Database system in the KEK LINAC PC-based control

(1. Operation Logging and Statistical Processing System)

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Abstract

In the KEK e+/p- (electronic positron) Linac (linear accelerator), 2.5GeV was boosted to 8.0GeV, and its database was reinforced, particularly that for recording operational use and statistical processing. An outline of the system and its results are presented.

1 INTRODUCTION

A database (DB) [1] was made for KEK's 2.5GeV e+/p- linear accelerator, and has been used since 1994. In 1998 the accelerator was upgraded to 8GeV, with the DB system being expanded.

More than one might imagine, considering the required effort, to include tuning and maintenance, making a DB is not easy for an accelerator and examples of prominent success are indeed rare, conspicuously so in OODB.

However, recent progress in personal computer (PC) development has led to simplified, inexpensive PC DB systems being readily adaptable to the accelerator field, thus allowing greater flexibility, and practical-use statistical processing, etc.

Systems so far designed for 2.5GeV accelerators remain largely unchanged. Figure 1 shows a system diagram.

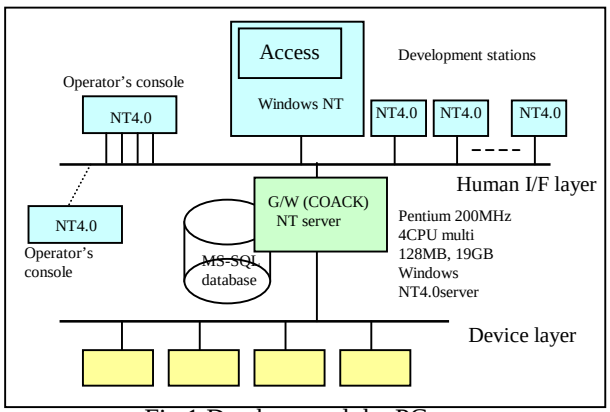

Fig.1 Database and the PC system

2 OPERATIONAL DATABASE ANALYSIS

After the PF incidentor began operation of an electronic positron linear accelerator, operational and trouble recording was hand-written, resulting in a huge volume of data that was already hard to reuse, with the records left to gather dust. Since past statistics require processing, the need for computerisation was discussed, and following the introduction of an NT server, it saw practical use in the MS-SQL and PC system. The accelerator's dynamic DB also records (1) beam operation, (2) accelerator operation and (3) trouble and troubleshooting, although they do not require a real-time response, compared with other dynamic DB.

In beam operation auto recording, matters related to its on/off operation and radiation safety as well as safety interlock systems are simultaneously logged in the DB, and a MS-Word file is also created daily, the DTP function can be used by selecting the appropriate file on any network PCs.

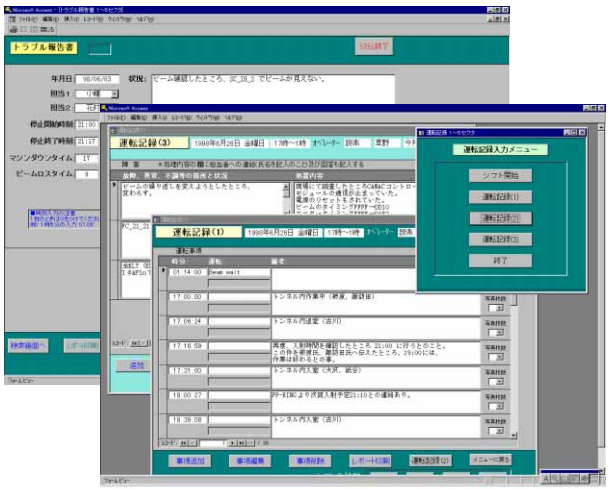

Fig.2 Layout of papers for publication at PCaPAC'99.

3 PRIOR TO APPLICATION

The following data structure analysis, a four-step process, was needed to make and apply the operational and trouble logging DB:

(1) Operational and trouble data-base analysis
(2) DB design and GUI design
(3) DB system verification of temporary data
(4) Operator training and transition periods
(5) Actual operation
(6) Performance evaluation
(7) Version upgrade

4 GUI AND DB

Based on an analysis of the DB needed for the MS-SQL 5, matters were decided, with the DB being made as a result. Since the GUI required better software development, several systems were studied; but considering the problem of compatibility with Windows, Access was chosen which enables simultaneous reduction of the SQL's CPU load. Shown below are input screens for operational and trouble recording.

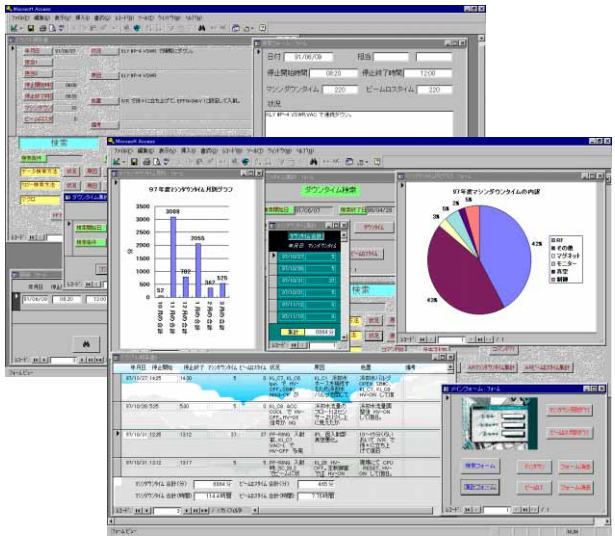

Fig.3
Operational/trouble Recording Input GUI Examples

5 DEBUGGING BY TEMPORARY DATA

By the time the system was completed, about three months worth of hand-written data had been input; also, operational performance, usability and speed tests had been completed, with its practicality verified. A variety of problems linked with transition to actual use were considered. Accordingly, a preparation period was provided instead of attempting the transition all at once.

6 OPERATOR TRAINING AND TRANSITION PERIOD

Accelerator operation is contracted to a third-sector company. With Japanese keyboard, since the load was greater than usual for operators unaccustomed to computers, a transition period was allowed. In as much as inputting Japanese for operational recording is harder than hand-writing, the issue of input speed was studied. The problem was treated in three stages, from hand-writing to combined hand-writing and computer input (1997 to May '98), then to computer input alone (May '98 and thereafter).

Prior to a shift to computerisation, a poll was taken among operators to determine how the transition would affect them, matters like the psychological burden and the VDT syndrome. Some operators mentioned that problems might occur, but effort went into mitigating their concern.

7 STATUS OF ACTUAL OPERATION

The SQL DB was constructed by MS-SQL Enterprise-M, with maintenance effected by MS-ISQL/W. Mmaintenance GUI windows were made by VB, enabling the operator to conduct all input and necessary searches via the GUI. In addition, the search function weny to related personnel other than operators via the web (Fig. 4).

Fig.4 Example of a Keyword Search by the Web

8 ANALYTICAL/STATISTICAL PROCESSING BY DB

Volume wise, accelerator operators input about 60MB of data regarding Linac operation from 1995 to 1998, including the test period; about 8MB were input in the trouble file during the same period. The following are examples of analytical and statistical processing of complications drawn from the trouble-recording database.

(1) Search by keywords related to shutdowns, etc. showed that 64% of all troubles stemmed from stoppage owing to one factor or another, 17% of the problems were of unknown origin. In nearly all cases normal resetting activated the accelerator Keyword search by device module names when itemising the origin of trouble revealed a trend where 18% of the problems involved power supply and a module of the same type.

(Trouble-related Statistical/analytical Processing)

From the aspect of keyword question frequency, it was learned that problems occurred in the order of power supply, unknown-origin troubles and communication faults.

(2) In analysing periodic troubles, an increase in the frequency during specific months described a trend over the past several years (Fig.5), it was learned that troubles often occur in the wake of the semi-annual maintenance.

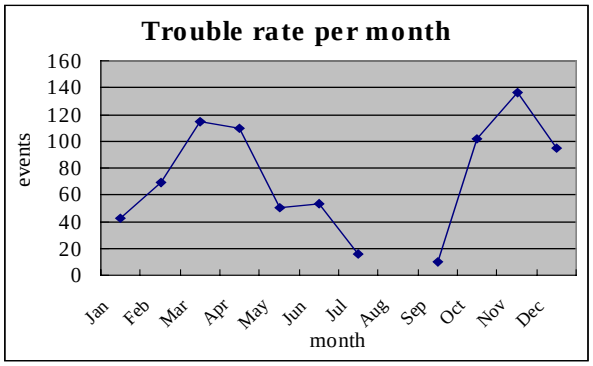

Figure 5 Trouble Frequency by Month

9 System Evaluation by Operators

(1) In operational recording, formerly hand-written storage-use and storage-use copy files had been prepared, the use of the DB has greatly lightened this drudgery.

(2) Substantial revisions of hand-written records caused a tremendous burden on operators. GUI tools enable doing the job far more smoothly.

(3) Previously, trouble recording, etc., had been recorded by hand, requiring extensive time; however the DB made the task possible within a remarkably short time (Fig. 6).

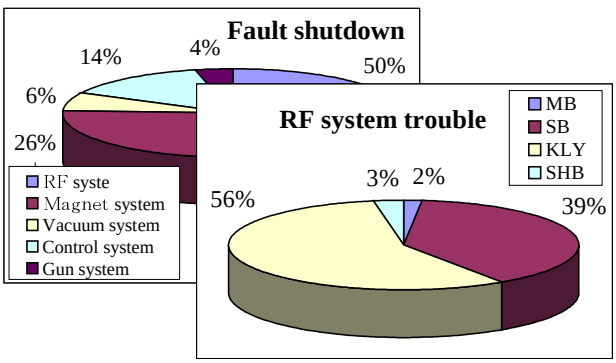

Figure 6 Statistical Processing Display Screen

(4) When investigating keyword search frequencies and trends, registering and inputting the results as keywords enables easy selection from the pop-up menu, which greatly lightens the keyboard input load.

(5) The new system makes it possible to retrieve examples corresponding to troubles with the GUI Access search program and visually display data that reflect accelerator operation, which is very convenient.

10 DATABASE OPERATION SUCCESS STORY

(1) DB total search capability enables trouble categorisation, which simplifies reflecting the results of tabulations concerning accelerator operation and maintenance.

(2) Although there were at first differences in entering the names of equipment and other factors, depending on the recorder, an analysis of actual past cases showed that the description content has been standardised as a result of the capacity to create and select keyword items from the pop-up menu, and statistical processing has become easier to perform and to understand.

11 FUTURE SUBJECTS

Based on evaluations of the DB system and its practical use to date, the following are expected to be tackled as future subjects:

- (1) Complete keyword definitions to enable expanded reuse, an increase of items, and lighter keyboard input load.
- (2) Create more screens to boost keyword flexibility and reinforce the macros for each type of tabulation.
- (3) Intensify the web-link density and increase the screens according to the general trend.

8 SUMMARY

The accelerator operational DB based on Windows NT, MS-SQL and MS-Access has proved itself satisfactory as a PC system. The foregoing describes the worth of the DB from the aspect of accelerator operation and trouble analysis. The processing speed fully responds to the necessary conditions. Consequently, it is foreseen that accelerator operation will become even easier in the future by effective application, and that highly detailed operations will be possible.

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