LLNL-PRES-727938

HPC4Mfg: Advancing Innovation in US Industry

HPC4Mfg Industry Engagement Day

Lori Diachin, HPC4Mfg Director

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

ADVANCED MANUFACTURING OFFICE

The HPC4Mfg program is designed to bring the many benefits of high-performance computing benefits brings many benefits to US Industry

- Accelerate innovation
- Lower energy costs
- Reduce testing cycles
- Reduce waste/reduce rejected parts
- Quality processes and Pre-qualify
- Optimize design
- Shorten the time to market

The HPC4Mfg program lowers the barriers to bringing the power of HPC to the manufacturing community at low risk

- **Industry Status**:
  - Some larger companies use HPC, but struggle to stay current
  - Few small to medium companies use HPC
- **DOE Status**:
  - DOE labs possess 5 of the top 10 HPC systems worldwide; 2 of top 4 in Graph500
  - Broad expertise in the application HPC
  - Can be a challenge for industry to understand the best way to partner with DOE

HPC4Mfg creates partnerships that leverage DOE lab expertise and compute resources to address critical problems in the manufacturing sector

The ideas behind HPC4Mfg were demonstrated in the "HPC for Energy" program at LLNL

- Council on Competitiveness conducted a study on advancing US Manufacturing
- LLNL utilized internal investment in 2011 to demonstrate how HPC can benefit the manufacturing industry
  - Defined best practices, such as developing the scope of work, effective interaction mechanism, CRADA and IP terms
  - Six pilot projects, six months in duration

DOE's Advanced Manufacturing Office asked LLNL to stand up HPC4Mfg based on these results

http://hpc4energy.org

The HPC4Mfg program is building an ecosystem to support HPC adoption by industry

- Showing what is possible with HPC through demonstration projects
  - AMO funds < $300k to laboratories
  - Industry funds at least 20% in-kind support w/ optional cash contribution
  - Project duration < 1 year
- Encouraging the adoption of HPC through capability projects
  - Execution mechanisms and funding source varies
  - Project duration: multiple year
- Building the HPC Manufacturing community
  - Industry Engagement Day
  - Student intern programs

Lori Diachin,
Director
HPC4Mfg

The HPC4Mfg Program has now reached steady state

March–September 2015

Launch Program

- LLNL established the program
- $1.5M
- 5 seedlings funded
- Industry outreach

September 2015–March 2016

Fall 2015 solicitation

- LBNL, ORNL join as partner labs
- $3M solicitation demonstration projects
  - 44 concept papers
  - 18 requests for full proposals
  - 9 projects funded

March 2016 –September 2016

Spring 2016 solicitation

- $3.3M solicitation
- VTO project funded at ORNL
  - 41 concept papers
  - 19 requests for full proposals
  - 13 projects approved

September 2016 – March 2017

Fall 2016 solicitation

- $3M solicitation
- Adding participating labs
  - 39 concept papers
  - 19 requests for full proposals

- *Semi-annual solicitations*
- *Compute resources from across the DOE complex*
- *Student internship programs*

Our unique approach to building teams helps ensure each project's success

HPC4 MANUFACTURING

FEDBIZOPPS.GOV Federal Business Opportunities

Engage industry

Industry submits challenges

Match challenge to PI

AMO approval; Feedback to industry

Sign agreements

Inform industry

Concept paper → **Full proposal** → **Award**

Technical Review Committee

Technical Merit Review Committee

- Partner labs and AMO representatives
- Heavy focus on **nation-wide** impact to energy efficiency and clean energy technology industry-wide

Execution streamlined through the required use of the DOE short form

A "one stop shop" for industry to engage the national lab's HPC expertise

Lawrence Livermore National Laboratory

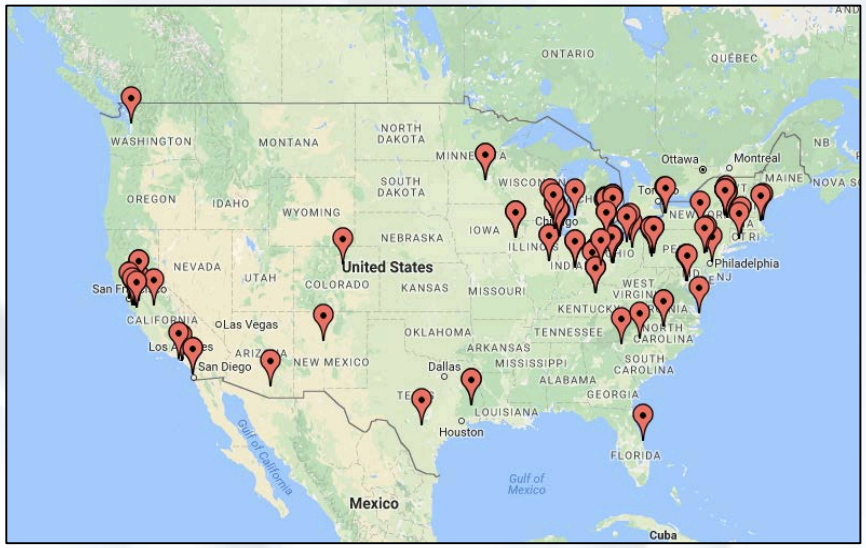
The program supports a diverse array of industrial partners and projects

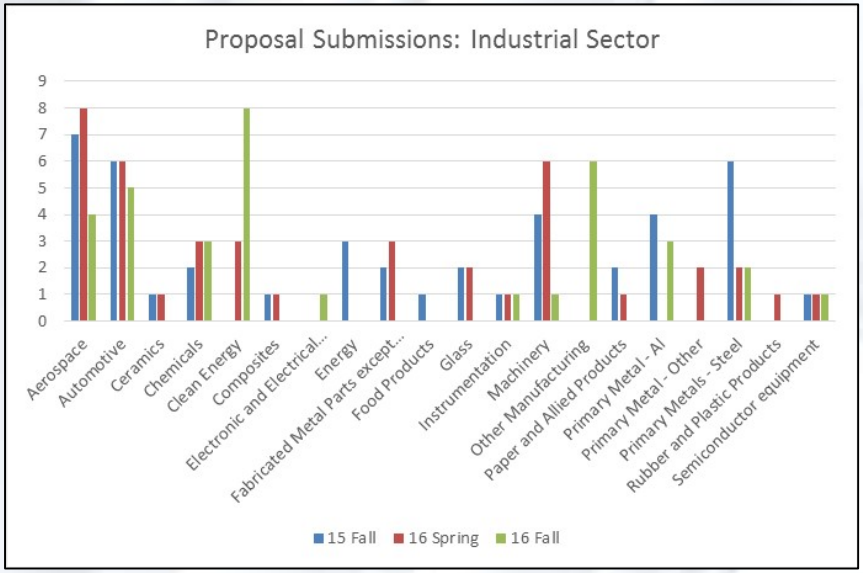
- $8.7M technical portfolio
  - Executing on 28 projects with 23 industry partners and 3 labs
  - 27 demonstration; 1 capability
  - Harper carbon fiber project funded by Office of Transportation

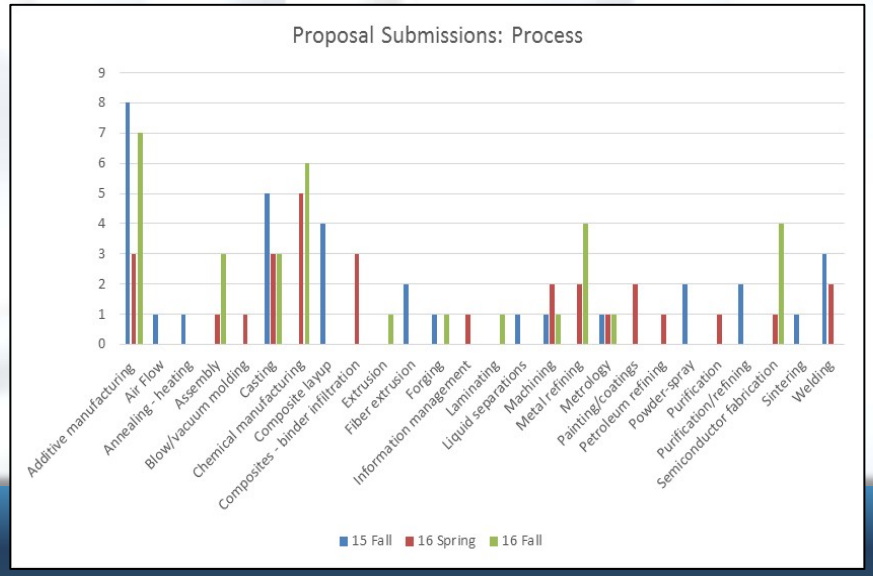
- Fall 2016 Solicitation recently concluded
  - Included 3 non-partner labs in full proposal submissions
  - Other DOE offices informally involved
  - Awards announced shortly

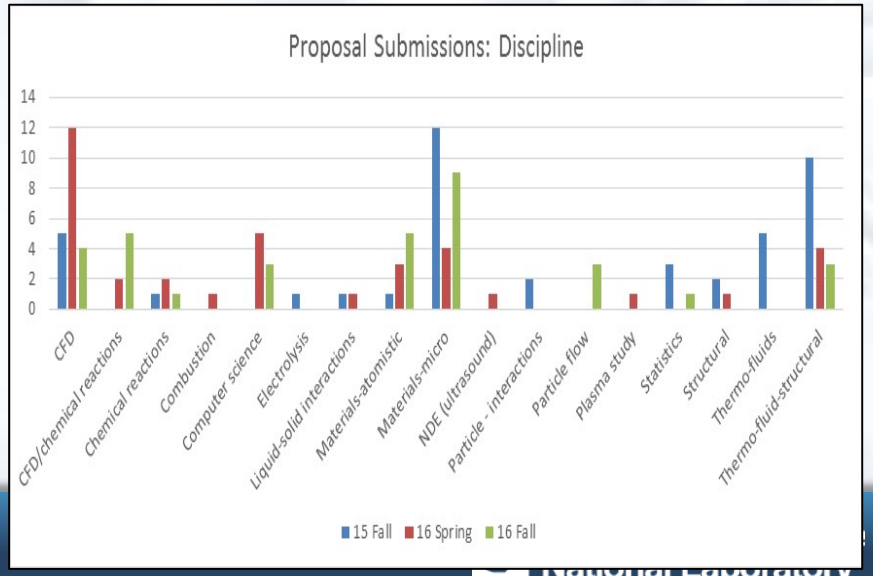
- **Key benefit** is a direct link to SMEs at each lab—knowledgeable POCs who direct companies to the right group and guide the statement of work.

The concept paper participation has been diverse in both geographic location and topic





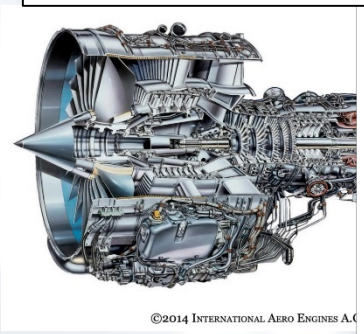


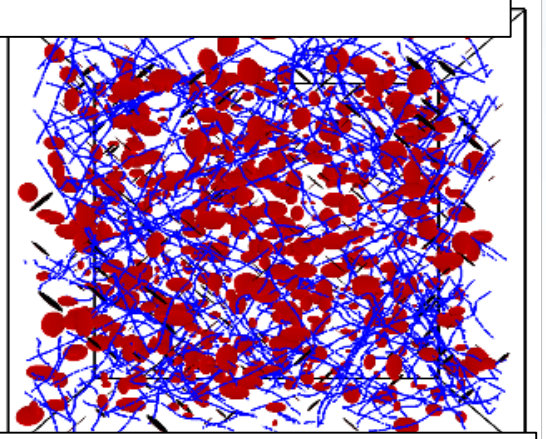


HPC4Mfg is extending our scientific knowledge in different industrial sectors.

Creating new lightweight alloys

Goal: Predict the strength of lightweight aluminum-lithium alloys produced under different process conditions; could save millions of fuel costs if used in aircraft design



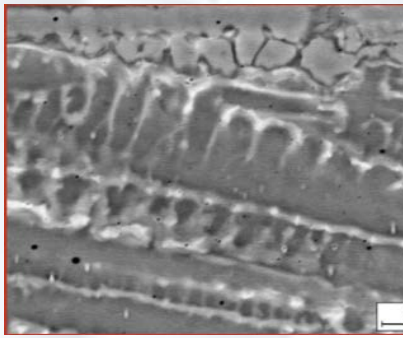


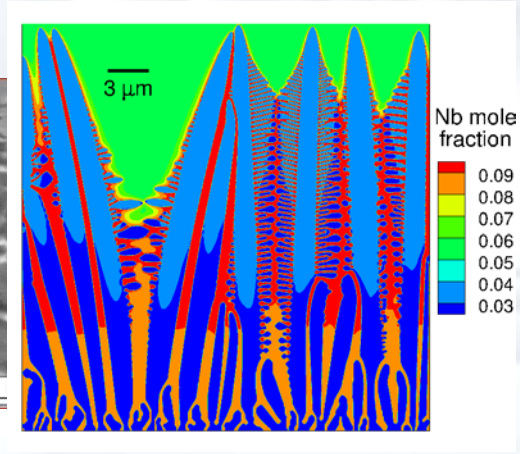
Results to date: Developed new dislocation mobility laws for Al-Li alloys; examining influence of different precipitate density; predicting yield strength for differing particle sizes

Team: LIFT with LLNL and Univ Mich.

Dendritic Growth in AM Parts

Goal: Use HPC to model multi-scale morphology of solidification microstructure of Nickel base 718





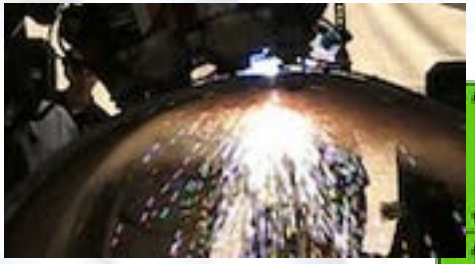
Results to date: Predicting crystal growth over large domains from multi-component alloys using phase field approaches; moving to new alloy systems and 3D

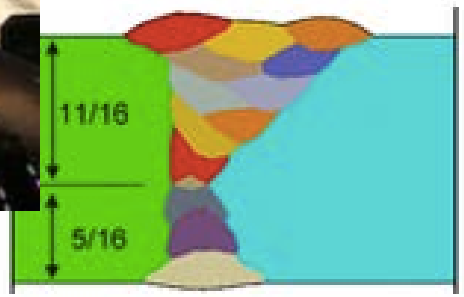
Team: UTRC with ORNL/LLNL

HPC4Mfg improving industrial workflows and speeding up modeling time using HPC

Weld Predictor Tool

Goal: Develop an improved online welding software modeling application using advanced 3D models, more material hardening laws, and open source parallel codes





Images courtesy of EWI

Results to date: Developed new front end interface and automated meshing tools; working on new parallel simulation tools for thermal analysis, microstructure prediction, and mechanical analysis

Team: Edison Welding Institute with ORNL/OSU

Paper Towel Design

Goal: Use HPC to evaluate different microfiber configurations to optimize drying time while maintaining user experience

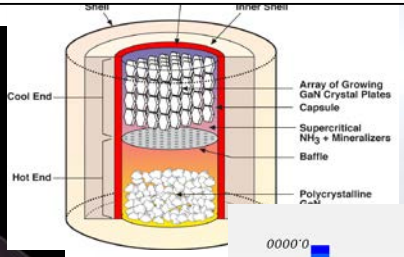
Results to date: New mesh tool reduces product design cycle by 2X cycle; additional cores by another 8X; largest non benchmark run of Paradyn code at LLNL

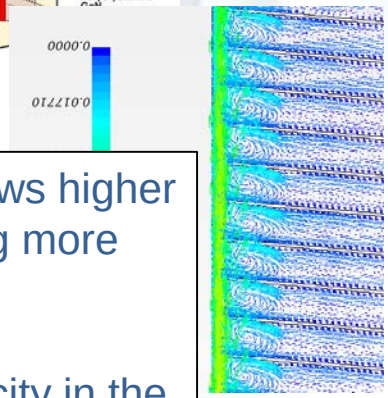
Team: Procter and Gamble with LLNL

HPC4Mfg is leading to significant energy savings in new products or processes

More efficient LED lightbulb

Goal: Model ammono-thermal crystal growth of GaN to scale up the process; reduce production costs of LED lighting by 20%



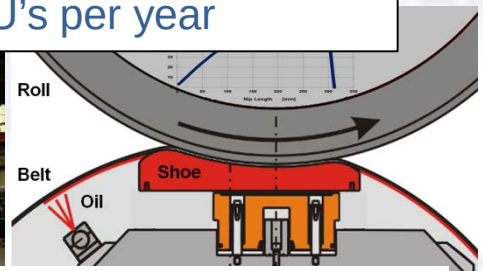


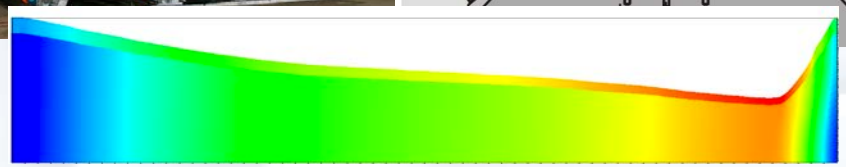
Results to date: HPC allows higher fidelity simulations showing more complicated flow structure, improved predictions of temperature and flow velocity in the reactor; now optimizing uniform growth of crystals

Team: SORAA with LLNL

Energy savings in paper making

Goal: Use multi-physics models to reduce paper rewetting in the pressing process; reduce 3rd most intense energy consumer in paper making; save 80 trillion BTU's per year

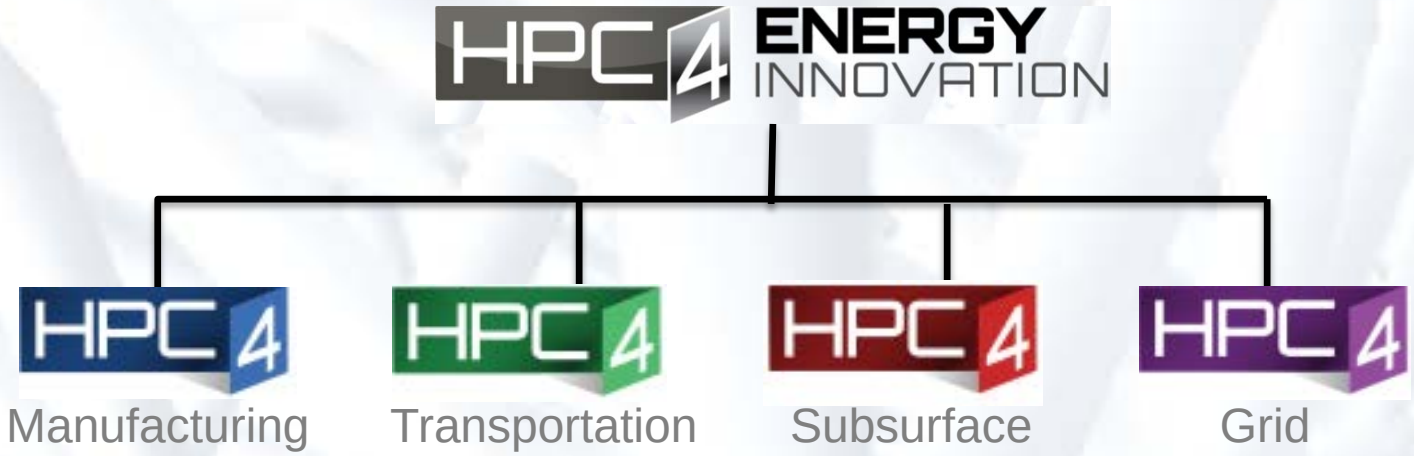




Results to date: Using both continuum and pore-scale approaches to determine how water flows through porous paper pulp; simulations can be used to optimize drying

Team: Agenda2020 with LBNL/LLNL

The HPC4Mfg Program was designed to be scaled to other focus areas



AMO sponsor, working with Jeff Roberts and others, is planning a significant increase and expansion in next 4 years

HPC4 MANUFACTURING

Industry Engagement Day

March 2-3, 2017

Lawrence Livermore National Laboratory | Berkeley Lab | Oak Ridge National Laboratory | U.S. Department of Energy Energy Efficiency & Renewable Energy Advanced Manufacturing Office | U.S. Department of Energy Office of Science

Information at HPC4Mfg.org

Questions to HPC4Mfg@llnl.gov

Questions?

Additional information at HPC4Mfg.org

Questions can be sent to HPC4Mfg@llnl.gov

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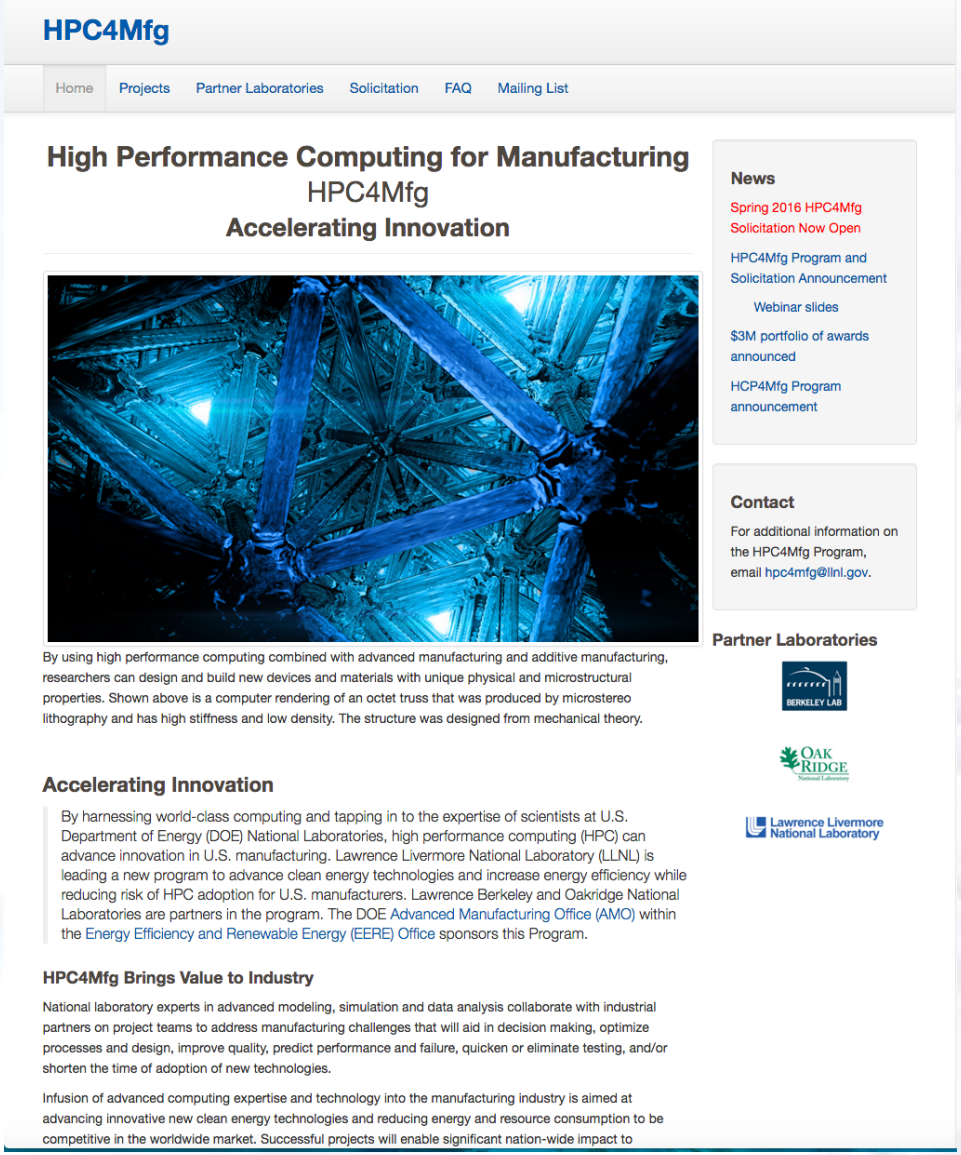

HPC4Mfg

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High Performance Computing for Manufacturing
HPC4Mfg
Accelerating Innovation

By using high performance computing combined with advanced manufacturing and additive manufacturing, researchers can design and build new devices and materials with unique physical and microstructural properties. Shown above is a computer rendering of an octet truss that was produced by microstereo lithography and has high stiffness and low density. The structure was designed from mechanical theory.

Accelerating Innovation

By harnessing world-class computing and tapping in to the expertise of scientists at U.S. Department of Energy (DOE) National Laboratories, high performance computing (HPC) can advance innovation in U.S. manufacturing. Lawrence Livermore National Laboratory (LLNL) is leading a new program to advance clean energy technologies and increase energy efficiency while reducing risk of HPC adoption for U.S. manufacturers. Lawrence Berkeley and Oakridge National Laboratories are partners in the program. The DOE Advanced Manufacturing Office (AMO) within the Energy Efficiency and Renewable Energy (EERE) Office sponsors this Program.

HPC4Mfg Brings Value to Industry

National laboratory experts in advanced modeling, simulation and data analysis collaborate with industrial partners on project teams to address manufacturing challenges that will aid in decision making, optimize processes and design, improve quality, predict performance and failure, quicken or eliminate testing, and/or shorten the time of adoption of new technologies.

Infusion of advanced computing expertise and technology into the manufacturing industry is aimed at advancing innovative new clean energy technologies and reducing energy and resource consumption to be competitive in the worldwide market. Successful projects will enable significant nation-wide impact to

News

Spring 2016 HPC4Mfg Solicitation Now Open

HPC4Mfg Program and Solicitation Announcement

Webinar slides

$3M portfolio of awards announced

HCP4Mfg Program announcement

Contact

For additional information on the HPC4Mfg Program, email hpc4mfg@llnl.gov.

Partner Laboratories

BERKELEY LAB

OAK RIDGE National Laboratory

Lawrence Livermore National Laboratory

Lawrence Livermore
National Laboratory