A&A Cluster in EGEE III

French participation

Scientific coordinators:
Franck Le Petit & Marie-Lise Dubernet - Paris Observatory

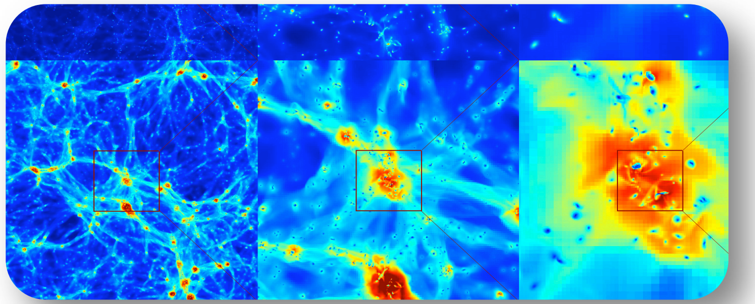
French participation

- Paris Observatory
  - GEPI
  - IMCCE
  - LERMA
  - LESIA
  - LUTH
  - SYRTE
  - USN
- Grenoble observatory
- Lyon observatory
- Nice observatory
- Strasbourg observatory / CDS

- Paris observatory federates the french activities

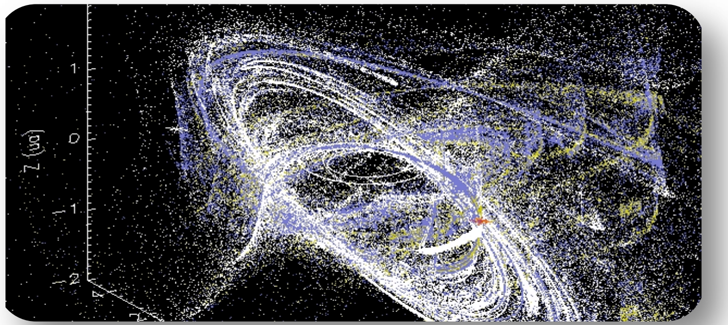
A&A Cluster in EGEE III
French participation

- **Horizon: Galaxy & Cosmology**
  - Cosmological parameters inference (Pier-Stefano Corsaniti et al. - LUTH)
  - Re-ionization period (B. Semelin - LERMA / D.Valls-Gabaud et al. - GEPI)
  - Galaxy Mergers (F. Combes et al. - LERMA / P. di Matteo - GEPI)
  - Gravitational galaxy dynamics (H. Wozniak - CRAL)



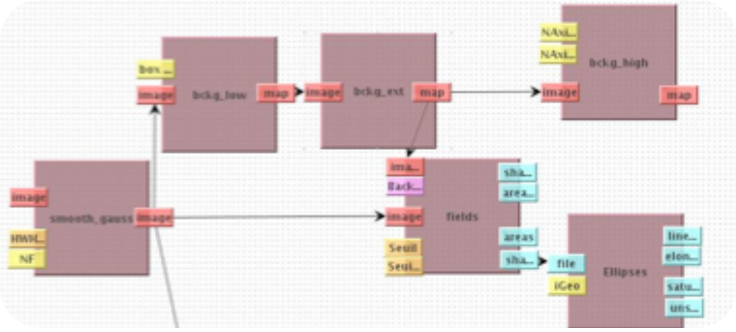
- **Herschel - ALMA preparation**
  - Atomic & Molecular physics (M.-L. Dubernet et al. LERMA, A. Faure et al. LAOG)
  - Physics and chemistry of ISM (F. Le Petit et al. - LUTH)
  - Protoplanetary disks (F. Menard - LAOG)

- **Celestial mechanics**
  - Long period evolution of comets.
  - Computation of meteoroid streams
  - Chaotic diffusion in the solar system



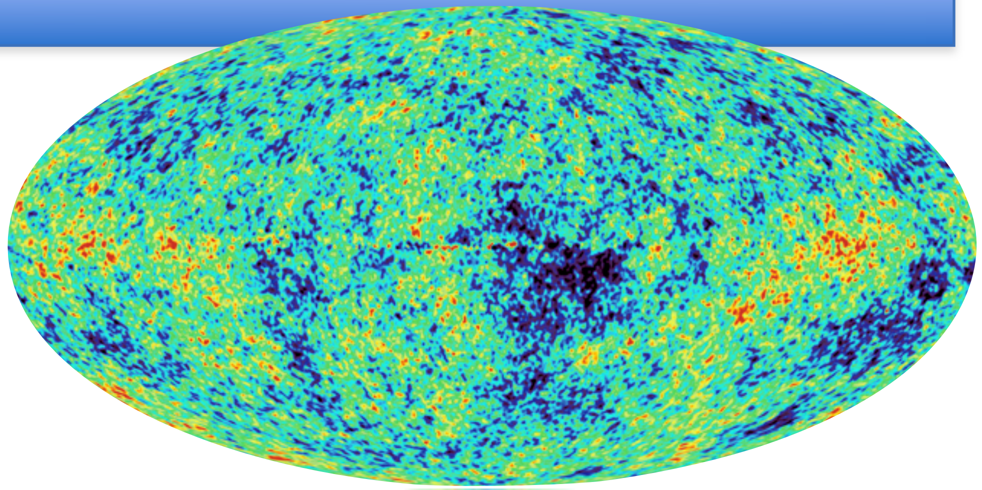
- **High energy astrophysics:** CTA design study (A. Zech et al. - LUTH)

- **Grid & Virtual Observatory**
  - Workflows for data reduction (E. Slezak - Nice obs. and A. Schaaf - CDS)
  - Online numerical simulation services (F. Le Petit - F. Roy / VO-LUTH)
  - Datamining (J. Berthier / VO-IMCCE)



Cosmological Parameter inference

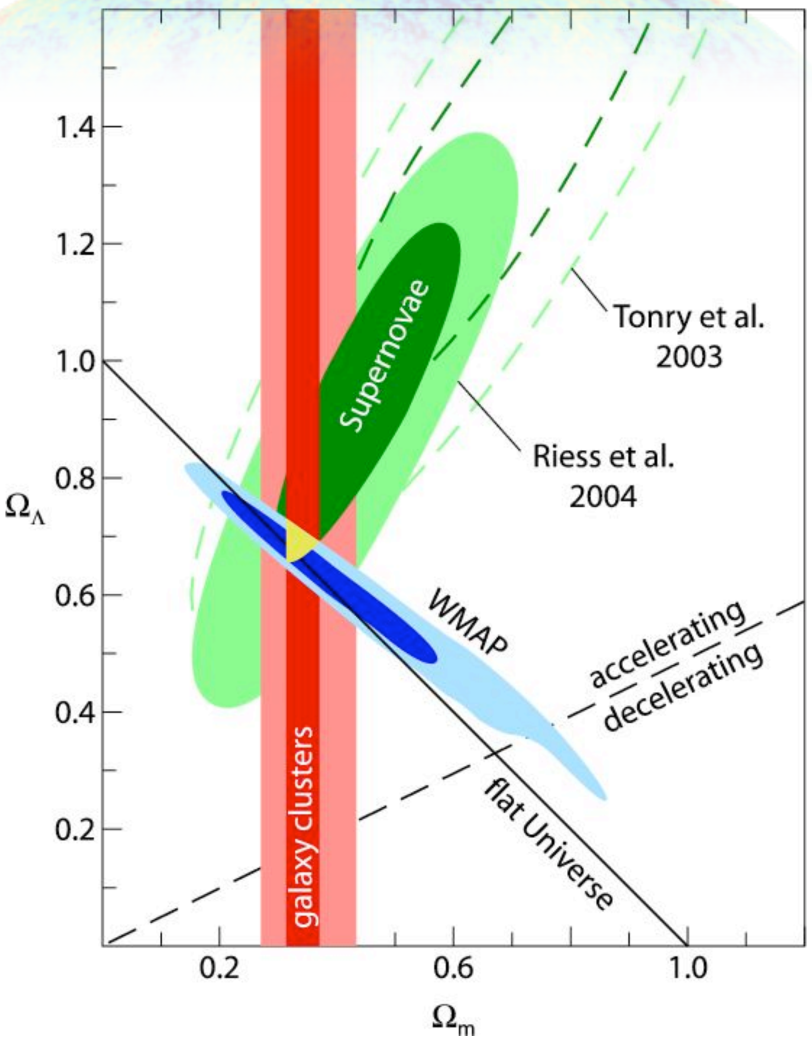
Pier-Stefano Corasaniti - LUTH



Goal: Constrain cosmological parameters

Method:

- Exploration of parameter space with Mark Chain Monte Carlo
- Large number of cosmological parameters
  - H: Hubble constant
  - Ω_λ: density parameter for the cosmological constant
  - Ω_M: density parameter for matter
  - Ω_X: density parameter for dark energy
  - Ω_r: density parameter for radiation
  - ...
- Evaluating the likelihood between the model and the observations
  - CMB
  - Supernovae
  - Galaxy clusters



Similar problem has been successfully deployed on the Grid:
ZEN project - André Tilquin - Centre de physique des particules de Marseille.

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Study of the re-ionization

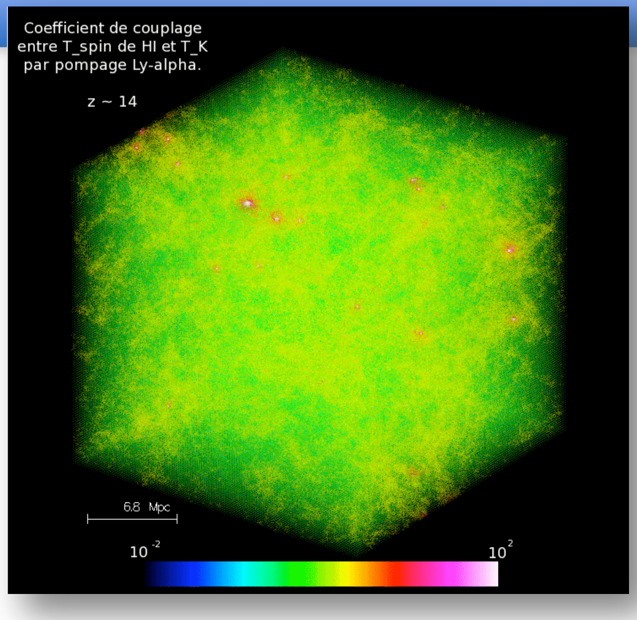
David Valls-Gabaud, Carolina Leon, GEPI / Observatoire de Paris
Benoît Semelin, Françoise Combes, LERMA / Observatoire de Paris

Goal: Simulate the ionization processes in a small volume of the high-redshift universe

in perspective to SKA

- Bring a large scale structure simulation on the grid
- Monte Carlo radiative transfer on this simulation
    - ionization at different transitions
    - Lyman-alpha and 21cm line emission

Grid will permit to refine the radiative transfer



Monte Carlo radiative transfer of the 21 cm H I line on a large scale structures simulation

B. Semelin / LERMA / Paris Observatory

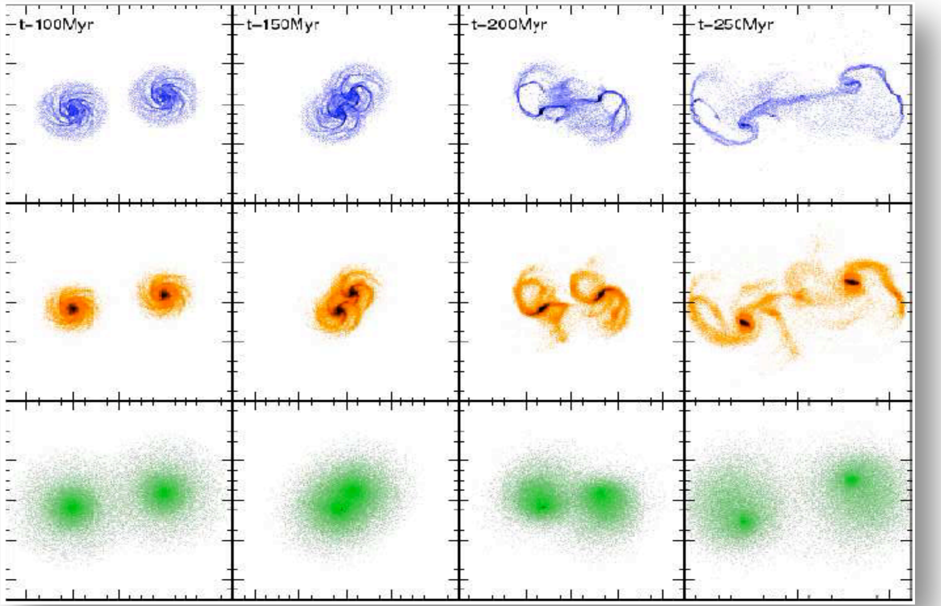
Galmer project: Galaxy Merger

F. Combes, P. Di Matteo, A.-L. Melchior, B. Semelin – LERMA / Paris Obs.

Goal: simulate galaxies interactions and mergers of galaxies to study their effects on galaxy evolution and stars formation

Grid will permit a refinement of the physics in the models

- Statistical study of mergers of galaxies
- Explore the effect of input physical parameters:
    - mass ratio, orbital parameters, tidal effect …

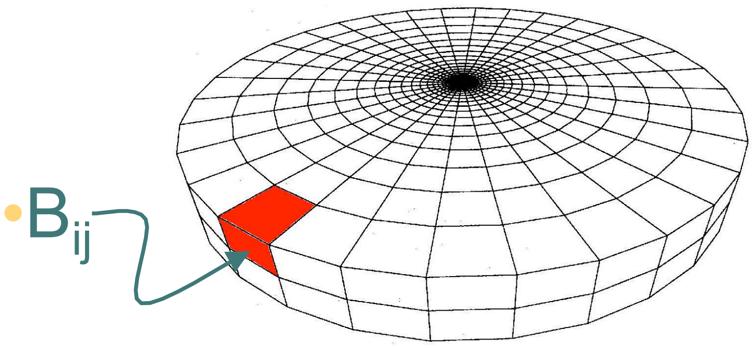


P. Di Matteo et al., A&A, 2007, 468, 61

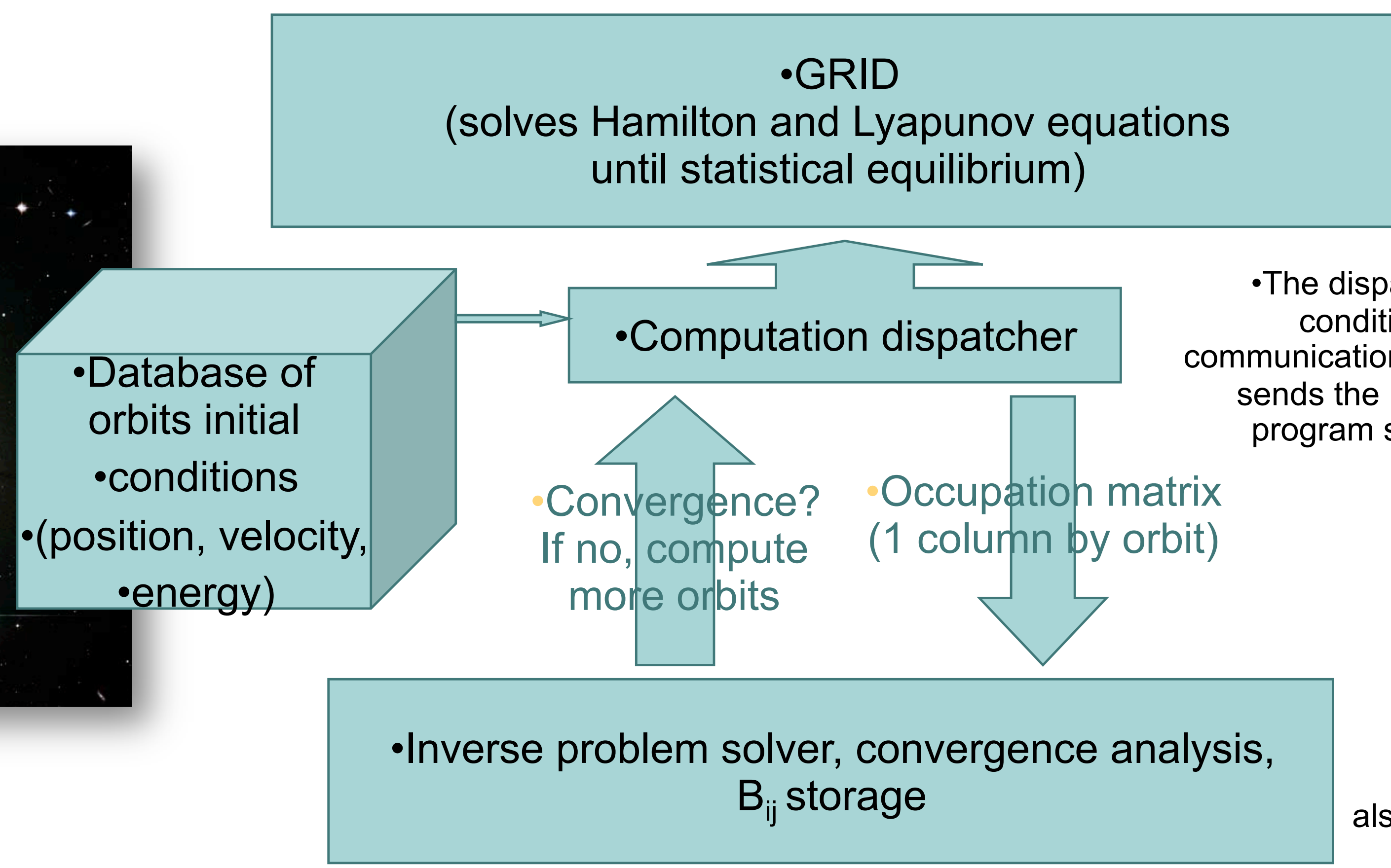
Gravitational galaxy dynamics

Hervé Wozniak - Observatoire de Lyon

Goal: Determination of orbits of stars in galaxies



- A galaxy is made of ~10^{10} stars moving in a gravitational potential due to the mass distribution of stars, dark matter, gas, dust, etc.
- Reproduce observed density distribution determining the number of stars per orbit.



•1 orbit by node

•The dispatcher reads initial conditions and manages communication with the GRID. It sends the results back to the program solving the inverse problem.

•The inverse problem solver (NNLS) is implemented on a 32-64 Go RAM machine but may also make use of the GRID.

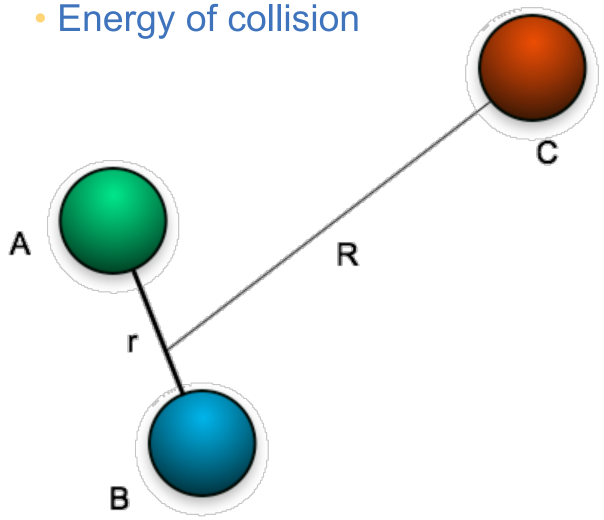
Atomic & Molecular physics

M.-L. Dubernet, C. Balança, F. Dayou, N. Feautrier, A. Spielfiedel – LERMA / Paris Observatory
A. Faure, P. Valiron - Grenoble / LAOG

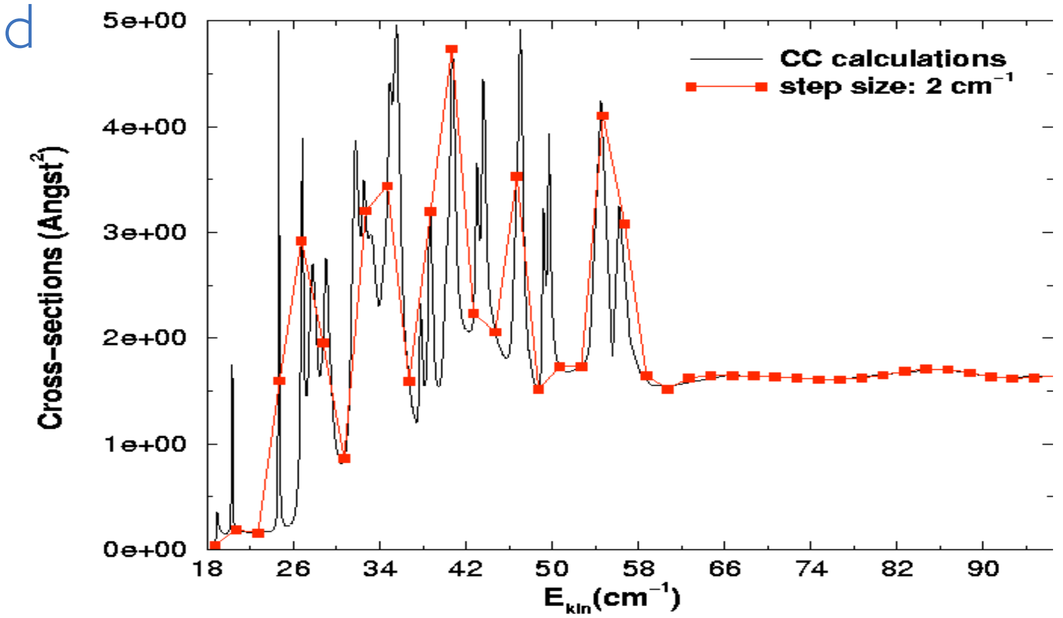
Goal: Determination of collision rates in molecular systems and chemical reaction rates for interpretations of observations in non-LTE media.

Collision rate coefficients are function of temperature
- high temperature: enough high kinetic E
  - Required to interpret observations in shocks & Star forming regions
- Low temperature: enough point close to threshold (resonance)
  - Required to interpret observations in warm and cold cloud

Molecule AB whose spectra is observed
Parameters:
- Initial levels
- Geometry: R, angle
- Energy of collision



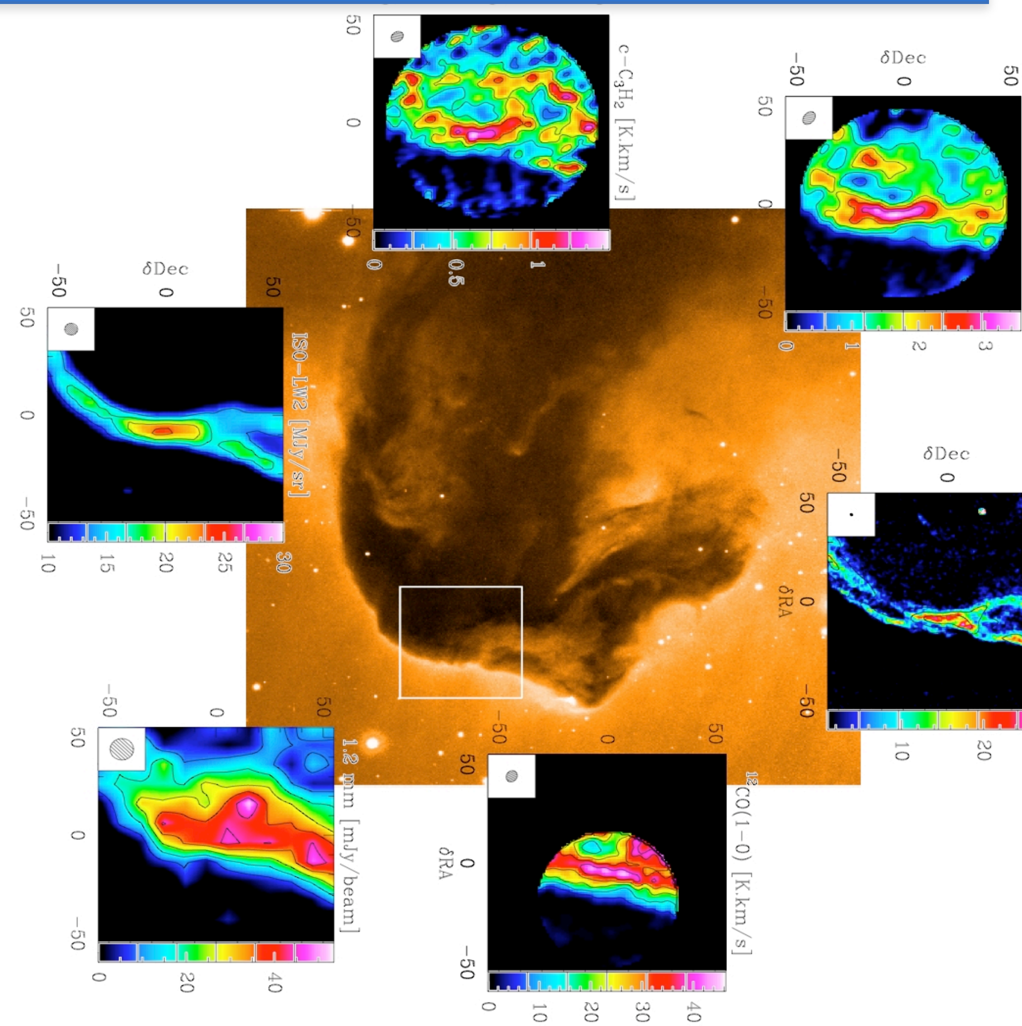
Thanks to the large number of processors in the Grid:
- get faster results
- treat systems with large number of freedom degrees



Experience of Grenoble team on CIGRI grid for such simulations

Modeling of the Interstellar Medium

F. Le Petit, F. Roy, J. Le Bourlot, E. Roueff - LUTH / Paris Obs.



Pety et al.

Goal:

- Explore the influence of parameters (density, UV field, ...) on the chemical structure of interstellar clouds.

Models of photodissociation regions solves in a consistent way

- Radiative transfer, chemistry, thermal processes in non LTE media
- Large number of input parameters
  - Property of the gas: Illumination, density structure, chemical abundances
  - grains composition and properties

Thanks to the large number of processors in the Grid we can expect:

- Sharper interpretations of observations from next generation of instruments
- Explore in more details parameters space:
  - Study “exotic ISM” as diffuse clouds at high redshifts: Damped Lyman systems
  - 240 000 CPU hours to build a grid covering parameter space as for standards ISM

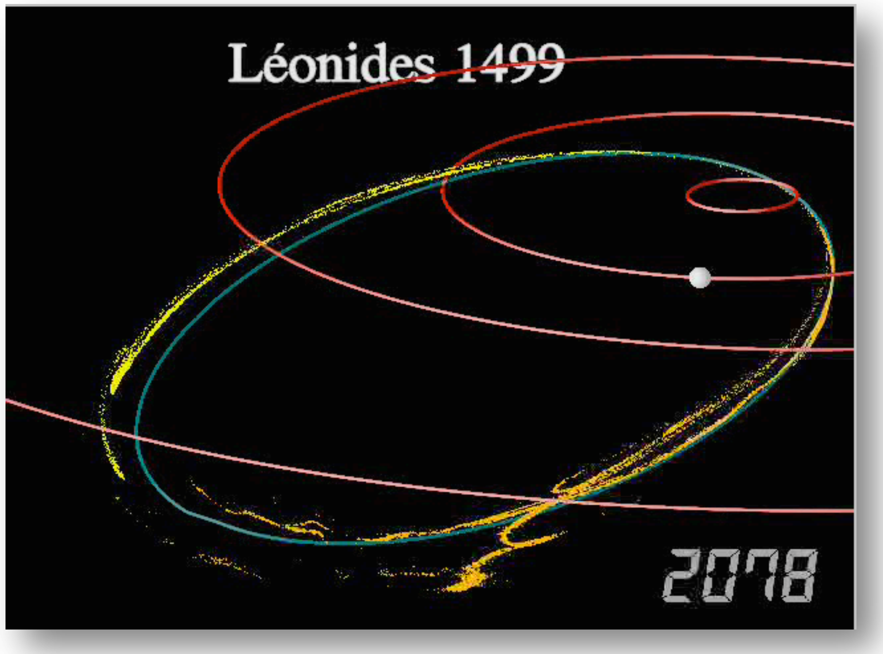
Celestial mechanics

J. Berthier, M. Fouchard, J. Frouard, M. Gastineau, V. Lainey, J. Laskar, J. Lecubin, F. Vachier, J. Vaubaillon, W. Thuillot
IMCCE / Paris Observatory / CNRS

- Long term evolution of comets - M. Fouchard
  - Transportation from Oort cloud to the Earth neighbourhood
  - Trace of the Solar System formation.

Technique: Simulate the evolution of a large number of comets (10^6) on time scale equals to the age of the solar system.

- Forecasting meteor showers - J.Vaubaillon
  - Reproduce the ejection of meteoroids regular meteoroid influx on the Earth
  - Follow the evolution of the flux of metoroids by perturbators
  - Estimate when the Earth cross the trajectory



Activity level prediction of Leonids - J. Vaubaillon

Celestial mechanics - IMCCE / Paris Observatory / CNRS

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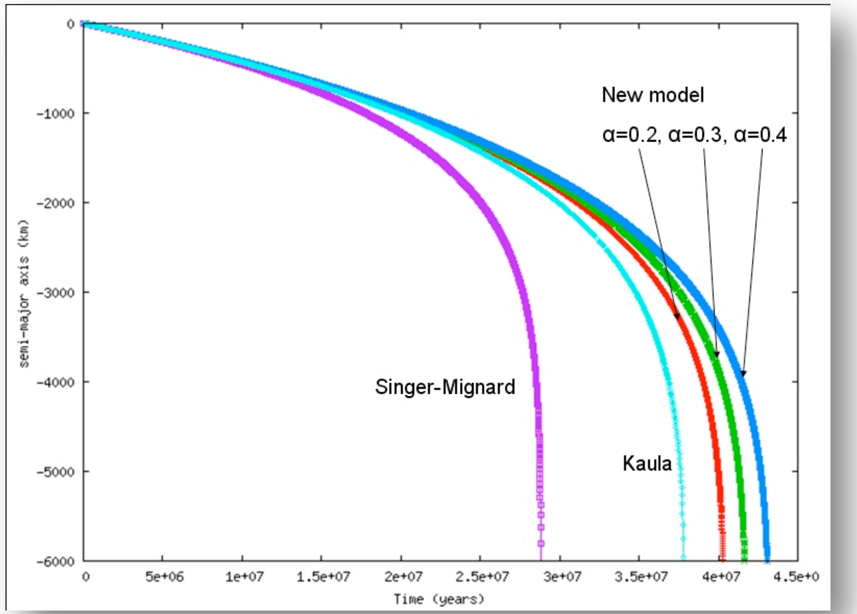
IMCCE / Paris Observatory / CNRS

- Orbital models of natural satellites - V. Lainey
  - Numerical integration of thousands of differential equations simultaneously, with a small step size.
  - Integration of the equations of motion over thousands of million years
- Orbital models of asteroid satellites - J. Berthier
  - Inversion problem solved by metaheurisitics
- Chaotic diffusion in the Solar System : J. Laskar, M. Gastineau
  - Determine the stability of the planetary orbits over 5 Gyr.
  - Partners: IN2P3 & Grid Institute



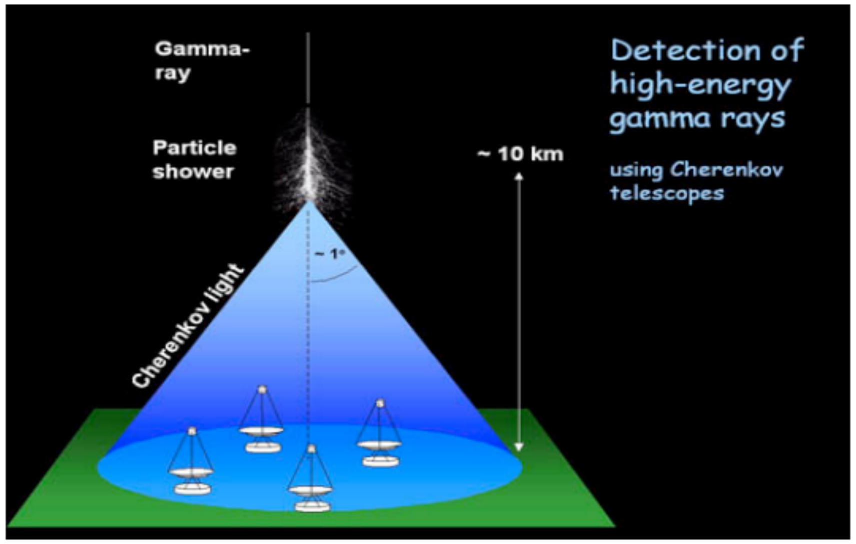
Determination of the fall of Phobos on Mars
V. Lainey

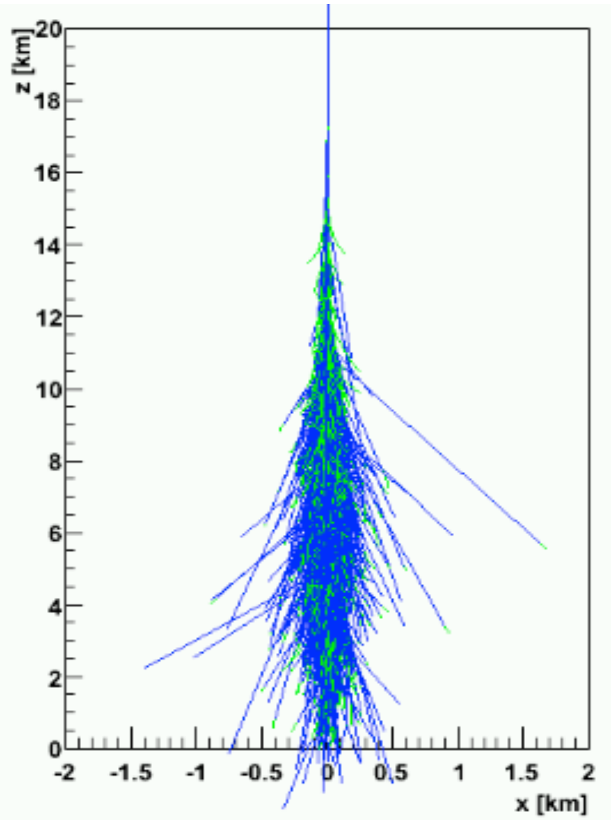
High energy astrophysics

A. Zech - LUTH / HESS collaboration

Cherenkov Telescop Array Design Study

- Detection of Very High Energy (~TeV) Gamma Rays observing the "showers" of charged particles when entering the atmosphere.
- CTA will have several tens of telescopes of different sizes to improve sensitivity and resolution and to greatly increase the number of observed sources.





Goals:

- Design Study to possible array and telescope configuration over a large range of parameters (e.g. distance, size, number of telescopes etc.) with massive simulations.

Take advantage of the GRID to:

- obtain results rapidly (large CPU time needed)
- access shared data storage resources (a few % of LHC data volume)
- coordinate contributions by many institutes in different countries.

Virtual Observatory & Grid

- International project to build an interoperability layer on archives, databases, tools and services provided by datacenters
- Provide services and data with added value to the community

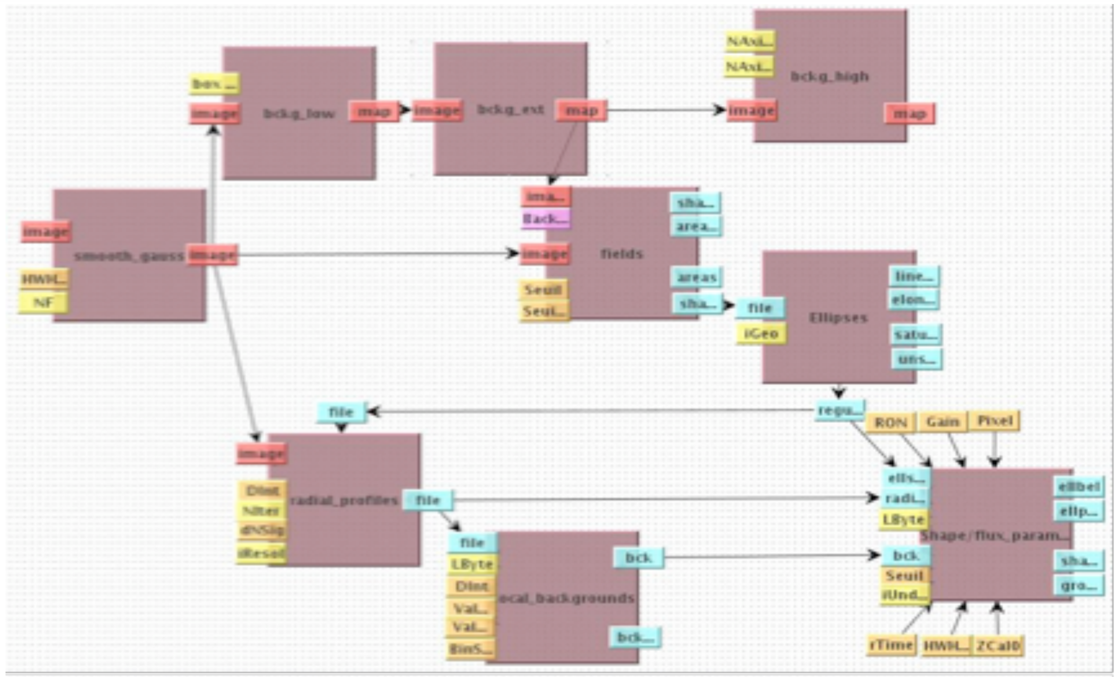
- Strong links between Virtual Observatory and Grid in the A&A community
  - Grid working group in ASOV (Action Spécifique of CNRS on Virtual Observatory)
  - Common meeting in Garching mars 2008: VO-Theory and Grid
  - EuroVO-DCA WP5: Grid leaded by Giuliano Taffoni

Restauration of images by wavelets

Eric Slézak - Observatoire de Nice / CNRS
André Schaaff - Observatoire de Strasbourg / CNRS

- Developement of a workflow allowing to automate images restoration using wavelets methods thanks to Aïda, a workflow engine developed at Strasbourg Observatory.

- Porting this workflow on the EGEE grid will allow a faster data reduction.



This work will be done in a first time on MEGACAM images from the CFH telescope.

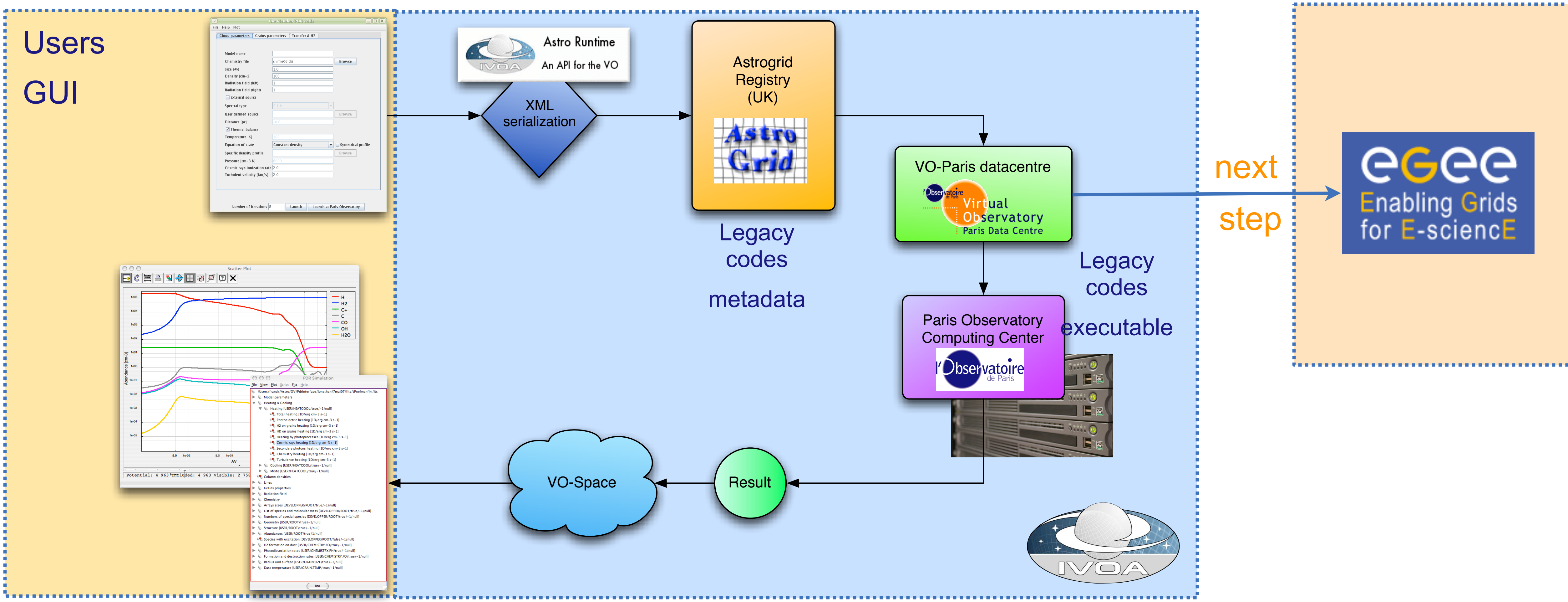
Access to online legacy codes via the Virtual Observatory

F. Le Petit, F. Roy - LUTH Paris Observatory

Goal: provide to the community online access to state-of-the-art simulation codes through the Virtual Observatory

with computing ressources on demand.

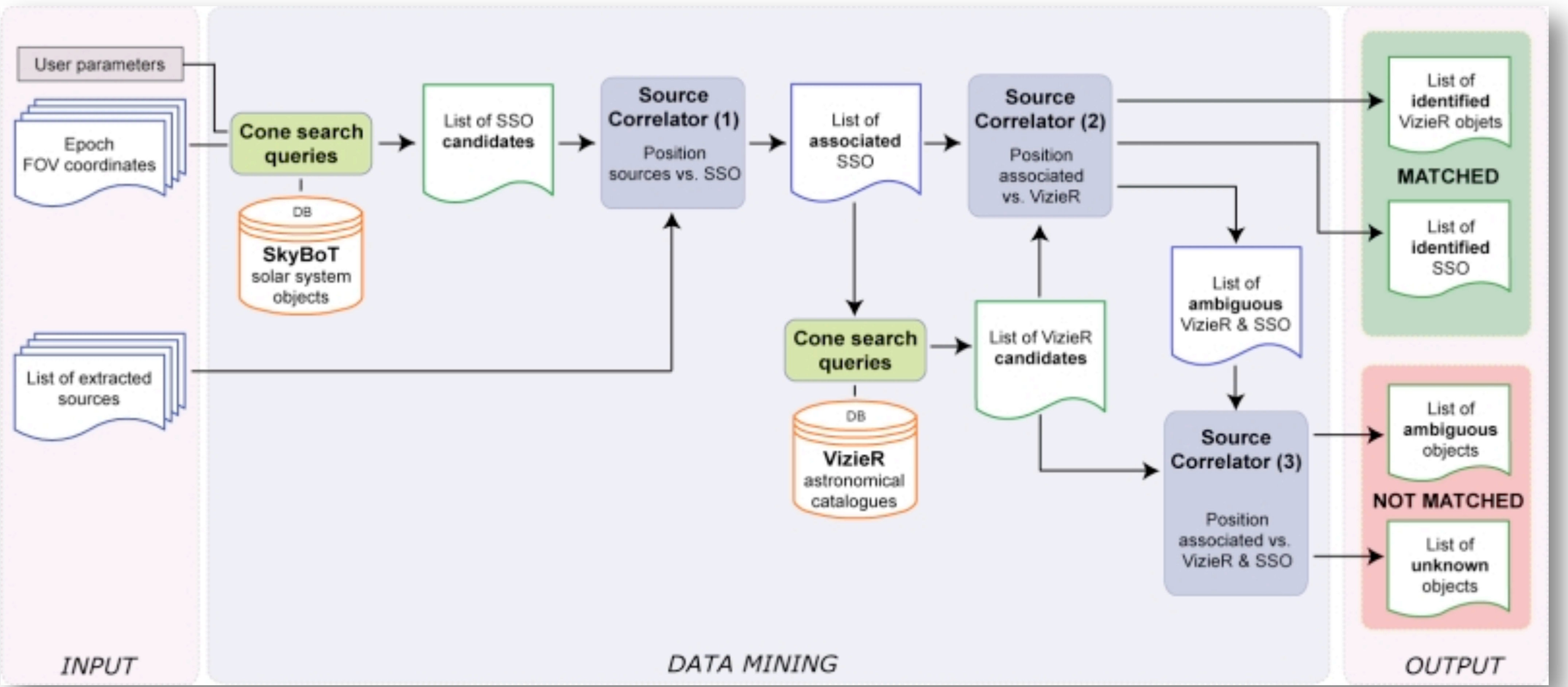
- Make use of Astrogrid infrastructure
- Codes run at Paris Observatory
- Users do not see the complexity behind the GUIs
- Collaboration with Naples Observatory to use transparently the Grid



Workflows & datamining

J. Berthier, W. Thuillot in collaboration with GEPI - CAI
Institut de Mécanique céleste et de calcul des éphémérides - Paris observatory - CNRS

Massive data mining of astronomical archives to seek for pre-discovery astrometric positions of small solar system objects (mainly asteroids and comets)



Status of the project

Organization

P. Le Sidaner, A. Marchand, A. Shih - SIO / Paris Observatory

Paris Observatory coordinates the french national efforts for the A&A Cluster in EGEE III

Paris observatory provides:

- EGEE node at Paris Observatory in 2008 (funding by INSU & Paris Observatory)
  - more than 100 CPU shared on the grid in EGEE
- Manpower
  - servers and middleware management
  - help scientists to deploy applications on the Grid
- Coordination of training for the french A&A community

Challenges:

Heterogenous applications: Strong tests for EGEE and for applications
- different librairies, compilers, sharewares (Molpro) are required

Challenging applications:
- Large simulations: **lots of ressources required**
  - Investigation of input parameters space - Order 0 parallelization
  - Optimization at algorithms levels
    - Radiative transfer
    - Collaboration Applied Mathematics Department Centrale Paris / LUTH
  - Full benefit of the Grid: error management
  - Share experience between projects: CTA project / Auger Project

- **Mass of data sharing on the Grid** - Virtual Observatory projects

- Requirement for **processors types** for reproducibility
  - chaotic diffusion in the Solar System

Conclusion

- Strong motivation of A&A scientists to bring their applications on the Grid.
- Mainly applications in numerical simulations: need CPU
- Use of the grid for large instruments (Ex: CTA) also require storage and data sharing

- But no experience on grid computing and gridification
- Need for training and support:
  - deploy application on the grid
  - management

- Benefit from the help of:
  - IPSL / Earth Science - M. Petitdidier & David Weissenbach
  - INAF - Giuliano Taffoni