Accelerator complex based on DC-60 cyclotron

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DC-60 heavy ion accelerator [1], put into operation in 2006, according to its specifications - spectrum, charge and energy of accelerated ions, has the high scientific, technological and educational potential. The highest possible universality both by spectrum of accelerated ions and acceleration energy and regimes was built in DC-60 heavy ion accelerator designing. The new interdisciplinary research complex based on cyclotron DC-60 makes it possible to create a highly-developed scientific-technological and educational environment in the new capital of Kazakhstan.

DC-60 accelerator is a dual cyclotron, which is capable of charged particles acceleration up to kinetic energies in MeV/nucleon, expressed in the following relation: $E = 60(z_i/A)^2$, where z_i - accelerated ion charge, A - atomic weight of ion. Relation (z_i/A) in formula must be within the following limits: $(z_i/A) = (1/6 \div 1/12)$, that impose constraints on charge of accelerated ions.

Prototypes ECR heavy-ion source are sources DECRIS-2 and DECRIS-3 which is used in the accelerator DC-60. On the "ECR - surface" is used magnetic field configuration «minimum B» for the plasma confinement and electronic heating. This configuration is obtained as a result of the superposition of an axial field of magnetic mirror and a radial field of a sextupole magnet. Two single coils with an iron yoke form an axial magnetic field and the radial magnetic field is created by an NdFeB permanent sextupole of a magnet.

The operating frequency of UHF the ECR generator is 14 GHz. The flash chamber of source is insulation meant for a voltage up to 25 kV. The extraction of ions is performed two elements Plasma electrode and the mobile extraction electrode.

For the beam transport from the ECR ion source to the cyclotron created an powerful system of axial injection of beam, which is consisting of:

- focusing element;
- energy-analysing magnet;
- detecting of elements;
- bunchers;
- vacuum pumps;
- electrostatic inflectors.

The entrapment of phase to accelerate in the center of the cyclotron is 30° | 35°. This means that no more than 10% of ion of the desired charge will be involved in the acceleration process. To increase efficiency the entrapment of the beam by axial injection systems is installed the bancher with a sine wave, which includes the beam particles in the desired range of phases and increases the capture coefficient to 30|50 %. Turn of the beam from the vertical axial injection channel in the median plane of the cyclotron using the electrostatic spiral of inflector.

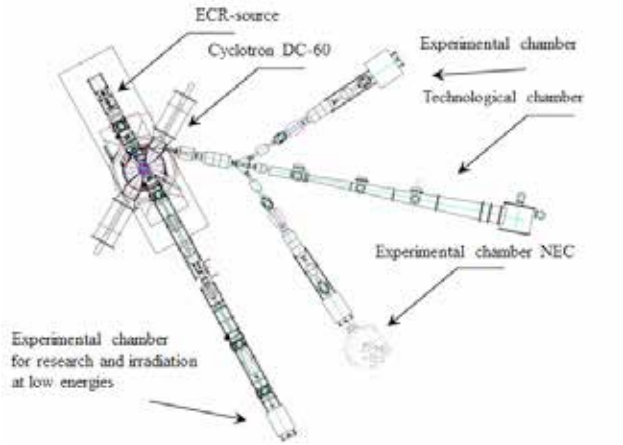

Figure 1. The scheme of the accelerator complex

The upper energy of the accelerated ions is 1.75 MeV/nucleon. The variation of the energy of ions in the range from 0.35 to 1.75 MeV/nucleon is provided by changes in the charge of the accelerated particles and magnetic field of the cyclotron.

High frequency system has a variation of the frequency in the band 12 - 18 MHz and provides the acceleration of ions on harmonics 4 and 6.

The electrostatic deflector with the electric field strength of 75 kV/cm is used for the beam extraction from the cyclotron which located in the cavity of the magnet. The beam transport channels from the cyclotron to the target chamber include the standard system focusing and rotation of the accelerated ions. Thus, range of ions accelerated on DC-60 cyclotron is ^{6}Li to ^{132}Xe, variation of ion energy is over the range 0.35 to 1.75 MeV/nucleon.

References

[1] B. Gikal *et al., DC60 heavy ion cyclotron complex: First beams and project parameters. Physical of particles and nuclei letters. V5(7), 642–644.*