

## AUTOMATIC DATA PROCESSING IN SCINTILLATION COUNTING

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### WORKSHOP SESSION

I shall endeavour to present an overview of this topic and keep in mind the worker who is considering the use of automatic data processing to assist in handling his data. I do not intend to dwell on programming or statistics but rather to present the advantages and pitfalls of the technique.

In scintillation spectrometry, data processing comes into two distinct categories. Firstly there is the simple processing such as is used for calculating counts per minute, channels ratio or percent free for radioimmunoassays. Secondly there is the more sophisticated approach which involves quench correction curves, statistical appraisal of data and checking for the performance of the sample and the instrument.

Consider the first of these two categories. It is the requirement which is in most demand in those laboratories using scintillation spectrometers. We all know that the instrument producing data made up of raw counts usually gets set to count for one or ten minutes with the preset count terminator adjusted to its maximum. It is thus very easy for the worker to obtain CPM since no manual division is required. This is clearly very wasteful in terms of counter time when most people should be considering a preset count of say  $10^4$  as their major terminator. They are of course resistant to this approach since the data then needs to be reduced manually. The use of a small dedicated calculator (on-line) is clearly an advantage in this case and with the cost of small processors and pocket calculators

getting even lower it seems that these could be offered at a much more attractive price than say five years ago. Such units offer advantages not only for those laboratories where a few samples are counted at a time (say less than 20) but also in those laboratories with a service commitment, say in a hospital where hundreds per day must be processed.

In the second category we consider data processing in its fullest meaning. It is much more involved than the approach just described and should not be embarked upon without considerable forthought. This approach inevitably means the use of some kind of computer which can be programmed by the worker or someone on his behalf. The dedicated on-line computer is what most people think they need to solve their processing problems. I suggest that this is not necessarily the case unless they plan to have several counters on-line at the same time each with a multitude of samples or with a particularly intricate processing problem to carry out. Since counters generally produce only a relatively few numbers every minute and the computer can process these in a fraction of a second it is clear that for 99% of its time the computer has little or nothing to do and it is obviously an inefficient use of the instrument.

The batch processing of data is probably the best approach for most people. Here the data is punched on paper tape and is then accumulated until it is processed at a computer installation. Punched paper tape still seems to be the method of choice as a medium for data transfer. Cassettes and cartridges of magnetic tape are not yet in regular use although they do seem to offer considerable advantages. The lack of availability of a suitable reader at the computer installation could certainly be a drawback and it is of course almost mandatory that a printed copy of the data be made at the same time as it is recorded on the tape. It may be the cost of such a system which precludes its common introduction.

Interactive processing is an excellent way to deal with scintillation data. Here the user can interact with the program and make decisions as to the best mode of action. It is too, if the program is well written, the ideal way for the beginner to become familiar with the program and its do's and its dont's. There is also the advantage just as in the batch system that it can be used for a unique run

just as well as for a production run.

Turnaround time is often an item which must be considered against the costs involved. If the worker has access to a large institutional computer installation, the turnaround time may be as long as a couple of days. For some purposes this may be entirely adequate while for others such as in the clinical chemistry laboratory this is quite unsatisfactory. In the latter case the user should perhaps consider the purchase of a small computer. The costs of these is decreasing almost daily and since the unit can be used for processing data from other laboratory instruments this mode of action may be the one of choice. Certainly all that is needed is say 16 or 32 K of core, a high speed paper tape reader and a printer together with a visual display unit. Sometimes it may be advantageous for several groups of people in one institution to make a joint purchase, however the politics of such a decision may have overriding consideration. If a joint purchase is considered it is important to have responsibilities, both financial and departmental, established well in advance since informal arrangements have a habit of being "misunderstood" at a later date.

Let us now turn our attention to some of the features which can be written into a program. These include selection of working parameters e.g. one or two isotopes; which of perhaps several spectrometers has been used to obtain the data; how many standards and what is their DPM; is decay during the counting process significant; how many unknowns; how is efficiency to be determined, by channels ratio or external standardization; In the latter case, the program may have code to decide whether or not the technique is valid, for example external standardization should not be used for heterogeneous samples and channels ratio is not very adequate for measuring the efficiency of tritium.

Next comes the procedure of fitting the curve for the standards so to obtain, for example, an external standard ratio vs efficiency relationship. This seemingly easy task has caused many frustrating problems for the uninitiated user basically because it is not always prudent to obtain a curve which fits all the points very closely. Consider the situation where one standard point has a gross error. Should the curve be constrained to go through that point or should it merely pass close to it and be weighted by all the

other points. It would appear that a polynomial expansion, say a cubic, will generally be adequate for many purposes. Carroll and Houser (1) have discussed the problem of curve fitting in an excellent article and some statistical criteria which should be applied in such decision making.

Some workers require to know the standard deviation of their result and this in my opinion is hard to obtain. Radioactive events follow Poisson statistics. However, background counts generally do not and thus there is a statistical dilemma where low activity samples are concerned. Next we must consider vials, their variation in background, their geometry and also the transmission of light through their walls. While these individual features vary only a little they can and do accumulate and of course effect not only the standards but also the unknowns. Then we must take account of the overall uncertainty of the standard materials themselves and this can vary from around  $\pm 1\%$   $\rightarrow$   $\pm 3\%$ . The error associated with pipetting or weighing of the standard is also pertinent. If external standardization is employed we have to know the error associated with the fitted curve, the error of the external standard ratio of the standards and the unknowns. All in all there are at least six major points at which statistical variation can occur and being able to incorporate and evaluate all of them and bring them into a final error term is a considerable undertaking not only from the programming point of view but also from the workers point of view. To be able to obtain an accurate estimate of DPM from CPM for quenched samples is I believe not easy. Getting an adequate error estimate is almost impossible.

Finally let us consider one area where data processing can save a lot of trouble and embarrassment and this is in detecting for example instrument drift, power failure (and proper recovery), chemiluminescence etc. These phenomena can be detected rather readily and the worker alerted to the problem. The advent of fast microprocessors makes it possible to have such detection equipment built into the spectrometer.

An excellent all-round review of data processing in scintillation spectrometry has been written by Spratt recently (2) and a good example of a well laid out and flexible program has been described by Bowyer and Pearson (3).

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### REFERENCES

1. C.O. Carroll and T.J. Houser, *Int. J. Appl. Radiat. Isotop.* 21, 261 (1970).
2. J.L. Spratt in *Liquid Scintillation Counting*, Vol. 2, p. 245 (M.A. Crook, P. Johnson and B. Scales, Eds.). London : Heyden & Son (1972).
3. D.E. Bowyer and J.D. Pearson in *Liquid Scintillation Counting*, Vol. 3, p. 94 (M.A. Crook and P. Johnson, Eds.). London : Heyden & Son (1974).

