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8.28 The Ray Trace Type Polarimeter "MUSASHI" for the Spectrograph DUMAS

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In order to measure the polarization of protons emitted by nuclear reactions with high efficiency, a carbon polarimeter named "MUSASHI" has been newly constructed at Research Center for Nuclear Physics , Osaka University. The polarimeter MUSASHI has a large solid angle of acceptance and can distinguish between elastic and inelastic scatterings from carbon. This polarimeter is placed at the achromatic focus point of the spectrograph "DUMAS"[1].

A scale drawing of the polarimeter MUSASHI is shown in Fig. 1. It consists of carbon analyzer targets, three types of multi-wire proportional chamber (MWPC ; large, middle and small type) and several plastic scintillators.

Seven carbon sheets (2×2 cm^2) are arranged at the center of the polarimeter with a separation distance of 3 cm , in the vacuum chamber. The thickness of the carbon sheet is chosen from among 40, 74 and 157 mg/cm^2, according to the proton energy.

The specifications of the MWPCs are listed in Table 1. For all MWPC, the anode and cathode are 20 μm gold-plated tungsten wire and 125 μm Cu/Be wire, respectively. The anode-cathode gap and the wire spacing of the small type are narrow comparing with the other two types, because the small type was planned for measurements at high counting rates (i.e. to reduce the space charge effect). A standard magic gas mixture[2] is used. Two MWPC telescopes (LM-LL, RM-RL in Fig. 1.) give position information which is used to determine from which target the proton scattered and at which scattering angle (see Fig. 2. and Fig. 3.). As shown in Fig. 2, each carbon target was well identified.

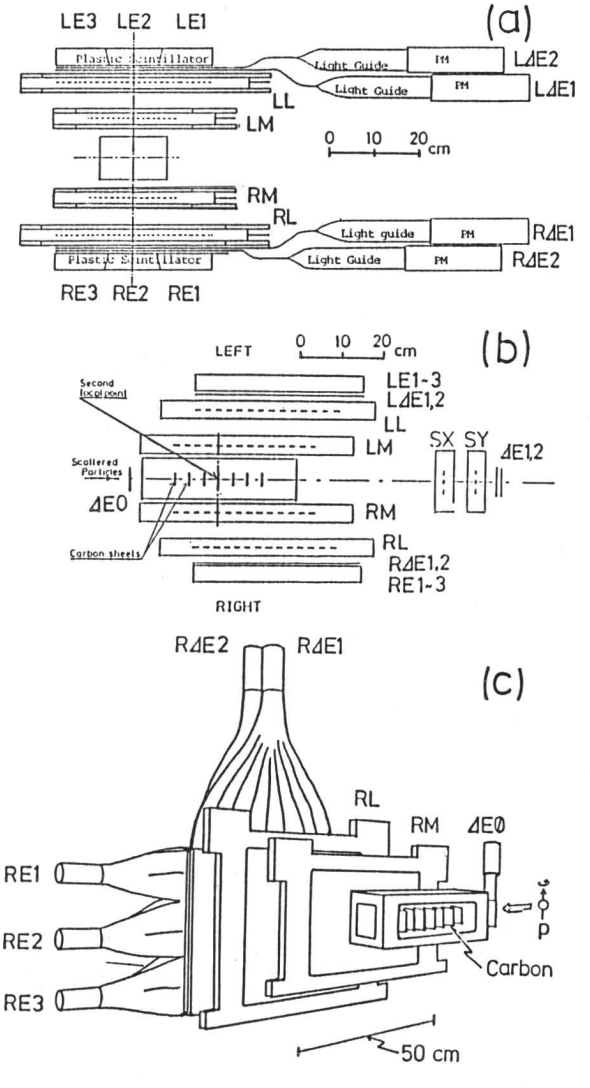

Fig. 1. The scale drawing of the polarimeter MUSASHI. (a) front view ; (b) top view ; (c) schematic representation (the left half and PX,PY are omitted to avoid confusion.)

Table 1 Specifications of MWPC

	large	middle	small
* anode	20 μm gold-plated tungsten wire		
* cathode	125 μm Cu/Be		
* wire spacing	2 mm	2 mm	1 mm
* anode cathode gap	6 mm	6 mm	3 mm
* effective region	350x350 mm^2	350x200 mm^2	70x70 mm^2
* gas mixture	argon : isobutane : freon : methylal = 66 : 33 : 0.3 : 4		
* supplied voltage	4.7 kV	4.7 kV	3.7 kV

The plastic scintillator to measure the proton energy is divided into three parts parallel to the incident proton axis (L(R)E1-L(R)E3) in order to improve the energy resolution.

The size of plastic scintillators is as follows ; L(R)E1-L(R)E3 is 40 cm × 12 cm × 25 mm , L(R)ΔE1 and L(R)ΔE2 is 40 cm × 35 cm × 2 mm (or 3 mm or 5mm). The thickness of ΔE plastic scintillators prepared for left and right is selected from among 2, 3 and 5 mm according to the incident proton energy. For measurement of protons below 40 MeV, L(R)ΔE2 is omitted. The plastic scintillators are used to trigger the read out system by the logic of ΔE0 · XΔE1 · XΔE2 · (XE1 +XE2+XE3), (X=L for left and X=R for right). Fig. 4 shows the proton energy spectra of the plastic scintillator LE2 corresponding to protons scattered from the second carbon sheet in the angular range 40° - 45° . The separation between the peaks of elastic and inelastic (4.44 MeV) scatterings is fairly good.

Protons which pass through the carbon sheets are monitored continuously with two MWPCs (PX,PY) to check the achromatic focus and counted by plastic scintillators (PΔE1, PΔE2) to measure the analyzing power of the first target from the ratio of counts with the beam polarization oriented up and down.

The effective analyzing power and the overall efficiency are estimated at 0.86 and 1×10^{-4} in the vicinity of 65 MeV[3].

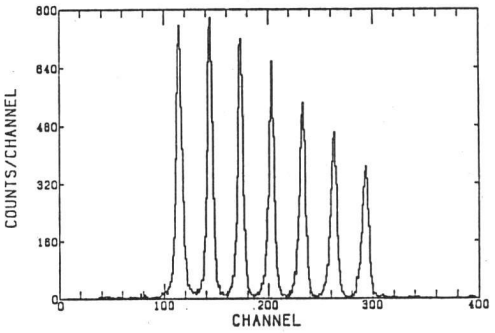

Fig. 2. Scattering position spectrum at the carbon sheets. Each carbon sheet is well identified.

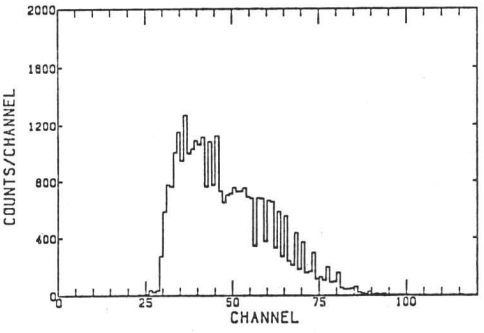

Fig. 3. Scattering angle spectrum for the carbon sheets.

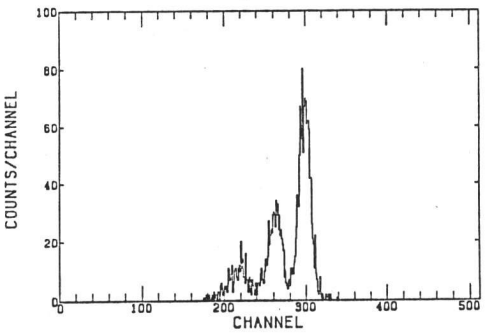

Fig. 4. Proton energy spectrum of the E plastic scintillator.

References

1) T. Noro et al., RCNP annual report (1983) 173. ; contribution to this conference.
2) R. Bouclier et al., Nucl. Instr. & Meth. 88 (1970) 149.
3) M. Ieiri et al., contribution to this conference.