Evaluation of half-life data

M.J.Woods, S.M.Collins, S.A.Woods

JANUARY 2004

January 2004

Evaluation of half-life data

M J Woods[a], S M Collins[b] and S A Woods[b]

[a] Ionising Radiation Metrology Consultants Ltd
152 Broom Road
Teddington
Middlesex
United Kingdom
TW11 9PQ

[b] Centre for Acoustics and Ionising Radiation
National Physical Laboratory
Teddington
Middlesex
United Kingdom
TW11 0LW

ABSTRACT

As part of a Coordinated Research Project of the International Atomic Energy Agency to update a previous publication on radionuclide decay data, TECDOC 619, the National Physical Laboratory was asked to evaluate the half-lives of over 60 radionuclides. These radionuclides were identified as being of major importance in one or more of the various user groups which employ radionuclides.

The data that were used in the evaluations were those that were publicly available in the open literature. Various criteria were established both to determine the admissibility of the data and to maintain a common evaluation method for all of the radionuclides concerned.

This report details the evaluation criteria, the data used and the results of the evaluations.

ISSN 1740-0953

National Physical Laboratory
Teddington, Middlesex, UK TW11 0LW

Approved on behalf of Managing Director, NPL,
by Dr M Sené, Head of Centre, Centre for Acoustics and Ionising Radiation

CONTENTS

Page

TABLES

APPENDICES

1. INTRODUCTION

In the field of standards, those which relate to radioactivity are unique in that their activity values change with time. In order that the most economic use may be made of such standards, it is important that the half-life value used with any radionuclide standard is the most accurate available and that the associated uncertainties are well defined. It is important, too, having determined a 'best' half-life value, that the standardising and user communities both use that value.

Many sources of half-life data exist, being either individual determinations published in the open literature or evaluations. Users are faced then with the tasks of conducting their own searches to identify the various evaluations and of then making their own judgement about which evaluation data to use.

In the world of metrology, where there is increasing importance being given to the equivalence of measurement standards, it is critical that steps are taken to minimise the uncertainties on the degrees of equivalence between different measurement organisations. Such a potential source of uncertainty arises when users adopt different nuclear data. It is important, therefore, that there exist internationally recommended and accepted sets of nuclear data. For that recognition to be achieved, the evaluations need to be conducted by a group who are expert both in evaluations and in the relevant field of metrology. Such groups also need to ensure that they use a common and objective set of evaluation criteria.

In 1985, an International Atomic Energy Agency (IAEA) Coordinated Research Project (CRP) was established with the aim of evaluating decay scheme data for 36 radionuclides, which were of importance for the calibration of gamma-ray detectors. The data concerned related to gamma-ray emission probabilities and half-lives. The National Physical Laboratory and the Physikalisch-Technische Bundesanstalt undertook the evaluation of the half-life data and established an agreed evaluation criteria. The gamma-ray emission probability evaluations were undertaken by a larger group of internationally respected evaluators of nuclear data. The results of this work were summarised and published in 1991 as the IAEA-TECDOC-619 [1]. The half-life evaluations and results for these radionuclides were published in more detail in the NPL Report RS (EXT) 95 in 1988 [2].

Since the publication of the IAEA-TECDOC-619, new measurements have been completed and published. New radionuclides have been developed for applications in the field of nuclear medicine and new demands have arisen from the nuclear and environmental monitoring communities for improved nuclear data. These requirements led the IAEA to convene a Consultants Meeting in 1997 to discuss the quality of the relevant nuclear decay data and to define a suitable programme to resolve the various issues. The outcome was a new CRP to Update X- and Gamma-ray Decay Data Standards for Detector Calibrations and Other Applications. This CRP commenced its work at a meeting in Vienna in 1998 with subsequent meetings of the CRP participants in Braunschweig in 2000 and Vienna in 2002.

It was agreed that NPL would conduct all of the half-life evaluations as well as evaluating the gamma-ray emission probabilities for 6 radionuclides. This report addresses the half-life evaluations only.

2. OBJECTIVES OF THE COORDINATED RESEARCH PROJECT

The primary objective of the CRP was to improve detector efficiency calibration in the most critical non-energy applications including safeguards, material analysis, environmental monitoring, nuclear medicine, waste management, dosimetry, and basic spectroscopy.

Ancillary objectives of the CRP were identified with the following steps:

- selection of appropriate calibrant nuclides;
- assessment of the status of the existing data;
- identification of data discrepancies and limitations;
- stimulation of measurements to meet major data needs;
- evaluation and recommendation of improved efficiency calibration data.

Every effort was made to cover as wide a range of photon energies as possible. X- and gamma-ray emitting radionuclides were included to cover the energy range from 1 keV to 5 MeV. Other considerations for the selection of radionuclides included:

- commonly used and readily available nuclides;
- nuclides used and offered as standards by national laboratories, including multi-line nuclides for rapid calibrations;
- definition of a set of single-line nuclides to avoid the need for coincidence summing corrections;
- nuclides with accurately known emission probabilities.

A recommended list of over 60 radionuclides evolved from the meetings of the IAEA CRP, including specific parent-daughter combinations and two heavy-element decay chains. The list is shown in Table 1 and includes the areas of application in which the radionuclides are regarded as being important in terms of requiring accurate decay data. The radionuclides are also annotated as to whether they are used principally as primary or secondary standards. A primary standard is defined in this context as a nuclide for which gamma-ray emission probabilities (or intensities) are calculated from various data that do not include significant gamma-ray measurements (emission probabilities are usually close to 1.0, expressed per decay); these data may include internal conversion coefficients and intensities of weak beta branches. Secondary standards are nuclides for which the recommended γ-ray intensities depend on prior measurements of the gamma-ray intensities.

Laboratories contributing to the CRP evaluations are also listed in Table 1.

3. SOURCES OF HALF-LIFE DATA

The initial sources of nuclear data were the original reports [1, 2] and Nuclear Data Sheets (both specific nuclide evaluation publications and Recent References). Having used these to identify the original publications, hard copies of each publication were retrieved. It was necessary to peruse the original publications to ensure that there had been no transcription errors and that the confidence level of the quoted uncertainties was known. These publications also acted as a source of other relevant published data. It was also important to ensure that the result quoted was in fact a specific measurement of the half-life as opposed to a confirmation of the half-life when the radionuclide was being used to confirm the integrity of the measurement equipment.

In tabulating the input data to this evaluation, it was decided that, in conformance with the practice in the previous evaluation, the half-life values should be quoted in days and the associated uncertainties at a coverage factor, k = 1, which approximates to a confidence level of 67% or 1 standard deviation.

4. SELECTION OF DATA IN THE EVALUATION

One of the major problems in the evaluation of the half-lives was the setting of criteria which ensured maximum objectivity and minimised any subjective intervention by the evaluator. The simplest approach would have been to take a weighted mean of all published data. This pre-supposes many things, such as:

- all measurements were made with the principal intention of determining an accurate value of the half-life;
- all measurements were made with the same degree of scientific robustness;
- all uncertainties were estimated comprehensively;
- all uncertainties were estimated and combined according to the same rules;
- all correction factors, such as impurities, were determined accurately, corrected for and taken into account in the uncertainty budget;
- all measurement results were from the same population.

The importance of reading the published articles cannot be over-stated. For example, the first supposition above has already been mentioned but some values recorded in the open literature were the results of adventitious measurements. These measurements were often afterthoughts and were made because some relevant radioactive material happened to be available as a result of some other work. Alternatively, the stabilities of some measurement systems were confirmed by monitoring their responses over time using a radioactive source. The stabilities were then confirmed by comparing the observed half-life against the known value at that time. The observed half-life is then reported but this can not be regarded as a valid measurement for the purposes of evaluation because it presupposes the measuring equipment is stable – the very purpose of the half-life observation itself.

Reading the published papers also brings the evaluator to the conclusion that none of the other suppositions is true either. In respect of uncertainties, it is clear that the rules for combining individual components of uncertainty have changed significantly over the years and indeed were often different between different metrologists even at the same point in time. The comprehensiveness of uncertainty budgets has also left much to be desired as have methods of estimation, which range from scientifically- and experimentally-based to “best guesses”.

In the field of detecting and correcting for impurities, significant variations exist between measurements. This is very much a time-dependent problem. The availability of equipment with detection resolution sufficient to identify and quantify impurities has improved with time. In particular, the emergence of Ge detectors produced a quantum step in the capabilities in this area.

A further, and possibly contentious, issue is that relating to the publication of more than one half-life value by an author or institution. In the context of national standards of radioactivity, it is agreed that any NMI can only support one activity value for a standard even though it may have been determined by several different methods (with consequently different results). It is incumbent on the NMI to determine its “best” value and then to declare the value it supports. The method by which it combines its several results to produce a “best” value may be interesting but the critical result is the “best” value itself together with its associated uncertainty. The philosophical point is that an NMI cannot support more than one value. With the half-life evaluations, the same principle has been employed. Where an institution, via a publication from its employees, has declared a half-life value, it is assumed that this supersedes and replaces any previously published value from that same institution.

5. EVALUATION PROTOCOL

Evaluation techniques vary between evaluators and several different scenarios may be encountered, such as:

- the selection of only one measurement, perhaps that with the smallest uncertainty;
- the variation of evaluation criteria and rules between different evaluators and different radionuclides;
- the use of statistical techniques to modify reported uncertainties in order to produce a more “acceptable” evaluated result;
- the use of different statistical techniques for different radionuclides within the same evaluation exercise.

It is clear that there is often not a commonality of approach and that half-life values have not always been derived with the same depth of analysis.

It is critical, therefore, that a transparent and standardised approach is employed. To this end, a set of criteria were discussed and agreed for the purposes of this evaluation exercise. Those criteria were:

- generally, only data published after 1967 was accepted for evaluation (it is assumed that 1968 is the approximate date from which Ge detectors became generally available). It was necessary to break this rule where there was insufficient recent data.

- only the latest published data from any institution was included;

- published values without an associated uncertainty estimate would not be used;

- unless otherwise stated in the text, the published uncertainty would be regarded as being at the one standard deviation level;

- all published values would be converted to days before evaluation and evaluated results would also be quoted in days, using a conversion of 365.2422 days per year;

- the principle of "limitation of relative statistical weights" would be invoked so that no individual value would have a statistical weight of greater than 50% when calculating the mean value;

- when evaluating a set of data, the external (SW1) and internal (SW2) uncertainties of the weighted mean (WM) were calculated together with the standard deviation (SU) of the unweighted mean (UM). If the sum of SU and the larger of SW1 and SW2 were larger than the difference between WM and UM, WM would be used as the best estimate of the mean value together with a standard uncertainty equal to the larger of SW1 and SW2. Failing this, the best estimate would be represented by UM and a standard uncertainty of SU;

- the uncertainty on the best estimate would be increased, where necessary, to ensure that the published value with the smallest uncertainty estimate would be within the interval represented by the best estimate plus or minus its standard uncertainty;

- the evaluators would be allowed to reject values which were clearly outliers.

6. PRESENTATION OF THE RESULTS OF THE EVALUATION

It was agreed to use the shorthand notation whereby the value 312.40 ± 0.14 is written 312.40 (14). Given this notation, each final uncertainty is given as an integer between 3 and 29 inclusive, and the half-life value is rounded to the nearest significant digit. All rounding of uncertainties is, however, upwards. Thus the result 950.82 ± 0.31 is presented as 950.8(4), while 78.120 ± 0.122 becomes 78.12(13).

The results of the present evaluation are summarised in Table 2, columns 1 and 2. Full details of the analysis of data for each radionuclide are given in Appendix 1, together with some explanatory comments. The significance of columns 3 to 7 of Table 2 is discussed below.

7. RECOMMENDATIONS FOR FUTURE MEASUREMENTS

It is considered to be a duty of the evaluators, having completed their analysis of existing data, to make recommendations where necessary for further measurements. The need for the latter may arise from one or more of the following reasons:

- the existing data set is too small; two measured values is the absolute minimum for an evaluation but six measurements used in the final evaluation is regarded as a preferred minimum;
- the existing data set is inconsistent, i.e. the unweighted mean is required to be used or the reduced chi-squared value is greater than unity;
- the uncertainty on the value derived from the existing data set is too large.

The last-mentioned of the above requires consideration of the use that is made of half-life data. In harmony with the principles adopted for the previous evaluation, the present authors have assumed that any given radioactive source used for calibration purposes may remain in use for a period of 15 years or 5 half-lives, whichever is the shorter. The authors have, further, adopted the principle that the maximum uncertainty arising from the uncertainty in the half-life of the calibration source should not exceed 0.1%. This condition leads to the relationship

$$\frac{dT}{T} = 0.00144 \frac{T}{T_1}$$

where dT is the maximum permissible uncertainty in the half-life T, and T_1 is the maximum source-in-use period for the particular radionuclide.

From the above relationship, for example, it follows that a half-life of 15 years should have an uncertainty not exceeding ± 0.15%, while a half-life of 3 years should be known to ± 0.03%.

The information in columns 3 to 6 of Table 2 informs the discussion and conclusions below.

8. DISCUSSION

The importance of the accuracy of half-lives is often forgotten alongside the more scientifically-interesting aspects of the measurement itself and the implications that it has on the results of standardisations and the values attributed to calibration standards themselves. However, the uncertainty on the radionuclide half-life is an important and perhaps determining factor in its efficacy and continued usefulness. This in turn will have its own economic impact in that, when its uncertainty contribution exceeds a critical value, it will be necessary to replace or re-calibrate the standard.

Typically, the overall level of uncertainty for measurements involving radioactive materials is of the order of a few percent or less. In order to achieve this, individual contributors to the overall uncertainty budget should be of the order of a magnitude smaller and this is the main driver which resulted in the preferred accuracy criteria described above. It is interesting, therefore, to examine the results in more detail.

The 1968 cut-off date is based on sound scientific reasons. In general, half-lives are determined by plotting the time-related response of a radiation-sensitive instrument which is following the decay of the radionuclide of concern. For very long-lived radionuclides, it may be argued that the presence of an impurity will be recognised by the non-linearity of the decay curve of the responses. On the other hand, the resources required to follow the decay of a very long-lived radionuclide are very large and alternative procedures are often invoked and which entail, effectively, a single measurement at a single point in time (e.g. mass spectrometry). Such a measurement minimises the opportunity to confirm, or otherwise, the presence of impurities. An accurate and independent method of identifying impurities is required and Ge spectrometry is the method of choice for gamma-ray emitting contaminants. This consideration reinforces the 1968 cut-off date.

Measurements covering a period of about 40 years had normally to be considered in order to obtain a meaningful number of data points for any radionuclide, and the majority of these data were published between 25 and 40 years ago. There have been significant changes in measurement capabilities, detection of impurities and uncertainty estimation procedures during this time and (as would be expected) in none of the cases considered in this evaluation exercise could all of the required criteria be satisfied.

Despite the 1968 deadline, there are a number of radionuclides where there are insufficient, or even no, measurements after this date. Of particular note are three radionuclides, ^{66}Ga, ^{166}Ho^{m} and ^{226}Ra.

Although ^{66}Ga is regarded as being of particular importance for the provision of calibration photons with energies above 3600 keV, the latest published half-life data originate from 1939, 1952, 1959 and 1964. The reduced chi-squared value indicates that these four values are from the same population. However, the evaluated uncertainty is 0.64%, and is a factor of 22 too large if the “0.1% uncertainty contribution over 5 half-lives” criterion for calibration nuclides is invoked.

For ^{226}Ra, this radionuclide has been used for many years as a reference source yet the latest half-life measurement was performed in 1966. ^{166}Ho^{m} is being recommended as an alternative, long-lived reference source, challenging ^{226}Ra. Of even more concern than that relating to ^{226}Ra is that only one definitive measurement of the half-life of ^{166}Ho^{m} has been reported and that was in 1965. Given the concerns expressed above about the effect of impurities and the ability to satisfactorily detect and correct for these, the measurement date of 1965 gives cause for concern.

It is important that several measurements are available in order that a robust estimate of the uncertainty of the recommended value can be determined, and which does not depend in any significant way on the uncertainty estimate from an individual metrologist. It is notable that over 75% of the radionuclides in this study have less than six reported measurements published since 1968.

Since the publication of TECDOC-619 in 1991, only about 70 new half-life values have been published for the radionuclides in this evaluation. If these new data are examined in more detail, almost all of these publications are in fact updates of data that have been previously published, and principally from only three institutes, namely Atomic Energy of Canada Ltd, the National Institute for Standards and Technology, and Physikalisch-Technische Bundesanstalt. These new data are generally replacements and do not increase the number of data points available for evaluation. Therefore, the number of new, independent data is only of the order of 20.

Again, a closer examination of these new data is interesting. For many of the replacement data, the uncertainty quoted is larger than that previously published. This no doubt indicates that the relevant uncertainty budgets have been considered in more depth and more robustly than before. Some of these new data have uncertainties that are significantly larger than the rest of the data in the evaluation set for the radionuclide of concern. When the evaluation is conducted, the resulting weighting factor for these data mean that they have little or no significant impact on the final result. In essence, these values add little or nothing to the improvement in evaluated half-lives.

The quality of reporting half-life values has not always seen the improvements that might be desired. There are two points in particular. If qualitative evaluations are to be performed with any degree of confidence, it is important that the uncertainties are identified, estimated, combined and reported in accordance with the latest ISO recommendations. It is essential therefore that referees insist that these recommendations are adhered to, that the referees themselves are expert in the measurement techniques and that they examine the relevant uncertainty budgets critically. Secondly, where half-lives are monitored for the purposes of validating the stability of measurement systems, the observed half-lives should not be published to the extent that they can be mistaken for independent determinations. Again, this responsibility rests with the referees.

The previous report centred on just 36 radionuclides and recommended that, because of the importance of these radionuclides as the sources of calibration standards, further measurements were required for over half (20) of these radionuclides.(for which 211 published values had been used for their evaluations). In practice, only 50 new measurements have been reported, covering these 20 radionuclides. For 2 radionuclides, no new measurements have been reported whilst of the 50 new measurements, 30 of these are replacement values (values from institutions which already had a previous value in the evaluation set). As discussed above, these replacement values have not always resulted in a decrease in the evaluated uncertainty.

It is noteworthy too that those institutions that have access to measurements systems which can, potentially, provide very accurate half-life measurements have not themselves all been active in making such measurements. Ironically, it is some of these institutions which have the greatest interest in obtaining more accurate half-life values.

Summarising this discussion, a few salient points can be made:

- where further measurements were recommended in TECDOC-619, on average, only one new measurement from a new institution has been conducted;
- for those radionuclides in TECDOC-619, this present exercise has resulted in increased uncertainties for 6 of those radionuclides;
- in the present exercise, over 75% of the half-lives require further measurements to either improve the uncertainty or to increase their robustness;

- over 50% of evaluations have unsatisfactory chi-squared values, indicating possible deficiencies in uncertainty estimates or impurity corrections;
- about 60% of the half-life uncertainties are too large, according to the present criteria, if the corresponding radionuclides are to be used as calibration standards with a useful working life.

9. CONCLUSIONS AND RECOMMENDATIONS

Using the criteria described above, over 75% of the radionuclides considered require further measurements to be made.

Given that these radionuclides are used as calibration standards across a wide range of industries and activities which have an impact on the quality of life, there is an urgent requirement to reduce uncertainties to acceptable levels.

Despite the recommendations of the previous report, there has not been any concerted effort to target particular radionuclides for further half-life measurements. It is recommended that those institutions which have access to measurement instruments which have the capability of making significant improvements to the accuracies of half-life values should establish a concerted, harmonised and planned measurement programme.

It is recommended that a priority list of radionuclides should be established for future half-life measurements together with target uncertainties. The recommendations given in column 7 of Table 2 represent the views of the present authors: it is for the metrologists, and those who commission measurements, to assign priorities.

It is interesting to note that institutions which use the same measurement technique often produce uncertainty values which indicate that their estimation procedures are significantly at variance. There is potential for a group of expert metrologists to establish "state-of-the-art" uncertainty budgets for particular measurement techniques and radionuclides.

It is recommended that a more critical evaluation protocol should be developed by a group of expert metrologists.

10. ACKNOWLEDGEMENTS

The authors acknowledge the financial support of the National Measurement System Policy Unit of the United Kingdom Department of Trade and Industry.

11. REFERENCES

The references for the individual data points used in these evaluations are listed together in Appendix 2. Since many of these are common to several radionuclides, for convenience they have been grouped by publication year and then alphabetically by the first author

[1] X-ray and gamma-ray standards for detector calibration. IAEA-TECDOC-619. Vienna, International Atomic Energy Agency, 1991.

[2] WOODS, M.J., MUNSTER, A.S. Evaluation of half-life data. NPL Report RS(EXT)95, February 1988.

Table 1 - Selected radionuclides, applications and evaluators

D = dosimetry standard
M = medical applications
E = environmental monitoring
W = waste management
S = safeguards

P = primary efficiency calibration standard
S = secondary efficiency calibration standard

Nuclide	X/γ-Ray Standard	D	M	E	W	S	Evaluators	
							Emission probability	$\tau_{1/2}$
^{22}Na	P		x					NPL
^{24}Na	P						INEEL	NPL
^{40}K				x			INEEL	NPL
^{46}Sc	P						INEEL	NPL
^{51}Cr	P		x				INEEL/PTB	NPL
^{54}Mn	P			x	x		INEEL/PTB	NPL
^{56}Mn			x				AEA	NPL
^{55}Fe	P		x		x		LNHB	NPL
^{59}Fe			x				LNHB	NPL
^{56}Co	S						NPL	NPL
^{57}Co	P		x			x	KRI	NPL
^{58}Co	P			x			LNHB	NPL
^{60}Co	P		x	x	x	x	INEEL	NPL
^{64}Cu			x				INEEL	NPL
^{65}Zn	P			x	x		INEEL	NPL
^{66}Ga	S		x				CIEMAT/UNED	NPL
^{67}Ga			x				KRI	NPL
^{68}Ga			x				PTB	NPL
^{75}Se	S		x				LBL/PTB	NPL
^{85}Kr				x			NPL	NPL
^{85}Sr	P		x	x			PTB	NPL
^{88}Y	P						PTB	NPL
^{93m}Nb		x					KRI	NPL
^{94}Nb	P						NPL	NPL
^{95}Nb	P			x			INEEL	NPL
^{99}Mo			x				LNHB/ KRI	NPL
^{99m}Tc			x				LNHB	NPL
^{103}Ru			x	x			NPL	NPL
^{106}Rh			x	x			NPL	NPL
^{106}Ru			x	x			NPL	NPL
^{110m}Ag				x	x		INEEL	NPL
^{109}Cd	P			x			PTB	NPL
^{111}In	P		x				KRI	NPL

Nuclide	X/γ-Ray Standard	D	M	E	W	S	Evaluators	
							Emission probability	$\tau_{½}$
^{113}Sn	P						INEEL	NPL
^{125}Sb				x			CIEMAT/UNED	NPL
^{123m}Te	P						LNHB	NPL
^{123}I			x				LNHB	NPL
^{125}I	P	x	x				PTB	NPL
^{129}I				x	x		KRI	NPL
^{131}I		x	x	x			LNHB	NPL
^{134}Cs				x			USP	NPL
^{137}Cs	P	x		x	x		INEEL	NPL
^{133}Ba	S		x				KRI	NPL
^{139}Ce	P			x			PTB	NPL
^{141}Ce	P			x			PTB	NPL
^{144}Ce	P		x	x			PTB	NPL
^{153}Sm			x				INEEL	NPL
^{152}Eu	S			x	x	x	USP	NPL
^{154}Eu				x	x	x	KRI	NPL
^{155}Eu	P			x	x		KRI	NPL
^{166}Ho			x			x	PTB	NPL
^{166m}Ho			x			x	PTB	NPL
^{170}Tm	P						KRI	NPL
^{169}Yb			x				PTB/LNHB	NPL
^{192}Ir		x	x				LBL/INEEL/USP	NPL
^{198}Au	P						PTB	NPL
^{203}Hg	P						AEA	NPL
^{201}Tl			x				PTB	NPL
^{207}Bi			x				LNHB	NPL
^{226}Ra		x		x	x		INEEL	NPL
^{228}Th	P			x			AEA	NPL
^{234m}Pa				x	x		AEA	NPL
^{241}Am	P			x	x	x	KRI	NPL
^{243}Am					x		CIEMAT/UNED	NPL

AEA - AEA Technology plc, UK.

CIEMAT - Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas, Spain.

INEEL - Idaho National Engineering and Environmental Laboratory, USA.

KRI - V.G. Khlopin Radium Institute, Russian Federation.

LBL - Lawrence Berkeley Laboratory, USA.

LNHB - Laboratoire National Henri Becquerel, France.

NPL - National Physical Laboratory, UK.

PTB - Physikalisch Technische Bundesanstalt, Germany.

UNED - Universidad Nacional de Educacion a Distancia, Spain.

USP - University of Sao Paulo, Brazil.

Table 2 - Evaluated half-lives and analysis

Nuclide	$\tau_{1/2}$ (days)	Std. uncertainty (evaluated/required)	χ^2 / (n-1)	Number of data points		More data required?
				Used	Since 1968	
^{22}Na	950.57 (23)	0.84	5.6	3	3	YES
^{24}Na	0.62329 (6)	0.33	1.42	10	13	NO
^{40}K	4.563 (13) x 10^{11}	0.00	3.0	3	2	YES
^{46}Sc	83.79 (4)	1.66	2.5	6	7	YES
^{51}Cr	27.7009 (20)	0.25	1.3	6	10	NO
^{54}Mn	312.29 (26)	2.89	38	8	9	YES
^{55}Fe	1002.7 (23)	7.96	6.1	5	5	YES
^{56}Co	77.236 (26) d	1.17	1.9	6	8	YES
^{56}Mn	0.107449 (19)	0.61	11.1	6	6	YES
^{57}Co	271.80 (5)	0.64	2.6	6	7	YES
^{58}Co	70.86 (6)	2.94	2.3	6	8	YES
^{59}Fe	44.494 (13)	1.01	3.1	5	6	YES
^{60}Co	1925.23 (27)	0.49	0.2	5	7	NO
^{64}Cu	0.52929 (18)	1.18	1.8	9	9	YES
^{65}Zn	243.86 (20)	2.85	4.1	5	7	YES
^{66}Ga	0.3889 (34)	30.36	0.2	4	0	YES
^{67}Ga	3.2616 (4)	0.43	1	7	7	NO
^{68}Ga	0.04703 (7)	5.17	2.9	3	3	YES
^{75}Se	119.778 (29)	0.84	0.2	3	4	NO
^{85}Kr	3927 (8)	7.07	14.3	3	2	YES
^{85}Sr	64.851 (5)	0.27	0.7	9	10	NO
^{88}Y	106.625 (24)	0.78	0.1	5	8	NO
^{93}Nb^{m}	5.73 (22) x 10^3	25.49	28	4	3	YES
^{94}Nb	7.3 (9) x 10^6	0.06	0.2	3	0	YES
^{95}Nb	34.985 (12)	1.19	2.6	4	6	YES
^{99}Mo	2.7478 (7)	0.88	23.9	4	4	YES
^{99}Tc^{m}	0.250281 (22)	0.31	0.2	6	9	NO
^{103}Ru	39.247 (13)	1.15	3.3	4	4	YES
^{106}Rh	0.000348 (4)	39.91	7.3	2	1	YES
^{106}Ru	371.8 (18)	16.81	9	5	2	YES
^{109}Cd	461.4 (12)	9.03	16.2	6	7	YES
^{110}Ag^{m}	249.85 (10)	1.39	4.1	4	5	YES

Nuclide	$\tau_{1/2}$ (days)	Std. uncertainty (evaluated/required)	χ^2 / (n-1)	Number of data points		More data required?
				Used	Since 1968	
^{111}In	2.8049 (6)	0.74	3.7	5	8	YES
^{113}Sn	115.09 (4)	1.21	0.03	5	5	YES
^{123}I	0.55098 (9)	0.57	1.4	4	6	NO
^{123}Te^{m}	119.45 (25)	7.27	12.5	2	2	YES
^{124}I	4.16 (6)	50.08	0.08	3	3	YES
^{125}I	59.402 (14)	0.82	0.6	7	11	NO
^{125}Sb	1007.48 (21)	0.72	0.5	3	3	NO
^{129}I	5.89 (23) x 10^9	0.00	3.2	4	2	YES
^{131}I	8.0228 (24)	1.04	7.1	6	8	YES
^{133}Ba	3848.7 (12)	1.08	2.4	6	6	YES
^{134}Cs	753.5 (10)	4.61	4.6	5	6	YES
^{137}Cs	1.099 (4) x 10^4	1.26	23.8	11	11	YES
^{139}Ce	137.642 (20)	0.50	1	6	6	NO
^{141}Ce	32.503 (14)	1.50	0.07	5	5	YES
^{144}Ce	285.1 (5)	6.09	55.3	6	6	YES
^{147}Pm	9.4 (4) x 10^2	147.75	5	4	0	YES
^{152}Eu	4941 (7)	4.92	3.7	5	8	YES
^{153}Sm	1.938 (10)	17.92	24.3	6	6	YES
^{154}Eu	3138.1 (14)	1.55	0.01	4	4	YES
^{155}Eu	1736 (6)	12.00	0.9	4	6	YES
^{166}Ho	1.1165 (13)	4.04	36.3	3	4	YES
^{166}Ho^{m}	4.4 (7) x 10^5	1.38	-	1	0	YES
^{169}Yb	32.016 (6)	0.65	1.3	6	7	NO
^{170}Tm	127.8 (8)	21.74	4.7	4	2	YES
^{192}Ir	73.822 (9)	0.42	0.4	4	5	NO
^{198}Au	2.6950 (7)	0.90	3.7	8	9	YES
^{201}Tl	3.0422 (17)	1.94	4.2	5	5	YES
^{203}Hg	46.594 (12)	0.89	1.3	4	6	NO
^{207}Bi	1.18 (3) x 10^4	8.20	2	4	4	YES
^{226}Ra	5.862 (22) x 10^5	0.02	1.3	4	0	YES
^{228}Th	698.60 (23)	1.14	0.8	3	2	YES
^{234}Pa^{m}	0.000805 (11)	47.45	2.6	4	1	YES
^{241}Am	1.5785 (23) x 10^5	0.04	2.2	6	5	YES
^{243}Am	2.692 (8) x 10^6	0.00	0.08	3	3	NO

APPENDIX 1

Evaluated half-life tables

Notation and formulae used in evaluations and tables

T_i individual half-life values for a particular radionuclide
s_i standard deviation of T_i (coverage factor, k = 1)
n number of results being averaged

Σ always means $\sum_{i=1}^{n}$

UM unweighted mean

$$\mathbf{UM} = \frac{1}{n}\sum T_i$$

SU standard deviation of the unweighted mean

$$\mathbf{SU}^2 = \frac{\sum (T_i - UM)^2}{n(n-1)}$$

WM weighted mean

$$\mathbf{WM} = \frac{\sum (T_i / s_i^2)}{\sum (1/s_i^2)}$$

i.e. weight of ith value = $1/s_i^2$

SW1 standard deviation of the weighted mean ("external uncertainty")

$$\mathbf{SW1}^2 = \frac{\sum [(T_i - WM)^2 / s_i^2]}{(n-1)\sum (1/s_i^2)} = \frac{\chi^2}{(n-1)} . SW2^2$$

SW2 "internal uncertainty"

$$\mathbf{SW2}^2 = 1/\sum (1/s_i^2)$$

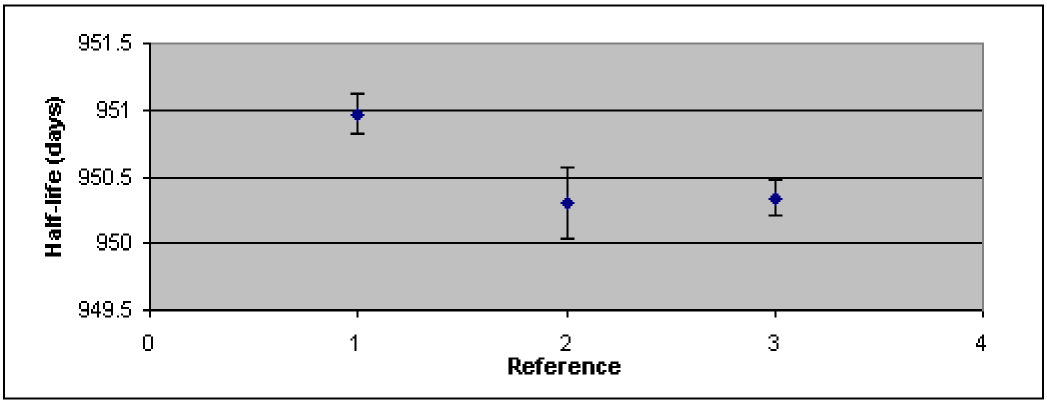
χ^2

$$\frac{\chi^2}{(n-1)} = \frac{SW1^2}{SW2^2} = \frac{\sum [(T_i - WM)^2 / s_i^2]}{(n-1)}$$

Note: All uncertainties in the Tables are quoted with a coverage factor of k = 1, corresponding to a confidence level of approximately 68%.

^{22}Na

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
950.97	0.15	0.3788	1992	Unterweger	[1]
950.3	0.27	0.1169	1980	Rutledge	[2]
950.34	0.13	0.5043	1980	Houtermans	[3]



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
950.537	0.217	950.574	0.219	0.092	5.62

SU + SW1 = 0.436 |UM-WM| = 0.037 **Use WTD Mean**

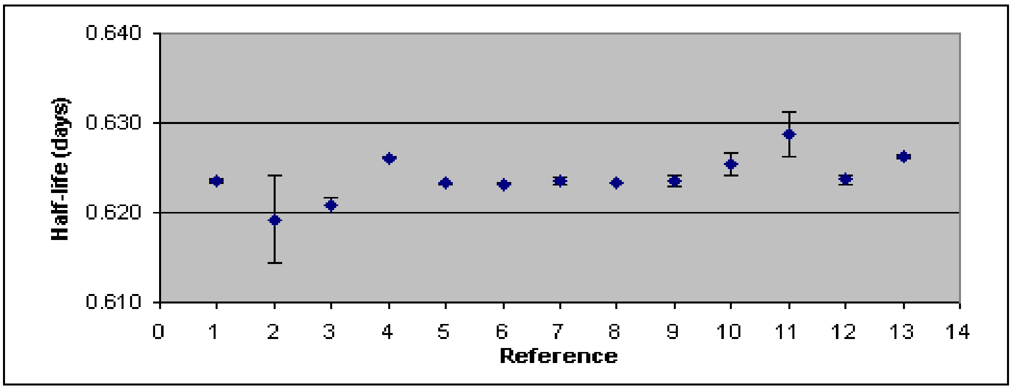
Increase SW1 to 0.23 to include lowest uncertainty value

EVALUATED $\tau_{1/2}$ (days) = 950.57 (23)

^{24}Na

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	0.623483	0.000167	0.0457	2003	Unterweger	[1]
	0.61924	0.00486	0.0001	1994	Mignonsin	[2]
2	0.6208	0.0009	0.0016	1991	Bode	[3]
2	0.62613	0.00009	0.1573	1989	Abzouzi	[4]
	0.62323	0.00012	0.0885	1983	Walz	[5]
	0.62317	0.00011	0.1053	1982	Lagoutine	[6]
	0.62354	0.00042	0.0072	1980	Rutledge	[7]
1	0.623292	0.000050	0.5096	1980	Houtermans	[8]
	0.62350	0.00063	0.0032	1980	Muckenheim	[9]
	0.62542	0.00117	0.0009	1978	Davis	[10]
	0.6288	0.0025	0.0002	1976	Genz	[11]
	0.6237	0.0005	0.0051	1974	Chakraborty	[12]
2	0.62625	0.00013	0.0754	1972	Emery	[13]

1 = Normalise Weight < 0.5 *2 = Reject, far from mean*



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
0.623889	0.000670	0.623955	0.00036	0.000036	98.94

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
0.623483	0.000167	0.0898	2003	Unterweger	[1]
0.61924	0.00486	0.0001	1994	Mignonsin	[2]
0.62323	0.00012	0.1739	1983	Walz	[5]
0.62317	0.00011	0.2069	1982	Lagoutine	[6]
0.62354	0.00042	0.0142	1980	Rutledge	[7]
0.623292	0.000071	0.4966	1980	Houtermans	[8]
0.62350	0.00063	0.0063	1980	Muckenheim	[9]
0.62542	0.00117	0.0018	1978	Davis	[10]
0.6288	0.0025	0.0004	1976	Genz	[11]
0.6237	0.0005	0.0100	1974	Chakraborty	[12]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
0.623738	0.000743	0.623288	0.000060	0.000050	1.42

SU + SW1 = 0.000802 |UM-WM| = 0.000450 **Use WTD Mean**

EVALUATED $\tau_{1/2}$ (days) = 0.62329 (6)

(continued overleaf)

^{24}Na (cont)

Comments

Kemeny (1969) omitted as background not subtracted
Chakraborty (1974) is weighted mean of six values

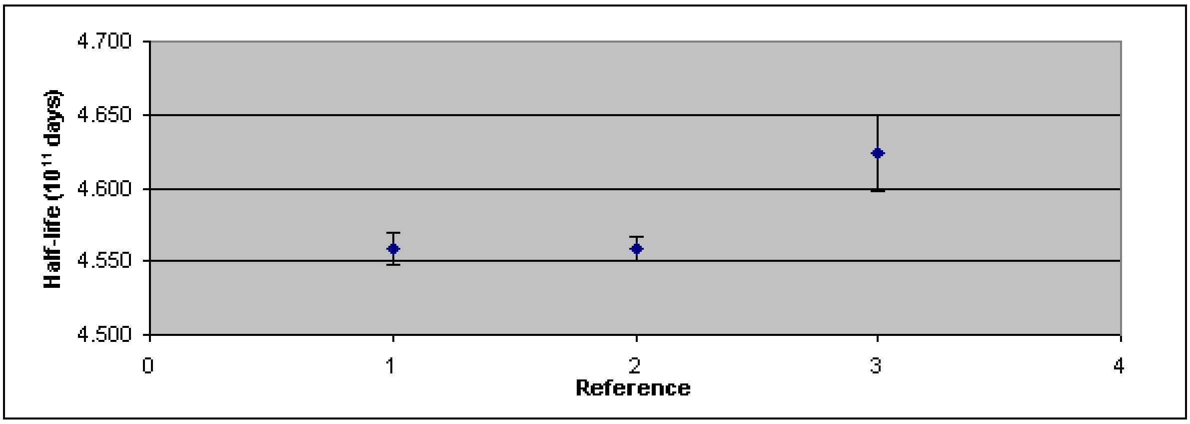
0.62383	0.00056
0.62368	0.00073
0.6223	0.00092
0.62267	0.00072
0.62626	0.00117
0.62575	0.0011

Original published data	Reference	Half-life	Uncert	Units
	[1]	14.9636	0.0040	hours
	[3]	14.90	0.02	hours
	[4]	15.027	0.002	hours
	[6]	14.956	0.008 (3σ)	hours
	[7]	14.965	0.010	hours
	[8]	14.9590	0.0012	hours
	[9]	14.964	0.015	hours
	[10]	15.010	0.028	hours
	[13]	15.030	0.003	hours

^{40}K

Half-life (10^{11} days)	Uncert (10^{11} days)	Norm. wt	Year	Author	Ref
4.558	0.011	0.3258	2004	Kossert	[1]
1 4.558	0.008	0.6159	2002	Grau Malonda	[2]
4.624	0.026	0.0583	1965	Leutz	[3]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
4.5800	0.0220	4.5618	0.0109	0.0063	3.03

Half-life (10^{11} days)	Uncert (10^{11} days)	Norm. wt	Year	Author	Ref
4.558	0.011	0.4589	2004	Kossert	[1]
4.558	0.011	0.4589	2002	Grau Malonda	[2]
4.624	0.026	0.0821	1965	Leutz	[3]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
4.5800	0.0220	4.5634	0.0128	0.0075	2.96

SU + SW1 = 0.0348 |UM-WM| = 0.0166 **Use WTD Mean**

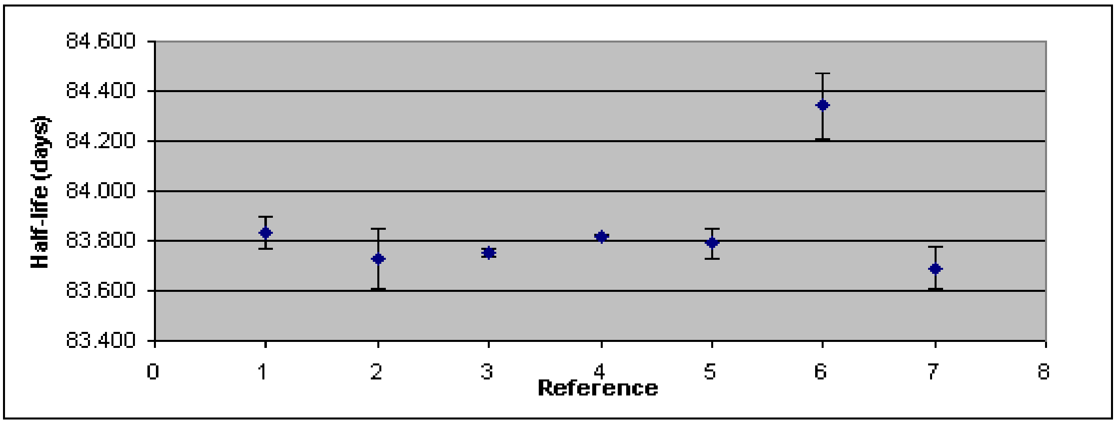
EVALUATED $\tau_{1/2}$ (days) = 4.563 (13) x 10^{11}

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[1]	*1.248*	*0.003*	*10^9 y*
	[2]	*1.248*	*0.004 (2s)*	*10^9 y*
	[3]	*1.266*	*0.007*	*10^9 y*

^{46}Sc

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	83.831	0.066	0.0070	1992	Unterweger	[1]
	83.73	0.12	0.0021	1983	Walz	[2]
	83.752	0.015	0.1347	1980	Rutledge	[3]
1	83.819	0.006	0.8418	1980	Houtermans	[4]
	83.79	0.06	0.0084	1980	Olomo	[5]
2	84.34	0.13	0.0018	1974	Cressy	[6]
	83.691	0.084	0.0043	1972	Bambynek	[7]

1 = Normalise Weight < 0.5 *2 = Reject, far from mean*



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
83.8504	0.0837	83.8100	0.0136	0.0055	6.08

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
83.831	0.066	0.0224	1992	Unterweger	[1]
83.73	0.12	0.0068	1983	Walz	[2]
83.752	0.015	0.4330	1980	Rutledge	[3]
83.819	0.014	0.4970	1980	Houtermans	[4]
83.79	0.06	0.0271	1980	Olomo	[5]
83.691	0.084	0.0138	1972	Bambynek	[7]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
83.7688	0.0221	83.7871	0.0157	0.0099	2.53

SU + SW1 = 0.0378 |UM-WM| = 0.0183 **Use WTD Mean**

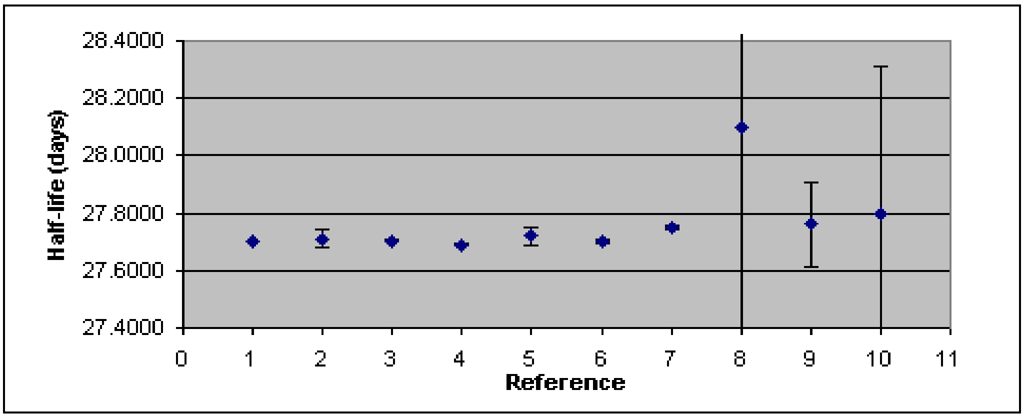
Increase SW1 to 0.032 to include lowest uncertainty value

EVALUATED $\tau_{1/2}$ (days) = 83.79 (4)

^{51}Cr

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1	27.7010	0.0012	0.7951	1992	Unterweger	[1]
	27.71	0.03	0.0013	1983	Walz	[2]
	27.704	0.003	0.1272	1980	Rutledge	[3]
	27.690	0.005	0.0458	1980	Houtermans	[4]
	27.720	0.03	0.0013	1975	Lagoutine	[5]
	27.703	0.008	0.0179	1974	Tse	[6]
2	27.750	0.009	0.0114	1973	Visser	[7]
2	28.1	1.7	0.0000	1973	Araminowicz	[8]
2	27.76	0.15	0.0001	1972	Emery	[9]
2	27.80	0.51	0.0000	1968	Bormann	[10]

1 = Normalise Weight < 0.5 *2 = Reject, far from mean*



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
27.76380	0.03888	27.70151	0.00197	0.00107	3.38

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
27.7010	0.0025	0.4864	1992	Unterweger	[1]
27.71	0.03	0.0034	1983	Walz	[2]
27.704	0.003	0.3378	1980	Rutledge	[3]
27.690	0.005	0.1216	1980	Houtermans	[4]
27.720	0.03	0.0034	1975	Lagoutine	[5]
27.703	0.008	0.0475	1974	Tse	[6]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
27.70467	0.00406	27.70087	0.00197	0.00174	1.28

SU + SW1 = 0.006034 |UM-WM| = 0.003801 **Use WTD Mean**

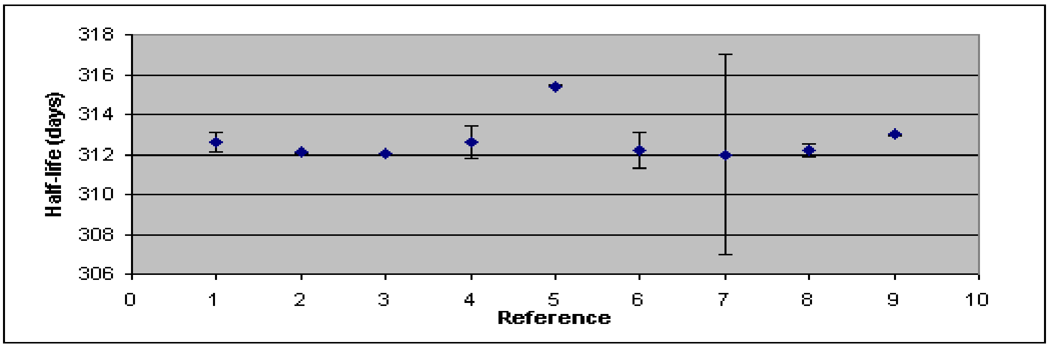
Evaluated $\tau_{1/2}$ (days) = **27.7009 (20)**

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[5]		*0.08 (3σ)*	*days*
	[7]		*0.03 (3σ)*	*days*

^{54}Mn

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	312.6	0.5	0.0014	2000	Huh	[1]
	312.11	0.05	0.1432	1997	Martin	[2]
1	312.028	0.034	0.3096	1992	Unterweger	[3]
	312.6	0.8	0.0006	1974	Cressy	[4]
2	315.40	0.03	0.3977	1973	Visser	[5]
	312.2	0.9	0.0004	1969	Boulanger	[6]
	312	5	0.0000	1968	Hammer	[7]
	312.2	0.3	0.0040	1968	Lagoutine	[8]
	312.99	0.05	0.1432	1968	Zimmer	[9]

1 = Normalise Weight < 0.5 after rejection of outlier *2 = Reject, far from mean*



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
312.6809	0.3571	313.5203	0.5510	0.0189	848.34

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
312.6	0.5	0.0024	2000	Huh	[1]
312.11	0.05	0.2448	1997	Martin	[2]
312.028	0.035	0.4995	1992	Unterweger	[3]
312.6	0.8	0.0010	1974	Cressy	[4]
312.2	0.9	0.0008	1969	Boulanger	[6]
312	5	0.0000	1968	Hammer	[7]
312.2	0.3	0.0068	1968	Lagoutine	[8]
312.99	0.05	0.2448	1968	Zimmer	[9]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
312.3410	0.1241	312.2868	0.1524	0.0247	37.95

SU + SW1 = 0.2765 |UM-WM| = 0.0542 **Use WTD Mean**

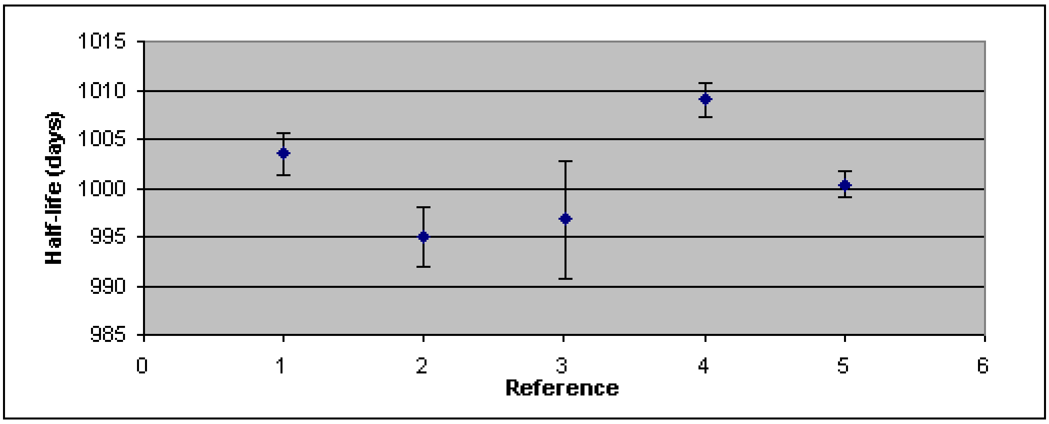
Increase SW1 to 0.26 to include lowest uncertainty value

EVALUATED $\tau_{1/2}$ (days) = 312.29 (26)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[5]		*0.1 (3.3σ)*	*days*
	[8]		*0.9 (3σ)*	*days*
	[9]		*0.10 (2σ)*	*days*

^{55}Fe

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1003.5	2.1	0.1740	2000	Schotzig	[1]
995	3	0.0852	1998	Karmalitsyn	[2]
996.8	6	0.0213	1994	Morel	[3]
1009	1.7	0.2655	1982	Hoppes	[4]
1000.4	1.3	0.4540	1980	Houtermans	[5]



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
1000.94	2.49	1002.69	2.17	0.88	6.14

SU + SW1 = 4.66 |UM-WM| = 1.75 **Use WTD Mean**

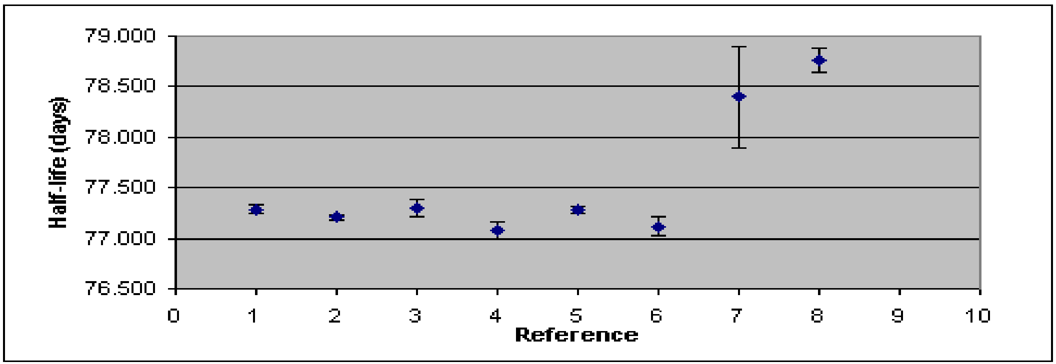
Increase SW1 to 2.3 to include lowest uncertainty value

EVALUATED $\tau_{1/2}$ (days) = 1002.7 (23)

^{56}Co

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	77.290	0.040	0.2098	1992	Funck(Woods)	[1]
	77.210	0.028	0.4282	1992	Funck(Blanchis)	[2]
	77.30	0.09	0.0414	1989	Alburger	[3]
	77.08	0.08	0.0525	1989	Lesko	[4]
	77.28	0.04	0.2098	1989	Schrader	[5]
	77.12	0.10	0.0336	1977	Anderson	[6]
1	78.4	0.5	0.0013	1974	Cressy	[7]
1	78.76	0.12	0.0233	1972	Emery	[8]

1 = Reject, far from mean



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
77.555	0.228	77.273	0.091	0.018	24.59

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
77.290	0.040	0.2151	1992	Funck(Woods)	[1]
77.210	0.028	0.4390	1992	Funck(Blanchis)	[2]
77.30	0.09	0.0425	1989	Alburger	[3]
77.08	0.08	0.0538	1989	Lesko	[4]
77.28	0.04	0.2151	1989	Schrader	[5]
77.12	0.10	0.0344	1977	Anderson	[6]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
77.213	0.038	77.236	0.026	0.019	1.91

SU + SW1 = 0.064 |UM-WM| = 0.023 **Use WTD Mean**

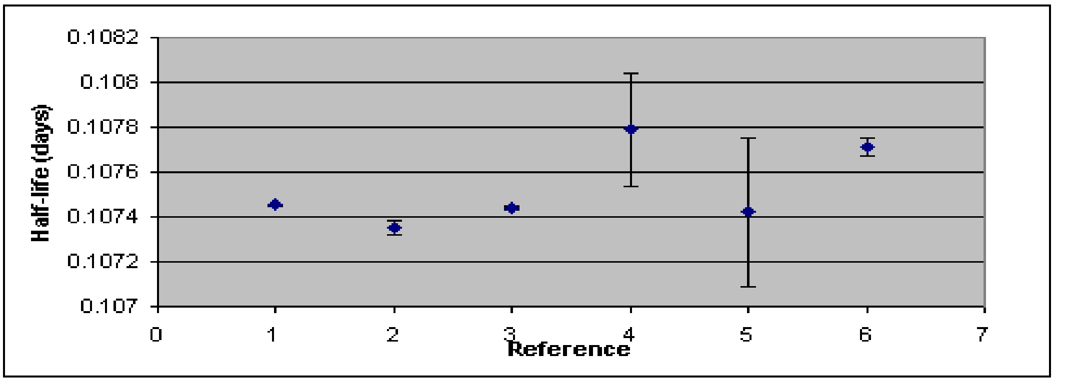
Evaluated $\tau_{1/2}$ (days) = 77.236 (26)

[1] and [2] values from different NMIs in same paper

^{56}Mn

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1	0.107454	0.000004	0.7843	1992	Antony	[1]
	0.107350	0.000033	0.0115	1980	Rutledge	[2]
	0.107438	0.000008	0.1961	1973	Lagoutine	[3]
	0.10779	0.00025	0.0002	1972	Emery	[4]
	0.10742	0.00033	0.0001	1971	Goodier	[5]
	0.10771	0.00004	0.0078	1968	Sher	[6]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
0.1075270	0.0000727	0.1074517	0.0000119	0.0000035	11.26

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
0.107454	0.000008	0.4761	1992	Antony	[1]
0.107350	0.000033	0.0280	1980	Rutledge	[2]
0.107438	0.000008	0.4761	1973	Lagoutine	[3]
0.10779	0.00025	0.0005	1972	Emery	[4]
0.10742	0.00033	0.0003	1971	Goodier	[5]
0.10771	0.00004	0.0190	1968	Sher	[6]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
0.1075270	0.0000727	0.1074485	0.0000184	0.0000055	11.14

SU + SW1 = 0.0000912 |UM-WM| = 0.0000785 **Use WTD Mean**

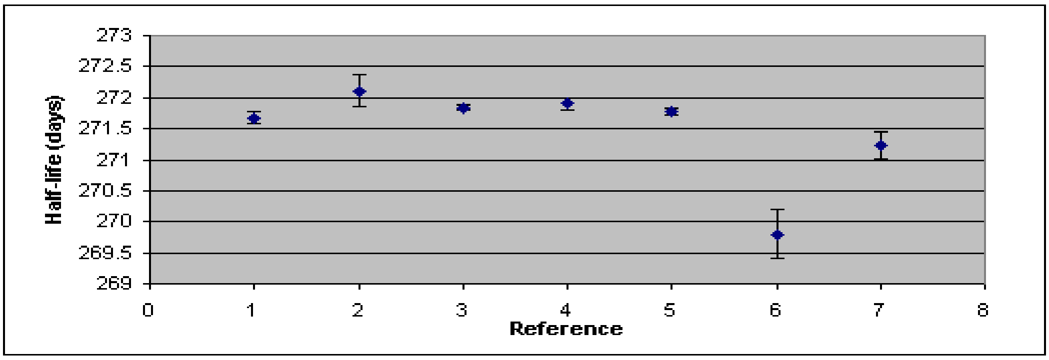
EVALUATED $\tau_{1/2}$ (days) = 0.107449 (19)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[1]	*2.5789*	*0.0001*	*hours*
	[2]	*2.5764*	*0.0008*	*hours*
	[3]	*2.5785*	*0.0006 (3σ)*	*hours*
	[4]	*2.587*	*0.006*	*hours*
	[5]	*2.578*	*0.008*	*hours*
	[6]	*2.585*	*0.001*	*hours*

^{57}Co

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	271.68	0.09	0.0938	1997	Martin	[1]
	272.11	0.26	0.0112	1992	Unterweger	[2]
	271.84	0.04	0.4751	1983	Walz	[3]
	271.90	0.09	0.0938	1981	Vaninbroukx	[4]
	271.77	0.05	0.3040	1980	Houtermans	[5]
1	269.8	0.4	0.0048	1972	Emery	[6]
	271.23	0.21	0.0172	1972	Lagoutine	[7]

1 = Reject, far from mean



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
271.476	0.297	271.792	0.069	0.028	6.35

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
271.68	0.09	0.0943	1997	Martin	[1]
272.11	0.26	0.0113	1992	Unterweger	[2]
271.84	0.04	0.4773	1983	Walz	[3]
271.90	0.09	0.0943	1981	Vaninbroukx	[4]
271.77	0.05	0.3055	1980	Houtermans	[5]
271.23	0.21	0.0173	1972	Lagoutine	[7]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
271.755	0.121	271.802	0.045	0.028	2.63

SU + SW1 = 0.165 |UM-WM| = 0.047 **Use WTD Mean**

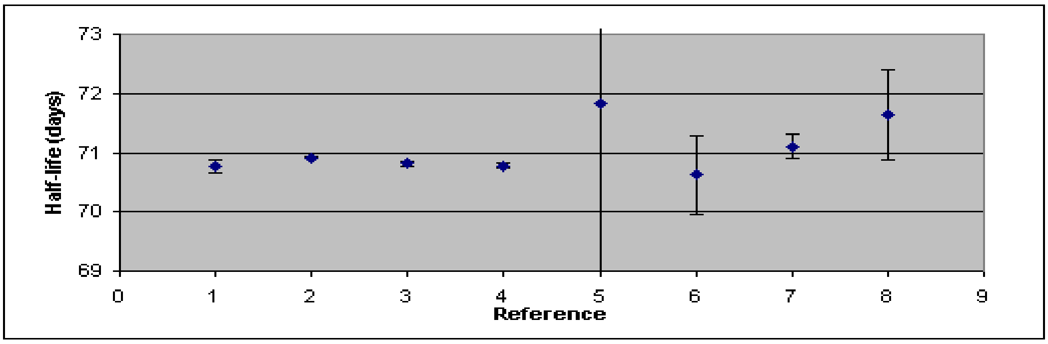
EVALUATED $\tau_{1/2}$ (days) = 271.80 (5)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[7]		*0.63 (3σ)*	*days*

^{58}Co

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	70.77	0.11	0.0141	1992	Unterweger	[1]
1	70.916	0.015	0.7566	1980	Houtermans	[2]
	70.81	0.033	0.1563	1976	Vaninbroukx	[3]
	70.78	0.05	0.0681	1975	Lagoutine	[4]
2	71.83	6.12	0.0000	1973	Aramanowicz	[5]
	70.62	0.67	0.0004	1972	Crissler	[6]
	71.1	0.2	0.0043	1972	Werner	[7]
2	71.64	0.75	0.0003	1968	Decowski	[8]

1 = Normalise Weight < 0.5 *2 = Reject, far from mean*



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
71.0583	0.1564	70.8890	0.0204	0.0130	2.46

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
70.77	0.11	0.0295	1992	Unterweger	[1]
70.916	0.027	0.4899	1980	Houtermans	[2]
70.81	0.033	0.3280	1976	Vaninbroukx	[3]
70.78	0.05	0.1429	1975	Lagoutine	[4]
70.62	0.67	0.0008	1972	Crissler	[6]
71.1	0.2	0.0089	1972	Werner	[7]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
70.8327	0.0660	70.8589	0.0285	0.0189	2.28

SU + SW1 = 0.0946 |UM-WM| = 0.0262 **Use WTD Mean**

Increase SW1 to 0.059 to include lowest uncertainty value

EVALUATED $\tau_{1/2}$ (days) = 70.86 (6)

Comments

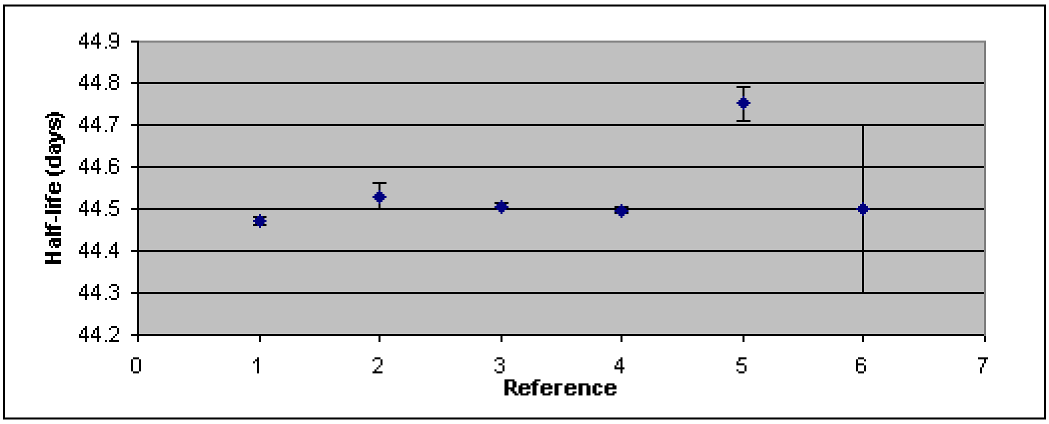
[6] Crissler = weighted mean of 70.8 (9) and 70.4 (1) days

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[3]		*0.010 (3σ)*	*days*
	[4]		*0.13 (3σ)*	*days*

^{59}Fe

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	44.472	0.008	0.2737	1997	Martin	[1]
	44.5074	0.0072	0.3379	1992	Unterweger	[2]
	44.53	0.03	0.0195	1983	Walz	[3]
	44.496	0.007	0.3575	1980	Houtermans	[4]
1	44.75	0.04	0.0109	1973	Visser	[5]
	44.5	0.2	0.0004	1972	Emery	[6]

1 = Reject, far from mean



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
44.542567	0.042183	44.496728	0.01364	0.004185	10.62

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
44.472	0.008	0.2767	1997	Martin	[1]
44.5074	0.0072	0.3417	1992	Unterweger	[2]
44.53	0.03	0.0197	1983	Walz	[3]
44.496	0.007	0.3615	1980	Houtermans	[4]
44.5	0.2	0.0004	1972	Emery	[6]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
44.501080	0.009351	44.493924	0.00745	0.004209	3.14

SU + SW1 = 0.016805 |UM-WM| = 0.007156 **Use WTD Mean**

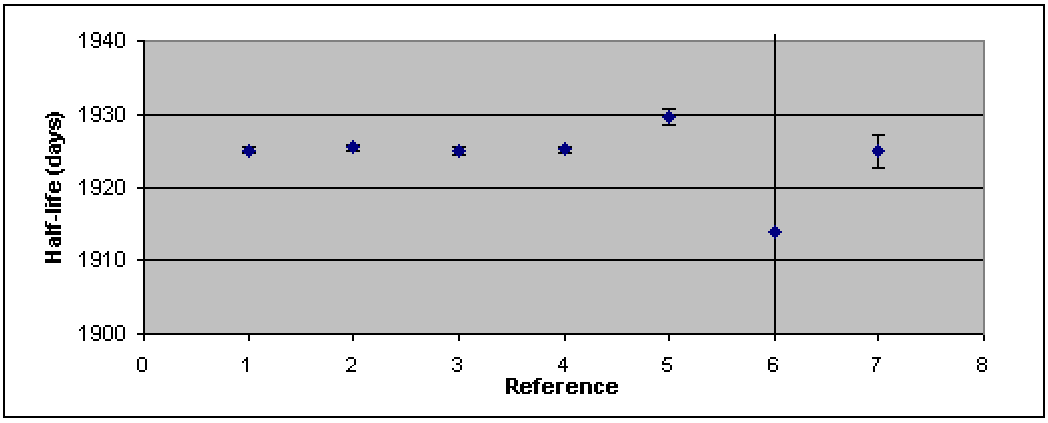
Increase SW1 to 0.013 to include lowest uncertainty value

EVALUATED $\tau_{1/2}$ (days) = 44.494 (13)

^{60}Co

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	1925.12	0.46	0.2077	1992	Unterweger	[1]
	1925.5	0.4	0.2747	1983	Walz	[2]
	1925.02	0.47	0.1990	1983	Rutledge	[3]
	1925.2	0.4	0.2747	1980	Houtermans	[4]
1	1929.6	1.0	0.0363	1976	Vaninbroukx	[5]
1	1914	77	0.0000	1973	Harbottle	[6]
	1924.9	2.4	0.0076	1968	Lagoutine	[7]

1 = Reject, far from mean



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
1924.191	1.812	1925.419	0.372	0.209	3.17

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1925.12	0.46	0.2155	1992	Unterweger	[1]
1925.5	0.4	0.2850	1983	Walz	[2]
1925.02	0.47	0.2065	1983	Rutledge	[3]
1925.2	0.4	0.2850	1980	Houtermans	[4]
1924.9	2.4	0.0079	1968	Lagoutine	[7]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
1925.148	0.101	1925.229	0.092	0.214	0.18

SU + SW2 = 0.315 |UM-WM| = 0.081 **Use WTD Mean**

Increase SW2 to 0.27 to include lowest uncertainty value

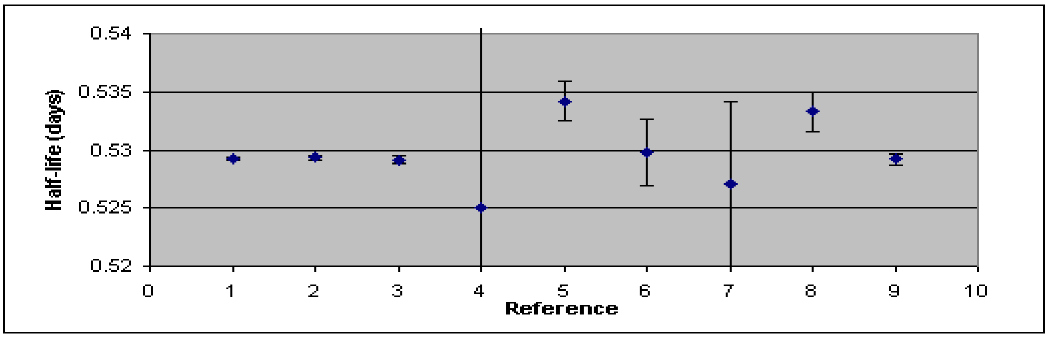
EVALUATED $\tau_{1/2}$ (days) = 1925.23 (27)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[5]	*5.283*	*0.008 (3σ)*	*years*
	[6]	*5.24*	*0.21*	*years*
	[7]	*5.27*	*0.02 (3σ)*	*years*

^{64}Cu

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1	0.52921	0.00013	0.6674	1980	Rutledge	[1]
	0.52933	0.00025	0.1805	1974	Ryves	[2]
	0.52913	0.00034	0.0976	1973	Dema	[3]
	0.525	0.04	0.0000	1973	Araminowicz	[4]
	0.5342	0.0017	0.0039	1973	Newton	[5]
	0.5298	0.0029	0.0013	1972	Emery	[6]
	0.5271	0.0071	0.0002	1969	Bormann	[7]
	0.5333	0.0017	0.0039	1968	Kemeny	[8]
	0.5292	0.0005	0.0451	1968	Heinrich	[9]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
0.529586	0.000935	0.529259	0.000144	0.000106	1.83

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
0.52921	0.00019	0.4844	1980	Rutledge	[1]
0.52933	0.00025	0.2798	1974	Ryves	[2]
0.52913	0.00034	0.1513	1973	Dema	[3]
0.525	0.04	0.0000	1973	Araminowicz	[4]
0.5342	0.0017	0.0061	1973	Newton	[5]
0.5298	0.0029	0.0021	1972	Emery	[6]
0.5271	0.0071	0.0003	1969	Borman	[7]
0.5333	0.0017	0.0061	1968	Kemeny	[8]
0.5292	0.0005	0.0700	1968	Heinrich	[9]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
0.529586	0.000935	0.529286	0.000178	0.000132	1.81

SU + SW1 = 0.00111 |UM-WM| = 0.00030 **Use WTD Mean**

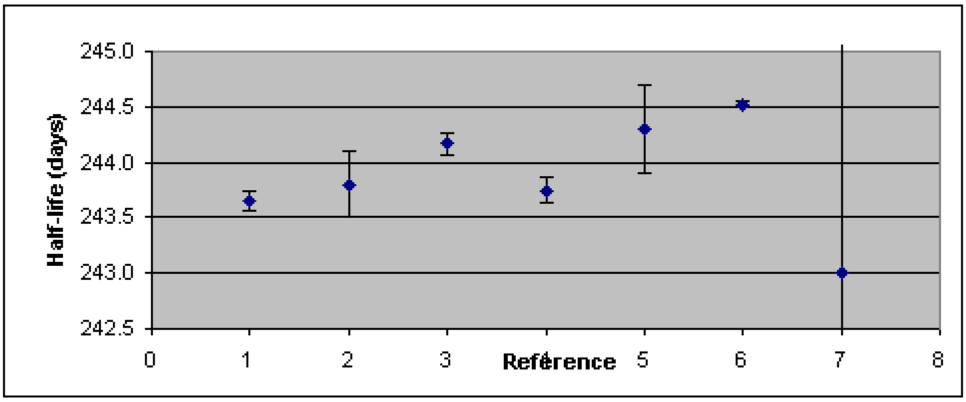
EVALUATED $\tau_{1/2}$ (days) = 0.52929 (18)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[1]	*12.701*	*0.003*	*hours*
	[2]	*12.704*	*0.006*	*hours*
	[3]	*12.699*	*0.008*	*hours*
	[4]	*12.6*	*1*	*hours*
	[5]	*12.82*	*0.04*	*hours*
	[6]	*12.715*	*0.007*	*hours*
	[7]	*12.65*	*0.17*	*hours*
	[8]	*12.8*	*0.04*	*hours*
	[9]	*12.701*	*0.011*	*hours*

^{65}Zn

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	243.66	0.09	0.0519	2004	Schrader	[1]
	243.8	0.3	0.0047	2004	Van Ammel	[2]
	244.164	0.099	0.0429	1992	Unterweger	[3]
	243.75	0.12	0.0292	1975	Lagoutine	[4]
	244.3	0.4	0.0026	1974	Cressy	[5]
1	244.52	0.022	0.8687	1973	Visser	[6]
1	243	4	0.0000	1968	Hammer	[7]

1 = Reject, far from mean



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
243.8849	0.1898	244.4336	0.0969	0.0205	22.31

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
243.66	0.09	0.3953	2004	Schrader	[1]
243.8	0.3	0.0356	2004	Van Ammel	[2]
244.164	0.099	0.3267	1992	Unterweger	[3]
243.75	0.12	0.2224	1975	Lagoutine	[4]
244.3	0.4	0.0200	1974	Cressy	[5]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
243.9348	0.1252	243.8625	0.1148	0.0566	4.11

SU + SW1 = 0.2400 |UM-WM| = 0.0723 **Use WTD Mean**

Increase SW1 to 0.20 to include lowest uncertainty value

EVALUATED $\tau_{1/2}$ (days) = 243.86 (20)

Comments

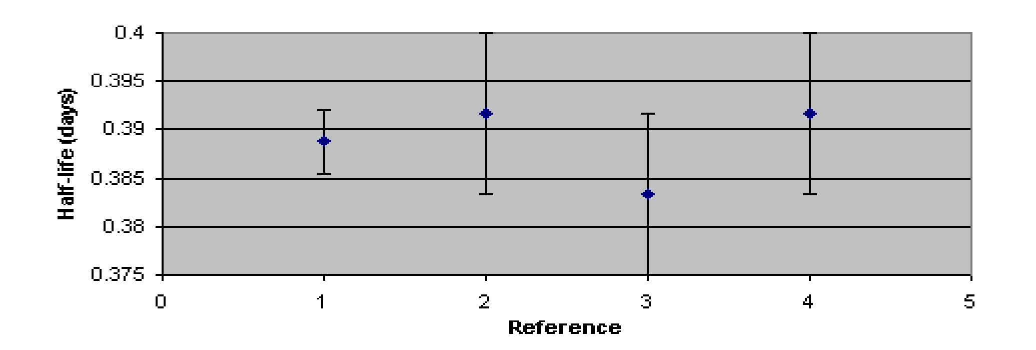
Crissler - not a measurement
Visser - consistent reject for other nuclides - high bias

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[4]		*0.35 (3σ)*	*days*
	[6]		*0.07 (3.3σ)*	*days*

^{66}Ga

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1	0.3888	0.0033	0.6783	1964	Rudstam	[1]
	0.3917	0.0083	0.1072	1959	Carver	[2]
	0.3833	0.0083	0.1072	1952	Mukerji	[3]
	0.3917	0.0083	0.1072	1938	Buck	[4]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
0.38888	0.00198	0.38883	0.0013	0.00272	0.23

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
0.3888	0.0048	0.4992	1964	Rudstam	[1]
0.3917	0.0083	0.1669	1959	Carver	[2]
0.3833	0.0083	0.1669	1952	Mukerji	[3]
0.3917	0.0083	0.1669	1938	Buck	[4]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
0.38888	0.00198	0.38885	0.00162	0.00339	0.23

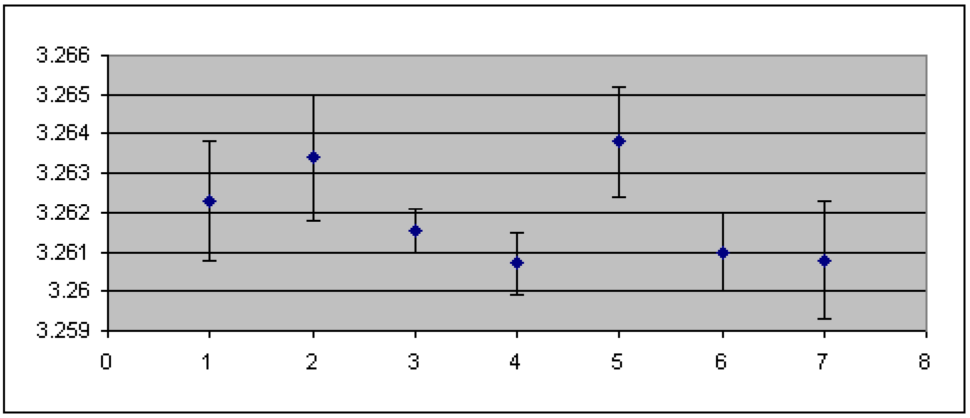
SU + SW2 = 0.00537 |UM-WM| = 0.00002 **Use WTD Mean**

EVALUATED $\tau_{1/2}$ (days) = 0.3889 (34)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[1]	*9.33*	*0.08*	*hours*
	[2]	*9.4*	*0.2*	*hours*
	[3]	*9.2*	*0.2*	*hours*
	[4]	*9.4*	*0.2*	*hours*

^{67}Ga

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
3.2623	0.0015	0.0571	2004	Schrader	[1]
3.2634	0.0016	0.0502	2004	Silva	[2]
3.26154	0.00054	0.4407	1992	Unterweger	[3]
3.2607	0.0008	0.2008	1980	Houtermans	[4]
3.2638	0.0014	0.0656	1978	Lagoutine	[5]
3.261	0.001	0.1285	1978	Meyer	[6]
3.2608	0.0015	0.0571	1972	Lewis	[7]



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
3.261934	0.000478	3.261545	0.000354	0.000358	0.98

SU + SW2 = 0.000837 |UM-WM| = 0.000390 **Use WTD Mean**

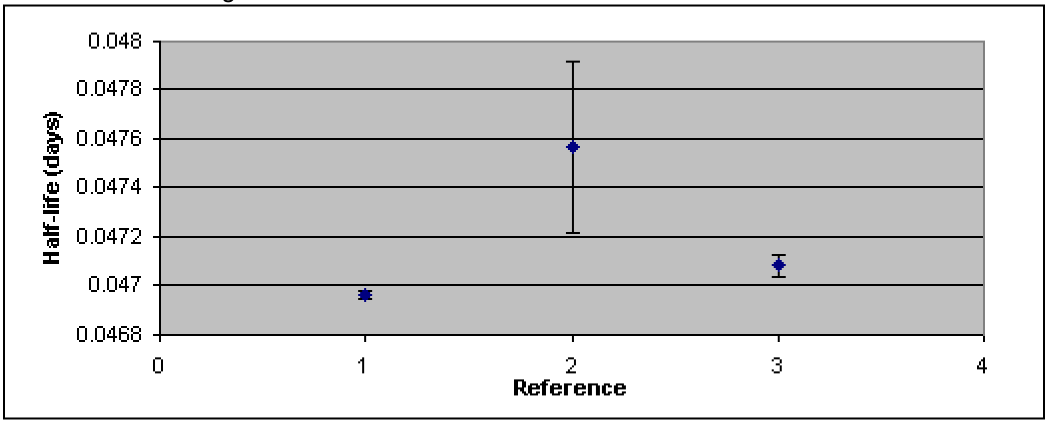
EVALUATED $\tau_{1/2}$ (days) = 3.2616 (4)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[5]	*78.33*	*0.010 (3σ)*	*hours*
	[7]	*78.26*	*0.07 (3σ)*	*hours*

^{68}Ga

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1	0.0469646	0.0000167	0.8818	1983	Iwata	[1]
	0.04757	0.00035	0.0020	1971	Oottukulam	[2]
	0.047083	0.000046	0.1162	1971	Smith	[3]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
0.04720587	0.00018525	0.04697958	0.00003272	0.00001568	4.35

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
0.0469646	0.0000460	0.4957	1983	Iwata	[1]
0.04757	0.00035	0.0086	1971	Oottukulam	[2]
0.047083	0.000046	0.4957	1971	Smith	[3]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
0.04720587	0.00018525	0.04702848	0.00005481	0.00003239	2.86

SU + SW1 = 0.00024005 |UM-WM| = 0.00017739 **Use WTD Mean**

Increase SW1 to 0.00007 to include lowest uncertainty value

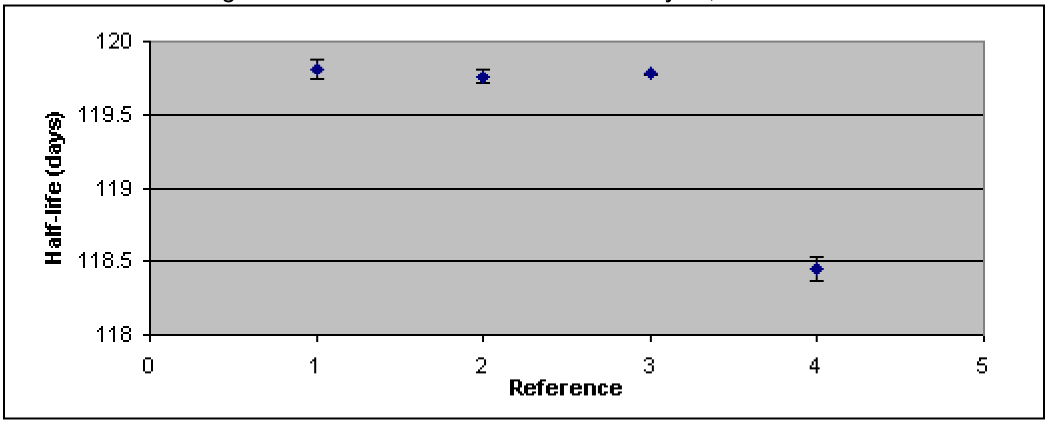
EVALUATED $\tau_{1/2}$ (days) = 0.04703 (7)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[1]	*67.629*	*0.025*	*minutes*
	[2]	*68.5*	*0.5*	*minutes*
	[3]	*67m48s*	*4s*	

^{75}Se

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	119.809	0.066	0.0036	1992	Unterweger	[1]
	119.76	0.05	0.0063	1983	Walz	[2]
1	119.779	0.004	0.9881	1980	Houtermans	[3]
2	118.45	0.084	0.0020	1975	Lagoutine	[4]

1 = Normalise Weight < 0.5 *2 = Reject, far from mean*



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
119.4495	0.3333	119.7764	0.0339	0.0040	72.66

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
119.809	0.066	0.1830	1992	Unterweger	[1]
119.76	0.05	0.3188	1983	Walz	[2]
119.779	0.04	0.4982	1980	Houtermans	[3]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
119.7827	0.0143	119.7784	0.0118	0.0282	0.18

SU + SW2 = 0.0425 |UM-WM| = 0.0042 **Use WTD mean**

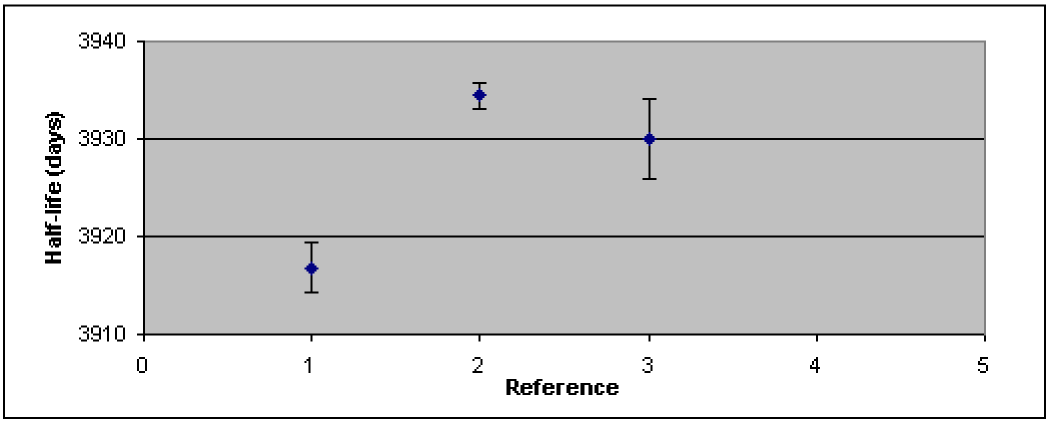
EVALUATED $\tau_{1/2}$ (days) = 119.778 (29)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[2]		*0.04%*	
	[4]		*0.25 (3σ)*	*days*

^{85}Kr

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	3916.8	2.5	0.2184	2004	Schrader	[1]
1	3934.4	1.4	0.6963	1992	Unterweger	[2]
	3930	4	0.0853	1963	Lerner	[3]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
3927.07	5.29	3930.18	5.07	1.17	18.87

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
3916.8	2.5	0.3729	2004	Schrader	[1]
3934.4	2.2	0.4815	1992	Unterweger	[2]
3930	4	0.1456	1963	Lerner	[3]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
3927.07	5.29	3927.20	5.76	1.53	14.25

SU + SW1 = 11.05 |UM-WM| = 0.13 **Use WTD Mean**

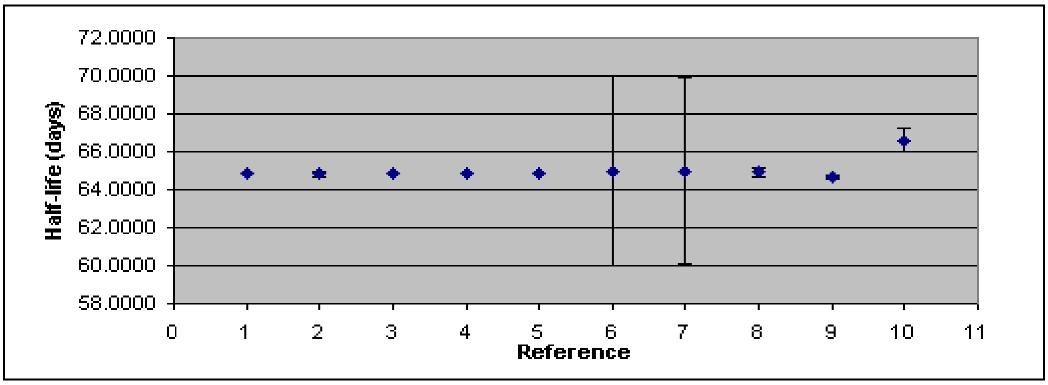
EVALUATED $\tau_{1/2}$ (days) = 3927 (8)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[2]		*0.21%*	
	[3]	*10.76*	*0.02*	*years*
	[4]	*10.27*	*0.18*	*years*

^{85}Sr

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	64.8530	0.0081	0.3089	1992	Unterweger	[1]
	64.85	0.14	0.0010	1983	Walz	[2]
	64.845	0.009	0.2502	1980	Rutledge	[3]
	64.856	0.007	0.4136	1980	Houtermans	[4]
	64.84	0.03	0.0225	1978	Thomas	[5]
	65.0	5.0	0.0000	1974	Vatai	[6]
	65.0	4.9	0.0000	1973	Araminowicz	[7]
	64.93	0.22	0.0004	1972	Emery	[8]
	64.68	0.08	0.0032	1972	Lagoutine	[9]
1	66.6	0.6	0.0001	1969	Grotheer	[10]

1 = Reject, far from mean



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
65.04540	0.17516	64.85153	0.00568	0.00450	1.59

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
64.8530	0.0081	0.3089	1992	Unterweger	[1]
64.85	0.14	0.0010	1983	Walz	[2]
64.845	0.009	0.2502	1980	Rutledge	[3]
64.856	0.007	0.4137	1980	Houtermans	[4]
64.84	0.03	0.0225	1978	Thomas	[5]
65.0	5.0	0.0000	1974	Vatai	[6]
65.0	4.9	0.0000	1972	Araminowicz	[7]
64.93	0.22	0.0004	1972	Emery	[8]
64.68	0.08	0.0032	1972	Lagoutine	[9]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
64.87267	0.03246	64.85143	0.00385	0.00450	0.73

SU + SW2 = 0.03696 |UM-WM| = 0.02124 **Use WTD Mean**

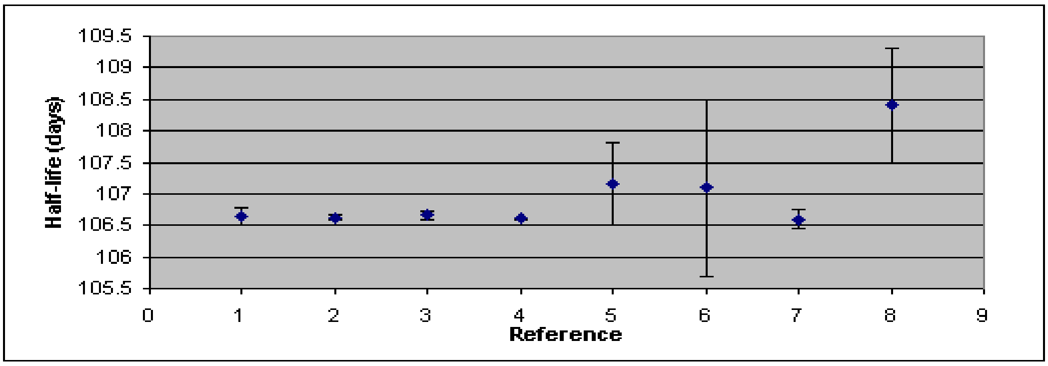
EVALUATED $\tau_{1/2}$ (days) = 64.851 (5)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[9]		*0.23 (3σ)*	*days*

^{88}Y

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	106.65	0.13	0.0098	1997	Martin	[1]
	106.626	0.044	0.0859	1992	Unterweger	[2]
	106.66	0.06	0.0462	1983	Walz	[3]
1	106.612	0.014	0.8488	1980	Houtermans	[4]
2	107.15	0.65	0.0004	1977	Konstantinov	[5]
2	107.1	1.4	0.0001	1976	Borman	[6]
	106.6	0.14	0.0085	1975	Lagoutine	[7]
2	108.4	0.9	0.0002	1969	Grotheer	[8]

1 = Normalise Weight < 0.5 *2 = Reject, far from mean*



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
106.9748	0.2186	106.6163	0.0114	0.0129	0.78

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
106.65	0.13	0.0334	1997	Martin	[1]
106.626	0.044	0.2919	1992	Unterweger	[2]
106.66	0.06	0.1570	1983	Walz	[3]
106.612	0.034	0.4889	1980	Houtermans	[4]
106.6	0.14	0.0288	1975	Lagoutine	[7]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
106.6296	0.0113	106.6245	0.0089	0.0238	0.14

SU + SW2 = 0.0350 |UM-WM| = 0.0051 **Use WTD Mean**

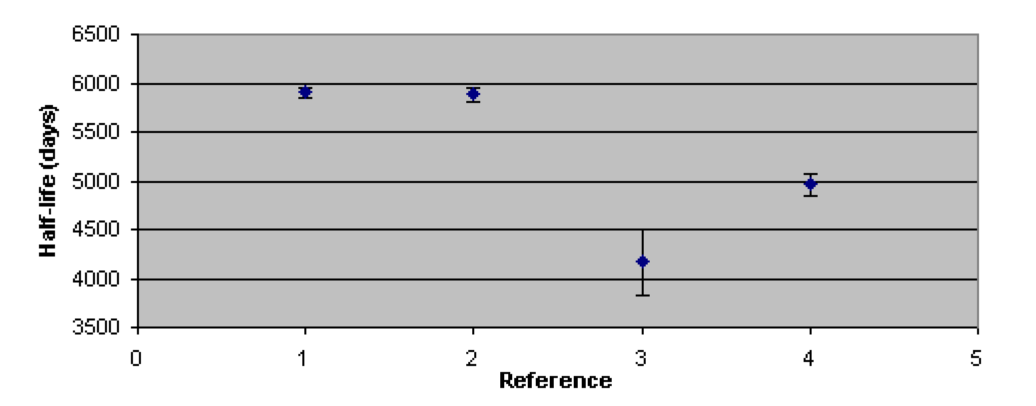
EVALUATED $\tau_{1/2}$ (days) = 106.625 (24)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[7]		*0.4 (3σ)*	*days*

$^{93}Nb^{m}$

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1	5891	55	0.5277	1983	Vaninbroukx	[1]
	5884	70	0.3258	1981	Lloret	[2]
	4164	330	0.0147	1976	Hegedues	[3]
	4967	110	0.1319	1965	Flynn	[4]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
5226.5	415.3	5741.5	211.4	40.0	27.99

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
5891	59	0.4926	1983	Vaninbroukx	[1]
5884	70	0.3499	1981	Lloret	[2]
4164	330	0.0157	1976	Hegedues	[3]
4967	110	0.1417	1965	Flynn	[4]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
5226.5	415.3	5730.4	217.7	41.4	27.64

SU + SW1 = 633.0 |UM-WM| = 503.9 **Use WTD Mean**

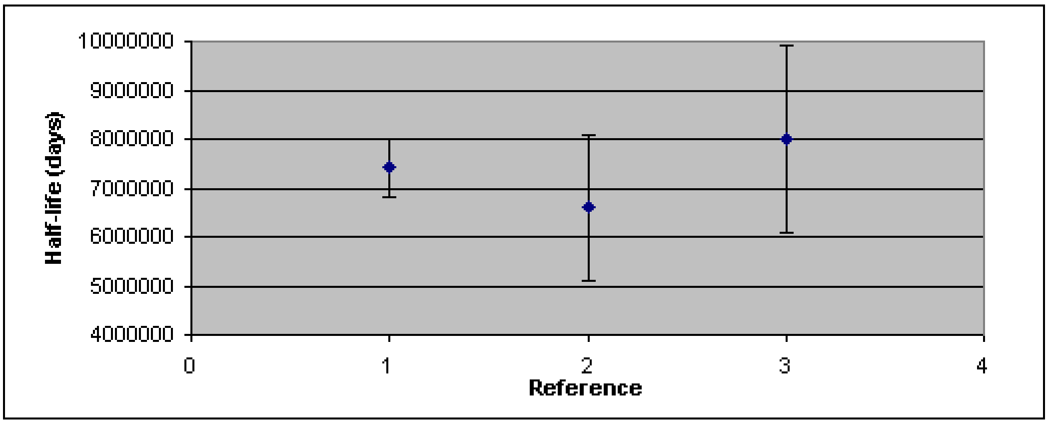
Evaluated $\tau_{1/2}$ (days) = 5.73 (22) x 10^3

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[1]	*16.13*	*0.15*	*years*
	[2]	*16.11*	*0.19*	*years*
	[3]	*11.4*	*0.9*	*years*
	[4]	*13.6*	*0.3*	*years*

^{94}Nb

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1	7410000	590000	0.7993	1959	Schumann	[1]
	6600000	1500000	0.1237	1955	Rollier	[2]
	8000000	1900000	0.0771	1953	Douglas	[3]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
7336666.7	405805.1	7355310.3	229094.3	527472.1	0.19

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
7410000	1180000	0.4989	1959	Schumann	[1]
6600000	1500000	0.3087	1955	Rollier	[2]
8000000	1900000	0.1924	1953	Douglas	[3]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
7336666.7	405805.1	7273462.1	354180.9	833438.3	0.18

SU + SW2 = 1239243.4 |UM-WM| = 63204.6 **Use WTD Mean**

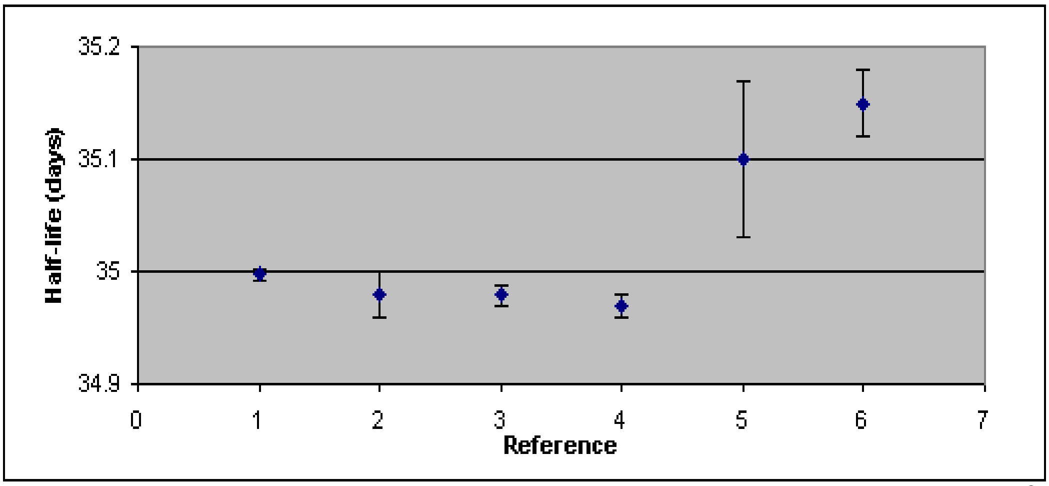
EVALUATED $\tau_{1/2}$ (days) = 7.3 (9) x 10^6

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[1]	*2.03×10^4*	*0.16×10^4*	*years*
	[2]	*1.8×10^4*	*0.4×10^4*	*years*
	[3]	*2.2×10^4*	*0.5×10^4*	*years*

^{95}Nb

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1	34.997	0.006	0.5150	1997	Martin	[1]
	34.98	0.02	0.0463	1980	Rutledge	[2]
	34.979	0.009	0.2289	1980	Houtermans	[3]
	34.97	0.01	0.1854	1976	Hansen	[4]
2	35.10	0.07	0.0038	1968	Lagoutine	[5]
2	35.15	0.03	0.0206	1968	Reynolds	[6]

1 = Normalise Weight < 0.5 *2 = Reject, far from mean*



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
35.0358	0.0373	34.9906	0.0188	0.0043	19.00

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
34.997	0.007	0.4510	1997	Martin	[1]
34.98	0.02	0.0552	1980	Rutledge	[2]
34.979	0.009	0.2728	1980	Houtermans	[3]
34.97	0.01	0.2210	1976	Hansen	[4]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
34.9763	0.0032	34.9852	0.0076	0.0047	2.59

SU + SW1 = 0.0107 |UM-WM| = 0.0089

Increase SW1 to 0.012 to include lowest uncertainty value

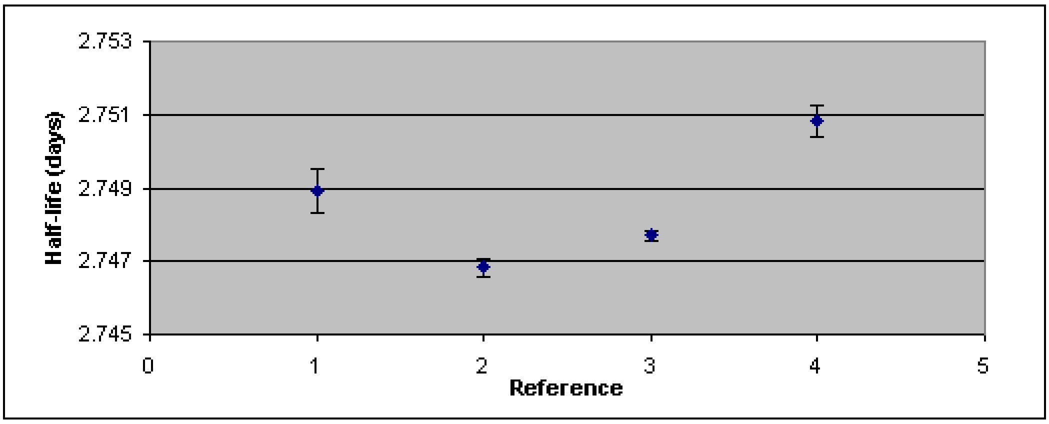
EVALUATED $\tau_{1/2}$ (days) = 34.985 (12)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[4]		*0.03 (3σ)*	
	[5]		*0.21 (3σ)*	

^{99}Mo

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	2.7489	0.0006	0.0328	2004	Schrader	[1]
	2.746829	0.000242	0.2016	1992	Unterweger	[2]
1	2.74771	0.00013	0.6987	1980	Houtermans	[3]
	2.75083	0.00042	0.0669	1972	Emery	[4]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
2.7485673	0.0008654	2.7477802	0.0005322	0.0001087	23.98

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
2.7489	0.0006	0.0550	2004	Schrader	[1]
2.746829	0.000242	0.3380	1992	Unterweger	[2]
2.74771	0.00020	0.4948	1980	Houtermans	[3]
2.75083	0.00042	0.1122	1972	Emery	[4]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
2.7485673	0.0008654	2.7478278	0.0006876	0.0001407	23.89

SU + SW1 = 0.0015531 |UM-WM| = 0.0007395 **Use WTD Mean**

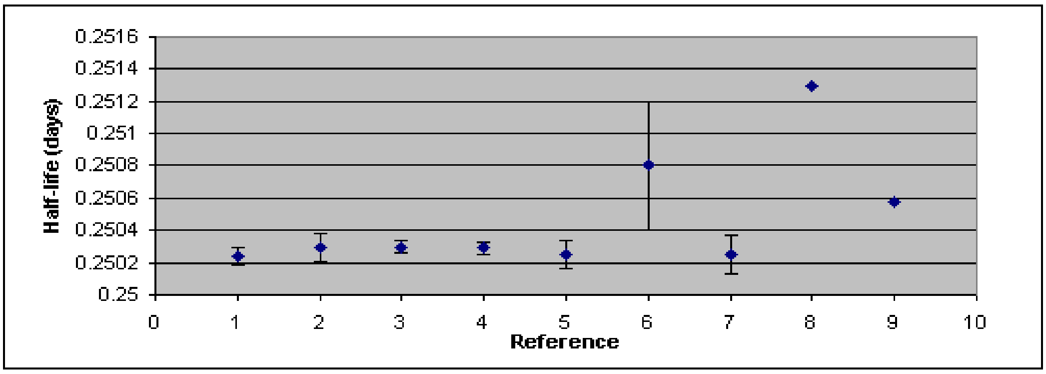
EVALUATED $\tau_{1/2}$ (days) = 2.7478 (7)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[2]	*65.9239*	*0.0058*	*hours*
	[3]	*65.945*	*0.003*	*hours*
	[4]	*66.02*	*0.01*	*hours*

$^{99}Tc^{m}$

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	0.25024	0.00005	0.1829	2004	Schrader	[1]
	0.2502975	0.0000863	0.0614	2004	Silva	[2]
	0.2502992	0.0000363	0.3471	1992	Unterweger	[3]
	0.25029	0.00004	0.2858	1989	Santry	[4]
	0.25025	0.00009	0.0565	1980	Houtermans	[5]
1	0.2508	0.0004	0.0029	1972	Emery	[6]
	0.25025	0.00012	0.0318	1971	Goodier	[7]
1	0.25129	0.00017	0.0158	1970	Legrand	[8]
1	0.25058	0.00017	0.0158	1969	Vuorinen	[9]

1 = Reject, far from mean



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
0.25047741	0.00011983	0.25030285	0.00004791	0.00002139	5.02

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
0.25024	0.00005	0.1895	2004	Schrader	[1]
0.2502975	0.0000863	0.0636	2004	Silva	[2]
0.2502992	0.0000363	0.3595	1992	Unterweger	[3]
0.25029	0.00004	0.2961	1989	Santry	[4]
0.25025	0.00009	0.0585	1980	Houtermans	[5]
0.25025	0.00012	0.0329	1971	Goodier	[7]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
0.25027112	0.00001111	0.25028066	0.00001064	0.00002176	0.24
SU + SW2 =	0.00003287	|UM-WM| =	0.00000954	**Use WTD mean**	

EVALUATED $\tau_{1/2}$ (days) = 0.250281 (22)

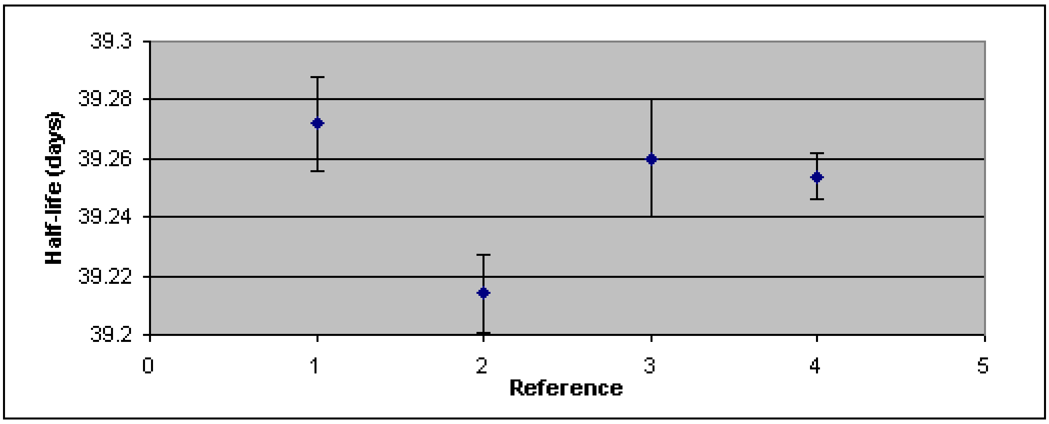
Yassine (1994) is not a measurement,

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[2]	*6.00714*	*0.00207*	*hours*
	[3]	*6.00718*	*0.00087*	*hours*
	[4]	*6.007*	*0.002 (2σ)*	*hours*
	[5]	*6.006*	*0.002*	*hours*
	[6]	*6.02*	*0.01*	*hours*
	[7]	*6.006*	*0.0029*	*hours*
	[8]	*6.031*	*0.012 (3σ)*	*hours*
	[9]	*6.014*	*0.004*	*hours*

^{103}Ru

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	39.272	0.016	0.1398	1983	Walz	[1]
	39.214	0.013	0.2117	1981	Miyahara	[2]
	39.260	0.020	0.0895	1981	Vaninbroukx	[3]
1	39.254	0.008	0.5591	1980	Houtermans	[4]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
39.2500	0.0126	39.2486	0.0109	0.0060	3.33

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
39.272	0.016	0.1750	1983	Walz	[1]
39.214	0.013	0.2651	1981	Miyahara	[2]
39.260	0.020	0.1120	1981	Vaninbroukx	[3]
39.254	0.010	0.4480	1980	Houtermans	[4]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
39.2500	0.0126	39.2472	0.0121	0.0067	3.27

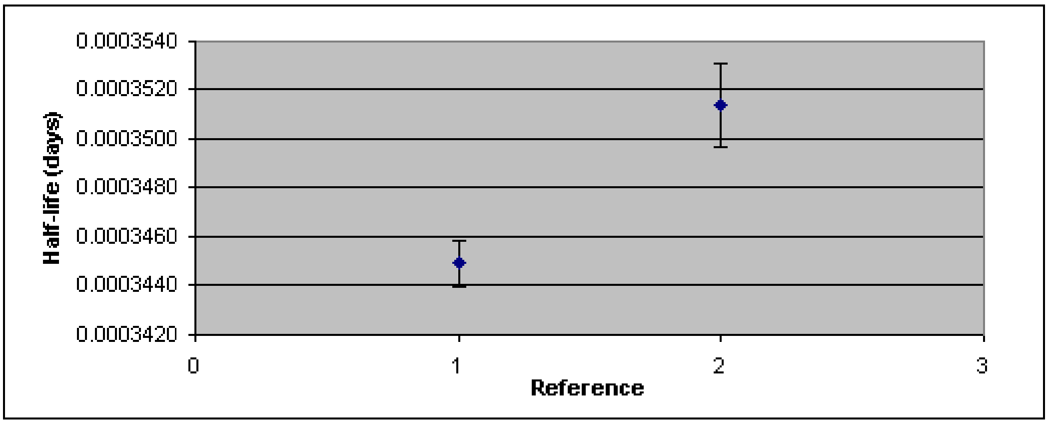
SU + SW1 = 0.024665 |UM-WM| = 0.002781 **Use WTD Mean**

EVALUATED $\tau_{1/2}$ (days) = 39.247 (13)

^{106}Rh

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1	0.0003449	0.0000009	0.7811	1969	Kobayashi	[1]
	0.0003514	0.0000017	0.2189	1966	Middelboe	[2]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
0.00034815	0.00000325	0.00034632	0.00000269	0.00000080	11.42

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
0.0003449	0.0000017	0.5000	1969	Kobayashi	[1]
0.0003514	0.0000017	0.5000	1966	Middelboe	[2]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
0.00034815	0.00000325	0.00034815	0.00000325	0.00000120	7.31

SU + SW1 = 0.00000650 |UM-WM| = 0.00000000 **Use WTD Mean**

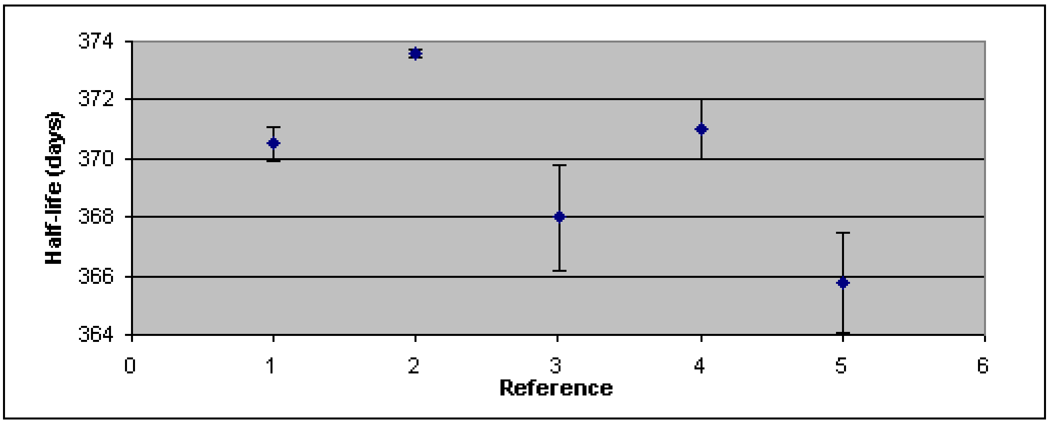
EVALUATED $\tau_{1/2}$ (days) = 0.000348 (4)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[1]	*29.8*	*0.08*	*seconds*
	[2]	*30.36*	*0.15*	*seconds*

^{106}Ru

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	370.5	0.6	0.0568	2004	Schrader	[1]
1	373.59	0.15	0.9093	1980	Houtermans	[2]
	368.0	1.8	0.0063	1965	Flynn	[3]
	371	1	0.0205	1961	Wyatt	[4]
	365.8	1.7	0.0071	1960	Easterday	[5]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
369.778	1.333	373.271	0.549	0.143	14.72

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
370.5	0.6	0.3166	2004	Schrader	[1]
373.59	0.48	0.4947	1980	Houtermans	[2]
368.0	1.8	0.0352	1965	Flynn	[3]
371	1	0.1140	1961	Wyatt	[4]
365.8	1.7	0.0394	1960	Easterday	[5]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
369.778	1.333	371.812	1.015	0.338	9.04

SU + SW1 = 2.348 |UM-WM| = 2.034 **Use WTD Mean**

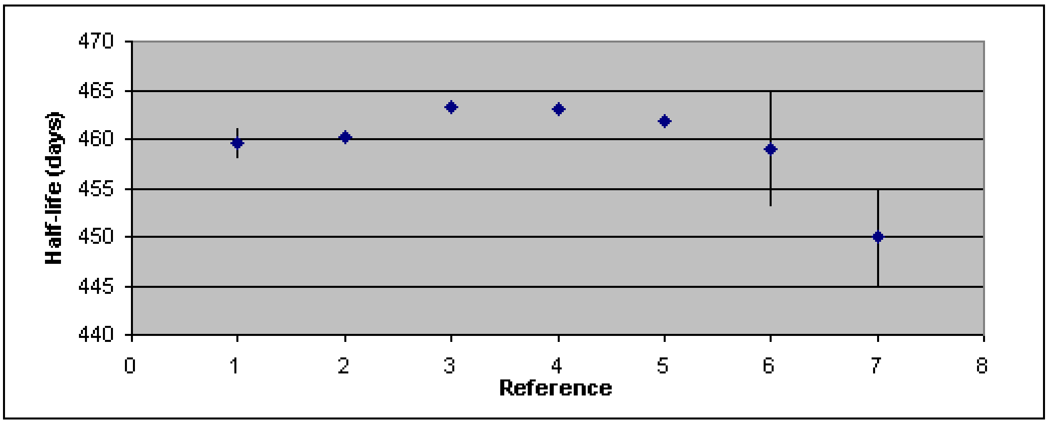
Increase SW1 to 1.9 to include lowest uncertainty value

EVALUATED $\tau_{1/2}$ (days) = 371.8 (18)

^{109}Cd

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	459.6	1.7	0.0069	2004	Schrader	[1]
	460.2	0.2	0.4984	1997	Martin	[2]
	463.26	0.63	0.0502	1992	Unterweger	[3]
	463.1	0.3	0.2215	1982	Lagoutine	[4]
	461.90	0.30	0.2215	1981	Vaninbroukx	[5]
	459	6	0.0006	1968	East	[6]
1	450	5	0.0008	1968	Reynolds	[7]

1 = Normalise Weight < 0.5 *2 = Reject, far from mean*



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
459.580	1.717	461.360	0.535	0.141	14.33

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
459.6	1.7	0.0069	2004	Schrader	[1]
460.2	0.2	0.4988	1997	Martin	[2]
463.26	0.63	0.0503	1992	Unterweger	[3]
463.1	0.3	0.2217	1982	Lagoutine	[4]
461.90	0.30	0.2217	1981	Vaninbroukx	[5]
459	6	0.0006	1968	East	[6]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
461.177	0.747	461.369	0.568	0.141	16.17

SU + SW1 = 1.315 |UM-WM| = 0.192 **Use WTD Mean**

Increase SW1 to 1.2 to include lowest uncertainty value

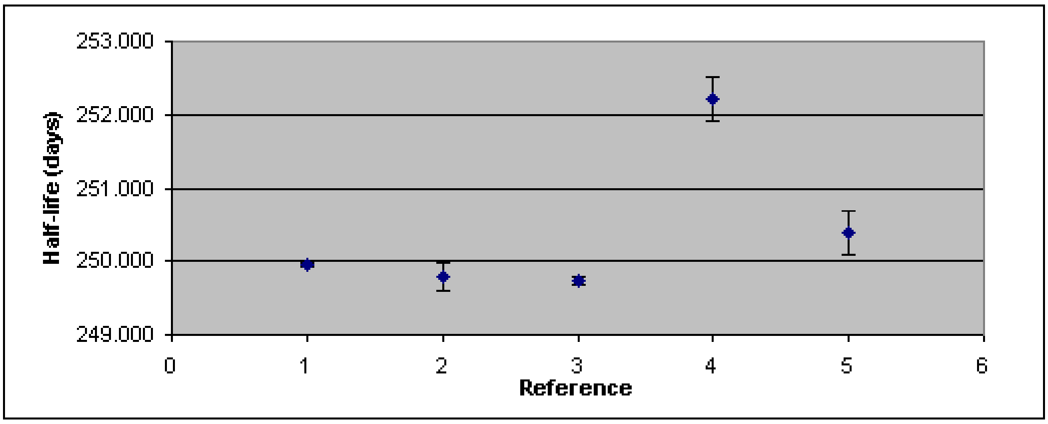
EVALUATED $\tau_{1/2}$ (days) = 461.4 (12)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[4]		*0.08 (3σ)*	*days*

$^{110}Ag^{m}$

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1	249.950	0.024	0.7952	1992	Unterweger	[1]
	249.79	0.2	0.0115	1983	Walz	[2]
	249.74	0.05	0.1832	1980	Houtermans	[3]
2	252.2	0.3	0.0051	1970	Emery	[4]
	250.38	0.30	0.0051	1969	Lagoutine	[5]

1 = Normalise Weight < 0.5 *2 = Reject, far from mean*



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
250.4120	0.4610	249.9233	0.0927	0.0214	18.76

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
249.950	0.048	0.4988	1992	Unterweger	[1]
249.79	0.2	0.0287	1983	Walz	[2]
249.74	0.05	0.4597	1980	Houtermans	[3]
250.38	0.30	0.0128	1969	Lagoutine	[4]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
249.9650	0.1454	249.8544	0.0689	0.0339	4.12

SU + SW1 = 0.2143 |UM-WM| = 0.1106 **Use WTD Mean**

Increase SW1 to 0.10 to include lowest uncertainty value

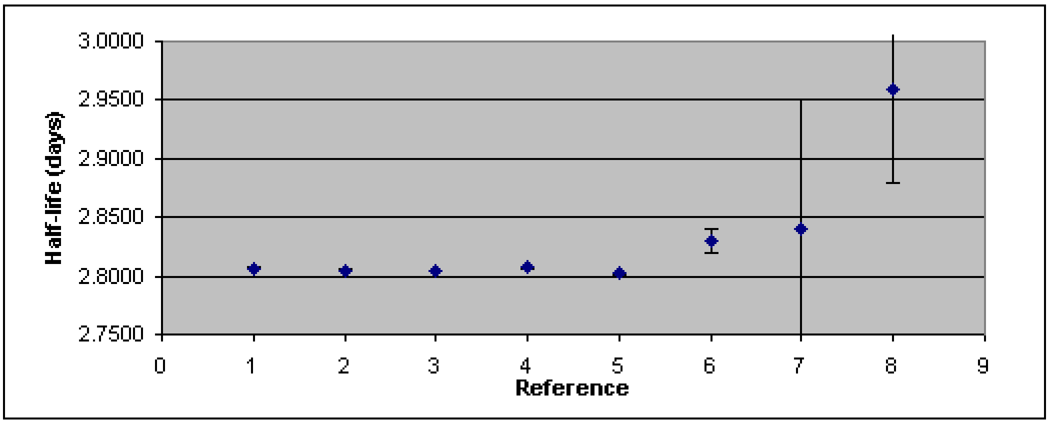
EVALUATED $\tau_{1/2}$ (days) = 249.85 (10)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[5]		*0.09 (3σ)*	*days*

^{111}In

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	2.8063	0.0007	0.0191	2004	Schrader	[1]
	2.80477	0.00053	0.0333	1992	Unterweger	[2]
1	2.8048	0.0001	0.9341	1986	Rutledge	[3]
	2.8071	0.0015	0.0042	1980	Houtermans	[4]
	2.802	0.001	0.0093	1978	Lagoutine	[5]
2	2.83	0.01	0.0001	1972	Emery	[6]
2	2.84	0.11	0.0000	1968	Liskien	[7]
2	2.96	0.08	0.0000	1968	Smend	[8]

1 = Normalise Weight < 0.5 *2 = Reject, far from mean*



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
2.831871	0.018952	2.804814	0.00018	0.000097	3.57

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
2.80630	0.0007	0.1461	2004	Schrader	[1]
2.80477	0.00053	0.2548	1992	Unterweger	[2]
2.8048	0.00038	0.4957	1986	Rutledge	[3]
2.8071	0.0015	0.0318	1980	Houtermans	[4]
2.802	0.001	0.0716	1978	Lagoutine	[5]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
2.804994	0.000872	2.804884	0.00051	0.000268	3.67

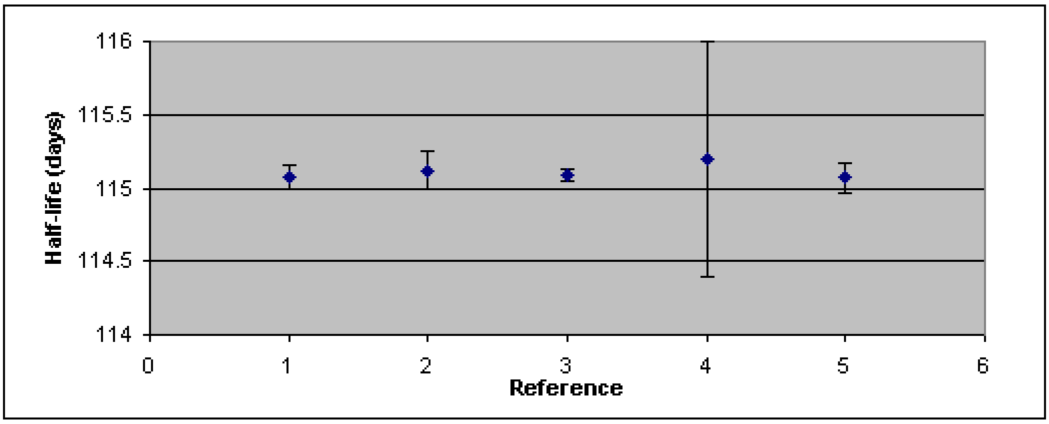
SU + SW1 = 0.001384 |UM-WM| = 0.000110 **Use WTD Mean**

EVALUATED $\tau_{1/2}$ (days) = 2.8049 (6)

^{113}Sn

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	115.079	0.08	0.1659	1992	Unterweger	[1]
	115.12	0.13	0.0628	1980	Rutledge	[2]
1	115.09	0.04	0.6635	1980	Houtermans	[3]
	115.2	0.8	0.0017	1972	Emery	[4]
	115.07	0.10	0.1062	1972	Lagoutine	[5]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
115.112	0.024	115.088	0.006	0.033	0.03

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
115.079	0.08	0.2627	1992	Unterweger	[1]
115.12	0.13	0.0995	1980	Rutledge	[2]
115.09	0.06	0.4670	1980	Houtermans	[3]
115.2	0.8	0.0026	1972	Emery	[4]
115.07	0.10	0.1681	1972	Lagoutine	[5]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
115.112	0.024	115.087	0.007	0.041	0.03

SU + SW2 = 0.065 |UM-WM| = 0.025 **Use WTD Mean**

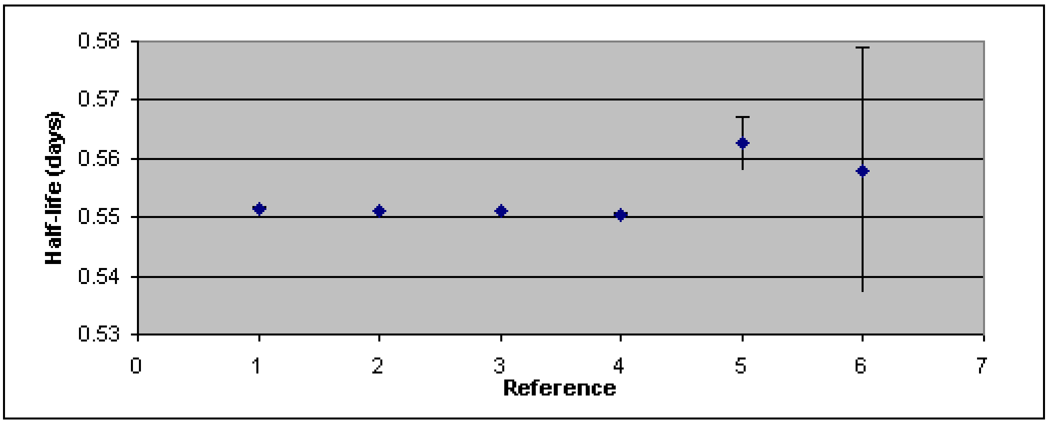
EVALUATED $\tau_{1/2}$ (days) = 115.09 (4)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[5]		*0.3 (3σ)*	*days*

^{123}I

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	0.55135	0.00027	0.0549	2004	Schrader	[1]
	0.55095	0.00012	0.2781	2004	Silva	[2]
1	0.550979	0.000079	0.6417	1992	Unterweger	[3]
	0.5504	0.0004	0.0250	1982	Lagoutine	[4]
2	0.5625	0.0046	0.0002	1973	Karim	[5]
2	0.558	0.021	0.0000	1968	Jonsson	[6]

1 = Normalise Weight < 0.5 *2 = Reject, far from mean*



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
0.554030	0.002055	0.550979	0.00009	0.000063	2.09

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
0.55135	0.00027	0.0769	2004	Schrader	[1]
0.55095	0.00012	0.3892	2004	Silva	[2]
0.550979	0.000106	0.4988	1992	Unterweger	[3]
0.5504	0.0004	0.0350	1982	Lagoutine	[4]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
0.550920	0.000196	0.550976	0.00009	0.000075	1.35

SU + SW1 = 0.000283 |UM-WM| = 0.000056 **Use UNWTD Mean**

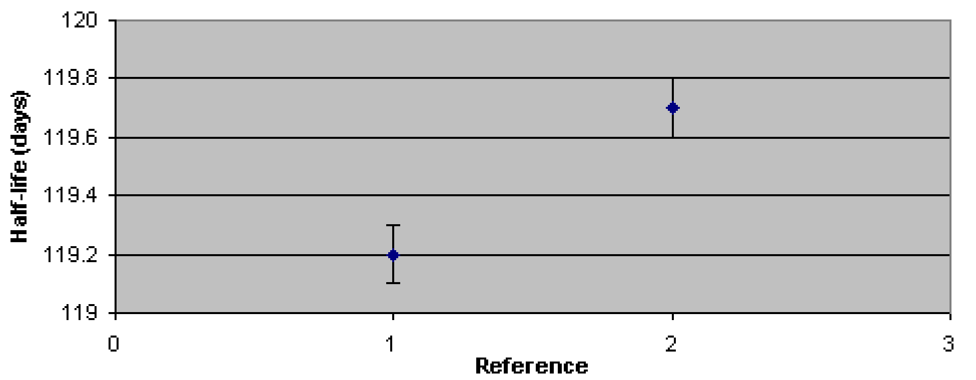
Increase SU to 0.005 to include lowest uncertainty value

EVALUATED $\tau_{1/2}$ (days) = 0.55098(9)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[3]	*13.2235*	*0.0019*	*hours*
	[4]	*13.21*	*0.03 (3σ)*	*hours*
	[5]	*13.50*	*0.11*	*hours*
	[6]	*13.4*	*0.5*	*hours*

$^{123}Te^{m}$

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
119.2	0.1	0.5000	1992	Coursey	[1]
119.7	0.1	0.5000	1972	Emery	[2]



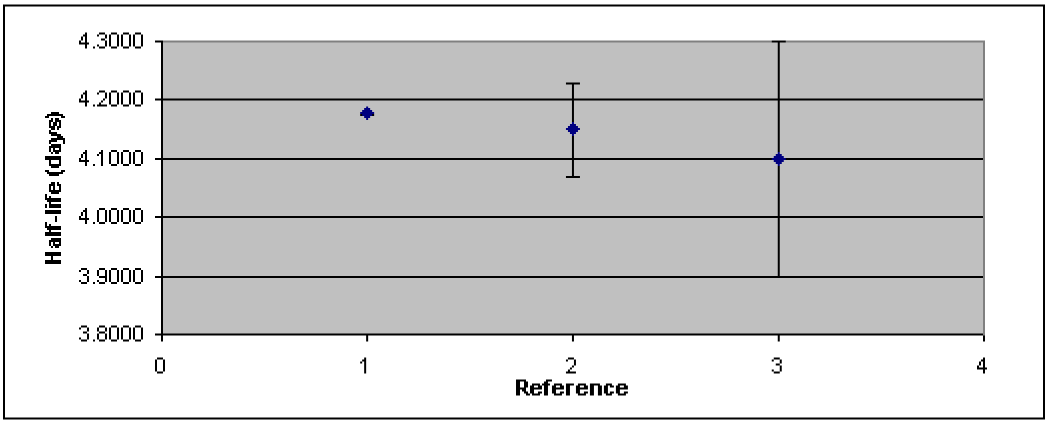
UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
119.45	0.25	119.45	0.25	0.07	12.50
SU + SW1	0.50	[UM-WM]=	0.00		**Use WTD Mean**

EVALUATED $\tau_{1/2}$ (days) = 119.45 (25)

^{124}I

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1	4.1760	0.0003	1.0000	1992	Woods	[1]
	4.15	0.08	0.0000	1973	Karim	[2]
	4.1	0.2	0.0000	1968	Jonssen	[3]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
4.14200	0.02230	4.17600	0.00011	0.00030	0.13

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
4.1760	0.0750	0.4952	1992	Woods	[1]
4.15	0.08	0.4352	1973	Karim	[2]
4.1	0.2	0.0696	1968	Jonssen	[3]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
4.14200	0.02230	4.15939	0.01450	0.05278	0.08

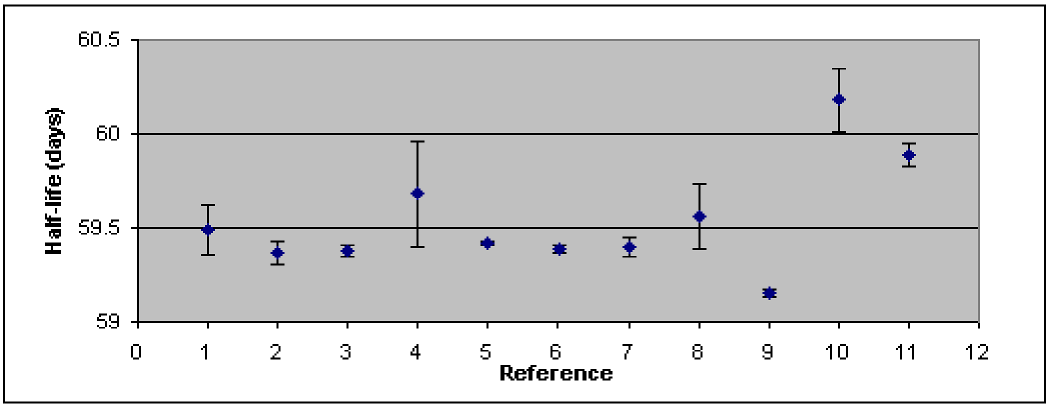
SU + SW2 = 0.07508 |UM-WM| = 0.01739 **Use WTD Mean**

EVALUATED $\tau_{1/2}$ (days) = 4.16 (6)

^{125}I

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	59.49	0.13	0.0034	1992	Unterweger	[1]
	59.37	0.06	0.0161	1991	Altzogiou	[2]
	59.38	0.03	0.0646	1990	Felice	[3]
	59.68	0.28	0.0007	1990	Konstantinov	[4]
1	59.416	0.010	0.5811	1990	Woods	[5]
	59.39	0.02	0.1453	1989	Schrader	[6]
	59.40	0.05	0.0232	1989	Simpson	[7]
	59.56	0.17	0.0020	1983	Kubo	[8]
2	59.156	0.020	0.1453	1980	Houtermans	[9]
2	60.18	0.17	0.0020	1972	Emery	[10]
2	59.89	0.06	0.0161	1968	Lagoutine	[11]

1 = Normalise weight < 0.5 *2 = Reject, far from mean*



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
59.5375	0.0860	59.3809	0.0370	0.0076	23.62

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
59.49	0.13	0.0071	1992	Unterweger	[1]
59.37	0.06	0.0335	1991	Altzogiou	[2]
59.38	0.03	0.1340	1990	Felice	[3]
59.416	0.016	0.4713	1990	Woods	[5]
59.39	0.02	0.3016	1989	Schrader	[6]
59.40	0.05	0.0483	1989	Simpson	[7]
59.56	0.17	0.0042	1983	Kubo	[8]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
59.4294	0.0264	59.4021	0.0081	0.0110	0.55

SU + SW2 = 0.0374 |UM-WM| = 0.0273 **Use WTD Mean**

Increase SW1 to 0.014 to include lowest uncertainty value

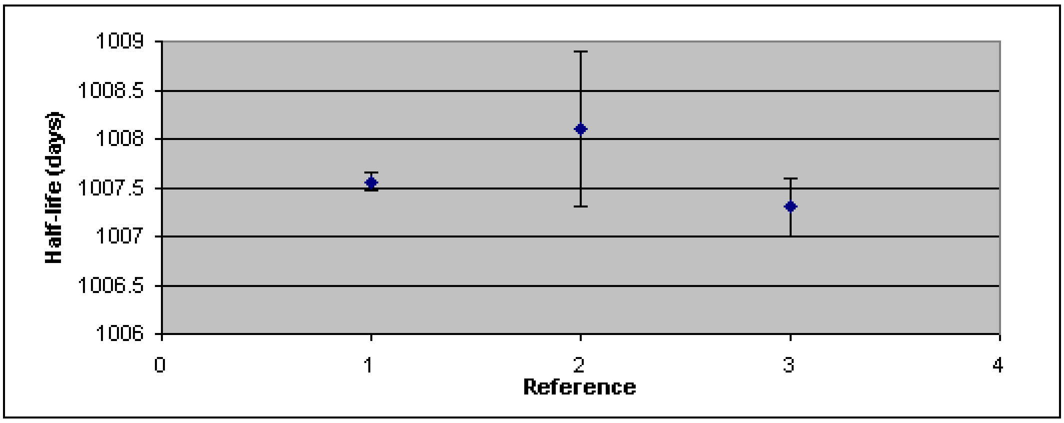
Evaluated $\tau_{1/2}$ (days) = 59.402 (14)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[11]		*0.180 (3σ)*	*hours*

^{125}Sb

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1	1007.56	0.10	0.8875	1992	Unterweger	[1]
	1008.1	0.8	0.0139	1983	Walz	[2]
	1007.3	0.3	0.0986	1980	Houtermans	[3]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
1007.653	0.236	1007.542	0.072	0.094	0.58

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1007.56	0.29	0.4841	1992	Unterweger	[1]
1008.1	0.8	0.0636	1983	Walz	[2]
1007.3	0.3	0.4523	1980	Houtermans	[3]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
1007.653	0.236	1007.477	0.145	0.202	0.52

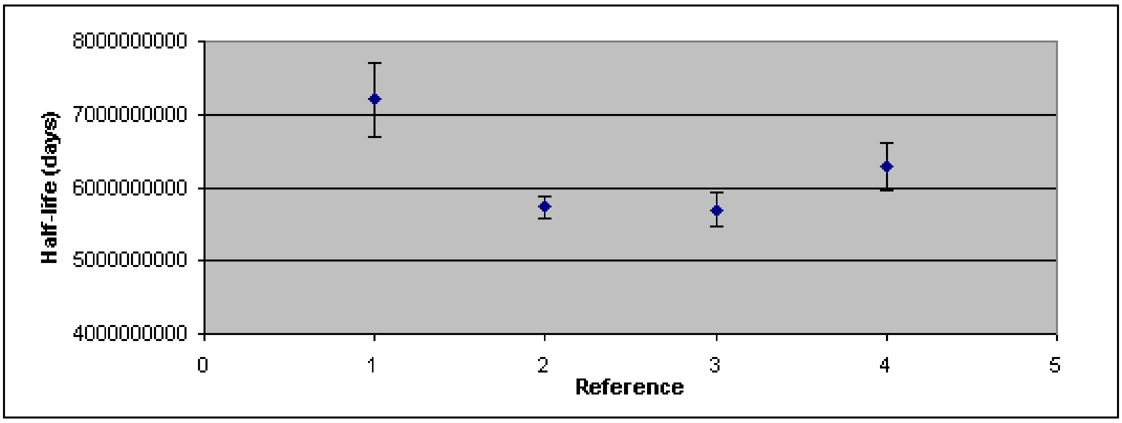
SU + SW2 = 0.437 |UM-WM| = 0.177 **Use WTD Mean**

EVALUATED $\tau_{1/2}$ (days) = 1007.48 (21)

^{129}I

Half-life (10^9 days)	Uncert (10^9 days)	Norm. wt	Year	Author	Ref
7.20	0.51	0.0492	1973	Kuhry	[1]
1 5.73	0.15	0.5688	1972	Emery	[2]
5.70	0.22	0.2644	1957	Russell	[3]
6.28	0.33	0.1175	1951	Katcoff	[4]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
6.2275	0.3505	5.859	0.2045	0.1131	3.27

Half-life (10^9 days)	Uncert (10^9 days)	Norm. wt	Year	Author	Ref
7.20	0.51	0.0596	1973	Kuhry	[1]
5.73	0.18	0.4781	1972	Emery	[2]
5.70	0.22	0.3201	1957	Russell	[3]
6.28	0.33	0.1423	1951	Katcoff	[4]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
6.2275	0.3505	5.8862	0.2218	0.1245	3.18

SU + SW1 = 0.5723 |UM-WM| = 0.3413 **Use WTD Mean**

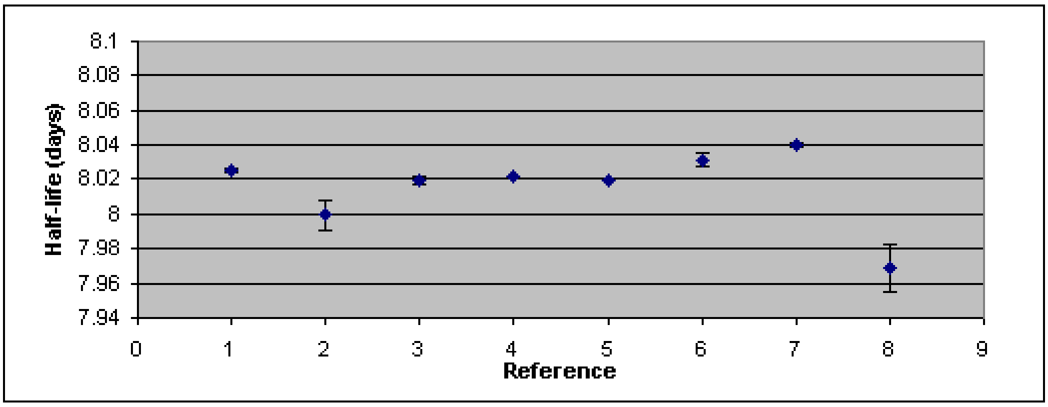
EVALUATED $\tau_{1/2}$ (days) = 5.89 (23) x 10^9

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[1]	*$1.97x10^7$*	*$0.14x10^7$*	*years*
	[2]	*$1.57x10^7$*	*$0.04x10^7$*	*years*
	[3]	*$1.56x10^7$*	*$0.06x10^7$*	*years*
	[4]	*$1.72x10^7$*	*$0.09x10^7$*	*years*

^{131}I

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1	8.0252	0.0006	0.4410	2004	Schrader	[1]
	7.9994	0.009	0.0020	2004	Silva	[2]
	8.0197	0.0022	0.0328	1992	Unterweger	[3]
	8.0213	0.0009	0.1960	1980	Houtermans	[4]
	8.020	0.001	0.1588	1978	Lagoutine	[5]
	8.031	0.004	0.0099	1974	Karsten	[6]
2	8.040	0.001	0.1588	1972	Emery	[7]
2	7.969	0.014	0.0008	1971	Zoller	[8]

1 = Normalise weight < 0.5 *2 = Reject, far from mean*



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
8.01570	0.00782	8.02574	0.00259	0.00040	42.24

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
8.0252	0.0007	0.4479	2004	Schrader	[1]
7.9994	0.0090	0.0027	2004	Silva	[2]
8.0197	0.0022	0.0453	1992	Unterweger	[3]
8.0213	0.0009	0.2709	1980	Houtermans	[4]
8.020	0.001	0.2195	1978	Lagoutine	[5]
8.031	0.004	0.0137	1974	Karsten	[6]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
8.01943	0.00437	8.02276	0.00124	0.00047	7.06

SU + SW1 = 0.00561 |UM-WM| = 0.00333 **Use WTD Mean**

EVALUATED $\tau_{1/2}$ (days) = 8.0228 (24)

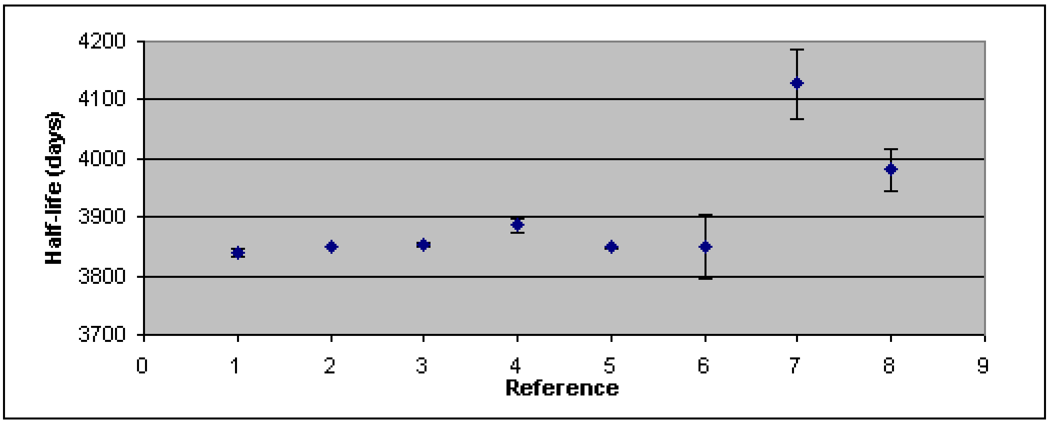
Chackett (1971) impurities noted but not taken into account

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[5]		*0.003 (3σ)*	*days*

^{133}Ba

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	3840.5	6.5	0.0080	2004	Schrader	[1]
1	3848.9	0.7	0.6859	1997	Martin	[2]
	3853.6	3.6	0.0259	1992	Unterweger	[3]
	3885.9	12.9	0.0020	1983	Kits	[4]
	3848.0	1.1	0.2778	1980	Houtermans	[5]
	3850	55	0.0001	1980	Hansen	[6]
2	4127	60	0.0001	1973	Lloyd	[7]
2	3981	37	0.0002	1972	Emery	[8]

1 = Normalise Weight < 0.5 *2 = Reject, far from mean*



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
3904.36	35.77	3848.84	1.49	0.58	6.64

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
3840.5	6.5	0.0134	2004	Schrader	[1]
3848.9	1.1	0.4696	1997	Martin	[2]
3853.6	3.6	0.0438	1992	Unterweger	[3]
3885.9	12.9	0.0034	1983	Kits	[4]
3848.0	1.1	0.4696	1980	Houtermans	[5]
3850	55	0.0002	1980	Hansen	[6]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
3854.48	6.52	3848.70	1.18	0.75	2.44

SU + SW1 = 7.70 |UM-WM| = 5.79 **Use WTD Mean**

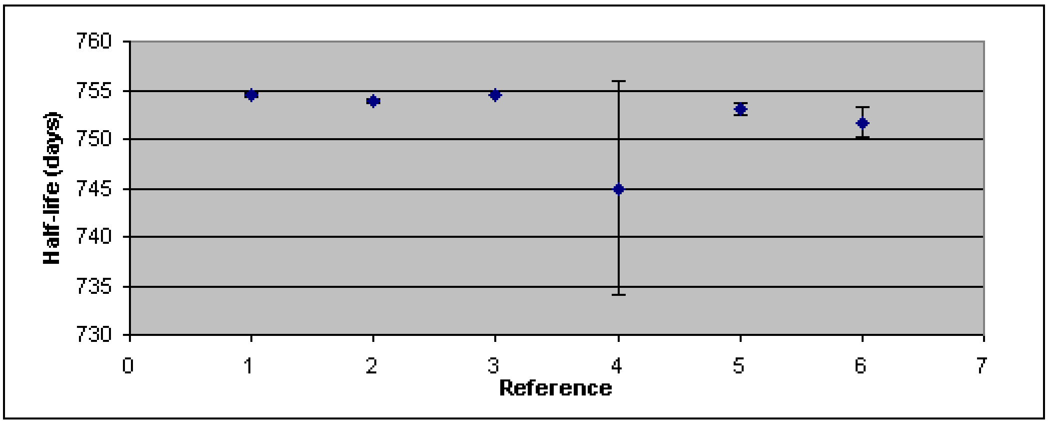
EVALUATED $\tau_{1/2}$ (days) = 3848.7 (12)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[9]	*10.9*	*0.1*	*years*

^{134}Cs

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	754.5	0.2	0.0903	1997	Martin	[1]
	753.88	0.15	0.1606	1992	Unterweger	[2]
1	754.5	0.07	0.7374	1980	Houtermans	[3]
2	745	11	0.0000	1978	Bulovic	[4]
	753.1	0.6	0.0100	1973	Dietz	[5]
	751.7	1.5	0.0016	1972	Lagoutine	[6]

1 = Normalise Weight < 0.5 *2 = Reject, far from mean*



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
752.113	1.486	754.382	0.129	0.060	4.58

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
754.5	0.2	0.1759	1997	Martin	[1]
753.88	0.15	0.3127	1992	Unterweger	[2]
754.5	0.12	0.4887	1980	Houtermans	[3]
753.1	0.6	0.0195	1973	Dietz	[5]
751.7	1.5	0.0031	1972	Lagoutine	[6]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
753.536	0.526	754.270	0.180	0.084	4.62

SU + SW1 = 0.707 |UM-WM| = 0.734 **Use UNWTD Mean**

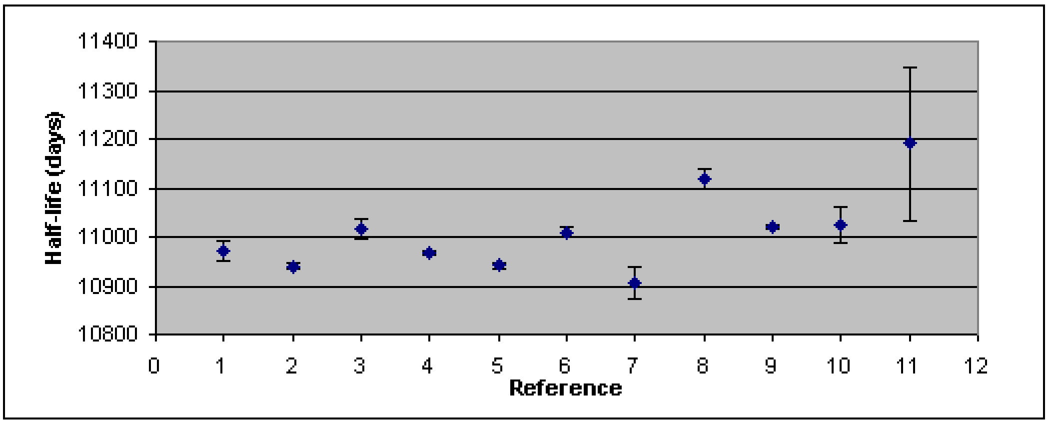
Increase SU to 1.0 to include lowest uncertainty value

EVALUATED $\tau_{1/2}$ (days) = 753.5 (10)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[4]	*2.04*	*0.03*	*years*
	[5]	*2.062*	*0.005 (3σ)*	*years*
	[6]	*2.058*	*0.012 (3σ)*	*years*

^{137}Cs

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
10970	20	0.0149	2004	Schrader	[1]
10940.8	6.9	0.1250	1992	Gostely	[2]
11015.0	20.0	0.0149	1992	Unterweger	[3]
10967.8	4.5	0.2939	1990	Martin	[4]
10941	7	0.1215	1989	Kochin	[5]
11009	11	0.0492	1980	Houtermans	[6]
10906	33	0.0055	1973	Gries	[7]
11118	19	0.0165	1973	Corbett	[8]
11021.1	4.1	0.3541	1973	Dietz	[9]
11023	37	0.0043	1972	Emery	[10]
11191	157	0.0002	1970	Harbottle	[11]



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
11009.34	24.95	10985.24	11.90	2.44	23.78

SU + SW1 = 36.85 |UM-WM| = 24.10 **Use WTD Mean**

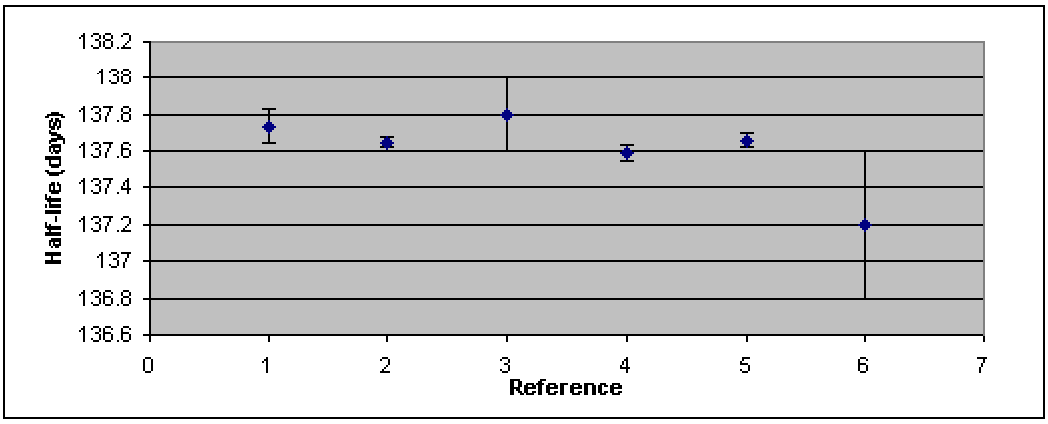
Increase SW1 to 36 to include lowest uncertainty value

EVALUATED $\tau_{1/2}$ (days) = 1.099 (4) x 10^4

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[7]	*29.86*	*0.270 (3σ)*	*years*
	[8]	*30.44*	*0.05*	*years*
	[9]	*30.174*	*0.034 (3σ)*	*years*
	[10]	*30.18*	*0.10*	*years*
	[11]	*30.64*	*0.43*	*years*

^{139}Ce

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
137.734	0.091	0.0481	1992	Unterweger	[1]
137.65	0.03	0.4421	1980	Rutledge	[2]
137.8	0.2	0.0099	1982	Rytz	[3]
137.59	0.04	0.2487	1978	Lagoutine	[4]
137.66	0.04	0.2487	1976	Vaninbroukx	[5]
137.2	0.4	0.0025	1972	Emery	[6]



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
137.6057	0.0864	137.6420	0.0196	0.0199	0.97

SU + SW2 = 0.1064 |UM-WM| = 0.0363 **Use WTD Mean**

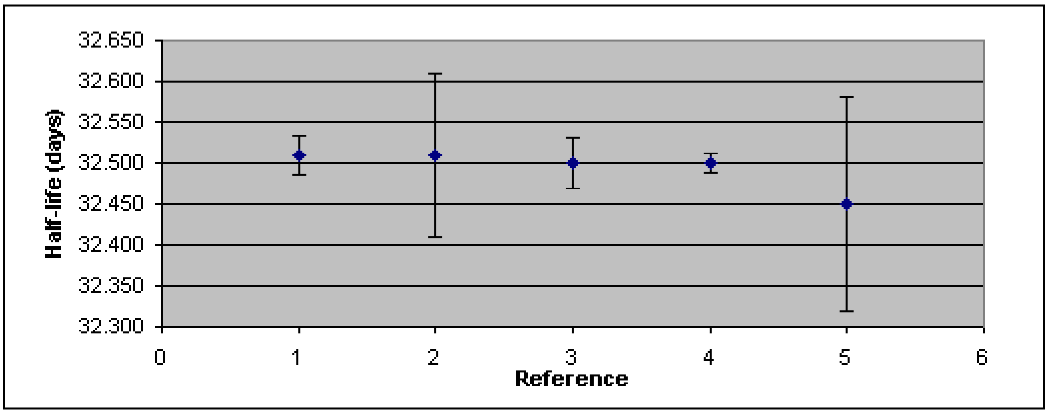
EVALUATED $\tau_{1/2}$ (days) = 137.642 (20)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[5]		*0.12 (3σ)*	*days*
	[6]		*1.3 (3σ)*	*days*

^{141}Ce

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	32.510	0.024	0.1946	1992	Unterweger	[1]
	32.51	0.10	0.0112	1983	Walz	[2]
	32.50	0.03	0.1245	1980	Rutledge	[3]
1	32.500	0.013	0.6631	1977	Vaninbroukx	[4]
	32.45	0.13	0.0066	1972	Emery	[5]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
32.4940	0.0112	32.5017	0.0029	0.0106	0.08

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
32.510	0.024	0.3005	1992	Unterweger	[1]
32.51	0.10	0.0173	1983	Walz	[2]
32.50	0.03	0.1924	1980	Rutledge	[3]
32.500	0.019	0.4795	1977	Vaninbroukx	[4]
32.45	0.13	0.0102	1972	Emery	[5]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
32.4940	0.0112	32.5027	0.0035	0.0132	0.07

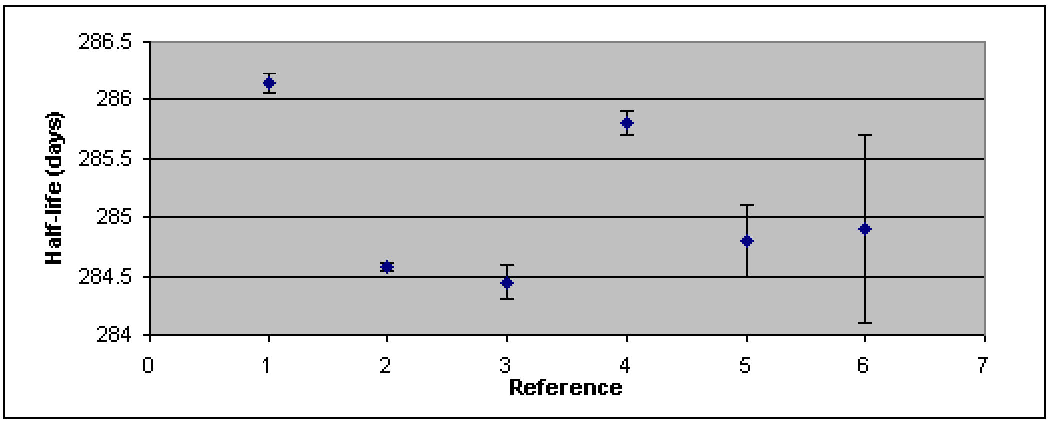
SU + SW2 = 0.0244 |UM-WM| = 0.0087 **Use WTD Mean**

EVALUATED $\tau_{1/2}$ (days) = 32.503 (14)

^{144}Ce

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	286.14	0.09	0.1269	1997	Martin	[1]
1	284.58	0.038	0.7117	1992	Unterweger	[2]
	284.45	0.15	0.0457	1983	Walz	[3]
	285.8	0.1	0.1028	1980	Houtermans	[4]
	284.8	0.3	0.0114	1968	Lagoutine	[5]
	284.9	0.8	0.0016	1968	Reynolds	[6]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
285.112	0.282	284.900	0.269	0.032	70.17

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
286.14	0.09	0.2211	1997	Martin	[1]
284.58	0.06	0.4975	1992	Unterweger	[2]
284.45	0.15	0.0796	1983	Walz	[3]
285.8	0.1	0.1791	1980	Houtermans	[4]
284.8	0.3	0.0199	1968	Lagoutine	[5]
284.9	0.8	0.0028	1968	Reynolds	[6]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
285.112	0.282	285.138	0.315	0.042	55.33

SU + SW1 = 0.597 |UM-WM| = 0.027 **Use WTD Mean**

Increase SW1 to 0.48 to include lowest uncertainty value

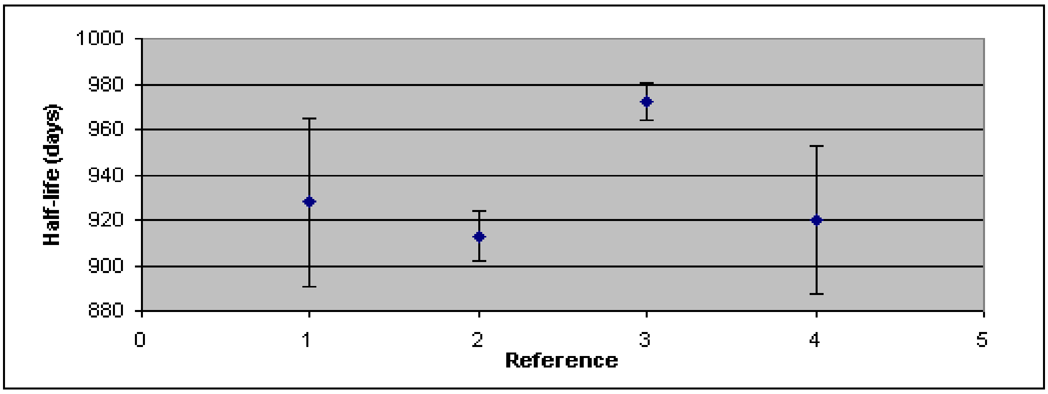
EVALUATED $\tau_{1/2}$ (days) = 285.1 (5)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[5]		*1.0 (3σ)*	*days*

^{147}Pm

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	928	37	0.0286	1965	Flynn	[1]
	913	11	0.3236	1958	Wyatt	[2]
1	972	8	0.6118	1956	Schuman	[3]
	920	33	0.0360	1955	Melaika	[4]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
933.3	13.3	949.8	16.2	6.3	6.69

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
928	37	0.0402	1965	Flynn	[1]
913	11	0.4546	1958	Wyatt	[2]
972	11	0.4546	1956	Schuman	[3]
920	33	0.0505	1955	Melaika	[4]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
933.3	13.3	940.8	16.6	7.4	4.98

SU + SW1 = 29.8 |UM-WM| = 7.5 **Use WTD Mean**

Increase SW1 to 31 to include lowest uncertainty value

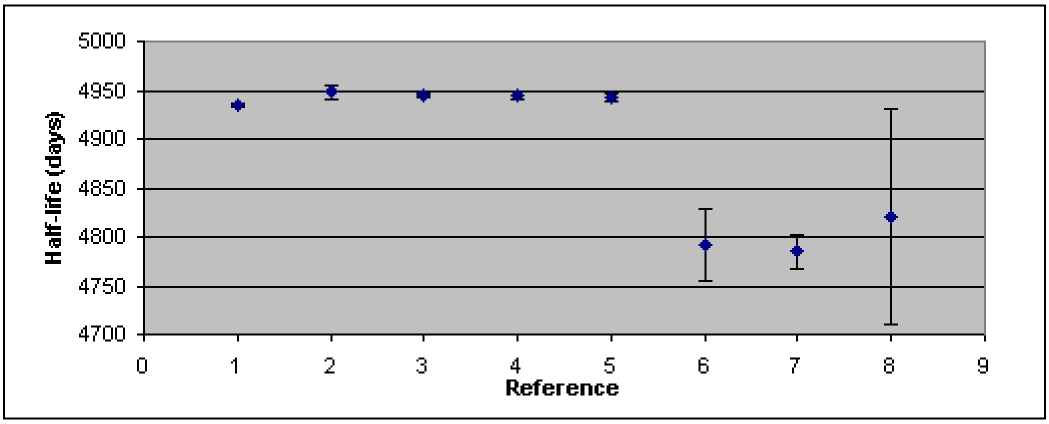
EVALUATED $\tau_{1/2}$ (days) = 9.4 (4) x 10^2

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[1]	*2.54*	*0.1*	*years*
	[2]	*2.5*	*0.03*	*years*
	[3]	*2.66*	*0.02*	*years*
	[4]	*2.52*	*0.09*	*years*

^{152}Eu

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	4934.1	2.3	0.3605	2004	Schrader	[1]
	4948	7	0.0389	1997	Martin	[2]
	4945.5	2.3	0.3605	1992	Unterweger	[3]
	4944.4	4.1	0.1134	1990	Kuzmonko	[4]
	4943	4	0.1192	1986	Woods	[5]
1	4792	37	0.0014	1983	Baba	[6]
1	4785	18	0.0059	1978	Lagoutine	[7]
1	4821	110	0.0002	1972	Emery	[8]

1 = Reject, far from mean



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
4889.13	26.57	4939.89	5.39	1.38	15.23

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
4934.1	2.3	0.3632	2004	Schrader	[1]
4948	7	0.0392	1997	Martin	[2]
4945.5	2.3	0.3632	1992	Unterweger	[3]
4944.4	4.1	0.1143	1990	Kuzmonko	[4]
4943	4	0.1201	1986	Woods	[5]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
4943.00	2.37	4941.03	2.66	1.39	3.69

SU + SW1 = 5.03 |UM-WM| = 1.97 **Use WTD Mean**

Increase SW1 to 6.9 to include lowest uncertainty value

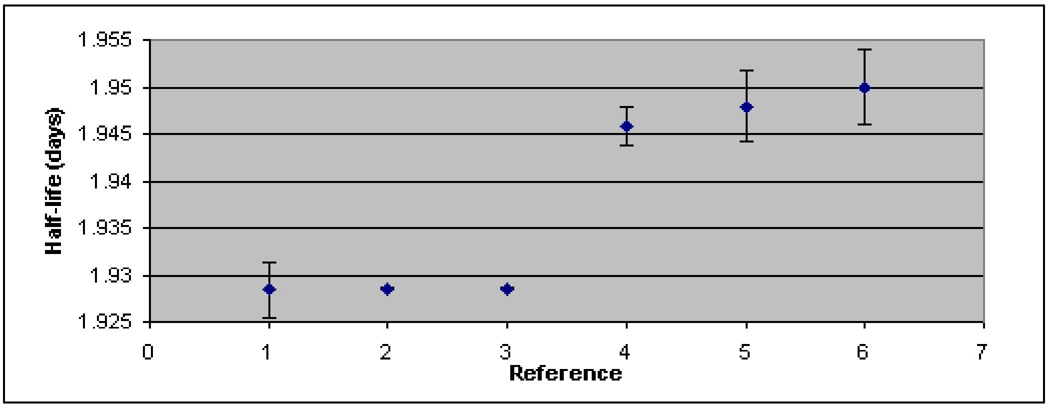
EVALUATED $\tau_{1/2}$ (days) = 4941 (7)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[4]	*13.537*	*0.011*	*years*
	[6]	*13.12*	*0.10*	*years*
	[7]	*13.10*	*0.15 (3σ)*	*years*
	[8]	*13.2*	*0.3*	*years*

^{153}Sm

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	1.9284	0.0029	0.0004	2004	Schrader	[1]
	1.92854	0.00017	0.1041	1998	Bowles	[2]
1	1.928554	0.000058	0.8944	1994	Coursey	[3]
	1.9458	0.0021	0.0007	1989	Abzouzi	[4]
	1.9479	0.0038	0.0002	1970	Chu	[5]
	1.950	0.004	0.0002	1968	Reynolds	[6]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
1.93820	0.00437	1.92857	0.00027	0.00005	24.40

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1.9284	0.0029	0.0017	2004	Schrader	[1]
1.92854	0.00017	0.4966	1998	Bowles	[2]
1.928554	0.00017	0.4966	1994	Coursey	[3]
1.9458	0.0021	0.0033	1989	Abzouzi	[4]
1.9479	0.0038	0.0010	1970	Chu	[5]
1.950	0.004	0.0009	1968	Reynolds	[6]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
1.93820	0.00437	1.92864	0.00059	0.00012	24.32

SU + SW1 = 0.00496 |UM-WM| = 0.00956 **Use UNWTD Mean**

Increase SU to 0.01 to include lowest uncertainty value

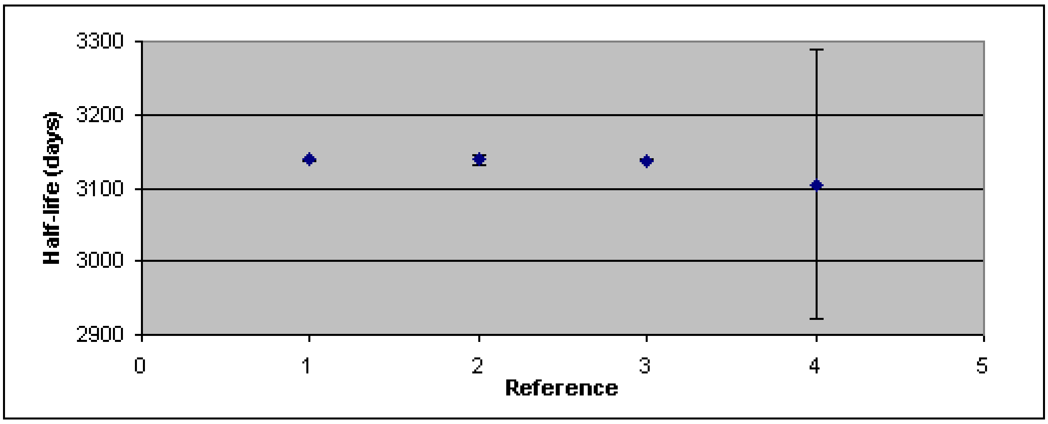
EVALUATED $\tau_{1/2}$ (days) = 1.938 (10)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[2]	*46.285*	*0.004*	*hours*
	[3]	*46.29*	*0.0014*	*hours*
	[4]	*46.70*	*0.05*	*hours*
	[5]	*46.75*	*0.09*	*hours*
	[6]	*46.8*	*0.1*	*hours*

^{154}Eu

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1	3138.1	1.1	0.7490	2004	Schrader	[1]
	3138.2	6.1	0.0244	1992	Unterweger	[2]
	3138	2	0.2266	1986	Woods	[3]
	3105	183	0.0000	1972	Emery	[4]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
3129.83	8.28	3138.08	0.10	0.95	0.01

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
3138.1	1.9	0.5001	2004	Schrader	[1]
3138.2	6.1	0.0485	1992	Unterweger	[2]
3138	2	0.4513	1986	Woods	[3]
3105	183	0.0001	1972	Emery	[4]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
3129.83	8.28	3138.06	0.14	1.34	0.01

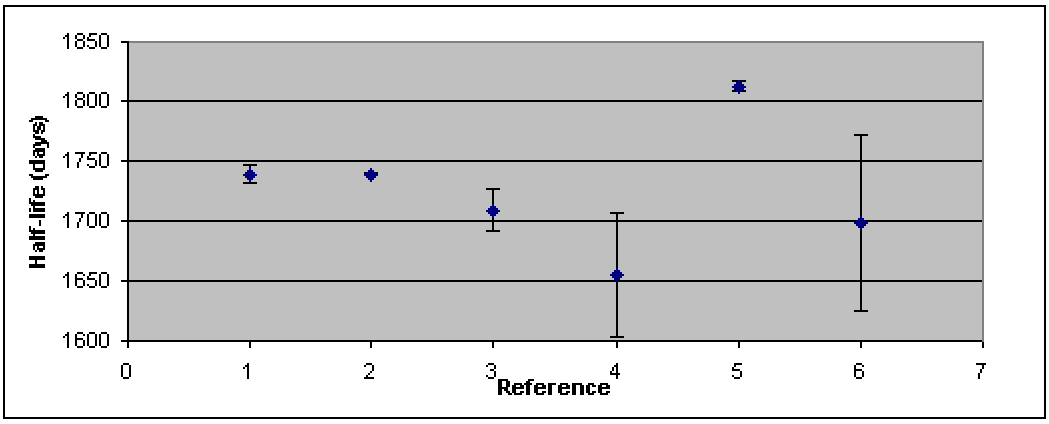
SU + SW2 = 9.62 |UM-WM| = 8.23 **Use WTD Mean**

EVALUATED $\tau_{1/2}$ (days) = 3138.1 (14)

^{155}Eu

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	1739	8	0.0037	1998	Siegert	[1]
1	1738.97	0.49	0.9807	1993	Unterweger	[2]
	1709	18	0.0007	1992	Daniels	[3]
2	1655	51	0.0001	1972	Rao	[4]
2	1812	4	0.0147	1972	Emery	[5]
	1698	73	0.0000	1970	Mowatt	[6]

1 = Normalise Weight < 0.5 *2 = Reject, far from mean*



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
1725.328	21.482	1740.014	3.969	0.485	66.90

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1739	8	0.4148	1998	Siegert	[1]
1738.97	7.3	0.4982	1993	Unterweger	[2]
1709	18	0.0819	1992	Daniels	[3]
1698	73	0.0050	1970	Mowatt	[6]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
1721.243	10.487	1736.322	4.999	5.153	0.94

SU + SW2 = 15.640 |UM-WM| = 15.080 **Use WTD Mean**

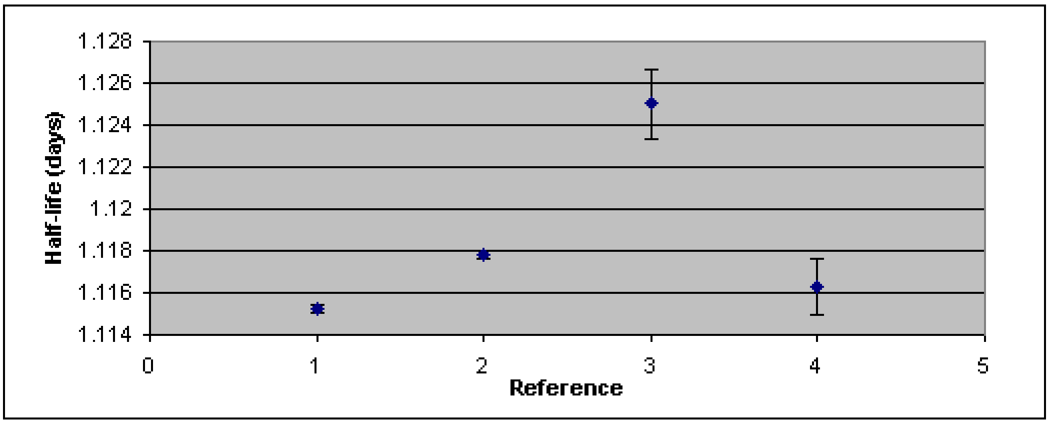
EVALUATED $\tau_{1/2}$ (days) = 1736 (6)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[4]	*4.53*	*0.14*	*years*
	[5]	*4.96*	*0.01*	*years*
	[6]	*4.65*	*0.2*	*years*

^{166}Ho

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1	1.11526	0.00018	0.5665	1994	Coursey	[1]
	1.11779	0.00021	0.4162	1989	Abzouzi	[2]
2	1.1250	0.0017	0.0064	1976	Venkata Ramaniah	[3]
	1.1163	0.0013	0.0109	1968	Nethaway	[4]

1 = Normalise Weight < 0.5 *2 = Reject, far from mean*



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
1.118588	0.002200	1.116386	0.000819	0.000135	36.50

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1.11526	0.00021	0.4936	1994	Coursey	[1]
1.11779	0.00021	0.4936	1989	Abzouzi	[2]
1.1163	0.0013	0.0129	1968	Nethaway	[4]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
1.116450	0.000734	1.116522	0.000889	0.000148	36.30

SU + SW1 = 0.001623 |UM-WM| = 0.000072 **Use WTD Mean**

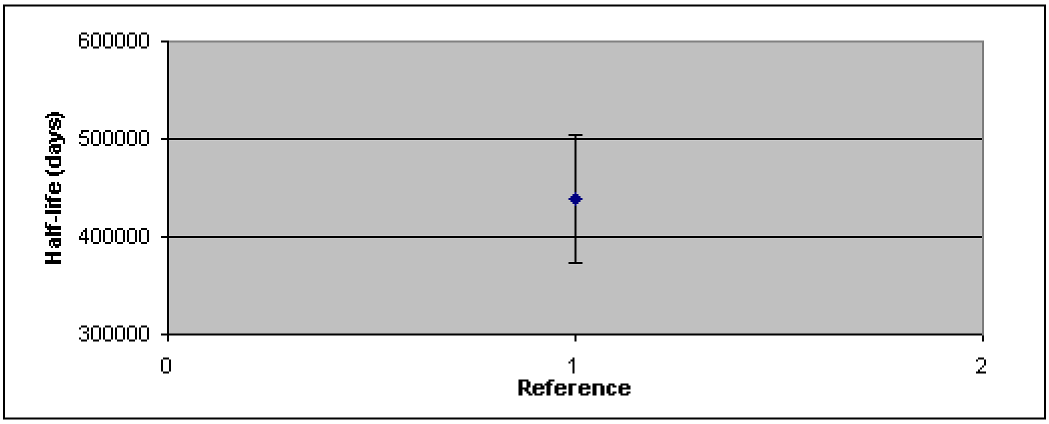
Increase SW1 to 0.0013 to include lowest uncertainty value

EVALUATED $\tau_{1/2}$ (days) = 1.1165 (13)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[1]	*26.7663*	*0.0044*	*hours*
	[2]	*26.827*	*0.005*	*hours*
	[3]	*27*	*0.04*	*hours*
	[4]	*26.79*	*0.03*	*hours*

$^{166}Ho^{m}$

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
438300	65745	1.0000	1964	Faler	[1]



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
438300	65745	438300			

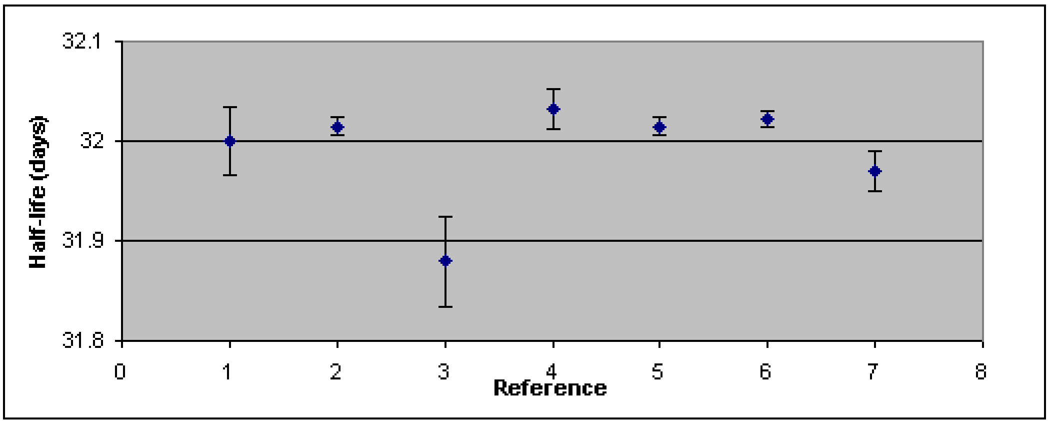
EVALUATED $\tau_{1/2}$ (days) = 4.4 (7) x 10^5

Only one value available

^{169}Yb

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	32.001	0.034	0.0188	2001	Delgado	[1]
	32.0147	0.0093	0.2519	1992	Unterweger	[2]
1	31.88	0.045	0.0108	1990	Parker	[3]
	32.032	0.02	0.0545	1983	Funck	[4]
	32.015	0.009	0.2690	1980	Rutledge	[5]
	32.022	0.008	0.3405	1980	Houtermans	[6]
	31.97	0.02	0.0545	1975	Lagoutine	[7]

1 = Reject, far from mean



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
31.99067	0.01991	32.01407	0.00755	0.00467	2.61

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
32.001	0.034	0.0191	2001	Delgado	[1]
32.0147	0.0093	0.2547	1992	Unterweger	[2]
32.032	0.02	0.0551	1983	Funck	[4]
32.015	0.009	0.2719	1980	Rutledge	[5]
32.022	0.008	0.3442	1980	Houtermans	[6]
31.97	0.02	0.0551	1975	Lagoutine	[7]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
32.00912	0.00885	32.01552	0.00544	0.00469	1.34

SU + SW1 = 0.01429 |UM-WM| = 0.00641 **Use WTD Mean**

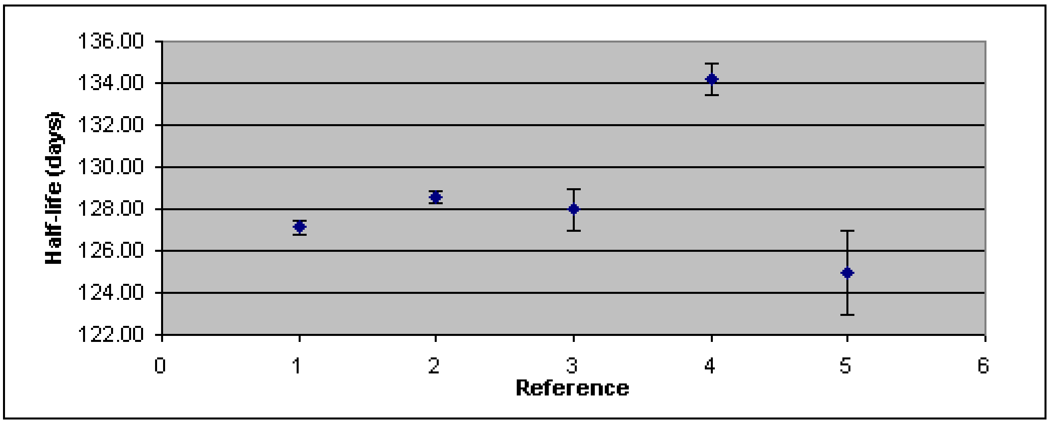
EVALUATED $\tau_{1/2}$ (days) = 32.016 (6)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[3]		*0.14%*	
	[7]		*0.050 (3σ)*	*days*

^{170}Tm

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	127.10	0.31	0.4277	1969	Lagoutine	[1]
	128.6	0.3	0.4567	1968	Reynolds	[2]
	128	1	0.0411	1967	Kerrigan	[3]
1	134.2	0.8	0.0642	1965	Flynn	[4]
	125	2	0.0103	1962	Bonner	[5]

1 = Reject, far from mean



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
128.580	1.532	128.256	0.867	0.203	18.29

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
127.10	0.31	0.4571	1969	Lagoutine	[1]
128.6	0.3	0.4880	1968	Reynolds	[2]
128	1	0.0439	1967	Kerrigan	[3]
125	2	0.0110	1962	Bonner	[5]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
127.175	0.788	127.849	0.455	0.210	4.72

SU + SW1 = 1.243 |UM-WM| = 0.674 **Use WTD Mean**

Increase SW1 to 0.8 to include lowest uncertainty value

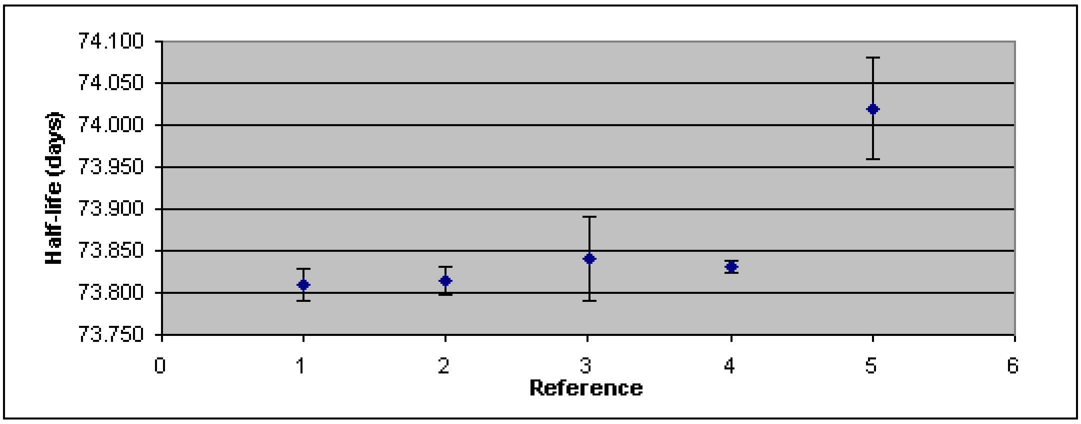
EVALUATED $\tau_{1/2}$ (days) = 127.8 (8)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[1]		*0.92 (3σ)*	*days*

^{192}Ir

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	73.810	0.019	0.1229	1992	Unterweger	[1]
	73.814	0.017	0.1536	1992	Woods(Woods)	[2]
	73.840	0.05	0.0178	1992	Woods(Reher)	[3]
1	73.831	0.008	0.6934	1980	Houtermans	[4]
2	74.02	0.06	0.0123	1972	Lagoutine	[5]

1 = Normalise Weight < 0.5 *2 = Reject, far from mean*



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
73.8630	0.0396	73.8283	0.0115	0.0067	3.00

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
73.810	0.019	0.2208	1992	Unterweger	[1]
73.814	0.017	0.2758	1992	Woods(Woods)	[2]
73.840	0.05	0.0319	1992	Woods(Reher)	[3]
73.831	0.013	0.4716	1980	Houtermans	[4]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
73.8238	0.0071	73.8220	0.0057	0.0089	0.41

SU + SW2 = 0.0160 |UM-WM| = 0.0018 **Use WTD Mean**

EVALUATED $\tau_{1/2}$ (days) = 73.822 (9)

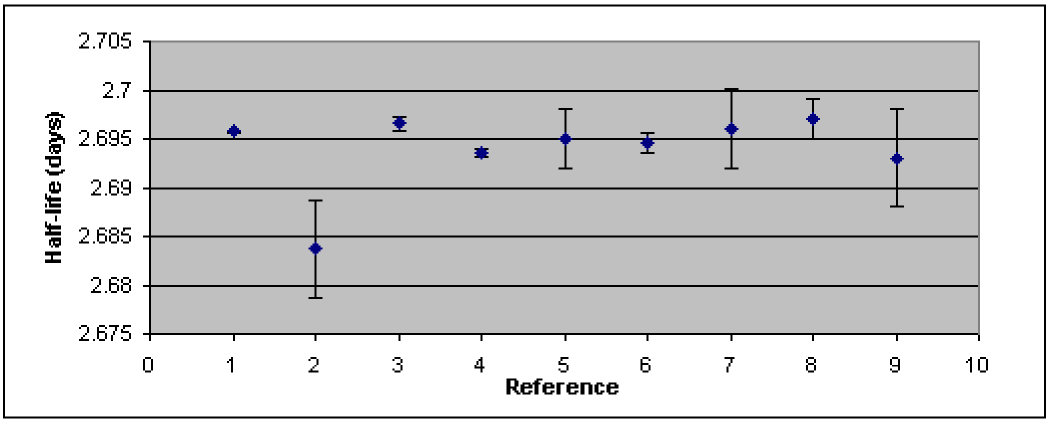
[2] and [3] values from different NMIs in same paper

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[5]		*0.18 (3σ)*	*days*

^{198}Au

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
2	2.69573	0.00014	0.8390	2004	Unterweger	[1]
1	2.68373	0.00504	0.0006	1994	Mignonsin	[2]
	2.6966	0.0007	0.0336	1990	Abzouzi	[3]
	2.6935	0.0004	0.1028	1980	Rutledge	[4]
	2.695	0.003	0.0018	1971	Goodier	[5]
	2.6946	0.0010	0.0164	1970	Cabell	[6]
	2.696	0.004	0.0010	1970	Costa Paiva	[7]
	2.697	0.002	0.0041	1968	Lagoutine	[8]
	2.693	0.005	0.0007	1968	Reynolds	[9]

1 = Normalise Weight < 0.5 *2 = Reject, far from mean*



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
2.693907	0.001348	2.695506	0.00028	0.000128	4.66

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
2.69573	0.00033	0.4849	2004	Unterweger	[1]
2.6966	0.0007	0.1078	1990	Abzouzi	[3]
2.6935	0.0004	0.3300	1980	Rutledge	[4]
2.695	0.003	0.0059	1971	Goodier	[5]
2.6946	0.0010	0.0528	1970	Cabell	[6]
2.696	0.004	0.0033	1970	Costa Paiva	[7]
2.697	0.002	0.0132	1968	Lagoutine	[8]
2.693	0.005	0.0021	1968	Reynolds	[9]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
2.695179	0.000504	2.695036	0.00044	0.000230	3.65

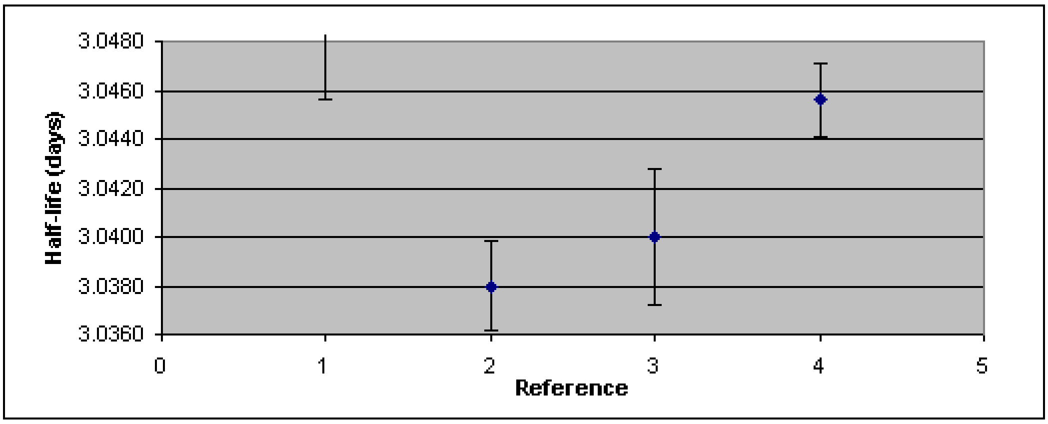
SU + SW1 = 0.000943 |UM-WM| = 0.000143 **Use WTD Mean**

EVALUATED $\tau_{1/2}$ (days) = 2.6950 (7)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[5]		*0.008 (3σ)*	*days*
	[8]		*0.005 (3σ)*	*days*

^{201}Tl

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
3.0486	0.0030	0.0740	2004	Schrader	[1]
3.0380	0.0018	0.2055	2004	Souza	[2]
3.0400	0.0028	0.0849	1994	Simpson	[3]
3.0456	0.0015	0.2959	1992	Unterweger	[4]
3.0408	0.0014	0.3397	1982	Lagoutine	[5]



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
3.042600	0.001951	3.042154	0.00167	0.000816	4.19

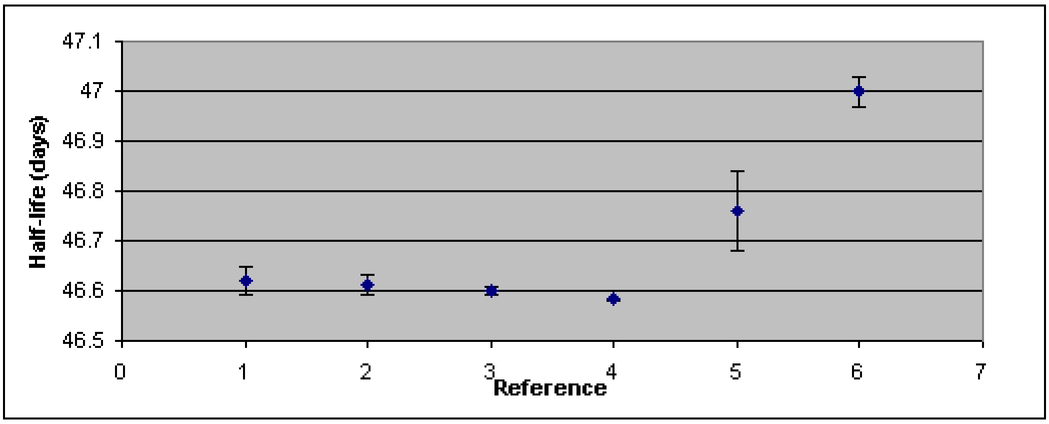
SU + SW1 = 0.003621 |UM-WM| = 0.000446 **Use WTD Mean**

EVALUATED $\tau_{1/2}$ (days) = 3.0422 (17)

^{203}Hg

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	46.619	0.027	0.0052	1992	Unterweger	[1]
	46.612	0.019	0.0104	1983	Walz	[2]
	46.60	0.01	0.0377	1980	Rutledge	[3]
1	46.582	0.002	0.9419	1980	Houtermans	[4]
2	46.76	0.08	0.0006	1972	Emery	[5]
2	47.00	0.03	0.0042	1968	Lagoutine	[6]

1 = Normalise Weight < 0.5 *2 = Reject, far from mean*



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
46.6955	0.0663	46.5850	0.0124	0.0019	40.85

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
46.619	0.027	0.0518	1992	Unterweger	[1]
46.612	0.019	0.1046	1983	Walz	[2]
46.60	0.01	0.3775	1980	Rutledge	[3]
46.582	0.009	0.4661	1980	Houtermans	[4]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
46.6033	0.0081	46.5938	0.0070	0.0061	1.30

SU + SW1 = 0.0151 |UM-WM| = 0.0094 **Use WTD Mean**

Increase SW1 to 0.012 to include lowest uncertainty value

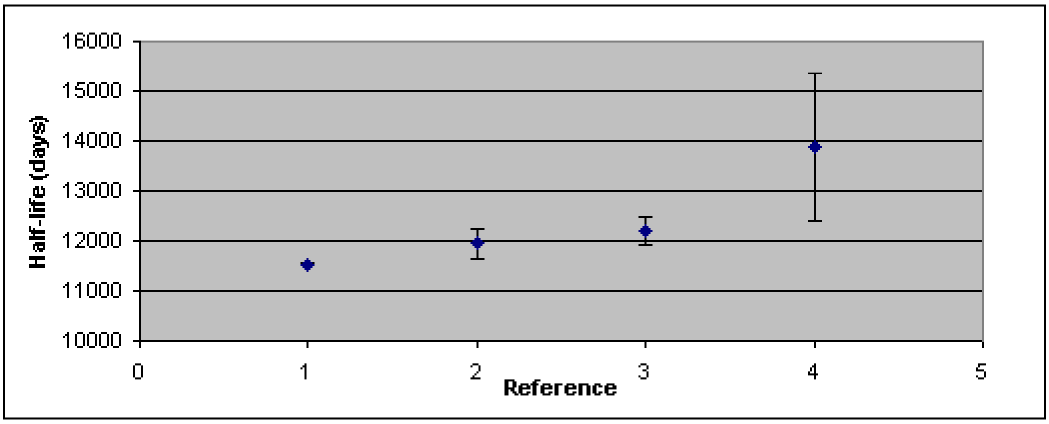
EVALUATED $\tau_{1/2}$ (days) = 46.594 (12)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[6]		*1.00 (3σ)*	*days*

^{207}Bi

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1	11523	19	0.9914	1992	Unterweger	[1]
	11944	292	0.0042	1991	Lin	[2]
	12199	292	0.0042	1978	Yanokura	[3]
	13880	1461	0.0002	1972	Rupnik	[4]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
12386.5	517.0	11528.0	34.5	18.9	3.32

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
11523	210	0.4866	1992	Unterweger	[1]
11944	292	0.2517	1991	Lin	[2]
12199	292	0.2517	1978	Yanokura	[3]
13880	1461	0.0101	1972	Rupnik	[4]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
12386.5	517.0	11822.8	204.6	146.5	1.95

SU + SW1 = 721.6 |UM-WM| = 563.7 **Use WTD Mean**

Increase SW1 to 300 to include lowest uncertainty value

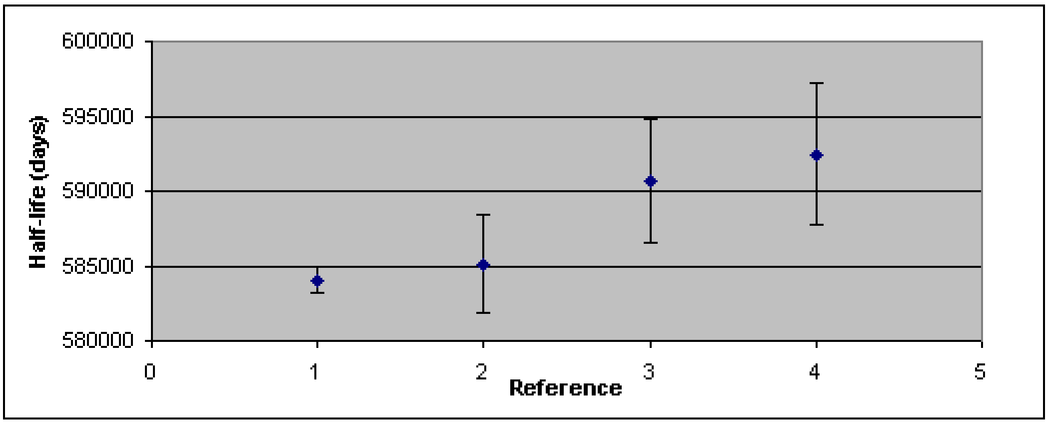
EVALUATED $\tau_{1/2}$ (days) = 1.18 (3) x 10^4

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[2]	*32.7*	*0.08*	*years*
	[3]	*33.4*	*0.8*	*years*
	[4]	*28*	*3*	*years*

^{226}Ra

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1	584035	853	0.8728	1966	Ramthun	[1]
	585131	3204	0.0619	1959	Martin	[2]
	590609	4135	0.0371	1956	Sebaoun	[3]
	592436	4749	0.0282	1949	Kohman	[4]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
588052.8	2049.9	584583.6	1059.3	796.9	1.77

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
584035	2250	0.4966	1966	Ramthun	[1]
585131	3204	0.2449	1959	Martin	[2]
590609	4135	0.1470	1956	Sebaoun	[3]
592436	4749	0.1115	1949	Kohman	[4]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
588052.8	2049.9	586206.5	1807.4	1585.6	1.30

SU + SW1 = 3857.4 |UM-WM| = 1846.3 **Use WTD Mean**

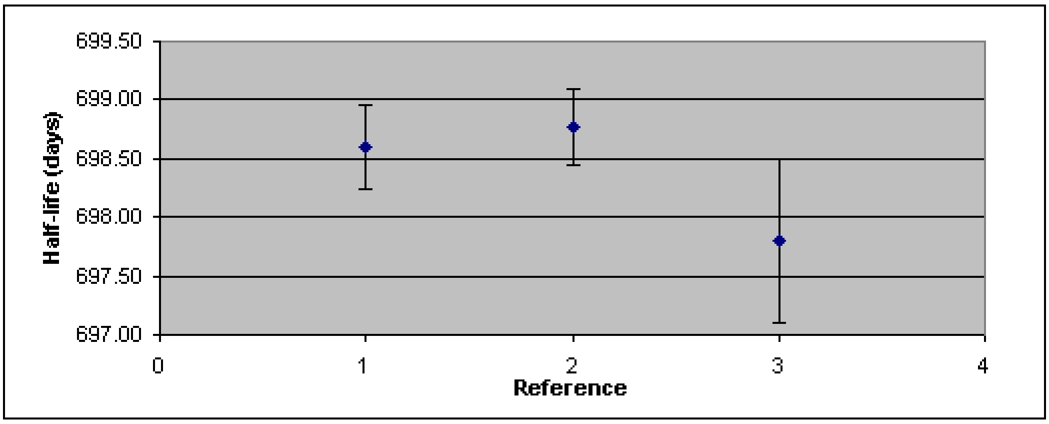
Increase SW1 to 2200 to include lowest uncertainty value

EVALUATED $\tau_{1/2}$ (days) = 5.862 (22) x 10^5

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[1]	*1599*	*7 (3σ)*	*years*
	[2]	*1602*	*0.55%*	*years*
	[3]	*1617*	*12*	*years*
	[4]	*1622*	*13*	*years*

^{228}Th

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
698.60	0.36	0.3952	1992	Unterweger	[1]
698.77	0.32	0.5002	1971	Jordan	[2]
697.8	0.7	0.1045	1956	Kirby	[3]



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
698.390	0.299	698.601	0.202	0.226	0.79

SU + SW2 = 0.529 |UM-WM| = 0.206 **Use WTD Mean**

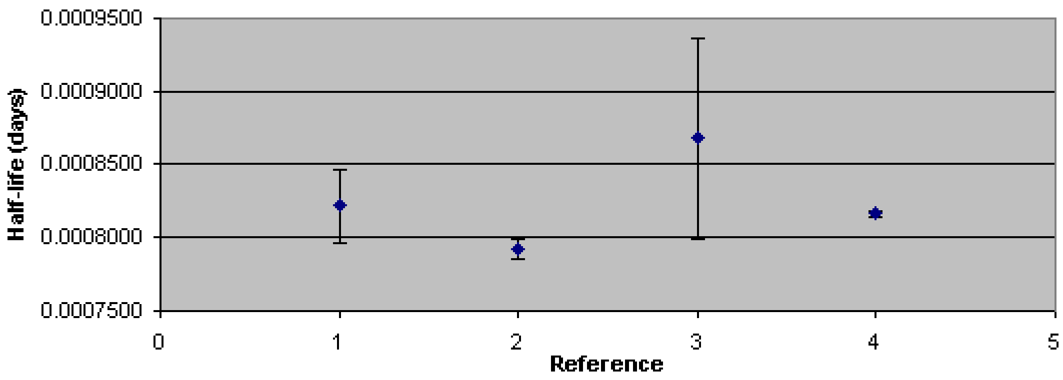
EVALUATED $\tau_{1/2}$ (days) = 698.60 (23)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[2]	*1.91313*	*0.00088*	*years*
	[3]	*1.9*	*0.002*	*years*

$^{234}Pa^{m}$

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
	0.0008215	0.0000257	0.0061	1969	Saeki	[1]
	0.0007917	0.0000069	0.0842	1963	Bjornholm	[2]
	0.000868	0.000069	0.0008	1956	Hok	[3]
1	0.0008160	0.0000021	0.9089	1951	Barendregt	[4]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
0.00082430	0.00001594	0.00081403	0.00000401	0.00000200	4.02

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
0.0008215	0.0000257	0.0336	1969	Saeki	[1]
0.0007917	0.0000069	0.4667	1963	Bjornholm	[2]
0.000868	0.000069	0.0047	1956	Hok	[3]
0.0008160	0.0000067	0.4950	1951	Barendregt	[4]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
0.00082430	0.00001594	0.00080509	0.00000753	0.00000471	2.55

SU + SW1 = 0.00002347 |UM-WM| = 0.00001921 **Use WTD Mean**

Increase SW1 to 0.000011 to include lowest uncertainty value

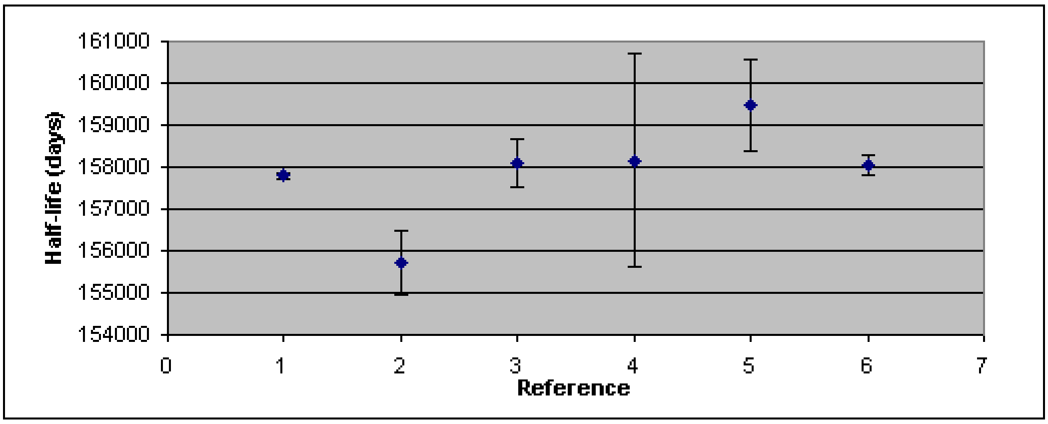
EVALUATED $\tau_{1/2}$ (days) = 0.000805 (11)

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[1]	*1.183*	*0.037*	*minutes*
	[2]	*1.14*	*1*	*minutes*
	[3]	*1.25*	*0.1*	*minutes*
	[4]	*1.175*	*0.003*	*minutes*

^{241}Am

	Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
1	157788	73	0.8991	1975	Ramthun	[1]
	155706	767	0.0081	1972	Jove	[2]
	158080	566	0.0150	1972	Polyukhov	[3]
	158153	2557	0.0007	1968	Brown	[4]
	159468	1096	0.0040	1968	Stone	[5]
	158044	256	0.0731	1967	Oetting	[6]

1 = Normalise Weight < 0.5



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
157873.2	496.6	157801.1	102.5	69.2	2.19

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
157788	220	0.4952	1975	Ramthun	[1]
155706	767	0.0407	1972	Jove	[2]
158080	566	0.0748	1972	Polyukhov	[3]
158153	2557	0.0037	1968	Brown	[4]
159468	1096	0.0200	1968	Stone	[5]
158044	256	0.3657	1967	Oetting	[6]

UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
157873.2	496.6	157853.5	227.8	154.8	2.17

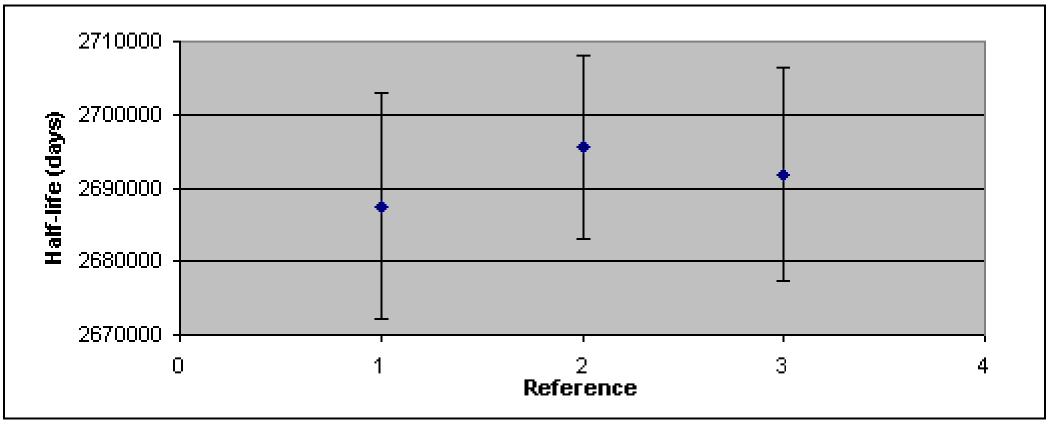
SU + SW2 = 724.4 |UM-WM| = 19.7 **Use WTD Mean**

EVALUATED $\tau_{1/2}$ (days) = 1.5785 (23) x 10^5

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[1]	*432.0*	*0.2*	*years*
	[2]	*426.3*	*2.1*	*years*
	[3]	*432.8*	*3.1 (2σ)*	*years*
	[4]	*433*	*7*	*years*
	[5]	*436.6*	*3*	*years*
	[6]	*432.7*	*0.7*	*years*

^{243}Am

Half-life (d)	Uncert (d)	Norm. wt	Year	Author	Ref
2687510	15341	0.2756	1986	Aggarwal	[1]
2695545	12419	0.4206	1974	Polyukhov	[2]
2691893	14610	0.3039	1968	Brown	[3]



UM	SU	WM	SW1	SW2	$\chi^2/(n-1)$
2691649.3	2322.7	2692221.0	2323.3	8053.5	0.08

SU + SW2 = 10376.2 |UM-WM| = 571.7 **Use WTD Mean**

EVALUATED $\tau_{1/2}$ (days) = 2.692 (8) x 10^6

Original published data	*Reference*	*Half-life*	*Uncert*	*Units*
	[1]	*7358*	*42*	*years*
	[2]	*7380*	*34*	*years*
	[3]	*7370*	*40*	*years*

APPENDIX 2

References to data used in evaluations

2004

K. Kossert, E. Günther, Appl. Radiat. Isot. (to be published).

2002

A. Grau Malonda, A. Grau Carles, Appl. Radiat. Isot. **56** (2002) 153.

2001

J. U. Delgado, A. Iwahara, R. Poledna, C. J. Da Silva, R. T. Lopes, L. Tauhata, Appl. Radiat. Isot. **54** (2001) 483.

2000

C. A. Huh, L. F. Liu, J. Radioanal. Nucl. Chem **246** (2000) 229.

U. Schotzig, App. Radiat. Isot. **53** (2000) 469.

1999

U. Schotzig, E. Schonfeld, E. Gunther, R. Klein, H. Schrader, App. Radiat. Isot. **51** (1999) 169.

1998

N. E. Bowles, S. A. Woods, D. H. Woods, S. M. Jerome, M. J. Woods, P. De Lavison, S. Lineham, J. D. Keightley, I. Poupaki, App. Radiat. Isot. **49** (1998) 1345.

N. I. Karmalitsyn, T. E. Sazonova, A. V. Zanevsky, S. V. Sepman, Int. J. Appl. Radiat. Isot **49** (1998) 9.

H. Siegert, H. Schrader, U. Schotzig, Appl. Radiat. Isot.. **49** (1998) 1397.

1997

R. H. Martin, K. J. W. Kerry, J. G. V. Taylor, Nucl. Instrum. Meth. **A390** (1997) 267.

1994

B. M. Coursey, J. M. Calhoun, J. Cessna, D. B. Golas, F. J. Schima, M. P. Unterweger, Nucl. Instrum. Meth. Phys. Res. **A339** (1994) 26.

E. P. Mignonsin, Appl. Radiat. Isot. **45** (1994) 17.

J. Morel, M. Etcheverry, M. Vallee, Nucl. Inst. Meth. **A339** (1994) 232.

B. R. S. Simpson, B. R. Meyer, Appl. Radiat. Isot. **45** (1994) 669.

1992

M. S. Antony, D. Oster, A. Hachem, J. Radioanal. Nucl. Chem. **197** (1992) 199.

B. M. Coursey, D. B. Golas, D. H. Gray, D. D. Hoppes, F. J. Schima, Nucl. Instrum. Meth. Phys. Res. **A312** (1992) 121.

J. J. Gostely, Appl. Radiat. Isot. **43** (1992) 949.

U. Schotzig, H. Schrader, K. Debertin, Proc. Int. Conf. Nucl. Data for Science and Technology.K, (1992) 562.

M. P. Unterweger, D. D. Hoppes, F. J. Schima, Nucl. Instrum. Meth. Phys. Res. **A312** (1992) 349.

M. J. Woods, S. E. M. Lucas, D. F. G. Reher, G. Sibbens, Nucl. Instrum. Meth. Phys. Res. **A312** (1992) 346.

1991

T. Altzitzoglou, Appl. Radiat. Isot. **42** (1991) 493.

P. Bode, Appl. Radiat. Isot. **42** (1991) 692.

W.-J. Lin, G. Harbottle, J. Radioanal. Nucl. Chem. **153** (1991) 51.

1990

A. Abzouzi, M. S. Antony, A. Hachem, V. B. N. Ndongue, J. Radioanal. Nucl. Chem. **144** (1990) 359.

P. D. Felice, P. Lentile, C. Zicari, Nucl. Instrum.Meth. Phys.Res. **A286** (1990) 514.

A. E. Kochin, H, Schmidt-Orr, H. Behrens, Z. Phys. **A337** (1990) 169.

A. A. Konstantinov, T. E. Sazonova, S. V. Sepman, A. V. Zanevsky, Proc 40th Ann Conf. Nucl. (1990) 78.

N. K. Kuzmonko, V. O. Sergeev, V. P. Chechev, Proc.40th Ann. Conf. Nucl. Spectrosc. Struct. At. Nuclei, Leningrad (1990) 476.

J. L. Parker, Nucl. Instrum. Meth. Phys. Res. **A286** (1990) 502.

M. J. Woods, S. E. M. Lucas, Nucl. Instrum. Meth. Phys.Res. **A286** (1990) 517.

1989

A. Abzouzi, M. S. Antony, V. B. Ndocko, J. Radioanal. Nucl. Chem. **135** (1989) 1.

D. E. Alburger, Phys. Rev. **40c** (1989) 2789.

K. T. Lesko, E. B.Norman, B. Sur, R. M. Larimer, Phys. Rev. **C40** (1989) 445.

D. C. Santry, G. C. Bowes, Health Phys. **57** (1989) 673.

H. Schrader, Appl. Radiat. Isot. **40** (1989) 381.

B. R. S. Simpson, B. R. Meyer, Appl. Radiat. Isot. **40** (1989) 819.

1987

B. M. Coursey, D. D. Hoppes, F. J. Schima, M. P. Unterweger, App. Radiat. Isot. **38** (1987) 31.

1986

A. R. Rutledge, L. V. Smith, J. S. Merritt, Int. J. Appl. Radiat. Isot. **37** (1986) 1029.

M. J. Woods, S. E. M. Lucas, Intern. J. Appl. Radiat. Isot. **37** (1986) 1157.

1983

S. Baba, S. Ichikawa, K. Gunji, T. Sekine, H. Baba, T. Komori, Intern. J. Appl. Radiat. Isot. **34** (1983) 891.

E. Funck, U. Schotzig, K. F. Walz, Int. J. Appl. Radiat. Isot. **34** (1983) 1215.

Y. Iwata.Y, M. Kawamoto, Y. Yoshizawa, Int. J. Appl. Radiat. Isot. **34** (1983) 1537.

J. Kits, F. Latal, M. Choc, Int. J. Appl. Radiat. Isot. **34** (1983) 935.

H. Kubo, Med. Phys. **10** (1983) 889.

V. Vaninbroukx, Int. J. Appl. Radiat. Isot. **34** (1983) 1211.

K. F. Walz, K. Debertin, H. Schrader, Int. J. Appl. Radiat. Isot. **34** (1983) 1191.

1982

D. D. Hoppes, J. M. R. Hutchinson, F. J. Schima, M. P. Unterweger, NBS-SP-626 (1982) 85

F. Lagoutine, J. Legrand, Int. J. Appl. Radiat. Isot. **33** (1982) 711.

A. R. Rutledge, L. V. Smith, J. S. Merritt, NBS-SP-626 (1982) 5.

A. Rytz, NBS-SP-626 (1982) 32.

1981

R. Lloret, Radiochem. Radioanal. Lett.. **50** (1981) 113.

H. Miyahara, T. Gotoh, T. Watanabe, Int. J. Appl. Radiat. Isot. **32** (1981) 573.

R. Vaninbroukx, G. Grosse, W. Zehner, Int. J. Appl. Radiat. Isot. **32** (1981) 589.

1980

S. K. Aggarwal, A. R. Parab, H. C. Jain, Phys. Rev. **C22** (1980) 767.

H. H. Hansen, G. Grosse, D. Mouchel, R. Vaninbroukx, CBNM Annual Progress Report (1980) 44.

H. Houtermans, F. Reichel, O. Milosevic, Int. J. Appl. Radiat. Isot. 31 (1980) 153.

W. Muckenheim, P. Rullhusen, F. Smend, M. Schumacher, Nucl. Instrum.Meth. **173** (1980) 403.

J. B. Olomo, T. D. MacMahon, J. Phys. **G6** (1980) 367.

1978

V. Bulovic, J. Simic, J. Radioanal. Chem. **44** (1978) 241.

M. C. Davis, W. C. Bowman, J. C. Robertson, Int. J. Appl. Radiat. Isot. **29** (1978) 331.

W. H. Gries, J. Steyn, Nucl. Instrum. Meth. 152 (1978) 459.

F. Lagoutine, J. Legrand, C. Bac. Int. J. Appl. Radiat. Isot. **29** (1978) 269

R. A. Meyer, A. L. Prindle, W. A. Myers, P. K. Hopke, D. Dieterly, J. E. Koops, Phys. Rev. **C17** (1978) 1822.

D. J. Thomas, Z. Phys. **A289** (1978) 51.

M. Yanokura, H. Kudo, H. Nakahara, K. Miyano, S. Ohya, O. Nitoh, Nucl. Phys. **A229** (1978) 92.

1977

M. E. Anderson, Nucl. Sci. Eng. **62** (1977) 511

1976

M. Bormann, H. K. Feddersen, H. H. Holscher, W. Scobel, H. Wagner, Z. Phys. **A277** (1976) 203.

H. Genz, J. Reisberg, A. Richter, B.M. Schmitz, G. Schrieder, K. Werner, H. Behrens, Nucl. Instrum. Meth. **134** (1976) 309.

H. H. Hansen, Z. Phys, **A278** (1976) 317.

F. Hegedues, Report EUR 5667E, I(1976) 757.

R. Vaninbroukx, G. Grosse, W. Zehner, Int. J. Appl. Radiat. Isot. **27** (1976) 727.

K. Venkata Ramaniah, V. Lakshminarayana, K. Venkata Reddy, Curr. Sci. (India), **45** (1976) 473.

1975

F. Lagoutine, J. Legrand, C. Bac, Int. J. Appl. Radiat. Isot. **26** (1975) 131.

1974

S. Chakraborty, Radiochem. Radioanal. Lett. **17** (1974) 61.

P. J. Cressy Jr, Nucl. Sci. Eng. **55** (1974) 450.

W. R. Daniels, D. W. Barr, G. F. Grisham, F. O. Lawrence, J. Inorg. Nucl. Chem. **36** (1974) 3874.

J. H. M. Karsten, P. G. Marais, F. J. Haasbroek, C. J. Visser.C.J. Agrochemophysica, **6** (1974) 25.

V. G. Polyukhov, G. A. Timofeev, P. A. Privalova, V. Y. Gabekiriya, A. P. W. Chetverikov, . Soviet J. At. Energy. **37** (1974) 1103.

T. B. Ryves, K. J. Zieba, J. Phys. A. **7** (1974) 2318.

C. W. Tse, J. N. Mundy, W. D. McFall, Phys. Rev. **C10** (1974) 838.

E. Vatai, A. C. Xenoulis, K. R. Baker, F. Tolea, R. W. Fink, Nucl. Phys. **A219** (1974) 595.

1973

J. Araminowicz, J. Dresler, Report INR-1464 (1973) 14.

J. A. Corbett, Nucl. Eng. Int. **18** (1973) 715.

I. Dema, G. Harbottle, Radiochem. Radioanal. Letts. **15** (1973) 261.

L. A. Dietz, C. F. Pachucki, J. Inorg. Nucl. Chem. **35** (1973) 1769.

R. D. Lloyd, C. W. Mays, Int. J. Appl. Radiat. Isot. **24** (1973) 189.

D. A. Newton, S. Sarkar, L. Yaffe, R. B. Moore, J. Inorg. Nucl. Chem. **35** (1973) 361.

G. Harbottle, C. Koehler, R. Withnell, Rev. Sci. Instr. **44** (1973) 55.

H. M. A. Karim, Radiochim. Acta, **19** (1973) 1.

J. G. Kuhry, G. Bontems, Radiochem. Radioanal. Lett. **15** (1973) 29.

F. Lagoutine, J. Legrand, Nucl. Instrum. Meth. **112** (1973) 323.

C. J. Visser, J. H. M. Karsten, F. J. Haasbroek, P. G. Marais, Agro. Chemo. Physica. **5** (1973) 15.

1972

W. Bambynek, G. Bortels, D. Reher, EUR-4855e (1972).

D. F. Crissler, H. B. Eldridge, R. Kunselman, C. S. Zaidins, Phys. Rev. **C5** (1972) 419

J. F. Emery, S. A. Reynolds, E. I. Wyatt, G. I. Gleason, Nucl. Sci. Eng. **48** (1972) 319.

J. Jove, R. Robert, Radiochem. Radioanal. Lett. **10** (1972) 139.

F. Lagoutine, J. Legrand, C. Perrot, J. P. Brethon, J. Morel, Int. J. Appl. Radiat. Isot. **23** (1972) 219.

V. E. Lewis, M. J. Woods, I. W. Goodier, Int. J. Appl. Radiat. Isot. **23** (1972) 279.

V. G. Polyukhov, G. A. Timofeev, P. A. Privalova, P. F. Baklanova, Soviet J. At. Energy **36** (1972) 402.

B. N. S. Rao, Curr. Sci. (India). **41** (1972) 692.

E. De Roost, E. Funck, A. Spernol, R. Vaninbroukx, Z. Phys. **250** (1972) 395.

T. Rupnik, Phys. Rev. **C6** (1972) 1433.

R. D. Werner, D. C. Santry, J. Nucl. Energy, **26** (1972) 403.

1971

G. A. Chackett, K. F. Chackett, J. B. Welborn, Int. J. Appl. Radiat. Isot. **22** (1971) 715.

I. W. Goodier, M. J. Woods, A. Williams, Proc. Int. Conf. Chemical. Data. (1971) 175

K. C. Jordan, G. W. Otto, R. P. Ratay, J. Inorg. Nucl. Chem. **33** (1971) 1215.

J. M. Oottukulam, M. K. Ramaswamy, Amer. J. Phys. **39** (1971) 221.

D. Smith, A. Williams, Int. J. Appl. Radiat. Isot. **22** (1971) 615.

W. H. Zoller, P. K. Hopke, J. L. Fasching, E. S. Macias, W. B. Walters, Phys. Rev. **C3** (1971) 1699.

1970

M. J. Cabell, M. Wilkins, J. Inorg. Nucl. Chem. **32** (1970) 1409.

Y. Y. Chu, E. M. Franz, G. Friedlander, Phys. Rev. **C1** (1970) 1826.

J. F. Emery, S. A. Reynolds, E. I. Wyatt, Report ORNL-4466 (1970) 75.

G. Harbottle, Radiochim. Acta. **13** (1970) 132.

J. Legrand, F. Lagoutine, J. P. Brethon, Int. J. Appl. Radiat. Isot. **21** (1970) 139.

R. S. Mowatt, Can. J. Phys. **48** (1970) 1933.

M. M. C. Paiva, E. Martinho, Int. J. Appl. Radiat. Isot. **21** (1970) 40.

1969

M. Bormann, B. Lammers, Nucl. Phys. **A130** (1969) 195.

J. P. Boulanger Thesis. Univ. Paris (1968): Report CEA-R-3590 (1969).

H. H. Grotheer, J. W. Hammer, K. W. Hoffman, Z. Phys. **225** (1969) 293.

Y. Kobayashi, Report JAERI-1178 (1969) 21.

F. Lagoutine, J. Legrand, Y. L. Gallic, Int. J. Appl. Radiat. Isot. **20** (1969) 868.

M. Saeki, K. Kimura, T. Ishimori, JAERI Report, JAERI-1178 (1969) 25.

A. Vurinen, Ann. Acad. Sci. Fennicae, Ser. **31** (1969) 1.

1968

M. Bormann, A. Behrand, I. Riehle, O. Vogel, Nucl. Phys. **A115** (1968) 309.

L. C. Brown, A. C. Propst, .A.C, J. Inorg. Nucl. Chem. **30** (1968) 2591.

P. Decowski, W. Grochulski, A. Marcinkowski, K. Siwek, I. Sledzinska, Z. Wilhelmi, Nucl. Phys. **A112** (1968) 513.

L. V. East, H. M. Murphy Jr., E.R. Lewis, Nucl. Phys. **A107** (1968) 382.

J. W. Hammer, Z. Phys. **216** (1968) 355.

F. Heinrich, G. Philippin, Helv. Phys. Acta **41** (1968) 431

G. G. Jonssen, and B. Forkman, Nucl. Phys. **A107** (1968) 52.

P. Kemeny, Roumaine Phys. **13** (1968) 901.

F. Lagoutine, Y. L. Gallic, J. Legrand, Int. J. Appl. Radiat. Isot **19** (1968) 475.

H. Liskien, Nucl. Phys. **A118** (1968) 379

D. R. Nethaway, M. C. Missimer, J. Inorg. Nucl. Chem. **30** (1968) 15.

S. A. Reynolds, J. F. Emery, E. I. Wyatt, Nucl. Sci. Eng. **32** (1968) 46.

A. H. Sher, B. D. Pate, Nucl. Phys. **A112** (1968) 85.

F. Smend, W. Weirauch, W. D. Schmidt-Ott, Z. Phys. **214** (1968) 437

R. E. Stone, E. K. Hulet, J. Inorg. Nucl. Chem. **30** (1968) 2003.

W. H. Zimmer, R. E. Dahl, Nucl. Sci. Eng. **32** (1968) 132.

1967

F. L. Oetting, S. Grum, J. Inorg. Nucl. Chem. 29 (1967) 2659.

W. I. Kerrigan, J. Inorg. Nucl. Chem. **29** (1967) 2657.

1966

V. Middelboe, Nature **211** (1966) 283.

H. Ramthun, Nukleonik **8** (1966) 244.

1965

K. F. Flynn, L. E. Glendenin, E. P. Steinberg, Nucl. Sci. Eng. **22** (1965) 416.

H. Leutz, G. Schulz, H. Wenninger, Z. Phys. **187** (1965) 151.

1964

K. T. Faler, J. Inorg. Nucl. Chem. **27** (1964) 25.

G. Rudstam, Nucl. Phys. **56** (1964) 593.

1963

S. Bjornholm, O. B. Nielsen, Nucl. Phys. **42** (1963) 642.

J. Lerner, J. Inorg. Nucl. Chem. **25** (1963) 749.

1962

N. A. Bonner, W. Goishi, W. H. Hutchin, G. M. Indings, H. A. Tewes, Phys, Rev. **127** (1962) 217.

1961

E. I. Wyatt, S. A. Reynolds, T. H. Hardley, H. A. Parker, Nucl. Sci. Eng. **11** (1961) 74.

1960

H. T. Easterday, R. L. Smith, Nucl. Phys. **20** (1960) 155.

N. K. Saha, F. N. I. Gupta, J. B. Gupta, Proc. Natl. Inst. Sci. India **26** (1960) 486.

1959

J. H. Carver, G. A. Jones, Nucl. Phys. **11** (1959) 400.

G. R. Martin, D. G. Tuck, Int. J. Appl. Radiat. Isot. **5** (1959) 141.

R. P. Schumann, P. Goris, J. Inorg. Nucl. Chem. **12** (1959) 1.

1957

H. T. Russell, ORNL Report 2293 (1957)

1956

O. P. Hok, J. Th. Verschoor, P. Born, Physica **XXII** (1956) 465.

H. W. Kirby, G. R. Grove, D. L. Timma, Phys. Rev. **102** (1956) 1140.

W. Sebaoun, Ann. Phys. (Paris) **1** (1956) 680.

1955

M. A. Rollier, E. Saeland, D. Morpurgo, R. Vaninbroukx, Acta Chem. Scand. **9** (1955) 57.

1953

D. L. Douglas, A. C. McWherter, R. P. Schumann, Phys. Rev. 92 (1953) 369.

T. Wanless, Can. J. Phys. **31** (1953) 517.

1952

A. Mukerji, P. Preiswerk, Helv. Phys. Acta **25** (1952) 387.

1951

F. Barendregt and Sj. Tom, Physica **XVII** (1951) 817.

S. Katcoff, O. A. Schaeffer, J. M. Hastings, Phys. Rev. **82** (1951) 688.

1949

T. P. Kohman, D. P. Ames, J. Sedlet, Nat. Nucl. Energy Series **14** (1949) 1675.

1939

J. H. Buck, Phys. Rev. **54** (1939) 1025.