Charge-exchanged beam measurement using a grid-biased Faraday cup

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Charge-exchange is a significant process for transport phenomena of energetic particles in magnetically confined plasmas. Studying those phenomena using a small device with a energy controled beam[1] has experimental advantages in flexibility and accessibility. However, measurement of a small current-neutral beam is difficult especially when the beam is a mixture of ion and neutral component. In this paper, a separate measurement of a neutral beam current under ion beam mixing is proposed and is applied to a charge-exchanged neutral helium beam passing through a linear device, where a Faraday cup with mesh-grids is used. Response signal of a neutral beam is originated from the secondary electron emission. Since the coefficient of the secondary electron emission sensitively depends on the surface condition, we propose a method for *in situ* determination of the coefficient of the secondary electron emission.

Schematic of the Faraday cup is shown in Fig. 1. The closest grid, grid 1, controls the secondary electron emission, while others repel electron and ion of a bulk plasma. When the grid 1 is biased in a sufficiently negative voltage, the secondary electron completely suppressed; the collector current $I_{\mathrm{c}}{}^{-} = eS\Gamma_{\mathrm{i}}$ is obtained, where S and Γ_{i} are collecting area and beam-ion flux, respectively. On the other hand , when the grid 1 is positively biased, the secondary electron fully emitted from the collector; the collector current $I_{\mathrm{c}}{}^{+} = eS(\Gamma_{\mathrm{i}} + \eta\Gamma_{\mathrm{i}} + \eta\Gamma_0)$, where η and Γ_0 are the emission coefficient and neutral flux, respectively. The emission coefficient η is then determined by pure ion-beam detection with the positive and negative biasing voltage. Finally the neutral beam current is obtained by $es\Gamma_0 = [I_{\mathrm{c}}{}^{+} - (1+\eta)I_{\mathrm{c}}{}^{-}]/\eta$. Experimental results are obtained for a helium ion beam injected into a helium gas chamber showing good agreement with those formulation.

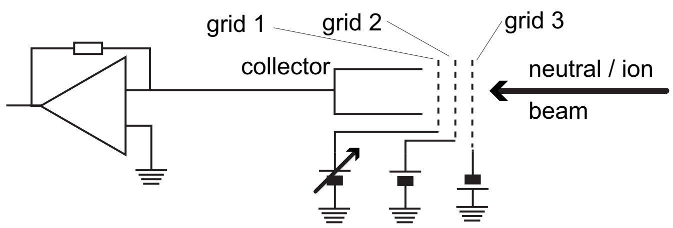

Figure 1: Schematic of a grid-biased Faraday cup.

[1] A. Okamoto, T. Isono, T. Kobuchi, S. Kitajima, M. Sasao, J. Plasma Fusion Res. SERIES **8** (2009) in press.