Development of BASIC Program for Radiocarbon Dating

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Kunio OMOTO

1 Introduction

The development of the gas-filled proportional counter, since W.F. Libby and co-workers confirmed the existence of natural radiocarbon and initiated the first radiocarbon dating system in the late 1940's, established a method for age determination based on the decay of radiocarbon (^{14}C). Continuous improvement of the system and the needs, in seeking a superior tool by science and industry, have produced today's successful radiocarbon dating system to detect very low energy ß-radioactivity. However, it still takes longer than 1,000 minutes for sample counting.

In the gas counting system, it is very difficult to keep drift of the impressed high voltage for the proportional counter to less than 5 volts throughout the counting time. Temperature and characteristics of the gas itself also change through the experiment. Reading errors caused by different operators often occur in the laboratory. The accumulation of the above mentioned drift and errors are closely concerned with the accuracy and reliability of the radiocarbon dates.

Detection and reduction of the above-mentioned laboratory errors is only possible by using a "fully automatic radiocarbon dating system" linked to a personal computer system. The author was able to build this in 1981 by a Grant in Aid for Developmental Scientific Research from the Ministry of Education, and reported on the results (Omoto 1981 and 1982a). In this paper, he presents BASIC (Beginner's All-purpose Symbolic Instruction Code) program for full automatic radiocarbon dating system developed by himself.

2 Outline of the system

The fully automatic radiocarbon dating system is comprized of four systems and/or instruments: a set of personal computer system, two kinds of interface sets, scaler control system and a sample gas-enclosing system. The full system is shown schematically in Fig. 1.

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2.1. Computer system

The author investigated several computer systems of home and foreign products, and decided to perchase a set of PC-8000 series personal computer system made by NEC (Nippon Electric Co., Ltd.). The central processing unit (CPU) is μPD780C-1 mounted in PC–8001, which has a 3.9936 Mhz clock, 32k byte (maximum) ROM, and 32k byte (maximum) RAM. It has several interfaces built-in and it is possible to connect it to some I/O devices. Applying these functions, the author linked the PC–8001 with a CRT display (PC–8042), line printer (MP–80), and expansion unit (PC–8011) which provided other functions such as an I/O adapter, IEEE–488 bus line, RS–232C bus line and dual type mini disk unit (PC–8031) and three interfaces (TLD–42, TLD–43 and RD–488).

2.2. Interface

I/O modules interface a microprocessor to relays, and transducers of the instruments and they control peripheral devices and their interface with the central processor. In this study, the author has developed two kinds of interfaces: scaler control interface and gas-enclosing control interface.

(1) Scaler control interface

This interface is connected with system bus line of PC–8011, and can control "Plateau counting" and "ß-rays counting". The I/O modules have the functions of TTL compatibility of positive logic and five connectors for data input. It has also another function which can control pulse motor drive of the high voltage unit for the cencter counter.

(2) Gas-enclosing control interface

This interface is connected with the system bus line of the scaler control interface and controls the "gas-enclosing experiment". The I/O modules have functions of TTL compatibility of positive logic and can control switching of 15 relays (45 relays at maximum) whose conditions are indicated by LED. Using these relays the author succeeded in controlling magnet valves of the vacuum circuit of the gas-enclosing system.

2.3. Scaler control system

The system function is to control whole data to be transmitted from the instruments to CPU in ß-rays counting experiment. They are temperature, pressure and impressed high voltage of the center counter, time interval, anti-coincidenced center scaler and center scaler data. They are expressed in digital value of BCD parallel and positive logic. The commands for start, stop, sample hold and reset of the instruments are controlled by the CPU. Another function

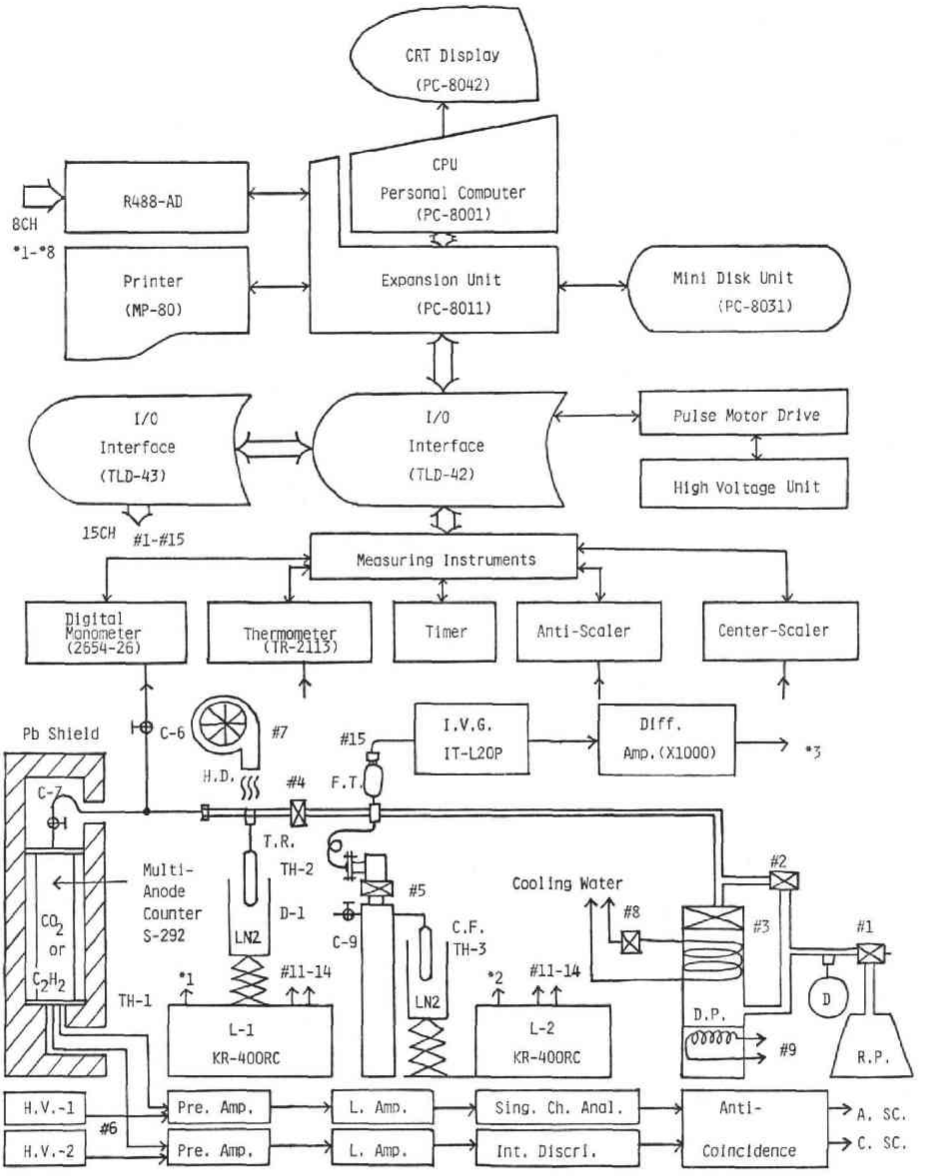

Fig. 1 Block diagram of the fully automatic radiocarbon dating system.

Explanations: A. SC.; Anti-coincidence scaler, C. SC.; Center counter scaler, C6, 7 and 9; Vacuum cock, #1–#5, Magnet vacuum valve controlled by CPU, #6, 7 and 9; Magnet relay number of TLD–43, #8; Magnet water valve for cooling D.P., C.F.; Cold finger, D.; Damper, D–1 and 2; Thermos filled with liquid nitrogen to collect sample gas, Diff. Amp.; Differential amplifier (ca. 30dB) connected between I.V.G. and R488–AD, D.P.; Diffusion pump, F.T.; Fougel tube connected with I.V.G., H.D.; Hair dryer, H.V.–1 and 2; High voltage module, Int. Discri.; Integral discriminator module, I.V.G.; Ionization vacuum gauge, L–1 and 2; Lift and elevation meter, LN2; Liquid nitrogen, L. Amp.; Linear-amplifier module, Pre. Amp.; Pre-amplifier module, R.P.; Vacuum rotary pump, Sing. Ch. Anal.; Single channel analyzer, TH–1, 2 and 3; Thermistor element connected with TR–2113, T.R.; Trap.

of the system is characterized by controlling the impressed high voltage. For the purpose, the pulse motor drive and high voltage control unit is built-in.

2.4. Gas-enclosing system

The system controls the vacuum circuit and its related instruments in the gas-enclosing experiment of the radiocarbon dating. Prior to ß-ray counting, it is necessary to fill (enclose) the proportional counter with sample gas; however, it has been considered to be impossible to build a fully automatic system of the experiment. The operations are divided into two processes; (1) gas-collection experiment, and (2) gas-enclosing experiment. In both experiments, the main operation is opening and closing of the valves of the vacuum circuit, and switching on or off of the vacuum circuit, all these functions are controllable by relays of the interface.

The data from the system to the CPU are three temperature data (center counter, gas-trap and cold finger), data indicating the levels of liquid nitrogen and two pressure data. Except temperature and pressure data, the rest are analogue data which are changed into digital data by R488–AD and transmitted to the input bus line of IEEE–488 of the PC–8011.

3 Software development

Online systems are now widely used in scientific applications where users must develop programs by themselves. The programs can be created, edited, assembled, debugged and executed by the users. However, the programing should begin with constructing a flowchart that defines the required sequence of operations. The author prepared several levels of flowcharts – macro program flowchart showing the main logic of the computer program and micro flowchart detailing the logic portions of the program. After the flowcharts had been completed and reviewed for errors, codings were begun with the flowcharts serving as a guide. The flowcharts produced for a fully automatic radiocarbon dating system are shown in Fig. 2 and whole programs are shown in the end of this paper.

The programming language was "N-BASIC" based on MICROSOFT™ BASIC. The author wrote into the program with numerous remark statements so that it could be understood by users without detailed knowledge of the operation of personal computer system or of radiocarbon dating. The programs developed were recorded on a mini floppy storage device linked to the computer. The author used two diskets, one for the program and the other for the data file because the disk provides quick-access magnetic storage for both.

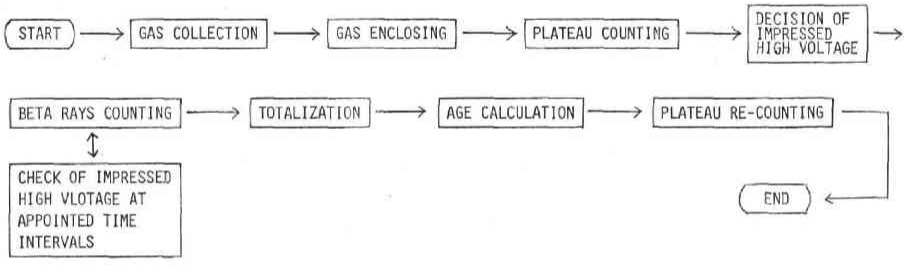

Fig. 2 Schematic diagram showing fully automatic radiocarbon dating programs in macro scale.

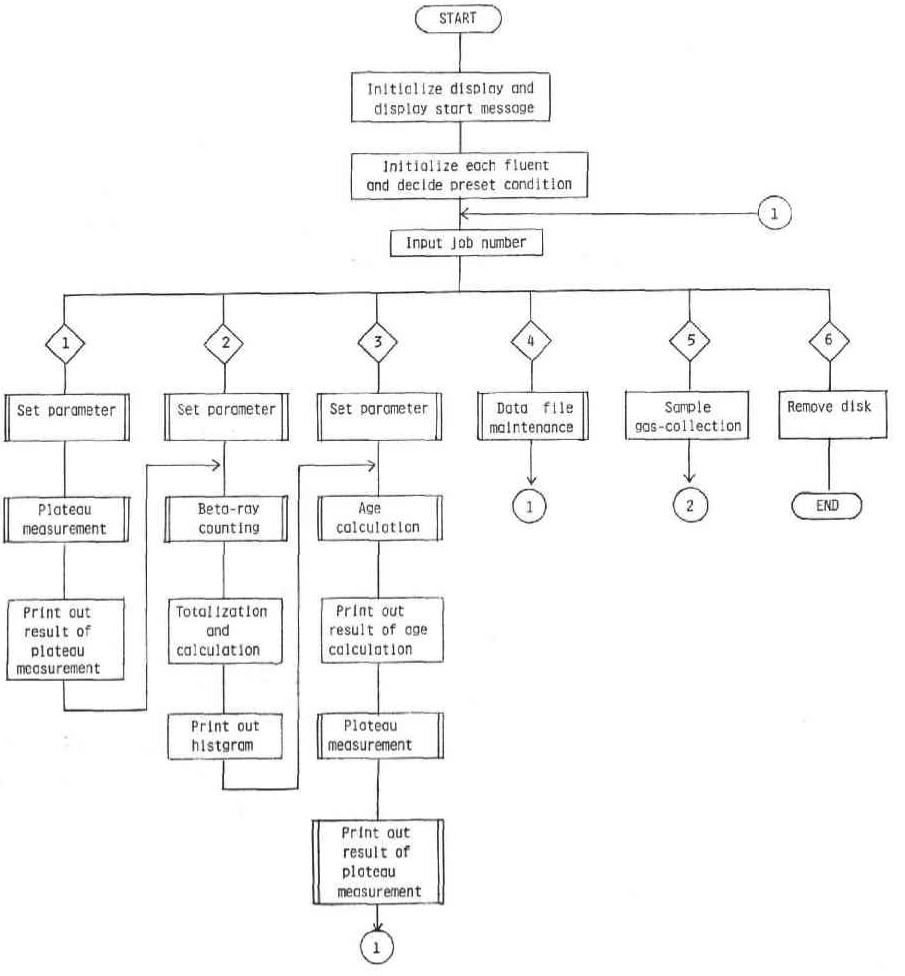

Fig. 3 Flowchart of radiocarbon dating program.

3.1. Gas-enclosing program

This program can be divided into two online programs: (1) gas-collection and (2) gas-enclosing. They have three control functions; automatic voltage setting, opening and closing of the relays and timer control. Through these control sections, automatic, integrated operation of the entire computer system is achieved.

3.2. Scaler control program

This program is formed by three online programs and one offline program as shown in Fig. 3. It is divided into four operations or jobs; (1) plateau counting, (2) ß-ray counting, (3) age calculation and (4) data file maintenance. Details of each program and flowchart will be described later.

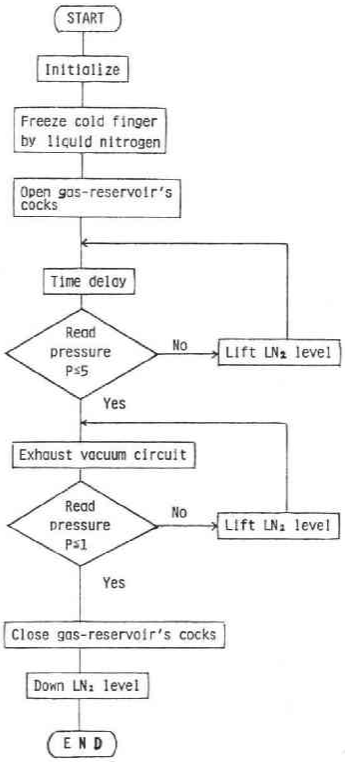

Fig. 4 Flowchart of gas-collection experiment.

4 Details of the programs

4.1. Gas-collection (ECL*)

The purpose of the program is to collect sample gas into a gas reservoir automatically instead of manually. The program operates as follow (see also Fig. 4); It starts by initializing CRT display and variable field in lines 1000 to 1080. The CPU then asks the operator, after reading some preset conditions of the instruments, in lines 100 to 240 and 400 to 490, whether he wants to change or input new data in lines 1090 to 1180. If no change is necessary, then he may press the RETURN key. The present conditions of the instruments are then printed out to the CRT display and the printer (lines 1200 to 1240). The operator must prepare two thermoses with liquid nitrogen and must confirm the level of them prior to the beginning of the experiment.

The main program starts at line 2000. Firstly, the CPU reads the impressed high voltage for the center counter and makes it as low as 2000 volts automatically by the "automatic voltage set subroutine" written in lines 600 to 740. The CPU again reads the high voltage as 2000 volts and the power supply of the high voltage unit is cut at lines 2040 to 2065 and 300 to 360 (relay on and off subroutine).

* ECL is a file name. See also program list presented in the end of this paper.

Next, the cold finger of the gas-reservoir is refrigerated by the liquid nitrogen and the magnet valves between the center counter and the cold finger are opened one by one, based on the program in lines 2070 to 2285. On the result, the sample gas moves and becomes dry ice in the cold finger. If the pressure of the vacuum circuit between the center counter and the gas-reservoir is larger than 5 mmHg, the level of the liquid nitrogen will be lifted to a 2 cm higher position automatically based on the program. The magnet valves of the circuit are closed completely when the sample gas has moved to the gas-reservoir. Then the CRT display begins to turn on and off, printing "*Set new flask ! and hit RETURN key !*" at line 2330. Alarm sounds, lasting a few seconds, are output from a speaker of the display (line 2340). The procedures of the experiments, instrument data and the time of the events which occur are printed out as a record of the experiment.

4.2. Gas-enclosing (ECL)

This program aims to enclose the sample gas of the gas-reservoir into the center counter by automatic procedures controlled by the personal computer system and is contained in lines 3000 to 3780. It operates as follows (see also Fig. 5). Prior to the program starts, the operator must set a new sample gas-reservoir and a thermos filled with liquid nitrogen. After preparation, he must press the RETURN key and the program starts. Lines 3000 to 3195 contain the initialization of the preset conditions and the main program starts at line 3200. The procedures of the experiment are divided into three processes: (1) exhausting experiment, (2) enclosing of the sample gas into the center counter and (3) adjustment of the pressure.

The exhausting experiment starts after print out of the primary conditions to the CRT display and to the printer (lines 3250 to 3410). When the circuit condition of the vacuum line is high enough to move the sample gas (usually ca. 8×10^{-4} torr.), the magnet valves for vacuum pumps are closed and the enclosing experiment starts. Prior to the movement of the sample gas a trap is refrigerated by the liquid nitrogen automatically.

The enclosing experiment or the movement of the sample gas starts at line 3420, by opening the magnet valve of the gas-reservoir. The gas moves within five minutes into the trap and becomes dry ice. If the pressure of the circuit is larger than 5 mmHg, then the level of the liquid nitrogen is lifted 2 cm higher. After a short time delay, the CPU reads pressure data again. If the pressure of the gas is low enough, the magnet valves are opened and the rest gas is exhausted by the vacuum pumps (lines 3460 to 3480). When the vacuum gauge reaches ca. 5×10^{-4} torr., the magnet valve and power supply for the deffusion pump are closed and the thermos is moved downwards from the trap. A hair dryer is turned

on for five minutes. By heating the trap thus, the sample gas is enclosed in the center counter. The experiment is controlled in lines 3490 to 3640.

Adjustment of the pressure is done when the maximum pressure of the circuit exceeds 850 mmHg (lines 3670 to 3690). If the pressure is high enough exceeding

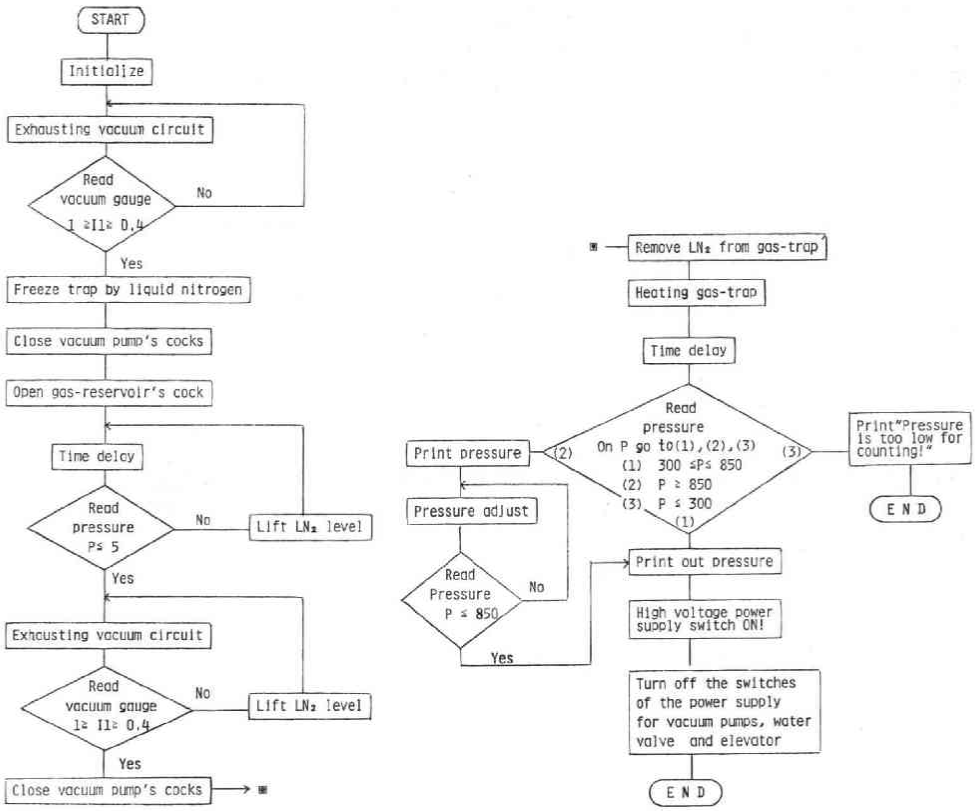

Fig. 5 Flowchart of gas-enclosing experiment.

300 mmHg, then the switch of the high voltage supply is turned on, but unless it is lower than 300 mmHg, an alarm sounds from the speaker of the CRT display and an alarm message will be printed out on the CRT display. These operations are executed in lines 3660 to 3740 and the program ends. The loading of the next program takes place as usual at the final line.

The program for reading the data of the instruments is executed in lines 1020 to 1027. The operations of opening and closing of the relays are executed by lines 300 to 360, as written in the subroutine.

4.3. Plateau counting (RCD)

This program is written in lines 2000 to 2940 and operates in the following way. As soon as the program starts CRT display and variable field are initialized (see Fig. 6) and as a result a start message is printed out on the CRT display. After reading some present conditions of the instruments, then CPU asks to the operator whether he wants to input or change preset values. If no change is necessary, then he may press the RETURN key at once or wait for a few seconds for time delay. These primary operations are written in lines 70 to 1700, except for lines 120 to 480.

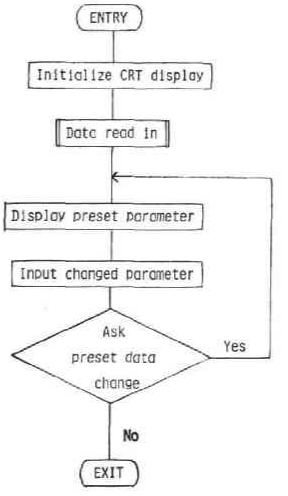

Fig. 6 Flowchart for setting parameters.

Impressed high voltage to start ß-ray counting is calculated on the basis of the input data, such as temperature and pressure of the center counter and is set automatically by jumping to the automatic voltage set subroutine, written in lines 2660 to 2778 (see also Fig. 7). After a subroutine is completed, the computer returns to the original program. When the program requests data from an input device, it inputs or reads data. When the program transfers data to an output device, it outputs or writes data. Commands for timer reset, timer start, data input and transmitting pulse for pulse motor drive are programmed in lines 210 to 480.

The main program is written in lines 2090 to 2200 and expressed in a flowchart (Figs. 8A and 8B). Whole data obtained, such as counting time, anti-scaler counts, center-scaler counts, impressed high voltage for the center counter and their mean values, are expressed on the CRT display and printed out by lines 2410 to 2550 and 2810 to 2840. Then the optimum impressed high voltage of the center counter for the first two hours of ß-ray counting is decided based on the calculation of the ß-ray counting data executed between lines 2910 and 2940.

4.4. ß-ray counting (RCD)

This program is written in lines 3000 to 4340 and shown schematically in Figs. 9A and 9B. It operates as following way. After initialization of the local variable field, the CPU outputs preset values on the CRT display and the printer. They are, for example, time intervals and preset times for ß-ray counting,

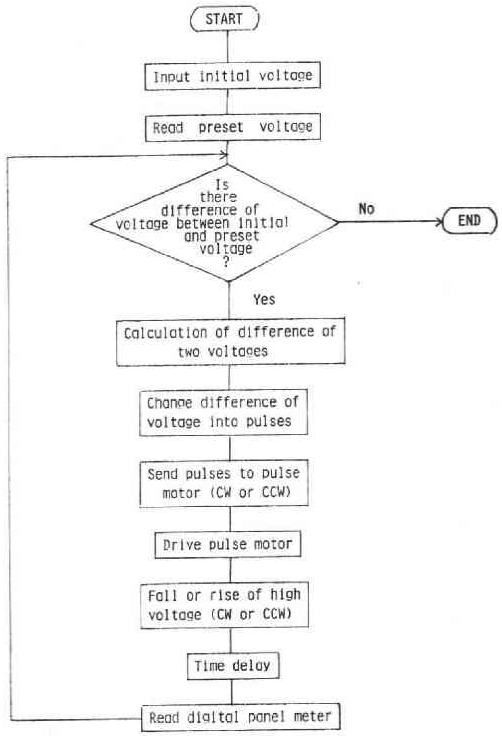

Fig. 7 Flowchart for decision of impress voltage for center counter.

background and activity of N.B.S. for age calculation, data file name (usually code No.), histgram ranges of the anti-center and center-scaler and time intervals of checking and re-setting the impressed high voltage for the center counter during the ß-ray counting. The programs for reading input data and age calculation are written in subroutine expressed in lines 120 to 480 and 5000 to 5510 respectively.

Input data at preset intervals are the number of sampling data, time interval, anti-center counts, center counts, impressed high voltage, pressure, temperature of the counter, mean anti-center value and a calculated radiocarbon age. In this program, the microprocessor continuously checks for interruption of the data output and for changes in the preset times or intervals throughout ß-ray counting.

When the number of sampling data reaches the preset number, the disk file is closed and the totalization program, written in lines 3590 to 3840 and 4180 to 4220, is executed. Then histgrams for anti-center counts and center counts are drawn by the program (lines 4080 to 4160 and 4240 to 4340) and the ß-ray counting program ends.

4.5. Age calculation (RCD)

This program is written in lines 5000 to 5510 and is expressed in a flowchart in Fig. 10. It is possible to access it as an online program and as an offline one. A subroutine program for age calculation is written in lines 5340 to 5510. It operates as follows. In the offline program, the operator must input such data as code number, pressure, temperature, total time of ß-ray counting, total counts of anti-scaler, background and activity of N.B.S. In the online program, data are the

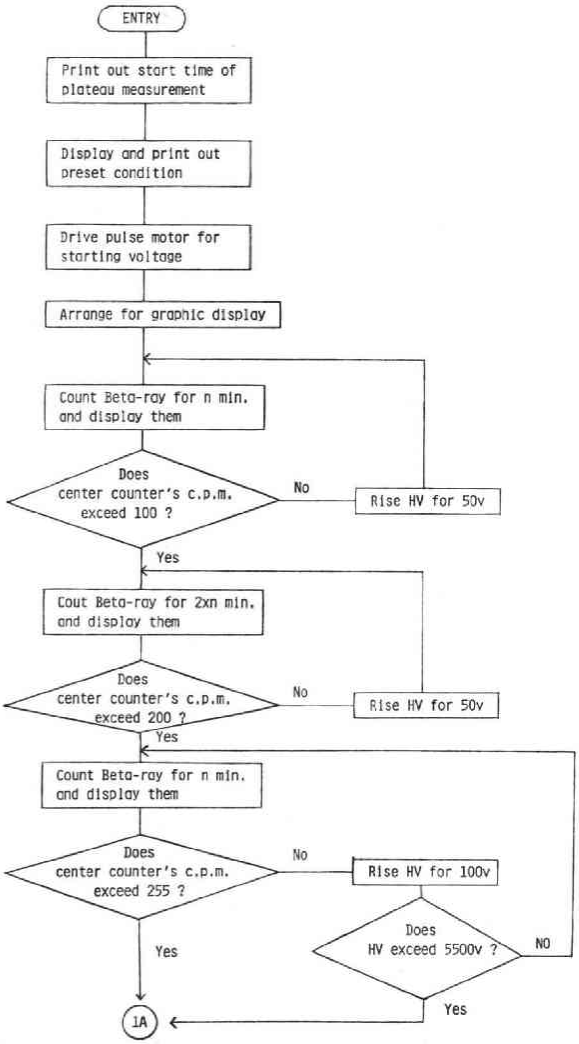

Fig. 8A Flowchart of plateau measurement (1).

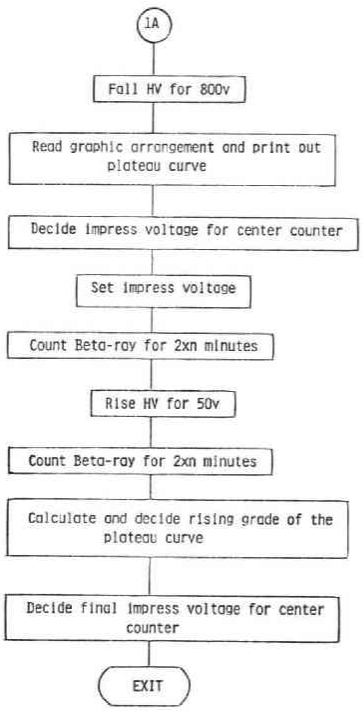

Fig. 8B Flowchart of plateau measurement (2).

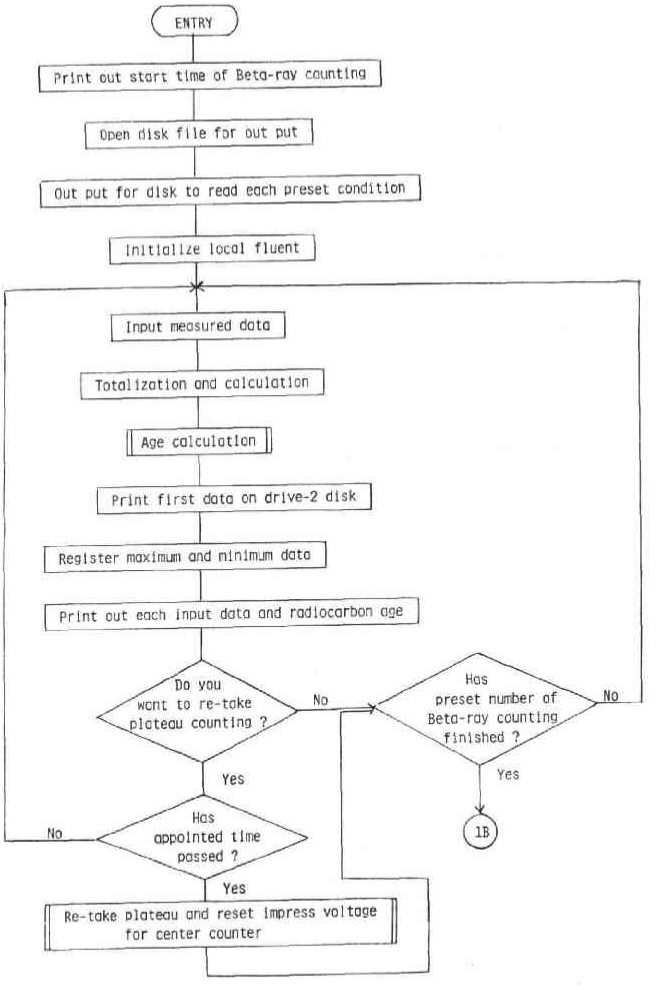

Fig. 9A Flowchart of ß-ray counting (1).

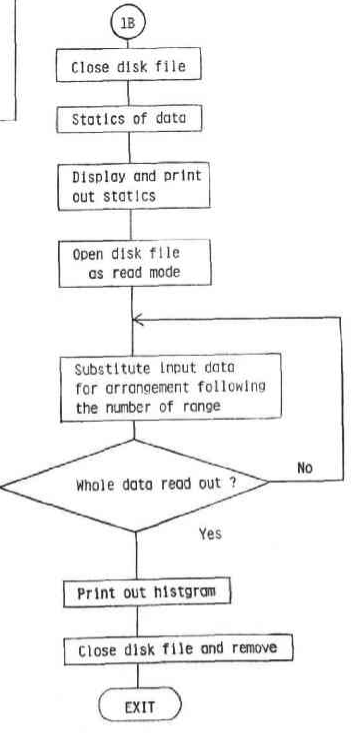

Fig. 9B Flowchart of ß-ray counting (2).

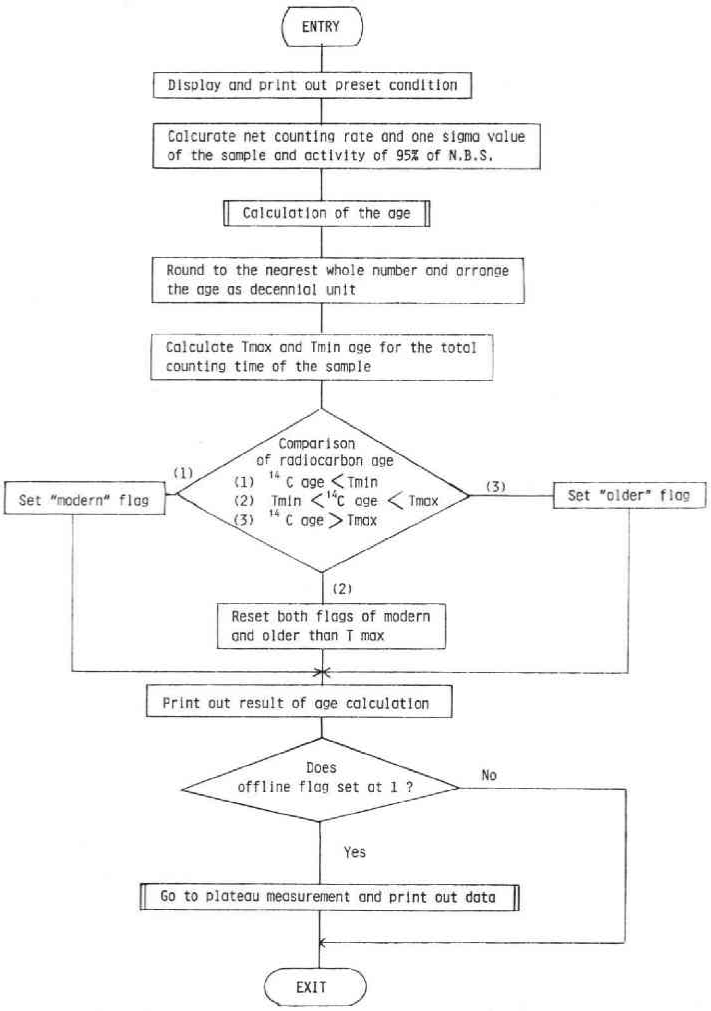

Fig. 10 Flowchart of radiocarbon age calculation.

same as the preset values of the sample under counting and the age calculation is executed automatically, unless there was no command to interrupt the program.

If the offline flag is set at 1 after age calculation, then the plateau counting and decision of the impressed high voltage for the center counter will be executed again in lines 2900 to 2940.

In the age calculation subroutine, the radiocarbon age is decided based on Libby's half life of the natural radiocarbon, 5,570±30 years. An "infinite" date is given with a limit corresponding to the activity of 3σ when the sample activity is

less than 2σ above the background, while a "modern" date is given with the limit equal to 3σ below 95% of the N.B.S. standard minus 2σ. In the ß-ray counting program, "older" or "modern" radiocarbon age is expressed on the CRT display and the printer when the sample radioactivity was very low or very high, respectively. The maximum and the minimum radiocarbon age are calculated based on the data of the sample; pressure, temperature, total time, total anti-counts and preset background and the activity of N.B.S. The errors are expressed based on one standard deviation ($\pm 1\sigma$) in statistical error of the sample counts.

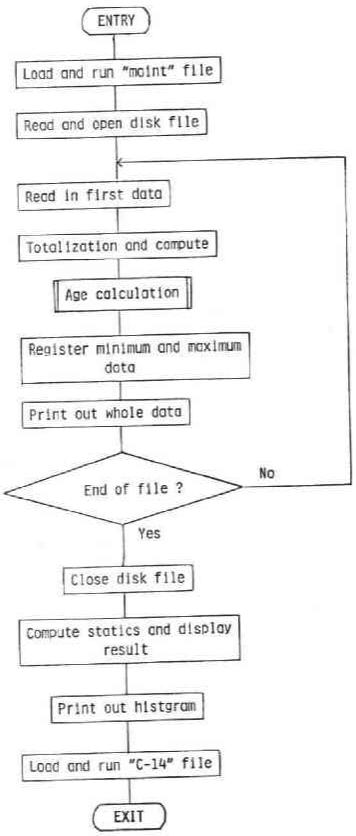

Fig. 11 Flowchart of data file maintenance.

4.6. Data file maintenance (MTN)

Since it is necessary in radiocarbon dating to keep the data for future use, the author wrote a program for data file maintenance (Fig. 11). The drive program is short (lines 6000 to 7020) but the main program is long enough to be given a file name. It is essentially the same as the former one and was written by editing and deleting the useless lines except those between 6000 and 7020. The code number, preset values, output data from the instruments and the radiocarbon ages of the sample at every time interval were stored in the drive-2 memory device (disket) in the PC–8031, which contains at least 143k byte.

The program operates as follows. It is offline, therefore the operator must input *mount 1* and press the RETURN key in the first place, except when the main program is in the CPU. And he must input also *run "maint"* and press the RETURN key. Then it begins to execute and may ask him the code number which he wants printed out. After key input of the code number, the following data will be printed out to the CRT display and the printer: code number, date, operator name, preset values for the sample, the same output data of the ß-ray count and the radiocarbon ages at every sampling interval. When the number of the sample data reaches the preset number, the disk is closed and the totalization program is executed. The results are printed

out on the CRT display and the printer; then the final age calculation is executed and its result printed out. When all the data of the sample have transferred and printed out, the loading of the main program takes place as usual.

4.7. How to access the programs

The programs developed can usually be accessed in the following way. The whole system is usually standing by to start *i.e.* all switches necessary in the experiments are turned on. The operator may then prepare and insert a program disk and a data disk into drive-1 and drive-2 of the PC–8031. Then he may input *mount 1* and press the RETURN key using the keyboard of the PC–8001. The next statement is *run "ECL"* (*ECL* is the file name of the gas-enclosing experiment).

If he needs to use the program as an offline, he must input *mount 1* and pres the RETURN key in the first place. Next, he must input *run "ECL"* or *"RCD"* (*RCD* is the file name of the ß-ray counting program) and press the RETURN. He must press the STOP key at once when the first message is printed out on the CRT display. Then he may input *go to* #### (#### is the line in which he wants to execute the job).

The important operations for the PC–8031 are to command (input) *mount* and *remove* before using and taking off the diskets, and to press the RETURN key after input.

5 Execution of the program and the results

The author has succeeded in controlling the whole system expressed in Fig. 1, as a "fully automatic system" by using a personal computer system of the NEC's PC–8000 series and by using software programs developed by himself. A method of the fully automatic radiocarbon dating system is presented by a series of experiments, not only enclosing the sample gas into a proportional counter, but also counting it in very stable conditions at the optimum condition every time by correcting the present values even if the primary preset conditions might be changed during the long counting period. It is needless to say that the experiments have been controlled by the software programs described already; however, it took much longer than expected to perform whole experiments because the programs were developed by the author who was not a specialist nor trained in system development. Fortunately, in more than a year since he succeeded in developing fully automatic radiocarbon dating, no problems have arisen.

Using these systems, he found that the radiocarbon dating experiment had greatly progressed in speed and elimination of labour (1/100), and that the accuracy

and reliability of the date itself had also improved very much (1/5–1/10) compared with former manual systems. These results and detailed hardware have described in other papers (see also Omoto 1982a and 1982b).

Acknowledgement

The author wishes to express his sincere appreciation to Prof. K. Kigoshi of Gakushuin University for his continuing encouragement and advice in radiocarbon dating. He also wishes to acknowledge Mr. M. Jinno who taught him the softwares of the personal computer system and Mrs. M. Jinno who helped typing the program lists. Thanks are also given to Dr. G. Thom of the British Embassy, Tokyo, who revised the manuscript. This study was sponsored by the Ministry of Education as a Grant in Aid for Developmental Scientific Research between 1980 and 1981 (588036 and 00588036).

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Program 1. Radiocarbon Dating Experiment Program (ECL).

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10 '*************************************************************
15 '*                                                           *
20 '*          RADIOCARBON DATING EXPERIMENT PROGRAM            *   "ECL"
25 '*                FOR GAS COUNTING SYSTEM                    *   820511
30 '*                                                           *   820609
35 '*                    Programed by Dr.k.Omoto  Nov.15,1981   *
40 '*                    Modified                 Feb.10,1982   *
45 '*                                             Mar.11,1982   *
50 '*************************************************************
90 GOTO 1000
100 '***** Temporary data read out *****
110 OUT&HB1,8 :OUT&HB3,2 :OUT&HB3,0 :OUT&HB1,0 :'Timer reset
120 OUT&HB1,16 :OUT&HB3,2 :OUT&HB3,0 :OUT&HB1,0 :'Timer start
130 FOR Z=1 TO 1000 :NEXT Z :'Short delay
140 FOR I=1 TO 6
150 OUT&HB1,1 :OUT&HB3,4 :OUT&HB3,0 :OUT&HB1,0 :'Equip.select pulse
160 OUT&HB1,2 :OUT&HB3,4 :OUT&HB3,0 :OUT&HB1,0 :D=INP(&HB0) :'Read Lower byte
170 OUT&HB1,2 :OUT&HB3,4 :OUT&HB3,0 :OUT&HB1,0 :E=INP(&HB0) :'Read Middle byte
180 OUT&HB1,2 :OUT&HB3,4 :OUT&HB3,0 :OUT&HB1,0 :F=INP(&HB0) :'Read Higher byte
190 D=INT(D/16)*10+(D MOD 16)
200 E=INT(E/16)*10+(E MOD 16)
210 F=INT(F/16)*10+(F MOD 16)
220 E=100*E :F=10000*F
225 F(I)=D+E+F
230 NEXT I
235 IT=F(1)/10 :AN=F(2) :CE=F(3) :H=F(4) :P=F(5)/10 :T=F(6)/10
237 REM:GOSUB 900:GOSUB 400:PRINT IT;AN;CE;H;P;T:GOSUB100
240 RETURN
300 '***** Relay on/off subroutine *****
310 IF RN>30 OR RN<1 OR RO>1 OR RO<0 THEN GOTO 380
315 IF RN>15 THEN RN=RN+33:RO=ABS(NOT RO)
317 REM:print HEX$(RN)
320 RL=RN+48-16*RO
330 OUT&HB1,RL :'relay condition
340 OUT&HB3,8 :OUT&HB3,0 :'on/off pulse
350 OUT&HB1,0 :'clear the port
360 RETURN
370 REM:INPUT RN:INPUT RO:GOSUB 300:GOTO 370
380 PRINT "Illegal relay number! "
400 '***** Read data of I.V.G. & Level indicator *****
410 'CH0=IVG:CH1=Level-1:CH2=Level-2
455 PRINT@5;"D0C"
460 FOR N=0 TO 2
465 PRINT@5;N
470 INPUT@5;AD(N)
475 NEXT N
480 I1=AD(0)/10000:LV1=AD(1):LV2=AD(2)
490 RETURN
500 '***** Exhaust subroutine *****
505 GOSUB 100 :P$="Read Digital manometer" :Q$=STR$(P)+" mmHg" :GOSUB 950
510 RN=2 :RO=0 :GOSUB 300 :P$="Open C-2" :GOSUB 900 :TD=30  :GOSUB 850
520 REM:GOSUB 100 :IF P>.2 THEN 510
530 RN=4 :RO=0 :GOSUB 300 :P$="Open C-4" :GOSUB 900 :TD=30  :GOSUB 850
540 RN=14 :RO=0 :GOSUB 300 :P$="I.V.G. SW ON" :GOSUB 900
545 RN=15 :RO=0 :GOSUB 300 :P$="I.V.G. Heater resset  SW ON" :GOSUB 900
550 GOSUB 400 :P$="Read Ionization vacuum gauge ( I.V.G. )" :Q$=STR$(I1)+" 10-4
torr." :GOSUB 950
560 RN=14 :RO=1 :GOSUB 300 :P$="I.V.G. SW OFF" :GOSUB 900
565 RN=15 :RO=1 :GOSUB 300 :P$="I.V.G. Heater resset  SW OFF" :GOSUB 900
570 IF I1>1  ELSE I1<.4 THEN TD=300:GOSUB 850:GOT 540
580 RN=4 :RO=1 :GOSUB 300 :P$="Close C-4" :GOSUB 900
590 RETURN
```

```
600 '***** Automatic voltage set *****
610 IF HC>5500 THEN HC=5500 ELSE IF HC<2000 THEN HC=2000
620 GOSUB 100
625 X=H-HC :IF X<0 THEN W=1 ELSE W=2
630 X1=ABS(X) :XP=INT(X1/.45) :IF XP<256 THEN Y=XP :Z=0 :GOTO 660
640 Z=INT(XP/256):IF Z>28 THEN Z=28
650 Y=XP-256*Z
660 OUT&HB1,Y :OUT&HB3,1 :OUT&HB3,0 :OUT&HB1,0 :'latch low byte
670 OUT&HB1,Z :OUT&HB3,1 :OUT&HB3,0 :OUT&HB1,0 :'latch high byte
680 OUT&HB3,1 :OUT&HB3,0 :'load pulse for pulse motor
690 IF W=2 THEN 710 ELSE 700
700 OUT&HB1,129 :OUT&HB3,2 :OUT&HB3,0 :OUT&HB1,0 :GOTO 720
710 OUT&HB1,130 :OUT&HB3,2 :OUT&HB3,0 :OUT&HB1,0
720 OUT&HB1,4 :OUT&HB3,2 :OUT&HB3,0 :OUT&HB1,0 :'pulse start
730 Q=INP(&HB2):IF (Q AND 4)<>0 THEN 730
735 GOSUB 100:K=INT(H-HC)
740 IF K<-1 THEN 625 ELSE IF K>1 THEN 625 ELSE RETURN
800 '***** timer *****
810 H$=LEFT$(TIME$,2) :M$=MID$(TIME$,4,2) :S$=RIGHT$(TIME$,2)
820 VH=VAL(H$) :VM=VAL(M$) :VS=VAL(S$) :V=VH*3600+VM*60+VS :RETURN
830 XT=POS(0) :YT=CSRLIN :LOCATE 70,0,0 :PRINT TIME$ :LOCATE XT,YT,1 :RETURN
850 GOSUB 810 :TP=V
860 GOSUB 810 :GOSUB 830 :IF V<TP+TD THEN 860 ELSE RETURN
900 '***** Print out time & condition *****
910 GOSUB 930 :PRINT :LPRINT :RETURN
930 PRINT TIME$;TAB(10);P$; :LPRINT TIME$;TAB(10);P$; :RETURN
950 GOSUB 930 :PRINT TAB(62);Q$ :LPRINT TAB(62);Q$ :RETURN
1000 '***** Initialize *****
1010 C$="GMT-nnnn" :N$="K.Omoto"
1020 PRINT CHR$(12) :WIDTH 80,20 :COLOR 5 :CONSOLE 0,20,0,1
1021 DEFUSR0=&H6000
1022 A=USR0(1)
1023 CMD DELIM=0
1024 CMD TIMEOUT=1
1025 DIM AD(3) :ISET IFC
1026 IF AD(1)>2400 THEN AD(1)=2400
1027 IF AD(2)>3850 THEN AD(2)=3850
1030 A1$="       ***************************************************************"
1040 A2$="       * RADIOCARBON DATING EXPERIMENT ( CO2 COLLECTION ) PROGRAM *"
1050 A3$="       * Programed by Dr. K.Omoto                    Nov.10.1981.    *"
1060 A4$="       ***************************************************************"
1070 PRINT A1$ :PRINT A2$ :PRINT A3$ :PRINT A4$
1080 LPRINT A1$ :LPRINT A2$ :LPRINT A3$ :LPRINT A4$
1090 PRINT :PRINT "Enter Parameters" :PRINT :COLOR 7
1100 PRINT "Code No.=";C$;TAB(30);:INPUT"New Code No. ";C$ :ON ERROR GOTO 1160
1110 PRINT "Date = ";DATE$;TAB(30);:A$=DATE$:INPUT"New Date ";A$:DATE$=A$
1120 PRINT "Time = ";TIME$;TAB(30);:A$=TIME$:INPUT"Present time ";A$:TIME$=A$
1130 PRINT "Name = ";N$;TAB(30);:INPUT"What is your Name ";N$
1140 PRINT "High Voltage = ";HC;TAB(30);:INPUT"Center Counter ";HC
1150 GOSUB 100 :COLOR 4 :GOTO 1200
1160 IF ERL=1110 THEN 1170 ELSE IF ERL=1120 THEN 1180 ELSE PRINT "Error ";ERR:RE
SUME NEXT
1170 PRINT "Illegal format of DATE.Type again":RESUME 1110
1180 PRINT "Illegal format of TIME.Type again":RESUME 1120
1200 '***** Print preset condition *****
1210 PRINT CHR$(12) :PRINT :PRINT A2$ :PRINT :PRINT "Code No.: ";C$;TAB(25);"Dat
e : ";DATE$;TAB(50);"Operator : "N$ :PRINT :PRINT "*** Preset condition ***":PRI
NT :PRINT "Pressure : ";P;"mmHg";TAB(30);"Temperature : ";T;"deg.C."
1220 PRINT "Impressed High voltage of the Center counter : ";HC;"volts"
1230 LPRINT :LPRINT :LPRINT "Code No.: ";C$;TAB(25);"Date : ";DATE$;TAB(50);"Ope
rator : "N$ :LPRINT :LPRINT "*** Preset condition ***":LPRINT :LPRINT "Pressure
: ";P;"mmHg";TAB(30);"Temperature : ";T;"deg.C."
1240 LPRINT "Impressed High voltage of the Center counter : ";HC;"volts"
```

```
2000 '***** Main Program *****
2010 COLOR 7 :PRINT :PRINT :LPRINT :LPRINT
2020 P$="Program Start" :GOSUB 900
2030 PRINT :LPRINT
2040 P$="Off High voltage unit of the center counter" :GOSUB 900 :HC=2000 :GOSUB
 600
2050 RN=6 :RO=1 :GOSUB 300 :GOSUB 100 :IF H<100 THEN 2050 :TD=120:GOSUB 850:'Hig
h volt off
2060 P$="Read Digital volt meter" :GOSUB 100:Q$=STR$(H)+" Volts" :GOSUB 950
2065 IF HC<5 THEN 2070 ELSE IF HC>5 THEN TD=90:GOSUB 850:GOTO 2060
2070 RN=8 :RO=0 :GOSUB 300 :P$="Open Water valve" :GOSUB 900 :TD=30  :GOSUB 850
2080 RN=1 :RO=0 :GOSUB 300 :P$="Rotary Pump switch ON" :GOSUB 900 :TD=30 :GOSUB
850
2090 RN=9 :RO=0 :GOSUB 300 :P$="Diffusion Pump ON" :GOSUB 900:TD=30:GOSUB 850
2100 RN=11:RO=0 :GOSUB 300 :P$="Change level meter No.1":GOSUB 900 :TD=30  :GOSU
B 850
2105 GOSUB 400:P$="Read Level (1)":Q$="STR$(I1)+"10-4 TORR.":GOSUB 950
2110 RN=12:RO=0 :GOSUB 300 :P$="Freeze cold finger with liquid N2" :GOSUB 900
2120 GOSUB 400 :IF LV1>1200 THEN RN=12:RO=1 :GOSUB 300 ELSE 2120 :'stop elevator
2130 RN=10 :RO=0 :GOSUB 300 :TD=30:GOSUB 850 :' Change the Thermo element No.1
2140 GOSUB 100 :P$="Read Temperature (1) [ Cold finger ]" :Q$=STR$(T)+" deg.C."
:GOSUB 950
2145 GOSUB 400:P$="Read Level (1)":Q$="STR$(I1)+"10-4 TORR.":GOSUB 950
2150 GOSUB 100 :IF T<-140 THEN 2200
2160 RN=12:RO=0 :GOSUB 300 :P$="Up the level(1) of liquid N2" :GOSUB 900
2170 GOSUB 400 :IF LV1>1800 THEN RN=12:RO=1 :GOSUB 300 ELSE 2170 :'stop elevator
2180 GOSUB 100 :IF T<-140 THEN 2190 ELSE 2180
2190 GOSUB 100: P$="Read Temperature (1) [ Cold finger ]" :Q$=STR$(T)+" deg.C."
:GOSUB 950:TD=30  :GOSUB 850
2200 RN=4  :RO=0  :GOSUB 300:P$="Open C-4" :GOSUB 900  :TD=30 :GOSUB 850
2205 RN=5  :RO=0 :GOSUB 300 :P$="Open C-5": GOSUB 900 :TD=30  :GOSUB 850
2210 GOSUB 100 :P$="Read Digital manometer" :Q$=STR$(P)+" mmHg" :GOSUB 950
2220 GOSUB 100 :IF P<5 THEN 2265
2230 RN=12:RO=0 :GOSUB 300 :P$="Up the level(1) of liquid N2" :GOSUB 900
2240 GOSUB 400 :IF LV1>2300 THEN RN=12:RO=1 :GOSUB 300 ELSE 2240 :'stop elevator
2245 GOSUB 400:P$="Read Level (1)":Q$="STR$(I1)+"10-4 TORR.":GOSUB 950
2250 GOSUB 100 :IF P<5 THEN 2260 ELSE 2250TD=150:GOSUB 850
2260 P$="Read Digital manometer" :Q$=STR$(P)+" mmHg" :GOSUB 950
2265 RN=2 :RO=0 :GOSUB 300 :P$="Open C-2" :GOSUB 900 :TD=30  :GOSUB 850
2270 RN=4 :RO=1 :GOSUB 300 :P$="Close C-4" :GOSUB 900:TD=150:GOSUB 850
2275 RN=5 :RO=1 :GOSUB 300 :P$="Close C-5" :GOSUB 900
2280 RN=2 :RO=1 :GOSUB 300 :P$="Close C-2" :GOSUB 900 :TD=30  :GOSUB 850
2285 RN=13:RO=0 :GOSUB 300 :P$="Down the level(1) of liquid N2" :GOSUB 900
2290 GOSUB 400 :IF LV1<200 THEN RN=13:RO=1 :GOSUB 300 ELSE 2290 :'stop elevator
2300 GOSUB 400:P$="Read Level (1)":Q$="STR$(I1)+"10-4 TORR.":GOSUB 950
2310 P$="Remove liquid N2  and reserver flask." :GOSUB 900:TD=150:GOSUB 850
2320 Y=CSRLIN :IF Y=19 THEN Y=18
2330 BEEP1 :P$="Set NEW Flask !! and HIT Return Key " :GOSUB 900
2340 BEEP0 :LOCATE 10,Y :PRINT STRING$(60,CHR$(32)); :BEEP1 :LOCATE 10,Y :PRINT
P$; :FOR A=1 TO 50 :NEXT A :IF INKEY$="" THEN 2340
2350 BEEP0
2360 CHR$(12):LPRINT :LPRINT :LPRINT :LPRINT :LPRINT
3000 '***** Initialize *****
3010 C$="OMT-nnnn" :N$="K.Omoto"
3020 PRINT CHR$(12) :WIDTH 80,20 :COLOR 5 :CONSOLE 0,20,0,1
3030 B1$="        ************************************************************"
3040 B2$="        * RADIOCARBON DATING EXPERIMENT ( CO2 ENCLOSING  ) PROGRAM *"
3050 B3$="        * Directed by Dr. K.Omoto  Nov.10.1981. Mod. Nov.23,1981   *"
3060 B4$="        ************************************************************"
3070 PRINT B1$ :PRINT B2$ :PRINT B3$ :PRINT B4$
3080 LPRINT B1$ :LPRINT B2$ :LPRINT B3$ :LPRINT B4$
3090 PRINT :PRINT "Enter Parameters" :PRINT :COLOR 7
3100 PRINT "Code No.=";C$;TAB(30);:INPUT"New Code No. ";C$ :ON ERROR GOTO 3160
3110 PRINT "Date = ";DATE$;TAB(30);:A$=DATE$:INPUT"New Date ";A$:DATE$=A$
3120 PRINT "Time = ";TIME$;TAB(30);:A$=TIME$:INPUT"Present time ";A$:TIME$=A$
3130 PRINT "Name = ";N$;TAB(30);:INPUT"What is your Name ";N$
3160 IF ERL=3110 THEN 3170 ELSE IF ERL=3120 THEN 3180 ELSE PRINT "Error ";ERR:RE
SUME NEXT
3170 PRINT "Illegal format of DATE.Type again":RESUME 3110
3180 PRINT "Illegal format of TIME.Type again":RESUME 3120
3190 PRINT CHR$(12) :PRINT :PRINT A2$ :PRINT :PRINT "Code No.: ";C$;TAB(25);"Dat
e : ";DATE$;TAB(50);"Operator : "N$ :PRINT :PRINT
3195 LPRINT :LPRINT :LPRINT "Code No.: ";C$;TAB(25);"Date : ";DATE$;TAB(50);"Ope
rator : "N$ :LPRINT :LPRINT
```

```
3200 '***** Main Program *****
3210 COLOR 7 :PRINT :PRINT :LPRINT :LPRINT
3220 P$="Program Start" :GOSUB 900
3230 PRINT :LPRINT
3250 RN=2 :RO=0 :GOSUB 300 :P$="Open C-2" :GOSUB 900 :TD=30  :GOSUB 850
3270 RN=4 :RO=0 :GOSUB 300 :P$="Open C-4" :GOSUB 900 :TD=300 :GOSUB 850
3280 RN=2 :RO=1 :GOSUB 300 :P$="Close C-2" :GOSUB 900 :TD=30  :GOSUB 850
3290 RN=3 :RO=0 :GOSUB 300 :P$="Open C-3" :GOSUB 900 :TD=300:GOSUB 850
3300 RN=11:RO=1 :GOSUB 300 :P$="Change level meter No.2":GOSUB 900 :TD=30 :GOSUB
 850
3305 GOSUB 400:P$="Read Level (2)":Q$="STR$(I1)+"10-4 TORR.":GOSUB 950
3310 RN=12:RO=0 :GOSUB 300 :P$="Freeze trap with liquid N2 ( Up the level of liq
uid N2 )" :GOSUB 900
3320 GOSUB 400 :IF LV2>3200 THEN RN=12:RO=1 :GOSUB 300 ELSE 3320 :'stop elevator
3325 GOSUB 400:P$="Read Level (2)":Q$="STR$(I1)+"10-4 TORR.":GOSUB 950
3330 RN=10 :RO=1 :GOSUB 300 :TD=30:GOSUB 850 :'Change the Thermo element No.2
3340 GOSUB 100 :P$="Read Temperature (2)" :Q$=STR$(T)+" deg.C." :GOSUB 950
3350 RN=14 :RO=0 :GOSUB 300 :P$="I.V.G. SW ON" :GOSUB 900
3355 RN=15 :RO=0 :GOSUB 300 :P$="I.V.G. Heater resset  SW ON" :GOSUB 900
3360 GOSUB 400 :P$="Read Ionization vacuum gauge ( I.V.G. )" :Q$=STR$(I1)+" 10-4
 torr." :GOSUB 950
3370 RN=14 :RO=1 :GOSUB 300 :P$="I.V.G. SW OFF" :GOSUB 900
3375 RN=15 :RO=1 :GOSUB 300 :P$="I.V.G. Heater resset  SW OFF" :GOSUB 900
3380 IF I1>1  ELSE I1<.4 THEN TD=300:GOSUB 850:GOTO 3350
3390 GOSUB 100 :P$="Read Temperature (2)" :Q$=STR$(T)+" deg.C." :GOSUB 950
3400 IF T<-140 THEN GOSUB 100 :P$="Read Digital manometer" :Q$=STR$(P)+" mmHg" :
GOSUB 950
3410 RN=3  :RO=1 :GOSUB 300 :P$="Close C-3" :GOSUB 900 :TD=30 :GOSUB 850
3420 RN=5  :RO=0 :GOSUB 300 :P$="Open C-5": GOSUB 900 :TD=30  :GOSUB 850
3425 GOSUB 400:P$="Read Level (2)":Q$="STR$(I1)+"10-4 TORR.":GOSUB 950
3430 RN=12:RO=0 :GOSUB 300 :P$="Freeze trap with liquid N2 ( Up the level of liq
uid N2 )" :GOSUB 900
3440 GOSUB 400 :IF LV2>3350 THEN RN=12:RO=1 :GOSUB 300 ELSE 3440 :'stop elevator
3445 GOSUB 400:P$="Read Level (2)":Q$="STR$(I1)+"10-4 TORR.":GOSUB 950
3450 IF T<-140 THEN GOSUB 100 :P$="Read Digital manometer" :Q$=STR$(P)+" mmHg" :
GOSUB 950
3455 GOSUB 100:P$="Read Digital manometer" :Q$=STR$(P)+" mmHg" :GOSUB 950:IF P>5
 THEN 3455
3460 RN=2 :RO=0 :GOSUB 300 :P$="Open C-2" :GOSUB 900 :TD=300 :GOSUB 850
3470 RN=2 :RO=1 :GOSUB 300 :P$="Close C-2" :GOSUB 900 :TD=30 :GOSUB 850
3480 RN=3 :RO=0 :GOSUB 300 :P$="Open C-3" :GOSUB 900 :TD=300 :GOSUB 850
3490 RN=14 :RO=0 :GOSUB 300 :P$="I.V.G. SW ON" :GOSUB 900
3500 RN=15 :RO=0 :GOSUB 300 :P$="I.V.G. Heater resset  SW ON" :GOSUB 900
3510 GOSUB 400 :P$="Read Ionization vacuum gauge ( I.V.G. )" :Q$=STR$(I1)+" 10-4
 torr." :GOSUB 950
3520 RN=14 :RO=1 :GOSUB 300 :P$="I.V.G. SW OFF" :GOSUB 900
3525 RN=15 :RO=1 :GOSUB 300 :P$="I.V.G. Heater resset  SW OFF" :GOSUB 900
3530 IF I1>1  ELSE I1<.4 THEN TD=300:GOSUB 850:GOTO 3490
3540 RN=3  :RO=1 :GOSUB 300 :P$="Close C-3" :GOSUB 900 :TD=30 :GOSUB 850
3545 GOSUB 400:P$="Read Level (2)":Q$="STR$(I1)+"10-4 TORR.":GOSUB 950
3600 RN=13:RO=0 :GOSUB 300 :P$="Down the level(2) of liquid N2 and remove it fro
m the trap" :GOSUB 900 :TD=3  :GOSUB 850
3610 GOSUB 400 :IF LV2<2800 THEN RN=13:RO=1 :GOSUB 300 ELSE 3610 :'stop elevator
3612 GOSUB 400:P$="Read Level (2)":Q$="STR$(I1)+"10-4 TORR.":GOSUB 950
3615 RN=4 :RO=1 :GOSUB 300 :P$="Close C-4" :GOSUB 900 :TD=30 :GOSUB 850
3620 RN=5  :RO=1 :GOSUB 300 :P$="Close C-5": GOSUB 900 :TD=30 :GOSUB 850
3630 RN=7  :RO=0 :GOSUB 300 :P$="Heat up the trap" :GOSUB 900 :TD=300 :GOSUB 850
3640 RN=7  :RO=1 :GOSUB 300 :P$="Heat off the trap" :GOSUB 900 :TD=30 :GOSUB 850
3650 RN=9 :RO=1 :GOSUB 300 :P$="Off the Diffusion Pump" :GOSUB 900 :TD=300:GOSB
850
3660 GOSUB 100 :P$="Read Digital manometer (Maximum pressure)" :Q$=STR$(P)+" mmH
g" :GOSUB 950
3670 IF P>850 THEN RN=4 :RO=0 :GOSUB 300 :'Open C-4 for adjusting pressure
3680 RN=4 :RO=1 :GOSUB 300 :P$="Close C-4" :GOSUB 900
3690 GOSUB 100 :P$="Read Digital manometer" :Q$=STR$(P)+" mmHg" :GOSUB 950
3700 IF P>400 THEN TD=30:GOSUB 850:RN=6 :RO=0 :GOSUB 300 :P$="High voltage ON" :
GOSUB 900 :GOTO 3720
3710 P$="Pressure is not over 400 mmHg" :GOSUB 900 :TD=18  :BEEP1 :GOSUB 850 :BE
EP0
3720 TD=1800 :GOSUB 850
3730 RN=1 :RO=1 :GOSUB 300 :P$="Rotary Pump switch OFF (C-1 Open)" :GOSUB 900 :T
D=30 :GOSUB 850
3740 RN=8  :RO=1 :GOSUB 300 :P$="Close Water valve" :GOSUB 900
3750 PRINT:P$="Program End":GOSUB 900
```

```
3760 FOR A=1 TO 10 :LPRINT :NEXT A
3770 PRINT CHR$(12):RUN"RCD"
3780 END
4000 '***** Read data of temp.,press.,voltage,for test operation *****
4010 P=RND(1)*800 :T=RND(1)*-180
4020 H=RND(1)*5000
4030 RETURN
5000 '***** Read data of I.V.G. and Level meter for test operation *****
5010 I1=RND(1)*10
5020 L1=RND(1)*10
5030 L2=RND(1)*10
5040 RETURN
5500 '***** Exhaust experiment test program ****
5510 P$="**** Exhaust experiment test program ****" :GOSUB 950
5520 RN=6:RO=1:GOSUB 300:GOSUB 900:TD=30:GOSUB 850
5530 GOSUB 100 :P$="Read Digital voltmeter" :Q$=STR$(H)+" volts" :GOSUB 950
5540 GOSUB 100 :P$="Read Digital manometer" :Q$=STR$(P)+" mmHg" :GOSUB 950
5550 RN=1 :RO=0 :GOSUB 300 :P$="Open C-1" :GOSUB 900 :TD=30  :GOSUB 850
5560 RN=2 :RO=0 :GOSUB 300 :P$="Open C-2" :GOSUB 900 :TD=30  :GOSUB 850
5570 RN=3 :RO=0 :GOSUB 300 :P$="Open C-3" :GOSUB 900 :TD=30  :GOSUB 850
5580 RN=4 :RO=0 :GOSUB 300 :P$="Open C-4" :GOSUB 900 :TD=30  :GOSUB 850
5590 RN=5 :RO=0 :GOSUB 300 :P$="Open C-5" :GOSUB 900 :TD=30  :GOSUB 850
5600 GOSUB 100 :P$="Read Digital manometer" :Q$=STR$(P)+" mmHg" :GOSUB 950
5610 IF P>.2 THEN 5620 ELSE 5640
5620 TD=30  :GOSUB 850:GOTO 5600
5640 TD=30:GOSUB 850
5650 RN=5 :RO=1 :GOSUB 300 :P$="Close C-5" :GOSUB 900:TD=30:GOSUB 850
5660 RN=4 :RO=1 :GOSUB 300 :P$="Close C-4" :GOSUB 900:TD=30:GOSUB 850
5670 RN=3 :RO=1 :GOSUB 300 :P$="Close C-3" :GOSUB 900:TD=30:GOSUB 850
5680 RN=2 :RO=1 :GOSUB 300 :P$="Close C-2" :GOSUB 900:TD=30:GOSUB 850
5690 RN=1 :RO=1 :GOSUB 300 :P$="Close C-1" :GOSUB 900:TD=30:GOSUB 850
5700 END
9000 '**** Test operation for reading data by R488-AD ***
9970 FOR A=1 TO 30:RN=A:RO=1:GOSUB 300:NEXT
9990 REM:GOTO 9970
10000 GOSUB 900:GOSUB 400;:PRINT TAB(15);AD(0);AD(1);AD(2):LPRINT TAB(15);AD(0);
AD(1);AD(2)
10005 FOR A=1 TO 1000  :NEXT
10010 GOTO 9970
```

Program 2. Radiocarbon Age Measurement Program (RCD).

```
10 REM  ************************************************************
15 REM  *                                                          *
20 REM  *    RADIOCARBON AGE MEASUREMENT PROGRAM     v-1.0         * "RCD"820502
25 REM  *                                                          *
30 REM  *                Directed by Dr.K.Omoto                    *
35 REM  *                Programed by M.JINNO       NOV.10.1980 *
40 REM  *                Modified for Full Automatic System        *
45 REM  *                by Dr. K.OMOTO             FEB.25,1981 *
50 REM  ************************************************************
60 REM
70 PRINT CHR$(12);:CONSOLE 0,19,1,1:WIDTH 80,20:COLOR 7
80 PRINT TAB(16);"************************************************"
90 PRINT TAB(16);"*       RADIOCARBON DATING PROGRAM START       *"
100 PRINT TAB(16);"************************************************"
105 REMOVE:GOTO 1500
120 REM *** Input data ***
130 GOTO 210
140 X$=INKEY$:IF X$="" THEN 230
150 IF X$="t" THEN PRINT:PRINT"Time interval =";TI;:INPUT"New interval ";TI
160 IF X$="p" THEN PRINT:PRINT"Preset time =";PT;:INPUT"New preset time ";PT
170 GOTO 230
210 OUT &HB1,8:OUT &HB3,2:OUT &HB3,0:OUT &HB1,0
220 OUT &HB1,16:OUT &HB3,2:OUT &HB3,0:OUT &HB1,0
230 Y=INP(&HB2):IF(Y AND 2)<>0THEN 140
240 FOR Z=1 TO 1000:NEXT Z
245 FORI=1TO6
250 OUT &HB1,1:OUT &HB3,4:OUT &HB3,0:OUT &HB1,0
260 OUT &HB1,2:OUT &HB3,4:OUT &HB3,0:OUT &HB1,0:D=INP(&HB0)
270 OUT &HB1,2:OUT &HB3,4:OUT &HB3,0:OUT &HB1,0:E=INP(&HB0)
280 OUT &HB1,2:OUT &HB3,4:OUT &HB3,0:OUT &HB1,0:F=INP(&HB0)
290 D=INT(D/16)*10+(DMOD16)
300 E=INT(E/16)*10+(EMOD16)
310 F=INT(F/16)*10+(FMOD16)
320 E=100*E:F=10000*F
330 F(I)=D+E+F
340 NEXTI
350 F(5)=F(5)/10:F(6)=F(6)/10
360 TI=F(1)/10:AN=F(2):CE=F(3):H=F(4):P=F(5):T=F(6)
370 RETURN
450 REM *** Temporary data read out ***
460 OUT &HB1,8:OUT &HB3,2:OUT &HB3,0:OUT &HB1,0
470 OUT &HB1,16:OUT &HB3,2:OUT &HB3,0:OUT &HB1,0
480 GOTO 240
500 REM *** Set parameter ***
510 ON ERROR GOTO 590
520 PRINT:PRINT"Enter parameters":PRINT:COLOR7
530 PRINT"Code No.=";C$;TAB(40);:INPUT"New Code No.=";C$
540 PRINT"Date = ";DATE$;TAB(40);:A$=DATE$:INPUT"New Date ";A$:DATE$=A$
550 PRINT"Time = ";TIME$;TAB(40);:A$=TIME$:INPUT"Present time ";A$:TIME$=A$
560 PRINT"Name of operator= ";N$;TAB(40);:INPUT"New name of oprerator";N$:PRINT"
Pressure = ";P;TAB(40);:INPUT"New data ";P
570 PRINT"Temperature = ";T;TAB(40);:INPUT"New data ";T
580 COLOR 4:RETURN
590 IF ERL=530 THEN 600 ELSE IF ERL=540 THEN 610 ELSE IF ERL=550 THEN 620 ELSE
PRINT"Error ";ERR:RESUME NEXT
600 PRINT"Illegal format of Code No. type again":RESUME 530
610 PRINT"Illegal format of DATE. type again":RESUME 540
620 PRINT"Illegal format of TIME. type again":RESUME 550
630 REM *** Plateau parameter ***
640 COLOR 7:PRINT"Start of high voltage = ";HS;TAB(40);:INPUT"New data ";HS
670 COLOR 7:PRINT"Time interval =";TI;TAB(40);:INPUT"New interval? ";TI
680 COLOR 4:RETURN
```

```
700 REM *** Beta rays count parameter ***
710 COLOR 7:PRINT"Preset time = ";TP;TAB(40);:INPUT"New data ";TP
720 PRINT"High volt center = ";HC;TAB(40);: INPUT"new data";HC
730 PRINT"Guard counter = ";GC;TAB(40);:INPUT"New data ";GC
740 COLOR 7
750 PRINT"Histgram range (Center) = ";CH;TAB(40);:INPUT"New range ";CH:PRINT"
          ( ANTI ) = ";AH;TAB(40);:INPUT"New range ";AH
760 PRINT"Back ground = ";B;TAB(40);:INPUT"New data ";B
770 PRINT"N.B.S. (cpm) = ";N;TAB(40);:INPUT"New N.B.S. ";N:IF J=3 THEN COLOR4:RE
TURN
780 PRINT"Data file name = ";F$;TAB(40);:INPUT"New file name ";F$:COLOR4:RETURN
800 REM *** Radiocarbon age calculation parameter ***
810 TT=TI*TP:COLOR7:PRINT"Total time = ";TT;TAB(40);:INPUT"New data ";TT
820 PRINT"Total counts = ";TC;TAB(40);:INPUT"New data ";TC
830 GOTO 760
850 REM *** Preset condition print out to screen ***
860 PRINT:PRINT"Code No.: ";C$;TAB(25);"Date : ";DATE$;TAB(50);"Operator : ";N$:
PRINT:PRINT"*** Preset condition ***":PRINT:PRINT"Pressure                : ";P;"
mmHg";TAB(45);"Temperature      :    ";T;"deg.C.":RETURN
870  PRINT"Total time              :  ";TT;"minutes";TAB(45);"Total counts     :
";TC;"counts"
880 PRINT"Background              : ";B;"c.p.m.";TAB(45);"N.B.S.           : ";N;"
c.p.m.":RETURN
900 REM *** Ask preset data change ***
910 PRINT:COLOR6:PRINT"Do you want to change the preset data ? (Y/N) ";
920 FOR X=1 TO 4000:Z$=INKEY$:IF Z$="" THEN NEXT X
930 PRINT Z$:COLOR4:RETURN
950 REM *** Preset condition print out to printer ***
960 LPRINT:LPRINT"Code No.: ";C$;TAB(25);"Date : ";DATE$;TAB(50);"Operator : ";N
$:LPRINT:LPRINT"*** Preset condition ***":LPRINT:LPRINT"Pressure                :
 ";P;"mmHg";TAB(45);"Temperature      :    ";T;"deg.C.":RETURN
970  LPRINT"Total time              :  ";TT;"minutes";TAB(45);"Total counts     :
 ";TC;"counts"
980 LPRINT"Background              : ";B;"c.p.m.";TAB(45);"N.B.S.           : ";N;
"c.p.m.":RETURN
1000 '-------------------------------------------------------------------------
1010 REM *** Initialize ***
1020 C$="TH-nnnn":N$="K.Omoto"
1030 GOSUB 450:HC=2000:GOSUB 2660:HS=INT(2.85*(273*P)/(273+T)+1800):HS=(INT(HS/1
00))*100
1040 TI=5:GC=3950:HB=350:CC=150
1050 ST=100:TP=204:CH=20:AH=5:F$="data1"
1060 HE=4500:GC=4000:TC=10000:B=6.793:N=24.773:REM *** Constant for test operati
on
1080 REM *** Select Job ***
1090 OF=0:COLOR4:A$="Beta rays count - ":B$="Age Calculation "
1100 PRINT"Job No.1 : Plateau - ";A$;B$
1110 PRINT"Job No.2 : ";A$;B$
1120 PRINT"Job No.3 : ";B$;"( Off line )"
1130 PRINT"Job No.4 : File maintenance ( Off line )"
1140 PRINT"Job No.5 : Sample gas exchange ( Off line )"
1150 PRINT"If you want to END then HIT 5 key and RETURN key"
1160 COLOR6:PRINT:INPUT"Enter job number ";J:COLOR4
1170 ON J GOTO 2000,3000,5000,6000,8000
1500 '
1510 MOUNT:PRINT "The rest of cluster number is";:PRINT TAB(30) DSKF(2);:PRINT "
.";
1520 PRINT"If the rest of cluster number is less than 6, then hit STOP key and
input REMOVE 2 and change drive-2 disk! Then hit f.5  key!"
1540 FOR I=1 TO 2000:NEXT I
1610 GOSUB 450:IF P<300 THEN 1620 ELSE 1660
1620 PRINT CHR$(12):PRINT :PRINT
1630 PRINT :PRINT "Pressure is too low to date! Change your sample!"
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```
1640 PRINT :PRINT :PRINT "After setting new sample, then hit STOP key and push f
.5 key!"
1650 FOR I=1 TO 5000:NEXT I:GOTO 1630
1660 IF HC<1000 THEN 1670 ELSE 1680
1670 RN=6:RL=0:GOSUB 1800:'HV ON
1680 FOR I=1 TO 2000:NEXT I
1690 REMOVE:GOSUB 450:PRINT :PRINT "Power supply for high voltage has turned on
just now .Center counter impressed voltage is";:PRINT ;H;"volts."
1700 FOR I=1 TO 2000:NEXT I:GOTO 1000
1800 '*** Relay control ***
1810 IF RN>30 OR RN<1 OR RL>1 OR RL<0 THEN GOTO 1890
1820 IF RN>15 THEN RN=RN+33:RL=ABS(NOT RL)
1825 ':PRINT HEX$(RN)
1830 RL=RN+48-16*RL
1840 OUT&HB1,RL:':relay condition
1850 OUT&HB3,8:OUT&HB3,0:':on/off pulse
1860 OUT&HB1,0:':clear the port
1870 RETURN
1880 ':INPUT RN:INPUT RL:GOSUB 1800:GOTO 1880
1890 PRINT "Illegal relay number!"
2000 '-------------------------------------------------------------------------
2010 PRINT CHR$(12),"***** AUTOMATIC  PLATEAU  MEASUREMENT *****":PRINT
2020 GOSUB 450:GOSUB 500:HS=INT(2.85*(273*P)/(273+T)+1800):HS=(INT(HS/100))*100:
FA=1:GOSUB 2030:GOTO 3040
2030 COLOR 7:PRINT"Start of high voltage = ";HS;TAB(40);:INPUT"New data ";HS:PRI
NT"Value of plus HV(center) = ";HB;TAB(40);:INPUT"New data ";HB
2040 PRINT"Value of half count = ";CC;TAB(40);:INPUT"New data ";CC:GOSUB 740:GOS
UB 2500:COLOR 7:PRINT:INPUT"Do you want to check and reset high voltage for cent
er counter through Beta rays counting (Y/N) ";R$
2050 GOSUB 2600
2060 LPRINT"Start of Plateau measurement :";TIME$:GOSUB 2500:HC=HS:GOSUB 2660
2070 K=AN/TI:L=CE/TI:M=H:DIM K(50):DIM L(50):DIM M(50):NO=1
2080 LPRINT:LPRINT:LPRINT" No.    Time    Anti    Cent    H.V.    Anti/min    Ce
nt/min"
2090 TI=5:GOSUB 120:GOSUB 2400:GOSUB 2785
2100 IF CE/TI>100 THEN 2120
2110 HC=HC+50:GOSUB 2660:GOTO 2090
2120 TI=10:GOSUB 120:XT=TI:XA=AN:XC=CE
2130 GOSUB 120:TI=TI+XT:AN=AN+XA:CE=CE+XC:GOSUB 2400
2140 GOSUB 2785:IF CE/TI>200 THEN 2150 ELSE HC=HC+50:GOSUB 2660:GOTO 2120
2150 HC=HC+100:IF HC>5000 THEN 2170 ELSE GOSUB 2660:TI=5
2160 GOSUB 120:GOSUB 2400:GOSUB 2785:IF CE/TI<=255 THEN 2150
2170 HC=HC-800:GOSUB 2660:GOSUB 2800
2180 FOR A=1 TO 50:C1=L(A):IF C1>=CC-30 THEN 2200 ELSE NEXT A
2190 PRINT"Illegal data !! Try again plateau measurement!":GOSUB 2000
2200 HZ=M(A):PRINT HZ:GOSUB 2900:ERASE K,L,M:RETURN
2400 REM *** Print out input data ***
2410 PRINT:PRINT" No.    Time    Anti    Cent    H.V.    Anti/min    Cent/min"
2420 PRINT NO;TAB(8);TI;TAB(16);AN;TAB(23);CE;TAB(31);H;TAB(41);:PRINT USING"##.
###";AN/TI;:PRINT TAB(53);:PRINT USING"###.##";CE/TI:XC=CSRLIN-3:LOCATE 0,XC,1
2430 LPRINT NO;TAB(8);TI;TAB(16);AN;TAB(23);CE;TAB(31);H;TAB(41);:LPRINT USING"#
#.###";AN/TI;:LPRINT TAB(53);:LPRINT USING"###.##";CE/TI:RETURN
2500 REM *** Print preset condition of Plateau ***
2510 PRINT : PRINT"Start of Plateau measurement :";TIME$
2520 TT=PT*TI:PRINT CHR$(12);"      ***** Counting condition 1  Plateau measurem
ent *****":GOSUB 450:GOSUB 850
2530 PRINT"Impressed high voltage :";TAB(45);"Center Start    :    ";HS;"volts"
2540 PRINT TAB(45);:PRINT"Guard counter    :    ";GC;"volts"
2550 GOTO 870
2600 REM *** Print preset condition of Plateau to printer ***
2610 LPRINT:LPRINT"Start of Plateau measurement :";TIME$
2620 FOR A=1 TO 5:LPRINT:NEXT A:LPRINT"      ***** Counting condition 1  Plateau
 measurement *****":GOSUB 950
2630 LPRINT"Impressed high voltage :";TAB(45);"Center Start    :    ";HS;"volts"
2640 LPRINT TAB(45);:LPRINT"Guard counter    :    ";GC;"volts"
2650 GOTO 970
```

```
2660 REM **** AUTOMATIC VOLTAGE SETTING ****
2665 IF HC>5500 THEN HC=5500 ELSE IF HC<2000 THEN HC=2000
2667 GOSUB 450
2670 X=H-HC:IF X<0 THEN W=1 ELSE W=2
2680 X1=ABS(X):XP=INT(X1/.42):IF XP<256 THEN Y=XP:Z=0:GOTO 2700
2690 Z=INT(XP/256):IF Z>28 THEN Z=28
2695 Y=XP-256*Z
2700 OUT &HB1,Y:OUT &HB3,1:OUT &HB3,0:OUT &HB1,0
2710 OUT &HB1,Z:OUT &HB3,1:OUT &HB3,0:OUT &HB1,0
2720 OUT &HB3,1:OUT &HB3,0
2730 IF W=2 THEN 2750 ELSE 2740
2740 OUT &HB1,129:OUT &HB3,2:OUT &HB3,0:OUT &HB1,0:GOTO2760
2750 OUT &HB1,130:OUT &HB3,2:OUT &HB3,0:OUT &HB1,0
2760 OUT &HB1,4:OUT &HB3,2:OUT &HB3,0:OUT &HB1,0
2770 Q=INP(&HB2):IF(Q AND 4)<>0 THEN 2770
2775 GOSUB 450:K=INT(H-HC)
2778 IF K<-1 THEN 2670 ELSE IF K>1 THEN 2670 ELSE RETURN
2785 REM *** Save Plateau data ***
2790 K(NO)=AN/TI:L(NO)=CE/TI:M(NO)=H:NO=NO+1:RETURN
2800 REM *** Create of Plateau curve ***
2810 LPRINT:LPRINT TAB(7);"0";TAB(17);"50";TAB(27);"100";TAB(37);"150";TAB(47);"
200";TAB(57);"250";TAB(67);"300";TAB(77);"350":LPRINT TAB(7);"┌";:FOR A=1 TO 70:
LPRINT"─";:NEXT A:LPRINT:NO=0
2820 NO=NO+1: IF M(NO)=0 THEN 2840
2830 LPRINT TAB(7);"|":LPRINT" ";M(NO);TAB(7);"|";TAB(8+INT(L(NO)/5));"■":GOTO 2
820
2840 LPRINT:LPRINT:RETURN
2900 REM *** Decision of impress voltage for center counter ***
2910 HC=HZ:GOSUB 2660:GOSUB 2940:XA=XC:V1=H
2920 HC=HC+50:GOSUB 2660:GOSUB 2940,XB=XC:V2=H:IF XB>=CC*XT THEN 2930 ELSE XA=XB
:V1=V2:IF HC>4500 THEN RETURN ELSE GOTO 2920
2930 HC=INT(V1+(CC*XT-XA)/((XB-XA)/(V2-V1))+HB):LPRINT:LPRINT"A=";XA,"B=";XB,"V1
=";V1,"V2=";V2:LPRINT"High voltage center is";HC;"volts":GOTO 2660
2940 GOSUB 120:XT=TI:XC=CE:GOSUB 120:XT=XT+TI:XC=XC+CE:RETURN
3000 '──────────────────────────────────────────────────────────
3010 REM *** Beta rays counting ***
3020 PRINT CHR$(12),"***** BETA RAYS COUNTING *****"
3030 GOSUB 500:GOSUB 670:GOSUB 700:REM *** input parameter
3035 COLOR 7:CC=150:PRINT"Value of half count = ";CC;TAB(40);:INPUT"New data ";C
C:PRINT:INPUT"Do you want to check and reset impressed high voltage for centerco
unter through Beta rays counting (Y/N) ";R$
3040 PRINT CHR$(12);"        ***** Counting condition 2  Beta rays counting *****
"
3050 GOSUB 850:GOSUB 3900:REM *** print preset condition
3060 GOSUB 900:IF Z$="y" THEN 3020 ELSE IF Z$="Y" THEN 3020
3070 FOR A=1 TO 5:LPRINT:NEXT A:LPRINT"        ***** Counting condition 2  Beta r
ays counting *****"
3080 GOSUB 950:GOSUB 3990:REM *** print preset condition to printer
3085 GOSUB 2660
3100 REM *** Beta rays counting main routine ***
3110 ON ERROR GOTO 4340
3120 MOUNT 2:TM$=TIME$:RT=0 :NT=120
3125 TM$=TIME$:RT=0 :NT=120
3130 LPRINT:LPRINT"Start of Beta rays counting at ";TM$;" JST":LPRINT
3140 GOSUB 3520
3150 COLOR5:PRINT:PRINT"Start of Beta rays counting at ";TM$;" JST"
3160 COLOR7:CONSOLE 1,19,0,1:OPEN "2:"+F$ FOR OUTPUT AS #1
3170 PRINT #1,C$","DATE$","N$","P;T;TI;TP;TT;HC;GC;CH;AH;B;N
3180 NO=1:TI=0:AN=0:CE=0:H=0:P=0:T=0:TT=0:AT=0:CT=0:HT=0:PT=0:TE=0:AG$="":AX=0:C
X=0:HX=0:PX=0:TX=0:AJ=1000:CJ=10000:HJ=10000:PJ=1000:TJ=100:RA=0:RC=0:DA=0:DC=0:
FD=0:Q1=0:Q2=0:Q3=0:Q4=0:Q5=0
3190 GOSUB 120:'input measurement data
3200 TT=TT+TI:AT=AT+AN:CT=CT+CE:HT=HT+H:PT=PT+P:TE=TE+T:AM=AT/TT:CM=CT/TT:HM=HT/
NO:PM=PT/NO:TM=TE/NO:Q1=Q1+AN^2:Q2=Q2+CE^2:Q3=Q3+H^2:Q4=Q4+P^2:Q5=Q5+T^2:AZ=AN:C
Z=CE
```

```
3260 TC=AT:GOSUB 5340:'age calculation subroutine
3270 ON Y5 GOTO 3280,3290,3300:GOTO 3310
3280 AG$=" Over ":GOTO 3310
3290 AG$=" Modern":GOTO 3310
3300 AG$=STR$(Y2)
3310 PRINT #1,NO;IT;AN;CE;H;P;T;AM;AG$
3320 GOSUB 3370:IF R$="Y" THEN 3325 ELSE IF R$="Y" THEN 3325 ELSE 3330
3325 RT=RT+TI:IF RT>=NT THEN HZ=HC-330:LPRINT:LPRINT TIME$:GOSUB 2900:RT=0: NT=3
00
3330 NO=NO+1:IF NO<=PT THEN 3190 ELSE COLOR5
3340 GOSUB 3570:WIDTH 80,20:CONSOLE 0,19,1,1:ERASE A,C:GOTO 5040
3350 PRINT CHR$(12):IF OF=0 THEN GOSUB 2500:HC=HS:GOSUB 2660:GOSUB 2243:HC=2000:
GOSUB 2660:GOSUB 8000
3360 REM *** Calculate of max.,min.,data and print input data
3370 IF AN>AX THEN AX=AN
3380 IF CE>CX THEN CX=CE
3390 IF H>HX THEN HX=H
3400 IF P>PX  THEN PX=P
3410 IF T>TX  THEN TX=T
3420 IF AN<AJ THEN AJ=AN
3430 IF CE<CJ THEN CJ=CE
3440 IF H<HJ THEN HJ=H
3450 IF P<PJ  THEN PJ=P
3460 IF T<TJ  THEN TJ=T
3470 PRINT:PRINT NO;TAB(7);TI;TAB(13);AN;TAB(21);CE;TAB(31);H;TAB(41);P;TAB(50);
T;TAB(58):PRINT USING"##.###"; AM;:PRINT TAB(68);AG$
3480 LPRINT:LPRINT NO;TAB(7);TI;TAB(13);AN;TAB(21);CE;TAB(31);H;TAB(41);P;TAB(50
);T;TAB(58);:LPRINT USING"##.###"; AM;:LPRINT TAB(68);AG$
3490 RETURN
3500 REM
3510 REM *** print out header of table
3520 PRINT CHR$(12);" No.    Time  Anti      Cent       H.V.      Press.    Temp.    A
nti mean    Age"
3525 PRINT:PRINT"-------------------------------------------------------------------
-------------"
3530 LPRINT" No.    Time  Anti      Cent       H.V.      Press.    Temp.    Anti mean
  Age"
3535 LPRINT:LPRINT"-------------------------------------------------------------------
-------------"
3540 RETURN
3560 REM *** Print out data of compile statistics ***
3570 CLOSE
3575 PRINT:PRINT"-------------------------------------------------------------------
-------------"
3580 LPRINT:LPRINT"-------------------------------------------------------------------
-------------"
3590 PRINT:PRINT"Total";TAB(7);TT;TAB(13);AT;TAB(21);CT;TAB(31);HT;TAB(41);PT;TA
B(50);TE
3600 LPRINT:LPRINT"Total";TAB(7);TT;TAB(13);AT;TAB(21);CT;TAB(31);HT;TAB(41);PT;
TAB(50);TE
3605 AM=AT/TP:CM=CT/TP
3610 PRINT"Mean";TAB(13);:PRINT USING"###.###";AM;:PRINT TAB(22);:PRINT USING"##
##.###";CM;:PRINT TAB(32);:PRINT USING"####.#";HM;
3620 PRINT TAB(42);:PRINT USING"###.#";PM;:PRINT TAB(51);:PRINT USING"##.#";TM
3630 LPRINT"Mean";TAB(13);:LPRINT USING"###.###";AM;:LPRINT TAB(22);:LPRINT USIN
G"####.###";CM;:LPRINT TAB(32);:LPRINT USING"####.#";HM;
3640 LPRINT TAB(42);:LPRINT USING"###.#";PM;:LPRINT TAB(51);:LPRINT USING"##.#";
TM
3650 PRINT"Maximum";TAB(13);AX;TAB(21);CX;TAB(31);HX;TAB(41);PX;TAB(50);TX
3660 LPRINT"Maximum";TAB(13);AX;TAB(21);CX;TAB(31);HX;TAB(41);PX;TAB(50);TX
3670 PRINT"Minimum";TAB(13);AJ;TAB(21);CJ;TAB(31);HJ;TAB(41);PJ;TAB(50);TJ
3680 LPRINT"Minimum";TAB(13);AJ;TAB(21);CJ;TAB(31);HJ;TAB(41);PJ;TAB(50);TJ
3690 AR=AX-AJ:CR=CX-CJ:HR=HX-HJ:PR=PX-PJ:TR=TX-TJ
3700 PRINT"Range";TAB(13);AR;TAB(21);CR;TAB(31);HR;TAB(41);PR;TAB(50);TR
3710 LPRINT"Range";TAB(13);AR;TAB(21);CR;TAB(31);HR;TAB(41);PR;TAB(50);TR
3720 X=Q1:M=AM:Z=TT:GOSUB 4190:AV=V:AD=D:AF=F:A2=D2
3730 X=Q2:M=CM:Z=TT:GOSUB 4190:CV=V:CD=D:CF=F:C2=D2
3735 AM=AT/TT:CM=CT/TT:NO=NO-1
3740 X=Q3:M=HM:Z=NO:GOSUB 4190:HV=V:HD=D:HF=F:H2=D2
3750 X=Q4:M=PM:Z=NO:GOSUB 4190:PV=V:PD=D:PF=F:P2=D2
3760 X=Q5:M=TM:Z=NO:GOSUB 4190:TV=V:TD=D:TF=F:T2=D2
3765 NO=NO+1
3770 PRINT"Variance";TAB(11);:PRINT;AV;TAB(21);:PRINT;CV;TAB(31);:PRINT;HV;TAB(4
1);:PRINT;PV;TAB(51);:PRINT;TV
3780 LPRINT"Variance";TAB(11);:LPRINT;AV;TAB(21);:LPRINT;CV;TAB(31);:LPRINT;HV;T
AB(41);:LPRINT;PV;TAB(51);:LPRINT;TV
3790 PRINT"S.D.1";TAB(11);AD;TAB(20);CD;TAB(30);HD;TAB(40);PD;TAB(50);TD
3800 LPRINT"S.D.1";TAB(11);AD;TAB(20);CD;TAB(30);HD;TAB(40);PD;TAB(50);TD
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```
3810 PRINT"Fluctuation";TAB(11);AF;TAB(20);CF;TAB(30);HF;TAB(40);PF;TAB(50);TF
3820 LPRINT"Fluctuation";TAB(11);AF;TAB(20);CF;TAB(30);HF;TAB(40);PF;TAB(50);TF
3830 PRINT"S.D.2";TAB(11);A2;TAB(20);C2;TAB(30);H2;TAB(40);P2;TAB(50);T2
3840 LPRINT"S.D.2";TAB(11);A2;TAB(20);C2;TAB(30);H2;TAB(40);P2;TAB(50);T2
3850 WIDTH 80,25:CONSOLE 0,25,0,1:GOSUB 4240:'histgram display
3870 P=PM:T=TM
3880 RETURN
3900 REM *** Print preset condition of Beta rays count ***
3910 PRINT"Time interval          :      ";TI;"minutes";TAB(45);"Preset time
:     ";TP;"times"
3920 TT=TI*TP:PRINT"Total time              :   ";TT;"minutes"
3930 PRINT"Impressed high voltage :";TAB(45);"Center counter   :    ";HC;"volts"
3940 PRINT TAB(45);:PRINT"Guard counter    :    ";GC;"volts"
3950 PRINT"Histgram range          :      ";TAB(45);"Center           :      ";CH;"
counts"
3960 PRINT TAB(45);"Anti             :       ";AH;"counts"
3970 RETURN
3990 REM *** Print preset condition of Beta rays count to printer ***
4000 LPRINT"Time interval          :      ";TI;"minutes";TAB(45);"Preset time
 :     ";TP;"times"
4010 LPRINT"Total time             :   ";TT;"minutes"
4020 LPRINT"Impressed high voltage :";TAB(45);"Center counter   :    ";HC;"volts"
4030 LPRINT TAB(45);:PRINT"Guard counter    :    ";GC;"volts"
4040 LPRINT"Histgram range          :      ";TAB(45);"Center           :      ";CH;
"counts"
4050 LPRINT TAB(45);"Anti             :       ";AH;"counts"
4060 RETURN
4080 REM *** Histgram data storage ***
4090 IF RA<AZ THEN 4100 ELSE IF RA>AZ THEN 4110 ELSE 4120
4100 RA=RA+AH:DA=DA+1:IF RA>=AZ THEN 4090 ELSE 4100
4110 RA=RA-AH:DA=DA-1:IF RA<=AZ THEN 4120 ELSE 4110
4120 A(DA)=A(DA)+1
4130 IF RC<CZ THEN 4140 ELSE IF RC>CZ THEN 4150 ELSE 4160
4140 RC=RC+CH:DC=DC+1:IF RC>=CZ THEN 4130 ELSE 4140
4150 RC=RC-CH:DC=DC-1:IF RC<=CZ THEN 4160 ELSE 4150
4160 C(DC)=C(DC)+1:RETURN
4180 REM *** Calculation of compile statistics ***
4185 PT=NO
4190 V=X/TP-(M*M)
4200 D=SQR(V)
4210 F=D/M*100
4220 Z=NO:D2=D/Z:RETURN
4240 REM *** Histgram creation and display ***
4250 DIM A(INT((AX-AJ)/AH+2)):DIM C(INT((CX-CJ)/CH+2)):DA=1:DC=1:RA=INT(AJ/AH)*A
H:RC=INT(CJ/CH)*CH:OPEN"2:"+F$ FOR INPUT AS #1:INPUT #1,X$,Y$,Z$:FOR X=1 TO 11 :
INPUT #1,Y:NEXT
4255 INPUT #1,Z1,Z2,AZ,CZ,Z3,Z4,Z5,Z6,Z7$ : GOSUB 4080 : IF EOF(1) THEN 4258 ELS
E 4255
4258 RA=AJ:RC=CJ:CLOSE:REMOVE 2
4260 PRINT:PRINT"***** Histgram (anti) *****":PRINT
4270 LPRINT:LPRINT"***** Histgram (anti) *****":LPRINT
4280 FOR A=1 TO INT(AX/AH-AJ/AH)+1:X=A(A):PRINT RA;X;:LPRINT RA;X;:GOSUB 4320:RA
=RA+AH:NEXT A
4290 PRINT:PRINT"***** Histgram (center) *****":PRINT
4300 LPRINT:LPRINT"***** Histgram (center) *****":LPRINT
4310 FOR A=1 TO INT(CX/CH-CJ/CH)+1:X=C(A):PRINT RC;X;:LPRINT RC;X;:GOSUB 4320:RC
=RC+CH:NEXT A:RETURN
4320 PRINT TAB(11);:LPRINT TAB(11);:IF X=0 THEN PRINT:LPRINT:RETURN
4330 FOR Y=1 TO X STEP 1:PRINT"■";:LPRINT"■";:NEXT Y:PRINT:LPRINT:RETURN
4340 IF ERL=3120 THEN PRINT"Disk is mounted":RESUME 3125 ELSE IF ERL=3160 THEN M
OUNT 2:RESUME 3160 ELSE PRINT:PRINT"Error ";ERR:RESUME NEXT
5000 '------------------------------------------------------------------------
5010 REM *** Radiocarbon age calculation ***
5020 OF=1:PRINT CHR$(12),"***** RADIOCARBON AGE CALCULATION *****"
5030 TT=PT*TI:GOSUB 500:GOSUB 800:REM *** input parameter
5040 PRINT CHR$(12);"          ***** Radiocarbon Age Calculation *****"
5050 GOSUB 850:GOSUB 870:GOSUB 900:REM *** print preset condition
5060 IF Z$="y" THEN 5020 ELSE IF Z$="Y" THEN 5020
5070 FOR A=1 TO 5:LPRINT:NEXT A:LPRINT"          ***** Radiocarbon Age Calculati
on *****"
```

```
5080 GOSUB 950:GOSUB 970:'print preset condition to printer
5090 GOSUB 5340:REM *** age calculation subr.
5100 COLOR5:PRINT:PRINT"*** Counting rate ( Adjusted reading ) ***"
5110 LPRINT:LPRINT"*** Counting rate ( Adjusted reading ) ***"
5120 PRINT:PRINT"Sample                    : ";:PRINT USING"##.###";S;:PRINT" c.p.m
.";:PRINT TAB(45);:PRINT"1 sigma          :     ";:PRINT USING"#.###";SI;:PRINT" c
.p.m."
5130 LPRINT:LPRINT"Sample                   : ";:LPRINT USING"##.###";S;:LPRINT" c
.p.m.";:LPRINT TAB(45);:LPRINT "1 sigma          :     ";:LPRINT USING"#.###";SI;:
LPRINT" c.p.m."
5140 PRINT"N.B.S. (95%)             : ";:PRINT USING"##.###";N9;:PRINT" c.p.m."
5150 LPRINT"N.B.S. (95%)             : ";:LPRINT USING"##.###";N9;:LPRINT" c.p.m."
5160 COLOR7:PRINT:PRINT"*** Radiocarbon age of the sample ***":PRINT
5170 LPRINT:LPRINT"*** Radiocarbon age of the sample ***":LPRINT
5180 PRINT TAB(32);"+";X2
5190 LPRINT TAB(32);"+";X2
5200 PRINT TAB(6);C$;" :";TAB(26);Y2;TAB(38);"Y BP";TAB(50);:IF Y5=1 THEN PRINT"
Older than ' Tmax '" ELSE IF Y5=2 THEN PRINT"Modern" ELSE PRINT
5210 LPRINT TAB(6);C$;" :";TAB(26);Y2;TAB(38);"Y BP";TAB(50);:IF Y5=1 THEN LPRIN
T"Older than ' Tmax '" ELSE IF Y5=2 THEN LPRINT"Modern" ELSE LPRINT
5220 PRINT TAB(32);"-";Z2
5230 LPRINT TAB(32);"-";Z2
5240 PRINT TAB(50);"Tmax =";INT(MAX);" Y BP"
5250 LPRINT TAB(50);"Tmax =";INT(MAX);" Y BP"
5260 PRINT TAB(26);Y4;"Y ";:IF Y3<0 THEN PRINT"AD"; ELSE IF Y3>=0 THEN PRINT"BC"
;
5270 LPRINT TAB(26);Y4;"Y ";:IF Y3<0 THEN LPRINT"AD"; ELSE IF Y3>=0 THEN LPRINT"
BC";
5280 PRINT TAB(50);"Tmin =";INT(MIN);" Y BP"
5290 LPRINT TAB(50);"Tmin =";INT(MIN);" Y BP"
5300 FOR A=1 TO 10:LPRINT:NEXT A
5320 PRINT CHR$(12):IF OF=1 THEN GOSUB 1000 ELSE GOSUB 2500:HC=HS:GOSUB 2660:GOS
UB 2243:HC=2000:GOSUB 2660
5325 RETURN
5330 RETURN
5340 REM *** Radiocarbon age calculation subroutine ***
5350 S=TC/TT:SI=SQR(SQR(TC)/TT*SQR(TC)/TT+SQR(B*TT)/TT*SQR(B*TT)/TT):N9=((N-B)/7
60*P*273/(273+T))*.95+B
5360 X=S+SI:Y=S-SI:Z=5570/LOG(2)
5370 X1=Z*LOG((X-B)/(N9-B)):Y1=Z*LOG((S-B)/(N9-B)):Z1=Z*LOG((Y-B)/(N9-B))
5380 X2=INT(ABS(Z1-Y1)):V=X2:GOSUB 5480:X2=W
5390 Y2=INT(ABS(Y1)):V=Y2:GOSUB 5480:Y2=W
5400 Z2=INT(ABS(Y1-X1)):V=Z2:GOSUB 5480:Z2=W
5410 Y3=ABS(Y1)-1950:Y4=INT(ABS(Y3)):V=Y4:GOSUB 5480:Y4=W
5420 MAX=Z*LOG(N9*SQR(TT)/SQR(8*B))
5430 MIN=Z*LOG((N9-B)/((N9-(2*SQR(N9/TT)))-B))
5440 IF Y2 >= MAX THEN Y5=1 ELSE IF Y2 <= MIN THEN Y5=2 ELSE Y5=3
5450 V=MAX:GOSUB 5480:MAX=W
5460 V=MIN:GOSUB 5480:MIN=W:RETURN
5480 REM *** Round off the fractions to one digit places ***
5490 V1=V/10:V2=INT(V1):V3=V1-V2
5500 IF V3>=.5 THEN 5510 ELSE W=V2*10:RETURN
5510 W=(V2+1)*10:RETURN
6000 '-------------------------------------------------------------------------
6010 REM *** Data file maintenance of Beta rays count ***
6020 MOUNT 1
6030 RUN"MTN"
7000 REMOVE 1,2
7010 PRINT"OK! DISK IS REMOVED "
7020 END
8000 '-------------------------------------------------------------------------
8010 REMOVE:RN=6:RL=1:GOSUB 1800:'HV off
8020 PRINT CHR$(12):PRINT :PRINT
8050 PRINT :PRINT "Just now, dating has ended and power supply of high voltage h
as turned off!    Change your sample carefully!"
8060 PRINT :PRINT :PRINT "After setting new sample, then hit STOP key and push f
.5 key!"
8070 FOR I=1 TO 10000:NEXT I:GOTO 8020
9999 SAVE"C-14":FILES:REMOVE 2
```

Program 3. Data File Maintenance Program (MTN).

```
10 REM  ************************************************************
20 REM  *    Data File Maintenance Program          v-1.5      *
30 REM  *       For Radiocarbon Dating                          *     "MTN"
40 REM  *                                                       *
50 REM  *                Programed by Dr.K.Omoto  NOV.15.1980 *     82/4/29
60 REM  *                Modified                 Feb.25,1981 *
65 REM  *                                         Mar.11,1981 *
70 REM  ************************************************************
80 REM
90 PRINT CHR$(12);:CONSOLE 0,19,1,1:WIDTH 80,20:COLOR 5
100 GOTO 6000
840 REM
850 REM *** Preset condition print out to screen ***
860 PRINT:PRINT"Code No.: ";C$;TAB(25);"Date : ";D$;TAB(50);"Operator : ";N$
865 PRINT:PRINT"*** Preset condition ***":PRINT:PRINT"Pressure          :";:PRIN
T TAB(21);:PRINT USING"###.###";P;:PRINT" mmHg";:PRINT TAB(40);:PRINT"Temperatur
e    :    ";:PRINT USING"##.###";T;:PRINT" deg.C.":RETURN
870 PRINT"Total time        :    ";TT;"minuts";TAB(40);"Total counts    :    "TC;
"counts."
880 PRINT"Background        :     ";B;"c.p.m.";TAB(40);"N.B.S.          :    ";N;"
c.p.m.":RETURN
890 REM
900 REM *** Ask preset data change ***
910 PRINT:COLOR6:PRINT"Do you want to change the preset data ? (Y/N) ";
920 FOR X=1 TO 4000:Z$=INKEY$:IF Z$="" THEN NEXT X
930 PRINT Z$:COLOR4:RETURN
940 REM
950 REM *** Preset condition print out to printer ***
960 LPRINT:LPRINT"Code No.: ";C$;TAB(25);"Date : ";D$;TAB(50);"Operator : ";N$
965 LPRINT:LPRINT"*** Preset condition ***":LPRINT:LPRINT"Pressure          :";:
LPRINT TAB(21);:LPRINT USING"###.###";P;:LPRINT" mmHg";:LPRINT TAB(40);:LPRINT"T
emperature    :    ";:LPRINT USING"##.###";T;:LPRINT" deg.C.":RETURN
970 LPRINT"Total time        :    ";TT;"minuts";TAB(40);"Total counts    :    "TC
;"counts."
980 LPRINT"Background        :     ";B;"c.p.m.";TAB(40);"N.B.S.          :    ";N;
"c.p.m.":RETURN
3350 REM
3360 REM *** Calculate of max.,min.,data and print input data
3370 IF AN>AX THEN AX=AN
3380 IF CE>CX THEN CX=CE
3390 IF H>HX THEN HX=H
3400 IF P>PX  THEN PX=P
3410 IF T>TX  THEN TX=T
3420 IF AN<AJ THEN AJ=AN
3430 IF CE<CJ THEN CJ=CE
3440 IF H<HJ THEN HJ=H
3450 IF P<PJ  THEN PJ=P
3460 IF T<TJ  THEN TJ=T
3470 PRINT NO;TAB(7);TI;TAB(13);AN;TAB(21);CE;TAB(31);H;TAB(41);P;TAB(50);T;TAB(
58);:PRINT USING "##.###";AM;:PRINT TAB(68);AG$
3480 LPRINT NO;TAB(7);TI;TAB(13);AN;TAB(21);CE;TAB(31);H;TAB(41);P;TAB(50);T;TAB
(58);:LPRINT USING "##.###";AM;:LPRINT TAB(68);AG$
3490 RETURN
3500 REM
3510 REM *** print out header of table
3520 PRINT CHR$(12);" No.   Time  Anti      Cent       H.V.      Press.    Temp.    A
nti mean    Age"
3525 PRINT"-------------------------------------------------------------------------
---------":PRINT
3530 LPRINT" No.   Time  Anti      Cent       H.V.      Press.    Temp.    Anti mean
  Age"
3535 LPRINT"-------------------------------------------------------------------------
---------":LPRINT
3540 RETURN
3550 REM
3560 REM *** Print out data of compile statistics ***
3570 CLOSE:REMOVE 2
3575 PRINT:PRINT"-------------------------------------------------------------------
-----------"
3580 LPRINT:LPRINT"-----------------------------------------------------------------
-----------"
```

```
3590 PRINT:PRINT"Total";TAB(7);TT;TAB(13);AT;TAB(21);CT;TAB(31);HT;TAB(41);PP;TA
B(50);TE;TAB(58);:PRINT USING "##.###";AM
3600 LPRINT:LPRINT"Total";TAB(7);TT;TAB(13);AT;TAB(21);CT;TAB(31);HT;TAB(41);PP;
TAB(50);TE;TAB(58);:LPRINT USING "##.###";AM
3610 PRINT"Mean";TAB(13);:PRINT USING"##.###";AM;:PRINT TAB(22);:PRINT USING"###
.###";CM;:PRINT TAB(32);:PRINT USING"####.#";HM;
3620 PRINT TAB(42);:PRINT USING"###.#";PM;:PRINT TAB(51);:PRINT USING"##.#";TM;:
PRINT TAB(58);:PRINT USING"##.###";AM
3630 LPRINT"Mean";TAB(13);:LPRINT USING"##.###";AM;:LPRINT TAB(22);:LPRINT USING
"###.###";CM;:LPRINT TAB(32);:LPRINT USING"####.#";HM;
3640 LPRINT TAB(42);:LPRINT USING"###.#";PM;:LPRINT TAB(51);:LPRINT USING"##.#";
TM;:LPRINT TAB(58);:LPRINT USING"##.###";AM
3650 PRINT"Maximum";TAB(13);AX;TAB(21);CX;TAB(31);HX;TAB(41);PX;TAB(50);TX
3660 LPRINT"Maximum";TAB(13);AX;TAB(21);CX;TAB(31);HX;TAB(41);PX;TAB(50);TX
3670 PRINT"Minimum";TAB(13);AJ;TAB(21);CJ;TAB(31);HJ;TAB(41);PJ;TAB(50);TJ
3680 LPRINT"Minimum";TAB(13);AJ;TAB(21);CJ;TAB(31);HJ;TAB(41);PJ;TAB(50);TJ
3690 AR=AX-AJ:CR=CX-CJ:HR=HX-HJ:PR=PX-PJ:TR=TX-TJ
3700 PRINT"Range";TAB(13);AR;TAB(21);CR;TAB(31);HR;TAB(41);PR;TAB(50);TR
3710 LPRINT"Range";TAB(13);AR;TAB(21);CR;TAB(31);HR;TAB(41);PR;TAB(50);TR
3720 X=AT:M=AM:Z=TT:GOSUB 4190:AV=V:AD=D:AF=F:A2=D2
3730 X=CT:M=CM:Z=TT:GOSUB 4190:CV=V:CD=D:CF=F:C2=D2
3740 X=HT:M=HM:Z=NO:GOSUB 4190:HV=V:HD=D:HF=F:H2=D2
3750 X=PP:M=PM:Z=NO:GOSUB 4190:PV=V:PD=D:PF=F:P2=D2
3760 X=TE:M=TM:Z=NO:GOSUB 4190:TV=V:TD=D:TF=F:T2=D2
3770 PRINT"Variance";TAB(11);:PRINT USING"#.###^^^^";AV;:PRINT TAB(21);:PRINT US
ING"#.###^^^^";CV;:PRINT TAB(31);:PRINT USING"#.###^^^^";HV;:PRINT TAB(41);:PRIN
T USING"#.###^^^^";PV;:PRINT TAB(51);:PRINT USING"#.###^^^^";TV
3780 LPRINT"Variance";TAB(11);:LPRINT USING"#.###^^^^";AV;:LPRINT TAB(21);:LPRIN
T USING"#.###^^^^";CV;:LPRINT TAB(31);:LPRINT USING"#.###^^^^";HV;:LPRINT TAB(41
);:LPRINT USING"#.###^^^^";PV;:LPRINT TAB(51);:LPRINT USING"#.###^^^^";TV
3790 PRINT"S.D.1";TAB(11);AD;TAB(20);CD;TAB(30);HD;TAB(40);PD;TAB(50);TD
3800 LPRINT"S.D.1";TAB(11);AD;TAB(20);CD;TAB(30);HD;TAB(40);PD;TAB(50);TD
3810 PRINT"Fluctuation";TAB(11);AF;TAB(20);CF;TAB(30);HF;TAB(40);PF;TAB(50);TA
3820 LPRINT"Fluctuation";TAB(11);AF;TAB(20);CF;TAB(30);HF;TAB(40);PF;TAB(50);TA
3830 PRINT"S.D.2";TAB(11);A2;TAB(20);C2;TAB(30);H2;TAB(40);P2;TAB(50);T2
3840 LPRINT"S.D.2";TAB(11);A2;TAB(20);C2;TAB(30);H2;TAB(40);P2;TAB(50);T2
3850 WIDTH 80,25:CONSOLE 0,25,0,1:GOSUB 4230:REM *** histgram display
3860 FOR A=1 TO 2000:IF INKEY$="" THEN NEXT A
3870 P=PM:T=TM
3880 RETURN
3890 REM
3900 REM *** Print preset condition of Beta rays count ***
3910 PRINT"Time interval      :        ";TI;"minutes";TAB(40);"Preset time     :
   ";PT;"times"
3920 PRINT"Total time         :     ";TT;"minutes"
3930 PRINT"Impressed voltage :    ";TAB(40);"Center counter :      ";HC;"volts"
3940 PRINT TAB(40);"Guard counter  :      ";GC;"volts"
3950 PRINT"Histgram range     : ";TAB(40);"Center          :        ";CH;"counts
3960 PRINT TAB(40);"Anti            :         ";AH;"counts"
3970 GOTO 880
3980 REM
3990 REM *** Print preset condition of Beta rays count to printer ***
4000 LPRINT"Time interval      :        ";TI;"minutes";TAB(40);"Preset time     :
    ";PT;"times"
4010 LPRINT"Total time         :     ";TT;"minutes"
4020 LPRINT"Impressed voltage :    ";TAB(40);"Center counter :      ";HC;"volts"
4030 LPRINT TAB(40);"Guard counter  :      ";GC;"volts"
4040 LPRINT"Histgram range     : ";TAB(40);"Center          :        ";CH;"counts
4050 LPRINT TAB(40);"Anti            :         ";AH;"counts"
4060 GOTO 980
4070 REM
4080 REM *** Histgram data storage ***
4090 IF RA<AN THEN 4100 ELSE IF RA>AN THEN 4110 ELSE 4120
4100 RA=RA+AH:DA=DA+1:IF RA>=AN THEN 4090 ELSE 4100
4110 RA=RA-AH:DA=DA-1:IF RA<=AN THEN 4120 ELSE 4110
4120 A(DA)=A(DA)+1
4130 IF RC<CE THEN 4140 ELSE IF RC>CE THEN 4150 ELSE 4160
4140 RC=RC+CH:DC=DC+1:IF RC>=CE THEN 4130 ELSE 4140
4150 RC=RC-CH:DC=DC-1:IF RC<=CE THEN 4160 ELSE 4150
4160 C(DC)=C(DC)+1:RETURN
4170 REM
```

```
4180 REM *** Calculation of compile statistics ***
4190 PT=NO:V=(X/PT)-(M*M)
4200 IF V<0 THEN V=ABS(V):D=SQR(V)
4210 F=D/M*100
4220 Z=NO:D2=D/Z:RETURN
4230 REM
4240 REM *** Histgram creation and display ***
4250 DA=INT(AJ/AH):DC=INT(CJ/CH):RA=DA*AH:RC=DC*CH
4260 PRINT:PRINT"***** Histgram (anti) *****":PRINT
4270 LPRINT:LPRINT"***** Histgram (anti) *****":LPRINT
4280 FOR A=DA TO AX/AH:X=A(A):PRINT RA;X;:LPRINT RA;X;:GOSUB 4320:RA=RA+AH:NEXT
A
4290 PRINT:PRINT"***** Histgram (center) *****":PRINT
4300 LPRINT:LPRINT"***** Histgram (center) *****":LPRINT
4310 FOR A=DC TO CX/CH:X=C(A):PRINT RC;X;:LPRINT RC;X;:GOSUB 4320:RC=RC+CH:NEXT
A:RETURN
4320 PRINT TAB(11);:LPRINT TAB(11);:IF X=0 THEN PRINT:LPRINT:RETURN
4330 FOR Y=1 TO X STEP 1:PRINT"■";:LPRINT"■";:NEXT Y:PRINT:LPRINT:RETURN
4340 IF ERL=3120 THEN PRINT"Disk is mounted":RESUME 3130 ELSE IF ERL=3150 THEN M
OUNT 2:RESUME 3160 ELSE PRINT:PRINT"Error ";ERR:RESUME NEXT
5000 REM
5010 REM *** Radiocarbon age calculation ***
5020 PRINT CHR$(12),"***** RADIOCARBON AGE CALCULATION *****"
5030 TT=PT*TI:GOSUB 500:GOSUB 790:REM *** input parameter
5040 PRINT CHR$(12);"          ***** Radiocarbon Age Calculation *****"
5050 GOSUB 840:GOSUB 870:GOSUB 890:REM *** print preset condition
5060 IF Z$="y" THEN 5020 ELSE IF Z$="Y" THEN 5020
5070 FOR A=1 TO 5:LPRINT:NEXT A:LPRINT"          ***** Radiocarbon Age Calculati
on *****"
5080 GOSUB 940:GOSUB 970:REM *** print preset condition to printer
5090 GOSUB 5330:REM *** age calculation subr.
5100 COLOR5:PRINT:PRINT"*** Counting rate ( Adjusted reading ) ***"
5110 LPRINT:LPRINT"*** Counting rate ( Adjusted reading ) ***"
5120 PRINT:PRINT"Sample          :   ";:PRINT USING"##.###";S;:PRINT" c.p.m.";
TAB(40);"1 sigma      :     ";:PRINT USING"#.###";SI;:PRINT" c.p.m."
5130 LPRINT:LPRINT"Sample          :   ";:LPRINT USING"##.###";S;:LPRINT" c..m
.";TAB(40);"1 sigma      :     ";:LPRINT USING"#.###";SI;:LPRINT" c.p.m."
5140 PRINT"N.B.S. (95%)      :   ";:PRINT USING"##.###";N9;:PRINT" c.p.m."
5150 LPRINT"N.B.S. (95%)      :   ";:LPRINT USING"##.###";N9;:LPRINT" c.p.m."
5160 COLOR7:PRINT:PRINT"*** Radiocarbon age of the sample ***":PRINT
5170 LPRINT:LPRINT"*** Radiocarbon age of the sample ***":LPRINT
5180 PRINT TAB(32);"+";X2
5190 LPRINT TAB(32);"+";X2
5200 PRINT TAB(6);C$;" :";TAB(26);Y2;TAB(38);"Y BP";TAB(50);:IF Y5=1 THEN PRINT"
Older than ' Tmax '" ELSE IF Y5=2 THEN PRINT"Modern" ELSE PRINT
5210 LPRINT TAB(6);C$;" :";TAB(26);Y2;TAB(38);"Y BP";TAB(50);:IF Y5=1 THEN LPRIN
T"Older than ' Tmax '" ELSE IF Y5=2 THEN LPRINT"Modern" ELSE LPRINT
5220 PRINT TAB(32);"-";Z2
5230 LPRINT TAB(32);"-";Z2
5240 PRINT TAB(50);"Tmax =";INT(MAX);" Y BP"
5250 LPRINT TAB(50);"Tmax =";INT(MAX);" Y BP"
5260 PRINT TAB(26);Y4;"Y ";:IF Y3<0 THEN PRINT"AD"; ELSE IF Y3>=0 THEN PRINT"BC"
;
5270 LPRINT TAB(26);Y4;"Y ";:IF Y3<0 THEN LPRINT"AD"; ELSE IF Y3>=0 THEN LPRINT"
BC";
5280 PRINT TAB(50);"Tmin =";INT(MIN);"    Y BP"
5290 LPRINT TAB(50);"Tmin =";INT(MIN);"    Y BP"
5300 FOR A=1 TO 10:LPRINT:NEXT A
5310 FOR A=1 TO 2000:IF INKEY$="" THEN NEXT A
5320 PRINT CHR$(12):RUN"RCD"
5330 REM
5340 REM *** Radiocarbon age calculation subroutine ***
5350 S=TC/TT:SI=SQR(TC)/TT:N9=((N-B)/760*P*273/(273+T))*.95+B
5360 X=S+SI:Y=S-SI:Z=5570/LOG(2)
5370 X1=Z*LOG((X-B)/(N9-B)):Y1=Z*LOG((S-B)/(N9-B)):Z1=Z*LOG((Y-B)/(N9-B))
5380 X2=INT(ABS(Z1-Y1)):V=X2:GOSUB 5470:X2=W
5390 Y2=INT(ABS(Y1)):V=Y2:GOSUB 5470:Y2=W
5400 Z2=INT(ABS(Y1-X1)):V=Z2:GOSUB 5470:Z2=W
5410 Y3=ABS(Y1)-1950:Y4=INT(ABS(Y3)):V=Y4:GOSUB 5470:Y4=W
5420 MAX=Z*LOG(N9*SQR(TT)/SQR(8*B))
5430 MIN=Z*LOG((N9-B)/((N9-(2*SQR(N9/1000)))-B))
5440 IF Y2 >= MAX THEN Y5=1 ELSE IF Y2 <= MIN THEN Y5=2 ELSE Y5=3
5450 V=MAX:GOSUB 5470:MAX=W
5460 V=MIN:GOSUB 5470:MIN=W:RETURN
```

```
5470 REM
5480 REM *** Round off the fractions to one digit places ***
5490 V1=V/10:V2=INT(V1):V3=V1-V2
5500 IF V3>=.5 THEN 5510 ELSE W=V2*10:RETURN
5510 W=(V2+1)*10:RETURN
6000 REM
6010 REM *** Data file maintenance of Beta rays count ***
6020 PRINT CHR$(12);"       ***** Data file maintenance of Beta rays counting **
***"
6030 ON ERROR GOTO 6320
6040 MOUNT 2
6050 PRINT:COLOR 6:INPUT"Data file's name ";F$
6060 OPEN "2:"+F$ FOR INPUT AS #1
6070 INPUT #1,C$,D$,N$,P,T,TI,PT,TT,HC,GC,CH,AH,B,N
6080 COLOR 4
6090 PRINT:PRINT"Code No.: ";C$;TAB(25);"Date : ";D$;TAB(50);"Operator : ";N$:PR
INT:PRINT"*** Preset condition ***":PRINT:PRINT"Pressure          :    ";P;" mmHg
";TAB(40);"Temperature    :      ";T;" deg.C."
6100 GOSUB 3910:REM *** print preset condition
6110 FOR A=1 TO 5:LPRINT:NEXT A
6120 LPRINT"       ***** Data file maintenance of Beta rays counting *****"
6130 GOSUB 940:GOSUB 3980:REM *** print preset condition to printer
6140 REM
6150 REM *** File maintenance of Beta rays count main ***
6160 LPRINT:GOSUB 3520
6170 COLOR7:CONSOLE 1,19,0,1
6180 NO=1:IT=0:AN=0:CE=0:H=0:TT=0:AT=0:CT=0:HT=0:PP=0:TE=0:AG$="":AX=0:PX=0:TX=0
:AJ=1000:CJ=10000:HJ=10000:PJ=1000:TJ=100:RA=0:RC=0:DA=0:DC=0:FD=0
6190 IF EOF(1) THEN 6290
6200 INPUT #1,NO,TI,AN,CE,H,P,T,AM,AG$
6210 TT=TT+TI:AT=AT+AN:CT=CT+CE:HT=HT+H:PT=PT+P:TE=TE+T:AM=AT/TT:CM=CT/TT:HM=H/N
O:PM=PT/NO:TM=TE/NO
6220 IF FD<>0 THEN 6260:REM *** If FD=0 Do histgram data area initial
6230 DIM A(2*AN/AH):DIM C(2*CE/CH):FD=1
6240 IF RA>AN THEN RA=RA-AH:DA=DA-1 ELSE RA=RA+AH:DA=DA+1:GOTO 6240
6250 IF RC>CE THEN RC=RC-CH:DC=DC-1 ELSE RC=RC+CH:DC=DC+1:GOTO 6250
6260 GOSUB 4070:REM *** store histgram data
6270 GOSUB 3370
6280 GOTO 6190
6290 COLOR5
6300 GOSUB 3570:REM *** Print out value of compile statistics
6310 WIDTH 80,20:CONSOLE 0,19,1,1:P=PM:T=TM:TC=AT:ERASE A,C:GOTO 5040
6320 IF ERL=6040 THEN PRINT"Disk is mounted":RESUME 6050 ELSE IF ERL=6060 THEN M
OUNT 2:RESUME 6060 ELSE PRINT:PRINT"Error ";ERR:RESUME NEXT
7020 END
```