Yang Liu

Mobile: 734-546-7392
E-mail: liuyangzhuan@lbl.gov
Address: MS 50A-3111, 1 Cyclotron Rd, Berkeley, CA
Homepage: https://liuyangzhuan.github.io/

Research Interests

Scientific Computing: Direct solvers and preconditioners for sparse and dense linear systems, low-rank and butterfly compression, randomized matrix and tensor algorithms, high-performance computing, autotuning, Bayesian optimization, scientific machine learning, as well as their applications to fusion simulation, accelerator modeling, seismic modeling, optical computing, quantum chemistry, quantum computing, bio-science, nuclear physics, power grid and inverse problem applications.

Computational Electromagnetics: Fast integral and differential equation solvers for large-scale electromagnetic problems, multi-resolution algorithms for transient scattering, multi-physics and multi-scale modeling, inverse scattering, and high-frequency ansatz.

Research Experience

Career (Tenured) Research Scientist, Lawrence Berkeley National Laboratory, Feb. 2022 - Present

- Develop autotuning and uncertainty quantification techniques for DOE applications
- Develop scalable sparse linear solvers
- Develop efficient solvers for kinetic plasma simulations
- Develop new formulations and solvers for acoustic and electromagnetic problems
- Develop fast linear and multi-linear algorithms for quantum chemistry computation
- Develop randomized algorithms for challenging inverse problems
- Develop domain-aware deep learning algorithms

Career-Track Research Scientist, Lawrence Berkeley National Laboratory, Aug. 2019 - Jan. 2022

- Develop butterfly-based direct solvers for sparse linear systems
- Develop autotuning techniques for exascale applications
- Develop GPU-accelerated exascale sparse linear solvers
- Develop efficient direct solver-based RF cavity modeling tools

Postdoctoral Research Fellow, Lawrence Berkeley National Laboratory, Aug. 2017 - Jul. 2019

- Develop low-rank and butterfly-based hierarchical solvers for highly oscillatory problems.
- Develop scalable triangular solution algorithms for sparse direct solvers.

Postdoctoral Research Fellow, University of Michigan, June 2015 - July 2017

- Develop randomized algorithms for butterfly factorizations and butterfly-based fast direct integral equation solvers for high-frequency Helmholtz problems.

Research Assistant, University of Michigan, Sept. 2010 - May 2015

- Develop provably scalable and wavelet-enhanced plane-wave-time-domain algorithms for integral equation analysis of large-scale transient problems.

Teaching Experience

Lecturer, ACES 2024 Conference, May 2024

- Short course: Direct solvers for sparse and dense systems in electromagnetics and multi-physics simulations.

Lecturer, IEEE NEMO Conference, June 2023

- Short course: Rank-structured fast direct solvers for electromagnetics and multiphysics simulations.

Lecturer, Exascale Computing Project Annual Meeting, May. 2023

- Tutorial: SuperLU and STRUMPACK: GPU accelerated sparse factorization solvers
- Tutorial: Autotuning ECP Codes Using the GPTune Package

Lecturer, Exascale Computing Project Annual Meeting, May. 2022

- Tutorial: GPU Capable Sparse Direct Solvers
- Tutorial: Performance Autotuning of ECP Applications with Gaussian Process-Based and Cloud Database-Enhanced GPTune Package

Lecturer, Exascale Computing Project Annual Meeting, Apr. 2021

- Tutorial: GPTune: Performance Autotuner for ECP Applications

Lecturer, Exascale Computing Project Annual Meeting, Feb. 2020

- Tutorial: STRUMPACK / SuperLU: fast parallel direct linear solvers and preconditioners

Lecturer, Super Computing, Nov. 2019

- Tutorial: fast parallel direct linear solvers and preconditioners

Lecturer, IEEE NEMO Conference, May 2019

- Short course: Scalable direct solvers for electromagnetics and multiphysics simulations.

Teaching Assistant, Shanghai Jiao Tong University, Mar. 2009 - June 2009

- Instruct students in FPGA programming for digital circuit designs.

EDUCATION

- Ph.D., Electrical Engineering, University of Michigan, May 2015
  Advisor: Eric Michielssen
- M.S., Mathematics, University of Michigan, Nov. 2014
- B.S., Electrical Engineering, Shanghai Jiao Tong University, June 2010

HONORS AND AWARDS

- DOD SBIR Award (Co-PI), 2023
- LBNL Laboratory Directed Research and Development (LDRD) Award (PI), 2022
- Young Scientists Award, 3rd URSI Atlantic Radio Science Meeting (AT-AP-RASC), 2022
- Sergei A. Schelkunoff Transactions Prize Paper Award, IEEE Antennas and Propagation Society, 2018
- 1^{st} Place in Student Paper Competition, 12th International Workshop on Finite Elements for Microwave Engineering, 2014
- 2^{nd} Place in Student Paper Competition, 28th Annual Review of Progress in Applied Computational Electromagnetics, 2012
- Rackham Travel Grant, University of Michigan, 2012 to 2014
- Outstanding Graduate Award, Shanghai Jiao Tong University, 2010
- Third Prize in National Electronic Contest, China, 2009

SOFTWARE DEVELOPMENT

- **ButterflyPACK**, https://github.com/liuyangzhuan/ButterflyPACK
- **GPTune**, https://github.com/gptune/GPTune
- **Superlu_DIST**, https://github.com/xiaoyeli/superlu_dist
- **STRUMPACK**, https://github.com/pghysels/STRUMPACK

REVIEWER EXPERIENCE

Proposals

- DOE SBIR/STTR proposals
- Dutch Research Council (NWO) proposals

- Israel Science Foundation (ISF) proposals

Conference Proceedings

- PC member for International Parallel and Distributed Processing Symposium (IPDPS) 2023, 2024
- PC member for IEEE Cluster 2021
- PC member for International Conference on Parallel Processing (ICPP) 2021, 2023
- PC member for Supercomputing (SC) 2021, 2022
- IEEE AP-S/URSI Symposium 2021, 2022, 2023
- PC member for SIAM Conference on Parallel Processing for Scientific Computing (PP), 2022, 2023

Journals

- Communications in Computational Physics
- CCF Transactions on High Performance Computing
- CSIAM Transactions on Applied Mathematics
- Journal of Computational Physics
- ACM Transactions on Mathematical Software
- Applied and Computational Harmonic Analysis
- The Journal of the Acoustical Society of America
- SIAM Journal of Scientific Computing
- SIAM Journal on Matrix Analysis and Applications
- Mathematical Reviews of AMS
- IEEE Transaction on Antennas and Propagation
- IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control
- IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems
- IEEE Antennas and Propagation Magazine
- IEEE Transaction on Microwave Theory and Techniques
- IEEE Transactions on Parallel and Distributed Systems
- IEEE Antennas and Wireless Propagation Letters
- IEEE Journal on Multiscale and Multiphysics Computational Techniques
- International Journal of Numerical Modelling: Electronic Networks, Devices and Fields
- Concurrency and Computation: Practice and Experience
- Journal of Applied Computational Electromagnetics Society
- International Journal of Antennas and Propagation
- The Open Electrical and Electronic Engineering Journal
- Journal of Microwaves, Optoelectronics and Electromagnetic Applications
- Mathematics of MDPI

SESSION ORGANIZER

- Chair for "Fast Algorithms," IEEE NEMO Conference, May 2024
- Chair for "Fast Algorithms," ACES 2024 Conference, May 2024
- Publication chair for IEEE NEMO Conference, 2023
- Committee Member for "DOE SciDAC FASTMath Seminar Series", 2021, 2022
- Chair for "Low-Rank Compression-Based Fast Sparse Direct Solvers," SIAM Conference on Parallel Processing for Scientific Computing, 2020
- Chair for "Fast and Accurate Integral Methods for Highly Oscillatory Phenomena," SIAM Conference on Computational Science and Engineering, 2019
- Chair for "Time-Domain Computational Methods for Complex Electromagnetic and Multiphysics Problems," IEEE International Symposium on Antennas and Propagation and USNC-URSI Radio Science Meeting, 2019
- Chair for "Parallel Sparse Triangular Solve on Emerging Platforms," SIAM Conference on Applied Linear Algebra, 2018

- Chair for "Acceleration Techniques for Integral Equations," IEEE International Symposium on Antennas and Propagation and USNC-URSI Radio Science Meeting, 2017.
- Chair for "Time-Domain Numerical Methods," IEEE International Symposium on Antennas and Propagation and USNC-URSI Radio Science Meeting, 2012
- Judge for the 10th Annual Engineering Graduate Symposium, University of Michigan, 2015
- Steering Committee for "Celebrating Maxwell's Equations: 150 Years" workshop, 2015.
- Chapter Treasurer for IEEE Southeastern Michigan Section, Chapter IV, 2011-2016.
- Secretary for Technical Activities Committee, IEEE Southeastern Michigan Section, 2015-2016.

BOOK CHAPTERS

[1] **Y. Liu**, and E. Michielssen "Parallel fast time-domain integral-equation methods for transient electromagnetic analysis," in Parallel algorithms in computational science and engineering. Birkhauser, 2020.

REFEREED JOURNAL PUBLICATIONS

[1] W. Boukaram, Y. Hong, **Y. Liu**, T. Shi, and X. S. Li, "Batched sparse direct solver design and evaluation in SuperLU DIST," *Int. Journal of High Performance Computing Applications,* 2024. (submitted)

[2] Z. Wang, A. Aldossary, T. Shi, **Y. Liu**, X. S. Li, and M. Head-Gordon, "Local second-order Møller–Plesset theory with a single threshold using orthogonal virtual orbitals: theory, implementation, and assessment," *J. Chem. Theory Comput.,* 2023. doi:10.1021/acs.jctc.3c00744.

[3] **Y. Liu**, T. Luo, A. Rani, H. Luo, and X. Li, "Detecting resonance of radio-frequency cavities using fast direct integral equation solvers and augmented Bayesian optimization," *IEEE J. Multiscale Multiphysics Comput. Tech.,* 2023. doi:10.1109/JMMCT.2023.3311322.

[4] L. Claus, P. Ghysels, **Y. Liu**, T. Nhan, R. Thirumalaisamy, A. P. S. Bhalla, and X. Li, "Sparse approximate multifrontal factorization with composite compression methods," *ACM Trans. Math. Softw.,* 2023. doi:10.1145/3611662.

[5] X. Li, **Y. Liu**, P. Lin, and P. Sao, "Newly released capabilities in distributed-memory SuperLU sparse direct solver," *ACM Trans. Math. Softw.,* 2023. doi:10.1145/3577197.

[6] H. Luo, Y. Cho, J. W. Demmel, X. S. Li, and **Y. Liu**,, "Hybrid models for mixed variables in Bayesian optimization," *Journal of Machine Learning Research,* (arXiv:2206.01409).

[7] W. Sheng, A. C. Yucel, **Y. Liu**, H. Guo, and E. Michielssen, "A domain decomposition based surface integral equation simulator for characterizing EM wave propagation in mine environments," *IEEE Trans. Antennas Propag.,* 2023. doi:10.1109/TAP.2023.3256579.

[8] **Y. Liu**, J. Song, R. Burridge, and J. Qian, "A fast butterfly-compressed Hadamard-Babich integrator for high-frequency inhomogenous Helmholtz equations in variable media," *SIAM J. Multiscale Model Simul.,* 2023. doi:10.1137/21M1450422.

[9] M. Wang, **Y. Liu**, P. Ghysels, and A. C. Yucel, "VoxImp: impedance extraction simulator for voxelized structures," *IEEE Trans. Comput.-Aided Des. Integr. Circuits Syst.,* 2022. doi:10.1109/TCAD.2022.3218768.

[10] S. B. Sayed, **Y. Liu**, L. J. Gomez, and A. C. Yucel, "A butterfly-accelerated volume integral equation solver for broad permittivity and large-scale electromagnetic analysis," *IEEE Trans. Antennas Propag.,* 2021. doi:10.1109/TAP.2021.3137193.

[11] H. Luo, J. W. Demmel, Y. Cho, X. S. Li, and **Y. Liu**, "Non-smooth Bayesian optimization

in tuning problems," *Journal of Machine Learning Research,* (arXiv:2111.01730).

[12] **Y. Liu**, P. Ghysels, L. Claus, and X. Sherry Li, "Sparse approximate multifrontal factorization with butterfly compression for high frequency wave equations," *SIAM J. Sci. Comput.,* 2021. doi:10.1137/20M1349667.

[13] **Y. Liu**, Xin Xing, H. Guo, E. Michielssen, P. Ghysels, and X. Sherry Li "Butterfly factorization via randomized matrix-vector multiplications," *SIAM J. Sci. Comput.,* 2021. doi:10.1137/20M1315853.

[14] **Y. Liu**, W. Sid-Lakhdar, E. Rebrova, P. Ghysels, and X. Sherry Li, "A parallel hierarchical blocked adaptive cross approximation algorithm," *Int. Journal of High Performance Computing Applications* 2020. doi:10.1177/1094342020918305

[15] **Y. Liu**, and H. Yang, "A hierarchical butterfly LU preconditioner for two-dimensional electromagnetic scattering problems involving open surfaces," *J. Comput. Phys.* 2019. doi:10.1016/j.jcp.2019.109014

[16] H. Guo, **Y. Liu**, J. Hu, and E. Michielssen, "A butterfly-based direct solver using hierarchical LU factorization for PMCHWT equations," *Microw. Opt. Technol. Lett.,* 2018. doi:10.1002/mop.31166

[17] **Y. Liu**, A. C. Yucel, H. Bagci, A. C. Gilbert, and E. Michielssen, "Wavelet-enhanced plane-wave time-domain algorithm for analysis of transient scattering from electrically large conducting objects," *IEEE Trans. Antennas Propag.,* 2017. doi:10.1109/TAP.2018.2809555

[18] A. C. Yucel, W. Sheng, C. Zhou, **Y. Liu**, H. Bagci, and E. Michielssen, "An FMM-FFT accelerated SIE simulator for analyzing EM wave propagation in mine environments loaded with conductors," *IEEE J. Multiscale and Multiphys. Comput. Techn.,* 2017. doi:10.1109/JMMCT.2018.2802420.

[19] **Y. Liu**, H. Guo, and E. Michielssen, "A HSS matrix-inspired butterfly-based direct solver for analyzing scattering from two-dimensional objects," *IEEE Antennas Wireless Propag. Lett.* 2017. doi:10.1109/LAWP.2016.2626786

[20] H. Guo, **Y. Liu**, J. Hu, and E. Michielssen, "A butterfly-based direct integral equation solver using hierarchical LU factorization for analyzing scattering from large conducting objects," *IEEE Trans. Antennas Propag.,* 2017. doi:10.1109/TAP.2017.2727511

[21] **Y. Liu**, A. Al-Jarro, H. Bagci, and E. Michielssen, "Parallel PWTD-accelerated explicit solution of the time domain electric field volume integral equation," *IEEE Trans. Antennas Propag.,* 2016. doi:10.1109/TAP.2016.2546964

[22] **Y. Liu**, A. C. Yucel, H. Bagci, and E. Michielssen, "A scalable parallel PWTD-accelerated surface integral equation solver for analysis of transient scattering from large-scale objects," *IEEE Trans. Antennas Propag.,* 2016. doi:10.1109/TAP.2015.2508483

[23] **Y. Liu**, A. C. Yucel, V. Lomakin, and E. Michielssen, "Graphics processing unit implementation of multilevel plane-wave time-domain algorithm," *IEEE Antennas Wireless Propag. Lett.,* vol. 1, pp. 1-1, 2014. doi:10.1109/LAWP.2014.2350967

[24] A. C. Yucel, **Y. Liu**, H. Bagci, and E. Michielssen, "Statistical characterization of electromagnetic wave propagation in mine environments," *IEEE Antennas Wireless Propag. Lett.,* vol. 12, pp. 1602-1605, 2013. doi:10.1109/LAWP.2013.2293288

CONFERENCE PAPERS

[1] **Y. Liu**, N. Ding, P. Sao, S. Williams, and X. S. Li, "Unified communication optimiza-

tion strategies for sparse triangular solver on CPU and GPU clusters," in *The International Conference for High Performance Computing, Networking, Storage, and Analysis*, 2023. doi:10.1145/3581784.3607092

[2] .G Dinh, I. Valsala, H. Luo, C. Hong, Y. Cho, J. Demmel, X. S. Li, and **Y. Liu**, "Sample-efficient mapspace optimization for DNN accelerators with Bayesian learning," in *Architecture and System Support for Transformer Models*, 2023. doi:10.1145/3581784.3607092

[3] Y. Cho, J. W. Demmel, J. King, X. S. Li, **Y. Liu**, and H. Luo, "Harnessing the crowd for autotuning high-performance computing applications," in *IEEE International Parallel and Distributed Processing Symposium*, 2023. doi:10.1109/IPDPS54959.2023.00069

[4] **Y. Liu**, "A comparative study of butterfly-enhanced direct integral and differential equation solvers for high-frequency electromagnetic analysis involving inhomogeneous dielectrics," in *3rd URSI Atlantic Radio Science Meeting (AT-AP-RASC)*, 2022. doi:10.23919/AT-AP-RASC54737.2022.9814197

[5] X. Zhu, **Y. Liu**, P. Ghysels, D. Bindel, and X. S. Li, "GPTuneBand: multi-task and multi-fidelity Bayesian optimization for autotuning exascale applications," in *SIAM PP*, 2022. doi:10.1137/1.9781611977141.1

[6] Y. Cho, J. W. Demmel, X. S. Li, **Y. Liu**, and H. Luo, "Enhancing autotuning capability with a history database," in *IEEE 14th International Symposium on Embedded Multicore/Many-core Systems-on-Chip (MCSoC)*, 2021. doi:10.1109/MCSoC51149.2021.00044

[7] **Y. Liu**, W. M. Sid-Lakhdar, O. Marques, X. Zhu, C. Meng, J. W. Demmel, and X. S. Li. "GPTune: multitask learning for autotuning exascale applications," in *PPoPP21*, 2021. doi:10.1145/3437801.3441621

[8] N. Ding, S. Williams, **Y. Liu** and X. S. Li "A message-driven, multi-GPU parallel sparse triangular solver," in *SIAM ACDA*, 2021.

[9] G. Chavez, E. Rebrova, **Y. Liu**, P. Ghysels and X. S. Li "Scalable and memory-efficient kernel ridge regression," in *34th IEEE International Parallel and Distributed Processing Symposium*, 2020. doi:10.1109/IPDPS47924.2020.00102

[10] N. Ding, S. Williams, **Y. Liu** and X. S. Li "Leveraging one-sided communication for sparse triangular solvers," in *SIAM Workshop on Combinatorial Scientific Computing,* 2020. doi:10.1137/1.9781611976137.9

[11] **Y. Liu**, M. Jacquelin, P. Ghysels, and X. S. Li, "Highly scalable distributed-memory sparse triangular solve algorithms," in *SIAM Workshop on Combinatorial Scientific Computing,* 2018. doi:10.1137/1.9781611975215.9

[12] E. Rebrova, G. Ghavez, **Y. Liu**, P. Ghysels, and X. S. Li, "A study of clustering techniques and hierarchical matrix formats for kernel ridge regression," in *Proc. IEEE IPDPSW,* 2018. doi:10.1109/IPDPSW.2018.00140

[13] **Y. Liu**, V. Lomakin, and E. Michielssen, "Graphics processing unit-accelerated implementation of the plane wave time domain algorithm," *28th Ann. Rev. Prog. Appl. Computat. Electromagn.,* 2012.

[14] J. Liang, **Y. Liu**, W. Zhang, Y. Xu, X. Gan, and X. Wang, "Joint compressive sensing in wideband cognitive networks," in *IEEE WCNC,* 2010. doi:10.1109/WCNC.2010.5506392

SELECTED PRESENTATIONS

[1] **Y. Liu**, "Recent Algorithm Developments in the ButterflyPACK Package", in *ACES Con-*

ference, 2024.

[2] **Y. Liu**, M. Rahman, J. King, C. Sovinec, X. Wei, Z. Bai and S. William, "Efficient Fourier Neural Operators for Fusion Simulations", in *NIMROD Team Meeting*, 2024.

[3] **Y. Liu**, M. Kielstra, T. Shi, H. Luo, and J. Qian, "Fast Iterative Solvers in Tensor Butterfly Format", in *18th Copper Mountain Conference on Iterative Methods*, 2024.

[4] **Y. Liu**, "Butterfly Algorithms: from Matrix to Tensor", in *SIAM Conference on Parallel Processing for Scientific Computing*, 2024.

[5] **Y. Liu**, "Efficient Matrix, Tensor, Machine Learning Algorithms for Computational Science and Engineering Applications", in *Purdue University Seminar*, 2024.

[6] **Y. Liu**, "Babich Ansatz: a Geometrical-Optics-Like Ansatz for Green's Function of Wave Equations with Variable Coefficients", in *DOE FASTMath Seminar*, 2023.

[7] **Y. Liu**, "Progress on Faster Butterfly Construction Based on Randomized Matrix-Vector Multiplication", in *SIAM CSE*, 2023.

[8] **Y. Liu**, "Fast Direct Solvers for Electromagnetic, Optics, Acoustic, and Elastic Applications", in *Physics-2022*.

[9] **Y. Liu**, "Butterfly Compressed Babich Integrator for Solving Helmholtz Equations in Inhomogeneous Media", in *BIRS-CMO Workshop on Outstanding Challenges in Computational Methods for Integral Equations*, 2022.

[10] **Y. Liu**, "Fast Direct Integral and Differential Equation Solvers for Electromagnetic Applications at All Frequency Ranges", in *Howard University Seminar*, 2021.

[11] **Y. Liu**, "Fast Direct Integral and Differential Equation Solvers for Electromagnetic, Acoustic, and Elastic Applications at All Frequency Ranges", in *Michigan MICDE Seminar*, 2021.

[12] **Y. Liu**, "Fast Direct Integral and Differential Equation Solvers for Electromagnetic, Acoustic, and Elastic Applications at All Frequency Ranges", in *Flatiron Seminar*, 2021.

[13] **Y. Liu**, "Autotuning HPC and ML Applications Using GPTune ", in *Google Research Seminar*, 2021.

[14] **Y. Liu**, P. Ghysels, and X. S. Li, "Butterfly-based Hierarchically Semi-separable Matrix for Integral Equation Solvers", in *URSI GASS*, 2021.

[15] **Y. Liu**, X. Xing, L. Claus, P. Ghysels, and X. S. Li, "Optimal-Complexity Butterfly Algorithm Based on Randomized Matvec", in *SIAM CSE*, 2021.

[16] **Y. Liu**, T. Luo, and S. Tan, "A Fast Direct IE Solver for Characterization of Accelerator Cavities with Waveguide Ports", in *ICCEM*, 2020.

[17] **Y. Liu**, P. Ghysels, L. Claus, and X. S. Li, "Butterfly-based Multifrontal Preconditioner for Wave Equations", in *HPC China*, 2020.

[18] **Y. Liu**, X. Zhu, W. S-Lakhdar, X. S. Li, O. Marques, and J. Demmel, "Multitask Learning and Multi-Armed Bandit-Based Bayesian Optimization for HPC Applications", in *NYSDS*, 2020

[19] **Y. Liu**, P. Ghysels, and X. S. Li, "Parallel butterfly-based Sherman–Morrison–Woodbury inversion," in *SIAM Conference on Parallel Processing for Scientific Computing,* 2020.

[20] P. Ghysels, **Y. Liu**, and X. S. Li, "Incorporating hierarchical matrix compression and butterfly factorizations in a multifrontal LU solver," in *SIAM Conference on Parallel Processing for Scientific Computing,* 2020.

[21] W. M. Sid-Lakhdar, **Y. Liu**, X. S. Li, O. A. Marques, and J. Demmel, "Autotuning exascale applications," in *SIAM Conference on Parallel Processing for Scientific Computing,* 2020.

[22] **Y. Liu**, "Fast Algebras on Optimized Butterfly Structures," in *SIAM Conference on Computational Science and Engineering,* 2019.

[23] **Y. Liu**, "A blocked adaptive cross approximation algorithm and its hierarchical generalization," in *Copper Mountain Conference On Multigrid Methods,* 2019.

[24] **Y. Liu**, M. Jacquelin, and X. S. Li, "Enhancing scalability of parallel sparse triangular solve in SuperLU," in *SIAM Conference on Applied Linear Algebra,* 2018.

[25] **Y. Liu**, and E. Michielssen, "Parallel butterfly-based direct solvers for highly oscillatory problems," in *SIAM Conference on Parallel Processing for Scientific Computing,* 2018.

[26] **Y. Liu**, H. Guo, and E. Michielssen, "A HSS-type butterfly-based direct integral equation solver for 3D perfect electrically conducting objects," in *Proc. IEEE Int. Symp. AP-S/URSI,* 2017.

[27] **Y. Liu**, H. Guo, and E. Michielssen, "A linear-complexity randomized butterfly scheme for direct integral equation solvers," in *Proc. IEEE Int. Symp. AP-S/URSI,* 2017.

[28] W. Sheng, H. Guo, **Y. Liu**, A. C. Yucel, and E. Michielssen, "A butterfly-based domain decomposition SIE simulator for EM analysis of wireless communication systems in mine environments," in *Proc. IEEE Int. Symp. AP-S/URSI,* 2017.

[29] **Y. Liu**, H. Guo, and E. Michielssen, "A new MLMDA-based direct integral equation solver for electrically perfect conducting objects," in *Proc. IEEE Int. Symp. AP-S/URSI,* 2016.

[30] **Y. Liu**, H. Guo, and E. Michielssen, "A new butterfly reconstruction method for MLMDA-based direct integral equation solvers," in *Proc. IEEE Int. Symp. AP-S/URSI,* 2016.

[31] **Y. Liu**, A. C. Yucel, A. C. Gilbert, H. Bagci, and E. Michielssen, "A wavelet-based PWTD algorithm-accelerated time domain surface integral equation solver," in *Proc. IEEE Int. Symp. AP-S/URSI,* 2015.

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[33] **Y. Liu**, A. C. Yucel, H. Bagci, and E. Michielssen, "Parallel time domain solvers for electrically large transient scattering problems," **invited talk**, in *Proc. EUCAP,* 2014.

[34] A. C. Yucel, L. Gomez, **Y. Liu**, H. Bagci, and E. Michielssen, "A FMM-FFT accelerated hybrid volume surface integral equation solver for electromagnetic analysis of re-entry space vehicles," in *Proc. IEEE Int. Symp. AP-S/URSI,* 2014.

[35] H. Guo, **Y. Liu**, H. Jun, and E. Michielssen, "A parallel MLMDA-based direct integral equation solver," in *Proc. IEEE Int. Symp. AP-S/URSI,* 2013.

[36] A. C. Yucel, **Y. Liu**, H. Bagci, and E. Michielssen, "A fast-multipole domain decomposition integral equation solver for characterizing electromagnetic wave propagation in mine environments," in *Proc. IEEE Int. Symp. AP-S/URSI,* 2013.

[37] **Y. Liu**, H. Bagci, and E. Michielssen, "Solving very large scattering problems using a parallel PWTD-enhanced surface integral equation solver," in *Proc. IEEE Int. Symp. AP-S/URSI,* 2013.

[38] **Y. Liu**, A. Al-Jarro, H. Bagci, and E. Michielssen, "Parallel, explicit, and PWTD-enhanced

time domain volume integral equation solver," in *Proc. IEEE Int. Symp. AP-S/URSI,* 2013.

[39] **Y. Liu**, A. C. Yucel, V. Lomakin, and E. Michielssen, "A scalable parallel implementation of the plane wave time domain algorithm on graphics processing unit-augmented clusters," in *Proc. IEEE Int. Symp. AP-S/URSI,* 2012.