UNK STATUS

UNK staff , IHEP, Protvino, Moscow Region, 142284, Russia
presented by Yu. Fedotov

Abstract

An accelerating-storage complex (UNK) is being constructed at the Institute for High Energy Physics (IHEP). Due to financial difficulties the UNK activity is concentrated now on the construction of a 600 GeV synchrotron, which is a booster for UNK. The beam transfer line between UNK and existing 70 GeV synchrotron (U–70), which will be an UNK injector, was built first and in March 1994 was tested, with a 65 GeV beam. At present the building work in the UNK tunnel is coming to its end, and the UNK equipment is being tested and prepared for installation. The present paper reports on the status of the construction of the IHEP accelerating-storage complex.

1 INTRODUCTION

At the beginning, a 3000 GeV superconducting accelerator for a proton beam was to be the basic element of the UNK project [1]. The accelerated beam was supposed to be extracted at the first phase and used in the experiments with an external target. It was foreseen to construct later on a second superconducting ring in the UNK tunnel, with the beam injection in the inverse direction, and to organize experiments with colliding proton–proton beams with the energy of 0.4×3 or 3×3 TeV. The warm–iron proton synchrotron which accelerates beam from 70 up to 400 GeV is a booster for the superconducting machines. It can also operate as an independent machine accelerating and extracting 600 GeV proton beam [2]. In 1993 the State Scientific Committee of the Russian National programme "High Energy Physics" took a decision to concentrate efforts in the UNK affairs on the construction and commissioning the 600 GeV machine (UNK–600).

2 MAIN PARAMETERS OF UNK–600

Fig.1 shows the location of UNK–600. The accelerator has six straight sections. In the South, in the first straight section, the following systems are situated: injection in the straightforward direction, RF acceleration, beam scraping and proton losses collimation, beam abort onto the external absorber. In the North, in the fourth straight section, the system to extract a beam onto an external target is situated. The experimental facility NEPTUN is accommodated in the third straight section. Here, the circulating UNK–600 beam interacts with the internal gas jet target.

In order to use the UNK booster as an independent machine with the energy of 600 GeV and have a possibility to extract a beam onto the external target some UNK perfomances were changed: the magnetic cycle shape, magnetic field correction system and regime of the main power supply.

At 72 s injection flatbottom the UNK–600 orbit is filled with 12 pulses of the proton beam from the U–70 machine. Each pulse is 5 mks long and its intensity is up to 5×10^{13} particles. The maximum intensity to be stacked can be as large as 6×10^{14} protons. In 20 seconds rise time, the beam is accelerated up to 600 GeV, and then, at the 20 s field flattop, it can be extracted with the ejection system. Simultaneously, the circulating 600 GeV proton beam can interact with the internal gas jet target of NEPTUN facility. The mode when UNK–600 would operate only with NEPTUN facility is foreseen. In this case, the beam is accelerated only up to 400 GeV, and then it interacts with the gas target for about an hour.

The extraction system can eject the accelerated beam in different modes: one turn for 65 mks extraction, slow resonant extraction with the uniform spill during 20 s flattop, fast resonant extraction with 1–3 ms pulse in a period of 2 s up to 10 times over flattop. A nonlinear third order resonance $3Q_r = 110$ is supposed to be used for resonant extraction. To improve the time structure of the spill the noise exitation of longitudinal oscillations is to be used.

Table 1 presents the main parameters of UNK-600.

Table 1. UNK–600 parameters.

Maximum energy, GeV	600
Injection energy, GeV	65
Orbit length,m	20771.9
Maximum field, T	1
Acceleration time,s	20
Field flattop time,s	20
Total cycle duration,s	120
Number of RF harmonic	13860
RF frequency, MHz	200
Peak RF voltage, MV	7
Transition energy, GeV	42
Average beam current, A	1.4

3 UNK–600 CONSTRUCTION

3.1 Beam Transfer Line

The UNK beam trasfer line is used to transfer the beam from U–70 to UNK–600. It consists of two branches, so that in the future we will have a possibility to carry out colliding beam experiments (fig.1). The straightforward

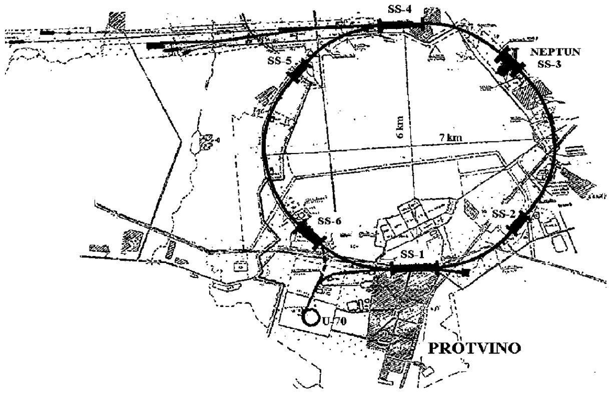

Figure 1: UNK location.

branch for beam injection into straight section 1 is about 2.7 km long and assigned to transfer a beam with the energy of 50–65 GeV, momentum spread $\pm 2 \times 10^{-3}$ and transverse emittance 2 mm$\times$mrad (fig.2). Such a considerable

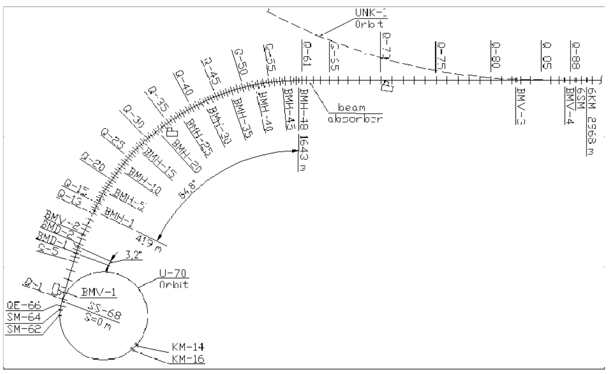

Figure 2: Straightforward BTL.

length of the BTL was determined by the requirements to accommodate the UNK–600 tunnel in appropriate geological conditions.

The one turn extraction system from U–70 into the UNK BTL includes a full aperture kicker–magnet, two septum magnets and a bump system to bring the beam with the closed orbit distortion to the septa. The BTL lattice has a strong focusing FODO structure, consisting of 88 quadrupoles, 52 dipoles and 56 correction magnets. The beam channel diagnostics system consists of beam current monitor, 46 beam position monitors, 26 beam profile monitors, beam loss and halo monitors.

The BTL test was successfully carried out with the beam in March 1994 [3]. A small fraction of the normal U–70 beam intensity (5 bunches out of 30) was accelerated up to 65 GeV. Then at the field flattop the beam was recaptured from U–70 accelerating frequency of 6 MHZ to UNK–600 frequency of 200 MHZ. It was extracted into the channel and transported up to the beam absorber, situated at the end of the bending section of the channel. The beam dimensions obtained in the channel were in a good agreement with the calculated ones.

During the BTL commissioning a prototype of the UNK control system, developed in collaboration with CERN, was succesfully tested [4].

3.2 UNK–600 Equipment

Table 2 shows the current status of manufacturing UNK–600 equipment by April 1996.

Table 2. UNK–600 equipment.

Equipment	Total Required	Available
Dipoles	2226	1550
Quadrupoles	537	503
Correctors	1180	1180
Main power converters	25	13
RF cavities	16	8
RF power converters	8	8
RF amplifiers	8	3
Vacuum chamber	23.7 km	17 km
Beam pos. monitors	550	150

About 70% of total quantity of the equipment has already been delivered to IHEP.

According to the results of preliminary magnetic measurements at the manufacturing plant, all dipoles and quadrupoles meet the requirements as far as the magnetic field is concerned. The relative rms spread of effective lengths of dipoles and quadrupoles is not larger than 1×10^{-3}. In order to reduce the initial closed orbit distortion during the commissioning, sorting of the UNK–600 dipoles was investigated according to results of the magnetic measurement and with the taking into account UNK–600 lattice. In this case, with a relative accuracy of the magnetic measurements of 1×10^{-4} the expected distortion of the closed orbit should not exeed 1.5 mm.

At present, preassembling magnetic measurements of UNK dipoles and quadrupoles are being performed at the IHEP test facilities. The spread of effective lengths, multipole field components in the working aperture of ± 35 mm, the position of magnetic field median plane are being measured. About 100 units of the equipment have already been tested. The assembling of tested dipoles with the vacuum chamber has started and they are being prepared to be installed in the UNK tunnel (fig.3).

The vacuum chamber, pumping equipment, their power supplies and gate valves are being tested on the test facilities. On the stand, which is a section of the vacuum system of the UNK regular lattice cell, the vacuum of 2×10^{-9} Torr

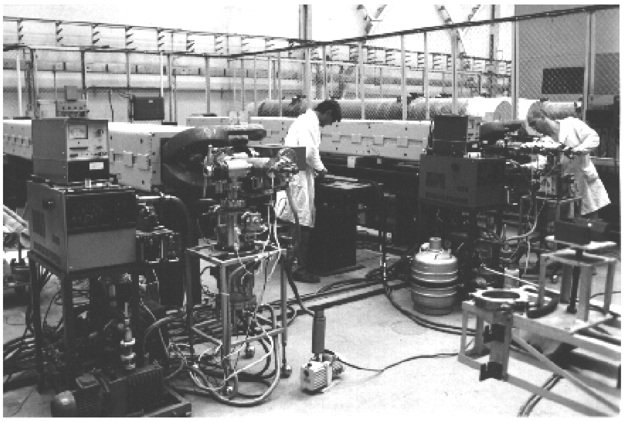

Figure 3: Assembling of the dipoles with the vacuum chambers.

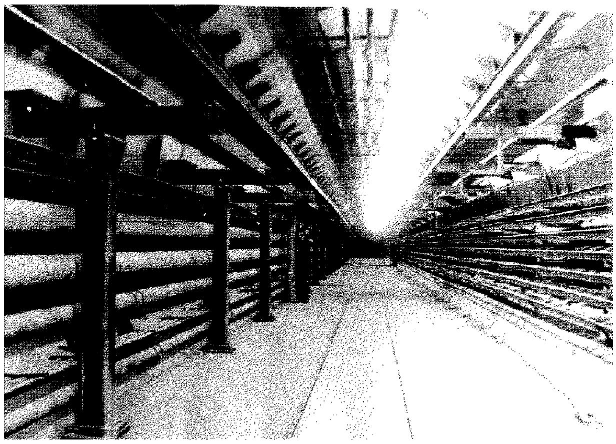

Figure 4: UNK–600 tunnel ready for the equipment installation.

has been obtained with standard pumping equipment without preliminary baking. Before assembling the stand, each chamber was treated with a discharge in the argon atmosphere. Such a cleaning procedure is foreseen after installation the vacuum chamber into each magnet.

Half of the power supply units for the main ring magnets is available at IHEP. One of them is used as a power supply of the dipoles of the bending section of the BTL. Its tests in the channel showed that its characteristics satisfied the requirements necessary for the operation of UNK–600.

The UNK–600 RF accelerating system consists of 8 accelerating modules. Each module includes two cavities, supplied via quadrature hybrid from a powerful RF amplifier. RF amplifiers are installed in a special building on the earth surface and are connected with the accelerating modules through a waveguide feeders about 50 m long. An RF amplifier output power is about 800 kW in CW operation mode. This power is obtained by summing in the bridges the powers from four cascades. In each cascade a specially designed 250 kW power tetrode is used. All RF power supplies and 3 out of 8 amplifiers have been received from industry. Waveguides and accelerating cavities are manufactured at IHEP. Almost 60% of that equipment has already been produced and being tested.

One of the accelerating modules has been installed in U–70 for recapturing the accelerated beam from 6 to 200 MHz before injection into UNK.

3.3 UNK Tunnel

The accelerator ring tunnel 20.8 km long has been completed. About 11 km are ready for the equipment installation. Auxiliary equipment and supports for electromagnets have already been installed along 3 km of the tunnel (fig.4).

The underground halls for the NEPTUN experiment in straight section 3 are being constructed. The construction of a complex of three buildings on the earth surface, that is to provide air conditions for assembling the electromagnetic equipment in the initial section of the accelerator ring, is being completed.

Methods for the installation of the equipment in the UNK tunnel with high accuracy have been elaborated. The stability of the tunnel base is being monitored for a long period of time. Slow displacements of about 1mm per month were observed during the very first months after completion of digging the tunnel and beginning of special facing work. In 2–3 years the stability of the foundation became better. The displacements make up about 0.1 mm, which is at the level of measurement accuracy.

4 CONCLUSION

In spite of the financial difficulties in constructing UNK, its activity is going on, though somewhat slower. Work on upgrading U–70 is in progress. An injection channel has been constructed and put into operation. About 3 km of the tunnel are being prepared for the magnets installation. About 100 dipoles are ready to be installed in the ring at its initial section. The assembling will begin in the autumn of 1996. The next milestone - the construction of the UNK–600 primary section 1.5 km long - is supposed to be completed by 1997.

5 REFERENCES

[1] K. Myznikov. Proceedings of the 13th Russian Conference on Charged Particle Accelerators,1993,V.1, p.43 (in Russian).

[2] K. Myznikov. Proceedings of Workshop ”UNK–600”, Protvino, 1994,p.3

[3] A. Ageev et al. Proceedings of European Conference on Charged Particle Accelerators, London, 1994, V.3, pp.2426–2428.

[4] A. Ageev et al. Proceedings of the 14th Russian Conference on Charged Particle Accelerators, Protvino, 1994, V.2, pp.152–162. (in Russian).