

AEGIS Propulsion Systems Integration

Alabama Experiment for Galactic-ray In-situ Shielding

PRC Presentation – 2/28/2020





Project Presentation - Goals

UNIVERSITY OF

6U CubeSat developed by 5 (7 in the future) Universities in Alabama sponsored by the ASGC

- Science Goals:
 - Measure the performance of lunar regolithbased shielding for reducing radiation.
 - Acquire data to use for validating shielding simulations.
- Educational Goals:
 - Students participate in the design and development of real aerospace system









Project Presentation – Launch Vehicle

Artemis-2

Perigee Raise Maneuver (PRM) by B Crew Module (CM) / STrans-Lunar Outbound: 4 days with Outbound Trajectory Interim Cryogenic Propulsion Stage Service Module (SM) separation Corrections (OTC) by Orion Aux Engines (ICPS) into 100x975 nmi orbit Entry and Landing Crew and Orion **Capsule Recovery** Lunar Fly-by 🛕 Trans-Earth Return: 4 days **Return Trajectory Corrections** (RTC) by Orion Aux Engines Apogee Raise Burn to 1 High Earth Orbit with ICPS Disposal 4-- 10 1 24 hour period for to Heliocentric orbit Systems Checkout Orion Trans-Lunar Injection followed by ICPS (TLI) by Orion Orbital Maneuvering System (OMS) separation from Orion Launch — Earth Orbit — High Earth Orbit — Trans Lunar — Trans Earth — Earth Re-Entry --- Payload Orbit/Disposa SLS Configuration (Block 1) with Human Rated ICPS | 22x975 nmi (40.7x1806 km) insertion orbit | 28.5 deg inclination 4 astronauts | Total distance traveled: 1,090,320 km - Mission duration: 9 Days - Re-entry speed: 24,500 mph (Mach 32)

Secondary Payload



6U Cubesat





Science Orbit Trade

Science Requirement

Science observational distance (from Earth): 400,000 km (+- 150k km)

Orbit Trade

- Lunar orbit
 - Cons → ~6months transfer. Complicated trajectory highly depending on initial vector and launch date
 - Pros \rightarrow Close to the moon, better science return (marginal)
- Cislunar Orbit:
 - Cons → Not close to the moon
 - Pros \rightarrow Stable, science mission can start sooner.

Decision: Cislunar Orbit

 \rightarrow Need to be able to impart 12 m/s ΔV before perilune









Trade Study

Thruster	Manufacturer	Туре	Volume, [m^3]	Thrust, [N]	Thruster Mass, [kg]	l _{sp} , max, [s]	Propellant Mass, [kg]	Power, [W]	TRL	
EPSS C1K	NanoAvionics	Green Propellant Thruster	0.001	0.1	0.8	200	0.92	1.9	9	
BGT-X5	Busek	Green Monopropellant	0.001	0.5	0.8	225	0.82	20	5	
MPS 130 Champs	Aerojet	Adaptable Modular High-Impulse Green	0.001	1.25	1.06	235	0.79	8	6	
1N HPGP	Bradford ECAPS	HPGP	0.00445	1.00	0.38	231	0.80	10	9	
Hydros-C	Tethers Unlimited, Inc.	Alternative (Green)	0.003321	1.2	1.87	310	0.60	20		Low Volume High AV
BIT-3	Busek	RF Ion	0.00161568	0.00124	1.5	2640	0.11	80	_ ı	hrust Vectorina
RITu-X	Airbus	Radio Frequency Ion	1.45E-03	0.0005	0.44	3000	0.10	50	5	/
BmP-220	Busek	Electric	3.10E-04	0.00002	0.5	536	0.54	7.5	9	
BIT-1	Busek	Inductively Coupled Plasma (ICP)	0.001	1.85E-04	0.053	1600	0.18	28	5	
Nano-FEEP (IFM-Nano)	Enpulsion	Field Emission Electric Propulsion	6.60E-04	0.0002	0.64	6000	0.05	25	6	





Current State

IFM Nano Thruster



- 145 g of fuel remaining for disposal, or future changes to the orbit maneuvers
- Thrust vectoring allows to drop RCS system for desaturation in pitch and yaw
- Risk: Due to the low thrust depending on the actual trajectory and bus stop availability for Artemis 2 this propulsion system might not be able to provide the required ΔV before perilune



AEGIS current Baseline Trajectory

Maneuver	ΔV [m/s]	Fuel [g]
Pre-Lunar Fly-by Burn	11.92	7.67
Apoapsis Lowering Burn	36.75	23.6
Reaction Wheels Desaturation	-	53
Current Margin	-	145.73





Questions?





Backup Figures





