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National Center for Nuclear Security

The Nuclear Forensics Project

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National Center for Nuclear Security (NCNS) Mission

- Chartered mission is to enhance the Nation's verification and detection capabilities in support of nuclear arms control and nonproliferation through R&D activities at the NNSS
- Three focus areas:
  - **Treaty Verification Technologies**
  - **Nonproliferation Technologies**
  - **Technical Nuclear Forensics**

What is Nuclear Forensics?

- The collection, characterization, analysis, and evaluation of nuclear or radiological materials, samples, devices, constituent parts, output signals, debris, and other related items resulting from the illicit use or intended use of radiological or nuclear material.
- Established within U.S. Government in several ways, including Public Laws (e.g., PL 111-140, the Nuclear Forensics and Attribution Act of 16 Feb. 2010)
- A "key Administration initiative" in the Nuclear Posture Review (U.S. Dept. of Defense, April 2010)
- These interests reinforced in the DOE Strategic Plan (May 2011) & National Nuclear Security Administration Strategic Plan (May 2011)

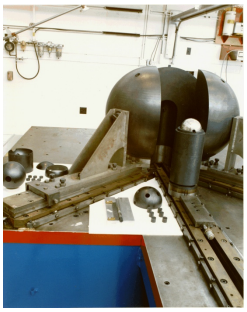
Nuclear Forensics Project

Objectives: Reduce uncertainty in the nuclear forensics process & improve the scientific defensibility of nuclear forensics conclusions when applied to near-surface nuclear detonations

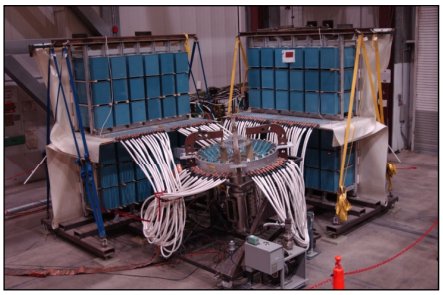
- Research in 4 threads:
  - Nuclear Physics
  - Debris collection and analysis
  - Prompt diagnostics
  - Radiochemistry
- Complementary to other Department of Energy (DOE) nuclear forensics R&D
- Field experimentation plan in development

Nuclear Physics: An emphasis on utilizing the Dense Plasma Focus (DPF) devices and the criticality machines hosted at NNSS

- R-value measurements
- Short lived fission product yield determinations
- Isotopic cross section measurements



Flattop Assembly



Dense Plasma Focus (DPF) rotated tube

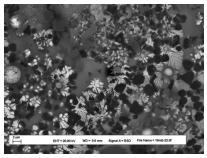
Prompt Diagnostics: Development of instruments and techniques to measure prompt signals from a nuclear detonation

- Experiments to validate and verify predictive models of prompt signal propagation
- Validation of radiation transport simulations
  - Large MCNP computational scale of high-fidelity calculations
- Test diagnostic sensors of prompt signals that have characteristics similar to those of weapons outputs and weapons effects
  - Optical signals
  - Radiofrequency (RF) signals
  - Overblast Pressures
  - Other

Nuclear Detonation – the Climax shot (1953) at the U.S. Nevada Test Site.

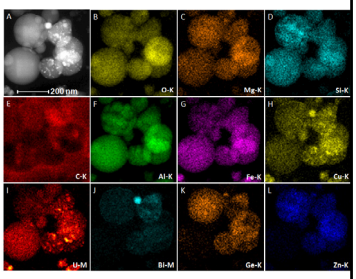
Debris Collection and Analysis

- Collect fallout debris samples deposited on the ground from several legacy near-surface NNSS (NTS) nuclear shots
- Work involves field sample collection, field packaging and radioanalytical assessment



Radiochemistry

- Research on the production and measurement of diagnostically useful radioisotopes that are in the refractory debris matrices that can be formed in an urban nuclear detonation.
- Create synthetic urban debris for scenario response and experiments
  - Develop production methods for surrogate debris with compositions relevant to nuclear forensics data evaluation
  - Materials containing radioactive and stable isotopes
- Research conducted independently and collaboratively
  - LANL
  - LLNL
  - NSTec
  - PNNL
  - UNLV
- Exercise nuclear forensics laboratory analysis capabilities



X-ray mapping of debris. Note the mottled distribution of all elements including Si and O

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BEEF: Big Explosive Experimental Facility

- High Explosive testing
- Can do experiments using signals and properties of explosions
- Offers vital data in support of arms control & treaty verification

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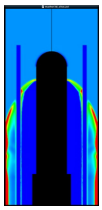
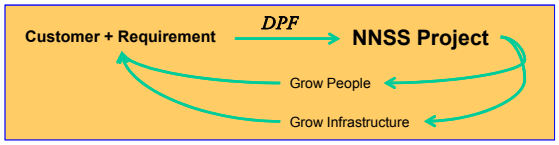
Dense Plasma Focus: Characterization, Calibration, and Qualification of Detectors, & Detection Systems



- Dense Plasma Focus Labs
- Two major sources
  - Most powerful operating DPF
    - 1 x 10^{12} DD neutrons/pulse
  - DT source at NNSS
    - 1 x 10^{12} DT
    - Staged upgrade
      - 10^{13} Fy12, 10^{14} FY13 (DT)
      - R = 5 cm, thus very high per pulse fluence
  - Fission and Thermals
- NCNS Forensics
  - R-value experimental support
  - Activation
  - Cross-section
  - Sample production
- Lab Support
  - Neutron Resonance Spectroscopy
  - K_{eff} (future)
  - System Calibration
    - LANL U1a
    - SNL
    - LLNL
  - Large BEEF experiment
- DTRA and University support
- Other Support



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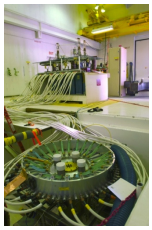
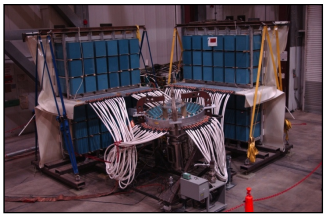


Neutron Services



NCNS Phase1 DT source Upgrade	Neutron Resonance Spectroscopy	NCNS Physics	DE&SS Physics	Short Term
• X 10 Yield • Horizontal LOS • Forensics • NRS • Imaging • Keff Prep	• Feasibility Study, DD • Static Temp System • Static DT Temp Measure • Dynamic with High Yield DT	• 3 Physics • 1 Rad-Chem • Characterize Source • Neutron Driven Assembly	• U1a detector cal • X-ray streak • LLNL irradiate • SNL Calibration • Imaging • Keff Study	• SDRD • Active Interrogation • HS&DA Support

These are NOT independent activities !! They are inter-related.

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NCNS – Nuclear Forensics and Non Proliferation– Conclusions

- Development of a Nuclear Forensics Test Bed
  - Collaborative experiments
- Using existing facilities and locations as appropriate
  - BEEF, NPTEC, Dense Plasma Focus, NCERC
- Attacking problems from the basic science perspective to make significant advances in Nonproliferation technologies
  - Improving uncertainties on R-value measurements
  - Debris characterization
  - Short-lived fission studies
  - Prompt technology advances and testing
  - Creation of synthetic debris

Questions?