Space Launch System Departure Trajectory Analysis for Cislunar and Deep-Space Exploration

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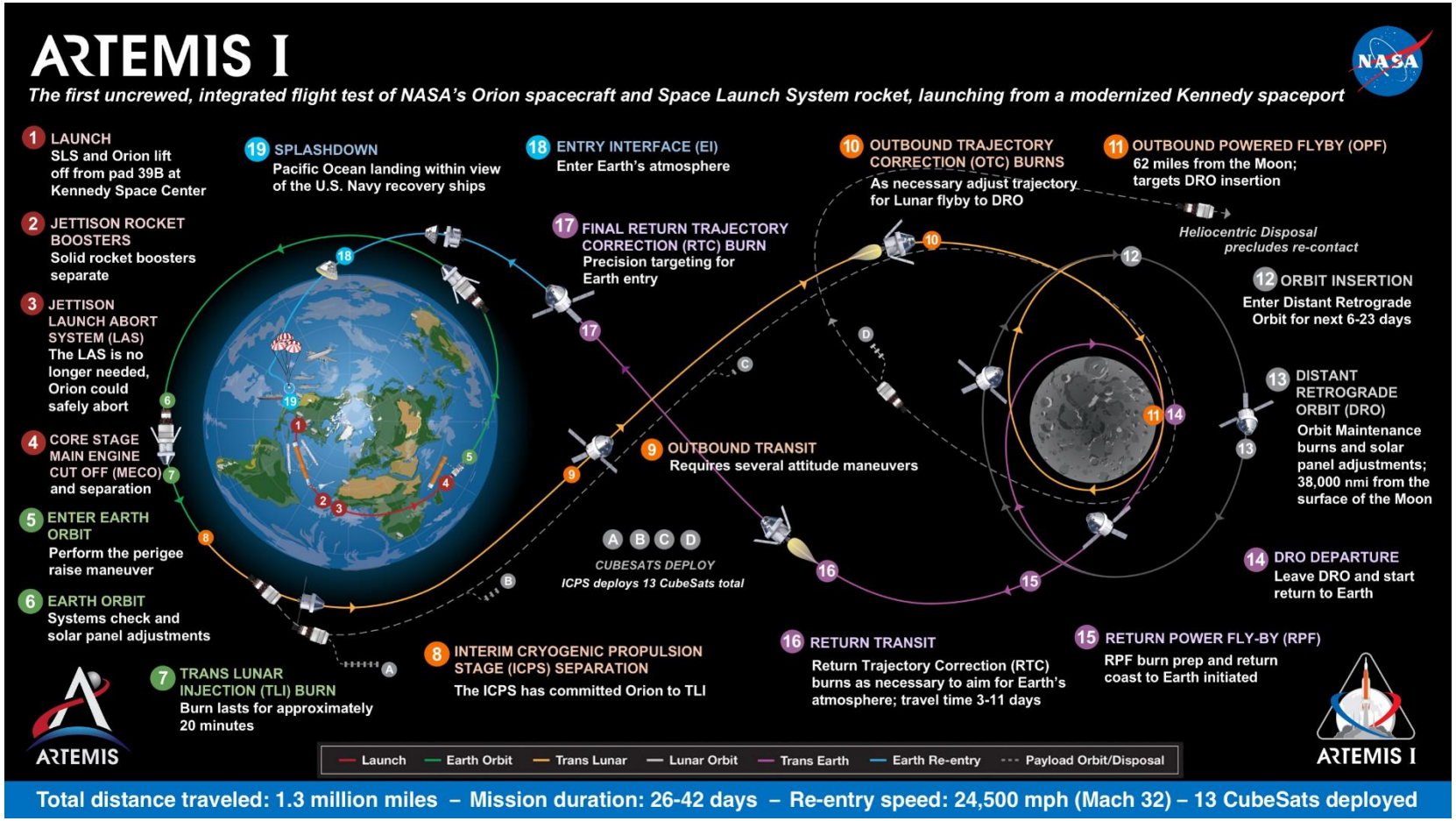
Introduction

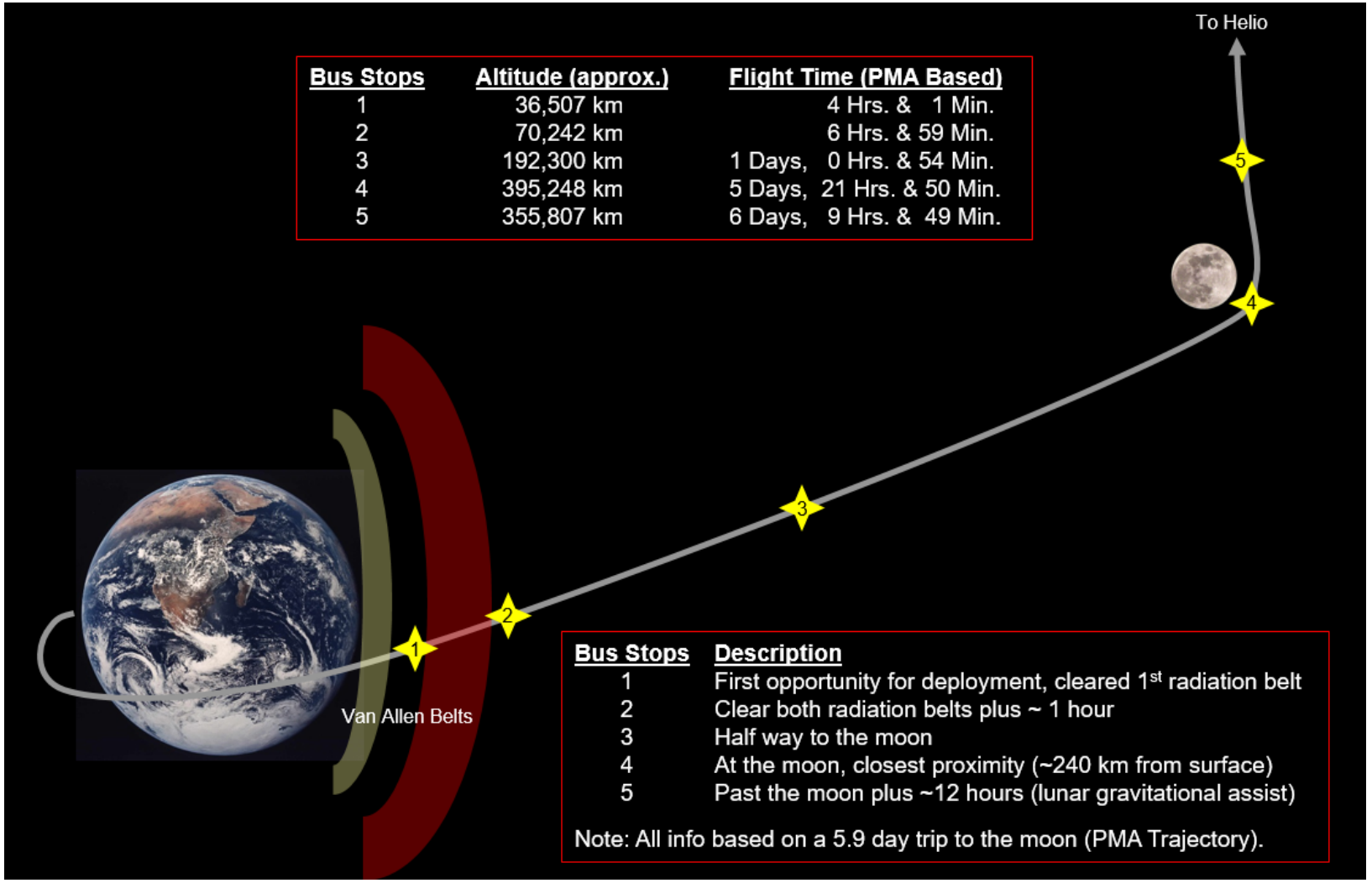
- There are secondary payload opportunities for Artemis I and Artemis II
  - 13 6U Cubesats will fly with Artemis I
  - TBD number of secondaries on Artemis II, 12U or 6U Cubesats
- Currently both missions call for heliocentric disposal of the ICPS
- Secondary insertion states for secondaries will be broadly similar
- Challenges and opportunities also similar

Artemis I Overview



Secondaries are deployed following ICPS disposal burn

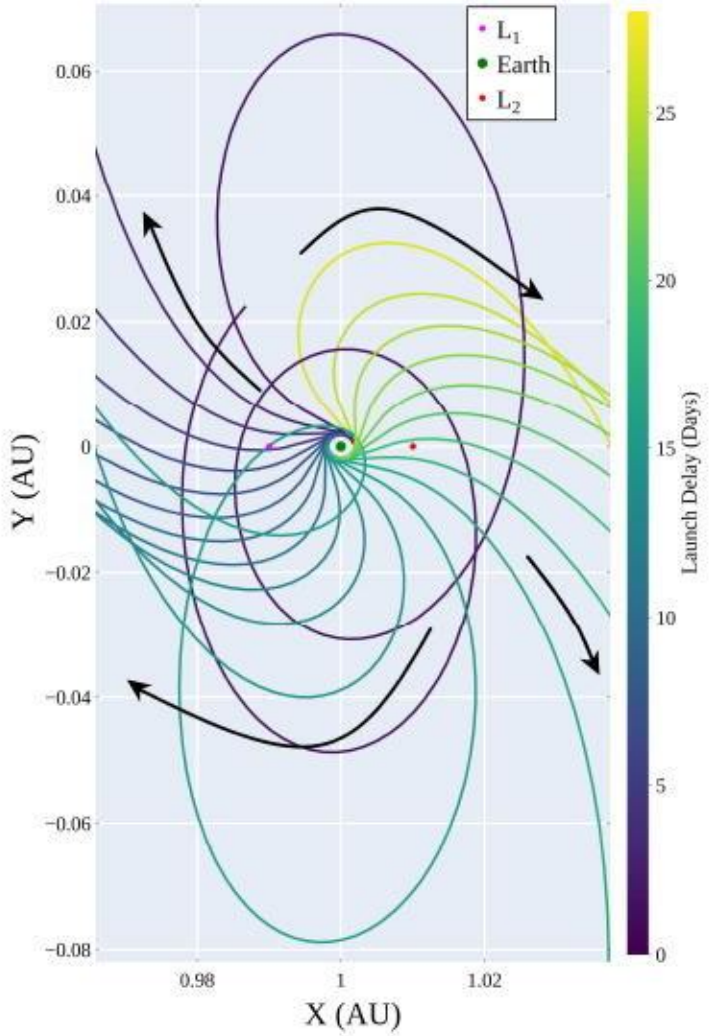
Artemis I “Bus Stops”



There are multiple opportunities for the secondaries to deploy from the spent ICPS upper stage

A key discriminator is prior to and after the lunar flyby, which is a Lunar Gravity Assist (LGA) to dispose of the ICPS

Artemis I Departure States



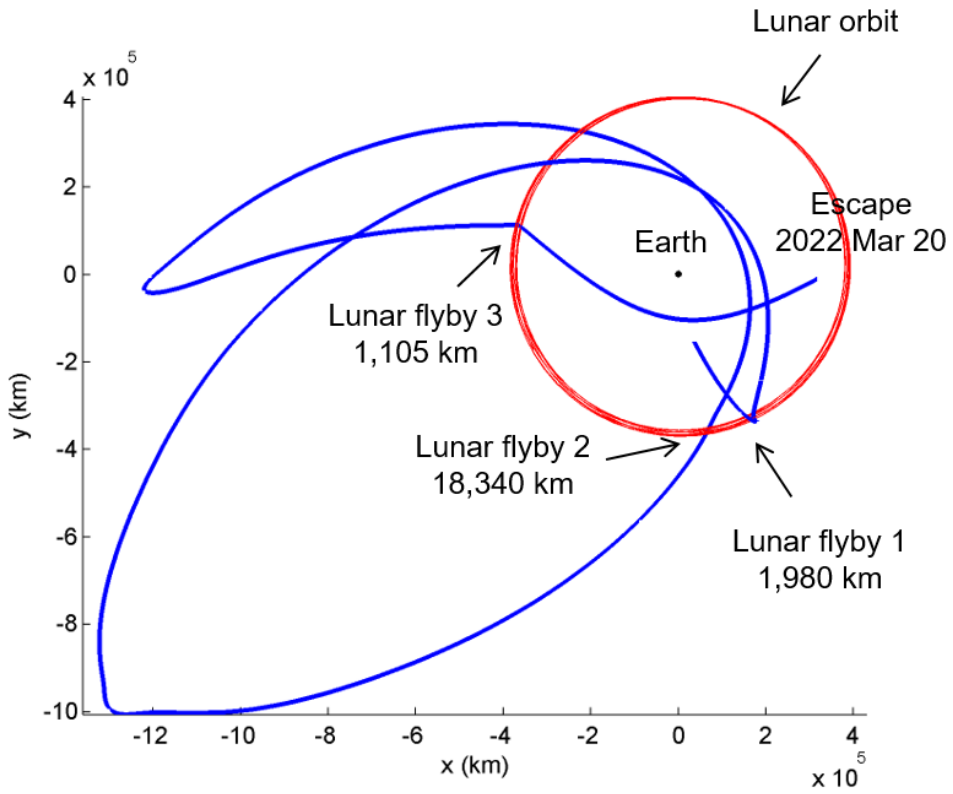
Artemis I targets Lunar Perigee

Lunar Perigee changes as a function of launch date/time

Depending on the time of month and year, departure direction can vary greatly

Thus the nature of the heliocentric orbit and orbit phasing vary greatly as a function of launch date

Secondary Opportunities on Artemis I

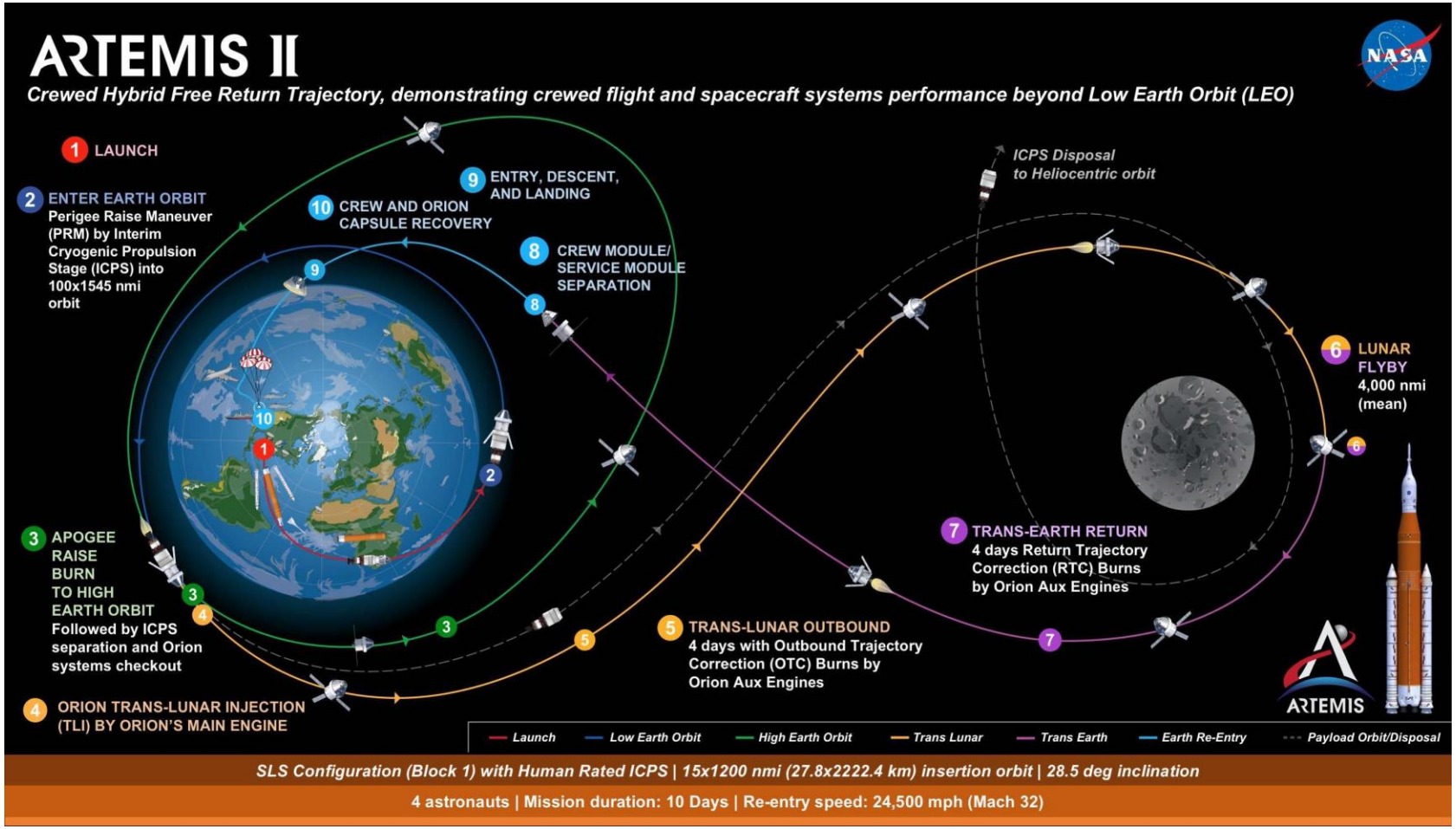


Opportunities are a strong function of secondary propulsive capability

Maneuvers can target lunar orbits or cislunar/deep space orbits

NEA Scout example: Does Delta-V prior to initial lunar flyby to target subsequent lunar flybys and achieve up to 1.5 km/sec escape velocity

Artemis II Overview

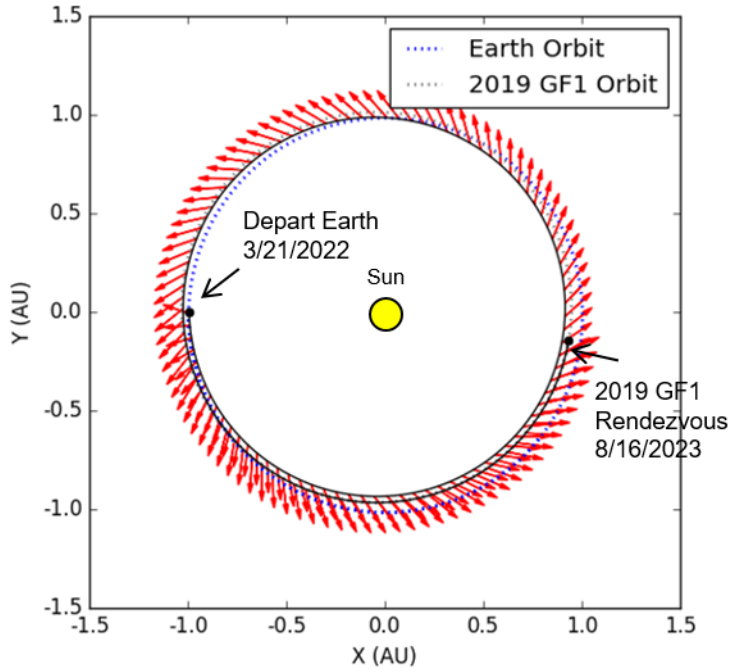


Secondaries are again deployed following ICPS disposal burn

Artemis II Opportunities

With less constrained mass (26 kg vs 14 kg and volume (12U vs 6U), Artemis II payloads can carry more Delta-V

Using these relaxed constraints to double the size of it's solar sail, NEA Scout could slash TOF from 563 days to 413 days



Another example is that a spacecraft with a "green prop" propulsion system could do a Mars flyby with the relaxed 12U constraints allowing a greater propellant mass

However Artemis II secondary payloads concept of operations is far less mature than for Artemis I, so ground rules and assumptions may change

Conclusions

Artemis I and II have secondary payload opportunities are both a strong function of:
- Artemis launch window
- propulsive capability of the payloads

A secondary payload targeting Earth escape will have better performance doing the Delta-V prior to the lunar flyby

With higher limits on mass and volume, Artemis II payloads can achieve more

Artemis II concept of operations for secondaries is still maturing