

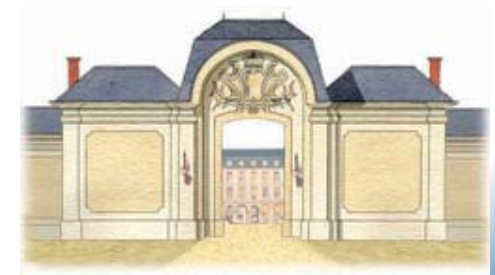
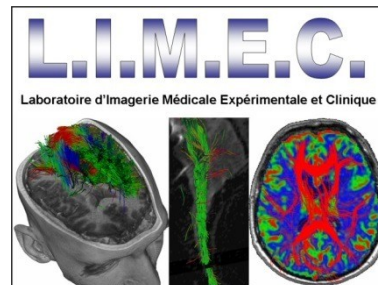


UNIVERSITÉ  
**PARIS-SUD 11**

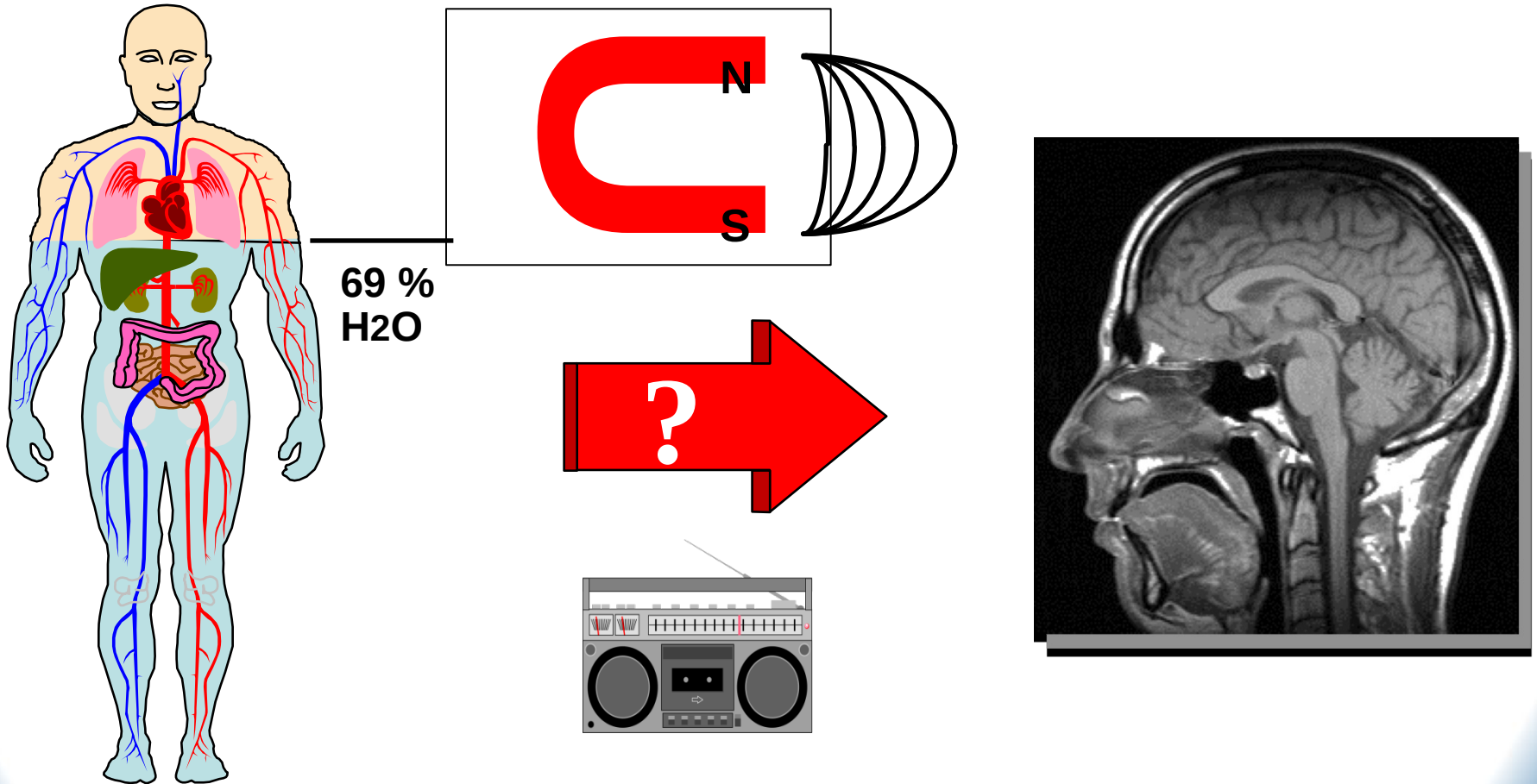
# Imagerie des Cérébro-lésés : Comment apprécier la récupération neurologique

*Pr Denis Ducreux, MD, PhD*  
**Neuroradiologie, CHU Bicetre**  
**CNRS IR4M (UMR 8081),**  
**Université Paris 11**

Hôpitaux  
universitaires  
**Paris-Sud**  
Antoine-Béclère Bicêtre Paul-Brousse



# I.R.M.

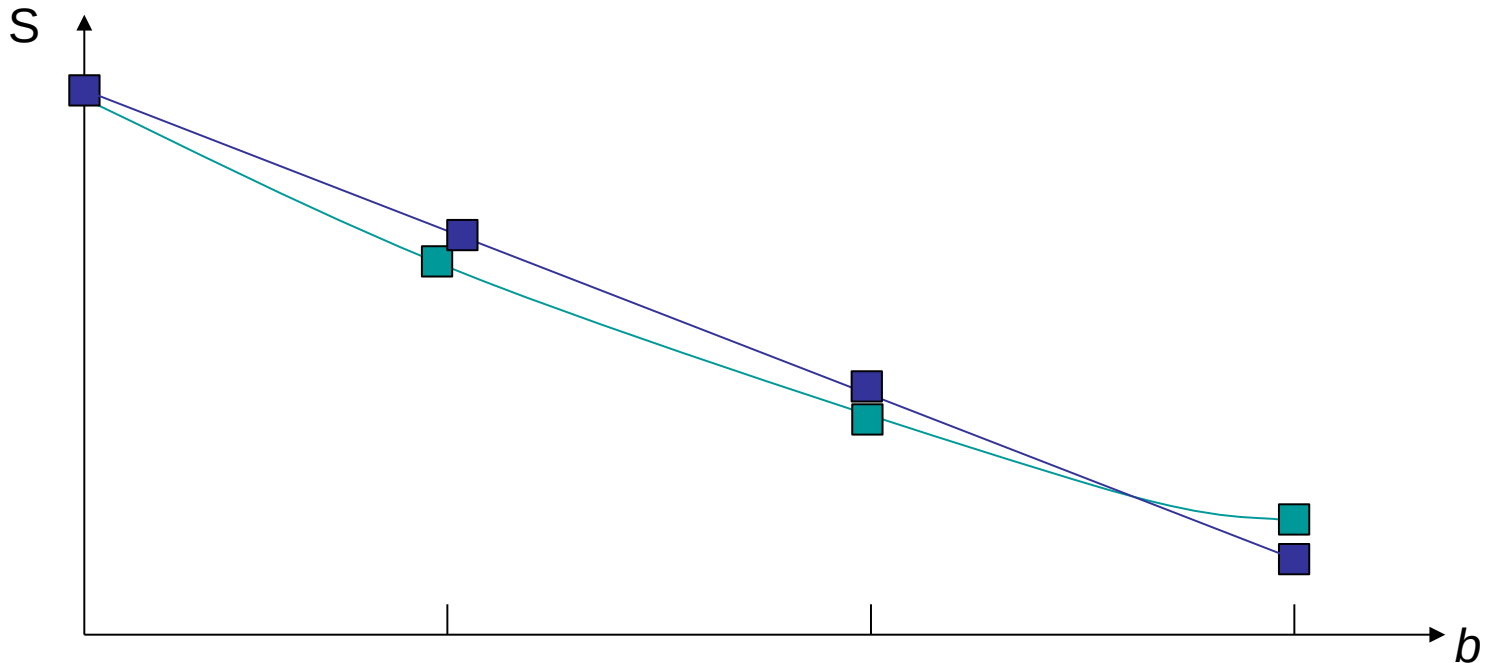


D'après JM Franconi et F Giboreau. « Bases physiques de l'IRM »

# **IRM de Diffusion**

# IRM de DIFFUSION

## Modèles mono et bi-compartmentaux

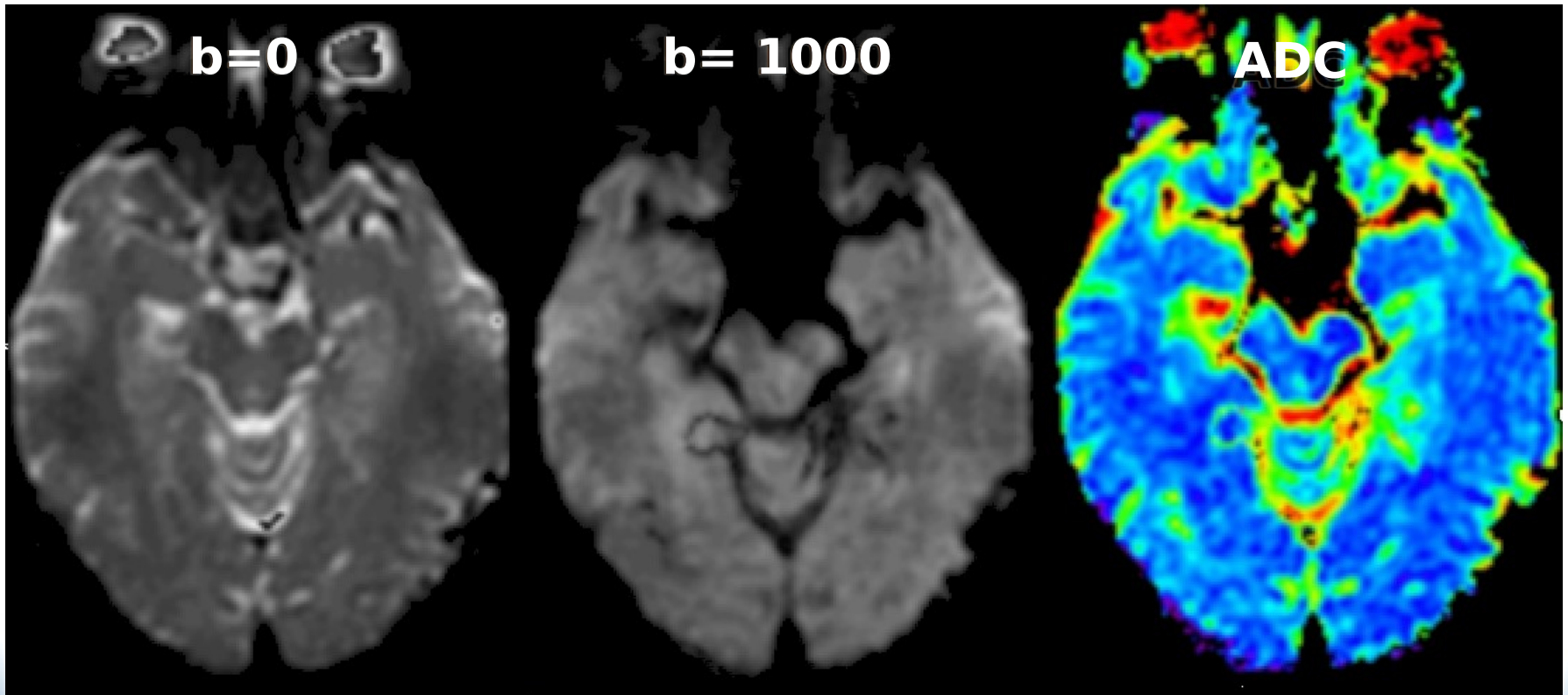


$$S_b \equiv S_0 \cdot e^{-b \cdot D} \text{ versus } S_i(te, b) = [S_a \cdot e^{-te/T2a} \cdot e^{-b \cdot Da}] + [S_b \cdot e^{-(te/T2b)} \cdot e^{-b \cdot Db}]$$

# IRM de

# DIFFUSION

Coefficient Apparent de  
Diffusion



$$SA \approx e^{-b \cdot ADC} = e^{-\gamma^2 G^2 \delta^2 (\Delta - \delta/3) ADC}$$

# **Applications Cliniques**

# IRM de DIFFUSION

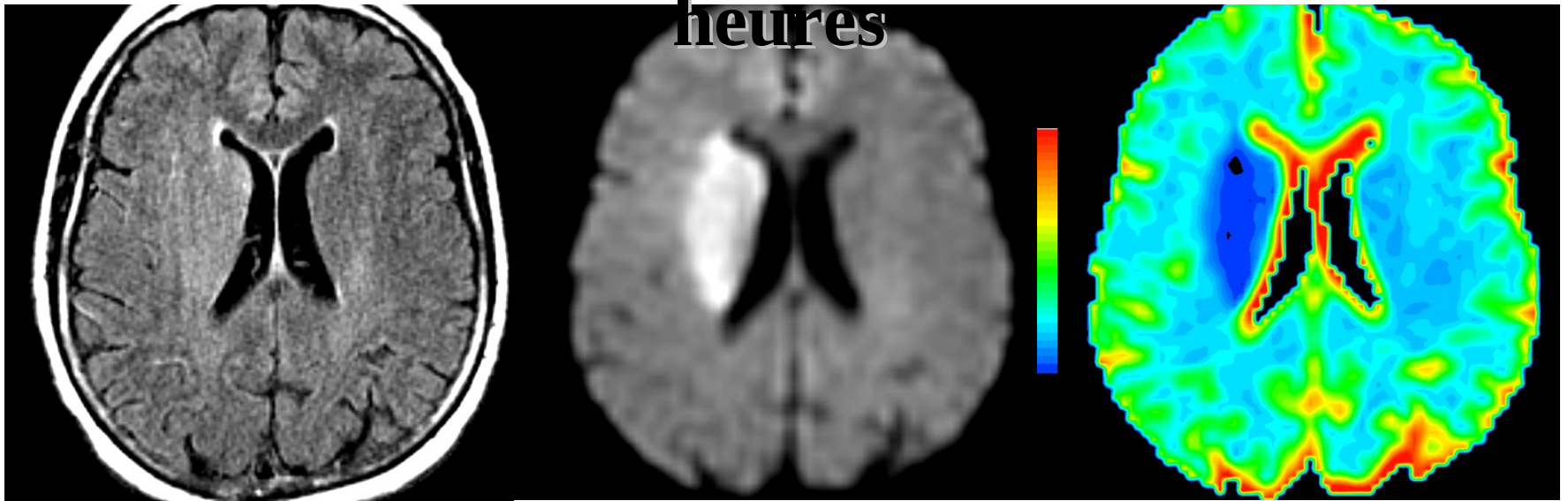
Ischémie  
Artérielle





# IRM de Ischémie Artérielle **DIFFUSION**

Hémiplégie gauche brutale. IRM à 5.5 heures



**FLAIR**

**DWI**

**ADC**



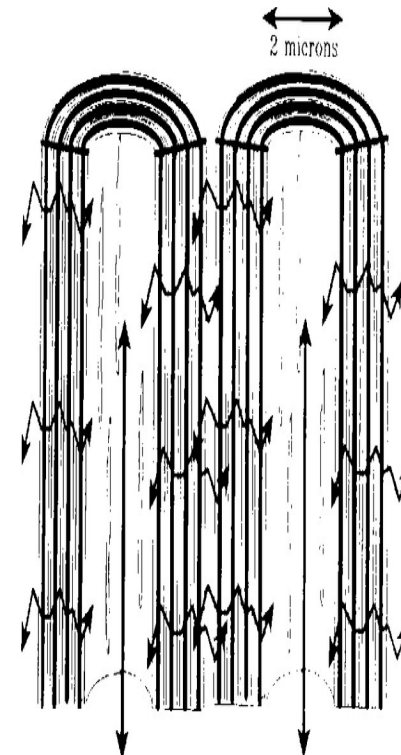
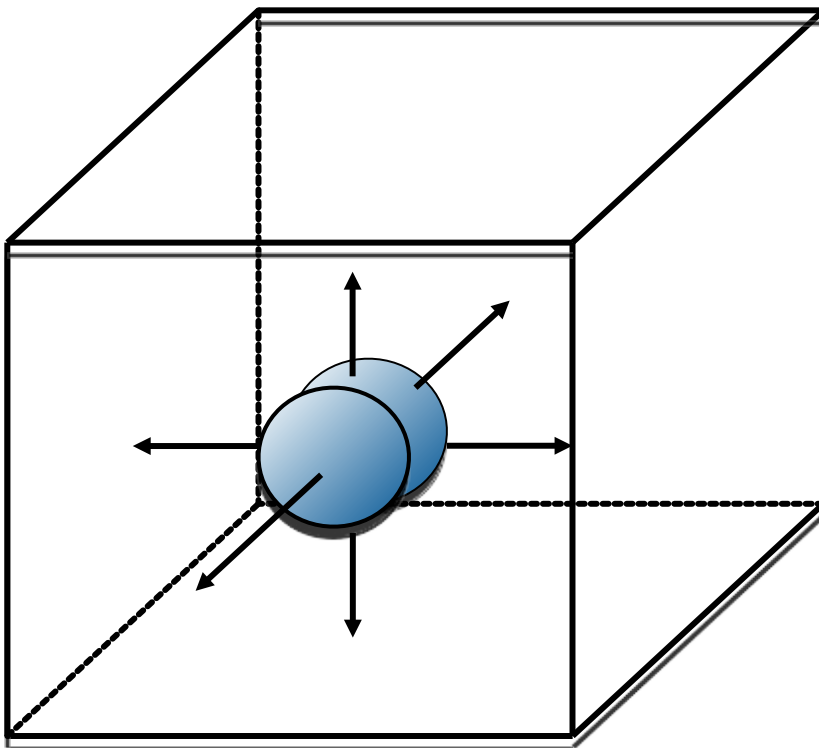
# **IRM de Tenseur de Diffusion**

# IRM de Tenseur de

## Méthode de Diffusion

### Oeuvre

- Description complète des propriétés de diffusion d'un voxel
- Tenseur de diffusion (gradients dans  $\geq 6$  dir. de l'espace)



(d'après D. Le Bihan)

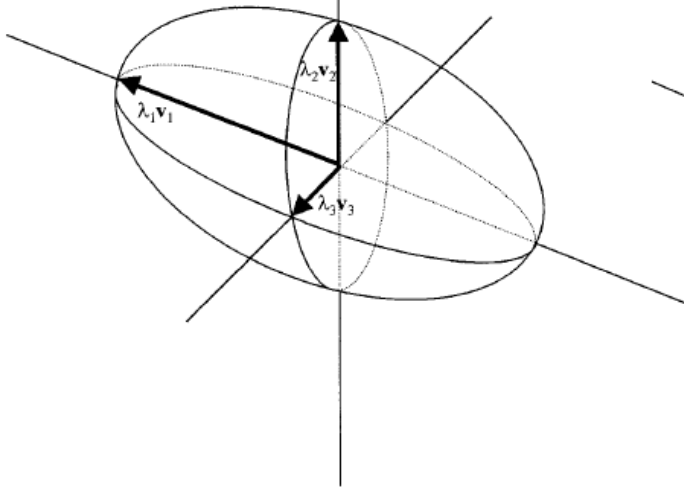
# IRM de Tenseur de

## Méthode de Diffusion

Oeuvre

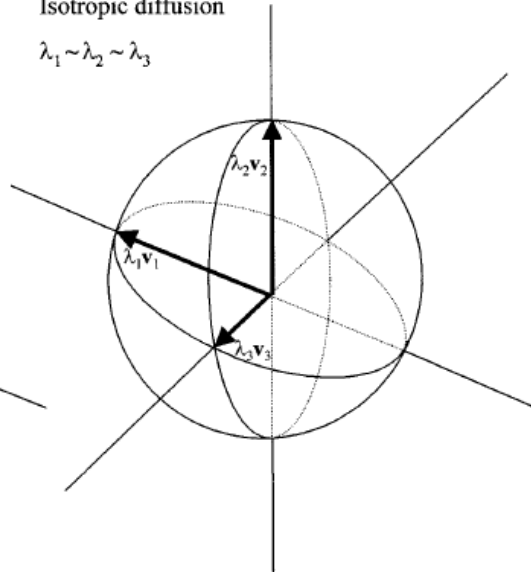
Anisotropic diffusion

$$\lambda_1 \geq \lambda_2 \geq \lambda_3$$



Isotropic diffusion

$$\lambda_1 \sim \lambda_2 \sim \lambda_3$$



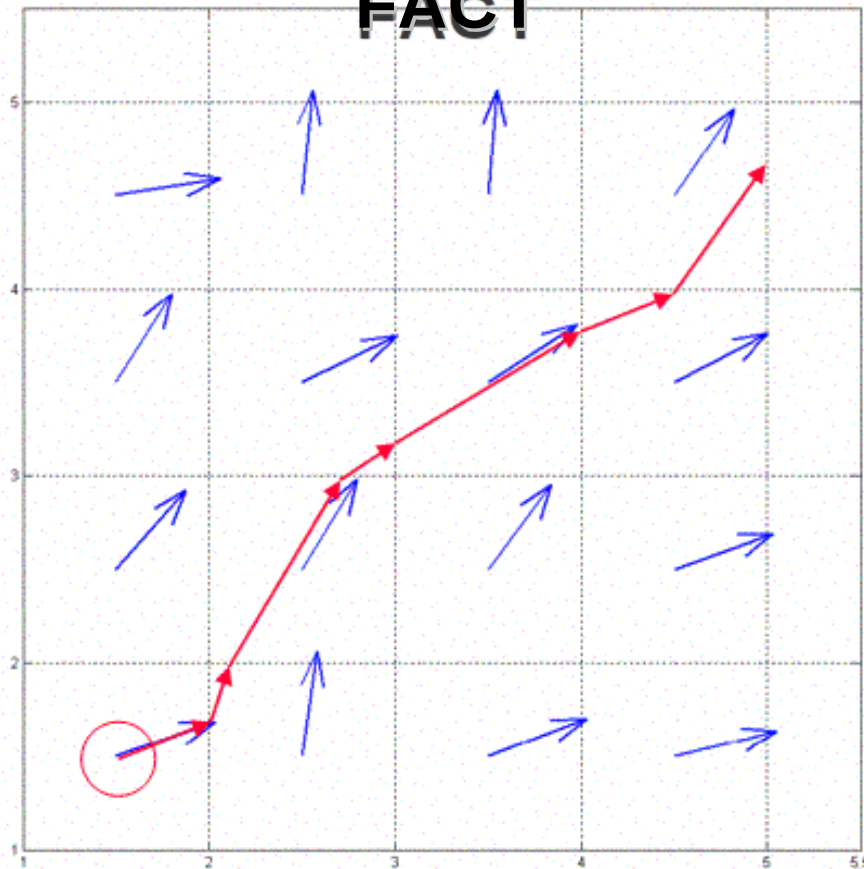
$v_1, v_2$  et  $v_3$   
directions

$\lambda_1, \lambda_2$  et  $\lambda_3$   
valeurs propres  
(longueurs)

- Tenseurs utilisés pour décrire la diffusion peuvent être conceptualisés et visualisés comme des ellipsoïdes
- Si les trois valeurs propres sont égales, la diffusion est isotrope et le tenseur de diffusion peut être visualisé comme une sphère

# IRM de Tenseur de

## Tractographie par Diffusion FACT



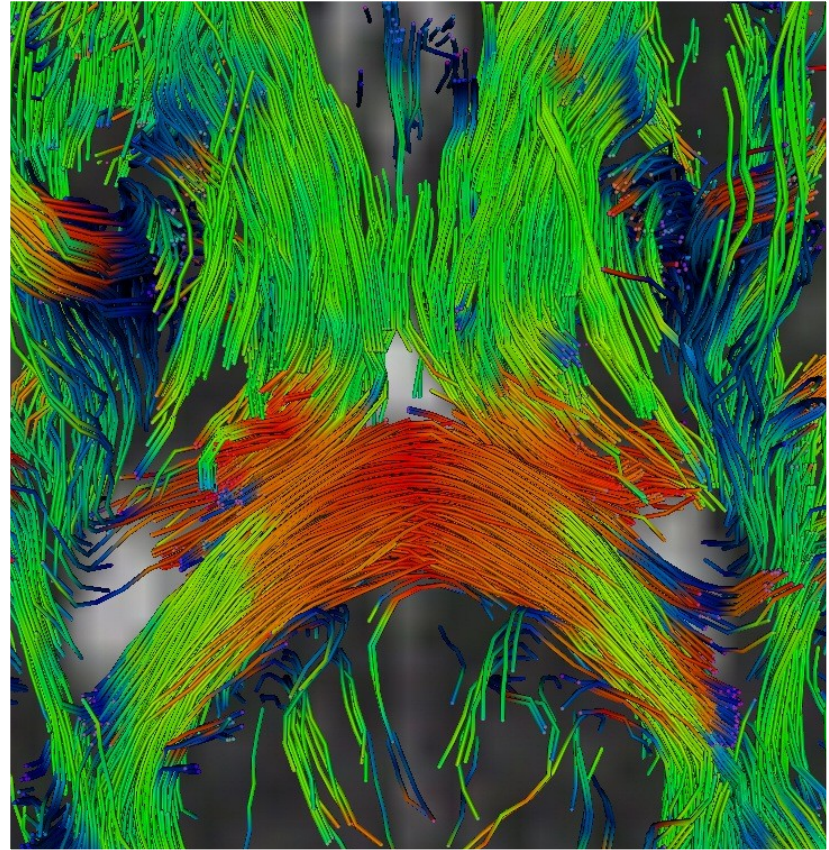
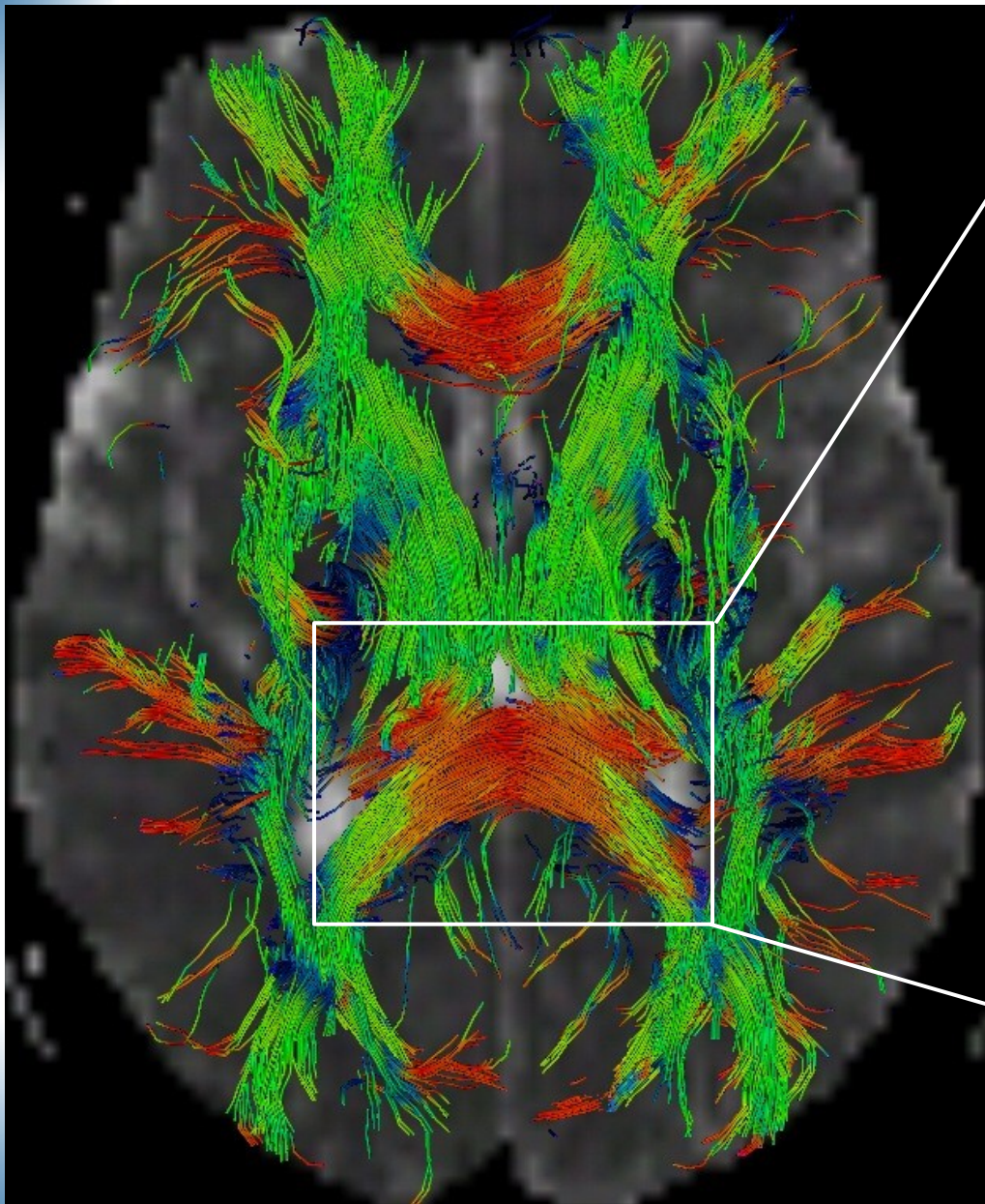
A partir du point  $S(0)$ , on a l'équation en 3D suivante :

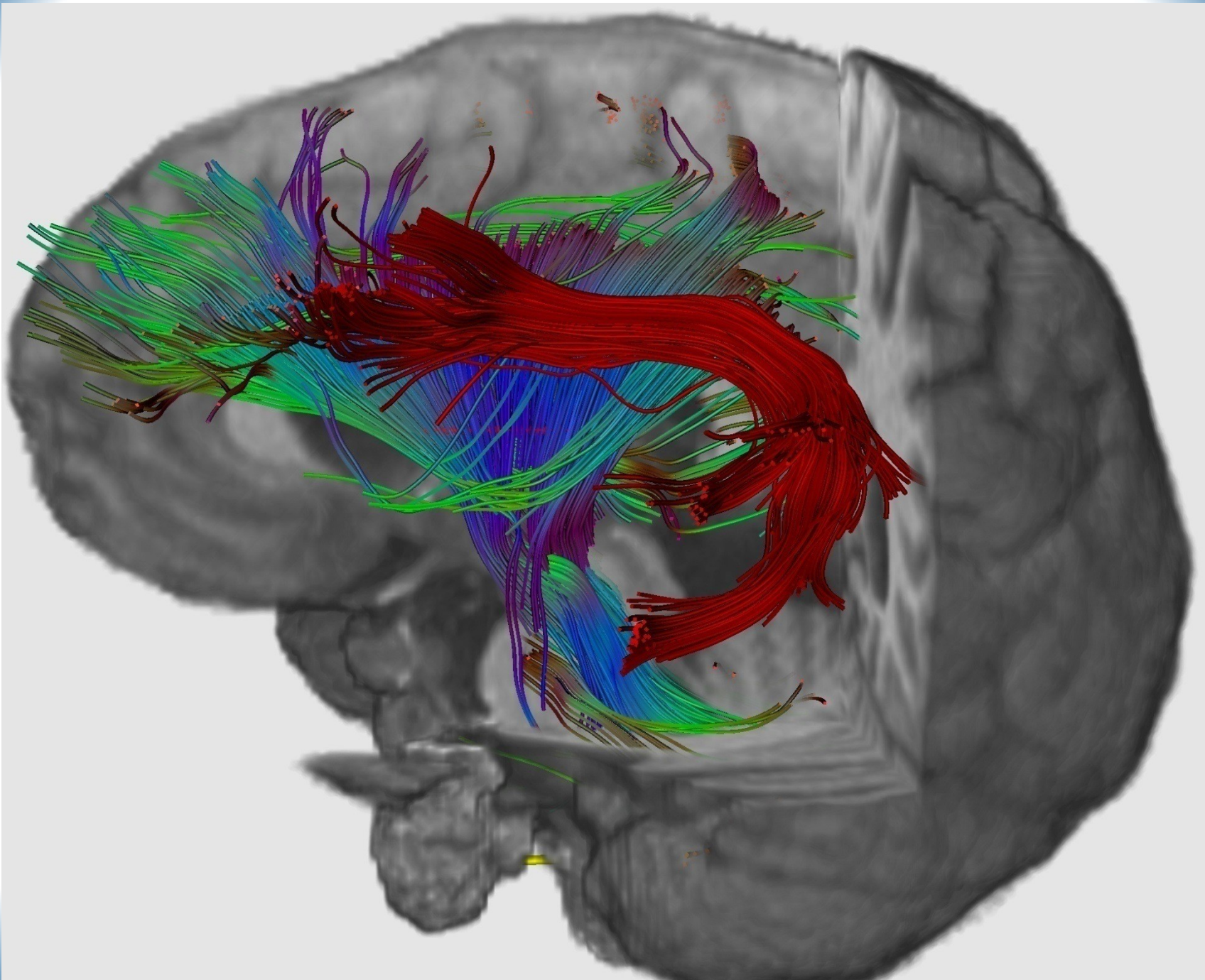
$$\delta S(t)/\delta t = R(t)$$

Avec :

- $S(t)$  : position de la fibre curviligne au temps  $t$
- $R(t)$  : tangente à la direction du faisceau

# **Anatomie Cérébrale Normale**

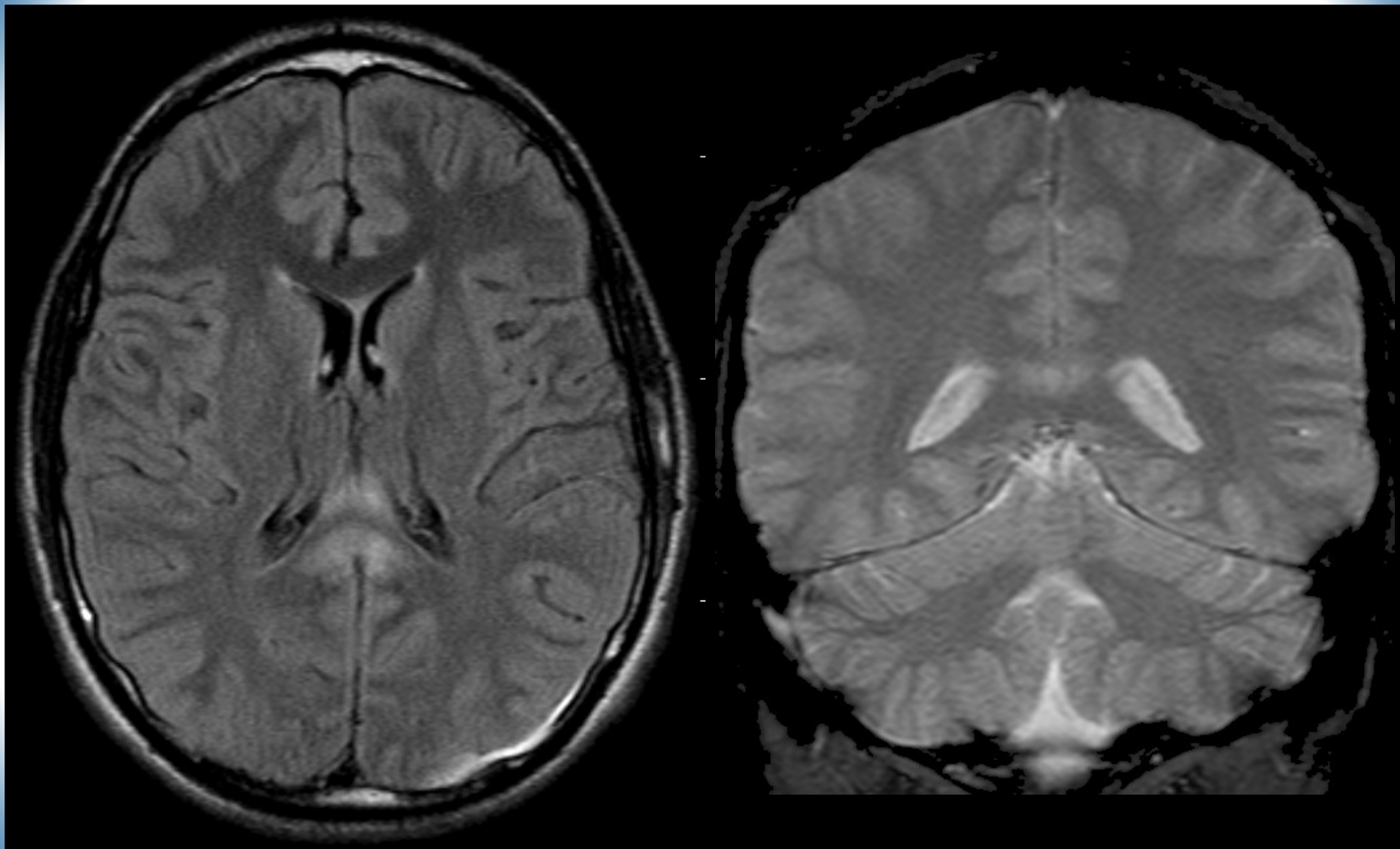


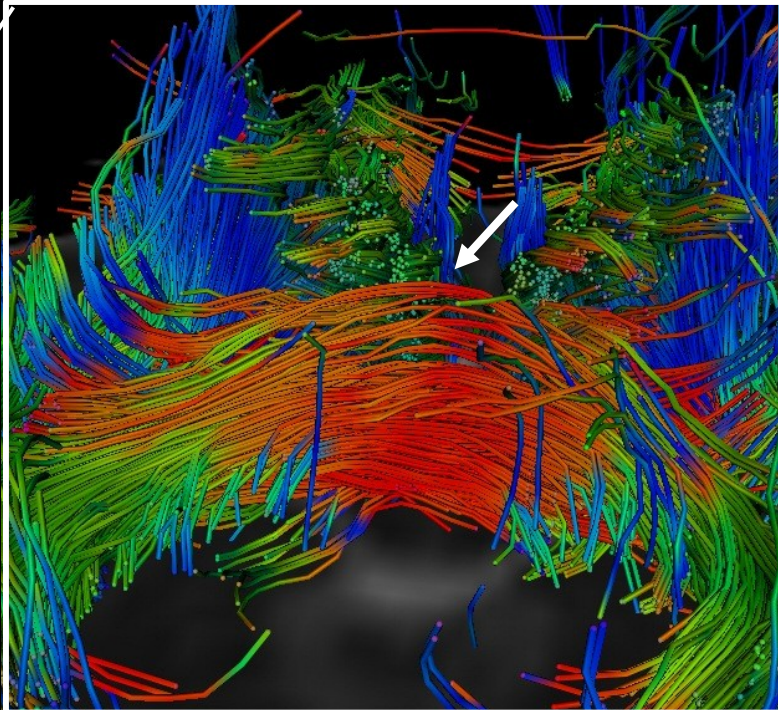
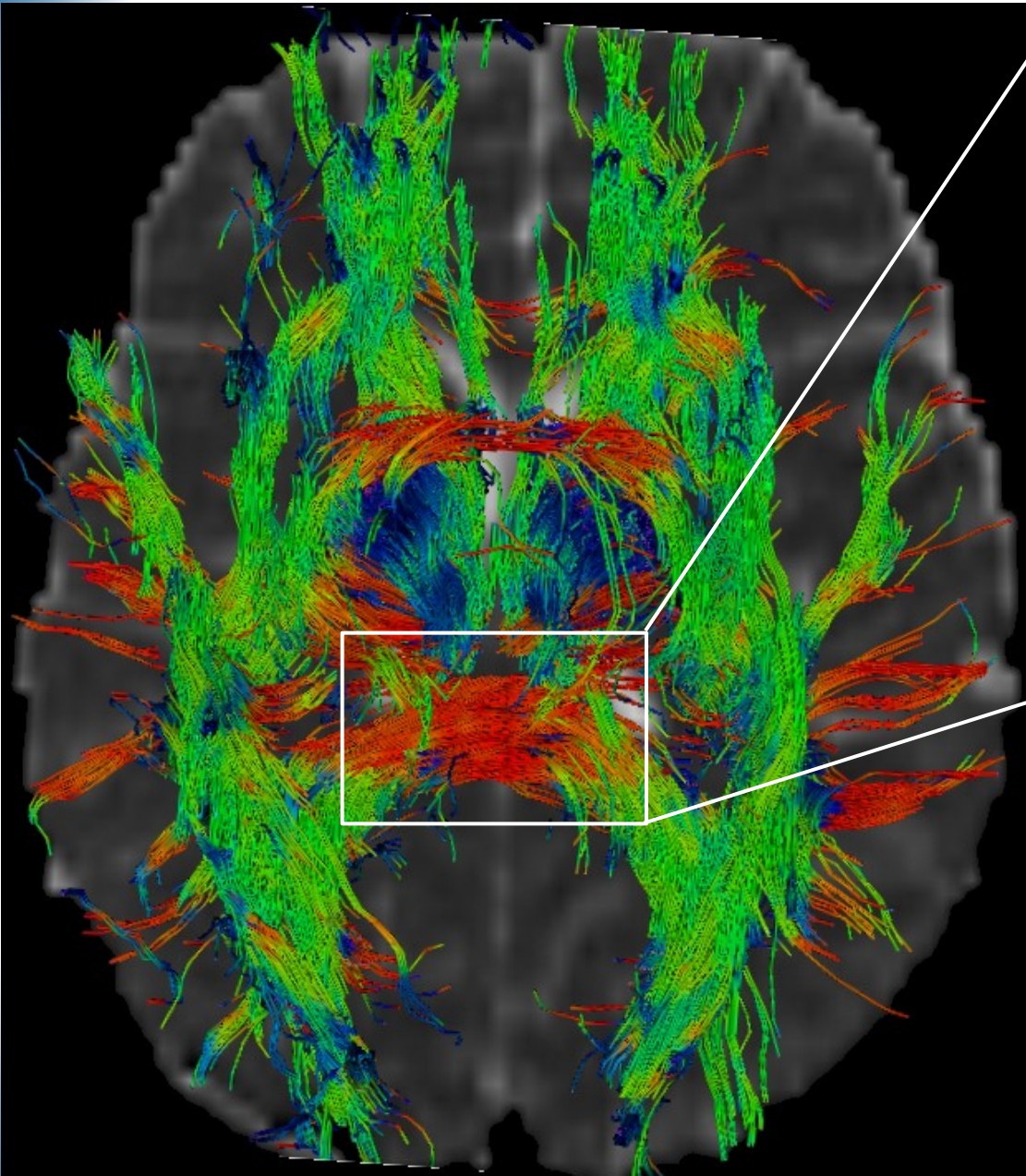


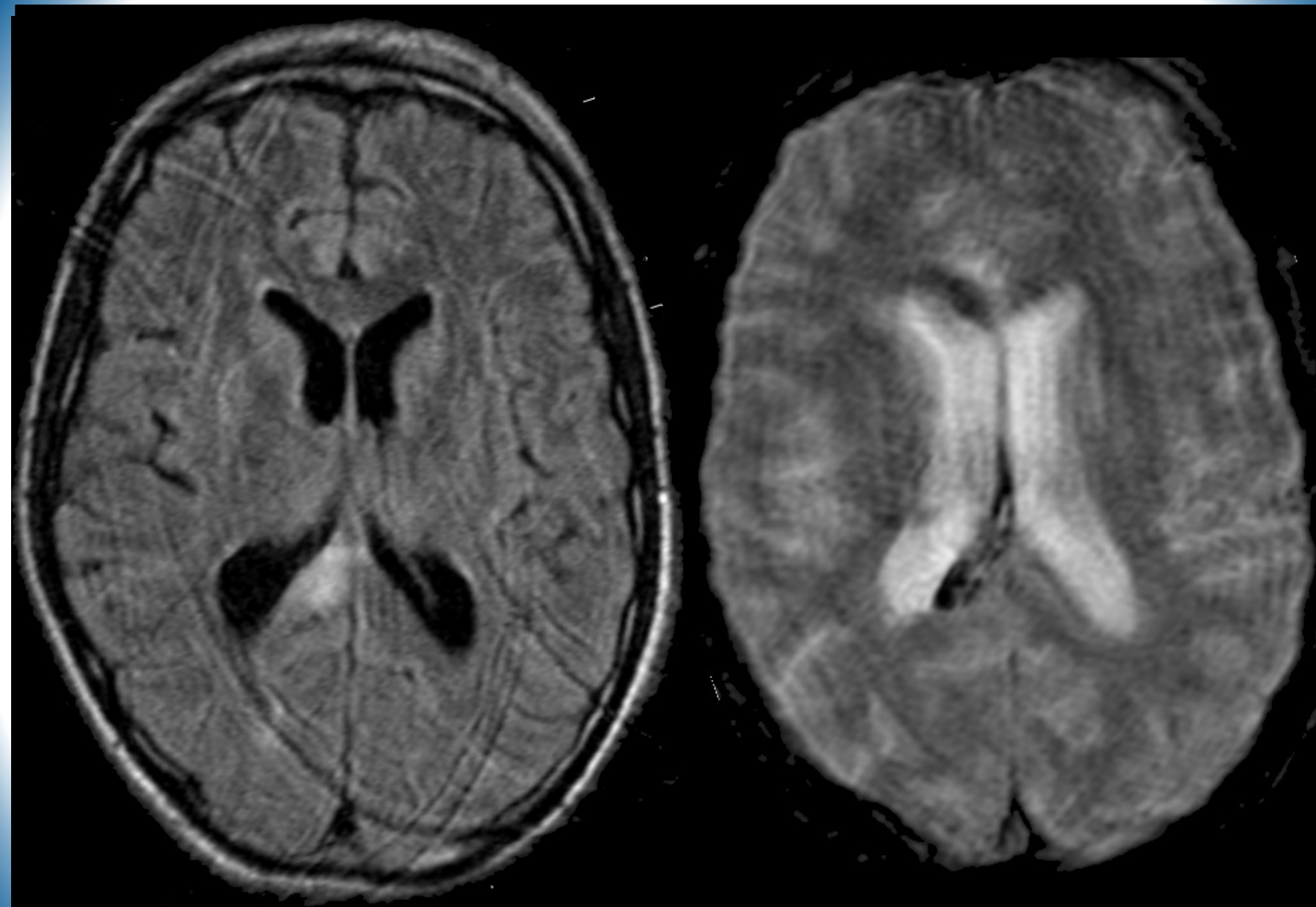


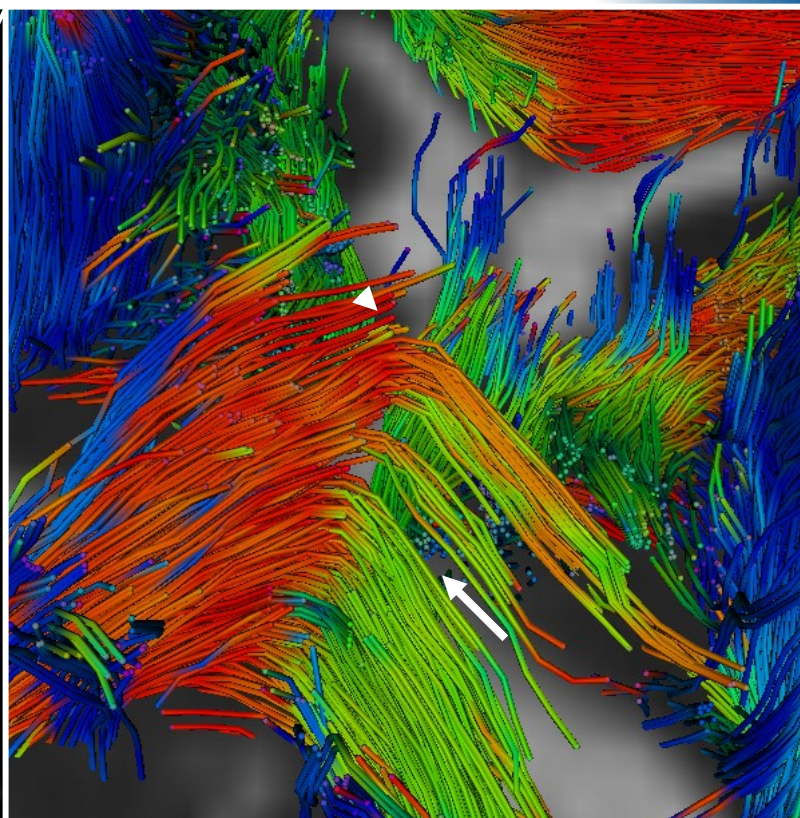
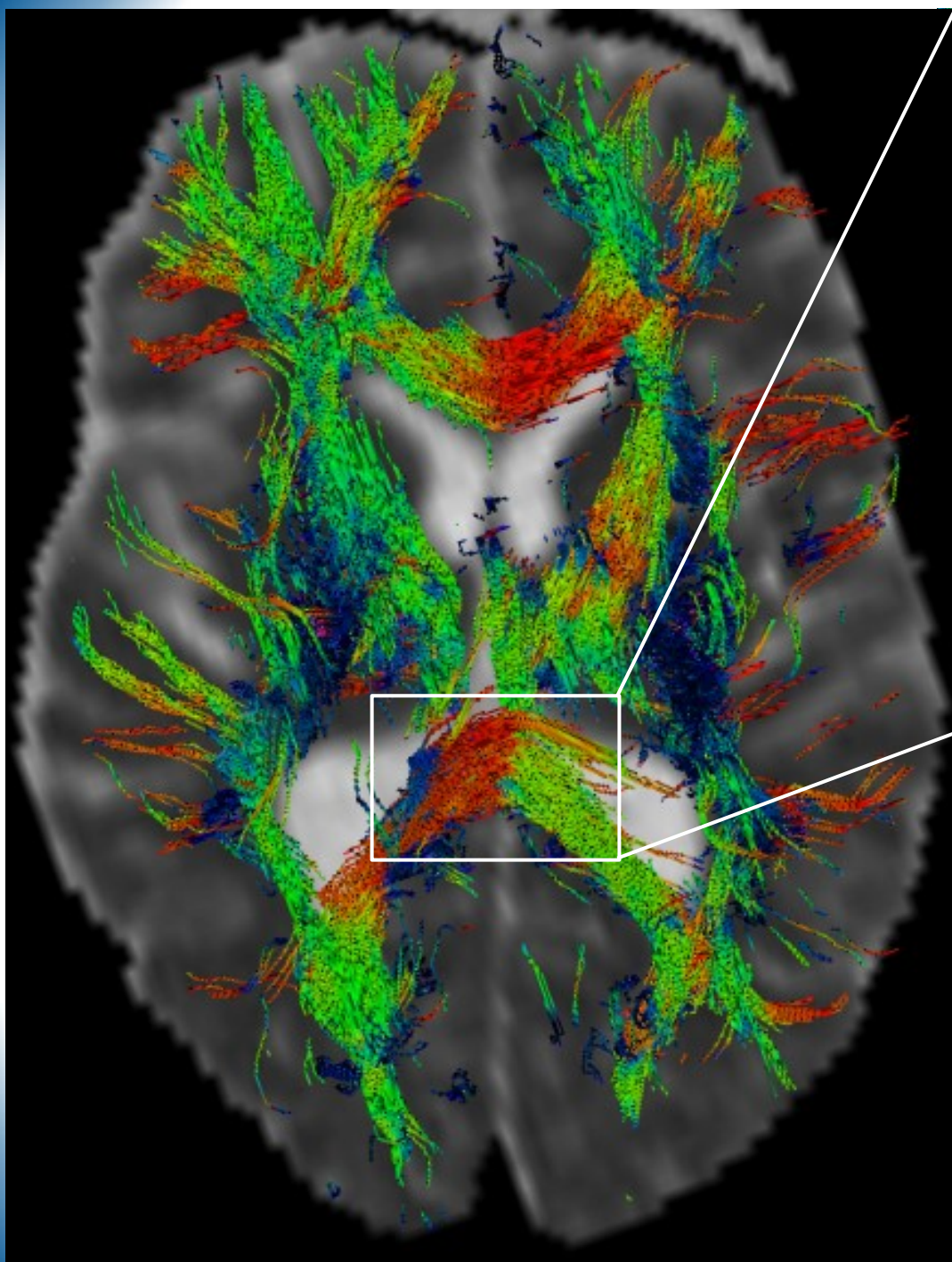


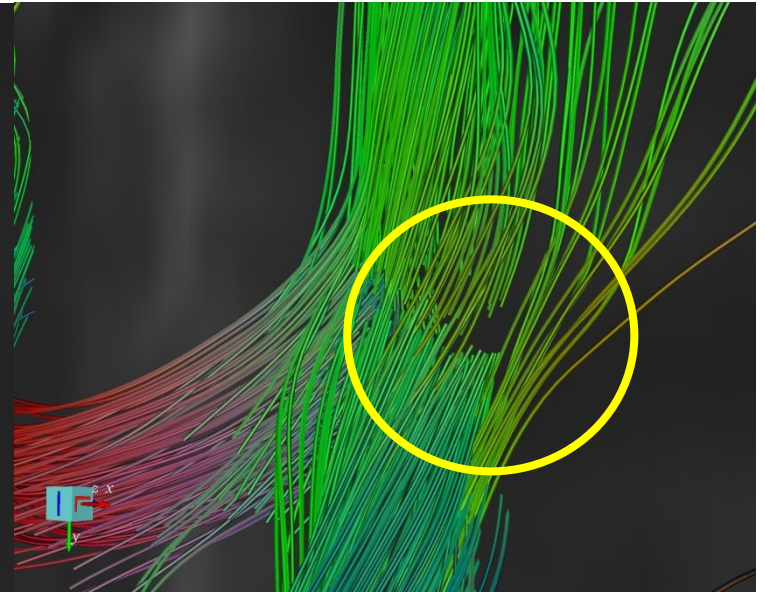
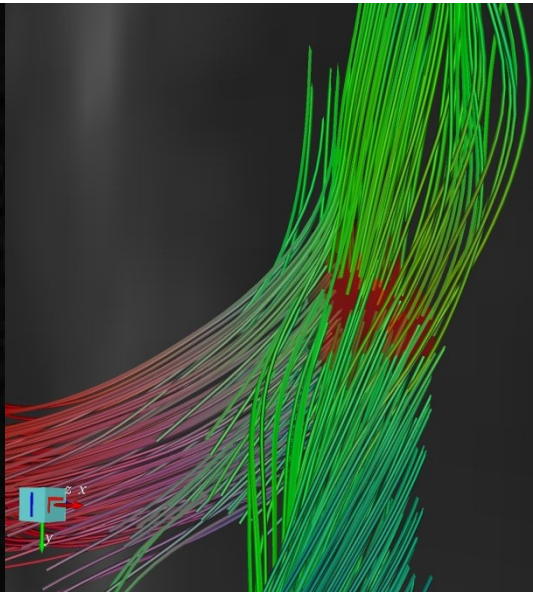
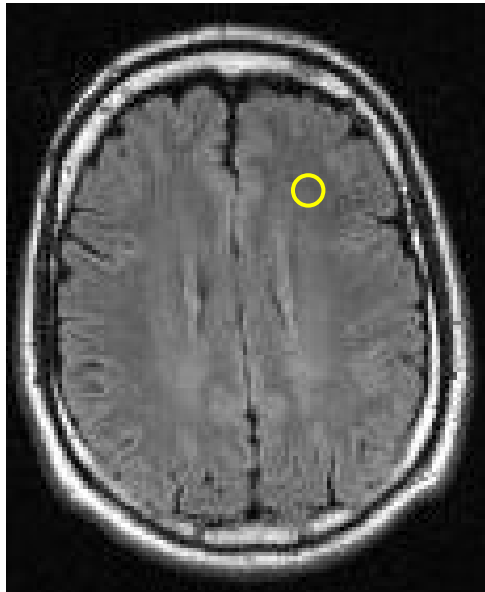
# **Lésions de Cisaillement axonal**











**Région :**

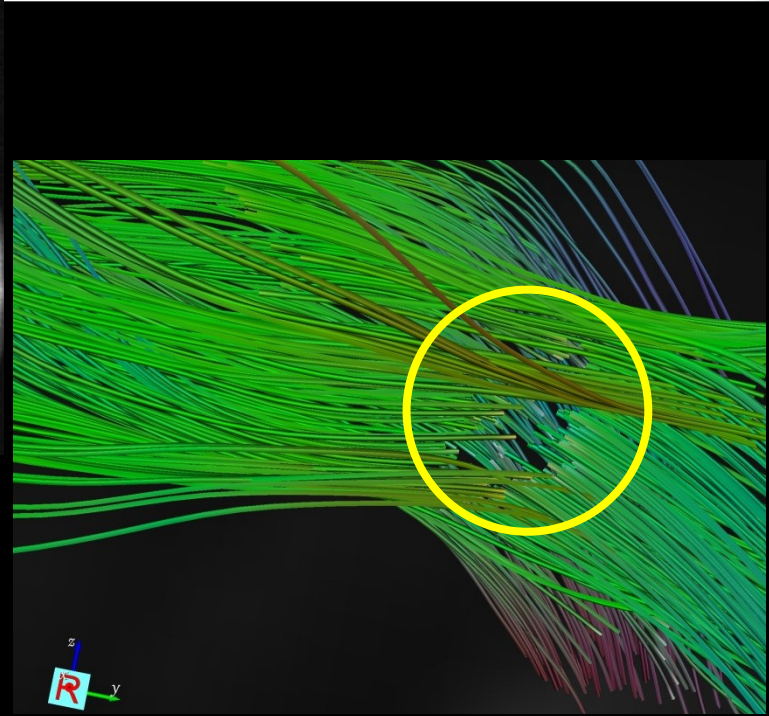
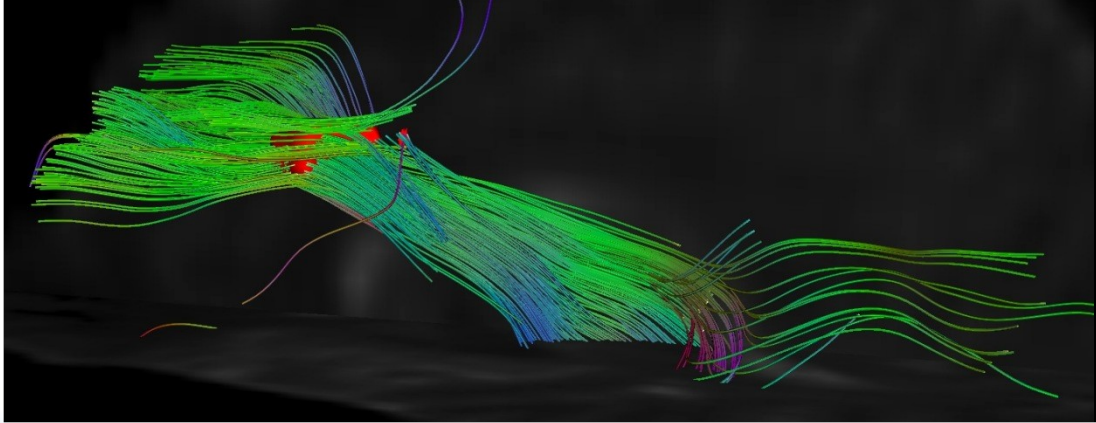
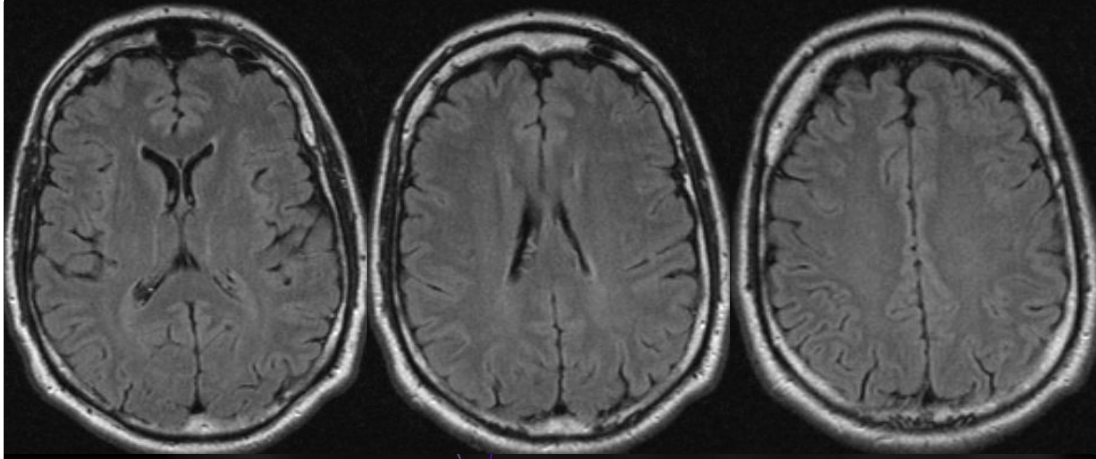
Z-score (moy.): -2.95

FA (moy.): 0.23

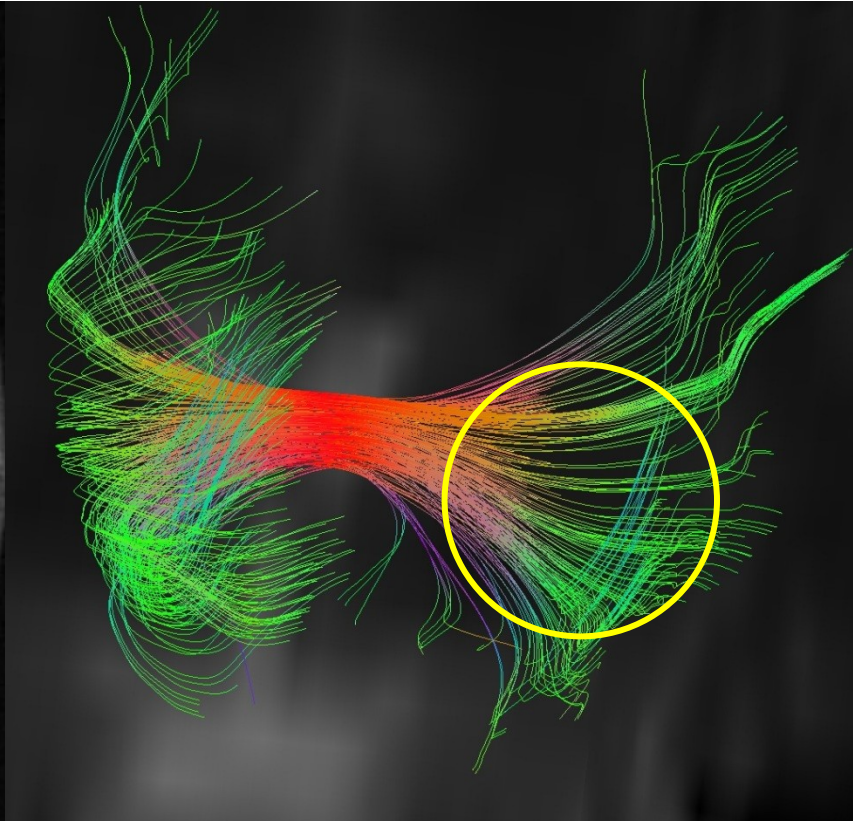
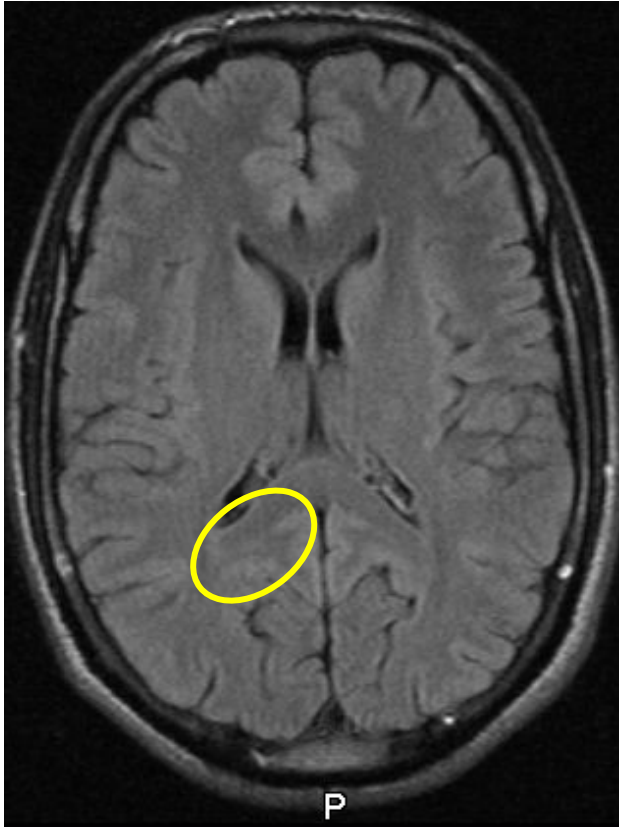
**Région**

523 faisceaux

Longueur (moy.): 53 mm

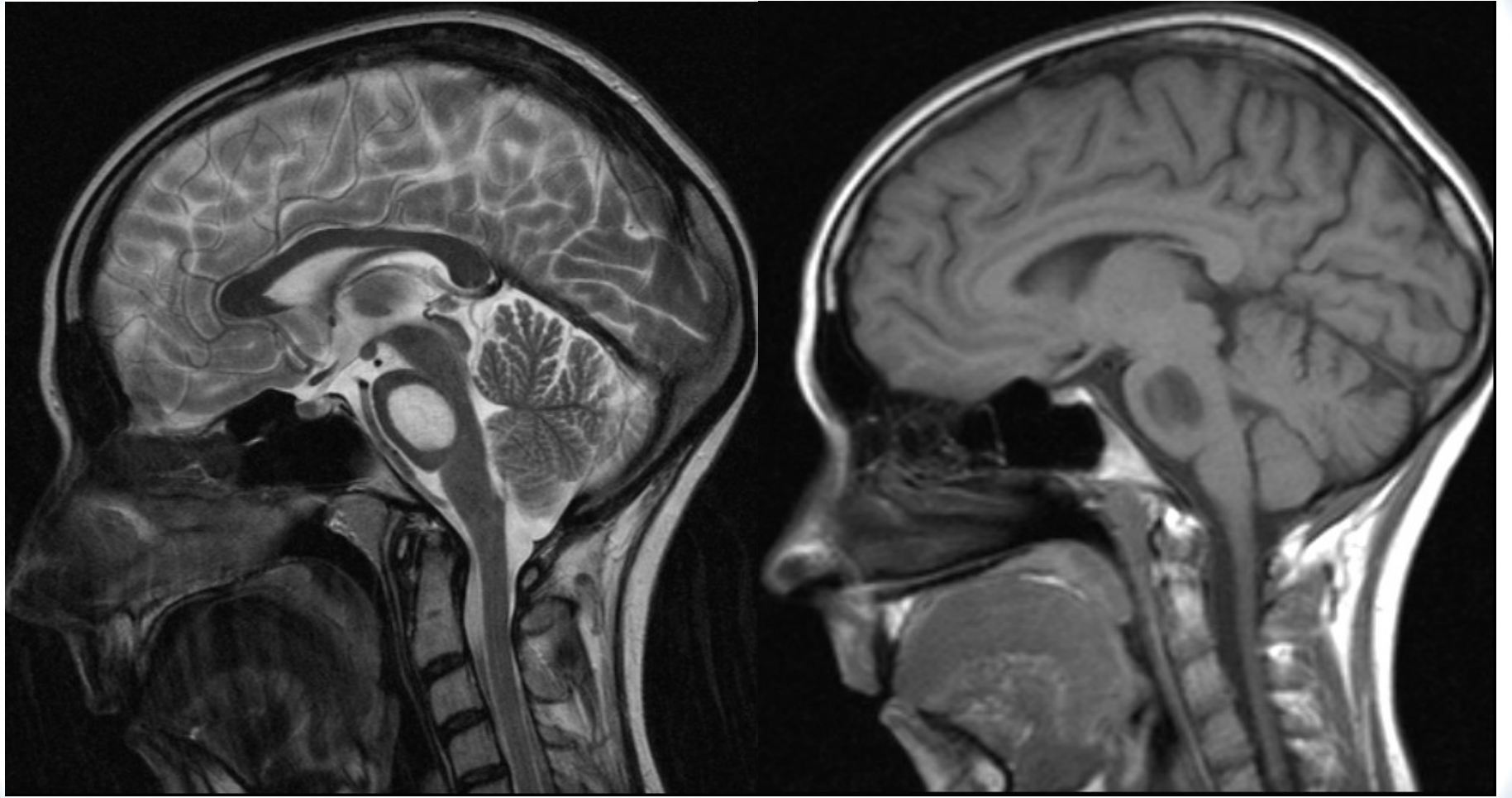


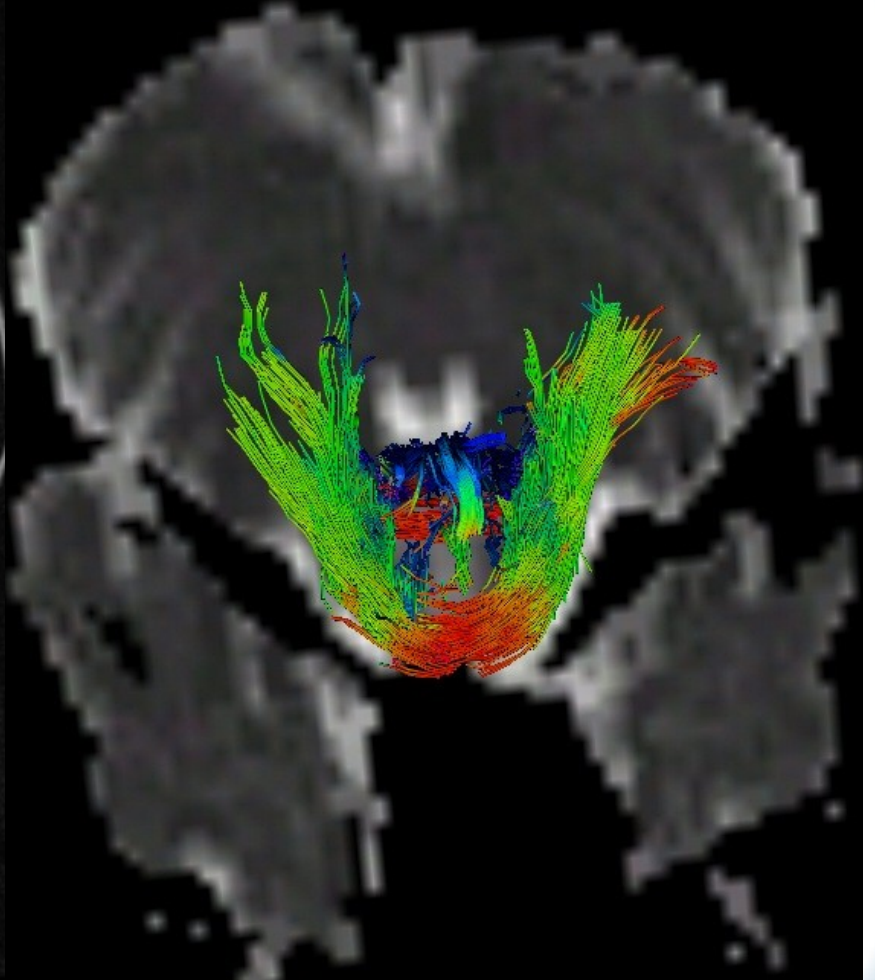
**Faisceau FOT droit**

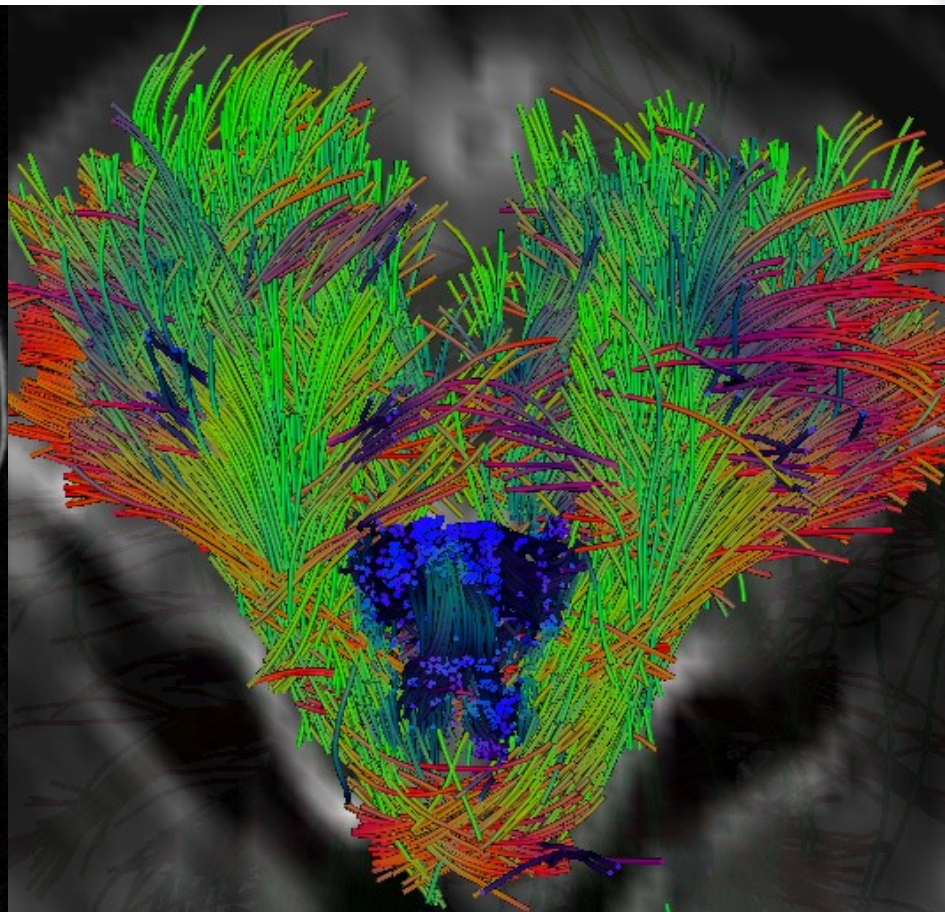
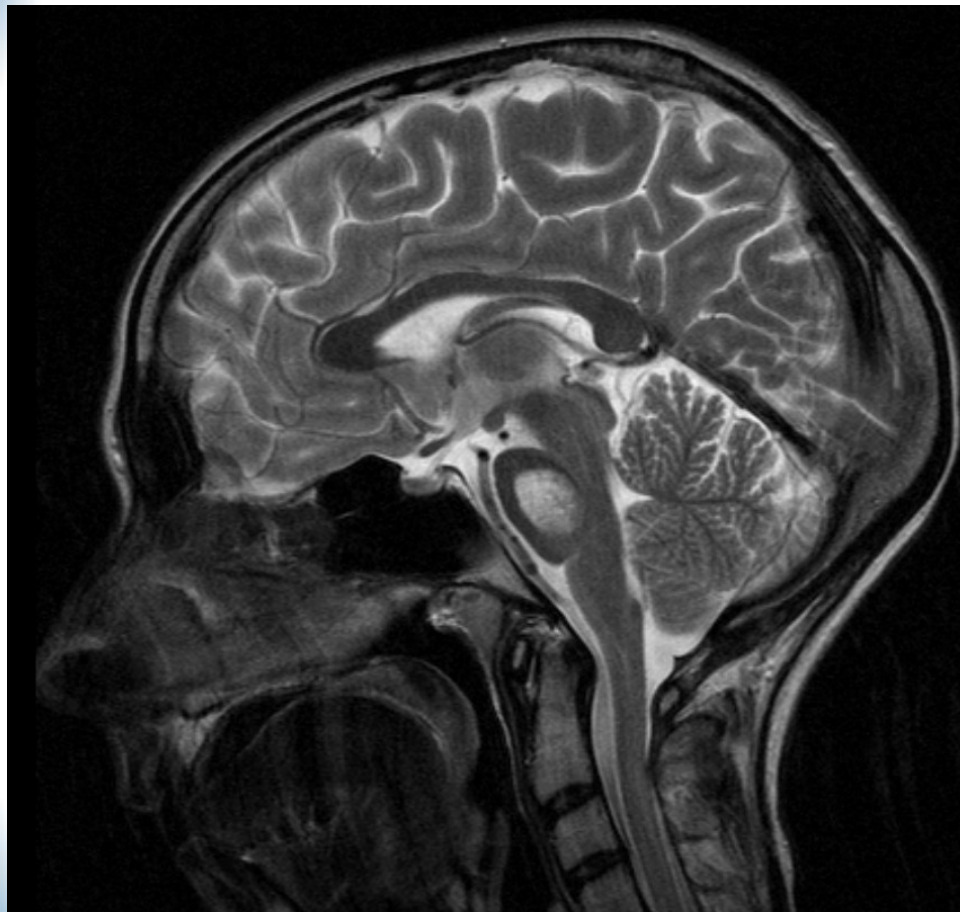




# **Myélinolyse Centro-pontique**

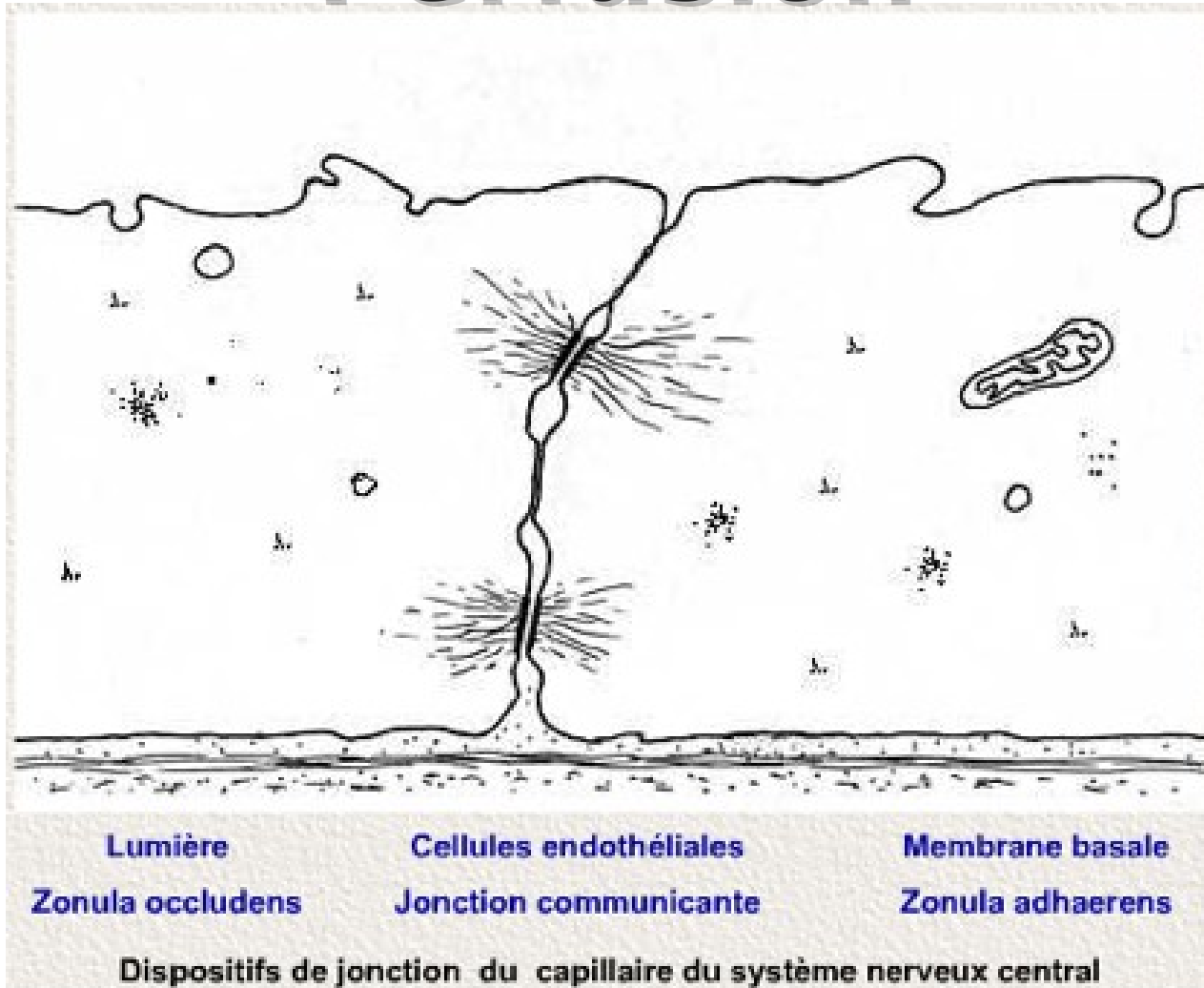




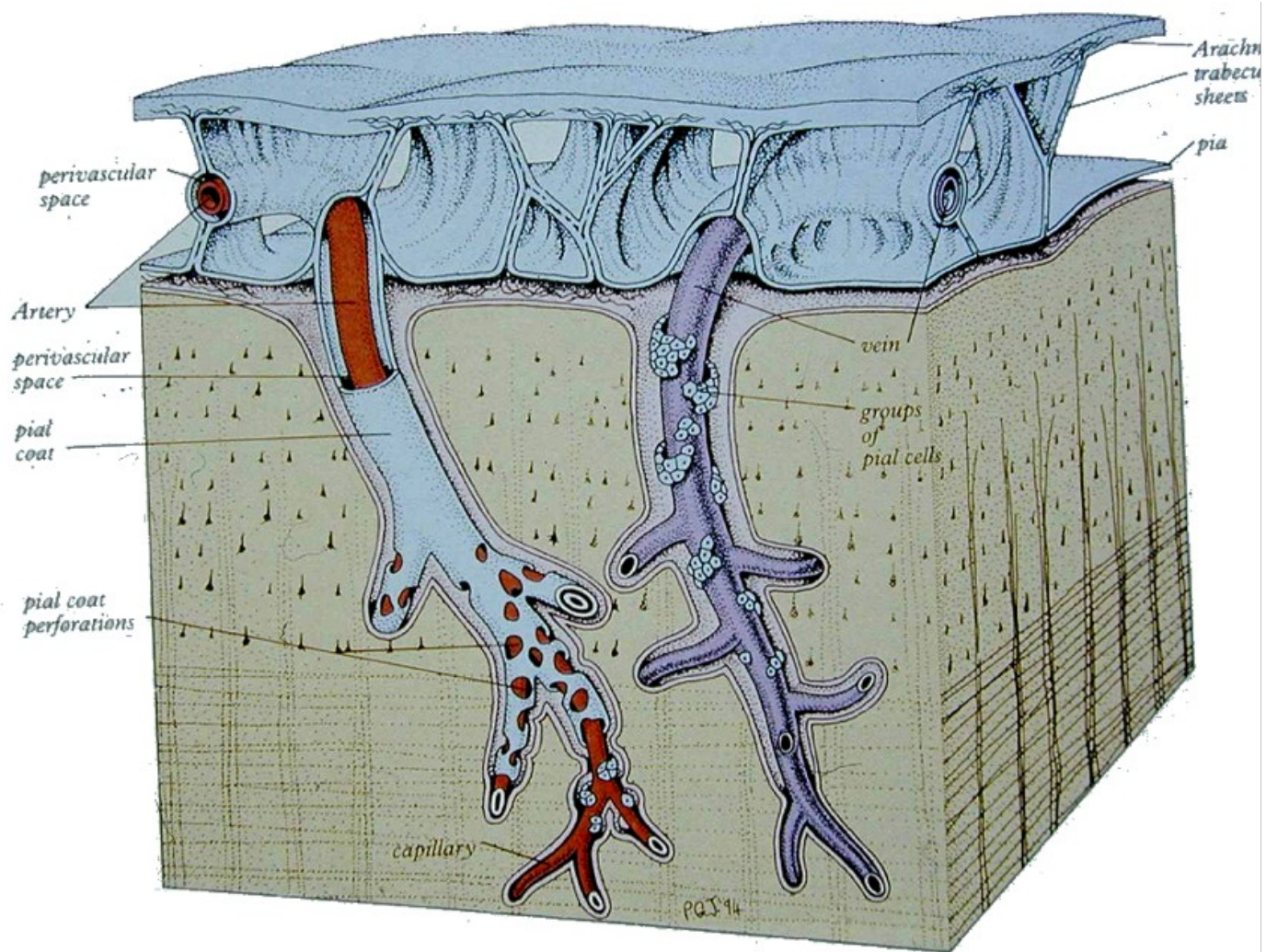


# **IRM de Perfusion**

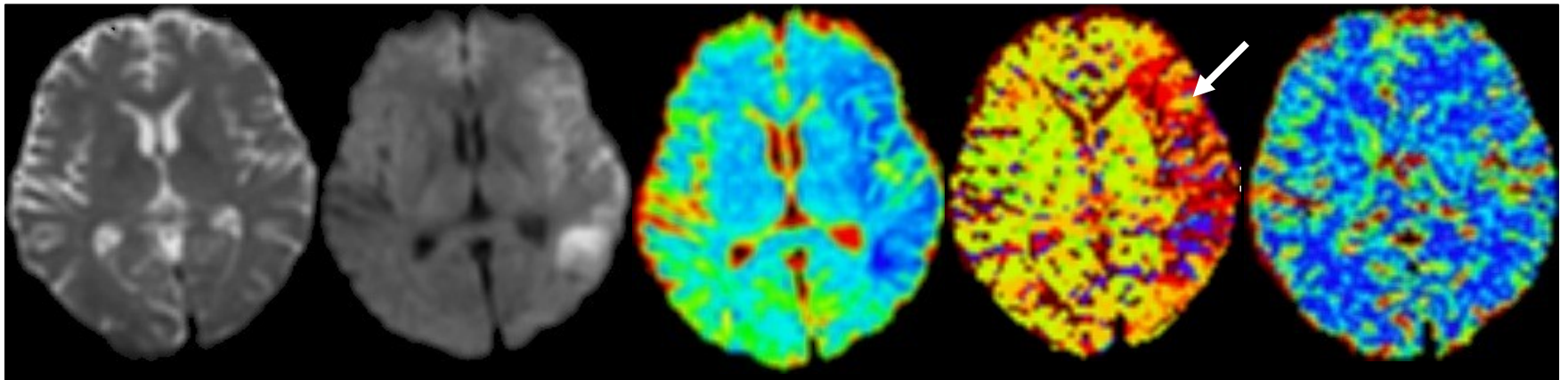
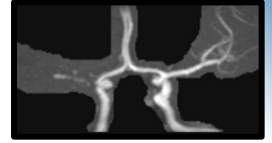
# IRM de Microcirculation et MRE



# IRM de Circulation Périvasculaire



# IRM de Mismatch en IRM Perfusion



**T2**

**DWI**

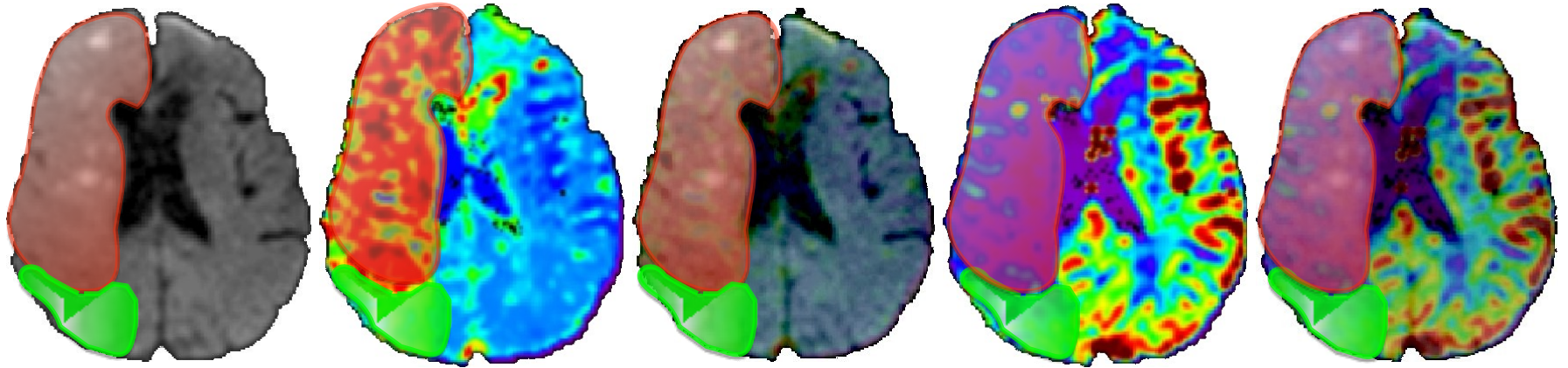
**ADC**

**MTT**

**CBV**



# IRM de Mismatch en IRM Perfusion

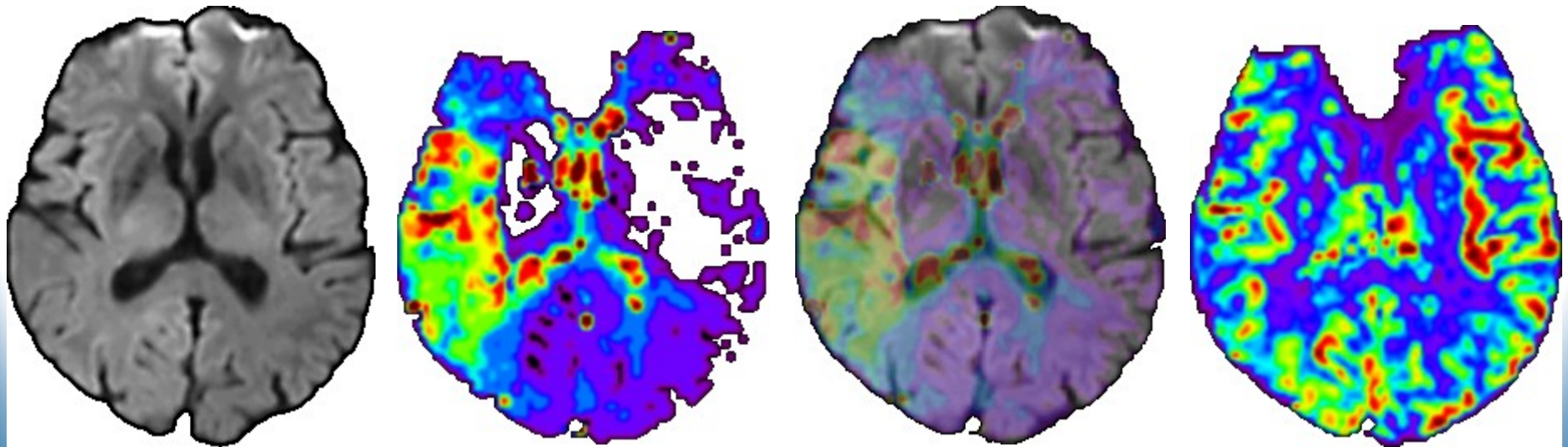
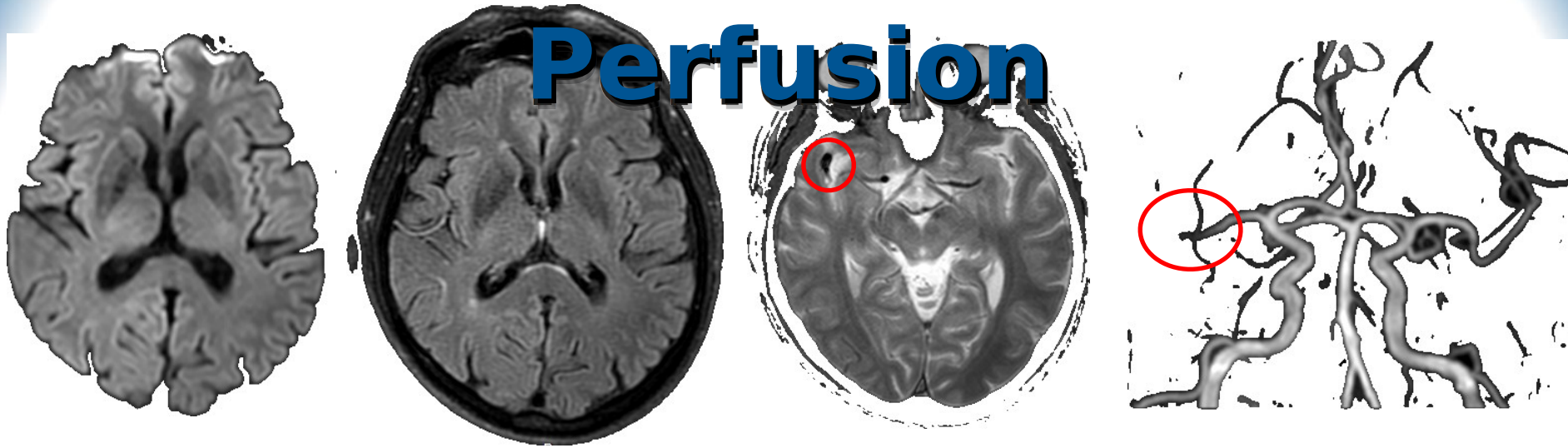


DW  
I

MT  
T

CB  
F

# IRM de Perfusion

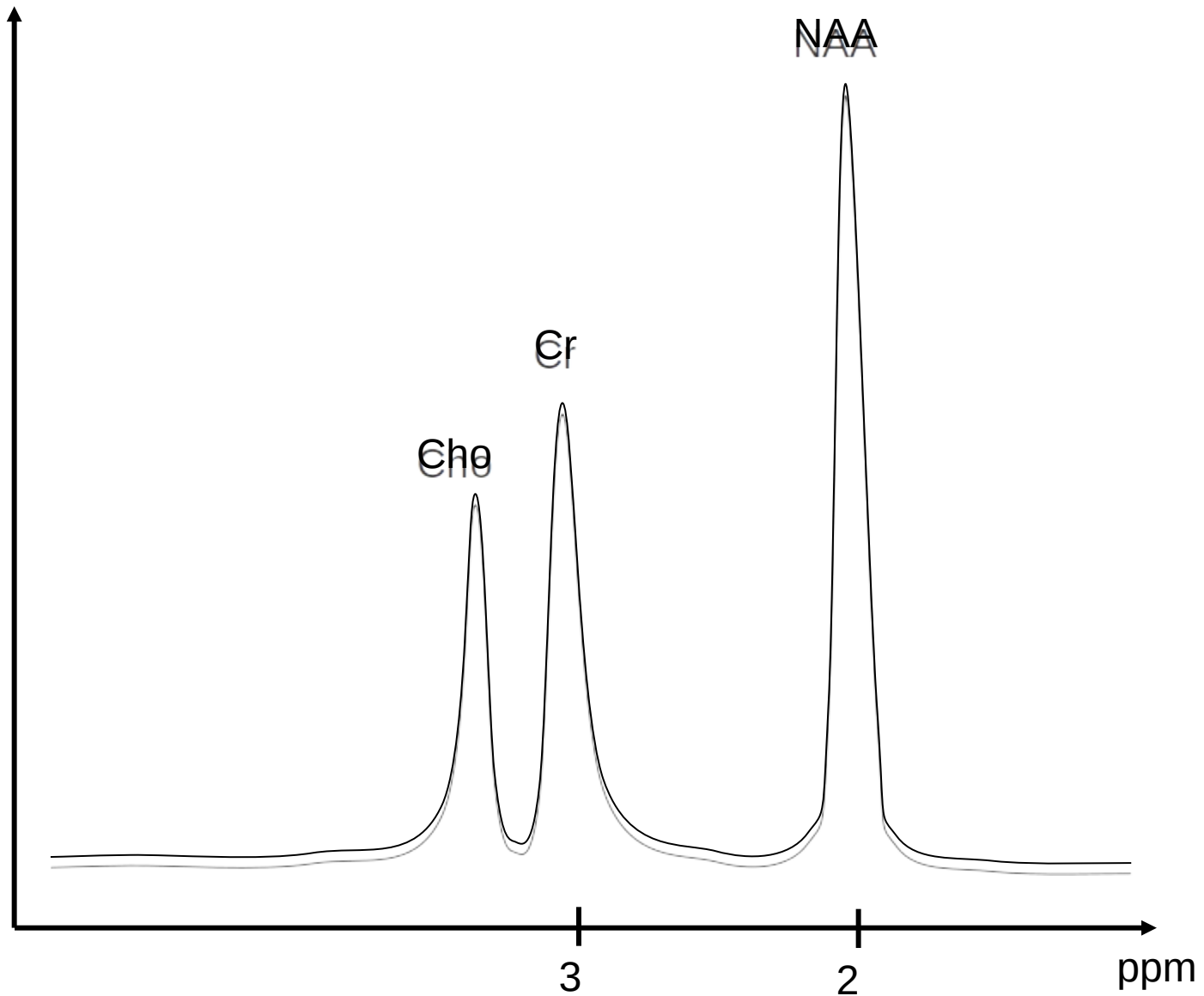


**TMA**

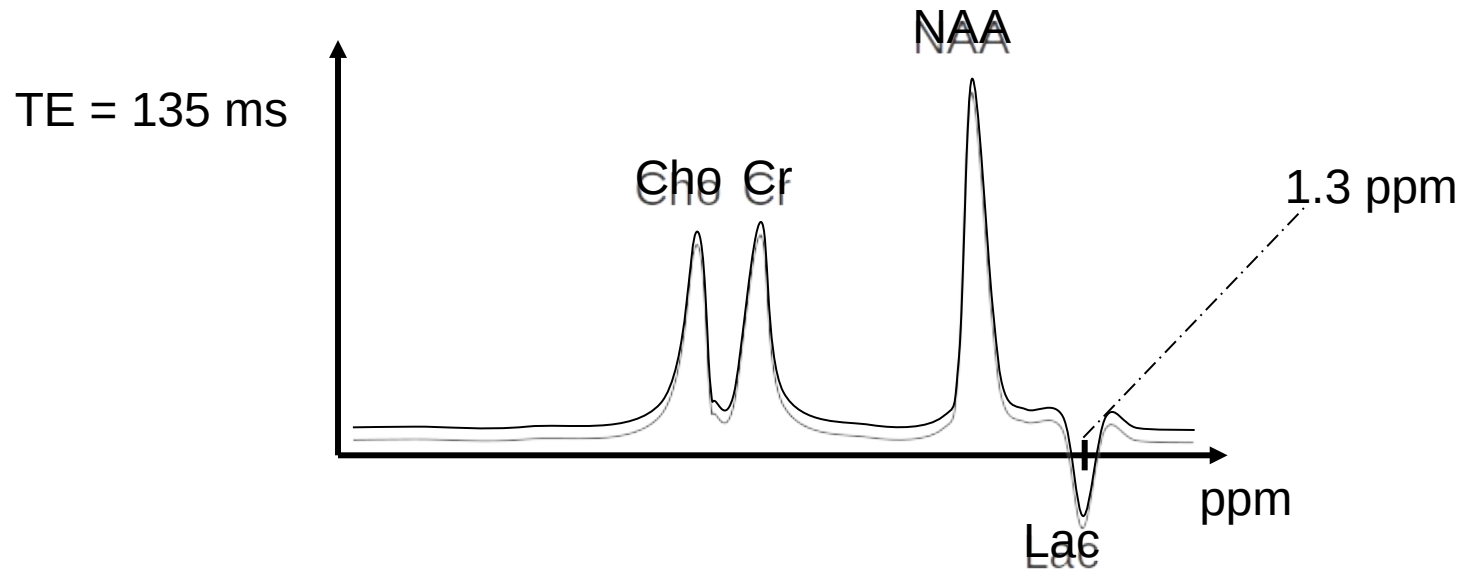
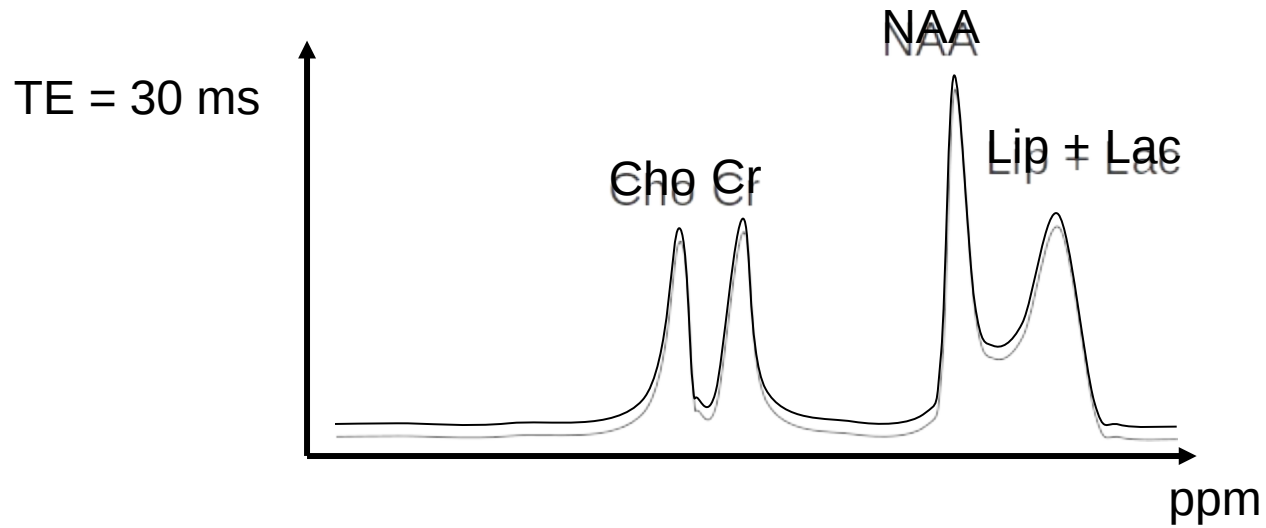
**CB**

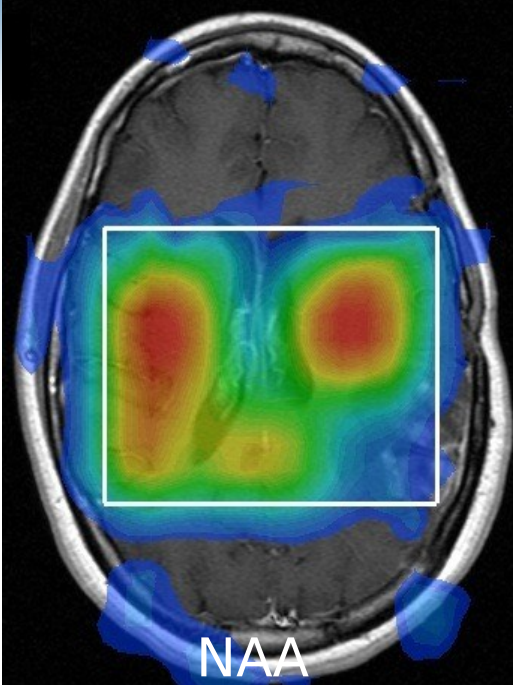
# **Spectro IRM**

# Spectre Normal

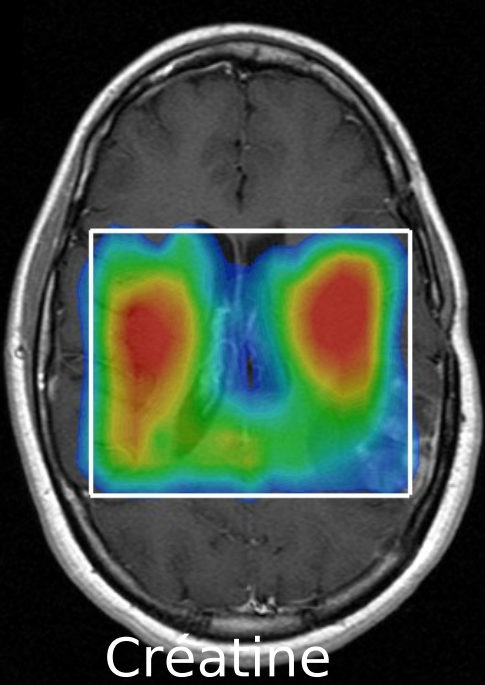


# Lactates

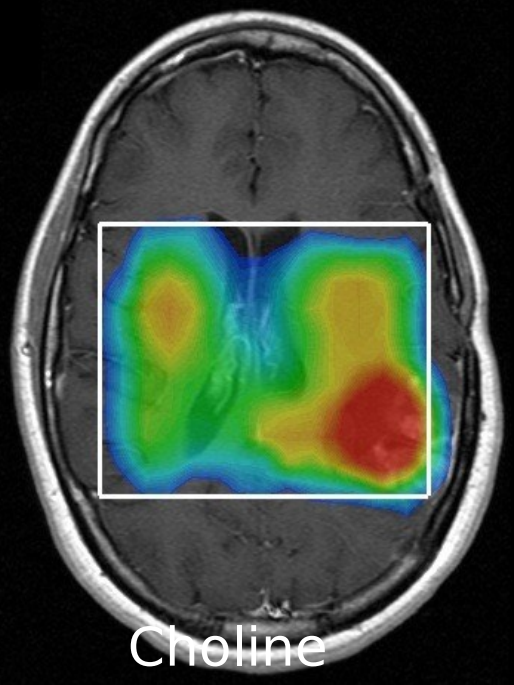




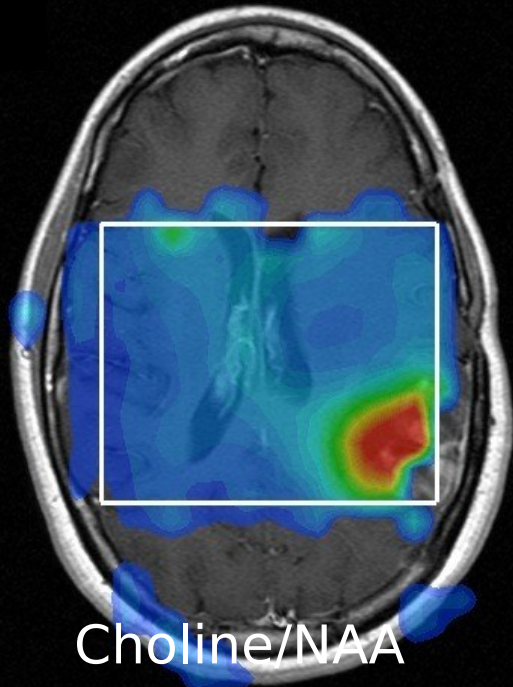
NAA



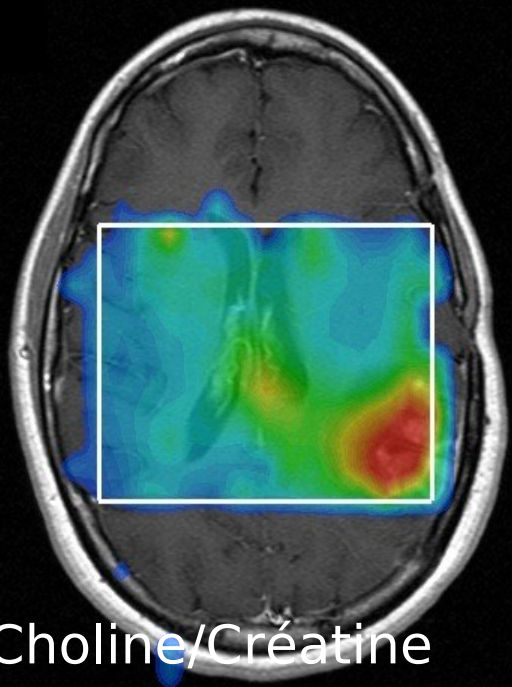
Creatine



Choline



Choline/NAA

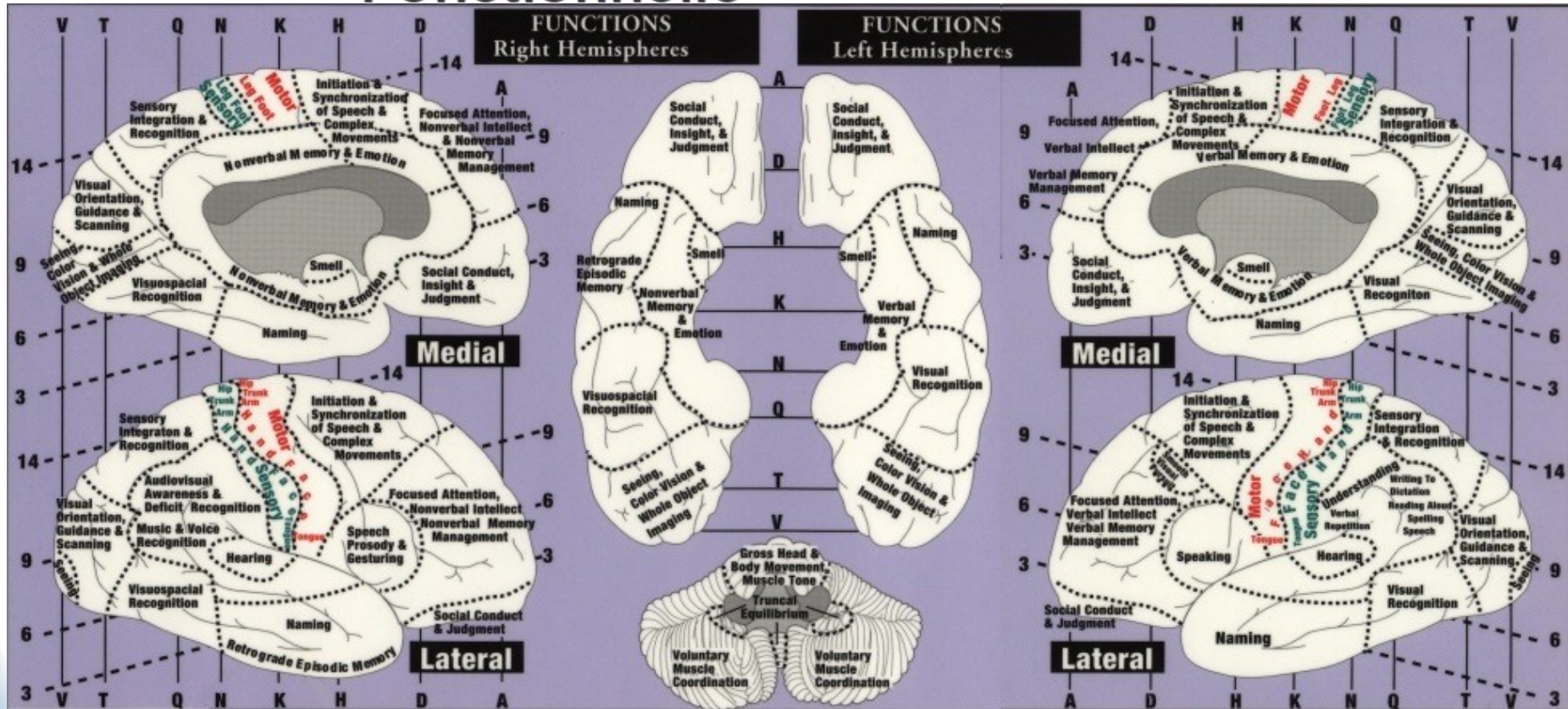


Choline/Créatine

# **IRM d'Activation**

# IRM

## Neuro-Anatomie d'Activation Fonctionnelle





**I. Couche Molec**

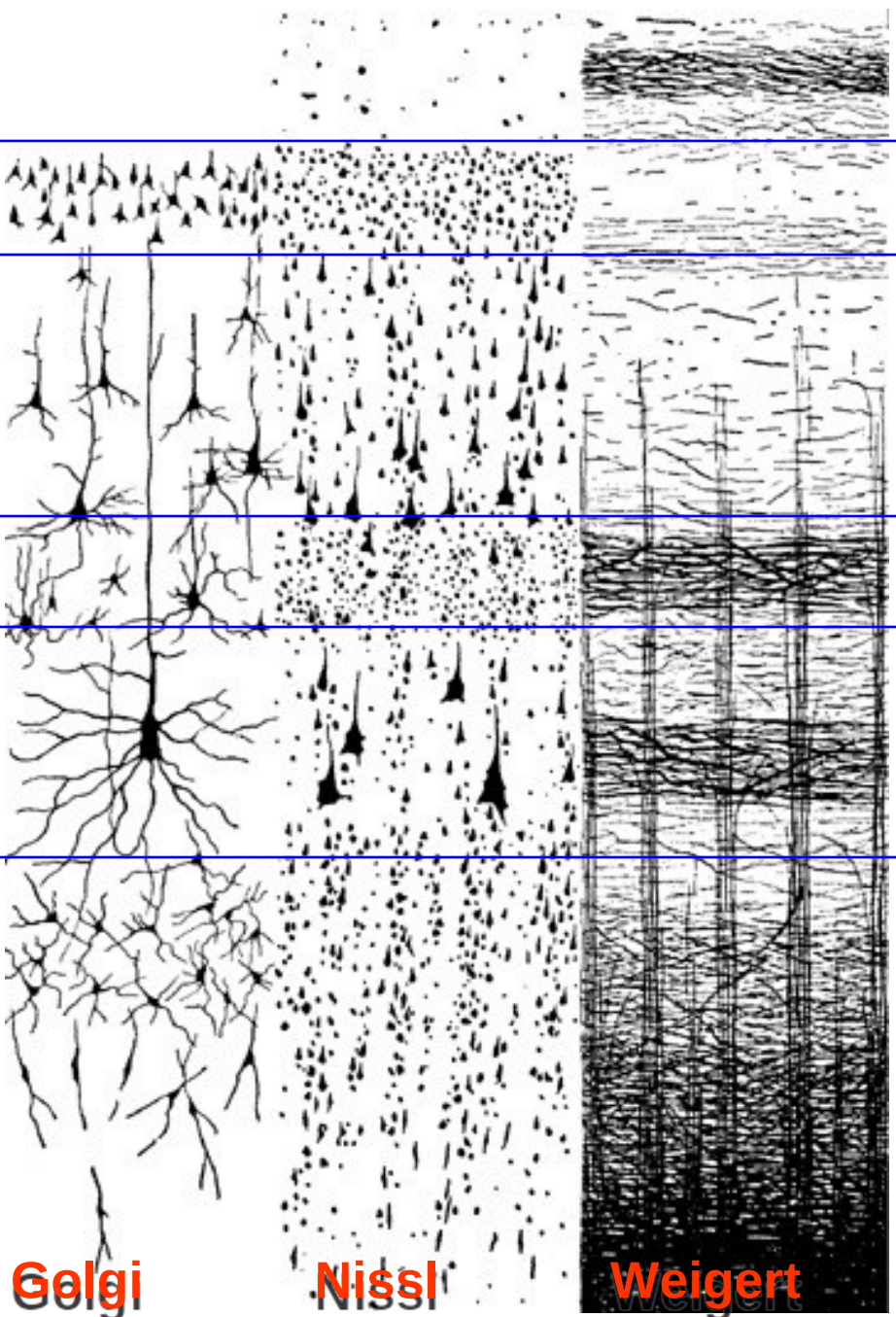
**II. Granulaire ext**

**III. Pyramidale ext**

**IV. Granulaire int**

**V. Pyramidale int**

**VI. Couche Mltform**



**Golgi**

**Nissl**

**Weigert**

# IRM

Couplage Activation  
Perfusion

Activation

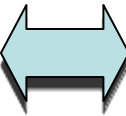
DSC



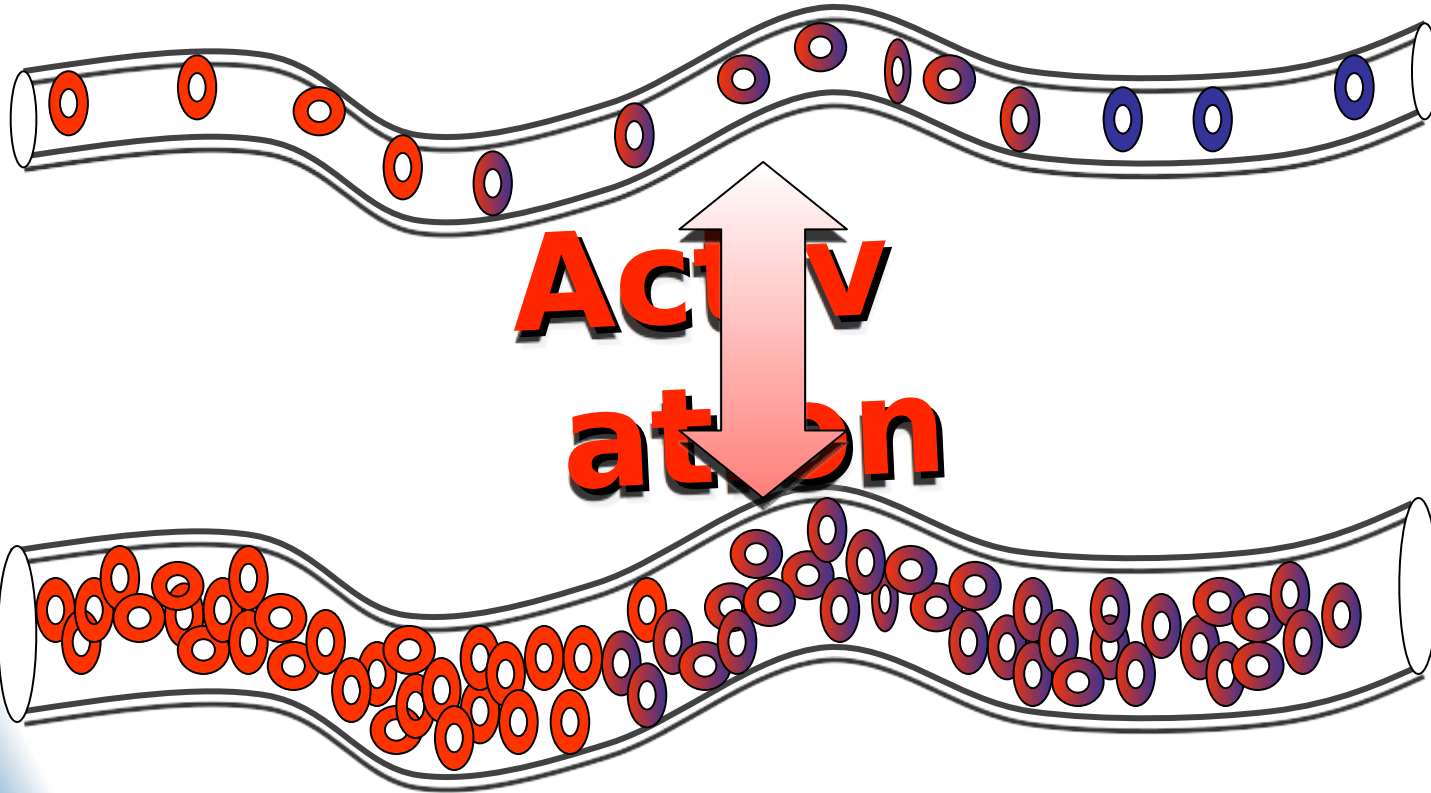
$O_2$   
In



$O_2$  Ext



$O_2$   
Out



# IRM

Couplage Activation  
Perfusion

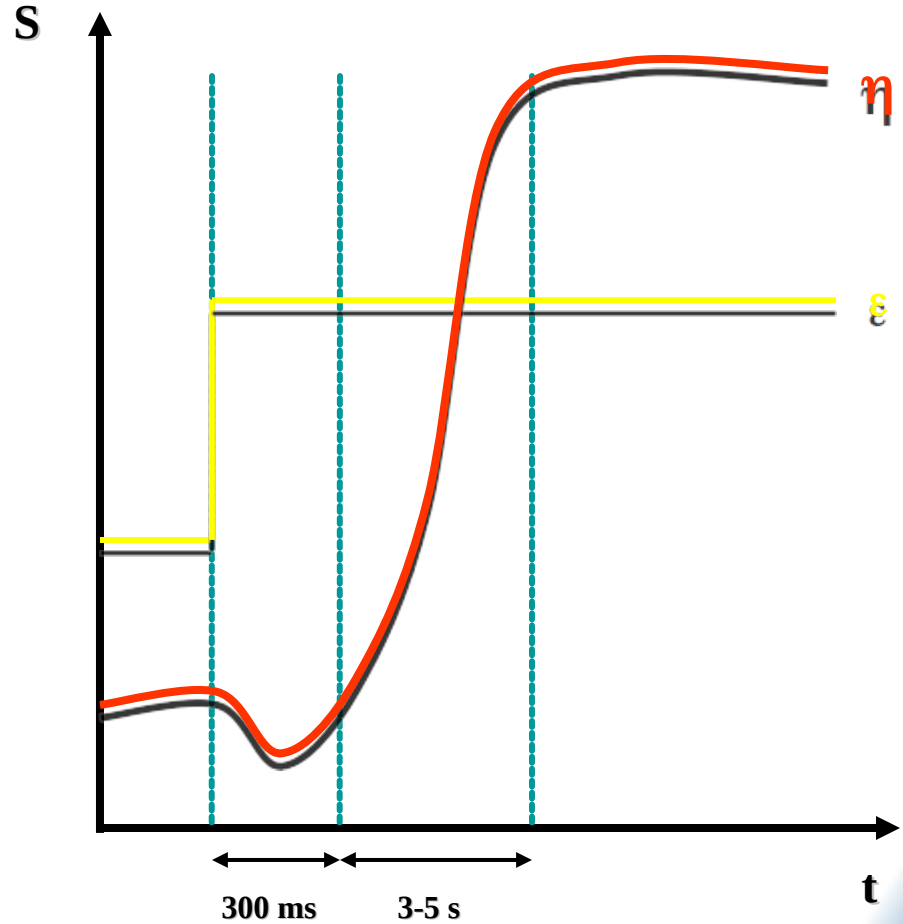
Blood

Oxygenatio

n

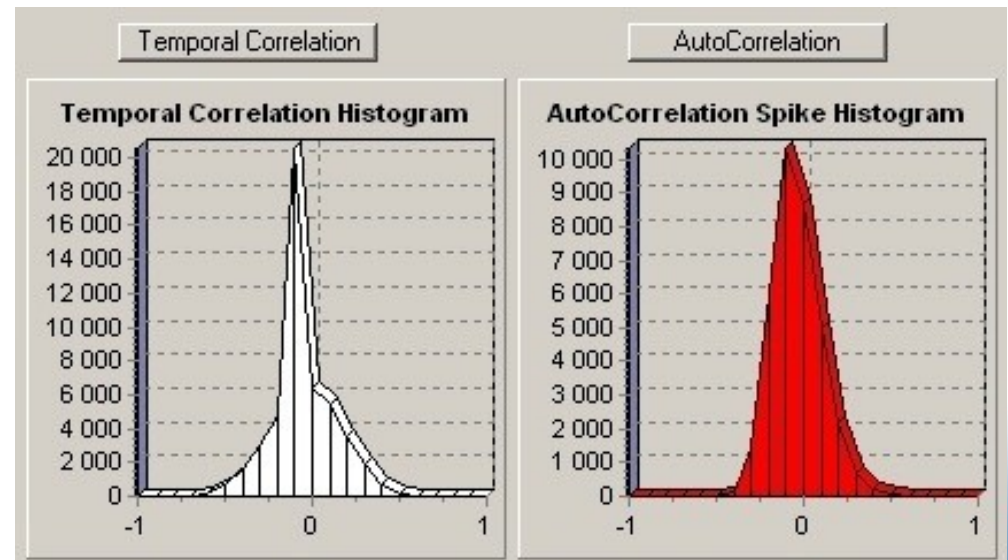
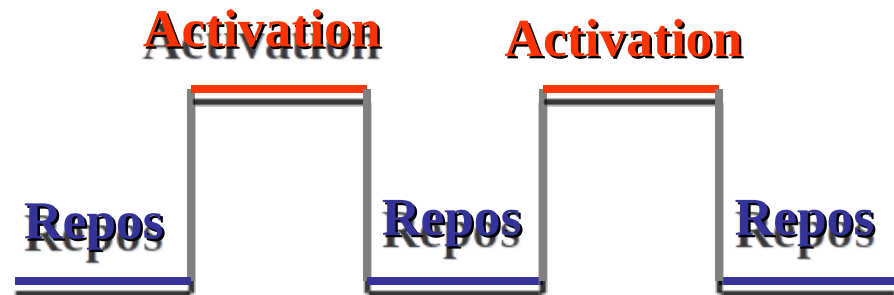
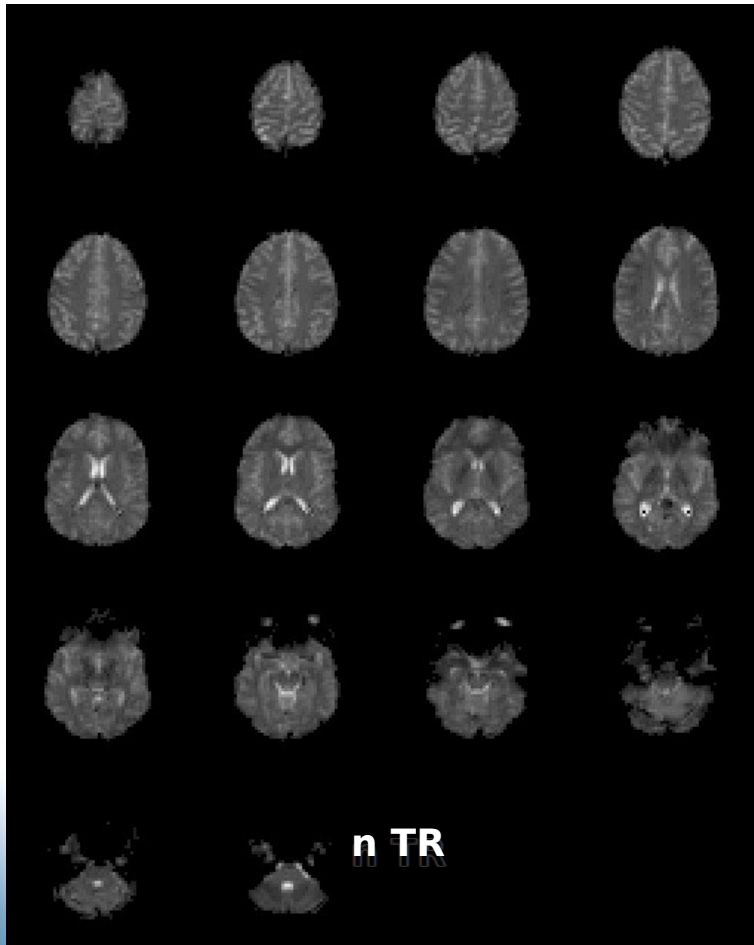
Level

Dependent



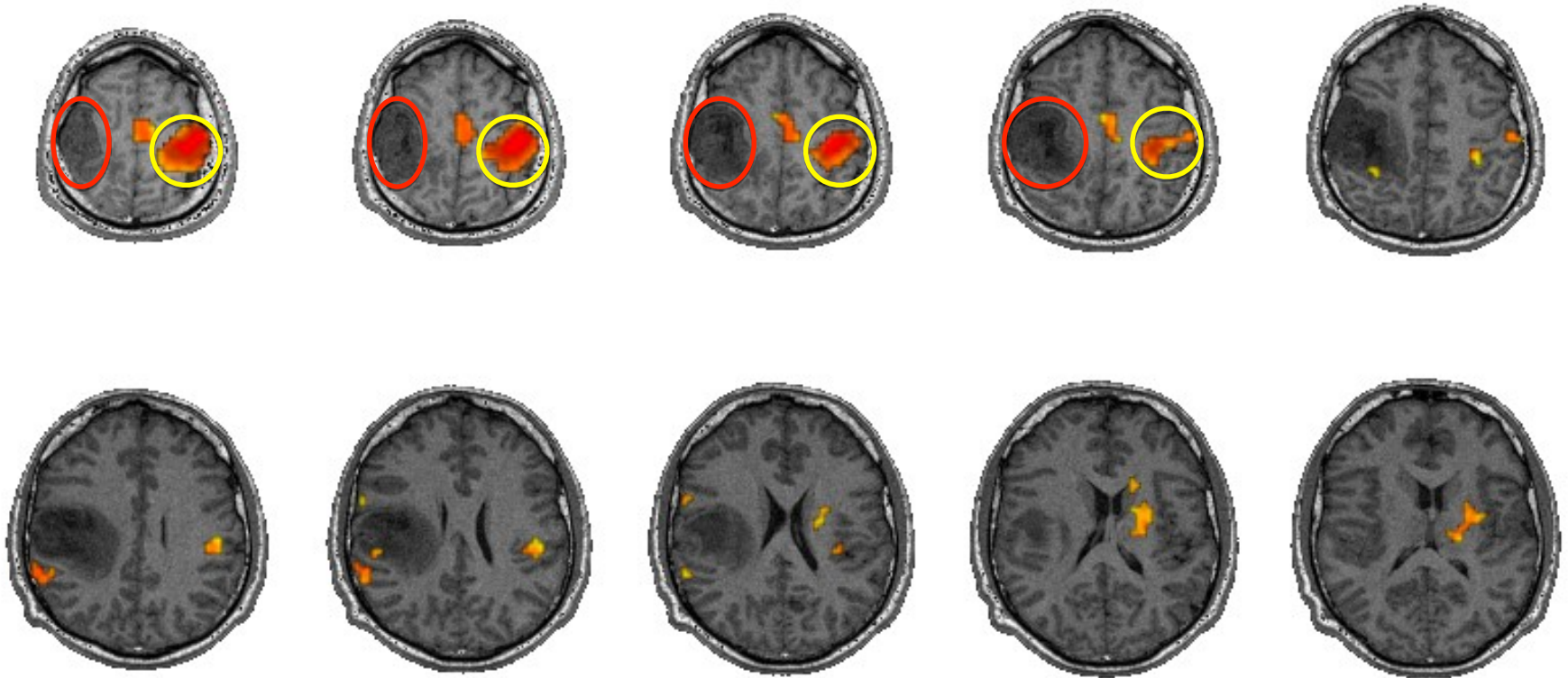
# IRM

## Traitement des Images d'Activation



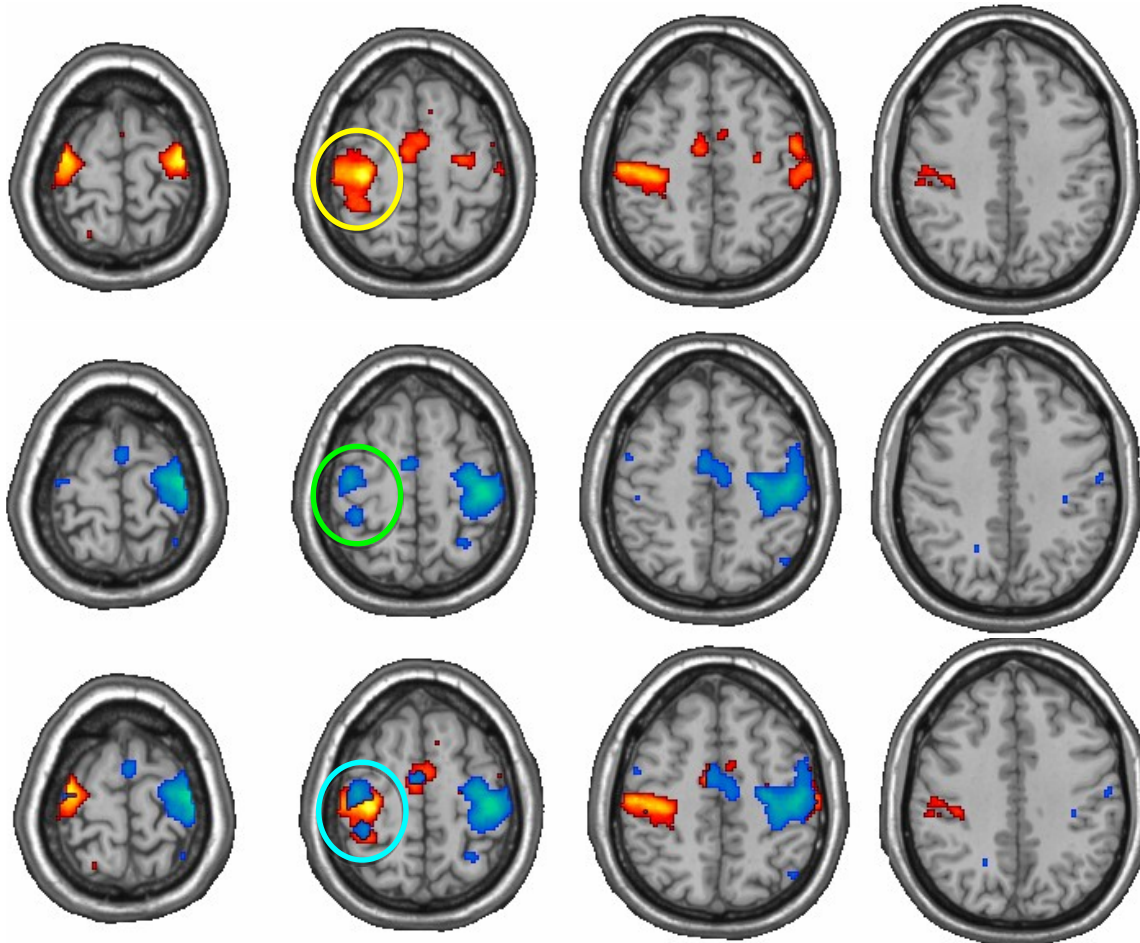
# IRM

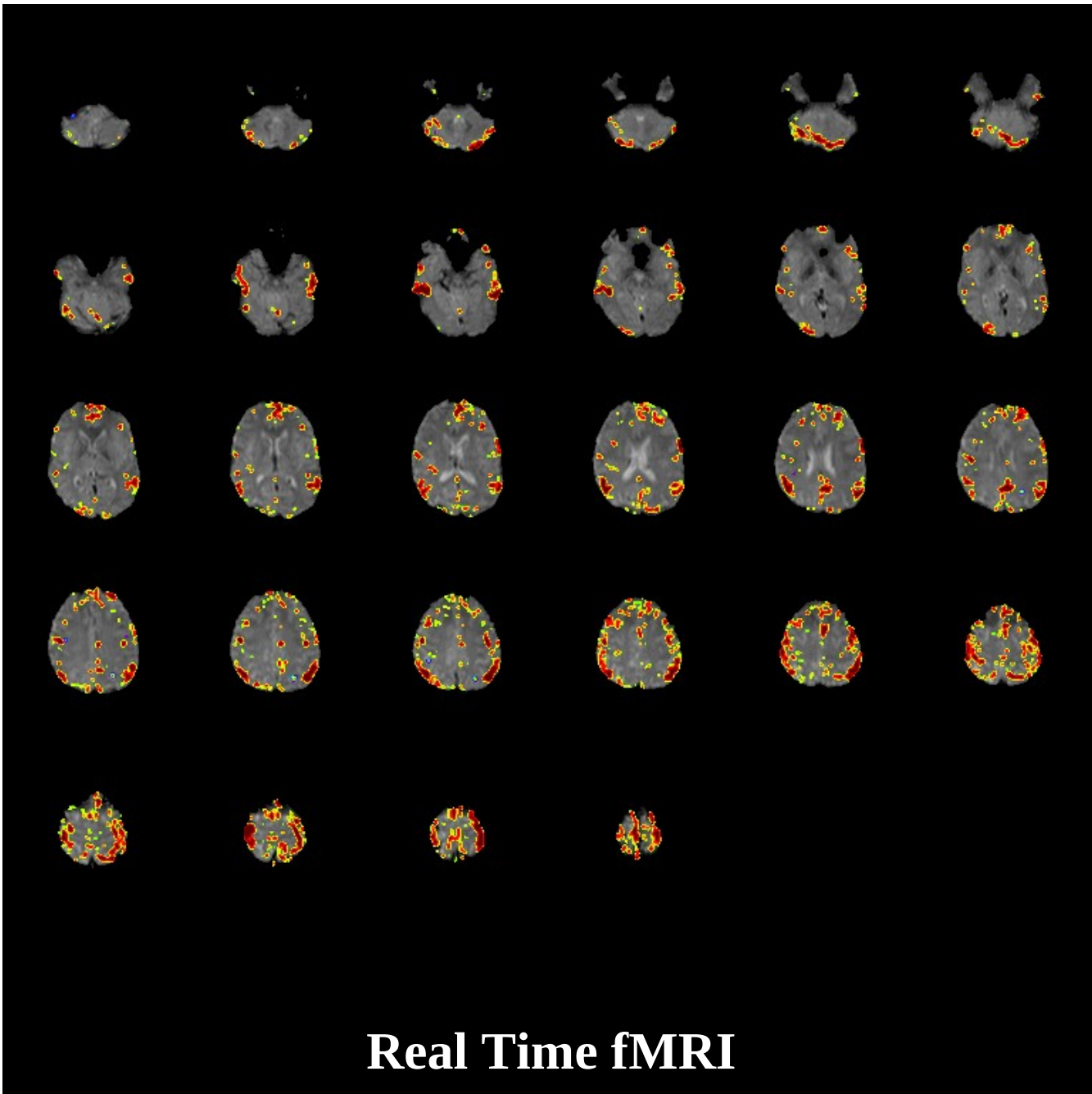
## Motricité - Bilan d'Activation Tumorale

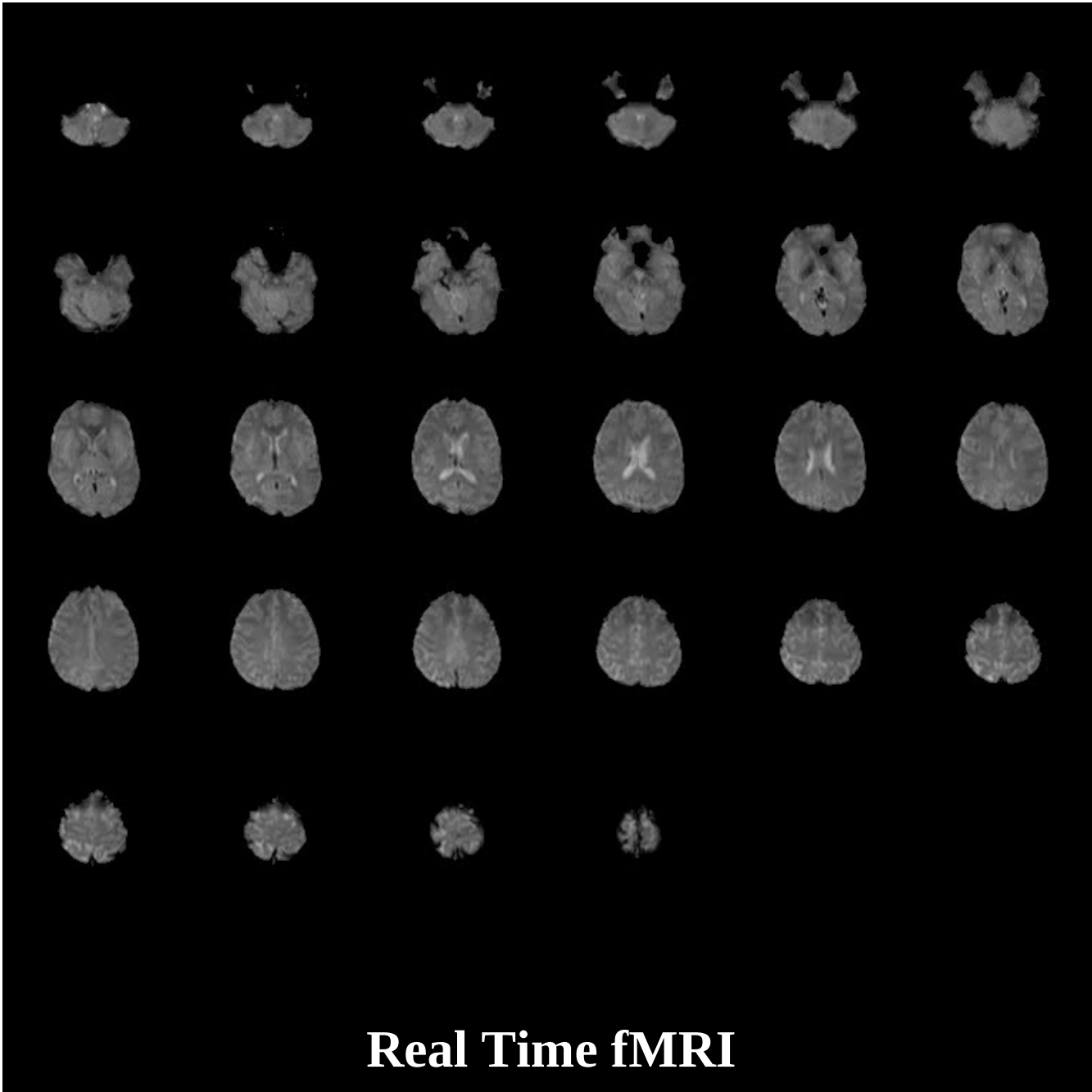


# IRM

## Imagerie Mentale Motrice d'Activation

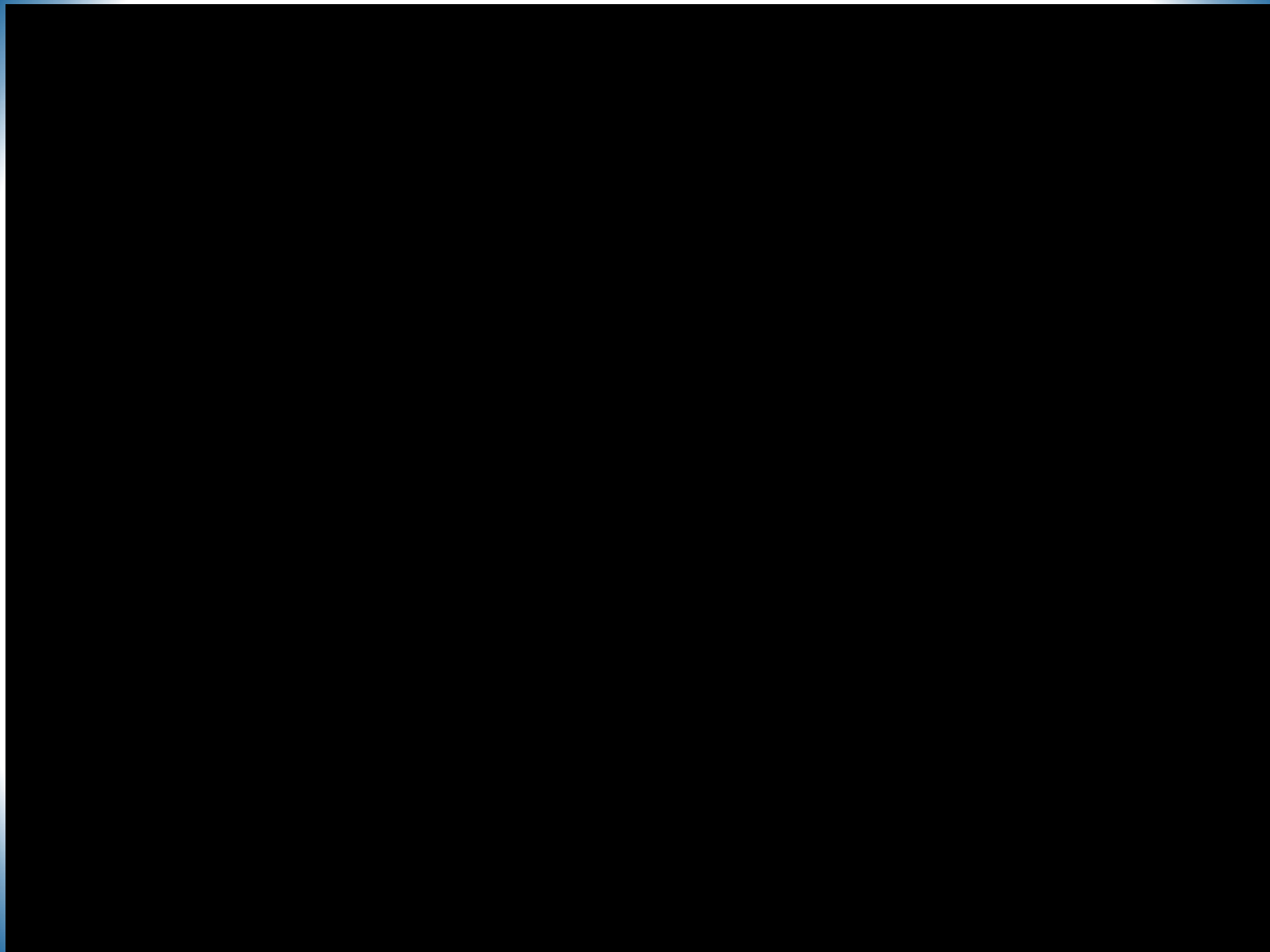






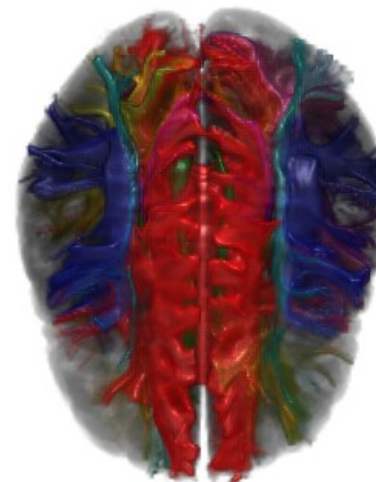
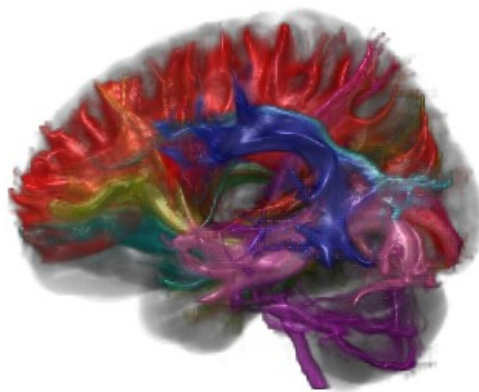
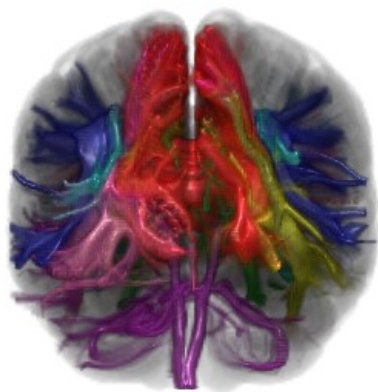
**Real Time fMRI**



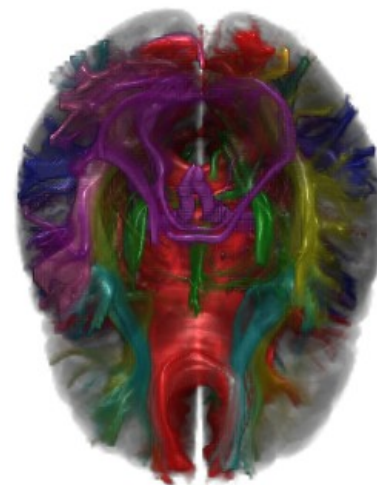
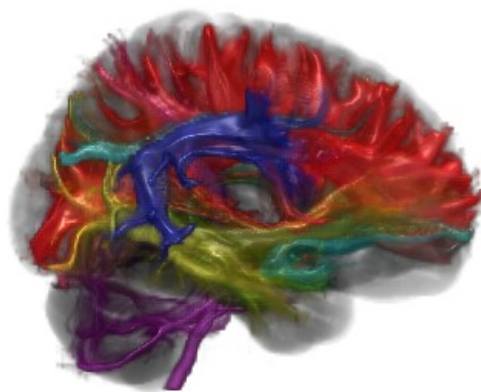
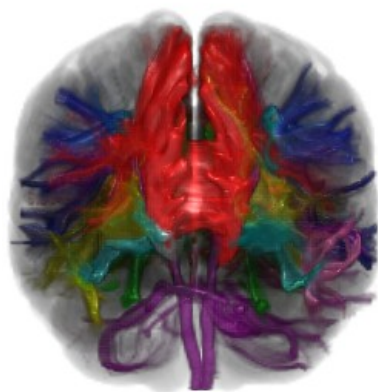


# **Connectomique Structurelle, Fonctionnelle et Effective**

# Morphological Connectomic

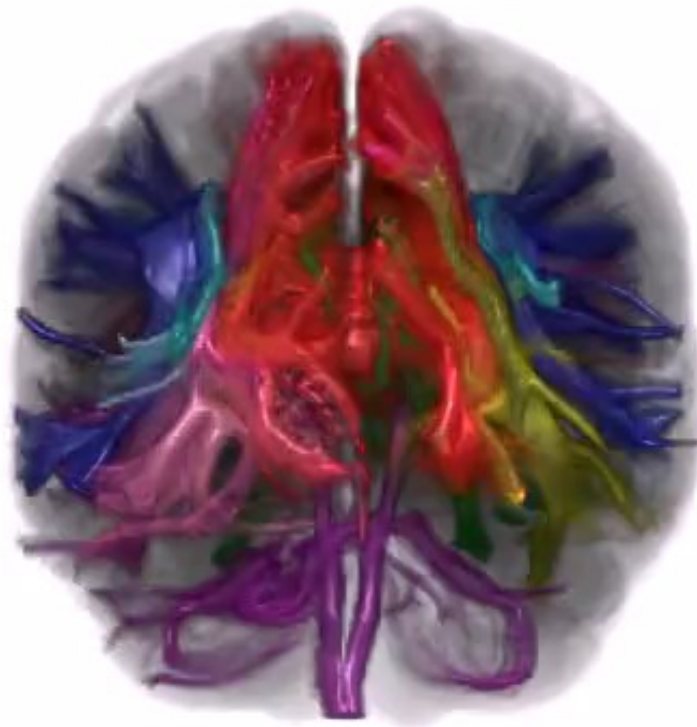


Made with Connectopedia

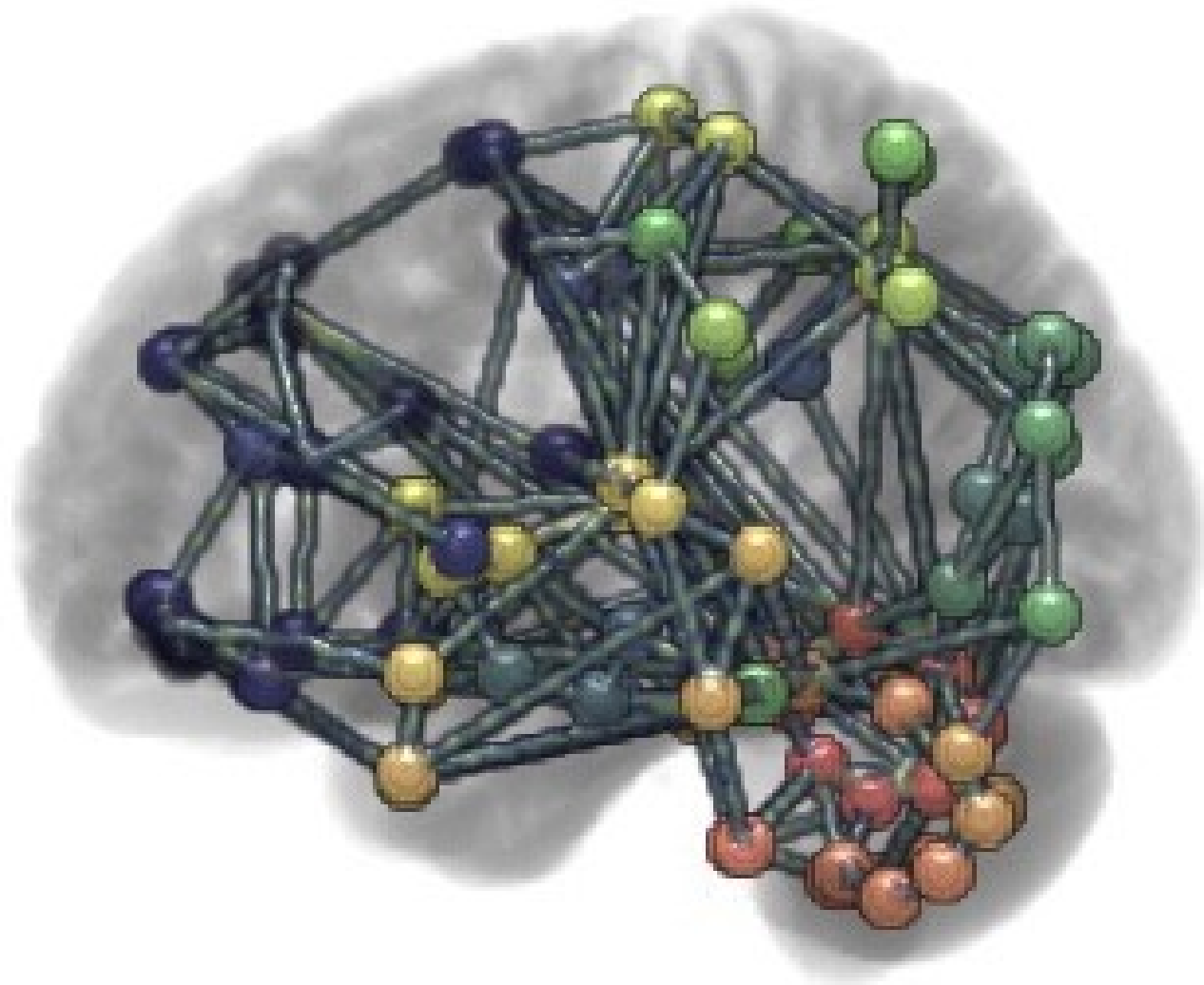


# Morphological Connectomic

Made with Connectopedia

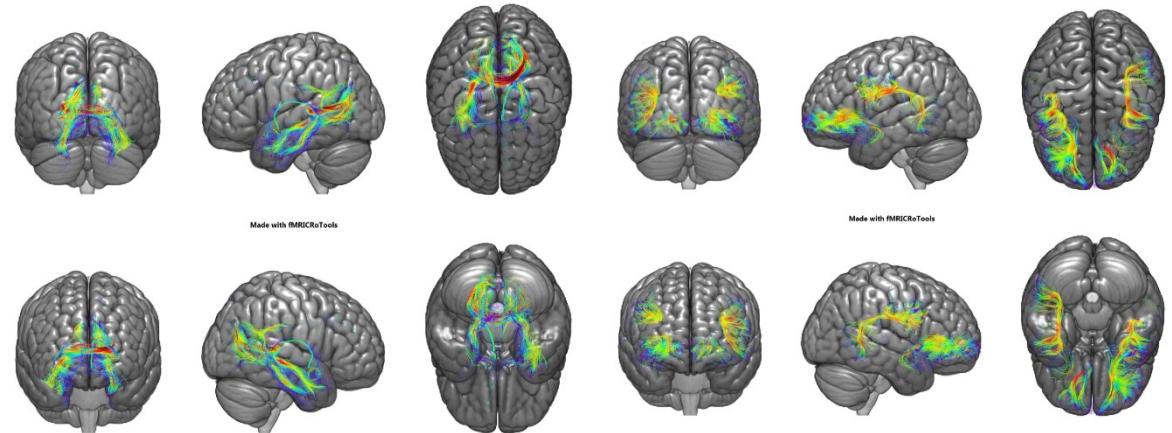
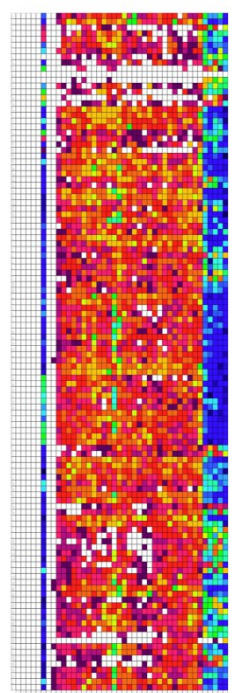
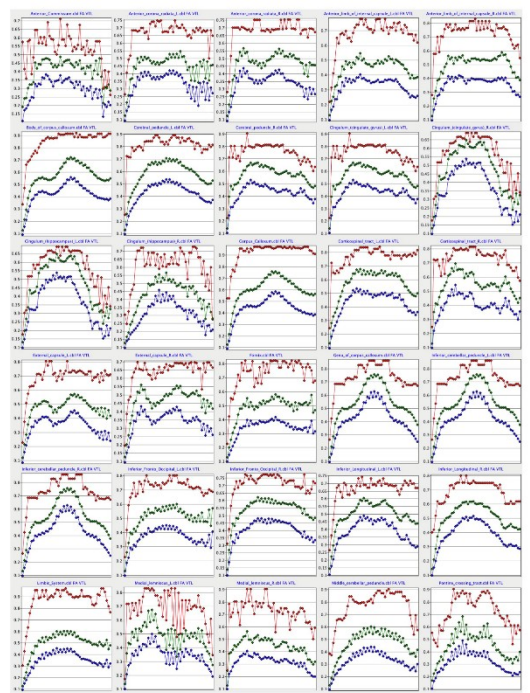


# Brain Connectoms





# RTConTrack

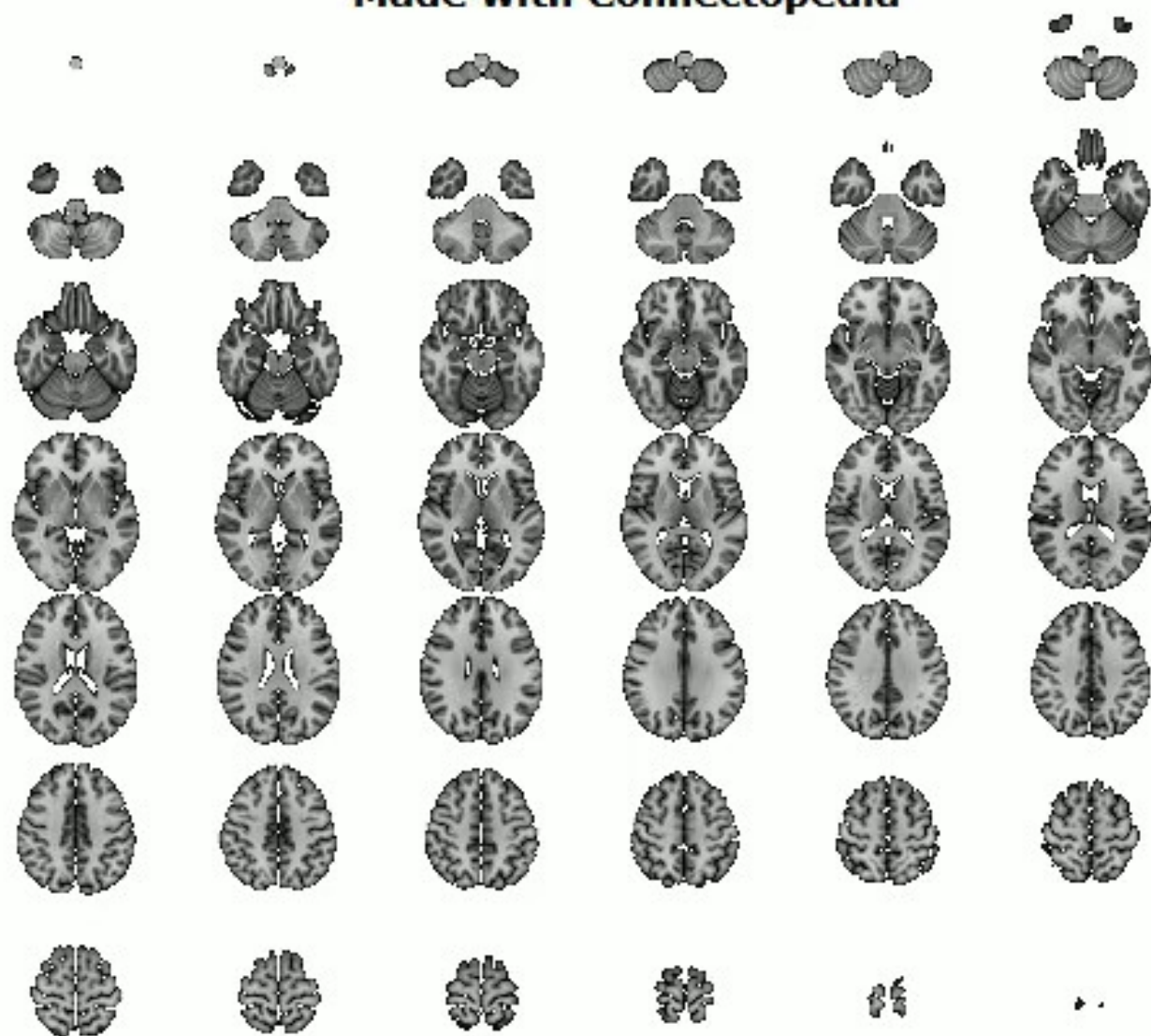


**Grey, White Matter and  
Brain Functions:  
The Future is Now with**

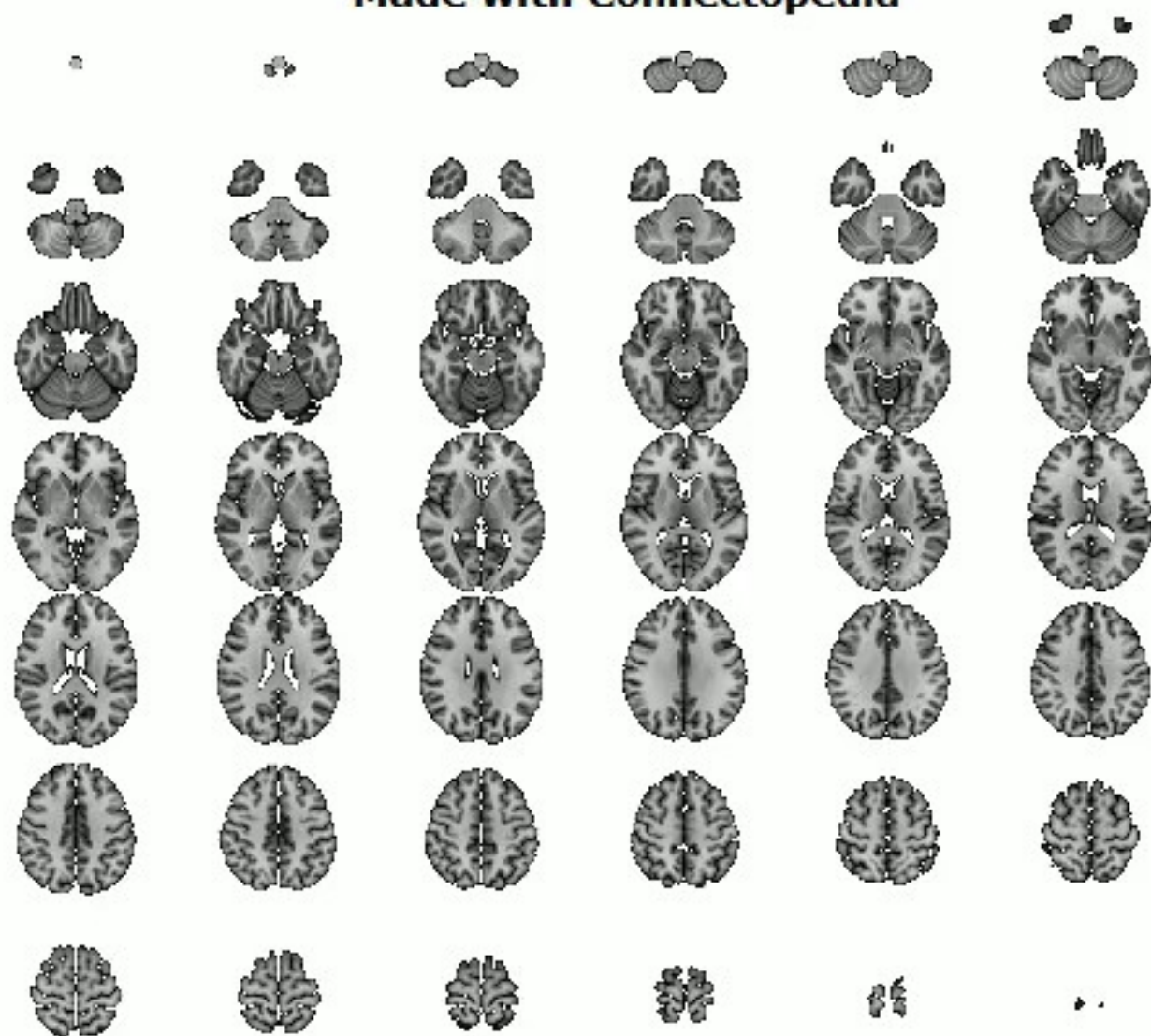
**Connectomics**

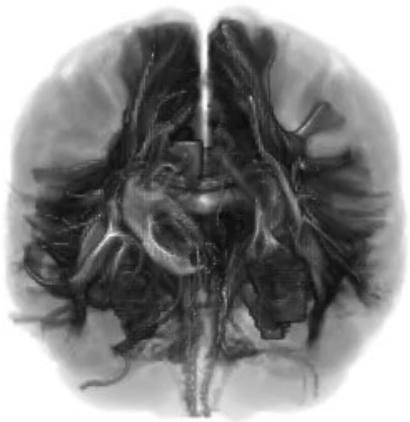


# Made with Connectopedia

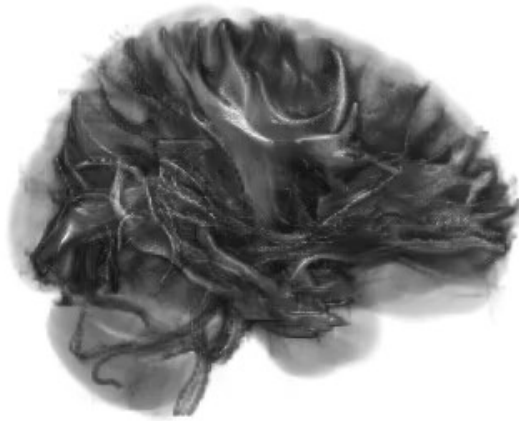
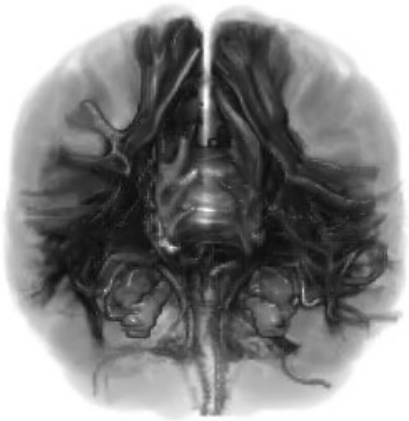


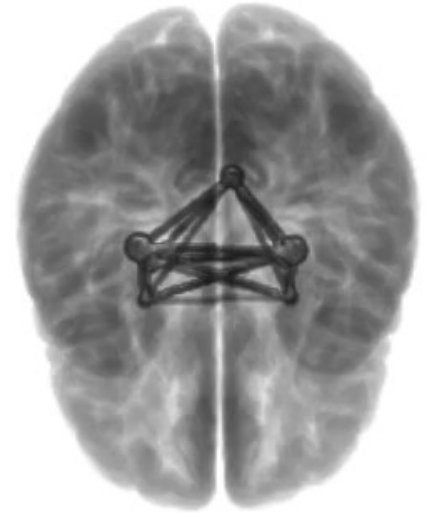
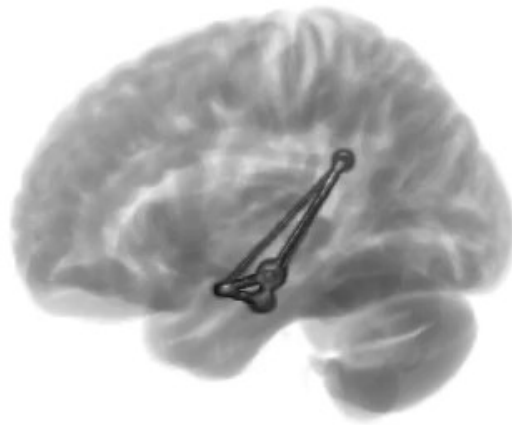
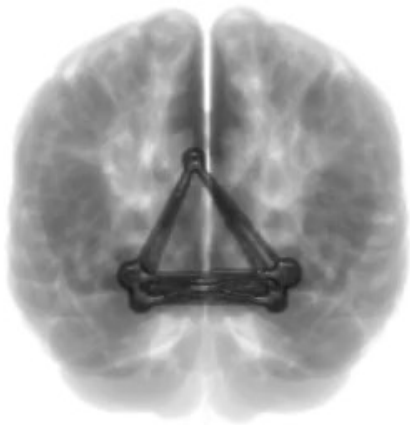
# Made with Connectopedia



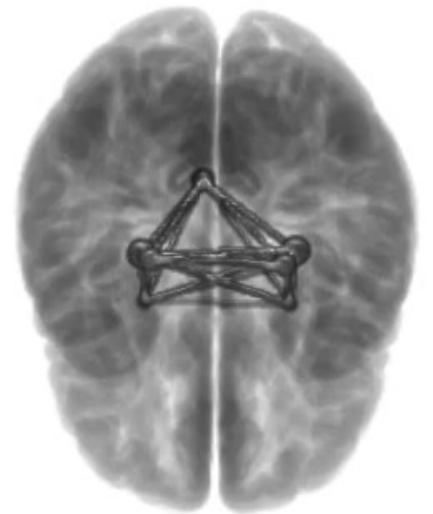
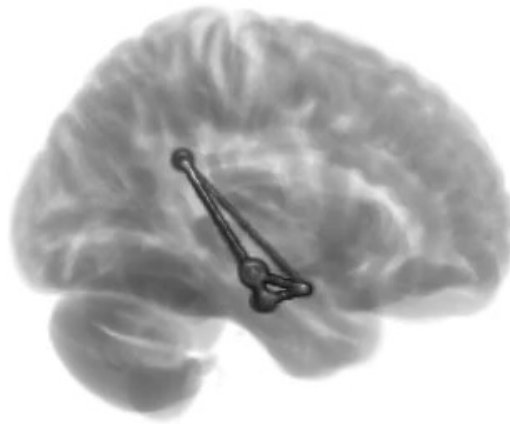
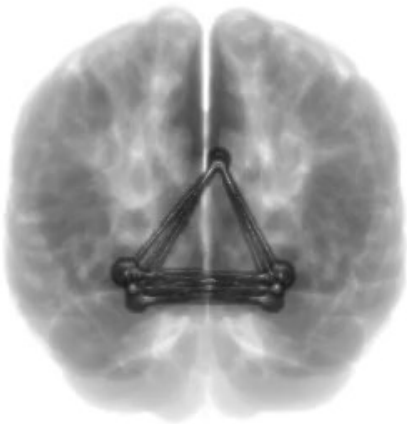


Made with Connectopedia





Made with Connectopedia

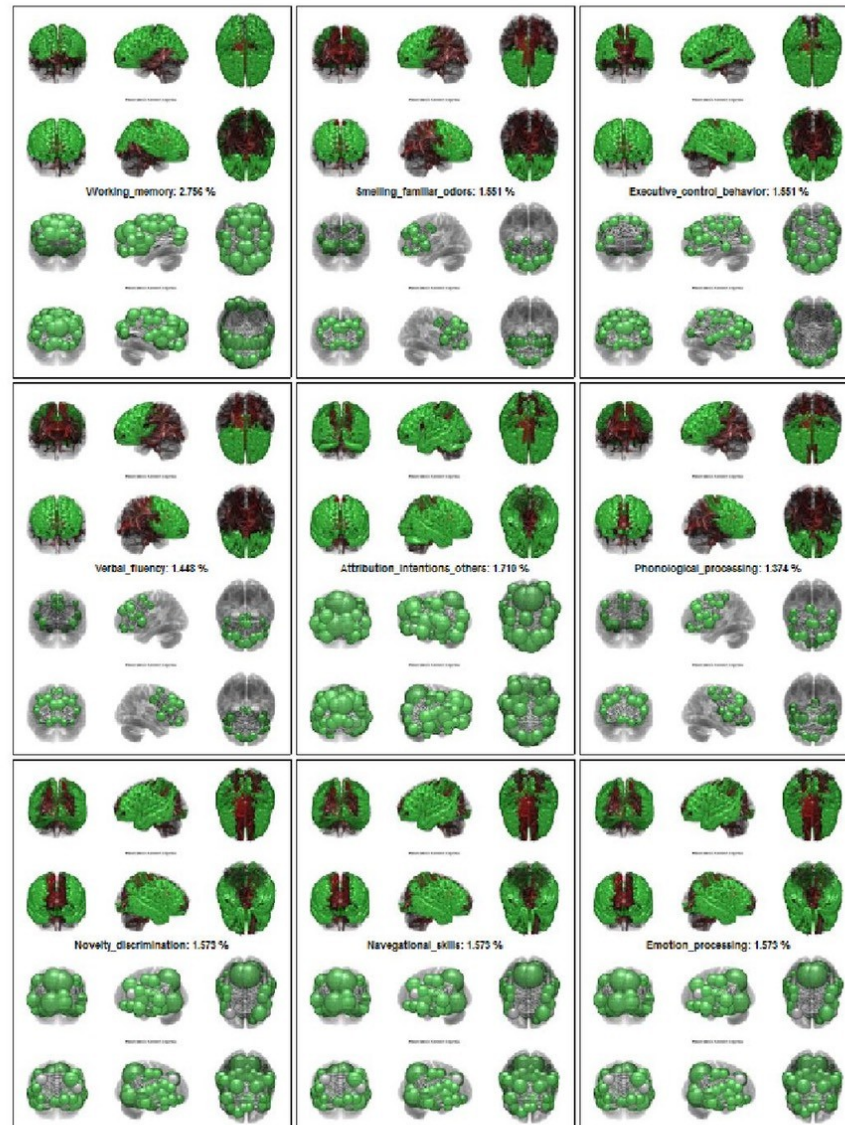


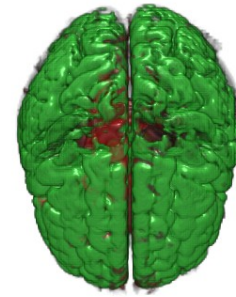
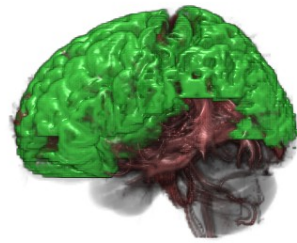
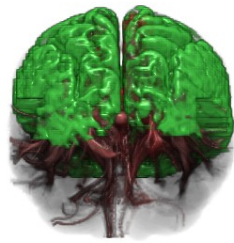




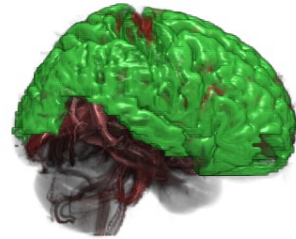
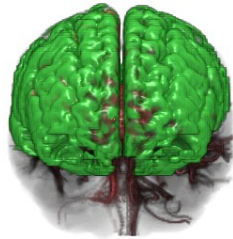
# Brain analysis for file: Olfaction-Menthe

Occurrence(s):

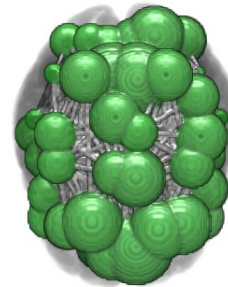
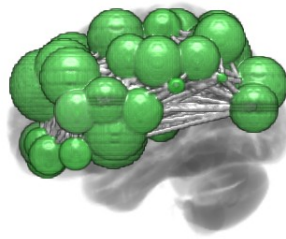
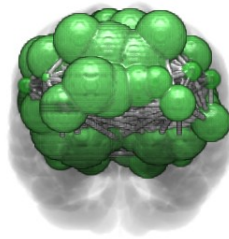




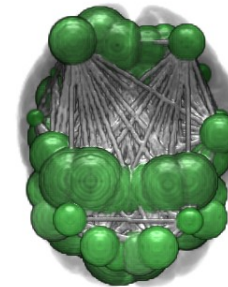
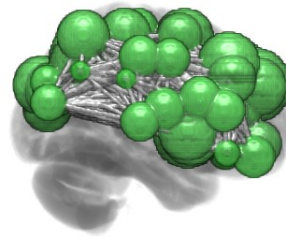
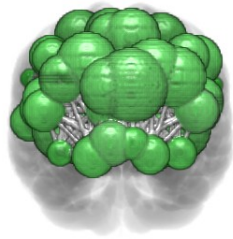
Made with Connectopedia



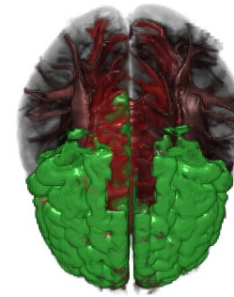
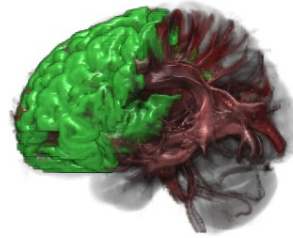
**Working Memory : 2,756 %**



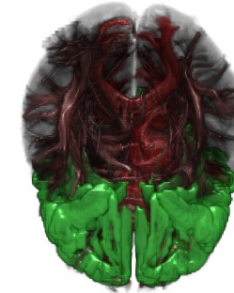
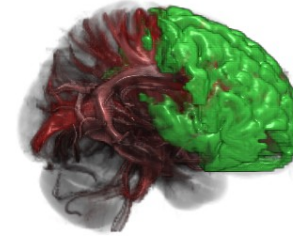
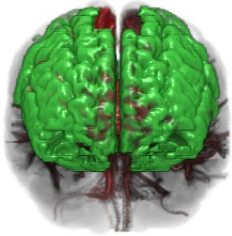
Made with Connectopedia



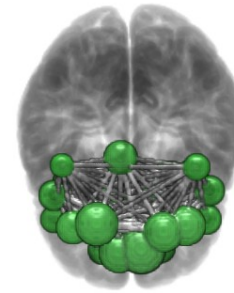
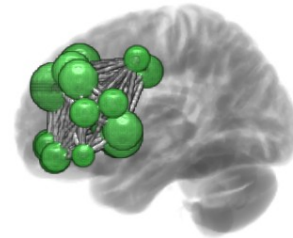
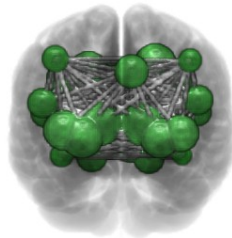




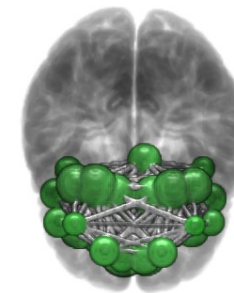
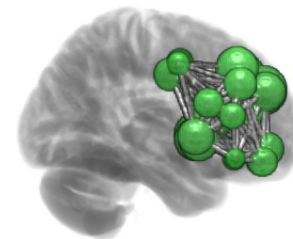
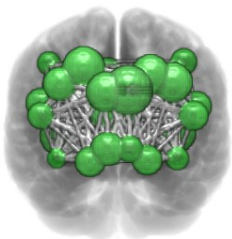
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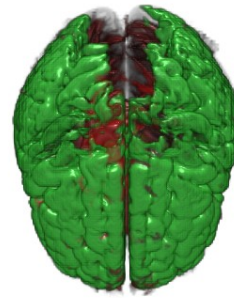
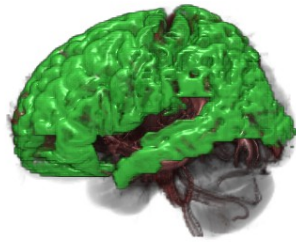


***Smelling Familiar Odor: 1,551 %***

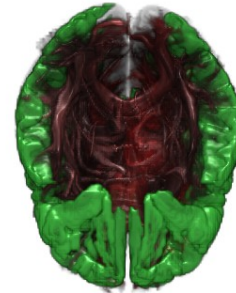
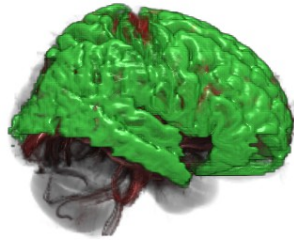
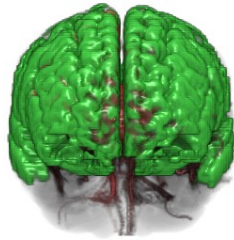


Made with Connectopedia

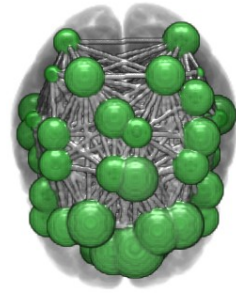
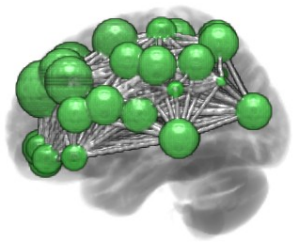
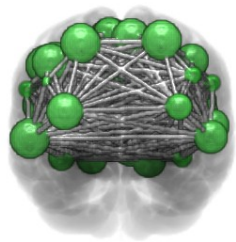




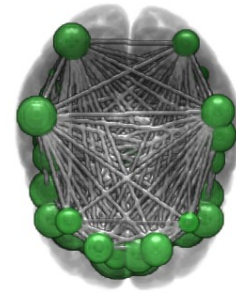
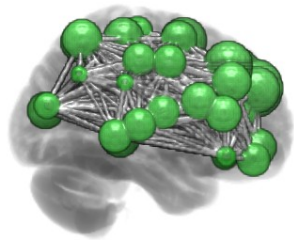
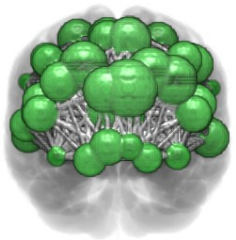
Made with Connectopedia

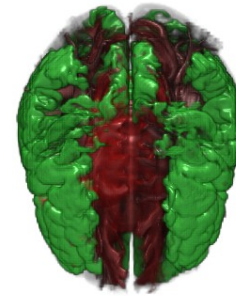
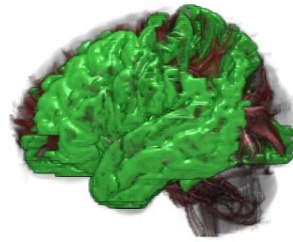
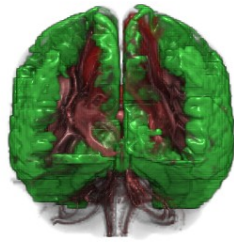


***Executive Control Behavior: 1,551 %***

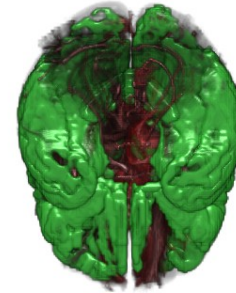
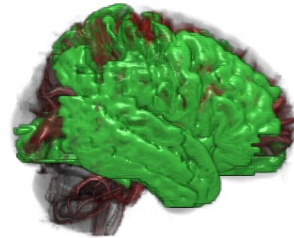
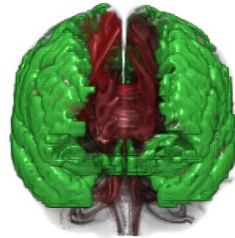


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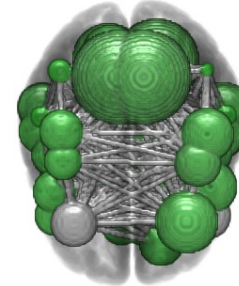
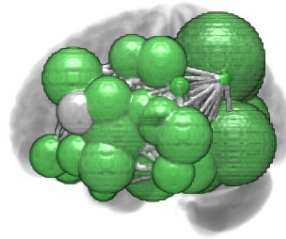
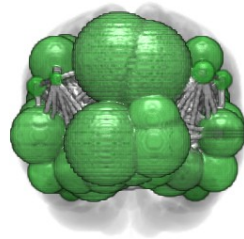




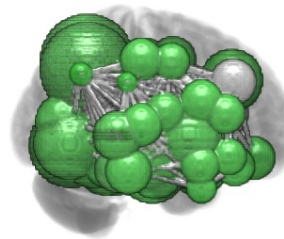
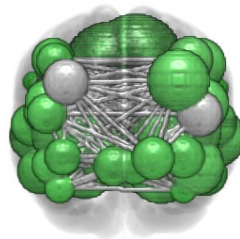
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***Emotion Processing: 1,573 %***

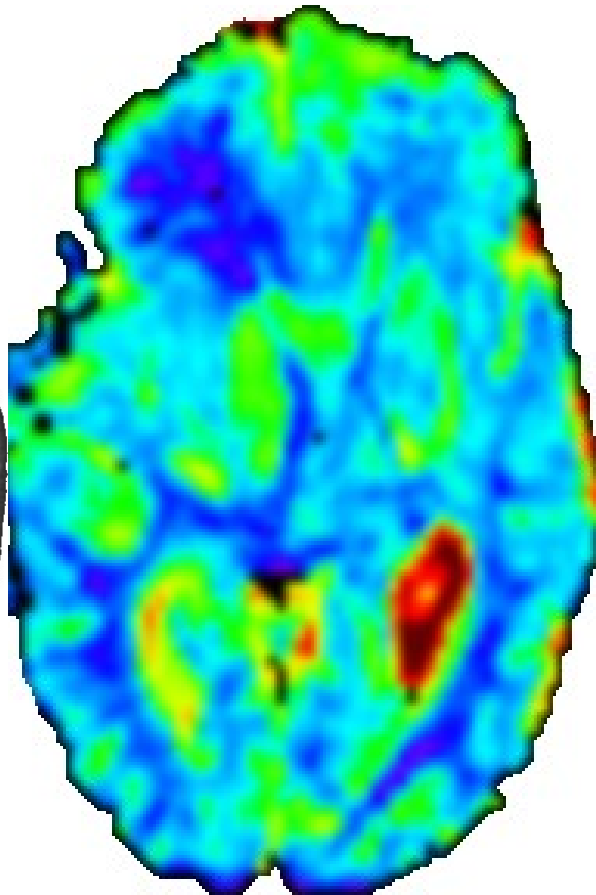


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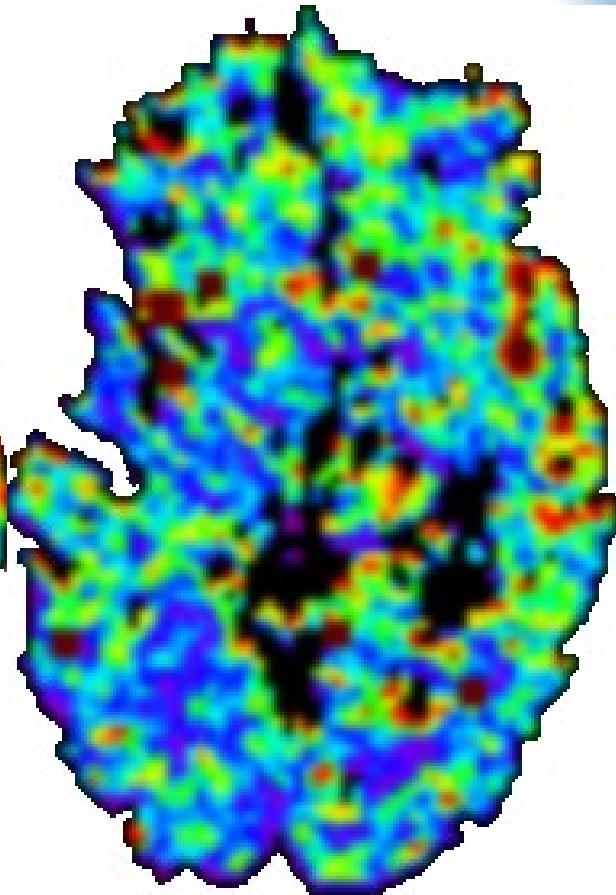




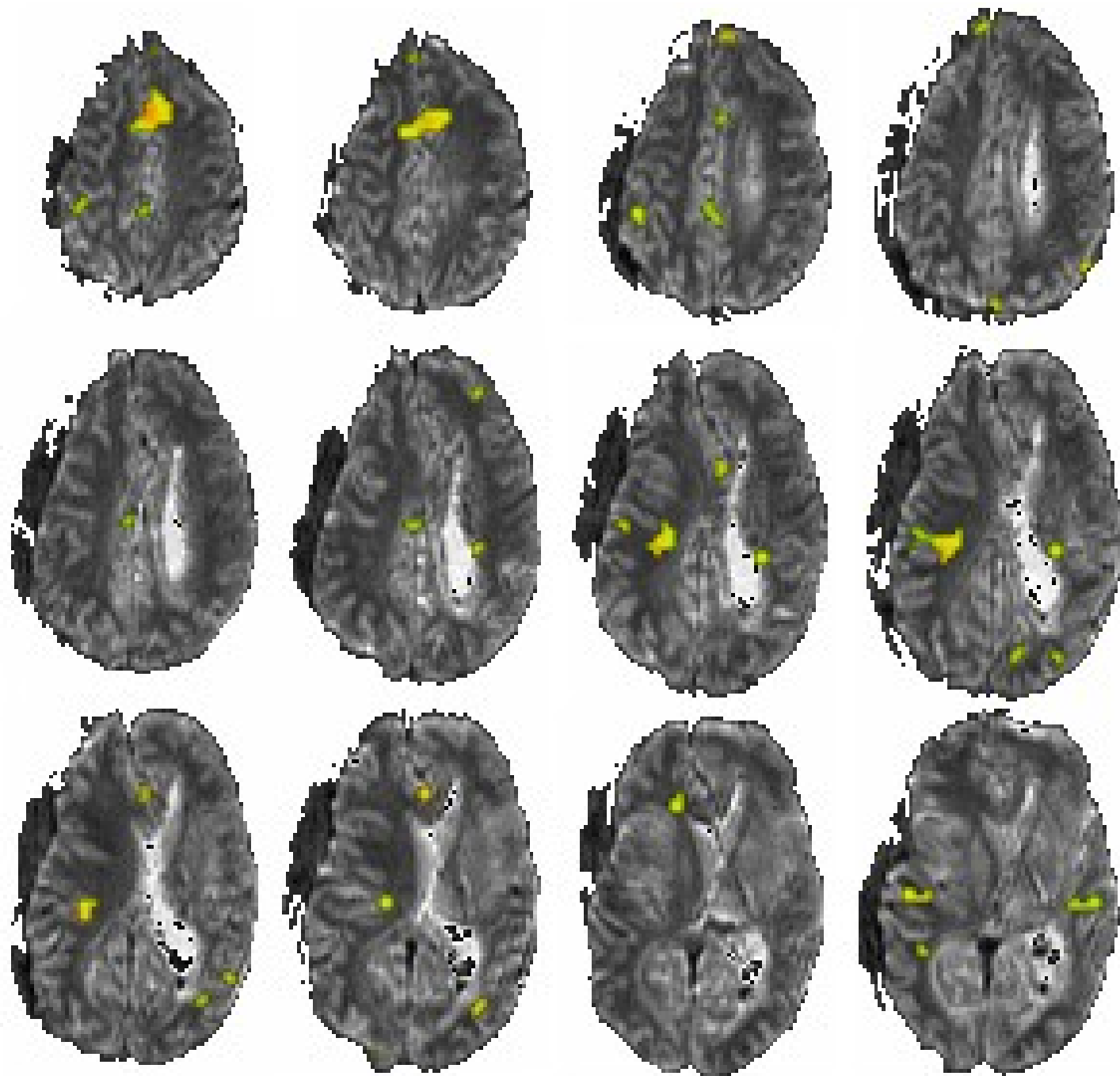
Flair

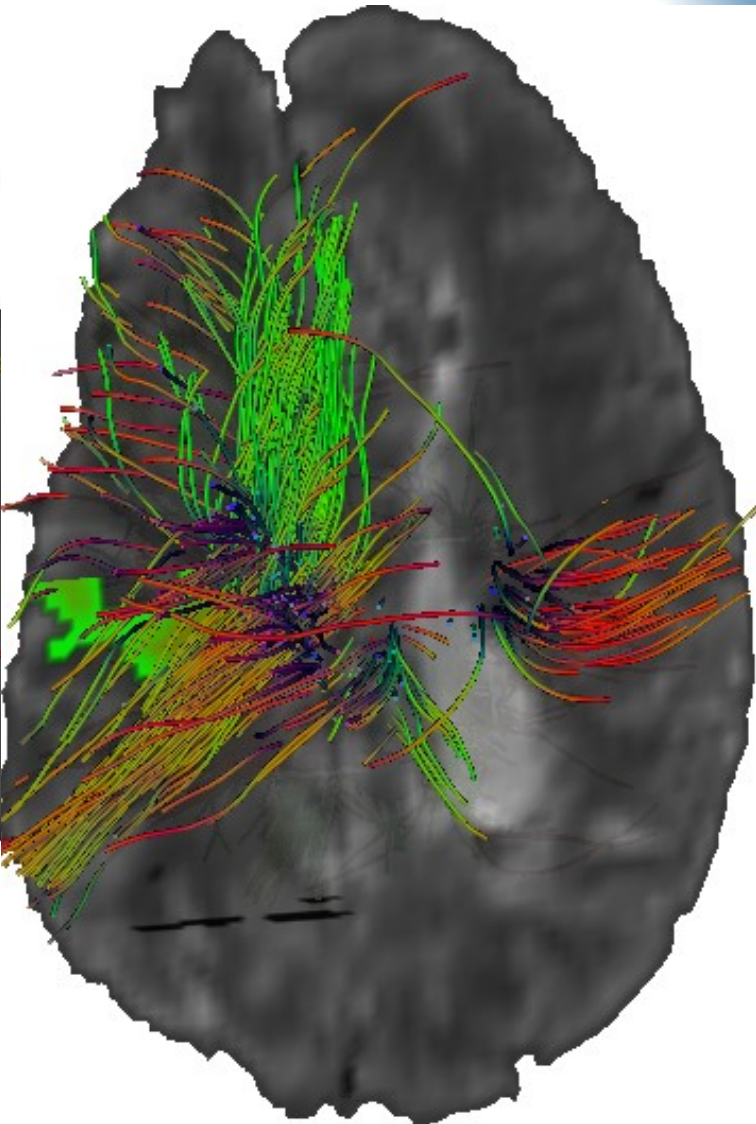
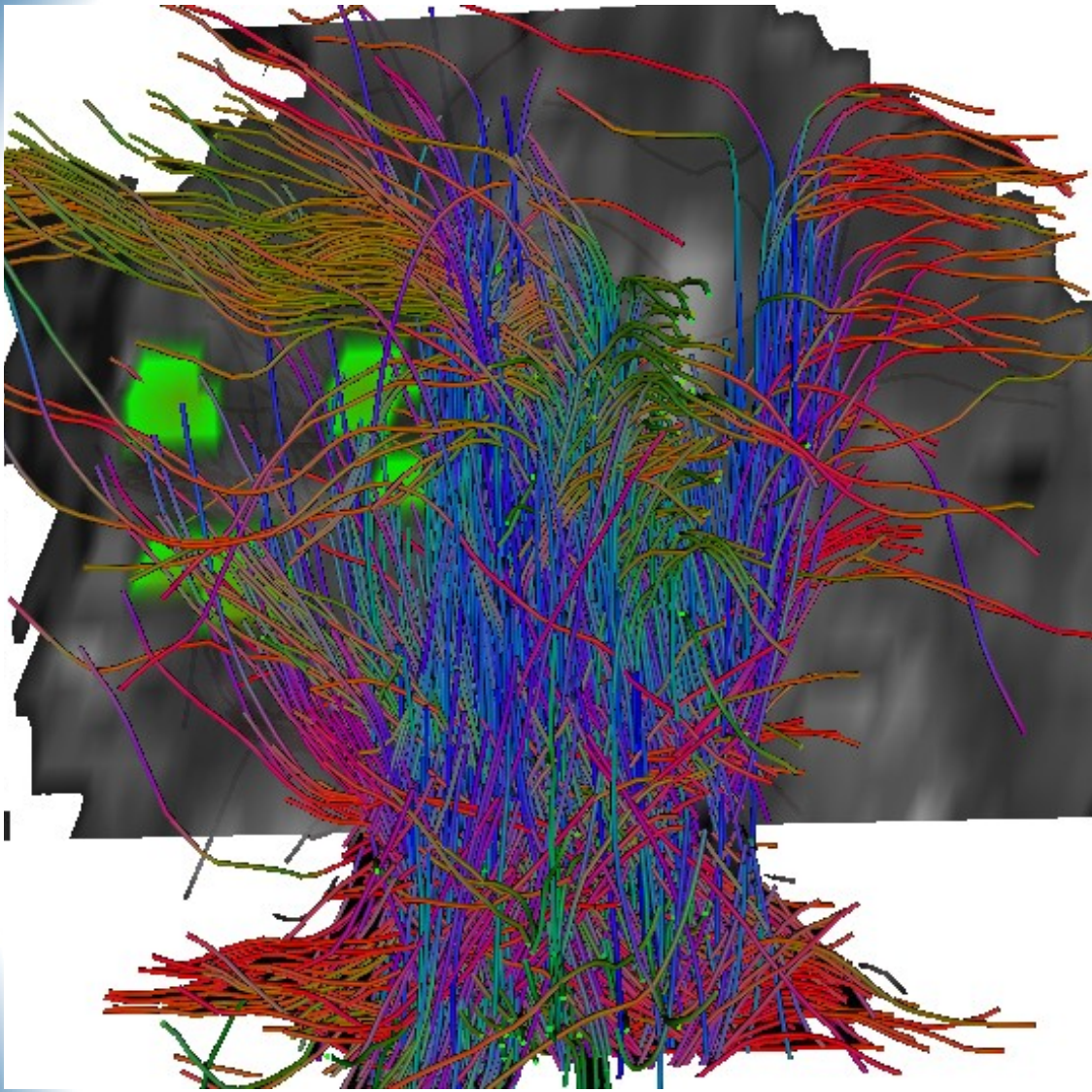


ADC

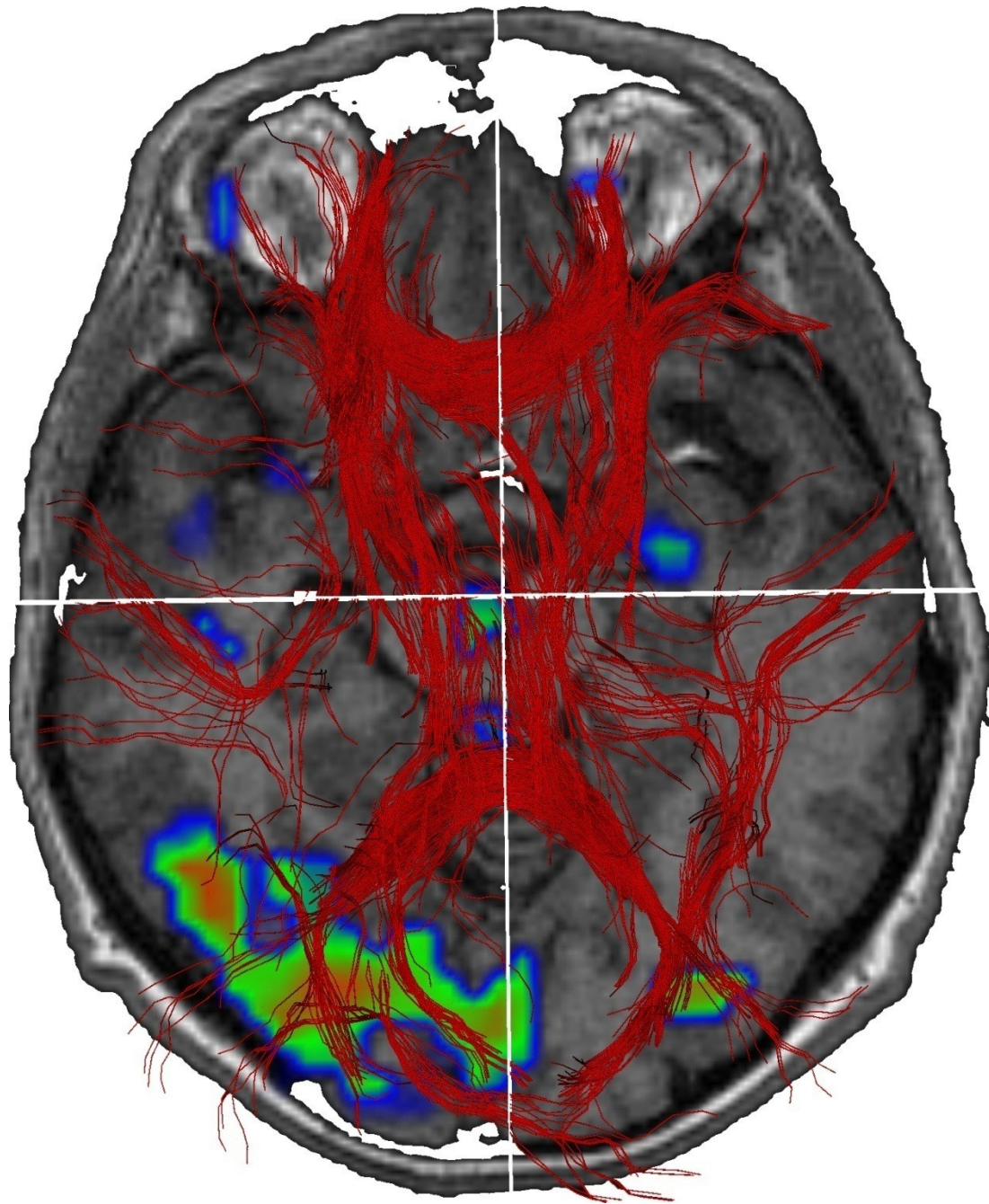


CBF





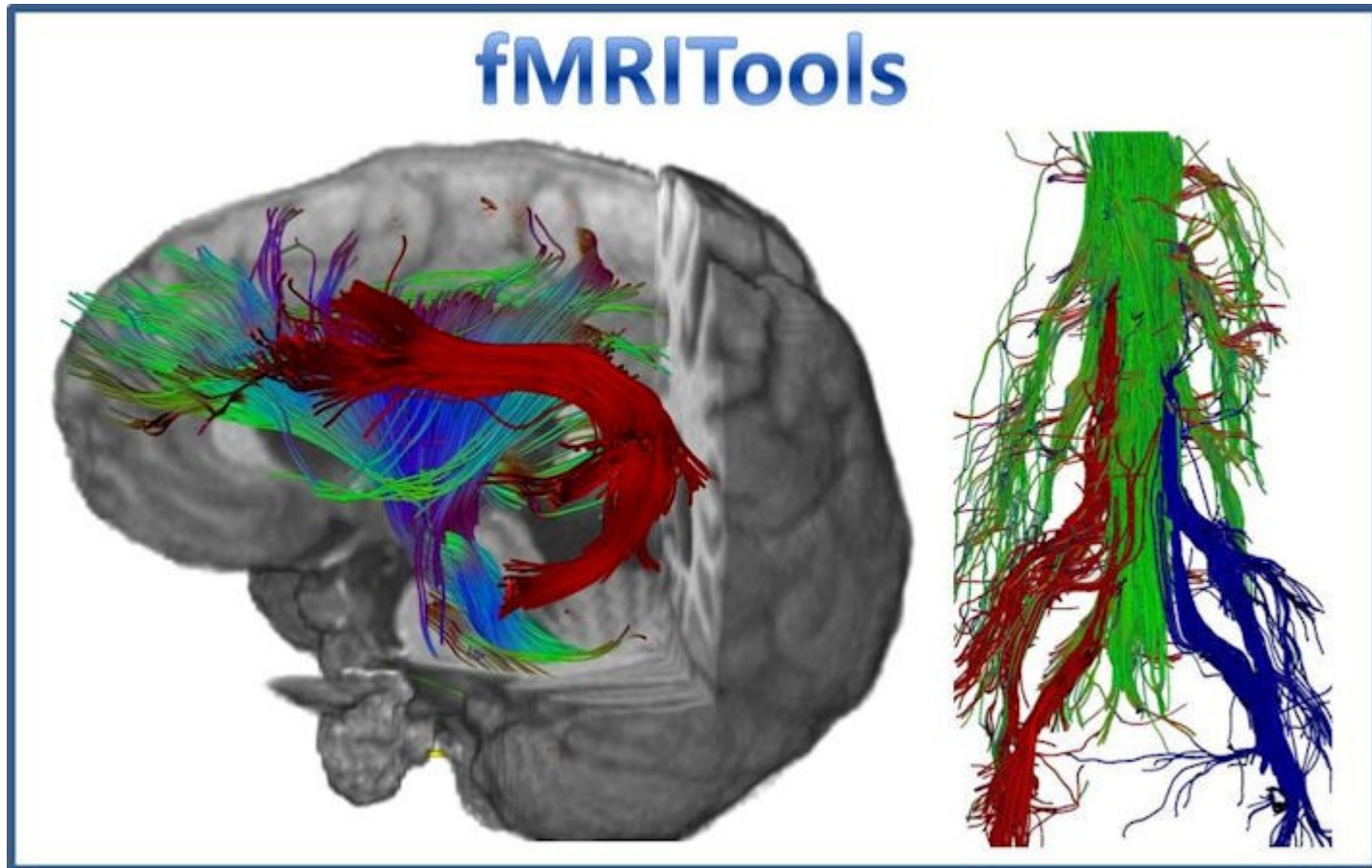
# **Conclusions**





# L.I.M.E.C.

Laboratoire d'Imagerie Médicale Expérimentale et Clinique



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