EXTERNAL BEAM POSSIBILITIES FOR THE MGC-20 CYCLOTRON PROJECT IN EGYPT

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The MGC-20 cyclotron has to be the base of the National Accelerating Centre Project in Egypt designed to realise a wide research programme. External beam possibilities of the Egyptian project that may be provided by the beam transport and analysing system are described in this paper. Some ideas to improve the external beam quality and to expand the experimental areas in future are discussed.

1 Introduction

The MGC-20 cyclotron is designed for acceleration of protons, deuterons, alpha-particles and double-charged ions of helium-3 up to energies of 5-20 z^2/A MeV (where z is the charge number and A is the mass number of an accelerated ion). This cyclotron is well known and is described in literature in considerable details [1]. The history of the cyclotron MGC-20 dates back to 1969 when a prototype of this machine was started-up in St. Petersburg and continues up to date; the 8th similar machine will be delivered to Cairo.

Advantages of the cyclotron can be completely realised only if it is equipped with an external beam transport system, providing optimum experimental conditions. Designing of the beam transport system is a vital engineering problem, and the efficiency of the cyclotron operation depends on its successful settling. In the paper it is demonstrated how the settlement of this problem is foreseen in the cyclotron project MGC-20 for Arab Republic of Egypt.

2 Programme of researches on the cyclotron

The National Accelerating Centre in Arab Republic of Egypt is supposed to be established on the basis of the MGC-20 cyclotron. It is intended for performing researches in various fields of science and engineering:

- fundamental investigations in the field of nuclear and atomic physics;
- production of a wide spectrum of radioactive isotopes;
- radiation material science, including study of the radiation damage of solids, corrosion, etc., included;
- radiation analysis using charged particles, neutrons, as well as X-ray and gamma radiation;
- investigations in the field of fast neutron applications both for fundamental and applied sciences: medicine, geology, etc.;
- more exact determination of nuclear constants in the physics of nuclear reactions.

The programme of the experiments to be performed on the cyclotron is given more comprehensively in proceedings of the Egyptian-Russian School and Workshop on Cyclotrons and Applications. [2]

3 Main principles of the equipment layout

The main design principle of the external beam transport system is to provide the pursuance of experiments on the cyclotron in accordance with the available programme. For successful realisation of the programme, it is highly desirable that each line of researches be provided with a separate room, specially planned and equipped, considering specific features of a particular experiment to be performed. If take into account interest to researches in nuclear physics, the beam transport system should include a magnetic analyser.

Actually, the designing process consists in finding a reasonable compromise between such factors as the cost of the transportation equipment, ease of the cyclotron beam handling, separation of experiments, radiation safety.

Two principles of the general layout of the transportation channels are known, namely, "corridor" and "fan" ones. The first allows to design convenient experimental rooms; the second needs less number of magnetic elements for its realisation. The analysis of the design schemes of the beam transport systems used in various centres makes it apparent that the mostly used one is a combination of the two principles.

In designing and specialisation of the transportation channels, it is very important to take into consideration specific features of experiments carried out with the beam. For example, the programme includes the experiments when the maximum beam power is to be used, either small energy spread is to be provided, or the background radiation around the target is to be minimised. These circumstances define sizes of the rooms and their disposition relative to the cyclotron.

What is more, even the perfect experimental programme on the cyclotron can be changed with time. In this case, potentialities of further broadening of the beam transportation channels are of interest.

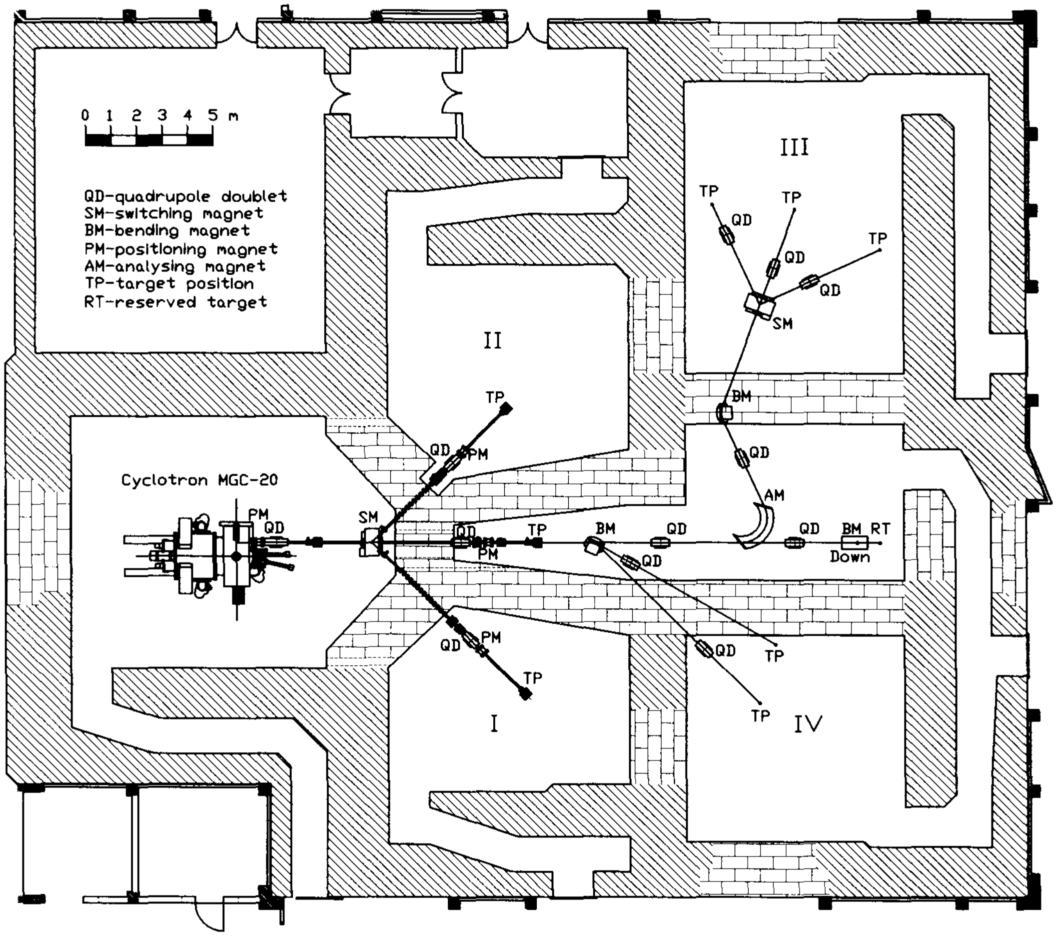

Fig.1. Layout the first (bold) and second stages of the beam transport system

4 Features of the beam transport system

In designing, the experience of the development of transportation channels for other MGC-20 machines was used. The most similar project is the beam transport system of the MGC-20 cyclotron installed in Debrecen, Hungarian Republic [3]. The layout of the transportation equipment of the Egyptian cyclotron is given in Fig.1.

The concept of specialised rooms is rather clearly defined in this project. For example, the room I is intended for experiments on the neutron-activation analysis; the room II is to be used for production of radioisotopes. The room III may be used for researches in nuclear physics, when the beam of high energy uniformity is needed. In nuclear physics experiments a large-scale equipment, for example, a secondary particle analyser may be used. Therefore, the room III is rather large in area. The room IV is supposed to be used for researches under low background radiation. The beam deflected by the 90^0 magnet downwards to the room V may be used for radiation studies of materials.

In the considered project a possibility of further broadening of the transportation channels is foreseen. In the room V a single target position under vertically incident beam is provided. If more targets are needed, a switching or a bending magnet can be installed. Besides, a spare target, located in point RT in Fig.1, can be used with the given scheme of the beam transport system.

5 Prospects of upgrading

Beam transport systems of different MGC-20 cyclotrons are equipped with magneto-focusing elements, one of which is a double-focusing 115^0 analyser [4]. Energy resolution of the analyser is better than 0,1% at 2 mm width of the definition and analysing slits. This analyser is known as a device reliable and simple in operation, however, analysing equipment of higher precision will be needed to perform more accurate researches in nuclear physics. Use of the doubled 115^0 magnetic analyser may be an appropriate solution of such a problem for already existing cyclotron project. Two similar magnets are installed in tandem, so that the analysing slit of the first is the definition slit of the second analyser. The magnets deflect the beam in opposite directions, so that their dispersions are summed. Similar designs are applied widely enough [5]. If the width of the slits is reduced to 1 mm, one may expect the energy expansion of a similar tandem to be about 0.03% or even better. A possible version of the similar analyser location inside the existing building is shown in Fig.2. The shielding wall should be moved to place a target.

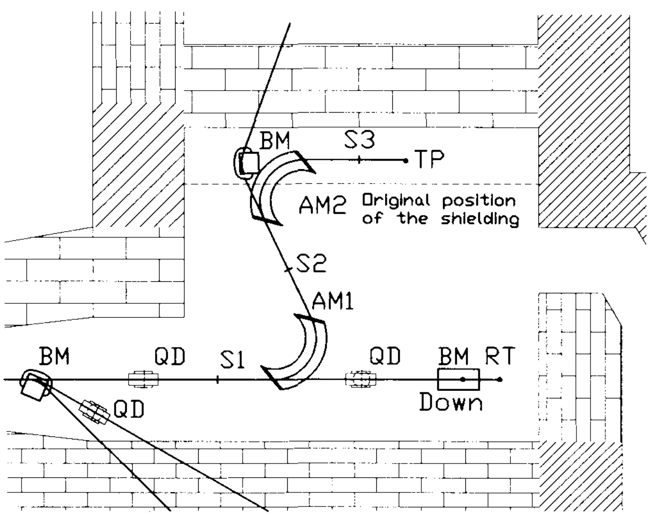

Fig.2. The tandem of 115^0 analysers in the beam transport system

6 Conclusion

At present, the equipment of the first stage of the beam transport system has been manufactured at the Efremov Institute. The transportation scheme described in the report is intended for the second stage of the cyclotron complex construction. It is the authors' opinion that the suggested scheme of the MGC-20 cyclotron external beam transportation may be used as the basis for realisation of the cyclotron project as the National Accelerating Centre in Egypt.

References

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