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Stepping Stones

Exploring a series of increasingly challenging destinations on the way to Mars...

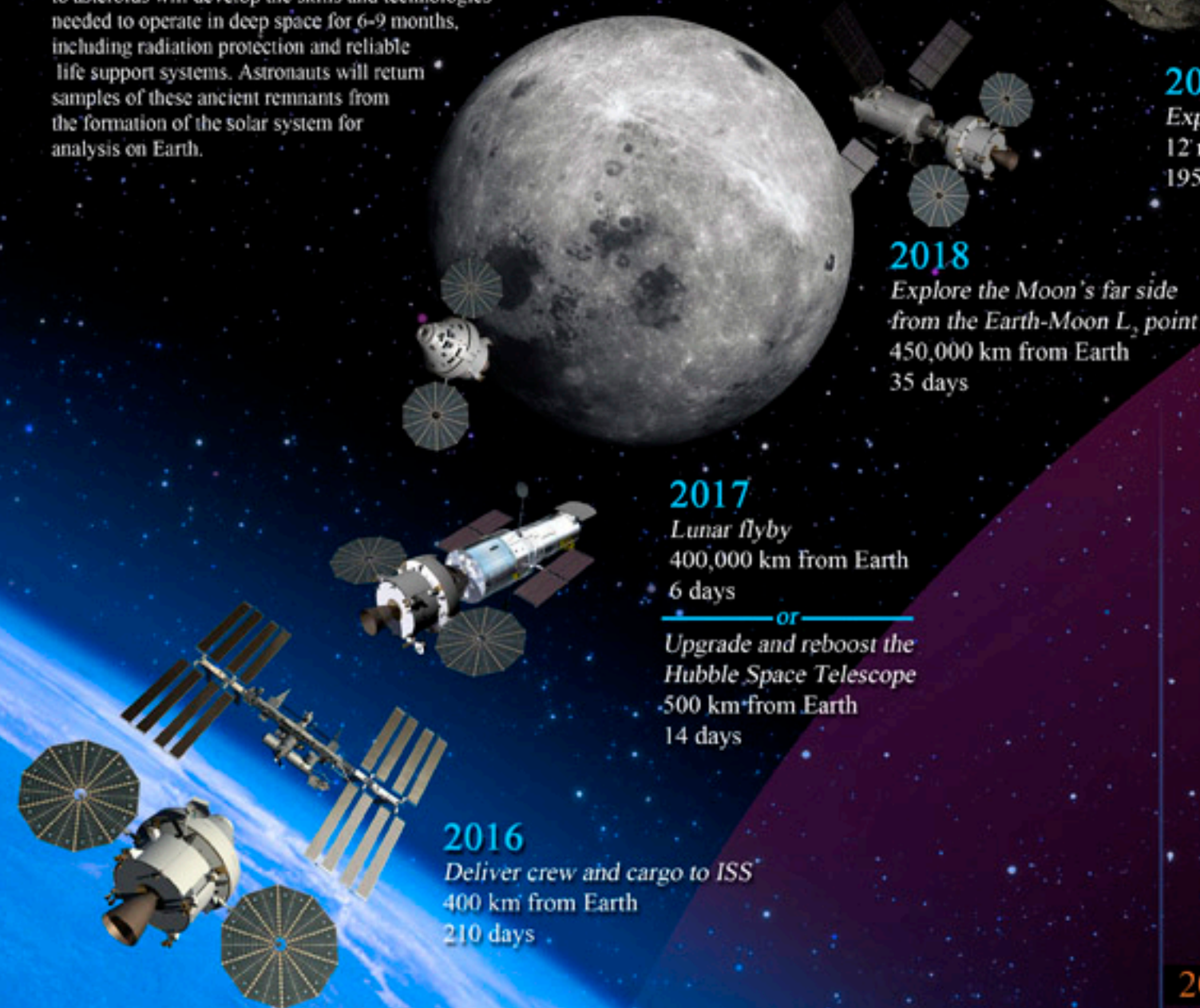


Human Exploration Stepping Stones

The Stepping Stones plan for human space exploration is a series of increasingly challenging exploration missions which begins with initial flights to the International Space Station using today's launch vehicles and Orion spacecraft and builds incrementally towards America's long term goal of exploring Mars. Each mission will develop technologies and demonstrate new capabilities which enable subsequent missions to push farther into space and explore for longer durations. Step by step, at a sustained tempo, astronauts will push beyond Low Earth Orbit to the Moon, and then to distant asteroids, and finally to the moons of Mars. At each destination astronauts will address key science objectives relating to the formation of the solar system and the origins of life.

Early flights to the International Space Station will demonstrate Orion's basic functions and provide crew and cargo transportation capability to support ISS. Month-long missions to the L2 point beyond the Moon will allow astronauts to remotely operate robots on the lunar farside to return samples from one of the deepest and oldest craters in the solar system, and to set up a radio telescope array which can detect faint signals from the Big Bang. The farside mission proves Orion's capability to operate beyond Low Earth Orbit and perform high-speed reentry before attempting an asteroid mission. It also develops a capability for astronauts to perform orbital teleoperations of surface robots which will be used later in Mars orbit.

Next, a set of progressively more challenging Plymouth Rock missions to asteroids will develop the skills and technologies needed to operate in deep space for 6-9 months, including radiation protection and reliable life support systems. Astronauts will return samples of these ancient remnants from the formation of the solar system for analysis on Earth.



2018
Explore the Moon's far side
from the Earth-Moon L₂ point
450,000 km from Earth
35 days



2019
Explore asteroid 2008 EA9
12 million km from Earth
195 days



2023
Artificial gravity testbed
180 days
Low Earth Orbit

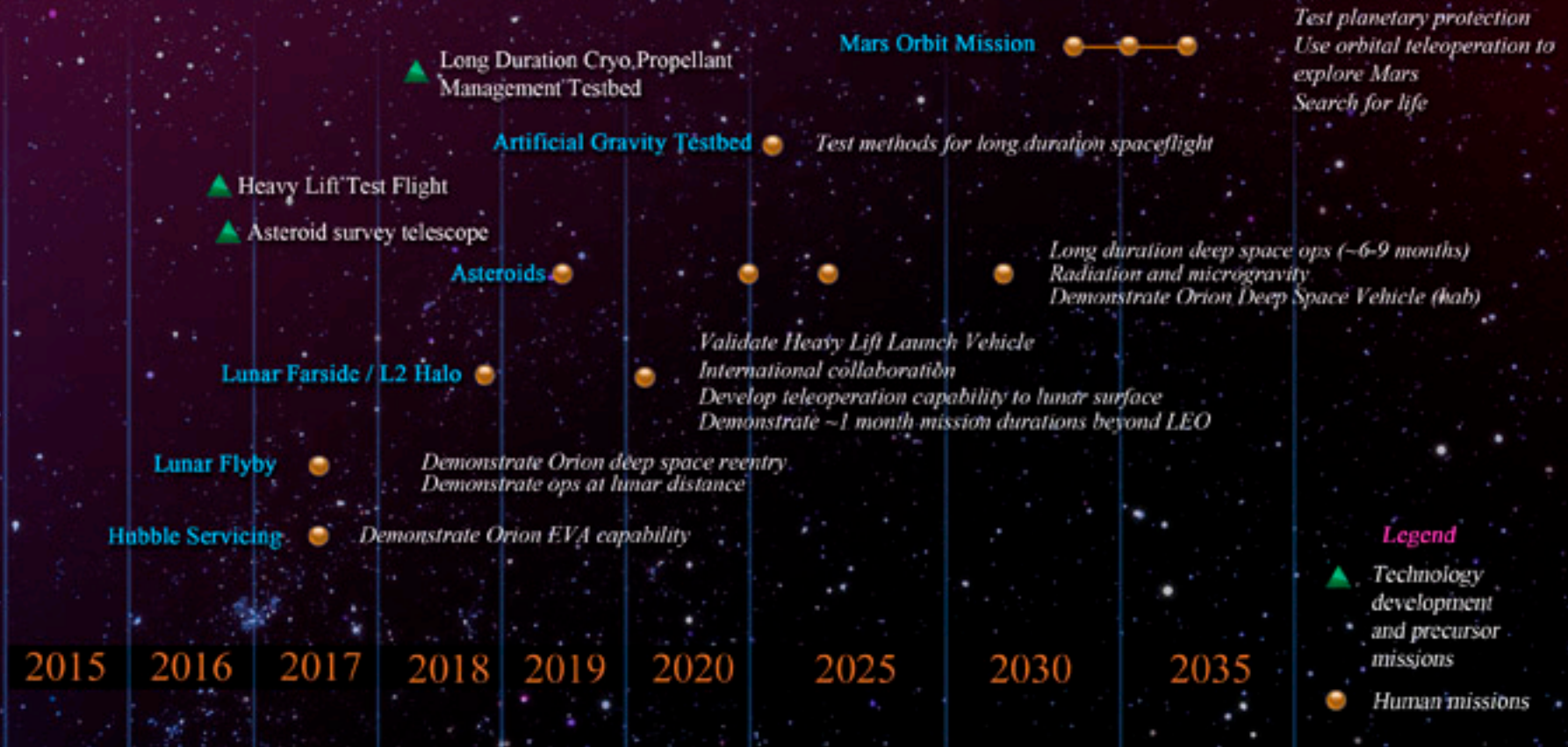


2029
Explore asteroid 2000 SG344
150 days
8 million km from Earth



2031-2035
Explore Deimos
in Mars orbit
900 days

In the mid 2030's astronauts can take advantage of a rare opportunity to more easily visit the moons of Mars. The lowest delta-V mission opportunities in the 15-year Earth/Mars orbital mechanics cycle will coincide with the phase in the 11 year solar activity cycle when the Sun provides the most protection from galactic cosmic rays. Using the capabilities for telerobotic operation and long duration deep space exploration pioneered by the Lunar Farside and asteroid missions, astronauts can visit Deimos and control rovers on the Martian surface to collect samples from locations of possible biological interest. Sending the first astronauts to Mars orbit rather than to the surface avoids the need for a variety of difficult technologies such as advanced propulsion, atmospheric entry and landing, and biological containment.



Test planetary protection
Use orbital teleoperation to
explore Mars
Search for life

Mars Orbit Mission
Test methods for long duration spaceflight

Long duration deep space ops (~6-9 months)
Radiation and microgravity
Demonstrate Orion Deep Space Vehicle (hab)

Validate Heavy Lift Launch Vehicle
International collaboration
Develop teleoperation capability to lunar surface
Demonstrate ~1 month mission durations beyond LEO

Demonstrate Orion deep space reentry
Demonstrate ops at lunar distance

Demonstrate Orion EVA capability

Legend
▲ Technology development and precursor missions
● Human missions

...and returning safely to the Earth



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