ICY SATELLITES IMPACTOR PROBES FOR THE JOVIAN ICY MOONS ORBITER. J. H. Shirley[1], W. F. Zimmerman[1], W. Strauss[1], R. Ivlev[1], T. Duong[1], D. Hunter[1], E. Slimko[1], F. Nacaise[1], E. Archer[1], B. Nesmith[1], and A. Behar[1], [1]California Institute of Technology, Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena CA 91109. (Email: jshirley@jpl.nasa.gov).

Introduction: We present a preliminary design and mission description for Icy Satellites Impactor Probes (IPs). This design addresses two of the scientific themes of this Icy Galilean Satellites Forum: Surface Chemistry and Geophysics, and Interior Structures. Impactor probes may also make significant contributions in the areas of surface geology and mineralogy.

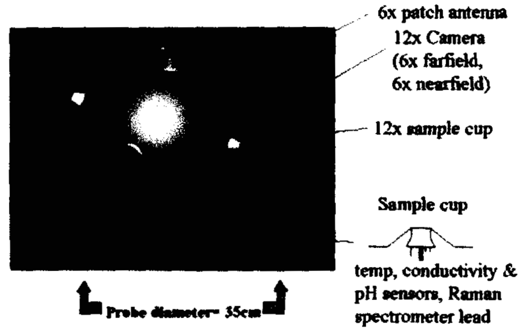
Scientific Objectives: One of the outstanding scientific open questions involving Europa is the composition of the ubiquitous hydrated, non-ice surface materials. Are these mainly sulfate salts derived from brines [1], or are they dominantly hydrated sulfuric acid, produced by a radiolytically-driven sulfur cycle [2]? In-situ observations can distinguish between these possibilities though pH measurments. The IP design presented here will passively capture samples for analysis during impact.

A second pressing issue involves the (evidently ongoing) cryo-tectonism of Europa's ice shell. There are a number of mechanisms that could produce fracturing of the icy crust [3]. One or more miniature passive seismometers placed on the surface could detect the seismic energy released in fracturing. More importantly, a passive seismic experiment on Europa would also provide independent evidence of the thickness of the ice shell and the presence or absence of a subsurface ocean [4]. Thus we include a seismometer in our IP instrument package.

The surface mineralogy of the Jovian icy satellites is a subject with more questions than answers in the post-Galileo era. We include a miniature Raman spectrometer with viewports and fiber-optic leads for sample excitation and spectroscopic data collection.

Mission Description: The IP package would separate from the JIMO orbiter at 100 km altitude, and would employ retropropulsion engines to cancel the ~1-2 km s^{-1} orbital velocity relative to the target surface. A stop and drop manuever at 1-2 km altitude would result in impact velocities of ~ 80 km s^{-1} for the 15 kg spherical probe. The impact site would be visible to the orbiter for a short period of time following impact. A crater of 0.1-0.4 m depth would be formed; if impact occurs on a slope, ejection of the probe from the crater may occur. Once at rest, the probe will determine its own orientation, and begin investigations. Battery life is estimated to be ~ 2-3 orbital periods of Europa. Three alternative scenarios deserve mention. One would be to drop a single IP at Europa. Another choice would be to deploy 3 probes, one at each moon. Lastly, we might also consider dropping 3 at Europa, for a more detailed seismic characterization of that body.

Jovian Moon Impactor External Configuration



Probe Instruments and Design: In addition to the seismometer and Raman spectrometer, the IP package includes a simple imaging system with multiple ports. Conductivity and temperature sensors are included along with the pH sensor within the sample capture cups (conceptual design shown).

The IP communicates with the Orbiter via patch antennas distributed over the surface. The shell provides radiation shielding. The total mass (including propulsion) is ~ 60 kg per probe.

Summary: This design offers a considerable science return at a moderate cost, with relatively low development risk. It has a significant heritage from DS-2 and other studies, and may find application in later missions to other targets.

References: [1] McCord T. B. et al. (1999) *JGR, 104,* 11827–11851. [2] Carlson R. W. et al. (1999) *Science., 286,* 97-99. [3] Hoppa G. V. et al. (1990) *Science,285,* 1899–1902. [4] Kovach R. L. and Chyba C. F. (2001) *Icarus 150,* 279-287.

Additional Information: This design effort was commissioned as part of the On-Orbit Assembly Fission Option study (H. Price, Team Leader) performed for the NASA Nuclear Science Initiative Jovian Icy Moons Tour investigations (led by G. Burdick and E. Nilson).