MULTIINPUT SYSTEM FOR INVESTIGATIONS WITH NEUTRONS USING TIME-OF-FLIGHT METHOD

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INTRODICTION

Because of putting into operation of the new neutron source IREN on a base of linear accelerator the conditions of experimentation changed essentially. The short path is used for time-of flight experiments, the new electronics for spectra registration with a narrow channel width and conforming to this software are worked up. In this work the hardware-software system for time-of-flight spectra recording is described, which is intended for investigation of IREN characteristics, of new detectors, and also for execution of the precise experiments in new conditions, specifically, in the experiment for obtaining the n,e-scattering length b_{ne} with the accuracy 2%.

Thereto it is proposed to use the new 8-channel time encoder in the precise experiment for measuring the angular anisotropy of neutrons scattered by noble gases in energy region from a few meV up to 1 eV with use of time-of-flight method. This time encoder connected to the computer USB-2 port will register signals from four neutron detectors and two monitor counters, which control a relative neutron flux in the beam. The program was developed to realize interchange of detectors positions at adjusted parameters, exposition in each of positions and information reservation in 8 spectrums (for each ^{3}He-counter in two positions). The control of data storage stability relative to monitor reading is provided by this program, and handy visualization of current and collected information is also realized by it.

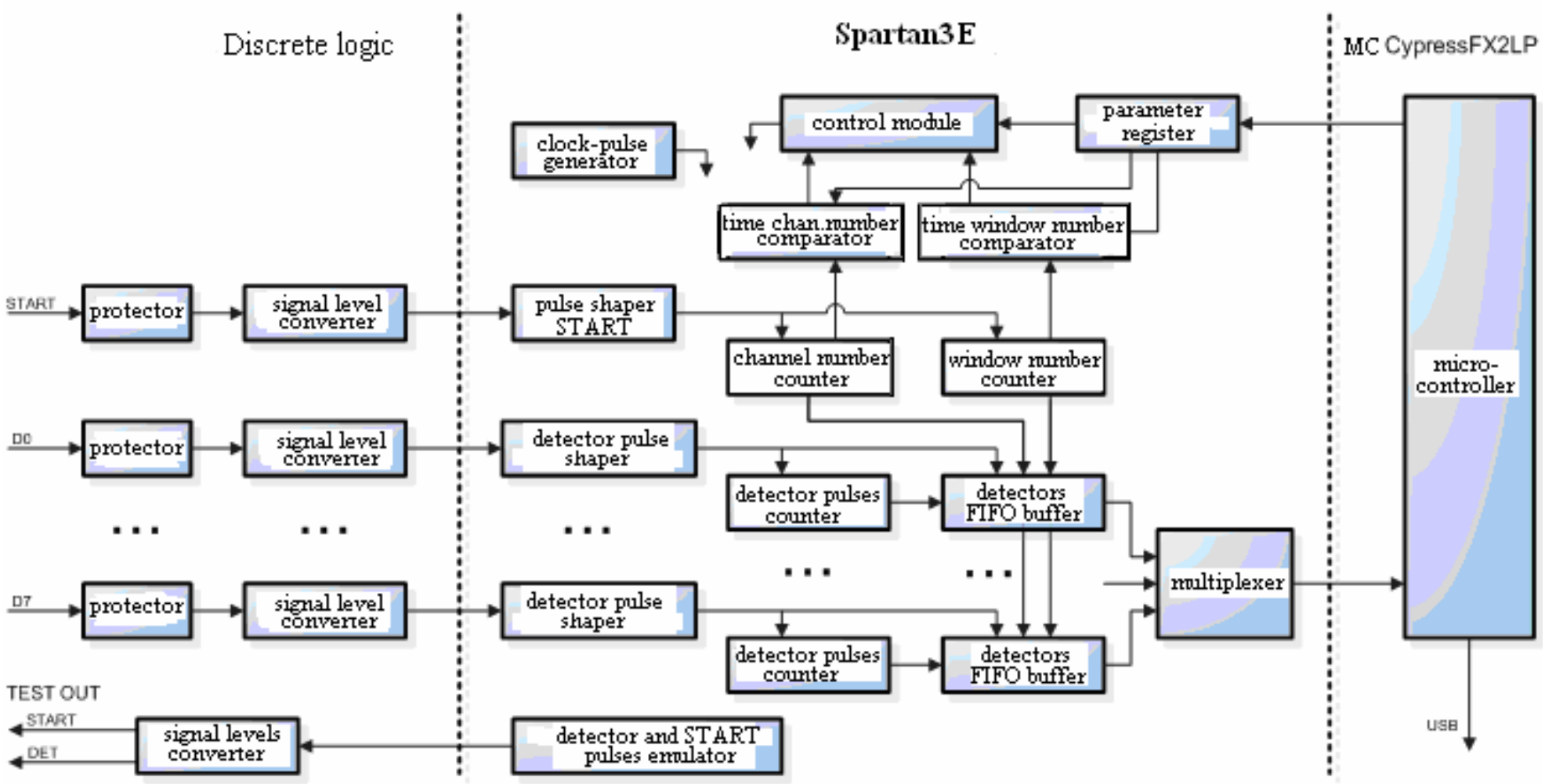

Fig.1. Functional scheme of the time coder

Fig.3. The time coder appearance

1. TIME ENCODER DESCRIPTION

The device was made on a base of discrete logic, programmable logical integral circuitry Xilinx of Spartan3E series and microcontroller Cypress of FX2LP series. A functional scheme of the time encoder was shown in Fig.1.

Safeguards were destined to set amplitude limits of voltage and current pulses produced by static electricity discharge and by static of powerful electromagnetic sources. Level of limitation is determined under permissible parameters of scheme elements. The level converters transform an output NIM-CAMAC signal of neutron detectors into LV-TTL standard needed for device operating. A driving generator produces a signal with frequency of 100 MHz, which is used for clocking (synchronization) of all another scheme elements working. Device realizes a detachment of entry pulses fronts (of detector and START pulses) and forms the control signals for a given time moment. The START entry is additionally blocked at a short time (1000 mks) after pulse coming, what guarantee higher stability of device working in conditions of powerful electromagnetic static.

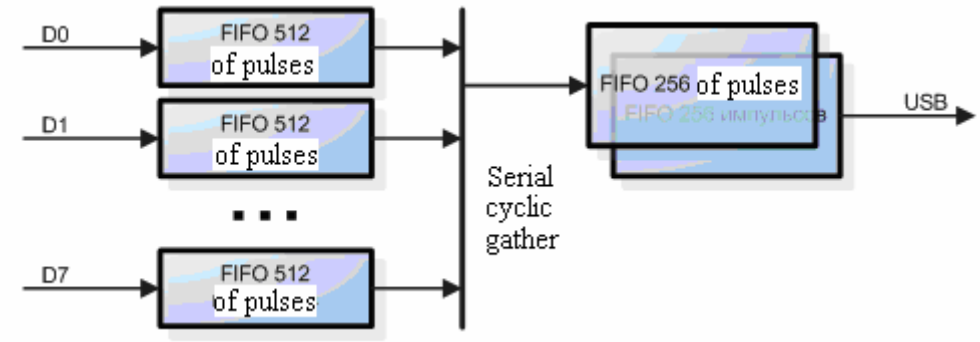

Fig.2. Internal buffers FIFO structure

The time counter cleared and increment of START signal counter is made, when the START pulse come. The value of the time counter is increased every 10 (or 100) ns and “is freezed” on reaching a maximal count. The increment frequency of this counter determines a discontinuity of measurement and maximal time of signal entrance from detector relative to

the START one. Each detector pulse produces an increment of corresponding counter of detector pulses, and information about the pulse (current value of time counter and detector number 0….7) is stored to the certain buffer FIFO. If the buffer is overflowed a pulses count is continued without recording of information right up to buffer deallocation (at least partial). A blocking of all detector entry for a given time from the beginning of time window (START pulse appearance) is realized with use of time channel number comparator.

In the parameter registers there is information about parameters of the current measurement run:

- recording process status, and the state of detector buffers FIFO;
- desired number of START signals (time windows) for control of recording continuance;
- period of time counter increment (10 or 100 ns);
- duration of blocking the intervals of detector entrances.

A control module coordinates a synchronous work of scheme elements.

An emulator of detector and START pulses may be used for calibration and testing. It works irrespective of the rest part of scheme producing pulses of 20 ns duration with periods 10, 485, 760 for detector signals and 10, 485, 740 ns for START pulses. These pulses are converted to physical levels of standard NIM-CAMAC.

Microcontroller implements the next functions:

- data moving from the detector buffers FIFO to inside binary buffer FIFO USB;
- data communications through USB;
- alignment up to transferable data volume (divisible by buffers length);
- receiving and fulfilment of usb-command;
- transfer of information about state of recording process and of detectors buffers FIFO by USB interface.

2. TECHNICAL PARAMETERS OF THE TIME ENCODER

- The number of independent detector entries — 8
- Signal standard — NIM-CAMAC (16 mA)
- Minimal duration and interval between detector pulses — 10 ns
- Minimal width (discontinuity) of time channel — 10 / 100 ns
- Number of pulse time channel — $0…2^{21}-1$
- Maximal working duration of the time window — 20/ 200 мс
- Summary number of pulses over each channel — $0…2^{25}-1$
- Allowable intensity of recorded pulses:
  - average total count over all detectors — $8*10^5$ pulse/s
  - average count at each detector — $9*10^5$ pulse/s
  - peak “ momentary” total count over all detectors — 4096 pulse
  - peak “ momentary” count at each detector — 512 pulse
- Preliminary setting the number of START signals (windows) — $1…2^{24}-1$
- Parameter of the data volume alignment for transfer — $1…2^{16}-1$ byte
- Parameter of duration of entry blocking — $0…2^{21}-1$ chan.
- Interface — USB2.0 HS
- Overall sizes — 140*115*35 mm
- Power supply device — USB (250 mA)

3. SOFTWARE OF TOF SYSTEM

Software of TOF system is operated by Windows and includes:

- programs of driver level;
- a control program;
- program of data sorting control;
- program of data treatment;
- secondary service programs.

CONCLUSION

The time-of-flight spectra obtained at 9-m path of IREN facility is shown in Fig.3. Neutrons were measured by ^{3}He-counter CHM-17. The spectra consists of three groups of channels with widths 20 ns (in channels up to 1000), 200 ns (in the channel interval 1001 – 5000) and 2000 ns (from 5001 to 8000 channel).

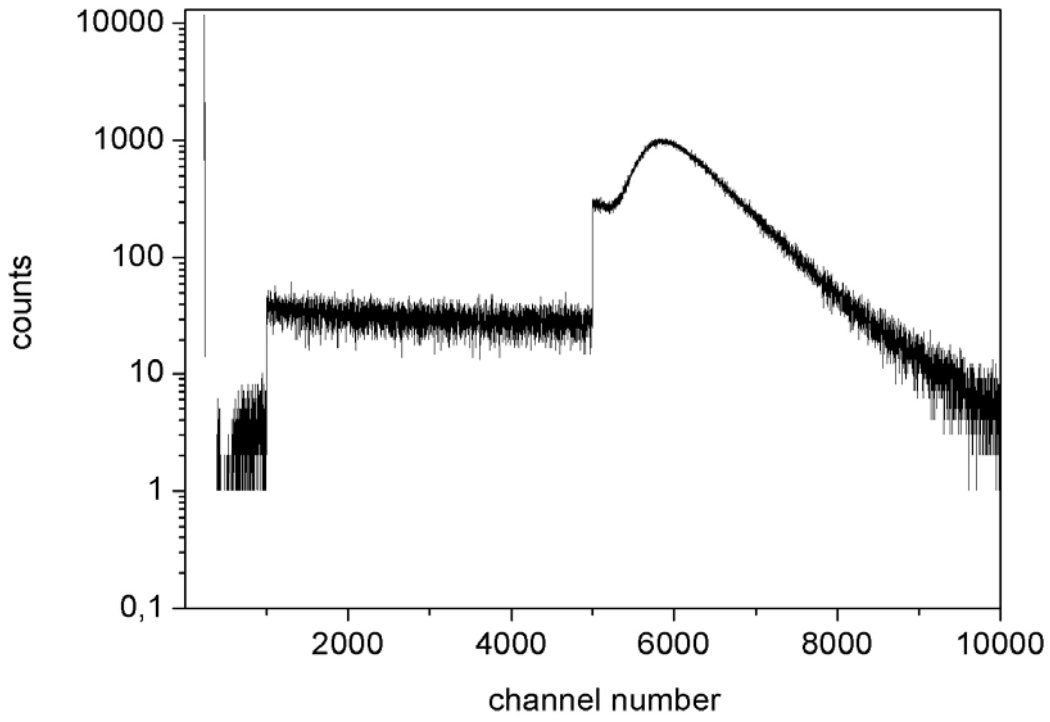

Fig. 4. Neutron spectra obtained at 9 m path of IREN facility

Embodiment of USB-interface provides the system with mobility. It can be used also in out experiments.