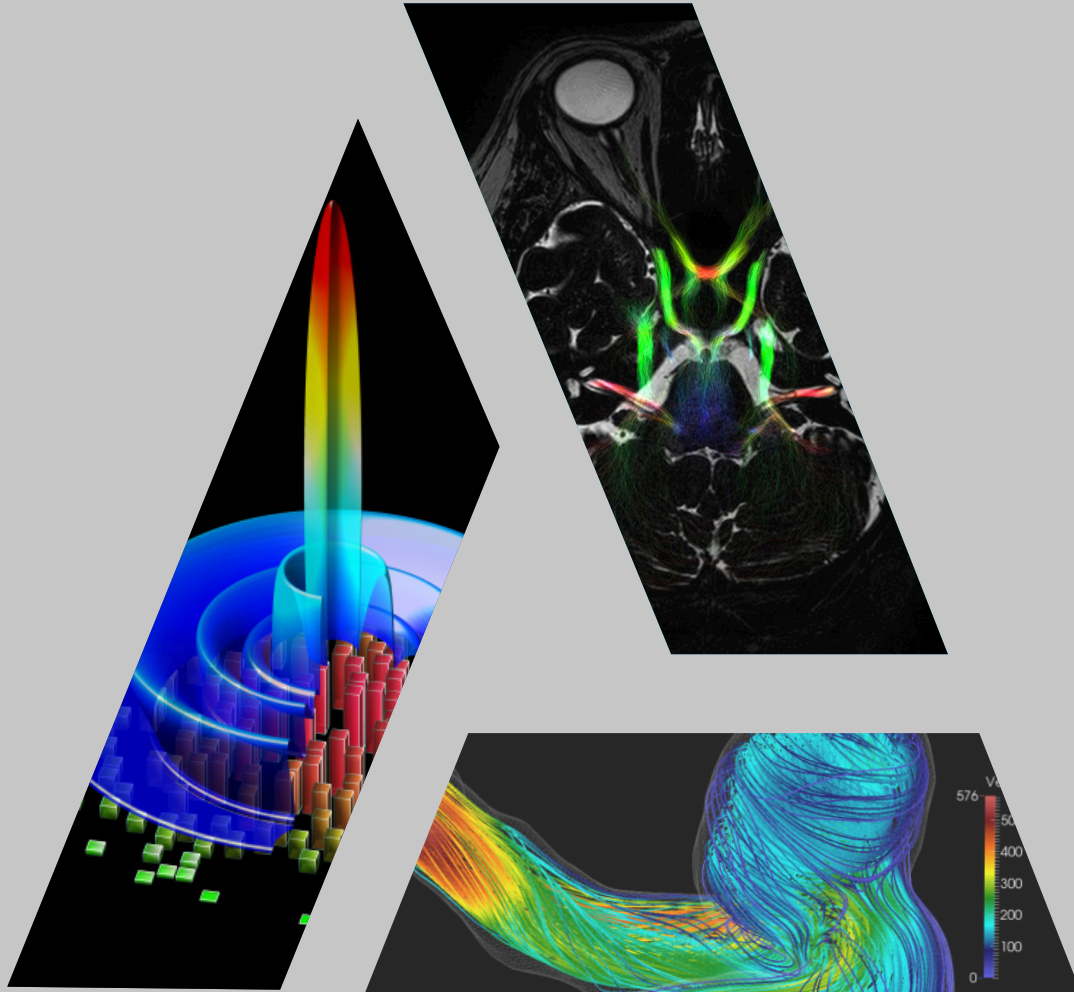


CREATIS



Centre de REcherche en Acquisition et Traitement de l'Image pour la Santé
CNRS UMR 5220 - INSERM U1206 - INSA LYON - UNIVERSITÉ CLAUDE BERNARD LYON 1 - UJM SAINT-ÉTIENNE

A WORD FROM THE DIRECTOR

CREATIS is a multidisciplinary laboratory encompassing a wide spectrum of skills in medical imaging. This major player in the field of health technology has multiple locations in the Auvergne-Rhône-Alpes region. It is renowned for its expertise in magnetic resonance imaging, ultrasound, X-ray, and optics, with related skills in physics, mathematics, computer science and instrumentation.



Through a long standing and close collaboration with hospitals and the radiologists in our teams, we are contributing to the development of a personalized, predictive medicine of future, developing techniques to identify imaging biomarkers for the early diagnosis, monitoring of a disease and the prediction of its progression and response to treatment.

Ischemic heart diseases, multiple sclerosis, cancer and stroke are among the most widespread diseases and main causes of death or disability that are studied in our laboratory. Our research is rooted in clinical practice and has a lot to bring to the future of medicine.

Olivier Beuf, Director of the CREATIS laboratory

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OUR IDENTITY

Life sciences

180
members

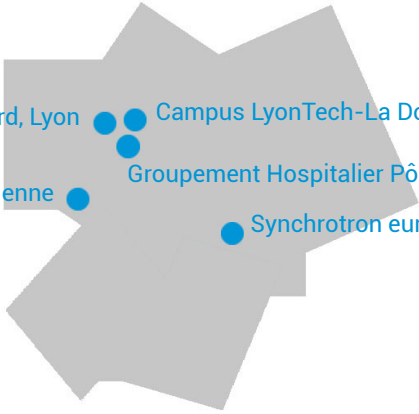
Research center

5
research
teams

7 600 000
euro
annual budget

Health
technology

200
A-rank
publications per
year



Centre Léon Bérard, Lyon

Campus LyonTech-La Doua

CHU, Saint Etienne

Groupement Hospitalier Pôle Est, Lyon

Synchrotron européen (ESRF), Grenoble

Engineering

5
supervisory
institutions:
CNRS, INSERM,
INSA Lyon, UCB
Lyon 1 et UJM
Saint-Étienne

Medical imaging

Information
science

3
technological
platforms

Personalized medicine

HISTORY

INSA INSTITUT NATIONAL
DES SCIENCES
APPLIQUÉES
LYON



1957
The Corpuscular Optics
Laboratory (LOC) affiliated
to INSA is created
by Prof. Goutte



1986
First recognition by the CNRS

1972
The LOC becomes the Laboratory
for Signal Processing and Ultra-
sound and is partnered with the
University Hospital Radiology Unit
led by Prof. Amiel



Lyon 1



1994
Members of the unit move
to the ESRF in Grenoble



© ESRF/D. MOREL



Creatis

1995
The LTSU becomes CREATIS



2011
Members of the CREATIS lab move to a new site, the Centre Léon Bérard in Lyon

2004
Accreditation from the INSERM

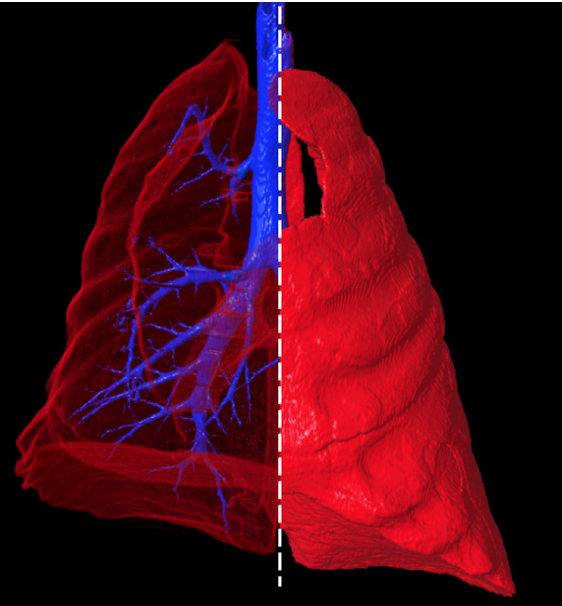


2007
The NMR and CREATIS laboratories merge

2016
The UJM becomes a supervisory institution for CREATIS



VASCULAR, THORACIC AND CEREBRAL MODELING AND IMAGING RESEARCH TEAM



17

permanent members



17

PhD students



5

French National Agency for Research (ANR) projects funded between 2016 and 2018

Our multidisciplinary team is developing a translational approach that includes pre-clinical and clinical multi-modal imaging methodologies, data processing and analysis, and modeling in order to improve the evaluation of vascular, thoracic and brain diseases.

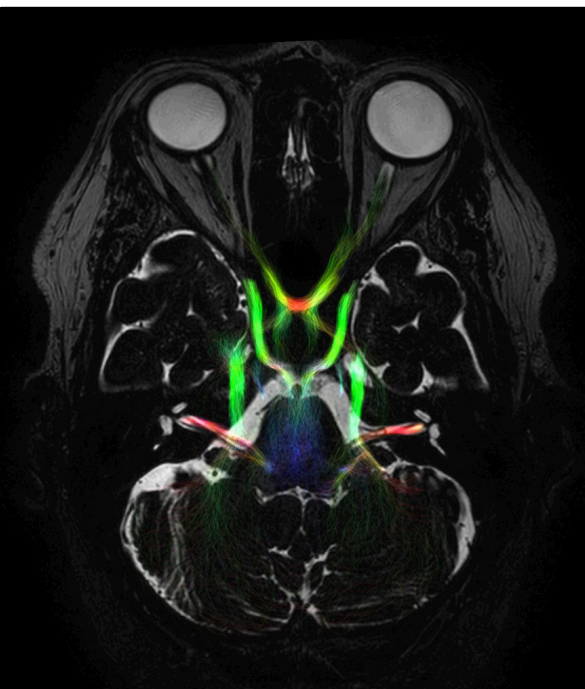
Patrick Clarysse, CNRS Research Director

Multi-modal imaging
Multi-resolution
Simulation
Modeling
Multi-scale
Digital
Cerebral
Vascular
Atherosclerosis
Stroke
Thoracic
Analysis

A CLOSER LOOK AT EXPERIMENTATION TO MODELING FOR THE EVALUATION OF HEART AND BRAIN DISEASES PROJECT

Various imaging methods, the synchrotron, holography and diffusion MRI were used to describe the tissue ultra-structure (myocardium) or to analyze the progression of pathophysiological processes scales (thrombosis), from submicrometric to macrometric. This new information was then used in phenomenological models in order to derive new functional indicators or scenarios for the advent of abnormalities. Within collaborative contexts, the team notably studied the relationship between the cardiac fiber structure and the regional deformation, and elaborated a blood clot formation scenario in intracranial aneurysms.

IMAGES AND MODELS RESEARCH TEAM



Medical image processing and analysis for diagnostics or treatment purposes leads to very specific technical and methodological locks. This team aims to develop models and advanced processing methods to overcome these locks.

Denis Friboulet, University professor at INSA Lyon



13

permanent
members



15

projects funded
between 2015
and 2018



53

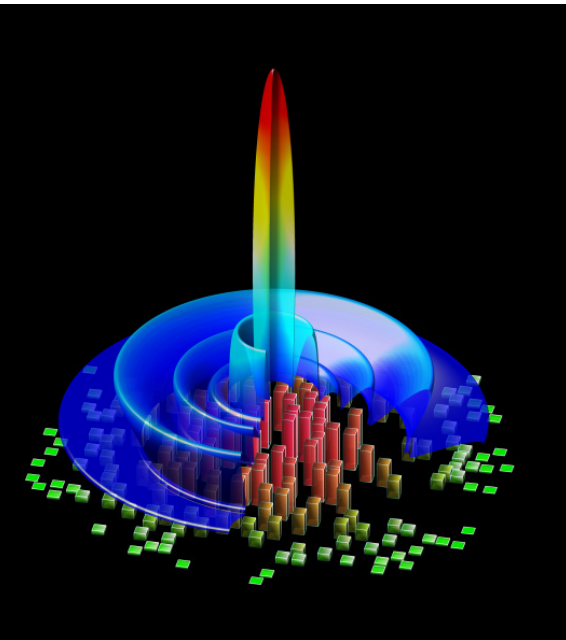
% of papers
coauthored
internationally

Automatic learning
Analysis
Segmentation
Image processing
Reconstruction and
quantification
Simulation
Movement calculation
Recalibration
Diagnostic and
prognostic model

A CLOSER LOOK AT THE SEGMENTATION OF BRAIN STRUCTURES BY DEEP LEARNING WITH CONSTRAINTS PROJECT

By combining the powerful models derived from artificial intelligence and our image processing expertise, we have pushed the boundaries of conventional approaches. We have proposed a method for the segmentation of brain structures based on deep learning. The originality of this method relies on integrating conventional learning and a basic anatomical fact: two structures may only be adjacent if this is anatomically possible. This deep learning segmentation method with constraints has halved the maximum segmentation error and essentially eliminated anatomical errors. This project was a finalist for the “Young Investigator” Awards at the 2018 MICCAI conference.

ULTRASONIC IMAGING RESEARCH TEAM



12
permanent
members



50
% of PhD students
go abroad during
their doctoral
studies



73
% of publications
are coauthored
with a partner

We work on the probe from design to clinical applications. For several years now, we have been working closely with cardiovascular disease specialists. As part of this collaboration, three cardiologists and one vascular medicine professor have now joined our team.

Hervé Liebgott, University professor at UCBL1

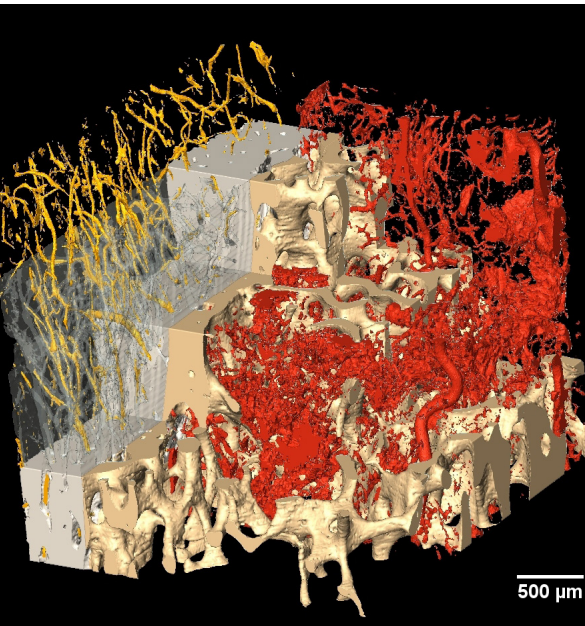
High frame rate
3D Ultrasound
Elastography
Cardiovascular
Doppler
Doctoral training
International collaboration
Platform

A CLOSER LOOK AT THE LABCOM ATYSCREA : DOPPLER AND HIGH-FREQUENCY ULTRASOUND IMAGING

Doppler and high-frequency ultrasound imaging. The Atys Médical company and the Ultrasound Imaging team at CREATIS are partners. The Labcom works on two areas of research: detecting micro-embolisms using transcranial Doppler and the quantification of the dermis and of lesions using 2D/3D high-resolution ultrasound imaging.

The analysis software for the transcranial Holter marketed by Atys Medical has a new machine learning-based algorithm which was developed through this partnership. This new solution aims to improve stroke prevention.

TOMOGRAPHIC IMAGING AND RADIATION THERAPY RESEARCH TEAM



The team is developing inverse problem solving and simulation methods for tomographic X-ray imaging and image-guided radiation therapy. This work aims to support two applications: 3D imaging of bone tissue and advanced radiation therapy in cancer treatment.

Françoise Peyrin, Director of research at INSERM



13
permanent
members



15
international
partnerships
between 2015
and 2018



20
projects
funded
between
2015 and
2018

Tomographic reconstruction

CT X-rays

Simulation

Ionizing radiation

Radiation therapy

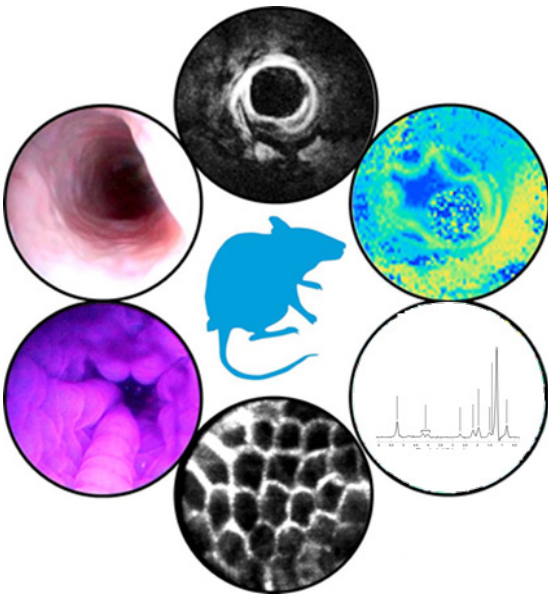
Inverse problems

Dosimetry

A CLOSER LOOK AT RADIOLOGY AND PROTON TOMOGRAPHY

We are working on an innovative radiation therapy method using protons instead of X-rays, a burgeoning field with two research centers in France. This method provides more precision during administration, which reduces the exposure of healthy tissue. The project aims to develop new software solutions to improve radiographic and proton tomography image quality, while also offering new proton treatment protocols based on these proton images. This project has received support from the Foundation for Medical Research and the European Union through the H2020 Marie Curie initiative.

NMR AND OPTICS : FROM MEASURE TO BIOMARKER RESEARCH TEAM



15
permanent
members



36
academic
and industrial
partners



15
PhD students

Our work primarily focuses on developing devices and acquisition methods linked to suitable data processing methods to quantify physical or physiological characteristics. Our aim is to find new imaging biomarkers improving diagnosis. Our target applications are multiple sclerosis, cancer, myocardial ischemia and metabolic disorders.

Hélène RATINEY, Researcher at the CNRS

Signal physics

Instrumentation

Quantification

Multi-parametric

**Clinical
applications**

Diffusion/Perfusion

Multi-modal

Optimal control

Spectroscopy

Contrasts

A CLOSER LOOK AT THE MULTIMODAL MRI-OPTICS ENDOLUMINAL IMAGING PROJECT

The diagnosis of digestive tract diseases that may lead to colorectal cancer is a major public health issue.

Instrumental and methodological developments combining imaging and MR spectroscopy with conventional endoscopy and confocal endoscopy were conducted on a chemically-induced colitis model in mice. This has improved the detection sensitivity and improved the characterization of colorectal tissue lesions.

OUR PHD STUDENTS

One of our key aims at CREATIS is to create new knowledge while contributing to education through research. Our PhD students are a vital asset for developing modern and innovative research.

At the CREATIS laboratory, they fully participate in the every day life of the unit, have representatives

on the laboratory board, they help organize PhD Student Days and actively participate in seminars. We aim to recruit the best students both from the laboratory's supervisory institutions and from top schools and universities in France and abroad.



DIVERSE PROFILES

53 PhD students

4 doctoral schools

51 % of PhD students from abroad



CAREER OPPORTUNITIES

28 % of PhD students go on to work in industry

55 % of PhD students pursue a career in academic research

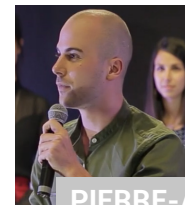


OPPORTUNITIES

8 % of PhD students have industrial partners

40 % move abroad after their doctorate

“For me, a PhD is a human adventure that leads us to face and solve challenges. This is an ideal environment that supports our success and where we can always find answers to our questions. It also provides opportunities to become interested in new problems or to lend our experience to help other researchers. During my three years working at CREATIS, I was given the opportunity to see other PhD students flourish in their fields, which is extremely motivating!”



PIERRE-ANTOINE GANAYE
MEDICAL IMAGING
PHD STUDENT

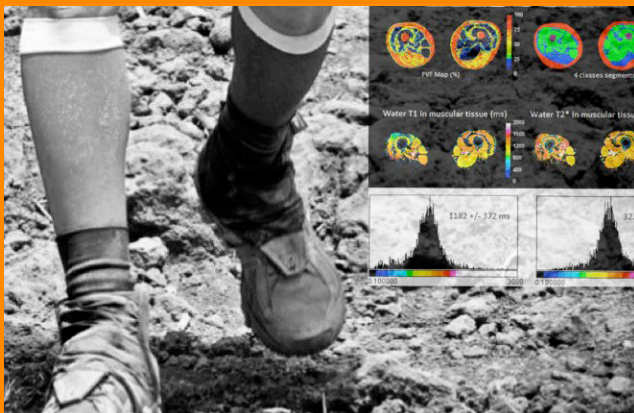
KEY FACTS AND EVENTS

MUST RESEARCH PROJECT

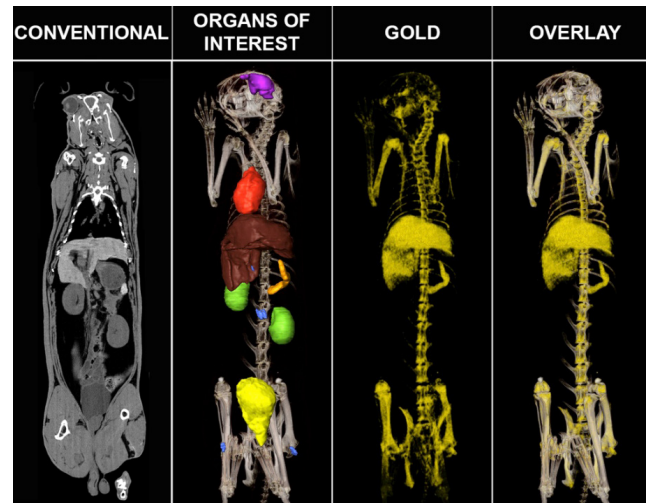
The aim of the MUST project was to understand the effects of ultra-endurance on the body and its impact on muscles and the heart.

The study was conducted in 2014 during the Le Tor des Géants Mountain Ultra-Marathon, and used magnetic resonance imaging (MRI) and ultrasound to investigate major inflammatory responses and muscle and cardiac changes in extreme stress conditions.

This project received the support of the Club of Sports Cardiologists, the INSERM, Siemens Healthineers and the Supersonic Imagine company.



SPCCT PROJECT

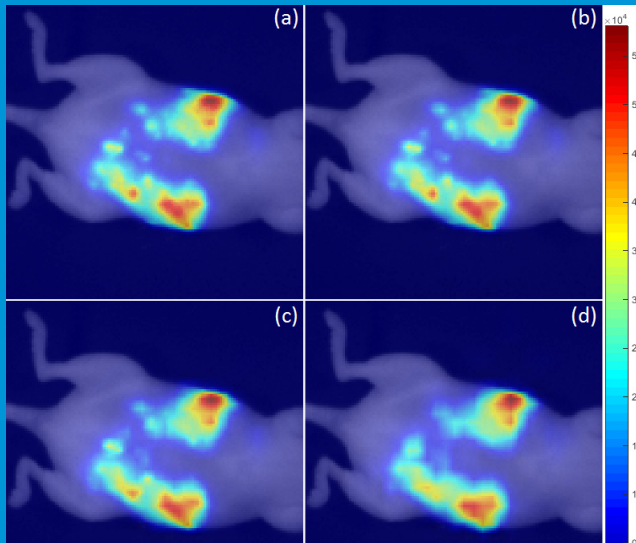


Spectral Photon Counting Computed Tomography (SPCCT) is a new imaging modality based on energy discrimination that produces images of the concentration of a wide variety of atoms, such as iodine, gadolinium, gold or bismuth. CREATIS and Philips partnered in creating the European H2020-SPCCT project aiming to develop and validate a quantitative imaging technology that combines spectral computed tomography and dedicated contrast agents to detect, characterize and follow-up neurological and cardiovascular diseases. This project has led to building the first pre-clinical SPCCT prototype in the world in Lyon.

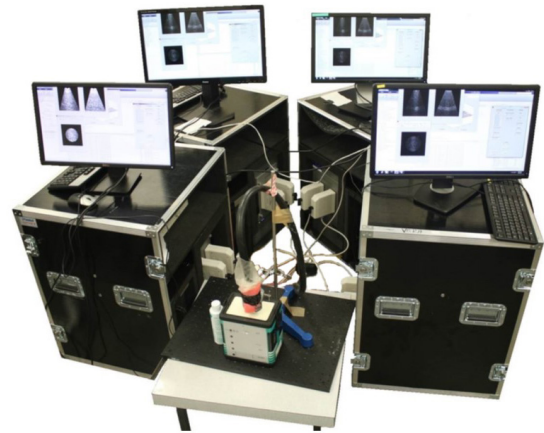
KEY FACTS AND EVENTS

COMPUTATIONAL OPTICAL IMAGING

At the crossroads of applied mathematics, optics and computer science, computational optical imaging makes it possible to design low-cost optical imaging systems that are more effective than their conventional counterparts. These approaches are especially relevant to infrared imaging, hyperspectral imaging or time-of-flight photon spectroscopy. We focus our research on image-guided neurosurgery, where computational optical imaging can show the surgeon the precise location of brain tumors during the operation.



FAST 3D ULTRASOUND IMAGING



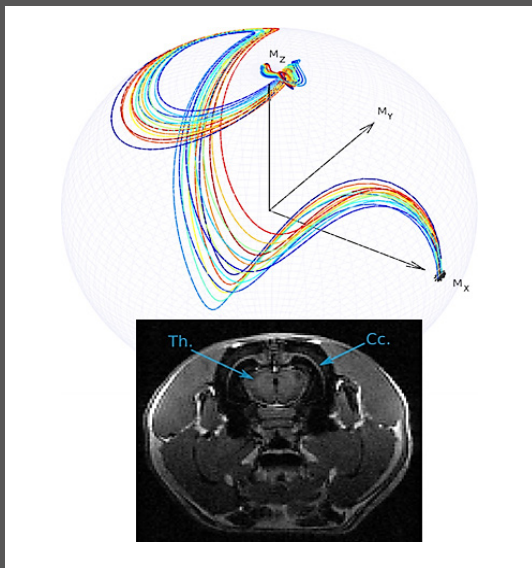
In 2017, CREATIS became one of three centers worldwide that offered fast 3D ultrasound imaging (more than 1,000 volumes per second). This project was possible thanks to the close collaboration with researchers at LABTAU, a unit affiliated with INSERM in Lyon.

The two research units shared four Verasonics systems that are able, together, to drive 1024 channels, as well as one 32x32 matrix probe. These facilities increased the visibility and attractiveness of the Lyon site.

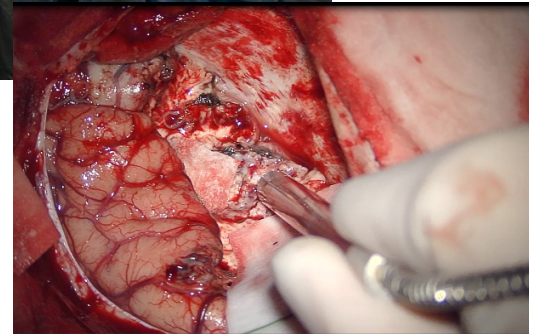
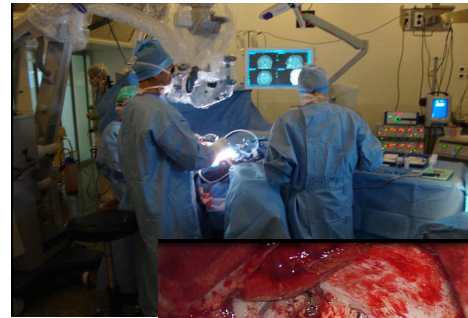
KEY FACTS AND EVENTS

OPTIMAL CONTROL IN MRI

Optimal control in MRI is a new methodology based on the mathematical framework of Pontryagin's maximum principle to design an MRI sequence with improved contrast, or new NMR signal encoding strategies. We have developed a numerical optimization methodology to generate radio-frequency (RF) waves to produce non-trivial in vivo contrast between white matter and gray matter in the brain. This work has also developed RF impulses that can encode movement in the NMR signal phase that can be used for elastography applications.



INTRAOPERATIVE OPTICAL DEVICE



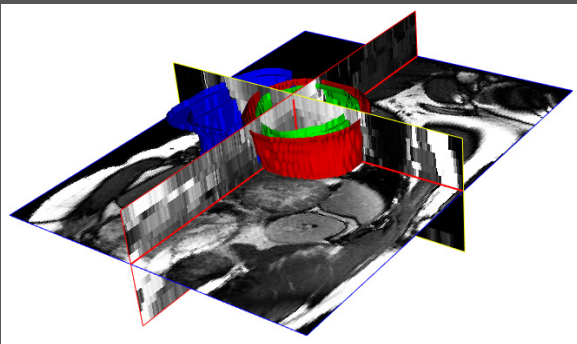
This optical medical device assists surgeons during surgical resection of brain cancers. It identifies the tumor margin in gliomas, which are invasive cancers. It was used in a 2016 clinical trial in the neurosurgery unit of the Hospices Civils de Lyon.

The device, which includes an optical probe placed on the brain and a fluorescence spectroscopy system, has identified biomarkers that show the boundary between healthy tissue and tumors, and the technique is being extended to low-grade gliomas.

KEY FACTS AND EVENTS

MICCAI CHALLENGE

CREATIS co-organized the “Automated Cardiac Diagnosis Challenge” at the 2017 MICCAI conference. The aim of this challenge was to compare the performance of automatic segmentation methods for the endocardium, the left ventricular epicardium and the right ventricular endocardium, and to compare the performance of automatic examination classification methods for four diseases: infarction, dilated cardiomyopathy, hypertrophic cardiomyopathy and abnormal right ventricle. The challenge used a database of Cine-MRI images from 150 patients at the Dijon University Hospital. Ten research teams from ten different countries took part in the challenge. The evaluation platform and the database are now freely available to the image processing community.



OTHER MAJOR EVENTS:

- **The Human Heart Project:**

CREATIS is developing a single storage location for medical data and cardiac imaging software applications. This will enable research teams to share annotated data easily and quickly so they can test advanced computational methods. This storage location strengthens our international collaborations.

- **Video Magnification Applied in Ultrasound:**

CREATIS is developing a very fast ultrasound imaging and visualization method to study the kinematics and flow of blood vessel walls.

- **The LYriCAN project:**

This project brings together researchers in the fields of biology, physics, computer science and medicine to address a single translational issue: analyzing and combating cell plasticity in order to develop innovative cancer treatments. CREATIS develops the imaging capabilities required to quantify and analyze this plasticity.

- **Radiomics for oncology:**

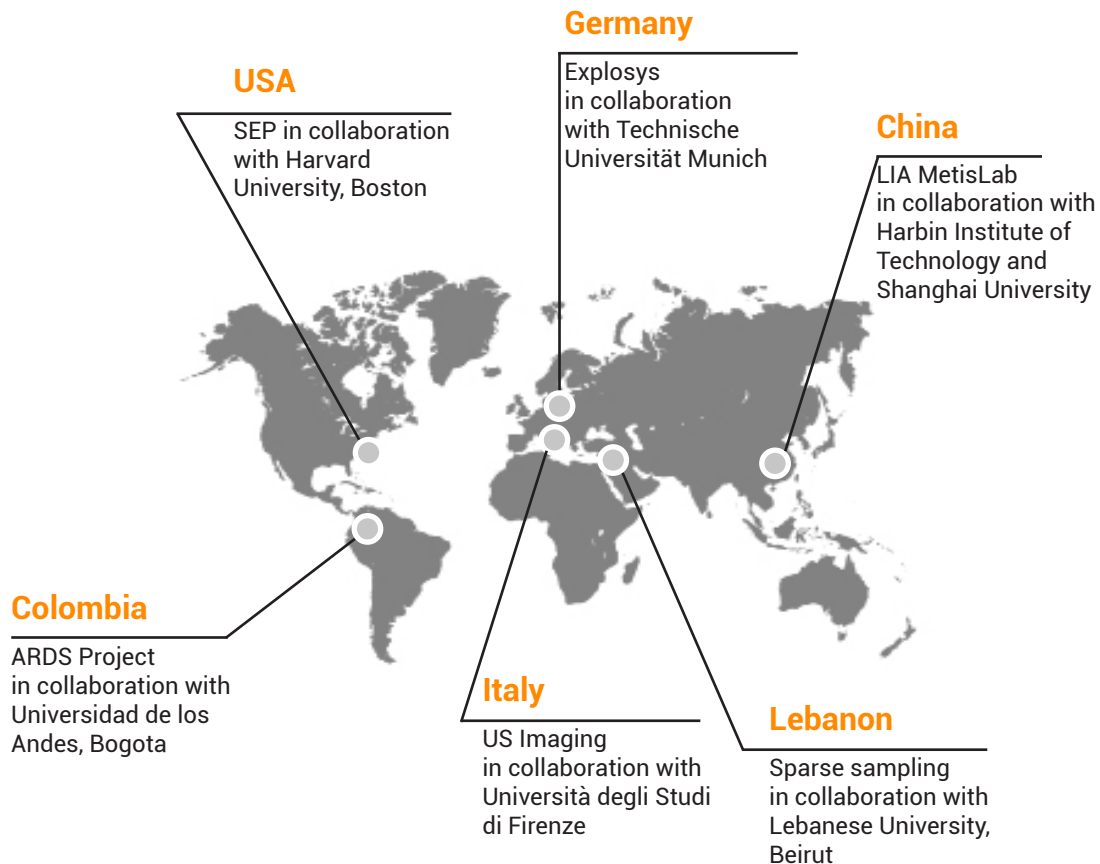
A macroscopic characterization of the tumor's phenotype from quantitative MRI imaging after processing and statistical analysis.

INTERNATIONAL

26
partner countries

18
international PhD
students each year

9
international
projects



INTERNATIONAL COLLABORATIONS: AN ADVANTAGE FOR RESEARCH

CREATIS has built strong, lasting partnerships with top universities and institutions worldwide in order to conduct world-class research and contribute to promoting the excellence of French academic research. Through its partner networks, the laboratory conducts large-scale scientific projects and builds international exchanges funded by the European Commission.

RESEARCH TRANSFER AND INDUSTRIAL PARTNERSHIPS

CREATIS has close ties to the business sphere, which is a key component for the recognition of our research at the local scale with young, innovative companies, as well as at the international scale, with major players in medical imaging. This is a very active field that is constantly evolving not only scientifically, but also in the technologies it employed.

CREATIS enables its partner companies to validate methodological concepts and contribute to clinical validation.

The wide spectrum of expertise at CREATIS is a true asset for our partners, as it provides opportunities for fast industrial development with positive socio-economic benefits.

THE BIOCLINICA SUCCESS STORY

In October 2001, CREATIS supported the founding and development of the Theralys company, which provides technological services for medical imaging in clinical trials, in particular for the central nervous system and the cardiovascular system. Theralys was sold to Bio-Imaging in 2007, and has now become Bioclinica, an international company that conducts the clinical trials needed to bring new pharmaceutical products to market.

OUR INDUSTRIAL PARTNERS

IBA Siemens
Kapteos
Supersonic Imagine
Carestream
Electa Philips
Bracco
Olea Medical
MicroDB
ATYS Pierre Fabre
Kitware GEHC
Hitachi

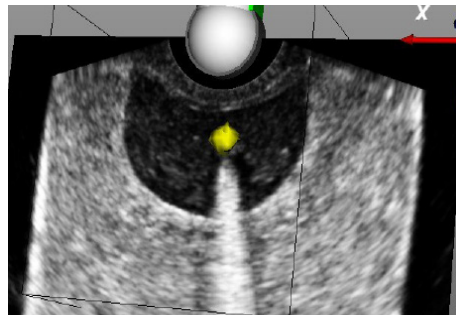
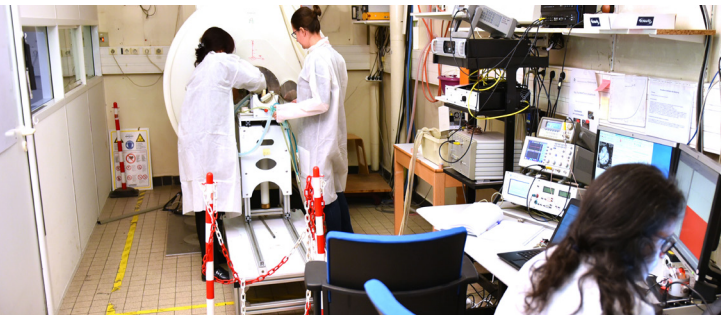


72
projects funded
since 2015



20
industrial
partners,
on average

PILOT is an innovative multimodal imaging platform that brings together MRI, optics and ultrasound. It is located on the LyonTech-La Doua campus and enables academic and industrial users alike to address complex issues, thanks to its certification for animal experimentation.



3
imaging platforms: MRI,
optics and ultrasound

400
half-days of project
support

5
staff people

300
m2 platforms
(3200 sq. ft.)

OUR AIMS

- Contributing to scientific progress in methodological research and research applied to living organisms at the macroscopic to microscopic scale.
- Providing measurement and quantification services for anatomical, physiological and functional data with our staff trained in animal experimentation and well-being.
- Satisfying our clients with our quality system to improve the platform's performance and know-how.

OUR SKILLS

- Determining the best methods and techniques to measure physical or biological phenomena thanks to the multidisciplinary PILOT team and the expertise of CREATIS researchers.
- Implementing new acquisition methods to address needs.
- Precision and reliability testing of imaging or spectroscopy techniques.

SCIENTIFIC COMPUTING PLATFORM

The laboratory uses a heterogeneous computer networks running on Linux and being used with asynchronous task management software. These computers are available to be used by members of the laboratory.

OUR AIMS

- To pool computer resources
- To provide a computing environment similar to the one researchers use at their workstations
- Heavy calculations in a suitable server room

OUR SKILLS

- Assistance in developing and submitting calculations
- Personalizing the work environment by installing additional software
- Documenting and circulating maintenance information



26 800
days of computation
time used in a year

32
machines

452
processors

55
TB storage space

5
NVidia GPUs,
including 4 V100s

189 000
jobs submitted
in a year

VIP PLATFORM



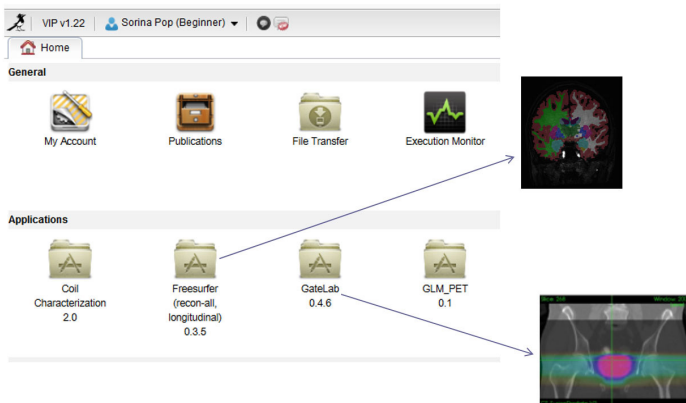
The Virtual Imaging Platform, VIP, is a web portal for medical simulation and data analysis. It uses the resources available in the biomedical virtual organization of the EGI e-infrastructure to provide a service available to researchers all around the world.

OUR AIMS

- Provide transparent access to distributed computing resources
- Provide access to scientific applications as a service
- Facilitate the sharing of applications and data to foster open and reproducible science

OUR SKILLS

- Support and guidance on application integration into VIP
- Expertise and research in the area of distributed computing
- Provide innovative services for research



1 000
registered users

20
applications available
as a service

220
CPU-years used by
VIP applications in
2017

44
publications by VIP
users who have been
using the platform to
generate their results
since 2011

2
challenges in the 2016
MICCAI conference, with
23 new applications
from 15 research groups
imported and executed
in VIP

CREATIS 2020

All of the laboratory teams working at the LyonTech-La Doua campus will join a new building in 2020. This new work space will bring together all PLoT technical platforms, which means that all of CREATIS' imaging capabilities will be housed in the same building, fostering synergy and pairings. This will also lead to a new research momentum by encouraging exchanges between the various

scientific communities at CREATIS in order to master the different steps needed for imaging, such as the measurement, reconstruction and extraction of the relevant characteristics of the image. Finally, this consolidation, along with the new very high magnetic field MRI system, will increase the fundamental and preclinical research imaging capabilities at the LyonTech-La Doua site.



120

staff members
on site, on
average



6

technical platforms
for MRI, animal
studies, computation
and electronics



11,7

Tesla
pre-clinical
MRI



2 600

m2 of office space
and technical
platforms
(28,000 sq. ft.)



WHY CREATIS?

Are you a student?

- We can enable you to work on projects that address real public health issues and work in collaboration with world-class universities
- We provide opportunities to further your career in academic research or in industry
- We offer a work environment that treats doctoral students as full members in the daily life and development of the laboratory

Are you an academic?

- We provide you with our expertise to co-develop projects
- We give you access to technical platforms for MRI, animal studies, ultrasound, optics, computation and electronics to further your research

Are you a company?

- We give you the opportunity to draw from the knowledge of experts in many different fields
- We enable you to collaborate with a laboratory that already has established partnerships with major players in the medical imaging industry
- We provide you access to cutting-edge medical imaging technologies



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PARTNERSHIPS AND TRANSFER

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