# Development of new type impedance probe with continuous detection of the UHR frequency

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The impedance probe has been used for over 40 years, to obtain the absolute value of electron density in space plasma with high accuracy (Oya, 1966). In association with two campaign observations, in-situ measurements of electron density by using impedance probe have been successfully carried out. Moreover, a phase detection type impedance probe method has been developed to realize a continuous observation of the plasma density.

In the previous instrumentation for the in-situ observations such as SEEK-2 in 2002 and DELTA in 2004 (namely, ordinary type impedance probe), the impedance probe showed an observation limit that it could not detect the fine structure of plasma irregularity due to the plasma instabilities. Detection of fine structure of the plasma density becomes very much important to understand the physical processes generated in the ionosphere. So, accurate observation of fine structure of plasma distribution with absolute value is essential to study the electro-dynamics in the ionosphere.

We tried to develop the phase detection type impedance probe by using PLL (Phase Locked Loop) method. The methodology of phase detection type was confirmed in laboratory and space science chamber. Based on these experiments, we clarified that it was possible to detect the phase shift at UHR and SHR frequencies. However, in the space chamber experiment, the phase shift showed difference from the simulation results by using LC resonant circuit in the laboratory experiment. Also the results of simulation by using the Micro-Cap V CQ suggested that this difference seemed to be due to the collision effect in space chamber. Quantitative evaluation about the collision effect should be examined in future works. Finally, we achieved to make the continuous detection of UHR frequency by using the PLL operation. In comparison with the ordinary type impedance probe, it was shown that the locked frequency changed in correspondence with the electron density variation inside the space chamber. The UHR frequency indicated by phase detection mode showed lower value (11 % at most) than the UHR detected by the swept frequency mode. It is also needed to evaluate the time resolution of UHR frequency for development works in the near future. As it has been discussed in this thesis, further extended physical quantities of space plasma are possible to be measured by using the method of the impedance probe.