CONCEPTUAL DESIGN FOR A DOUBLE-SIDED MICROTRON

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Abstract

A study of a C.W. 1-GeV double-sided microtron for medical use of pions and a source of free electron laser has been started at Nihon University. In this paper, we propose an idea for beam transport system to reduce vertical beam defocusing and make magnetic field uniform along the orbit of the first turn.

Introduction

A principle of the double-sided microtron was proposed at middle of the 1950's. However, because of strong vertical defocusing for the low energy region at the field edge of bending magnets, no double-sided microtron has been built.

A microtron type electron accelerator, which includes clasicale, race-track (RTM) and double-sided (DSM), can accelerate in a small room in comparison with a linac for same beam energy. The clasical microtron employs a uniform magnetic field. This configuration is not suitable for heigh-energy C.W. applications because of limitation of the energy gain per turn. This limitation is eliminated by splitting the guide field magnet into two equal halves, allowing the insertion of an accelerator section of arbitrary length, which is the RTM. The RTM appears to be an excellent choice for energy up to 500-800 MeV, from consideration of both cost and performance. In the geometry of the RTM, at constant B, the weight of the end-magnets increace as E^3, becoming excessive for energies above about 800 MeV. The size of the RTM magnets can be reduced by a large factor by the DSM. The DSM would be significantly less expensive for energies up to at least 2 GeV.

The coherence condition of the DSM is expressed by the relation

$$\left(\frac{\pi - 2}{c}\right)\Delta V \cos \phi_s = \nu \lambda B$$

where ΔV is the energy gain of an electron which traverses the accelerating section at peak RF phase, λ the free-space RF wavelength, ν an integer, B the value of the (uniform) magnetic field in four quadrant magnets, and ϕ_s the synchronus phase.

Conceptual Design

The basic components of the microtron include an electric gun a buncher, a 5MeV linac injector, a DSM, an extraction system. A schematic view of the accelerator is shown in Figure 1. Basic design parameters of our proposal of the DSM are tabulated in Table 1.

The electron energy at the output of the gun will be 100 keV. The beam will be bunched and accelerated to 5 MeV and then injected the DSM. The DSM will be built with two 16 MeV linacs and four 90° sector bending magnets. Each linac will use eight 2-meter long disk and washer structurs operated at 2.4 GHz.

To avoid vertical beam defocusing and make magnetic field uniform, we adopte rather complicated magnet system for the first recircuration orbit as seen in Figure 1, in which the system is drawn emphasized. Using the system, because the first orbit can be free from the microtron coherence condition, it can be used for longitudinal phase matching.

Table 1. Basic design parameters.

Maximum energy	1	GeV
Current	300	μA
Injection energy	5	MeV
Energy gain per turn	32	MeV
Accelerating field	1	MV/m
Number of recircurations	32.5	
Wave length	12.5	cm
Magnetic field	0.97	T
Linac length	16	m
Number of linacs	2	
RF power losses	0.9	MW
Shunt impedance	75	MΩ/m
Maximum orbit radius	3.59	m
Minimum orbit radius	0.072	m

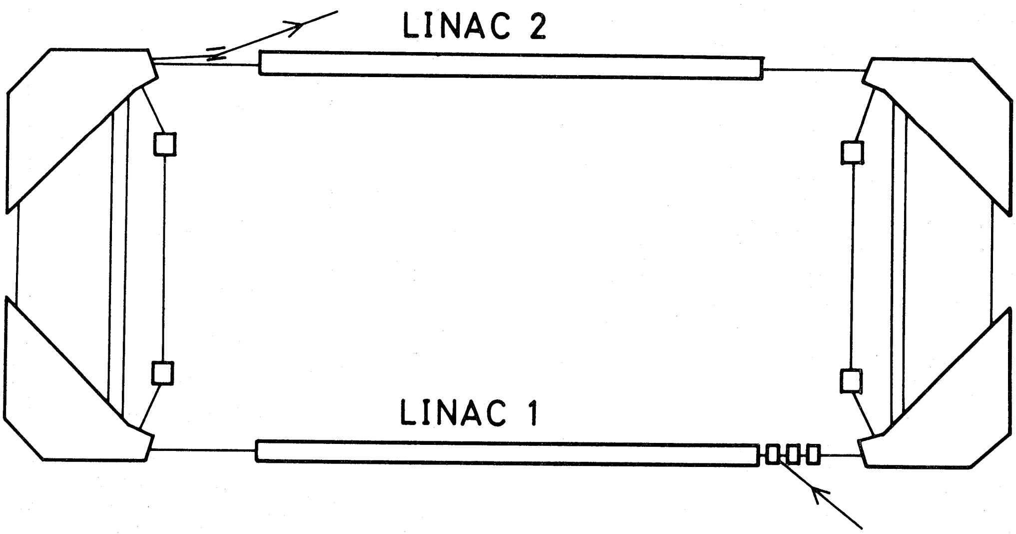

Figure 1. Schematic view of the DSM.