- **Programme**

- 9:00 introduction by Isabelle Magnin and Pierre Croisille

- 9:30 - 12:30 scientific presentation by project leaders
- **A. Ischemic disease and consequences: vascular, cardiac and cerebral**
- **B. Hybrid and multi-physics Imaging (MRI/optics, US/optics, MRI/PET,…**
- **C. Reconstruction, modelling and simulation**

- *12:30 - 14:00 lunch*

- 14:00 - 15:30 discussion with researchers, demos
- **A. 3D interactive segmentation and mesh generation**
- **B. Hybrid simulation of the dose and the images of cone-beam CT scanners**
- **C. Motion estimation with tagged ultrasound images**

- 15:30 - 16:30 deliberations of the Committee with official representatives
- 16:30 - 17:00 conclusion

Creatis

Medical Imaging Research Center

Head : Isabelle Magnin - Future Vice-head : Pierre Croisille

Research center affiliated with several institutes :
INSA Lyon, University Lyon 1,
CNRS (UMR 5220) and Inserm (U1044)

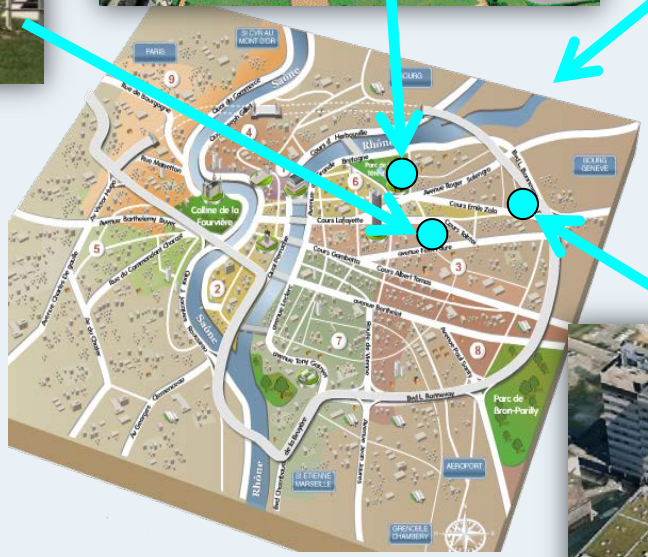
http://www.creatis.insa-lyon.fr

Present on 5 different sites in Rhône-Alpes

Campus LyonTech
La Doua

Cancer Center
Léon Bérard, Lyon

Saint-Etienne Hospital

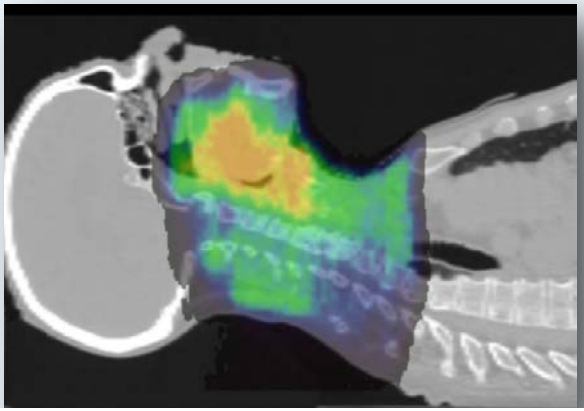


ESRF European Synchrotron
Radiation Facility, Grenoble

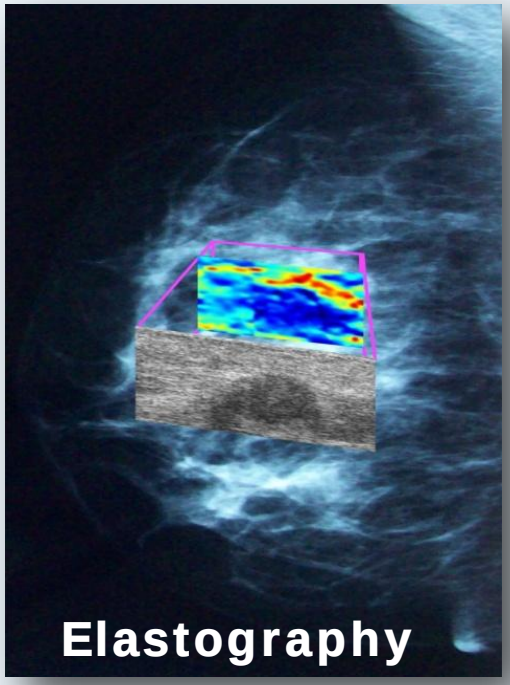
Pôle Est Hospital
Louis Pradel, Lyon

Hôpitaux de Lyon

CREATIS is a european laboratory devoted to biological and medical imaging

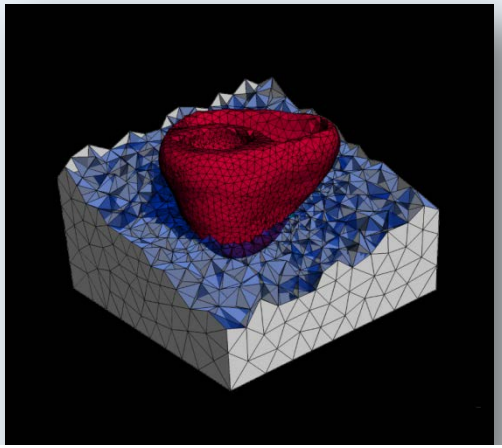


Simulation of dose distribution for radiotherapy



Creatis

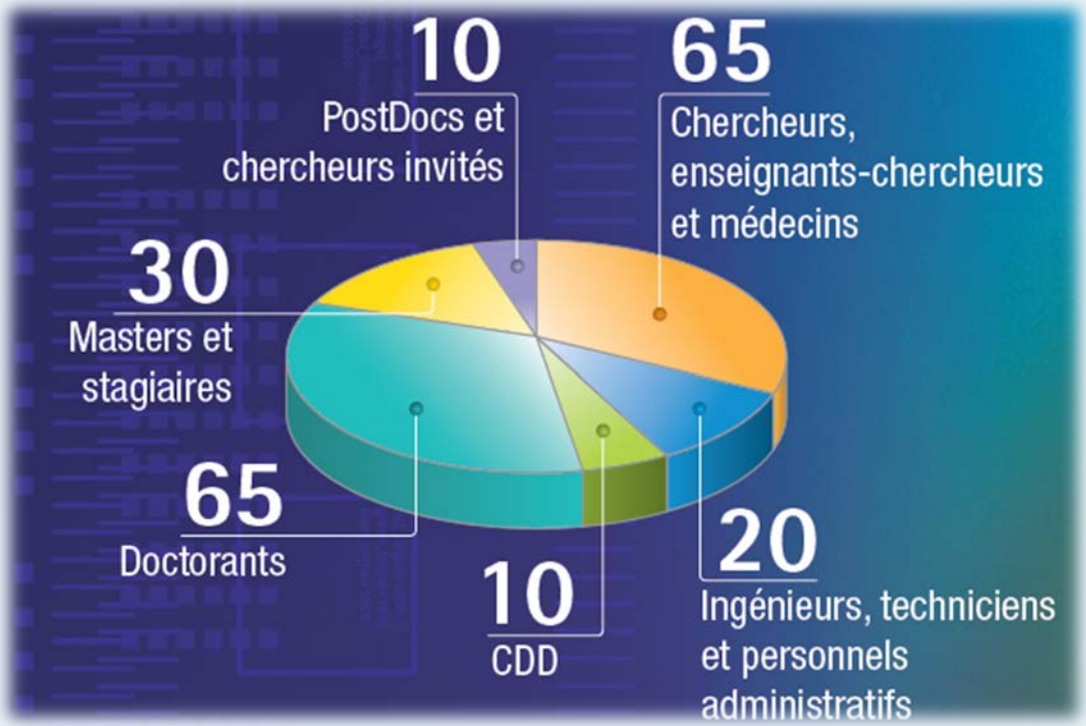
At the interface between **engineering**, **computer science** and **living science**



3D modelling of human heart based on MRI

About 200 persons :

250 publications per year, more than 100 peer review journals



Budget :
9M€ : total including salaries
2M€ : research contacts

Creatis

Objectives and missions

New imaging tools and models for observing the human physiology and biology and for understanding and answering selected medical and biological questions

« From bench to bedside »

3 scientific communities

Engineering and instrumentation,

Signal and image,

Life science.

We focus on the major pathologies

- Vessels: atherosclerosis
- Heart : ischemia and infarct
- Lung injury
- Brain : Stroke and neurodegenerative diseases

Basics : Inflammation, perfusion

Specific interest on poor prognosis cancers (lung, liver bone)

With the help of

- Small and medium animal imaging
- Clinical studies

Involving new contrast agents

Theoretical and technological Imaging research guided by the medical questions

step 1: Identify the unanswered biological / medical questions

Step 2: Optimize the acquisition, create new concepts and Combine imaging modalities

Step 3: Process the data considering their physical nature

Derive new signal-image processing methods to succeed

Step 4 Develop theoretical models and computer simulation to understand the phenomenon involved

Compare simulations and real data

Step 5: Transfer methodologies and softwares to real cases

Step 6: Perform animal experiments and translational research

Step 7: Perform human validation with clinical studies (cohorts), quantitative interpretation and feedback to the patient

Creatis

The specificities of the living world

- Complex organised structures
- Variable morphology with unknown geometry
- Moving deformable organs
- Multi-scale objects: from the molecule to the organs
- Functional systems
- Evolving phenomenons

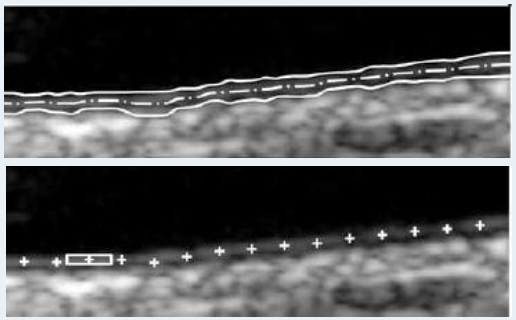
with

Þ No ground truth

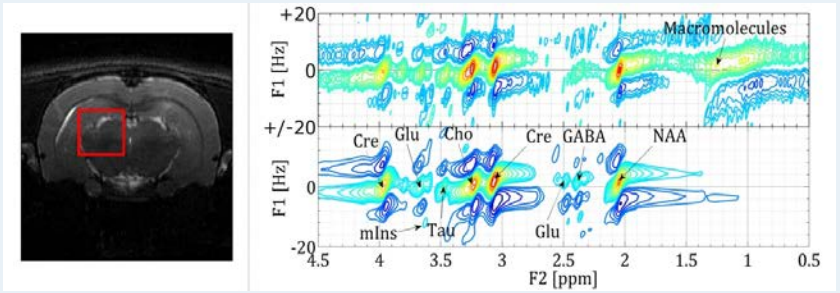
Þ No concept of « normality »

Þ Large inter- and intra- individual variability

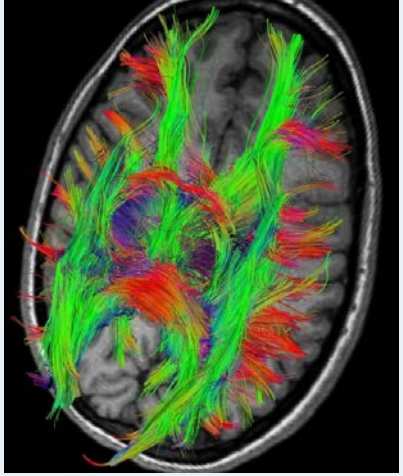
➢ Need for dedicated, multi-physics, multi-scale fast imaging techniques



Segmentation and tracking of carotid artery wall in US



MR spectroscopy



Diffusion Tensor Imaging of the brain

6 research teams

1 - Imaging of the Heart-Vessels-Lungs — *P. CLARYSSE*

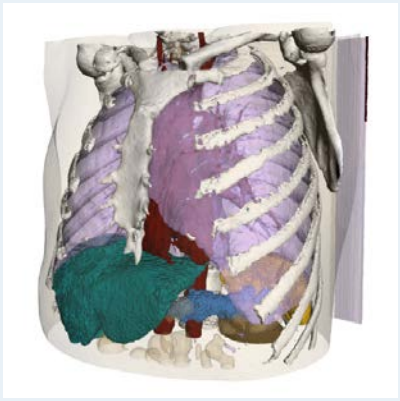
2 - Images et models — *R. PROST*

3 - Ultrasound Imaging — *P. DELACHARTRE*

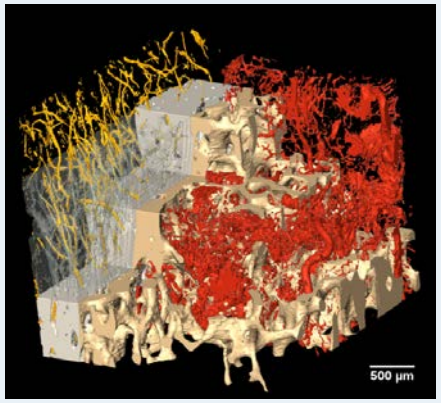
4 - Tomographic imaging and therapy with radiation — *F. PEYRIN*

5 - MRI and Optics : Methods and Systems — *O. BEUF*

6 - Brain imaging — *N. NIGHOGHOSSIAN*



Multi-organs segmentation



Microarchitecture and micro-vasculature of bone(1 voxel=1,4µm)

Dynamic model of the heart

Multiphysics advanced imaging techniques:

- X ray (radiography, Computed Tomography, synchrotron radiation, NEW spectral CT)
- Ultrasound (Radio frequency signals (RF), opto-acoustics)
- Magnetic resonance (MRI, SMRI, DT-MRI)
- Nuclear medecine (SPECT, PET)
- Optical imaging (diffuse, fluorescent)
- Hybrid and multi-physics imaging (PET-MRI, US-optics,..)

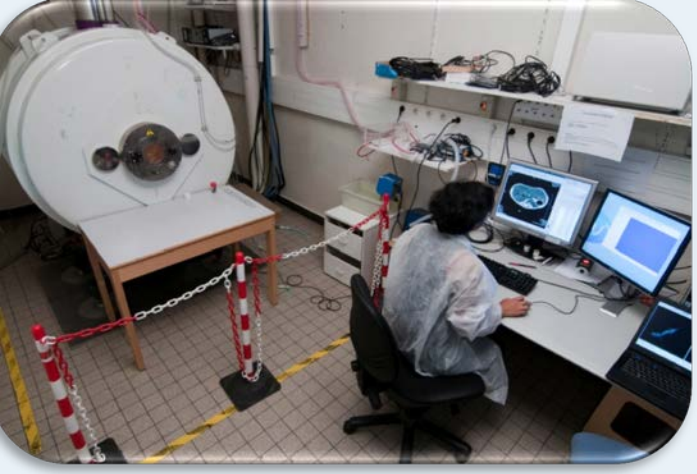
coupled to

Instrumental systems design (bi-modal sensors)

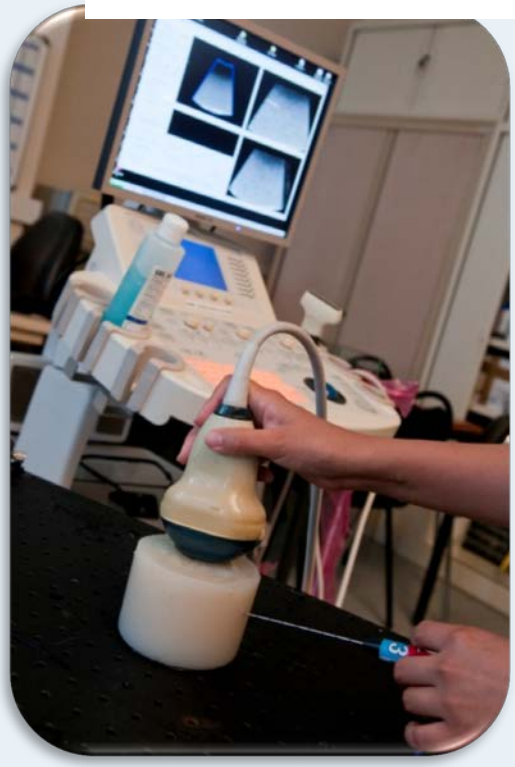
Dedicated data processing (big data, cohorts),

Modeling and Simulation (grid computing, GPU)

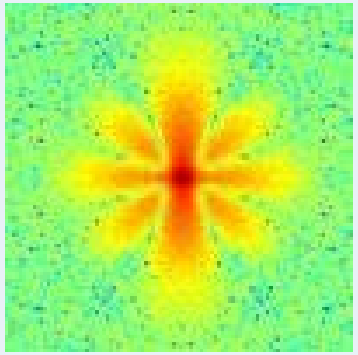
The CREATIS multimodal imaging platform



MRI and MRS
2 magnets 4.7T and 2T



Ultrasound imaging
3 research echographs,
motorized and automated acquisition



Technical platform for optical imaging
Cameras, Laser

XRay imaging
X Ray tubes 20 kV to 450 kV
FLI node: NEW spectral CT

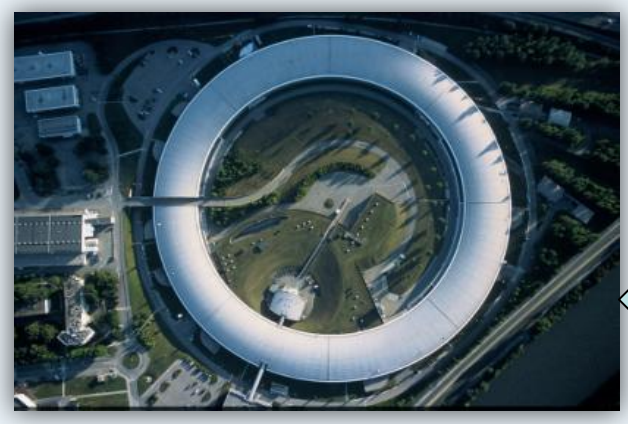
Access to imaging facilities of our partners (Teams 1, 4, 5, 6)

Radiotherapy, Elekta, CLB

- Lyon Hospitals, HCL , DHU IRIS (2013 Int. Com. Outstanding)
- CHU ST Etienne
- Cancer Center Léon Bérard
- CERMEP, Life imaging

Clinical imaging CT, CT 4D, MRI,PET, PET-CT, US, PET-MRI

SIEMENS Avanto 1,5T, Hôp. Neuro-cardio, HCL



Long Term Project at the ESRF (European Synchrotron Radiation Facility), Grenoble

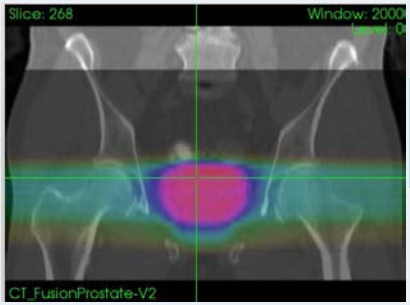
The high performance computing and software plateform

- At CREATIS
  - 27 multiprocessor computers, 120 processor cores
  - A Node open to the scientific community of the EGI

- Access to the CNRS computing center IN2P3
  - 1344 computers, 17142 processor cores (2011)

- Creatis a member of the EGI (European Grid Infrastructure) and national GIS FranceGrille

Data processing and simulation on the grid



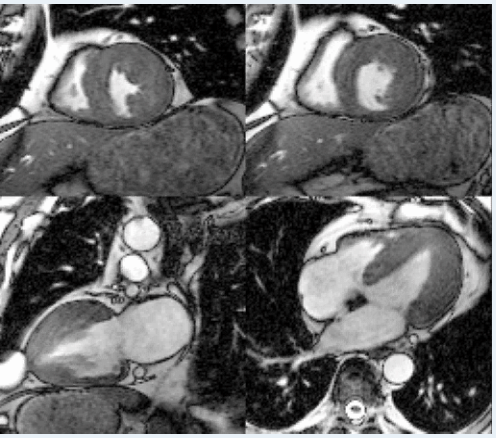
Realistic ultrasound simulator

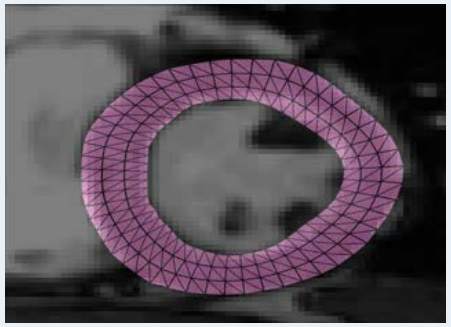
GATE : Dose Simulator for radiotherapy

Large scale simulations And processing,....

ANR Virtual Imaging Platform (VIP)

Transversal project

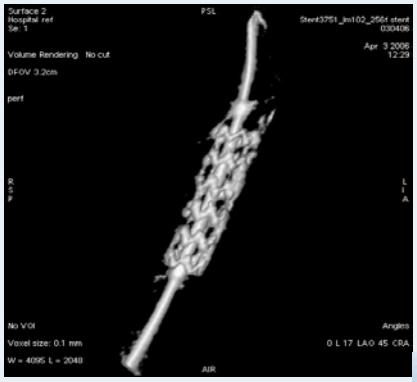




(MRI)cardiac function quantification

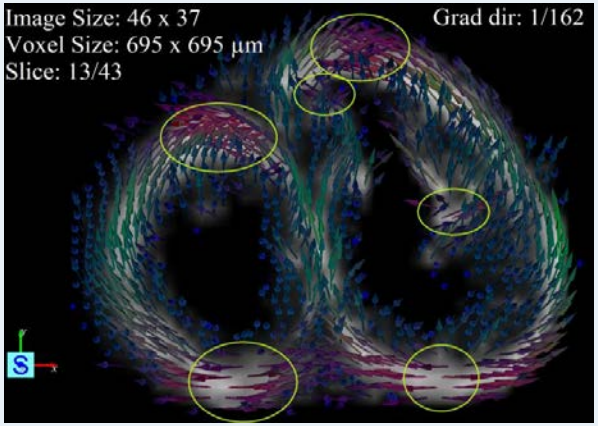
3D dynamic model of the heart including fiber orientation.
Coll. Auckland Bioengineering Institute

Ischemic disease and consequences: vascular, cardiac and cerebral



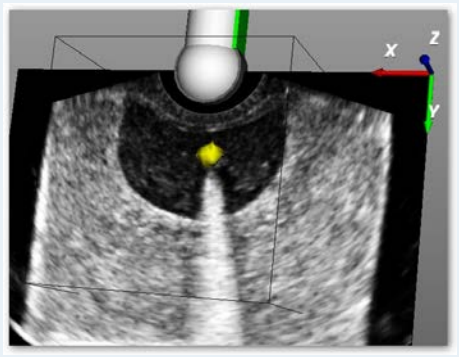
3D tomographic reconstruction of a stent, Coll. GEHealthcare

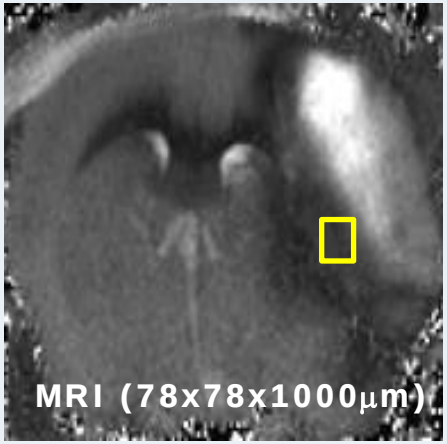
High resolution simulation of diffusion tensor imaging
LIA Metislab Harbin Institute of Technology

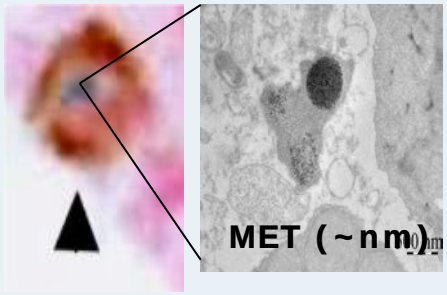


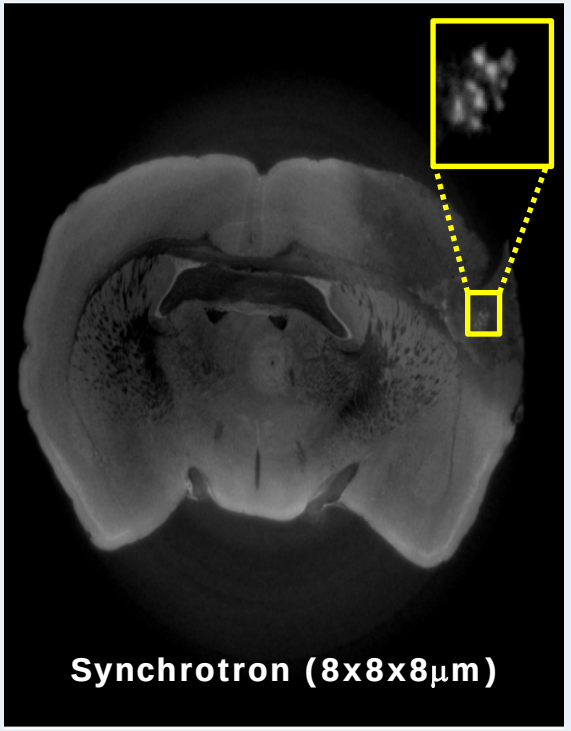
Transversal project

Bimodality imaging US-optics.
Prostate cancer diagnosis
Coll. Vermon/CEA LETI





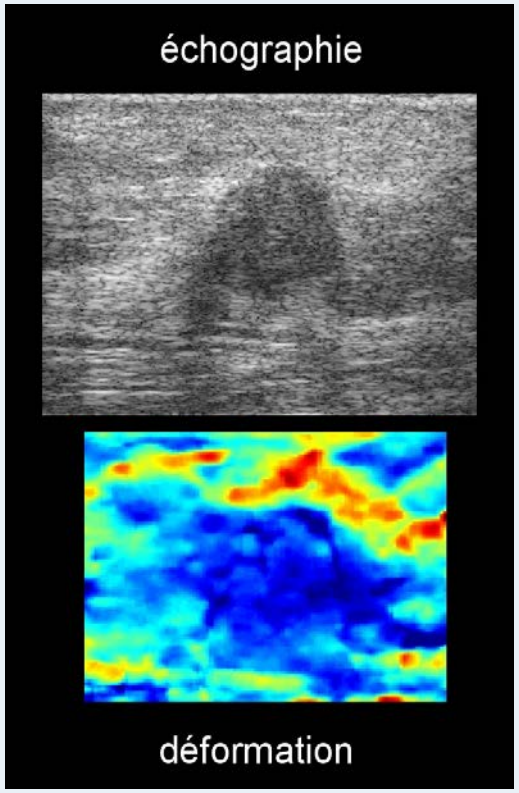




Multimodal and multiscale imaging of cerebral inflammation (Coll. Guerbet, ESRF)

Hybrid and multi-physics Imaging (MRI-optics, US-optics, MRI-PET, PET-CT, MRI-X Rays synchrotron,…)

Cancer
SYRIC
CLB – HCL

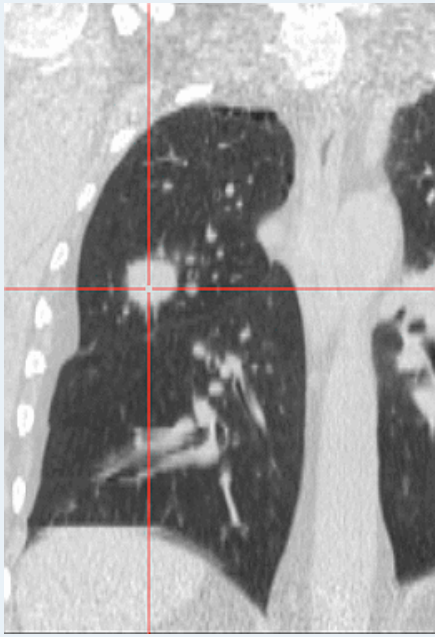


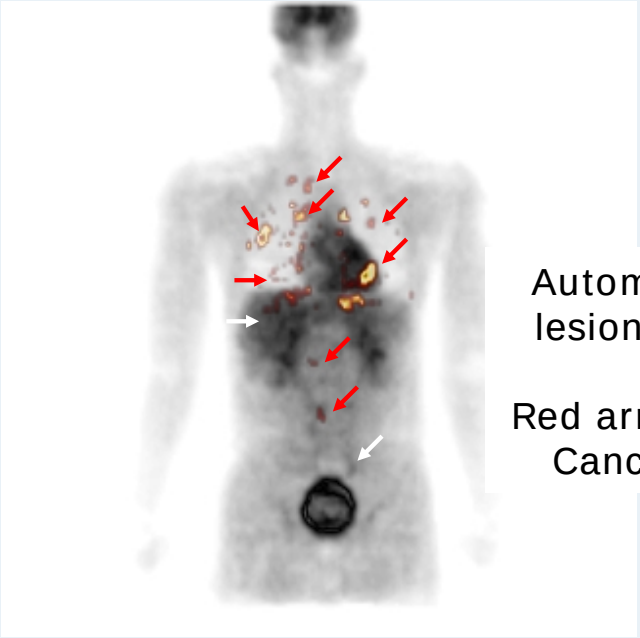
Imaging biological deformation *in vivo*
2D ultrasound **elastography**

Breast cancer, Coll. HCL and
Institute of Cancer Research, London

Radiotherapy guided by image
New acquisition protocols **4D X-ray CT** (CLB)

Clinical project « MidP » with
industrial partners ELEKTA, IBA, Philips



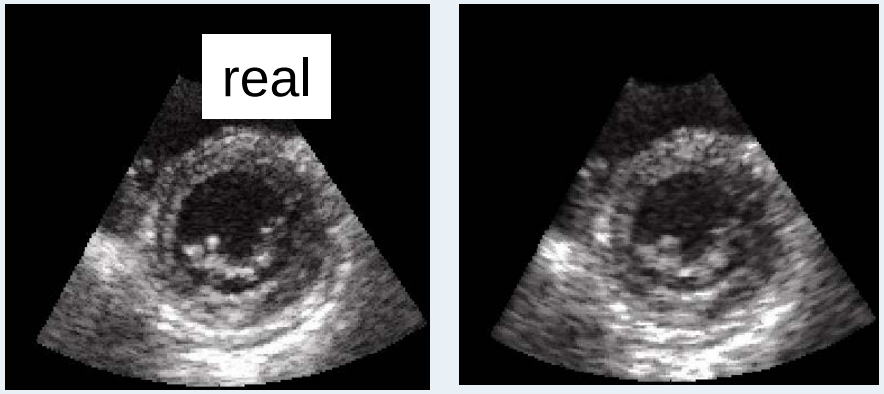


Automatic detection of tumor
lesions with **3D TEP** imaging

Red arrows : correct detections
Cancer diagnosis, coll. HCL

Creatis

Transversal project



Real (left) and simulated (right)

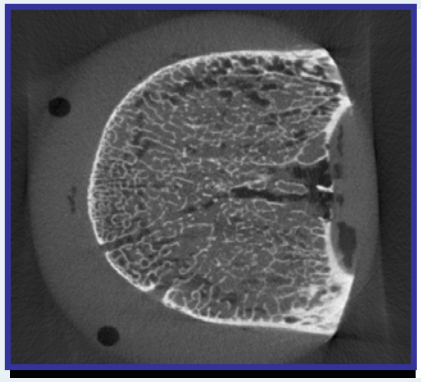
2D+t echocardiography

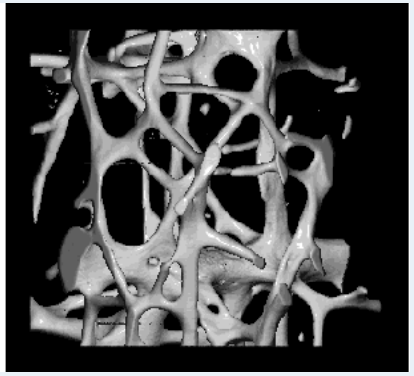
Reconstruction, modelling and simulation

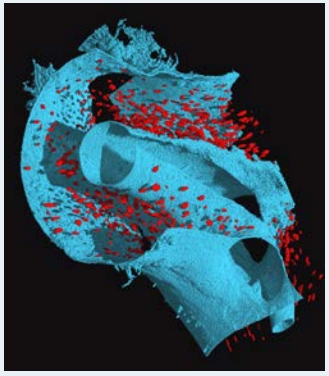
Bone microstructure through the scales

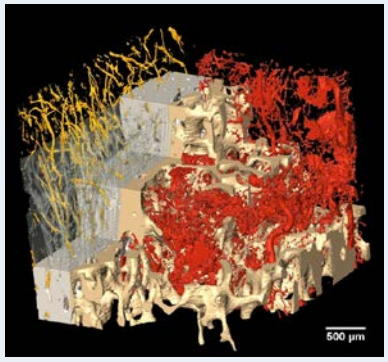
Collaboration ESRF, Grenoble and LTBO, Inserm U1044, Saint-Etienne

5 cm **4 mm** **150 µm** 1,4 µm









Clinical scanner

Synchrotron imaging

Bone microstructure and microvascular system

Collaborations and european projects

- NoE VPH, NoE EIBIR, EST Warthe,
- COST P19,
- STReP EGEE (3 projects), STReP I_KNOW,
- STReP THROMBUS (leader),
- ITN Oiltebia

- Ecole Polytechnique Fédérale de Lausanne - (Switzerland)
- Institute of Biomedical Engineering (IBT), Zürich, (Switzerland)
- Erasmus University of Rotterdam - Thoraxcenter (Netherlands)
- University Hospital Leiden (Netherlands)
- University of Leuven - Medical Image Computing (Belgium)
- University of Firenze (Italy)
- University of Roma (Italy)
- Oxford University - Medical Vision Laboratory (UK)
- Helsinki University of Technology - LBME (Finland)
- University of Barcelona (Spain)
- Czech Technical University, Prague (*Czech Republic*).

Creatis International Collaborations

Americas

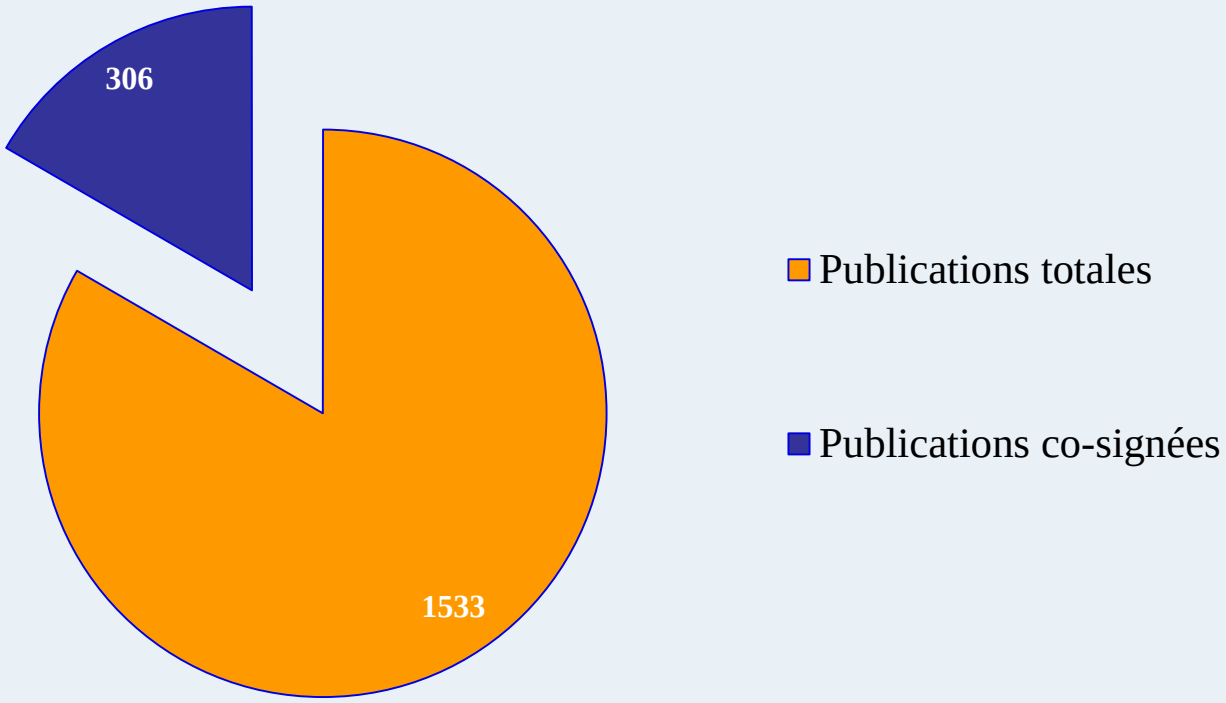
- *Imagine Group*, Los Andes University, Bogota (Colombia)
- Dept of Radiology, University of California San Francisco (USA)
- Image Computing Systems Lab, University of Washington, Seattle, (USA)
- Skirball Institute of Biomolecular Medicine, NYU Medical Center, (USA)
- Johns Hopkins Hospital, Baltimore, (USA)
- Harvard Medical School, Boston, (USA)
- Mayo clinic, Rochester, (USA)

Asia

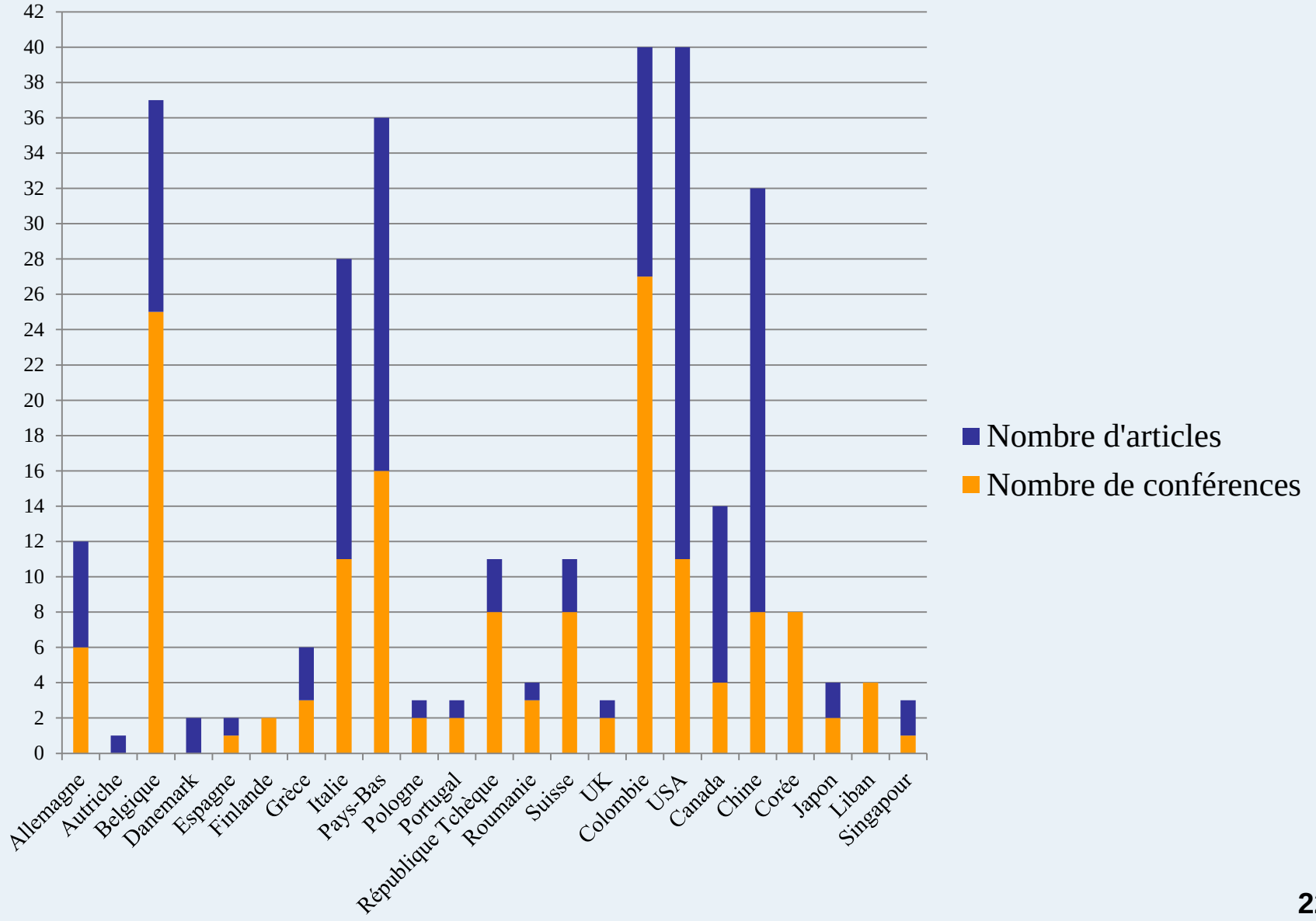
- Harbin Institute of Technology HIT (China)
  - ➔ **international laboratory METISLab, 2013 LIA CNRS**
- University Shanghai JiaoTong (China)
- Yeungnam University (South Korea)
- Tokyo University, Computer Graphics Laboratory (*Japan)*

Creatis

Part of the publications co-authored with external researchers



Countries of the co-authors (23 pays)



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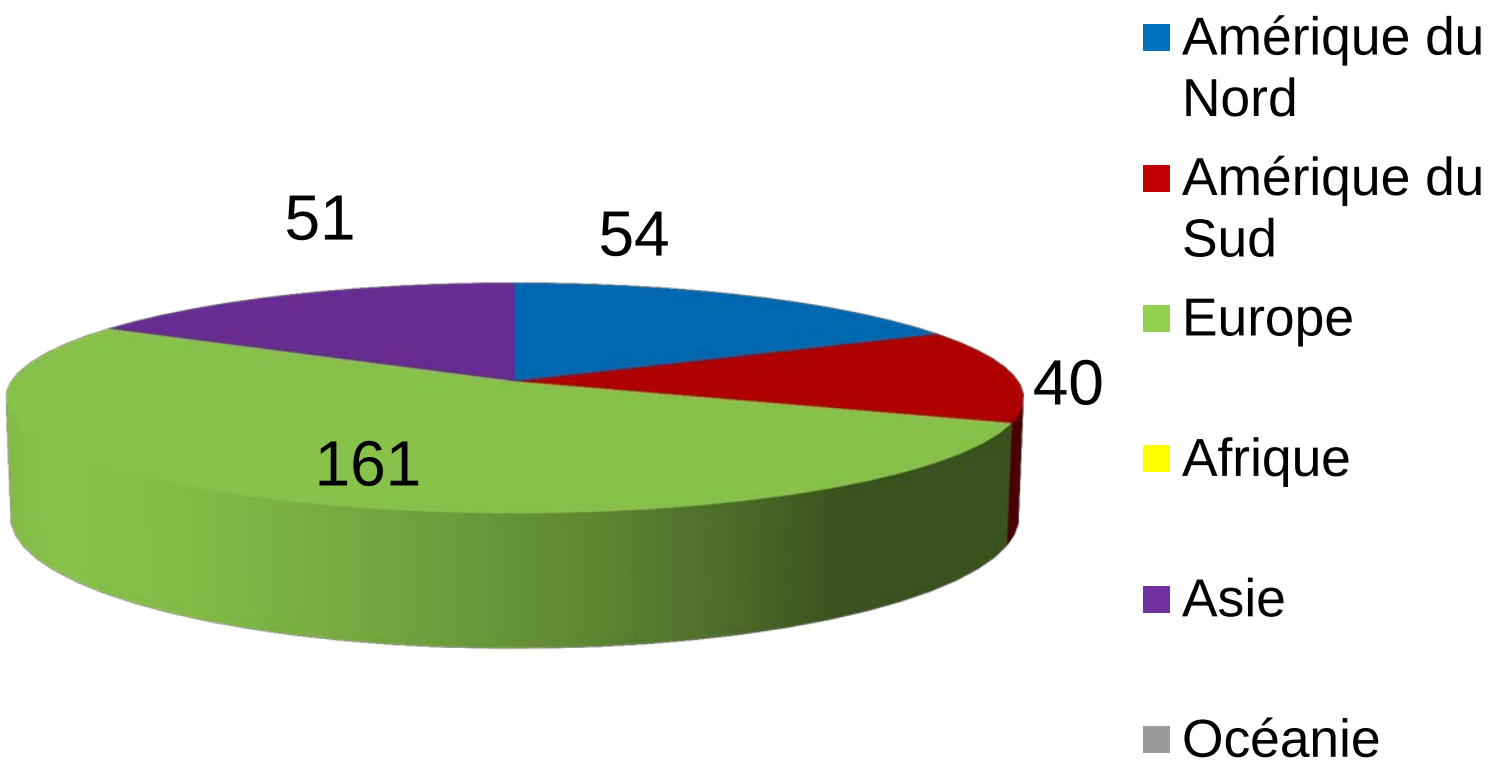
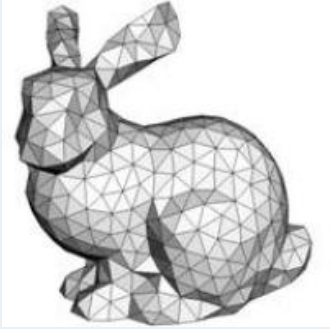
Co-authors by continents




Canada
USA
Germany
UK
Austria
Belgium
Danemark
Finland
Italy
Norway
Netherlands
Poland
Romania
Switzerland
Czech rep.
China
Japan
Korea
Vietnam
Colombia
Australia
New-Zealand
AMERIQUE
AFRIQUE
ASIE
AUSTALIE.

SOFTWARE production



- **ACVD** Simplification & remesh
- **Wavemesh** Progressive compression
- **Gdcm library** DICOM Lib ➔ Kitware
- **CreaTools suite** Image processing library open-source and multi-platforms
- **MARACAS** vascular imaging in 3D ➔ ➔ HITACHI
- **inTag** plugin OsiriX for tagged MRI cardiac data
- **jMRUI** MR spectroscopy, temporal analysis in vivo (spectra in 1D, 2D, 3D and 3D-MRSI)
- **SIMRI** MRI simulation
- **Vv** open-source, multi-platform software for visualization of multidimensional image
  - And also CreaSeg, Elavisu, CreaBimo

Partnership

- Start-ups created from CREATIS:

- 2001 : Theralys - BioClinica
- 2002 : Intellimed Consulting.
- 2008 : CIRMA , MRI diagnosis for animals

- Partnership with industry :

- Siemens, Philips, General Electric, Guerbet, Elekta, Theraclion, OBICA-3D, Lipha, DMS, Merck Health, Bracco, Novartis, Vermon , Dosisoft, IBA....

  and also Michelin, SNCF, Plastic Omnium, L'Oreal…

- 15 patents since 2001

Creatis

Thank you

Creatis

2 Laboratories of Excellence

- **PRIMES(Pilot)** : Physics, Radiobiology, Medical Imaging and simulation
- **CeLyA**: Centre lyonnais d'acoustique

1 National Infrastructure in Biology and Health :

France Life Imaging: Spectral scanner prototype

1 Equipement of excellence: MRI-PET

SYRIC: Cancer Integrated Research Center

Clinics

2011Emerging **IHU** OPeRa: Organ Protection and Replacement

2013 DHU *IRIS*: Ischemia Reperfusion Syndroms