UCID- 17466

Lawrence Livermore Laboratory

DT FUSION NEUTRON IRRADIATION OF LLL Nb_3Sn AND LLL SUPERCONDUCTOR WIRES AT 4.2°K

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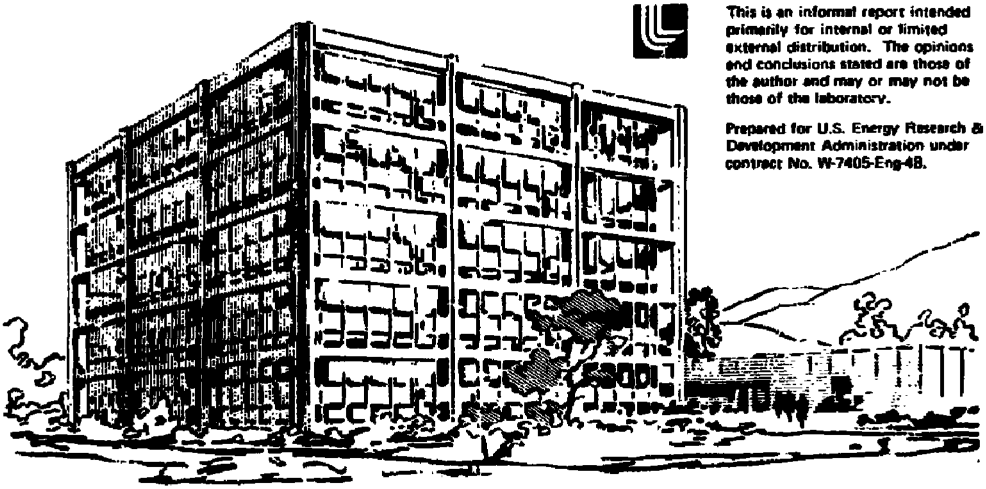
May 17, 1977



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

ABSTRACT

The DT fusion neutron irradiation of one LLL superconductor wire and one LLL Nb_3Sn foil at 4.2°K is described. The sample position, beam — on time, and neutron dose record are given. The results from two "profile" dosimetry foils measuring the lateral variation in neutron flux are included.

DT FUSION NEUTRON IRRADIATION OF LLL Nb_3Sn AND LLL SUPERCONDUCTOR WIRE AT 4.2°K

The Rotating Target Neutron Source (RTNS) irradiation during the week of September 13-17, 1976 was scheduled for Dr. Ronald M. Scanlon of LLL. During the irradiation his samples were held at liquid helium temperature. The samples were one superconductor wire and one piece of Nb_3Sn foil.

Two niobium dosimetry wires of approximately 10 mm in length and 0.25 mm in diameter were parallel to the sample wire. The dosimetry wire closer to the superconductor sample was designated Nb-RS-4 and the second dosimetry wire, farther from the sample, was Nb-RS-5.

A niobium dosimetry foil, 0.14 mm thick and 24 mm square, was scribed into 36 squares, 4 × 4 mm each, labeled and taped to the front of the Helitran containing R. Scanlon's samples. The niobium "profile" foil was included in order to measure the lateral variation in the neutron flux. Each square on the foil was labeled with a two digit figure. The first number indicated the horizontal row, top to bottom 1 to 6. The second number designated the vertical rows, left to right, 1 to 6.

The line between the fourth and fifth horizontal rows on the niobium profile foil was over the position of the superconductor wire sample inside the Helitran. Autoradiographs of a copper foil (with a 6 mm diameter hole in it) following a few minutes of irradiation were used to align the sample position with the neutron beam.

The irradiation was carried out by the E Division Accelerator Staff. Neutron production was monitored continuously with a proton recoil counter and recorded each hour. The irradiation was interrupted the third day so that the experimental apparatus could be moved back from the target and measurements could be taken. Before repositioning the Helitran and continuing the irradiation a new niobium profile foil replaced the first one. The foil was labeled in the same manner except that the vertical rows were designated A to F, left to right. Total beam — on time was 69.52 hours. The dose record is attached.

The center of the neutron beam had been within 1 mm of the sample wire on the first portion of the irradiation. However, an autoradiograph of the second profile foil showed the beam spot to have been considerably off center.

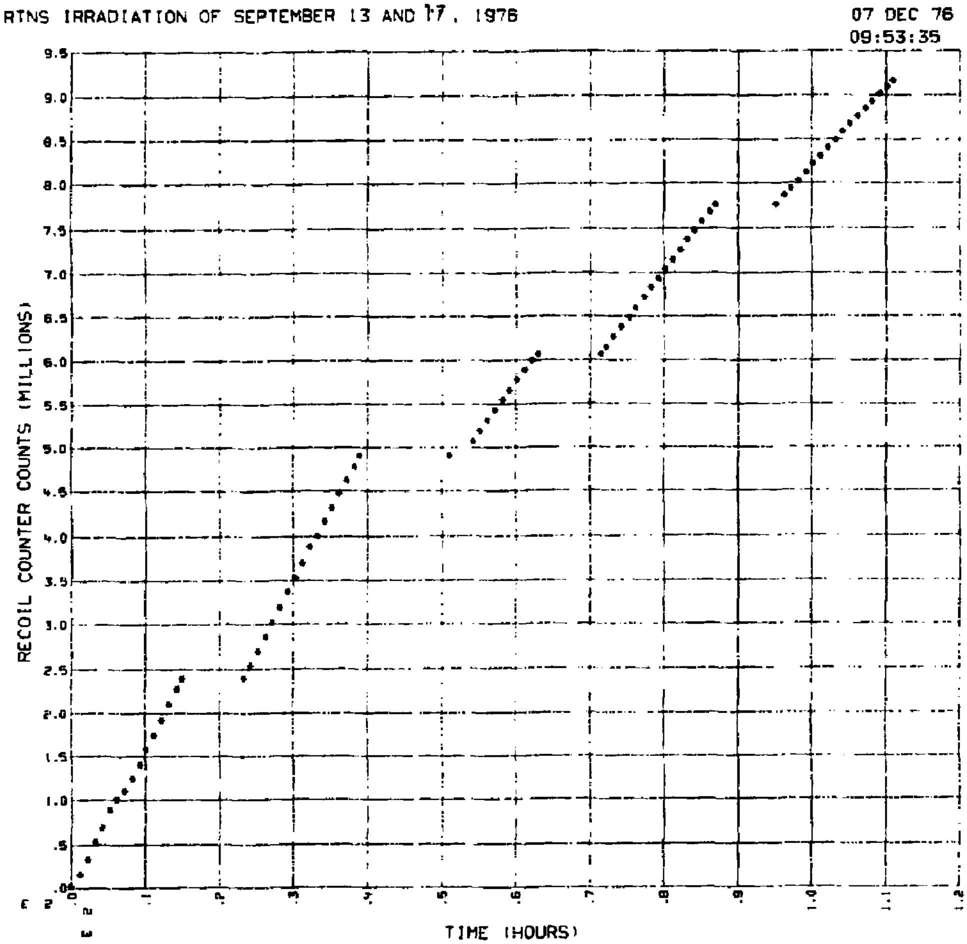
The niobium profile foils were cut along the scribed lines and each of the sections weighed. These along with the niobium dosimetry wires were delivered to Ruth Anderson in the LLL Radiochemistry Division. She carried out the gamma ray counting.

The average fluence of each dosimeter was calculated using the method described in UCRL-51393, Rev. 1. However, the cross section used for the activation of the 10.16 day isomer of niobium by 14.8 MeV neutrons was changed to 458 millibarns. The fluences of the first profile foil sections are given in Figures II and III and the fluences of the second profile foil pieces are shown in Figures IV and V.

During the first portion of the irradiation, the sample wire and dosimetry wires were parallel with the horizontal lines on the profile foil. However, during the second part of the irradiation the profile foil was rotated 30° in relationship to the sample. This correction of the dose record was taken into account when calculating the fluence on the dosimetry wires.

Dosimetry Wire	Fluence (neutrons/cm^2)
Nb-RS-4	4.24×10^{16}
Nb-RS-5	5.04×10^{16}

The estimated overall uncertainty of these results is ±20%. The relative uncertainty between any two values is about ±5%. The values given here represent average fluences over the volume of each dosimetry wire or foil.


RTNS IRRADIATION OF SEPTEMBER 13 AND 17, 1976
07 DEC 76
09:53:35
RECOIL COUNTER COUNTS (MILLIONS)
TIME (HOURS)
.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2

11 1.00×10^{16}	12 1.35×10^{16}	13 1.53×10^{16}	14 1.40×10^{16}	15 1.13×10^{16}	16 8.44×10^{15}
21 1.51×10^{16}	22 2.43×10^{16}	23 3.04×10^{16}	24 2.71×10^{16}	25 1.87×10^{16}	26 1.25×10^{16}
31 2.12×10^{16}	32 3.98×10^{16}	33 5.48×10^{16}	34 4.77×10^{16}	35 2.94×10^{16}	36 1.73×10^{16}
41 2.23×10^{16}	42 4.47×10^{16}	43 7.04×10^{16}	44 7.01×10^{16}	45 4.31×10^{16}	46 2.24×10^{16}
51 1.88×10^{16}	52 3.68×10^{16}	53 6.33×10^{16}	54 7.36×10^{16}	55 4.88×10^{16}	56 2.37×10^{16}
61 1.38×10^{16}	62 2.45×10^{16}	63 4.05×10^{16}	64 5.03×10^{16}	65 3.59×10^{16}	66 1.94×10^{16}

Figure II. Fluence Results for First Niobium Profile Foil (neutrons/cm^2).

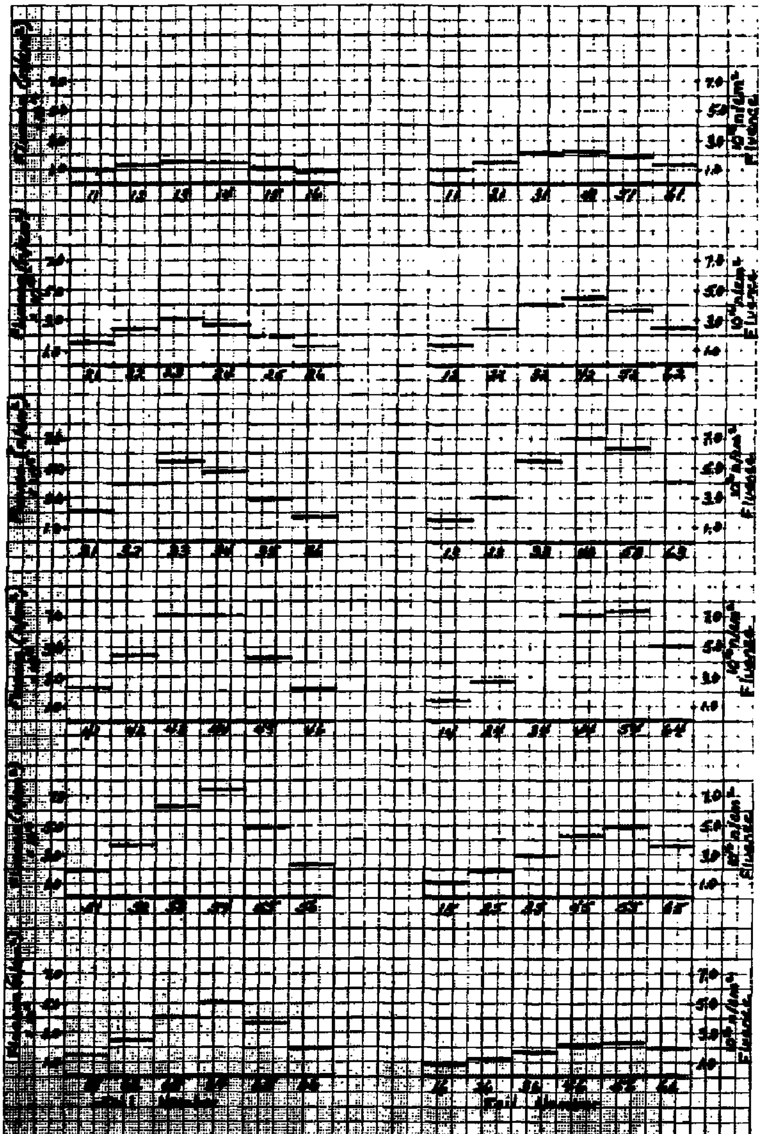
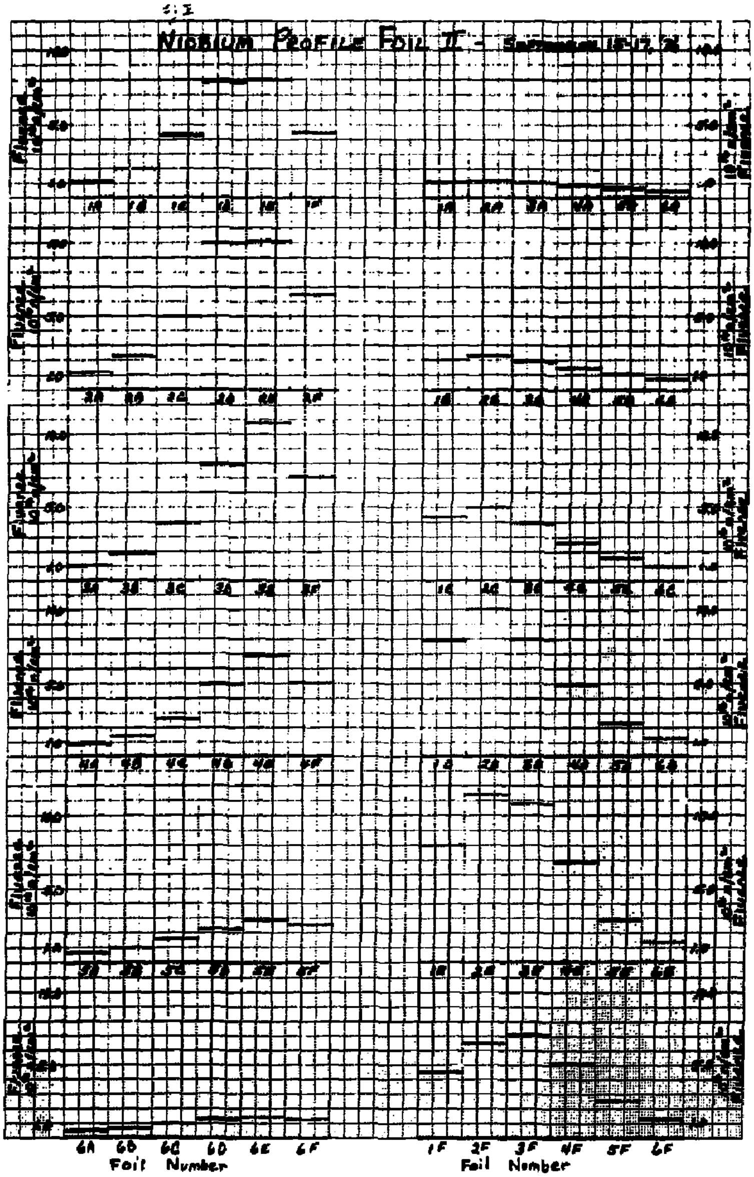


Figure III NIOBIUM PROFILE FOIL I - SEPTEMBER 13-14, 1976

1A 1.10×10^{16}	1B 2.02×10^{16}	1C 4.35×10^{16}	1D 7.94×10^{16}	1E 8.01×10^{16}	1F 4.47×10^{16}
2A 1.18×10^{16}	2B 2.27×10^{16}	2C 4.97×10^{16}	2D 1.00×10^{17}	2E 1.14×10^{17}	2F 6.53×10^{16}
3A 1.08×10^{16}	3B 1.89×10^{16}	3C 3.94×10^{16}	3D 7.97×10^{16}	3E 1.08×10^{17}	3F 7.09×10^{16}
4A 9.02×10^{15}	4B 1.45×10^{16}	4C 2.62×10^{16}	4D 4.98×10^{16}	4E 6.83×10^{16}	4F 5.10×10^{16}
5A 6.97×10^{15}	5B 1.02×10^{16}	5C 1.60×10^{16}	5D 2.34×10^{16}	5E 2.86×10^{16}	5F 2.55×10^{16}
6A 5.43×10^{15}	6B 7.17×10^{15}	6C 1.02×10^{16}	6D 1.28×10^{16}	6E 1.39×10^{16}	6F 1.26×10^{16}

Figure IV. Fluence Results for Second Niobium Profile Foil (neutron/cm^2).


NIOBIUM PROFILE FOIL II -
6A 6B 6C 6D 6E 6F
Foil Number
1F 2F 3F 4F 5F 6F
Foil Number