PS1 P 02

Data processing automatization and improvements of D-Pace OWS-30 wire scanner

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Introduction

A source of epithermal neutrons based on vacuum-insulated tandem accelerator and a lithium target was proposed and developed for the technique of boron neutron capture therapy. A stationary proton beam of 2 MeV with a current of up to 6 mA was obtained in the accelerator. It was found that increasing of the negative hydrogen ions beam current injected into the accelerator leads to the need to change the lens focusing force, increasing the frequency of breakdowns and heating of the electrode diaphragms. For the beam diagnostics, a wire scanner OWS-30 (D-Pace, Canada) was installed.

Materials and Methods

The work was carried out on an accelerating neutron source created at the Budker Institute of Nuclear Physics. The wire scanner was installed to the vacuum camera in front of accelerator inlet. The scanner has two wires fixed to a common rod. When the rod moves, the current on the wires and the rod angle are measured, which makes it possible to reconstruct the transverse profile of the ion beam along two perpendicular directions. We have modernized the scanner by placing the metal rings in front and behind the scanner with a negative potential to suppress the secondary emission of electrons from the scanner wires. We are the first who proposed and implemented a new way of measurement of the beam emittance. A movable diaphragm was inserted in front of the wire scanner. Ion beam passing through the aperture of the diaphragm was measured with a high quality detalization when the diaphragm was moved along one radius. We have developed a software in which methods for calculating the position and size of the beam, methods for calculating the total current are implemented. The software is developed using the Qt 5.8 framework. in C++.

Results

Modernization of the scanner has made it possible to expand its capabilities. The suppression of the secondary electron emission made it possible to reconstruct the current profile of the ion beam and determine the value of the total current. The use of a movable diaphragm made it possible to measure the phase portrait of the beam in two planes with

a high quality detalization. The developed program allowed to display the coordinates of the beam, its dimensions and the total current. The use of a modernized scanner made it possible to detect the effect of space charge and the effect of spherical aberration of focusing magnetic lenses on a beam of negative hydrogen ions.

Conclusion

The OWS-30 wire scanner was upgraded to suppress secondary electron emission. For the first time, a new method for measuring the phase portrait of an ion beam was proposed and implemented. A diaphragm was introduced into the beam in front of the wire scanner and the profile of the passed beam was measured. Methods for calculating the position, dimensions of the beam and calculating the total current, are proposed and developed. Software for displaying beam parameters has been developed. The use of the modernized scanner made it possible to optimize the injection of a beam of negative hydrogen ions into the accelerator, which led to an increasing in the proton current and an improvement of the accelerator stability. The modernized scanner with an additional program for processing the results data and visualization has become a reliable device for beam diagnosing and for controlling its entry into the accelerator.

Keyword: vacuum-insulated tandem accelerator, BNCT, profilometer

PS1 P 03

Visualization of a negative hydrogen ions beam in a vacuum insulation tandem accelerator

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Introduction

A source of epithermal neutrons based on vacuum-insulated tandem accelerator and a lithium target was proposed and developed for the technique of boron neutron capture therapy. A stationary proton beam of 2 MeV with a current of up to 6 mA was obtained in the accelerator. High acceleration rate (up to 25 kV/cm) and a strong input electrostatic lens that determines the trajectory of the ion beam and the heating of the accelerator elements characterize the accelerator. It was necessary to develop a diagnosis of the position