SR COMPLEX SIBERIA: THE BEGINNING OF THE COMMISSIONING

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Abstract

The SR complex SIBERIA consists of the dedicated 2.5 GeV storage ring SIBERIA-2, a small 450 MeV storage ring SIBERIA-1 (a booster is planning to be used both as a booster and a VUV and soft X-ray source), a 80 MeV linac and two transfer lines EOC-1 and EOC-2. Now the injection part which includes the linac, the booster and the transfer lines has entered into commissioning phase. The paper briefly describes the first results on the commissioning.

1. Introduction

At present, in the Institute of Nuclear Physics, Novosibirsk, Russia the dedicated synchrotron radiation (SR) source electron storage ring Siberia-2 [1] is created for the Institute of Atomic Energy (Kurchatov Institute, Moscow, Russia). The facility is intended for experiments with SR in atomic and molecular spectroscopy, in the field of solid-state physics, in crystallography, biology researches, EXAFS-spectroscopy of amorphous materials, trace-element analysis, Mossbauer experiments, high-time-resolution experiments, Compton and nuclear spectroscopy. These tasks determined a required SR wavelength region of 0.1-2000 A and an 2.5 GeV electron energy.

Siberia-2 is optimized to achieve high flux and brightness of SR. Synchrotron Radiation is taken out of the bending magnets and insertion devices which will occupy nine straight sections of the main ring.

2. Status.

At the end of 1991 both electrical and mechanical works on the linac, Siberia-1 and EOC-1 were finished in a new building constructed for housing all complex of the facilities. As reported earlier [2], in 1990 the Siberia-1 storage ring has been dismantled and transferred to a new building to serve a part of the injection system of the Siberia-2 storage ring. A total replacement of the power supplies for the bending magnets, the magnet optical elements, the connection circuits and the engineering communications has been realized in 1991. All power supplies and control of the magnetic system, RF-system, input pulse septum magnet, nanosecond generators for the kickers needed for the injection and acceleration were put into operation. A new septum magnet for the electron beam ejection in the vertical plane was installed in the straight section instead 4.3 T wiggler. Now a optical system for the electron beam sizes observation is revised and remounted according with the ejection scheme, the efforts for improving the vacuum are continued. The Siberia-1 storage ring is mainly ready to operate in the injection mode.

The EOC-1 electron beam diagnostic and measurement devices were successfully commissioned. With the help of a magneto-induction monitor it is possible to observe a 15 nanosecond pulse of electron current from the output of linear accelerator. With the help of a secondary emission wire monitor one can measure a transverse space distribution of the electrons in the beam, and then, a beam emittance and an amplitude functions of the transfer line EOC 1 can be found out. The Faraday cup with a slit collimator before it and a vertical bending magnet of EOC-1 constitute a spectrometer intended for electron energy spectrum measurement.

In INP a manufacture of two superconducting wiggler vacuum chambers is completed, they will be ready in July-August 1992. In February 1992 the vacuum chambers for the bending magnets and quadrupole lenses were produced totally. The creation of the so called pumping and diagnostic blocs is going on. Each bloc includes both movable and stationary SR absorbers, beam monitor station, false smoothing chamber, pumping system, mass-spectrometer.

At present, in IAE the electrical and mechanical assembling is continued mainly on the EOC-2 and Siberia-2 systems. At the end 1991 all bending magnets of the main ring were installed on the supports. There is a hope the remaining doublets and triplets of quadrupole lenses will be placed on the ring in autumn 1992.

Two RF-generators and two waveguides of Siberia-2 facility will be produced completely and delivered in IAE near the end of 1992. Two 181 MHz rf-cavities were made for a long time. They will be tested at full power in June-August 1992. The installation onto the ring of the rf-cavities is planed at the autumn 1992.

3. The beginning of the linac commissioning

The beam parameters required on the injector output are given in Table 1.

Table 1

Energy	80-100 MeV
Energy spread	1 %
Current in a pulse	200 mA
Pulse duration	15 ns
Transverse emittance	0.1 mrad*cm
Repetition rate	1 pulse/s

The linac design is based on the 2.8 GHz modified DAW structure (Andreev structure) with disks and diaphragms [3]. Each disk is supported by three radial rods, which have the length close to one fourth of the wave length. The DAW structure operates in the stored energy mode enabling one to solve the following problems:

- because of a high shunt impedance one can reach a maximum energy of electrons [4];
- because of a large stored energy one can accelerate the beam with a maximum current;
- because of a high group velocity there is a possibility to make an accelerating structure in the form of single resonance section with a single power input and thus to avoid phasing of separate sections and also to simplify the requirements to the accuracy of manufacturing and tuning.

The DAW structure parameters are given in Table 2.

Table 2.

Working mode	$TM_{02\pi}$
Exp. shunt impedance	92 MOhm/m
Frequency	2795.7 MHz
Quality factor	27000
Charact. impedance	3.4 kOhm/m
Overvoltage coef.	4.0
Rel. group velocity	0.4
Length	6.1 m

The linac has a simple injection system without a special buncher. The nonbunched 40 keV electron beam formed by a diode gun is injected directly into the first resonator of the structure.

RF-system of the linac consists of the klystron generator connected with the accelerating structure by means of 90*45 mm*mm vacuum rectangular waveguide. Since we use high power S-band generator of 20 MW therefore full length of the structure equal to only 6.1 m. The experimental value of a shunt impedance is 92 MOhm/m.

In December 1991 the commissioning of high power pulse generator "Olivine" together with a klystron was carried out. The klystron was feeding the water cooled matched load. The part of waveguide placed in between the load and an exit ceramic window of the klystron was filled in the nitrogen at a pressure of 0.63 MPa. With klystron cathode voltage equal to 270 kV a design output RF voltage of 20 MW in a pulse was obtained. The parameters of RF-pulse were next: a repetition frequency - 100 ɸHz, a pulse duration at a level 0.9 from a magnitude - 8 mks, a inhomogeneity of the envelop top less 0.4 %, a front duration - 2 mks. This permitted us to realize a physical setting in operation of the linac, to begin a training of the waveguide and the resonator structure aiming to overcome a multipacting and a breaks-down to obtain in the structure a stored pulse power about 3 MW and to start the works with electron beam in the structure.

In January 1992 the measurement of magnetic field distribution were carried out near the linac. This field consists of the Earth field and the field due to magnetic materials in the vicinity of the linac axis. Keeping in mind a small aperture of the linac accelerating structure (8.7 mm) and a low injection energy (40 kV) it is necessary compensate with a good accuracy magnetic field values as large as 0.2-0.5 Gs mainly near the electron gun and first accelerating cells. In fact without such compensation the 40 kV electron reaches the aperture limit at a distance less than 40 cm from the gun cathode. During these measurements the sources of parasitic magnetic field were detected and eliminated, the magnetic screen (Permalloy) was installed at initial part of linac. Taking into account the results of the measurement of the electron passing through a monitor of beam current and beam position, the gun axis was adjusted more correctly concerning the structure axis. In the low injection energy linac without a spatial buncher for creating the conditions of a synchronism in full accelerating length of structure and so achieving accelerated electrons at the linac exit the rate of acceleration should be reached about 11 MeV/m. In our case this corresponds to 9-10 MW pulse power in the incident RF-wave and approximately 50 MeV minimum energy of accelerated electron.

We note the 0.6 m long section of structure has been tested earlier at a high power [5]. The stable voltage pulse was got in 8 hours of training by means of multipacting and breaks in the leading edge. The field level achieved on surface of structure corresponds to accelerating gradient of 15 MeV/m.

In January 1992 the RF-training of waveguide and structure was effected. The work was being done at a repetition rate 2 Hz. The stable voltage pulse was not obtained at the required power level in this run. With the 11 MW incident wave power the break through of the ceramic window happened and now the klystron is under repair. To avoid in future an appearance of RF discharges on the ceramic surface or breaks through of the klystron exit window we decided to stop the commissioning of linac and to modify the waveguide. Additional ceramic window will be put in the wave guide at one half of their length approximately, a part of the waveguide will be filled by nitrogen up to 0.63 MPa. Now a design and a manufacture of the waveguide sections and a gas system are made.

4. References:

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