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8.25 Polarized ^{3}He target device at U-240 cyclotron

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The described in this work polarized ^{3}He target is destined for measurements with the beams of protons, deuterons, alpha-particles and heavy ions. The construction of the target allows to rotate it, including the magnetic system, around the beam axis which is important for the measurements of spin-correlation and polarization-transfer observables. The general scheme of the device is shown in Fig.1.

The target itself is the pyrex cell 60 mm in diameter with the wall thickness between 50 and 100 μ. The entrance pyrex window is 30 μ thick removed from the spherical cell by means of 100 mm long cylindrical branch pipe. Due to such a design it became possible to avoid almost completely the background of particles double scattered from entrance window and spherical walls, except the measurements at small angles $\theta_{lab} \leq 19°$. The thickness of entrance window and its homogenity was separately tested before its sealing to the cell by the measurement of spectra of elastically scattered particles using a HPGe detector.

In experiments with low energy beams and (or) low energy reaction products, the target and detectors are placed in the vacuum chamber. In the case of high energy beams and products the detectors are placed in atmosphere and are moved along the cylindrical guide. After passing through the collimator and the target the beam is collected in a Faraday cup. In front of the Faraday cup there is a system of beam position control which consists of four silicon spectrometers detecting the particles scattered by Au target.

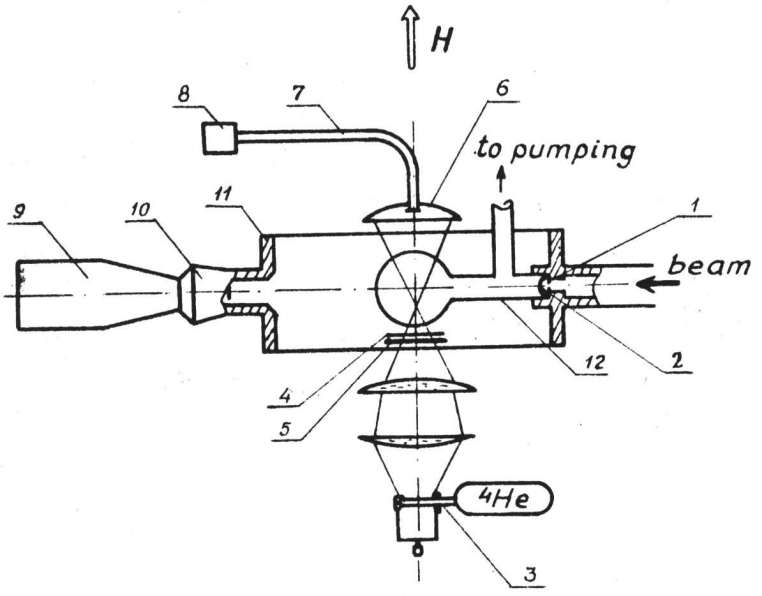

Fig. 1. General scheme of the device. Detectors are placed (not shown) in the normal plane and moved along guide 11.
1 - collimator; 2 - entrance window; 3 - pumping lamp; 4 - polaroid; 5 - $\lambda/4$ plate; 6 - mirror; 7 - light guide; 8 - photodetector; 9 - Faraday cup; 10 - beam position control; 11 - chamber; 12- entrance branch pipe.

The distinctive feature of the device is the employing of target can be pumped instead of being sealed off. This allows to vary the gas pressure without replacement of glass cell, to fill the target with fresh gas in the case of contamination after a long operation, and to control the background conditions with empty target. In addition, it becomes possible to compensate the enhanced diffusion of helium-3 through the glass walls due to significant local heating in the cases of long operation with the beam, especially at low energies. The once filled target operates without sizeble decrease of polarization approximately for 5 hours.

The source of resonant 1.083μ pumping radiation is a quartz lamp of disk shape 24 mm in diameter and 1.5 mm thick. It is filled with helium-4 to a pressure of 15 Torr. The lamp has a 500 cm^3 reservoir to compensate the diffusion of helium and is excited with $2.5 \cdot 10^3$ MHz microwave power. A compulsory air blowing off is used to keep the temperature of the lamp at a level between 60 and 70°C. The circular (accurate within 2.5%) polarization of resonant light is provided with a polaroid 40 mm in diameter and a quarter wave cristall quartz plate. The direction of target polarization can be authomatically reversed within 0.2 s by rotation of polaroid using on-line computer system.

The magnetic field up to 100 Gs is homogeneous to $3.5 \cdot 10^{-4}$ over the target volume.

The value of polarization was calibrated[1] by measurement of the asimuthal asymmetry of a pha-particles scattered by polarized ^3He at $E_\alpha = 35.6$ MeV, using the data[2] on analyzing power of $^4He(^3He,^3He)^4He$ scattering obtained with polarized beam at $\theta_{cm} = 50°$. The energy of alpha-particle beam was determined within 1%. According to the calibration, the target polarization is equal to 0.161 ± 0.021 at 1.5 Torr pressure, the indicated error is only statistical one. The use of appropriate lasers provides further increase of the target polarization[3,4].

References

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