Feedback of Operators' Experiences to Console Programs in the KEK e^-/e^+ Linac

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Abstract

The J-Linac portion of the KEK electron-positron (e^-/e^+) Linac is currently under construction (1994-1998); its addition will improve and reinforce the accelerator control system. Until now, the operation of the 2.5 GeV PF Linac, particularly its routine operation, has been contracted to a private company.

Recently, a survey using questionnaires was conducted among these private-sector operators to evaluate the operators' console software running at the present Linac. Based on the result of the survey, an improved console is being built to operate the new J-Linac portion.

1 Need to evaluate the operator's console software

In terms of a human interface, the display windows and other operators' console components were heretofore often built by personnel in charge, or those associated with control, rather than by the operators themselves. Operators have in general grown accustomed to handle the accelerator by learning its functions and operation system. The personnel responsible for its regular use have pointed out that the console is not necessarily easy to manage and efficient. In building the J-Linac portion, the recent survey was aimed to learn the awareness of the daily operators, and to reflect their opinions in the establishment of a human interface. The survey also sought to find more efficient and functional ways to operate the accelerator and to improve its operation time by making the necessary analysis and specific proposals.

2 Accelerator operation phases

The operation of the accelerator can be divided into the following phases:

(1) Accelerator design, the simulation phase;
(2) Partial test runs (device-by-device operation);
(3) Linac start-up (or, shut down) operation;
(4) Adjustment operation (including beam commissioning, machine studies, etc,.);
(5) Normal operation (pattern operation, or daily routine work);
(6) Diagnosis of Linac problems; and
(7) Operation for maintenance.

Since each phase requires different specifications, if the survey were to cover them, the area treated would be enormous. Thus, the survey focused only on regular operation of the Linac, as described in (5), to examine various problems in detail. Obviously, it is desirable that there be independent operation displays and other components for each of the above mentioned items.

3 Stratified abstraction of operation

Since it was decided that the survey should focus on the accelerator's regular operation phase, various aspects of use were reviewed. Apart from the awareness of operators the use of the accelerator in that phase consists of three physical layers:

(1) All kinds of operations on the HI/F (top layer);
(2) Database and processing (middle layer);
(3) Device operation (lower layer).

Although the accelerator can be operated from any of the layers, it is common knowledge that, in general, larger accelerators should be operated from a human interface through GUI. Accordingly, this paper limits the operator's standpoint to the human interface.

Viewed from the upper layer, the accelerator, itself, is first abstracted by the device layer; next, it is abstracted by the data base (DB) and other routines in the middle layer[1]. Intercommunication with databases is thus similar to communication with the devices. In other words, the question is whether operation in the upper layer is sufficiently abstracted to be easily understood by the users. Only after this question is answered functionality and operability should be discussed.

4 Functional and characteristic classification of operation

After the accelerator operation phases are clarified with the strata of operation being made lucidity abstract, the required functions can be sorted as follows:

1) Operation of each of the various devices;
2) Cooperative operation among the devices;
3) Macro operation, automation;
4) Operation support based on the log trend;
5) Operation by the correlation analysis support;
6) Database support operation, contains CBR.;
7) Multimedia support operation;
8) Global network operation; and
9) DTP-linked applications.

The number of items described above tends to increase as the computer control evolves, and becomes specially noteworthy in (3) through (9) above. It deserves to be mentioned that (7) and (9) plus some of the others have recently shown new developments. With these as operation target areas, this paper describes the results of the survey concerning the awareness of contracted operators responsible for handling and maintaining the accelerator,

and extracts operation domain knowledge; it also investigates the relationship between the survey results and domain knowledge so as to make analyses for improving system operation.

5 Survey conditions

The survey focused on contracted as well as in-house operators of the accelerator. Thirty-page questionnaires[2] were prepared for nine of the former type. Questions referred to:

(1) evaluation of specific operation procedures and the console display;
(2) knowledge of one's own field of endeavor;
(3) operator awareness when on duty, plus other items.

This treatise presents the answers to representative questions.

6 Software evaluation from the viewpoint of operator knowledge

The operator creates spheres in which he excels when handling the accelerator based on personal expertise and judgment. He runs and diagnoses the accelerator accordingly. The survey revealed that the extent of operator knowledge and judgment regarding the use of the accelerator has generated problems in the current situation as well as desires for future improvement; it also disclosed the possibility of evaluating software from the viewpoint of functions and operability.

7 Survey results (re operation, display, etc.)

(1) *Programs prepared by the personnel in charge*.

These programs contain many technical displays as well as those for maintenance, none of which are appreciated by operators as being hard to read while the accelerator is running. It was pointed out that programs prepared by personnel in charge are often used by professionals and tend to be avoided by operators.

(2) *Programs prepared by operators*

Programs of this type tend to be simple to use and are acceptable regarding operability. Things deemed necessary are easily reflected in these programs, as are displays which operators require to be easily understood. The opinions of colleague operators are also incorporated without effort. Those operators who prepare the programs can help colleagues to learn them. In this manner, operators can understand details of the program. This enables them to manage the accelerator with greater efficiency.

(3) *Programs prepared by software firms*

The operators surveyed replied that programs made by software companies need to be improved and refined in terms of design. Due to the difficulty of these programs in detail, they tend to be less and less used. Frequent upgrading of software greatly burdens the software firms with respect to cost and discussions concerning specifications if the software is outsourced.

7.1 Survey results (awareness of operators)

Most of the operators polled are intensely interested in computers and exposed to PCs and workstations. About 90% of the operating systems which they use on a daily basis are Windows and Macintosh. Most of the operators cited Windows 95 and NT as their favorite, and 22% stated their preference for UNIX, indicating a desire to use a simple, easy-to-learn system. With respect to the programming language, some 70% chose the VB and C languages, thus showing a high level of skill. In terms of hardware, they replied that the current variety is good enough. Operators tend to like subdued screen colors which strain the eyes. Operators feel that the console should have a keyboard, and they are adept at using one. However, due to the problem of keying in Roman letters for conversion to Japanese characters (input in Japanese), the majority expressed an interest in some easier method by which they can key directly in Japanese. Currently, no better device is available, however. Operators have divided opinions concerning the touch panel, but seem not to feel the need for a touch panel for Windows displays.

7.2 Assessment from the viewpoint of human factors

(1) Mental stress arising from operability.
Many operators replied that their eyes grow tired when using the computer, and cited stiff shoulders and other forms of discomfort as their next serious problem. Only one operator replied that there was no problem, and almost all complained of at least one problem; 33% of the operators said that they experience stress when looking at the computer screen.
(2) The desire for a support system by which operators can gain domain knowledge of accelerator use was expressed.
(3) It was found that in addition to console operability, the accuracy of displays and other factors, operators expect multimedia support, such as an improvement of photographs and drawings, databases, log trends, etc.

8 Improvement points

Within the scope of areas established for this survey, it was learned that operators have experience and skills that enable them to participate in program development. It was also found that an improved software environment wherein operators can develop programs is also needed. Proposals include:

[1] Programming through tools for possible standardized processing;
[2] Reuse of non-standardized procedures done by accelerator professionals;
[3] Learning support and expansion of domain knowledge through model base operations, etc;
[4] Creation of one's own displays for the purpose of reducing mental stress;

[5] Establishment of means of transferring knowledge through multimedia support.

9 Specific improvement measures

Based on the results of this survey and in order to formulate measures for improving accelerator operation software in the future, a shift to objects in GUI is being promoted to achieve the improvement points listed above. Tools are being prepared to enable operators to create their favorite operation procedures and displays by rearranging component objects as they like and by defining macro procedures. Operator opinions are being incorporated into the operation software to the greatest extent possible. An example which was made by operator using visual components (MMI objects) is shown in Fig. 1

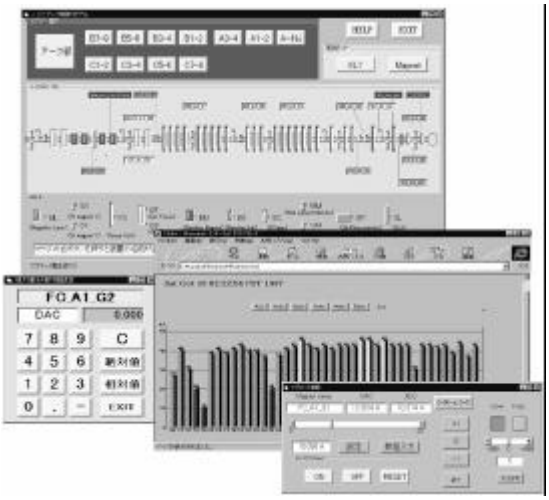

Fig. 1 windows made by operator using visual components.

10 Conclusion

An attempt was made to review, from the viewpoint of operators, an operations system designed by personnel in charge of the accelerator when it was being built. As a result, it has been confirmed by both the survey of operators and the opinion of the personnel in charge of the control system design that it is possible to improve the control system, particularly the operators console, to use the device with greater efficiency and convenience, instead of simply maintaining the objective set when the accelerator was designed. Various efforts are being made attain the goal of improving the control system, particularly the operators console. A method which has emerged promising for the operator is to use MMI objects[3,4,5] built by professionals.

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