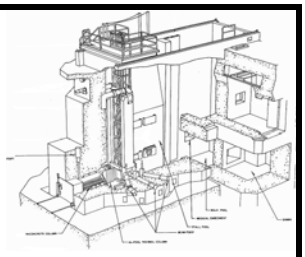
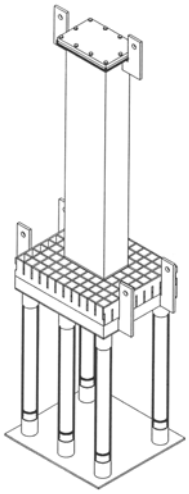
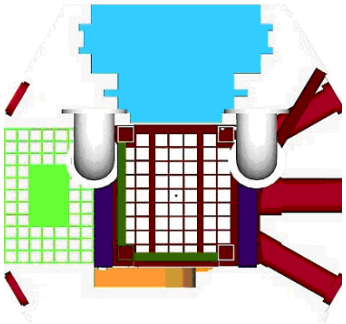


UNIVERSITY OF MASSACHUSETTS LOWELL RESEARCH REACTOR

FAST NEUTRON IRRADIATION (FNI) FACILITY



- Supports samples as large as 30cm x 30cm x 12cm
- Fast flux and 1 MeV equivalent flux $\geq 10^{11}$ n/cm^2-s
- Greater than 40:1 fast-to-thermal flux ratio
- Gamma dose rate to the sample $\leq$ 100 Krad/hr
- 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

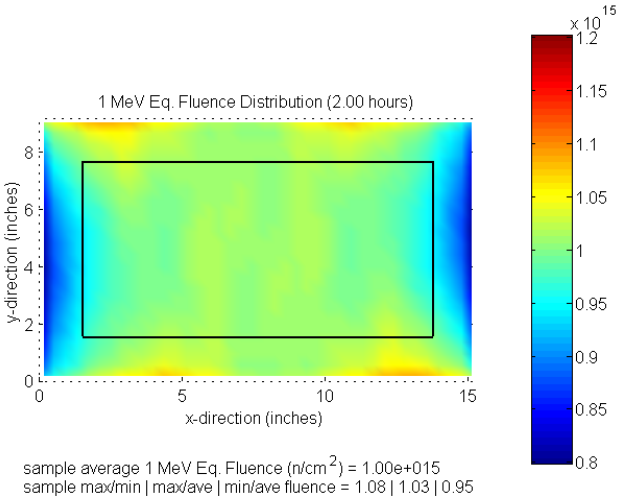


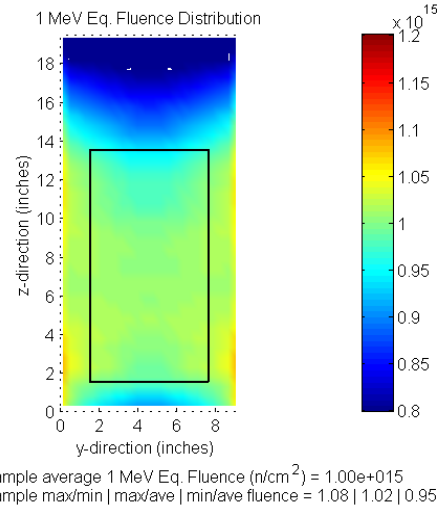
A large, ex-core, fast neutron irradiation (FNI) facility is now part of the University of Massachusetts Lowell Research Reactor (UMLRR). This new experimental facility replaces three beam ports that originally existed on the left side of the reactor core. It is designed to give a fast flux level $\geq 10^{11}$ n/cm^2-s, with relatively low thermal fluence and 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^o rotation of the sample canister at the midpoint of the irradiation period. The FNI facility offers a significantly larger sample volume than previously available within the University of Massachusetts Lowell Research Reactor (UMLRR).

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

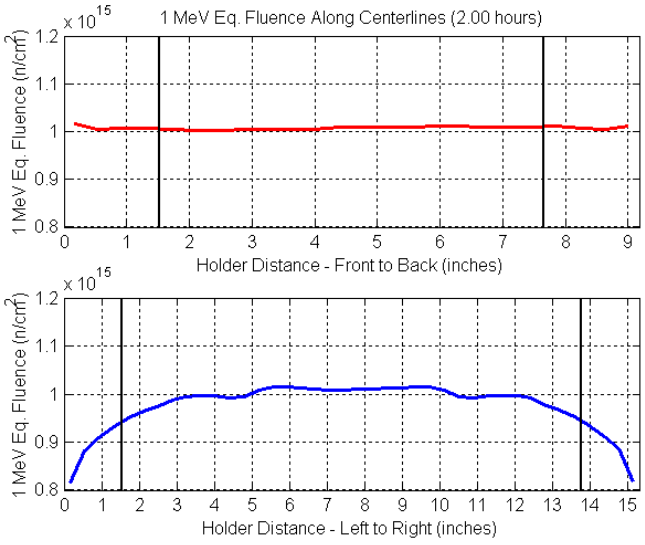
Uniformity of Fast Neutron Flux

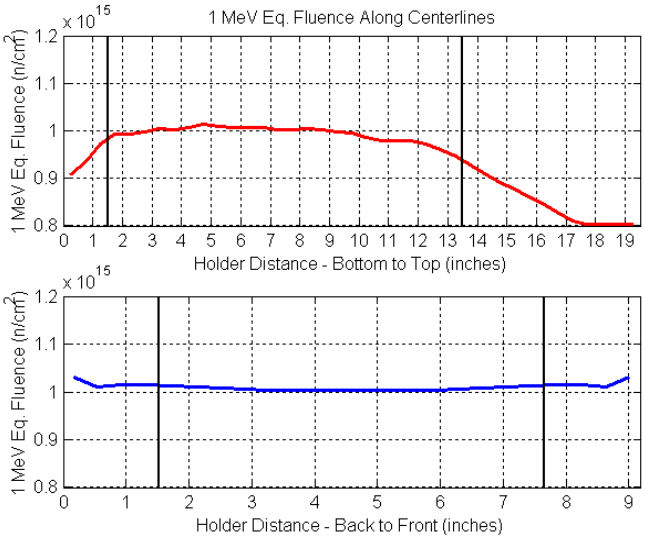




<u>Above Left</u>: Depicts the calculated 1 MeV equivalent neutron fluence distribution from side to side of the sample holder (i.e., view from above the sample holder, where the x-direction is along the side of the reactor core, y-direction is distance from the reactor core).

<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

Calculations are performed using the VENTURE and DORT codes. VENTURE provides few-group diffusion theory calculations for the reactor core region and its immediate surroundings. It is used to address core operations (reactivity worth, power distribution, etc.). DORT provides multi-group radiation transport computations to determine the in-core neutron and gamma spectra, and for all ex-core radiation transport analyses. It is used to quantify the space and spectral distribution of the neutron and gamma radiation environments. Both codes are provided by Radiation Safety Information Computational Center (RSICC) at Oak Ridge National Laboratory.

For Further Information about Fast Neutron Irradiation:
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