Status of the Injector Complex for $c\tau$–factory at Novosibirsk.

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Abstract

A complex of electron-positron factories, including $c\tau$ and Φ factories, is under construction at BINP in Novosibirsk [1]. To provide the effective operation of this installation, the injector complex that comprises the pre-injector and the damping ring is being worked out. This paper presents the current status of the injector complex.

1 INTRODUCTION

The main goal of the $c\tau$-factory project is to provide high luminosity in the beam energy region of $0.7 \div 2.5$ GeV.

The beam parameters for the $c\tau$-factory should satisfy the requirements for obtaining a maximum high luminosity of $1.0 \cdot 10^{34}\text{cm}^{-2}\text{s}^{-1}$.

In addition to the maximum luminosity regime, it is planned to obtain the beam parameters required for the so-called monochromatization of colliding beams and polarized colliding ones.

In order to obtain such a luminosity it is planned to build two storage rings located one over the other and intercrossing at the interaction point. The length of the rings should provide a high frequency of bunch collisions and in addition allow to allocate room for the beam emittance control systems. The large circumference helps to have a very small beam emittance exited by synchrotron radiation in the bending magnets.

The most interesting possibility of obtaining the maximum luminosity is setting up an interaction point with a small β-function using a strong longitudinal field (9.6 T and 2.18 m long). Possessing symmetrical focusing in both directions, such a system satisfies the idea of operation with round beams and can allow us to obtain the parameters for a space charge $\xi_{max} > 0.1$.

The $c\tau$-factory parameters for the maximum luminosity regime are shown in Table 1.

Energy (GeV)	2.1
Number of particles in bunch	$2.0 \cdot 10^{11}$
Bunch spacing (m)	8.14
Beta-function at IP (cm)	1
Value of ξ_{max}	0.1
Beam radius σ(μm)	33
Beam emittance $\epsilon_x = \epsilon_y (cm)$	10^{-5}
Beam current (A)	1.12
RF frequency (MHz)	700
Circumference (m)	773.036
Radius of ring (m)	89.63
Straight section length (m)	100
Luminosity (cm^{-2}s^{-1})	$1.0 \cdot 10^{34}$

Table 1: Parameters of the $c\tau$-factory.

2 INJECTOR COMPLEX

In order to provide an effective operation of $c\tau$ and Φ–factories and the existing collider VEPP-4, an injector complex comprising a pre-injector and a damping ring is developed. The general layout of the injector complex and Φ–factory are shown in Fig. 1. The pre-injector is a basic element of the injector complex and is designed to provide initial production of electron and positron bunches and their acceleration up to an energy of 510 MeV [2]. The main pre-injector parameters are given in Table 2. It consists of two

Output energy (MeV)	510
Number of electrons per bunch	10^{11}
Number of positrons per bunch	10^{9}
Repetition rate (Hz)	50
Energy spread:	
electron bunch (%)	± 1
positron bunch (%)	± 3
RF frequency (MHz)	2856
Klystron pulse power (MW)	~ 63

Table 2: Main pre-injector parameters.

S-band (2856 MHz) linacs. The first linac at an energy of 300 MeV produces intensive electron bunches for positron production. The second linac accelerates both positron and electron bunches (produced by an RF Gun with a laser-triggered photocathode) up to an energy of 510 MeV. Fourteen accelerating sections of the pre-injector will be fed by 4 RF assemblies based on SLAC 5045 klystrons.

The damping ring is designed to provide accumulation, cooling and extraction of electron and positron beams at an energy of 510 MeV with a particle production rate of $2 \cdot 10^{10}$ per second for injection into Φ and (after additional acceleration) $c\tau$ factories. The main parameters of the damping ring are given in Table 3. The lattice consists of four symmetrical quadrants. The magnetic field polarity does not change with changing from electrons to positrons.

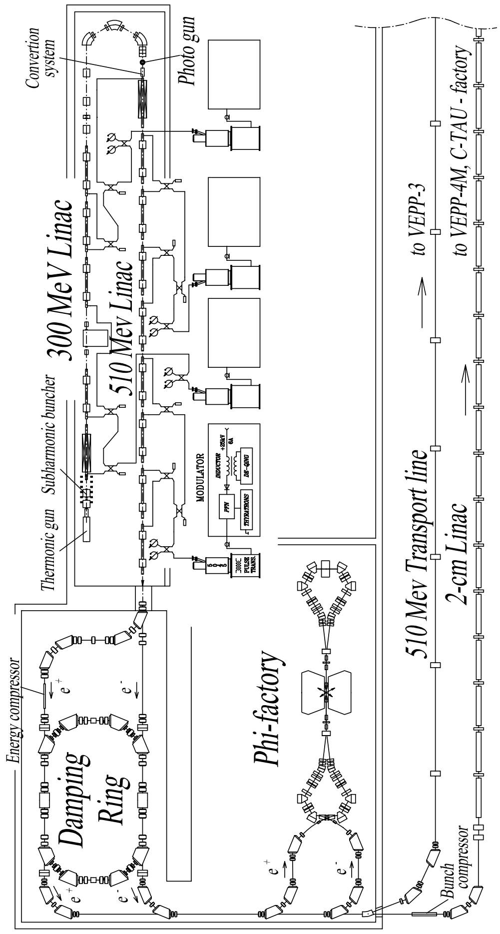

Figure 1: Layout of injector complex.

The single turn injection scheme with the orbit bump and horizontal kick is used.

3 PRESENT STATUS OF PRE-INJECTOR

In 1997 the work was continued on the design, production, assembly, tune and test of the elements for the pre-injector. The main attention was paid to preparing for the manufacture of accelerating structures, and the production of basic parts of the magnetic system and the waveguide lines. The RF load prototype was designed, produced and prepared for operational tests. By the end of 1997 the vacuum furnace for half-structure brazing was put into operation.

The production of the accelerating structures is started by clean technology. 80% of the pre-injector quadrupole lenses and 30% of the accelerating structure supports were produced last year, there were waveguide lines also produced and assembled for first three accelerating sections.

In the klystron gallery the work is started to put into operation the third and the fourth modulators for 5045 klystrons.

The assembly of the system of the master oscillator at a pre-injector operating frequency of 2856 MHz is completed, the adjustment is started.

Energy (MeV)	510
Circumference (m)	27.401
Number of particles per bunch	$2 \cdot 10^{10}$
RF frequency (MHz)	700
RF power (kW)	70
Energy loss/turn (keV)	5.3
Synchrotron damping time (ms)	11.9
Horizontal damping time (ms)	11.3
Vertical damping time (ms)	17.5
Injection frequency (Hz)	50
Extraction frequency (Hz)	1
Vertical emittance (cm·mrad)	2.3
Horizontal emittance (cm·mrad)	0.5
Energy spread (%)	0.07
Bunch length (cm)	0.5

Table 3: Damping ring parameters.

The production of a waveguide line for the second pre-injector klystron is completed, four systems of the power compression (SLED type) are fabricated (the first system is prepared for an RF test at an operational level of the input power of 63 MW). The design of waveguide lines from the third and the fourth klystrons of pre-injector is completed, their production is started.

In 1997 the 200 keV source of electrons was modified in order to achieve the required pre-injector parameters, the preparation for its test is started.

In 1997 first experiments on RF photogun prototype with a GaAs photocathode were carried out. The lifetime of the activated photocathode in the RF cavity was measured. The measurements of the dark current from the GaAs photocathode surface in a high RF field were made for the first time [4]. By the end of 1997 several series of experiments were carried out to measure the cathode lifetime and the dark current for different values of the RF field on the cathode, the measurement results are under processing now.

In 1997 the experiments on the VEPP-5 pre-injector prototype were carried out [3]. As a result, separate elements of the beam diagnostic system were tested and modified, all the beam diagnostic monitors were designed and put into production.

Complete tests of the pre-injector cooling system elements are done, their fabrication is started.

Measurements of magnetic fields of the pulsed magnet-concentrator prototype for the pre-injector positron system are done, the prototype is designed and produced and prepared for testing.

4 PRESENT STATUS OF DAMPING RING

Last year the design, production, construction and equipment of facilities were continued for different systems of the damping ring: the RF system, the power supply system, the optical system and the injection-extraction system.

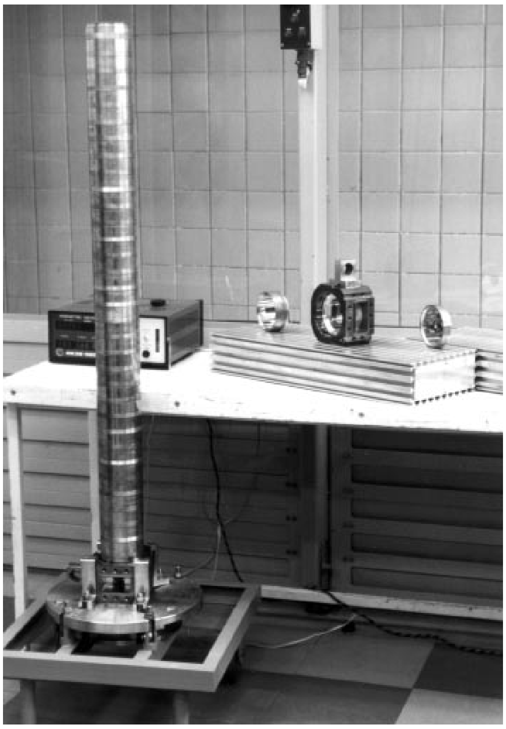

Figure 2: Accelerating structure before brazing.

In 1997 the production of the all damping ring bending magnets was completed.

The thorough magnet measurements for all produced elements were carried out, including the field pattern tests in the bending magnets with a field gradient. First series production quadrupole lenses are produced and tested. The measurements showed good agreement of the experimental data with the calculated ones. Dipole magnets are installed and aligned.

The design of the initial part of the injection beam line is also continued: the beam dump with its diagnostic system and separator magnets (mechanically turning). This separator uses permanent magnets to generate dipole field. The prototype of the separator magnet is produced and tested.

The design and production of the power supply sys-

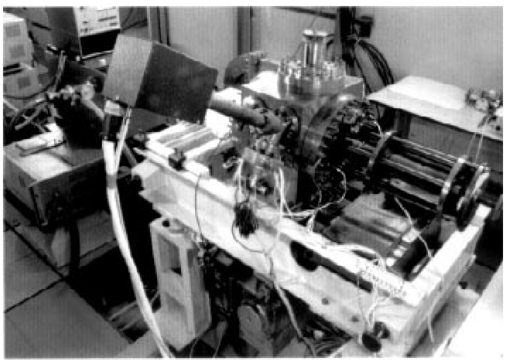

Figure 3: RF photogun prototype.

Figure 4: Damping ring hall.

tem is continued. The first high voltage generator for the injection-extraction kickers is tested, modified and the rest three generators are put into production.

Basic elements of the RF source system are produced, installed and tested. A 60 kW circulator to protect klystron from reflected power is produced, assembled and tested for the power. An RF cavity is fabricated and ready for a final cold measurement. The optimization of the computer control of the RF system is continued. The control system is based on PC and a transputer CAMAC controller.

The main part of the vacuum system is also fabricated.

In particular vacuum valves are produced with cross-sections corresponding to that of the vacuum chamber (to eliminate impedance).

5 CONCLUSION

Plans for 1998 include:

- producing, assembling and testing the first stage pre-injector elements (including 3 accelerating section) in order to achieve a beam energy of about 180 MeV;
- completing the production of the damping ring magnetic system;
- assembling and testing (at a working power) of the damping ring RF system, including the cavity;
- assembling the ring vacuum chamber and the most part of the chamber of the injection beam lines.

6 REFERENCES

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