Creatis LRMN

Grid enabling ThIS CAVIAR

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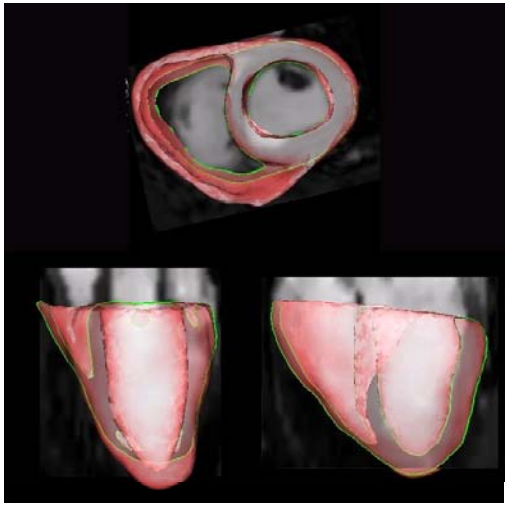
Introduction

ThIS: ***Th****erapeutic* ***I****rradiation* ***S****imulator*

A Geant4-base **simulator** of patient **irradiation** with beams of photons, protons or light ions (Hadrontherapy)

⇨ Improvement of **Cancer** treatment

(David SARRUT, Laurent GUIGUES)



CAVIAR*: CA**rdio-**V**ascular* ***I****mages* ***A****nalysis on g**R**id*

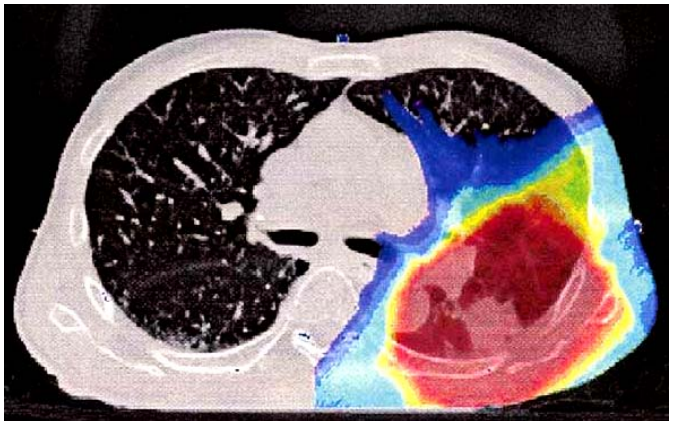
- Cardio-vascular structure **segmentation** with physically based deformable models
- **Motion tracking** of the cardio-vascular structure

⇨ Improvement of **cardio-vascular diseases** diagnosis and treatment

(Patrick CLARYSSE, Bertrand DELHAY, Joel SCHAERER)

ThIS application

ThIS: Context and aims



Cancer treatment by irradiation of patient with beams of photons, protons or carbons

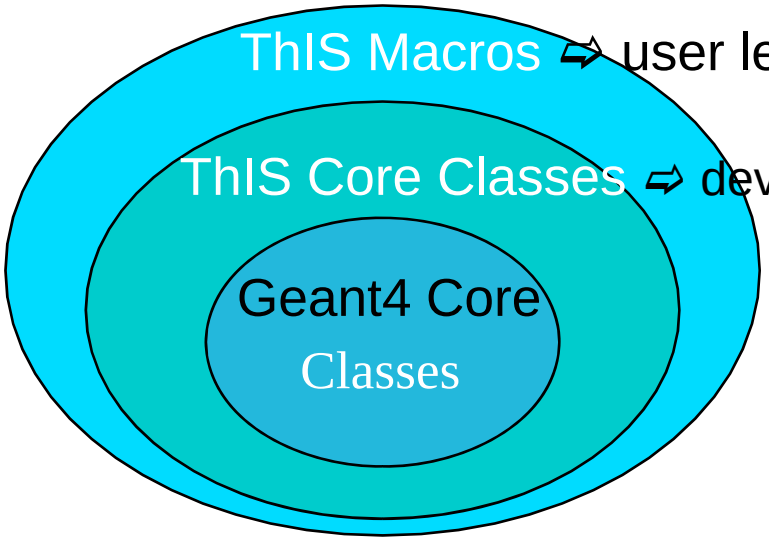
French ETOILE project: Development of hadrontherapy (carbon beam) clinical usage

✓Offer an **open platform** to researchers for **Monte Carlo simulations optimisation** (fast navigation algorithms, parallelization/grid, hybrid simulations...)

✓Offer a **fast and reliable simulation tool** for researchers in medical physics (**treatment planning**) and medical imaging for **treatment control**.

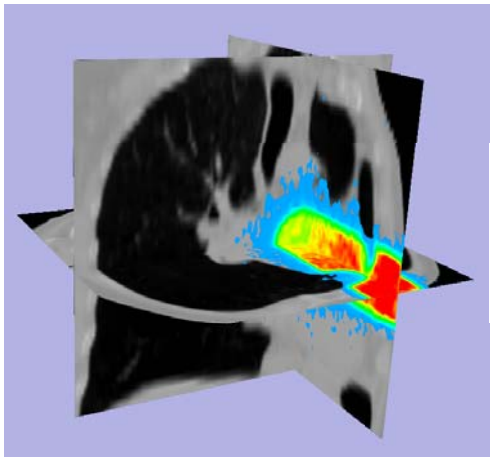
✓Produce a **reference dataset** (energy deposit, positron emitters distributions, ...) for non-conventional therapies (hadrontherapy).

ThIS: technical choices



- **GEANT4:** intensive and extensible physics (C++)
- *ThISiS* (ThIS **image suite**) : Itk image based library
  - 3D volume management (CT slices, 3D dose maps)
- **ThIS is easy !**
  - High level macro language (“GATE like”)
  - `ThIS MyBeautifulSimu.mac`
    - No C++, no compilation, just a macro file

ThIS: Grid issues

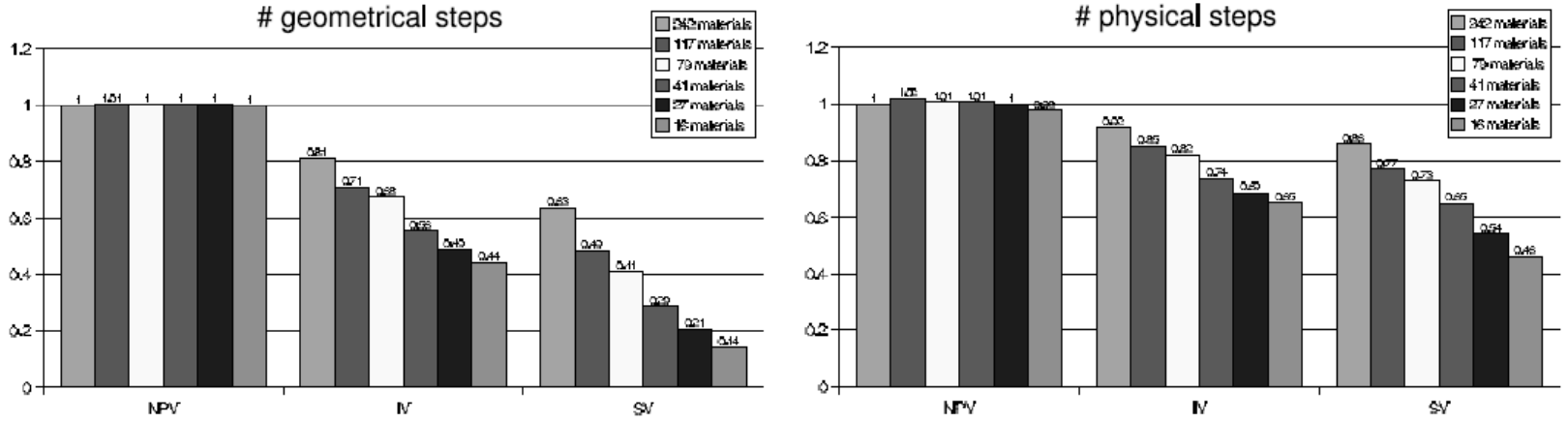


- **Intensive computing**
  - Monte Carlo simulation (900 h cpu x 10 to 100)
  - 3D image pre-processing: Segmentation
- **Metadata management** (image, simulation experience)
- **User interface & Workflow** to offer an efficient service

of **treatment planning and control**

ThIS: Scientific core

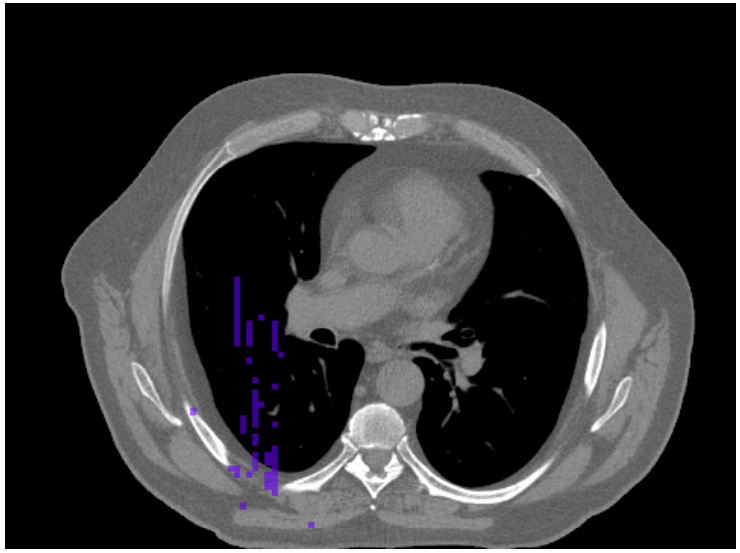
• ThIS includes an original Region-oriented CT image representation to fasten computing time of MC simulation



Nested Parameterized Volume (vs) Isothetic Volume (vs) Segmented Volume
512x512x77 CT volume, 100 Millions primary events simulated
900 h of CPU

ThIS: Current status

- **ThIS core version Beta**
  - ThIS Macro layer
  - ThIS Core layer
  - ThIS image suite



3D dose distribution, 700h CPU
CT image (482x360x141)

- **ThIS cluster version operational**
  - Distribution of the MC tasks via shell script
  - Linear gain with the nodes number

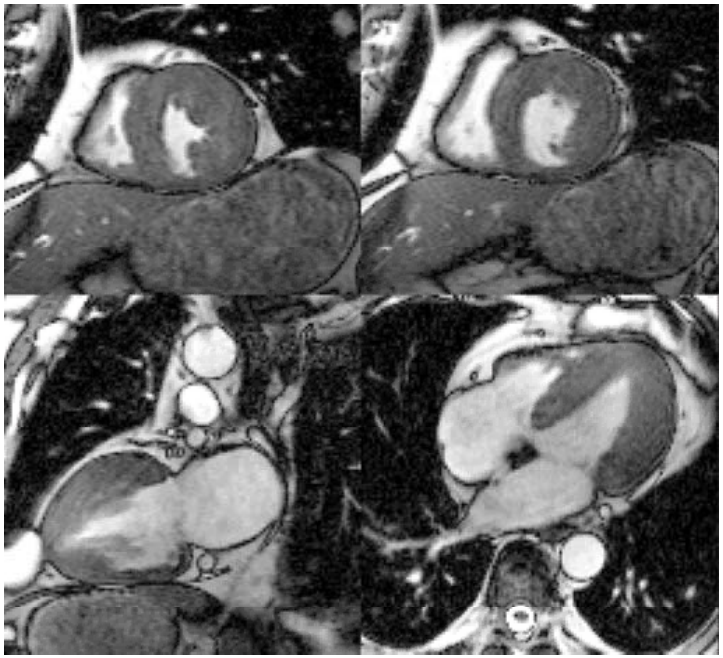
ThIS: Perspectives

- Finalization the **grid-porting** on EGEE
- Developing a **web portal** to provide irradiation simulation service based on *ThIS* package
- **Validation and usage** of ThIS tool for **HadronTherapy**:
  - French **ANR SIMCA2 project**, http://gwendia.polytech.unice.fr/doku.php
  - National French ETOILE project , http://www.projet-etoile.fr/sommaire.html

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

CAVIAR application

CAVIAR: Context and aims



Dynamic cardiac MRI
around 0.5 GB per patient
and per examination

Progress of image acquisition devices makes possible better exploration of **moving organs dynamic** such as the beating heart.

Aim: On line **3D+time** structure **segmentation** and **motion quantification** of the normal and pathological heart.

CAVIAR: Grid issues

Huge amount of medical data

Computer intensive image analysis programs

Processing of 3D image sequences: several CPU hours on a single processor:

- 2 minutes CPU by instant of 3D segmentation
- 20 hours CPU for 160^3 motion estimation

Quantitative imaging Workflow

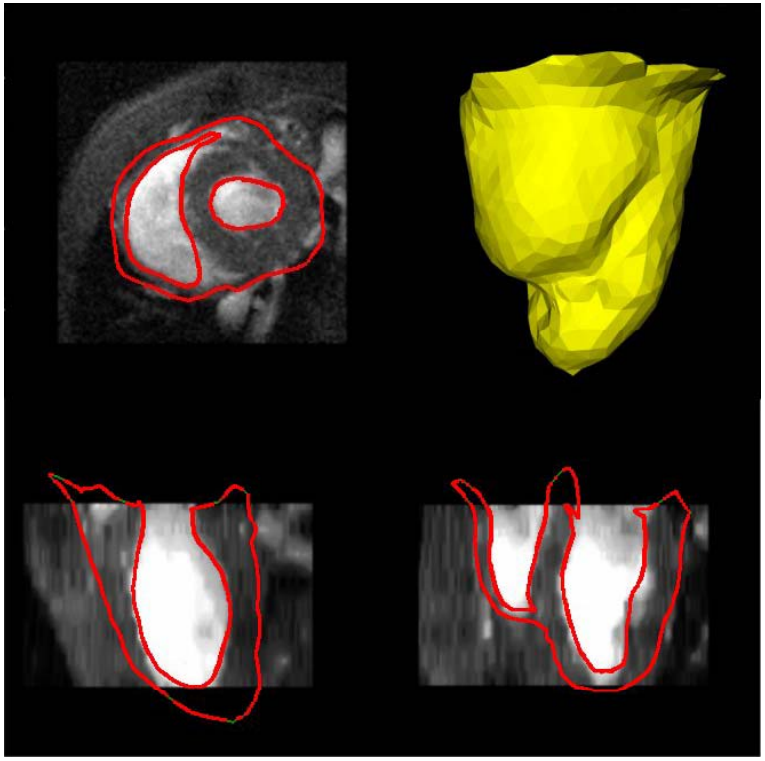
Grid aided Cardio-Vascular Diseases diagnosis and treatment

- Remote access to High Computing Power
- Remote access to distant databases with a secured access

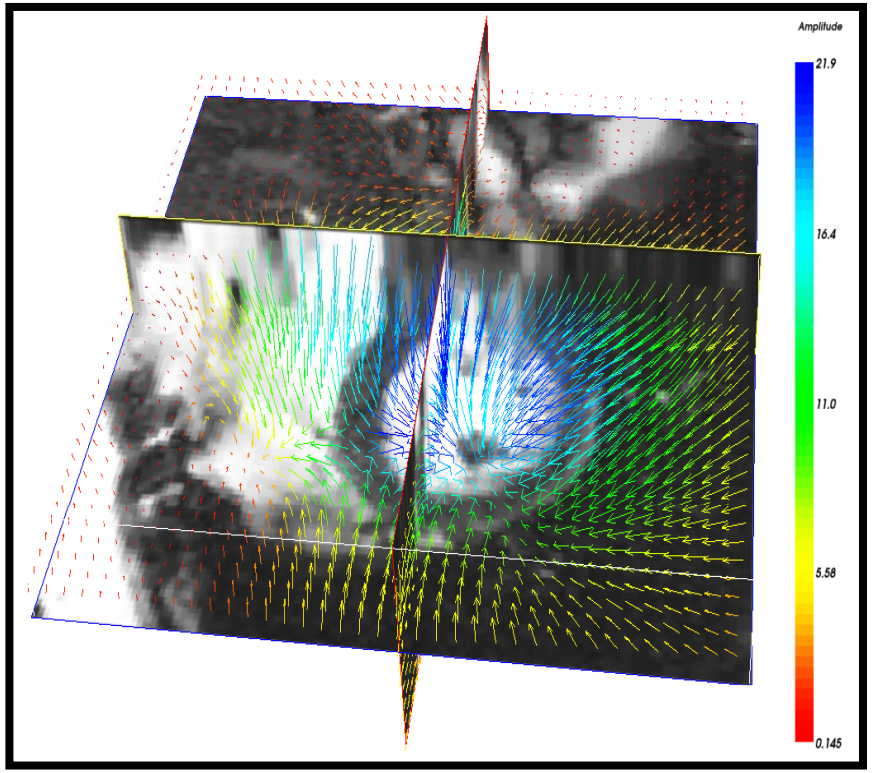
Target ⇨ Large distributed studies on CVD patients

CAVIAR: Scientific core

3D+time heart segmentation



3D+time motion estimation & tracking



- **Non linear elastic deformable model**
- **Spatio-temporal process (sequence)**
- **Image registration based approach**
- **State space modelling & temporal filtering**

CAVIAR: Current status

✓ **Parallel versions** (multithread and **MPI**) of spatio-temporal motion estimation and segmentation methods deployed on:

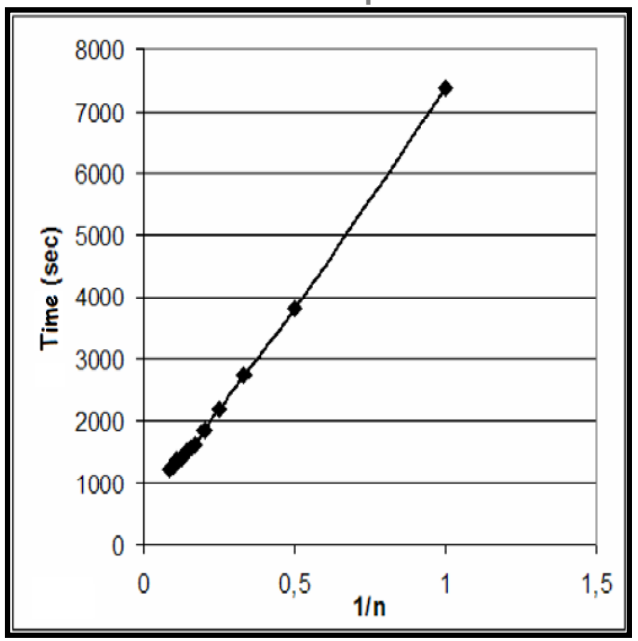
- SMP-SGI architecture
- Clusters
- EGEE Grid.

✓ **Linear gain in CPU** with the node number n

$$T(n) = A + \frac{B}{n}$$

A and *B* stand for experimental constants which depend on inter-node communications

Motion process



✓ Extensive testing in progress on EGEE grid trough UI IN2P3 and VO Biomed: All data to process are stored on a SE located and called through the JDL script thanks to their Logical File Name.

CAVIAR: Perspectives

- Development of a **web portal** to provide the medical imaging service based on the analysis tools developed within the CAVIAR Project
- Enlargement of **tests on clinical data**
- Development of a **cardio-vascular workflow** in order to**:**
  - Design efficient image **processing pipelines** for dedicated middlewares
  - **Chain/merge** motion estimation and segmentation procedures
  - Provide a framework to develop **statistical atlases** for different populations
  - French **ANR GWENDIA project**, http://gwendia.polytech.unice.fr/doku.php)

[1] J Schaerer et al., CinC, Lyon, pp. 231-234, 2005, 2005.
[2] J. Schaerer et al., MICCAI, Copenhagen, 2006
[3] Y. Rouchdy et al., Inverse Problems 23 (2007)
[4] B. Delhay et al., CinC, Lyon, pp. 423-426, 2005.
[5] B. Delhay et al., A MICCAI, Copenhagen, 2006.

Conclusion

Conclusion

From

EGEE2: **Medical imaging applications** deployment

- SIMRI: MRI simulation
- ThIS: Therapeutic Irradiation Simulator
- CAVIAR: Cardio-Vascular Image Analysis on gRid

To

EGEE3: Collaborative set of **medical imaging services**

- **Storage and access services** for multimodal medical images and metadata
- **Quantitative medical imaging workflows** including pipelining of dedicated library (Vtk, Itk)
- **Generic web portals** dedicated to medical imaging applications