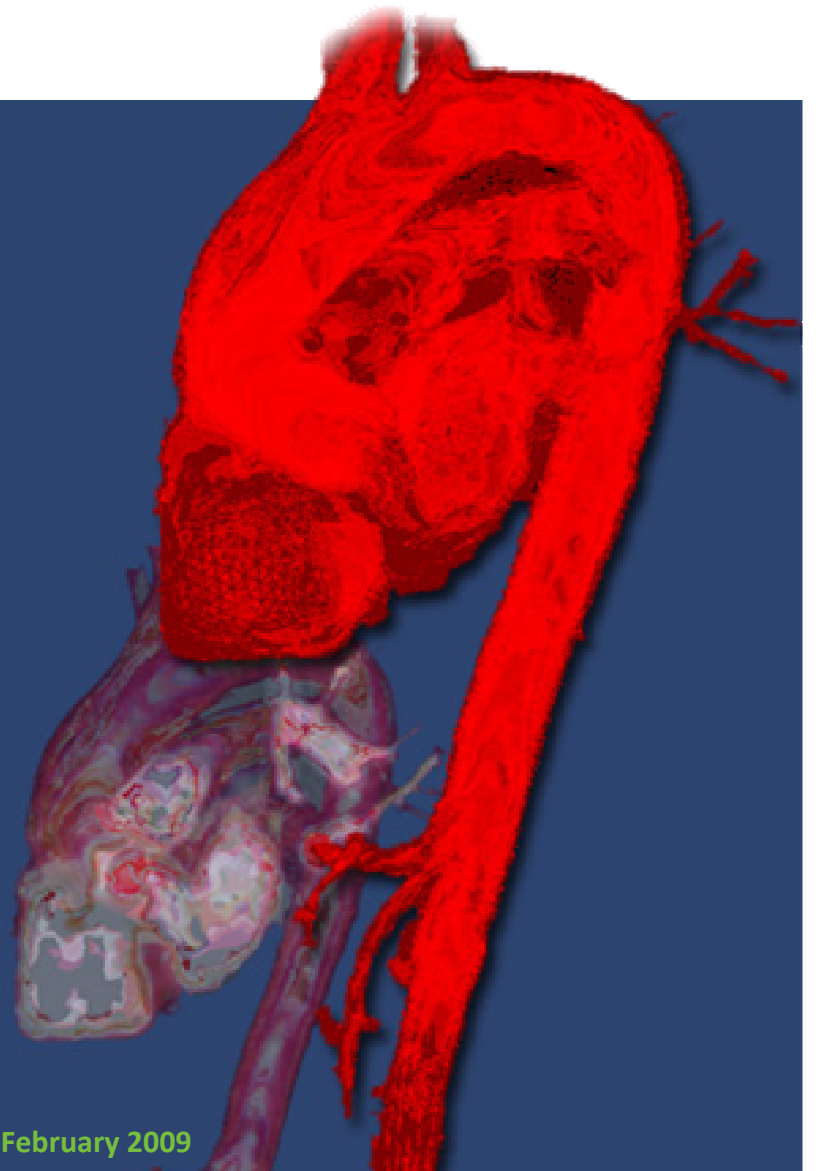


Research Lines and RTD Project in Biomedical Engineering



CIMNE - February 2009

Research Lines & RTD Project in Biomedical Engineering

CIMNE - February 2009

Centro Internacional de Métodos Numéricos en Ingeniería
Gran Capità s/n, 08034 Barcelona, España

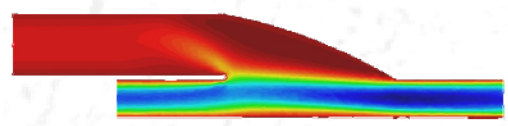
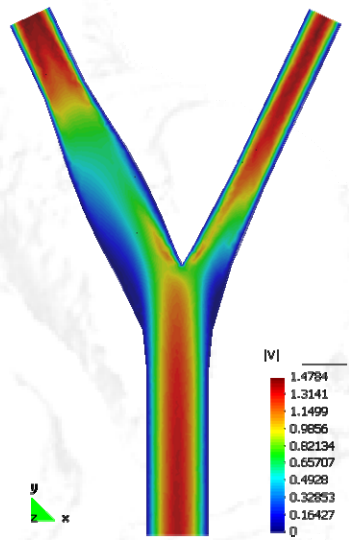
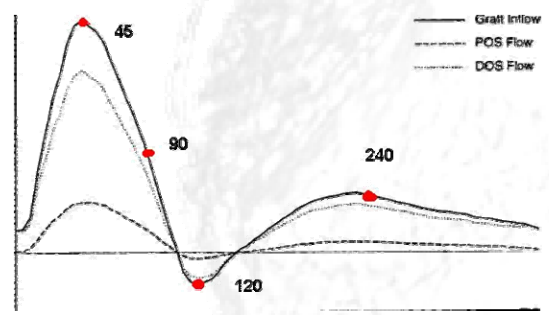
Research Lines in Biomedical Engineering

**Computational Fluid Dynamics
Solid and Structural Biomechanics
Health Decision Support Systems
Cardiovascular System
Biomaterials
Artificial Intelligence
Neurosciences
Medical-GiD
Urology
Pre and post processing**



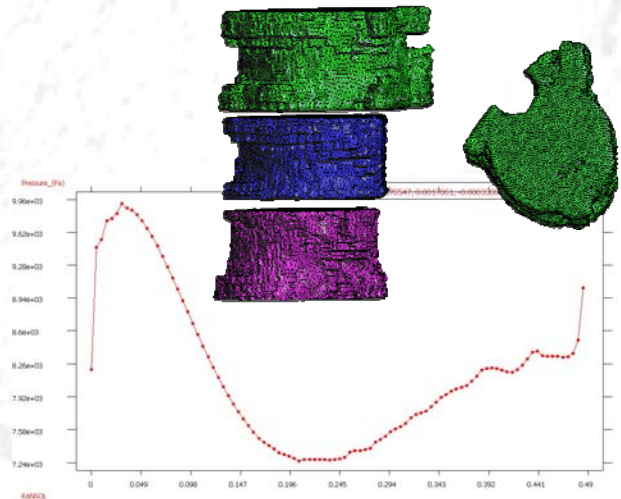
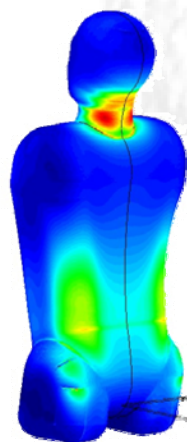
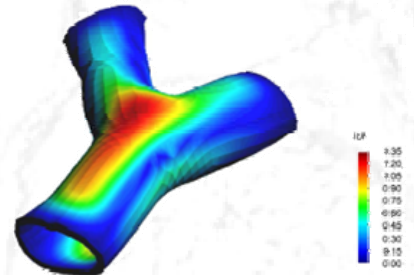
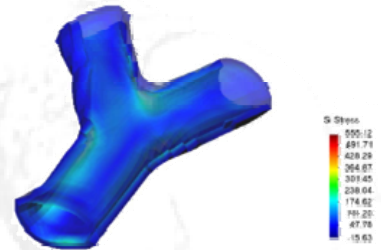
Computational Fluid Dynamics

- Stabilized finite element and finite difference methods in incompressible fluid dynamics.
- Finite element methods for analysis of fluid – structures interactions problems.
- Convection-Diffusion-Reactions equations for biomechanical studies.



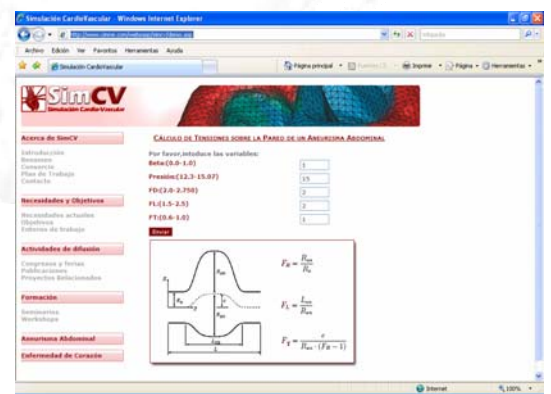
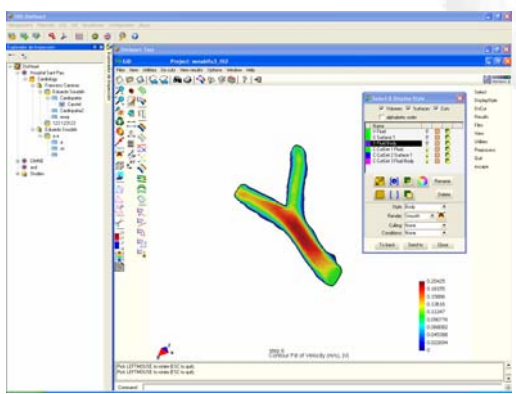
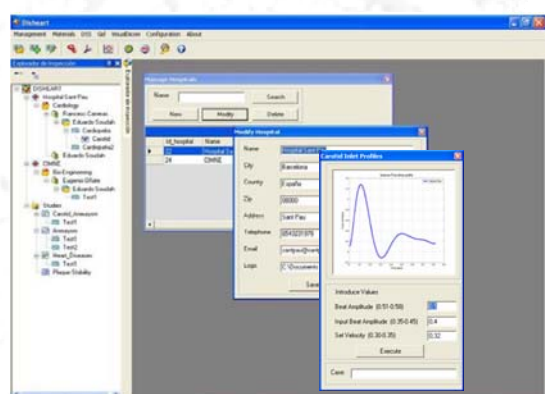
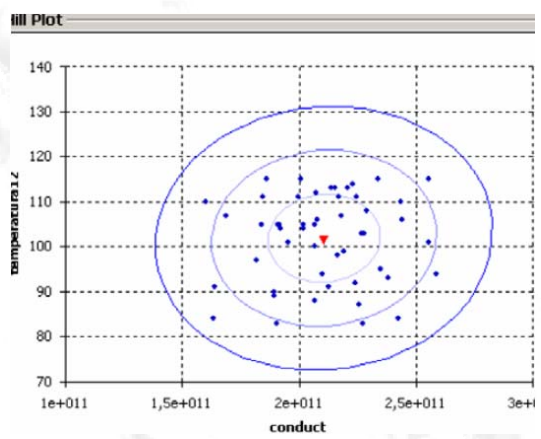
- Numerical methods applied in multidisciplinary problems in fluid biomechanics (fluid structure interaction, thermal flows, absorption theory etc).
- Coupling 3D with 2D or 1D models to improve study details.

- Finite element methods for linear and non linear analysis of solids structures.
- Coupled problems in solid biomechanics (fluid structure interaction, thermal flows, absorption theory etc).
- Finite element methods for biomechanical devices analysis and prototype design (stent, prosthesis, etc).
- Finite element methods analysis of solid biology structures (hearth mechanics, vessel stresses response, etc).
- New constitutive models for vessels and bones. Modelling and characterization of vessels.

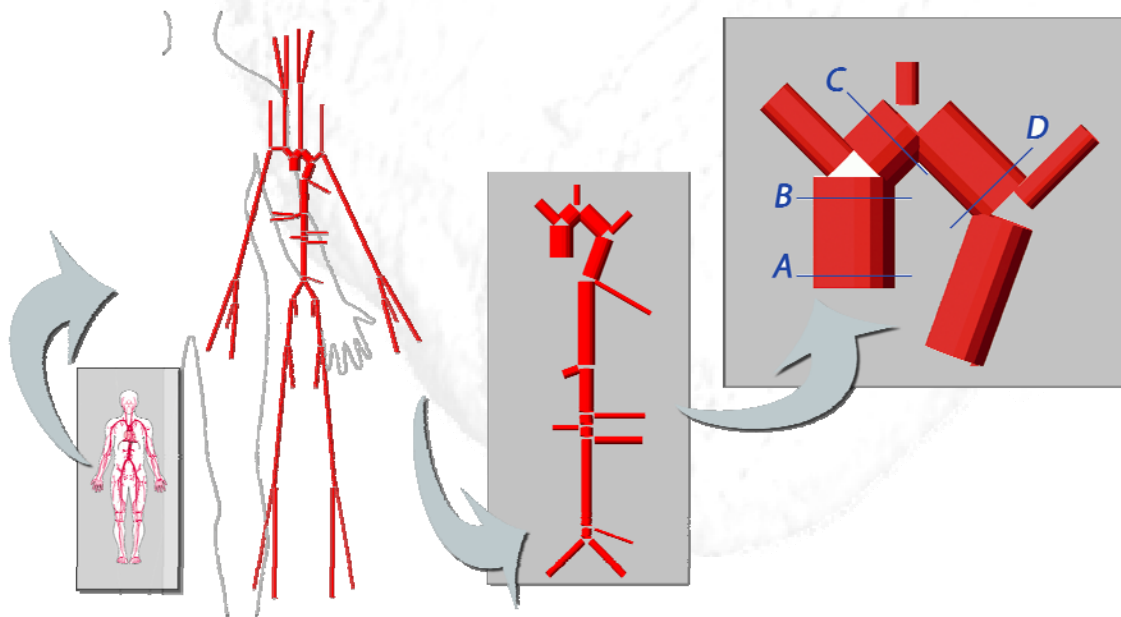
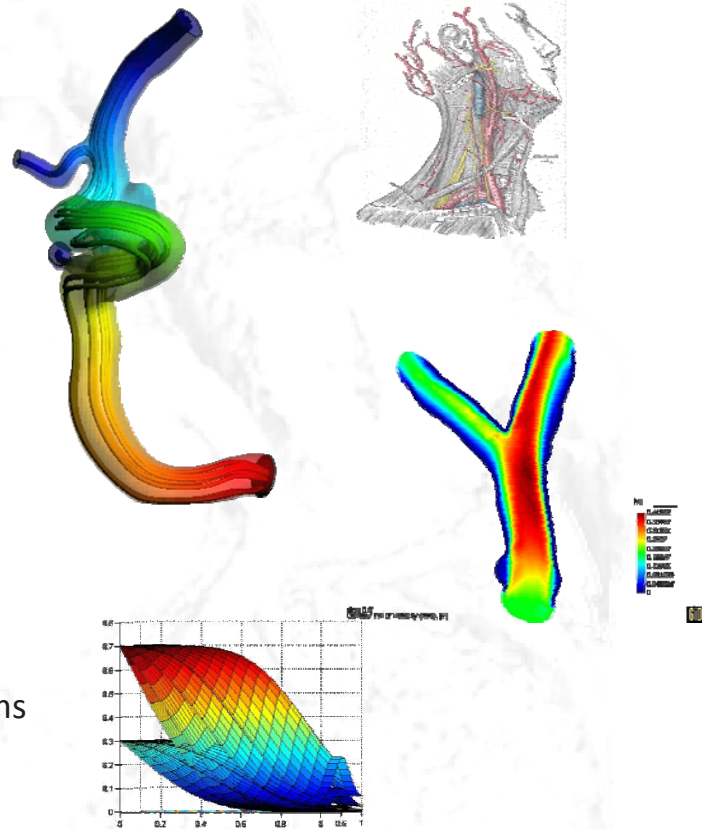




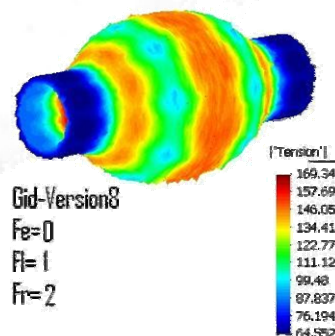
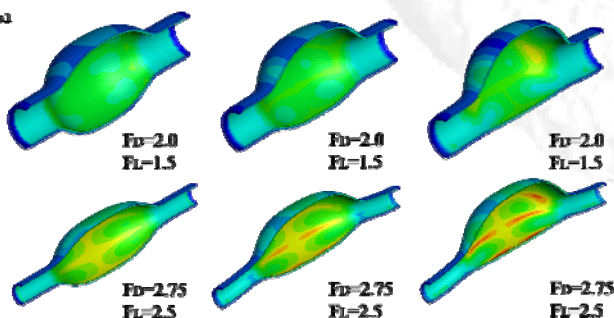
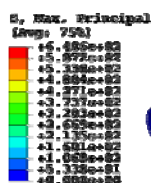
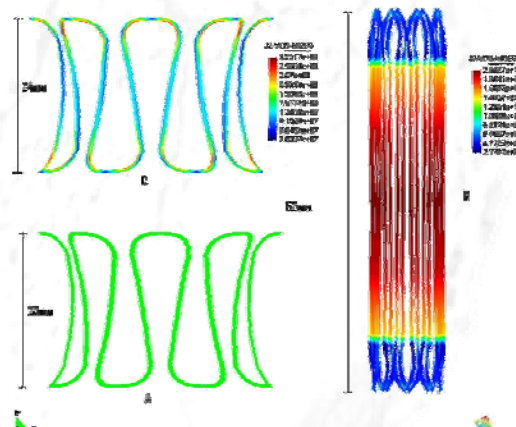
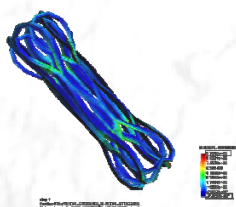
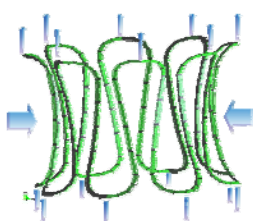
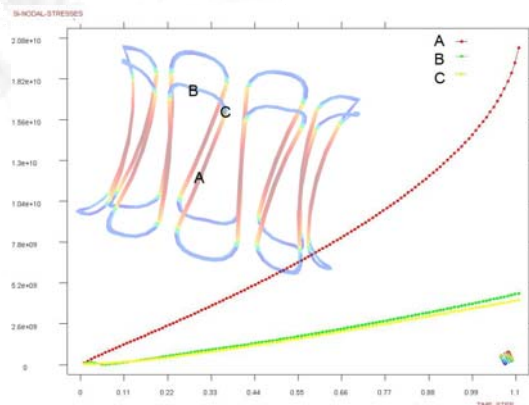
- Development of intelligent platform to help physician work, informatization of routinely medical work.
- Finite element use to improve medical diagnosis and to perfect analysis processes.
- Biostatistical models applied ad hoc for several medical problems and cases.
- Bioinformatic technology solutions (finite elements methods, biostatistical tools and artificial intelligence).
- Monte-Carlo methods for stochastic analysis in computational biomechanics and in biofluid dynamics.
- Parameter identification via stochastic methods.
- Coupling TIC solutions, stochastic methods and finite element methods to improve and get faster medical analysis and decision



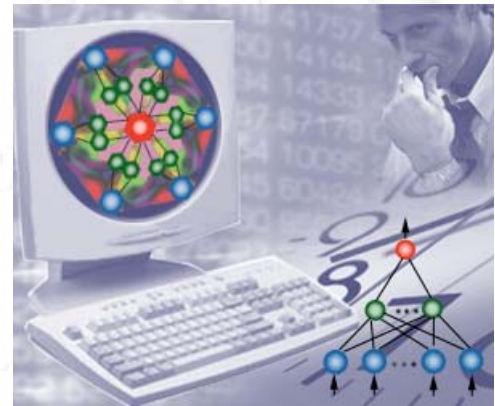
- Development of simulations algorithms for cardiovascular diseases.
- Finite element for the simulation of problematic scenarios (aneurism, atherosclerotic plaque, etc).
- Finite element method for platelets deposition and blood coagulation.
- 1D model for boundary conditions in 2D and 3D problems.
- Real geometries.
- Automatic 2D and 3D geometries for aneurisms and atheroma.



- Development of biocompatible geometries for internal or external devices (stents, internal prostheses)
- Finite element analysis for stress and strain in biomaterials and medical devices
- Design and study of biocompatible devices for human medical experimental use.
- New constitutive models and shape memory alloys
- Parameter identification and models of biological tissues

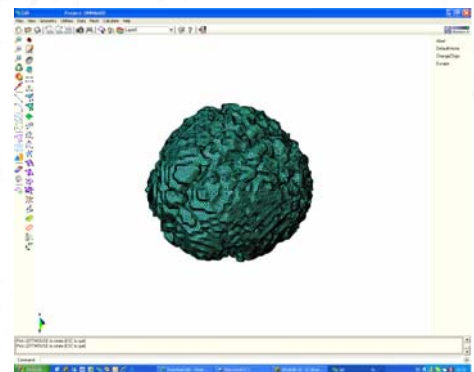
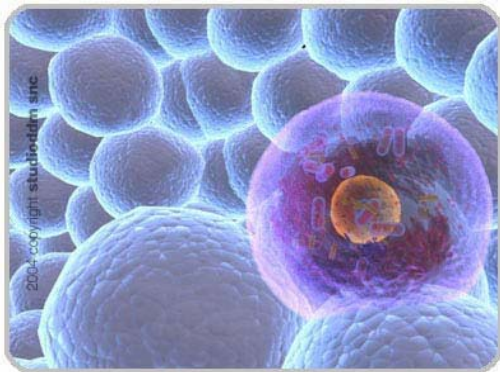
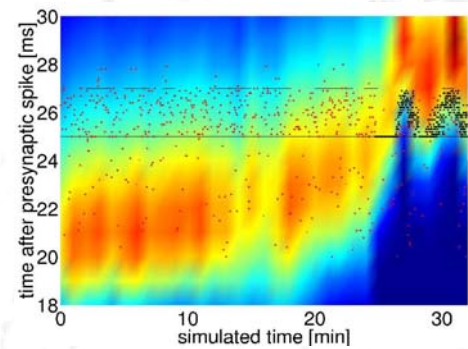
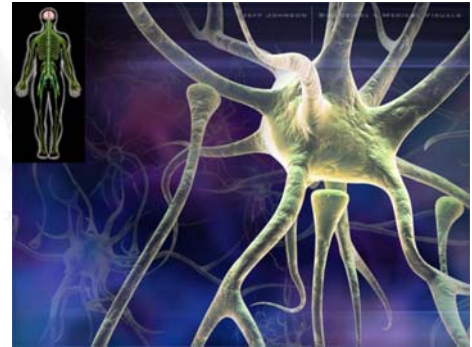


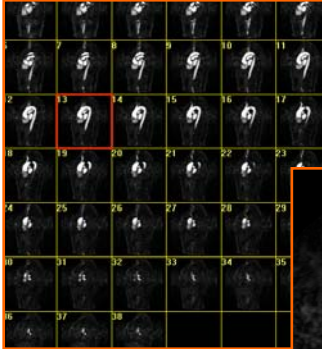
- Development of artificial neural networks (ANN) for optimization, inverse analysis and medical decision support fast decision taking.
- Integration of artificial neural networks (ANN) in decision support systems combining wireless sensors, computer simulations methods and artificial intelligence technology.
- Development of artificial intelligence techniques based in agent simulations.
- Applications of artificial neural networks (ANN) technology for parameter identification in constitutive laws
- Development of intelligent finite element methods via AI Technology



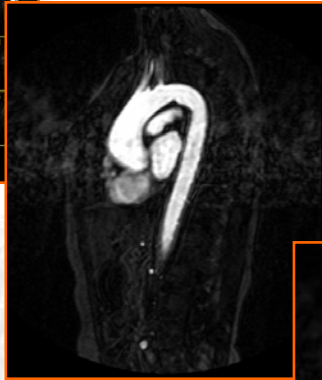
<http://www.cimne.com/flood/>

- Finite element methods for the analysis of brain cellular activity in pathological and physiological scenarios.
- 1D Finite element methods to study the propagations of neuronal signals in complex networks.
- Statistical methods to fast response in biochemical brain analysis.
- Dementia diseases studies: finite element methods and bioinformatic solutions to reinforce the investigation about the causes of several brain dysfunction.
- Amyloids, Polymers and Cerebral Membrane Characterization

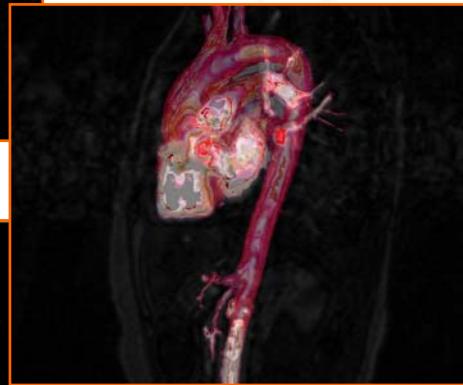




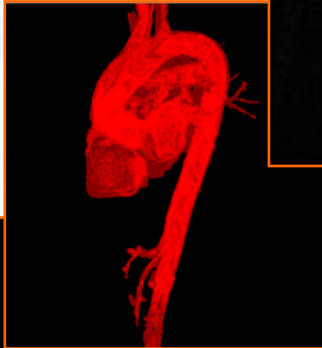
Magnetic Resonance (2D)



2D Detail



Edition/Generation



Deformable isosurface model



Meshing of heart and aorta

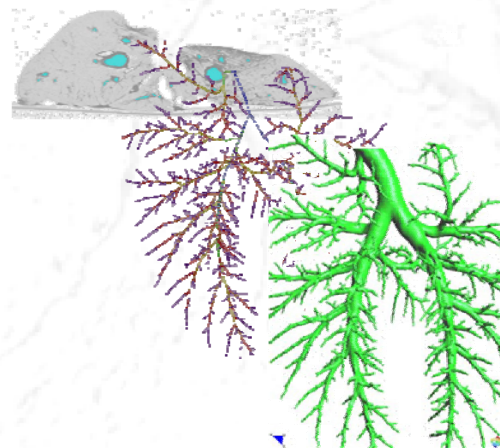
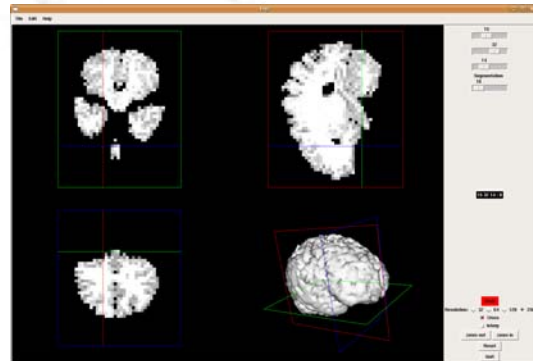


Meshing of heart

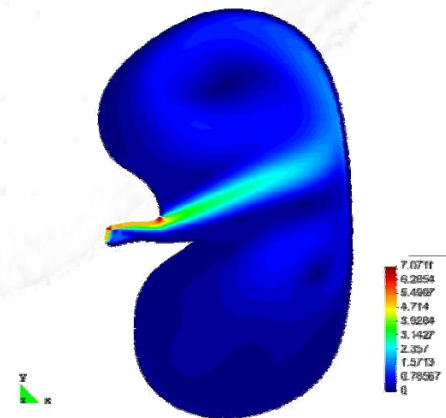
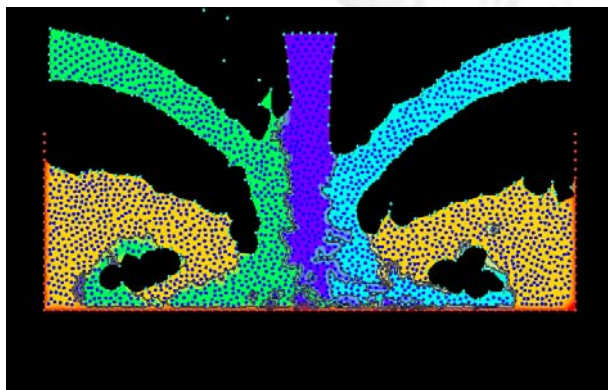
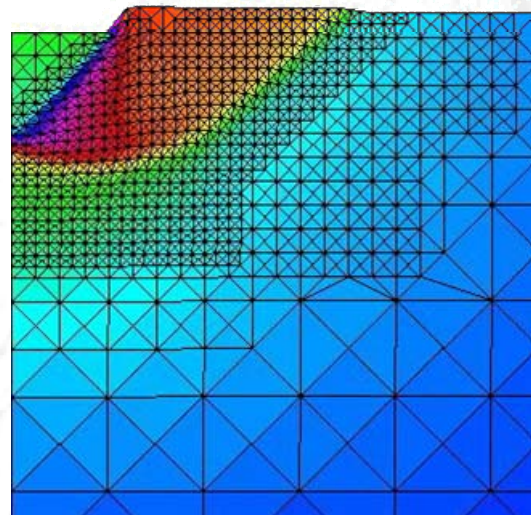
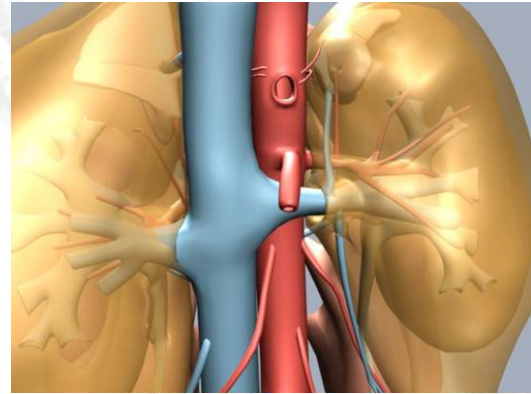


3D heart

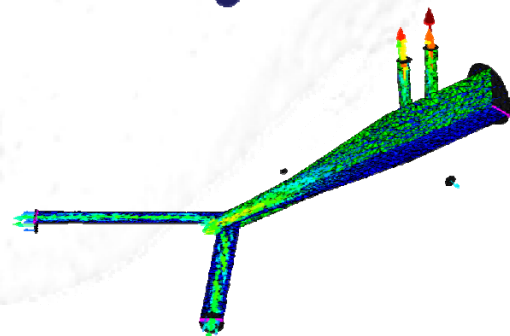
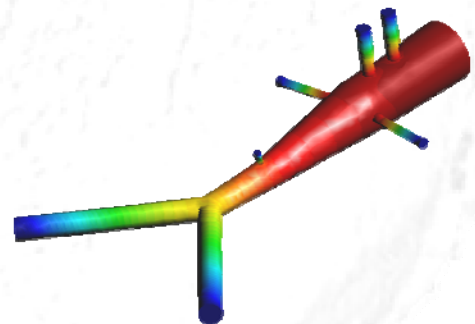
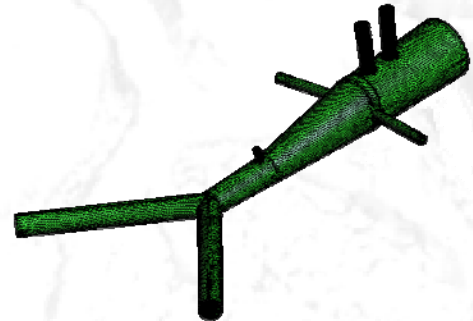
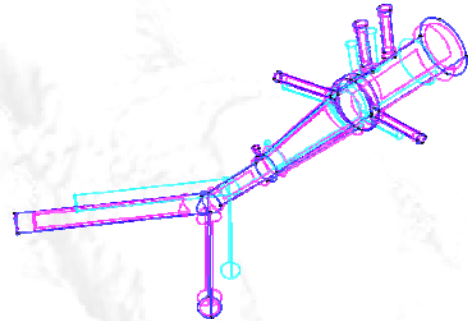
- Segmentation and 3D reconstruction of medical images.
- Meshing of segmented geometries: creation of surface meshes or volume meshes.
- Visualization of 4D images (3D + time), creation of flux vectors and study of time developing in the image.
- Anatomical real cases.
- Coupling with simulation programs and with finite element methods solver.
- Friendly platform and portability of the informatics solutions adopted.



- Finite Element Method for the simulation of the urinary bladder and its parts like the destrusor (little smooth muscle)
- Study of biological materials and its multi-scale hierarchy, creation of simplified models with classical nonlinear continuum mechanics theory.
- Characterization of destrusor-tissue model is based in the representation (based on hyperelastic matrix, and viscoelastic fibres)
- Analisis of the interaction between bladder wall with urine modelled via the Particle Finite Element Method (PFEM)

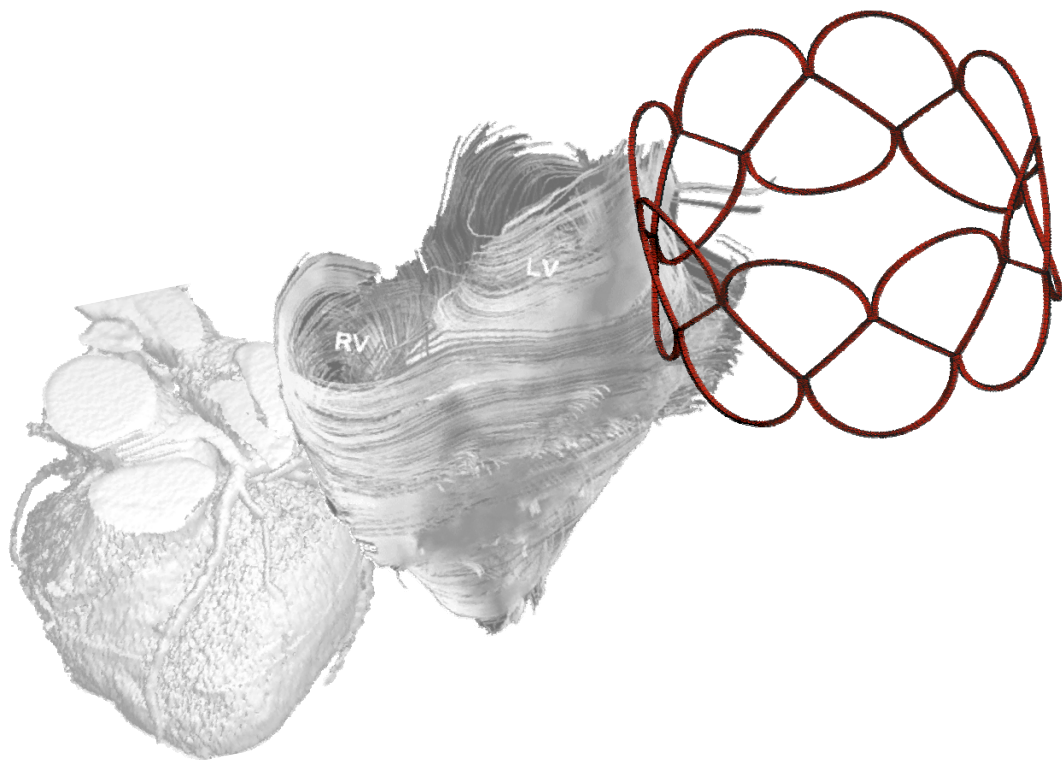


- Development and maintenance of GiD pre and post processing system (www.gidhome.com).
- Development of methods for generating structure and unstructured meshes.
- Development of input data technology for large scale computational problems.
- Graphical visualization techniques for large scale simulation problems.
- Generation of input data for finite element analysis from medical images. (MedicalGiD)
- Meshless methods for parameterization of geometries for shape optimization problems.



www.gidhome.com

Research & Development Projects in Biomedical Engineering



On going RTD projects:

Development of a **NeuroInformatic-Support System for the Molecular Characterization and Therapeutic Approaches in SYNaptopathies (Synapsys)**

Coordinator: UIC

Partners: CIMNE, UIC, UL, Leibniz Institute of Polymers Research Dresden, Stockholm University, Università di Camerino, UniCAM, UAB, D-Pharma Ltd, NHIT, NBIO (Since 2009)

Development of a **Bio-Informatics Decision Support System for Characterization and Treatment of Neurological Diseases (Nynfa)**

Coordinators UIC

Partners: CIMNE, UIC (Since 2009)

Development of a **Cooperative Advanced REsearch for Medical Efficiency (CARE 4 ME)**

Coordinator: Philips HealthCare

Partners: Philips HealthCare, CIMNE, VTT, ISI, Alma IT Systems, Sapheneia, Fraunhofer MEVIS, Bull

Development of **The Virtual Dental Patient (Daedalus)**

Coordinator: Attenborough Dental Laboratories

Partners: Attenborough Dental Laboratories, CIMNE, Nottingham University, Aristotle University, FIMI Philips, DIGILEA SA (Since 2008)

Development of **Medical-GiD-** From medical images to numerical simulations.

Coordinator: CIMNE

Partners: Hospital Sant Pau- Hospital de Friburgo (Since 2008)

Development of a **Computational model for applications in Urology**

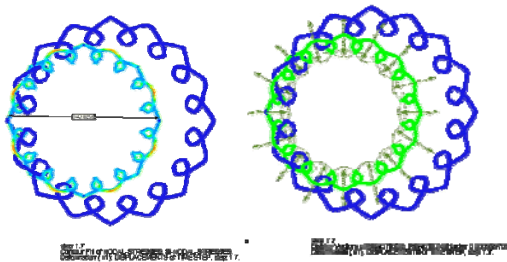
Coordinator: CIMNE

Partners: Hospital Sant Pau- CIMA (Since 2008)

Finished RTD projects:

Estudio de soportes cardiovasculares

Coordinator: IberHospitex
Partners: CIMNE, UPM, Tecknalia,
Robotiker
2007-2008



SIMCV. - Simulación del comportamiento del corazón y periferia vascular en condiciones sanas y patológicas. Aplicación al diseño y evaluación de dispositivos intravasculares y válvulas cardiacas

Ref: DPI2004-07410-C03-02
MINISTERIO de EDUCACIÓN Y CIENCIA
PLAN NACIONAL I+D
Coordinator: Universidad de Zaragoza
Partners Universidad de Zaragoza CIMNE,
Universidad de Sevilla
2004-2007



Disheart.DSS - Grid based decision support system for assisting clinical diagnosis and interventions in cardiovascular problems

EUROPEAN COMMISSION, FP6
Coordinator: CIMNE
Partners: I3A, Technical University Graz,
TIMC-IMAG, COMPASS, HEARTCORE,
George Mason University, ENDOART,
QUANTECH (ES)
2003-2006



Development of **New concept of tools for integrating medical images with simulation data**

Coordinator: CIMNE
2007- 2008