

Modélisation et simulation prédictive, patient dépendante et temps-réel, des mouvements physiologiques induits par la respiration libre

« Les journées Imagerie Robotique Médicale et Chirurgicale
de Strasbourg »

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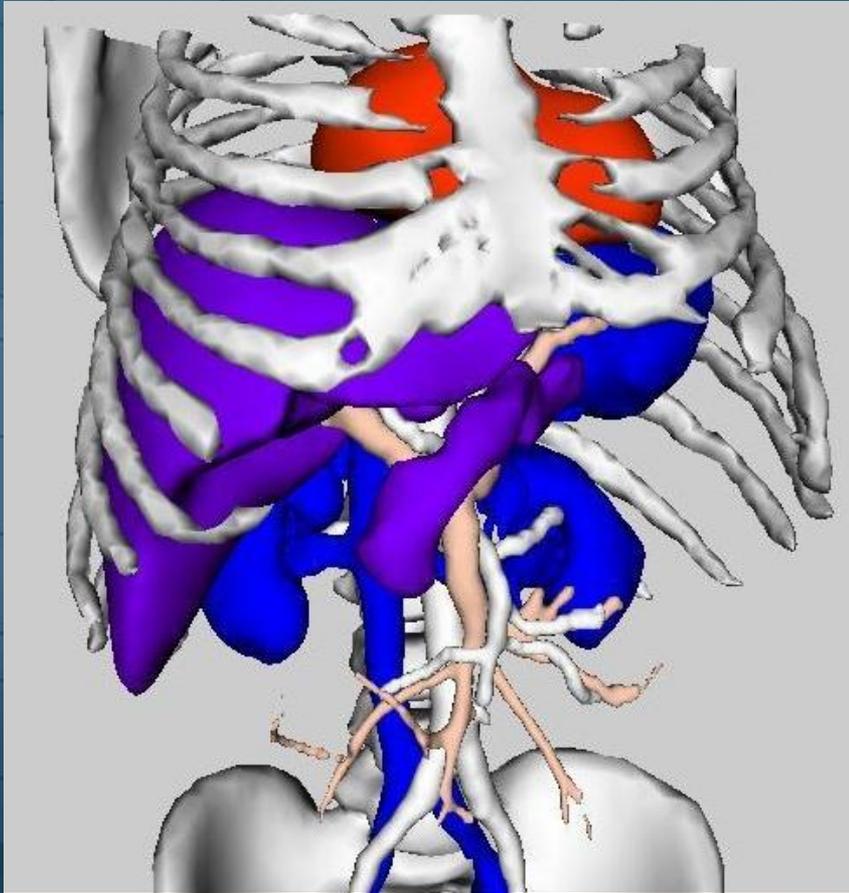
Yves Rémond, IMFS

Plan

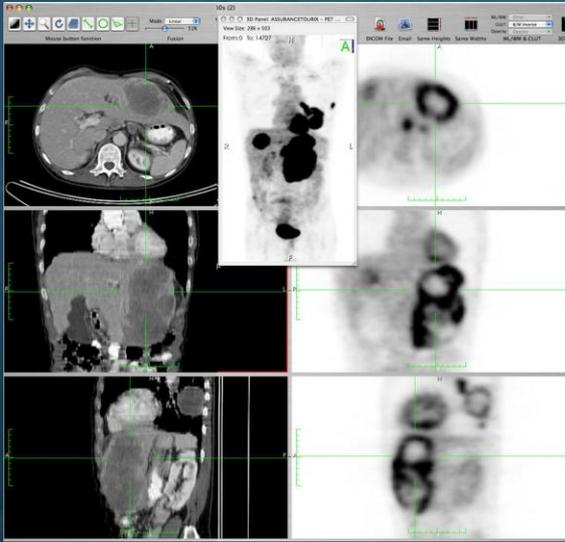
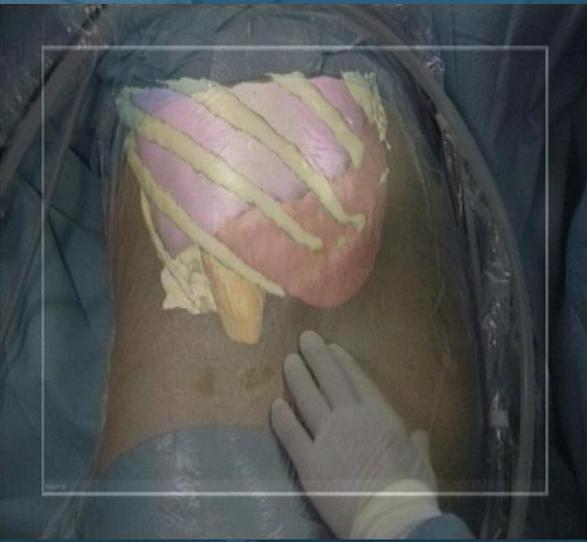
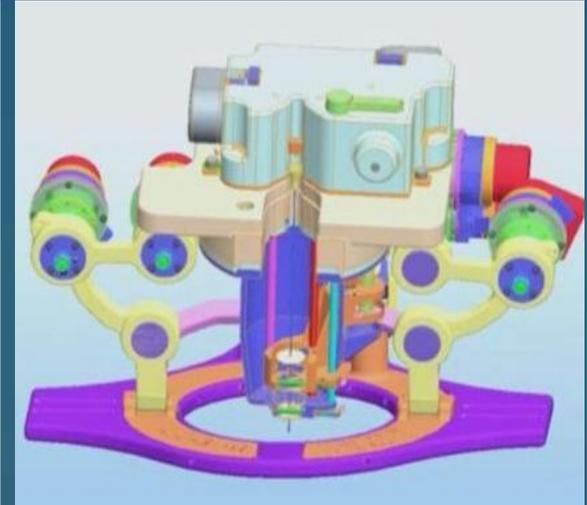
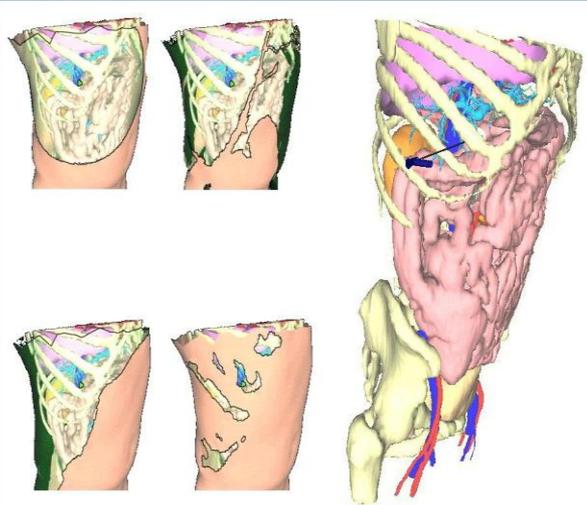
- Introduction
 - Problématique
 - Contexte médical
- Analyse du mouvement respiratoire
- Modélisation et simulation prédictive
 - Méthode
 - Résultats
- Conclusion

Problématique

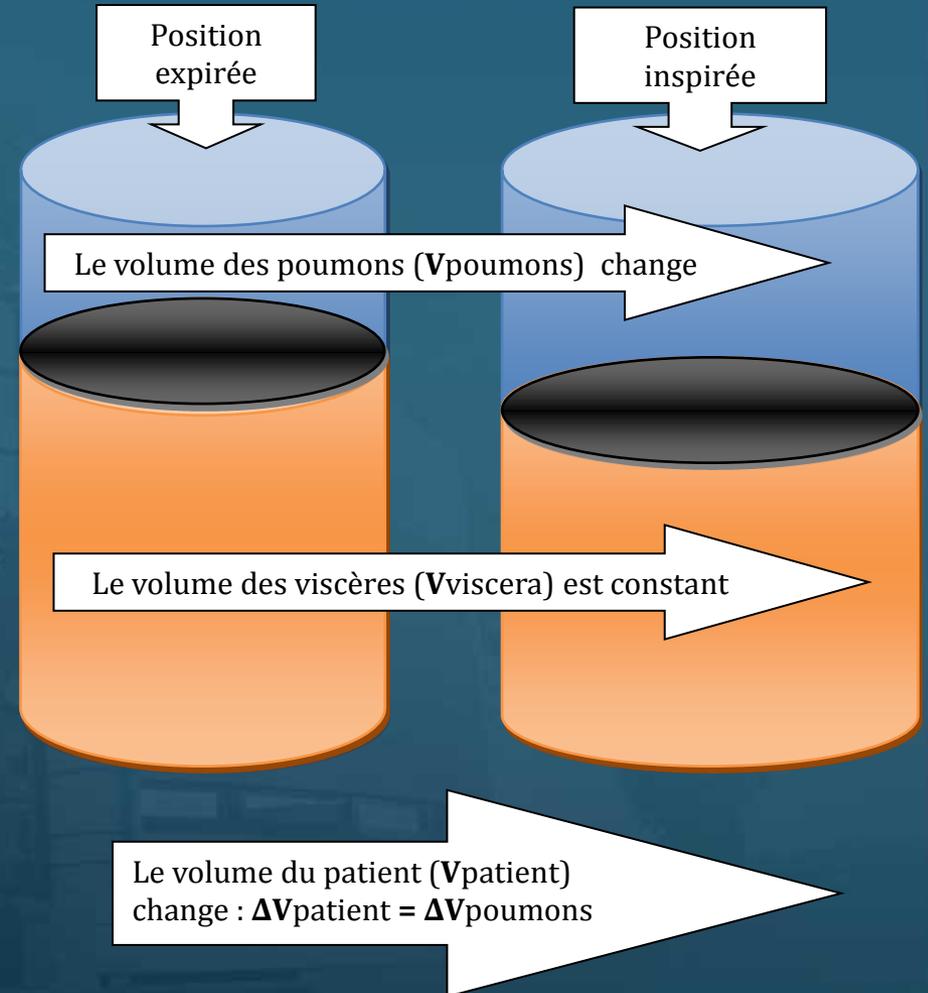
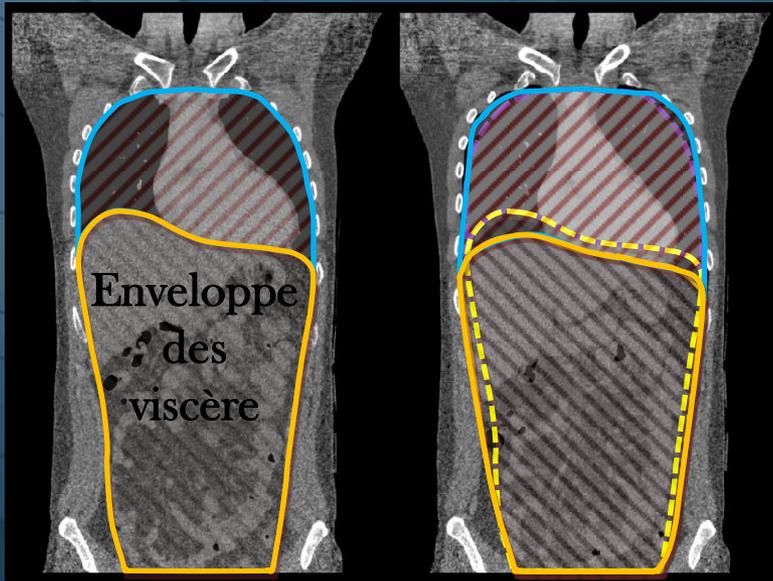
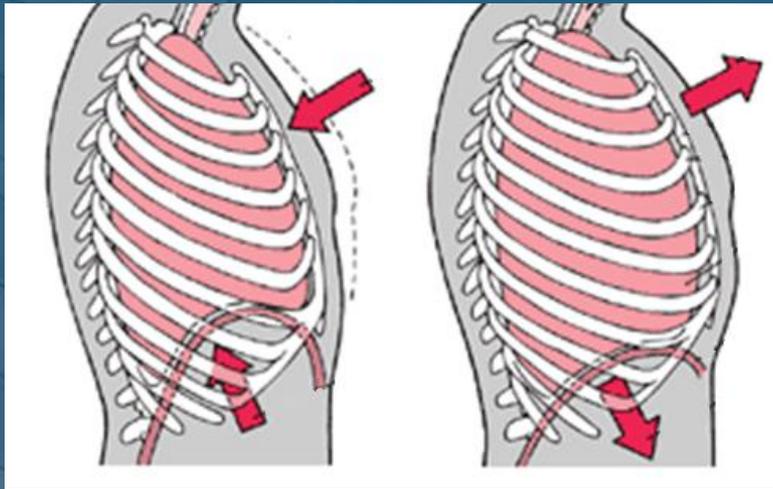
- Modélisation et simulation du mouvement



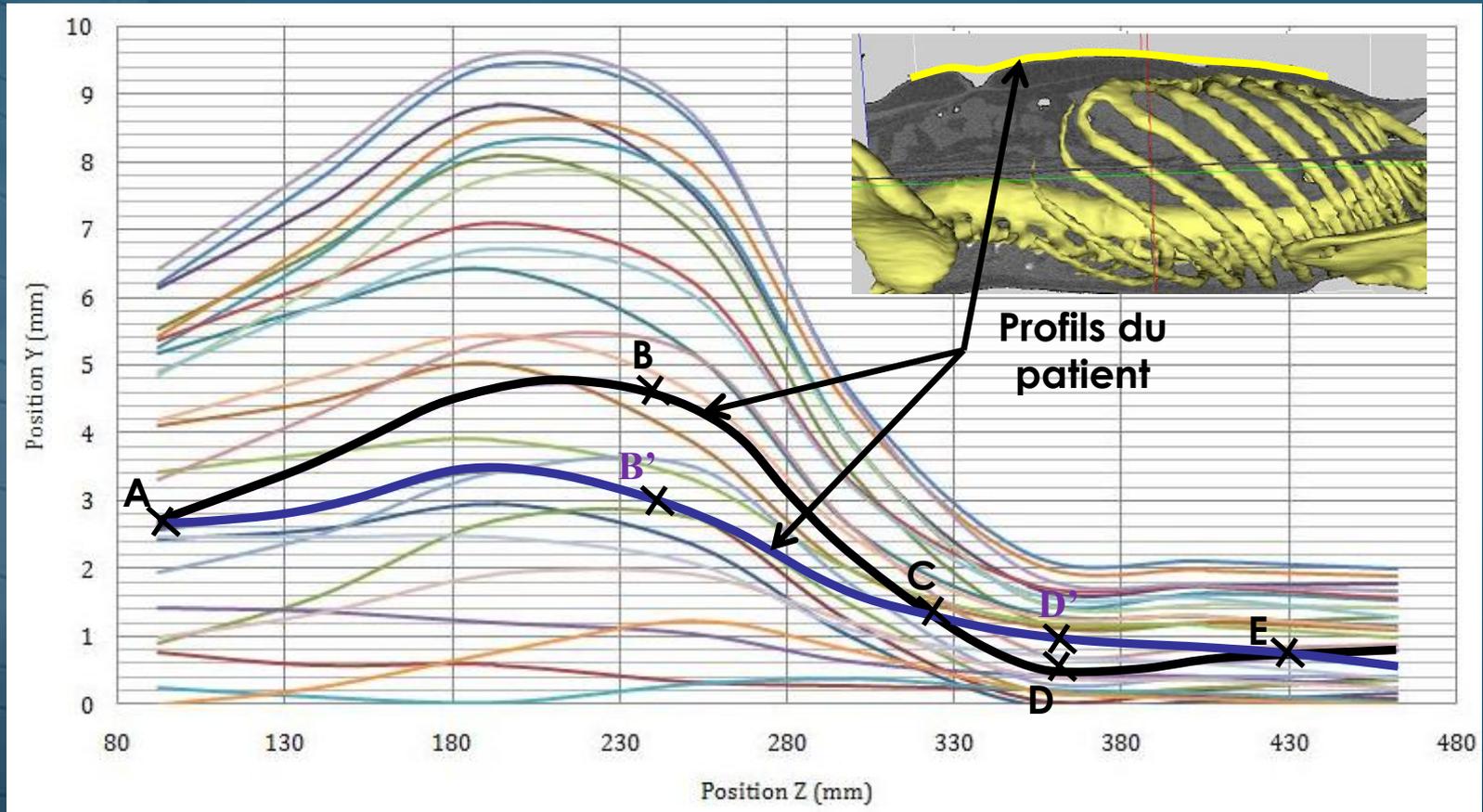
Contexte médical



Analyse du mouvement



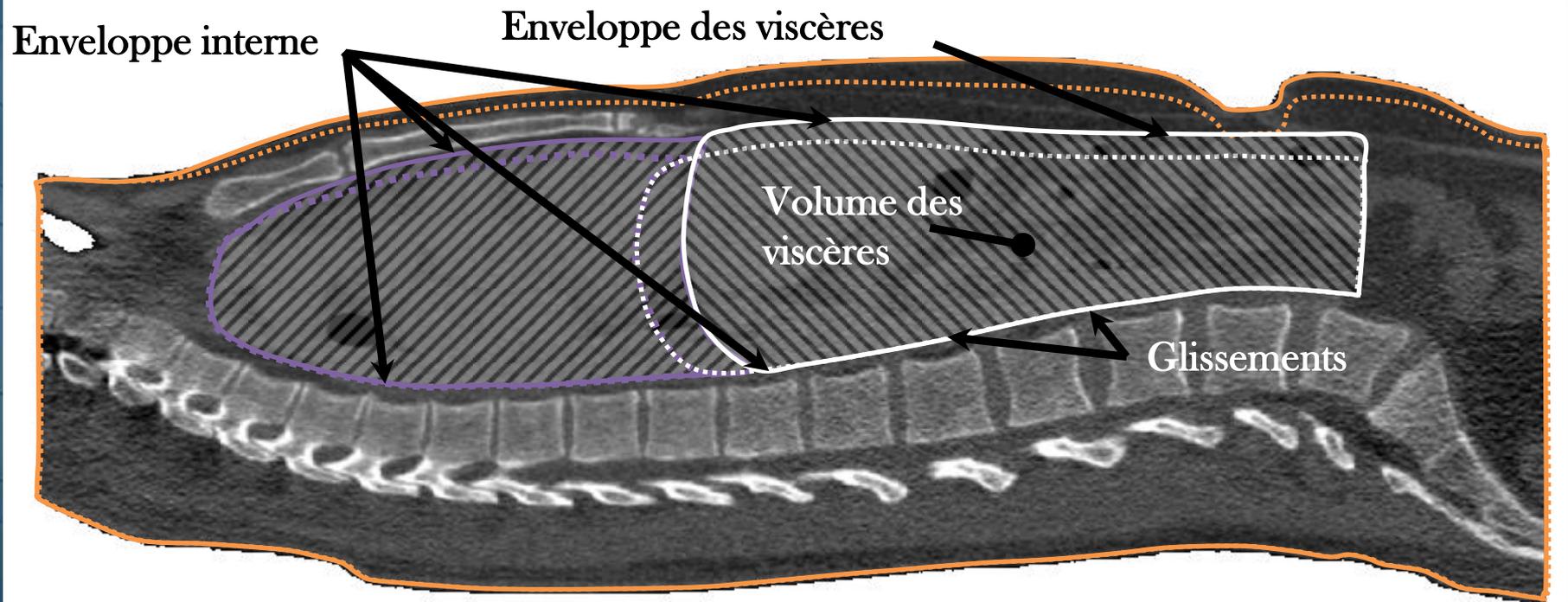
Analyse du mouvement



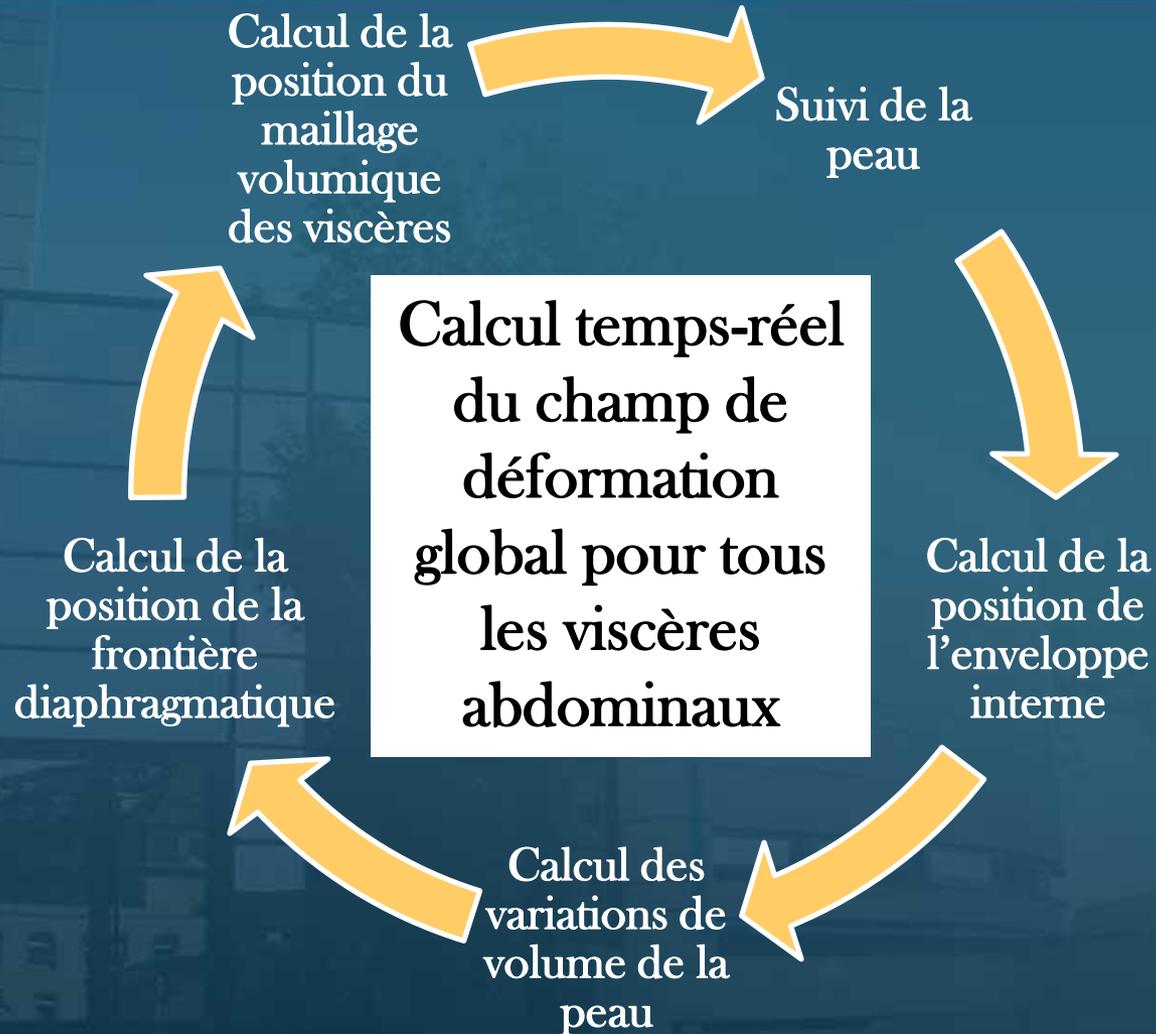
Méthode

- Idées principales :
 - Calculer un champ de déformation
 - Les viscères abdominaux sont assimilés à une entité unique et incompressible appelée “volume des viscères”
 - Les viscères abdominaux glissent le long d’une frontière appelée “enveloppe interne”
 - Suivi temps-réel de la position de la peau
 - Modélisation du comportement du diaphragme

Méthode

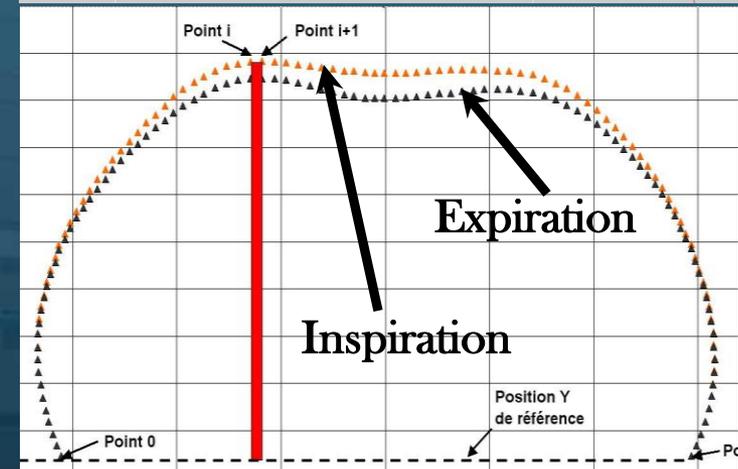
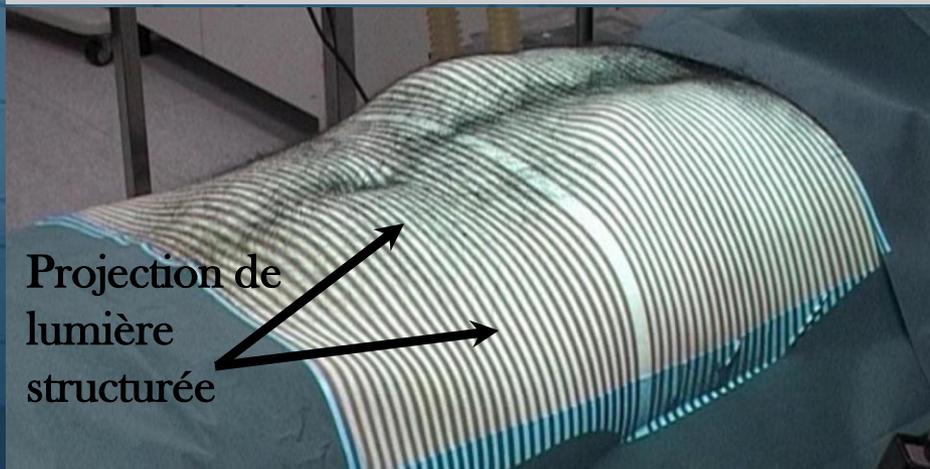
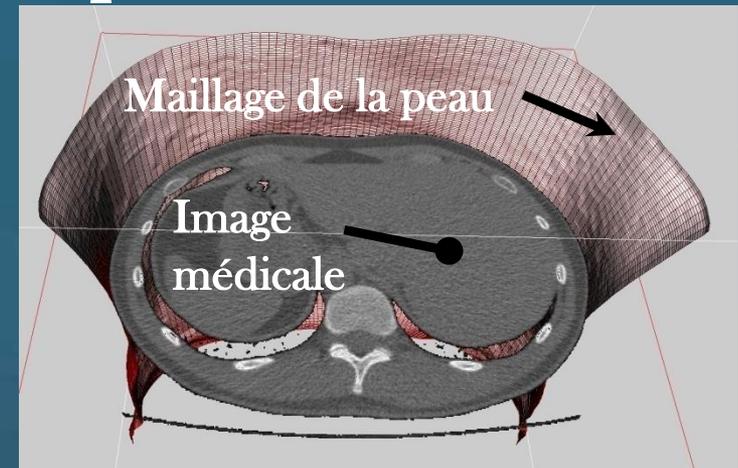
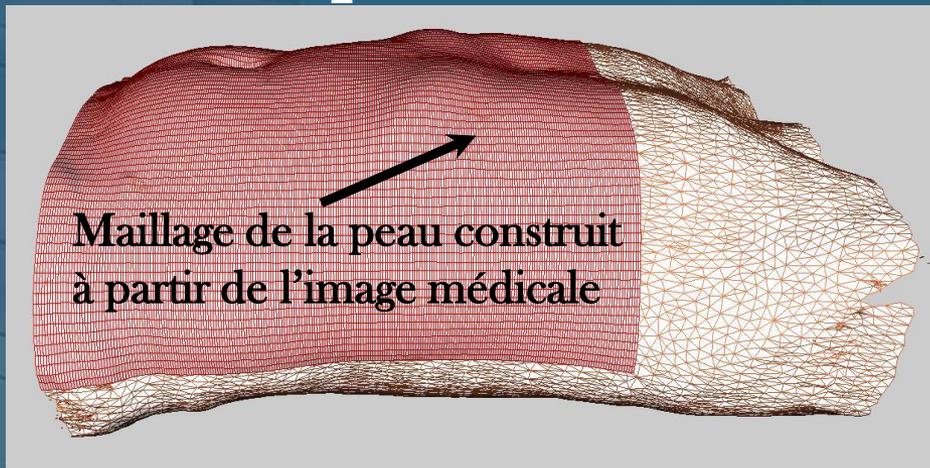


Méthode



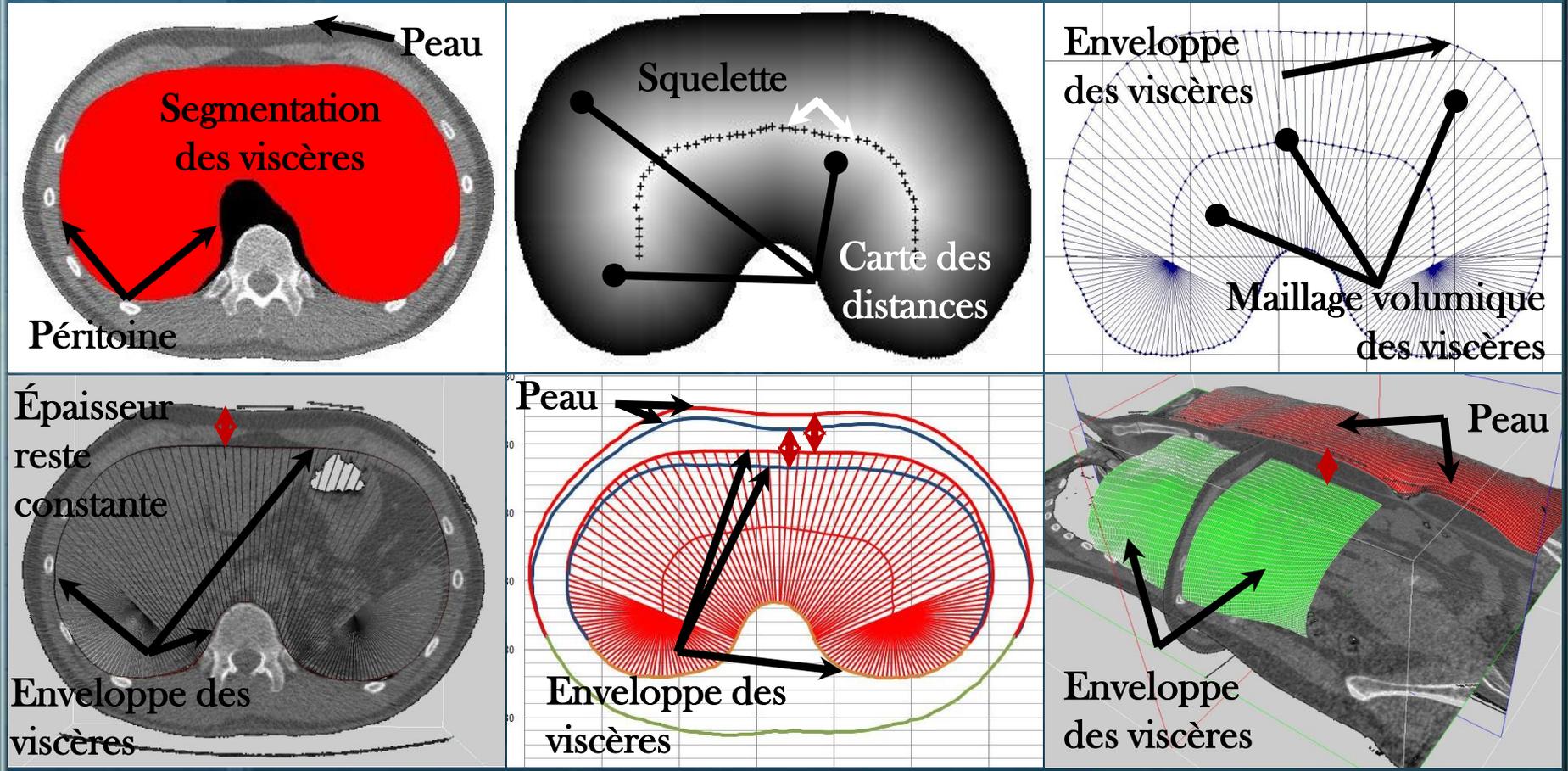
Méthode

- Suivi et paramétrisation de la peau



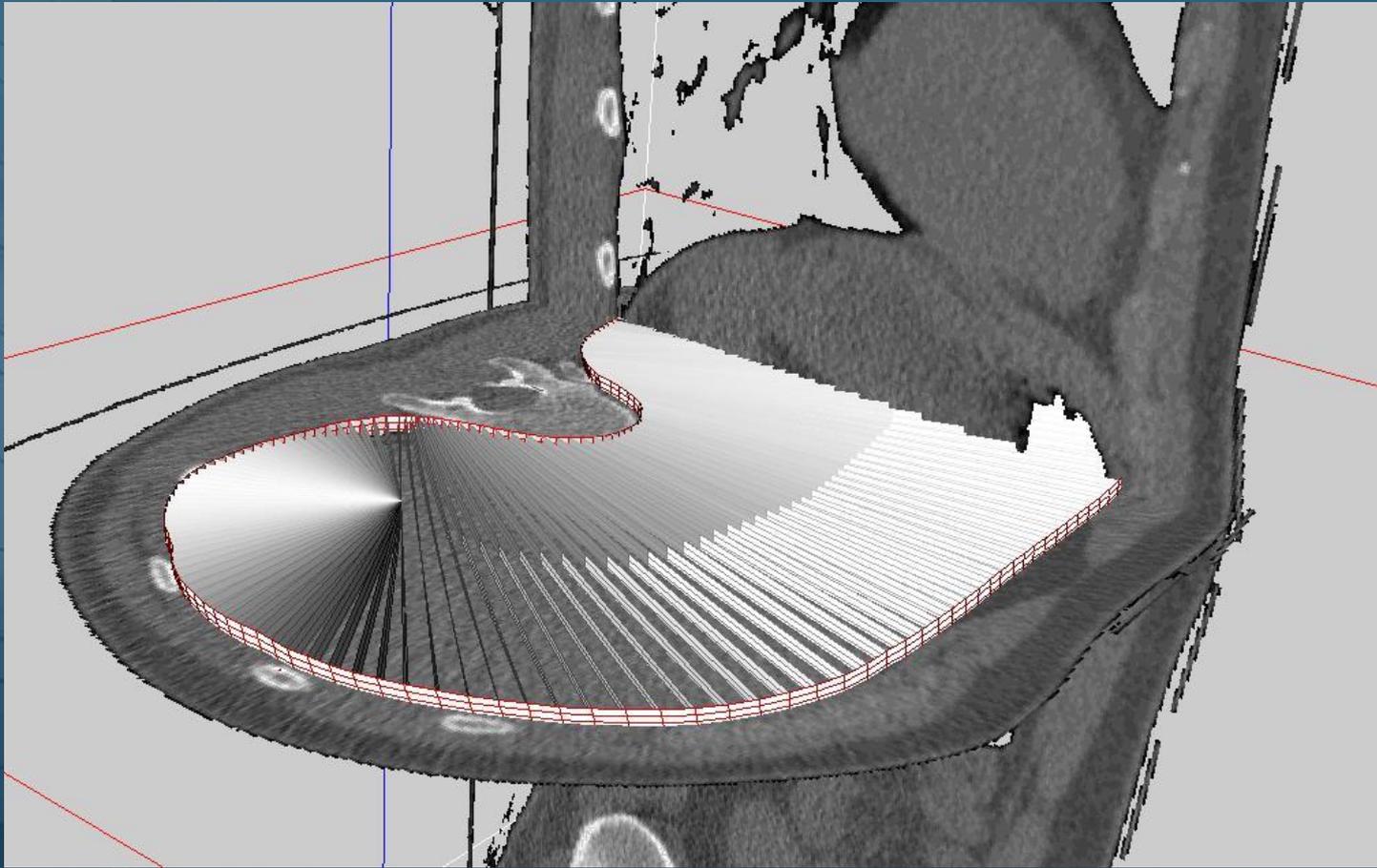
Méthode

• Paramétrisation des viscères



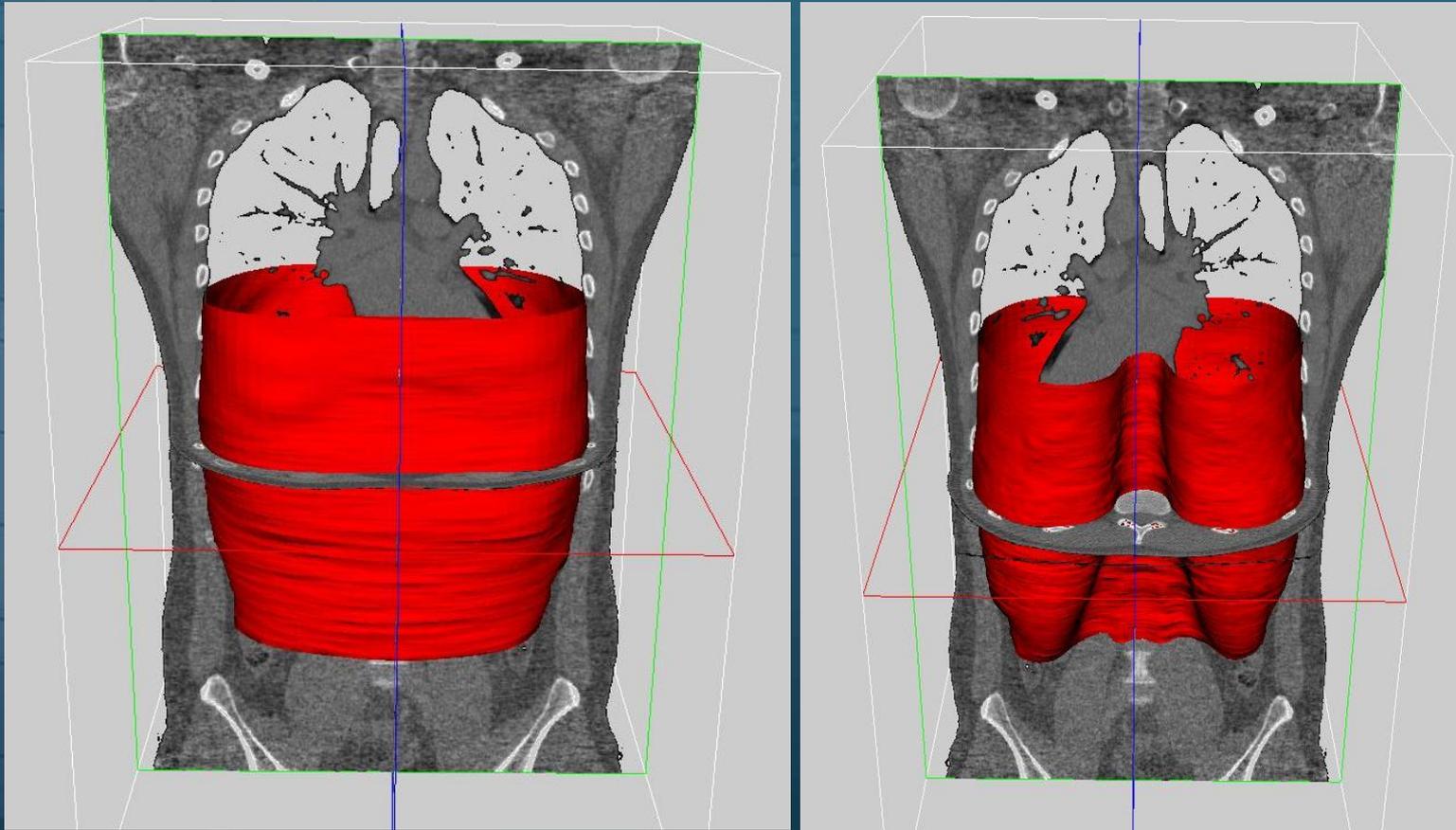
Méthode

- Paramétrisation des viscères



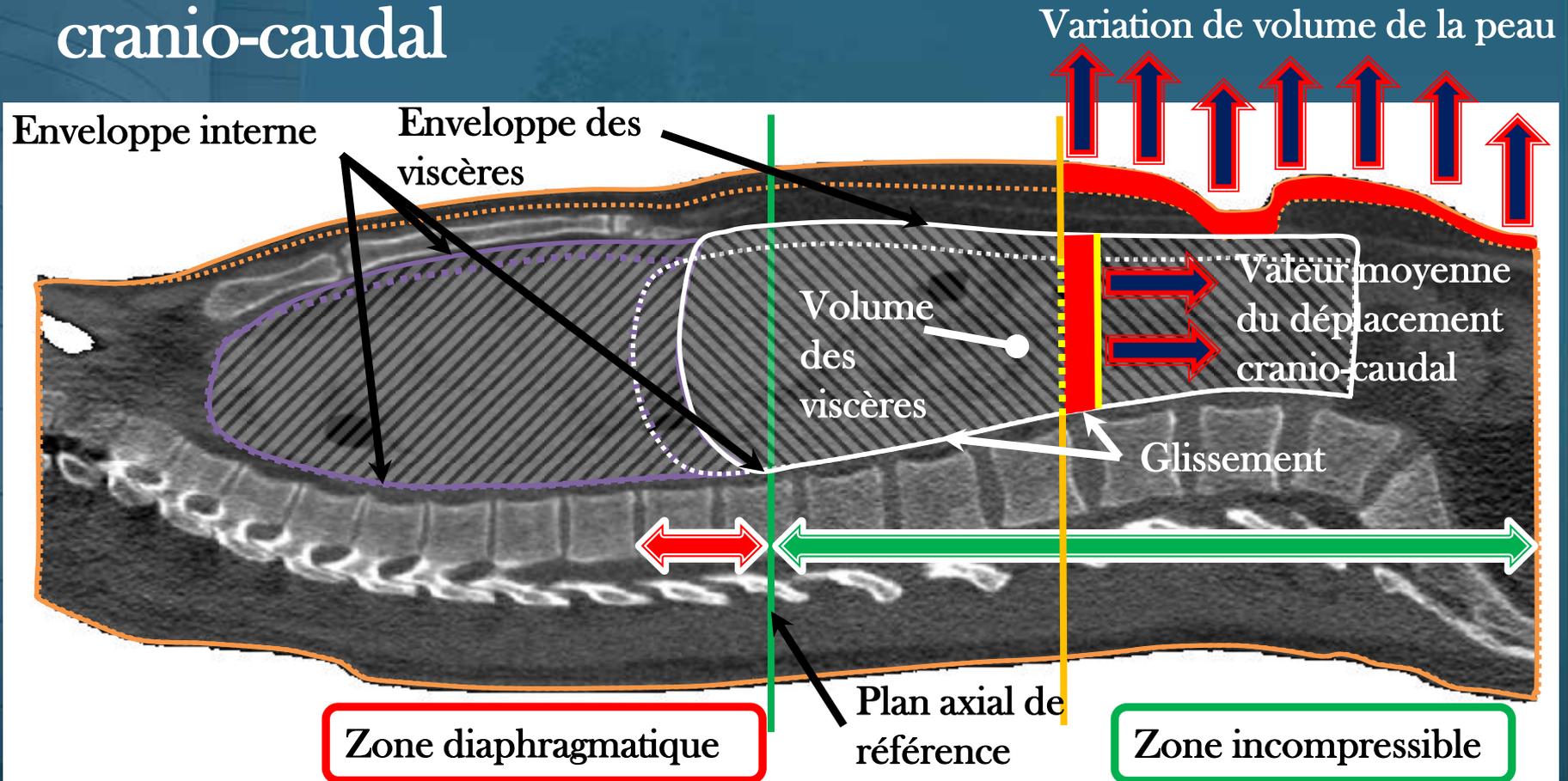
Méthode

- Paramétrisation des viscères



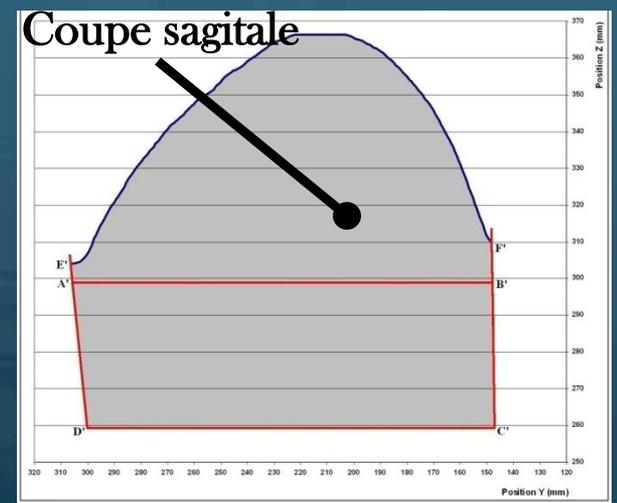
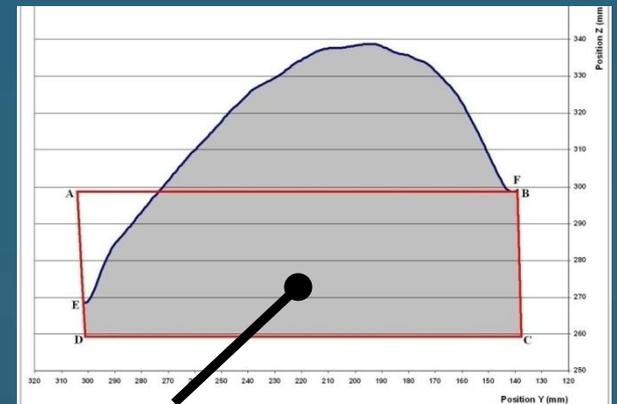
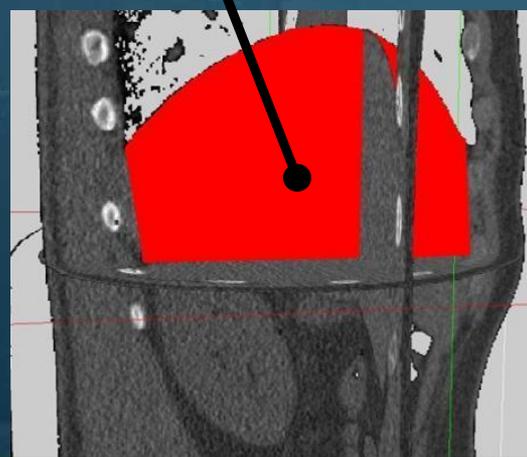
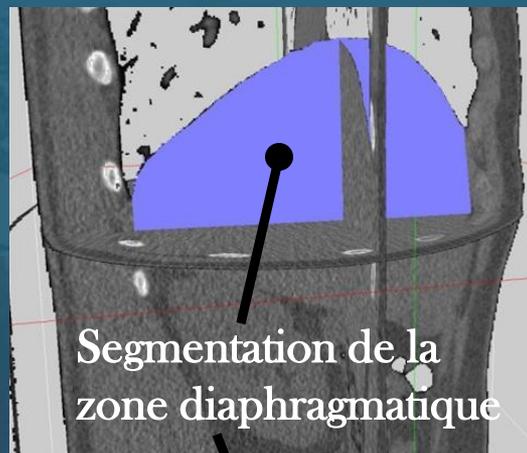
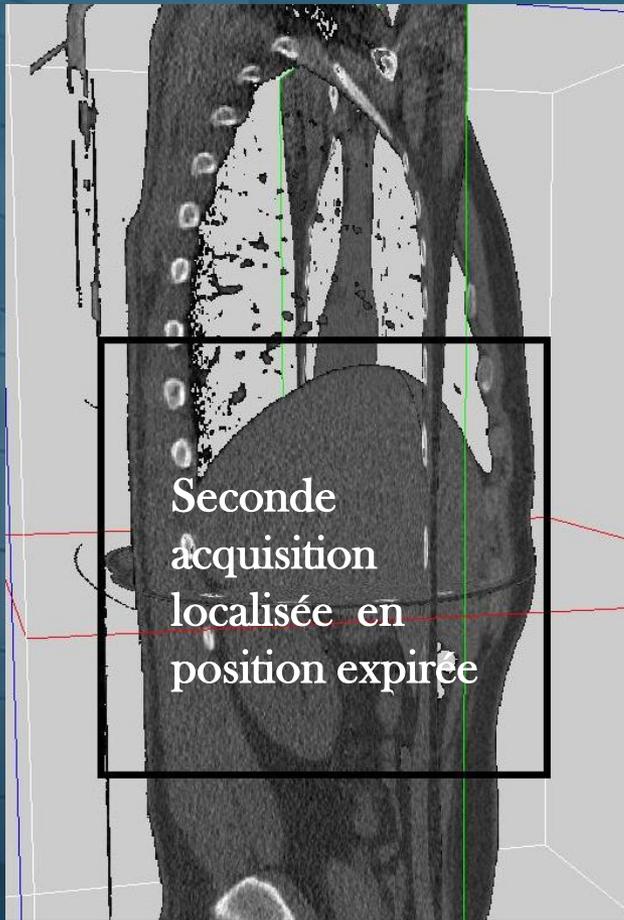
Méthode

- Calcul de la valeur moyenne du déplacement crano-caudal



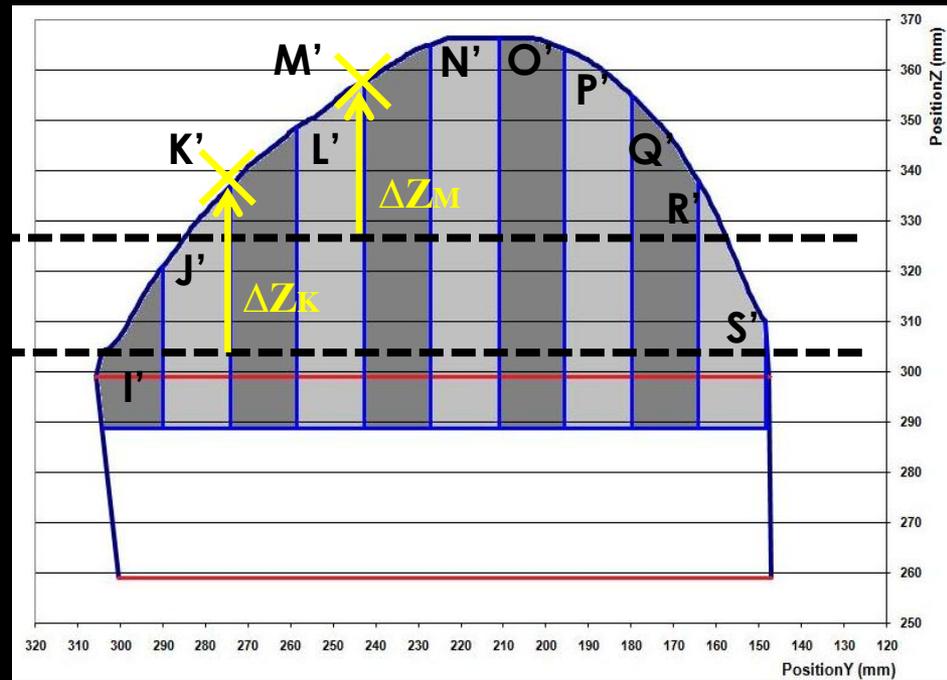
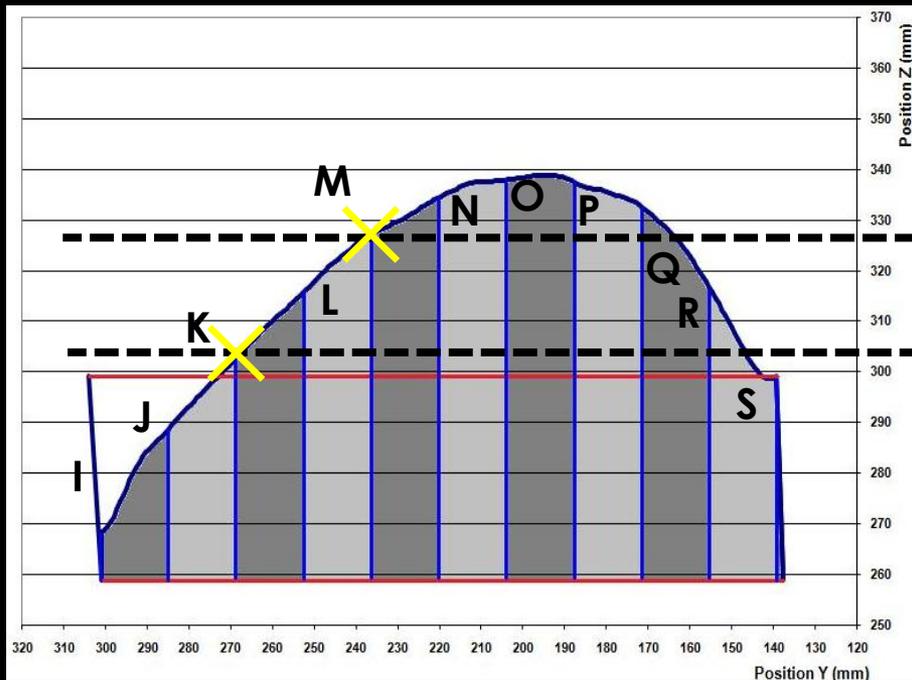
Méthode

- Parameterisation de la zone diaphragmatique



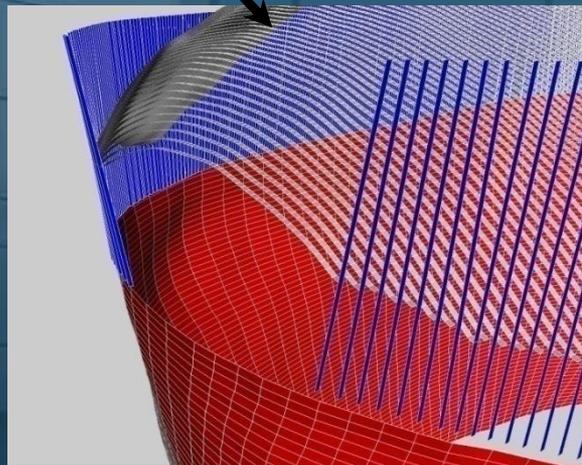
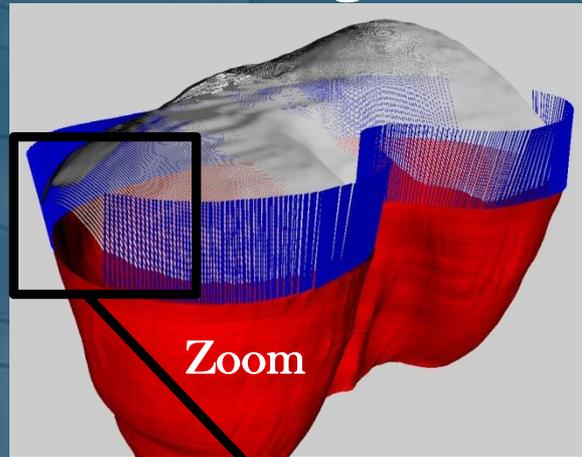
Méthode

- Parameterisation du diaphragme

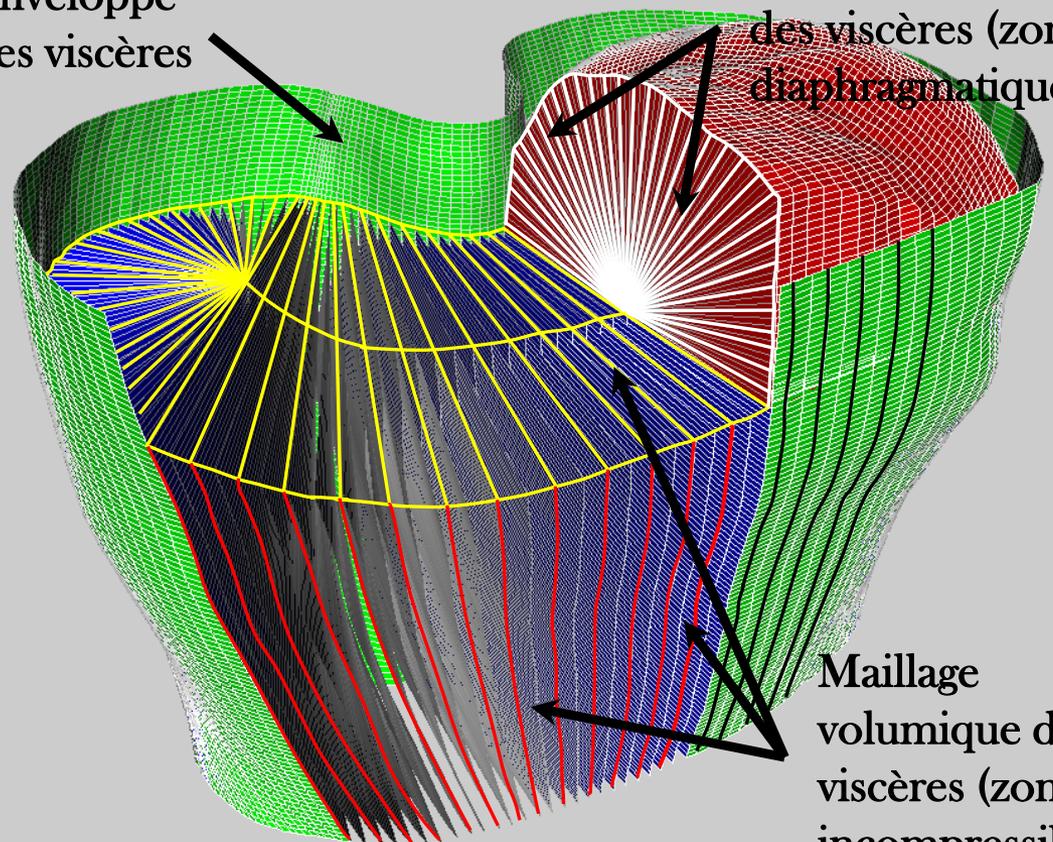


Méthode

- Maillage volumique des viscères



Enveloppe
des viscères

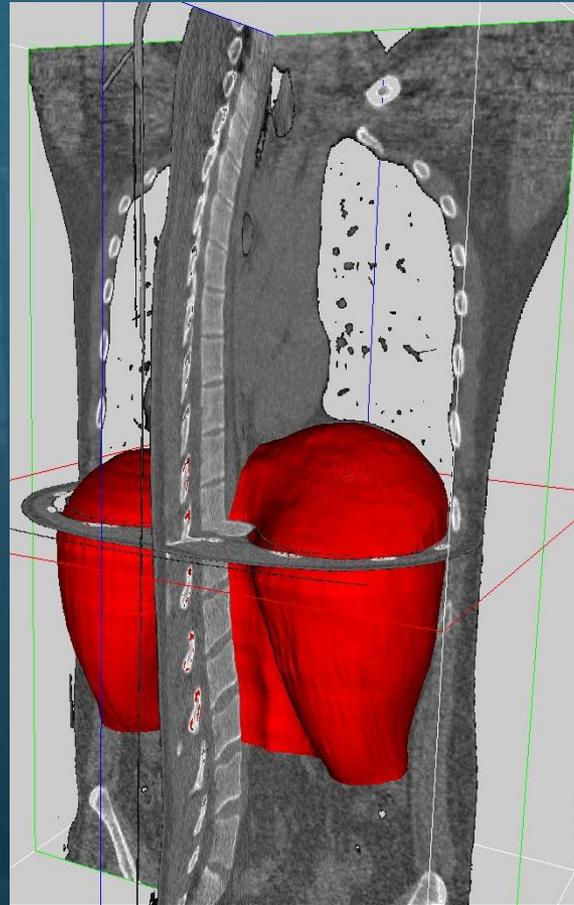
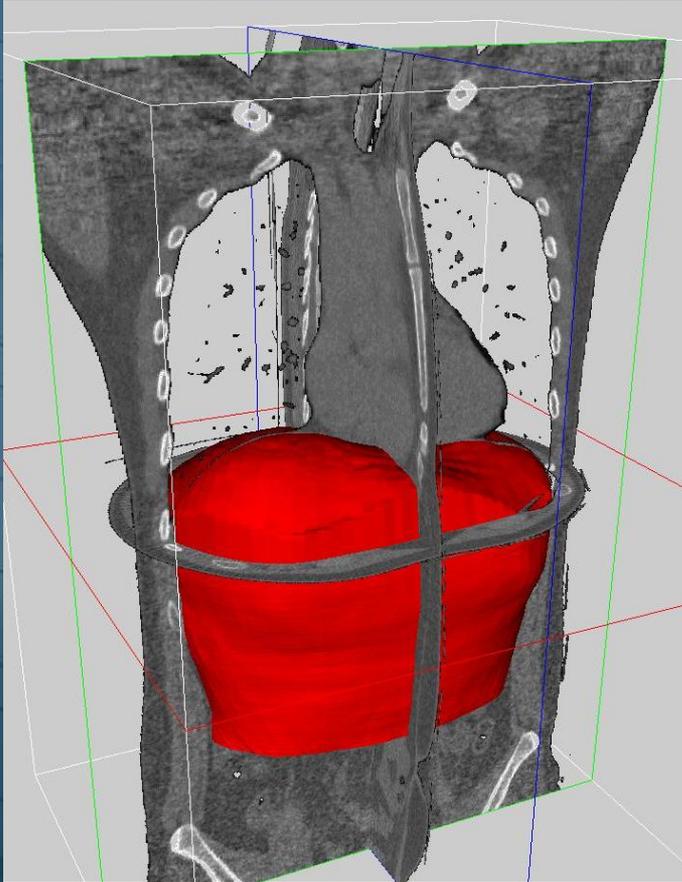


Maillage volumique
des viscères (zone
diaphragmatique)

Maillage
volumique des
viscères (zone
incompressible)

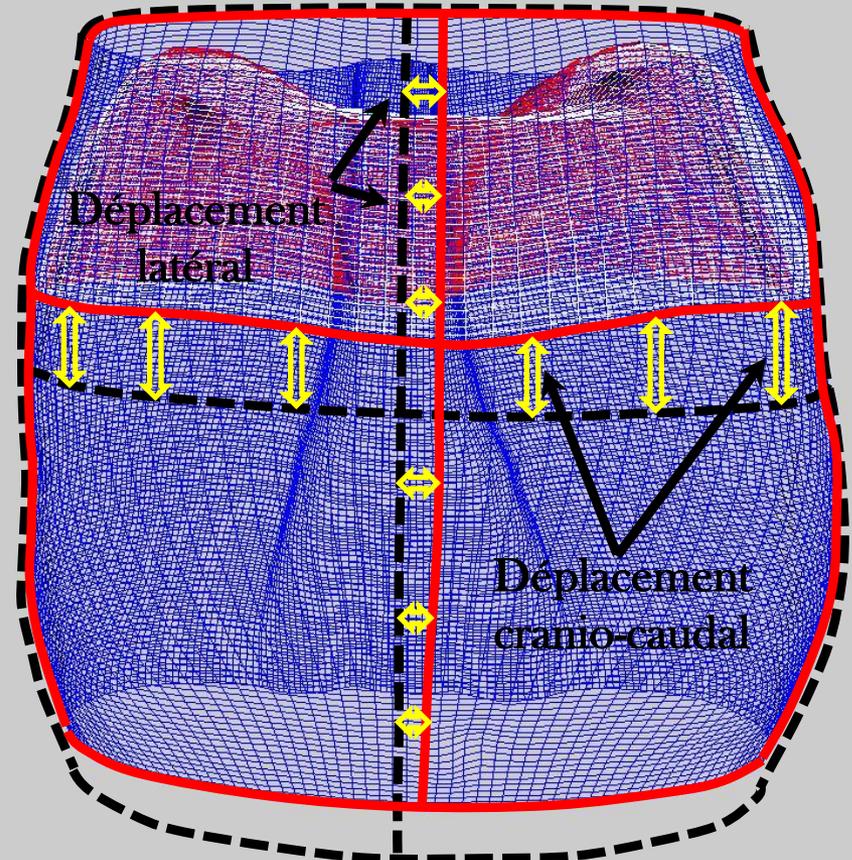
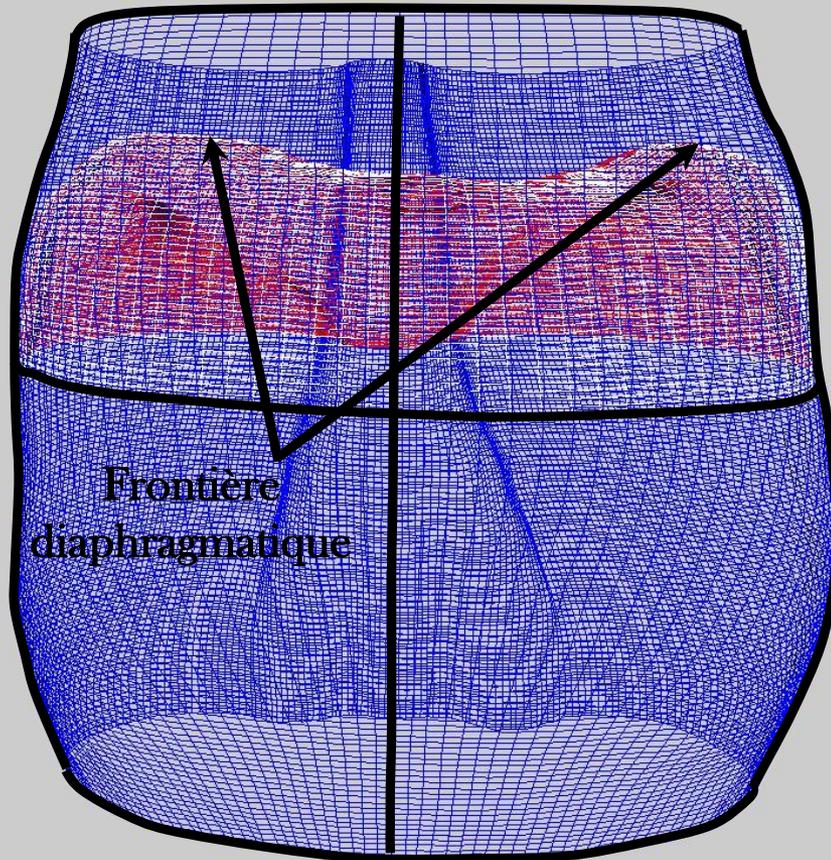
Méthode

- Modélisation de la frontière diaphragmatique



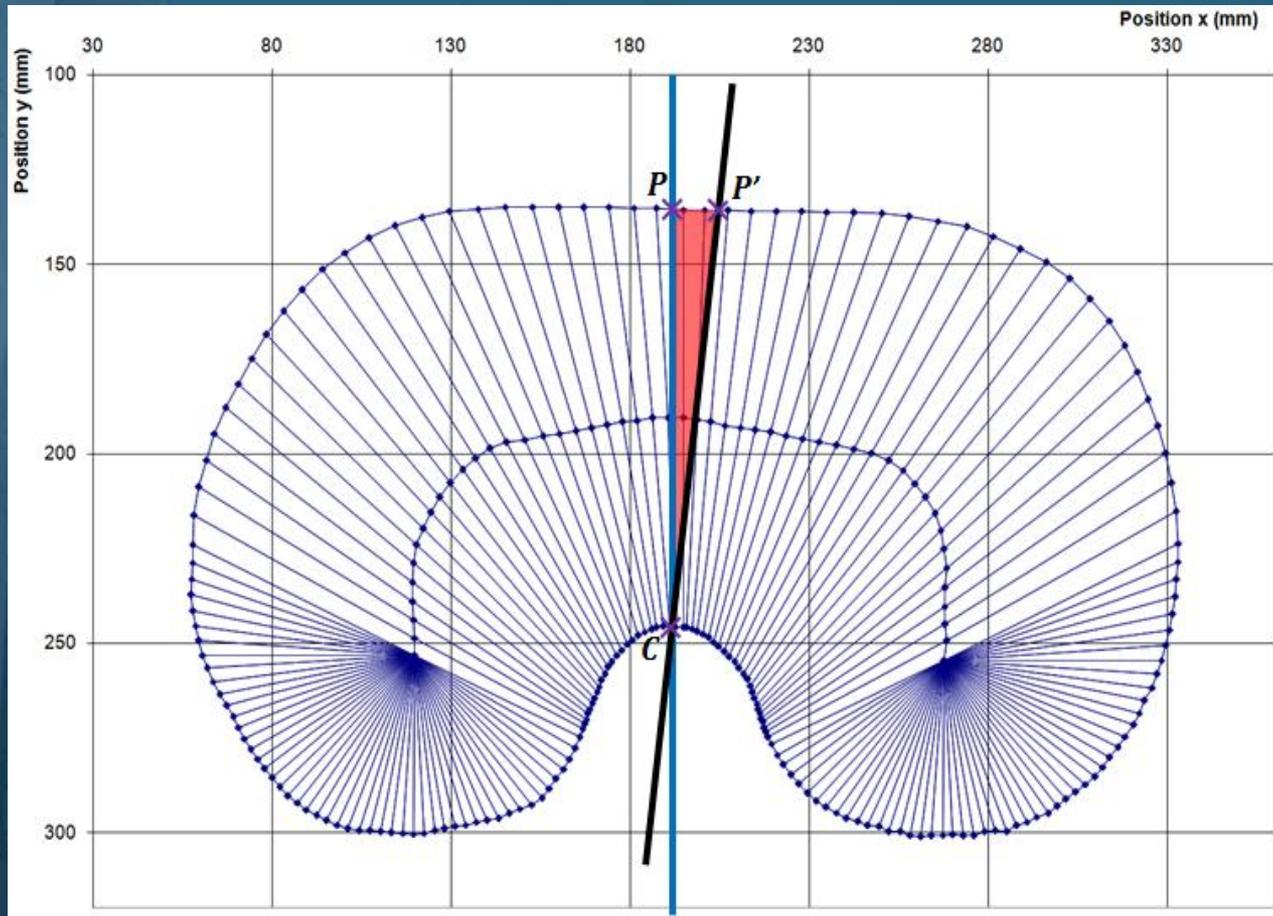
Méthode

- Déplacement cranio-caudal et latéral



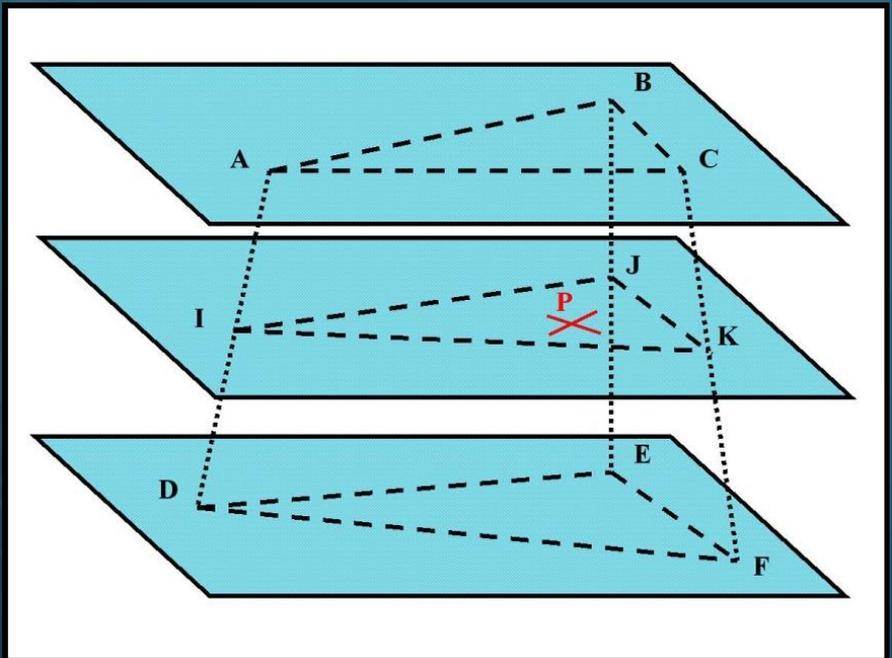
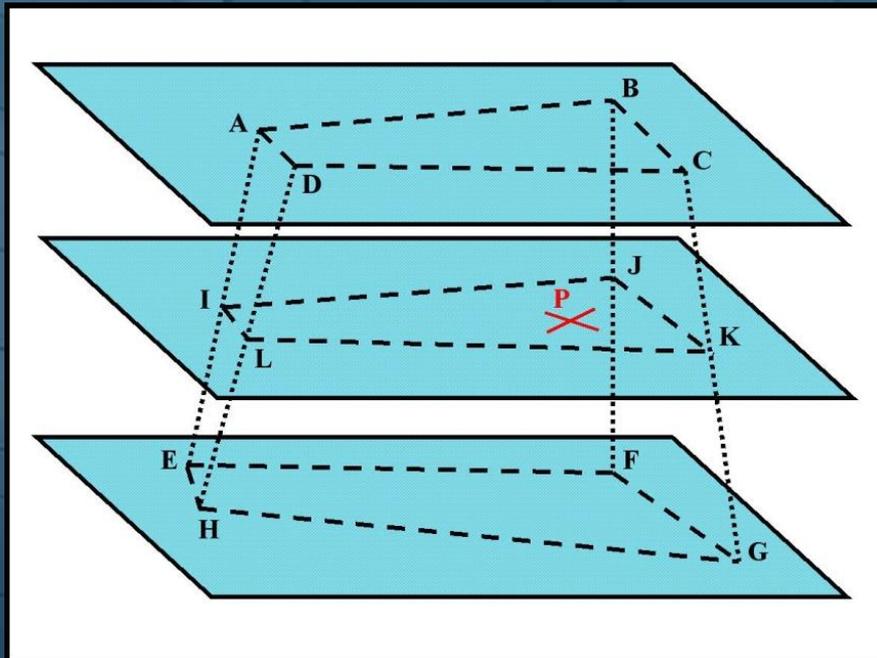
Méthode

- Compensation volumique

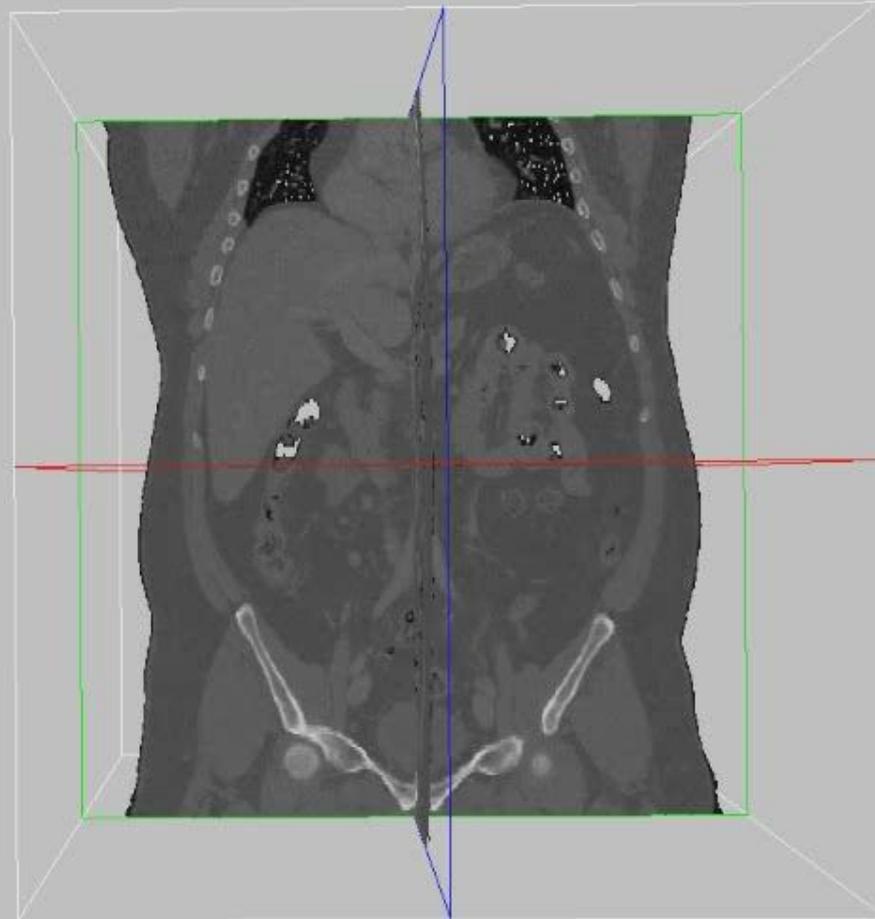


Méthode

- Positionnement des vertex dans le maillage volumique



Résultats



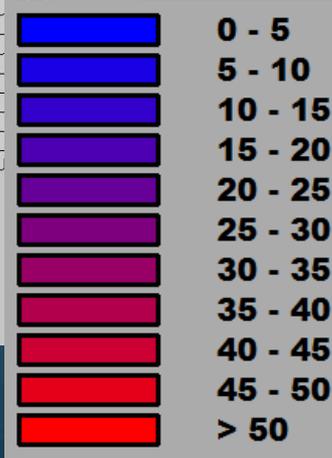
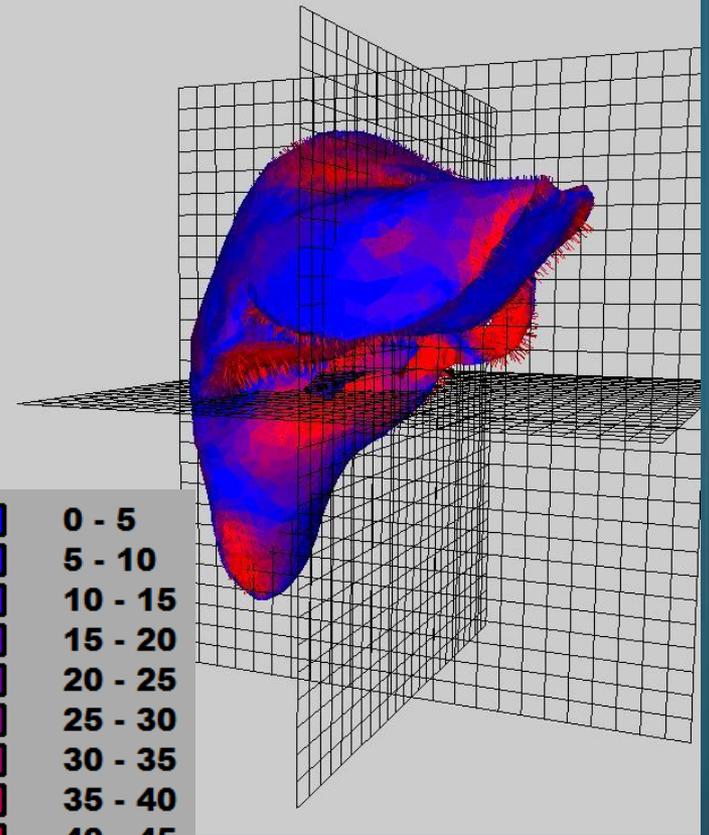
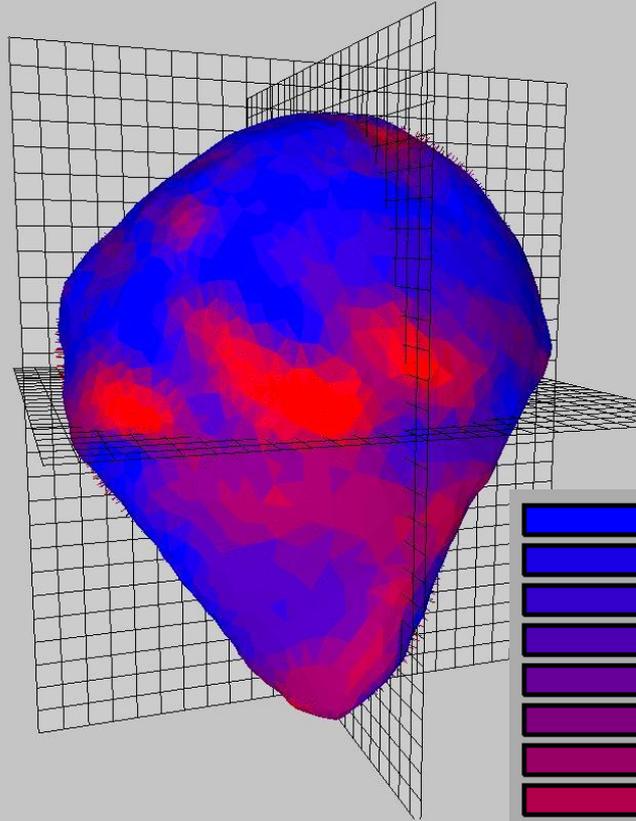
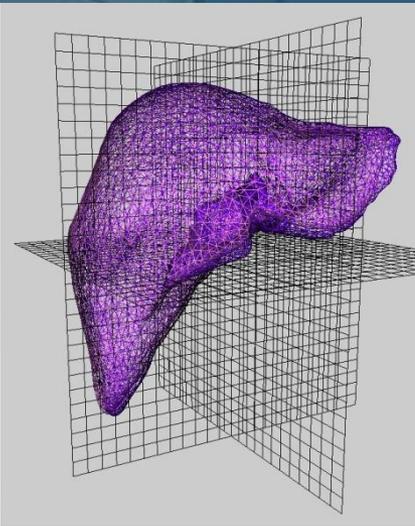
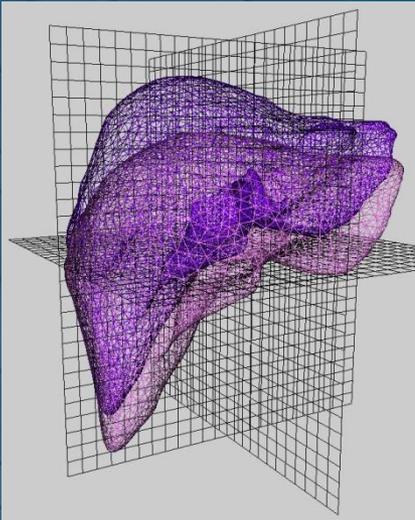
Alexandre Hostettler - Mardi 15 Juin 2010
Alexandre.hostettler@ircad.fr

Résultats

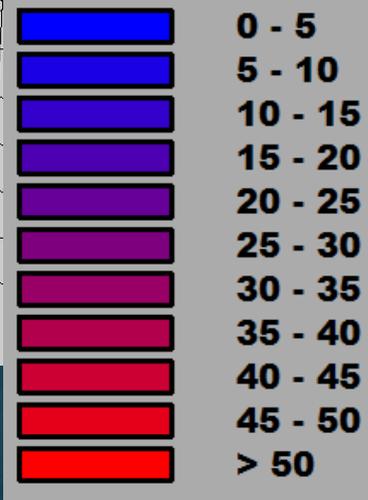
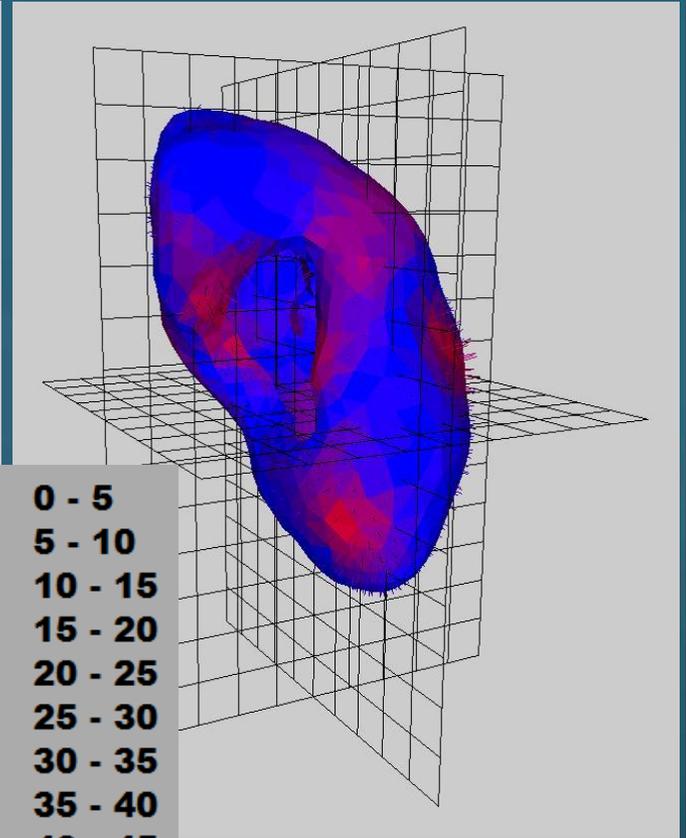
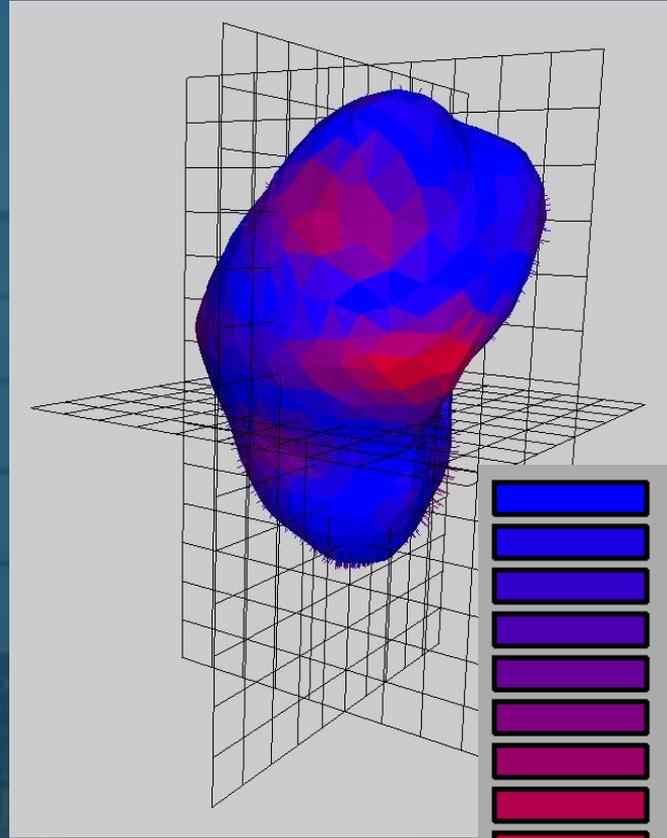
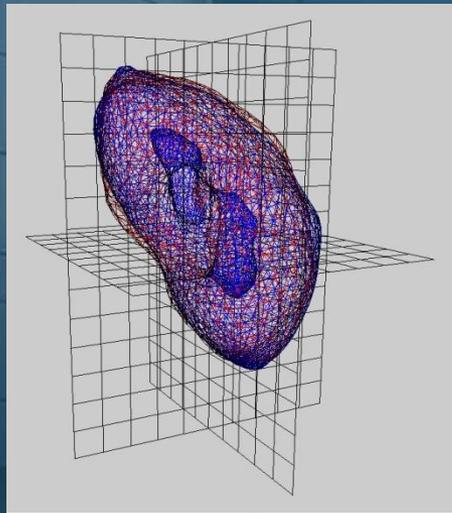
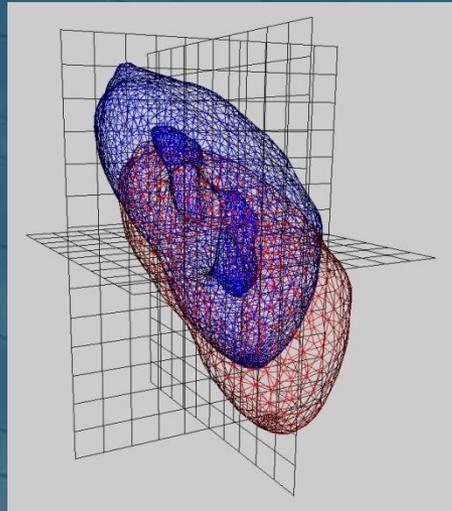
- Comparaison entre positions réelles et simulées

Organes	Patient I	Patient II
Foie	2.4 mm	2.2 mm
Rein droit	1.9 mm	1.7 mm
Rein gauche	1.7 mm	1.4 mm
Rate	2.8 mm	2.3 mm
Pancréas	X	2.5 mm

Résultats



Résultats

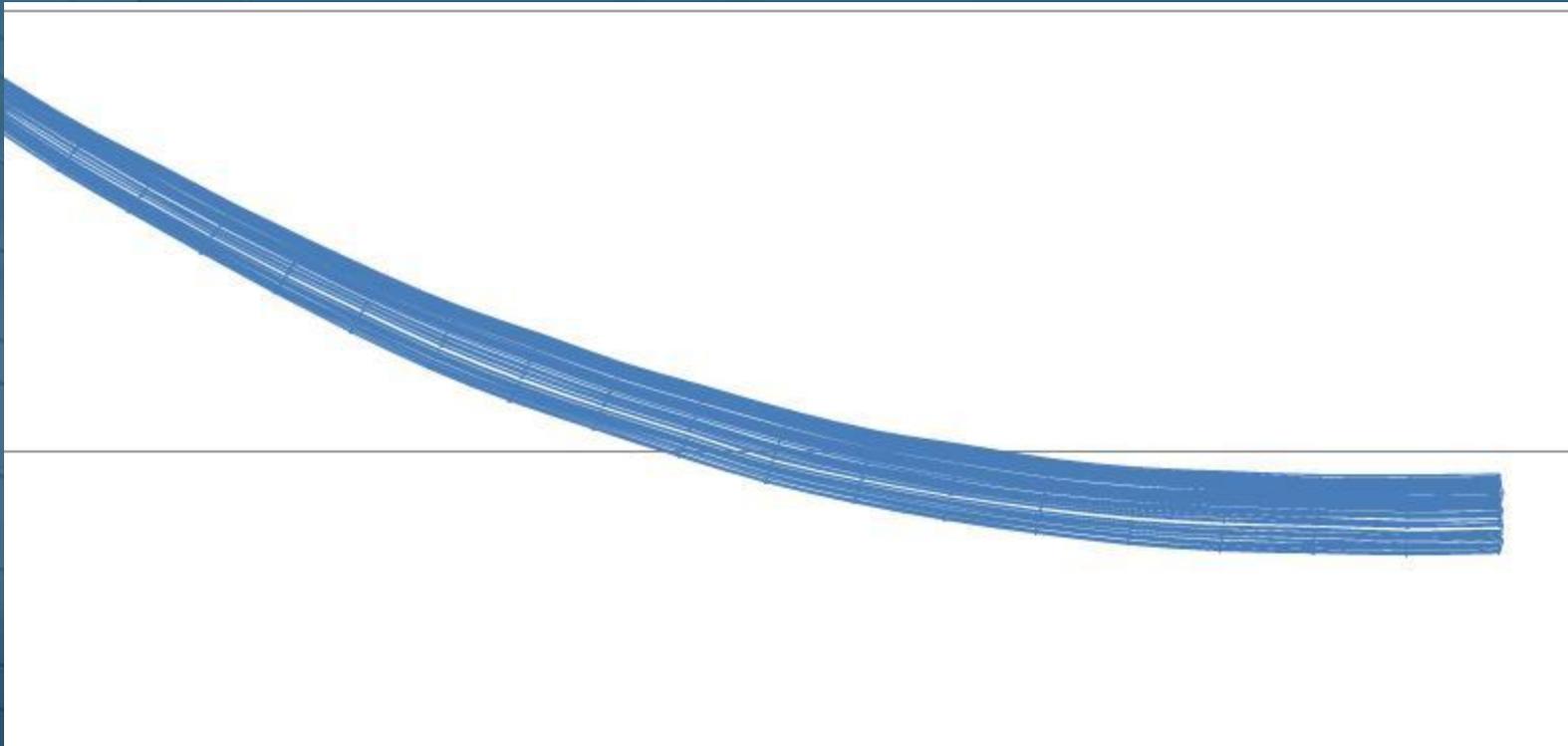


Conclusion

- Contributions
 - Méthode précise (??) et rapide
 - Temps pré-calcul $< 5s$
 - Calcul à 60 Hz
 - Faible dépendance à la segmentation
 - Première application (simulateur prédictif)
- Futur
 - Intégration de Sofa
 - Simulation du pneumopéritoine
 - Validations (MRI acquisitions)

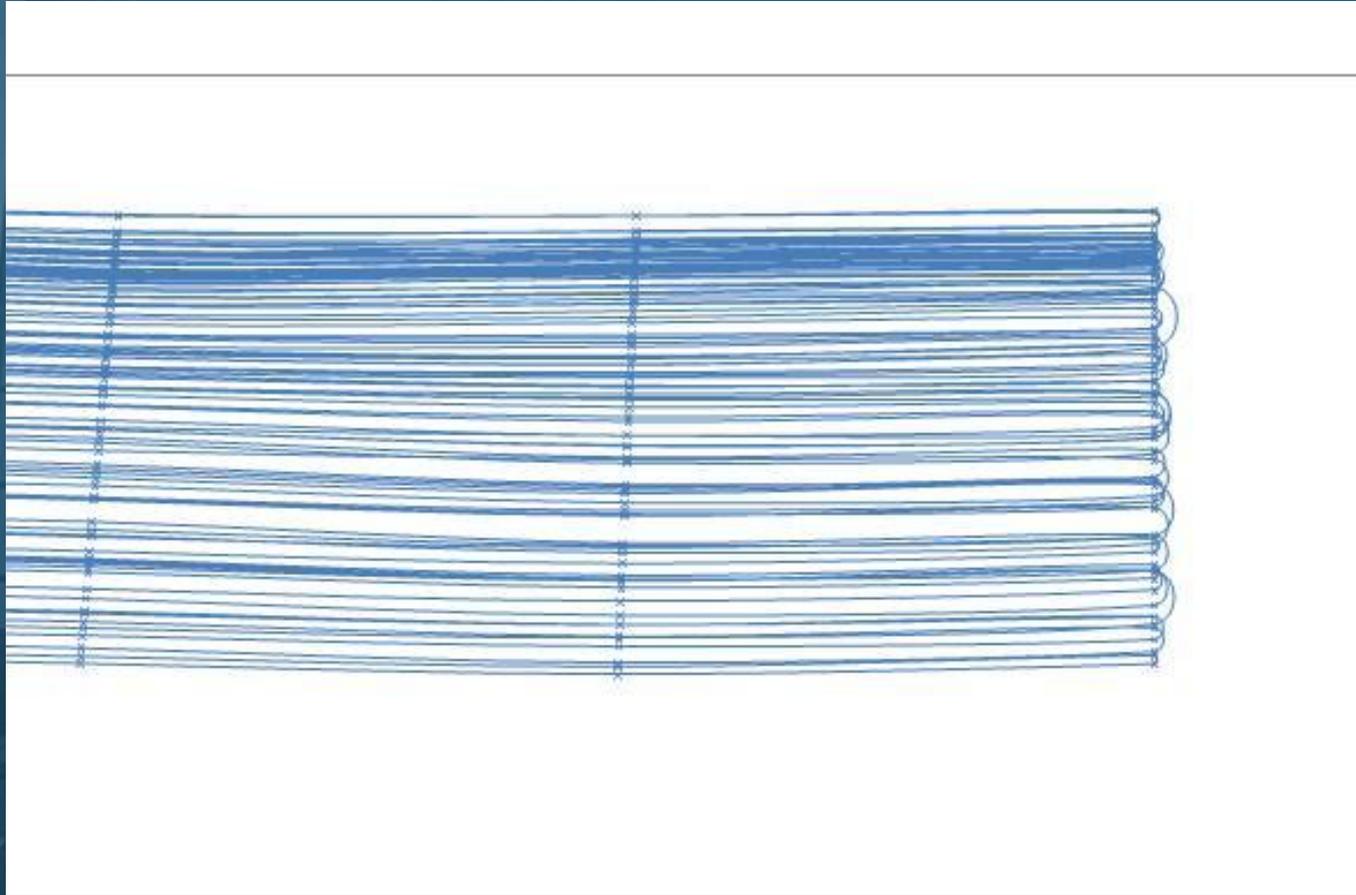
Validation

- Mouvement de la peau dans un demi plan axial



Validation

- Zoom du mouvement de la peau



Validation

- **Modélisation de la position de la peau en fonction:**
 - Position inspirée
 - Position expirée
 - Position du profil correspondant au plan sagittal médian
 - Acquisition sous IRM de deux images:
 - Plan sagittal médian
 - Position d'un organe cible

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