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Development of 1D ion flow vector measurement by use of Doppler probe array with two pairs of view-lines

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Doppler spectroscopy has been widely used for ion temperature and flow measurements both in laboratory experiments and in space observations. Using the line spectrum emitted from ions, we can measure Doppler spectrum profile in the line of sight by means of which ion temperature and flow component can be calculated. Since the emitted light is integrated along the view-line, some tomographic reconstruction[1] or direct measurement by probes is required to calculate local ion temperature and velocity. The former already succeed in measurement of ion temperature but it is still difficult to reconstruct ion flow. On the other hand, previous research by Princeton University has developed the MRX IDS probe[2], which can measure local ion flow vector, but it can measure only one point for a single discharge and its size is much larger than measurement area, causing large plasma perturbation. We developed a new type of Doppler probe which realizes both 1D local ion flow vector measurement by a single discharge and low plasma perturbation.

Figure shows the internal structure of the new probe. Insertion of the two straight glass tubes (ϕ=10mm) is needed for 1D flow and temperature measurement, indicating the plasma perturbation much less than MRX IDS probe. Each measurement area is surrounded by 4 mirrors and using their reflections, the four optical fibers receive emitted lights from two pairs of view-lines (sight A&B, C&D). Then they are lead to a spectrometer and finally to an ICCD camera for two pairs of line spectra measurements. Since Doppler shifts of each pair of spectra are caused by ion velocity component in each line of sight, the local ion flow vector can be calculated by the two velocity components. The 1D measurement areas for ion velocity vector are aligned between the two parallel glass tubes. The first test of the new Doppler probe array demonstrated successfully the 1D profile measurement of ion velocity and temperature by a single discharge and low plasma perturbation by the two glass tubes.

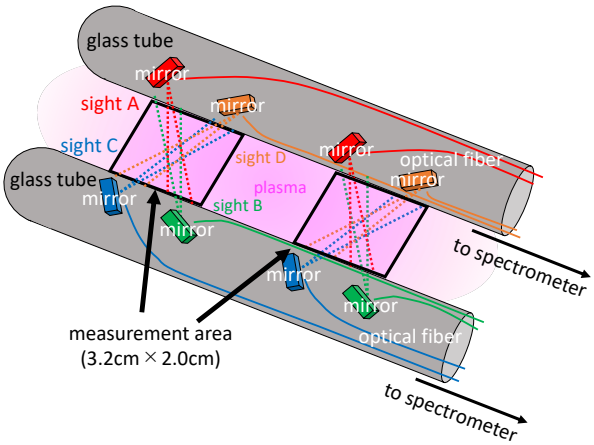

Fig. 1D array of Doppler probes for two-pairs of view-lines[3]

References

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