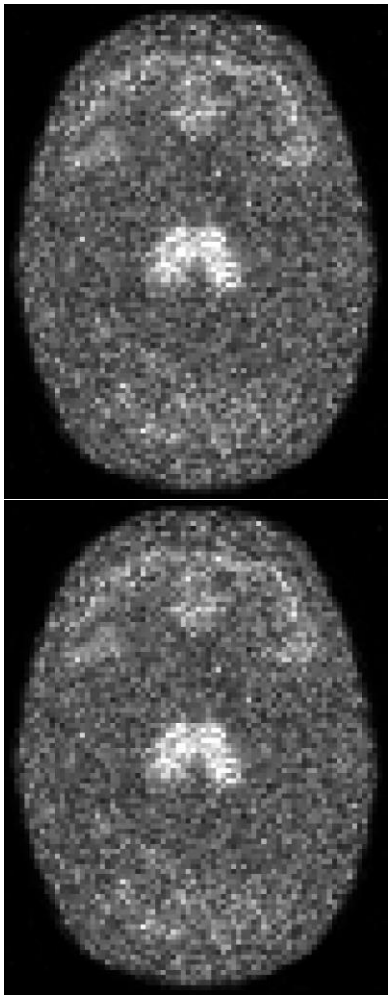


Calcul parallèle

Traitement d’images TEP 4D

Analyse numérique et calcul parallèle



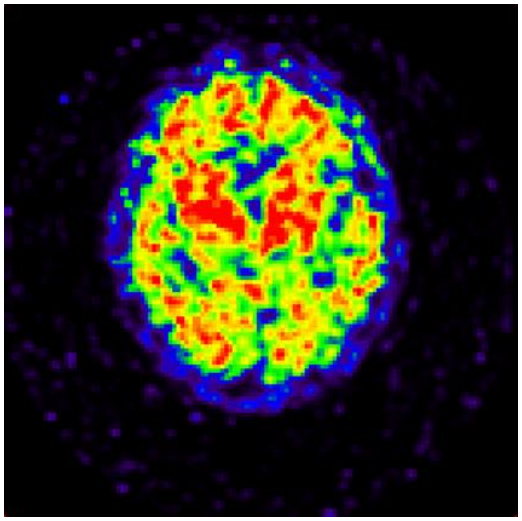


Traitement d'images TEP 4D

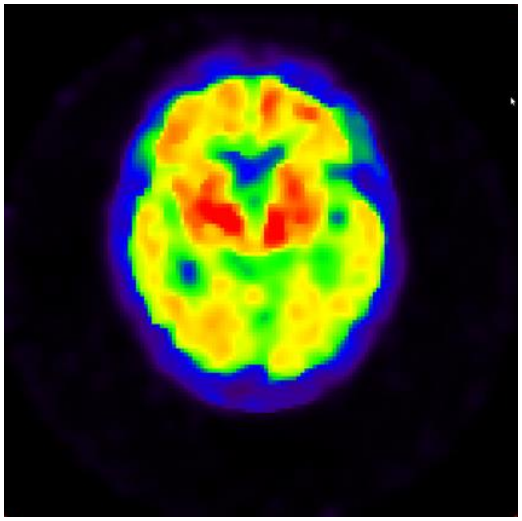
Cas d'images réelles

Amélioration du RSB dans les images TEP au [18F]AV45

[18F]AV45 : 1min frame

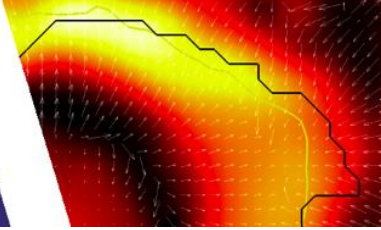


Même frame après 100 it. de VRAD

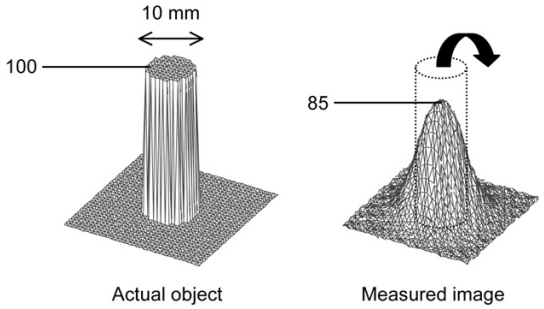


Traitement d'images TEP 4D

Elevation de l'ordre de la diffusion pour la préservation de l'EVP

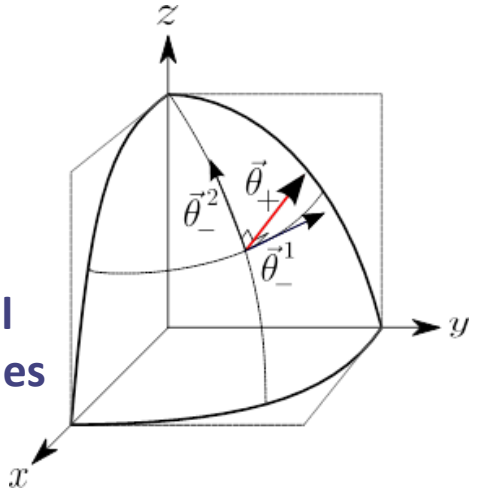


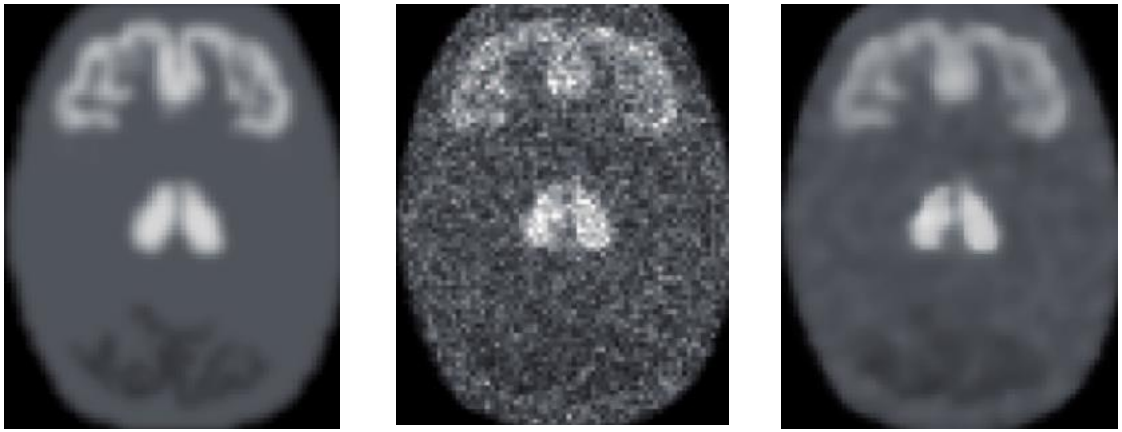
Problème de l'effet de volume partiel



Problématiques posées

- **Comment preserver l'EVP**
- **Qu'est ce qu'un contour vectoriel**
- **Qu'est ce qu'un point d'inflexion vectoriel**
- **Comment prendre en compte la qualité des frames**



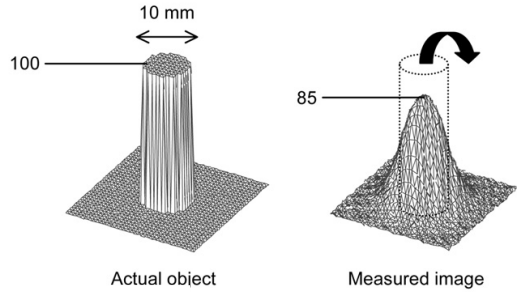


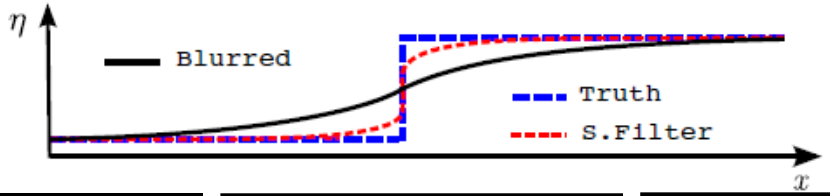
Traitement d'images TEP 4D

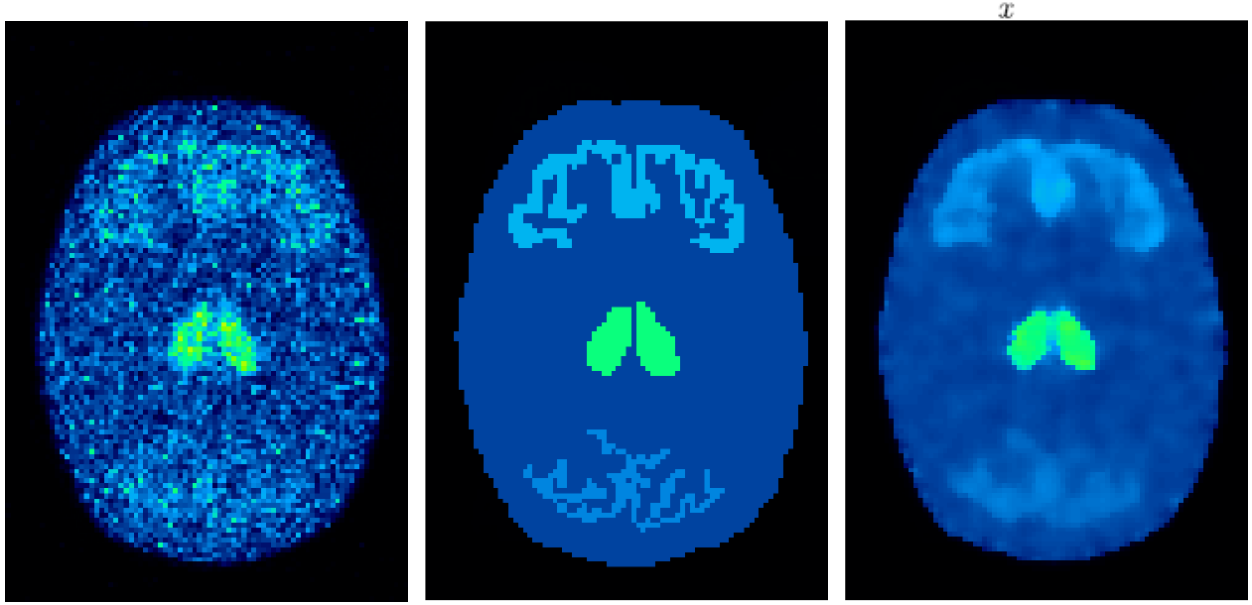
Filtrage et compensation partielle de l'EVP

Compensation partielle de l'EVP sans connaissance de la PSF

- **Filtre choc vectoriel**
- **Régularisation**
- **Préservation de la variation totale**
- **Pas de connaissance sur la PSF**

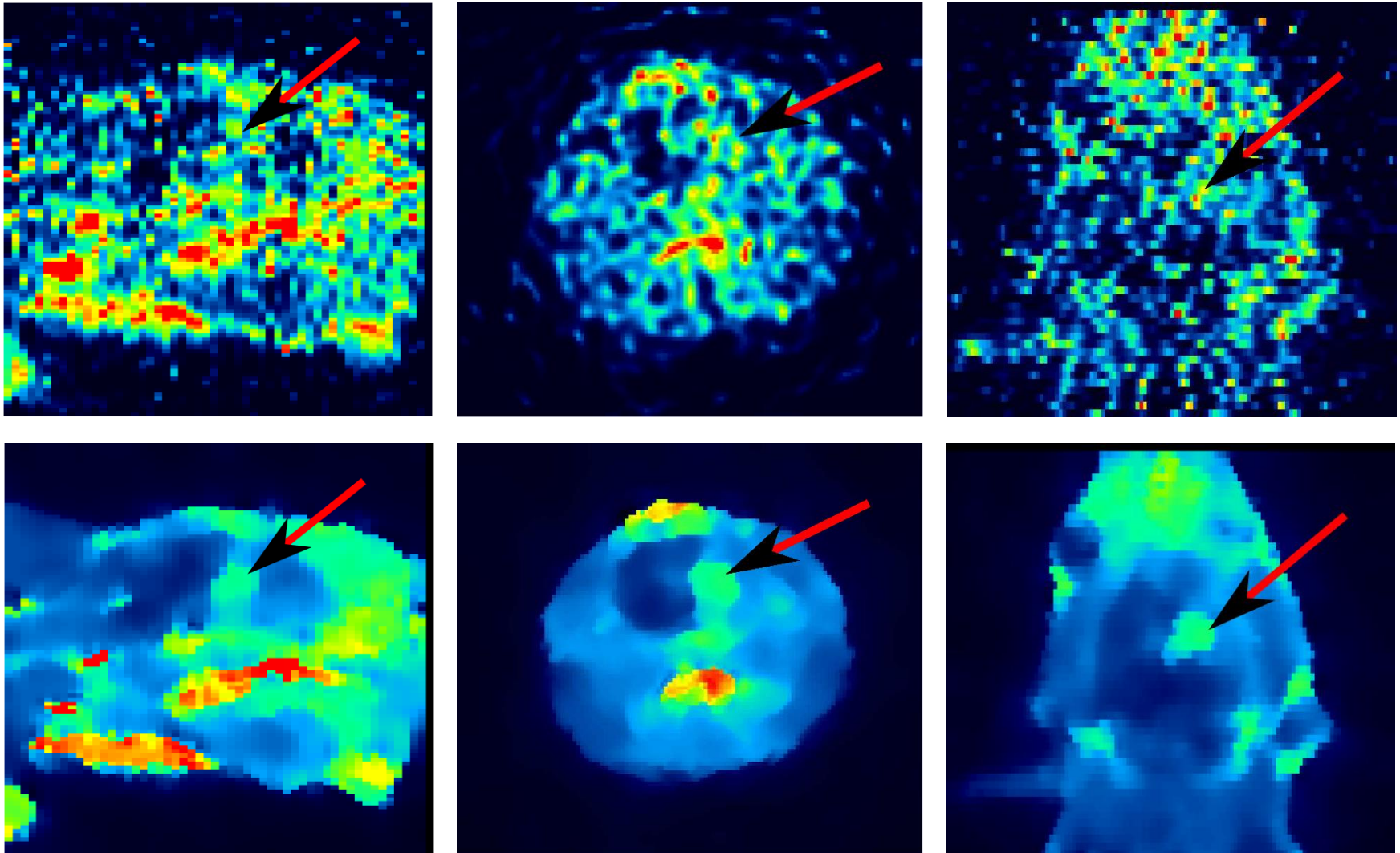






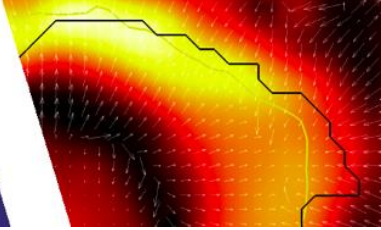
Traitement d'images TEP 4D

Filtrage couplé diffusion/choc

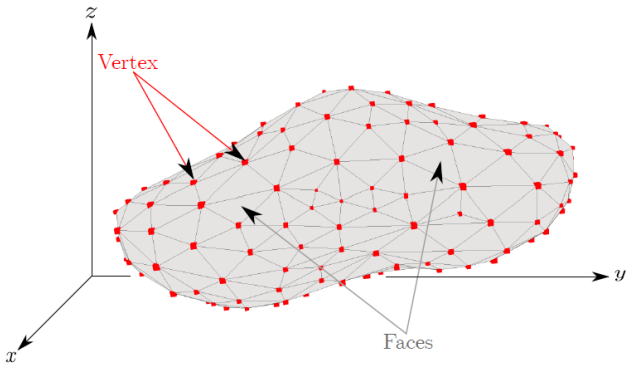


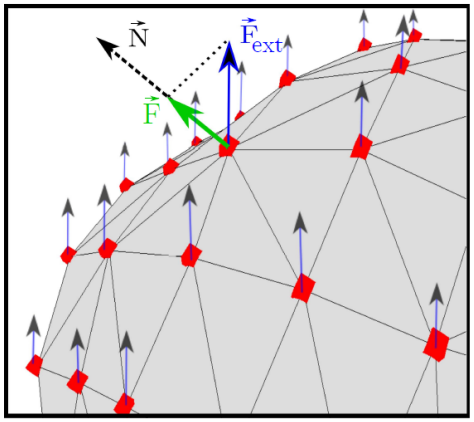
Traitement d'images TEP 4D

Segmentation de région connexe



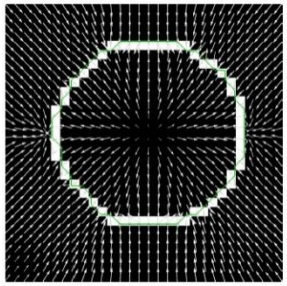
Surface active 4D



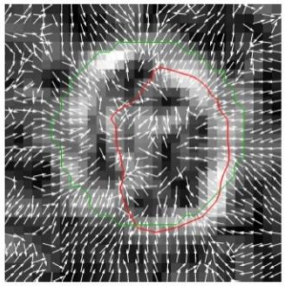


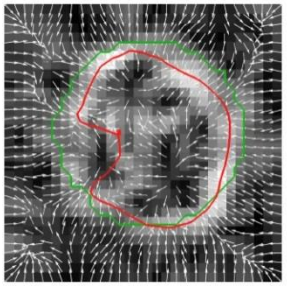
- **Carte vectorielle des contours 4D**
- **Schéma de ponderation adaptatif**

Vérité terrain

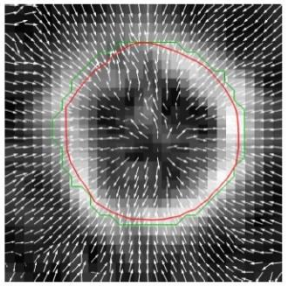


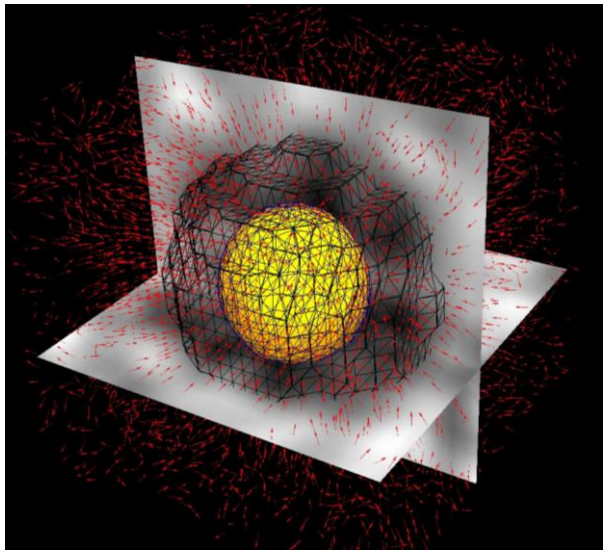
Approches classiques





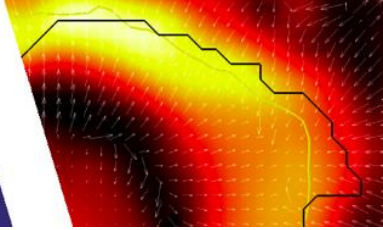
4DGVF



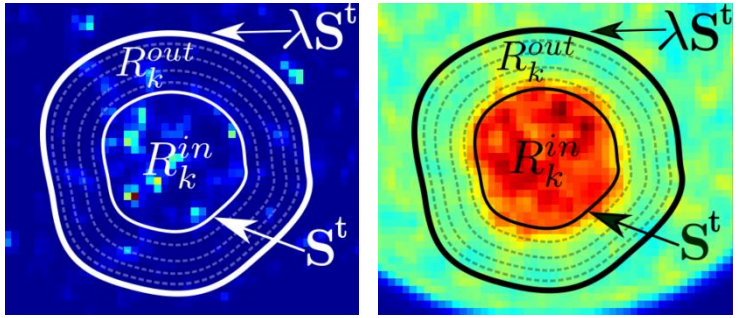


Traitement d'images TEP 4D

Surface active 4D



Approche 4DGVF



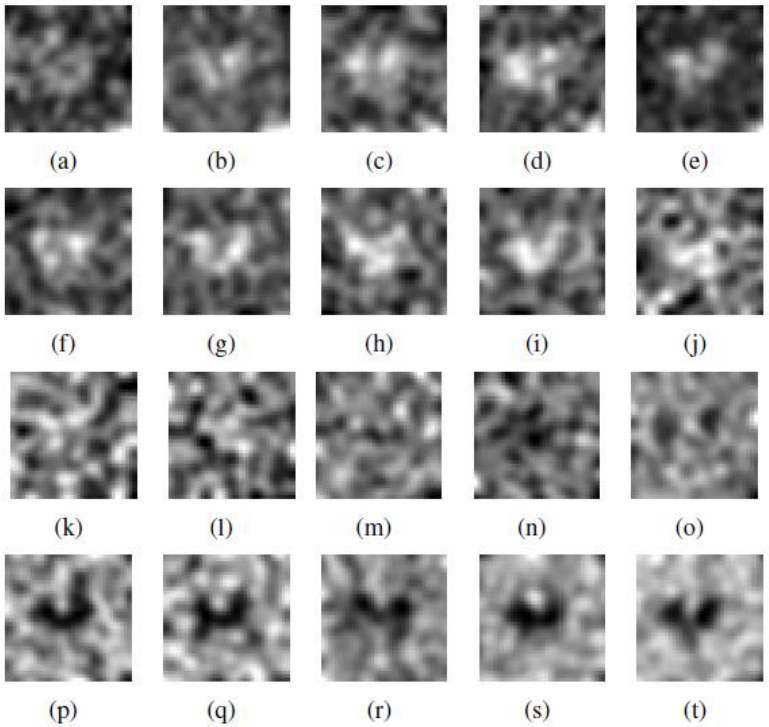
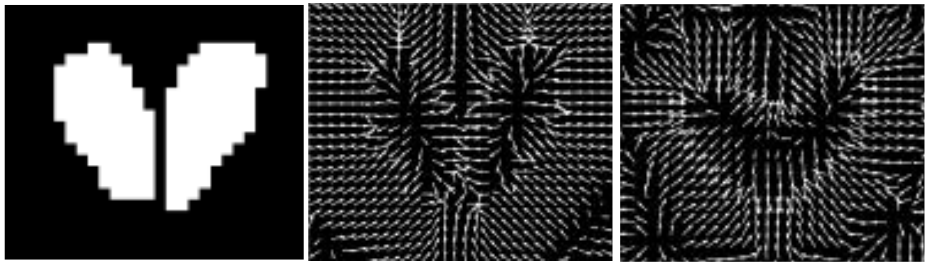


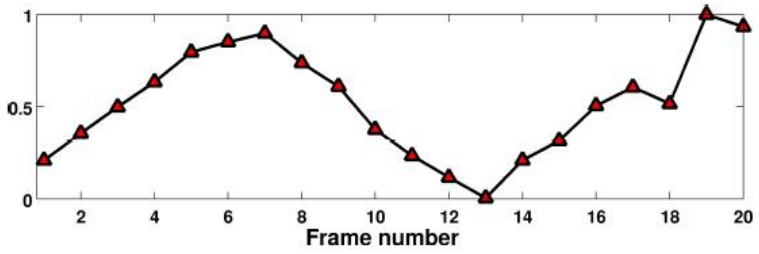
Schéma de pondération

Représentativité de la région dans les frames



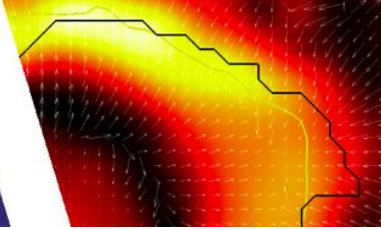
Ground truth

4DGVF

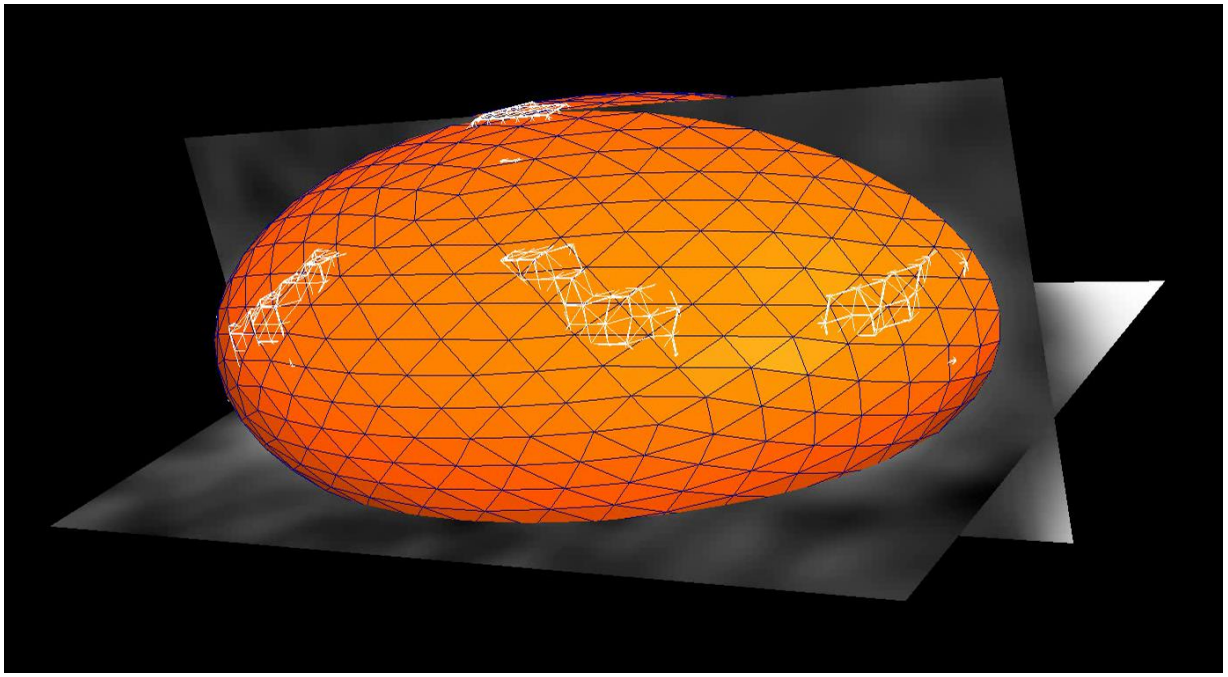


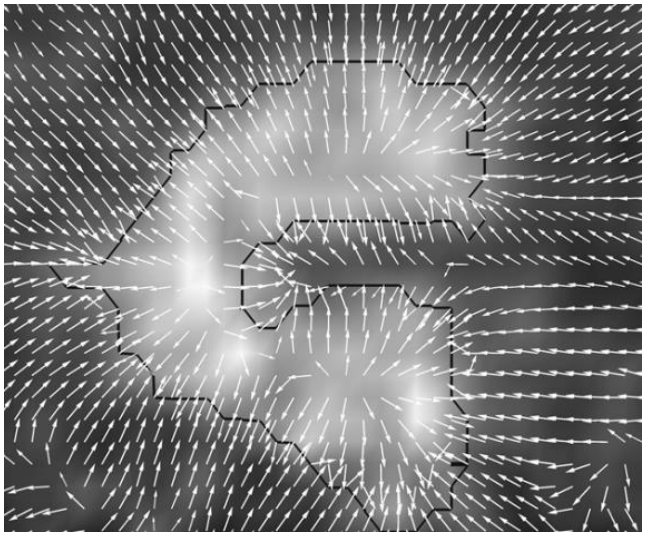
Traitement d'images TEP 4D

Surface active 4D



Segmentation 4DGVF du cervelet

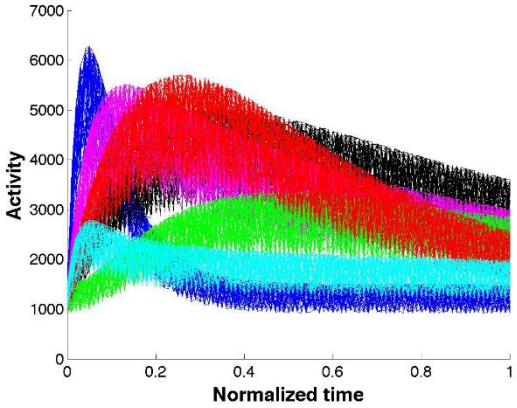


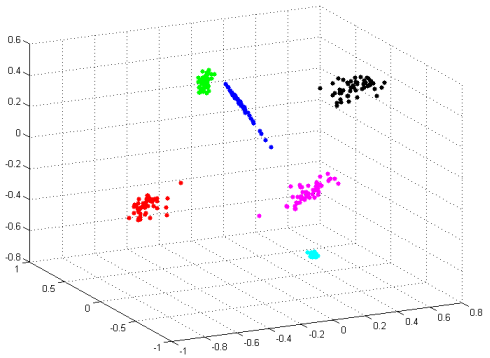


Traitement d'images TEP 4D

Segmentation en régions non connexes

Classification spectrale cinétique





Conclusion

Traitement d'images médicales

- Les propriétés des images peuvent être améliorées par les modèles mathématiques
- Nécessité du traitement d'images pour l'imagerie médicale
- Actuellement un des facteurs limitant : beaucoup à exploiter, fort potentiel
- Besoin de résultats robustes, quantitatifs et reproductibles

Objectifs du RTR Image

RTR IMAGE
RÉSEAU THÉMATIQUE DE RECHERCHE IMAGE
RÉGION CENTRE

- Favoriser les collaborations (maths, physique, informatique, biomedical...)
- Favoriser des transferts méthodologiques vers la Clinique
- Identifier des connexions avec d'autres domaines du traitement d'image