

IAF SPACE EXPLORATION SYMPOSIUM (A3)
Small Bodies Missions and Technologies (Part 2) (4B)

Author: Mr. Tetsuya Masuda
NEC Corporation Space Systems Div., Japan, t-masuda2011@nec.com

Dr. Toshio Kamiya
NEC Corporation, Japan, tkamiya@nec.com

Mr. Kazutsuna Hebiishi
NEC Corporation Space Systems Div., Japan, k-hebiishi@ak.jp.nec.com

Dr. Yuichi Tsuda
Japan Aerospace Exploration Agency (JAXA), Japan, tsuda.yuichi@jaxa.jp

Dr. Takanao Saiki
Japan Aerospace Exploration Agency (JAXA), Japan, saiki.takanao@jaxa.jp

Dr. Fuyuto Terui
Japan Aerospace Exploration Agency (JAXA), Japan, terui.fuyuto@jaxa.jp

Dr. Makoto Yoshikawa
Japan Aerospace Exploration Agency (JAXA), Japan, 6093.makoto@kta.biglobe.ne.jp

Mr. Takeshi Oshima
NEC Corporation Space Systems Div., Japan, t-ohshima@nec.com

THE PHILOSOPHY OF DESIGN AND OPERATION OF SPACE PROBES FOR UNKNOWN
ASTEROIDS INCLUDING HAYABUSA AND HAYABUSA2.**Abstract**

Hayabusa2, the asteroid sample return space probe was launched on December 3, 2014, and successfully arrived at the asteroid Ryugu on June 27, 2018. The probe executed some low-altitude observation, and deployed three Rovers, MINERVA-II-1A/1B and MACOT, on the asteroid surface. On February 22, 2019, the first touchdown operation was successfully executed. After that, Hayabusa2 created an artificial crater by SCI (Small Carry-on Impactor), and the second touchdown near the crater was succeeded on July 11, 2019. Hayabusa2 is on the way bringing the sample of the asteroid to the earth at the end of 2020. Following Hayabusa, which was succeeded to return to the earth with the sample of the asteroid Itokawa in 2010, we designed, manufactured, and validated the Hayabusa2 system and most of its subsystems and components including hardware and flight software, i.e. Data Handling Subsystem, Attitude and Orbit Control Subsystem, Communication Subsystem, and so on, under the direction of JAXA. We also have developed the operation design of the Hayabusa2, and provided technical support to JAXA's operation as the system and operation integrator, with the aim of contributing towards their mission success. This paper describes the achievements through Hayabusa and Hayabusa2 project in the context of NEC vision of space business, which include the establishment of the philosophy of small probe design and operation, and of the platform technology for the unknown asteroids. This paper also details the important technologies enabling the achievements above, specifically the robustness and flexibility to deal the uncertainty of the asteroid under the resource limitation, and operation planning and procedure validation considering the revealed information by the proximity observation. This paper finally indicates our expectation for the future space exploration programs with small body probes, and our dedication to those futures.