The Next Generation small-body Sample Return mission: a concept study of a comet sample return

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The Next Generation small-body Sample Return (NGSR) mission is a small-body sample return mission following Hayabusa2 and MMX, as a candidate for JAXA/ISAS's strategic large-class mission to be realized in the 2030s. The main goal of NGSR is to develop an innovative deep space round-trip exploration system consisting of a Deep Space Orbital Transfer Vehicle (DSOTV) and a separative touch-and-go sampling probe and to realize samples return from a primitive small body for elucidating the origins of the solar system and life in the Galaxy.

Considering the results and issues of Hayabusa2, we have set the scientific goals as (SMG-I) to elucidate the origin of solar system "materials" by tracing the evolution of galactic materials and (SMG-II) to elucidate the origin of solar system "objects" by approaching the process of planetesimal formation. We have selected the Jupiter-family comet 289P/Blanpain as the nominal target body. The nominal mission timeline is to launch in 2034, arrive in 2040, and return to Earth in 2046. We have multiple backup launch windows and backup objects, although the best windows are in the early 2030s for 289P.

During the proximity phase, optical navigation cameras will observe the target surface topography and determine its shape. Gravity measurements will be performed using LIDAR to estimate the bulk density of the body. Surface physical properties will be investigated using a thermal infrared imager. Combining this information, landing candidate sites will be selected. Cometary samples will be collected by touchdown operations using the probe's sampler, and volatile and organic matter will be analyzed using a small mass spectrometer. A small carry-on impactor (SCI) will be used to collect subsurface material unaffected by cometary activity, space weathering, etc. After freeze-drying the samples and rendezvous-docking the probe to the DSOTV, the samples will be transported to the small, lightweight sample return capsule on the DSOTV, then returned to Earth via ultra-high-speed reentry and hard landing (SMG-I). In addition, seismometer operations combined with the SCI/sampling operations and radar tomography observation using a multi-spacecraft system will be performed to investigate the internal structure of the cometary nucleus (SMG-II).

This presentation will introduce an overview of the mission based on the mission proposal to JAXA/ISAS and the science community in July 2024.