STATUS OF THE DC-280 CYCLOTRON PROJECT

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Abstract

The current status of the project of the DC-280 cyclotron is presented. The DC-280 will be the basic facility of the Super Heavy Element Factory which is being created at the FLNR JINR. The main parts of the DC-280 are already made. In according to FLNR plans the cyclotron has to be assembled in the period from 2016 to 2017. The cyclotron commissioning will be in the end of 2017.

INTRODUCTION

The DC-280 cyclotron designed at the Flerov Laboratory of Nuclear Reaction of the Joint Institute for Nuclear Research in Dubna (FLNR, JINR, Dubna) is intended for carrying out fundamental and applied investigations with ions from He to U (masses from A = 2 up to 238) produced by ECR sources. The DC-280 will be the basic facility of the Super Heavy Element Factory (SHEF) that is being created at the FLNR. The energy of the ions extracted from the cyclotron may vary from 4 up to 8 MeV/amu. The expected ion beam intensity at DC-280 extraction is 10 pμA for ions with masses up to 50 [1]. The main parameters of the DC-280 cyclotron specified in Table 1.

Table 1: Main Parameters of the DC-280

Parameter	Value
Injecting beam potential	Up to 100 kV
Pole diameter	4 m
A/Z range of accelerated ions	4-7.5
Magnetic field	0.6-1.35 T
K factor	280
Gap between plugs	400 mm
Valley/hill gap	500/208 mm/mm
Magnet weight	1100 t
Magnet power	300 kW
Dee voltage	2x130 kV
RF power consumption	2x30 kW
Flat-top dee voltage	2x13 kV
Flat-top power consumption	2x2 kW
Beam orbit separation	10-16 mm
Radial beam bunch size	3 mm
Electrostatic deflector length	1300 mm
Electrostatic deflector voltage	80 kV
Magnetic channel length	900 mm
Magnetic channel gradient	4.6-8.4 T/m
Efficiency of beam transfer	>50%
Total accelerating potential	up to ~ 40 MV

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The DC-280 (Fig. 1) will be equipped with high voltage injection system. The system will consist of two high voltage (HV) platforms with ECR sources. The injection has to provide effective ion transportation from the ECR-ion source to the cyclotron center [2]. To produce required ions, two types of ECR ion sources will be created at the FLNR: the DECRIS-PM source with permanent magnets [3] and a superconducting ECR one.

The DC-280 will be the isochronous cyclotron with four pairs of focusing sectors. For ion acceleration, two main 40° dees and two flat-top 20°dees will be used [4]. The expected beam parameters are listed in Table 2.

Table 2: Expected Beam Parameters of the DC-280

Ion	Ion energy [MeV/amu]	Intensity [pps]
^{7}Li	4	1×10^{14}
^{18}O	8	1×10^{14}
^{40}Ar	5	1×10^{14}
^{48}Ca	5	6×10^{13}
^{54}Cr	5	2×10^{13}
^{58}Fe	5	1×10^{13}
^{84,86}Kr	5	2×10^{12}
^{136}Xe	5	1×10^{12}
^{238}U	7	5×10^{10}

Figure 1: Layout of the DC-280 in the SHEF building (see Fig. 2).

The cyclotron ion beam extraction system the will be equipped with an electrostatic deflector and a passive focusing magnetic channel (Table 1).

To transport accelerated ion beams to experimental set-ups five beam lines will be utilized. All the beam lines will have the common switching magnet. The experimental hall will be divided into three separated parts that have to be radiation shielded. The total experimental area will be about 1000 m^2 [5].

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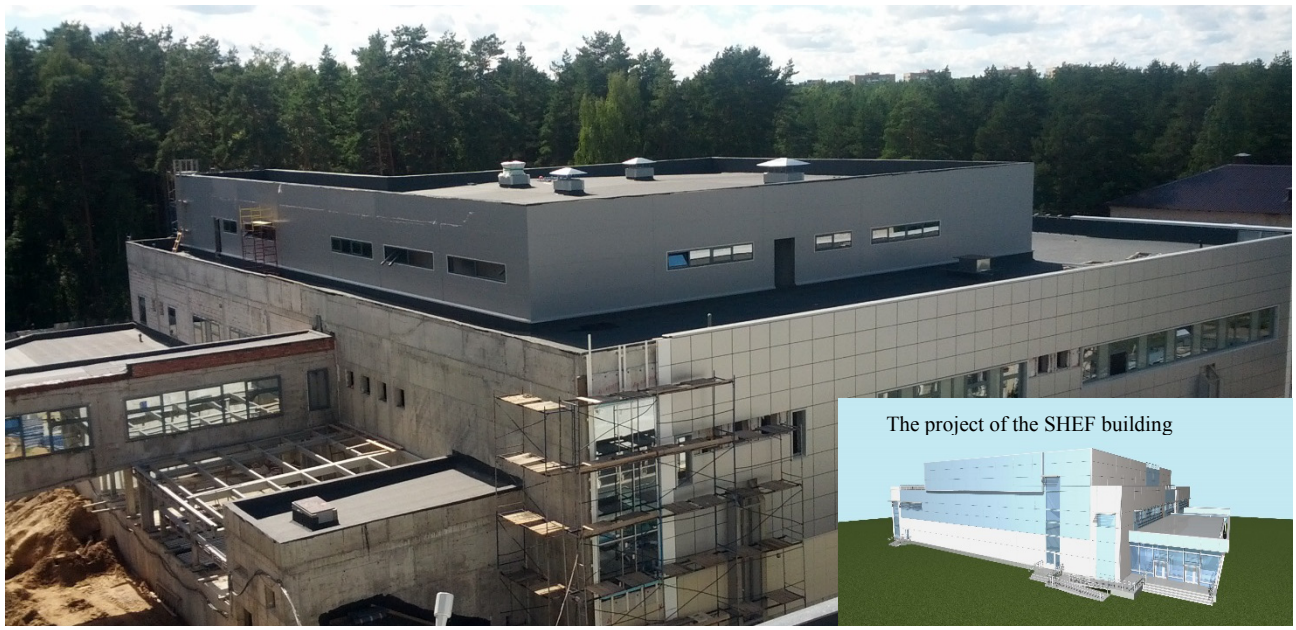

Figure 2: The SHEF building under construction at the Flerov Laboratory. August 2016.

STATUS OF DC-280 SYSTEMS

The main parts of the cyclotron, such as the main magnet with the vacuum chamber, the RF resonators, the dees and the beam transport lines have been manufactured and ready to be assembled. Other cyclotron parts are in manufacturing process and have to be supplied before the mid of 2017.

Main Magnet

The main magnet (Fig. 3) with the vacuum chamber has been manufactured at the "NKMZ" plant, Ukraine. Now we are preparing to the magnet assembling in the SHEF building. The power supply for the magnet has been made by the EVPU, Slovakia.

Figure 3: The main magnet of the DC-280 at plant.

RF Resonators, Dees and generators

The RF resonators (Fig. 4) with shafts have been manufactured at the "ZAVKOM" plant, Tambov, Russia. The main dees (Fig. 5) have been made at the EVPU, Slovakia. The flat-top dees are being manufactured at the JINR. The RF generators have been made by the QEI Corporation, NJ, USA.

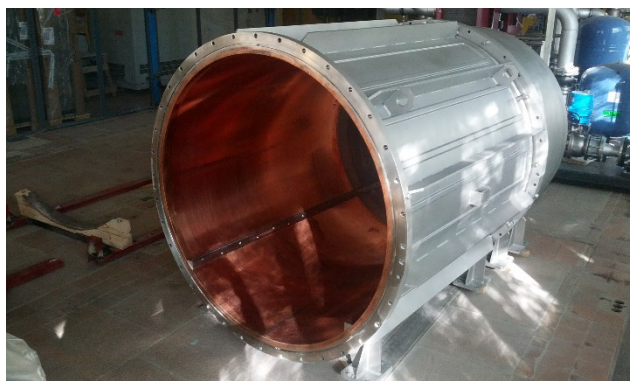

Figure 4: The RF resonator.

Figure 5: Copper dees at the EVPU.

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Main Coils, Trimming Coils Quadrupoles

The main magnet coils have been manufactured at the "N&V" firm, Romania. The block of radial trimming coils have been produced by the EVPU. The blocks of azimuthal trimming coils (Fig. 6) have been made at the GKMP, Bryansk, Russia.

Figure 6: The blocks of azimuthal trimming coils.

Axial Injection

At the first stage, we are creating only one HV planform with the DECRIS-PM ion source. The HV platform will be manufactured and tested at the FLNR. The DECRIS-PM magnetic system has been produced by "ITT-Group", Moscow, Russia (Fig. 7). The ion source will be assembled and tested at the FLNR. The beam focusing solenoids and the analyzing magnet (AM) of the injection channel are being manufactured at the EVPU. The 75 kV acceleraton tube was supplied by the "NEC" company, USA. All vacuum elements of the channel, such as vacuum lines, the AM vacuum chamber, diagnostic boxes, the Einzel lens, the electrostatic bender and the polyharmonic buncher have been made at the "Vacuum Praha" firm, Czech Republic.

Figure 7: The DECRIS-PM magnetic system.

Beam Transport Channels

The magnetic beam focusing elements (quadrupole lenses, steering magnets) have been manufactured by the "N&V". The switching magnet with a vacuum chamber (Fig. 8) has been manufactured at the "NKMZ".Vacuum elements of the channels have been made at the "Vacuum Praha".

Figure 8: The switching magnet.

Beam Extraction System and Diagnostics

The electrostatic deflector will be produced at the JINR. The focusing magnetic channel and beam diagnostics such as Faraday cups, profilometers, current probes have been produced at the Institute for Nuclear Research of the Academy of Science, Bulgaria.

Auxiliary Systems

Vacuum pumps and other components have been supplied by "Vacuum Praha". The vacuum pumping system will be created at the FLNR. The water cooling system is being created at the FLNR.

CONCLUSION

The main parts of the DC-280 have been manufactured. In according to FLNR plans the main magnet of the cyclotron has to be assembled in the end of 2016. Other systems will be mounted in 2017. The DC-280 commissioning will be in the end of 2017.

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