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U.S. DEPARTMENT OF ENERGY

Troubleshooting experience: ^{23}Ne β- decay data normalization and systematic uncertainty

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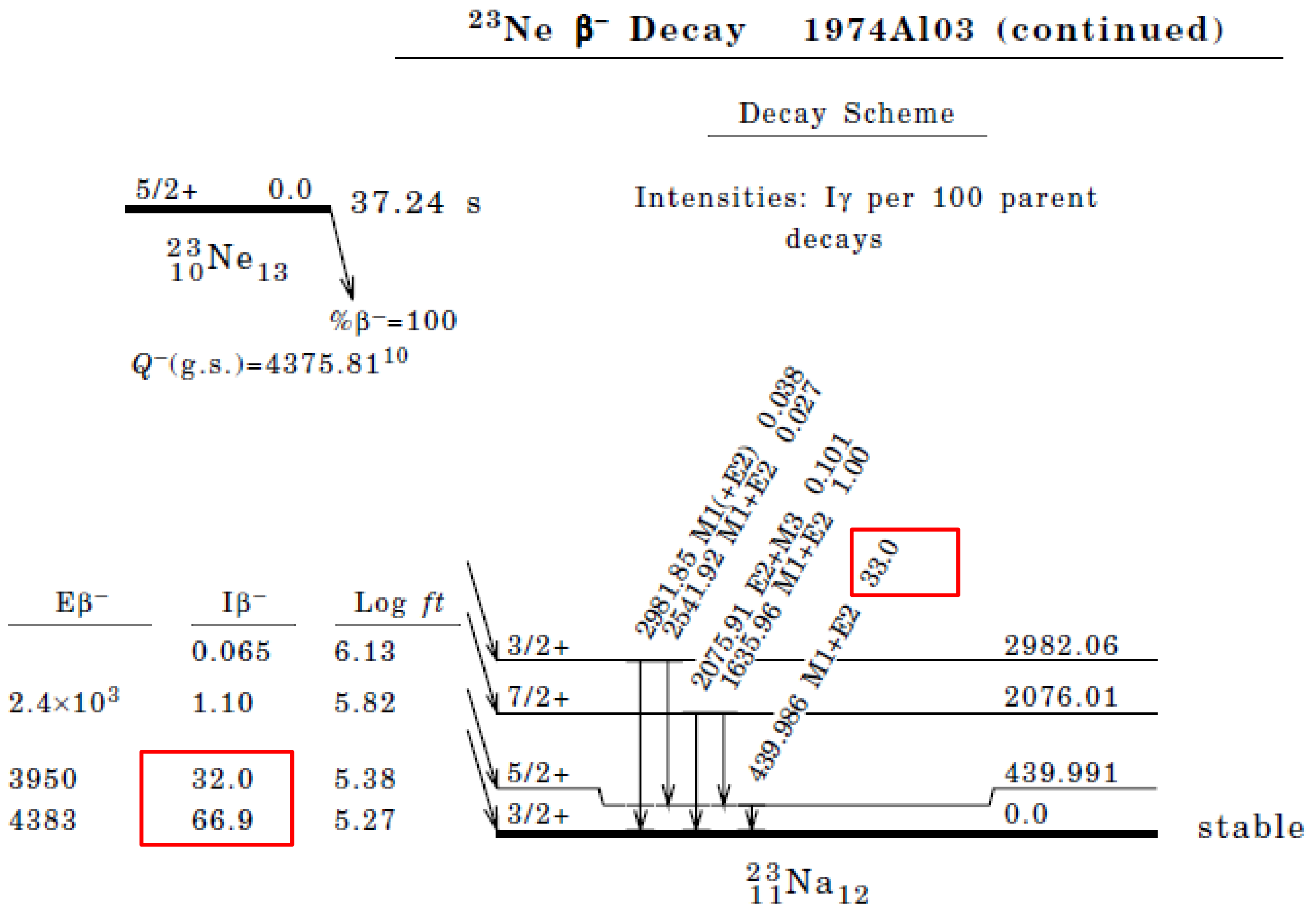
^{23}Ne β- decay

2007Fi02



^{23}Ne β- decay

2007Fi02

β^- radiations

$E\beta^-$	E(level)	$I\beta^{-\dagger}$	Log *ft*	Comments
(1393.75 *11*)	2982.06	0.065 *3*	6.13 *2*	
2.4×10^3 *1*	2076.01	1.10 *4*	5.82 *2*	$E\beta^-$,$I\beta^-$: From 1957Pe12, Iβ=1.00 *15*.
3950 *50*	439.991	32.0 *13*	5.38 *2*	$E\beta^-$,$I\beta^-$: From 1957Pe12. Iβ=32 3. Other value: Iβ=32 1 (1963Ca06).
4383 *8*	0.0	66.9 *13*	5.27 *1*	$E\beta^-$,$I\beta^-$: From 1963Ca06 (PRC 132, 2239, 1963), Iβ=67 1. Other value: Eβ=4390 50, Iβ=67 3.

† Absolute intensity per 100 decays.

γ(^{23}Na)

Missing the normalization note

Eγ	E(level)	$I\gamma^\dagger$	Mult.	δ	Comments
439.986	439.991	33.0 *13*	M1+E2	+0.058 *3*	Iγ: 4% uncertainty assumed by the evaluator.
1635.96	2076.01	1.00 *4*	M1+E2	+0.19 *2*	
2075.91	2076.01	0.101 *6*	E2+M3	−0.14 *11*	
2541.92	2982.06	0.027 *2*	M1+E2	−0.09 *3*	
2981.85	2982.06	0.038 *2*	M1(+E2)	−0.01 *2*	

† Absolute intensity per 100 decays.

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Communications:

- User: Main disagreement was on the beta feeding uncertainty

2007Fi02

Level	%β-feeding	unc	%unc
g.s.	66.9	1.3	1.94
1st ex. state	32	1.3	4.06
2nd ex. state	1.10	0.04	3.64
3rd ex. state	0.065	0.003	4.62

From Iγ balance

User

%β-feeding	unc	final unc	%unc
67	3	3	4.48
32	3	3	9.38
1.10	0.04[10]	0.11	9.79
0.065	0.003[6]	0.007	10.32

From I_β=32(3) 1957Pe12

Other I_β=32(1) 1963Ca06

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During A=23 revision:

- Checking data in older evaluations:
  - 1998En04 (NP), 1990En08 (NP), 1978En02 (NP)
  - Table of Isotopes; 7th Edition; C.M. Lederer, V.S. Shirley, 1978
  - Table of Radioactive Isotopes; Browne, Firestone, Shirley, 1986

Photons (^{23}Ne)

$\langle\gamma\rangle$=165 *5* keV

γ_{mode}	γ(keV)	γ(%)†
γ (M1+0.3%E2)	439.85 *13*	32.9
γ (M1+3.5%E2)	1636.5 *3*	0.99 *3*
γ (E2+3.0%M3)	2076.3 *3*	0.102 *7*
γ (M1+0.9%E2)	2542.45 *19*	0.0270 *20*
γ (M1)	2982.25 *17*	0.0378 *20*

† 3.0% uncert(syst)

γ: (norm: $\gamma_{0.440}$ (γ 32.9 *10%*), from level scheme, EB) **0.440** *1* (†$_\gamma$100), **1.639** *3* (†$_\gamma$3.0 *1*), **2.079** *3* (†$_\gamma$0.31 *2*), **2.545** *3* (†$_\gamma$0.082 *6*), **2.985** *3* (†$_\gamma$0.115 *6*) *Ge(Li), scint, Ge(Li)–scint γγ coinc, scint γγ sum coinc* {NP A107 236(68), NP 69 384(65), NP A214 1(73), PR C9 991(74), EB}
others: {PScr 5 159(72), PR 105 647(57), PR 101 774(56)}

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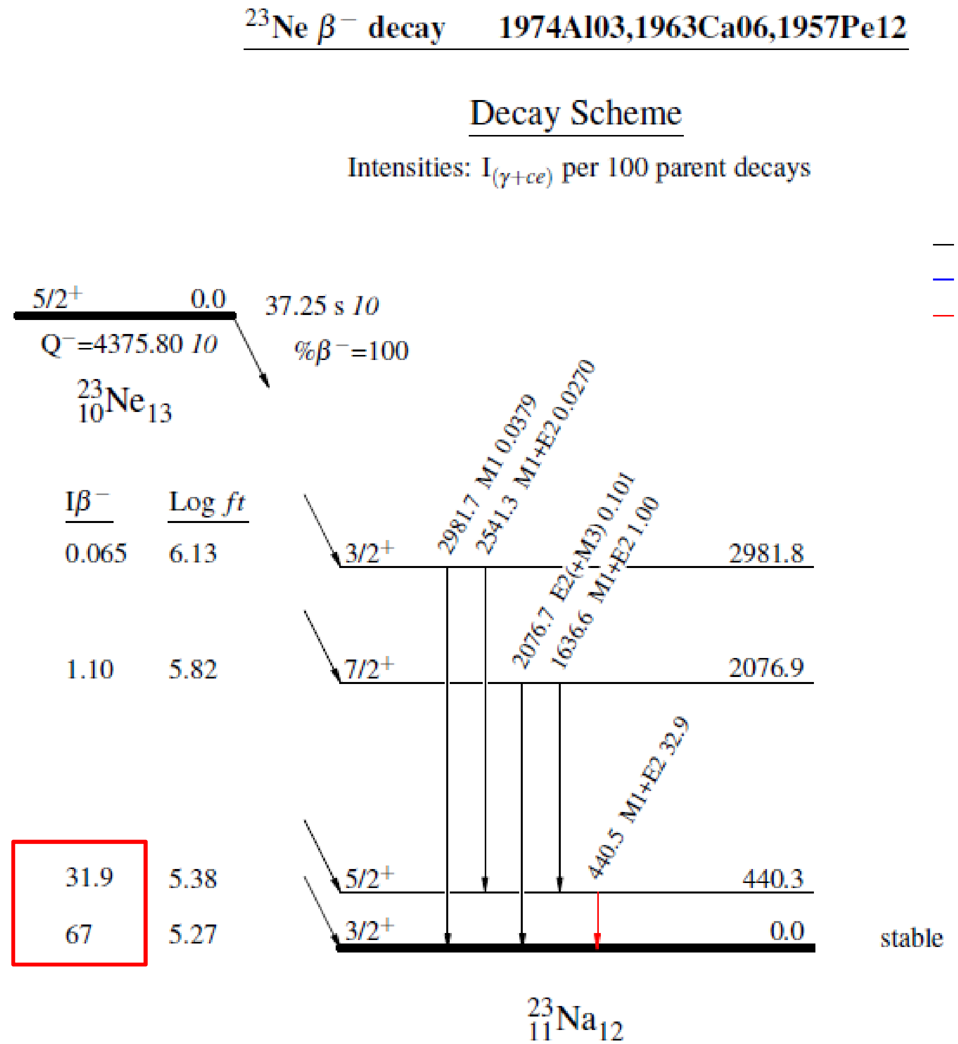
Uncertainty: Excited state β feeding in ^{23}Ne β- decay

1957Pe12 - β measurements

g.s. feeding: 67 ± 3
1^{st} excit. state: 32 ± $\boxed{3}$
2^{nd} excit. state: 1.00 ± 0.15

1974Al03 - γ measurements

E_γ (keV)	Iγ (relative) Present
440	33.0
1636	1.00 ± 0.04
2076	0.101 ± 0.006
2542	0.027 ± 0.002
2982	0.038 ± 0.002



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Uncertainty: Revised dataset (^{23}Ne β- decay)

2021Ba01

β^- radiations

E(decay)	E(level)	$I\beta^{-\dagger\ddagger}$	Log *ft*	Comments
(1394.0 *7*)	2981.8	0.065 *4*	6.13 *3*	
(2298.9 *7*)	2076.9	1.10 *6*	5.82 *2*	E(decay),$I\beta^-$: $E\beta=2.4\times10^3$ *1* (1957Pe12). $I\beta$=1.00 *15* (1957Pe12).
(3935.5 *9*)	440.3	31.9 *10*	5.38 *2*	E(decay),$I\beta^-$: $E\beta$=3950 *50* (1957Pe12). $I\beta$=32 *1* (1963Ca06) and 32 *3* (1957Pe12).
(4375.80 *10*)	0.0	67 *1*	5.27 *1*	E(decay): 4383 *8* (1963Ca06) and 4390 *50* (1957Pe12). $I\beta^-$: 67 *1* (1963Ca06) and 67 *3* (1957Pe12).

† From γ-ray intensity balance.
‡ Absolute intensity per 100 decays.

γ(^{23}Na)

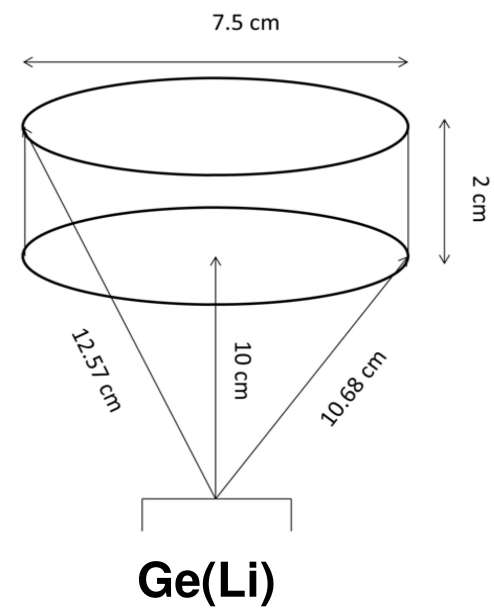
Iγ normalization: From Σ I(γ+ce) to g.s.=33 *1* (100 – 67 *1* (1963Ca06)), assuming 1% statistical uncertainty for the 440γ.

$E_\gamma^\dagger$	$I_\gamma^{\ddagger\#}$	E_i(level)	J_i^π	E_f	J_f^π	Mult.†	$\delta^\dagger$	$\alpha^@$	Comments
440.5 *6*	100	440.3	$5/2^+$	0.0	$3/2^+$	M1+E2	+0.065 *5*	5.45×10^{-5} *8*	%Iγ=32.9 *10* E_γ: 440 (1974Al03), 440.0 *6* (1968Mo03). I_γ: 33.0 (1974Al03).

‡ 1974Al03 present Iγ relative to Iγ(440)=33 (listed in comments). Evaluators present Iγ relative to Iγ(440)=100. The uncertainties of Iγ (1974Al03) are statistical only. A larger systematic uncertainty can be expected for the cylindrical gas cell (diameter 7.5 cm and height 2 cm) counting geometry. However, the recommend uncertainty of the absolute γ-ray emission probability is expected to be valid due to the unique feature of the decay scheme as Iγ(1+α)(440) represents 99.6% of ΣIγ(1+α) to the g.s. from excited states and the β branching to the g.s. and 1st excited state dominate the total Iβ, (67+32)=99%, that yields the same uncertainties as %Iβ=67 *3*, 32 *3* (1957Pe12), 67 *1*, 32 *1* (1963Ca06), for the g.s. and 1st excited states, respectively. As a result, the uncertainty of the Iγ(440) can be considered equivalent to ΔIβ(1st excited state at 440).

Thoughts on uncertainty statements in decay datasets:

- 1974Al03 used a cylindrical cell (diameter:7.5 cm, height: 2 cm)
- About 15% uncertainty for detector efficiency can be estimat for counting geometry. No statement in 1974Al03.
- Stated as “a larger systematic uncertainty” in ^{23}Ne b- decay



Photons (^{23}Ne)

$\langle\gamma\rangle$=165 5 keV

γ_{mode}	γ(keV)	γ(%)†
γ (M1+0.3%E2)	439.85 13	32.9
γ (M1+3.5%E2)	1636.5 3	0.99 3
γ (E2+3.0%M3)	2076.3 3	0.102 7
γ (M1+0.9%E2)	2542.45 19	0.0270 20
γ (M1)	2982.25 17	0.0378 20

† 3.0% uncert(syst)

1986BRZQ

Table of Radioactive Isotopes, Browne, Firestone, Shirley, 1986

Perhaps no guideline or policy is available on this issue

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Conclusions:

- In ENSDF/NDS – more data less text as expected.
  - ✓For special cases – additional text is helpful not only for users but also for the evaluators later.
  - ✓In the latest revision – notes are added to follow the facts of normalization and related data in ^{23}Ne b- decay dataset.

- There are different methods for decay data normalization.
  - ✓It seems any statements would be useful about systematic uncertainty, when applicable.
  - ✓Reporting of statistical and systematic uncertainties is a common practice in the literature, what about in NSD?

Any comments/thoughts?

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Thank you