7 High Level Beam Handling

After the initial setup, the beam will need some refinements. The *tune* and *chromaticity* may need to be changed. There are routines, also available in *libcoc.a*, that calculate the deviation of the corresponding power supplies. This deviations can easily be effectuated and restored. It is often desirable to create a local distortion near the injection point and extraction point. In the *libcoc.a* library there is a routine that uses the *lattice* file to calculate the necessary offsets of the steering magnets. Such a distortion - called a *bump* - is expressed in terms of position and angle of the stored beam. It is possible to create them at any point in the ring.
The final refinement, known as *Closed Orbit Correction*, is established using the stripline monitors. There are 32 of these monitors placed along the ring and are not beam interfering. They yield a horizontal and vertical displacement. The ADC readout of the monitors is passed to a special program, called *rococo*. This program calculates an offset for all steering magnets in order to create a reproducible and optimal beam.

8 AmPS Magnet Graphical User Interface

A set of GUI's was developed to handle all items described above. The GUI's were designed using the *DataViews* interface builder. The main GUI shows a basic layout of AmPS with the choice of viewing a certain aspect, e.g. the beam-interfering monitors or a family of magnets. Several other GUI's are available, all handling a specific item, among them a GUI for the *tune*, *chromaticity* and *bumps* of the beam.

References

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on the operation mode. In fact the coefficients are the normalized beam width, the angle and the correlation between the elements. The file starts with the first element from the injection point, going around in successive order until the last element just before the injection point. The lattice file is available on all hosts in our network. A special library, *liblattice.a*, is made to retrieve any information from the *lattice* file.

5 Global Magnet Data

As mentioned above, the beam is kept in orbit by a set of 200 magnets. The following list gives a brief overview.

- **dipoles** (32 in total). They are placed in the curves of AmPS to bend the beam over 90°. Eight dipoles are placed in each curve and all of them are powered by a common power supply.
- **quadrupoles** (68 in total). Magnets of this type are scattered along the ring. Due to the symmetry, the quadrupoles can be divided into 10 families, which are controlled by common power supplies. They are placed at well defined positions to achieve a global effect on the beam. Two families are responsible for the *tune* of the beam.
- **sextupoles** (32 in total). Almost the same story as for the quadrupole magnets. They are grouped in 2 families, each equipped with a common power supply, and are directly responsible for the *chromaticity* of the beam.
- **steering magnets** (64 in total). They correct the beam in horizontal or vertical directions and are equidistantly placed along the ring. They are bipolar and each of them has its own power supply. Local distortions can be made by using the steering magnets, as well.

The *tune* and *chromaticity* function are orthogonal with respect to the beam properties.
For an initial setup of the magnets, the following procedure is used. All steering magnets are set in neutral state. Then the energy of the injected beam is determined very accurately. This energy is the main parameter for all derivations. For each family of magnets the relation between the energy and the required magnetic field is known. The relation between the magnetic field and the necessary current is also known. Finally, the relation between current and DAC value, is empirically determined for each individual power supply. All relations are available as functions in a library, called *libcoc.a*. As a result it is very easy to determine an AmPS setting that is sufficient to start with, by calculating the theoretical DAC settings from the beam energy.

6 The Magnet Server

Setting a DAC of a power supply to a calculated theoretical value is not the only action in dealing with magnets. There are some high level algorithms necessary, mostly due to the fact that a magnet has a *hysteresis*. Actions like *cycling*, *degaussing* and *wobbling* are carried out by a server, running somewhere in the network. This *magnet* server, as it is called, has knowledge of all the important properties of the magnets and their attached power supplies. Specific exceptions are thus hidden for the user. Actions like *status*, *reset* and *power on/off* are also performed by the magnet server. The possible user interfaces all make use of this server, via a well defined interface.

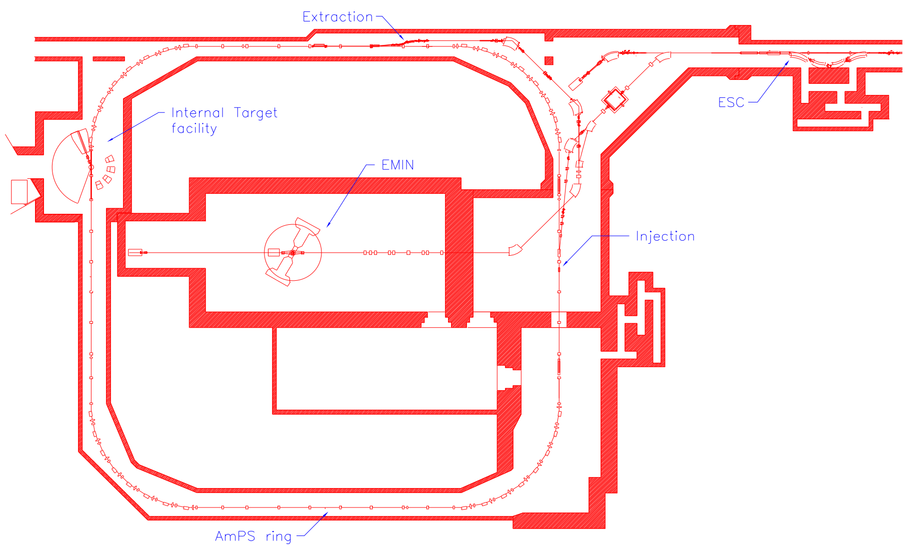

Figure 1: AmPS layout

level actions on the database are carried out by these servers. The user interfaces perform their actions via the servers or directly on the database. The user interface level can be regarded as the top layer.
The local control layer lies below the database layer. These are processes running on a local station, mostly VME based microprocessors. Such a process is dedicated to service a part of the database and is responsible of updating the status variables. Furthermore it takes over updates in its write part of the database and performs the corresponding action.

3 Low Level Magnet Control

The dipoles, quadrupoles and sextupoles are powered by *Danfysik* power supplies and coupled by a *Force* Intelligent Serial I/O-2 VME module. The steering magnets are powered by an in house developed power supply with a local BITBUS node. The BITBUS networks are coupled to VME by an *INCAA* VME-VBB interface module. Each power supply has its own identical control process and for both type of power supplies a driver is written. From the outside the magnets behave the same. A further layering of control is achieved by splitting the magnet control in a hardware dependent (driver) process and a logic process.

4 The Lattice File

The main objective of the AmPS magnet control is to achieve a reproducible beam. Quantities like *tune*, *chromaticity* and the ability to create local distortions, had to be incorporated in the control system too. The foundation of beam manipulations is the so-called *lattice* file. This file describes AmPS in terms of the beam optics and the interactions between the different components and beam properties. It is a plain ASCII file, which makes it easy to modify, with on each line a magnetic element with its length and matrix coefficients of the transformation function depending

AmPS Magnet Control

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Abstract

The Amsterdam Pulse Stretcher AmPS is injected by the Medium Energy Accelerator MEA (Emax < 1 GeV). The beam in the stretcher ring is controlled by 200 magnets of various kinds: dipoles, quadrupoles, sextupoles and steering magnets. Some of them are controlled by a single power supply, others share one to be part of a family of magnets. The power supplies are part of the distributed control system. They are interfaced by VME modules and BITBUS networks. A special *magnet server* was created, which enables the operator to perform high level actions on the magnets, such as: *cycling*, *degaussing* and *wobbling*. Also a set of *Closed Orbit Correction* routines was developed to calculate the theoretical values for the power supplies to maintain a stable beam in the ring. This set also contains routines to calculate physical quantities as *tune*, *chromaticity*, and local distortions (*bumps*). The set of library routines obtains its information from the *lattice* data of the ring. A set of GUI's was designed to make use of all the capabilities.

1 Introduction

The Amsterdam Pulse Stretcher (AmPS) is a circular electron beam guidance system with an outline of 212 meter. It is meant to store electrons with a maximum energy of 1 GeV. The Medium Energy Accelerator (MEA) is used as an injector, delivering a pulsed beam. AmPS is used in two different operation modes: storage mode and stretcher mode. In storage mode the beam is kept inside the ring in order to enable experiments with internal targets. In stretcher mode an injected beam is gradually extracted towards the spectrometer, thus getting a high duty factor ($> 90\%$). Several monitoring devices, such as beam profile monitors, stripline monitors, synchroton monitors and beam viewers, are applied to examine the beam. The beam is guided by a set of 200 magnets of different kinds: dipoles, quadrupoles, sextupoles and steering magnets. The power supplies of the magnets are integrated in the distributed control system and remotely accessible.

2 The MEA/AmPS Control System

Between the operator's user interface and the actual DAC setting, several layers can be distinguished in the control system. The most important one is located in the middle. It is a *real-time* database, putting the control on a higher and more abstract level. It contains all MEA/AmPS variables, both status (*read*) and change (*write*) variables. Modifying a *write* variable results in an action on a lower level. Changes on these levels are reported back in the status variables of the database. The database is accessible from all hosts in our network by means of a well defined interface. Above the database layer a number of *function servers* has been implemented. High