Proton-Carbon CNI Polarimeter and MCP Detector

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The polarization analyzing power of the elastic proton-carbon scattering at Coulomb-nuclear interference (CNI) region was recently proposed as a possible polarimeter for RHIC. It is quite attractive because measurement is compatible with the pion polarimeter and the detectors could be simple and inexpensive.

The analyzing power of p-C CNI scattering can be described by spinflip and nonflip amplitudes of nuclear and Coulomb interaction. Long time ago we measured them at $T_p = 65MeV$ which are shown in the Figure. At this low energy, the analyzing power at the CNI region mainly comes from the nuclear spin-flip amplitude. However, at high energy limit, nuclear spinflip amplitude is expected to be zero and nonflip amplitude as pure imaginary (diffractive scattering). Then the analyzing power can be reliably calculated and is 4% at maximum (Figure). The analyzing power of p-p CNI was measured at 200 GeV and consistent with the theoretical values within the errors. For the p-C CNI scattering, recoil carbon must be detected. The kinetic energy of the carbon ranges from 90 to 500 keV for the CNI region. We have tested the micro-channel plate (MCP) as a possible detector for the recoil carbon.

We have measured p-C elastic scattering using 10 MeV proton beam from the Tandem van de Graaf of Kyoto Univ. The scattered proton is detected with a scintillator and the carbon with the MCP in coincidence (Figure). The carbon was successfully detected with the MCP to about 100 keV. The energy spectra of the carbon were obtained at several angles by using the TOF between the proton and carbon (Figure). The TOF resolution was checked by p-p scattering and it was 240psec.

The present MCP is double-layered and has an effective area of 14mm dia. The MCP is easy to handle like a photomultiplier due to its high gain especially against electronical noises. However it is sensitive to the low energy electrons and X-rays. By using this MCP, we plan to study the multiple scattering and energy loss of the carbon in the carbon foil, and the charge states of the recoil carbons, which are important for the design of the RHIC polarimeter. The combination of the MCP and silicon detectors will be also studied. For the RHIC polarimeter, the rectangular shaped MCP with multi anodes will be used to obtain both timing and position information.

In summary, by the present test measurement we found the MCP as useful device to detect the recoil carbon for the RHIC p-C CNI polarimeter.

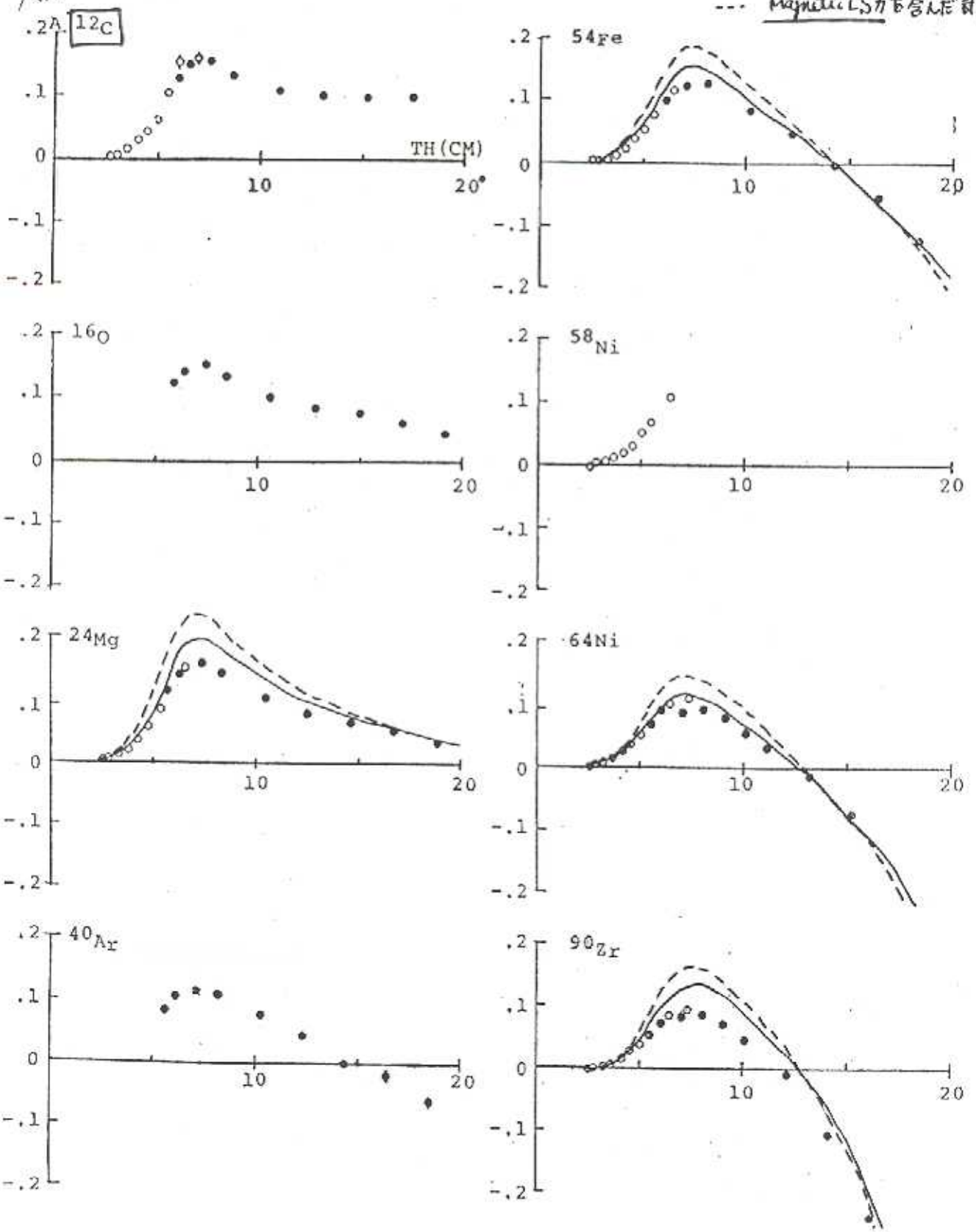
Fig. 2

ANALYZING POWER IN ELASTIC P-NUCLEUS SCATTERING AT FORWARD ANGLES

Ep=65MeV

— Optical Potential 計算値

--- Magnetic LS力を含んだ計算値



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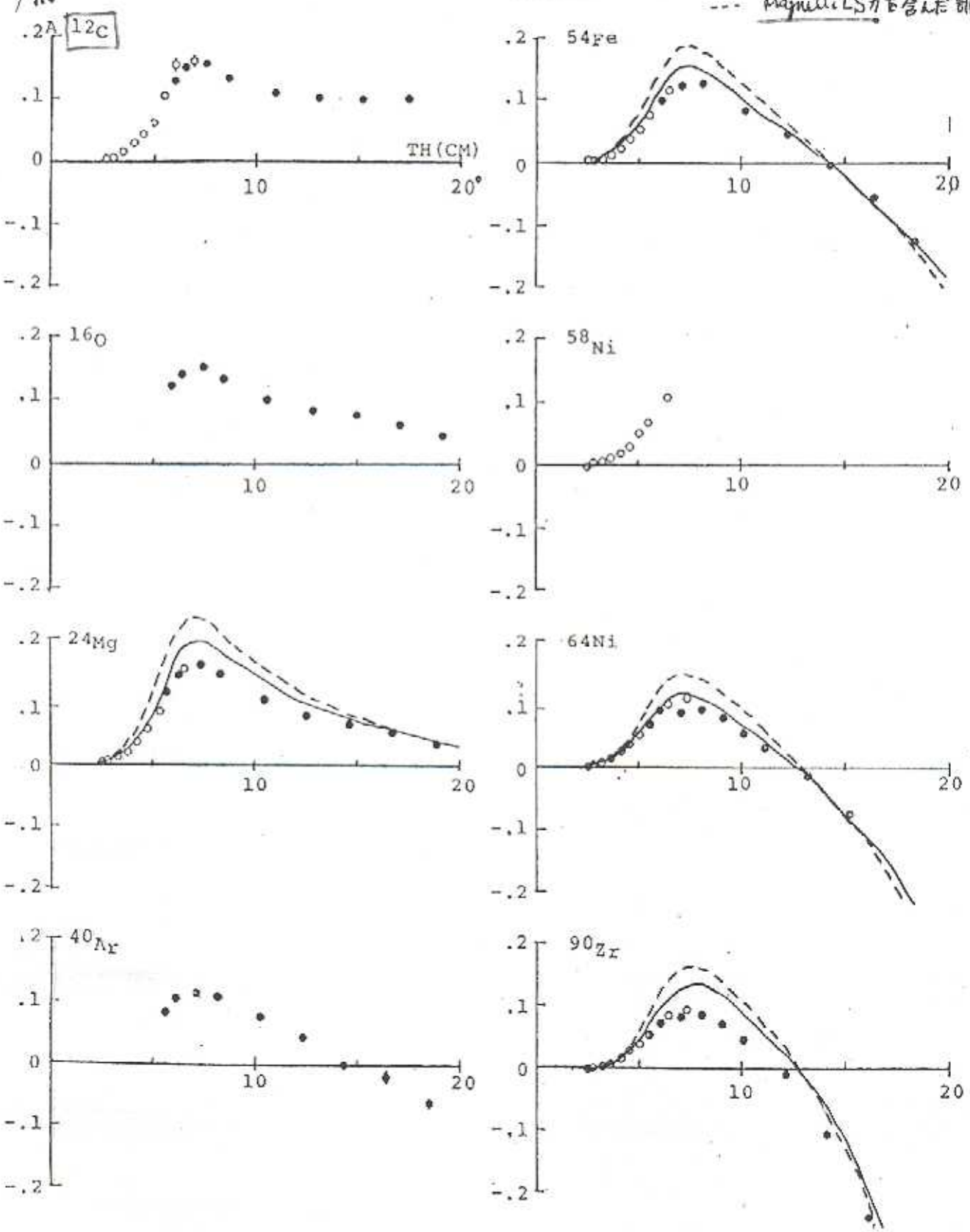

Hamamatsu. MCP (F4655).

- Double layer
- sensitive area 14.5 $mm\phi$.
- diameter of channel 12 μm
- HV max. (MCP) 2.4 KV.
- vacuum. $< 1 \times 10^{-5}$ Torr.
- Gain. (2KV) 1×10^7
- dark count 3 C/sec/cm^2
- Rise time 250 psec.
- Pulse height Resolution 50% (FWHM)

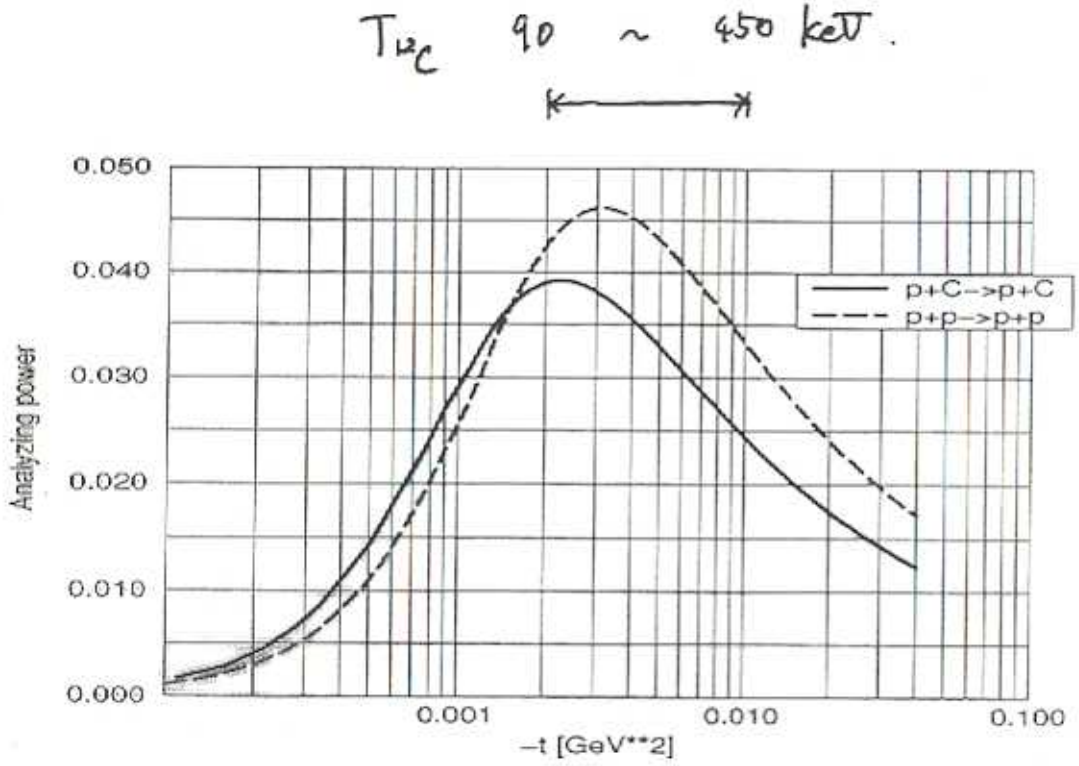

Figure 1. Coulomb-Nuclear interference analyzing power for pp and pC scattering at 250 GeV.

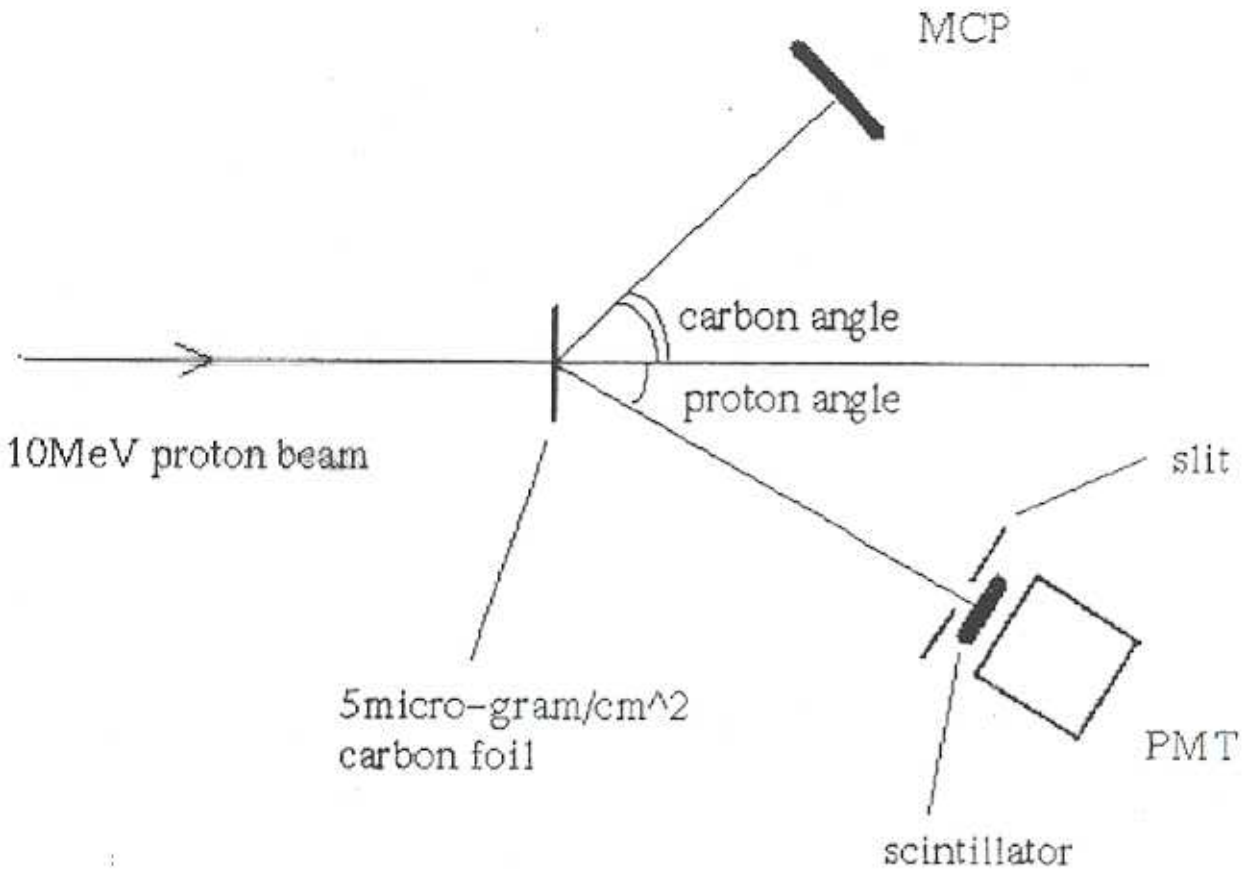

Fig.1 Experimental setup

θ_p	θ_{carbon}	E_{carbon}
27.7°	75°	190 keV
36.1°	70.5°	318 "
46.4	65.0	510 "
61.2	57.5°	824 "

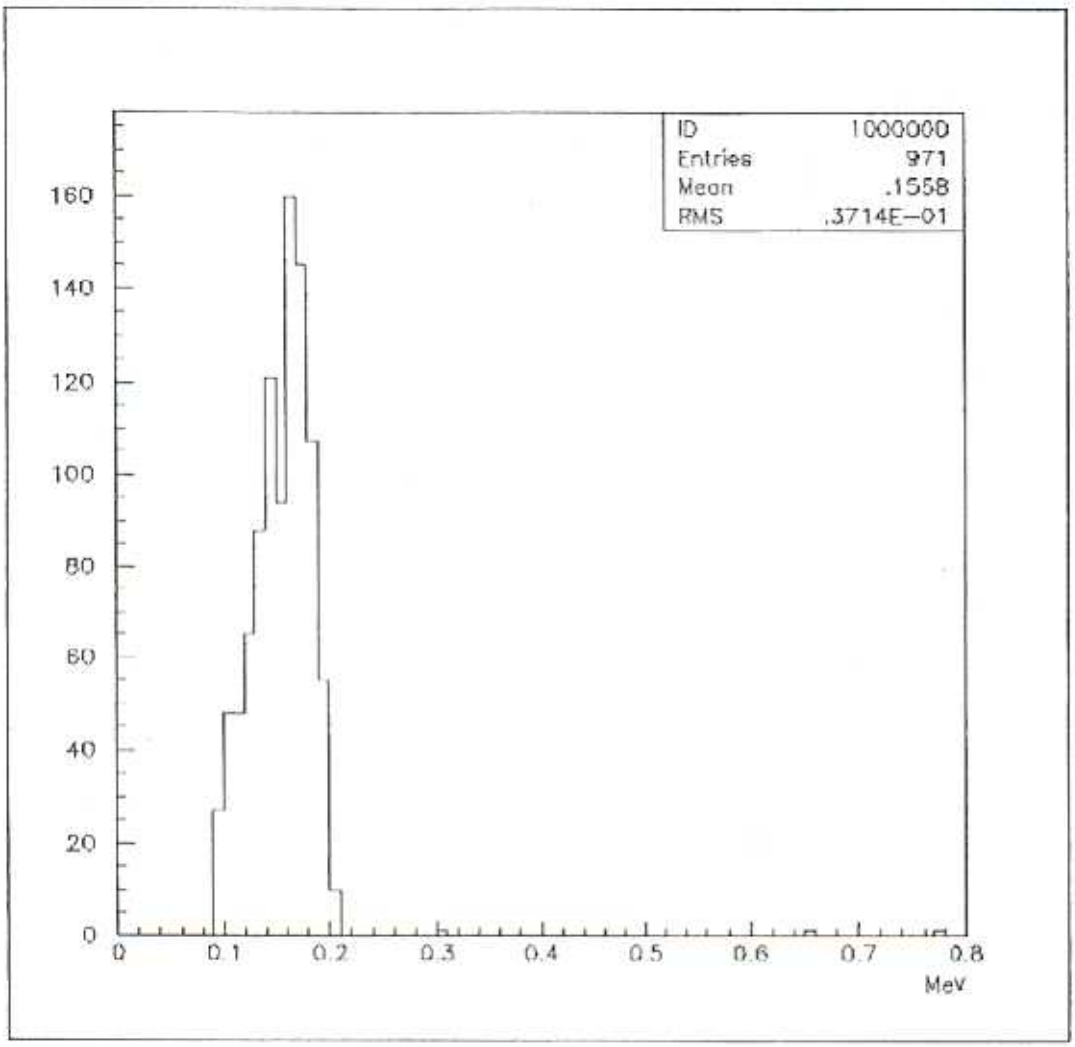

Fig.3 The energy spectrum of the carbon ions.
proton angle = 27.74 , carbon angle = 75.0

E_c = 190 keV.