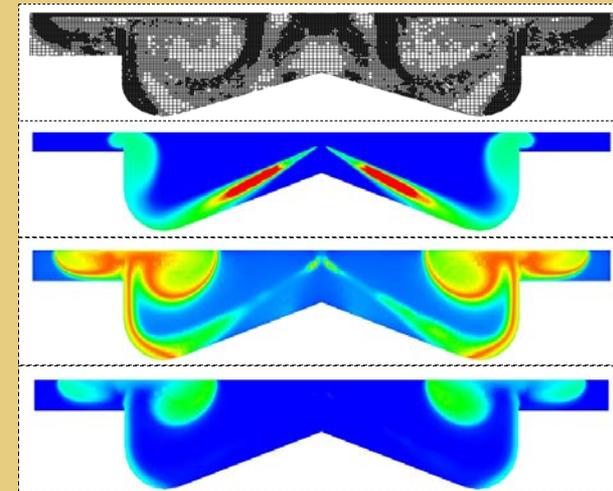
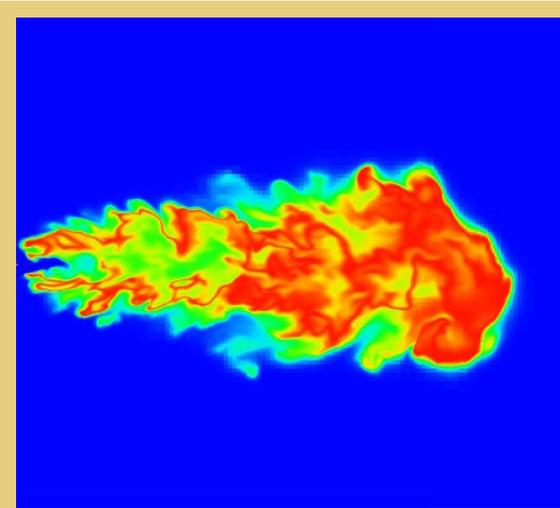


Workshop for High-Performance Computing- Enabled Engine Simulations

Hosted by

The Virtual Engine Research Institute and Fuels Initiative (VERIFI)



Dr. Sibendu Som

Principal Mechanical Engineer - Argonne National Laboratory

Computational Fellow – University of Chicago

Agenda for Nov. 12th

9:15-9:30 am – Welcome to Argonne (Peter Littlewood)

9:30-10:00 am - Keynote: Dr. Lou Balmer-Millar, CAT Inc.

Product Development : Keys for Success

10:00- 10:30 am – Gurpreet Singh, DOE

DOE Perspective - the Need for High Performance Computing in Engine Simulation

10:45-11:00 am – Sibendu Som, Argonne National Laboratory

Workshop Objectives and Mechanics

11:00-11:30 am - John Deur: Director of Combustion Research, Cummins Inc.

High Performance Computing and Combustion System Design at Cummins

11:30-12:00 am - Ron Grover: Senior Research Engineer at GM R&D

Diagnostics and Simulation of Sprays for Automotive Applications

12:00 am-12:30 pm - Jin Yan: Manager, Computational Combustion Lab, GE Global Research Center

LES Modeling of In-cylinder Engine Performance

1:45-2:15 pm - Peter K. Senecal: Vice President and co-owner, Convergent Science Inc.

The Importance of High Performance Computing from a Software Vendor's Perspective

2:15-2:45 pm - Keven Hofstetter: Engineering Technical Steward for Machine Simulation, CAT Inc.

Product Development Excellence through Modeling & Simulation

2:45-3:15 pm - Rishikesh Venugopal: Senior Staff Engineer, Achates Power

Advanced CFD for the Modeling and Optimization of Opposed Piston Combustion Systems

3:15-3:45 pm - Marcus Hermann: Associate Professor, University of Arizona

High Fidelity Simulations of Liquid Fuel Atomization in Internal Combustion Engines and Complex Gas Turbine Injectors

3:45-4:15 pm- Yuri Wright: Senior Researcher, ETH Zurich

Model free flow simulations in engine-like geometries – the role of HPC towards improved understanding of cycle-to-cycle variations



Agenda for Nov. 12th

4:30-5:00 pm - Sibendu Som, Principal Mechanical Engineer, Argonne National Laboratory

HPC Enabling a Paradigm Shift in IC Engine CFD

5:00-5:30 pm – Ray Bair & David Martin, Argonne National Laboratory

Leveraging Argonne Computing Facilities and Expertise for Industry Challenges

5:30-6:00 pm – Doug Longman & Steve Pratt, Argonne National Laboratory

Integrating Fundamental and Applied Combustion Research

6:15-7:00 pm – *Reception (Guest House)*

7:00-8:00 pm – *Dinner (Guest House)*

7:30-8:30 pm – Speaker, Dr. Marius Stan, Sr. Computational Energy Scientist, Argonne National Lab

Science and Cinema

Not all presentations will be available for distribution



Agenda for Nov. 13th

- **9:15 – 11: 45 am: Three tours for everyone**
 - Engine facilities and RCM
 - APS
 - ALCF
- Noon – 1:30 pm – *Lunch (Guest House)*
12:30-1:15 pm: Diane Hart “Working with Argonne”
- **1:30 – 5:30 pm - Two parallel sessions (@ 240)**
 - “Hands-on” (Room 1404/1405)
 - “One-on-One”



Nov. 13th: Tour Descriptions

Engine Facilities and RCM

Argonne's engine testing capability spans from light duty to heavy duty, with engine's ranging in size from 0.5L up to 19L. The facilities are equipped with state-of-the-art instrumentation for in-cylinder visualization, regulated and un-regulated emissions characterization (gaseous and particulate). These experiments generate high-quality data for validation of VERIFI simulations. Argonne is also the only National Lab with a rapid-compression machine for generating very controlled, engine-like conditions for studying fuel ignition and combustion properties.

APS

The Advanced Photon Source (APS) is a user facility at Argonne which produces the brightest x-ray beams in the western hemisphere and is dedicated to multi-disciplinary to advance science. A dedicated hutch at APS allows VERIFI researchers to gain fundamental understanding of fuel injection and spray phenomena (such as cavitation and jet interactions) and aid advanced model developments.

ALCF

The Argonne Leadership Computing Facility is a user facility at Argonne that provides the computational science community with a world-class computing capability dedicated to breakthrough science and engineering. The tour will include a visit to Argonne's 10PetaFlop MIRA super-computer. VERIFI team uses these facilities and collaborates extensively with ALCF scientists to scale-up engine calculations.





Tour Schedule (9:15 to 11:45 am): Nov. 13th

- **Load up the buses and van from 9:00 – 9:15 am at guest house**
- **Bus 1: (Guide: Qingluan Xue)**
 - 9:15 to 9:55: Engine Facilities and RCM
 - 10:10 to 10:50: APS lobby
 - 11:05 to 11:45: ALCF
- **Bus 2 (Guide: Yuanjiang Pei)**
 - 9:15 to 9:55: APS lobby
 - 10:10 to 10:50: ALCF
 - 11:05 to 11:45: Engine Facilities and RCM
- **Van 1 (Guide: Janardhan Kodavasal)**
 - 9:15 to 9:55: ALCF
 - 10:10 to 10:50: Engine facilities and RCM
 - 11:05 to 11:45: APS lobby
- **Buses and van bring back to guests to the guest house for lunch**



Nov. 13th: Parallel Sessions

“Hands-on” Session

VERIFI researchers will guide the participants on how to login to a BlueGene machine and set-up engine simulations. The participants will run simulations on 1000s of processors and realize the benefits of HPC tools for engine simulations. Tips on how to scale up engine problems on massively parallel architecture will be discussed.

You will need to pre-register for participating in this session.

“One-on-One” Session

VERIFI experts will be available for discussions with industry representatives to understand their computing needs and provide guidance on how VERIFI projects could help them design and optimize the next-generation engines and fuels.

You will need to pre-register for participating in this session.



Workshop Objectives

Industry Feedback

- Current state-of-the art in IC Engine CFD for product design
- Need for HPC for their next generation product design

Latest Trends in Academia

- Status of DNS for device simulations

National Laboratories are rich

Identify how Argonne can help

- Engine CFD: Nozzle flow, Spray, combustion, single and multi-cylinder, ...
- Alternate fuels: Fuel surrogate, Fuel cell, ...
- High-fidelity experimental data: Combustion engines, shock tube, rapid prototyping, ...
- Computational resources: for both ...



OPTIMIZE Engine Combustion FAST

Argonne NATIONAL LABORATORY

VERIFI

MIRA
10-Petaflop Supercomputer

The First and Only Source in the World for

- High-fidelity • Three-dimensional • End-to-end
- Combustion engine simulation/visualization
- Simultaneous powertrain and fuel simulation and
- Uncertainty quantification!

The image is a promotional graphic for the VERIFI project at Argonne National Laboratory. It features a central image of an internal combustion engine with glowing orange and yellow flames. The word 'VERIFI' is written in large, white, bold letters across the engine. Above the engine, the text 'OPTIMIZE Engine Combustion FAST' is displayed. In the top right corner, the Argonne National Laboratory logo is visible. To the right of the engine, there is a circular inset showing a server rack with the word 'MIRA' and '10-Petaflop Supercomputer' written below it. At the bottom, a list of capabilities is provided, including high-fidelity, three-dimensional, end-to-end combustion engine simulation/visualization, simultaneous powertrain and fuel simulation, and uncertainty quantification.



HPC is enabler for Simulation based Engine Design

Use of High-spatial and temporal resolution

Robust turbulence models

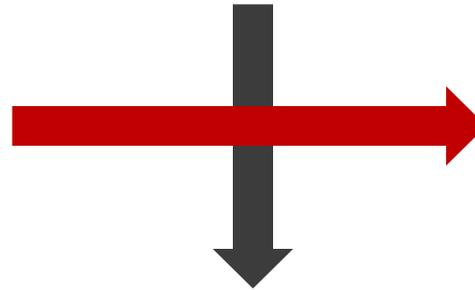
Use of detailed chemistry based combustion models

Solving “one-of-a-kind” problem

Cluster



Super-Computer



Benefits

Unprecedented insights into the combustion process

Grid-convergent results

Increased predictive capability

Modify “best practices” in industry

DOE Engine Simulation Roadmap Workshop - August 18, 2014

Organizers: Leo Breton & Gurpreet Singh



Special Thanks to the Workshop Sponsors





Thanks to all the VERIFI Organizers

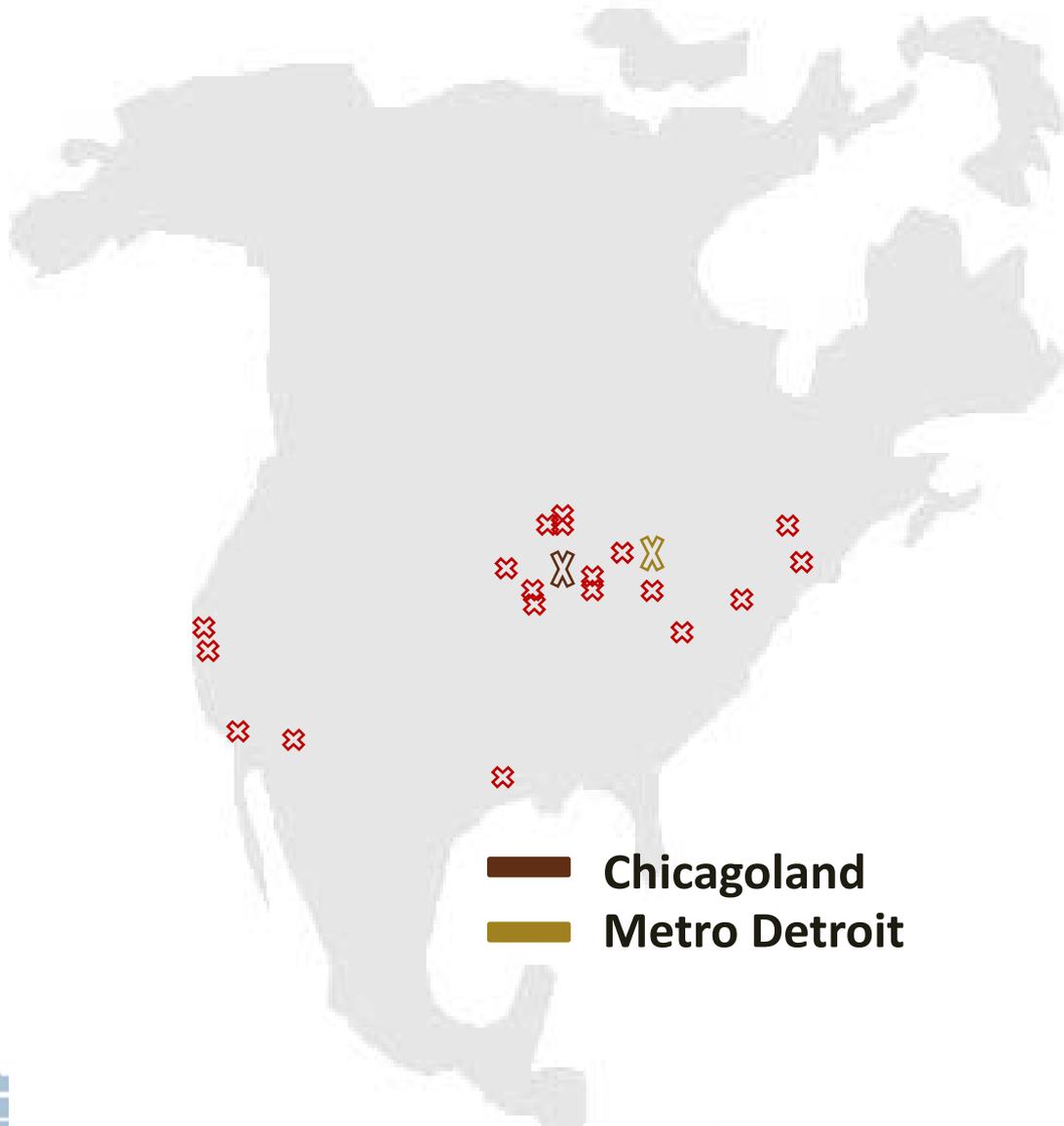


Thanks to All the Participants

- ✓ 80 participants
- ✓ 30 industries represented
- ✓ 37 total institutions represented

International Participants

- Italy
- Switzerland
- Japan
- China
- Greece
- Finland



Chicagoland
Metro Detroit



Acknowledgements

Sponsors: U.S. Department of Energy, Office of Vehicle Technology under the management of Gurpreet Singh, Leo Breton, Kevin Stork

