ROBERT SCHEICHL

University of Bath
Department of Mathematical Sciences
Bath BA2 7AY
United Kingdom

DoB: 6th February 1972
+44 - 1225 - 386034
R.Scheichl@bath.ac.uk
http://people.bath.ac.uk/masrs/

EDUCATION

Ph.D. in Mathematics
University of Bath, United Kingdom — December 2000

Diplom-Ingenieur der Technischen Mathematik (mit Auszeichnung)
Johannes Kepler Universität Linz, Austria — October 1997

PROFESSIONAL EXPERIENCE

Deputy Head of Department
Department of Mathematical Sciences, University of Bath, UK — since 2016

Professor of Scientific Computing
Department of Mathematical Sciences, University of Bath, UK — since 2011

Senior Lecturer in Applied Mathematics
Department of Mathematical Sciences, University of Bath, UK — 2010–2011

Lecturer in Applied Mathematics
Department of Mathematical Sciences, University of Bath, UK — 2002–2010

Marie-Curie Postdoctoral Fellow
Institut Français du Pétrole, Paris, France — 2001–2002

ACADEMIC PRIZES AND DISTINCTIONS

SIAM Student Paper Prize, Society of Industrial and Applied Mathematics, 2000

Distinguished Romberg Guest Professorship, University of Heidelberg, 2014–2017

VISITING POSITIONS (only listing those of 1 month or more)

Isaac Newton Institute, Cambridge, UK (2003, 2012 & 2018)
University of Stuttgart, Germany (2007)
Johann Radon Institute, Austrian Academy of Sciences, Linz, Austria (2007 & 2011)
University of New South Wales, Sydney, Australia (2007, 2009 & 2015)
Lawrence Livermore National Laboratory, Livermore, CA (2009)
Penn State University, State College, PA (2010)
University of Heidelberg, Germany (2015, 2016 & 2017)

OTHER ACADEMIC ROLES AND POSITIONS OF ESTEEM

Associate Editor for *SIAM/ASA J. Uncertainty Quantification*, since 2015
Associate Editor for *SIAM J. Scientific Computing*, since 2016
Associate Editor for *ESAIM: Mathematical Modelling and Numerical Analysis*, since 2019
Associate Editor for *Internat. J. of Computer Mathematics, Section B*, 2009–2015

Member of the *SIAM Membership Committee*, 2014-2016 & 2017-2019

Scientific Advisory Board Member, *Weierstrass Inst. Appl. Anal. Stoch. (WIAS)*, Berlin, 2016–2020

Scientific Advisory Board Member for a €3M *Norwegian Research Council* research programme on "Thermo-Mechanical Subsurface Energy Storage", 2016–2020

Scientific Advisory Board Member, UQ Research Centre (SRI-UQ), KAUST, Saudi Arabia, 2014

Chair of *RICAM Special Semester* on "Multiscale Analysis and Simulation in Energy and the Environment" Radon Institute, Austrian Academy of Sciences, Linz, 2011

Co-chair of *LMS Durham Research Symposium* "Numerical Analysis of Multiscale Problems", 2010

Scientific Committee Member for *SIAM Conf. on Computational Science and Engineering 2019*, *IMA Conference Series on Numerical Methods for Simulation* and the *International Conference Series Preconditioning Techniques for Scientific & Industrial Applications*

Head/Joint Head of 3 appointment committees for 5 permanent positions in Applied Maths, as well as Search Champion (twice) for 2 professorial appointments in Statistics, University of Bath

Chair of Department Promotions Committee, University of Bath, since 2016

Reviewer for two W3 and two W1 positions in Germany (Bonn, Darmstadt, FU Berlin, Stuttgart)

Review Panel Member on SFB programmes of Austrian FWF (2016) and German DFG (2018)

External Examiner on the *MASDOC MSc*, University of Warwick, 2014-2017

External Examiner on the Habilitation of Olaf Ippisch, University of Heidelberg, 2014

External PhD Examiner at Oxford (2004, 2015), Heidelberg (2010, 2016), Greenwich (2010), Leipzig (2011), Cardiff (2011), Heriott-Watt (2015), EPFL Lausanne (2015), Bergen (2016), Uppsala (2017)

Reviewer on grant proposals for the UK EPSRC & NERC, the German DFG, the US NSF, the Swiss NSF, the French ANR, the Austrian FWF, the Swedish Vetenskapsrådet, the Dutch NWO

CURRENT & RECENT RESEARCH PROJECTS

- "Multilevel Monte Carlo Methods for Elliptic Problems with Applications to Radioactive Waste Disposal" (EPSRC Grant EP/H051503/1 w. KA Cliffe, Nottingham; MB Giles, Oxford; UK Nuclear Decomissioning Authority; Serco Assurances): 1 Postdoc & 1 PhD student at Bath, finished 2014.
- "Parallel Scalability of Elliptic Solvers in Weather and Climate Prediction" (part of 5-year programme on *Next Generation Dynamical Core for the UK Met Office* with STFC, Imperial College, Universities of Exeter, Leeds, Manchester, Reading, two NERC Grants NE/J005576/1, NE/K006754/1): 1 Postdoc & 1 PhD student at Bath (both finished), until June 2016.
- "Multilevel Monte Carlo Methods in Atmospheric Dispersion Modelling" (with E. Mueller, T. Shardlow, and Met Office, EPSRC CASE Award + Met Office funding): 1 PhD until 2018.
- "Multiscale Modelling and Uncertainty Quantification for Aerospace Composites" (with R. Butler, Mech. Eng. Bath, and GKN Aerospace, Bristol, EPSRC Grant EP/K031368/1 and EPSRC Industrial CASE Award): 2 Postdocs and 1 PhD student until June 2017.
- "Tensor product numerical methods for high-dimensional problems in probability and quantum calculations", EPSRC Postdoctoral Fellowship EP/M019004/1 for Sergey Dolgov, starts January 2016.
- "Multiscale computational studies of energy materials", interdisciplinary project with Alison Walker (Physics, **PI**) and Saiful Islam (Chemistry) as part of the H2020-EINFRA-2015-1 EU-funded *Energy Oriented Centre of Excellence for Computer Applications (EoCoE)*, 1 Postdoc, started October 2015.

RESEARCH STATEMENT

My scientific interests lie on the interface of scientific computing, rigorous theoretical mathematics and industrial applied mathematics. The overarching philosophy in my research is the use of model hierarchies, e.g., in the design of robust multilevel preconditioners for multiscale PDEs, of multiscale discretisation techniques for heterogeneous problems, or of multilevel sampling approaches in uncertainty quantification.

Interdisciplinary Focus. Most of my research projects have been either industrially related or interdisciplinary, and the results of my research have in most cases had a direct impact on the competitiveness of the industrial or application partner. One of my strongest assets is my ability to distill the (mathematical) essence out of a problem and my flair for recognising promising approaches for solving the problem. There are several examples of these skills in my track record, from many areas of engineering and physics, as well as finance. A good example is the case of my recent collaboration with the UK Met Office. In discussions with senior scientists at the Met Office, it emerged that some of the most restrictive computational difficulties in their codes for atmospheric flow were very similar to the ones I had encountered in previous work on subsurface flow. It required some persistence on my part to overcome their scepticism towards the multilevel methods I proposed and to persuade them to fund a PhD project. The results we obtained were ground-breaking, enabling them to tackle previously infeasible problems and problem sizes, and our new methods were implemented in their operational data assimilation codes, as well as in the currently operational dynamical core. It also led to an invitation by NERC to apply for funding to contribute to the design of a new, massively parallel, dynamical core for the Met Office weather and climate prediction systems. This 5-year programme, in collaboration with other partners across the UK, has led to the development of a new code framework based on modern numerical methods and code generation, that is currently being implemented and will have a direct impact on future weather and climate forecasts. There are many other examples of leadership and enterprise skills in my career that demonstrate that I am able and keen to go beyond the state-of-the-art.

Numerical Analysis. An important additional priority in my career is the role of rigorous theoretical justification in applied mathematics. In my opinion, the analysis of numerical methods, answering questions such as how accurate/robust/efficient a method is, or whether it converges, are not just mathematical "exercises". It actually provides insight and will guide the design of better methods. Numerical testing alone (on thousands of benchmark problems) is not sufficient to guarantee that a method will work in a real application. If the application concerns the risks of a nuclear waste repository for the environment, we cannot afford to neglect a rigorous justification of our methodology and reasoning. Current computational technologies to quantify the inherent uncertainties in subsurface flow are still unable to predict these risks to a satisfactory accuracy. In a PhD project, started in October 2009, and in a subsequent EPSRC project, started in July 2011, we proposed and rigorously analysed a novel uncertainty quantification (UQ) tool, the multilevel Monte Carlo method. I was one of the first and biggest advocates of this technology which now is being heavily pursued and researched around the world – at the recent SIAM Conference on UQ, there were almost 50 talks related to this method. It leads to huge efficiency gains over standard Monte Carlo methods and outperforms other novel UQ methods such as polynomial chaos, stochastic Galerkin or sparse grid approaches for rough and high-dimensional problems.

Main Contributions. My strongest theoretical results are in the numerical analysis of (a) domain decomposition (DD) and multigrid (MG) methods applied to elliptic PDEs with highly variable (possibly discontinuous or random) coefficients and (b) multilevel Monte Carlo (MLMC) and (multilevel) Quasi-Monte Carlo (QMC) methods for forward and inverse UQ. Problems of this type are at the heart of many applications. The novel DD and MG theory that I developed together with several colleagues shows very precisely when standard methods lose robustness and how they can be modified to improve their performance. This was only possible by going beyond the state-of-the-art and developing new theoretical tools (e.g. uniform weighted Poincaré inequalities). Two quotes from referees on two of my papers underline this: “I consider it one of the best papers I have seen lately in Domain Decomposition” and “It is an important and original contribution to our knowledge of FETI algorithms and it breaks new ground in its analysis of problems with coefficients which are allowed to vary a lot inside the individual subdomains; the paper is also quite strong technically”. This work has also strong implications for multiscale approximation and upscaling. While there is a fairly long history of empirically successful upscaling techniques, mainly in the engineering literature, the rigorous numerical analysis of such methods is in its infancy. My work has opened new horizons in the analysis of these methods that go beyond homogenisation theory, and it has led to many invitations for keynote lectures. The MLMC method was originally proposed in the context of stochastic differential equations (SDEs), QMC in the context of high-dimensional quadrature in general. But my papers on MLMC and QMC are considered to be among the original references in the context of UQ and, accordingly, receive large numbers of citations. Especially, the analysis of MLMC, QMC and MLQMC for the diffusion equation with lognormal coefficients, one of the most heavily studied model problems, is the original work of my collaborators and me. I have given several keynote lectures and short courses on the subject.

Research Audience & Impact. My focus has always been on quality over quantity. My papers are all substantial pieces of work with an average printed length of 24 pages. Most of my articles are in the leading scientific journals in numerical analysis (e.g. *SIAM J Sci Comput*, *Numer Math*, *SIAM J Num Anal*) or in leading journals in the application area (e.g. *J Comput Phys*, *J Membrane Sci*, *Quart J Royal Meteo Soc*). They are being cited regularly, with a total of 1624 citations and a current average of almost 300 citations per year (Source: `Google Scholar`, 14/9/2016). The key audiences are leading scholars in the field, as well as people working in the specific application areas. Some of my papers are very theoretical, others are more applied. My papers have led to (a) a whole series of invitations to deliver keynote and plenary presentations at long-running international conferences and targeted workshops (for details see below), (b) visiting positions at some of the world's leading research institutions (such as the Newton Institute, the Radon Institute, the IWR Heidelberg, Laboratoire J.-L. Lions, Lawrence Livermore National Labs, Penn State, Caltech, and UNSW Sydney), and (c) contacts and collaborations with some of the leading researchers in my field. They have also led to a successful application to the London Mathematical Society (LMS), to host one of their prestigious 10-day research symposia in Durham in 2010 on “Numerical Analysis of Multiscale Problems” (with Graham, Bath & Hou, Caltech), and to an invitation by Heinz Engl (Director of RICAM) to host one of their Special Semesters in 2011 on “Multiscale Simulation and Analysis with Applications in Energy and the Environment”. On the application side, my collaborations with industry have led to (a) improved efficiency of commercial and legacy parallel simulation tools (e.g., PANBOX, Siemens; TEMIS3D, IFP-EN; VAR, Met Office; ENDGAME, Met Office) and thus to an increased competitiveness of the UK and Europe as industrial locations, and (b) direct funding for my research from industry (for details see below).

Major Research Achievements

Analysis of domain decomposition and multigrid methods for multiscale elliptic PDEs [2, 7, 14, 21-27, 33-39, 54, 55, 57-60, 52-66]. In this series of well-cited papers (∼<u>800 citations</u> in 10 years) I have extended (together with co-workers) the theory for subspace correction and FETI-type domain decomposition methods for elliptic PDEs to the highly varying coefficient case. In [23, 36], we also consider extensions to multigrid methods. We show rigorously how the condition number of the preconditioned system matrix depends on the coefficient variation within subdomains or coarse grid elements. Previous literature only dealt with resolved coefficients. This analysis then provides us with a handle to design new robust methods that eliminate the dependence of the condition number on the coefficient variation. We make use of ideas from algebraic multigrid methods, multiscale approximation theory and numerical homogenisation, and prove novel uniform weighted Poincaré-type inequalities [22, 59, 60, 63]. Conversely, our new theoretical ideas are now also being applied in the analysis of numerical upscaling techniques, e.g. in [2]. Currently, we are considering the use of abstract coarse spaces that are based on the solution of local eigenproblems in [14] for the design of novel multiscale discretisation schemes for the modelling of aerospace composites.

Multilevel Monte Carlo and (multilevel) Quasi-Monte Carlo methods [1, 4, 8-12, 17, 18, 28-29, 43, 45-46, 52, 56]. This ground-breaking work (more than 500 citations in just 6 years) has been my recent focus. In the earlier work [43] we were mainly interested in accelerating the computation of individual samples in classical Monte Carlo (MC) methods for stochastic elliptic PDEs arising in subsurface flow modelling (which spawned the theoretical work on DD methods above). My recent work on this topic focuses on accelerating the convergence of classical MC methods for PDEs with random coefficients through (a) the introduction of deterministic *Quasi-Monte Carlo* (QMC) sampling rules [11, 29] and (b) the introduction of a hierarchy of spatial approximations in *Multilevel Monte Carlo* (MLMC) [8, 17-18, 28, 46, 52]. The two novel approaches are complementary and combining them in a *Multilevel QMC* method leads to significant additional gains as we proved rigorously for the lognormal coefficient case in [1]. Multilevel MC methods in particular, are currently a very hot topic worldwide and my research is at the forefront. Several recent invitations to deliver keynote lectures and short courses on the topic prove this. More recently, I also made some important contributions in the application of MLMC methods to Lévy processes (arising in the modelling of novel financial products; successful Royal Society Newton Fellowship for A. Ferreiro-Castilla) [4, 12], to stochastic differential equations (SDEs) in atmospheric dispersion modelling [10] (+ a PhD thesis and 3 papers in preparation), as well as in the certification process of light-weight aerospace composites [52] (+ a PhD thesis and 2 papers in preparation). My most interesting recent work in this field and a central area of my future research is the application of multilevel and quasi Monte Carlo ideas in the inverse, Bayesian setting [9, 45]. Probably one of my strongest and most innovative papers to date is [9], where a multilevel Markov chain Monte Carlo (MCMC) algorithm is presented and analysed that has the potential to revolutionise Bayesian inference for large-scale problems, in particular in the context of PDE models but also for particle systems (through coarse graining – this is a recent collaboration with colleagues in physics in Bath).

(Massively) parallel multilevel preconditioners for systems of PDEs and applications [5-6, 15-16, 30-31, 41-44, 50, 51, 67-69]. These papers (∼220 citations) are all application-driven (i.e. nuclear reactor simulation, groundwater flow, sedimentary basin simulation, atmospheric flow). In each case, more than one physically relevant quantity is treated as a primary variable, either due to multiphysics or due to mixed discretisation schemes. The resulting linear equation systems are typically not symmetric positive definite (SPD), and powerful preconditioning techniques, such as multigrid or domain decomposition, cannot be applied directly. However, by studying the underlying structure inherited from the original PDEs or by exploiting certain invariants (e.g. divergence-freeness), I was able (with co-workers) to adapt successful preconditioners for SPD systems to the indefinite/non-symmetric cases and to show in all applications (by numerical experiment) their robustness with respect to mesh refinement and coefficient variation, as well as their (near) optimal parallel efficiency. For indefinite problems arising in mixed discretisations of groundwater flow in 2D, the coefficient robustness can even be justified theoretically, by combining the theory in [6] with that in [12-14]. The theory in [7] (which uses tools from algebraic topology and graph theory) led to my receiving the SIAM Student Paper Prize 2000. More recently, I started to collaborate with the UK Met Office to improve their data assimilation and atmospheric flow simulation codes. The original collaboration focused on their currently operational forecasting tools that employ latitude-longitude grids. The central task, both in data assimilation and in atmospheric dynamics, is the solution of an elliptic PDE. In a PhD project, we modified standard multigrid in such a way as to render it robust to the anisotropy caused by the presence of the pole in these grids through a non-uniform coarsening strategy [30-31], substantially improving the capabilities and robustness of the Met Office's forecasting tools. More recently, as part of a NERC programme, we studied alternative grids and massively parallel scenarios with more than 10^{10} unknowns [5-6, 15]. We were able to show excellent parallel scalability up to more than 65000 CPU cores of standard AMG packages, such as DUNE-ISTL or Hypre-BoomerAMG, as well as of our bespoke geometric multigrid algorithm. Our largest tests, in [6] with almost 10^{12} unknowns and a code ported to GPUs, scaled to 16384 GPUs on the 2nd largest computer at the time, TITAN (ORNL). We exploit between 25 and 50% of the memory bandwith of the machine and achieve a speed of about 0.78 PetaFLOP/s].

Future Research Plans

The focus of my research is on *stochastic uncertainty quantification* (in particular sampling methods), *high dimensional problems* and *multiscale simulation and analysis*.

My currently most exciting future research plans are in the area of Bayesian inference for large-scale problems. Building on the success of the multilevel MCMC method proposed in [9], I have recently started a PhD project to merge this approach with complementary ideas from information geometry [Girolami, Calderhead, '11], [Cui, Law, Marzouk, '16], [Amari, '16]. The project is in collaboration with Anaya-Izquierdo and Simpson, two statistician at Bath specialising in information geometry and in large-scale Bayesian inversion, resp., as well as Cui (Exxon Mobil), Marzouk (MIT) and Fox (Otago, NZ; who will be on sabbatical at Bath Sep-Nov '16). In related work with Dodwell (Exeter), we are finalising a massively parallel implementation of our MLMCMC methods within `DUNE`, the Distributed and Unified Numerics Environment (`https://www.dune-project.org/`).

Building on the success of MLMC for UQ in PDE-based models, I recently started talks and collaborations with physicists, chemists and biologists at Bath and Heidelberg (as Romberg Visiting Professor), to employ multilevel ideas in the direct stochastic simulation of biological systems, in kinetic MC simulations of solar cells, and (via coarse graining) in MCMC simulations of complex fluids. This has already led to an EU grant on multiscale modelling of solar cells with Walker (Phys.) and Islam (Chem.) at Bath, and to a grant application (in process) on self-consistent multiscale simulations of complex fluids with Jack and Wilding (Phys., Bath). I have successfully proposed a *Thematic Semester on MCMC Methods* in Bath (Sep-Dec 2016, supported by our SAMBa Graduate School and the Bath Institute for Mathematical Innovation) to bring together mathematicians, statisticians, engineers and physicists, working on MCMC methods, to exchange ideas and to start interactions.

A major part of my future work will continue to be in collaboration with the Composite Research Centre at Bath and with GKN Aerospace, our industrial partner. Future aircraft will consist of ever more composite materials and purely experimental certification of such aircraft will be impossible (according to chief engineers at Boeing). Numerical simulation and UQ will become paramount, but the modelling of defects in composites depend on accurate multiscale methods and adaptivity. This is why our current current EPSRC project that aims to implement such tools (again within `DUNE`) is so timely and important. In parallel, we are also developing sample-adaptive multilevel MC methods for the UQ process (where FE tolerance is the level parameter rather than mesh size), as well as multilevel subset simulation approaches [Au, Beck, 2011] for the accurate quantification of rare events. The design of efficient methods for rare events in particular, is a problem with massive global interest from many application areas and our preliminary results are very promising.

Further plans concern more theoretical and applied work on QMC methods, especially to extend our theory (a) to other parametrisations of random fields, such as circulant embedding (w. Graham, Kuo, Nuyens, Sloan) and (b) to eigenvalue problems and integrodifferential equations, such as the neutron transport equation (w. Graham, a PhD student & industrial partner AMEC-FW). A recently started project focuses on efficient, parallel, low-rank tensor methods within UQ and for other high-dimensional problems (w. Dolgov) and I have an ongoing collaboration with Bastian, Heidelberg, on efficient parallel multigrid solvers for high-order DG approximations (w. Müller).

RESEARCH INCOME (only explicitly listing grants of £10K or more)

Total grant support obtained to date: £3.5M (£2.35M as PI)

Great Western Research & MET Office PhD Studentship , "Numerical Methods for Weather and Climate Models: Elliptic Solvers" with UK Met Office (**PI**, 2006-10) [**£55K**]

EPSRC funded LMS Durham Research Symposium in Durham on "Multiscale Numerical Analysis" (**CI & Co-Chair**, PI: J Bolton, 2010) [**£97K**]

Two Subcontracts with Lawrence Livermore National Laboratory (**CI**, PI: L Zikatanov, Penn State, 2009 & 2010) [**£36K**]

EPSRC Knowledge Transfer Network PhD Student Internship on "Clutter Mapping for Radar Trackers" with Thales UK (**PI**, 2010-11) [**£12K**]

RICAM Special Semester 2011 on "Multiscale Simulation and Analysis in Energy and the Environment" (**PI & Chair**, 2011) [**€220K**]

EPSRC Collaborative Grant (**EP/H051503/1**, **EP/H051589/1**, **EP/H05183X/1**, under the Energy Mission Programme) with Nottingham, Oxford, Nuclear Decommissioning Authority, Serco TAS (**Lead-PI**, 2011-14) [**£677K**]

NERC Programme Grant on "Next generation weather and climate prediction systems" (total: £5M, Bath: **NE/J005576/1**, **NE/K006754/1**) with Met Office, STFC, Exeter, Reading, Imperial, Leeds, Manchester (**Bath PI**, 2011-16) [Bath share: **£455K**]

Royal Society Newton Fellowship A. Ferreiro-Castilla (**CI**, PI: A. Kyprianou, 2012-14) [**£100K**]

EPSRC CASE Studentship with Met Office on "Multilevel Monte Carlo Methods for Atmospheric Dispersion Modelling" (**PI**, 2013-17) [**£90K**]

EPSRC Maths for Manufacturing Grant (**EP/K031368/1**) "Multiscale modelling and UQ for aerospace composites" with GKN Aerospace (**joint PI** w. Butler, Eng., 2014-17) [**£499K**]

EPSRC KTN Industrial CASE Award "Multiscale Modelling and Stochastic Uncertainty Quantification in Aerospace Composites" with GKN Aerospace (**PI**, 2013-17) [**£97K**]

EPSRC IAA (Impact Acceleration Account) Grant with DNV-GL (Det Norske Veritas – German Lloyds) (**CI**, PI: Shardlow) [**£56K**]

HGS MathComp Romberg Guest Professorship, University of Heidelberg (**PI**, 2014-17) [**€24K**]

NAIS *(EPSRC Science & Innovation Centre) funded international workshop* "Spatial Statistics and Uncertainty Quantification on Supercomputers", Bath (**PI & Chair**, 2014) [**£17K**]

ClusterVision & Fac. Sci. co-funded PhD studentship on a "Performance-portable framework for atomistic simulations on novel chip architectures" (**CI**, PI: Müller, 2015-19) [**£70K**]

EPSRC Postdoc Fellowship for S. Dolgov (**EP/M019004/1**, **CI & Mentor**, 2016-18) [**£279K**]

EU Horizon2020 Consortium grant **(H2020-EINFRA-2015-1; total: €5.4M)** in "HPC for Energy" w. CEA Paris, FZ Jülich & others (**CI**, Bath PI: Alison Walker, 2015-18) [**€285K**]

Bath Institute for Mathematical Innovation (IMI) Global Chair Visiting Professorship for Prof. Colin Fox, Univ. Otago, NZ (**CI & Host**, 2016) [**£10K**]

Schlumberger & Fac. Sci. co-funded PhD studentship on "On-line drill system parameter estimation and hazardous event detection" (**CI**, PI: Heine, 2018-21) [**£64K**]

Leverhulme Research Grant **(RPG-2017-203)** on "A self-consistent coarse-graining method for soft-matter systems" (**CI**, PI: Rob Jack, Cambridge, 2018-21) [**£273K**]

RESEARCH OUTPUT (Publications and Presentations)

48 journal papers appeared or in press in top journals (**2151 citations; h-index: 25**) (Source: Google Scholar 10/01/18). I have also published **21 proceedings papers** and **4 books**.

Top 12 Most Influential Publications **[Citations]**

R Scheichl, R Masson, J Wendebourg. Decoupling and block preconditioning for sedimentary basin simulations, *Comput. Geosci.* **7**, 2003 **[52]**

IG Graham, P Lechner, R Scheichl. Domain decomposition for multiscale PDEs, *Numer. Math.* **106**, 2007 **[162]**

C Pechstein, R Scheichl. Analysis of FETI methods for multiscale PDEs, *Numer. Math.* **111**, 2008 **[90]**

KA Cliffe, MB Giles, R Scheichl, AL Teckentrup. Multilevel Monte Carlo methods and applications to elliptic PDEs with random coefficients, *Comput. Visual. Sci.* **14**, 2011 **[264]**

IG Graham, FY Kuo, D Nuyens, R Scheichl, IH Sloan. Quasi-Monte Carlo methods for elliptic PDEs with random coefficients and applications, *J. Comput. Phys.* **230**, 2011 **[99]**

P Bastian, M Blatt, R Scheichl. Algebraic multigrid for discontinuous Galerkin discretizations of heterogeneous elliptic problems, *Num. Lin. Alg. Appl.* **19**, 2012 **[38]**

R Scheichl, PS Vassilevski, LT Zikatanov. Mutilevel methods for elliptic problems with highly varying coefficients on non-aligned coarse grids, *SIAM J. Numer. Anal.* **50**, 2012 **[37]**

J Charrier, R Scheichl, AL Teckentrup. FE error analysis of elliptic PDEs with random coefficients and its application to MLMC methods, *SIAM J. Numer. Anal.* **51**, 2013 **[119]**

N Spillane, V Dolean, P Hauret, F Nataf, C Pechstein, R Scheichl. Abstract robust coarse spaces for systems of PDEs via generalized eigenproblems in the overlaps, *Numer. Math.* **126**, 2014 **[98]**

E Müller, R Scheichl. Massively parallel solvers for elliptic partial differential equations in numerical weather and climate prediction, *Q. J. Royal Meteorol. Soc.* **140**, 2014 **[43]**

IG Graham, FY Kuo, JA Nicholls, R Scheichl, C Schwab, IH Sloan. Quasi-Monte Carlo finite element methods for elliptic PDEs with log-normal random coefficients, *Numer. Math.* **131**, 2015 **[51]**

TJ Dodwell, C Ketelsen, R Scheichl, AL Teckentrup. A hierarchical multilevel Markov chain Monte Carlo algorithm with applications to uncertainty quantification in subsurface flow, *SIAM/ASA J Uncertain. Quantif.* **3**, 2015 **[47]**

Keynote Lectures (Selection)

15th Computational Techniques and Applications Conference (CTAC2010) Sydney, Nov 2010
(the major international computational applied maths conference in Australia and New Zealand, since 1981)

20th Inter. Conference on Domain Decomposition Methods (DD20) San Diego, Feb 2011
(the most highly regarded and influential international conference series in domain decomposition, since 1987)

7th Inter. Conference on Preconditioning Techniques for Scientific & Industrial Applications Bordeaux, May 2011

Society of Petroleum Engineering (SPE) & SIAM Conference on Mathematical Methods in Fluid Dynamics and Simulation of Giant Oil and Gas Reservoirs Istanbul, September 2012

26th Chemnitz FEM Symposium (series running since 1978) Chemnitz, September 2013

20th Inter. Conference on Computational Methods for Water Resources Stuttgart, June 2014
(the largest conference in computational hydrology, running since 1976)

12th European Multigrid Conference (series running since 1981) Leuven, September 2014

6th Inter. Conf. Computational Methods in Applied Mathematics (CMAM) Strobl (A), Sep 2014

26th Biennial Conference on Numerical Analysis Glasgow, June 2015
(longest standing and internationally most highly regarded conference in numerical analysis, since 1965)

10th IMACS Seminar on Monte Carlo Methods Linz, July 2015

12th European Conference on Numerical Mathematics (ENUMATH) Bergen, September 2017

Other Important Conference/Workshop Invitations (Selection)

Isaac Newton Institute Programmes, Cambridge, 2003, 2012 & 2018
(Mathematical Challenges in PDEs / Multiscale Numerics for Atmosphere & Ocean / UQ for Complex Systems)

RICAM Special Semester, Linz, 2007 & 2008 (as well as Chair in 2011, see above)
(Quantitative Biology analyzed by Mathematical Methods / Stochastics with Emphasis on Finance)

LMS Durham Research Symposia, Durham (UK), 2008 & 2014
(Computational Linear Algebra for PDEs / Modern Approaches to Numerical PDEs)

Oberwolfach Workshops and Mini-Workshops, Oberwolfach, 2009, 2013 & 2014
(DD & Upscaling / Numerical Upscaling (Determ. & Stoch.) / Reactive Flows in Deformable, Complex Media)

ICMS (International Centre for Mathematical Sciences) Workshops, Edinburgh 2009, 2009 & 2013
(Multiscale Algorithms / Stochastic PDEs / Porous Media: Process & Mathematics (EPSRC network kick-off))

MoMaS Workskops, French CNRS, Marseille, 2009 & 2012
(Research network on *Mathematical modelling and simulation of radioactive waste management problems*)

Workshop Series "Numerical Analysis of SPDEs", Freiberg 2010 & Gothenburg 2016 (declined)

MATCH Workshop "Analytical and Numerical Methods for Multiscale Systems", Heidelberg, 2011

Royal Meteorological Society Meeting on "Data Assimilation", Reading, 2013

HCM (Hausdorff Centre for Mathematics) Workshop "Numerical Methods for UQ", Bonn, 2013

SPPEXA-Workshop "New Algorithms for Exascale Computing", Köln, 2013

Invitation-only Workshop *Challenges in High-Dimensional Analysis & Computation*, Venice, 2016
(Organisers: G Biau, A Cohen, W Dahmen, R DeVore, Y Maday)

Institut Mittag-Leffler Workshop on "Uncertainty Quantification", Stockholm, 2016

Dagstuhl Seminar "Uncertainty Quantification and HPC", Dagstuhl, 2016 (declined)

Short Courses

"Multilevel Monte Carlo Methods" (3h lecture course) at RICAM Special Semester, Linz, 2011

"Numerical Analysis of PDEs with Random Coefficients" (4h lecture course) at a workshop on *PDEs with Random Coefficients*, WIAS, Berlin , 2013

"Novel Monte Carlo Methods for the Earth Sciences" (2h lecture) at EPSRC Centre for Doctoral Training *Maths for Planet Earth*, Imperial & Reading, 2014

"Efficient Use of Model Hierarchies in UQ" (3h lecture course) at AICES (interdisciplinary graduate school, engineering and scientific computing), RWTH Aachen, 2015

"Computational Methods in UQ" (1 week compact course) at HGS MathComp (interdisciplinary graduate school for maths & scientific computing in the sciences), Heidelberg, 2015

"Computational Methods in UQ" (8h lecture course) in the Taught Course Centre (virtual UK graduate school network between Bath, Bristol, Imperial, Oxford & Warwick), 2015

"Multilevel Monte Carlo Methods", GAMM Summer School on UQ, WIAS, Berlin, 2016 (declined)

RESEARCH SUPERVISION

Graduated PhD Students: R Norton (2004-08), S Buckeridge (2006-10), E Dodgson (2008-11), A Teckentrup (2009-13), S Cook (MPhil, 2012-13)

Current PhD Students: S Kynaston (since 2013), G Katsiolides (since 2014), M Parkinson (since 2015), G Detommaso (since 2016), T Pennington (since 2017)

Postdocs (completed): J Van lent (2006-08), E Ullmann (2011-14), E Mueller (2011-15), A Ferreiro-Castilla (2012-13), T Kim (2014-15), V Bayona-Revilla (2016), A Reinarz (2016-2017)

Postdocs (current): S Dolgov (2016-18), TT Nguyen (2017-2018)

OTHER INDUSTRIAL COLLABORATIONS & NETWORKING

(in addition to the UK NDA, Serco Assurance and GKN Aerospace, mentioned above)

Institut Francais du Petrole (supported by IFP, British Council, Nuffield), 2002-05

UK Met Office (various projects supported by Met Office, GWR, NERC, EPSRC), 2006-17

Lawrence Livermore National Laboratory (consultancy supported by LLNL), 2009-11

Thales UK (EPSRC Knowledge Transfer Network Internship for S Buckeridge), 2010-11

DNV-GL, risk assessment software (support: EPSRC Impact Acceleration Acc., DNV) 2014-15

AMEC-FW, UQ in nuclear reactor simulation (support: AMEC-FW, SAMBa), 2015-18

Schlumberger, On-line drill system parameter estimation and hazardous event detection (support: Schlumberger, Faculty of Science), 2018-21

EPSRC network *Porous Media – Processes and Mathematics* (www.pmpm.org.uk)

EPSRC network *Living with Environmental Change* (www1.maths.leeds.ac.uk/mathsforesees)

RCUK network *Models to Decisions* (http://blogs.exeter.ac.uk/models2decisions)

CONFERENCE AND WORKSHOP ORGANISATION

Conference (co-chair), Workshop (co-chair) and Summer School (co-organiser) as part of the 5-year EPSRC-funded *Bath Institute for Complex Systems*, University of Bath, 2006 & 2007

LMS Durham Research Symposium on "Numerical Analysis of Multiscale Problems" (**Co-Chair** w. IG Graham, T Hou), Durham, 2010. (www.maths.dur.ac.uk/events/Meetings/LMS/2010/NAMP)

Special Semesters on "Multiscale Simulation and Analysis in Energy and the Environment" with 4 embedded workshops (**Chair**), Linz, 2011. (www.ricam.oeaw.ac.at/specsem/specsem2011)

5th Numerical Analysis of SPDEs Workshop (**Co-Organiser** w. KA Cliffe, A Stuart), Warwick, 2012. (www2.warwick.ac.uk/fac/sci/maths/research/events/2011-2012/symposium1112/naspde)

NAIS (EPSRC S&I Centre) International Workshop "Spatial Statistics and Uncertainty Quantification on Supercomputers" (**Chair**), Bath, 2014. (www.icms.org.uk/workshop.php?id=322)

7th Internat. Conf. on Scientific Computation and Differential Equations (SciCADE 2017) (**Co-Organiser**; Chair: CJ Budd), Bath, 2017. (https://sites.google.com/site/scicade2017)

Newton Institute Programme on "Uncertainty Quantification for Complex Systems" (**Co-Organiser** for Workshop 1), Cambridge, 2018. (https://www.newton.ac.uk/event/unqw01)

As well as 13 minisymposia at international conferences since 2006 and some smaller workshops.

TEACHING RECORD

2001/02 Sem 2	*Scientific Computing and Introduction to Parallel Comp.* (MA50177, MSc)
2002/03 Sem 2	*Scientific Computing and Introduction to Parallel Comp.* (MA50177, MSc)
2003/04 Sem 2	*Scientific Computing and Introduction to Parallel Comp.* (MA50177, MSc)
2004/05 Sem 2	*Scientific Computing and Introduction to Parallel Comp.* (MA50177, MSc)
2005/06 Sem 2	*Scientific Computing and Introduction to Parallel Comp.* (MA50177, MSc)
2006/07 Sem 2	*Scientific Computing and Introduction to Parallel Comp.* (MA50177, MSc)
2007/08 Sem 2	*Scientific Computing and Introduction to Parallel Comp.* (MA50177, MSc)
2008/09 Sem 2	*Scientific Computing and Introduction to Parallel Comp.* (MA50177, MSc)
2009/10 Sem 2	*Scientific Computing and Introduction to Parallel Comp.* (MA50177, MSc)
2010/11 Sem 2	*Scientific Computing and Introduction to Parallel Comp.* (MA50177, MSc)
2011/12 Sem 2	*Scientific Computing and Introduction to Parallel Comp.* (MA50177, MSc)
2012/13 Sem 2	*Scientific Computing and Introduction to Parallel Comp.* (MA50177, MSc)
2013/14 Sem 2	*Scientific Computing and Introduction to Parallel Comp.* (MA50177, MSc)
2002/03 Sem 1	*Vector Calculus and Partial Differential Equations* (MA20010, Year 2)
2003/04 Sem 1	*Vector Calculus and Partial Differential Equations* (MA20010, Year 2)
2004/05 Sem 1	*Vector Calculus and Partial Differential Equations* (MA20010, Year 2)
2005/06 Sem 1	*Vector Calculus and Partial Differential Equations* (MA20010, Year 2)
2006/07 Sem 1	*Vector Calculus and Partial Differential Equations* (MA20010, Year 2)
2003/04	*Finite Element Methods for Maxwell's Equations* (PhD)
2005/06 Sem 2	*Numerical Solution of PDEs I* (MA30170, Year 3)
2006/07 Sem 2	*Numerical Solution of PDEs I* (MA30170, Year 3)
2007/08 Sem 2	*Numerical Solution of PDEs I* (MA30170, Year 3)
2008/09 Sem 2	*Numerical Solution of PDEs I* (MA30170, Year 3)
2007/08 Sem 2	*Topic Review in Applied Mathematics* (MA50200, MSc)
2008/09 Sem 2	*Topic Review in Applied Mathematics* (MA50200, MSc)
2008/09 Sem 2	*Numerical Analysis* (MA20014, Year 2)
2009/10 Sem 1	*Numerical Analysis* (MA20222, Year 2)
2010/11 Sem 1	*Numerical Analysis* (MA20222, Year 2)
2011/12 Sem 1	*Multilevel Monte Carlo Methods* (RICAM Special Sem.)
2011/12 Sem 1	Seminar on *Multiscale Discretisation Techniques* (RICAM Special Sem.)
2014/15 Sem 1	*Advanced Mathematical Modelling* (XX40175, Chem. Eng. Service Course)
2015/16 Sem 1	*Advanced Mathematical Modelling* (XX40175, Chem. Eng. Service Course)
2014/15 Sem 2	*Computational Methods for Uncertainty Quantification* (HGS Math Comp)
2015/16 Sem 1	*Computational Methods for Uncertainty Quantification* (TCC Course Bath)
2015/16 Sem 2	*Numerical Optimisation and Large-Scale Systems* (MA40050, Year 4)
2016/17 Sem 2	*Numerical Optimisation and Large-Scale Systems* (MA40050, Year 4)

Notes

- I have taught a wide variety of courses, using various teaching methods across all levels from large undergraduate core modules (>200 students) to specialist PhD-level graduate courses.
- Not listed are tutorial classes on *Numerical Analysis*; *Analysis*; *Algebra*; *Functions, Differentiation, Analytic Geometry*; *Vectors & Applications*, *Matrices & Multivariate Calculus.*
- I have developed and introduced new courses: *Scientific Computing* (2002), *Topic Review in Applied Mathematics* (2008) and *Numerical Optimisation and Large-Scale Systems* (2016).
- I have pioneered new assessment techniques (computer aided assessment; peer assessment) supported by grants from the university's *Teaching Development Fund* (total income: **£20K**)
- I have been Director of Studies (2006-10) and lead the 5-year degree scheme review for the *MSc in Modern Applications of Mathematics* (2007).

FULL LIST OF PUBLICATIONS

Journal Papers

1. G. Katsiolides, E.H. Mller, R. Scheichl, T. Shardlow, M.B. Giles and D.J. Thomson, Multilevel Monte Carlo and Improved Timestepping Methods in Atmospheric Dispersion Modelling, ***Journal of Computational Physics***, **354**:320-343, **2018**.
2. A. Reinarz, T. Dodwell, T. Fletcher, L. Seelinger, R. Butler and R. Scheichl, `dune-composites` - A New Framework for High-Performance Finite Element Modelling of Laminates, ***Composite Structures***, **184**:269-278, **2018**.
3. R. Scheichl, A. Stuart and A.L. Teckentrup, Quasi-Monte Carlo and Multilevel Monte Carlo Methods for Computing Posterior Expectations in Elliptic Inverse Problems, ***SIAM/ASA Journal of Uncertainty Quantification***, **5**(1):493-518, **2017**.
4. D. Drzisga, B. Gmeiner, U. Rüde, R. Scheichl and B. Wohlmuth, Scheduling Massively Parallel Multigrid for Multilevel Monte Carlo Methods, ***SIAM Journal on Scientific Computing***, **39**(5):S873-S897, **2017**.
5. F.Y. Kuo, R. Scheichl, Ch. Schwab, I.H. Sloan and E. Ullmann, Multilevel Quasi-Monte Carlo Methods for Lognormal Diffusion Problems, ***Mathematics of Computation***, **86**:2827-2860, **2017**.
6. D. Peterseim and R. Scheichl, Robust Numerical Upscaling of Elliptic Multiscale Problems at High Contrast, ***Computational Methods in Applied Mathematics***, **16**(4):579-603, **2016**.
7. T.A. Fletcher, T. Kim, T.J. Dodwell, R. Butler, R. Scheichl and R. Newley, Resin Treatment of Free Edges to Aid Certification of Through Thickness Laminate Strength, ***Composite Structures***, **146**:26-33, **2016**.
8. A. Ferreiro-Castilla, A.E. Kyprianou and R. Scheichl, An Euler-Poisson Scheme for Levy driven SDEs, ***Journal of Applied Probability***, **53**(1):262-278, **2016**.
9. A. Dedner, E.H. Mueller and R. Scheichl, Efficient Multigrid Preconditioners for Atmospheric Flow Simulations at High Aspect Ratio, ***International Journal on Numerical Methods in Fluids***, **80**(1):76-102, **2016**.
10. E.H. Mueller, R. Scheichl and E. Vainikko, Petascale Solvers for Anisotropic PDEs in atmospheric modelling on GPU Clusters, ***Parallel Computing***, **50**:53-69, **2015**.
11. S. Loisel, H. Nguyen and R. Scheichl, Optimized Schwarz and 2-Lagrange Methods for Multiscale PDEs, to appear in ***SIAM J. Scientific Computing***, **37**(6):A2896-A2923, **2015**.
12. I.G. Graham, R. Scheichl and E. Ullmann, Mixed Finite Element Analysis of Lognormal Diffusion and Multilevel Monte Carlo Methods, ***Stochastic Partial Differential Equations: Analysis and Computations***, **4**(1):41-75, **2015**.
13. T.J. Dodwell, C. Ketelsen, R. Scheichl and A.L. Teckentrup, A Hierarchical Multilevel Markov Chain Monte Carlo Algorithm with Applications to Uncertainty Quantification in Subsurface Flow, ***SIAM/ ASA Journal on Uncertainty Quantification***, **3**(1):1075-1108, **2015**.
14. E.H. Mueller, R. Scheichl and T. Shardlow, Improving MLMC for SDEs with Application to the Langevin Equation, to appear in ***Royal Society Proceedings A***, **471**:20140679, **2015**.
15. I.G. Graham, F.Y. Kuo, J.A. Nicholls, R. Scheichl, C. Schwab and I.H. Sloan, Quasi-Monte Carlo Finite Element Methods for Elliptic PDEs with Log-normal Random Coefficients, ***Numerische Mathematik***, **131**(2):329–368, **2015**.
16. A. Ferreiro-Castilla, A.E. Kyprianou, R. Scheichl and G. Suryanarayana, Multilevel Monte Carlo Simulation for Levy Processes Based on the Wiener-Hopf Factorisation, ***Stochastic Processes and their Applications***, **124**(2):985-1010, **2014**.

17. M. Dauge, R.A. Norton and R. Scheichl, Regularity of Maxwell Eigenproblems in Photonic Crystal Fibre Modelling, ***BIT Numerical Mathematics***, **55**(1):59-80, **2014**.
18. 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, ***Numerische Mathematik***, **126**(4):741–770, **2014**.
19. E. Mueller and R. Scheichl, Massively Parallel Solvers for Elliptic PDEs in Numerical Weather and Climate Prediction, ***Q. J. Royal Meteorol. Soc.***, **140** (685):2608–2624, **2014**.
20. E. Mueller, X. Guo, R. Scheichl and S. Shi, Matrix-free GPU implementation of a preconditioned conjugate gradient solver for anisotropic elliptic PDEs, ***Computing and Visualisation in Science***, **16**(2):41–58, **2013**.
21. 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***, **125**(3):569-600, **2013**.
22. 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**.
23. R. Norton and R. Scheichl, Planewave Expansion Methods for Photonic Crystal Fibres, ***Applied Numerical Mathematics***, **63**:88-104, **2013**.
24. M. Marletta and R. Scheichl, Eigenvalues in Spectral Gaps of Differential Operators, ***Journal of Spectral Theory***, **2**(3):293-320, **2012**.
25. 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**.
26. C. Pechstein and R. Scheichl, Weighted Poincare Inequalities, ***IMA Journal on Numerical Analysis***, **33**(2):652-686, **2012**.
27. 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**.
28. P. Bastian, M. Blatt and R. Scheichl, Algebraic multigrid for discontinuous Galerkin discretizations of heterogeneous elliptic problems, ***Numerical Linear Algebra with Applications***, **19**(2):367-388, **2012**.
29. R. Scheichl, P.S. Vassilevski and L.T. Zikatanov, Weak Approximation Properties of Elliptic Projections with Functional Constraints, ***Multiscale Modeling and Simulation (SIAM)***, **9**:1677-1699, **2011**.
30. 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**.
31. C. Pechstein and R. Scheichl, Analysis of FETI Methods for Multiscale PDEs - Part II: Interface Variation, ***Numerische Mathematik***, **118**(3):485-529, **2011**.
32. 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 & Visualization in Science***, **14**(1):3-15, **2011**.
33. I. G. Graham, F. Y. Kuo, D. Nuyens, R. Scheichl, and I. H. Sloan, Quasi-Monte Carlo Methods for for Elliptic PDEs with Random Coefficients and Applications, ***Journal of Computational Physics***, **230**(10):3668-3694, **2011**.
34. 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, ***Quarterly Journal of the Royal Meteorological Society***, **137**(657):1083-1094, **2011**.

35. S.D. Buckeridge and R. Scheichl, Parallel Geometric Multigrid for Global Weather Prediction, ***Numerical Linear Algebra with Applications***, **17**:325-342, **2010**.
36. R. Norton and R. Scheichl, Convergence Analysis of Planewave Expansion Methods for Schrödinger Operators with Discontinuous Periodic Potentials, ***SIAM Journal on Numerical Analysis***, **47**(6): 4356-4380, **2010**.
37. C. Pechstein and R. Scheichl, Scaling Up through Domain Decomposition, ***Applicable Analysis***, **88**(10):1589-1608, **2009**.
38. 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**.
39. C. Pechstein and R. Scheichl, Analysis of FETI Methods for Multiscale PDEs, ***Numerische Mathematik***, **111**(2):293-333, **2008**.
40. 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**. (Special issue dedicated to Prof. W. Hackbusch on the occasion of his 60th birthday)
41. R. Scheichl, E. Vainikko, Additive Schwarz with Aggregation-Based Coarsening for Elliptic Problems with Highly Variable Coefficients, ***Computing***, **80**:319-343, **2007**.
42. I.G. Graham, P. Lechner and R. Scheichl, Domain Decomposition for Multiscale PDEs, ***Numerische Mathematik***, **106**:589-626, **2007**.
43. I.G. Graham and R. Scheichl, Robust Domain Decomposition Algorithms for Multiscale PDEs, ***Numerical Methods for Partial Differential Equations***, **23**(4):859-878, **2007**.
44. 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**.
45. R. Scheichl, R. Masson, J. Wendebourg, Decoupling and Block Preconditioning for Sedimentary Basin Simulations, ***Computational Geosciences***, **7**(4):295-318, **2003**.
46. R. Scheichl, Decoupling Three-dimensional Mixed Problems Using Divergence-free Finite Elements, ***SIAM Journal of Scientific Computing***, **23**(5):1752-1776, **2002**.
47. 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**.
48. R. Scheichl, Parallel Solvers for the Transient Multigroup Neutron Diffusion Equations, ***International Journal for Numerical Methods in Engineering***, **47**:1751-1771, **2000**.

Preprints

49. J. Lang and R. Scheichl, Adaptive Multilevel Stochastic Collocation Method for Randomized Elliptic PDEs, Preprint Nr. 2718, Fachbereich Mathematik, TU Darmstadt, **Nov 2017** (https://opus4.kobv.de/opus4-trr154/files/199/PP2017TUDA-LangScheichl.pdf).
50. I.G. Graham, F.Y. Kuo, D. Nuyens, R. Scheichl and I.H. Sloan, Circulant Embedding with QMC - Analysis for Elliptic PDE with Lognormal Coefficients, submitted to ***Numer. Math.***, Preprint arXiv:1710.09254, **Oct 2017** (http://arxiv.org/abs/1710.09254).
51. I.G. Graham, F.Y. Kuo, D. Nuyens, R. Scheichl and I.H. Sloan, Analysis of Circulant Embedding Methods for Sampling Stationary Random Fields, submitted to ***SIAM Journal on Numerical Analysis***, Preprint arXiv:1710.00751, **Sep 2017** (http://arxiv.org/abs/1710.00751).
52. S. Dolgov and R. Scheichl, A hybrid Alternating Least Squares - TT Cross algorithm for parametric PDEs, submitted to ***SIAM/ASA Journal of Uncertainty Quantification***, Preprint arXiv:1707.04562, **July 2017** (https://arxiv.org/abs/1707.04562).

Books & Theses

53. M. Cullen, M.A. Freitag, S. Kindermann and R. Scheichl (Editors), *Large Scale Inverse Problems: Computational Methods and Applications in the Earth Sciences*, Radon Series on Computational & Applied Mathematics, vol.13, De Gruyter, Berlin, **2013**.
54. P. Bastian, J. Kraus, R. Scheichl and M.F. Wheeler (Editors), *Simulation of Flow in Porous Media: Applications in Energy and Environment*, Radon Series on Computational & Applied Mathematics, vol. 12, De Gruyter, Berlin, **2013**.
55. 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**.
56. R. Scheichl, *Iterative Solution of Saddle Point Problems Using Divergence-free Finite Elements with Applications to Groundwater Flow.* PhD Thesis, University of Bath, **2000**.
57. 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

58. I.G. Graham, M.J. Parkinson and R. Scheichl, Modern Monte Carlo Variants for Uncertainty Quantification in Neutron Transport, invited article for the "Festschrift for the 80th birthday of Ian Sloan" (Dick J, Kuo FY, Wozniakowski H, Eds.), Springer, **2018**.
59. T.J. Dodwell, A. Sandhu and R. Scheichl, Customized Coarse Models for Highly Heterogeneous Materials, in "Bifurcation and Degradation of Geomaterials with Engineering Applications" (Papamichos E, Papanastasiou P, Pasternak E, Dyskin A, Eds.), IWBDG 2017, Springer Series in Geomechanics and Geoengineering, Springer, **2017**.
60. T. Fletcher, A. Reinarz, T.J. Dodwell, R. Butler, R. Scheichl and R. Newley, Efficient Modelling and Accurate Certification of Curved Aerospace Laminates, 17th European Conference on Composite Materials, Munich, 26-30 June **2016**.
61. R. Butler, T.J. Dodwell, T. Kim, S. Kynaston, R. Scheichl, R.T. Haftka and N.H. Kim, Uncertainty Quantification of Composite Structures with Defects using Multilevel Monte Carlo Simulations, AIAA SciTech Conference, Kissimmee, 5-9 January **2015**.
62. T. Kim, T. Fletcher, T.J. Dodwell, R. Butler, R. Scheichl, J. Ankersen and R. Newley, The Effect of Free Edges on Inter-Laminar Performance of Curved Laminates, AIAA SciTech Conference, Kissimmee, 5-9 January **2015**.
63. R. Scheichl, Robust Numerical Upscaling at High Contrast, in Oberwolfach Report 43/2014. Oberwolfach Workshop on "Reactive Flows in Deformable, Complex Media" (Organ.: M. Gerritsen, J.M. Nordbotten, I.S. Pop, B. Wohlmuth), 21-27 September **2014**.
64. 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, in Domain Decomposition Methods in Science and Engineering XXI (J Erhel, MJ Gander et al, Eds.), pp. 447-455, *Lecture Notes in Computational Science and Engineering*, vol. 98, **2014**.
65. R. Scheichl, MLMCMC – Multilevel Markov Chain Monte Carlo, in Oberwolfach Report 07/2013. Oberwolfach Miniworkshop on "Numerical Upscaling for Media with Deterministic and Stochastic Heterogeneity" (Organ.: Y. Efendiev, O. Iliev, P. Vassilevski), February **2013**.
66. R. Scheichl, Robust Coarsening in Multiscale PDEs, in Domain Decomposition Methods in Science and Engineering XX (R Bank, M Holst, O Widlund, and J Xu, Eds.), pp. 51-62, *Lecture Notes in Computational Science and Engineering*, vol. 91, **2013**.

67. V. Dolean, F. Nataf, R. Scheichl and N. Spillane, A Two-Level Schwarz Preconditioner for Heterogeneous Problems, in Domain Decomposition Methods in Science and Engineering XX (R Bank, M Holst, O Widlund, and J Xu, Eds.), pp. 87-94, *Lecture Notes in Computational Science and Engineering*, vol. 91, **2013**.
68. C. Pechstein, M. Sarkis and R. Scheichl, New Theoretical Coefficient Robustness Results for FETI-DP, in Domain Decomposition Methods in Science and Engineering XX (R Bank, M Holst, O Widlund, and J Xu, Eds.), pp. 313-320, *Lecture Notes in Computational Science and Engineering*, vol. 91, **2013**.
69. 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, J Xu, Eds.), pp. 197-204, *Lecture Notes in Computational Science and Engineering*, vol. 78, **2011**.
70. 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), Montecatini, Italy, June **2010**.
71. 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**.
72. C. Pechstein and R. Scheichl, Weighted Poincare Inequalities for High-Contrast Coefficients, in Oberwolfach Report 10/2010. Oberwolfach Workshop "Computational Electromagnetism and Accoustics" (Org.: R Hiptmair, RHW Hoppe, P Joly, U Langer), February **2010**.
73. R. Scheichl, Domain Decomposition and Upscaling, in Oberwolfach Report 12/2009. Oberwolfach Miniworkshop on "Numerical Upscaling for Flow Problems: Theory and Applications" (Organisers: A. Brandt, Y. Efendiev, O. Iliev), March **2009**.
74. 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**.
75. 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**.
76. 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 2003 (Lirkov I., Margenov S. et al., Eds.), *Lecture Notes in Computer Science* 2907, Springer, **2004**.
77. R. Scheichl, Parallel Solvers for the Two-Group Neutron Diffusion Equations of Reactor Kinetics, in Proceedings of the 11th International Conference on Domain Decomposition Methods, Greenwich, July 1998 (C.H. Lai, P.E. Bjorstad, et al, Eds.), Domain Decomposition Press, Bergen, **1999**.
78. 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**.

Bath, 10th January 2018.