MAGNETIC BRAKING AND HEAT SHIELD RESEARCH WITH A CAPSULE-TYPE REENTRY BODY.

T. Abe, Institute of Space and Astronautical Science, Yoshinodai 3-1-1, Sagamihara, Kanagawa 229, Japan, tabe@gd.isas.jaxa.jp).

For the reentry body, the aerodynamic heating is the biggest challenge and must be managed somehow. Currently the thermal protection system composed of heat resistant tile and so on is employed for this purpose. The electrodynamic heatshield technique which employs a strong static magnetic field around a reentry body of high speed flight is a promising technique to reduce the heating itself during an atmospheric flight. This can be realized as a result of the interaction between the magnetic field and the weakly ionized flow generated around the vehicle. Through this interaction, the body force due to the Lorentz force acts on the flow directly and enables us to control it. In return, the reaction of the body force affects the vehicle trajectory or its attitude. Because of those expected performances of the technique, the electrodynamic heatshield technique may be able to replace the current heatshield system. In addition, the technique may provide us a way to maneuver the vehicle trajectory and the vehicle attitude without moving parts such as aerodynamic control surfaces.

So far, much research effort has been devoted to realize this technique. The research includes the basic investigations by not only experimental but also numerical methods. For the experimental investigation, several facilities such as arc-jet wind tunnel, shock-tunnel and expansion tube have been utilized to make the flow condition close to the flight condition as much as possible, and the results obtained have successfully verified the technology[1]. For the numerical investigation, detailed investigations have been done and verified that the electrodynamic heat shield technology is reasonably effective in the flight condition from LEO for instance[2]. Furthermore, it was shown that this technique can be applicable to the aerobraking vehicle.

Nevertheless the technology is remained to be verified by a flight experiment which is necessary since the existing ground facility can not provide the proper flight condition. In this study, the feasibility of the flight experiment is critically discussed. Figure 1 shows an example of procedure to realized such flight experiment. For this experiment, a suborbital flight is made used of. Such a suborbital flight can be realized by using a sounding rocket SS-520. Since the flight speed, at least, of 7 km/sec during an atmospheric flight is necessary to demonstrate the technology, the third stage motor, to accelerate the payload downward, is added to the original rocket composed of 2-stages. In the experiment, the payload is a micro-capsule-type vehicle which is equipped with a strong magnetic field generator inside it. Such a vehicle is schematically shown in Fig. 2. The diameter of the capsule is 40 cm and its weight is around 17 kg. The magnetic field generator inside the capsule provides a magnetic field intensity of 1T at the stagnation point of the vehicle. This magnetic field generator can be realized by using the high temperature bulk superconductor[3] installed inside a cryostat especially-designed. For the moment, we have developed an engineering model of such a magnetic field generator. The testing for it is now under way.

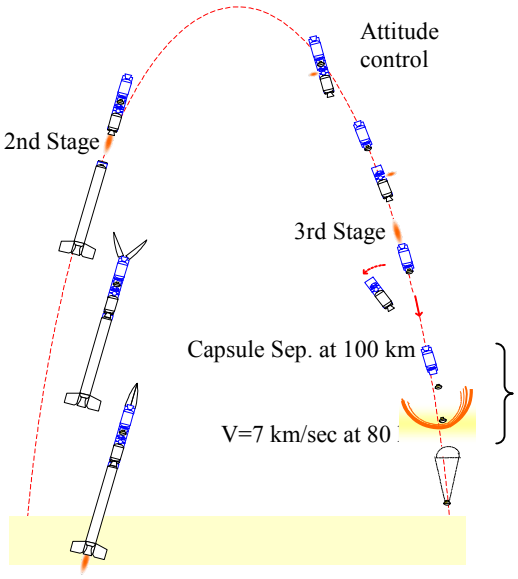

Fig. 1 Suborbital flight experiment.

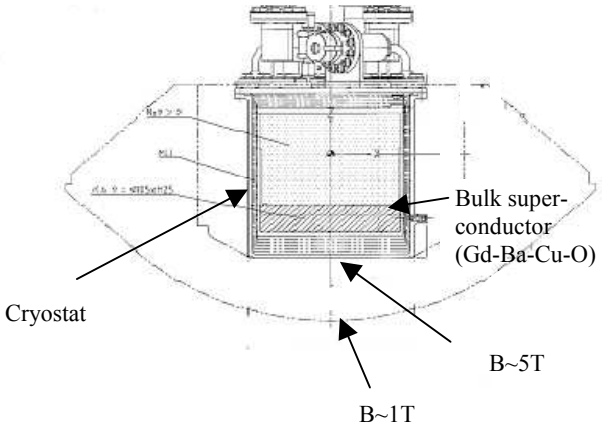

Fig. 2 Capsule type vehicle with the strong magnetic field generator onboard.

References: [1] Y. Takizawa, et. al., (2006)*Phys. Fluids, 18,* 117105-10. [2] H. Otsu, et. al., (2006) *AIAA 2006-3566.* [3] M. Tomita and M. Murakami (2003), *NATURE* Vol. 421, p. 517.