3,5 BEV ELECTRON-POSITRON COLLIDING BEAM MACHINE VEPP-3 AT NOVOSIBIRSK

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A number of experiments on I60 Mev e^--e^- colliding beam machine (VEP-I) have been recently accomplished at Novosibirsk and other experiments on 700 Mev e^--e^+ (VEPP-2) colliding beam machine are in progress. In order to complete the whole program a 3,5 Bev colliding beam machine VEPP-3 (e^--e^+) is under construction. This energy is close to the practical limit determined by the synchrotron radiation.

The storage ring has a strong-focusing magnetic system and consists of two semi-circles with a radius equal to about 8 m separated by two straight sections I2 m long. The operating point is chosen near the centre of the stability region where the equilibrial beam sizes are minimal. The increase of the betatron wave phase per cell may be reduced to $\frac{\pi}{3}$. The straight sections have an unit transformation matrix. When maximal magnetic field is used for the radiation damping of the radial betatron oscillations and in order to make the machine both cheaper and more simple in design we have chosen a somewhat unusual strong-focusing system: short focusing and defocusing magnets and long zero-gradient magnets.

Each magnetic cell contains five elements: zero-gradient, focusing, zero-gradient, defocusing, small non-field straight section. The length and the characteristics of elements are listed in Table II. The magnet is O-shape. The magnetic fields on the equilibrium orbit in focusing and defocusing magnets are essentially different being equal to 0.46 and 0.78 of the mean field on orbit.

The vacuum chamber is made of stainless steel and has an aperture 26x65 mm^2. The evacuation of the chamber is achieved by magnetic-discharge pumps placed in non-field element of each cell.

The chamber is baked up to 400-600°C outside the magnet and may be baked up to 200°C inside the magnet. The investigation on models showed that the pressure inside the chamber will be no worse than 10^{-9} torr. With I00 ma current the estimated life-time is about one hour. When necessary the pressure in the interaction region may be significantly decreased.

The coil consists of four turns (including two with return current) running along each semi-circle. For the tuning of the betatron wave numbers each focusing and defocusing magnet has additional windings supplied by I5% of the total current. Each cell has small correcting coils with about I% of the total current for the adjustment of field and gradient. The gradient magnets also have correcting coils for the independent production of the quadratic and cubic nonlinearities in the field. The maximal current in each turn is equal to 25 ka.

The solution of the kind permitted to fabricate the cell in one detail with a common coil and no commutation.

The long straight section have four pairs of quadruples joined by doublets. The choice of focusing in straight sections was determined by following: small beam size in the interaction region, unit transformation matrix and the necessity to have one of the drift length significantely larger then the others. Without complications of the system we have about 3 m of free space in the centre of the interaction region.

The instability regions of parametric resonance appear for integer betatron wave numbers when the transformation matrix of the straight section differs from an unit. The straight section I2 m long has the minimal response to the deviation of the matrix from an unit. The long straight section provide for the decrease of the beam cross section in the interaction region.

The injection of electrons and positrons into a storage ring is performed in one of the straight section from the synchrotron like it is done on e^--e^+ VEPP-2 machine. The injection energy for electrons is 500 Mev.

The partcles are stored into each of the I8 separatrixes followed by their capture by one. The expected positron storing rate is 10^{12} per hour.

Magnetic measurements were performed on a number of models of separate storage ring elements and cell model. These measurements allowed to estimate the necessary corrections with stray fields in mind. These measurements also proved that the magnetic system will not be a restriction for the energy up to 3.5 Bev.

Simultaneosly the VEPP-3 storage ring is designed to be used as booster for antiprotons in p-$\bar{p}$ storage ring machine now under construction. This influenced to some extent its placing and design. At the moment building works are fully completed and the construction and the adjustment of magnets is under way. The constrution of the synchrotron-injector is nearing the end. It is expected that the machine will be put into operation by summer I968.

The total cost of the e^--e^+ machine VEPP-3 does not exceed 2 million rubles.

DISCUSSION (condensed and reworded)

F. Amman (Frascati): Does the ring operate on the first harmonic?

Lebedev: Yes, but injection is done in 18 bunches, and then all particles will be captured into one bunch.

G.A. Voss (CEA): What is the design luminosity?

Lebedev: 10^{31} cm^{-2} s^{-1}.

TABLE I

MAGNET

Number of normal cells	I6
Number of superperiods	2
Number of long straight sections	2
Mean radius	802 cm
Length of long straight section	I200 cm
Vertical aperture	3 cm
Horizontal aperture	7 cm
Number of betatron waves in straight sections	I+I
Total number of betatron waves	3.25
Momentum compaction	0.I
Revolution time	0.25 msec
Weight of copper	4 tons
Whight of iron	50 tons
Magnet power	I700 KW

RF SYSTEM

Harmonic order	I8
Frequency	72.5 MHz
RF voltage at 3.5 Bev	3 megavolts

BEAM PROPERTIES AT 3.5BEV

Vertical damping time	I.I5 msec
Horizontal damping time	I.30 msec
Quantum fluctuation radial beam size	0.8 cm

TABLE II

CELL CHARACTERISTICS

Cell length 3I5 cm, N=I6

	O	D	O	F	straight
Length (cm)	95	52	I05	48	I5
Field (kGs)	I8.4	II.4	I8.4	6.7	-
Distance from asymptote (cm)	-	6.2	-	3.5	-