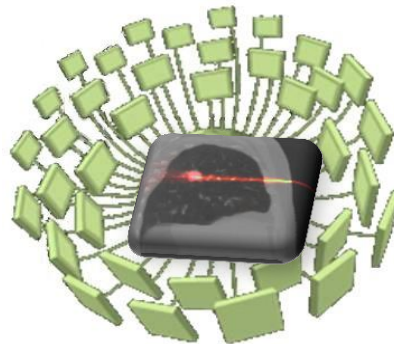


Virtual Imaging Platform - VIP -



Sorina Pop

Laboratoire Creatis

Université de Lyon, CREATIS; CNRS UMR5220; Inserm U1044; INSA-Lyon; Université Lyon 1, France

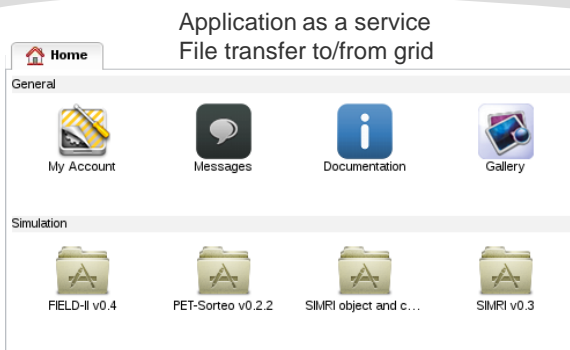


- General VIP presentation
- Performance optimizations
- Tools for multi-modality simulations
- Conclusions and perspectives
- Hands-on

Virtual Imaging Platform

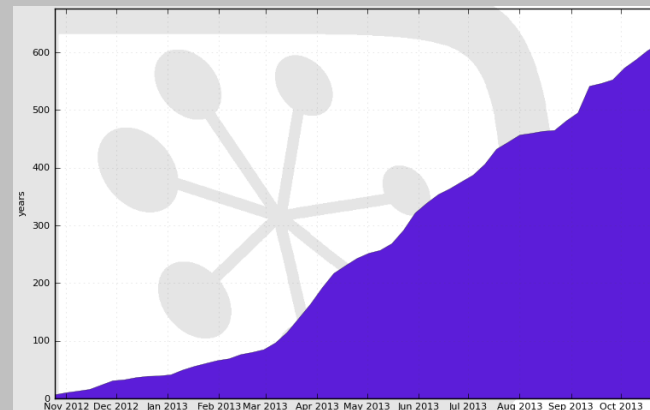
<http://www.creatis.insa-lyon.fr/vip>

Web portal



Infrastructure

Supported by EGI Infrastructure
Uses biomed VO (most used EGI VO for life sciences in 2013)
VIP accounts for **~25% of biomed's activity**
VIP consumes **~50 CPU years** every month



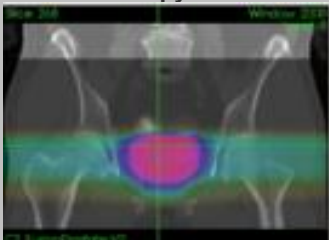
France-Grilles



DIRAC

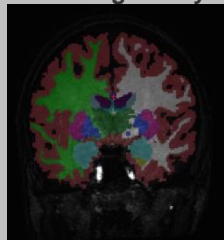
Scientific applications

Cancer therapy simulation



Prostate radiotherapy plan simulated with GATE (L. Grevillot and D. Sarrut)

Neuro-image analysis



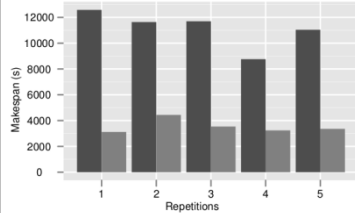
Brain tissue segmentation with Freesurfer

Image simulation



Echocardiography simulated with FIELD-II (O. Bernard *et al*)

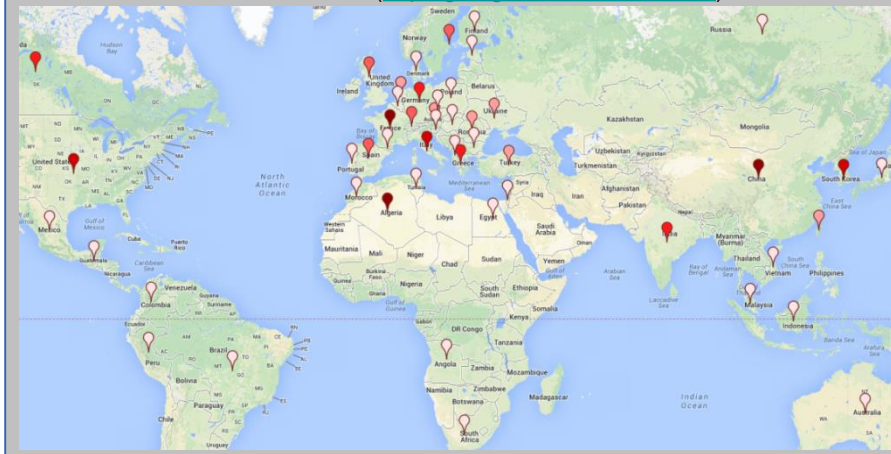
Modeling and optimization of distributed computing systems



Acceleration yielded by non-clairvoyant task replication (R. Ferreira da Silva *et al*)

Users

579 registered users in April 2014 (200 in France)
Most used robot certificate in EGI (<http://go.egi.eu/wiki.robot.users>)



Virtual Imaging Platform (VIP)

A web portal for medical image applications on grids

The screenshot displays the VIP web portal interface. At the top, there is a 'Home' button. Below it, a 'General' section contains icons for 'My Account', 'Messages', 'Documentation', 'Gallery', 'File Transfer', 'Models', 'Simulation Editor', and 'Simulation Monitor'. A 'Simulation' section follows, showing icons for 'FIELD-II v0.4', 'PET-Sorteo v0.2.2', 'SIMRI object and c...', 'SIMRI v0.3', 'Simri v0.3 64cores', and 'Sindbad 0.1.2'. A red-bordered box with the text 'Launch applications' is positioned to the right of these icons. Below the simulation section is a 'File Transfer' section. It features a 'Platform Files' area with a dropdown menu set to '/vip/Home' and a table of files. A red-bordered box with the text 'Transfer files' is placed over the table. To the right of the table is a 'Pool of Transfers' section with a 'Clear List' button and a list of transfers, including '/vip/Home/0deg0mm_img0_0_ae.sdt' and '/vip/Home/RT_PET_1.zip'. A 'More operations' button is located at the bottom of the transfer list.

Name	Size	Modification Date
01-11-2011_10:43:40		
01-11-2011_10:57:15		
01-11-2011_10:57:59		
01-11-2011_14:39:02		
01-11-2011_14:44:55		
02-11-2011_09:32:41		

Pool of Transfers
/vip/Home/0deg0mm_img0_0_ae.sdt Uploaded - February 23, 2012 14:15
/vip/Home/RT_PET_1.zip Download - December 23, 2011 10:41

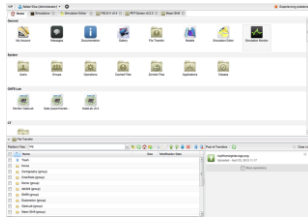
<https://vip.creatis.insa-lyon.fr>

VIP Architecture



User

0. Login
1. Send input data



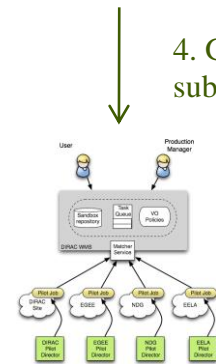
Web portal

3. Launch workflow



Workflow engine
(Moteur + GASW)

4. Generate and submit task



Pilot Manager
(DIRAC)

5. Submit and 6. Schedule pilot jobs

2. Transfer input files



Storage system

8. Get files
9. Execute
10. Upload results



Computing sites

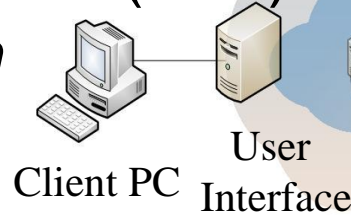
7. Get task

Distributed computing infrastructures

- High Throughput Computing (HTC)
 - ↪ Several computing clusters across multiple administrative boundaries
 - ↪ Loosely coupled jobs

- European Grid Infrastructure (EGI)

- ↪ Biomed Virtual Organization
 - ~100 computing centers



- Challenges

- ↪ ~15% of job failures (quota violations, file transfers, application errors)
- ↪ Waiting times of a few minutes to a few hours

DCI

Monte-Carlo simulations

- Repeated random sampling of solution space

- ↪ Large number of independent events*

- Parallelisation: split and merge

- ↪ Define a domain of possible inputs.*

- ↪ Process the inputs.*

- ↪ Merge the results.*

- Example: GATE simulator

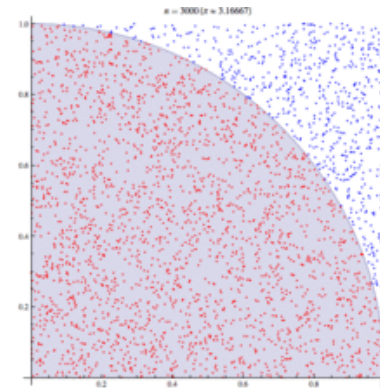
- ↪ Simulation of particle tracking*

- ↪ Based on GEANT4*

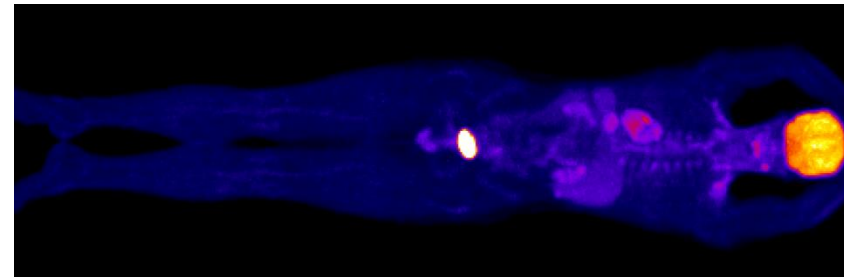
- ↪ Nuclear medicine simulations for Positron Emission Tomography (PET) and radiation therapy imaging*

- ↪ OpenGATE international collaboration*

- ↪ [Allison et al., 2006]*



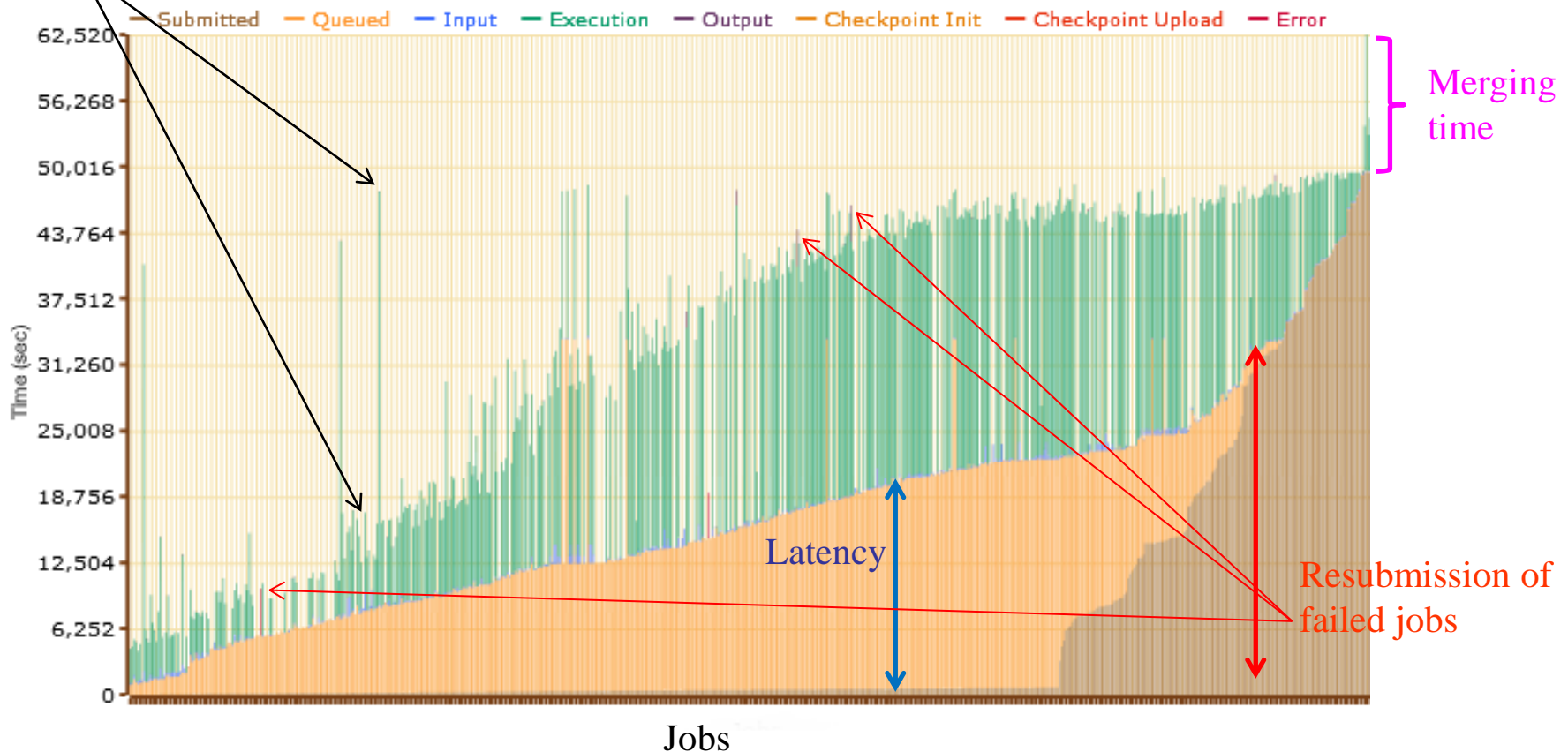
Computing π
Source: Wikipedia



3D whole-body F18-FDG PET scan simulated with GATE, representing 4,000 CPU hours (5.3 months). Credits: IMNC-IN2P3.

Example of a static-splitting Monte-Carlo execution on EGI

Heterogeneity (same start, different finish time)



- General VIP presentation
- Performance optimizations
- Tools for multi-modality simulations
- Conclusions and perspectives
- Hands-on

Proposed dynamic parallelization

- N parallel workers simulate as much as possible (up to E)

Static Worker

Simulate E/N events

Dynamic Worker

Simulate as much as possible

Dynamic Worker

While “stop” not received:

 Simulate events during x seconds

 Update master counter

End while

Master

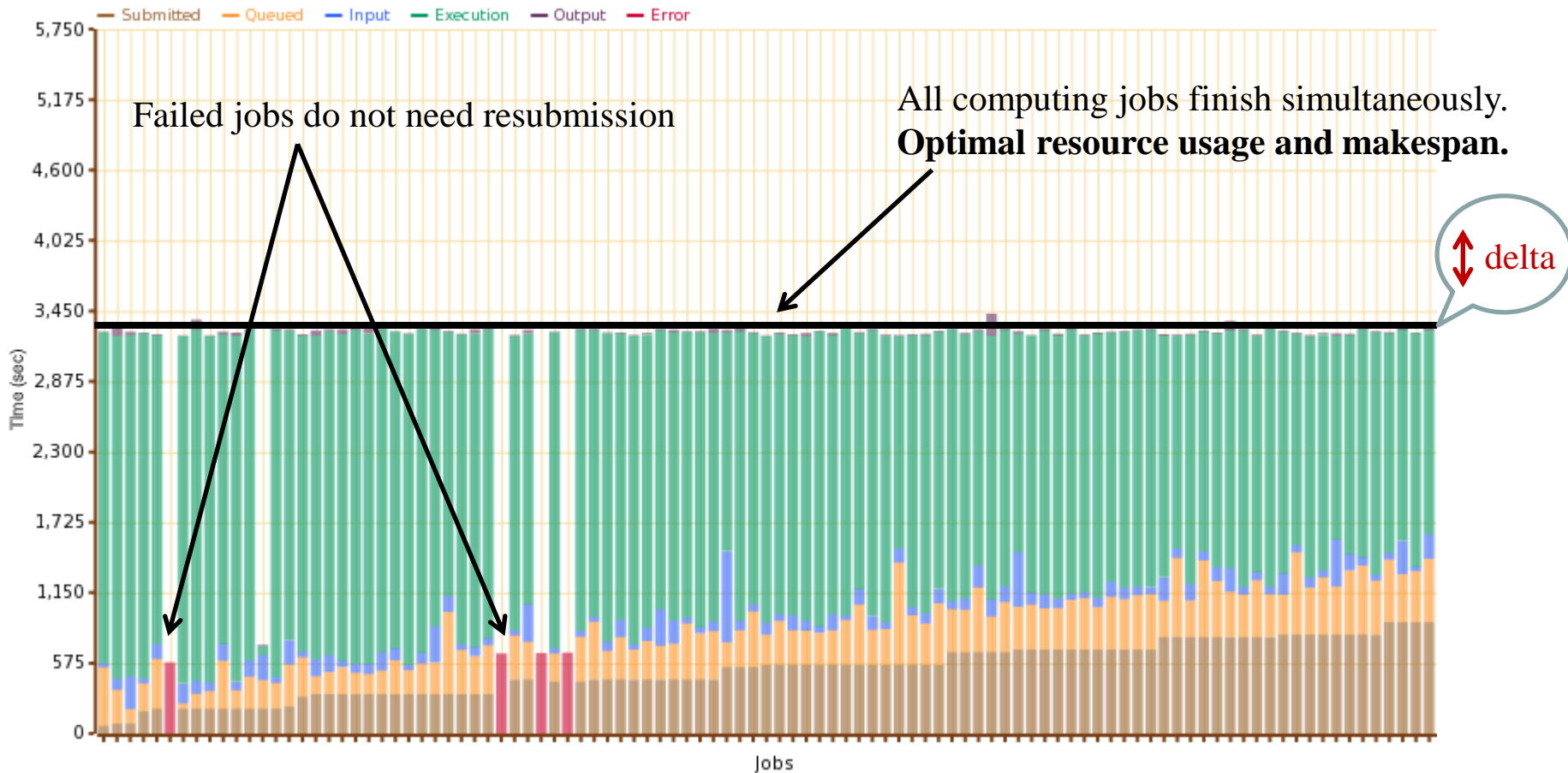
While $e \neq E$

$e \leftarrow \#$ simulated events

End while

Stop the workers

Dynamic parallelization results

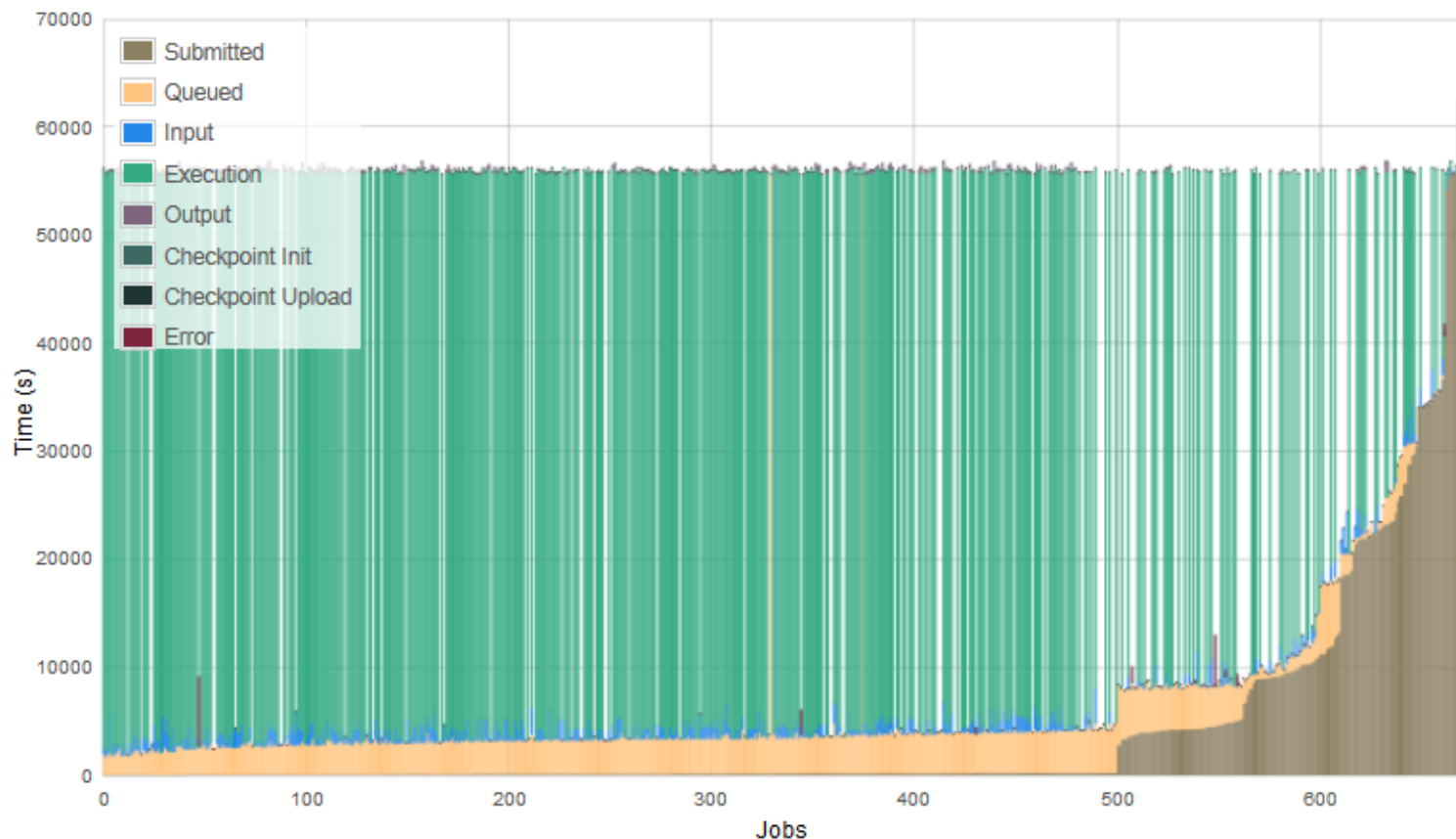


Dynamic execution in production

- GATE execution

- ↪ Using the proposed dynamic algorithm → speed-up 392

- ↪ Cumulated CPU time of 282 days executed with the GATE-Lab in 17.3 hours



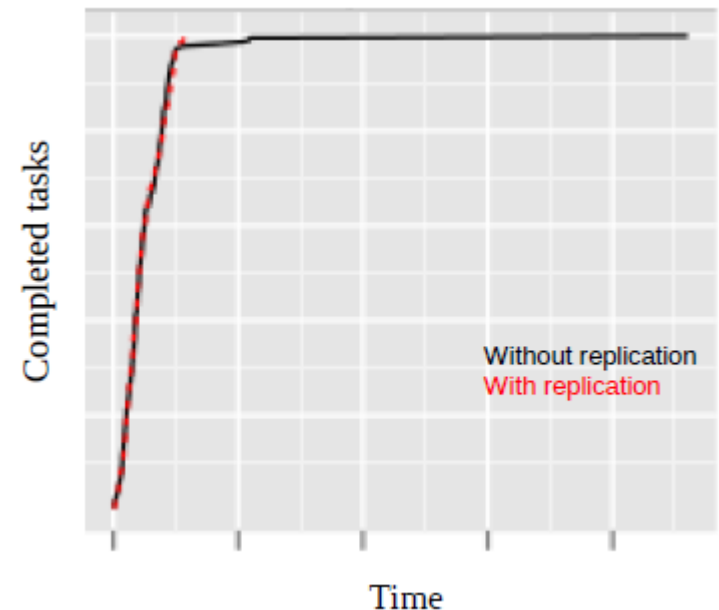
Automatic task replication

- Replicate late tasks to increase chances of fast completion
- Be careful of resource waste
- Algorithm

Credits: Rafael Ferreira da Silva, Tristan Glatard and Frédéric Desprez, [Silva et al, FGCS 2013]

```
If task is detected late
  If task only has late replicas
    If no task replica is queued
      Replicate task
    End if
  End if
End if

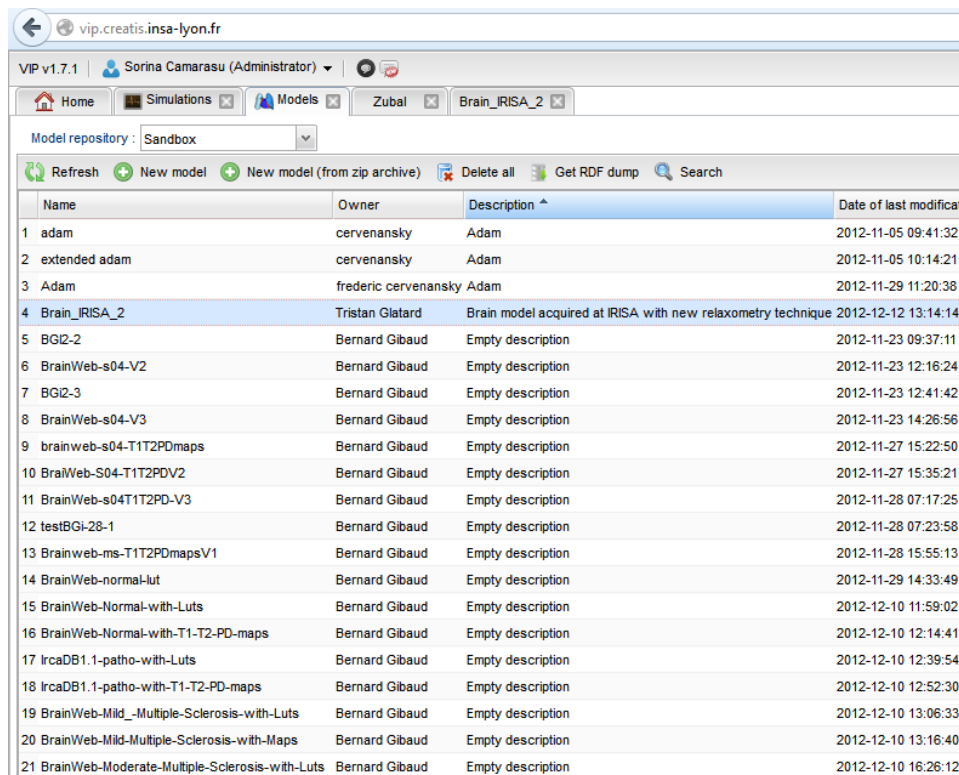
If a task replica is detected late
  Cancel task replica
End if
```



- General VIP presentation
- Performance optimizations
- Tools for multi-modality simulations
- Conclusions and perspectives
- Hands-on

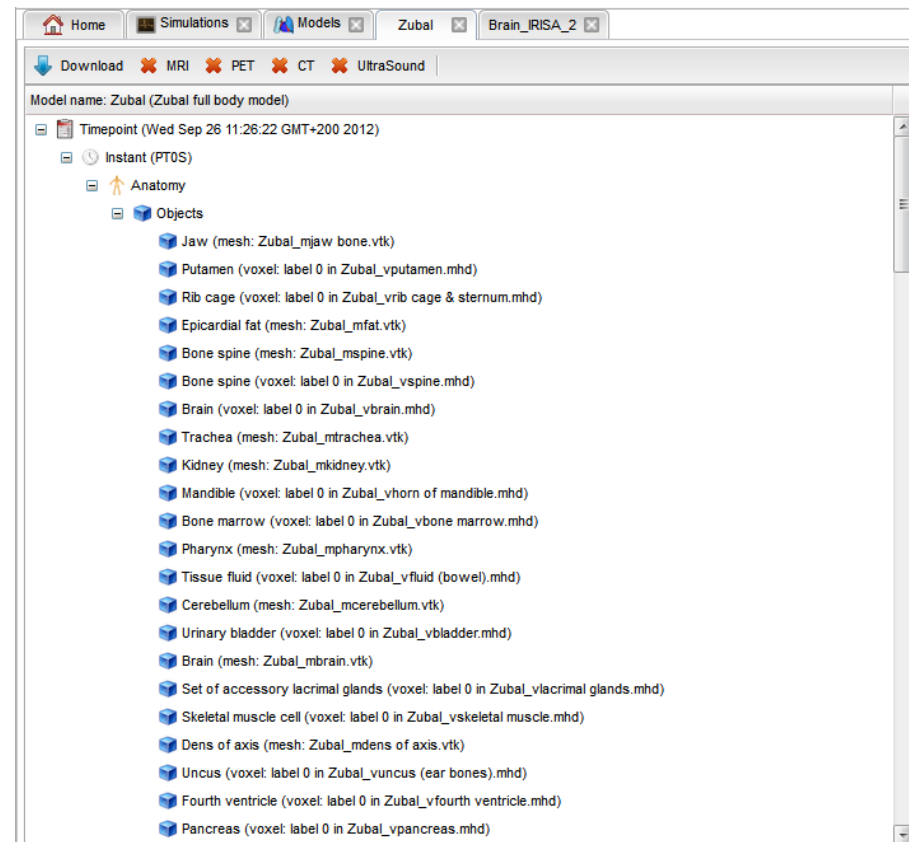
A repository of multi-physics models

- Semantic description of models, simulation processes and data
- Multi-modality models can be shared and used in simulations



The screenshot shows the VIP v1.7.1 web interface. The browser address bar displays 'vip.creatis.insa-lyon.fr'. The user is logged in as Sorina Camarasu (Administrator). The interface includes a navigation menu with 'Home', 'Simulations', 'Models', 'Zubal', and 'Brain_IRISA_2'. Below the navigation is a 'Model repository' section with a search bar and a table of models.

Name	Owner	Description	Date of last modification
1 adam	cervenansky	Adam	2012-11-05 09:41:32
2 extended adam	cervenansky	Adam	2012-11-05 10:14:21
3 Adam	frederic.cervenansky Adam		2012-11-29 11:20:38
4 Brain_IRISA_2	Tristan Glatard	Brain model acquired at IRISA with new relaxometry technique	2012-12-12 13:14:14
5 BGQ2-2	Bernard Gibaud	Empty description	2012-11-23 09:37:11
6 BrainWeb-s04-V2	Bernard Gibaud	Empty description	2012-11-23 12:16:24
7 BGQ2-3	Bernard Gibaud	Empty description	2012-11-23 12:41:42
8 BrainWeb-s04-V3	Bernard Gibaud	Empty description	2012-11-23 14:26:56
9 brainweb-s04-T1T2PDmaps	Bernard Gibaud	Empty description	2012-11-27 15:22:50
10 BrainWeb-S04-T1T2PDV2	Bernard Gibaud	Empty description	2012-11-27 15:35:21
11 BrainWeb-s04T1T2PD-V3	Bernard Gibaud	Empty description	2012-11-28 07:17:25
12 testBGI-28-1	Bernard Gibaud	Empty description	2012-11-28 07:23:58
13 Brainweb-ms-T1T2PDmapsV1	Bernard Gibaud	Empty description	2012-11-28 15:55:13
14 BrainWeb-normal-lut	Bernard Gibaud	Empty description	2012-11-29 14:33:49
15 BrainWeb-Normal-with-Luts	Bernard Gibaud	Empty description	2012-12-10 11:59:02
16 BrainWeb-Normal-with-T1-T2-PD-maps	Bernard Gibaud	Empty description	2012-12-10 12:14:41
17 IrcaDB1.1-patho-with-Luts	Bernard Gibaud	Empty description	2012-12-10 12:39:54
18 IrcaDB1.1-patho-with-T1-T2-PD-maps	Bernard Gibaud	Empty description	2012-12-10 12:52:30
19 BrainWeb-Mild-Multiple-Sclerosis-with-Luts	Bernard Gibaud	Empty description	2012-12-10 13:06:33
20 BrainWeb-Mild-Multiple-Sclerosis-with-Maps	Bernard Gibaud	Empty description	2012-12-10 13:16:40
21 BrainWeb-Moderate-Multiple-Sclerosis-with-Luts	Bernard Gibaud	Empty description	2012-12-10 16:26:12



The screenshot shows the detailed view of the 'Zubal' model in the VIP v1.7.1 web interface. The browser address bar displays 'vip.creatis.insa-lyon.fr'. The user is logged in as Sorina Camarasu (Administrator). The interface includes a navigation menu with 'Home', 'Simulations', 'Models', 'Zubal', and 'Brain_IRISA_2'. Below the navigation is a 'Model repository' section with a search bar and a table of models.

Model name: Zubal (Zubal full body model)

Timepoint (Wed Sep 26 11:26:22 GMT+200 2012)

Instant (PTOS)

Anatomy

Objects

- Jaw (mesh: Zubal_mjaw bone.vtk)
- Putamen (voxel: label 0 in Zubal_vputamen.mhd)
- Rib cage (voxel: label 0 in Zubal_vrib cage & sternum.mhd)
- Epicardial fat (mesh: Zubal_mfat.vtk)
- Bone spine (mesh: Zubal_mspine.vtk)
- Bone spine (voxel: label 0 in Zubal_vspine.mhd)
- Brain (voxel: label 0 in Zubal_vbrain.mhd)
- Trachea (mesh: Zubal_mtrachea.vtk)
- Kidney (mesh: Zubal_mkidney.vtk)
- Mandible (voxel: label 0 in Zubal_vhorn of mandible.mhd)
- Bone marrow (voxel: label 0 in Zubal_vbone marrow.mhd)
- Pharynx (mesh: Zubal_mpharynx.vtk)
- Tissue fluid (voxel: label 0 in Zubal_vfluid (bowel).mhd)
- Cerebellum (mesh: Zubal_mcerebellum.vtk)
- Urinary bladder (voxel: label 0 in Zubal_vbladder.mhd)
- Brain (mesh: Zubal_mbrain.vtk)
- Set of accessory lacrimal glands (voxel: label 0 in Zubal_vlacrima glands.mhd)
- Skeletal muscle cell (voxel: label 0 in Zubal_vmuscle.mhd)
- Dens of axis (mesh: Zubal_mdens of axis.vtk)
- Uncus (voxel: label 0 in Zubal_vuncus (ear bones).mhd)
- Fourth ventricle (voxel: label 0 in Zubal_vfourth ventricle.mhd)
- Pancreas (voxel: label 0 in Zubal_vpancreas.mhd)

A repository of simulated data

- A repository stores semantically annotated simulated data

PET						
	Simulated Data File	Type	Simulation Parameters	Model	Simulation Name	Simulation Date
1	dataLMF.ccs.sino	PET-sinogram	protocol.txt	fantome.v	test sorteo	10/09/2013
2	dataLMF.ccs.sino	PET-sinogram	protocol.txt	fantome.v	test sorteo	05/22/2013
3	dataLMF.ccs.sino	PET-sinogram	protocol.txt	fantome.v	test	01/31/2013
4	dataLMF.ccs.sino	PET-sinogram	protocol.txt	fantome.v	Zubal	12/12/2012

Ultrasound						
	Simulated Data File	Type	Simulation Parameters	Model	Simulation Name	Simulation Date
1	RF.mat	US-raw-signal	probeUS_PASA-small.mat	frame1.mat	2Dt cardiac sequence - parasternal short axis - 1 frame	06/17/2013
2	image.mhd ; image.raw	US-simulated-image	probeUS_PASA-small.mat	frame1.mat	2Dt cardiac sequence - parasternal short axis - 1 frame	06/17/2013
3	image.mat	US-simulated-image	probeUS_PASA-small.mat	frame1.mat	2Dt cardiac sequence - parasternal short axis - 1 frame	06/17/2013
4	image.mat	US-simulated-image	probeUS_PASA-small.mat	frame1.mat	2Dt cardiac sequence - parasternal short axis - 1 frame	12/14/2012
5	image.mhd ; image.raw	US-simulated-image	probeUS_PASA-small.mat	frame1.mat	2Dt cardiac sequence - parasternal short axis - 1 frame	12/14/2012
6	RF.mat	US-raw-signal	probeUS_PASA-small.mat	frame1.mat	2Dt cardiac sequence - parasternal short axis - 1 frame	12/14/2012
7	image.mat	US-simulated-image	probeUS_PASA-small.mat	frame1.mat	2Dt cardiac sequence - parasternal short axis - 1 frame	12/14/2012
8	image.mhd ; image.raw	US-simulated-image	probeUS_PASA-small.mat	frame1.mat	2Dt cardiac sequence - parasternal short axis - 1 frame	12/14/2012

CT						
	Simulated Data File	Type	Simulation Parameters	Model	Simulation Name	Simulation Date
1	results.tar.gz	CT-simulated-image	scan_1proj.sca (simulation-parameter-set) ; chaine_volume_C phantom_CHE_ELO_v2.tar.gz (CT-simulation-compatible-model)	phantom_XRAY	Chantal_SIM_Sindbad	12/14/2012
2	results.tar.gz	CT-simulated-image	chaine_volume_CHE_ELO_v2.mdf (simulation-parameter-set) ; organes.pegs4dat (CT-simulation-compatible-model)	phantom_XRAY		12/14/2012
3	results.tar.gz	CT-simulated-image	scan_1proj.sca (simulation-parameter-set) ; geo_volume_Det8 organes.pegs4dat (CT-simulation-compatible-model)	phantom_XRAY		12/14/2012
4	results.tar.gz	CT-simulated-image	scan_1proj.sca (simulation-parameter-set) ; chaine_volume_C organes.pegs4dat (CT-simulation-compatible-model)	phantom_XRAY		12/14/2012
5	results.tar.gz	CT-simulated-image	geo_volume_Det800_800_2mm.geo (model-to-scanner-geom) organes.pegs4dat (CT-simulation-compatible-model)	phantom_XRAY		12/14/2012
6	results.tar.gz	CT-simulated-image	geo_volume_Det800_800_2mm.geo (model-to-scanner-geom) phantom_CHE_ELO_v2.tar.gz (CT-simulation-compatible-model)	phantom_XRAY		12/14/2012
7	results.tar.gz	CT-simulated-image	chaine_volume_CHE_ELO_v2.mdf (simulation-parameter-set) ; phantom_CHE_ELO_v2.tar.gz (CT-simulation-compatible-model)	phantom_XRAY		12/14/2012
8	results.tar.gz	CT-simulated-image	chaine_volume_CHE_ELO_v2.mdf (simulation-parameter-set) ; organes.pegs4dat (CT-simulation-compatible-model)	phantom_XRAY		12/14/2012

MRI						
	Simulated Data File	Type	Simulation Parameters	Model	Simulation Name	Simulation Date
1	T1_SrepFullSmoothComp0.nii.gz-T2_SrepFullSmoothComp0.nii	MR-simulated-image	8.4 (echo-time) ; 500 (repetition-time)	T2_SrepFullSmoothComp0.nii.gz (T2);M0_SrepFullSmoothComp0.nii.gz (T1)	SrepFullSmooth	10/06/2013
2	T1_SrepFullSmoothComp0.nii.gz-T2_SrepFullSmoothComp0.nii	MR-simulated-image	4 (echo-time) ; 1880 (repetition-time)	T2_SrepFullSmoothComp0.nii.gz (T2);T1_SrepFullSmoothComp0.nii.gz (T1)	SrepFullSmooth	10/06/2013
3	T1_CarveSrepTextureComp0.nii.gz-T2_CarveSrepTextureComp0.nii	MR-simulated-image	500 (repetition-time) ; 8.4 (echo-time)	T1_CarveSrepTextureComp0.nii.gz (T1);M0_CarveSrepTextureComp0.nii.gz (T2)	T1_CarveSrepTexture	10/06/2013
4	T1_SrepFullComp0.nii.gz-T2_SrepFullComp0.nii.gz-M0_SrepFullComp0.nii	MR-simulated-image	500 (repetition-time) ; 8.4 (echo-time)	T2_SrepFullComp0.nii.gz (T2);T1_SrepFullComp0.nii.gz (T1);M0_SrepFullComp0.nii.gz (T0)	TestfullSrep	10/04/2013

- General VIP presentation
- Performance optimizations
- Tools for multi-modality simulations
- Conclusions and perspectives
- Hands-on

- VIP

- ↗ One of the most used EGI platforms*
- ↗ Users can transfer files and launch applications*
- ↗ Computing sites and file locations are automatically selected*
- ↗ Applications are external to the portal*
- ↗ Integrates tools for multi-modality simulations*

- Perspectives

- ↗ Keep it up and running for daily scientific production*
- ↗ Integrate cloud resources (DIRAC-VM ?)*
- ↗ Integrate new applications*

- Log in at <https://vip.creatis.insa-lyon.fr/>
- Check your account type
 - ↪ Join groups tutorial and GateLab*
- Launch simulations
 - ↪ Install Java plugin : `sudo apt-get install icedtea-7-plugin`*
 - ↪ Download GateLab inputs*
 - ↪ Launch GateLab*
 - ↪ Launch SimuBloch (SimuBloch SE 0.3 with example inputs)*
- Follow simulations
 - ↪ Look at the logs and performance statistics*
- Retrieve and visualize outputs
 - ↪ `/opt/vv-1.3.1-Linux/bin/vv-1.3.1-x86_64`*

Acknowledgements

- CREATIS lab
 - Tristan Glatard
 - Nouha Boujelben
 - Frédéric Cervenansky
 - Hugues Benoit-Cattin
- France-Grilles
- MOTEUR2
 - Johan Montagnat ; CNRS I3S
- Pilot jobs
 - Jakub T. Moscicki ; *CERN*
 - A. Tsaregorodtsev, V. Hammar ; *CPPM*
- EGI grid support
 - <https://ggus.eu>

Thank you for your attention!

Questions?