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MODERN BEAM MONITORING SYSTEMS DURING SEE TESTING ON ISDE&JINR HEAVY ION FACILITY

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Abstract

Diagnostic systems of ion beam parameters were modernized at beam-lines for electronic tests at FLNR accelerator complex. Scintillation detectors based on flexible optical fibers, multichannel and 15-channel beam profile detectors and energy measurement system for the high energy beam-line based on U400M were created.

INTRODUCTION

Beams of accelerated ions of low intensity are required for applied research, e.g., research of radiation resistance of electronics [1] or in biology.

Three beam-lines have been built in the accelerator complex of the FLNR JINR for testing electronic components: two low energy beam-lines (3-9 MeV/nucleon) and one high energy beam-line (15-60 MeV/nucleon) [2]. For testing, it is necessary to know the following parameters of heavy ion beams: ion energy, flux density and uniformity of beam distribution. To determine these parameters during the tests, a system for diagnosing ion beams based on scintillation detectors was developed. But this system does not meet all requirements. First, online flow density control is conducted away from the test sample. Secondly, on the high-energy channel, there is no direct measurement of energy at the location of the sample. Third, there are no ion beam profile detectors on the low energy channel.

Diagnostics systems of ion beam parameters were modernized to eliminate shortcomings. A multichannel ion beam profile detector, scintillation detectors on flexible fibers, and a system for measuring ion energy at the location of the test sample were created.

SCINTILLATION DETECTORS BASED ON FLEXIBLE OPTICAL

Detectors are designed to online flux measurement near DUT. Detectors are consist of PMT H10721 (Hamamatsu), wavelength shifting fibers Y-11 (200) (Kuraray) and plastic scintillator. The area of plastic scintillator is 1 cm^2. There are up to 8 detectors to each beam-line. Detectors are mounted on vacuum flange DN-63 and installed on the test chamber. Photo of detectors is shown on Fig. 1.

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The detectors are calibrated with polycarbonate or polyethylene terephthalate track detectors. Some results of the calibration are presented in the Table 1.

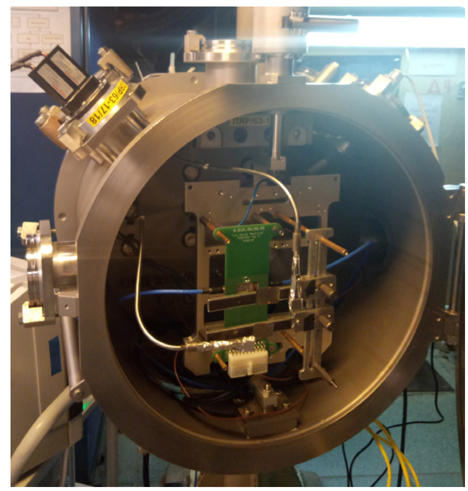

Figure 1: Photo of detectors.

Table 1. Results of Detector Calibration

№	№ of detector	The scint. detector fluence	The track detector fluence	k
83	1	5.50E+07	5.90E+07	1.07
	2	5.11E+07	5.60E+07	1.10
84	1	5.41E+07	5.50E+07	1.02
	2	4.96E+07	5.60E+07	1.13
85	1	5.38E+07	5.70E+07	1.06
	2	5.11E+07	6.10E+07	1.19
86	1	5.57E+07	5.85E+07	1.05
	2	5.29E+07	5.90E+07	1.12
87	1	1.98E+07	2.10E+07	1.06
	2	1.85E+07	1.80E+07	0.97
88	1	1.98E+07	2.10E+07	1.06
	2	1.83E+07	2.30E+07	1.26

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A MULTICHANNEL BEAM PROFILE DETECTOR FOR THE LOW ENERGY BEAM-LINE BASED ON U400

A multichannel beam profile detector (see Fig. 2) is designed to beam profile measurement at the low energy beam-line based on U400. The sensitive area of the detector is 200x200 mm^2.

The detector is consist of 64 plastic scintillator with area 1 cm^2, 4 16 channel PMT H12445 (Hamamatsu) and wavelength shifting fibers Y-11 (200) (Kuraray). The thickness of scintillators is 1 mm. The distance between the centers of scintillator is 25 mm.

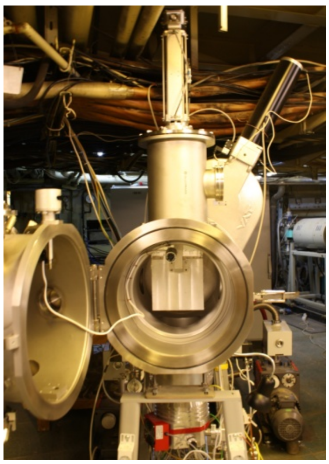

Figure 2: Photo of the multichannel profile detector on the beam-line.

A 15-CHANNEL BEAM PROFILE DETECTOR FOR THE HIGH ENERGY BEAM-LINE BASED ON U400M

A 15-channel beam profile detector is designed to beam profile measurement at the high energy beam-line based U400M. The sensitive area of the detector is 60 mm in diameter.

The detector is consist of 15 plastic scintillators with area 1 cm^2, 16 channel PMT H12445 (Hamamatsu) and wavelength shifting fibers Y-11 (200) (Kuraray). The thickness of scintillators is 5 mm.

Scintillators are located inside 2 circles. There are 6 scintillators inside the circle with a diameter of 40 mm, 8 scintillators - inside the circle with a diameter of 60 mm and one detector - in the center.

ION ENERGY MEASUREMENT SYSTEM FOR THE HIGH ENERGY BEAM-LINE BASED ON U400M

In our SEE testing facilities energy of ions are measured by TOF method. But at the high energy beam-line 10 micron Ni foil is installed between TOF detector and the test chamber. It is separated two vacuum volume of the beam-line. TOF detectors are located in high vacuum volume (~ $5*10^{-7}$ Torr). Testing of samples is carried out in fore-vacuum volume (~ 2 Torr). Therefore, ion energy is not measured directly.

Ion energy measurement system is designed to measure ion energy at the location of the test sample. The system consists of two detectors: silicon detector (500 um) and scintillation CsI (5 mm) detector. The system is calibrated with TOF detectors. Detectors are installed in the high volume vacuum to calibration.

The silicon detector is designed to measure energy of heavy ions such as Xe, Kr and Bi. PD 150-12-500 AM Canberra is used to measurement. The charge sensitive preamplifier A1422 Caen is used to amplifier the signal of the detector. Digital multichannel analyzer DT5780 Caen is used to data acquisition and processing.

The scintillation CsI detector is used to measure energy of light ions such as Ar, Ne and O.

CONCLUSIONS

New beam diagnostic systems have been created: scintillation detectors based on flexible optical fibers, multichannel and 15-channel beam profile detectors and ion energy measurement system. They will eliminated shortcomings which have old diagnostic system.

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