

DATA OBTAINING AND PROCESSING SOFTWARE FOR ION-BEAM MONITOR AT THE FRANKFURT 14GHZ ECRIS

A. Kayukov, V. Alexandrov, M. Koryovkina, O. Strekalovsky, K.E. Stiebing

Abstract

A program package for control of the beam monitor, data acquisition and the subsequent processing is developed. BMCM PC20 and PCI300 input-output cards are used for control and data acquisition. The control program is written on VisualC, the processing program is written on LabView. The control program allows to supervise position of a beam in real time and to save data files for two types of monitors. The processing program enables the preliminary analysis of the data and to calculate emittance of the ion beam.

DESCRIPTION OF THE INSTALLATION

The ion beam monitor for definition of x/x' and y/y' emittance has been developed and tested at the ERCIS facility in Frankfurt IKF[1]. The monitor consists of a specially shaped screen rotating around the Faraday cup and of a system of two gaps, positioned at an angle of 90° . Gaps are inserted into the beam by means of stepper motors. The monitor is located 1 meter away from the ion source. The step length of gaps moving used is 0,5 mm to achieve a measurement accuracy of emittance about 102π mm mrad. The typical kind of pulse current is shown in Fig. 1a, which is measured in each position of x-and y-gaps with the aid of Faraday cup. The differentiated signal looks like that shown in Fig. 1b.

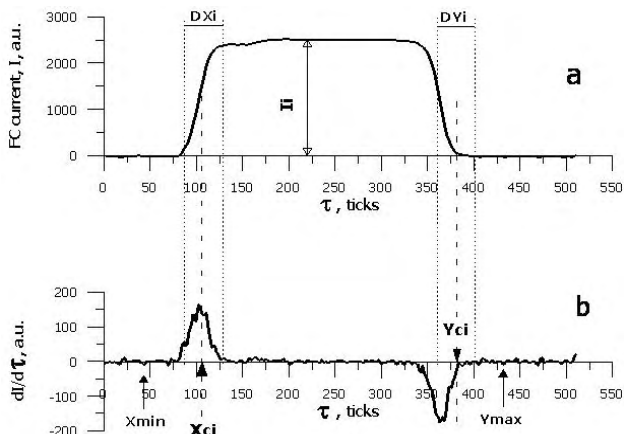


Figure 1. The current pulse form and differentiated signal.

Processing of the signal yields; current amplitude I_i , coordinates of the mass centre (X_{ci} , Y_{ci}) and sizes D_{xi} and D_{yi} of the beam portion cut out by gaps.

BEAM MONITOR CONTROL PROGRAM

Controls

The beam monitor contains the following controls:

- step motors No. 1 and No.2, which move gaps for 0° beam
- step motor No.3, which move gaps for 90° beam
- direct current motor, which rotates the screen for 0° beam
- direct current motor, which rotates the screen for 90° beam

Each direct current motor also rotates a disk fixed on the same pulley, where the screen is fixed. A part of such disk circle arch is marked in black color that means the "Stop" signal of measurement. The light part of the disk circle arch activates the "Start" signal.

I/O Cards

There are 2 I/O cards used in the control system: PC20 with bus ISA and PCI300 with bus PCI. Each card contains 12-bit ADC, DAC and digital I/Os. ADCs are used to obtain a signal from the Faraday cup, digital I/Os – to control stepper motors and to receive the "Start" signal. Access to I/O cards ports is realized by means of drivers delivered by the company BMCM as a part of the complete delivery set.

The Program Structure

It is possible to divide the beam control program into the following blocks conditionally:

- The synchronization block
- The data read-out block
- The visualization block
- The data saving block
- The step motors control block
- The automatic beam scanning block with consecutive moving of step motors

All blocks forms a single whole and executes according to beam scanner work algorithm.

The Interface

The program is based on the Dialog application.

Principle of Program Functioning

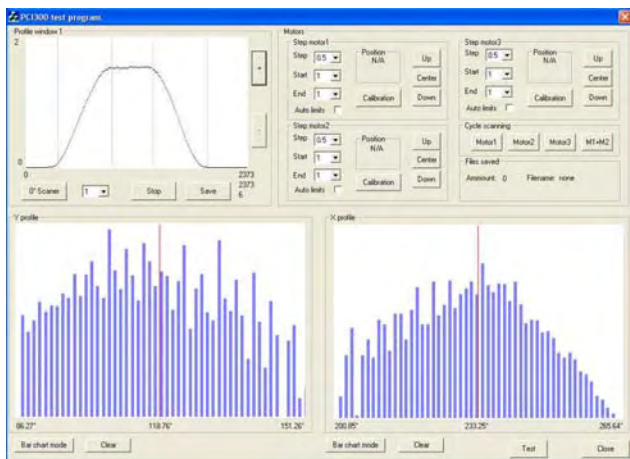


Fig. 2: Program interface in beam monitor mode.

In the beam monitor mode (Fig. 2), the top window displays a signal received from Faraday cup during the signal "Start". The ADC input voltage is displayed on OY axis, and the angle of the beam screen turn is shown on axis OX. Derivatives of signal front and recession within the top window limits are displayed in right and left bottom windows in the beam monitor mode. The signal recession derivative is inverted with respect to OY axis.

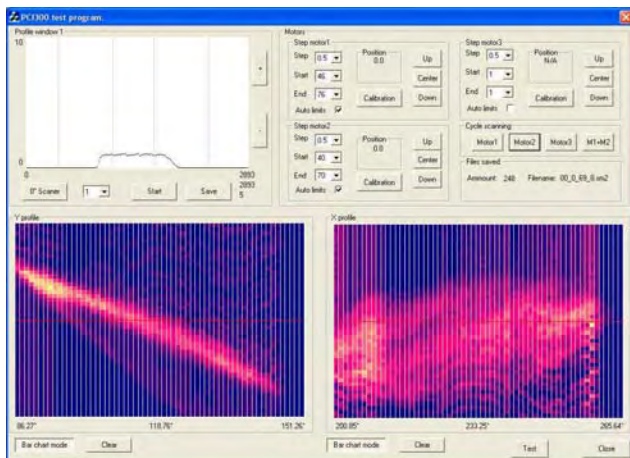


Fig. 3: Program interface in beam scanner mode with consecutive gaps moving.

Pseudo-three-dimensional histograms of derivative levels of corresponding pulse fronts and recessions are displayed in bottom windows in beam scanner mode with consecutive moving of gaps (Fig.3) where value ranges are shown in different colors. The quantity of histogram lines corresponds to the quantity of gap steps from the beginning to the end of scanning. The dialog elements located in the right top part of a window are used for the start of scanning and control of gaps, adjustment of their position and lengths of steps.

By default, the program works in beam monitor mode (Fig. 2). About 15000 readouts from Faraday cup are received during signal "Start" at frequency of beam screen rotation of about 1 Hz. Before the work begins the synchronization block defines speed of rotation and the readouts quantity for summation of average values to reduce the array size up to 2500-3000 readouts. The synchronization block is called also at each change of disk rotation speed. Further the read-out block is started for the data, which are displayed in corresponding windows by the block of visualization. This operation mode is used for beam form adjustment. Current data can also be saved to a file manually using the data saving block.

Before the work with step motors begins their calibration on all length of gaps moving is carried out, the motor steps quantity, necessary for moving a gap for 1mm is calculated. Then initial and final position of gaps and a step of their moving must be selected. It's possible to set a standard range of measurement. Beam scanning with consecutive gaps moving starts after translation the derivative display mode to the pseudo-three-dimensional mode. Gaps move as follows: the gap No.1 moves for 1 step, then the gap No.2 moves from the beginning to the end of the scanning range with a set step. Further the gap No.1 moves for 1 step and the gap No.2 moves from the end to the beginning of the scanning range with a set step. Then the movement proceeds until the final position is reached by the gap No.

After each gap moving the data are displayed in corresponding windows (Fig. 3) as a diagram of the signal received from Faraday cup and derivatives histograms of pulse front and recession. Also the data are saved in a file. Files are organized in the directories named according to scanning beginning time and date. Also the pulse diagram window image before the beginning of scanning and images of derivative pulses histograms windows after the ending of scan are saved.

The program is designed for work with two types of scanners: 0° and 90°. They differ in the configuration of screens and quantity of gaps, i.e. step motors. To scan the 0° beam, one pass of single gap with a set step is required, and to scan the 90° beam, consecutive gaps moving is required.

DATA PROCESSING PROGRAM

The data which are received as a result of experiment are processed with program. Graphical language G of LabView programming environment was used to create it. This program allows to select data file and to display current pulse form. Differentiated signals are calculated and represented as diagrams. It is possible to select and delete erroneous data, to determine the data field for subsequent processing. Three cursors are used for it. The zoom button, the cursor movement tool and panning tool are used to make data look more convenient.

The color palette is used for three-dimensional representation of differentiated signals (X-direction – X slit coordinate, Y-direction – number of channels, Z-direction – value of differentiated signal). Every specified value interval has its defined color. The following values are calculated in the program: the characteristics of phase ellipse, angle of inclination of beam axis to channel centerline, displacement of beam centre of mass on the scanner Δx_{cm} relative to its position X_{cm} in slit area, mean-square emittance, 100% emittance. Calculated data and experimental values are visualized on the graphs. Programm allows to convert data from binary format to spreadsheet format.

CONCLUSION

The program complex developed fully automates control of the beam monitor for its adjustment and emittance calculation. The control program combines blocks of step motors control both in manual, and in an automatic mode. Synchronization with beam screen rotation frequency occurs automatically at change of rotation speed. Results of an automatic scanning session are displayed in a form convenient for a preliminary emittance estimation. All data are saved in directories structured by date and time of the measurement beginning. The files received are processed by the emittance calculation program which results of work are diagrams and emittance values on axes.

REFERENCES

- [1] Kurt E. Stiebing, J.D.Meyer, O.Strekalovsky, V.Alexandrov, A.Kayukov, G.Shirkov In Proc of the 10th International Conference on Ion Sources, JINR, Dubna, September, 2003

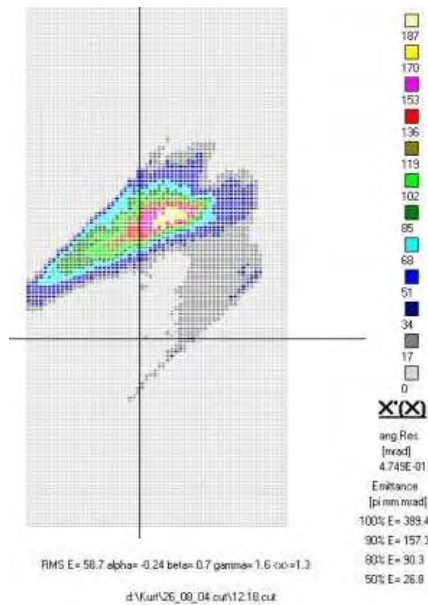


Fig. 4: Result of work of data processing program for the 0° beam scanner

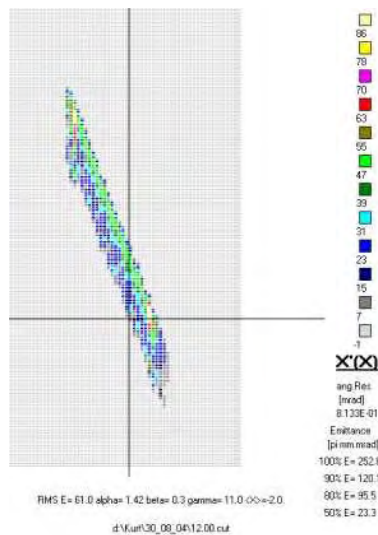


Fig. 5: Result of work of data processing program for the 90° beam scanner