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Nuclear Science User Facility

Infrastructure Management Program

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R&D Infrastructure Lead

Nuclear Energy Advisory Committee
Washington, D.C.
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NSUF Nuclear Science User Facilities

INL/LTD-15-37336

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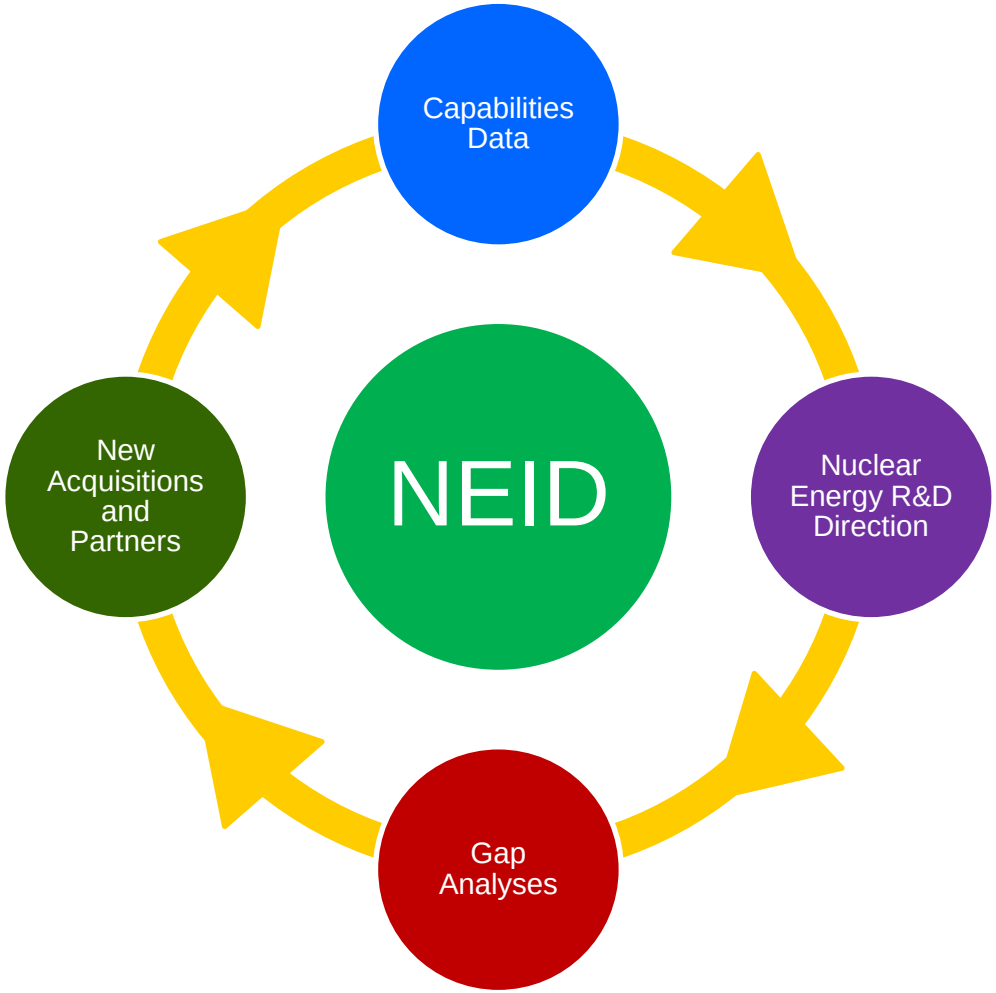
NEID Philosophy

NSUF Nuclear Science User Facilities

1. Gather Data on Nuclear Energy R&D Capabilities
2. Estimate Near, Mid and Long-term R&D Directions
3. Use these to perform gap analyses for Nuclear Energy R&D.
4. Assist funding decisions and incorporate the results into the NEID.



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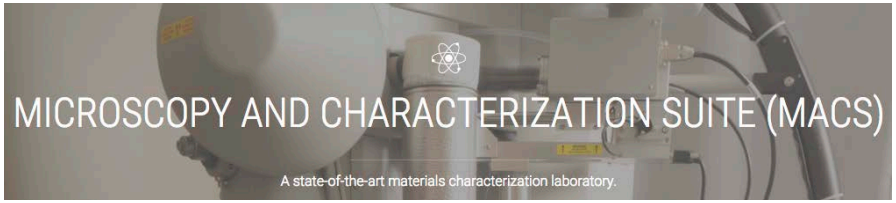
Database Organization

NSUF Nuclear Science User Facilities

Institutions



Facilities

FEI Quanta 3D FEG
Focused Ion Beam
SEM Microscope

Instruments

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Database Characteristics

NSUF Nuclear Science User Facilities

Data

100 Institutions

400 Facilities

800 Instruments

Users

INL Idaho National Laboratory

34 Federal Government & National Laboratories

PSU

22 Universities & NGOs

Westinghouse

5 Nuclear Energy Industry

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Database Categories ("fields")

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Facility Information	Facility Conditions	Facility Utilization	Data Sources
Facility/Instrument Name	Commissioning Date	User Facility or Contract?	Contact information
Abbreviation	Recent Major Upgrade	Cost to Use	Email Address
Owner Type	Material Condition	Cost to Maintain	Web Site
Institution	Mission Upgradable?	Cost to Replace	Source(s) of Data
State	Supporting Physical Plant	Funding Sources	Date of Data
Region	Regulating Agency	NSUF Partner?	
Country	License End Date	DOE-NE Use [%]	
Primary Capability		NE Objectives [1,2,3,4]	**Reactor Type**
Secondary Capability		Utilization [%]	Thermal Power
Tertiary Capability		# of users	Pulse Power
Core Capability		# of staff	Thermal Flux
Unique Capability			Fast Flux
Radiological Limits			In-core locations
Hot Work Facilities			Ex-core locations
Support Equipment			Pneumatic Transfer System
Sample Encapsulation			Flow Loops
Atmosphere/environment			Beam Ports

40 common database fields for all entries

5-20 fields specific to facility/instrument type

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Database Functionality

Nuclear Science User Facilities

The NE Infrastructure DB has/will have the ability to:

1. **Search (query) by:**
   - Keyword or Capability
   - Facility type
   - Instrument type
   - Geography/Institution
   - Group of terms

2. **Generate custom reports based on these queries.**

3. **Feed directly into a visualization system for custom maps**
   - Future implementation of GIS technology
   - Graph network system with inputs, outputs and dependencies

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Landing Page

NSUF.Infrastructure.INL.gov

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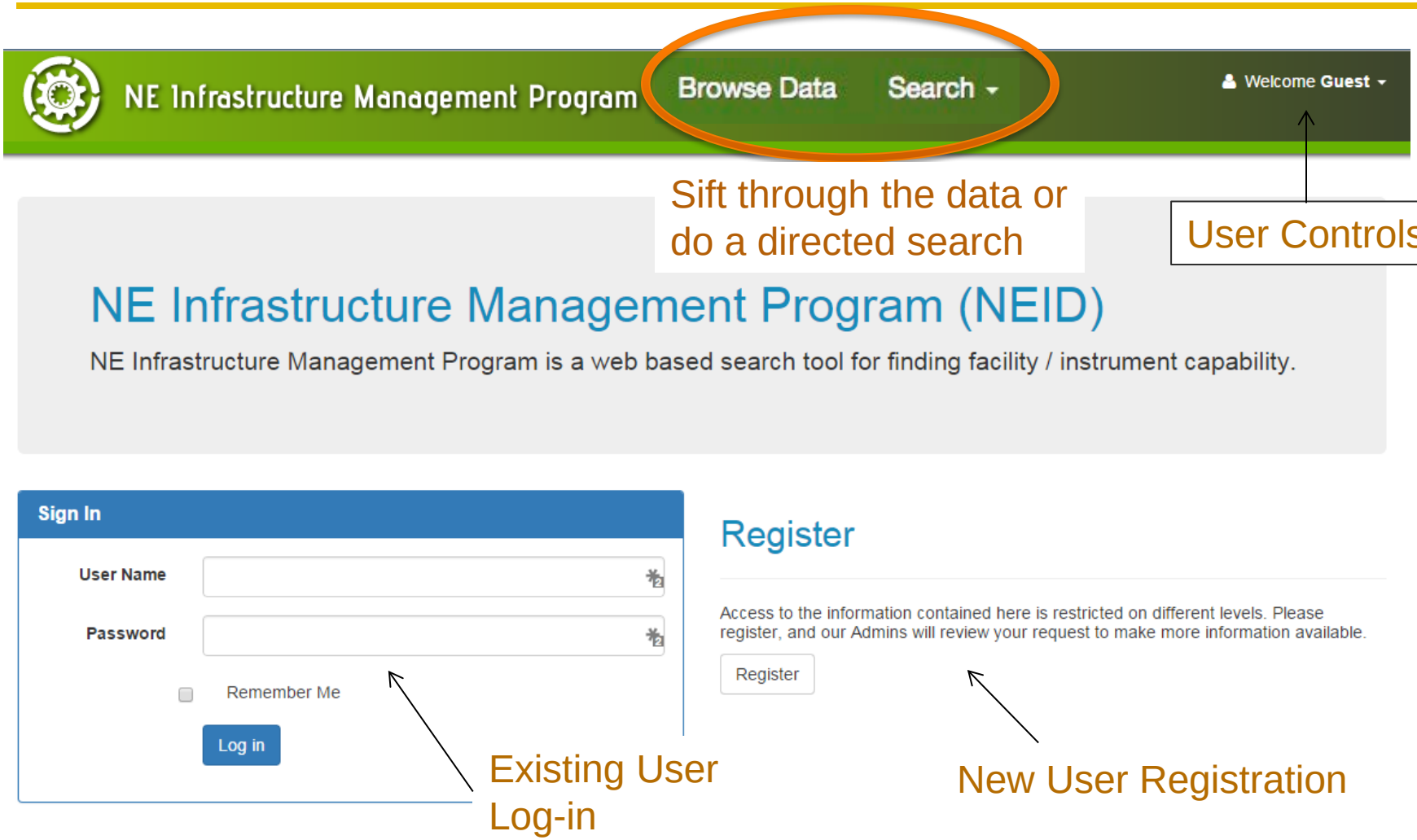
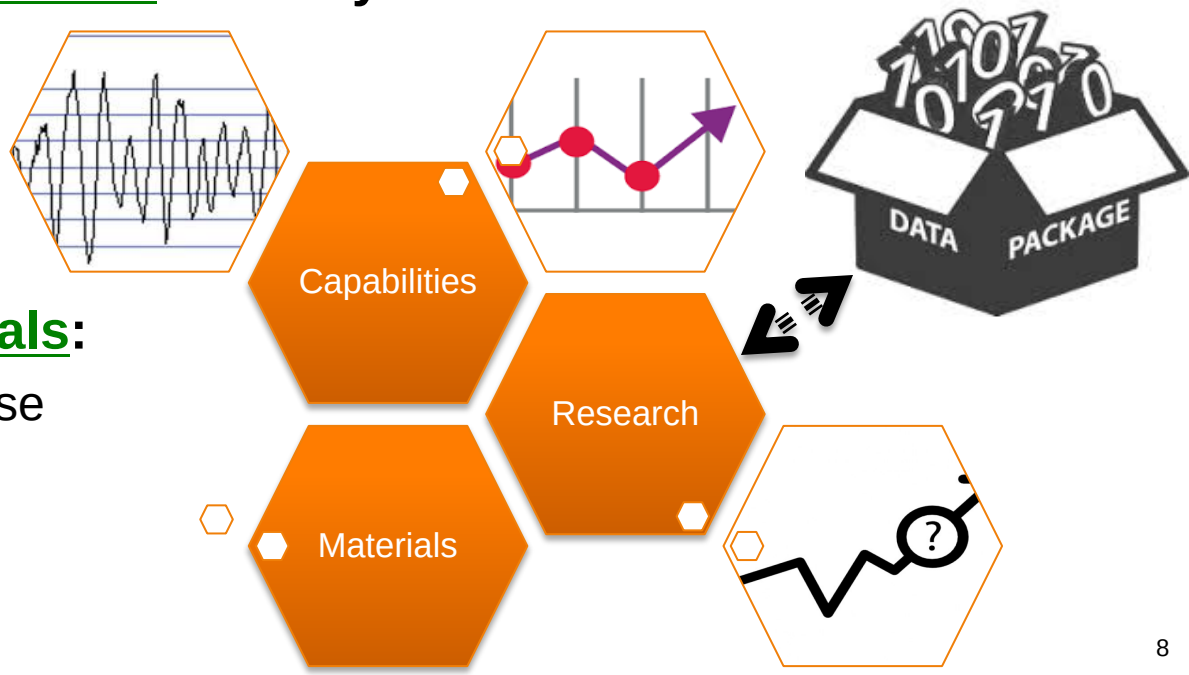


Three NSUF Databases

- **We can connect facilities and instruments as parts of a process to accomplish a research method or process, such as:**
  - Microstructural characterization of irradiated fuel.
  - Irradiation experiment (through design, fabrication, irradiation, etc.)

- **We can connect researchers this way as well:**
  - Through co-authors
  - Subject matter
  - Facilities utilized

- **We can include materials:**
  - Sample Library Database
  - Link to facilities utilized
  - Link to researchers



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Gap Analysis Structure

Nuclear Science User Facilities

1. **Analyzed capabilities include both facilities and capital equipment**
   - Mission-mapped facilities from program documents.
   - Geographical distribution and availability of access.
   - Age and availability (utilization and reliability).
   - Infrastructure requests (NEUP/NEET and RFI)

2. **What areas of NE R&D have researchers expressed interest in pursuing?**
   - What areas are currently being pursued? (NEUP R&D applications)
   - What areas are on the horizon? (work-scope RFI)
   - What R&D capabilities will be required to support the researchers? (NEID)

3. **Support for the NE-4 Infrastructure FOA writing and reviewing process**
   - Review support provided for the FY 2015 FOA
   - Drafting and Review support provided for the FY 2016 FOA
   - Drafting, review and gap analysis support to be provided for FY 2017

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Proposed Funding Recommendation Methodology

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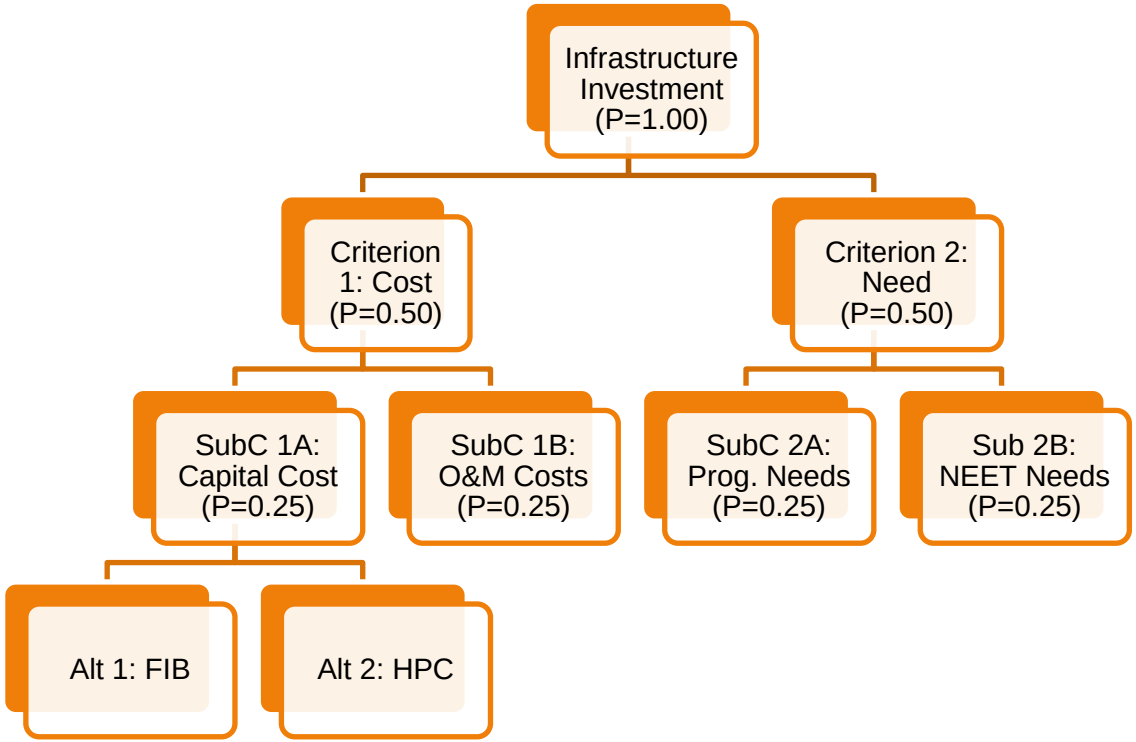
- An **Analytical Hierarchy Process** (AHP) is a transparent and rigorous process developed in the 1970's to aid in decision-making for groups.
- Uses a similar process to the 2015 Innovation Workshops
- The process begins with a list of alternatives and a list of constraining criteria.
- The alternatives will be judged against one another against each criteria.



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Analytical Hierarchy Process Flow

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1. First, rank the **criteria** using the AHP
   - NEID DRP can perform this task
   - Cost, mission need, cross-cutting applicability, etc.
   - This will result in a ranking of the criteria from most to least important (they will have numeric weights assigned).

2. Second, rank the **alternatives** 2-by-2 against each criterion
   - NEAC-FSC can perform this task.

3. Finally, **weight** the alternatives rankings by the criteria importances from step 1.

4. The **result** is a ranked (and scored) list of the investment alternatives.

Current Efforts

Ion Beam Investment Options Workshop

- Major issue arising from FY 2015 Infrastructure RFI
- Workshop scheduled for March 22-25, 2016 at INL
- Summary report due June 30, 2016.
- Inviting major facility representatives, industry and regulators.
- First NSUF application of the AHP for infrastructure decision-making.

Updated Gap Analysis Report

- Due June 30, 2016.
- Based upon:
  - FY2016 CINR and Infrastructure FOA data.
  - Analytical Hierarchy Process results
  - Updated infrastructure RFI (planned for a December 2015 release)
  - Continued effort to expand the NEID and add detailed data
    - Emphasis on excess capacity in the community


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NEID Database Review Panel

NSUF Nuclear Science User Facilities

Comprised of five members representing:

- University research (Peter Hosemann – Berkeley)
- University reactors (Lin-wen Hu - MIT)
- Nuclear Industry (Peng Xu – WEC)
- National Laboratories (Dave Senor – PNNL)
- DOE Programs (Jason Tokey – NE-31)

1. **Determine Database Sufficiency**
   - Appropriate and complete
   - Additional sources of information
2. **Validate Database**
   - Common terminology in entries
   - Error checking of data entries
3. **Investigate Infrastructure Needs Drivers** (gap analysis)
   - R&D infrastructure requirements
   - Missing or over-utilized capabilities

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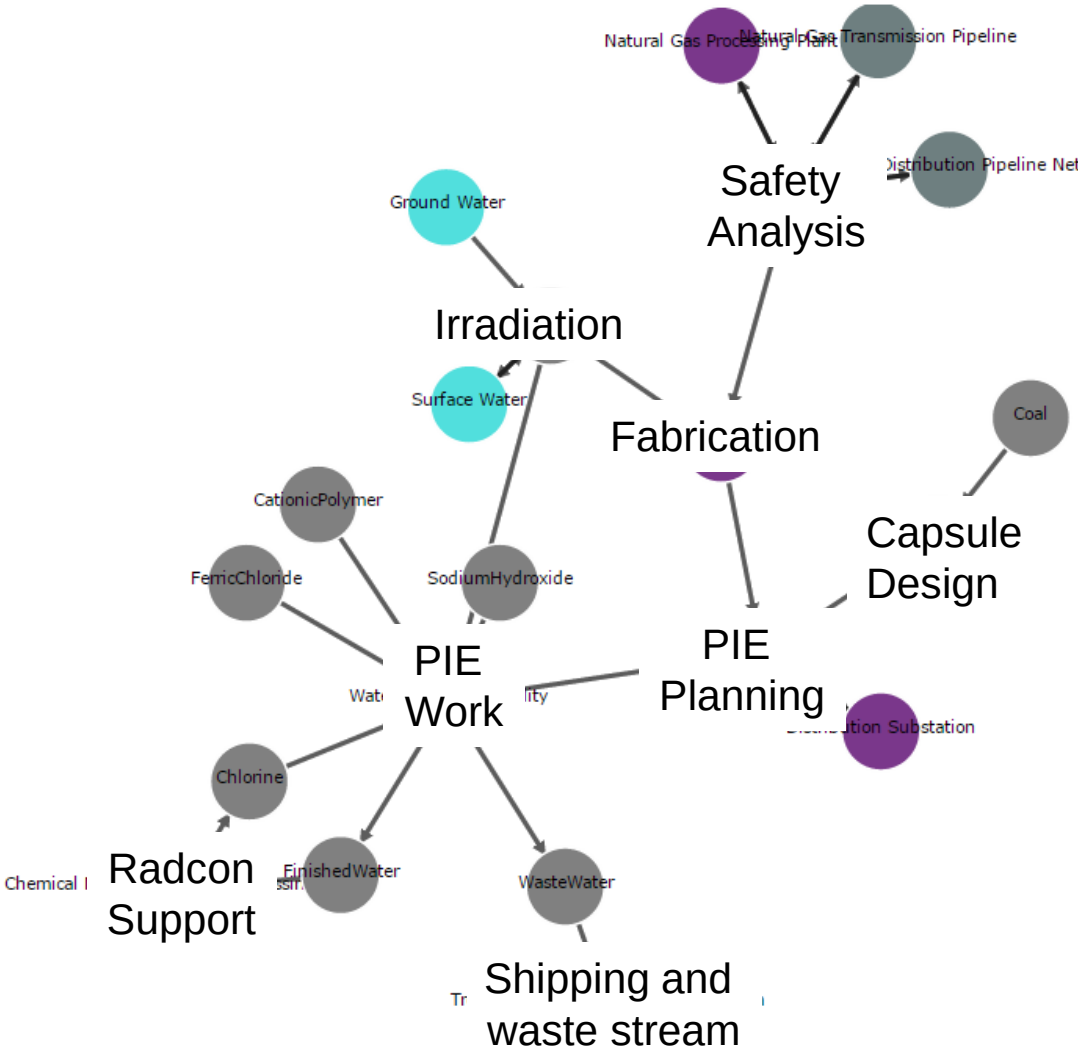
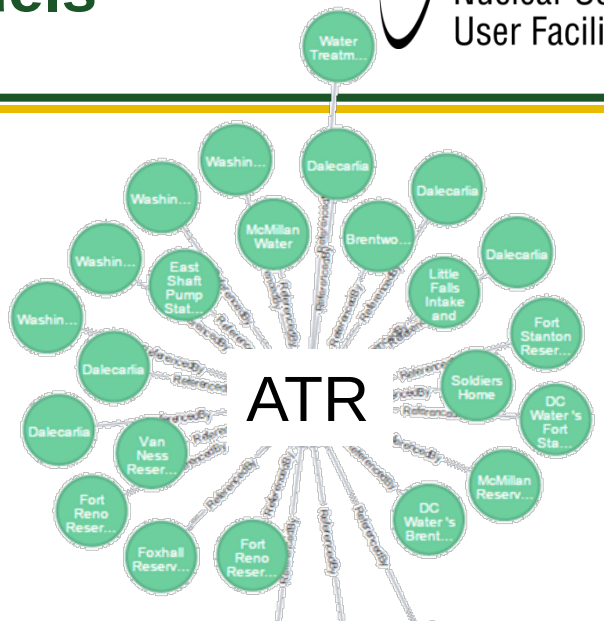
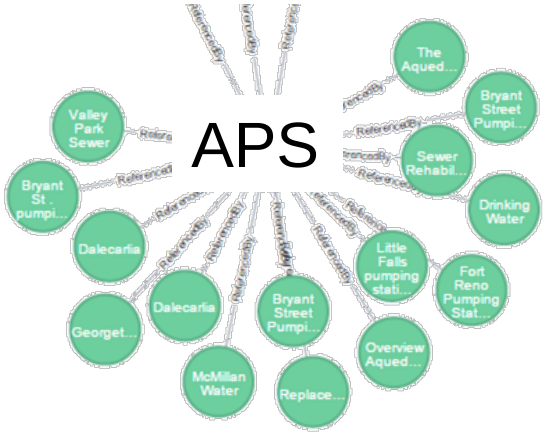
Graph (Social) Network Dependency Models

Nuclear Science User Facilities





Cross-Disciplinary Researchers



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INL/MFC NE R&D Process Flow Diagram

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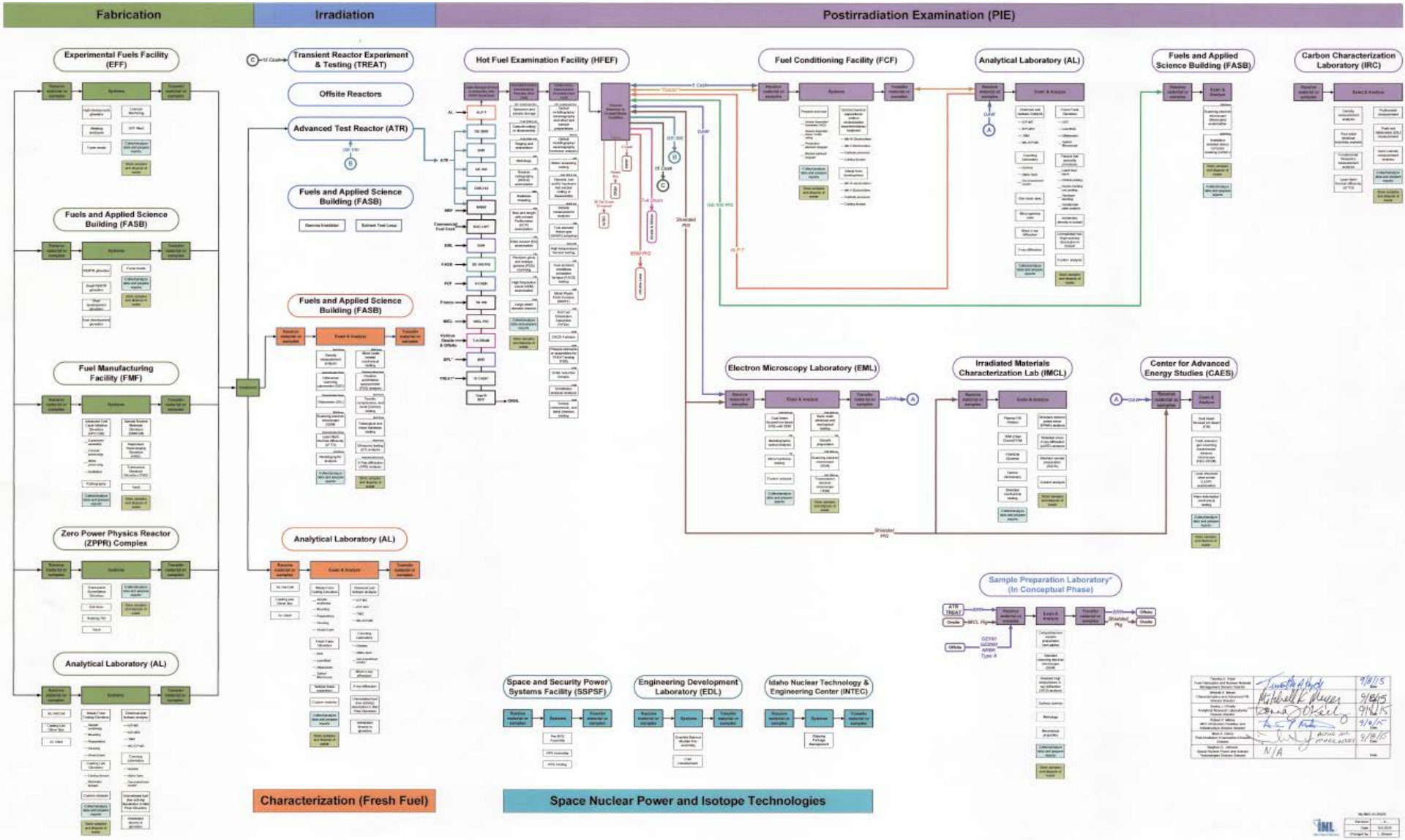

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Gap Analysis Plan

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1. **Capability analysis**, based on:
   - **Nuclear Energy Infrastructure Database**
   - A study of recent **NEUP infrastructure applications**
   - **NEET-NSUF work-scope access applications**
   - **R&D capabilities survey (RFI: DE-SOL-0008318)**

Applications/Submissions		
	FY 15	FY 16
RRI	13	10
GSI-1	25	30
GSI-2	12	8
NSUF	31	67
Infra-RFI	26/34	
WS-RFI	124/238	

2. **R&D Directions analysis**, based on:
   - **NE-4 R&D work-scope survey (RFI: DE-SOL-0008246)**
   - **A study of recent NEUP R&D applications**
   - **Programmatic input:** NE R&D Roadmap (2010), Facilities for the Future of NE R&D (2009), Required Assets for an Applied R&D Program (2009)

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Infrastructure Needs Referenced in RFIs

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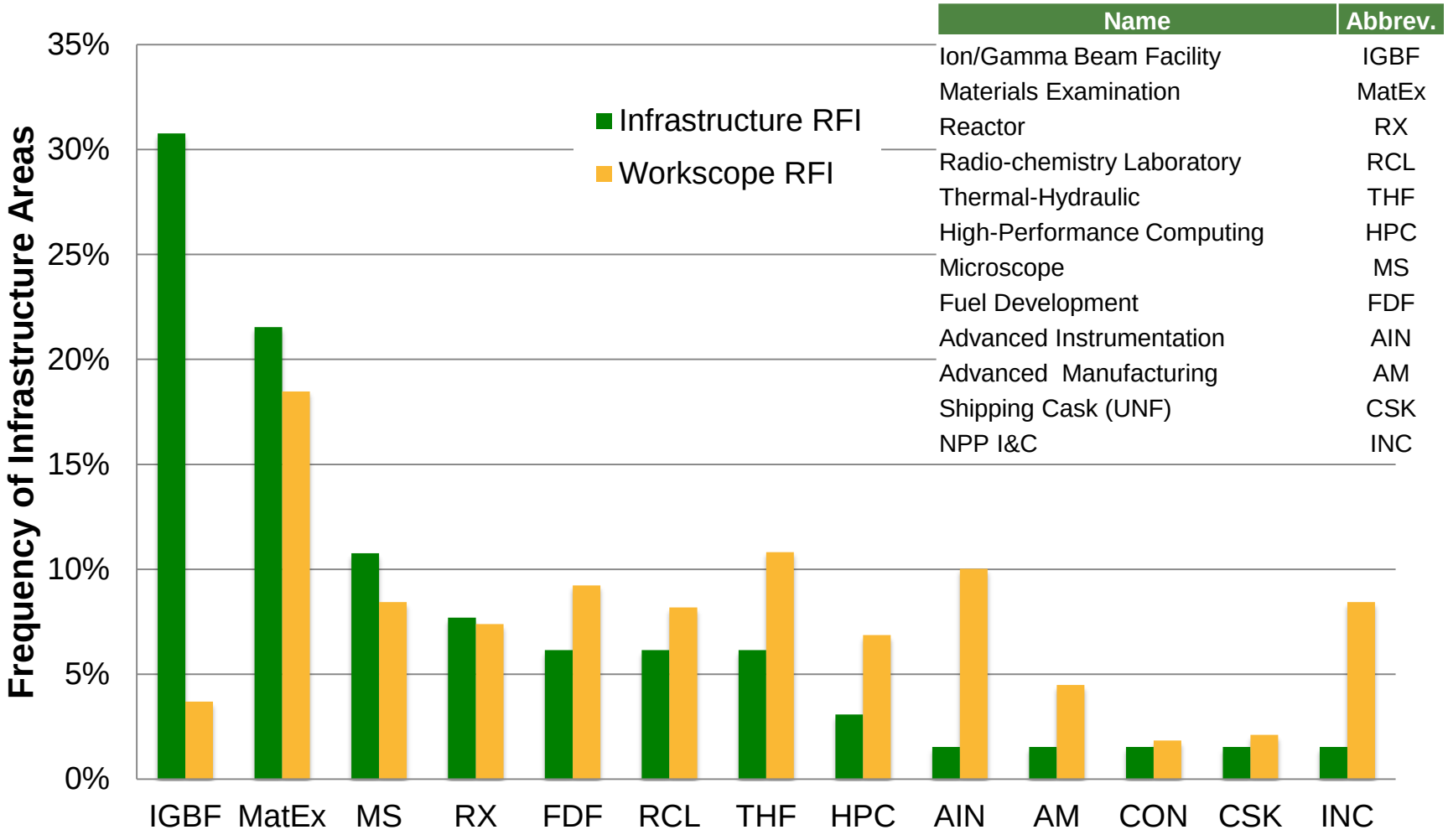

Name	Abbrev.
Ion/Gamma Beam Facility	IGBF
Materials Examination	MatEx
Reactor	RX
Radio-chemistry Laboratory	RCL
Thermal-Hydraulic	THF
High-Performance Computing	HPC
Microscope	MS
Fuel Development	FDF
Advanced Instrumentation	AIN
Advanced Manufacturing	AM
Shipping Cask (UNF)	CSK
NPP I&C	INC

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NE R&D Areas Referenced in RFIs

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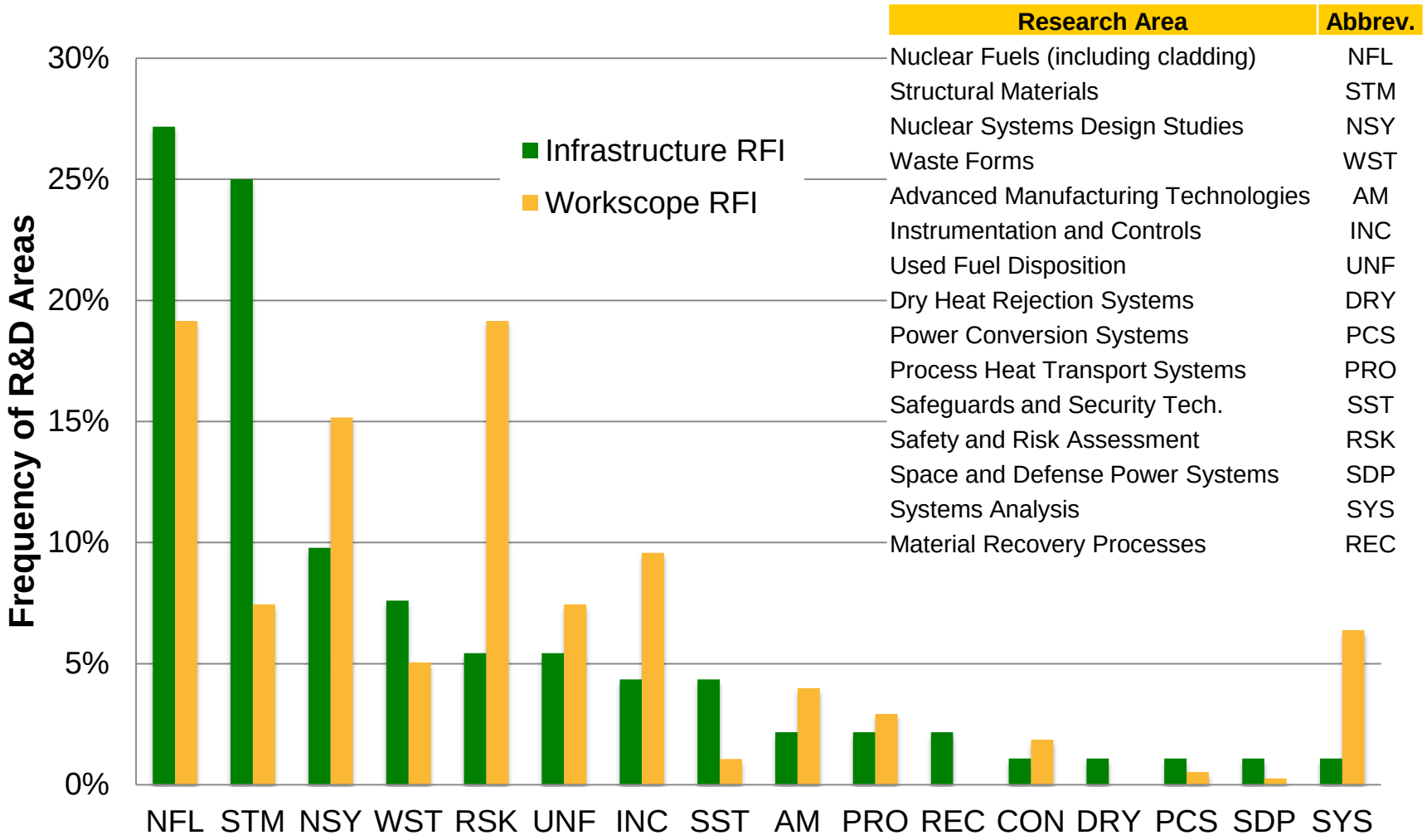

Research Area	Abbrev.
Nuclear Fuels (including cladding)	NFL
Structural Materials	STM
Nuclear Systems Design Studies	NSY
Waste Forms	WST
Advanced Manufacturing Technologies	AM
Instrumentation and Controls	INC
Used Fuel Disposition	UNF
Dry Heat Rejection Systems	DRY
Power Conversion Systems	PCS
Process Heat Transport Systems	PRO
Safeguards and Security Tech.	SST
Safety and Risk Assessment	RSK
Space and Defense Power Systems	SDP
Systems Analysis	SYS
Material Recovery Processes	REC

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Example Analysis
(infrastructure-based)

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Step 1: (Broad Question) What materials-irradiation resources are potentially available to US researchers?

Step 2: (Data Review): access database, run a query & generate a report

Results →

52 Total US Reactors devoted to research

Test Reactors	1 (ATR)
Beam-line reactors (with in-core capability)	2 (HFIR and NBSR)
Research Reactors	
University Research and Training Reactors	23
Private Research Reactors	2 (GE and Dow)
Federal Government Research Reactors	3 (USGS, NRAD and AFRRI)
State Government Research Reactors	1 (RINSC)
Transient Testing Facilities	
Fast Burst Reactors	2 (White Sands & Godiva)
Thermal Pulsing Reactors	1+1 (ACRR & TREAT)
Fusion Neutron Sources	6 (Associated with DOE-SC)
Critical Facilities	6 (5 federal & 1 university)
US Navy Prototype & Training Reactors	2+2 (NY & SC)

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Example Analysis

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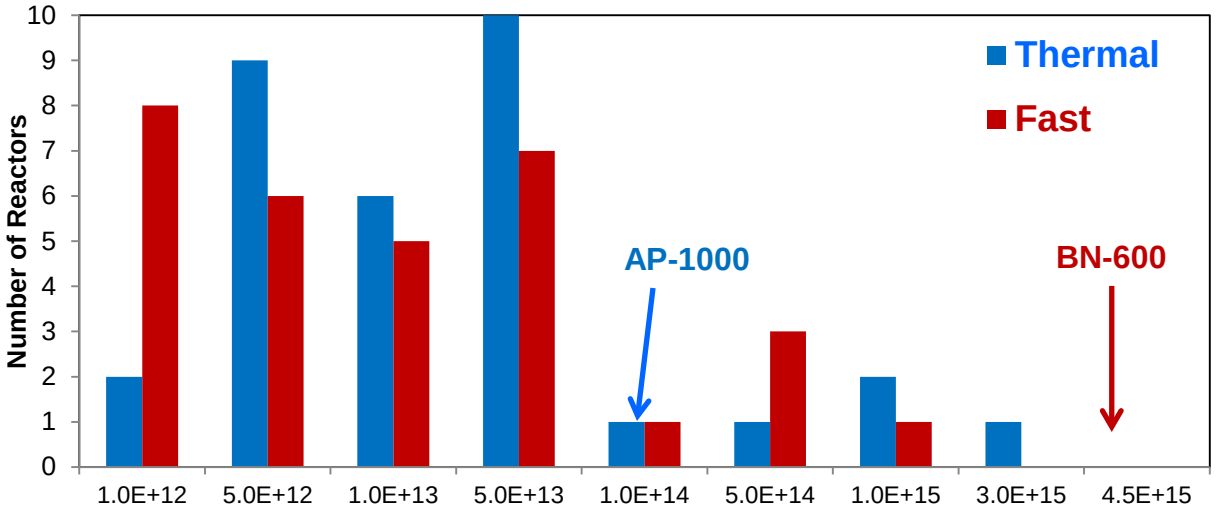
Step 3: (Narrow Question) What about the neutron energy spectra?

Step 4: (Data Review): A fine-detail query of data from step 2

Flux from Available Research and Test Reactors



Time in an Available Test Reactor to Simulate 50 years in a Power Reactor	
Thermal	1 year
Fast	225 years

Step 5: (Conclusion): Currently, there is no US-based, large-scale fast neutron capability comparable to ATR, HFIR, NBSR or MURR.

Step 6: (Recommendation): Consider **investing** in fast flux facility or **partnering** with an international facility like **Joyo(JP)**.

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Alternative's Data Summary Example

NSUF Nuclear Science User Facilities

Applicant Institution	Idaho National Laboratory	**Title**	HPC Capabilities at NSUF
Applicant	Denise Stephens	**Capital Intensity**	Minor Refit
Applicant Type	National Laboratory	**Capital Cost (MM$)**	10
Capability Location	@ INL	**Construction Time (years)**	5 (incremental spending each year to add HPC capacity)
Tracking ID	RFI-IN-9792	**O&M Costs (MM$/yr)**	2
Summary	Build upon existing HPC infrastructure at INL and expand NSUF access to HPC facilities and resources.		
Existing Capabilities	Many similar facilities, including DOE-SC, but these are local and not NE-focused.		
Expected Utilization	Expected utilization is high, based on support for V&V for NEAMS and CASL as well as experimental design for ATR and TREAT and other simulation needs.		
NE Priority	Modeling and simulation are a growing area. The capability will support the TREAT restart, as well as CASL and NEAMS programs.		
Functional Areas	HPC		
NE Missions	LWRS	ARC	RD&D
R&D Areas	NF	RSK	ST

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User Access Levels

NSUF Nuclear Science User Facilities

Once approved, the user will be assigned to one of five levels of access.

User Type	Level	Example	Data Access/Read	Write (add or edit)	Delete Record	Add Users and Change Levels
Administrator	5	BJH, IM, NSUF	ALL	YES	YES	YES
NSUF Partner (Laboratory)	4	ORNL, PNNL	ALL	YES	NO	NO
NSUF Partner (Univ./Industry)	3	MIT, WEC	SOME	YES	NO	NO
Internal User	2	INL, DOE, etc.	ALL	NO	NO	NO
External User	1	NE applicant	SOME	NO	NO	NO
Outsider	0	Prior to Authorization	NONE	NO	NO	NO

Additional User Improvements

In order to better support the CINR FOA and the NSUF RTE:

- Develop tools (JAVA) to help users and NSUF Tech Leads:

1. **Estimate sample activity following irradiation**
   - Estimate time to be able to ship samples
   - Determine facilities that can accept materials
   - Estimate dose from characterization procedures

2. **Irradiation resource selection**
   - Neutron flux and spectrum for NSUF reactors
     - » Most efficient allocation of resources
   - Convert Neutron Fluence to DPA
     - » Materials scientists request dpa
     - » Reactor engineers think in terms of fluence
     - » Compound materials can be difficult

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Contact Information

NSUF Nuclear Science User Facilities

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