

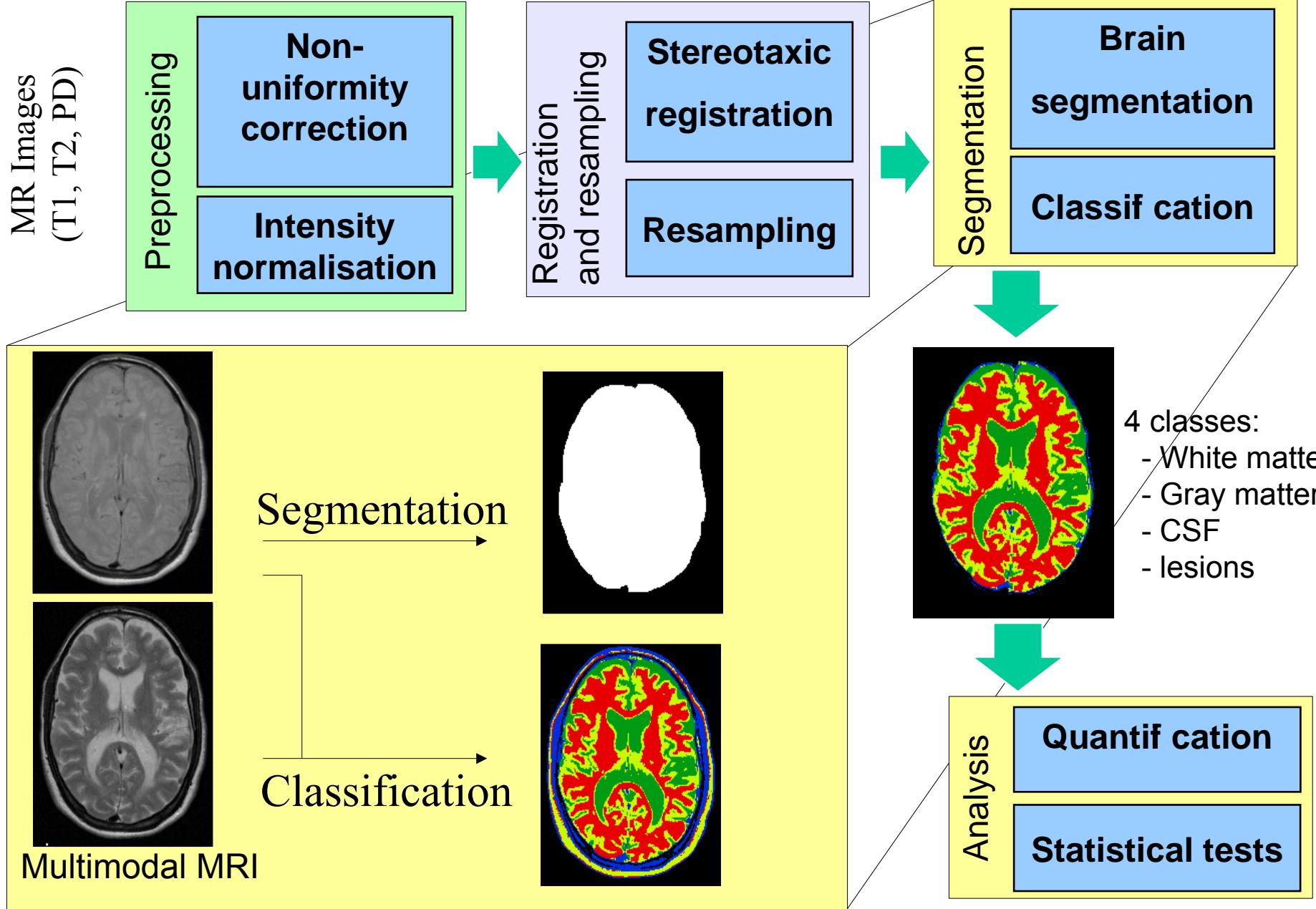


# Imagerie médicale sur la grille

Johan Montagnat, CNRS / I3S

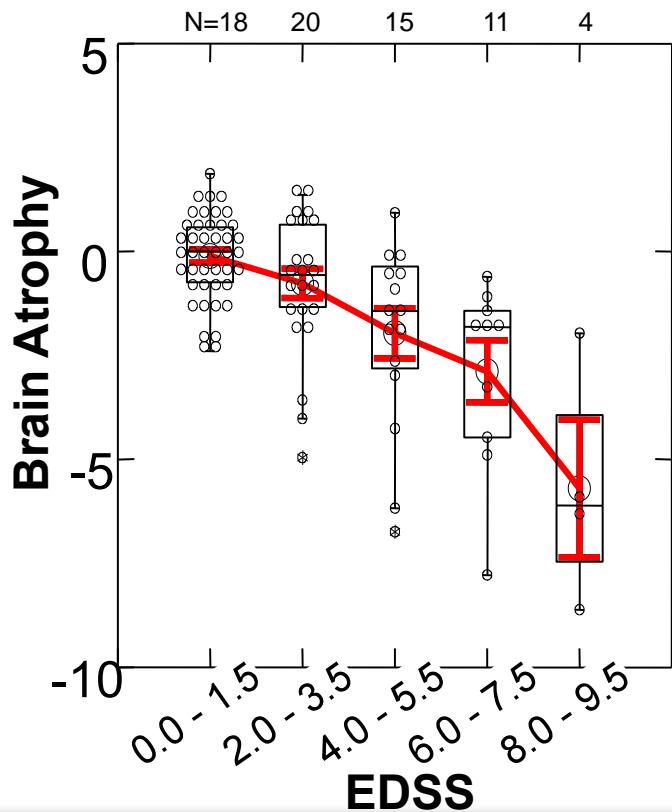


# Use case: multiple sclerosis

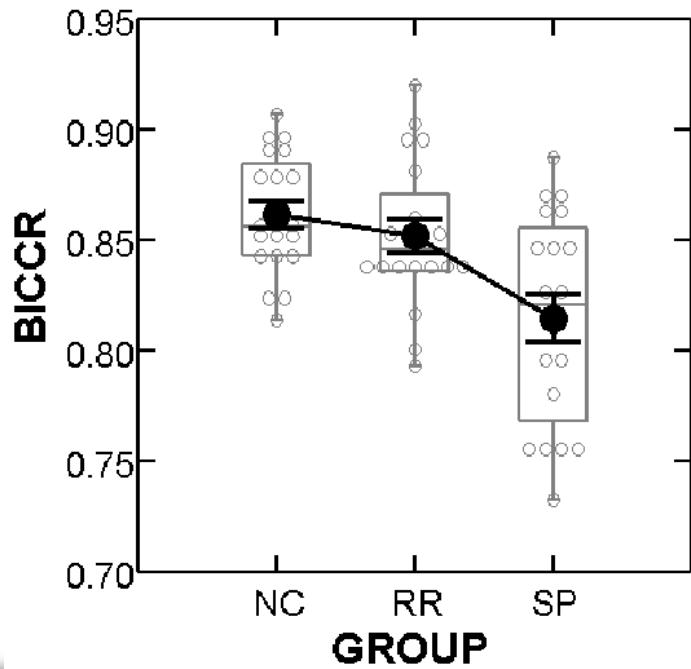


# Use case: multiple sclerosis

- Brain atrophy correlation with clinical score (EDSS)

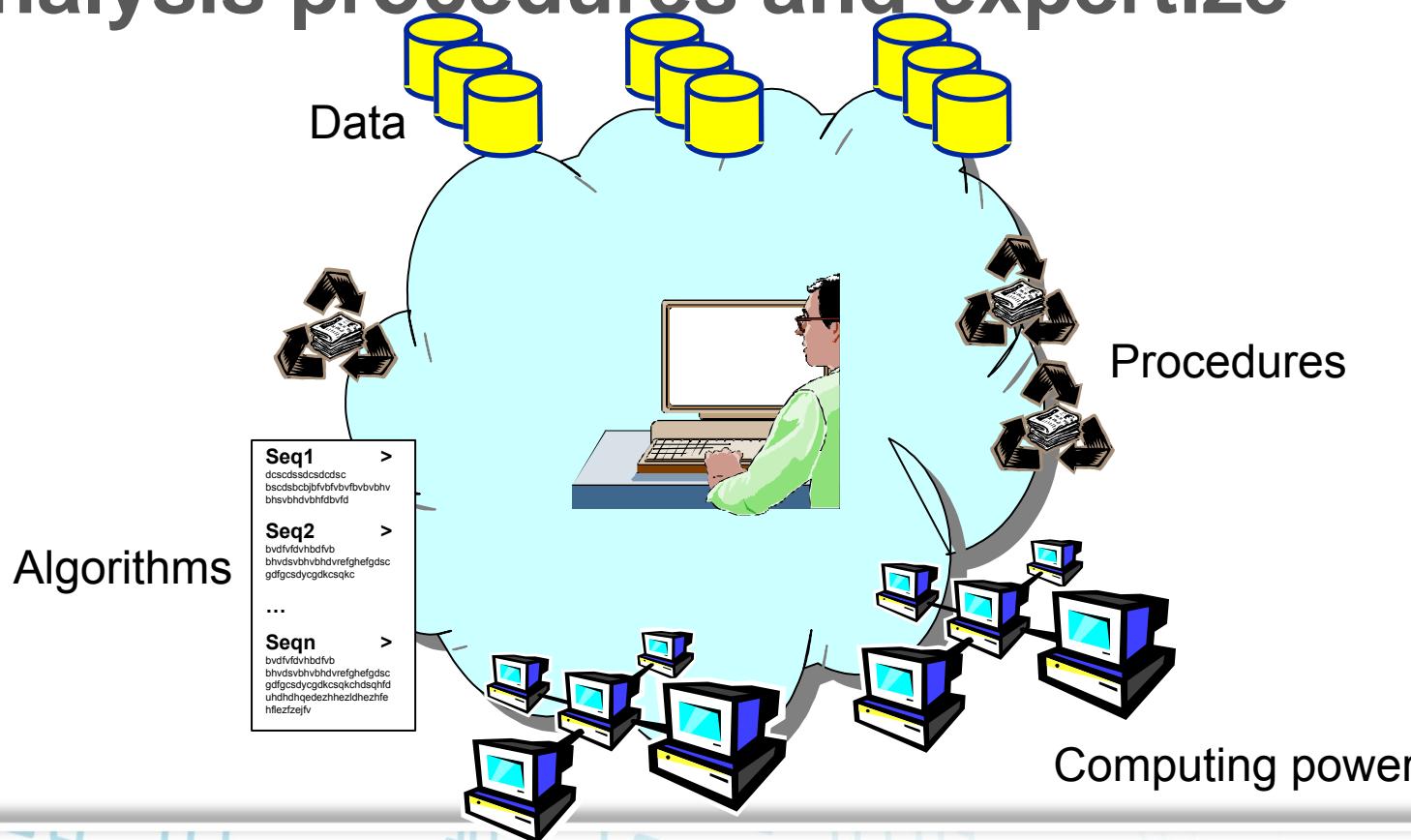


- Statistical correlations between Normal Controls (NC), Relapsing-Remitting patients (RR) and Secondary Progressive patients (SP).



# Why grids for medical imaging?

- Sharing computing resources, data sets, analysis procedures and expertize





# Medical imaging sector activity

➤ Involved (as guinea pig) since EDG (2001)

➤ gPTM3D

- LRI-LAL-LIMSI (CNRS - Orsay)



➤ HOPE, GATE

- LPC (CNRS – Clermont Ferrand)



➤ SiMRI3D, ThIS, CAVIAR, Virtual Imaging Platform

- CREATIS (CNRS - Lyon)



➤ NeuroLOG, Bronze Standard

- I3S (CNRS – Sophia), INRIA



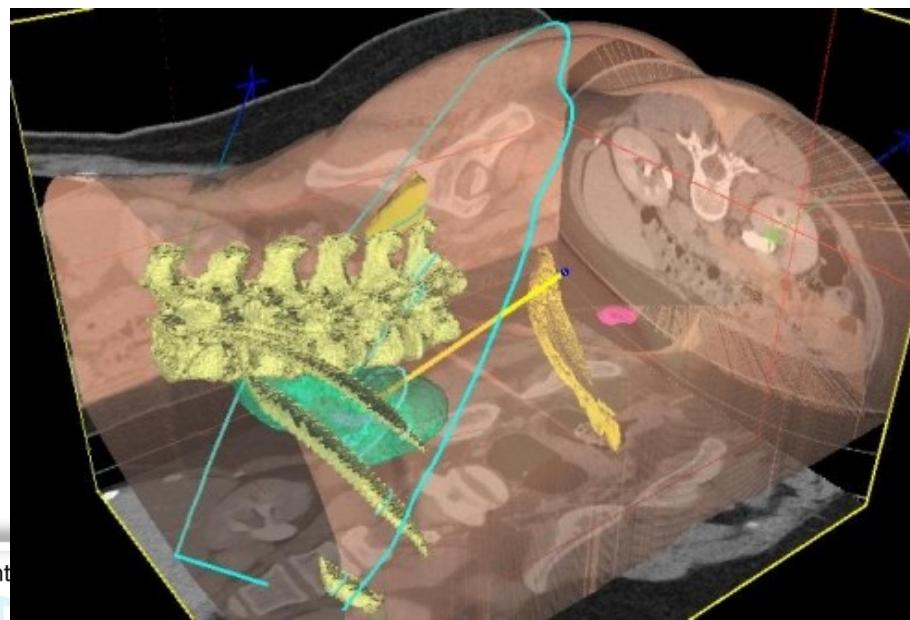
# gPTM3D: radiology data analysis

## ➤ Scientific objectives

- Reconstruction of organ shapes from CT-scans
- Targets augmented reality and therapy planning

## ➤ Method

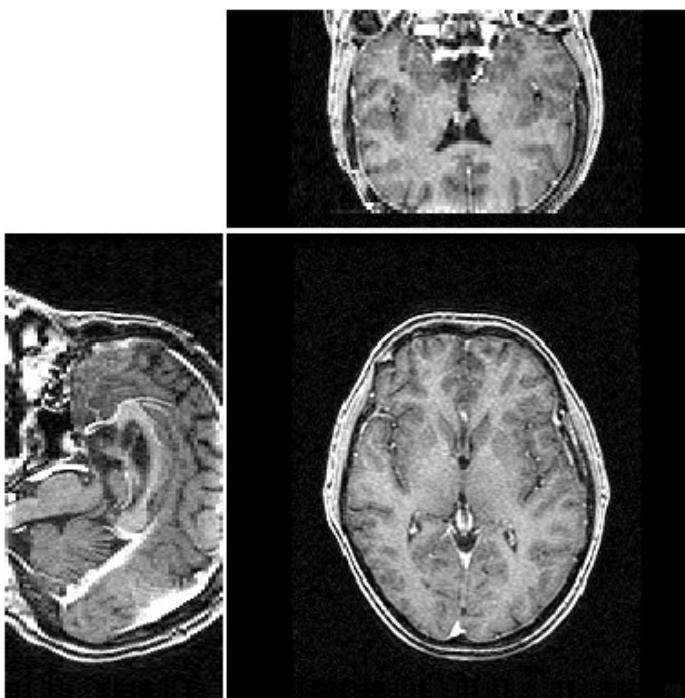
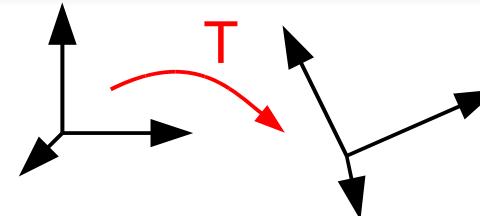
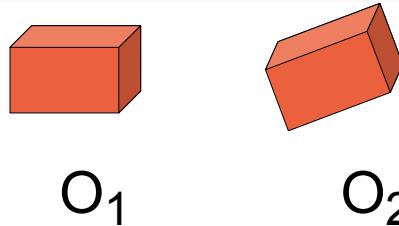
- Supervised radiology volume images reconstruction
  - Semi-automatic segmentation algorithm
  - Interactive corrections



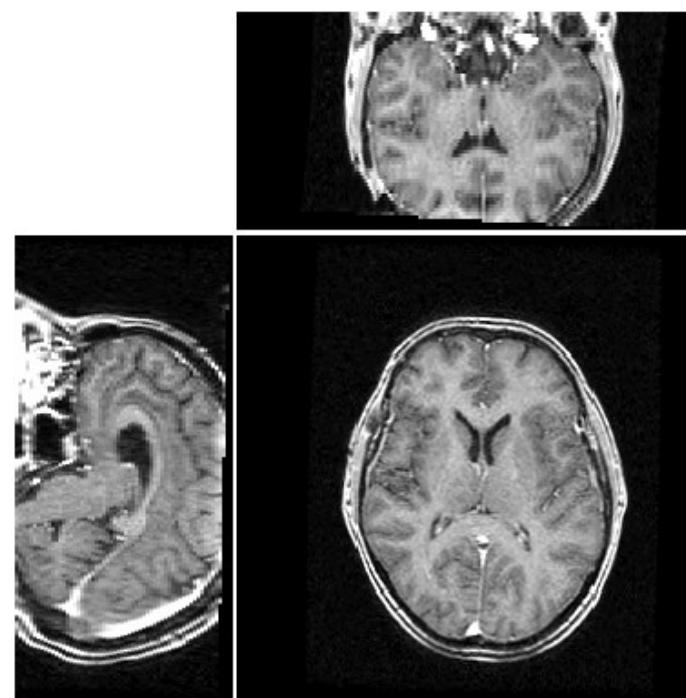


# Bronze Standard:

## Rigid registration algorithms evaluation



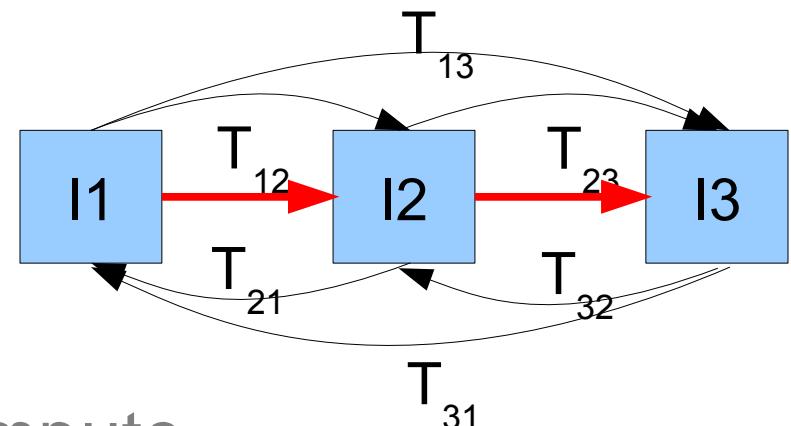
Unregistered



Registered

# Bronze Standard

- $N$  images,  $m$  algorithms
  - $N(N-1).m$  transformations measured
  - $N-1$  transformations to estimate
- } Redundancy

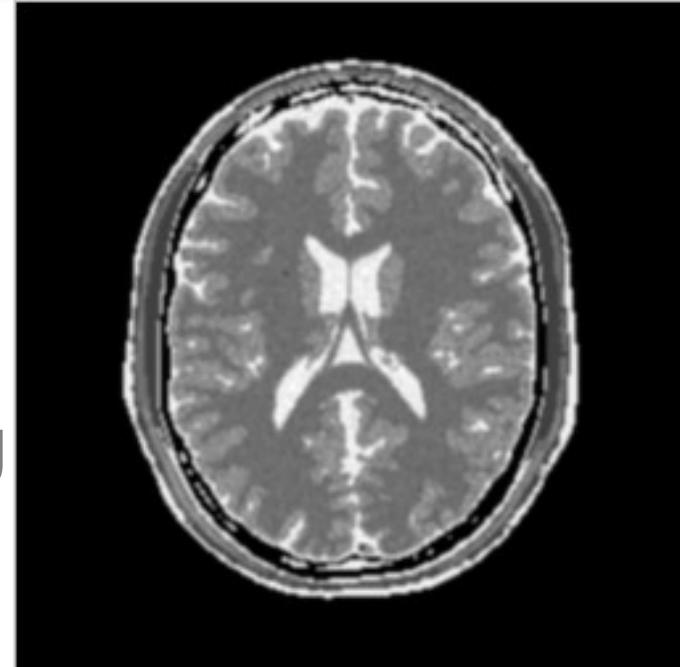


- Exploit redundancy to compute
  - Mean transformations  $\bar{T}_{ij}$  (Bronze standard)
  - Variances on the transformations (Accuracy)

# SiMRI3D: MRI simulator

## ➤ Scientific objectives

- Better understand MR physics
- Study MR sequences in-silico
- Study MR artefacts
- Validate MR Image processing algorithms on synthetic yet realistic images



## ➤ Method

- Simulate Bloch's electromagnetism equations
- Parallel (MPI) implementation

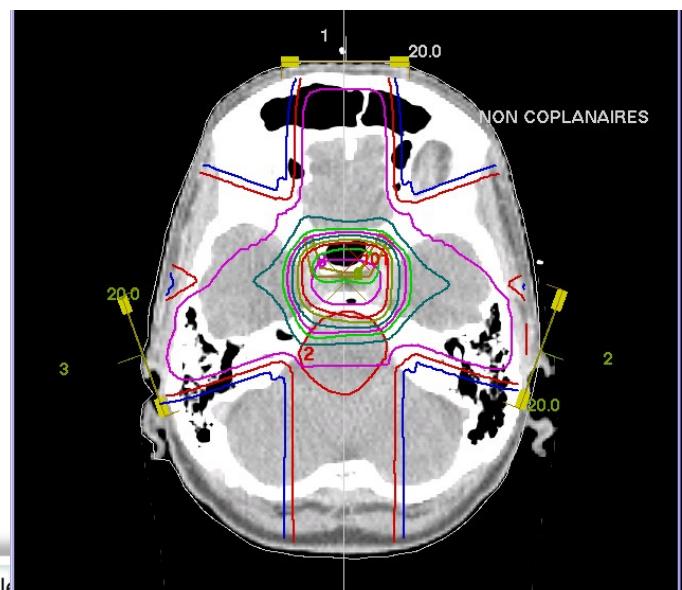
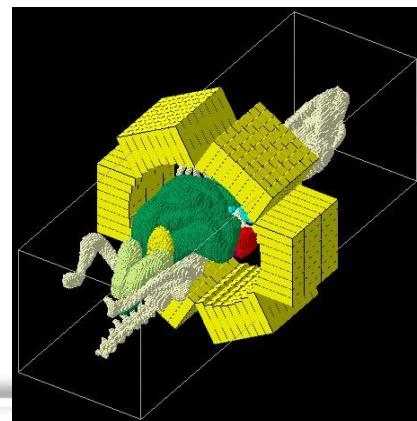
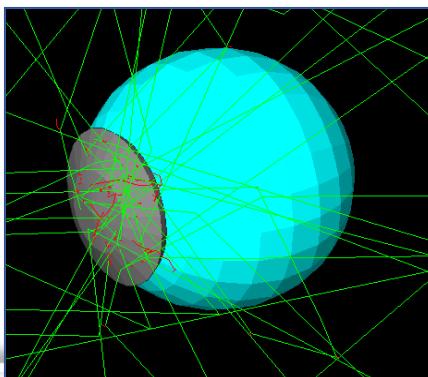
# GATE application to radiotherapy

## ➤ Scientific objectives

- Medical physics: PET camera simulation, radiotherapy, ocular brachytherapy treatment...

## ➤ Method

- GEANT4-based software (Monte Carlo)
- Open-GATE collaboration  
<http://opengatecollaboration.org>

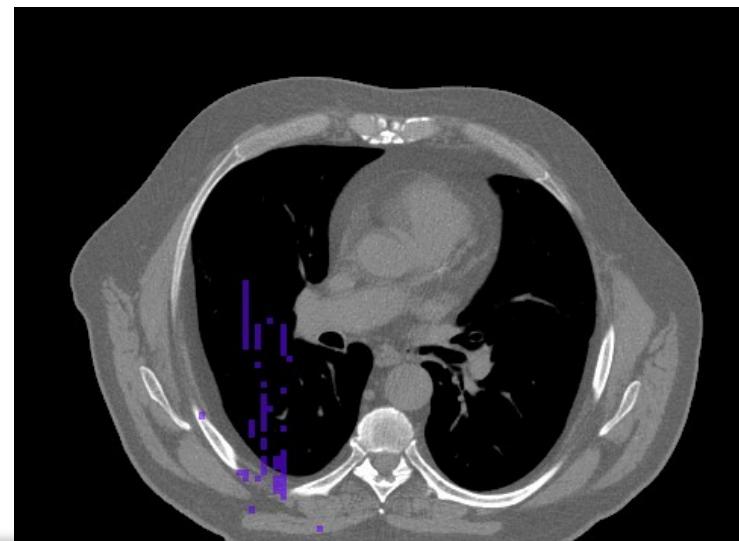




# ThIS

## Therapeutic Irradiation Simulator

- **Cancer treatment by irradiation of patient with beams of photons, protons or carbons**
- **CT images (482x360x141)**
- **3D dose distribution computation**
  - 700h CPU
  - Monte Carlo-based

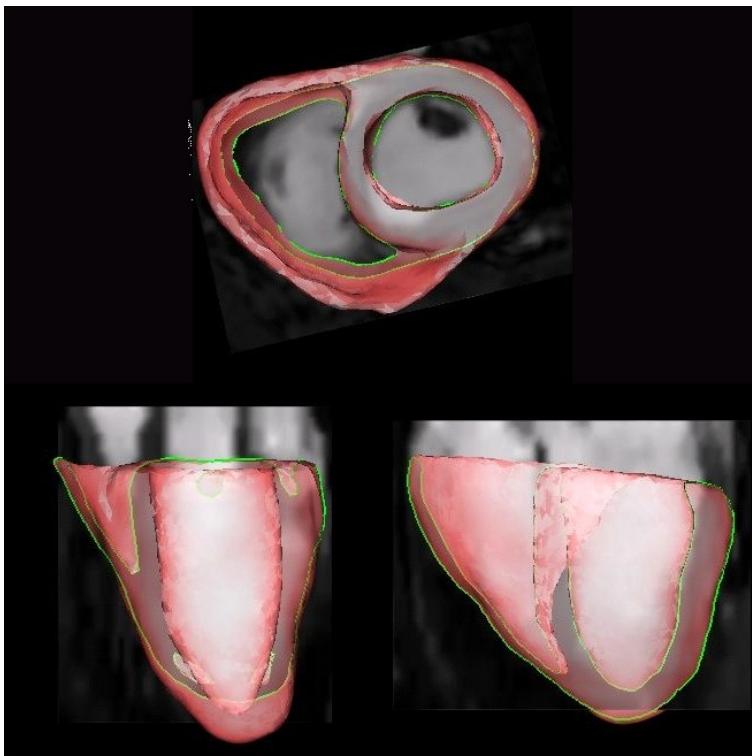




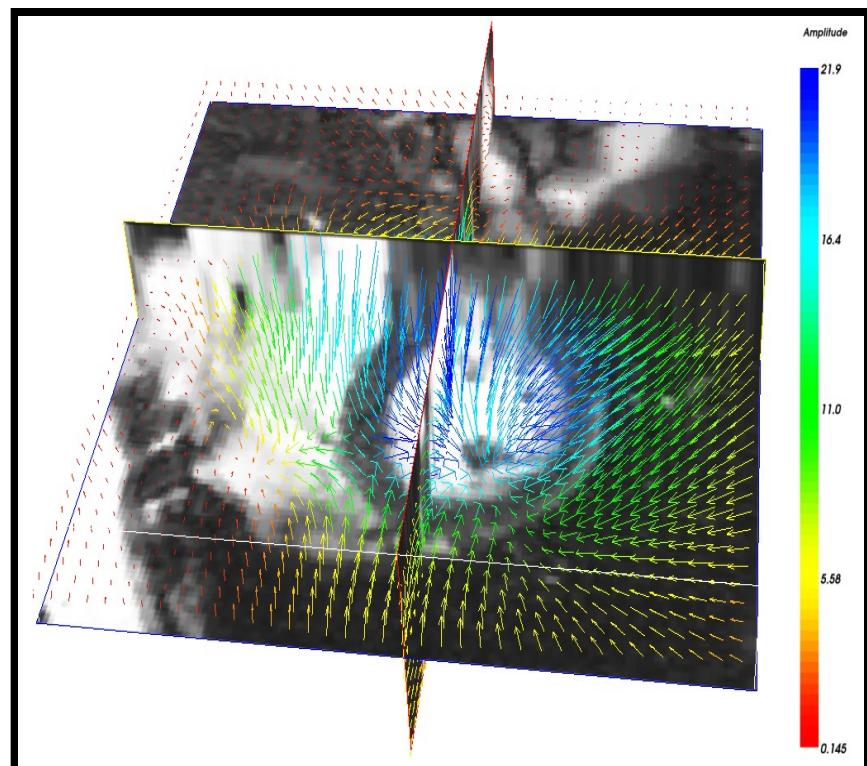
# CAVIAR

## Cardiovascular sequences analysis

**3D+time heart  
segmentation**



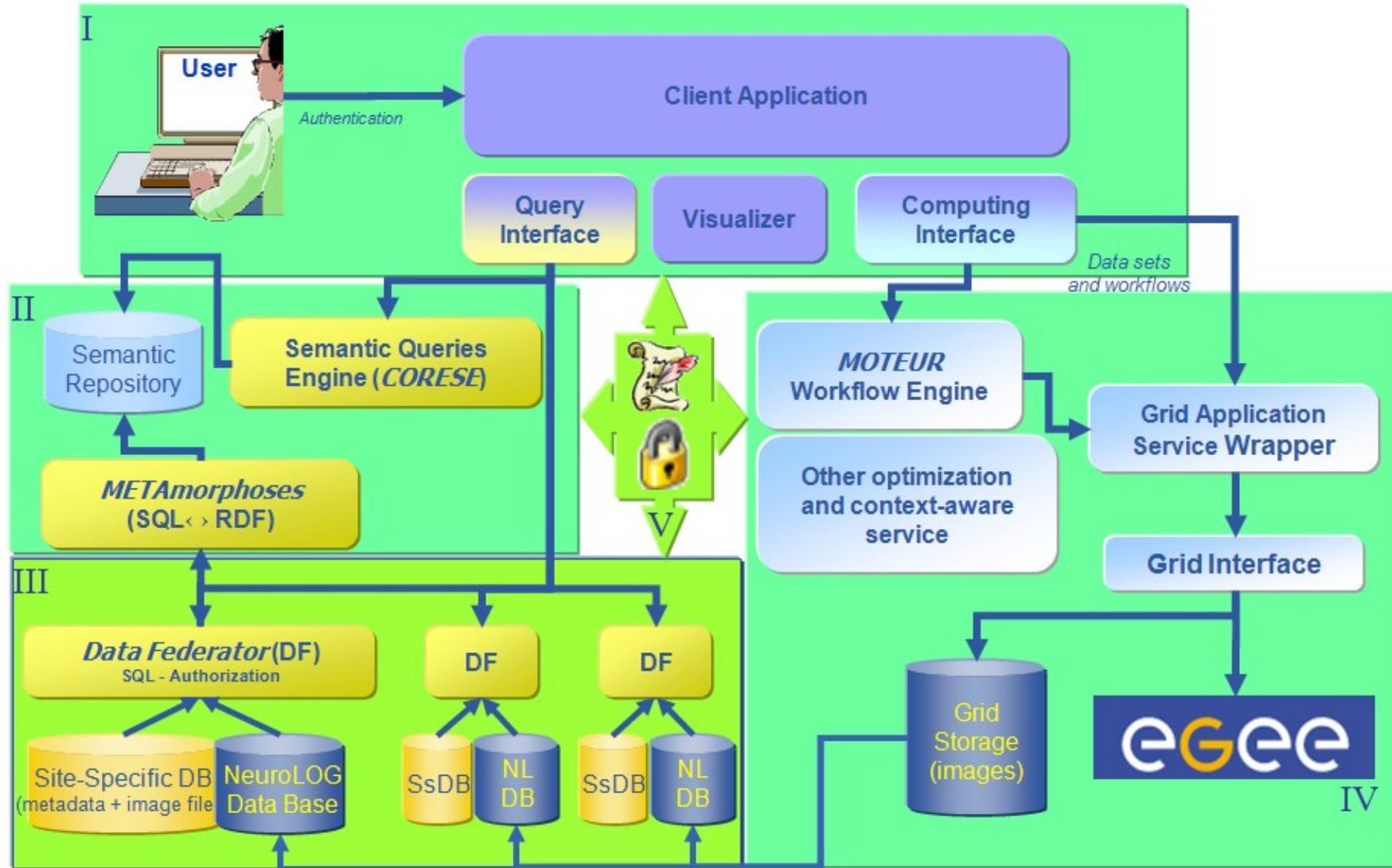
**3D+time motion  
estimation & tracking**





# NeuroLOG

## Neurosciences collaborative platform

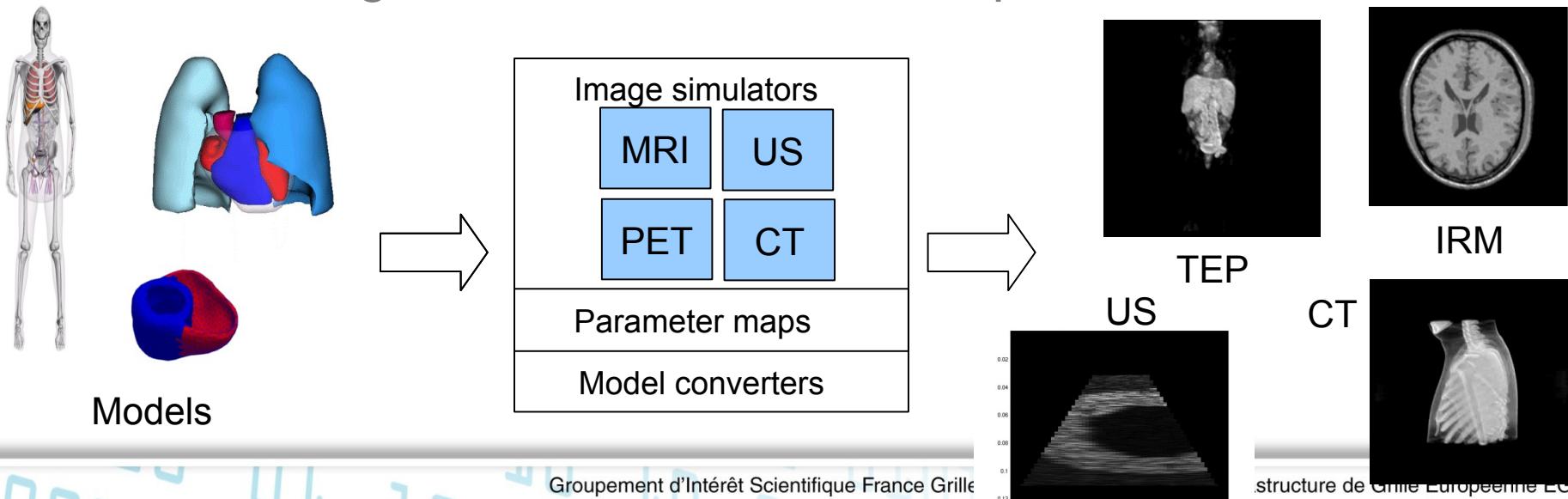




# VIP Virtual Imaging Platform

## ➤ Multi-modality images simulation platform

- Integrating multiple models and simulators
- Easily accessible and extendable
- Simulators interoperability (multiple modality simulations)
- Harnessing the simulation tools computation needs





# Tools for grid usage

## ➤ Offer community-level services

- e.g. Medical data management

## ➤ Make grid accessible to non-specialists, deliver adapted user interfaces

- GUI and Web portals: e.g. NeuroLOG and VIP

## ➤ Integrate into existing problem solving environments

- Deal with legacy: e.g. NeuroLOG
- Help porting existing applications: e.g. workflow

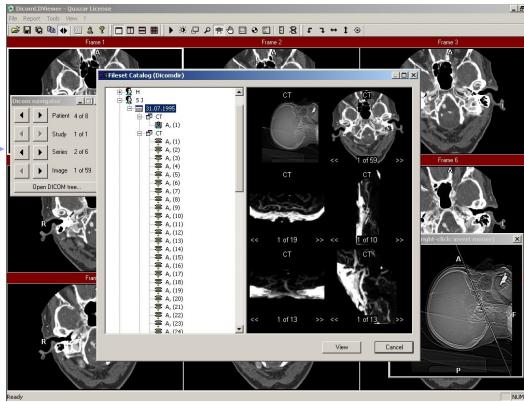


# MDM

## gLite Medical Data Manager

### ► Objectives

- Expose a standard grid interface (SRM) for medical image servers (DICOM)
- Use native DICOM storage format
- Fulfill medical applications security requirements
- Do not interfere with clinical practice



DICOM server

DICOM clients



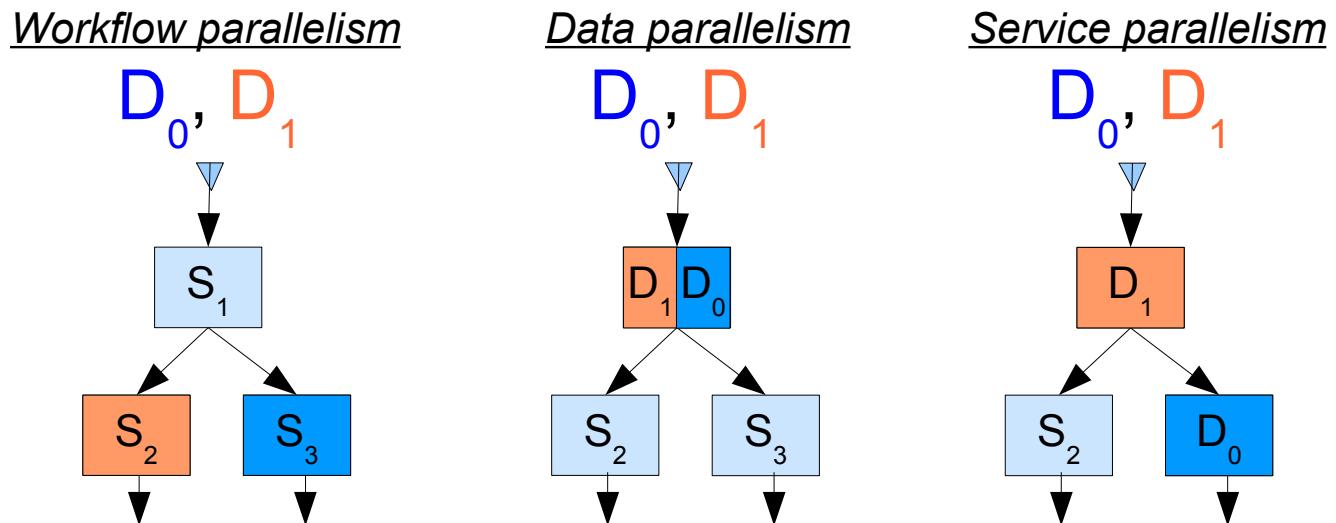
Worker Nodes



User Interfaces

### ➤ Open source workflow enactor

- Code + docs + tutorial: <http://modalis.polytech.unice.fr/softwares>
- Targets: ease of use, flexibility, transparent exploitation of application parallelism

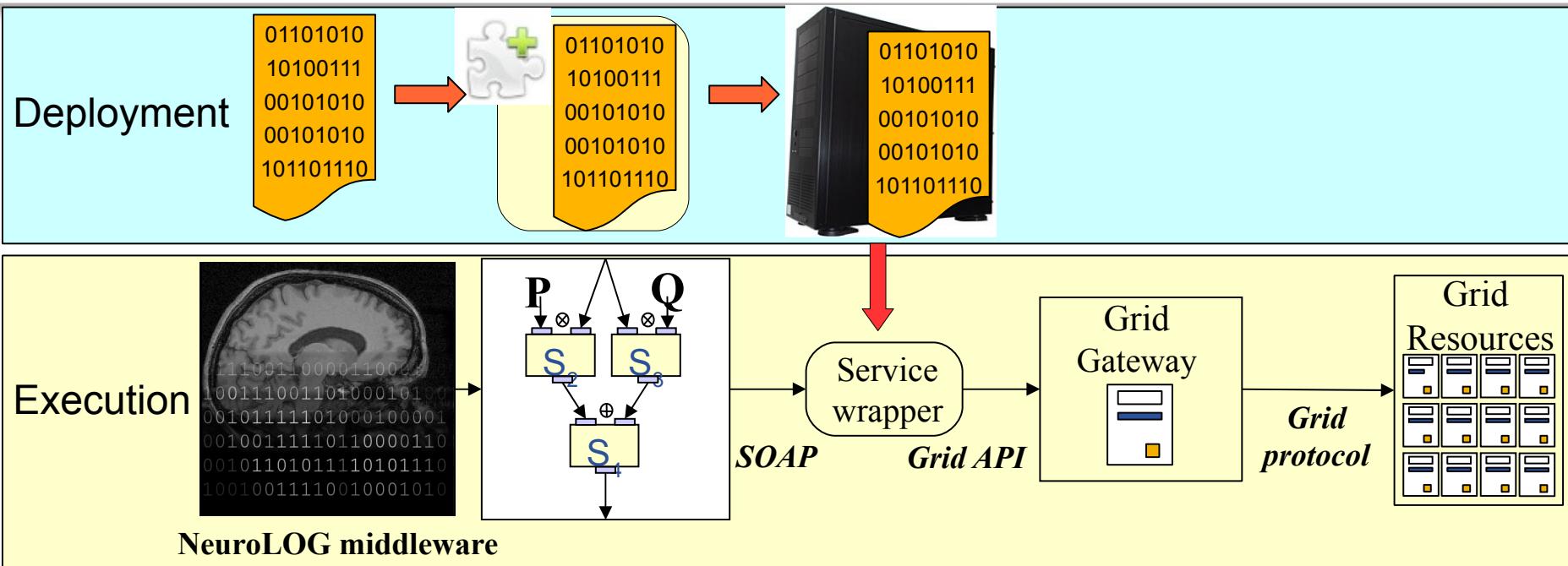


### ➤ Supports

- Scuf language (from myGrid/Taverna) + GWENDIA extensions
- Intefaced to gLite middleware (EGI) and DIET (Grid'5000)



# Application workflow execution environment



- Legacy codes packaging and deployment
- Grid enactment



# Towards a ready-to-go execution environment

- **Integrated, easy-to-deploy environment**
- **Proposed as a base service**
  - By no way mandatory
- **Including**
  - Graphical front-end (GUI)
  - Application description / enactment (workflow)
  - Experiments monitoring (dashboard)
  - Reliability / performance (pilots)



# vBrowser GUI

<http://www.vl-e.nl/vbrowser>



## ➤ Manages VOMS credentials

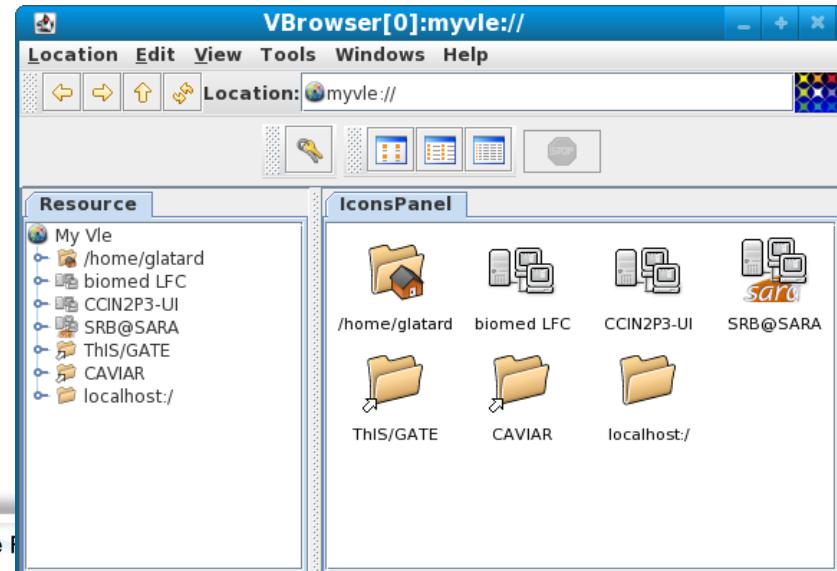
- create VOMS proxy from certificate

## ➤ Data transfers from/to local host

- Browses input/result files
- read/write files on grid LFC+SE

## ➤ Execution

- Launches workflows
- Specific plugins



**FranceG**

VBrowser[0]:<https://ws1.grid.sara.nl/~glatard/workflow/workflow-PTlv75/workflow-PTlv75.html>

**Location Edit View Tools Windows Help**

**Resource**

- My Vle
- /home/glatard
- biomedLFC
- SRB@sara
- viz-login
- gwendia\_cardiac
- vlemedLFC
  - alex
  - amc
  - amc2
  - amc-ng-enc
  - hard\_tips
  - remi
  - glatard
- jalkemade
- jeroene
- kboulebiar
- martin
- matthan
- mdm
- piter.t.de.boer
- remi
  - data\_storage
  - db
  - joblogs
  - masks
  - output
  - output-may-2008
  - output\_26-08
  - scripts
  - workflows
    - group
    - individual
    - iaps
    - nback
    - roi
      - groupAnalyses
      - individualAnalyses
      - inputs
- http
  - results
  - silvia
  - testVFSLFC
  - testVFSLFC2
  - tristan
  - wibisono
  - garbage.sh
  - hello-1228916611960604456.t
- ccUI
- Desktop
- applisCreatis

**Grid files browsing, reading and writing**

CobraViewer

Status Services Input Results Info

**Workflow monitoring**

indivAnalysis

flirtIndiv  
done:2  
running:0  
failed:0

roi

roiIndiv  
done:0  
running:10  
failed:0

zstat2standard

JOB STATUS:workflow-PTlv75

| N# | JobID                                                                     | JobStatus     | link Out   | S... |
|----|---------------------------------------------------------------------------|---------------|------------|------|
| 1  | <a href="https://rb.grid.sara.nl:9000/">https://rb.grid.sara.nl:9000/</a> | DONE (SUC...) | Not yet... |      |
| 2  | <a href="https://rb.grid.sara.nl:9000/">https://rb.grid.sara.nl:9000/</a> | DONE (SUC...) | Not yet... |      |
| 3  | <a href="https://rb.grid.sara.nl:9000/">https://rb.grid.sara.nl:9000/</a> | SCHEDULED     | Not yet... |      |
| 4  | <a href="https://rb.grid.sara.nl:9000/">https://rb.grid.sara.nl:9000/</a> | READY         | Not yet... |      |
| 5  | <a href="https://rb.grid.sara.nl:9000/">https://rb.grid.sara.nl:9000/</a> | READY         | Not yet... |      |
| 6  | <a href="https://rb.grid.sara.nl:9000/">https://rb.grid.sara.nl:9000/</a> | READY         | Not yet... |      |
| 7  | <a href="https://rb.grid.sara.nl:9000/">https://rb.grid.sara.nl:9000/</a> | WAITING       | Not yet... |      |

**Job monitoring**

Load from file Save to file Add Parameter List Add Parameter Range Add Parameter Tag Path Delete selected

|       |               |        |        |                                                                             |
|-------|---------------|--------|--------|-----------------------------------------------------------------------------|
| Name: | indivAnalysis | Group: | Value: | <code>Ifn://lfc.grid.sara.nl/grid/vlemed/remi/output/feat-dofhigh-12</code> |
| Name: | roi           | Group: | Value: | <code>Ifn://lfc.grid.sara.nl/grid/vlemed/remi/amygdLR_bin.nii.gz</code>     |

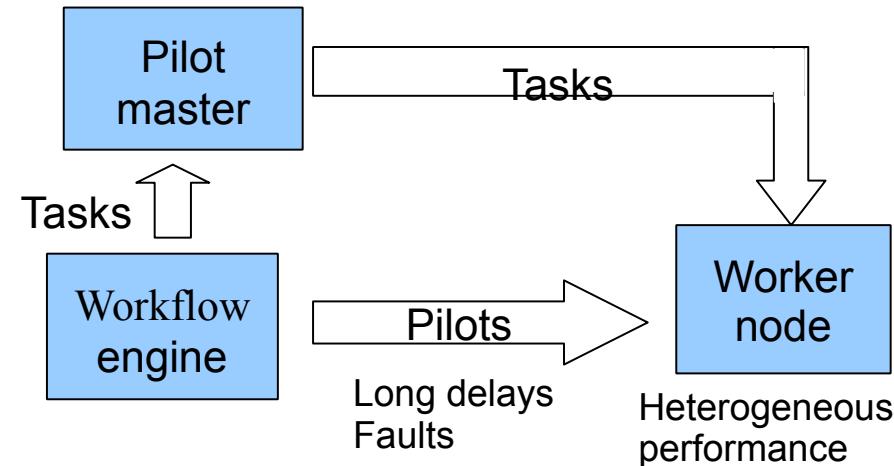
Run Workflow Web service URL: <https://ws1.grid.sara.nl/~glatard/workflow/workflow-PTlv75/workflow-PTlv75.html>

**Workflow inputs**

# Pilot jobs DIANE or DIRAC

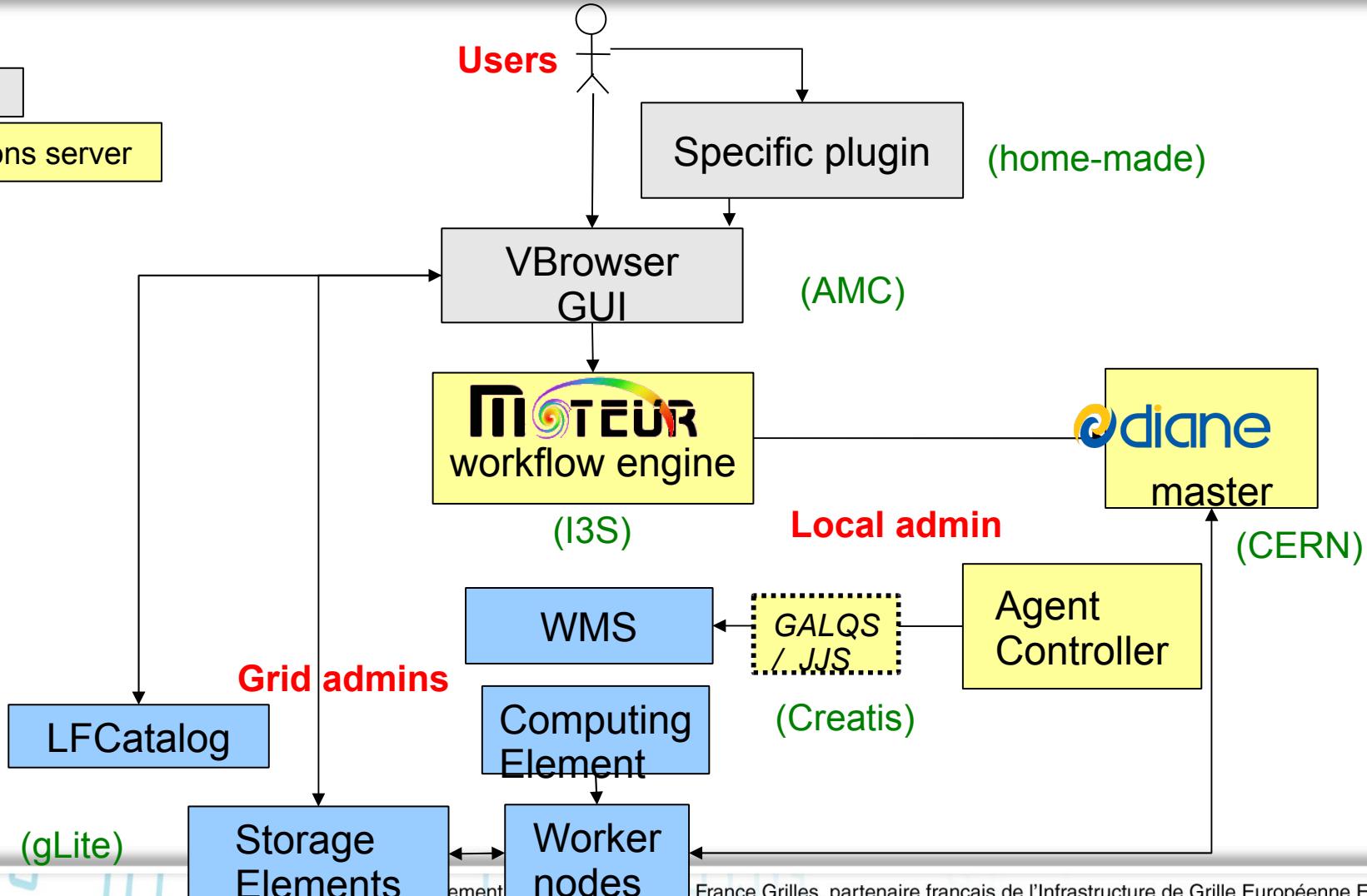
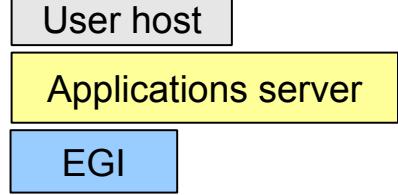
## ➤ Benefits

- Fault tolerance
- Reduced latency
- Resource allocation
- Heterogeneity of computing resources performance





# Integrated environment





# Life Sciences Virtual Research Community

## ➤ Community model

- 1 VRC, several VOs (per region / project / ...)
- 1 catch-all international-scale VO (“biomed”)
- Mutualize resources and expertise

[https://dav.healthgrid.org/lsvrc/LSVRC\\_proposition\\_09-08-2010-final.pdf](https://dav.healthgrid.org/lsvrc/LSVRC_proposition_09-08-2010-final.pdf)

## ➤ Sub-domain scientific leaders

- Sub-groups defined in biomed VO (as VOMS groups)
- Sub-groups may require specific resources (e.g. data access control)

## ➤ Open to new users

- Registration into groups (sub-domain, projects, country)



# VO/VRC management tools

- **Need to formalize agreements with resource providers**
  - Improve years-old informal agreements without guarantee and frequent decommissioning
- **Work on-going on the definition of a users DB**
  - To manage scientific affiliation and authorization
  - To define user (mailing) lists (per sub-domain, per project...)
  - To maintain consistency (remove non-active / expired users)
  - To follow-up users activity
  - Link users DB with VOMS service and applications DB



# VO/VRC monitoring tools

- Monitor grid services operation at the VO-level (VOMS, LFC, CEs, SEs)
- Monitor VO production (CPU/data efficiency, number of failed jobs, data placement, etc)

| All | Biomed VO Storage Elements | Biomed VO general tests                       | Last Success       | Last Failure       | Last Duration |
|-----|----------------------------|-----------------------------------------------|--------------------|--------------------|---------------|
| S   | W                          | Job ↓                                         |                    |                    |               |
|     |                            | <a href="#">All Storage Elements</a>          | 6 mo 0 days (#6)   | 6 mo 0 days (#5)   | 4 hr 26 min   |
|     |                            | <a href="#">Failure</a>                       | N/A                | 6 mo 1 day (#1)    | 0.35 sec      |
|     |                            | <a href="#">Init jobs</a>                     | 3 days 19 hr (#67) | 5 mo 18 days (#21) | 2 min 33 sec  |
|     |                            | <a href="#">LFC response time</a>             | 1 hr 10 min (#45)  | N/A                | 0.94 sec      |
|     |                            | <a href="#">Proxy infos</a>                   | 1 hr 10 min (#17)  | N/A                | 0.85 sec      |
|     |                            | <a href="#">Proxy init</a>                    | 1 hr 10 min (#16)  | N/A                | 4.7 sec       |
|     |                            | <a href="#">SE agh15.atlas.unimelb.edu.au</a> | 3 mo 11 days (#29) | N/A                | 4.6 sec       |
|     |                            | <a href="#">SE agh3.atlas.unimelb.edu.au</a>  | 1 mo 2 days (#28)  | 1 mo 1 day (#29)   | 2 min 42 sec  |
|     |                            |                                               |                    |                    |               |



# Conclusions

- **Medical imaging activity active on the grid since 2001**
  - Strong community in France
- **Beyond applications, tools**
- **Beyond tools, common environment**
- **Beyond environment, towards community structure**
  - Still a lot to be done at the international level