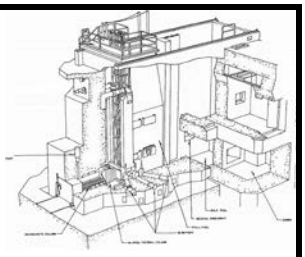
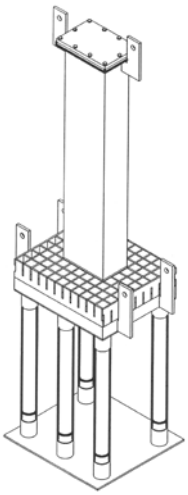
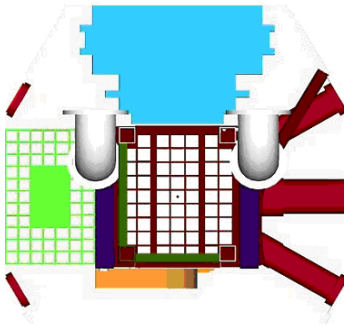


UNIVERSITY OF MASSACHUSETTS LOWELL RESEARCH REACTOR

FAST NEUTRON IRRADIATION (FNI) FACILITY



- Supports samples as large as 30cm x 30cm x 15cm
- Sample volume of 10,000 cm^3
- Fast flux and 1 MeV equivalent flux ≥ 10^{11} n/cm^2-s
- Greater than 4000:1 fast-to-thermal flux ratio
- Gamma dose rate to the sample ≤50 Krad/hr
- Neutron/Gamma ratio of 7E9 n/cm^2 per rad
- Uniform flux distribution to ±10% of the average
- Fully characterized by computational & experimental methods
- Optimized neutron spectrum minimizes thermal and fast radioactivation of samples for rapid return

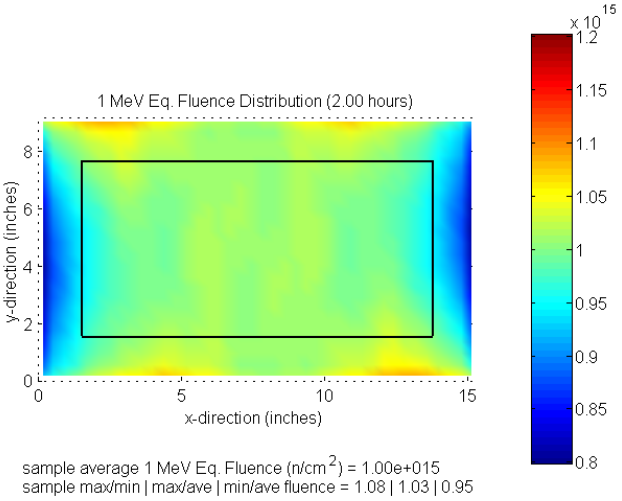


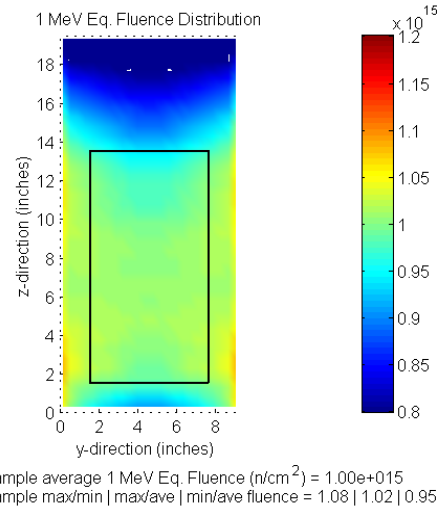
The University of Massachusetts Lowell Research Reactor (UMLRR) offers a large, ex-core, fast neutron irradiation (FNI) facility. It is designed to give a fast neutron flux level ≥ 10^{11} n/cm^2-s, with very low thermal neutron fluence and low gamma dose rates. Samples with a cross-sectional area as large as 30cm(12") x 30cm(12") and up to 15cm(6") thick can be irradiated. The fast neutron flux is designed to be nearly uniform over the 30cm(12") x 30cm(12") area facing the core, and the fast fluence variation through the sample thickness is minimized via a single 180° rotation of the sample canister at the midpoint of the irradiation period. The FNI facility offers a significantly larger sample volume than available at most other nuclear research reactor facilities.

Computed Fast Flux Indicators in FNI Sample Region

Fast Flux Indicator	Calculated Value (n/cm^2-s)
Flux > 0.01 MeV	2.55E+11
Flux > 0.1 MeV	1.83E+11
Flux > 1 MeV	5.08E+10
1 MeV Equivalent Flux	1.39E+11

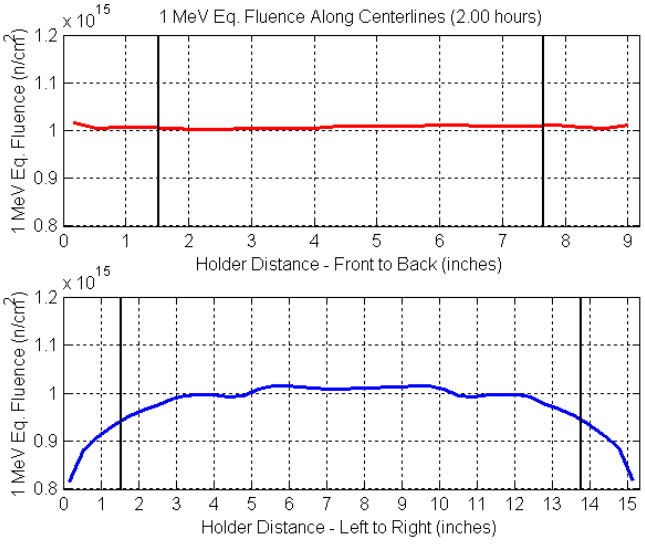
Uniformity of Fast Neutron Flux

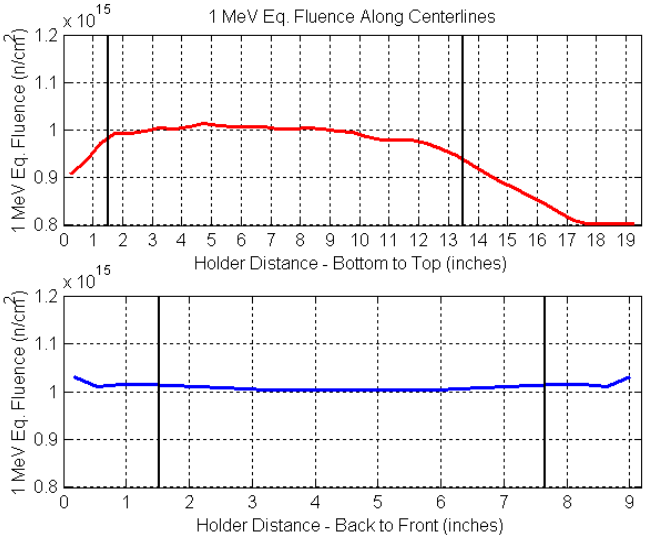




<u>Above Left</u>: Depicts the calculated 1 MeV equivalent neutron fluence distribution from side to side of the sample holder (i.e., view from above the sample holder, where the x-direction is along the side of the reactor core, y-direction is distance from the reactor core).

<u>Above Right</u>: Depicts the calculated 1 MeV equivalent neutron fluence distribution from bottom to top of the sample holder (i.e., view along the side of the sample holder, where the z-direction is the height from the bottom, y-direction is distance from the reactor core).





<u>Left Side</u>: Graphs depict the calculated 1 MeV equivalent neutron fluence profiles along centerlines of the FNI in the XY model

<u>Right Side</u>: Graphs depict the 1 MeV equivalent neutron fluence profiles along centerlines of the FNI in the YZ model.

Summary Data

Summary uniformity information for several distributions in the XY and YZ models (2 hour irradiation time with midpoint rotation)		
Parameter	**XY Model**	**YZ Model**
1 MeV Equivalent Fluence (n/cm^2)		
sample average	1.00E+15	1.00E+15
max/min	1.08	1.08
max/ave	1.03	1.02
min/ave	0.95	0.95
Thermal Neutron Fluence (n/cm^2)		
sample average	3.48E+13	3.69E+13
max/min	1.12	1.15
max/ave	1.04	1.04
min/ave	0.92	0.91
Gamma Dose to Silicon (Krad)		
sample average	92.2	131
max/min	1.21	1.16
max/ave	1.09	1.08
min/ave	0.90	0.93

Integral parameters for in-core location D2 and the ex-core FNI facility		
Parameter of Interest	**Radiation Basket D2**	**FNI Sample**
Broad Group Fluxes (n/cm^2-sec)		
Fast Flux >0.1 MeV	3.26E+12	1.83E+11
Epithermal Flux	3.42E+12	2.45E+11
Thermal Flux <1 eV	1.14E+13	4.85E+09
Total Neutron Flux	1.81E+13	4.33E+11
Total Gamma Flux	2.95E+13	5.05E+10
Additional Fast Flux Characterization		
Fast Flux >1 MeV	1.72E+12	5.08E+10
Fast Flux >0.01 MeV	4.02E+12	2.55E+11
1 MeV Equiv. Flux	3.08E+12	1.39E+11
RDF	0.77	0.55
Energy Deposition Rates (Krad/hr)		
Neutrons in Air	2.58E+04	1.38E+02
Neutrons in Silicon	9.37E+02	3.20E+01
Gammas in Air	3.50E+04	4.40E+01
Gammas in Silicon	3.74E+04	4.62E+01

Dosimetry

All fast neutron irradiations are performed using neutron dosimetry meeting ASTM requirements[1]. Upon request, gamma dosimetry may also be provided[2].

1. ASTM E256: *Measuring Reaction Rates and Fast Neutron Fluences by Radioactivation of Sulfur-32*.
2. ASTM F1190: *Neutron irradiation of Unbiased Electronic Components*.

For Further Information about Fast Neutron Irradiation:
Call: (978)-934-3365, or email: Leo_Bobek@uml.edu, or write to: Radiation Services Manager, Radiation Laboratory, UMASS Lowell, Lowell, MA 01854