HERACLES – The exploration of the Moon including sample return mission

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Inspired by the Global Exploration Roadmap (GER), the HERACLES (Human-Enhanced Robotic Architecture and Capability for Lunar Exploration and Science) is designed to demonstrate key elements and capabilities for sustainable human exploration of the Moon while maximizing opportunities for unprecedented scientific knowledge gain. To enable human lunar exploration, which is one of the four cornerstones of the European Exploration Envelope Program, it is planned to launch a sub-scale demonstration mission in the mid-2020's timeframe to test key components of lunar vehicles, including a lander, rover and ascent vehicle. European Space Agency (ESA) will coordinate and undertake the study of the ascent module, Japan Aerospace Exploration Agency (JAXA) will study the lander, and the Canadian Space Agency (CSA) will investigate the rover element. In parallel, we are developing surface operational scenarios that reflect the input from the international lunar science community. This will include the selection and characterization of a potential landing site with a large scientific potential and return of lunar samples of high scientific value before conducting a long distance traverse that will provide further opportunities for in-situ science and exploration. The coordination of the planning of science opportunities is performed by the multi-agency HERACLES Science Working Group (SWG). This working group is also responsible for developing a mission science management plan to describe science team and science payload selection processes, and data and sample policies. In the next steps, we will engage the science communities of the study agencies and install an international HERACLES Science Definition Team (iSDT). The iSDT will generate a prioritized list of investigations and will provide input for the landing site selection. In the initial phase of mission planning, the HERACLES study team has developed a nominal scenario with Schrödinger basin as the reference landing site with the purpose of driving engineering requirements. On the basis of studies by the Lunar Planetary Science Institute in 2015 and preliminary studies by the HERACLES team, Schrödinger basin might be a potential landing site that could satisfy may science objectives although other sites may also be considered. The iSDT will provide the report on candidate landing sites in mid-December 2018.

The current mission planning foresees a 70-day surface sample return mission, followed by a 1-year traverse encompassing one or more additional potential human exploration landing sites. We plan to return maximum of 15 kg of samples. A possible mission scenario to accomplish these objectives is shown in Fig. 1. The first HERACLES mission starts with the launch of a mid-sized launch vehicle (baseline Ariane 64) to lunar transfer orbit (LTO). The lunar descent element (LDE) will performs the landing to the lunar surface carrying the Lunar Ascent Element (LAE) and the rover. It is assumed that the landing is to occur during daylight conditions. On the surface, the rover egresses the LDE and starts the surface campaign. Initial exploration of the surface by the rover is supported by ground control and time-tagged commanding until the crew arrives on the Lunar Orbital Platform-Gateway (LOP-G). Once the crew is present, the crew-supported surface mobility operations will start. The rover then is commanded to drive, to perform sample collection and to transfer the sample container to the LAE. The sample collection phase can take multiple lunar day-night cycles and ends with the deposition of the samples into the LAE. The LAE will ascends from the surface, and initiates the transfer to the LOP-G. The sample container will be removed from the LAE by the LOP-G robotic arm. HERACLES's rover remains functional on the surface and is driven by ground-control along the planned traverse to demonstrate long-life, long-range surface mobility and exploration activities (in-situ investigations and sampling).

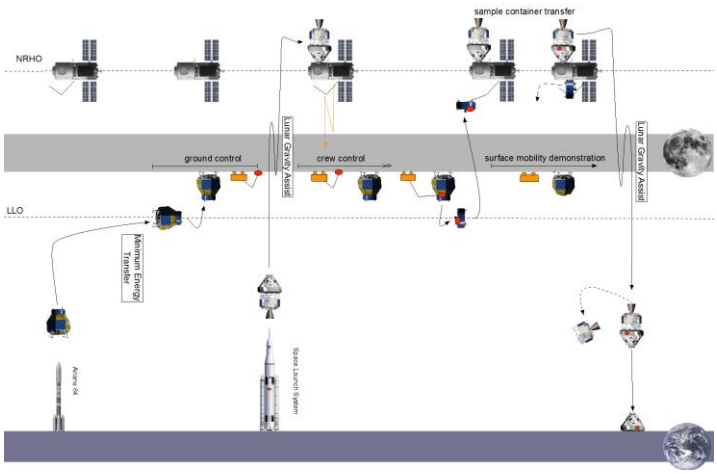

Figure 1. Baseline Mission Operations Scenario (left to right).