EXPLORING EUROPA WITH THE EUROPA CLIPPER. D. Senske[1], L. Prockter[2], R. Pappalardo[1], B. Paczkowski[1], S. Vance[1], B. Goldstein[1], T. Magner[2], and B. Cooke1[2], [1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, [2]Johns Hopkins Applied Physics Laboratory, Laurel, MD, 20723.

Introduction and Science Goal: Europa is recognized by the Planetary Science Decadal Survey [1] as a prime candidate to search for a present-day habitable environment in our solar system. As such, NASA has pursued a series of studies, facilitated by a Science Definition Team (SDT), to define a strategy to best advance our scientific understanding of this icy world with the science goal: *Explore Europa to investigate its habitability*. Working in concert with a technical team, a set of mission architectures were evaluated to determine the best way to achieve the SDT defined science objectives. The favored architecture would consist of a spacecraft in Jupiter orbit making many close flybys of Europa, concentrating on remote sensing to explore the moon. An innovative mission design would use gravitational perturbations of the spacecraft trajectory to permit flybys at a wide variety of latitudes and longitudes, enabling globally distributed regional coverage of Europa's surface, with nominally 45 close flybys, typically at altitudes from 25 to 100 km. This concept has become known as the Europa Clipper [2].

Science Objectives: To achieve the overarching science goal for exploring Europa, the SDT recommended three science objectives for the Europa Clipper (In June of 2014, the SDT completed its tasks):

Ice Shell and Ocean – Characterize the ice shell and any subsurface water, including their heterogeneity, ocean properties, and the nature of surface-ice-ocean exchange;

Composition – Understand the habitability of Europa's ocean through composition and chemistry; and

Geology – Understand the formation of surface features, including sites of recent or current activity, and characterize high science-interest localities.

The Europa SDT also considered implications of the recent HST detection of plumes at Europa [3], specifically whether any modifications might be warranted to the recommended science objectives and/or the investigations that flow from them.

Reconnaissance Goal and Objectives: Building on the global-regional characterization of Europa by the Clipper, a possible subsequent exploration step would be to send a soft lander to its surface. In the process of considering Europa strategic mission options, a stand-alone lander was deemed premature at present because there is insufficient information to understand whether or where Europa's surface provides accessible landing sites. As such, it has been proposed that the Europa Clipper concept should include the capability to perform reconnaissance for potential a future lander.

In consultation with NASA Headquarters, the SDT developed a reconnaissance goal: *Characterize scientifically compelling sites, and hazards, for a potential future landed mission to Europa*. Flowing from this goal are two reconnaissance objectives:

Site Characterization – Assess the distribution of surface hazards, the load-bearing capacity of the surface, the structure of the subsurface, and the regolith thickness of at least 15 sites of interest for a future landed mission;

Science Value – Assess the composition of surface materials, the geologic context of the surface, the potential for geologic activity, the proximity of near surface water, and the potential for active upwelling of ocean material of at least 15 sites of interest for a future landed mission.

Model Payload: The set of investigations derived from the science objectives traces to a model payload for science, consisting of: Ice Penetrating Radar (for sounding of ice-water interfaces within and beneath the ice shell), Topographical Imager (for stereo imaging of the surface), ShortWave Infrared Spectrometer (for surface composition), Neutral Mass Spectrometer (for atmospheric and possible plume composition), Magnetometer and Langmuir Probes (for inferring the satellite's induction field to characterize an ocean), and Gravity Science (to confirm an ocean). This notional payload for science serves as a proof-of-concept for the Europa Clipper during its formulation stage. The actual payload would be chosen through a NASA Announcement of Opportunity.

To accomplish the site characterization reconnaissance objective and the investigations that flow from it, two additional instruments are included in the notional payload: a Reconnaissance Camera (for high-resolution imaging) and a Thermal Imager (to characterize the surface through its thermal properties). These instruments, in tandem with the notional payload for science, could also assess the science value of potential landing sites.

Conclusions: The Europa Clipper concept provides an efficient means to explore Europa and investigate its habitability through understanding the satellite's ice shell and ocean, composition, and geology. The ability to characterize the surface and evaluate the science value of sites for a potential future lander would also be enabled by the Clipper concept.

References: [1] Space Studies Board, (2011) The National Academies Press, Washington, DC. [2] Europa Study Team (2012) *Europa Study 2012 Report*. JPL D-71990, 2012. [3] Roth L. et al. (2013) *Science Express,* DOI: 10.1126/science.1247051*,* Published Online December 12 2013.