

## Chapter 21

# On-line Liquid Scintillation Counting

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Calculation of quench corrections to liquid scintillation counting data is not intrinsically difficult, but is repetitive and time consuming. These characteristics make the calculations tedious to perform by hand but ideally suited to automatic processing. It is therefore not surprising that many computer programs to perform such calculations have been reported in the literature.<sup>1-3</sup>

Manufacturers of scintillation counters usually supply teletypes or card punches to produce punched paper tape or cards as the storage medium for the data. Consequently, most computer programs are orientated towards processing punched tape in a batch operation at a central computer. In general this approach is inflexible and slow, although flexibility may be much increased by adopting a pseudo-on-line programming technique.<sup>4,5</sup>

Recently the cheapness of microprocessors has encouraged manufacturers to offer more computing ability and job control within the scintillation counter itself. However, these options tend to be expensive because of the cost of the associated dedicated peripheral devices such as floppy disks, videos or teletypes.

At an installation operating several scintillation counters there is much to be gained by concentrating the processing on one computer and its peripherals. In this department I have successfully linked three scintillation counters to a Data General Nova 2/10 minicomputer to offer inexpert computer users a flexible, fast and easily used data logging and computing service.

### HARDWARE

Figure 1 illustrates the interrelationships between the computer and its peripherals; the analog-to-digital converter and the main console video are not directly involved in the operation of the on-line counting system.

The scintillation counters are each interfaced with the computer by removing the output teletype, and sending the counter output to one channel of the multiplexor. Since a V24 (U.S. EIA) interface was adopted for the multiplexor, the data transmission mode was converted from 20 mA (Nuclear-Chicago ISO-Cap 300) or 60 mA (Packard 3255). Some additional circuits between the Nuclear-Chicago instruments and the output teletype had to be led to ground to avoid interrupting the output sequence of the counters.

### SOFTWARE

The program, SCOL! (Scintillation Counting On-Line)\*, is run in the foreground, with its own control teletype, while the background has been used simultaneously for program development and BASIC programming (Fig. 2). The program is written for economy of space in Data General assembly language.

\* The name SCOL! and the SCOL! computer program are the copyright of the author.

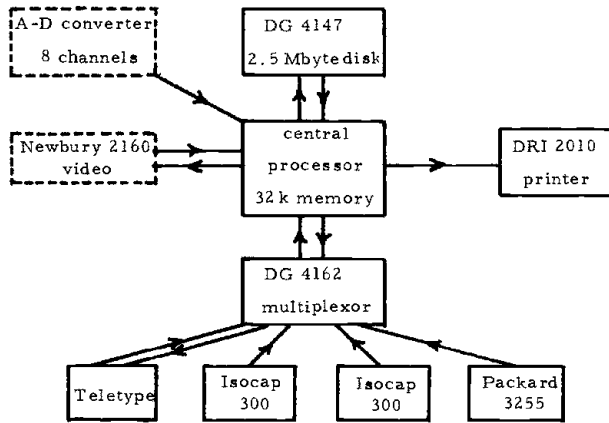


Fig. 1 Configuration of Data General Nova 2/10 minicomputer.

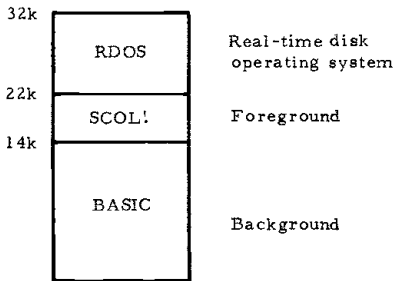


Fig. 2 Utilization of core store.

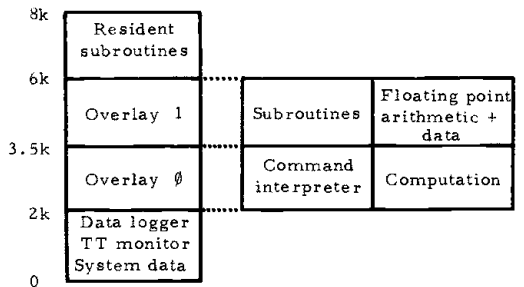


Fig. 3 Organization of SCOL!

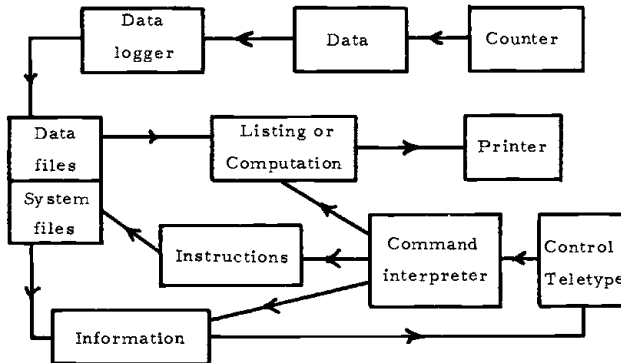


Fig. 4 Operation of SCOL!

SCOL! is orientated towards the use of disk files for both the storage of program overlays and data; Fig. 3 illustrates how the effective size of the program is greatly increased by partitioning part of the core store into two overlay areas allowing either command interpreter or computation routines to be brought into core as necessary. The core-resident part of the program includes a system data area, the data logger and a monitor of the control teletype.

Multi-tasking programming techniques are used to allow the concurrent operation of the two main parts of SCOL!, the data logger and the command interpreter. The flow of data and information is represented in Fig. 4. Scintillation counters generate

data which is sent by the data logger to files previously set up by users issuing commands at the control teletype. The commands themselves are of three types:

1. Eliciting information about the state of the system, which is returned to the teletype. The information may describe the status of each of the counters, the availability of quench correction parameters or the utilization of vial space within each counter, for example.
2. Instructing the system. The instruction may be to start, or stop, logging data from particular vials, or to modify system parameters.
3. Initiating computation or listing of data held in files. The computation may be a quench calibration, a quench correction or a radioimmunoassay.

#### USE OF SCOL!

A user approaching an on-line scintillation counter with a batch of vials starts a sequence of events in three phases.

1. Definition of a group of vials and provision of associated information.
2. Logging data relating to vials in that group.
3. Listing of raw data or computation of results.

The definition of a group requires the locations of the first and last vials within the counter by reference to their positions in a continuous belt or in-trays. A typical command to accomplish this separation might be

```
INCLUDE VIALS 89 TO 147
```

which establishes a group of 59 vials starting at location 89. The SCOL! program will not log data for vials which have not previously been declared to the system by such a command.

The additional required information specifies counting conditions to the program — SCOL! is not able to adjust settings on the scintillation counters themselves. A title is optional; a background vial is assumed not to be present unless defined at this time. The specification includes the following:

- (a) Counter program number (if machine is programmable).
- (b) Isotopes present — one or two from tritium, carbon, phosphorus.
- (c) Scintillator cocktail identifier.
- (d) Quench correction required — NONE, SCR or ESCR.
- (e) Number of cycles of counts required.

In practice, under user control, preset values called 'standard options' are automatically assigned to each group. The user may overwrite these values by typing additional commands after the INCLUDE instruction, for example:

```
ISOTOPE TRITIUM
QUENCH ESCR
```

When the user starts the definition of a group, the program opens a new data file and serial number, writes a header giving date and time of creation and inscribes any descriptive title which has been given to the group.

At the end of the group definition sequence the program checks the specification for:

1. Mutual consistency, e.g. no attempt to count an isotope using wrong counter program.
2. Availability of facilities, e.g. automatic external standard for ESCR.
3. Availability of quench correction parameters (if quench correction specified).

If a discrepancy is detected an informative message is printed on the teletype and SCOL! awaits a correction or cancellation of the group. If the specification is valid, it is written in code form after the header and title, the file is closed and logging commences.

Data logging is purely passive as far as the user is concerned. When a counter has generated a complete line of data, it is examined for a vial number by the SCOL!



## RELIABILITY

A system which operates in conjunction with three scintillation counters, 24 h each day, should be robust in its equipment and programming. SCOL has been proved in operation for 18 months during which time some 1600 data files have been processed. The most serious problems in reliability were encountered with the disk unit, largely due to inadequate routine maintenance. A rigorous but not demanding procedure has been adopted which involves cleaning the disk surface once a month and servicing of the read/write heads and filters once every four months. Recently the system has been operational for more than 95% of the time.

## ACKNOWLEDGEMENT

In devising the extended command processor I am indebted to earlier work and discussions with my former colleague, Dr B. Seaton.

## REFERENCES

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## DISCUSSION

P. JOHNSON: In describing the flexibility of your system you emphasized an apparent inflexibility in the system described by Johnson et al. (p. 169) which is in fact a myth. The only inflexibility in our system is our unshakeable belief that the dpm which the user obtains should be meaningful. What the user does with those dpm is his choice. Our counting service accommodates a variety of types of use with various nuclides, but does not provide the research worker with reams of data, only dpm. If he chooses to use those dpm in a more complicated computational package, that is his affair. It can be on-line or off-line, but has nothing to do with liquid scintillation counting.

M.R. KIBBY: Yes, we are in agreement with that.