MPFD Foil Activation Experiment Resource

John Boyington
Kansas State University

For each wand:

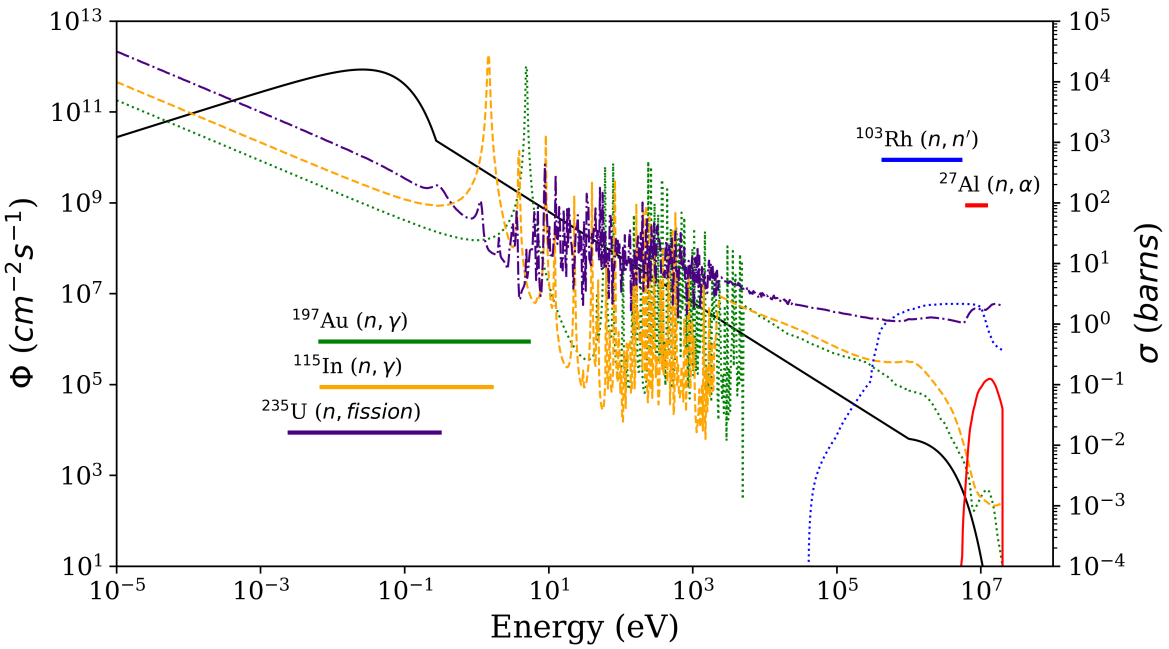
Inventory

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

Procedures

1. Raise reactor power to P then insert wand into reactor core.
2. Irradiate foil for t_i.
3. Scram reactor and promptly remove wand from reactor core.
4. While dose is above 50 mR/h at 1 ft., keep stored in fuel rod storage.
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.

Principle Reactions

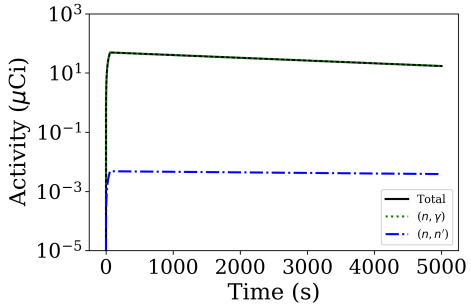


Reaction	$T_{1/2}$	ROI (eV)	Important Gammas (keV)
^{115}In(n,γ)^{116}In	54 m	7.0021e-03, 1.6130e+00	417, 819, 1090, 1293, 1508, 2111
^{115}In(n,γ)^{116}In Cd	54 m	1.1955e+00, 1.9916e+00	417, 819, 1090, 1293, 1508, 2111
^{197}Au(n,γ)^{198}Au	2.7 d	6.7266e-03, 5.2684e+00	412, 676, 1088
^{197}Au(n,γ)^{198}Au 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

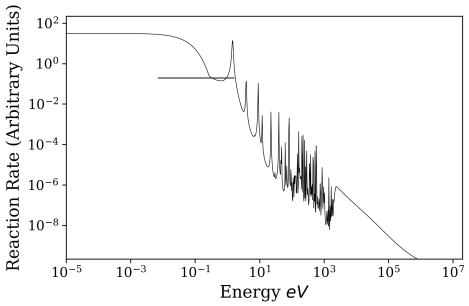
Indium

Power Level: 1.0 kW(th)
Time at Power: 60 s
Wait Time: 400 s
Total Activity at Removal: 1.79e+02 μCi

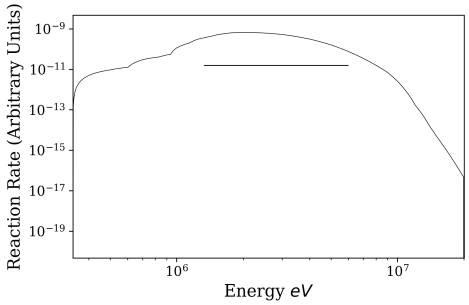
Position	Mass mg	Start Counting s	Counting Time s	Counting Activity μCi
1	1.7	460	300	4.51e+01
2	1.5	760	300	3.73e+01
3	1.4	1060	300	3.27e+01
4	1.6	1360	300	3.50e+01



(a) Position #1



(b) (n, γ) Reaction Rate



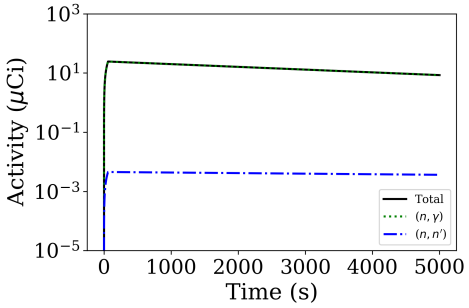
(c) (n, n') Reaction Rate

Reaction	$T_{1/2}$	ROI (eV)	Important Gammas (keV)
(n, γ)	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)

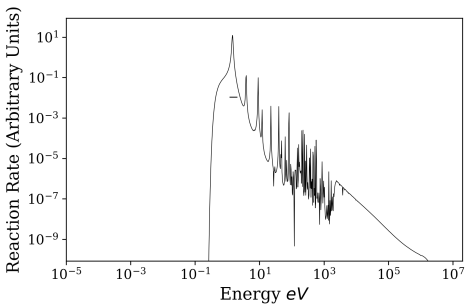
Indium (Cd)

Power Level: 1.0 kW(th)
Time at Power: 60 s
Wait Time: 400 s
Total Activity at Removal: 8.85e+01 μCi

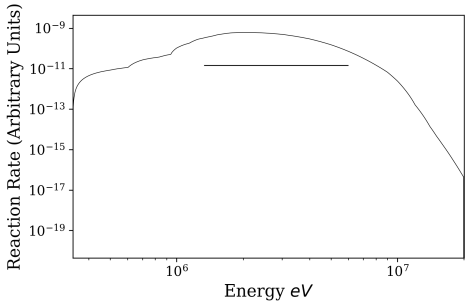
Position	Mass mg	Start Counting s	Counting Time s	Counting Activity μCi
1	1.7	460	300	2.23e+01
2	1.5	760	300	1.84e+01
3	1.4	1060	300	1.61e+01
4	1.6	1360	300	1.73e+01



(a) Position #1



(b) (n, γ) Reaction Rate



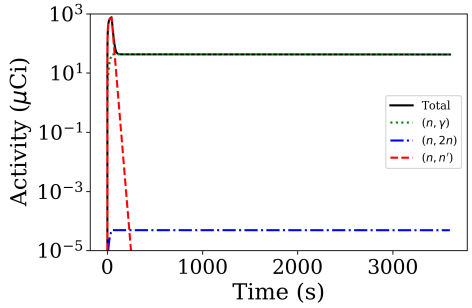
(c) (n, n') Reaction Rate

Reaction	$T_{1/2}$	ROI (eV)	Important Gammas (keV)
(n, γ)	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)

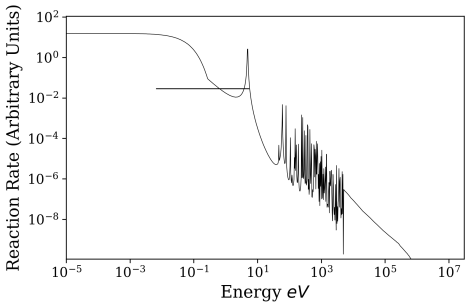
Gold

Power Level: 100 kW(th)
Time at Power: 45 s
Wait Time: 300 s
Total Activity at Removal: 2.73e+03 μCi

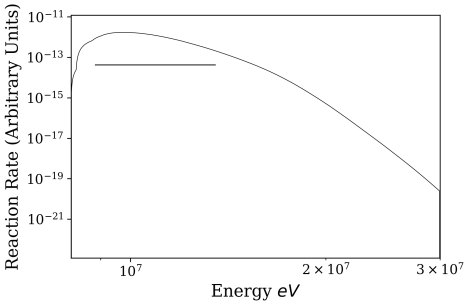
Position	Mass mg	Start Counting s	Counting Time s	Counting Activity μCi
1	5.0	345	300	4.24e+01
2	4.35	645	300	3.69e+01
3	4.3	945	300	3.64e+01
4	4.37	1245	300	3.70e+01



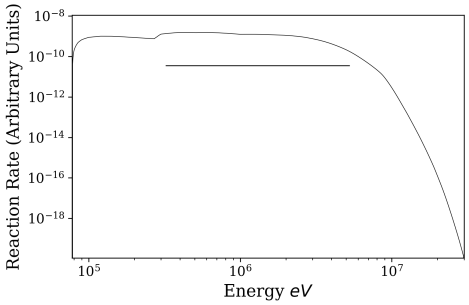
(a) Position #1



(b) (n, γ) Reaction Rate



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



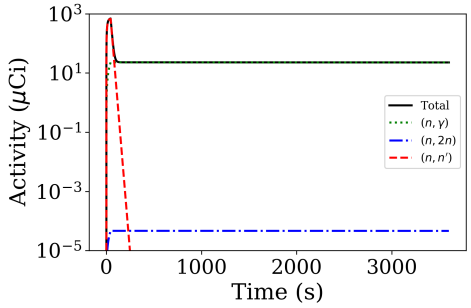
(d) (n, n') Reaction Rate

Reaction	$T_{1/2}$	ROI (eV)	Important Gammas (keV)
(n, γ)	34992000.0 d	6.73e-03, 5.27e+00	412(0.95), 676(0.01), 1088(0.002)
$(n, 2n)$	80092800.0 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)

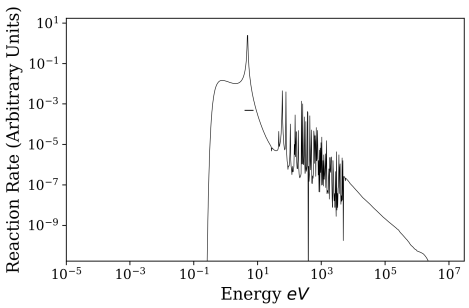
Gold (Cd)

Power Level: 100 kW(th)
Time at Power: 45 s
Wait Time: 300 s
Total Activity at Removal: 2.49e+03 μCi

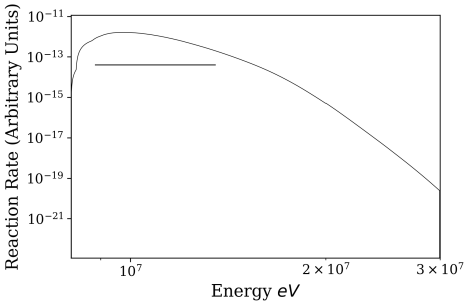
Position	Mass mg	Start Counting s	Counting Time s	Counting Activity μCi
1	5.0	345	300	2.28e+01
2	4.35	645	300	1.98e+01
3	4.3	945	300	1.96e+01
4	4.37	1245	300	1.99e+01



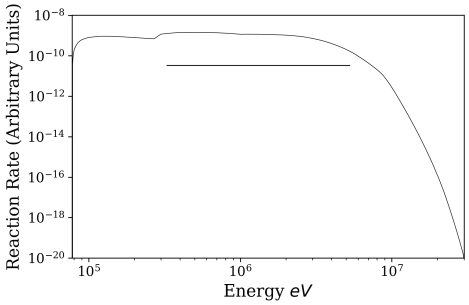
(a) Position #1



(b) (n, γ) Reaction Rate



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



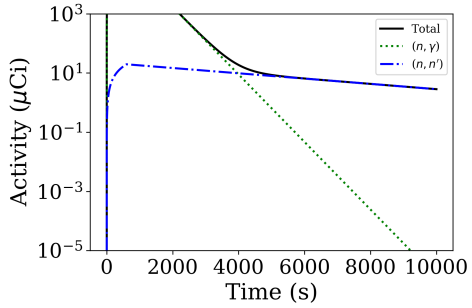
(d) (n, n') Reaction Rate

Reaction	$T_{1/2}$	ROI (eV)	Important Gammas (keV)
(n, γ)	34992000.0 d	4.08e+00, 7.17e+00	412(0.95), 676(0.01), 1088(0.002)
$(n, 2n)$	80092800.0 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)

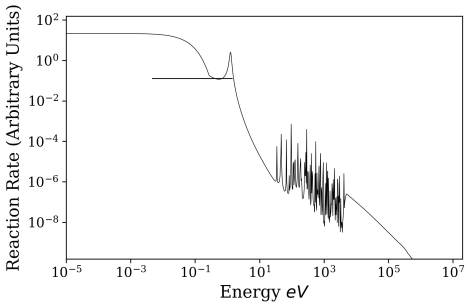
Rhodium

Power Level: 100 kW(th)
Time at Power: 600 s
Wait Time: 5000 s
Total Activity at Removal: 2.20e+05 μCi

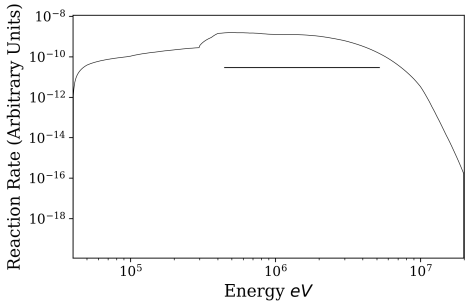
Position	Mass mg	Start Counting s	Counting Time s	Counting Activity μCi
1	0.7	5600	600	7.13e+00
2	0.55	6200	600	4.88e+00
3	0.5	6800	600	3.91e+00
4	0.55	7400	600	3.79e+00



(a) Position #1



(b) (n, γ) Reaction Rate



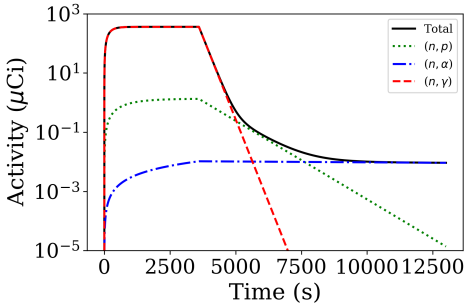
(c) (n, n') Reaction Rate

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)

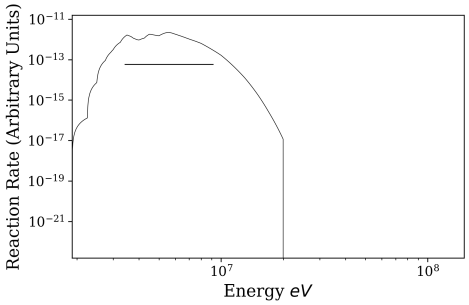
Aluminum

Power Level: 250 kW(th)
Time at Power: 3600 s
Wait Time: 1800 s
Total Activity at Removal: 9.62e+02 μCi

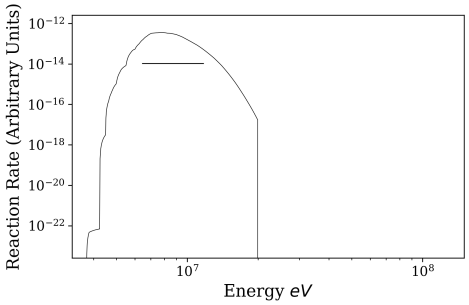
Position	Mass mg	Start Counting s	Counting Time s	Counting Activity μCi
1	0.3	5400	1800	1.92e-01
2	0.2	7200	1800	1.75e-02
3	0.1	9000	1800	3.83e-03
4	0.2	10800	1800	6.44e-03



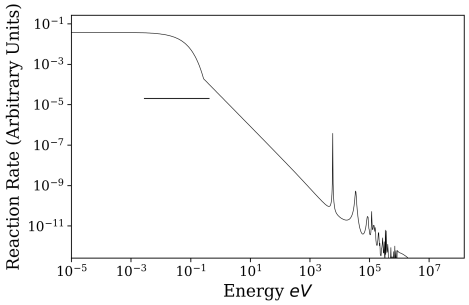
(a) Position #1



(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	3.42e+06, 9.14e+06	180(0.007), 840(0.7), 1013(0.3)
(n, α)	15.0 h	6.46e+06, 1.17e+07	1369(1), 2754(1)
(n, γ)	2.2 m	2.82e-03, 4.15e-01	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/