BIOPLUS—AN ECLECTIC LABORATORY INFORMATION MANAGEMENT SYSTEM FOR THE ORNL RADIOBIOASSAY LABORATORY

R. L. Ferguson, H. L. Hwang,* C. P. Bishop, R. L. Blair, R. L. Cornett,
B. D. Gonzalez, M. Hotchandani, J. A. Keaton, J. L. Miller,
R. D. Myers, M. J. Ohnesorge, and M. Thein
Office of Radiation Protection
Oak Ridge National Laboratory**
Oak Ridge, Tennessee 37831

Introduction

At Oak Ridge National Laboratory (ORNL), the Radiobioassay Laboratory (RBL) utilizes several computer-controlled counting instruments for measuring a variety of radionuclides in bioassay samples. To facilitate the collection of data from these instruments, as well as the reporting and archiving of bioassay results, RBL personnel have developed a laboratory information management system (LIMS) which retrieves data directly from the instrument computers and incorporates them into a database.

Data management activities in analytical laboratories can include sample scheduling, logging, and tracking, as well as results collection and reporting. In the RBL, such activities were formerly accomplished by entering data in log books and on forms followed by manual entry of data into a computer database. These procedures were found to be reasonably reliable and effective, but required large amounts of technician and supervisor time. As sample load has increased and further emphasis has been placed on improving efficiency and on error reduction, it has become worthwhile to automate the laboratory's information management. In addition, a Bioassay Data Management System (BDMS) has been developed for use by all five of the DOE sites managed by Martin Marietta Energy Systems (MMES) in order to centralize bioassay data management for internal dosimetry purposes. BIOPLUS, the LIMS described in this paper, provides an interface with BDMS and automates RBL information management to a large extent. It has been implemented primarily in the dBASE language (with the FoxPro[1] database management system) on a personal computer.

The system provides for downloading personnel data from a central computer, logging in samples, and bar-code sample tracking, as well as recording, reporting, archiving, and trending of analysis results. In this paper, sketches of the hardware and software will be presented, and some details of the instrument interface modules will be discussed. In the oral presentation, examples of menus and data entry screens will be shown and the system's performance evaluated in comparison with that of RBL's previous manual data handling procedures.

---

*Energy Division, Oak Ridge National Laboratory.

**Managed by Martin Marietta Energy Systems, Inc., for the U.S. Department of Energy under Contract No. DE-AC05-84OR21400.

Organization

Figure 1 is a representation of the hardware utilized by BioPlus. The "ghost" hardware shown is being added in an upgrade of the system now in progress.

Figure 2 indicates the organization of the software. The primary principle guiding its development was, "Use as much of what we have as possible." This resulted in the decision to accept output formats provided by the counting instrument vendors and, thus, to develop "front-end" modules to interpret those various formats to obtain data to be included in the BIOPLUS database. In fact, the general data structures were based on an earlier system (BIO) developed by Beckie Heatherly of the MMES Computing and Telecommunications organization, and a hard-copy results report was patterned after the manually filled-in form that had been in use at the RBL for some time.

Implementation

Digital Command Language[2] (DCL) and QuickBASIC[3] (QB) modules running on the computers that control the counting instruments retrieve information from memory or from disk files. A dBASE program processes these sample data and analysis results on an IBM-compatible PC and prepares files for transmission to BDMS.

On the VAXStation 3100 that controls a Canberra Industries/Nuclear Data (CI/ND) alpha-spectroscopy system,[4] analysis results are extracted from CI/ND configuration files with a DCL command procedure that makes use of the CI/ND PARS utility, then written to an ASCII file on the DEC machine, and transferred (at present) with KERMIT to a PC connected to the VAXstation's terminal port. From there the file is copied to a floppy disk and transferred to the PC running the BioPlus database program. The DCL procedure is run as a batch process at noon, after sample processing has normally been completed on the CI/ND system, and it resubmits itself to run again at the same time the following day. An analyst intervenes to perform the transfer from the VAXstation to the local PC and then to the database PC.

On the PC controlling a Tennelec LB-4000 system,[5] data are captured on a hard disk by the use of QB programs which are called by the Tennelec software and which retrieve parameters from the appropriate memory locations. An input routine is evoked with the Tennelec "Auto Exec Batch Program" in order to input data not provided for on the Tennelec input screens. A "print" program, which is called by the Tennelec data acquisition program on completion of data acquisition, performs calculations, such as efficiency and growth-and-decay corrections, prints a report, and appends the results to file on the PC's fixed disk. Periodically, an analyst copies this file to a floppy diskette and then transfers the data to the database computer.

Results of measurements made on other instruments are currently input to the database via a manual entry screen. All results are printed to provide an easily auditable record, which is signed by analyst and reviewer, and are written in an ASCII file for transfer to the central VAX computer running BDMS. This transfer is currently effected with KERMIT over the ORNL "System Select Network."

Function

Desired functions are chosen from the BioPlus main menu screen. Other screens are evoked by some of the menu or submenu choices to allow data entry or further choices. Typical usage of the system would be as follows:

Download from BDMS (with KERMIT and floppy disk) a file indicating samples to be analyzed.

Log samples in when received. Enter "collection" data. Transfer log-in data to diskette and upload to BDMS weekly.

Group samples into batches as desired. Print sample ID bar code label.

Enter tracer etc. data. Print bar-coded data from database for entry into instrument computers.

After samples are counted, retrieve results data from instruments on diskette.

Load results into database computer and print hardcopy.

Transfer results to diskette and upload to BDMS weekly.

Further System Development

A local area Ethernet network, that includes a new VAXStation 4000/60, is being installed to connect counting instruments and the database computer and, thus, replace the current data transfer media (floppy disk and bar code). Interface modules are being developed for additional counting instruments.

References

1. FoxPro, Fox Software, Inc., Perrysburg, Ohio, August 1991.

2. VMS User's Manual, Digital Equipment Corporation, Maynard Massachusetts, Order Number: AA-LA98B-TE, June 1989.

3. Microsoft QuickBASIC, Microsoft Corporation, Redmond Washington, Document No. 410700014-450-R01-0988, 1988.

4. Genie System Spectroscopy Applications and Display User's Guides, Canberra Nuclear, Nuclear Data Systems Division, Itasca, Illinois, 07-0196, May 1991.

5. LB 4000 Instruction Manual, Oxford Instruments Nuclear Measurements Group, Oak Ridge, Tennessee, L4000MA00F01, December 1989.

Figure Captions

Figure 1. BIOPLUS Hardware Setup. Hardware components are represented symbolically. LBPC indicates a low background proportional counter system and LSA, a liquid scintillation analyzer. Data flow is indicated with solid lines for hard wired connections, dash-dot lines for diskette transfer, and dash-dot-dot lines for either keyboard or bar code data entry. A local area network being installed is represented in "ghost" image and with dotted lines.

Figure 2. BIOPLUS Software Organization. The main Menu provides choices of the functions shown in rectangles. Submenus allow data entry or choice of functions shown in parallelograms. Input and output media are indicated symbolically.

Figures

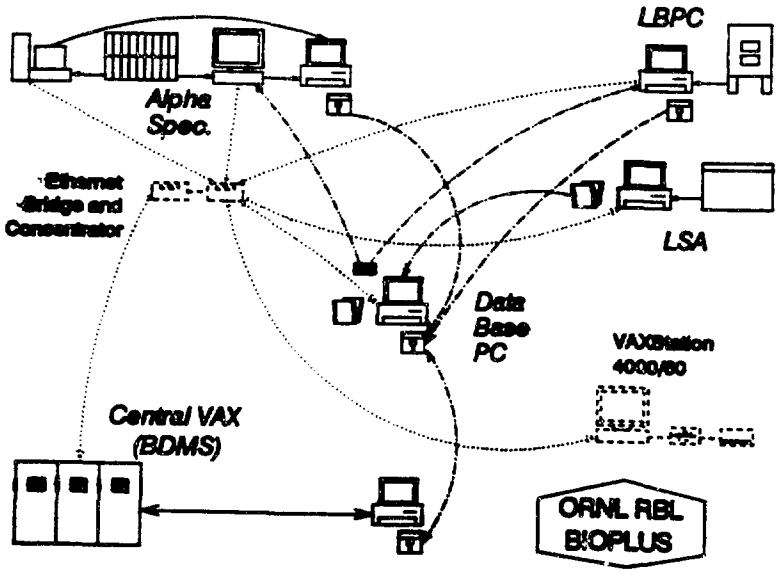


Fig. 1. BIOPLUS Hardware Setup

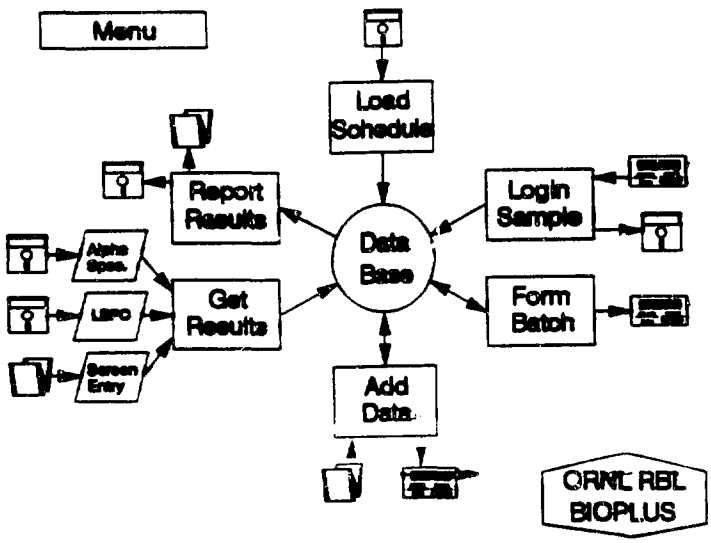


Fig. 2. BIOPLUS Software Organization

[illegible] LABORATORY INFORMATION MANAGEMENT SYSTEM FOR THE ORNL RADIOBIOASSAY LABORATORY

R. L. [illegible], C. [illegible], R. L. Blair, R. L. Cornett,
[illegible], J. L. Miller,
[illegible] M. Thein

[illegible]

ORNL Director

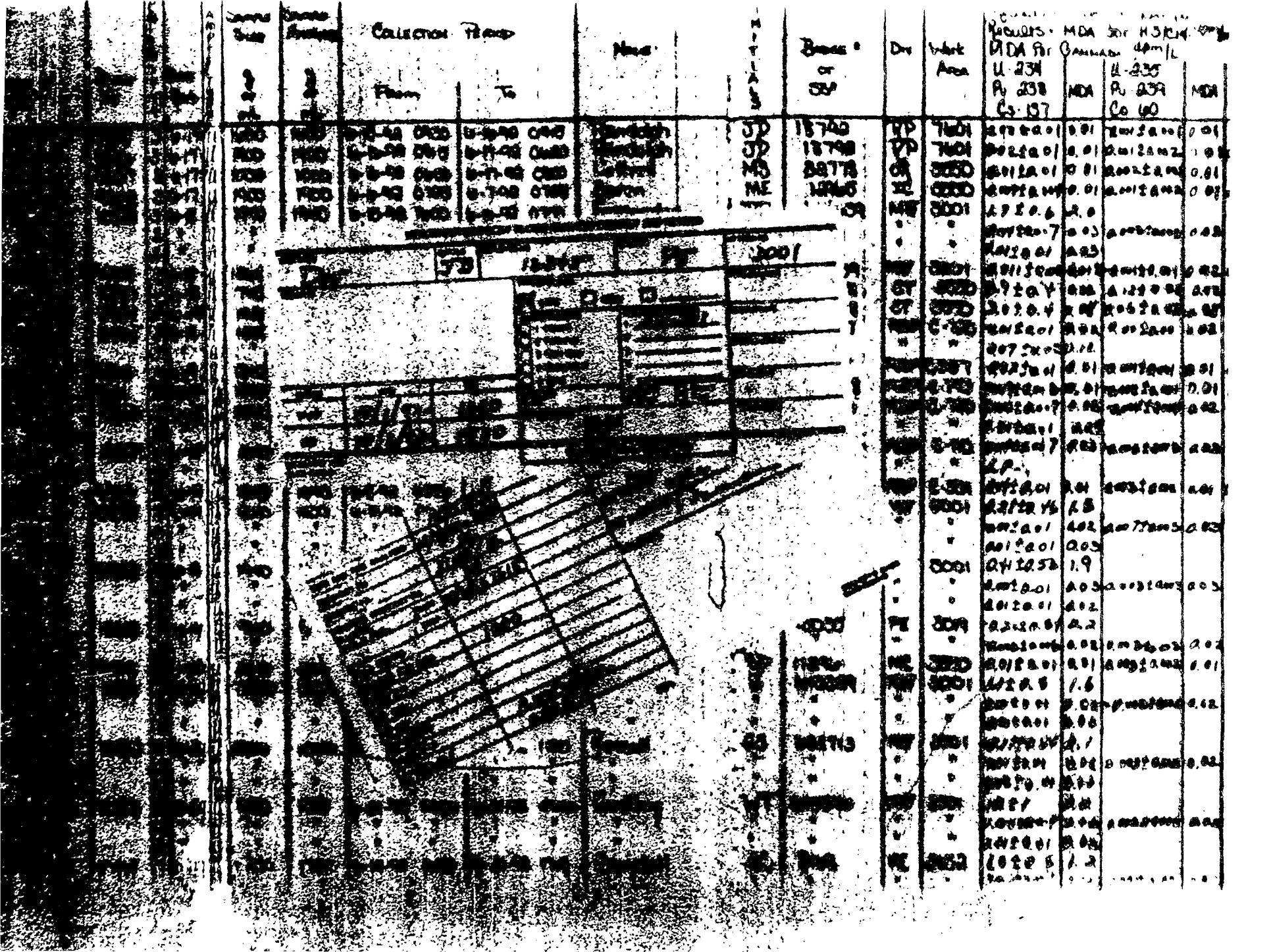
Office of Environmental, Safety and Health Compliance

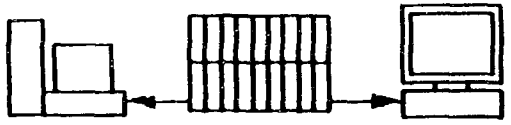
Office of Radiation Protection

[illegible] Dosimetry [illegible]

[illegible]

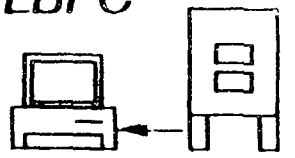
[illegible] | [illegible] | Internal Dose Assessment

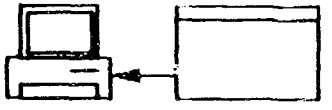




Alpha
Spec.

LBPC

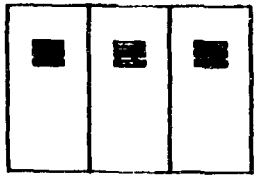




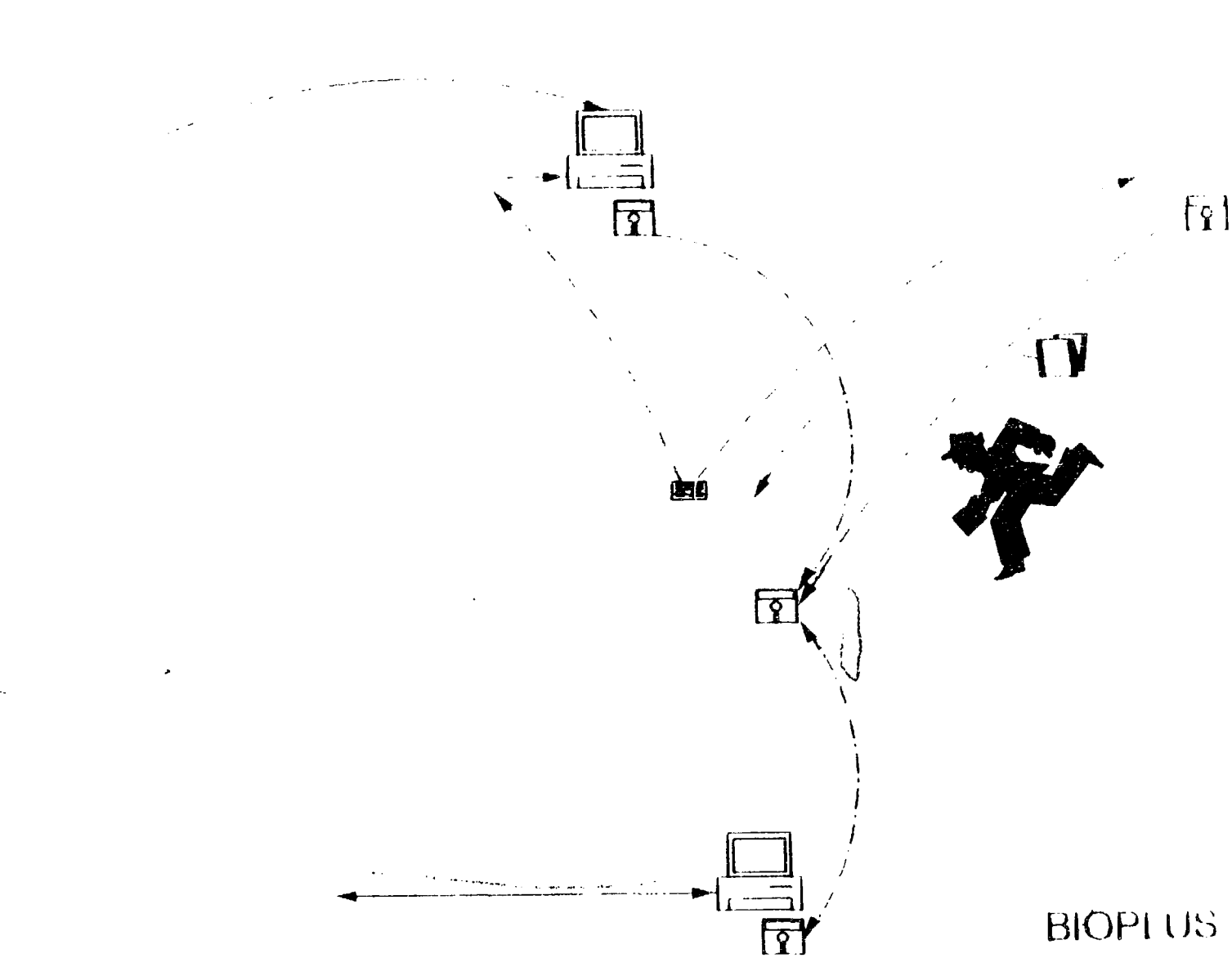
LSA

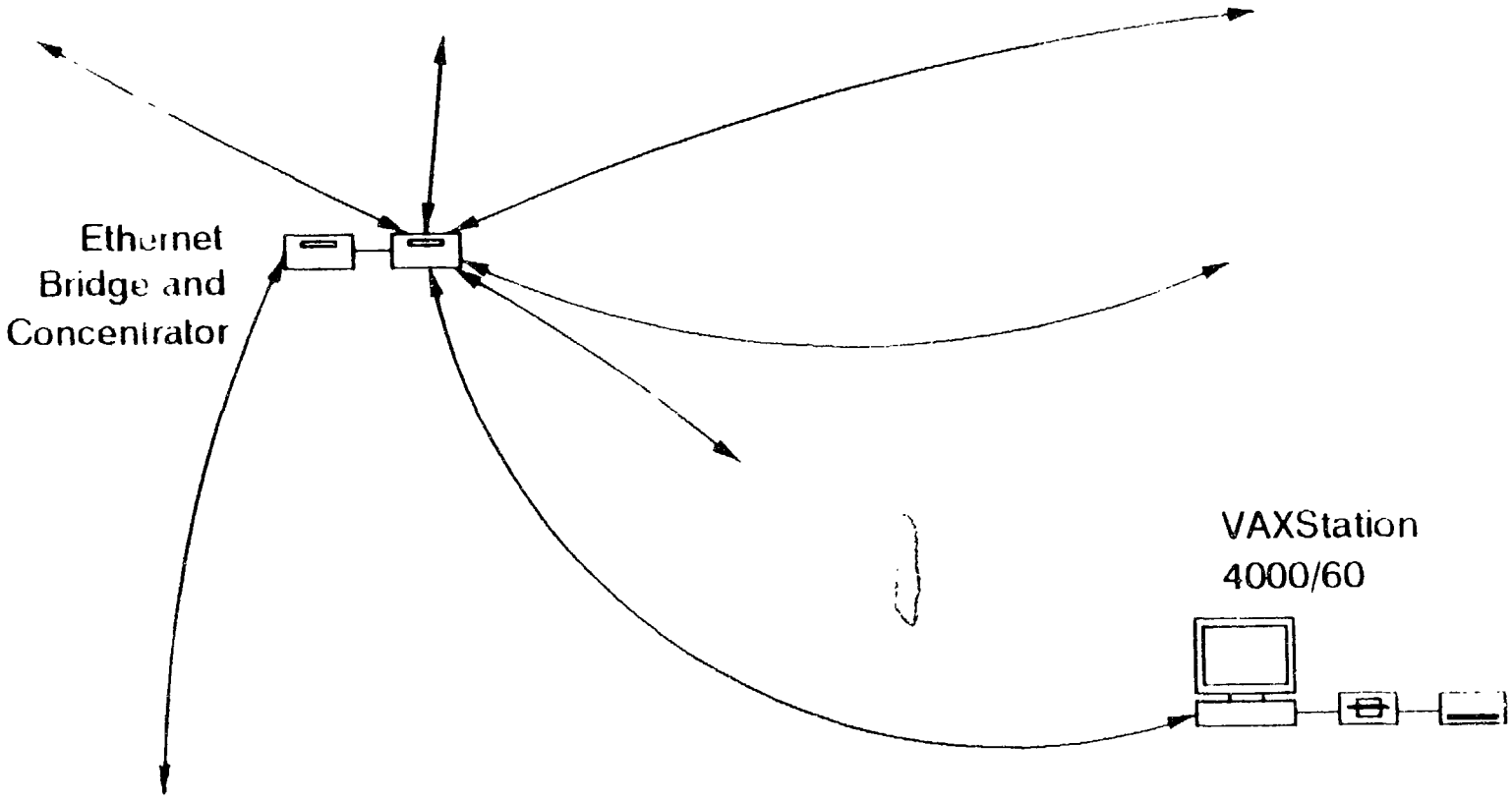
Data
Base
PC

Central VAX
(BDMS)

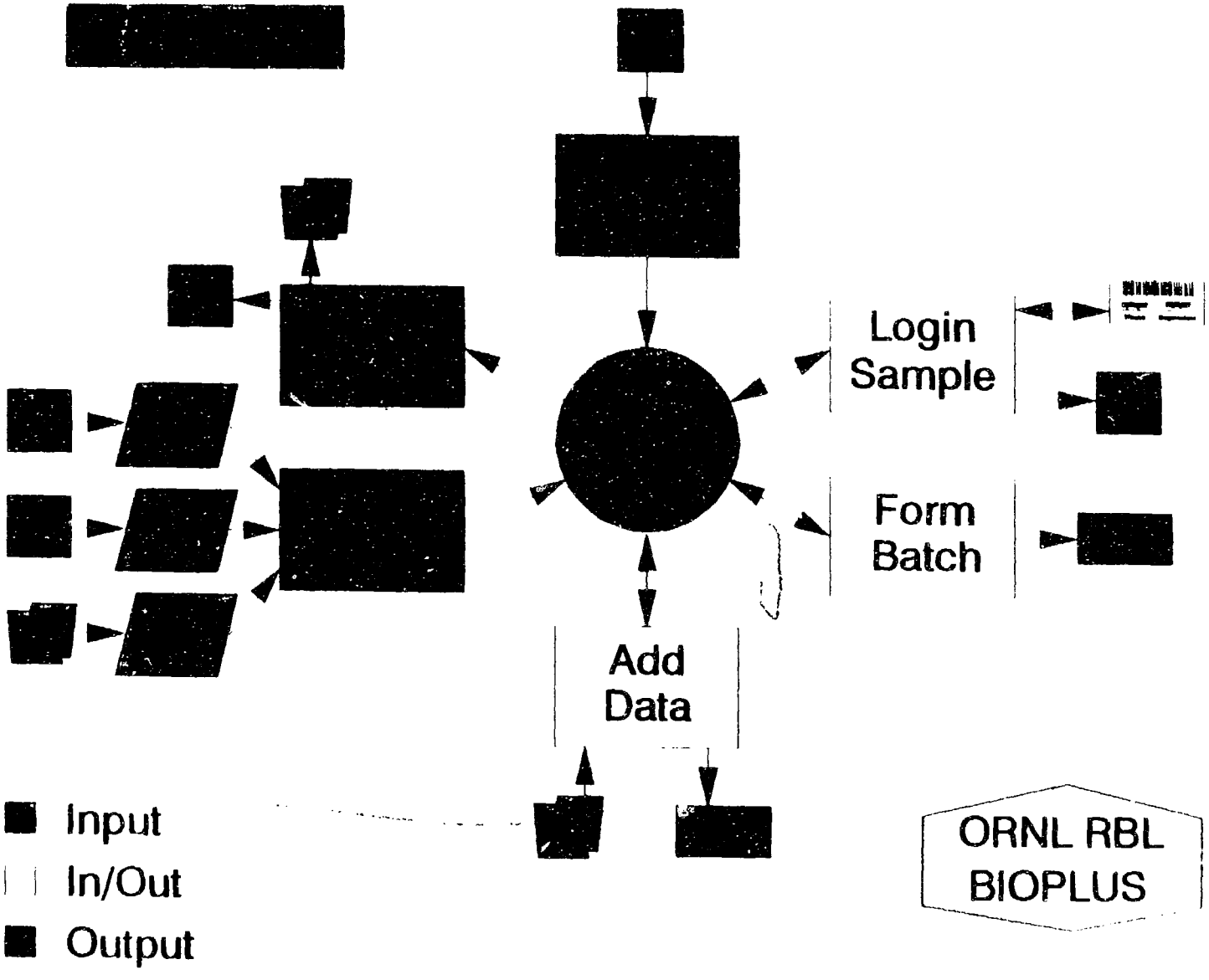


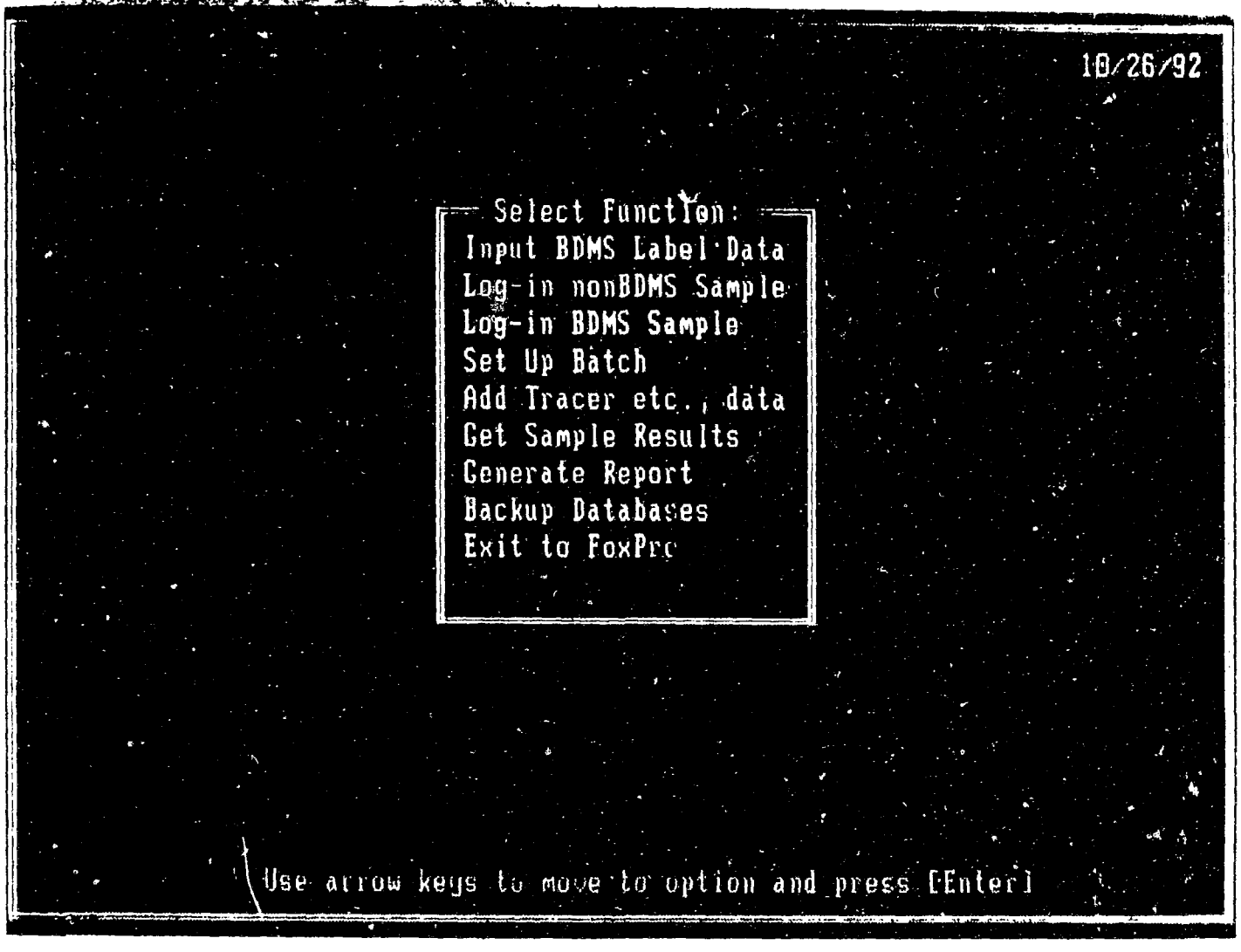
ORNL RBL

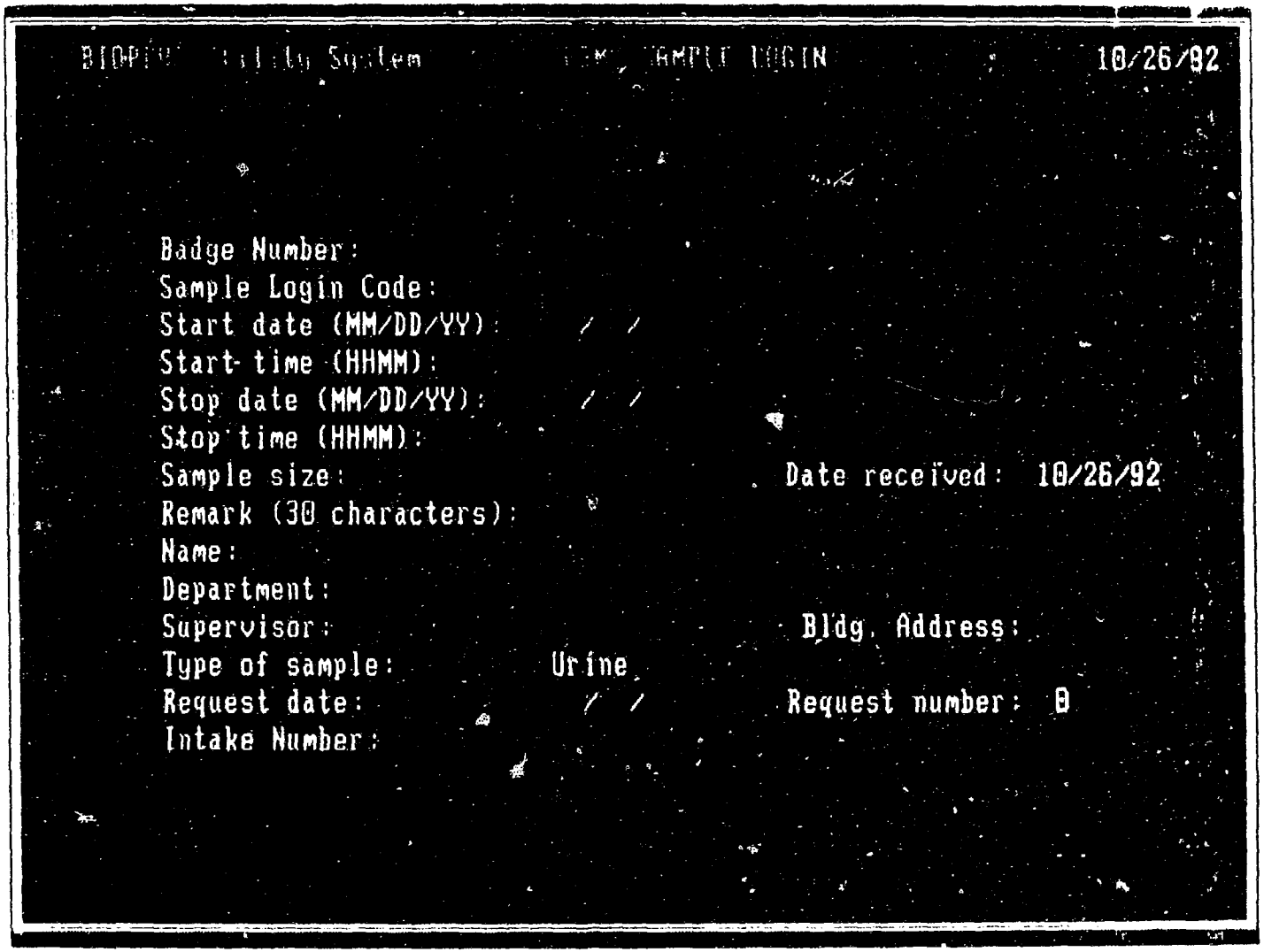

BIOPLUS

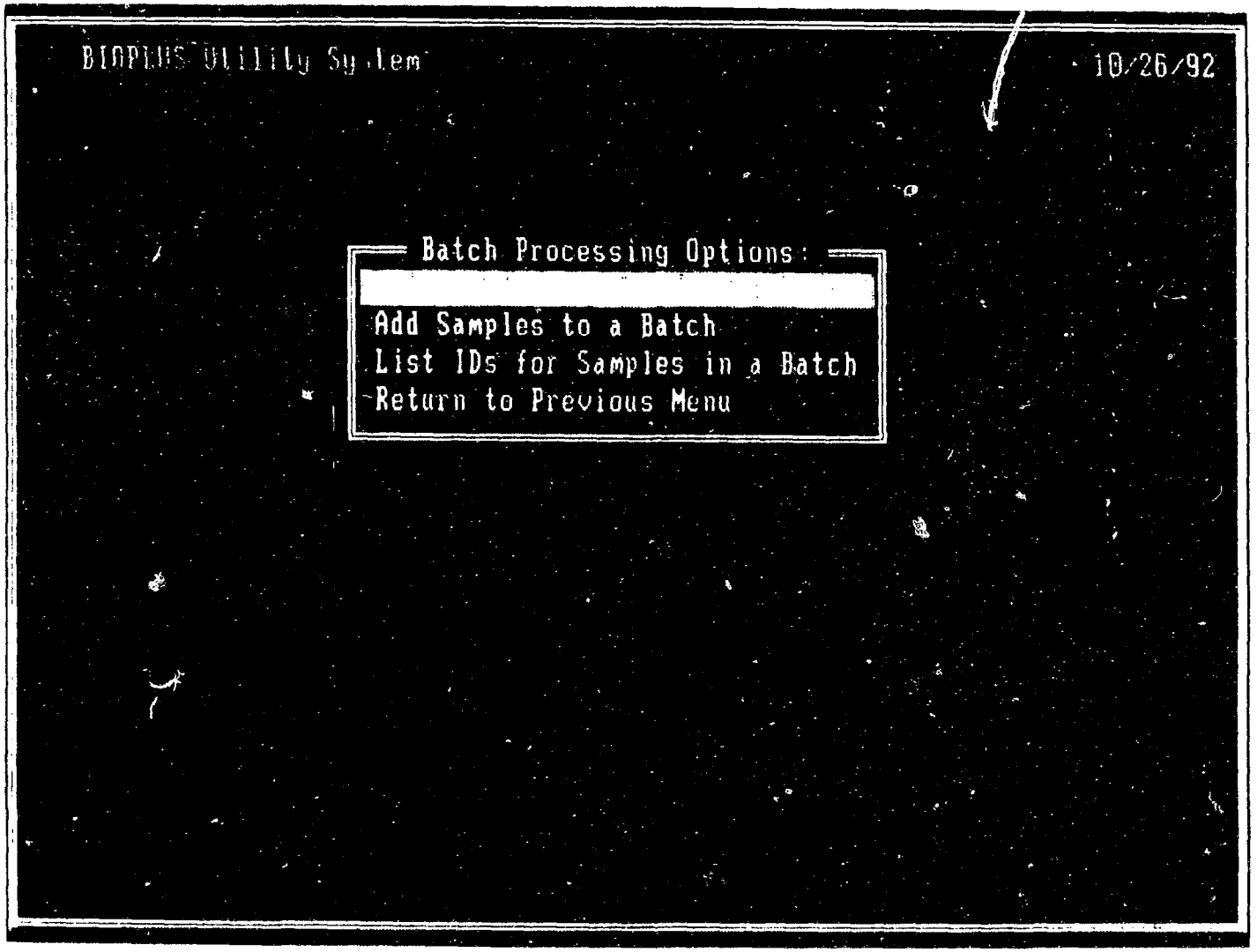


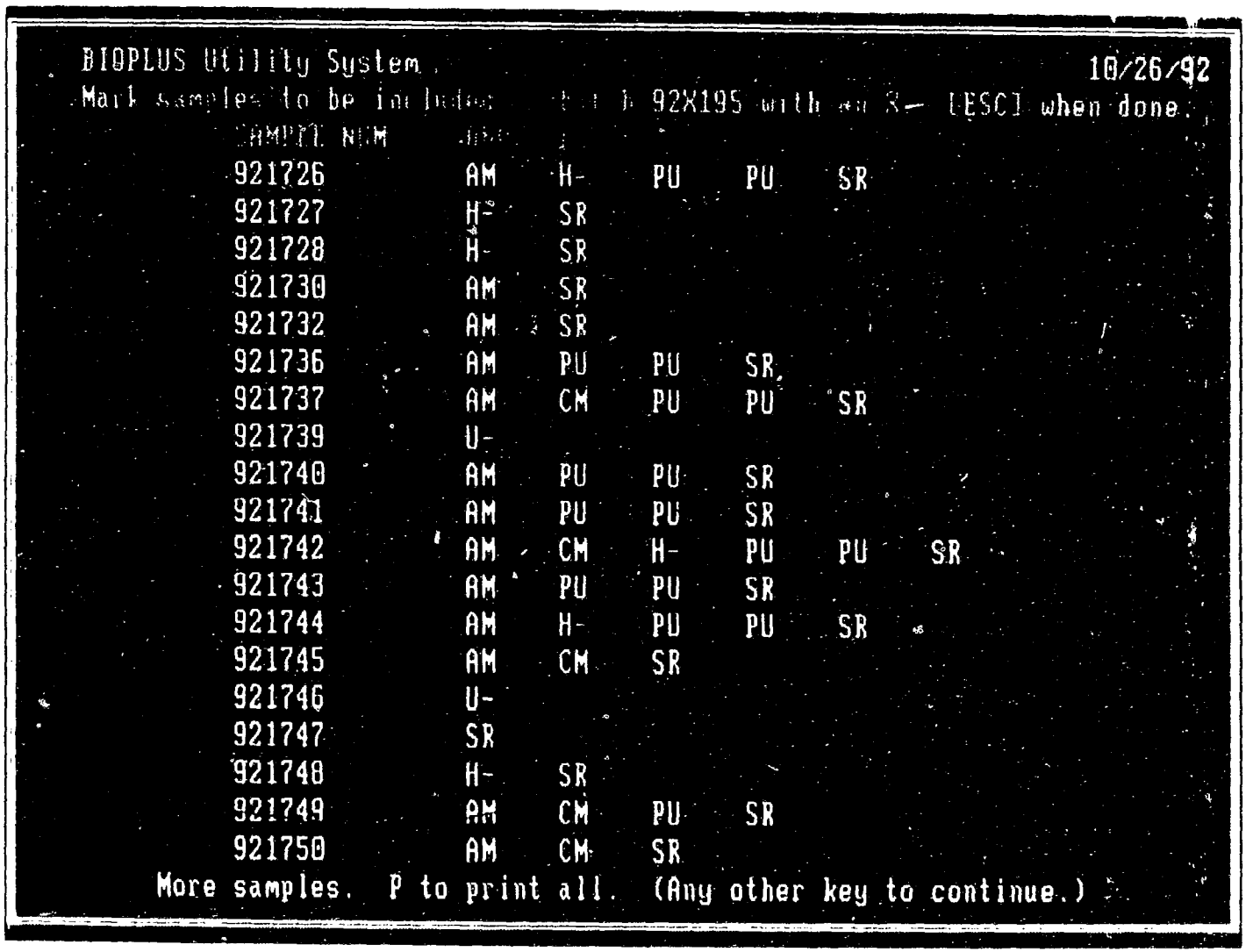
BIOPLUS

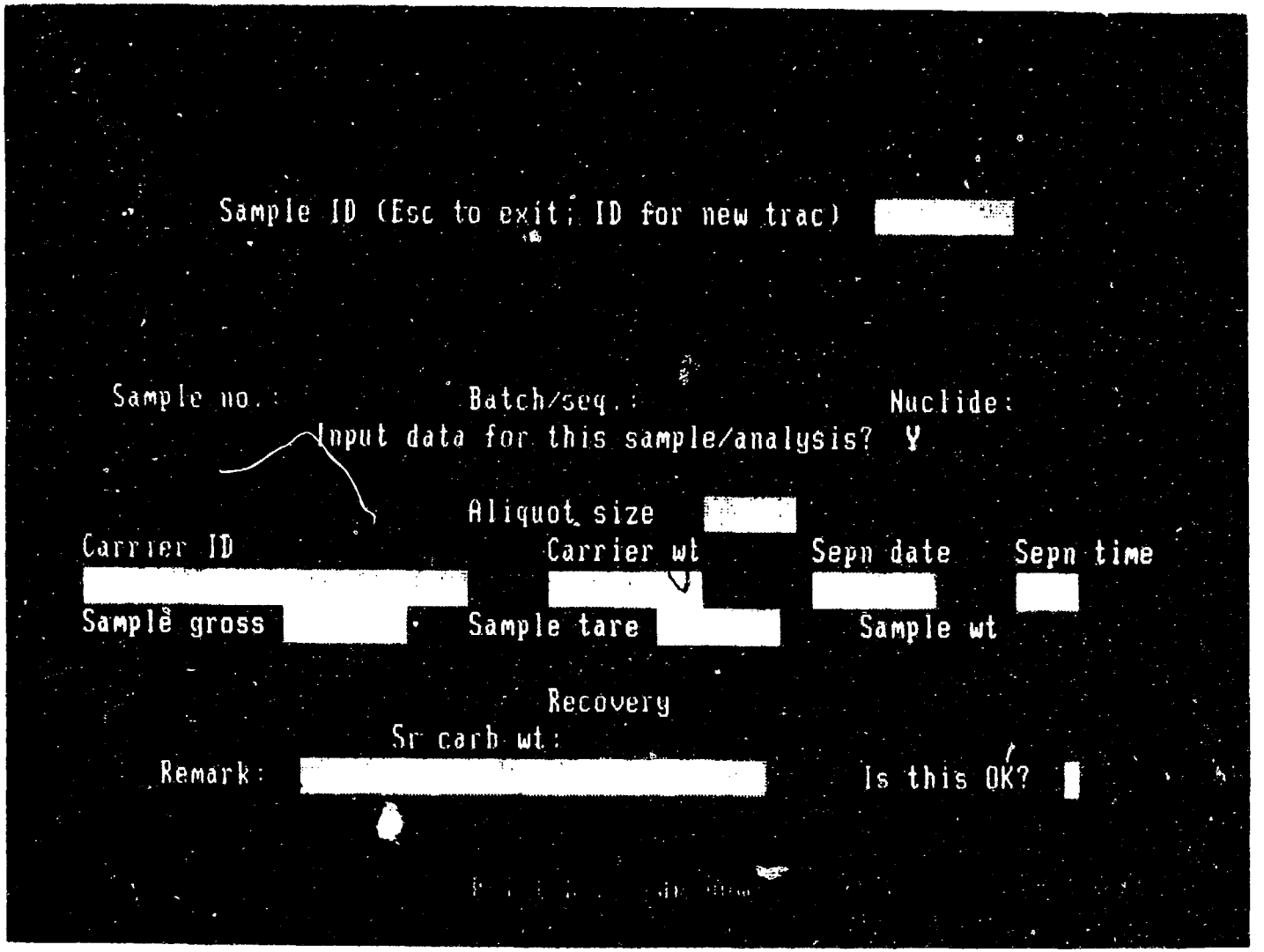

Login
Sample
Form
Batch
Add
Data
Input
In/Out
Output
ORNL RBL
BIOPLUS

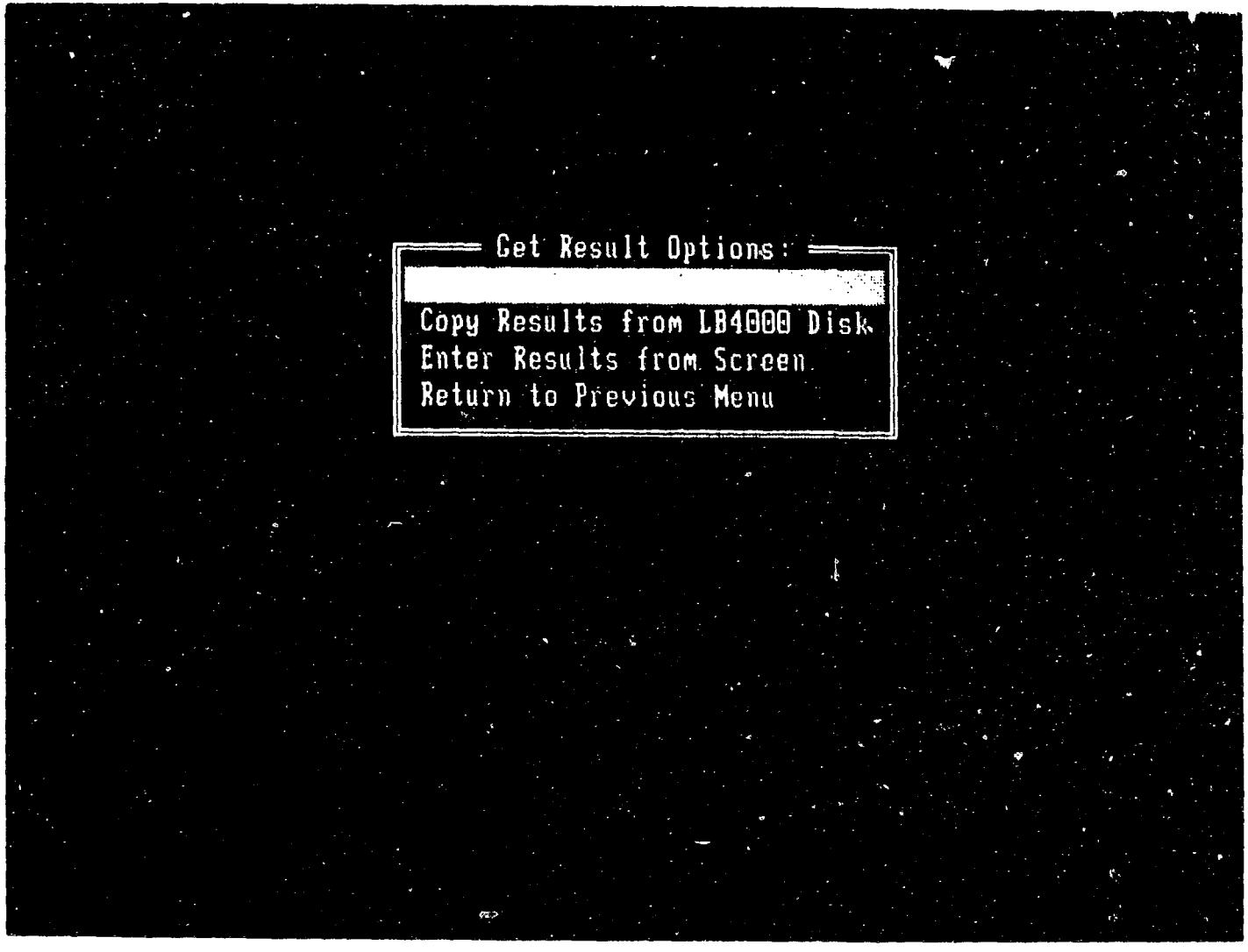

10/26/92
Select Function:
Input BDMS Label Data
Log-in nonBDMS Sample
Log-in BDMS Sample
Set Up Batch
Add Tracer etc., data
Get Sample Results
Generate Report
Backup Databases
Exit to FoxPro
Use arrow keys to move to option and press [Enter]

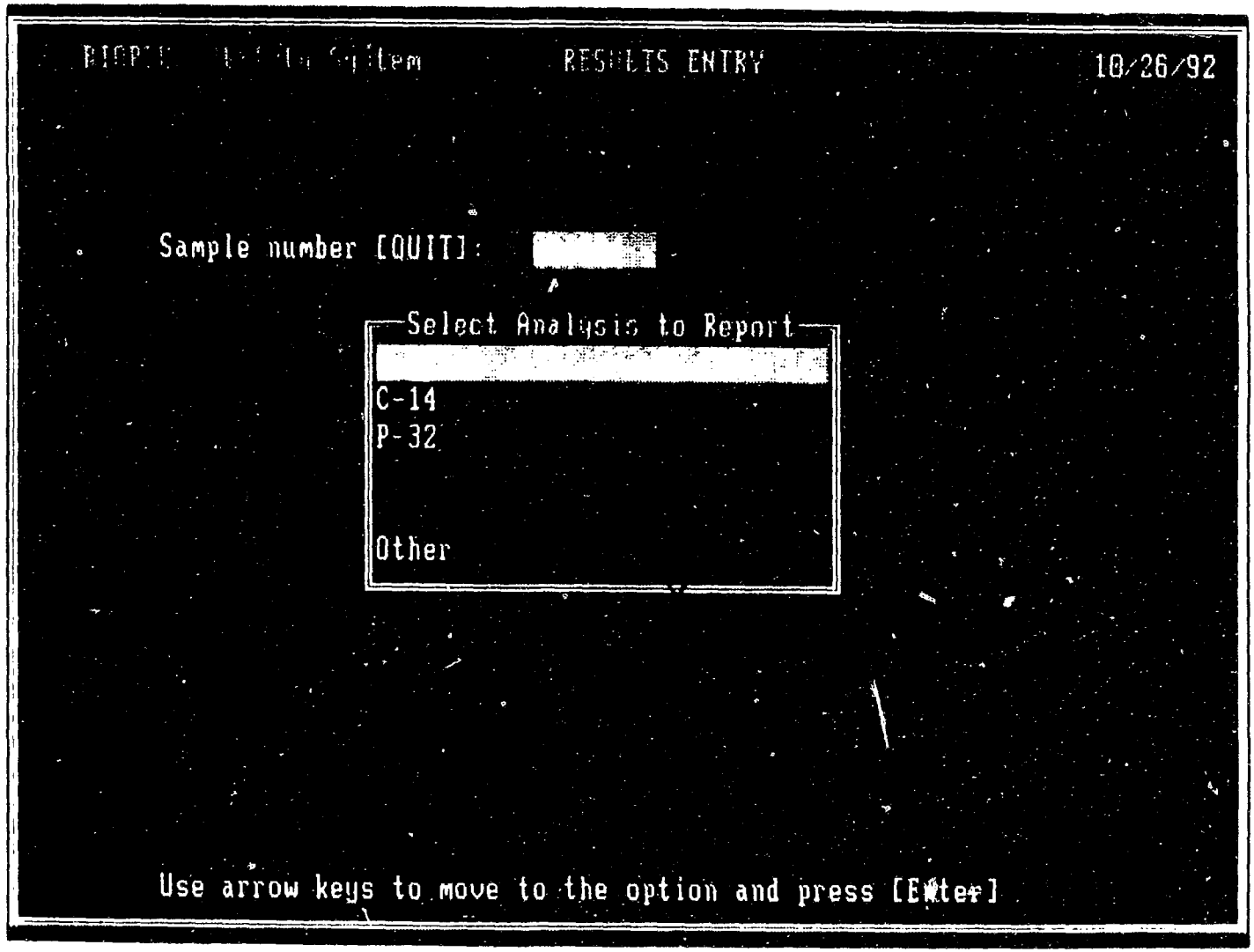

10/26/92
Badge Number:
Sample Login Code:
Start date (MM/DD/YY): / /
Start time (HHMM):
Stop date (MM/DD/YY): / /
Stop time (HHMM):
Sample size:
Date received: 10/26/92
Remark (30 characters):
Name:
Department:
Supervisor:
Bldg. Address:
Type of sample: Urine
Request date: / /
Request number: 0
Intake Number:

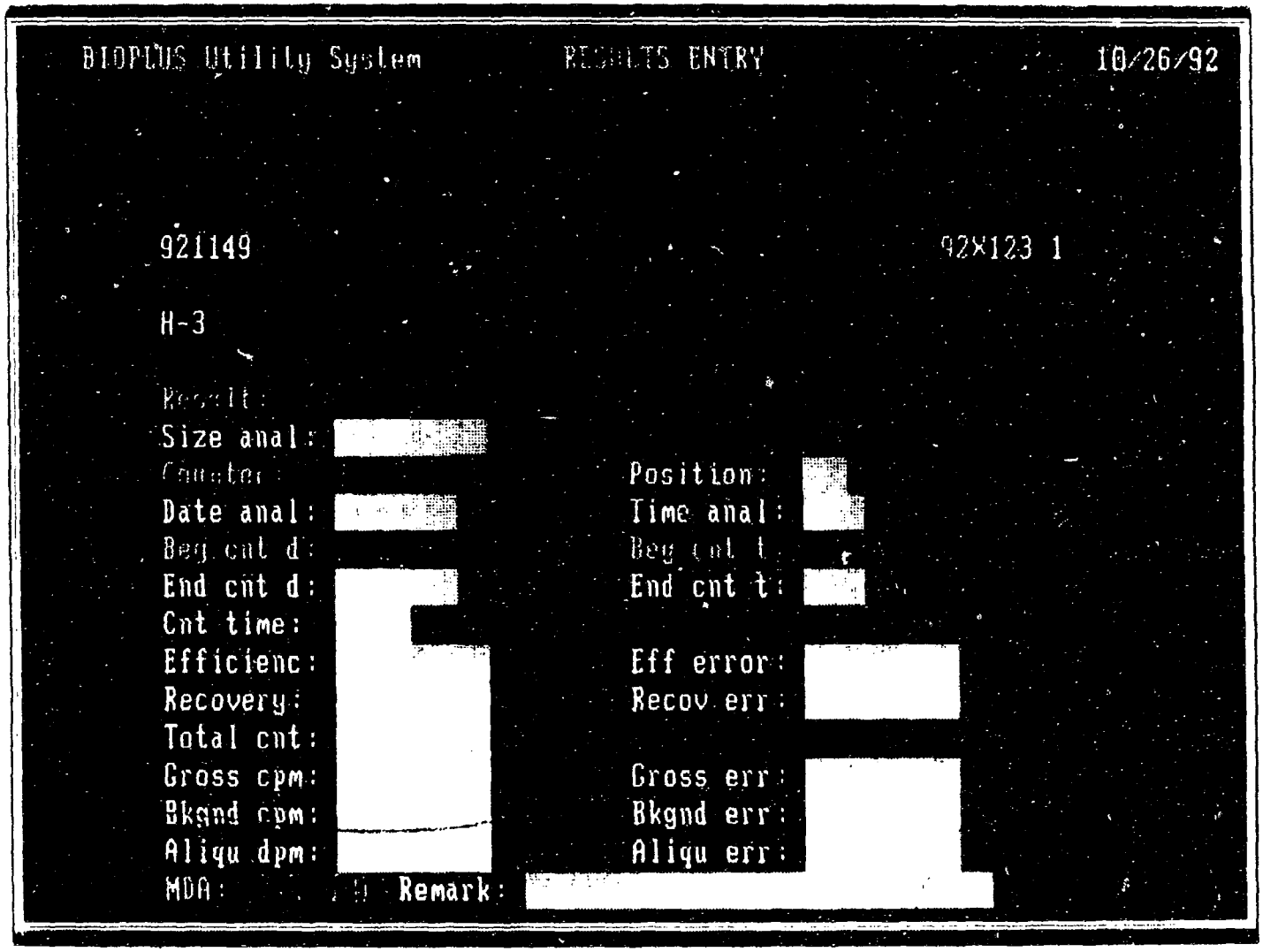

BIOPLUS Utility System
10/26/92
Batch Processing Options:
Add Samples to a Batch
List IDs for Samples in a Batch
Return to Previous Menu


BIOPLUS Utility System
10/26/92
Mark samples to be included with an X— [ESC] when done.
SAMPLE NUM
921726 AM H- PU PU SR
921727 H- SR
921728 H- SR
921730 AM SR
921732 AM SR
921736 AM PU PU SR
921737 AM CM PU PU SR
921739 U-
921740 AM PU PU SR
921741 AM PU PU SR
921742 AM CM H- PU PU SR
921743 AM PU PU SR
921744 AM H- PU PU SR
921745 AM CM SR
921746 U-
921747 SR
921748 H- SR
921749 AM CM PU SR
921750 AM CM SR
More samples. P to print all. (Any other key to continue.)


Sample ID (Esc to exit; ID for new trac)
Sample no.:
Batch/seq.:
Nuclide:
Input data for this sample/analysis? Y
Aliquot size
Carrier ID
Carrier wt
Sepn date
Sepn time
Sample gross
Sample tare
Sample wt
Recovery
Sr carb wt:
Remark:
Is this OK?


Get Result Options:
Copy Results from LB4000 Disk
Enter Results from Screen
Return to Previous Menu


RESULTS ENTRY
10/26/92
Sample number [QUIT]:
Select Analysis to Report
C-14
P-32
Other
Use arrow keys to move to the option and press [Enter]


BIOPLUS Utility System
RESULTS ENTRY
10/26/92
921149
92X123 1
H-3
Result:
Size anal:
Counter:
Position:
Date anal:
Time anal:
Beg cnt d:
Beg cnt t:
End cnt d:
End cnt t:
Cnt time:
Efficienc:
Eff error:
Recovery:
Recov err:
Total cnt:
Gross cpm:
Gross err:
Bkgnd cpm:
Bkgnd err:
Aliqu dpm:
Aliqu err:
MDA:
Remark:

BIOPLUS Performance

Time savings:	Avg. 20 min. per sample 600 hrs. per year
Error reduction:	90%
Results reporting:	Electronic transmission for dose estimates
Trending/Reports:	1 hr. turnaround

ORNL RadioBioassay Laboratory

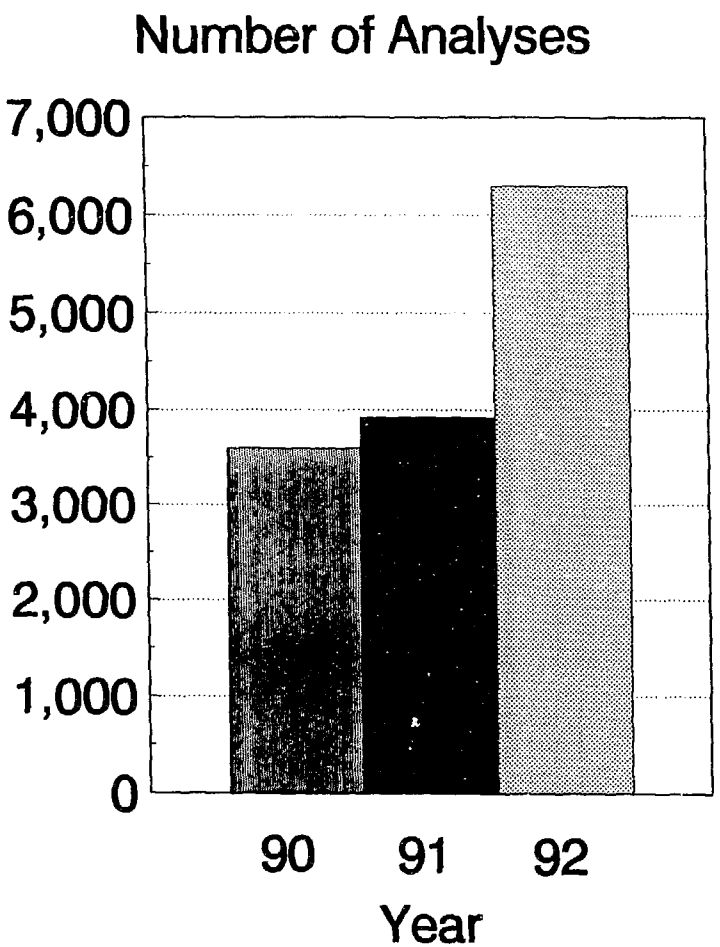
Performs routine (~95%) and special (~5%) bioassays in support of the internal dosimetry program.

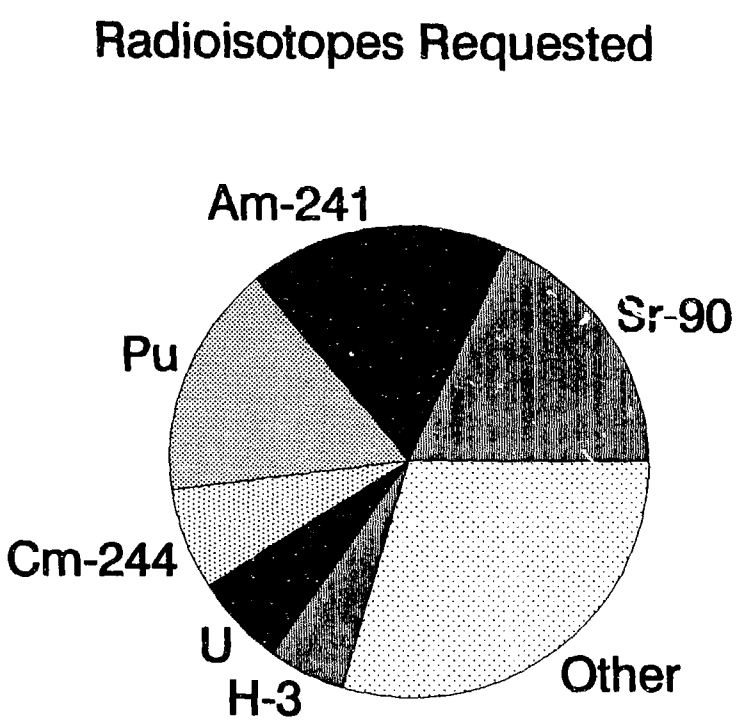
Laboratory population is ~5000 (including subcontract personnel).

Internal dose monitoring program includes 900-1000 persons.

Routine analyses performed for 8 alpha emitters, 4 beta emitters, and several gamma emitters.

Participates in internal and external quality assurance programs.


Number of Analyses
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
90
91
92
Year


Radioisotopes Requested
Am-241
Sr-90
Pu
Cm-244
U
H-3
Other