Nuclear Science User Facilities (NSUF) Overview and Status

J. Rory Kennedy, Ph.D.
Director, NSUF
Idaho National Laboratory

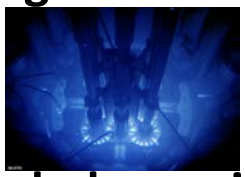
9th Nuclear Academics Discussion Meeting
Virtual
September 8, 2020

nsuf.inl.gov

NSUF Nuclear Science User Facilities

NSUF Historical

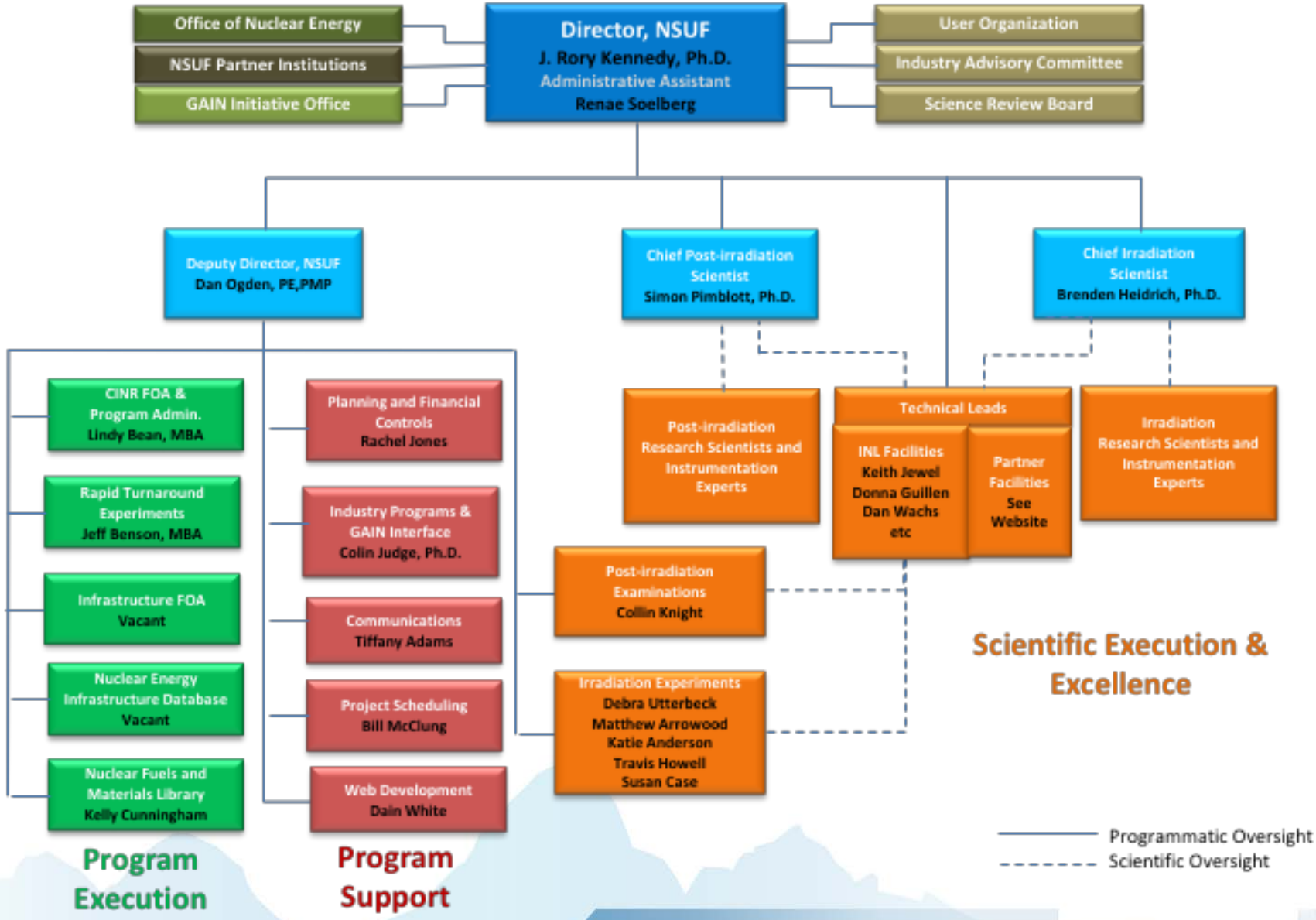
- Established 2007 as US DOE Office of Nuclear Energy (DOE-NE) user facility. Intended to support the mission of DOE-NE by linking national intellectual capital with DOE-NE infrastructure.



- Irradiation Effects in Nuclear Fuels and Materials
- Founded at Idaho National Laboratory initially intended as a single institution user facility. INL remains lead and primary institution.
- NSUF operates as typical US user facility (no cost to user, competitive proposal processes, no funding to users) but also some unique aspects.
- Generally select projects through open competitive proposal processes
  - Consolidated Innovative Nuclear Research (CINR FOA, 1 call/year)
    - Irradiation + PIE ($1.0M - $4.0M, up to 7 years) includes design, analyses, fabrication, transport, irradiation, disassembly, PIE, disposition
    - PIE only (~$500K, up to 3 years)
    - Irradiation only ($500K - $3.5M)
    - Beamlines at other user facilities
    - Possibility to also receive user R&D funding on limited work scopes

  - Rapid Turnaround Experiments (RTE, 3 calls/year, limited $$, executed within 9 months) – open to researchers outside US as PIs
- Proposals welcome from university, government laboratory, industry, and small business researchers. Only non-proprietary projects accepted. All awarded projects are fully forward funded.

NSUF Organization Chart



NSUF Capabilities Offer Research Opportunities

Neutron Irradiations	Ion Irradiations	Gamma Irradiations	Hot Cells & Shielded Cells	Low Activity Laboratories	Beamlines	High Performance Computing
INL	Wisconsin	INL	INL	INL	Brookhaven National Laboratory	INL
Oak Ridge National Laboratory	University of Michigan	Oak Ridge National Laboratory	Oak Ridge National Laboratory	CAES Center for Advanced Energy Studies	Argonne National Laboratory	
Massachusetts Institute of Technology	Argonne National Laboratory	Sandia National Laboratories	PNNL	Oak Ridge National Laboratory	NC State University	
NC State University	Sandia National Laboratories		Los Alamos National Laboratory	Cal	Los Alamos National Laboratory	
Ohio State	Texas A&M University		Westinghouse	PNNL		
Sandia National Laboratories	Lawrence Livermore National Laboratory		University of Michigan	Los Alamos National Laboratory		
SCK•CEN			SCK•CEN	NC State University, University of Michigan, Purdue University, Wisconsin, University of Florida		
				SCK•CEN		

Visit nsuf.inl.gov for details at individual facilities

INL +

9 Universities

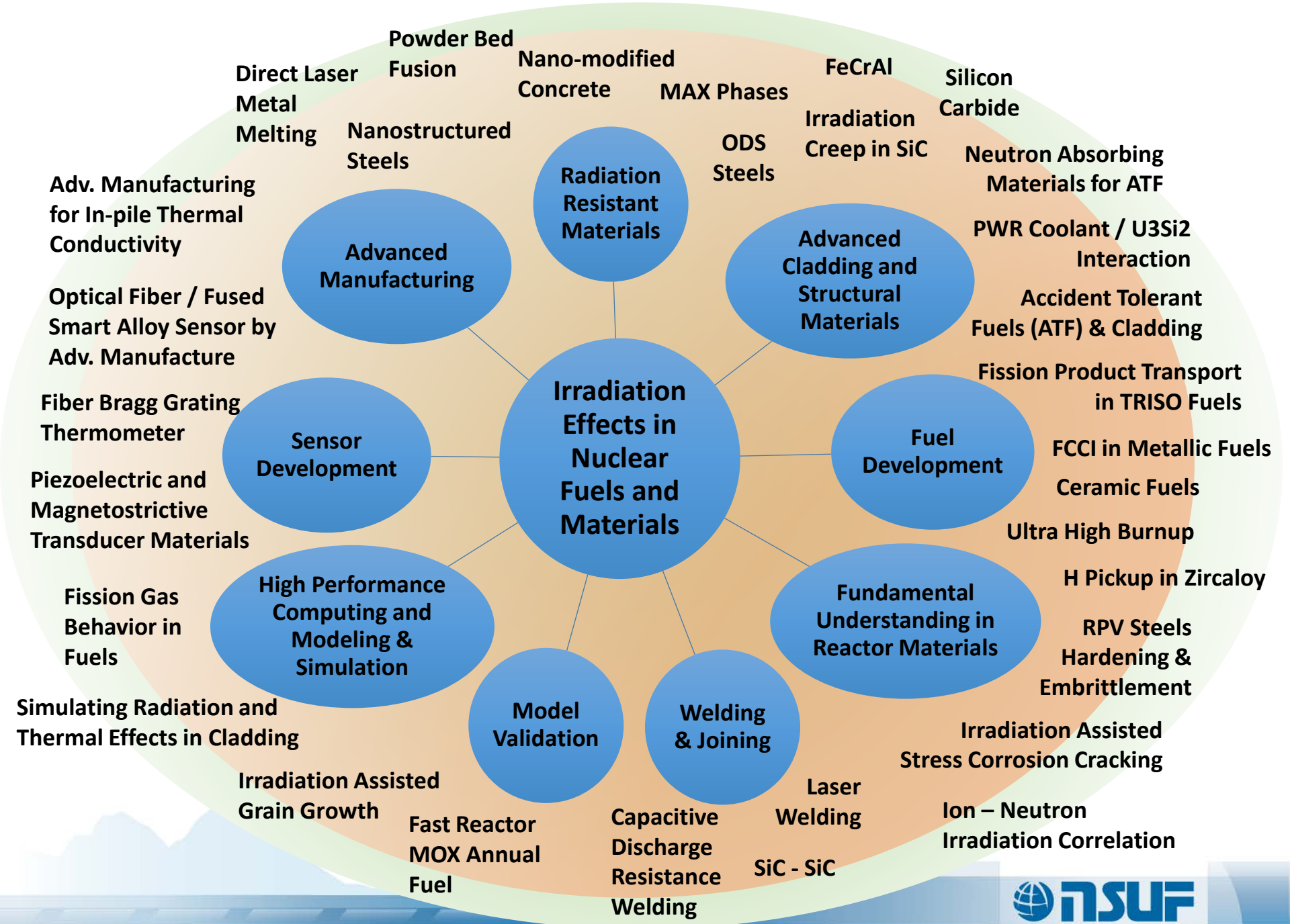
CAES (4 Unis)

7 National Labs

1 Industry

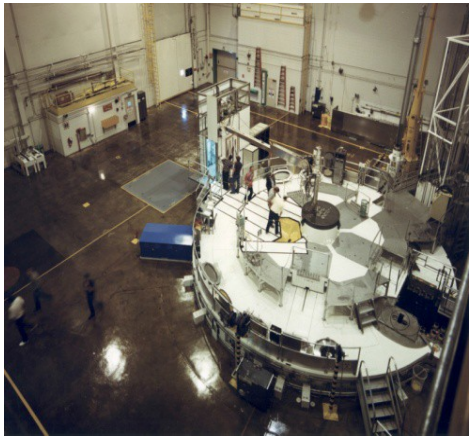
1 int'l affiliate

NSUF


Irradiation Effects in Nuclear Fuels and Materials
Radiation Resistant Materials
Advanced Manufacturing
Advanced Cladding and Structural Materials
Sensor Development
Fuel Development
High Performance Computing and Modeling & Simulation
Fundamental Understanding in Reactor Materials
Model Validation
Welding & Joining
Powder Bed Fusion
Direct Laser Metal Melting
Nano-modified Concrete
MAX Phases
FeCrAl
Silicon Carbide
Nanostructured Steels
ODS Steels
Irradiation Creep in SiC
Neutron Absorbing Materials for ATF
Adv. Manufacturing for In-pile Thermal Conductivity
PWR Coolant / U3Si2 Interaction
Optical Fiber / Fused Smart Alloy Sensor by Adv. Manufacture
Accident Tolerant Fuels (ATF) & Cladding
Fiber Bragg Grating Thermometer
Fission Product Transport in TRISO Fuels
Piezoelectric and Magnetostrictive Transducer Materials
FCCI in Metallic Fuels
Ceramic Fuels
Ultra High Burnup
Fission Gas Behavior in Fuels
H Pickup in Zircaloy
RPV Steels Hardening & Embrittlement
Simulating Radiation and Thermal Effects in Cladding
Irradiation Assisted Stress Corrosion Cracking
Irradiation Assisted Grain Growth
Laser Welding
Ion – Neutron Irradiation Correlation
Fast Reactor MOX Annual Fuel
Capacitive Discharge Resistance Welding
SiC - SiC

NSUF Projects Summary

FY 2007 – FY2020*



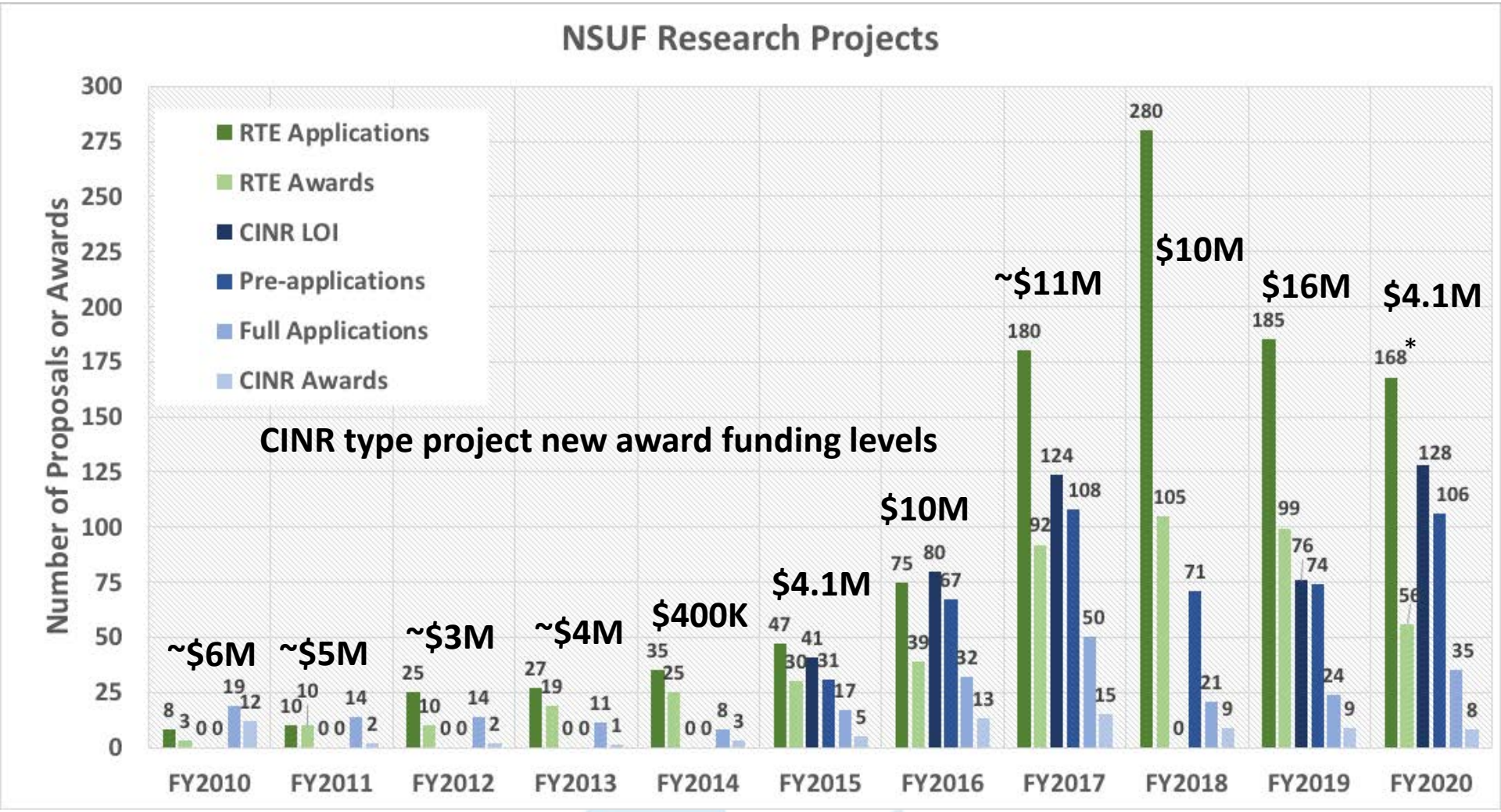
- Total of 43 CINR type projects executed
- Total of 48 CINR type projects currently ongoing
- Total of 398 RTEs executed
- Total of 90 RTEs ongoing
- 579 total projects awarded
  - 359 projects to 51 US universities
  - 167 projects to 7 national laboratories
  - 22 projects to 9 industry
  - 31 projects to 17 international (Oxford U., Manchester U., Liverpool U., Bristol U., Sheffield U., Huddersfield U., Sabanci U., Queens U., Leoben U., NNL, ANSTO, CEA Saclay, Institutio Italiano di Technologia, SCK-CEN, EC-JRC-Karlsruhe, Studsvik Nuclear, Canadian Nuclear Laboratories)

FY 2020

- Effective FY2020 budget: ~$12M (vs ~$30M FY16 – FY19)
- Total effective FY 2020 budget allocated to projects: ~$6.4M direct (CINR + RTE) + ~$3M supporting (PIE coordination, experiment managers, experiment analyses, shipping, SCK-CEN pilot projects)
- At any particular time, NSUF is typically managing ~100 – 130 projects

* As of 9/2020

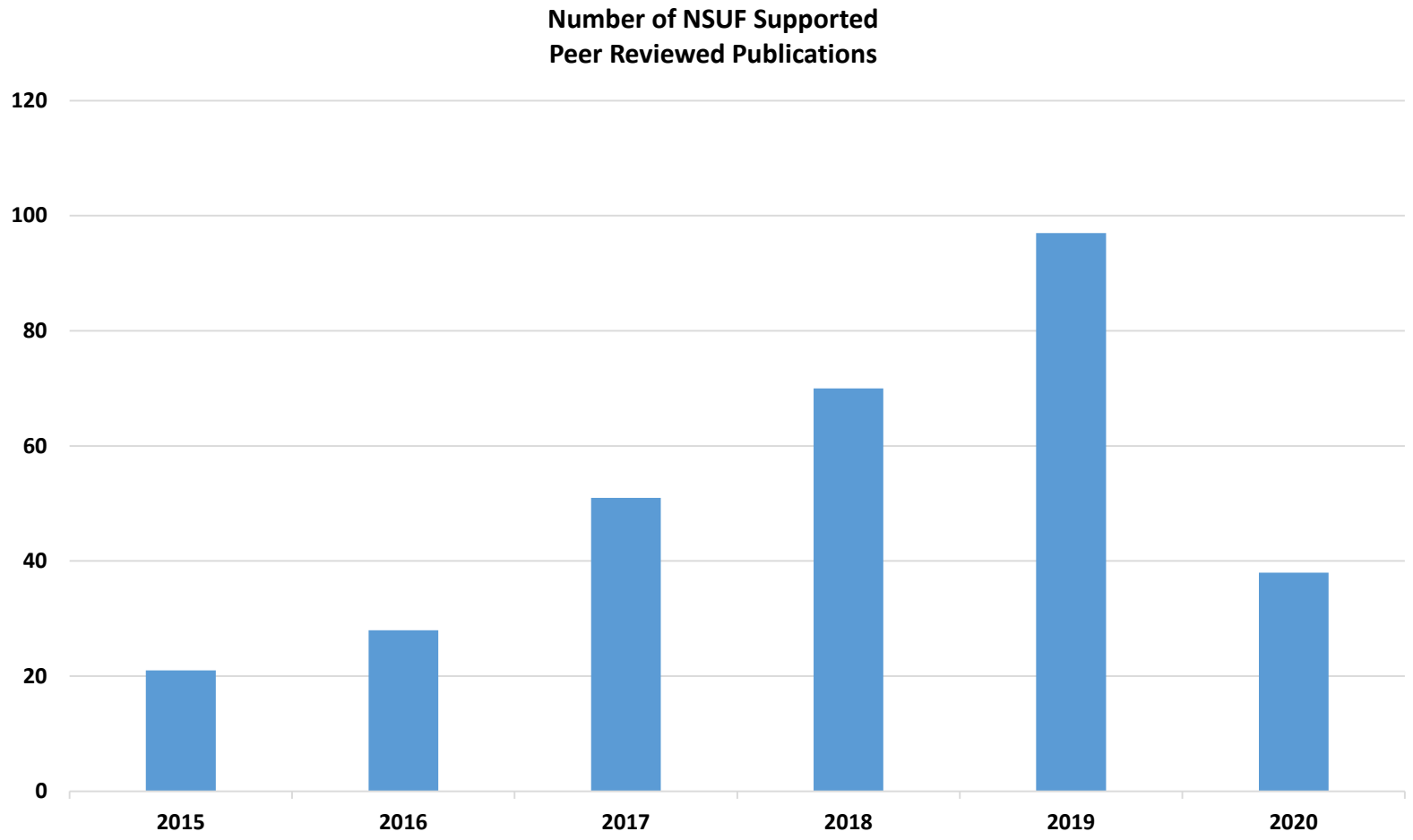
Interest and Support Continue to Grow



* Only 2 RTE solicitations in FY 2020

Graphics created by
Brenden Heidrich

NSUF Publications



- Continuing to see results from early irradiation tests
- Increase in RTE awards.
- H-index score of 27 (score of 17 in 9/2019)
- Journal of Nuclear Materials is by far the most published in journal.

International Collaborations

- **DOE-NE / NSUF and UK / NNUF**
  - **DOE-NE and NSUF invited to Nuclear Academics Discussion Meetings**
  - **Initial area of mutual user facility interest and cooperation**
    - **Nuclear Fuels and Materials Library (Archive)**
  - **US – UK Nuclear Energy R&D Cooperative Action Plan (signed Sept 2018)**
    - **Enabling Technologies Working Group**
      - **University Engagement – DOE (NEUP) & EPSRC**
      - **National User Facilities – NSUF & NNUF (facility sharing)**
      - **Resource Libraries - NEID, NFML, NERD, etc**
      - **Public Engagement**
      - **Gareth Headdock (NNL, NNUF) is UK Lead and Rory Kennedy (INL, NSUF) is US Lead**

Scope of Enabling Technologies Working Group

Focus on four areas:

1. **Universities engagement**
   - Continue robust nuclear energy research collaboration program that has been ongoing between U.S. and U.K. universities through competitive solicitations
2. **Nuclear Science User Facilities (NSUF) and National Nuclear User Facility (NNUF) Collaboration**
   - coordinate the establishment and implementation of processes to facilitate the sharing of user facility resources
   - coordinate nuclear fuels and materials sample library and archive assets
3. **Resource libraries**
   - identify programs and data of mutual interest; determining the ownership, format, and location of the key data and materials;
   - identify a means by which to capture and share the data and materials.
4. **Public understanding and engagement**
   - work with leadership on how to implement best practices and how to communicate effectively with the public

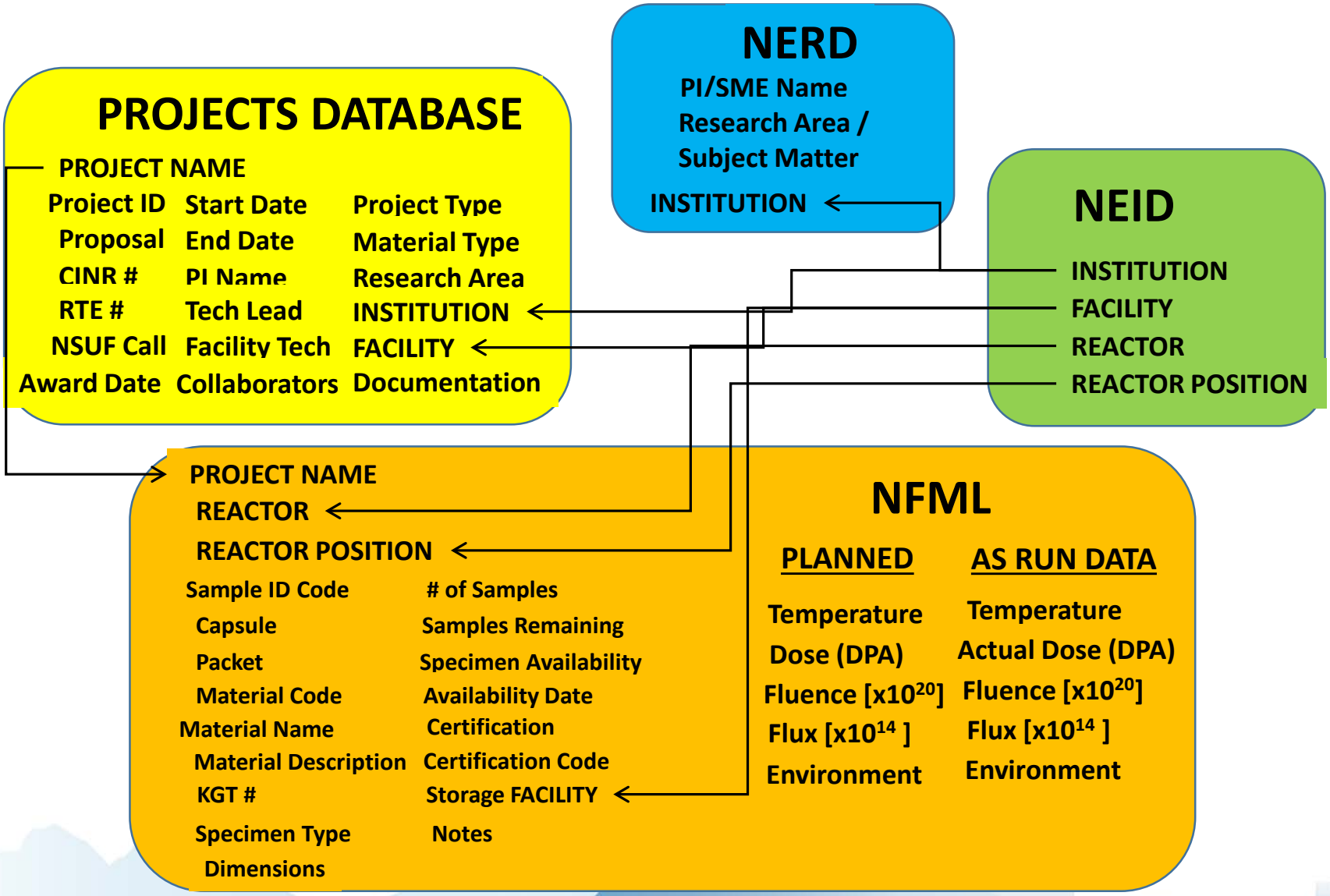
Working Group Associated Activities

- **US and UK award research to US and UK joint projects. In the U.S through the Consolidated Innovative Nuclear Research (CINR) funding opportunity announcement and in the UK through the Research Councils United Kingdom (RCUK) Energy Program, led by the Engineering and Physical Science Research Council (EPSRC) – currently paused in 2020 and 2021, hopefully restart in 2022.**
- **There have been 24 projects awarded since 2016 in the areas of modeling and simulation, fuels and materials, fuel manufacturing, and advanced reactors.**
- **Please send references for any joint publications (past, present, and future) to me (rory.kennedy@inl.gov) and Gareth Headdock (gareth.headdock@nnl.co.uk) for credit. Please also include joint publications associated with other US Office of Nuclear Energy programs (e.g., Advanced Reactor Technologies – ART or NEUP-IRP).**

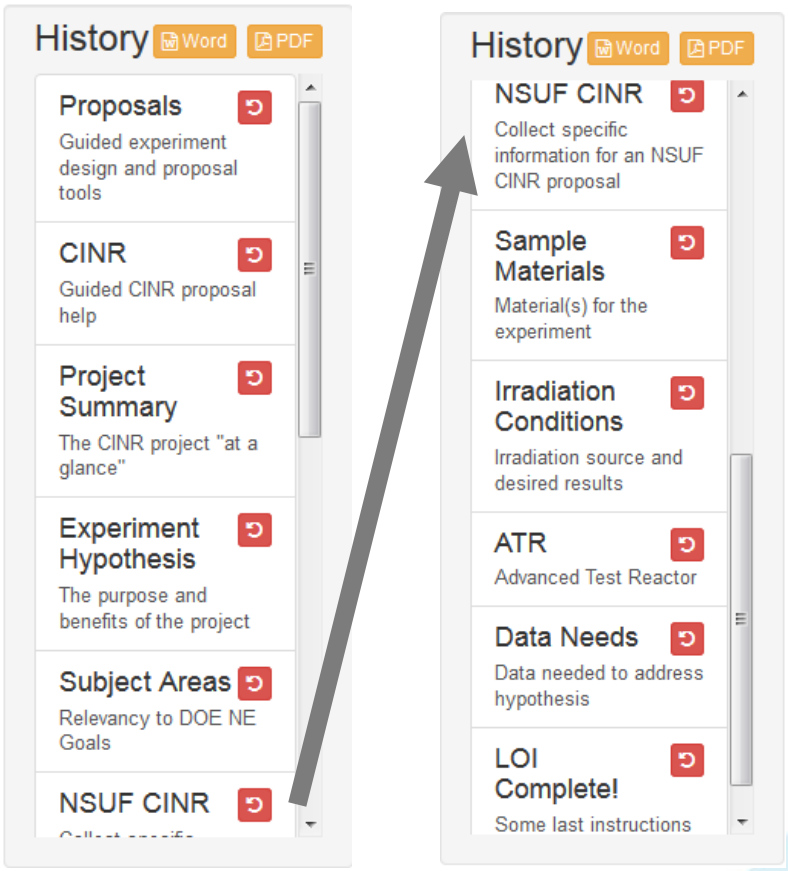
Working Group Associated Activities

- Under the NSUF part of the CINR solicitation, four projects have been awarded with UK collaborators on advanced manufacturing, advanced alloys, and fundamental irradiation effects.
- 18 Rapid Turnaround Experiments (RTE) awards have been made to UK organizations in the areas of nano-structure effects, ion-neutron irradiation correlations, advanced alloys and ceramics, fundamental studies on irradiation effects, nuclear waste encapsulation, fuels, cladding, and structural materials.
- Confirmed 11 publications acknowledging NSUF. Please send references for any publications (past, present, and future) to me (rory.kennedy@inl.gov) and Gareth Headdock (gareth.headdock@nnl.co.uk) for credit.
- Recent exchanges between NNUF Management Group and NSUF on potential joint projects and teleconference meetings between the Irradiated Materials Archive Group (IMAG) and NSUF on sharing results of IMAG Pedigree Survey and Materials Archive Options Study and NSUF Materials Needs Survey.

Database Integration
Combined Materials Experiment Toolkit (CoMET)

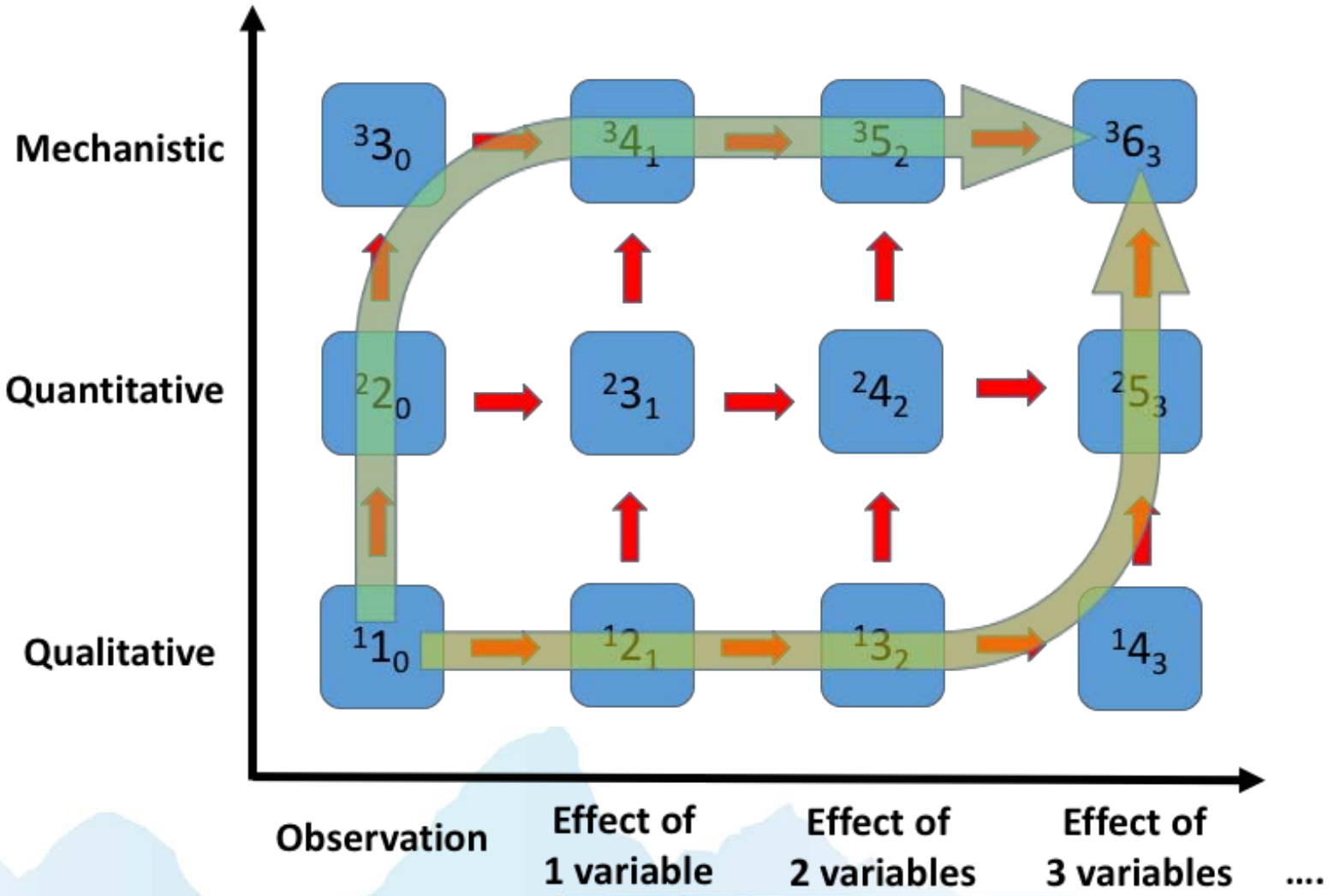


CoMET is Executed through a Process Guidance Application (Wizard)



- **The Wizard guides the user through their undertaking (proposal preparation in this case)**
- **Each box in the history represents a stage in the undertaking where a decision was made and/or information/data was input. At each stage of the undertaking, the user is offered access to additional reference data and information.**
- **Multiple team members, NSUF technical experts, program managers, and others can all work on an undertaking at the same time, keeping all information in one place.**
- **The Wizard clearly communicates all relevant information needed for the decision or input required at each stage.**
- **CoMET and the Wizard launched on July 31, 2020**
- **Webinar presented on September 1, 2020 (recording available through nsuf.inl.gov)**

Quantifying the Impact of NSUF Fuels and Materials Understanding Scale (FaMUS)




NSUF
Nuclear Science
User Facilities