

§9. Energy Analyzer Candidates for 6MeV LHD Heavy Ion Beam Probe

Fujisawa, A., Iguchi, H., Hamada, Y., Sasao, M.

For the 6MeV heavy ion beam probe, the traditional 30 parallel plate energy analyzer is not applicable because its operational voltage is far beyond the practical limit. Therefore, a new type of the energy analyzer should be considered. One of the most feasible candidate is cylindrical energy analyzer. The well known 127.3 energy analyzer has a first order focusing property. This may be insufficient for the HIBP application where the beam energy should be measured with a precision of 10^{-4} - 10^{-5} .

However, there exists a possibility that the focusing property may be improved in the cylindrical analyzers if drift spaces are equipped in front of both the entrance and exit of the cylinder. A theoretical study[1] was executed to confirm this proposition. In the analysis, the treatment of the fringing field penetrating into the drift regions around the ends of cylinder is essential since the fringing field will affect the focus property of first order. The effects are mainly divided into alternation of the beam velocity and deflection of beam at the cylinder ends.

One of the main results of the analysis is that the second order focus can be achieved when the angle length is larger than 127.3. Therefore, the acceptance angle become remarkably wider than that of a 127.3 analyzer if the angle length is properly chosen. However, the energy resolution of this type of analyzer is predicted to be worse than the traditional 127.3 analyzer. The further analysis shows that that the 210 energy analyzer will be suitable for the LHD HIBP analyzer owing to its excellent focusing property[1].

When the drift region lengths of

entrance and exit are chosen to be $h=0.160$, $l=0.552$, the focusing property can be described (see Fig.1),

$$\Delta r/\Delta\theta = -0.0113 + 0.15\delta\theta^3 - 0.36\delta\theta^4 +$$

Then the resolution can be represented by

$$\Delta r/\Delta v = -0.0113 - 0.31\delta v - 0.27\delta v^2 +$$

In the case of our HIBP, in principle, the beam incident angle into the analyzer should be kept to be the same for any observation points by controlling the trajectories with the four sets of the sweep plates. If this method can reduce the uncertainty of the beam incident angle to a sufficiently small level, for an example, the 105 cylindrical analyzers, whose design is based on the 127.3, may be favorable due to its simpler structure. Our final decision of the energy analyzer should be made after investigating the usefulness of the trajectory control method and the validity of the theoretical prediction of cylindrical analyzer property.

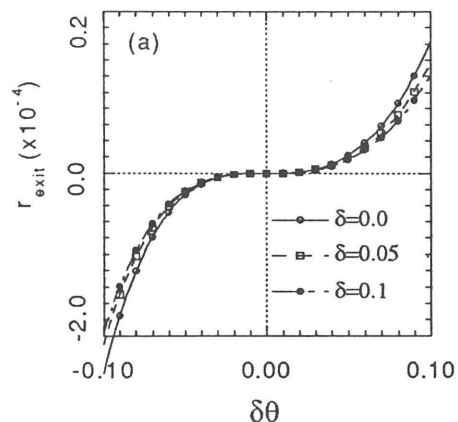


Fig. 1. Expected acceptance of beam entrance angle for 210 cylindrical energy analyzer.

Reference

- 1) A. Fujisawa, Y. Hamada, Rev. Sci. Instrum. 64, 3503(1993).