THE DOSIMETRY PROTECTION OF THE MPD ELECTRONIC EQUIPMENT AT THE NEW NICA COLLIDER — THE PROTOTYPE SYSTEM*

A. Chlopik[a,b,†], A. Bancer[a], M. Bielewicz[a,b,‡], A. Dudzinski[a]
E. Jaworska[a], D. Dabrowski[c,b], N. Dunin[c], J. Grzyb[a]
M. Milewicz-Zalewska[c,b], M.J. Peryt[c,b,§], K. Roslon[c,b]
J. Rzadkiewicz[a]

[a]National Centre for Nuclear Research, Otwock-Świerk, Poland
[b]Joint Institute of Nuclear Research, Dubna, Russia
[c]Warsaw University of Technology, Warsaw, Poland

(Received January 20, 2021)

The large accumulation of the electronic measuring devices near MPD raises concerns about its radiation resistance in the MPD-PIT room. The goal is to design and build a monitoring unit for ionizing radiation harmful to personnel as well as neutrons generated in the experimental process for the operation of electronic equipment. The prototype dosimetry system to protect electronic equipment project was started in the Joint Institute for Nuclear Research (JINR) in Dubna, for continuous monitoring of Multi-Purpose Detector (MPD) Slow Control electronics. The article describes the state of that system after two years of work on its development and future plans.

DOI:10.5506/APhysPolBSupp.14.549

1. Motivation

An important incentive to develop the described system is the need to ensure the safety of the experiment staff and the lack of important guidelines on how to create and secure an expensive research suite against the damaging effects of uncontrolled radiation effects arising during high-energy physics experiments. A new collider complex is built at the Joint Institute for Nuclear Research in Dubna and it is called the Nuclotron-based Ion Collider fAcility (NICA) [1]. The Multi-Purpose Detector (MPD) [2, 3] is a

* Presented at NICA Days 2019 and IV MPD Collaboration Meeting, Warsaw, Poland, October 21–25, 2019.

† Deceased.
‡ Corresponding author: marcin.bielewicz@ncbj.gov.pl
§ Deceased.

part of the NICA complex. It is located in the specially prepared concrete room (MPD-PIT). The work of MPD must be permanently monitored and remotely controlled. It is achieved by a specially designed set of electronic equipment. Most of these electronics will be placed in the racks located on the NICA-MPD-PLATFORM.

2. System description

2.1. Hardware

The project uses a combined probe of two Geiger–Müller counters (technical data can be found in [4]): one for low radiation level (EKO-C [5]), the other for high radiation level (EGM-104 [6]). Both systems are equipped with an RS-485 interface, which facilitates system integration with the Experiment Control System environment for NICA-MPD-PLATFORM. Selected interfaces are compatible with the NICA-MPD-PLATFORM communication structure. It is planned to use one EGM-104 probe and several EKO-C probes at each selected level of the PLATFORM structure (Fig. 1). The system will eventually be integrated with the NICA-MPD-PLATFORM management system, which is Supervisory Control and Data Acquisition (SCADA) WinCC from SIEMENS. Measurement data as well as system initialization parameters will be saved and read from Equipment Database (EqDb [8]) for the whole experiment. The system will be expanded with neutron probes in the future. The choice of Thermo Fisher FHT6020 Wendi-2 [9] wide-energy neutron detectors with an RS-485 interface is analyzed. It is characterized by high sensitivity and good energy and angle parameters.

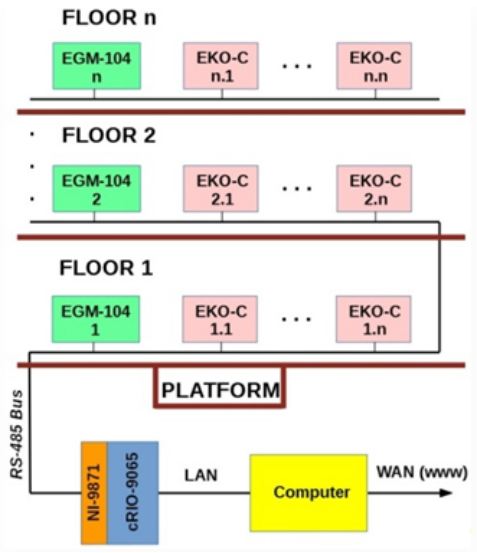

Fig. 1. The schematic of the prototype dosimetry system.

2.2. Software

Most of the prototype works in our group are performed in the LabVIEW National Instruments environment [10]. This guarantees a low entry threshold and allows engineers to easily build software modules. This also permits quick and effective creation of new solutions, especially for apparatus working on-line.

— RUN — operating mode (Fig. 2).
— ENGINEERING — allows a competent operator to change some settings.
— SERVICE — full access to operator functions.

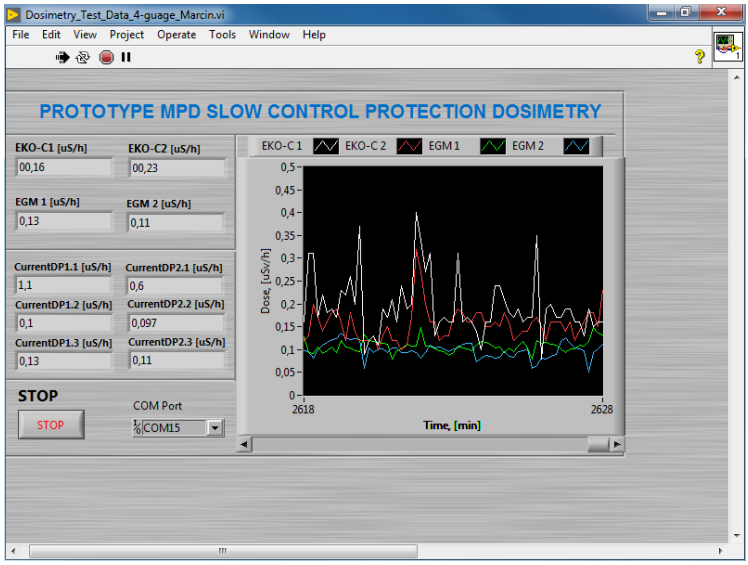

Fig. 2. The prototype dosimetry system Run Panel GUI for operating mode control.

3. Tests and results

The prototype dosimetry system test stand shown in Fig. 3 was established at the Joint Institute for Nuclear Research in Dubna, Russia. The test stand was complied with the following rules:

— all dosimeters were connected to half-duplex RS-485 bus,
— RS-485 bus was connected to PC computer,
— special connectors were made based on RJ-50 connector type (to easily expand RS-485 bus),

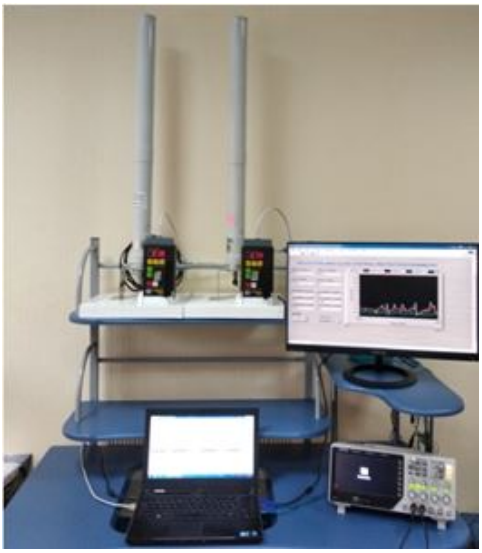

Fig. 3. Test stand in JINR.

— the Run Panel GUI was displayed on an additional monitor for a better view of displayed data, the RS-485 bus signals were tested and displayed using a 4-channel oscilloscope.

It uses RJ-50 connectors which were printed on a 3D printer. This construction enables to expand RS-485 with new devices. The connector and other self-made parts are presented in Fig. 4. Figure 2 shows Run Panel GUI where the last collected data from measurements of radiation level and charts of all probes data collected during last 10 minutes are presented. The two upper left fields are the data from EKO-C probes and the next two fields beneath are the data from EGM-104 probes. Since the EGM-104 consists of 3 chambers, then there are also shown all the measured values of two

Fig. 4. The parts of the dosimetry system. Left: the way of connecting power supply and RS-485 bus signals from the USB-RS485 converter. Center: T-branching signals on the RS-485 bus. Right: new EKO-C connector.

EGM-104 probes. There is also the STOP button which stops the measurement loop. Next to it is the virtual COM port number to which the RS-485 converter is connected via a USB port.

The described testing stand was presented to the MPD project and engineering managers. They approved the proposed system and made their suggestions for adding new features and expanding the system in the future.

4. Summary

We plan to continue the work on the development of the prototype dosimetry system by:

— extending the system with a neutron detector (the present measuring system is not sensitive for neutron at all), *e.g.* the commercial RS-485 Thermo Fisher FHT6020 Wendi-2 Wide-Energy Neutron Detector which has high sensitivity and an excellent energy and angular response,

— adding to the Run Panel GUI some new fields: the maximum radiation dose during the last day and the mean radiation dose for the last day,

— replacing USB-RS485 converter with cRIO [11] and make appropriate software modifications.

This research was supported by the Research Program for the research group at JINR and research centers in Poland by the grant of Polish Plenipotentiary at the Joint Institute for Nuclear Research number: Pr.254 p.2 (26.IV.2018), Pr.129 p.2 (28.II.2019) and Pr.75 p.3 (3.II.2020).

REFERENCES

[1] http://nica.jinr.ru/complex.php

[2] V. Golovatyuk *et al.*, *Eur. Phys. J. A* **52**, 212 (2016).

[3] M. Bielewicz *et al.*, *Eur. Phys. J. Web Conf.* **204**, 07016 (2019).

[4] M. Bielewicz *et al.*, *SPIE Proc.* **10808**, 1080847 (2018).

[5] A. Chlopik *et al.*, *Acta Phys. Pol. B Proc. Suppl.* **11**, 745 (2018).

[6] D. Dabrowski *et al.*, *Acta Phys. Pol. B Proc. Suppl.* **9**, 203 (2016).

[7] K. Roslon *et al.*, *Acta Phys. Pol. B Proc. Suppl.* **9**, 299 (2016).

[8] Technical documentation: http://www.polon-ekolab.com.pl/ekoc/ekoc.htm

[9] Technical documentation: http://nuvia-group.com/en/blog/product/components/nudet-detectors-and-probes/nudet-egm/

[10] Technical documentation: https://nuvia.cz/ke-stazeni/en/products/radiometric-systems/nudet-egm.pdf

[11] Technical documentation: https://www.ni.com/pl-pl/shop/select/compactrio-controller-legacy?modelId=119763

[12] Technical documentation: https://www.ni.com/pl-pl/shop/select/compactrio-controller-legacy?modelId=125712

[13] M.J. Peryt, T. Traczyk, *Acta Phys. Pol. B Proc. Suppl.* **9**, 293 (2016).

[14] Technical documentation: https://www.thermofisher.com/search/results?query=FHT6020%20Wendi-2&focusarea=Search%20All

[15] Technical documentation: http://www.ni.com/en-us/shop/labview.html