β decay properties of deformed ^{104,104m}Nb and its contribution to nuclear data

S. Nandi Physics Division, Argonne National Laboratory

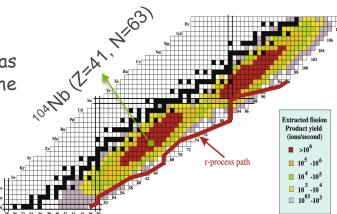
Town Hall Meeting on Nuclear Structure, Reactions and Astrophysics, Nov 14-16, 2022, ANL

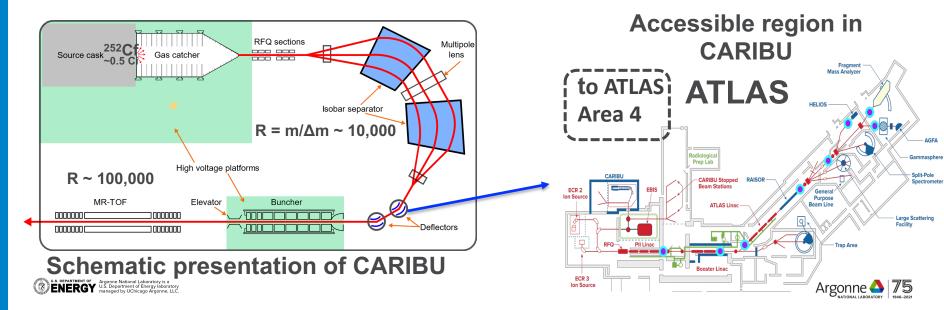




Motivations & Decay Spectroscopy tools@ ANL

- The difficulty in accessing the nuclei in neutron rich A~100 has not allowed sufficient information which is important for the understanding of astrophysical r process scenario.
- > The β -decay properties are important to predict the reactor antineutrino spectra.



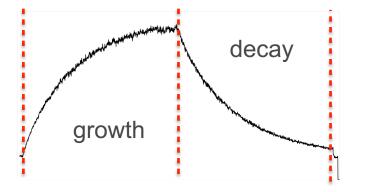


New β -decay station @ ANL

direct implantation on the tape
control the growth & decay times

 selectivity by T_{1/2}

β-γ-γ(t) coincidences





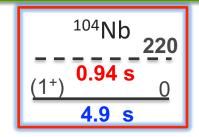


HEART - HExagonal ARray for Triggering

 ✓ 6 EJ-204 plastic scint. & 12 SiPM
 ✓ ε_β~75% from β-γ singles & coin.

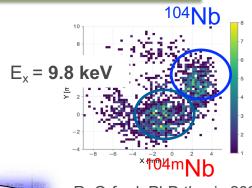
powerful γ-γ-β-t coincidence device

A~100 deformed region

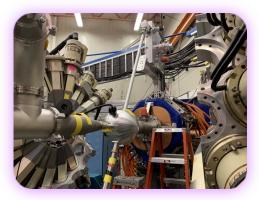


J. Blachot, NDS 108 (2007) 2035

U 56	101 44	U 57	$^{102}_{44}$ R	U 58	¹⁰³ ₄₄ R	U 59	$^{104}_{44}$ R	U 60	105 44	U 61	¹⁰⁶ 44	U 62	107 44	Y							
ie 0+ 17.4(3) 46(7)%	17.5 ps 10/2- Box627.56 CT-046	Stable 5/5++ &=47958.1(4) nat=17.48(2)A	4+-891	le 0+ 06.4(4) .55(14)%	1.49 ms 11/3- Ecologi.2 ThtMPs	38,345 6 3/2+ 8+-67367,2(4) 8++000	Stable ∆=-88035 nat=18.6 28-	1.8(25) 2(27)%	340 mi 5/3+ Eco20,606 17:0095	4.439 h 3/0+ d==85054.5(25) J==0805	4=-85	8 d 0+ 323(5) 108%	3,75 (6=-8 8=-	1865							
C 56	100 43	C 57	101 43	C 58	102 Т	C 59	103 T	C 60	104 43	C 61	105 43	C 62	106 43	C 63	107 43 T	C 64			43	C 66	110 43
01.1 ky 5/2++ 1+-17127.9(5) 3-+1815	8.32 pt 140+ Desc100.07 Dis1000	15.46 s 1+ 1=-00021.4(14) 0=-004 c=0.0020304	686 ps 1/2- tes:201.326 15:00%	14.22 ± 5/2+ 2=40365(24) 3=6005	4.35 m (4+) Bentikk J-+Likh IT 7	5.28 i 19 4=440700 \$=000	54.2 s Δ=-8464 β-=10	14(10)	3.3 ps (5-) (ex=6.7 (1+00%	28.3 m (3+) 8+40499(23) 8+40494	t=-823	(3/2-) 250(40) 1084	¥ (3.	1,2)(+#) /15/ 105		1.2 x (3/0 1-71758(3) 8-71895		(2)+)(9) 84	905 ns Δ=-7429 β+τ β+ 0.0		900 пз d=-710 В=-1 В=п+8.
0 56	99 42	0 57	100 M	0 58	101 M 42 M	O 59	102 M	O 60	103 42	O 61		O 62	105 M	O 63	106 M	O 64	107 42	O 65	¹⁰⁸ 42	0 66	109 M
00Ty 0+ 56(17) 12(80)% 7	15.5 µt 5/2+ Ecc47,715 (7-046	3.5.3 μt 512+ Ecol1.115 0.5302 h 102+ 4-0510.11020 7.47 Ey 8+ 4-065193.013 1241W β-080 rat=9.744(65) 2β-1884 2β-1884		93.0(3) 744(65)%	220 mil 3/2+ 60+02-00 15-000 (3-001) (3-000) (3-000) (3-000)		11.3 = 0+ Δ→-83561(8) β-=109%		67.5 s 3/2+ Δ=-88954(9) β-=1885		4 1565566 VI 51005		36.3 s (5/2-) Δ=-77331(9) β==100%		8.73 s 8+ L=-75128(9) β-=188%		46 m (5/2+) 6cm65.4 37+306 3+12545(3) 3+2365 3+2365		$\begin{array}{cccc} 1.105 & s & \theta + \\ \Delta = -78749(9) \\ \beta = 100\% \\ \beta = nc\theta, 5\% \end{array}$		238 ns 5094 bro45.7 174386
) 56	98 41	b 57	99 N 41 N	b 58	100 N 41 N	b 59	¹⁰¹ 41	b 60	102 41	b 61	103 N 41 N	b 62	104 41	b 63	¹⁰⁵ N	b 64	106 41	b 65	107 N	b 66	108 N
12.1 x 162+ 8=4548(4) 8=4548	51.1 n (5)+ Eers84 J-+10% 27 7	2.86 s 1s 4=-0221(5) 3=-0095	2.5 x 1/3- 5ex-365.17 3-4088 15-7	15.0 s 3(0++ 4+-42335(12) J==5005	2.89 s (Se) Secold) J-r(MPs	1.5 s 1s p=79797 p=100	7.1 s 0		18 s (b) Rea4 p-608 11 7	4.3 s (4+) 2=-76298.3(25) 3=r6895	A=-75 B-0	s 5/2++ 829(4) 188% n 7	4.9 s (0-,0-) Eerr5.1 J-c005 J-c01.0(3(4	0.50 s (5+) 2+-71911.0(10) 3+-5005 3+-60.05(3)4	2.91 s Δ=-699 β-π1 β-rn1.	16(4)	1.30 s (4-) Ecolom J-stills IT 7	989 es 1-4 de-66302.7034) j-es4.513/h	286 ns Δ=-637; β-=10 β-m=7.4	24(8) Mite	100 no 64 Sectoria 11:580
r 56	97 Z	r 57	98 Z	r 58	99 Z	r 59	100 Z	r 60	¹⁰¹ 40	r 61	¹⁰² 40	r 62	¹⁰³ 40	r 63	104 Z	r 64	¹⁰⁵ 40	r 65	¹⁰⁶ 40	r 66	¹⁰⁷ Z
/ 8+ 86(11) 9(2)% 9%	194.8 nr 7/2+ ben1214.35 D1-195	16,785 h 1/2++ 4+-1206,81022 \$+-186	1.9 ps (11-) fexet001.9 17-009	38,7 5 8+ 8+8030(8) 8+6885	334 ns 7/2+ 5cm251.94 11-1485	2.1 s 1/29 as-THO(00 p=000	7.1 s Δ=-763 β==1	73(8)	Le-73	s 3/2+* 3161(8) =180%	A=-71	. s 8+ 581(9) 100%	663 B-1	s (5/2-) 7809(9) =180% n<1%	920 π Δ=-657 β-41 β-rr	18(9)	61-61- 8-4	s 1/2+8 458(12) 1005 s<2%	179 m Δ=-58758 β-41i β-no	(260)#	145.7 π b=5443 β=1 β=0
56	96 39	57	97 39	58	98 39	59	99 39	60	100 39	Y 61	101 39	Y 62	10. 3ª	R	103 39	64	104 39	Y 65	105 39	66	106 39
01.3 m 1/2++ 2++61200(7) 3++1005	S.6 x Do Ecol\$40 J=100	5.34 ± 0++ 4+-7030(6) (0+2005	1.17 x 1/19 fex/67.52 f->81.38 1768.76	1.75 s 1,0+e Δe-76215(7) β-c00% β-cn0,055(4)4	615 ns 2- Ecol2N-18 Th1895	548 m 0++ 0+72286(8) 0+2100 0+000	(E=)00A	1.484 s 3/2++ Δ+-78644(7) β=0498 β=6+0.777(19)4	127 ns 144 Ecold4 J=<00% J=n=1.40(6)%	940 ns 400 20-67323(11) 3-100% 3-0 7	874 es 13/2-4 Ecs+1285.4 17:188	426 ns 5/2+4 3+43855(7) 3+4385 3+442,3(3)4	300 m (0+,1+) Em-1000 J=5008 J=6008 J=642.04, 11 (1 34 m (5-) 2 0113(4) -(308 7 p-(2.4)	239 ms Δ=-5842 β==1 β=m=8.0	57(11) 88%	6-540 P-1	(0+,1+)# 88(200)# 108% 1)%, β-2n 7	95 ns 3 Δ=-58578 β-=10 β-ri<82%,	(480)# M%	75 m Δ=-4575 β== β=n ?,
r 56	95 S	r 57	96 S	r 58	97 S	r 59	98 S	r 60	99 S	r 61	¹⁰⁰ 38	r 62	101 C	. ,	¹⁰² 38S	r 64	¹⁰³ 38	r 65	¹⁰⁴ S	r 66	¹⁰⁵ 38
	23.90				23.2 15 7/24						112 85 (4+)		113.7 #		69 m		53 m				39 m





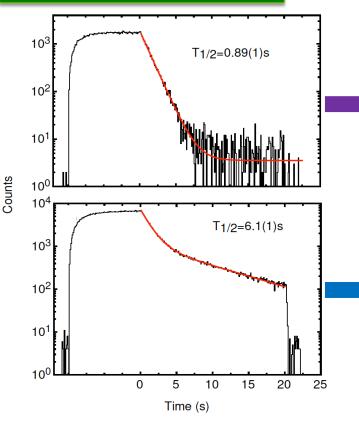


CARIBU @Gammasphere

- The data are collected in two different tape cycle modes 10/20s and 10/40s.
- 10/40s cycle is considered to get daughter and grand-daughter decay of ¹⁰⁴Nb.



Half-life $(T_{1/2})$ values



T_{1/2} value obtained using single exponential decay curve fit.

Populate high spin levels

* $T_{1/2}$ value obtained using two exponential decay curve fit where the $T_{1/2}$ of short-lived state has been used as an input.

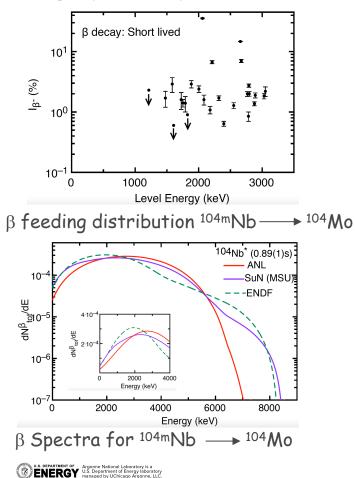
Populate low spin levels

> Two comprehensive decay schemes have been established from the two β -decay states in ^{104,104m}Nb.

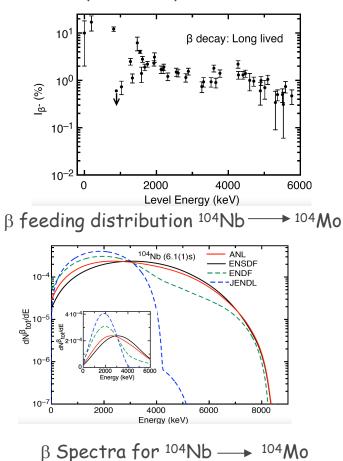




High spin β decay (T1/2 = 0.89(1) s)



Low spin β decay (T1/2 = 6.1(1) s)





Collaborators

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