



3rd International Workshop

Reduced Basis, POD and PGD Model Reduction Techniques

École Normale Supérieure de Cachan
France - November 4-5-6, 2015

An IACM Special Interest Conference



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co-organized by
LMT-Cachan (ENS Cachan / CNRS / Université Paris-Saclay)
GeM Institute (Centrale Nantes / CNRS / Université de Nantes)



Workshop

Reduced Basis, POD and PGD Model Reduction Techniques

Co-Chairmen

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Scope

After Cachan 2011 and Blois 2013, this new workshop is devoted to recent advances in model reduction techniques and their potential impact in computational and prediction sciences, especially (but not only) in mechanical engineering.

Practical focus will be on recent developments in Reduced Basis (RB) approaches, Proper Orthogonal Decomposition (POD) and Proper Generalized Decomposition (PGD) methods for the numerical resolution of models involving partial differential equations. Other model size reduction methods are welcome in order to foster cross-fertilization of ideas and their synergy.

Mechanics, like other domains, continues to supply numerous engineering problems which, despite the impressive progress of computational simulation techniques, remain intractable today. RB, PGD and other model reduction methods are leading to a new generation of high-performance computational tools which provide solutions to engineering problems which are inaccessible to standard codes based on classical and well-established numerical techniques. This is a true breakthrough with a potential gain of several orders of magnitude.

The workshop is intended to be a meeting ground for the various contributors, including mechanicians, applied mathematicians and other researchers and engineers involved in testing and computation. The Workshop should provide answers to such questions as:

- What are the benefits, but also the drawbacks, of RB and POD/PGD methods?
- What engineering challenges, especially in mechanics, could be addressed in the near future?
- What are the key scientific issues?

Main topics

- Advances in RB, POD and PGD methods
- Convergence analysis
- Verification and adaptive approaches
- Multiscale and multiphysics problems
- Uncertainty quantification and propagation
- Quasi-real-time simulation and control, optimization and design
- Engineering applications

Local organizing and scientific committee

P.-A. Boucard, L. Chamoin, F. Chinesta, C. Farhat, D. Guedra-Degeorges,
P. Ladevèze, Y. Maday, D. Néron, A. Nouy

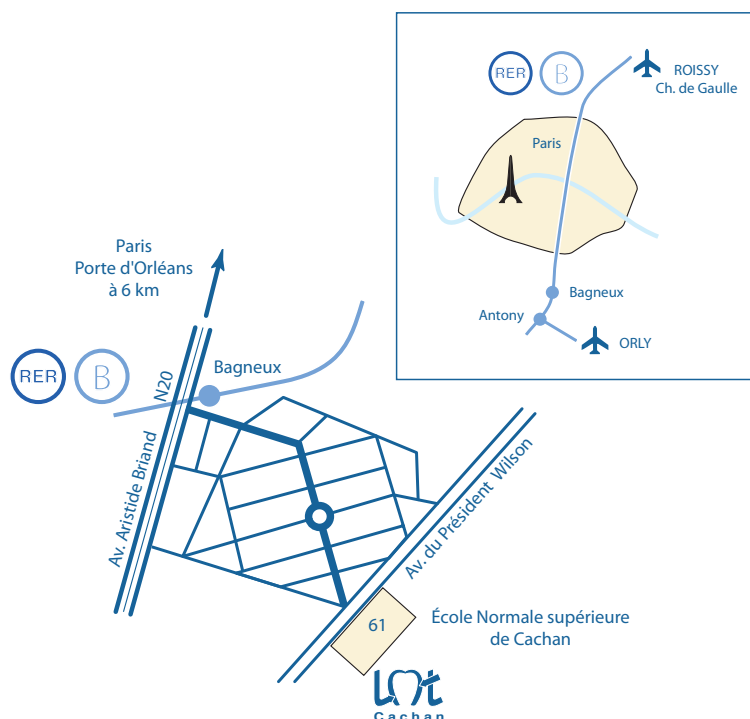
Advisory scientific committee

S. Andrieux	EDF
C. Farhat	Stanford University
D. Guedra-Degeorges	AIRBUS Group Innovations
A. Huerta	Universitat Politècnica de Catalunya
T. Hugues	University of Texas at Austin
Y. Maday	UPMC
H. Matthies	Technical University of Braunschweig
A. Patera	Massachusetts Institute of Technology
T. Oden	University of Texas at Austin
E. Onate	Technical University of Catalonia
A. Quarteroni	EPFL
B. Schrefler	University of Padua
P. Wriggers	Leibniz Universität Hannover
G. Yagawa	University of Tokyo

Supporting organizations



Location



Programme

Day 1 - Wednesday, November 4

07:45

Registration

08:30

08:30

Opening

08:45

Pierre-Paul Zalio (President of ENS Cachan), Pierre Ladevèze, Francisco Chinesta

Session I (chair: Francisco Chinesta)

08:45

Keynote: Yvon Maday

09:20

A new concept of reduced basis approximation for convection dominated problems

09:20

Keynote: Karen Willcox

09:55

Data-Driven Model Reduction to Support Decision Under Uncertainty

09:55

Technical paper: Roxana Crisovan, Rémi Abgrall, David Amsallem

10:15

Robust Model Reduction by L1-norm Minimization and Approximation via Dictionaries: Application to Linear and Nonlinear Hyperbolic Problems

10:15

Coffee break

10:45

Session 2 (chair: Karen Willcox)

10:45

Invited technical paper: Bernard Haasdonk, Markus Dohlmann

11:10

A Reduced Basis Kalman Filter for Certified and Rapid State Estimation of Parametrized PDEs

11:10

Invited technical paper: David Ryckelynck

11:35

Model calibration by using hyper-reduction in statics and dynamics of elastoplastic materials

11:35

Invited technical paper: Joaquin A. Hernandez, Javier Oliver

12:00

Dimensional hyperreduction of nonlinear parameterized models

12:00

Technical paper: Andrea Manzoni, Stefano Pagani

12:20

A reduced-order framework for the efficient solution of inverse Uncertainty Quantification problems

12:20

Technical paper: Patrick Héas, Cédric Herzet

12:40

Inverse Reduced-Order Modeling

12:40	Lunch
14:15	

Session 3 (chair: Antonio Huerta)	
14:15	Keynote: Philip Avery, Todd Chapman, <u>Charbel Farhat</u>
14:50	Dimensional Reduction of Nonlinear Deformable Dynamic Contact Problems
14:50	Keynote: <u>Pierre Ladevèze</u>
15:25	Reduced Models in Nonlinear Solid Mechanics: State of the Art and Challenges
15:25	Technical paper: <u>Serge Prudhomme</u>, Kenan Kergrène, Marc Laforest
15:45	PGD formulations for interface problems

15:45	Break
16:00	

Session 4 (chair: Bernard Haasdonk)	
16:00	Invited technical paper: <u>Antonio Huerta</u>
16:25	Domain decomposition for in-plane/out-of-plane model reduction approaches by the Proper Generalized Decomposition
16:25	Invited technical paper: <u>Elias Cueto</u>
16:50	Manifold learning techniques for shape characterization and interpolation
16:50	Technical paper: <u>Timoleon Kipouros</u>, Andoni Agirre-Mentxaka, Marco Hahn
17:10	Historic data mapping for aircraft computational design
17:10	Technical paper: <u>Boyan S. Lazarov</u>
17:30	Topology optimization under manufacturing uncertainties using reduced order models

18:45	Visit of Louvre museum
20:15	
20:30	Diner at Saint James Albany Restaurant (202 Rue de Rivoli, 75001 Paris, close to Louvre museum)
23:00	

Day 2 - Thursday, November 5

Session 5 (chair: Alfio Quarteroni)	
08:30	Keynote: <u>Francisco Chinesta</u>
09:05	Computational vademecums for large industrial applications
09:05	Keynote: A. Radermacher, <u>Stephanie Reese</u>, Brett Bednarczyk
09:45	Displacement-based multiscale modeling and substructuring by means of POD
09:45	Invited technical paper: <u>Claude Lebris</u>
10:10	Reduced order models (and beyond) for the optimization of microstructures in materials science
10:10	Invited technical paper: <u>Ramon Codina</u>, Joan Baiges, Sergio Idelsohn
10:35	Dynamic reduced order subscales for POD models in fluid mechanics

10:35	Coffee break
11:00	

Session 6 (chair: Stephanie Reese)	
11:00	Invited technical paper: <u>Sergio Idelsohn</u>, Julio Marti, Norberto Nigro
11:25	Enriched spaces: a class of Reduced Order Model for problems with moving interfaces
11:25	Invited technical paper: <u>David Néron</u>, Pierre-Alain Boucard, Pierre Ladevèze
11:50	PGD-Reduced Models for several parametrized nonlinear problems
11:50	Invited technical paper: <u>David Amsallem</u>, Bernard Haasdonk
12:15	Nonlinear Model Reduction Using hp-Local Reduced-Order Bases
12:15	Technical paper: <u>Michel Visonneau</u>
12:40	A new PGD-based time space decomposition for the unsteady Navier-Stokes equations applied to incompressible flows

12:40	Lunch
14:15	

Session 7 (chair: Charbel Farhat)	
14:15	Keynote: <u>Albert Cohen</u>
14:50	Data assimilation in reduced modeling
14:50	Keynote: <u>Alfio Quarteroni</u>
15:25	DGRBE (Discontinuous Galerkin Reduced Basis Element) methods for PDEs on partitioned domains
15:25	Invited technical paper: <u>Abdallah El Hamidi</u>
15:50	On the PGD for non-smooth variational problems
15:50	Technical paper: <u>Kevin Carlberg, Matthew Barone, Harbir Antil</u>
16:10	Discrete-optimal projection in nonlinear model reduction

16:10	Break
16:40	

Session 8 (chair: Gianluigi Rozza)	
16:40	Invited technical paper: <u>Amine Ammar, Francisco Chinesta, Elias Cueto</u>
17:05	Chemical Master Equation: Separated representation resolution and empirical moment-closures
17:05	Invited technical paper: <u>Piotr Breitkopf, Pierre Villon</u>
17:30	Shape manifold approach for reduced order modeling in optimization, springback quantification and inverse analysis

Session 9	
17:30	Poster presentation: Yvon Maday, Pierre Villon
21:00	Posters, Wines and Cheeses

Day 3 - Friday, November 6

Session 10 (chair: Albert Cohen)	
08:30	Keynote: <u>Hermann G. Matthies</u>
09:05	Construction of Reduced Order Models via Bayesian Identification
09:05	Keynote: <u>Didier Mazon</u>
09:40	Challenges in Tokamak control and links with measurements and actuators
09:40	Invited technical paper: <u>Florian De Vuyst</u>
10:05	Time-dependent problem solvers: a survey of IMEX, LATIN, PARAEXP and PARAREAL algorithms, and use of exponential integrators and other ROMs
10:05	Invited technical paper: <u>Anthony Gravouil, David Dureisseix, Anthony Giacomini, Michel Rochette</u>
10:30	Multi-scale acceleration techniques for non-linear analysis of structures with frictional contact

10:30	Coffee break
11:00	

Session 11 (chair: Hermann G. Matthies)	
11:00	Invited technical paper: <u>Gianluigi Rozza</u>
11:25	Recent advances and perspectives on Model Order Reduction in CFD
11:25	Invited technical paper: <u>Anthony Nouy, Olivier Zahm</u>
11:50	Preconditioners for parameter-dependent equations and goal-oriented model order reduction
11:50	Invited technical paper: <u>Athanasios C. Antoulas</u>
12:15	Data-driven model reduction in the Loewner framework.
12:15	Invited technical paper: <u>Pedro Díez, Sergio Zlotnik, Antonio Huerta</u>
12:40	Error arising from the separation of input data in PGD: a priori estimates and implementation best practices
12:40	Technical paper: <u>Jose Paulo Moitinho de Almeida, Carlos Tiago</u>
13:00	PGD solutions for Kirchhoff plates on an elastic foundation: Error bounds and other issues

13:00	Lunch and End of the Workshop
14:30	

Poster Session

Pierre-Eric Allier, Ludovic Chamoin, Pierre Ladevèze

PGD driven by the Constitutive Relation Error - Minimal CRE/PGD

Benjamin Brands, Julia Mergheim, Paul Steinmann

Reduced-Order Modelling using Nested POD

Nicolas Bur, Pierre Joyot, Francisco Chinesta, Pierre Villon

Optimal control for heat equation using PGD

Ba Trung Cao, Steffen Freitag, Günther Meschke

Hybrid RNN-GPOD surrogate model for real-time simulations with uncertain data in mechanised tunnelling

Amaury Courard, David Néron, Pierre Ladevèze, Alain Bergerot, Ludovic Ballere

Engineering structural design and optimization through PGD-virtual charts

Pierre Despret, Jean-Luc Dulong, Pierre Villon

A new way to solve the heat equation with PGD

Felix Fritzen, Matthias Leuschner, Liang Xia

Nonlinear multi-scale topology optimization using the FE2 Reduced (FE2R) method

Raquel García-Blanco, Pedro Díez, Domenico Borzacchiello, Francisco Chinesta

LATIN-PGD Solver for the Electric Grids Power Flow Problem

Christian Gogu

Topology optimization with millions of design variables aided by reduced order modeling

Dennis Grunert, Jörg Fehr

Identification of nonlinear behavior with clustering techniques in car crash simulations for better model reduction

Thomas Henneron, Stéphane Clénet

PGD and (D)EI methods apply to solve non-linear magnetostatic Problems coupled with electric circuit equations

Martin Horák, Samuel Forest, David Ryckelynck, Djamel Missoum-Benziane

Order reduction models and generalized continua

Alexandre Janon, Maëlle Nodet, Clémentine Prieur

Goal-oriented error estimation for the reduced basis method, Application to sensitivity analysis

Maxime Jessus, David Néron, Pierre Ladevèze

PGD-models for Lack-of-Knowledges' prediction in nonlinear structural problems

Ettore Lappano, Franck Naets, Martijn Vermaut, Domenico Mundo, Wim Desmet

Application of Parametric Model Order reduction to beam-based structures

Liang Meng, Piotr Breitkopf, Balaji Raghavan, Gérard Mauvoisin, Olivier Bartier, Xavier Hernot

Identification of material properties using indentation test and shape manifold learning approach

Laurent Montier, Thomas Henneron,, Stéphane Clénet, Benjamin Goursaud

Reduction of Finite Element Model of a rotating electrical machine

Mohamed A. Nasri, Camille Robert, Saber El Arem, Franck Morel, Amine Ammar

Proper Generalized Decomposition (PGD) for numerical calculation of polycrystalline aggregates under cyclic loading

Yannick Paquay, Olivier Brüls, Christophe Geuzaine

Model Order Reduction of Nonlinear Magnetodynamics with Manifold Interpolation

Matthieu Vitse, Pierre-Alain Boucard, David Néron

Seismic structural problems: damage prediction and its variability through PGD-models

Liang Xia, Piotr Breitkopf

Multiscale structural topology optimization with an approximate constitutive model for local material microstructure

Thanks for your participation!

**Hoping that you had a pleasant and fruitful workshop,
have a nice trip back and see you soon !**



Views of the future ENS Cachan building after the move to the Campus of Paris-Saclay University in 2018 (Renzo Piano Buildings Workshop, Architects)