March 1, 2016

An Overview of HEMI, and How to Join It

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What is an Institute?

- An Institute exists across multiple divisions of the University, and is structured accordingly.
- An Institute may incorporate multiple Centers.
- Our version of this:
  - An Institute provides an intellectual focus.
  - A Center provides a research focus.
  - A Department provides an academic focus.

What is an Institute II

- Institutes are organizational constructs that provide an intellectual focus and are designed to enhance

  (a) collaboration among faculty

  (b) availability of resources (facilities, staff, postdocs, interns, grants)

  (c) the impact of available resources on the research and academic efforts of the faculty

  (d) visibility and impact w.r.t. the outside world

Basic HEMI Principles

- The success of the faculty determines the success of the Institute and of the University.
- Tenure-track faculty are hired by the Departments, not the Institute.
- Research activity and quality is enhanced by synergy between the Departments and the Institute: the Institute should enhance faculty activity, productivity and impact.
- Participation in institutes should be driven by faculty self-interest.
- We seek to do the best science, and produce great people - success will follow.
- We view collaboration as the key to transformational science.
- We recognize that collaboration usually involves creative tension and the accommodation of multiple interests.
- We develop, study and communicate innovative collaborative approaches to doing basic science.

We do strategically-driven fundamental science.

Core Values for HEMI

- Be at the leading edge of the science of extreme events.
- Develop technologies that protect people, structures and the planet.
- Teach people how to think about extreme environments.
- Build collaborative partnerships to address complex and compelling problems.
- Enhance the research and academic reputation of Johns Hopkins University.
- Broaden opportunities for faculty and students.

Anything we do should enhance at least one of these core values.

HEMI Vision and Mission

Vision

- HEMI develops the science and technology that protects people, structures and the planet.

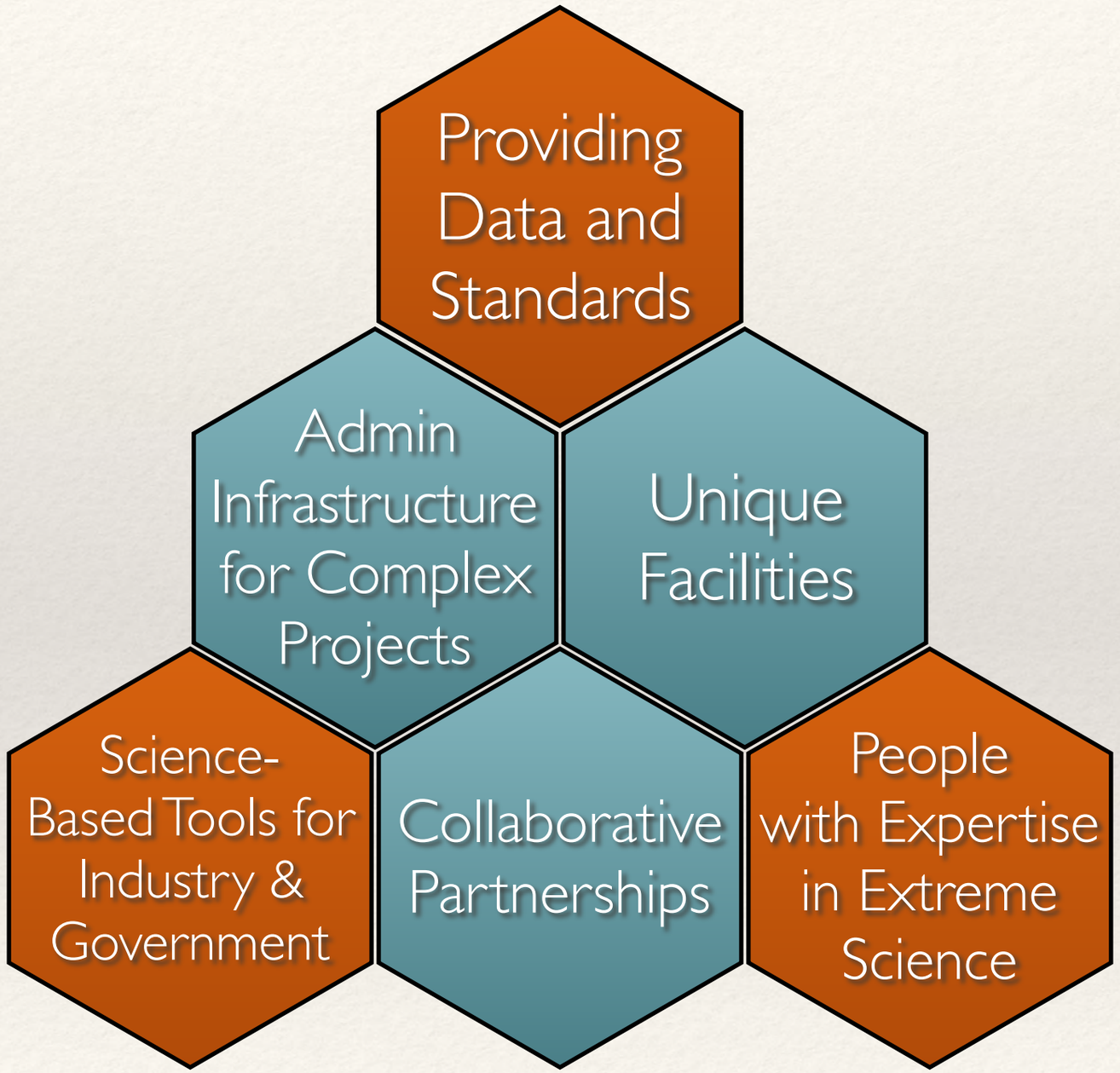
Mission

- Provide global intellectual leadership to advance the fundamental science associated with materials and structures under extreme conditions and demonstrating extreme performance.

So what does extreme mean?

- **Extreme Conditions**
- Very high pressures
- Very high temperatures
- Cryogenic temperatures
- Intense radiation environments
- Very high strain rates
- High-power laser interactions with matter
- High energy densities
- Blast, impact, crash
- Hypervelocity impact (> 5 km/s)
- Natural disasters, hurricanes, earthquakes
- Nuclear events
- Planetary impact and hazard mitigation
- Extreme electromagnetic fields
- **Extreme Performance**
- Revolutionary combinations of properties
- Extreme toughness with high strength
- Strongly nonlinear behaviors due to coupled fields
- Programmable matter, programmable structures
- Simultaneous mechanism control at multiple scales
- Mechanism-based design of materials

Core Competencies and Outputs for HEMI



How is HEMI organized?

- **Executive Committee**: makes all major decisions
  (currently Robbins, Weihs, Graham-Brady, Nakano, Ramesh; McGhee)
- **Appointments Committee**: approves all appointments
  (currently Graham-Brady (Chair), Robbins, Ghosh, Weihs, Ramesh)
- **Facilities Committee**: builds and manages all HEMI facilities
  (currently Weihs (Chair), Robbins, Hufnagel, El-Awady; McGhee, Shaeffer)
- **Computing subcommittee**: manages computational resources
  (currently Robbins (Chair), Weihs, El-Awady, Budavari)
- **Academic Committee:** oversight of academic activities
  (currently Hufnagel, Guest, Kang, Shields, Papanikolaou)
- **Internal Advisory Group**:
  Chairs of all participating departments. Meet as individuals occasionally.

HEMI People at Hopkins

- Faculty: 24 faculty members, 2 APL Professional Staff, visiting faculty at various times
- Staff: 3-4 FTE paid on HEMI budget, 4 FTE on sponsored budgets
  - Senior administrator, research service manager, budget analyst, staff engineer, two admin coordinators; media coordinator, database analyst
- Two adjunct research scientists, two visiting scholars, multiple government and national lab collaborators

HEMI Faculty at JHU as of 2016

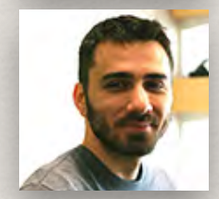
Civil Engineering


Lori Graham-Brady
Professor & Chair


Somnath Ghosh
Callas Chair in CE


Jamie Guest
Associate Professor


Michael Shields
Assistant Professor


Stavros Gaitanaros
Assistant Professor

HEMI

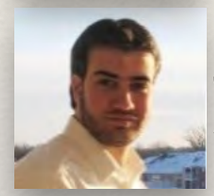

Victor Nakano
Executive Prog Director/
Associate Res. Scientist

Mechanical Engineering


KT Ramesh
Decker Prof. of
Science & Eng

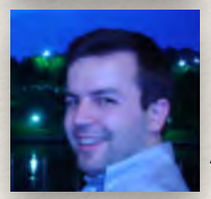

Kevin Hemker
Decker Chair in ME


Vicky Nguyen
Associate Professor


Jaafar El-Awady
Assistant Professor


Sung Hoon Kang
Assistant Professor


Nitin Daphalapurkar
Asst Research Prof


Stefanos
Papanikolaou
Asst Research Prof


Ryan Hurley
Asst Research Prof

Materials Science & Eng


Tim Weihs
Professor


Todd Hufnagel
Professor


Michael Falk
Professor

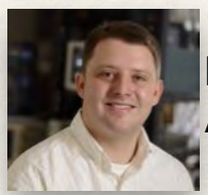
Evan Ma
Professor


Margarita
Herrera-Alonso
Assistant Professor

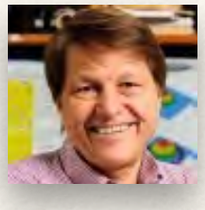
Applied Math & Statistics


Tamas Budavari
Assistant Professor

Electrical and Computer Eng


Mark Foster
Associate Professor

Physics & Astronomy


Mark Robbins
Professor

Geography & Environ Eng


Erica Schoenberger
Professor

Chem & Biomolecular Eng


Joelle Frechette
Associate Professor

Applied Physics Laboratory


PK Swaminathan
Research Professor


Olivier Barnouin
Research Professor

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People Footprint of HEMI

- 51 faculty across the country
- 45 collaborating scientists
- 45 postdocs
- 74 graduate students
- 76 undergraduates
- 9 high school students
- 4 research scientists
- 9 visiting scholars
- 23 undergraduate Interns
  - Morgan State ESI: 17
  - MICA Extreme Arts: 2

Joining HEMI

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Who can join HEMI?

- Any Hopkins faculty member (tenure-track or otherwise).
- Any Hopkins postdoc, with faculty advisor's permission.
- Any Hopkins graduate student, with faculty advisor's permission.
- Any member of the APL Professional Staff.

How does a faculty member join HEMI?

- Just let us (start with KT) know you'd like to join HEMI.
- Provide a CV, and identify technical research interests, e.g., materials, mechanics, physics, chemistry...
- Provide this together with email and contact information to Bess Bieluczyk, bess@jhu.edu
- HEMI Executive Committee approves the addition of the faculty member.

Why should you join HEMI?

- HEMI faculty can take advantage of HEMI's infrastructure (both research and administrative) and staff resources.
- HEMI faculty can submit proposals through the institute, using institute resources and expertise for both traditional and complex collaborative research programs.
- Take advantage of seed grants, undergraduate internships, relationships with Morgan State and Maryland Institute College of Art (MICA)
- Priority access to HEMI experimental, computing and data sharing facilities
- Take advantage of our rapidly developing strategies for scientific and technical collaboration across disciplines and organizations.
- Make long-term contacts with industry, national labs and funding agencies.
- Give your groups priority access to workshops, HEMI bootcamp, and short courses.

Expectations of HEMI faculty

- Participate in HEMI faculty meetings (held quarterly)
- Participate, as and when appropriate, in HEMI activities
- Serve on a HEMI committee on request
- Help bring in and/or maintain HEMI facilities and resources for general use
- If you're funded through HEMI, participate in a HEMI-sponsored conference or workshop

What resources do we have in HEMI?

- Administrative and technical staff
- Graduate fellowship and travel funds
- Seed grants
- Collaborative spaces in Malone Hall
- Document and Data Sharing Infrastructure (DDSI)
- Facilities and equipment

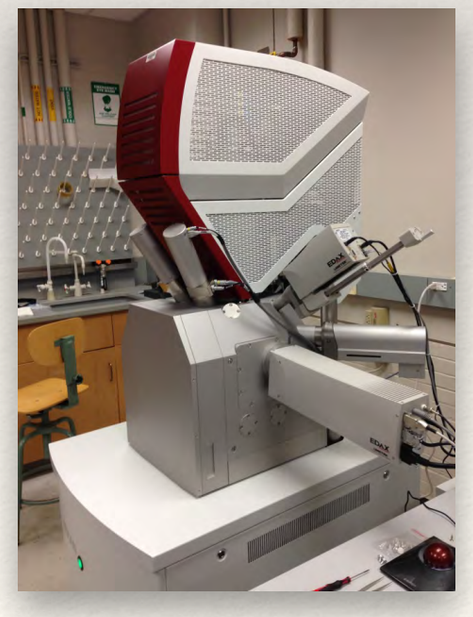
How do we allocate resources?

- Broad consensus building activities among all faculty defines major principles
- HEMI Executive Committee makes decisions based on these principles
- Inevitably, we will have to balance some competing interests
- The Department Chairs and the JHU leadership are consulted as needed

Facilities associated with HEMI

Note that, as always, individual PIs may choose to share their own facilities. Ask!

- 3D Characterization Facility
- In situ nanomechanical testing
- Ultra-high-speed cameras
- Kolsky bars with high speed imaging
- Plate impact facility (300 m/s)
- High-performance computing
- Planetary Impact Laboratory at APL (1000 m/s)
- Additive manufacturing
- Instrumented drop tower
- Laser Shock Facility*
- Hypervelocity Impact Facility (5-10 km/s)*



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*Under development

HEMI Space in Malone Hall

- Space for 34 graduate students mixed in large open area
- Space for 12 postdocs in same area
- Student meeting space contiguous to student offices
- Laboratory space in basement
- File and data servers, private network
- Faculty and visitor offices
- Administrative offices
- Boardroom , seminar rooms

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Some HEMI Activities

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Some Current HEMI Technical Activities

- Protecting People: Materials in Extreme Dynamic Environments (ARL)
- Urban Protection: Collateral Building Damage Due to Airblast (DTRA)
- Dynamic failure of rocks and geomaterials (DTRA)
- Concussions: In-Vivo Measurement of Brain Biomechanics (NIH)
- Blast Protection: Developing Eye Simulants (Army)
- Planetary Protection: Fragmentation and Disruption of Asteroids (NASA)
- Plasticity mechanisms (Air Force)
- LIFT: American Lightweight Materials Manufacturing Innovation Institute

Key Partnerships

- **Materials in Extreme Dynamic Environments Collaborative Research Alliance (MEDE CRA**). A $90M basic research program with the Army Research Laboratory focused on developing lightweight protective material systems.
- **Lightweight Innovations for Tomorrow**. A $148M Presidential initiative as part of the national network of manufacturing innovation. HEMI is a partner in blast and ballistics research.
- **Solar System Exploration Research Virtual Institute (SSERVI)**. A NASA institute focused on fostering collaborations to conduct research on lunar and planetary sciences while advancing human exploration of the solar system.
- **Defence Science and Technology Laboratory** in the United Kingdom. Interactions on design and behavior of ceramics, metals and polymers.
- **Institute of Shock Physics,** Imperial College of London. Interactions on impact and blast injury biomechanics, laser shocks.
- **Ernst Mach Institut,** Freiburg, Germany. Interactions on impact, shock, resilience, failure of ceramics, glass and polymers.
- **Lawrence Livermore National Laboratory**. Development of unique experimental and modeling capabilities.

Academics: HEMI Short Courses

- HEMI Short Courses so far:
  - *Dynamic Behavior of Brittle Materials*: Prof. G. Subhash, U. Florida
  - *Fundamentals of Equations of State*: Dr. G. Kerley, retired from Sandia
  - *Dynamic behavior of soft materials*: Prof. Wayne Chen, Purdue
  - *Penetration dynamics*: Dr. Charlie Anderson, Southwest Research Institute
  - *Shock Physics and Applications,* Dr. Lalit Chhabildas, Sandia / Air Force Research Laboratory
- Coming up soon:
  - *Big Data in Materials* (Prof. Surya Kalidindi, Georgia Tech)
  - *Constitutive Models for Codes* (Prof. Rebecca Brannon, Utah)

Extreme Science Internships

- Foundational program with Morgan State University in Baltimore
- Work at any of the participating MEDE institutions
- Total no. of MSU undergraduates who have been awarded internships: 17
- Three Extreme Science Scholars in 2015

Academic Year	Internal ESI	External ESI
2013-14	11	6
2014-15	12	5

Extreme Arts Program

- Program with Maryland Institute College of Art (MICA) in Baltimore
- Involve artists in discussions of extreme events and environments
- Engage artists in data visualization; interpretation, translation, and effective *communication* of data
- Bring the scientific community together through *creative* expression based on our work.
- First shows soon.

Extreme Arts Interns, Summer 2015

Amanda Metcalf
Interdisciplinary Sculpture

Samantha French
Information Visualization

Artist-in-Residence, Spring 2016

Jay Gould,
Professor of Photography

Other HEMI Academic Activities

- HEMI Bootcamp for all "new" grad students (19 grad students, 3 postdocs attended in 2015)
- HEMI Proposals Workshops:
  - I. Funding agencies and proposal topics
  - II. Developing and writing scientific proposals
- HEMI Seminars (external speakers)
- HEMI Colloquia (JHU speakers)
- Undergraduate internships

HEMI Academic Bootcamps, 2015

- Intro to Shared Facilities, including tours
- Research Practices I
  - Library searches, bibliographies and reference tools, LaTex
- Research Practices II
  - Extreme Science Talk
  - Developing a Research Overview
  - How To Write a Scientific Paper
- Panel Discussion: Succeeding in Graduate School
- Research Tools I
  - Materials Characterization Tools
  - Experimental Methods in Mechanics
  - Center for Leadership Education
- Research Tools II
  - Data management and sharing
  - Computational Tools
  - High Performance Computing
  - Python

Annual Mach Conferences in Annapolis

- 2014
  - Total Attendees: 176
  - Plenary speakers: 6
  - Presentations: 98
  - Posters: 17
- 2015
  - Total Attendees: 225
  - Plenary speakers: 5
  - Presentations: 112
  - Posters: 45
  - 7 countries
- 2016 conference April 6-8.

Join us!

Questions? Talk to KT, Victor, or anyone on the Executive Committee.

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