Stephen Herbein

Computer Scientist, Livermore Computing
Lawrence Livermore National Laboratory

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Education

2014-2018 **Ph.D., Computer Science**, *University of Delaware*, GPA 4.0.
Advisor: Dr. Michela Taufer

2016 **M.S., Computer Science**, *University of Delaware*, GPA 4.0.

2014 **Honors B.S. with Distinction, Computer Science**, *University of Delaware*.
GPA 3.932; Magna Cum Laude

Research Interests

- Next-generation resource management and job scheduling
- Exascale workflows and HPC+Cloud convergence
- I/O-aware scheduling

Research Experience

2018-Present **Lawrence Livermore National Laboratory**, *Computer Scientist*.
- Flux: developing features, supporting users, and readying code for future Exascale system - El Capitan
- HPC+Cloud: PI of $175K project to find gaps in LLNL's converged computing capabilities
- Exaworks: creating a portable, performant, and hardened workflow SDK
- ZFP: developed python bindings for this LLNL compression library

2014-2018 **University of Delaware**, *Graduate Research Assistant*.
Created next-generation job schedulers for HPC clusters utilizing the Flux resource manager

2014-2017 (Summers) **Lawrence Livermore National Laboratory**, *Research Intern*.
2014: Created a discrete event simulator for the Flux resource manager
2015: Designed an automatic job aggregator and hierarchical scheduler, resulting in a 4x speed up over the existing scheduler
2016: Added dynamicity to my hierarchical scheduler to eliminate resource fragmentation
2017: Integrated my hierarchical scheduler with the Uncertainty Quantification Pipeline (UQP), resulting in a 37% improvement in workload runtime

2013-2014 **University of Delaware**, *Undergraduate Research Assistant*.
Applied auto-tuning techniques to improve I/O performance of scientific applications on clusters with a Lustre filesystem

Summer 2013 **Oak Ridge National Laboratory**, *Research Intern (DOE SULI)*.
Integrated the ADIOS I/O library into the QMCPack scientific application to improve performance on ORNL's supercomputer, Titan

2012-2013 **University of Delaware**, *Undergraduate Research Assistant*.
Improved the efficiency of GPU accelerated codes in scientific workflows on large-scale clusters

Summer 2012 **University of Houston**, *Research Intern (NSF REU)*.
Optimized VolpexMPI library for use on large-scale clusters

Awards & Honors

Summer 2019 Spot Award - LLNL ATDM Next Generation Computing Enablement
Summer 2019 Dissertation Award - IEEE Technical Committee on Scalable Computing
Summer 2016 Best Poster - Annual LLNL Poster Symposium

Spring 2016	Outstanding Graduate Student Award - CIS Department
Spring 2016	HPDC Student Travel Award for $1000 - HPDC
Spring 2016	Invited to attend and present at Salishan Conference - LLNL
Fall 2014	ICPADS Student Travel Award for $1000 - ICPADS/TCPP
Spring 2014	Outstanding Senior Student Award - CIS Department
Fall 2013	Undergraduate Student Research Competition Award - ACM
Spring 2013	Outstanding Junior Student Award - CIS Department
Fall 2012	General Honors Award - University of Delaware
2011 - 2014	Presidential Achievement Scholarship - University of Delaware

Peer-Reviewed Publications

Conference Papers

[1] Harsh Bhatia, Francesco Di Natale, Joseph Y. Moon, Xiaohua Zhang, Joseph R. Chavez, Fikret Aydin, Chris Stanley, Tomas Oppelstrup, Chris Neale, Sara Kokkila Schumacher, Dong H. Ahn, **Stephen Herbein**, Timothy S. Carpenter, Sandrasegaram Gnanakaran, Peer-Timo Bremer, James N. Glosli, Felice C.Lightstone, and Helgi I. Ingólfsson. Generalizable Coordination of Large Multiscale Ensembles: Challenges and Learnings at Scale. In *Proceedings of the International Conference for High Performance Computing, Networking, Storage, and Analysis*, SC, St. Louis, MO, November 2021.

[2] Michael Wyatt, **Stephen Herbein**, Kathleen Shoga, Todd Gamblin, and Michela Taufer. CanarIO: Sounding the Alarm on IO-Related Performance Degradation. In *Proceedings of the 34th IEEE International Parallel and Distributed Processing Symposium*, IPDPS, New Orleans, LA, May 2020.

[3] Samuel D. Pollard, Nikhil Jain, **Stephen Herbein**, and Abhinav Bhatele. Evaluation of an Interference-free Node Allocation Policy on Fat-tree Clusters. In *Proceedings of the International Conference for High Performance Computing, Networking, Storage, and Analysis*, SC, pages 333–345, Dallas, TX, November 2018.

[4] Michael Wyatt, **Stephen Herbein**, Todd Gamblin, Adam Moody, Dong H. Ahn, and Michela Taufer. PRIONN: Predicting Runtime and IO using Neural Networks. In *Proceedings of the 47th International Conference on Parallel Processing*, ICPP, Eugene, OR, August 2018. (Acceptance Rate: 99/305, 32.5%).

[5] Ryan McKenna, **Stephen Herbein**, Adam Moody, Todd Gamblin, and Michela Taufer. Machine Learning Predictions of Runtime and IO Traffic on High-end Clusters. In *Proceedings of the IEEE International Conference on Cluster Computing*, CLUSTER, pages 255–258, September 2016. (Acceptance Rate: 57/162, 35%).

[6] **Stephen Herbein**, Dong H. Ahn, Don Lipari, Thomas R.W. Scogland, Marc Stearman, Mark Grondona, Jim Garlick, Becky Springmeyer, and Michela Taufer. Scalable I/O-Aware Job Scheduling for Burst Buffer Enabled HPC Clusters. In *Proceedings of the 25th International Symposium on High-Performance Parallel and Distributed Computing*, HPDC, pages 69–80, Kyoto, Japan, June 2016. (Acceptance Rate: 20/129, 15.5%).

[7] **Stephen Herbein**, Ayush Dusia, Aaron Landwehr, Sean McDaniel, Jose Monsalve, Yang Yang, Seetharami R. Seelam, and Michela Taufer. Resource Management for Running HPC Applications in Container Clouds. In *Proceedings of 31st International Supercomputing Conference*, ISC, pages 261–278, Leipzig, Germany, June 2016. (Acceptance Rate: 25/60, 40%).

[8] Michael Matheny, **Stephen Herbein**, Norbert Podhorszki, Scott Klasky, and Michela Taufer. Using Surrogate-based Modeling to Predict Optimal I/O Parameters of Applications at the Extreme Scale. In *Proceedings of the 20th IEEE International Conference on Parallel and Distributed Systems*, ICPADS, pages 568–575, Dec 2014. (Acceptance Rate: 96/322, 29.8%).

[9] **Stephen Herbein**, Michael Matheny, Matthew Wezowicz, Jaron Krogel, Jeremy Logan, Jeongnim H. Kim, Scott Klasky, and Michela Taufer. Performance Impact of I/O on QMCPack Simulations at the Petascale and Beyond. In *Proceedings of the 16th IEEE International Conference on Computational Science and Engineering*, CSE, pages 92–99, Dec 2013.

[10] Samuel Schlachter, **Stephen Herbein**, Michela Taufer, Shuching Ou, Sandeep Patel, and Jeremy S. Logan. Efficient SDS Simulations on Multi-GPU Nodes of XSEDE High-End Clusters. In *Proceedings of the 9th IEEE International Conference on e-Science*, eScience, pages 116–123, Oct 2013. (Acceptance Rate: 41/98, 41.8%).

Journal Papers

[11] Dong H. Ahn, Ned Bass, Albert Chu, Jim Garlick, Mark Grondona, **Stephen Herbein**, Helgi I. Ingólfsson, Joseph Koning, Tapasya Patki, Thomas R.W. Scogland, Becky Springmeyer, and Michela Taufer. Flux: Overcoming scheduling challenges for exascale workflows. *Future Generation Computer Systems*, 110:202 – 213, 2020.

[12] Robert Searles, **Stephen Herbein**, Travis Johnston, Michela Taufer, and Sunita Chandrasekaran. Creating a Portable, High-Level Graph Analytics Paradigm For Compute and Data-Intensive Applications. *International Journal of High Performance Computing and Networking*, 13:105–118, Jan 2019.

[13] **Stephen Herbein**, Sean McDaniel, Norbert Podhorszki, Jeremy Logan, Scott Klasky, and Michela Taufer. Performance characterization of irregular I/O at the extreme scale. *Parallel Computing*, 51:17 – 36, Jan 2016. Special Issue on Parallel Programming Models and Systems Software for High-End Computing.

[14] Sam Schlachter, **Stephen Herbein**, Shuching Ou, Jeremy S. Logan, Sandeep Patel, and Michela Taufer. Pursuing Coordinated Trajectory Progression and Efficient Resource Utilization of GPU-Enabled Molecular Dynamics Simulations. *IEEE Design Test*, 31(1):40–50, Feb 2014.

Workshop Papers

[15] **Stephen Herbein**, David Domyancic, Paul Minner, Ignacio Laguna, Rafael Ferreira da Silva, and Dong H. Ahn. MCEM: Multi-Level Cooperative Exception Model for HPC Workflows. In *Proceedings of the 9th International Workshop on Runtime and Operating Systems for Supercomputers*, ROSS, Phoenix, AZ, June 2019.

[16] Dong H. Ahn, Ned Bass, Albert Chu, Jim Garlick, Mark Grondona, **Stephen Herbein**, Joseph Koning, Tapasya Patki, Thomas R. W. Scogland, Becky Springmeyer, and Michela Taufer. Flux: Overcoming Scheduling Challenges for Exascale Workflows. In *Proceedings of the 13th Workshop on Workflows in Support of Large-Scale Science*, WORKS, pages 10–19, Dallas, TX, November 2018.

[17] Robert Searles*, **Stephen Herbein***, and Sunita Chandrasekaran. A Portable, High-Level Graph Analytics Framework Targeting Distributed, Heterogeneous Systems. In *Proceedings of the 3rd Workshop on Accelerator Programming Using Directives*, WACCPD, pages 79–88, Salt Lake City, UT, November 2016. *Equal contribution.

[18] **Stephen Herbein**, Scott Klasky, and Michela Taufer. Benchmarking the Performance of Scientific Applications with Irregular I/O at the Extreme Scale. In *Proceedings of the 7th International Workshop on Parallel Programming Models and Systems Software for High-End Computing*, P2S2, pages 292–301, Sept 2014.

Posters & Presentations

[19] **Stephen Herbein**. Flux: Solving Exascale Workflow and Resource Challenges; Plus - How Open-Source Drives Our Project Design. In *Free and Open source Software Developers' European Meeting*, FOSDEM'21, Online, February 7 2021.

Best Poster Candidate

[20] **Stephen Herbein**, Tapasya Patki, Dong H. Ahn, Don Lipari, Tamara Dahlgren, David Domyancic, and Michela Taufer. Fully Hierarchical Scheduling: Paving the Way to Exascale Workloads. In *Proceedings of the 29th ACM/IEEE International Conference for High Performance Computing and Communications*, SC, Denver, CO, November 2017. (Acceptance Rate: 98/169 58.0%).

[21] **Stephen Herbein**. Exploring the Trade-off Space of Hierarchical Scheduling for Very Large HPC Centers. In *Proceedings of the 27th ACM/IEEE International Conference for High Performance Computing and Communications*, SC, Austin, TX, November 2015.

[22] Sean McDaniel, **Stephen Herbein**, and Michela Taufer. A Two-Tiered Approach to I/O Quality of Service in Docker Containers. In *Proceedings of the IEEE International Conference on Cluster Computing*, CLUSTER, pages 490–491, September 2015.

[23] **Stephen Herbein**. Enabling Fine-grained Gathering of Scientific Data in QMCPack Simulations on Titan. In *Proceedings of the 25th ACM/IEEE International Conference for High Performance Computing and Communications*, SC, Denver, CO, November 2013.

[24] Matthew Wezowicz, Michael Matheny, **Stephen Herbein**, Jeremy Logan, Jeognim Kim, Jaron Krogel, Scott Klasky, and Michela Taufer. Predictions of Large-scale QMCPack I/Os on Titan using Skel. In *Proceedings of the 25th ACM/IEEE International Conference for High Performance Computing and Communications*, SC, Denver, CO, November 2013.

Theses

[25] **Stephen Herbein**. *Advanced Schedulers For Next-Generation HPC Systems*. Thesis, University of Delaware, Newark, DE, 2018.

[26] **Stephen Herbein**. *Benchmarking and Auto-tuning I/O Intensive Applications at the Extreme Scale*. Thesis, University of Delaware, Newark, DE, May 2014.

Tutorials

February, 2021 **Using Flux to Overcome Scheduling challenges of Exascale Workflows**,
Exascale Computing Project Annual Meeting.

February, 2020 **Flux: Using Next-Generation Resource Management and Scheduling Infrastructure for Exascale Workflows**,
Exascale Computing Project Annual Meeting.

February, 2019 **Flux: Using Next-Generation Resource Management and Scheduling Infrastructure for Exascale Workflows**,
Exascale Computing Project Annual Meeting.

November, 2018 **Introduction of Practical Approaches to Data Analytics for HPC with Spark**,
International Conference for High Performance Computing, Networking, Storage, and Analysis.

Invited Talks

March, 2019 **Flux: Using Next-Generation Resource Management and Scheduling Infrastructure for Exascale Workflows**,
University of Tennessee, Knoxville.

December, 2015 **Towards Resource QoS In Container Clouds**,
IBM Thomas J. Watson Research Center.
6th Student Workshop on Cloud and Data Services

Professional Services & Activities

Committee Member

2019-2021 Planning Committee: Mobile App - SuperComputing (SC)

2017 Lead Student Volunteer - Information Booth at SuperComputing (SC)

Conference (Sub-)Reviewer

2021 SC, IJHPCA
2020 PASC, HPC Asia, IJHPCA, JPDC
2018 SC, HPDC, PARCO
2017 IPDPS
2016 PARCO, Cluster, COM-HPC, SBAC-PAD
2015 WoC

Other

2012-2016 Student Volunteer at SuperComputing (SC)

Memberships

- Association for Computing Machinery (ACM)
- Institute of Electrical and Electronics Engineers (IEEE)

Skills

Languages Python, C, C++, Rust, Lua, Java
Parallel MPI, Apache Spark, OpenMP, OpenCL, CUDA
Cloud Docker, AWS, Kubernetes
Python pandas, numpy, scikit-learn, matplotlib, sphinx, cffi, cython, pyspark
Web Development PHP, MySQL, HTML, CSS, Javascript, ColdFusion
Dev Tools git, autotools, CMake, (z)sh, svn, Latex

Open-Source Software Projects

flux-core Next-generation resource manager
flux-sched Next-generation batch job scheduler
BREWCOP BREWCOP is a Raspberry pi that Electronically Weighs COffee Pots