1st Workshop on Uncertainty Modeling for ElectroMagnetic Applications (UMEMA)

June 29th – July 1st 2015

Saint-Nectaire, Hotel « Les Bains Romains »

Editorial

The increasing concerns about the importance of uncertainties in electromagnetic context (theoretical, numerical, and experimental) lead to a growing number of studies, programs and applications in this domain. In this framework, and on behalf of UMEMA organization committee, it is our great pleasure to thank you and your co-workers for attending the first edition of the Workshop on **Uncertainty Modeling for ElectroMagnetic Applications (UMEMA)** to be held in Saint-Nectaire (Auvergne, FRANCE) from **June 29 to July 1st 2015**. We also would like to thank our valuable partners and sponsors for their care and help in organizing UMEMA 2015.

The workshop is planned in country side: Saint-Nectaire is situated around 45 kilometers South-West from Clermont-Ferrand. It is located to a height of 700 meters and is well-known for its Roman church, thermal treatments (and casino!), and also known for its cheese you may enjoy!

The aim of this event is to offer a forum including scientific presentations and discussions about academic and industrial aspects of uncertainty modeling for electromagnetic issues. More than fourty people, coming from Croatia, France, Germany, Italy, Lebanon and United Kingdom, attend UMEMA 2015.

We hope Saint-Nectaire will provide an appropriate atmosphere for rich scientific exchanges including invited talks given from leading scientists and researchers in the domain and discussions.

In this context, we would like to thank Prof. Flavio Canavero (Politecnico Torino, Italy), Bas Michielsen (ONERA, France), Prof. David Thomas (The University of Nottingham, UK), Joe Wiart (Orange Labs, France), Jean-Marc Bourinet (IFMA, France), Lars-Ole Fichte (Helmut Schmidt University, Germany) and Flavia Grassi (Politecnico Milano, Italy) for their convened talks covering different applications and dedicated techniques to tackle the issue of uncertainty in electromagnetics.

Posters session and round-tables (benchmark testing proposals) are planned to enrich discussions and we also would like to thank authors and co-authors for their relevant contributions. A session for demonstrations and discussions is also planned to walk-through modelling steps of COMSOL Multiphysics under uncertain assumptions.

Finally, we hope this event is a nice opportunity to initiate exchanges and programs with colleagues coming from both academic and industrial words about the problem of considering uncertainties in electromagnetic issues.

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Partnership and sponsoring

Convened Sessions

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Invited talks
Room "Pascaline"
(3rd floor)

Tuesday, June 30th, 8:30 – 9:30, Room "Pascaline" (3rd floor)

Flavio Canavero (Politecnico Torino, Italy) & Paolo Manfredi (Ghent University, Belgium)

Polynomial Chaos for Variability Assessment of Electronic and Microwave Designs

Numerical simulation of microwave and electronic circuits and devices is a fundamental step in the development of high-performance electronic products due to the urging necessity to perform right-the-first-time designs. Stochastic analysis is extremely useful in the early design phase for the prediction of the system performance and for setting realistic margins whenever manufacturing tolerances or uncertainties on design parameters cannot be neglected. With the scope of developing efficient design tools, outperforming classical but time-consuming sampling-based techniques like Monte Carlo, new techniques have been proposed recently. Among these, the methodology based on the polynomial chaos theory (ie., based on the representation of the stochastic solution of a dynamical circuit in terms of orthogonal polynomials) turns out to be accurate and much faster than the commonly adopted Monte Carlo method. Polynomial chaos, whose applications in several domains of Physics are known, is presented here in the context of the simulation of single and multiconductor transmission lines and lumped linear and nonlinear multiport circuits, representing the basic elements of microwave and electronic devices. Both frequency- and time-domain approaches are discussed, and a solution paradigm directly implementable in commercial circuit solvers is presented. Also, an extension that allows decoupling the polynomial chaos equations is presented. The methodology is based on a transformation that renders the polynomial chaos coefficients decoupled, so that the computation is performed via repeated non-intrusive simulations. The advocated method not only maintains comparable accuracy with respect to the state-of-the-art approaches, but it allows also the treatment of cases with a relatively large number of random parameters, thus making feasible the simulation of realistic designs, as illustrated by examples relevant to microwave and electrical applications.

Tuesday, June 30th, 9:30 – 10:30, Room "Pascaline" (3rd floor)

Bas Michielsen (ONERA, France)

Modelling the interaction of stochastic electromagnetic fields and stochastic structures

Time-domain electromagnetic interaction theory is briefly recalled for local configurations in an embedding space. We show that generic observables, quantifying essential characteristics of an interaction, are represented by distributions corresponding to ``time-reversed'' space-time distributions of electric charge. Canonical stochastic electromagnetic fields are defined such that their covariance operator is ``natural'' and has the embedding space's Green function as kernel distribution. With these definitions, we derive expressions for the auto-covariance function of observables on stochastic fields. This gives the possibility to construct stochastic processes which are statistically equivalent with the actual observables. In order, to account for the uncertainties in the local physical configuration itself, we replace the distribution defining the observable by a stochastic distribution, defined by the solution of a stochastic boundary value problem. A simplified analysis of stochastic distributions is presented in the form of a frequency domain integral equation on a surface with small stochastic fluctuations. It is shown how we can characterise the stochastic observable when both the geometry and the environment field are stochastic.

Tuesday, June 30th, 11:00 – 12:00, Room "Pascaline" (3rd floor)

David Thomas (University of Nottingham, UK)

The characterisation and propagation of stochastic fields from printed circuit boards

The noisy electromagnetic emissions from high density circuit devices can be very complex. Efficient methods for characterising the emissions and their propagation are required. The challenge of measuring and characterizing the emissions is discussed and compared with traditional frequency domain methods. It is shown that radiated emissions from circuits can be very complex in both the time and frequency domain. A new numerical method for calculating the propagation of the stochastic fields based on ideas from wave chaos theory using Wigner-Weyl transformation and phase-space propagation techniques is discussed. It makes use of the connections between wave correlation functions and phase space densities and can directly provide statistical measures such as averages and field correlations. From analysis of propagation using the Wigner-Weyl transformation it is shown that new insights into the requirements for emission characterisation can be extracted.

Tuesday, June 30th, 13:45 – 14:45, Room "Pascaline" (3rd floor)

Joe Wiart (Orange Labs, France)

Stochastic Dosimetry to Handle the Variability in Numerical Human Exposure to RF EMF

Despite the intensive use of wireless communication systems there is today an important public concern about the exposure to electromagnetic field (EMF). The assessment of the radio frequency(RF) EMF is therefore more and more important and large effort have been conducted since 20 years to develop the RF dosimetry (i.e. numerical and experimental methods to quantify the RF exposure) and check the compliance to limits. Taking advantage of the progress in high performance calculation (HPC) the numerical dosimetry is more and more use to assess the exposure. Numerical method such as the finite difference in time domain (FDTD) method is daily use to calculate the Specific Absorption Rate (SAR) and design radio communication systems. With the increasing and versatile use of wireless communication systems the usual dosimetry is facing the challenge of the variability. In spite of large progress in HPC the FDTD calculations still request large computation time that are not compatible with usual Monte Carlo method often used to handle the variability. The stochastic dosimetry is a novel approach combing numerical electromagnetic solver and statistics to manage the influence of variations of the inputs on the outputs of heavy dosimetric numerical calculations using a combination of deterministic and statistical methods. In this talk we will present, with example, the state of the art in the deterministic dosimetry and we will introduce the new method based on surrogate modeling. We will explain how such surrogate model can be built with a truncated sparse Generalized Polynomial Chaos Expansion and regression to estimate the coefficient of the polynomials. Example such as brain exposure induced by a mobile phone having variable location will be given in the talk to illustrate the efficiency of such innovative method to handle the variability in numerical human RF exposure.

Tuesday, June 30th, 14:45 – 15:45, Room "Pascaline" (3rd floor)

Jean-Marc Bourinet (IFMA, France)

Strengths and limits of reliability assessment methods - Illustration in the field of EMC

The proper functioning of electronic systems threatened by electromagnetic interferences (EMI) is prone to uncertainties that may arise at several levels: polarization and angle of incidence of electromagnetic waves, system configuration such as placement of electronic devices and routing of cables, material electric parameters,... These uncertainties may cause severe degradations of the electromagnetic compatibility (EMC) performances of these systems (susceptibility, emission, crosstalks) and quantifying their effects on outputs of simulation models, also known as observables, is therefore of practical importance in many engineering applications.

When high safety level requirements or standards are imposed, it becomes necessary to estimate probabilities that critical systems fail w.r.t. a given failure criterion or set of criteria, e.g. currents, voltages or powers above/below prescribed threshold values. The talk will review the most efficient reliability assessment methods for estimating low failure probabilities, covering both approximation methods (FORM and SORM) and sampling methods (Monte Carlo, subset simulation). A specific focus will also be put on adaptive surrogate models (namely support vector machines) based on very recent developments, of practical importance in applications involving expensive-to-evaluate numerical models used in a non intrusive way. Some examples in the field of transmission lines will illustrate the talk and highlight the strengths and limits of reliability assessment methods.

Wednesday, July 1st, 8:30 – 9:30, Room "Pascaline" (3rd floor)

Lars-Ole Fichte (University of Hamburg, Germany)

Towards new Engineering Standards Accounting for Uncertainty in Electromagnetic Compatibility

Every new electric device has to been submitted to various tests to ensure that it does function even when exposed to an interfering external electromagnetic field. The parameters of these tests are defined by standards on national and international level, which prescribe tests under normal external fields for every operation mode of the device.

Yet, a couple of problems have occurred in the last years that should be discussed:

- In recent years, a number of research areas provided the industry with various methods to check if a shipment of items meets the prescribed specification for its items by testing a sample, e.g. acceptance sampling or hypothesis tests and confidence intervals. When one applies these methods to EMC testing, the result is very unfavorable - in the worst case, EMC testing yields results with a confidence level of less than 50 %.

- Many of the test standards were written in a time when devices did only have a small number of operation states, whereas modern digital devices show many more. Thus, the complexity of the digital world is not accounted for in the standards.
The only way around this problem is to employ statistical evaluations and to redesign the test standards.

- Aging effects, especially in semiconductors, never were discussed in EMC. Yet, since devices deteriorate during their lifetime, their emissions and their susceptibility to interference must influence their EMC characteristics even before the device breaks down.

Wednesday, July 1st, 9:30 – 10:30, Room “Pascaline” (3rd floor)

Flavia Grassi (Politecnico Milano, Italy)

Radiated susceptibility of complex cable harnesses: From deterministic to statistical modeling

The development of statistical approaches for radiated susceptibility prediction in setups involving complex wiring harnesses has recently gained increasing attention from the Electromagnetic Compatibility (EMC) Community. Indeed, the inherently-random nature of both the interfering electromagnetic field, whose characteristics are usually partially unknown, and of the cable harness, whose geometrical and electrical parameters are known with a certain degree of uncertainty, may significantly weaken the validity of deterministic modeling. Within the speech, explicative examples of wiring structures involving twisted-wire pairs running above ground and illuminated by external electromagnetic fields will be presented. Modeling of such wiring structures will be firstly addressed from the deterministic viewpoint. The problem will be then reconsidered from the statistical viewpoint, with the objective to develop computationally-efficiency prediction models accounting for random variations of EM-field characteristics and geometrical/electrical parameters of the cable harness. The statistics of the common-mode and differential-mode noise induced at the terminations of the wiring structures under analysis will be eventually investigated.

Contributions

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Posters Session

Tuesday June 30th, 15:45 – 17:00

Room “Les Bains Romains” (ground floor)

Influences of volatile and deterministic effects on the quality of an open area test site

I. Barbary[1], R. Pape[2], L.O. Fichte[1], S. Lange[3], T. Kleine-OStmann[2], M. Shaarschmidt[3], F. Sabbath[3], T. Schrader[2], and M. Stiemer[1]

[1] Helmut Schmidt University, Holstenhofweg 85, 22043 Hamburg, Germany, ines.barbary@hsu-hh.de
[2] Physikalisch-Technische Bundesanstalt (PTB), Bundesallee 100, 38118 Braunschweig, Germany
[3] Bundeswehr Research Institute for Protective Technologies (WIS), Humboldtstraße 1, 29633 Munster, Germany

Open Area Test Sites (OATS) are used for high precision antenna calibration. A real OATS (finite, not perfectly conducting ground plane) is considered to be of good quality if its measured site insertion loss deviates from the insertion loss of an ideal OATS less than 1 dB minus measurement errors for 24 specified frequencies between 30 and 1000 MHz. The insertion loss of an ideal OATS can be calculated by simulation of two antennas above an infinite, perfectly conducting ground plane. For such calculations, the software NEC (Numerical Electromagnetics Code) is usually employed. However, NEC cannot consider nearby objects which influence the insertion loss. To account for such objects and to incorporate dielectric material, the software Protheus is used. The aim of this study is to accurately quantify the influences of volatile and deterministic effects on the site insertion loss of a real OATS.

Statistical analysis of scattered field by building facades using polynomial chaos expansion

P. Kersaudy[1], S. Mostarshedi[2], B. Sudret[3], O. Picon[2], and J. Wiart[1]

[1] Orange Labs, Issy-les-Moulineaux, France
[2] ESYCOM (EA 2552), UPEM, Marne-la-Vallée, France, shermila.mostarshedi@upem.fr
[3] Chair of Risk, Safety and Uncertainty Quantification, ETH, Zurich, Swiss

Wireless communications experienced a great expansion worldwide and the networks are very dense in urban areas. Predictive tools are essential to assess the distribution of electromagnetic fields in a fast and accurate way in order to optimize the implementation of base stations and minimize the human exposure. Wave propagation simulators are based on different models of urban environment and employ appropriate calculation methods. We can mention empirical, statistical, theoretical, site specific models or a combination of them to generate a hybrid model. Given the complex and variable environment, the prediction of electromagnetic fields with such deterministic simulators has to be accompanied by an acceptable amount of uncertainty. Consequently the assessment of the electromagnetic waves in urban environment in terms of the propagation of uncertainties presents an important challenge. To this aim, different numerical methods can be used such as Monte Carlo method, perturbation techniques, moment equations, operator based methods, polynomial chaos, etc. [1]. This paper is a communication based on our recently published work [2].

Reliability methods applied to a transmission line illuminated by a plane wave

M. Larbi[1,2], P. Besnier[1], B. Pecqueux[2], F. Puybaret[2]

[1] INSA: Institut d'Électronique et de Télécommunications de Rennes, Rennes, France, mourad.larbi@insa-rennes.fr
[2] CEA, DAM, GRAMAT, F-46500 Gramat, France, bernard.pecqueux@cea.fr

In this paper, a statistical approach is used to deal with a reliability analysis of an EMC problem. This approach relies upon reliability methods from probabilistic engineering mechanics. An estimation of a failure probability given a defined criterion and a sensitivity analysis of this failure probability is carried out by taking into account uncertainties on input parameters. These reliability methods allow estimating a failure probability with a reduced computational cost compared to Monte Carlo simulation and provide a sensitivity analysis.

Sensitivity study of a permanent magnet DC machine

T.T. Nguyen[1], D.H. Mac[2], S. Clénet[3]

[1] L2EP, Université Lille 1, thu-trang.nguyen@univ-lille1.fr
[2] L2EP, ENSAM, macduyhung.enpc@yahoo.fr
[3] L2EP, ENSAM, stephane.clenet@ensam.eu

This paper makes a global sensitivity analysis on a magnetic holder using the different Regression methods. The output of numerical model is the attractive force, this output depend on geometry and properties of the magnetic holder. Thanks to these methods, the Sobol indices of 11 model parameters are calculated.

Evaluation des intervalles de confiance en CEM

C. Kasmi[1], S. Lalléchère[2], S. Girard[2], P. Bonnet[2], F. Paladian[2], E. Prouff[1]

[1] French Network and Information Security Agency - ANSSI, 51 bvd de la Tour Maubourg, 75007 Paris, France, chaouki.kasmi@ssi.gouv.fr
[2] Université Clermont Auvergne, Université Blaise Pascal, Institut Pascal, CNRS UMR 6602, 63178 Aubière, France

L'étude de systèmes complexes nécessite, pour la prise en compte des incertitudes sur les différents paramètres, a priori de réaliser des simulations ou d'effectuer des mesures pour l'ensemble des configurations possibles. Cette approche exhaustive étant rarement envisageable en pratique, une analyse statistique est alors nécessaire afin d'estimer l'effet de ces variables aléatoires sur une ou plusieurs grandeurs physiques. Classiquement, des méthodes d'échantillonnage (e.g. Monte-Carlo, MC) sont utilisées afin d'estimer par exemple les premiers moments statistiques des variables aléatoires considérées. L'obtention de ces grandeurs (moyenne, écart-type) reste privilégiée majoritairement en raison de contraintes de coût. Malheureusement, la convergence lente des techniques de type MC s'avère contraignante. Dans cet article, nous nous intéressons aux techniques de ré-échantillonnage pour l'estimation de l'intervalle de confiance de la statistique de l'observable.

Uncertain capacitance of a coaxial line in a stochastic context

A. Kouassi[1,2], S. Lalléchère[1,2], J-M. Bourinet[1,2], P. Bonnet[1,2], M. Fogli[1,2]

[1] Clermont Université, Université Blaise Pascal & IFMA, Institut Pascal, B.P. 10448, F-63171 Aubière, France, attibaud.kouassi@etudiant.univ-bpclermont.fr
[2] CNRS, UMR 6602, Institut Pascal, F-63171 Aubière, France

This paper addresses the statistics assessment of an ElectroMagnetic Compatibility (EMC) device's per-unit-length (p.u.l.) parameters, namely a coaxial line's capacitance. We assume that the physical parameters of this coaxial line are uncertain. The objective is to assess the first statistical moments and the probability density function of this capacitance. The work is based on the polynomial chaos expansion method. The efficiency and accuracy of this method are compared with reference results obtained by Monte Carlo method.

Modéliser l'incertain pour l'étude des effets électromagnétiques dans le domaine aérospatial

R. Perraud[1], T. Abboud[2], S. Guillet[3], J. Aspas[4], C. Vollaire[5]

[1] Airbus Group Innovations, 12 rue Pasteur 92152 Suresnes Cedex, richard.perraud@airbus.com
[2] IMACS, XTEC Ecole Polytechnique, 91128 Palaiseau cedex, abboud@imacs.polytechnique.fr
[3] Airbus Helicopters, Aéroport International Marseille Provence 13700 Marignane, steven.guillet@airbus.com
[4] Astrium ST, 51-61, Route de Verneuil, 78130 Les Mureaux Cedex, jesus.aspas-puertolas@astrium.eads.net
[5] Ecole Centrale de Lyon, 36 avenue Guy de Collongue, 69134 Ecully, christian.vollaire@ec-lyon.fr

Le dimensionnement des contraintes électromagnétiques sur les grands systèmes sont souvent basées sur des approches pire cas sans pouvoir chiffrer la marge que l'on dispose. Le projet UMEPS (ANR-11-ASTR-03901) introduit une démarche d'analyse probabiliste qui permettra de mieux définir cette marge et de répondre à des objectifs de fiabilité chiffrée.

Extreme value theory applied to EMC problems

T. Bdour[1] and A. Reineix[1]

[1] OSA Dept, XLIM Research Institute, Limoges

The purpose of this paper is to model tail behavior of electric field distribution in frequency-stirring cylindrical cavity using Extreme Value Theory (EVT) [1]. Electric field maxima can be described by Generalized Extreme Value (GEV) distributions: Gumbel, Frechet and Weibull. GEV helps us to calculate extreme electric field quantiles more accurately than classical Rayleigh distribution. Anderson-Darling (AD) [2] test and some diagnostic graphs (cdf, PP and QQ plots) have been successfully applied to check goodness-of-fit between experimental and predicted data.

Stochastic sensitivity in homogeneous electromagnetic-thermal dosimetry model of human brain

M. Cvetkovic[1], S. Lalléchère[2], K. El Khamlichi Drissi[2], P. Bonnet[2], D. Poljak[1]

[1] University of Split, FESB, Split, Croatia, mcvetkov@fesb.hr
[2] Blaise Pascal University, Pascal Institute, Clermont-Ferrand, France

In this work we examined how the variability in the brain morphology and the tissue properties affect the assessment of the homogeneous human brain exposed to high frequency electromagnetic (EM) field. Using the deterministic EM-thermal modeling and the stochastic theoretical basis we have studied the effects of these uncertainties on the maximum induced electric field, maximum local Specific Absorption Rate (SAR), average SAR, maximum temperature and the maximum temperature increase, respectively. The results show a good convergence of stochastic technique and an assessment of mean and variance of outputs for the incident plane wave of 900 MHz.

P.R.E.I. DGA PRINCE : Prise en compte de l'incertain pour des couplages électromagnétiques

P. Bonnet[1], C. Chauvière[2], S. Lalléchère[1], S. Girard[1], K. Kerroum[1], J. Benoit[3], I. El Baba[4], F. Paladian[1], B. Pecqueux[5]

[1] Université Clermont Auvergne, UBP, Institut Pascal, BP 10448, F-63000 Clermont-Ferrand, pierre.bonnet@lasmea.univ-bpclermont.fr
[2] Université Clermont Auvergne, UBP, Laboratoire de Mathématiques, BP 10448, F-63000 Clermont-Ferrand, cedric.chauviere@univ-bpclermont.fr
[3] CEA, LIST, F-91191, Gif-sur-Yvette, France
[4] Université Libanaise, Institut Universitaire de Technologie, BP 813, Saida, Liban
[5] CEA, DAM, GRAMAT, F-46500 Gramat, France

Actuellement les défis de la modélisation et de la simulation en électromagnétisme ne portent plus tant sur le développement de nouvelles méthodes que sur leurs utilisations judicieuses. La plupart des codes de calcul sont basés sur des approches déterministes qui requièrent une connaissance a priori parfaite des valeurs d'entrée. Or, en pratique, de nombreuses incertitudes affectent les données (vieillissement des matériaux, absence de connaissance,…) qui peuvent entraîner des variations notables des résultats. Dans ce cadre, la prise en compte des aléas portant sur les différents paramètres d'entrée représente un enjeu important. L'objectif principal de cette étude était de mettre en œuvre une approche originale et efficace pour prendre en compte l'incertain dans les simulations en électromagnétisme. Des problèmes analytiques, expérimentaux, numériques 1D, 2D, 3D de propagation, de diffraction, de couplage sur des lignes de transmission, de calcul de SER, d'antennes, de couplages sur PCB et de CEM ont été proposés.

Demonstrations

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COMSOL Multiphysics

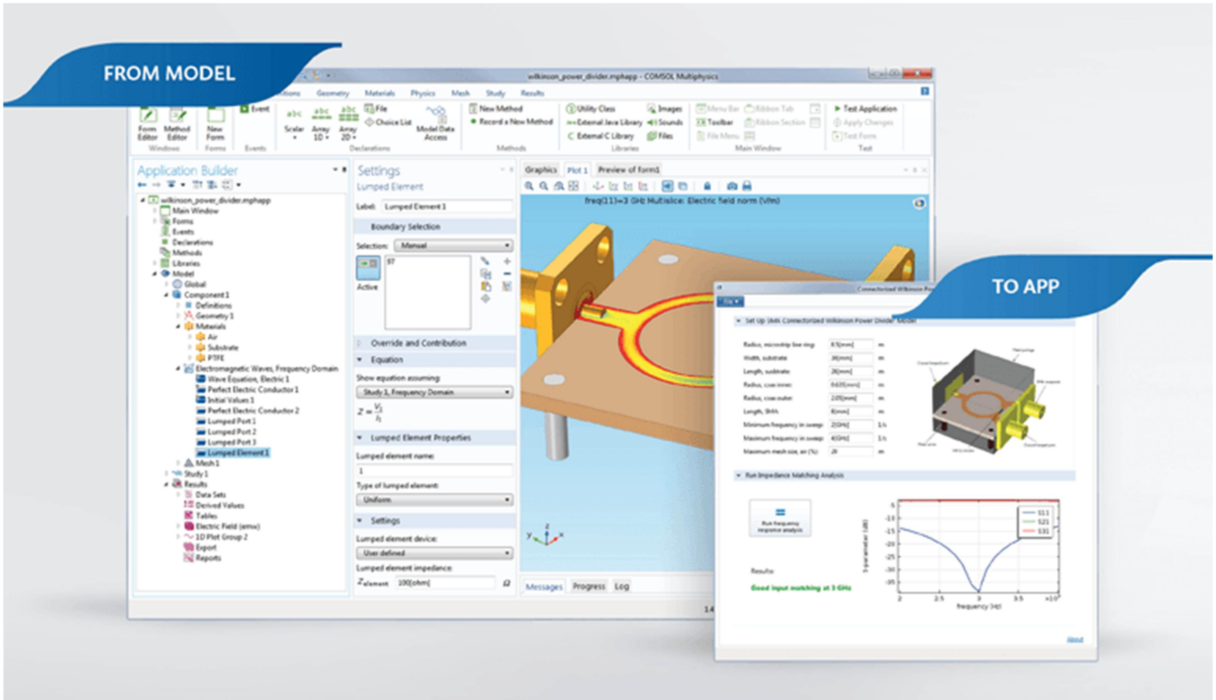
Tuesday June 30th, 17:30 – 19:00

Room "Les Bains Romains" (ground floor)

Jean-Marc Petit (COMSOL, France)

Uncertainties in Simulation with COMSOL Multiphysics

This session begins with a walk-through of the fundamental modeling steps in COMSOL Multiphysics. We will then focus on uncertainties of the numerical model, linked to convergence criteria or influence of model parameters (sensitivity analysis), and will look consequences of the uncertainties of entering data. You will leave with new skills to work on your own applications using your free, two-week COMSOL trial.



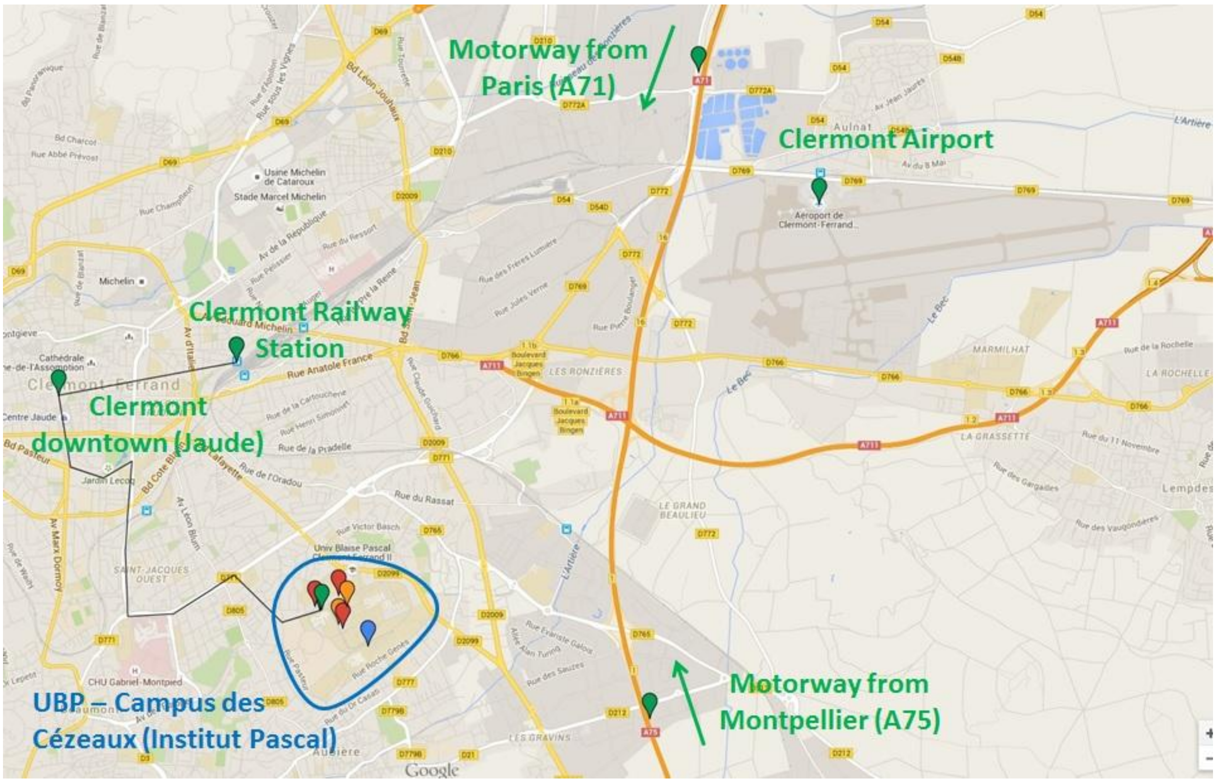
Venue

Towards Université Blaise Pascal – Campus des Cézeaux

Campus « Les Cézeaux » is located:

- Around 25 to 30 min from French SNCF railway station by choosing bus B (towards « Royat, Pl. Allard ») until « Jaude » station, then tramway towards « La Pardieu Gare »,
  or bus n°8 (towards « Matussat Chataîgneraie ») until station « CHU G. Montpied », then tramway towards « La Pardieu Gare »,

- 15 min from Clermont-Fd downtown by choosing tramway towards « La Pardieu Gare »

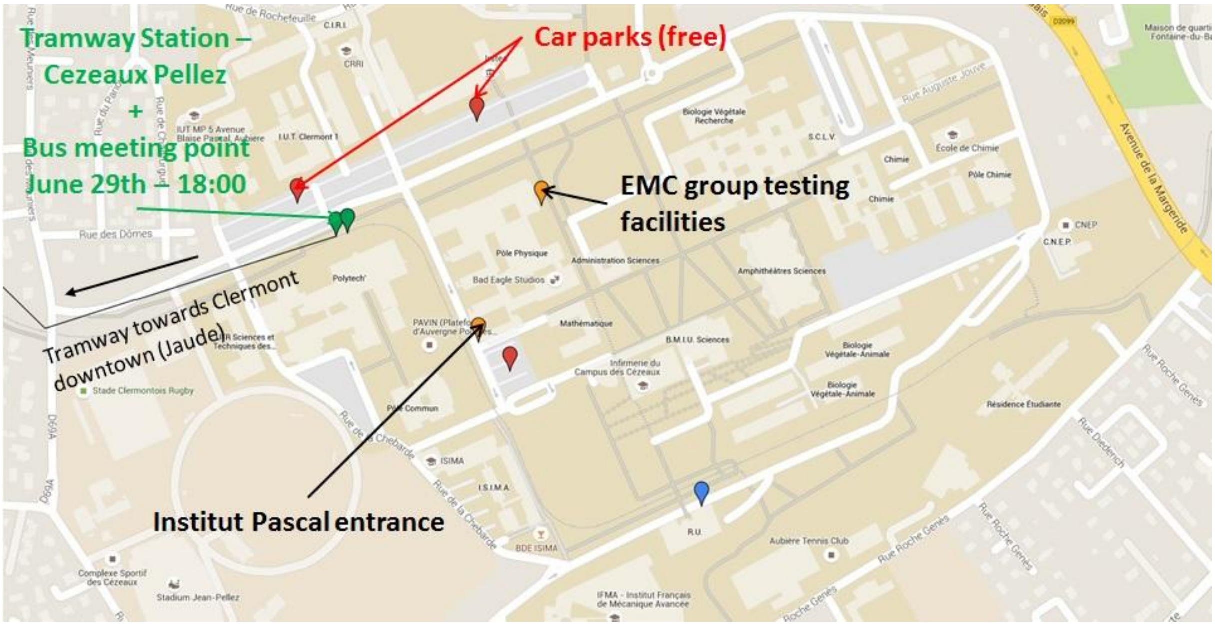


Towards meeting point:

UBP – Campus Les Cezeaux (Aubière), Monday June 29th

By car: after entering « Campus les Cézeaux », find a parking space on free car parks located in front of IUT or IRSTEA institutes.

By tramway: please choose « Cézeaux Pellez » tramway stop.



After reaching « Campus les Cézeaux », please walk to **Institut Pascal entrance** (near tramway railway) and:

- Either use intercom unit (40-72-20, Christine Turcat),
- Or phone (+33 (0)6 79 75 49 14, Sébastien Lalléchère),

to access Institut Pascal.

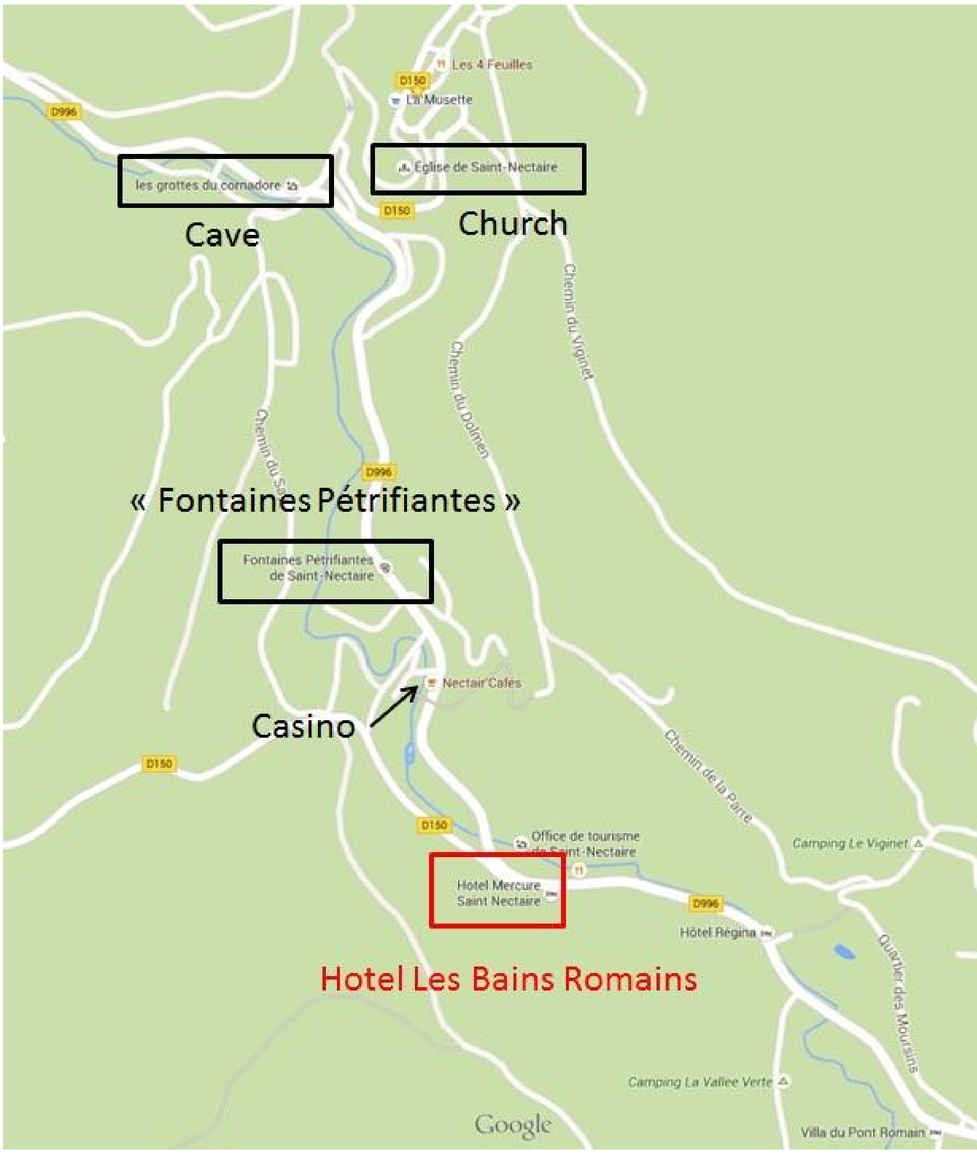
Please remind the departure of the bus (coach transfer between Clermont-Fd and St-Nectaire) is scheduled @ 18:00 (bus meeting point close to Tramway stop "Cezeaux Pellez").

The workshop will entirely take place inside "Hotel Mercure Les Bains Romains", Saint-Nectaire. The location of session rooms is straightforward given in program. Different panels are provided inside the hotel to find session rooms "Pascaline" (3rd floor) and "Les Bains Romains" (ground floor).

Towards Hotel Mercure "Les Bains Romains", Saint-Nectaire

By coach transfer: A bus transfer is organized between "Campus Les Cezeaux" (Aubière) and "Hotel Mercure Les Bains Romains" @ 18:00 Monday June 29th from tramway stop "Cezeaux Pelez" (close to Institut Pascal).
In order to organize you return, the bus shuttle is scheduled to come back to "Campus Les Cezeaux" Wednesday July 1st @ 15:00.

By car: Saint-Nectaire is a countryside town (located around 45 kilometers South-West from Clermont-Ferrand). It is located to a height of 700 meters and is well-known for its Roman church, thermal treatments (and casino!), and also known for its cheese!



UMEMA 2015 – Final Program

Monday, June 29th 2015

- 16:00 - 18:00 : Welcome at Institut Pascal *Campus des Cézeaux, Aubière*
- 18:00 - 19:00 : Clermont-Ferrand / Saint-Nectaire by bus
- 20:00 - 22:30 : Welcoming words - Dinner at Hotel Mercure "Les Bains Romains"

Tuesday, June 30th 2015

Session Room « Pascaline » (Hotel Mercure, 3rd floor)

- 08:30 - 09:30: **Flavio Canavero** (Politecnico Torino, Italy)
  Polynomial Chaos for Variability Assessment of Electronic and Microwave Designs
- 09:30 - 10:30: **Bas Michielsen** (ONERA, France)
  Modelling the interaction of stochastic electromagnetic fields and stochastic structures

10:30 - 11:00: Coffee break - *Bar & Restaurant « Hotel Mercure », 1st floor*

Session Room « Pascaline » (Hotel Mercure, 3rd floor)

- 11:00 - 12:00: **David Thomas** (University of Nottingham, UK)
  The characterisation and propagation of stochastic fields from printed circuit boards

12:15 - 13:45: *Lunch at Restaurant « Hotel Mercure », 1st floor*

Session Room « Pascaline » (Hotel Mercure, 3rd floor)

- 13:45 - 14:45: **Joe Wiart** (Orange Labs, France)
  Stochastic Dosimetry to Handle the Variability in Numerical Human Exposure to RF EMF
- 14:45 - 15:45: **Jean-Marc Bourinet** (IFMA, France),
  Strengths and limits of reliability assessment methods - Illustration in the field of electromagnetic compatibility

Session Room « Les Bains Romains » (Hotel Mercure, ground floor)

- 15:45 - 17:00: Poster Session

17:00 - 17:30: Coffee break - *Bar & Restaurant « Hotel Mercure », 1st floor*

Session Room « Les Bains Romains » (Hotel Mercure, ground floor)

- 17:30 - 19:00: Uncertainties in Simulation with COMSOL Multiphysics

20:00 - 22:30: Dinner at *Restaurant « Hotel Mercure », 1st floor*

Wednesday, July 1st 2015

Session Room « Pascaline » (Hotel Mercure, 3rd floor)

- 08:30 - 09:30: **Lars-Ole Fichte** (University of Hamburg, Germany)
  Towards new Engineering Standards Accounting for Uncertainty in Electromagnetic Compatibility
- 09:30 - 10:30: **Flavia Grassi** (Politecnico Milano, Italy)
  Radiated susceptibility of complex cable harnesses: From deterministic to statistical modeling

10:30 - 10:45: Coffee break - *Bar & Restaurant « Hotel Mercure », 1st floor*

Session Room « Pascaline » (Hotel Mercure, 3rd floor)

- 10:45 - 11:30: Round table – Synthesis (posters, talks), proposals
- 11:30 - 12:00: Informal exchanges about the workshop – Conclusions

12:15 - 13:45: *Lunch at Restaurant « Hotel Mercure », 1st floor*

End of workshop – back to Institut Pascal Campus des Cézeaux, Aubière

14:00 - 15:00: Saint-Nectaire / Clermont-Ferrand by bus