

# VPH2

## Virtual Pathological Heart of the Virtual Physiological Human

VPH2 (Virtual Pathological Heart of the Virtual Physiological Human) aims to develop a patient-specific computational modelling of the heart to assist cardiologists/cardiac surgeons in defining the severity and extent of disease in patients with post-ischemic Left Ventricular Dysfunction (LVD), with or without ischemic mitral regurgitation (IMR).

### Objectives of the Project

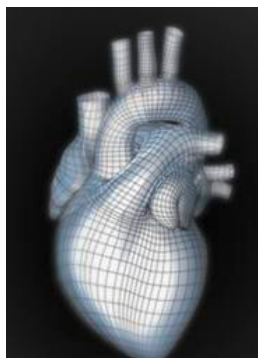
#### Problem or Context

Heart failure accounts for almost a quarter of all hospital admissions due to cardiovascular events, has a high mortality (median survival around 18 months), and places a great burden on all healthcare systems, with estimated direct costs of £ 905 m (€ 1350 m) in the United Kingdom in 2000, 2% of total NHS expenditure.

#### Project

The task of the “Virtual Pathological Heart of the Virtual Physiological Human” is the development of a high power framework platform aiming at improving the management processes of heart diseases in defining the severity and extent of disease in patients with post-ischemic LVD, and in particular at:

- Integrating clinical, biological and genetic data retrieved from medical records and laboratories research results in order to offer an innovative therapeutic tool for the surgical and medical decision making
- Supporting cardiac surgeons with advanced simulation and modelling tools to be applied for obtaining better selection and simulation of specific surgical procedures
- Providing a new framework and multimodal approach that will be then useful in other clinical scenarios of cardiology and cardiac-surgery involving for example hybrid imaging PET-CT, molecular and functional imaging, etc.



### Project Description

VPH2 will provide a fundamental framework clearly beyond the current state of the art which will allow to build **subject-specific multiscale model of the heart (from tissue to genes) and the valves** targeting a specific clinical application area. Research and Technology Development results will be:

- Cross-correlation methods and computational models for **representing and interpreting heterogeneous data sets** (such as clinical data, genomics, environmental and biological ones).
- Creation of a **computational model to simulate pathology and disease progression** in order to assist clinical decision making and new technology development.
- Advanced imaging and visualisation techniques with particular emphasis on **advanced multimodal visualisation and modelling algorithms**, 4-D representation.

The final VPH2 system will be installed in test-beds and its services will be exercised. The objective of this task is to make the VPH2 system available to non-IT partners or other end users to assess it from an operational point of view. In order to accomplish this objective, a series of scenarios on the use of the system will be realised by the respective partners. The scenarios will be described for each validation site and measurable indicators will be identified. During this task, a questionnaire will be prepared and distributed to the users of the system in order to provide clear results on the ease of use and validity of services.

### Expected Results & Impacts

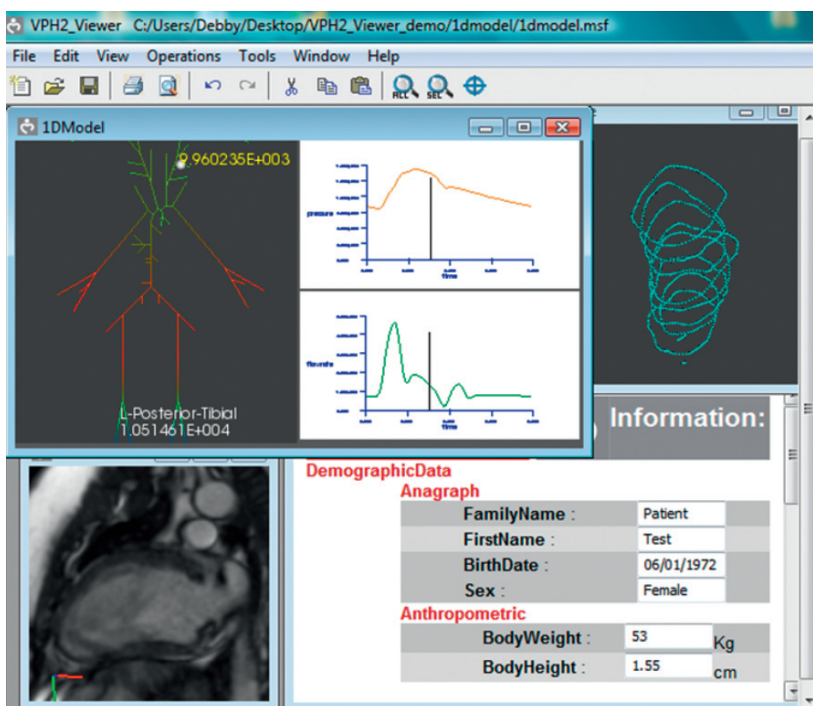
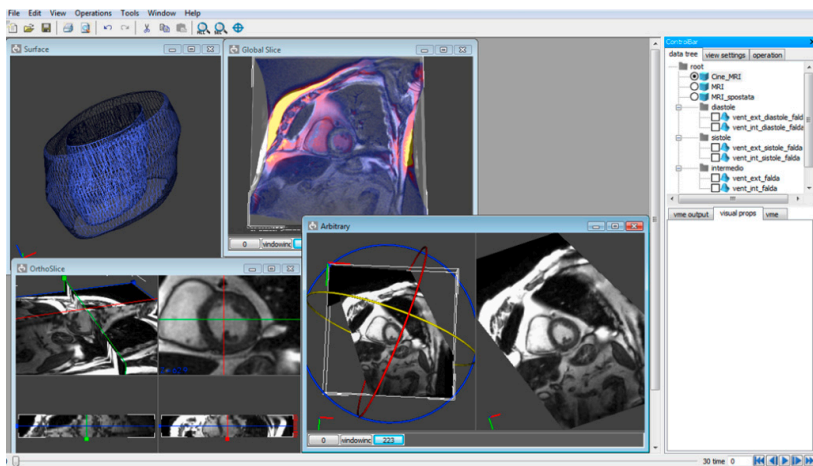
VPH2 is a simulation-based medical planning system for cardiovascular diseases to evaluate other options than surgical treatment.

#### SCENARIO

Mr Miller has been admitted to the hospital for dyspnoea six months after myocardial infarction. High blood levels of BNP and PCR are measured. Genetic variant for MMP-9 has been identified. MRI depicts ventricular remodeling, moderate mitral incompetence and areas of scar by gadolinium. Despite optimal pharmacologic therapy, the VPH2 model predicts unfavourable evolution of the disease, unless this is prevented by surgical myocardial restoration. Simulation of the intervention displays the virtual cut of fibrosis and patch size to be applied, with no need for mitral repair. Surgery is successfully attained; the two surgeons compare live the operation in the operating room with the virtual VPH2 restoration.

One important factor is the availability of tools for collecting, storing, analysing and linking different types of data: this will help clinicians in their daily activity and allow researchers to look at all data originated by scientific instrumentation or available in databanks. The simulation of the heart function offers a tool to better understand the pathogenesis of heart failure (HF) and to develop proper treatment strategies to reduce readmissions.

Although the main task of the project (simulation of the reconstructed left ventricle) will start only in Year 2, according to the First ATR Consensus Report, the "Project as a whole has been making a good progress in relation to the Description of Work". All Milestones foreseen for Year 1 (M1 to M5) have been achieved, bringing the project to a good advance level – Overall Architecture has been completed, as well as the (partial) identification of new genetic variants, the definition of Data Mining techniques, the first release of VPH2 framework prototype and the release of Functional Assessment Tool for the extraction of geometrical and mechanical features of the patient's heart from cardiac magnetic resonance images.



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### Partners:

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- Westfälische Wilhelms-Universität Münster (Germany)
- Regione Lombardia (Italy)
- Super Computing Solutions SRL (Italy)
- Ecole Polytechnique Fédérale de Lausanne (Switzerland)
- University of Bedfordshire (United Kingdom)
- Sorin Biomedica Cardio S.R.L. (Italy)
- Quality & Reliability A.E. (Greece)
- Ereynitiko Akadimaiko Institutou technologias Ypologiston (Greece)
- Intercon SP. Z O.O. (Poland)
- Patmos S.R.L. (Italy)
- National Research Council – Clinical Physiology Institute (Italy)
- Politecnico di Milano – Bioengineering dept. (Italy)

Timetable: from July 2008 to June 2011

Total cost: € 5,179,049.89

EC funding: € 3,778,500.00

Instrument: STREP

Project Identifier: FP7-224635

### KEYWORDS

Human Heart Modelling, Knowledge Extraction, Genomics, Post-ischemic Dysfunction, Drug Treatment