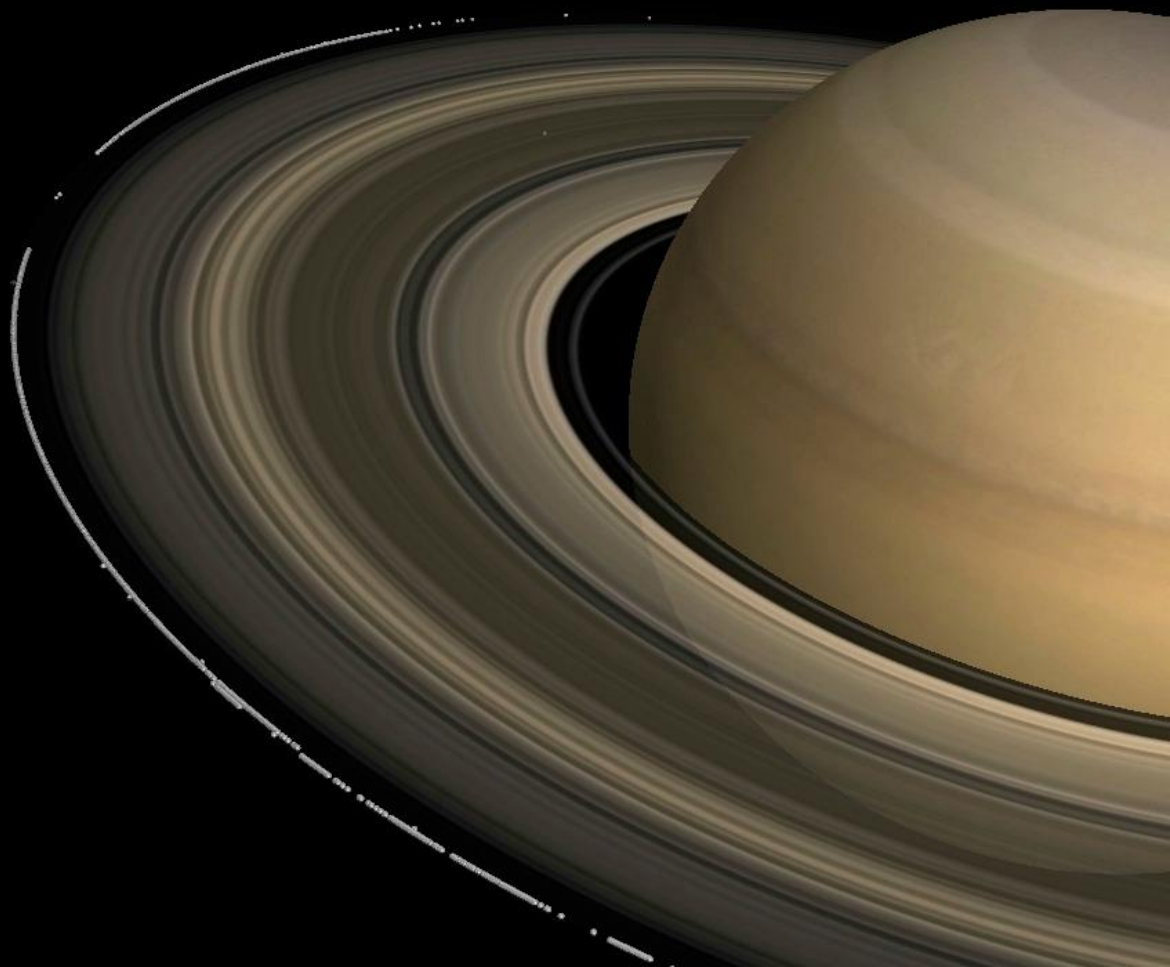
La visualisation scientifique à l'IRFU

Daniel Pomarède, IRFU/SEDI/LILAS
Journée HPC
25 mai 2016

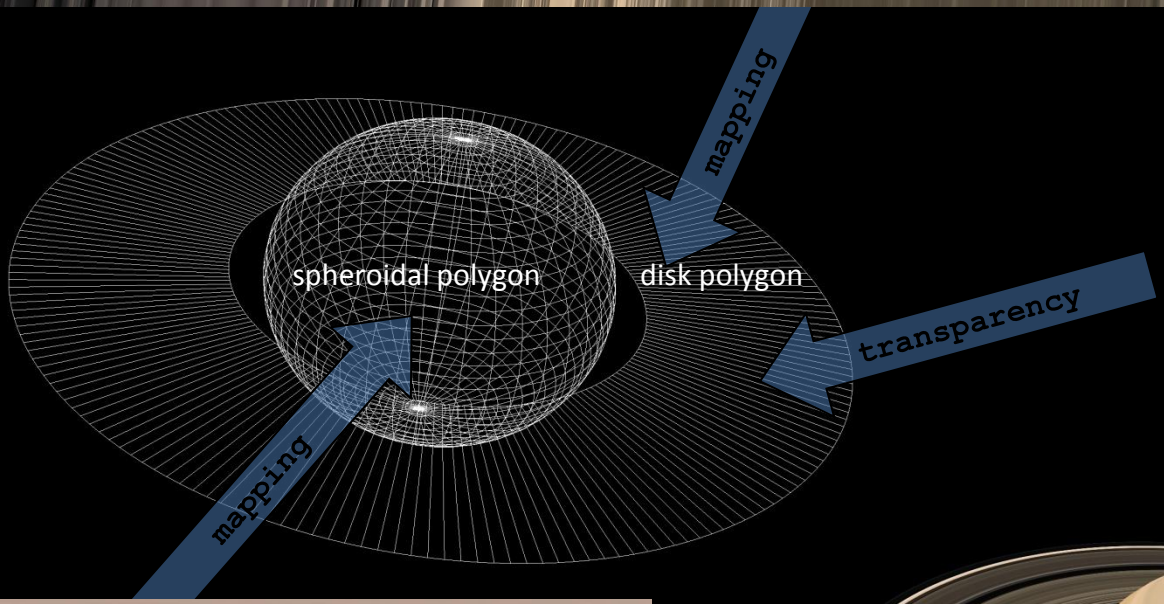
BUL simulations of ring dynamics

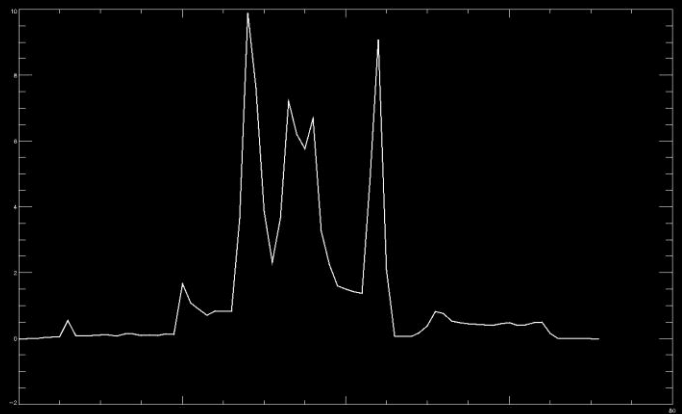
- The BUL “Burlish-Stoer” code relies on the orbital integration technique to compute the motion of bodies orbiting around a massive central planet, cf A. Brahic, “*Numerical Simulation of a System of Colliding Bodies in a Gravitational Field*”, J. Comp. Phys., vol. 22, 1976, p. 171.
- It takes into account detailed physics, including radiative effects, collisions, aspherical central body, impact detection.



Visualization of Cassini observations of Saturn and its rings

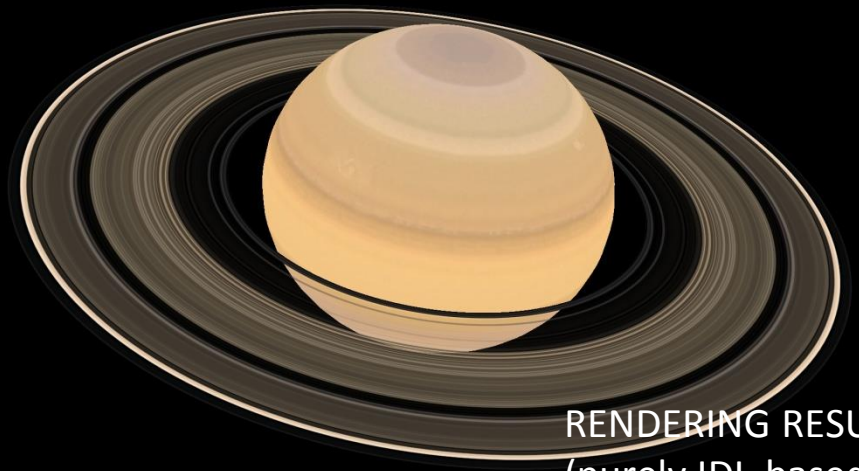
Reconstructed mosaic from the Cassini narrow-angle camera images (available up to ~12000 pixel wide)





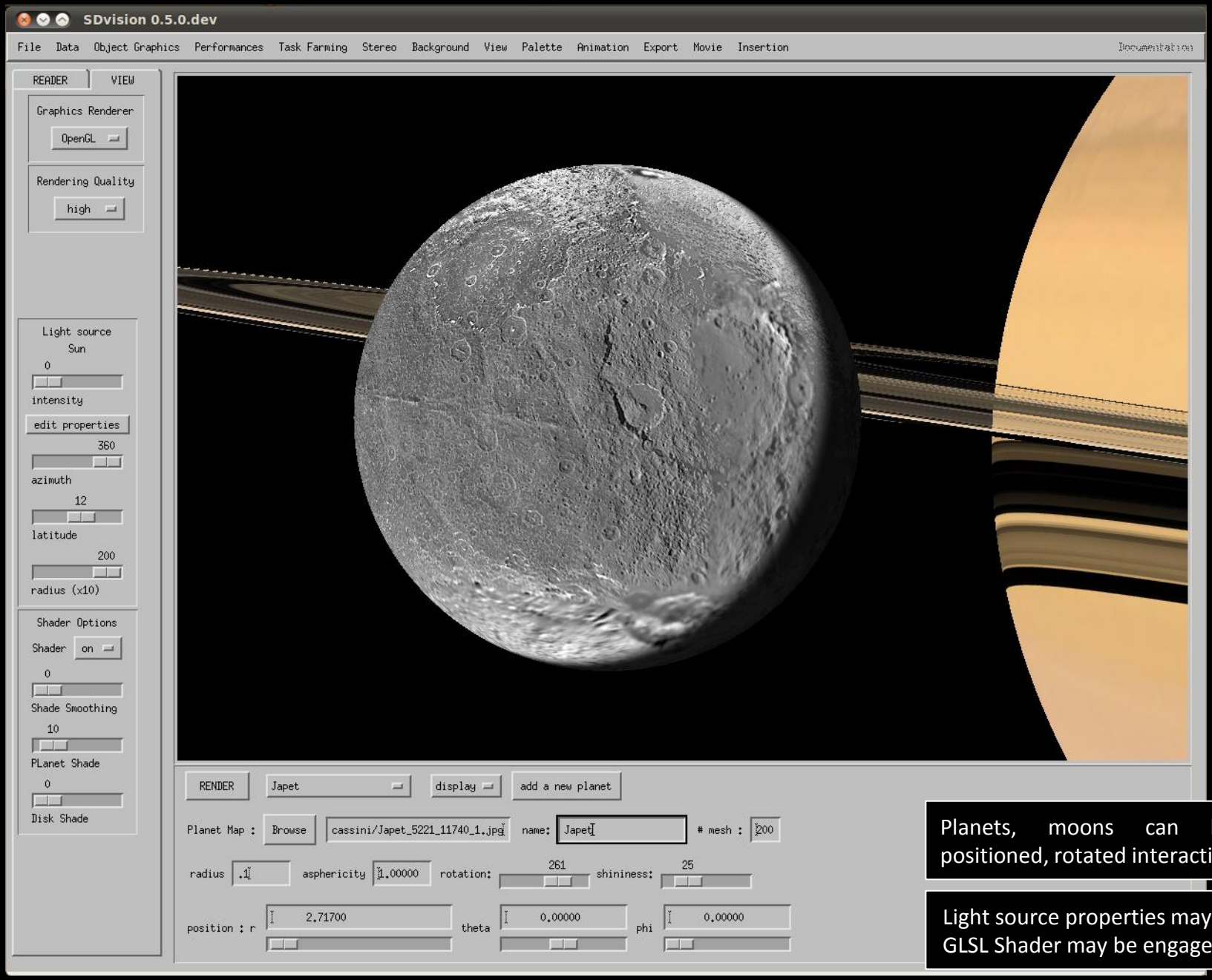
Measurement of the rings optical depth using Cassini instruments

Reconstructed map of the Saturn atmosphere (combination of Voyager 2 and Cassini data)



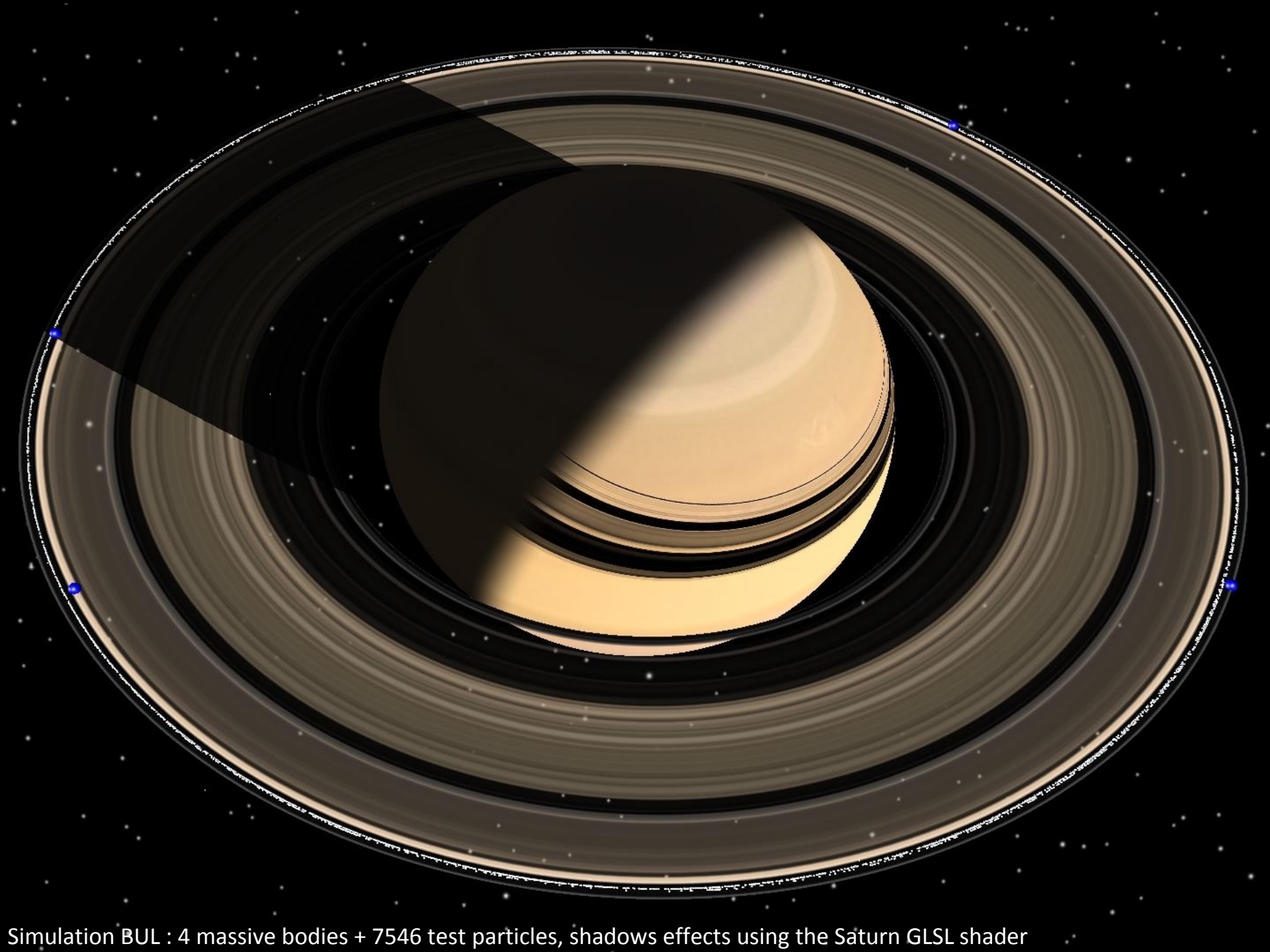
RENDERING RESULT (purely IDL-based)

The SDvision planet interface



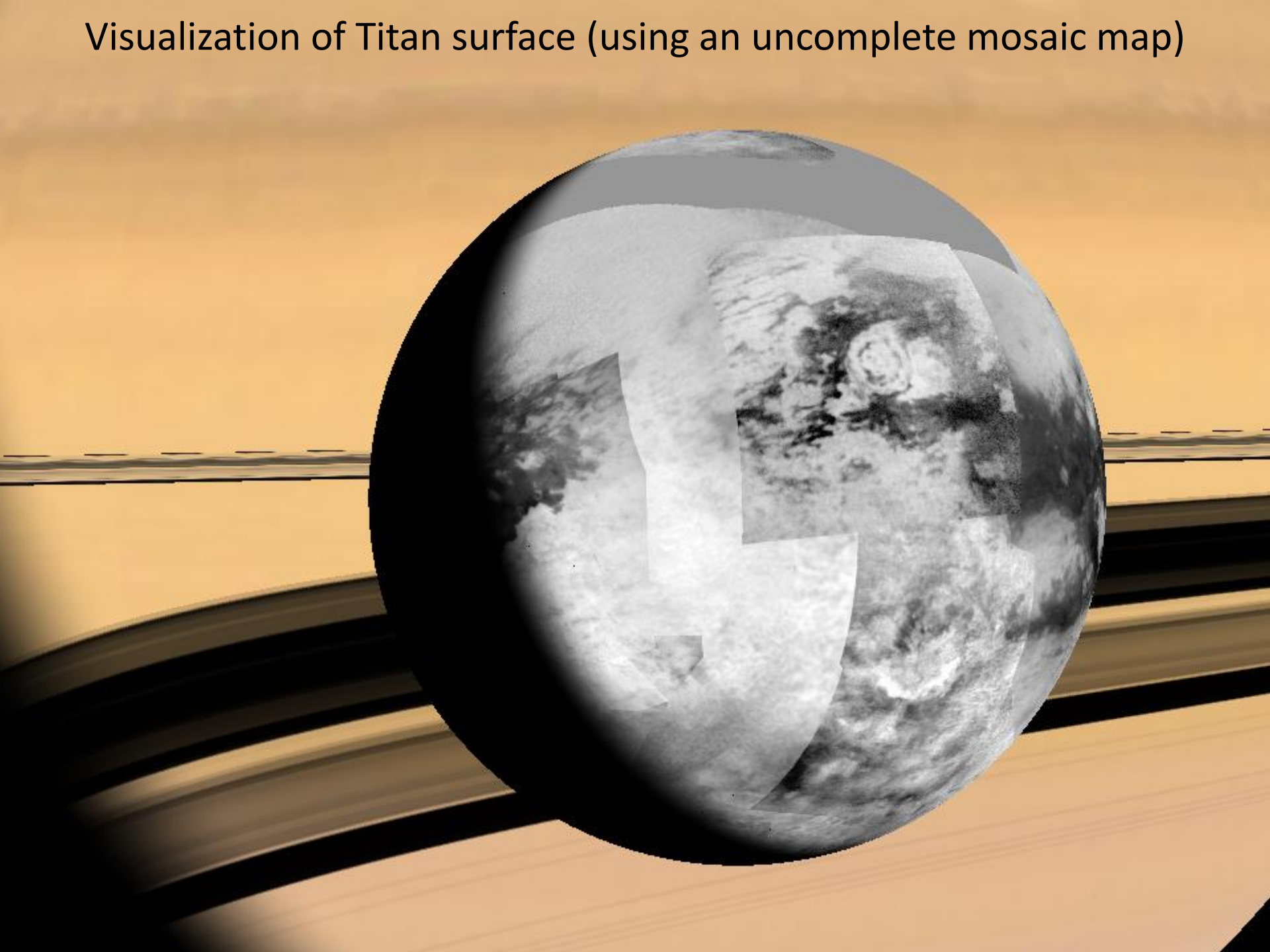
Planets, moons can be rendered, positioned, rotated interactively

Light source properties may tuned as well GLSL Shader may be engaged

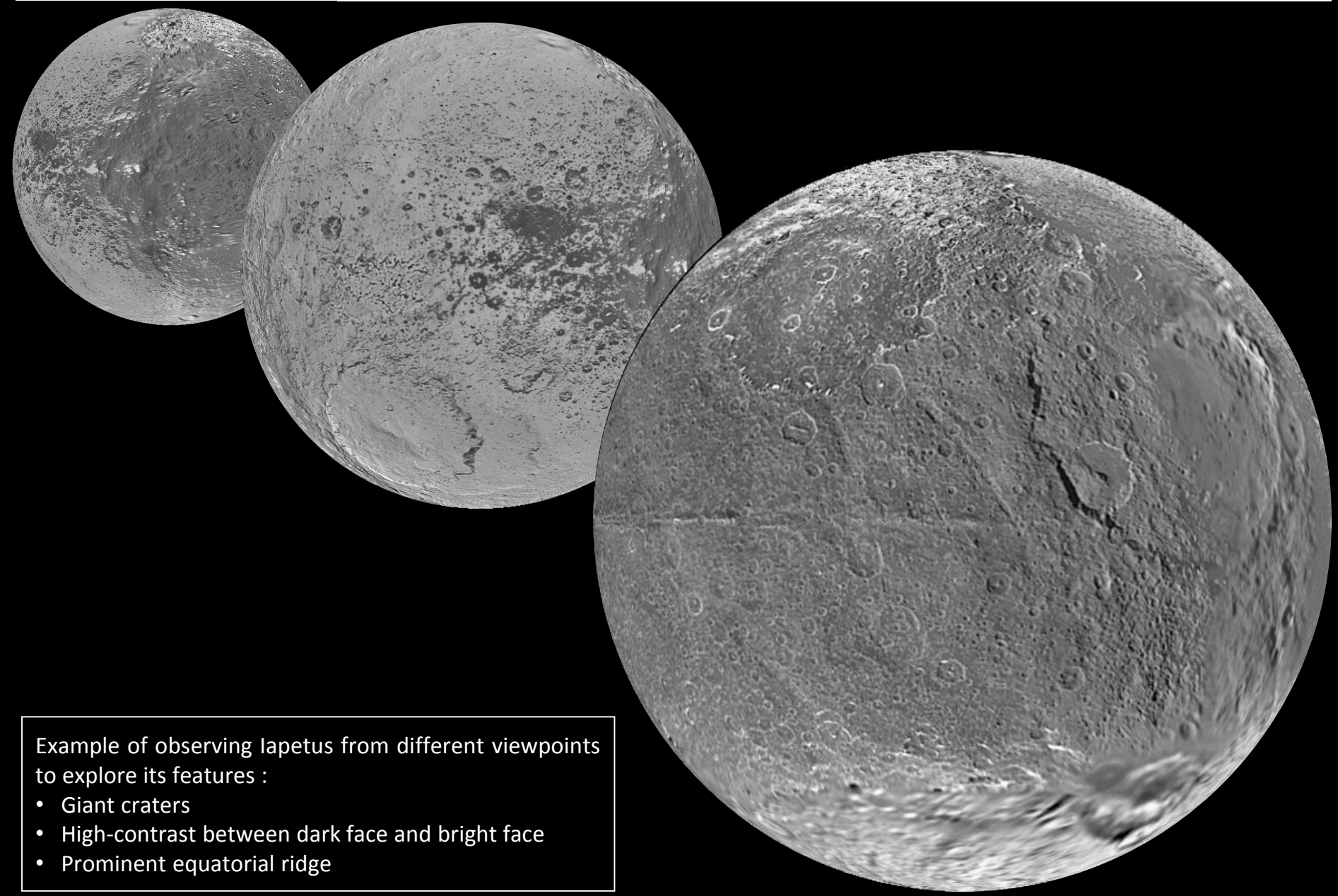


Simulation BUL : 4 massive bodies + 7546 test particles, shadows effects using the Saturn GLSL shader

Visualization of Titan surface (using an uncomplete mosaic map)



Exploratory visualization of the moons



Example of observing Iapetus from different viewpoints to explore its features :

- Giant craters
- High-contrast between dark face and bright face
- Prominent equatorial ridge

Les logiciels de visualisation

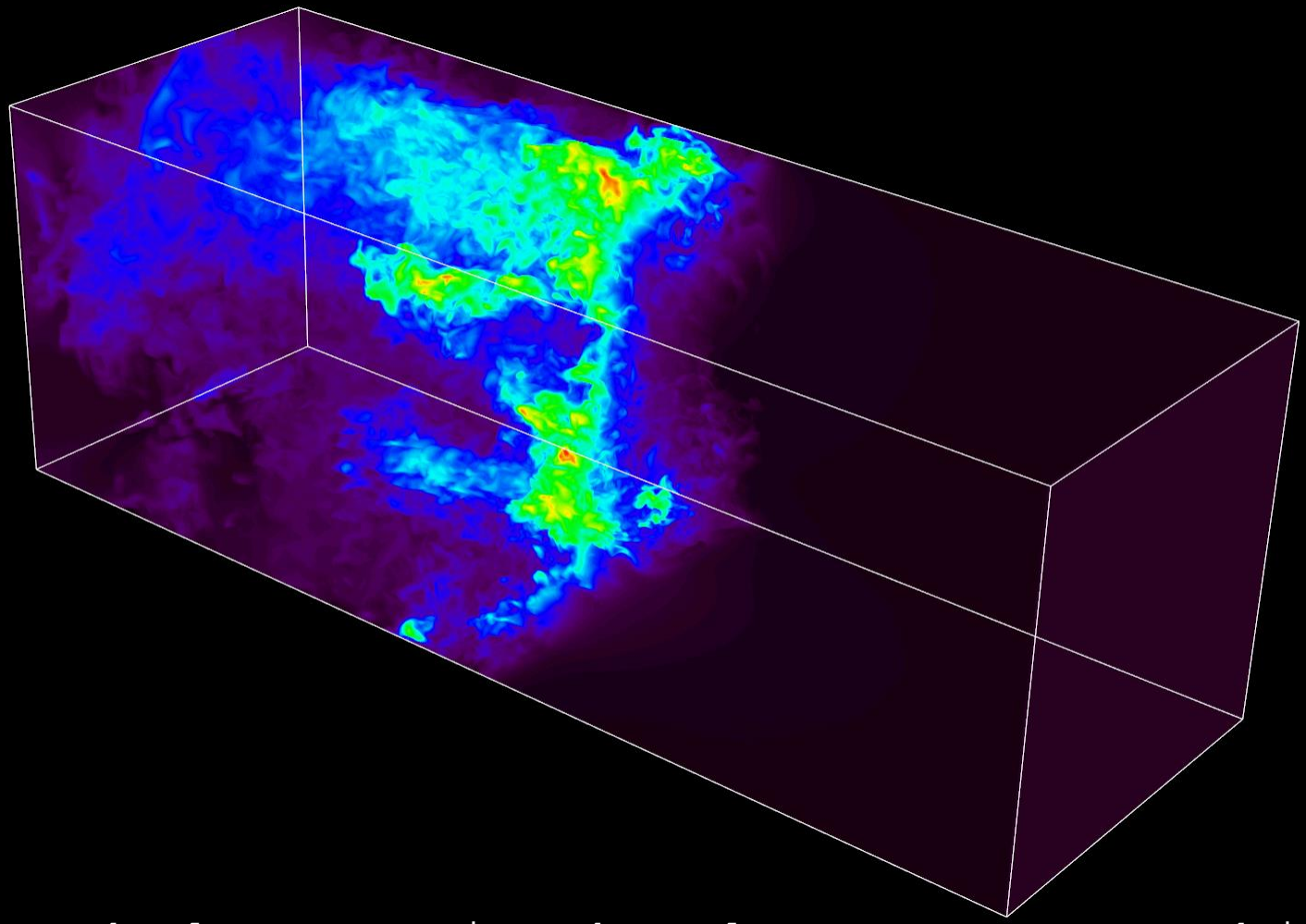
SDvision:

démarrage du projet au SEDI en 2005
100000 lignes de code
IDL Object Graphics
exploitation des architectures multicoeurs et de l'accélération par la carte graphique, shaders GLSL

PyMSES:

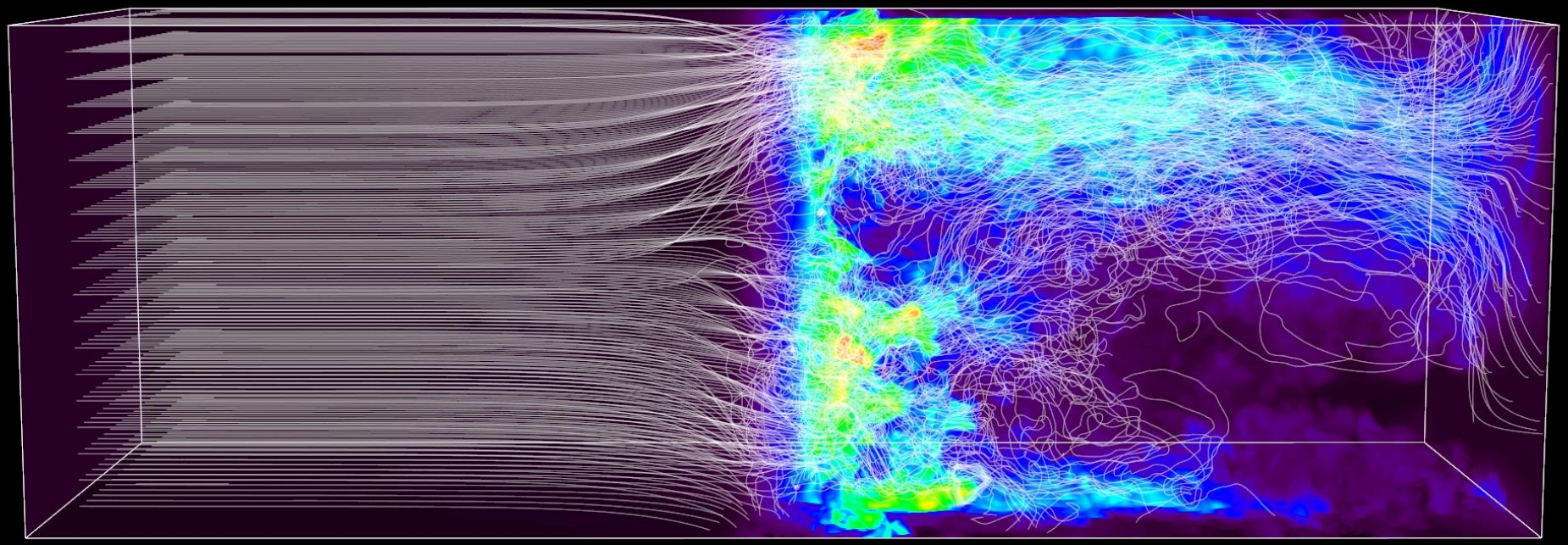
Projet lancé par Damien Chapon pendant sa thèse au SAp, repris au SEDI dans le cadre de la thèse de Marc Labadens.
Algorithme dédié au format de données RAMSES

Visualisation de simulations numériques



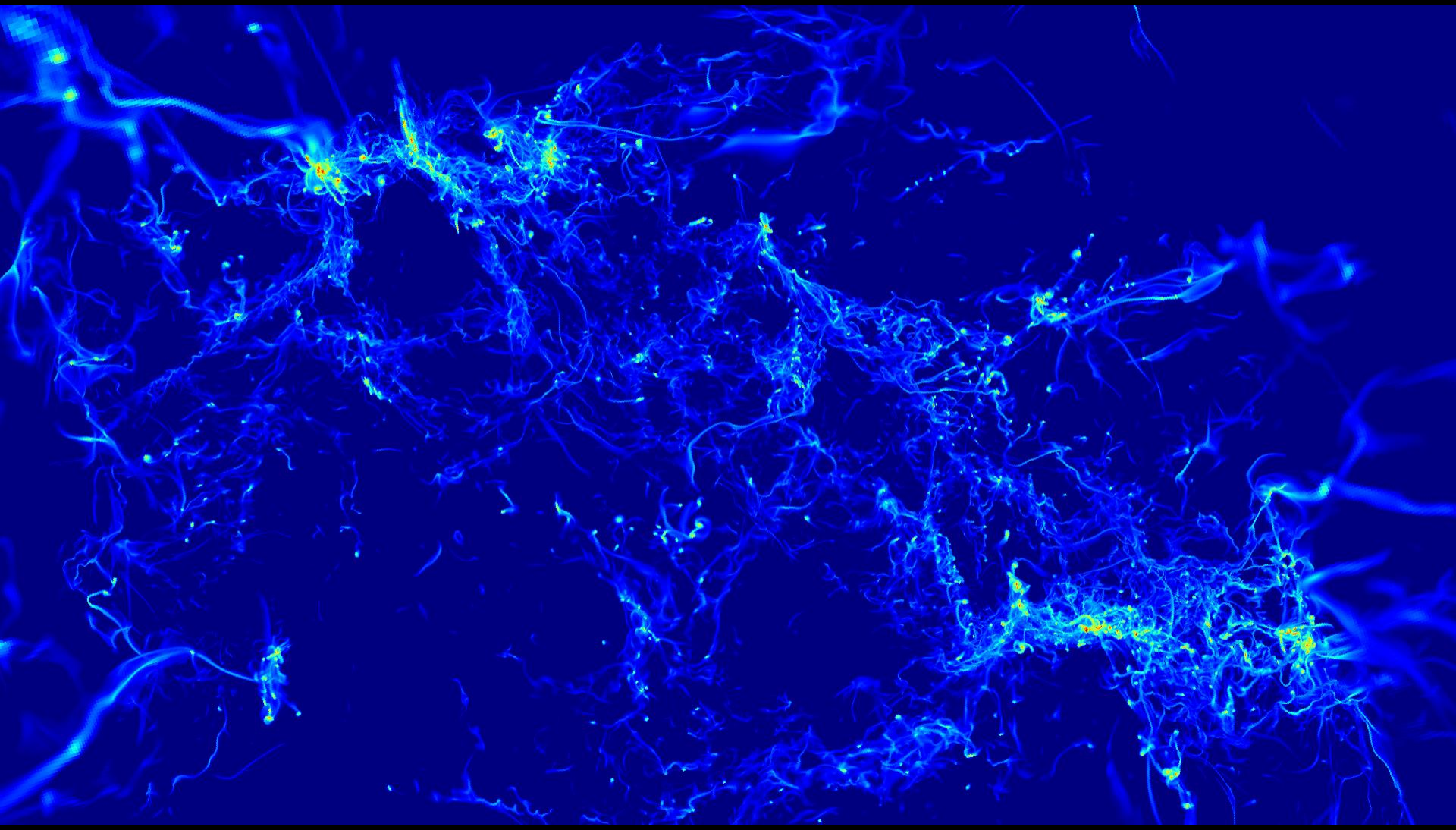
Simulation de la convection dans les supernovae produite par Remi Hosseini Kazeroni avec le code DUMSES sur Occigen avec 768 cœurs et 35000h CPU.

Visualisation de simulations numériques



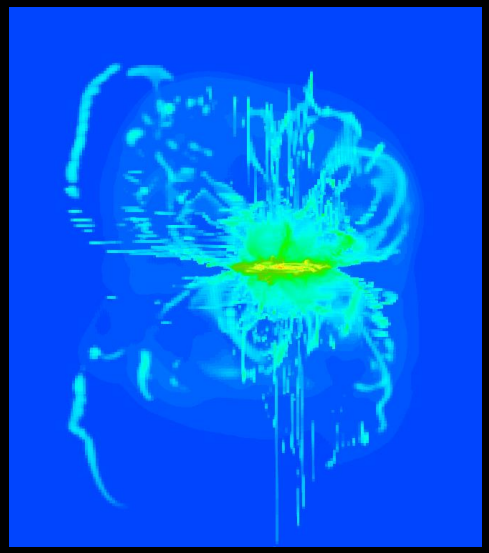
Simulation de la convection dans les supernovae produite par Remi Hosseini Kazeroni avec le code DUMSES.
Visualisation des lignes de courant.

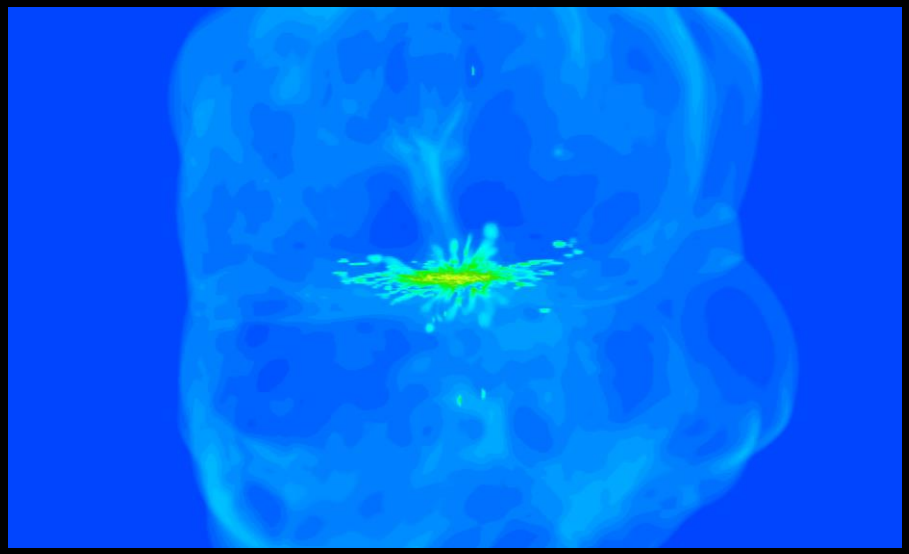
Visualisation de simulations numériques

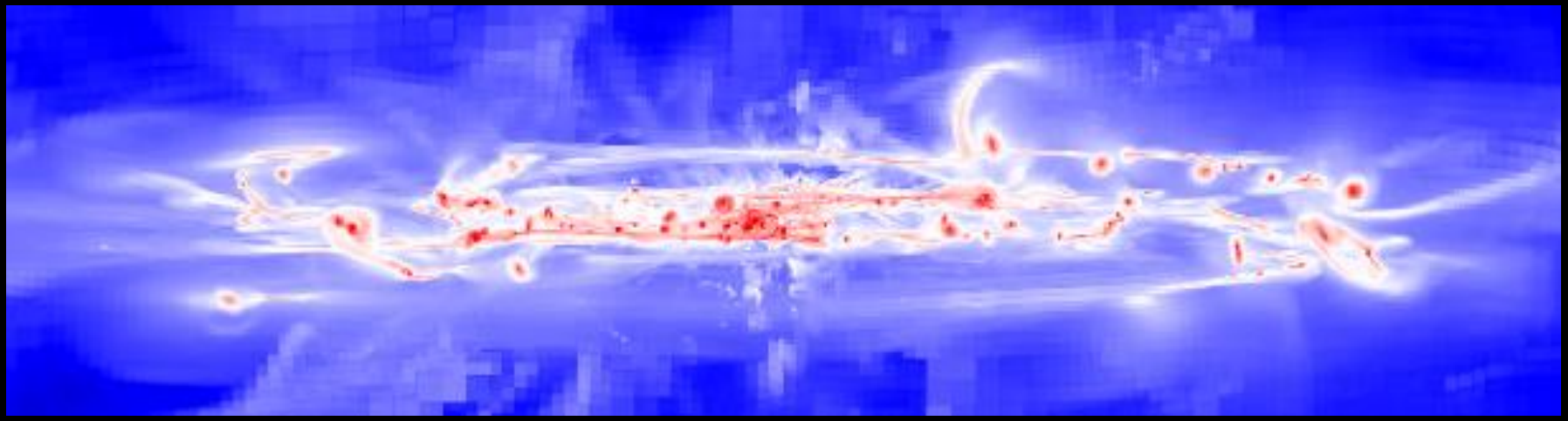


Simulation FRIG *From intermediate galactic scales to cores* obtenue avec le code RAMSES sur Curie (PI Patrick Hennebelle).

Visualisation de simulations numériques

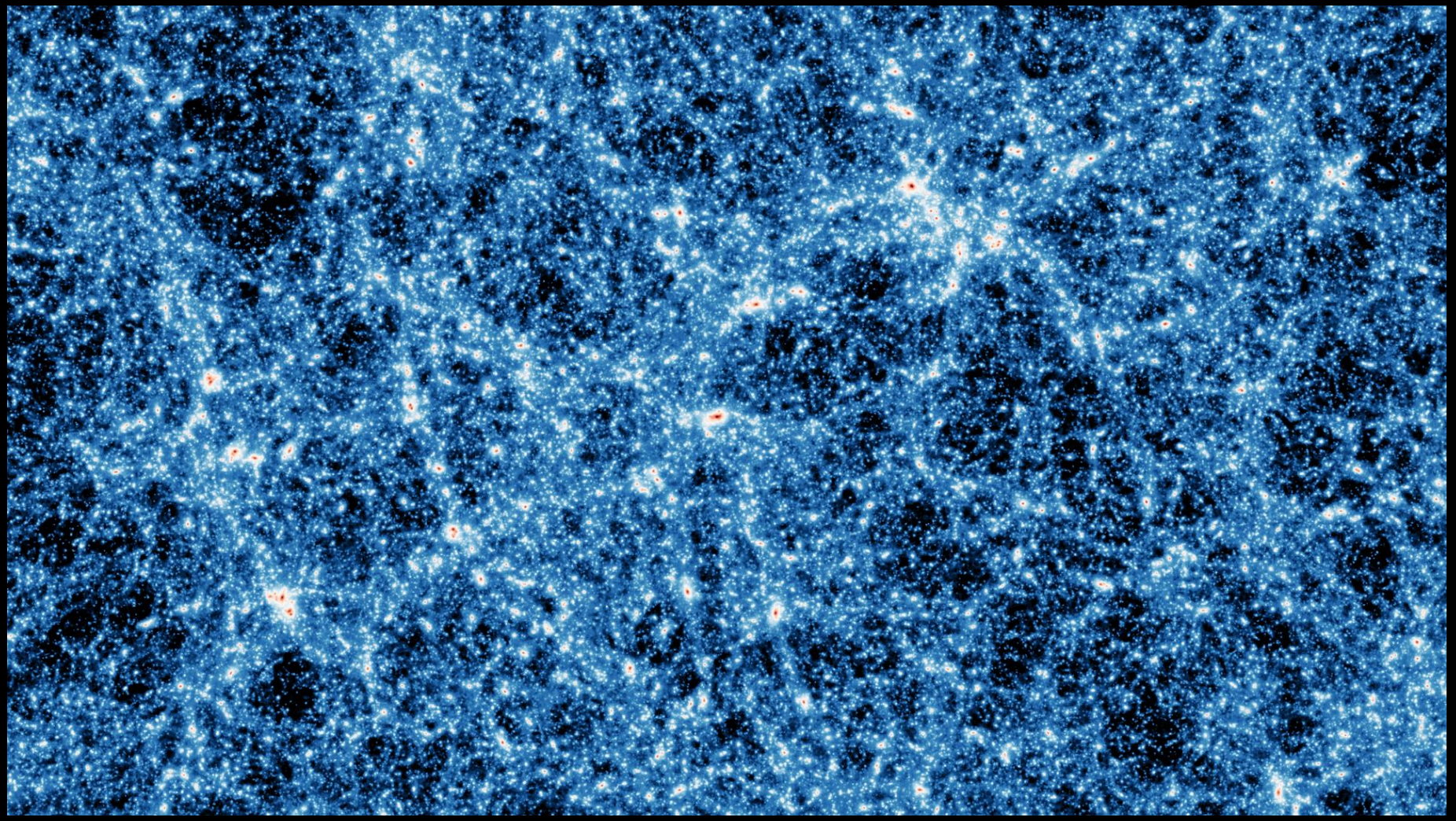






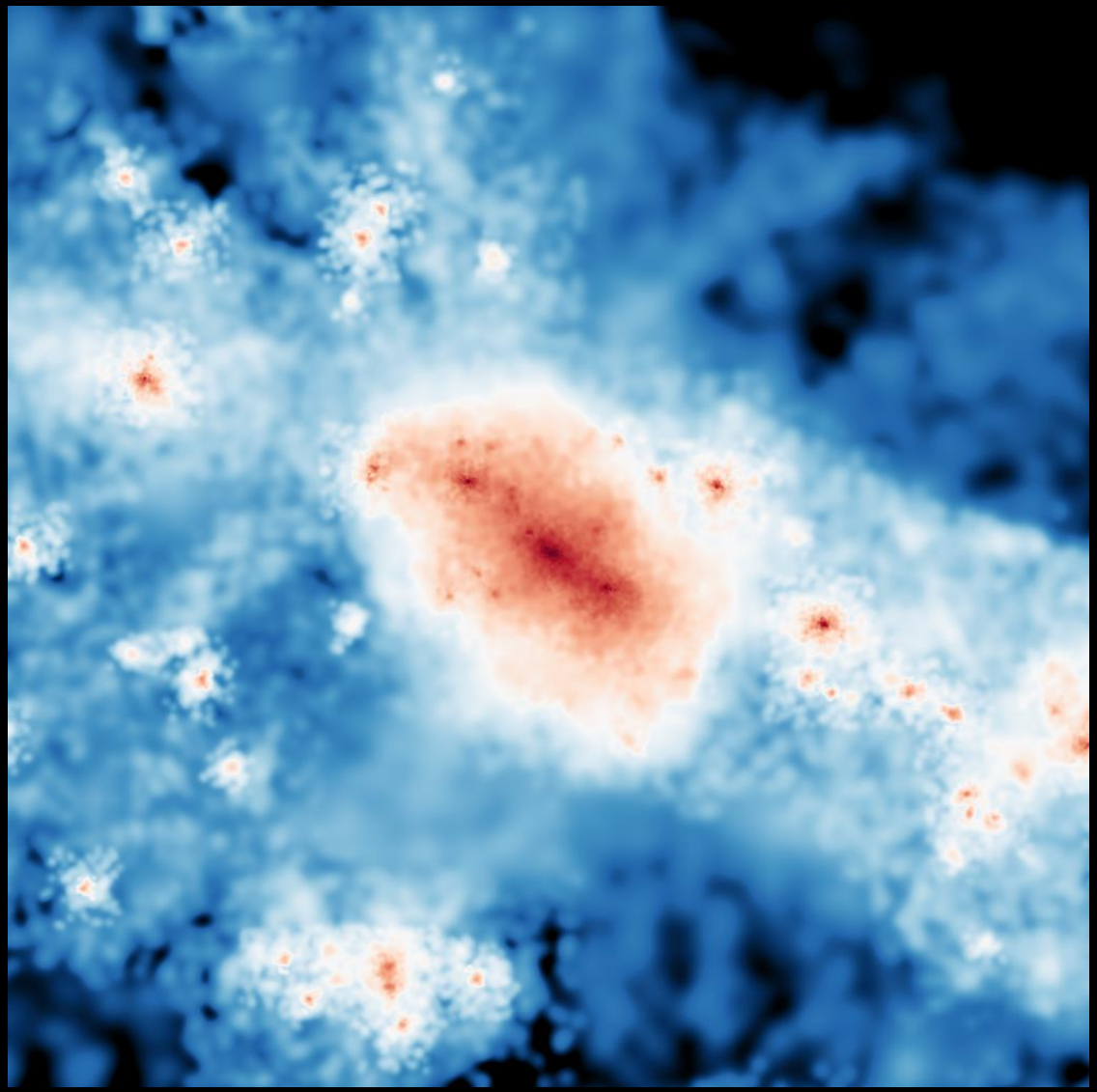
Simulation POGO *The Physical Origins of Galactic Outflows* obtenue avec le code RAMSES sur Curie (PI Orianne Roos).

Visualisation de simulations numériques



Simulation cosmologique obtenue avec le code RAMSES sur Occigen (Amandine Le Brun).

Visualisation de simulations numériques



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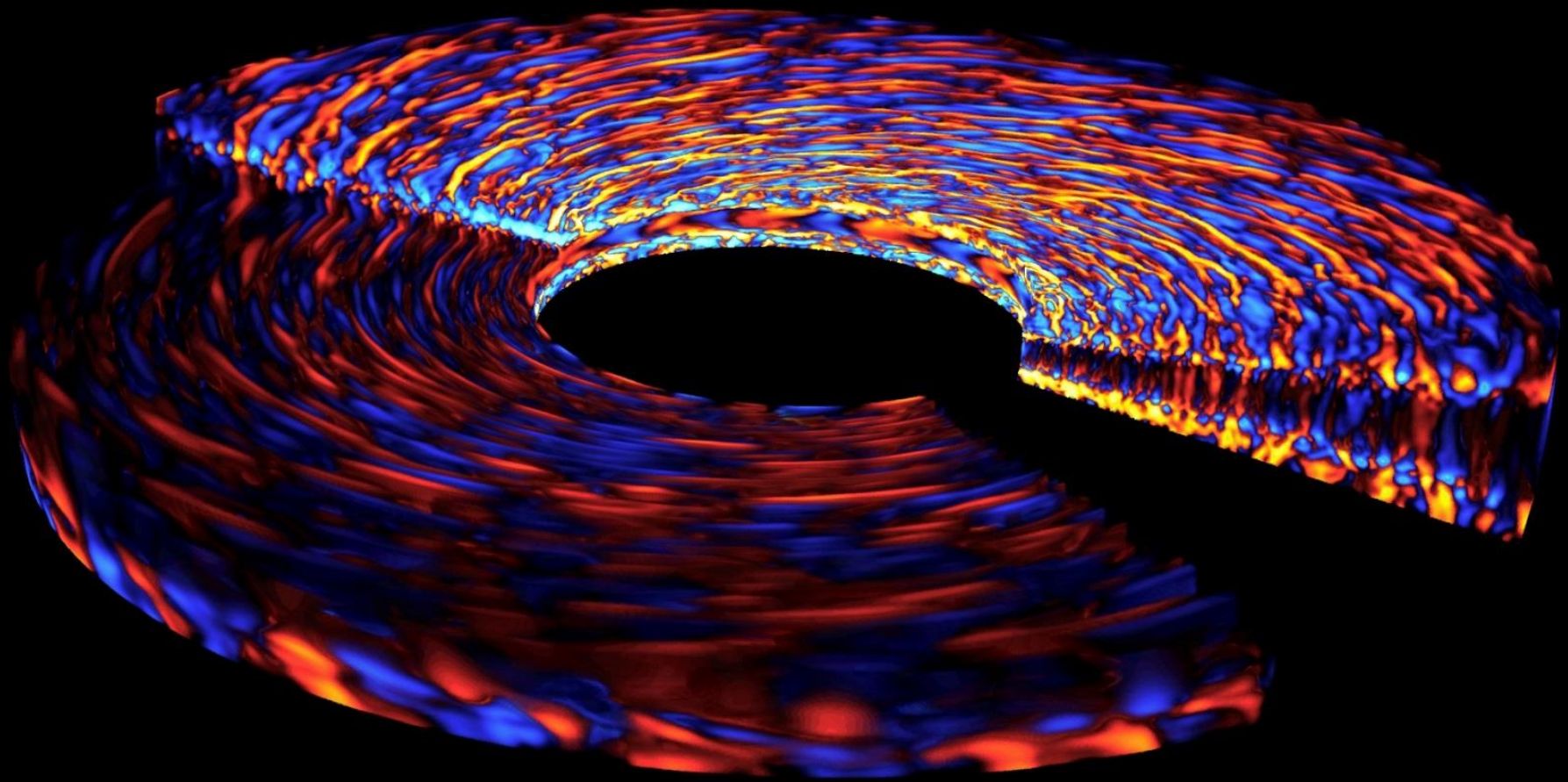
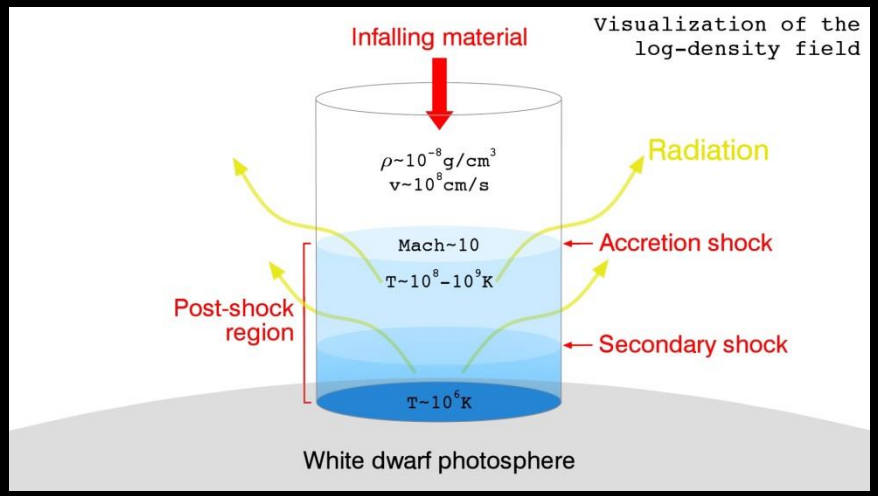


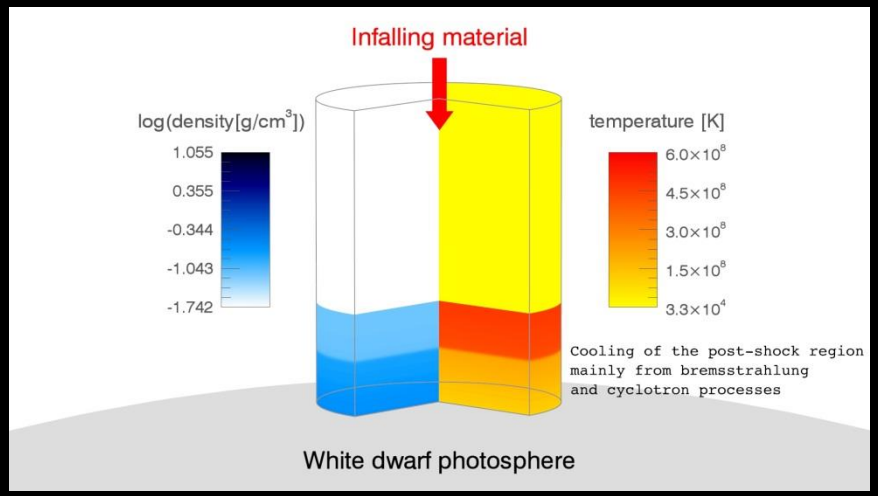
Simulation RMHD d’un disque protoplanétaire obtenue avec le code PLUTO sur Curie (Mario Flock).

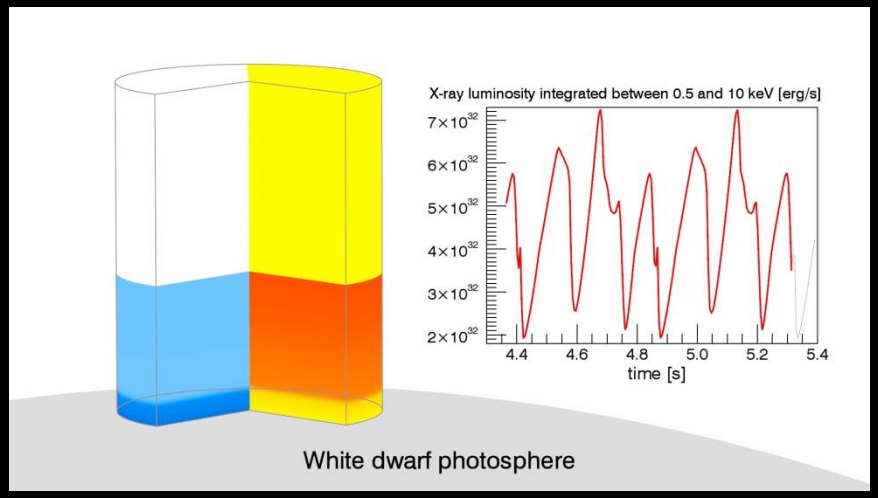
Visualisation de simulations numériques

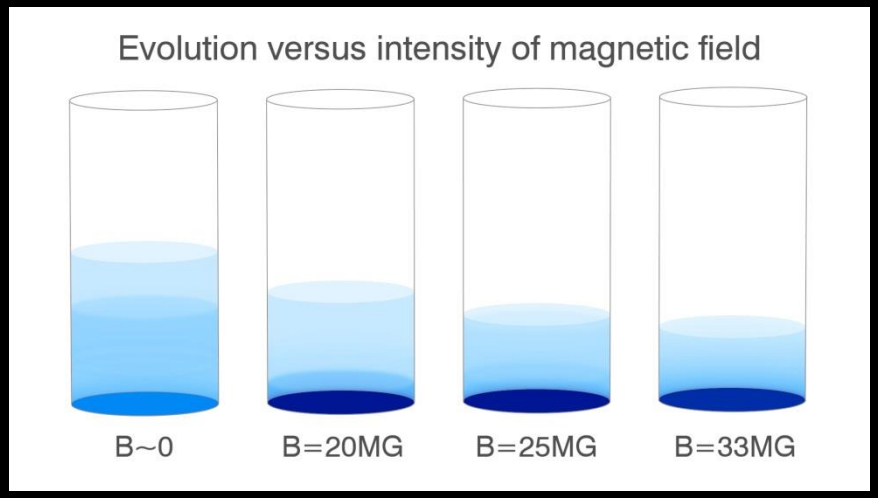
Simulation 1D de la colonne d'accrétion d'une naine blanche magnétique produite avec le code HADES-Cool / Collaboration avec la DAM

Visualisation de simulations numériques



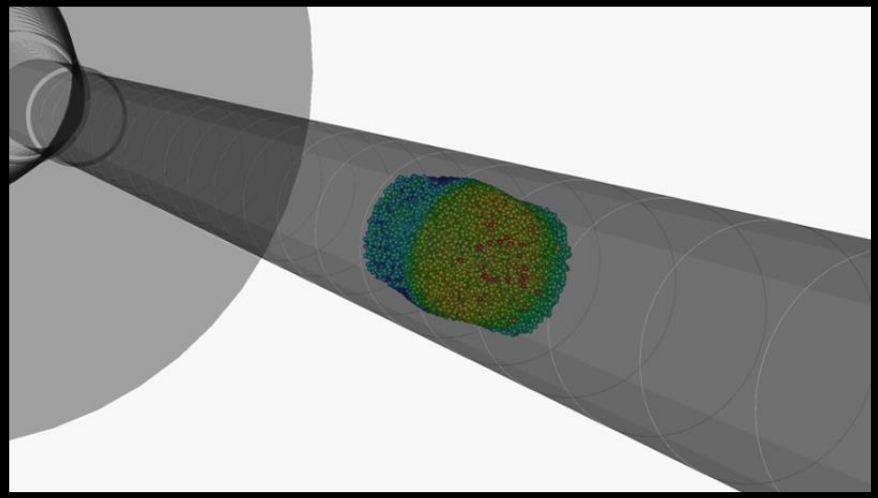




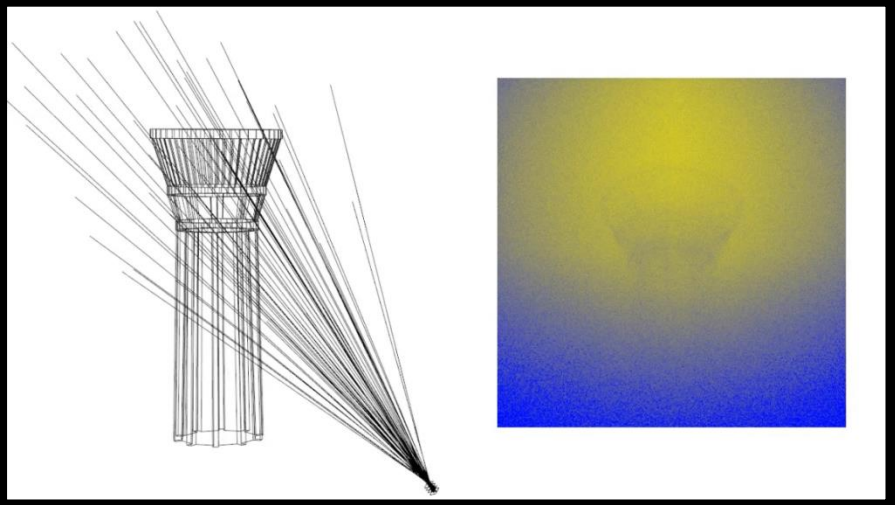


Video de 3 minutes
http://irfu.cea.fr/polar

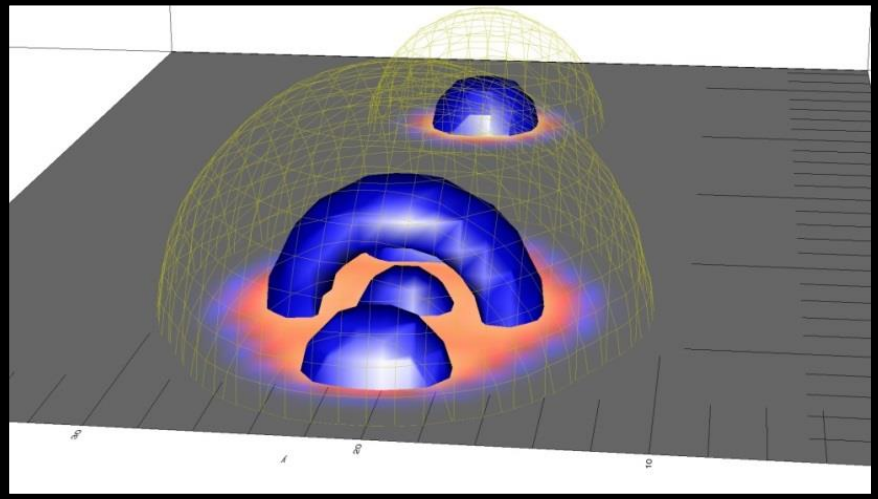
Visualisation pour d’autres projets hors astro



SACM: simulation de l’accélérateur IFMIF-EVEDA



SEDI: Projet WatTo de tomographie muonique



SPhN: simulation de la fonction d’onde d’une collision d’actinides

Cosmographie

Collaboration avec R.B. Tully (U. of Hawaii), H. Courtois (IPNL), Y. Hoffman (Raccah Institute of Physics, Jerusalem)

2013 Cosmography of the Local Universe, AJ 146, 69

2014 The Laniakea supercluster of galaxies, Nature 513, 7516, 71

2015:

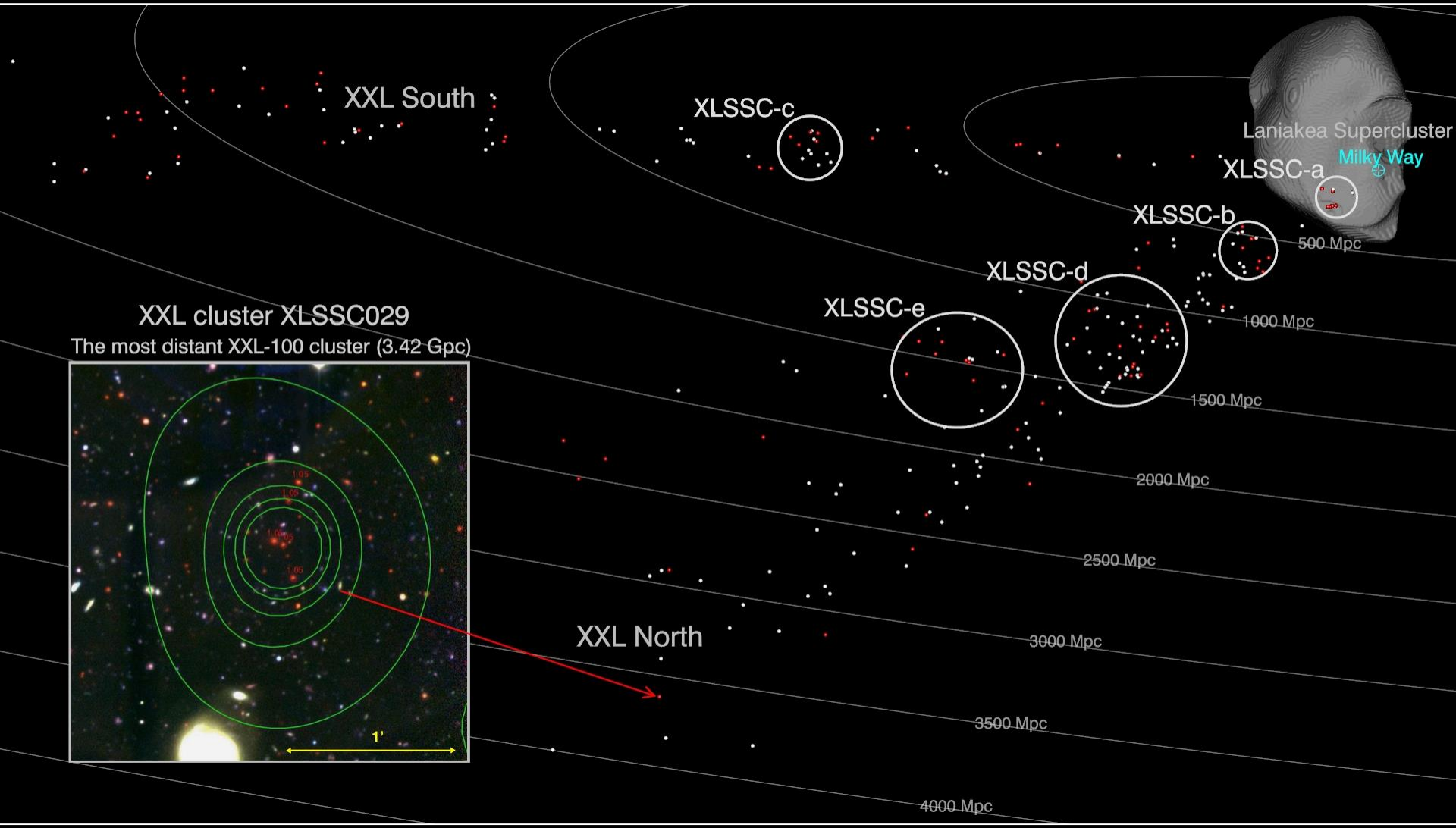
- Planes of satellite galaxies and the cosmic web, MNRAS 452,1052
- Giant disc galaxies: where environment trumps mass in galaxy evolution, MNRAS 448, 1767
- The Arrowhead mini-supercluster of galaxies, ApJ 812, 1, 17
- Cosmicflows constrained Local Universe simulations, MNRAS 455, 2078

2016:

Deux articles en préparation

- sur le cosmic web (submitted to *Nature Astronomy*)
- sur l'origine du mouvement de 630 km/s du Groupe Local par rapport au CMB

Cosmographie / Survey XXL



Vidéo produite pour le Press Release Astronomy & Astrophysics
http://vimeo.com/pomarede/xxl

Cosmographie / impact

The Laniakea supercluster of galaxies: ~60 citations (Scholar)

En cosmographie:

- *The Network behind the Cosmic Web*, B.C. Coutinho, et al, astro-ph:1604.03236
- *Does the Corona Borealis Supercluster form a giant binary-like system?*, G. Baiesi Pillastrini, astro-ph:1506.04314
- *Discovery of a massive supercluster system at z~0.47*, H. Lietzen, et al, Astron. Astrophys 588 (2016) L4
- *Cosmic troublemakers: the Cold Spot, the Eridanus Supervoid, and the Great Walls*, A. Kovacs & J. Garcia-Bellido, astro-ph:1511.09008
- *A giant ring-like structure at 0.78<z<0.86 displayed by GRBs,* L.G. Balazs, et al, MNRAS 452 (2015) 2236
- *Unusual A2142 supercluster with a collapsing core: distribution of light and mass,* M. Einasto, et al, Astron. Astrophys., 580 (2015) A69

En cosmologie:

- *Cosmology in one dimension: Vlasov dynamics*, G. Manfredi, et al, Phys. Rev. E 93 (2016) 04221
- *Multiple nonspherical structures from the extrema of Szekeres scalars*, R. A. Sussman & I. Delgado Gaspar, Phys. Rev. D 92 (2015) 83533
- *Dynamics of minimally coupled dark energy in spherical halos of dark matter*, B. Novosyadlyj, et al, Gen. Rel. Grav. 48 (2016) 20
- *The Spatial Curvature Endgame*, C.D. Leonard, et al, astro-ph:1604.01410
- *Constraints on pre-inflation cosmology and dark flow*, G.J. Mathews, et al, PKAS 30 (2015) 309

Cosmographie / impact

The Laniakea supercluster of galaxies: ~60 citations (Scholar)

En astrophysique

- *The Low Redshift survey at Calar Alto (LoRCA)*, J. Comparat, et al, MNRAS 458 (2016) 2940
- *Supergiant pulses from extragalactic neutron stars*, J.M. Cordes & I. Wasserman, MNRAS 457 (2016) 232
- *The Galaxy in Context: Structural, Kinematic and Integrated Properties*, J. Bland-Hawthorn & O. Gerhard, to appear in Ann. Rev. of Astronomy & Astrophys. 54 (2016)

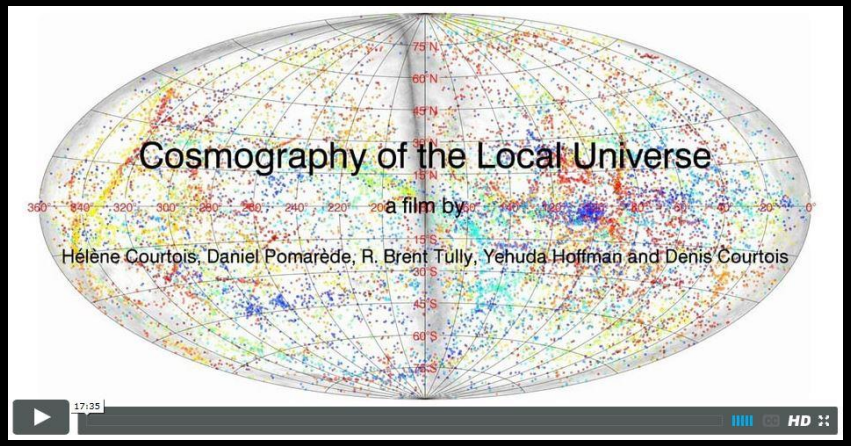
En physique fondamentale:

- *Constraints on the Photon Mass with fast radio burst*, X.-F. Wu, et al, ApJL 822 (2016) L15
- *Testing Einstein's Equivalence Principle with supercluster Laniakea's gravitational field*, Z.-X. Lua, et al, JHEA 9 (2016) 35
- *Limits on the Neutrino Velocity, Lorentz Invariance, and the Equivalence Principle with TeV neutrinos from Gamma-Ray Bursts*, J.-J. Wei, et al, astro-ph:1603.07568
- *Modified gravity and large scale flows*, J. Mould, et al, astro-ph:1504.03027

Cosmographie / impact

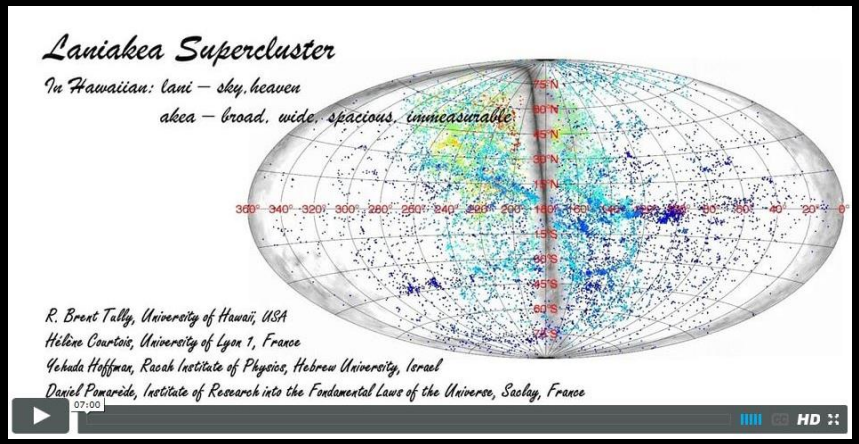
Les vidéos:

http://irfu.cea.fr/cosmography

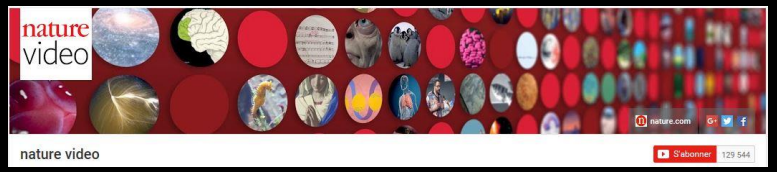


17min35s, 400000 vues, environ 50 vues/jour

http://irfu.cea.fr/laniakea



YouTube NatureVideo channel



295 vidéos produites en 8 ans

130000 abonnés, 30 millions de vues

Diffusion des savoirs