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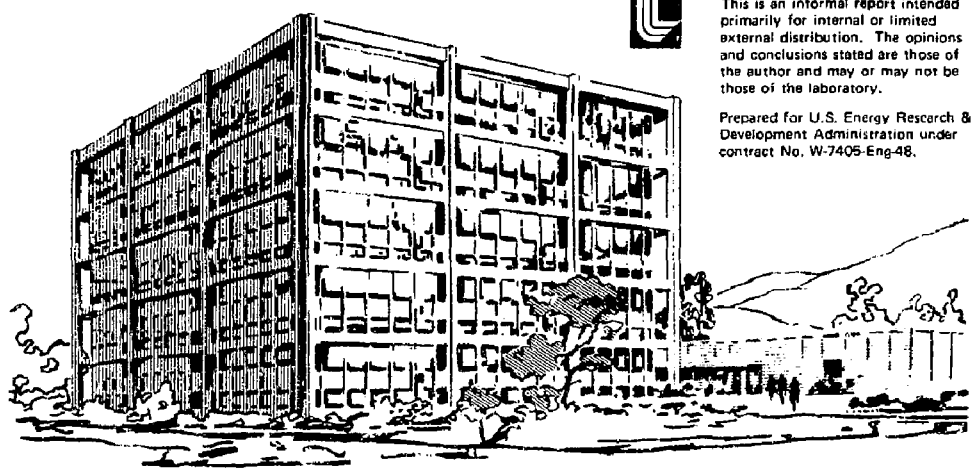
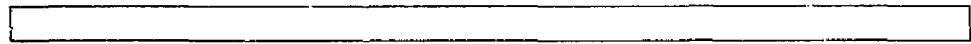
UCID- 17427

# Lawrence Livermore Laboratory

FISCAL YEAR 1976 DT FUSION NEUTRON IRRADIATIONS AND DOSIMETRY AT THE LLL  
ROTATING TARGET NEUTRON SOURCE

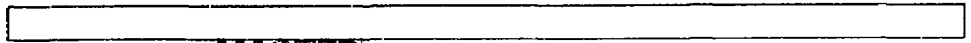
S. C. MacLean

March 31, 1977



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Prepared for U.S. Energy Research & Development Administration under contract No. W-7405-Eng-48.



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FISCAL YEAR 1976 DT FUSION NEUTRON IRRADIATIONS AND DOSIMETRY AT THE LLL  
ROTATING TARGET NEUTRON SOURCE

ABSTRACT

The DT fusion neutron irradiation of 319 samples during 19 irradiation periods (beam-on time of more than 1026 hours) is described. Experiments from 24 individuals representing 11 institutions are summarized. The numbers of the UCID dosimetry reports detailing each of the irradiations are given.

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Fiscal Year 1976 DT Fusion Neutron  
Irradiations and Dosimetry at the LLL  
Rotating Target Neutron Source

Susan C. MacLean

In order to most efficiently utilize the LLL Rotating Target Neutron Source (RTNS) during the Fiscal Year 1976, 319 samples from 24 experimenters were combined during 19 irradiation periods. Beam-on time was more than 1,026 hours during FY 76.

The tables following list the dates, experimenters and their laboratory, and the samples for each irradiation. The temperature of the irradiation and the maximum fluence are also given.

Fourteen of the 19 irradiations were at room temperature. For ten of these room temperature runs, the average flux on the front dosimetry foil (12 mm in diameter and as close to the neutron source as possible) was  $7.79 \times 10^{11}$  neutrons/cm<sup>2</sup>-sec with the range being  $4.66-9.31 \times 10^{11}$  n/cm<sup>2</sup>-sec.

Three of the irradiations were at cryogenic temperatures and two were at 210°C.

The  $\text{Nb}^{93}(n,2n)\text{Nb}^{92m}$  reaction was used to determine the 14.8 MeV neutron fluences (UCRL-51393, Rev. 1). The cross section used for the activation of the 10.16 day isomer of niobium by 14.8 MeV neutrons was 458 millibarns. The UCID number for each irradiation is given if more details of the irradiation history and individual sample dosimetry are required.

Positioning and aligning the samples with the neutron beam prior to the irradiations was handled by Ralph H. Condit and Curtis L. Rowe. The neutron irradiations were carried out by members of the LLL E Division Accelerator Staff, Lewis P. Mego, Richard M. Penpraze, and Sharon A. Snowden. The gamma ray counting of the niobium dosimetry foils was performed by Ruth N. Anderson or Austin L. Prindle.

## BI Fusion Neutron Irradiations - Fiscal Year 1976

Irradiation dates	June 30 - July 1, 1975	July 15-16, 1975	July 18-29, 1975		
UCID #	16874	16900	16951		
Beam-on time (hours)	28.35	19.11	96.17		
Experimenters	L. E. Fleischer	M. W. Gaiwan	L. E. Fleischer	L. E. Mitchell R. A. Van CONDONVILLE	M. J. Moran
Laboratory	Westinghouse Research & Development Center	III	Westinghouse Research & Development Center	III	III
Samples	One each, Ia, Ib, Ic and V, high purity foils, 12.7 mm diameter, 0.127 mm thick, seven 3 mm diameter microscope specimens partially pre-punched from each	One each, Ib, V, and Mo wires	One each Ia, Ib, Ic, and V high purity foils, 12.7 mm diameter 0.127 mm thick, seven 3 mm diameter microscope specimens partially pre-punched from each	Nine Al tensile specimens, 28.0 mm long, 9.5 mm wide, 0.5 mm thick, with gauge sections 6.5 mm long and 1.6 mm wide	Two supracell samples, each approx. 3 x 3 x 10 mm
Temperature of experiment	Room temperature	4.2°K	Room temperature	Room temperature	Room temperature
Average fluence on front of samples (n/cm <sup>2</sup> )	$6.87 \cdot 10^{16}$	$2.69 \cdot 10^{15}$	$2.90 \cdot 10^{17}$	$1.94 \cdot 10^{16}$	$2.58 \cdot 10^{16}$
Measured property or technique used for analysis	Electron microscopy	Electrical resistivity	Electron microscopy	Tensile testing	IRK

## DI Fusion Neutron Irradiations - Fiscal Year 1976

Irradiation dates	July 31, 1975	August 1-8, 1975	August 18, 1975		
UCID #	16978	16952	16989		
Beam-on time (hours)	9.67	2.77	3.90		
Experimenters	B. M. Farkin C. L. Sneed	I. Finney	J. D. Mitchell E. A. Van Gronzenburg S. C. Demask C. L. Tiolet	M. L. Moran	
Laboratory	IASL BNL	ILL - Whitman College	ILL	ILL and Queens College ILL	
Samples	2 superconductor wires: two 19-core Nb <sub>3</sub> Sn multifilament, three Nb <sub>3</sub> Sn single core, three V <sub>6</sub> Si single core, two NBTI Supercor 502, two NBTI cupronickel jacketed, 19 to 28 mm in length	Four annealed Al foil, 12.7 mm diameter, 0.025 mm thick	Five Cu tensile specimens, 25.6 mm long, 9.5 mm wide, 0.5 mm thick, with gauge sections 6.5 mm long and 1.0 mm wide	four Al-19Cu wires, each wound in a double flat coil	two superconductor samples, each approximately 4 × 4 × 8 mm
Temperature of experiment	Room temperature	Room temperature	210°C	Room temperature	Room temperature
Average fluence on front of samples (n/cm <sup>2</sup> )	$1.08 \cdot 10^{16}$	$3.77 \cdot 10^{15}$	$9.25 \cdot 10^{15}$	$7.51 \cdot 10^{15}$	$8.13 \cdot 10^{15}$
Measured property or technique used for analysis	Critical current and temperature	Al <sub>K</sub> beamline at the alpha in spectrometer irradiation	Tensile testing	Resistivity	ED

Deuteron Neutron Irradiation - Calendar Year 1976

Irradiation dates	August 16-22, 1976				August 26-29, 1976	
UGO #	16979				19021	
Beam-on time (hours)	66.12				6.57	
Experimenters	D. M. Parkin C. L. Snead	L. B. Mitchell E. A. Van Bonnynburg	D. M. Parkin C. L. Snead	L. B. Mitchell E. A. Van Bonnynburg	D. M. Parkin C. L. Snead	L. B. Mitchell E. A. Van Bonnynburg
Laboratory	IASI ISI	Westinghouse Research and Development Center	IASI ISI University of California	IASI ISI	IASI ISI	IASI ISI
samples	12 superconductor wires; two 19-core Nb <sub>3</sub> Sn multifilament, three Nb <sub>3</sub> Sn single-core, two NbTi supercon 402, two NbTi cupronickel jacketed, three V-tai single-core, 19 Co, 28 mm in length	one each, 19, Nb <sub>3</sub> Sn, and V-tai high purity coils, 0.17 mm thick, 12.7 mm diameter, seven 3 mm diameter microspecimens, partially pre-punched free ends	9 and 10 NbTi samples enclosed in 19-core cupronickel	Nine Al tensile specimens, 28.6 mm long, 9.5 mm wide, 9.5 mm thick, with gauge sections 6.3 mm long and 1.6 mm wide	12 superconductor wires; two 19-core Nb <sub>3</sub> Sn multifilament, three Nb <sub>3</sub> Sn single-core, two NbTi cupronickel jacketed, three V-tai single-core, 19 Co, 28 mm in length	Nine Co tensile specimens, 28.6 mm long, 9.5 mm wide, 9.5 mm thick, with gauge sections 6.3 mm long and 1.6 mm wide
Temperature of experiment	Room temperature	Room temperature	Room temperature	Room temperature	Room temperature	Room temperature
Average fluence on front of samples, (n/cm <sup>2</sup> )	$2.15 \cdot 10^{17}$	$1.68 \cdot 10^{17}$	$4.77 \cdot 10^{16}$	$6.17 \cdot 10^{16}$	$1.70 \cdot 10^{17}$	$1.33 \cdot 10^{17}$
Measured property or technique used for analysis	critical current and temperature	Electron microprobe	Electrical resistivity and volume changes	tensile testing	critical current and temperature	Tensile testing

## D1 Fusion Neutron Irradiations - Fiscal Year 1976

Irradiation dates	August 26-29, 1975 (cont.)	September 16-19, 1975					
UCID #	17021	17078					
Beam-on time (hours)	56.57	58.03					
Experimenters	H. Barsehall	D. M. Parkin C. L. Snead	R. H. Condit	J. L. Brinball	J. H. Mitchell S. A. Van Kuylenburg	M. J. Moran	H. Barsehall
Laboratory	University of Wisconsin and LLL	LANS BNL	LLL	SPSNL	LLL	LLL	University of Wisconsin and LLL
Samples	13 high purity foils one each Al, Fe, Ta, Ni, Nb, Cu, W, Mo, Zr, Sn, Ti, V, Cr, 12 mm diameter, 0.025 to 0.127 mm thick	12 superconductor wires; two 19-core Nb <sub>3</sub> Sn multifilament, three Nb <sub>3</sub> Sn single core, two NbTi Supercon 302, two NbTi copper-nickel jacketed, three V <sub>6</sub> Si single core, 19 to 28 mm in length	Six high purity Nb foils, 12 mm diameter, 0.137 mm thick	Mo and Ni foil samples enclosed in a brass envelope	Seven Al tensile specimens, 28.6 mm long, 9.5 mm wide, 0.5 mm thick, with gauge sections 5.4 mm long and 1.6 mm wide	Two supracell samples, each approximately 3 x 3 x 8 mm	13 high purity foils, one each Al, Fe, Ta, Ni, Nb, Cu, W, Mo, Zr, Sn, Ti, V, Cr, 12 mm diameter, 0.025 to 0.127 mm thick
Temperature of irradiation	Room temperature	Room temperature	Room temperature	Room temperature	Room temperature	Room temperature	Room temperature
Average fluence on front of samples (n/cm <sup>2</sup> )	$3.51 \cdot 10^{16}$	$1.69 \cdot 10^{17}$	$1.33 \cdot 10^{17}$	$1.13 \cdot 10^{17}$	$8.91 \cdot 10^{16}$	$2.59 \cdot 10^{16}$	$1.55 \cdot 10^{16}$
Measured property or technique used for analysis	Long lived activity	Critical current and temperature	Helium generation	Electrical resistivity and volume changes	Tensile testing	ESL	Long lived activity

DI Fusion Neutron Irradiation - Fiscal Year 1975

Irradiation dates	October 3-13, 1975				October 20-31, 1975			
UCID #	17055				17075			
Beam-on time (hours)	102.53				117.05			
Experimenters	D. M. Parkin C. L. Sneed	E. L. Biron <sup>1</sup>	A. Chan	H. T. "Mac" Miller E. A. Van Emmenegger	M. Marshall	J. W. Mitchell T. A. Van Ruynebeck	L. N. Watkins	
Laboratory	LASL IRE	ORNL	ORNL	ORNL	Lawrence Livermore Laboratory	ORNL	Sandia Livermore Laboratory	
Samples	12 superconductor wires, two D9-core Nb <sub>3</sub> Sn multithreaded, three Nb <sub>3</sub> Sn single-core, 350-1500 single-core, 12-3500 superconducting pellets, two D9-12 pellets, 194, 12 x 1/8 in length	12 and 14 x 1/8 samples	12 x 1/8 x 1/8 pellets, approximately 12	12 x 1/8 x 1/8 pellets, approximately 12	12 x 1/8 x 1/8 pellets, approximately 12	12 x 1/8 x 1/8 pellets, approximately 12	12 x 1/8 x 1/8 pellets, approximately 12	two fiber optic bundles
Temperature of irradiation	Room temperature	Room temperature	Room temperature	Room temperature	Room temperature	Room temperature	Room temperature	
Average neutron flux (n/cm <sup>2</sup> )	$1.02 \times 10^{14}$	$1.02 \times 10^{14}$	$1.02 \times 10^{14}$	$1.02 \times 10^{14}$	$1.02 \times 10^{14}$	$1.02 \times 10^{14}$	$1.02 \times 10^{14}$	$1.02 \times 10^{14}$
Measured property or technique used for analysis	Critical current and temperature	Electrical resistivity and flux change	Optical absorption	Optical absorption	Optical absorption	Optical absorption	Optical absorption	



DE Fusion Neutron Irradiation - Fiscal Year 1976

Irradiation dates	December 15, 1975		January 19-23, 1976				
UCID #	17076		17962				
Beam-on time (hours)	5.42		75.13				
Experimenters	D. M. Barkin C. L. Sneed	R. L. Gray W. C. Morgan	L. S. Penn	W. E. Larson J. C. Helms	J. C. Helms J. C. Helms	R. E. Condit	R. L. Lyles
Laboratory	IASI BNL	Battelle Pacific Northwest Labs.	ILL	ILL	ILL	ILL	ASL
Samples	12 superconductor wires; two 19-core Nb <sub>3</sub> Sn multifilament, three Nb <sub>3</sub> Sn single core, three V <sub>3</sub> Ga single core, two NbTi Supercon 402, two NbTi cupronickel jacketed, 19 to 28 mm long.	A pure Al capsule (53 mm long, 12 mm diameter) containing graphite sample holders, graphite samples and 20 deuterium coils	Twenty-four FeV <sub>10</sub> 59 bundles	Five Nb foils, 0.925 mm thick, 32 mm diameter, three "tritium-tricked" to helium concentrations of 25, 50, and 100 ppm	Spattering experiment	Three crystal samples; SiC, 120 grit; B <sub>4</sub> C; Al <sub>2</sub> O <sub>3</sub>	Copper capsule, 9 mm in diameter containing electron microscopy samples in a 33 mm long stack.
Temperature of experiment	Room temperature	Room temperature	77°K Liquid Nitrogen	77°K Temperature	77°K Temperature	Room temperature	Room temperature
Average fluence on front of samples (n/cm <sup>2</sup> )	$1.72 \cdot 10^{16}$	$1.37 \cdot 10^{16}$	$2.58 \cdot 10^{14}$	$1.73 \cdot 10^{17}$	$9.31 \cdot 10^{16}$	$1.73 \cdot 10^{16}$	$1.22 \cdot 10^{15}$
Measured property or technique used for analysis	Critical current and temperature	Change in Fermi's modulus using ultrasonic technique	Optical absorption	Electron microscopy	In situ microprobe	Helium release	Electron microscopy

at Fusion Neutron Irradiation - Fiscal Year 1976

Irradiation dates	January 28-30, 1976		April 12-16, 1976		May 11-13, 1976				
UCID #	17061		17142		17160				
Beam-on time (hours)	43.67		54.92		71.45				
Experimenters	R. H. Condit		W. J. Gray W. C. Morgan		M. W. Ginnin	R. A. Nelson	G. M. Edwards, Y. Chen	J. M. Bunch	
Laboratory	LLJ		BNL		LLJ		LBL		
Samples	Three high purity Sb foils, 12 mm diameter, 0.127 mm thick, plus two thin SiC crystals wrapped in Al foil.	A pure Al capsule (23 mm long, 12 mm diameter) containing graphite sample holders, graphite samples and Sb dosimetry foils.	one each, Nb, Mo, V wires	isolated SrCl <sub>2</sub> enclosed in plastic capsule	nine SiC crystals, simplest structure were 16 mm diameter discs, 0.51 ± 0.02 mm thick; five of these contained Pt electrodes. Two samples were Al foil foils with two or three Al <sub>2</sub> O <sub>3</sub> crystal inlets.	Mo crystal 10 × 10 × 2.8 mm	99% sapphire, 90% sapphire, sputral, and YAl <sub>3</sub> all 25-29 mm diameter, 0.3-0.5 mm thick		
Temperature of experiment	Boon temperature		Room temperature		4.2 K	Room temperature	Room temperature	Room temperature	
Average fluence on front of samples (n/cm <sup>2</sup> )	$1.53 \cdot 10^{17}$		$1.13 \cdot 10^{17}$		$1.78 \cdot 10^{16}$	$3.22 \cdot 10^{15}$	$1.23 \cdot 10^{17}$	$2.54 \cdot 10^{16}$	$1.73 \cdot 10^{16}$
Measured property or technique used for analysis	Helium generation		Change in Young's modulus using ultrasonic technique		Initial damage rate	Activation	Conductivity during electron irradiation	Optical absorption and EPR	Optical absorption

## DT Fusion Neutron Irradiation - Fiscal Year 1976

Irradiation dates	June 7-17, 1976			June 22-29, 1976		June 30, 1976	
UCID #	17293			17311		17294	
Beam-on time (hours)	137.15					4.0	
Experimenters	J. B. Mitchell	R. H. Jones	R. M. Scanlan	S. R. Gunn	R. R. Vandervoort	R. M. Scanlan	
Laboratory	LLL	BPNL	LLL	LLL	LLL	LLL	
Samples	Six V tensile specimens, 28.6 mm long, 9.5 mm wide, 0.5 mm thick, with gauge sections 6.4 mm long and 1.6 mm wide	Wire-toll basket (33 wires and/or tensile specimens) Nb, Ni, stainless steel	Nb <sub>3</sub> Sn tape approx. 7 x 13 x 0.03 mm. Also a carbon resistor about 4 mm long and 1 mm diameter	Two glass samples, 12.7 mm diameter, 51x thermoelectric temperature sensors	Four 316 stainless steel tensile specimens with gauge sections 6.4 mm wide, 0.5 mm thick, 116 S.S. sample 10 x 10 x 0.5 mm, 116 S.S. sample 5 x 8 x 0.5 mm	One superconductor wire	
Temperature of experiment	Room temperature	Room temperature	Room temperature	Room temperature	Room temperature	4.2°K	
Average fluence on front of samples (n/cm <sup>2</sup> )	$2.13 \times 10^{17}$	$6.13 \times 10^{16}$	$3.63 \times 10^{16}$	$3.17 \times 10^{16}$	$3.11 \times 10^{16}$	$2.27 \times 10^{15}$	
Measured property or technique used for analysis	Tensile testing	tensile testing	critical current	critical current	tensile testing and temperature	critical current	

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Printed in the United States of America

Available from

National Technical Information Service

U.S. Department of Commerce

5285 Port Royal Road

Springfield, VA 22161

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