Overview of MSEE URA

Professors Tim Weihs and Todd Hufnagel
(July 21-22, 2020)
Outline

• Mission and Goals
• Research Strategy
• The URA Team
• Management Structure
• Work Force Development
• Enhancing and Monitoring Collaboration
• Government and Corporate Affiliates Program
As a fundamentally-focused consortium, we will support DTRA’s mission to defend against weapons of mass destruction (WMDs) and provide reach-back support to the warfighter by:

More Than 300 Chemical Attacks Launched During Syrian Civil War, Study Says, February 17, 2019, NPR.ORG

An image of a toddler on Sunday after a suspected chemical attack in the rebel-held Syrian suburb of Douma, near Damascus. NY Times, April 8, 2018
As a fundamentally-focused consortium, we will support DTRA’s mission to defend against weapons of mass destruction (WMDs) and provide reach-back support to the warfighter by:

New START Treaty Aggregate Numbers of Strategic Offensive Arms

BUREAU OF ARMS CONTROL, VERIFICATION AND COMPLIANCE
Fact Sheet
January 1, 2020

(Data in the Fact Sheet comes from the bilateral exchange of data required by the Treaty. It contains data declared current as of September 1, 2019. Data will be updated on a six-month period after entry into force of the Treaty.)

<table>
<thead>
<tr>
<th>Category of Data</th>
<th>United States of America</th>
<th>Russian Federation</th>
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</thead>
<tbody>
<tr>
<td>Deployed ICBMs, Deployed SLBMs, and Deployed Heavy Bombers</td>
<td>608</td>
<td>513</td>
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<tr>
<td>Warheads on Deployed ICBMs, on Deployed SLBMs, and Nuclear Warheads Counted for Deployed Heavy Bombers</td>
<td>1,376</td>
<td>1,426</td>
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A 23 kiloton tower shot called BADGER, fired on April 18, 1953 at the Nevada Test Site, as part of the Operation Upshot-Knothole nuclear test series. https://en.wikipedia.org/wiki/Nuclear_explosion
MSEE URA Goals

• Advance the fundamental understanding of materials and chemistries under extreme pressure, temperature, and radiation

• Create state-of-the-art diagnostics tools, predictive models, and advanced materials and transition them

• Manage and foster a collaborative research environment

• Train, mentor, and inspire the next-generation workforce
Research Strategy for Extreme Environments

Conventional Fireball for Agent Defeat

Nuclear Fireball

https://en.wikipedia.org/wiki/Nuclear_explosion
Research Strategy for Extreme Environments

See it  Understand it  Control it
See it

Omega Facility

HyFIRE Facility

Blast (HE) Facility

X-ray Phase Contrast Imaging

U and UO in Laser Produced Plasmas
Understand it

First principles calculations → Materials properties → Hydrocode simulations of experiments → Experimental data → Canonical model experiments

UQ framework
- Parameter uncertainty
- Model discrepancy
Controlled Energy and Nano-oxide Release for Agent Defeat

Tamper Materials for Laser Ablation Experiments

Laser

Nano-oxide Film
A team of experts with a history of collaboration and work force development
- 186 Joint Pubs among PIs
- 400+ Pubs with national/DoD labs
- 87 students and PDs transitioned
MSEE URA Organization – 18 Institutions, 13 states
Draper

DRAPER

Greg Fritz

James Vedral
CCDC Army Research Lab

Brian Barnes

Betsy Rice
Hergen Eilers
Red Team

Randy Manner  Leo Bradley  Bill Wilson  Kevin Fournier
HEMI – Home to MSEE URA

Hopkins Extreme Materials Institute
MSEE Structure

• Four Thematic Research Areas (RA)
• Two to Three Focus Areas (FA) within each RA
• Cross-cutting Research Initiatives
MSEE Structure – 4 Research Areas

• RA1: Material Properties and Failure
• RA2: Materials and Manufacturing for Synergistic Effects
• RA3: Chemistry in Extreme Environments
• RA4: Photon-Material Interactions
MSEE Structure – RAs and FAs

RA1: Material Properties and Failure
• FA1: Material Properties for Reducing Model Uncertainty
• FA2: Material Constitutive Models (Soil, Rock, Concrete)
• FA3: Materials Properties of Energetic Materials and Additively Manufactured Energetics Materials (delayed)

RA2: Materials and Manufacturing for Synergistic Effects
• FA1: Multimodal Shielding (delayed)
• FA2: Tailoring Chemistry via Materials
• FA3: Characterize and Predict Physical/Chemical Effects in Turbulent Environments
MSEE Structure – RAs and FAs

RA3: Chemistry in Extreme Environments
• FA1: Nuclear Fireball Plasma Chemistry
• FA2: High Temperature Properties and Chemistry of Agents and Simulants

RA4: Photon-Material Interactions
• FA1: X-ray Induced Blow-off and Plasma
• FA2: Direct Laser Impulse

Cross-cutting Research Initiatives
## MSEE URA Organization

### TECHNICAL MANAGEMENT GROUP
- **MSEE CAM:** Mike Robinson, TPOCs: Jacob Calkins, Jeff Davis, Dave Petersen
- **MSEE PM:** Tim Weihs, RALs: Todd Hufnagel, Mike Zachariah, Nick Glumac, Farhat Beg

### MSEE URA ADMINISTRATION
- **MSEE PM:** Tim Weihs, Associate PM: Todd Hufnagel, Alliance Administrator: Victor Nakano

### Cross Cutting Research Initiatives (CCRI): Foster

<table>
<thead>
<tr>
<th>RA1</th>
<th>RA2</th>
<th>RA3</th>
<th>RA4</th>
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<tbody>
<tr>
<td>RAL: Hufnagel (JHU)</td>
<td>RAL: Zachariah (UCR)</td>
<td>RAL: Glumac (UIUC)</td>
<td>RAL: Beg (UCSD)</td>
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<td>TPOCs: Calkins, Davis</td>
<td>TPOC: Davis</td>
<td>TPOCs: Petersen, Davis</td>
<td>TPOC: Calkins</td>
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<tr>
<td>FA1 Coord: Gaffney</td>
<td>FA2 Coord: Zachariah</td>
<td>FA1 Coord: Curreli</td>
<td>FA1 Coord: Miloshevsky</td>
</tr>
<tr>
<td>FA2 Coord: Hurley</td>
<td>FA3 Coord: Menon</td>
<td>FA2 Coord: Eilers</td>
<td>FA2 Coord: Beg</td>
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Developing the Next-Generation MSEE Workforce

**High School**
- REAP Internships
- JSHS Competition

**Undergraduate**
- MSEE-URA research internships
- Extreme Science Internships

**Graduate**
- MSEE-URA Boot Camp
- Visiting Research Fellowships

**Postdoc**
- MSEE-URA Boot Camp
- Visiting Research Fellowships

**Professional**
- DoD SMART Scholars
- JHU D.Eng Program
- Staff Rotations

**Junior Faculty**
- Young Investigator Award (YIA)
- Seed grants
- Leadership opportunities & mentoring
Workforce Development

**HIGH SCHOOL**

- REAP Internships
- JSWS Competition

**UNDERGRADUATE**

- MSEE-URA research internships
- Extreme Science Internships

Research Engineering Apprenticeship Program for students from under-represented/under-served groups (sponsored by Army Educational Outreach Program)

Junior High School Sciences and Humanities competition

Competitive summer research internships for UG students from all URA institutions.

**Extreme Science Internships (ESI)** for students from Morgan State (a HBCU) to participate in research at URA institutions.
Annual **boot camp** for new graduate students and post-docs to orient them to the outlook, opportunities, facilities, and techniques of the URA.

**Visiting research fellowships** to encourage PhD students to spend at least one extended (several months) internship at an outside lab (DOD/DOE, industrial, or URA partner)

Short courses in **professional development** offered by JHU Center for Leadership Education (examples include oral and written communication, project management, and personnel management)
Recruit candidates to earn PhDs under the Science, Mathematics, and Research for Transformation (SMART) fellowship program.

JHU Doctor of Engineering (DEng) program allows lab employees to earn doctoral degree (mostly remotely) while continuing full-time work.

**Staff rotations** and **short-courses** for current DTRA/lab employees

**Young Investigator Awards** for junior faculty (start of first and third BPPs) to develop new talent

**Seed grants** for junior faculty to develop new research areas relevant to MSEE

Develop junior faculty via mentorship and providing leadership opportunities
Strategies for Collaboration -

Select principal investigators (PIs) with a history of collaboration

Design integrated research tasks

Incorporate best practices from the existing consortia

Evaluate PIs on collaboration
## Annual MSEE Schedule

<table>
<thead>
<tr>
<th>January</th>
<th>2021</th>
<th>December</th>
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<tbody>
<tr>
<td><strong>Spring Semester</strong></td>
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<td></td>
<td>(JUN)</td>
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<tr>
<td><strong>Technical</strong></td>
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<tr>
<td></td>
<td>=APR</td>
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<tr>
<td>TMG Meetings (Quarterly)</td>
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<tr>
<td>FA Meetings (Biweekly/Monthly); RA and CCRM Meetings (Quarterly)</td>
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<tr>
<td><strong>Research Experience</strong></td>
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<tr>
<td>2-3 Month Graduate Research Fellowships at DoE/DoD labs and GCAP Partners</td>
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<tr>
<td>Summer Fellowships</td>
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<td>DoD SMART Scholars Program</td>
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<tr>
<td>JHU Doctorate of Engineering Program</td>
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<tr>
<td>Young Investigator Seed Grants</td>
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<tr>
<td>AEOP REAP (High School)</td>
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<tr>
<td>Extreme Science Internships with Morgan State U. (Undergraduate)</td>
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<tr>
<td><strong>Educational</strong></td>
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<tr>
<td>Mach Conference</td>
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<tr>
<td>Lecture series (annually)</td>
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<tr>
<td>Short courses (varies based on availability of instructors and other key events)</td>
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<td>▼</td>
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<tr>
<td>Bootcamp</td>
<td>▼</td>
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<tr>
<td>Workshops (bi-annually)</td>
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Government and Corporate Affiliates Program

Goals
• Facilitate the transfer of scientific and technological advances
• Provide a network to enhance collaboration between academia, industry, and government organizations
• Assist in recruiting and developing the “next generation” workforce.

Activities
1. Annual Review
2. Student Internships
3. Lecture Series
4. Workshops
5. Short Courses
6. Enhanced Research Tasks
PI Shields organized Uncertainty Quantification in Computing Solid and Structural Materials Modeling in 2019 with 26 speakers and over 90 attendees from 50 different academic, laboratory and industrial organizations. The URA will hold similar workshops.
Annual MSEE Schedule

- Cooperative Agreement (CA) supports two funding categories
  - Basic research (6.1)
  - Applied research (6.2)

- GCAP members can support testing, modeling, and materials development with specific PIs through enhanced tasks

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<td>Spring Semester</td>
<td>Summer</td>
<td>Fall Semester</td>
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<tr>
<td>(JUN)</td>
<td>Annual Tech. Review (1-2 days)</td>
<td>GCAP Event (1 day)</td>
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<td>TMG Meetings (Quarterly)</td>
<td>=OCT</td>
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<td>=JUL</td>
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- DoD SMART Scholars Program
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- Mach Conference
- Bootcamp
- Lecture series (annually)
- Workshops (bi-annually)
- Short courses (varies based on availability of instructors and other key events)
Thanks for your Attention

Questions?