NUCLOTRON EXTRACTED BEAMS SPACE PARAMETERS MEASURING SYSTEM FOR LOW INTENSITY LEVELS

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Abstract

The system using a multi-wire proportional chamber in counting regime for the space parameters measurement of Nuclotron accelerator extracted beams at low intensity levels was developed. As the preamplifiers are used fast operational amplifiers, as shapers serve fast comparators with lock-in input and counter system is built on the base of the programmable logic arrays. For control and communication serves the built-in single board computer. In this contribution description of this measuring system and measured parameters of system are given. As an example a measured beam parameters are also mentioned.

1 INTRODUCTION

The complex of Nuclotron Slow Beam Extraction System [1] was put into operation in 1999. The extracted beams diagnostics apparatus is a part of beam slow extraction subsystem [2], which is also incorporated into the Nuclotron automated control system [3]. Diagnostics tools must allow the check of the spatial parameters of beams in intensity range from 10^2 to 10^{11} particles per second at extraction time from hundreds of milliseconds to ten seconds. In the Laboratory of High Energies, JINR is very good developed technology of beams spatial parameters measurement at intensities more than $5x10^6$ particles per second based on the multi-wire proportional chambers (MWPC) usage in the analogue mode. In 2001-2002, the experimental variant of the apparatus for low intensity levels was developed and tested in stand measurement conditions as well as in real extracted beams conditions. This apparatus utilises all of the currently available progressive methods and technology.

Figure 2: Apparatus for the beams spatial

2 DIAGNOSTIC APPARATUS

The spatial parameters measurement of extracted beams in intensity range up to $1x10^7$ particles per second is performed by the multi-wire proportional chambers in the

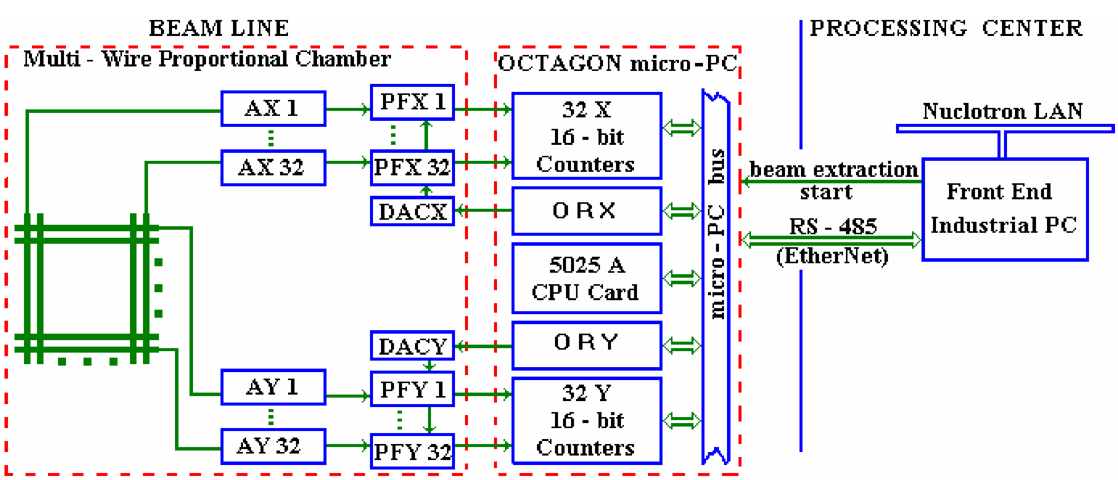

Figure 1: Structural layout of profilometer based on MWPC use.

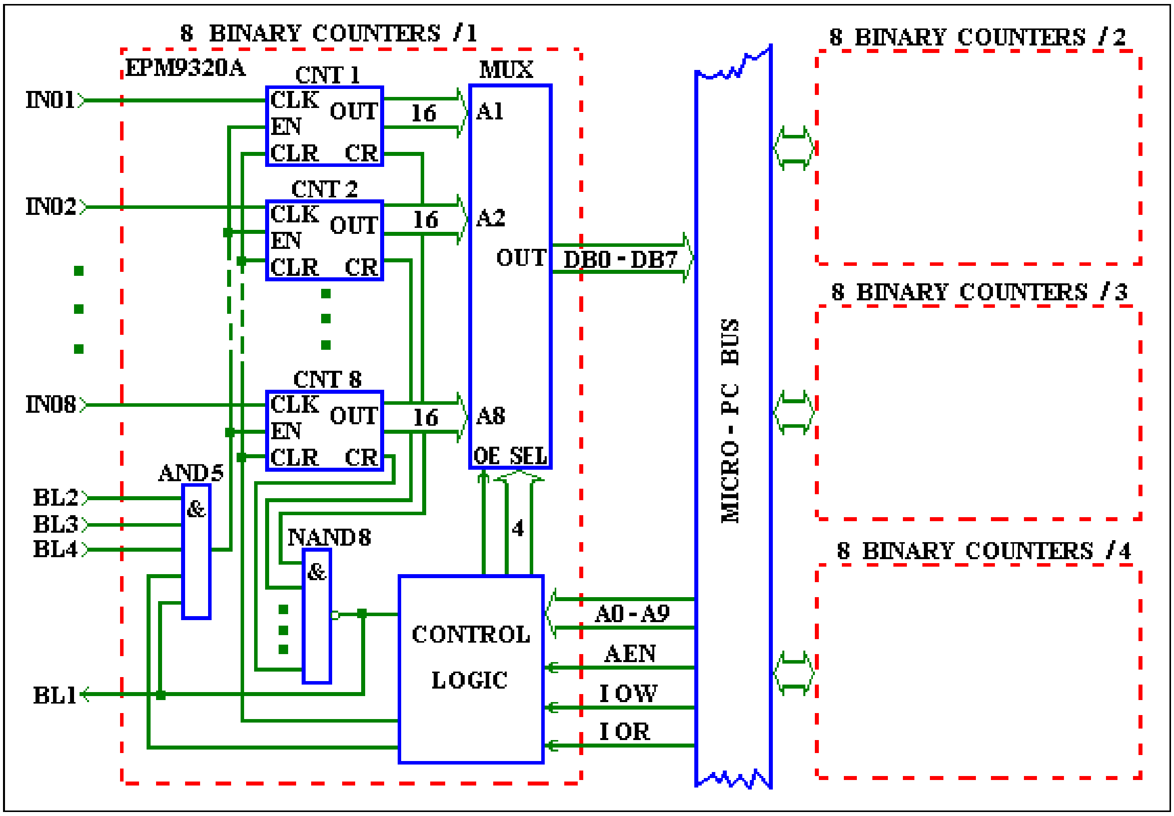

Figure 3: Structural layout of counters module.

digital mode [Fig.1, Fig. 2]. The proportional chamber consists of two signal planes (X and Y) and three cathode high voltage planes. Each of signal planes includes 32 wires of gold plated wolfram with diameter 25 µm. Distance between signal wires (2-6 mm) is chosen on the basis of characteristic beam dimensions at the chamber placement . The high voltage planes are made of Be-Cu alloy wires with diameter 100µm. The gap between signal and high voltage planes is 6-8 mm. The chamber is filled with a gas mixture Ar (80%) and CO_2 (20%). The

Figure 4: Counters module with PC and chamber.

operational high voltage is up to 3500V. The amplifiers (AX, AY) and signal shapers (PFX, PFY), which are realised by operational amplifiers OPA 4650 and comparators AD 8598 as well as the digital to analogue converters (DACX, DACY) for the comparators thresholds setting, controlled by the output registers (ORX,ORY), are located in the chamber box. The dead time of the registration channel is 300ns. Dispersion of the amplifying coefficient is less than 3%. Cross talk between channels is less than –44dB. Two 32-channels modules of the 16-bit binary pulse counters are realised on the basis of a programmable logic device (PLD) ALTERA EPM9320 ALC84-10 in the micro-PC OCTAGON standard (size of the PC–board 124x114 mm) (Fig.3, Fig.4). Four PLD are located in one standard module. Each of these PLD's contains 8 counters, multiplexer allowing byte after byte reading and control logic. An arbitrary counter in overflow state generates signal, which makes counting impossible in all counters of the module. It eliminates an incorrect data reading in the beam profile measurement. The counter blocking signal is formed by the NAND8 element and is led to the output for other counters blocking in all PLD's. The own blocking signal, blocking signals from other PLD and blocking signal for counters from the micro-PC are collected on the element AND5, and its output signal is led to all counters. The control logic block, directly connected to micro-PC bus, generates control signals for counters (counter reset, enable, blocking) as well as controls the multiplexer in the counters reading process. The address selector defines the basic address in the micro-PC address space. The microcomputer together with counters modules are placed in a separate crate, which is located in 2 m distance from the chamber (Fig. 2). The processor module OCTAGON 5025A contains a 80386CX processor (25 MHz), three solid state discs, serial interfaces RS-232/422/485, parallel port, external synchronising signals receiver, and other auxiliary units. Operational memory capacity is 2MB. The micro-PC is connected to one of diagnostic subsystem front-end industrial computers by means of a serial channel.

3 TESTING OF THE MEASURING SYSTEM

In the process of developed measuring system characteristics testing, parameters of extracted beams (protons, deuterons, carbon, and magnesium) were reliably measured in the intensity range from several hundreds to $5x10^7$ particles per second. Optimal registration efficiency was reached by the chamber high voltage changes in the range 2000-3500 V and comparators threshold changes.

Two functioning modes of extracted beams spatial parameters measuring system were implemented:

- Mode of beam parameters data collection for whole extraction time and one information reading (integral beam profile, Fig.5). In this mode counting is allowed after receiving of synchro pulse "start of extraction" and finished after the "end of beam extraction".
- Multiple data reading and counter reset within extraction time. Several tens of profiles are registered within each accelerator cycle. It allows following the beam spatial parameters evolution within extraction process (Fig.6).

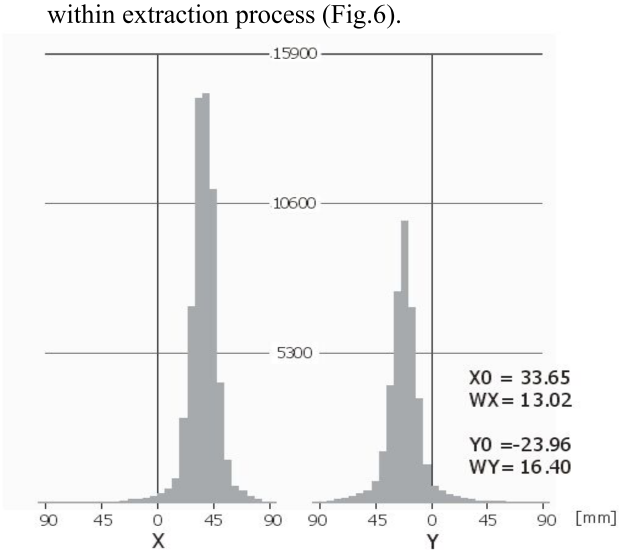

Figure 5: Integral beam profiles.

This mode also allows us to avoid the counters overflow for the arbitrary extraction time. Operator sets initial delay, period and number of reading as well as comparator thresholds. According to measurement results, the beam dimensions and their centre of gravity positions are calculated. Beam dimensions along the beam transfer lines are basis data for beam emittance characteristics calculations.

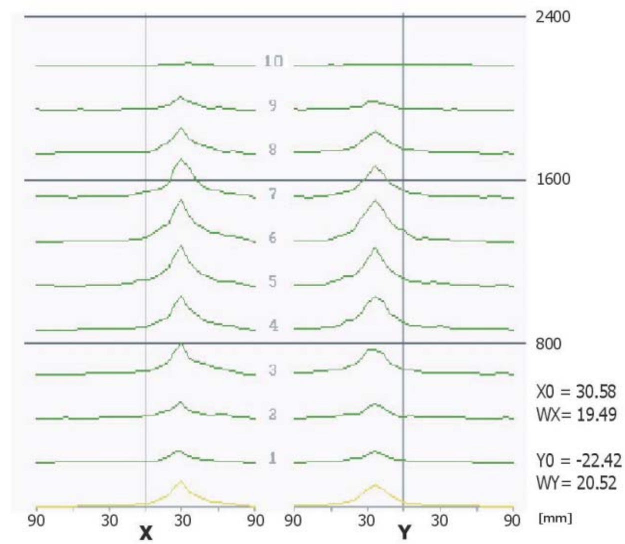

Figure 6: Representation of the data measured in the multiple reading mode.

4 CONCLUSION

Successful testing of the measuring system and initiation its exploitation show, that the parameters of the Nuclotron extracted beams can be successfully and reliably registered in the whole intensity range. The present approved decision was to equip the Nuclotron beam transfer lines with this measuring system.

REFERENCES

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