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CEA LIST
NDE Department
Saclay, France

EXPERT IN SHM & NDT @ CEA

FRENCH ATOMIC ENERGY AND ALTERNATIVE ENERGIES COMMISSION

EXPERIENCE

Since 2010: **Project manager at CEA, NDE Department (Saclay, France)**

- Development manager of activities and SHM partnerships (scientific orientations, public funding)
  Main topics: Simulation of guided waves SHM systems in CIVA software, POD for SHM, MAPOD approach, PZT and Fiber Bragg Grating transducers for guided waves

- Coordination of several projects including industrial and academic partners involved in NDT & SHM
  Latest examples:
  - Development & experimental validation of hydrate plug monitoring system in pipes using guided waves
  - Design of ultrasonic phased array transducer for nuclear components
  - Ultrasonic and radiographic inspection of composite fan blade
  - Simulation supported POD curves for Automated Ultrasonic Testing of girth welds
  - Development of an SHM system for honeycomb sandwich structures using guided waves generated by PZT transducers and received by Fiber Bragg Grating sensors
  - Corrosion detection in plates using passive (ambient noise cross-correlation) Tomography.

- Since 2013: Expert of the International Institute of Welding (IIW) in Commission V *Non-destructive Testing and Quality Assurance of Welded Products*
  Main activities: Coordination of a Best Practice document devoted to the use of simulation for POD curves determination. Draft reviewed by several POD experts (J. Aldrin, C. Annis, N. Dominguez, D. Forsyth, D. Kanzler, T. Walker); Organization of a seminar on SHM (July 2015) and publication of related proceeding

- Project manager for the first version of CIVA software guided waves module (2011-2012): management of the development team ; software validation tests

- (co-)Supervision of PhD students:
  2011-14: M. El Bakkali (20%) guided waves inspection in bended pipes
  2014-*17*: T. Druet (100%) corrosion detection in plates using passive (ambient noise cross-correlation) tomography
  2014-*17*: A. Recoquillay (50%) imaging algorithms for guided waves using linear sampling method
  2015-*18*: P. Zabbal (50%) quantitative NDE of bonded structures
  2016-*19*: A. Kulakovskyi (100%) detection of delaminations in honeycomb sandwich structures using guided waves

- Teaching (Master degree: introduction to SHM, POD, experimental activities on guided waves at Paris 7 Univ. and ENSTA ParisTech, France).

2007-2010: **PhD Student at ONERA, the French Aerospace Lab (Châtillon, France)**
Title: *Ultrasonic structural health monitoring of composite patches bonded to metallic structures*
Advisors: D. Royer, N. Terrien, D. Osmont, and D. Balageas

- Experimental developments using guided waves emitted and detected by PZT discs embedded in composite patches
- Pulsed stimulated thermography
- Finite-element modelling of guided waves propagation in composite plates
- Experimental measurement and theoretical modelling of guided waves energy focusing in anisotropic plates

2006-2007: **Consulting services for EDF (Chatou, France)**, the main operator in France and Europe in the sector of energy
Meteorological data processing using Matlab

2006: **Research internship at Politecnico di Milano (University of Milan, Italy)**
Fatigue testing of high temperature materials for turbine disks
Experiments and comparison of different fatigue criteria

2005: **Bricklayer (Buenos Aires, Argentina)**
Reconstruction and restoration of apartments

EDUCATION

2010:	**PhD University Paris 7 / ONERA, the French Aerospace Lab (Châtillon, France)** With highest honors
2007:	**M.Sc. in Engineering, Superior National School of Advanced Techniques (ENSTA ParisTech – Paris, France)** Majors: materials, fatigue, finite elements, signal processing, acoustics
2007:	**M.Sc. Structure dynamics and coupled systems (Centrale Paris/ENSTA ParisTech – Paris, France)** Majors: vibrations, vibro-acoustics, modal analysis
2002-2004:	**Two-year intensive program preparing for the national competitive exam for entry to engineering schools** Admitted to ENSTA ParisTech, top French engineer school
2002:	**High school diploma, Lycée International Europole (Grenoble, France)** With highest honors, Italian-language international section (study of Italian language and culture)

PROFESSIONAL SKILLS

French:	Mother tongue
Italian:	Bilingual
English:	Fluent (TOEIC: 925/990)
Spanish:	Basic level
CEA	Since 2015: expert in SHM and NDT Very good knowledge of ultrasonics, guided waves and POD modules of CIVA software Management of development team
IIW	International Institute of Welding Since 2013: expert of the Commission V *Non-destructive Testing and Quality Assurance of Welded Products*

PUBLICATIONS

Papers in Major National and International Conference Proceedings

[1] **Chapuis, B.**; Terrien, N.; Royer, D. & Déom, A. Smart composite repairs using PZT discs as actuators/sensors *Proceedings of the Fourth European Workshop on Structural Health Monitoring*, Cracow, **2008**

[2] **Chapuis, B.;** Terrien, N.; Royer, D. & Déom, A. Léger, A. & Deschamps, M. (Eds.) Structural health monitoring of bonded composite patches using Lamb waves *Springer Proceedings in Physics*, **2008**, 128

[3] **Chapuis, B.;** Baronian, V.; Royer, D. & Terrien, N. Disbond Detection in Composite Repairs Using Lamb Waves Excited and Detected by PZT Discs *Proc. of the 7th Int. Workshop on Structural Health Monitoring*, Stanford, **2009**

[4] **Chapuis, B.** & Royer, D. Smart composite patches using PZT discs as actuators and sensors of Lamb waves *Proceedings of ITT (Innovation and Technologies in Transportation) congress*, Paris, **2009**

[5] Balageas, D.; **Chapuis, B.**; Deban, G. & Passilly, F. Quantitative assessment of the improvement of the detection of defects by pulse thermography thanks to the TSR approach in the case of a smart composite repair patch *Proceedings Xth QIRT Conference*, **2010**

[6] Balageas, D.; **Chapuis, B.**; Deban, G. & Passilly, F. Evaluation quantitative de l'amélioration apportée par la méthode TSR à la détection de défauts par thermographie stimulée impulsionnelle. Cas d'un patch composite instrumenté. *Congrès Français de Thermique Energies et Transports durables*, SFT, Le Touquet, **2010**

[7] **Chapuis, B.**; Cavailles, C.; Rallo, D.; Osmont, D. & Royer, D. Fatigue testing of a smart composite patch *Proceedings of the 5th EWSHM*, Sorrento, **2010**

[8] Balageas, D.; **Chapuis, B.**; Deban, G. & Passilly, F. Enhanced pulsed stimulated thermography for final inspection process of smart repair patches for aerospace structures *Proc. of the 5th European Workshop on SHM*, Sorrento, **2010**

[9] **Chapuis, B.**; Osmont, D.; Terrien, N. & Royer, D. Contrôle santé intégré de patchs composites collés sur des structures métalliques par ondes de Lamb *Actes du 10ème congrès français d'acoustique*, Lyon, **2010**

[10] **Chapuis, B.**; Terrien, N. & Royer, D. Modeling and experimental investigations of Lamb waves focusing in anisotropic plates *Journal of physics: Conference Series*, **2011**, 269

[11] **Chapuis, B.**; Jezzine, K.; Baronian, V.; Ségur, D. & Lhémery, A. Simulation of ultrasonic guided wave inspection in CIVA software platform *Proceedings of the 18th World Conference on Nondestructive Testing*, Durban, **2012**

[12] **Chapuis, B.**; Jenson, F.; Vivier, F.; De Roumilly, L.; Chassignole, B. & Lhuillier, P.-E. Zone sensitivity optimization for the ultrasonic inspection of complex 3D geometries using CIVA software *Proc. of the 10th ICNDE*, Cannes, **2013**

[13] **Chapuis, B.**; Dominguez, N.; Jenson, F.; Willaume, P. & Yalamas, T. Merging of Experimental and Simulated Data Sets with a Bayesian Technique in the Context of POD Curves Determination *5th European-American Workshop on Reliability of NDE*, Berlin, **2013**
[14] **Chapuis, B.**; DiCrisci, G.; Hamilton, J.; Jenson, F. & Pomié, L. Pipeline Girth Welds Inspection Using Automated Ultrasonic Testing (AUT) with Zonal Discrimination – Simulation of POD Curves Using CIVA Software *5th European-American Workshop on Reliability of NDE*, Berlin, **2013** (poster)
[15] **Chapuis, B.**; Jenson, F.; Hamilton, J.; DiCrisci, G. & Pomié, L. Inspection des soudures circonférentielles de pipes en utilisant des systèmes d'inspection US automatisés (AUT) avec la méthode de discrimination zonale - Simulation de courbes de probabilités de détection (POD) en utilisant le logiciel CIVA *Conf. COFREND*, Bordeaux, **2014**
[16] **Chapuis, B.**; Jenson, F. & Pomié, L. Détection et caractérisation de bouchons dans des pipelines à l'aide d'ondes guidées *Conférence COFREND*, Bordeaux, **2014**
[17] **Chapuis, B.**; Jenson, F.; Vivier, F.; de Roumilly, L.; Chassignole, B. & Lhuillier, P.-E. Optimisation de la couverture en sensibilité pour l'inspection ultrasonore de pièces de géométrie complexe 3D en utilisant le logiciel CIVA *Conférence COFREND*, Bordeaux, **2014**
[18] **Chapuis, B**.; Baronian, V.; Jenson, F. & Pomié, L. Hydrate plug localization and characterization using guided waves *11th European Conference on Non-Destructive Testing (ECNDT)*, Prague, **2014**
[19] **Chapuis, B.**; Baronian, V.; Jezzine, K. & Calmon, P. Guided wave testing simulation *IIW annual meeting*, Commission V, Seoul, Korea, **2014**
[20] Pomié, L.; Tzotzi, C.; Faderne, C.; **Chapuis, B.** & Jenson, F. Hydrate Plug localization and Characterization with US and Guided Waves Techn. *9th North American Conf. on Multiphase Techn.*, 11-13 June, Banff, Canada, **2014**
[21] Druet, T.; **Chapuis, B.** & Moulin, E. Feasibility of passive tomography of extended defects using ambient elastic noise correlation, *International Congress on Ultrasonics*, Metz, **2015**
[22] El Bakkali, M.; Lhémery, A.; **Chapuis, B.**; Berthelot, F. & Grondel, S. Optimal Computation of Guided Wave Propagation and Scattering in Pipeworks Comprising Elbows: Numerical and Experimental Validations and Parametric Studies *Review of Progress in Quantitative Nondestructive Evaluation*, **2015**
[23] Druet, T.; **Chapuis, B.**; Jules, M.; Laffont, G. & Moulin, E. Passive SHM system for corrosion detection by guided wave tomography, *SHM seminar, IIW experts annual assembly*, Helsinki, **2015**
[24] Baronian, V.; Jezzine, K. and **Chapuis, B.** Simulation of Guided Wave Inspections Using Hybrid Modal/Finite Element Formulation: Application to a SHM System for Pipe Monitoring with Complex Geometries *Proceedings of the 10th International Workshop on Structural Health Monitoring*, Stanford, **2015**
[25] Carmona, M.; Laffont, G.; Jules, M.; **Chapuis, B.**; Paléologue, A. & Billères, M. Optical Fiber Sensors, MEMS Accelerometers and Acoustic-based Non-Destructive Technique: Three High-ends and Complementary Technologies for Advanced SHM Applications *Proc. of the 10th IWSHM*, Stanford, **2015** (poster)
[26] **Chapuis, B.**; Jezzine, K.; Baronian, V.; Taupin, L. & Ségur, D. Simulation of guided waves in CIVA platform: models for SHM of composite structures *Proc. of the 10th IWSHM*, Stanford, **2015**
[27] Druet, T.; Jules, M.; **Chapuis, B.**; Laffont, G. & Moulin, E. Towards Passive Guided Wave Tomography of Extended Defects Using Ambient Elastic Noise Cross-correlations *Proceedings of the 10th IWSHM*, Stanford, **2015**
[28] **Chapuis, B.**; Jezzine, K.; Baronian, V.; Taupin, L. & Ségur, D. Simulation of guided waves SHM system in CIVA platform *Proceedings of the 7th International Symposium on NDT in Aerospace*, Bremen, **2015**
[29] El Bakkali, M.; Lhémery, A.; Baronian, V. and **Chapuis, B.** Guided wave propagation and scattering in pipeworks comprising elbows: Theoretical and experimental results *Journal of Physics: Conf. Series* 581 (AFPAC 2014), **2015**
[30] **Chapuis, B.**; Jezzine, K.; Baronian, V. & Legoupil, S. Plateforme CIVA : Vers un outil de simulation pour la conception de systèmes SHM et la démonstration de performances *3ème Journée Thématique DGA-ONERA "Contrôle Santé des Structures - Biomimétisme"*, **2015**
[31] **Chapuis, B.**; Jezzine, K.; Baronian, V. & Lhémery A. CIVA platform: towards a simulation tool for guided waves SHM systems and performance demonstration, *Indo-French seminar on smart systems and SHM for structures under harsh environments*, Pondicherry, India, **2016**
[32] Taupin, L.; **Chapuis, B.**; Ducousso, M.; Ben Khalifa, W.; Panizzoli, F.; Jenson, F. & Cuvillier, N. Adhesive thickness measurement on composite aerospace structures using guided waves, *World Conf. on Non-Destructive Testing (WCNDT)*, Munich, **2016**
[33] Calmon, P.; **Chapuis, B.**; Jenson, F. & Sjerve, E. The use of simulation in POD curves estimation: An overview of the IIW best practices proposal, *World Conference on Non-Destructive Testing (WCNDT)*, Munich, **2016**
[34] Druet, T.; **Chapuis, B.**; Calmon, P. & Moulin, E. Feasibility of Passive SHM for Corrosion Detection by Guided Wave Tomography, *World Conference on Non-Destructive Testing (WCNDT)*, Munich, **2016**
[35] **Chapuis, B.;** Kulakovskyi, A.; Bedreddine, N. & D'Almeida, O. Development of an SHM system of sandwich composite panels using guided elastic waves, *Proceedings of the 8th EWSHM*, Bilbao, **2016**

PhD thesis

[1] **Chapuis, B.** *Ultrasonic structural health monitoring of composite patches bonded to metallic structures* University Paris 7 - Denis Diderot, **2010**

Journal papers

[1] Balageas, D.; **Chapuis, B.**; Deban, G. & Passilly, F. Improvement of the detection of defects by pulse thermography thanks to the TSR approach in the case of a smart composite repair patch *Quantitative InfraRed Thermography Journal*, Taylor & Francis, **2010**, 7, 167-187

[2] **Chapuis, B.**; Terrien, N. & Royer, D. Excitation and focusing of Lamb waves in a multilayered anisotropic plate *Journal of the Acoustical Society of America*, **2010**, 127, 198-203

[3] **Chapuis, B.**; Jenson, F.; Calmon, P.; DiCrisci, G.; Hamilton, J. & Pomié, L. Simulation supported POD curves for automated ultrasonic testing of pipeline girth welds *Welding in the World*, **2014**, 58, 433-441

Patents

[1] **Chapuis, B.** Monitoring of industrial structures, WO 2015082292 A1, **2013**

[2] 3 other patents pending

Best Practice document

[1] **Chapuis, B.**; Calmon, P. and Jenson, F., *Best Practices (Guidance and Principles) for the Use of Simulation in POD curves estimation – Application to UT weld inspection*, International Institute of Welding (IIW) Commission V, Ref: V-1696-15, **2015**. *to be adopted for publication during the IIW annual assembly in Melbourne (July 2016)*

INVOLVEMENT IN SHM COMMUNITY:

During my PhD studies at the ONERA French research center on aerospace, I had the chance to join one of the first SHM oriented group in Europe (D. Balageas – organizer of the 1st EWSHM, D. Osmont, M. Lemistre), mainly involved in advanced developments on both guided waves and electromagnetic (HELP-layer) techniques.

Since then, I strongly published and participated to several EWSHM (2008, 2010, 2014, 2016) and IWSHM (2009, 2015) workshops, and to a lot of sessions dedicated to SHM in major international NDT conf. (WCNDT, ECNDT, QNDE).

In 2010, I joined the CEA Saclay NDE Department, as project manager where I coordinated several industrial and academic projects on different topics related to NDT (essentially on UT, EM and radiographic techniques). I also managed the internal development team for the release of the very first version of CIVA[1] guided waves module software. Under my impulse, next developments of this module will now be oriented on SHM, taking into account specificities of this approach, compared to NDT (sensor network, durability) in order to make it a useful tool to design an SHM system, as well as to prove its performances. This will be done in partnership with other teams I am currently in charge to identify, in order to build the roadmap under CIVAMONT project model[1].

As an expert belonging to the Commission # V (Non-destructive Testing and Quality Assurance of Welded Products) of International Institute of Welding (IIW)[2], I have been very active these last years in the promotion of the use of simulation for the determination of POD curves (Model-Assisted Probability of Detection – MAPOD – approach). Indeed, I coordinated on this topic the redaction of a Best Practice document that should be published in a few weeks after a long process of revision by several international POD experts.

SHM is a subject of interest for the IIW. Therefore, in 2015 I organized a seminar in order to create a working group on SHM within IIW. One of the topic that will be analyzed by this working group will be MAPOD for SHM.

Since 2014, I am also in charge at CEA of the development of activities and partnerships on SHM (scientific orientations, public funding). In that purpose, I coordinate and participate to several consortiums for French or European project proposals and suggest work program topics for future R&D calls.

In parallel, I participate to the development of technologies for SHM mainly based on guided waves and Optical Fiber Sensors (FBG transducers) for aeronautics and oil & gas applications, through projects and PhD thesis supervision. Moreover, I intend to introduce and promote these topics to students at master level through teaching activities.

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[1] CIVA remains the world leader simulation software for NDT. It gathers together in a unified interface several modules for simulation of UT (and guided waves), radiographic and EM. Cross-techniques modules are available for optimization, parametric analysis and probabilistic studies (POD). CIVA is distributed by the company Extende (www.extende.com) and used by more than 200 companies worldwide.

CIVA is developed by the CEA, with the involvement of a consortium of academic labs across Europe through the CIVAMONT project.

[2] International Institute of Welding (IIW) is a non-profit Institute whose main goal is to create, identify, develop and exchange best practices around joining technologies. IIW is one of only three bodies approved as International Standardizing Organizations by ISO to develop International Standards. Some standards are under the direct responsibility of IIW Secretariat.