

HPC & Manufacturing

A partly-research focused view from NIST

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NIST | ITL | Software & Systems | Information Systems Group, Leader

CHIPS Act

NIST Search NIST Menu

CHIPS.GOV [CHIPS: Investments in innovation, resilience, and a more competitive American future]

CHIPS for AMERICA

- A Message from the Secretary of Commerce
- Funding Opportunities +
- Research and Development Programs +
- National Security
- Workforce Development
- News & Releases
- Webinars & Events
- Current CHIPS Job Openings
- Implementation Strategies

NOFO NEW! A funding opportunity for the semiconductor supply chain

NOFO Learn more about incentives for commercial fabrication facilities

Find a potential partner with this teaming list

The next Industrial Advisory Committee meeting is Nov.

chips.gov

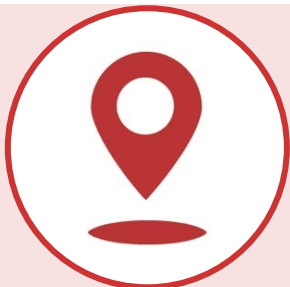
▶ Office of Advanced Manufacturing (OAM)



Manufacturing USA Program: to convene and support a network of institutes with interagency partners



National Program Office at NIST: to oversee and carry out the Program and support the NSTC Subcommittee on Advanced Manufacturing (SAM)



Funding Opportunities: Advanced Manufacturing Technology Roadmaps, new Manufacturing USA institute competitions, public service awards

- **CHIPS & Science Act:** up to 3 semiconductor institutes

About Manufacturing USA

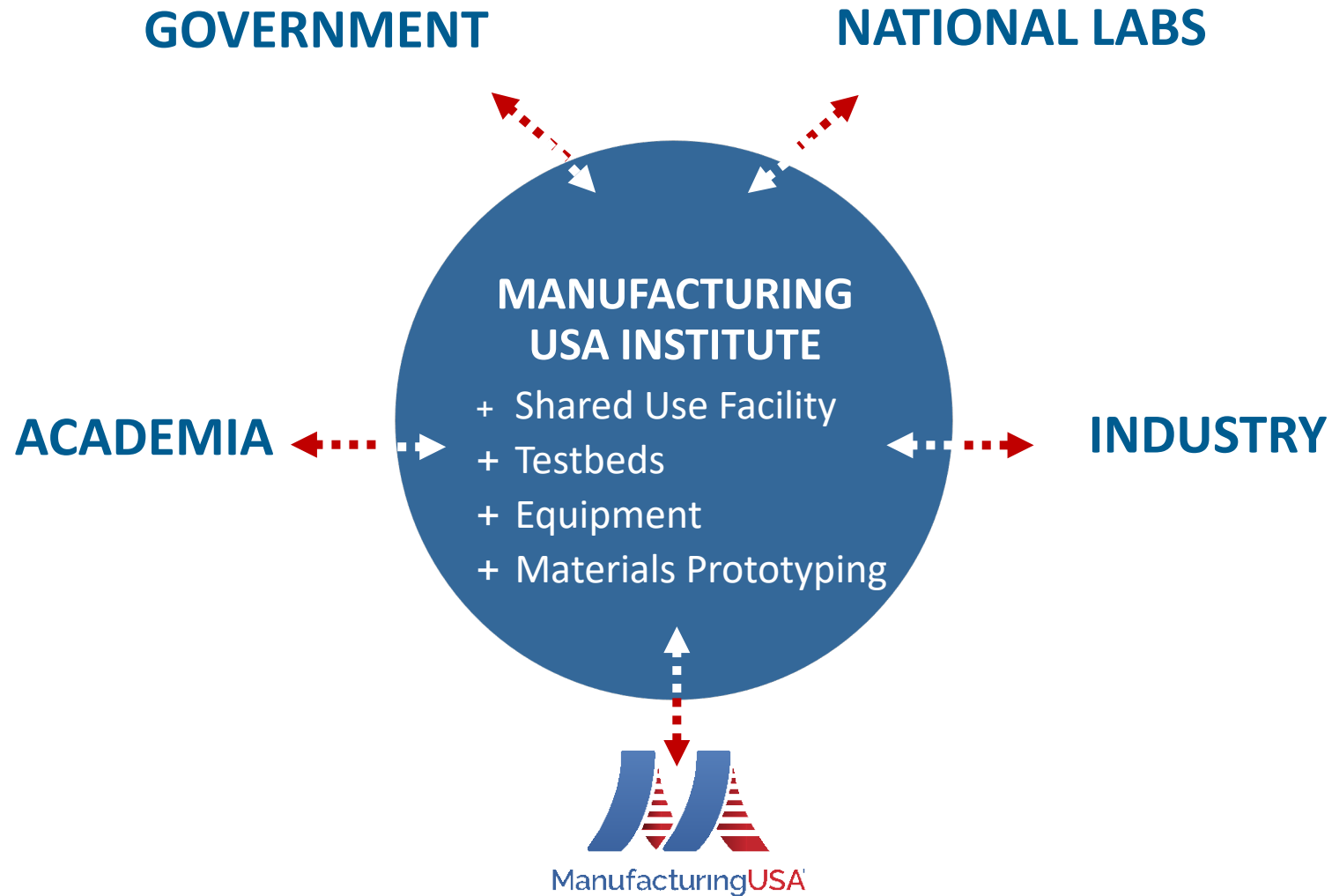
VISION: Securing U.S. Global Leadership in Advanced Manufacturing

MISSION: Connecting people, ideas, and technology to:

- solve industry-relevant advanced manufacturing challenges
- enhance industrial competitiveness and economic growth
- strengthen our national security



Institutes Enable Large-Scale Collaboration



Common Institute Functions:

- + Industry-led consortia
- + Neutral collaboration space
- + Technology development
- + Workforce development
- + Public-private partnership

▶ Manufacturing USA Network

ELECTRONICS



Integrated Photonics
Albany, NY
Rochester, NY



Flexible Hybrid
Electronics
San Jose, CA



Wide Bandgap Semiconductors
Raleigh, NC

MATERIALS



Advanced Fibers and
Textiles
Cambridge, MA



Advanced Composites
Knoxville, TN
Detroit, MI



Lightweight Materials
Detroit, MI

ENERGY/ ENVIRONMENT



Modular Chemical
Process Intensification
New York, NY



Sustainable
Manufacturing
Rochester, NY



Smart Manufacturing
Los Angeles, CA



Industrial Process
Decarbonization
Phoenix, AZ

DIGITAL/ AUTOMATION



Additive Manufacturing
Youngstown, OH
El Paso, TX



Advanced
Robotics & AI
Pittsburgh, PA



Digital
Manufacturing &
Cybersecurity
Chicago, IL



Cybersecurity in
Manufacturing
San Antonio, TX

BIO- MANUFACTURING



Regenerative
Manufacturing
Manchester, NH



Biopharmaceutical
Manufacturing
Newark, DE



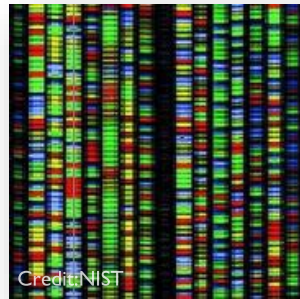
Bioindustrial
Manufacturing
St. Paul, MN

NIST Hollings Manufacturing Extension Partnership (MEP)

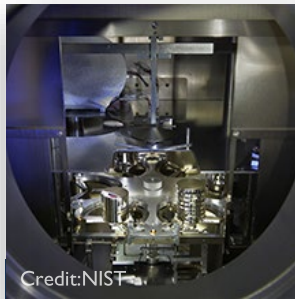
- ▶ MEP National Network
 - ▶ Local & State Manufacturing Institutes
- ▶ <https://www.nist.gov/mep>
- ▶ Supplier Scouting
- ▶ Finding & Retaining Talent
- ▶ Etc.

The screenshot shows the NIST Manufacturing Extension Partnership (MEP) website. At the top, there is a navigation bar with the NIST logo, a search bar, and a menu icon. Below the navigation bar is a blue header section with the text "MANUFACTURING EXTENSION PARTNERSHIP (MEP)" and a quote: "MEP is a public-private partnership with Centers in all 50 states and Puerto Rico dedicated to serving small and medium-sized manufacturers. Last year, MEP Centers interacted with more than 33,500 manufacturers, leading to \$18.8 billion in sales, \$2.5 billion in cost savings, \$6.4 billion in new client investments, and helped create or retain more than 116,700 jobs." Below the header is a grid of six blue tiles with white text and images, each representing a different aspect of the MEP program: "HOW THE NETWORK HELPS MANUFACTURERS", "CONNECT WITH YOUR LOCAL MEP CENTER", "SUPPLIER SCOUTING", "THE MANUFACTURERS' GUIDE TO FINDING AND RETAINING TALENT", "EXECUTIVE ORDER ON ENSURING THE FUTURE IS MADE IN ALL OF AMERICA BY ALL OF AMERICA'S WORKERS", and "MEP NATIONAL NETWORK WORKFORCE PROGRAMS, SERVICES AND TRAININGS". Below the grid is a section titled "MANUFACTURING VIDEOS: REAL STORIES, REAL RESULTS" with a paragraph of text and a link to "Watch More Videos". On the left side of the page, there is a vertical list of menu items with plus signs next to them: "ABOUT NIST MEP", "MEP NATIONAL NETWORK", "EXECUTIVE ORDER 14005", "SUPPLIER SCOUTING", "CYBERSECURITY RESOURCES FOR MANUFACTURERS", "MATTR", "MATTR+", "MANUFACTURING INFOGRAPHICS", "MANUFACTURING REPORTS", "MANUFACTURING DAY", and "MANUFACTURING".

NIST Laboratory Programs



**Material
Measurement
Laboratory**



**Physical
Measurement
Laboratory**



**Engineering
Laboratory**



**Information
Technology
Laboratory**



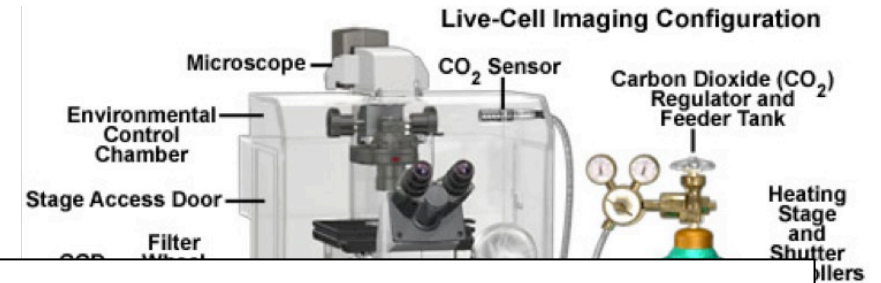
**Communication
Technology
Laboratory**



**NIST
Center for
Neutron
Research**

Life Sciences Instruments

- ▶ High end microscopes
 - ▶ Reaches \$350 K!
 - ▶ Nikon Live Cell Imaging station ([URL](#))
- ▶ CT scan machine
 - ▶ Reaches \$1M!
- ▶ Supercomputer inside
 - ▶ Prediction being realized
 - ▶ 5–10 % of cost



Computationally-enabled instruments

1. Sensor:
 - Acquire signal
2. Computing:
 - Extract measurement



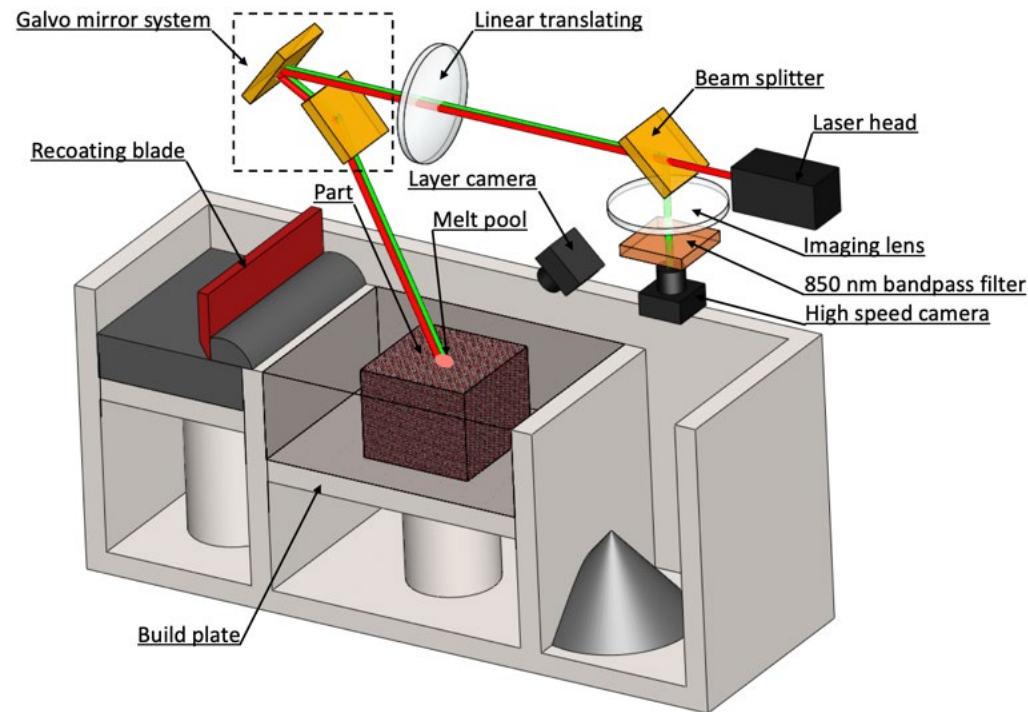
mind.ilstu.edu/dev/animations/ct_scan/ct_scan_machines.html

Additive Manufacturing

- ▶ Activities in multiple labs
 - ▶ Engineering Laboratory (EL)
 - ▶ Materials Measurement Laboratory
 - ▶ Physical Measurement Laboratory
 - ▶ Contact: EL's Yan Lu (yan.lu@nist.gov)
- ▶ Research collaboration with EL
 - ▶ Real-Time Processing
 - ▶ UMD's Prof. S. Bhattacharyya + students
 - ▶ Image Analytics
 - ▶ Material Point Methods
 - ▶ Utah's Prof. M. Berzins & Sree Kadiyala

The screenshot displays two video thumbnails and a section titled 'The Research'. The left video thumbnail is titled 'Measurement Science for Additive Manufacturing' and features Shawn Moylan, Program Manager, Group Leader, Production Systems Group, Intelligent Systems Division, Engineering Laboratory, National Institute of Standards and Technology. The right video thumbnail is titled 'Additive Manufacturing of Metals – MML Overview' and features Lyle Levine, Additive Manufacturing Center, Project Lead, Additive Manufacturing Benchmark Series, Founder & Lead, Material Measurement Laboratory (MML). Below the thumbnails, the 'The Research' section includes a 'PROJECTS & PROGRAMS' list with 'Advanced Materials Design: Structural Applications' (ONGOING) and 'Additive Manufacturing Fatigue and Fracture'. An 'ADDITIONAL RESOURCES LINKS' list includes 'AM Materials Database', 'AM Test Artifact', and 'Tool and Instruments'. A play button icon is visible in the bottom right corner of the screenshot.

Additive Manufacturing Metrology Testbed (AMMT)



[Yang et al, 2019]

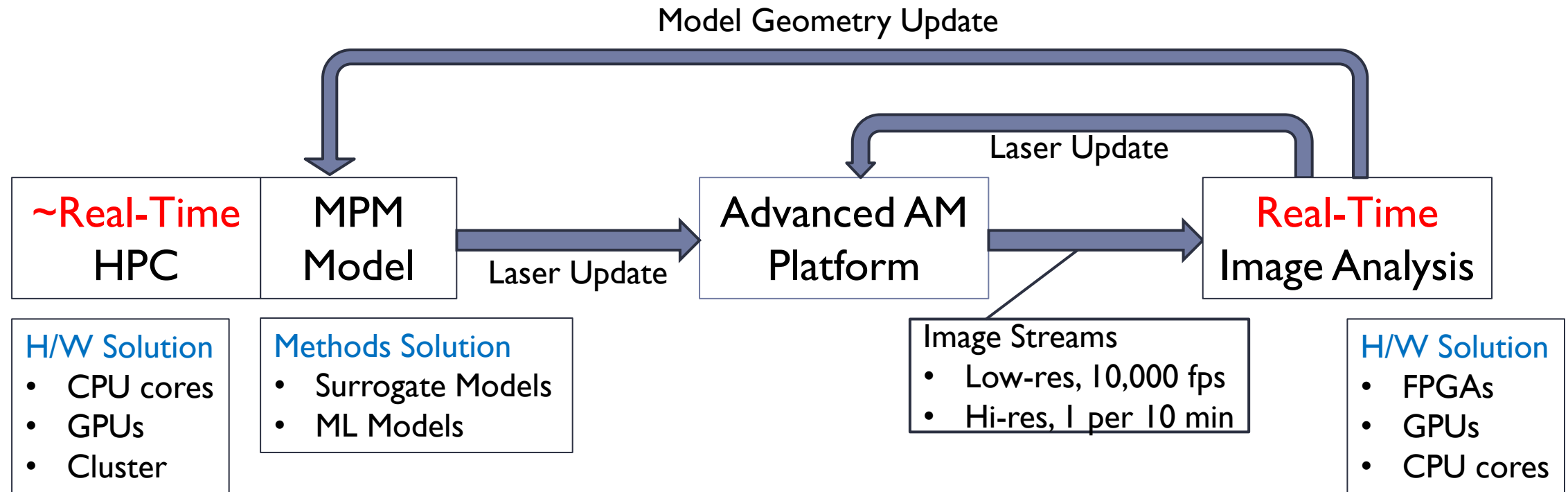
► Problems

- Unevenly spread powder leads to ridges and valleys.
- Melt pool sparks leads to divots and depositing material in other locations.

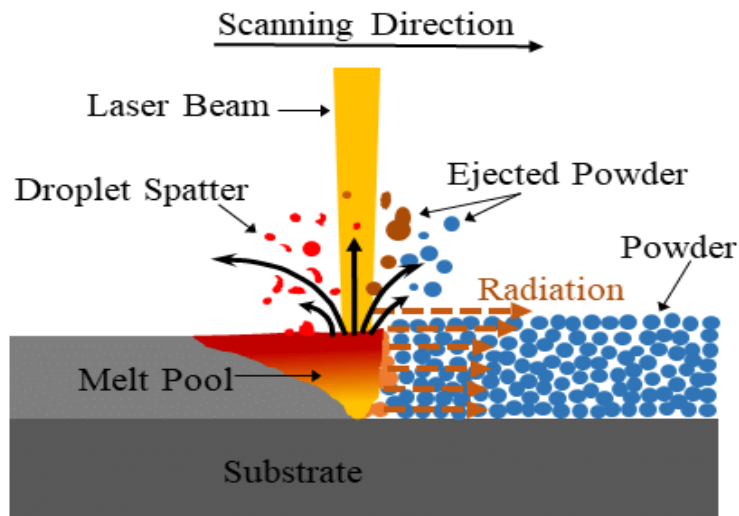
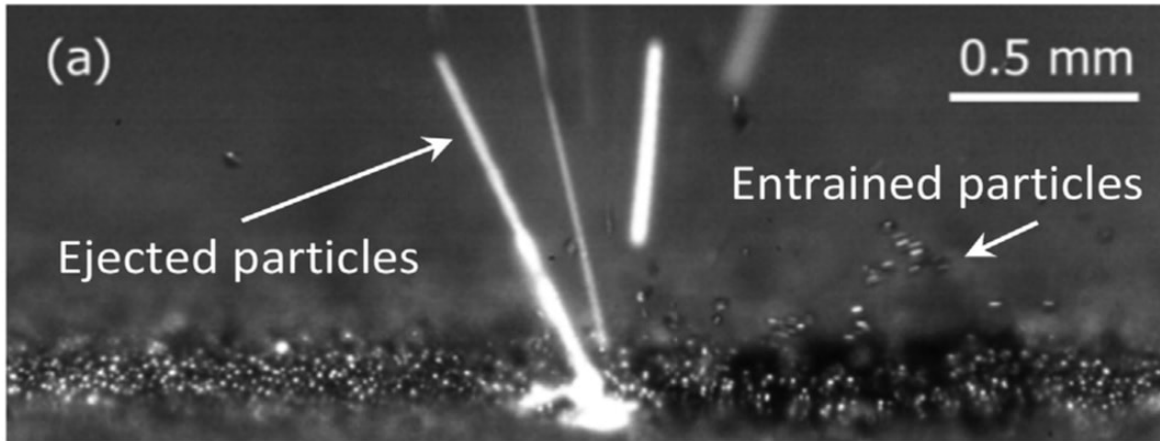
► Solution

- Detect defects with CT scan after manufacturing
 - Requires waiting for part to be complete
- Detect defects during manufacture
 - Abort, fix by remelting, or avoid by adjusting laser power or respreading

Additive Manufacturing + HPC



Laser Sintering — Keyholing and Spatter



- ▶ Keyhole fluctuations and underlying physics (growth, shrinkage, collapse, etc.) are not fully understood.
- ▶ Combine mathematical models, surrogate models, and real-world experimental data to gain insights into the physics of keyholing and defect formation.

DOI: [10.1016/j.actamat.2017.09.051](https://doi.org/10.1016/j.actamat.2017.09.051)

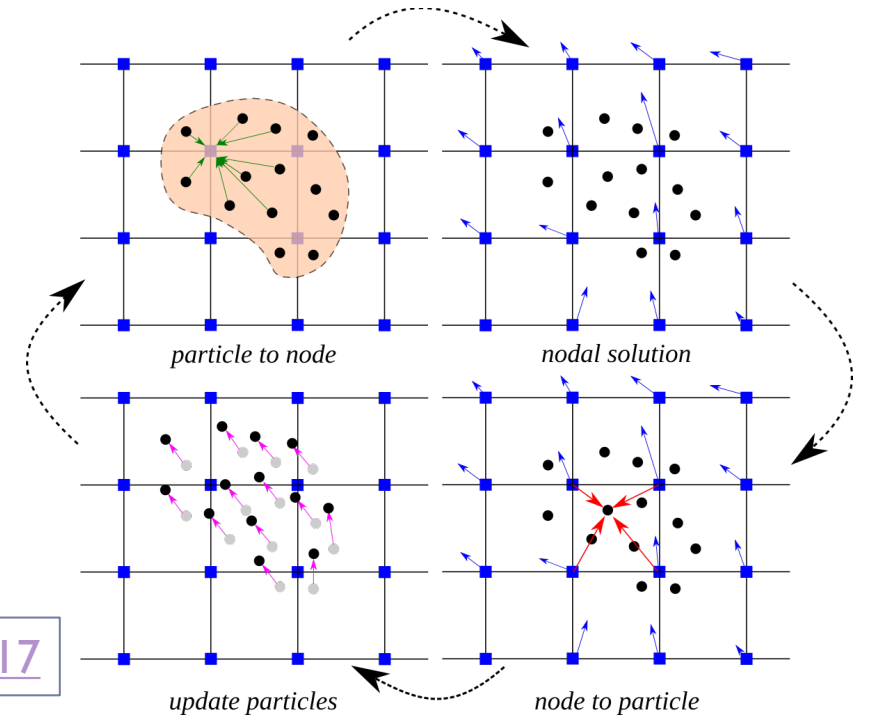
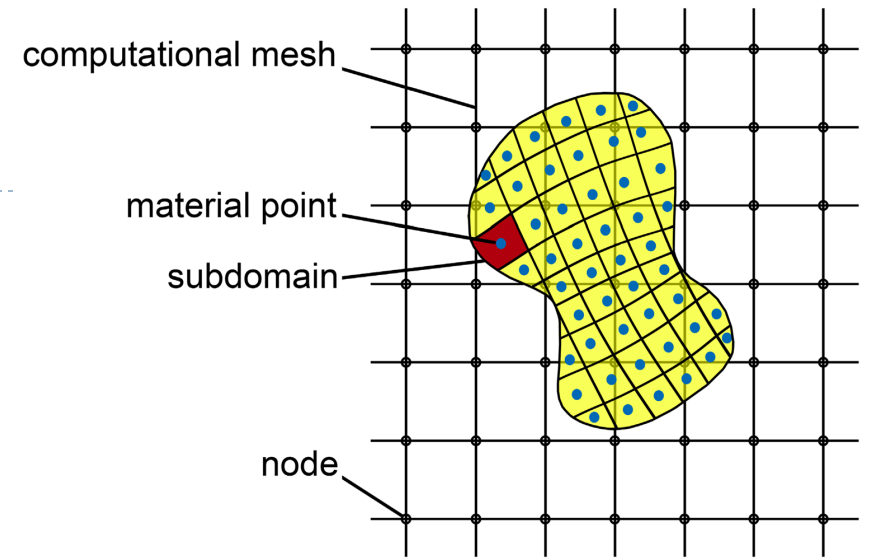
Material Point Method + HPC

▶ Material Point Method

- ▶ Discretized by Lagrangian particles over fixed Eulerian background grid.
- ▶ Robust for multi-phase interactions.
- ▶ Computationally expensive.

▶ Solution

- ▶ Highly optimized GPU MPM code
- ▶ Use Hedgehog + cluster to simulate complex multi-physics phenomena (melt pool behavior).



DOI: [10.3390/w12102817](https://doi.org/10.3390/w12102817)