MPFD Foil Activation Experiment Resource

John Boyington
Kansas State University

Inventory

1. Loaded wand
2. Stopwatch
3. Sample Bags (Four plastic bags labeled #1, #2, #3, and #4; #1 corresponds to the highest axial position.)
4. Sample pig for transportation
5. Wire Cutters

Procedures

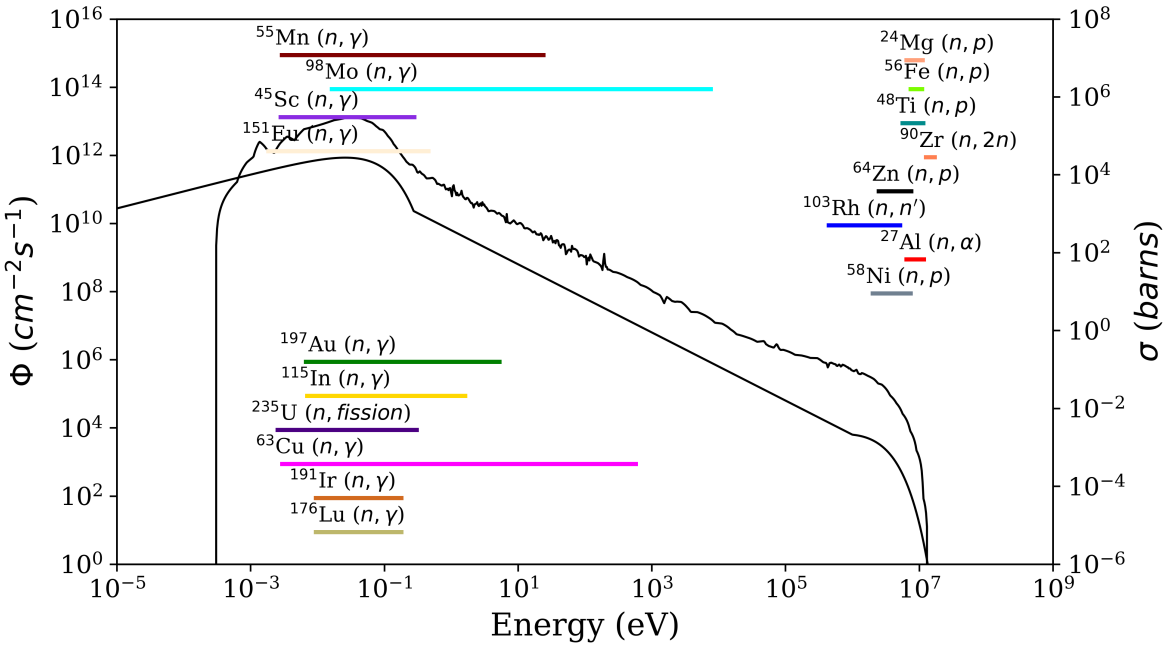
For each wand:

1. Raise reactor power to P then insert wand into reactor core.
2. Irradiate foil for t_i.
3. Scram reactor and remove wand from reactor core.
4. Place in fuel storage rack for t_w.
5. Pull wand to surface and remove internals. Remove foils from internals and place in labeled bags. Place bags in sample pig.
6. Count foils one at a time with HPGe for listed counting time.

Irradiation Order (6/22/18)

1. Wand 0 Rh, Au, In
2. Wand 2 In(Cd)
3. Wand 3 Au(Cd)
4. Wand 4 Al

Principle Reactions

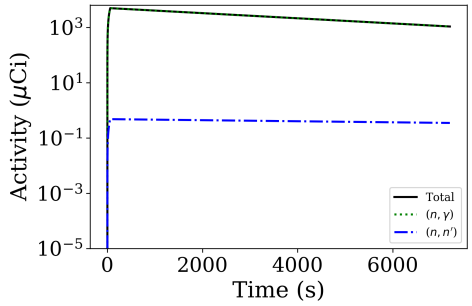


Reaction	$T_{1/2}$	ROI (eV)	Important Gammas (keV)
^{115}In(n,γ)^{116}In	54 m	7.0021e-03, 1.6130e+00	417, 819, 1090, 1293, 1508, 2111
^{115}In(n,γ)^{116}In Cd	54 m	1.1955e+00, 1.9916e+00	417, 819, 1090, 1293, 1508, 2111
^{197}Au(n,γ)^{198}Au	2.7 d	6.7266e-03, 5.2684e+00	412, 676, 1088
^{197}Au(n,γ)^{198}Au Cd	2.7 d	4.0752e+00, 7.1730e+00	412, 676, 1088
^{103}Rh(n,n')^{103m}Rh	56.12 m	4.4469e+05, 5.1947e+06	40
^{27}Al(n,α)^{24}Na	15.03 h	6.4564e+06, 1.1695e+07	1369, 2754

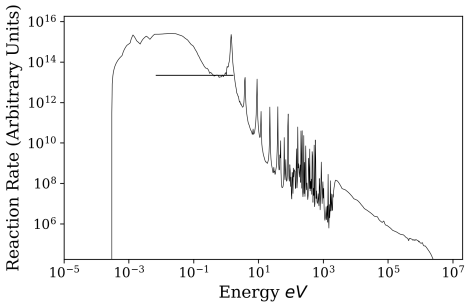
Indium

Power Level: 100 kW(th)
Time at Power: 60 s
Wait Time: 26400 s
Total Activity at Removal: 9.98e+02 μCi

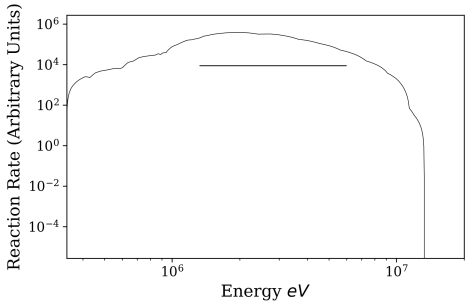
Position	Mass mg	Start Counting s	Counting Time s	Counting Activity μCi	Expected Area (Count
1	1.7	26460	60	4.19e+00	6.21e+05
2	1.5	26520	60	5.32e+00	7.87e+05
3	1.4	26580	60	4.63e+00	6.86e+05
4	1.6	26640	60	2.90e+00	4.30e+05



(a) Position #1



(b) (n, γ) Reaction Rate



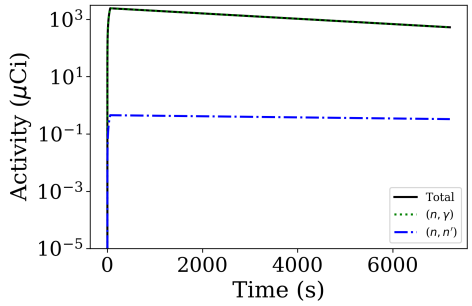
(c) (n, n') Reaction Rate

Reaction	$T_{1/2}$	ROI (eV)	Important Gammas (keV)
(n, γ)	54.0 m	7.00e-03, 1.61e+00	138(0.03), 417(0.36), 819(0.17), 1090(0.53), 1293(0.8), 1508(0.11),
(n, n')	4.4 h	1.33e+06, 5.96e+06	335(0.5)

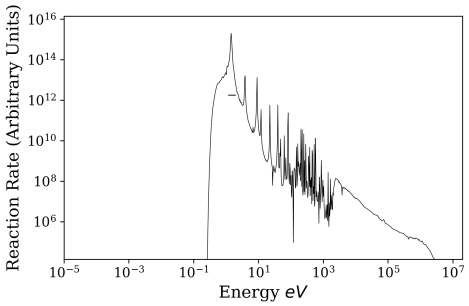
Indium (Cd)

Power Level: 100.0 kW(th)
Time at Power: 60 s
Wait Time: 3600 s
Total Activity at Removal: 8.83e+03 μCi

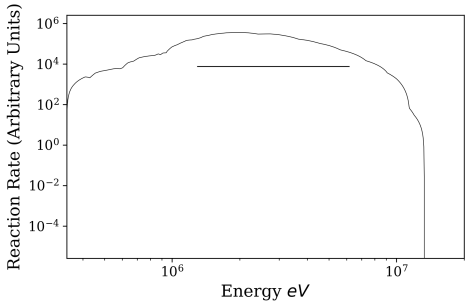
Position	Mass mg	Start Counting s	Counting Time s	Counting Activity μCi
1	1.7	3660	300	1.12e+03
2	1.5	3960	300	9.30e+02
3	1.4	4260	300	8.14e+02
4	1.6	4560	300	8.73e+02



(a) Position #1



(b) (n, γ) Reaction Rate



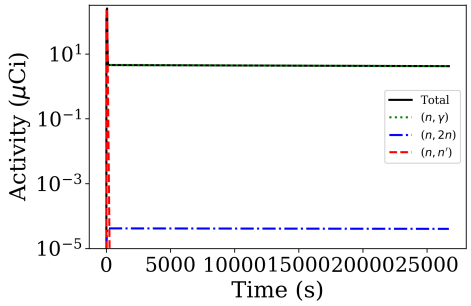
(c) (n, n') Reaction Rate

Reaction	$T_{1/2}$	ROI (eV)	Important Gammas (keV)
(n, γ)	54.0 m	1.20e+00, 1.99e+00	138(0.03), 417(0.36), 819(0.17), 1090(0.53), 1293(0.8), 1508(0.11),
(n, n')	4.4 h	1.34e+06, 5.97e+06	335(0.5)

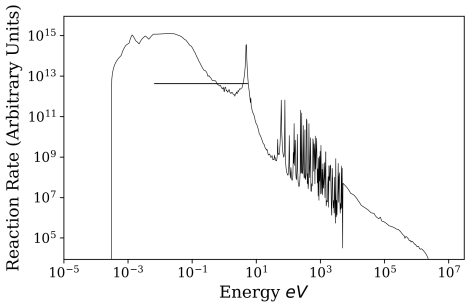
Gold

Power Level: 100 kW(th)
Time at Power: 60 s
Wait Time: 345600 s
Total Activity at Removal: 1.13e+03 μCi

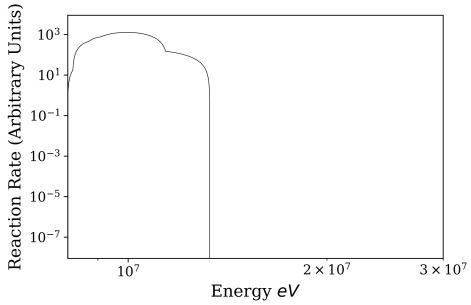
Position	Mass mg	Start Counting s	Counting Time s	Counting Activity μCi	Expected Area (Count
1	2.5	345660	60	2.39e+00	3.53e+05
2	2.7	345720	60	3.71e+00	5.49e+05
3	3.2	345780	60	4.10e+00	6.08e+05
4	2.5	345840	60	1.76e+00	2.60e+05



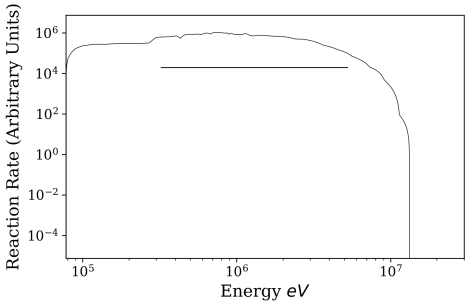
(a) Position #1



(b) (n, γ) Reaction Rate



(c) $(n, 2n)$ Reaction Rate



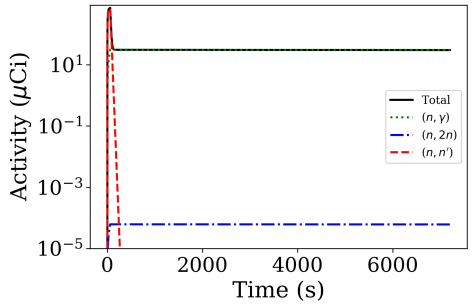
(d) (n, n') Reaction Rate

Reaction	$T_{1/2}$	ROI (eV)	Important Gammas (keV)
(n, γ)	2.7 d	6.73e-03, 5.27e+00	412(0.95), 676(0.01), 1088(0.002)
$(n, 2n)$	6.2 d	8.83e+06, 1.35e+07	333(0.25), 356(0.94), 426(0.06), 1091(0.002)
(n, n')	7.8 s	3.24e+05, 5.25e+06	130(0.08), 279(0.75)

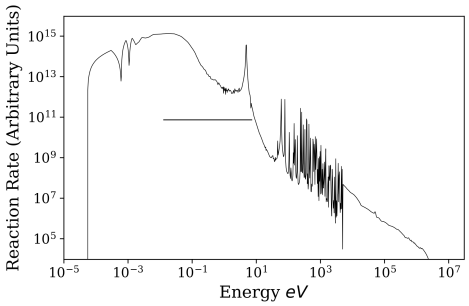
Gold (Cd)

Power Level: 100 kW(th)
Time at Power: 60 s
Wait Time: 3540 s
Total Activity at Removal: 2.52e+03 μCi

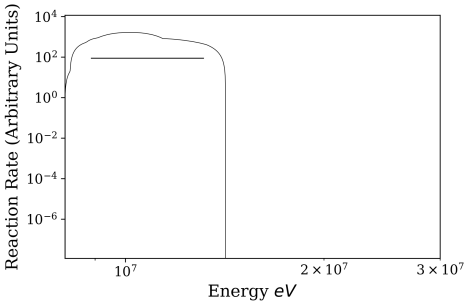
Position	Mass mg	Start Counting s	Counting Time s	Counting Activity μCi
1	5.0	3600	300	3.01e+01
2	4.35	3900	300	2.62e+01
3	4.3	4200	300	2.59e+01
4	4.37	4500	300	2.63e+01



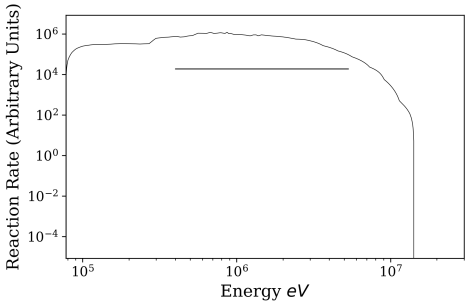
(a) Position #1



(b) (n, γ) Reaction Rate



(c) $(n, 2n)$ Reaction Rate



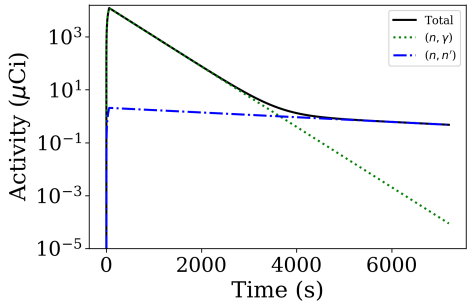
(d) (n, n') Reaction Rate

Reaction	$T_{1/2}$	ROI (eV)	Important Gammas (keV)
(n, γ)	2.7 d	4.08e+00, 7.17e+00	412(0.95), 676(0.01), 1088(0.002)
$(n, 2n)$	6.2 d	8.83e+06, 1.35e+07	333(0.25), 356(0.94), 426(0.06), 1091(0.002)
(n, n')	7.8 s	3.28e+05, 5.28e+06	130(0.08), 279(0.75)

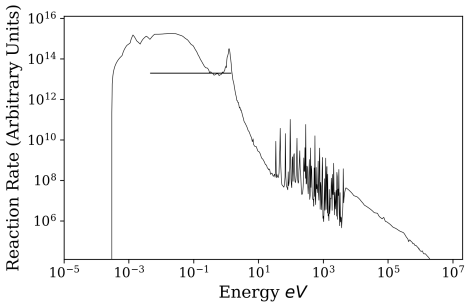
Rhodium

Power Level: 100 kW(th)
Time at Power: 60 s
Wait Time: 3600 s
Total Activity at Removal: 4.02e+04 μCi

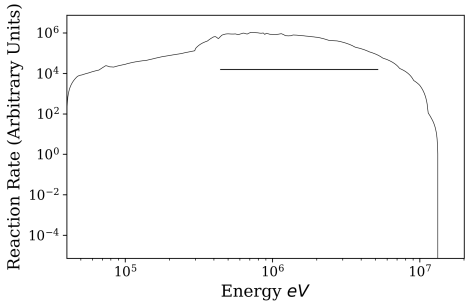
Position	Mass mg	Start Counting s	Counting Time s	Counting Activity μCi
1	0.7	3660	600	1.95e+00
2	0.55	4260	600	8.41e-01
3	0.5	4860	600	5.79e-01
4	0.55	5460	600	5.41e-01



(a) Position #1



(b) (n,γ) Reaction Rate



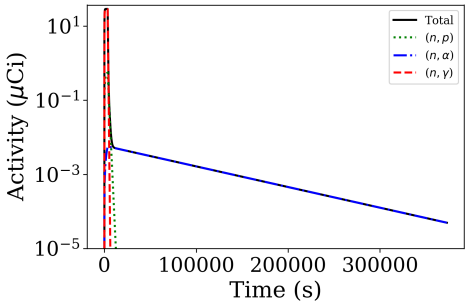
(c) (n,n') Reaction Rate

Reaction	$T_{1/2}$	ROI (eV)	Important Gammas (keV)
(n,γ)	4.4 m	4.67e-03, 1.39e+00	51(0.47), 78(0.025), 560(0.026), 770(0.0018)
(n,n')	56.1 m	4.45e+05, 5.19e+06	40(0.004)

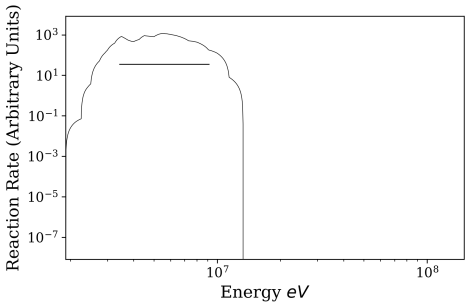
Aluminum

Power Level: 100 kW(th)
Time at Power: 3600 s
Wait Time: 354870 s
Total Activity at Removal: 8.36e+01 μCi

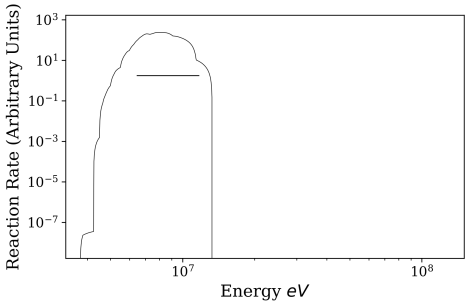
Position	Mass mg	Start Counting s	Counting Time s	Counting Activity μCi	Expected Area (Count
1	0.3	358470	3600	6.27e-05	2.79e+02
2	0.2	362070	3600	6.09e-05	2.72e+02
3	0.1	365670	3600	2.25e-05	1.00e+02
4	0.2	369270	3600	2.00e-05	8.91e+01



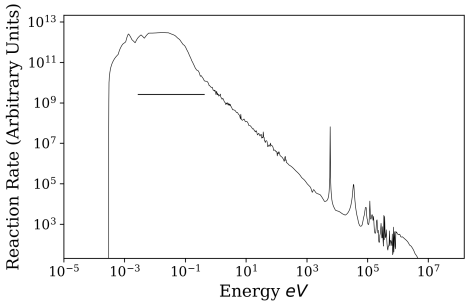
(a) Position #1



(b) (n, p) Reaction Rate



(c) (n, α) Reaction Rate



(d) (n, γ) Reaction Rate

Reaction	$T_{1/2}$	ROI (eV)	Important Gammas (keV)
(n, p)	9.5 m	3.44e+06, 9.21e+06	180(0.007), 840(0.7), 1013(0.3)
(n, α)	15.0 h	6.48e+06, 1.07e+07	1369(1), 2754(1)
(n, γ)	2.2 m	6.67e-03, 4.15e+00	1780(1)

Useful Links

Activation Calculator
https://www.ncnr.nist.gov/resources/activation/

Online Spectrum Catalogs for Ge and Si(Li)
http://www4vip.inl.gov/gammaray/catalogs/ge/catalog_ge.shtml

Decay Radiation Search
https://www.nndc.bnl.gov/nudat2/indx_dec.jsp

Evaluated Nuclear Data File (ENDF) Retrieval & Plotting
https://www.nndc.bnl.gov/sigma/