

Nuclear Science User Facilities

NSUF Overview



J. Rory Kennedy Director, NSUF

FY 2016 NSUF Annual Program Review DOE NE Germantown Facility November 1-2, 2016



NSUF Support Structure and Technical Expertise



Nuclear Energy

DOE

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Ion Beams

Dr. Gary Was (UM) Dr. Beata Tyburska-Puchel (UW) Dr. Meimei Li (ANL)

Examinations

Dr. Assel Aitkaliyeva (INL) Dr. Brandon Miller (INL) Dr. Jian Gan (INL) Dr. Yaqiao Wu (CAES) Ms. Joanna Taylor (CAES) Dr. Andrew Casella (PNNL) Dr. Kurt Terrani (ORNL) Dr. Maria Okuniewski (Purdue) Dr. Peter Hoseman (UCB) Mr. Ron Crone (INL) Dr. Mitch Meyer (INL) Dr. Dan Wachs (INL) Ms. Katelyn Wachs (INL) Dr. Jim Cole (INL) Meimei Li (IVEM,ANL)

Synchrotron Irradiation Dr. Jeff Terry (IIT) Dr. Lynne Ecker (BNL)







- NSUF General
- FY 2016 Accomplishments Milestones
- **FY 2016 Accomplishments Highlights**
- FY 2017 Action Areas and Milestones



NSUF Organization Chart Call







Nuclear Energy

NSUF General



Established 2007 as DOE Office of Nuclear Energy first and only user facility

- Idaho National Laboratory is lead institution
- Irradiation effects in nuclear fuels and materials
- Provide access to capabilities and expertise at no cost to user
- Support design, fabrication, transport, irradiation, PIE, disposition
- Link intellectual capital with nuclear research infrastructure to fulfill mission of DOE-NE

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)
 - PIE only (~\$500K, up to 3 years)
 - Irradiation only (\$500K \$3.5M)
 - Beamlines at other user facilities
- Rapid Turnaround Experiments (RTE, 3 calls/year, limited \$\$, executed within 9 months)
- Proposals welcome from University, National Laboratory, Industry, Small Business, Int'l researchers





NSUF – A consortium

A group formed to undertake an enterprise beyond the resources of any one member







NSUF General Capabilities



- Neutron Irradiations
 - ATR (loop, rabbit), ATRC, HFIR (rabbit), MITR (loop), PULSTAR, NRAD (Future: BR2 SCK-CEN Belgium), Halden Norway ?)
- Ion Irradiations
 - Tandem Accelerator Ion Beam (U. Wisc), Michigan Ion Beam Lab (U. Mich), IVEM (ANL) (Future: TAMU, SNL, LANL)
- Hot Cells
 - INL(HFEF, FCF, AL, IASCC), ORNL (IFEL, IMET, REDC), PNNL (RPL), U. Mich (IMC), Westinghouse (MCOE)
- High radiation level measurements/instrumentation
 - Neutron radiography, elemental & isotopic analyses, gas sampling and analyses, profilometry, gamma scanning, mechanical testing, electron and optical microscopy, thermal analyses, eddy current, IASCC, EPMA, AES, XPS, focused ion beam (FIB)
- Low radiation level measurements/instrumentation
 - SEM, TEM, APT, FIB, hardness, micro- & nano-indentation, tensile, thermal analyses, XRD, XPS, AES, SIMS, NMR, PAS
 - Beamlines
 - X-ray (ANL APS: MRCAT, IIT; BNL NSLS-II: XPD, NST Dept)
 - Neutron, positron (PULSTAR, NCSU)
- Visit nsuf.inl.gov under Research Capabilities tab for details at individual facilities



Nuclear Energy

NSUF General



- Total of 29 awarded CINR type projects executed
- Total of 20 CINR type projects currently ongoing
- Total of 106 RTEs executed
- Total of 21 RTEs ongoing
- 186 total projects awarded
 - □ 125 projects to 25 US universities
 - □ 54 projects to 5 national laboratories
 - □ 1 project to industry

□ 6 projects to 3 international (Oxford U., Manchester U., ANSTO)

- 180 total projects across 33 states
- Total of ~\$153M in DOE support (2007-2016)
- Effective FY2016 budget: ~\$29M (\$11.7M increase from FY15)
- Personnel changes in FY 2016
 - □ Jim Cole, Chief Scientist left (10/1/15) need Chief Irradiatin Scientist + Chief Post Irradiation Scientist
 - □ Jonathan Kirkham (10/1/15) NEID specialist
 - □ Kelly Cunningham (11/4/15) NFML "librarian" + contracts assistant





NSUF and GAIN







Nuclear Energy

FY 2016 Level 2 Milestones



- Completed all (13) level 2 milestones on time
- Provide NSUF RTE Award Recommendations for the FY16 1st Call 11/30/2015 (11/20/2015)
- EPRI-3 Ready to Insert -12/24/2015 (12/22/2015)
- Deploy Public Database (NEID) 12/24/2015 (11/6/2015)
- Complete As-run Analyses on NSUF Experiments Irradiated in ATR 3/31/2016 (3/30/2016)
- Provide NSUF RTE Award Recommendations for the FY16 2nd Call 3/31/2016 (3/28/2016)
- Submit Report for Annual Program Review 4/28/2016 (4/28/2016)
- Provide Award Recommendations for the FY 2016 CINR FOA 6/15/2016 (5/24/2016)
- Ion Beam Investment Options Workshop Report 6/30/2016 (6/30/2016)
- Provide NSUF RTE Award Recommendations for the FY16 3rd Call 7/29/2016 (7/27/2016)
- GAIN Execution Plan 8/31/2016 (8/26/2016)
- Establish the Nuclear Fuels and Materials Library Web-based Interactive Database 9/29/2016 (9/26/2016)
- Complete 100% of the FY 2015 awarded RTE's 9/30/2016 (9/23/2016)
- Gap Analysis Progress Report for FY 2016 9/30/2016 (9/29/2016)



Nuclear Energy

FY 2016 Level 3 Milestones



- Completed 25 of 32 level 3 milestones on time
- Completed 1 of 32 level 3 milestones late (1 week)
- 6 of 32 level 3 milestones pushed into FY 2017
- Complete UCF-1 Sample Shipment to NSLS-II (Brookhaven National Laboratory) 12/15/2015 (11/19/2015)
- UCF-3 Ready-to-Insert in ATR cycle 158B 12/24/2015 (11/15/2016)
- SAM-1 Ready to Insert in ATR Cycle 158B 12/24/2015 (1/25/2016)
- Complete BSU design review 1/28/2016 (11/30/2016)
- Final SiC Report on Sensor Process Improvement 1/29/2016 (1/28/2016)
- FY 2016 Cycle 1 IVEM Utilization 2/29/2016 (2/29/2016)
- Complete practice SCC test in new EIL laboratory with PWR water chemistry 2/29/2016 (2/29/2016)
- Compile and Analyze FY 2015 Performance Metrics 3/30/2016 (3/30/2016)
- Complete Utah State University (USU) PIE 3/31/2016 (3/31/2016)
- Complete Microscopy Analysis for EPRI X-750 tensile specimens 3/31/2016 (1/6/2016)
- Provide mid-year HPC Utilization data for NSUF projects 4/29/2016 (4/28/2016)
- UCF-2 Ready-to-Insert in ATR cycle 160A 5/15/2016 (3/31/2017)



FY 2016 Level 3 Milestones



- Nuclear Energy
- Complete installation of the HFEF in-cell load frame feedthrough 5/31/2016 (4/16/2016)
- Ship first set of U of Illinois 8305 samples to APS 5/31/2016 (3/22/2016)
- Implement LabView SCC/Fracture control software in CAES or EIL test system 5/31/2016 (5/31/2016)
- Complete Boise State 8242 Design Review 6/30/2016 (12/15/2016)
- FY 2016 Cycle 2 IVEM Utilization 6/30/2016 (6/28/2016)
- 2015 NSUF Annual Report electronic publication on the NSUF website 6/30/2016 (6/14/2016)
- Submit NSUF Users Meeting Report 7/28/2016 (7/25/2016)
- Perform Type B Experiment Shipment, ATR to HFEF 7/26/2016 (6/27/2016)
- GAIN Technology Focused Workshops Report 8/30/2016 (8/30/2016)
- Complete procurement and initial phase 1 mockup of new extensometer for HFEF Instron – 9/30/2016 (9/28/2016)
- FY 2016 Cycle 3 IVEM Utilization 9/30/2016 (9/21/2016)
- Provide year-end HPC utilization data for NSUF projects 9/30/2016 (9/28/2016)
- Complete procurement and initial phase 1 mockup of new, multi-zone furnace for HFEF Instron – 9/30/2016 (9/28/2016)



FY 2016 Level 3 Milestones



- Sign a CRADA with SCK-CEN to initiate collaborative activities 9/30/2016 (12/22/2016)
- Submit FY 2016 Year End IVEM Utilization Report 9/30/2016 (9/22/2016)
- Complete UI 355 Testing at MRCAT 9/30/2016 (5/3/2016)
- Knowledge & Validation Center planning document update 9/30/2016 (9/29/2016)
- GAIN Communication Plan 9/30/2016 (9/27/2016)
- Submit memo to the NSUF Director documenting completion of examination on the first set of U of Illinois 8312 Samples – 9/30/2016 (9/28/2017)
- Complete first set of INL MO 8418 beamline experiments at APS 9/30/2016 (4/28/2016)





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NSUF reporting presentations or participation

- Nuclear Engineering Department Head Organization Meeting NEDHO (November, 2015)
- Nuclear Energy Advisory Committee NEAC (December, 2015)
- **EPRI Nuclear Power Council Meeting (February, 2016)**
- □ NSUF FY 2015 Annual Program Review Meeting (March, 2016)
- □ Nuclear Fuel Industry Research NFIR Karlsruhe, Germany (April, 2016)
- NEAC Subcommittee on Infrastructure (May, 2015)
- INL NS&T Directorate Review (May, 2016)
- BWR Vessel and Internals Program Committee (June, 2016)
- National User Facilities Organization NUFO (June, 2016)
- NSUF Users Organization Meeting (June, 2016)
- Nuclear Engineering Department Head Organization Meeting NEDHO (June, 2016)
- □ NSUF Scientific Review Board Meeting (August, 2016)
- UK Nuclear Academics Discussion Meeting Bristol, UK (September, 2016)





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NSUF general presentations, exhibits, or other

- □ Test, Research, and Training Reactor Conference TRTR (October, 2015)
- **EPRI Primary Systems Corrosion Technical Advisory Committee (October, 2015)**
- □ ANS Winter Meeting (November, 2015) exhibit
- **EPRI Nuclear Vendor Forum (November, 2015)**
- □ MRS Winter Meeting (December, 2015) exhibit
- □ TMS Annual Meeting (February, 2016) exhibit
- □ Ion Beam Investment Workshop (March, 2016)
- □ Nuclear Regulatory Commission (April, 2016)
- □ NSUF Users Meeting (June, 2016)
- ANS Annual Meeting (June, 2016) 2 NSUF Sessions in Nuclear Fuels and Structural Materials Embedded Topical (June, 2016)
- □ MeV School (July, 2016)
- □ EPRI Webinar (August, 2016)
- □ Nuclear Innovation Bootcamp (August, 2016)
- **DOE-NE Cross-cut Coordination Meeting (August, 2016)**
- □ Test, Research, and Training Reactor Conference TRTR (August, 2016)
- **EPRI Int'I LWR Materials Reliability Conference and Exhibition (August, 2016) exhibit**
- □ TopFuel (September, 2016) exhibit
- □ Hot Lab Conference Karlsruhe, Germany (September/October, 2016)



CINR type projects support

- **FY 2014 \$400K, 8 full proposals, 3 awards**
- FY 2015 \$4.1M, 41 LOIs, 31 pre-proposals, 17 full proposals, 5 awards (1 R&D coupled, 4 NSUF only)
- FY 2016 \$9.7M (\$5.7M in FOA), 80 LOIs, 67 pre-proposals, 32 full proposals, 12 awards (8 R&D coupled, 4 NSUF only)





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Rapid Turnaround Experiments

- 75 proposals submitted from 24 institutions
 - 16 US Universities
 - 5 National Laboratories
 - 2 Foreign Institutions (UK Universities)
 - 1 Industry

□ 39 experiments accepted from 18 institutions

- 11 US Universities
- 5 National Laboratories
- 2 Foreign Institutions (UK Universities)
- □ 8 NSUF facilities performed experiments
 - 17 CAES
 - 9 LAMDA
 - 3 IVEM
 - 1 Massachusetts Institute of Technology
 - 2 North Carolina State University
 - 2 University California, Berkeley
 - 3 Idaho National Laboratory
 - 2 Pacific Northwest National Laboratory







Highlights

Outcome of FY2016 CINR

Nuclear Science User Facilities

Nuclear Energy

Effects of High Dose on Laser Welded, Irradiated AISI 304SS (NEET CTD)

- Boise State University
- \$613K, PIE only
- INL, Westinghouse
- Understand the phase transformation of thermally aged and neutron irradiated duplex stainless steels used in LWRs (NEET CTD)
 - University of Florida
 - \$579K, Beamline
 - IIT, MRCAT (APS)
- Enhancing Irradiation Tolerance of Steels via Nano-structuring by Innovative Manufacturing Techniques (NEET CTD)
 - Idaho National Laboratory
 - \$2459K, Irradiation + PIE
 - INL, ATR
 - Irradiation Performance Testing of Specimens Produced by Commercially Available Additive Manufacturing Techniques (NEET CTD)
 - Colorado School of Mines
 - \$2030K, Irradiation +PIE
 - INL, ATR



Highlights

Outcome of FY2016 CINR

Nuclear Science User Facilities

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Feasibility of Combined Ion-Neutron Irradiation for Accessing High Dose Levels (Nuclear Reactor Technologies)

- University of Michigan
- \$187K, Irradiation + PIE
- MIBL (UM), ORNL
- Radial Heat Flux Irradiation Synergism in SiC ATF Cladding (Fuel Cycle R&D)
 - Oak Ridge National Laboratory
 - \$843K, Irradiation + PIE
 - HFIR, ORNL
- Fission Product Transport in TRISO Fuel (Advanced Reactor Technologies)
 - University of Michigan
 - \$22K, Irradiation
 - MIBL (UM)
- Radiation Enhanced Diffusion of Ag, Ag-Pd, Eu and Sr in Neutron Irradiated PyC/SiC Diffusion Couples (Advanced Reactor Technologies)
 - Oak Ridge National Laboratory
 - \$518K, Irradiation + PIE
 - MIBL, HFIR, ORNL



Highlights

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Outcome of FY2016 CINR



Irradiation Testing of LWR Additively Manufactured Materials (NSUF Only)

- GE-Hitachi Nuclear Energy
- \$1982K, Irradiation +PIE
- ATR, INL
- Effect of Gamma Irradiation on the Microstructure and Mechanical Properties of Nano-modified Concrete (NSUF Only)
 - Vanderbilt University
 - \$185K, Irradiation
 - ORNL
- Correlative Atom Probe and Electron Microscopy Study of Radiation Induced Segregation at Low and High Angle Grain Boundaries in Steels (NSUF Only)
 - Oak Ridge National Laboratory
 - \$185K, PIE only
 - ORNL
- Role of Minor Alloying Elements on Long Range Ordering in Ni-Cr Alloys (NSUF Only)
 - Oregon State University
 - \$90K, Irradiation
 - University of Wisconsin





Nuclear Energy

Irradiation Activities

- □ Static Capsule Irradiation Experiments
 - Completed irradiations FY 2016:
 - None
 - On-going irradiations in FY 2016:
 - EPRI-ZG-C & EPRI-ZG-D "Irradiation and Post-irradiation Examination (PIE) to Investigate Hydrogen Assisted Anomalous Growth in Zirconium Alloys"
 - Started (design) in FY 2016:
 - UCF-3 "Microstructural Evolution in Low Fluence Irradiated Metallic Fuels"
 - BSU-269 "High Temperature In-pile Irradiation Test of Single Phase U3Si2"
 - BSU-8242 "Irradiation Influence on Alloys Fabricated by Powder Metallurgy and Hot Isostatic Pressing for Nuclear Applications"
 - INL-JD-8389 "Ultrasound-Based Sensors for Enhanced Monitoring of Irradiation Testing "





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Irradiation Activities

- Instrumented Lead Experiments
 - None
- Pressurized Water Loop (Loop 2A) Experiments
 - Completed irradiations in FY 2016:
 - EPRI-3 "Irradiation and PIE of Alloys X-750 and XM-19"
 - On-going irradiations in FY 2016:
 - None
- Hydraulic Shuttle (rabbit) Irradiation Experiments
 - Completed irradiations in FY 2016:
 - SAM-1
 - Started (design) in FY 2016:
 - UCF-2 "Microstructural Evolution in Low Fluence Irradiated Metallic Fuels"
- New tools reactor fluxes vs dpa and burnup achievements



Highlights



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PIE Activities

- **Materials Projects**
 - Completed PIE in FY 2016:
 - Utah State University "Irradiation Effect on Thermophysical Properties of Hf₃Al-Al Composite: A Concept for Fast Neutron Testing at ATR"
 - University of Illinois 355 "Post Irradiation Tensile Performance of Fe-Cr Base Alloys"
 - CNL (AECL) "Cahracterization of X-750 garten springs from CANDU reactor"
 - On-going PIE in FY 2015:
 - EPRI-ZG-A and EPRI-ZG-B "Irradiation and Post-irradiation Examination (PIE) to Investigate Hydrogen Assisted Anomalous Growth in Zirconium Alloys"
 - EPRI-2 "Irradiation and PIE of Alloys X-750 and XM-19"
 - NRC "Irradiation and PIE od 304SS"
 - Started PIE in FY 2016:
 - University of Illinois 8305 "In-situ Synchrotron Wide-Angle X-ray Scattering (WAXS) Tensile Investigation of Neutron Irradiated Ferritic Alloys"
 - University of Illinois 8312 "Advanced Characterizations of Low-dose Neutron Irradiated T91 and HT9 Alloys "



Highlights



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PIE Activities

- **Fuels Projects**
 - Completed PIE in FY 2016:
 - University of California, Berkeley "Hydride LWR Fuel Rod Irradiation"
 - Ongoing PIE in FY 2016:
 - University of Central Florida 1 "Microstructural Evolution in Low Fluence Behavior of Metallic Fuels"
 - Started PIE in FY 2016:
 - Purdue University 8418 "Microstructural Evolution in Low Fluence Behavior of Metallic Fuels"
- Instrumentation Projects
 - None





Nuclear Energy

Industry Programs

- Strong and increasing industry interest
 - FY14/FY15 0 CINR type pre-apps
 - FY15/FY16 3 pre-apps, 2 full apps, 1 awarded + 1 user facility
 - FY16/FY17 -
 - 1 RTE application
 - 10 industry PI applications
 - 2 small business PI applications
 - 5 industry co-PI applications
 - 7 small business co-PI applications
 - 1 international co-PI
 - 3 user facility use applications







Nuclear Energy

Communications

- Promotion
 - Very successful (applications and partner applications)

Branding

- New INL PIE Guide (50 pages)
- New Users Organization factsheet
- Updated exhibit materials
- Annual Report
- New Website

Partner utilization

- Partner facilities are more engaged
 - Applications were submitted by and/or for all partner facilities except Purdue and UNLV (ORNL especially pro-active)
- □ Partnering interest growing
 - Argonne National Laboratory/IVEM accepted as partner facility in FY2016
 - Brookhaven National Laboratory/NSLS-II partnering negotiations underway
 - Los Alamos National Laboratory applied
 - Sandia National Laboratory applied
 - Texas A&M University applied
 - Lawrence Livermore National Laboratory applied
 - The Ohio State University applied





Highlights



Nuclear Energy

Metrics – all metrics met

- Efficient use of funding for new awards
 - >50% funding to new awards (>60%)
- □ Effective use of NSUF capabilities
 - >20% funding to partner facilities (>30%)
- Publications and presentations
 - >20 peer reviews articles or presentation proceedings (>30)
- Prominence and positive exposure for NSUF
 - Invited lectures, etc. 5% increase per year
- Expand and diversify NSUF user community
 - Analyze data and act on trends

High Performance Computing

- HPC access emphasized in CINR
- System in place for quickly granting NSUF access and prioritizing work
- Support as-run, thermal, neutronics, and structural analyses
- Moose-Bison-Marmot (MBM) support
 - Considering MBM workshop/training in place of users meeting in FY17
- □ Tools to improve and simplify user experience
 - Falonviz, website, training







Highlights

Overall Area and Cost



Nuclear Energy

Large Scale Project Distribution





Highlights

Nuclear Energy

Overall Area and Cost



Small Scale Project Distribution







Nuclear Energy

Infrastructure / Capabilities

- □ Hired NEID capabilities scientific support
- Nuclear Energy Infrastructure Database (NEID) updating/expansion continued
- Over 125 institutions operating over 450 facilities housing over 950 instruments
- Current NEID users include researchers from 75 Federal Government and National Laboratories, 38 Universities and NGOs, and 25 Industry organizations.

□ Used for infrastructure gap analysis, RFI, FOA

- Nuclear Fuels and Materials Library (NFML)
 - Hired NFML "librarian"
 - □ Increased library content (10K by 2016 year end)
 - □ 12 experiments used NFML materials
 - Collaboration with UK NNUF material archive progressed. Other international interest developed.
 - □ First SAM irradiation (SAM-1) completed







Highlights

International



Nuclear Energy

DOE-NE / NSUF / INL and SCK-CEN / BR2 / LHMA

- In-kind contributions
- CRADA with four tasks
 - Reactor Performance and Thermal Modeling Benchmarking Using SiC Temperature Monitors.
 - Disc Irradiation for Separate Effects Testing with Control of Temperature (DISECT)
 - Irradiation and PIE of Uranium Silicide Fuel Under PWR Conditions Using Pressurized Water Capsule irradiation Device at BR2.
 - Cooperative In-Pile Instrumentation Development

DOE-NE / NSUF and UK / NNUF

- UK National Nuclear User facility (NNUF)
 - National Nuclear Laboratory (NNL)
 - Dalton Nuclear Institute (U. Manchester)
 - Culham Centre for Fusion Energy
- Initial area of mutual user facility interest and cooperation
 - Nuclear Fuels and Materials Library (Archive)
- NSUF to allow access through NNUF
 - Agreement in early stages of development



International



Nuclear Energy

DOE-NE / NSUF and Norway / Halden Reactor / IFE

- Excess irradiation testing capacity at Halden
- Range of specialized testing rigs
- Re-fabrication facilities
- Visit and discussions initiated in August 2016
- **DOE-NE / NSUF and Sweden / Studsvik**
 - Likely only w/r/t irradiation at Halden Reactor (transport issue)
 - Visit and discussions initiated in August 2016
- AREVA BWR thermal hydraulic facility in Karlstein, Germany
 - Visit and discussions initiated in September 2016
- European Commission (EC) Joint Research Centres (JRC)
 - Restructured putting all nuclear activities under one directorate
 - Dr. Maria Betti, Director of Nuclear Safety and Security Directorate expressed interest in NSUF function and will visit US in FY 2017



Nuclear Energy



FY 2017



FY 2017 Action Areas



- Execute awarded projects (CINR, pre-CINR, RTEs, CRADAs)
 - Irradiation coordination
 - **PIE coordination**
- CINR (FY17 ?, FY16 \$10M, FY15 \$4.1M, FY14 \$400K)
 - 124 LOIs (80 in FY16), 108 pre-proposals (67 in FY16), ~50-60 full proposals (32 in FY16)
 - Cost and resource challenge
- Rapid Turnaround Experiments (3 calls per year, 39 awarded in FY16)
- Nuclear Energy Infrastructure Database (NEID)
 - Continue to update (international + area exansion)
- Nuclear Fuels and Materials Library (NFML)
 - Improve web based interactive tools
 - Increase capacity and content including SAM series
 - Enable easier and less expensive access
- Expand beamline access and international cooperation/collaboration



FY 2017 Action Areas



Nuclear Energy

Industry

- Mechanical testing IASCC (crack growth, fracture, and tensile testing)
- High Performance Computing
 - ~30% of cpu time on Falcon machine available through NSUF
 - Continue to offer and emphasize through CINR and RTE calls
- Infrastructure Support
 - National Laboratory capability enhancement
 - Reactor and university competitive calls
- Instrumentation/scientist support
 - Support instrument scientists at ~20% time to maintain instrument, develop/adapt/implement cutting edge techniques and maintain or establish international reputation
- Communication/Training/Development/Expansion/
 - Users Meeting, website development, exhibits, interns
 - Ion Beam Roadmap Committee, ThermoHydraulics Workshop, Partner Facilities Working Group



FY 2017 Action Areas



- GAIN support
 - Management and execution
- TREAT support
 - Limited view hodoscope refurbishment
 - Data acquisition system
 - Full view hodoscope design and implementation
 - Experimental vehicle development and PIE preparations
- Knowledge & Validation Center (NEKVaC)
 - Management and execution
- Molten Salt Reactor Feasibility Study
- NEAC and NEAC Subcommittee support



FY 2017 Milestones



- 14 Level 2 Milestones (13 in FY 2016)
- 35 Level 3 Milestones (30 in FY 2016)
- 53 Work Packages
- 1st Quarter (10/1/2016 12/31/2016)
 - 4 Level 2 milestones
 - 4 Level 3 milestones
- 2nd Quarter (1/1/2017 3/31/2017)
 - 2 Level 2 milestones
 - 4 Level 3 milestones
- 3rd Quarter (4/1/2017 6/30/2017)
 - 3 Level 2 milestones
 - 10 Level 3 milestones
- 4th Quarter (7/1/2017 9/30/2017)
 - 5 Level 2 milestones
 - 17 Level 3 milestones

EXAMPLE 1 Nuclear Science User Facilities