

T-FINER THIN-FILM ISOTOPE NUCLEAR ENGINE ROCKET

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DRAPER



Northwestern University

BWXT
BW Technologies, Inc.

NIAC
NASA Innovative Advanced Concepts

Los Alamos
NATIONAL LABORATORY



YALE

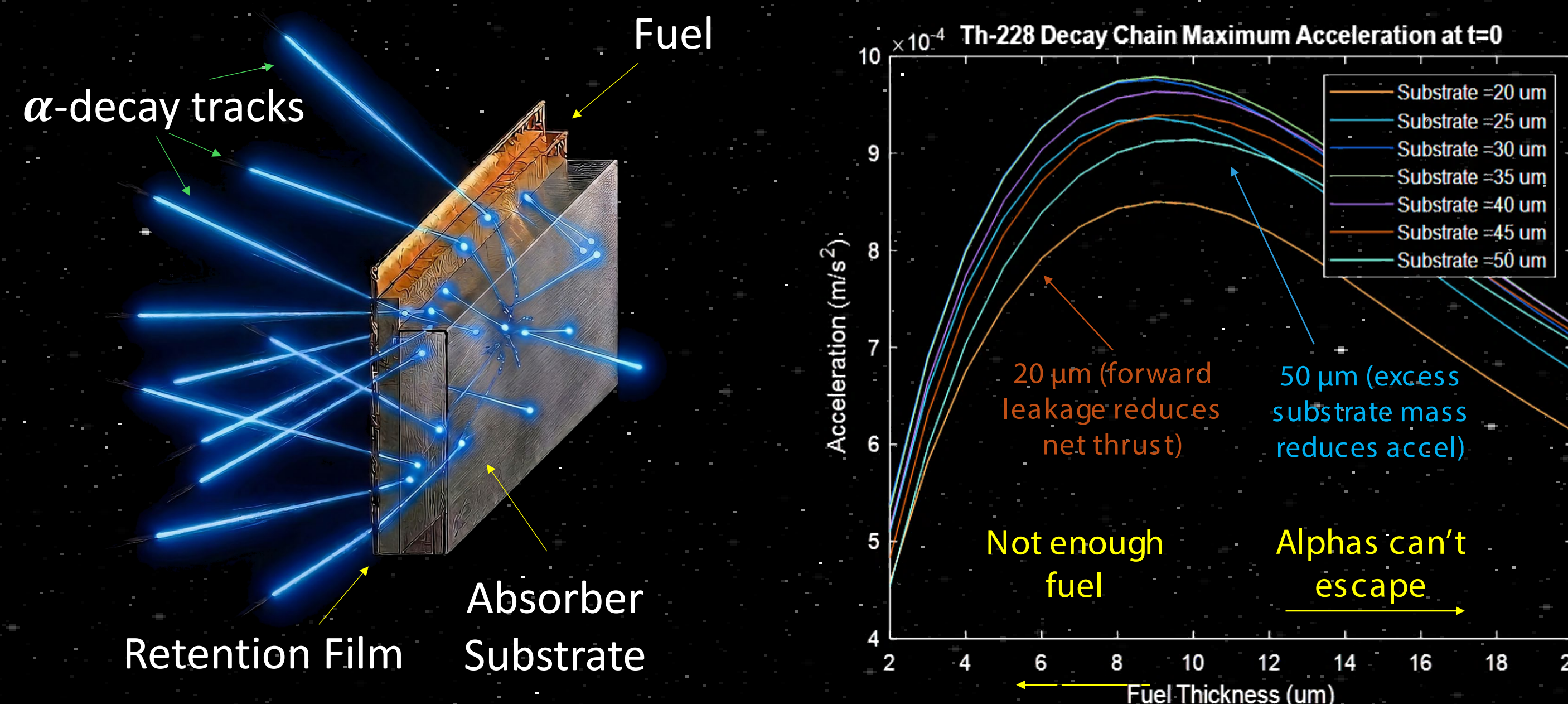


MSFC
Marshall Space Flight Center

Ansys
part of SYNOPSIS

ANSYS
GOVERNMENT
INITIATIVES

NUCLEAR THRUST SHEETS



Fuel Options and Performance Limits

Parameter	Unit	Cf-254	Po-210	Cm-242	Th-228	Ra-228	Ac-227	U-232
Nuclear Decay Half Life	Years	0.17	0.38	0.44	1.91	5.74	21.77	68.81
Number of Alpha Decays	#	0 (SF)	1	1	5	5	5	6
Total Decay Energy	MeV	185	5.41	6.22	32.58	32.58	33.34	37.99
Specific Impulse	sec	1.83M	1.64M	1.76M	1.78M	1.78M	1.79M	1.79M
Idealized Velocity Limit	km/sec	9926	301	288	1814	1617	1783	1906
Likely Velocity Limit (1 half life)	km/sec	323	10	12	64	64	65	75
Likely Velocity Limit (3 half lives)	km/sec	640	20	20	111	111	113	131
Nuclear Production Pathway	Source	Reactor	Reactor	Reactor	Accelerator	Accelerator	Accelerator	Reactor

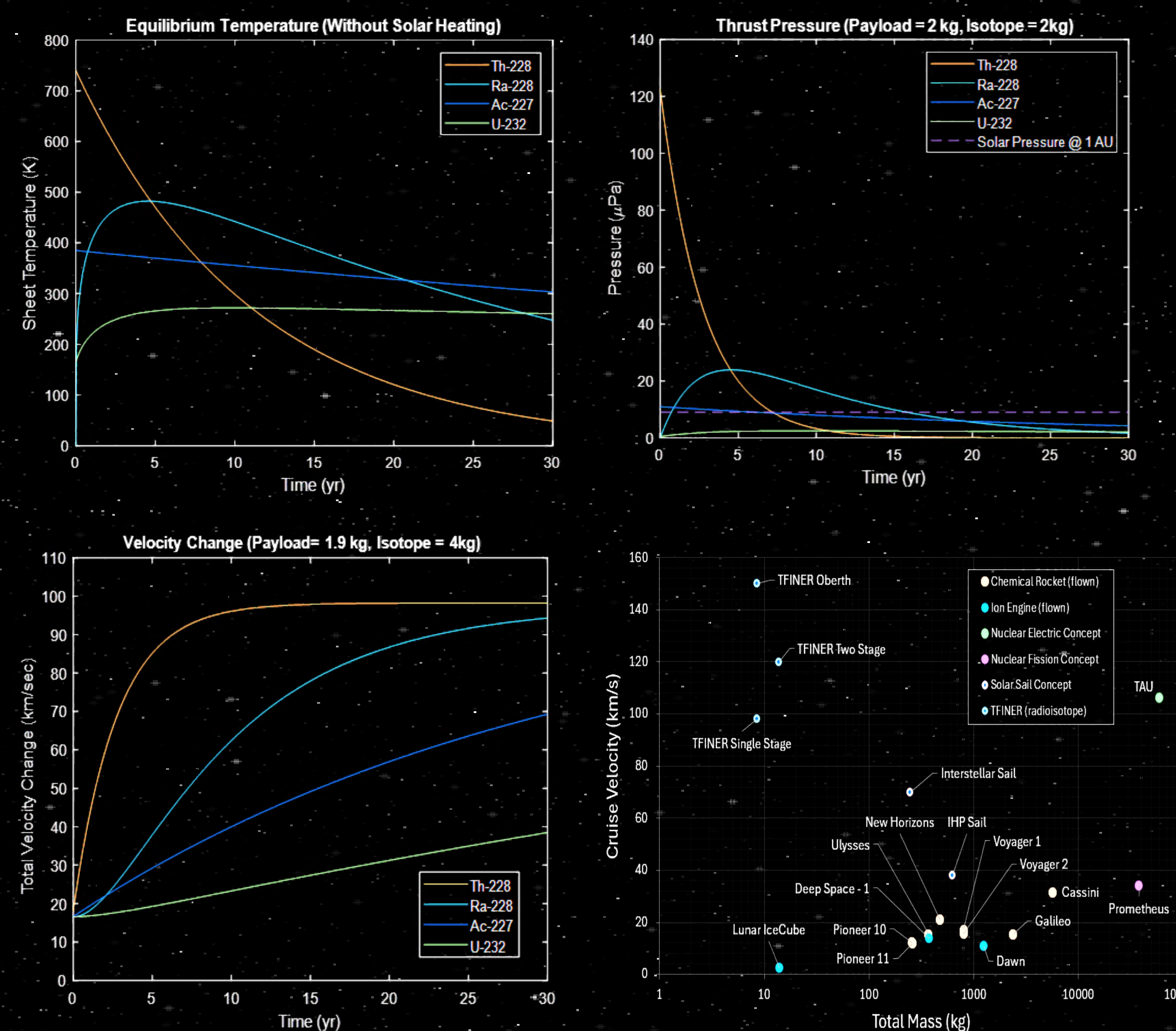
FUEL PRODUCTION AND FABRICATION

Estimated Fuel Production Energy Use (Ac-227): 325 MW-yr / kg

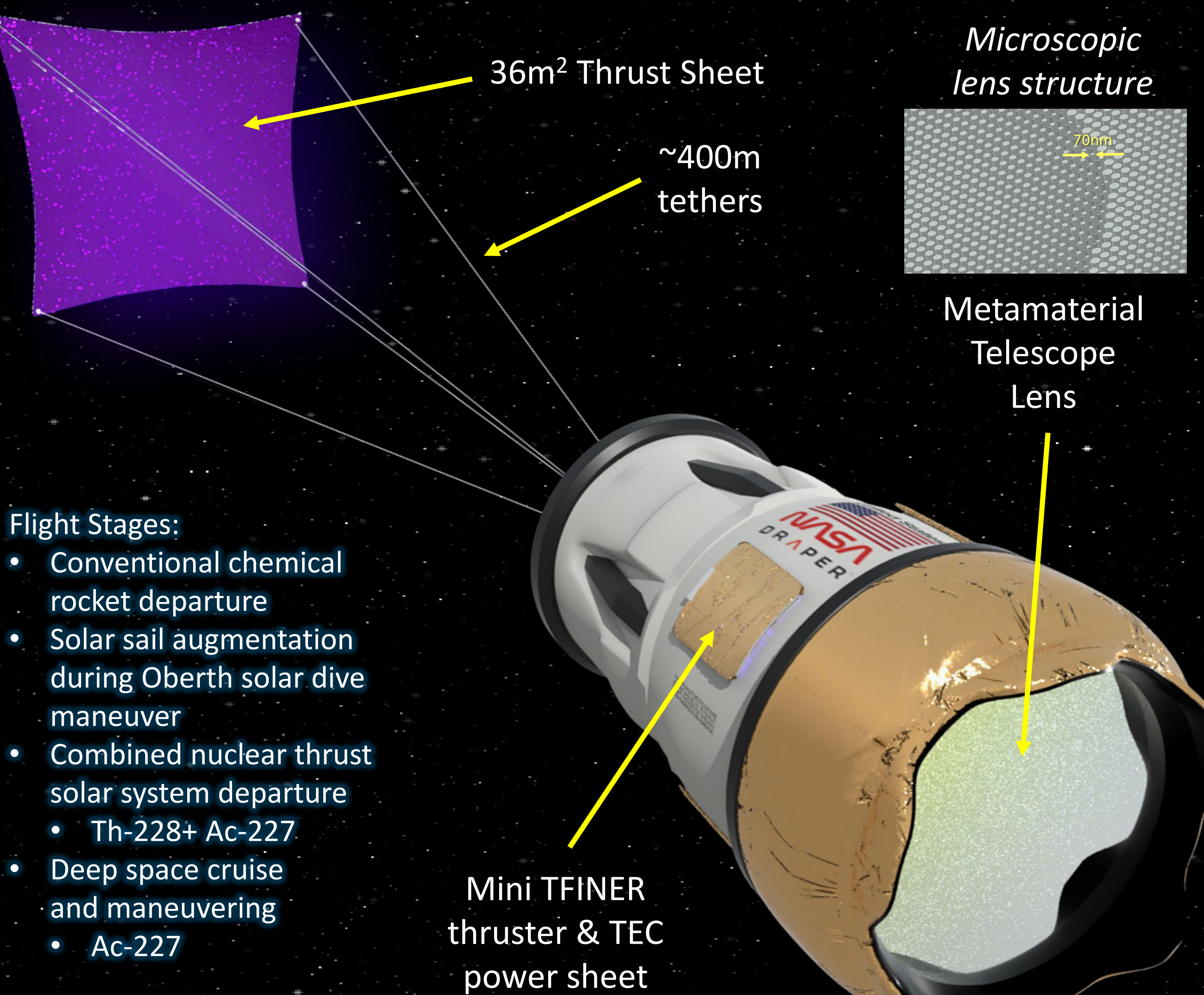
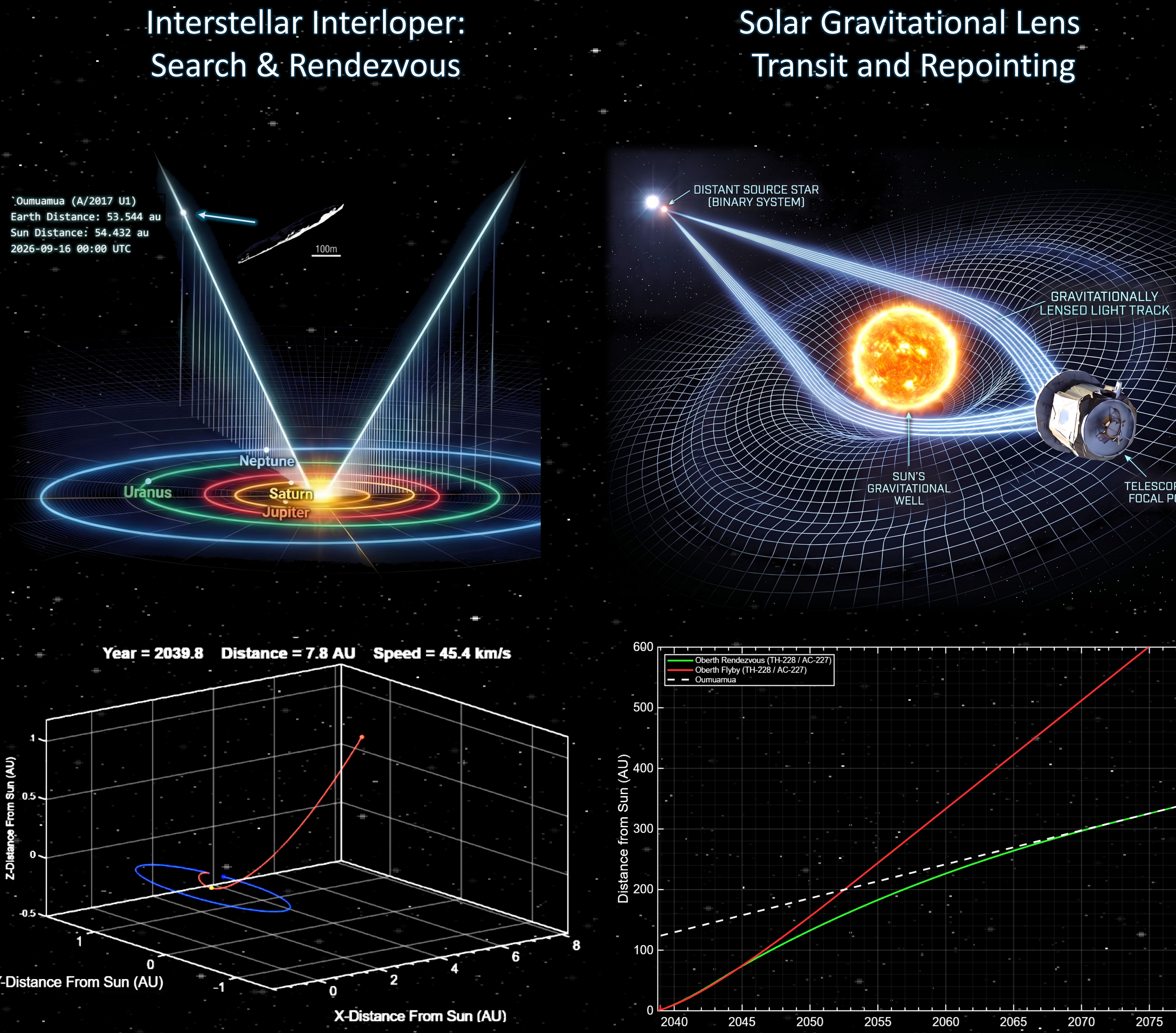


PERFORMANCE ANALYSIS

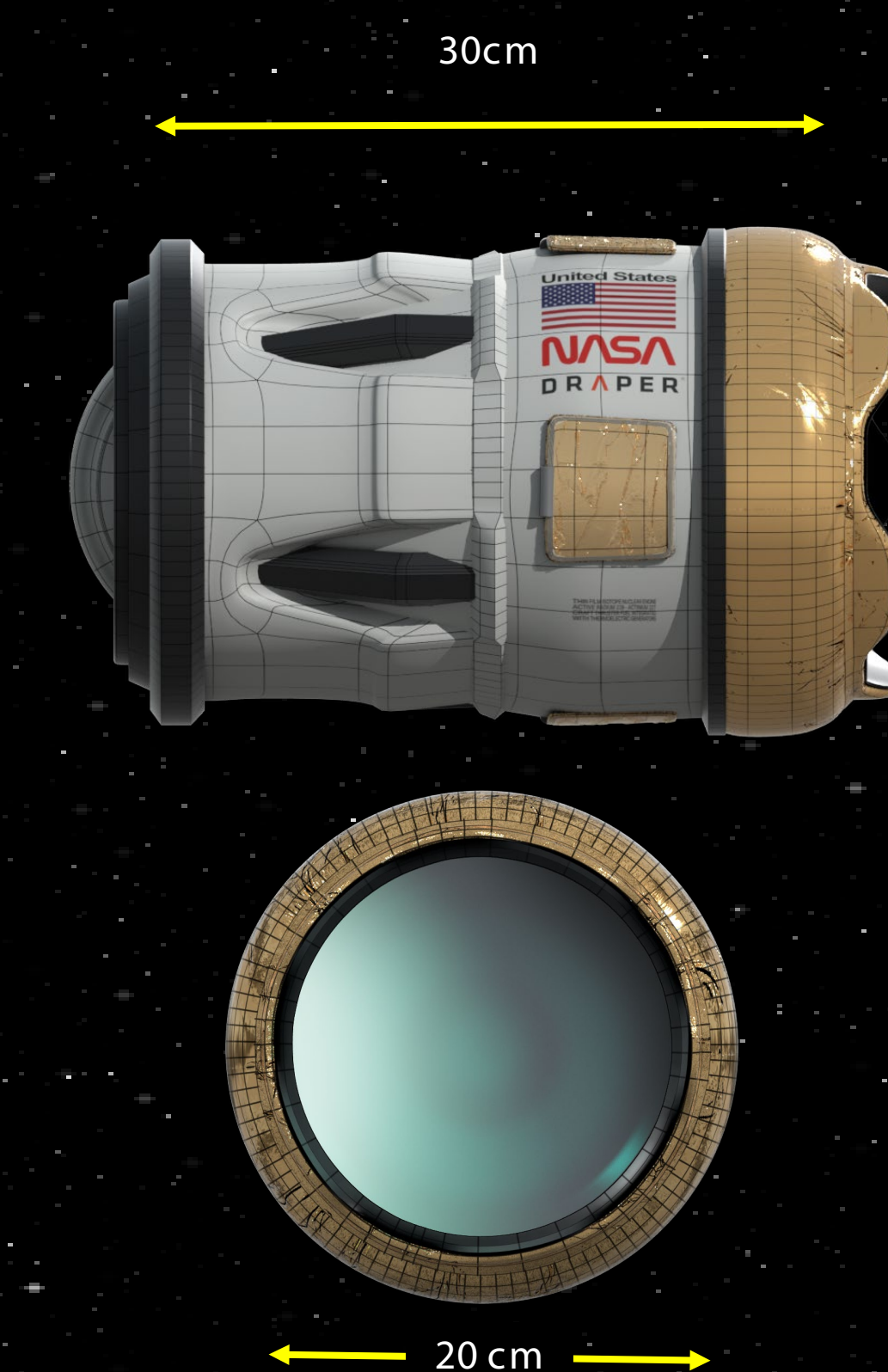
Multiple Stages and Oberth Maneuvers Augment Performance



OPERATIONAL DEEP SPACE MISSIONS

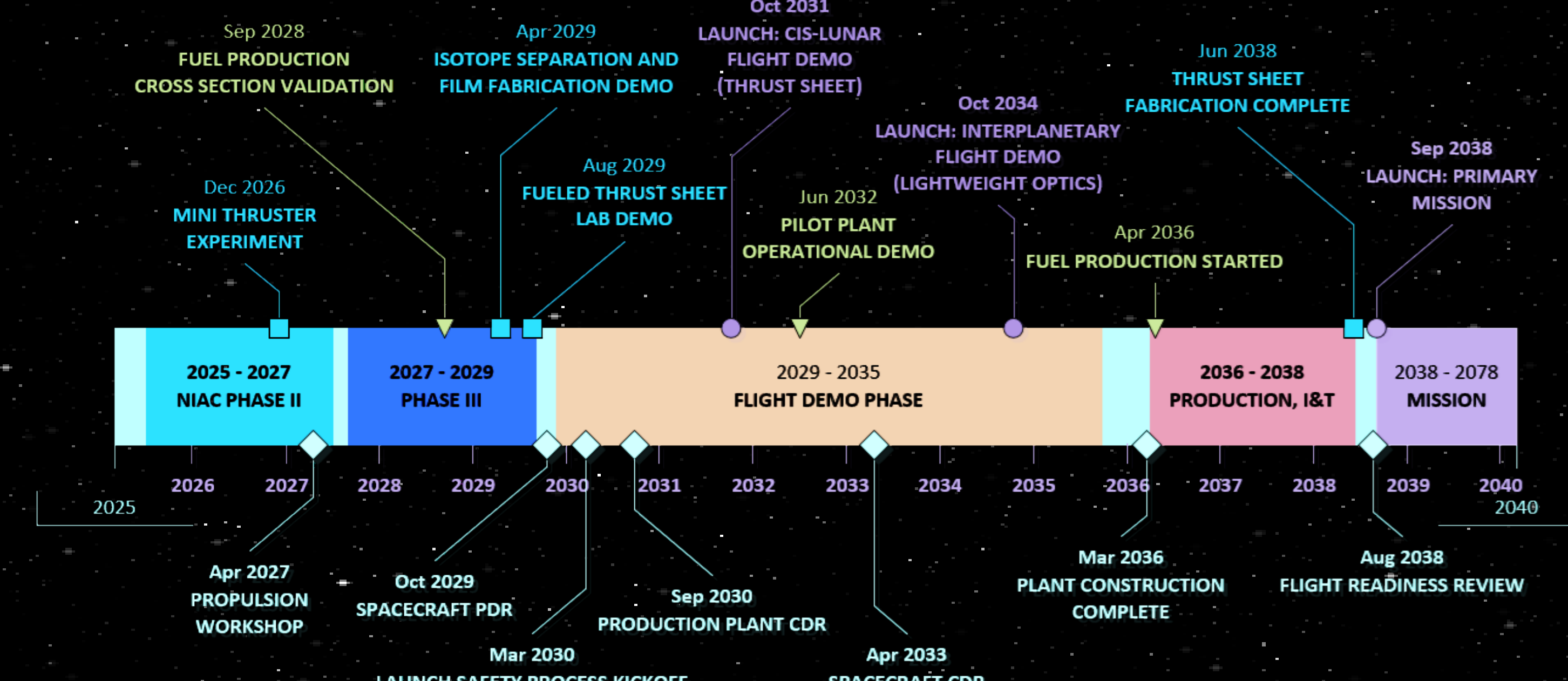


- Flight Stages:
- Conventional chemical rocket departure
 - Solar sail augmentation during Oberth solar dive maneuver
 - Combined nuclear thrust solar system departure
 - Th-228+ Ac-227
 - Deep space cruise and maneuvering
 - Ac-227

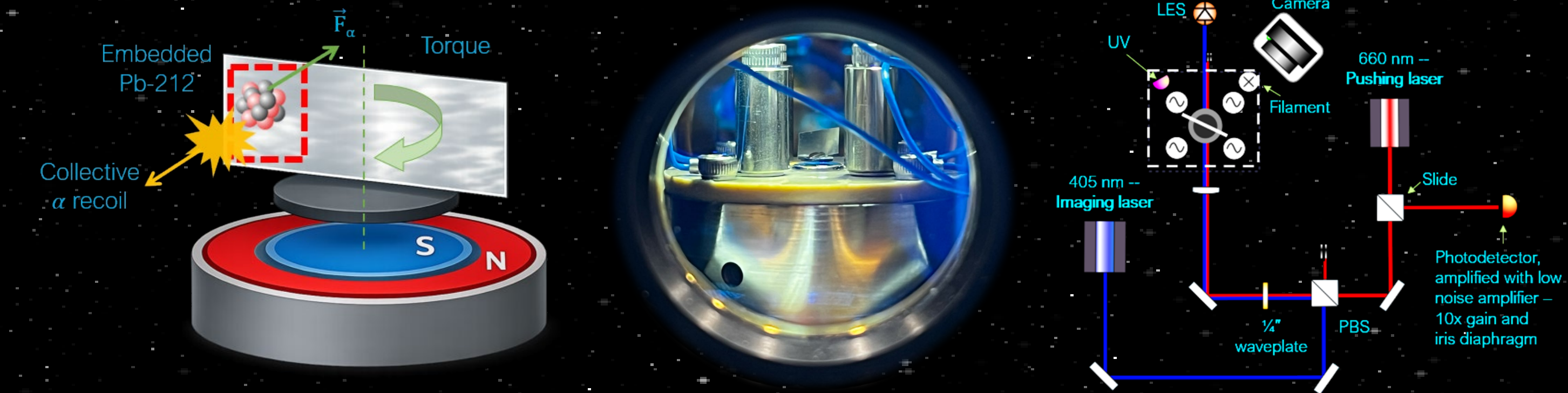


Component	Mass (kg)	Estimation Basis
Thrust Sheet (fuel)	4.000	Ac-227 (36m² area @ t=10µm)
Thrust Sheet (substrate)	2.355	Be (35 µm substrate)
Sheet Tensioners	0.372	2 x 8.5m booms
Tether Wires	0.162	8 x 400m 32-gauge wires
Actuators	0.139	4 x DC gear motor (10 rpm)
Telescope Optics	0.043	20cm SOI wafer (metallens)
Laser Source	0.162	25A 40V OEM diode driver
Sensors / Electronics	0.160	CMOS imager + electronics
Bus Frame	0.211	1cmx0.5mm Mg
Bus Skin	0.151	200 um Be foil
RTG Power	0.275	30We TEC with Cm-244 at t0
Battery	0.142	Lion 300W for 5 min
Miscellaneous	0.173	10% mass contingency
Total (thrust sheet)	6.355	Fuel and substrate
Total (payload)	1.902	Sensors, bus & power
Total (with thrust sheet)	8.257	Sum of all components

DEVELOPMENT PLAN



Mini-Thruster Experiment (Phase 2 Demo)

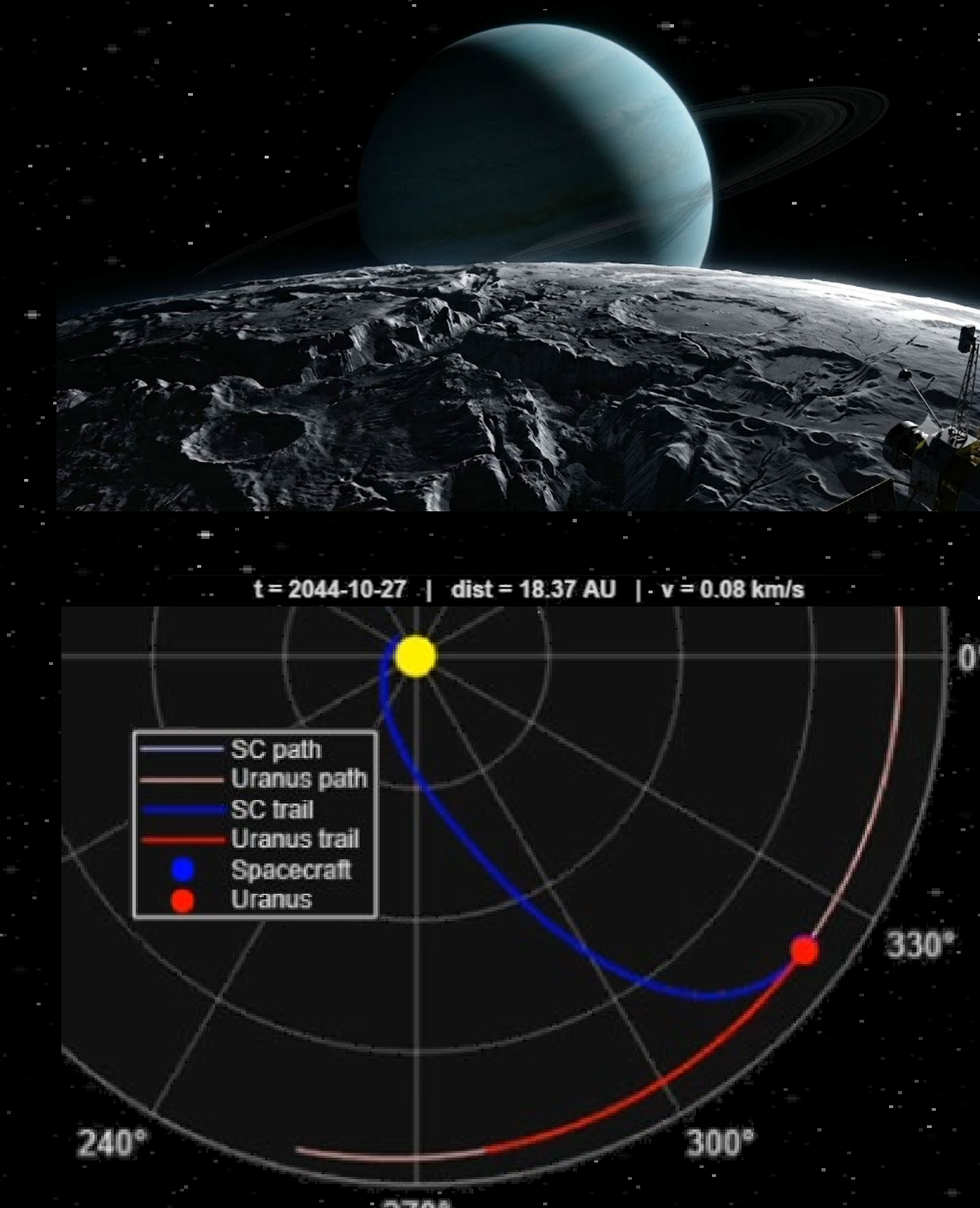


DEMO MISSIONS

Cis-lunar Exploration: Cm-242 (Apollo 11 LM Search)



Uranus Exploration: Ra-228 (Decadal Survey Priority)



CIS-LUNAR DEMO SPACECRAFT

Technology Demonstrator Using Reactor Derived Fuels

