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THE MOVABLE POLARIZED TARGET FOR HIGH ENERGY SPIN PHYSICS EXPERIMENTS

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The accelerator complex of the Joint Institute for Nuclear Research (JINR) in Dubna becomes now a unique place to provide 3-12 GeV/c polarized deuteron beams with high intensity and good polarization. It is possible to obtain quasi-monoenergetic neutron and proton beams too using a break-up of accelerated deuterons. A new generation of experiments can be carried out at this accelerator complex [1].

To get full benefit of this opportunity, the experiments with polarized beams must be performed in conjunction with polarized proton or deuteron targets. To produce in a shortest possible time a working combination of a polarized beam and polarized target, it was agreed to use, after reconstruction, the Saclay-Argonne frozen spin proton polarized target which was built for and used initially in an experiment at FERMILAB (USA) [2].

For the purposes of the physics program in Dubna the target has been reassembled and upgraded adding the missing parts. A new quality was given to the target assembly during this reconstruction - a transportability from one experimental area to another. This is a "movable" polarized target (MPT) concept. It means that all the major parts of the target assembly disposed closely to the beam line (target cell inside a ^{3}He / ^{4}He dilution refrigerator, magnets, power supplies, service liquid helium dewars, ^{3}He pumps etc.) are mounted on two separate decks (Fig.1) which can be moved as blocks in and out of the beam, and also between various accelerators. These decks may be translated on high precision rails fixed on a main frame. During the experiment, the working target may be moved in or out of the beamline within some minutes without interference with the polarizing or frozen spin mode in process. Between experiments, transportation to another area does not need disassembly of the equipped decks. The dimensions of the decks with their equipments correspond to dimensions of a standard sea container.

Larger of two decks contains the ^{3}He / ^{4}He dilution refrigerator with a horizontal axis mounted on a 1.5 tons concrete cube, a 30 l service helium dewar of the refrigerator, a 1000 l supply helium dewar and a ^{3}He pumping system. The pumping system consisting of one Geraer compressorenwerk (RPW3600) 3600 l/s roots pump and two Leybold pumps (WS-1000 and WS-250) with pumping speeds 1000 l/s and 250 l/s is mounted on a compact stage and placed onto the deck using pneumatic dampers for vibration isolation, similar to [3]. The pumping system is connected to the dilution refrigerator through about 1.5 m piece of 200 mm diameter stainless steel tube with bellows inserts. A quality of the vibration isolation is demonstrated by the fact that it was possible to work in a frozen polarization mode at a working temperature $\leq$ 50 mK without any additional thermal load to the refrigerator, and small phonic noise on the NMR coils.

A polarising superconducting solenoid, its 300 l service helium dewar and power supply are mounted on a smaller deck. For easier operation and for good access to the physics detectors, the equipment, that is not mounted on the decks, is placed outside of the radiation controlled area.

A remote control of the entire operation of the MPT was achieved from the control room installed inside the trailer. It contains an operating vacuum, ^{3}He and ^{4}He systems, an interlock system, a microwave system, and a NMR system. A new powerful two-arm cleaning system for ^{3}He was built containing liquid nitrogen cooled charcoal traps and warm silicagel traps.

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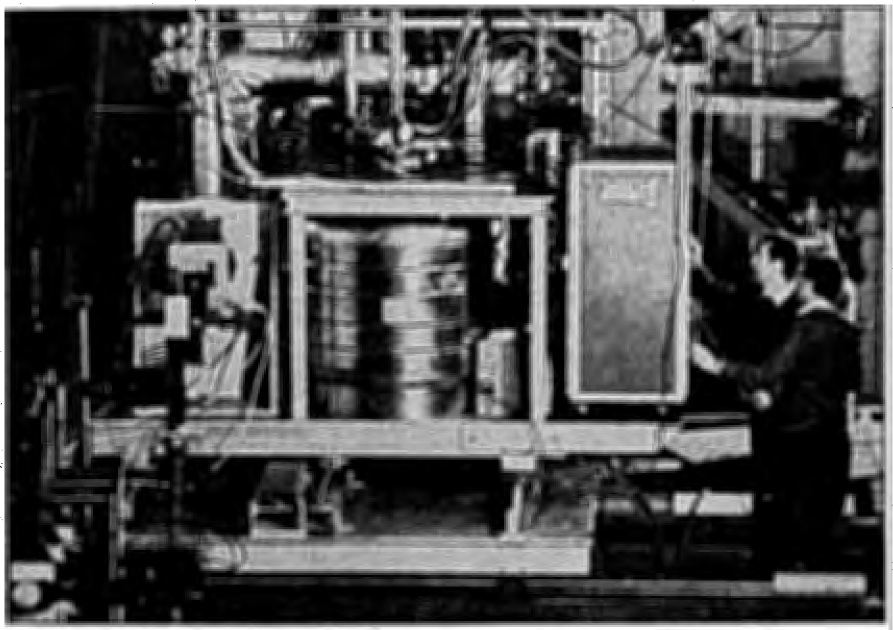

Fig. 1. Photograph of the movable polarized target

The microwave system intended for proton polarization build-up consists of a microwave source, a waveguide, and a power supply. A diffraction radiation generator with 4 mm wavelength was used as the microwave source. Its main characteristics are:

- frequency range: 70-78 GHz,
- output power: no less than 5 W,
- relative frequency instability: no more than 10^{-5},
- FWHM of a radiation line: no more than 0.5 MHz.

The waveguide consists of warm and cold parts. The warm part contains a directed brancher intended to measure the frequency, an electronic attenuator, and a wavemode transformer. The microwave power comes to the refrigerator in H01 mode. The cold part of the waveguide inside the refrigerator was left unchanged. 1,2-propanediol with a paramagnetic Cr(5) impurity having a spin concentration of 1.5×10^{20} cm^{-3} was used as a target material [4]. A load of 140 cm^3 of propanediol beads in a plastic container having 200 mm length and 30 mm diameter was placed inside the dilution refrigerator.

The target polarization measurements were carried out using a computer controlled NMR system. Maximum values of proton polarization obtained were 80% and 85% for positive and negative polarizations, respectively. Difference of microwave frequencies corresponding

to polarization maxima was measured to be 340 MHz. A duration of one continuous run at a given sign of target polarization was about 12 hours. Polarization degradation during this period was insignificant since the nuclear spin relaxation time in a frozen mode (at a temperature 50 mK and magnetic field 2.5 T) is over 1000 hours.

First experiment using MPT and polarized neutron beam of JINR accelerator complex has been done in February 1995. The difference in the transmission cross sections of polarized neutrons through the polarized proton target when beam and target polarization directions are parallel or antiparallel has been measured. All the work on target reconstruction, its transfer to the beam line and the first experiment have taken approximately 8 months.

For further experiments transverse polarization of protons (and deuterons) is needed. A set of holding coils for achieving transverse polarization, as well as a new polarizing solenoid, are being built.

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