Characteristics intense pulsed ion beam produced Plasma Focus device
プラズマフォーカス装置におけるイオンビームの特性評価

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High energy ions produced in plasma focus device was found to have in very large spread of emission angle up to ±80 deg.To evaluate the characteristics of the beam incidence angle resolved energy spectrometer was employed. From the evaluation, we found that ions with small emission angle have higher energy and wide spread of incidence angle. The ion energy and spread of incidence angle decrease with increasing emission angle.

1. Introduction

Plasma focus device (PF) is a kind of z-pinch device that produces dense magnetically compressed plasma at the end of coaxial electrodes. The device produced intense high energy charged particle beams of ions and electrodes. Many works have been done to evaluate the characteristics of the particle beams to clarify the acceleration mechanism, as well for the application of the ion and beam. The particle beams have been considered to be accelerated mainly in axial direction. However, in our resent works high current density ion beams are observed even in far off-axis positions. To clarify the characteristics of the beam we have evaluated the dependence of ion energy spectrum on the emission angle.

2. Experiment

In the experiment Mather-type plasma focus device is used with a capacitor bank of 44.8μF/30kV[1]. Figure 1 shows the electrode configuration. The inner electrode (anode) is 240 mm long,60 diameter cupper cylinder. The outer electrode (cathode) is 230 mm long and composed of 24 copper rods. Figure 2 shows the experimental arrangement. In the downstream of the electrode hemispherical inner wall is placed to support the incidence angle resolved electric ion energy spectrometer. Figure 3 shows the geometry of the observation. Pinholes of each spectrometer area placed on the positions corresponding to the ion emission angle (angle from the axis (θ)). The slit is placed 43mm downstream from the pinhole. The direction of the slit is parallel to the θ direction.

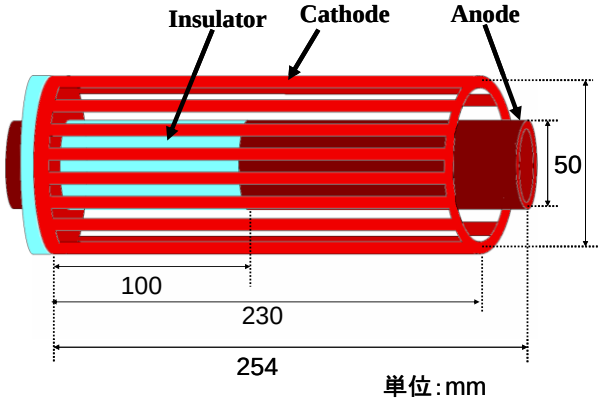

Fig.1. Electrode configuration

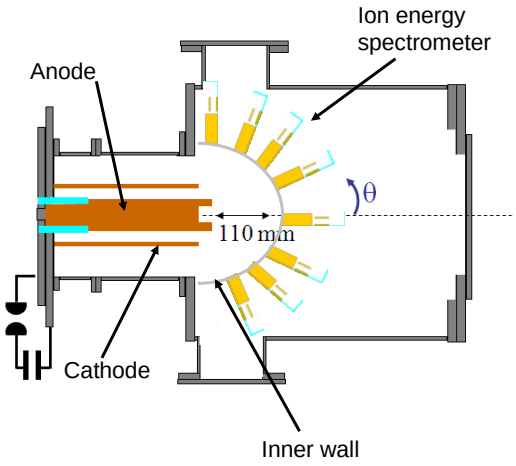

Fig.2. Experimental arrangement.

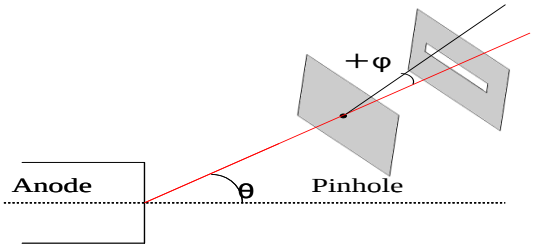

Fig.3. Geometry of the observation.

Figure 4 shows the incidence angle (ϕ) resolved ion energy spectrometer used in the experiment. In the spectrometer ions are injected from the pinhole, collimated parallel to the axis- θ plane by slit, deflected by the electric field and recorded on the ion track detecting plastic plate of CR-39.

In the experiment the plasma focus chamber was evacuated up to 5.0×10^{-3} Pa, and after that filled with hydrogen gas of 300 Pa.

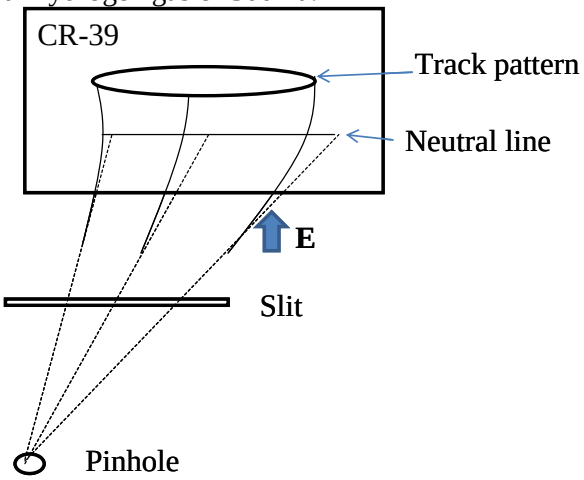

Fig.4. The incidence angle (ϕ) resolved ion energy spectrometer.

Figure 5 shows the example of the track pattern recorded on CR-39. As seen in the figure ion beam has a wide spread on ϕ direction. The ion track density in each position was carefully counted under the microscope and evaluated the ion energy spectrum in each incidence angle.

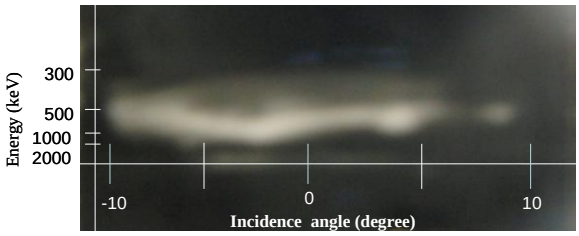

Fig.5. Track pattern recorded on CR-39. (θ =0degree)

Figure 6 shows the results of evaluation. As seen from the figure, for the case of large emission angle (θ = 0 degree), ions are observed up to ϕ = $\pm$10 degree. The ion energy and ion number tend to decreases with increasing ϕ .

In contrast , for the case of smaller emission angle (θ = 70 degree), the spread of the incidence angle was much reduced. In addition, the energy and number of ions was much reduced.

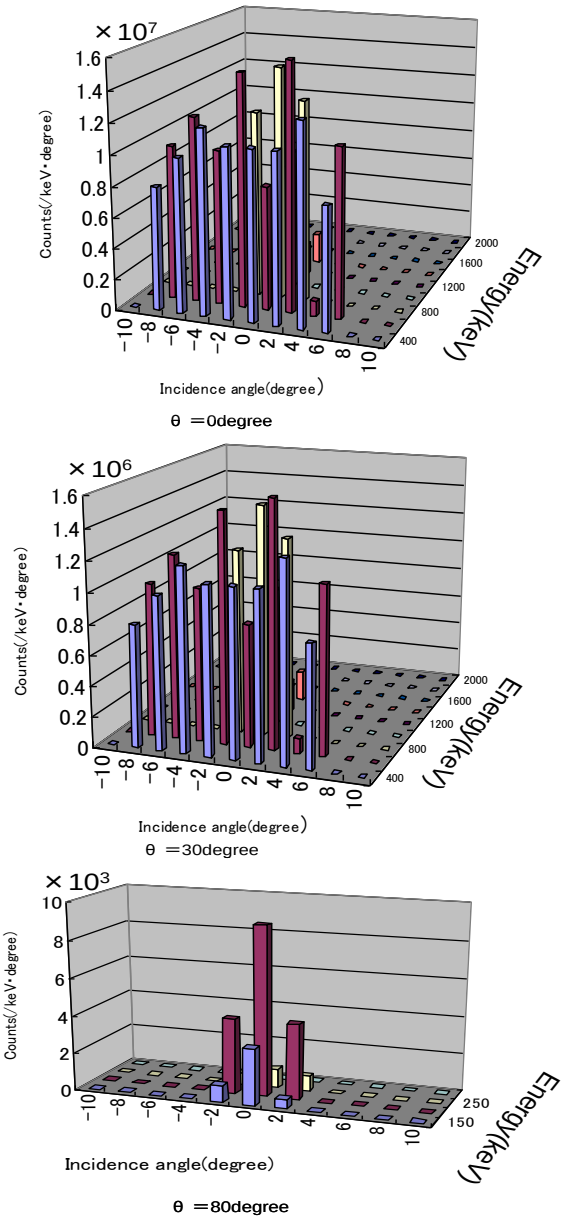

Fig.6. Counts number of tracks.

3. Summary

The ion energy spectrum for each emission angle was evaluated by the incident angle resolved ion energy spectrometer. From the evaluation, we found that ions with small emission angle have higher energy and wide spread of incidence angle. the ion energy and spread of incidence angle decreases with increasing emission angle.

References

[1] Yuki Nishinio, Akira Huruya, Hiroaki Ito, Katsumi Masugata,*Characteristics intense pulsed proton beam produced Plasma Focus device*, Institute of Electrical Engineers of Japan national conference (2010.3)