U.S. DEPARTMENT OF ENERGY | Nuclear Energy

Nuclear Energy University Programs (NEUP)
Fiscal Year (FY) 2016 Annual Planning Webinar

Nuclear Materials Control and Instrumentation (FC-3)

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FC: 3 Next Generation Nuclear Materials Management

- **Mission** – Develop innovative technologies and analysis tools to enable *next generation nuclear materials management* for existing and future U.S. nuclear fuel cycles, to manage and minimize proliferation and terrorism risk.
- **Objectives**
  - Develop and demonstrate advanced material control and accounting technologies that would, if implemented, fill important gaps
  - Develop, demonstrate and apply MPACT analysis tools to assess effectiveness and efficiency and guide R&D
  - Develop tools, technologies, and approaches in support of used fuel safeguards and security for extended storage, electrochemical processing, and other advanced nuclear energy systems

  Technology Development

  - Perform technical assessments in support of advanced fuel cycle concepts and approaches

  Applications

  - Develop guidelines for safeguards and security by design and apply to new facility concepts

  Leadership

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MPACT Campaign – 5-Year High Level Milestones

- **Develop field test plans for at least two promising new instrumentation technologies (*completed 2014*)**
- **Initiate at least three new exploratory instrumentation projects (*two in 2014*)**
- **Develop an integrated approach for EChem safeguards and security**
- **Test at least two technologies for EChem safeguards and security**
- **Perform sensitivity studies for EChem safeguards and security performance**
- **Develop a risk-based concept and approach for safeguards and security of used fuel extended storage**
- **Develop physics-based time-dependent signatures to guide advanced monitoring technology development**
- **Perform consequence and vulnerability assessments of used fuel extended storage and advanced nuclear energy systems of interest**

2020 Milestone – complete lab-scale demonstration of advanced safeguards and security system

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Long Term Objectives (10 – 20 years)

- Help to establish Safeguards and Security by Design as a standard paradigm for nuclear energy systems
- Demonstrate and implement next generation nuclear materials management technologies and approaches
  - Echem, H-Canyon, bilateral engagements, new fuel cycle facilities,…
- Address safeguards and security issues associated with technology development in other Campaigns
- Support NRC rulemaking through engagement and data generation
- International engagement to help influence and support the nuclear energy enterprise and demonstrate U.S. leadership

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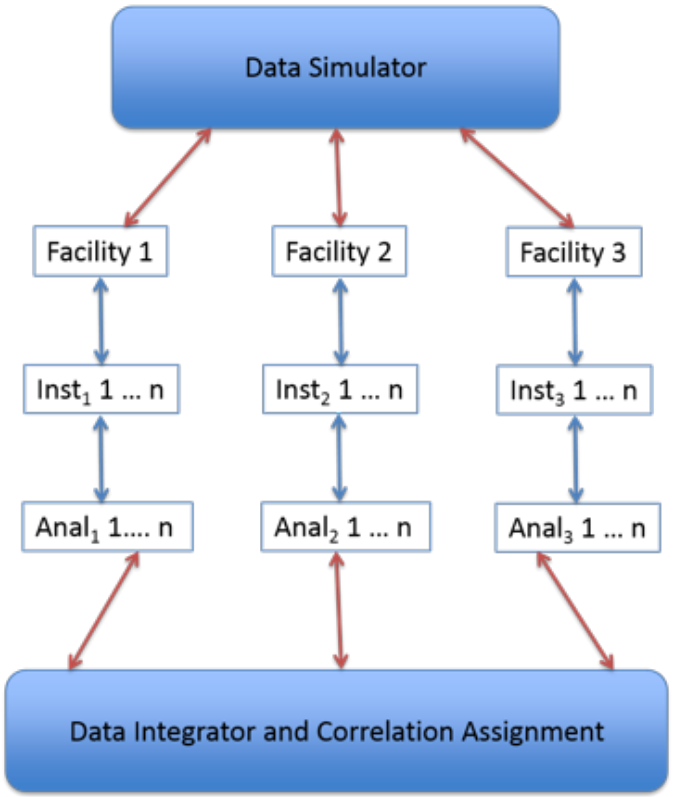
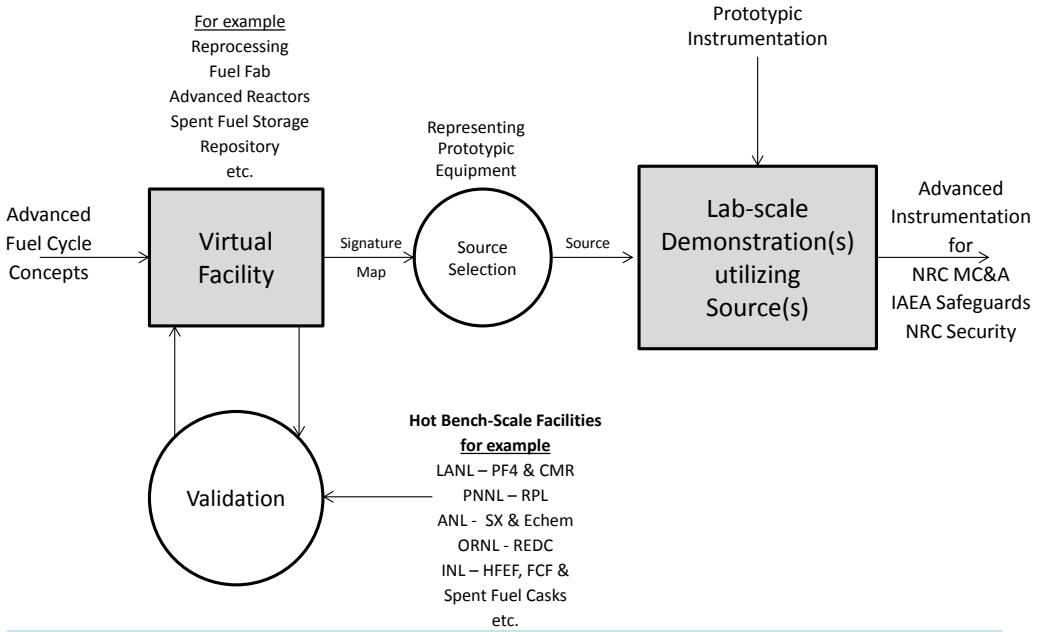
Distributed Test Bed for Lab-Scale Demonstration





- **Take advantage of facilities, materials, capabilities where they exist**
- **Data driven, gaps bridged by modeling and simulation**
- **Applicable to process, facility and fuel cycle level**
- **Integrated analysis of process, facility, fuel cycle performance**

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Nuclear Material Control and Instrumentation (FC-3)

"Advanced Safeguards Data Integration:

Methods to integrate and distill data from traditional nuclear material accountancy with other data streams to achieve a higher level of awareness of nuclear material flows are being sought.

An example of particular interest to the Fuel Cycle Technologies R&D program is the case of electrochemical processing where integration of traditional nuclear material accountancy data (with assignable uncertainties) with advanced process monitoring (salt level and density, voltages, temperatures, etc.) is needed for near real time accountancy and process awareness. Such methods should keep an eye towards decreasing the Standard Error of the Inventory Difference (SEID) by innovative means of integrating data streams of relevant process data."

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Backup

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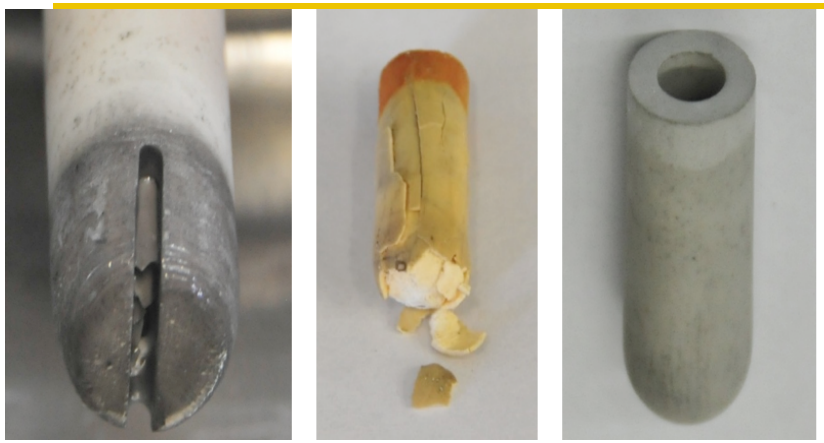
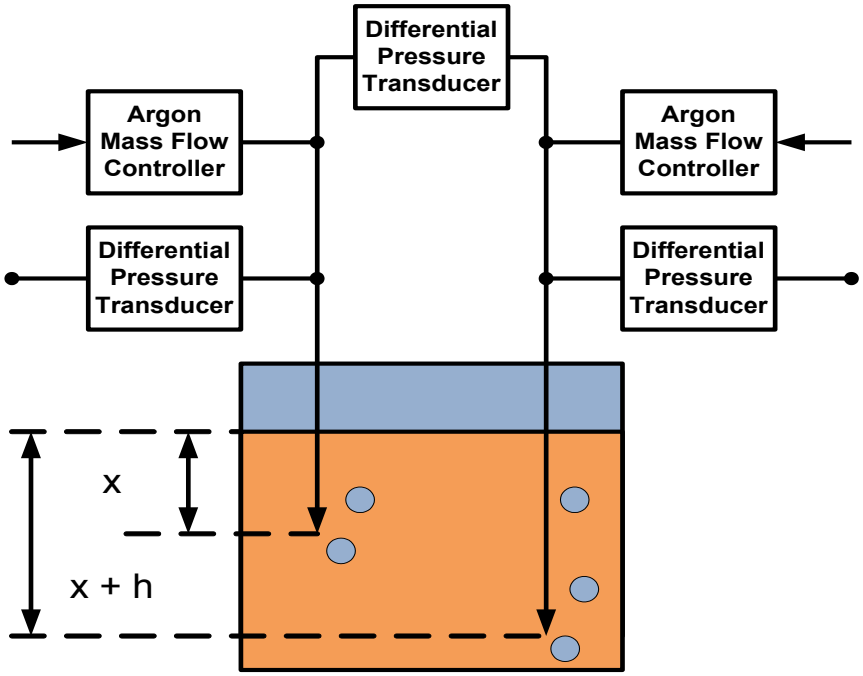
Potentiometric Sensors and Double Bubbler for Electrochemical Processing



- Ion exchange sensor for direct measurement of Pu in molten salt using β”-alumina as carrier material
- Precursors tested – Sr^{+2}, K^{+}, and Na^{+}, with only Na^{+} surviving molten salt test



- Differential pressure sensors for level and density measurement of molten salt

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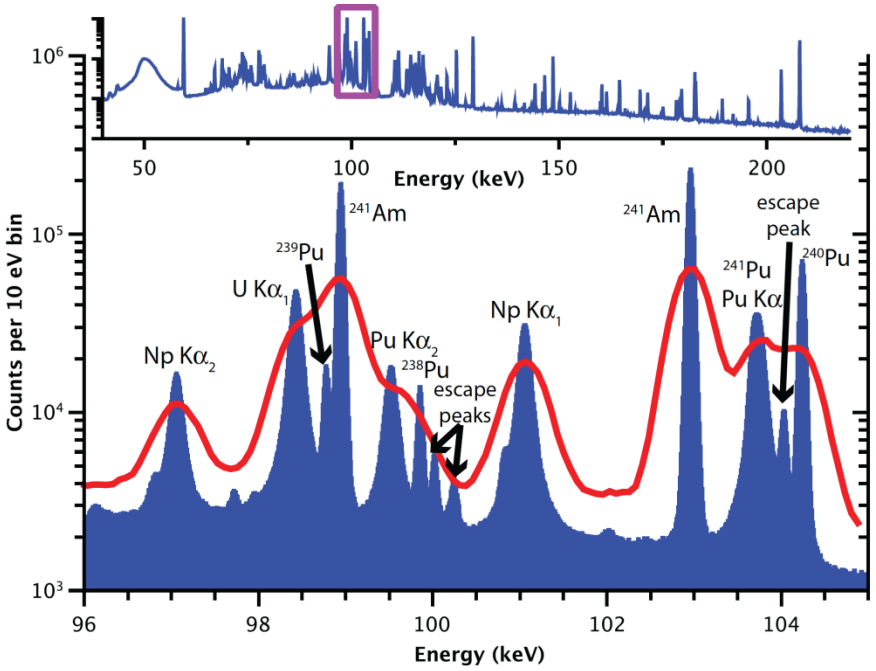
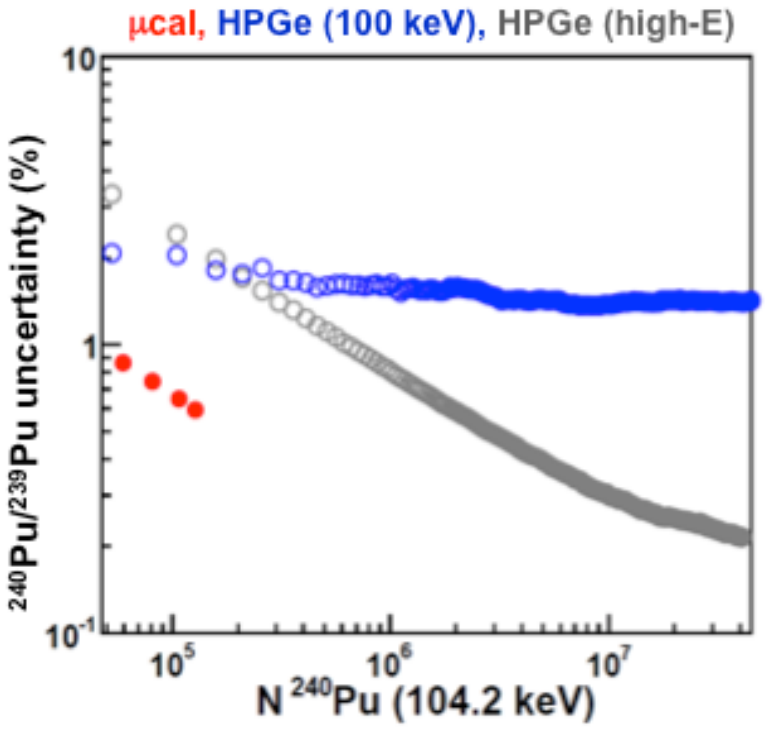
Super-High Resolution Gamma-Ray Spectroscopy



- Significant improvement in the uncertainty of Pu isotopic determination demonstrated

- Cryogenic gamma-ray spectroscopy has demonstrated 10x improvement in resolution over HPGe



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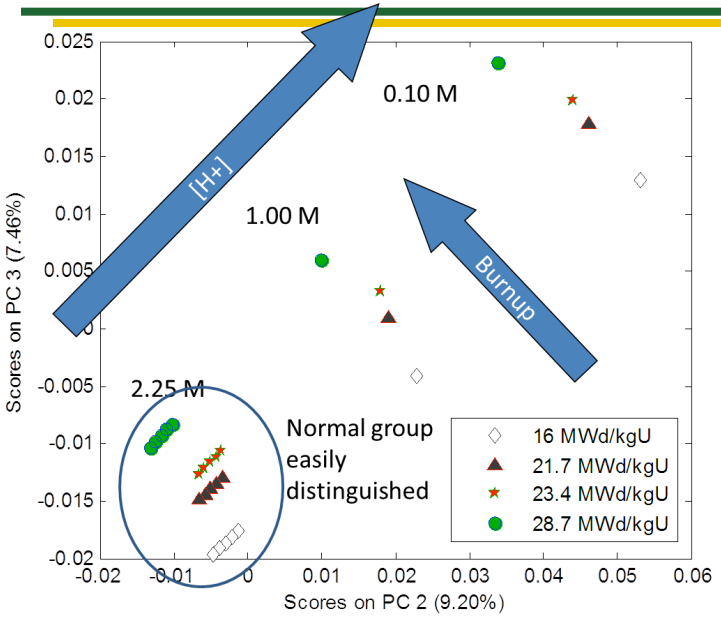
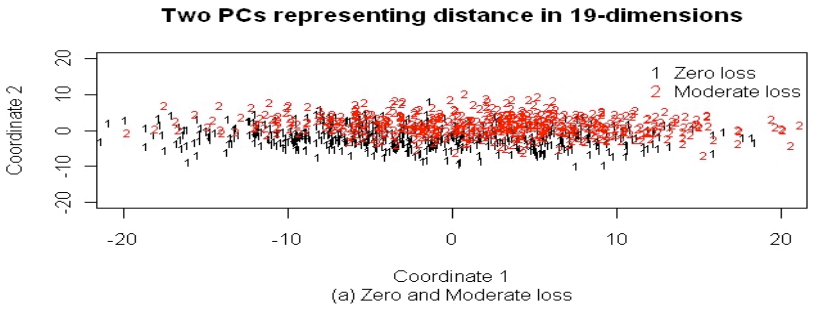
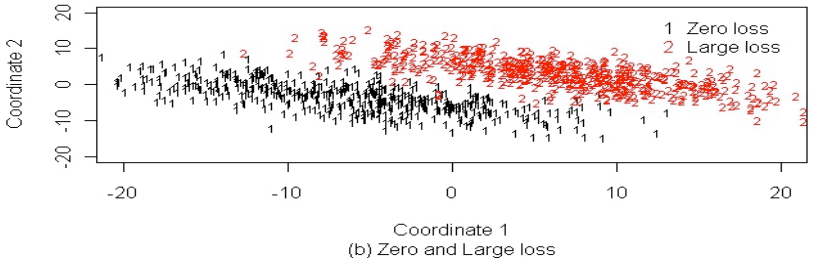
Multi-Isotope Process Monitor and Pattern Recognition



- **Correlation of multiple isotopes via gamma spectroscopy to enable detection of process changes**



- **Pattern recognition of multivariate data – putting process monitoring on equal footing with nuclear material accountancy**



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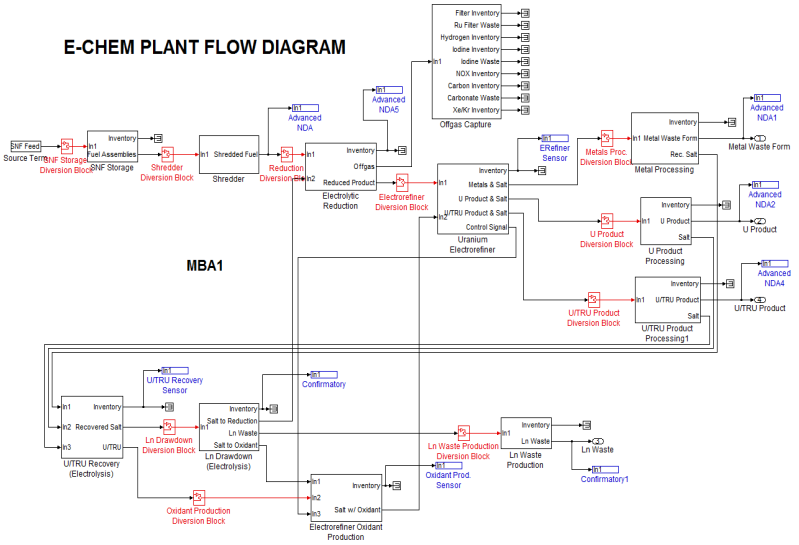
Safeguards and Security Performance and Fundamental Chemistry Models



- Facility model incorporating safeguards and security can be used to conduct system performance studies, including uncertainties

- Fundamental chemistry models can aid understanding in how nuclear material behaves thereby facilitating its management and control