GENERIC CONFIGURATION MANAGEMENT SYSTEM FOR DOCUMENTATION AND ON-LINE BEAM OPTICS APPLICATIONS IN THE CERN PS COMPLEX

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Abstract

The new CERN ACcelerator Information System (ACCIS) is being used for the description and documentation of the PS complex particle accelerators. The accelerator elements are defined in ACCIS as components of a certain class. Each class has a number of attributes describing the element e.g. the dipole class will hold specifications such as magnet length and physical properties such as calibration coefficients. The layout of the machine is described in a hierarchical structure in which the components are linked to each other. The communication between the database and other programs is done with application dependent "filters". One of these filters will provide the reference input data to a beam optics program (BeamOptics). The reference data can also be updated with the actual current settings. Then the current characteristics of the accelerator can be visualized and evaluated for comparison with independent measurements. Discrepancies between predictions and experiments may thus help in fault finding and optimization. We will here discuss i) experience gained in analyzing and describing the PS Booster, ii) the linkage of application programs to the database and iii) a generic beam optics application using the database.

1 INTRODUCTION

To achieve good agreement between the calculated and measured beam properties in an existing accelerator or transfer structures it is essential to have precise and up-to-date input data. Surprisingly enough this is often the biggest problem encountered when approaching a beam optics problem in an existing structure. The difficulty is that accelerators are evolving structures with many sub-groups and many people working within the different sub-groups e.g. changes are usually well documented within each section of the machine but are not always communicated to or/and recognized by the others. Modern computer based documentation systems in combination with easy to use user-interfaces, such as the World Wide Web, offers an alternative solution to classical documentation procedures. The documentation can, as earlier, be done within each sub-group of the machine but a common documentation system is used to which all people working at the machine have controlled access. Furthermore, software using information available in this documentation can get it directly from the common database which avoids problems with ambiguous and aging input files. CERN is presently evaluating available commercial engineering data management system (EDMS) and will in the future make such a system available for all CERN users [1] . However, considering the urgent need of a magnet and instrumentation database for the ABS project (Automatic Beam Steering) project at the PS complex the work on making such a common documentation database for the PS Booster has already been started [2] . We are for this project using the CERN developed accelerator information system, ACCIS [3] and we have implemented a common documentation of all magnets, some instrumentation and power supplies.

2 ON-LINE DOCUMENTATION AT THE PS BOOSTER

2.1 Structure and organization of PS Booster database

The simplest version of generic data handling software is probably a spread-sheet like *Excel*. However, when the amount of data severely exceeds what can be easily made visible on the computer screen it becomes both cumbersome and difficult to both access and use such a sheet. A good alternative at this stage is to store the data in a database rather than in a spread sheet.

The database contains the definition of a number of classes, each of which is described by a number of attributes. An instance of a class is called an item e.g. the first vertical correction dipole in the Booster injection line is an item called BI.DVT10 (an instance of the class called ELEMENT) and it is described by attributes like magnetic length, position and magnetic field as a function of current. Some of the attributes describing a certain element might be common for several elements and grouping these attributes in a new class will make it possible to use the same reference for several elements. The sub-grouping enables the use of a single basic class for all elements as the differences between e.g. a quadrupole and a dipole only appears in the sub-groups. All elements in the Booster database is of the basic class ELEMENT but e.g. the in-situ properties for a quadrupole is stored in items of class “QUADRP SITU” and the specifications for dipoles is stored in items of class “DIPOLE SITU”.

The description of the individual items holding the data for all elements can obviously be organized in different ways. A common way is to use alphabetic order chronology order or some form of structural order. In the PSB we have chosen to store the elements in a hierarchical way which resembles the layout of the machine (see figure 1). The top-level is the PSB machine and under that the different parts of the machine such as the booster injection section and the booster ring are found. In some parts of the machine it is necessary to continue with more sub-levels e.g. the booster ring has a sub-level of the four rings, the four rings has a sub-level consisting of the 16 periods and only in the periods the individual elements can be found.

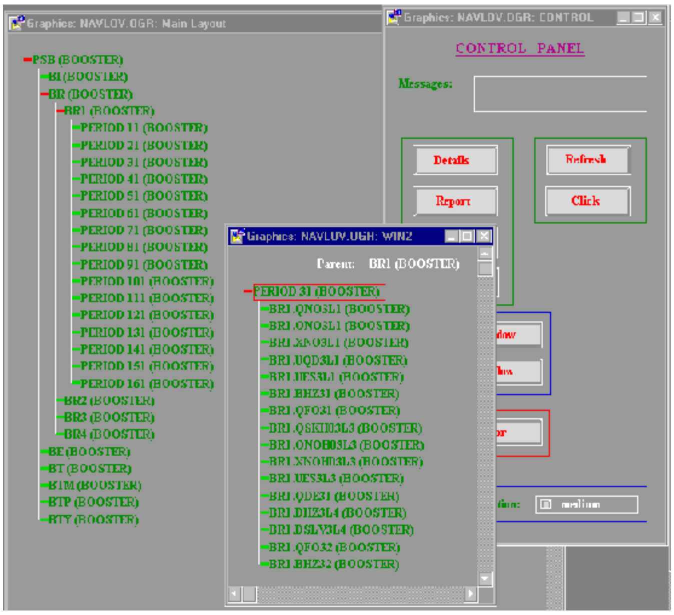


Figure: 1 The individual elements are stored in a hierarchical structure which resembles the layout of the machine e.g. for the booster ring (BR) there is a sub-level consisting of the four rings (BR1, BR2, BR3 and BR4) and a further sub-level consisting of the 16 periods (PERIOD11, PERIOD21 etc.). The extra index on the period names is necessary to get a unique name for each period within each ring.

The responsibility for keeping the data complete and up to date falls on the different subgroups who can have very different views of the machine. The person responsible for the power supplies might think of the power supplies rather as belonging to different buildings, rooms and racks than to parts of the machine. Furthermore, he or she might also be responsible for power supplies belonging to more than one machine. These differences can in the database be reflected by organizing the individual items in different environments (or contexts) e.g. the *layout environment* consisting of a layout structure with all the different elements and the *power supply environment* consisting of the power supply structure (building, room and racks) and the individual power supply descriptions. Hierarchies of elements can be made up of items belonging to other environments enabling people accessing the layout environment to see the power supply associated to an element rather than as part of a certain building, room and rack.

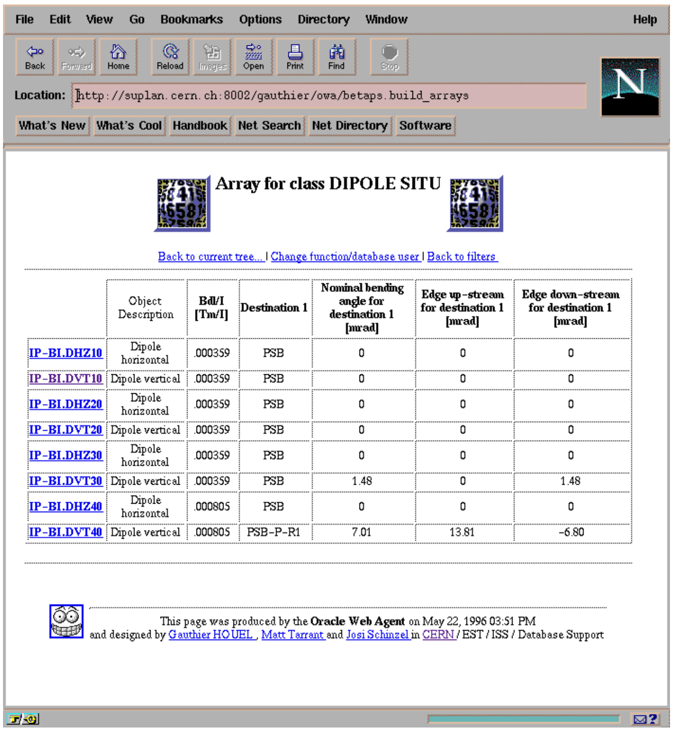
2.2 ACCIS

The PS Booster database is presently maintained using the CERN produced ACcelerator Information System (ACCIS). ACCIS is an ORACLE based Generic Configuration Management System capable of dynamic documentation of any complex system or organization. The data can be accessed either via an ORACLE form interface or a Word Wide Web interface.

In ORACLE forms the data is accessed through a number of graphical menus in which elements, classes and structures can be created, changed, deleted etc. After choosing an environment the user will get access to the "raw-data" through a menu from which the user either can work with individual elements disregarding the hierarchical structure or work with or within the structure itself. Examples of the ACCIS environment can be seen in figure 1.

The Word Wide Web interface for the database can presently only be accessed for data-retrieval. The interface follows the general structure of the database and includes a number of facilities for displaying and comparing data. In figure 2 we have listed selected attributes for all dipoles in the injection line using the Web interface.

The reliability of the database depends entirely on the routines for entering and updating the database. To this end ACCIS has a very efficient series of management routines. The security routines are such that we can allow individual specialists both read and write access to the database.



	Object Description	Bdl/I [Tm/I]	Destination 1	Nominal bending angle for destination 1 [mrad]	Edge up-stream for destination 1 [mrad]	Edge down-stream for destination 1 [mrad]
IP-BI.DHZ10	Dipole horizontal	.000359	PSB	0	0	0
IP-BI.DVT10	Dipole vertical	.000359	PSB	0	0	0
IP-BI.DHZ20	Dipole horizontal	.000359	PSB	0	0	0
IP-BI.DVT20	Dipole vertical	.000359	PSB	0	0	0
IP-BI.DHZ30	Dipole horizontal	.000359	PSB	0	0	0
IP-BI.DVT30	Dipole vertical	.000359	PSB	1.48	0	1.48
IP-BI.DHZ40	Dipole horizontal	.000805	PSB	0	0	0
IP-BI.DVT40	Dipole vertical	.000805	PSB-P-R1	7.01	13.81	-6.80

Figure: 2 Selected attributes can easily be displayed and compared using the Web interface. Here the nominal bending angles and pole face geometry are displayed for all the dipoles in the injection line.

3 LINK BETWEEN DATABASE AND APPLICATION PROGRAMS

Two application programs of the ABS project, called *BeamOptics[4]* and *CorrectionMatrix* need optical parameters of the elements to run. These parameters correspond to the attributes of the elements stored in the database. Consequently, with a specific filter, called *Selector* in *Mathematica*, we can select raw information from the database. The filter will return a list of elements organized according to the format of the calling application e.g. the input data for the PS Booster ISOLDE transfer line would be retrieved with:

Selector["BOOSTER","BTY","BeamOptics","ISOGPS"]

(used in the example in fig. 3). In the framework of ABS, the output of the *Selector* is a sequence of elements (with their optical parameters) corresponding to what the beam will "see" when it runs through the accelerator.

With our prototype filter, the *Selector*, we have established the possibility of using a general dynamic link between *the* database and *BeamOptics.* (and thereby increase the capacity of Mathematica applications). The output of the *Selector* might be used in several ways e.g. producing ASCII files for the use in popular application programs. For the future we plan to implement a more generic version of the selector where the user through an interface can control the selection and destination of the data.

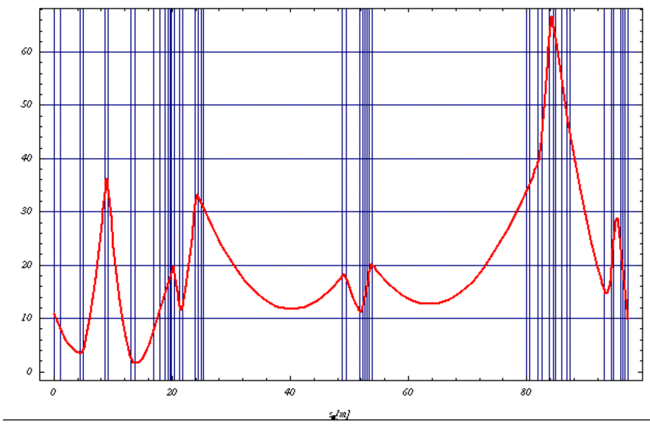


Figure: 3 The *BeamOptics* program can be used in operation with the help of an interfacing program in the PS control environment. We have here plotted the beta function along the ISOLDE transfer line at the PS Booster.

4 GENERIC ON-LINE BEAM OPTICS PROGRAMS

Modern analytical program packages, such as *Mathematica*, offers an alternative analytical approach to some of the more common problems within beam optics. The aim of the ABS project is to with such an approach introduce on-line beam optics applications as part of the standard control environment. At the PS Booster a program for automatic beam trajectory corrections is already being used for optimization of the transfer line between the PS and the PS Booster.

We are now working on a generic on-line beam-optics program which we believe will be highly useful both in operation and for machine experiments. In its simplest version typical beam properties like beam dimension and Twiss values can be plotted along any beam-line for both the actual setting and the nominal setting. We picture it being used for both diagnosis and quick cure in operation and for machine studies (e.g. commissioning of new structures and matching studies). The program accepts input data from the user, exports the data to the *BeamOptics* package and imports the produced plots for display, see figure 3.

The database also holds geometrical data, such as inner dimensions of vacuum chambers, and calibration factors. In a future version of the on-line beam optics applications program we plan to include overlay plots of beam constrains and a more dynamic on-line modeling of beam properties using actual and proposed settings on the active elements in the line.

5 CONCLUSIONS

Generic beam optics calculation programs have already proved to be highly useful but they depend on correct and up-to-date input data. The PS Booster database is serving as an on-line input file for the beam optics application program produced within the ABS project.

The database is presently mainly holding necessary data for beam optics application and will hopefully also serve as a common on-line documentation database for the PS Booster. The validity of the data depends critically on participation from all groups working at the PS Booster in the maintenance of the database. A general support for keeping the database up-to-date is facilitated by having a user friendly software as an interface to the database. We have found that the presently used interface, ACCIS, already is fulfilling most criteria's for being a suitable link. However, the development towards using the Word Wide Web as the main environment for the interfacing software seems to have a big potential and the support of the users.

REFERENCES

[1] J.-L.Chevalley et al., Progress Report of the Engineering Data Management System Task Force, LHC/96-03 (VAC), or see http://cadd.cern.ch/cedar/

[2] V.Ducas, A.Kazymov and M.Lindroos, Documentation of the PS Booster using an ORACLE database, PS/OP/Note 96-22

[3] J. Schinzel , Software Specification for a ACCIS- An ACCelerator Information System, Oct.95,.

[4] B.Autin and E.Wildner, BeamOptics a program for symbolic beam optics, PS/DI/Note 95-18