Malachi Phillips

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Education

University of Illinois — Champaign, IL
Ph.D. in Computer Science, GPA: 3.93/4.00 — 2018–2023

- Thesis: "Spectral Element Poisson Preconditioners for Heterogeneous Architectures"

University of Oklahoma — Norman, OK
B.S. in Chemical Engineering, GPA: 4.00/4.00 — 2014–2018

- Thesis: "On biomass gasification of surgarcane bagasse and conversion into methanol products"

Experience

Sandia National Laboratories — Albuquerque, NM
Postdoctoral Appointee — Sep 2023–Current

- Speed up multiphysics simulations by 2-3x through automated multiphysics preconditioner construction in Trilinos/Teko
- Improve solve time by incorporating material property information in Green's functions inspired strength-of-connection methods in Trilinos/MueLu
- Implement multiphysics preconditioners for thermal battery simulations using Trilinos/Teko
- Speedup thermal battery simulation linear solve times by a factor of 5
- Port tabular property evaluators for flamelet simulations to utilize GPUs

University of Illinois — Champaign, IL
Graduate Researcher, Dr. Paul Fischer — Fall 2018 –Aug 2023

- Develop nekRS, an integral contribution to the Center of Efficient Exascale Discretizations Project
- Prepare nekRS for Frontier
- Optimize GPU kernels through OCCA
- Speedup code performance by a factor of 3
- Implement several features: novel matrix-free pressure Poisson preconditioners, ALE, AVM, ...

Sandia National Laboratories — Albuquerque, NM
Student Intern — May 2016–Aug 2023

- Port large finite element method multiphysics simulation code to utilize GPUs through Kokkos
- Integrate new solver techniques, such as GCRODR, into code base
- Develop GPU kernel fusion through objected-oriented node fusion in expression graph

University of Oklahoma — Norman, OK
Undergraduate research assistant, computational fluid transport — August 2015 –May 2016

- Perform numerical simulations on transitional and fully-turbulent fluid flow
- Experience writing/debugging F77 code for DNS/Lagrangian scalar tracking

University of Oklahoma — Norman, OK
Undergraduate research assistant, computational chemistry — June 2014 –May 2016

- Design computational experiments to probe stability of amyloid fibrils
- Experience running simulations in popular programs such as GROMACS and AMBER

Publications

[1] **Malachi Phillips** and Paul Fischer. Optimal chebyshev smoothers and one-sided v-cycles. *In review at Numerical Linear Algebra with Applications. Also available as arXiv:2210.03179*, 2024.

[2] Elia Merzari, Steven Hamilton, Thomas Evans, Misun Min, Paul Fischer, Stefan Kerkemeier, Jun Fang, Paul Romano, Yu-Hsiang Lan, **Malachi Phillips**, et al. **(Gordon Bell Prize Finalist Paper)** Exascale multiphysics nuclear reactor simulations for advanced designs. In *Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis*, pages 1–11, 2023.

[3] Tzanio Kolev, Paul Fischer, Ahmad Abdelfattah, Ramesh Balakrishnan, Natalie Beams, Jed Brown, Jean-Sylvain Camier, Hugh Carson, Robert Carson, Noel Chalmers, Matthew Churchfield, Veselin Dobrev, Sebastian Grimberg, Yichen Guo, Stefan Kerkemeier, Yu-Hsiang Lan, Victor A. Mateevitsi, Matthew McCall, Elia Merzari, Misun Min, Ketan Mittal, Will Pazner, **Malachi Phillips**, Finnur Pind, Thilina Ratnayaka, Robert N. Rieben, Kris Rowe, Mark S. Shephard, Cameron W. Smith, Thomas Stitt, Michael Sprague, Amik St-Cyr, Solvi Thrastarson, Ananias Tomboulides, Stanimire Tomov, Vladimir Tomov, Arturo Vargas, Tim Warburton, and Kenneth Weiss. CEED ECP Milestone Report: Document and popularize CEED-developed software and standards, October 2023.

[4] Tzanio Kolev, Paul Fischer, Ahmad Abdelfattah, Zachary Atkins, Adeleke Bankole, Natalie Beams, Jed Brown, Jean-Sylvain Camier, Robert Carson, Noel Chalmers, Veselin Dobrev, John Holmen, Kenneth E Jansen, Stefan Kerkemeier, Yu-Hsiang Lan, Damon McDougall, Elia Merzari, Misun Min, **Malachi Phillips**, Thilina Ratnayaka, Kris Rowe, Mark S. Shephard, Cameron W. Smith, Jeremy L. Thompson, Ananias Tomboulides, Stanimire Tomov, Vladimir Tomov, Umesh Unnikrishnan, Arturo Vargas, Tim Warburton, and James Wright III. CEED ECP Milestone Report: Support ECP applications in their exascale challenge problem runs, April 2023.

[5] **Malachi Phillips**, Stefan Kerkemeier, and Paul Fischer. Tuning spectral element preconditioners for parallel scalability on gpus. In *Proceedings of the 2022 SIAM Conference on Parallel Processing for Scientific Computing*, pages 37–48. SIAM, 2022.

[6] Paul Fischer, Stefan Kerkemeier, Misun Min, Yu-Hsiang Lan, **Malachi Phillips**, Thilina Rathnayake, Elia Merzari, Ananias Tomboulides, Ali Karakus, Noel Chalmers, et al. Nekrs, a gpu-accelerated spectral element navier–stokes solver. *Parallel Computing*, 114:102982, 2022.

[7] Misun Min, Yu-Hsiang Lan, Paul Fischer, Elia Merzari, Stefan Kerkemeier, **Malachi Phillips**, Thilina Rathnayake, April Novak, Derek Gaston, Noel Chalmers, et al. Optimization of full-core reactor simulations on summit. In *2022 SC22: International Conference for High Performance Computing, Networking, Storage and Analysis (SC)*, pages 1067–1077. IEEE Computer Society, 2022.

[8] Tzanio Kolev, Paul Fischer, Ahmad Abdelfattah, Adeleke Bankole, Natalie Beams, Michael Brazell, Jed Brown, Jean-Sylvain Camier, Noel Chalmers, Matthew Churchfield, Veselin Dobrev, Yohann Dudouit, Leila Ghaffari, John Holmen, Stefan Kerkemeier, Yu-Hsiang Lan, Yimin Lin, Damon McDougall, Elia Merzari, Misun Min, Ketan Mittal, Will Pazner, **Malachi Phillips**, Thilina Ratnayaka, Kris Rowe, Mark S. Shephard, Cameron W. Smith, Michael Sprague, Jeremy L. Thompson, Ananias Tomboulides, Stanimire Tomov, Vladimir Tomov, Tim Warburton, and James Wright III. CEED ECP Milestone Report: Improve performance and capabilities of CEED-enabled ECP applications on Frontier/Aurora EA, October 2022.

[9] Tzanio Kolev, Paul Fischer, Ahmad Abdelfattah, Natalie Beams, Jed Brown, Jean-Sylvain Camier, Robert Carson, Noel Chalmers, Veselin Dobrev, Yohann Dudouit, Leila Ghaffari, Aditya Y. Joshi, Stefan Kerkemeier, Yu-Hsiang Lan, Damon McDougall, David Medina, Misun Min, Abhishek Mishra, Will

Pazner, **Malachi Phillips**, Thilina Ratnayaka, Mark S. Shephard, Morteza H. Siboni, Cameron W. Smith, Jeremy L. Thompson, Ananias Tomboulides, Stanimire Tomov, Vladimir Tomov, and Tim Warburton. CEED ECP Milestone Report: High-order algorithmic developments and optimizations for more robust exascale applications, May 2022.

[10] Ahmad Abdelfattah, Valeria Barra, Natalie Beams, Ryan Bleile, Jed Brown, Jean-Sylvain Camier, Robert Carson, Noel Chalmers, Veselin Dobrev, Yohann Dudouit, Paul Fischer, Ali Karakus, Stefan Kerkemeier, Tzanio Kolev, Yu-Hsiang Lan, Elia Merzari, Misun Min, **Malachi Phillips**, Thilina Rathnayake, Robert Rieben, Thomas Stitt, Ananias Tomboulides, Stanimire Tomov, Vladimir Tomov, Arturo Vargas, Tim Warburton, and Kenneth Weiss. Gpu algorithms for efficient exascale discretizations. *Parallel Computing*, 108:102841, 2021.

[11] Tzanio Kolev, Paul Fischer, Natalie Beams, Jed Brown, Jean-Sylvain Camier, Noel Chalmers, Veselin Dobrev, Yohan Dudouit, Stefan Kerkemeier, Yu-Hsiang Lan, Yimin Lin, Neil Lindquist, Damon McDougall, David Medina, Elia Merzari, Misun Min, Scott Moe, Will Pazner, **Malachi Phillips**, Thilina Ratnayaka, Kris Rowe, Mark S. Shephard, Cameron W. Smith, Stanimire Tomov, and Tim Warburton. CEED ECP Milestone Report: Port and optimize the CEED software stack to Aurora / Frontier EA Systems, September 2021.

[12] Elizabeth Koning, **Malachi Phillips**, and Tandy Warnow. ppiacerdc: a new scalable phylogenetic placement method. In *Proceedings of the 12th ACM Conference on Bioinformatics, Computational Biology, and Health Informatics*, pages 1–9, 2021.

[13] Tzanio Kolev, Paul Fischer, Ahmad Abdelfattah, Valeria Barra, Natalie Beams, Jed Brown, Jean-Sylvain Camier, Noel Chalmers, Veselin Dobrev, Stefan Kerkemeier, Yu-Hsiang Lan, Elia Merzari, Misun Min, **Malachi Phillips**, Thilina Ratnayaka, Kris Rowe, Jeremy Thompson, Ananias Tomboulides, Stanimire Tomov, Vladimir Tomov, and Tim Warburton. CEED ECP Milestone Report: Support CEED-enabled ECP applications in their preparation for Aurora/Frontier, October 2020.

[14] Manikanthan Bhavaraju, **Malachi Phillips**, Deborah Bowman, Juan M Aceves-Hernandez, and Ulrich HE Hansmann. Binding of ace-inhibitors to in vitro and patient-derived amyloid-β fibril models. *The Journal of Chemical Physics*, 144(1):015101, 2016.

[15] Erik J Alred, **Malachi Phillips**, Manikanthan Bhavaraju, and Ulrich HE Hansmann. Stability differences in the nmr ensembles of amyloid β fibrils. *Journal of Theoretical and Computational Chemistry*, 15(07):1650059, 2016.

[16] Erik J Alred, **Malachi Phillips**, Workalemahu M Berhanu, and Ulrich HE Hansmann. On the lack of polymorphism in aβ-peptide aggregates derived from patient brains. *Protein Science*, 24(6):923–935, 2015.

Teaching

- **Graduate Teaching Assistant** at University of Illinois — Spring 2020
  Numerical Methods for PDEs (CS555)
- **Graduate Teaching Assistant** at University of Illinois — Fall 2019
  Numerical Analysis (CS450)
- **Graduate Teaching Assistant** at University of Illinois — Spring 2019
  Numerical Analysis (CS450)
  - Nominated for Teaching Assistant Award

Skills

- **Languages:** C++, Python, FORTRAN90
- **Programming Models:** MPI, OpenMP, OCCA, Kokkos, CUDA, HIP
- **Tools:** LaTeX, Git

Projects

- **nekRS**
  Open source Navier Stokes solver based on the spectral element method targeting modern processors and accelerators.
- **Trilinos**
  Open source library for developing algorithms for large-scale, complex multi-physics problems.
- **PETSc**
  Library for the scalable solution of partial differential equations.
- **hypre**
  High performance solver library for large, sparse systems of equations.
- **occa**
  Open source library for programming on heterogeneous architectures.
- **LFAToolkit.jl**
  Open source library for conducting Local Fourier Analysis for high-order finite element discretizations.
- **pplacerDC**
  Scalable phylogenetic placement tool.
- **Sierra Mechanics**
  Sandia's engineering mechanics simulation code suite.

Scholarships and Awards

- Kuck Computational Science and Engineering Scholarship for the 2020-21 academic year.
- Chickasaw Nation Higher Education Scholarship.
- SURGE Fellowship.

Volunteering & Mentoring

- UIUC SIAM student chapter president 2020–2023
  Plan social events, seminars for SIAM student chapter at UIUC.