ELECTRON AND POSITRON BEAMS TRANSPORTATION CHANNELS TO BINP COLLIDERS*

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Abstract

There are two accelerator complexes VEPP-2000 and VEPP-4M in BINP. There is preparatory work for building of new accelerator – Super Charm-Tau Factory. As an injector of positrons for Super c-τ Factory the existing injection complex VEPP-5 will be used. Existence of the powerful injection complex provokes the desire to use it for needs of the working accelerator complexes VEPP-2000 and VEPP-4M. Replacement of the existing injection subsystems with the injection complex VEPP-5 will allow us to increase the speed of accumulation of positrons at the accelerator complexes VEPP-2000 and VEPP-4M in 1000 and 100 times respectively. For VEPP-2000 this improvement has a great significance as the existing conversion system doesn't provide the demanded quantity of positrons for designed luminosity of a collider $1x10^{32}$ $cm^{-2}s^{-1}$.

In the article the short review of transportation channels from the injection complex VEPP-5 to the accelerator complexes VEPP-2000 and VEPP-4M, time sequence of an injector's work for both complexes are given. The transportation channel from the injection complex VEPP-5 to the booster ring BEP of the accelerator complex VEPP-2000 is described in details.

BINP COLLIDERS AND INJECTION COMPLEX

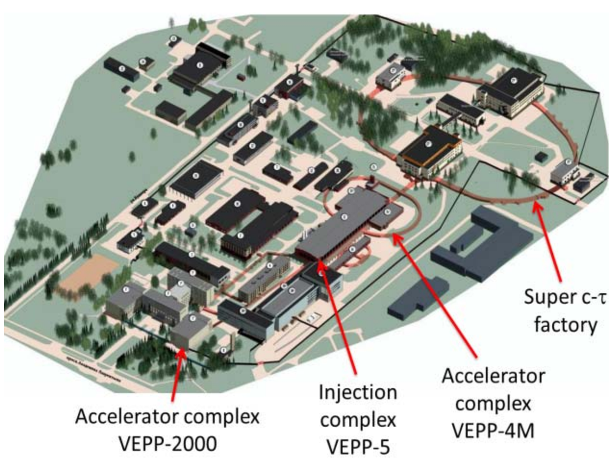

Figure 1: Colliders and Injection Complex in BINP.

In Figure 1 the arrangement of colliders and the injection complex in the territory of BINP is shown. Their detailed schemes are submitted in Figures 2-4.

The existing injection system of VEPP-2000 provides $2x10^7$ positrons per second that allows us to reach luminosity $5x10^{30}$ $cm^{-2}s^{-1}$ at energy 1GeV in one bunch. Achievement of designed luminosity $1x10^{32}$ $cm^{-2}s^{-1}$ requires $1x10^8$ positrons per second.

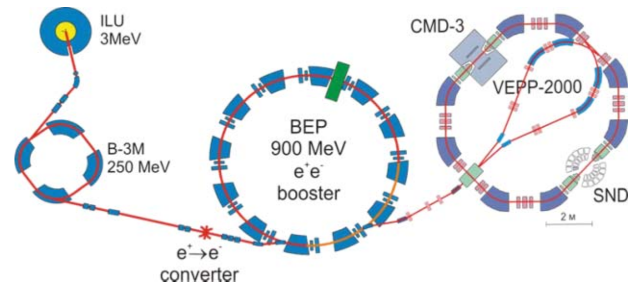

Figure 2: Accelerator Complex VEPP-2000.

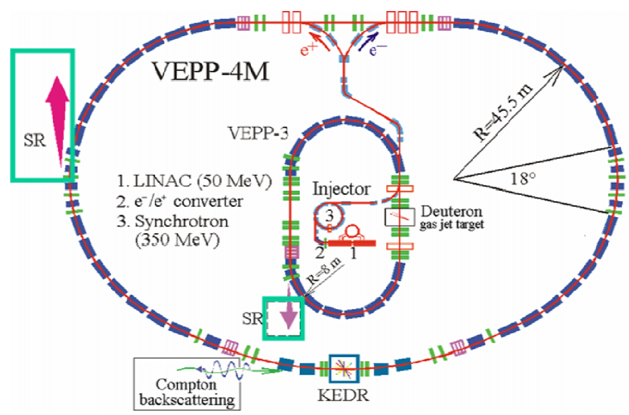

Figure 3: Accelerator Complex VEPP-4M.

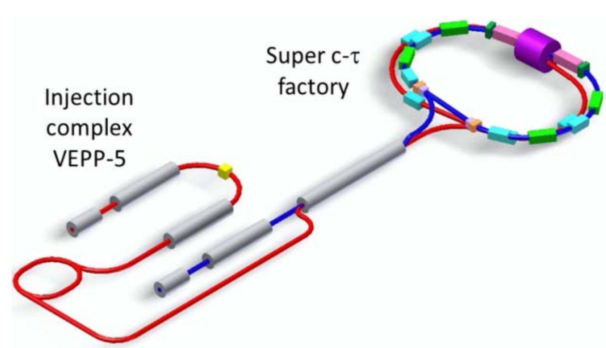

Figure 4: Super Charm-Tau Factory and Injection Complex VEPP-5.

The existing injection system of VEPP-4M makes $2x10^8$ positrons per second that allows us to reach luminosity $2x10^{30}$ $cm^{-2}s^{-1}$ at energy 1.8 GeV in one bunch. Achievement of the future designed luminosity $8x10^{31}$ $cm^{-2}s^{-1}$ at energy 5.5 GeV in one bunch requires $2x10^{10}$ positrons per second.

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For future Super c-τ Factory with designed luminosity $1\text{x}10^{35}$ $\text{cm}^{-2}\text{s}^{-1}$ $6\text{x}10^{11}$ positrons per second will be required.

The Injection complex VEPP-5 parameters are: energy 510 MeV, number of positrons $2\text{x}10^{10}$ per second, energy spread $5.1\text{x}10^{-4}$, emittances ε_x $2.3\text{x}10^{-6}$ cm·rad ε_z $5\text{x}10^{-7}$ cm·rad. These are enough for needs of VEPP-2000 and VEPP-4M. Super c-τ Factory requires more productivity of the injector. Improvement of the injection complex will be made along with construction of Super c-τ Factory.

OPERATION: INJECTOR VEPP-5 FOR VEPP-2000 & VEPP-4M

Work at VEPP-4M: accumulation of electrons in a booster ring VEPP-3 to current 200 мA in one minute; energy rise to 1.8 GeV in 10 minutes; transportation of electrons to collider VEPP-4M; a polarity reversal of booster ring VEPP-3 in 2 minutes; accumulation of positrons to 200 мA; transportation to VEPP-4M collider, once again electrons and positrons. After injection to the collider of two bunches of electrons and two bunches of positrons, there is a rise to the energy of experiment from 1 to 5.5 GeV per bunch. Receiving four bunches and energy rise takes 1 hour. After that experiment runs 3 hours.

Work of the accelerator complex VEPP-2000 differs from VEPP-4M. The collider of VEPP-2000 can work for experiment constantly as its booster ring BEP is capable to change the energy in all range of experiments from 0.16 to 1 GeV per bunch. After receiving electrons, BEP boost them to the energy of experiment in 10 seconds. After transportation of electrons to VEPP-2000 collider, the booster reverses polarity in 20 seconds. Then BEP takes positrons, increases their energy, transports to collider ring, reverses polarity and so on.

TRANSPORTATION CHANNEL FROM INJECTIOR VEPP-5 TO BOOSTER BEP

Geometry and optics

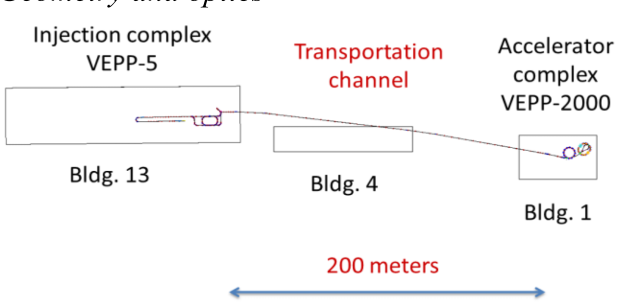

Figure 5: Location of the transportation channel in the BINP.

The transportation channel layout is presented in Figure 5. The detailed geometry and lattice functions are shown in Figures 6-13.

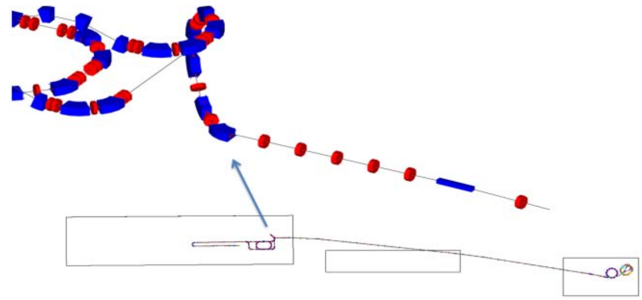

Figure 6: Descent from the storage ring of VEPP-5.

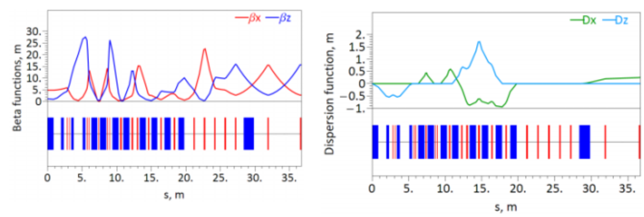

Figure 7: Lattice functions of descent.

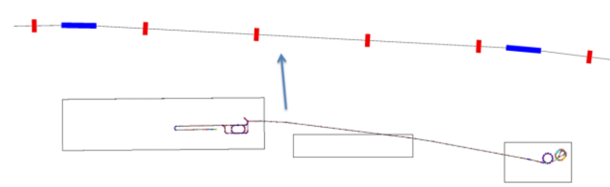

Figure 8: First horizontal bend.

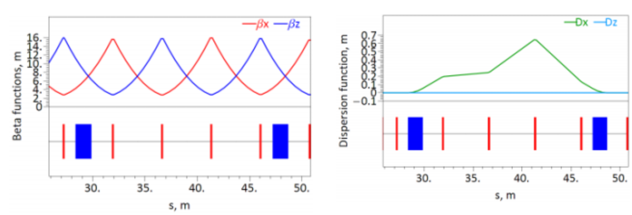

Figure 9: Lattice functions of first horizontal bend in regular part.

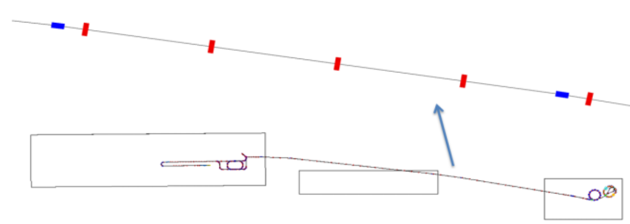

Figure 10: Second horizontal bend.

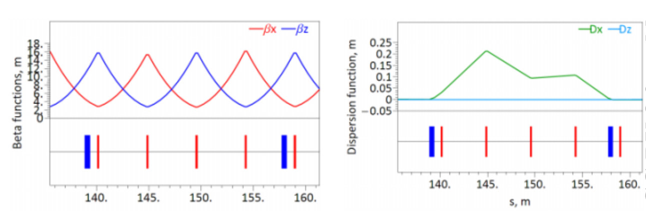

Figure 11: Lattice functions of second horizontal bend in regular part.

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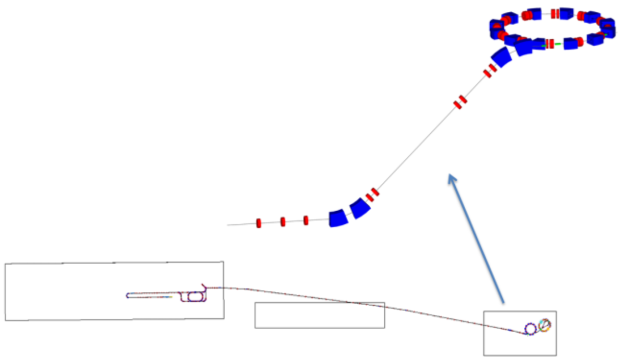

Figure 12: Ascent to booster BEP.

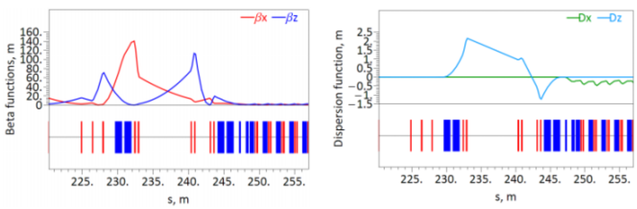

Figure 13: Lattice functions of ascent.

Beam Diagnostics and Vacuum

For beam diagnostics two types of sensors are used: 12 luminophor probes and 23 image current monitors. Probes used for the first beam-pass, they are not transparent for the beam. Monitors are used for supervision of bunches at the time of the beam-pass. They are located after the dipole correctors with betatron phase advance of 2/3p. It allows us to observe effectively the influence of dipole correctors on a bunch trajectory.

At present the vacuum is 10^{-8} Torr, for this purpose 8 pumps NMD-016 are installed.

Magnets and Power Supply

Magnets and power supplies of the transportation channel are listed in Table 1. The first three power supplies are in production. Other power supplies and all magnets are already manufactured.

PERSPECTIVE

Work of beam-pass from Injection complex VEPP-5 to the booster BEP is planned to carry out from December, 2014 to March, 2015. Experiment on collider VEPP-2000 is planned to begin in May, 2014.

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Table 1: Magnets and Power supplies

Element	Parameters	Power supply
2 horizontal magnets, 1-st bend	H=0.08T, L=0.5m	1 DC, UM-20, I=20A
2 horizontal magnets, 2-nd bend	H=0.08T, L=1.5m	1 DC, UM-20, I=20A
4 vertical magnets of the ascent to the booster BEP	H=0.7T, L=1m	1 AC, GID-3000, W=3kJ
1 horizontal magnet before the septum magnet in the booster BEP	H=1.7T, L=0.3m	1 AC, W=2.4kJ
1 septum magnet of the booster BEP	H=1.7T, L=0.4m	1 AC, W=2.4kJ
42 lenses of regular part	G=2.5T/m, L=0.2m	8 AC, GID-25, W=25J
17 lenses of matching parts	G=10-20T/m, L=0.2m	17 AC, GID-25, W=25J
12 dipole correctors in 12 lenses	Hmax=0.2T, L=0.1m	12 AC, GID-25, W=25J
27 dipole correctors	Hmax=0.2T, L=0.1m	27 DC, PS-3-A, I=3A

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