# 2014-2015 LEGATO TEAM GREETINGS

[Real time cutting for surgical simulation — Hadrien Courtecuisse (ERC RealTcut), collaboration Inria](#)
[open access version of the paper, paper @ the journal's site, video]

A new type of entomological study! ;-)

Electromagnetic wave scattering around a sphere by isogeometric analysis.

Result of our collaborator Dr Tahsin Khajah. We are writing up the paper. Stay tuned for more insect-looking figures!
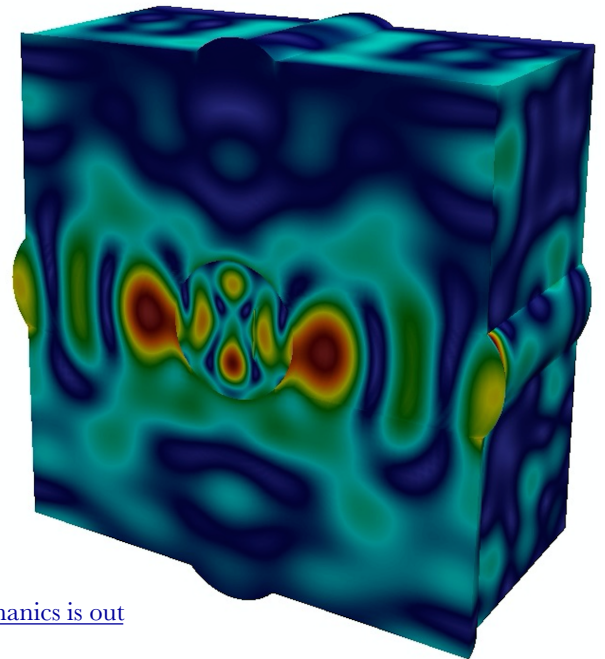
[Volume 48 of Advances in Applied Mechanics is out](#)

It has been 2 full and exciting years since Lars Beex and I arrived at the University of Luxembourg. Jack Hale joined us from the start from Imperial College and we had no time to get bored since our arrival (see list of publications in annex)!

Early 2016, the Legato-Lux-team, created this year will be made up of approximately 10-15 researchers, mainly post-doctoral fellows, and three PhD students.

An exciting piece of news is that Luxembourg is moving into the Computational Modelling direction, with the creation of an interdisciplinary research centre high on the agenda. Through collaborations with Mathematics, Physics and Life Sciences, this promises to lead to productive years and exciting multi-disciplinary research.

Pierre Kerfriden has been leading the Cardiff computational mechanics group since Stéphane left in 2013 with great success. 2016 will be a year where we will intensify exchanges between Cardiff and Luxembourg.

The core of this year's research was within the ERC Starting Grant RealTcut, and Stéphane's University of Strasbourg Institute for Advanced Studies Fellowship. Our collaboration with INRIA, both with Stéphane Cotin and Christian Duriez has strengthened. For example, we have developed a **real-time error estimation and mesh adaptation technique** for soft tissue simulations (Phuoc Huu Bui).

Jack Hale, now permanent researcher at Legato has developed strong relationships with ICES Texas (Tan Bui-Thanh), Oxford Mathematics Department (Farrell) and the FEniCS project. He is working on the release of a **FEniCS Shell project** (Maurini). jack.hale@uni.lu

Lars Beex has continued working on the quasi-continuum method, making significant improvement to the projection and interpolation methods, devising a new integration technique for reduced order models, and, with our student Hussein Rappel and Jack, a new Bayesian inversion approach for elasto-plasticity. He has also developed a comprehensive crystal-plasticity coding environment in Matlab ®.

Lars is also responsible for a number of projects, in particular in collaboration with e-Xstream, in particular for the M-ERANET funded project STOMMMAC. Lars has been very actively pursuing our collaboration with Prague, in particular with Jan Zeman. He has also started a collaboration with Saarbrücken (S. Diebels' group, in particular A. Jung). lars.beex@uni.lu

Stéphane continued to work with Andrés and the CENAERO team on 3D adaptive methods for fracture using the extended finite element method. This work is done in collaboration with Yuan Jin, Olivier Pierard and Eric Wyart at CENAERO and Andrés Gonzalez Estrada, now an academic at Universidad Industrial de Santander in his native Columbia.

Stéphane, Jack and Satyendra have started a fruitful collaboration with Mathematicians in Besançon: Franz Chouly, Alexei Lozinski on goal-oriented error estimation for large deformation problems. This project is in collaboration with Yohan Payan, Marek Bucki (Texisense) and Pierre-Yves Rohan.

Happy 2016! Let us aim for 2016 to be a year full of tolerance and understanding. Let us do good around us in the hope that it propagates further on with its own momentum.

Stéphane P.A. Bordas and the team

(viel) Spaß
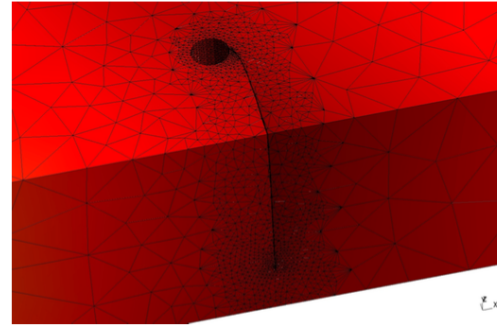
Step 32 (276692)

Automatic mesh adaptation for XFEM/level set crack growth simulations (with Cenaero, Belgium). These simulations show that a mesh of 276k DOFs leads to similar accuracy to a mesh of 1.783 million DOFs.

Automatic, real-time mesh adaptation based on Zhu-Zienkiewicz mesh error estimation for real-time cutting simulations (with iCube and Inria, University of Strasbourg, Phuoc Huu Bui).

2016 highlights

- **Jan**: Visits of Elena Atroshchenko and Julien Réthoré
- **Feb**: Luxembourg workshop in medical simulation
- **May**: GIAN Course at IIT Madras (with Sundararajan Natarajan)
- ECCM Crete: large presence of Legato planned
- Lars to present in St-Petersburg for a Plenary lecture at Advanced Problems in Mechanics
- Luxembourg to join ECCOMAS with the creation of the Luxembourg Association for Computational Mechanics
- **Faculty position open in computational mechanics**
- **Volume 49 of Advances in Applied Mechanics**
- New collaboration with Roman Nowak (Finland) to start
- New collaboration with Elias Aifantis, Pierre Kerfriden and Elena Atroshchenko

We are still very fortunate to have Winthrop Professor Karol Miller from University of Western Australia (Distinguished Honorary Professor at Cardiff University) under the INTERMOBILITY Scheme from the Luxembourgish National Research Fund (FNR) for his sabbatical visit. Our joint work has been most productive in terms of joint publications, in particular in collaboration with George Bourantas (submitted and in preparation). In 2015, Karol became **associate editor** of the Journal Annals of Biomedical Engineering.

With **Elena Atroshchenko** work on Cosserat, IGABEM continued and was very productive and fun. We all look forward to 2016! Stéphane is now an adjunct professor at the University of Western Australia, Department of Mechanical and Chemical Engineering, Intelligent Systems for Medicine Laboratory.
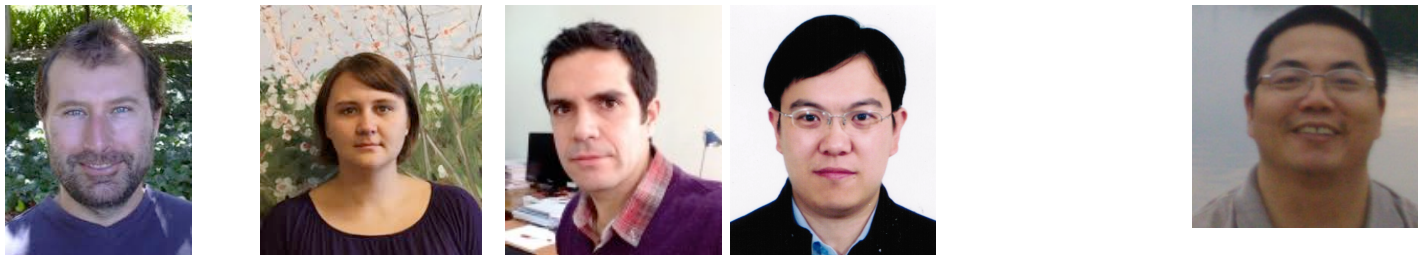
Luxembourg team

Without you, Marie, no 2015… and less 2016…
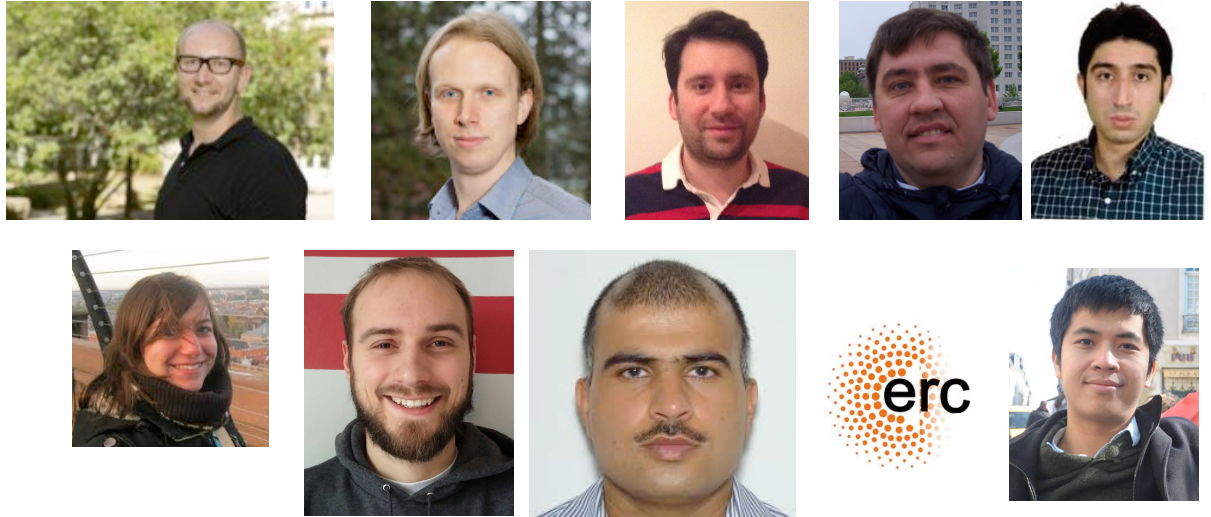
Visiting professors

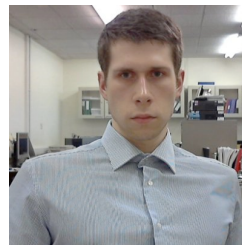# Alumni

Partners

External PhD

Chang-Kye Lee
now in Sheffield with Zeike Taylor

Haojie Lian who just finished a post-doc with Ole Sigmund (DTU)

Ahmad Akbari, now faculty member in Iran

Danas Sutula, looking for a post-doc position while finishing up his thesis.

New colleagues in Luxembourg

Vahid Ziaei Rad

erc

Kostas Agathos

[Davide Baroli](#)

and… Paul Hauseux!

As part of ERC RealTCut, Vahid will work on massively parallel phase field models of fracture in large deformations, Davide on model order reduction for patient specific models, Kostas will continue his excellent work on well-conditioned XFEM for fracture and Paul Hauseux will focus on uncertainty quantification for biomechanics problems.
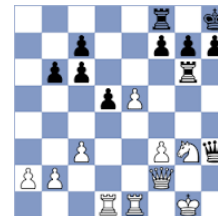
We will have the chance to receive a number of Chinese-Scholarship-Council—funded PhD students from China in Cardiff (and Luxembourg) in 2016. Welcome to Jason Deng this year!

New CSC PhD students in Cardiff

Farewell

Elisa is leaving and now seeking a faculty position. We are very grateful to have worked together with you and wish you well for your career, which promises to be most

Alex will fly to warmer horizons in Nice to model breasts… We will be staying in touch to complete a few (!) papers and hope to collaborate through H2020 proposals…

Thank you for being our webmaster this year! You will be hard to "replace…"

2016 Lab report
[2015 lab report](#)

Previous reports

A) 2015 Publications with peer review process

1. Zhao, X., **Bordas**, S., & Qu, J. (2015). Equilibrium morphology of misfit particles in elastically stressed solids under chemo-mechanical equilibrium conditions. *Journal of the Mechanics and Physics of Solids, 81*, 1-21. http://hdl.handle.net/10993/21331

2. Atroshchenko, E., & **Bordas**, S. (2015). Fundamental Solutions and Dual Boundary Element Method for Crack Problems in Plane Cosserat Elasticity. *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences*. DOI: 10.1098/rspa.2015.0216 http://hdl.handle.net/10993/17878

3. Hoang, K. C., Kerfriden, P., **Bordas**, S., & Khoo, B. C. (2015). An efficient goal-oriented sampling strategy using reduced basis method for parametrized elastodynamic problems. *Numerical Methods for Partial Differential Equations*. *31*(2), pp.575-608. http://hdl.handle.net/10993/15814

4. Lian, H., Kerfriden, P., & **Bordas**, S. P. A. (2015). Implementation of regularized isogeometric boundary element methods for gradient-based shape optimization in two-dimensional linear elasticity. *International Journal for Numerical Methods in Engineering*. DOI: 10.1002/nme.5149 http://onlinelibrary.wiley.com/doi/10.1002/nme.5149/full

5. Agathos, K., Chatzi, E., **Bordas**, S., & Talaslidis, D. (2015). A well-conditioned and optimally convergent XFEM for 3D linear elastic fracture. *International Journal for Numerical Methods in Engineering*. DOI: 10.1002/nme.4982 http://onlinelibrary.wiley.com/doi/10.1002/nme.4982/full http://hdl.handle.net/10993/19960

6. Beex, L., Rokos, O., Zeman, J., & **Bordas**, S. (2015). Higher-order quasicontinuum methods for elastic and dissipative lattice models: uniaxial deformation and pure bending. *GAMM Mitteilungen, 38*(2), 344-368. http://hdl.handle.net/10993/21832

7. Jung, A., Beex, L., Diebels, S., & **Bordas**, S. (2015). Open-Cell Aluminium Foams with Graded Coatings as Passively Controllable Energy Absorbers. *Materials & Design, 87*, 36-41. http://hdl.handle.net/10993/19431

8. Phung-Van, P., Nguyen, L. B., V. Tran, L., T.D., D., Thai, C. H., Wahab, M., **Bordas**, S., & Nguyen-Xuan, H. (2015). An efficient Computational approach for control of nonlinear transient responses of smart piezoelectric composite plates. *International Journal of Non-Linear Mechanics*, *76*, pp.190-202. http://hdl.handle.net/10993/21435

9. Nguyen, V.-P., Anitescu, C., **Bordas**, S., & Rabczuk, T. (2015). Isogeometric analysis: an overview and computer implementation aspects. *Mathematics and Computers in Simulation*. 117, pp 89-116 http://hdl.handle.net/10993/21428

10. P., P.-V., M., A.-W., K.M., L., **Bordas**, S., & H., N.-X. (2015). Isogeometric analysis of functionally graded carbon nanotube-reinforced composite plates using higher-order shear deformation theory. *Composite Structures, 123*, 137-149. http://hdl.handle.net/10993/20798

11. Akbari, A., Kerfriden, I., & **Bordas**, S. (2015). Error Controlled Adaptive Multiscale Method For Fracture Modelling in Polycrystalline materials. *Philosophical Magazine*. 95(28-30), pp 3328-3347 http://hdl.handle.net/10993/18262

12. **Bordas**, S., González-estrada, O. A., Ródenas, J. J., Nadal, E., Kerfriden, P., & Fuenmayor, F. J. (2015). Locally equilibrated stress recovery for goal oriented error estimation in the extended finite element method. *Computers & Structures*. 152, pp.1-10. http://hdl.handle.net/10993/19509

13. Ghasemi, H., Kerfriden, P., Muthu, J., Zi, G., Rabczuk, T., & **Bordas**, S. (2015). Interfacial shear stress optimization in sandwich beams with polymeric core using non-uniform distribution of reinforcing ingredients. *Composite Structures*, *120*, pp.221-230. http://hdl.handle.net/10993/18818

14. Hoang, K. C., Kerfriden, P., & **Bordas**, S. (2015). A fast, certified and "tuning-free" two-field reduced basis method for the metamodelling of parametrised elasticity problems. *Computer Methods in Applied Mechanics & Engineering*, *298*, pp.121-158. http://hdl.handle.net/10993/18972

15. Sheng, M., Li, G., Shah, S., Lamb, A. R., & **Bordas**, S. (2015). Enriched finite elements for branching cracks in deformable porous media. *Engineering Analysis with Boundary Elements*, *50*, 435-446. http://hdl.handle.net/10993/21330

16. Yang, S.-W., Budarapu, P. R., Mahapatra, D. R., **Bordas**, S., Zi, G., & Rabczuk, T. (2015). A meshless adaptive multiscale method for fracture. *Computational Materials Science, 96*(PB), 382-395. http://hdl.handle.net/10993/19535