A FLEXIBLE CONTROL SYSTEM FOR AN ELECTROSTATIC STORAGE RING*

Carsten P. Welsch[1], Holger Liebermann, Alwin Schempp, Institut für Angewandte Physik
Horst Schmidt-Böcking, Institut für Kernphysik
Johann Wolfgang Goethe Universität
Frankfurt am Main, Germany

Abstract

An electrostatic storage ring for all different kinds of ions of energies up to 50 keV has been designed at IAP, Frankfurt. One main point of interest is the knowledge of the beam parameters around the ring. Different diagnostic elements, including pick-up probes, scrapers and single particle detectors are part of the system. The whole system is completely remote controlled by a LabView / Group 3 control system. Direct analysis of the received data is possible and part of the control system. The different diagnostic elements will be presented, the structure of the control system shown and possibilities of data analysis discussed.

1 INTRODUCTION

The main difference between "classical" magnetic rings and electrostatic rings is the mass-independence of the fields in the electrostatic case. Once the injection energy and charge state of the particles to be stored have been fixed, the mass of the ions does not affect the fields in the bending or focussing sections. Stray magnetic fields from the ion pumps and surrounding magnetic fields slightly alter the particles' trajectories and require adjustment [1].

The beam diagnostics has to take into account that the ion species to be detected will change into a wide range. Online set-up and control of all the beam parameters is necessary as well as fast analysis of the data.

2 FIELD CONTROL

At IAP a quarter of an electrostatic storage ring is begin build up. Although the final design of the whole machine has not been determined yet [2], this section already contains all the necessary optical and diagnostic elements.

Basis of this system is a Group3 PC interface card connected with an external CNA control module and analogue input / output cards via glass fibers.

Figure 1 shows the main screen of the control system. The present values set in the different supplies are shown. Direct access of all the elements in the section is possible by a simple mouse click.

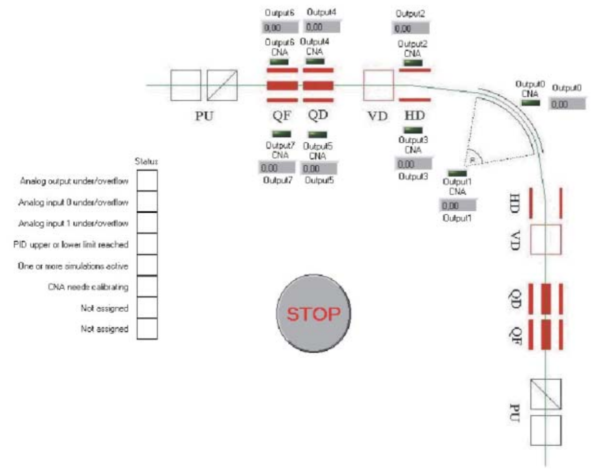

Fig. 1: Main screen of the control system

Figure 2 shows the corresponding LabView diagram.

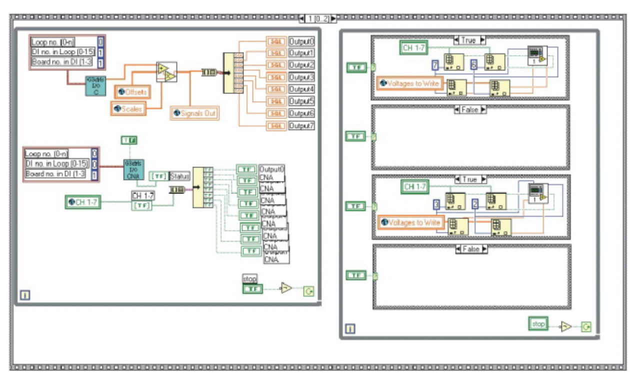

Fig. 2: LabView Diagram of the main screen

A following, more detailed screen allows the setting of every parameter of the supplies. The voltages are read / set simultaneously.

*Work supported by BMBF
[1]electrostatic.ring@sunkist.physik.uni-frankfurt.de

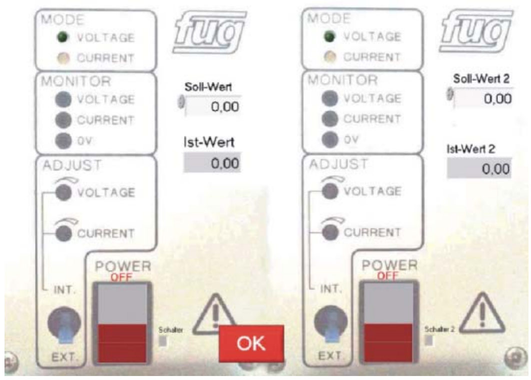

Fig. 3: Control Screen of the voltage supplies

The LabView diagram of this screen is given in figure 4. Different modules have been written for the supplies in the quarter ring. Fast adjustment of the fields is possible.

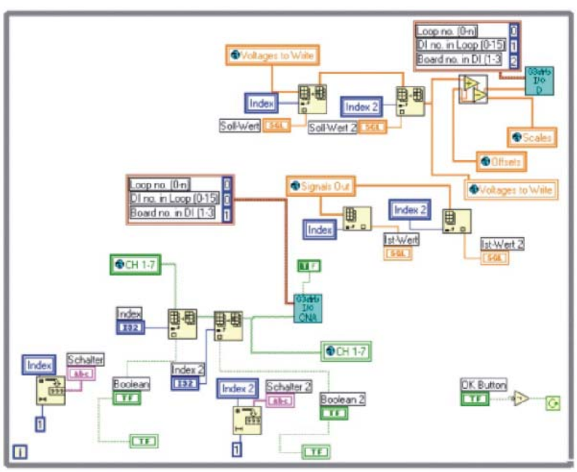

Fig. 4: Close-Up View of the voltage supply module

Each of the 18 voltage supplies can be accessed directly and different field setup-ups can be stored in the system.

3 BEAM MEASUREMENT

During Operation, the position and longitudinal behaviour of the beam has to be known at all times. The ions are always injected in bunches of about 10^7 particles allowing current measurement with the help of induced voltages. Pick-up electrodes of the shoebox type as shown in figure 5 are used for that purpose.

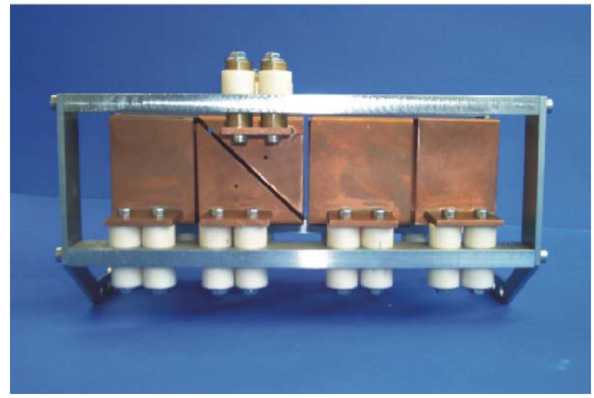

Fig. 5: Electrostatic Pick-Up

The diagonal cut leads to a linear response function. The position of the beam can be determined by measuring sum and difference signal of the induced voltages of the passing beam

$$x = \frac{h}{2 \cdot \alpha} \frac{\Delta}{\Sigma}$$

In our case, the width of the electrodes is $h=50mm$.

Since stored ion current will be in the region of a few *nA*, an excellent signal-to-noise ration in the amplifier is necessary in order to obtain good measurements. The layout of the CERN AD head amplifier has been used for that purpose [3].

The amplified signal is recorded by a Tektronix TDS-224 digital oscilloscope. An internal FFT module allows direct analysis of the signal.

Fig. 6: TDS-224 4-channel digital oscilloscope

All four channels are permanently transmitted to the workstation via its GPIB port. LabView records this data and allows exporting it in different formats for further analysis.

Mechanical collimators in both the radial and vertical direction are used to calibrate the measurements with the pick-up electrodes. In combination with neutral particle detectors at the end of the straight sections of the ring, measurement accuracy in the range of a tenth of a millimetre is possible.

In addition to the above mentioned diagnostic elements, destructive methods, including a faraday cup for current determination and a device for emittance measurement will be used. These methods are available at IAP and also completely remote controlled. A future step will be the incorporation of these elements into the control system and development of one single program for complete analysis of the beam parameters.

Depending on the experiment, beam properties not covered with the present diagnostic elements might be of interest. The developed system allows easy incorporation of additional modules and extension of the analytic functions.

4 ACKNOWLEDGEMENTS

The authors would like to thank Lars Søby for the help with the head amplifiers and Søren Pape Møller for his support with all occurring problems.

This work was supported by BMBF and Studienstiftung des deutschen Volkes.

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