

Advanced Fuel Cycle Initiative
Transmutation Science Interests,
ADS Facilities and Research Needs

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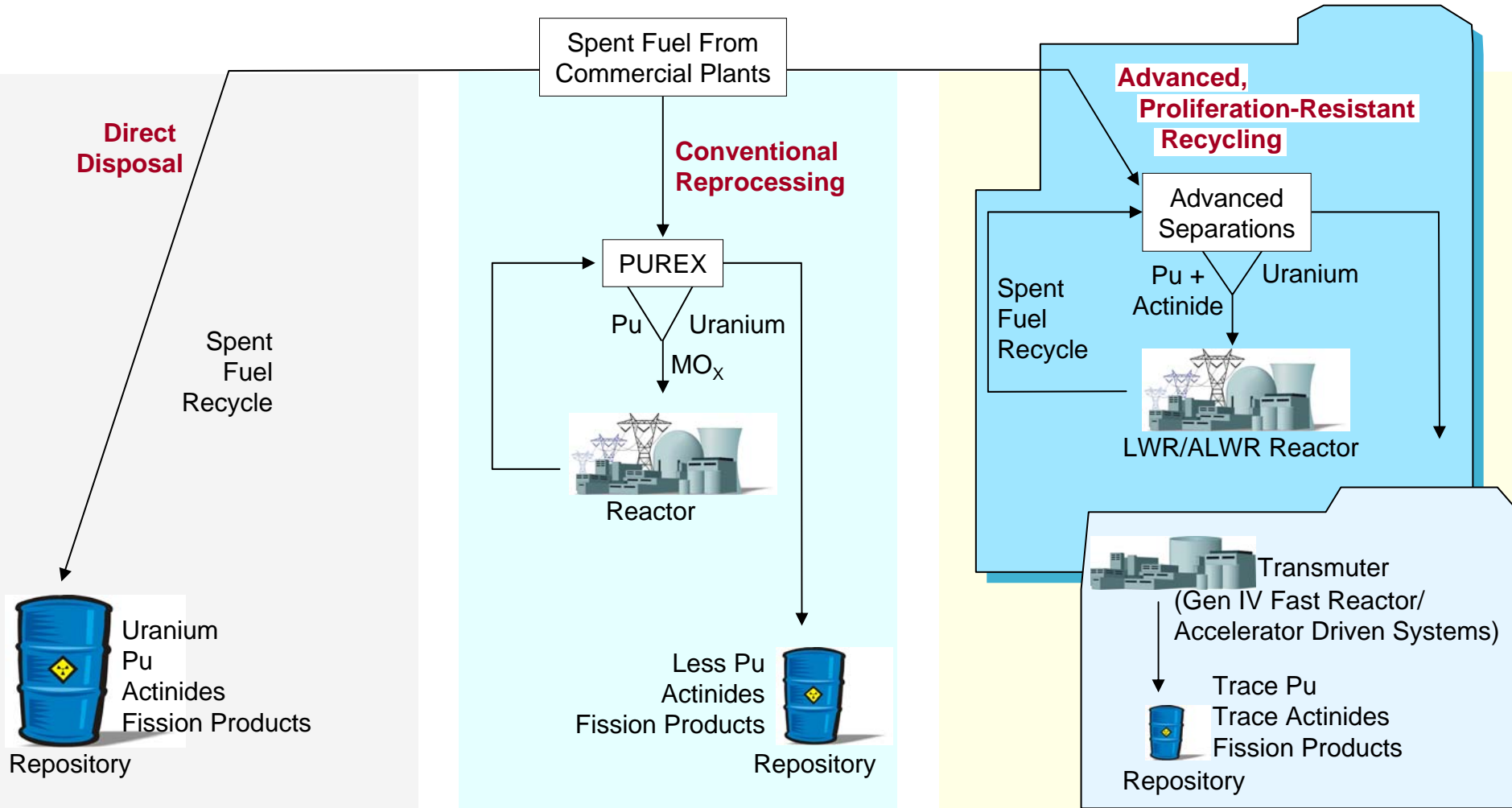
Outline

- Transmutation and ADS in the context of the AFCI program
- Role of Transmutation Science
- Future role of ADS in transmutation
- Facility and Research Needs

The AFCI Program Addresses the Issues of Spent Nuclear Fuel and Nuclear Material Management

- **Vision**
Sustainable nuclear energy and environmental quality.
- **Goals**
 - Eliminate the need for a second repository
 - Reduce plutonium inventories by 99%
 - Close the Fuel Cycle using advanced separations and safeguards
 - Reduce the threat of nuclear weapons proliferation
- **Plan**
 - Provide the secretary with sufficient information in the 2007 time frame regarding a recommendation on the second repository
 - Develop proliferation resistant technology to reduce the volume of SNF
 - Develop advanced fuels that enable proliferation resistant consumption of plutonium
 - Develop proliferation-resistant treatment and transmutation technologies to significantly reduce the toxicity of SNF

To Provide Alternative Solutions to Waste Management, the AFCI is Investigating Open versus Closed Fuel Cycles

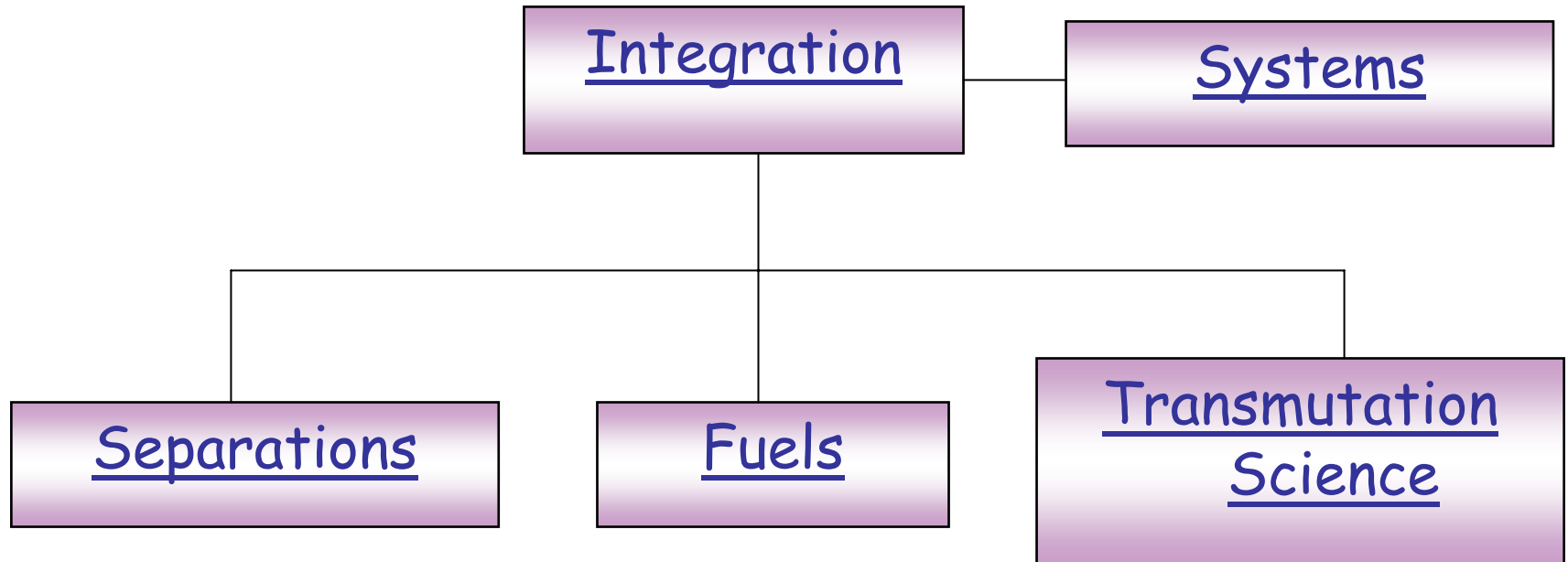


Once Through Fuel Cycle: The Current Approach in the US

Plutonium Re-Cycle

AFCI - Proliferation Resistant 4 Fuel Cycle Options

The AFCI is Organized in Four Main Functional Areas



Objectives of Transmutation Science: Research Interests

- Develop engineering basis for the transmutation of Plutonium, minor actinides and long-lived fission products. Support for key program decisions and the DOE 2007 decision on the second repository:
 - Fuel Cycle implementation strategy
 - Transmutation System to be used in the Fuel Cycle

ADS

- Coupling of accelerator to sub-critical reactor
- Operation and safety
- Target technology
- Accelerator reliability

Materials

- Structural material degradation during irradiation: material limits
- Coolant technology and corrosion mitigation for fast spectrum reactor and ADS

Physics

- MA nuclear data in thermal, epi-thermal and fast spectra
- MA safety data
- Computational Codes

The Role of ADS is to Complement Reactors in a Closed Fuel Cycle

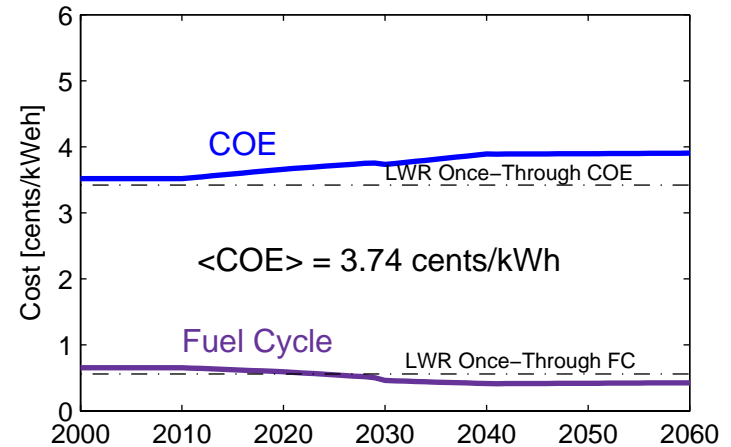
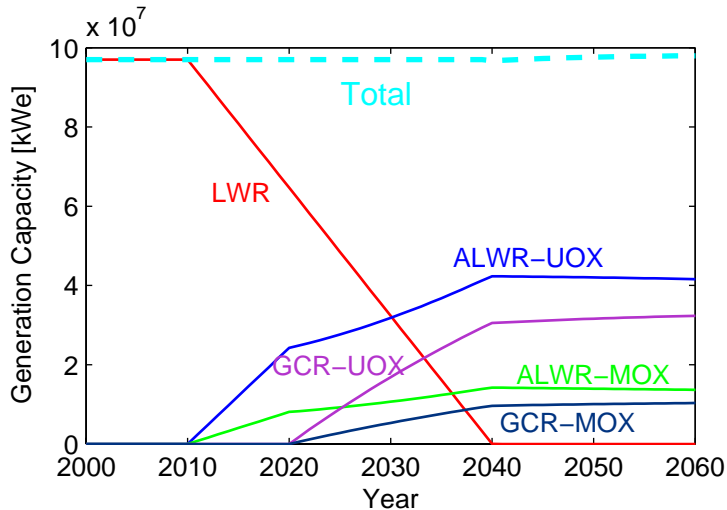
ADS is cheaper per unit mass of TRU transmuted.

Reactors are cheaper per unit of electricity produced.

Thus, the choice depends on the relative importance of cheaper electricity versus cheaper nuclear waste disposal

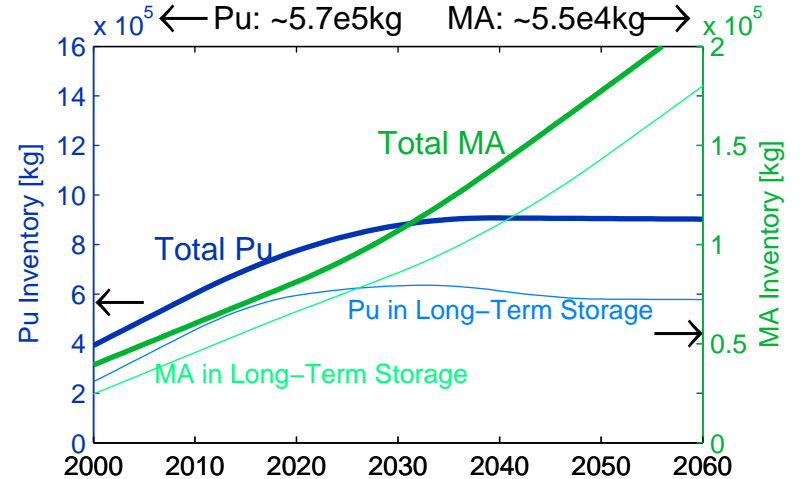
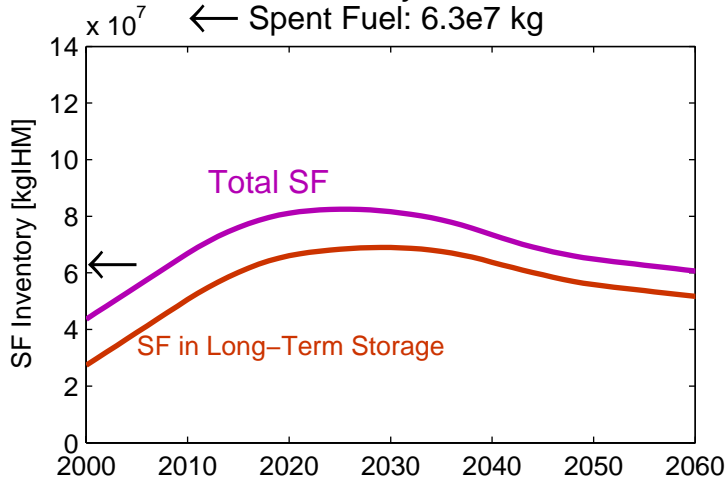
The correct answer for the U.S. should be an optimized combination of reactors and ADSs where the ratio is adjusted based on the future nuclear energy demand.

System Analysis Example: MOX Recycle Can Stabilize Pu Inventory, but Minor Actinides are Still an Issue

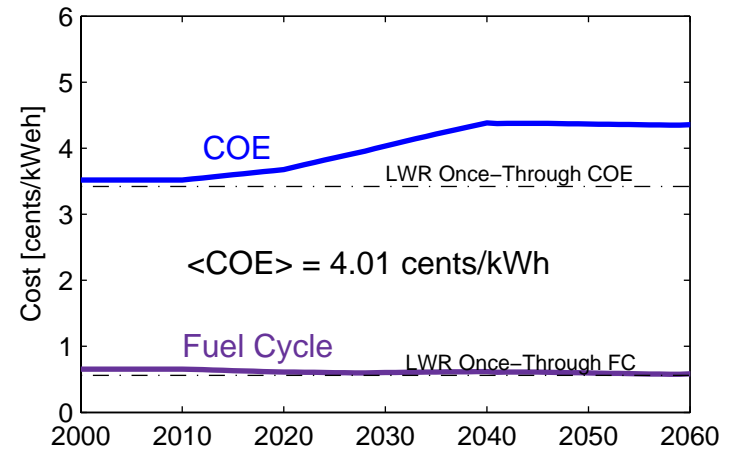
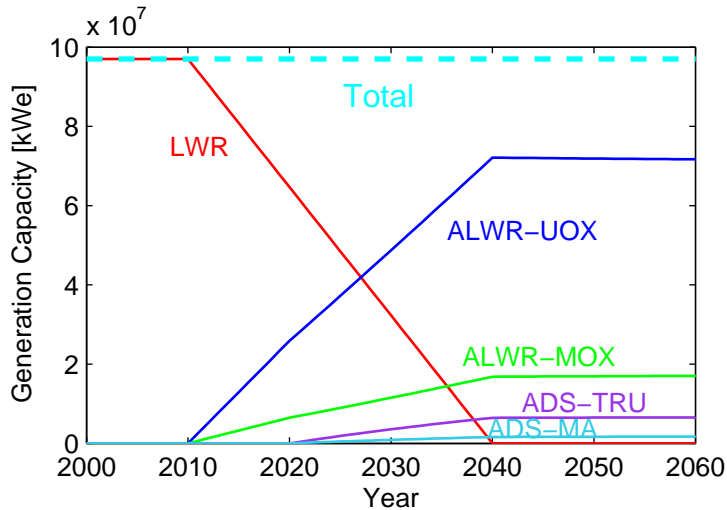


YM statutory limit is 63,000 MTIHM. For three LWR waste forms, this limit is:

← Spent Fuel: $6.3e7$ kg

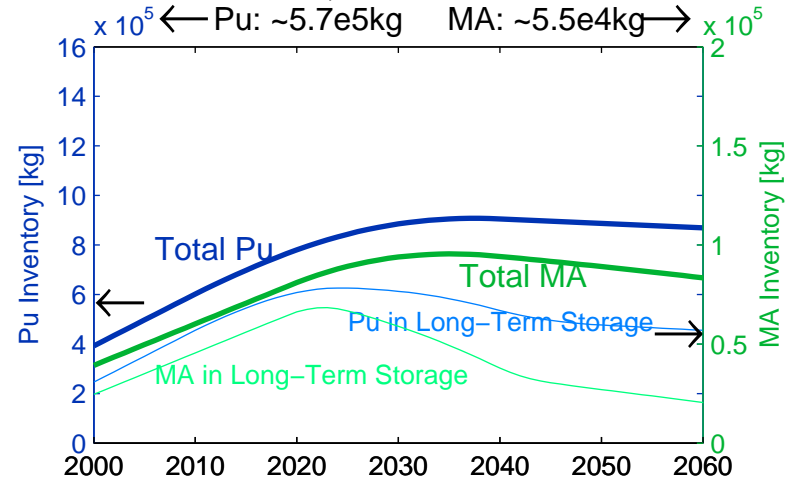
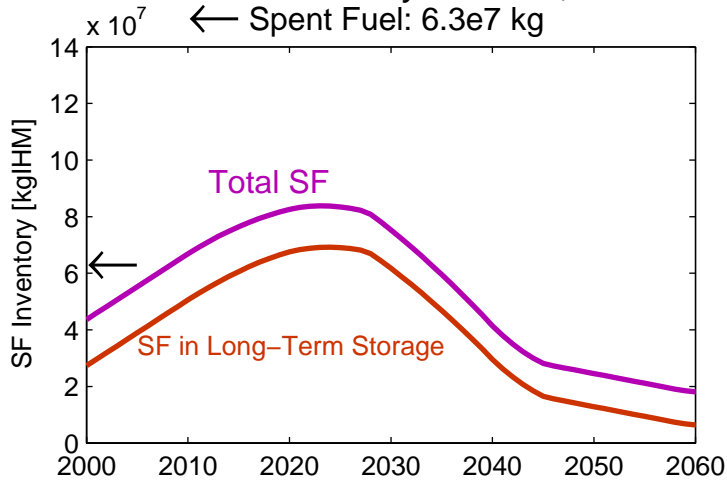


Combine with ADS Treatment of SNF and Minor Actinides are Transmuted



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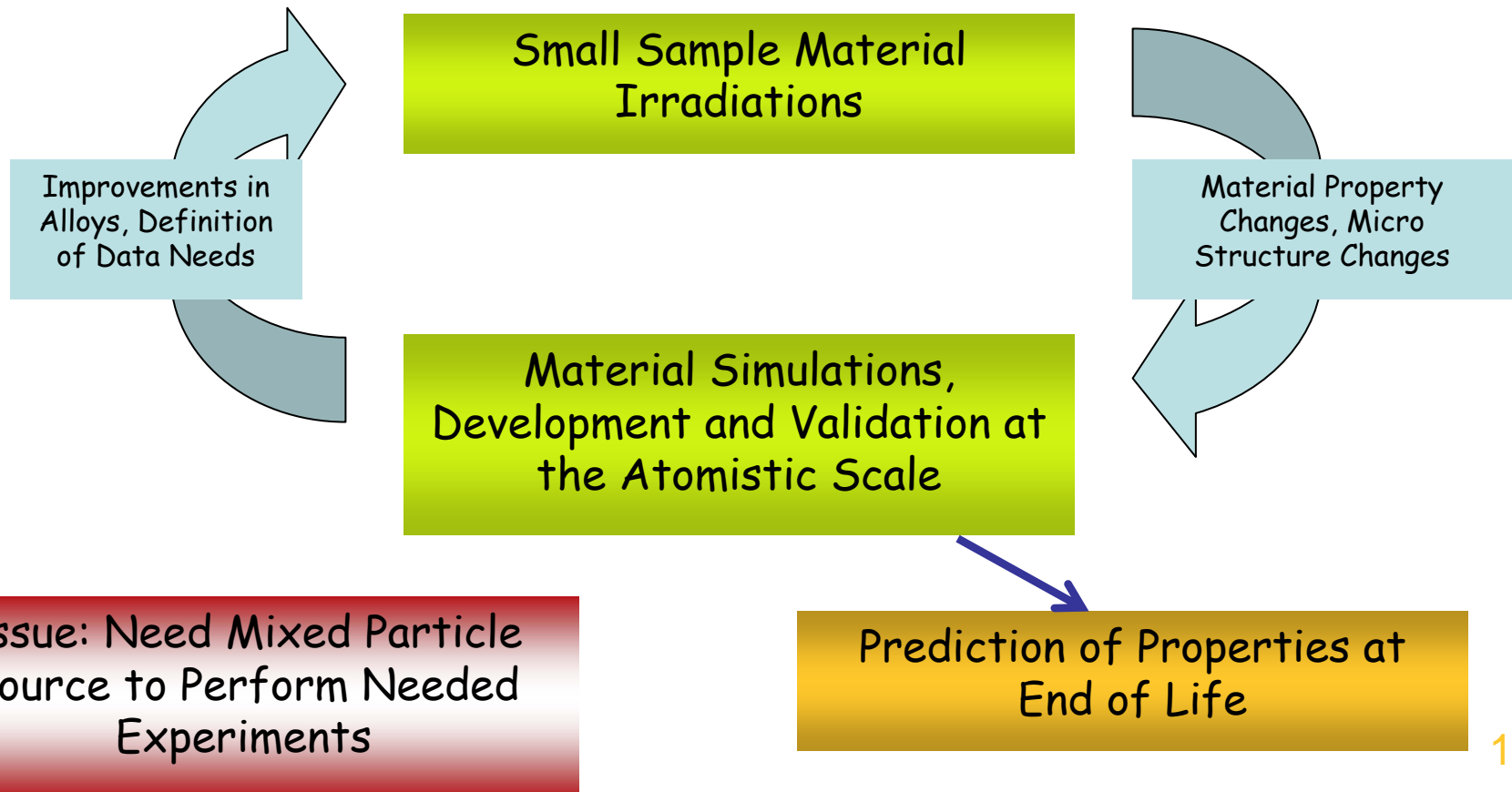


ADS Research Needs

- Safety strategy for an ADS
- ADS reliability
 - Thermal-fatigue of components due to beam trips
 - Reduced beam trips thru accelerator improvements
 - Instead of electricity production, should ADS focus on storable energy forms (hydrogen ?)
- Technologies leading to cost reduction in accelerators
- Materials: ADS availability with emphasis on target lifetime

Materials Research Needs:

Research Approach to Structural Materials is one of Science Based Prediction



The LANSCE Materials Test Station

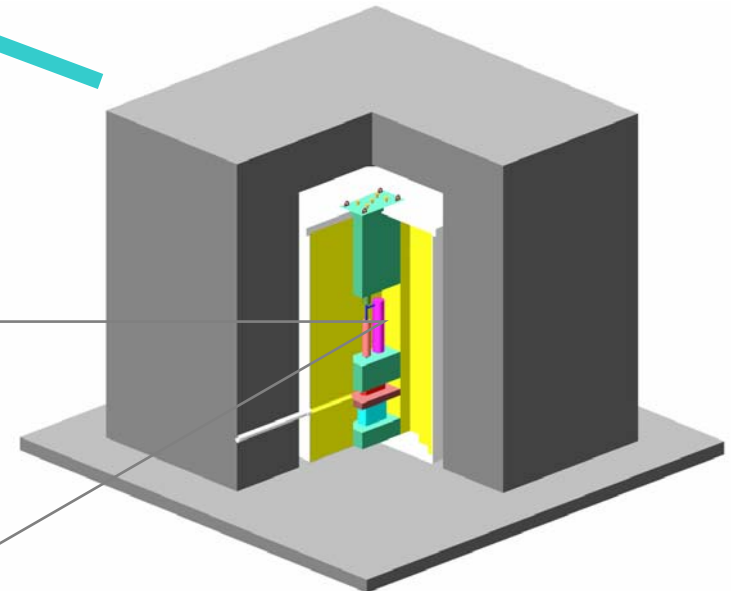


MTS Attributes

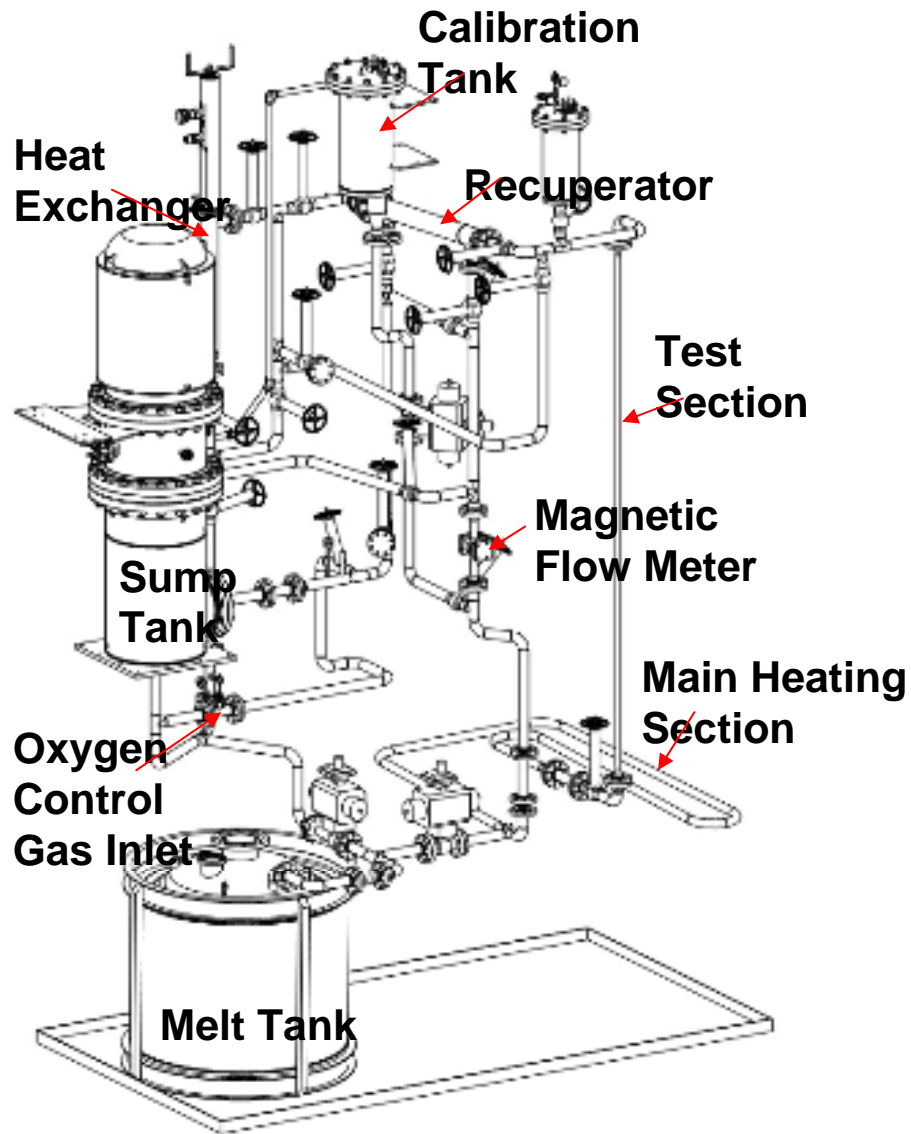
- **Intense fast spectrum neutron source** for development of AFCI transmuter and GenIV reactor materials.
- **Closed loops** for prototypic coolants and temperatures and "run to failure" capability.
- **Beam Ports** for neutron radiography (potential support of weapons program).
- **Transient testing** for demonstration of off-normal conditions.

MTS Schedule and Cost

FY04	FY05	FY06	FY07	FY08
Installation/Commission			Operation/Testing	
Costs (operating funds): \$5M	\$8M	\$7M	\$3M	\$3M



DELTA Loop



•Lead Bismuth
Eutectic Coolant
Technology
Research:

Corrosion
Sensor Development
High Temperature
Operation

Summary

- Transmutation Science plays an important role in AFCI and provides technical basis for alternatives to geologic repositories.
- ADS is an important option and will complement reactor-based transmutation of Plutonium and Minor Actinides.
- Small scale experiments and modeling plays a fundamental role in large scale and end of life predictions.
- Research needs are extensive and will be accomplished thru National Lab and University collaborations.