MAGNETIC STRUCTURE OF THE NSC KIPT NUCLEAR AND HIGH ENERGY PHYSICS ELECTRON ACCELERATOR

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The magnetic-optical structure of the basic NSC KIPT accelerator with a continuous electron beam of energy up to 730 MeV has been considered.

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1. INTRODUCTION

The main challenge in the design of the basic accelerating installation of the NSC KIPT [1,2] has been the creation of a continuous electron beam source at the minimum cost. This was achieved in the following way:

- The use of existing floor areas and infrastructure as the decisive factors that determine the overall dimensions of the facility;
- the proper choice of the scheme for the recirculation accelerator, i.e., with a multiple beam traversing one and the same accelerating structure, this substantially reducing the capital investments and service expenses;
- integration of magnetic elements transferred by the Technische Universiteit Eindhoven [2] into the magnetic structure.

This paper describes a new variant of the magnetic structure for the NSC KIPT 730 MeV recirculator.

2. MAGNETIC STRUCTURE OF THE FACILITY

To reduce the number of magnetic elements and to fit the available floor space, we have chosen a planar arrangement of magnetic elements with two 360° bends of the beam and two large straight sections (see Fig. 1).

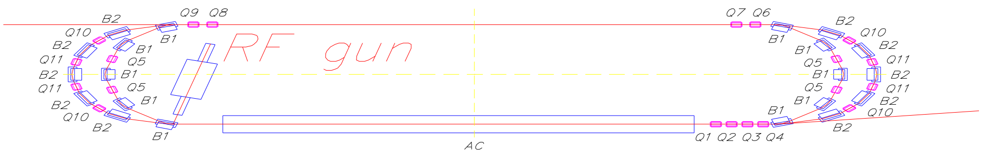

Fig. 1. *Recirculator lay-out*

A standard accelerating module (AC), 15.927 m in length, devised for the TESLA collider [3] and comprising 12 sections is proposed to be used as an accelerating system. The recent technological achievements [4] encourage us to hope for attaining the accelerating gradient of ~20 MeV/m and a 240 MeV energy gain with the section operating in cw-mode.

Reasoning from the proposed program of physical research, two injectors will be used at the accelerator. One of them is intended for the nuclear physics program. It should produce polarized electron beams. The second high-current injector, based on a high-frequency gun, is supposed to be used for studies on neutron physics and physics of free electron lasers (FEL). The two injectors will be placed inside the recirculator orbit. The 10 MeV beam will be injected into the bending magnet with its yoke turned outwards.

Then the beam will be accelerated in the module, which is located in the 19 m long straight section of the recirculator. The spacing between the large straight sections of the recirculator is 5.45 m.

The first turn of beam is realized with the help of 10 magnets of the storage ring EUTERPE [5] (B1), transferred to the NSC KIPT in 2003 by the Technische Universiteit Eindhoven. The second turn is effected with the use of 10 magnets of another type to be designed for the facility.

For the chosen layout of dipole magnets, the locations and powers of lenses providing achromaticity of the straight sections were determined with the use of the computer programs TRANSPORT and MAD. Twenty quadrupoles of the EUTERPE storage ring (Q1-Q11) will be used for beam focusing.

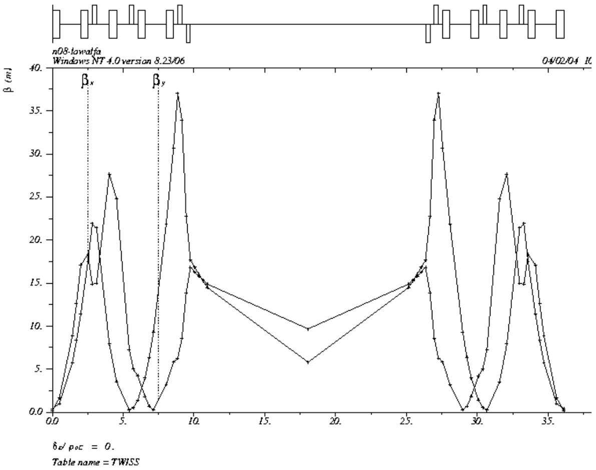

Fig. 2a. *Beta-functions at 250 MeV*

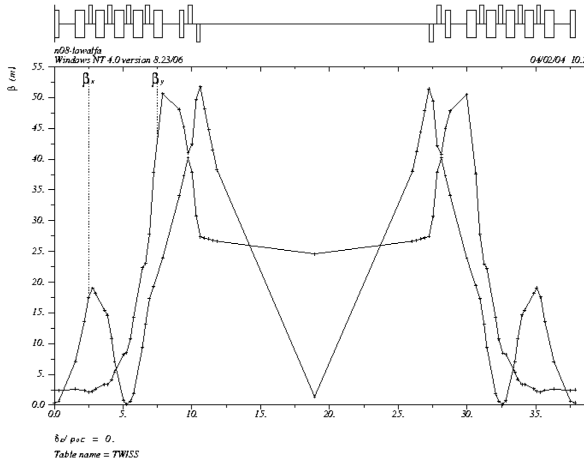

Fig. 3a. *Beta-functions at 490 MeV*

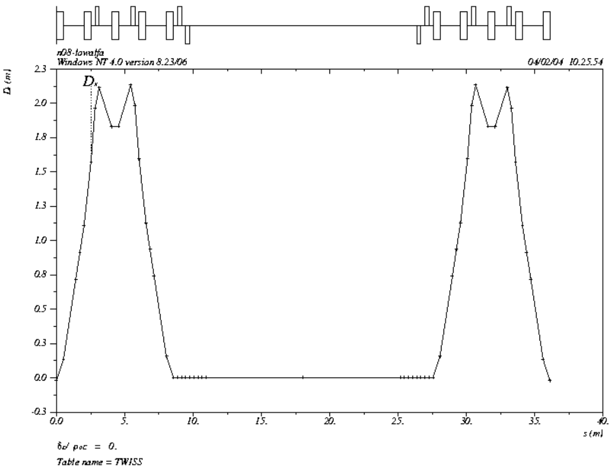

Fig. 2b. *Dispersion function at 250 MeV*

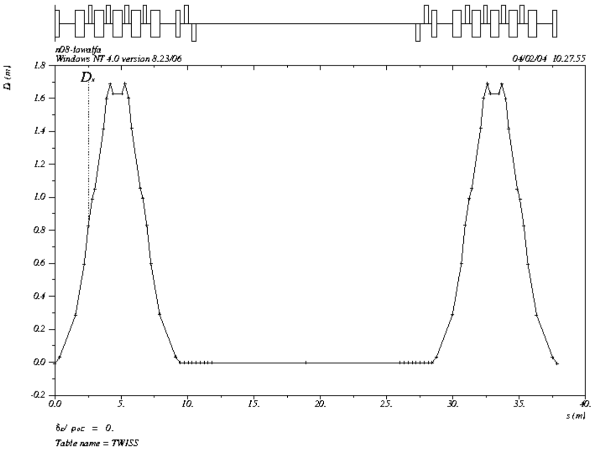

Fig. 3b. *Dispersion function at 490 MeV*

Main parameters of the recirculator

Injection energy, MeV	10
Injection beam emittance, π·mm·mrad	0.05 … 0.295
Energy spread of the injection beam, %	0.0578 … 0.129
Energy gain for single pass, MeV	240
Number of magnets B2	10
Number of magnets B1 (EUTERPE)	10
Highest field in dipole magnets, T	1.345
Number of quadrupole magnets (EUTERPE)	20
Maximum gradient in quadrupole magnets, T/m	6.5
Total length of the recirculator, m	130.95
Emittance at exit point of the accelerator, π·mm·mrad	0.0007 … 0.004
Energy spread, %	0.0008 … 0.00176
Highest value of beam envelope, X, Z, cm	± 0.65; ± 0.2

If all the recirculator magnets are used, the beam will traverse the acceleration structure three times, and experiments with an electron beam of energy up to 730 MeV can be performed in the now existing spectrometer room. By using various combinations of magnetic element switching, the beam of energy up to 490 MeV can be guided to a few other rooms. The magnetic equipment of the EUTERPE storage ring, transferred to the NSC KIPT, makes it possible to put the accelerator into operation for a maximum energy of 490 MeV and to begin experimental studies on the beam.

Figs. 2,3 show the amplitude and dispersion functions for the arcs of energies 250 and 490 MeV, respectively. The main parameters of the recirculator are given in the table.

CONCLUSIONS

At the present stage of the design, the present variant of the recirculator seems more preferable as compared to the previously proposed version [1,2]. First of all, it is attractive to us because of the magnetic system simplicity, no necessity to design and manufacture a great number of new types of magnetic elements that would considerably reduce the time for putting the setup into operation for the physical program. This factor substantially compensates for a high cost of the HF system. The electron energy range is increased. Owing to a less number of recirculations, a much higher output current of the accelerator can be obtained. With this accelerator as the basis, an intense neutron source and a powerful FEL can be created.

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МАГНИТНАЯ СТРУКТУРА БАЗОВОГО ЭЛЕКТРОННОГО УСКОРИТЕЛЯ ННЦ ХФТИ ПО ЯДЕРНОЙ ФИЗИКЕ И ФИЗИКЕ ВЫСОКИХ ЭНЕРГИЙ

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Представлены расчётные характеристики магнитной структуры ускорительного комплекса ННЦ ХФТИ для работ по физике ядра и физике высоких энергий с максимальной энергией электронов до 730 МэВ.

МАГНІТНА СТРУКТУРА БАЗОВОГО ЕЛЕКТРОННОГО ПРИСКОРЮВАЧА ННЦ ХФТІ ПО ЯДЕРНІЙ ФІЗИЦІ ТА ФІЗИЦІ ВИСОКОХ ЕНЕРГІЙ

А.М. Довбня, І.С. Гук, С.Г. Кононенко, M. van der Wiel, J.I.M. Botman, Ф.А. Пеєв, О.С. Тарасенко

Представлені розрахункові характеристики магнітної структури прискорювального комплексу ННЦ ХФТІ для виконання робіт по ядерній фізиці та фізиці високих енергій з максимальною енергією електронів до 730 МеВ.