ETI & LANL

Geoffrey Fairchild, Ph.D.

Consortium for
ENABLING TECHNOLOGIES & INNOVATION

LANL's Role in the Nuclear Nonproliferation Consortia

- Provide Unique Technical Opportunities for a Talented Student Pipeline
  - LANL provides students and faculty access to unique technical capabilities (facilities, expertise) helping them understand and tackle dynamic national security challenges through game-changing science and engineering.
- Educational Opportunities
  - NDA Fundamentals Course (Nuclear Inspector School)
  - Keepin Summer Program
  - Graduate Seminar Speakers
  - Adjunct & Advisory Faculty Members
- Technical Collaborations
  - Student Internships
  - Collaborative Research
  - Utilizing Unique Facilities
    - Nuclear Criticality Experiment Research Center, etc.
  - Hosting a LANL scientist
  - Hosting Postdocs and Professors
- Ultimate Landing Place of Consortia Alumni
  - Over 125 Consortia Student Interns in past 7 years
  - Over 30 Consortia Alumni on staff

Metropolis Center for Modeling & Simulation

SIGMA Facility

Los Alamos Neutron Science Center (LANSCE)

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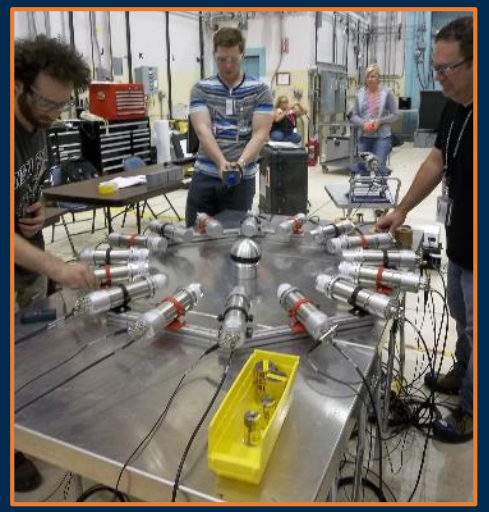
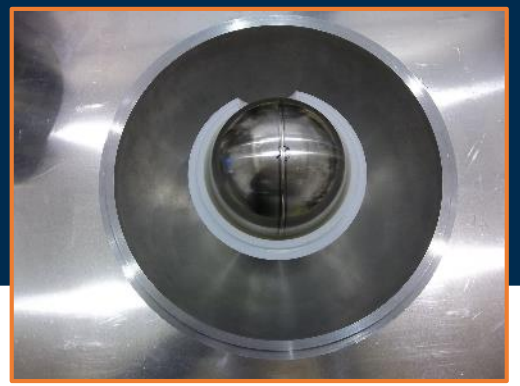
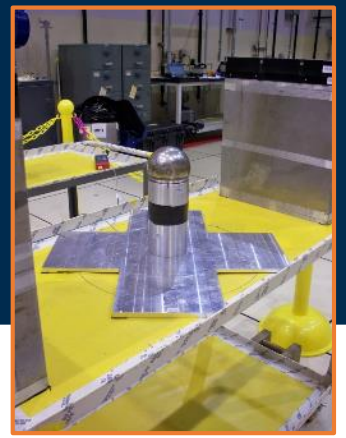
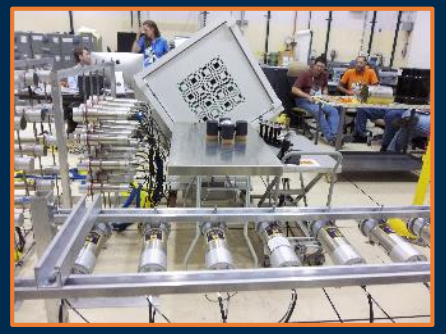
Unique Opportunities Example: Measurements at NCERC

- Provide students with a one-of-a-kind experience conducting subcritical experiments with Category I special nuclear material (SNM) at the Nevada National Security Site (NNSS)
- Conduct annual experiments with Cat I SNM at the NNSS
- Kicked off 2015, currently planning for the fifth year of measurements.
- Coordinated between various consortia with John Mattingly (NCSU) as lead
  - LANL provides the facility, the material, configurations, and material handling
  - The Universities provide the low Technology Readiness Level detection systems









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Unique Opportunities Example: Keepin Summer Program

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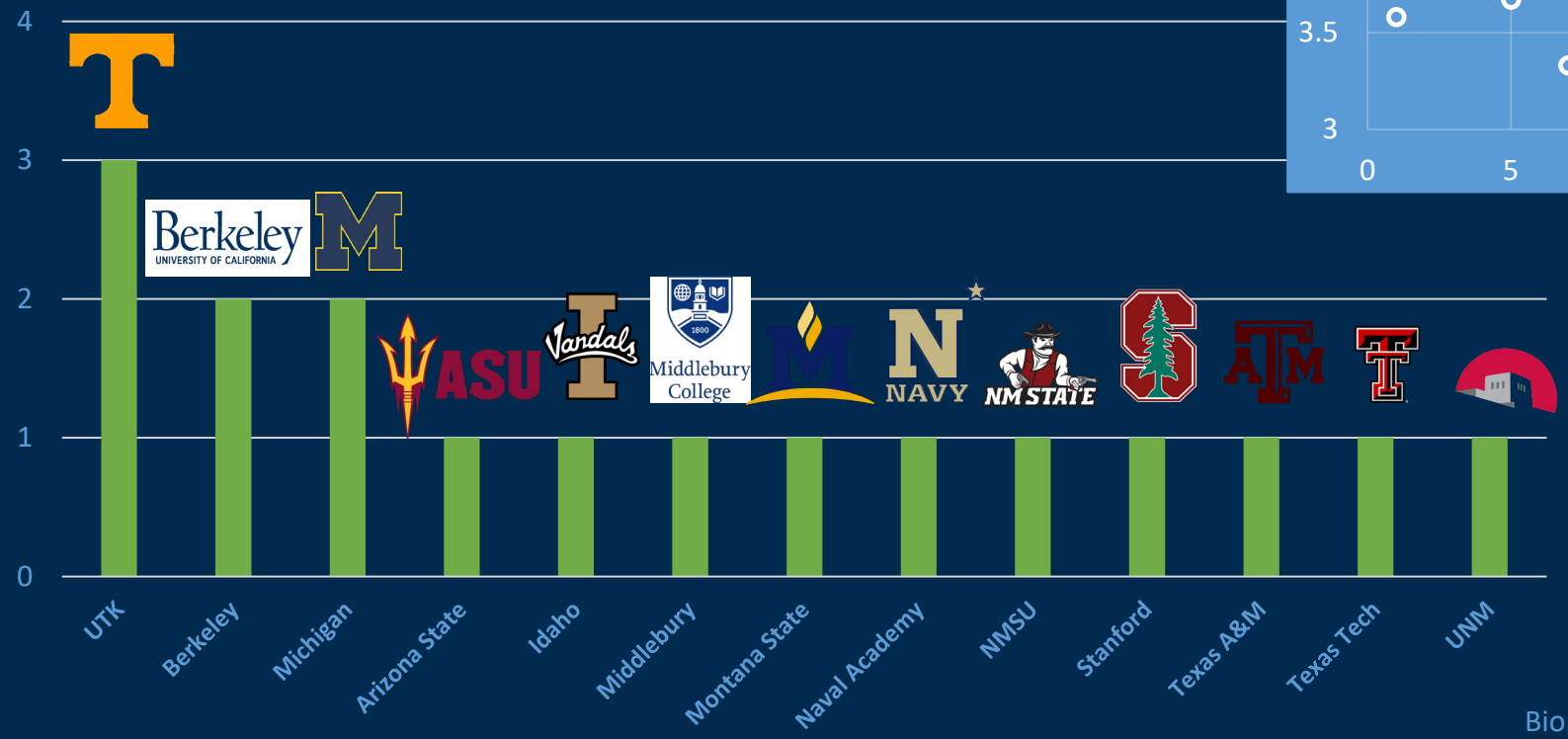
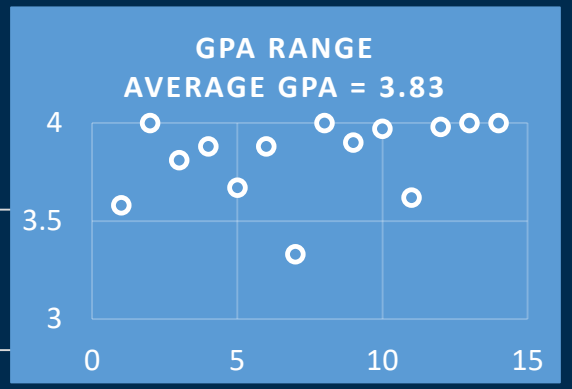
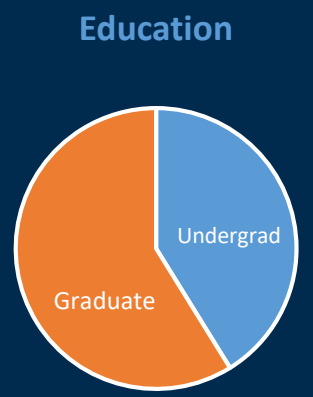
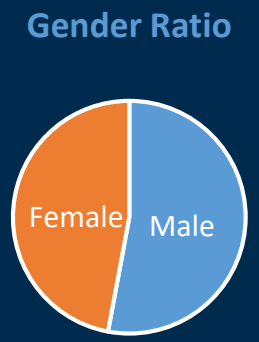
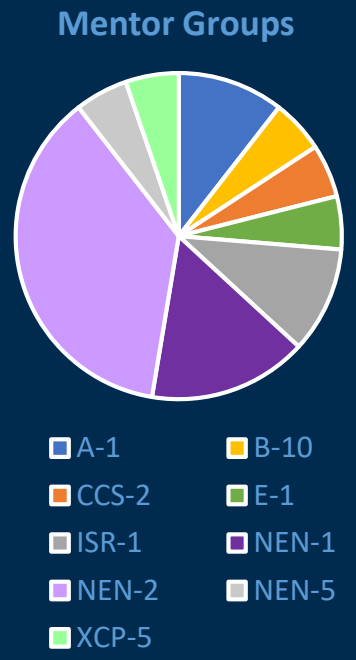
2019 Keepin Program: Student Demographics

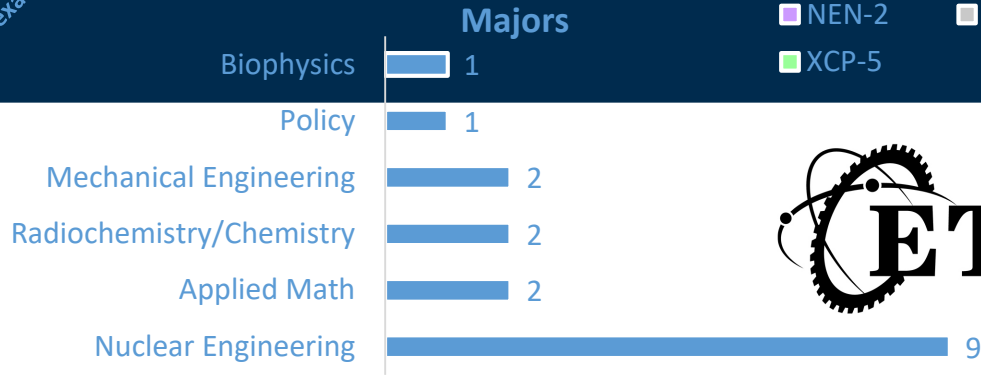












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Consortia Alumni Spotlight
Robert Weinmann-Smith: R&D Engineer

- Robby Weinmann-Smith
  - Ph.D. from University of Florida (CVT)
  - Completed PhD work in residence at LANL
  - Hosted by Safeguards Science & Technology group (NEN-1)
  - Research included:
    - Interrogation source neutron spectra
    - Uranium enrichment cylinder verification
  - Select Publications:
    - RK Weinmann-Smith, et al. Estimating the AmLi Spectrum from Measured Ring Ratios. 2016 Annual Consortium for Verification Technology Workshop. Ann Arbor, MI. October 2016
    - RK Weinmann-Smith, et al. Monte Carlo Modeling Study of an Unattended Cylinder Verification Station for UF6 Cylinders. Proceedings of the 57th Annual Meeting of the Institute of Nuclear Materials Management, Atlanta, GA. July 2016
  - Now working as a Staff member in NEN-1

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Summer Schools Hosted by LANL's Information Science and Technology Institute (ISTI)

- Parallel Computing Summer School – https://parallelcomputing.lanl.gov
- Supercomputer Institute – https://clustercomputing.lanl.gov
- Codesign School – https://codesign.lanl.gov
- Data Science at Scale School – https://datascience.lanl.gov
- Cyber Security School – https://cyberfire.lanl.gov/school
- Applied Machine Learning Research Internship – https://aml.lanl.gov
- Quantum Computing School – https://quantumcomputing.lanl.gov
- Computational Physics Workshop – https://compphysworkshop.lanl.gov

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https://www.lanl.gov/projects/national-security-education-center/information-science-technology/summer-schools/index.php

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Thrust Area 1: Computer & Engineering Sciences for Nonproliferation

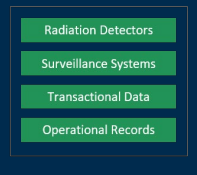
Fundamental Advances in Data Science Algorithms

Data Analytics for Nuclear Safeguards Applications

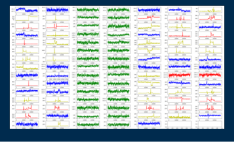
Vlad Henzl and Paul Mendoza

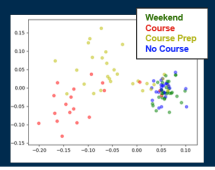
Safeguards Science and Technology group

- Experimental testbed for developing methods in multisource data integration for enhanced detection of undeclared activities at safeguarded facilities



Nuclear Facility → Disparate Data Streams





Persistent Collection → Activity Classification

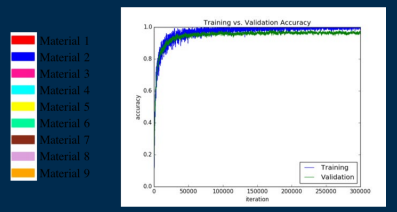
Machine Learning for Remote Sensing Applications

Kevin Mitchell

Chemistry & Physical Spectroscopy group

Earl Lawrence

Statistical Sciences group



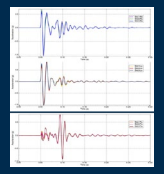
- Advanced machine learning, combined with physics-based processing, for target identification in hyperspectral imagery

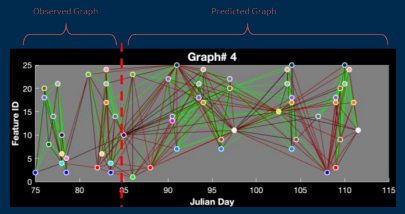
ADAPD: Advanced Data Analytics for Proliferation Detection

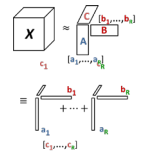
James Smith

ADAPD Science Integration Lead

- New data science methods for integrating direct and indirect data and subject matter expertise (SME) to enhance early detection of proliferation
- SME-based process models integrated with machine learning predicting temporal event sequences and physical observables







Plus many others! – MINOS, Persistent Dynamics, and more!

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Thrust Area 2: Advanced Manufacturing for Nonproliferation

Additive Manufacturing

Paul Dunn and Deniece Korzekwa

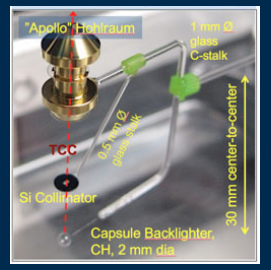
SIGMA Division

- Additive manufacturing is used throughout LANL on various materials including metals, polymers and ceramics
- Employing manufacturing science to understand the relationship between processing parameters, material properties and part performance
- Sensors and diagnostics during fabrication that can guide understanding of the process physics as well as ensure product quality

Pressure vessel additively manufactured from stainless

Micro-manufacturing

Engineered Materials group



- LANL's Target Fabrication Facility designs and manufactures target assemblies for inertially confined fusion experiments.
- These assemblies typically have specialized materials created through chemical synthesis, additive manufacturing, and coating technologies.
- These materials are then micro-machined to have micron tolerances.
- Once assembled, they are analyzed to ensure quality of the finished part.

Micro-reactors / Micro-fluidics

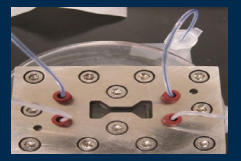
Becky Chamberlin

Actinide Analytical Chemistry group

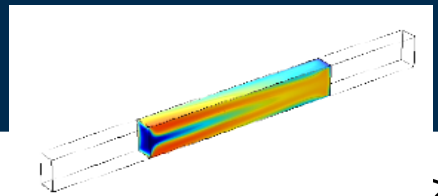
George Goff

Materials Synthesis and Integrated Devices group

- Design, fabrication and testing of functional micro-reactor chips for extractive metallurgy



- Multiphysics modeling of the phenomena occurring at the micro-reactor length scales



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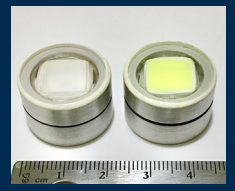
Thrust Area 3: Novel Instrumentation for Nuclear Fuel Cycle Monitoring

Novel Instrumentation – Development from Materials through Applications

Jesson Hutchinson *using "Bubble" detector with students at the NCERC/DAF*

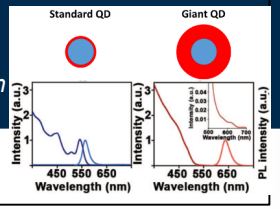
UF6 Cylinder Counter



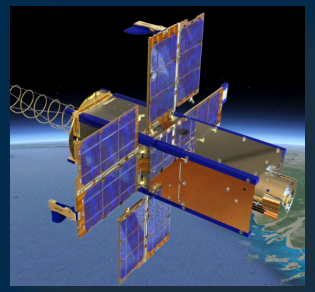
Wavelength shifting coatings convert scintillation wavelength to longer wavelengths that are better matched with the high QE of photodiodes

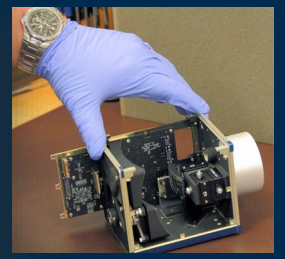
LANL's "giant" quantum dots:

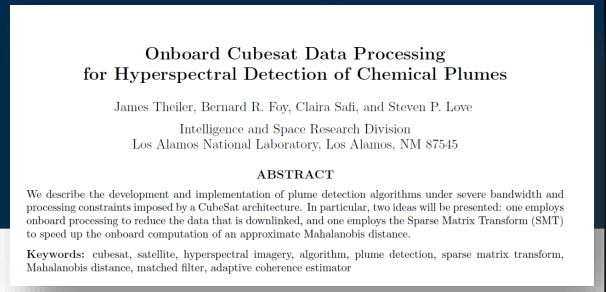
- *Highly tunable emission across entire visible region*
- *Lack of self-reabsorption*



CubeSat-based Hyperspectral Imaging for Atmospheric Trace Gas Monitoring







Onboard Cubesat Data Processing
for Hyperspectral Detection of Chemical Plumes

James Theiler, Bernard R. Foy, Claira Safi, and Steven P. Love

Intelligence and Space Research Division
Los Alamos National Laboratory, Los Alamos, NM 87545

ABSTRACT

We describe the development and implementation of plume detection algorithms under severe bandwidth and processing constraints imposed by a CubeSat architecture. In particular, two ideas will be presented: one employs onboard processing to reduce the data that is downlinked, and one employs the Sparse Matrix Transform (SMT) to speed up the onboard computation of an approximate Mahalanobis distance.

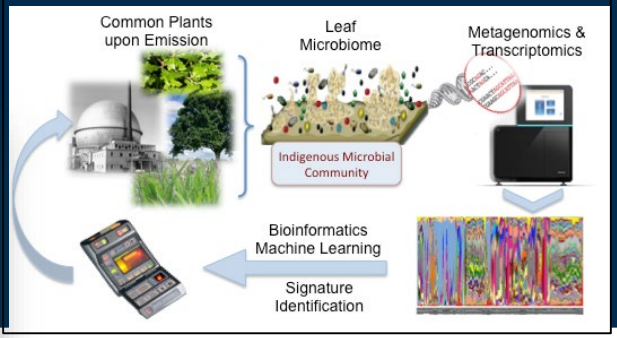
Keywords: cubesat, satellite, hyperspectral imagery, algorithm, plume detection, sparse matrix transform, Mahalanobis distance, matched filter, adaptive coherence estimator

Leaf microbiome as a monitoring tool for nuclear activities

Helen Cui

Biosecurity and Public Health group

- Examine and characterize metagenomic signatures in leaf microbial communities that respond to specific chemical and/or radiation signals from nuclear production activity.



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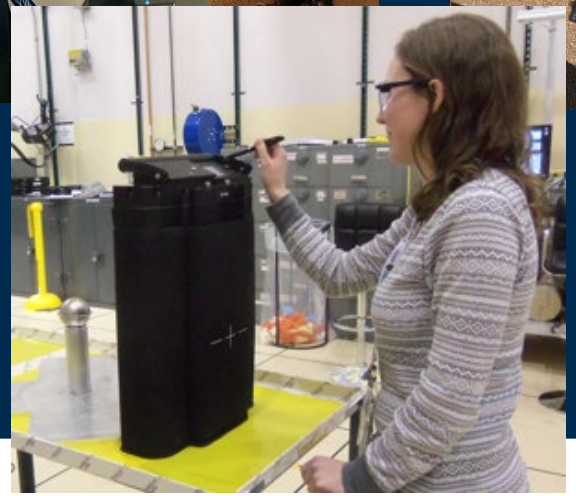
Consortia Students at LANL



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