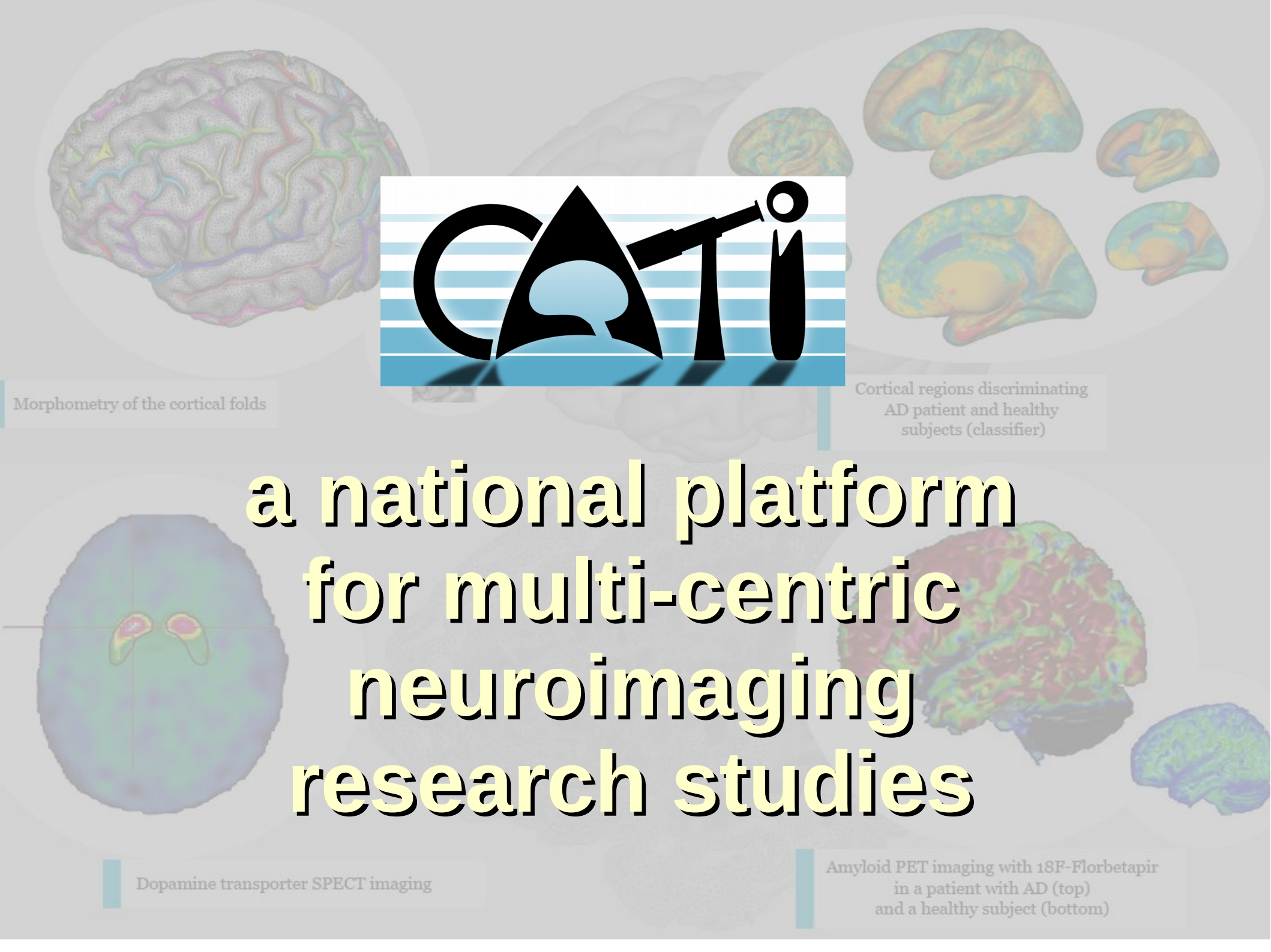


a national platform for multi-centric neuroimaging research studies

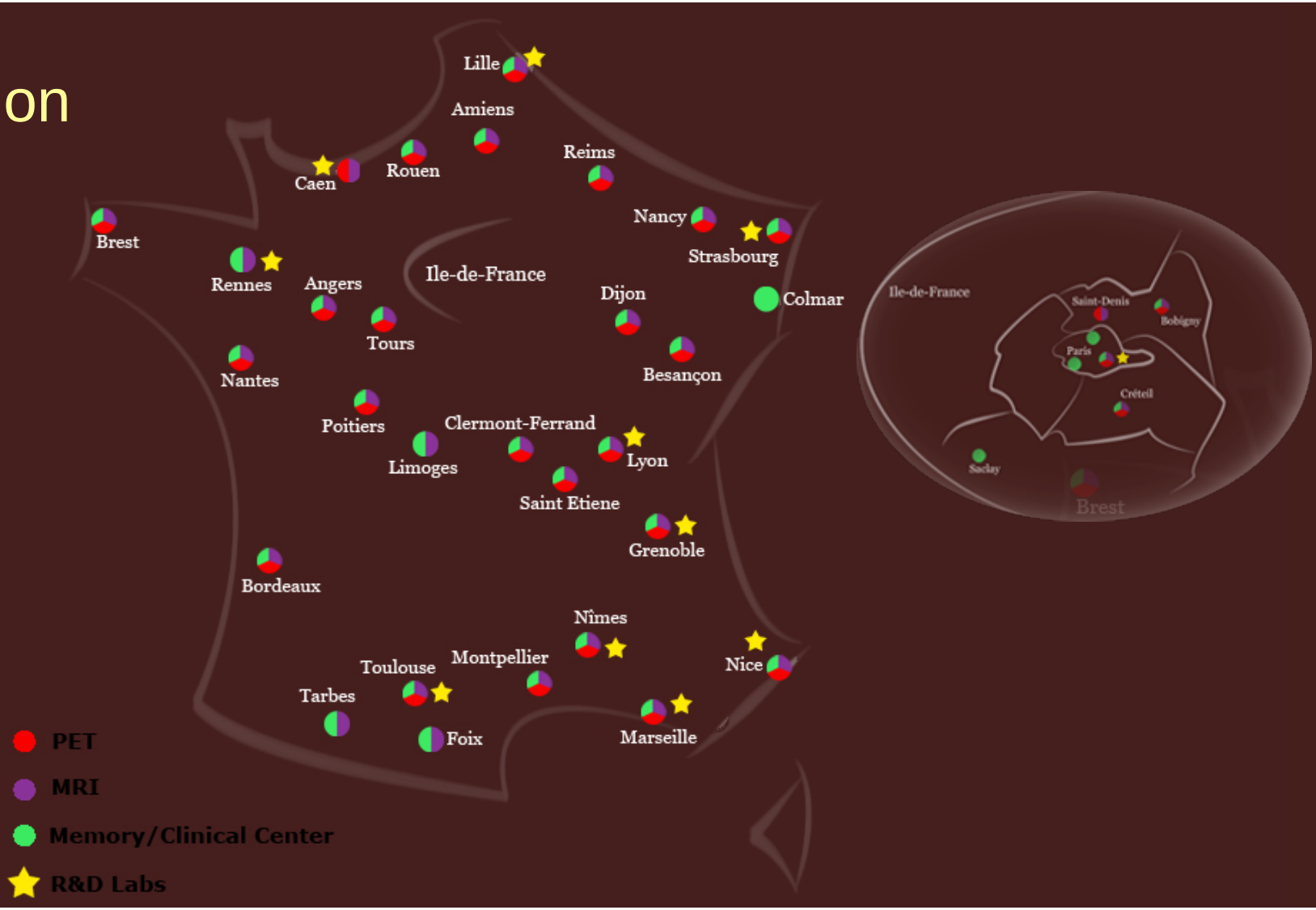
What is the CATI ?

French national **platform** for research projects requiring **neuroimaging** data on **big cohorts** of subjects.

- Scientific advices (MRI, nuclear imaging)
- Data acquisition
- Data management
- Data analysis
- Quality control

Acquisition network

50 acquisition centers in France



Research projects

- **Alzheimer**

  17 studies, around 8000 subjects
- **Parkinson**

  6 studies, around 2500 subjects
- **Huntington**

  1 study, around 100 subjects
- **Hypertension**

  1 study, around 800 subjects
- **ALS**

  1 study, around 1000 subjects
- **Hippocampus Sclerosis**

  1 study, around 100 subjects
- **Psychiatry**

  3 studies, around 500 subjects
- **Aging**

  1 study, around 2400 subjects

31 studies
15 400 subjects

CATI consortium

CEA Neurospin:

UNATI, Neurospin, I2BM, DSV, CEA: J.-F. Mangin, Y. Cointepas, D. Rivière, E. Duchesnay, F. Poupon

UNIRS, Neurospin, I2BM, DSV, CEA: C. Poupon, A. Vignaud

UNIACT, Neurospin, I2BM, DSV, CEA: M. Bottlander

Parietal, Neurospin, INRIA: B. Thirion, G. Varoquaux

I2BM, DSV, CEA: R. Trebossen

Pitié-Salpêtrière Hospital (GHPS):

CENIR, ICM: S. Lehéricy, E. Bardinet

ARAMIS team, CNRS, INSERM, UPMC, INRIA, ICM: M. Chupin, O. Colliot, S. Durrleman

IM2A: B. Dubois, B. Batrancourt

LIB, INSERM, UPMC: H. Benali, M.-O. Habert, M. Pellegrini-Issac, A. Kas

CATI Partners

CHU Toulouse: P. Payoux

Clinical Imaging Core faCility – CI2C, CHRU Lille: C. Delmaire, R. Lopes, J. Dumont

INSERM U1077, Caen: G. Chételat

Neurinfo platform / IRISA VisAGeS research team, Rennes, France: E. Bannier, I. Corouge, C. Barillot, J.-C. Ferré

Plateforme d'imagerie in-vivo / ICube lab, Strasbourg: P. Loureiro de Sousa

IRMaGe platform / GIN lab, Grenoble: I. Troprès, L. Lamalle, A. Krainik, J. Warnking

IR4M, UMR8081, Paris-Sud University – CNRS, Orsay: L. de Rochefort

Plateforme Ibio / INCIA, Bordeaux: B. Dilharreguy, M. Allard

CERMEP, Lyon: F. Lamberton, D. Ibarrola

MRI platform, ISCT, Toulouse: H. Gros-Dagnac, N. Vayssière

MRI platform, I2FH, CHU Gui de Chauliac, Montpellier: E. Le Bars, N. Menjot de Champfleur

Unité Imagerie et Cerveau, Tours: L. Barantin

LaBRI – UMR 5800, Bordeaux : P. Coupé

Asclepios, Sofia-Antipolis : N. Ayache, X Pennec

INSERM U897 ISPED / GMA / Bordeaux: C. Dufouil, G. Chêne, V. Bouteloup

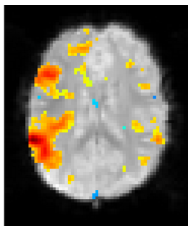
INT / CNRS UMR6168, Marseille: O. Coulon, G. Auzias, J. Lefèvre

MIRCen, Fontenay-aux-Roses: T. Delzescaux, N. Souedet

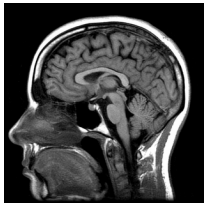
Athena, Sofia-Antipolis : R. Deriche

Distribution of skills

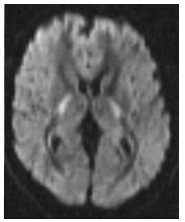
Acquisition



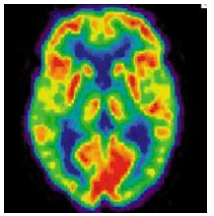
fMRI



aMRI



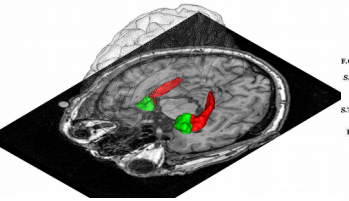
dMRI



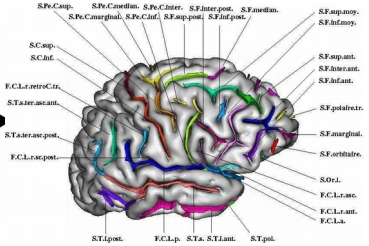
PET

• • •

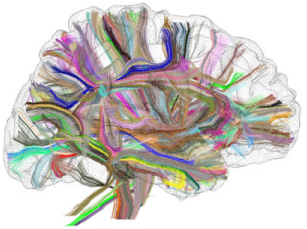
Processing



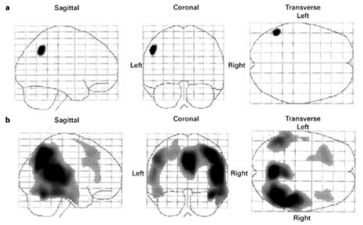
Sacha



Morphologist



connectomist



SPM

freesurfer

• • •

5 research labs

Cogimage
Neuroscier
Imagerie C

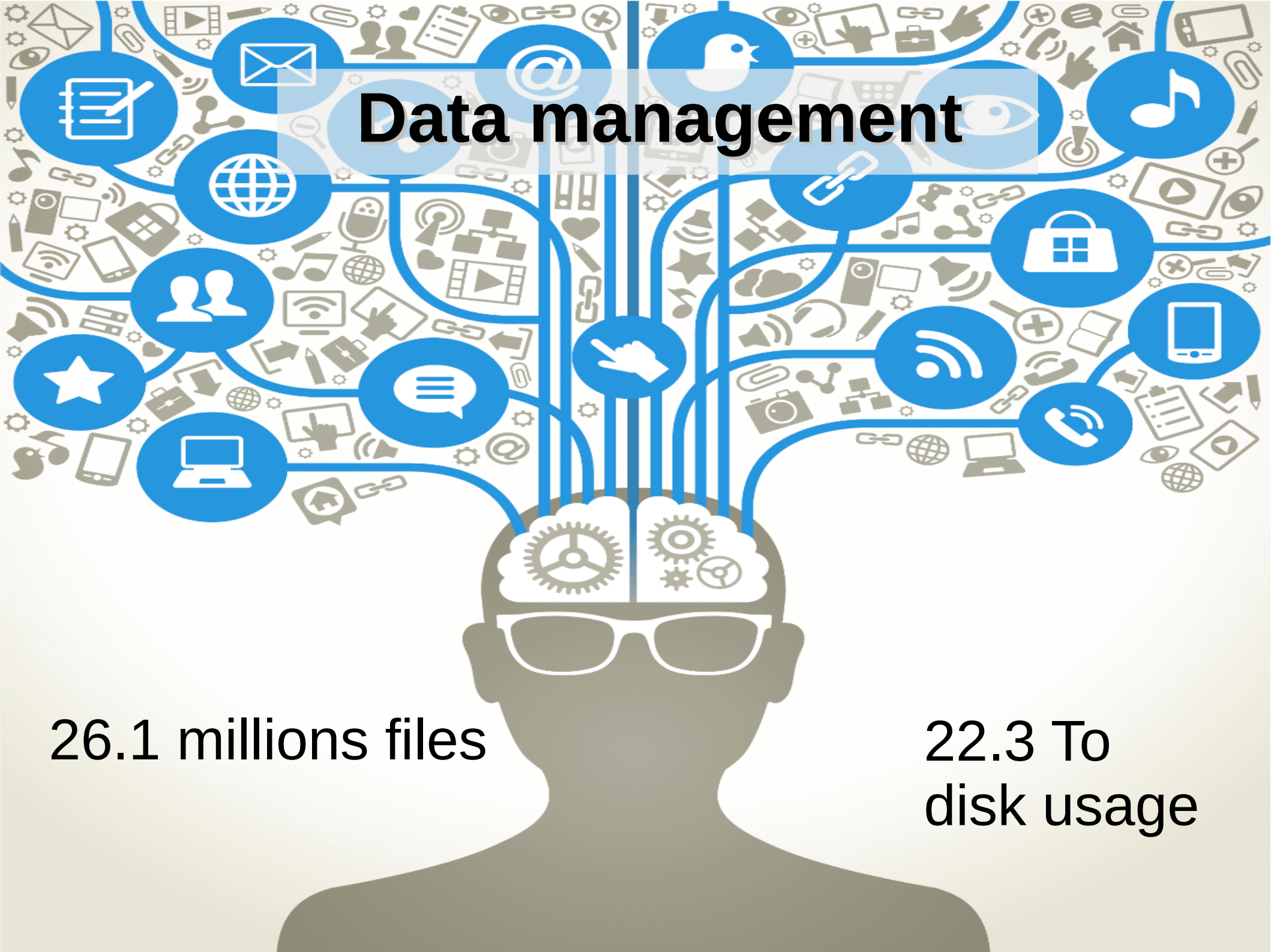
LIB

Ima
institut
de la mémoire
et de la maladie
d'Alzheimer

UNAO

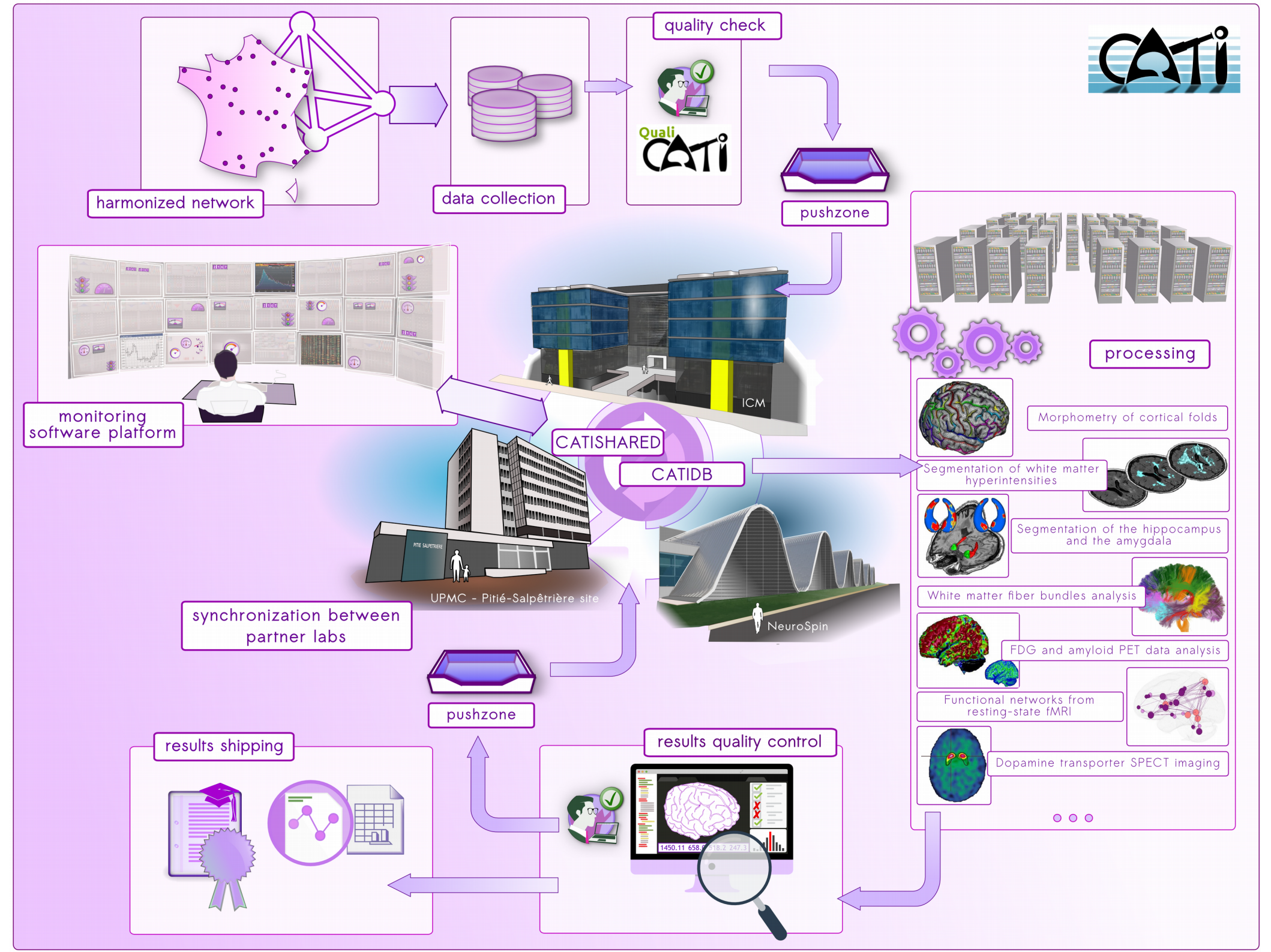
UNRS

Data management

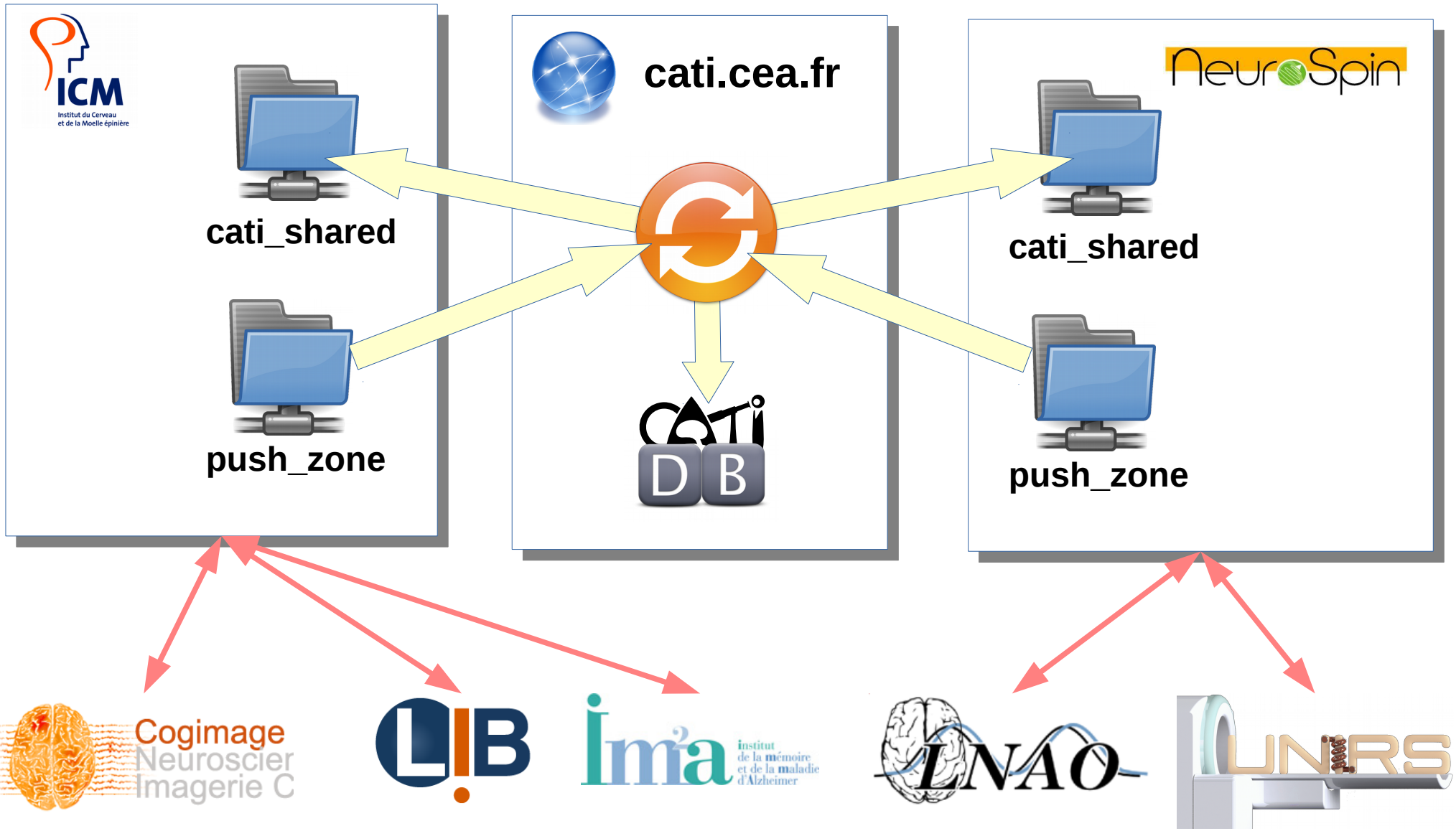


26.1 millions files

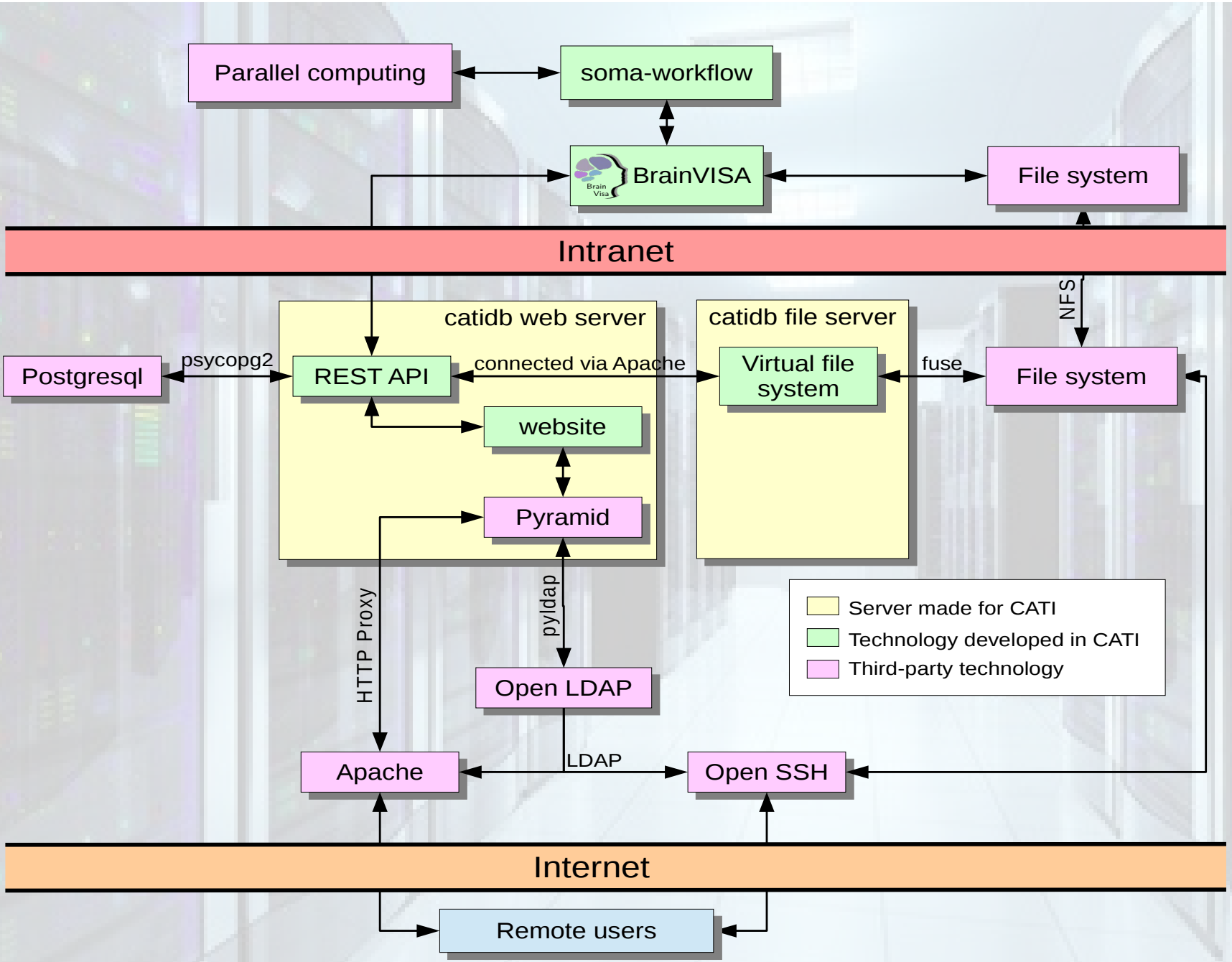
22.3 To
disk usage


harmonized network
data collection
quality check
Quali CATI
pushzone
monitoring software platform
ICM
CATISHARED
CATIDB
PITIE SALPETRIERE
UPMC - Pitié-Salpêtrière site
NeuroSpin
synchronization between partner labs
pushzone
processing
Morphometry of cortical folds
Segmentation of white matter hyperintensities
Segmentation of the hippocampus and the amygdala
White matter fiber bundles analysis
FDG and amyloid PET data analysis
Functional networks from resting-state fMRI
Dopamine transporter SPECT imaging
results quality control
results shipping

Distributed architecture



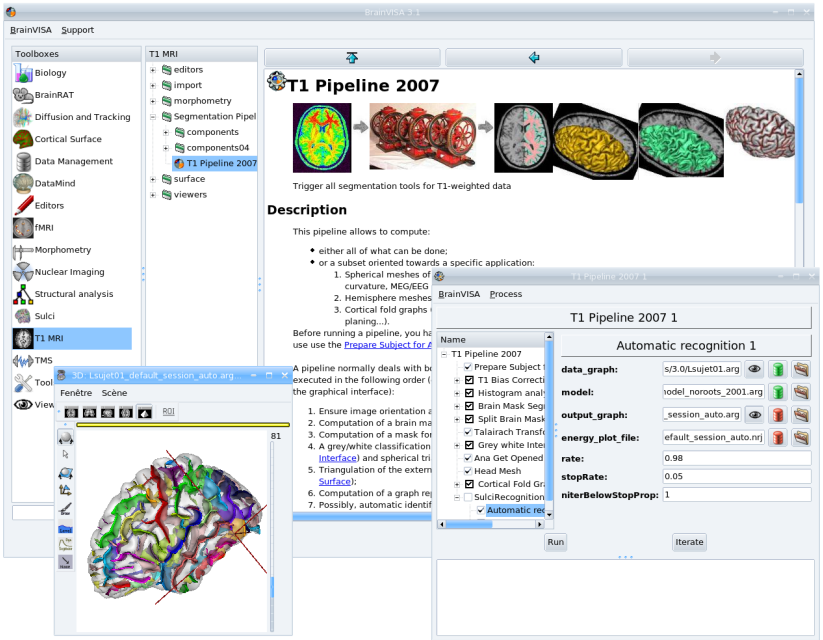
Server infrastructure

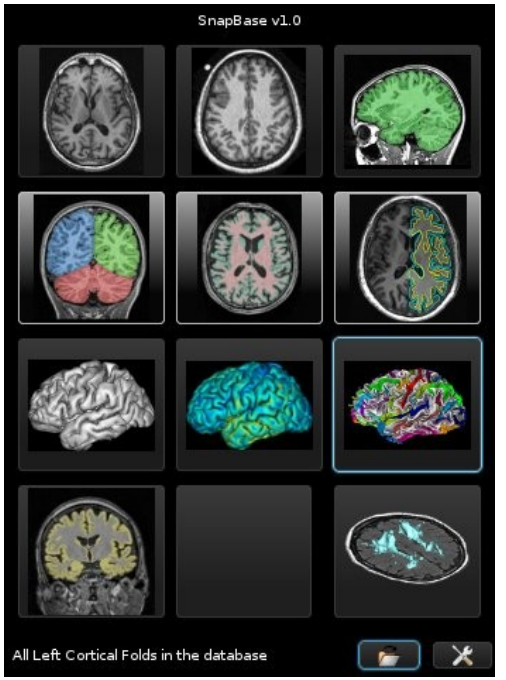


BrainVISA platform

http://brainvisa.info

- Multi OS development environment
- Data organization framework
- Pipeline infrastructure
- User interfaces
- Interactive visualization



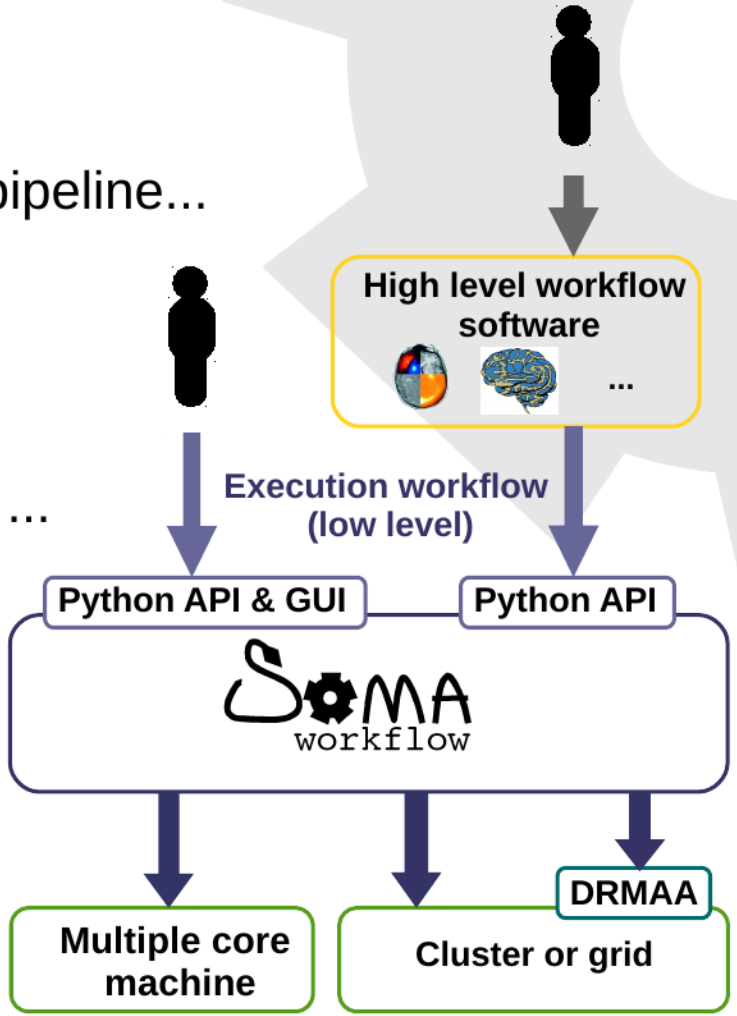


Soma workflow

- Soma-workflow deals with execution workflows (low level)

- ≠ from high level workflow software
  - In neuroimaging: BrainVISA, NiPype, LONI pipeline...
  - Higher level description of workflow
  - Higher level features

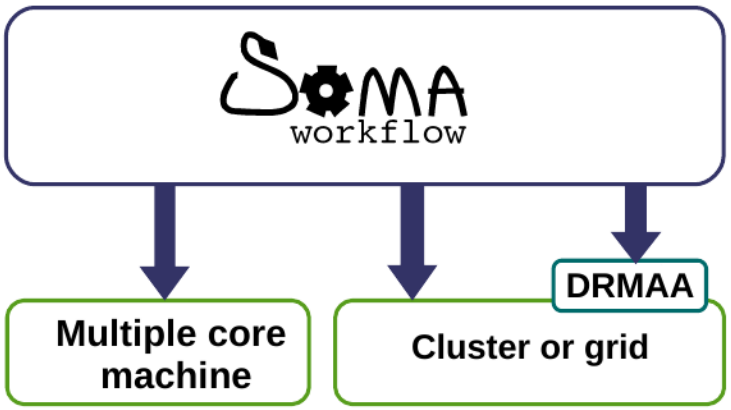
- Bridges the gap between parallel resources and ...
  - Non expert user
    - Documentation
    - Python API made to be simple
    - GUI
  - High level workflow software



Interface with computing resources

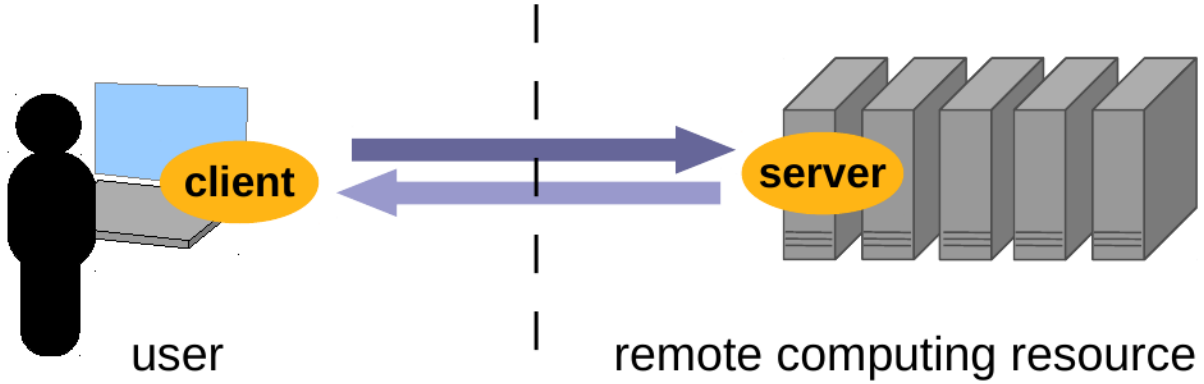
- Uses only very basic computing resource functionalities
  - ➔ Compatibility with a wide range of resources
- Creation of an interface with a new resource
  - ➔ Implementation of 4 Python methods
- Built in interfaces:
  - Ready to use on multiple core machines
  - Interface with the Distributed Resource Management Application API (DRMAA)
    - Software standard developed by the Open Grid Forum
    - S-w was used with success on clusters with the systems:
      - Oracle Grid Engine
      - Torque
      - LSF
      - Condor

- Job submission
- Job suppression
- Job status
- Job exit information



Remote access to computing resources

- Soma-workflow can be used as a client-server application :
  - Same Python API and same GUI
  - Disconnection at any time
  - The remote communication done with Pyro in a ssh tunnel
- If no shared file system between the user machine and the resource:
  - File path mapping tool
  - File and directory transfer tool
    - Soma-workflow takes into account the state of file transfer when executing a workflow.



GUI overview

List of the configured resources

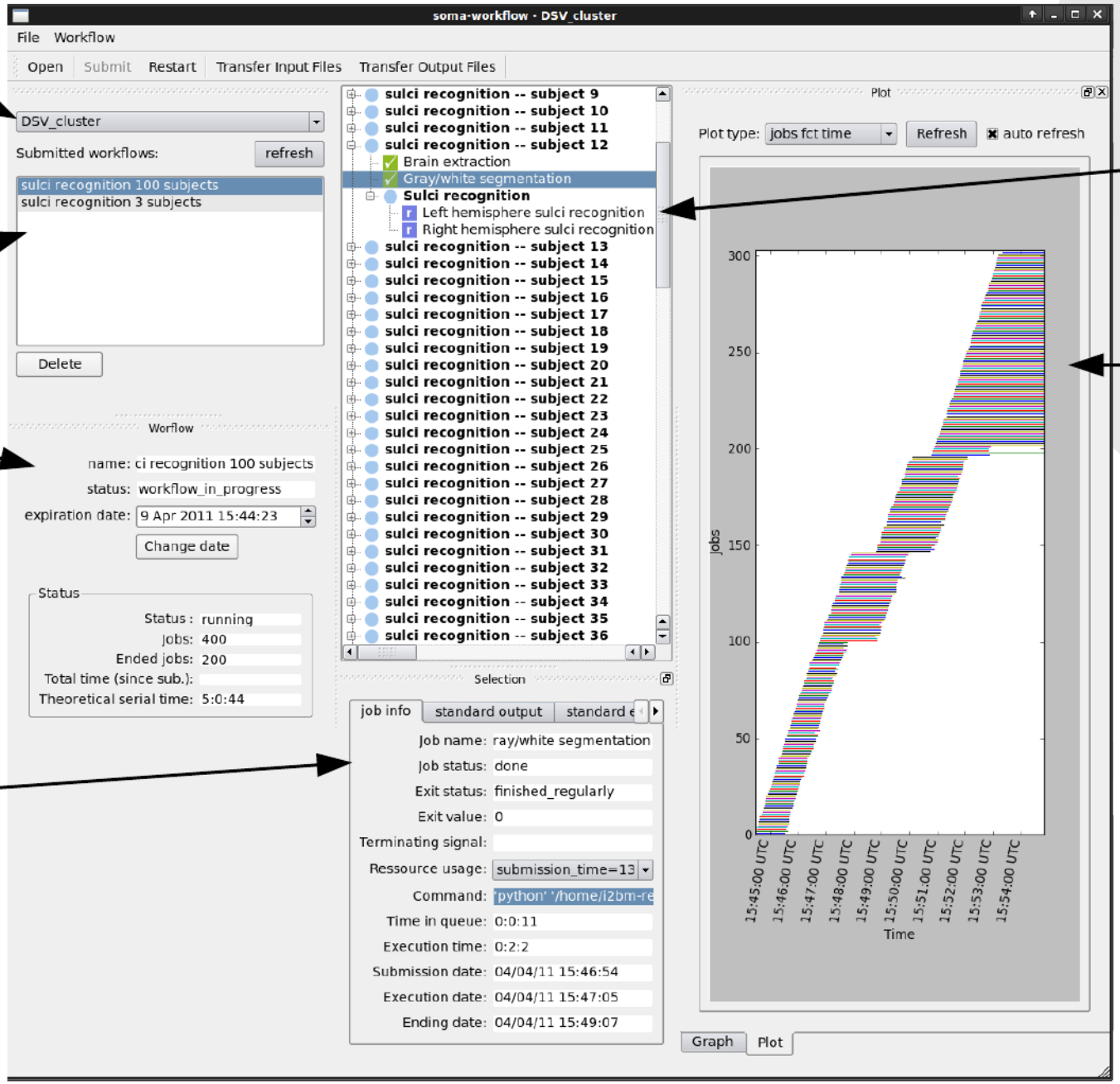
Submitted workflows

Current workflow information

Current selection Information (here a ended job)

Representation of the workflow as a tree

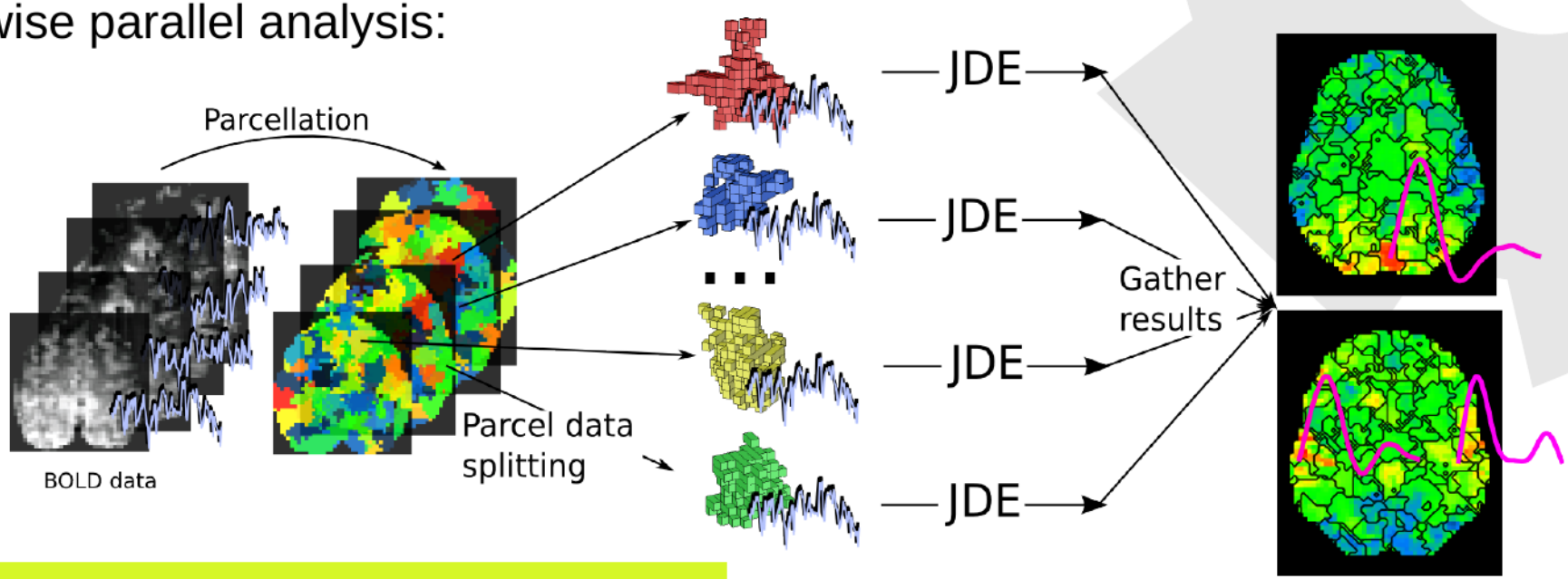
workflow execution plots



The future of CATI

Case 1: Acceleration of a single data analysis

- Functional neuroimaging application: Joint detection-estimation (JDE)[1]
  - Detection of the parts of the brain which are involved in a given stimulus
  - Estimation of the Hemodynamic Response Function (HRF)
- Parcel-wise parallel analysis:

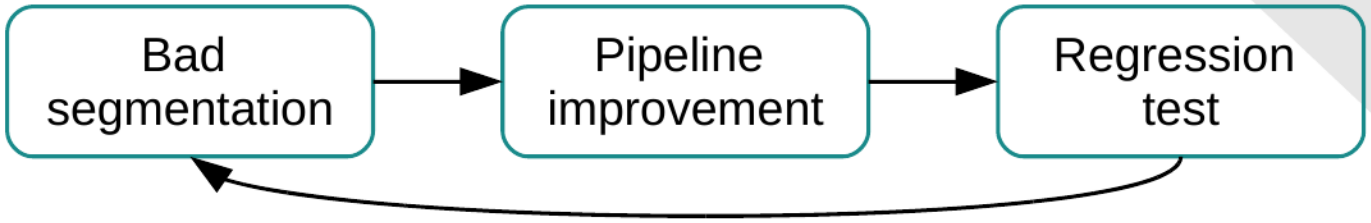


➔ Wrapping of existing code in a workflow
➔ A whole brain processing:
  - 10 hours on 1 CPU
  - 15 mins on the cluster
➔ A group study of 20 subjects: ~ 1 day

[1] Vincent, T., Risser, L., Ciuciu, P. Spatially adaptive mixture modeling for analysis of within-subject fMRI time series IEEE Trans. Med. Imag. 29, 1059–1074 (2010)

Case 2: Robustness improvement with regression tests

- Objective: to reduce the sensitivity of the Morphologist pipeline of BrainVISA [2]
- Morphologist: extraction of the main brain structures from T1 MRI
  - hemispheres, gray/white matter, cortical surface, cortical folds, etc.
- Step by step morphologist was tested on about 1000 T1 MR images.



- Regression test are frequently done on a database made of 80 T1 MRI

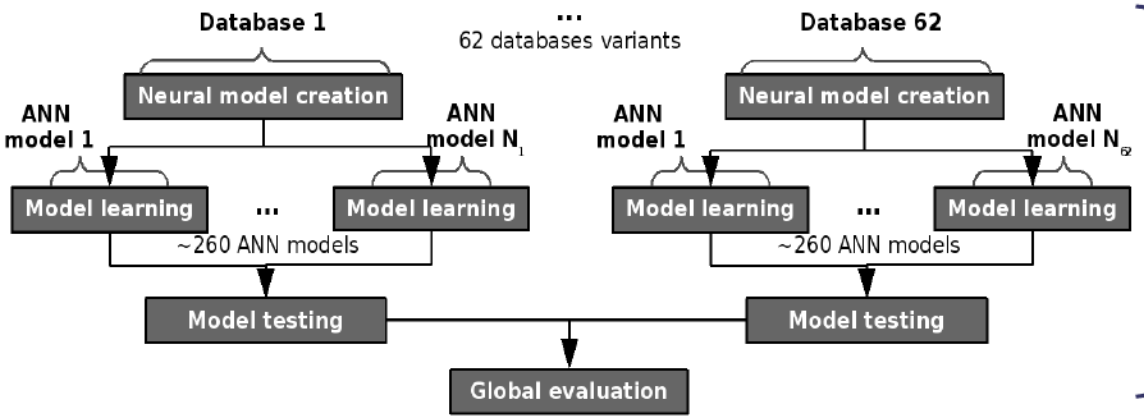
➔ workflows generated by BrainVISA
➔ 23 hours on 1 CPU
➔ ~ 1h on the cluster

⇒ More frequent regression tests
Tests on larger dataset

[2] Cointepas, Y.
The BrainVISA project: a shared software development infrastructure for biomedical imaging research.
Proceedings 16th HBM (2010)

Case 3: Extensive validation

- Extensive cross-validation of cortical sulci identification models [3] and comparison with the newer method by Perrot [4]
- Each neural model is trained using a supervised learning scheme, based on a learning database of 62 manually identified brains
- Leave-one-out cross-validation of the models on the learning database



➔ 70000 individual jobs
➔ > 7 months on 1 CPU
➔ ~ 3 days on ~ 100 CPU

[3] Rivière, D., Mangin, J.-F., Papadopoulos-Orfanos, D., Martinez, J.-M, Frouin, V., Régis, J. Automatic recognition of cortical sulci of the Human Brain using a congregation of neural networks. Medical Image Analysis. vol. 6, no. 2, pp. 77–92 (2002)

[4] Perrot, M., Rivière, D., Mangin, J.-F. Cortical sulci recognition and spatial normalization. In: Medical Image Analysis. In press (2011)