ACCELERATING COMPLEX SALO

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Abstract

During last three years NSC KIPT and Technische Universiteit Eindhoven develop the recirculator project with superconducting accelerating structure TESLA on energy up to 730 MeV.

The accelerator will be disposed in existing buildings on linac LU2000 exit. The source of polarized electrons will allow to receive quasicontinuous beams with energy from 250 up to 730 MeV and a current up to 100 μA. RF photogun will accelerate continuous and impulse electron beams with a charge up to 1 nC in one bunch and an average current up to 1 мА.

Base tasks which to be solved with the help of new accelerator:

1. Problems of fundamental nuclear physics
2. Framing accelerator driven sub-critical assembly facility, neutron source and its applications in different fields of science
3. Free electron laser
4. Radiation physics, nuclear physics applications, isotope manufacturing.

INTRODUCTION

As shows the analysis [1], there is a huge quantity of problems in the fundamental nuclear physics which are actual in the intermediate energy region nuclear physics. Till 1995 a part of these problems in Ukraine were solved with use of linear accelerators on energy 300 and 2000 MeV.

These accelerators created in 50-60 of the last century have become outdated morally and physically. Release of a part of completing and account materials for this equipment by the industry is stopped. For this reason there was a need for creation of the accelerator corresponding requirements of modern physical experiment and constructed on new element base.

Researches carried out by us [2] have led us to belief, that use of last achievements in the field of creation of superconducting accelerating structures in a combination to idea of repeated passage of a beam through accelerating structure allows to create enough compact facility [3]. It can be placed in existing rooms of accelerating complex LU2000. Electron and photon beams of facility can be used in existing physical halls, and also there is an opportunity of creation new beam channels. They can be used in a number of the tasks, being actual in a number of areas of physics: free electron lasers, uses of electron accelerators for beam control of subcritical assembly, for manufacture of medical isotopes, in the radiation physics.

FACILITY STRUCTURE

For tasks of nuclear physics and creation of the free electron laser the electron energy straggling should be minimal.

The minimization of the beam energy spread has been reached by isochronicity of all sections of the beam line, since injection beam line and including two sites of beam recirculation. For realization such structure it was necessary to refuse from uniform distribution of dipole magnets along the sections of the beam rotation on angle 180^{o}. Besides, the straight section opposite accelerating one was made "lenses-free", that allows to make independent focusing of both sites of recirculation.

On Fig. 1 the general view of reciculator SALO MOS new version together with injection beam lines and possible directions of output powerful beam with energy 130 MeV is shown. For injection three magnets bypass is used. Such a system allows to produce injection of 9.5-MeV beam, bypassing arc magnet which designed for a field ~1.2 T and has the leakage fields intensive enough. Besides, such injection system allows to regulate smoothly the accelerated beam energy. In more detail features of MOS are resulted in work [3].

With use of TRANSPORT code at initial energy spread in beam 0.1 % and a longitudinal size 0.082 cm the energy spread for a beam with energy 249.5, 489.5 and 729.5 MeV has been calculated. The values of relative energy spread are accordingly $6.5*10^{-5}$, $3*10^{-5}$, $2*10^{-5}$ for each energy. The maximum values of enveloping are $\sigma_x \approx 0.3$ cm, $\sigma_x \approx 0.65$cm.

The offered isochronous MOS of SALO recirculator is optimized both by an amount of quadrupole lenses, and on their positions. It has allowed to reduce, at rather moderate quadrupole lenses gradients, not only resulting energy spread, but also the enveloping of beam circulating.

FACILITY OPERATING MODES

For performance of the program of works recirculator should have two injectors [3]. The first intends for works with polarized electron beam for the nuclear physics, the second - for work in a mode of a neutron source and free electron laser. The scheme of injection allowing enough quickly to pass from work with one injector up to work with another has been chosen. The injection beam after turn by an injection magnet (see fig. 1), in accelerating structure receives a gain 240 MeV and can be used in an existing hall of magnetic spectrometers SP-103.

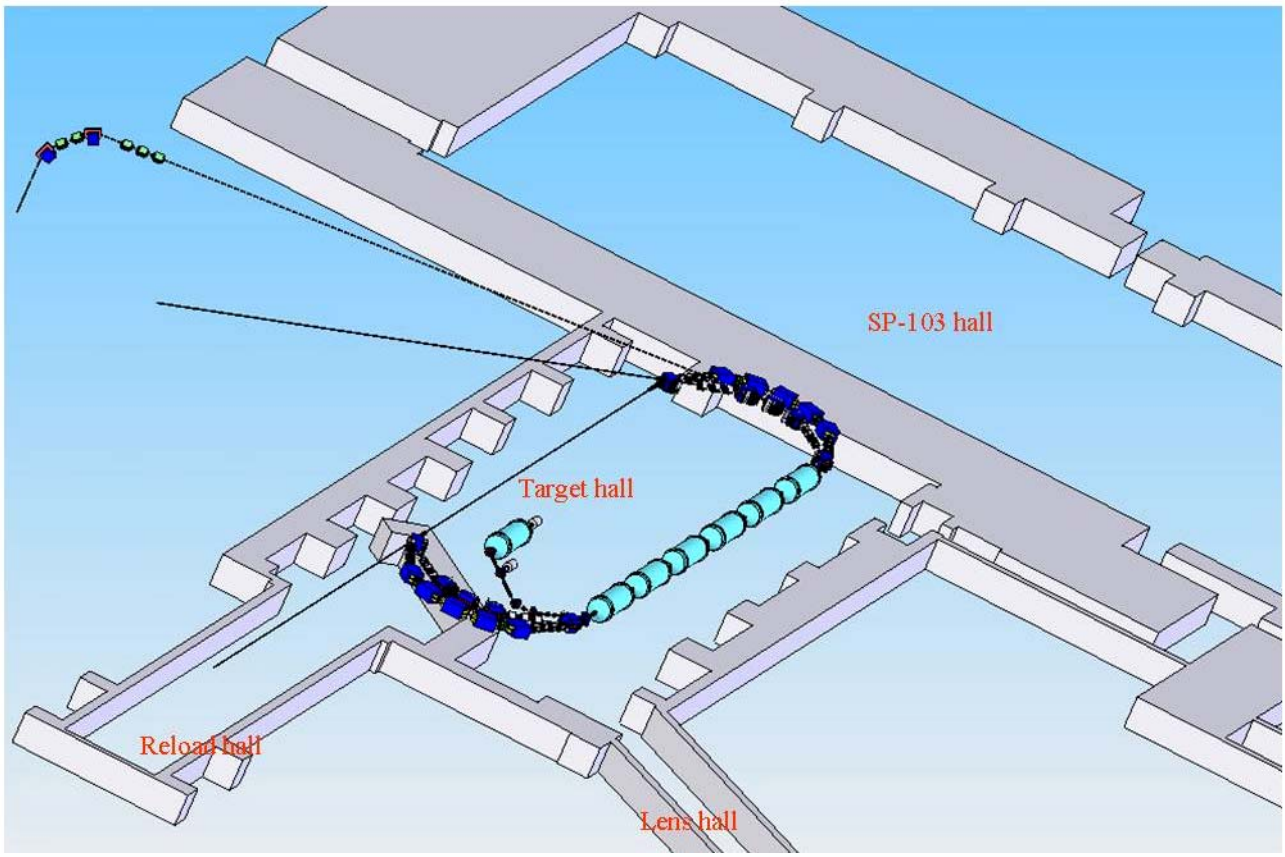

Figure 1: Layout of facility.

At inclusion of five magnets by the first arc the beam can be directed to a reload hall and further on a neutron target. At inclusion of five more magnets of the first ring a beam the second time will pass accelerating structure and with energy 489.5 MeV can be used in hall SP-103. At inclusion of first five magnets of the second half ring the beam can be used in a hall of a neutron target, and at partial inclusion of following two magnets of this ring the bunch can be directed to bunker LU-2000. Full inclusion of all magnets of the second ring will allow to receive in hall SP-103 energy 730 MeV. Free electron laser undulator can be installed both in a free rectilinear recirculator path and in hall SP-103, lens hall or a hall going to a neutron target. Features of recirculator work in a mode of a neutron source will be examined below.

ACCELERATING STRUCTURE

The most suitable for realization of our project parameters the superconducting accelerating structure TESLA developed in DESY [2] possesses. The technology of mass structure production, some techniques of processings of a structure surface which allow to receive in structure accelerating gradient up to 35 MeV/m at work in a continuous mode [2] is fulfilled. In really working facilities with several structures in a continuous mode the average current 1 мА has been received, that essentially expands opportunities of recirculator beam use. Accelerating structure characteristics are stable in time. Some criomodules types for various structure numbers have been developed and produced. We choose the module for two sections which is made by small series firm ACCEL. Such module allows to receive a gain of energy 20 MeV for a current up to 100 μA. In the linear accelerator of an accelerating complex SALO it will be used such six modules. Thus, the maximal beam energy on an output of the accelerator will be close to 730 MeV. For currents 1 мА the accelerating gradient is equal 10 MeV/m. This operating mode will be used for a variant of use of the accelerator as the driver for subcritical assembly [4]. On fig.2 elements of magnetic system of a complex which allow realizing this mode are presented. The beam output can be carried out in three directions. On the end of transportation channels the system of dipoles and quadrupoles settles down, allowing to receive a beam of the necessary sizes on targets surface [4].

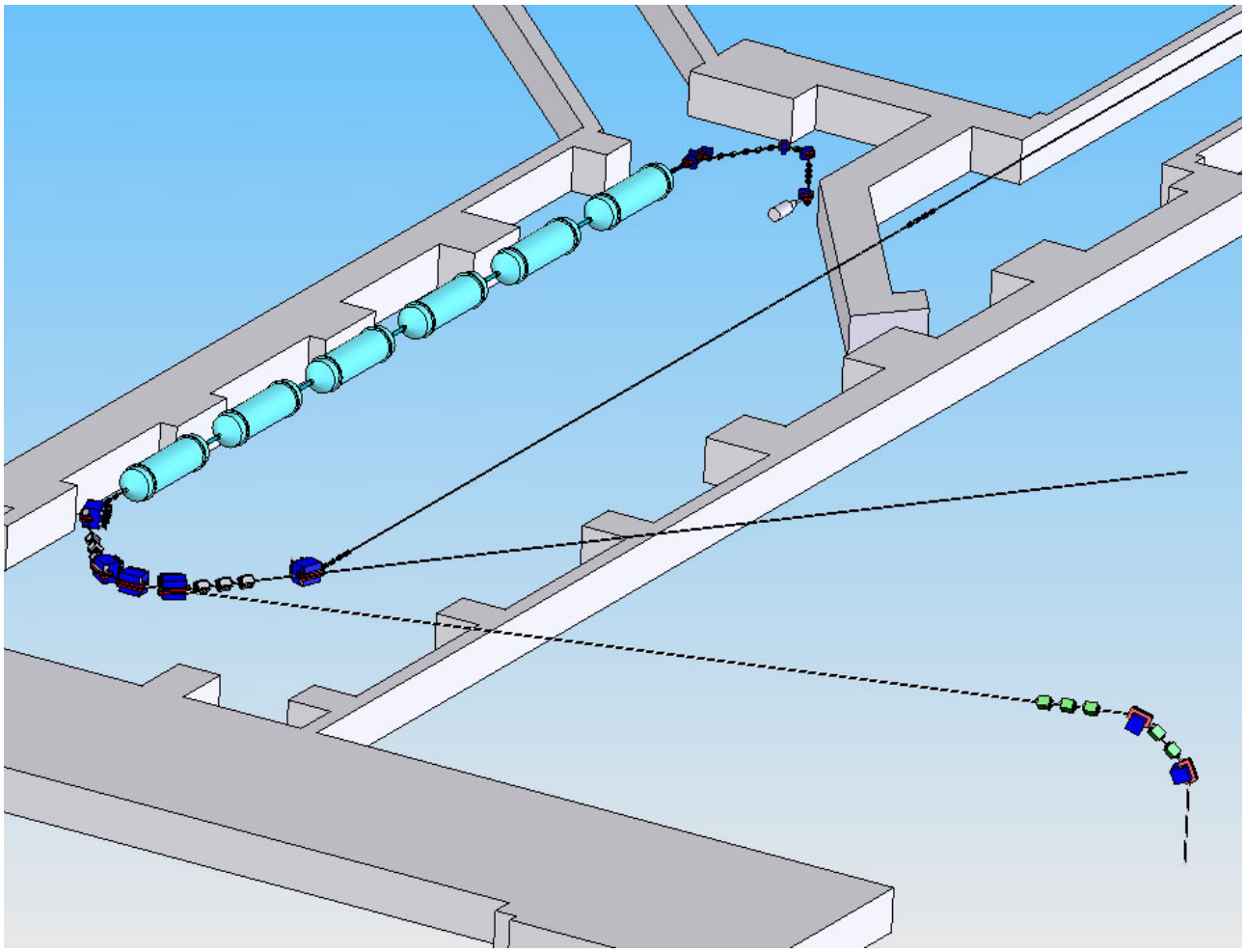

Figure 2: The elements of a complex used in a mode of the driver.

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