MONITORING OF LOW INTENSITY ION BEAMS AT FLNR ACCELERATOR COMPLEX

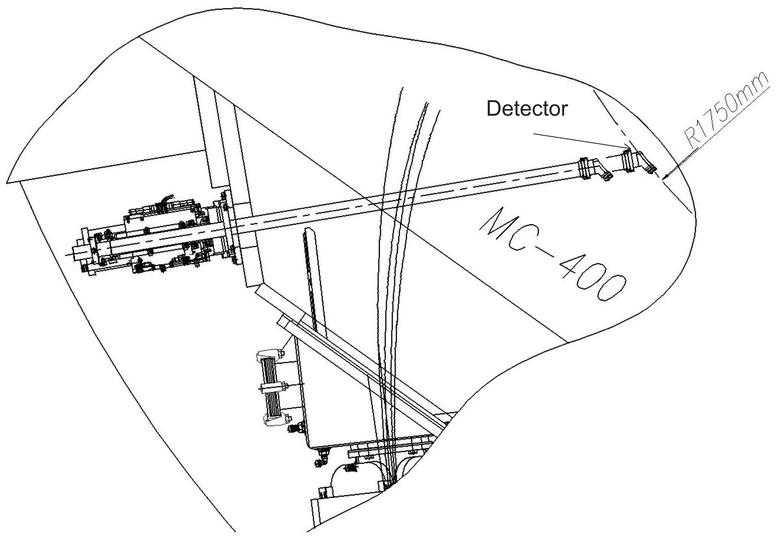
Yu.G. Teterev, S.V. Mitrofanov and A.I. Krylov
Flerov Laboratory of Nuclear Reactions, Joint Institute for Nuclear Research, Dubna, Moscow Region, Russia

ABSTRACT

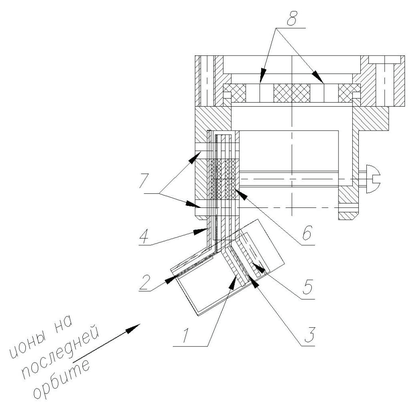
Детекторы предназначаются для диагностики пучков внутри ускорителя, на трассе их транспортировки и для контроля пучка у пользователя. С помощью детекторов контролируются: интенсивность пучков от единичных ионов до pnA, энергия, плотность распределения и сортность пучков. В зависимости от условий эксплуатации используются ионизационные камеры, пропорциональные счетчики, сцинтилляционные детекторы и многоламельные датчики с двойным экраном. Главными критериями при создании детекторов являются безотказность их работы в течении длительного времени эксплуатации в условиях радиации, магнитных полей и быстроменяющихся состояний вакуума, а также возможность быстрого ремонта или замены. Детекторы диагностики установлены на каналах для исследования радиационной стойкости электроники и на канале для биологических исследований.

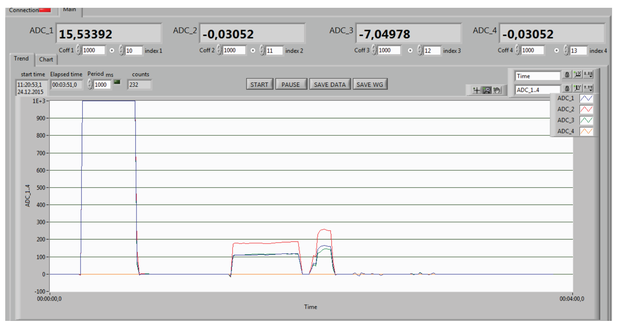
Detectors are developed to diagnose ion beams inside the accelerator, during beam transportation, and to control beam in the user area. The intensity of beam in the range from several ions per second up to pnA, the energy, the density distribution and the grade of the beam are monitored by the detectors. Depending on the operating conditions the ionization chambers, the proportional counters, the scintillation detectors and lamellar sensors with dual screen are used. The main criteria for the detector design are the reliability in long time operation under radiation, in magnetic fields and in rapidly changing vacuum conditions, and the possibility of quick repair or replacement. The diagnostic detectors are located in the channels to study the radiation resistance of electronics, and in the channel for the biological research.

Measurement of beam current inside the cyclotron



The detector based on secondary emission with three lamellas

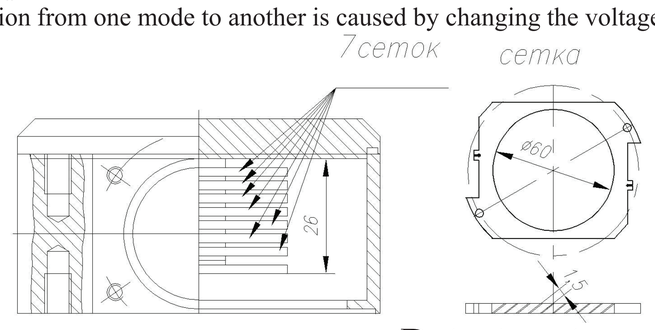


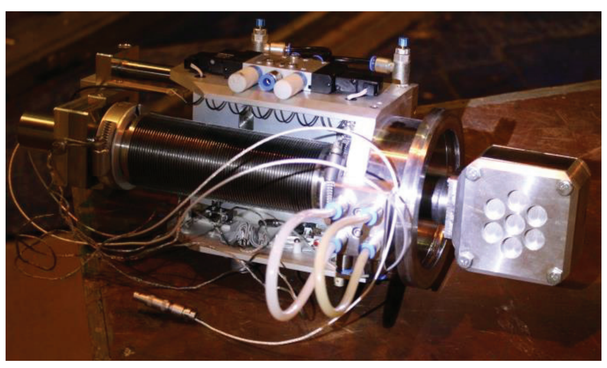


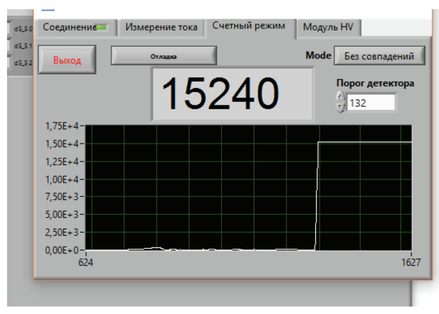
The measurement range is from 10^3 up to 10^8 ions/s.

The detector to measure the beam current after the exit from the cyclotron

The detector operates in two modes: proportional counter and ionization chamber.
The working gas is an air.
The measurement range is from few ions/s up to 10^5 ions/s in the proportional counter mode and up to 10^8 ions/s in ionization chamber mode.
The transition from one mode to another is caused by changing the voltage on the detector.



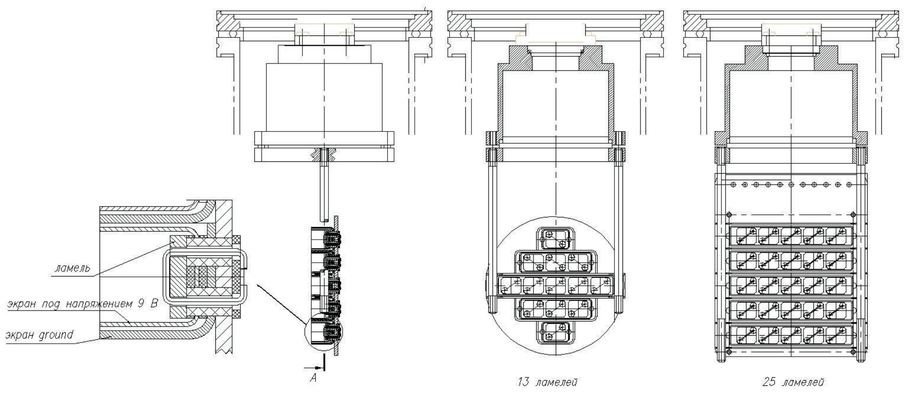


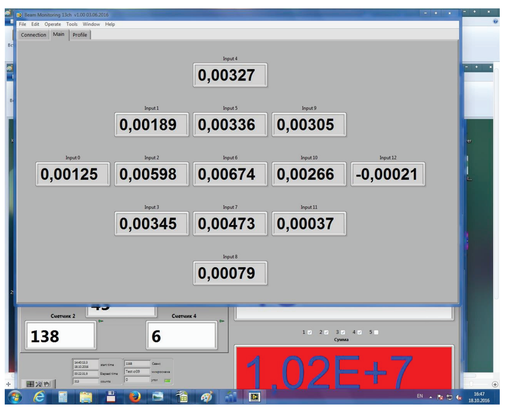


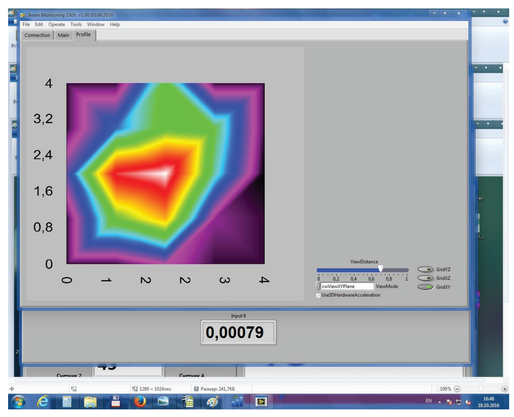
Screenshot of the control detector program with the result of beam intensity measurement.

Detectors to measure the beam profile during transportation of the beam to users

The detector based on secondary emission with13 or 25 lamellas



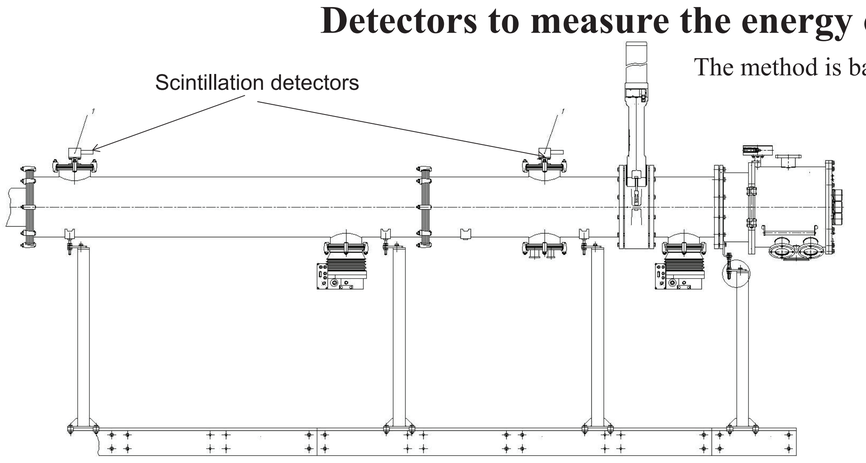


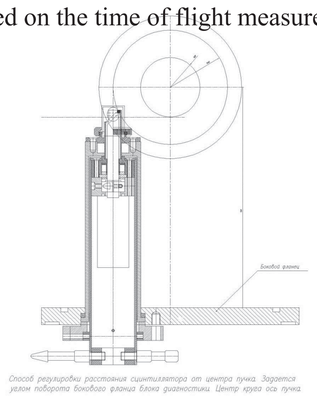


The scale of beam current measurement on each lamellae ranges from 1 pA to 10 nA

Detectors to measure the energy of ion beam during the transportation to the user area.

The method is based on the time of flight measurements.





Scintillation detector

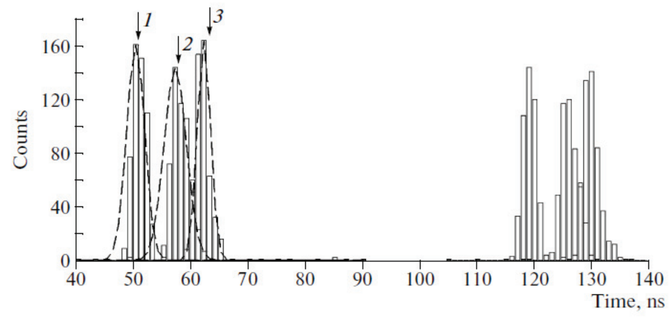
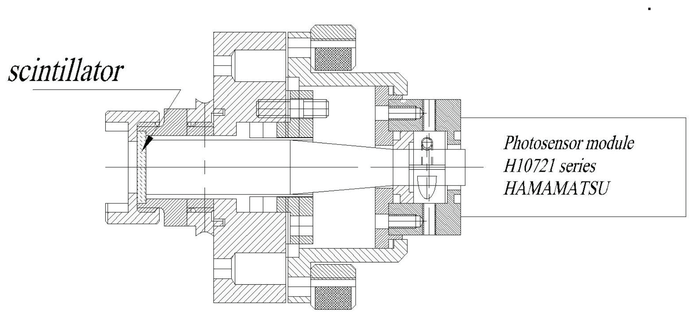


Fig. 5. The time-of-flight spectrum measured for Ar ions with the DRS Evaluation Board after passage of 9 (*1*), 12.5, (*2*) and 15 μm (*3*) Ta degrader foil. The maxima were extrapolated using the gauss function to accurately determine the center of distribution.

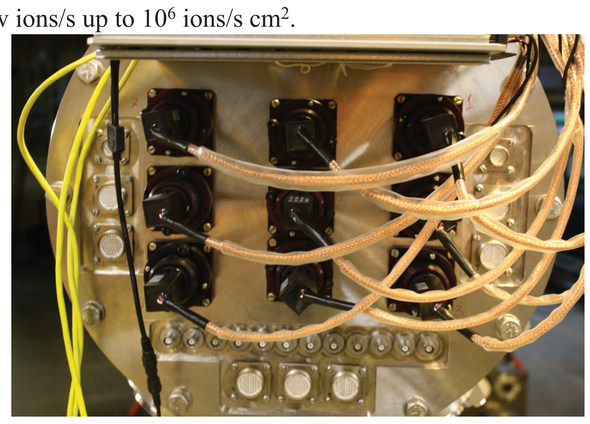
Detectors to measure the spatial uniformity of ion beam distribution in the irradiation region of the user objects.

The monitoring the distribution homogeneity and the ion beam intensity during irradiation of the objects.

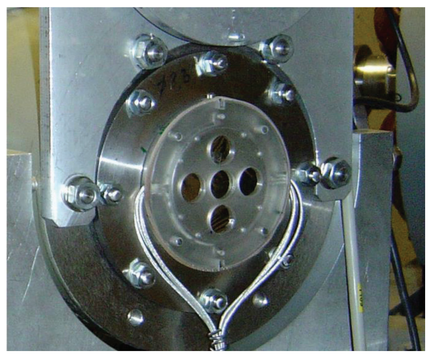
The measurement range is from a few ions/s up to 10^6 ions/s cm^2.



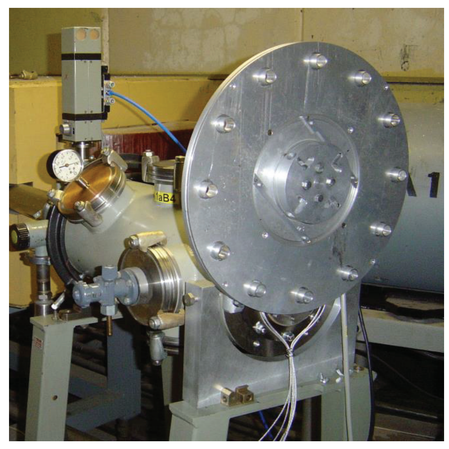
The detector with thin scintillator for low energy ions



These detectors are located at the perimeter and in the center of the irradiation area 200 mm x 155 mm .



Five-channel ionization chamber for monitoring the irradiation of biological objects



The equipment to irradiate the biological objects

REFERENCES:
1. V. A. Skuratov et al. Ion Beam Diagnostics for SEE Testing at U400M FLNR JINR Cyclotron. **RADECS 2012** Proceedings
2. V. A. Skuratov et al. *Instruments and Experimental Techniques, 2014, Vol. 57, No. 1, pp. 11–16. Published in Pribory i Tekhnika Eksperimenta, 2014, No. 1, pp. 15–21.*
3. A.A. Besbach et al, Upgrade of the “Genome” Facility for Radiobiological Experiments at Heavy Ion Beams, Physics of Particles and Nuclei Letters *2013, v.10, No. 2, pp. 274-280.*