

## 【Grant-in-Aid for Scientific Research (S)】

### Broad Section C



#### Title of Project : Hypersonic Airframe/Engine Integration Experiment Using a Sounding Rocket FTB

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Keyword : Hypersonic Vehicle, Flight Experiment, Airframe/Engine Integration, FTB

#### 【Purpose and Background of the Research】

In Japan, system firing tests of hypersonic turbojet engines such as the ATREX and the Precooled Turbojet have been carried out ahead of other countries. However, little knowledge on the airframe/engine integration and control has been obtained under the actual flight condition due to the difficulty of conducting a hypersonic flight experiment. Thus, we propose a Mach-5 class flight experiment named “HIMICO” using a S-520 sounding rocket. “HIMICO” is an abbreviation for High Mach Integrated Control Experiment and its objective is to demonstrate the integration control technologies of the airframe and engine. Construction of the hypersonic flight technology using the sounding rocket is supposed to make a breakthrough in developing hypersonic transportation systems.

#### 【Research Methods】

Figure 1 shows the sequence of the HIMICO flight test. The test vehicle is mounted in the nose cone of the S-520 sounding rocket. The nose cone is opened and the attitude of the rocket with HIMICO is controlled by RCS. Then, HIMICO is separated from the rocket. When the dynamic pressure is recovered, HIMICO is aerodynamically controlled to lift its nose up, which is called the “pull-up maneuver.” Finally, the ramjet engine starts at the condition with an altitude of about 20 km and Mach number of around 5. It splashes into the sea after the experiment. During the hypersonic flight, the air-intake and nozzle of the engine are controlled to match the flight condition while controlling the elevons and ladder of the airframe simultaneously.

Prior to the flight test, we plan to conduct an integrated airframe / engine control experiment using the Ramjet Test Facility (RJTF) of JAXA. This is a free-jet test. HIMICO installed on a thrust measurement test stand is exposed to air flow at a total temperature of  $T_t = 1320$  K equivalent to Mach 5 condition. A three-component force balance is installed in the test stand. When the engine thrust is generated, a pitch-up moment is applied to the vehicle. The elevons attached to the horizontal tail are controlled so as to cancel this moment, which is measured by the balance. Compared to the flight test, RJTF test cannot simulate the unsteady condition of the freestream. However, it is possible to obtain detailed data including the unstart operation of the air intake. Figure 2 shows a photograph of the past combustion test at Mach 4 ( $T_t = 884$  K).

#### 【Expected Research Achievements and Scientific Significance】

The expected outcome is to acquire the hypersonic flight data with strong airframe/engine interference. In addition, it is to acquire a Japanese unique flight test infrastructure with high independence and flexibility. These technologies will be applied to a sub-orbital spacecraft. This test covers many aerospace research fields and is expected to have educational effects for young researchers.

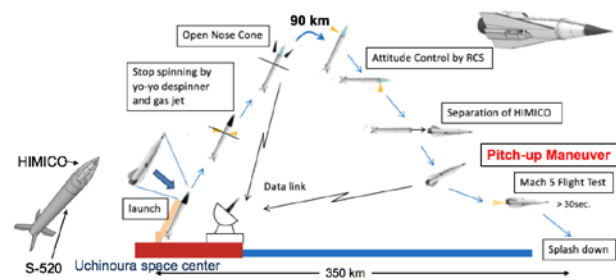


Figure 1 Flight sequence of HIMICO



Figure 2 Combustion test under Mach 4 condition

#### 【Publications Relevant to the Project】

- Sato, T, et al., Program of High Mach Integrated Control Experiment, “HIMICO” using S-520 Sounding Rocket, Transactions of JSASS, Aerospace Technology Japan, to be published.

【Term of Project】 FY2020-2024

【Budget Allocation】 150,600 Thousand Yen

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