vl·e

virtual laboratory for e·science

VL-e Med, VL-fMRI and all that

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Overview

- VL-e, VL-e Medical
- Use Case: Functional MRI
  - Introduction
  - Virtual Lab for fMRI
    - Approach
    - Implementation
- Final Remarks

Virtual Lab for e-Science

Towards a new Science Paradigm

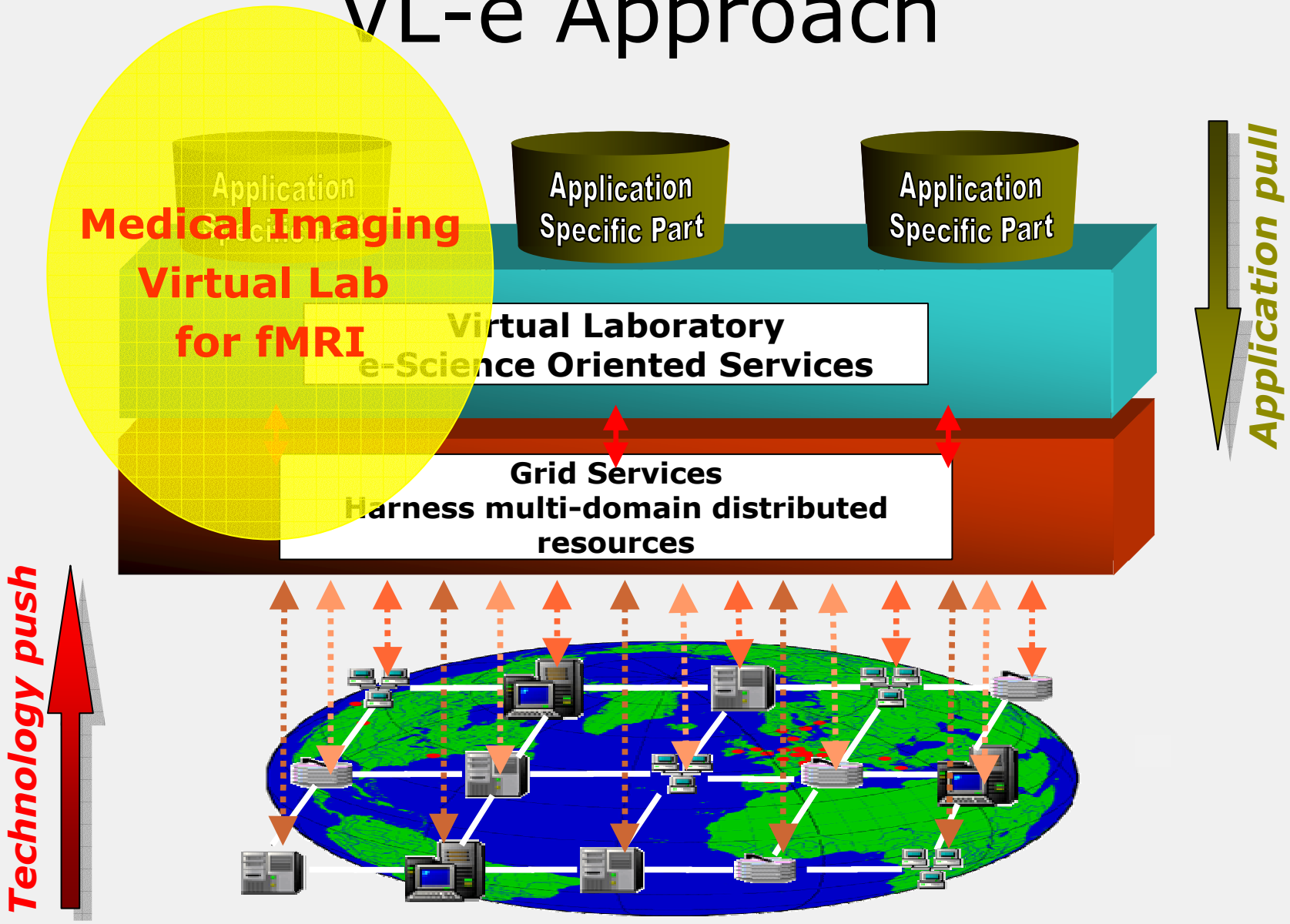
Project Director
Prof. Dr. L.O. Hertzberger

This work is supported by a BSIK grant of the
Dutch Ministry of Education, Culture and Science (OC&W)
and is part of the ICT innovation programme of the
Dutch Ministry of Economic Affairs (EZ)

VL-e

- Goal
  - "bridge the gap between the technology push of the high performance networking and the Grid and the application pull of a wide range of scientific experimental applications"
- Approach
  - Provide infrastructure
  - Facilitate expertise exchange (grid technology and application domain)
  - Development of e-Science applications

VL-e Approach



- The meaning of “e” in e-Science is…
  - electronic
  - enhanced

Enhancement in Medical Imaging?

- Data Storage
  - Large capacity, long-term
- Data Analysis
  - Computation capacity (latency, throughput)
  - Software interoperability
- Data Access
  - Remote access (dispersed organizations)
  - Collaboration
  - Security (patient data)
- Data Logistics and Management
  - Heterogeneous and dispersed systems
  - Workflow management

VL-e Medical Subprogram

- Goal:
  - Develop grid-enabled problem-solving environments to *enhance* advanced clinical and research in medical imaging
- Activities
  - High performance image analysis
  - Workflow
  - Visualization
  - Virtual Lab for fMRI

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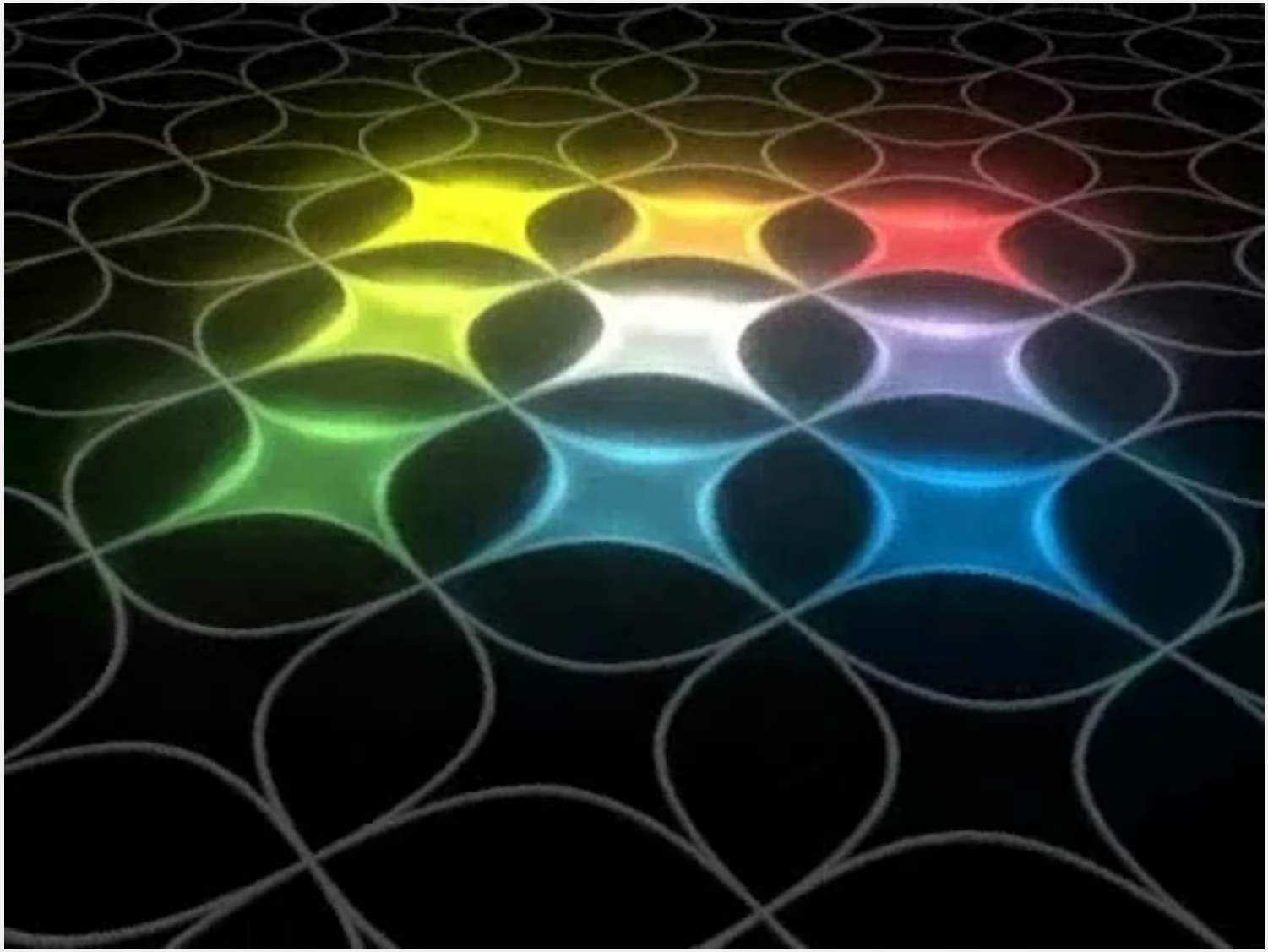
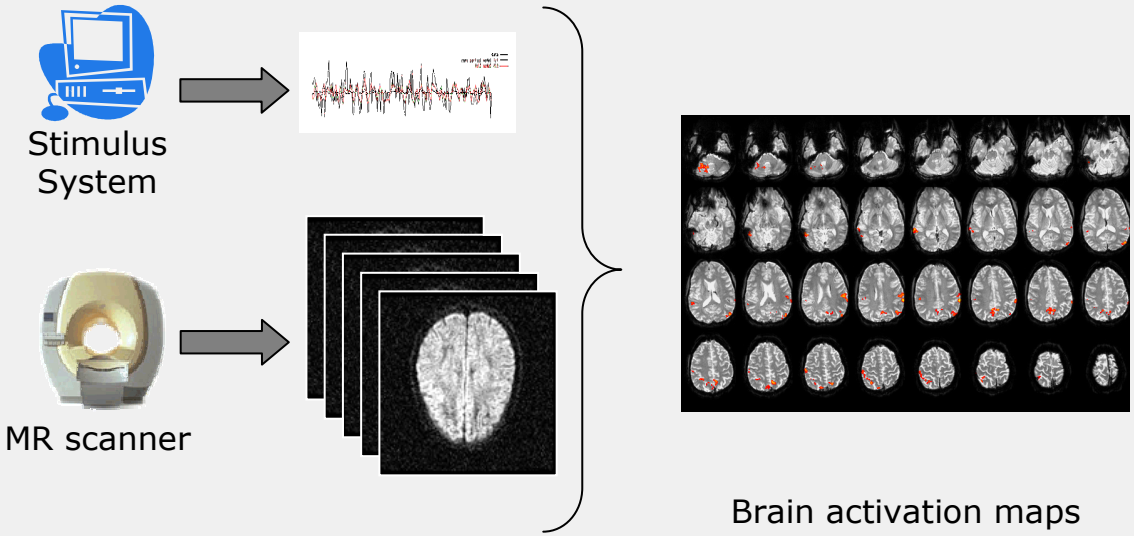
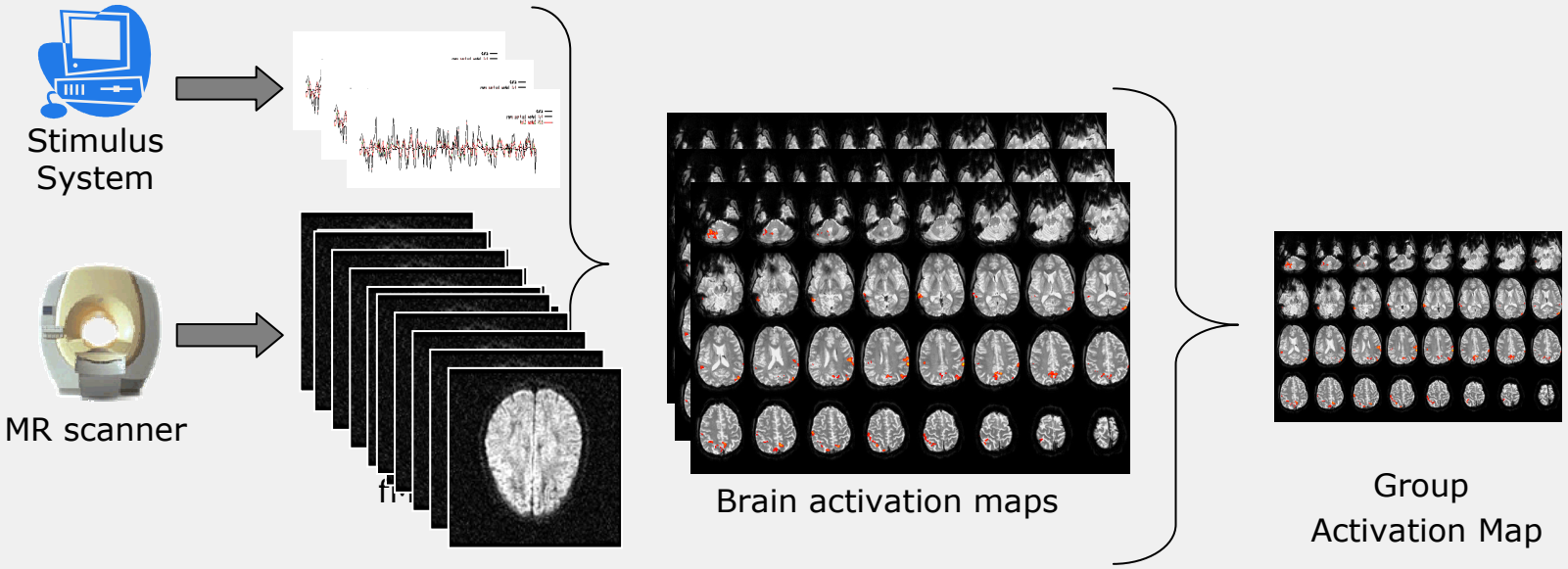
Functional Imaging of the Brain with fMRI



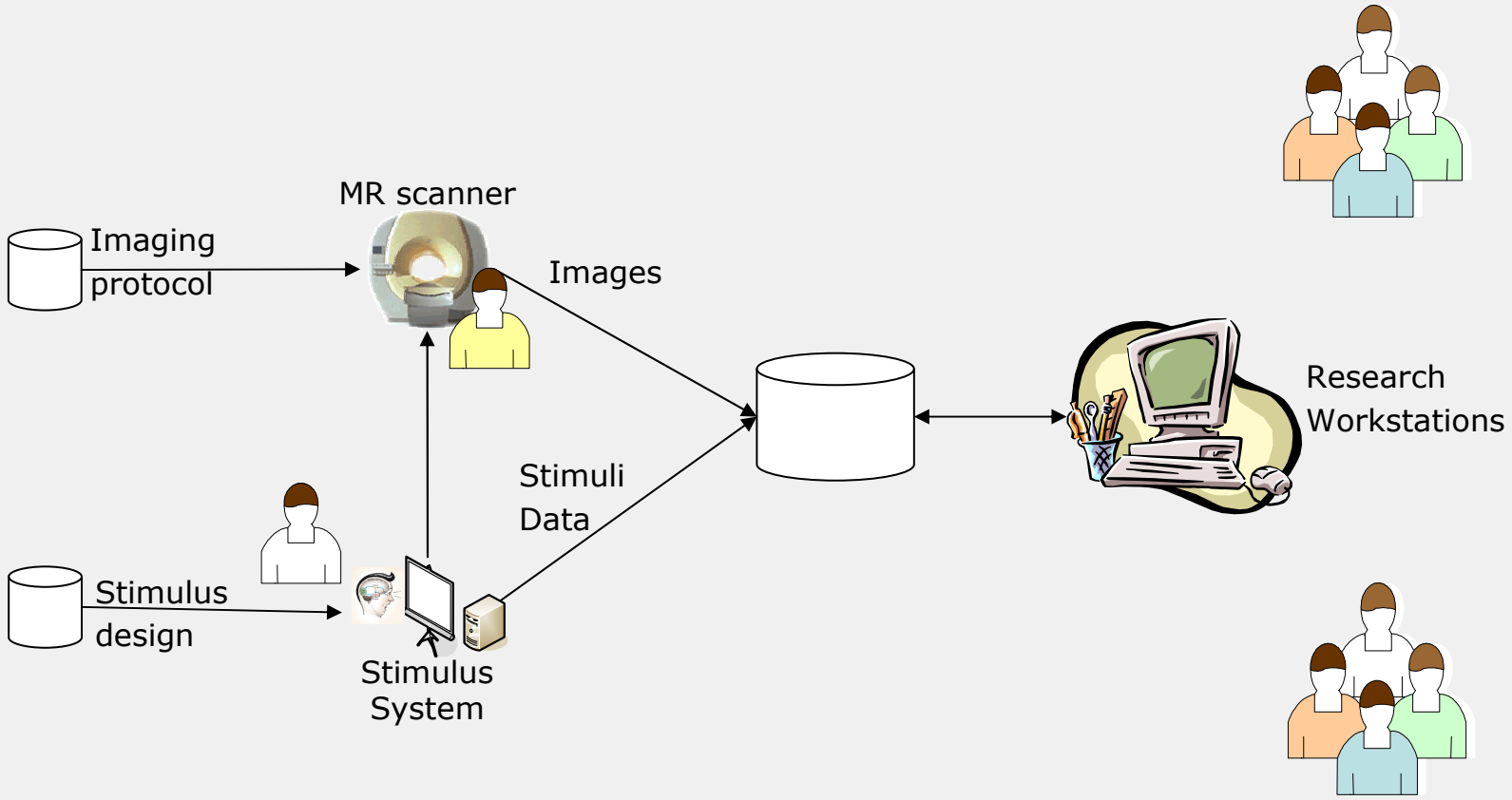
fMRI: Individuals



fMRI: Group Studies

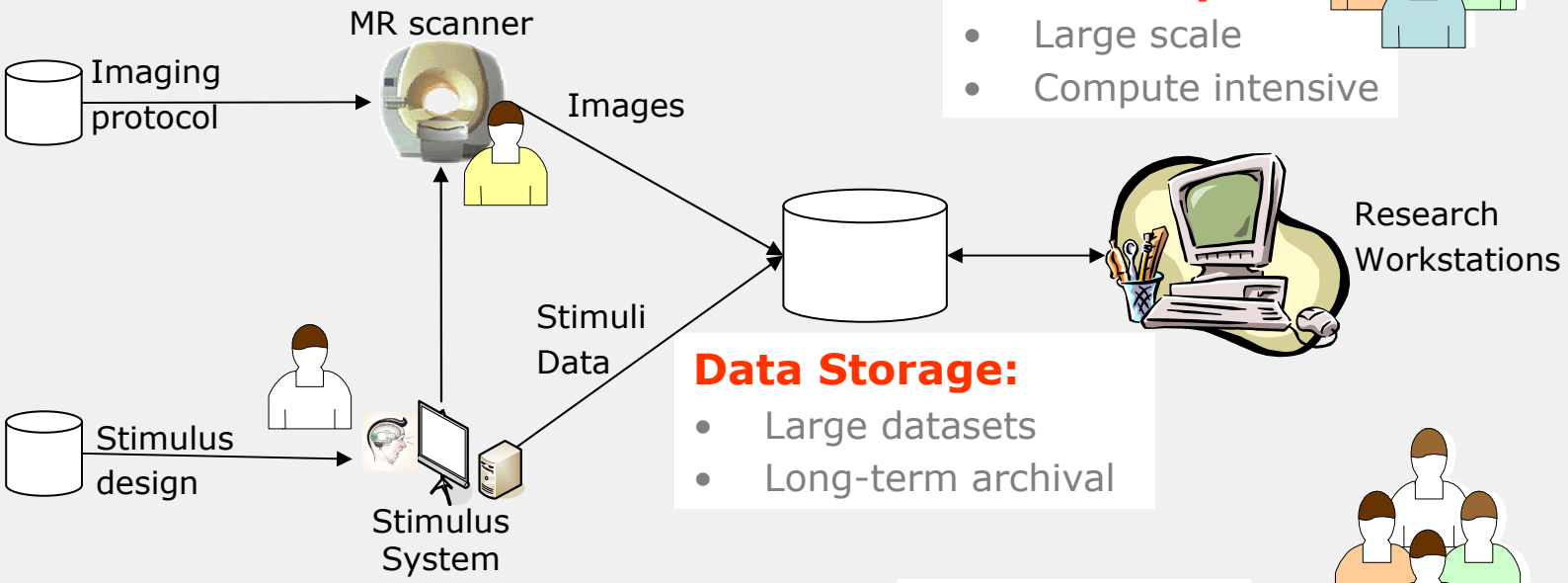


Data Management in fMRI



Data Management in fMRI

Data Acquisition:
- Dispersed equipments
- Data privacy



Data Analysis:
- Large scale
- Compute intensive

Data Storage:
- Large datasets
- Long-term archival

Data Access:
- Collaboration
- Dispersed

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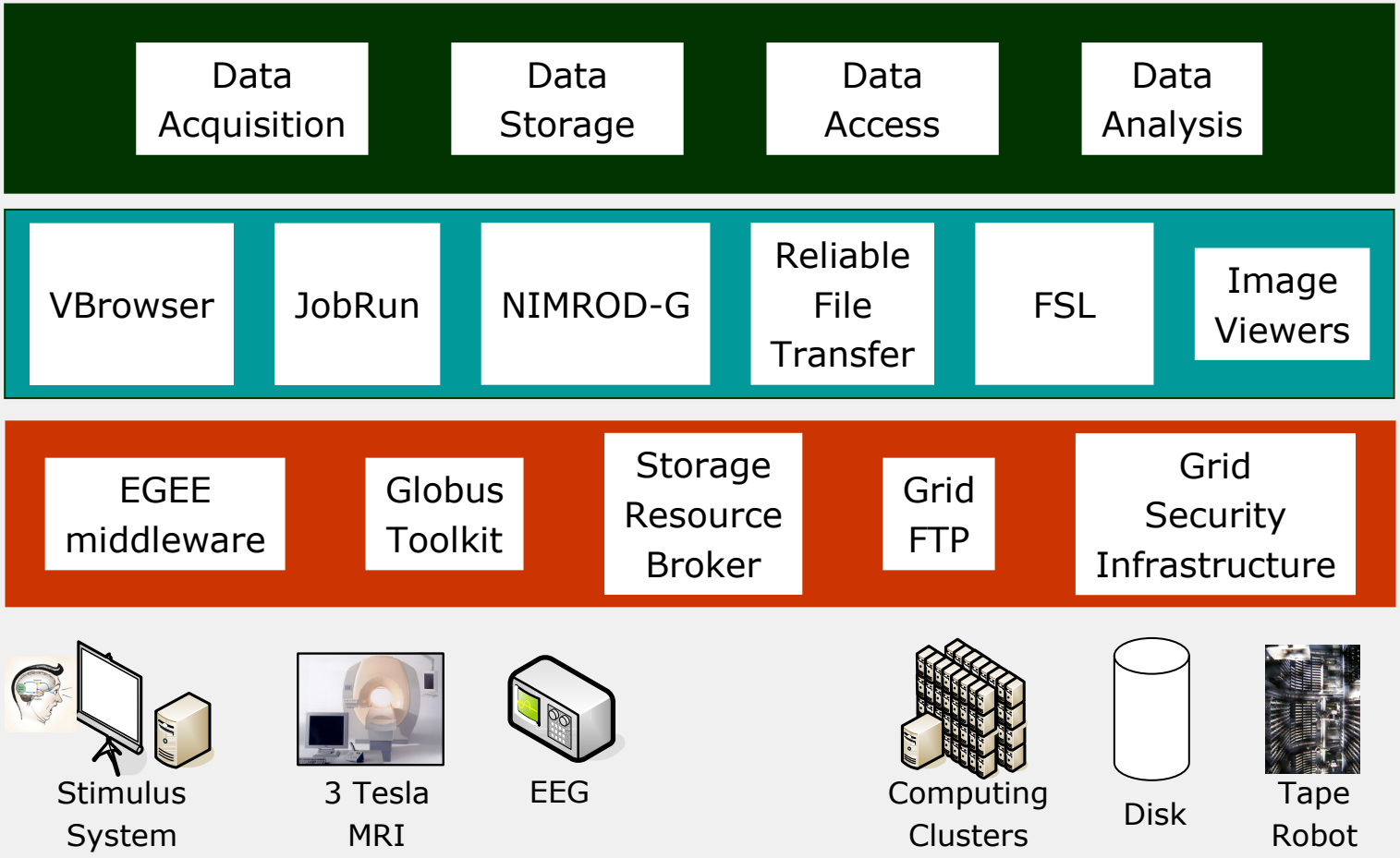
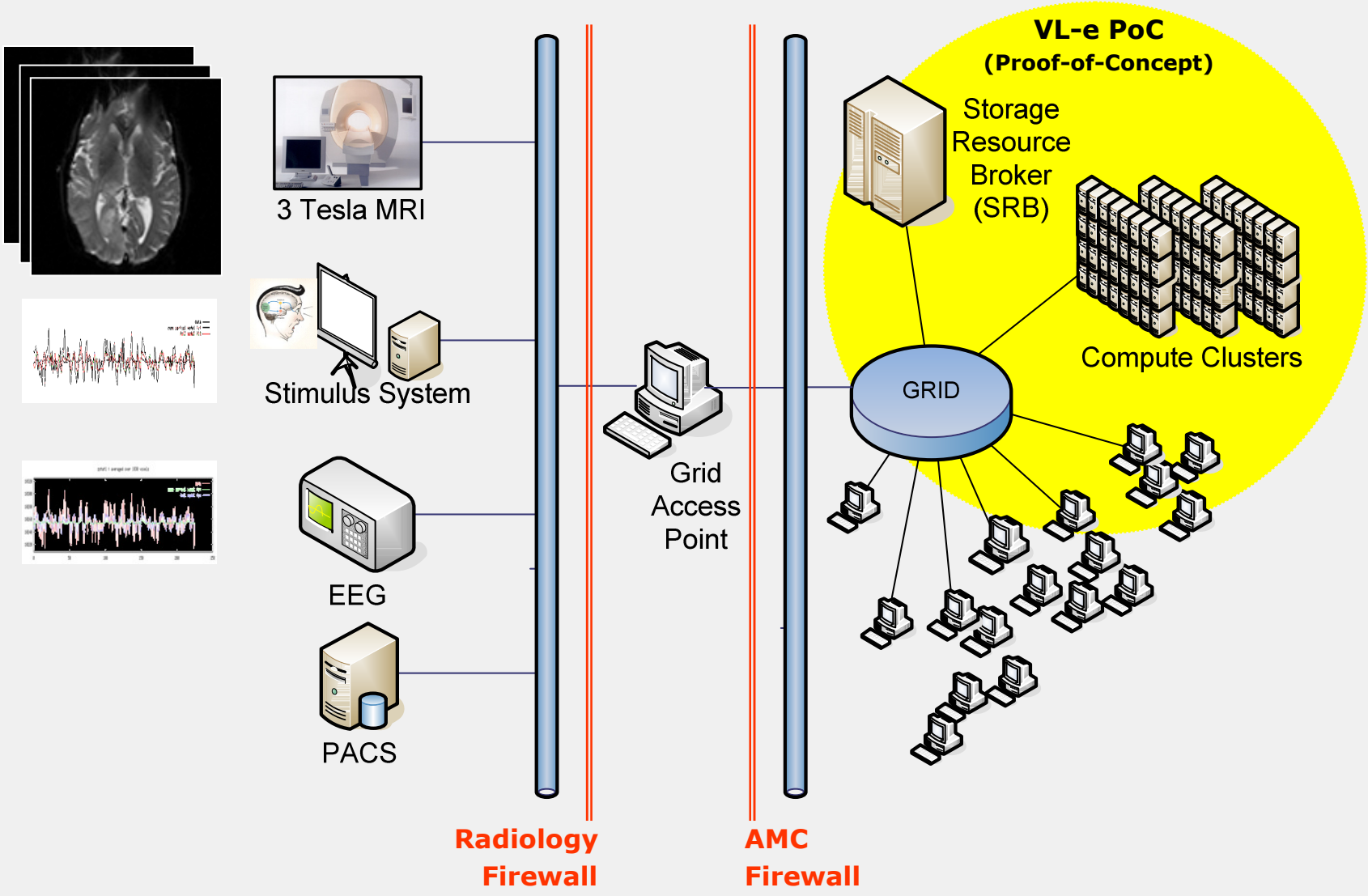
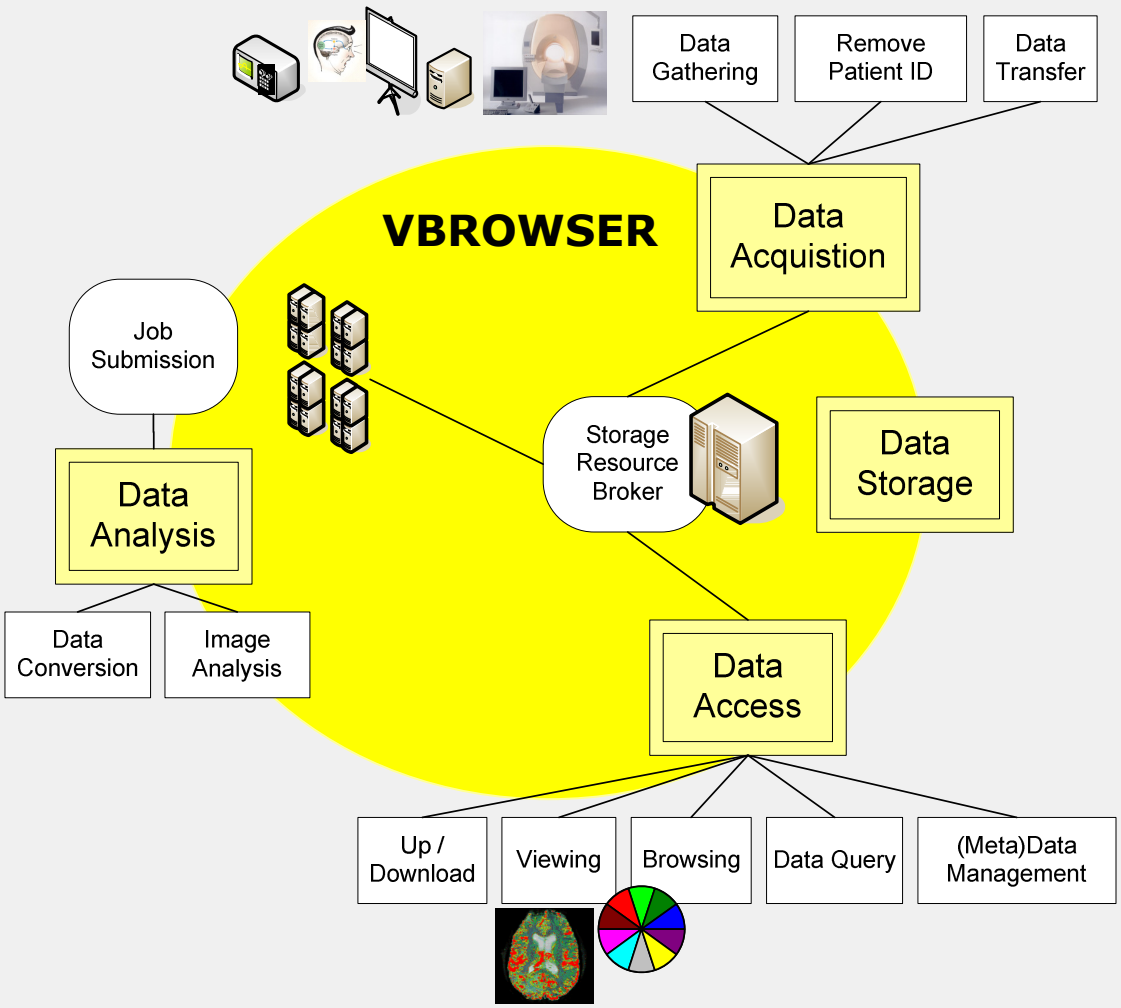
Virtual Lab for fMRI



VL-fMRI: Resources



VL-fMRI: Services



Virtual Resource Browser

Contrib: Piter de Boer (IvI,UvA)

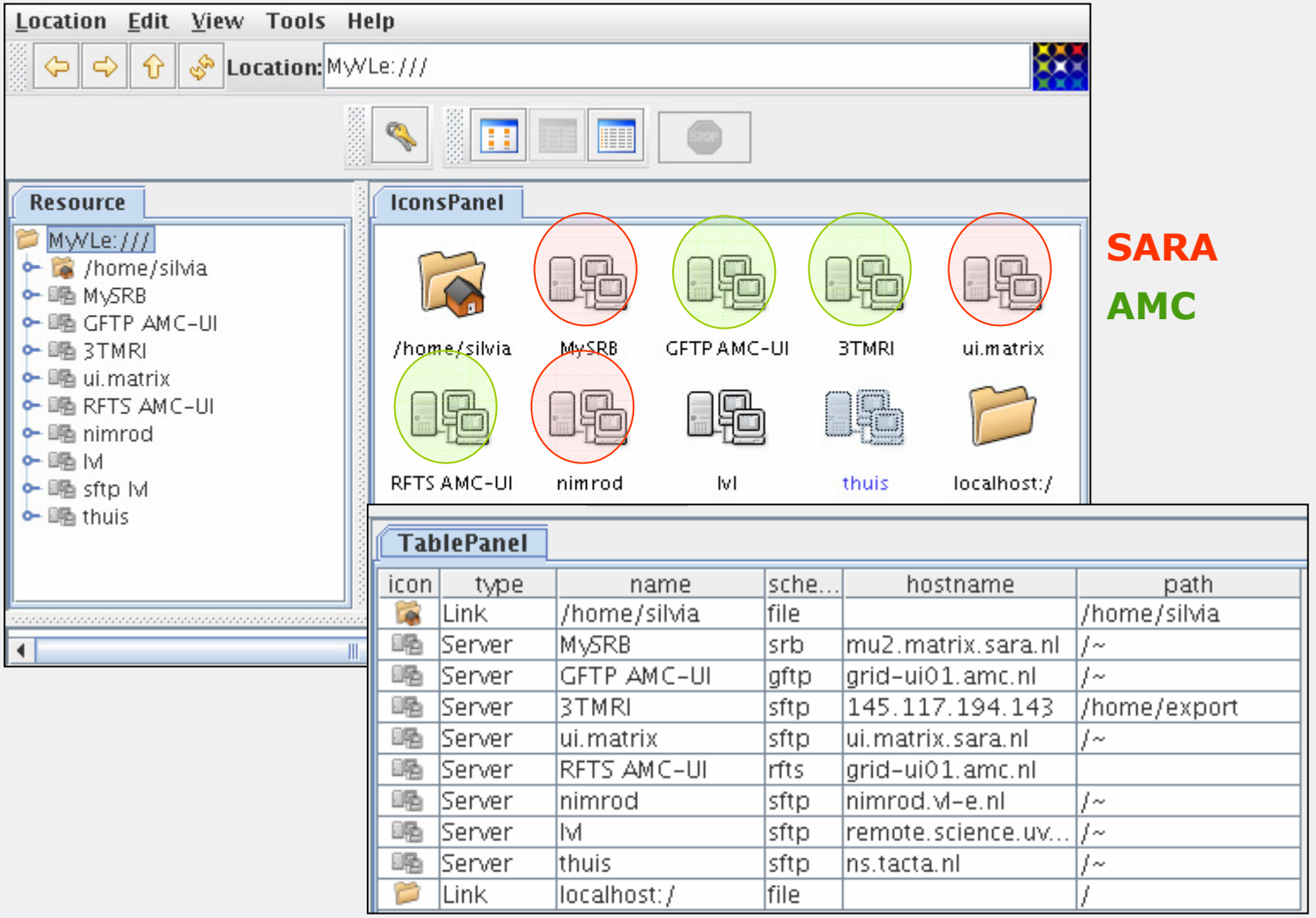
- Interactive GUI for resource browsing
- Access to virtual (grid-enabled) resources

- MIME-type enabled

- Built on VL-e Toolkit (VLET)
- Plug-ins
- Multi-platform (Java)

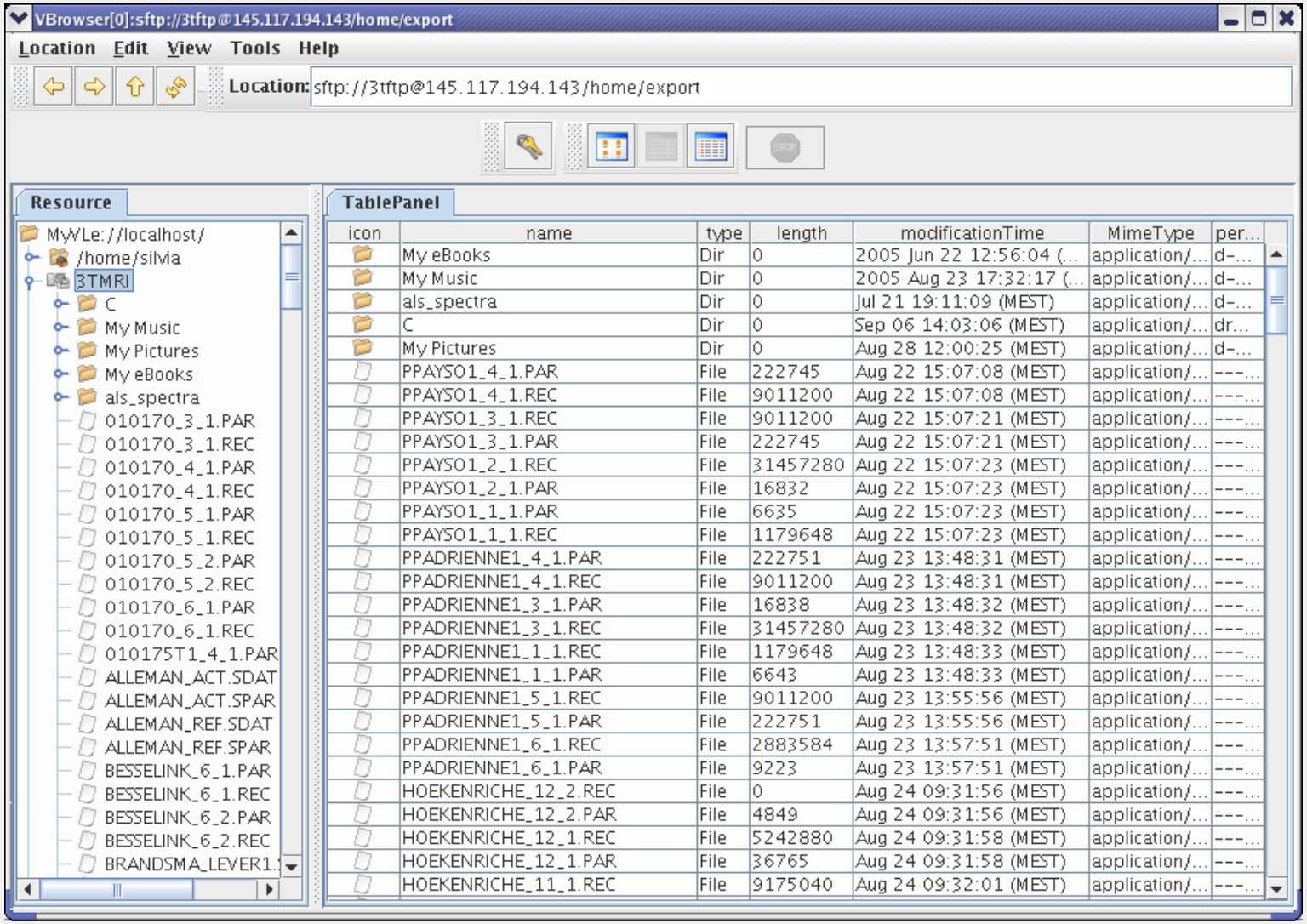
vl·e

Data Acquisition

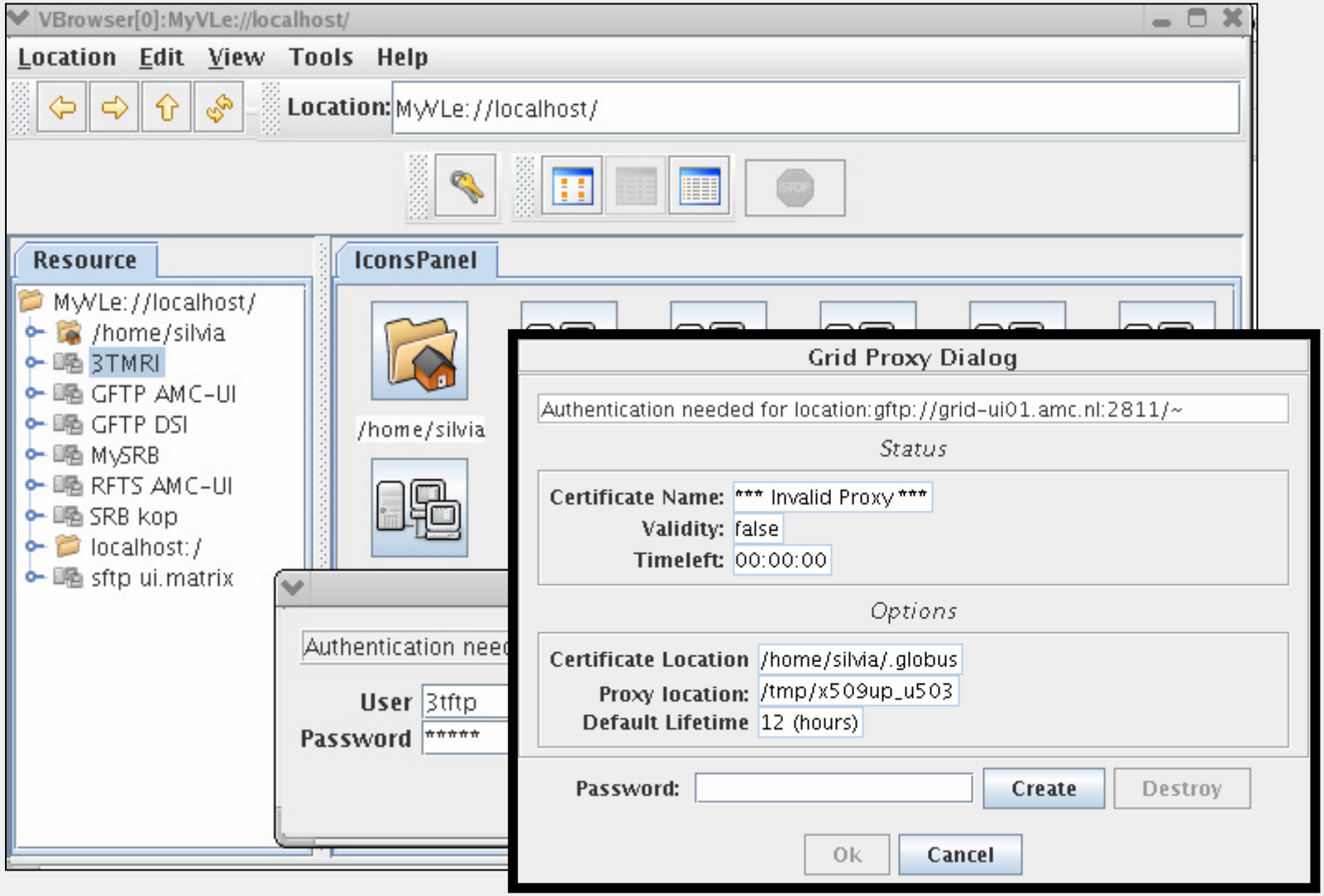


icon	type	name	sche...	hostname	path
	Link	/home/silvia	file		/home/silvia
	Server	MySRB	srb	mu2.matrix.sara.nl	/~
	Server	GFTP AMC-UI	gftp	grid-ui01.amc.nl	/~
	Server	3TMRI	sftp	145.117.194.143	/home/export
	Server	ui.matrix	sftp	ui.matrix.sara.nl	/~
	Server	RFTS AMC-UI	rfts	grid-ui01.amc.nl	
	Server	nimrod	sftp	nimrod.vl-e.nl	/~
	Server	lvl	sftp	remote.science.uv...	/~
	Server	thuis	sftp	ns.tacta.nl	/~
	Link	localhost:/	file		/

Data Acquisition: 3.0 Tesla MRI



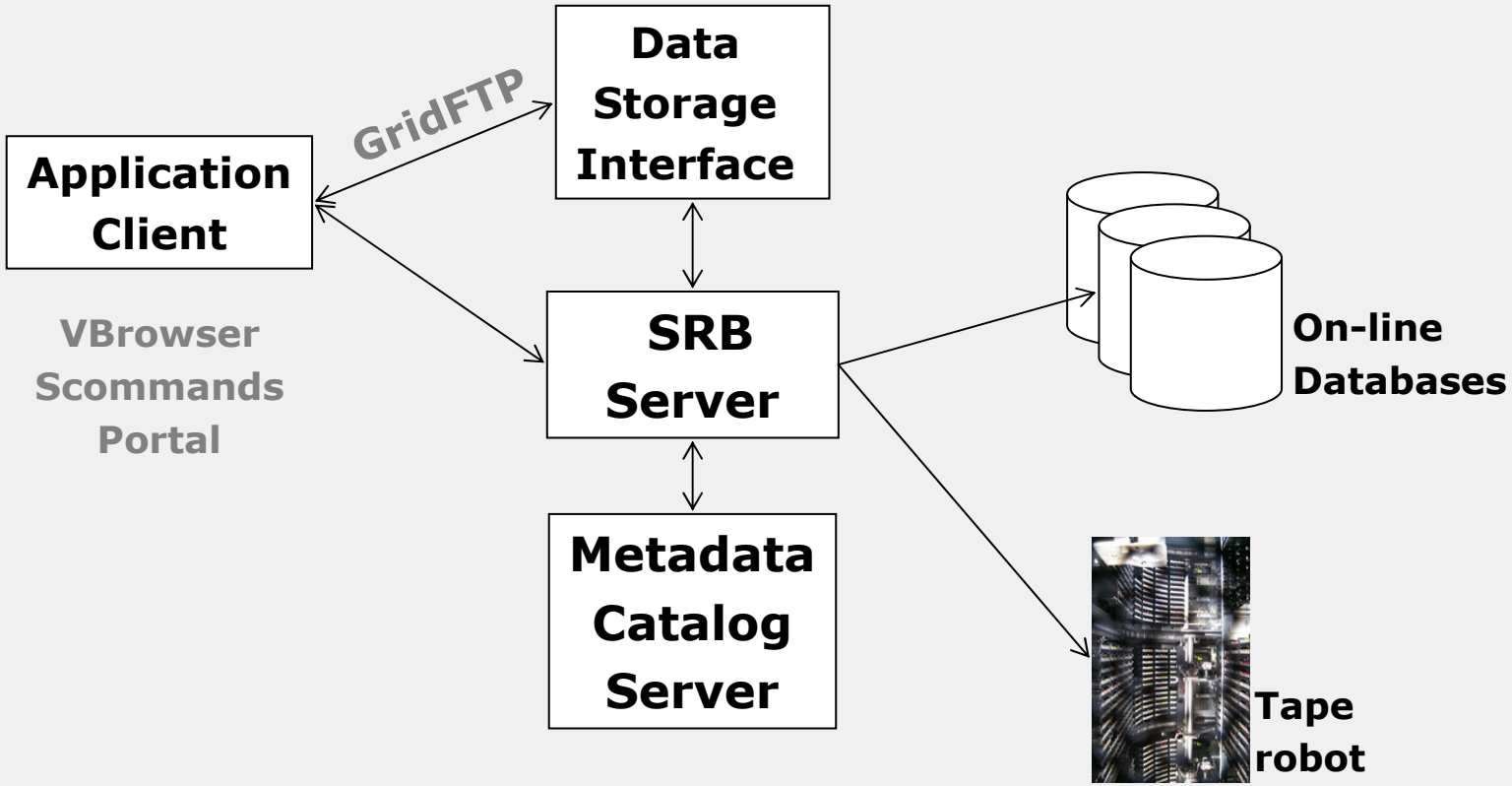
User Authentication



Data Storage

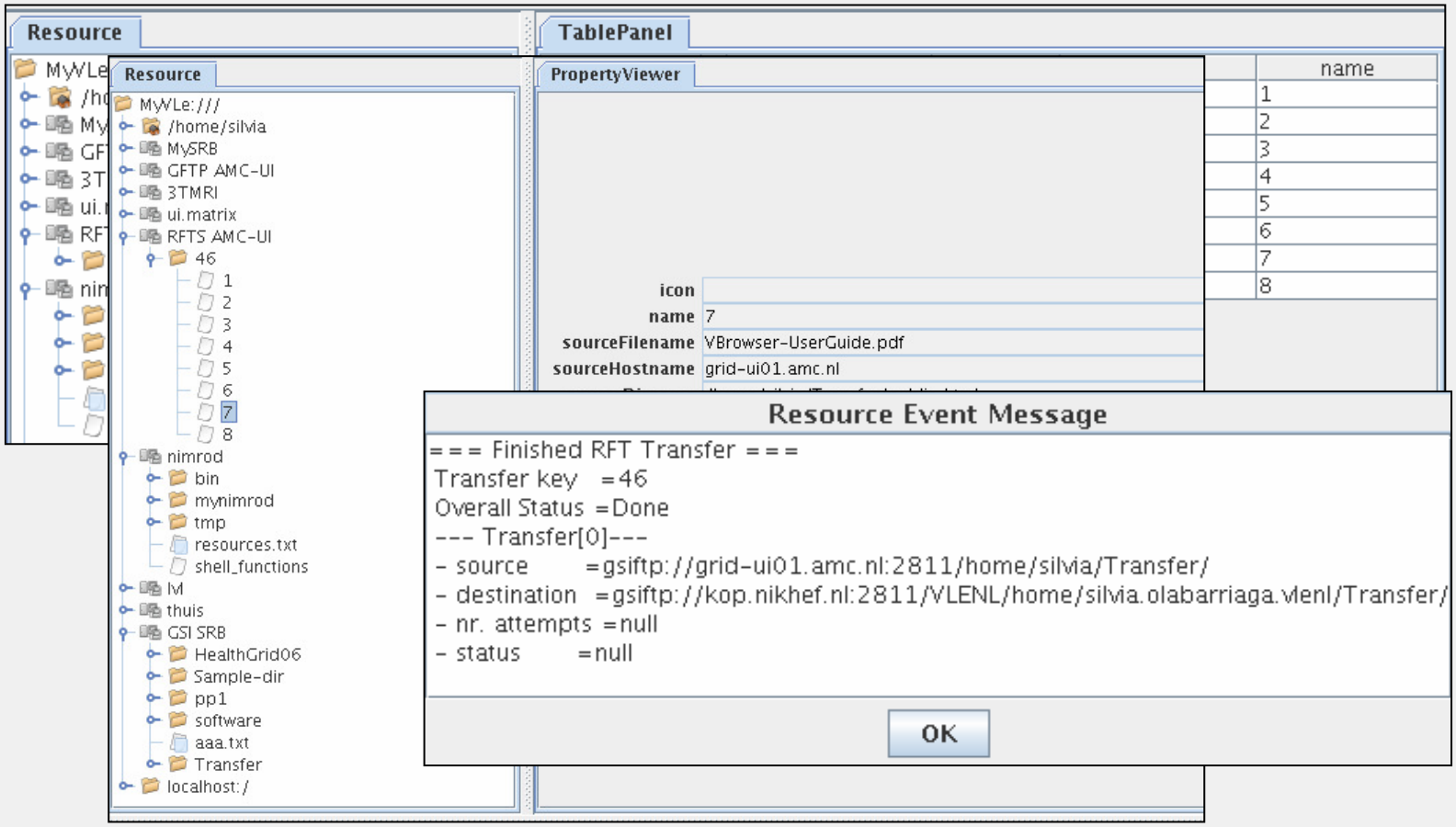
- SDSC Storage Resource Broker (SRB)
  - single file hierarchy for data distributed across heterogeneous storage systems in multiple organizations.
  - supports the management, collaboration, controlled sharing, publication, replication, transfer, and preservation of distributed data.
- In VL-e PoC
  - SRB server hosted by SARA
  - On-line storage
  - Near-line storage (tape)

SRB @ VL-e PoC

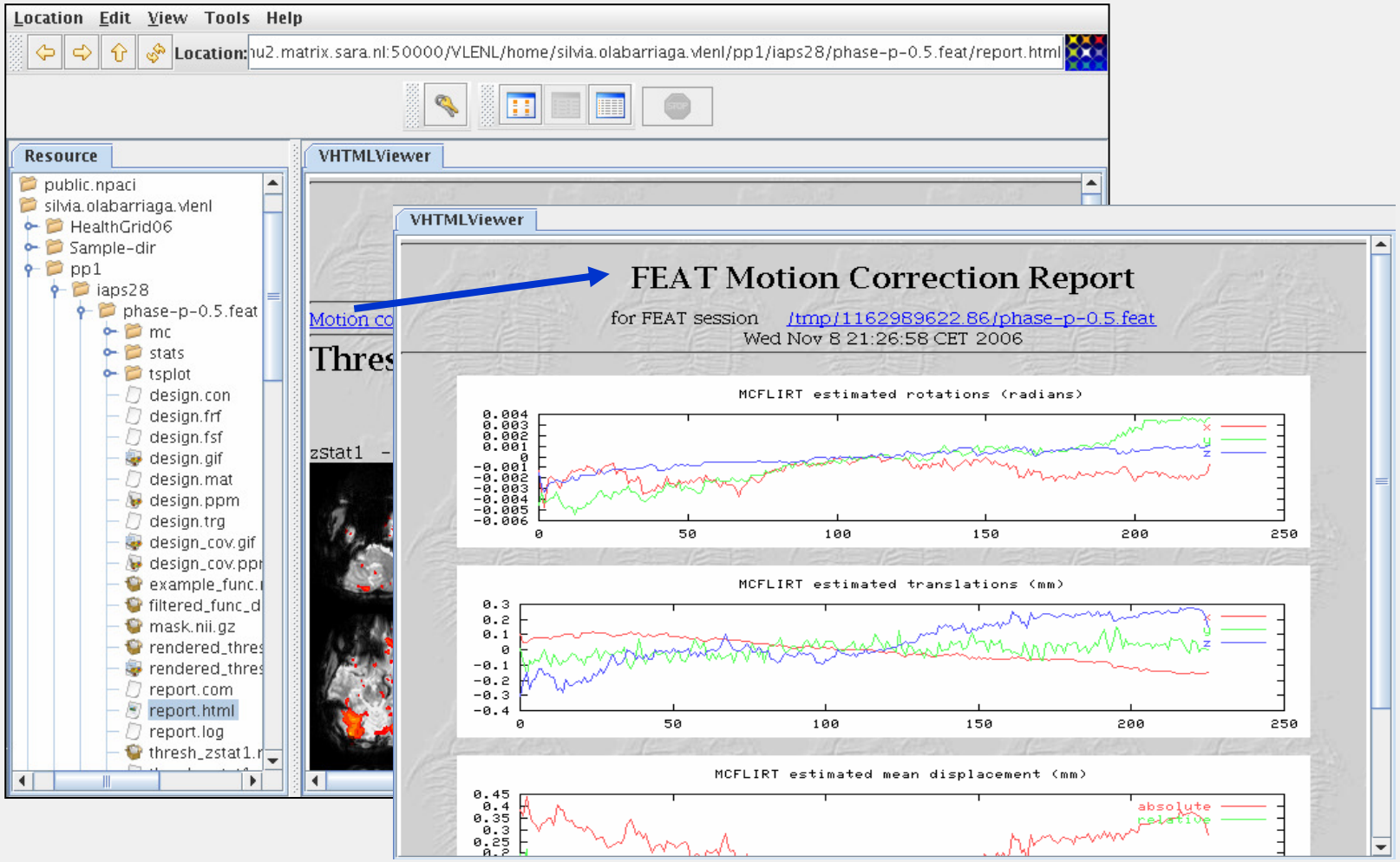

Data
Storage
Interface
GridFTP
Application
Client
VBrowser
Scommands
Portal
SRB
Server
On-line
Databases
Metadata
Catalog
Server
Tape
robot

Reliable File Transfer (GT4) Service

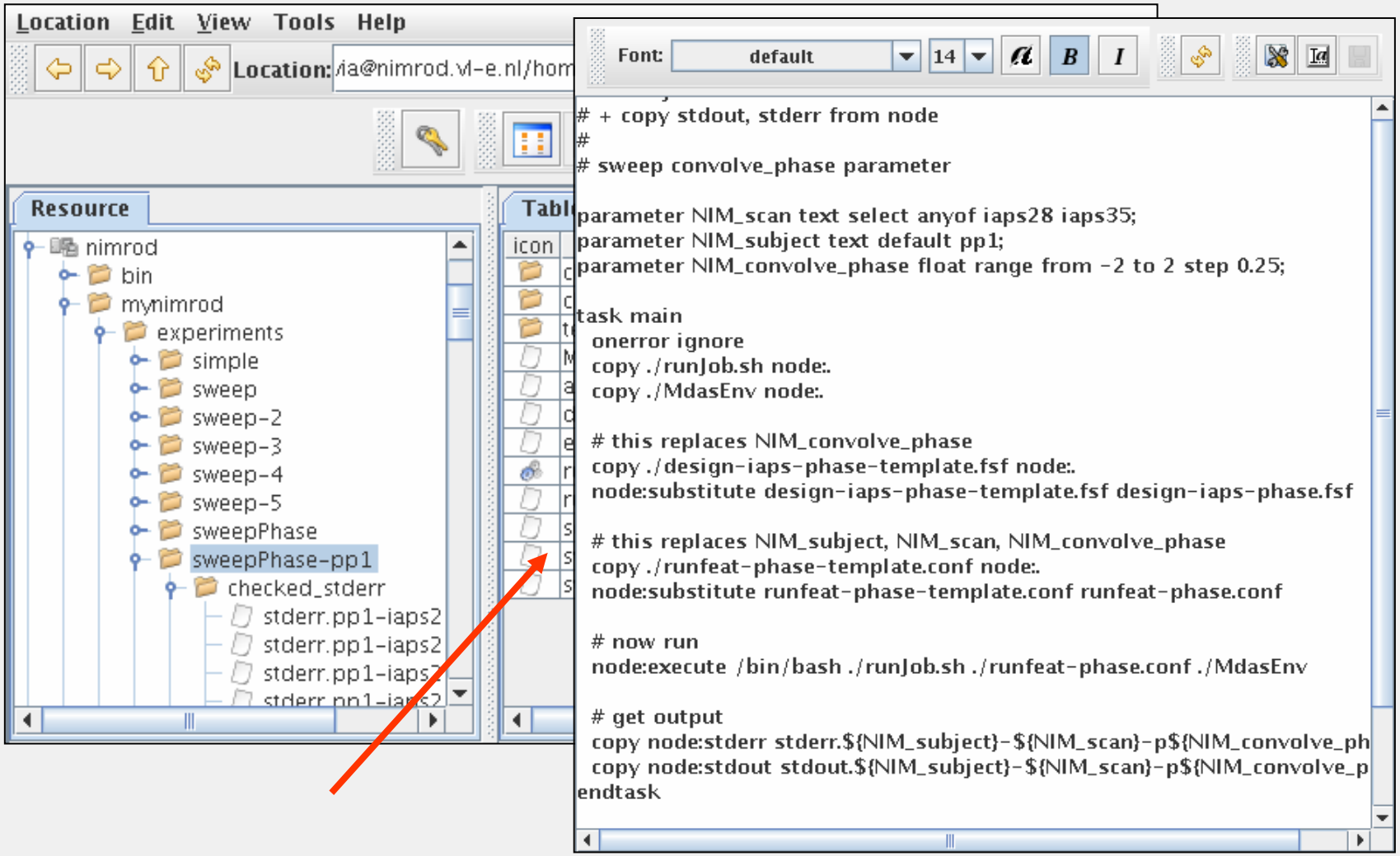
Contrib: Ketan Maheshwari (IvI,UvA)



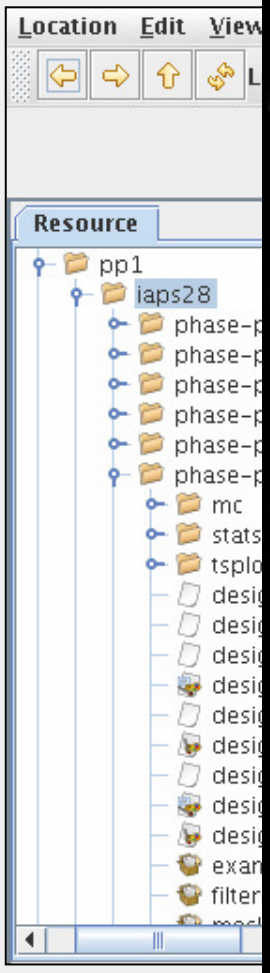
Data Access

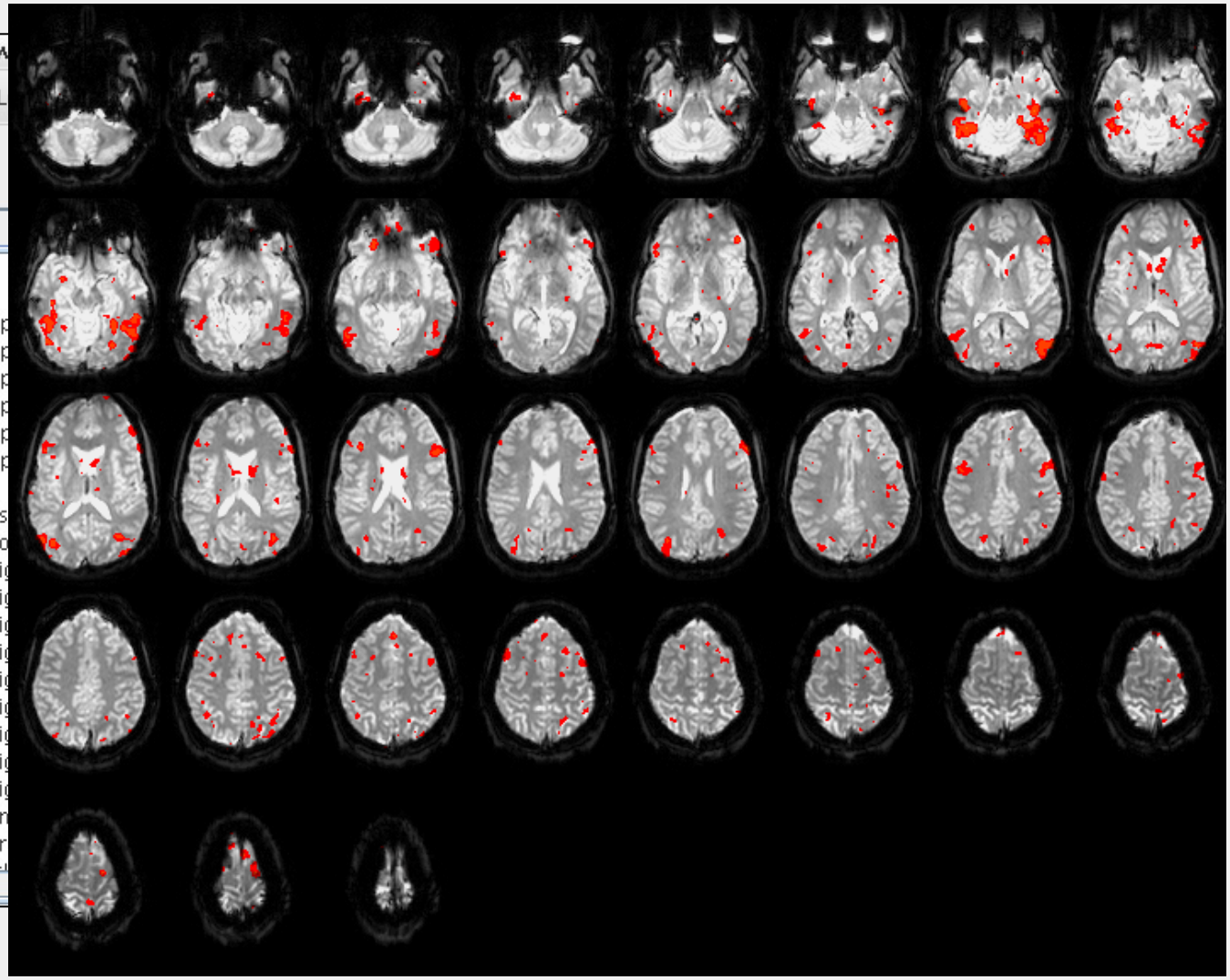

Location Edit View Tools Help
Location: hu2.matrix.sara.nl:50000/VLENL/home/silvia.olabarriaga.vlenl/pp1/iaps28/phase-p-0.5.feat/report.html
Resource
public.npaci
silvia.olabarriaga.vlenl
HealthGrid06
Sample-dir
pp1
iaps28
phase-p-0.5.feat
mc
stats
tsplot
design.con
design.frf
design.fsf
design.gif
design.mat
design.ppm
design.trg
design_cov.gif
example_func.
filtered_func_d
mask.nii.gz
report.com
report.html
report.log
VHTMLViewer
VHTMLViewer
FEAT Motion Correction Report
for FEAT session /tmp/1162989622.86/phase-p-0.5.feat
Wed Nov 8 21:26:58 CET 2006
MCFLIRT estimated rotations (radians)
MCFLIRT estimated translations (mm)
MCFLIRT estimated mean displacement (mm)
absolute
relative

Data Access (2)



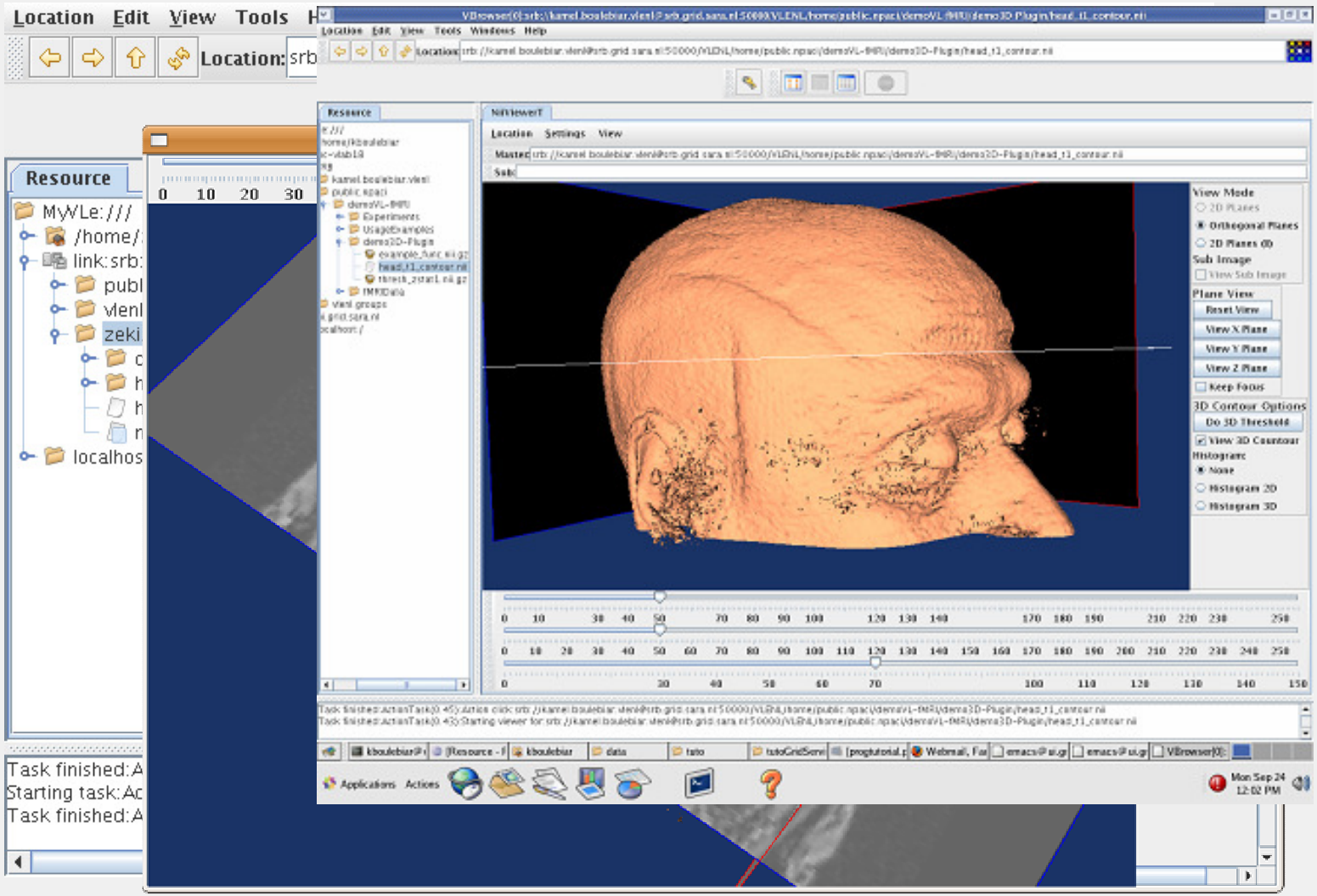
Data Access (3)





Data Access (4)

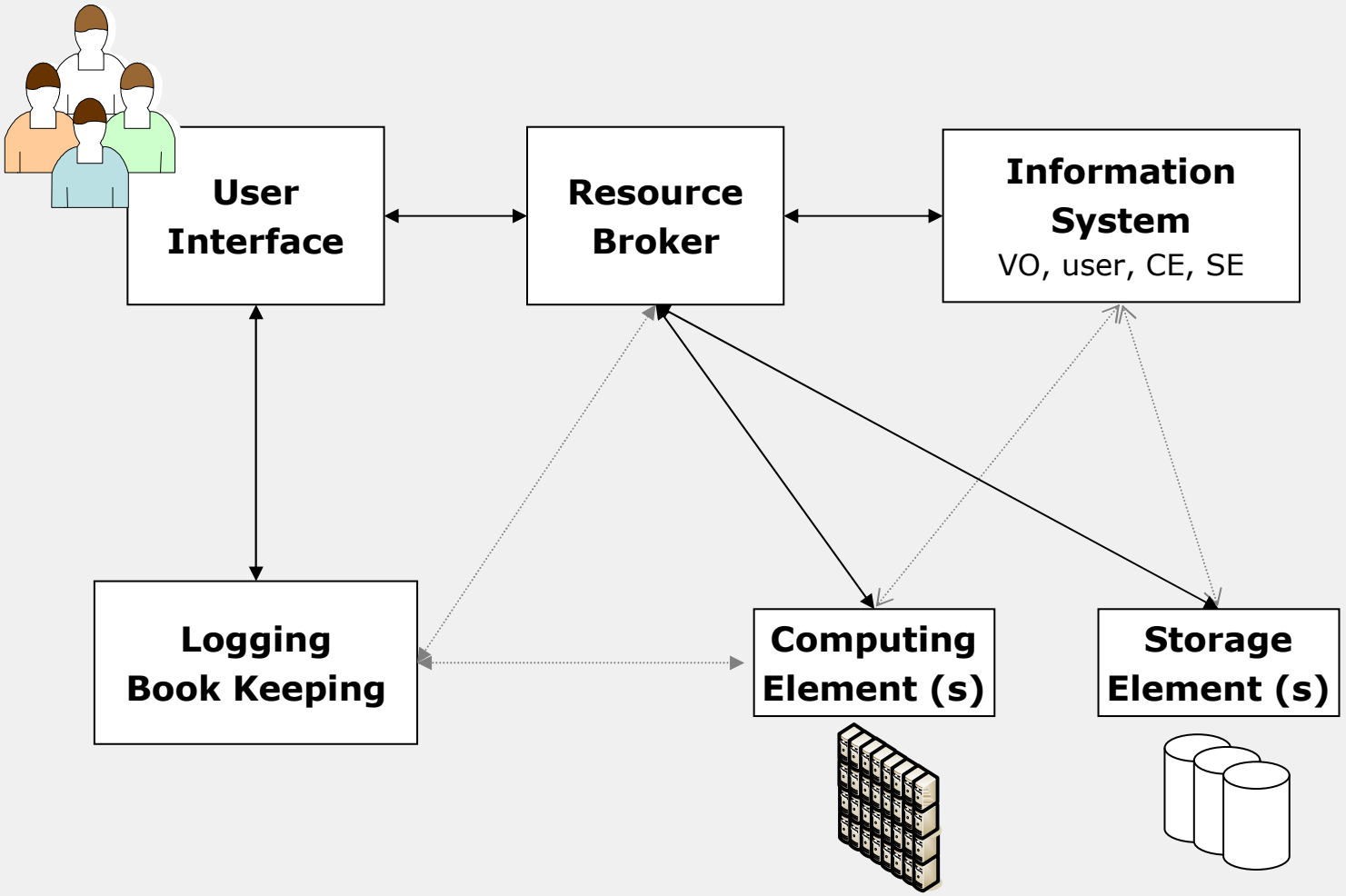
Contrib: Abdullah Ozsoy (IvI,UvA)



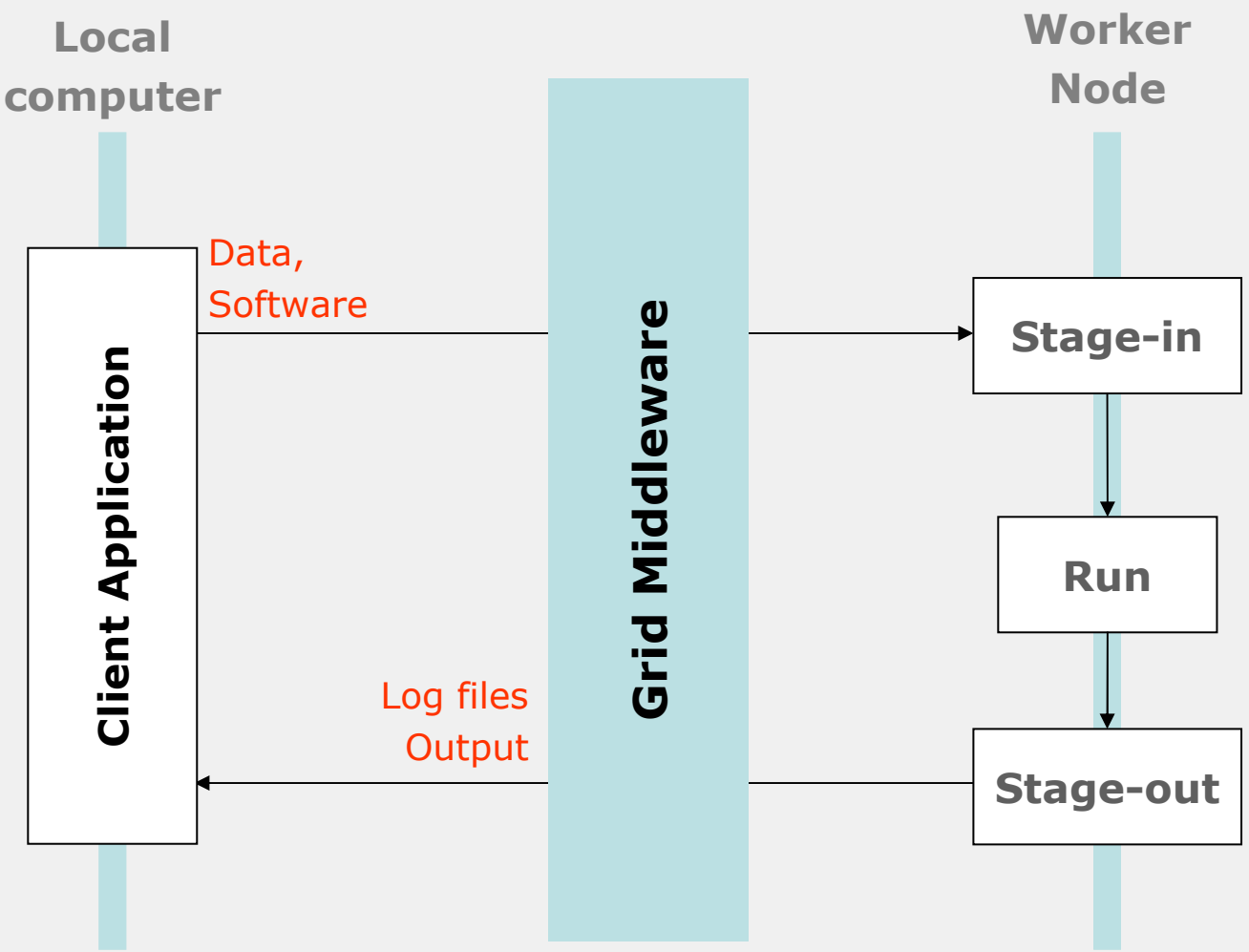
Data Analysis

- Computing clusters
  - SARA, NIKHEF, AMC
  - many others: BIGGrid, DAS-3
- Standard software installation
  - VL-e PoC
  - Includes imaging packages (VTK,ITK,FSL)
- Various middleware
  - EGEE
  - Experiment managers (NIMROD, custom)

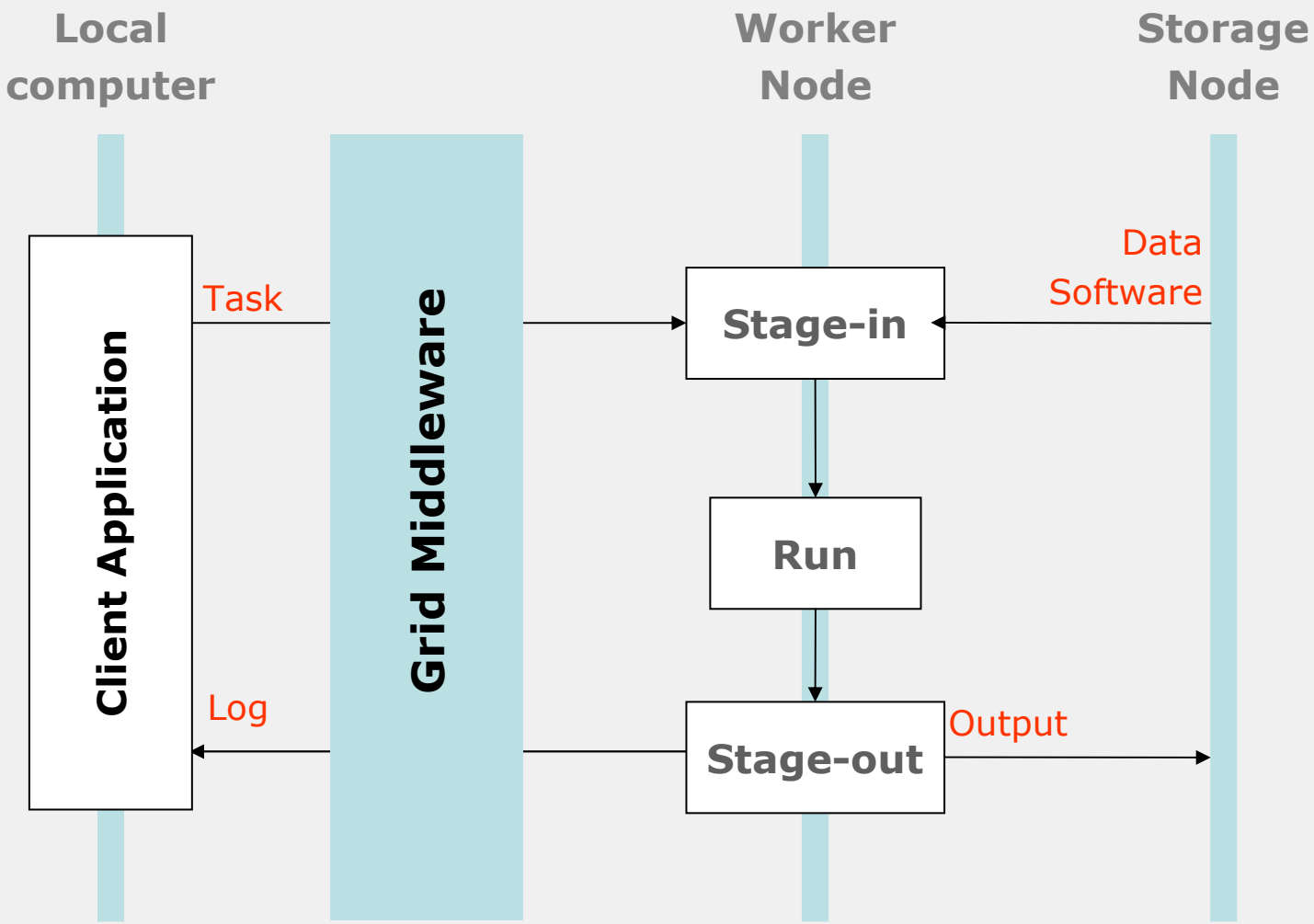
Computing @ VL-e PoC
EGEE Middleware



Computing Jobs on the Grid
Local storage



Computing Jobs on the Grid
External storage



jobrun Package

- bash script
- Features:
  - SRB as file system
  - Error checking
  - Configurable
- Usage
  - jobrun.sh <job-config> <SRB-config>

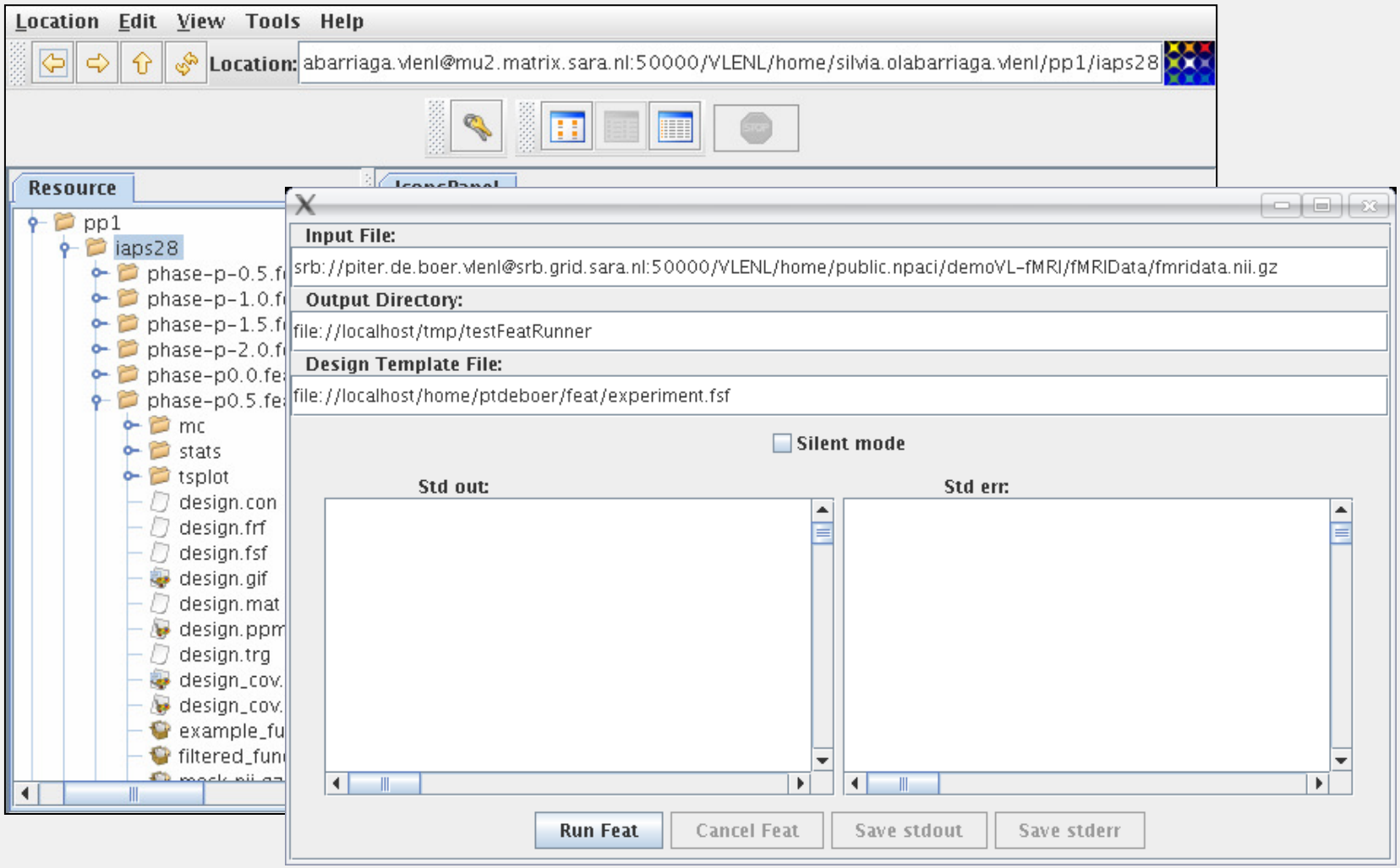
jobrun: Submission

- *edg-job-submit job.jdl*

```
Executable = "runJob.sh";
Arguments  = "testJob.conf MdasEnv";
StdOutput  = "std.out";
StdError   = "std.err";
OutputSandbox = {"std.out" , "std.err" };
InputSandbox  = {"runJob.sh", "testJob.conf" , "MdasEnv" };
Requirements  = Member("nl.vl-e.poc-release-1.0", \
    other.GlueHostApplicationSoftwareRunTimeEnvironment);
```

fMRI Analysis Jobs: *feat* wrapper

Contrib: Kamel Boulebiar (IvI,UvA)



Experiment Manager

- Facilitates data and job management of large experiments
  - Parameter and image sweeps

with facilities for

  - Distribution of jobs on resources
  - Monitoring
- Example:
  - NIMROD (Monash University, Australia)

Experiment Plan

parameters

stage in

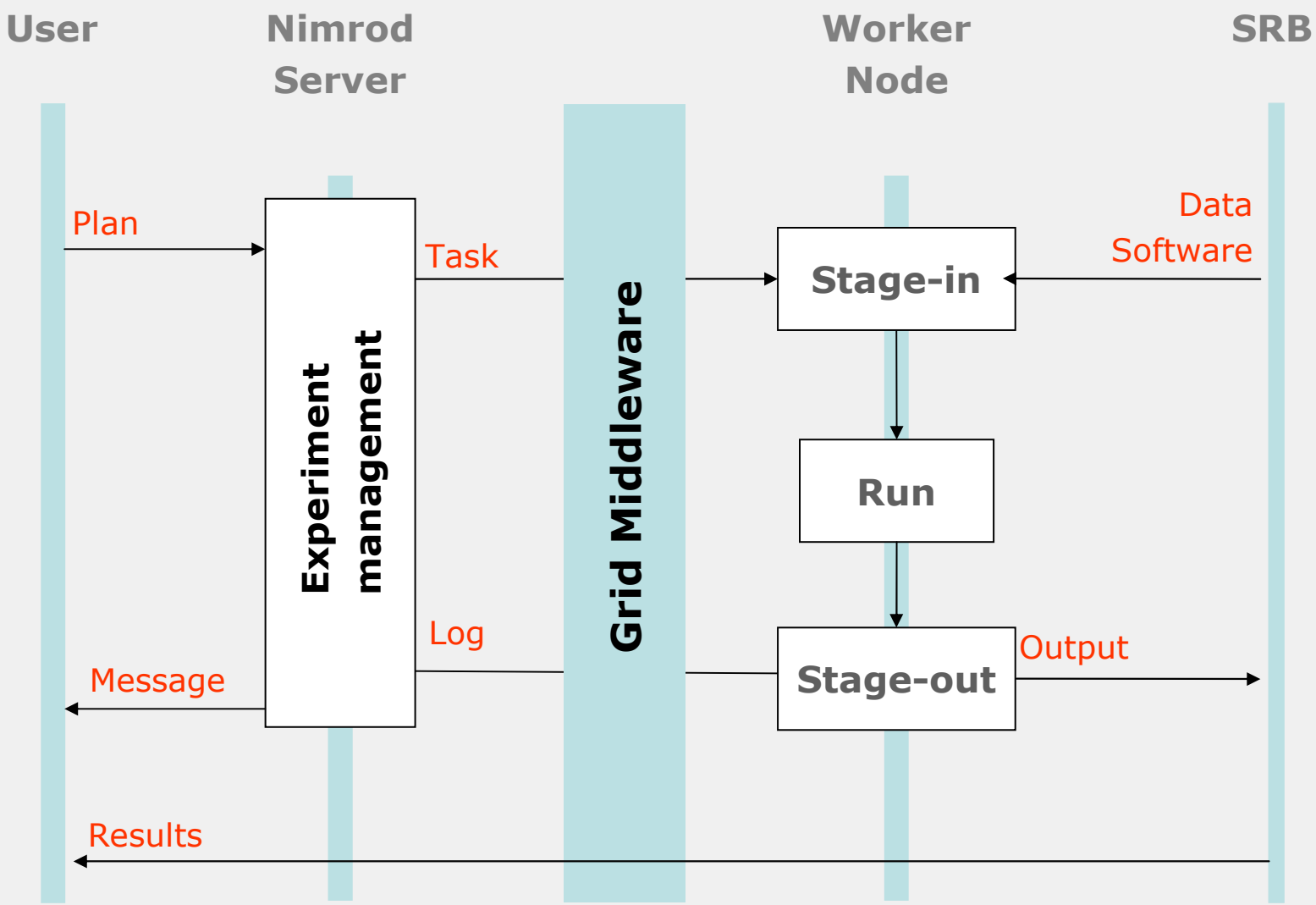
run task

stage out

Font: default 14

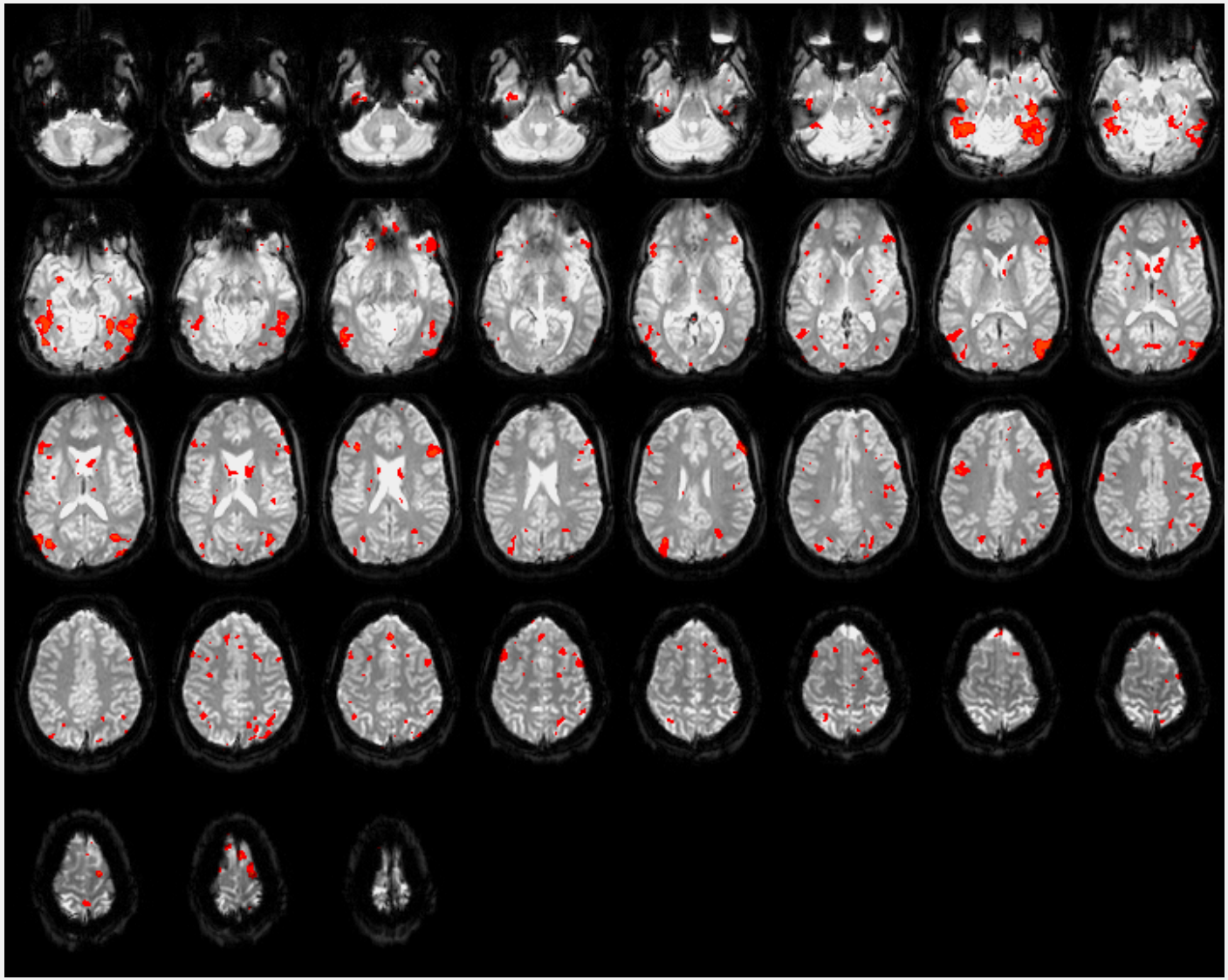
```
# + copy stdout, stderr from node
#
# sweep convolve_phase parameter

parameter NIM_scan text select anyof iaps28 iaps35;
parameter NIM_subject text default pp1;
parameter NIM_convolve_phase float range from -2 to 2 step 0.25;

task main
  onerror ignore
  copy ./runJob.sh node:.
  copy ./MdasEnv node:.

  # this replaces NIM_convolve_phase
  copy ./design-iaps-phase-template.fsf node:.
  node:substitute design-iaps-phase-template.fsf design-iaps-phase.fsf

  # this replaces NIM_subject, NIM_scan, NIM_convolve_phase
  copy ./runfeat-phase-template.conf node:.
  node:substitute runfeat-phase-template.conf runfeat-phase.conf

  # now run
  node:execute /bin/bash ./runJob.sh ./runfeat-phase.conf ./MdasEnv

  # get output
  copy node:stderr stderr.${NIM_subject}-${NIM_scan}-p${NIM_convolve_ph
  copy node:stdout stdout.${NIM_subject}-${NIM_scan}-p${NIM_convolve_p
endtask
```

Large Experiments on the Grid

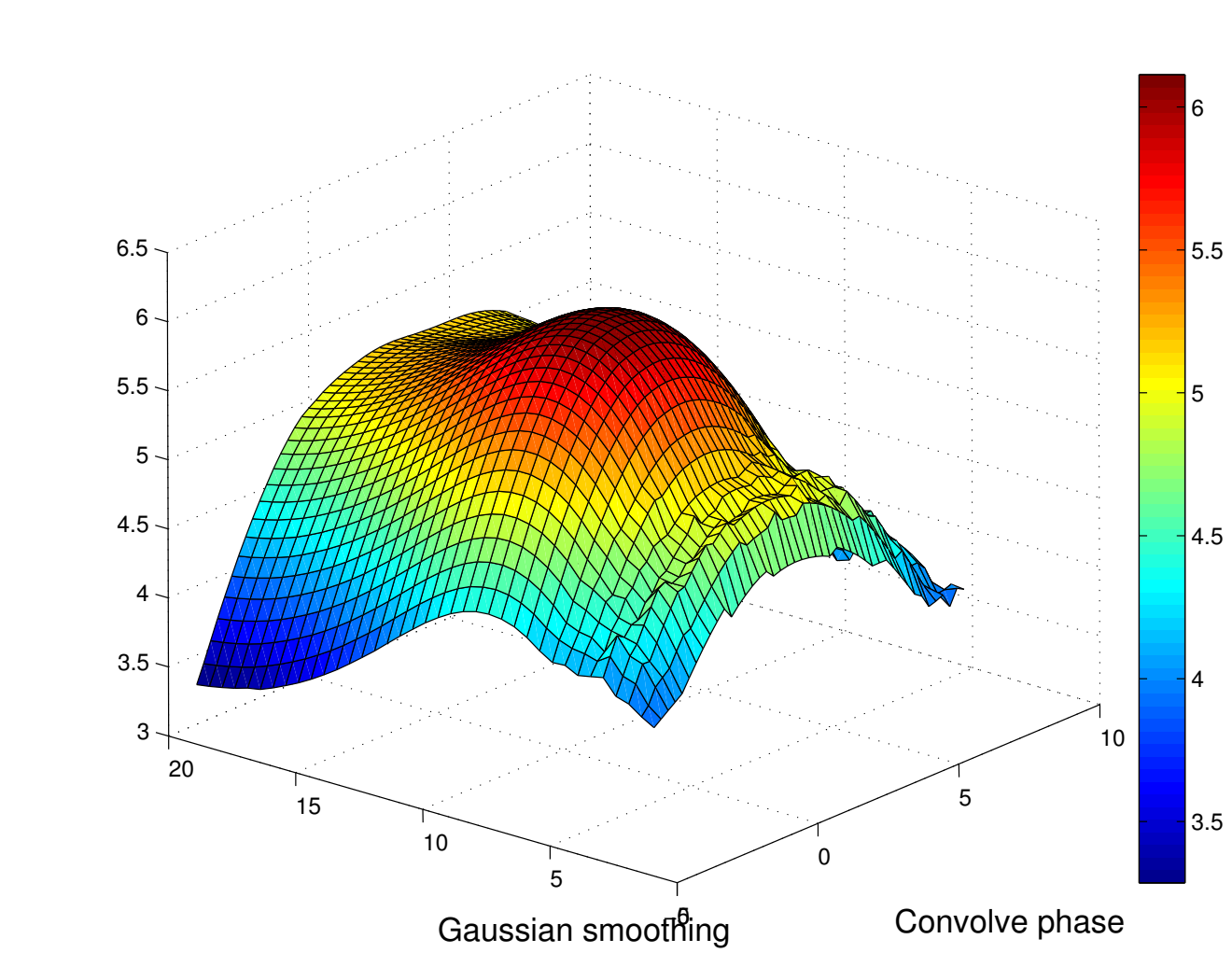


1-D Parameter Sweep

22 scans, 17 values, 374 jobs, 420h CPU



2-D Parameter Sweep
1 scan, 1665 jobs, ~555h CPU



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Current Status

- GAP at AMC
- Feat analysis from VBrowser
- New experiment manager under development
- Added value for clinical research?

- More info
  - www.science.uva.nl/~silvia/vlfmri

Final Remarks

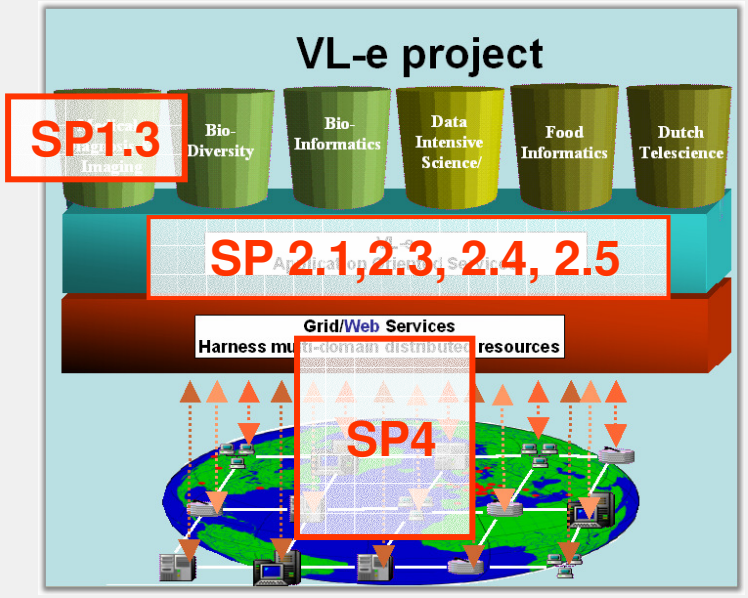
- No “rocket science”, no “free lunch” …
  - Evolving technology and requirements
  - Evolving/unstable/poorly documented infrastructure
  - Tools with low usability for “end users”
  - Insufficient experts for application development
  - Difficult communication across domains and expertises (informatics, medical)

Conclusions

- "High Energy Physics Experiment" model is not appropriate for all application domains
- Collaboration among experts from various fields is essential for development of grid applications
- VL-e provides the scope for this collaboration

VL-e Medical & Co

- AMC (SP1.3)
  - Aart Nederveen, Matthan Caan, Sanna Gevers, Silvia Olabarriaga
  - Kees Grimbergen, Ard den Heeten, Charles Majoie
- IvI
  - Kamel Boulebiar (SP1.3)
  - Piter de Boer, Adam Belloum (SP2.5)
  - Abdullah Ozsoy, Robert Belleman (SP2.1)
  - Breanndán Ó Nualláin (SP2.1)
  - Guido van't Noordende, Matthijs Koot (SP2.4)
- SARA (SP4)
  - Maurice Bouwhuis, Bart Heupers
  - grid-support@sara.nl
- NIKHEF (SP4)
  - Jan Just Keijser, Dennis van Dok
  - grid-support@nikhef.nl
- VUMC (SP1.3)
  - Keith Cover, Bob van Dijk
  - Hugo Vrenken, Frederik Barkov
- Previous members
  - K. Maheshwari
  - J. Snel, J. Alkemade
  - A. Bucur, H. Obbink, J. van Leeuwen



Special Credits

- VBrowser: P. de Boer
- RFTS: K. Maheshwari
- 3D Viewer plug-in: A. Ozsoy
- fMRI analysis plug-in: K. Boulebiar
- GAP installation support: J.J. Keijser
- Clinical data: A. Nederveen

- Prof. Dr. Bob Hertzberger

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Dutch Ministry of Education, Culture and Science
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Thanks for your attention!

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http://www.vl-e.nl/