

AGIR

Analuse Globalisée des Données d'Imagerie Radiologique

Grid Analysis of Radiological Data

C. Germain pour le projet AGIR

ACI

Masses

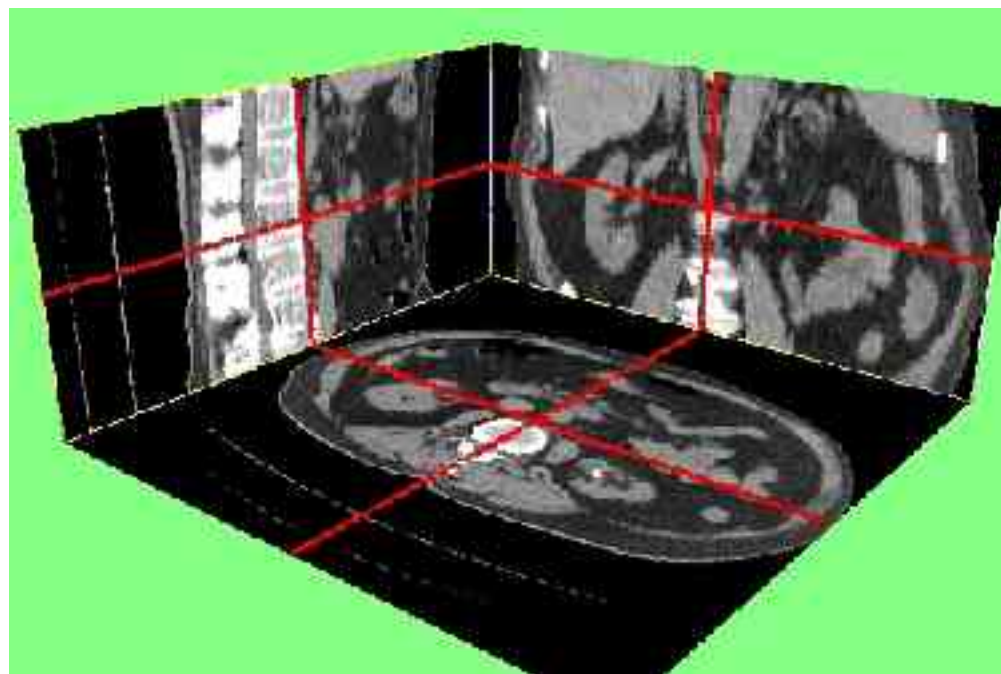
De

Données



- **Issues in medical image processing**
- **AGIR overview**
- **Two actions**

- In this talk: medical images are 3D densities – CT, MRI,...
- Huge amount of data
 - ONE radiology department – 10TB/year
 - ONE CT dataset -500MB-2GB



- Huge amount of distributed data
- Compute-intensive analysis
 - Non-linear registration

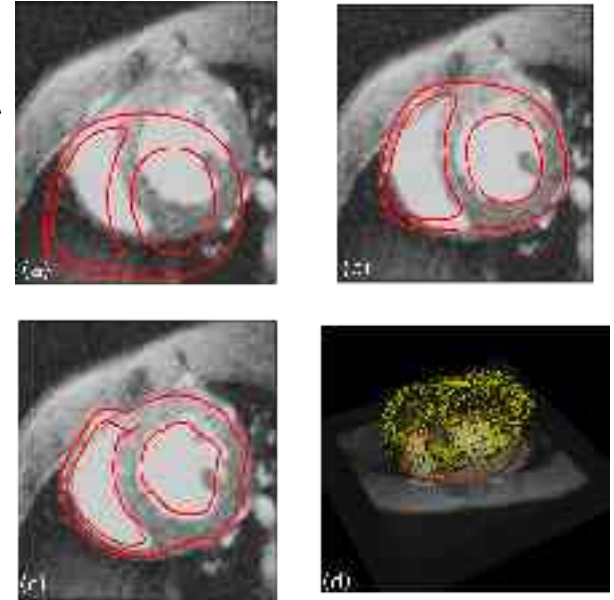


Adaptive non-stationary visco-elastic inter-subject registration

5mn on 15 PC

[R. Stefanescu, X. Pennec, and N. Ayache, *MIM* 2005]

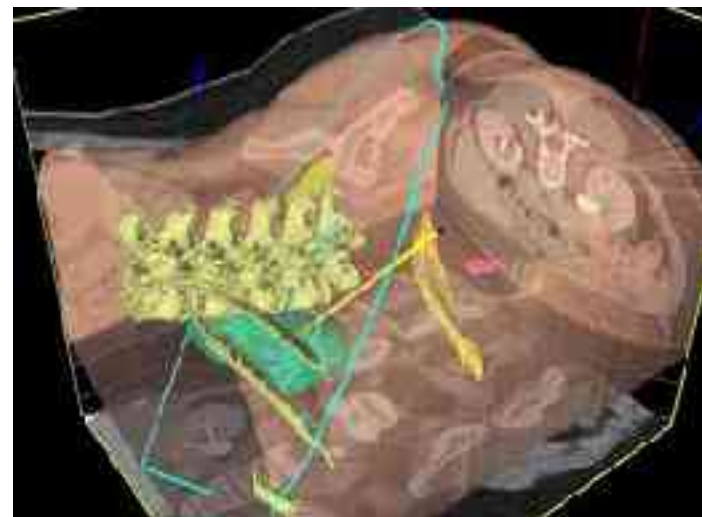
- Huge amount of distributed data
- Compute-intensive analysis
 - Non-linear registration
 - Deformable models



CARDia3D – 3D+time segmentation of MRI cardiac images

[J Schaerer, P Clarysse, B Hiba, P Croisille, IE Magnin
Computers In Cardiology 2005]

- **Huge amount of distributed data**
- **Compute-intensive analysis**
 - **Non-linear registration**
 - **Deformable models**
 - **Volume reconstruction**



PTM3D volume reconstruction applied to planning percutaneous nephrolithotomy

20mn sequential

[A. Osorio, O.Traxer, S.Merran, F. Dargent, X. Ripoche, J. Atif, RSNA-INFORAD 2004, Cum Laude Award]

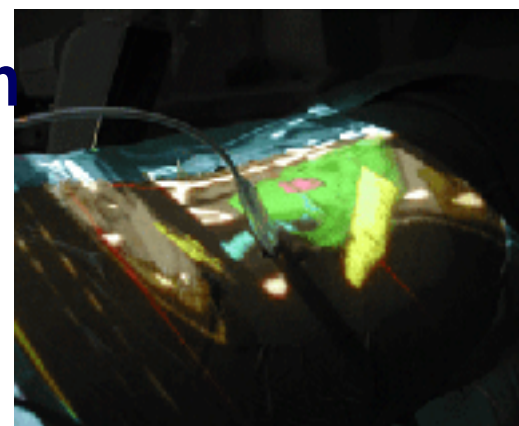
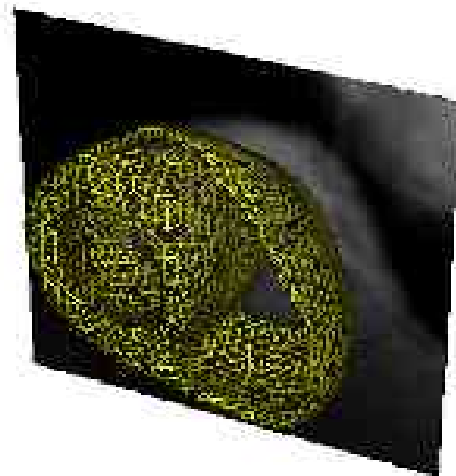
- **Huge amount of distributed data**
- **Compute-intensive analysis**
- **Various use cases**

- Clinical
Diagnostic &
Intervention planning
- Research
Clinical, Neuroscience,
Automatic image analysis



- **Huge amount of distributed data**
- **Compute-intensive analysis**
- **Various use cases**
- **But**
 - **There is a gap between medical image analysis research and clinical & clinical research**
 - **Data sharing techniques are rudimentary at best**

- **Bridge the gap: from imaging research to medical research and clinical practice through the interactions between medical image processing and **integrated computational and storage grids** as a unified resource provider for analysis and data-sharing**
- **New image analysis algorithms, validation methods, visualization pipelines**
- **New grid services, dedicated to the medical application level**



Analyse Globalisée des Données d'Imagerie Radiologique



LRI – coll LAL
LIMSI - St Anne Tenon FMP

AlGorille
CRAN



LPC
CHRU Clermont-Ferrand



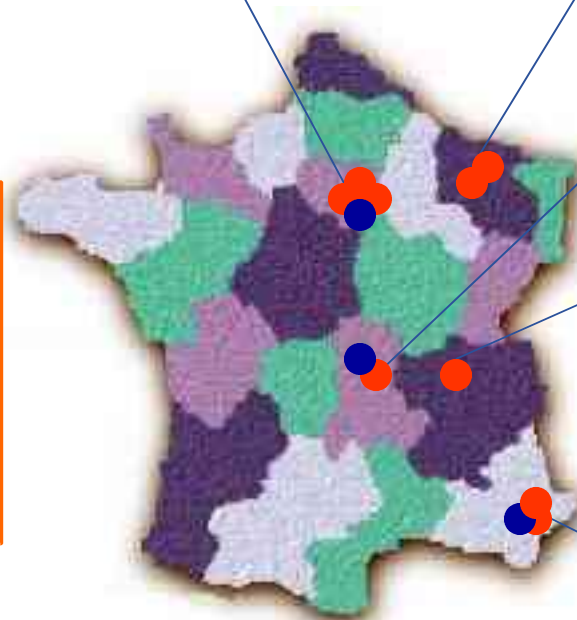
CREATIS



Rainbow
Epidaure
Centre Antoine Lacassagne

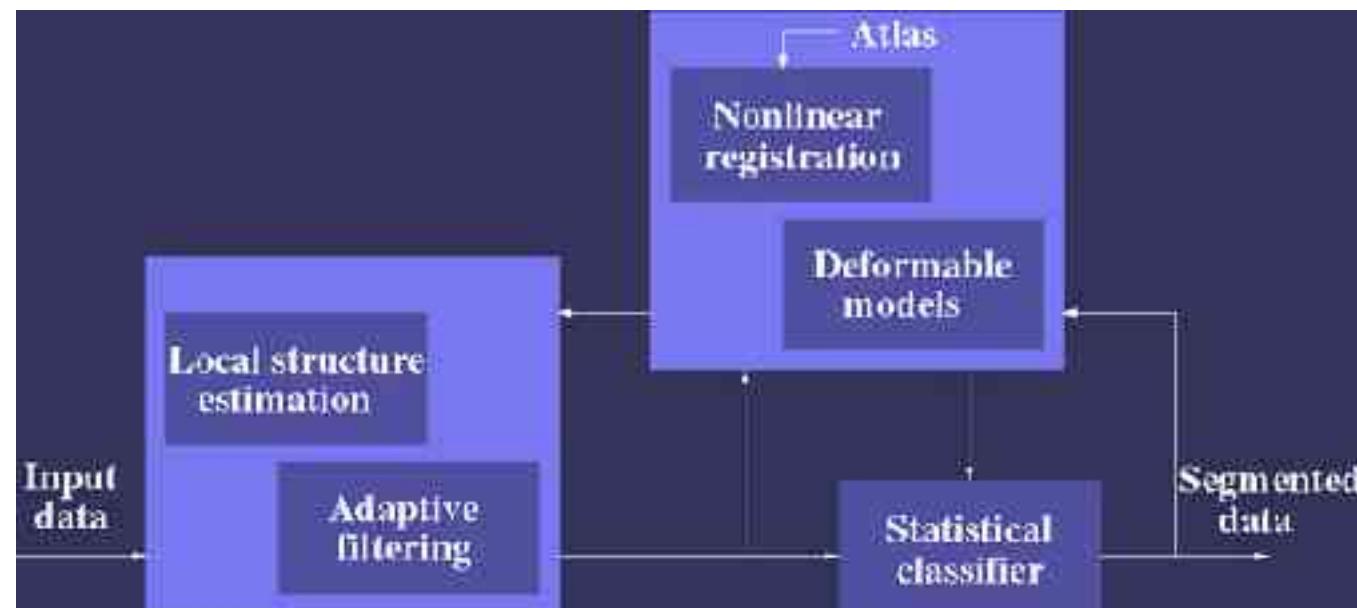


CNRS-STIC
CNRS-IN2P3
INRIA
INSERM
Hospitals



- **Parallel Architecture - LRI – U. Paris-Sud & CNRS STIC** *Grid models & middleware*
 - *Cécile Germain-Renaud, Romain Texier*
- **LIMSI – CNRS STIC** *Medical Image processing & software – Clinical research*
 - *Angel Osorio, Julien Nauroy and team, Emmanuelle Frenoux*
- **AI Gorille – LORIA - U. Nancy & INRIA Lorraine** *Grid models & algorithms*
 - *Emmanuel Jeannot*
- **CRAN – U. Nancy & CNRS STIC** *Image processing – compression*
 - *Jean-Marie Moureaux, Yann Gaudeau*
- **CREATIS – CNRS STIC, INSERM** *Medical Image processing*
 - *Isabelle Magnin, Patrick Clarysse and team*
- **LPC – U. Clermont & CNRS IN2P3** *EGEE & Medical grids*
 - *Vincent Breton, Yannick Legré, Antoine Llorens*
- **EPIDAURE - INRIA Sophia** *Image processing*
 - *Xavier Penned, Radu Stefanescu*
- **RAINBOW-I3S CNRS STIC & U. Nice** *Software engineering – distributed components*
 - *Johan Montagnat, Tristan Glatard*
- **Centre Antoine Lacassagne** *Clinical Research*
 - *Pierre-Yves Bondiau*
- **Collaboration EGEE-LAL**
 - *Charles Loomis, Daniel Jouvenot*

- **Individual image analysis**



From [R. Kikinis, S. Warfield, C.F. Westin , *High Performance Computing (HPC) in Medical Image Analysis (MIA) at the Surgical Planning Laboratory (SPL)*]

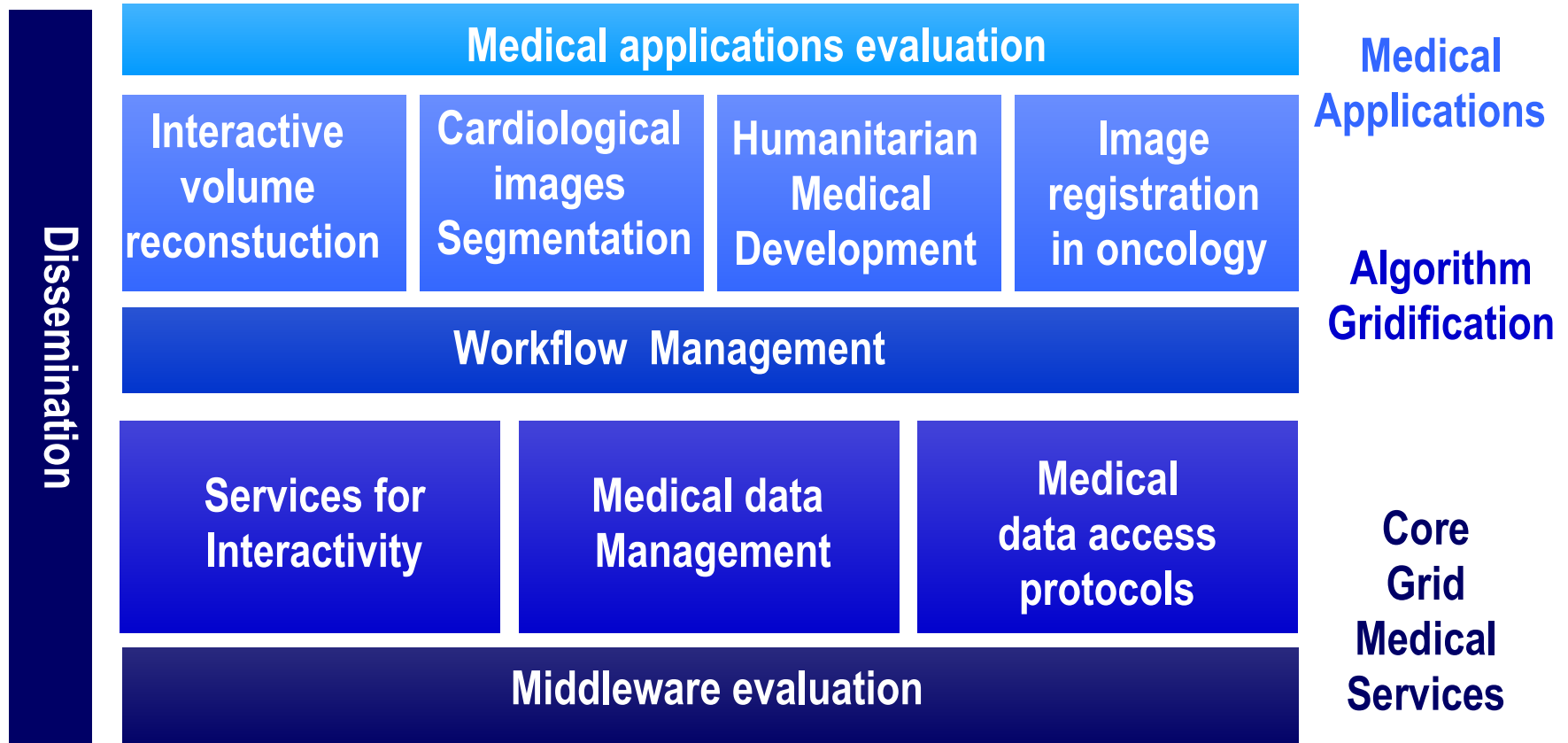
- **Rationale: noisy data, pathologies, liability**
- **Requires to depart from the computing center model**
 - Seamless integration of grid resources with local tools: analysis, graphics, interaction...
 - Unplanned access to high-end computing power and data

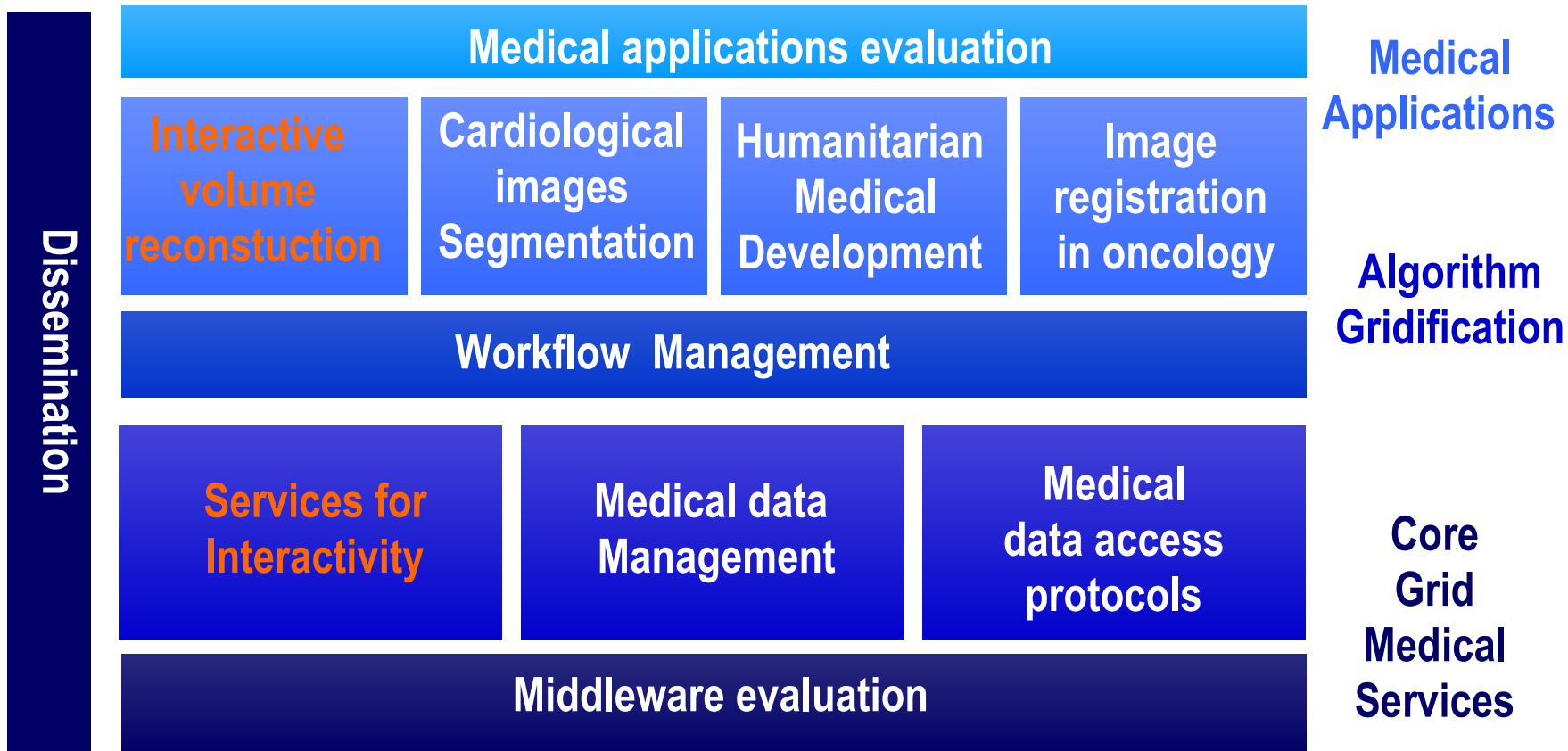


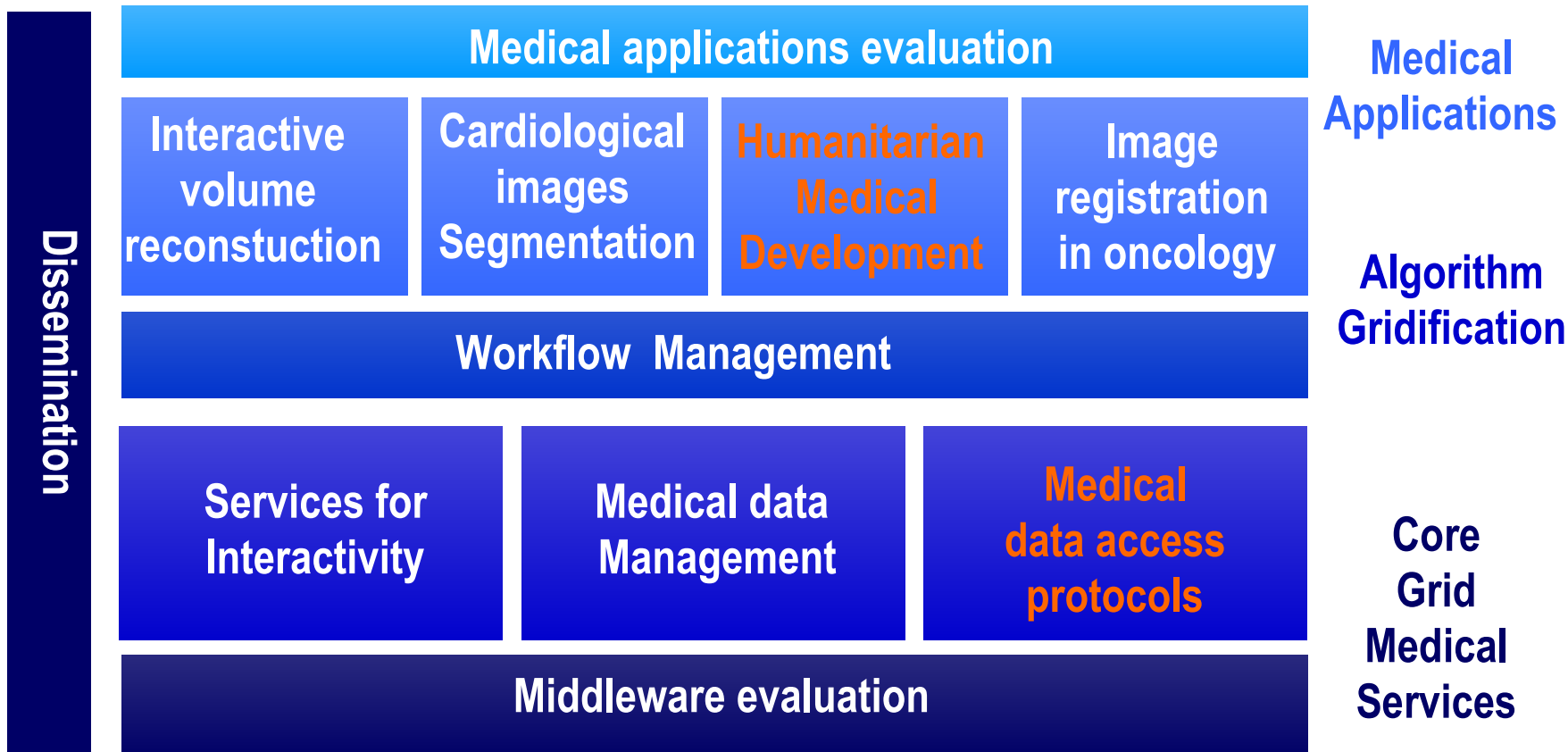
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f01n01.10873.0	qzha	5/19 07:34	R	50	fewcpu	f11n07
f01n03.6292.0	agma	5/22 14:50	R	50	standard	f12n02
f01n03.6293.0	publ	5/22 16:16	R	50	standard	f03n09
f01n03.6304.0	agma	5/22 22:46	R	50	standard	f11n05
f01n03.6309.0	agma	5/23 12:41	R	50	standard	f01n11
f01n01.10914.0	ying	5/23 14:17	R	50	fewcpu	f06n03
f01n02.4596.0	dpān	5/23 15:33	I	50	standard	
f01n03.6310.0	divi	5/23 16:03	I	50	standard	

- **Scaling critical components of distributed systems**
 - **Scheduling: where and when?**
 - Agent-based scheduling and QoS: sharing resources across users
 - Workflow management: application performance
 - Contexts: (multi)processor scheduling, parallel scheduling
 - **Medical data and metadata management (coll. MediGrid)**
 - Interoperability between medical service/format standards and grid storage services
 - Security/privacy and medical requirements eg patient benefit
- **Adaptive storage and transmission**
 - **Compression algorithms**
 - **Network-adaptive compression (coll Network team CRAN)**
 - **User-adaptive compression: Intelligent remote data access - Data of Interest**
 - **Impact of network QoS (coll UREC)**

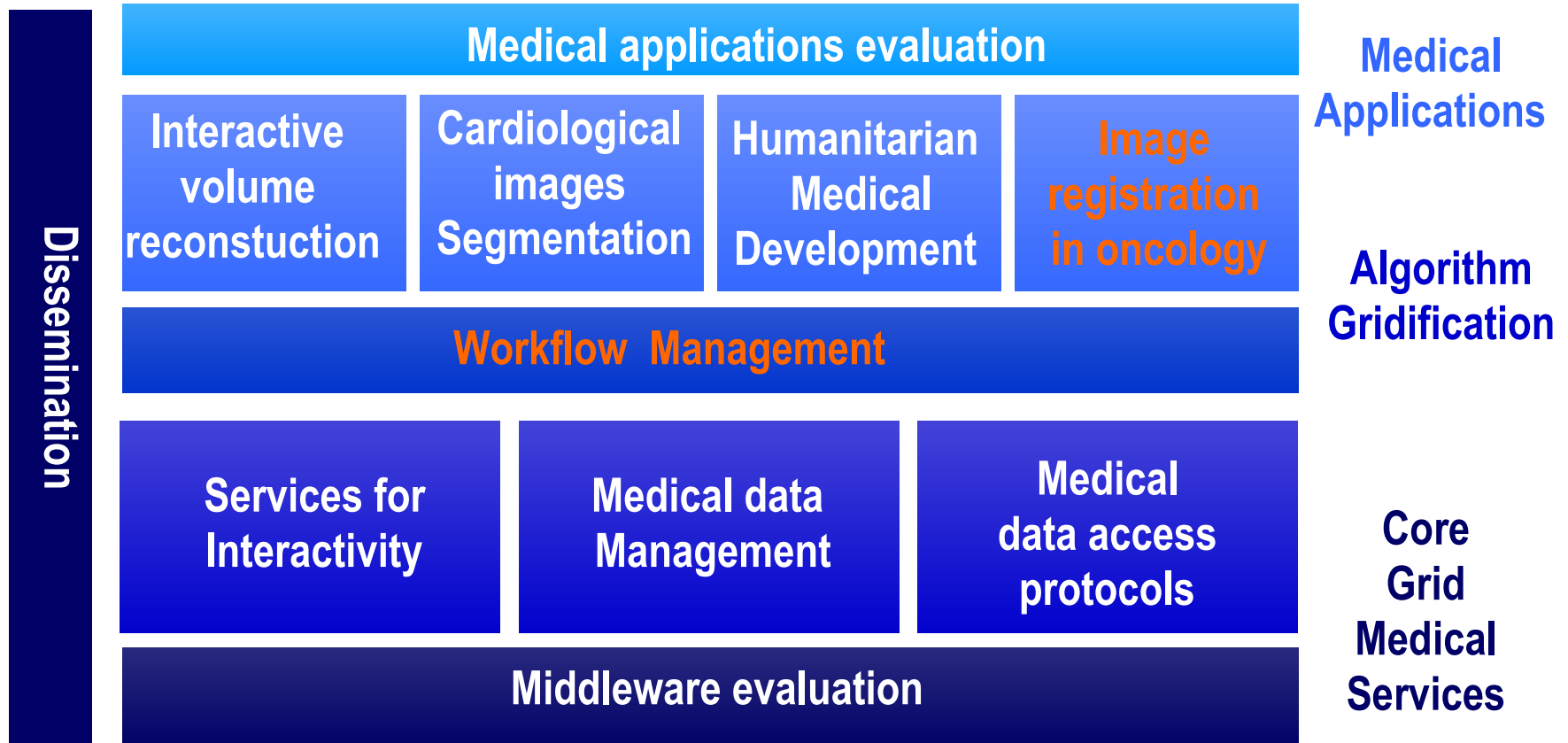
- **Medical imaging algorithms**
 - Parallel processing: 3D + time segmentation, non-linear registration
 - Bronze standard evaluation
- **Interaction between compression and image processing**
 - Impact on intrinsic performance
 - Integration of multi-scale/multi-level methods and compression



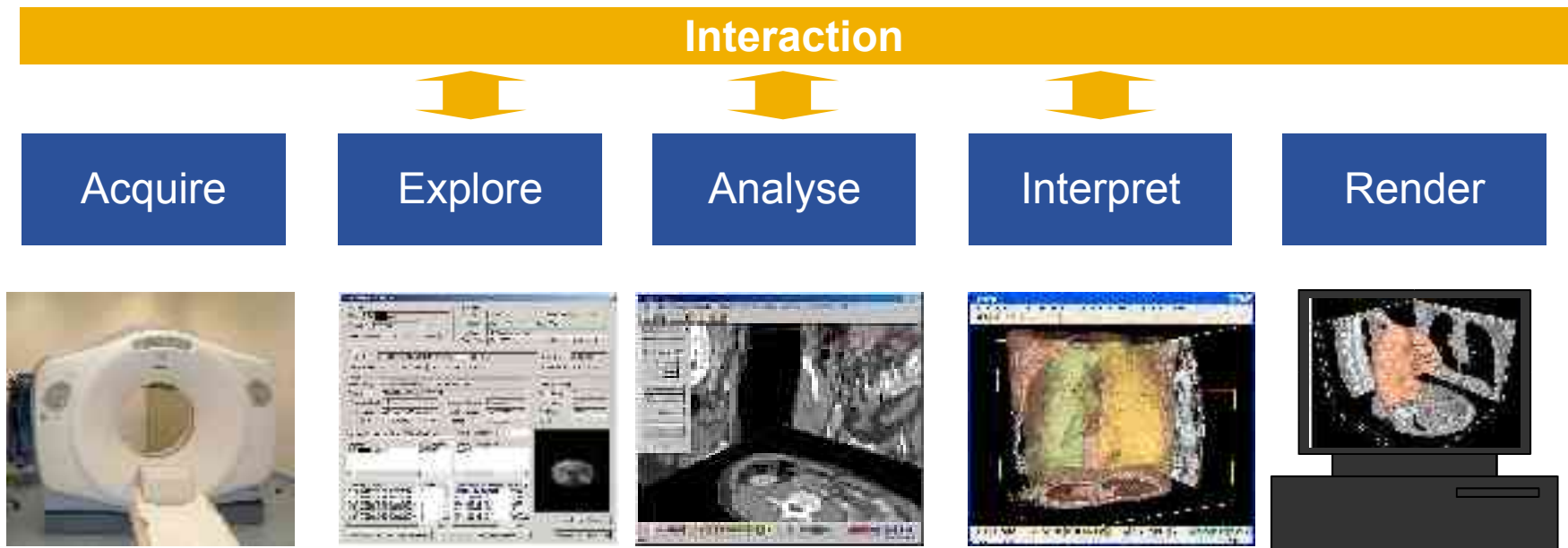




DEMO

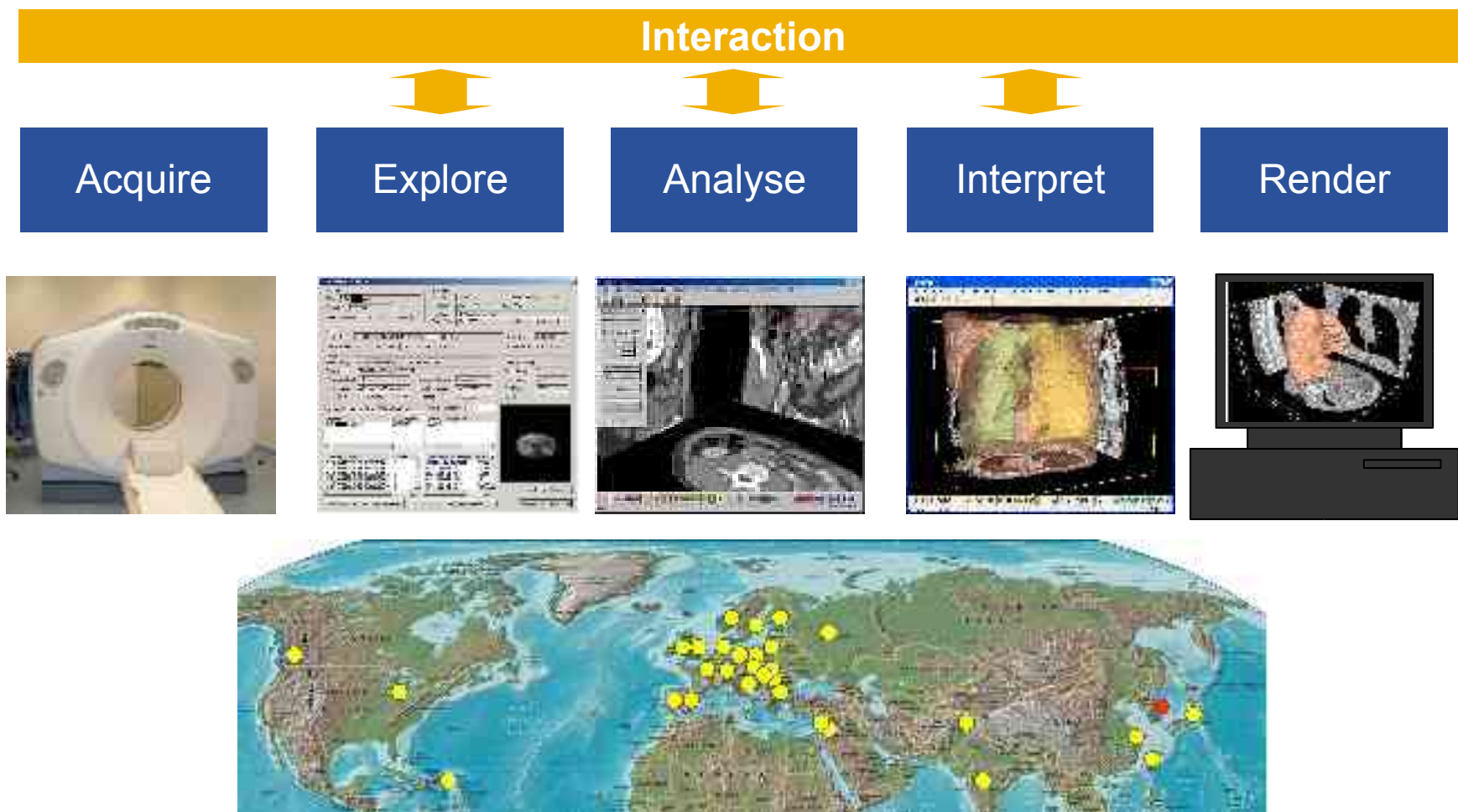


- An augmented reality system



- A.Osorio & team – LIMSI Clinical use RSNA 2002, 2003, 2004
- Complex interface: optimized graphics and medically-oriented interactions
- Physician **interaction** is required **at and inside all steps**

- Grid-enable PTM3D on a production grid





● Country providing resources

● Country anticipating joining EGEE/LCG

In EGEE-0 (LCG-2):

⇒ > 130 sites

⇒ > 14,000 CPUs

⇒ > 5 PB storage

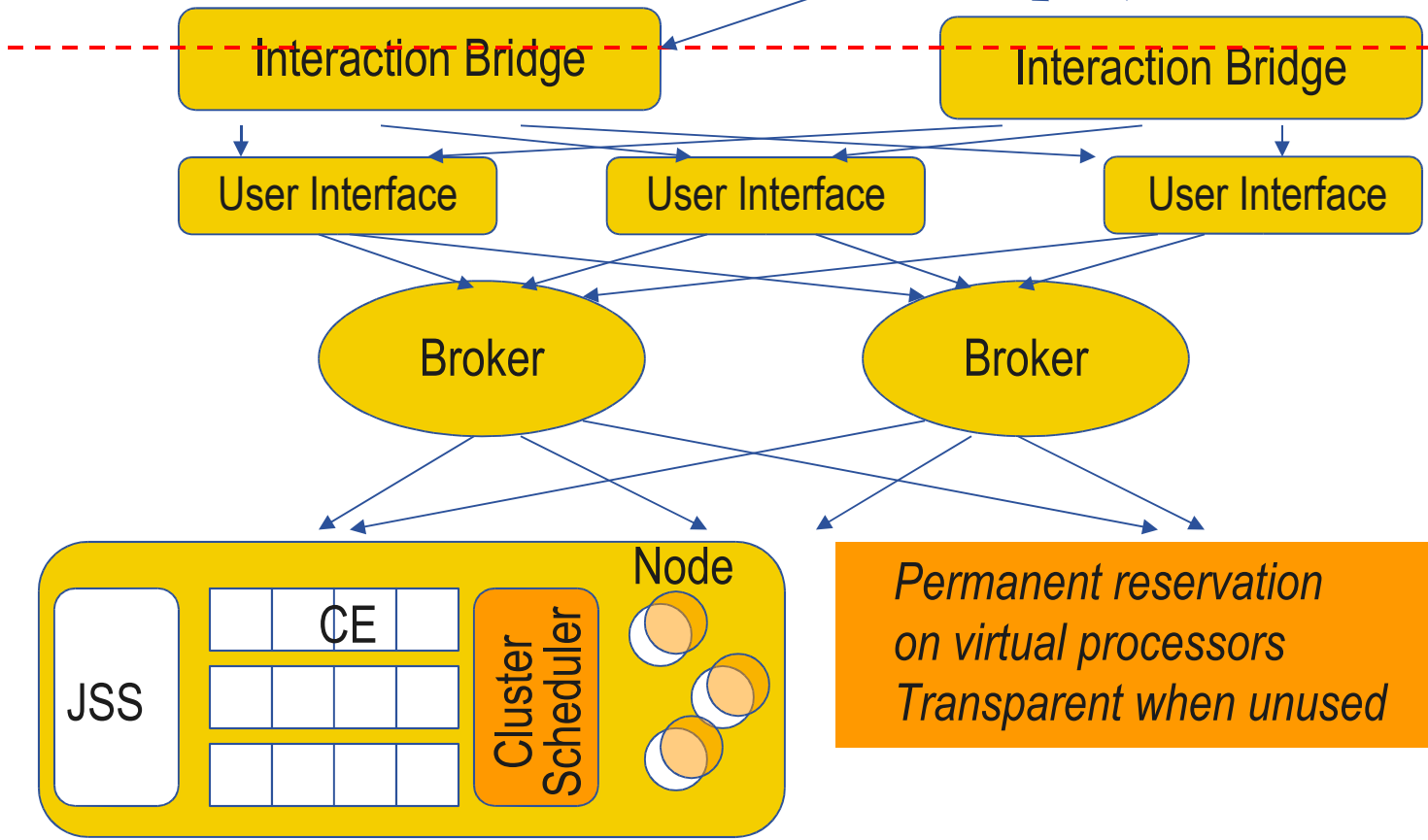
70 leading institutions

27 countries, federated in regional Grids

EGEE

Enabling Grids for E-science

- **Short Deadline Jobs**
 - A moldable application: individual tasks are very fine-grained
 - **Cope with the grid submission penalty**
 - **Soft deadline**
 - **No reservation**: should be executed immediately or rejected
- **Sharing contract**
 - Bounded slowdown for regular jobs
 - Do not degrade resource utilization
 - No strong preemption
 - Fair share across SDJ
- **Contexts**
 - (multi) Processor soft real-time scheduling
 - Network routing Differentiated Services

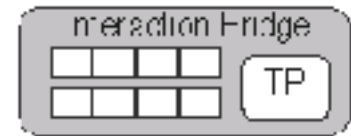
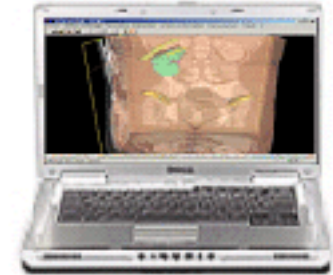


Job submission
Proxy
Tunneling

Matchmaking

*Permanent reservation
on virtual processors
Transparent when unused*

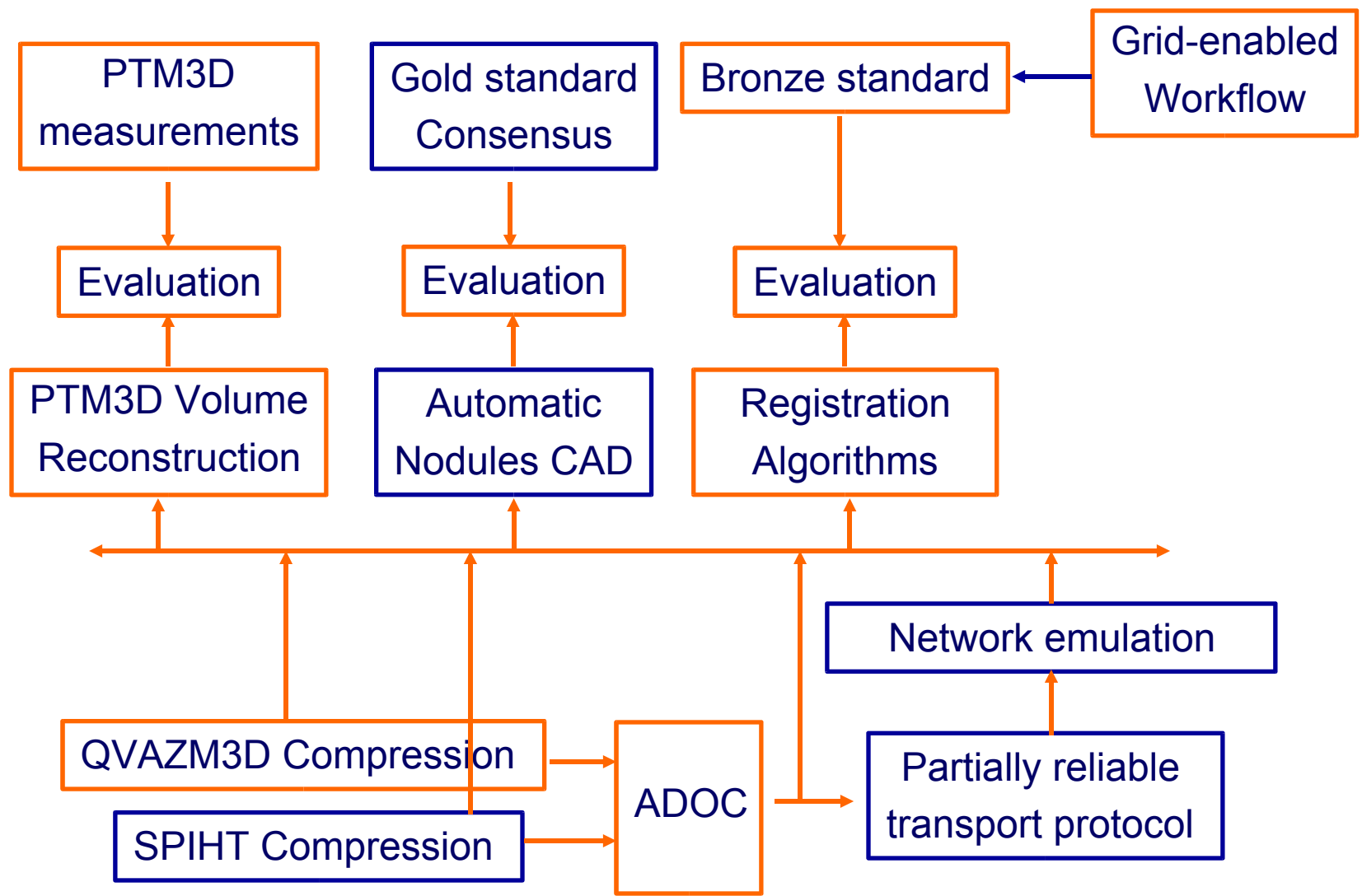
- Interactive response time for volume reconstruction
- With unmodified interaction scheme
- Demonstrated at the first EGEE EU review
- SDJ working group
- **Demo**

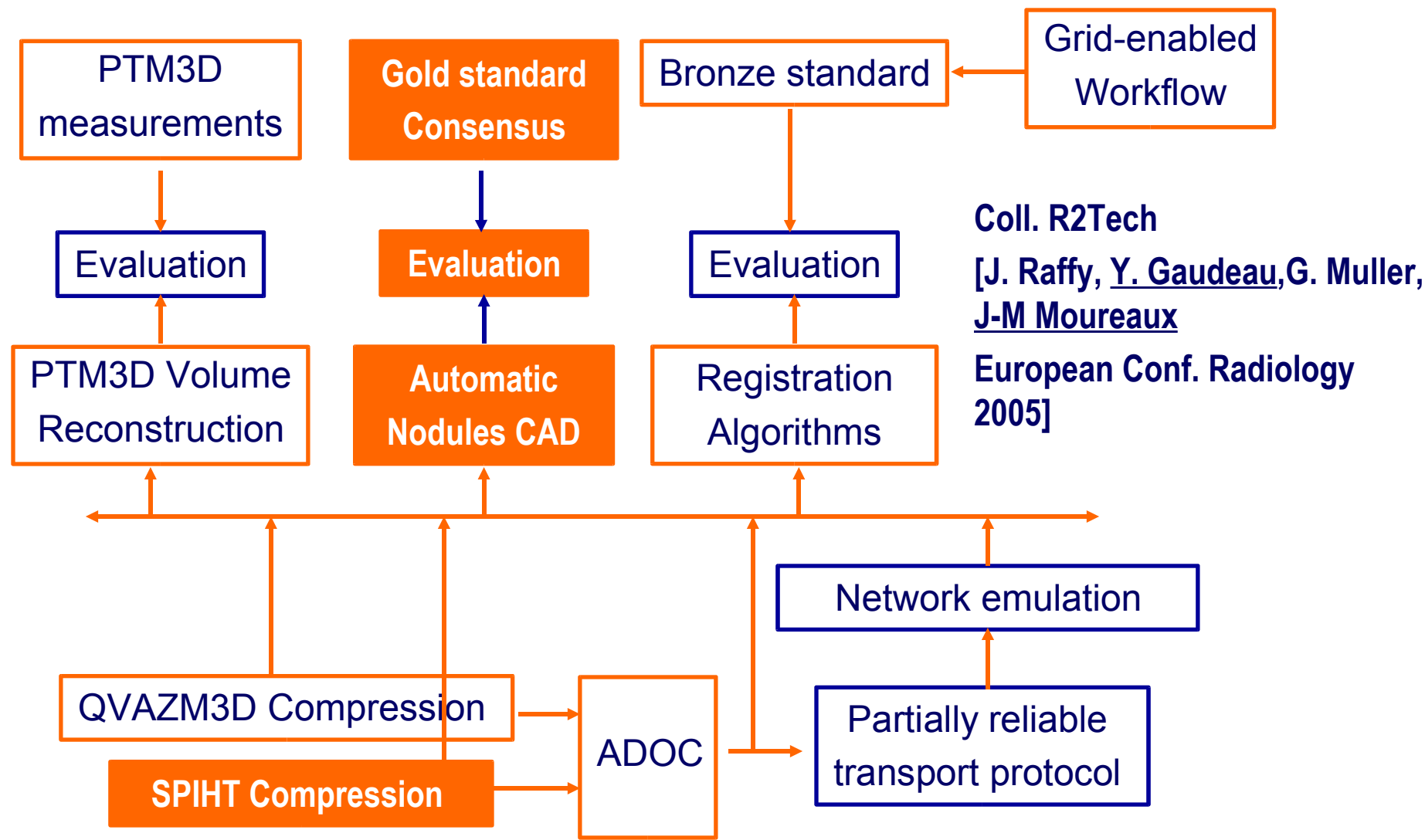


[C. Germain, R. Texier, A. Osorio.
Methods of Information in Medecine. 44
(2) 2005]

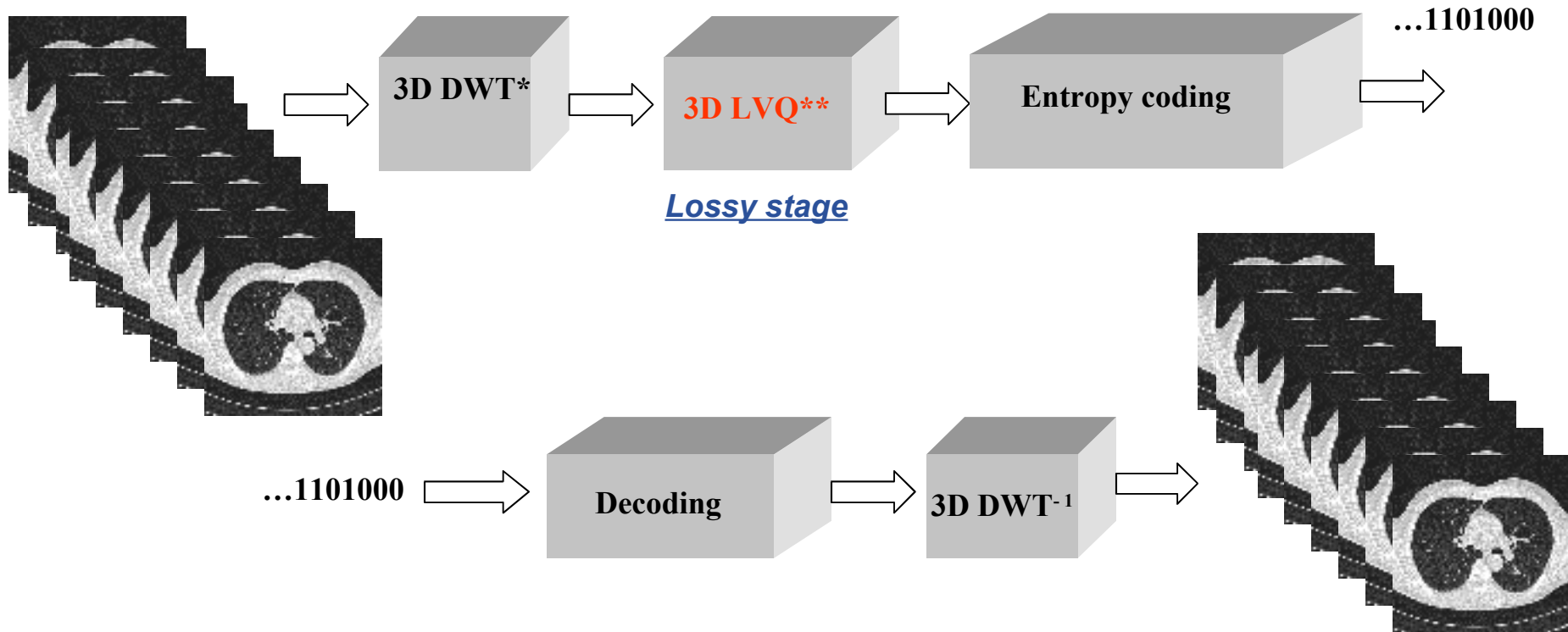
- **Integration with tasks Medical data access & Medical data protocols**
- **Remote access may exploit the structure of a medical image**
 - **Medical Windowing**
 - **Interactive or automatic or aided selection on summary data**
- **Intelligent prefetch mechanisms to capture and anticipate the way data are explored and analyzed**

- **Objectifs: stockage différencié et transmission efficace**
- **Intégré dans DICOM**
- **Compression avec perte/sans perte**
 - Les images médicales possèdent des tolérances à la compression avec perte suivant le type d'image. [Bradley 2000]
- **Intégrer de nouvelles fonctionnalités**
 - Transmission progressive, ROI
- **Compatibilité avec d'autres traitements (tatouage ...)**
- **Evaluation des performances**
 - Taux de compression/qualité/complexité
 - Dépendent contenu informatif de l'image
 - Classement sur piles d'images [Schelkens 2003] : SPIHT 3D en tête, JPEG2000 2D en dernier





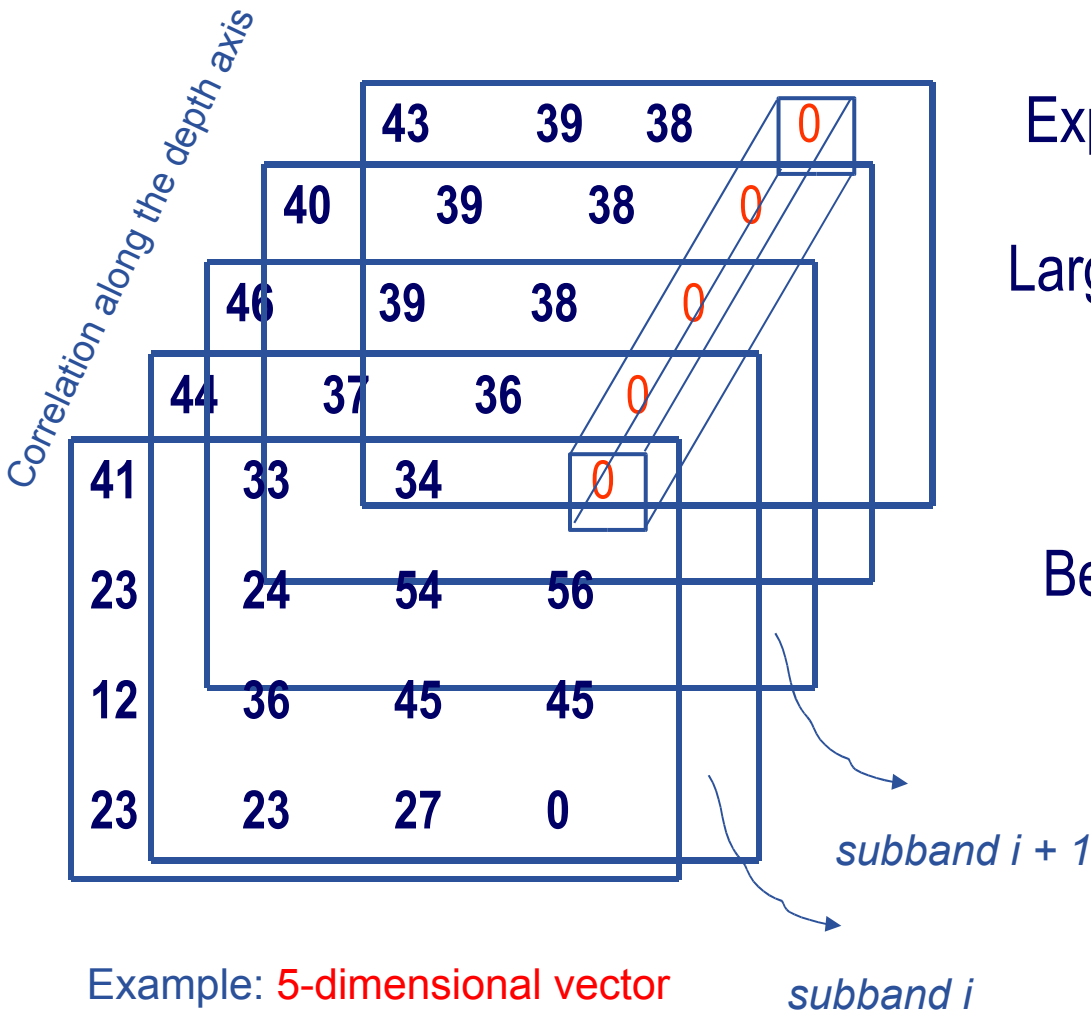
Original image stack



* Discrete Wavelet Transform

** Lattice Vector Quantization: fast vector quantization method

Reconstructed image stack



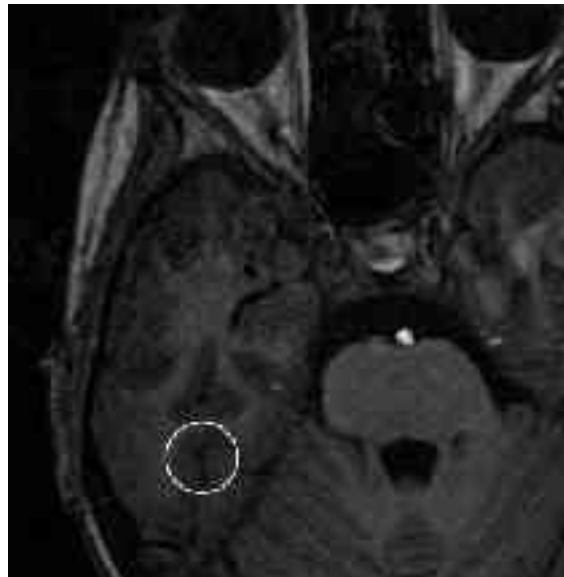
Exploiting correlations within vectors
+
Large non significant coefficient areas



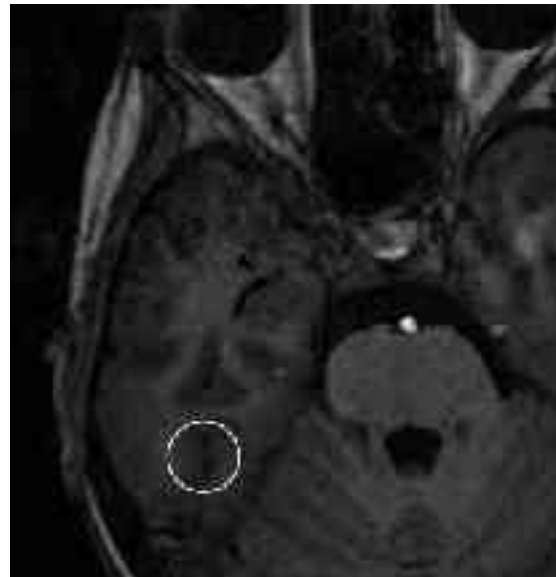
Better bit rate / distortion efficiency

IRM de cerveau* (512x512x32x8 bits)

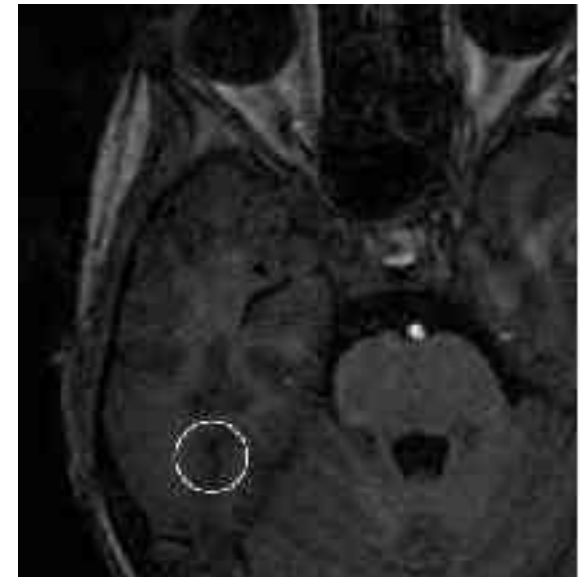
(zoom de la coupe 18)



✚ Originale

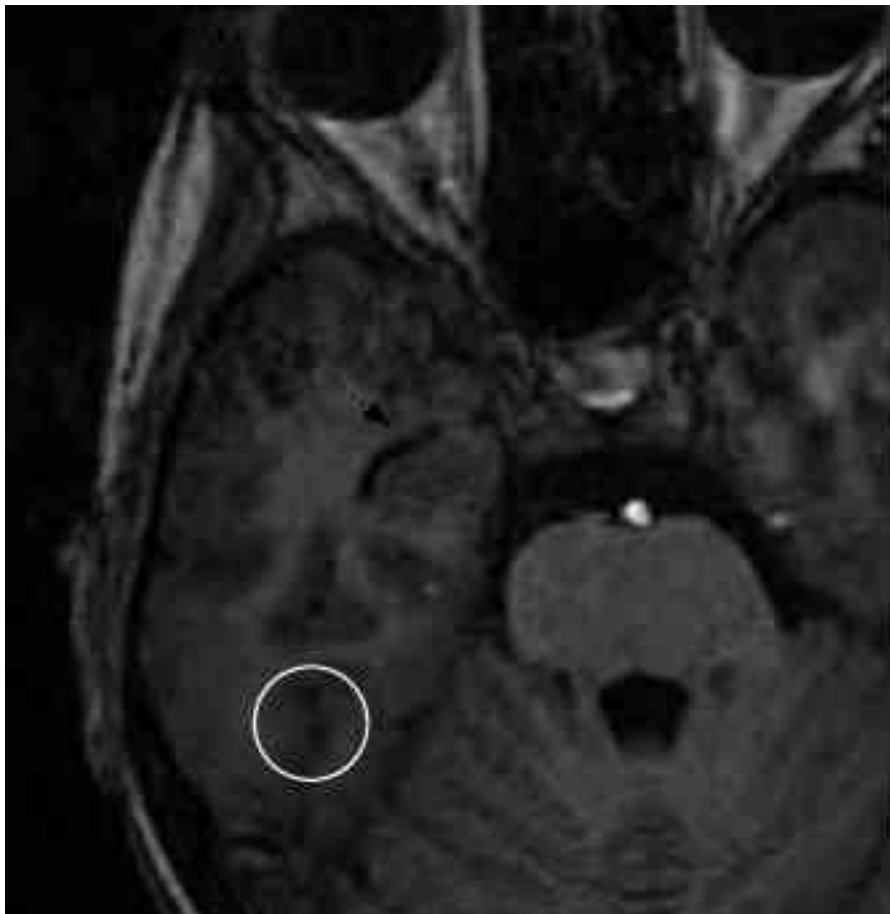


✚ 3D SPIHT (TC = 64:1)



✚ QVAZM 3D (TC = 64:1)

* Images fournies par Didier Wolf (CRAN - Responsable du thème Ingénierie pour la Santé)



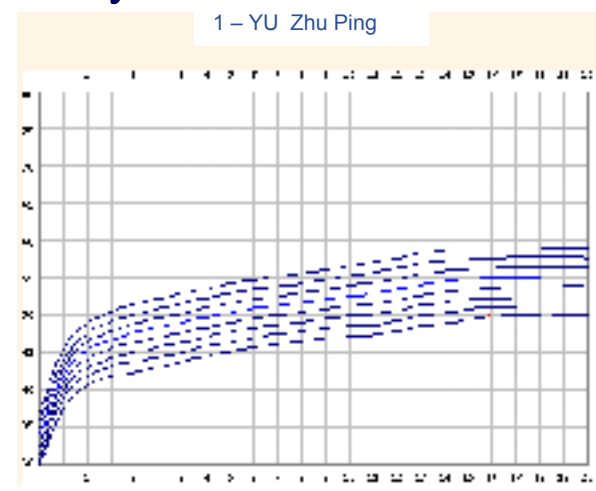
3D SPIHT (TC = 64:1)



QVAZM 3D (TC = 64:1)

• CHINA – Collaboration between Hospitals for International Neurosurgery Applications

- Goals: Enable medical data exchange
- Text-based data and medical images
- For second remote diagnosis
- A web-based application -> Grid
- **Very lossy** transport layer



- **Provide an image dataset to the partners**
 - Clinical CT-Scans and MRI
 - Phantoms CT-Scans
 - Soon: synthetic MRI (coll. SIMR3D at Creatis)
- **Anonymization compliant to SFR requirements**
- **Clinical research: PHRC Transplantation d'Hépatocytes**

The screenshot shows a web browser window titled "AGIR Medical Images Database - Microsoft Internet Explorer". The address bar displays "http://www.aci-agir.org/". The website features a navigation menu with "Home", "About Us", and "Contact Us". A login section includes fields for "login" and "password" with a "Log In" button. Below this is a search area with "filter results" and dropdown menus for "Type" (set to "All"), "Priority" (set to "All"), and "Sort by" (set to "Dynamically"), accompanied by a "Submit" button. At the bottom left, there are logos for "W3C HTML 4.01" and "W3C CSS". The main content area displays a grid of medical image thumbnails, each with a text overlay stating "Data is available only to registered members." The browser's taskbar at the bottom shows several open applications, including "démarrer", "E-cad", "Explor...", "C:\IMDC...", "http://shoc...", "AGIR Medical...", and "Microsoft...".

- **EGEE**
 - SDJ qualified as a priority, WG
 - Contributions from EGEE to developments
- **Grid 5000 deployment of the workflow enactor MOTEUR**
- **Health Grid**
 - gPTM3D part of the SC05 demonstration
 - AGIR invited at the next HG conference
- **Invited at the GDR STIC-Santé day orgnized by Neurobase**

- **Medical image analysis is an ideal grid use case**
- **Medical computing practice must be considered as first order requirements, not interface of practical issues**
- **Revisit classical problems such as time-sharing or streaming or region of interest with new hypothesis**



- **Use cases and general issues**
 - The HealthGrid white paper whitepaper.healthgrid.org
 - Report on Images, medical analysis and grid environments workshop. D. Berry, C. Germain-Renaud, D. Hill, S. Pieper and J. Saltz. www.nesc.ac.uk/technical_papers/UKeS-2004-02.pdf
- **AGIR**
 - C. Germain, V. Breton, P. Clarysse, Y. Gaudeau, T. Glatard, E. Jeannot, Y. Legré, C. Loomis, J. Montagnat, J-M Moureaux, A. Osorio, X. Pennec, R. Texier. Grid-enabling medical image analysis. *CCGrid 2005 Bio-Grid workshop, IEEE Press*. Extended version to appear in *Journal of Clinical Monitoring and Computing*
 - www.aci-agir.org