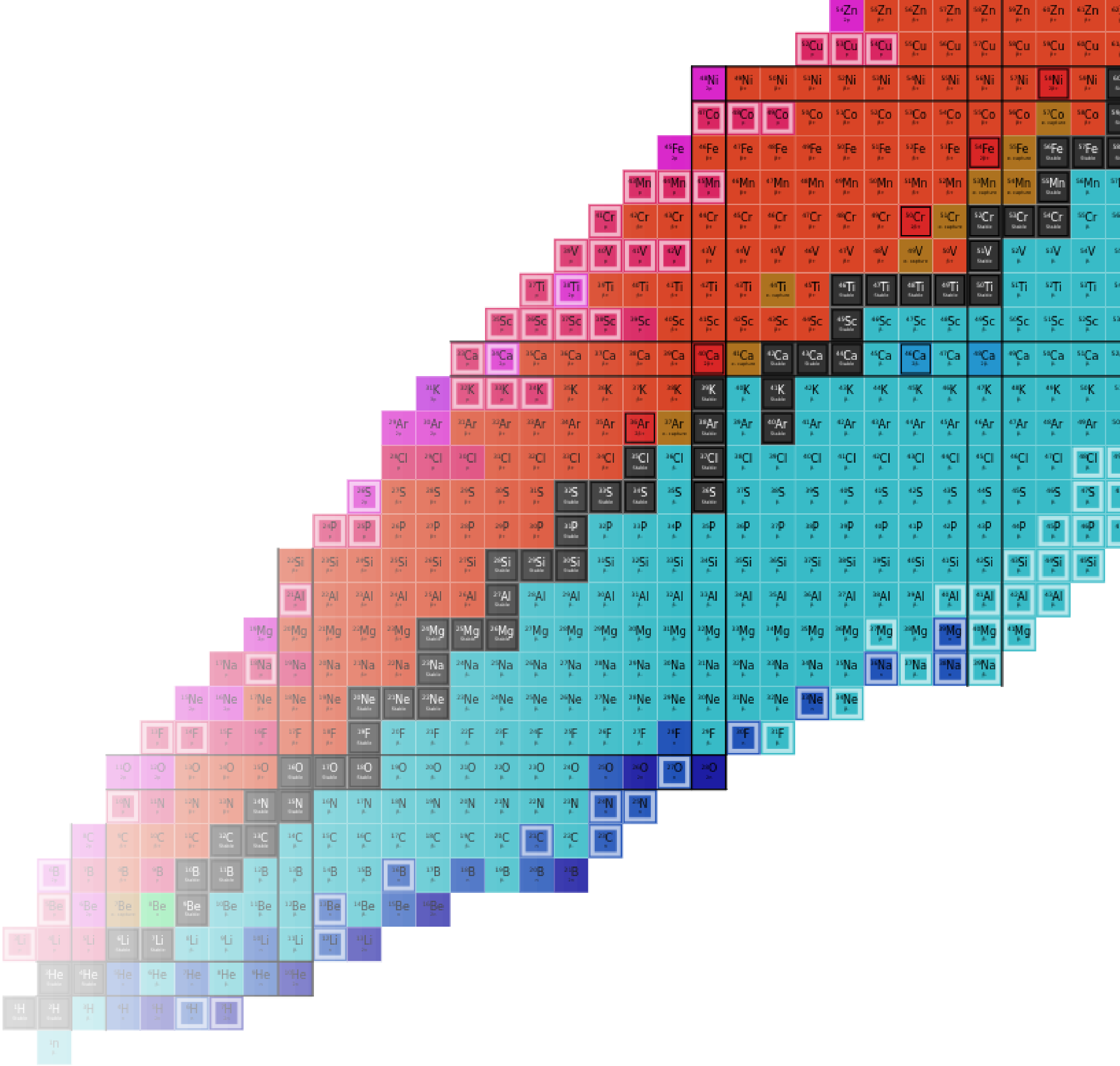
Probing the low spin structure of ^{46}K via ^{46}Ar β decay



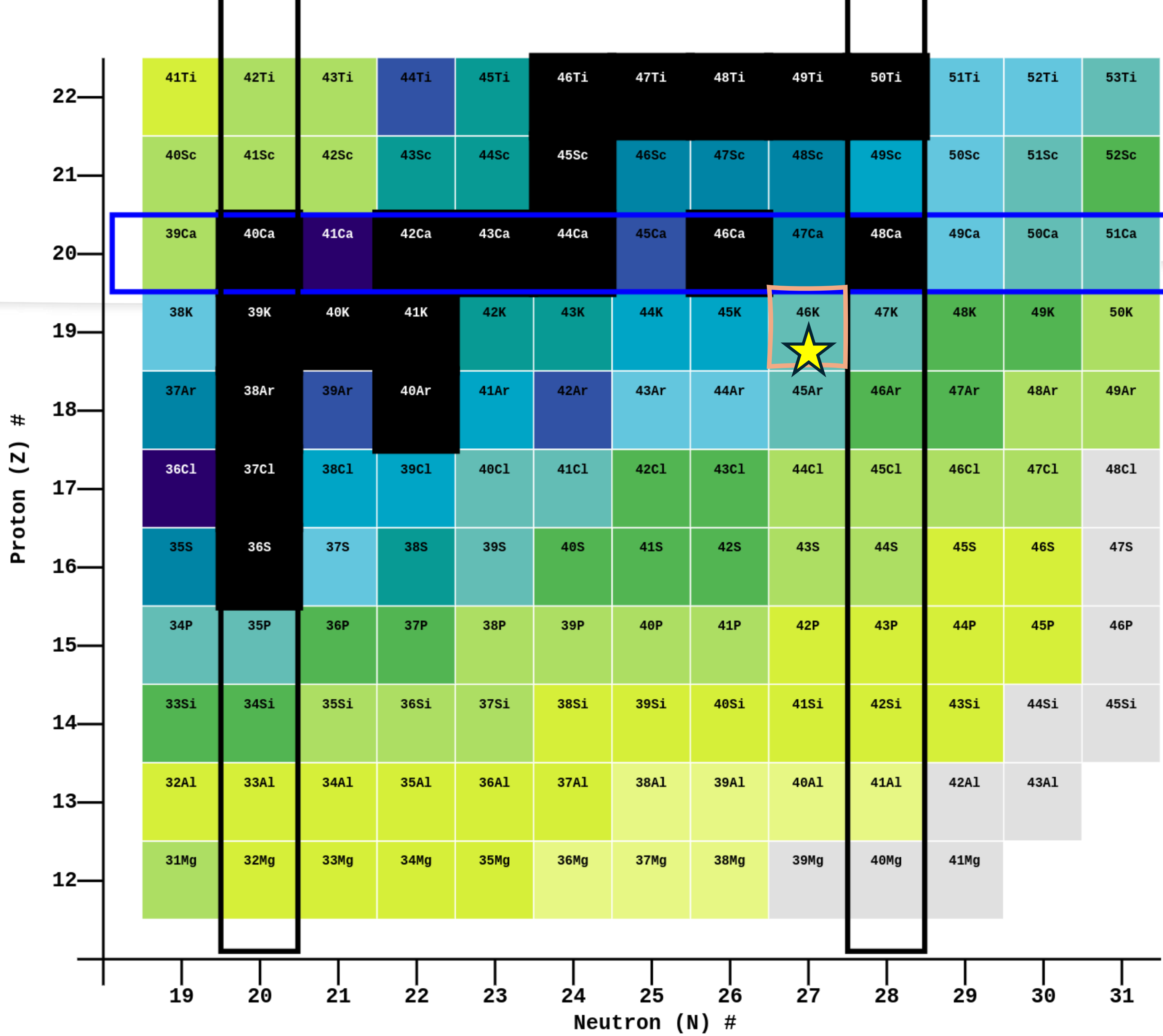
Sara Pigliapoco

24eme GANIL Colloque

laboratoire commun CEA/DRF CNRS/IN2P3

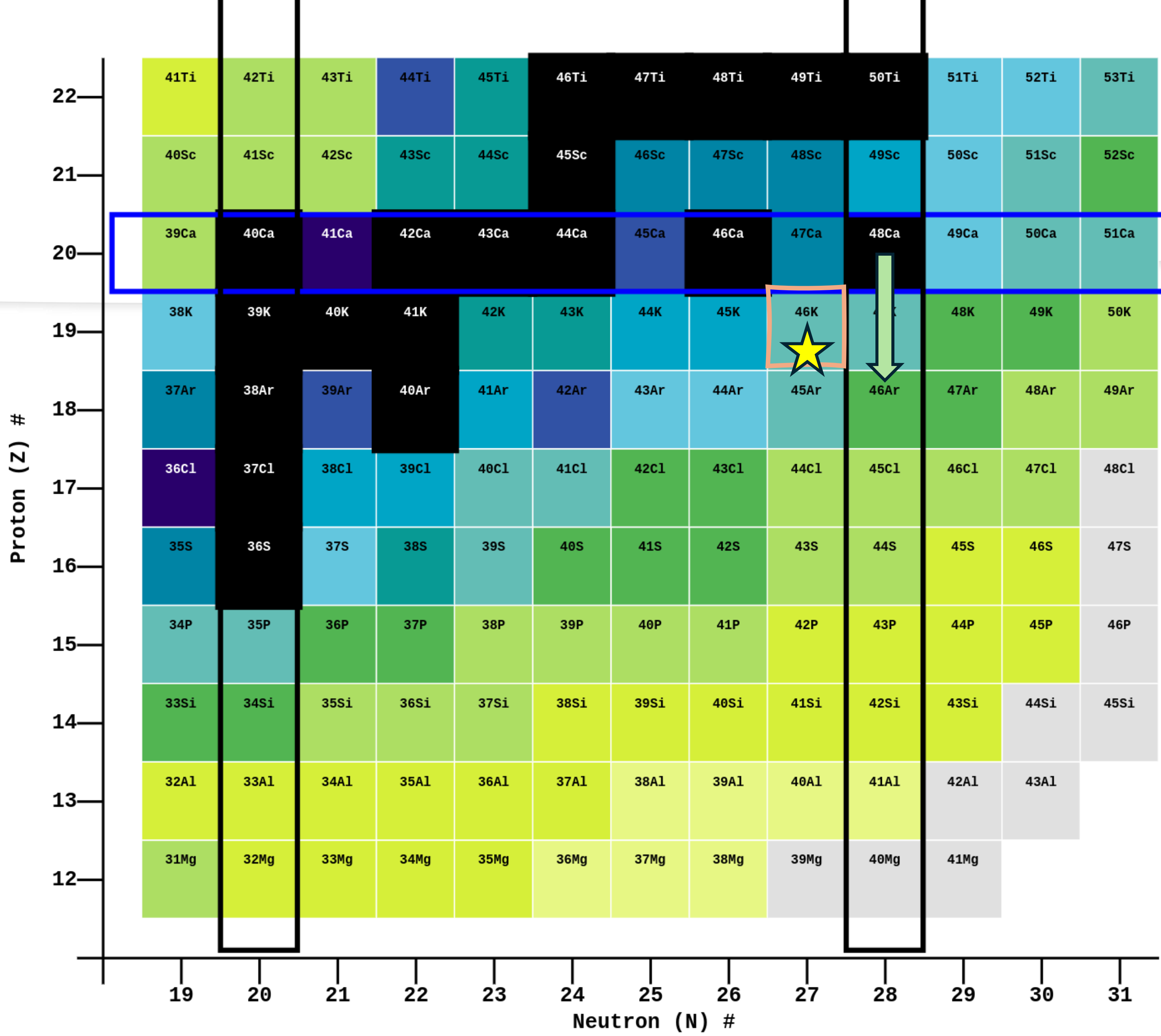
Overview

- ^{46}K (N=27, Z=19)



Overview

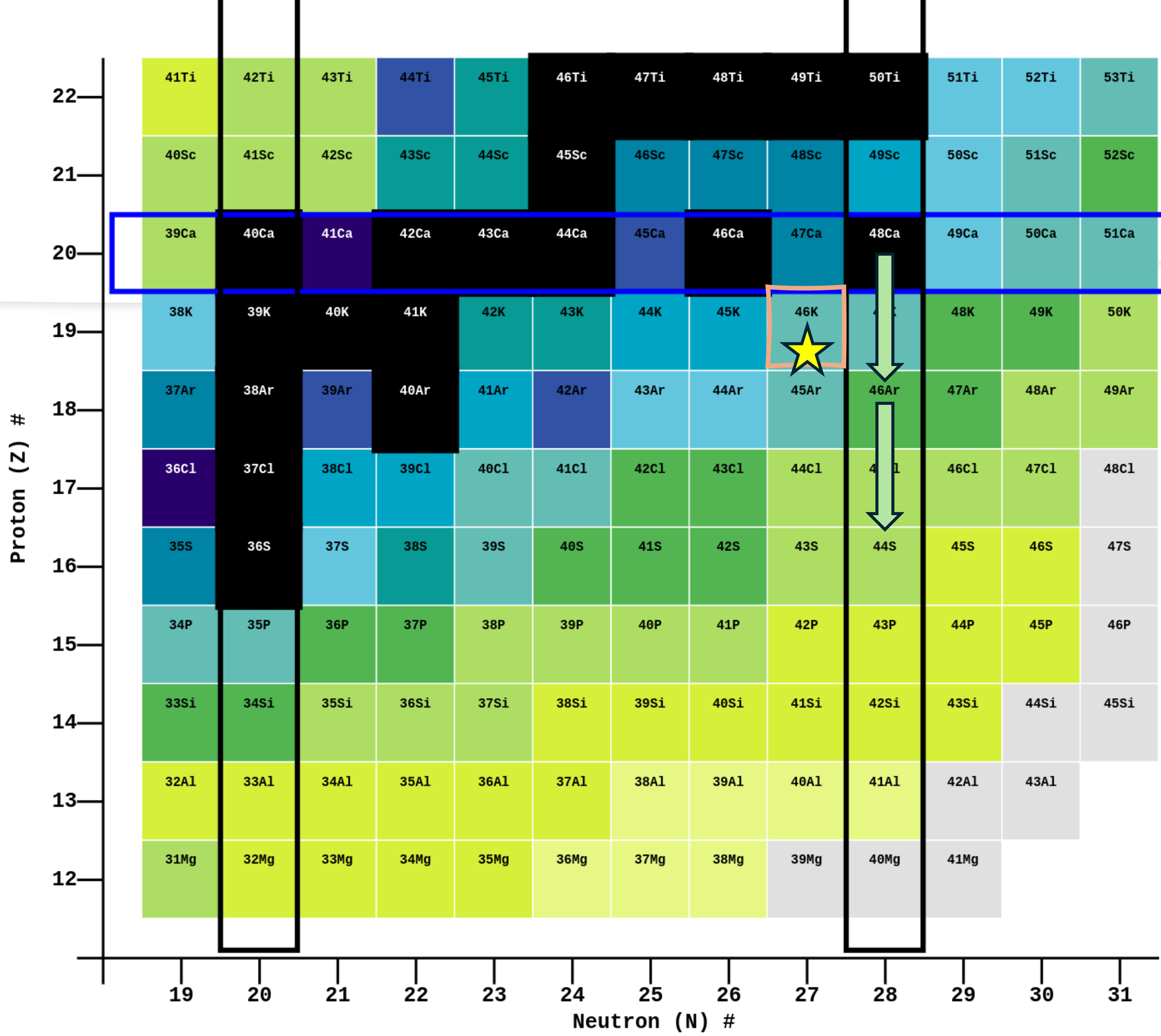
- ^{46}K (N=27, Z=19)
- **^{46}Ar**(d,p) → N=28 gap smaller by **330(90) keV**



[1] O. Sorlin and Porquet, Phys. Scr. T152, 014003(2013)
[2] Gaudefroy et al., PRL 97, 092501 (2006)
[3] Bastin et al., PRL 99, 022503 (2007)

Overview

- ^{46}K (N=27, Z=19)
- **^{46}Ar**(d,p) → N=28 gap smaller by **330(90) keV**
- **^{44}S/^{42}Si** → shape coexistence and collectivity



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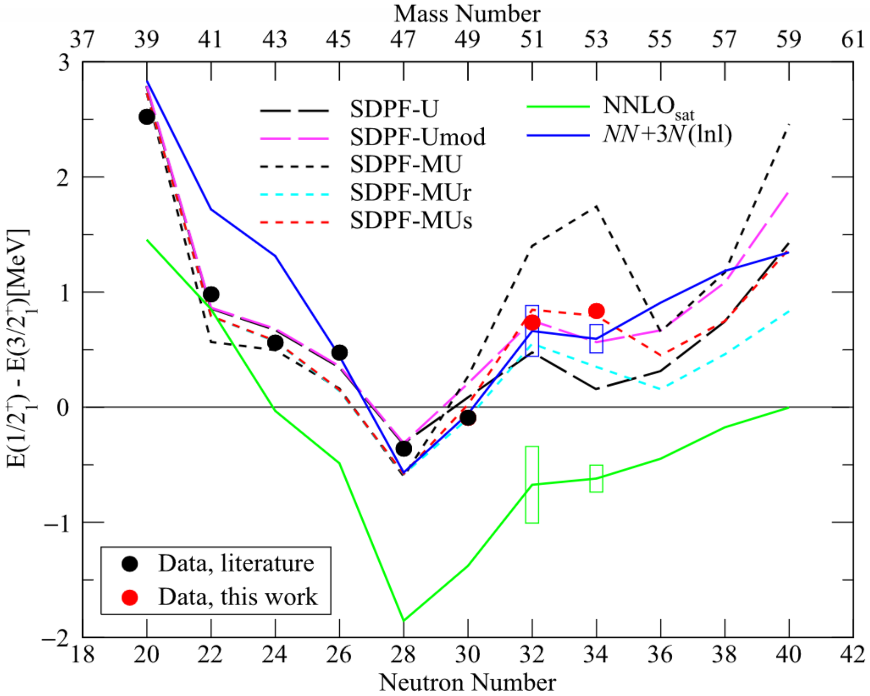
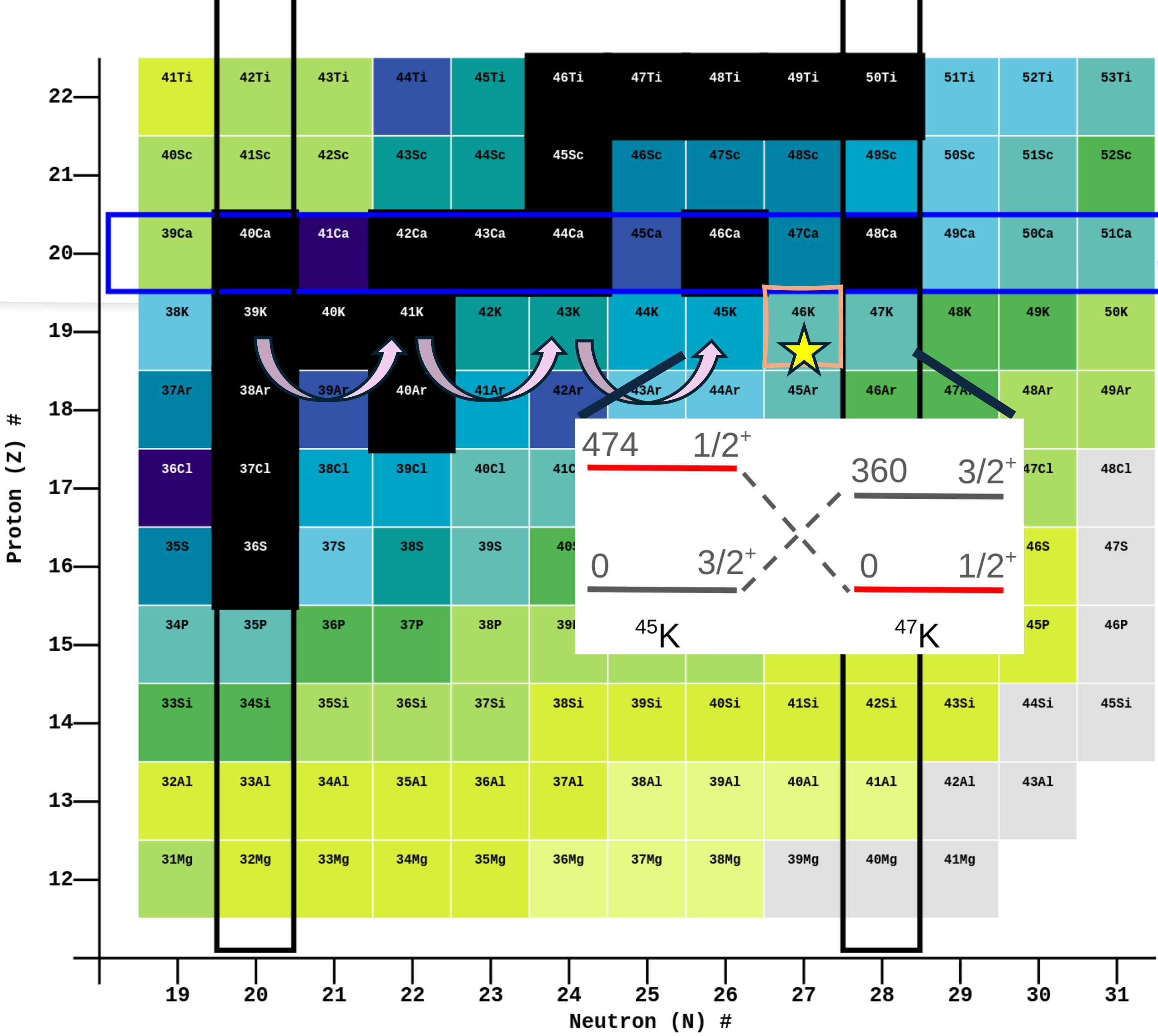
Overview



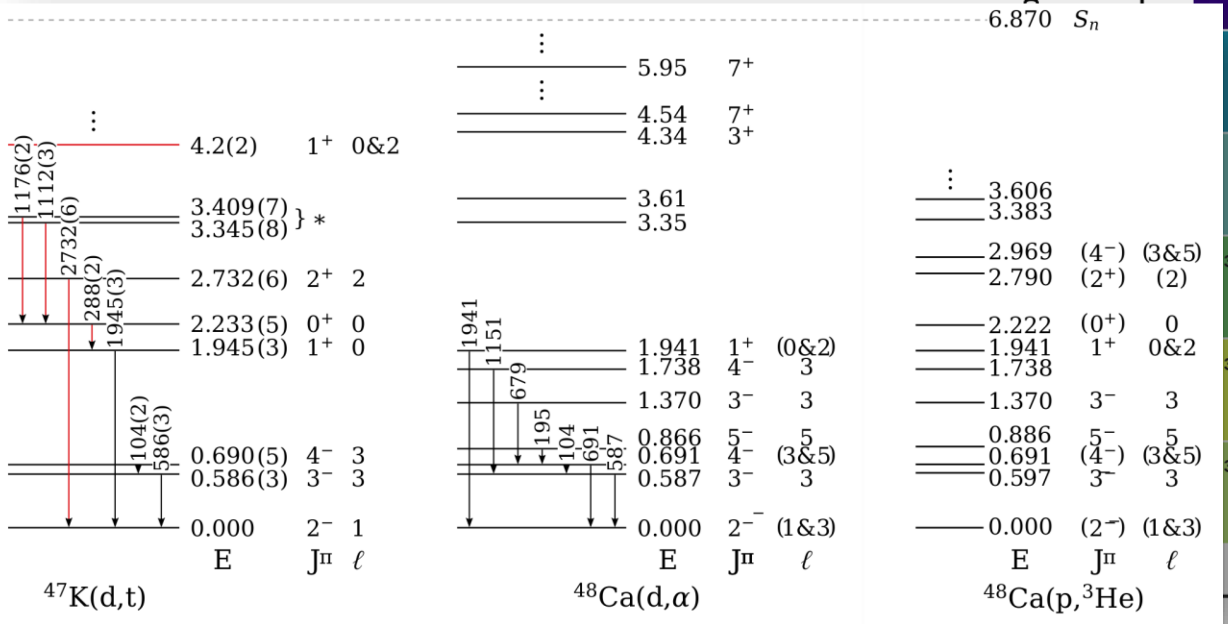


[1] Y.L.Sun et al.,Phys. Lett. B 802, 135215 (2020)
[2] J. Papuga et al., PRL 110, 172503 (2013)
[3] J. Papuga et al., PRC 90, 034321 (2014)

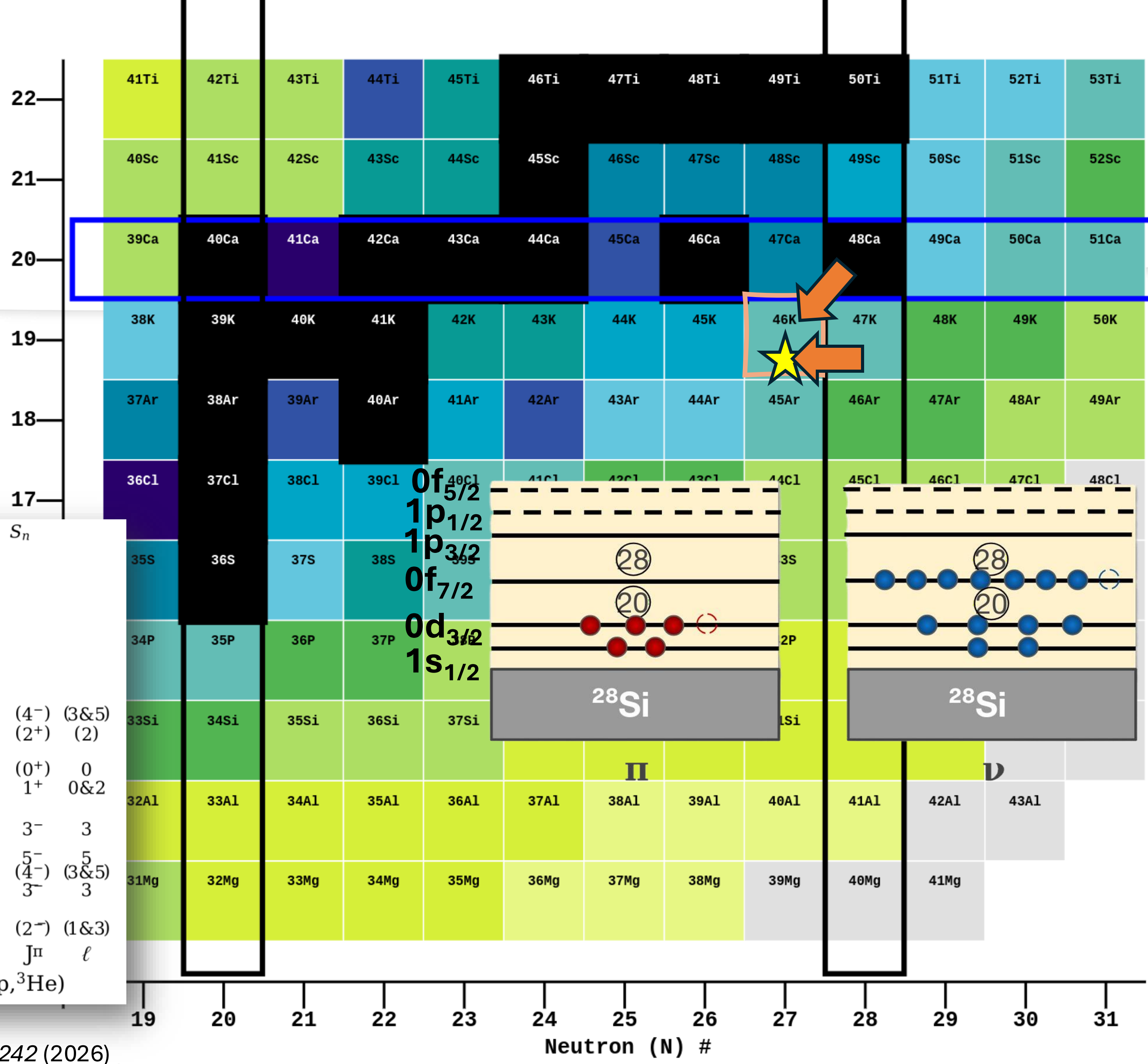
Overview

- $^{47}K(p,d)^{46}K$
- $^{48}Ca(p,{}^{3}He)$ & $^{48}Ca(d,\alpha)$

W. W. Daehnick and R. Sherr, Phys. Rev. C 7.1, 150 (1973)
W. W. Daehnick et al., Phys. Rev. C 10.1, 136 (1974)
C. J. Paxman *et al.*, *arXiv preprint arXiv:2601.06242* (2026) - Phys. Rev. C **Accepted** 2026

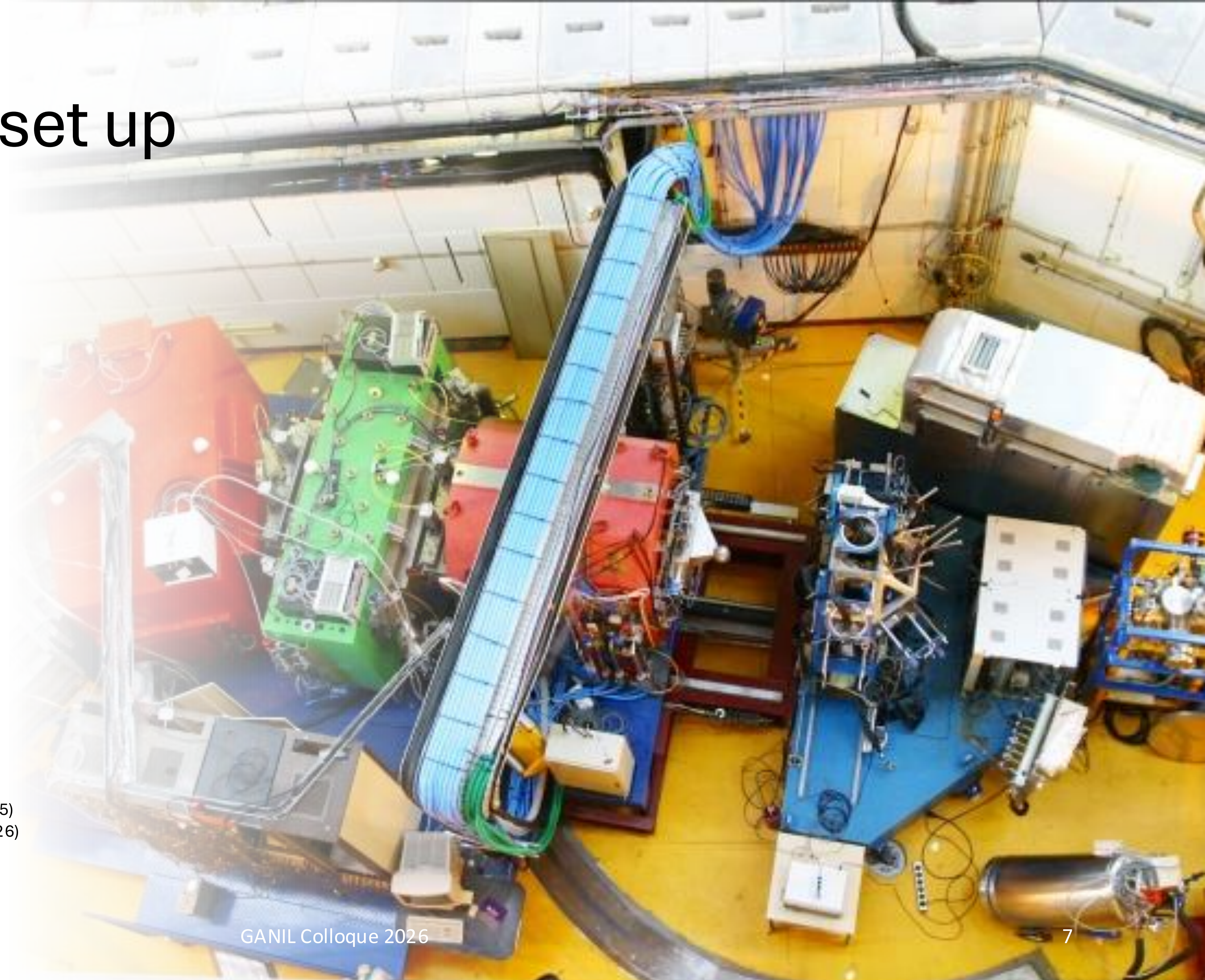


Adapted from
C. J. Paxman *et al.*, *arXiv preprint arXiv:2601.06242* (2026)



Experimental set up

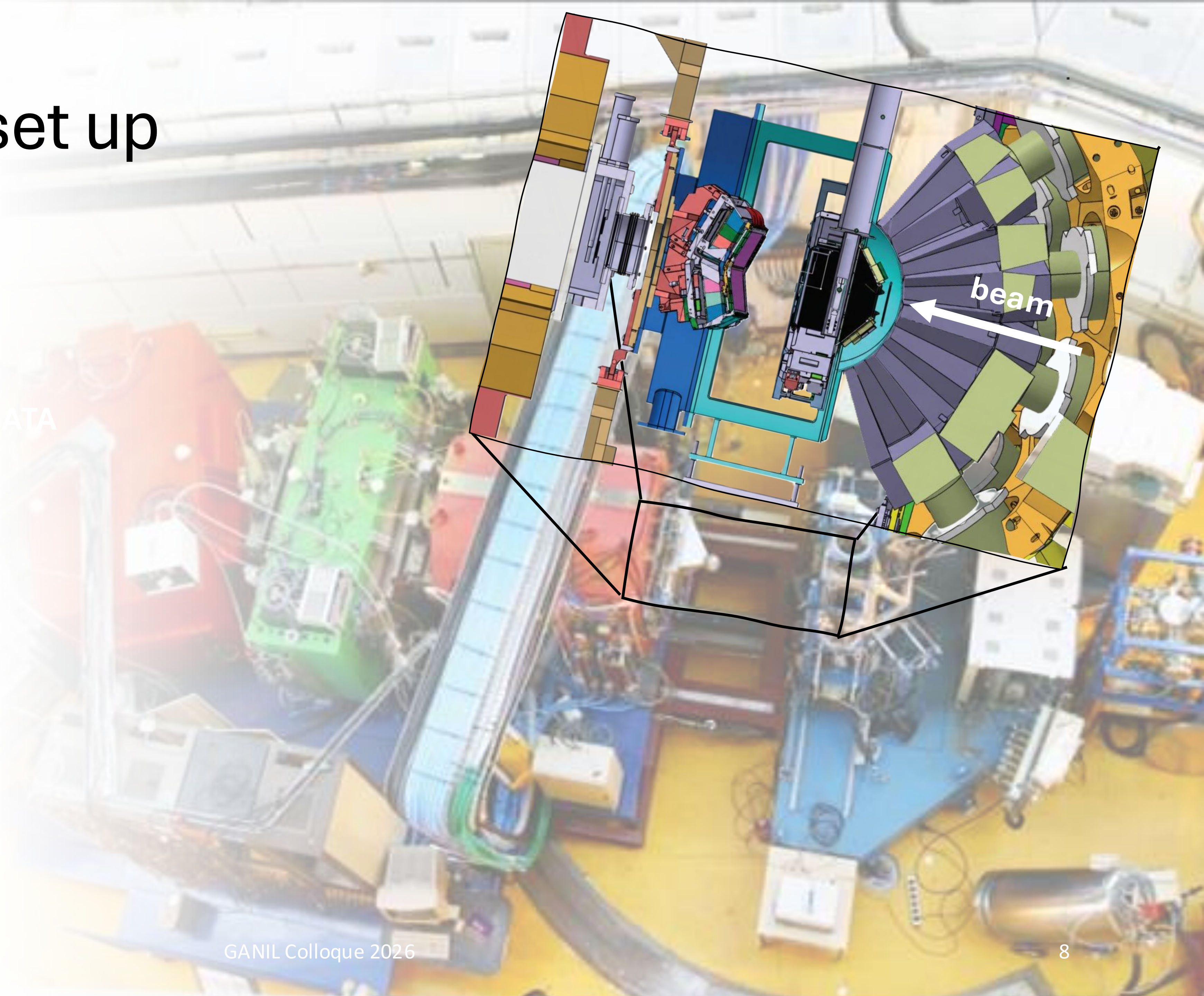
- AGATA+VAMOS+ MUGAST campaign @ GANIL 2019
  - ^{46}Ar(^{3}He,d)^{47}K[1,2]
  - ^{47}K(p,d)^{46}K[3]



[1] D. Brugnara, University of Padova, PhD thesis (2022)
[2] D. Brugnara et al., *arXiv preprint arXiv:2506.23228* (2025)
[3] C. J. Paxman *et al.*, *arXiv preprint arXiv:2601.06242* (2026)
[4] M. Assié *et al.*, Nucl. Inst. Meth A 1014, 165743 (2021)

Experimental set up

- AGATA+VAMOS+ MUGAST campaign @ GANIL 2019
  - $^{46}Ar(^{3}He,d)^{47}K$ [1,2]
  - $^{47}K(p,d)^{46}K$ [3]
- ^{46}Ar [1,2] beam from SPIRAL1 @ 10 MeVu
- **39 AGATA crystal** operational



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Literature of ^{46}Ar β decay

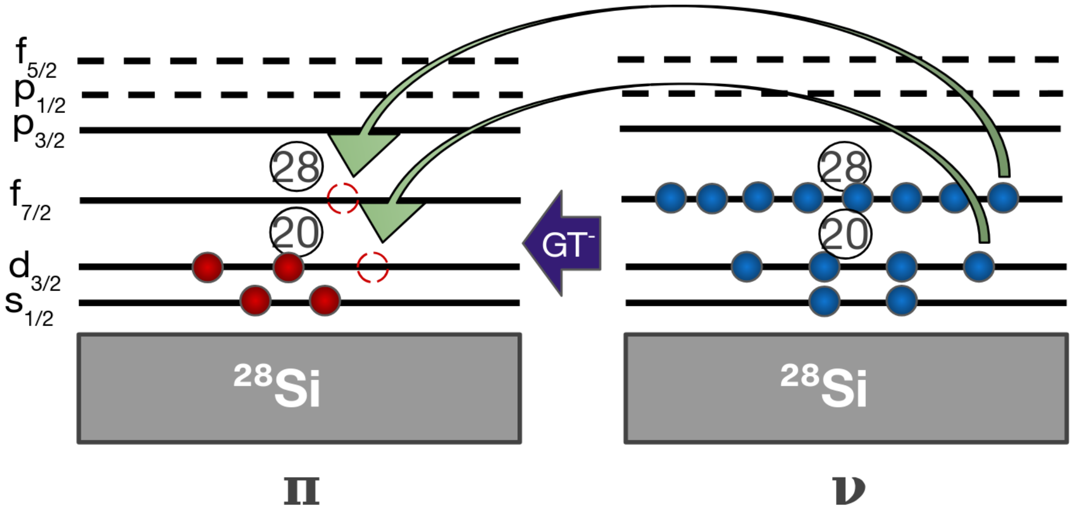
- Two previous studies of ^{46}Ar β decay:

TABLE IV. Energy and relative intensity of γ rays following β decay of ^{46}Ar.

E_γ (keV)	I_γ	E_i (MeV)	E_f (MeV)
288.1 ± 0.7	7 ± 2	(2.23	1.94)
584.7 ± 1.5	4 ± 1		
1020.3 ± 1.2	8 ± 3		
1944.3 ± 0.1	1000	1.94	0

A. Huck *et al.*, Phys. Rev. C 21.2, 712 (1980)
R. F. Petry *et al.*, Phys. Rev. C 17.6, 2197 (1978)

$$\hat{O}^{\pm}_{GT} = \sum_k \boldsymbol{\sigma}(k)\, \tau_{\pm}(k)$$



- $(\pi f_{7/2})^{-1} \times (\nu f_{7/2})^{-1}$
- $(\pi d_{3/2})^{-1} \times (\nu d_{3/2})^{-1}$
- $(\pi s_{1/2})^{-1} \times (\nu s_{1/2})^{-1}$

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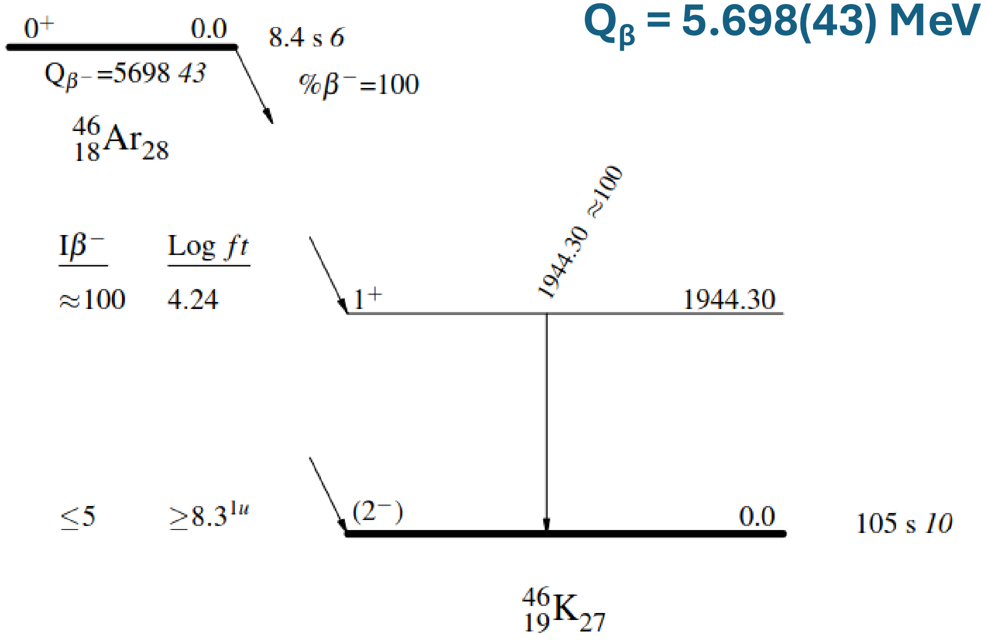
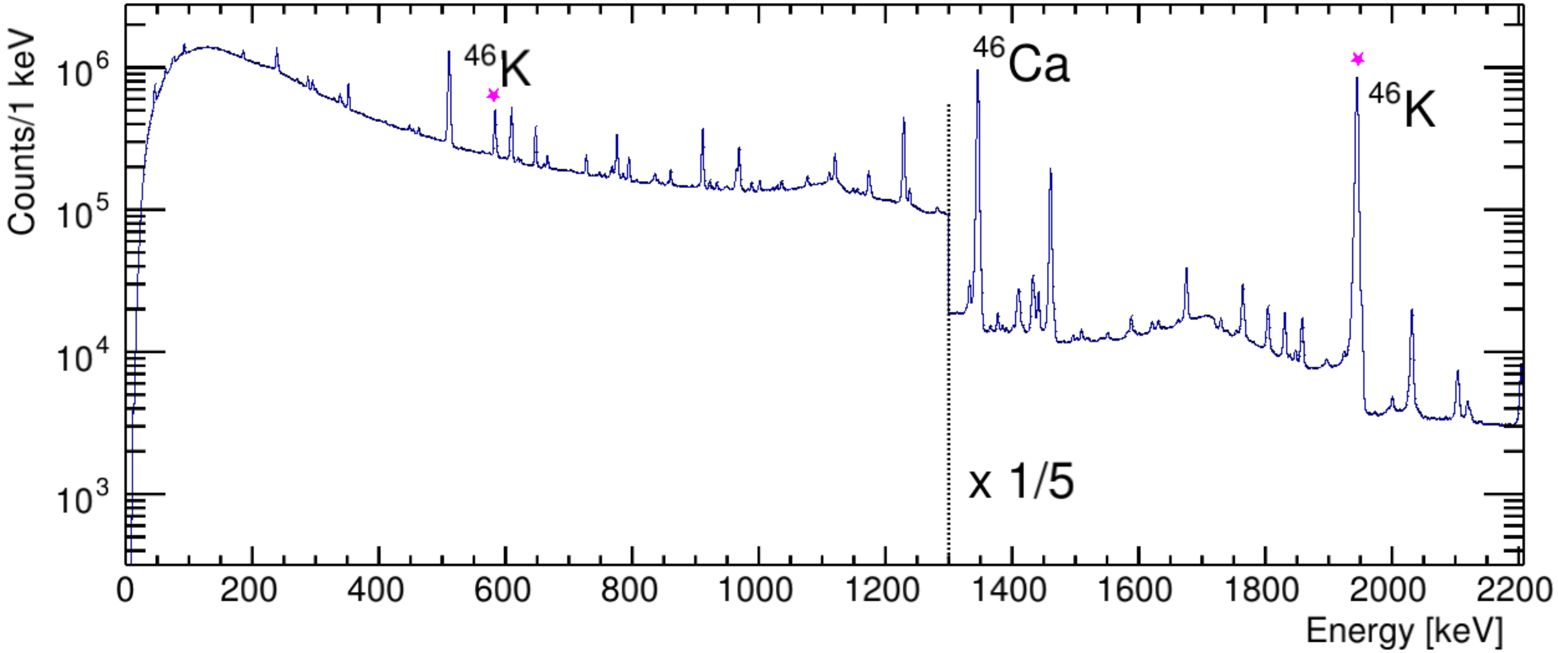
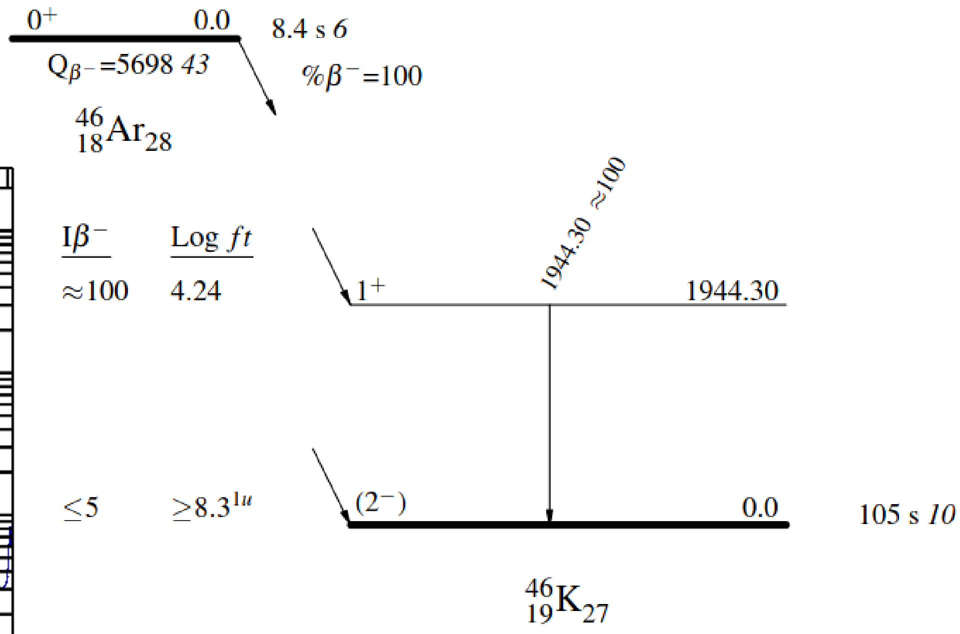
$T_{1/2}(^{46}\mathrm{Ar})$ = 8.4(6) s
Q_β = 5.698(43) MeV



^{46}Ar β decay

- **>~10^3** statistics with respect previous studies





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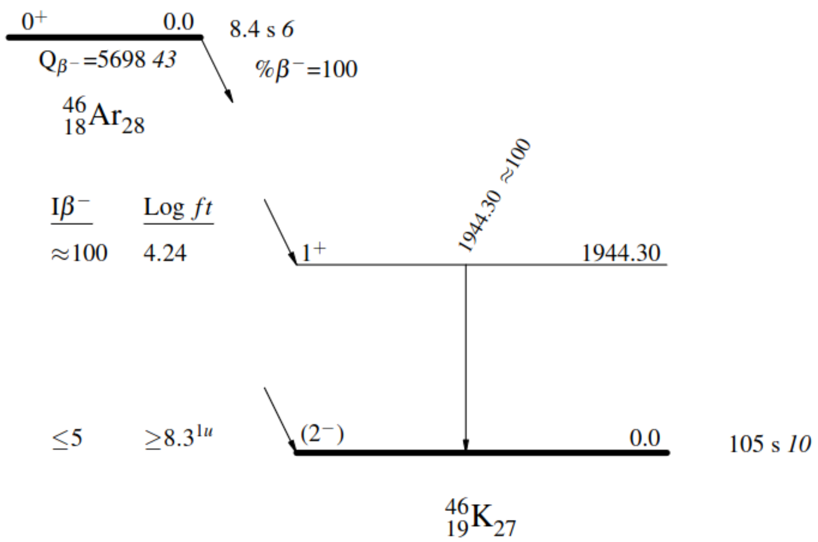
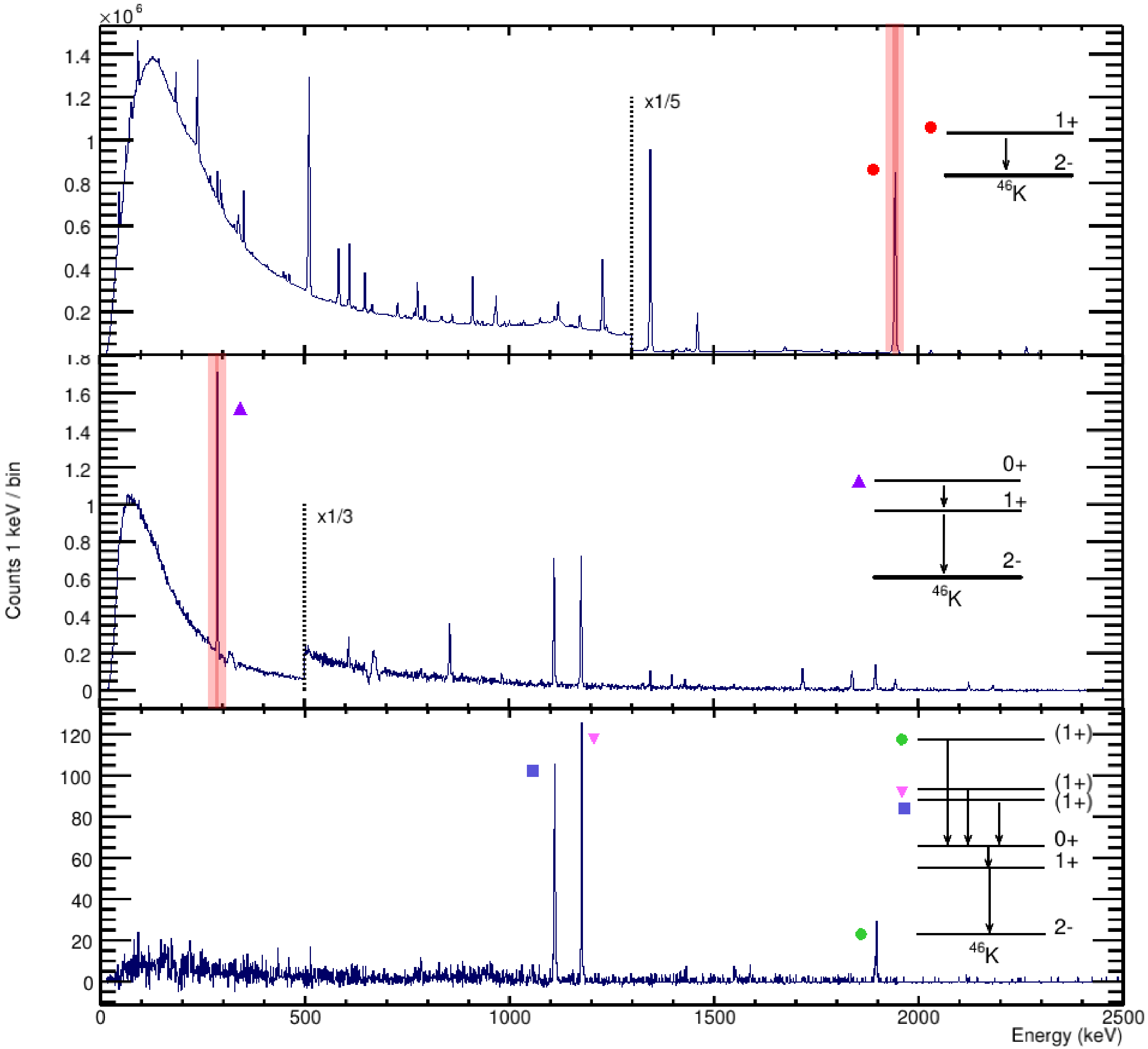
^{46}Ar β decay

⚠ γ-γ and γ-γ-γ coincidences due to ^{46}K → ^{46}Ca contaminants





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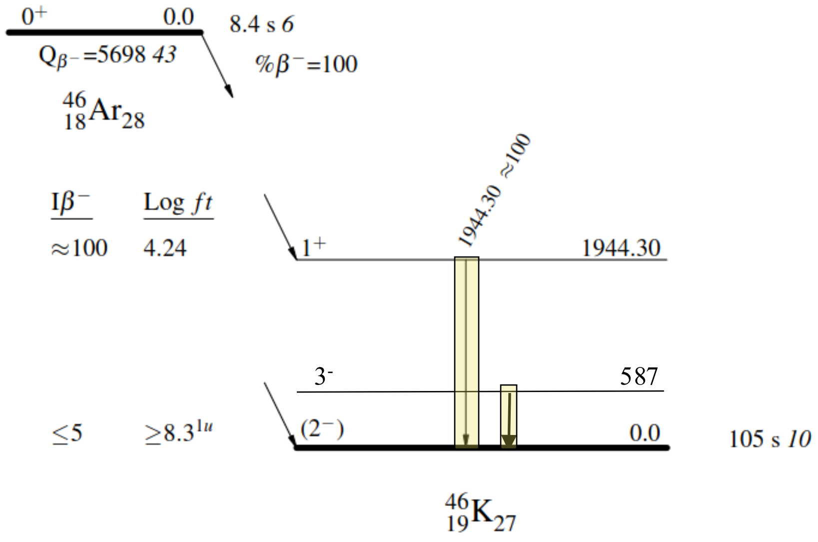
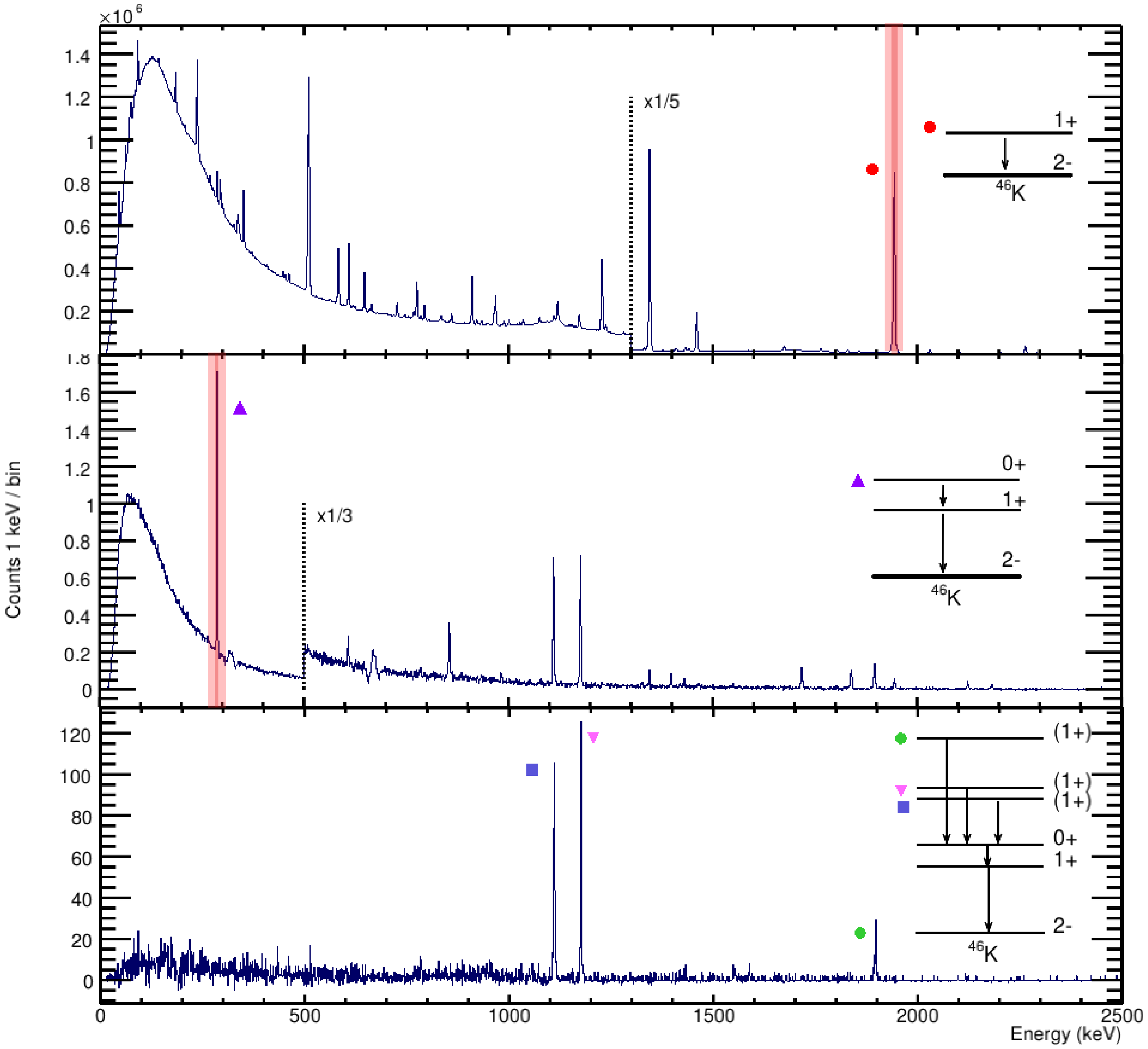
^{46}Ar β decay

- ⚠ γ-γ and γ-γ-γ coincidences due to ^{46}K → ^{46}Ca contaminants
- ⚠ We observe also **negative parity** states!





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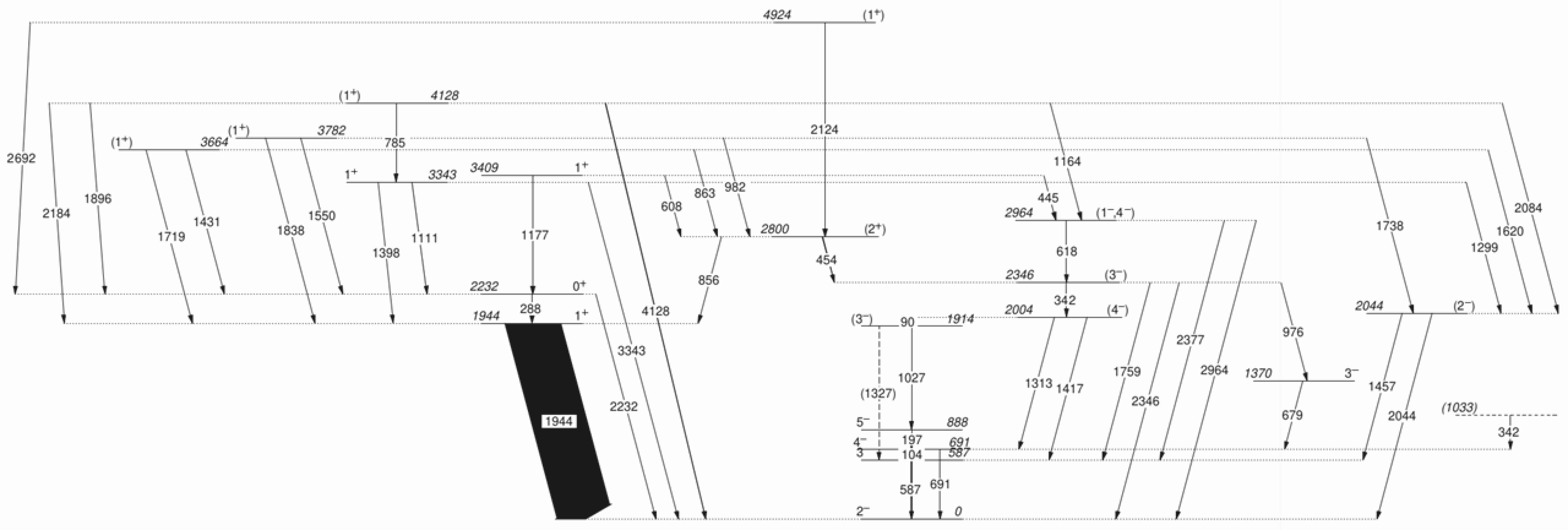
^{46}K partial level scheme



^{46}K – this work

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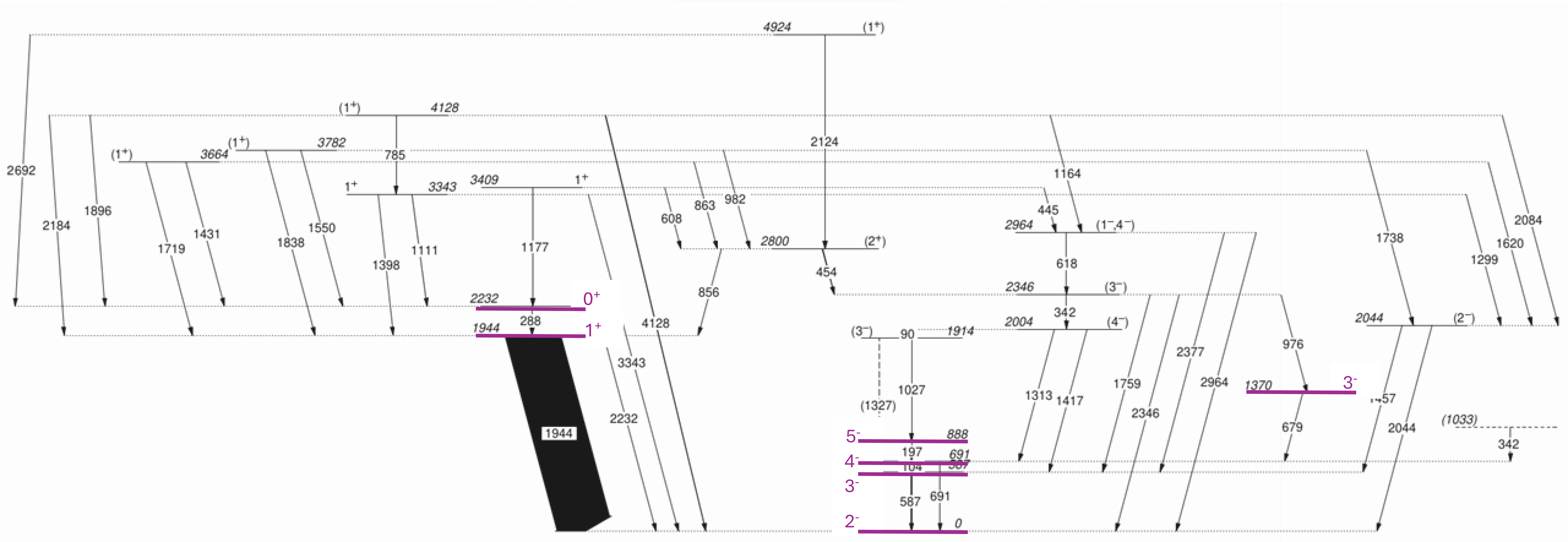

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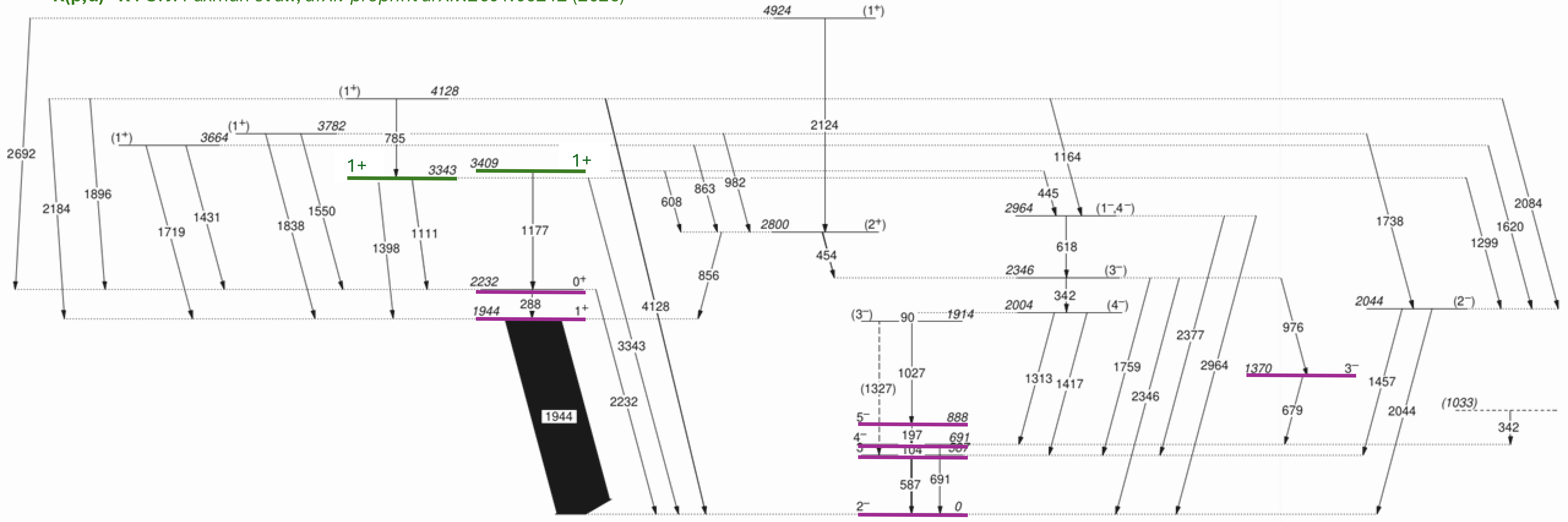

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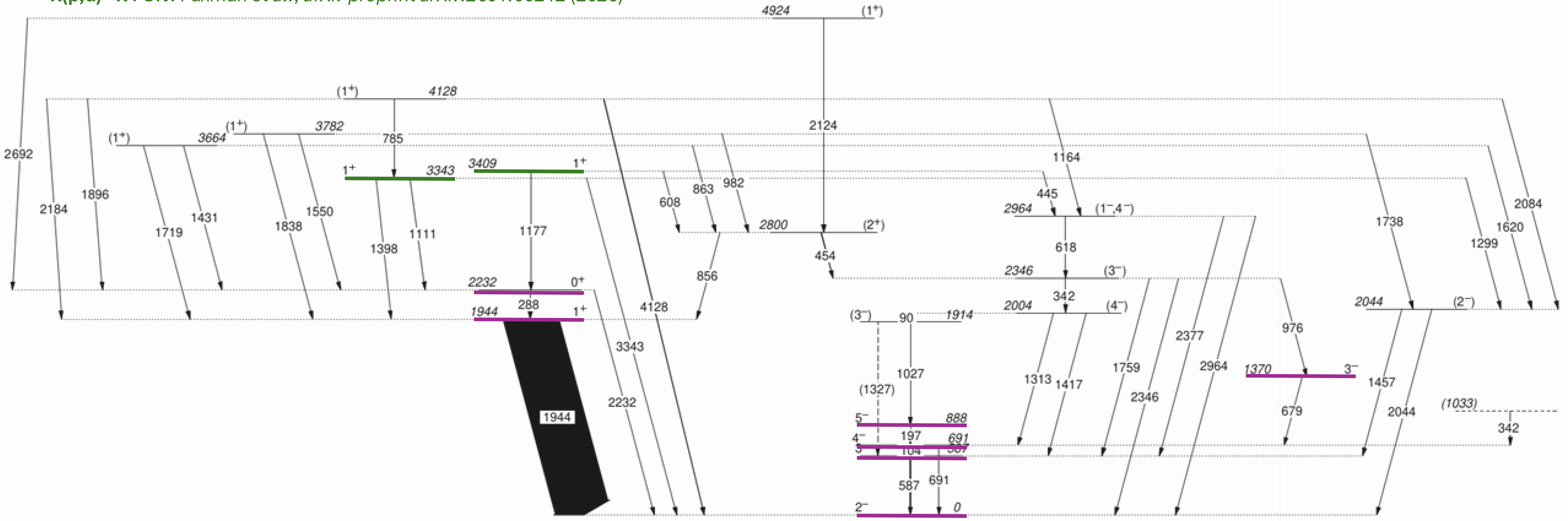
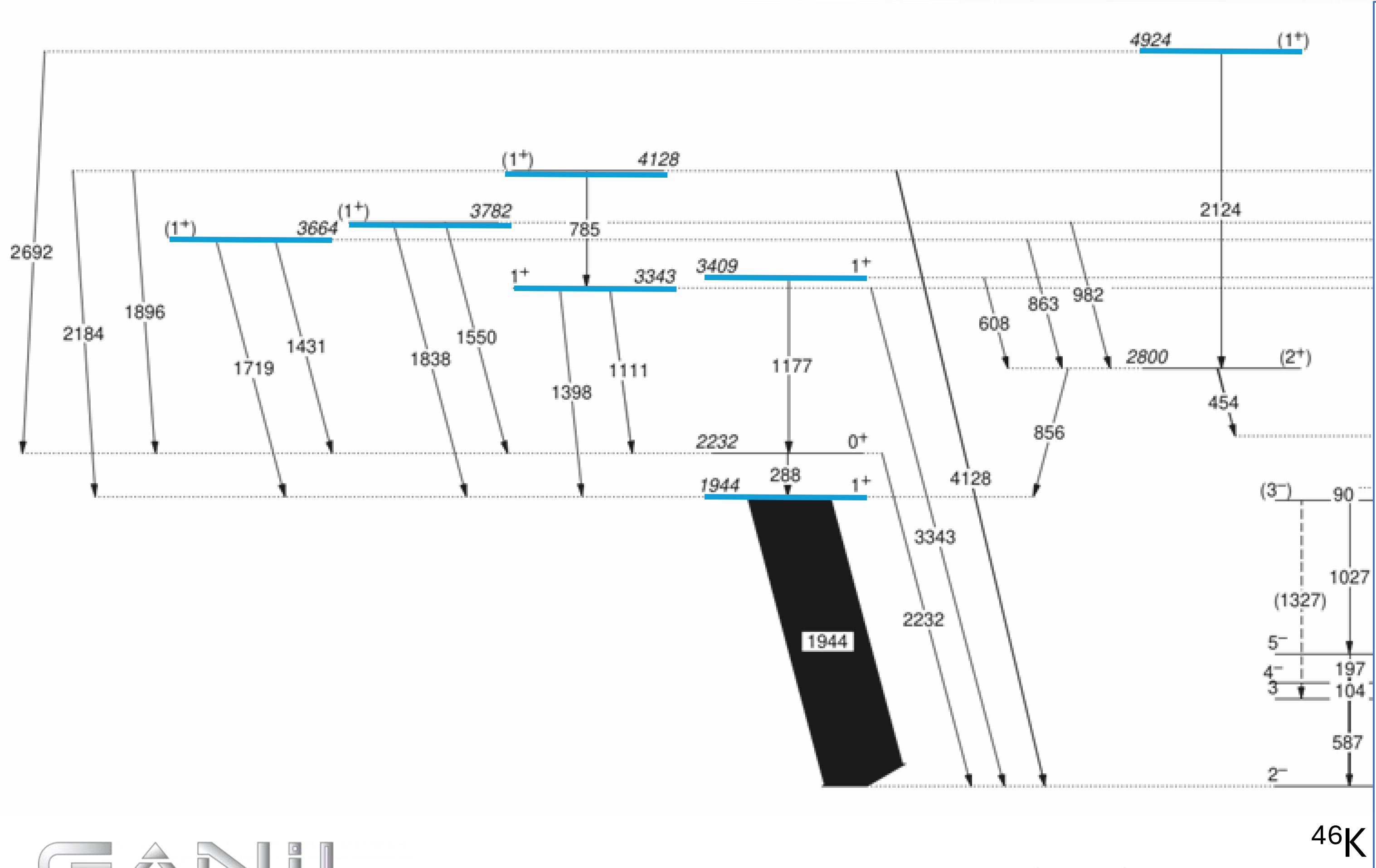
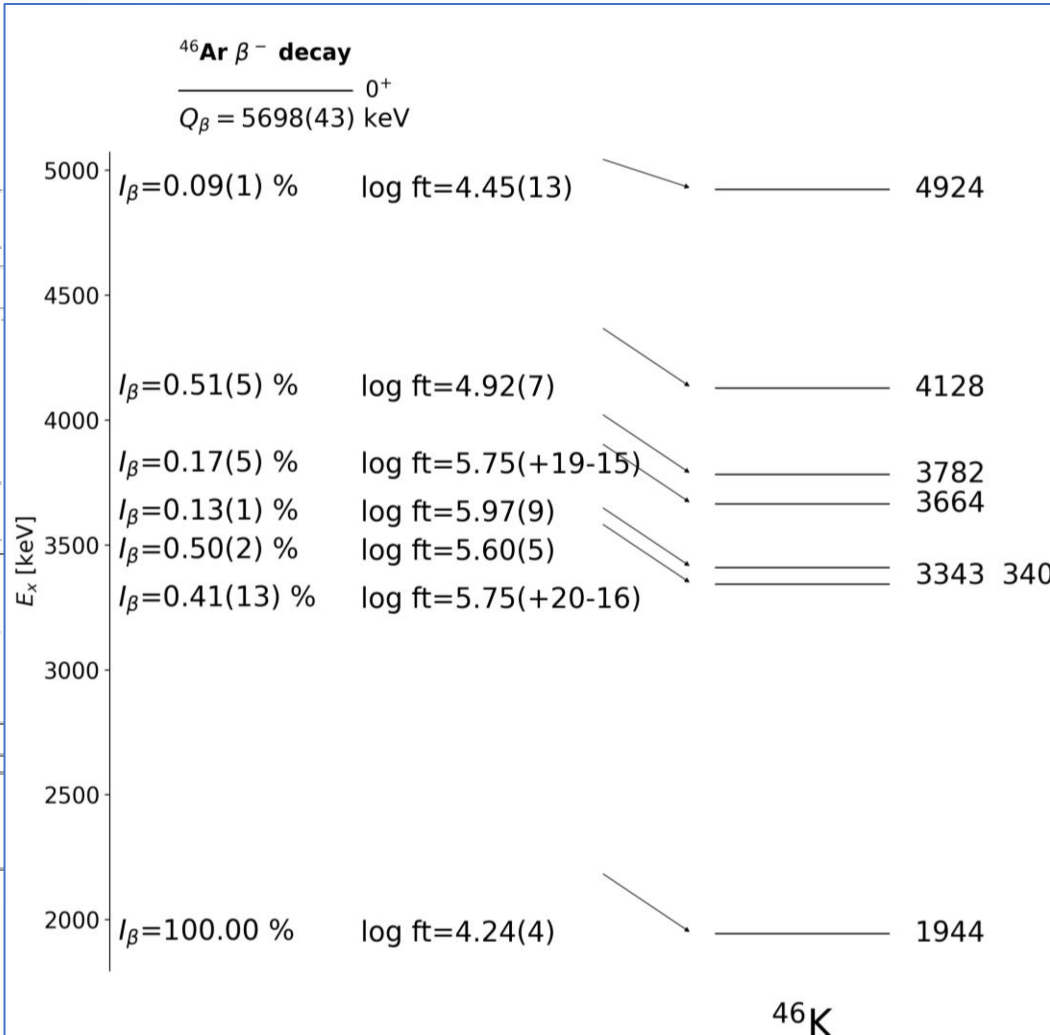


^{46}K – this work

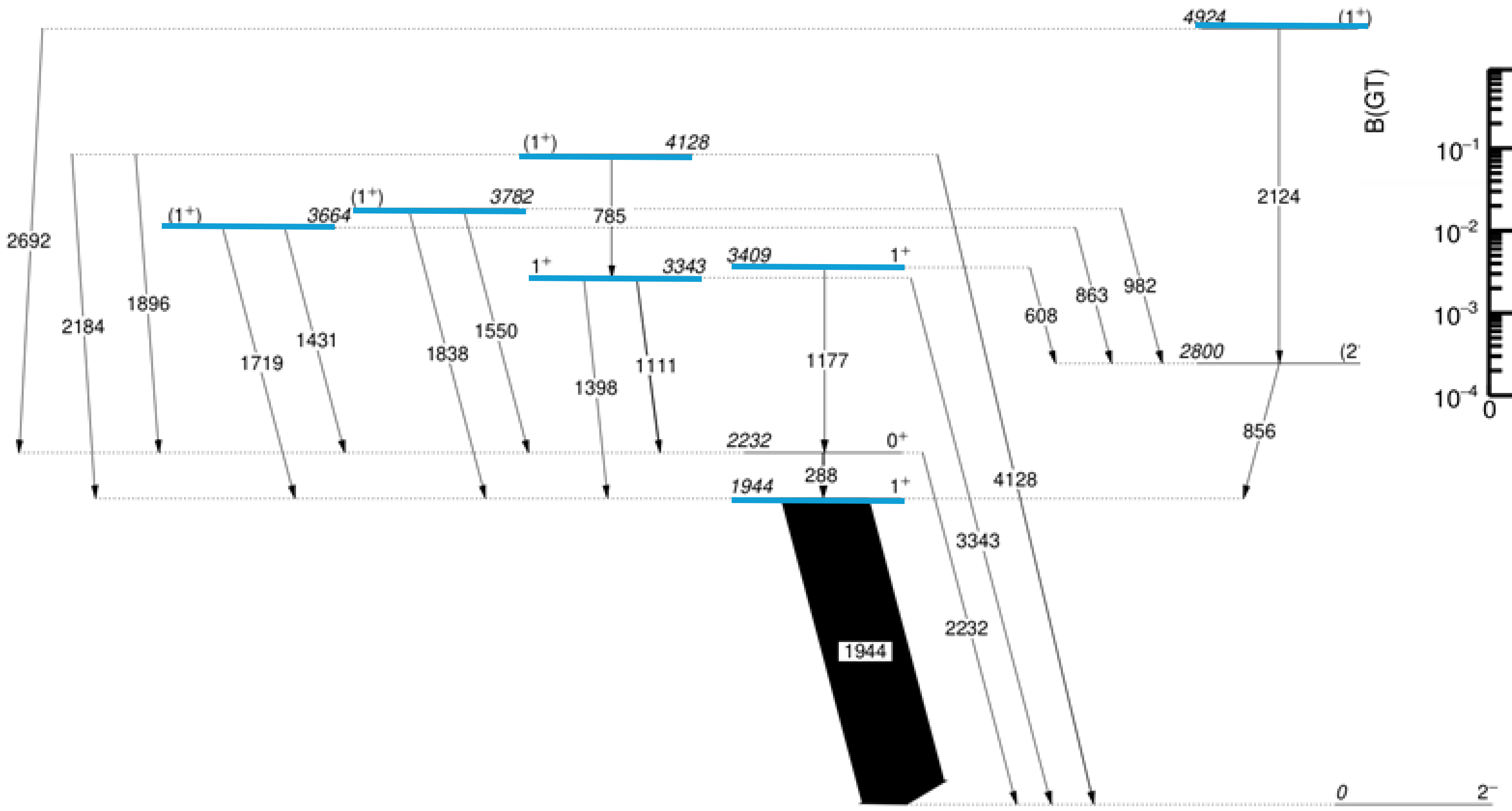
Gamow-Teller strength

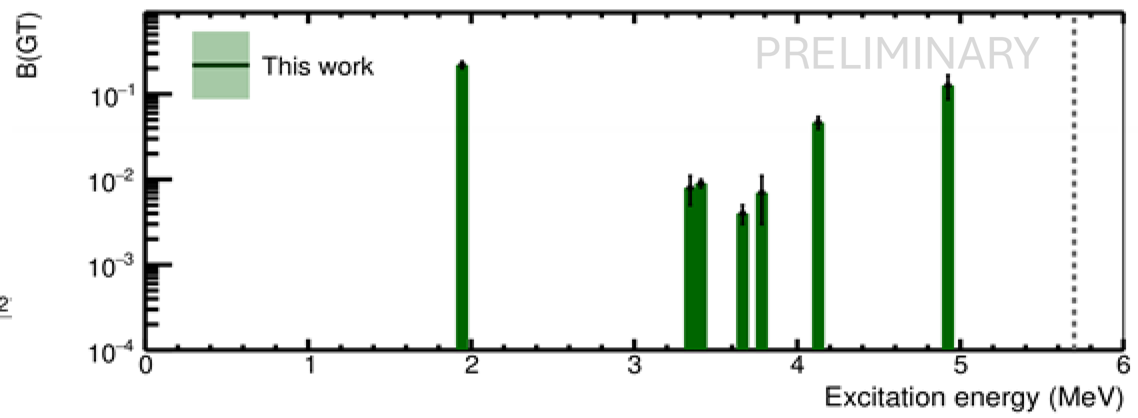




Gamow-Teller strength

$$B(GT_i) \propto \frac{I_{\beta,i}}{g_A^2\, f(Q_\beta - E_{x,i})\, T_{1/2}}$$





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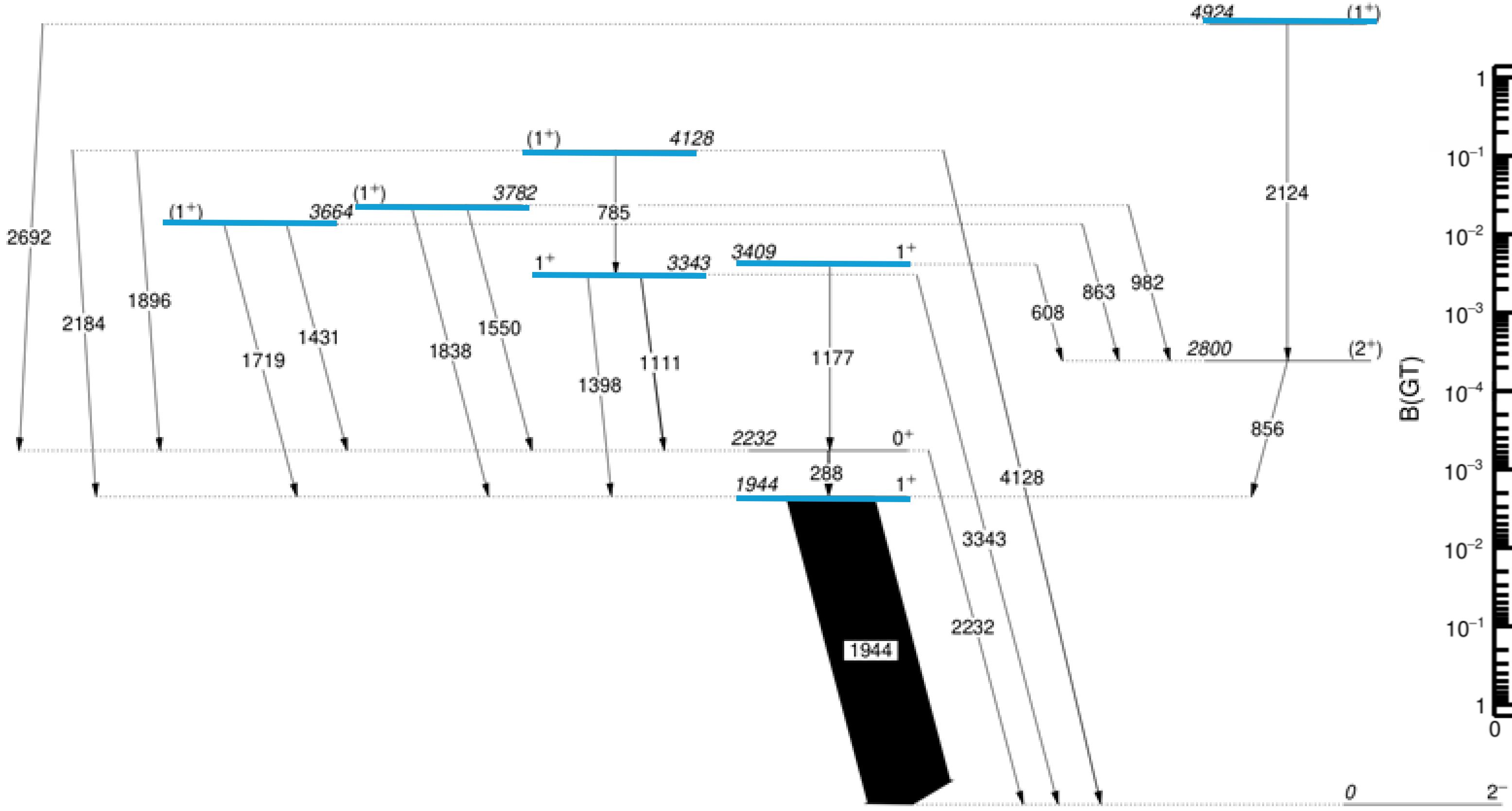

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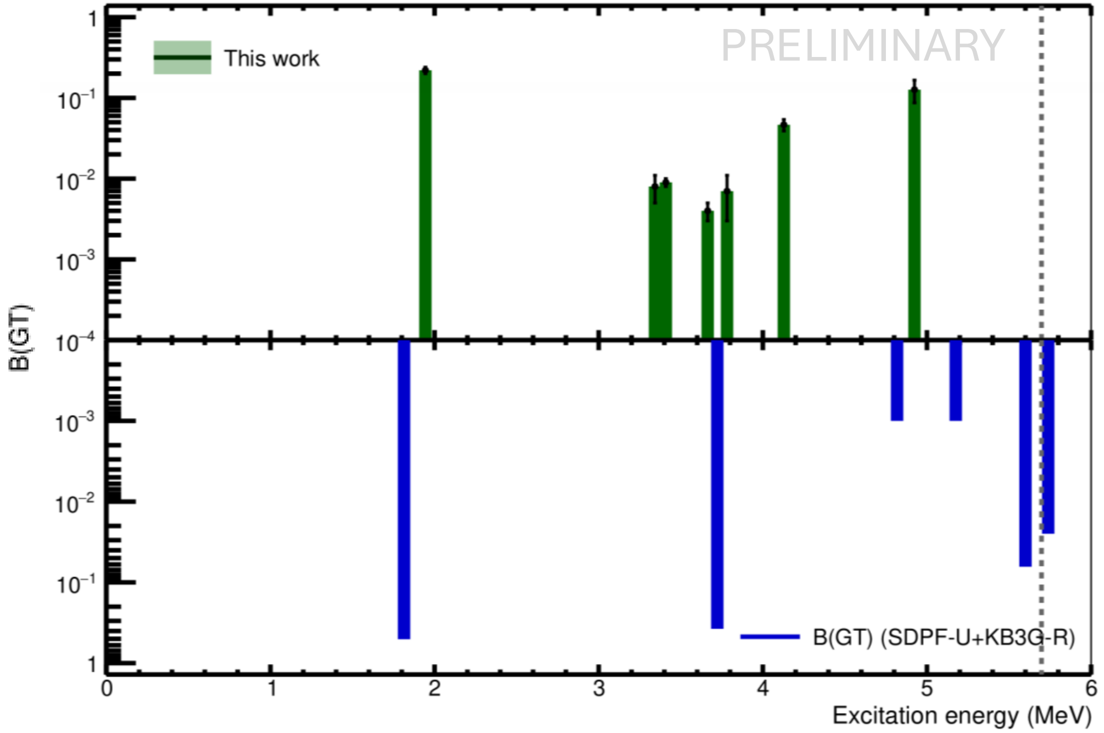
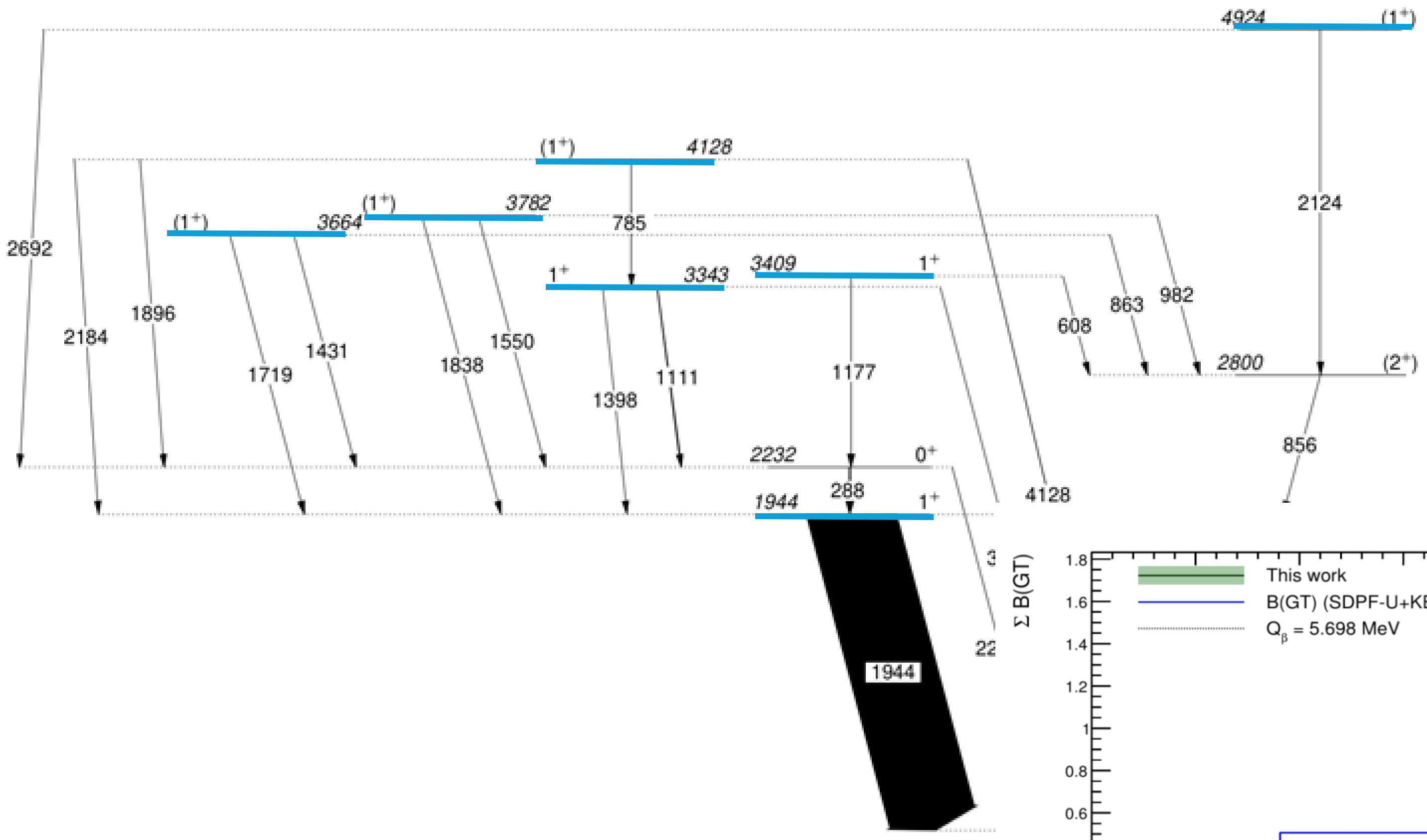


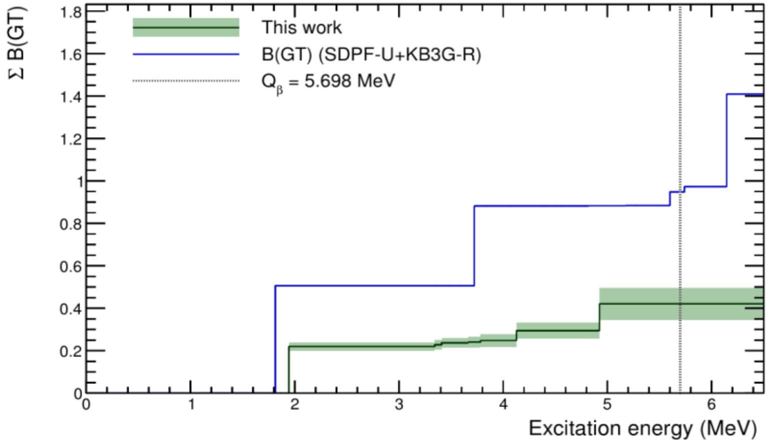
Gamow-Teller strength

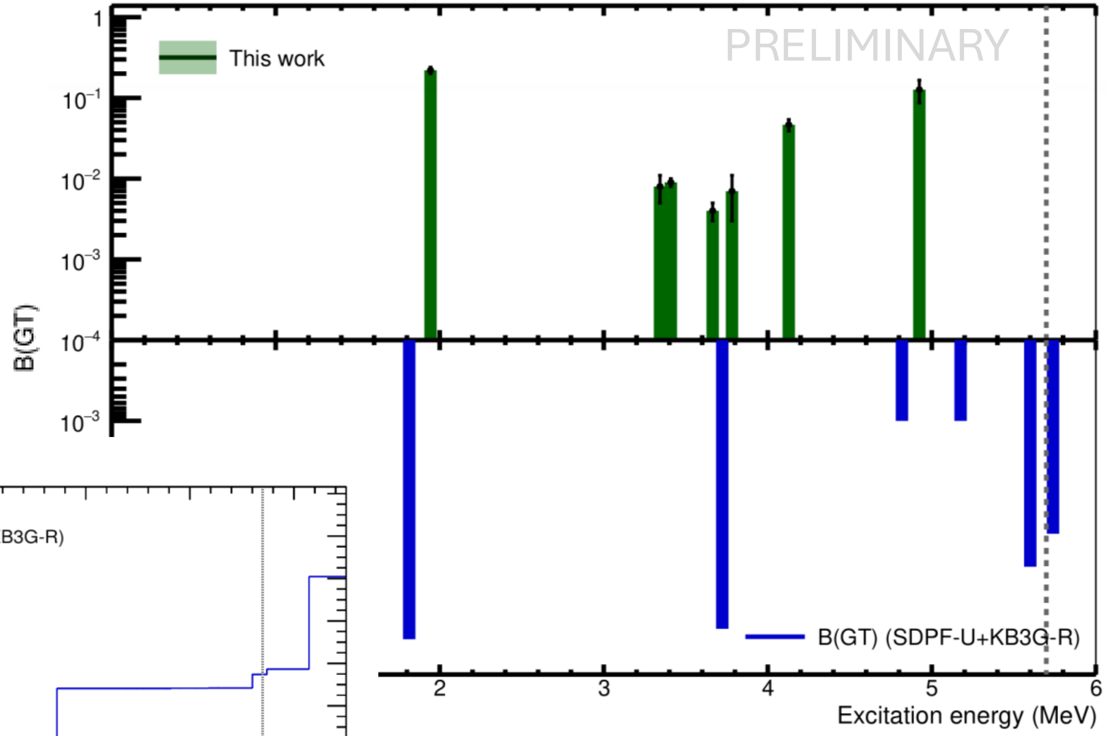
LSSM B(GT) calculation with **SDPF-U+KB3G-R**:

- B(GT:1_1^+) : 0.65 (*1p-1h*)
- B(GT:1_1^+) : 0.51 (*2p-2h*)

Better agreement with exp B(GT) values upon **relaxing the truncation**







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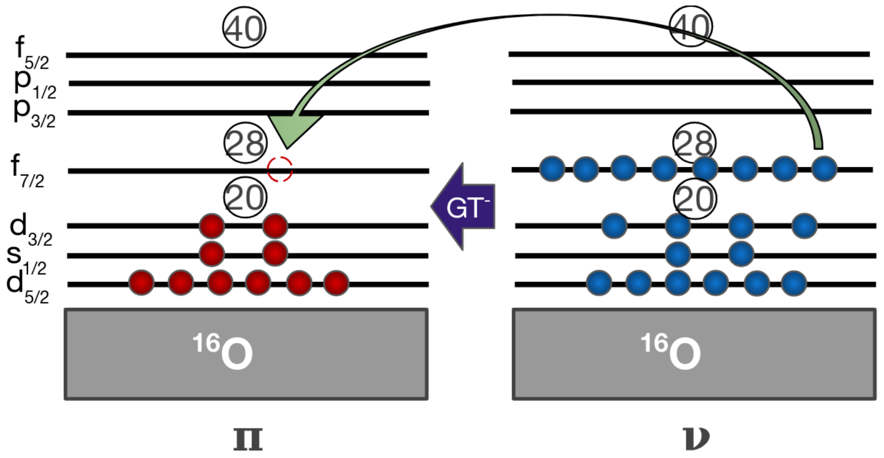
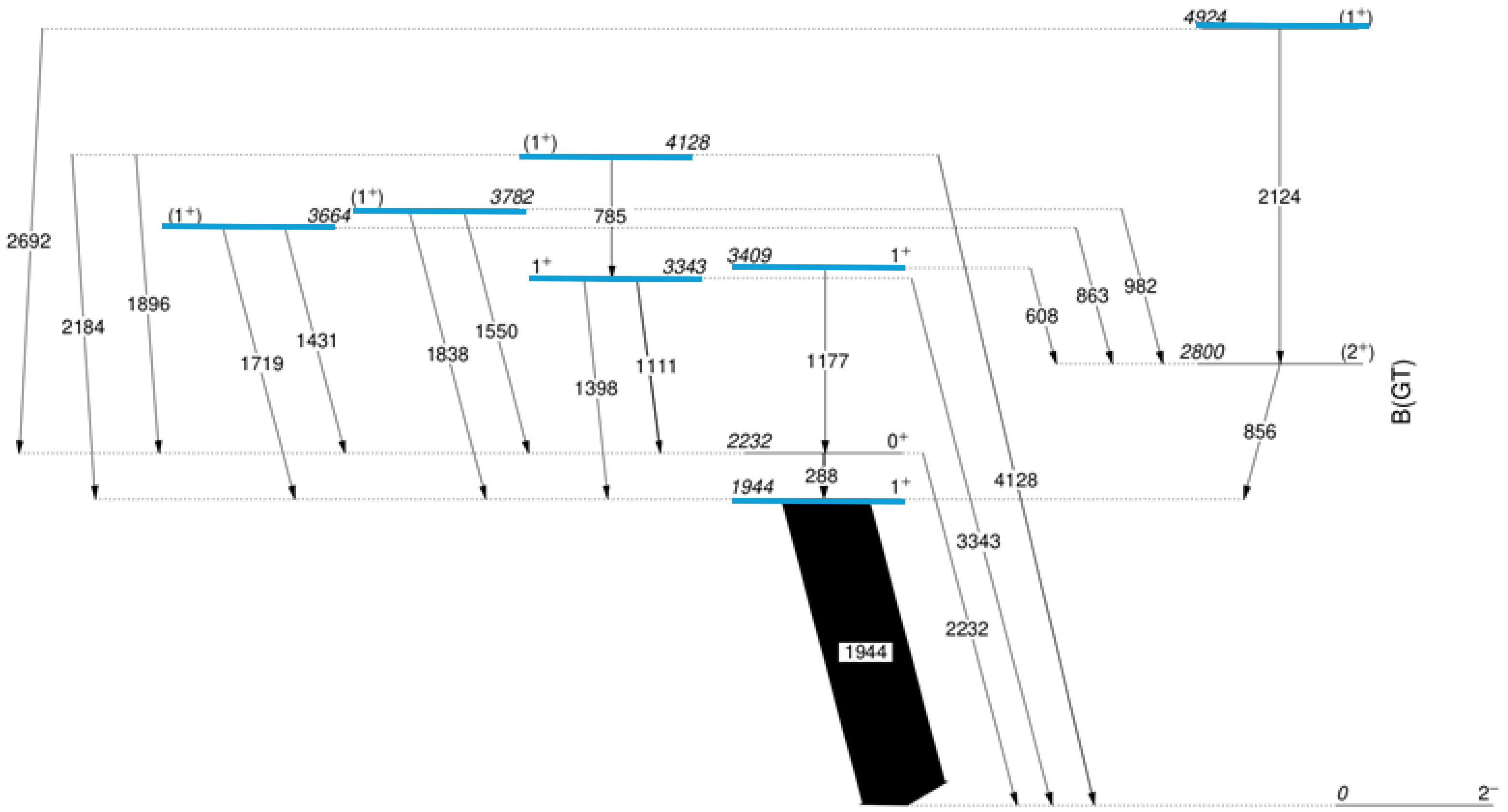
Gamow-Teller strength

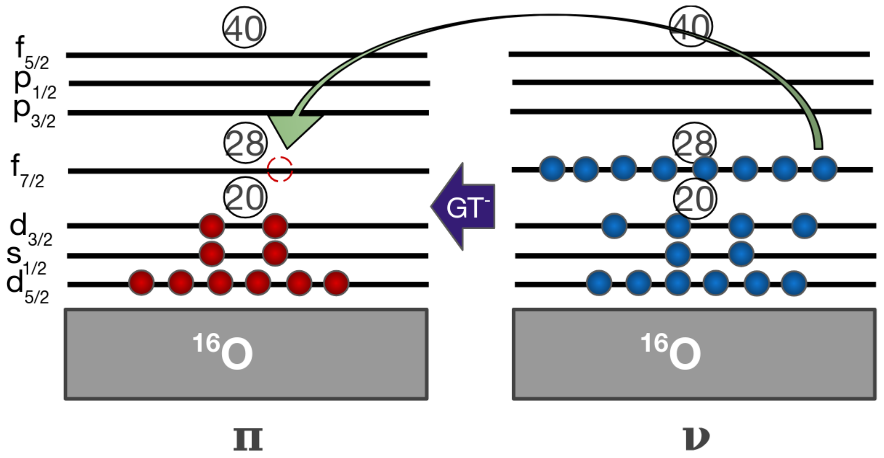


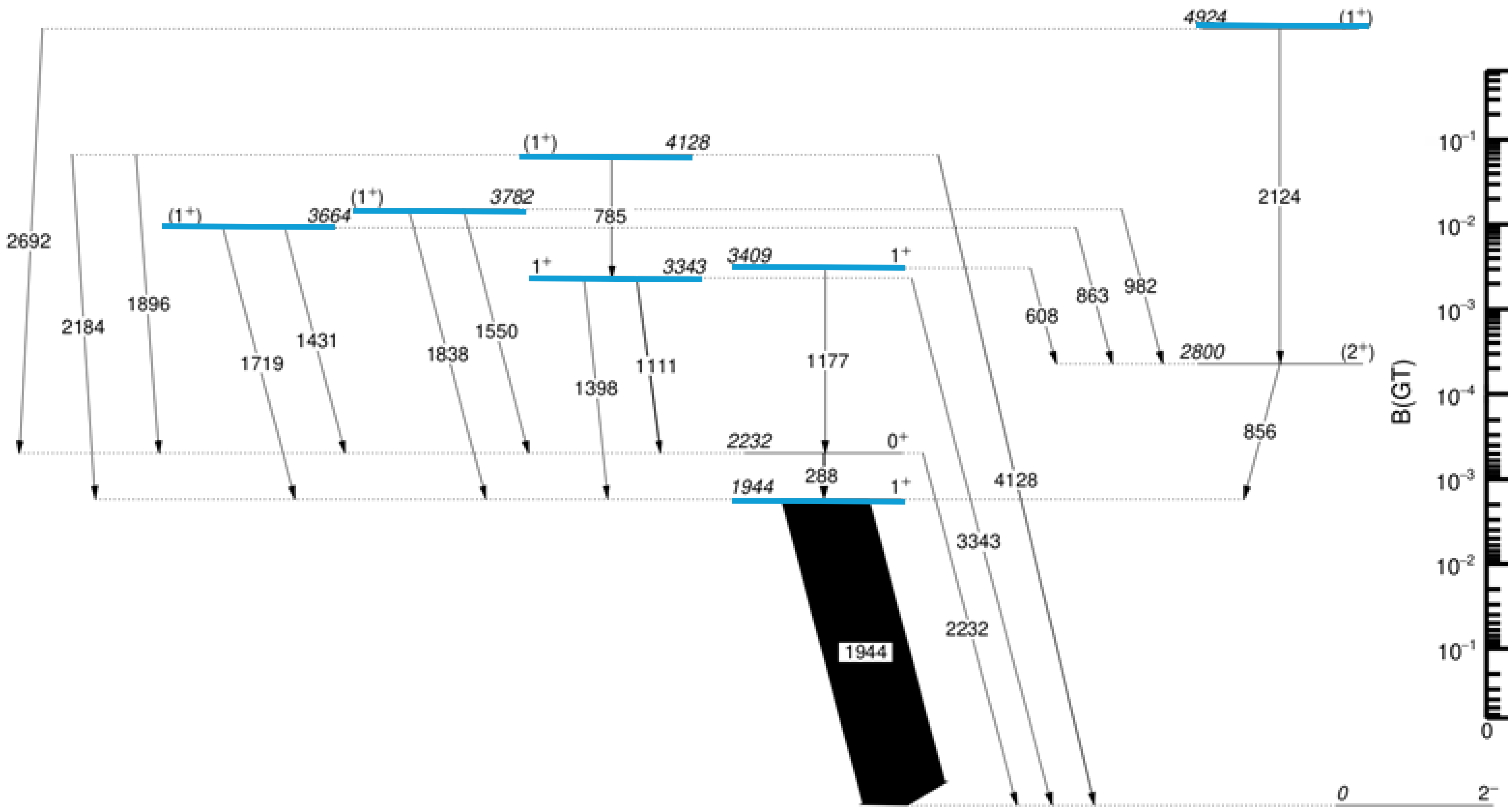


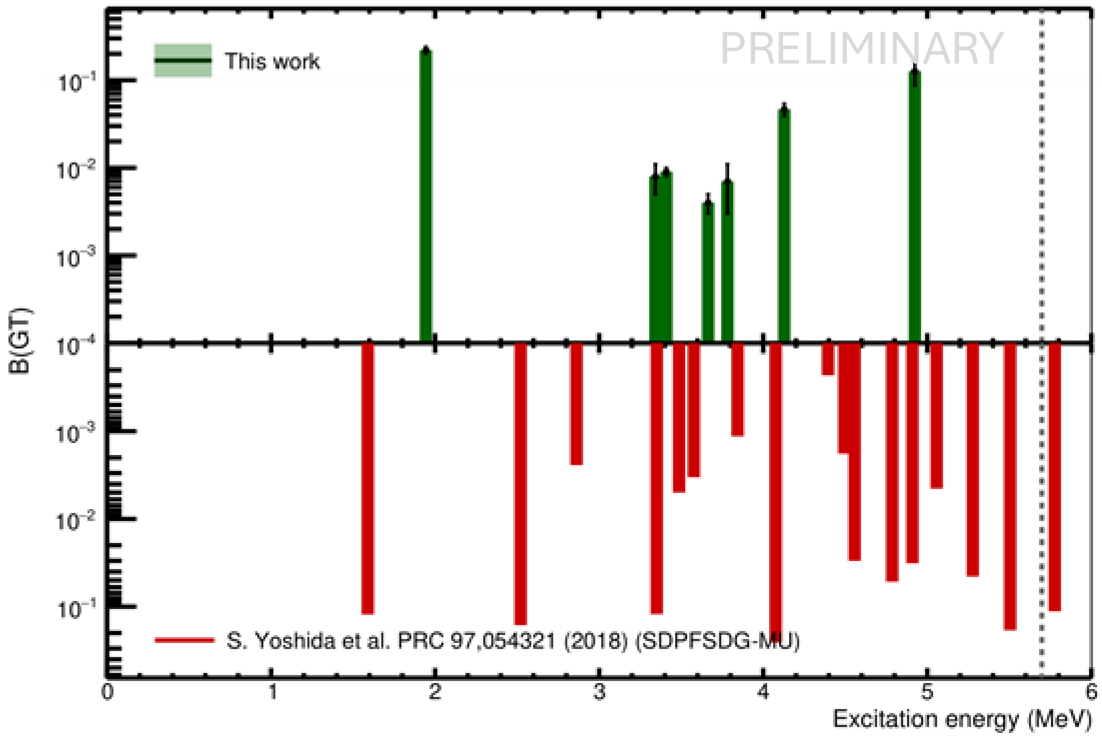
^{46}K – this work

Gamow-Teller strength

- GT strength calculated with the **Lanczos strength function method** (300 iterations)







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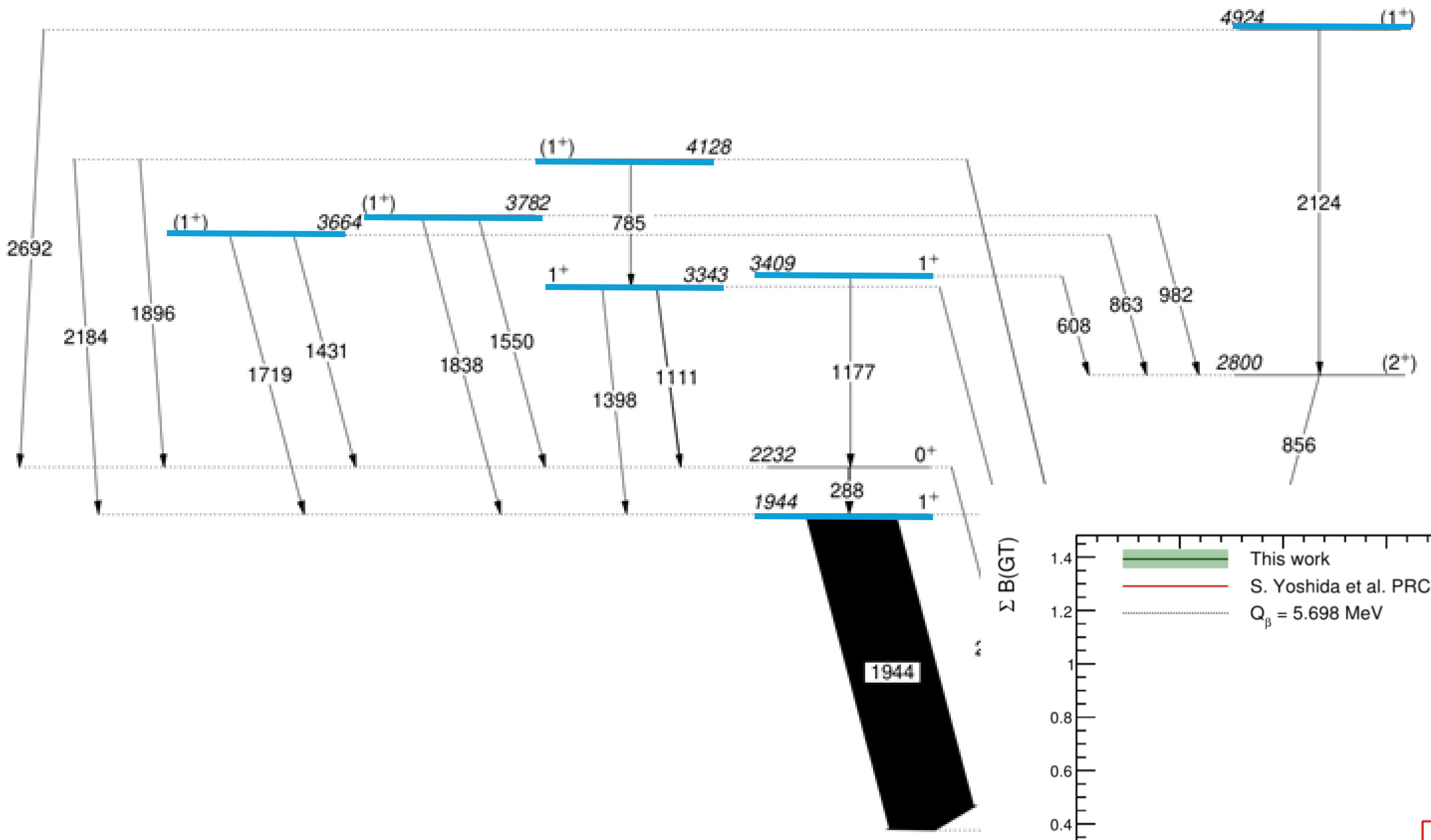
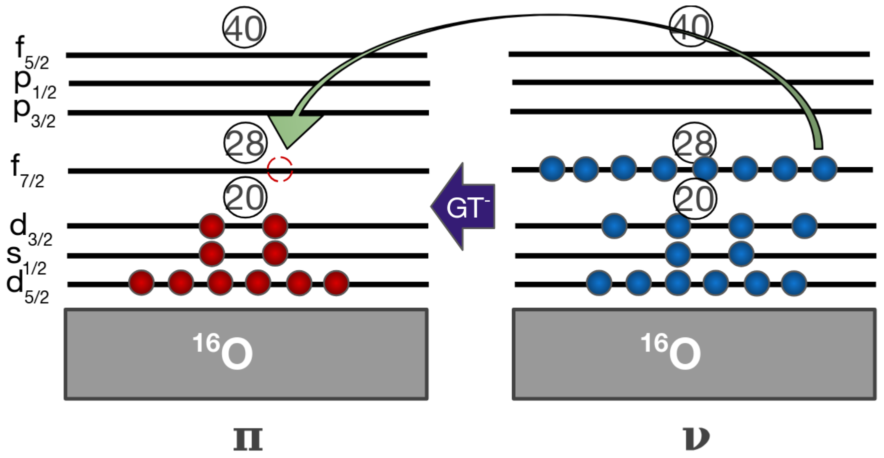
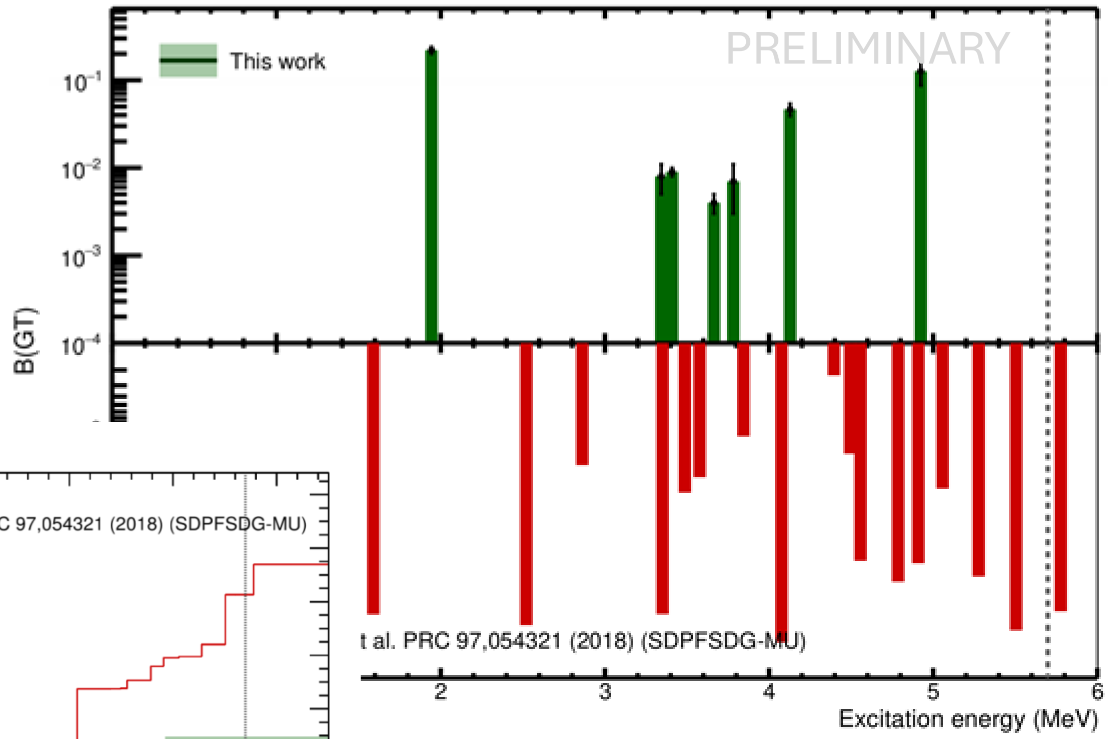
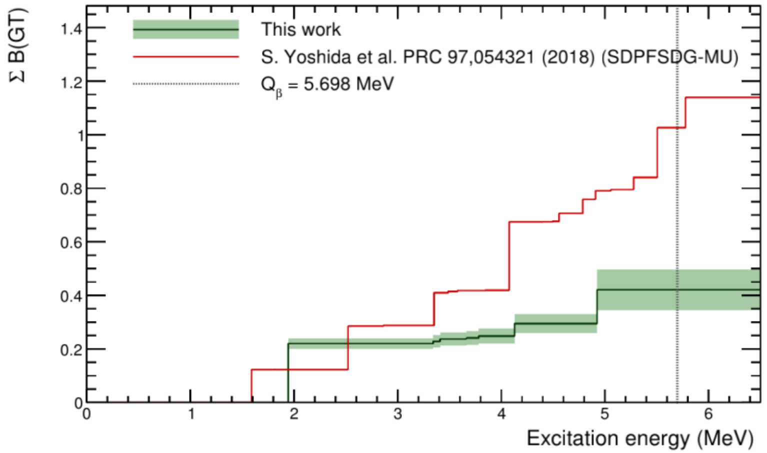








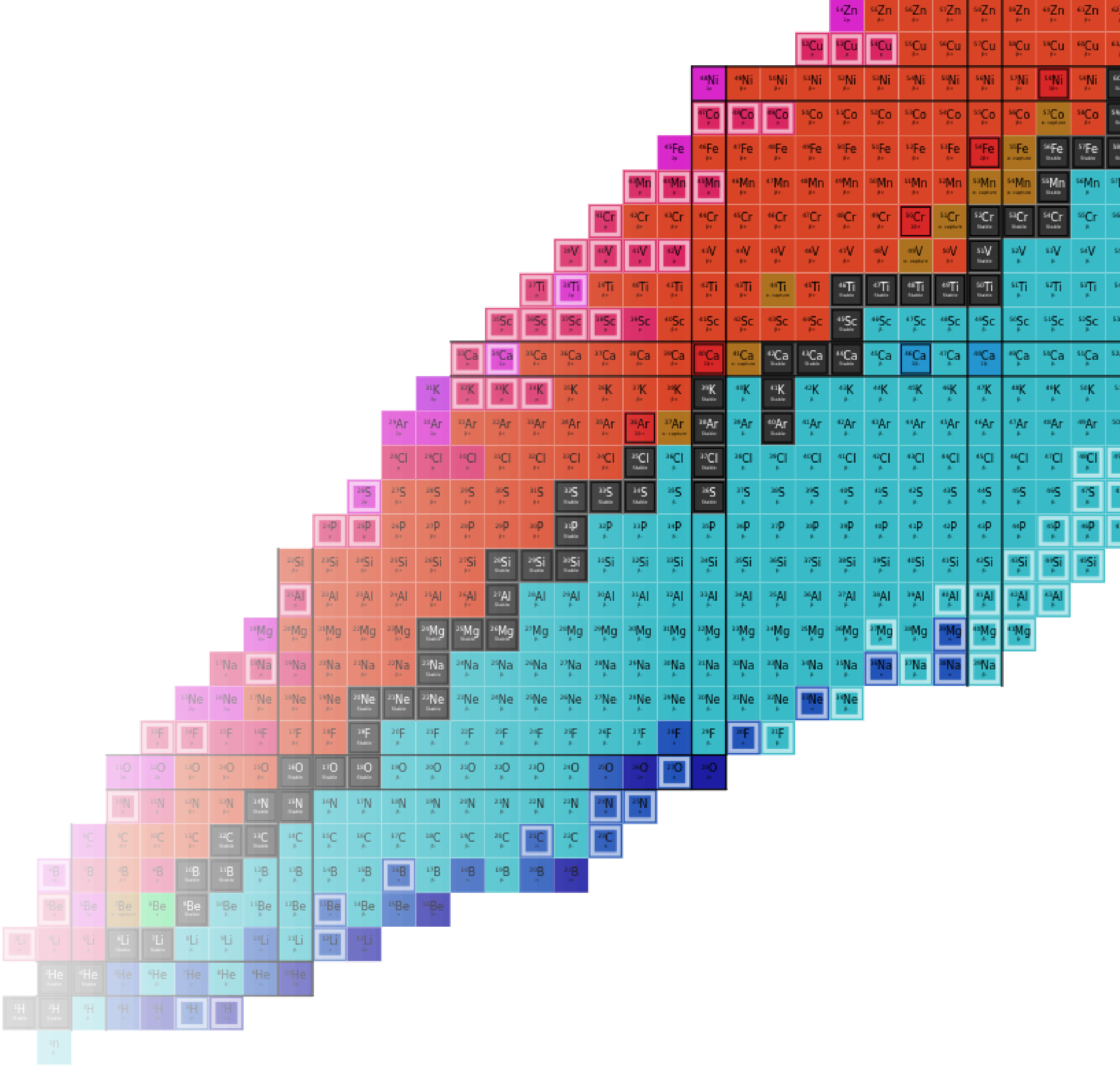
Summary

- High-resolution γ-ray spectroscopy of the *odd-odd* ^{46}K with **AGATA@GANIL**
  - Large statistics → **γ-γ** and **γ-γ-γ** coincidences
  - Reconstruction of **8 new states**
- Comparison with LSSM calculations with 3 different effective interactions
  - **B(GT) strength** and 1^+ state fragmentation better reproduced **increasing the model space** (SDPFSDG-MU)
  - $\nu d_{3/2} \rightarrow \pi d_{3/2}$ and $\nu s_{1/2} \rightarrow \pi s_{1/2}$ predicted energetically more convenient than $\nu f_{7/2} \rightarrow \pi f_{7/2}$ at low energy

Perspectives:

- Extract a normalization of the observed strength on $^{46}K \rightarrow {}^{46}Ca$, in order to estimate the percentage of non-observed GT strength
- The β decay of ^{46}Ar could provide another piece of the puzzle in understanding its ground-state wave function.

Thank you!



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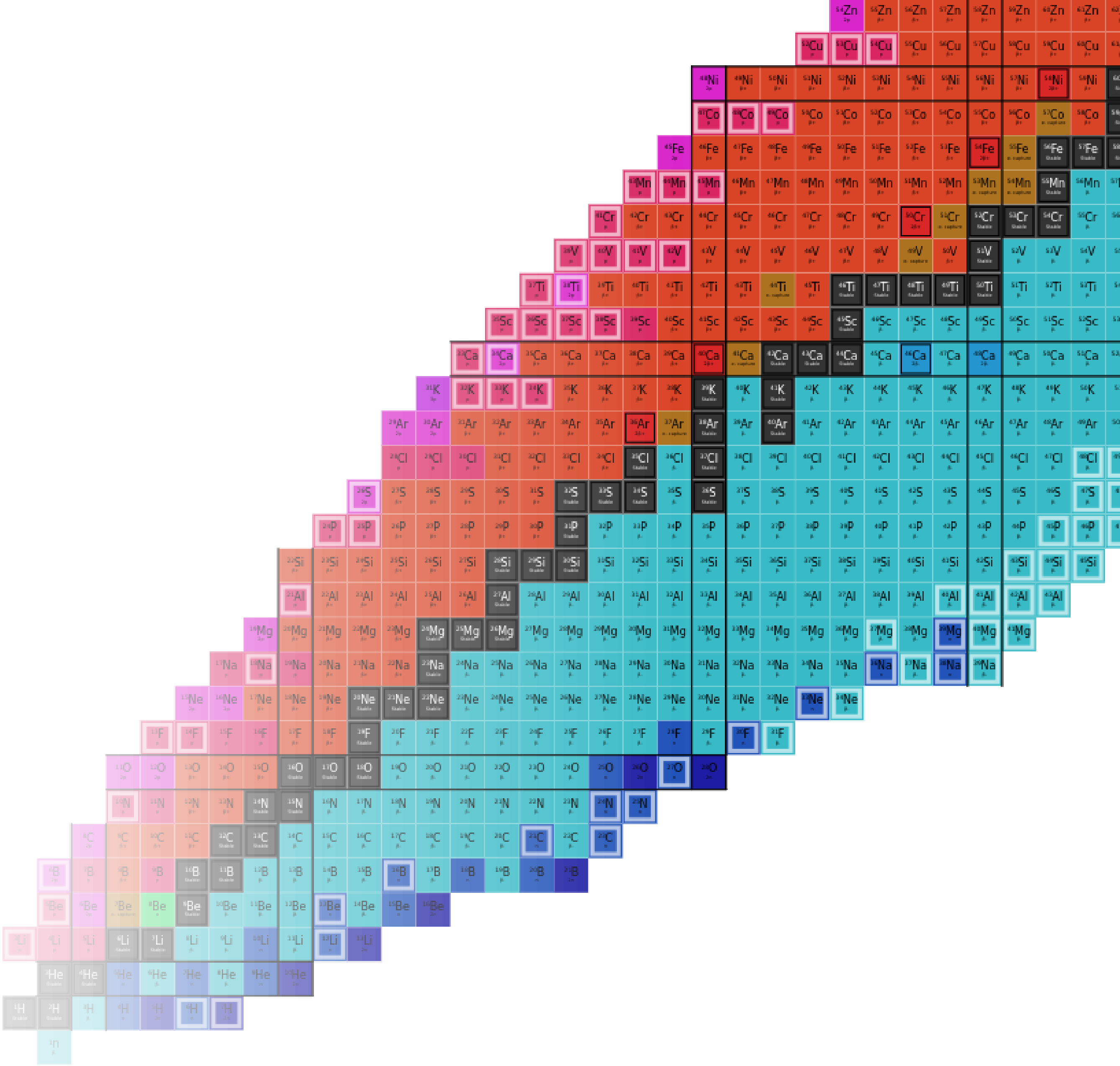
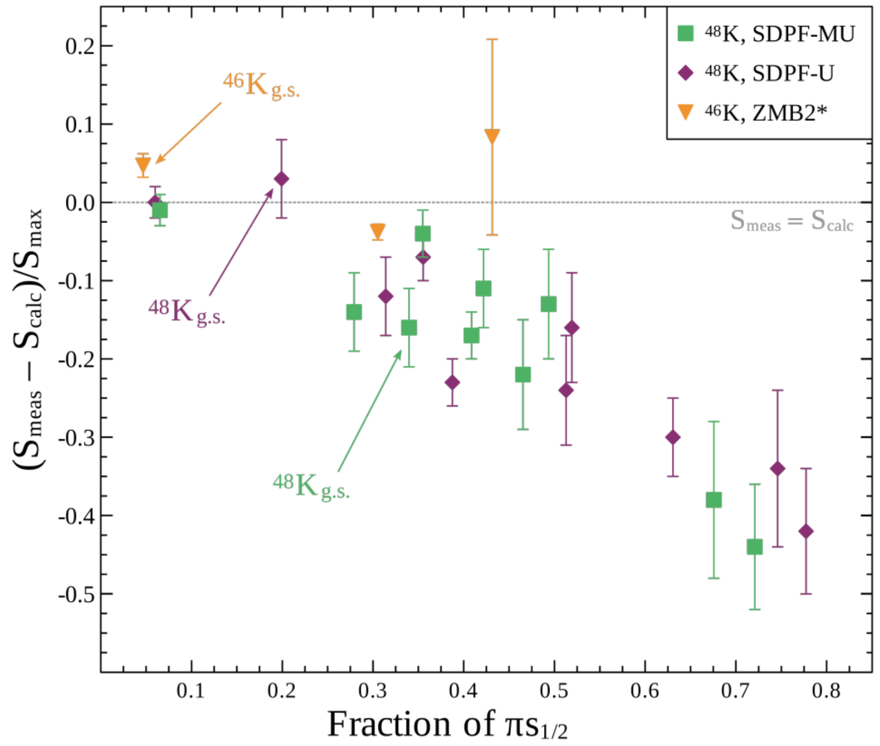
Backup slides

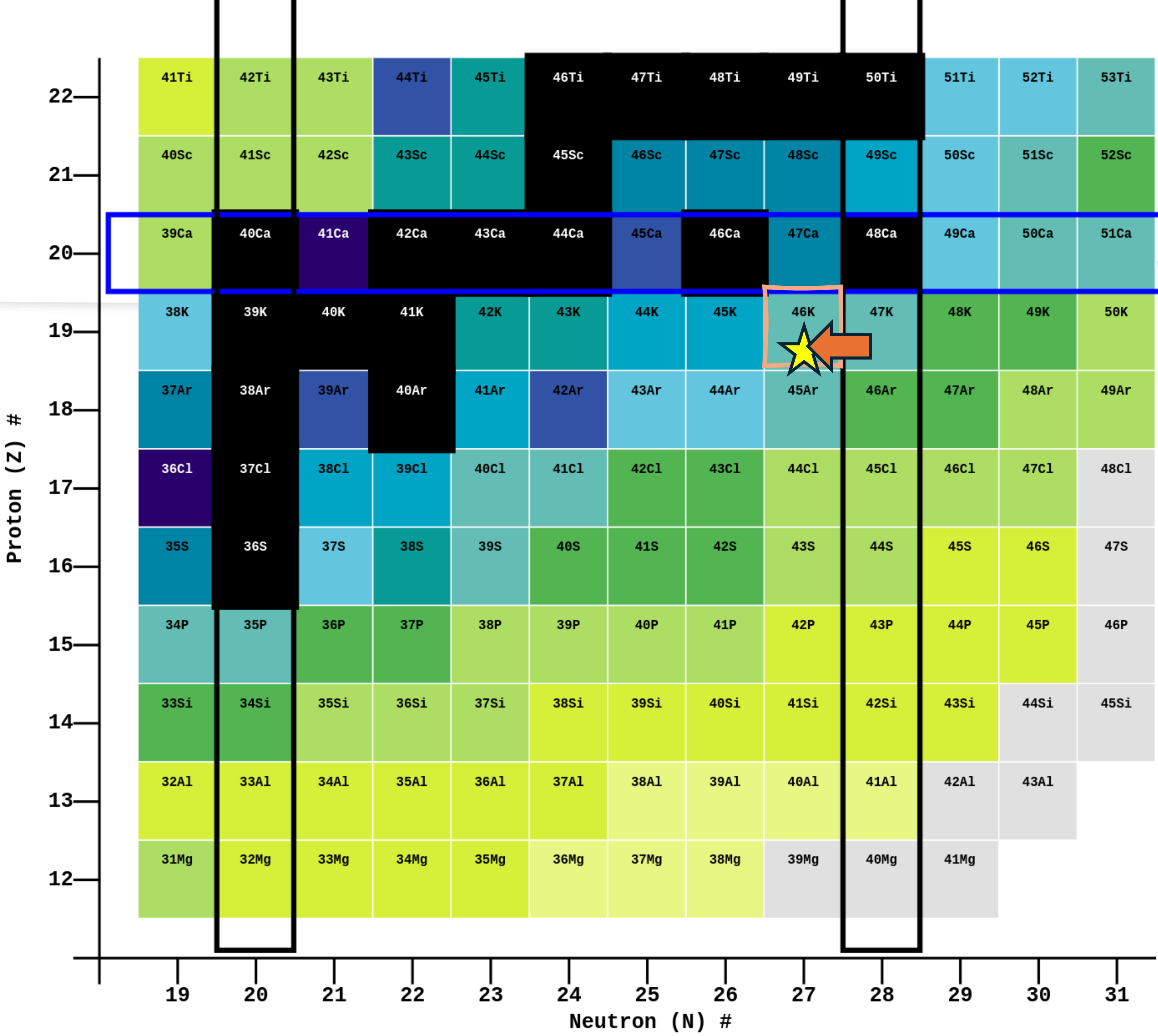


laboratoire commun CEA/DRF CNRS/IN2P3

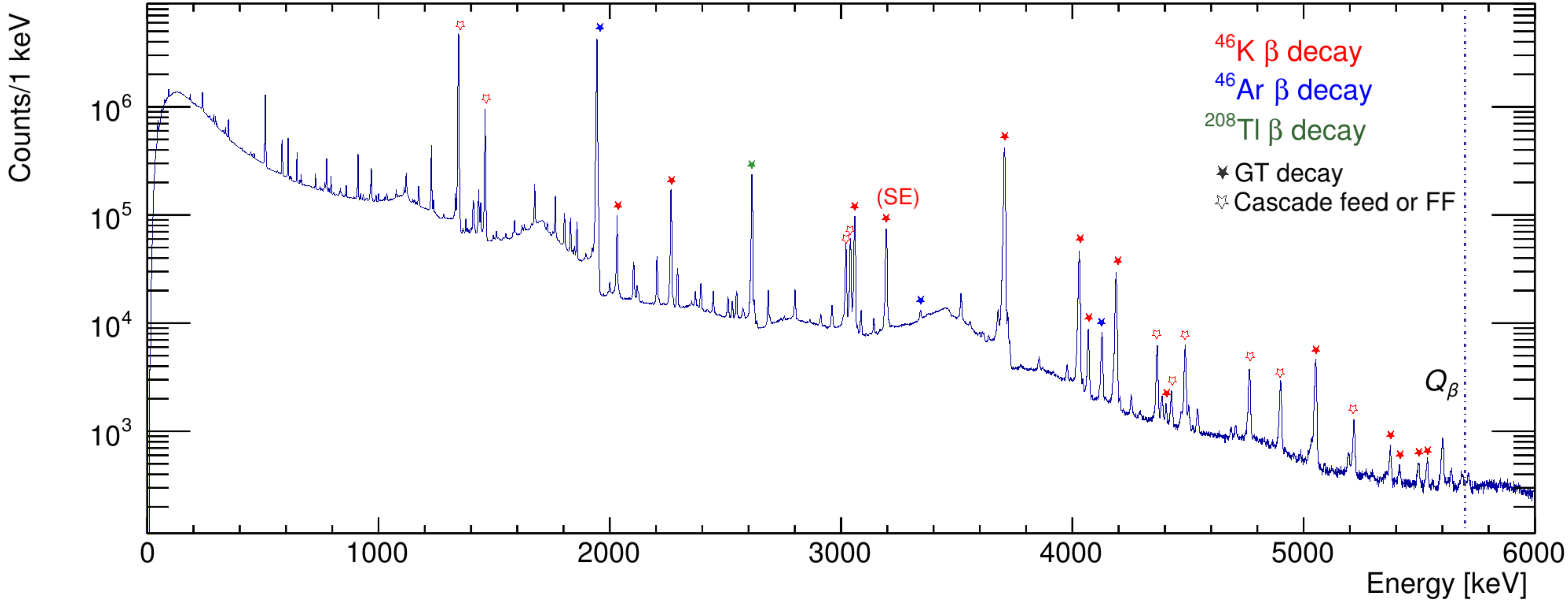
Overview



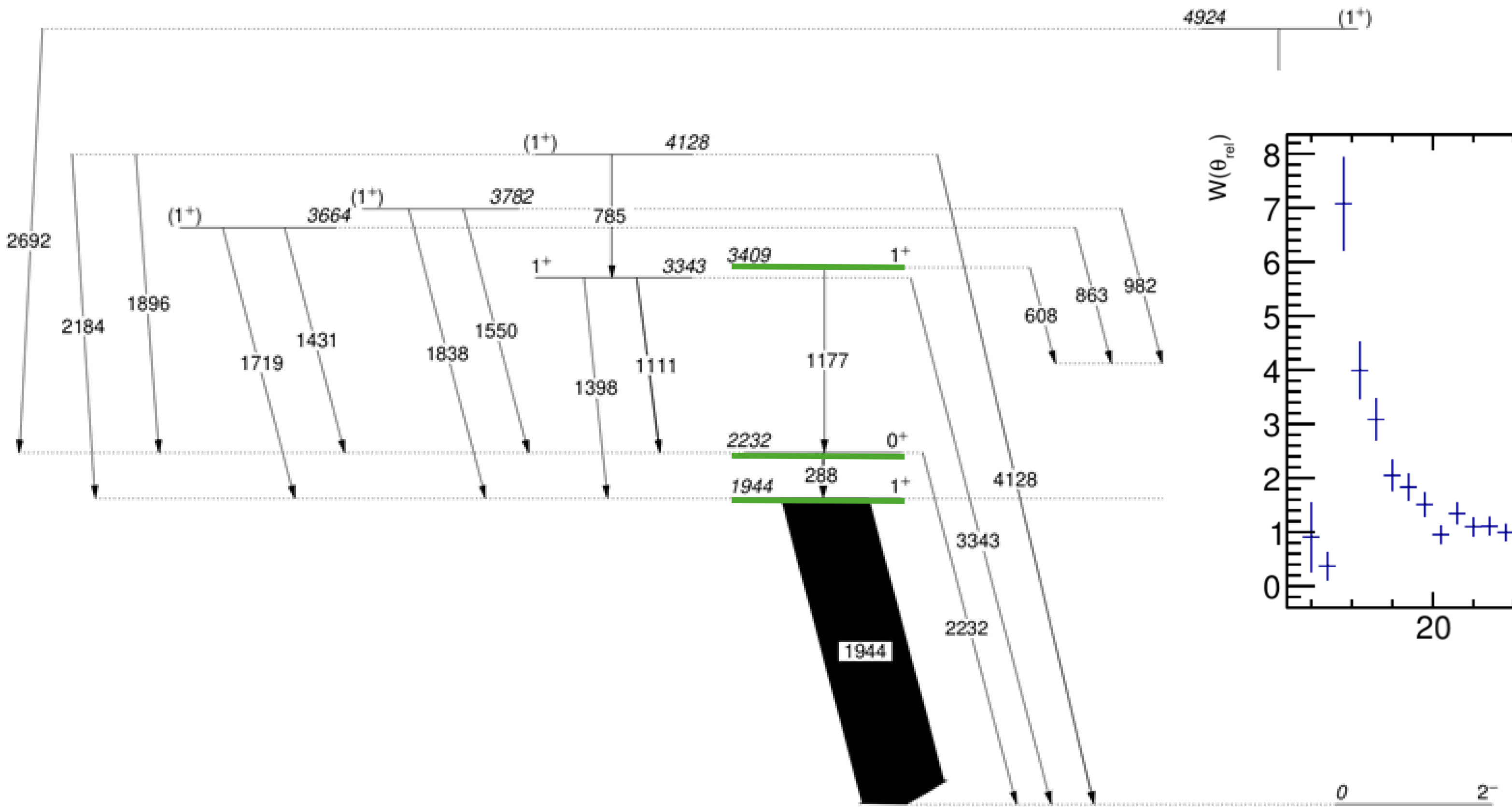
[4] C. J. Paxman et al., arXiv:2601.06242 (2026, preprint)

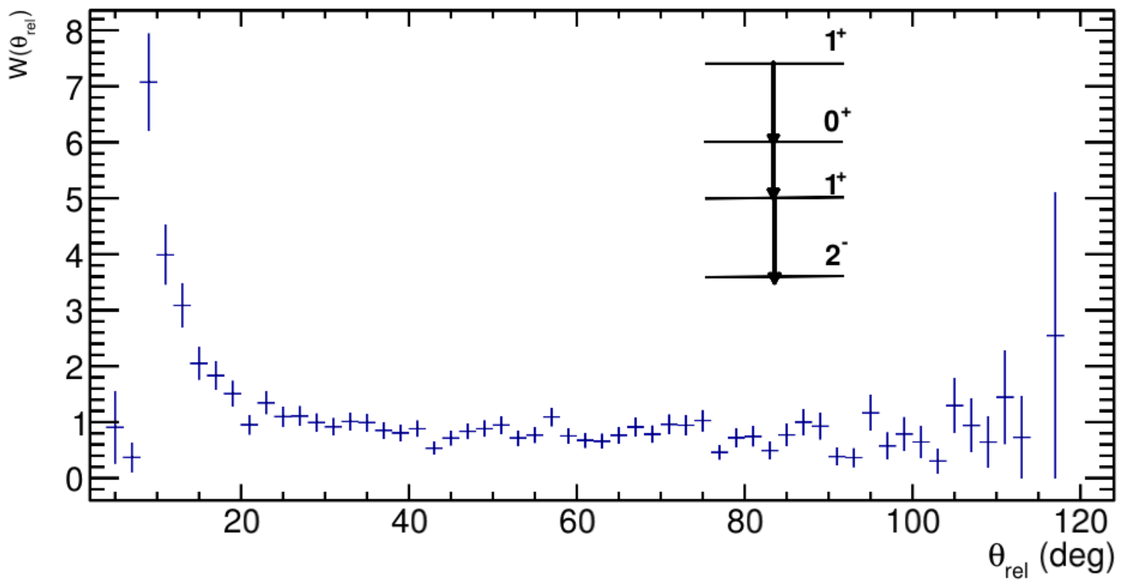


Full γ-ray spectrum



Angular correlations





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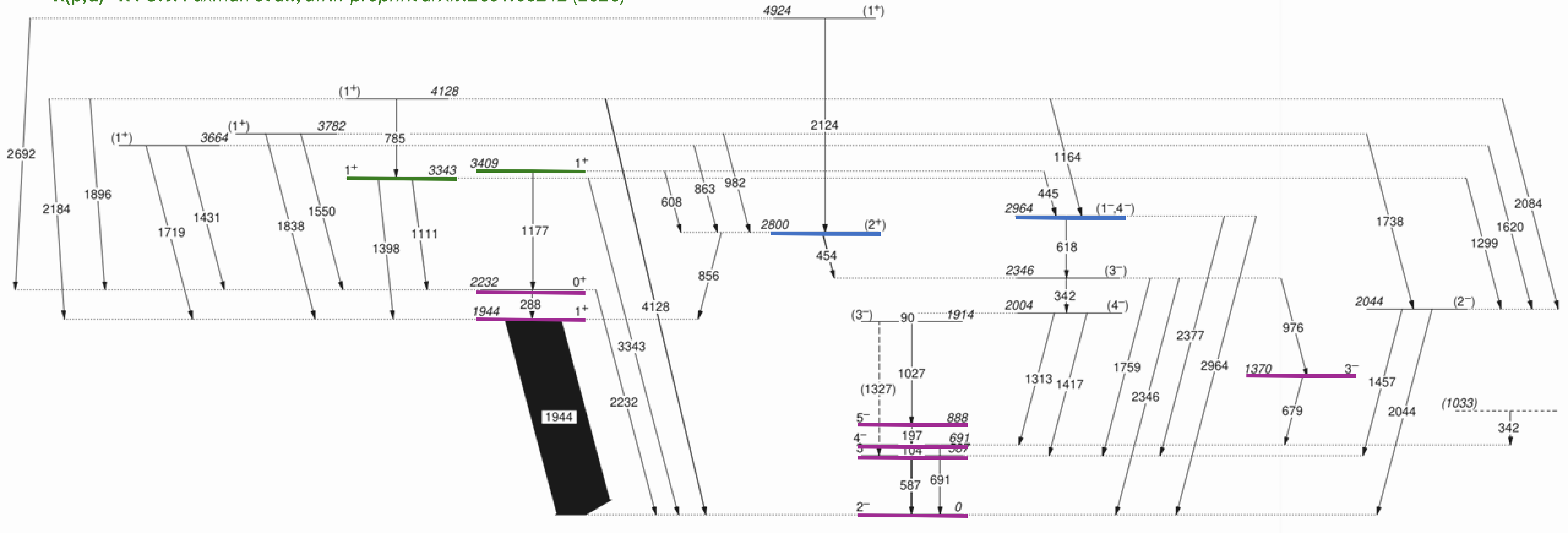
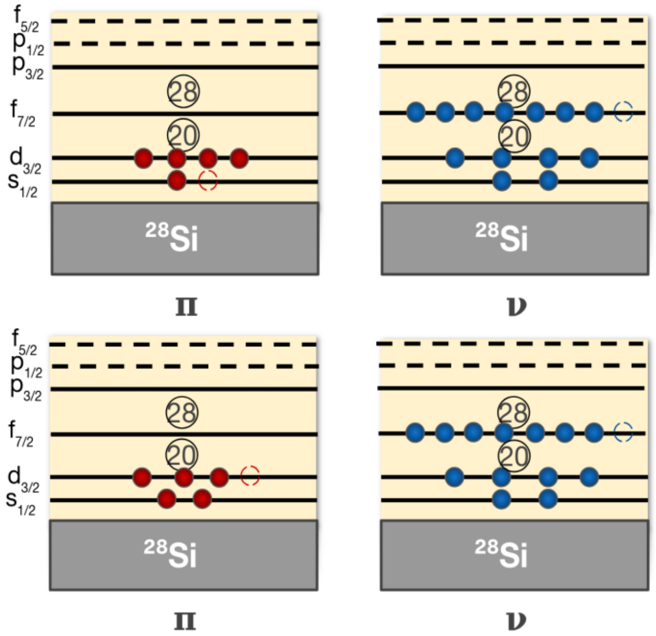
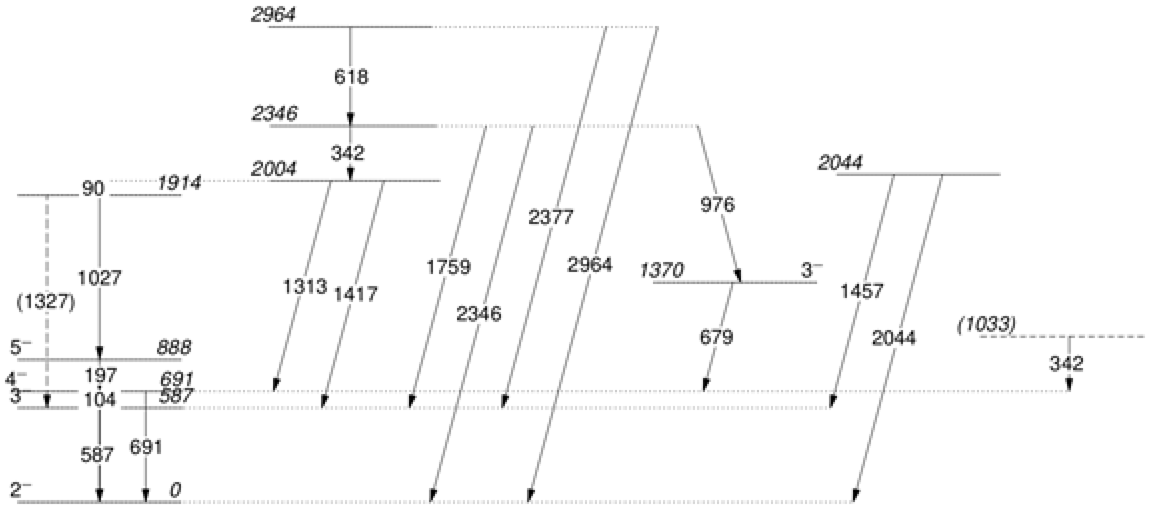


^{46}K – this work

^{46}K partial level scheme: negative parity states

- $(\pi d_{3/2})^{-1}\times(\nu f_{7/2})^{-1}$: $2^-,\ldots,5^-$
- $(\pi s_{1/2})^{-1}\times(\nu f_{7/2})^{-1}$: $3^-,4^-$
- $(\pi d_{3/2})^{-1}\times(\pi d_{3/2})^{-1}$: 0-,…,3-

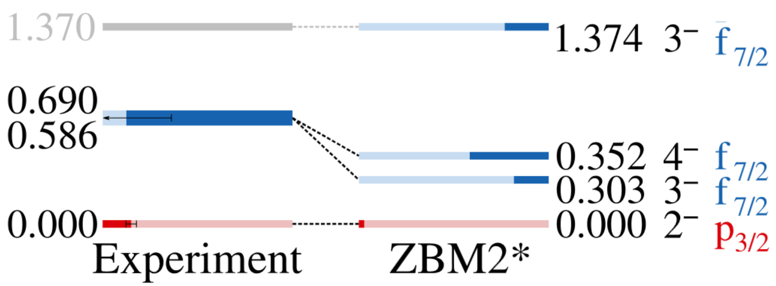




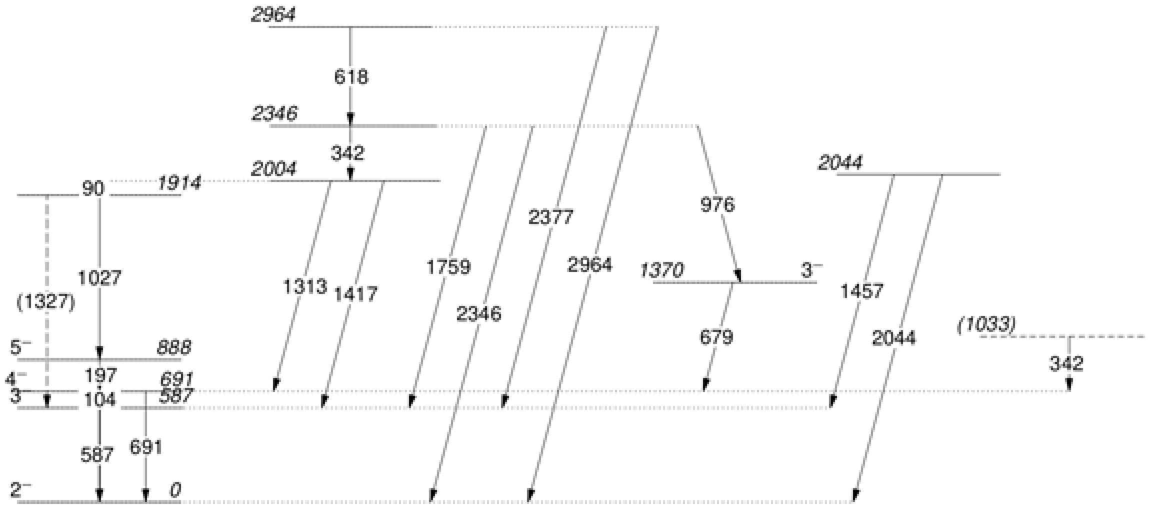
^{46}K – this work

^{46}K partial level scheme: negative parity states

- $(\pi d_{3/2})^{-1} \times (\nu f_{7/2})^{-1}$: $2^-,\ldots,5^-$
- $(\pi s_{1/2})^{-1} \times (\nu f_{7/2})^{-1}$: $3^-,4^-$
- $(\pi d_{3/2})^{-1} \times (\pi d_{3/2})^{-1}$: 0-,…,3-



C. J. Paxman *et al.*, *arXiv preprint arXiv:2601.06242* (2026) - Phys. Rev. C - **Accepted** 14 July, 2026



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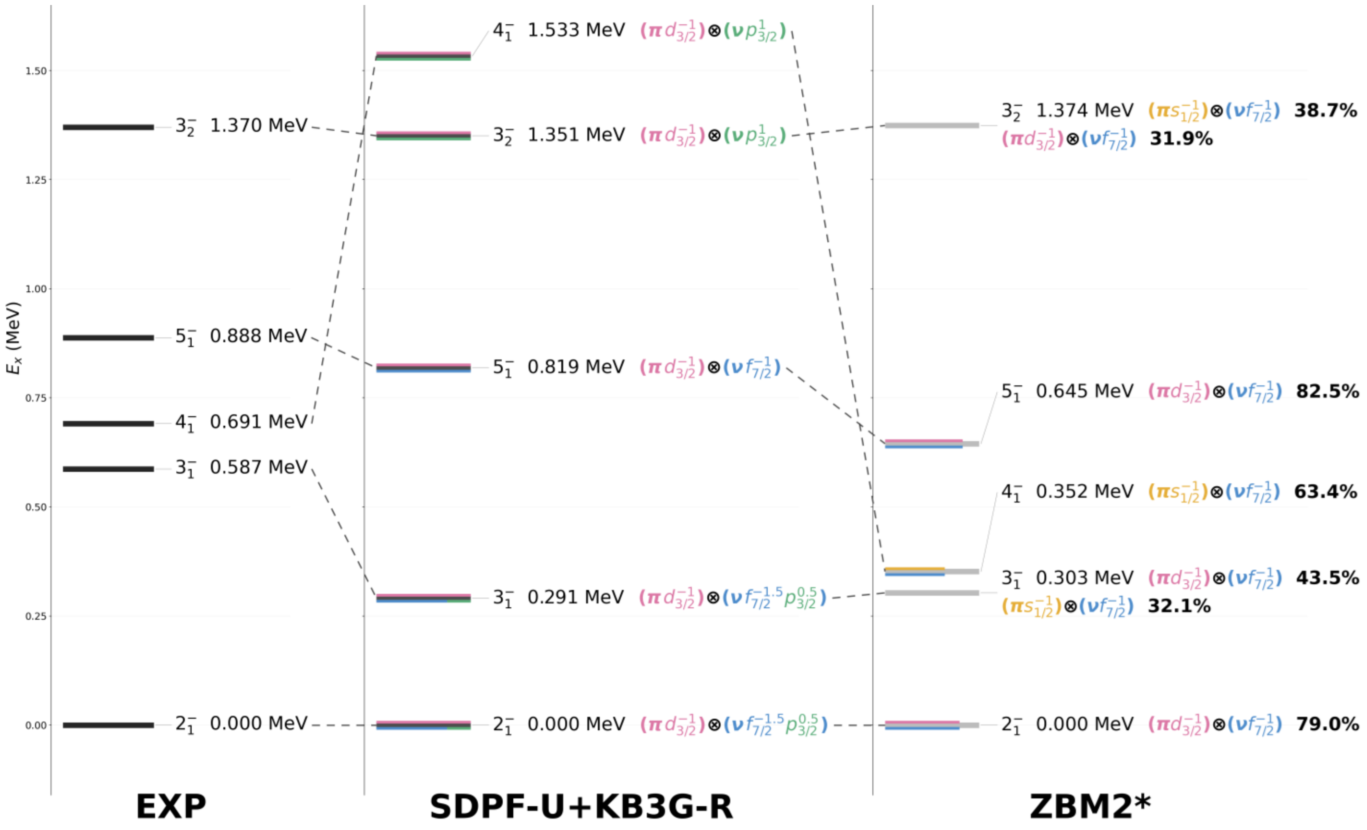
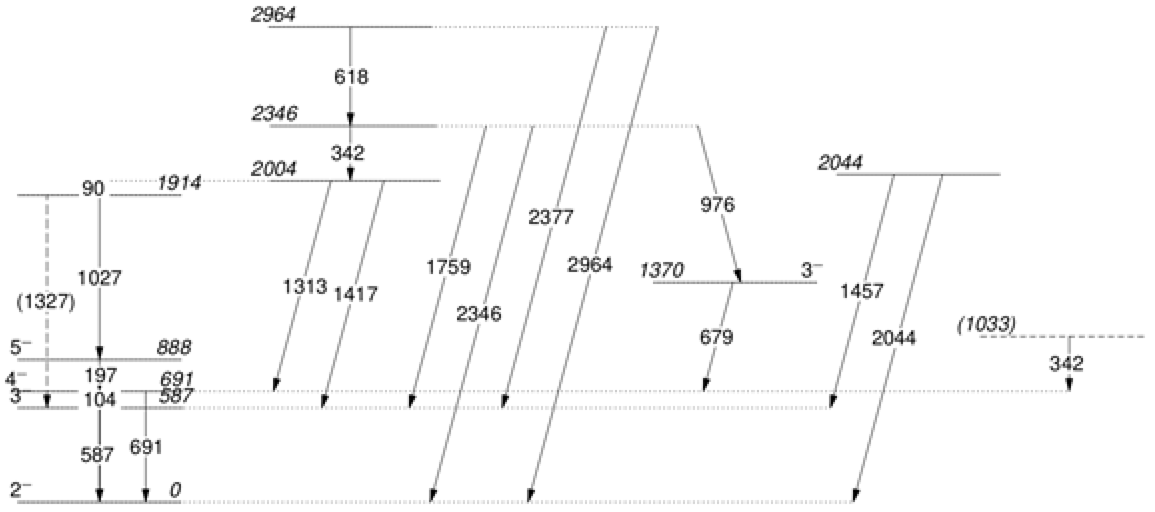
^{46}K partial level scheme: negative parity states





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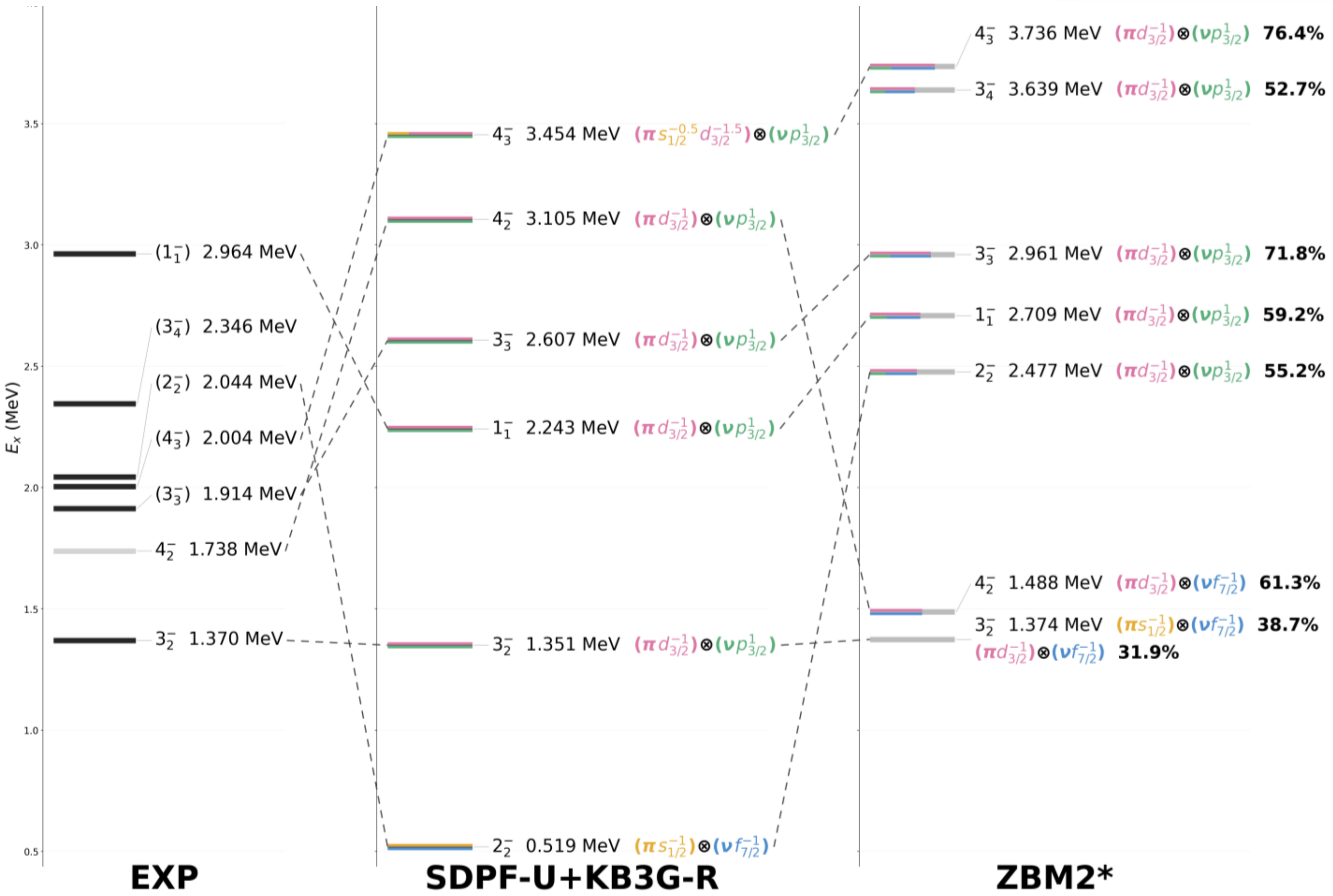
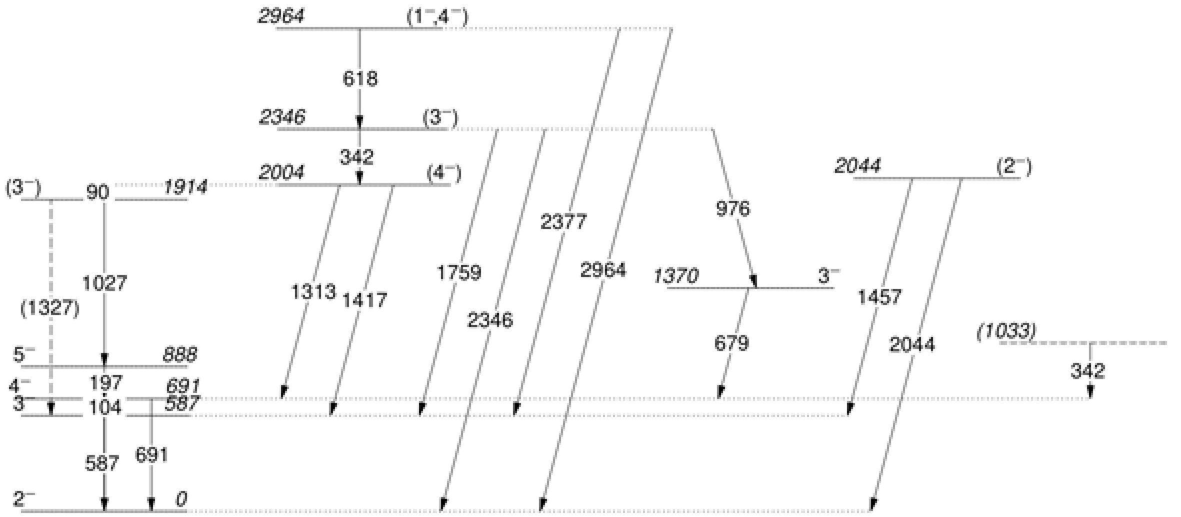
^{46}K partial level scheme: negative parity states





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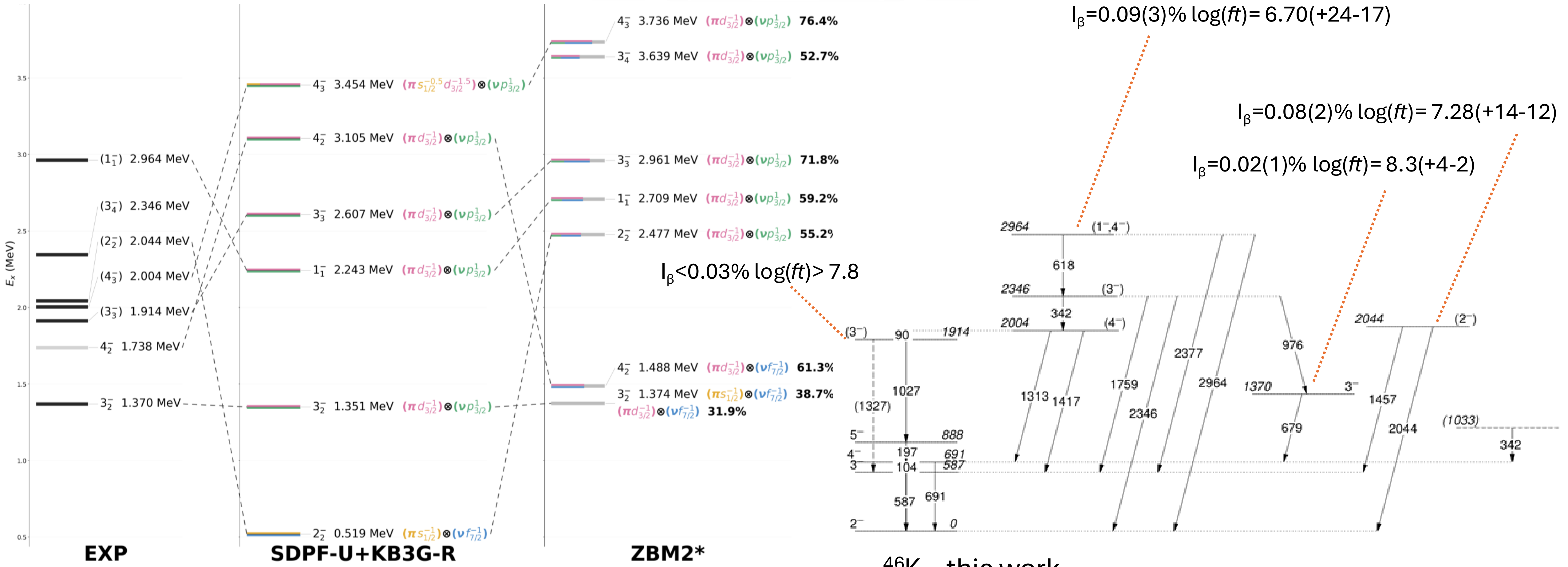
^{46}K partial level scheme: negative parity states



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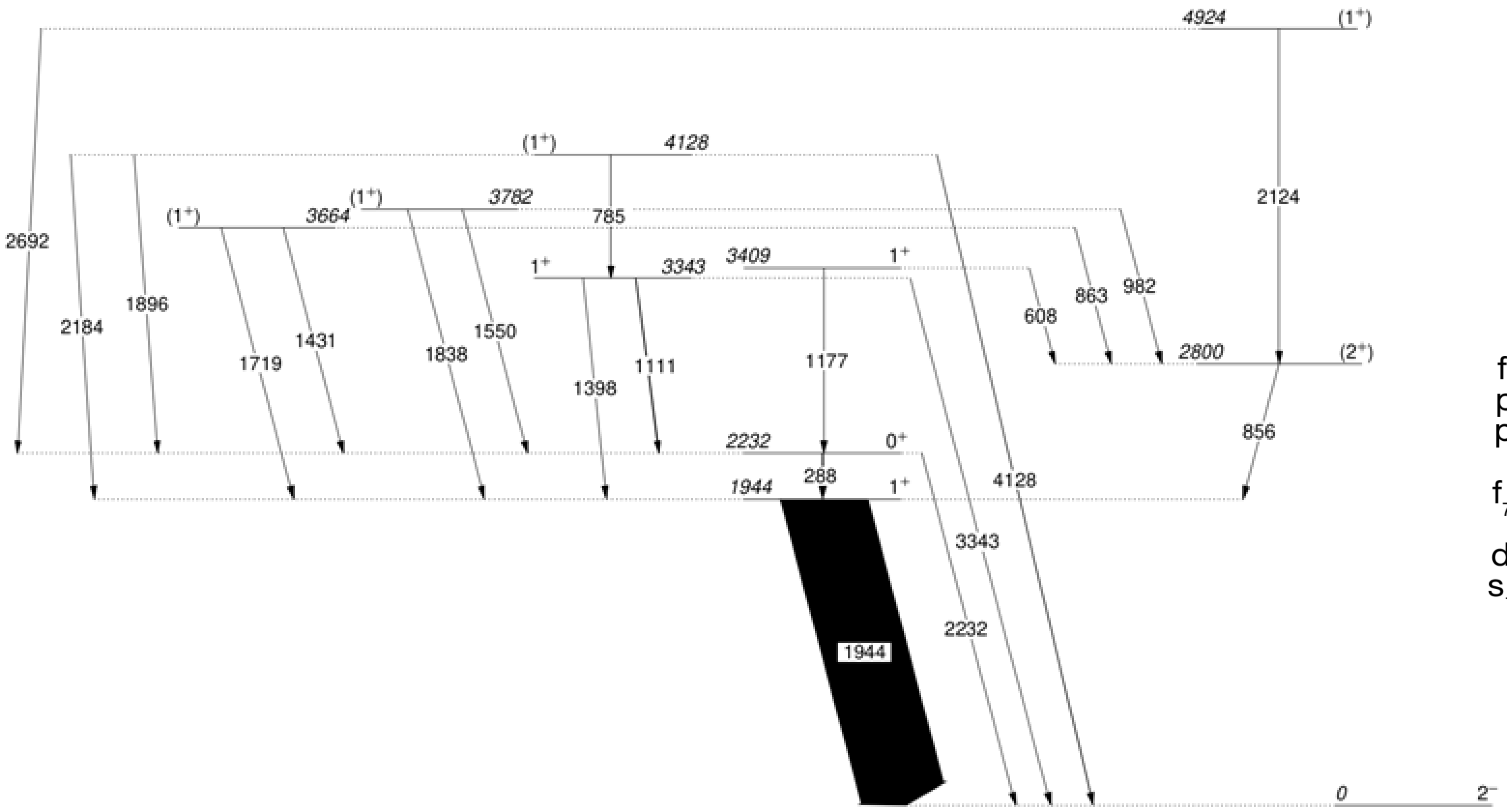
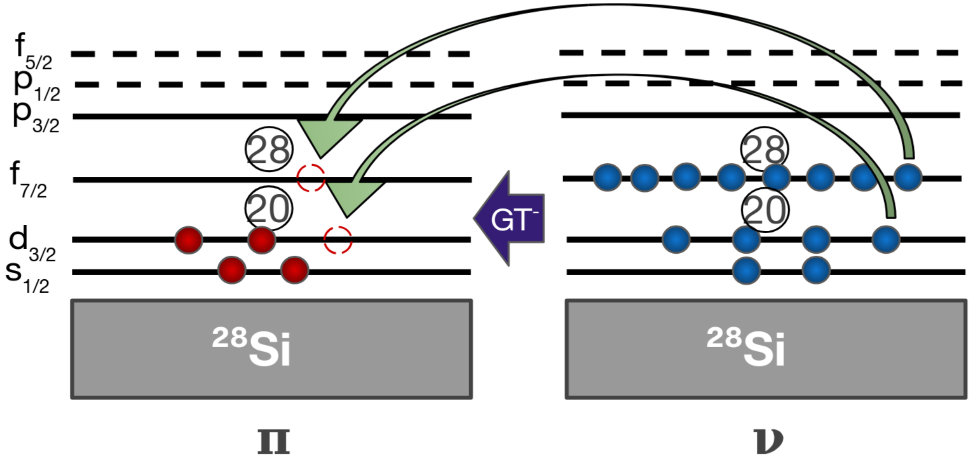
^{46}K partial level scheme: positive parity states



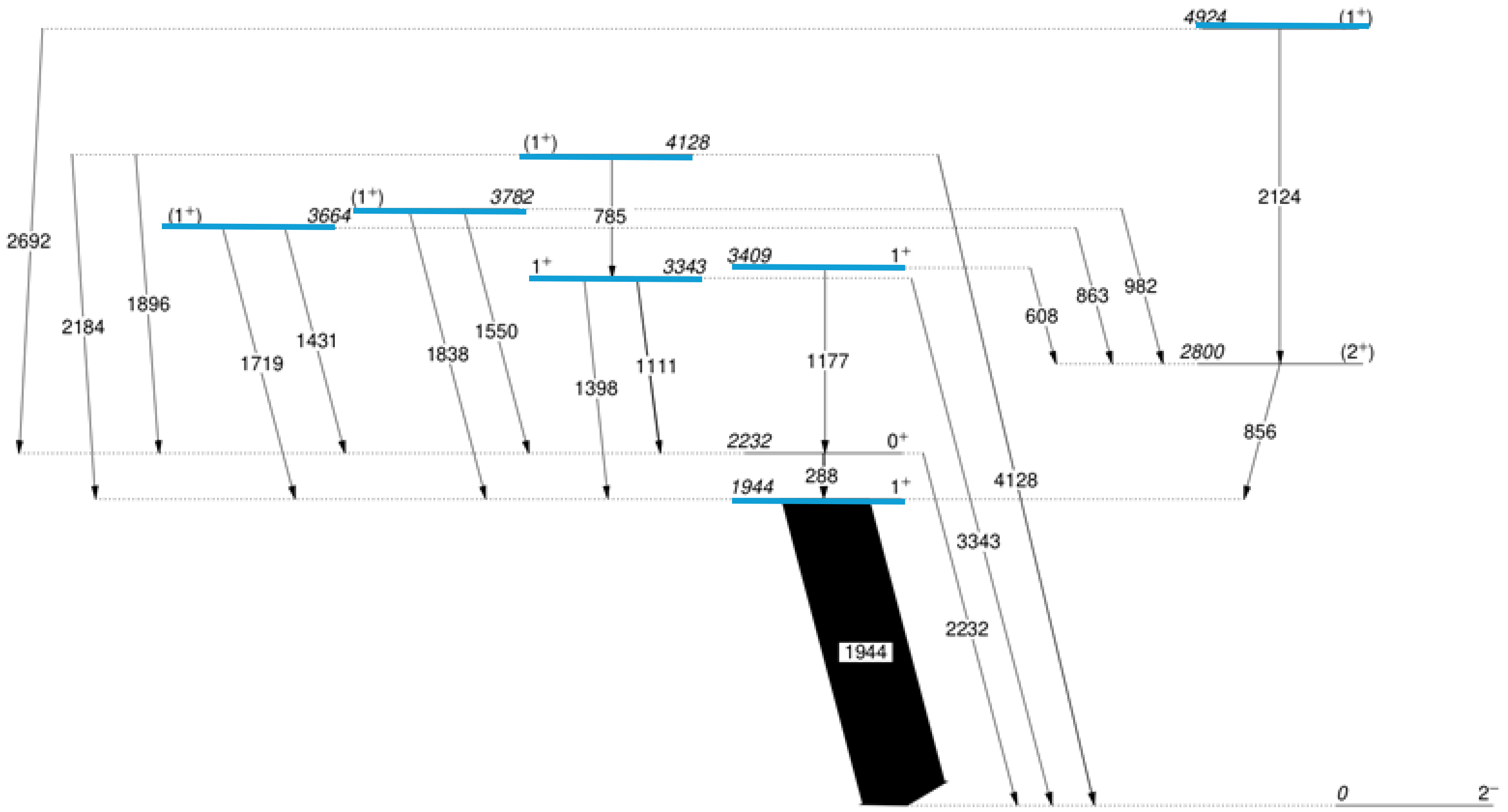
^{46}K – this work

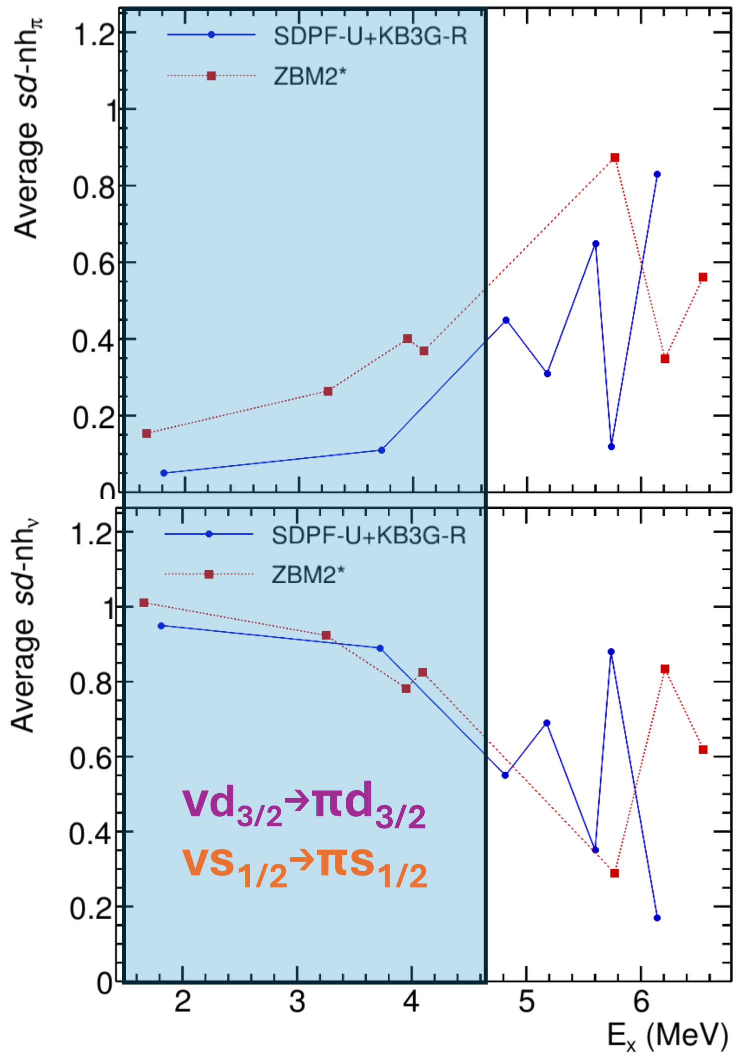
$$\hat{O}^{\pm}_{\mathrm{GT}} = \sum_k \boldsymbol{\sigma}(k)\, \tau_{\pm}(k)$$

- $(\pi d_{3/2})^{-1} \times (\nu d_{3/2})^{-1}$: $0^+,\ldots,3^+$
- $(\pi s_{1/2})^{-1} \times (\nu s_{1/2})^{-1}$: $0^+,1^+$
- $(\pi f_{7/2})^{-1} \times (\nu f_{7/2})^{-1}$: $0^+,\ldots,7^+$



^{46}K partial level scheme: positive parity states





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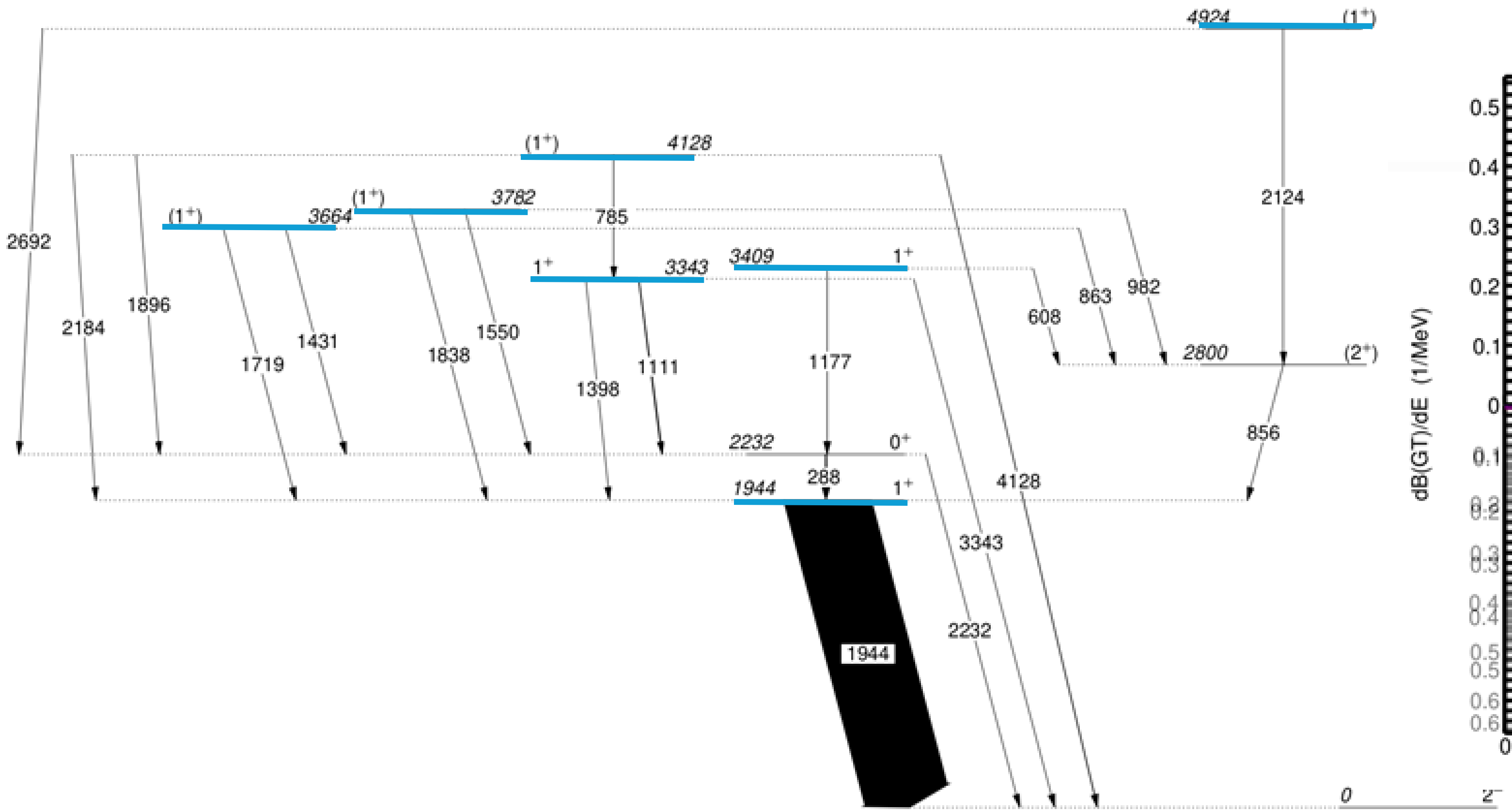
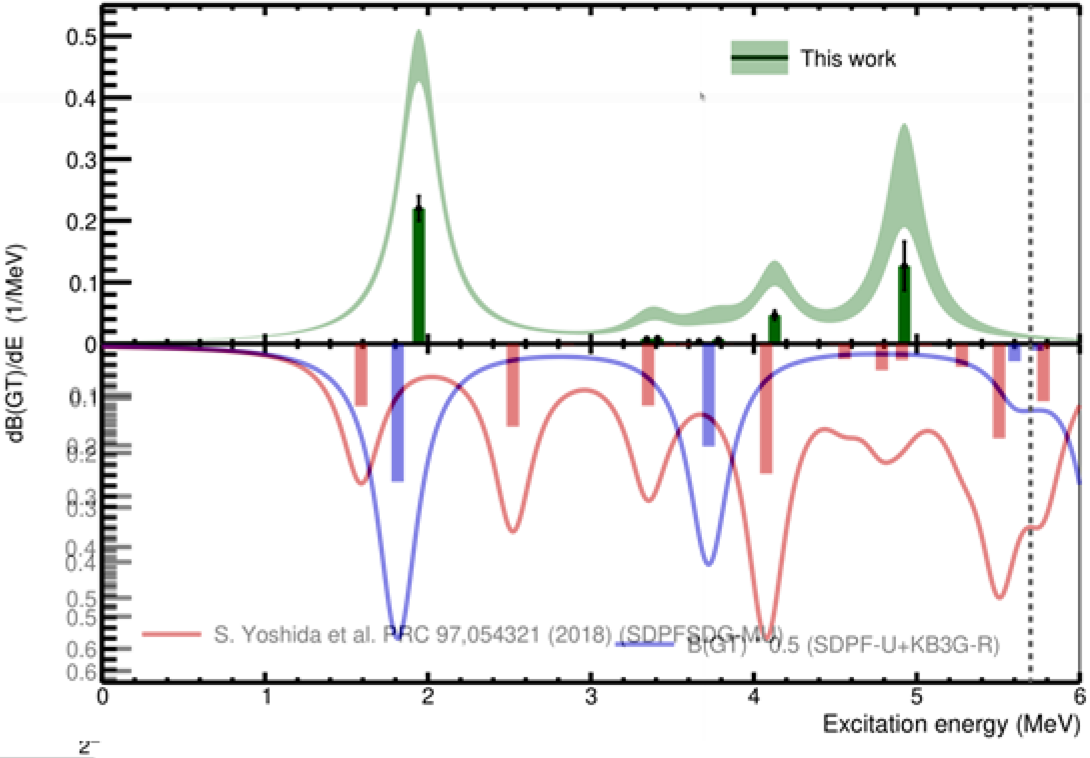
Gamow-Teller strength





^{46}K – this work

odd-A K isotopes

[2] J. Papuga et al., PRL 110, 172503 (2013)