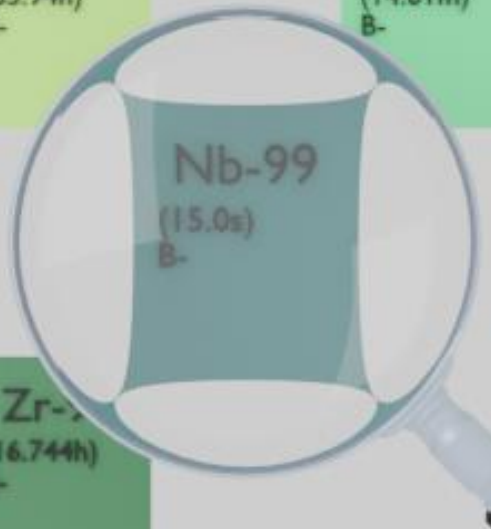




Mo-98 (STABLE)	Mo-97 (STABLE)	Mo-96 (STABLE)	Mo-95 (65.94h) B-	Mo-101 (14.61m) B-	Mo-102 (11.3m) B-
Nb-95 (4.991d)	Nb-96 (23.35h) B-	Nb-97 (72.1m) B-	Nb-99 (15.0s) B-		
Zr-94 (STABLE)	Zr-95 (64.032d) B-		Zr-96 (16.744h) B-		

NIOBIUM-99

SUMMARY DATA

GENERAL

CLASSIFICATION

Isotope: Nb-99
Atomic number (Z): 41
Mass number (A): 99
Neutron number (N): 58

RADIOACTIVE DECAY

Decay modes: β^-
Half-life: 15.0 [s]
Decay constant: $4.6210\text{e-}02$ [1/s]
Daughters: Mo-99 (100.0%)
Radioactive daughters: Mo-99

DOSIMETRIC CONSTANTS

Mean alpha energy: 0.0 [MeV]
Mean electron energy: 1.51322 [MeV]
Mean photon energy: 0.17425 [MeV]
Air kerma rate constant, Γ_{10} : $1.249\text{e-}17$ [Gy $\cdot$ m²/Bq $\cdot$ s]
Air kerma coefficient, K_{air} : $1.249\text{e-}17$ [Gy $\cdot$ m²/Bq $\cdot$ s]
Equilibrium dose constant for weakly-penetrating radiations (α and/or electrons), Δ_{wp} : $2.424\text{e-}13$ [Gy $\cdot$ kg/Bq $\cdot$ s]
Equilibrium dose constant for alphas, Δ_{α} : $0.000\text{e+}00$ [Gy $\cdot$ kg/Bq $\cdot$ s]

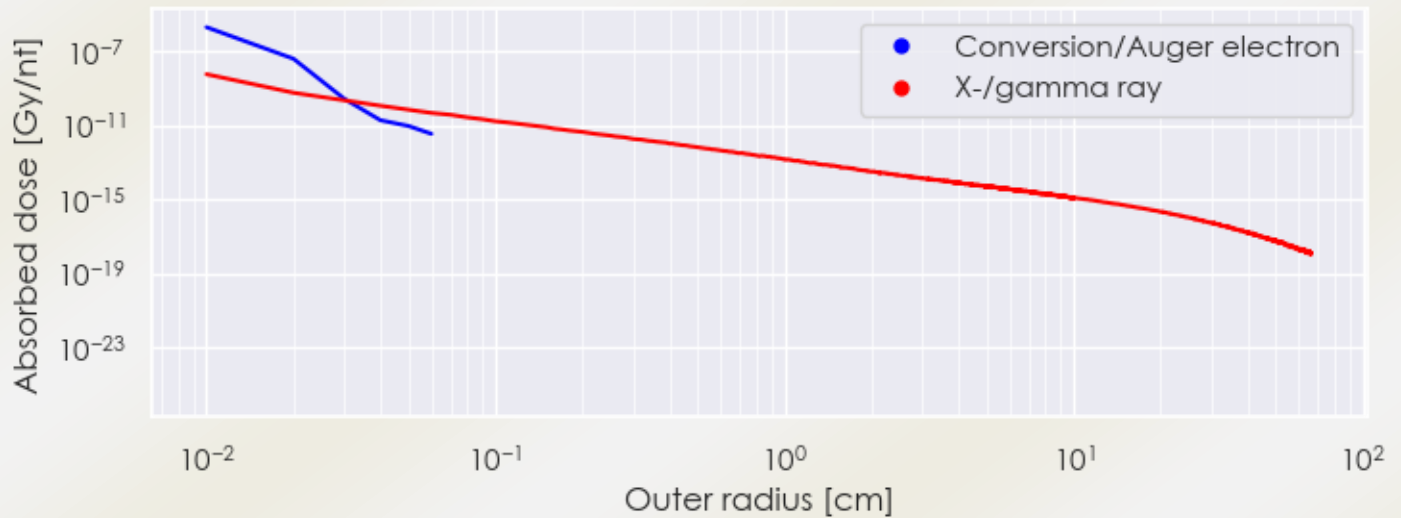
Equilibrium dose constant for betas/electrons, $\Delta_{\beta,\beta^+,e^-}$: 2.424×10^{-13} [Gy·kg/Bq·s]

Equilibrium dose constant for photons, Δ_p : 2.792×10^{-14} [Gy·kg/Bq·s]

DOSE POINT KERNELS (PLOT)

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

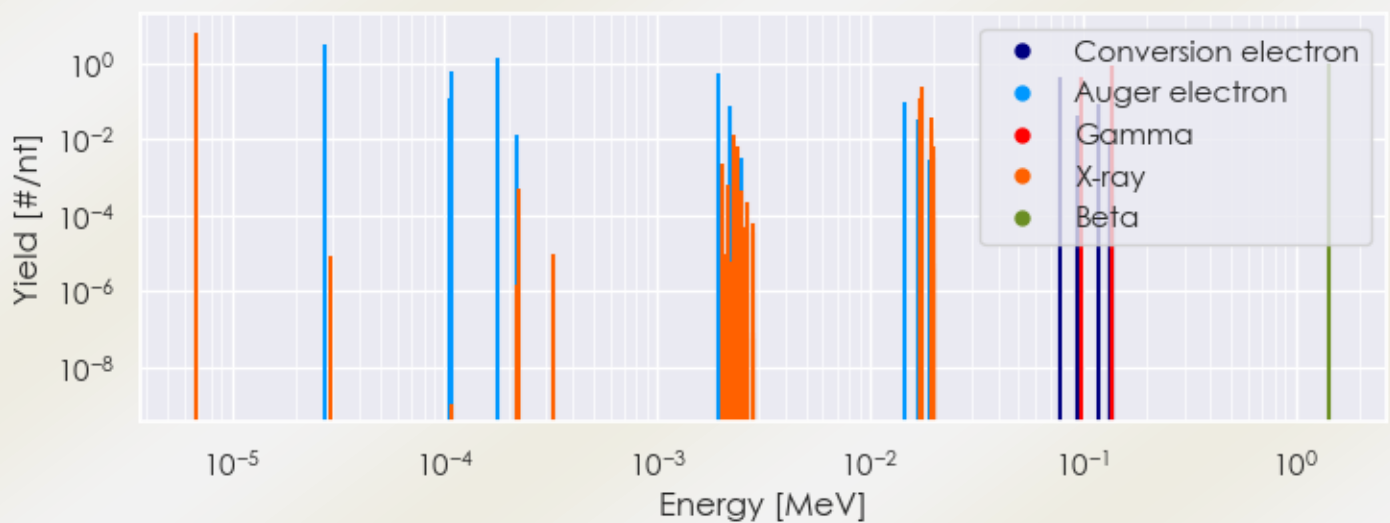
Note: Bins are spaced every 0.1 mm until a radius of 10 cm, and every 1 mm until a radius of 2 m.



Download tabulated dose point kernel file here: www.mirdsoft.org/products/MIRDspecs/Nb-99 DPK.csv

SUMMARY SPECTRA (PLOT)

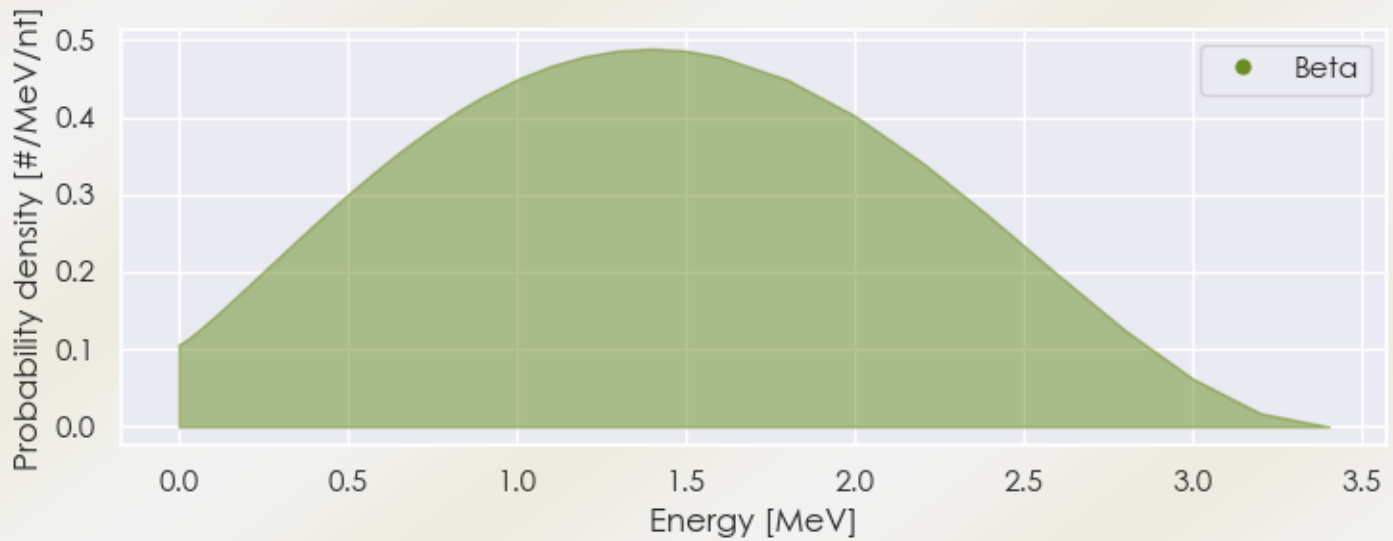
Spectra source: **ICRP Publication 107: Nuclear Decay Data for Dosimetric Calculations. Ann. ICRP 2008, 38 (3).**



Download tabulated summary spectra file here: www.mirdsoft.org/products/MIRDspecs/Nb-99 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/Nb-99 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/Nb-99 Summary Spectrum.csv

Energy [MeV]	Yield [# / nt] if > 0.01	Radiation type
6.84811e-06	6.549e+00	X-ray
2.28400e-03	1.352e-02	X-ray
1.73355e-02	1.194e-01	X-ray
1.74440e-02	2.275e-01	X-ray
1.95554e-02	1.854e-02	X-ray
1.95734e-02	3.608e-02	X-ray
9.77850e-02	4.322e-01	Gamma
1.37723e-01	9.046e-01	Gamma
1.45197e+00	1.000e+00	Beta
2.73686e-05	3.032e+00	Auger electron

1.05007e-04	1.136e-01	Auger electron
1.07068e-04	5.788e-01	Auger electron
1.76172e-04	1.382e+00	Auger electron
2.17824e-04	1.323e-02	Auger electron
1.95192e-03	5.563e-01	Auger electron
2.20085e-03	7.874e-02	Auger electron
1.47064e-02	9.099e-02	Auger electron
1.69714e-02	3.371e-02	Auger electron
7.78200e-02	4.560e-01	Conversion electron
9.49385e-02	4.189e-02	Conversion electron
9.51555e-02	2.184e-02	Conversion electron
9.52640e-02	2.841e-02	Conversion electron
9.73934e-02	1.692e-02	Conversion electron
1.17758e-01	8.347e-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/SNMMI-MAIN/iCore/Store/StoreLayouts/Item_Detail.aspx?iProductCode=0-932004-80-6