SUPERCONDUCTING POLARIZING MAGNET FOR A MOVABLE POLARIZED TARGET

N.G.ANISHCHENKO[a], V.D.BARTENEV[a], N.A.BLINOV[a], N.S.BORISOV[a], V.M.DROBIN[a], G.DURAND[b], S.A.IVASHKEVICH[a], B.K.KURYATNIKOV[a], F.LEHAR[b], S.V.MIRONOV[a], V.D.MOROZ[a], A.B.NEGANOV[a], N.M.PISKUNOV[a], Yu.V.ROMANOV[a], Yu.I.TYATYUSHKIN[a], Yu.A.USOV[a], A.N.FEDOROV[a], G.P.TSVINEVA[a],Yu. A. SHISHOV[a]

[a] *Joint Institute for Nuclear Research, 141980 Dubna, Moscow region, Russia*

[b] *DAPNIA, CEA/ Saclay, 91191 Gif-sur-Yvette Cedex, France*

The superconducting polarizing magnet was constructed for movable polarized target (MPT) with working volume 200 mm long and 30 mm in diameter. The magnet provides a polarizing magnetic field up to 6 T with the uniformity of 4.5×10^{-4} in the working volume of the target. The magnet windings are made of a NbTi wire, impregnated with the epoxy resin and placed in the horizontal cryostat with "warm" aperture diameter 96 mm. The design and technology of the magnet winding are described. Results of the magnetic field map measurements using a NMR-magnetometer are given. The MPT setup is installed in the beam line of polarized neutrons produced by break-up of polarized deuterons extracted from the synchrophasotron of LHE, JINR, Dubna.

MPT in Dubna was reconstructed from the previous proton polarized target (PPT) built in 1985-1988 at Saclay by ANL and Saclay experts for purposes of the E-704 Fermilab experiment. This PPT has been used at FNAL during 1988- 1990. It has been transported to JINR (Dubna) in 1994 and reconstructed before the end of the year as the movable target, easily transportable from one beam line to another [1]. The international experimental program with MPT on the polarized neutron beam at the Dubna synchrophasotron was accepted in early 1994. The first experiment in physics was carried out in February-March 1995 [2]. Just after the measurements, the original polarizing magnet was dispatched to Mainz (Germany). Therefore, a new magnet was needed to be manufactured.

The superconducting polarizing magnet (Figure 1) contains a main solenoidal winding 1 (558 mm in long, 206 and 144 mm in outside and inside diameters, respectively) as well as compensating 6 and correcting 7 windings at its ends. Multifilament NbTi wires are wound on welded frame 2 of steel 1X18H10T consisting of a pipe and flanges, insulating with demountable half-disks 3. Frame 2 with an outside vessel and other parts forms welded helium vessel 4, which is fixed into vacuum casing 5 with the help of glasstextolite support cone 8. The thermal insulation of the helium vessel is provided with cooled helium vapours by copper screens 9 and multilayer screens 10 made of metal- coated mylar.

Among the basic technical requirements on the magnet, note the following: the induction of a magnetic field in the centre of the magnet with a maximum working current of 186 A should be 6.7 T, the uniformity of the field in a "warm" working volume no worse than 10^{-4}. The windings are mounted on frame 2 (pipe ϕ 143.5 mm) with case electric glasstextolite insulation. The main winding consists of 6 concentric sections. When winding, glasstextolite spacers 0.2 mm thickness are used to keep layer cylindricity. Two sections of compensating winding 6 are wound up (also by wire ϕ 1 mm) sequentially with the basic section and over it. There are two correcting NbTi windings 7 of a wire ϕ 0.75 mm over the compensating windings.

The wire strain with winding the magnet was 10 $\div$ 12 kg. During the winding layer-by-layer cylindricity was periodically controlled by measuring the winding diameter in six cross sections along the magnet axis by a micrometric device with an accuracy of no worse than 0.01 mm. The temperature

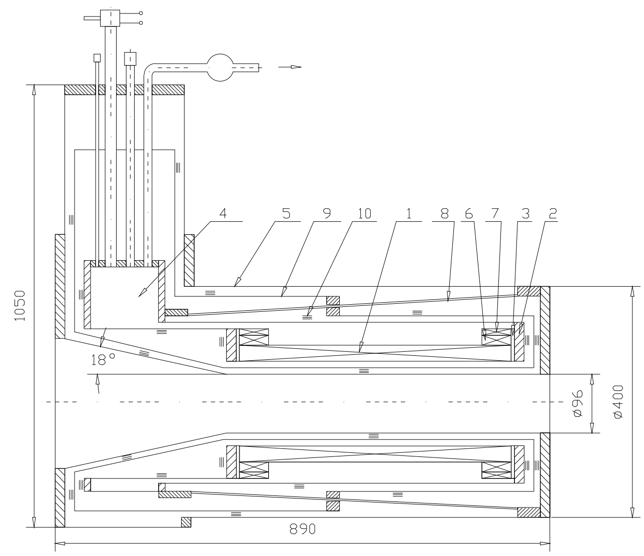

Figure 1: Polarizing magnet MPT.

of adiabatic heating the hottest point in case of the transition of the winding to a normal state and the evacuation of stored energy for an external damping resistance of 2 Ohms was calculated. The most dangerous regime was considered : the origin of a normal zone at the point of wire soldering; the conditions of heating are adiabatic; the current at the moment of transition is 200. The calculation has shown that the heating does not exceed 100 K.

The system of measurements the magnetic field map in the warm working solenoid volume contains the magnetometer using the nuclear magnetic resonance (NMR).The errors of the magnetic field induction measurement turned below 10^{-5}. The volume of an active part containing polarizable protons was approximately 3.5 mm^3.

The magnetic field map inside the warm working magnet volume was repeatedly measured. The measurements were carried out over the length from the middle of the magnet, along its axis. Other measurements were performed at R = 15 mm in horizontal steps of 10 mm and in an angle step of 45^0. The field uniformity of 4.6 $\times 10^{-4}$ within the right (the first along the beam path) half of working volume was achieved. This uniformity in the second was better - 7.8×10^{-5}.

The magnet operated reliably in the July 1997 physics experiment in which polarized neutron beam together with MPT was again used. The longitudinal MPT polarization, averaged over the target volume was 73%. During the whole run, the magnet field uniformity along the working volume axis was better than 5.7×10^{-4}.

References

1. N.Anishchenko, N.Bazhanov, B.Benda *et al.* A New Movable Polarized Target at Dubna, 11th Intern. Symposium on High Energy Spin Physics, Bloomington, Indiana, USA, Sept. 1994, AIP Conference Proceedings **343**, Editors K.Heller and S.Smith, AIP Press, Woodbury N.Y., pp. 572-575.
2. B.P.Adiasevich, V.G.Antonenko, S.A.Averichev *et al.* Measurement of the Total Cross Section Difference DsL in np Transmission at 1.19, 2.49 and 3.65 GeV. Zeitschrift fur Physics C **71** (1996), pp. 65-74.