

# Multidisciplinary Research (MDR): An Engine for Innovation



*PRESENTED BY*

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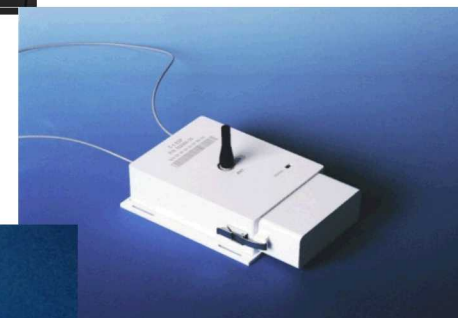
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# What is innovation?

- Anything new and useful
  - Creates new capacity, value
  - Significant positive change
- It can be
  - An item, system or a service
  - Evolutionary or revolutionary
- It is rarely born fully grown



# Innovation process

- It is the artistic process
  - Vision
  - Creativity
  - Intuition
- Balanced against
  - Ability
  - Time/resources
- Informed by science
- Enabled by technology





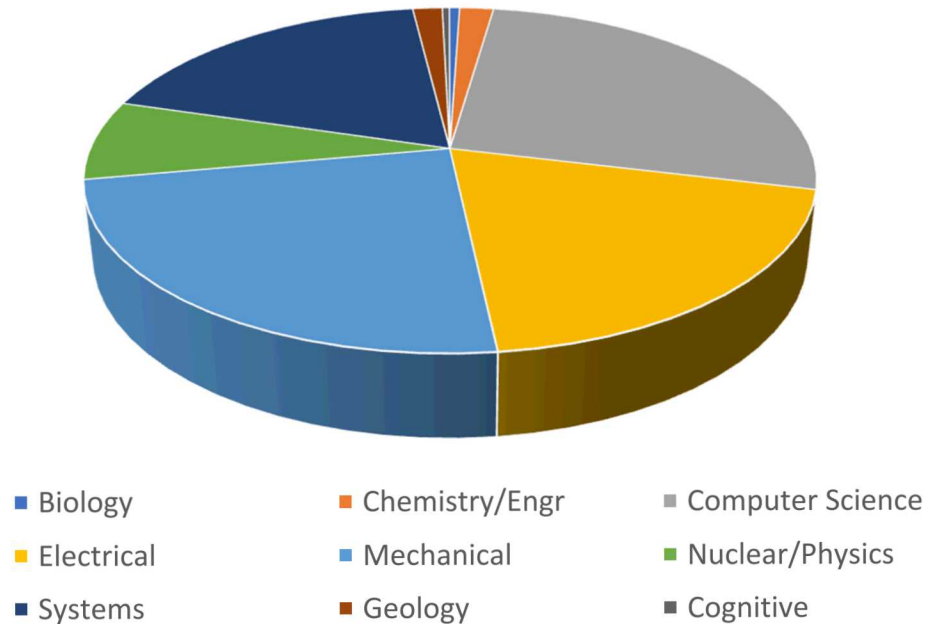
# Characteristics of innovative research teams

- Collaborative problem solving and collective genius
- Inclusive
  - Diversity of skills and perspectives
- Open communication
  - Minds and mouths
- Actively seek to
  - Combine opposing ideas
    - AND not OR
  - Reconfigure ideas into new ways

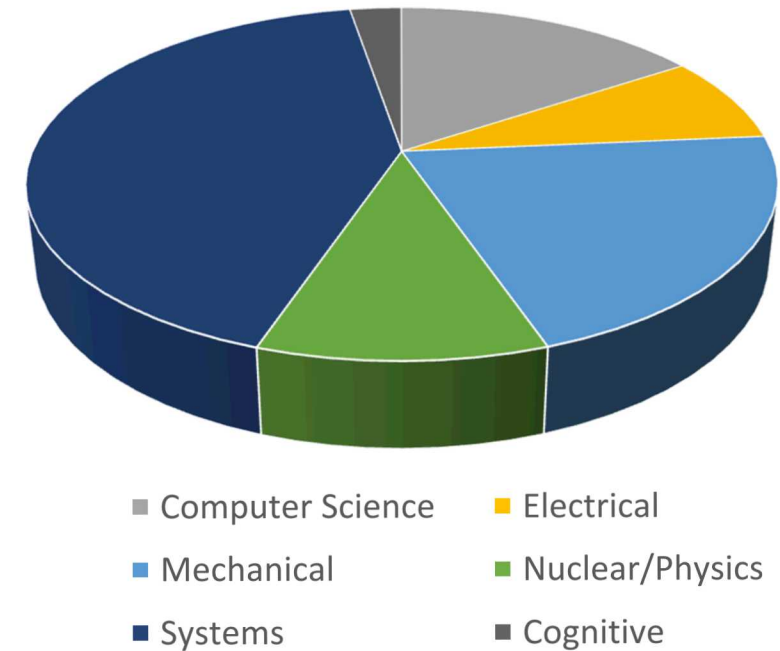


# At Sandia we have a technically diverse workforce

SNL Technical Staff

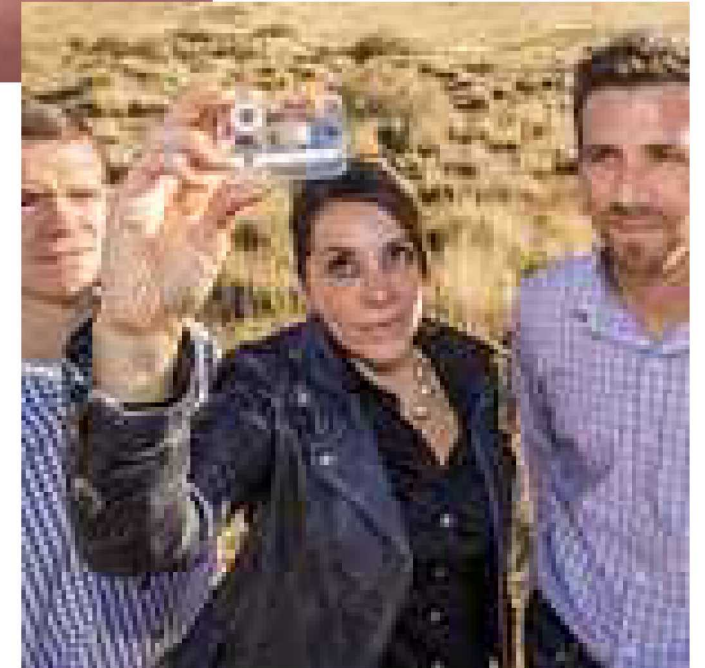


Nuclear Security and Nonproliferation Technical Staff



# MDR teams are needed for many of our challenges

- Understand application space
  - Translation of need to requirements
    - What it must do
    - How it must do it
    - Operational environments
    - Threats/vulnerabilities
  - Iterate with end users
- Assess and evaluate technical approaches
  - Disciplines
  - Technical risks
  - Technical Readiness Level (TRL)







# MDR examples-applied to Global Nuclear Security and Safeguards Mission



# Technical Challenge: Track Items

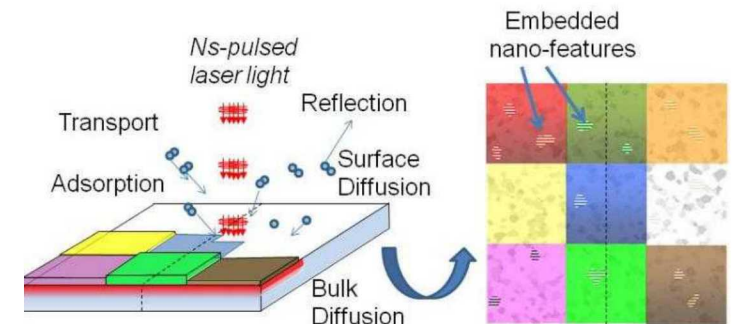
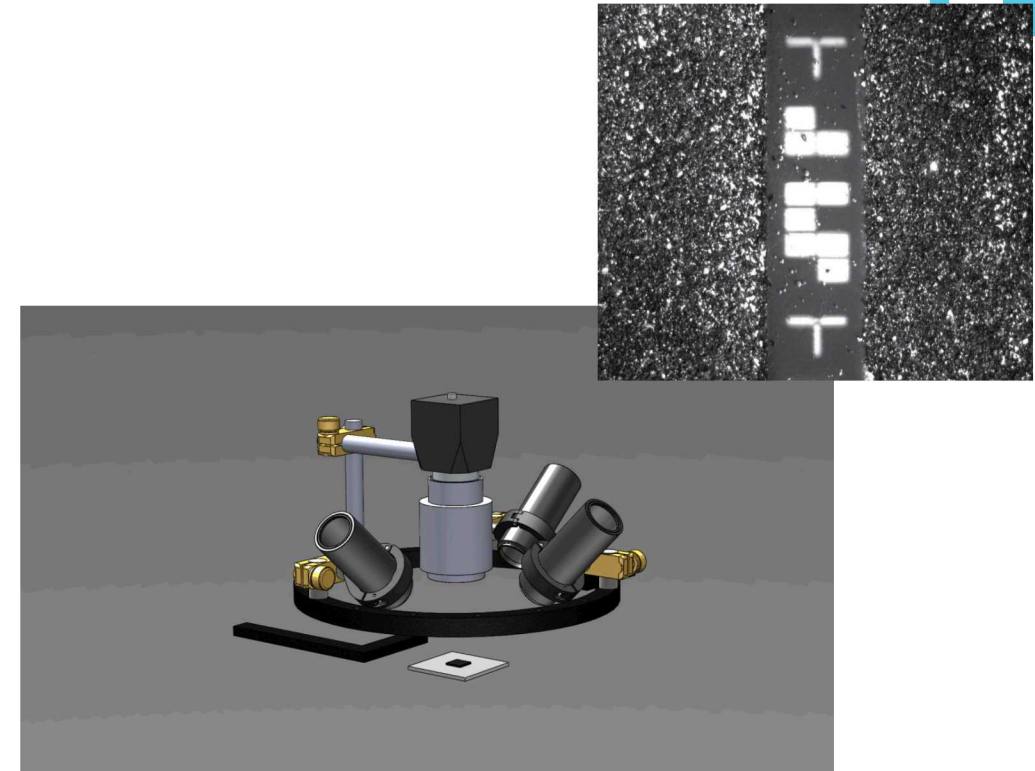
- Item Tag
  - Provides ability to uniquely identify asset
  - Can provide evidence of tampering
- Risks to Tags include
  - Complexity
  - Compromise
  - Counterfeit
- Efficiency in lifecycle deployment is optimal
- Technically skilled adversaries make tag research and advancement a necessity





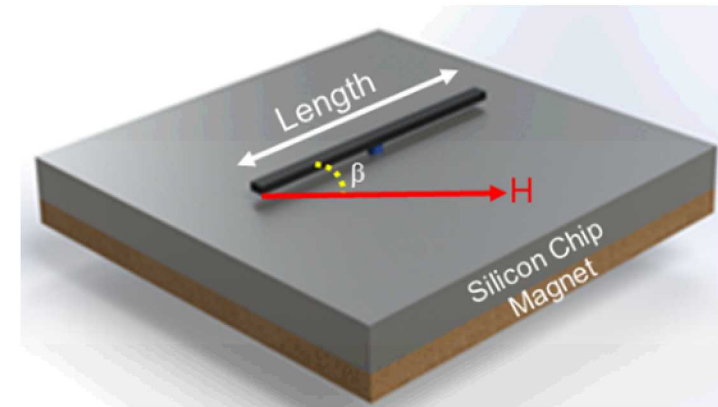
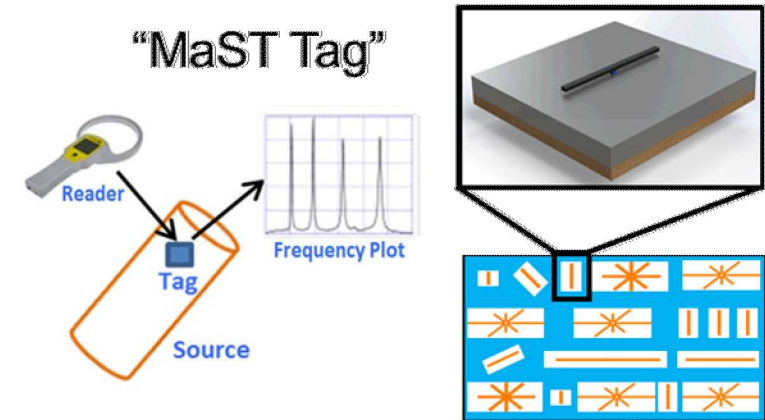
# Tags research: RPT & USE

- Reflective Particle Tags (RPT)
  - Hematite particles embedded in adhesive matrix that creates unique and difficult pattern to duplicate
  - Skills on research team: Nonproliferation safeguards, chemistry, physics, optics, modelling, and software engineer
- Unique Surface Encoded (USE) Tag
  - Intrinsic, unique identification markings and patterns
  - Skills on research team: Nonproliferation safeguards, chemistry, physics, material science



# Tags research: MaST

- Magnetic Smart Tag
  - Multi-resonator arrays that create unique response to near-field AC magnetic field interrogation.
  - Skills on research team: Nonproliferation safeguards, electrochemistry, physics, material science, microelectronics



**Resonator Frequency** is determined by the resonator length and magnetic bias angle,  $\beta$ .

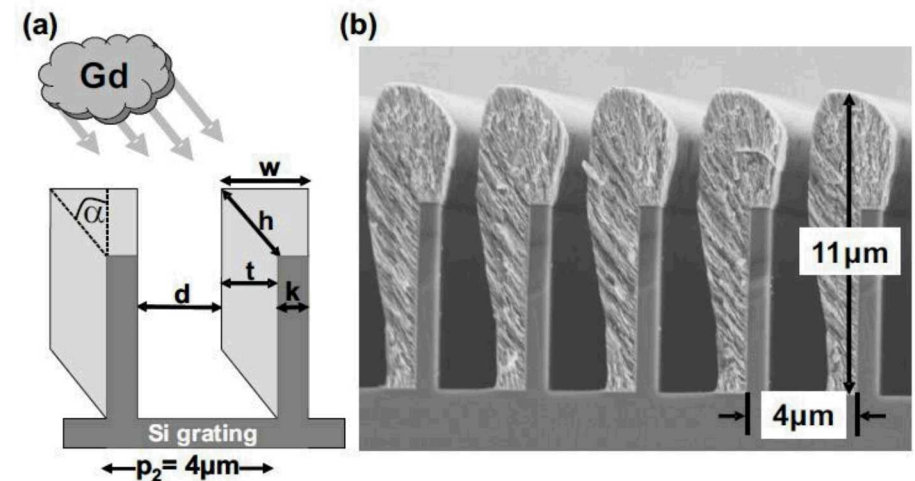
# Technical challenge: Material Characterization

- Neutron based measurements (i.e. scattering) recognized as key technique for elucidating broad range of physical phenomena
  - Atomic structure
  - Electromagnetic interplay
  - Interactions and flow of colloids and macromolecules
  - Dynamics and superstructure of complex biomolecule assemblies
- One recent research need requires coherent neutron beam
- The physicist defined the parameters of the beam but then needed to achieve it
  - Previous research by Swiss team resulted in prototype Gd neutron gratings



# Materials Characterization: Neutron Gratings

- Neutron Grating
  - Creation of coherent neutron beam as an interrogation technique
  - Skills on research team: additive manufacturing, physics, chemistry, electrochemistry, vacuum science



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# In conclusion

- Innovation results in new, often paradigm shifting, capabilities
- Diverse and inclusive research teams provide opportunities to explore broad range of options
  - Multidisciplinary team members allow for broad solution sets to be explored
- I have presented a few of the MDR projects in Global Nuclear Security and Safeguards at SNL
  - Many have patented IP
  - Some are continuing
  - Teams that were built continue to explore new opportunities and innovations



Thank you for your time.

**Questions?**

