Séminaire de l'institut Farman FR 3311 CNRS - ENS Cachan –- 5 avril 2016

« ***Ecoulements dans les turbomachines hydrauliques*** »

François Avellan, Professeur, École polytechnique fédérale de Lausanne (EPFL), directeur du Laboratory for Hydraulic Machines (EPFL)

Résumé : *Suivant leur condition de fonctionnement les turbines hydrauliques ou les pompes-turbines réversibles sont le siège d'écoulements turbulents instationnaires complexes associant la turbulence à très grand nombre de Reynolds, des instabilités hydrodynamiques à l'origine de phénomène de décollement et des phénomènes de cavitation. Le séminaire de présentera quelques exemples de recherche menée à l'EPFL sur ce types d'écoulements*.

Biographie : Prof. François Avellan, director of the EPFL Laboratory for Hydraulic Machines, graduated in Hydraulic Engineering from Ecole nationale supérieure d'hydraulique, Institut national polytechnique de Grenoble, France, in 1977 and, in 1980, got his doctoral degree in engineering from University of Aix- Marseille II, France. Research associate at EPFL in 1980, he is director of the EPFL Laboratory for Hydraulic Machines since 1994 and, in 2003, was appointed Ordinary Professor in Hydraulic Machinery. Supervising 36 EPFL doctoral theses, he was distinguished by SHF, Société hydrotechnique de France, awarding him the "*Grand Prix 2010 de l'hydrotechnique*".
His main research domains of interests are hydrodynamics of turbine, pump and pumpturbines including cavitation, hydro-acoustics, design, performance and operation assessments of hydraulic machines. Prof. Avellan was Chairman of the IAHR Section on Hydraulic Machinery and Systems from 2002 to 2012. He has conducted successfully several Swiss and international collaborative research projects, involving key hydropower operators and suppliers, such as:

- Coordination for the FP7 European project n° 608532 "*HYPERBOLE: **HY**dropower plants **PER**formance and flexi**B**le **O**peration towards **L**ean integration of new renewable **E**nergies*" (2013-2017);
- Deputy Head of the Swiss Competence Center for Energy Research – Supply of Electricity (SCCER-SoE) to carry out innovative and sustainable research in the areas of geo-energy and hydropower for phase I (2013-2016) and Phase II (2017-2020).
- EUREKA European research projects: N° 4150 and N° 3246, "HYDRODYNA, Harnessing the dynamic behavior of pump-turbines", (2003-2011), N° 1605, "FLINDT, Flow Investigation in Draft Tubes", http://flindt.epfl.ch/, (1997-2002). N° 2418, "SCAPIN, Stability of Operation of Francis turbines, prediction and modeling"; Swiss KTI/CTI research projects with ALSTOM Hydro, Birr, SULZER Pumps, Winterthur and ANDRITZ Hydro, Zürich.
- ETH Domain, HYDRONET Project for the Competence Center Energy and Mobility, PSI Villingen.

Moreover, he is involved in scientific expertise and independent contractual experimental validations of turbines and pump turbines performances for the main hydropower plants in the world. In recognition for his work as Convenor of the IEC TC4 working group of experts in editing the IEC 60193 standard he received the IEC 1906 Award.

"**Microfluidique pour les applications biomédicales: exemple de recherches portant sur l'étude de la déformabilité cellulaire**"

Olivier Français, Maître de conférences, Laboratoire SATIE UMR 8029, ENS Cachan.

Résumé : *La microfluidique est désormais un « outil technologique » qui se décline en quatre familles (continue, centrifuge, digitale et papier) et ses applications concernent de plus en plus le monde*

biomédical. Le séminaire introduira le concept de la microfluidique et l'intérêt des écoulements aux petites échelles. Il présentera les développements qui sont menés au SATIE (Groupe Biomis), en appui de la plateforme microfluidique de l'Institut d'Alembert, pour l'étude de pathologies du globule rouge altérant ses propriétés mécaniques (Drépanocytose et Malaria).

Biographie : Olivier Français est Maître de Conférences à l'ENS de Cachan et chercheur au laboratoire SATIE. Il y mène des travaux dans le domaine des bio-microsystèmes et de la microfluidique. Il s'intéresse plus spécifiquement à l'étude de l'interaction entre champ électrique et cellules biologiques sur puces microfluidiques (diélectrophorèse, électroperméabilisation, bioimpédance…). Récemment, son activité de recherche s'est orientée sur l'ingénierie et la mise en œuvre d'environnements biomimétiques autour de la reconstruction osseuse et de l'étude de l'écoulement sanguin au sein de micro-capillaires pour l'analyse et le diagnostic de la déformabilité de cellules (globules rouges).

« **Computational Fluid Mechanics: recent numerical solvers with special focus on HPC performance modeling**»

Florian De Vuyst, Professeur, Laboratoire CMLA UMR 8536, ENS Cachan.

Résumé : *Our first experience in GPU computing was to design "real-time" interactive computational 2D flow dynamics simulation, using Infra Red pointers. First experiments succeeded and showed significant speedups on NVIDIA TESLA boards, but with noteworthy variations according to the choice of data structures but also to the choice of the computational approach. Performance issues appeared to be somewhat difficult to understand. So we decided to focus on performance modeling, on multicore architectures as a first stage. Starting from a legacy Hydrodynamics solver (of the Lagrangian remapping family), we achieved the performance modeling of the method using first a roofline-type model, then a finer Execution Cache Memory (ECM) model. The analysis kernel-per-kernel has given strong highlights on the global performance of the numerical approach. It even gave us new ideas of redesign of alternative computational approaches. SIMD feature, arithmetic intensity and data alignment are of course key factors. More generally, some computational approaches appear to be particularly suitable for HPC on manycores like Lattice Boltzmann approaches for example, sometimes inviting for changes of paradigm for the numerical model*.

Biographie : Florian De Vuyst is full-professor at Ecole Normale Supérieure de Cachan Université Paris-Saclay, co-director of Centre de Mathématiques et de leurs applications, CMLA CNRS UMR 8536, Director of the multidisciplinary Farman Institute FR 3311 and teaches at the Department of Mathematics. Florian's fields of Research are scientific computing of PDEs, numerical modeling, numerical analysis, HPC on manycore/multicore, parallel algorithms, CFD and reduced-order modeling. He is involved in the governance of Fondation de Mathématiques Jacques Hadamard FMJH, the structure of Mathematics at Paris-Saclay University. He was also awarded for a NVIDIA CUDA Research Center in 2013 and for the EquipEx DIGISCOPE, big infrastructure of large display walls and devices for visualization and interaction withing Saclay's area.