"One Team": The dynamics and structure of the Europa Clipper Science Team. C. R. Richey[1], R. T. Pappalardo[1], D. A. Senske[1], H. Korth[2], R. Klima[2], C. B. Phillips[1], K. Craft[2], and the Europa Clipper Science Team, [1]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr, Pasadena, CA, USA 91109 (christina.r.richey@jpl.nasa.gov) [2]Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Rd., Laurel, MD 20723, USA.

Introduction: The Europa Clipper Mission, in formulation for launch in the 2020s, will pursue a science goal of exploring Europa to investigate its habitability. The mission will send a solar-powered, radiation-tolerant spacecraft into orbit about Jupiter and then will conduct more than 40 flybys of Europa, most reaching closest approaches of 25–100 km.

The payload comprises a suite of nine science instruments that together will support three key objectives:

1. Ice Shell & Ocean: Characterize the ice shell and any subsurface water, including their heterogeneity, ocean properties, and the nature of surface-ice-ocean exchange
2. Composition: Understand the habitability of Europa's ocean through composition and chemistry
3. Geology: Understand the formation of surface features, including sites of recent or current activity, and characterize high science interest localities

Science Team: The Europa Clipper Science Team operates as a single entity, working to fulfill the science goal and objectives of the Europa Clipper mission and is composed of members of its Investigations, Project Science, Affiliates, and (anticipated in the future) any Participating Scientists. All Europa Clipper Science Team members have the opportunity to participate in the science strategic planning effort through the Interior, Geology, Composition, and Habitability Thematic Working Groups, and in Project Science Group (PSG) meetings and other cross-investigation meetings. Access to data products and the process for participation in publications of team members is codified in a set of "Rules of the Road."

Project Science: The Project Science Team is composed of the Project Scientist (PS), Deputy Project Scientists (DPSs), Project Staff Scientists (PSSs), and Investigation Scientists (ISs). Under the leadership of the Project Scientist, this group works to ensure the scientific integrity and overall scientific success of the mission. Diversity in all aspects is encouraged of the Project Science Team.

Science Investigations: Overseen and managed by a Principal Investigator (PI), the Science Investigations are each composed of a group of scientists selected by NASA to perform science activities through the implementation and operation of an instrument as part of the Europa Clipper mission.

The nine Europa Clipper Mission science instruments can be classified into five remote sensing techniques and five in situ techniques:

1. Europa-Ultraviolet Spectrograph (Europa-UVS), PI Kurt Retherford, SwRI, San Antonio;
2. Europa Imaging System (EIS), PI Elizabeth Turtle, JHU/APL;
3. Mapping Imaging Spectrometer for Europa (MISE), PI Diana Blaney, JPL;
4. Europa-Thermal Emission Imaging System (E-THEMIS), PI Phillip Christensen, Arizona State University, Tempe;
5. Radar for Europa Assessment and Sounding: Ocean to Near-surface (REASON), PI Donald Blankenship, Univ. of Texas, Austin;
6. Interior Characterization of Europa using Magnetometry (ICEMAG), PI Carol Raymond, JPL;
7. Plasma Instrument for Magnetic Sounding (PIMS), PI Joseph Westlake, JHU/APL;
8. Mass Spectrometer for Planetary Exploration/Europa (MASPEX), PI Jack Hunter Waite, SwRI, San Antonio;
9. Surface Dust Analyzer (SUDA), PI Sascha Kempf, Univ. of Colorado, Boulder.

Additionally, Gravity Science will be performed with Doppler tracking using the telecommunication system to investigate ocean and ice shell properties. Moreover, Radiation Science will be possible using the radiation monitor, an engineering subsystem.

Investigation Scientists (IS): Each Science Investigation has one or more IS(s) who serve as a science liaison between the Investigation PI and other elements of the project.

Thematic Working Groups and Focus Groups: Implementation of the Europa Clipper science is supported by a set of Thematic Working Groups (TWGs) that are designed to provide a high-level, cross-instrument and cross discipline, objective-driven science perspective. This aids in ensuring that the goal and objectives of the mission are met, and that the highest quality integrated science is achieved, thereby maximizing its scientific impact. Associated Focus Groups address key science topics related to each TWG.

Shown in Figure 1 is the interaction structure of the Europa Clipper TWGs and focus Groups (fGs). The Habitability Working Group (WG) cross-cuts the

other WGs as it strives to maximize how the mission science capabilities address the overarching mission goal of investigating Europa's habitability. Recent efforts by this WG include considering combinations of measurements that create synergies which may not be captured as mission requirements.

The activities of the other three TWGs are as follows: The Interior WG coordinates investigations into the geophysical structure of Europa from the rocky interior, through the ocean to the ice shell. Recent efforts include refining details of collaborative data coverage for determining interior structure from magnetic sounding; radar studies supported by imaging data; and tidal deformation. The charge of the Composition WG is to provide evaluation and recommendations to the Europa Clipper Science Team regarding priorities relative to compositional objectives, bringing a multidisciplinary perspective to understanding surface and exospheric materials and their link to the subsurface and ocean. Most recently, the Composition WG has been focusing on assessing the level of coordination required to ensure that observations made by the various instruments can be integrated so as to address key composition science objectives. The associated Radiation fG is considering the science implications of the radiation dose at different locations on Europa's surface. The charge of the Geology WG is to ensure and coordinate cross-instrument science activities to understand the array of Europa's geologic processes. Recent work has included assessing the capabilities of software necessary to enable data sharing as well as planning observations and visualizing obtained and planned data sets. The associated Reconnaissance fG considers strategies for characterization of potential landing regions, concentrating on engineering considerations that could feed forward into a future landing site selection process involving the broader scientific community, for a future landed mission.

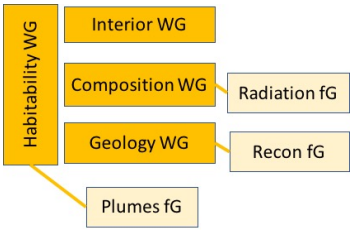

Figure 1. Interaction structure of the Working Group (WG) and focus Groups (fG) of the Europa Clipper mission

One Team: To summarize the Europa Clipper science team philosophy: Each of the nine Europa Clipper instruments will investigate Europa and its environs, each finding critical clues about how Europa works as a planetary body. In combining and assessing the details, limitations, and datasets from each instrument's experiments, we can collectively gain clarity into the mysteries of Europa. To achieve our mission's goal of exploring Europa to understand its habitability, we are compelled to step beyond the comfort zone of our own scientific discipline, to celebrate and engage the expertise of our colleagues. As is often true in science, it is at the overlapping boundaries of our sub-fields that the greatest insights and discoveries will be made.

Integrated science is promoted by visibility across the science team. Visibility includes understanding each other's processes, techniques, data sets, analyses, caveats, and results. Integration and its associated visibility also provide holistic solutions to problems that could arise. For example, if in the future some Europa Clipper investigation is at risk of not achieving its contribution to a science objective, then informed representatives of other instruments will be more readily motivated to offer resources to ensure success for the at-risk technique's contribution to the greater whole. Our Europa Clipper Science Team's Rules of the Road codify such visibility and integration, for example through the sharing of collaborative data among all of the science team members and by calling for coordination of manuscripts in preparation. These rules are meant as a common covenant—an ethos shared among partners in exploration.

Integrated science celebrates our individual expertise, challenges our assumptions, breaks through our limitations, and expands our intellectual boundaries. Associated visibility brings trust, promotes partnerships, and enhances personal relationships. These aspirations are the inherent basis for functioning as one science team. Toward our ultimate goal of exploring Europa, "it's all about the journey," so we strive to make it a great one, for the good of our science and our mission.