*Istituto Nazionale di **O**ceanografia*

*e di **G**eofisica **S**perimentale*

National Institute of Oceanography and Experimental Geophysics

GEMS Group

Géza Seriani

SPICE kick-off meeting

19-21 January 2004

OGS

Is a public research institute located at Sgonico (Trieste).

Its mission is to promote, coordinate and perform studies and research on the earth and its resources.

- geophysical and environmental sciences;
- location and valuation of mineral and energy resources on-shore and off-shore;
- marine sciences, with specific focus on the interaction of the oceans with the atmosphere and the lithosphere;
- studies of seismic, geodynamic and hydrodynamic phenomena and their influence on the environment, and also for risks assessment;
- developments of innovative techniques for geophysical data acquisition, processing, interpretation and archiving.


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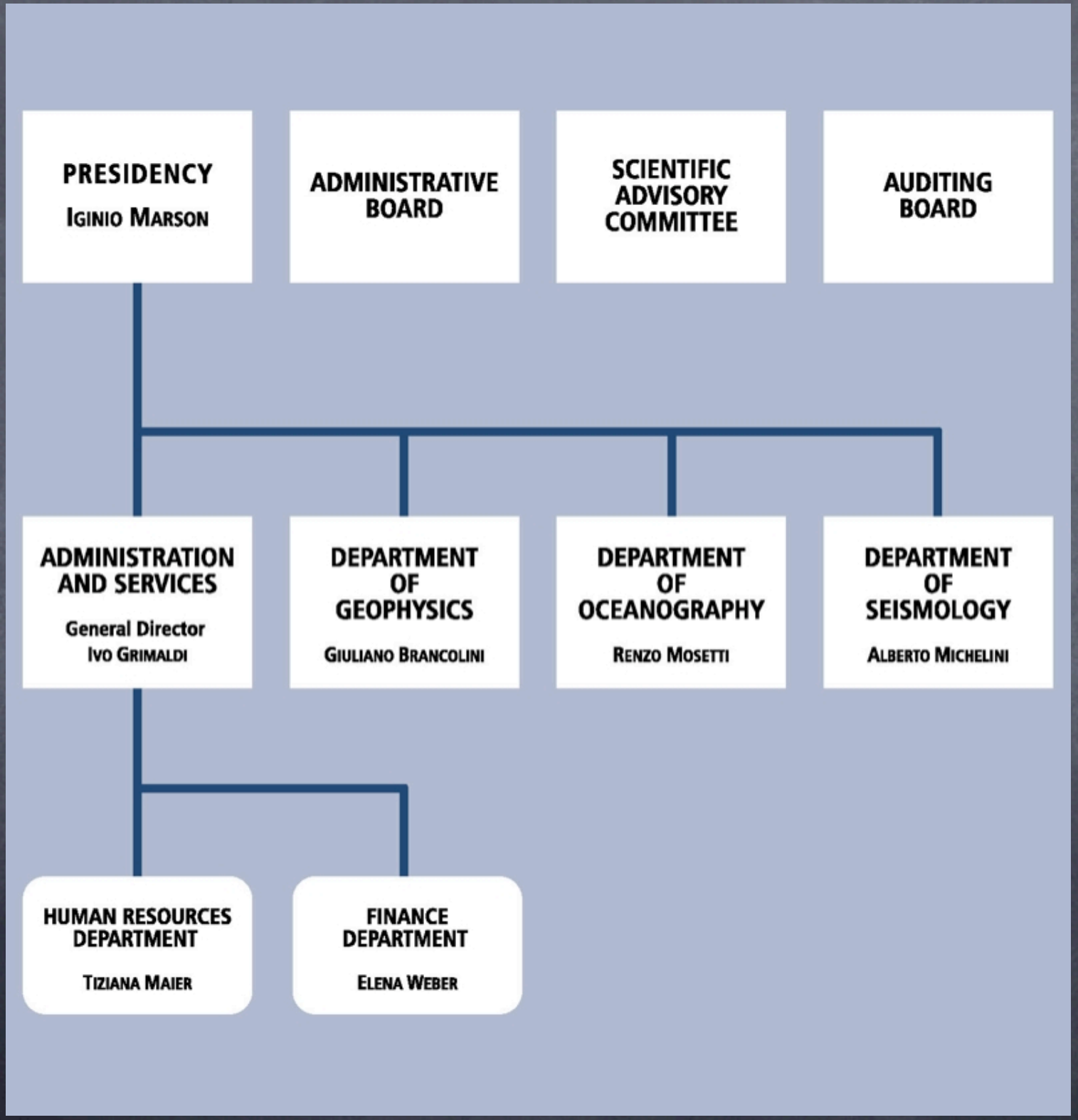
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HUMAN RESOURCES DEPARTMENT
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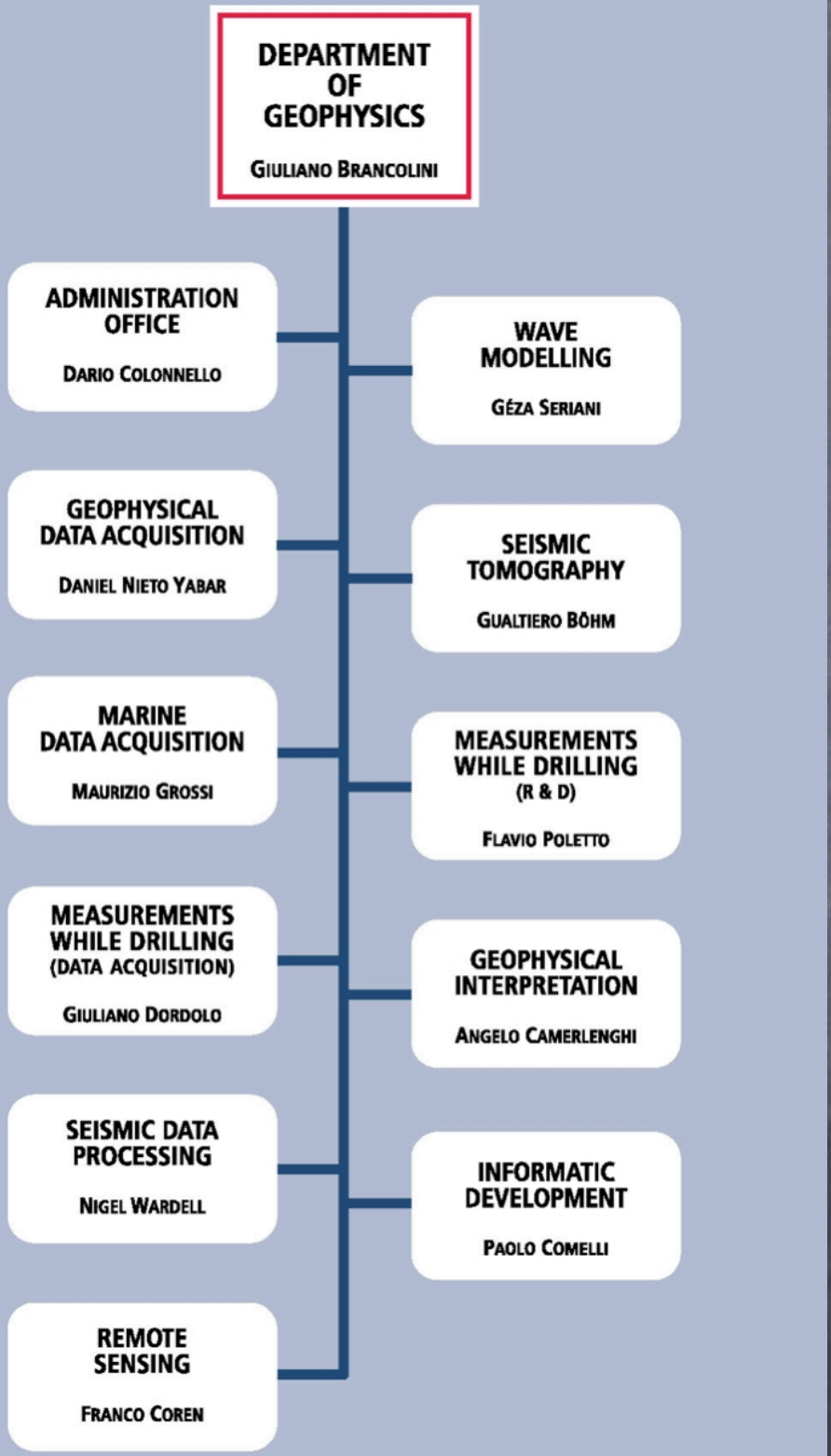
FINANCE DEPARTMENT
ELENA WEBER

OGS

Departments:

- **GEOPHYSICS OF THE LITHOSPHERE**
- **OCEANOGRAPHY**
- **CENTRE OF SEISMOLOGICAL RESEARCH**


DEPARTMENT OF GEOPHYSICS
GIULIANO BRANCOLINI
ADMINISTRATION OFFICE
DARIO COLONNELLO
GEOPHYSICAL DATA ACQUISITION
DANIEL NIETO YABAR
MARINE DATA ACQUISITION
MAURIZIO GROSSI
MEASUREMENTS WHILE DRILLING (DATA ACQUISITION)
GIULIANO DORDOLO
SEISMIC DATA PROCESSING
NIGEL WARDELL
REMOTE SENSING
FRANCO COREN
WAVE MODELLING
GÉZA SERIANI
SEISMIC TOMOGRAPHY
GUALTIERO BÖHM
MEASUREMENTS WHILE DRILLING (R & D)
FLAVIO POLETTO
GEOPHYSICAL INTERPRETATION
ANGELO CAMERLENGHI
INFORMATIC DEVELOPMENT
PAOLO COMELLI

GEMS Group

- At Dept. of GEOPHYSICS OF THE LITHOSPHERE

- Permanent Staff

  Géza Seriani

  José Carcione

  Fabio Cavallini

- 3 non-permanent researchers

GEMS Group

Geophysical Modelling & Simulation

(..... since 1987)

The numerical modelling of seismic and electromagnetic waves propagating in the earth has a key role in exploration geophysics, reservoir engineering, and environmental protection.

The GEMS research group promotes and performs research activity in this field, and contributes to related technological development, in view of industrial and environmental applications.

Research fields

- *rock physics and continuum mechanics with emphasis on inhomogeneous anisotropic composite materials and porous media (single/multi-phase viscoelastic);*
- *propagation of seismic and electromagnetic waves in the subsoil and in complex geologic structures;*
- *development of computational algorithms for large-scale numerical simulations of realistic case-studies on parallel and massive parallel computers;*
- *participation to multi-disciplinary researches in exploration and reservoir geophysics, in oceanography, environmental management and protection, and in engineering seismology.*

Recent studies .....

- *Seismic waves in porous media (detection of overpressure from seismic and well data, and seismic signature of gas hydrates);*
- *Effects of pressure and saturating fluid on wave velocity and attenuation of anisotropic rocks;*
- *Acoustic and mechanical response of reservoir rocks under variable saturation and effective pressure;*
- *Seismic-modelling methodology for the interpretation of the Earth's crust;*

..... Recent studies

- *Time-domain seismic modeling of constant Q-wave propagation using fractional derivatives;*
- *Engineering seismology application of wave modelling;*
- *Acoustic and electromagnetic properties of soils saturated with salt water and NAPL;*
- *Three-dimensional ground penetrating radar response of a karstic zone;*

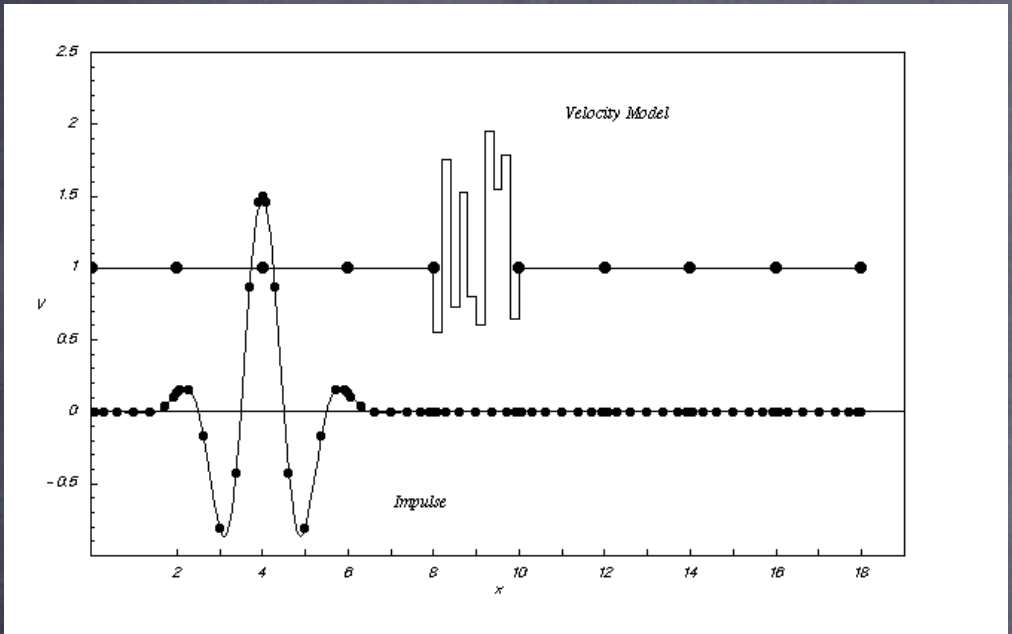
Numerical Methods

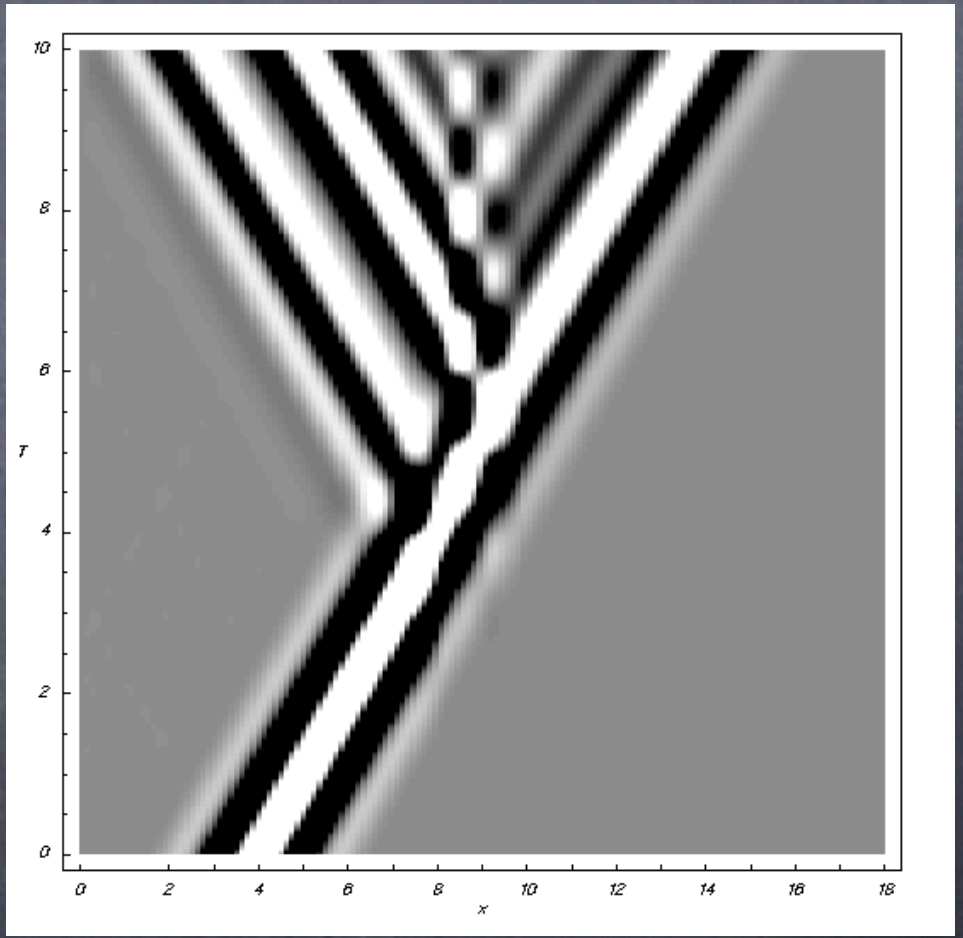
- *Fourier & Chebyshev pseudospectral (High Order FD);*
- *Chebyshev spectral elements;*
- *Implicit / explicit time integration;*
- *Iterative solvers;*
- *2-D & 3-D;*
- *SHMEM / MPI parallel protocols;*

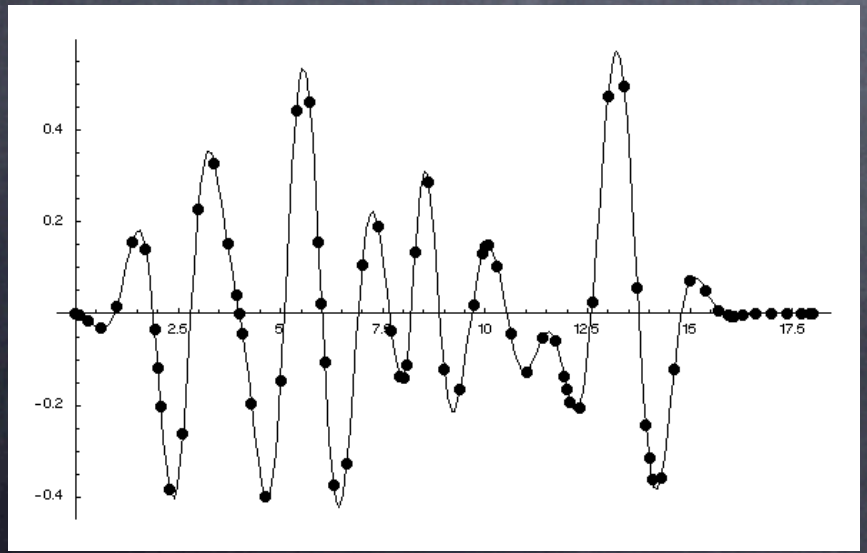
Recent Developments
(Computational)

- *Pseudospectral poro-elastic/poro-viscoelastic codes;*
- *Acoustic wave modelling by double-grid spectral elements;*
- *Chebyshev spectral elements on adaptive meshes;*
- *Parallel 3D staggered pseudospectral modelling with viscoelasticity & PML (MPI);*
- *Parallel 3D multi-domain block pseudospectral (MPI & ghost cells).*

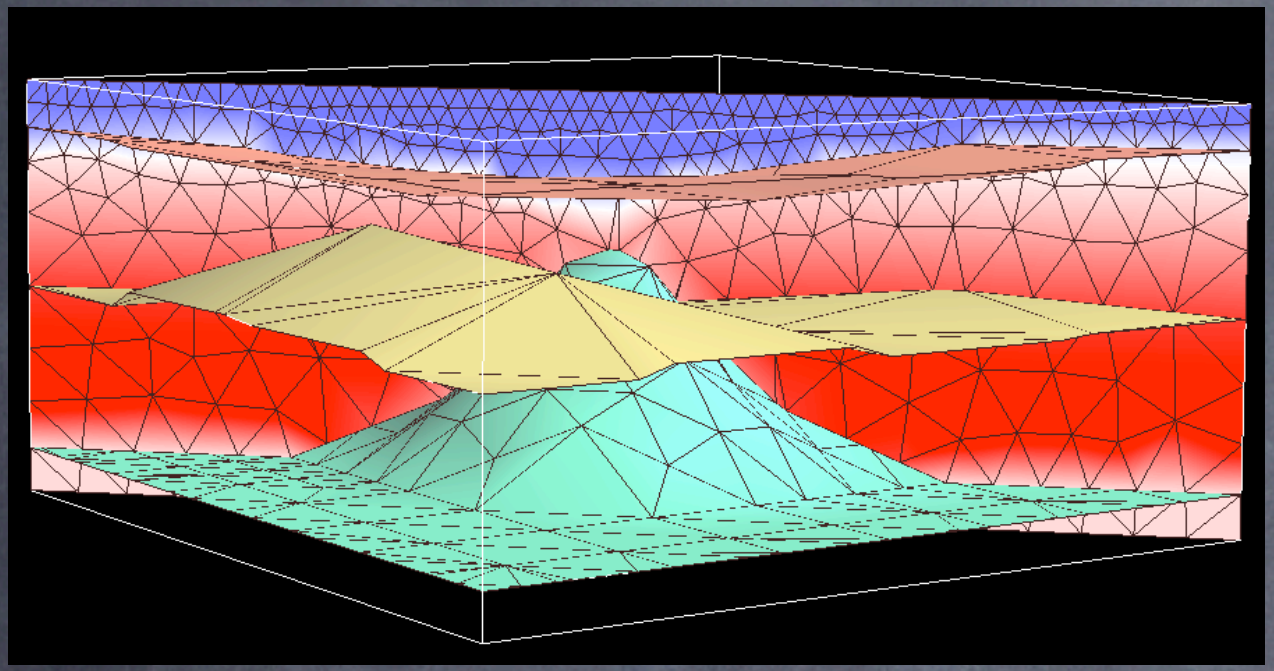
Double-grid spectral elements

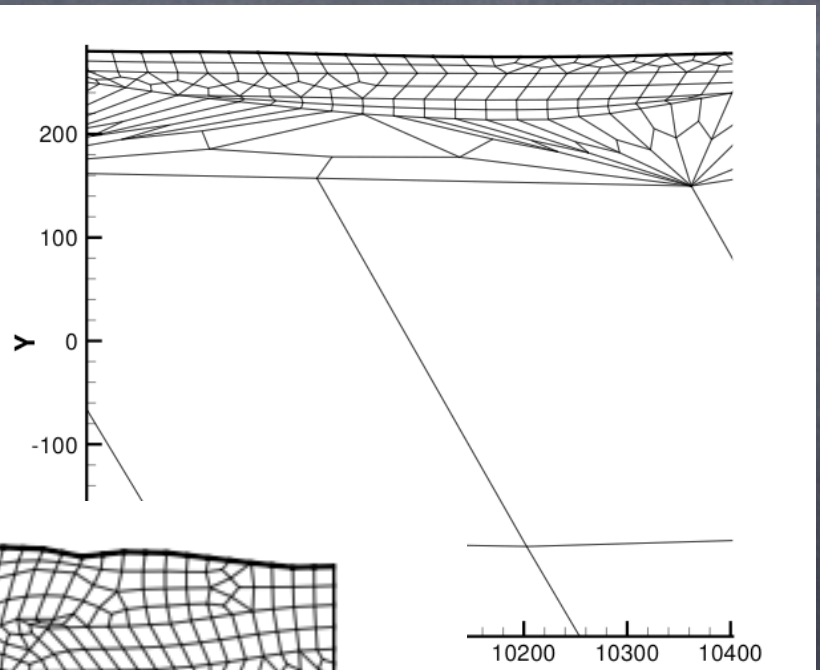


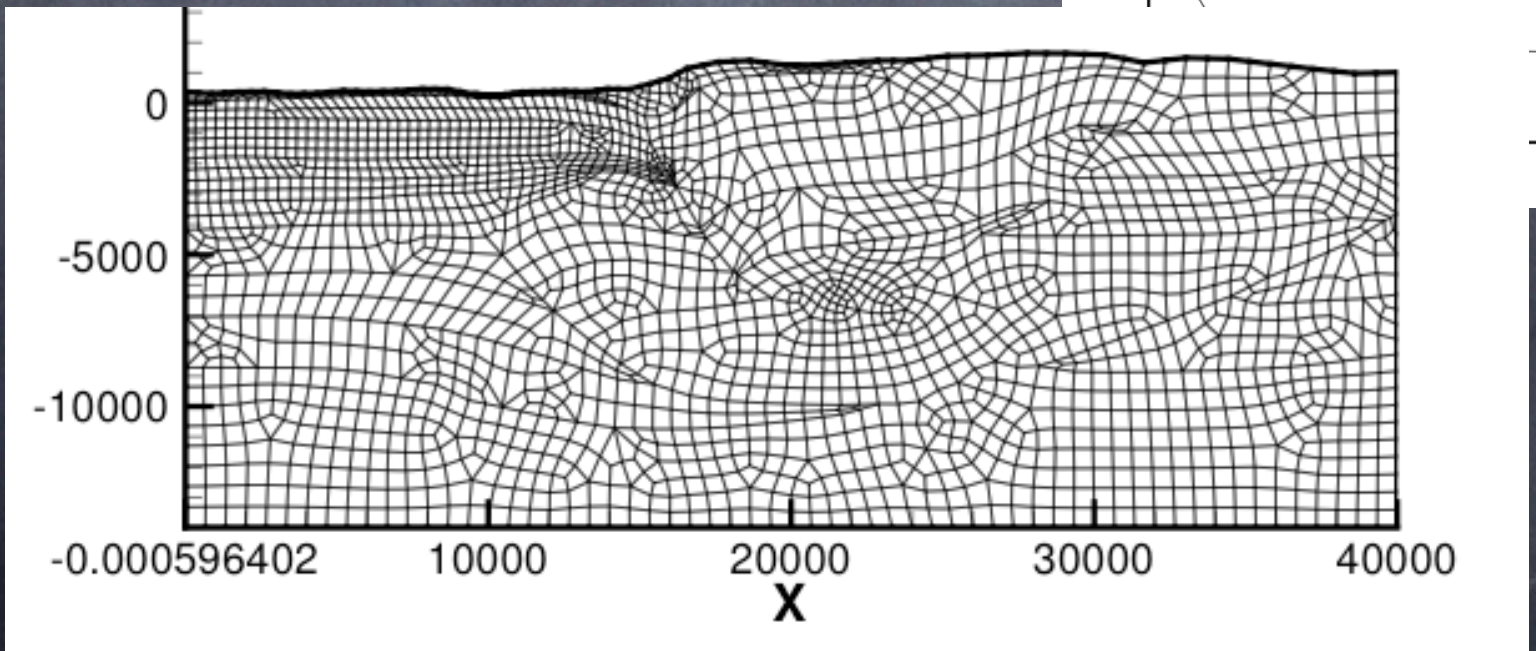




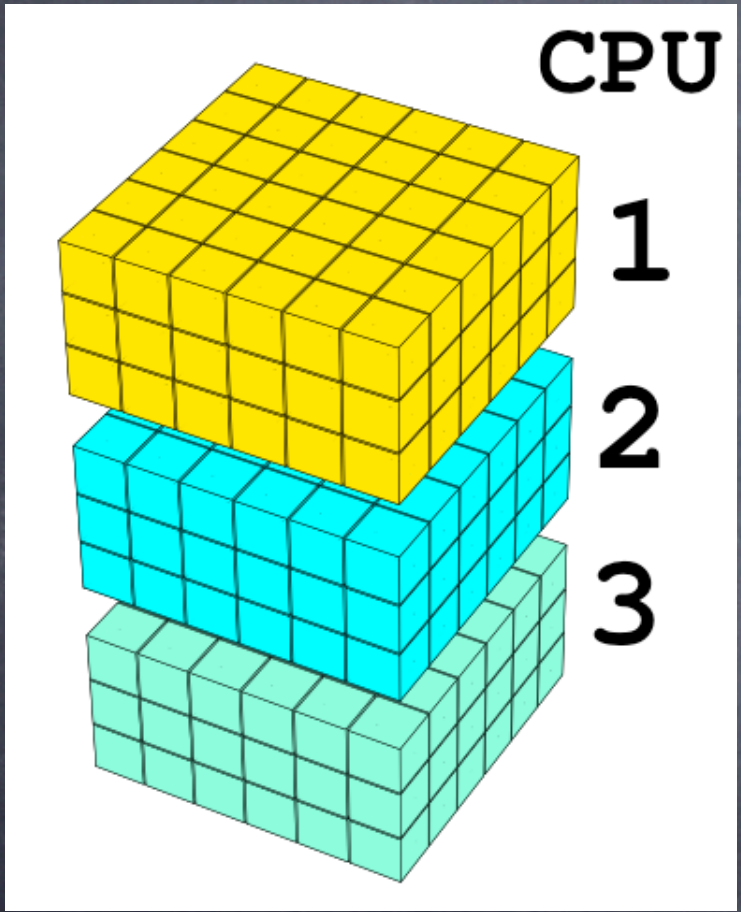
Spectral elements & adaptive meshes



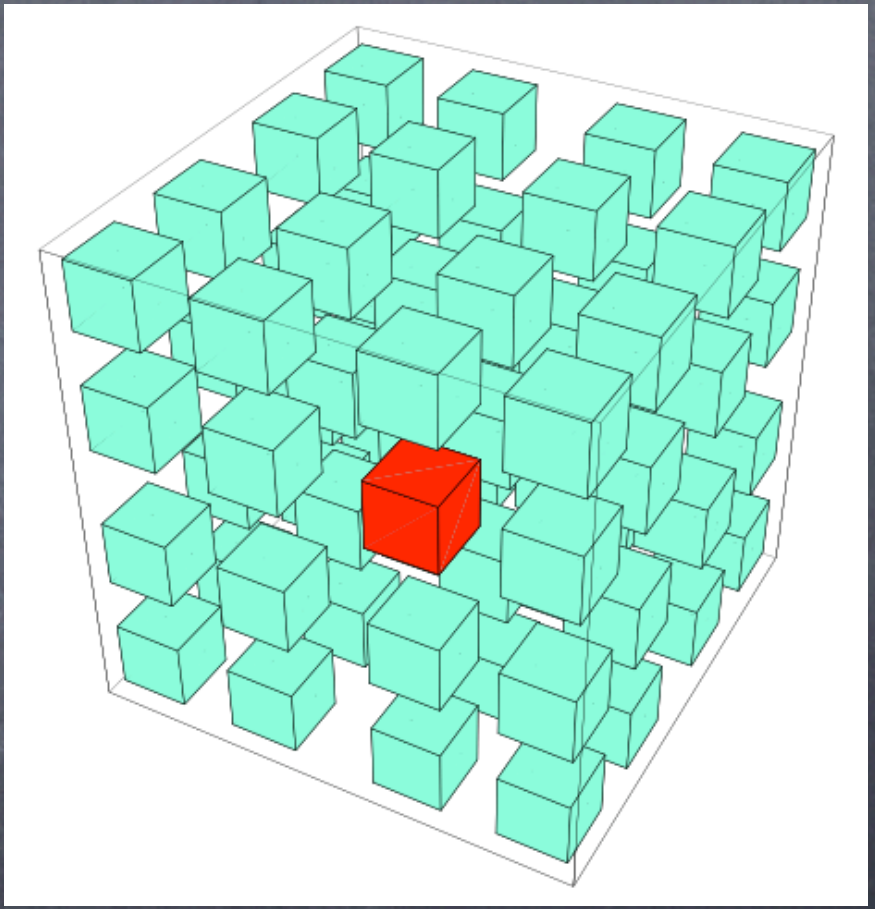




3D MPI// multi-domain block pseudospectral (ghost cells)



Block decomposition



Multi-domain/Block decomposition

Related Projects

- *TREMOR - An integrated system for seismic modelling (It);*
- *HYGEIA - Hybrid Geophysical technology for the Evaluation of Insidious contaminated Areas (EC);*
- *CONFITANET - CO_2 sequestration project (It);*
- *CASTOR - CO_2, From Capture To Storage (EC);*
- *CO2-GeoNet - Network of Excellence on CO_2 geological sequestration (EC);*

Infrastructures

- *Software: Modelling codes, Gocad, Tecplot, Mathematica, Matlab, UNIRAS, C, C++, Fortran90, Python, wxPython, VTK;*
- *Hardware: HP, SGI & PowerMac G4/G5 UNIX workstations;*
- *OGS Server: SGI O300/8 ;*
- *Cineca Servers: IBM SP4/512, IBM Linux Cluster/128, SGI ORIGIN 3800/128;*
- *Visualization: 3D SGI Virtual Theater (Cineca);*
- *Seismic processing: Paradigm Geophysical ECHOS suite & SeisX, Vista 2D/3D, Petrosys, Hampson-Russell suite, CAT3D tomographic code (OGS);*

Infrastructures

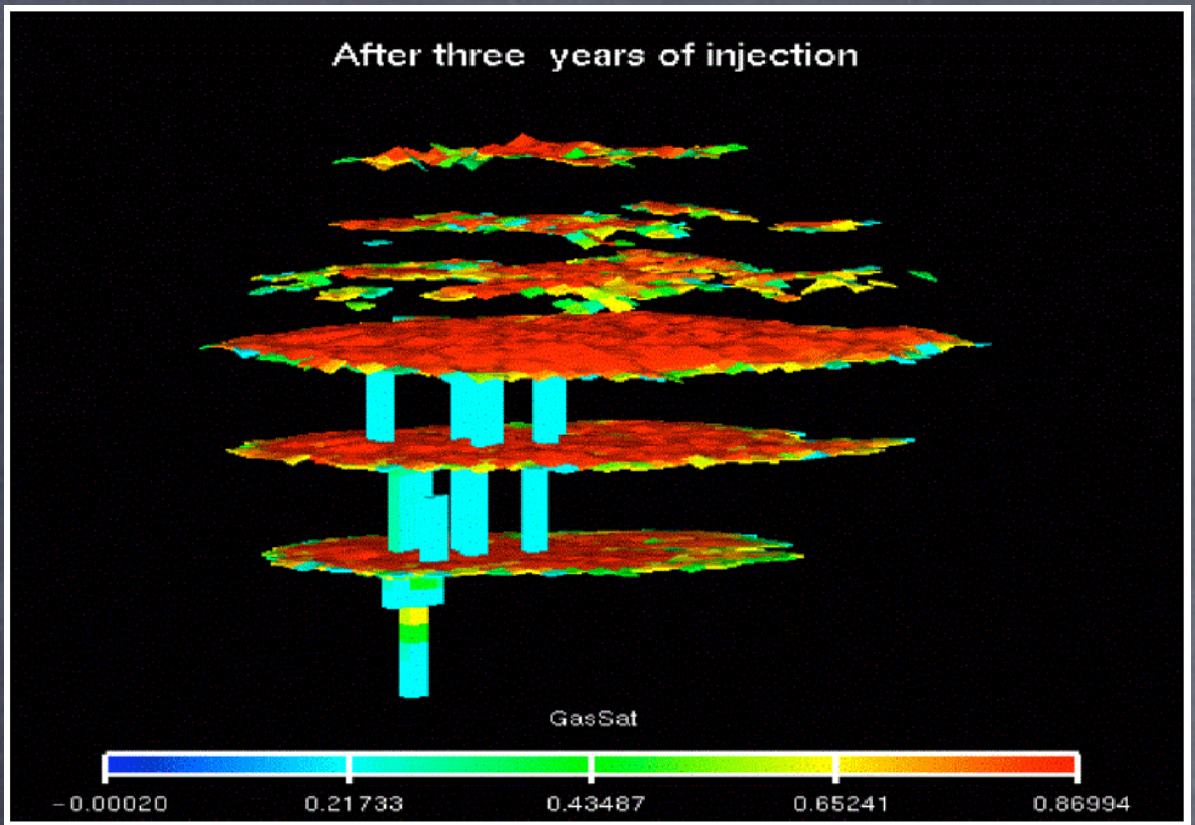
- *Data acquisition: Various geophysical instrumentations;*

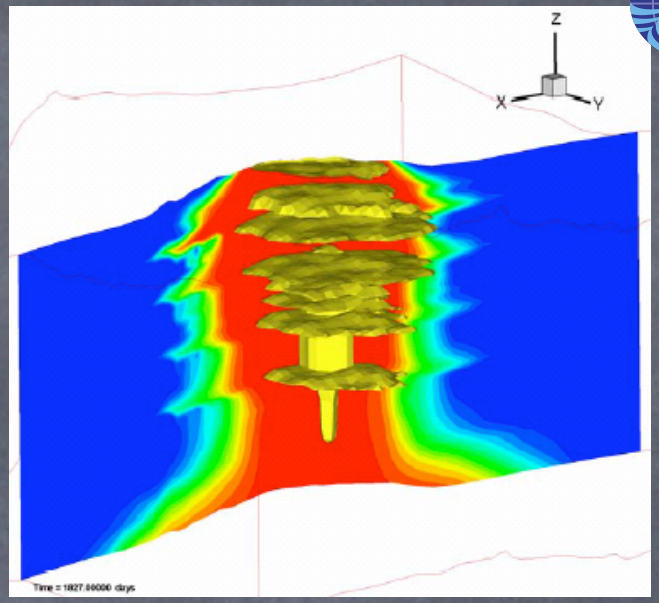
Developments

- *Software:* No *software engineers* but *High Level Open Source Libraries*, must be portable;
  - *Programming:* Based on Fortran90/95, Python, C, C++, OpenGL, wxPython, VTK;
- *External support:*
  - *Programming & Op. System:* Cineca computing center;
  - *Software on demand:* Paneura - software house (TS). It can develop specific software;

PhD Projects

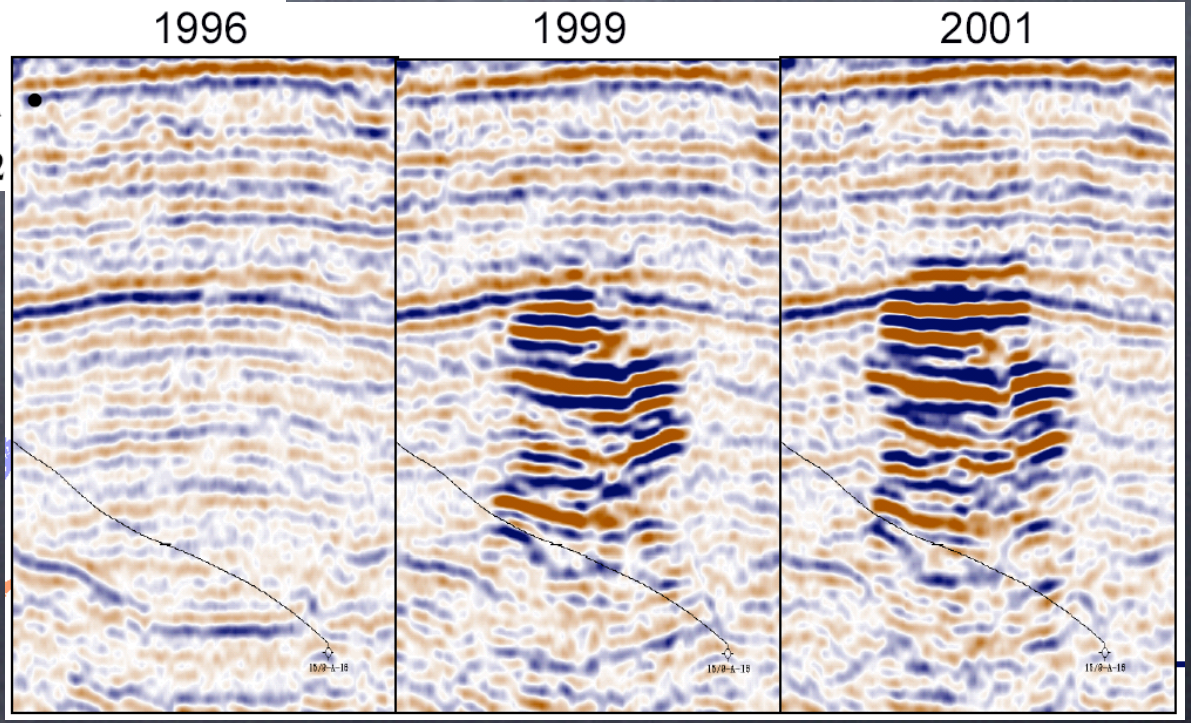
- *Pseudospectral & Spectral Element methods;*
- *Wave modelling:*
  - *in 3D porous & in random/fractal media;*
  - *of surface waves in viscoelastic media;*
  - *of inhomogeneous body waves in anisotropic/anelastic media;*
  - *in cylindrical and spherical coordinates;*
  - *at fluid/solid interfaces;*
  - *for CO2 sequestration problems.*





Simulated picture of CO_2 after three years.
Largest bubble 800 m wide and the total 200 m

Ref: SINTEF Petroleum 2



Time Lapse Seismic

at Utsira acquifer (Norway)