

U-230 (20.8d) A	U-231 (4.2d) ECA	U-232 (68.9y) A	U-233 (1.592E+5y) A	U-234 (2.455E+5y) A	U-235 (7.04E+8y) A	U-236 (2.342E+7y) A	U-237 (6.75d) B-	
Pa-228 (22h) CB+A	Pa-229 (1.50d) ECA	Pa-230 (17.4d) ECB-A	Pa-231 (3.27y) A	Pa-232 (1.31d) B-EC	Pa-233 (2.43h) B-	Pa-234 (6.70h) B-	Pa-235 (24.5m) B-	Pa-236 (9.1m) B-
Th-227 (18.68d) A	Th-228 (1.9116y) A	Th-229 (7.34E+3y) A	Th-230 (7.538E+4y) A	Th-231 (25.5h) B-	Th-232 (1.405E+10y) A	Th-233 (22.3m) B-	Th-234 (24.10d) B-	Th-235 (7.1m) B-

PROTACTINIUM-232

SUMMARY DATA

GENERAL

CLASSIFICATION

Isotope: Pa-232
Atomic number (Z): 91
Mass number (A): 232
Neutron number (N): 141

RADIOACTIVE DECAY

Decay modes: β^- , Electron capture
Half-life: 1.31 [d]
Decay constant: $6.1241\text{e-}06$ [1/s]
Daughters: U-232 (100.0%), Th-232 (0.003%)
Radioactive daughters: U-232, Th-232

DOSIMETRIC CONSTANTS

Mean alpha energy: 0.0 [MeV]
Mean electron energy: 0.1738 [MeV]
Mean photon energy: 0.93929 [MeV]
Air kerma rate constant, Γ_{10} : $4.511\text{e-}17$ [Gy·m²/Bq·s]
Air kerma coefficient, K_{air} : $4.511\text{e-}17$ [Gy·m²/Bq·s]
Equilibrium dose constant for weakly-penetrating radiations (α and/or electrons), Δ_{wp} : $2.785\text{e-}14$ [Gy·kg/Bq·s]
Equilibrium dose constant for alphas, Δ_{α} : $0.000\text{e+}00$ [Gy·kg/Bq·s]

Equilibrium dose constant for betas/electrons, $\Delta_{\beta-, \beta+, e-}$: 2.785×10^{-14} [Gy·kg/Bq·s]

Equilibrium dose constant for photons, Δ_p : 1.505×10^{-13} [Gy·kg/Bq·s]

DOSE POINT KERNELS (PLOT)

Dose point kernel source: **Graves, et al. Medical Physics. 2019 Nov.; 46(11):5284-5293.**

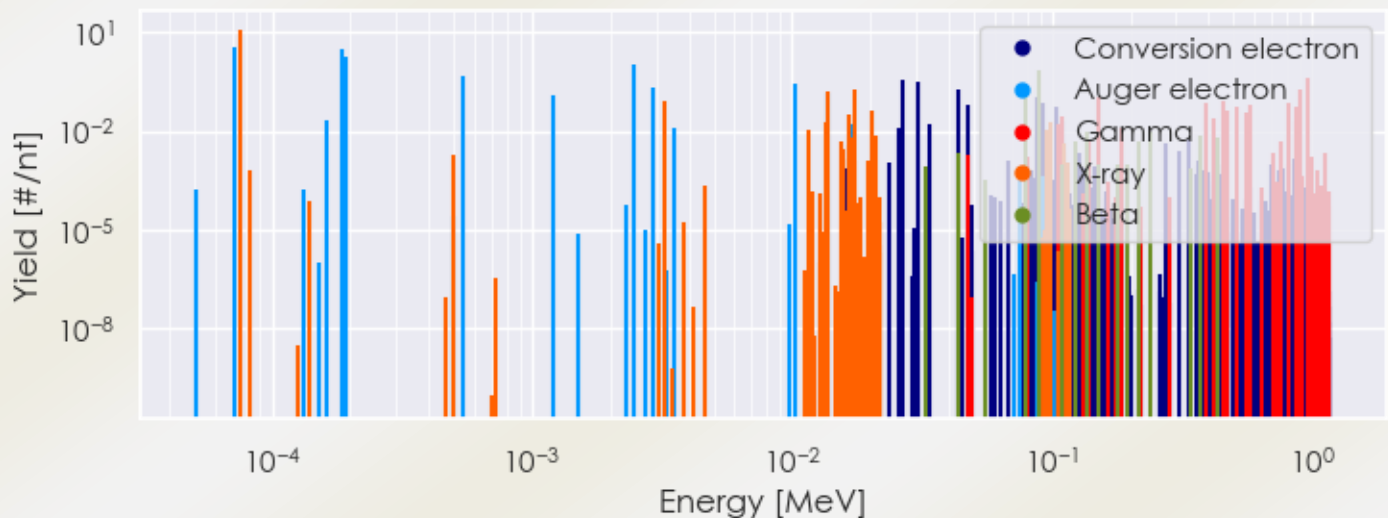
Note: Bins are spaced every 0.1 mm until a radius of 10 cm, and every 1 mm until a radius of 2 m.



Download tabulated dose point kernel file here: www.mirdsoft.org/products/MIRDspecs/Pa-232 DPK.csv

SUMMARY SPECTRA (PLOT)

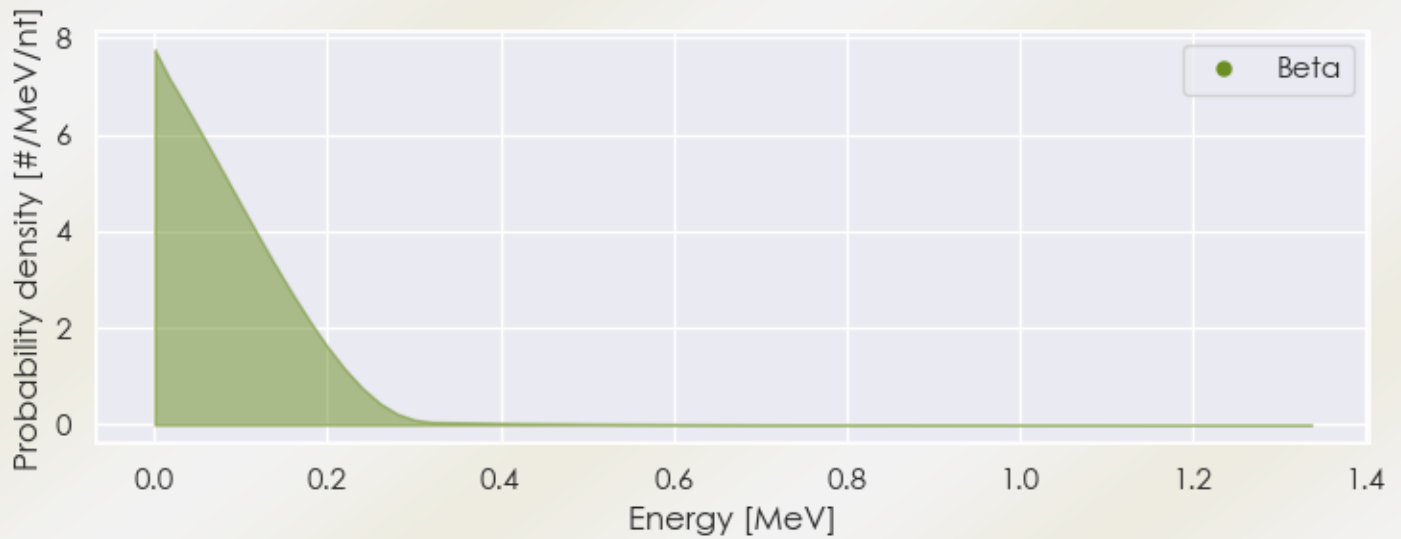
Spectra source: **ICRP Publication 107: Nuclear Decay Data for Dosimetric Calculations. Ann. ICRP 2008, 38 (3).**



Download tabulated summary spectra file here: www.mirdsoft.org/products/MIRDspecs/Pa-232 Summary Spectrum.csv

BETA SPECTRA (PLOT)

Spectra source: **ICRP Publication 107: Nuclear Decay Data for Dosimetric Calculations. Ann. ICRP 2008, 38 (3).**



Download tabulated beta spectra file here: www.mirdsoft.org/products/MIRDspecs/Pa-232 Beta Spectrum.csv

TABULATED DATA

SUMMARY SPECTRA (TABLE)

Spectra source: **ICRP Publication 107: Nuclear Decay Data for Dosimetric Calculations. Ann. ICRP 2008, 38 (3).**

Note: Radiations with yield < 0.01 are excluded from the table, but are available in the linked *.csv data.

Download tabulated summary spectra file here: www.mirdsoft.org/products/MIRDspecs/Pa-232 Summary Spectrum.csv

Energy [MeV]	Yield [# /nt] if > 0.01	Radiation type
7.55221e-05	1.276e+01	X-ray
3.26018e-03	7.793e-02	X-ray
1.16607e-02	1.141e-02	X-ray
1.34452e-02	1.859e-02	X-ray
1.36268e-02	1.633e-01	X-ray
1.64468e-02	3.425e-02	X-ray
1.73072e-02	1.736e-01	X-ray
2.02658e-02	3.933e-02	X-ray
9.50660e-02	1.117e-02	X-ray
9.89281e-02	1.787e-02	X-ray

1.05470e-01	1.646e-02	Gamma
1.08960e-01	2.807e-02	Gamma
1.50059e-01	1.084e-01	Gamma
1.84101e-01	1.258e-02	Gamma
3.87884e-01	6.970e-02	Gamma
4.21932e-01	2.517e-02	Gamma
4.53655e-01	8.615e-02	Gamma
4.72390e-01	4.162e-02	Gamma
5.15607e-01	5.518e-02	Gamma
5.63197e-01	3.678e-02	Gamma
5.81398e-01	6.002e-02	Gamma
8.19187e-01	7.454e-02	Gamma
8.63890e-01	1.936e-02	Gamma
8.66760e-01	5.808e-02	Gamma
8.94351e-01	1.984e-01	Gamma
9.69315e-01	4.162e-01	Gamma
7.91246e-02	2.413e-01	Beta
8.94034e-02	7.066e-01	Beta
7.21814e-05	3.436e+00	Auger electron
1.63132e-04	2.193e-02	Auger electron
1.86419e-04	3.366e+00	Auger electron
1.92507e-04	1.933e+00	Auger electron
5.41471e-04	4.963e-01	Auger electron
1.21093e-03	1.283e-01	Auger electron
2.44400e-03	1.110e+00	Auger electron
2.91673e-03	2.087e-01	Auger electron
3.53677e-03	1.229e-02	Auger electron
1.02903e-02	2.782e-01	Auger electron
1.36227e-02	1.416e-01	Auger electron
1.69911e-02	1.697e-02	Auger electron
2.58820e-02	1.237e-02	Conversion electron
2.66060e-02	3.576e-01	Conversion electron
3.04680e-02	3.108e-01	Conversion electron
3.39490e-02	1.636e-02	Conversion electron
4.33604e-02	1.884e-01	Conversion electron
4.76500e-02	6.627e-02	Conversion electron
8.79160e-02	1.089e-01	Conversion electron
9.17780e-02	7.169e-02	Conversion electron

1.04670e-01	5.207e-02	Conversion electron
1.08960e-01	1.832e-02	Conversion electron

USEFUL LINKS

Isotope decay characteristics are periodically updated as better measurements can be made - changes that may not be reflected on this page. Please see useful links:

National Nuclear Data Center (NNDC): <https://www.nndc.bnl.gov/nudat3/mird/>

International Atomic Energy Agency (IAEA) Livechart: <https://www-nds.iaea.org/relnsd/vcharthtml/VChartHTML.html>

REFERENCE LINKS

ICRP Report 107: <https://www.icrp.org/publication.asp?id=ICRP%20Publication%20107>

Graves et al. Dose Point Kernels: <https://doi.org/10.1002/mp.13789>

MIRD Decay Schemes 2nd Edition: https://sites.snmmi.org/SNMML-MAIN/iCore/Store/StoreLayouts/Item_Detail.aspx?iProductCode=0-932004-80-6