

Table S-2. Roadmapping Neutron Sources

Facility	Isotopes	General Nuclear Science	Nuclear Power Technology	Space	Defense	Notes
<i>Reactors</i>						
Advanced Test Reactor (ATR)	> 10 ¹⁵ high flux products (Ir ¹⁹² , Co ⁶⁰ , Gd ¹⁵³ , Ni ⁶³) Short-lived products High energy products	General material irradiation Transplutonium production Fusion materials research	Fast flux irradiation, Thermal flux irradiation (P)- Fuels and Materials	2-5kg Pu-238 production Fuels and materials irradiation tests	Cross-sections–gms Cross section measurements Naval fuels (5/9 loops) (P) Pu disposition fuel testing	ATR 3 loops and numerous unused drop-in positions
Annular Core Research Reactor (ACRR)	Fission Products (Mo ⁹⁹ , I ¹³¹ , Xe ¹³³ , I ¹²⁵)	Fundamental transient effects and high pumped rate physics	Transient and in-core accident tests	Transient tests of fuels and materials	Isotope production for Radiochemistry, Cross-sections–gms Vulnerability testing Cross section measurements	ACRR is dedicated to medical isotope production
High Flux Isotope Reactor (HFIR)	High energy products (P) Short lived products (P) > 10 ¹⁵ high flux products Transuranics (P)	Neutron activation analysis Over subscribed for neutron beam research General materials irradiation Transplutonium production (P)	Fast flux irradiation, Thermal flux irradiation for fuels and materials	Fuels and materials irradiation Component testing Pu-238 prod < 2 kg	Cross-sections–gms Cross section measurements Naval fuels	* HFIR is almost fully loaded and can meet only part of the 5kg need for Pu-238
ANL-W NRAD			Neutron radiography			
SPR II and III at SN		Fundamental studies of transient effects and high pumped rate physics			Vulnerability testing	
BMRR		Boron neutron capture therapy				

Table S-2. Roadmapping Neutron Sources (continued)

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<i>Reactors</i>						
Tower Reactor Facility (to be privatized)		Boron neutron capture therapy				
LANL Critical Facility (LACEF)			Th, Fast critical experiments		Critical geometry, critical mass	
NIST		Over subscribed for neutron beam research				
Missouri University Research Reactor (MURR)	Short-lived products				Radiochemistry cross sections - gms	
MIT		Boron neutron capture therapy				
Most TRIGA reactors			Neutron radiography		Cross section measurements	
General University Reactors		Neutron activation analysis Boron neutron capture therapy (MIT)				
Commercial LWR			Thermal Fuels Irradiation	Pu-238 production Fuels and materials testing	Tritium–kgs (Preferred Rx Source) Transuranics–kgs Non-Pu material disposition	

Table S-2. Roadmapping Neutron Sources (continued)

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<i>Reactors</i>						
HFBR (Standby)	Short-lived products (Sm ¹⁵³ , Sc ⁴⁷ , Cu ⁶⁷)	Neutron activation analysis General material irradiation Over subscribed for neutron beam research*	Materials irradiation			Standby. Awaiting Secretarial decision on restart
FFTF (Standby)	> 10 ¹⁵ high flux products Ir ¹⁹² , W ¹⁸⁸ , Sn ^{177m} Transuranics, Short lived products	General materials irradiation Transplutonium production Fusion materials irradiation (P)	Fuels and Materials Fast flux irradiation (P) ATW testing General fuels and materials	2-5 kg Pu238 production Fuels, materials, and component testing	Naval fuels Non-Pu material disposition Cross-section–gms Cross section measurements Tritium Production	
TREAT (standby)			Transient (P) and in-core accident tests Neutron radiography	Transient testing of fuels and materials	Vulnerability testing	
ZPPR (standby, non-operational)			Th, Fast critical experiments		Cross section measurements Critical mass	
PBF (shutdown, non-operational)			Transient and in-core accident tests	Transient testing of fuels and materials	Vulnerability testing	
New reactor, similar to HFIR @ year 2020	>10 ¹⁵ high flux products Ir ¹⁹² , W ¹⁸⁸ , Sn ^{177m}					
New Annular reactors					Critical mass	

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<i>Accelerators</i>						
LANSCE	Spallation products A1-26 50-100MeV proton products	Neutron beam research Ultra cold neutrons	Nuclear cross sections	<800 Mev radiation effects on materials & tissue	Nuclear cross sections dynamic radiography	
IPNS		Neutron beam research (low flux) and materials testing			Materials, Pu properties, static radiography, dynamic radiography, isotope production, nuclear cross sections, detector research	
BLIP	50-100 proton products					
CEBAF, BATES		Nuclear science				
HRIBF- ORNL, ATLAS-ANL, LBNL-Heavy ion		Nuclear science		Radiation effects on materials and tissues		
ORNL LINAC (ORELA)		Nuclear science	Neutron cross section data		Nuclear cross sections, detector research	
AGS-Heavy ion		Nuclear science		>800 Mev, radiation effects on materials & tissue	Dynamic radiography	

Table S-2. Roadmapping Neutron Sources (continued)

Facility	Isotopes	General Nuclear Science	Nuclear Power Technology	Space	Defense	Notes
<i>Accelerators</i>						
BAF @ BNL Booster assisted facility-Heavy ion				Radiation effects on materials & tissue		
FXR (LLNL)					Dynamic radiography	
LLNL LINAC			Neutron cross section data			
RPI LINAC			Neutron cross section data			
DUKE University		Nuclear science				
BNL Cyclotron (shutdown)	10-30 MeV proton					
ORNL Cyclotron (shutdown)	10-30 MeV proton					
DARHT (LANL) (under construction)					Dynamic radiography	
SNS (In design)	Spallation products A1-26	Fundamental studies of radiation SNS (12 years out) Neutron beam research and material testing and neutron activation analysis			Materials, Pu properties, static radiography, nuclear cross sections, detector research	

Table S-2. Roadmapping Neutron Sources (continued)

Facility	Isotopes	General Nuclear Science	Nuclear Power Technology	Space	Defense	Notes
<i>Accelerators</i>						
APT/ATW (In design)	Numerous		none		Tritium production. Transmutation, MD, isotope production	
Radioactive Ion Beam (RIB) (In design)		nuclear science			Nuclear cross sections detector research	
LPSS (Proposed upgrade to LANSCE)	Spallation products A1-26	Neutron beam research Materials testing			Materials, Pu properties, static radiography, isotope production	
(IFMIF) New proposed fusion materials testing accelerator		14 MeV neutrons for fusion materials testing				
High energy P-Rad facility (proposed)					Dynamic radiography	

Table S-2. Roadmapping Neutron Sources (continued)

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		Science	Technology			
Hot Cells						
ANL-E Irradiated Materials Facility (IMF) AGHCF Bldg 205			AGHCF for partial length and metal fuel cells, dry glove box for reactor process development. Bldg 205 for fuels analysis.	IMF for materials GHCF for fuels		
ANL-W HFEF Analytical lab		HFEF for general materials irradiation	HFEF for shielded fab facility for metal fuels development, PIE for full and partial length and metal fuel cells, neutron radiography support (NRAD). Analytical lab for fuels analysis. FCF, Analytical lab for aqueous glove box for reactor process development.	HFEF for fuels		
BNL TPL MEL HIRDL	BLIP - 10. + 2 if HFBR restarted	MEL for nuclear science	MEL for PIE of partial length fuel cells Hot cell near BNL Booster.	MEL for materials.		

Table S-2. Roadmapping Neutron Sources (continued)

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<i>Hot Cells</i>						
Hanford/PNNL FMEF HLRF SAL Mini-hot cell SNMF PITL 222 West	12 cells - if FFTF restarted.	IEM, FMEF, HLRF for general materials irradiation and trans-Pu production.	FMEF for shielded lab facility for fuels development and PIE of metal fuels. IEM. PITL for PIE of full length and metal fuel cells. HLRF for partial length fuel cells, fuels analysis, reactor process development. SAL, 222 West for fuels analysis.	FMEF for Pu-238. HLRF for materials and fuels examinations.		
INEEL TAN FPF Remote Analytical lab (RAL). Intl Isotopes Inc (III)	5 - III		FPF, FCF, TAN for shielded fab facility for fuels development. TAN for PIE of full length fuel cells for reactor process development. RAL for fuels analysis. FPF for aqueous reactor process development.	TAN for space reactor fuels and materials examinations		

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<i>Hot Cells</i>						
Los Alamos	8 - LANSCE	CMR to LANSCE	CMR for PIE of full	CMR for materials	CMR for materials	

CMR TA-48		neutron beam research	and partial length and metal fuel cells, and fuels analysis. TA - 48 for fuels analysis. Hot cell near critical facility, near LANSCE for ATW.	and fuels	and isotope research TA-48 for analysis, training, vulnerability testing	
Oak Ridge REDC RMAL Bldg 4501 IMET RDL IFEL	7 - HFIR	IMET for general materials irradiation and nuclear science. REDC for trans-Pu production (P)	REDC for shielded lab facility for fuels dev't. IFEL for PIE of particle fuel. RMAL for fuels analysis. Hot cell near SNS Bldg 7920 for wet and 4501 for dry reactor process development. HFIR pool facility for gamma irradiation facility.	REDC for Pu 238 IMET for materials IFEL for fuel PIE	Materials recovery	
Sandia HCF LICA	4 - HCF (Mo99).	HCF (mission conflict with Mo99)	PIE of partial length fuel cells. Gamma irradiation facility.			

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<i>Hot Cells</i>						
Savannah River Site:	12 - if APT built		DWPF high level cells for fuels analysis	HLC/ILC for materials		Many hot cells at SRS are used

DWPF High level cells Int. level cells Cf shipping/ receiving Cf processing facility			F or H canyons and CPF for aqueous reactor process development	SRTC for fuels H canyon/HB for Pu238 (note: this facility is not being considered in the PU-238 EIS due to high operating costs)		to support EM
B&W Lynchburg Technology Center			PIE of full and partial length fuel rods	Material and fuels research		
GE Vallecitos			PIE of full and partial length fuel rods	Materials and fuels research		
Westinghouse RMF			Cladding and materials research	Materials research		
KAPL					Naval Reactors research	