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^{14}C ELECTRONIC MEASUREMENT SYSTEM WITH A MICROCOMPUTER

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ABSTRACT. Even though the reliability of equipment has improved, the quality of measurement should still be checked. This task may be performed by a microcomputer with the physicist's intervention only when an error in measurement is detected.

Up till now, two processes at work at the same time in conventional ^{14}C techniques were the improvement of equipment as well as methods for checking its reliability. Now that equipment is considered very stable and reliable, sophisticated contemporary methods of stability inspection are, in fact, unnecessary. Should we reject these old habits? Absolute faith in electronics, gas purity, etc, is certainly unreasonable.

At the Radiocarbon Laboratory in Gliwice the whole process of counting pulses is now verified automatically, without any personal intervention, except when the measurement is assessed as incorrect. Our system includes a microcomputer which evaluates measurements.

The assessment of measurements is based on the following statistics: average $\overline{x}$, variance s^2 (Pazdur, 1976; Müller, 1978), coefficient of assymetry $g_1 \sim \Sigma(x_i - \overline{x})^3$, autocorrelation $F \sim \Sigma(x_i - x_{i-1})^2$ (Hilaire, 1973; Kendall and Stuart, 1975), coefficient of correlation r, which are calculated for anticoincidence and different coincidence counting rates and their quotients. Eight most important independent parameters have been chosen for a statistical test. Each parameter is compared with two limiting values, a lower (significance level $\alpha = 0.02$) and a higher ($\alpha_1 = \alpha^2 = 0.0004$) one. The result of the test is "OK" if no parameter exceeds the higher value and not more than one exceeds the lower one (thus the significance level of the test is $\alpha_s \approx 0.01$). Such a definition of the test seems to be optimal according to the results of analysis of a few hundred measurements. These measurements confirmed the theoretical relation between the frequency of negative test results and the significance level. In addition to the statistical test we monitor other parameters, eg, the guard counting rate which is strictly limited to a fixed interval during routine operation. If any of these parameters exceeds the admissible interval, the measurement is rejected.

The counting analysis code includes rejection outliers (Walanus, 1979). Two factors of note here are first, that the criterion for rejecting outliers is symmetrical, *ie*, values that are too low or too high are rejected, in which case there is no bias on the average value. The second factor concerns the significance level of the criterion. According to the results of the Monte Carlo simulation of disturbed measurements (Walanus, 1985) there is an optimal value of the quotient of the frequency of rejections to the significance level, equal to ca 12. The optimal significance level can be calculated. The frequency of rejections is very sensitive to equipment stability and measurement conditions; its value is taken into account in the assessment of the validity of measurements.

In summary, the final measurement consists of the anticoincidence count rate, its Poisson error, and the assessment of validity. The procedure results in a one-bit (yes or no) answer. As long as the measurements are correct, we need not be interested in anything else but this simple information. For an "incorrect" signal many physical and statistical parameters are needed to determine the failure. This precise procedure is more objective and saves time.

A Sinclair ZX 81 with a 64K memory and a TV set is all that is necessary for a self-checking system which provides a simple final result of the ^{14}C determination with a minimal amount of data manipulation.

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