Half-life of ^{52}V

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Abstract. In this work, the half life of the β decay of ^{52}V was measured by following the activity of 32 samples of 50 μg each after they were irradiated in the IEA-R1 reactor of IPEN-CNEN/SP. The results were then fitted using a non-paralizable dead time correction to the regular exponential decay and the individual half-life values obtained were then analyzed using different statistical methods (*Weighted Average*, *Normalized Residuals* and *Rajeval Technique*), resulting in a value of 3.733(4) min. The obtained result is somewhat smaller than tabulated one but the difference does not surpass two standard deviations.

Keywords: ^{52}V; half life
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INTRODUCTION

Nuclear applications often require a good degree of knowledge on several parameters of the nuclei involved, both regarding the safety of the experiment and the reliability of the results. For instance, in Nuclear Activation Analysis (NAA), many nuclear parameters, such as cross section and decay half life, have to be well known in order to compute the results, and the uncertainties in these parameters frequently undermine the results obtained in the analyses [1]. Even when the instrumental variation of NAA, which relies on the use of a well known comparator irradiated together with the samples in order to eliminate most of the nuclear parameters from the equations, the value of the decay half life is still an important parameter. Moreover, it appears inside an exponential function and its uncertainty must be carefully assessed because, under some conditions, it may well undermine the results of the whole analysis.

EXPERIMENTAL PROCEDURE

In the present experiment, samples were produced by pippetting 50.0 μL of a 1000 mg$\cdot$L^{-1} vanadium standard solution in pieces of Whatman 40 filter paper; the samples were left to dry naturally and then folded and packed into sealed polyethilene bags. These samples were then irradiated in the IEA-R1 nuclear reactor pneumatic station under a thermal neutron flux of $\sim 5 \times 10^{12}$ n$\cdot$cm$^{-2}\cdot$s^{-1} and analysed in a 25% HPGe detector coupled to a 8192-channel MCA. The optimum irradiation time and source-detector distance were experimentally determined as 15 s and 9 cm, respectively, so as to provide for dead times below 15% when the counting was initiated. The data acquisition was made in a batch of short subsequent acquisitions. In the first measurements both the duration of each acquisition and total number of acquisitions were

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evaluated. The optimal condition, judging from the relative standard deviation of the half life obtained, was determined to be 20 subsequent acquisitions of 2 minutes each.

DATA ANALYSIS

For the determination of the half-life of ^{52}V, the spectrum for each individual acquisition was analysed using the Genie-2000 computer software [2]. The counts per second associated with the 1434.068 keV peak ($I_\gamma = 100\%$) were fitted against the initial time of each acquisition using the non-paralizable dead-time correction model shown in Eq. 1 [3], where A_0, λ ($= \ln(2)/T^{1/2}$) and τ were the fit parameters. The fit was performed using a covariant Gauss-Marquardt routine implemented in the MatLab environment.

$$A = \frac{A_0 \cdot e^{-\lambda t}}{1 + A_0 \cdot \tau} \quad (1)$$

The results obtained were then analysed using the regular σ^{-2}-weighted mean as well as two techniques designed specifically for the analysis of discrepant data, the *Normalized Residuals* and the *Rajeval Technique* [4], in order to obtain a more robust final value which won't be too influenced by possible outliers.

RESULTS

The results obtained in this experiment are shown in Table 1, together with the values obtained using all three statistical analyses and with the value from the last ENSDF compilation [5]; it can be seen that both robust analysis methods reached the same final result, $3.733(4)$ min, which is compatible with the reference value of $3.743(5)$ min, with a slightly smaller uncertainty.

TABLE 1. Results obtained in each individual measurement for the half life of ^{52}V, together with the three different averages and the literature value.

measurement number	half-life (min)	measurement number	half-life (min)	measurement number	half-life (min)
1	3.719 (32)	2	3.65 (10)	3	3.90 (16)
4	3.697 (29)	5	3.751 (31)	6	3.765 (31)
7	3.784 (25)	8	3.760 (23)	9	3.720 (22)
10	3.737 (20)	11	3.712 (18)	12	3.726 (19)
13	3.704 (18)	14	3.731 (18)	15	3.721 (18)
16	3.708 (18)	17	3.724 (19)	18	3.839 (21)
19	3.722 (19)	20	3.736 (19)	21	3.737 (21)
22	3.770 (21)	23	3.696 (22)	24	3.757 (21)
25	3.716 (19)	26	3.768 (22)	27	3.731 (19)
28	3.726 (19)	29	3.745 (18)	30	3.731 (18)
31	3.754 (18)	32	3.722 (18)		

Weighted Average	3.735 (4)
Normalized Residuals	3.733 (4)
Rajeval Technique	3.733 (4)
ENSDF value [5]	3.743 (5)

REFERENCES

1. R. M. Lindstrom, R. Zeisler, and R. R. Greenberg, *Journ. Radioanal. Nucl. Chem* **271**, 311–315 (2007).
2. Canberra Industries, *Genie-2000 Spectroscopy System – operations manual*, Meridien, USA, 1999.
3. G. F. Knoll, *Radiation Detection and Measurement, 3rd Edition*, Wiley, New York, 1999, pp. 119–127.
4. M. U. Rajput, and T. D. MacMahon, *Nucl. Instrum. Meth. A* **312**, 289–295 (1992).
5. H. Junde, H. Su, and M. Chunhui, *Nucl. Data Sheets* **108**, 773–882 (2007).