Marc T. Henry de Frahan

US citizen, Applied Mathematics/Mechanical engineer

marchdf@gmail.com
github.com/marchdf
Google Scholar
marchdf.github.io

Highlighted work in GPU Programming

Programming GPUs since 2011
- Writing CUDA kernels for compressible fluid dynamics, Ph.D. and M.S. thesis
- Implementing performance portable frameworks for exascale (Kokkos, AMReX)
- Developing ECP software for early access to new exascale systems (Frontier, Aurora)

High impact leader for GPU capable software
- More than 1000 contributions annually to open-source for the past 5 years (github.com/marchdf)
- Principal developer of Exascale Computing Project software (Pele, ExaWind)
- Principal investigator of GPU porting projects

Leveraging GPUs for ML/AI
- Developed Deep Learning models for physics-based applications
- Developed Reinforcement Learning methods for control of complex applications

Work Experience

Computational Scientist, National Renewable Energy Laboratory 2019-present
- GPU performance portability for reacting flows and wind turbine physics
- Principal investigator for several projects (*Adaptive Mesh and Algorithm Refinement*, 500k; *Scalable Parallel Discrete Events Simulations*, 550k)
- Principal developer of Exascale Computing Project software (Pele, ExaWind)

Post-doctoral Researcher, National Renewable Energy Laboratory 2016-2019
Next-generation simulations of wind farms and reacting flow processes

Education

Ph.D. in Mechanical Engineering 2011-2016
University of Michigan, Ann Arbor, MI
Thesis: *Numerical simulations of shock and rarefaction waves interacting with interfaces in compressible multiphase flows*
Advisor: E. Johnsen, Assistant Professor of Mechanical Engineering

M.S. in Applied Mathematics Engineering 2009-2011
Université Catholique de Louvain, Belgium
Thesis: *Implementation of a Discontinuous Galerkin Method for hyperbolic PDEs on GPUs*
Advisors: Prof. J-F Remacle, Prof. P. Chatelain, Prof. V. Legat.

B.S. in Applied Mathematics Engineering 2007-2009
Université Catholique de Louvain, Belgium

Leadership and Mentorship Experience

Principal Investigator, Scalable Parallel Discrete Events Simulations, NREL 2023-Present
Develop performance portable GPU parallel discrete events simulations (550k)

Principal Investigator, Adaptive Mesh and Algorithm Refinement, NREL 2021-2023
Develop two-way coupled continuum-atomistic modeling framework (500k)

Acting Group Manager for the High Performance Algorithms and Complex Fluids group, NREL 2020-2021
Group lead for a team of 15+ scientists

Mentoring students and scientists, NREL and University of Michigan 2013-Present
Mentored more than 10 students, post-docs, and junior scientists

Selected Recent Journal Articles on GPU and ML/AI

M. B. Kuhn, M. T. Henry de Frahan, et al., **AMR-Wind: A performance-portable, high-fidelity flow solver for wind farm simulations**, *Wind Energy*, vol. 28, 5, 2025

M. T. Henry de Frahan, et al., **The Pele Simulation Suite for Reacting Flows at Exascale**, *Proc. 2024 SIAM Conf. Parallel Proc. Sc. Comput.*, 15-25, 2024

A. Sharma, ..., M. T. Henry de Frahan, et al., **ExaWind: Open-source CFD for hybrid-RANS/LES geometry-resolved wind turbine simulations in atmospheric flows**, *Wind Energy*, vol 27, 3, 225-257, 2024

L. Esclapez, ..., M. T. Henry de Frahan, et al., **PeleLMeX: an AMR Low Mach Number Reactive Flow Simulation Code without level sub-cycling**, *J. Open Source Software*, 8, 90, 5450, 2023

N. T Wimer, M. T. Henry de Frahan, et al., **Deep reinforcement learning to discover multi-fuel injection strategies for compression ignition engines**, *Int. J. Eng. Res.*, vol 24, 9, 2023

N. Malaya, ..., M. T. Henry de Frahan, et al., **Experiences Readying Applications for Exascale**, *SC23 Proc. Int. Conf. HPC*, 2023

M. T. Henry de Frahan, et al., **PeleC: An adaptive mesh refinement solver for compressible reacting flows**, *Int. J. High. Perf. Comp. App.*, vol. 37, 2, 2022

B. Perry, M. T. Henry de Frahan, et al. **Co-optimized machine-learned manifold models for large eddy simulation of turbulent combustion**, *Comb. and Flame*, 244, 112286, 2022

M. T. Henry de Frahan, et al., **Deep reinforcement learning for dynamic control of fuel injection timing in multi-pulse compression ignition engines**, *Int. J. Eng. Res.*, vol 23, 9, 2021

M. T. Henry de Frahan, et al., **Deep learning for presumed probability density function models**, *Comb. and Flame*, 208:436–450, Pages 436-450, 2019

Recent Awards

President's Team Award, for GPU speedup of ExaWind, NREL 2024
Best Visualization Award for ExaWind at Supercomputing 2023 2023
Chairperson's Team Award for GPU speedup of Pele, NREL 2023
Milton van Dyke Award for Pele visualization, American Physical Society 2022
President's Award for Exceptional Performance, AI/ML development, NREL 2022
Gallery of Fluid Motion Award Winners for Pele Visualization, APS 2020
President's Team Award for AI work on GPUs, NREL 2019

Scientific Programming Skills

C/C++, Python, GPU (CUDA, SYCL, ROCM, Kokkos, AMReX), MPI, OpenMP, OpenACC, Git, Pytorch, Tensorflow, OpenGym