DESIGN OF THE VEPP-2000 VACUUM SYSTEM

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Abstract
The Budker Institute of Nuclear Physics (BINP) project of the VEPP-2000 electron-positron Round Colliding Beams in the energy range 2*(0.2 - 1.0) GeV will have an average synchrotron radiation (SR) power of up to 1000W per meter, a very tight packing magnetic elements and beam diagnostic devices. The high photon stimulated desorption rate in the beginning of operation makes the use of the non-evaporated getter (NEG) coating and the cold surface of the cryogenic optics as an effective molecular pumping quite reasonable. The aim of this work is the vacuum system design and estimation of residual gas pressure time profile during conditioning period of the VEPP-2000 operation. The description of manufacturing, cleaning and proposed bake-out procedures for the beam vacuum chambers are presented.

INTRODUCTION
A decision to upgrade the VEPP-2M complex by replacing the existing collider with a new one in order to improve the luminosity and at the same time to increase the maximum attainable energy up to 2 GeV will significantly broaden the potential of experiments performed at the collider. The new project is called “VEPP-2000” based on the center-of-mass energy and year when the project has been approved.

Figure 1 shows the layout of the VEPP-2000 complex. It consists of a 2.5 MeV linac, 250 MeV synchrotron, booster ring and the VEPP-2000 storage ring. The booster can change polarity to store subsequently electrons and positrons and is capable of accelerating beams up to the energy of 900 MeV. Above this level, the energy of the collider will be ramped to the energy of experiment. The injector is kept unchanged from the VEPP-2M collider.

The design luminosity of the VEPP-2000 $1 \times 10^{32} \text{cm}^{-2}\text{s}^{-1}$ at 1 GeV could be available due to the Round Colliding Beams concept [1]. In order to realise the round transverse section beams, four special superconducting solenoids with magnetic field 13T will be applied close to Interaction Points (IP) at both sides of the Spherical Neutral Detector (SND) and the Cryogenic Magnetic Detector (CMD).

Note, that perimeter of VEPP-2000 is 24.4m only and the average density of SR flux is $1.2 \times 10^{19}$ photon/s per meter and SR power is 1000W per meter at maximum design currents $I_{e-}=I_{e+}=200$ mA. Special SR absorbers will be used along the total length of the ring except interaction regions and RF cavity. An intense gas load due to photon stimulated desorption should be compensated by high enough molecular pumping speed. But, even in case, the use of solenoid cold surfaces as the efficient pump, there is no enough room along the ring to arrange an effective molecular pumping speed over 1500 litre/s. Numerical simulations show that at this pumping, the maximum currents $I_{e-}=I_{e+}=200$ mA could be available (from vacuum point of view) after a half a year continuous conditioning. To decrease conditioning duration, a getter molecular pump was approved for application in the straight beam vacuum chambers.

This paper contains numerical simulations of the residual gas pressure dynamic with/without getter application and concepts of the bending magnet and straight vacuum chambers design.

![Figure 1: Layout of the VEPP-2000 complex.](image)
A decrease in the photodesorption yield with accumulated dose is taken into account according to the following empirical expression [2]:

\[ \eta = \eta_0 \left( \frac{\Gamma}{\Gamma_0} \right)^{-0.6} \]

where \( \eta \) (molecule/photon) – photodesorption yield, \( \Gamma \) (photon/m) is accumulated photon dose, \( \eta_0 \) – photodesorption yield at the accumulated dose \( \Gamma_0 \). Here, the volumes \( \eta_0 = 2 \times 10^{-4} \), \( \Gamma_0 = 10^{21} \) are used for calculation.

### VACUUM CHAMBERS DESIGN AND TECHNOLOGY

#### Conceptual design

The conceptual design of the bending magnet vacuum chamber is shown in Fig. 2. The pumping slots (2) connect the chamber with ion pumps. The estimated pumping speed is 70 litre/s at each end. The double sites morrow (3) is used for monitoring both e- and e+ beams profile and positioning. The design of the SR absorbers (1) is the same as that in the straight vacuum chambers (Fig. 5). The copper strip is brazed to the specially designed stainless steel cooling tube welded to the beam chamber. The stainless steel thickness between copper and water is 1mm only. This design allows to avoid water–welding seam–vacuum transitions and provides the necessary cooling capacity.

Main material for vacuum chamber production is stainless steel sheets 316LN. The cleaning procedure of the vacuum chambers follows several steps:
- degrease in perchloroethylene;
- ultrasonic cleaning in alkaline detergent (pH=9.7) at 60°C for 30 minutes;
- degrease in perchloroethylene;
- ultrasonic cleaning in alkaline detergent (pH=9.7) at 60°C for 30 minutes;
- immediate rinsing with demineralised water jet;
- immediate rinsing in demineralised water by immersion;
− drying in the air oven at 150°C.
− pre-bakeout under vacuum at 300°C.
− deposition of 3mkm getter TiZrV film inside straight vacuum chamber using magnetron discharge in Kr atmosphere.

Bakeout procedure
The proposed bakeout is two step procedure: a) the uncoated part of vacuum system is baked to 300°C during 24 hours whilst the TiZrV coated part is held at 80°C; b) for NEG activation the uncoated part is maintained at 150°C whilst the TiZrV coated chamber is activated at 190 ± 5°C for 24 hours [4].

CONCLUSION
The numerical estimations of the pressure profile and reachable I_e- I_e+ current during conditioning were done. Results show that NEG coating applied even in straight vacuum chamber significantly decreases conditioning duration (cost) of VEPP-2000. The conceptual design of vacuum chamber is presented.

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REFERENCES