

## §10. Prototype of 210 Cylindrical Energy Analyzer for the LHD Heavy Ion Beam Probe

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A new kind of energy analyzer is indispensable for the LHD heavy ion beam probe instead of the traditional 30 parallel plate energy analyzer. It is because the operation voltage of the parallel plate energy analyzer for 6MeV beam is far beyond the practical limit. Cylindrical energy analyzers are promising candidates. Although the famous 127.3 cylindrical energy owns the first order focusing, the focusing property may be improved if drift spaces are equipped in front of both the entrance and exit of the cylinder. A theoretical analysis was executed to investigate this proposition.

The analysis showed that the cylindrical analyzer with the angle length of 210 should have a second order focusing property. The property will give sufficient acceptance angle width. However, this type of analyzer is predicted to have a poorer energy resolution. On the other hand, the analysis indicates that the cylindrical analyzer whose angle length is a little less than 127.3 will have a better energy resolution, although its focus is of first order. In order to examine the experimental properties of these analyzers, prototypes of 210, 105 cylindrical energy analyzers were constructed; the major radius is 150mm; the gap width between the electrodes is 36mm.

By use of the  $Cs^+$  beam test stand, the property of 210 cylindrical energy analyzer has been examined. The entrance and exit slit positions are movable in order to allow us to find the better focusing points. Figure 1 shows one of the results with the second order focusing property of the analyzer; in this case, the entrance slit is located from the end of the

cylinder at 50mm, and the exit slit is at 60mm, and the positive and the negative voltages on the cylinders (electrodes) are 2.273kV, -3.055kV, respectively. It is worth while to say that this second order focusing is obtained when the split plate center is located by +0.5mm from the center line of the analyzer. The least square fitting method gives

$$\Delta r/\Delta\theta = -0.022\Delta\theta^2 + 1.93\Delta\theta^3 - 1.36\Delta\theta^4.$$

Then the energy resolution is  $\Delta r/\Delta e = -0.017$ . Thus, the cylindrical analyzer has a very wide acceptance angle, however, the energy resolution is worse. Since these characteristics are greatly dependent on the fringing field structure, more favorable property may be obtained by making an appropriate fringing field structure.

The examination about the other 105 energy analyzer has not been finished yet. After investigation of this energy analyzer, the final decision will be made for the analyzer of the LHD HIBP.

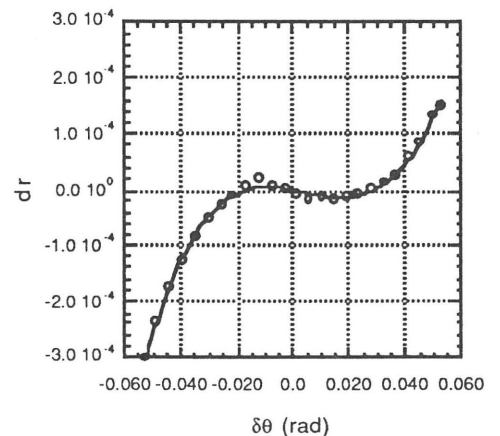


Fig.1. Second order focusing property obtained in the 210 cylindrical energy analyzer.

### Reference

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