

# Towards the development of a tool for the analysis of individual multiparametric data in functional imaging of the brain

E. Condamine, O. Heck, N. Boudiaf, T. Perret, J. Pietras, E. Barbier, A. Krainik

*UMS IRMaGe - MR facility, Grenoble  
Department of neuroradiology. University hospital of Grenoble  
INRIA, Grenoble  
Grenoble institute of neurosciences  
LPNC, Grenoble*

# CVR imaging issue: a profusion of results

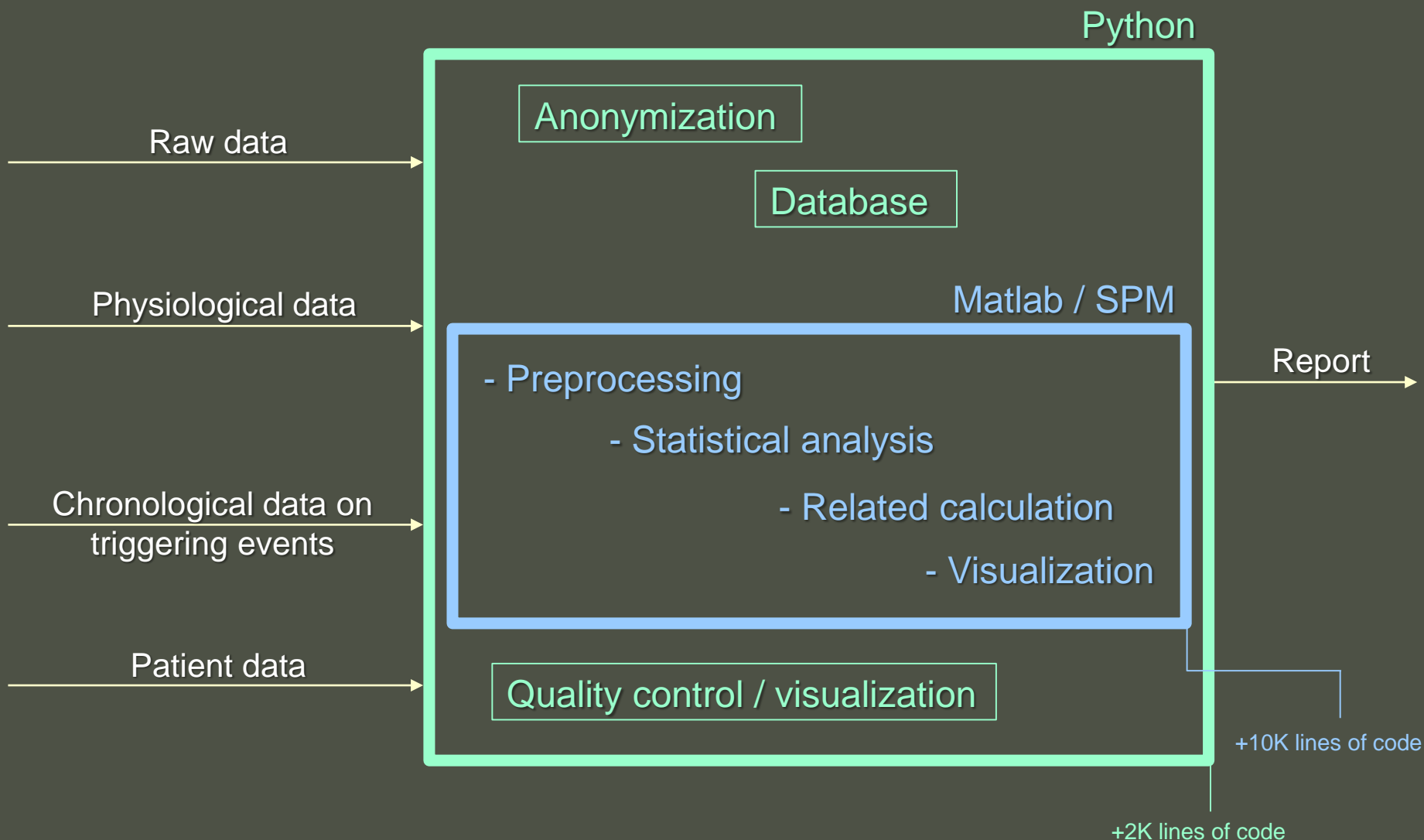


- Anatomical images
- Functional images
- Parametric maps
- Related results
- Data quality control, etc.



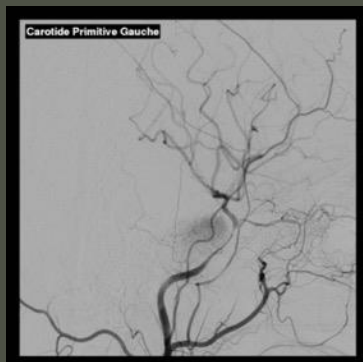
Need for a tool automatically producing a summary of the results and related quality controls ...

# Objective: development of an analysis support software



# Results: report layout – 21 pages

Woman, 42 yo.  
Watershed stroke  
due to left ICA SIAS  
(*meningioma left cavernous sinus*)



**A**utomatic **M**edical **I**mages **G**enerat**O**r v0.3

**desi270314 report: 2016.03.22**

---

**SITE** : Grenoble University Hospital - CLUNI  
**MRI SCANNER** : Philips Achieva 3.0T TX  
**STUDY NAME** : cevastoc  
**EXAMINATION DATE** : 2014.03.27 / 08:58:49  
**PATIENT REFERENCE** : desi270314  
**PATIENT SEX** : F  
**PATIENT AGE** : 41  
**PATHOLOGY** : ACI\_G  
**REFERENCE GROUP** : CVR\_temoins\_IL  
**SOFTWARES** : Python 2.7.11  
MATLAB Vers. 8.6 (R2015b)  
Statistical Parametric Mapping Vers. 6470 (SPM12)  
Image Processing Toolbox Vers. 9.3 (R2015b)  
Signal Processing Toolbox Vers. 7.1 (R2015b)  
Operating System Mac OS X Ver. 10.11.3

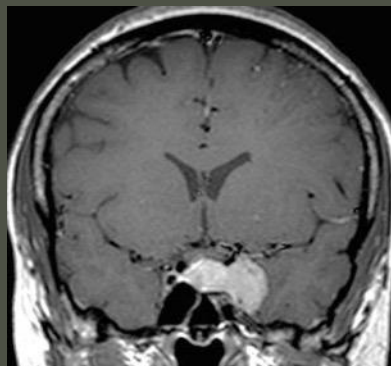
---

#### DISCLAIMER

AMIGO software is executed in a research environment on anonymized data. The conclusions obtained with AMIGO software by IRMaGe are an help to diagnose and prognosticate. They do not substitute themselves to the clinical care of the physicians and remain under their responsibilities. Consequently, IRMaGe is not responsible for any direct or indirect damages resulting from the use of data, informations, or results stemming from the AMIGO software. The user recognizes to use these informations under his sole and exclusive responsibility.

#### DECHARGE DE RESPONSABILITE

Le logiciel AMIGO est exécuté dans un environnement de recherche sur des données anonymisées. Les conclusions obtenues grâce au logiciel AMIGO d'IRMaGe sont une aide au diagnostic et au pronostic. Elles ne se substituent pas à la prise en charge médicale des médecins et demeurent sous leurs responsabilités. Par conséquent, IRMaGe ne peut être tenu responsable de dommage direct ou indirect résultant de l'utilisation des données, des informations ou des résultats issus du logiciel AMIGO. L'utilisateur reconnaît utiliser ces informations sous sa seule et entière responsabilité.







**A**utomatic **M**edical **I**mages **G**enerat**O**r V0.3

# Anatomy

Basal perfusion

CVR

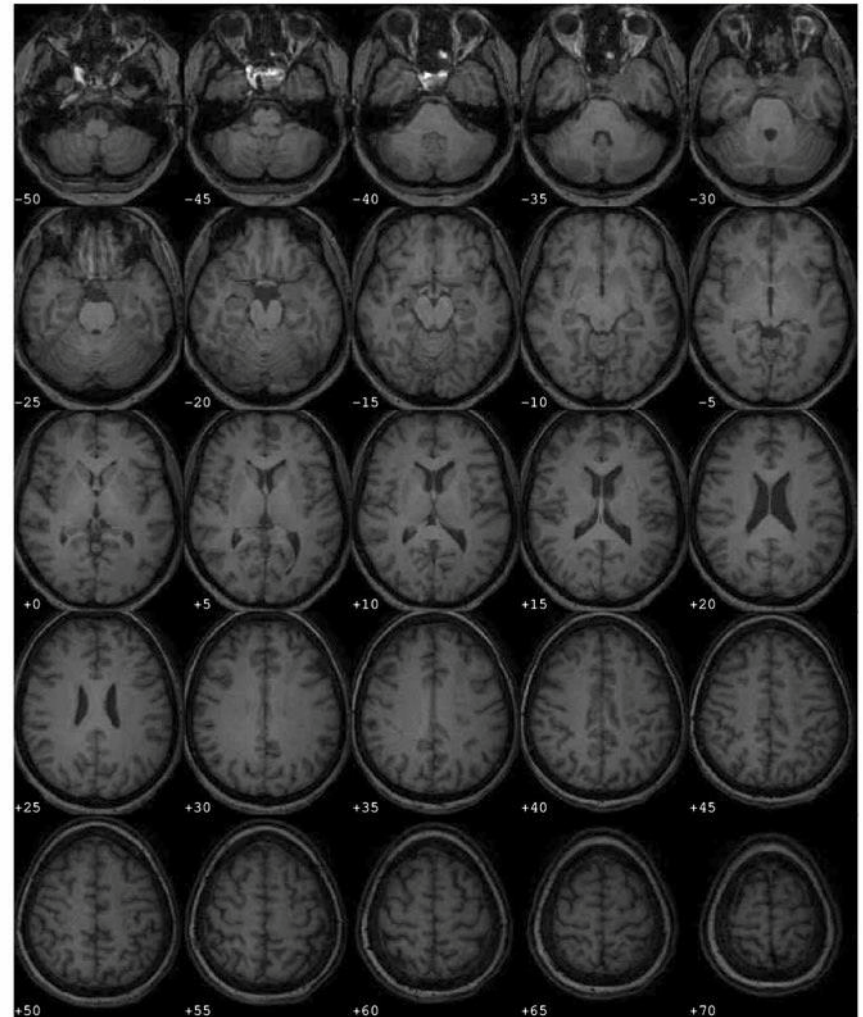
## Anatomical MRI

## Anatomy: MNI normalized axial images

### Acquisition parameters:

- Protocol name / Acquisition nr: T1 3D SENSE / 7
- Acquisition mode
  - Technique: T1TFE
- Geometry parameters
  - Number of slices: 160
  - Slice thickness / Slice gap [mm]: 1.0 / 0.0
  - FOV (ap / fh / rl) [mm]: 256.0 / 256.0 / 160.0
  - Scan resolution (x / y): 256 / 256
  - Voxel size (x / z / y) [mm]: 0.5 / 0.5 / 1.0
- Temporal parameters
  - TR [ms] / TE [ms] / Image flip angle [deg]: 9.9 / 4.6 / 8.0
  - Number of dynamics: 1
  - Acquisition duration [s]: 272

"Radiological" convention, the left side of the image corresponds to the right side of the brain.





**A**utomatic **M**edical **I**mages **G**enerat**O**r V0.3

Anatomy

Basal perfusion

CVR

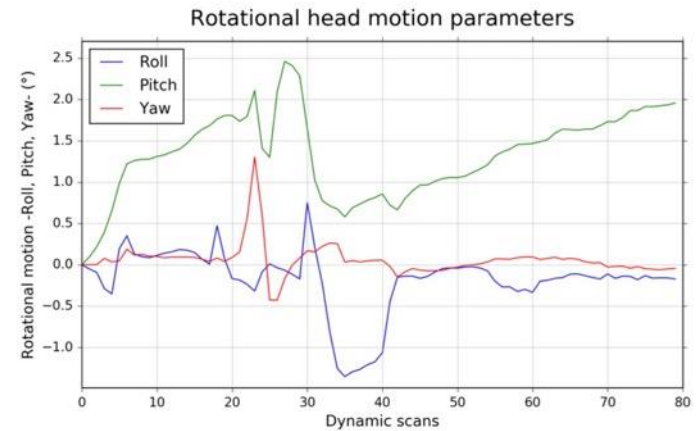
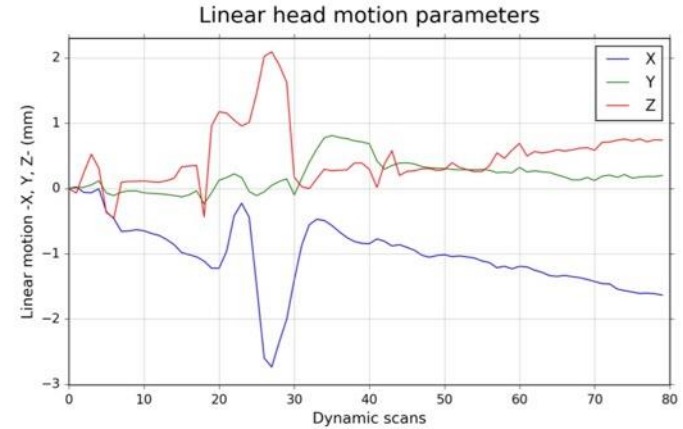
# Dynamic Susceptibility Contrast Perfusion MRI

DSC perfusion quality check: movements



## Acquisition parameters:

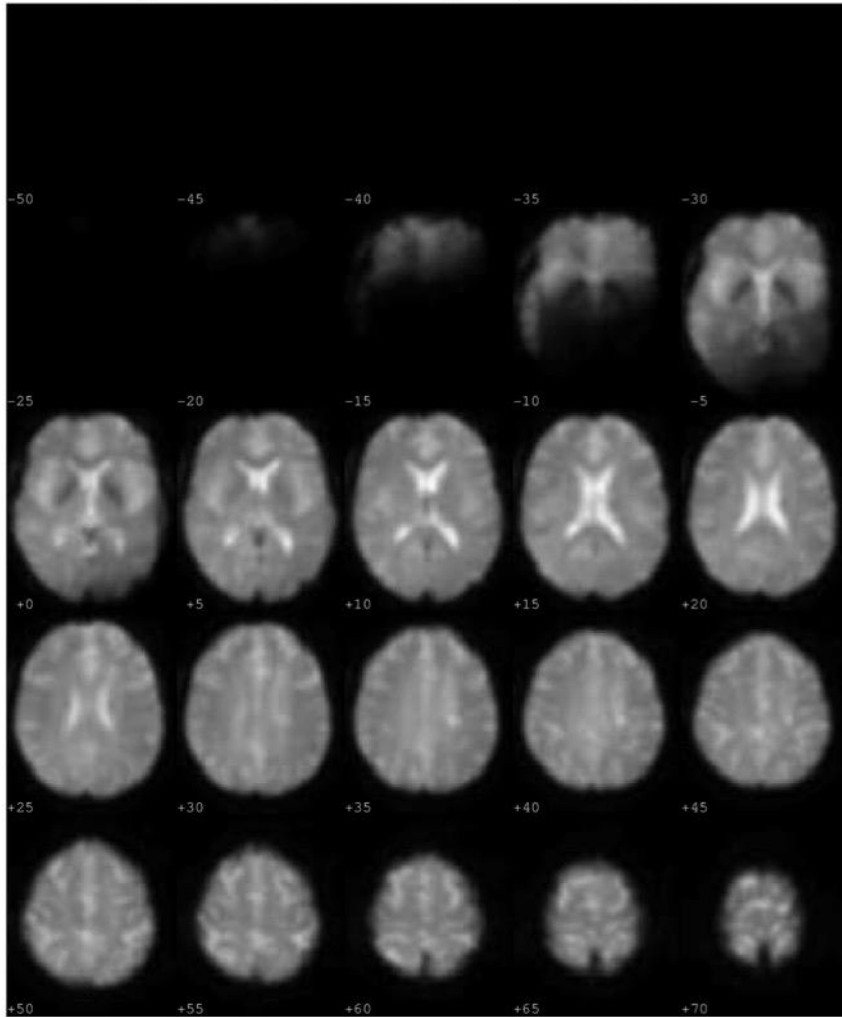
- Protocol name / Acquisition nr: PERF Large Julien SENSE / 15
- Acquisition mode
  - Technique: FEEPI
- Geometry parameters
  - Number of slices: 25
  - Slice thickness / Slice gap [mm]: 4.0 / 0.0
  - FOV (ap / fh / rl) [mm]: 224.0 / 100.0 / 184.0
  - Scan resolution (x / y): 112 / 112
  - Voxel size (x / z / y) [mm]: 2.0 / 4.0 / 2.0
- Temporal parameters
  - TR [ms] / TE [ms] / Image flip angle [deg]: 1671.1 / 40.0 / 75.0
  - Number of dynamics: 80
  - Acquisition duration [s]: 140



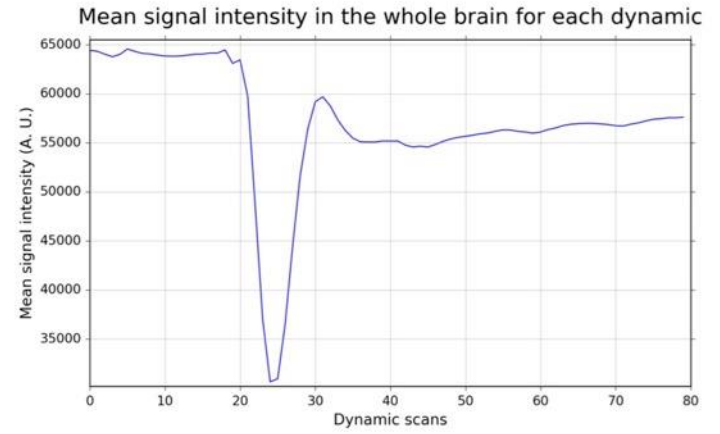


## DSC perfusion: MNI normalized axial images (1<sup>st</sup> dynamic)

"Radiological" convention, the left side of the image corresponds to the right side of the brain.

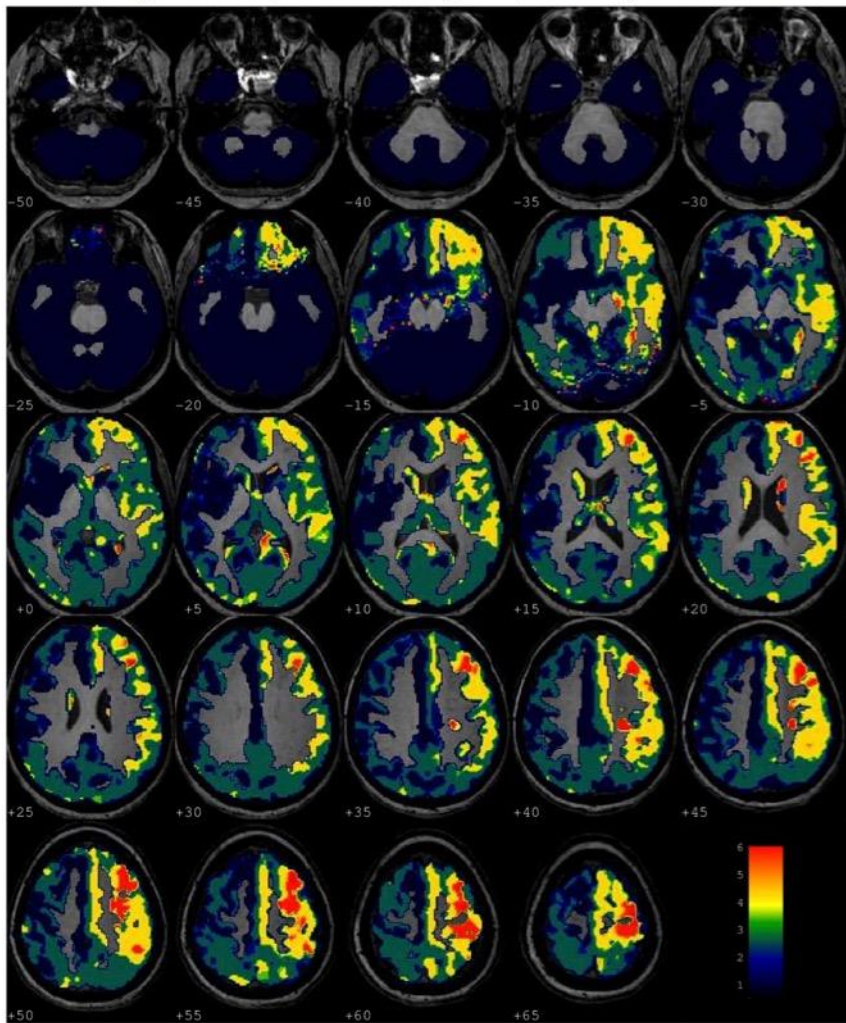


## DSC perfusion quality check: Mean signal intensity in the whole brain



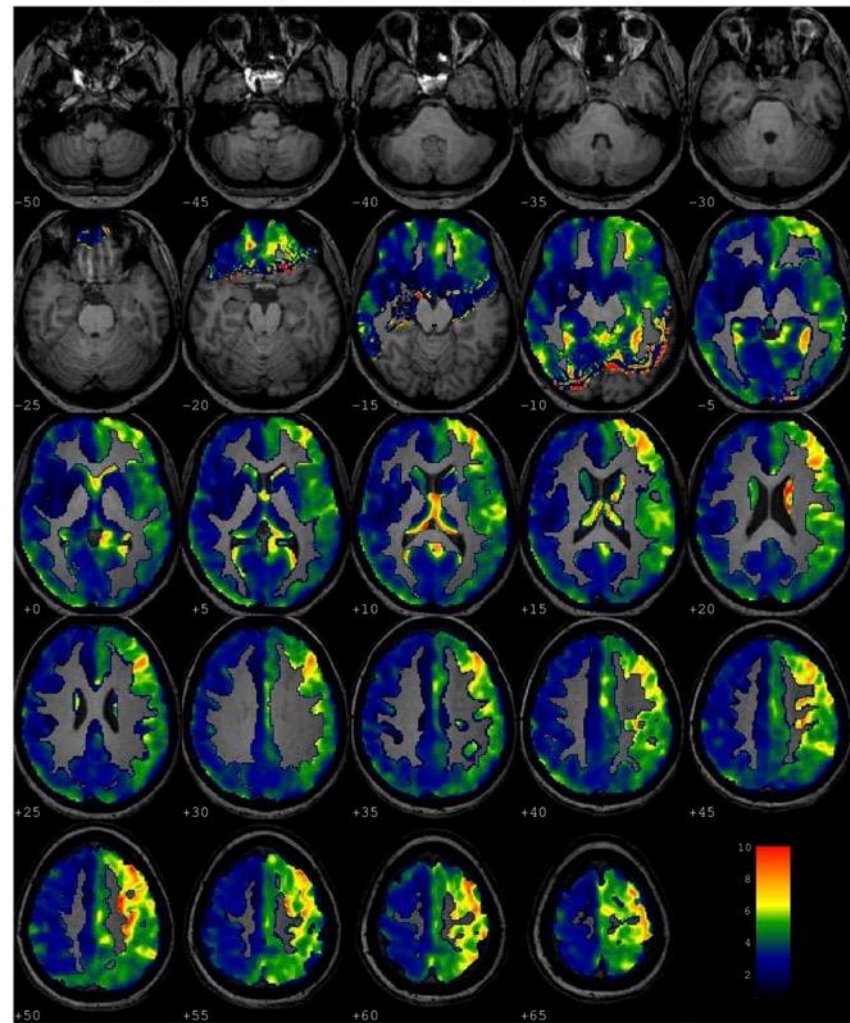
### Parametric maps: Delay in sec.

"Radiological" convention, the left side of the image corresponds to the right side of the brain.



### Parametric maps: Mean Transit Time in sec.

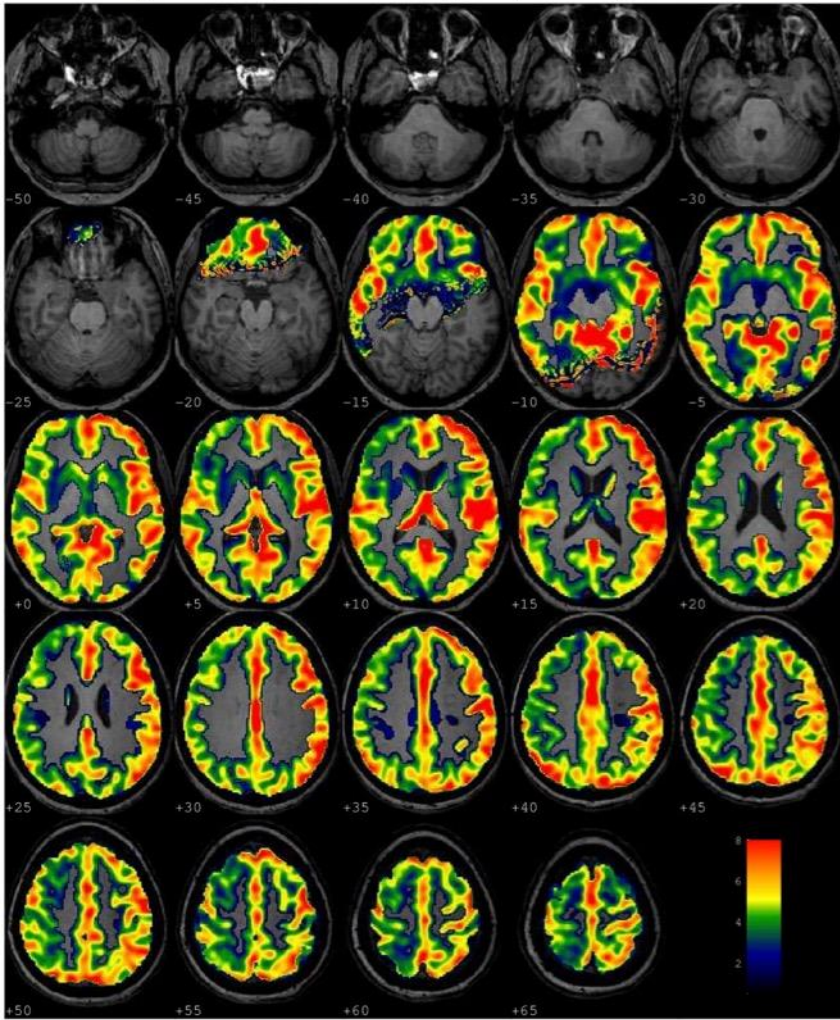
"Radiological" convention, the left side of the image corresponds to the right side of the brain.





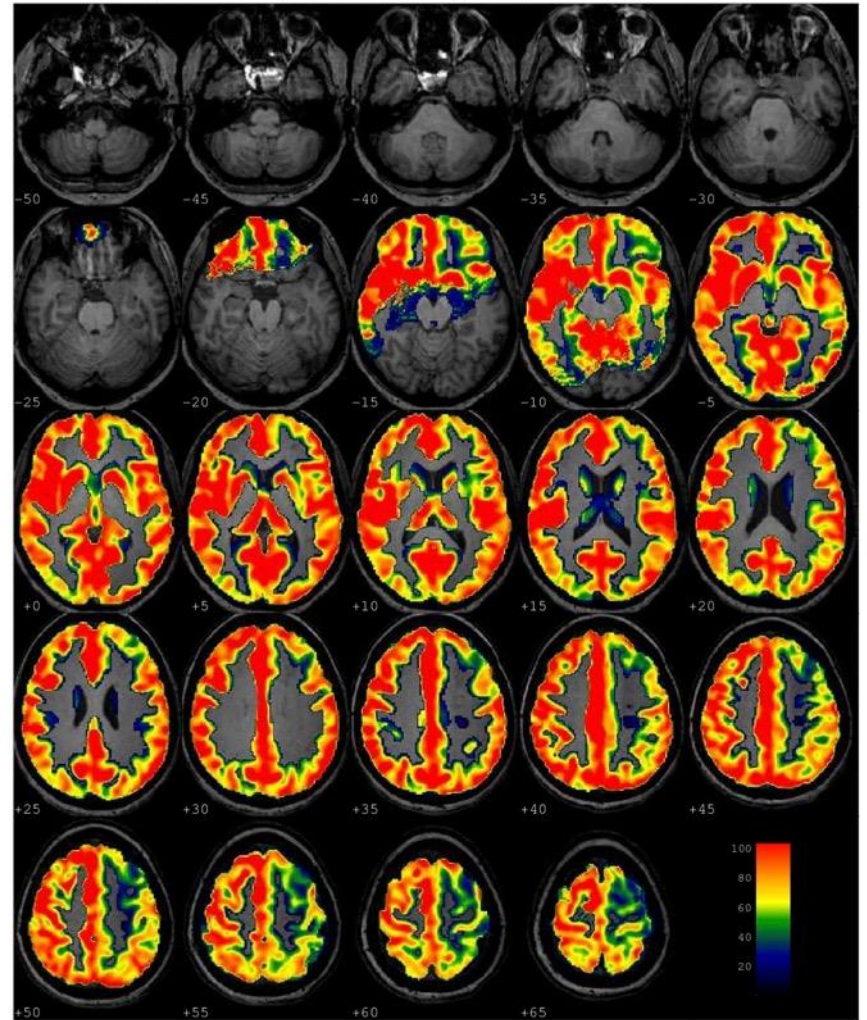
### Parametric maps: Cerebral Blood Volume in A. U.

"Radiological" convention, the left side of the image corresponds to the right side of the brain.



### Parametric maps: Cerebral Blood Flow in A. U.

"Radiological" convention, the left side of the image corresponds to the right side of the brain.





**A**utomatic **M**edical **I**mages **G**enerat**O**r V0.3

Anatomy

Basal perfusion

CVR

# fMRI under a vasoactive stimulus (hypercapnia)

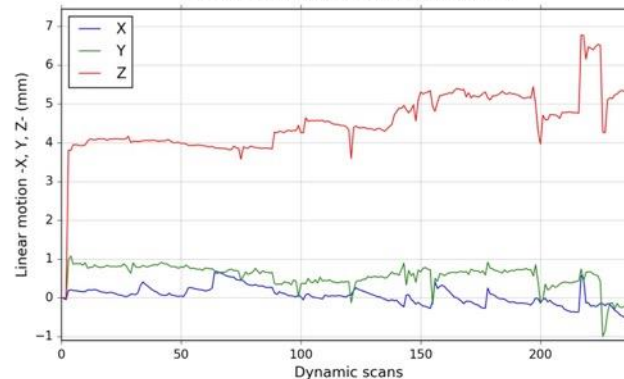
## Acquisition parameters:

- Protocol name / Acquisition nr: irmf CO2 SENSE / 6
- Acquisition mode
  - Technique: FEEPI
- Geometry parameters
  - Number of slices: 32
  - Slice thickness / Slice gap [mm]: 4.0 / 0.0
  - FOV (ap / fh / rl) [mm]: 256.0 / 128.0 / 256.0
  - Scan resolution (x / y): 64 / 64
  - Voxel size (x / z / y) [mm]: 4.0 / 4.0 / 4.0
- Temporal parameters
  - TR [ms] / TE [ms] / Image flip angle [deg]: 3000.0 / 35.0 / 90.0
  - Number of dynamics: 240
  - Acquisition duration [s]: 732

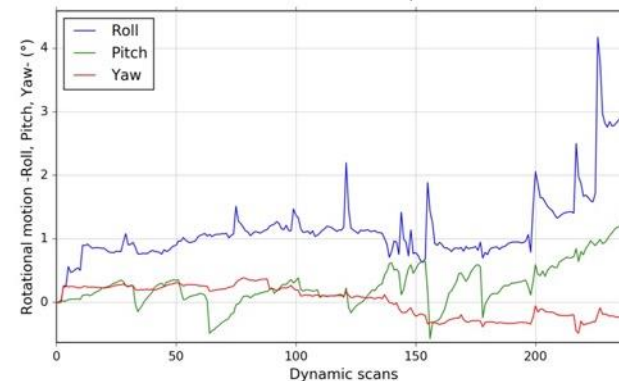
## fMRI quality check: movements



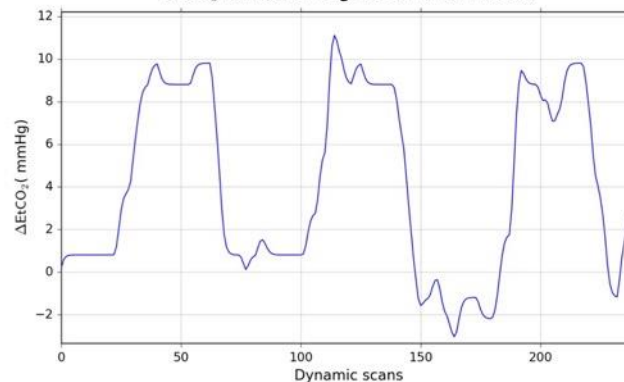
Linear head motion parameters



Rotational head motion parameters

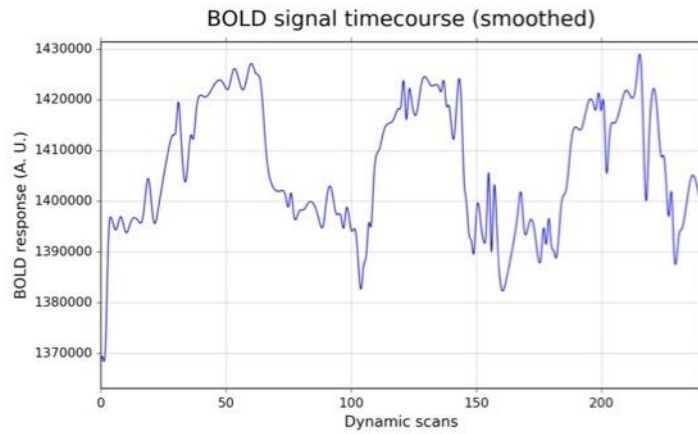
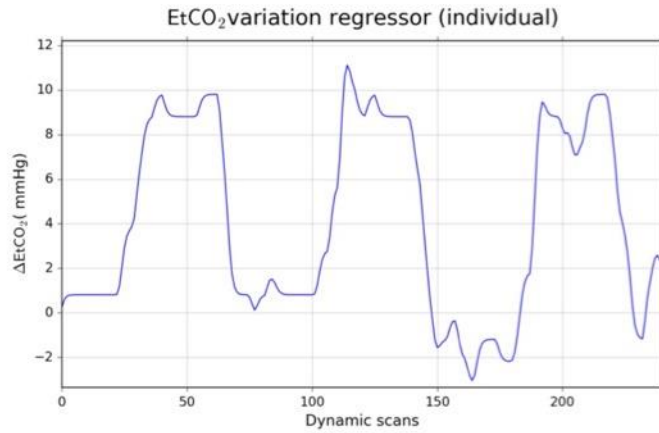


EtCO<sub>2</sub> variation regressor (individual)



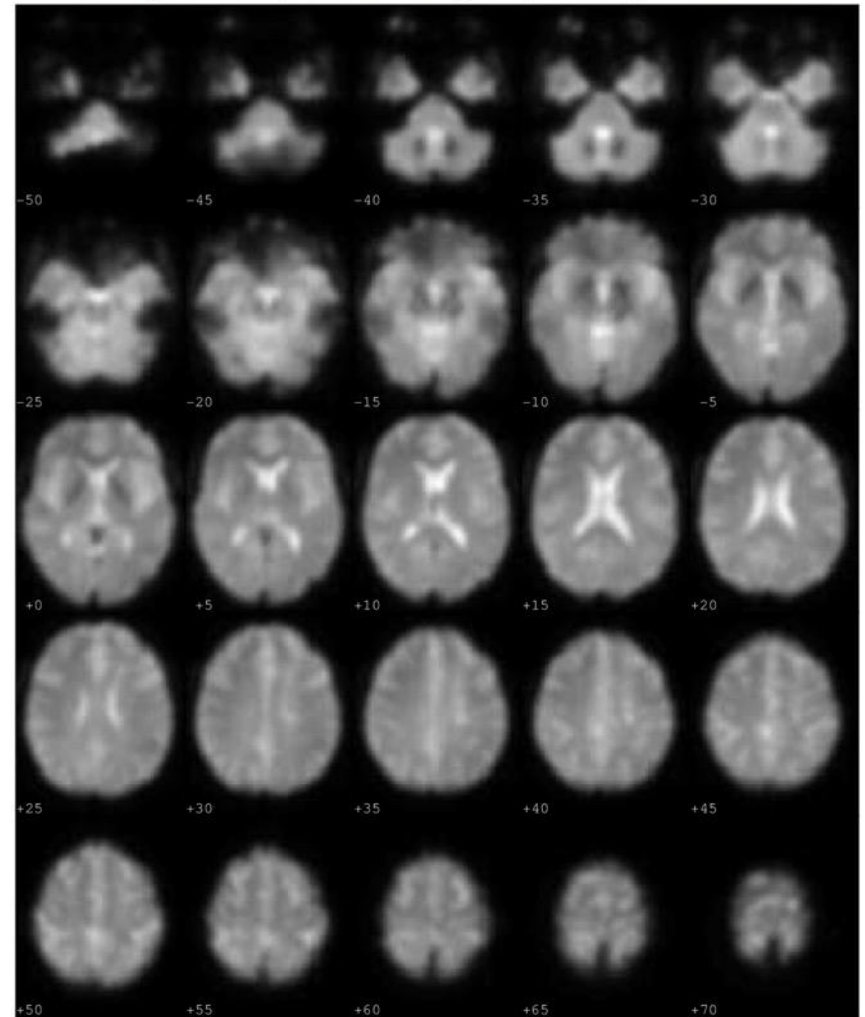


## fMRI quality check: BOLD signal timecourse Vs EtCO<sub>2</sub> model



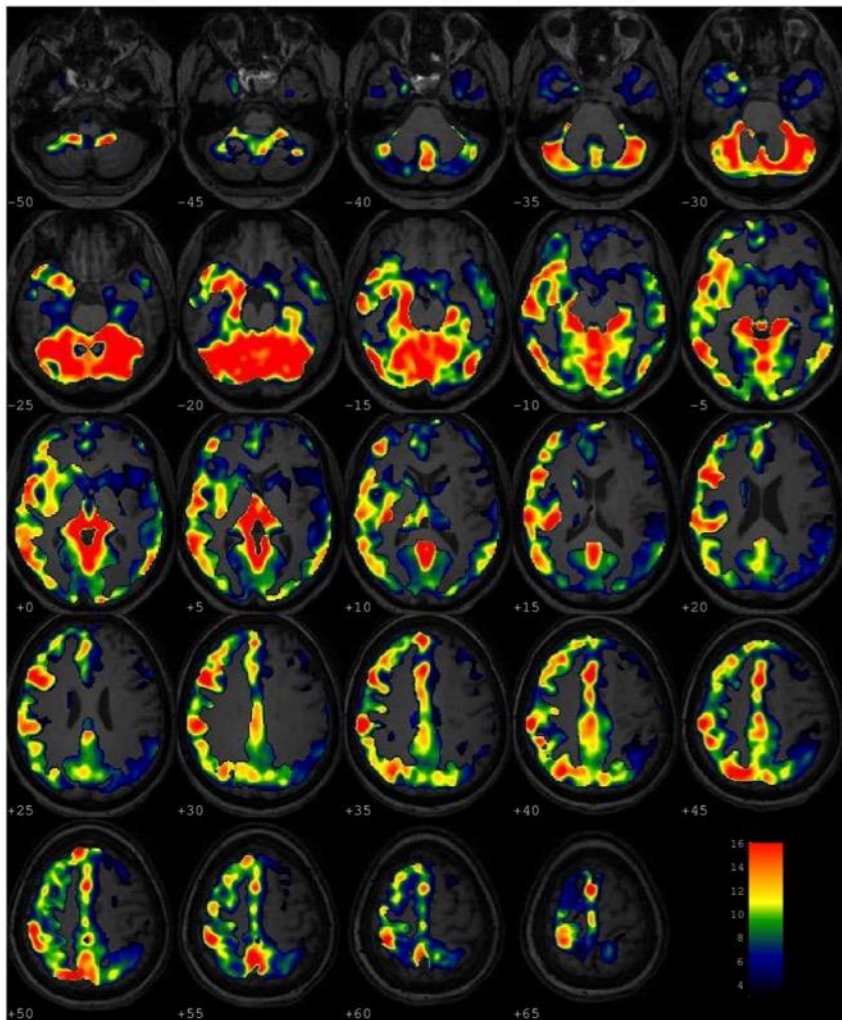
## BOLD: MNI normalized axial images (1<sup>st</sup> dynamic)

"Radiological" convention, the left side of the image corresponds to the right side of the brain.



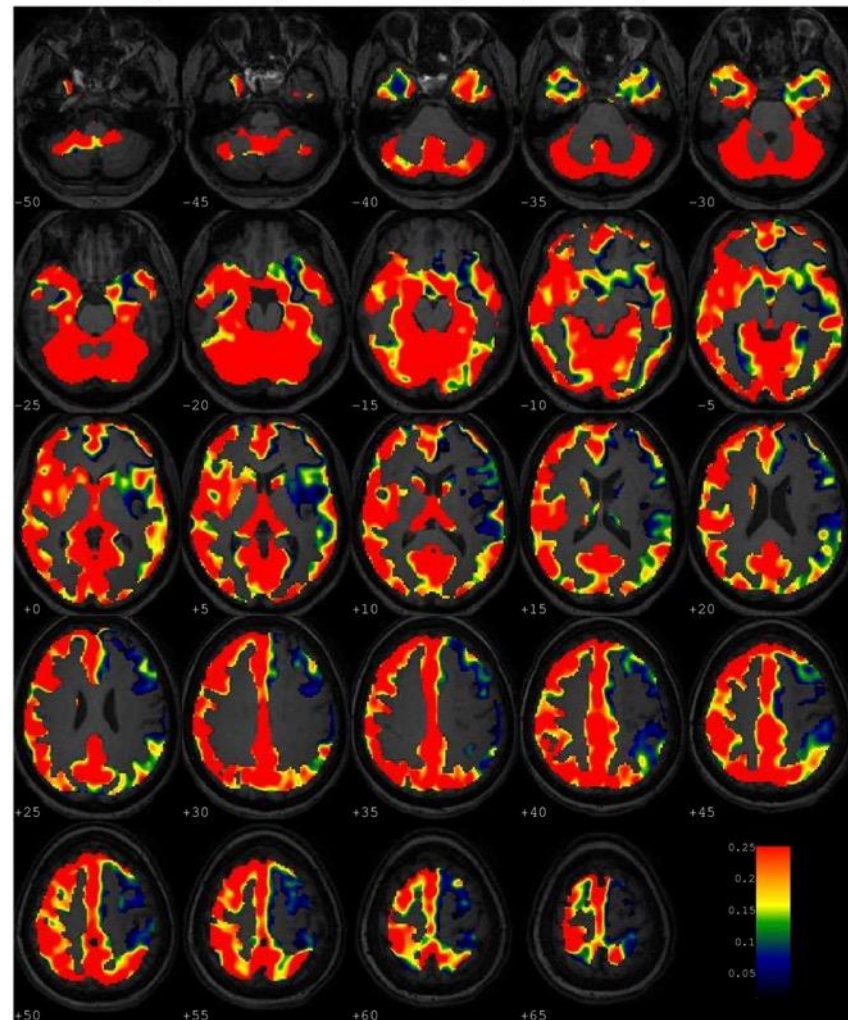
### Parametric maps: statistic parametric t-Map (SPMt)

"Radiological" convention, the left side of the image corresponds to the right side of the brain.



### Parametric maps: $\beta$ weight values in $\Delta(\%BOLD) / EtCO_2$ (mmHg)

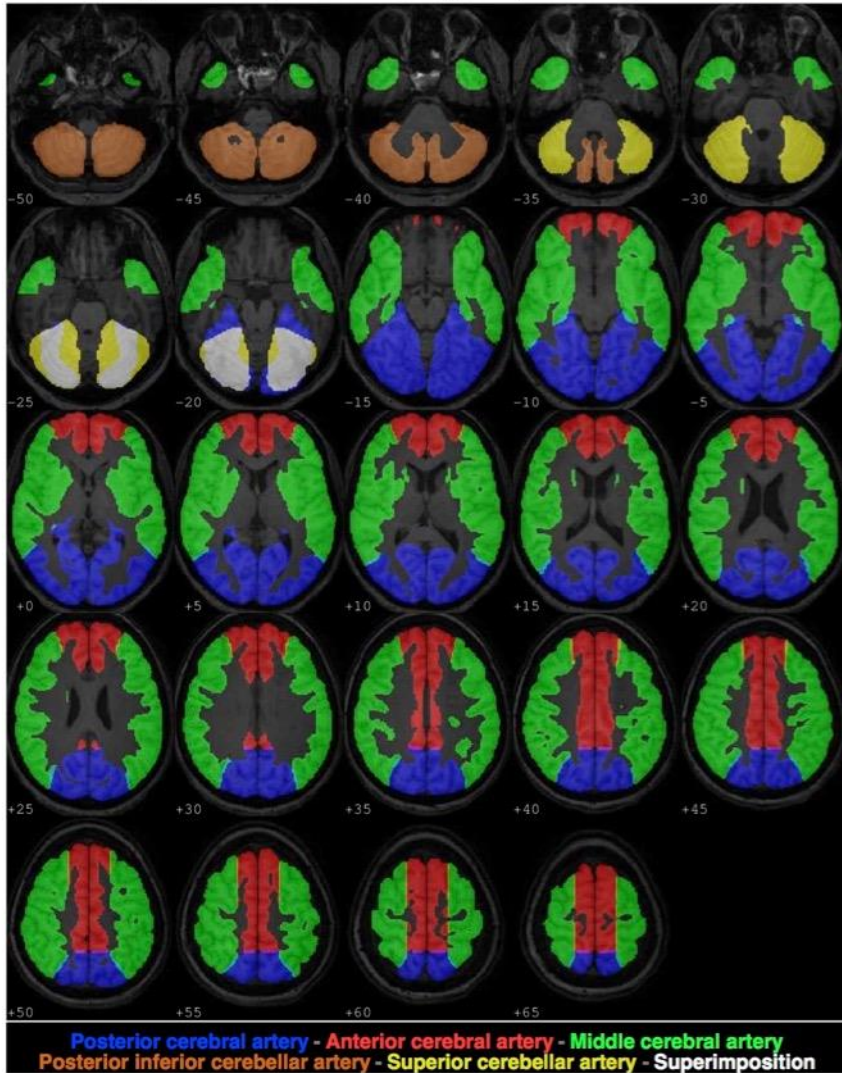
"Radiological" convention, the left side of the image corresponds to the right side of the brain.





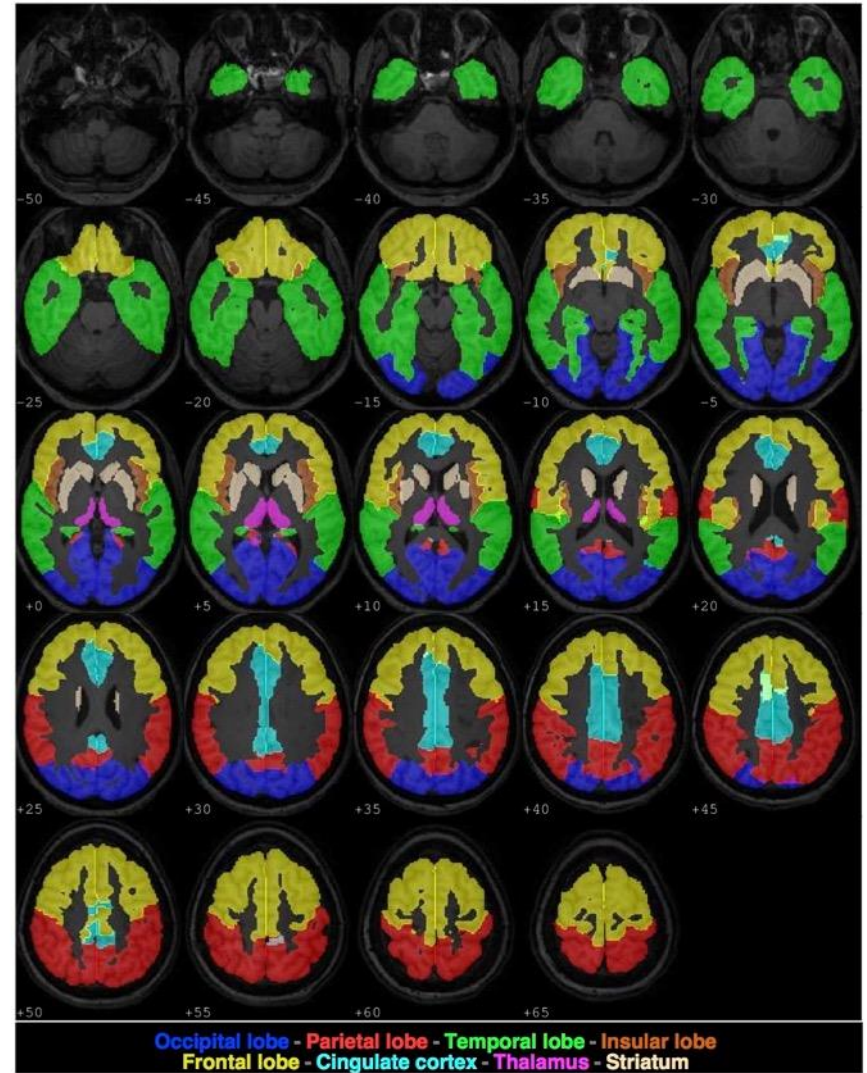
## Vascular territories of the cerebral arteries used for IL determination

"Radiological" convention, the left side of the image corresponds to the right side of the brain.



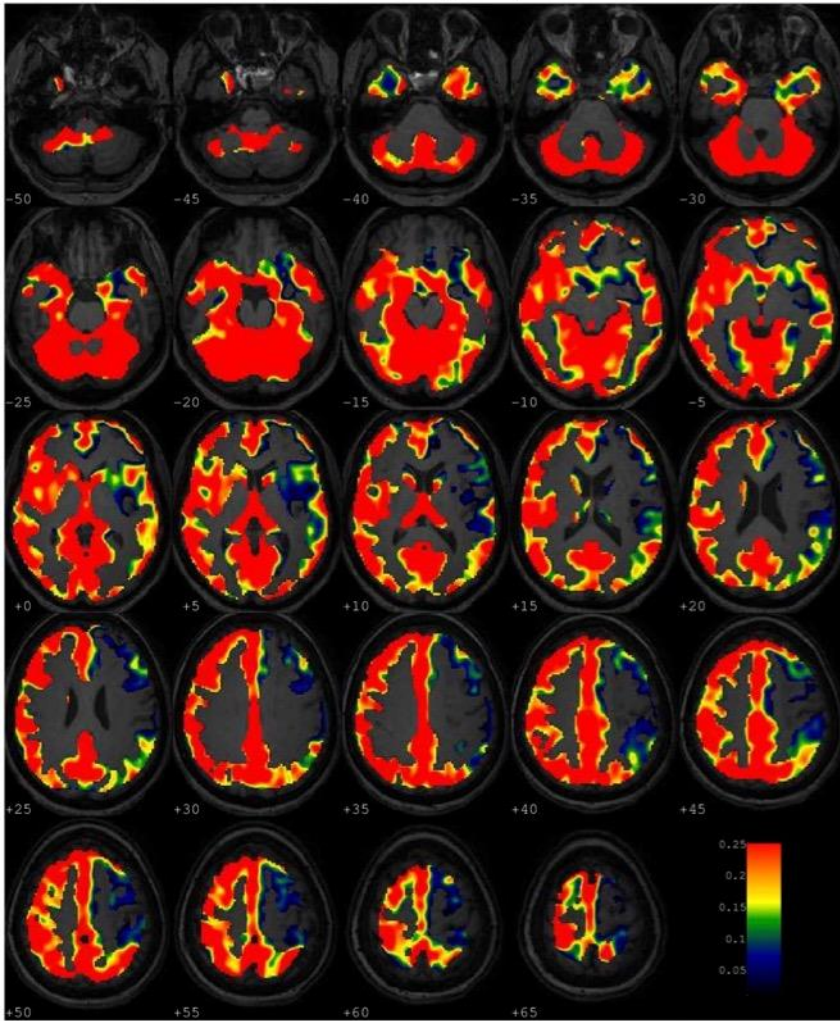
## Lobes of the brain used for IL determination

"Radiological" convention, the left side of the image corresponds to the right side of the brain.

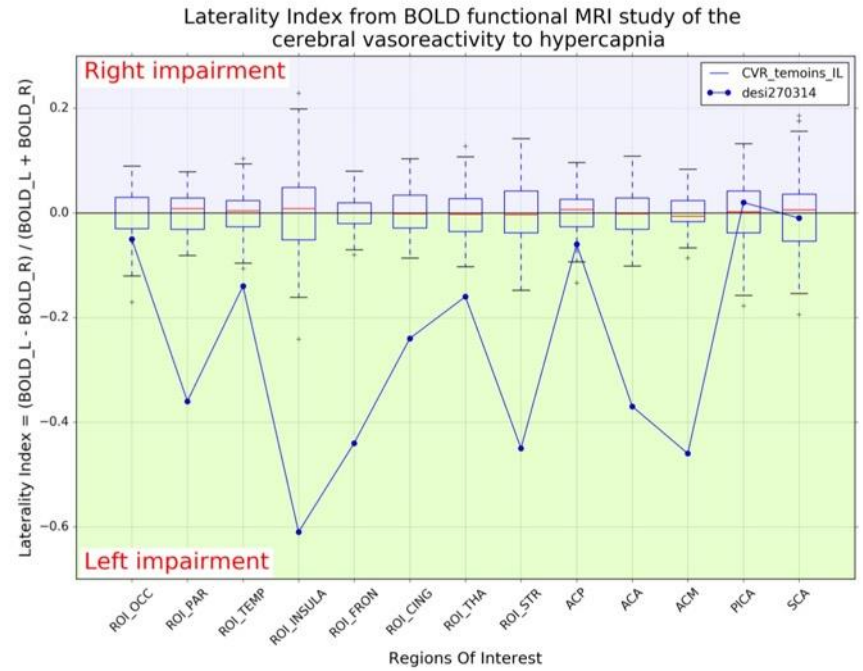


Parametric maps:  $\beta$  weight values in  $\Delta(\%BOLD) / EtCO_2$  (mmHg)

"Radiological" convention, the left side of the image corresponds to the right side of the brain.



Laterality index values for desi270314 against the box and whisker plot for a reference population





## Neuroradiology – MRI Dpt and IRMaGe

Arnaud Attyé  
Naïla Boudiaf  
Sylvie Grand  
Olivier Heck  
Alexandre Krainik  
Laurent Lamalle  
Johan Pietras  
Chantal Remy  
Irène Troprès

## GIN

Emmanuel Barbier  
Jan Warnking

## INRIA

Thomas Perret

