

# Mechanical Engineering Research & Opportunities at Sandia National Laboratories

Christopher Lin

[clin@sandia.gov](mailto:clin@sandia.gov)

NM Weapon Systems Engineering

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND -2005-6648P



# National Laboratories



KEY:

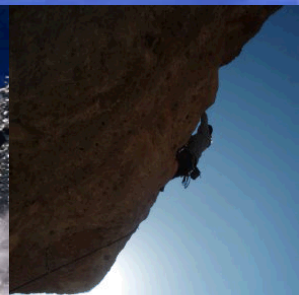
- = NNSA Labs
- = Science
- = Nuclear Energy

- = Environmental Management
- = Fossil Energy
- = Energy Efficiency and Renewable





# Sandia National Laboratories in Albuquerque, New Mexico

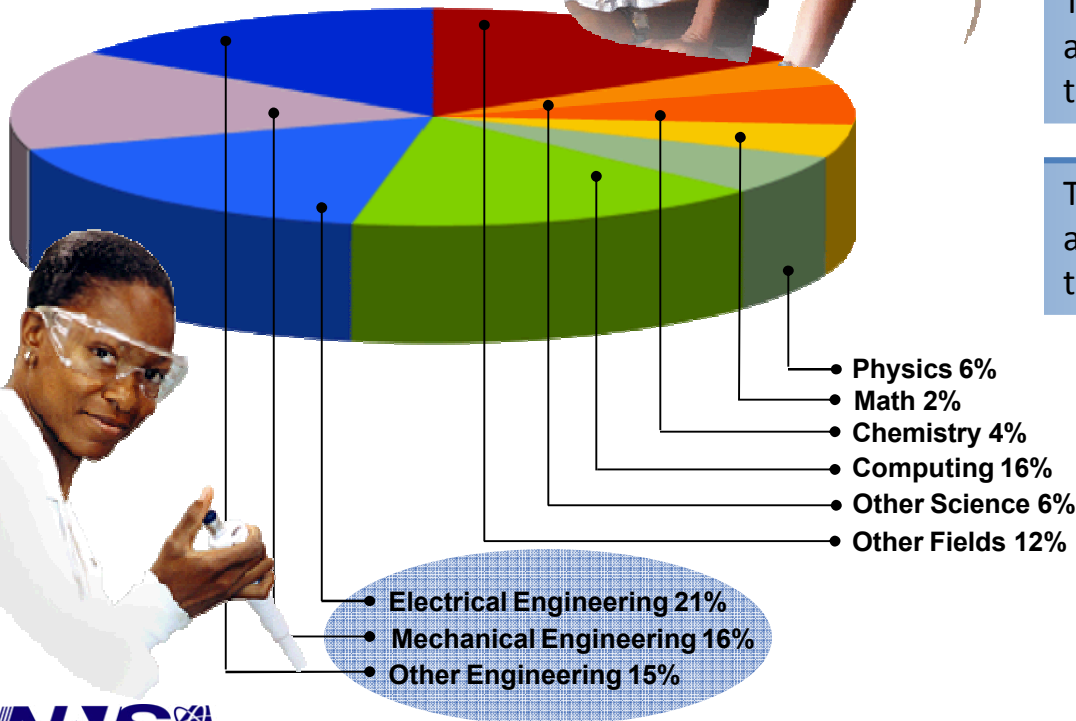


# Sandia's People

- On-site workforce: 11,677
- FY10 permanent workforce: 8,607
- FY10 gross payroll: \$898.7M
- FY10 budget: \$2.3B



Technical Staff (4,277) by Degree (End of FY10)



## Disciplines of Most Technical Hires (FY06 – FY09)

Top 3 hire fields comprise approximately 52% of technical hires

- CS/CE
- EE
- ME

Top 5 hire fields are approximately 68% of technical hires

- Chemistry
- Physics

Top 10 hire fields represent approximately 82% of technical hires

- Nuclear Eng
- Geo & Environmental Sciences
- Bio/Biochem
- Materials Science
- Math



# Nuclear Weapons Mission Area

- Research, Design, and Development of Non-Nuclear Components (96% of Total NW Parts)
- Life Extension of Nuclear Weapons
- Neutron Generator (NG) Manufacturing
- Stockpile Support – maintenance, military liaison, surveillance, dismantlement, logistics
- Nuclear Materials Protection



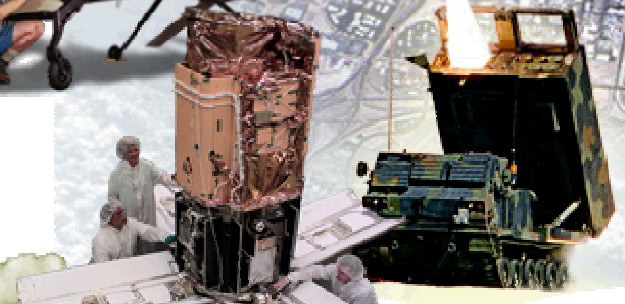
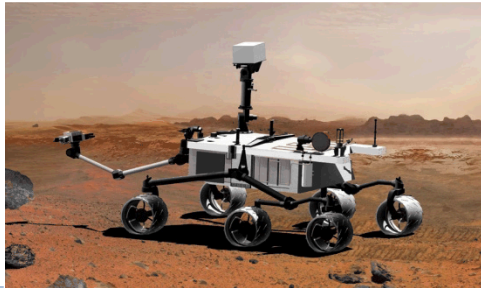
C4/D5 Missile



Trident Submarine

# Defense Systems Mission Area

- Science & Technology Products
- Surveillance & Reconnaissance
- Integrated Military Systems
- Remote Sensing and Verification
- Proliferation Assessment



National Nuclear Security Administration



# Energy Resources Mission Area

Who is leading globally in energy research...

Energy & Fuels:  
Institutions Ranked by Citations

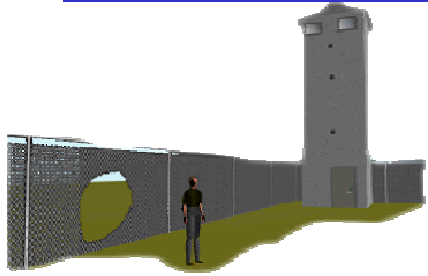
Rank	Institution	Citations 1998-2008
1	<b>Sandia National Labs</b>	4,147
2	Natl. Renewable Energy Lab	3,773
3	CSIC (Spain)	3,678
4	Chinese Academy of Sciences	3,541
5	Indian Institutes of Technology	3,166

*Source: Thomson Reuters Science Citation Index*

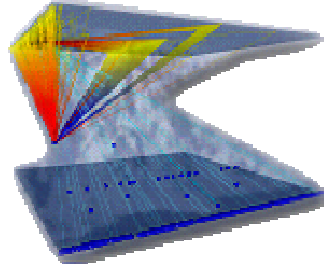
- U.S. national labs lead the way
- National labs and U.S. universities comprise 9 of the top 20 research institutions
- Sandia is 1<sup>st</sup> in total citations of energy and fuels research and 3<sup>rd</sup> in papers cited in photonics research.



# Homeland Security Mission Area



Synthetic Aperture Radars



Radiation Remediation Foam

Cyber Security



TWA Flight 800

Explosive Detection Portal



Tunnel Characterization



Explosive Destruction System



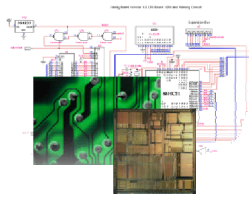
Analysis of the I-35 Bridge Collapse



Unabomber and Shoe Bomber Investigations

# Active Recruiting Areas

- Computational Science and Engineering



Architectures



Algorithms



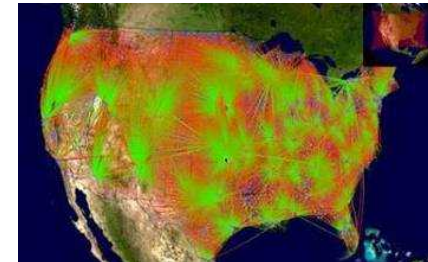
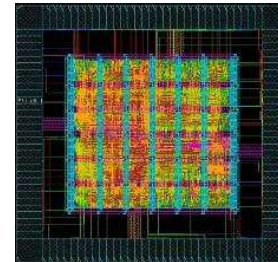
Applications

One 1994 computer day  $\approx$  One 2006 computer minute

1997: 1 Teraflop in a *room*.  
2007: 1 Teraflop on a *chip*.

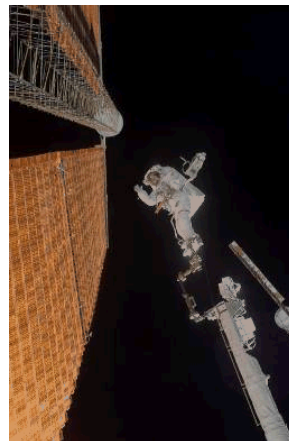
- Cyber Security

- Includes Infrastructure Modeling, Cryptographic Chips, and Microelectronic Development

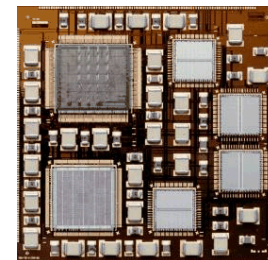


- Space Systems

Galileo Spacecraft



Laser Dynamic Range Imager Orbiter Inspection System (LOIS)



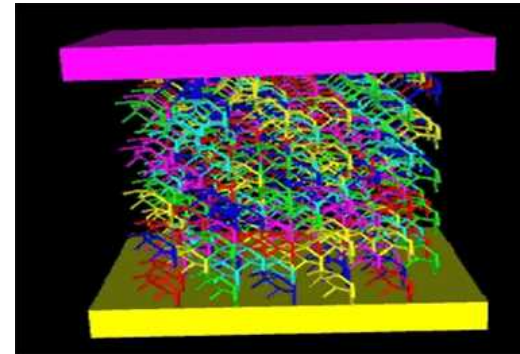
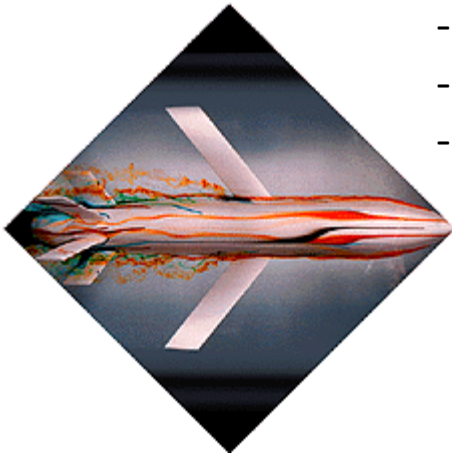
Rad-hard chips & MEMS devices

# 1510 – Thermal, Fluid & Aero Sciences

*Mission: Provide the research, development, and applications expertise in thermal fluid and aero technology areas required for Sandia to accomplish its mission in nuclear weapons and other national security areas*

Areas of study:

- Compressible Fluid Mechanics
- Aerodynamics
- Flight dynamics
- Aerothermodynamics

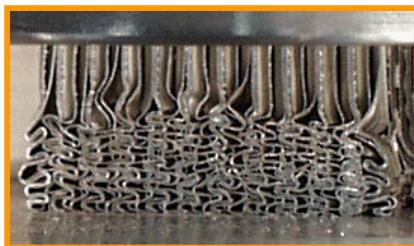
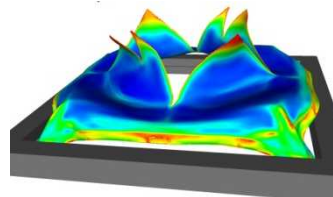
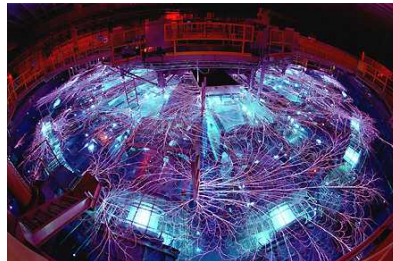


# 1520 – Solid Mechanics/ Structural Dynamics

*Mission: Provide the research, development, and applications expertise in solid mechanics and structural dynamics required for Sandia to accomplish its mission in nuclear weapons and other national security areas*

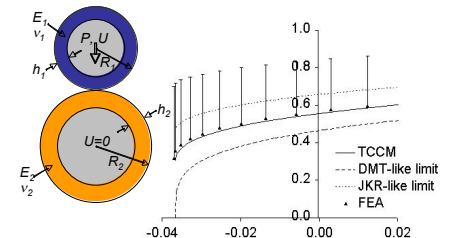
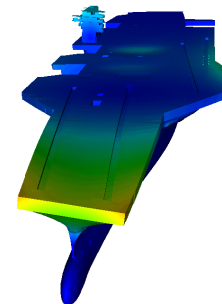
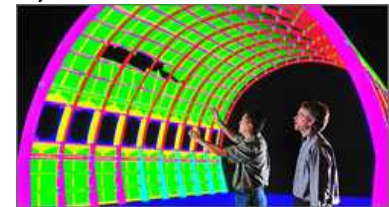
## Solid Mechanics

- Nonlinear Computational Mechanics
- Experimental Solid Mechanics
  - Diagnostic Development & Application
  - Production Testing
  - Certification & Failure Margin Testing & Discovery
- Material Response



## Structural Dynamics

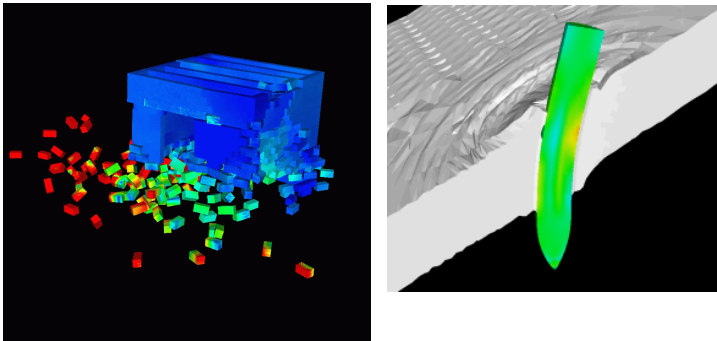
- Modal, Shock & Vibration, acoustics
  - Computational
  - Experimental
- Nonlinear Structural Dynamics
- Smart Structures & Controls
- Nondeterministic Methods & Optimization



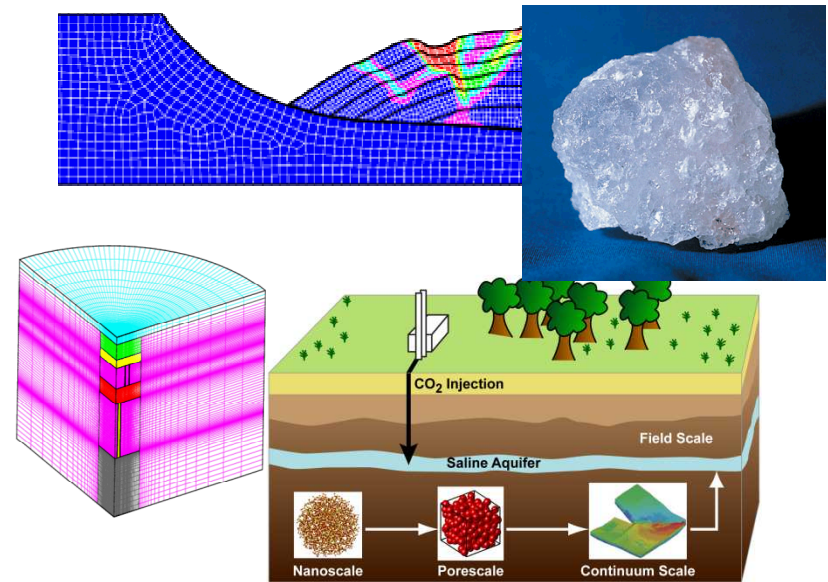
# Computational Structural Dynamics

Develop and apply multi-physics simulation capabilities to assess structural performance in extreme environments.

## Blast, Impact, and High Speed Penetration Assessments



## Sub-Surface Engineering



# Analytical Structural Dynamics



- **Environments Engineering**
- **System Modeling and Model Validation**
- **Coupled Structural and Acoustic Modeling**
- **Advanced Computational Structural Dynamics**



# Experimental Mechanics, Non-Destructive Evaluation & Model Validation

- Characterize the structural response of systems to pressure, temperature, humidity, and load environments.
- Provide design expertise to support the development of experimental configurations.
- Develop and apply state of the art radiographic and acoustic diagnostics.

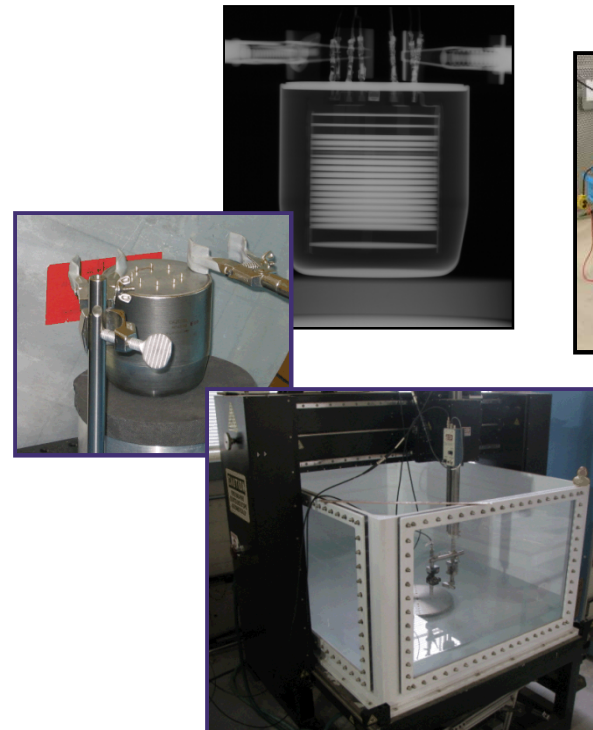
## Structural Mechanics



## Structural Dynamics



## Non-Destructive Testing



## Fixture Design





# Energy Metrics

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Following slides are courtesy of Tim Edwards in  
1523- Analytical Structural Dynamics

- The SRS (shock response spectrum) is by far the most widely used method to characterize shock
  - Derived in the 1930's to characterize response of buildings to earthquakes
  - Spread to the Navy and other DoD agencies
  - Almost all shock data has had the SRS computed
    - Many data bases just preserve the SRS



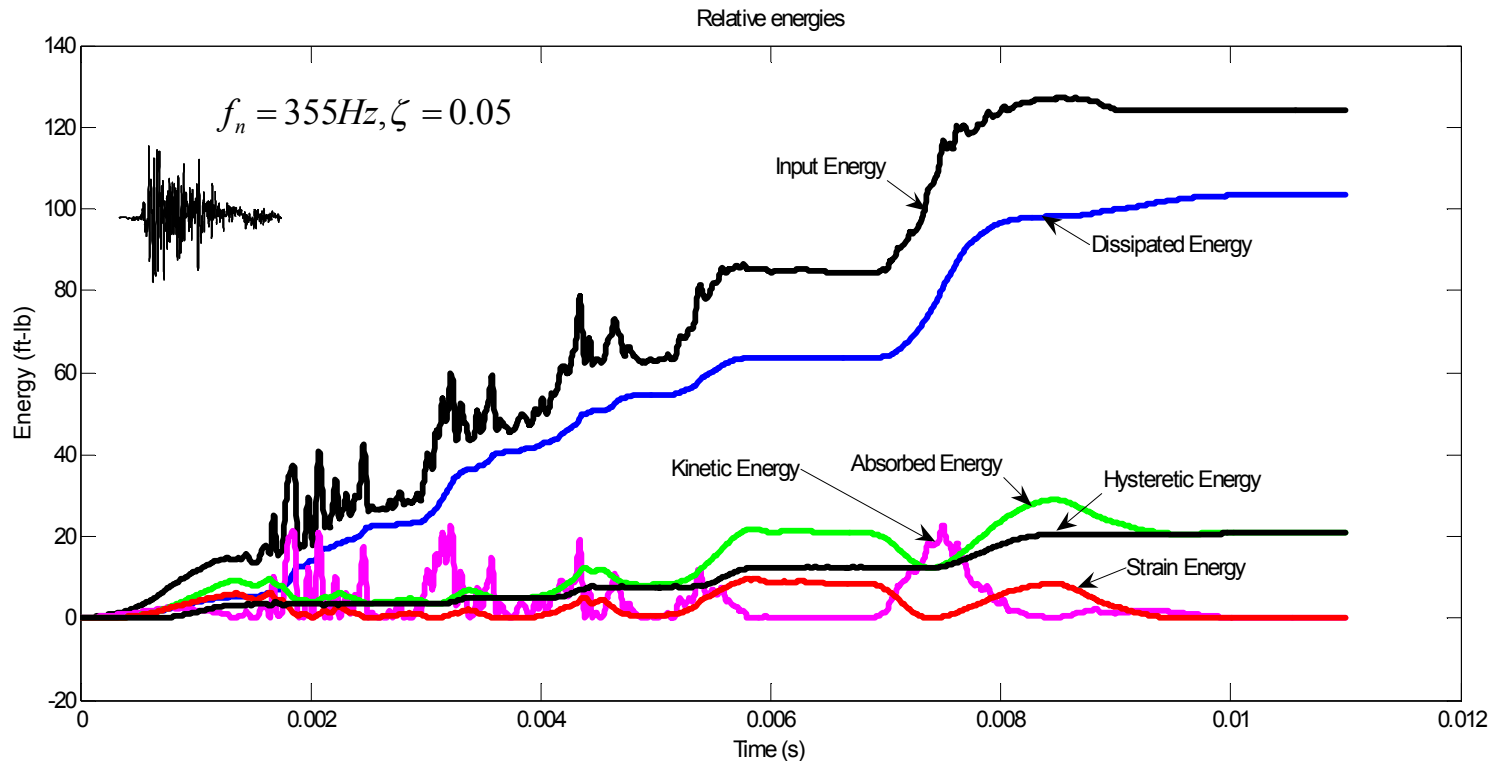
# Motivation

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- Ideally, the characterization of shock motion would be independent of structural response
- The measure of damage potential is a function of structural response
- Concepts of work and energy provide such a framework
  - Shock motion is characterized by energy delivered to a structure
    - Can be generalized to describe *ALL* forms of excitation
  - Damage potential is characterized by the way the structure distributes internally the energy delivered to it

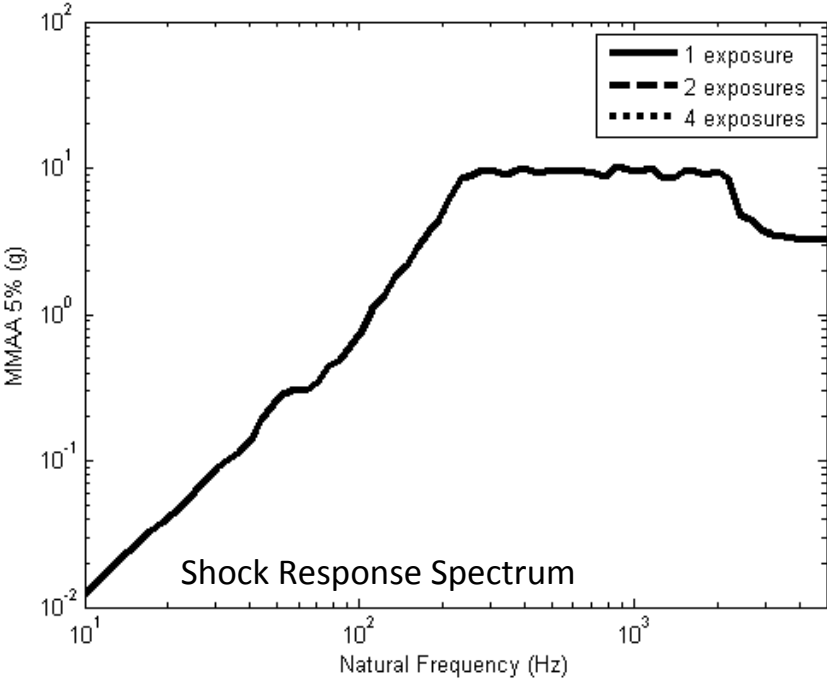
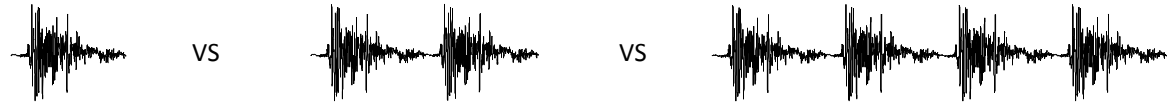
# Relative Energy

- The rate of work is power – related to failure
- Input energy vs. time can provide test specification guidance for selection of realistic waveforms

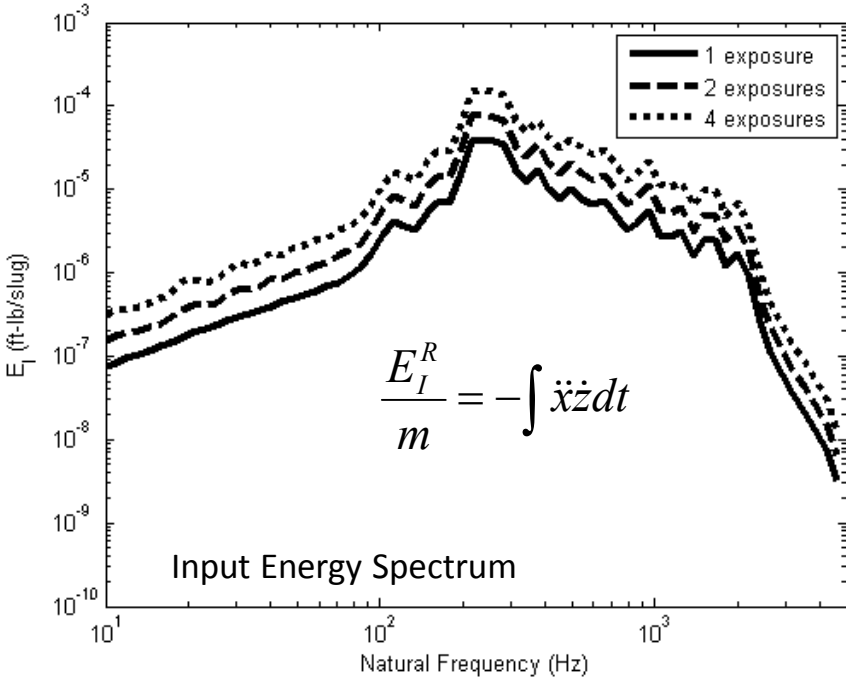


# Superposition

- Integral provides a mechanism for accounting for multiple exposures



- **Maximum response never changes, no matter how many exposures**



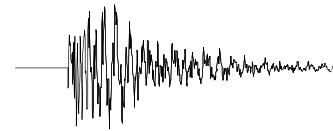
- **Input energy changes as work is done on the system**

# Shock Test 'Cheating'

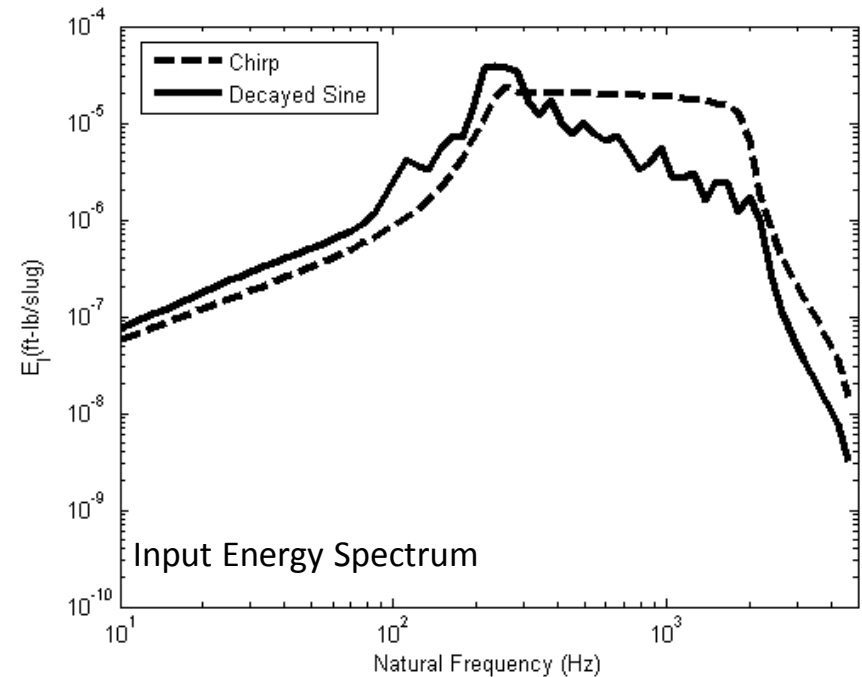
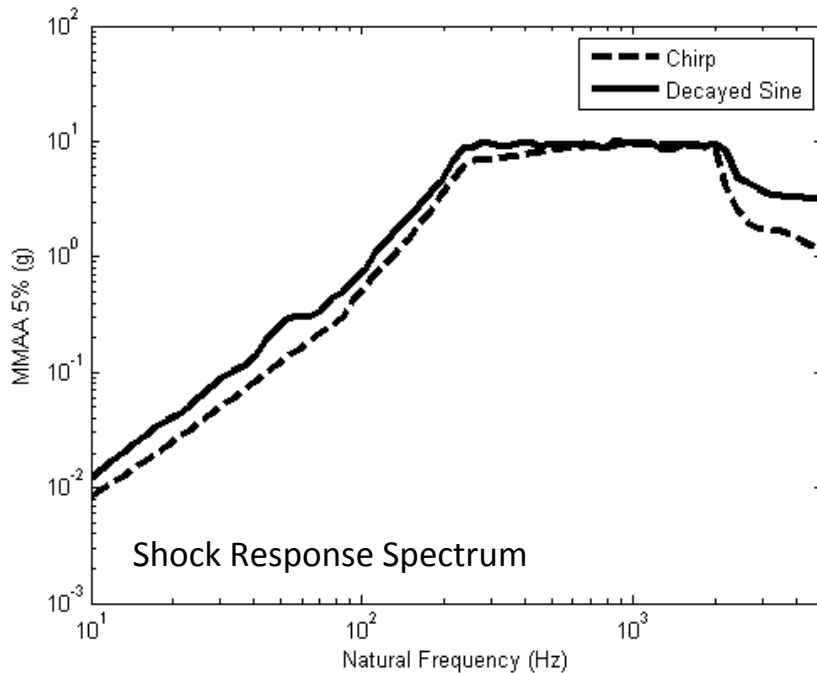


1g, 300 msec

VS



3g, 100 msec



- **Maximum response is approximately the same for both waveforms (10-2000Hz)**

- **Input energy falls-off with frequency**

# 1530 – Validation and Qualification

*Mission: Develop and perform experiments to provide information on the performance, safety, and reliability of nuclear weapons in mechanical environments and to acquire data to validate computational simulations of these events.*



Drop tower facility



Rocket sled track facility



29 ft centrifuge





# 2100 - Weapon System Engineering

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## Mission:

Center 2100 ensures that the nuclear weapon stockpile is known, with increasing certainty, to be safe, secure, reliable, and effective.

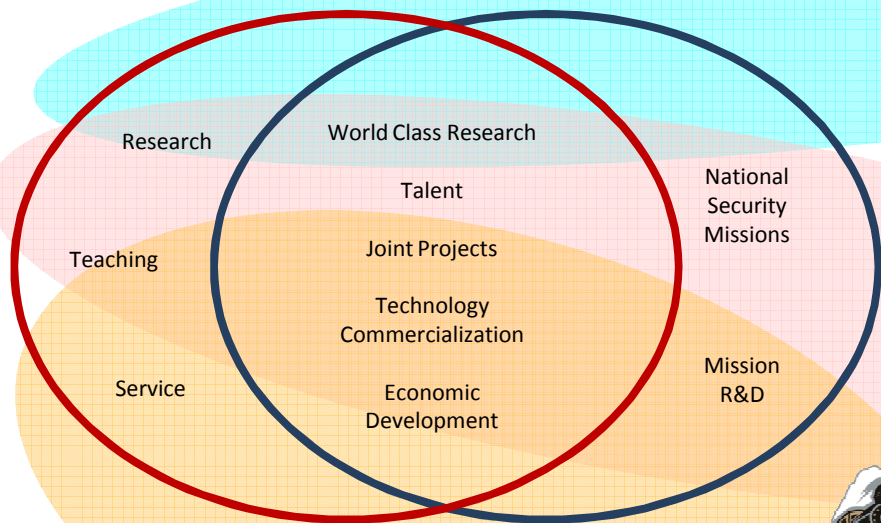
Provide system engineering and integration for NM-designed nuclear weapons and associated support equipment from concept development through stockpile support and dismantlement

Provide system leadership for transforming the stockpile and creating a more responsive nuclear weapon enterprise in support of the Nuclear Posture Review and other defining documents.

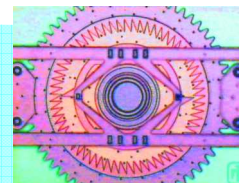
Provide system leadership for the development of new stockpile stewardship tools and capabilities, and drive deployment of these new tools and capabilities in stockpile system engineering activities.

# University Partnerships Deliver World Class Science + Top Talent...

## Universities Sandia National Laboratories



Universities... are the nation's primary source of new knowledge.



Sandia's world class research

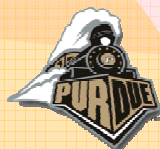
- \$25M in university research annually
- Faculty research sabbaticals
- PECASE awards

Universities... create the nation's talent pool.



Sandia's next generation of scientists and engineers

Universities... enhance research impact and funding through collaboration.



- 150 new technical employees annually
- 400 technical interns annually
- 90 Sandia graduate fellows
- 140 Post-docs

Carnegie Mellon

- Strategic university alliances:
- ASCI, RAMP, CINT, MESA, etc.
  - Campus Executive Program



Sandia's commitment to education

# Student Internships

## Institutes

- National Institute for Nanoscale Engineering (NINE)
- Physical Sciences Institute
- Computer Science Research Institute
- Center for Cyber Defenders
- Enabling Predictive Simulation Research Institute
- Sandia Institute for Modeling and Simulation
- National Security Engineering Institute



## Internships and Co-ops

- Year-round and summer
- Must be a U.S. citizen with full-time enrollment status
- Minimum cumulative GPA of 3.2/4.0 for undergraduates or 3.5/4.0 for graduate students
- STEM and business disciplines
- Apply online at Sandia's website: [www.sandia.gov](http://www.sandia.gov)
- Pay based on job classification and the number of academic credit hours completed prior to internship



# Master Program Fellowships

- The Critical Skills Master's Program (CSMP)
  - For engineering and computer science degrees
  - Aiming to hire 30 candidates this fiscal year
- Masters Fellowship Program (MFP)
  - For minority applicants
  - Aiming to hire 20 candidates this fiscal year
- Specifics for both programs:
  - For engineering and computer science degrees
  - Minimum GPA of 3.2
  - Pursue a graduate degree while on an annual stipend
  - Upon completion, return to Sandia as a member of the technical staff
  - Must apply to the program specific job posting at the Sandia website
  - For more information, contact:
    - Michael Kline, Staffing,  
[mkline@sandia.gov](mailto:mkline@sandia.gov)
    - Bernadette Montano, University Programs  
[tbmonta@sandia.gov](mailto:tbmonta@sandia.gov)



# PhD Research Opportunities

- Postdoctoral Fellowships
  - Pay is one of the highest for engineering post docs in the country
  - Special opportunities exist as:
    - Truman Fellowship (high-risk, high-value research in the national interest)
    - Alexander Hollaender Fellowship (biology and environmental research)
    - John Von Neuman Fellowship (computational science)
- Early Career R&D
  - Conduct your own research that is funded by Laboratory Directed Research & Development (LDRD) for up to 2/3 of your time





# Full Time Job Opportunities

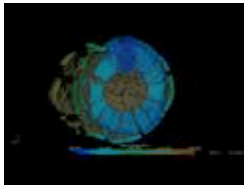
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- Several managers are looking to hire many Mechanical Engineers this year:
  - Thermal fluid theory and experiments
  - Structural dynamics and solid mechanics experimentalists
  - Experimentalists with specialties in non-destructive evaluation
  - Dynamics and vibration modeling
  - Component design:
    - Mechanism design
    - Mechanical Engineering with strong ties to Material Science
    - Mechanism design with fluid damping
    - Electromechanical engineering
    - Modelers for coupled fluid-structural systems
    - Small scale welders
- If any of these positions sounds like a good fit, let me know, and I'll take your resume/CV directly to the hiring manager

# Sandia Online

YouTube [www.youtube.com/user/SandiaLabs](http://www.youtube.com/user/SandiaLabs)

Top viewed videos:



Apothis destruction simulation



Z Machine at Sandia Labs



Rocket Powered Train Impact Test



<http://twitter.com/sandialabs>



[www.linkedin.com/home?trk=hb\\_logo](http://www.linkedin.com/home?trk=hb_logo)

Search by Group or Company



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