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AURORA-3

The first dedicated mission to an ice giant: a nuclear-powered orbiter that will spend four years inside Neptune's magnetosphere, map the hidden interior of the windiest world in the solar system, and meet its strangest moon.

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Mission overview

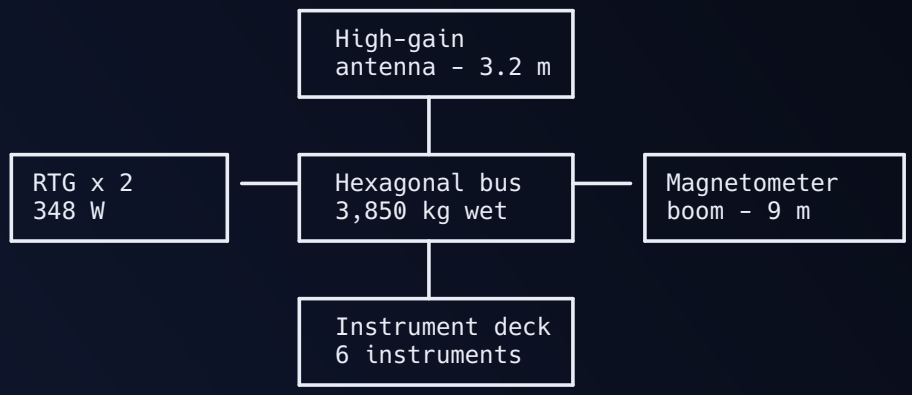
AURORA-3 is the National Space Exploration Directorate's flagship mission to Neptune — the most distant planet in the solar system and, with Uranus, one of only two worlds of its kind never studied from orbit. Nearly everything we know about the ice giants comes from a single afternoon: Voyager 2's 1989 flyby lasted hours and produced questions that have occupied planetary science for three decades. AURORA-3 will stay for four years.

The spacecraft launches in March 2027, borrows six kilometres per second from Jupiter fourteen months later, then cruises in hibernation for nearly a decade before firing its main engine behind Neptune's disc in September 2038. Once captured, it threads twenty-six polar orbits between the planet's narrow rings and its large retrograde moon Triton — a captured Kuiper Belt object with weather, seasons, and geysers of nitrogen ice.

4.6B km	11.4 yr	96 kg	348 W
CRUISE DISTANCE	FLIGHT TIME	SCIENCE PAYLOAD	POWER AT ARRIVAL
Earth to Neptune by way of Jupiter	launch through orbit insertion	six instruments and two booms	two radioisotope generators

The spacecraft

The orbiter is built around a hexagonal composite bus roughly the size of a compact car, wrapped in fifty-two layers of thermal blanketing. At Neptune, sunlight is nine hundred times weaker than at Earth, so solar power is not an option: two next-generation radioisotope generators supply 348 watts at arrival — about four light bulbs — and every subsystem is engineered inside that budget. A fixed 3.2-metre high-gain antenna returns 8.9 kilobits per second to the 70-metre deep-space stations, enough for two hundred images a week.



AURORA-3 flight configuration

Six instruments ride on the cold side of the bus, away from generator heat. The magnetometer sits at the tip of a nine-metre boom so the spacecraft's own electronics cannot contaminate its measurements. Readiness figures below reflect the January 2027 pre-ship review.

INSTRUMENT	WHAT IT MEASURES	MASS	READINESS
IceMag	Interior dynamo and magnetic field geometry	4.8 kg	97%
NIMS-2	Cloud composition and deep-atmosphere weather	21.3 kg	88%
PWS	Plasma waves and ring-particle impacts	6.7 kg	91%
UVS	Upper-atmosphere chemistry and auroras	4.4 kg	76%
DWE	Wind speeds by Doppler tracking	1.9 kg	94%

The journey

Getting to Neptune is a problem of patience more than of thrust. No launcher can fly there directly with a payload this size, so AURORA-3 takes the classic route: a sprint to Jupiter, a precisely timed gravity assist, and a long, quiet coast across the outer solar system. The full route is shown in Figure 1.

1 **Launch**

A twenty-one-day window opens on 14 March 2027. AURORA-3 lifts off from the Eastern Range on a Taurus-V heavy and injects directly onto a Jupiter transfer.

2 **Jupiter assist**

In June 2028 the spacecraft passes 4.1 million kilometres above Jupiter's cloud tops, stealing 6.3 km/s and bending its path toward Neptune.

3 **Deep cruise**

Nine quiet years, spin-stabilized, with an annual checkout each April. The flight team rehearses orbit insertion eleven times.

4 **Orbit insertion**

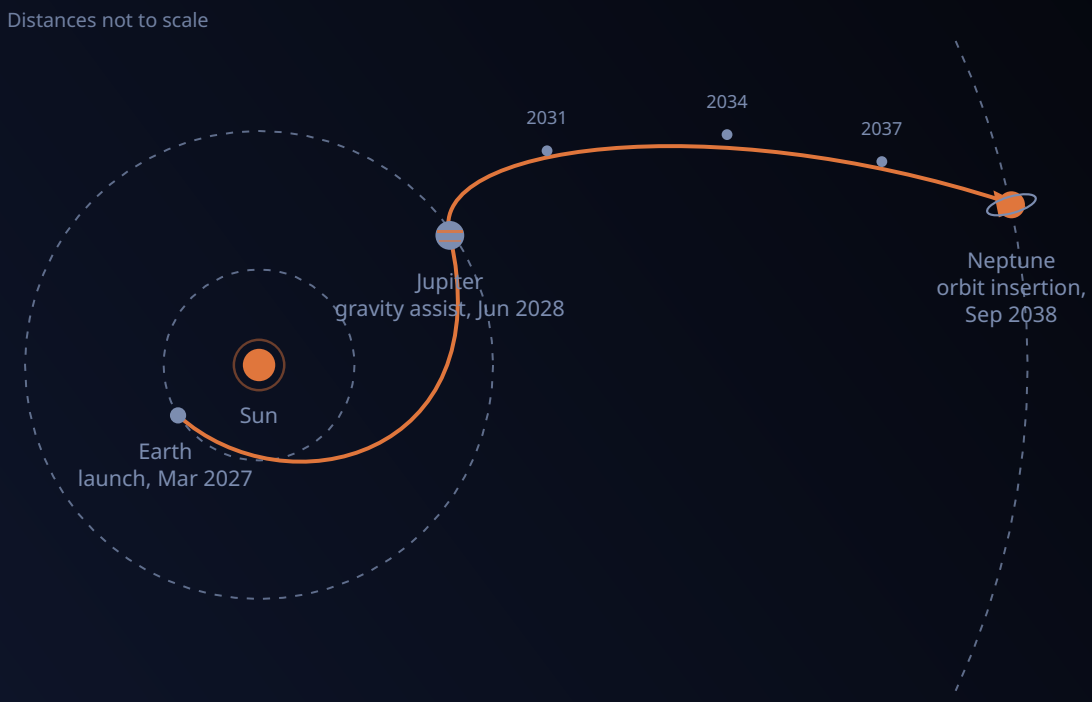
On 9 September 2038 the main engine burns for 47 minutes behind Neptune's disc — out of contact with Earth — and captures into a 78-day polar orbit.

5 **Ring-plane survey**

Twelve descending passes map the rings and the six small shepherd moons that keep them narrow.

6 **Prime science**

Twenty-six orbits and four Triton encounters, the closest at 190 kilometres above the moon's south polar plumes.



Interplanetary trajectory of AURORA-3, launch through Neptune orbit insertion

What AURORA-3 will learn

Four questions drive the mission, each inherited directly from the mysteries Voyager 2 left behind.

- Heat. Neptune radiates 2.6 times more energy than it receives from the Sun, and nobody knows why. The imbalance may power the fastest winds ever measured — 2,100 kilometres per hour.
- Interior. Models predict an ocean of superionic water beneath the clouds. The gravity experiment and IceMag will weigh the layers and test whether diamond really rains at 7,000 kilometres depth.
- Magnetism. The magnetic field is tilted 47 degrees from the spin axis and offset from the planet's centre. AURORA-3 will watch a dynamo unlike any other in operation.
- Triton. The moon orbits backwards, is geologically young, and vents nitrogen geysers. The final encounters fly through the plumes and sample a Kuiper Belt ocean world directly.

The answers reach beyond one planet. Ice giants are the most common class of exoplanet yet discovered, and Neptune is the nearest laboratory for how they work.

No world of its kind has ever been orbited. AURORA-3 goes to be the first.

Launch day

The window opens at 06:12 Eastern on 14 March 2027 and runs twenty-one days, with a two-hour opportunity each morning. The five-core Taurus-V burns for eleven minutes; the upper stage relights twice. First signal through the Canberra deep-space station is expected fifty-three minutes after lift-off, and the mission becomes AURORA-3 the moment the ground team confirms both booms are out.

> Launch viewing safety: the causeway sites sit 5.8 kilometres from the pad — the closest the public may stand. Stay behind the flagged line, bring hearing protection for children, and do not watch the first seconds of flight through binoculars: a five-core heavy at full thrust is brighter than a welding arc.

Quick facts

For editors and fact-checkers — the numbers most often asked for, in one place.

Launch window	14 March – 3 April 2027
Launch vehicle	Taurus-V heavy, five-core expendable
Spacecraft wet mass	3,850 kg
Science payload	96 kg, six instruments
Power at Neptune	348 W from two generators
One-way light time at arrival	4 h 06 min
Downlink rate from Neptune	8.9 kbit/s
Prime mission cost	$3.4 billion, launch included

When do the first images arrive? Cruise images of Jupiter come down in summer 2028. The first Neptune approach images to beat Voyager 2's best arrive in early 2038, about six months before orbit insertion.

Why Neptune and not Uranus? Both are compelling; Neptune won on Triton. A probable ocean world and a captured Kuiper Belt object in one system made the science case decisive.

What happens after 2042? If the spacecraft stays healthy, a two-year extension would lower the orbit inside the rings for fine gravity mapping, ending with a guided entry into Neptune's atmosphere.

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Assets and live coverage: nsd.gov/aurora3