

# The PC-Based Archive System at BEPC

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## Abstract

For a better understanding of the machine performance, a PC-based archive system was introduced for the Beijing Electron-Positron Collider (BEPC) in 1996. The kernel of the system is a Microsoft SQL server database. The data-taking is based on client and server application programs running on PCs with the operating system of the Microsoft Windows NT and on the DEC mini-computer under VMS. The archive system can provide various services of the data storage, query and analysis to the accelerator physicists and machine operators. This paper will give the detailed description of the archive system at BEPC.

## 1 INTRODUCTION

The Beijing Electron-Positron Collider (BEPC), which includes a 202-meter linac injector, an 120-meter beam transport line for each beam and a 240-meter circumference storage ring, is a large experimental facility for the high energy physics and the synchrotron radiation research. The BEPC has been in operation for around 10 years. Until autumn of 1996, there was no an archive system which uses an unified way of collecting and storing BEPC data for the off-line retrieval and analysis. The experience of running the BEPC machine showed that if we had a detailed record of the machine conditions preserved from a time ago for the comparison, it might have been easier to track changes and locate problems. The requirement of providing such an archive system was raised by more and more people, such as accelerator physicists, machine operators, equipment group people and administrative personnel.

In 1995, a project was started to upgrade the beam diagnostic instrumentation system of the BEPC. The technical solution is formed by the PC-based hardware and software. One task of the project is the creation of an archiving database with the Microsoft SQL server. The database can store beam parameters (such as intensity, lifetime, longitudinal and transverse size, closed orbit position, ...) from the beam diagnostic instrumentation system. The try operation during the BEPC spring run in 1996 showed that the archiving database system functions well and is very useful. A proposal was brought forward to expend the archiving database so that it can store not only the beam characteristics from the beam diagnostic instrumentation system but also all equipment settings and machine conditions, such as power converter currents, the reference magnet field, voltages of accelerating RF cavities, vacuum pressures, etc.

After about half an year of working, the upgraded ar-

chive system was put into operation routinely during the BEPC autumn run in 1996. The system has been running successfully since then.

## 2 SYSTEM DESCRIPTION

### 2.1 Hardware Structure

Figure 1 shows a schematic block diagram of the hardware structure related to the BEPC archive system. There are several PCs distributed at different places and all of them are connected to the Ethernet network. These front-end PCs were added for the purpose of upgrading the beam diagnostic instrumentation system<sup>[1]</sup> and they are mainly used for acquiring beam parameters. Among these PCs, the BIPC7 is served as the dynamic database and the archiving database server. This PC is the Model Compaq ProSignia 300 with a 120-MHz Pentium processor, 256-Kbyte two-way set-associative write-back cache, 64-Kbyte ECC memory and a 4-Gbyte SCSI-type hard disk. The BIPC7 is also equipped with a CD ROM driver and a Model HP SureStore Tape 5000 tape driver.

Many other data of hardware settings and environmental conditions are gathered from the on-line control mini-computer VAX4500 running under VMS.

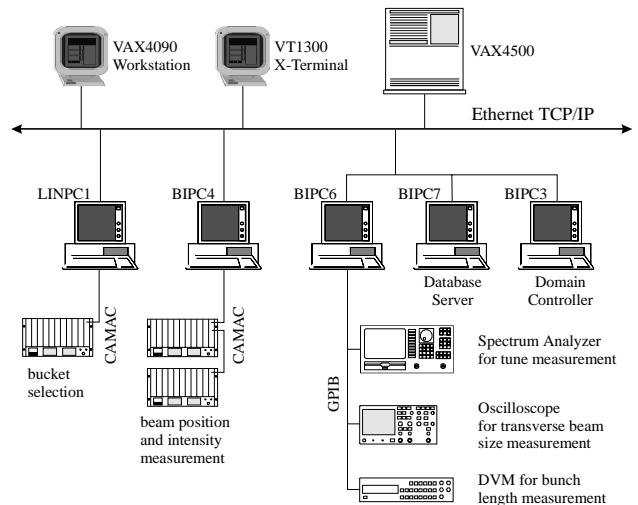


Figure 1: Hardware structure

### 2.2 Windows NT Platform

With the rapid progress of the computer technology, it is difficult to make a suitable choice of a computer model and an operating system. Many issues have to be carefully considered, such as modularity, reliability, hardware and software support, documentation, cost and budget.

Being an excellent application service platform, Microsoft Windows NT Server (Version 4.0 with service pack 3) was chosen as the primary software platform. The Windows NT Server is the network operating system (NOS), and also the application server. It is the most stable operating system for the IBM PCs or compatible and has a good price-performance ratio. All PCs used in the BEPC beam diagnostic instrumentation system are members of a Windows NT domain (called BEPCBI) for the security and easy management considerations. As it can be seen in Figure 1, the BIPC3 is the primary domain controller. Both Windows NT Workstation 4.0 and Windows 95 operating systems are also used for some client PCs.

### 2.3 Client/Server Model

The software of the system is based on the client/server model which is the most commonly used paradigm in constructing distributed applications. Figure 2 shows the software structure of the system. It can be divided into three layers. The server application running on BIPC7 plays a role of a dynamic database server and provides access to the dynamic database. This is the key application program in the system. The server application services the requests from the client applications which are distributed on the various PCs and VAX computers.

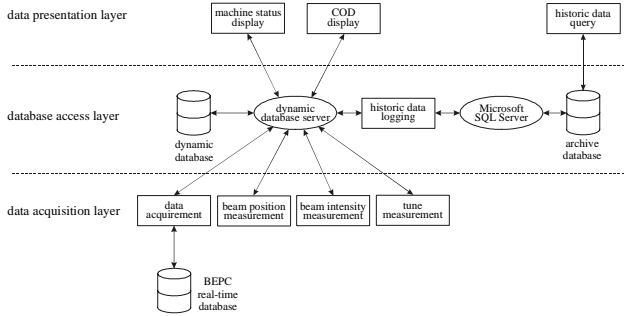


Figure 2: Software structure

The dynamic database is used as a data buffer between the data acquisition layer and the data presentation layer. It stores all important data of BEPC. The data taking rate varies from 1 to 60 seconds, coming from several data acquisition client applications. One of the client applications written in the Microsoft Visual C/C++ obtains the data from the dynamic database and stores them to the archiving database at the fixed time interval of 60 seconds.

Because PC and VAX computers in the system have different operating systems, a suitable network communication protocol has to be chosen. TCP/IP is such a protocol. The inter-process communication between the server and client applications relies on the TCP/IP socket library. The connection oriented transmission control protocol (TCP) is used for providing a reliable data delivery.

### 2.4 Microsoft SQL Server

The kernel of the archive system is the Microsoft SQL Server (Version 6.5) relational database management system (RDBMS) which is well integrated with the Microsoft Windows NT operating system. It is specially designed for the distributed client/server computing environment. We benefit from its internal data backup system, strong data management tools and the open client/server architecture.

Any computer connected with the BEPC network can be a client to the archiving database server, requesting get/put operation of values in the archiving database.

## 3 DATABASE IMPLEMENTATION

### 3.1 Database Structure

Within a relational database, data are stored in tables. There are eight tables in the BEPC archiving database. These tables are:

- R\_PS\_MAIN\_yymm
- R\_PS\_CORR\_DESI\_yymm
- R\_PS\_CORR\_IMON\_yymm
- R\_BPM\_yymm
- R\_INJ\_VA\_RF\_yymm
- R\_BI\_yymm
- T\_PS\_DESI\_yymm
- T\_PS\_IMON\_yymm

The names of the tables are self-explanatory, such as the table R\_PS\_CORR\_IMON stores the read-back values of the power converters for corrector magnets of the ring. The yyymm is a 4-digit number which means the year and the month in which the data were filled into the table.

Eight new tables can be generated at the first day of each month. Any of the eight tables has two fields (columns) with the same names, \_date and \_time. These two fields store the date and the time at which the data filling was taken. All other data in data columns of a table have the float-point data type.

### 3.2 Data Filling

The filling of the archiving database is done by a Microsoft Visual C/C++ program called "wrdb" with embedded SQL. The program taking data from the dynamic database and filling them to the appropriate table of the archiving database at a fixed time interval. Only data available in the dynamic database can be stored into the archiving database. A corresponding new record (row) is always appended to each table with a same date and time values, so the data in the different tables can be correlated with the common fields \_date and \_time.

The aim of the archive system is to provide a long term historic records of the machine, it is not a tool for the fast recording to study transient events. So the time interval is set to 1 minute to keep the disk space required to a reasonable size. All data logged is to be kept on-line for at least one year to allow comparison with data of the previ-

ous year.

The TCP/IP protocol is used for taking data from the dynamic database and the Open Database Connectivity (ODBC) enables applications to gain access to the SQL Server database.

### 3.3 Data Retrieval

The Microsoft Query tool, which has been integrated into the Microsoft Office, is used for the data retrieval. One can use the Microsoft Query to retrieve all and part of a set of data that is stored in the archiving database. You can view, edit and organize the data and insert the data into a windows-based application file, such as a Microsoft Excel worksheet.

Figure 3 shows a window of the Microsoft Query. There are three panes in the window. The table pane at the upper part of the window displays the field lists for the tables you add to the query. The tables contain the fields from which you retrieve data. When there are two or more tables in the table pane, each table must be connected by the join line(s) to another table. The data pane at the lower part of the window displays the result set Microsoft Query produces after you add fields from the table pane to the data pane and run the query. The criteria pane in the middle part of the window displays one or more conditions you specify to limit which records are included in the query's result set in the data pane.

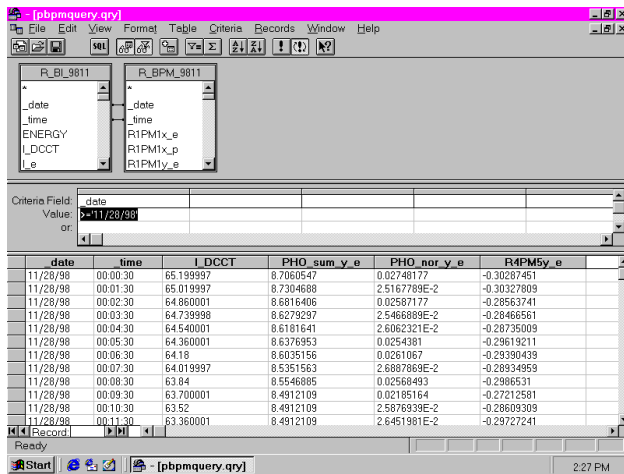


Figure 3: Data query window

Users can also put/get their data to/from the archiving database in a C/C++ program via the ODBC library.

### 3.4 Data Backup

For a computer based system, one of the most important things is the data. The data backup process has the special position in the whole system.

The SQL server database manager provides enhanced backup and recovery capabilities. Individual tables can be backed up and restored. A table restore can be performed from a table backup or full database backup. The SQL

server database manager also provides the capability of scheduling a backup task to occur on time or on a recurring schedule.

In our case, the table backup is used because the restore of a table is useful and easy in a disaster recovery situation. Each table has been backed up automatically onto the hard disk weekly. Under the present conditions, about 150 Mbytes of archive files are created per month for backing up all of 8 tables. These data are kept on the hard disk only for a limited period of time and then are copied to the tape or the compact disk (CD) to make the hard disk space available for new data.

The backup is performed in an on-line manner without interrupting the data storage.

## 4 SUMMARY

The BEPC archive system based on the Microsoft SQL Server 6.5 and the client/server model has been in operation since the October of 1996. After using the archive system for more than two years, it has been proved that the system is fully operational and useful. Over 2-Gbyte data have been stored. These data include the beam characteristics, hardware settings and environmental conditions of BEPC. All the data logged have been backed up to the off-line media. The technical support and data query services are also provided by the BEPC beam diagnostic instrumentation group.

At present, the data are filled into the archiving database at a fixed interval. The data filling for different data with variable time intervals is in consideration. The data publication on the World Wide Web is underway. The upgrade the Microsoft SQL Server from the version 6.5 to the version 7.0 is also in consideration.

## 5 ACKNOWLEDGMENTS

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