In 2016 NASA decided to invest in the long-term exploitation of the Moon both for commercial and scientific reasons [1]. This decision led to the definition of the Artemis III mission's strategy. Its goal is to bring a human crew of two astronauts to the Moon's South Pole surface to execute scientific experiments. Multiple walking excursions, collection of lunar samples, use of sophisticated portable instruments are just a few examples of the possible astronauts' operations [1].

Focusing on goals n. 6 and 7 of the macro strategical objectives of the mission [2]:

1. The study of planetary processes
2. Understanding volatile cycles
3. Interpreting the impact history of the Earth-Moon system
4. Revealing the record of the ancient Sun
5. Observing the universe from a unique location
6. Conducting experimental science in the lunar environment
7. Investigating and mitigating exploration risks to humans

We advance a hypothesis of the scientific goals accomplishable by the astronauts to fulfil the selected objectives. The idea is to optimize mission efficiency by a "cobotic" approach, i.e. through the copresence and collaboration of both robotic and human activities. Specific robots and instrumentation should execute sample analysis, particularly in the permanent shadow regions of the South Pole, and collect material samples to bring back to earth, while astronauts, who will represent the human kind coming back to the Moon for the first time in the 21st century, should test the exploration of new areas with a possibly harsh environment. The main challenge is related to the environmental conditions that astronauts will encounter in the pole, especially in terms of temperature, pressure and light [3]. The idea is to make an evaluation of how humans can adapt to such conditions and try to maximize the efficiency of their operations thanks to the collaboration with robotic instrumentation.

Following this reasoning, one of the most promising concepts to explore would be the opportunity to set up in the future a Space mining facility to exploit lunar resources, as building up a factory on the Moon's surface is technologically feasible [4]. In a futuristic vision, the factory might be the supplier of propellant to refurbish Space vehicles stopping on the Moon as a gateway to outer Space. An example of resources could be water from ice reserves, oxygen by lunar regolith, and hydrogen. Adding to that, the so-called KREEP (Potassium Rare-Earth elements and Potassium and Phosphorous containing material) and volatile species could be of interest for pure scientific purposes [5].

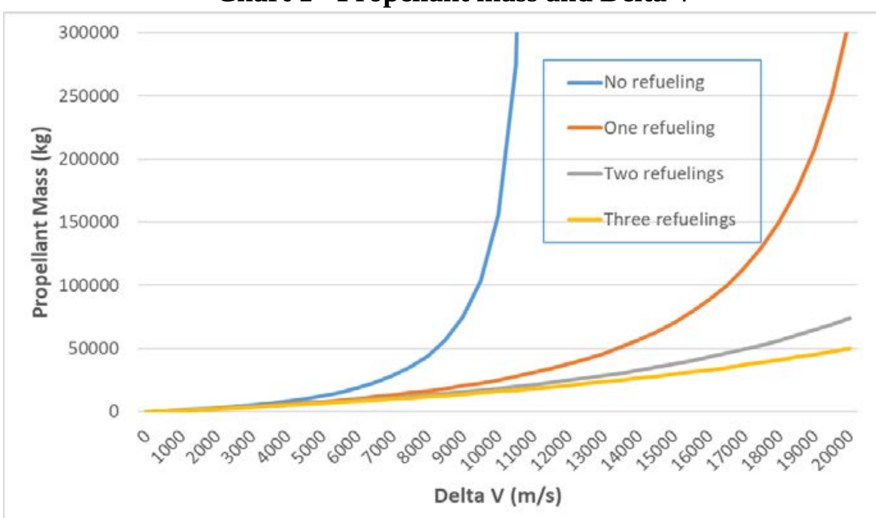
Trying to build on this vision, a few operations could be made by the crew during Artemis III mission to accomplish two of the most critical needs to assess the feasibility of such opportunity: bringing evidences of materials collected, and demonstrating adequate mining and recovery technological application. A few examples of the specific activities of the mining robots could be:

- Fast detection, inventory and monitoring of Moon's ices in remote areas using a microwave radiometer;
- Testing of drilling mechanisms to excavate and collect gas, liquid and solid lunar samples;

- Testing of sensors communicating with astronauts' suits by an IoT network to constantly monitor environmental parameters in extreme conditions.

A potential demand for propellant in space exists already. Counting the number of planned missions, both manned and unmanned allows the estimation of this potential demand. As NASA and international partners embark on the journey to Mars and beyond, refueling and stocking vehicles at a cislunar refueling point will be paramount in creating a feasible and sustainable exploration program (Chart 1). Low Earth orbit (LEO) can be also a destination for propellant to refuel the upper stage of rockets directed in geosynchronous orbit or to the Moon. Economic feasibility of this concept was proven in the case of a shared private-public model of investment, whereby governments complete a prospecting mission and private companies invest in mining operations, using the Net Present Value (NPV) methodology and calculating the Internal Rate of Return (IRR), with a Montecarlo simulation to mitigate the uncertainty on results. This analysis gave a yearly 6% return on investment for the governmental entities and a much higher impact for the entire society. [4]

Chart 1 - Propellant mass and Delta-v[1]



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[1] In astrodynamics and aerospace, a delta-v budget is an estimate of the total delta-v required for a space mission. Delta-v is a scalar quantity dependent only on the desired trajectory and not on the mass of the space vehicle. As input to the Tsiolkovsky rocket equation, it determines the required propellant for a vehicle of given mass and propulsion system.