USE RECIRCULATOR "SALO" IN THE MODE OF THE NEUTRON SOURCE

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Abstract

The opportunity of use developed in NSC KIPT recirculator SALO [1] with superconducting accelerating structure TESLA for reception of intensive neutron streams surveyed. As an injector it is supposed to use RF-gun with superconducting accelerating structure. An electron beam with the peak energy 130 MeV is transported on a target located apart of 100 m from recirculator. It is designed the focusing system which allow to obtain on a target the required density of a beam. The demands to magnetic element alignment precision are calculated.

INTRODUCTION

SALO facility - the electron accelerator of continuous action with beam recirculation on maximal energy ~730 MeV which is design in NSC KINT - is intended for researches in the field of nuclear physics and the physics of elementary particles [1].

The existing infrastructure and industrial rooms allow equipping at least three experimental halls where researches in various areas of physics with continuous electron beams with energy 9.5…730 MeV can be conducted.

Taking into account the increasing volume of researches with neutron use, in SALO facility project it is provided an opportunity to work in neutron source mode.

THE NEUTRON SOURCES PLANNED FOR SALO FACILITY

For a complex of neutron-generating targets placing the construction of special building located on distance ~100 m from recirculator is supposed. The complex of targets will consist of "fast" target from uranium or other material with large Z and multiplying target, which represents itself sub-critical assembly from enriched uranium and neutron-generating targets from uranium or tungsten. The "fast" target is intended for researches with time-of-flight technique, and multiplying target will generate quasicontinuous neutron stream of the large intensity.

On Fig.1 it is represented accommodation plan of accelerating complex SALO, which is equipped with neutron-generating targets.

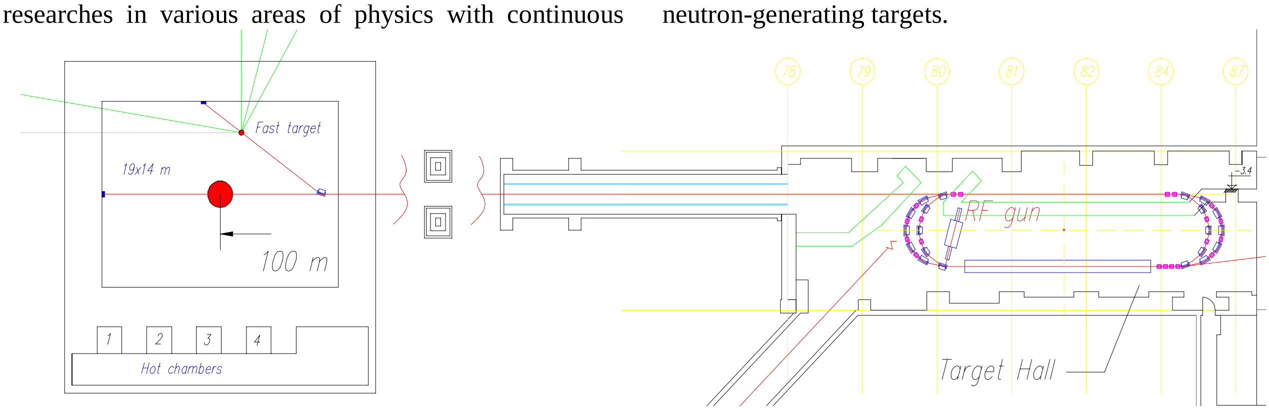

Figure 1

In SALO facility it is supposed to use superconducting injector, which was designed for accelerator ELBE [4], and superconducting accelerating structure TESLA [3]. In Table 1 the basic parameters of recirculator SALO beam are represented.

By means of a usual target from uranium it is possible to receive an average stream of neutrons ~9×10^{-14} s^{-1}. The use of multiple target allows increasing this stream in 50…330 times [5], thus targets from plutonium or uranium of a various degree of enrichment and with a various level sub-criticity can be used. The basic problem of such targets use is the heat removal [6].

Table 1

Injection energy, MeV	9,5
Operating mode	continuous
The injecting beam parameters: Transverse emittance, σ_x, m∗rad Vertical emittance, σ_y, m∗rad An energy spread, ΔE/E	 ~3×10^{-6}. ~3×10^{-6} ~10^{-3} [3]
The mean current, mA [4]	1
The beam energy at recirculator exit, MeV	130
Energy spread, ΔE/E	~10^{-4}

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In Table 2 the expected parameters of neutron sources on the basis of recirculator SALO are given.

Table 2

"Fast" target	
The neutron pulse length, τ	~40 ps
Pulse-recurrence frequency, MHz	≤1
The neutrons number per pulse, F	~10^{13}
The neutron beam quality, $\eta=F/\tau^2$	6.3×10^{33}
The multiplying target	
The total neutron stream	~3×10^{17} s^{-1}
The density of neutron stream at distance 0.5 m from multiplying target, $cm^{-2}*s^{-1}$	~10^{13}

BEAM LINE OF THE NEUTRON SOURCE WITH MULTIPLYING TARGET

On Fig.2 the plan of the neutron source with multiplying target is presented.

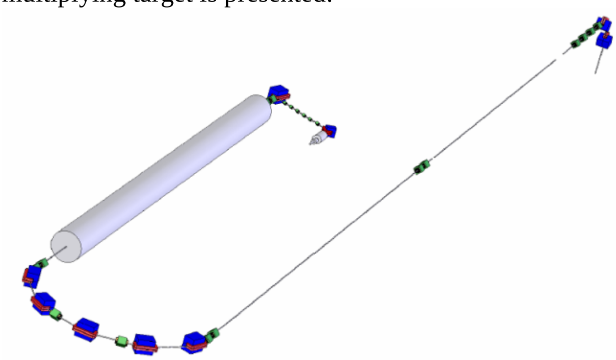

Figure 2

In the specified scheme it is conditionally possible to allocate three basic sites: 1) electron gun and injection beam line; 2) accelerating section and the first arc of accelerator; 3) the neutron source beam line with two bending magnets which produce the beam turning on 90^0 downwards to neutron target.The basic requirement shown to accelerator beam line is beam posting with the minimum cross sizes. To the same requirement should satisfy the beam line of the beam transportation to the neutron target. Besides, it should provide regulation of the beam cross-section on the target to not allow it's overheating and destruction.

The said requirements and long (~100 m) the beam flying base cause rigid enough requirements to stability of magnets power supply, to accuracy of magnets adjustment, to the beam trajectory correction, and as to admissible amplitudes of mechanical vibrations of electromagnetic elements.

It has been carried out researches of specified above factors influence on beam sizes on target. The results of calculations are presented in Table 3.

Table 3

Parameter	Maximum deviation	Annotation
The relative stability of magnetic field, ΔH/H	10^{-4}	Under condition the lenses and magnets are feeding from the same power source
Tolerance on mechanical vibration of magnetic elements	<10^{-2} cm on each degree of freedom	Under condition of common vibration radiant
Tolerance on an exactitude a beam trajectory correction	<3×10^{-2} cm	On accelerator output
Tolerance on an exactitude of an alignment of electromagnetic devices of the accelerator	$\Delta q_{x,y,z}\leq5\times10^{-3}$ cm $\Delta q'_{x,y,z}\leq10^{-1}$ mr	At such tolerances the beam enveloping does not exceed the aperture of magnetic devices

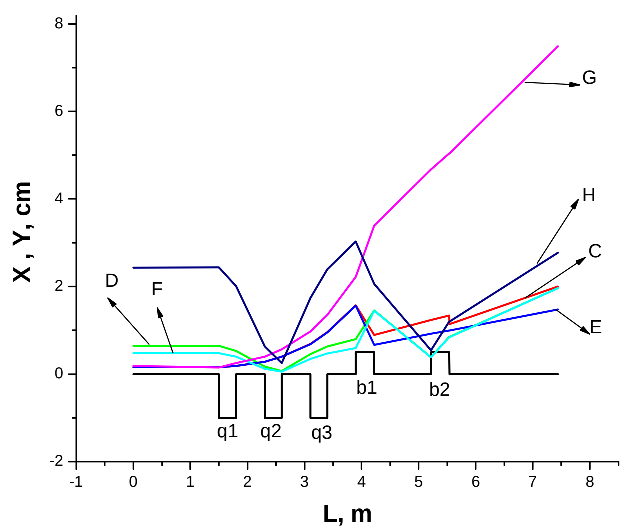

Figure 3

On Fig. 3 are presented calculated horizontal (X) and vertical (Y) the beam enveloping on output of transportation beam line before the neutron multiplying target. q1,2,3 are the quadrupole lenses. b1,2 are bending magnets. Curves C, D are enveloping for X and Y movements accordingly calculated for case ΔH/H=0; curves E and F are the same for case ΔH/H=10^{-4}; curves G and H are the same for case ΔH/H=10^{-3}.

At use the"fast" target of the requirements to tolerances are identical presented above.

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CONCLUSION

It is shown, that use of accelerator SALO in a neutron source mode with various types of targets allows to receive neutron beams with $\eta \sim 6*10^{33}$ s^{-2} and neutron streams $\sim 10^{17}$ s^{-1}. The calculations show, that requirements to exactitude of magnetic elements alignment and stability of magnetic fields are determined, basically, by accelerator beam line parameters. Realization of given project will allow to create on the indicated facility the neutron source of a world level that is extremely necessary as for development of fundamental researches in the field of nuclear physics and for maintenance of Ukraine nuclear power needs.

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