The Proton LINAC Control
as Part of the DESY Accelerator Chains Control System

A. Labudda, DESY, Hamburg, Germany

Abstract

The control system of the DESY 50 MeV Proton LINAC has been replaced by a PC-based distributed system. Applications of radio frequency control for the Alvarez structure and the quadrupoles, inside as well as the beam transport and monitoring system, are reported. The DESY accelerator chains control system [1] – mainly written in Visual Basic – is composed of small and flexible modules which can be linked into one of the three levels for servers, services and operation. Most of the LINAC control applications were taken from these modules with no or slight modifications.

1 INTRODUCTION

The first step in accelerating protons for the 920 GeV superconducting storage ring HERA is done in a linear accelerator called LINAC III. The protons, in the form of H^- ions, are generated in a magnetron source and are accelerated by several RF cavities (radio frequency quadrupol RFQ and Alvarez structure). The beam is focused by quadrupol magnets most of which are running in a pulsed mode and bent by permanently powered dipol magnets. Intensity and position of the beam are controlled at different positions down the beam line. The momentum for a small amount of the particles is measured after stripping the two electrons of the H^--ions. Thus turned into protons these particles are counterbended by a dipol magnet and turned towards a multiwire monitor (harp). All this equipment – complemented by controls for vacuum, temperature and beam burst triggering – is handled by a LAN linked PC system, which is in accordance with the DESY standard of distributed PC control for particle accelerators.

The basic features of this PC based system are

- Employ one PC for each group of devices as a server for one line of a „Serial Data Acquisition and Control bus“ (SEDAC [2]) dealing with several crates of device control units.
- All server and console PCs needed for one accelerator are gathered in one LAN segment. Broadcast messages play an important part in data communication and are send to all PCs in the segment.
- The server PCs regularly send the equipment status of their devices into the LAN-Segment by broadcast (”Updating”).
- The server PCs listen to the LAN for equipment control commands (”Operating”, ”File Handling”).
- Client applications are running on consol PCs.
- The consol programs listen to the LAN and display the actual status and recent monitoring.
- The consol programs also accept commands entered by an operator and communicate them to the respective server (operating).
- Program coding is done in Visual Basic supported by C based functions for Visual Basic extension.

Except HERA-P all of DESYs current particle accelerators are controlled or will be controlled by an instance of this control system for particle accelerators.

The LINAC III instance of the DESY accelerators control system has been designed and implemented since fall 1997. The project is almost done for all the components.

The magnetron source is still under control of a Norsk Data mini computer.

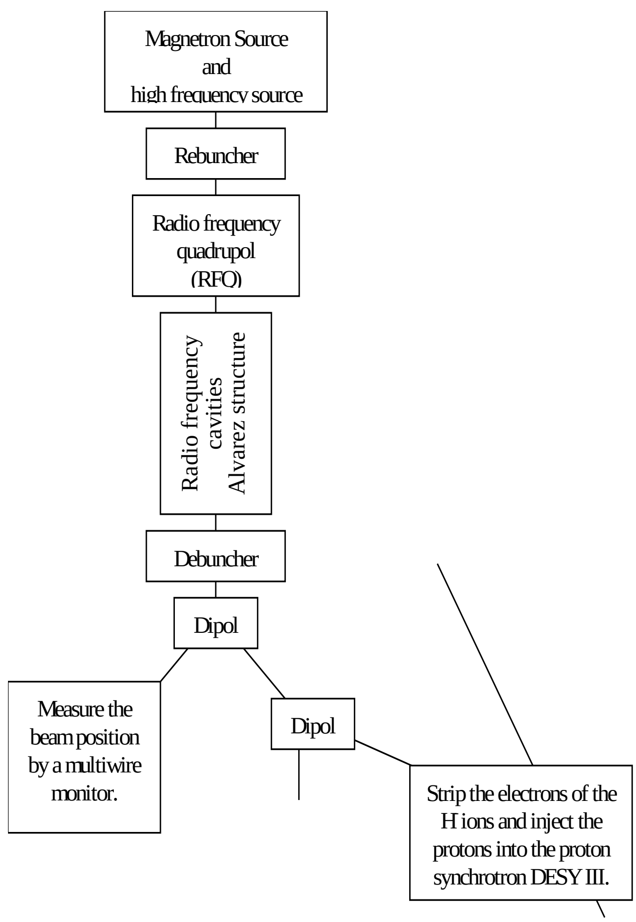

Figure 1: Schematic picture of the LINAC III

2 TOPICS OF LINAC III DEVICE GROUPS.

2.1 Radio

The radio [3] application is the control systems heart-beat. With a frequency of 1 Hz the application sends a data packet, called the „Cycle Message“, into the LAN. The Cycle Message contains the primary description of the accelerators state, like energy, current and the unique number of the particular Cycle Message.. By receiving the Cycle Message, every device server is doing the „update job“, i.e. read out of all of its devices present data and broadcast this data into the LAN.

2.2 File Operator

The file operator [4] is used to store and reload satisfactory device settings for a group of devices or all devices of an accelerator. The file operator is separated in two parts, the client and server. The client is the operators user interface. By the client the operator is able to manage the file list and send synchronised commands to the server. The LINAC III file operator is the same for any of DESYs accelerators, except HERA.

2.3 Multiwire Monitor

The harps consist of 32 wires for each monitor. Beam particles hitting the wires are discharged. The charges were gathered and amplified to create digital profiles of the beams x- and y-axis. The beam profiles are used to calculate the LINACs emmitance and energy. The software’s job is to read beam profile by the harps analog digital converter. Another job of the software is to read and set the harps position inside the beamline.

2.4 Monitoring

The LINAC III has got some groups of monitors to inspect the LINAC’s state. The different monitors observe the device temperature, magnetic fields, the beam current and the beam position. Every device server has to read out the monitors, triggered by the radio software. Additionally the beam position monitor has to move the monitors foil into or out of the beamline.

2.5 Correction Magnet

The correction magnets [5] of the LINAC III are situated between the Alvarez structure and DESY III to control the beam. The software was taken from the former developed instances of magnet control. Because of this reason the magnets device manager [5] and the connection to file operating is the same as any of DESYs accelerators.

2.6 Pulsed Magnets

There are 84 magnets to focus and steer the beam in the Medium Energy Beam Transportline and in the Alvarez tanks. The magnets are running in a pulsed mode because of the limited cooling capacity inside the Alvarez tanks. The programs by which they are operated are developed from those used for the main magnets. As most functions of the pulsed magnets are the same as of the other magnets, there is no difference in the program structure. Slight alterations had to be done considering different functionality (e.g. delays) and different modules controlling the power supplies.

2.7 Main Magnets in the High Energy Beam Transportline

In the High Energy Beam Transportline there are 18 quadrupoles and dipoles for focusing and beam steering. They are used by direct current power supplies. As the models controlling them are the same as in other DESY accelerators, the programs used there could be used here without alteration, with a different setup data only. The program set consists of a standard device manager [6] (a console program, by which each single magnet can be operated), a device server program which performs these operations, a device server program triggered by the radio which collects all magnet data and sends them into the LAN by broadcast and another device server program which serves the file operator.

2.8 RF and Cavity Tuning Control

There are now six cavities in LINAC III. The most important ones are the RFQ and three Alvarez tanks. They do the work of accelerating and partly focusing the beam. A rebuncher cavity between RFQ and the first tank as well as a debuncher between the last tank and DESY III only optimises the beam with respect to the input requirements of the next accelerator. The cavities are tuned to a RF frequency f_0 = 202.56 MHz. They are resonating at a duty cycle of typically $0.25*10^{-3}$. Radio frequency fine tuning of the cavities is done by motor driven piston tuners.

On the consoles there are service programs for switching the RF transmitters, phase and amplitude modulations and cavity tuning. Control items for these procedures are placed on a block-diagram-like background picture relating status and error flags, setting and monitoring values to their respective hardware in a simple way.

2.9 Oscilloscope

Every accelerator has between one and four oscilloscopes for signal diagnostics by the operator. There is one oscilloscope in LINAC III. Signalmultiplexers are used to see different signals on the scopes display. The whole set-up of multiplexers and scopes can be saved and loaded by operator commands. The scopes curve data is read out every second for further signal diagnostics by the software. The same software is also used for other accelerator controls. Oscilloscopes have not been supported by the former “Norsk Data mini computer control system”.

2.10 Vacuum

The LINAC III vacuum is separated in 6 sections. Between two sections a valve is installed. Every vacuum section has got vacuum measuring devices and vacuum pumps. Because of the huge area from normal air pressure to vacuum two different types of vacuum measuring devices and vacuum pumps are used.

Three device server, used for getter pumps, turbo pumps and valves, get all vacuum data. The server triggered by the radio to read the present data of the devices. The data is send into the LAN by broadcast. They can be displayed by the servers dedicated console applications. The console applications display the devices data with an optional history of one hour.

A more detailed description of Vacuum Control Systems Upgrade and Analysis Features is presented in these proceedings [7].

2.11 Beam Chopper

The beam chopper is used to cut the roundish signal of the beam source. The result is a pulse of the beam with sharp edges and well defined timings. Another job of the beam chopper is to optimise the beam length with respect to the input requirements of the next accelerator DESY III.

The beam chopper is controlled by the PC. All of the adjustments are taken every second and can be set by the operator using the beam choppers device manager or the File operator. The beam chopper software will be used to control the electron LINAC too.

3 CONCLUSION

The new LINAC III control system was built to replace the previous Norsk Data mini computer system. Because of the small and flexible application modules the upgrade was done in a short time. Applications with no device access like the radio could be copied directly from other acclerators control systems. If the same devices had been used at an upgraded acelerator control system, the source could be copied directly, too. Only the setup data had to be created new. Finaly the expenditure of porting an application from one accelerator control system to another depends on the compatibility of the devices. The range of spended time is from hours up to 6 months, e.g. the software of the scopes was copied from PETRA, the data base was created in one hour. The LINACs RF is a unique device. It took six months to rewrite the software.

4 REFERENCES

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