C2S@Exa Inria Project Lab (IPL)
Computer and computational sciences at exascale

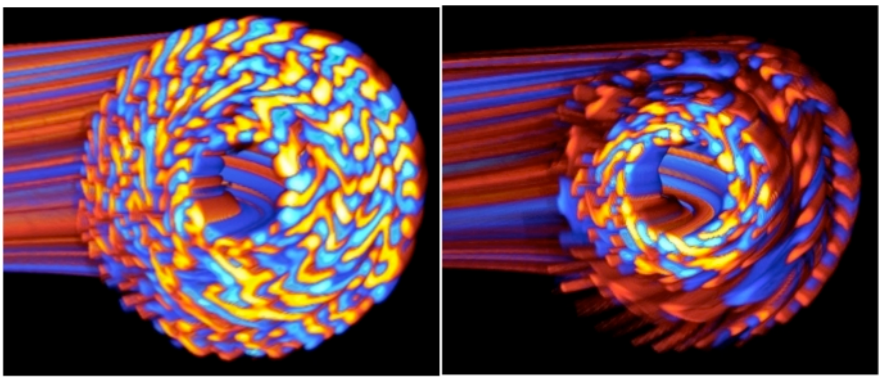
Kickoff meeting
Nuclear energy production application
Inria Sophia Antipolis – Méditerranée
Euler Violet meeting room, May 17, 2013

Location: Inria Sophia Antipolis – Méditerranée research center, 2004 route des Lucioles, 06902 Sophia Antipolis Cedex

Access: http://www.inria.fr/en/centre/sophia/overview/how-to-reach-the-centre

It is nowadays recognized that a multidisciplinary approach is required to overcome the challenges raised by the development of highly scalable numerical simulation software that can exploit computing platforms offering several hundreds of thousands of cores. To achieve this goal, the C2S@Exa IPL gathers (a) computer scientists that study programming models, and develop environments and tools for harnessing massively parallel systems, (b) algorithmicists that devise numerical kernels and core solvers, and develop generic libraries in order to take benefit from all the parallelism levels with the main goal of optimal scaling on very large numbers of computing entities and, (3) numerical mathematicians that are studying numerical schemes and develop parallel solvers for systems of partial differential equations in view of the simulation of complex physical problems. Based on this continuum of expertise, research and development activities conducted in the C2S@Exa IPL aim at the development of high performance numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. For each of the considered application domains, associated use cases have been defined in conjunction with external partners for the demonstration of the possibilities of the high performance numerical modeling methodologies that are developed in the project. The two external partners currently involved in the project are ANDRA (French National Agency for Radioactive Waste Management) and CEA-IRFM (French Alternative Energies and Atomic Energy Commission).

This one day meeting is concerned with one of the application domains considered in the C2S@Exa IPL namely, nuclear fusion. The goal is to gather researchers from CEA-IRFM on one hand, and from the Inria's project-teams involved in the C2S@Exa IPL on the other hand, to discuss about the high performance computing and numerical modeling methodological issues relevant to the nuclear fusion scientific challenges impacting the burning plasma program and the successful operation of the ITER tokamak.



CEA-IRFM participants
Virginie Grandgirard
Guillaume Latu
Yves Peysson

Inria participants
Olivier Aumage, RUNTIME project-team
Julien Bigot, Maison de la Simulation
Jacques Blum, University of Nice – Sophia Antipolis and CASTOR project-team
Francis Filbet, KHALIFFE project-team
Thierry Gautier, MOAIS project-team
Hervé Guillard, CASTOR project-team
Philippe Helluy, TONUS project-team
Nassim Jibai, NACHOS project-team
Rachid El Khaoulani, NACHOS project-team
Cédric Lachat, BACCHUS project-team
Stéphane Lanteri, NACHOS project-team
Pierre Navaro, TONUS project-team
Boniface NKonga, University of Nice – Sophia Antipolis and CASTOR project-team
Richard Pasquetti, University of Nice – Sophia Antipolis and CASTOR project-team
Christian Perez, AVALON project-team
Pierre Ramet, HIEPACS project-team
Jean Roman, HIEPACS project-team

Preliminary program

9h00-10h00 Welcome of the participants

10h00 - 10h10
Stéphane Lanteri, NACHOS project-team
C2S@Exa – An INRIA Project Lab on high performance computing for computational sciences

10h10 – 10h55
Virginie Grandgirard/Guillaume Latu, CEA-IRFM
Julien Bigot, Maison de la Simulation
JOREK, a parallel code for modelling non linear MHD in Tokamaks

10h55 – 11h20
Yves Peysson and Joan Decker, CEA-IRFM
HPC for advanced RF heating and current drive in tokamak plasmas
Radio-frequency waves are powerful tools for heating and current drive in tokamaks plasmas. Up to now, numerous assumptions have allowed to reduce the computational effort to an acceptable level for fast and accurate calculations. Accordingly, they can be incorporated in the complex chain of codes required for describing consistently the temporal evolution of a tokamak discharge, with respect to the various times scales of the magnetized plasma, without slowing down excessively the global simulation (Integrated Tokamak modeling). The need to take into account more realistic physical effects like mode conversion, diffraction, interferences with plasma fluctuation (B-field or density) for the wave propagation as well as non-axisymmetric perturbations of the toroidal MHD equilibrium (near magnetic islands for example) for kinetic calculations will lead to consider highly parallelized computations in a very near future for such kind of simulations. From the status of the existing C3PO/LUKE code, prospects for using HPC in this field of physics are discussed.

11h20 – 11h40
Philippe Helluy, TONUS project-team
This talk will present the activities undertaken in the TONUS project-team in relation with nuclear fusion and the ITER project.

11h40 – 12h00
Boniface NKonga/Richard Pasquetti, CASTOR project-team
This talk will present the HPC related activities undertaken in the CASTOR project-team.

12h00 – 12h20
Jacques Blum, "Fusion" IPL
This talk will present the objectives and research activities that will be undertaken in the "Fusion" Inria Project Lab.

12h20 – 14h00 Lunch

14h00 – 14h20
Francis Filbet, KHALIFFE project-team
Computing issues related to kinetic models for plasma physics
In this survey we will present several research problems related to numerical simulations of kinetic models (transport and collisions). Due to high dimensional problems 5D or 6D problems, specific methods must be developed to make these solvers efficient.

14h20 – 14h40
Pierre Ramet, HiePACS project-team
From hybrid architectures to hybrid solvers
The main goal of this presentation will be to give a brief overview of the HiePACS project-team linear solvers and to present the improvements of the algorithms and of the associated parallel implementations in a many core context.

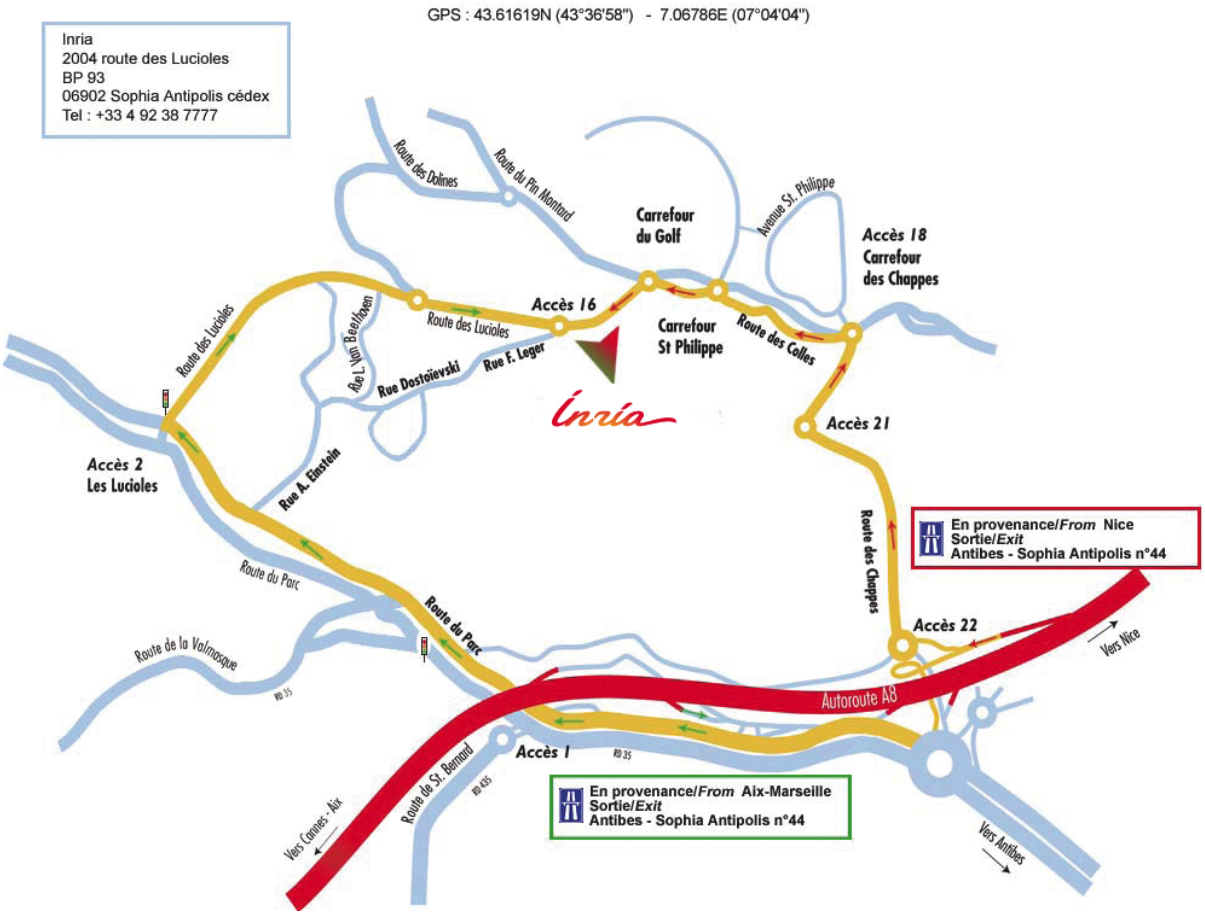
14h40 – 15h00
Cédric Lachat, BACCHUS project-team
The PaMPA tool for parallel mesh partitioning and adaptation
This talk will present the structure and operations of PaMPA (Parallel Mesh Partitioning and Adaptation), a middleware library dedicated to the management of unstructured meshes distributed across the processors of a parallel machine. Its purpose is to relieve solver writers from the tedious and error prone task of writing again and again service routines for mesh handling, data communication and exchange, remeshing, and data redistribution.

15h00 – 15h20
Christian Perez, AVALON project-team
Programming HPC applications with software components

15h20 – 15h40
Thierry Gautier, MOAIS project-team
OpenMP 4.X to programming HPC applications on heterogeneous architectures?

16h00 – 17h00 Discussion

17h00 End of the meeting



Christian Perez A : 9h30 et D : 18h15