SAMPLING MECHANISMS FOR ASTEROID SAMPLE RETURN MISSIONS AND THE HERA SURFACE SAMPLER. S. Gorevan[1], S. Rafeek[1], S. Stroescu[1], P. Bartlett[1], and D. W. G. Sears[2], [1]Honeybee Robotics, Inc., New York, NY 10012, USA (gorevan@hbrobotics.com), [2]Cosmochemistry Group, Department of Chemistry, University of Arkansas, Fayetteville AR 72701, USA (dsears@comp.uark.edu).

A mission to return samples from a Near-Earth Asteroid is the logical next step in the scientific investigation of asteroids, comets and meteorites. It is advocated in numerous advisory reports and in NASA's Space Science Strategic Plan and Roadmap. The successful test of Solar Electric Propulsion by Deep Space 1 mission, the successful maneuvers of Shoemaker NEAR in the vicinity of Eros, and the extraordinary increase in the rate of discovery of NEA, mean that a mission is now technically feasible. One of the new technologies required will be the sample collection device, and here we review past methods and describe a new method recently developed for a multiple Near-Earth Asteroid sample return mission called Hera.

To date, the Moon is the only extraterrestrial body that has been sampled by missions. The Apollo spacecraft was manned so most samples were collected by hand, although rake, drill core and drive tube samples were also obtained. The Luna missions used a small drill head attached to the end of a boom arm to collect samples from up to 2 m in depth. The cancelled Mars sample return missions used minicorers and grab sampling. The Muses C mission involves a lander which fires a projectile and collects the ejecta. Genesis uses passive collectors for solar particles and Stardust uses aerogel to slow and capture interplanetary and comet dust.

Methods potentially available for sample collections from comets and asteroids are percussion methods, trowel/claws, microrovers, trawlers, drillers/corers, penetrators, and scoops. Most of these methods require landing and anchoring, and involve considerable risk to the spacecraft. They also present major challenges in communication. The Hera surface sampler (HSS) avoids most of these difficulties by not landing. Instead, it dips momentarily to the surface, collects about 300 g of material, then returns to altitude before moving to another site.

The HSS consists of two or three pairs of cutting heads located on a flexible boom that can be deployed >1.5 meters below the spacecraft. The cutting heads counter rotate at high speeds (>3000 rpm) and upon contact with the surface, small fragments are thrown up into a temporary storage chamber behind the cutting heads. Up to 200 mL of sample may be captured with a 1 to 2 second encounter with the surface.

The cutting head assembly is about 75 mm across and temporary storage chamber is about 125 mm high. The HSS drive assembly consists of a high-speed motor coupled to a split differential where power is transferred to the counter rotating sampling bits. A flex-sleeve provides contact load between the rotating bits and the surface and also flexes to compensate for variations in spacecraft height during the "touch-and-go" surface contact maneuver. The counter rotating bits provide opposing cutting forces that keep the HSS at a fixed location.

The cutting head and temporary sample storage chamber is retracted back to the spacecraft through a cutout on a rotary table. The rotary table carries 3 sample return canisters with hermitic seals. With the cutting head/sample storage chamber fully retracted, a sample return container is indexed into a position under the cutting head/sample storage chamber. The cutting head/sample storage chamber is indexed down to mate with the return canister and the cutting head motion is reversed. This action along with a sample transfer auger inside the temporary sample chamber positively transfers the sample from the cutting head/sample storage chamber into the sample return canisters.

It is planned that the Hera spacecraft will have two such collectors and that at least nine samples will be collected from three asteroids.

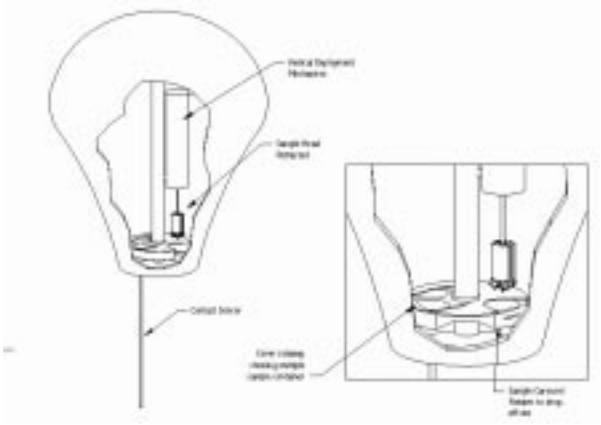

Diagram of the Hera surface sampler showing the sampler head (in the retracted position) and the sampler carousel with its multiple containers. When the sensor locates the surface, the sample head extends through the carousel to the surface.