

THE PULSE STRETCHER RING PSR-2000 CURRENT STATUS

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Abstract

The development of the Pulse Stretcher Ring PSR-2000 design, now under way simultaneously in KFTI (Kharkov) and NII-EFA (St.-Petersburg), is nearing completion. The paper presents the structures of the Pulse Stretcher Ring and the transport system after a definitive choice of the basic elements for electromagnetic and vacuum equipment. The design beam parameters are given for all the operating regimes of the storage ring.

1. INTRODUCTION

To investigate electromagnetic interactions of nucleons and nuclei, subnucleon degrees of freedom, etc., the physicists need continuous electron beams with energies ranging from several hundred MeV to a few GeV. For this purpose, several years ago we started to design the pulse stretcher ring PSR-2000 at the output of the operating at Kharkov 2GeV electron linear accelerator LA-2000 [1]. The main parameters of the PSR-2000 in the stretcher operation conditions have been given in [2,3], and a possibility for the machine to operate in the regime of a low radiation emittance as a source of synchrotron radiation has been considered in [4].

At present, the development of the general design is nearing completion; simultaneously some pilot samples of the equipment are being constructed; several test beds have been made

2. GENERAL DESCRIPTION AND DESIGN PARAMETERS

A schematic representation of the linac-stretcher ring complex is shown in Fig.1.

After passing through the magnetic debuncher, the phase length of the bunch at the linac output grows from $\pm 2.5^\circ$ to $\pm 45^\circ$. Passing then along the RF section ($E_{\max} = 40\text{MeV}$) of the energy compressor system (ECS) the beam reduces its energy spread, due to selfphasing, by a factor of ≈ 12 ; this allows us to obtain

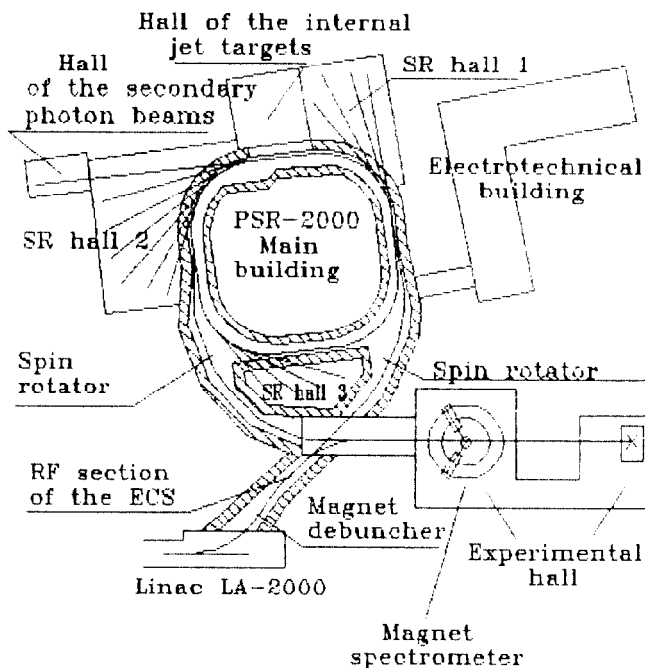


Figure 1. Schematic diagram of the complex. SR: synchrotron radiation.

$dE/E \approx 0.1\%$. In addition to conventional magnetic devices ensuring the beam guiding and the phase-space matching, the transport channels of the injected and extracted beams also comprise the insert to reverse the beam polarization vector from the longitudinal direction to the vertical one in the injection channel, and from vertical to longitudinal in the extraction channel. The insert includes superconducting solenoids and sets of quadrupole magnets, which make the insert "transparent" to the beam optics [2].

The injection to the ring is carried out with two septum magnets bringing the beam on the reference orbit perturbed by three pulsed bump magnets.

The PSR-2000 lattice consists of 4 super-periods providing for the achromatism of the

beam motion in straight sections. Each arc section has 8 dipole and 7 quadrupole magnets. In the straight sections there are 5 quadrupole magnets in each, ensuring the steadiness of the horizontal amplitude function β_x in the beam injection and extraction sections. To compensate the chromaticity, each arc section is equipped with 4 sextupole lenses, and each straight section comprises one sextupole lens to adjust the amplitude and the phase of the 16th harmonic of the sextupole field during a slow extraction at the third-order resonance.

The deviation of the extraction angle is compensated by four pulsed sextupole lenses. Five pulsed quadrupole lenses located in the straight sections serve to control detuning in the process of extraction. The extraction at a half-integer resonance of betatron oscillations is provided by the corresponding tuning of the quadrupole lenses of the straight sections. The reference orbit correction in the both planes is carried out with 30 dipole correctors.

To compensate the beam energy losses by synchrotron radiation, four RF sections, each consisting of 5 optimized Ω -cells, are mounted in one of the straight sections. The operating frequency of the RF system is 699.3MHz, the power of each of four klystrons is 100kW, the accelerating voltage is 3MV.

The beam is extracted from the ring by means of the electrostatic and two magnet septa.

The beam parameters are controlled by pickup stations, RF and magnetoinduction detectors, wire scanners, against synchrotron radiation, etc.

The basic structural material of the vacuum chamber is aluminum alloy. The chamber is elliptical in the cross section, the semi-axes being 70 and 19mm. In the dipole magnets of the ring the chamber with an antichamber is used.

The chamber is evacuated by five stations of combined pumps at a total pumping rate of no less than 100 l/s at a pressure of 10^{-8} Pa. The pumps comprise the magneto-discharge unit and titanium sputterer. Similar stations are mounted to evacuate RF cavities, electrostatic and magnet septa boxes.

The PSR-2000 is supposed to have an internal jet target with an appropriate detecting equipment as well as the systems of photon tagging and monoenergetic photon beam production due to the Compton interaction of laser light with the electron beam.

The main parameters of the PSR-2000 for two modes of operation are given in Table 1.

Table 1.
Main parameters of the PSR-2000

Parameter	Stretching mode	Low rad. emittance mode
-Energy range, GeV	0.9+3.0	0.75+2.5
-Circul. current, mA (multibunch mode)	140	400
-Average extracted beam current, μ A	30	-
-Emittance, mrad		
horizontal $\cdot 10^{-8}$	10 π	(2+15) π
vertical $\cdot 10^{-8}$	100 π	(2+15) π
-Beam duty factor	0.9	-
-Energy spread, %	0.1	-
-Orbit length, m	214.78	214.78
-Bending magnet radius, m	9.03	9.03
-Momentum compaction factor	0.048	0.021

The main building houses power supplies of magnet elements, septa, RF stations, local and central control boards. In the electro-technical building there are power facilities, heat exchangers, stands for magnetic measurements, vacuum technology tests, and also rooms for assembling, adjustment and repair of the instrumentation.

3. PSR-2000 STATUS

At present, the development of the general design is nearing completion. All facilities necessary for putting the machine into operation have been developed. The stand for magnetic measurements is constructed. The construction of the pilot samples of dipole and quadrupole magnets is to be started this year. The stand for the RF system is also constructed. The 699.3 MHz klystron with an average power of 100kW has been developed and tested. Welding technique has been refined, vacuum system elements and units for the transport channels have been made and prepared for tests. Components of diagnostics, electrostatic septum, etc. are being developed and tried out.

4. CONCLUSION

Analysis and design stages of work on the PSR-2000 are nearly completed. The realization of the project will depend now on the financing of the PSR-2000 construction. These problems are being under discussion. It is possible that other laboratories feeling interest in the project may participate.

5. REFERENCES

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