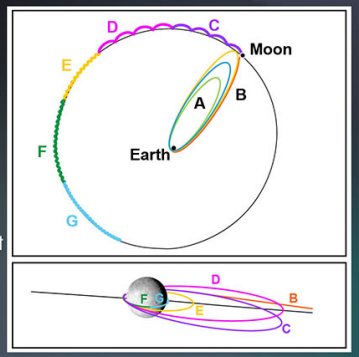
A Trajectory Plan

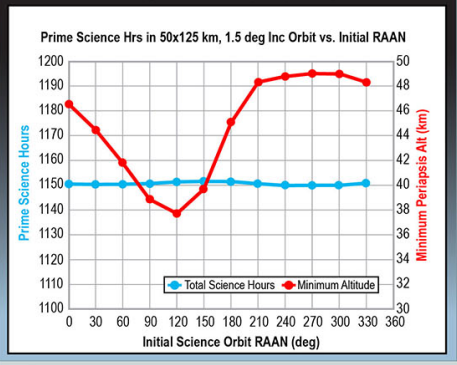
DARE phasing orbits (A), lunar transfer (B), lunar insertion 18 hr orbit (C), inclination trim orbits, from 5 or 20° to equatorial 0 – 3° (D), apoapsis lowering into 4 hr orbit (E), staging orbit (F), and frozen science orbit (G).



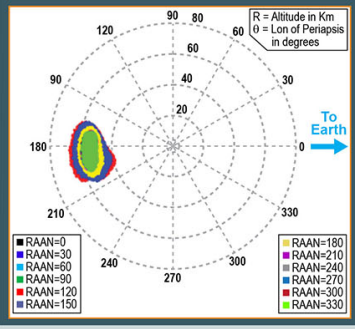
B Maneuver Timeline and Description (Baseline 08/01/2023 Launch Date)

Maneuver Number	Approx. Days from Launch	Days from Previous Maneuver	Maneuver Type	Nominal Magnitude or Allocation (m/s)	Description
--	<0.1	N/A	N/A	N/A	LV Phasing Orbit Injection & Separation
1	3	N/A	Engineering	10	AM1 Calibration of propulsion subsystem
2	6	3	Deterministic	31	PM1 Apo raising & phasing (varies with launch day)
3	9	3	Deterministic	<10	PAM (Plane change to compensate for launch window)
4	14	5	Deterministic	3	PM2 Apogee raising & phasing (varies with launch day)
5	24	10	Deterministic	0	PM3 Apogee raising (varies with launch day)
6	25	1	Statistical	<5	TCM1 Correction
7	27	2	Statistical	<5	TCM2 Correction
8	29	2	Deterministic	304	LOI1 capture into 18 hr orbit
9	32	3	Deterministic	14	LIM (Lunar Inclination Maneuver)
10	35	3	Deterministic	269	LOI2 lowers aposelene (4 hr orbit)
11	38	3	Deterministic	227	LOI3 lowers aposelene
12	48	9	Deterministic	31	OLM1 Orbit Lowering Maneuver
13	51	3	Deterministic	47	OLM2 if needed to achieve 50x125km science orbit
14	Variable	Variable	Deterministic	<7	RFI avoidance if needed
15	780	Variable	Deterministic	10	Deorbit

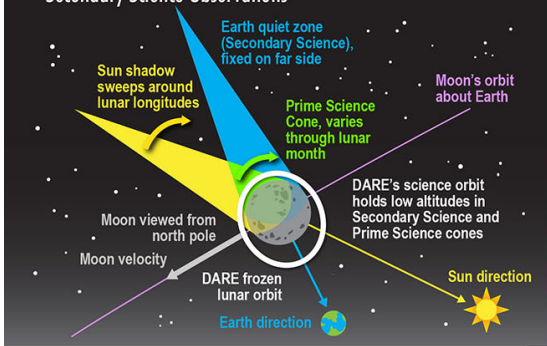
C DARE Prime Science Hours (blue curve on left axis) and Minimum Periapsis Altitude (red curve on right axis) as a Function of Science Orbit RAAN over 24 months (GRAIL 100x100 gravity model)



D Polar Plot of Science Orbit Periapsis Longitude and Altitude over 24-Months across all RAANs; in all cases periapsis remains fixed over the lunar far side, near a lunar longitude of 180 deg, without the need for orbit maintenance

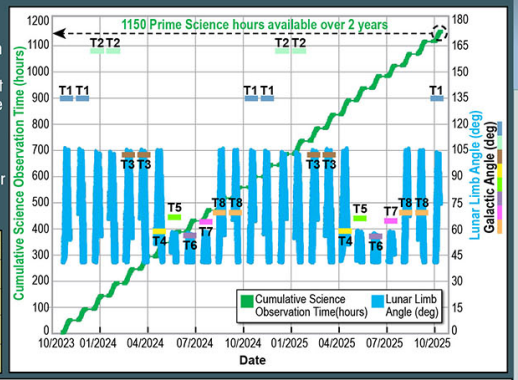


E DARE Frozen Orbit Geometry in Relation to Prime Science and Secondary Science Observations



F DARE cumulative Prime Science hours (green curve on left axis) and target observation timeline (with lunar limb and galactic angle indicated on right axis); targets specified in Figure H satisfy 800 hour science time requirement and minimum instrument pointing angle constraints to the Galactic Center and lunar limb of 55 and 40 degrees, respectively.

Minimum Prime Science Time over 2 yrs	1150 hrs
Required Prime Science Time	800 hrs
Possible EMI due to THEMIS or other S/C	100 hrs
Science Time Margin	250 hrs
Percent Science Time Margin (250/800)	31%



G Science Orbit Parameters and Eclipse Periods

Parameter	Min Value	Max Value
Altitude (km)	38	135
Orbit Period (min)	116.6	116.7
Inclination (deg)	0.1	3.0
Time in Shadow (min)**	46.3	47.5
Earth in View (min)	70.3	70.5
Prime Science Pass (min)	0	28.6
Sec. Science Pass (min)	28.3	28.6

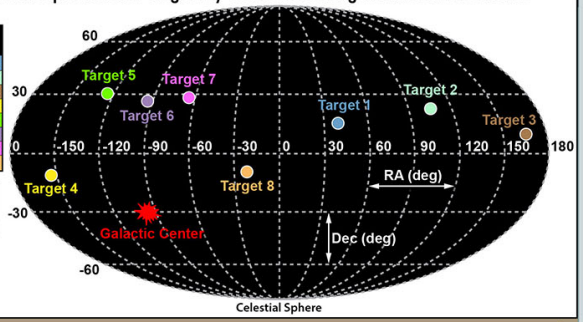
Lunar Eclipse Events	Duration (hh:mm)
Oct. 28, 2023	01:17
Sep 18, 2024	01:03
Mar 14, 2025	03:38
Sep 07, 2025	03:29
Mar 03, 2026	03:27
Aug 28, 2026	03:18

** Time reported here is due to Moon occultation & does not include periods of Earth occultation, which can extend the effective shadowing time.

H DARE points in 1 of 8 pre-defined target sky directions during science data collection

Target #	RA (deg)	Dec (deg)
T1	39.2271	15.3333
T2	105.399	22.6852
T3	165.5327	8.1824
T4	-153.549	-10.9293
T5	-124.955	30.6623
T6	-94.8459	26.8545
T7	-64.5761	28.8299
T8	-22.2432	-9.3177

Galactic Center RA (deg)	Galactic Center Dec (deg)
266.417	-29.008



I Mission Operations Timeline

08/01/2023			2024	2025	2026
Launch & Early Operations ~1 week	Phasing Loop Transfer & LOA ~31 days	Instrument Commissioning ~30 days	Science Operations ~2 years		Post Operations ~6 months
Launch + Seperation (Window: Aug '23)	Phasing Orbit Maneuvers	Science Orbit Lowering Maneuvers	Begin weekly tactical planning cycles		Finalize Data Reduction
Initial Ground Commanding	TCMs for precise lunar targeting	Instrument Ground Plane Deployment	Up to 28 minutes of Science Observations per Orbit		Analysis and Publication
Initial Orbit Determination	LOI-1 (lunar capture)	Instrument Checkout	120 Minutes of Data Transmission per Day		Deliver data sets to LAMBDA
First Data Download	Inclination Adjust	On-Orbit Instrument Antenna Calibration	Sun Pointing when not taking science, downloading		archive
First Command Sequence Upload	LOI-2 & 3		TLM, or during momentum management		
Observatory Subsystem Checkouts			Monthly On-Orbit Instrument Antenna Calibration		
Engineering Burn			Decommissioning/Deorbit		

J Science Phase Operations

The 29-day lunar cycle depicts Prime Science and Secondary Science observation geometry. Prime Science occurs throughout a ~1-week interval peaking at Full Moon. Maximum observations of 28-minutes occur in an ideal thermal environment over shadowed periods of DARE's 2-hour science orbit.

The detailed timeline depicts a prime science observation near Full Moon; a 65-min segment of the 2-hour orbit is shown, centered on the data collection period. Events in the upper two rows reflect Observatory, Sun and Moon geometry, while corresponding activities in the bottom row reflect on-board command sequences generated by MOS. Dotted lines represent earliest/latest event times accounting for orbit prediction uncertainty.

Observation Timeline (Near Full Moon Case)