

# Short Curriculum Vitae

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## Personal Information

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- **Date of Birth:** 6th February 1972
- **Nationality:** Austrian

## Employment History

- Jul 1996 – Aug 1997: *Research Student*, Siemens AG Munich, Germany.
- Nov 1997 – Dec 2000: *Graduate Teaching Assistant*, University of Bath, UK.
- Jan 2001 – Jan 2002: *Marie-Curie Fellowship*, Institut Francais du Petrole, Paris, France.
- Feb 2002 – Aug 2010: *Lecturer in Applied Mathematics*, University of Bath, UK.
- Sep 2010 – Oct 2011: *Senior Lecturer in Applied Mathematics*, University of Bath, UK.
- Nov 2011 – now: *Professor of Scientific Computing*, University of Bath, UK.

## Qualifications

- *Diplom-Ingenieur der Technischen Mathematik* (with distinction), University of Linz, Austria, 1997.
- *PhD in Mathematics*, University of Bath, UK, 2000.

## Major Grants as Principal Investigator

- *Great Western Research/MET Office* funded PhD studentship (2006-10) [**£55K**]
- *Austrian Academy of Sciences* funded special semester at the *Radon Institute (RICAM)*, Linz (2011) [**£195K**]
- *UK Engineering and Physical Sciences Research Council (EPSRC)* funded research project with Nottingham and Oxford, AMEC and the Government Nuclear Decommissioning Authority (2011-14) [**£677K**]
- *UK Natural Environment Research Council (NERC)* funded research project with the UK MET Office (Phase 1: 2011-13; Phase 2: 2013-16) [**£450K**]
- *EPSRC* funded research project with Richard Butler (Mechanical Engineering Bath) and GKN Aerospace (2013-16) [**£499K**]

plus further grants (as PI) from *British Council*, *Nuffield Foundation*, *Royal Society*, *Smith Institute* and *Institut Francais du Petrole* (2002-11) to a total value of [**~£100K**]

## Academic Prizes

- *SIAM Student Paper Prize*, SIAM Annual Meeting, Puerto Rico, 2000.
- Honourable Mention at the *Hansjörg Wacker Memorial Prize*, European Consortium for Mathematics in Industry (ECMI), 1998.

## Other Distinctions

- Over 40 scientific papers and 4 books published or in press. (4 papers submitted.)
- Over 30 invitations to speak at international conferences or workshops, including keynote lectures at the
  - *15th Biennial Comput. Techniques and Applications Conference*, Sydney, Nov 2010,
  - *20th Internat. Conf. on Domain Decomposition Methods*, San Diego, Feb 2011,
  - *7th Internat. Conf. on Preconditioning Techniques For Scientific And Industrial Applications*, Bordeaux, May 2011,
  - *20th Internat. Conf. on Comput. Methods in Water Resources*, Stuttgart, June 2014.
- Over 20 visiting positions and invited research visits ( $\geq 1$  week, with funding) at: Newton Institute Cambridge; Radon Institute Linz (Austrian Acad. Sci.); Lawrence Livermore National Lab; Laboratoire J.L. Lions Paris; UNSW Sydney; University of Texas at Austin; Caltech; University of Tartu (Estonia); University of Kiel; Max-Planck-Institut Leipzig; University of Heidelberg; University of Stuttgart.
- Invited presentations at more than 30 universities & laboratories internationally.
- Chairing a Special Semester on “*Multiscale Simulation and Analysis in Energy and the Environment*” at the Radon Institute for Computational and Applied Mathematics (RICAM), Austrian Academy of Sciences, Linz, 2011.
- Co-organiser of
  - 2 international workshops and one summer school, Bath Institute for Complex Systems (BICS), University of Bath, '06 & '07,
  - LMS Durham Research Symposium in “Numerical Analysis of Multiscale Problems”, University of Durham, July '10,
  - 5th workshop on *Numerical Analysis of Stochastic PDEs*, Warwick, June '12,
  - 11 minisymposia at international conferences, e.g. DD 17 '06, ICIAM '07, Waves '07, BAMC '09, DD 19 '09, DD 20 '11, DD 21 '12, NA Conf. Strathclyde '13.
- Supervision of 4 PDRAs, 5 PhD students, and 9 MSc students.
- Director of Studies for the *MSc in Modern Applications of Mathematics*, '06–'10.
- Member of the Editorial Board for the *Internat. J. of Computer Mathematics, Section B*.
- Referee for the *UK Research Council (EPSRC)*, the *Austrian Science Fund (FWF)*, for the *French Agence Nationale de la Recherche (ANR)*, for *American National Science Foundation (NSF)* and for the *Swedish Research Council (Vetenskapsrådet)*.
- Reviewer for *Mathematics Review* and *ZAMG* and for several leading international journals, such as *Math Comp*, *Numer Math*, *SIAM J Sci Comput*, *SIAM J Num Anal*, *SIAM J Mat Anal*, *Multiscale Model Simul (SIAM)*, *IMA J Numer Anal*, *ESAIM M2AN*.

## Research Interests/Achievements

The main part of my research is on the numerical simulation and analysis of multiscale PDEs and their application in energy and environment related areas, such as uncertainty quantification in radionuclide transport, single- and multiphase flow in porous media, sedimentary basin simulation, weather and climate modelling, and nuclear reactor safety calculations. In particular

- Efficient and robust parallel multilevel solvers for systems of PDEs
- Mixed finite elements and preconditioning
- Analysis of domain decomposition methods for multiscale PDEs
- Numerical homogenisation and upscaling
- Multiscale iterative methods
- PDEs with random coefficients and uncertainty quantification
- Parallel multigrid methods in weather and climate prediction

In addition, I have also done work on parameter identification, spectral methods for eigenproblems with discontinuous coefficients, and band gap computations in photonic crystal fibres.

## Current Research Projects

- “Multilevel Monte Carlo Methods for Elliptic Problems with Applications to Radioactive Waste Disposal” (with K.A. Cliffe, Nottingham, and M.B. Giles, Oxford, in collaboration with the UK Nuclear Decommissioning Authority and Serco Assurances, EPSRC Grant EP/H051503/1): 1 Postdoc and 1 PhD student at Bath.
- “Numerical Computation of Band Gaps and Guided Modes in Photonic Crystal Fibres” (with M. Marletta, Cardiff, in collaboration with D. Bird, Physics, Bath, EPSRC PhD studentship): 2 PhD students (one finished) at Bath.
- “Parallel Scalability of Elliptic Solvers in Weather and Climate Prediction” (with S. Pickles, Daresbury Laboratory, in a consortium with the UK MET Office and researchers at Exeter, Imperial College, Leeds, Manchester and Reading, NERC Grants NE/J005576/1 and NE/K006754/1): 1 Postdoc and 1 PhD student (finished) at Bath.
- “Multiscale Modelling of Aerospace Composites” (with R. Butler, Mech. Eng. Bath, and GKN Aerospace, Bristol, EPSRC Grant EP/K031368/1): 1 Postdoc and 1 PhD student.

as well as 1 PhD student working on “Atmospheric Dispersion Modelling” (CASE Studentship with the Met Office) and 1 Postdoc working on “Lévy-driven Stochastic Differential Equations in Mathematical Finance” (Royal Society Newton Fellow with Andreas Kyprianou, ProL@b).

Active research collaborations with (amongst others): Bastian (Heidelberg), Bebendorf (Bonn), Cliffe (Nottingham), Dauge (Rennes), Giles (Oxford), Graham (Bath), Kuo & Sloan (UNSW Sydney), Marletta (Cardiff), Nataf (Paris), Pechstein (Linz), Peterseim (Berlin), Sarkis (Worcester Polytechnic), Schwab (ETH Zürich), Vassilevski (LLNL), Zikatanov (Penn State).

## Publications

### Journals

1. A.L. Teckentrup, R. Scheichl, M.B. Giles and E. Ullmann, Further Analysis of Multilevel Monte Carlo Methods for Elliptic PDEs with Random Coefficients, *Numerische Mathematik*, published online March 12, 2013.
2. J. Charrier, R. Scheichl and A.L. Teckentrup, Finite Element Error Analysis of Elliptic PDEs with Random Coefficients and its Application to Multilevel Monte Carlo Methods, *SIAM Journal on Numerical Analysis* **51**(1):322-352, 2013.
3. R. Norton and R. Scheichl, Planewave Expansion Methods for Photonic Crystal Fibres, *Applied Numerical Mathematics*, **63**:88-104, 2013.
4. V. Dolean, F. Nataf, R. Scheichl and N. Spillane, Analysis of a Two-level Schwarz Method with Coarse Spaces Based on Local Dirichlet-to-Neumann Maps, *Computational Methods in Applied Mathematics*, **12**(4):391-414, 2012.
5. C. Pechstein and R. Scheichl, Weighted Poincare Inequalities, *IMA Journal on Numerical Analysis*, published online October 15, 2012.
6. R. Scheichl, P.S. Vassilevski and L.T. Zikatanov, Multilevel Methods for Elliptic Problems with Highly Varying Coefficients on Non-Aligned Coarse Grids, *SIAM Journal on Numerical Analysis*, **50**(3):1675-1694, 2012
7. M. Marletta and R. Scheichl, Eigenvalues in Spectral Gaps of Differential Operators, *Journal of Spectral Theory*, **2**(3):293-320, 2012.
8. P. Bastian, M. Blatt and R. Scheichl, Algebraic multigrid for discontinuous Galerkin discretizations of heterogeneous elliptic problems, *Numerical Linear Algebra with Applications*, **19**(2):367388, 2012.
9. R. Scheichl, P.S. Vassilevski and L.T. Zikatanov, Weak Approximation Properties of Elliptic Projections with Functional Constraints, *Multiscale Modeling and Simulation (SIAM)*, **9**(4):1677-1699, 2011.
10. N. Spillane, V. Dolean, P. Hauret, F. Nataf, C. Pechstein and R. Scheichl, A Robust Two Level Domain Decomposition Preconditioner for Systems of PDEs, *Comptes Rendus Mathematique*, **349**(23-24):1255-1259, 2011.
11. K.A. Cliffe, M.B. Giles, R. Scheichl and A.L. Teckentrup, Multilevel Monte Carlo Methods and Applications to Elliptic PDEs with Random Coefficients, accepted subject to minor corrections, *Computing & Visual. in Science*, **14**(1):3-15, 2011.
12. S.D. Buckeridge, M.J.P. Cullen, R. Scheichl and M. Wlasak A Robust Numerical Method for the Potential Vorticity Based Control Variable Transform in Variational Data Assimilation, *Quart J Roy Meteorological Society*, **137**(657):1083-1094, 2011.
13. C. Pechstein and R. Scheichl, Analysis of FETI Methods for Multiscale PDEs - Part II: Interface Variation, *Numerische Mathematik*, **118**(3):485-529, 2011.
14. I. G. Graham, F. Y. Kuo, D. Nuyens, R. Scheichl, and I. H. Sloan, Quasi-Monte Carlo Methods for Elliptic PDEs with Random Coefficients and Applications, *Journal of Computational Physics*, **230**(10):3668-3694, 2011.

15. S.D. Buckeridge and R. Scheichl, Parallel Geometric Multigrid for Global Weather Prediction, *Numerical Linear Algebra with Applications* **17**, 325-342, 2010.
16. R. Norton and R. Scheichl, Convergence Analysis of Planewave Expansion Methods for Schrödinger Operators with Discontinuous Periodic Potentials, *SIAM Journal of Numerical Analysis* **47**(6), 4356-4380, 2010.
17. C. Pechstein and R. Scheichl, Scaling Up through Domain Decomposition, *Applicable Analysis* **88**(10), 1589-1608, 2009.
18. J. Van lent, R. Scheichl and I.G. Graham, Energy Minimizing Coarse Spaces for Two-level Schwarz Methods for Multiscale PDEs, *Numerical Linear Algebra with Applications*, **16**(10), 775-799, 2009.
19. C. Pechstein and R. Scheichl, Analysis of FETI Methods for Multiscale PDEs, *Numerische Mathematik* **111**(2), 293-333, 2008 2008.
20. B. Aksoylu, I.G. Graham, H. Klie and R. Scheichl, Towards a Rigorously Justified Algebraic Preconditioner for High-Contrast Diffusion Problems, *Computing and Visualization in Science* **11**, 319-331, 2008.
21. R. Scheichl, E. Vainikko, Additive Schwarz with Aggregation-Based Coarsening for Elliptic Problems with Highly Variable Coefficients, *Computing* **80**, 319-343, 2007.
22. I.G. Graham, P. Lechner and R. Scheichl, Domain Decomposition for Multiscale PDEs, *Numerische Mathematik* **106**, 589-626, 2007.
23. I.G. Graham and R. Scheichl, Robust Domain Decomposition Algorithms for Multiscale PDEs, *Numer. Meth. for Partial Differential Equations* **23**(4), 859-878, 2007.
24. R. Scheichl, M.-H. Klopffer, Z. Benjelloun-Dabaghi, B. Flaconneche, Permeation of Gases in Polymers: Parameter Identification and Nonlinear Regression Analysis, *Journal of Membrane Science* **254**, 275-293, 2005.
25. R. Scheichl, R. Masson, J. Wendebourg, Decoupling and Block Preconditioning for Sedimentary Basin Simulations, *Computational Geosciences* **7**(4), 295-318, 2003.
26. R. Scheichl, Decoupling Three-dimensional Mixed Problems Using Divergence-free Finite Elements, *SIAM Journal of Scientific Computing* **23**(5), 1752-1776, 2002. (SIAM Student Paper Prize 2000)
27. K.A. Cliffe, I.G. Graham, R. Scheichl, and L. Stals, Parallel Computation of Flow in Heterogeneous Media Modelled by Mixed Finite Elements, *Journal of Computational Physics* **164**, 258-282, 2000.
28. R. Scheichl, Parallel Solvers for the Transient Multigroup Neutron Diffusion Equations, *Internat. J. for Numerical Methods in Engineering* **47**, 1751-1771, 2000.

## Books and Theses

29. M. Cullen, M.A. Freitag, S. Kindermann and R. Scheichl (Editors), *Large Scale Inverse Problems: Computational Methods and Applications in the Earth Sciences*, to appear in Radon Series on Computational & Applied Mathematics, vol.13, De Gruyter, Berlin, 2013.

30. P. Bastian, J. Kraus, R. Scheichl and M.F. Wheeler (Editors), *Simulation of Flow in Porous Media: Applications in Energy and Environment*, to appear in Radon Series on Computational & Applied Mathematics, vol. 12, De Gruyter, Berlin.
31. I.G. Graham, T.Y. Hou, O. Lakkis and R. Scheichl (Editors), *Numerical Analysis of Multiscale Problems*, Lecture Notes in Computational Science and Engineering, Vol. 83, Springer, Heidelberg, 2011.
32. R. Scheichl, *Iterative Solution of Saddle Point Problems Using Divergence-free Finite Elements with Applications to Groundwater Flow*. PhD Thesis, Univ. of Bath, 2000.
33. R. Scheichl, *Parallel Solution of the Transient Multigroup Neutron Diffusion Equations with Multi-Grid and Preconditioned Krylov-Subspace Methods*. Master's Thesis, Schriften der Johannes Kepler Universität Linz, Vol. C21, Trauner-Verlag, Linz, 1997.

### Conference Proceedings

34. R. Scheichl, MLMCMC – Multilevel Markov Chain Monte Carlo, Oberwolfach Miniworkshop on "Numerical Upscaling for Media with Deterministic and Stochastic Heterogeneity" (Organ.: Y. Efendiev, O. Iliev, P. Vassilevski), Feb 2013, Oberwolfach Report xx/2013.
35. N. Spillane, V. Dolean, P. Hauret, F. Nataf, C. Pechstein and R. Scheichl, Achieving Robustness Through Coarse Space Enrichment in the Two Level Schwarz Framework, to appear in Proceedings of the 21st International Conference on Domain Decomposition Methods (DD21), Rennes, June 2012.
36. R. Scheichl, Robust Coarsening in Multiscale PDEs, to appear in Proceedings of the 20th International Conf. on Domain Decomposition Methods (DD20), San Diego, Feb 2011.
37. C. Pechstein, M. Sarkis and R. Scheichl, New Theoretical Coefficient Robustness Results for FETI-DP, to appear in Proceedings of the 20th International Conference on Domain Decomposition Methods (DD20), San Diego, Feb 2011.
38. V. Dolean, F. Nataf, R. Scheichl and N. Spillane, A Two-Level Schwarz Preconditioner for Heterogeneous Problems, to appear in Proceedings of the 20th International Conference on Domain Decomposition Methods (DD20), San Diego, Feb 2011.
39. C. Pechstein and R. Scheichl, Weighted Poincare Inequalities and Applications in Domain Decomposition, in Domain Decomposition Methods in Science and Engineering XIX (Y Huang, R Kornhuber, O Widlund, and J Xu, Eds.), *Lecture Notes in Computational Science and Engineering*, vol. 78, 2011, pp. 197-204 (Proc. DD19, Zhangjiajie, Aug 2009).
40. E. Dodgson, D.A.S. Rees and R. Scheichl, Vortex Instability of Free Convection Boundary Layers in Porous Media, in Proceedings of 3rd International Conference on Porous Media and its Applications in Science and Engineering (ICPM3), June 2010, Montecatini, Italy.
41. C. Pechstein and R. Scheichl, Robust FETI Solvers for Multiscale Elliptic PDEs, in Proceedings of 6th International Conference on Mathematics in Industry – Scientific Computing in Electrical Engineering (SCEE 2008), Springer, 2010.
42. C. Pechstein and R. Scheichl, Weighted Poincare Inequalities for High-Contrast Coefficients, Oberwolfach Workshop "Computational Electromagnetism and Acoustics" (Org.: R Hiptmair, RHW Hoppe, P Joly, U Langer), Feb 2010, Oberwolfach Report 10/2010.

43. R. Scheichl, Domain Decomposition and Upscaling, Oberwolfach Miniworkshop on "Numerical Upscaling for Flow Problems: Theory and Applications" (Organisers: A. Brandt, Y. Efendiev, O. Iliev), March 2009, Oberwolfach Report 12/2009.
44. I.G. Graham and R. Scheichl, Coefficient-explicit Condition Number Bounds for Overlapping Additive Schwarz, in Domain Decomposition Methods in Science and Engineering XVII (U. Langer, M. Discacciati, D. Keyes, et al, Eds.), *Lecture Notes in Computational Science and Engineering*, vol. 60, Springer, 2008 (Proc. DD17, Strobl, Austria, July 2006).
45. R. Scheichl and E. Vainikko, Robust Aggregation-Based Coarsening for Additive Schwarz in the Case of Highly Variable Coefficients, in Proceedings of the European Conference on Computational Fluid Dynamics, ECCOMAS CFD 2006 (P. Wesseling, E. Onate, J. Periaux, Eds.), TU Delft, 2006.
46. R. Masson, P. Quandalle, S. Requena, R. Scheichl, Parallel Preconditioning for Sedimentary Basin Simulations, in Proceedings of the 4th International Conference on Large Scale Scientific Computations, Sozopol, Bulgaria, June 4-8, 2003 (Lirkov I., Margenov S. et al., Eds.), *Lecture Notes in Computer Science*, vol. 2907, Springer, New York, 2004.
47. R. Scheichl, Parallel Solvers for the Two-Group Neutron Diffusion Equations of Reactor Kinetics, in Proc. of 11th Inter. Conf. Domain Decomposition Methods, Greenwich, July 1998 (C.H. Lai, P.E. Bjorstad, et al, Eds.), Domain Decomposition Press, Bergen, 1999.
48. H. Finnemann and R. Scheichl, Efficiency Enhancements of Coupled RELAP5/ PANBOX Calculations Using Adaptive Methods, Transactions of the American Nuclear Society for the Annual Meeting, Boston, June 1999.

### Preprints (Submitted)

49. C. Ketelsen, R. Scheichl and A.L. Teckentrup, A Hierarchical Multilevel Markov Chain Monte Carlo Algorithm with Applications to Uncertainty Quantification in Subsurface Flow, submitted 29 March 2013, arXiv:1303.7343.
50. E. Mueller, X. Guo, R. Scheichl and S. Shi, Matrix-free GPU implementation of a preconditioned conjugate gradient solver for anisotropic elliptic PDEs, submitted 28 Feb 2013, arXiv:1302.7193.
51. A. Ferreiro-Castilla, A.E. Kyprianou, R. Scheichl and G. Suryanarayana (2012), Multi-level Monte Carlo Simulation for Levy Processes Based on the Wiener-Hopf Factorisation, submitted 22 October 2012, arXiv:1210.586.
52. N. Spillane, V. Dolean, P. Hauret, F. Nataf, C. Pechstein and R. Scheichl, Abstract Robust Coarse Spaces for Systems of PDEs via Generalized Eigenproblems in the Overlaps, submitted 31 October 2011, NuMa-Report 2011-07, Institute of Computational Mathematics, Johannes Kepler University Linz.