THE JINR PHASOTRON: STATUS AND PROGRESS

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The phasotron of the Joint Institute for Nuclear Research for 680 MeV protons was stopped for reconstruction in 1979. The reconstruction is aimed at replacement of all worn-out accelerator units (it has been in operation since 1949), at a higher mean current of the accelerated protons, and a more efficient beam extraction system. The maximum energy of the accelerated protons remains unchanged.

The main peculiarity of the new machine is the spatial variation of the magnetic field which ensures vertical focusing of accelerated particles in the magnetic field growing along the radius. This allows to reduce by half the frequency range of the accelerating electric field, thus enabling to make easier the operation conditions of the main unit of the high-frequency system - the rotating capacitor, and to increase the accelerating voltage up to 50 KV, bringing about a three-fold increase of optimum acceleration cycle repetition (before the reconstruction the voltage was three times less).

Extraction of the beam from the accelerator is performed by the regenerative method. The use of the electromagnetic input section of the magnetic channel raises the extraction efficiency from 5-7% - maximum obtained before the reconstruction, up to 60-70%, making generation of secondary beams of particles (mesons, neutrons) on internal targets completely unnecessary.

By early 1984, all units of the accelerator were almost completely replaced. The photographic presentation of the reconstructed phasotron is given in Fig. 1.

The main characteristics of the formed magnetic field are shown in Fig.2. Fig. 3 gives the field-corresponding dependencies of the radial and vertical oscillation frequencies Q_z and Q_r upon the radius.

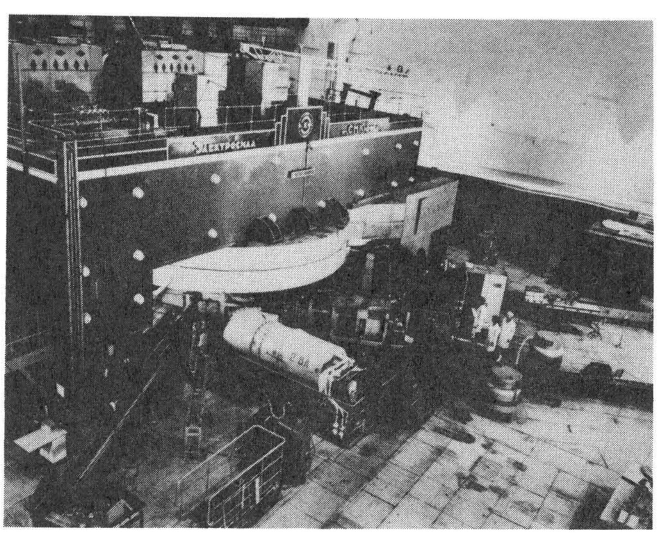

Figure 1.

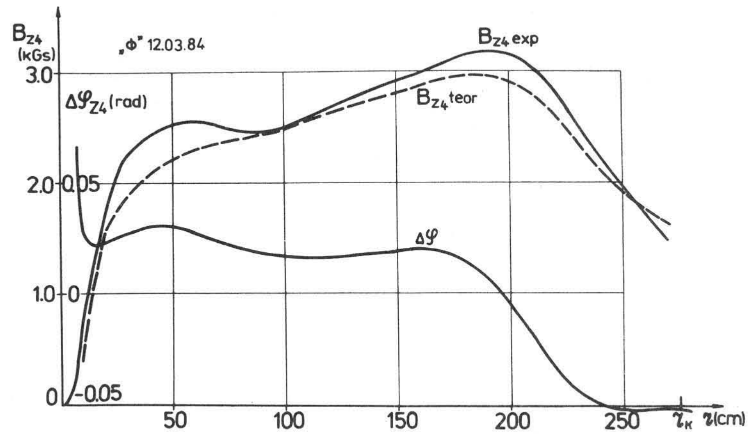

Figure 2.

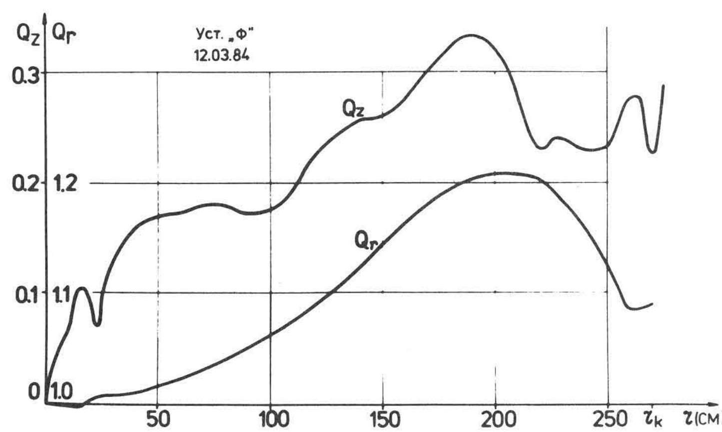

Figure 3.

In March 1984, a beam of accelerated protons was produced on the maximum radius of 270 cm corresponding to the particle energy of 680 MeV. The particles were accelerated only once every tenth cycle at a lower-than-optimum frequency of the cycle repetition, and with the accelerating voltage maintained at the level of 25-30 KV. Such conditions were selected in order to minimize the activation of the vacuum chamber and the dee, since the final shimming of the magnetic field in the centre of the chamber (after the ion source with a vertical inlet has been installed) and in the beam extraction system area is still to be completed.

Up to the radius of 80-100 cm (proton energy up to 70 MeV) the beam current was measured by a three-finger target installed on a probe. The data on the vertical distribution of the current was used for correcting the median plane of the magnetic field in the central part of the accelerator by using the compensating coils. The typical beam current-radius dependence is shown in Fig. 4.

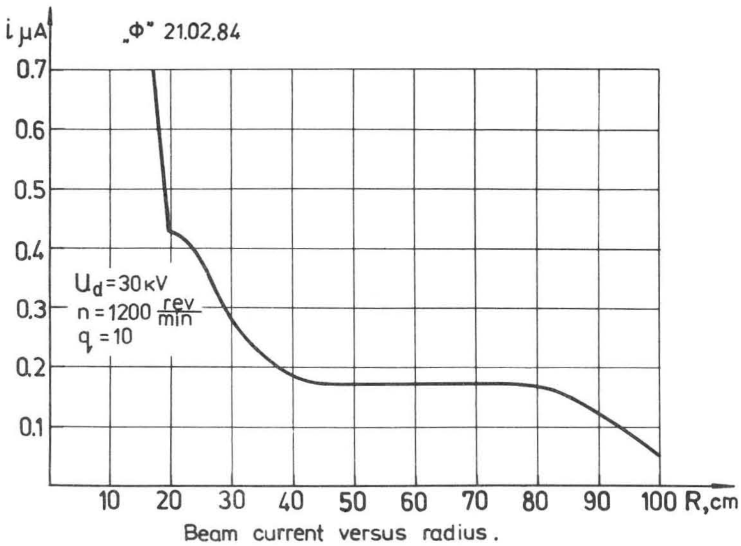

Figure 4.

On radii more than 100cm, where the accelerated particle path in the copper target exceeds 10 mm, accelerated beams were registered: by γ-emmission and neutron flux occurring during interaction of the proton beam with the probe's target; by signals generated from the pick-up electrodes; and by beam's autographs on glass.

The accelerator's chamber has five pairs of pick-up electrodes placed on radii 107 cm, 145 cm, 183 cm, 222 cm, and 262 cm to register passing beams. Signals obtained from the electrodes are shown in Fig. 5. Evaluation of the beam current by the signals' amplitude gives values coinciding with those of the target on radius 50 cm.

The autographs of the beam on several radii are given in Fig. 6. They prove that the vertical size of the beam on all radii does not exceed 10 mm, and that its vertical position, relatively to the medium plane, varies from -7 mm on radius 75 cm up to +10 mm with R=270 cm.

The study of the peculiarities of the phasotron's accelerating conditions is in progress. As soon as the new ion source with a vertical inlet is installed, and the extraction system is put to use, we hope to start physical experiments.

References

1. V.P. Dzhelepov et al., "The JINR Phasotron: Status and Progress". IEEE Transactions on Nuclear Science, Vol. NS-30, No. 4, p. 2134 (August 1983).

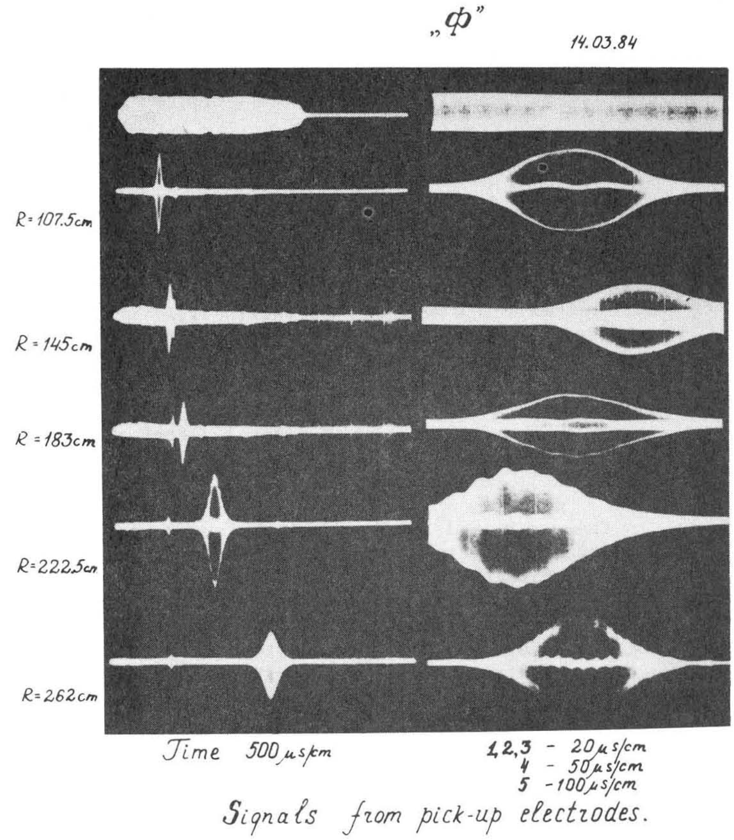

Figure 5.

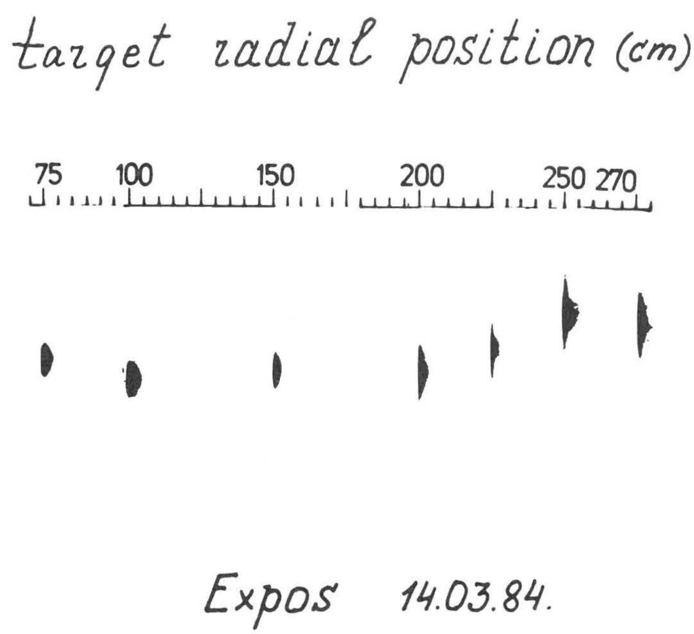

Figure 6.