Hartwig Anzt

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Summary

Hartwig Anzt is a Helmholtz-Young-Investigator Group leader at the Steinbuch Centre for Computing at the Karlsruhe Institute of Technology (KIT). He obtained his PhD in Mathematics at the Karlsruhe Institute of Technology, and afterwards joined Jack Dongarra's Innovative Computing Lab at the University of Tennessee in 2013. Since 2015 he also holds a Senior Research Scientist position at the University of Tennessee. Hartwig Anzt has a strong background in numerical mathematics, specializes in iterative methods and preconditioning techniques for the next generation hardware architectures. His Helmholtz group on Fixed-point methods for numerics at Exascale ("FiNE") is granted funding until 2022. Hartwig Anzt has a long track record of high-quality software development. He is author of the MAGMA-sparse open source software package and managing lead and developer of the Ginkgo numerical linear algebra library. Hartwig Anzt is a co-PI of the PEEKS project and the xSDK4ECP project inside the software technology effort of the US Exascale Computing Project (ECP). He is also the technical PI of the multiprecision effort in the xSDK project, a coordinated effort aiming at integrating low-precision functionality into high-accuracy simulation codes.

Professional Experience

May 2017 – now **Helmholtz Young Investigator Group**, *Karlsruhe Institute of Technology*, Karlsruhe.
Steinbuch Centre for Comuting (SCC)

June 2017 – now **Research Consultant**, *University of Tennessee*, Knoxville.
Innovative Computing Lab (ICL)

June 2015 – May2017 **Research Scientist**, *University of Tennessee*, Knoxville.
Innovative Computing Lab (ICL)

June 2013 – May 2015 **PostDoctoral Researcher**, *University of Tennessee*, Knoxville.
Innovative Computing Lab (ICL)

March 2010 – May 2013 **Research Associate**, *Karlsruhe Institute of Technology*, Karlsruhe.
Institute for Applied and Numerical Mathematics

Research Focus

- Design of algorithms for extreme parallelism.
- Algorithm development based on fixed-point iterations.
- Asynchronous and communication-avoiding algorithms.
- Algorithms for sparse liner algebra, and data analytics, in particular iterative methods and preconditioners.
- Mixed precision and adaptive precision numerics.
- Graph algorithms and data analytics.
- GPU computing and embedded systems.
- Energy efficiency in HPC.
- Sustainable software engineering.
- Production-ready math libraries
  - Ginkgo library: `https://ginkgo-project.github.io/`
  - MAGMA-sparse library: `http://icl.cs.utk.edu/magma/`

Hartwig Anzt *Curriculum Vitae*

Education

2013–2015 **PostDoctoral Researcher**, *University of Tennessee*, Numerical Linear Algebra.

Nov. 2012 **PhD, Mathematics**, *Asynchronous and Multiprecision Linear Solvers*, Prof. Dr. Vincent Heuveline, Prof. Dr. Jack Dongarra, Prof. Dr. Rudolf Lohner.

2010–2012 **PhD Student**, *Karlsruhe Institute of Technology*, Mathematics.

Dec. 2009 **Dipl. Math.-techn.**, *Hybrid Parallel Solvers for Computational Fluid Dynamics*, Prof. Dr. Vincent Heuveline, Jun.-Prof. Dr. Jan-Philipp Weiss.

2008–2009 **Graduate Student**, *University of Karlsruhe*, Mathematics, Physics, Computer Science.

2007–2008 **Graduate Student**, *University of Ottawa, CA*, Mathematics, Computer Science.

June 2006 **Prediploma**, *University of Karlsruhe*.

2004–2006 **Student**, *University of Karlsruhe*, Mathematics, Physics, Computer Science.

Professional Activities

Community Event Organization

- Workshop Co-chair: **ISC High Performance 2020**, `https://www.isc-hpc.com/`
- Workshop organizer: **Workshop on Scalable Data Analytics in Scientific Computing (SDASC)** at ISC High Performance 2019, `https://sdascconf.github.io/`
- Session organizer: **Scientific Computing** at GAMM 2019, `https://jahrestagung.gamm-ev.de/index.php/2019/2019-scientific-program/2019-timetable`
- Tutorial organizer: **Linear Algebra Software for High Performance Computing** at International Conference on Supercomputing, ISC 2017, Frankfurt

Program Committee

- Platform for Advanced Scientific Computing (PASC)
- International Workshop on Parallel Matrix Algorithms and Applications (PMAA)
- International Conference on Computational Science (ICCS)
- Workshop on Latest Advances in Scalable Algorithms for Large-Scale Systems (ScaLA)
- International European Conference on Parallel and Distributed Computing (EuroPar)
- Spring Simulation Multi-Conference (SpringSim)

Journal Reviews

- SIAM Journal on Scientific Computing (SISC)
- Transactions on Parallel and Distributed Systems (TPDS)
- Parallel Computing (ParCO)
- Journal of Parallel and Distributed Computing (JPDC)
- International Journal of High Performance Computing and Applications (IJHPCA)
- Transactions on Mathematical Software (ACM TOMS)
- Concurrency and Computation: Practice and Experience (CCPE)
- Computer Physics Communications (CPC)
- Numerical Algorithms
- Journal of Computational Science (JoCS)

Memberships

- Member of the IEEE Society
- Member of the Society of Industrial and Applied Mathematics (SIAM)
- Member of the Association for Computing Machinery (ACM)
- ACM SIGHPC Regional Group Middle Tennessee

Teaching Experience

2019 **Scientific Computing for Engineers**, *Invited Lecture in COSC 594 - 005*, University of Tennessee, Knoxville.

2019 **Selected Topics in Parallel Computing**, *Semianr*, Karlsruhe Institute of Technology.

2019 **Numerical Linear Algebra meets Machine Learning**, *Software Engineering Practice (PSE)*, Karlsruhe Institute of Technology.

2018 **Efficient numerical simulation on multi- and manycore processors**, *Invited Lecture*, Friedrich-Alexander University of Erlangen-Nuremberg.

2018 **Selected Topics in Parallel Computing**, *Semianr*, Karlsruhe Institute of Technology.

2018 **Scientific Computing for Engineers**, *Invited Lecture in COSC 594 - 005*, University of Tennessee, Knoxville.

2018 **Numerical Linear Algebra for Scientific High Performance Computing**, *LV 0110650*, Karlsruhe Institute of Technology.

2018 **Scientific Computing and Machine Learning on Multi- and Manycore Architectures**, *2018 NCTS Short Course*, National Taiwan University.

2017 **Numerical Linear Algebra for Scientific High Performance Computing**, *LV 0110650*, Karlsruhe Institute of Technology.

2017 **Scientific Computing for Engineers**, *COSC 594 - 005*, University of Tennessee, Knoxville.

2016 **Scientific Computing for Engineers**, *COSC 594 - 005*, University of Tennessee, Knoxville.

2015 **Introduction to High Performance Computing**, *Invited Lecture*, Georgia Institute of Technology.

2015 **Scientific Computing for Engineers**, *COSC 594 - 005*, University of Tennessee, Knoxville.

2012 **Module 1 of Certificate for University Teaching (HDZ-Certificate)**, *2012*.

2010 **Optimal Control for Partial Differential Equations, Teaching Assistant**, *Karlsruhe Institute of Technology*.

2007 **Linear Algebra II, Teaching Assistant**, *Karlsruhe Institute of Technology*.

2006 **Linear Algebra I, Teaching Assistant**, *Karlsruhe Institute of Technology*.

Scientific Metrics

Citations **812**, *(Google Scholar, August 2019)*.

h-index **17**, *(Google Scholar, August 2019)*.

i10-index **36**, *(Google Scholar, August 2019)*.

Recent Invited Talks

Slides available online: `https://hartwiganzt.github.io/`

2019 **Accepting High-Quality Software Contributions as Scientific Publications**, *Blog Article of the Better Scientific Software (BSSw) initiative*.

2019 **Algorithm design in the advent of exascale computing**, *4th International Symposium on Research and Education of Computational Science (RECS)*, The Computational Science Alliance of the University of Tokyo, 2019.

2019 **Addressing the Communication Bottleneck: Towards a Modular Precision Ecosystem for HPC**, *Focus Session at the ISC High Performance 2019: New Approaches, Algorithms Towards Exascale Computing*.

2019 **The Art of Writing Scientific Software in an Academic Environment**, *Blog Article of the Better Scientific Software (BSSw) initiative*.

2019 **Exploiting Node-level Performance in Sparse Linear Algebra** , *SIAM Conference on Computational Science and Engineering (SIAM CSE 2019), Spokane*.

2019 **An Automated Performance Evaluation Framework for the Ginkgo Software Ecosystem**, *90th Annual Meeting of the International Associaten of Applied Mathematics and Mechanics (GAMM 2019), Vienna*.

2018 **Towards a Modular Precision Ecosystem**, *Seminar talk at the University of the Republic Uruguay 2018, Uruguay*.

2018 **Towards a Modular Precision Ecosystem**, *Workshop on Clusters, Clouds, and Data for Scientific Computing (CCDC) 2018, Lyon*.

2018 **Fixed-Point and Mixed-Precision Methods for Numerics at Exascale**, *GridKa Workshop 2018, Karlsruhe*.

2018 **Numerical Linear Algebra for High Performance Computing**, *SBD Workshop: Transfer of HPC and Data Know-How to Scientific Communities, 2018, Juelich*.

2018 **ParILUT - a new parallel threshold ILU**, *SIAM PP2018, Tokyo*.

References

Prof. Jack Dongarra
- University Distinguished Professor of Computer Science, Electrical Engineering and Computer Science Department, University of Tennessee, USA
- Adjunct Professor, Computer Science Department, Rice University, USA
- Turing Fellowship in the schools of Computer Science and Mathematics, University of Manchester, UK
- Oak Ridge National Laboratory, USA

`http://www.netlib.org/utk/people/JackDongarra/`
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Prof. Enrique S. Quintana-Ortí
- Professor in Computer Architecture, Polytechnic University of Valencia (EPV), Spain

`http://www.upv.es/ficha-personal/enquior`
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Dr. Mike Heroux
- Senior Scientist, Sandia National Laboratories
- Scientist in Residence, St. John's University, MN

`https://maherou.github.io/`
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Prof. Edmond Chow
- Associate Professor, School of Computational Science and Engineering, Georgia Institute of Technology, USA

`https://www.cc.gatech.edu/~echow/`
echow@cc.gatech.edu

Prof. Marc Baboulin
- Professor at University of Paris-Sud (France)
- Director of the Computer Science Department at Polytech Paris-Sud
- Head of research team ParSys at Laboratoire de Recherche en Informatique (LRI)
- Head of project-team Postale at Inria Saclay

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Peer-Reviewed Publications

[1] Thomas Grützmacher, Terry Cojean, Goran Flegar, Fritz Göbel, and Hartwig Anzt. A customized precision format based on mantissa segmentation for accelerating sparse linear algebra. *Concurrency and Computation: Practice and Experience*, 0(0):e5418. e5418 cpe.5418.

[2] Heike Jagode, Anthony Danalis, Hartwig Anzt, and Jack Dongarra. Papi software-defined events for in-depth performance analysis. *The International Journal of High Performance Computing Applications*, 0(0):1094342019846287, 0.

[3] H. Anzt and G. Flegar. Are we doing the right thing? — a critical analysis of the academic hpc community. In *2019 IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW)*, pages 739–745, May 2019.

[4] H. Anzt, T. Ribizel, G. Flegar, E. Chow, and J. Dongarra. Parilut - a parallel threshold ilu for gpus. In *2019 IEEE International Parallel and Distributed Processing Symposium (IPDPS)*, pages 231–241, May 2019.

[5] T. Ribizel and H. Anzt. Approximate and exact selection on gpus. In *2019 IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW)*, pages 471–478, May 2019.

[6] Hartwig Anzt, Yen-Chen Chen, Terry Cojean, Jack Dongarra, Goran Flegar, Pratik Nayak, Enrique S. Quintana-Ortí, Yuhsiang M. Tsai, and Weichung Wang. Towards continuous benchmarking: An automated performance evaluation framework for high performance software. In *Proceedings of the Platform for Advanced Scientific Computing Conference*, PASC '19, pages 9:1–9:11, New York, NY, USA, 2019. ACM.

[7] Hartwig Anzt, Jack Dongarra, Goran Flegar, Nicholas J. Higham, and Enrique S. Quintana-Ortí. Adaptive precision in block-Jacobi preconditioning for iterative sparse linear system solvers. *Concurrency and Computation: Practice and Experience*, 31(6):e4460, 2019. e4460 cpe.4460.

[8] M. Goetz and H. Anzt. Machine learning-aided numerical linear algebra: Convolutional neural networks for the efficient preconditioner generation. In *2018 IEEE/ACM 9th Workshop on Latest Advances in Scalable Algorithms for Large-Scale Systems (scalA)*, pages 49–56, Nov 2018.

[9] T. Grützmacher, H. Anzt, F. Scheidegger, and E. S. Quintana-Orti. High-performance gpu implementation of pagerank with reduced precision based on mantissa segmentation. In *2018 IEEE/ACM 8th Workshop on Irregular Applications: Architectures and Algorithms (IA3)*, pages 61–68, Nov 2018.

[10] H. Anzt and J. Dongarra. A jaccard weights kernel leveraging independent thread scheduling on gpus. In *2018 30th International Symposium on Computer Architecture and High Performance Computing (SBAC-PAD)*, pages 229–232, Sep. 2018.

[11] H. Anzt, J. Dongarra, G. Flegar, and T. Grützmacher. Variable-size batched condition number calculation on gpus. In *2018 30th International Symposium on Computer Architecture and High Performance Computing (SBAC-PAD)*, pages 132–139, Sep. 2018.

[12] Hartwig Anzt, Edmond Chow, and Jack Dongarra. ParILUT—A New Parallel Threshold ILU Factorization. *SIAM Journal on Scientific Computing*, 40(4):C503–C519, 2018.

[13] Hartwig Anzt, Jack Dongarra, Goran Flegar, and Enrique S. Quintana-Ortí. Variable-size batched gauss–jordan elimination for block-jacobi preconditioning on graphics processors. *Parallel Computing*, 2018.

[14] Hartwig Anzt, Thomas K. Huckle, Jürgen Bräckle, and Jack Dongarra. Incomplete sparse approximate inverses for parallel preconditioning. *Parallel Computing*, 71(Supplement C):1 – 22, 2018.

[15] Hartwig Anzt, Moritz Kreutzer, Eduardo Ponce, Gregory D Peterson, Gerhard Wellein, and Jack Dongarra. Optimization and performance evaluation of the idr iterative krylov solver on gpus. *The International Journal of High Performance Computing Applications*, 32(2):220–230, 2018.

[16] Edmond Chow, Hartwig Anzt, Jennifer Scott, and Jack Dongarra. Using jacobi iterations and blocking for solving sparse triangular systems in incomplete factorization preconditioning. *Journal of Parallel and Distributed Computing*, 119:219 – 230, 2018.

[17] Thomas Grützmacher and Hartwig Anzt. A modular precision format for decoupling arithmetic format and storage format. In *Euro-Par 2018: Parallel Processing Workshops - Euro-Par 2018 International Workshops, Turin, Italy, August 27-28, 2018, Revised Selected Papers*, pages 434–443, 2018.

[18] J. Dongarra, S. Tomov, P. Luszczek, J. Kurzak, M. Gates, I. Yamazaki, H. Anzt, A. Haidar, and A. Abdelfattah. With extreme computing, the rules have changed. *Computing in Science Engineering*, 19(3):52–62, May 2017.

[19] H. Anzt, J. Dongarra, M. Gates, J. Kurzak, P. Luszczek, S. Tomov, and I. Yamazaki. Bringing high performance computing to big data algorithms. pages 777–806, 2017.

[20] Hartwig Anzt, Marc Baboulin, Jack Dongarra, Yvan Fournier, Frank Hulsemann, Amal Khabou, and Yushan Wang. Accelerating the conjugate gradient algorithm with gpus in cfd simulations. pages 35–43, 2017.

[21] Hartwig Anzt, Gary Collins, Jack Dongarra, Goran Flegar, and Enrique S. Quintana-Ortí. Flexible batched sparse matrix-vector product on gpus. In *Proceedings of the 8th Workshop on Latest Advances in Scalable Algorithms for Large-Scale Systems*, ScalA '17, pages 3:1–3:8, New York, NY, USA, 2017. ACM.

[22] Hartwig Anzt, Jack Dongarra, Goran Flegar, and Enrique S. Quintana-Ortí. Batched gauss-jordan elimination for block-jacobi preconditioner generation on gpus. In *Proceedings of the 8th International Workshop on Programming Models and Applications for Multicores and Manycores*, PMAM'17, pages 1–10, New York, NY, USA, 2017. ACM.

[23] Hartwig Anzt, Jack Dongarra, Goran Flegar, and Enrique S. Quintana-Ortí. Variable-Size Batched LU for Small Matrices and Its Integration into Block-Jacobi Preconditioning. In *2017 46th International Conference on Parallel Processing (ICPP)*, pages 91–100, 2017.

[24] Hartwig Anzt, Jack Dongarra, Goran Flegar, Enrique S. Quintana-Ortí, and Andrés E. Tomás. Variable-Size Batched Gauss-Huard for Block-Jacobi Preconditioning. *Procedia Computer Science*, 108:1783 – 1792, 2017. International Conference on Computational Science, {ICCS} 2017, 12-14 June 2017, Zurich, Switzerland.

[25] Hartwig Anzt, Mark Gates, Jack Dongarra, Moritz Kreutzer, Gerhard Wellein, and Martin Köhler. Preconditioned Krylov solvers on GPUs. *Parallel Computing*, 68:32–44, 2017. Applications for the Heterogeneous Computing Era.

[26] Goran Flegar and Hartwig Anzt. Overcoming load imbalance for irregular sparse matrices. In *Proceedings of the Seventh Workshop on Irregular Applications: Architectures and Algorithms*, IA3'17, pages 2:1–2:8, New York, NY, USA, 2017. ACM.

[27] Hartwig Anzt, Jack Dongarra, Moritz Kreutzer, Gerhard Wellein, and Markus Koehler. Efficiency of general krylov methods on gpus – an experimental study. In *2016 IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW)*, pages 683–691, May 2016.

[28] A. Abdelfattah, H. Anzt, J. Dongarra, M. Gates, A. Haidar, J. Kurzak, P. Luszczek, S. Tomov, I. Yamazaki, and A. YarKhan. Linear algebra software for large-scale accelerated multicore computing. *Acta Numerica*, 25:1–160, 5 2016.

[29] Hartwig Anzt, Edmond Chow, and Jack Dongarra. On block-asynchronous execution on GPUs. Technical Report 291, LAPACK Working Note, 2016.

[30] Hartwig Anzt, Edmond Chow, Thomas Huckle, and Jack Dongarra. Batched Generation of Incomplete Sparse Approximate Inverses on GPUs. In *Proceedings of the 7th Workshop on Latest Advances in Scalable Algorithms for Large-Scale Systems*, ScalA '16, pages 49–56, 2016.

[31] Hartwig Anzt, Edmond Chow, Jens Saak, and Jack Dongarra. Updating Incomplete Factorization Preconditioners for Model Order Reduction. *Numerical Algorithms*, 73(3):611–630, 2016.

[32] Hartwig Anzt, Edmond Chow, Daniel B. Szyld, and Jack Dongarra. Domain Overlap for Iterative Sparse Triangular Solves on GPUs. In Hans-Joachim Bungartz, Philipp Neumann, and Wolfgang E. Nagel, editors, *Software for Exascale Computing - SPPEXA*, volume 113 of *Lecture Notes in Computer Science and Engineering*, pages 527–545. Springer International Publishing, 2016.

[33] Hartwig Anzt, Jack Dongarra, and Enrique S. Quintana-Ortí. Fine-grained Bit-Flip Protection for Relaxation Methods. *Journal of Computational Science*, 2016.

[34] Hartwig Anzt, Stanimire Tomov, and Jack Dongarra. On the performance and energy efficiency of sparse linear algebra on GPUs. *International Journal of High Performance Computing Applications*, 2016.

[35] C. J. Newburn, G. Bansal, M. Wood, L. Crivelli, J. Planas, A. Duran, P. Souza, L. Borges, P. Luszczek, S. Tomov, Jack Dongarra, H. Anzt, M. Gates, A. Haidar, Y. Jia, K. Kabir, I. Yamazaki, and J. Labarta. Heterogeneous streaming. In *2016 IEEE International Parallel and Distributed Processing Symposium Workshops, IPDPS Workshops 2016, Chicago, IL, USA, May 23-27, 2016*, pages 611–620, 2016.

[36] Edmond Chow, Hartwig Anzt, and Jack Dongarra. Asynchronous Iterative Algorithm for Computing Incomplete Factorizations on GPUs. In *Lecture Notes in Computer Science*, volume 9137, pages 1–16, July 12 – 16 2015.

[37] J. I. Aliaga, H. Anzt, M. Castillo, J. C. Fernández, G. León, J. Pérez, and E. S. Quintana-Ortí. Unveiling the performance-energy trade-off in iterative linear system solvers for multithreaded processors. *Concurrency and Computation: Practice and Experience*, 27(4):885–904, 2015.

[38] H. Anzt, W. Sawyer, S. Tomov, P. Luszczek, and J. Dongarra. Acceleration of GPU-based Krylov solvers via Data Transfer Reduction. *International Journal of High Performance Computing*, 2015.

[39] Hartwig Anzt, Edmond Chow, and Jack Dongarra. Iterative sparse triangular solves for preconditioning. In Jesper Larsson Träff, Sascha Hunold, and Francesco Versaci, editors,

Euro-Par 2015: Parallel Processing, volume 9233 of *Lecture Notes in Computer Science*, pages 650–661. Springer Berlin Heidelberg, 2015.

[40] Hartwig Anzt, Jack Dongarra, and Enrique S. Quintana-Ortí. Adaptive Precision Solvers for Sparse Linear Systems. In *Proceedings of the 3rd International Workshop on Energy Efficient Supercomputing*, E2SC '15, pages 2:1–2:10, New York, NY, USA, 2015. ACM.

[41] Hartwig Anzt, Jack Dongarra, and Enrique S. Quintana-Ortí. Tuning Stationary Iterative Solvers for Fault Resilience. In *Proceedings of the 6th Workshop on Latest Advances in Scalable Algorithms for Large-Scale Systems*, ScalA '15, pages 1:1–1:8, New York, NY, USA, 2015. ACM.

[42] Hartwig Anzt, Blake Haugen, Jakub Kurzak, Piotr Luszczek, and Jack Dongarra. Experiences in autotuning matrix multiplication for energy minimization on GPUs. *Concurrency and Computation: Practice and Experience*, 27(17):5096–5113, 2015.

[43] Hartwig Anzt, Eduardo Ponce, Gregory D. Peterson, and Jack Dongarra. GPU-accelerated Co-design of Induced Dimension Reduction: Algorithmic Fusion and Kernel Overlap. In *Proceedings of the 2Nd International Workshop on Hardware-Software Co-Design for High Performance Computing*, Co-HPC '15, pages 5:1–5:8, New York, NY, USA, 2015. ACM.

[44] Hartwig Anzt, Stanimire Tomov, and Jack Dongarra. Accelerating the LOBPCG method on GPUs using a blocked Sparse Matrix Vector Product. In *Spring Simulation Multi-Conference 2015 (SpringSim'15)*, 2015.

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[46] Mark Gates, Hartwig Anzt, Jakub Kurzak, and Jack Dongarra. Accelerating Collaborative Filtering Using Concepts from High Performance Computing. In *IEEE International Conference on Big Data*, 2015.

[47] Jakub Kurzak, Hartwig Anzt, Mark Gates, and Jack Dongarra. Implementation and Tuning of Batched Cholesky Factorization and Solve for NVIDIA GPUs. *IEEE TRANSACTIONS ON PARALLEL AND DISTRIBUTED SYSTEMS*, 27(7):2036–2048, 2015.

[48] J. I. Aliaga, H. Anzt, M. Castillo, J. Fernández, G. Leó, J. Perez, and E. S. Quintana-Ortí. Performance and Energy Analysis of the Iterative Solution of Sparse Linear Systems on Multicore and Manycore Architectures. In *Lecture Notes in Computer Science*, volume 8384, 2014.

[49] H. Anzt, A. Beglarian, S. Chilingaryan, A. Ferrone, V. Heuveline, and A. Kopmann. A unified energy footprint for simulation software. *Computer Science - Research and Development*, 29(2):131–138, 2014.

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[51] Hartwig Anzt and Enrique S. Quintana-Ortí. Improving the energy efficiency of sparse linear system solvers on multicore and manycore systems. *Philosophical Transactions of the Royal Society of London A: Mathematical, Physical and Engineering Sciences*, 372(2018), 2014.

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IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW 2014), 2014.

[53] Hartwig Anzt, Stanimire Tomov, and Jack Dongarra. Implementing a Sparse Matrix Vector Product for the SELL-C/SELL-C-σ formats on NVIDIA GPUs. In *Technical Report*, 2014.

[54] Dimitar Lukarski, Hartwig Anzt, Stanimire Tomov, and Jack Dongarra. Hybrid Multi-Elimination ILU Preconditioners on GPUs. In *28th IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW 2014)*, 2014.

[55] Ichitaro Yamazaki, Hartwig Anzt, Stanimire Tomov, Mark Hoemmen, and Jack Dongarra. Improving the Performance of CA-GMRES on Multicores with Multiple GPUs. In *28th IEEE International Parallel and Distributed Processing Symposium (IPDPS 2014)*, 2014.

[56] J.I. Aliaga, J. Perez, E.S. Quintana-Orti, and H. Anzt. Reformulated Conjugate Gradient for the Energy-Aware Solution of Linear Systems on GPUs. In *Parallel Processing (ICPP), 2013 42nd International Conference on*, pages 320–329, Oct 2013.

[57] Hartwig Anzt, Stanimire Tomov, Jack Dongarra, and Vincent Heuveline. A block-asynchronous relaxation method for graphics processing units. *J. Parallel Distrib. Comput.*, 73(12):1613–1626, 2013.

[58] Hartwig Anzt. *Asynchronous and Multiprecision Linear Solvers - Scalable and Fault-Tolerant Numerics for Energy Efficient High Performance Computing* . PhD thesis, Karlsruhe Institute of Technology, Institute for Applied and Numerical Mathematics, Nov. 2012.

[59] H. Anzt, M. Castillo, J. C. Fernández, V. Heuveline, F. D. Igual, R. Mayo, and E. S. Quintana-Ortí. Optimization of power consumption in the iterative solution of sparse linear systems on graphics processors. *Computer Science - R&D*, 27(4):299–307, 2012.

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[62] Hartwig Anzt, Stanimire Tomov, Jack Dongarra, and Vincent Heuveline. Weighted Block-Asynchronous Iteration on GPU-Accelerated Systems. In *Euro-Par Workshops*, volume 7640 of *Lecture Notes in Computer Science*, pages 145–154. Springer, 2012.

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[64] H. Anzt, V. Heuveline, J. I. Aliaga, M. Castillo, J. C. Fernandez, R. Mayo, and E. S. Quintana-Orti. Analysis and optimization of power consumption in the iterative solution of sparse linear systems on multi-core and many-core platforms. In *Green Computing Conference and Workshops (IGCC), 2011 International*, pages 1–6, july 2011.

[65] H. Anzt, W. Augustin, M. Baumann, T. Gengenbach, T. Hahn, A. Helfrich-Schkarbanenko, V. Heuveline, E. Ketelaer, D. Lukarski, A. Nestler, S. Ritterbusch, S. Ronnas, M. Schick, M. Schmidtobreick, C. Subramanian, J.-P. Weiss, F. Wilhelm, and M. Wlotzka. Hiflow^3: A hardware-aware parallel finite element package. In *Tools for High Performance Computing 2011 - Proceedings of the 5th International Workshop on Parallel Tools for High Performance Computing, ZIH, Dresden, September 2011*, pages 139–151, 2011.

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[67] H. Anzt, V. Heuveline, B. Rocker, M. Castillo, J. C. Fernández, R. Mayo, and E. S. Quintana-Ortí. Power Consumption of Mixed Precision in the Iterative Solution of Sparse Linear Systems. In *IPDPS Workshops*, pages 829–836, 2011.

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