DESIGN OF THE VEPP-2000 VACUUM SYSTEM

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Abstract

The Budker Institute of Nuclear Physics (BINP) project of the VEPP2000 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 $1\times10^{32} cm^{-2}s^{-1}$ 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 $1.2*10^{19}$ photon/s per meter and SR power is 1000W per meter at maximum design currents Ie-=Ie+=200mA. 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 Ie-=Ie+=200mA 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.

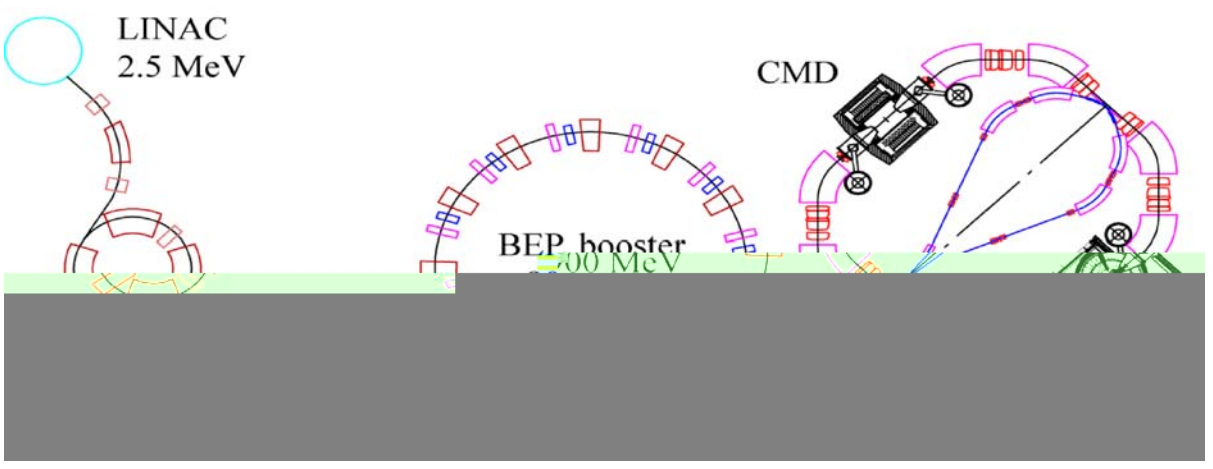

Figure 1: Layout of the VEPP-2000 complex.

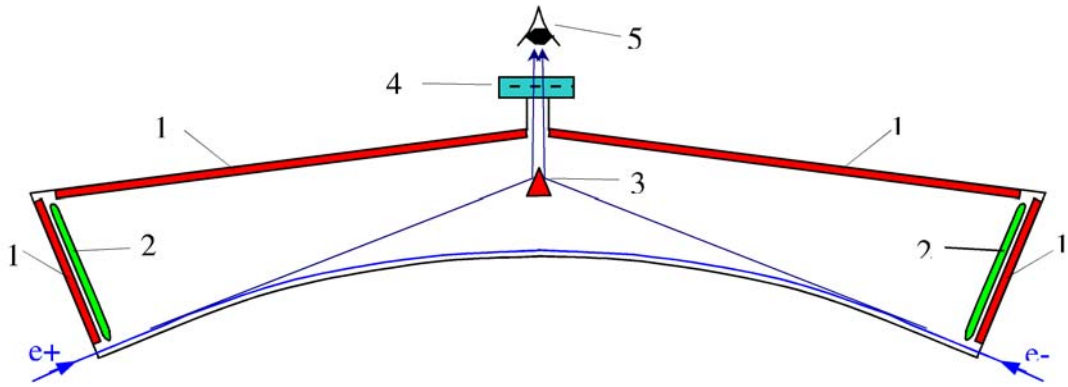

Figure 4. Bending magnet vacuum chamber. 1- Copper SR absorbers; 2- pumping holes to ion pumps; 3 - double sites morrow: 4 –window; 5 - beam profile monitor.

– drying in the air oven at 150°C.
– pre-bakeout under vacuum at 300C.
– deposition of 3mkm getter TiZrV film inside straight vacuum chamber using magnetron discharge in Kr atmosphere.

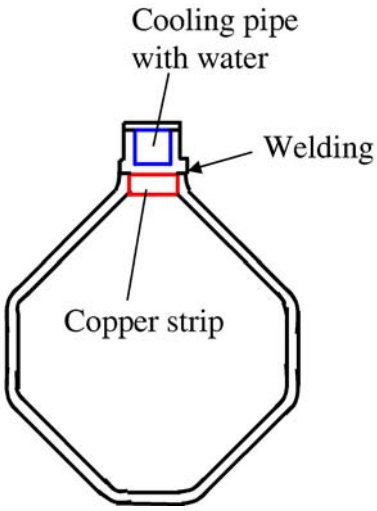

Figure 5. Cross-section of the straight vacuum chamber.

The TiZrV NEG was developed at CERN [3]. The decision to apply TiZrV coating in the VEPP-2000 was done due to its following properties:

- comparative low temperature of activation (180°C);
- quite large number of reactivation cycles (more than 20) without drastically losing the sorption properties;
- low photodesorption yields at bombardment by high energy photon [3];
- the coverage is cleaned by irradiation as a result of molecular dissociation and diffusion of atoms into the bulk of material [3]. This is very important because NEG will have large gas load from uncoated part during VEPP-2000 conditioning.

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 Ie- Ie+ 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.

ACKNOWLEDGMENTS

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