



agence d'évaluation de la recherche  
et de l'enseignement supérieur

Section des Unités de recherche

Report from the visiting committee

Research unit :

Simulation Avancée du Transport des  
Hydrocarbures – ERTint 1058

University Pierre et Marie Curie



February 2008



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*Le Directeur*

**Jean-Jacques Aubert**

February 2008

# Report from the visiting committee



## The research unit :

Name of the research unit : Simulation Avancée du transport des hydrocarbures

Requested label : ERTint

N° in case of renewal : 1058

Head of the research unit : Mr Frédéric COQUEL

## University or school :

University Pierre et Marie Curie - Paris 6

## Other institutions and research organization:

## Date(s) of the visit :

January 7 to 10 of 2008



# Members of the visiting committee

## Chairman of the committee :

Sir John BALL, Professor, Oxford University

## Other committee members :

Mrs Claudia KLÜPPELLBERG, Professor, Munchen Technic University

Mrs Ragni PIENE, Professor, Oslo University

Mr. Dominique BAKRY, Professeur, University of Toulouse 3

Mr Andreas BLASS, Professeur, University of Michigan

Mr Donald DAWSON, Professor, University of Carleton

Mr Philippe DEPOUILLY, IR1, Bordeaux

Mr Bjorn ENGQUIST, Professor, University of Texas

Mr Richard GILL, Professor, University of Leiden

Mr Fritz GRÜNEWALD, Professor, University of Dusseldorf

Mr Gilles LEBEAU, Professor, University of Nice-Sophia Antipolis

Mr Pierre PANSU, Professor, University of Paris-Sud

Mr J. Tobias STAFFORD, Professor, University of Manchester

Mr Dominique DE WERRA, Professor, Ecole Polytechnique Fédérale de Lausanne

## CNU, CoNRS, CSS INSERM, (représentant INRA, INRIA, IRD...) representatives :

Mr Fabrice PLANCHON, Professor, CNRS representative for UMR\_S, section 1, for IMJ, LOGIQUE MATH., LJLL, LPMA

Mr Philippe BAPTISTE, Chargé de Recherches, section 7, for ECO, CNRS representative for UMR\_S

H. QUEFFELEC, Professor, University of Lille 1, CNU 25 representative, for IMJ and LOGIQUE MATH.

E. SONNENDRÜCKER, Professor, University of Strasbourg 1, CNU 26 representative, for LJLL and ECO

A. DEBUSSCHE, Professor, ENS Cachan, CNU 26 representative, for LPMA and LSTA

## AERES scientific representative:

Mr Pascal AUSCHER and Mr Michel PIERRE

## University or school representative:

Mr Jean-Charles POMEROL, President of the University Pierre et Marie Curie - Paris 6

Mr Guy COUSINEAU, President of the University Denis Diderot - Paris 7

## Research organization representative (s) :

Mr Jean-Marc GAMBAUDO, Directeur Scientifique Adjoint, CNRS, MPPU, Mathématiques and Interactions

Mrs Valérie BERTHE, Chargée de mission, CNRS, ST2I, Informatique et Mathématiques



# Report from the visiting committee

## 1 • Short presentation of the research unit

Numbers of lab members including researchers with teaching duties, full time researchers, ingeneers, PhD. students, technicians and administrative assistants : 8 including 6 researchers with teaching duties from Laboratoire Jacques Louis Lions and 2 researchers from Institut Francais du Pétrole.

All the relevant numbers for scientists from Laboratory Jacques Louis Lions are printed on the LJLL report.

## 2 • Preparation and execution of the visit

The committee was in charge of making a review of six mathematical laboratories in the Chevaleret centre, of a federation and of an internal ERT. The committee was asked to produce an overall report on the mathematics of the Chevaleret centre. During the first day, the committee heard presentations by the directors. There was also a short presentation of the Masters programs and of the Ecole Doctorale des Sciences Mathématiques de Paris-Centre, and a presentation, with a visit, of the Chevaleret Research Mathematics Library. During the second and third day, the committee split into three subcommittees to review each laboratory separately. A review on technicians and administrative assistants was done in parallel. The committee ended the third day with a long debriefing. On the fourth day, the committee gathered again to meet the university and CNRS representatives. A brief summary of each subcommittee's conclusions was then presented to the directors and group leaders, in the context of a meeting of the whole review committee and the leaders of all the units under review. The fourth day ended with a long session during which the committee started the preparation of the reports.

An earlier project on flows of oil and gas mixtures in pipelines (ERTint 1058) and plans for the upcoming project on enhanced oil recovery were presented to the subcommittee (J. Ball, B. Engquist,, D. de Werra, F. Planchon, E. Sonnendrücker) on January 8 and 9 during the evaluation of Laboratoire Jacques Louis Lions. Researchers who are active in the projects presented them and gave good insight into the relevant scientific issues.

## 3 • Overall appreciation of the activity of the research unit, of its links with local, national and international partners

Oil reservoir modelling is a scientific field that has supplied computational mathematics with interesting and challenging problems, and more importantly, it is a field that has benefited greatly from advanced mathematical and numerical modelling.

The Laboratoire Jacques-Louis Lions (LJLL) is naturally not one of the major research units in the world in mathematical oil reservoir modelling. The ERT is just a small part of the activities in LJLL and should be seen as making very focussed efforts on particular well-defined problems. The fact that LJLL does not have a long history in the field but an excellent general background in mathematical and numerical analysis could well increase the possibility of original and unexpected contributions.



#### 4 • Specific appreciation team by team and/or project by project

The earlier project on numerical simulation of flow of oil gas mixtures in pipelines has produced important scientific results in numerical analysis that have been published in several papers, together with software for the simulation of slugging in pipes. This has significantly increased the understanding of the simulation of such processes.

The mathematical model is a nonlinear time-dependent one-dimensional hyperbolic partial differential equation for the dependent variables of density, velocity and gas mass fraction. The physical challenge is the existence of strong pressure peaks and the numerical challenges come, for example, from nonlinearities and stiffness. A number of elegant numerical techniques were devised, including implicit-explicit conservative schemes with multiresolution analysis and time-space adaptivity.

The new project on numerical techniques for enhanced oil recovery focusses on adaptive mesh refinement in finite-element approximations of multiphase flow in porous media. The physical problem is enhanced oil recovery where steam is injected to heat up an oil-water mixture.

The mathematical model couples Darcy's law to mass and energy conservation in a multi-dimensional nonlinear partial differential equation. Early tests have been done with adaptive mesh refinements for simple linear model problems. In order for this project to reach its full potential the team is encouraged to interact with other groups in LJLL, for example, with respect to goal oriented adaptivity, shock capturing and homogenization or upscaling.

#### 5 • Appreciation of resources and of the life of the research unit

The ERT research groups are coming from LJLL and IFP and well integrated in these larger units. The technology transfer between the ERT team and other groups in LJLL and IFP is essential and seems to have worked well.

#### 6 • Recommendations and advice

##### – Strong points :

The earlier project on the flow of oil gas mixtures in pipelines has produced results of a very high level both from the point of applications and the development and analysis of computational tools.

The new project on enhanced oil recovery has also the potential to become excellent by tapping into the full resources of LJLL.

##### – Recommendations :

The leadership of LJLL is strongly encouraged to continue and potentially extend this fruitful collaboration with IFP on specific and exciting research problems within the expertise of the laboratory.