eGee

Pharmacokinetics on Contrast Agents in Abdominal Cancer

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# Structure

- **Short Introduction of the Problem and Motivation.**

- **Brief Details of the Application.**

- **Live Demo.**

- **Analysis of the Results and Performance.**

- **Questions and Answers.**

- **A Lesion is Detected in an MRI Study of a Patient.**

- **Malignant and Benign Lesions have Similar Appearance in Medical Images and It is Difficult to Conclude with a Diagnosis with High Degree of Sensitively and Accuracy.**

- **The Final Analysis is the Biopsy.**

- **But Biopsy is Traumatic.**

- **This Delay in the Diagnosis Causes Patient Anxiety in Cases with Reasonable Uncertainity.**
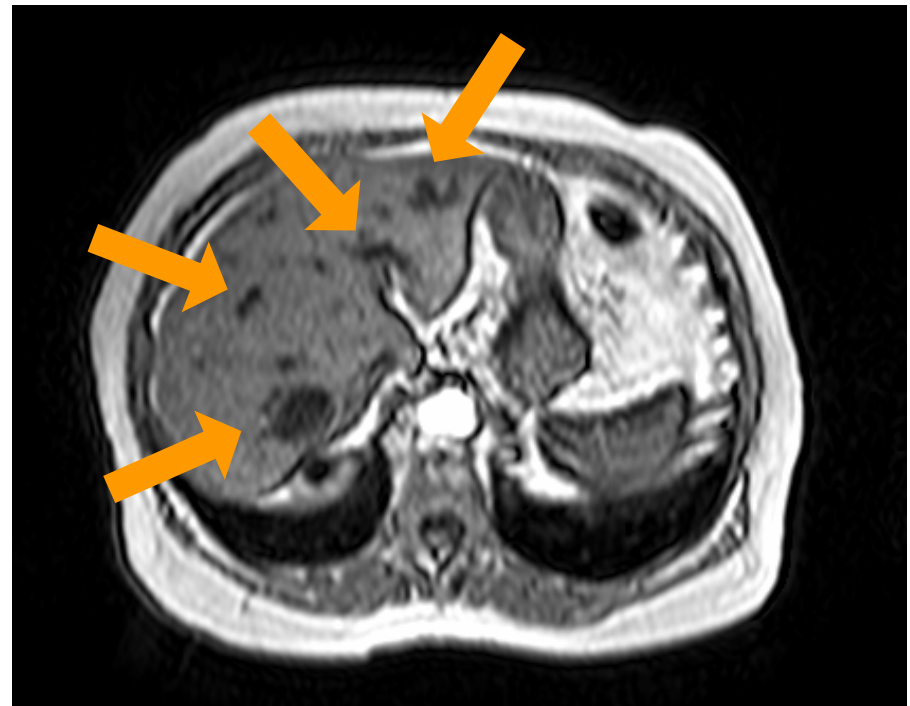
- **Characterization of the Tissular Nature by the Analysis of the Evolution of Contrast in a Time Series.**

- **Tumours Generate the Growing of Vessels Around the Tumoural Mass.**

- **Different Tissues Define Different Constants for Recycling and Flow Rate of the Physical Models.**

- **Those Constants can be used for the Creation of Parametric Images.**

Portal Vein $\xrightarrow{k_{pv}}$

Hepatic Artery $\xrightarrow{k_{ha}}$ **Liver Model**

k_l

Feedback
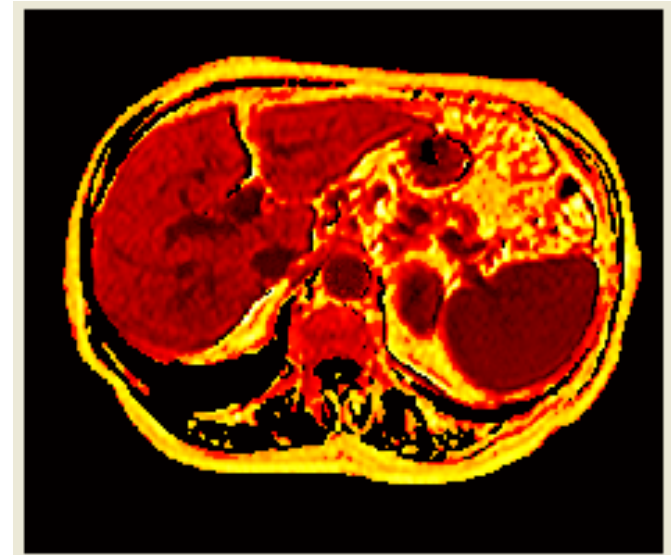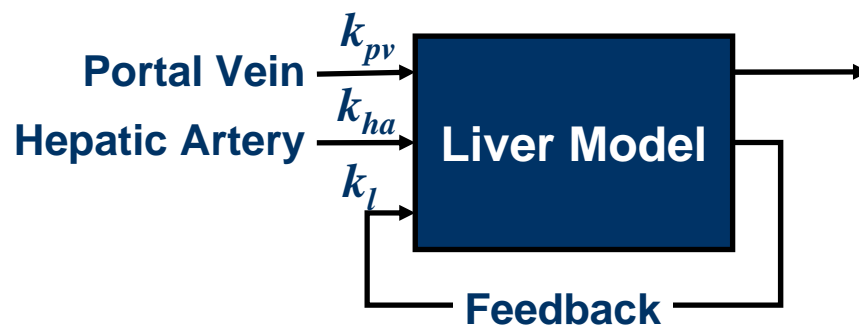
- **Pharmacokinetics in Contrast Evolution is a Hot Topic in Medical Research (845 Articles for Liver in PubMed).**

- **The Work is a Result of a Collaboration Among Four Research Groups (Radiologists, Chemical Engineering and Medical Informatics).**

- **The Problem is User-Driven with a High Interest by the Industry.**

- **The Objective is to**

  – Validate the Theory of the Model.

  – Work in 3D.

  – Demonstrate the Relation of the Constants and the Tissular Nature.

  – Create a New Image Modality.

- **The Model can be Used, with the Proper Tuning, to Other Areas where Vessel Growing is Significant (such as Infertility).**

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Enabling Grids for E-sciencE

- **Description**

  – The Process Requires Obtaining a Sequence of MRI Volumetric Images.

  – Different Images are Obtained in Different Breath-holds.

  – The Movement of the Abdomen is Unavoidable and Relevant when Voxels have Sub-millimetrical Dimensions.

  – Before Analyzing the Variation of each voxel, Images Must be Co-registered to Minimize Deformation due to Different Breath Holds.
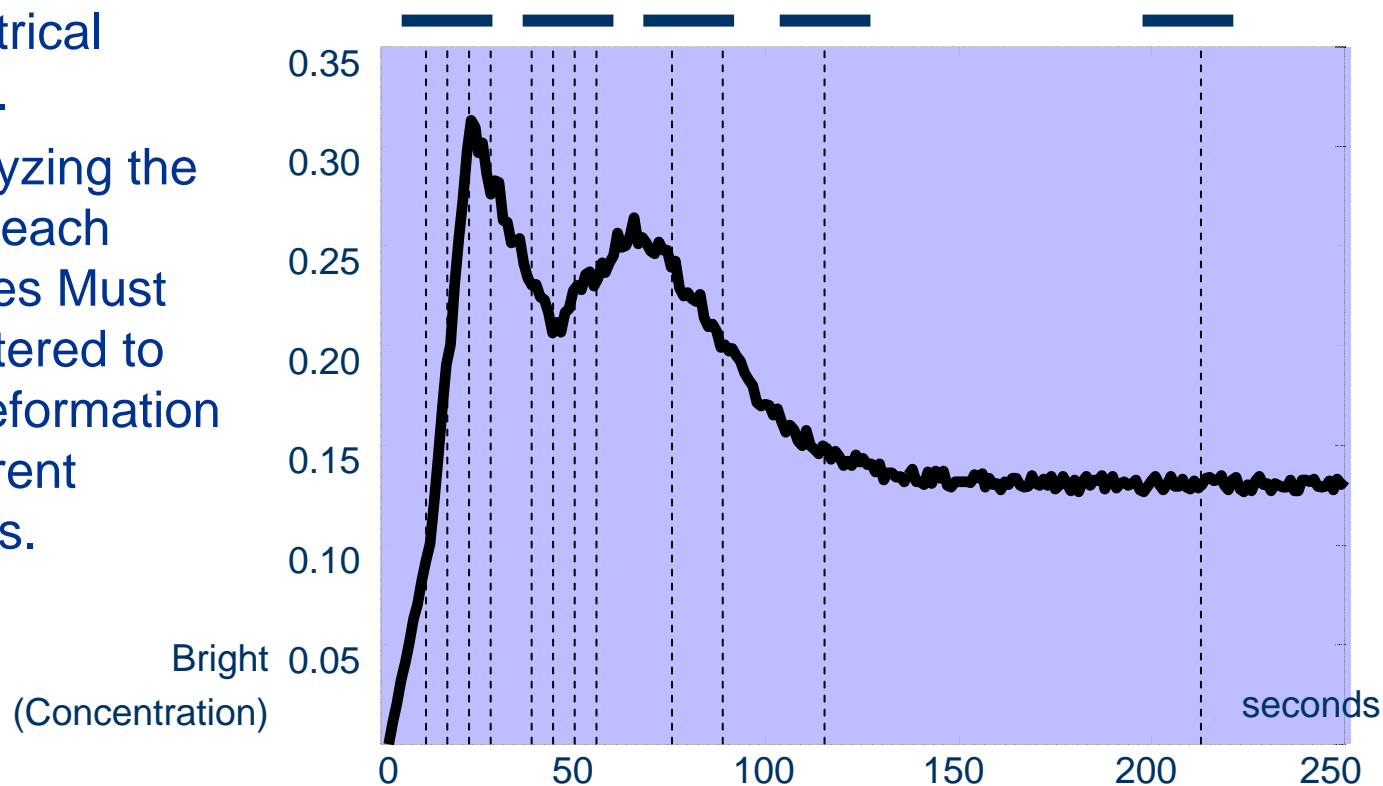
- **The Area of the Abdomen Requires the use of Deformable Registration Methods.**

- **Much More Computationally Intensive than Rigid Affine Registration.**

- **Moreover, Registration Must be Very Accurate to Reduce the Artefacts on the Interpolation, Leading to Test Different Parameters.**

- **The Total Computational Cost of a Clinical Trial of 20 Patients is Around 100 CPU Days.**
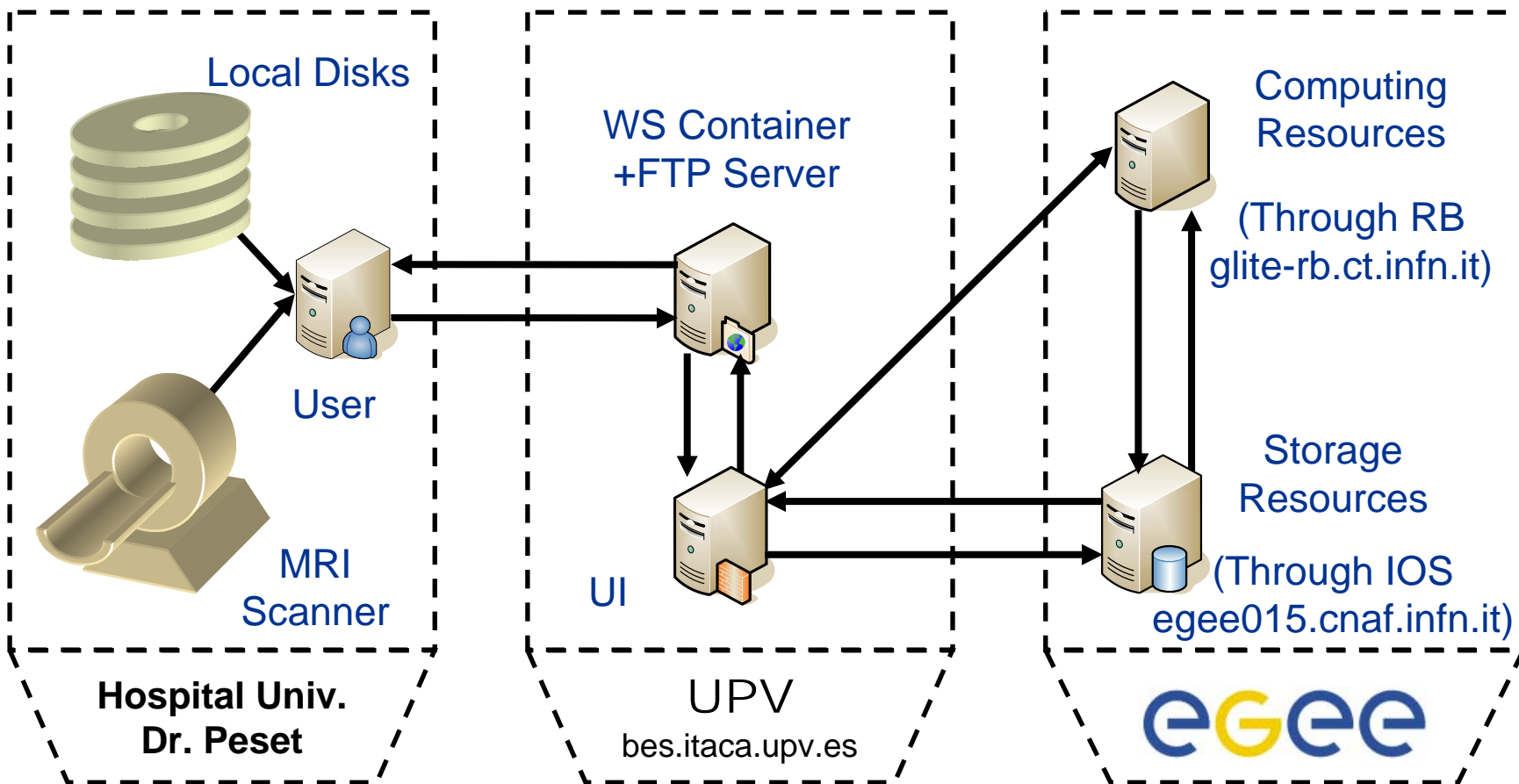
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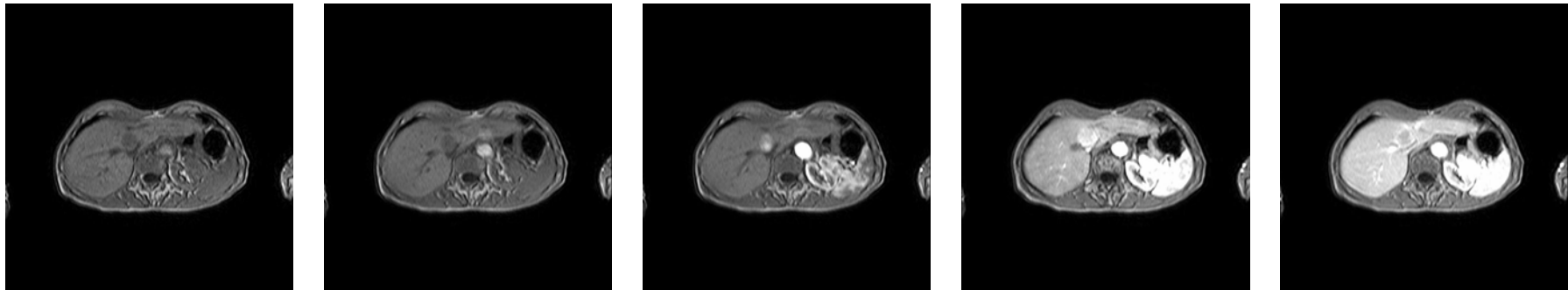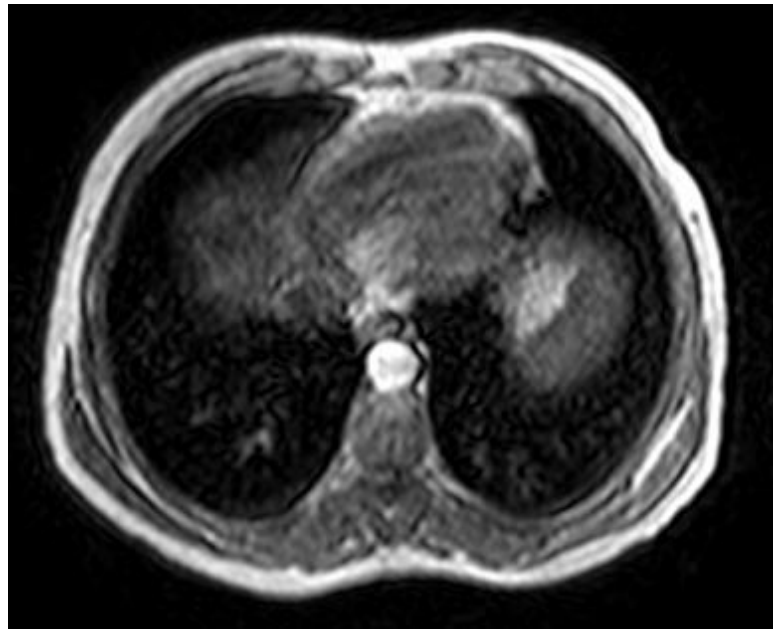
MRI Volume at Timestep 1

MRI Volume at Timestep 13

Enabling Grids for E-sciencE
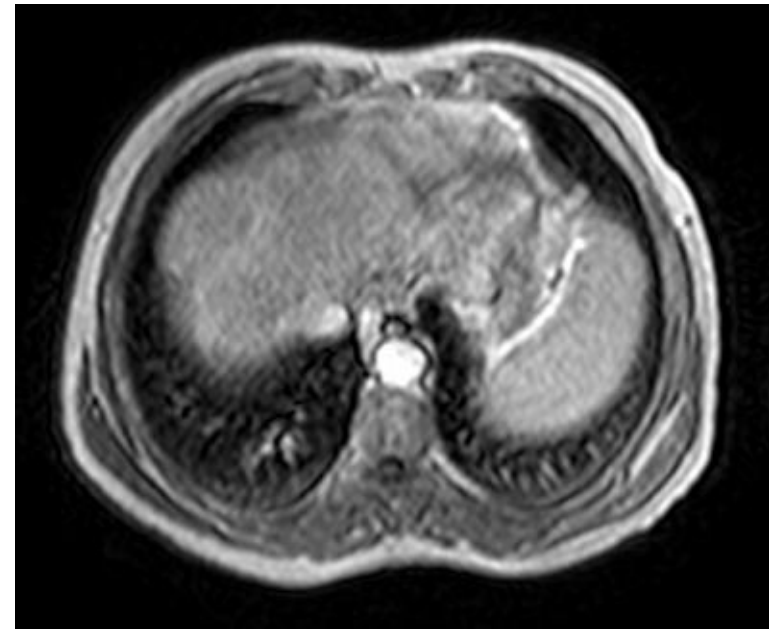
- **Performance**
  - Use of the Grid to Provide the Computational Power.

  >> Use a Large Grid Infrastructure

- **Usability**
  - Reduce the Complexity of Grids by Using a Friendly Interface.
  - Provide an Interface Open to its Integration in Other Applications.

  >> Implement a Web-Services Based Portal.

- **Security**
  - Deal With the Risks of Using Remote Resources.

  >> Anonymise and Access Control.

- **Reliability**
  - Production Capability.

  >>Provide Intelligence on Selecting the Sites.

Local Disks

WS Container +FTP Server

Computing Resources

(Through RB glite-rb.ct.infn.it)

User

UI

Storage Resources

(Through IOS egee015.cnaf.infn.it)

MRI Scanner

Hospital Univ. Dr. Peset

UPV

bes.itaca.upv.es

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Raw images →

← Results

- **A Graphical User Interface has Been Created.**

- **The GUI Calls the Web Services to Implement**

  – Creating the Proxy on the Grid.

  – Transferring the Data into the Grid Storage Area.

  – Select the Ranges of the Parameters to Test:

    ▪ Maximum Step Length for the Gradient Descent Optimisator.

    ▪ Maximum Number of Iterations for the Optimiser.

    ▪ Initial Scaling Factor.

    ▪ Initial Angle for Deformation.

  – Create the JDLs and Define the Arguments for the Scripts of Each Job

    ▪ One Job per Registration and Per Combination of Parameters.

  – Monitoring of the Evolution of a Set of Jobs.

  – Downloading the Output of All the Jobs in a Group with a Single Click.

- **First Development of a Version on LCG**
  - Good Performance and Large Scale.
  - Need for Improved Privacy on the Data.
  - Testing Lead to the Improvement of the Site Selection.
  - Final Version runs on LCG 2.4.0 - 2.6.0.

- **Evolution to a Version on gLite**
  - Shares the Same Interface and 90% of the Code.
  - Migration of Commands and Inclusion of Access Control.
  - Inclusion of Configuration Files.
  - Evolution from gLite 1.3 to gLite 1.4.

gLite
Lightweight Middleware for Grid Computing

Demo
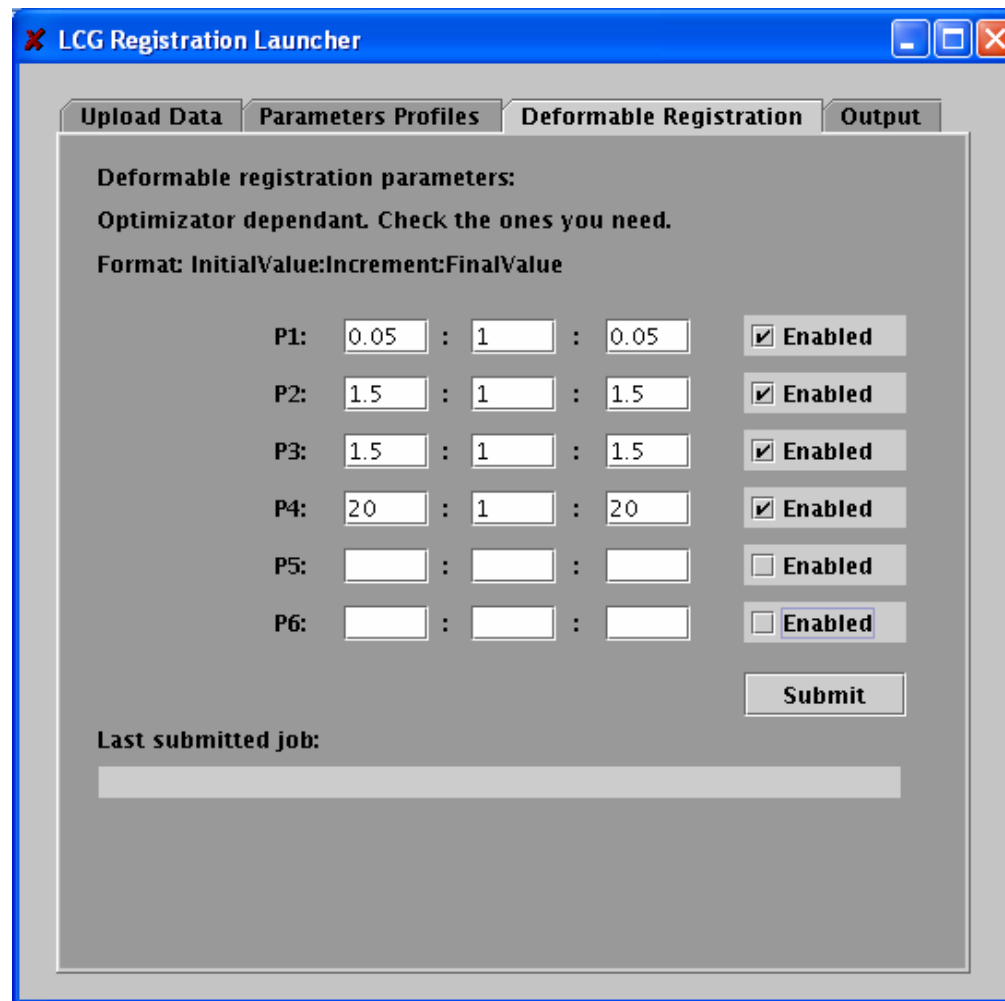
- **Password for Accessing a Pre-loaded Certificate.**
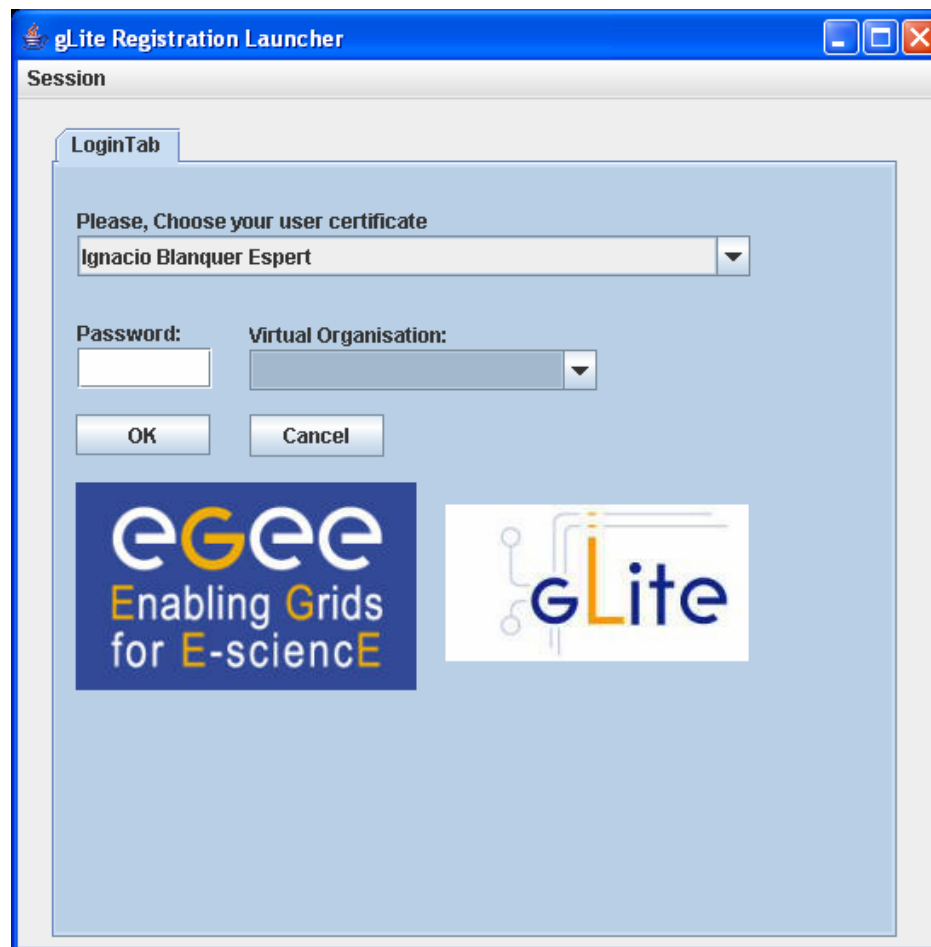
- **Uploading Reference and Deformable Medical Studies in Analyze Format.**

- **Register the Files on the Grid and Stores the LFN for the Scripts Creating the Jobs.**
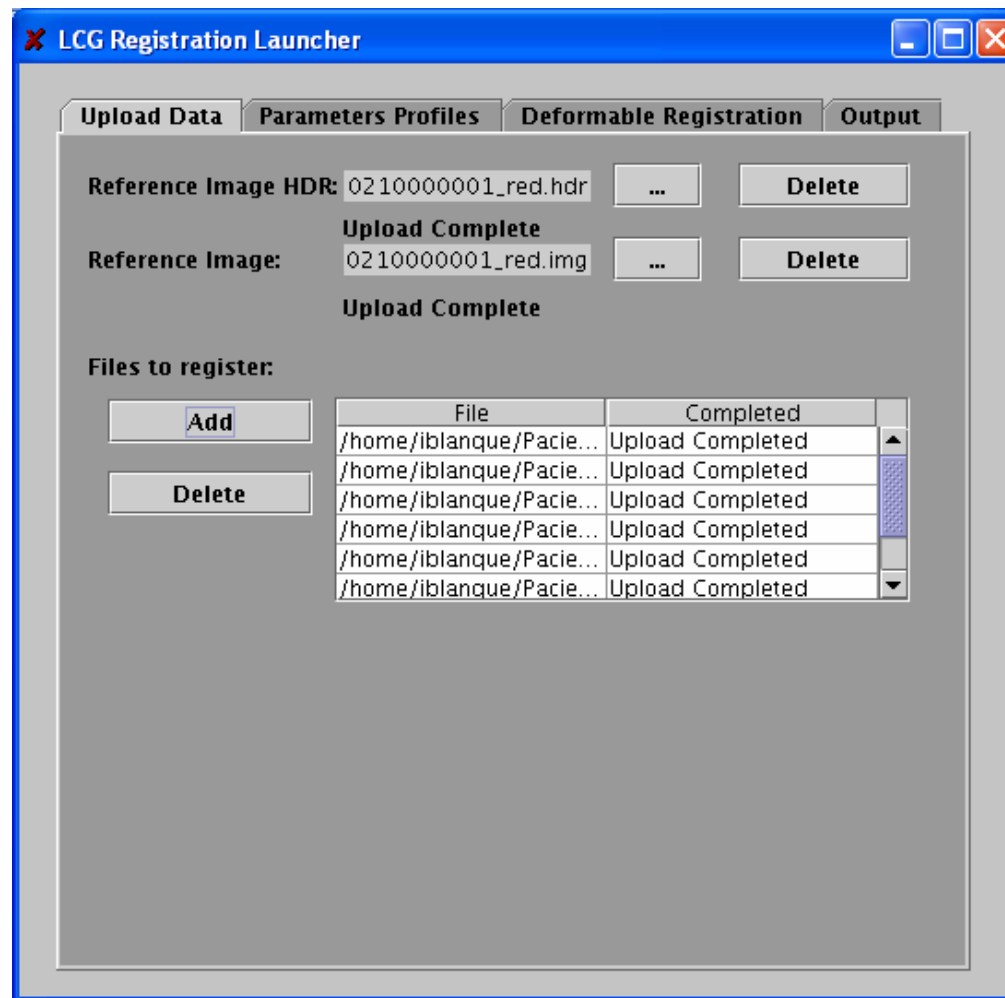
- **Both the JDL Files and the Necessary Scripts to Copy Locally the Input Data and Start the Co-registration.**

- **Create All the Instances Necessary for the Combination of Parameters.**

- **The Executable File is Easily Upgradeable to Test Different Methods.**

- **Submit all the JDLs Instances Through the RB and Monitoring the Jobs.**
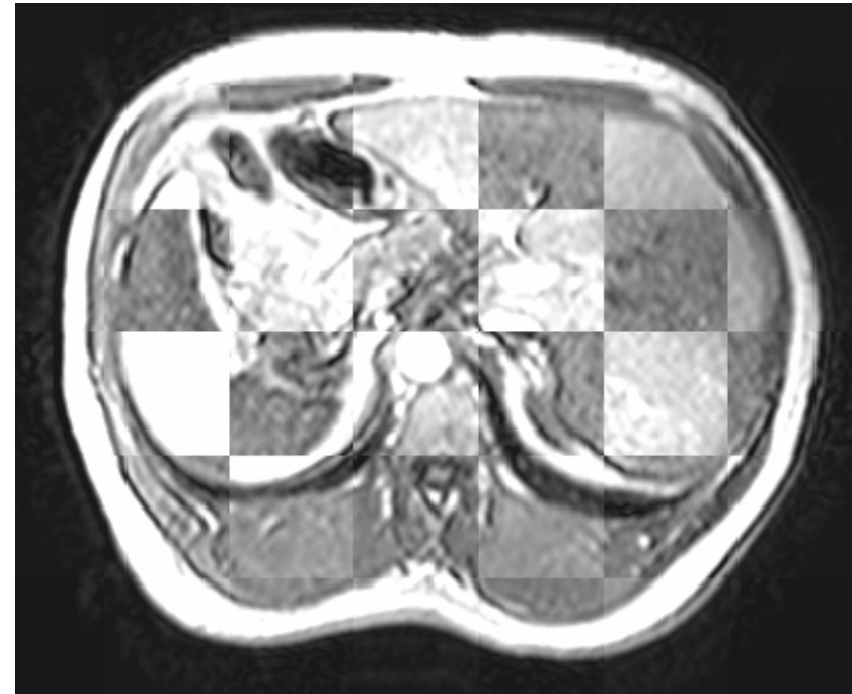- **Use a High-Level Name Identifier for the Jobs of a Group.**
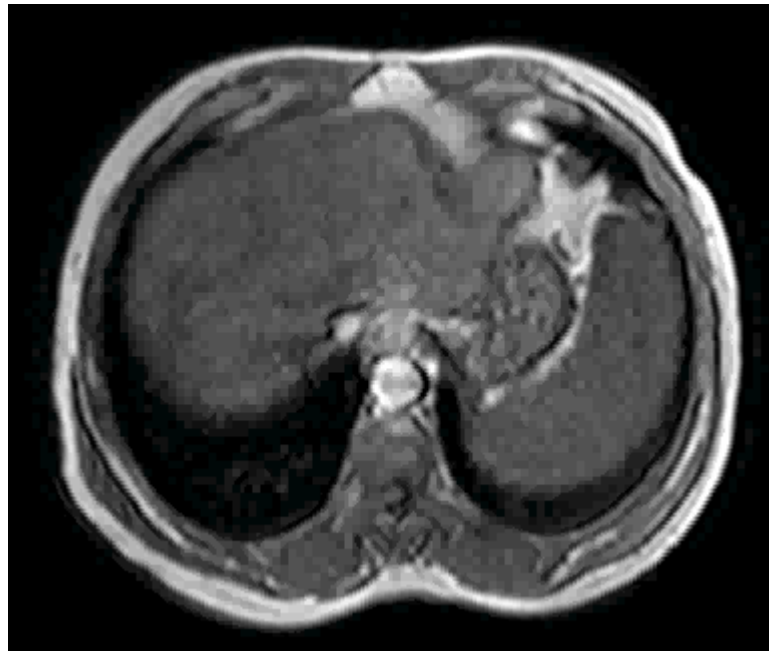
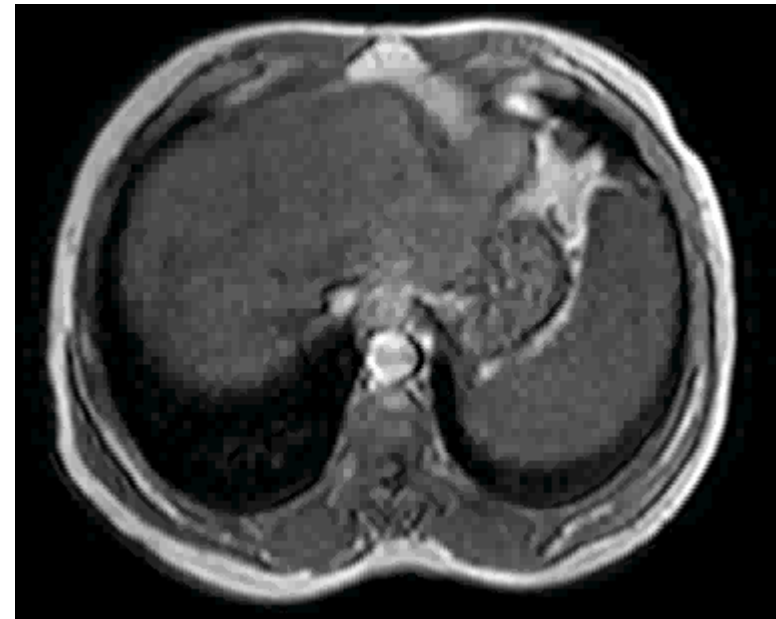- **Retrieve the Output Files from a Group of Jobs.**
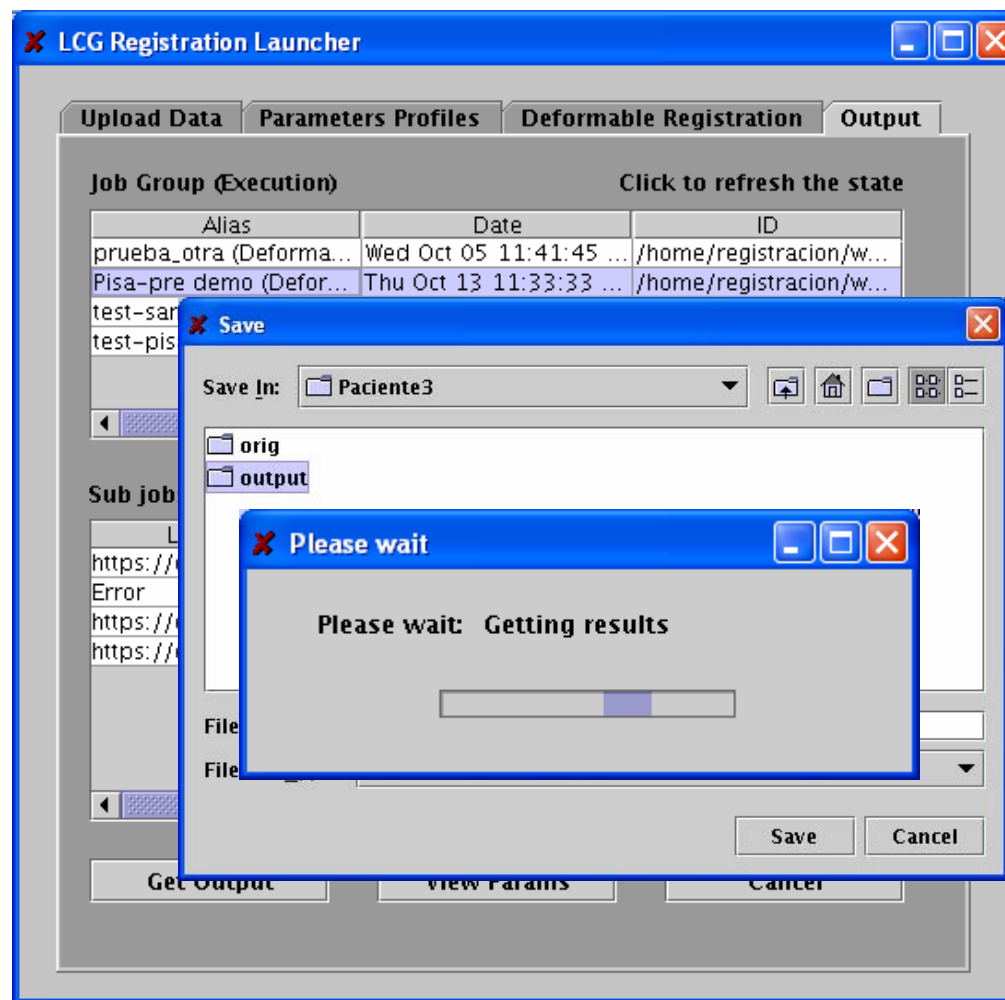
Before Co-registration
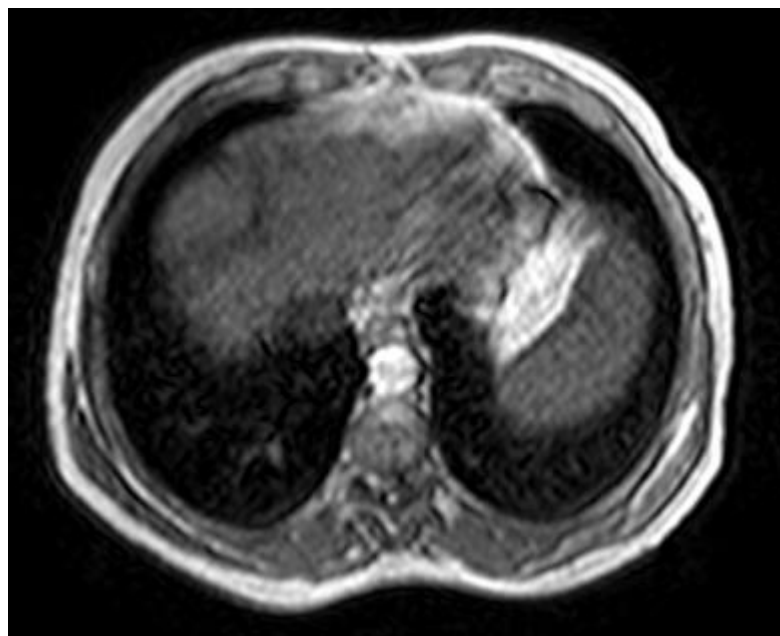
After Co-registration
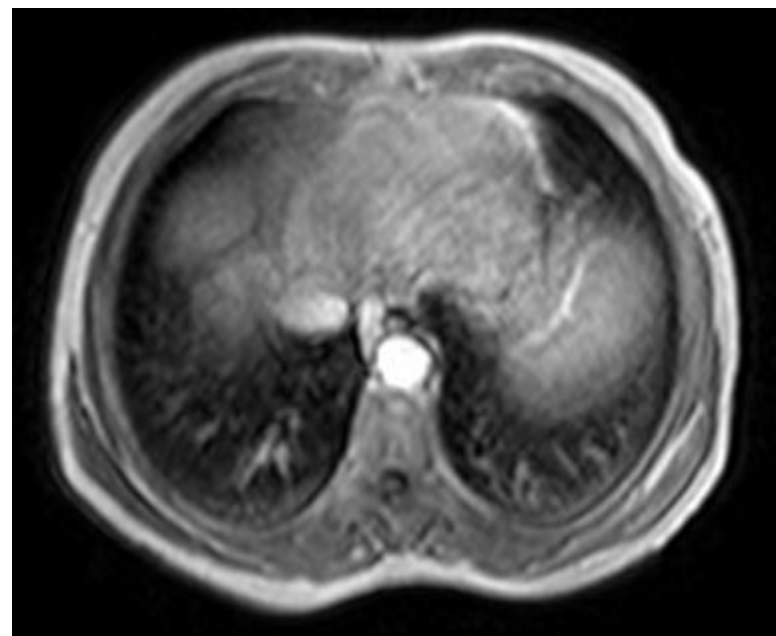
Before Co-registration
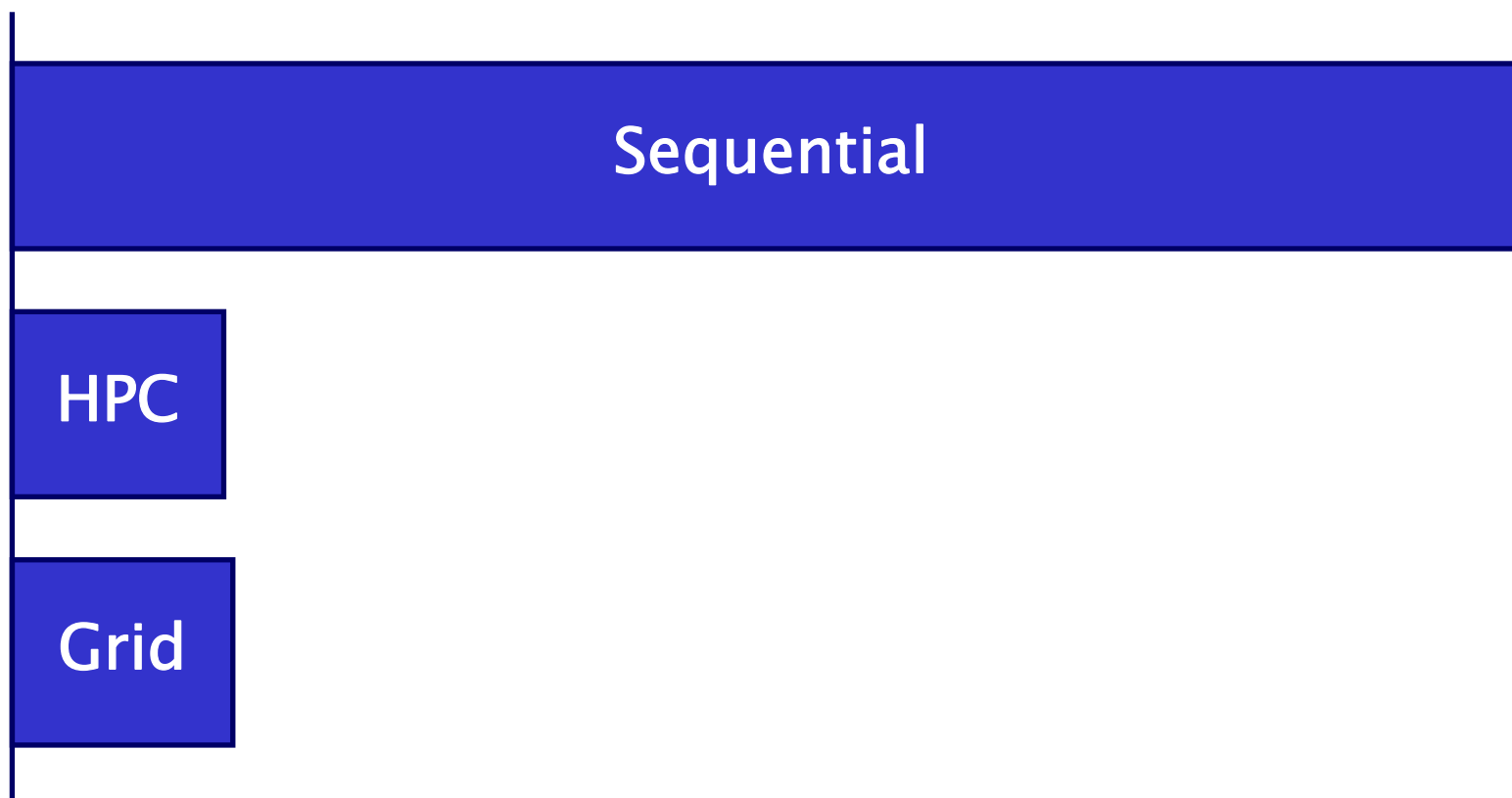
After Co-registration

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Correg Volume at Timestep 1

Correg Volume at Timestep 13

- **Cost of One Patient: 61h 08m.**

- **Cost Using a 20-Procs Computing Farm: 2h 30m.**

- **Computational Cost Using the Grid: 3h 10m.**

Sequential

HPC

Grid

- **Cost of 20 Patients: 2331h 22m.**

- **Cost Using a 20-Procs Computing Farm: 132h 50m.**

- **Computational Cost Using the Grid: 17h 35m.**

Sequential

HPC

Grid

**If you Have Enough Resources
20x12=240 Computers, EGEE has >15000**

Conclusions
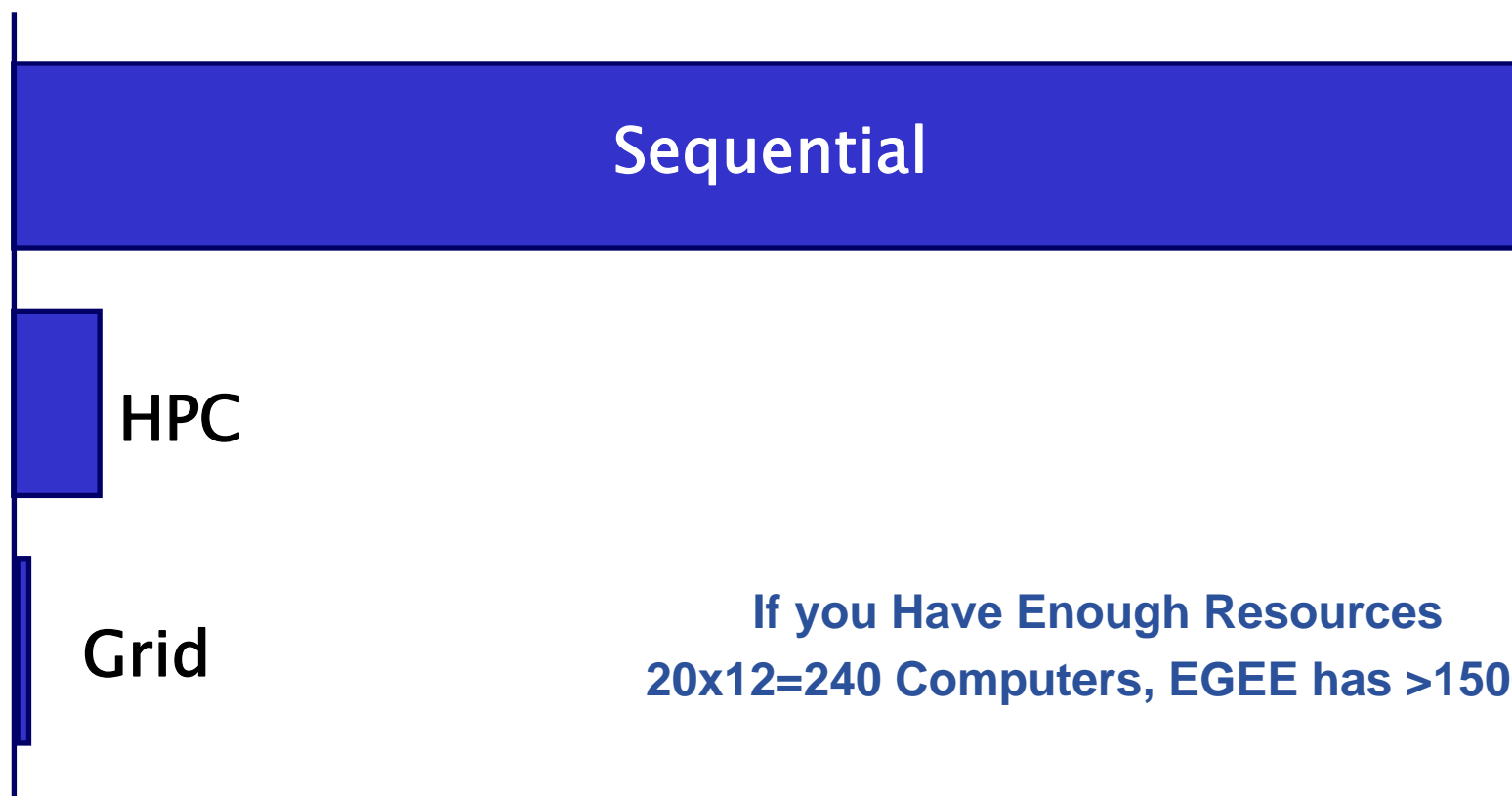
- **Need for the Grid**
  - The Computing Requirements for a Reduced Clinical Trial of 20 Patients Exceeds the Conventional Computational Capabilities of Either a Hospital or a Research Team.
  - The Need for Computing is Not Flat and Only After the Trials.
- **Added Value of EGEE**
  - Need for a Production Platform 24x7 (Users).
  - Outstanding Improvement in the State-of-the-art Knowledge on Grid Technologies (Developers).
- **Added Value of gLite**
  - Need for Access Control in Data and MetaData.
  - Rich MetaData Management.
  - Batch-Oriented Jobs.
- **Easy to Use Interface: No Need for Grid Knowledge.**
- **Usable From Any Computer Through a Web Service.**