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## Contact Details

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## Career

09/2018 - Prize Fellow, University of Bath, UK

01/2016 - 09/2018 Postdoctoral Research Associate, University of Cambridge, UK

05/2015 - 12/2015 Postdoctoral Research Associate, University College London, UK

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## Education

04/2012 - 04/2015 PhD in Medical Imaging, University College London, UK

10/2006 - 12/2011 MSc in Industrial Mathematics, University of Bremen, Germany

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## Honors and Awards

2020 Institute of Physics Outstanding Reviewer Award 2019

2019 Leverhulme Early Career Fellowship

2018 Prize Fellowship, Bath, UK

2017 Participant of the 5th Heidelberg Laureate Forum, Heidelberg, Germany

2016 Senior Member (College Post-Doctoral Associate), Jesus College, Cambridge, UK

2015 Pump-priming award: Six months funding to explore a new field of research, funded by the CMIC-EPSRC platform grant (EP/M020533/1)

Paper selected as a Highlight of 2015, IOP Inverse Problems

2014 Best Student Paper Finalist, IEEE NSS-MIC, Seattle, USA

LMS Best Poster Award, Cambridge, UK

### ■ Awards as supervisor

2020 My student Samuel Cortinhas was invited to present his work that he did with me in summer 2019 at Posters in Parliament as part of the British Conference of Undergraduate Research (BCUR).

2020 My PhD student Margaret Duff was invited to present her research at the UK Parliament as part of STEM for BRITAIN 2020.

2019 My student Samuel Cortinhas won an IMI Best Poster Award, Bath, UK, value £100

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## Third-party grants

The total amount of grants with my involvement is £2,434,305.41. Of this £640,597.87 were directly for me or my group.

### ■ Major awards

04/2020 - 03/2025 Col on EPSRC collaborative computational project on "Synergistic Reconstruction for Biomedical Imaging", value  $\approx$  £476k (£23k to support me)

05/2020 - 04/2023 PI on Leverhulme Early Career Fellowship, value  $\approx$  £93k

09/2019 - 08/2022 Co-Lead on EPSRC Business Healthcare Partnership, value  $\approx$  £821k (£346k to support me and my group)

07/2019 - 03/2021 Bath-PI on Faraday Institution: "Battery Characterisation, Quantitative Imaging of Multi-Scale Dynamic Phenomena at Electrochemical Interfaces", value  $\approx$  £1M (£139k to support me and my group)

### ■ Minor awards

**Awards for workshops:** 2x 2020, value  $\approx$  £7k, funders: Bath Institute for Mathematical Innovation, Isaac Newton Institute, London Mathematical Society

**Awards for undergraduate summer projects:** 2016, 2019, combined value  $\approx$  £3k, funders: Bath Institute for Mathematical Innovation, London Mathematical Society

**Pump-priming award:** six months of funding received from the CMIC-EPSRC platform grant (EP/M020533/1) to explore a new field of research, value  $\approx$  £20k, 2015

**Travel awards:** 2014, 4x 2019, combined value  $\approx$  £4k, funders: Bath Institute for Mathematical Innovation, Institute for

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**Publications**, † denotes alphabetical order of authors

I have published 14 peer-reviewed journal papers, 9 preprints and 4 peer-reviewed conference papers.

■ **Peer-Reviewed Journal Papers**

33. E. Ovtchinnikov, R. Brown, C. Kolbitsch, E. Pasca, C. da Costa-Luis, A. G. Gillman, B. A. Thomas, N. Efthimiou, J. Mayer, P. Wadhwa, M. J. Ehrhardt, S. Ellis, J. S. Jørgensen, J. Matthews, C. Prieto, A. J. Reader, C. Tsoumpas, M. Turner, D. Atkinson and K. Thielemans. SIRF: Synergistic Image Reconstruction Framework. *Computer Physics Communications* 249 (2020), 107087.
32. M. J. Ehrhardt, P. Markiewicz and C.-B. Schönlieb. Faster PET Reconstruction with Non-Smooth Priors by Randomization and Preconditioning. *Physics in Medicine & Biology* 64.22 (2019), 225019.
31. † M. Benning, E. Celledoni, M. J. Ehrhardt, B. Owren and C.-B. Schönlieb. Deep learning as optimal control problems: models and numerical methods. *accepted for Journal of Computational Dynamics* (2019).
30. V. Kolehmainen, M. J. Ehrhardt and S. R. Arridge. Incorporating Structural Prior Information and Sparsity into EIT using Parallel Level Sets. *Inverse Problems and Imaging* 13.2 (2019), 285–307.
29. V. Corona, M. Benning, M. J. Ehrhardt, L. F. Gladden, R. Mair, A. Reci, A. J. Sederman, S. Reichelt and C.-B. Schönlieb. Enhancing joint reconstruction and segmentation with non-convex Bregman iteration. *Inverse Problems* 35.5 (2019), 055001.
28. † A. Chambolle, M. J. Ehrhardt, P. Richtárik and C.-B. Schönlieb. Stochastic Primal-Dual Hybrid Gradient Algorithm with Arbitrary Sampling and Imaging Applications. *SIAM Journal on Optimization* 28.4 (2018), 2783–2808.
27. † L. Bungert, D. A. Coomes, M. J. Ehrhardt, J. Rasch, R. Reisenhofer and C.-B. Schönlieb. Blind Image Fusion for Hyperspectral Imaging with the Directional Total Variation. *Inverse Problems* 34.4 (2018), 044003.
26. Y. J. Tsai, A. Bousse, M. J. Ehrhardt, C. W. Stearns, S. Ahn, B. F. Hutton, S. Arridge and K. Thielemans. Fast Quasi-Newton Algorithms for Penalized Reconstruction in Emission Tomography and Further Improvements via Preconditioning. *IEEE Transactions on Medical Imaging* 37.4 (2018), 1000–1010.
25. P. J. Markiewicz, M. J. Ehrhardt, K. Erlandsson, P. J. Noonan, A. Barnes, J. M. Schott, D. Atkinson, S. R. Arridge, B. F. Hutton and S. Ourselin. NiftyPET: a High-throughput Software Platform for High Quantitative Accuracy and Precision PET Imaging and Analysis. *Neuroinformatics* 16.1 (2018), 95–115.
24. M. J. Ehrhardt, P. Markiewicz, M. Liljeroth, A. Barnes, V. Kolehmainen, J. Duncan, L. Pizarro, D. Atkinson, B. F. Hutton, S. Ourselin, K. Thielemans and S. R. Arridge. PET Reconstruction with an Anatomical MRI Prior using Parallel Level Sets. *IEEE Transactions on Medical Imaging* 35.9 (2016), 2189–2199.
23. M. J. Ehrhardt and M. M. Betcke. Multi-Contrast MRI Reconstruction with Structure-Guided Total Variation. *SIAM Journal on Imaging Sciences* 9.3 (2016), 1084–1106.
22. M. J. Ehrhardt, K. Thielemans, L. Pizarro, D. Atkinson, S. Ourselin, B. F. Hutton and S. R. Arridge. Joint Reconstruction of PET-MRI by Exploiting Structural Similarity. *Inverse Problems* 31.1 (2015), 015001. (**selected as a Highlight of 2015, IOP Inverse Problems**).
21. M. J. Ehrhardt and S. R. Arridge. Vector-Valued Image Processing by Parallel Level Sets. *IEEE Transactions on Image Processing* 23.1 (2014), 9–18.
20. M. J. Ehrhardt, H. Villinger and S. Schiffler. Evaluation of Decomposition Tools for Sea Floor Pressure Data: A Practical Comparison of Modern and Classical Approaches. *Computers & Geosciences* 45 (2012), 4–12.

■ **Preprints**

19. † M. J. Ehrhardt and L. Roberts. ‘Inexact Derivative-Free Optimization for Bilevel Learning’. arxiv:2006.12674. 2020.
18. † L. Bungert and M. J. Ehrhardt. ‘Robust Image Reconstruction with Misaligned Structural Information’. arxiv:2004.00589. 2020.
17. M. J. Ehrhardt. ‘Multi-modality imaging with structure-promoting regularisers’. arxiv:2007.11689. 2020.
16. † E. Celledoni, M. J. Ehrhardt, C. Etmann, R. I. McLachlan, B. Owren, C.-B. Schönlieb and F. Sherry. ‘Structure preserving deep learning’. arxiv:2006.03364. 2020.
15. D. Driggs, M. J. Ehrhardt and C.-B. Schönlieb. ‘Accelerating Variance-Reduced Stochastic Gradient Methods’. arxiv:1910.09494. 2019.
14. F. Sherry, M. Benning, J. C. D. los Reyes, M. J. Graves, G. Maierhofer, G. Williams, C.-B. Schönlieb and M. J. Ehrhardt. ‘Learning the Sampling Pattern for MRI’. arxiv:1906.08754. 2019.
13. E. S. Riis, M. J. Ehrhardt, G. R. W. Quispel and C.-B. Schönlieb. ‘A Geometric Integration Approach to Nonsmooth, Nonconvex Optimisation’. arxiv:1807.07554. 2018.

12. † M. J. Ehrhardt, E. S. Riis, T. Ringholm and C.-B. Schönlieb. 'A Geometric Integration Approach to Smooth Optimisation: Foundations of the Discrete Gradient Method'. arxiv:1805.06444. 2018.
11. † M. Benning, M. M. Betcke, M. J. Ehrhardt and C.-B. Schönlieb. 'Choose Your Path Wisely: Gradient Descent in a Bregman Distance Framework'. arxiv:1712.04045. 2017.

## ■ Peer-Reviewed Conference Papers

10. P. Markiewicz, M. J. Ehrhardt, N. Burgos, D. Atkinson, S. R. Arridge, B. F. Hutton and S. Ourselin. Unified Acquisition Modelling across PET Imaging Systems: Unified Scatter Modelling. *IEEE Nuclear Science Symposium and Medical Imaging Conference*. 2016.
9. Y.-J. Tsai, A. Bousse, M. J. Ehrhardt, B. F. Hutton, S. R. Arridge and K. Thielemans. Performance Evaluation of MAP Algorithms with Different Penalties, Object Geometries and Noise Levels. *IEEE Nuclear Science Symposium and Medical Imaging Conference*. 2015.
8. M. J. Ehrhardt, K. Thielemans, L. Pizarro, P. Markiewicz, D. Atkinson, S. Ourselin, B. F. Hutton and S. R. Arridge. Joint Reconstruction of PET-MRI by Parallel Level Sets. *IEEE Nuclear Science Symposium and Medical Imaging Conference*. 2014. (**best student paper finalist**).
7. P. Markiewicz, K. Thielemans, M. J. Ehrhardt, J. Jiao, N. Burgos, D. Atkinson, S. R. Arridge, B. F. Hutton and S. Ourselin. High Throughput CUDA Implementation of Accurate Geometric Modelling for Iterative Reconstruction of PET Data. *IEEE Nuclear Science Symposium and Medical Imaging Conference*. 2014.

## ■ Miscellaneous

6. D. Kazantsev, E. Pasca, M. Basham, M. Turner, M. J. Ehrhardt, K. Thielemans, B. A. Thomas, E. Ovtchinnikov, P. J. Withers and A. W. Ashton. Versatile regularisation toolkit for iterative image reconstruction with proximal splitting algorithms. *Proceedings of the 15th International Meeting on Fully Three-Dimensional Image Reconstruction in Radiology and Nuclear Medicine*. 2019.
5. † L. Bungert, M. J. Ehrhardt and R. Reisenhofer. Robust Blind Image Fusion for Misaligned Hyperspectral Imaging Data. *Proceedings in Applied Mathematics & Mechanics*. Vol. 18. 1. 2018.
4. M. J. Ehrhardt, P. J. Markiewicz, P. Richtárik, J. Schott, A. Chambolle and C.-B. Schönlieb. Faster PET Reconstruction with a Stochastic Primal-Dual Hybrid Gradient Method. *SPIE Optics+Photonics: Wavelets and Sparsity XVII, San Diego, USA*. 2017.
3. † M. Benning, M. Betcke, M. J. Ehrhardt and C.-B. Schönlieb. Gradient Descent in a Generalised Bregman Distance Setting. *Geometric Numerical Integration and its Applications, Melbourne, Australia*. 2016.
2. M. J. Ehrhardt. 'Joint Reconstruction for Multi-Modality Imaging with Common Structure'. PhD Thesis. University College London, 2015.
1. M. J. Ehrhardt. 'Sparsity in Geosciences Sparse Decomposition for Analysis of Sea Floor Pressure Data'. MSc Thesis. University of Bremen, 2011.

## ■ Review, Editorial & Scientific advisory activities

**Editorial:** Guest editor for the special issue on "Joint Reconstruction and Multi-Modality/Multi-Spectral Imaging" in IOP Inverse Problems (2017-18).

**Member of scientific advisory boards:** Synergistic Reconstruction Symposium 2019, IMA Conference on Inverse Problems 2019

**Referee for journals:** IEEE Access, IEEE Geoscience and Remote Sensing Letters, IEEE Transactions on Information Theory, IEEE Transactions on Medical Imaging, IEEE Transactions on Radiation and Plasma Medical Sciences, IEEE Transactions on Signal Processing IOP Inverse Problems, IOP Physics in Medicine and Biology, SIAM Journal on Imaging Science, SIAM Journal on Optimization, Springer Applied Mathematics & Optimization, Springer Journal of Mathematical Imaging and Vision, Springer Optimization Letters, Springer Sensing and Imaging; Wiley Magnetic Resonance in Medicine

**Reviewer for books:** CRC Press

**Reviewer for conferences:** MICCAI18, ICML19, NeurIPS20

**Reviewer for international funding bodies:** British Council (UK), EPSRC (UK), Research Grant Council (Hong Kong)

## ■ Organisation of Meetings

### ■ Conferences and Workshops

2020 LMS-Bath Symposium on the Mathematics of Machine Learning, Bath, UK

Organiser of virtual 5 day event with about 30 national and international speakers and more than 800 attendees.

2019 Hackathon, Bath, UK

Lead organiser of 2 day event to extend functionality of imaging software packages SIRF and CIL.

## ■ Minisymposia

- 2019 Applied Inverse Problems, Grenoble, France  
Multi-Modality/Multi-Spectral Imaging and Structural Priors (with S. Arridge and J. Jørgensen)  
British Applied Mathematics Colloquium, University of Bath, UK  
Machine Learning and Inverse Problems, Modern Approaches to Inverse Problems (both with M. Golbabaee)
- 2018 SIAM Conference on Imaging Science, Bologna, Italy  
Multi-Modality/Multi-Spectral Imaging and Structural Priors (with S. Arridge)
- 2017 Applied Inverse Problems, Hangzhou, China  
Multi-Modality/Multi-Spectral Imaging and Structural Priors (with Simon Arridge)  
Stochastic Optimization for Inverse Problems (with C. Schönlieb)  
British Applied Mathematics Colloquium, University of Surrey, UK  
Inverse Problems and Imaging (with C. Schönlieb and M. Benning)  
100 Years of the Radon Transform, Linz, Austria  
Beyond Filtered Backprojection: Radon Inversion with a Priori Knowledge (with C. Schönlieb and M. Benning)
- 2016 SIAM Conference on Imaging Science, Albuquerque, USA  
Multi-Modality Imaging and Structural Priors (with S. Arridge)
- 2014 Inverse Problems: Modelling and Simulation, Fethiye, Turkey  
Cross-Modality Priors in Tomography (with S. Arridge)

## ■ Academic supervision

### ■ Postdoctoral fellows

Claire Delplancke (since 01/2020). Randomized optimization for PET imaging.  
Jarrod Williams (since 12/2019). Multi-modality and data-driven reconstruction for battery imaging.

### ■ PhD students

Margeret Duff (since 06/2019). Machine Learning for Inverse Problems (lead supervisor with Neill Campbell, Computer Science, Bath).  
Eric Baruch Gutiérrez Castillo (since 02/2019). Randomized Algorithms for Large-Scale Convex Optimization.  
Ferdia Sherry (Cambridge, since 10/2016). Machine Learning for Inverse Problems (co-supervisor with Carola-Bibiane Schönlieb, Cambridge).

## ■ Teaching Experience

### ■ Lecturer

- 2018 Inverse Problems, University of Cambridge, UK  
Lent 2017/18. Part III of the Mathematical Tripos (master's level) with Lukas Lang. For more information see [www.damtp.cam.ac.uk/research/cia/teaching/201718lentinvprob.html](http://www.damtp.cam.ac.uk/research/cia/teaching/201718lentinvprob.html).
- 2016 Inverse Problems in Imaging, University of Cambridge, UK  
Michémas 2016/17. Part III of the Mathematical Tripos with Martin Benning. For more information see [www.damtp.cam.ac.uk/research/cia/teaching/2016inverseproblems.html](http://www.damtp.cam.ac.uk/research/cia/teaching/2016inverseproblems.html).

### ■ Student Supervision

**Master projects:** Varun Chhabra, Alice Smiddy (both 2018/19), Thomas Prideaux-Ghee (Cambridge, 2016/17)  
**Bachelor projects:** Sam Cortinhas (2019/20)  
**Undergraduate summer projects:** Sam Cortinhas (2019), Georg Maierhofer, Emile Okada, Chris Irving (all Cambridge, 2016)  
**Summer schools:** Supervisor for European Summer School in Modelling, Analysis and Simulation Crime and Image Processing (Oxford, 2016), Medical Image Computing Summer School (UCL, 2015)  
**Seminar:** From Computation to Information (Cambridge, 2019), Medical Image Computing Summer School (UCL, 2015)

### ■ Teaching Assistant

University College London, UK: Teaching assistant for Inverse Problems in Imaging (2012/13 and 2013/14), Introduction to MATLAB (2013/14), Writing Scientific Papers in  $\text{\LaTeX}$  (2013/14), Mathematics for Statisticians (2013/14)  
University of Bremen, Germany: Teaching assistant for Functional Analysis (2010/11)

## ■ Research Stays

- 2019 Institut Henri Poincaré, Paris, France (two weeks); École Polytechnique, Palaiseau, France (two weeks, hosted by Antonin Chambolle).
- 2018 King Abdullah University for Science and Technology, Saudi Arabia (one month, hosted by Peter Richtárik)

DTU, Copenhagen, Denmark (three weeks, hosted by Yiqiu Dong).

2017 École Polytechnique, Palaiseau, France (one week, hosted by Antonin Chambolle).

2016 La Trobe University, Melbourne, Australia (two weeks, hosted by Reinault Quispel)

KTH Stockholm, Sweden (one week, hosted by Ozan Öktem)

University of Edinburgh, UK (one week, hosted by Peter Richtárik).

## Public Outreach

2018 Coordinator of the CIA Pop-Up Lab, Mathematical Sciences Open Day at the Science Festival, Cambridge, UK  
Interactive exhibitions Puzzle Race, Beyond what the eyes can see, Face Fusion Photobooth and Shadow Tomography with Thomas Buddenkotte, Derek Driggs, Joana Grah, Pan Liu, Carola-Bibiane Schönlieb and Rob Tovey.

2017 Mathematical Sciences Open Day at the Science Festival, Cambridge, UK  
Two interactive exhibitions on Face Fusion Photobooth and Shadow Tomography with Martin Benning, Veronica Corona, Chris Irving, Emile Okada, Carola-Bibiane Schönlieb, Ferdia Sherry and Rob Tovey.

## Memberships

Member of SIAM (activity groups on imaging and optimization), Institute for Mathematics and its Applications

## Communication, \* denotes invited presentations

### ■ Oral Presentations at Conferences and Seminars

2020 \* SIAM Mathematics of Data Science, virtual.  
\* Scottish Numerical Methods Network 2020: Inverse problems and optimisation for PDEs, virtual.

2019 \* Applied Mathematics Seminar, Leicester, UK.  
\* Quantitative Imaging of Electrochemical Interfaces, Diamond Light Source, UK.  
2nd IMA Conference On Inverse Problems From Theory To Application, London, UK.  
\* Applied Inverse Problems, Grenoble, France.  
\* Inverse Problems Seminar, UCL, UK.  
\* SAMBa's 9th Integrative Think Tank, Bath, UK.  
\* Bath/RAL Numerical Analysis Day, Bath, UK.

2018 \* Numerical Analysis Seminar, Bath, UK.  
\* ISMP 2018: International Symposium on Mathematical Programming, Bordeaux, France.  
SIAM Conference on Imaging Science, Bologna, Italy.  
\* Applied and Interdisciplinary Mathematics Seminar, Bath, UK.  
\* Scientific Computing Seminar, DTU, Denmark.  
\* Optimization and Big Data, KAUST, Saudi Arabia.

2017 \* Mathematics and Applications Seminar, Sussex, UK.  
5th Heidelberg Laureate Forum, Heidelberg, Germany.  
IMA Conference on Inverse Problems from Theory to Application, Cambridge, UK.  
\* SPIE Optics+Photonics: Wavelets and Sparsity XVII, San Diego, USA.  
\* 27th Biennial NA Conference in Strathclyde, Glasgow, UK.  
\* Mini Workshop on Bayesian Inverse Problems and Imaging, Shanghai, China.  
\* Applied Inverse Problems, Hangzhou, China.  
British Applied Mathematics Colloquium, Guildford, UK.  
\* 100 Years of the Radon Transform, Linz, Austria.  
\* Mathematical Imaging with Partially Unknown Models, Cambridge, UK.

2016 \* UCL PET/MR Symposium, London, UK.  
\* Numerical Analysis Seminar, KTH Stockholm, Sweden.  
\* SIAM Conference on Imaging Science, Albuquerque, USA.  
\* Edinburgh Research Group in Optimization, University of Edinburgh, UK.  
\* Big Data, Multimodality & Dynamic Models in Biomedical Imaging, Cambridge, UK.

2015 Applied Inverse Problems Conference, Helsinki, Finland.  
\* The 4th Joint BMC and BAMC, Cambridge, UK.  
\* Data Processing Challenges in PET-MR, London, UK.

2014 \* STIR User Meeting at IEEE NSS-MIC, Seattle, USA.  
IEEE Medical Imaging Conference (NSS-MIC), Seattle, USA (**best student paper finalist**).  
\* Institute for Nuclear Medicine Seminar, UCL, UK.  
\* Oberseminar Angewandte Mathematik, Münster, Germany.  
Imaging with Modulated/Incomplete Data, Graz, Austria.  
\* Centre for Medical Image Computing Seminar, UCL, UK.  
SIAM Conference on Imaging Science, Hong Kong, China.  
Inverse Problems: Modelling and Simulation, Fethiye, Turkey.

2013 Inverse Days, Inari, Finland.  
\* Image Reconstruction in Emission Tomography and Hybrid Imaging, London, UK.

## ■ Poster Presentations

2019 Royal United Hospital, Bath, UK.  
2017 Developments in Healthcare Imaging - Connecting with Industry, Cambridge, UK.  
Generative Models, Parameter Learning and Sparsity, Cambridge, UK.  
Variational Methods, New Optimisation Techniques and New Fast Numerical Algorithms, Cambridge, UK.  
2016 CCIMI Launch Event, Cambridge, UK.  
University of Cambridge Mathematics and Big Data Showcase, Cambridge, UK.  
High-dimensional Statistics, Inverse Problems and Convex Analysis, London, UK.  
EPSRC CMiH Launch Event, Cambridge, UK.  
LMS Inverse Day: Big Inverse Problems, Nottingham, UK.  
2014 LMS Inverse Day: Sparse Regularisation for Inverse Problems, Cambridge, UK (**best poster award**).  
2013 Applied Inverse Problem Conference, KAIST, Daejeon, South Korea.