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A new tool for the search of nuclides with properties suitable for nuclear solid state physics based on the Evaluated Nuclear Structure Data Files

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ABSTRACT

A software tool for the displaying of nuclear decay schemes, the calculation of angular γ emission anisotropies, and the automated search for appropriate decay cascade properties based on the Evaluated Nuclear Structure Data Files (ENSDF) was created and published for free download. After a short introduction of this tool, candidate nuclides for time differential perturbed γ–γ angular correlation (TDPAC) measurements are presented. These candidates are grouped according to their parent nuclides' half-life periods in groups for online, on-site, and off-site measurements. For all candidates angular correlation coefficients (also called *anisotropy values*) were computed and are shown alongside magnetic and quadrupole moments from the ENSDF database and other sources.

An extension of the presented software for the search of nuclides for Mössbauer spectroscopy, Nuclear Resonant Scattering, and other methods is easily possible.

1. Introduction

In the last decades methods belonging to nuclear solid state physics have significantly contributed to the understanding of condensed matter at the otherwise hardly accessible atomic scale. While e.g. the emission channeling method [1] allows for direct determination of impurity locations in the unit cells, it is possible to investigate magnetic fields and electric field gradients at probe nuclei applying Mössbauer [2] or time differential perturbed γ–γ angular correlation (TDPAC) spectroscopy [3], among others.

In these specific cases various different radioactive isotopes are applied as probes. This has rendered rare isotope separators, such as ISOLDE [4], invaluable tools where hundreds of radioactive isotopes are available for scientific experiments—many of them not available through neutron irradiation at conventional nuclear reactors. For certain studies the probe atoms should belong to specific chemical elements of interest or at least chemically similar ones. Additionally, each of these methods requires the used radioactive probe to have distinct properties. These are e.g. a particular decay type and Q value, an appropriate lifetime of the parent nuclide, suitable or electron and γ energies among others.

TDPAC may be considered the most ambitious among all of these methods, since it requires not only a γ–γ cascade, but also sufficiently large angular correlation coefficients and an appropriate lifetime of the intermediate level in conjunction with convenient magnetic dipole and/or electric quadrupole moments of this level such that these moments' interactions with the surrounding crystal fields yield interaction frequencies adequate for the spectrometers used.

Especially for the TDPAC method there has been a tremendous revival during the last years following the first successful proof-of-concept [5,6] and high-capacity [7] implementations of fully digital setups, which lead to an unprecedented versatility, thus opening exciting perspectives for this method at online isotope separators as well as research reactors. In this respect it is useful to have a close look at the isotopes used so far for TDPAC spectroscopy and examine to which extent the list of isotopes may be extended in the future considering that the better performance of modern spectrometers allows for improved on-site as well as on-line investigations now. This is especially important in order to increase the number of chemical elements that might be investigated.

The task of identifying useful isotopes for TDPAC experiments is solvable due to the availability of comprehensive high quality nuclear structure databases like ENSDF [8] and XUNDL [9]. The machine

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readable form, in which data is accessible by means of these databases, makes it possible to automate large parts of the search tasks thereby reducing the risk of missing promising candidates.

Existing universal tools for the search in these databases like e.g. *NuDat* [10] and the *Live Chart of Nuclides* [11] allow for the search of nuclides according to nuclear properties like Q values, γ energy, or half-life. However up to now, no solution existed for the search of nuclear decay cascades with properties suitable for TDPAC measurements.

In the following section we will introduce a software tool which was developed for the search and examination of decay cascades based on ENSDF data and which is published alongside this article. Additionally edited results of three relevant search runs grouped by the parent nuclides' half-life are presented including the most important parameters for TDPAC measurements.

2. Angular correlation coefficients

The calculation of angular correlation coefficients $A_{k_1k_2}$ is based on the orientation coefficients

$$B_\Lambda(\gamma_1) = [F_\Lambda(1,1,I_i,I) - 2\delta(\gamma_1)F_\Lambda(1,2,I_i,I) + \delta^2(\gamma_1)F_\Lambda(2,2,I_i,I)]\cdot[1+\delta^2(\gamma_1)]^{-1} \quad (1)$$

and the directional distribution coefficients

$$A_\Lambda(\gamma_2) = [F_\Lambda(1,1,I_f,I) + 2\delta(\gamma_2)F_\Lambda(1,2,I_f,I) + \delta^2(\gamma_2)F_\Lambda(2,2,I_f,I)]\cdot[1+\delta^2(\gamma_2)]^{-1} \quad (2)$$

as defined by Krane and Steffen (compare Eqs. (10) and (11) in Ref. [12]).

In these equations I is the intermediate level's spin while I_i and I_f are the initial and final levels' spins, respectively. $\delta(\gamma_1)$ is the mixing ratio of the first emitted γ photon originating from the transition $I_i \longrightarrow I$ whereas $\delta(\gamma_2)$ is the mixing ratio of the second γ photon from the transition $I \longrightarrow I_f$.

The F-coefficients are defined by Frauenfelder and Steffen (compare Eq. (96) in Ref. [3]) as

$$F(L,L',I',I) = [(2L+1)(2L'+1)(2I+1)(2k+1)]^{1/2} \cdot (-1)^{I'+I-1}\begin{pmatrix} L & L' & k \\ 1 & -1 & 0 \end{pmatrix}\begin{Bmatrix} L & L' & k \\ I & I & I' \end{Bmatrix} \quad (3)$$

including the Wigner 3-j and 6-j symbols.

Using Eqs. (1) and (2), the angular correlation coefficients $A_{k_1k_2}$ can be calculated:

$$A_{k_1k_2} = B_{k_1}(\gamma_1)\cdot A_{k_2}(\gamma_2) \quad (4)$$

Unfortunately, $A_{k_1k_2}$ is usually defined with $k_1 = k_2$ in literature (compare Eq. (98) in Ref. [3] or Eq. (14.31) in Ref. [13]). This simplification is based on the disappearance of the interference terms in unperturbed cases. Since this precondition is not fulfilled under the influence of quadrupole interactions the mixed terms are however relevant for solid state physics applications of TDPAC and are in fact often used in literature although not explicitly defined (e.g. Ref. [3], p. 1127). Our software uses mixing ratio and spin values from the ENSDF in order to calculate $B_\Lambda(\gamma_1)$ and $A_\Lambda(\gamma_2)$ for each possible decay cascade. It then uses these results to determine A_{22}, A_{24}, A_{42}, and A_{44} according to Eq. (4).

3. Software

A software tool named *Nuclei* was created for the systematic search of candidate nuclides as well as helping in setting up TDPAC spectrometers during measurements. This software is licensed under the GPL and freely available via SourceForge [14,15] in versions for Linux, MacOS X, and Windows.

It automatically downloads the most recent ENSDF database during its first startup. The downloaded files are then parsed to make relevant data accessible for automated processing.

Fig. 1 shows the main window of the user interface of *Nuclei*. In the left part a list of all daughter nuclides found in the ENSDF database is shown. After unfolding the sub-branch of a daughter nuclide all available parent nuclides and decays become visible. If one of these decays is selected, the appropriate decay scheme is shown in the program window's central part.

In this decay schemes two γ transitions can be selected by mouse clicks. Detailed data for selected transitions and the intermediate level is shown in the windows' right part. As soon as a decay cascade (i.e. two γ transitions with a common energy level) is selected, angular correlation coefficients are calculated according to Section 2 using libAkk [15] and shown at the bottom of the central part. libAkk computes the 3-j and 6-j symbols from Eq. (3) using implementations from the GNU Scientific Library [16]. Uncertainties from the ENSDF are propagated and shown as uncertainty in units of the least significant figure. Since possible correlations of the parameters' uncertainties are neglected, the resulting uncertainties can be considered as worst case estimates. In cases where no uncertainty value is available or the given value is “approximate” in the ENSDF results are prefixed by a tilde (~). If only upper or lower limits are given for mixing ratios the values are considered unknown for the calculation of angular correlation coefficients.

Because experimental values for A_λ and B_λ are usually not contained in the ENSDF records, these values are calculated using δ values from the ENSDF and Eqs. (1) and (2).

The tool bar contains buttons which allow for the export of decay schemes as PDF or SVG files including the highlighted decay path for easy utilization in publications. Additional buttons allow opening and closing both side panels containing decay selection as well as decay information. Four buttons are usable to adjust the zoom levels of decay schemes and photo peaks.

Fig. 2 shows the search dialog available by clicking the tool button showing binoculars in the main window. It allows defining limits for the parent nuclide's as well as intermediate level's half-life, magnetic dipole and/or electric quadrupole moments, angular correlation coefficients, γ intensities and the mass range of the search. For moments and angular correlation coefficients it is also selectable if checks should be skipped for entries with unknown values i.e. if entries containing unknown values should be added to the search results as if the unknown value matched the criteria or if they should be ignored. For these properties it is additionally selectable if all criteria must match or if it is sufficient if at least one matches. The results of a search run are afterwards shown instead of the nuclide list in the main window's left part.

For new TDPAC nuclides the interpretation of energy spectra can be rather cumbersome and – much worse during a measurement – time consuming. *Nuclei* is able to show photo peak spectra for each selected decay in order to simplify this work. Fig. 3 shows the spectrum for ^{169}Yb as an example. Compton scattering as well as pair production is ignored for these spectra to avoid detector specific behavior and keep it simple as the shown photo peaks are usually sufficient for the tuning of TDPAC setups.

If a γ cascade was selected the start and stop components are highlighted green and red respectively in the photo peak view. Other γ contributions are plotted stacked onto the selected transitions in order to provide an idea about intensity relations.

The energy resolution as well as linear or logarithmic plot styles can be changed in the tool bar. Additionally it is possible to change the font properties of decay schemes as well as the matching tolerance for decay data and adopted levels: As ENSDF data consists of results from many different experiments, data sets are not always perfectly consistent. Especially information concerning nuclear moments is often only available from the adopted

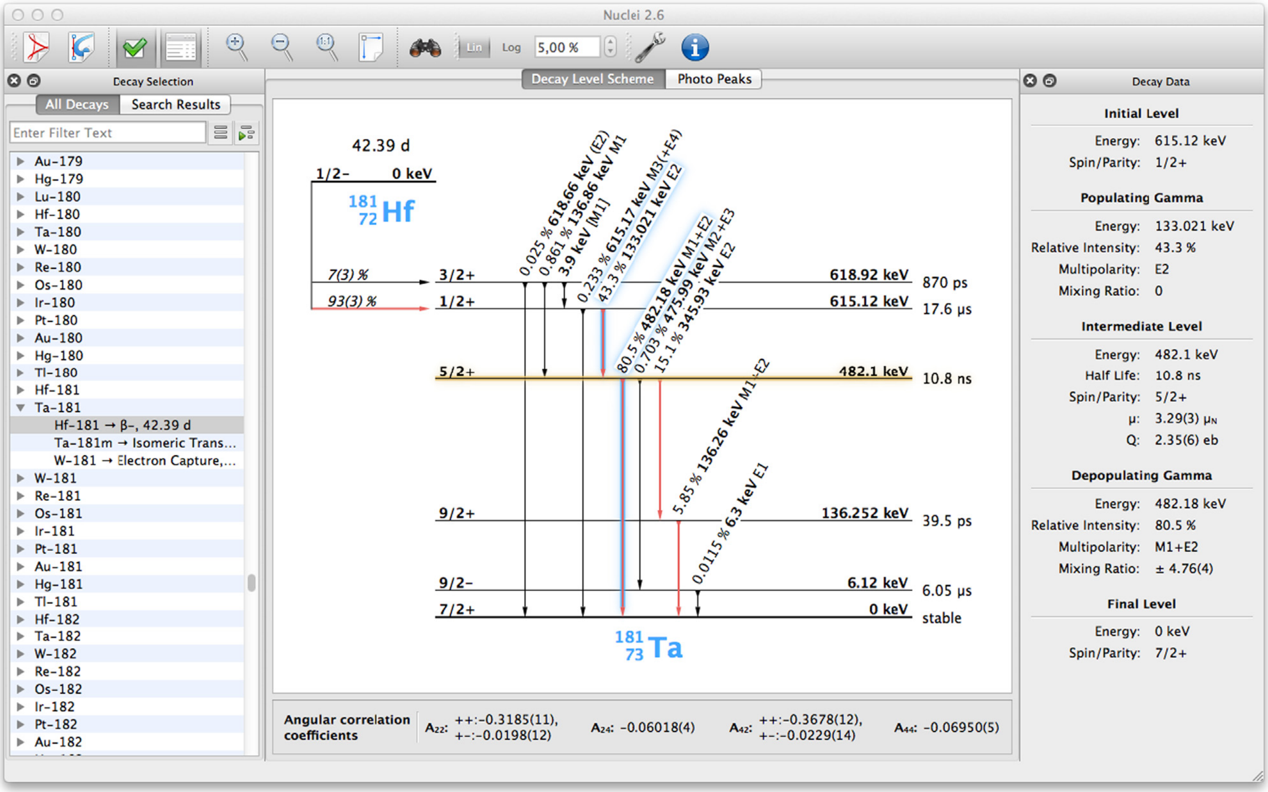

Fig. 1. Screenshot of the decay level scheme view of *Nuclei*.

levels data sets and not from the decay data sets. To yield as complete output as possible an automatic matching of these data sets was implemented. By default deviations of up to 0.5% from the γ energies and 4% from the level energies in the decay data set are tolerated and the closest matches are chosen. The algorithm evaluates the XREF records as described in the ENSDF manual [17] in case of energy level matching. Therefore the maximal tolerance can be set higher in case of level matching compared to γ matching since the XREF mechanism provides additional protection against matching of wrong pairs. Unfortunately XREF records alone are not sufficient and must be complemented by a search for the closest level because they do not provide exact energy matching information in most cases.

4. Candidates

In this section we present results of the search for TDPAC candidate nuclides using *Nuclei* as described in Section 3.

4.1. Categories

The search results are grouped according to the parent nuclides' half-life periods because this property makes a big difference concerning feasibility of measurements using different setups. There are three groups:

Off-site contains parent nuclides with a half-life longer than 24 h. These nuclides can reasonably be produced at one site (e.g. ISOLDE) and used for measurements at another site.

On-site consists of parent nuclides with a half-life between 10 min and 24 h. These nuclides can be transported between production and measurement but under normal conditions it is not feasible to transport them across long distances.

Online contains parent nuclides with a half-life shorter than 10 min. For these nuclides measurements should take place in the same chamber as implantation or creation as there would hardly be enough time for a transfer between implantation chamber and measurement setup. Special combined TDPAC and implantation setups are necessary for this kind of measurements.

4.2. Parameters

The candidate tables contain the following columns:

4.2.1. Decay parameters

Daughter: The daughter nuclides
Parent: The parent nuclides
Half-Life: The parent nuclide's half-life

4.2.2. Intermediate level parameters

Energy: The energy of the intermediate level of each decay cascade in keV
Half-Life: The intermediate level's half-life
Spin–Parity: The intermediate level's spin and parity
Q: The intermediate level's electric quadrupole moment (in electron-barns)
μ: The intermediate level's magnetic dipole moment (in units of the nuclear magneton μ_N)

4.2.3. Cascade parameters

Initial Energy: Energy of the cascade's initial level in keV
Final Energy: Energy of the cascade's final level in keV

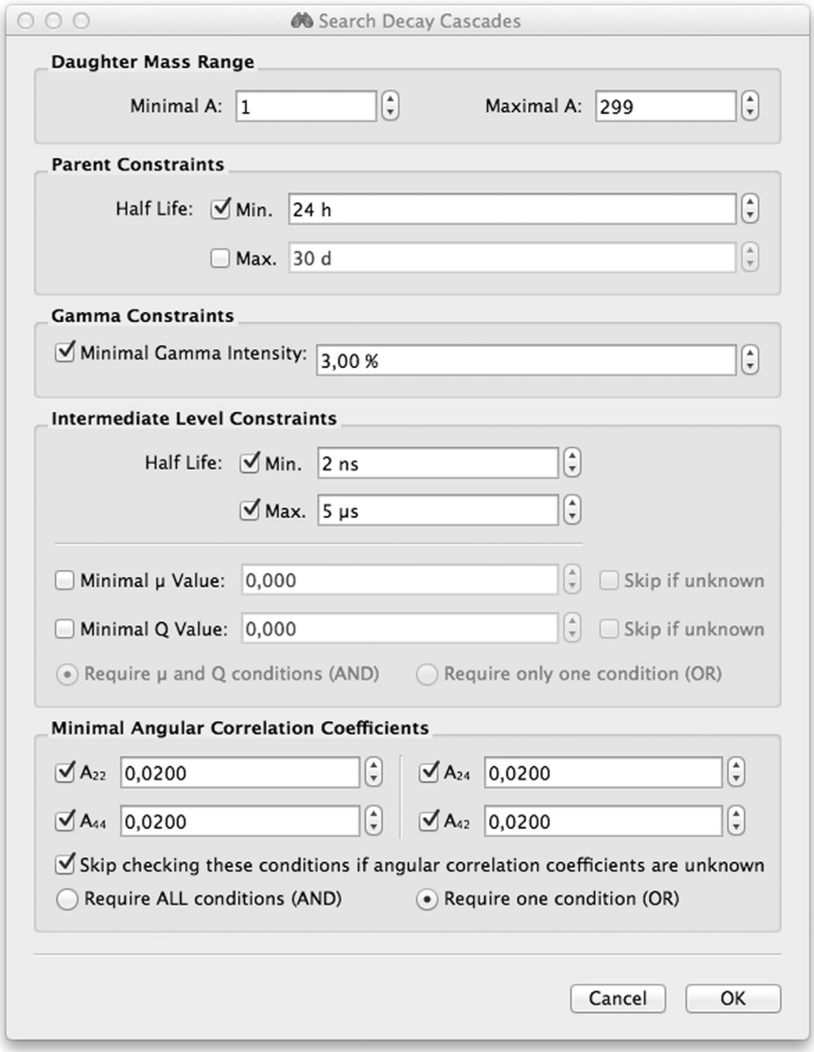

Fig. 2. Screenshot of the search dialog of *Nuclei*.

4.2.4. Angular correlation coefficients

Parameter sign combination: In cases where one or both mixing ratios of the populating and depopulating γ transitions are undefined, angular correlation coefficients for all possible combinations were computed. This field contains the combination of the signs used to compute the values in each row. The upper sign is the one which was used for the populating γ's mixing ratio while the lower sign was used for the depopulating γ's mixing ratio. If one of the signs is defined in the database only the other one was varied. In cases where both signs are defined this field remains empty.

$\boldsymbol{A}_{k_1k_2}$: These four fields contain the computed angular correlation coefficients.

4.3. Constraints

Search constraints had to be defined for the candidate table. We tried to achieve a good compromise between completeness and conciseness by choosing the following values. For each parameter the correspondent values of the most commonly used TDPAC daughter nuclides – ^{111}Cd and ^{181}Ta – are specified as an example.

For all groups the *intermediate half-life* was restricted to the range between 2 ns and 5 μs. Half-life values below the lower bound make measurements difficult because the difference between the time resolution limit of PAC setups and the intermediate state's life-time limit would allow only for a small range of frequencies to be measurable. For half-life values above the upper bound the needed number of decays for a successful measurement grows disproportional as only a small number falls into a given interval of time. Therefore the signal to noise ratio becomes increasingly problematic. Intermediate half-life values of ^{111}Cd and ^{181}Ta are 84.5 ns and 10.8 ns, respectively.

Because *nuclear moments* are still missing for many states in the ENSDF no restrictions were defined for these properties. We hope that the results of this search might motivate the determination of additional nuclear moments. The information about moments in the ENSDF is distributed between the decay and adopted levels records. These two sources for information can only be matched by means of the level energies. As energies originate from different sources they are not perfectly equal in most cases. To make information from adopted levels records available Nuclei uses a fuzzy matching which was limited to a maximal energy difference of 4% (in conjunction with XREF filtering, compare Section 3) for the candidate

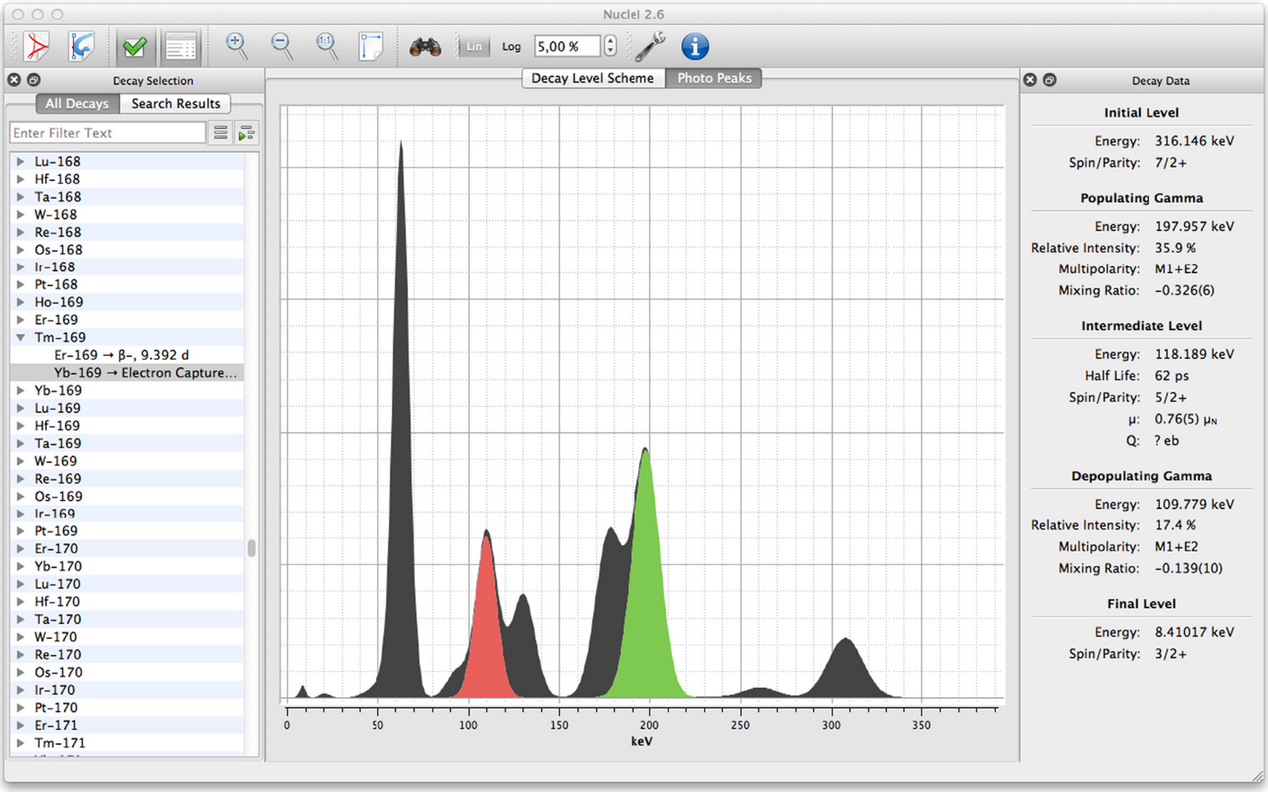

Fig. 3. Screenshot of the photo peak view of *Nuclei*. (For interpretation of the references to color in this figure caption, the reader is referred to the web version of this article.)

search. In Tables 1–3 unknown moments are flagged by question marks. The electric quadrupole moment values of the most commonly used TDPAC levels of ^{111}Cd and ^{181}Ta are 0.77 eb and 2.35 eb.[1] The corresponding magnetic moments are $-0.766\mu_N$ and $3.29\mu_N$. If available from Refs. [18–20], nuclear moments missing in the ENSDF data were added. These cases are highlighted in red and followed by a reference to the particular source.

Angular correlation coefficients filtering was activated and the chosen lower limit was 0.02 for the absolute value of all A_{k1k2} as defined in Eq. (4) and computed by *Nuclei*. A single absolute value above 0.02 was considered sufficient to add an entry to the search results. Off-site candidates were added to the table even in cases where A_{k1k2} values could not be calculated due to unknown parameters. For on-site and online candidates these cases were filtered. A_{22} values of the most common decay cascades of ^{111}Cd and ^{181}Ta are −0.178 and −0.319, respectively. For ^{181}Ta the table contains two A_{k1k2} values as one of the mixing ratios' signs is missing in the ENSDF although it is well known [21].

The γ *intensity* of all transitions involved in the decay cascades was limited to at least 3% for off-site candidates, 3% for on-site candidates, and 5% for online candidates as off-site and on-site measurements are generally less limited in terms of measurement time whereby online measurements need a better coincidence rate and thus more γ intensity to become feasible. Using the ENSDF normalization records intensities are calculated as the ratio of emitted γ photons to the number of decayed parent atoms, i.e. the absolute γ intensity.

4.4. Limitations

A search based on the ENSDF is of course limited by the integrity and quality of data available from this database. Fortunately the ENSDF is actively maintained and probably the best source for nuclear data available today. It is however advisable to verify results of particular interest.

The following tables are based on an ENSDF snapshot from 2013-03-13.

A few well-known but missing nuclear moments were added manually to the result table. These values are highlighted.

Nuclides that were already used for TDPAC measurements but are missing in the candidate tables most likely did not match the search criteria. The definition of these constraints is based on practical considerations concerning today's TDPAC setups.

5. Conclusion

Using the presented automated database driven approach, it becomes possible to create an exhaustive overview of candidate nuclides for TDPAC measurements based on the current knowledge of nuclear states and properties. This overview is very helpful in planning experiments as it allows for the selection of the optimal probe isotope as well as the optimization of the experimental setup.

Additionally the graphical user interface simplifies manual evaluation of search results and helps in finding cases where current databases might be incomplete and miss interesting candidates for TDPAC measurements. The combination of angular correlation coefficient calculations and the displaying of moments and intensities gives an immediate overview on all aspects of the feasibility of TDPAC measurements with each given decay cascade.

[1] The unit for electric quadrupole moments is electron-barn (eb). However the e is often omitted in literature.

Table 1

Off-site candidates (parent half-life: $t_{1/2} > 24$ h, minimal γ intensity: 3%, intermediate level's half-life: 2 ns $< t_{1/2} <$ 5 μs, lower angular correlation coefficient limit: 0.02 if known). The column ⋆ contains the sign combination of mixing ratios used for the computation of results contained in the particular row (compare Section 4.2.4). (For interpretation of the references to color in this table legend, the reader is referred to the web version of this article.)

Decay			Intermediate					Initial	Final	Angular correlation coefficients				
Daughter	Parent	Half-Life	Energy (keV)	Half-Life	Spin/Parity	Q (eb)	μ (μ_N)	Energy (keV)	Energy (keV)	⋆	A_{22}	A_{24}	A_{42}	A_{44}
^{44}Sc	^{44}Ti	59.1a	67.868	154.8 ns	1−	± 0.21(2)	0.342(6)	146.191	0		0.05	0	0	0
^{72}Ga	^{72}Zn	46.5 h	16.4	39.2 ns	2−	?	?	161.1	0		0.05	0	0	0
								207.9	0		0.05	0	0	0
^{83}Kr	^{83}Rb	86.2 d	9.4051	155.1 ns	7/2+	0.495(10)	−0.943(2)	561.957	0	$\binom{+}{+}$	0.0563(4)	$9.6(12) \times 10^{-6}$	0	0
										$\binom{+}{-}$	0.0437(4)	$9.6(12) \times 10^{-6}$	0	0
^{99}Tc	^{99}Mo	2.749 d	181.094	3.44 ns	5/2+	?	3.48(4)	920.637	0		0.103(4)	$7.6(8) \times 10^{-3}$	0.119(5)	$8.8(9) \times 10^{-3}$
^{99}Ru	^{99}Rh	16.1 d	89.76	20.5 ns	3/2+	0.231(12)	−0.284(6)	618.09	0		−0.254(4)	0	0	0
^{100}Rh	^{100}Pd	3.63 d	74.78	214 ns	(2+)	?	4.324(8)	158.8	32.68		?	?	?	?
								158.8	0		0.175	0	0	0
^{106}Pd	^{106}Ag	8.28 d	2305.75	2 ns	4−	?	?	2756.85	2084.06		0.082(6)	$1.2(4) \times 10^{-3}$	0	0
								2756.85	1557.71		0.05	0	0	0
^{111}Cd	^{111}In	2.8047 d	245.35	84.5 ns	5/2+	0.77(12)	−0.7656(25)	416.63	0		−0.1782(22)	−0.206(3)	$-1.28(5) \times 10^{-3}$	$-1.47(6) \times 10^{-3}$
^{120}Sn	^{120}Sb	5.76 d	2284.9	5.55 ns	5−	± 0.033(2)	−0.280(25)	2482.2	2195.1		−0.07143	0	−0.011	0
^{126}Sb	^{126}Sn	230000 a	104.6	553 ns	(3+)	?	?	127.9	17.7		−0.07143	−0.007034	0	0
^{131}I	^{131}Te	33.25 h	1797.08	5.9 ns	9/2−, 11/2−, 13/2−	~ ± 0.65	−1.2(4)	1899.14	1596.45		?	?	?	?
								1899.14	1556.16		?	?	?	?
^{132}I	^{132}Te	3.204 d	49.72	7.14 ns	3+	± 0.20(7)	2.06(18) [18]	277.86	0		−0.07143	0	−0.06448	0
^{133}Cs	^{133}Ba	10.551 a	80.9979	6.283 ns	5/2+	−0.33(2)	3.45(2)	383.849	0	$\binom{+}{+}$	0.146(13)	$1.19(13) \times 10^{-3}$	$1.2(22) \times 10^{-4}$	$1(18) \times 10^{-6}$
										$\binom{+}{-}$	−0.032(4)	$1.19(13) \times 10^{-3}$	$-3(5) \times 10^{-5}$	$1(18) \times 10^{-6}$
								437.011	0	$\binom{+}{+}$	−0.188(4)	$-1.53(9) \times 10^{-3}$	−0.217(4)	$-1.77(11) \times 10^{-3}$
										$\binom{+}{-}$	0.041(3)	$-1.53(9) \times 10^{-3}$	0.047(4)	$-1.77(11) \times 10^{-3}$
^{140}Ce	^{140}La	40.2852 h	2083.26	3.474 ns	4+	± 0.35(7)	4.35(10)	2412.02	1596.24		−0.099(5)	−0.067(3)	$-6.5(16) \times 10^{-4}$	$-4.4(11) \times 10^{-4}$
^{143}Pr	^{143}Ce	33.039 h	57.356	4.14 ns	5/2+	?	3.4(1)	350.622	0		0.203(12)	$1.9(8) \times 10^{-4}$	0.049(9)	$4.7(21) \times 10^{-5}$
								721.923	0		?	?	?	?
^{147}Eu	^{147}Gd	38.06 h	625.27	765 ns	11/2−	?	7.05(3)	995.17	229.323		−0.171(22)	−0.093(12)	$-1.1(9) \times 10^{-3}$	$-6(5) \times 10^{-4}$
								995.17	0		−0.30(4)	0.044(6)	$-1.9(16) \times 10^{-3}$	$2.9(24) \times 10^{-4}$
								1244.31	229.323		0.070(19)	0.038(10)	0	0
								1244.31	0		0.12(3)	−0.018(5)	0	0
								1554.29	229.323	$\binom{+}{+}$	−0.43(3)	−0.233(17)	−0.06(3)	−0.034(14)
										$\binom{-}{+}$	0.25(6)	0.14(3)	−0.06(3)	−0.034(14)
								1554.29	0	$\binom{+}{+}$	−0.75(5)	0.111(8)	−0.11(5)	0.016(7)
										$\binom{-}{+}$	0.44(10)	−0.066(15)	−0.11(5)	0.016(7)
^{149}Eu	^{149}Gd	9.28 d	496.386	2.45 μs	11/2−	?	7.0(3)	795.044	149.732		−0.181(19)	−0.187(23)	$-4.0(11) \times 10^{-3}$	$-4.1(12) \times 10^{-3}$
^{153}Eu	^{153}Sm	46.5 h	103.18	3.8 ns	3/2+	± 1.254(13)	2.048(6)	172.853	83.3673	$\binom{+}{+}$	$7.6(6) \times 10^{-3}$	0	0	0
										$\binom{-}{+}$	−0.0375(7)	0	0	0
								172.853	0	$\binom{+}{+}$	−0.0129(10)	0	0	0
										$\binom{+}{-}$	$1.88(23) \times 10^{-3}$	0	0	0
										$\binom{-}{+}$	0.0637(15)	0	0	0
										$\binom{-}{-}$	$-9.3(9) \times 10^{-3}$	0	0	0
^{153}Gd	^{153}Tb	2.34 d	41.54	4.08 ns	5/2−	?	?	212.012	0	$\binom{+}{+}$	−0.046(7)	0.0167(12)	0	0
										$\binom{+}{-}$	0.300(5)	0.0167(12)	0	0
^{156}Gd	^{156}Eu	15.19 d	88.966	2.2 ns	2+	−1.93(4)	0.774(8)	1154.13	0		0.2490(6)	0.4455(11)	0	0
								1168.14	0		0.3571	0.6389	0.6389	1.143
								1242.47	0		−0.25	−0.4472	0	0
								2186.74	0		0.54(6)	0.97(10)	−0.23(8)	−0.42(14)
	^{156}Tb	5.35 d	88.967	2.21 ns	2+	−1.93(4)	0.774(8)	288.2	0		0.102	0.1825	0.00507	0.00907
								1154.13	0		0.2490(6)	0.4455(11)	0	0
								1248	0		−0.269(4)	−0.481(7)	−0.04531(4)	−0.08105(7)
								1510.53	0		0.102	0.1825	0.00507	0.00907
								1934.29	0		−0.07143	−0.1278	0	0

^{158}Gd	^{158}Tb	180 a	79.5132	2.52 ns	2+	−2.01(4)	0.762(8)	261.457	0		0.102	0.1825	0.00507	0.00907
								1041.64	0		−0.07143	−0.1278	0	0
^{160}Dy	^{160}Tb	72.3 d	86.7877	2.02 ns	2+	± 1.8(4)	0.723(19)	283.822	0		0.102	0.1825	0.00507	0.00907
								966.169	0		0.24910(5)	0.44560(10)	0	0
								1049.1	0		−0.2598(12)	−0.4647(21)	−0.045396(10)	−0.081206(18)
^{165}Er	^{165}Tm	30.06 h	47.16	4 ns	5/2+	?	?	507.429	0		?	?	?	?
								853.514	0		?	?	?	?
^{168}Er	^{168}Tm	93.1 d	1094.04	109 ns	4−	?	0.96(4)	1541.55	895.794		0.076(12)	$1.2(6) \times 10^{-3}$	$2.6(6) \times 10^{-3}$	$4.2(23) \times 10^{-5}$
^{172}Yb	^{172}Lu	6.7 d	1172.39	8.33 ns	3+	± 2.9(4)	0.65(4)	1263.04	260.27		−0.212(23)	0.1144(22)	−0.025(3)	0.0137(3)
								1263.04	78.7427		0.32(3)	0.571(5)	0.038(4)	0.0685(8)
								1375.82	260.27		0.048(5)	−0.0260(5)	$4.8(5) \times 10^{-3}$	$-2.56(5) \times 10^{-3}$
								1375.82	78.7427		−0.072(7)	−0.1300(11)	$-7.1(7) \times 10^{-3}$	−0.01281(11)
								2073.12	78.7427		0.017(5)	0.030(8)	$2.4(7) \times 10^{-4}$	$4.3(11) \times 10^{-4}$
^{181}Ta	^{181}Hf	42.39 d	482.1	10.8 ns	5/2+	2.35(6)	3.29(3)	615.12	136.252		0.102	0.007855	0.1178	0.00907
								615.12	0	$\binom{+}{+}$	−0.3185(11)	−0.06018(4)	−0.3678(12)	−0.06950(5)
										$\binom{+}{-}$	−0.0198(12)	−0.06018(4)	−0.0229(14)	−0.06950(5)
^{194}Pt	^{194}Ir	171 d	1485.1	3.45 ns	(7−)	?	1.8(6)	2047.5	1373.5		0.102	0.04897	0.0189	0.00907
^{198}Au	$^{198\,m}$Au	2.272 d	312.1	124 ns	5+	?	−1.11(2)	516.2	214.89		0.096(23)	0	$7(6) \times 10^{-4}$	0
								645.92	214.89		−0.3	0	0.2309	0
^{219}Rn	^{223}Ra	11.43 d	4.47	15.4 ns	(9/2+)	?	?	158.64	0		−0.131	−0.08127	0	0
^{237}U	^{241}Pu	14.29 a	160	3.1 ns	5/2+	?	?	274	11.5	$\binom{+}{+}$	$6.2(8) \times 10^{-3}$	$2.62(9) \times 10^{-3}$	0	0
										$\binom{+}{-}$	0.0896(6)	$2.62(9) \times 10^{-3}$	0	0
^{246}Am	^{246}Pu	10.84 d	43.81	4.3 ns	(1+)	?	?	223.74	16.22		?	?	?	?

Table 2
On-site candidates (parent half-life: 10 min $< t_{1/2} <$ 24 h, minimal γ intensity: 3%, intermediate level's half-life: 2 ns $< t_{1/2} <$ 5 μs, lower angular correlation coefficient limit: 0.02). The column ⋆ contains the sign combination of mixing ratios used for the computation of results contained in the particular row (compare Section 4.2.4). (For interpretation of the references to color in this table legend, the reader is referred to the web version of this article.)

Decay			Intermediate					Initial	Final	Angular correlation coefficients				
Daughter	Parent	Half-Life	Energy (keV)	Half-Life	Spin/Parity	Q (eb)	$\mu(\mu_N)$	Energy (keV)	Energy (keV)	⋆	A_{22}	A_{24}	A_{42}	A_{44}
^{28}Al	^{28}Mg	20.915 h	30.64	2.07 ns	2+	?	4.3(4)	972.17	0		−0.072(5)	(-5×10^{-8})	−0.129(8)	(-8×10^{-8})
								1620.05	0		0.087(17)	(6×10^{-8})	$3(3) \times 10^{-3}$	$2(21) \times 10^{-9}$
^{48}V	^{48}Cr	21.56 h	308.24	7.09 ns	2+	?	0.44(2)	420.55	0	$\binom{+}{+}$	−0.077(9)	$-3.8(5) \times 10^{-3}$	$-3(11) \times 10^{-5}$	$-2(6) \times 10^{-6}$
										$\binom{-}{+}$	−0.066(9)	$-3.3(5) \times 10^{-3}$	$-3(11) \times 10^{-5}$	$-2(6) \times 10^{-6}$
^{62}Cu	^{62}Zn	9.193 h	40.8	4.57 ns	2+	?	1.1(1)	548.29	0		0.175	0	0	0
								637.45	0		0.175	0	0	0
^{66}Ga	^{66}Ge	2.26 h	43.81	18 ns	1+	?	?	234.065	0	$\binom{+}{+}$	−0.11(4)	0	0	0
										$\binom{-}{+}$	0.23(6)	0	0	0
^{73}As	^{73}Se	7.15 h	67.11	4.95 ns	5/2−	± 0.356(12)	1.63(10)	427.66	0		−0.057(4)	0	$-8.2(8) \times 10^{-3}$	0
^{77}Br	^{77}Kr	74.4 m	129.63	9.3 ns	5/2+	~ ± 0.4	3.30(3)	276.21	0	$\binom{+}{+}$	0.29(3)	0	0.016(8)	0
										$\binom{-}{+}$	−0.04(5)	0	0.016(8)	0
^{83}Br	^{83}Se	22.3 m	1091.9	4.1 ns	9/2+	?	?	1810.07	866.71		0.03(8)	$2(7) \times 10^{-4}$	$4(6) \times 10^{-3}$	$2(6) \times 10^{-5}$
^{86}Sr	^{86}Y	14.74 h	2229.89	5 ns	4+	?	?	3055.9	1076.76		−0.063(13)	−0.043(9)	$-1(4) \times 10^{-5}$	(-8×10^{-6})
^{86}Y	^{86}Zr	16.5 h	242.8	28.5 ns	2−	?	−1.06(6)	271.9	0		−0.07143	−0.003549	0	0
^{106}Pd	^{106}Rh	2.18333 h	2306.78	2 ns	4−	?	?	2757.94	2085.07		0.082(6)	$1.2(4) \times 10^{-3}$	0	0
								2757.94	1557.8		0.05	0	0	0
^{111}Cd	^{111m}Cd	48.54 m	245.4	84.5 ns	5/2+	0.77(12)	−0.7656(25)	396.22	0		0.1786	0.2062	−0.003749	−0.004329
^{116}Sn	^{116}Sb	60.3 m	2365.94	350 ns	5−	± 0.26(1)	−0.376(3)	2773.3	2266.14		−0.058(13)	−0.034(8)	$-4(8) \times 10^{-5}$	$-2(4) \times 10^{-5}$
								2773.3	1293.56		−0.102(23)	0.016(4)	$-7(13) \times 10^{-5}$	$1.0(21) \times 10^{-5}$
								2908.81	2266.14		0.102	0.05891	0.01571	0.00907

Table 2 (*continued*)

Decay			Intermediate					Initial	Final	Angular correlation coefficients				
Daughter	Parent	Half-Life	Energy (keV)	Half-Life	Spin/Parity	Q (eb)	$\mu(\mu_N)$	Energy (keV)	Energy (keV)	⋆	A_{22}	A_{24}	A_{42}	A_{44}
								2908.81	1293.56		0.1786	−0.02812	0.02749	−0.004329
								3209.95	2266.14		0.102	0.05891	0.01571	0.00907
								3209.95	1293.56		0.1786	−0.02812	0.02749	−0.004329
^{117}In	^{117}Cd	2.49 h	659.763	53.6 ns	3/2+	−0.59(1)	0.938(10)	749.486	315.302		−0.361(14)	0	0	0
^{118}Sn	^{118}Sb	5 h	2321.16	21.7 ns	5−	± 0.16(2)	−0.300(25)	2574.84	2280.35		−0.07143	0	−0.011	0
								2574.84	1229.66		0.1786	−0.02812	0.02749	−0.004329
^{129}Cs	^{129}Ba	2.23 h	6.55	72 ns	5/2+	?	?	135.57	0	$\binom{+}{+}$	−0.38(4)	−0.44(5)	−0.015(7)	−0.017(8)
										$\binom{-}{+}$	(0.007)	(0.008)	−0.015(7)	−0.017(8)
								220.74	0	$\binom{+}{+}$	−0.55(15)	−0.63(17)	−0.08(12)	−0.09(14)
										$\binom{-}{+}$	0.3(3)	0.3(4)	−0.08(12)	−0.09(14)
	^{129}Ba	2.16 h	6.55	72 ns	5/2+	?	?	135.57	0	$\binom{+}{+}$	−0.38(4)	−0.44(5)	−0.015(7)	−0.017(8)
										$\binom{-}{+}$	(0.007)	(0.008)	−0.015(7)	−0.017(8)
								188.93	0	$\binom{+}{+}$	0.097(11)	0.112(13)	$-3.7(6) \times 10^{-3}$	$-4.3(6) \times 10^{-3}$
										$\binom{-}{+}$	−0.252(13)	−0.291(15)	$-3.7(6) \times 10^{-3}$	$-4.3(6) \times 10^{-3}$
								220.74	0	$\binom{+}{+}$	−0.55(15)	−0.63(17)	−0.08(12)	−0.09(14)
										$\binom{-}{+}$	0.3(3)	0.3(4)	−0.08(12)	−0.09(14)
								426.47	0		0.102	0.1178	0.007855	0.00907
			188.93	2.26 ns	7/2+	?	?	648.42	6.55	$\binom{+}{+}$	0.031(8)	$-8.2(12) \times 10^{-3}$	$3.6(9) \times 10^{-3}$	$-9.5(14) \times 10^{-4}$
										$\binom{+}{-}$	−0.163(6)	$-8.2(12) \times 10^{-3}$	−0.0189(7)	$-9.5(14) \times 10^{-4}$
^{130}Te	^{130}Sb	39.5 m	1815.24	9.8 ns	6+	?	?	2146.15	1632.91		−0.027(4)	−0.0140(19)	$-4.8(8) \times 10^{-4}$	$-2.5(4) \times 10^{-4}$
			2146.15	115 ns	7−	?	?	2404.2	1815.24		0.091(15)	$1.6(4) \times 10^{-3}$	$3.1(17) \times 10^{-3}$	$5(3) \times 10^{-5}$
^{130}Xe	^{130}I	12.36 h	1204.61	2 ns	4+	?	1.7(2) [18]	1944.14	536.067		0.102	0.06937	0.01334	0.00907
			1944.14	2 ns	6+	?	?	2362.07	1204.61		0.167(15)	0.087(8)	−0.032(4)	−0.0168(20)
^{138}Ba	^{138}Cs	33.41 m	1898.71	2.164 ns	4+	?	3.2(6)	2445.72	1435.91		−0.08(3)	−0.055(17)	$-1.3(11) \times 10^{-3}$	$-9(8) \times 10^{-4}$
^{139}Pr	^{139}Nd	5.5 h	113.86	2.6 ns	7/2+	?	± 1.19(21)	822	0	$\binom{+}{+}$	(−0.007)	$-5(6) \times 10^{-3}$	-7×10^{-5}	$-5(21) \times 10^{-5}$
										$\binom{+}{-}$	−0.18(5)	$-5(6) \times 10^{-3}$	$-2(8) \times 10^{-3}$	$-5(21) \times 10^{-5}$
								851.96	0	$\binom{+}{+}$	(−0.009)	$-7(8) \times 10^{-3}$	(0.0008)	$6(7) \times 10^{-4}$
										$\binom{+}{-}$	−0.25(7)	$-7(8) \times 10^{-3}$	0.022(9)	$6(7) \times 10^{-4}$
			822	36.8 ns	11/2−	?	6.60(5)	1523.21	113.86		−0.44(18)	−0.10(7)	−0.03(5)	$-7(11) \times 10^{-3}$
			113.86	2.6 ns	7/2+	?	± 1.19(21)	2174.55	0	$\binom{+}{+}$	(0.003)	$2(3) \times 10^{-3}$	0	0
										$\binom{+}{-}$	0.093(25)	$2(3) \times 10^{-3}$	0	0
^{141}Pm	^{141}Sm	22.6 m	628.6	590 ns	11/2−	?	?	1167.2	196.6		−0.1182	−0.06433	0	0
								1313.2	196.6		−0.407(6)	−0.221(3)	−0.042(4)	−0.0227(24)
								1414.8	196.6		0.03(6)	0.01(3)	$-8(6) \times 10^{-3}$	$-4(3) \times 10^{-3}$
^{149}Pm	^{149}Nd	103.68 m	114.311	2.53 ns	5/2+	?	2.13(15)	270.17	0		0.047(4)	$3.9(10) \times 10^{-4}$	0	0
			270.17	2.59 ns	7/2−	?	2.19(11)	537.861	114.311		0.24(3)	0	0.011(6)	0
			114.311	2.53 ns	5/2+	?	2.13(15)	654.842	0		0.047(4)	$3.9(10) \times 10^{-4}$	0	0
^{151}Gd	^{151}Tb	17.609 h	108.093	2.8 ns	5/2−	?	−1.08(13)	395.449	0		−0.345(14)	0.0361(15)	−0.014(3)	$1.5(3) \times 10^{-3}$
								811.837	0		0.050(17)	$-5.2(18) \times 10^{-3}$	−0.020(3)	$2.0(3) \times 10^{-3}$
								839.319	0		0.25208(11)	−0.0264(4)	0.29107(13)	−0.0304(4)
^{154}Eu	^{154m}Eu	46 m	100.88	50 ns	4+	?	?	136.8	0	$\binom{+}{+}$	$8(9) \times 10^{-3}$	0	$4.9(22) \times 10^{-4}$	0
										$\binom{-}{+}$	0.093(9)	0	$4.9(22) \times 10^{-4}$	0
^{156}Eu	^{156}Sm	9.4 h	87.58	12 ns	1−	?	?	125.68	0		0.05	0	0	0
^{157}Ho	^{157}Er	18.65 m	53.05	20 ns	5/2+	?	?	174.44	0		0.05	0	0	0
^{158}Gd	^{158}Eu	45.9 m	79.51	2.52 ns	2+	−2.01(4)	0.762(8)	1263.67	0		−0.37(6)	−0.66(11)	$-5(5) \times 10^{-3}$	$-9(10) \times 10^{-3}$
^{159}Dy	^{159}Ho	33.05 m	177.616	9.2 ns	5/2+	?	?	395.264	0		0.05	0	0	0
^{160}Dy	^{160}Ho	25.6 m,	86.793	2.02 ns	2+	± 1.8(4)	0.723(19)	283.812	0		0.102	0.1825	0.00507	0.00907
								966.172	0		0.2485(11)	0.4446(20)	0	0
								1049.11	0		−0.264(16)	−0.47(3)	−0.04536(15)	−0.0811(3)
								1155.85	0		0.102	0.1825	0.00507	0.00907
								1285.61	0		−0.25	−0.4472	0	0
								1286.72	0		−0.0777(24)	−0.139(4)	$-2.9(22) \times 10^{-6}$	$-5(4) \times 10^{-6}$

								1398.97	0		−0.02(4)	−0.03(7)	$-2(3)\times10^{-4}$	$-4(6)\times10^{-4}$
								1456.75	0		0.3571	0.6389	0.6389	1.143
								1804.67	0		0.53(9)	0.95(16)	−0.35(8)	−0.62(14)
								2630.71	0		−0.28(10)	−0.51(18)	$-4(23)\times10^{-4}$	(−0.0007)
								2701.04	0		−0.22(15)	−0.4(3)	−0.0004	(−0.0007)
^{162}Dy	^{162}Ho	67 m	80.67	2.25 ns	2+	?	0.69(3)	265.66	0		0.102	0.1825	0.00507	0.00907
^{164}Ho	^{164m}Ho	37.5 m	37.34	2.8 ns	2+	?	?	93.98	0	$\binom{+}{+}$	0.017(5)	$8(4)\times10^{-5}$	$7(3)\times10^{-5}$	$3(2)\times10^{-7}$
										$\binom{+}{-}$	0.026(7)	$8(4)\times10^{-5}$	$1.0(4)\times10^{-4}$	$3(2)\times10^{-7}$
										$\binom{-}{+}$	0.063(7)	$2.7(15)\times10^{-4}$	$7(3)\times10^{-5}$	$3(2)\times10^{-7}$
										$\binom{-}{-}$	0.094(8)	$2.7(15)\times10^{-4}$	$1.0(4)\times10^{-4}$	$3(2)\times10^{-7}$
^{171}Tm	^{171}Er	7.516 h	5.028	4.77 ns	3/2+	?	?	116.653	0	$\binom{-}{+}$	0.1348(17)	0	0	0
										$\binom{-}{-}$	0.156(2)	0	0	0
								129.044	0	$\binom{+}{+}$	−0.0662(3)	0	0	0
										$\binom{+}{-}$	−0.07656(24)	0	0	0
^{173}Hf	^{173}Ta	3.14 h	107.15	180 ns	5/2−	?	?	197.4	0		−0.07143	−0.08248	0	0
^{177}Lu	^{177}Yb	114.66 m	150.25	130 ns	9/2−	?	5.5(3)	1230.73	0		0.05	0	0	0
^{177}Ta	^{177}W	2.2 h	186.15	3.62 μs	5/2−	?	2.05(13) [18]	372.57	0	$\binom{+}{+}$	0.1286(15)	0	0.0138(8)	0
										$\binom{-}{+}$	−0.051(3)	0	0.0138(8)	0
			70.47	70.2 ns	5/2+	?	4.8(5) [18]	487.62	0	$\binom{+}{+}$	−0.405(11)	−0.0142(12)	−0.467(13)	−0.0164(14)
										$\binom{+}{-}$	0.216(7)	−0.0142(12)	0.249(9)	−0.0164(14)
								497.41	0	$\binom{+}{+}$	0.283(8)	$9.9(9)\times10^{-3}$	0	0
										$\binom{+}{-}$	−0.151(5)	$9.9(9)\times10^{-3}$	0	0
								1253.3	0	$\binom{+}{+}$	0.283(8)	$9.9(9)\times10^{-3}$	0	0
										$\binom{+}{-}$	−0.151(5)	$9.9(9)\times10^{-3}$	0	0
^{181}Re	^{181}Os	105 m	356.75	96 ns	5/2−	?	2.03(10)	599.67	118.01	$\binom{+}{+}$	0.138(6)	0	0.021(5)	0
										$\binom{-}{+}$	−0.071(14)	0	0.021(5)	0
^{183}Re	^{183}Os	13 h	496.24	7.7 ns	9/2−	3.8(3) [19]	5.14(11) [19]	664.08	114.47	$\binom{+}{+}$	−0.01(3)	0	$1.2(12)\times10^{-3}$	0
										$\binom{-}{+}$	0.11(3)	0	$1.2(12)\times10^{-3}$	0
^{184}Ir	^{184}Pt	17.3 m	225.63	500 ns	3+	?	?	293.27	70.73	$\binom{+}{+}$	0.22(4)	$1(6)\times10^{-3}$	0.014(4)	$6(4)\times10^{-5}$
										$\binom{+}{-}$	0.01(3)	$1(6)\times10^{-3}$	$9(22)\times10^{-4}$	$6(4)\times10^{-5}$
										$\binom{-}{+}$	−0.054(16)	$-2.4(17)\times10^{-4}$	0.014(4)	$6(4)\times10^{-5}$
										$\binom{-}{-}$	$-3(8)\times10^{-3}$	$-2.4(17)\times10^{-4}$	$9(22)\times10^{-4}$	$6(4)\times10^{-5}$
^{185}Ir	^{185}Pt	70.9 m,	5.8	5 ns	9/2−	?	?	158.6	0		0.102	0.06333	0.01461	0.00907
								300.1	0	$\binom{+}{+}$	−0.471(10)	−0.292(6)	−0.10(6)	−0.06(4)
										$\binom{-}{+}$	0.32(8)	0.20(5)	−0.10(6)	−0.06(4)
			229.6	2.1 ns	3/2+	?	?	335.3	0	$\binom{+}{+}$	−0.0377(3)	0	0	0
										$\binom{-}{+}$	0.077(5)	0	0	0
			5.8	5 ns	9/2−	?	?	465.7	0	$\binom{+}{+}$	0.23(9)	0.14(5)	−0.03(4)	−0.019(25)
										$\binom{-}{+}$	−0.40(13)	−0.25(8)	−0.03(4)	−0.019(25)
								646.6	0		−0.07143	−0.04433	0	0
^{193}Pt	^{193}Au	17.65 h	14.276	2.52 ns	5/2−	?	?	269.83	1.642	$\binom{+}{+}$	0.331(21)	$1.5(8)\times10^{-4}$	0.035(10)	$1.6(10)\times10^{-5}$
										$\binom{+}{-}$	0.386(24)	$1.5(8)\times10^{-4}$	0.041(12)	$1.6(10)\times10^{-5}$
										$\binom{-}{+}$	−0.13(4)	$-6(4)\times10^{-5}$	0.035(10)	$1.6(10)\times10^{-5}$
										$\binom{-}{-}$	−0.15(4)	$-6(4)\times10^{-5}$	0.041(12)	$1.6(10)\times10^{-5}$
			1.642	9.7 ns	3/2−	?	?	269.83	0		−0.126(22)	0	0	0
^{194}Hg	^{194}Tl	32.8 m	1910.4	3.75 ns	7−	?	?	2138.4	1813.5	$\binom{+}{+}$	0.22(4)	0.107(21)	−0.06(3)	−0.029(16)
										$\binom{-}{+}$	−0.39(3)	−0.189(14)	−0.06(3)	−0.029(16)
								2463.9	1813.5		−0.1068	−0.05123	0	0
^{196}Pt	^{196}Ir	84 m	1374	4.01 ns	7−	?	−0.21(14)	1821.1	1270.7		0.102	0.04897	0.0189	0.00907
^{198}Pb	^{198}Bi	11.6 m	1823.4	50.4 ns	5−	?	0.38(3)	2141.3	1625.9		−0.07143	0	−0.011	0
			2141.3	4.19 μs	7−	?	−0.377(6)[19]	2231.3	1823.4		0.102	0.04897	0.0189	0.00907
^{199}Hg	^{199m}Hg	42.67 m	158.3	2.47 ns	5/2−	0.95(7)	0.88(3)	532.48	0		0.251(4)	0.289(5)	−0.0277(17)	−0.032(2)
^{204}Pb	^{204}Bi	11.22 h	1273.99	265 ns	4+	± 0.44(2)	0.224(3)	2065.17	899.15		−0.438(5)	−0.298(4)	−0.051(7)	−0.035(5)
								2185.73	899.15		0.2473	0.1681	−0.0431	−0.0293
	^{204m}Pb	66.93 m	1273.99	265 ns	4+	± 0.44(2)	0.224(3)	2185.88	899.15		0.2473	0.1681	−0.0431	−0.0293
^{208}Po	^{208}At	97.8 m	1524.17	4 ns	6+	?	5.3(6)	2041.24	1346.57		0.022(5)	0.011(3)	0	0
			1528.22	380 ns	8+	± 0.90(4)	7.37(5)	2160.09	1524.17		0.025(11)	0.012(5)	0	0

Table 2 (*continued*)

Decay			Intermediate					Initial	Final	Angular correlation coefficients				
Daughter	Parent	Half-Life	Energy (keV)	Half-Life	Spin/Parity	Q (eb)	$\mu(\mu_N)$	Energy (keV)	Energy (keV)	⋆	A_{22}	A_{24}	A_{42}	A_{44}
			1524.17	4 ns	6+	?	5.3(6)	2369.22	1346.57		−0.07143	−0.03702	0	0
			1528.22	380 ns	8+	± 0.90(4)	7.37(5)	2555.89	1524.17	$\binom{+}{+}$	−0.34(9)	−0.15(4)	−0.03(3)	−0.013(13)
										$\binom{-}{+}$	0.16(12)	0.07(5)	−0.03(3)	−0.013(13)
^{212}Rn	^{212}Fr	20 m	1502.5	8.8 ns	4+	?	± 4.0(2)	1640.8	1274.8		0.102	0.06937	0.01334	0.00907

Table 3

Online candidates (parent half-life: $t_{1/2} < 10$ min, minimal γ intensity: 5%, intermediate level's half-life: 2 $ns < t_{1/2} < 5$ μs, lower angular correlation coefficient limit: 0.02). The column ⋆ contains the sign combination of mixing ratios used for the computation of results contained in the particular row (compare Section 4.2.4). (For interpretation of the references to color in this table legend, the reader is referred to the web version of this article.)

Decay			Intermediate					Initial	Final	Angular correlation coefficients				
Daughter	Parent	Half-Life	Energy (keV)	Half-life	Spin/Parity	Q (eb)	μ(μN)	Energy (keV)	Energy (keV)	⋆	A_{22}	A_{24}	A_{42}	A_{44}
^{19}F	^{19}O	26.88 s	197.143	89.3 ns	5/2+	−0.072(4) [19]	3.607(8)[19]	1554.04	0		−0.2	−0.2309	0	0
^{22}Na	^{22}Mg	3.8755 s	583.11	243 ns	1+	?	0.535(10)	657.16	0		−0.07143	0	0	0
^{30}Al	^{30}Mg	335 ms	244.1	8 ns	2+	?	?	688	0		0.05	0	0	0
^{56}Mn	^{56}Cr	5.94 m	26	8.7 ns	2+	?	?	110	0		0.05	0	0	0
^{57}Fe	^{57}Mn	85.4 s	14.4129	98.3 ns	3/2−	0.082(8)	−0.1549(2)	706.399	0	$\binom{-}{+}$	0.297(3)	0	0	0
										$\binom{-}{-}$	0.301(3)	0	0	0
^{68}Cu	^{68m}Cu	3.75 m	84.11	7.84 ns	2+	?	?	721.26	0		−0.1545	0	0.007037	0
^{75}Kr	^{75}Rb	19 s	178.91	2.08 ns	(3/2−)	?	?	358	0	$\binom{+}{+}$	−0.035(5)	0	0	0
										$\binom{-}{+}$	0.069(12)	0	0	0
^{77}Kr	^{77}Rb	3.78 m	66.5	118 ns	3/2−	?	?	245.3	0		0.021(11)	0	0	0
^{77}Rb	^{77}Sr	9 s	146.937	5.1 ns	(5/2+)	?	?	307.03	0		−0.116(17)	0	$5.8(16) \times 10^{-3}$	0
^{78}Br	^{78m}Br	119.4 μs	32.3	14.2 ns	(2−)	?	−1.12(4)	180.9	0		−0.07143	0	−0.003549	0
^{79}Sr	^{79}Y	14.8 s	177.4	23 ns	(5/2+)	?	?	329.9	0		0.17(5)	$3(18) \times 10^{-5}$	$2.1(15) \times 10^{-3}$	$4(23) \times 10^{-7}$
^{87}Zr	^{87}Nb	3.75 m	201	2.44 ns	(7/2+)	?	?	335.8	0		~0.241	~−0.0155	~−0.0503	~0.00324
	^{87m}Zr	14 s	201.2	2.44 ns	(7/2+)	?	?	336.3	0		~0.241	~−0.0155	~−0.0503	~0.00324
^{91}Nb	^{91m}Nb	3.76 μs	1984.7	10 ns	(13/2−)	?	8.14(13)	2034.8	1790.6		0.102	0.05074	0.01824	0.00907
								2034.8	0		0.064(12)	0.097(14)	0.0114(21)	0.0174(25)
^{92}Tc	^{92}Ru	3.65 m	270.15	1.03 μs	(4+)	?	?	529.44	213.81		−0.07143	−0.009339	0	0
			529.44	100 ns	(3+)	?	?	576.9	270.15		0.05	0	0	0
			576.9	2 ns	(2+)	?	?	711.36	529.44		0.05	0	0	0
^{94}Ru	^{94}Rh	25.8 s	2498.62	65 ns	6+	?	8.12(5)[19]	2644.72	2186.91		0.102	0.05289	0.0175	0.00907

^{96}Pd	^{96}Ag	4.4 s	2530.5	2.2 μs	(8+)	?	10.97(6)	3783.5	2424.19		0.102	0.04622	0.02003	0.00907
^{98}Sr	^{98}Rb	96 ms	144.225	2.8 ns	2+	?	± 0.76(14)	433.52	0		0.102	0.1825	0.00507	0.00907
^{105}Tc	^{105}Mo	35.6 s	85.44	20.8 ns	(5/2+)	?	?	149.63	0		0.05	0	0	0
^{112}In	^{112m}In	2.81 μs	350.5	690 ns	7+	± 1.03(3)	4.72(4)	613.2	162.89		−0.07143	−0.03428	0	0
^{115}Sn	^{115m}Sn	159 μs	613.5	3.26 μs	7/2+	~ ± 0.26	0.683(10)	713.64	497.6		0.102	0.07816	0.01184	0.00907
^{115}Sb	^{115m}Sb	159 ns	1300.2	6.2 ns	11/2−	?	5.53(8)	2516.9	723.6		0.102	0.05554	0.01666	0.00907
								2516.9	0		0.1786	−0.02651	0.02916	−0.004329
								2638.5	723.6		0.102	0.05554	0.01666	0.00907
								2638.5	0		0.1786	−0.02651	0.02916	−0.004329
^{117}Sb	^{117m}Sb	355 μs	1322.91	3.8 ns	11/2−	?	5.35(9)	2323.07	1160.04		−0.07143	0	−0.01166	0
								2323.07	527.26		0.102	0.05554	0.01666	0.00907
								2323.07	0		0.1786	−0.02651	0.02916	−0.004329
								2412.76	1160.04		−0.07143	0	−0.01166	0
								2412.76	527.26		0.102	0.05554	0.01666	0.00907
								2412.76	0		0.1786	−0.02651	0.02916	−0.004329
^{120}Sn	^{120}In	47.3 s	2284.08	5.55 ns	5−	± 0.033(2)	−0.280(25)	2481.43	2194.25		−0.07143	0	−0.011	0
								2749.51	2194.25		0.036(9)	0	$6(8) \times 10^{-5}$	0
^{122}Sn	^{122}In	10.8 s	2245.89	7.9 ns	5−	?	?	2409.14	2142.14		−0.07143	0	−0.011	0
								2653.08	2142.14		0.036(9)	0	$6(8) \times 10^{-5}$	0
^{122}Sb	^{122m}Sb	4.191 m	61.413	1.7 μs	3+	0.41(4)	2.983(12)	137.472	0		−0.07143	0	−0.007034	0
^{123}Cs	^{123}Ba	2.7 m	94.57	9 ns	(5/2+)	?	?	214.57	0		−0.07143	−0.08248	0	0
								231.63	0		−0.10(7)	−0.12(9)	$-1(5) \times 10^{-4}$	$-1(6) \times 10^{-4}$
^{124}Sn	^{124}In	3.7 s	2204.5	270 ns	5−	?	?	2324.87	2101.59		−0.07143	0	−0.011	0
			2324.87	3.1 μs	(7−)	?	?	2568.01	2204.5		−0.114(21)	−0.055(10)	$-2(12) \times 10^{-5}$	-1×10^{-5}
			2204.5	270 ns	5−	?	?	2568.01	2101.59		0.045(9)	0	7×10^{-6}	0
^{124}Cs	^{124m}Cs	6.3 s	301.1	69 ns	(4−)	?	?	397.65	242.87	$(^{+}_{+})$	−0.16(3)	0	0.020(11)	0
										$(^{-}_{+})$	0.29(4)	0	0.020(11)	0
								397.65	211.62	$(^{+}_{+})$	−0.16(3)	0	0.020(11)	0
										$(^{-}_{+})$	0.29(4)	0	0.020(11)	0
^{126}Sn	^{126}In	1.64 s	2161.51	10.8 ns	5−	?	?	2218.96	2049.71		−0.07143	0	−0.011	0
^{127}Cs	^{127m}Cs	55 μs	66	24.88 ns	(5/2+)	± 0.58(12)	± 2.7(5)	138.6	0		−0.2	−0.2309	0	0
								272.2	0		−0.07143	−0.08248	0	0
								451.1	0		0.1786	0.2062	−0.003749	−0.004329
^{127}Ba	^{127}La	5.1 m	81.31	75 ns	(5/2+)	?	?	195.6	56.26		0.10(3)	0	$4(4) \times 10^{-4}$	0
^{130}Sn	^{130}In	290 ms	2084.8	52 ns	(5−)	?	?	2214.6	1995.57		0.08667	0	0	0
								2214.6	1946.84		−0.07143	−0.011	0	0
	^{130}In	540 ms	2084.89	52 ns	(5−)	?	?	2214.7	1995.66		0.08667	0	0	0
								2214.7	1946.93		−0.07143	−0.011	0	0
^{132}Sn	^{132}In	207 ms	4416.29	3.95 ns	(4+)	?	?	4715.91	4041.2		0.102	0.06937	0.01334	0.00907
			4715.91	20.1 ns	(6+)	?	?	4848.52	4416.29		0.102	0.05289	0.0175	0.00907
			4416.29	3.95 ns	(4+)	?	?	4942.53	4041.2		−0.07143	−0.04856	0	0
	^{132m}Sn	2.03 μs	4415.5	4 ns	(4+)	?	?	4714.7	4041.1		0.102	0.06937	0.01334	0.00907
			4714.7	20.2 ns	(6+)	?	?	4847	4415.5		0.102	0.05289	0.0175	0.00907
^{132}Sb	^{132}Sn	39.7 s	85.55	15.62 ns	(3+)	?	?	1078.31	0		0.27(5)	−0.047(10)	−0.071(19)	0.012(3)
^{132}Te	^{132}Sb	2.79 m,	1774.77	145 ns	6+	?	4.7(5)	1925.31	1671.33		−0.07143	−0.03702	0	0
	^{132}Sb	4.1 m	1774.56	145 ns	6+	?	4.7(5)	1925.23	1671.03		−0.07143	−0.03702	0	0
^{132}Xe	^{132m}Xe	8.39 ms	2214.06	87 ns	(7−)	± 0.010(5)	−0.06(3)	2752.16	2040.46		0.1786	0.0857	−0.009021	−0.004329
^{134}I	^{134m}I	3.52 m	44.4	10 ns	(5+)	?	?	316.5	0		−0.125	0	0.005249	0
^{136}Ce	^{136m}Ce	2.2 μs	2366.8	5 ns	6+	?	?	2990.1	1314.4		0.102	0.05289	0.0175	0.00907
			2214.4	5 ns	6+	?	?	2990.1	1314.4		0.102	0.05289	0.0175	0.00907
^{138}Ba	^{138}Cs	2.91 m	1899	2.164 ns	4+	?	3.2(6)	2090.7	1436		0.102	0.06937	0.01334	0.00907
^{145}Pr	^{145}Ce	3.01 m	62.65	4 ns	5/2+	?	?	347.18	0		0.05	0	0	0
								786.91	0		0.05	0	0	0
^{145}Gd	^{145}Tb	30.9 s	27.3	11.5 ns	3/2+	?	?	1014.9	0	$(^{+}_{+})$	−0.040(17)	0	0	0
										$(^{+}_{-})$	−0.08(3)	0	0	0
								1415.3	0	$(^{+}_{+})$	−0.048(5)	0	0	0
										$(^{+}_{-})$	−0.092(4)	0	0	0
^{147}Pr	^{147}Ce	56.4 s	93.29	12 ns	(7/2+)	?	?	362.03	0		0.1071	0	0	0
^{149}Dy	^{149m}Dy	490 ms	1073.2	12.5 ns	(13/2+)	?	?	2251.8	0		0.1786	−0.02422	0.03192	−0.004329
^{151}Er	^{151m}Er	580 ms	1140.3	10 ns	(13/2+)	?	?	2239.4	0		0.1786	−0.02422	0.03192	−0.004329
^{151}Tm	^{151m}Tm	24 ns	2655.67	451 ns	(27/2−)	?	?	3987.88	2515.27		0.102	0.03912	0.02366	0.00907

Table 3 (*continued*)

Decay			Intermediate					Initial	Final	Angular correlation coefficients				
Daughter	Parent	Half-Life	Energy (keV)	Half-life	Spin/Parity	Q (eb)	μ(μN)	Energy (keV)	Energy (keV)	⋆	A_{22}	A_{24}	A_{42}	A_{44}
^{152}Nd	^{152}Pr	3.63 s	72.6	4.5 ns	2+	?	?	236.7	0		0.102	0.1825	0.00507	0.00907
^{152}Tb	^{152m}Tb	4.2 m	342.2	960 ns	5−	?	?	501.74	283.29		−0.125	0	0.005249	0
^{154}Sm	^{154}Pm	2.68 m	82.004	3.02 ns	2+	−1.87(4)	0.78(4)	1706.78	0		0.256(15)	0.46(3)	−0.016(7)	−0.029(13)
^{155}Dy	^{155m}Dy	6 μs	39.384	3.34 ns	5/2−	?	?	86.767	0	$\binom{+}{+}$	$1.2(7) \times 10^{-3}$	$-7(4) \times 10^{-4}$	$-8.3(18) \times 10^{-5}$	$5.1(9) \times 10^{-5}$
										$\binom{+}{-}$	−0.016(10)	$-7(4) \times 10^{-4}$	$1.15(20) \times 10^{-3}$	$5.1(9) \times 10^{-5}$
										$\binom{-}{+}$	−0.0158(23)	$9.7(6) \times 10^{-3}$	$-8.3(18) \times 10^{-5}$	$5.1(9) \times 10^{-5}$
										$\binom{-}{-}$	0.22(1)	$9.7(6) \times 10^{-3}$	$1.15(20) \times 10^{-3}$	$5.1(9) \times 10^{-5}$
			132.195	51 ns	9/2+	?	?	234.33	86.767	$\binom{+}{+}$	−0.119(14)	0	0.0107(24)	0
										$\binom{-}{+}$	0.230(17)	0	0.0107(24)	0
^{156}Sm	^{156}Pm	26.7 s	75.89	2 ns	2+	?	?	249.71	0		0.102	0.1825	0.00507	0.00907
^{161}Er	^{161m}Er	7.5 μs	189	84 ns	9/2+	?	?	397	144		0.05	0	0	0
^{162}Dy	^{162}Tb	7.6 m	80.66	2.19 ns	2+	?	0.69(3)	888.19	0		~0.25	~0.447	~0	~0
								962.97	0		−0.185(16)	−0.33(3)	−0.04561(4)	−0.08158(8)
^{164}Dy	^{164}Tb	3 m	73.37	2.39 ns	2+	−2.08(15)	0.684(23)	242.22	0		0.102	0.1825	0.00507	0.00907
^{169}Hf	^{169}Ta	4.9 m	28.8	82 ns	(7/2+)	?	?	177	0		0.05	0	0	0
^{173}Ta	^{173}W	7.5 m	130.2	5 ns	7/2+	?	?	166	0	$\binom{+}{+}$	0.030(6)	0	$1(6) \times 10^{-4}$	0
										$\binom{-}{+}$	0.070(6)	0	$1(6) \times 10^{-4}$	0
			166	225 ns	9/2−	?	2.66(8)[18]	623.6	130.2	$\binom{+}{+}$	0.068(7)	$3.0(17) \times 10^{-4}$	0	0
										$\binom{+}{-}$	0.115(7)	$3.0(17) \times 10^{-4}$	0	0
								623.6	0		−0.131	−0.08127	0	0
^{177}Yb	^{177m}Yb	6.41 s	104.5	4.48 ns	(7/2−)	?	?	331.5	0		−0.125	0	0.02611	0
^{179}Os	^{179}Ir	79 s	145.4	500 ns	(7/2−)	?	?	242.9	100.2		0.05	0	0	0
^{181}Ta	^{181m}Ta	18.9 μs	482	10.8 ns	5/2+	2.35(6)	3.29(3)	615	135		0.102	0.007855	0.1178	0.00907
								615	0	$\binom{+}{+}$	−0.3185(11)	−0.06018(4)	−0.3678(12)	−0.06950(5)
										$\binom{+}{-}$	−0.0198(12)	−0.06018(4)	−0.0229(14)	−0.06950(5)
^{181}Pt	^{181}Au	13.7 s	116.66	300 ns	(7/2−)	?	?	166.64	93.93		0.1071	0	0	0
								276.02	93.93		0.05	0	0	0
^{184}Os	^{184m}Os	23.6 ns	773.9	2.2 ns	6+	?	?	1274.7	383.8		0.102	0.05289	0.0175	0.00907
								1613.2	383.8		0.176(3)	0.0911(14)	0	0
								1717.6	383.8		−0.046(15)	−0.024(8)	$-1.7(8) \times 10^{-3}$	$-9(4) \times 10^{-4}$
			1274.7	2.2 ns	8+	?	?	1870.9	773.9		0.102	0.04622	0.02003	0.00907
								2366	773.9		0.102	0.04622	0.02003	0.00907
^{185}Pt	^{185}Au	4.25 m,	200.89	728 ns	5/2−	?	?	424.09	181.09	$\binom{+}{+}$	~−0.124	~0	~0.0327	~0
										$\binom{-}{+}$	~0.33	~0	~0.0327	~0
								424.09	103.41	$\binom{+}{+}$	~0.177	~0.205	~−0.0467	~−0.0539
										$\binom{-}{+}$	~−0.472	~−0.545	~−0.0467	~−0.0539
								451.87	181.09		−0.07143	0	−0.005499	0
								451.87	103.41		0.102	0.1178	0.007855	0.00907
								510.08	103.41		~0.0224	~0.0259	~0	~0
								590.71	181.09	$\binom{+}{+}$	~−0.17	~0	~0.0241	~0
										$\binom{-}{+}$	~0.348	~0	~0.0241	~0
								590.71	103.41	$\binom{+}{+}$	~0.242	~0.28	~−0.0344	~−0.0397
										$\binom{-}{+}$	~−0.497	~−0.574	~−0.0344	~−0.0397
								615.65	181.09	$\binom{+}{+}$	~−0.158	~0	~0.0111	~0
								(±)	~0.293	~0	~0.0111	~0		
								615.65	103.41	$\binom{+}{+}$	~0.225	~0.26	~−0.0158	~−0.0183
										$\binom{-}{+}$	~−0.419	~−0.484	~−0.0158	~−0.0183
								728.01	181.09		~−0.0944	~0	~0	~0
								728.01	103.41		~0.135	~0.156	~0	~0
								846.73	181.09		0.05	0	0	0

								846.73	103.41		−0.07143	−0.08248	0	0
^{185}Au	^{185}Hg	49.1 s,	8.9	4.8 ns	(9/2−)	?	?	107.5	0		−0.131	−0.08127	0	0
								220.1	0		−0.07143	−0.04433	0	0
								221.3	0		0.102	0.06333	0.01461	0.00907
			40.8	7 ns	(3/2+)	?	?	233.9	23.6	$\binom{+}{+}$	~−0.0951	~0	~0	~0
										$\binom{+}{-}$	~−0.256	~0	~0	~0
										$\binom{-}{+}$	~0.215	~0	~0	~0
										$\binom{-}{-}$	~0.578	~0	~0	~0
								291.1	23.6	$\binom{+}{+}$	0.026(17)	0	0	0
										$\binom{+}{-}$	0.070(13)	0	0	0
			8.9	4.8 ns	(9/2−)	?	?	301.2	0	$\binom{+}{+}$	~0.203	~0.126	~−0.063	~−0.0391
										$\binom{-}{+}$	~−0.411	~−0.255	~−0.063	~−0.0391
			40.8	7 ns	(3/2+)	?	?	439.5	23.6	$\binom{+}{+}$	−0.037(24)	0	0	0
										$\binom{+}{-}$	−0.101(18)	0	0	0
			220.1	26 ns	(11/2−)	?	?	490.2	8.9		−0.1182	0	−0.06433	0
								682.3	8.9		−0.07143	0	−0.01166	0
^{187}Au	^{187}Hg	114 s	223.93	48 ns	(11/2−)	?	?	673.24	120.4		−0.07(23)	0	−0.01(4)	0
								749.3	120.4	$\binom{+}{+}$	−0.2(5)	0	0.03(9)	0
										$\binom{+}{-}$	−0.2(5)	0	0.03(9)	0
										$\binom{-}{+}$	0.3(9)	0	0.03(9)	0
										$\binom{-}{-}$	0.3(9)	0	0.03(9)	0
	^{187}Hg	2.4 m	223.96	48 ns	(11/2−)	?	?	476.59	120.43		−0.1(4)	0	−0.06(21)	0
^{189}Pt	^{189}Au	4.59 m	172.7	464 ns	9/2−	?	?	493.8	6.3		−0.160(5)	−0.099(3)	−0.09059(9)	−0.05622(6)
^{189}Au	^{189}Hg	7.6 m	325.1	190 ns	9/2−	?	?	491.51	247.3	$\binom{+}{+}$	−0.34(9)	−0.017(14)	−0.21(5)	−0.011(9)
										$\binom{+}{-}$	0.18(7)	−0.017(14)	0.11(5)	−0.011(9)
								770.73	247.3	$\binom{+}{+}$	0.84(22)	0.04(3)	0.14(6)	$7(6)\times10^{-3}$
										$\binom{+}{-}$	−0.44(18)	0.04(3)	−0.07(4)	$7(6)\times10^{-3}$
										$\binom{-}{+}$	−0.51(16)	−0.026(22)	0.14(6)	$7(6)\times10^{-3}$
										$\binom{-}{-}$	0.27(12)	−0.026(22)	−0.07(4)	$7(6)\times10^{-3}$
								911	247.3	$\binom{+}{+}$	0.24(6)	0.012(10)	0	0
										$\binom{+}{-}$	−0.13(5)	0.012(10)	0	0
	^{189}Hg	8.6 m	325.32	190 ns	9/2−	?	?	646.35	247.46	$\binom{+}{+}$	−0.19(5)	$-9(8)\times10^{-3}$	−0.027(7)	$-1.3(11)\times10^{-3}$
										$\binom{+}{-}$	0.10(4)	$-9(8)\times10^{-3}$	0.014(6)	$-1.3(11)\times10^{-3}$
								712.9	247.46	$\binom{+}{+}$	−0.33(12)	−0.017(14)	0.12(4)	$6(5)\times10^{-3}$
										$\binom{+}{-}$	0.18(9)	−0.017(14)	−0.06(3)	$6(5)\times10^{-3}$
										$\binom{-}{+}$	0.72(20)	0.04(3)	0.12(4)	$6(5)\times10^{-3}$
										$\binom{-}{-}$	−0.38(16)	0.04(3)	−0.06(3)	$6(5)\times10^{-3}$
^{189}Pb	^{189m}Pb	22.2 μs	1287.25	2.1 ns	(21/2+)	?	?	1825.43	818.8		0.102	0.04194	0.02207	0.00907
								2097.83	818.8		0.102	0.04194	0.02207	0.00907
			2097.83	2.1 ns	(25/2+)	?	?	2434.53	1567.45		0.1786	0.06981	−0.01107	−0.004329
								2434.53	1287.25		0.1786	0.06981	−0.01107	−0.004329
^{194}Au	^{194m}Au	420 ms	244.6	2.6 ns	(7+)	?	?	406.8	107.4		−0.370(21)	−0.178(10)	−0.074(8)	−0.035(4)
^{194}Pb	^{194}Bi	115 s,	2407.6	17 ns	(9−)	?	−0.38(14)	2581.4	2241.3		−0.07143	−0.03092	0	0
^{196}Pb	^{196}Bi	5.13333 m	1049.27	100 ns	2+	?	?	1738.59	0		0.102	0.1825	0.00507	0.00907
	^{196}Bi	4 m	1049.23	100 ns	2+	?	?	1738.62	0		0.102	0.1825	0.00507	0.00907
			1738.62	1 μs	4+	?	?	1797.96	1049.23		−0.07143	−0.04856	0	0
			1049.23	100 ns	2+	?	?	1797.96	0		0.1786	0.3194	−0.00242	−0.004329
			1797.96	140 ns	5−	?	± 0.490(15)	2170.2	1738.62		−0.07143	0	−0.011	0
								2170.2	1049.23		0.1786	−0.02812	0.02749	−0.004329
			2170.2	5 ns	7−	?	?	2308.6	1797.96		0.102	0.04897	0.0189	0.00907
								2591.8	1797.96		−0.07143	−0.03428	0	0
			2308.6	52 ns	9−	?	−0.33(9)	2646.1	2170.2		−0.07143	−0.03092	0	0
^{196}Po	^{196m}Po	856 ns	859.12	12 ns	2+	?	?	1387.75	0		0.102	0.1825	0.00507	0.00907
^{201}Hg	^{201m}Hg	94 μs	547.5	20 ns	9/2−	?	?	766.9	26.34	$\binom{+}{+}$	~0.219	~0.136	~−0.0325	~−0.0202
										$\binom{-}{+}$	~−0.0519	~−0.0322	~0.0646	~0.0401
^{203}Pb	^{203m}Pb	480 ms	1921.98	42 ns	21/2+	?	−0.641(21)	2795.76	1663.61	$\binom{+}{+}$	0.19(8)	0.08(3)	−0.03(3)	−0.012(12)
										$\binom{-}{+}$	−0.34(9)	−0.14(4)	−0.03(3)	−0.012(12)
								2949.11	1663.61		0.2208	0.09075	−0.04375	−0.01798

Table 3 (*continued*)

Decay			Intermediate					Initial	Final	Angular correlation coefficients				
Daughter	Parent	Half-Life	Energy (keV)	Half-life	Spin/Parity	Q (eb)	μ(μN)	Energy (keV)	Energy (keV)	*	A_{22}	A_{24}	A_{42}	A_{44}
^{211}Rn	^{211}Fr	3.1 m	540	4 ns	5/2−	?	?	1458	0		0.102	0.1178	0.007855	0.00907
^{212}At	^{212m}At	152 μs	885.4	18.7 ns	(11+)	?	± 5.94(11)	1262.4	701.6		0.05	0	0	0
								1262.4	223		−0.07143	−0.02894	0	0
			1317	2 ns	(11−)	?	?	1540.6	223		0.102	0.04135	0.02238	0.00907
			1604.5	35.4 ns	(15−)	?	± 9.46(8)	1763.9	1540.6		−0.07143	−0.02672	0	0
								2212.2	1540.6		−0.07143	−0.02672	0	0
								2250	1540.6		0.1786	0.0668	−0.01157	−0.004329
^{225}Ra	^{225}Fr	4 m	31.56	2.1 ns	3/2−	?	?	179.75	0		0.05	0	0	0
^{227}Fr	^{227}Rn	20.8 s	39.88	2.7 ns	3/2+	?	?	144.32	0	(++)	~−0.0339	~0	~0	~0
										(+−)	~−0.111	~0	~0	~0
										(−+)	~−0.0339	~0	~0	~0
										(−−)	~−0.111	~0	~0	~0
								306.53	0	(++)	~−0.049	~0	~0	~0
										(+−)	~−0.16	~0	~0	~0
										(−+)	~−0.049	~0	~0	~0
										(−−)	~−0.16	~0	~0	~0

6. Future work

The ENSDF format parser created for *Nuclei* provides a simple to use yet powerful interface to the nuclear data contained in this database. It can be used not only for the search of TDPAC candidates but also for other combinations of nuclear decay properties, e.g. for Mössbauer spectroscopy or Nuclear Resonant Scattering experiments. We are currently planning to extend *Nuclei* for variants of TDPAC spectroscopy like β, γ or n, γ based measurements. We welcome any contributions extending functionality. Contributions are easily possible since the source code of *Nuclei* is developed using a public repository [14,15].

Although the number of potential TPDAC isotopes is larger than expected, their usefulness cannot be definitely confirmed in many cases yet because the nuclear moments are still unknown. We hope that this gap will be closed within the next years by precise measurements of these moments at appropriate facilities.

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