Activity Report 2011

Section Contracts and Grants with Industry

Edition: 2012-03-22
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7. Contracts and Grants with Industry

7.1. SNECMA

Participants: Guillaume Baurin, Rémi Abgrall, Mario Ricchiuto [Corresponding member].

Dates: 2008-2011

Transfer and development of the Residual Distribution schemes in the N3S Natur code (in collaboration with INCKA).

7.2. DASSAULT

Participants: Rémi Abgrall [Corresponding member], Pierre-Elie Normand [PhD student, DGA grant, Dassault-Aviation].

Dates: 2008-2011

Study and validation of very high order SUPG schemes for turbulent flow with Spalart Allmaras turbulence model in AETHER. The SA model and the navier Stokes equations are only weakly coupled.

7.3. National Initiatives

7.3.1. ANEMOS: Advanced Numeric for ELMs, Modeling and Optimized Schemes

Participants: Xavier Lacoste, François Pellegrini, Pierre Ramet [Corresponding member].

Grant: ANR-11-MN

Dates: 2011 – 2015

Partners: CEA IRFM, JAD INRIA, Maison de la Simulation.

Overview:

The main goal of the project is to make a significant progress in understanding of largely unknown at present physics of active control methods of plasma edge MHD instabilities Edge Localized Modes (ELMs) which represent particular danger with respect to heat and particle loads for Plasma Facing Components (PFC) in ITER. Project is focused in particular on the numerical modeling study of such ELM control methods as Resonant Magnetic Perturbations (RMPs) and pellet ELM pacing both foreseen in ITER. The goals of the project are to improve understanding of the related physics and propose possible new strategies to improve effectiveness of ELM control techniques. The tool for the non-linear MHD modeling (code JOREK) will be largely developed within the present project to include corresponding new physical models in conjunction with new developments in mathematics and computer science strategy in order to progress in urgently needed solutions for ITER.

This proposal is the logic but even more challenging continuation of the previous ANR project ASTER (2006-2010). These works are involved in the large-scale initiative supported by INRIA on magnetic fusion and also take a place in a new LABEX VENUS proposal submitted in October 2011.

Web: http://aster.gforge.inria.fr/

7.3.2. PETALH: Preconditioning scientific applications on pETascALe Heterogeneous machines

Participants: Astrid Casadei, François Pellegrini [Corresponding member], Pierre Ramet.

Grant: ANR Cosinus 2010

Dates: 2011–2012

Partners: INRIA Saclay-Ile de France (leader of the project), Paris 6, IFP (Rueil-Malmaison), CEA Saclay.
Overview: In this collaborative effort, we propose to develop parallel preconditioning techniques for the emergent hierarchical models of clusters of multi-core processors, as used for example in future petascale machines. The preconditioning techniques are based on recent progress obtained in combining the well known incomplete LU (ILU) factorization with tangential filtering.

The track we are following in order to contribute to this goal is to investigate improved graph ordering techniques that would privilege the diagonal dominance of the matrices corresponding to the subdomains of the Schur complement. It amounts to integrating numerical values into the adjacency graph of the matrices, so that the importance of off-diagonal terms is taken into account when computing graph separators. The core of this work is planned to take place at the beginning of next year.

This project is a continuation of PETAL project that was funded by ANR Cosinus 2008 call.

Web: http://petal.saclay.inria.fr/

7.3.3. UFO: Uncertainty quantification For compressible fluid dynamics and Optimisation.
Participants: Rémi Abgrall, Pietro Marco Congedo.
Grant: ANR MN 2011
Dates: 2011-2014
Partners: INRIA Bordeaux Sud-Ouest (leader), ENSAM Paris Tech, INPG, ONERA, Phimeca.
Overview We are interested in the simulation and the optimisation of flows with uncertainties on the data and/or the models. Only non intrusive methods are considered in this project in order to re-use easily existing CFD codes, in particular the project members’. We concentrate on the uncertainties occurring in turbulence models for external aerodynamics and those occurring in thermodynamics models for organic fluids as those use in ORC machines. The number of uncertainties can be arbitrary, so we aim at developing methods that can handle as many uncertainties as possible, relying on good algorithms and massive parallelisation. Another aim is also to be able to use experimental data to calibrate pdf via Bayesian techniques. Epistemic uncertainties for turbulence modeling is also an important topic for the project, for which a theoretical framework need to be established.

7.4. European Initiatives

7.4.1. FP7 Projet

7.4.1.1. IDIHOM

Title: Industrialisation of High-Order Methods- A Top-Down Approach
Type: COOPERATION (TRANSPORTS)
Instrument: Specific Targeted Research Project (STREP)
Duration: October 2010 - September 2013
Coordinator: Deutsches Zentrum für Luft und Raumfahrt (Germany)

Others partners: Dassault Aviation (France), EADS Deutschland GmbH, Cassidian Air System (Allemagne), CENAERO (Belgique), NUMECA (Belgique), ARA (UK), Swedish Defence Research Agency (Suède), NLR (Pays Bas), ONERA (France), TSAGI (Russie), VKI (Belgique), ENSAM (France), Imperial College London (UK), Université de Bergamo (Italie), Université de Brescia (Italie), Université de Stuttgart (Allemagne), Poznan University of Technology (Pologne), Warsaw University of Technology (Pologne), Université de Linköping (Suède), Université catholique de Louvain (Belgique).

See also: http://www.dlr.de/as/en/desktopdefault.aspx/tabid-7027/11654_read-27492/
Abstract: The IDIHOM project is motivated by the increasing demand of the European aerospace industry to advance their CFD-aided design procedure and analysis by using accurate and fast numerical methods, so-called high-order methods. They will be assessed and improved in a top-down approach by utilizing industrially relevant complex test cases, so-called application challenges in the general area of turbulent steady and unsteady aerodynamic flows, covering external and internal aerodynamics as well as aeroelastic and aeroacoustic applications.

7.4.2. Collaborations in European Programs, except FP7

Program: IDEAS program, European Research Council
Project acronym: ADDECCO
Project title: ADaptive schemes for DEterministic and stoChastiC Flow PrOblems
Duration: December 2008-November 2013
Coordinator: Rémi Abgrall
Other partners: none

Abstract: The numerical simulation of complex compressible flow problem is still a challenge nowadays, even for the simplest physical model such as the Euler and Navier Stokes equations for perfect gases. Researchers in scientific computing need to understand how to obtain efficient, stable, very accurate schemes on complex 3D geometries that are easy to code and to maintain, with good scalability on massively parallel machines. Many people work on these topics, but our opinion is that new challenges have to be tackled in order to combine the outcomes of several branches of scientific computing to get simpler algorithms of better quality without sacrificing their efficiency properties. In this proposal, we will tackle several hard points to overcome for the success of this program.

We first consider the problem of how to design methods that can handle easily mesh refinement, in particular near the boundary, the locations where the most interesting engineering quantities have to be evaluated. CAD tools enable to describe the geometry, then a mesh is generated which itself is used by a numerical scheme. Hence, any mesh refinement process is not directly connected with the CAD. This situation prevents the spread of mesh adaptation techniques in industry and we propose a method to overcome this even for steep problems.

Second, we consider the problem of handling the extremely complex patterns that occur in a flow because of boundary layers: it is not always sufficient to only increase the number of degrees of freedom or the formal accuracy of the scheme. We propose to overcome this with class of very high order numerical schemes that can utilise solution dependent basis functions.

Our third item is about handling unsteady uncertainties in the model, for example in the geometry or the boundary conditions. This need to be done efficiently: the amount of computation increases a priori linearly with the number of uncertain parameters. We propose a non-intrusive method that is able to deal with general probability density functions (pdf), and also able to handle pdfs that may evolve during the simulation via a stochastic optimization algorithm, for example. This will be combined with the first two items of this proposal. Many random variables may be needed, the curse of dimensionality will be dealt thanks to multiresolution method combined with sparse grid methods.

The aim of this proposal is to design, develop and evaluate solutions to each of these challenges. Currently, and up to our knowledge, none of these problems have been dealt with for compressible flows with steep patterns as in many moderns aerodynamics industrial problems. We propose a work program that will lead to significant breakthroughs for flow simulations with a clear impact on numerical schemes and industrial applications. Our solutions, though developed and evaluated on flow problems, have a wider potential and could be considered for any physical problem that are essentially hyperbolic.

7.4.3. Major European Organizations with which you have followed Collaborations
Partner 1: von Karman Institute (Belgique)
Topic: Uncertainty quantification for hypersonic flows

Partner 2: von Karman Institute (Belgique)
Topic: Numerical approximation of compressible flows with residual distribution schemes

Partner 3: School of Computing, Leeds University (England)
Topic: Numerical approximation of free surface flows with residual distribution schemes

Partner 4: ONERA (France)
Topic: Numerical approximation of compressible flows with residual distribution schemes
7. Contracts and Grants with Industry

7.1. EADS
We cooperate with EADS on geometric representation and FEM.

7.2. Sony Corporation
We cooperate with Sony Corporation on the research of image-based translucent material transfer.

7.3. Samsung Advanced Institute of Technology
We cooperate with Samsung Advanced Institute of Technology (China) on the research of stereo matching.

7.4. CAS-BEGCL Imaging Technology Corporation
We cooperate with CAS-BEGCL Imaging Technology Corporation on fluid simulation, object deformation and realistic rendering.

7.5. ANR/NSFC AND SYSTEM@TIC: 2010-2013
The objectives of these Programs address Geometry Modeling and Computing, mainly Robustness and Tolerance as well as Geometric Uncertainties.
7. Contracts and Grants with Industry

7.1. National Initiatives

7.1.1. GIS Success

Participants: Vincent Perrier, Pascal Bruel.

We are presently participating in the CNRS GIS (Groupement d’Intérêt Scientifique) which is provisionally called "Super-calcul en Combustion et en Mécanique des Fluides dans les Géométries Complexes". This GIS intends to gather people working on HPC simulations for fluid mechanics. The other members of this GIS are EM2C (Centrale Paris), I3M (Montpellier), LEGI (Grenoble), IMFT (Toulouse), CERFACS, and IFP. The kick-off meeting will be held in Toulouse on March 2012.

7.2. European Initiatives

7.2.1. FP7 projects

Participants: Vincent Perrier [correspondant], Pascal Bruel.

Program: Propulsion
Project acronym: IMPACT-AE
Project title: Intelligent Design Methodologies for Low Pollutant Combustors for Aero-Engines
Duration: 01/11/2011 - 31/10/2015
Coordinator: Roll Royce Deutschland

Other partners:
- France: Insa of Rouen, ONERA, Snecma, Turbomeca.
- Germany: Rolls-Royce Deutschland, MTU Aeo Engine Gmbh, DLR, Technology Institute of Karlsruhe, University of Bundeswehr (Munich)
- Italy: AVIOPROP SRL, AVIO S.P.A., University of Florence
- United Kingdom: Rolls Royce PLC, Cambridge University, Imperial College od Science, Technology and Medecine, Loughborough University.

Abstract: The environmental benefits of low emissions lean burn technology in reducing NOx emissions up to 80% only be effective when these are deployed to a large range of new aero-engine applications. While integrating methodologies for advanced engine architectures and thermodynamic cycles. It will support European engine manufacturers to pick up and keep pace with the US competitors, being already able to exploit their new low emission combustion technology to various engine applications with short turn-around times. Key element of the project will be the development and validation of design methods for low emissions combustors to reduce NOx and CO emissions by an optimization of the combustor aero-design process. Preliminary combustor design tools will be coupled with advanced parametrisation and automation tools. Improved heat transfer and NOx models will increase the accuracy of the numerical prediction. The advanced representation of low emission combustors and the capability to investigate combustor scaling effects allow an efficient optimisation of future combustors targeting a cut of combustor development time by 50% work packages: WP1 ‘Development of smart design methodologies for clean combustion’ as central WP to deliver the new methodology for combustor design, WP2 ‘Modelling and design of advanced combustor wall cooling concepts’ for combustor liner design definition as key technology area, WP3 ‘Technology
Computational models and simulation - Contracts and Grants with Industry - Team CAGIRE

validation by detailed flame diagnostics’ to substantiate fuel injector design rules implemented into the design methodology and WP4 ‘Methodology demonstration for efficient low NOx combustors’ will validate the combustor design. The consortium consists of all major aero-engine manufactures in Europe, 7 universities and 3 research establishments with recognised experience in low emission combustion research and 10 SMEs. The contribution of our team is to create a direct numerical simulations (DNS) database relevant to the configuration of film cooling for subsequent improvement of RANS based simulations of isothermal and non isothermal wall flows with discrete mass transfer.

7.2.2. Major European Organizations with which Cagire has followed Collaborations

University of Ghent, Department of Flow, Heat and Combustion (Belgium)

Subject: this cooperation with E. Dick and Y. Moguen focuses on the improvement of the efficiency of numerical schemes used to simulate low Mach number flows.
CALVI Project-Team (section vide)
CONCHA Project-Team

7. Contracts and Grants with Industry

7.1. Optimal (Aerospace Valley)

Participants: Roland Becker, Kossivi Gokpy, Robert Luce, Eric Schall, David Trujillo.

Optimal is a research project related to the cooling of the stator of a turbomachinery. Both physical experiments and numerical simulations are employed. This project has three industrial (Liebherr, Epsilon, and SIBI) and three academic partners (Universities of Pau, Poitiers, and Toulouse). It has been evaluated by the cluster Aerospace Valley. The PhD-thesis of Kossivi Gokpy is financed by this project.

\[
\begin{array}{ccc}
 v_{in} & geo1 & geo2 \\
 10 & 135.97 & 130.53 \\
 20 & 216.73 & 213.59 \\
 50 & 352.61 & 341.47 \\
\end{array}
\]

Figure 21. Temperature field and recirculation for two geometries and computed Nusselt numbers for different inflow velocities.

Our contributions concern the numerical simulation of the viscous flow in different geometrical configurations. Comparison with experimental data will be investigated with respect to the Nusselt number. The computed temperature and streamlines for typical geometries are shown in Figure 21. In addition, the computed Nusselt numbers for the two configurations and varying inflow velocities are given.

Among the different questions concerning modeling such as the boundary conditions at the in- and outlets and the sensitivity to the geometry, a particular point of interest is the study of compressibility effects.

The experimental part of the product is conducted in collaboration with Mathieu Mory, professor at UPPA, and the post-doctoral position of Stéphane Soubacq, who started to work in 10/2009, is financed by the project. The modeling and numerical simulation is done in collaboration with Abdellah Saboni, professor at UPPA.

7.2. Fractured reservoir (Total)

Participants: Robert Luce, David Trujillo.

We have developed specific meshing tools in order to take into account the interaction between faults and a petroleum reservoir for the company Total. This work was done in collaboration with Eric Dubach and Pierre Puiseux from LMA.
Figure 22. Fractured reservoir

Figure 23. Intersection between fault and reservoir
7. Contracts and Grants with Industry

7.1. RODIN project

Participant: Grégoire Allaire.

Launching of the RODIN project (Robust Optimal Design in INdustry) in 2011 with EADS IW, Renault, ESI Group, Eurodecision, Ecole Polytechnique, Paris 6 University, INRIA. One of the aims of the RODIN project is to develop a new shape optimization software for solid structures in the framework of the SYSTUS code developed by ESI-group.

7.2. ANR, Program COSINUS, 2010-2013

Participants: Jing-Rebecca Li, Houssem Haddar, Armin Lechleiter.

We obtained 200K€ grant from ANR, program Cosinus, 2010-2013. J.R. Li is the coordinator of this project: “Simulation du signal d’IRM diffusion dans des tissus biologiques (SIMUDMRI)”, which is a joint proposal between INRIA-Saclay (Coordinator) and CEA Neurospin.

http://www.cmap.polytechnique.fr/~jingrebeccali/grants/simudmri.html

7.3. ANR, Program MN, 2011-2014

Participants: Houssem Haddar, Armin Lechleiter.

We obtained a 220K€ grant from ANR, program MN, 2011-2014, in the framework of the project: Modelization and numerical simulation of wave propagation in metamaterials. This is a joint ANR with POEMS (INRIA Rocquencourt), DMIA, Département de Mathématiques de l’ISAE and IMATH, Laboratoire de Mathématiques de l’Université de Toulon. https://www.rocq.inria.fr/poems/metamath

7.4. EDF R&D, 2010-2013

Participants: Houssem Haddar, Armin Lechleiter, Zixian Jiang.

We have partnership grant with STEP department of EDF R&D on non destructive testing using eddy current probes. This grant covers the expenses of the PhD thesis of Zixian Jiang.

7.5. PEPS (CNRS short grant), 2011

Participant: Grégoire Allaire.

PEPS (CNRS short grant) with EDF on optimal design of nuclear reactor cores. This grant covered the expenses of a sixth month internship (Master M2).

7.6. PhD advising

Participant: Grégoire Allaire.

Contracts covering PhD advising (Thèses CIFRE) with EADS, IFP and Renault (2011-2013).
4. Contracts and Grants with Industry

4.1. Contracts with Industry

- ANDRA, projet 1, Maillage adaptatif hexaédrique appliqué à une alvéole de stockage, D. Moreau et H. Borouchaki, 24 k-euros, 01/06/2010 - 31/05/2011.
- DASSAULT AVIATION, Maillage surfacique et topologie, P. Laug et H. Borouchaki, 33 k-euros, 01/01/2010 - 31/12/2012.

4.2. Grants with Industry

- Fondation EADS Grant, F. Alauzet, 150 k-euros, 2012-2015
- Fondation EADS Grant, A. Loseille, 140 k-euros, 2012-2015
6. Contracts and Grants with Industry

6.1. Contracts with Industry

6.1.1. Contract with CEA Bruyères-Le-Châtel: Determination of the numerical diffusion in a Lagrange-Projection type scheme with a slope limiter, using the associated equivalent equation

Participant: Nicolas Crouseilles.

Other participants (outside IPSO) are D. Bouche, J.P. Braeunig, Ch. Steiner, M. Mehrenberger. The main goal of this contract is to determine equivalent equations for standard numerical schemes dedicated to advection equations. In particular, the first term arising in these equivalent equation concerns the numerical diffusion. These computations enable to quantify the numerical diffusion in an analytical way.
7. Contracts and Grants with Industry

7.1. Program PREDIT

Participants: Charles-Henri Bruneau, Iraj Mortazavi.

Program PREDIT ADEME with Renault and Peugeot. The aim of this program is the work on drag reduction in order to decrease the fuel consumption.

7.2. Renault

Participants: Charles-Henri Bruneau, Iraj Mortazavi.

CARA VAJE project with ADEME (PREDIT Véhicules propres et économes) notified october 24th 2008. Collaboration with Renault and Peugeot, two PME and 3 labs to reduce the drag coefficient of a ground vehicle. 95 k euros for 3 years.

7.3. Plastic Omnium

Participant: Iraj Mortazavi.

The MC2 team works actually with the Plastic Omnium company in order to study the flow behaviour around square back ground vehicles (like buses, camions,...) using LES and DNS techniques. The main target of this collaboration is to identify the structures of velocity fields that generate aerodynamical losses, in order to design drag reduction control strategies using pulsed or synthetic jets. In the framework of this project, we also want to compute accurately instantaneous velocity fields, with high velocities. The computations should be performed on long time for complex geometries. A part of this work is included in the PhD thesis of Yoann Eulalie.

7.4. Contracts with Industry

Thierry Colin is Scientific consulting for the CEA CESTA
Angelo Iollo is consulting with OPTIMAD engineering.

7.5. Grants with Industry

CIFRE - Conventions Industrielles de Formation par la REcherche - with VALEOL (VALOREM Group)
MICMAC Project-Team

6. Contracts and Grants with Industry

6.1. Contracts and Grants with Industry

Many research activities of the project-team are conducted in close collaboration with private or public companies. A recent example is a contract with Michelin for greedy algorithms and uncertainty propagation in mechanics. The project-team is also supported by Office of Naval Research and European Office of Aerospace Research and Development, for multiscale simulations of random materials. All these contracts are operated at and administrated by the Ecole des Ponts.
7. Contracts and Grants with Industry

7.1. High order DGTD-\(P_p\) Maxwell solver for electric vulnerability studies

**Participants:** Joseph Charles, Loula Fezoui, Stéphane Lanteri, Muriel Sesques [CEA/CESTA, Bordeaux].

The objective of this research grant with CEA/CESTA in Bordeaux is the development of a coupled Vlasov-Maxwell solver combining the high order DGTD-\(P_p\) method on tetrahedral meshes developed in the team and a Particle-In-Cell method. The resulting DGTD-\(P_p\)/PIC solver is used for electrical vulnerability assessment of the experimental chamber of the *Laser MégaJoule* system.

7.2. High order DGTD-\(P_p\) Maxwell solver for numerical dosimetry studies

**Participants:** Stéphane Lanteri, Joe Wiart [WHIST Laboratory, Orange Labs, Issy-les-Moulineaux].

The objective of this research grant with the WHIST (Wave Human Interactions and Telecommunications) Laboratory at Orange Labs in Issy-les-Moulineaux is the adaptation of a high order DGTD-\(P_p\) method on tetrahedral meshes developed in the team and its application to numerical dosimetry studies in the context of human exposure to electromagnetic waves emitted from wireless systems. These studies involve realistic geometrical models of human tissues built from medical images.

7.3. Volumic, automatic, industrial and generic mesh generation (MIEL3D-MESHER)

**Participants:** Clément Durochat, Paul-Louis Georges [GAMMA project-team, INRIA Paris - Rocquencourt], Stéphane Lanteri, Mark Loriot [Distene, Pôle Teratec, Bruyères-le-Chatel], Philippe Pasquet [Samtech France].

MIEL3D-MESHER is a national project of the SYSTEM@TIC Paris-Région cluster which aims at the development of automatic hexahedral mesh generation tools and their application to the finite element analysis of some physical problems. One task of this project is concerned with the definition of a toolbox for the construction of non-conforming, hybrid hexahedral/tetrahedral meshes. In this context, the contribution of the team to this project aims at the development of a DGTD-\(P_p\)\(Q_k\) method formulated on such hybrid meshes. Here, \(P_p\) stands for the polynomial interpolation method on tetrahedral elements while \(Q_k\) denotes the polynomial interpolation method on hexahedral elements.

7.4. Seismic risk assessment by a discontinuous Galerkin method

**Participants:** Nathalie Glinsky, Stéphane Lanteri, Fabien Peyrusse.

The objective of this research grant with IFSTTAR [http://www.ifsttar.fr](http://www.ifsttar.fr) (French institute of sciences and technology for transport, development and networks) and CETE Méditerranée is concerned with the numerical modeling of earthquake dynamics taking into account realistic physical models of geological media relevant to this context. In particular, a discontinuous Galerkin method will be designed for the solution of the elastodynamic equations coupled to an appropriate model of physical attenuation of the wave fields for the characterization of a viscoelastic material.

7.5. Ultra-wideband microwave imaging and inversion (MAXWELL)

**Participants:** Victorita Dolean, Mohamed El Bouajaji, Stéphane Lanteri, Christian Pichot [LEAT, Sophia Antipolis].
The project-team is a partner of the MAXWELL project (Novel, ultra-wideband, bistatic, multipolarization, wide offset, microwave data acquisition, microwave imaging, and inversion for permittivity) which is funded by ANR under the non-thematic program (this project has started in January 2008 for a duration of 4 years). See also http://leat.unice.fr/pages/anr-maxwell/anr-maxwell.html

7.6. Analysis of children exposure to electromagnetic waves (KidPocket)

**Participants:** Stéphane Lanteri, Joe Wiart [WHIST Laboratory, Orange Labs, Issy-les-Moulineaux].

The project-team is a partner of the KidPocket project (Analysis of RF children exposure linked to the use of new networks or usages) which is funded by ANR in the framework of the Réseaux du Futur et Services program and has started in October 2009 for a duration of 3 years. See also http://whist.institut-telecom.fr/kidpocket

7.7. Statistical numerical dosimetry (DONUT)

**Participants:** Amine Drissaoui [Ampère Laboratory, Ecole Centrale de Lyon], Stéphane Lanteri, Philippe Leveque [XLIM Laboratory, Limoges], Ronan Perrussel [Ampère Laboratory, Ecole Centrale de Lyon], Damien Voyer [Ampère Laboratory, Ecole Centrale de Lyon].

The objectives of the DONUT project are to develop and validate a new numerical dosimetry approach for dealing with the variability of human exposure to electromagnetic fields, in order do directly deduce a statistical analysis of the effects of the exposure. The proposed numerical methodology which is based on a stochastic finite element method and can exploit in a non intrusive way existing Maxwell solvers for the calculation of the Specific Absorption Rate in biological tissues. This feature is demonstrated in the project by considering both finite difference, finite element and discontinuous Galerkin Maxwell solvers.
NANO-D Team (section vide)
7. Contracts and Grants with Industry

7.1. Contracts with Industry

ArcelorMittal-INRIA industrial contract n. 5013: Opale started a thorough collaboration in optimal design of high performance steel with the mentioned world leader industrial. The present contract has three years duration and funds a Ph.D. thesis and Research financial support.

7.2. National Initiatives

7.2.1. Project "Bulbe"

This project is funded by the Ministry of Fishing and gathers OPALE Project-Team, K-Epsilon company (specialized in CFD for naval hydrodynamics) and PROFIL company (naval architect). The objective is to design and optimize bow shapes for trawler ships, in order to reduce the fuel consumption during fishing campaigns. Our role is to construct an automated optimization loop to improve bow efficiency, on the basis of CFD tools provided by K-Epsilon company and naval architect recommendations.

7.2.2. Project "OASIS"

The OASIS project, Optimization of Addendum Surfaces In Stamping, is an R&D consortium (CS, Arcelor-Mittal, ErDF, INRIA, UTC, EURODECISION, ESILV, NECS, DeltaCAD, SCILAB-DIGITEO) of the Pole Systemtic Paris-Region dedicated to develop an optimal design framework (methods-software platforms-applications) for stamping processes. The EPI OPALE/INRIA is the leader within the consortium for the Optimization work-package (one of six WP). The OASIS project yields 2.4 Meuro total financial support (one Ph.D thesis, two post-doctoral positions and 12 months internship for OPALE).

7.2.3. Project "OMD2", Optimisation Multi-Disciplinaire Distribuée (Distributed Multidisciplinary Optimization)

This project funded by ANR deals with the development of a software platform devoted to Multidisciplinary Design Optimization (MDO) in the context of distributed computing. The notion of optimization platform based on distributed and parallel codes is undertaken with a distributed workflow management system running on a grid infrastructure using the ProActive middleware from INRIA, in collaboration with the OASIS project at INRIA Sophia-Antipolis. Renault is the coordinator of this project, which involves also EMSE, ENS Cachan, EC Nantes, Université de Technologie de Compiègne, CD-Adapco, Sirehna, Activeon, and INRIA project TAO, OASIS and OPALE. This contract provides the grant supporting two PhD theses (A. Zerbinati and L. Trifan).

7.2.4. Project "Optican"

This project is funded by the Ministry of sports and aims at improving the efficiency of canoes, in the perspective of London Olympic Games in 2012.
7.3. European Initiatives

7.3.1. FP7 Projects

7.3.1.1. EXCITING

Title: Exact Geometry Simulation for Optimized Design of Vehicles and Vessels
Type: COOPERATION (TRANSPORTS)
Instrument: Specific Targeted Research Project (STREP)
Duration: October 2008 - Mars 2012
Coordinator: Jozef Kepler universitet (Austria)
Others partners: SINTEF (SW), SIEMENS (GER), NTUA (GR), HRS (GR), TUM (GER), HYDRO (AUS), DNV (NOR)
See also: http://exciting-project.eu/
Abstract: The objective is to develop simulation and design methods and software based on the isogeometric concepts, that unify Computer-Aided Design (CAD) and Finite-Elements (FE) representation bases. Applications concern hull shape, turbine and car structure design.

7.3.1.2. MARS

Title: Manipulation of Reynolds Stress
Type: COOPERATION (TRANSPORTS)
Instrument: Specific Targeted Research Project (STREP)
Duration: October 2010 - September 2013
Coordinator: CENTRE INTERNACIONAL DE METODES NUMERICS EN ENGINYERIA (Spain)
Others partners: USFD (UK), AIRBUS (SP), FOI (SW), ALENIA (IT), DLR (GER), CNRS (FR), DASSAULT (FR), NUMECA (BEL), UNIMAN (UK), EADS (UK)
See also: http://www.cimne.com/mars/
Abstract: The objective is to study flow control devices for aeronautical applications. This project gathers twelve European partners and twelve Chinese partners for a common work that includes both experimental and numerical studies. Opale Project-Team is in charge of developing numerical algorithms to optimize flow control devices (vortex generators, synthetic jets).

7.3.1.3. GRAIN

Title: GReener Aeronautics International Networking
Type: CAPACITIES (TRANSPORTS)
Instrument: Coordination and Support Action (CSA)
Duration: October 2010 - September 2012
Coordinator: CENTRE INTERNACIONAL DE METODES NUMERICS EN ENGINYERIA (Spain)
Others partners: AIRBUS (SP), ALENIA (I), EADS-IW (F), Rolls-Royce (UK), INGENIA (SP), NUMECA (B), U. SHEFFIELD (UK), U. BIRMINGHAM (UK), CIRA (I), VKI (B), AIRBORNE (NL), LEITAT (SP), CERFACS (F), U. CRANFIELD (UK), CAE (CN), GTE (CN), ARI (CN), FAI (CN), ASRI (CN), SAERI (CN), BIAM (CN), ACTRI (CN), BUAA (CN), NPU (CN), PKU (CN), NUAA (CN), ZJU (CN).
See also: http://www.cimne.com/grain
Abstract: The GReener Aeronautics International Networking (GRAIN) is a 24 month project co-funded by the 7th Framework Programme of the European Community (EC) and by the Chinese Ministry of Industry and Information Technology (MIIT). It is managed by the European Commission as a Coordination and Support Action. The main objectives of GRAIN are to identify and assess the future development of large scale simulation methods and tools needed for greener technologies reaching the Vision 2020 environmental goals. GRAIN will prepare the R&T development and exploitation with new large scale simulation tools used on distributed parallel environments to deeper understand and minimize the effects of aircraft/engine design on climate and noise impact. This objective can be met by supporting joint Europe-China networking actions for defining the necessary technologies to improve green aircraft performance.

7.3.1.4. TraM3

Title: TRaffic Management by Macroscopic Models
Type: IDEAS
Instrument: ERC Starting Grant (Starting)
Duration: October 2010 - September 2015
Coordinator: INRIA (France)
See also: http://www-sop.inria.fr/members/Paola.Goatin/tram3.html
Abstract: The project intends to investigate traffic phenomena from the macroscopic point of view, using models derived from fluid-dynamics consisting in hyperbolic conservation laws. The scope is to develop a rigorous analytical framework and fast and efficient numerical tools for solving optimization and control problems, such as queues lengths control or buildings exits design.

7.3.2. Collaborations in European Programs, except FP7

Program: PHC Polonium
Project acronym: CROM3
Project title: Crowd Motion Modeling and Management
Coordinator: P. Goatin (France), M.D. Rosini (Poland)
Other partners: ICM, Warsaw University (Poland)
Abstract: The aim of this collaboration is to provide new analytical and numerical tools for solving control and optimization problems arising in pedestrian traffic management. Our scope is to develop a rigorous analytical framework and fast and efficient numerical tools for solving optimization and control problems, such as buildings exits design. This will allow to elaborate reliable predictions and to optimize traffic fluxes. To achieve this goal, we will study in details the structure of the solutions of the partial differential equations modeling traffic dynamics, in order to construct ad hoc methods to tackle the analytical and numerical difficulties arising in this study.

7.3.3. Major European Organizations with which you have followed Collaborations

Brescia University, Mathematics Department, Italy.
Analytical and numerical study of conservation laws with application to traffic modeling.

Jyväskylä University, Mathematics and Information Technology (MIT), Finland.
Numerical simulation and optimization.
7. Contracts and Grants with Industry

7.1. Contract POEMS-CEA-LIST-1 : CASSIS PROJECT

**Participant:** Gary Cohen.


G. Cohen participates to Project CASSIS headed by the LIST laboratory of CEA and funded by the EADS Foundation which started in June 2008. This project aims to simulate elastic waves in thin layered anisotropic media for non-destructive testing. In collaboration with E. Demaldent, G. Cohen must provide a code based on spectral element methods to model these waves.

7.2. Contract POEMS-CEA-LIST-2

**Participant:** Anne-Sophie Bonnet-Ben Dhia.


This contract is about the scattering of elastic waves by a stiffener in an anisotropic plate.

7.3. Contract POEMS-CEA-LIST-3

**Participants:** Laurent Bourgeois, Eric Lunéville.

Start: 10/01/2011, End: 09/30/2012. Administrator: ENSTA.

This contract is about the linear sampling methods for elastic waveguides.

7.4. Contract POEMS-CEA-LIST-DIGITEO

**Participants:** Anne-Sophie Bonnet-Ben Dhia, Sonia Fliss, Antoine Tonnoir.

Start: 10/01/2011, End: 09/30/2014. Administrator: ENSTA.

This contract is about the scattering of elastic waves by a local defects in an anisotropic plate. It consists on the funding of Antoine Tonnoir’s Phd.

7.5. Contract POEMS-DGA

**Participants:** Anne-Sophie Bonnet-Ben Dhia, Sonia Fliss, Patrick Joly.

Start: 09/01/2011, End: 12/31/2012. Administrator: ENSTA.

This contract is about the waveguide in photonic crystals: we want to develop new mathematical and numerical tools for the characterization, the study and the computation of the guided modes in photonic crystals.

7.6. Contract POEMS-ONERA-CE Gramat : DIGATOP PROJECT

**Participant:** Gary Cohen.


In collaboration with ONERA-DEM, G. Cohen participates to the FEMGD project funded by CEG (Centre d’Études de Gramat), which started in 2004. This project is devoted to the construction of a software using spectral discontinuous Galerkin methods for Maxwell’s equations.

7.7. Contract POEMS-CE Gramat : NADEGE PROJECT

**Participants:** Gary Cohen, Alexandre Sinding.
In collaboration with ONERA-DEMR, G. Cohen participates with A. Sinding to the NADEGE project funded by CEG (Centre d’Études de Gramat). This project is devoted to the construction of a software based on FEMGD for solving Vlasov-Maxwell’s equations by a PIC method.

7.8. Contract POEMS-Airbus : ADUMO PROJECT

Participant: Patrick Joly.

Start : 01/01/2011, End : 12/31/2011. Administrator : INRIA.
This contract is about the hybridation of time domain numerical techniques in aeroacoustics (Linearized Euler equations).
PUMAS Team (section vide)
6. Contracts and Grants with Industry

6.1. THALES
Participants: Christophe Besse, Thierry Goudon, Nicolas Vauchelet, Ingrid Lacroix-Violet, Saja Borghol.
On the one hand we have optimized and proposed a parallel version of the code SPARCS which is designed to compute the electric potential on the spacecraft and around it. On the other hand we have proposed alternative hydrodynamic models and a method to derive adapted boundary conditions for the macroscopic quantities in order to reproduce phenomena due to the kinetic ones.

6.2. CEA
Participants: Thierry Goudon, Martin Parisot.
We are starting a collaborative program with the CEA (Direction des Applications Militaires) devoted to the modeling and simulation of plasmas arising in Inertial Confinement Fusion devices. We are concerned with the derivation of the so-called nonlocal models, which are variations around the standard diffusion models.

6.3. ANDRA
Participants: Thierry Goudon, Antoine Gloria, Stella Krell, Zakaria Habibi.
The goal of the program relies on the determination of effective coefficients for models of transfer of solutes in porous media. The problem appeals to the homogenization of convection-diffusion equations. We wish to participate to the research efforts for the numerical simulation of the disposal of radioactive waste. This work is the object of a collaboration with S. Krell and A. Gloria.
6. Contracts and Grants with Industry

6.1. Contracts with Industry

6.1.1. DGA - Multiphase modelling of fluid–solid interaction

**Participants:** Sergey Gavrilyuk, Nicolas Favrie, Richard Saurel.

The aim of this study, supported by a DGA grant, is to get a conservative elastic-plastic-fluid flow model to deal with fluid-fluid coupling in extreme deformations. An active collaboration with Prof. S.K. Godunov is still active in this area.

6.1.2. CNES-SNECMA grants - Multiphase flows in cryogenic space launcher engines

**Participants:** Olivier Le Métayer, Richard Saurel, Jacques Massoni, Fabien Petitpas.

The aim of 4-years grant (3 years remaining), supported by CNES and SNECMA, is concerned with both modelling and simulation of two-phase flows in cryogenic engine of space launchers (Ariane V).
TROPICS Project-Team (section vide)
7. Contracts and Grants with Industry

7.1. Contract CNES-IRCOM-INRIA

Contract (reference Inria: 2470, CNES: 60465/00) involving CNES, XLim and Inria, whose objective is to work out a software package for identification and design of microwave devices. The work at Inria concerns the design of multiband filters with constraints on the group delay. The problem is to control the logarithmic derivative of the modulus of a rational function, while meeting specifications on its modulus.

7.2. Contract CNES-INRIA-UPV/EHU

Contract (reference CNES: RS10/TG-0001-019) involving CNES, University of Bilbao (UPV/EHU) and Inria whose objective is to set up a methodology for testing the stability of amplifying devices. The work at Inria concerns the design of frequency optimization techniques to identify the linearized response and analyze the linear periodic components.
7. Contracts and Grants with Industry

7.1. Contracts


- ANR Multiple Impact: INRIA Bipop, Peking’s university PKU (State Key Laboratory for Turbulence and Complex Systems).
- EdF: Documentation of the noisedf software
- L’OREAL: Contrat de recherche et de transfert with L’Oréal, performed from February to November 2011 for validating our model of frictional contact within large fiber assemblies.
7. Contracts and Grants with Industry

7.1. Contracts with Industry


7. Contracts and Grants with Industry

7.1. ANR

We continued in 2011 our activities connected to the existing ANR grants:

- CISIFS (Control of Fluid-structure Interactions), coordinated by Lionel Rosier and Takéo Takahashi: 90500 euros for 4 years (2009-2013);
- MICROWAVES (Microlocal Analysis and Numerical Methods for Wave Propagation), coordinated by Xavier Antoine: 103000 euros for 4 years (2009-2013);
- GAOS (Geometric Analysis of Optimal Shapes), with Antoine Henrot local coordinator: 83130 euros for 3 years (2009-2012);
- GCM (Geometric Control Methods), with Mario Sigalotti local coordinator: 129266 euros for 4 years (2009-2013).
- MOSICOB: this ANR project (2008-2011) is devoted to complex fluids and to fluid-structure interactions. Our work concerns mainly the analysis and simulation of vesicles in a fluid flow.
- ANR ARPEGE program ArHyCo (Since January 2009) is devoted to the stability analysis of hybrid systems with special attention to the observer-based control of multiscell power converters;

7.2. FRAE (Fondation de Recherche pour l’Aéronautique et l’Espace)

In March 2010, Karim Ramdani obtained a 2 years funding from FRAE³ to work on inverse problems in Aeronautics. The project involves two partners: INRIA Nancy Grand-Est (7 participants, from which 5 members of CORIDA) and ONERA Toulouse (4 participants).

7.3. EADS Foundation

We obtained a four years grant (2010-2014) of 147000 euros from EADS foundation. This project aims to develop new efficient numerical methods to solve electromagnetic scattering problems. Part of this grant is used to support the PhD of I. Zangré supervised by X. Antoine and C. Geuzaine (University of Liège). Y. Saad (university of Minneapolis) is also involved in this project.

³Fondation de Recherche pour l’Aéronautique et l’Espace : http://www.fnrae.org/
7. Contracts and Grants with Industry

7.1. Contracts with Industry

Alban Quadrat and Arnaud Quadrat (SAGEM Défense Sécurité, Etablissement de MASSY) have initiated discussions between SAGEM, the DISCO project and the L2S about a future collaboration in the direction of the analysis of the effect of the time-delay in inertially stabilized platforms for optical imaging systems. We hope that these discussions will conclude in a contract in 2012 on this subject.
GECO Team (section vide)
7. Contracts and Grants with Industry

7.1. Contracts/Contracts


- Thèse CIFRE de J-B. Dumont, financée par Orange Labs (encadrant Orange Labs: Mustapha Bouhtou, directeur de thèse: S. Gaubert), démarrée en septembre 2010. Sujet: tarification de services data et gestion des ressources dans les réseaux mobiles 3G et LTE.
7. Contracts and Grants with Industry

7.1. Grants and contracts with Industry

7.1.1. IFP

Accompanying contract with IFPEN (IFP Energies Nouvelles), in the framework of the PhD grant of A. Ben Khaled. The thesis explores new architectures and flexible scheduling methods to enhance the trade-off between the integration accuracy and the simulation speed of distributed real-time (hardware-in-the-loop) simulators, in particular in the framework of automotive power-trains [25].

7.1.2. AIRBUS

Accompanying contract with AIRBUS in the framework of the CIFRE PhD grant of P. Andrianiaina. The goal of this PhD thesis is to study flexible implementation methods for real-time controllers, aimed at reducing the conservatism induced by the current approach purely based on worst case considerations [24], [63], [51].

7.2. Technology transfer: start-up Karrus

The NeCS team is continuing its activity in road traffic modeling and control. The expected scientific contribution of NeCS in this field concerns the development of new estimation prediction and identification algorithms based on the measurements collected through sensor networks installed on freeways. The team study also the problems of time-to destination and control algorithms for ramp metering. The team is currently setting up a consortium with local authorities involved in traffic management to build to demonstrator called GTL for Grenoble Traffic Lab. One target of this activity is to transfer part of the developed technology to a start-up named Karrus and led by Denis Jacquet (http://www.karrus.fr/). The start-up was created in January 2010.
6. Contracts and Grants with Industry

6.1. Projects

- Project SYSIASS [http://www.sysiass.eu/];
  - Subject: Autonomous and Intelligent Healthcare System;
  - Partners: ISEN de Lille, Ecole Centrale de Lille, University of Kent, University of Essex, East Kent Hospitals University NHS Foundation Trust, Groupement Hospitalier de l’Institut Catholique de Lille;
  - Duration: 2010 - 2013;
  - Support: FEDER;

- Project CHASLIM [http://chaslim.gforge.inria.fr/];
  - Subject: Sliding mode control;
  - Partners: INRIA Grenoble-Rhône Alpes, INRIA Lille-Nord Europe, Ecole Centrale de Nantes;
  - Duration: 2011-2014;
  - Support: ANR;

- Project HYCON2 [http://www.hycon2.eu/];
  - Subject: Networked control systems;
  - Partners: See [http://www.hycon2.eu/?page=5&PHPSESSID=e185e278a6cab0a35c8dea0970c5723d];
  - Duration: 2010-2015;
  - Support: FP7;

- Project SENSAS [http://sensas.gforge.inria.fr/wiki/doku.php];
  - Subject: Sensor network Applications;
  - Partners: INRIA Grenoble-Rhône Alpes, INRIA Lille-Nord Europe, INRIA Sophia Antipolis-Méditerranée, INRIA Nancy-Grand Est;
  - Duration: 2010-2014;
  - Support: ANR;

6.2. Contracts with Industry

- New contract with EDF on the prediction of inflow into the Rhine;
- Contract with DIRIF (Direction Interdépartementale des Routes d’Île-de-France) to control the highway access problem.
- Imminent creation of a cooperation with SAS in December 2011.
6. Contracts and Grants with Industry

6.1. Contracts with Industry

Gérard Biau has been supervising the PhD thesis of Benoît Patra, which takes place within an industrial contract ("thèse CIFRE") with Lokad.com (http://www.lokad.com/).
7. Contracts and Grants with Industry

7.1. Contracts with industry

+ Opalean (2010-2011): Constrained network-flow optimization
GEOSTAT Project-Team (section vide)
MISTIS Project-Team (section vide)
MODAL Team

7. Contracts and Grants with Industry

7.1. Genes Diffusion

Participants: Julien Jacques, Julie Hamon.

“Data analysis from high throughput technologies: Synergy between statistics and combinatorial optimization.”

With the development of new technologies such as high-throughput genotyping and sequencing, data analysis needs to be improved. Genes Diffusion is specialized in animals studies, for which we can read genomics information on around 800,000 markers and we have more and more subjects. The aim of the PhD is to find new methods combining combinatorial optimization and statistics methods in order to characterize the best subjects according to quantitative criteria. A PhD CIFRE grant started on 2010 and it is a joined work with Clarisse Dhaenens (DOLPHIN).

7.2. Natural Security

Participants: Christophe Biernacki, Matthieu Marbac-Lourdelle, Vincent Vandewalle.

“Statistical modeling and simulation for card payment at medium distance.”

As part of the "Payment of a hand gesture", the Natural Security company uses a technology at medium distance based on biometrics to authenticate owner and to allow transaction with no card payment manipulation while limiting the risk fraud. Depending to the context of use (frequency of transactions) a theoretical expertise is needed to assess the viability of the system in term of probability of collision or wrong authentication. This collaboration has led to two contracts in 2011, 6 k€ each and about two weeks long each.

7.3. Arcelor-Mittal

Participants: Christophe Biernacki, Clément Thery.

“Supervised and semi-supervised classification on large data bases mixing qualitative and quantitative variables.”

Arcelor-Mittal is faced with some quality problems in the steel production which lead to supervised and semi-supervised classification involving (1) a small number of individuals comparing to the number of variables, (2) heterogeneous variables, typically categorical and continuous variables and (3) potentially highly correlated variables. A PhD CIFRE grant started on May 2011.

7.4. ASEL & CRESGE

Participant: Cristian Preda.

“Incidence of lymphoma in Nord-Pas-de-Calais, Annual Estimates and study of the evolution over the period 2001-2005.”

It is a contract with ASEL (Association Septentrionale pour l’Etude de Lymphomes) and CRESGE (Centre de Recherches Economiques Sociologiques et de Gestion) from Lille. This project of 6 k€ starts on December 1st 2011 and ends on September 2st 2012.
7. Contracts and Grants with Industry

7.1. Contract with EDF on maintenance planning

We are currently working on a project aiming to plan the energy production and the maintenance breaks for a set of nuclear power plants generating electricity. This problem has two different levels of decisions. The first one consist in determining, for a certain time horizon, when the different power plants will have to stop in order to perform a refueling and to decide the amount of this refueling. Given a set of scenarios defining variable levels of energy consumption, the second decision level aims to decide the quantity of power each plant will have to produce. The model that we are proposing combines issues of stochastic optimization (to handle demand scenarios), robust optimization (to account for variation in maintenance duration), and dynamic optimization (the maintenance of nuclear plants are programmed on a five year horizon, but the long term planning is review each month for adjustments due to perturbations.

This project is carried in collaboration between EDF R&D (OSIRIS lab) INRIA team Dolphin and Realopt. The research is the subject of the PhD thesis of Nicolas Dupin (DGA).
SELECT Project-Team

7. Contracts and Grants with Industry

7.1. Contracts with EDF

Participants: Gilles Celeux, Jean-Michel Poggi.

- SELECT has a contract with EDF regarding modelling uncertainty in deterministic models.
- SELECT has a contract with EDF regarding wavelet analysis of the electrical load consumption for the aggregation and desaggregation of curves to improve total signal prediction.

7.2. Other contracts

Participants: Gilles Celeux, Rémy Fouchereau.

- SELECT has a contract with SAFRAN - SNECMA, an high-technology group (Aerospace propulsion, Aircraft equipment, Defense Security, Communications), regarding modelling reliability of Aircraft Equipment (collaboration with Patrick Pamphile (Université Paris-Sud).
7. Contracts and Grants with Industry

7.1. Contracts and Grants with Industry

7.1.1. Addressing Business

Participants: Sertan Girgin, Philippe Preux.

Addressing Business develops a software to help their clients (companies) find new clients. Currently, this software is an information system, that helps the human decision maker.

The goal of this contract was to realize a first exploratory step towards using data mining techniques to handle, and possibly improve, this process. Confidentiality issues restrict the communication on this contract [60]. However, this study has been very successful, and we look forward further collaboration with this company on this topic.

7.1.2. Orange Labs

Participants: Jérémie Mary, Olivier Nicol, Philippe Preux, Christophe Salperwyck.

There has been various activities between SEQUEL and Orange Labs.

First, the collaboration around the PhD of Christophe Salperwyck has continued. Second, a CRE has been signed in 2011 to continue our work on web advertising, and more generally, collaborative filtering. On this topic, Sami Naamane has been hired in Fall 2011 as PhD student.

7.1.3. Effigenie

Participant: Jérémie Mary.

We worked on the next steps of the optimisation of thermal control of building with Effigenie. We presented a common project June and this start up won in summer the OSEO innovation prize (and the LMI one).

7.1.4. Squoring Technology

Participants: Boris Baldassari, Philippe Preux.

Boris Baldassari has been hired by Squoring Technology (Toulouse) as a PhD student in May 2011. He works on the use of machine learning to improve the quality of the software development process.

7.1.5. Through the pôle de compétitivité “Industries du commerce”

Participants: Sertan Girgin, Philippe Preux.

2011 is the last year of the “Ubiquitous Virtual Seller” project of the “Pôle de compétitivité Industries du Commerce” (PICOM). We have completed our contribution related to recommendation systems [59]. This work was done mostly in collaboration with Becquet and Oxylane.

7.1.6. Qualisteo

Participants: Pierre Chainais, Emmanuel Duflos.

In collaboration with Emmanuel Duflos, Pierre Chainais has been involved in the supervising of a Master 2 student within a collaboration with the company Qualisteo on the pattern recognition in electric power consumption signals. A PhD grant is under study. The purpose is to learn how to identify the origin of the electric consumption of a house from the power consumption alone. This problem combines signal processing as well as machine learning questions. This project is still under discussion.
SIERRA Project-Team (section vide)
7. Contracts and Grants with Industry

7.1. Contracts with Industry


- **PSA** – 2009-2012 (45 kEur), side-contract to Mouadh Yagoubi’s CIFRE Ph.D.; Participants: Marc Schoenauer, Mouadh Yagoubi.

- **THALES** – 2011-2014 (40 kEur), side-contract to Gaetan Marceau-Caron’s CIFRE Ph.D.; Participants: Marc Schoenauer, Gaetan Marceau-Caron.

- **EXQIM** – 2011-2014 (40 kEur), side-contract to Moez Hammami’s CIFRE Ph.D.; Participants: Michèle Sebag, Moez Hammami.


7.2. Grants with Industry

ALEA Project-Team

6. Contracts and Grants with Industry

6.1. Contract with EDF
The objective of this contract (2009-2011) between the teams ALEA and CQFD and EDF, is to develop algorithms for the recursive prediction of the electricity consumption. The team will organize a workshop on this subject in Institut Henri Poincaré.

6.2. Contract with EDF
The objective of this contract is to develop particle algorithms for the pricing of American-style options [33].

6.3. Contract with CEA
The objective of this contract (2010-2011) is to propose algorithms for the estimation of uncertainties in laser experiments [30], [31].
6. Contracts and Grants with Industry

6.1. Safety, complexity and responsibility based design and validation of highly automated air traffic management (iFLY) — FP6 Aerospace

Participant: François Le Gland.

See 3.3 and 4.2.

INRIA contract ALLOC 2399 — May 2007 to August 2011.

This FP6 project is coordinated by National Aerospace Laboratory (NLR) (The Netherlands), and ASPI is also collaborating with University of Twente (The Netherlands) and Direction des Services de la Navigation Aérienne (DSNA).

The objective of iFLY is to develop both an advanced airborne self separation design and a highly automated air traffic management (ATM) design for en-route traffic, which takes advantage of autonomous aircraft operation capabilities and which is aimed to manage a three to six times increase in current en-route traffic levels. The proposed research combines expertise in air transport human factors, safety and economics with analytical and Monte Carlo simulation methodologies. The contribution of ASPI to this project concerns the work package on accident risk assessment methods and their implementation using conditional Monte Carlo methods, especially for large scale stochastic hybrid systems: designing and studying variants [29] suited for hybrid state space (resampling per mode, marginalization) are currently investigated [18].

6.2. Optimization of sensors location and activation — contract with DGA / Techniques navales

Participant: François Le Gland.

See 3.3 and 4.2.

INRIA contract ALLOC 4233 — April 2009 to September 2011.

This is a collaboration with Sébastien Paris (université Paul Cézanne), related with the supervision of the PhD thesis of Mathieu Chouchane.

The objective of this project is to optimize the position and activation times of a few sensors deployed by a platform over a search zone, so as to maximize the probability of detecting a moving target. The difficulty here is that the target can detect an activated sensor before it is detected itself, and it can then modify its own trajectory to escape from the sensor. Because of the many constraints including timing constraints involved in this optimization problem, a stochastic algorithm is preferred here over a deterministic algorithm. The underlying idea is to replace the problem of maximizing a cost function (the probability of detection) over the possible configurations (admissible position and activation times) by the apparently simpler problem of sampling a population according to a probability distribution depending on a small parameter, which asymptotically concentrates on the set of global maxima of the cost function, as the small parameter goes to zero. The usual approach here is to use the cross-entropy method [65], [33].

The contribution of ASPI has been to propose a multilevel splitting algorithm, in order to evaluate the probability of detection for a given configuration. When this probability is small, these methods are known to provide a significant reduction in the variance of the relative error.

6.3. Information fusion for localisation (FIL) — ANR Télécommunications

Participant: François Le Gland.
The overall objective is to study and demonstrate information fusion algorithms for localisation of pedestrian users in an indoor environment, where GPS solution cannot be used. The sought design combines

- a pedestrian dead-reckoning (PDR) unit, providing noisy estimates of the linear displacement, angular turn, and possibly of the level change through an additional pressure sensor,
- range and/or proximity measurements provided by beacons at fixed and known locations, and possibly indirect distance measurements to access points, through a measure of the power signal attenuation,
- constraints provided by an indoor map of the building (map-matching),
- collaborative localisation when two users meet and exchange their respective position estimates.

Besides particle methods, which are proposed as the basic information fusion algorithm for the centralized server-based implementation, simpler algorithms such as the extended Kalman filter (EKF) or the unscented Kalman filter (UKF) have been investigated, to be used for the local PDA-based implementation with a map of a smaller part of the building. Constraints could be taken care of automatically with the help of a Voronoi graph [62], but this approach implies heavy pre-computations. A more direct approach, taking care of constraints on the fly, using a simple rejection method, has been preferred. Adapting the sample size using KLD-sampling [42] has also been investigated, which could be useful in the case of a poor initial information, or if the user walks in poorly informative area (open zone, absence of beacons). Collaboration between users has been implemented [41], which allows from a user with a poor localization to benefit from the more accurate localization of another user. In this implementation, the latter user is seen by the former user as a ranging beacon with uncertain position. See [28], [54] for a description of the overall fusion algorithm and an illustration with simulation results.

### 6.4. Ensemble methods for prediction and data assimilation (PREVASSEMBLE) — ANR Conception et Simulation

**Participants:** François Le Gland, Valérie Monbet.

*INRIA contract ALLOC 3767 — January 2009 to December 2012.*

This ANR project is coordinated by École Normale Supérieure, Paris. The other partner is Météo-France. This is a collaboration with Étienne Mémin and Anne Cuzol (INRIA Rennes Bretagne Atlantique, project-team FLUMINANCE).

The contribution of ASPI to this project is to continue [25] the comparison of sequential data assimilation methods initiated in [68], such as the ensemble Kalman filter (EnKF) and the weighted ensemble Kalman filter (WEnKF), with particle filters. This comparison will be made on the basis of asymptotic variances, as the ensemble or sample size goes to infinity, and also on the impact of dimension on small sample behavior.

### 6.5. Slightly-multimodal transmission and detection (STRADE) — ANR Réseaux du Futur et Services

**Participant:** Frédéric Cérou.

*INRIA contract ALLOC 4402 — November 2009 to October 2012.*

This ANR project is also coordinated by Alcatel-Lucent Bell Labs France.
The focus of our project is to reduce the impact of nonlinear effect. The objective is twofold: specify, design, realize and evaluate fibres of reduced nonlinear effects by firstly increasing the effective area to unprecedented values and secondly, by splitting optical power along two modes, using bimodal propagation. While the first step is ambitious but primarily relies in the evolution of current fibre technologies, the second is disruptive and requires not only deep changes in fibre technologies but also new advanced transmitter / receiver equipment, preferably based on coherent detection. Naturally, bimodal propagation also brings another key advantage, namely a twofold increase of system capacity.
CQFD Project-Team

7. Contracts and Grants with Industry

7.1. Astrium

Participants: Romain Azaïs, Adrien Brandejsky, Benoîte de Saporta, François Dufour, Anne Gégout-Petit, Huilong Zhang.

The goal of this project is to propose models for fatigue of structure and to study an approach to evaluate the probability of occurrence of events defined by the crossing of a threshold. In this context, Astrium funds the PhD Thesis of Adrien Brandejsky since September 2009 and is a partner of ANR Fautocoes.

7.2. Thales Optronique

Participants: Camille Baysse, Benoîte de Saporta, François Dufour, Anne Gégout-Petit, Jérôme Saracco.

The goal of the project is the optimization of the maintenance of a on board system with a HUMS (Health Unit Monitoring Systems). The collaboration is the subject of the PhD of Camille Baysse (CIFRE) on this subject.

7.3. DCNS

Participants: Benoîte de Saporta, François Dufour, Huilong Zhang.

In September 2010, an industrial collaboration started with DCNS on the application of Markov Decision Processes to optimal stochastic control of a submarine to maximize the acoustic signature of a target vessel. In 2011, we extended our previous results to multiple target vessels. This work was presented at the INRIA seminar Unithé ou café and gave rise to a new technical report Contrôle optimal stochastique appliqué à l’optimisation de trajectoire, cas multicible [53].

7.4. EDF Approdyn

Participants: Benoîte de Saporta, François Dufour, Huilong Zhang.

The objective of this project is develop new methodologies for studying the dynamic reliability of controlled systems used in the critical area of power generation and process industries. We work on a benchmark of steam generator with four physical processes: feedwater flowrate, steam flow, narrow range water level and wide range water level. A PID controller is used to maintain the water level within limits of set-points. The system is composed of seven components: 1 passive system representing vapor transport system, 3 extraction pumps, 2 feeding turbopumps, and 1 waterflow regulation valve. This work was presented as a poster at the 3SGS GIS workshop in Valenciennes in 2011.

7.5. Lyre (Lyonnaise Recherche)

Participant: Jérôme Saracco.

A project of collaboration started in December 2011 between LyRE (which is a research laboratory of Lyonnaise des Eaux, subsidiary company of Suez environnement) and INRIA team CQFD. One aim of this project is to develop tools for detection of leaks in water network based on a sampling study of continuous time monitoring of individual consumptions. A PhD thesis (2011-2014) is part of this project. The whole project also involves CEMAGREF and IMB (Institut de Mathématiques de Bordeaux). This work is in collaboration with Vincent Couallier (IMB).

7.6. EDF

Participant: Jérôme Saracco.
A new contract was signed in 2011 between EDF R & D team ICAME and INRIA teams CQFD and ALEA. This contract deals with modeling and forecasting of short term electricity loads for private client of EDF. Its purpose is to propose accurate short-term forecasts (each hour) for particular clients by using past electricity loads and temperature loads. Parametric models (such as ARMAX or SARIMAX) are semiparametric models (based on sliced inverse regression) have been studied and evaluated on the data. The total value of the contract is 20 000 euros.
I4S Team

7. Contracts and Grants with Industry

7.1. SVS

Participants:  Laurent Mevel, Michael Döhler.

Annual agreement INRIA-SVS 2381 + contract 4329

SVS (Structural Vibration Solutions A/S) is a company located in Aalborg, Denmark, having strong connections with the Department of Civil Engineering of University of British Columbia, CA (Prof. Carlos Ventura). SVS and I4S are investigating how to link the modal analysis software ARTeMIS of SVS and COSMAD. Through an annual agreement, I4S gets a license of ARTeMIS in exchange to offer support for integrating our damage detection software into SVS software and offerings. A contract has been signed, where I4S provides algorithms and expertise for integration within a damage detection structural health monitoring system and SVIBS does the implementation. This technology transfer has been funded by the ministry of transportation of British Columbia, Canada. The work is supervised by UBC, CA. The end product will be a web based structural health monitoring system for in operation bridges.

I4S is doing technology transfer towards SVS to implement I4S technologies into ARTEMIS Extractor Pro. This is done under a royalty agreement between INRIA and SVS. First achievements include the implementation of the so called Crystal Clear SSI, a subspace variant, with much lower signal to noise ratio, and whose interest in the mechanical engineering community is very high. This year, the merging algorithm [16] and the fast implementation of subspace methods [20] has been performed. Other I4S algorithms are currently under review to be integrated within ARTEMIS. SVS and I4S are also related in the related IAPP ISMS and the SIMS project.

7.2. SNECMA

Participant:  Laurent Mevel.

Contracts INRIA signed in December 2009 (2009-alloc 4589) and July 2010 (2010-alloc 5110).

In 2007, I4S has investigated for SNECMA an identification case study on some undisclosed engine structure. Successful results yield to the delivery of the COSMAD toolbox for internal evaluation at SNECMA. The end goal is the use of COSMAD in the industrial process of SNECMA. Internal evaluation of COSMAD has been performed inhouse by SNECMA in 2008. A contract has been signed and some software package has been developed to suit SNECMA needs in 2011. Work on the SNECMA prototype has been performed in 2009 to 2011.

7.3. PhD CIFRE with Dassault Aviation

Participants:  Laurent Mevel, Philippe Mellinger.

Following the FliTE2 project, a joint PhD thesis between INRIA and Dassault Aviation has been initiated. The thesis will pursue the work achieved in FliTE2 and started in June 2011 funded by Dassault Aviation and the CIFRE Agency.
6. Contracts and Grants with Industry

6.1. Contracts with Industry

Consortium Premia presently composed of CALYON, Société Générale, Natixis, and Pricing Partners.

6.2. Grants with Industry

- Chair “Risques financiers”, Fondation du Risque: 2007-2012
- Fondation Natixis grant
- Fondation Axa grant
7. Contracts and Grants with Industry

7.1. Grants with Industry

Academic and industrial collaborations are supported by CSDL (Complex Systems Design Lab) project of the Pôle de Compétitivité SYSTEM@TIC PARIS-REGION (11/2009-10/2012). Among the involved industrial partners, we can mention Dassault Aviation, EADS, EDF, MBDA and Renault. The goal of the project is the development of a scientific platform of decisional visualization for preliminary design of complex systems.
7. Contracts and Grants with Industry

7.1. Contracts with Industry

7.1.1. ANR projects

- N. Champagnat is member of the ANR MANEGE (Modèles Aléatoires eN Écologie, Génétique et Évolution, started in 2009 under the direction of S. Méléard, Ecole Polytechnique) whose aim is to provide methodological and conceptual advances in the study of stochastic processes modeling ecology, population genetics and evolution of life. This work is sustained by regular exchanges with biologists from several teams in France. In addition, the three working groups that operate in each of the three poles of the MANEGE project (Paris, Palaiseau, Marseille) gather all local probabilistic interests in the issues of this project. http://www.cmap.polytechnique.fr/~anr-manege/index_en.html

- N. Champagnat is member of the ANR MODECOL (Using mathematical MODeling to improve ECOlogical services of prairial ecosystems, started in 2009 under the direction of C. Mony, Univ. Rennes 1), whose goal is to develop computational ecological modeling of terrestrial plants communities via the simulation of a prairie in relation with environmental data. This project focuses on developing an original tool-box that takes advantage of complementary mathematical disciplines (partial differential equations, individual-based stochastic modelling...) to assess ecological problems. Simulations will be extensively processed using distributed computing and webcomputing. Our target application concerns the setup of herbal strips around intensive cereal fields for purificating water from extra nitrate and pesticides, imposed by the European Common Agricultural Policy. http://ecobio.univ-rennes1.fr/modecol/gb/description.php

- S. Herrmann, D. Talay and E. Tanré are member of the ANR MANDy (Mathematical Analysis of Neuronal Dynamics, started in 2009 under the direction of M. Thieullen, Univ. Paris 6). This project, which gathers mathematicians and neuroscientists, aims at developing mathematically rigorous approaches to neuroscience considering single neurons as well as interconnected neuronal populations. Our target is to conduct the mathematical analysis of existing models where there is still much work to be done and to enrich the modelling by proposing new models. See http://www.proba.jussieu.fr/pageperso/thieullen/MANDy/accueil.html for a more complete description of this project.

- P.-E. Jabin is member of the ANR MONUMENTALG (MOdélisation mathématique et simulations NUMériques pour la dégradation biologique des MONUMENTs et pour la prolifération des ALGues) on the dispersion of toxic algae, starting in 2010 (dirercted by M. Ribot, Univ. Nice – Sophia Antipolis). http://math.unice.fr/~ribot/anr.html

- A. Lejay is member of the ANR ECRU (Exploration des Chemins RUgueux, 2009–2011), whose aim is to explore new directions in the field of rough paths (directed by M. Gubinelli, Univ. Paris Dauphine). http://www.ceremade.dauphine.fr/~mgubi/ecru/index.html

- A. Lejay is member of the ANR SIMUDMRI (Simulation du signal d’IRM diffusion dans tissus biologiques) which started in November 2010 (directed by Jing-Rebecca Li, INRIA Rocquencourt).

7.1.2. Contracts with ADEME

Participants: Mireille Bossy, El Hadj Aly Dia, Jacques Morice, Laurent Violeau.
Local modeling for the wind velocity  Since 2005, M. Bossy was member of a collaboration with the Laboratoire de Météorologie Dynamique (Université Paris 6, École Polytechnique, École Normale Supérieure), funded by the French Environment and Energy Management Agency (ADEME), concerning the modeling and the simulation of local wind energy resources. We collaborate with P. Drobinski. This year was the last year of the second phase of this collaboration started in October 2007, with two other partners: A. Rousseau (MOISE team, INRIA Grenoble – Rhône-Alpes) and F. Bernardin (CETE Clermont-Ferrand).

We investigated a new numerical simulation method for the downscaling in CFD, with a strong orientation in applications to meteorology, particularly for the simulation of wind at small scales. The local model that we propose consists in modeling the fundamental equations of fluid motion by a stochastic Lagrangian model describing the behaviour of a fluid particle.

Because of the both Lagrangian and stochastic nature of our model, it is discretized thanks to an interacting particle system, combining a time Euler scheme for stochastic differential equations and a Monte–Carlo approximation method.

This model called SDM (Stochastic Downscaling Method) is adapted from previous works introduced by S.B. Pope [41] (see http://sdm.gforge.inria.fr/Accueil/index.en.php).

This year, we worked on the comparison of the SDM model (endowed with a physical geostrophic forcing and a wall log law) with simulations obtained with a LES method (Méso-NH code) for the atmospheric boundary layer (from 0 to 750 meters in the vertical direction), in the neutral case.

This work allowed to deeply understand the contribution of each elements of the Lagrangian model in terms of the turbulence production and dissipation, we analysed the returns of various closure parametrisations approaches, including viscosity turbulent approach. We also investigated anisotropic effect, with the introduction of a GLM model in SDM (see [41]), in particular the isotropic relaxation case. We gave our conclusions as a part of the final report for ADEME [28], http://hal.inria.fr/hal-00646422/en. A paper is in preparation.

Carbon value and carbon tax in the context of renewable energies deployment  Since January 2009, M. Bossy was member of a collaboration funded by the French Environment and Energy Management Agency (ADEME), involving the Center for Applied Mathematics (CMA) at Mines ParisTech, and COPRIN and TOSCA teams at INRIA Sophia Antipolis. It focuses on a short term carbon value derived from the so-called financial carbon market, the European Union Emission Trading Scheme (EU ETS), which is a framework for GHG emissions reduction in European industry.

The objective of this project is to study the compatibility and complementarity of a carbon tax and a target for renewable energy deployment. As a first step, we are developing a method for assessing the EU ETS value. We consider the constraints related to emission allowances distributed through national plans of allocation (NAP) and the mechanisms of taxes that are taking place. The work will focus on electricity producers, key players in the market in its first phase (NAP-I, 2005-2007). The impact of the Renewable Energies park of the electricity producers on their own carbon value will be particularly studied.

We have selected the financial concept of indifference price as a relevant methodology to assess the European Union Emission Trading Scheme (EU ETS) value. In this setting, modelling strategies of production and emission of market quotas rely on stochastic optimal control problems and associated Hamilton-Jacobi-Bellman equations.

This year, we worked on the calibration (with EPEX Spot data) of the selected panel of electricity spot price models, as input of the indifference price solver. We also added the reduction cases (studied in our collaboration with CMA-MinesParisTech mentioned above) into the solver and we started to implement the 3D case solver, required for some electricity spot price models. We used the current version of CarbonQuant to compare a tax situation with the allowances market situation.
We also continued the study of a game theoretic approach based on the Nash equilibrium concept for the coupled electricity and carbon markets (see the 2011 Activity Report of the COPRIN team).

7.1.3. Industrial contracts

- TOSCA Nancy starts a working group with the SME Alphability on risk measures and rare events in finance.
- The contract between TOSCA and GDF-Suez on the hedging of power plants ended in January.
- In collaboration with V. Reutenauer (CA-CIB) D. Talay and E. Tanré worked on the contract with CA-CIB (ex-CALYON), which concerned
  - the study of the liquidity risk in the interest rate options market;
  - the minimization of the hedging error in interest rates Gaussian models by means of strategies designed in an effective way by using stochastic optimization algorithms.

This contract ended this year.