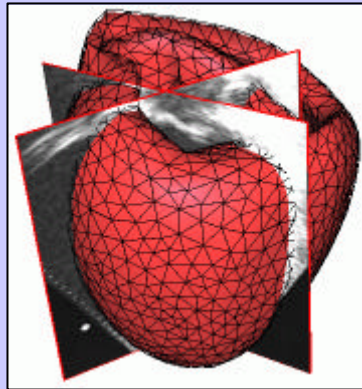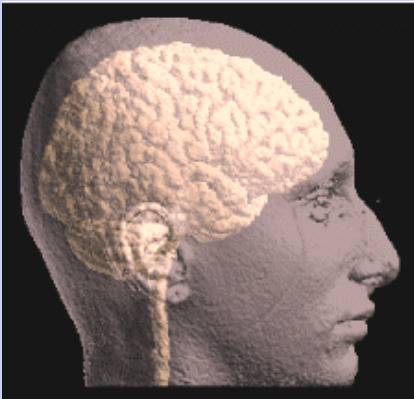# *Epidaure*

Medical Imaging and Robotics

INRIA - 2004 Route des Lucioles, 06902 Sophia-Antipolis , France

Epidaure Team

- Between 25-30 members including

  - 5 permanent researchers : N. Ayache, H. Delingette, M.A. Gonzalez-Ballester, G. Malandain, X. Pennec

  - 2 engineers: E. Bardinet, M. Traina

  - 14 PhD Students (engineers and MDs)

  - Post-Docs

  - External Collaborators (Profs, MDs)

  - Trainees (Scientists, MDs)

  - Assistant : I. Strobant

Objectives

- Design et Develop new Software Tools
  to Improve the Impact of 3-D Bio-Medical
  Images.

- Participate to their Validation and Transfer
  through Medical and Industrial Partnership, and
  also through transversal actions.
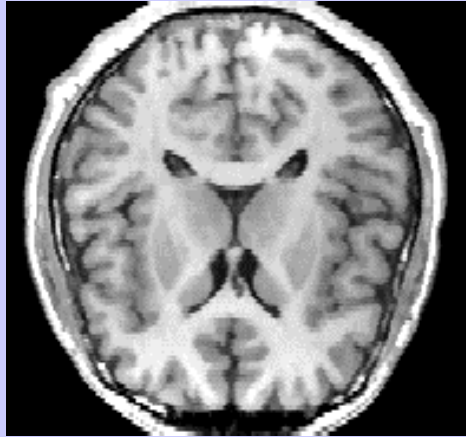
Current Situation of Medical Imaging

- **Research:** prevision of increase 30%/year until 2010 (x10)

- Constant stream of better imaging&signal modalities

- Emerging new modalities

- Provides higher and higher resolution complementary information (spatial/temporal, anatomical/functional)

- New image-guided therapies (includes MIT, robotics, cell and gene therapies)

- Possibility to quantify the effect of a new medicine

- Flow/quantity of information too high to allow optimal exploitation by simple visual examination
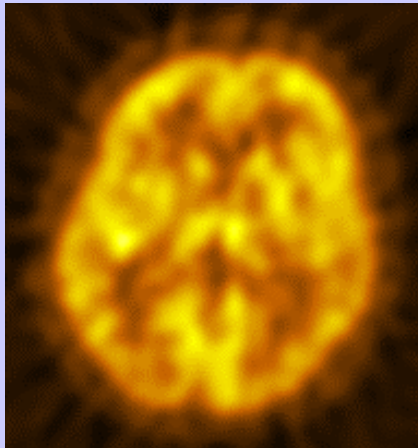
Some "Classical" Imaging Modalities
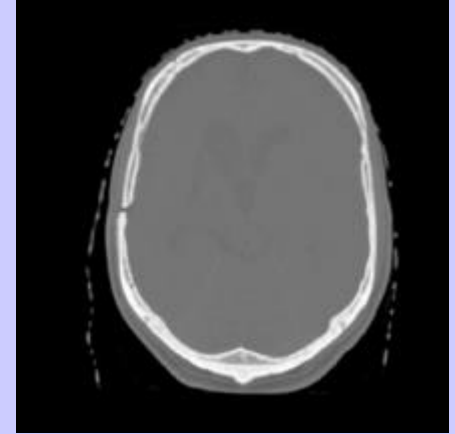
MRI

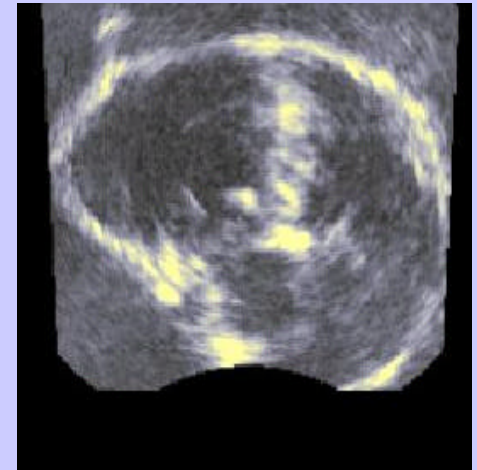Density and structure of Protons

CT-Scanner

Density of X-Ray absorption

Scintigraphy

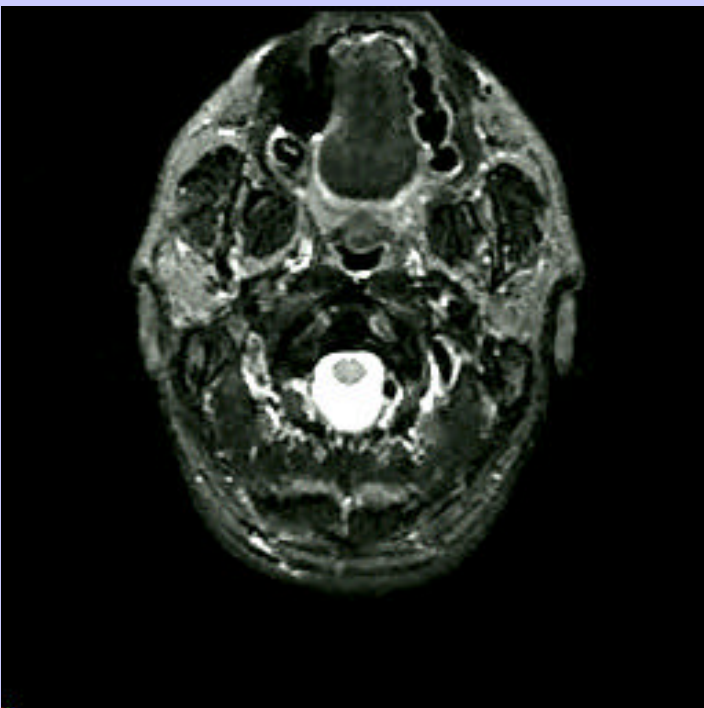Density of injected isotopes
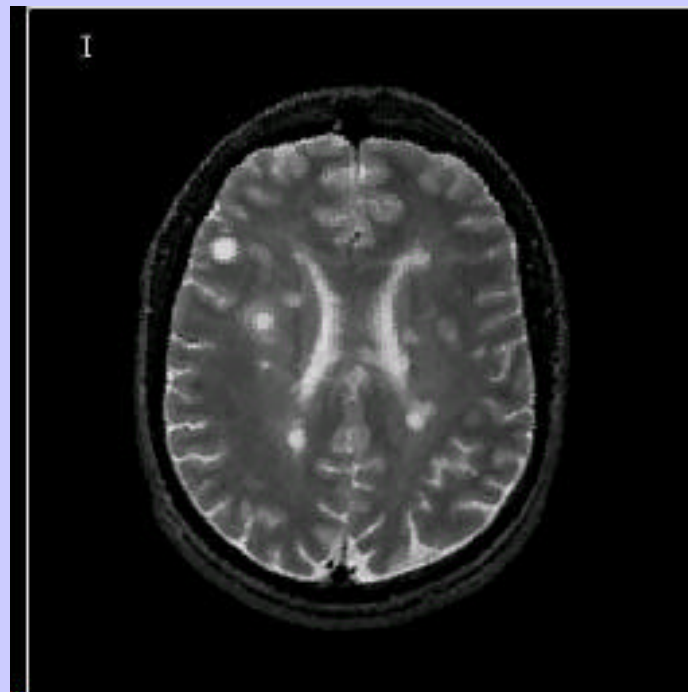

Ultrasound

Variations of Acoustic Impedance

Multidimensional Images

3 spatial dimensions
(MRI-T2)

Temporal Evolution of
Multiple Sclerosis
(collaboration with Harvard,
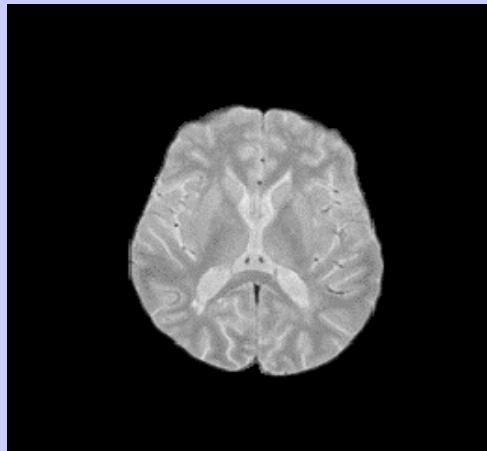CHU-Pasteur & QuantifiCare)
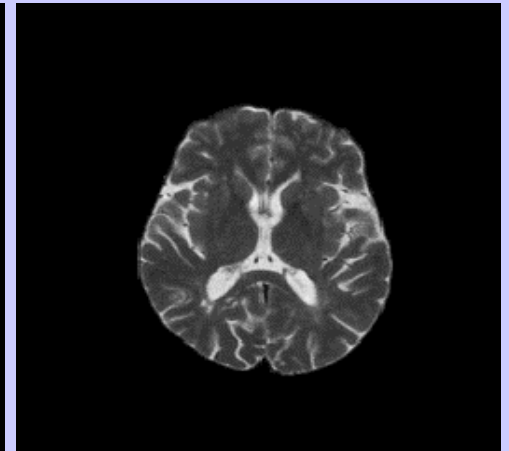
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Multispectral Images

- Same patient, various MR sequences.

T1

T2

PD

Gd

Flair

Epidaure

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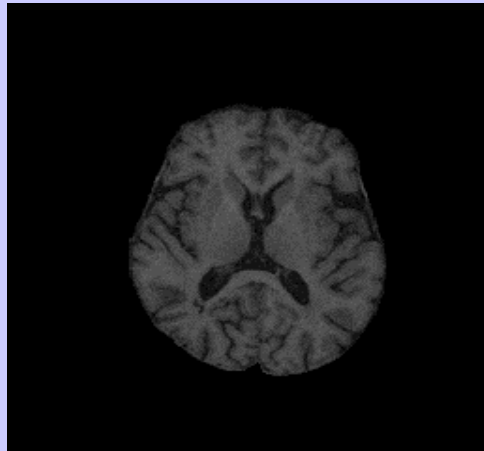
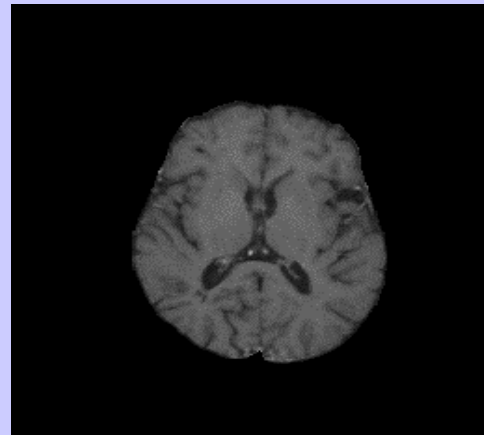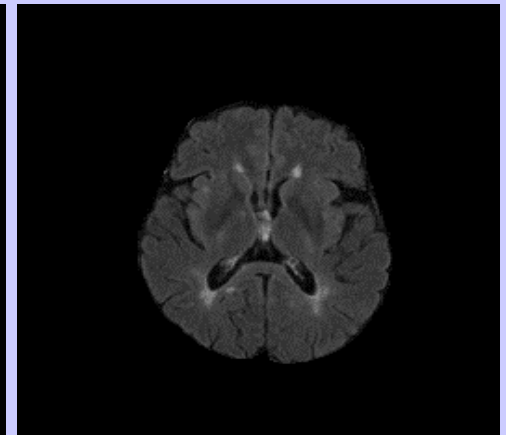# Some New/Complementary Imaging Techniques

- Optical imaging technologies
  - OCT (optical coherent tomography), Confocal imaging, auto/induced Fluorescence Imaging

- Endoscopic imaging

- Molecular imaging *(molecular probes)*

- Tissue Biomechanics from Ultrasounds

- NIR Topography/Tomography,

- Laser Doppler, Thermoacoustics, Terahertz imaging, etc…

- Histopathology images

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In Vivo Microscopic Confocal Imaging

Source: Mauna Kea Technologies

Reflectance imaging

Depth of Observation up to 100 microns

Epithelium

Lateral Resolution: 2 -- 4 mm

Axial Resolution: 8 -- 20 mm
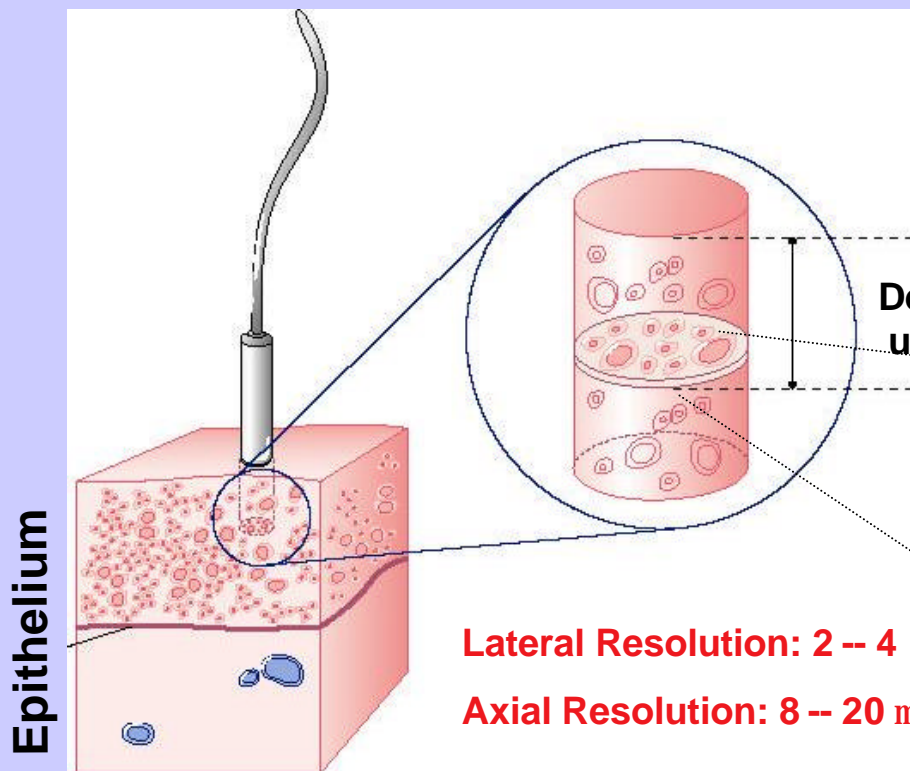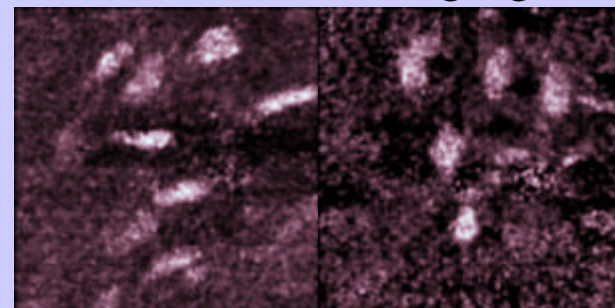
Fluorescence imaging
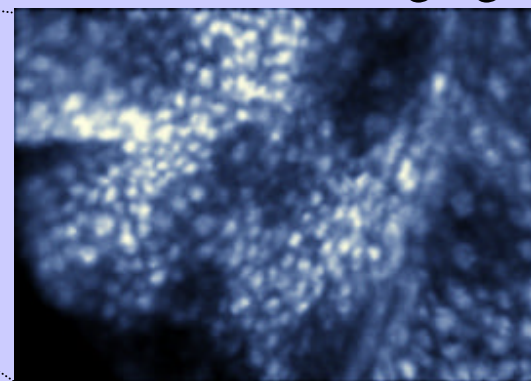
160 microns

- Confocal flexible microscope

- High resolution optical sections of tissues

28/04/2003

Epidaure
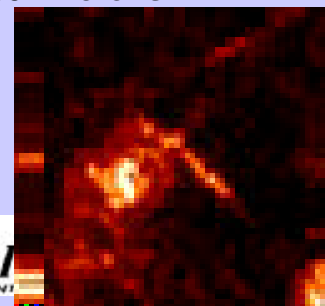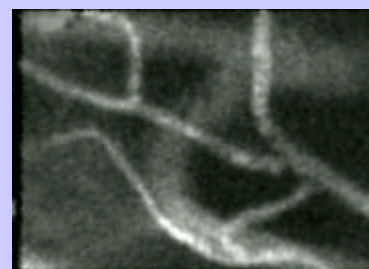
Why Medical Image Analysis?

- Better individualised diagnosis
  - quantitative and objective measurements
  - from various sources of images/signals
  - acquired at various scales
- Better individualised therapy
  - planning before
  - control during
  - evaluation after

Images in the Operating Room of the Future

DIAGNOSIS

THERAPY

Patient → Pre-operative → Patient

Patient ← Post-operative ← Patient

robot

SIMULATION

Radios, CT, MRI, US, NM, Others, ...

Virtual Patient

Radios, Video, US, iMRI, Others,...

Per-operative

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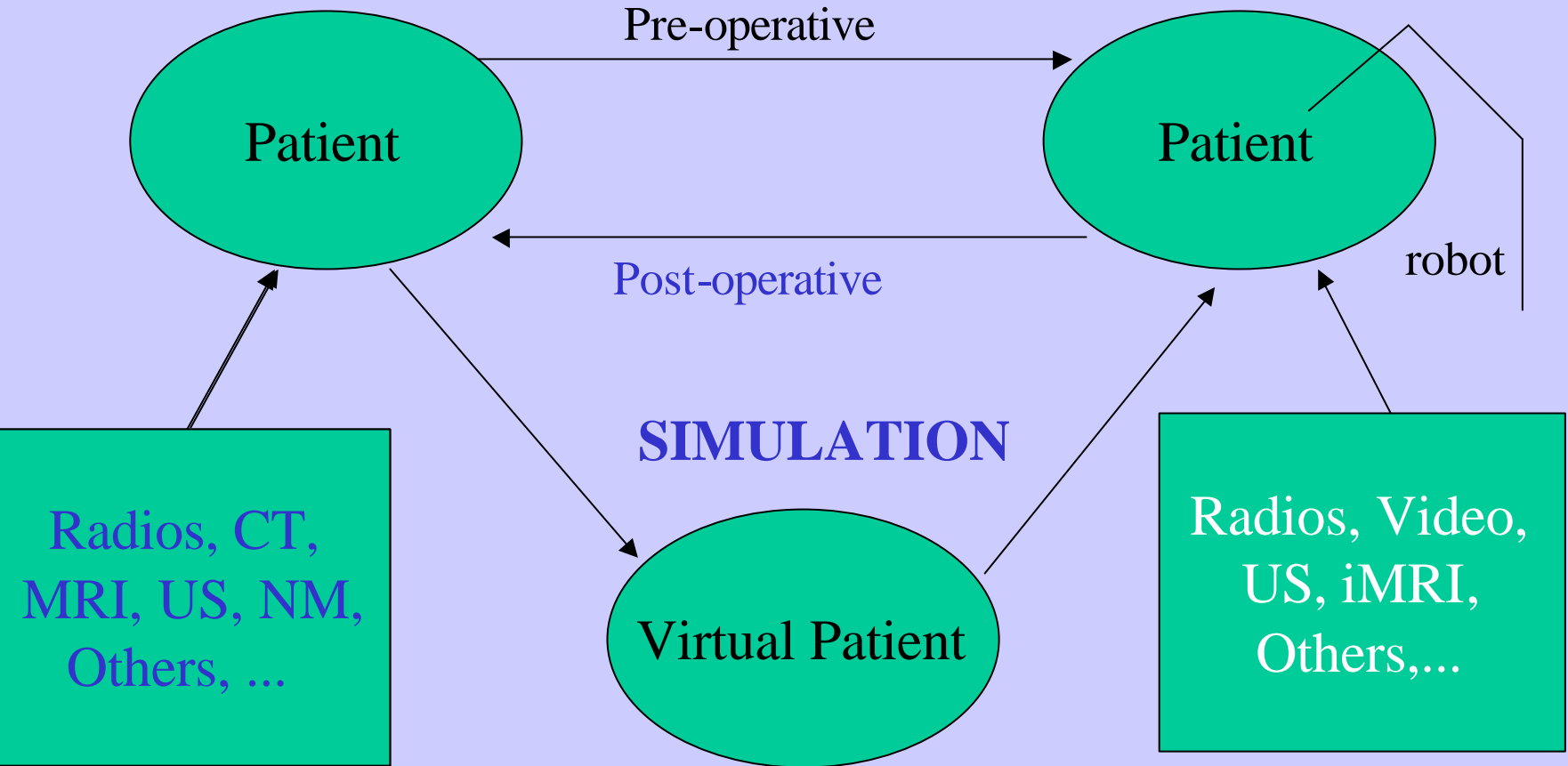
Epidaure
Some Generic Research Topics

Restoration

Physics based Segmentation

Registration and Fusion

Statistical Shape Analysis

Atlas construction

Cardiac Motion Analysis

- Functional MRI
- Surgery Simulation
- Biomechanical models
- Physiological models
- Visual/Haptic Interactions
- Coupling with robotics...

Some Current Clinical Projects

- **1. Multiple Sclerosis**
  - Harvard Medical School, CHU-Pasteur, *QuantifiCare*

- **2. Image-Guided Neurosurgery**
  - Roboscope,

- **3. Histological Atlases**
  - Pitié-Salpêtrière, *Medtronic*
  - Qamric, Mapawamo
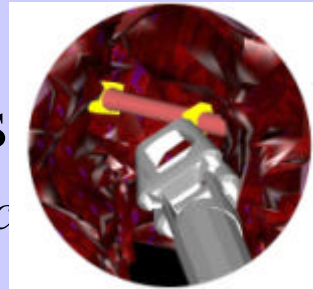
- **4. Cardiac Motion**
  - Johns Hopkins, *Philips, GEMSE, ICEMA*

- **5. Confocal Imagery**
  - Inserm-U455 (Toulouse), *TGS,*
  - *Mauna Kea Technologies,*

- **6. Functional MRI**
  - CEA-SHFJ, Leuven, Odyssée

- **7. Surgery Simulation**
  - Ircad (Strasbourg), *Mentice*
  - Harvard Medical School

- **8. Image-Guided Radiotherapy**
  - IGR, Curie, CAL, *DOSIsoft*

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Conclusion

Analyse des images bio-médicales

- recherche très active : recalage, mouvement, simulation, visualisation, indexation, segmentation, morphométrie, segmentation, statistiques, robotique, etc.

Nouvelles applications pharmaceutiques

- mesures locales et dynamiques de l'efficacité de nouvelles molécules, de nouvelles thérapies (génique, cellulaire, etc.),
- mesures quantitatives et objectives

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EPIDAURE

- *Medical Imaging and Robotics*

- **Design and Development of new Tools in Medical Image Analysis and Simulation to Improve Diagnosis and Therapy.**

RESEARCH AXES

□ Extraction of quantitative parameters (shapes, textures)
□ Image Registration (temporal, multimodal, multipatients, etc.)
□ Construction of anatomical, histological and functional atlases from images
□ Morphometry (Statistics on shapes and intensity)
□ Analysis of cardiac motion
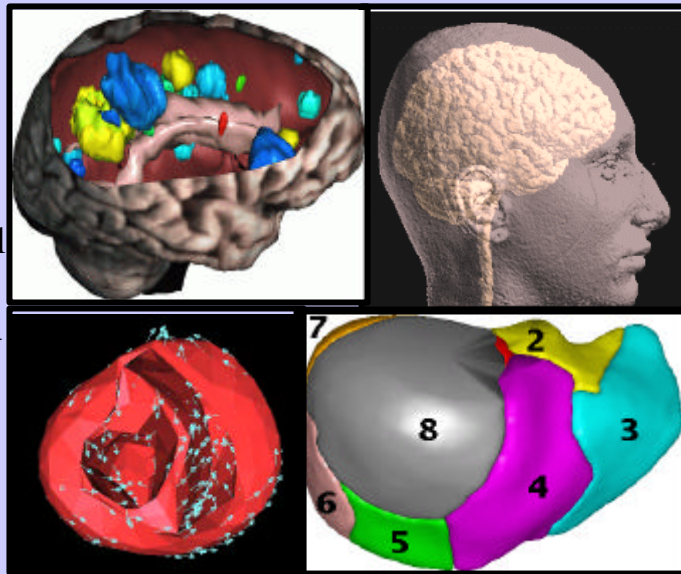
COLLABORATIONS

□ General Electric MS,
□ Philips MS,
□ Mauna Kea Tech.,
□ Medtronic,
□ Mentice,
□ Noesis,
□ Nycomed,
□ Philips MS,
□ QuantifiCare
□ Sanofi,
□ Siemens,
□ etc.

□ Virtual patients and surgery simulation (Visual and haptic feedback)
□ Image-Guided Surgery and Augmented Reality
□ Coupling medical imagery and medical robotics (with Chir)

http://www-sop.inria.fr/epidaure/Epidaure-fra.html

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General References

- Inria Reports and References on line
  - http://www-sop.inria.fr/

- Journals
  - Medical Image Analysis (Elsevier)
  - Computer Aided Surgery (Wiley)
  - Transactions on Medical Imaging (IEEE)...