National Aeronautics and Space Administration

EUROPA CLIPPER

Press Kit / September 2024

www.nasa.gov

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Introduction

Europa Clipper Press Kit

NASA’s Europa Clipper is the first mission to focus on Jupiter’s intriguing ocean moon Europa as a primary target. The agency is targeting a launch in October 2024 on a SpaceX Falcon Heavy rocket from NASA’s Kennedy Space Center in Florida.

Europa Clipper arrives at the Jupiter system and goes into orbit around the solar system’s largest planet in 2030, making dozens of close flybys of this ice-encased moon.

8 Things to Know about Europa Clipper

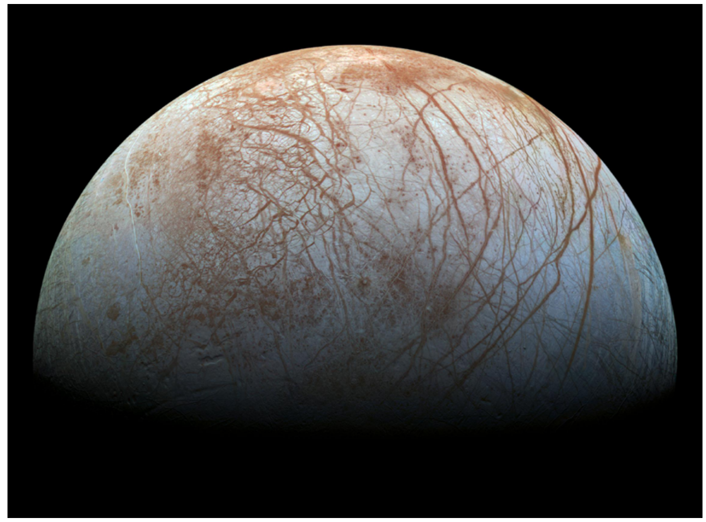
The Italian astronomer Galileo Galilei first sighted Europa through a homemade telescope in 1610. He observed bright dots surrounding the planet Jupiter, assuming they were distant stars. When Galileo realized the dots were dancing around Jupiter over several nights, he concluded that they were actually four moons orbiting the giant planet. The discovery upended the dominant idea at the time that Earth was the center of the universe. In fact, most celestial objects weren’t in orbit around Earth at all.

NASA’s first mission to study this Jovian moon in detail, Europa Clipper aims to help answer another fundamental question about our solar system and beyond: Are we alone? While Europa Clipper is not a life-detection mission, it will tell us whether Europa is a promising place to pursue an answer to this question.

Here are eight key facts about this mission to a moon that has captivated scientists for centuries:

1. Europa is one of the most promising places to look for currently habitable conditions beyond Earth.

Scientists think some worlds in our solar system, such as Mars, may have hosted life billions of years ago. But they suspect that the ingredients for life — water, chemistry, and energy — could exist at the moon Europa right now. Previous missions have found strong evidence of an ocean beneath the moon's thick icy crust, potentially with twice as much liquid water as all of Earth's oceans combined.



Europa's intriguing surface, as seen by NASA's Galileo mission. Credit: NASA/JPL-Caltech/SETI Institute | Full Image

Europa may be home to organic compounds, which are essential chemical building blocks for life. Europa Clipper will help scientists confirm whether organics are there, and also help them look for evidence of energy sources under the moon's surface. Scientists also wish to know if Europa's conditions have stayed consistent over about 4 billion years, which is the age of the solar system — long enough for life to possibly arise.

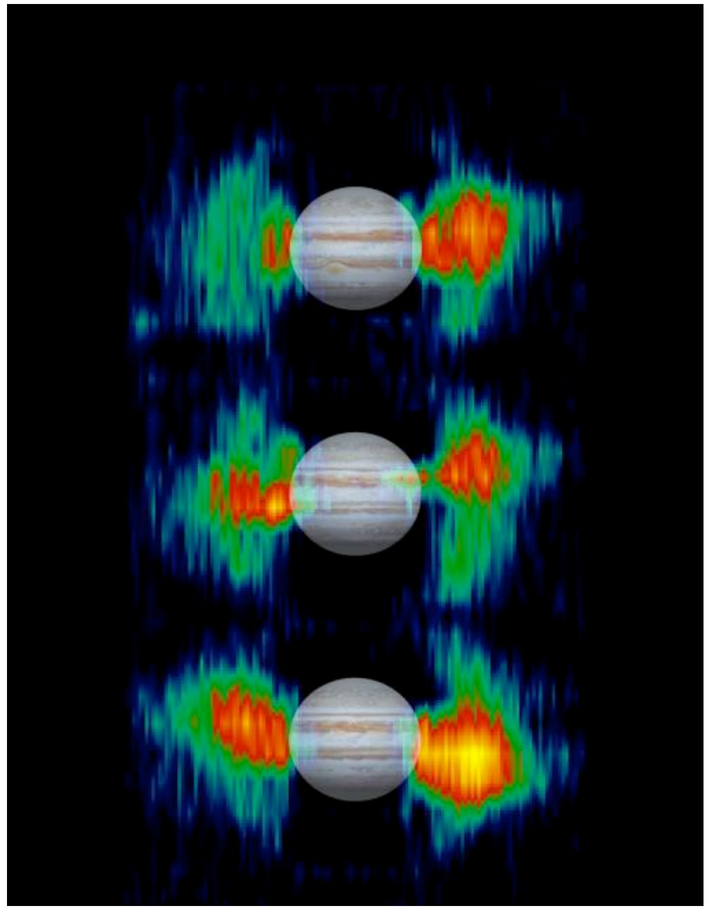
In the last few decades, scientists have found that other worlds in our solar system, in addition to the moon Europa, likely have oceans beneath icy crusts. If the Europa Clipper mission determines that Europa is habitable, it would mean there may be more habitable worlds in our solar system — and that we would learn a lot more about how they work as well as how widespread they may be.

Europa Clipper: NASA's Mission to Jupiter's Ocean Moon (Mission Trailer) bit.ly/3XFJtWa

The discoveries Europa Clipper makes will complement data from the ESA (European Space Agency) Jupiter Icy Moons Explorer (Juice) mission, which will focus its investigation on Ganymede, Europa's neighboring moon.

2. The spacecraft will fly through the most punishing radiation environment of any planet in the solar system.

Jupiter is surrounded by a gigantic magnetic field 20,000 times as strong as Earth's. As the magnetic field spins, it captures and accelerates charged particles from the surrounding area. This creates radiation — particles or energy that moves from one place to another — which can damage spacecraft and harm astronauts. Jupiter's radiation environment is the strongest of any planet in our solar system (second only to our Sun's), making it especially hazardous.



Europa's orbit lies within Jupiter's powerful radiation bands, shown here as mapped by NASA's Cassini mission. Credit: NASA/JPL-Caltech | Full Image

Europa Clipper's engineers came up with two key ways to minimize potential radiation damage: shielding the spacecraft's sophisticated electronics with a specially designed vault and limiting the time Europa Clipper spends in particularly dangerous parts of Jupiter's radiation. Even with these mitigations, during each flyby of the moon the electronics of the Europa Clipper spacecraft are expected to experience an average radiation dose of a few thousand to tens of thousands of rads (units of radiation absorbed by an object or person). This means that during each flyby, the spacecraft will get exposed to the equivalent of several million chest X-rays.

3. Europa Clipper will orbit the planet Jupiter, studying Europa while flying by the moon multiple times during its tour.

Europa Clipper's mission team designed a tour where the spacecraft makes looping orbits around Jupiter that bring it close to the moon Europa for 49 science-dedicated flybys. These orbits allow the spacecraft to spend less than a day in the dangerous radiation environment near Europa on each orbit. The spacecraft will zip out of the most intense radiation areas before it loops back to fly by Europa again two to three weeks later.

Artist's concept of the Europa Clipper spacecraft flying by Europa while orbiting Jupiter. Credit: NASA/JPL-Caltech | Full Image

4. Europa Clipper brings NASA's most sophisticated suite of science instruments yet to the Jupiter system.

To determine if Europa is habitable, Europa Clipper must assess the moon's interior, composition, and geology. The spacecraft carries nine science instruments and a gravity experiment that uses the orbiter's telecommunications system to complete these objectives.

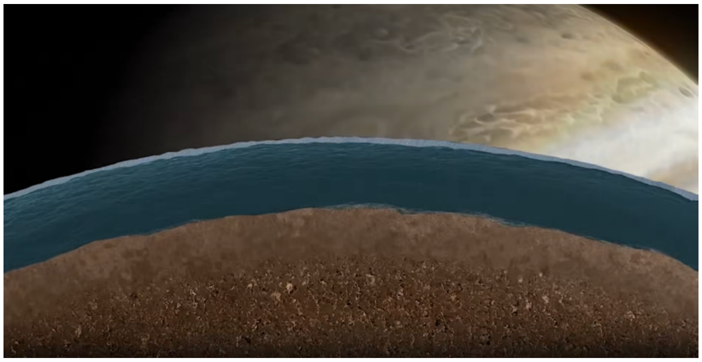
Technicians prepare Europa Clipper's dust-analyzing instrument for installation on the spacecraft. Europa Clipper carries a suite of nine instruments and a gravity experiment. Credit: NASA/JPL-Caltech | Full Image

One significant new tool Europa Clipper has is an ice-penetrating radar called the Radar for Europa Assessment and Sounding: Ocean to Near-surface (REASON). This instrument can bounce waves off any liquid water under the surface, creating a kind of CT scan of Europa's ice shell.

The Mass Spectrometer for Planetary Exploration/Europa (MASPEX) is the most complex and capable instrument of its kind ever flown to the outer solar system. It can "sniff" and analyze Europa's atmosphere and any gases erupting from beneath the surface.

Another instrument will also directly collect and examine dust at Europa: the SUrface Dust Analyzer (SUDA).

Four instruments will study the moon from a distance across a wide range of the light spectrum, from infrared through visible light to the ultraviolet. The Europa Thermal Emission Imaging System (E-THEMIS) will measure how the surface retains heat, which can provide information about the structure and materials present. It will also look for hot spots from erupting plumes or underground lakes. The Mapping Imaging Spectrometer for Europa (MISE) collects infrared light to determine the composition of the surface. It will produce the first detailed maps of the many materials and chemical compounds on the surface, including enigmatic reddish material that has intrigued scientists for decades. The dual-camera Europa Imaging System (EIS) will finish the job started by Voyager and Galileo to map the surface of Europa — at sufficiently high resolution to unravel the mystery of the moon's intricate and baffling geology. In addition to investigating Europa's surface composition, the Europa Ultraviolet Spectrograph (Europa-UVS) is a sensitive "plume finder" and will search for active eruptions like those detected by the Hubble Space Telescope.



Why Does NASA Want to Explore Jupiter's Ocean Moon? (Europa Clipper Science Overview)
bit.ly/3XpdPLh

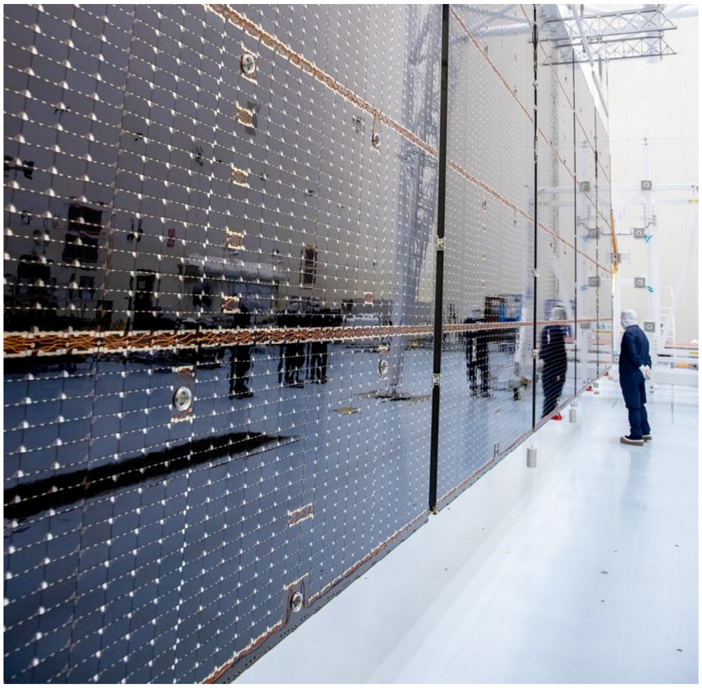
Two instruments will study Jupiter's magnetic field and charged particles, or plasma, trapped within that field to provide clues about the structure of Europa's interior: the Europa Clipper Magnetometer (ECM) and the Plasma Instrument for Magnetic Sounding (PIMS). The ECM will measure minute changes in Jupiter's magnetic field near Europa that can yield information about the size and salinity of Europa's ocean. Enabling the ECM to fulfill its role, PIMS provides information about the plasma environment around Europa. Together, both instruments will also help scientists better understand Jupiter's magnetic field and how it interacts with Europa.

A gravity and radio science experiment that analyzes frequency shifts in the spacecraft's signals to Earth will be able to independently confirm an ocean at Europa and give scientists additional insight into Europa's interior.

Because each opportunity to fly by Europa is precious, the mission plans for all science instruments to operate simultaneously during each pass. Scientists can then layer the data together to paint the full picture of Europa.

5. With antennas and solar arrays fully deployed, Europa Clipper is the largest spacecraft NASA has ever developed for a planetary mission.

When the spacecraft is completely stretched out, it will cover an area larger than a basketball court. That's more than 100 feet (30.5 meters) end to end and about 58 feet (17.6 meters) across. The arrays need to be so big to collect enough sunlight to power the spacecraft's instruments, electronics, heaters, and other subsystems despite sunlight at Jupiter being only about 4% of what Earth receives.



A technician examines one of Europa Clipper's two five-panel solar arrays. Credit: NASA | Full Image

6. It's a long journey to Jupiter.

Jupiter is on average some 480 million miles (about 770 million kilometers) from Earth, but Europa Clipper cannot fly directly to the solar system's largest planet. Both planets are constantly in motion, and a spacecraft can carry only a limited amount of fuel. So mission planners are sending Europa Clipper past Mars and Earth, using the planets' gravity as a slingshot to add speed to the spacecraft's journey to Jupiter.

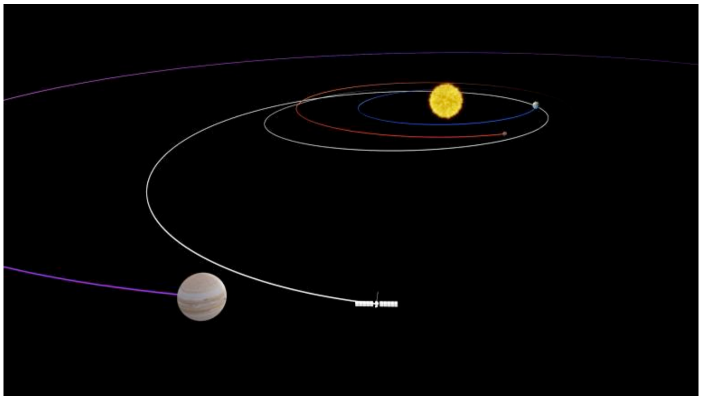


Illustration of Europa Clipper's journey past Mars and Earth to Jupiter. Credit: NASA/JPL-Caltech Full Image

Europa Clipper will put about 1.8 billion miles (2.9 billion kilometers) on its odometer over the course of 5 1/2 years. It will then use the gravity of the Jovian moon Ganymede to help slow down before firing its thrusters to get into orbit around Jupiter in 2030.

Europa Clipper team members have plenty to do during the journey, including testing science instruments and spacecraft subsystems, refining the software running on the spacecraft and instruments, and fine-tuning the details of the Jupiter tour so that the orbiter is fully ready on its first day there.

7. Institutions across the U.S. and Europe have contributed to Europa Clipper.

Engineers at the Johns Hopkins Applied Physics Laboratory prepare one of Europa Clipper's cameras for testing. Credit: NASA/APL/Ed Whitman

Full Image

Currently there are about a thousand people across the U.S. working on the Europa Clipper mission. This includes about 650 people at NASA's Jet Propulsion Laboratory in Southern California and at the Johns Hopkins Applied Physics Laboratory (APL) in Laurel, Maryland. JPL leads the development of the mission in partnership with APL. NASA's Goddard Space Flight Center in Greenbelt, Maryland, provided key contributions to the main spacecraft body, and NASA's Kennedy Space Center in Florida is overseeing final integration and launch services. The Planetary Missions Program Office at NASA's Marshall Space Flight Center in Huntsville, Alabama, provides program management of the Europa Clipper mission.

Over 220 scientists work on the mission, including instrument leads at JPL, APL, the Southwest Research Institute, NASA Goddard, the University of Texas, the University of Michigan, the University of Colorado Boulder, and Arizona State University. Science team members are based across the U.S. and Europe.

European facilities have also played key roles: The spacecraft's giant solar arrays were built in the Netherlands by Airbus, and the magnetometer sensors were tested in the countryside of Germany because scientists needed an extremely quiet location.

Since the mission was formally approved in 2015, more than 4,000 people have contributed to Europa Clipper, including teams who work for contractors and subcontractors.

8. More than 2.6 million of us are riding along with the spacecraft to Jupiter, bringing greetings from one water world to another.

As part of the Europa Clipper mission, people around the world are participating in a new version of the practice of sending a message in a bottle out into Earth's ocean: The spacecraft is carrying a poem by U.S. Poet Laureate Ada Limón, co-signed by millions of people from nearly every country in the world, as it sails out into the cosmic ocean. The names have been stenciled in tiny letters on a dime-size microchip.

Technicians at JPL install a specially designed metal plate on Europa Clipper bearing poetry, artwork, and other messages from Earth. Credit: NASA/JPL-Caltech | Full Image

Both the microchip and Limón's poem are on a tantalum metal plate on the electronics vault of the spacecraft, along with waveforms of people saying the word "water" in over 100 spoken languages. The poem — like the Europa Clipper mission — explores the connections between our two distant worlds, both full of mysteries. "O second moon," Limón writes, "we, too, are made of water, of vast and beckoning seas. / We, too, are made of wonders…"

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Products and Events

News Releases, Features, Advisories, and Status Reports

Progress reports on Europa Clipper's road to launch, including the latest information on launch dates, can be found on the Europa Clipper mission blog: blogs.nasa.gov/europaclipper.

News, updates, and feature stories about the Europa Clipper mission are available at science.nasa.gov/mission/europa-clipper/newsroom.

Additional information about launch windows (the potential time each day Europa Clipper can launch) can be found at science.nasa.gov/mission/europa-clipper/launch-windows.

Interviews with team members from the Europa Clipper mission may be arranged by calling the JPL newsroom at 818-354-5011 or filling out this form.

Video and Images

A collection of b-roll and animations for media and public use is available at bit.ly/EuropaRawVideo.

A collection of embeddable Europa Clipper videos is also available on JPL's YouTube channel.

Additional images related to the Europa Clipper mission are available at the mission's Multimedia page, the NASA Image and Video Library, Planetary Photojournal, and this press kit's Gallery section.

Read NASA's image use policy.

Read JPL's image use policy.

Media Events

A news conference presenting an overview of the mission will take place in the month before launch.

A prelaunch news conference and a science news conference open to accredited news media will take place at NASA's Kennedy Space Center in Florida in the days before launch. Additional media availabilities at NASA Kennedy are also expected in that time period.

All news briefings will be broadcast and livestreamed.

How to Watch

An up-to-date list of events for the media, social media, and the public about Europa Clipper, including where they will be streamed online, is available at science.nasa.gov/mission/europa-clipper/watch-online.

News briefings and launch commentary will be available on NASA+, the agency's streaming service. NASA+ is available on demand at no cost on streaming media players such as Apple TV and Roku, the NASA app on iOS and Android devices, and at plus.nasa.gov on both desktop and mobile.

Programming will also be livestreamed on the agency's website www.nasa.gov/live, YouTube.com/NASA, YouTube.com/NASAJPL, the NASA app, and NASA social channels. (On-demand recordings will also be available after the live events have finished on YouTube and NASA+.)

For more information about NASA's live programming schedule, visit plus.nasa.gov/scheduled-events.

Live Launch Feed

A live video feed of key launch activities and commentary from NASA Kennedy will be broadcast. Media outlets interested in a "clean feed" of the launch without NASA TV commentary should contact nasa-dl-nasaplus-programming@mail.nasa.gov

Audio Only

Audio only of launch coverage will be carried on the NASA "V" circuits, which may be accessed by dialing **321-867-1220, -1240, -1260,** or **-7135**. On launch day, "mission audio" – the launch conductor's countdown activities without NASA TV launch commentary – will be carried on **321-867-7135**.

On-Site Media Logistics

Read NASA's media accreditation policy.

Media accreditation for on-site access closes for international media on Sept. 20, 2024, and for U.S.-based media (U.S. citizens and permanent residents) on Sept. 27. Accredited media will have access to NASA Kennedy for launch and prelaunch activities related to NASA's Europa Clipper mission. Closer to launch, NASA will release an events-and-briefing advisory with additional information. To apply for accreditation, visit media.ksc.nasa.gov. For questions about accreditation, please email ksc-media-accreditat@mail.nasa.gov.

News media can arrange on-site interviews by contacting:

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321-747-8310
leejay.lockhart@nasa.gov

Laura Aguiar
321-593-6245
laura.aguiar@nasa.gov

Ways to Participate

For information about launch viewing sites on Florida's Space Coast that are open to the public, go to nasa.gov/centers/kennedy/launchingrockets/viewing.html.

The Europa Clipper mission also has a web page for mission updates, activities, spacecraft models, posters, stickers, animations, and more. This content is suitable for educators, students, and learners of all ages: science.nasa.gov/mission/europa-clipper/participate.

Additional Resources on the Web

Online and PDF versions of this press kit will be available at go.nasa.gov/EuropaClipperPressKit.

Additional detailed information about the Europa Clipper mission is available at europa.nasa.gov.

NASA's Eyes on the Solar System is a browser-based 3D simulation that allows users to experience the entire journey of the Europa Clipper mission, from launch to the end of the prime mission. See the spacecraft zip past Earth and Mars, fast-forward to Jupiter orbit insertion in 2030, or watch the complex sequence of moon flybys at the Jupiter system. The visualization is based on mission engineering data and is also available to embed. Explore this interactive experience at go.nasa.gov/EyesOnClipper.

Social Media

Join the conversation and get updates from these accounts:

- **X:** @EuropaClipper, @NASAJPL, @NASASolarSystem, @NASA
- **Facebook:** NASAEuropaClipper, NASAJPL, NASASolarSystem, NASA
- **Instagram:** @NASAJPL, @NASASolarSystem, @NASA

Spanish-Language Resources

For Spanish-language information about the Europa Clipper mission, including live broadcast coverage of the mission's launch, visit: ciencia.nasa.gov/europaclipper.

NASA en español is on social media at:

- **X:** @NASA_es
- **Facebook:** NASA_es
- **Instagram:** @NASA_es
- **YouTube:** NASA_es

Recursos en español

Para obtener información en español sobre la misión Europa Clipper y ver la transmisión del lanzamiento, en vivo y en español, visita: ciencia.nasa.gov/europaclipper.

NASA en español está en las redes sociales en:

- **X:** @NASA_es
- **Facebook:** NASA_es
- **Instagram:** @NASA_es
- **YouTube:** NASA_es

Quick Facts

Mission Name

The Europa Clipper mission name evokes the swift-sailing clipper ships of the 19th century.

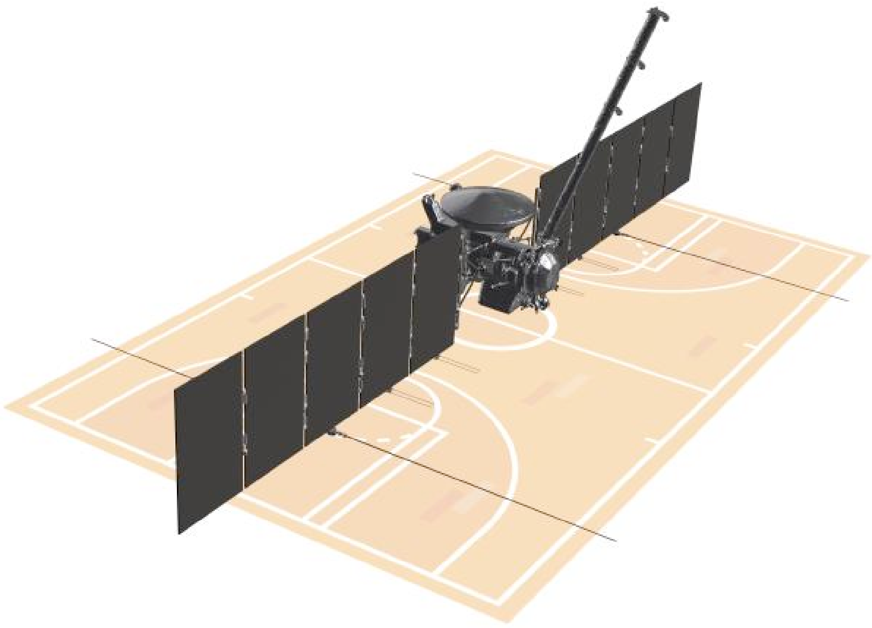
Spacecraft

Spacecraft Dimensions

The main spacecraft body, or bus, is about 10 feet (3 meters) wide, 15.5 feet (4.7 meters) tall, and 13 feet (4 meters) deep.

A 28-foot (8.5-meter) boom extends from the spacecraft bus.

With its solar arrays extended, the spacecraft spans just over 100 feet (30.5 meters). From end to end, pairs of radar antennas that extend from each solar array span a distance of about 58 feet (17.6 meters). In its fully deployed configuration, Europa Clipper is larger than a basketball court.



Artist's concept comparing size of Europa Clipper spacecraft to a basketball court. Credit: NASA/JPL-Caltech | Full Image

Mass

At launch, Europa Clipper will weigh approximately 12,800 pounds (about 5,800 kilograms), including about 6,060 pounds (about 2,750 kilograms) of propellant.

Europa Clipper Moves Into JPL's Space Simulator | bit.ly/4dl1lox

Payload Instruments

The spacecraft carries nine dedicated science instruments, plus a gravity and radio science investigation. The instruments will work together to gather data on Europa's atmosphere, surface, interior, and space environment.

Power

Europa Clipper is powered by two large solar arrays, each about 46.5 feet (14.2 meters) long and about 13.5 feet (4.1 meters) high. Such large solar arrays are needed to collect enough sunlight at Jupiter — which is more than five times farther from the Sun than Earth is — to power instruments, electronics, heaters, and other subsystems.

Electronics Vault

The spacecraft features a special vault to protect its electronics from the intense radiation environment at Jupiter. Inside, computers and other components are shielded behind sheets of aluminum-zinc alloy up to 0.36 inches (9.2 millimeters) thick.

Vault Plate

Following NASA's tradition of sending inspirational messages into space, Europa Clipper's electronics vault includes a unique tantalum metal plate featuring poetry, artwork, and a microchip stenciled with more than 2.6 million names submitted by the public.

Launch

Targeted Launch Period

Oct. 10 through Oct. 30. Updates on the road to launch can be found on the mission blog.

Targeted Launch Window

A Europa Clipper launch on Oct. 10 would occur at about 12:30 p.m. EDT (9:30 a.m. PDT). Additional information about launch windows (the time each day Europa Clipper can launch) can be found at science.nasa.gov/mission/europa-clipper/launch-windows.

Launch Site

Launch Complex 39A, NASA's Kennedy Space Center, Florida

Launch Vehicle

SpaceX Falcon Heavy rocket

Travel Distance to Jupiter

1.8 billion miles (2.9 billion kilometers)

Travel Time to Jupiter

5 1/2 years

Europa Clipper Mission

Duration

Prime mission of a little over four years, following arrival at Jupiter

Mission Milestones

Below is the planned timeline of key mission events.

- October 2024: Launch
- February/March 2025: Mars gravity assist
- December 2026: Earth gravity assist
- April 2030: Jupiter orbit insertion
- Early 2031: Europa flybys begin
- June 2034: End of prime mission

Europa

Europa as seen by NASA's Juno mission. Credit: NASA/JPL-Caltech/SwRI/MSSS (image data); Kevin M. Gill CC BY 3.0 (image processing) | Full Image

The mission's primary target, Europa, is one of Jupiter's four largest moons. There is strong evidence that Europa has a saltwater ocean beneath its icy surface that may be one of the best places to look for environments where life could exist beyond Earth.

Size

Europa's diameter is about 90% that of Earth's Moon, with an equatorial diameter of 1,940 miles (3,122 kilometers).

Temperature

Surface temperatures at Europa range from about minus 208 degrees Fahrenheit to minus 370 F (minus 133 degrees Celsius to minus 223 C).

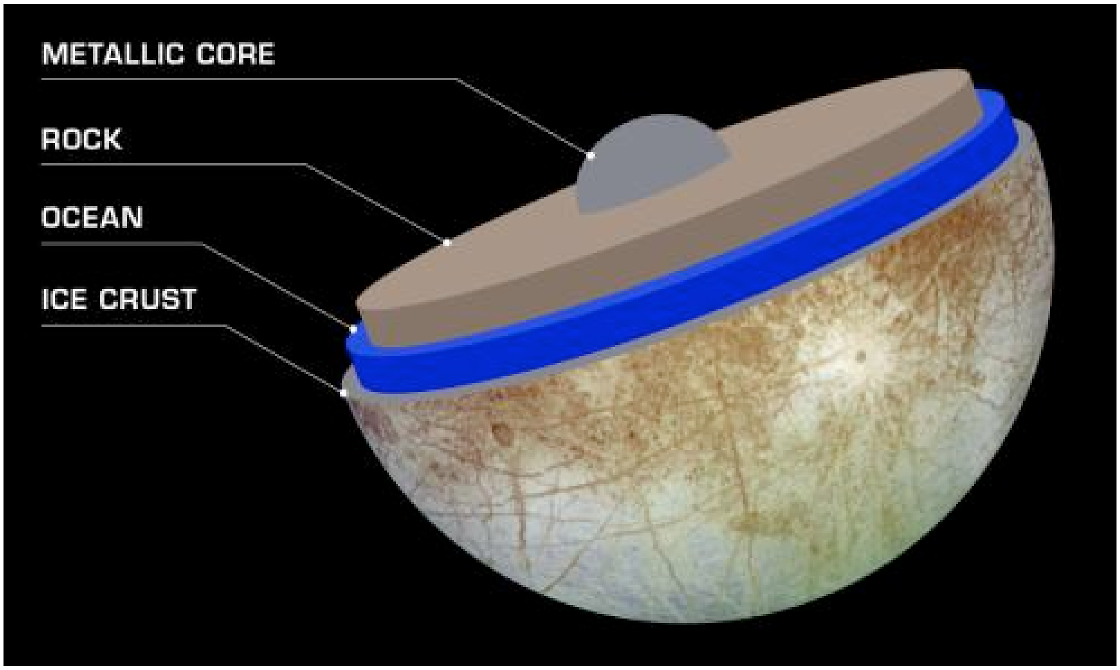
Orbit

Europa orbits Jupiter relatively quickly, circling the planet every 3.55 Earth days at a distance of about 417,000 miles (671,000 kilometers) from the planet — roughly 1.75 times farther than our own Moon is to Earth.

Like Earth's Moon, Europa is locked by gravity so that the same hemisphere of the moon always faces the planet.

Surface

Europa's surface is composed mostly of water ice, but it has a significant amount of reddish, non-ice material of unknown composition. This material appears to be present in areas of the surface that have been disturbed and could represent material from below that has been emplaced on the surface.



Artist's concept of Europa's interior structure. Credit: NASA/JPL-Caltech | Full Image

Ocean

Europa is believed to have a global saltwater ocean beneath its icy crust. Scientists estimate it could be around 40 to 100 miles (60 to 150 kilometers) deep — large enough to contain more than twice as much water as all Earth's oceans combined.

Name

In Greek mythology, Europa was a mortal who became a princess of Crete after Cupid hit Zeus (the Roman god Jupiter) with an arrow, causing him to fall under Europa's spell. The moon of Jupiter and the continent of Europe are named after her.

Program

NASA will invest a total of approximately $5.2 billion in the full life of the mission, which spans about two decades, starting in 2015 and going out to 2034 — the end of Europa Clipper's prime mission.

Mission: Overview

NASA is targeting a launch in October 2024 for the Europa Clipper spacecraft. It will launch from the agency's Kennedy Space Center in Florida on a journey to the Jupiter system, where it will make multiple flybys of the ocean moon Europa. With gravity assists from Mars and Earth, the journey to Jupiter will take 5 1/2 years. The spacecraft's prime mission, which will also include flybys of the Jovian moons Ganymede and Callisto, will be a little over four years, from 2030 to 2034.

NASA's Europa Clipper mission will lift off from Launch Complex 39A at the agency's Kennedy Space Center in Florida aboard a SpaceX Falcon Heavy rocket, just as NASA's Psyche mission, shown here, did in October 2023. Credit: NASA/Aubrey Gemignani | Full Image

Launch

Europa Clipper will lift off from Launch Complex 39A at Kennedy aboard a SpaceX Falcon Heavy rocket, procured by NASA's Launch Services Program. The spacecraft's launch period opens Oct. 10, 2024, with opportunities through Oct. 30. Additional contingency dates in early November are also available, if needed.

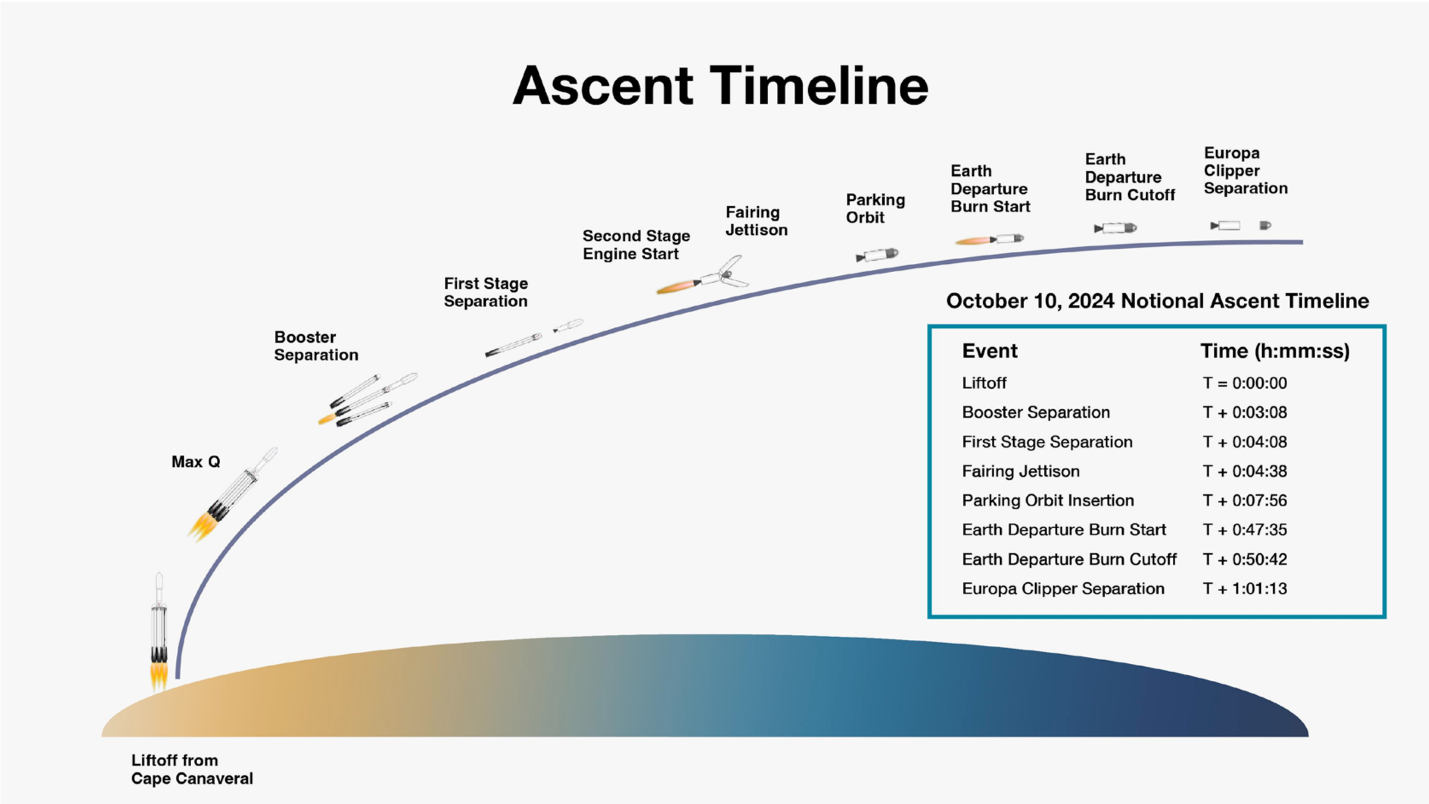
Throughout the launch period, liftoff is expected around midday EDT (in the morning PDT), moving slightly earlier each day. The launch window each day is instantaneous. For a table of launch dates and liftoff times, visit the launch timetable at science.nasa.gov/mission/europa-clipper/launch-windows.

Europa Clipper's team had to carefully plan the spacecraft's launch period because of celestial mechanics. The spacecraft needs to fly by Mars, then Earth, to gain velocity for its journey out to Jupiter, and the planets are constantly moving around the Sun. Mission designers had a limited set of choices for when Mars and Earth would be in the right places at the right times. The launch period also needed to account for a fixed date to arrive at Jupiter: April 11, 2030. (The mission required a set arrival date to plan out the complicated tour around Jupiter.)

Launch Sequence

SpaceX's Falcon Heavy is a two-stage rocket with side boosters. Because Europa Clipper needs a lot of energy for its interplanetary trajectory to Jupiter, the rocket for this launch will be fully expendable, with the exception of a recoverable fairing (nose cone). This means that there will be no return of first-stage boosters for this launch, though Europa Clipper is reusing the side boosters from the 2023 launch of NASA's Psyche mission to the asteroid Psyche.

Exact timelines will vary by launch date, but the Europa Clipper spacecraft will separate from the rocket a little over an hour after liftoff. The length of time between liftoff and separation grows slightly through the launch period from about one hour and one minute to about one hour and 10 minutes.

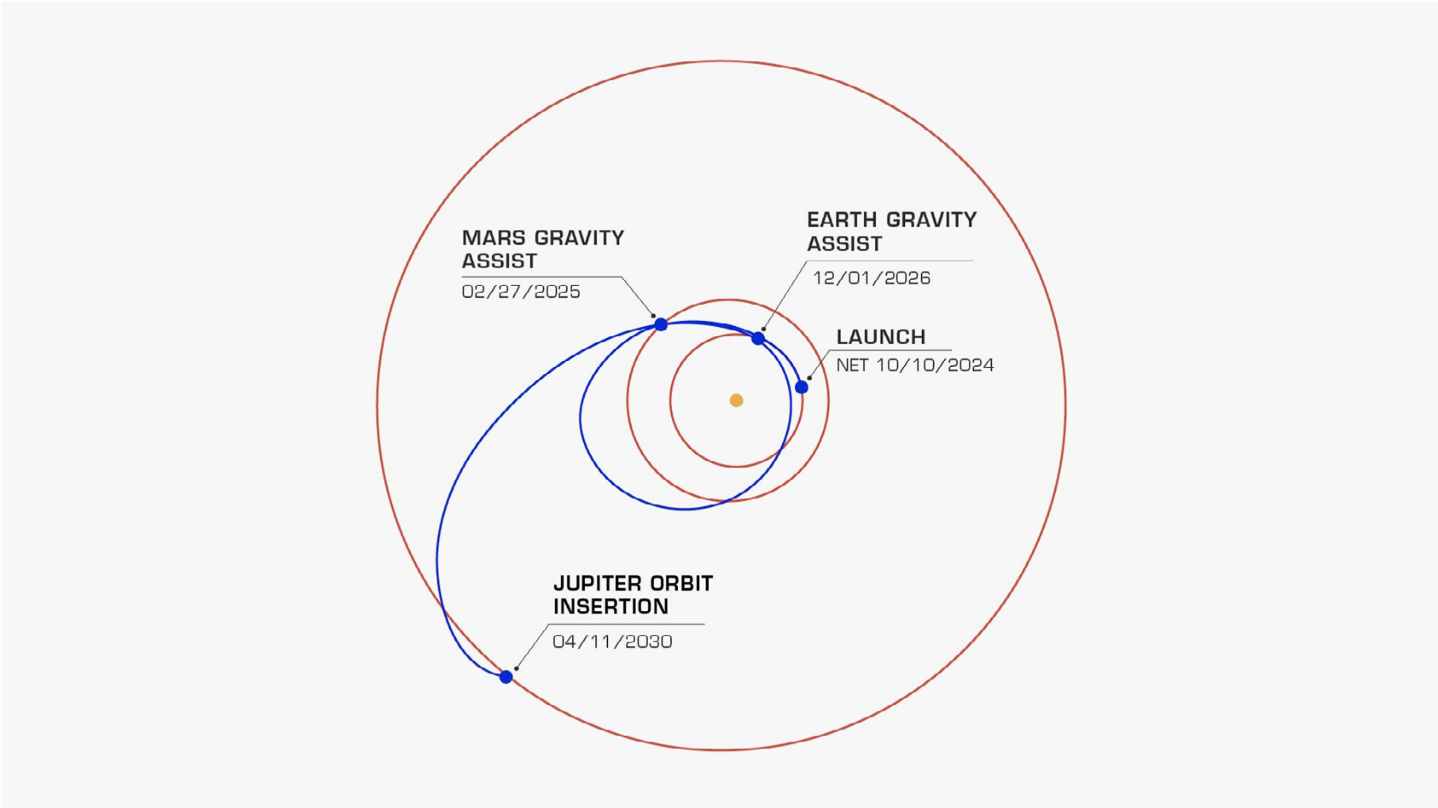


This is a sample ascent timeline for Oct. 10, 2024, the first day of Europa Clipper's launch period. The actual times of milestones will differ slightly depending on the launch day. Credit: NASA/JPL-Caltech | Full Image

After separating from the rocket, Europa Clipper will look for the Sun, as well as prepare the propulsion system to start controlling its orientation in space. Around this same time, the spacecraft will also start attempting to communicate with its operations team on Earth. How soon mission controllers first acquire Europa Clipper's signal will depend on when the spacecraft gets into an orientation that allows it to establish a direct connection with ground stations on Earth. The earliest the mission could acquire the spacecraft's signal is about five minutes after separation, but it may take up to about 19 minutes. The first data is expected to indicate that the spacecraft is alive but may not include full engineering information (telemetry), which allows engineers to assess how the spacecraft is functioning. That data is expected about 19 minutes after separation.

Another critical activity that takes place early after separation is the deployment of Europa Clipper's enormous solar arrays. If all goes as expected, the last latch holding the solar arrays folded against the spacecraft bus will be released at about two hours after the spacecraft separates from the rocket, and the arrays will take about 10 minutes to unfold.

Interplanetary Cruise



To boost its velocity out to Jupiter, the Europa Clipper spacecraft will make close flybys of Mars and then Earth, using the gravity of those planets to slingshot the spacecraft toward the outer solar system. Credit: NASA/JPL-Caltech | Full Image

During the cruise phase, Europa Clipper will travel to its destination in the Jupiter system and prepare for its activities there. This phase begins about a day after launch and lasts about five years and three months.

Europa Clipper will fly relatively close to Mars and Earth for two maneuvers known as gravity assists: The spacecraft will use the speed at which each planet travels around the Sun, harnessing the planet's gravity to increase Europa Clipper's own speed and change its direction. (This effect is similar to how a ball thrown at a moving train will bounce off the train in another direction at a higher speed.) Gravity assists help a spacecraft reach its destination faster for a given amount of propellant.

Depending on when Europa Clipper lifts off in its launch period, the Mars flyby will take place between Feb. 28 and March 4, 2025, with altitudes varying between about 304 and 646 miles (490 to 1,040 kilometers) above the surface. The Earth flyby will take place between Dec. 2 and 7, 2026, with altitudes varying from about 1,951 to 2,144 miles (about 3,140 to 3,450 kilometers) above the surface, depending on the actual launch date.

In addition, the mission team plans to shape the spacecraft's orbit with trajectory correction maneuvers, which require firing thrusters to keep the spacecraft on the right path to Jupiter.

During cruise, the spacecraft team will also deploy the magnetometer boom and radar antennas, test instruments and subsystems, and make sure the spacecraft is ready to study the Jupiter system.

Arrival

For all liftoff dates within the launch period, the spacecraft is scheduled to begin orbiting Jupiter on April 11, 2030. The arrival phase begins in January — three months before the engine burn that inserts the spacecraft into Jupiter orbit — and concludes a few hours after the maneuver.

Toward the end of the arrival phase, the spacecraft will perform a close flyby of the large Jovian moon Ganymede. The Ganymede flyby, which takes place about 12 hours before Jupiter orbit insertion, brings the spacecraft to within about 120 miles (200 kilometers) of Ganymede's surface.

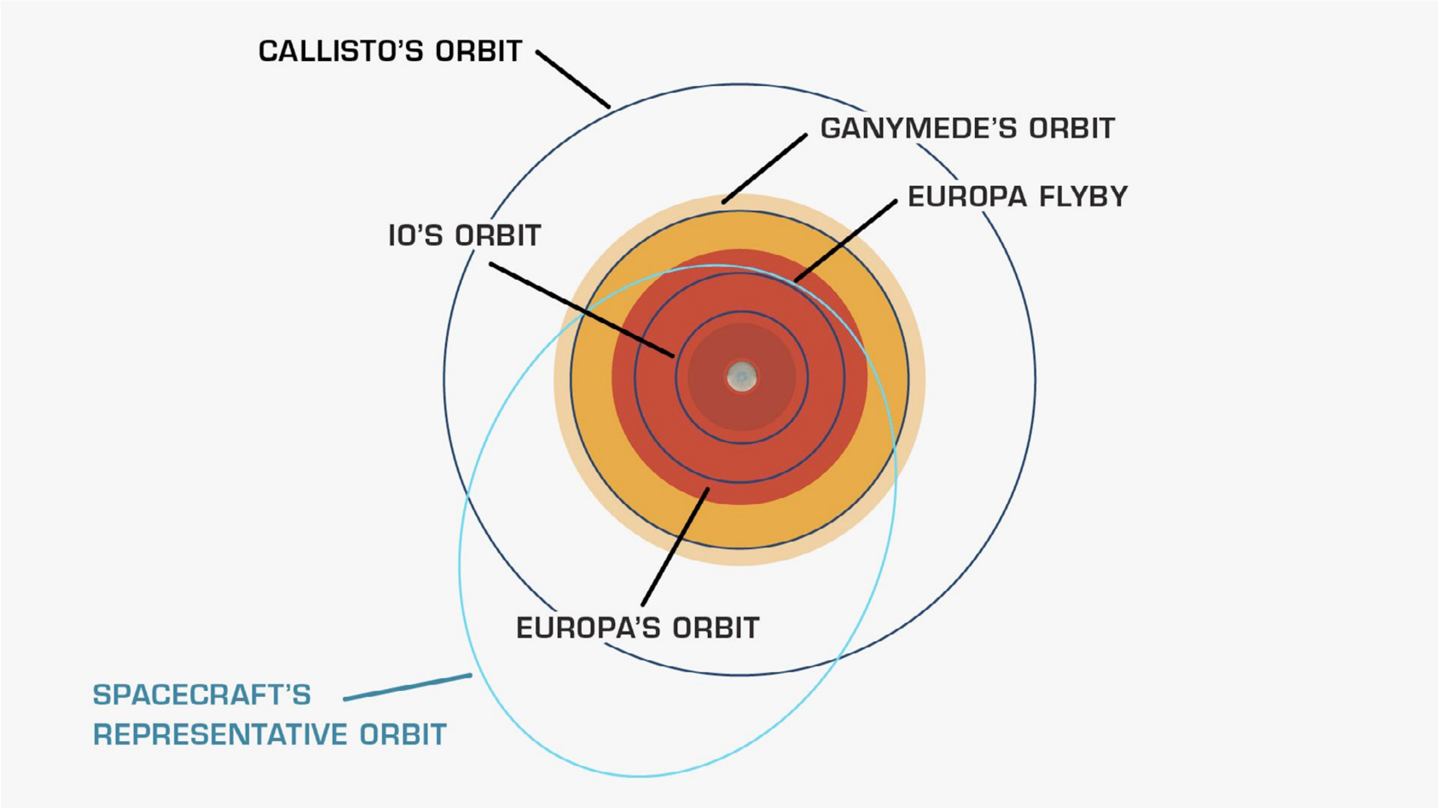
While the spacecraft will use Mars' and Earth's gravity to speed up on the way to Jupiter, the spacecraft will use Ganymede's gravity to slow down. Ganymede's gravity will pull the passing spacecraft back toward the moon, decreasing its velocity.

With the assist from Ganymede, the spacecraft can decrease the amount of time it needs to burn its engines to slow down enough to be captured by Jupiter's gravity. (The burn in this case will be about six hours.) After this burn, Europa Clipper will start its first orbit around the solar system's largest planet.

Jupiter Tour

Europa Clipper's tour of the Jupiter system begins April 11, 2030. The trajectory is designed to allow the spacecraft to observe as much of the moon Europa as possible while keeping the spacecraft as safe as possible from the hazardous radiation environment near the moon.

Capable of quickly damaging electronics, Jupiter's radiation environment is the most intense of any planet in the solar system. Europa resides in one of the most powerful zones of radiation around Jupiter.



This simplified illustration shows the average orbits of several moons around Jupiter and the radiation environments around the giant planet. The more intense the red color, the more dangerous the radiation. Europa's orbit is within the red zone, which means it is very hazardous for a spacecraft to stay within for extended periods. Mission designers have planned Europa Clipper's orbits — an example is shown in blue — where the spacecraft dips into the dangerous radiation zones for only limited periods of time. Credit: NASA/ JPL-Caltech | Full Image

Previous Jupiter missions have spent less time in the hazardous radiation zones. NASA's Galileo mission only flew a handful of times by Europa and Io, the moons in the most hazardous zones around Jupiter, during its primary mission from 1995 to 1997. Then, during its extended mission, which ended in 2003, Galileo did take on additional risk later in its tour of Jupiter by flying by Europa and Io several more times.

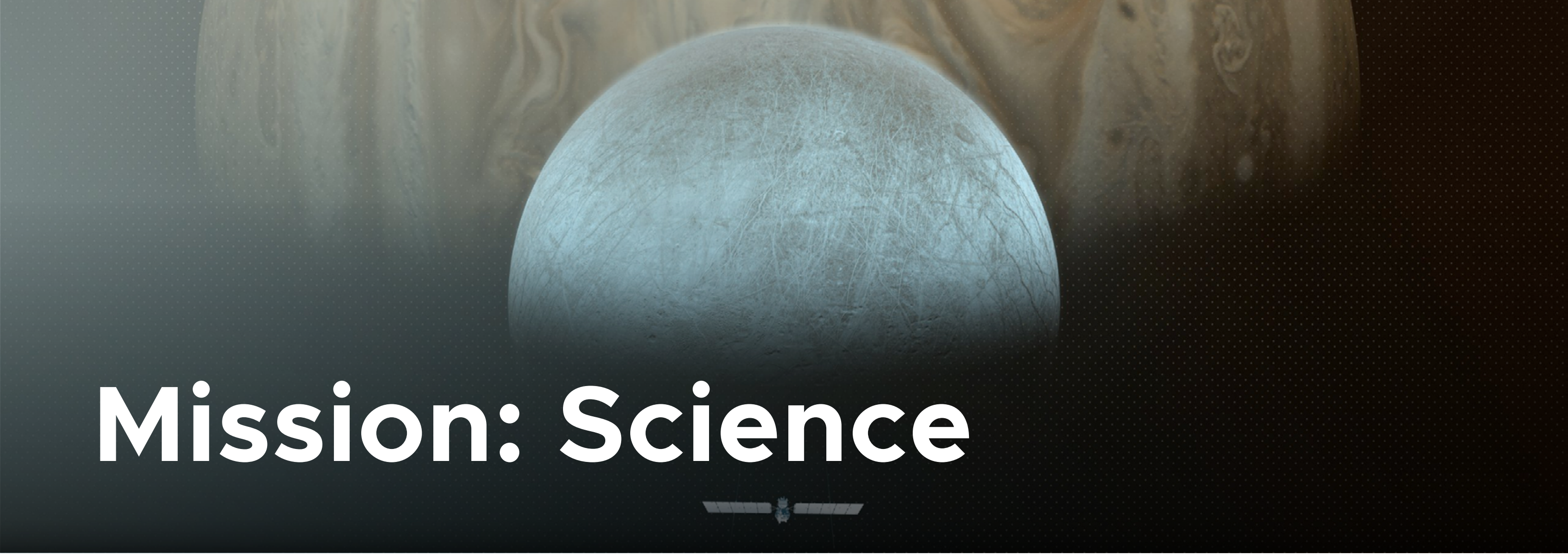
The radiation is also on average more dangerous in the plane around the planet's equator. NASA's Juno spacecraft, which arrived at Jupiter in 2016, generally orbits over the planet's poles. Like Europa Clipper, Juno's trajectory throughout its mission has also been designed to minimize time spent within Jupiter's most powerful radiation belts.

Europa Clipper's mission at Jupiter involves 49 flybys of Europa dedicated to scientific investigation, plus seven additional flybys of Ganymede and nine flybys of Callisto to help shape the spacecraft's trajectory.

For more on what kinds of science data Europa Clipper will be gathering during its tour of the Jupiter system, see the Science section.

End of Mission

Because it is scientifically important to ensure that the Europa Clipper spacecraft does not come in contact with Europa's surface and contaminate the moon with significant numbers of Earth microbes, NASA's current plan to dispose of the spacecraft after its science mission ends is by impacting with Ganymede. Planetary contamination is not an issue with Ganymede because Ganymede's surface is likely not active today and its ice shell is substantially thicker than Europa's, minimizing contact between the spacecraft and any possible ocean underneath. The current plan for disposal begins 30 days after the last science-dedicated flyby of Europa. Mission designers have planned for several additional flybys of Europa to shape the spacecraft's trajectory toward a final impact with Ganymede, which is currently expected in September 2034.



Mission: Science

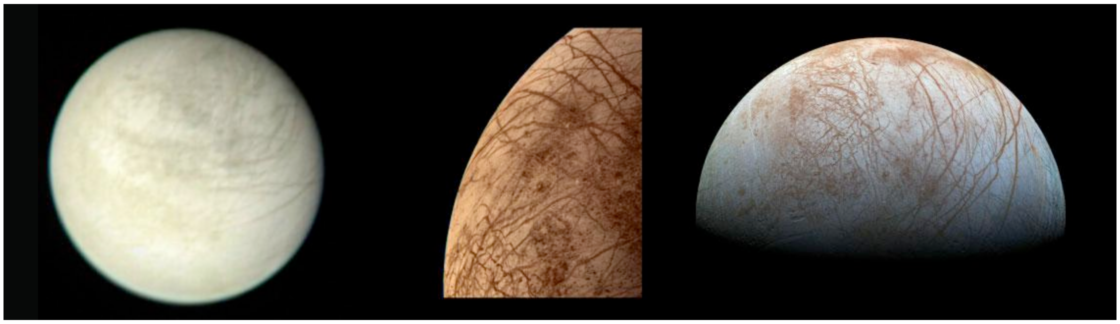
Why Europa?

Life beyond our own planet might exist under conditions that humans would struggle to imagine. We only know for certain the conditions that life needs here on Earth: a source of energy, appropriate chemical compounds, and water. Scientists suspect that Europa has all the necessary ingredients for life as we know it, including an enormous ocean under its thick, icy crust. Plus, Europa has time on its side: Scientists believe the moon has been harboring that subsurface ocean for 4 billion years — likely ample time for ingredients to “simmer” and for life to develop.

Here’s what we know about Europa’s potential ingredients for life: water, chemistry, and energy.

Water

Scientists have known for a long time that Europa’s surface is made mostly of water ice, judging from ground-based telescopic observations that began in the 1960s. Then in 1979, NASA’s Voyager spacecraft captured images of the surface that showed bands and ridges crisscrossing each other, with dark gaps that looked like they had been filled with icy or watery material. These images also showed only a handful of large impact craters, which usually accumulate on the surface of planets and moons over time as they are battered by pieces of comets and asteroids. So scientists theorized that even though Europa is over 4 billion years old, its surface may be much younger. Some kind of geologic activity, which could include tectonics (fracturing and faulting) and cryovolcanism (flowing, slushy ice instead of molten lava) must have refreshed the surface.



Europa as seen by NASA's Voyager 1, Voyager 2, and Galileo spacecraft (L-R).
Credit: NASA/JPL-Caltech | Full Image

Enter NASA's Galileo mission, which began orbiting Jupiter in 1995. One of the most important measurements by the spacecraft showed that Jupiter's magnetic field was altered in the space around Europa. This finding strongly implied that a special type of magnetic field had been created within Europa by a layer of fluid that conducts electricity. Based on the moon's icy composition, scientists think the fluid most likely to create this magnetic signature is a global ocean of salty water. They estimate that the ocean holds about twice as much water as all of Earth's oceans combined. Images from the Galileo spacecraft show how bizarre Europa's surface is, with many different kinds of ridges, and with chaotic areas where the surface has moved and is jumbled.

Chemistry

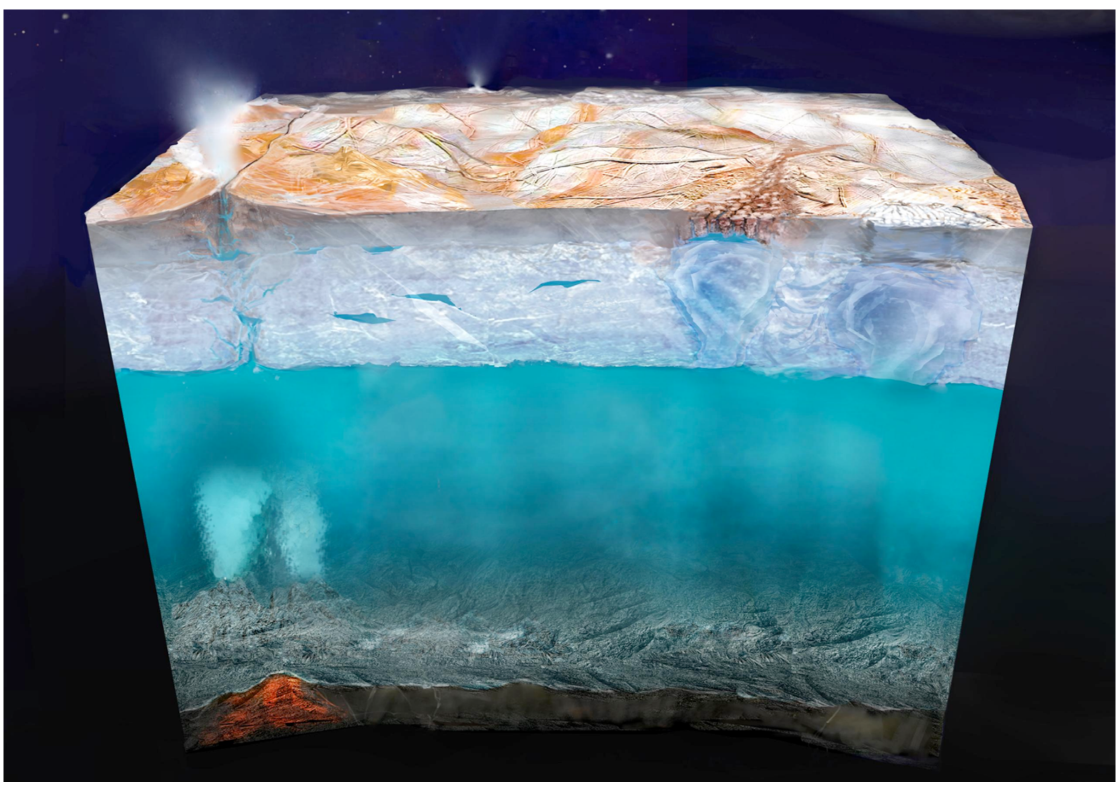
All life on Earth is built from organic molecules, which are made from certain chemical elements, including carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur. Scientists know from observations from ground-based and space telescopes that there are non-ice materials on Europa's surface, such as salts and carbon dioxide (dry ice). Organic molecules are expected, likely incorporated into Europa's crust as the moon formed and, later, as pieces of asteroids and comets collided with the moon, possibly leaving more organic materials. However, scientists do not yet have direct observations of organic molecules at Europa or of all the chemical elements needed to build them.

Some essential chemical elements may be embedded in Europa's icy shell. Others may originate from Europa's core and the moon's rocky interior. A process called tidal flexing, which happens as Europa orbits Jupiter and is intermittently squeezed by the massive planet's gravity, heats Europa's interior and may cycle water and nutrients between the moon's rocky interior, ice shell, and ocean. This watery environment may have the right conditions for chemistry conducive to life.

Energy

All lifeforms need energy to survive. On Earth, most of that energy for life comes from the Sun. For example, photosynthesis converts sunlight into energy for plants. On Europa, life would need a different energy source, because life could exist only beneath the moon's surface, where it would be protected from radiation. Instead of photosynthesis, it could be chemical reactions that provide the energy to fuel any lifeforms.

Chemical reactions are powered by a chemical imbalance, similar to the opposite ends of a battery. On Europa's seafloor, one end of the chemical battery can be created by reactions between water and rock, amplified by tidal heating, which results from tidal flexing of Europa. A warm seafloor could also indicate the presence of hydrothermal vents supplying chemical energy as they do on Earth's ocean floors, where they power vibrant ecosystems. The other end of the chemical battery could come from oxygen-containing materials created on Europa's surface when high-energy radiation strikes the surface ice. If these oxygen-containing materials can move from the surface down into the ocean, they could react with chemicals from the seafloor. In this way, Europa's ocean could have the chemical energy to power life.



Artist's concept of Europa's outer structure, including an icy shell and subsurface ocean. Credit: NASA/JPL-Caltech | Full Image

Science Goals and Objectives

NASA planetary science is guided by planetary science reports conducted every 10 years by the United States National Research Council. These decadal surveys, published in 2003, 2011, and 2022, recognized Europa as one of the best places in our solar system to look for signs of life. In 2015, NASA formally initiated the Europa Clipper project.

Goal

Europa Clipper is not designed to be a life-detection mission. Its primary science goal is to explore Europa to investigate its habitability. Europa Clipper will determine whether the moon is habitable — in other words, find out for certain if it has the ingredients for life and the potential to host it.

Objectives

To evaluate Europa's habitability, scientists need to better understand how the moon works. They will pursue three science objectives: assess the moon's interior, composition, and geology.

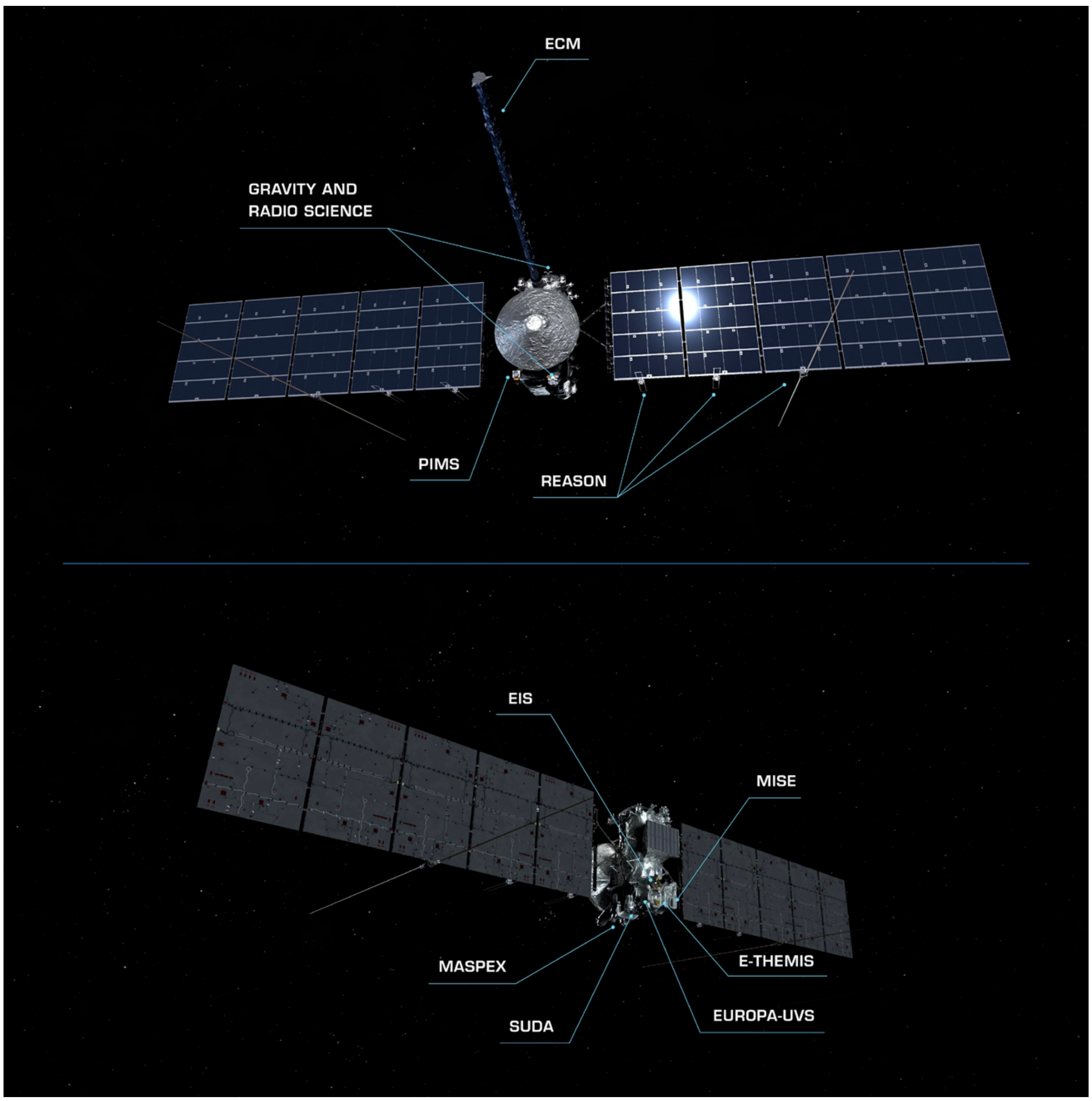
Interior: Focusing on the ice shell and the ocean, scientists will be able to determine a range of measurements for how thick the shell is. Does water from the ocean rise through the icy shell to the surface? Does anything from the surface work its way down into the ocean? Does the icy shell itself contain pockets of water inside it? Scientists want to know how deep and salty the ocean is in order to understand its potential to host life.

Composition: Scientists will investigate what makes up Europa's ocean, ice shell, surface, atmosphere, and space environment. They will learn about the chemistry of these materials and what their interaction says about the moon's ability to sustain life.

Geology: Studying how surface features formed and if any of the surface was refreshed recently will tell scientists how active the moon is and what creates those features, including ridges, bands, and chaos. The mission will look for evidence of plumes that could be venting water into space, as well as signs of sliding crustal plates. In this way, investigation of the geology will lend insight into not just the exterior of the moon, but also how the surface interacts with any water inside or underneath the icy shell.

Science Instruments

Determining if an ocean moon is habitable requires teamwork. For example, planetary geologists must understand Europa's surface features and what they are made of. But they also need to know how radiation affects the surface and how the ocean's chemistry works. Rather than looking at each set of data as an independent study, scientists will interweave them. Europa Clipper's nine science instruments are designed to collect information in tandem with one another during flybys of the moon, with the goal of contributing to each other's findings and creating a fuller understanding of this ocean world.



Artist's concept shows locations for Europa Clipper's science instruments. Credit: NASA/JPL-Caltech | Full Image

Cameras

Europa Imaging System (EIS)

Europa Clipper's visible-light cameras (extending slightly into near-infrared and ultraviolet wavelengths) will capture color and stereoscopic images of Europa's ridges, grooves, bands, and other surface features in unprecedented detail. EIS, which includes a narrow- and a wide-angle camera, will map about 90% of Europa at better than 330 feet (100 meters) per pixel. The imaging system will look for evidence of recent surface changes, which will tell scientists about geologic activity and how it relates to the materials on the surface.

Europa Thermal Emission Imaging System (E-THEMIS)

The thermal imager uses infrared light to distinguish warmer regions on the moon, where water may be near the surface or might have erupted onto the surface. Together with EIS, E-THEMIS will reveal much about Europa's geologic activity.

Spectrometry

Europa Ultraviolet Spectrograph (Europa-UVS)

Atoms and molecules emit, absorb, and reflect light in telltale ways. Scientists use spectrometry to dissect wavelengths of light and learn about the composition of surfaces and particles in space. By collecting ultraviolet light with a telescope and creating images, Europa-UVS will help determine the composition of Europa's atmospheric gases and surface materials. It also will monitor Europa's thin atmosphere and search for signs of plumes being emitted from the moon's surface.

Mapping Imaging Spectrometer for Europa (MISE)

The infrared spectrometer will reveal details about the chemistry of the top layer of Europa's ice shell. MISE will map the distribution of ices, salts, and organic compounds, and those maps will help scientists better understand the moon's geologic and compositional processes and history.

Magnetic Field and Plasma

Europa Clipper Magnetometer (ECM)

The spacecraft's magnetometer will be key to characterizing the ocean under Europa's icy shell. Jupiter's magnetic field is the largest of the solar system's planets and movement relative to Europa induces a magnetic field at Europa, most likely via electric currents flowing in the ocean. With a sensor deployed on a boom 25 feet (8.5 meters) long, the ECM will tell scientists more about the ocean, including how conductive and how deep it is — as well as how thick the ice shell is.

Plasma Instrument for Magnetic Sounding (PIMS)

The magnetometer will work hand-in-hand with PIMS to help scientists be sure they're studying clean, accurate measurements of Europa's induced magnetic field. They need to know more about the plasma — charged particles in ionized gas — that is trapped around Jupiter to understand how it affects Europa's magnetic field.

Radar

Radar for Europa Assessment and Sounding: Ocean to Near-surface (REASON)

Europa's radar instrument will be able to "see" below the moon's surface into the icy shell to search for any pockets of water inside it — and to determine how the ice and water within interacts with the ocean below. REASON will also study the moon's surface elevations.

Chemical Analysis

MAss Spectrometer for Planetary EXploration/Europa (MASPEX)

To identify the chemical makeup of the gases in Europa's extremely thin atmosphere, MASPEX will collect gases around the moon, including those in any potential plumes of water vapor. The instrument will then analyze their chemical makeup. Understanding the gases near Europa tells scientists more about the moon's ocean, how it interacts with the surface, and how radiation alters materials on the surface.

Surface Dust Analyzer (SUDA)

Scientists expect Europa Clipper to encounter not just gases but also dust particles that form in a thin cloud around the moon. Some of these particles will fly into the SUDA instrument and be vaporized, permitting the instrument to analyze their chemical makeup. SUDA data will tell scientists whether this material came from Europa or from elsewhere in the Jupiter system — possibly detecting organic compounds and helping scientists gauge the ocean's salinity.

Science Investigation Using Communications System

Gravity and Radio Science

While not a science instrument, the spacecraft's telecommunication system will help scientists investigate the interior of Europa. By analyzing the radio signals sent back and forth through space via the spacecraft's low-gain antennas, scientists can study how the frequency of these signals changes. Understanding that fluctuation will offer details about the motion of the spacecraft, which is affected by Europa's gravity field. Analyzing the gravity field, in turn, will reveal more details about the internal structure of the moon, including confirming the presence of the ocean that scientists suspect is there.

Joint Science with ESA (European Space Agency)

Europa Clipper isn't the only spacecraft set to study Europa in the 2030s. In April 2023, ESA launched its Jupiter Icy Moons Explorer (Juice), which will arrive in Jupiter orbit in 2031. Juice's main focus is Ganymede, which it will orbit for at least a year, conducting two prior flybys of Europa and 21 flybys of Callisto as well. Scientists for each mission are collaborating to design investigations that complement one another and can take advantage of the unprecedented opportunity of having two spacecraft in the Jupiter system at the same time. For example, collecting and comparing data simultaneously in locations near Europa could lend insight that neither mission team would gain on its own.

Mission: Spacecraft

A compelling and challenging target of study like Europa requires a special spacecraft. Equipped with expansive solar arrays, a suite of sophisticated science instruments, two dozen engines, and a radiation-hardened electronics vault, Europa Clipper is, when its solar arrays and antennas are fully deployed, the largest spacecraft NASA has ever built for a planetary mission.

When stowed for launch, the spacecraft is about 15.5 feet (4.7 meters) tall, 10 feet (3 meters) wide, and 13 feet (4 meters) deep. With solar arrays fully deployed, Europa Clipper stretches over 100 feet (30.5 meters) wide, while the body and its radar antennas measure about 58 feet (17.6 meters) deep.

The heavy radiation environment at Jupiter is tough on spacecraft, so Europa Clipper has a metal vault with thickened walls to protect its sensitive electronics. The vault features a unique plate engraved with messages in the form of artwork and poetry, along with a microchip stenciled with more than 2.6 million names submitted by the public.

Combining elements from multiple NASA centers and partners, the spacecraft was assembled principally at NASA's Jet Propulsion Laboratory in Southern California. The propulsion module — the structure of the main spacecraft body — was designed and built at the Johns Hopkins Applied Physics Laboratory in Laurel, Maryland, in collaboration with NASA's Goddard Spaceflight Center in Greenbelt, Maryland. Engineers at JPL then outfitted the module with key components, including nine science instruments, the electronics vault, and a high-gain antenna measuring 10 feet (3 meters) wide. Europa Clipper's large solar arrays were added during final prelaunch preparations at NASA's Kennedy Space Center in Florida.

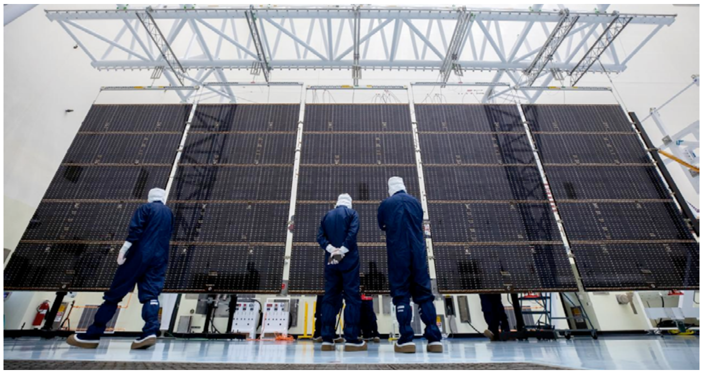
At launch, the fully fueled Europa Clipper is expected to weigh approximately 12,800 pounds (about 5,800 kilograms). Over 6,060 pounds (about 2,750 kilograms) will be propellant.

Instruments

Europa Clipper features nine science instruments, plus a gravity and radio science investigation that uses the spacecraft's communications system. The instruments are located in several places on the spacecraft, with most concentrated on two sides: one set facing Europa's surface during flybys and one pair facing in the spacecraft's direction of travel. A 28-foot (8.5-meter) boom extending from the spacecraft bus holds Europa Clipper's magnetometer sensors, while radar antennas extend in either direction from the spacecraft's two solar arrays.

Power

Europa Clipper's appearance is dominated by its two large solar arrays, which span more than 100 feet (30.5 meters) from tip to tip. Each array is composed of five panels, and measures approximately 46.5 feet (14.2 meters) wide and about 13.5 feet (4.1 meters) tall. Together the arrays provide about 1,100 square feet (102 square meters) of surface area for generating power.



Technicians at NASA's Kennedy Space Center examine one of Europa Clipper's two five-panel solar arrays. Credit: NASA/Ben Smegelsky
Full Image

Jupiter's distance from the Sun — over five times that of Earth's distance — makes such large solar arrays a necessity. The planet's radiation environment will also slowly degrade the arrays' performance over time, so the system accounts for that. It is designed to provide at least 700 watts throughout Europa Clipper's prime mission. When initially deployed shortly after launch, while the spacecraft is closer to the Sun, the solar arrays are expected to generate around 23,000 watts.

Propulsion

Europa Clipper's propulsion module — the structure of the main spacecraft body — is an aluminum cylinder about 10 feet (3 meters) tall and 5 feet (1.5 meters) wide. Its tanks can hold over 6,060 pounds (2,750 kilograms) of propellant. The system's 24 engines, each capable of generating 27.5 newtons of thrust, are used up to eight at a time for a maximum thrust of 220 newtons.

Thermal

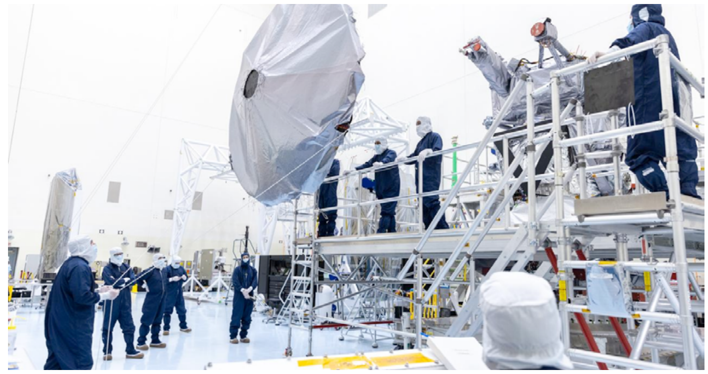
Europa Clipper must maintain a delicate thermal balance throughout its mission. While cruising through the inner solar system, the spacecraft endures considerable heating from the Sun, with some components able to reach temperatures above 212 degrees Fahrenheit (100 degrees Celsius). In such an environment, Europa Clipper must actively cool itself. But when operating farther out at Jupiter, the spacecraft must carefully manage its own heat so that it does not freeze during worst-case cold conditions, which could plunge some parts of the spacecraft to minus 382 F (minus 230 C).

Similarly, during flybys of Europa, when all its systems and instruments are turned on to collect and store science data, the spacecraft needs to recirculate the electronics' heat to prevent overheating. And to optimize the collection of science data, Europa Clipper must cool some detectors on its instruments below minus 310 F (minus 190 C).

To manage these fluctuating extremes, pumps on Europa Clipper circulate fluids through pipes to the spacecraft's sensitive electronics, carrying heat from hot spots to cold spots. Europa Clipper also has a radiator (which can be opened to shed heat), temperature sensors, heaters, and custom-sewn thermal blankets to help regulate the spacecraft's temperature.

Communications

Europa Clipper is equipped with a 10-foot-diameter (3-meter) dish-shaped high-gain antenna to communicate with Earth. The spacecraft also carries seven smaller antennas that provide redundancy and will be used for gravity and radio science investigations. Mounted in various locations and orientations around the spacecraft, they will allow Europa Clipper to maintain communication even when operations require it to point its high-gain antenna away from Earth. For example, during its cruise through the inner solar system, Europa Clipper will orient itself such that it can use its high-gain antenna as a sun shield. When the spacecraft is flying by Europa, the high-gain antenna will point upward and away from the moon, and not toward Earth.



Technicians at NASA's Kennedy Space Center prepare to install Europa Clipper's 10-foot (3-meter) high-gain antenna. Credit: NASA/Kim Shiflett
Full Image

Like all NASA interplanetary missions, Europa Clipper will send data and receive commands via the agency's Deep Space Network, which has three ground stations equidistant around Earth to communicate with and track spacecraft at or beyond the Moon. The Deep Space Network then routes the data back to Europa Clipper mission controllers through a ground data system at JPL.

Intense Radiation

Orbiting close to Jupiter, Europa is subject to intense radiation around the giant planet. To explore this hostile environment, Europa Clipper must orbit Jupiter at a distance, dipping in for a series of targeted flybys of Europa rather than orbiting the icy moon directly. However, even that will not be enough to fully avoid damage to the spacecraft's sophisticated electronics. To further protect the mission, Europa Clipper is outfitted with a special vault to shield these critical components.

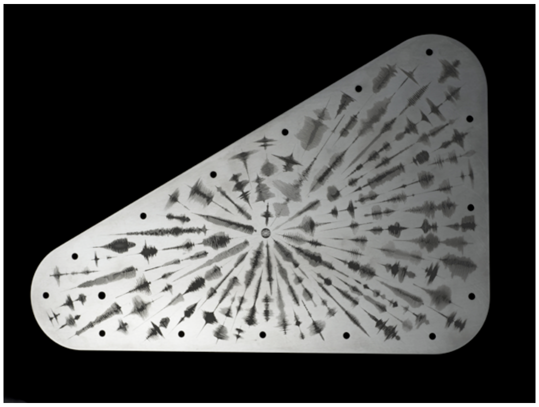
Made from sheets of aluminum-zinc alloy up to 0.36 inches (9.2 millimeters) thick, the vault is bolted to Europa Clipper's propulsion module, the structure of the main spacecraft body. Inside sit radiation-sensitive electronics that control key systems, such as the science instruments, guidance and control systems, and thermal pumps.

Europa Clipper's mission team will closely track the spacecraft's radiation exposure and performance throughout the mission. One of the tools the spacecraft carries is a radiation monitor, which uses a network of sensors to keep tabs on its instruments and engineering subsystems. Primarily used as an engineering tool, the radiation monitor will also allow scientists to gauge how much their data collection is affected by radiation.

A Message in a Bottle for the Cosmic Ocean

In keeping with a long tradition of NASA missions carrying inspirational messages from Earth, Europa Clipper's design incorporates a unique metal plate engraved with poetry, artwork, and other messages that pay tribute to the connection between Europa's ocean world and our own. Made of the metal tantalum, the triangular plate is about 7 by 11 inches (18 by 28 centimeters) and seals one of the openings on the electronics vault.

The outward-facing side of the vault plate features a design called "Water Words" — a visual representation of recordings of the words for water in over 100 languages from around the world. Water connects all life as we know it, as well as all human cultures.

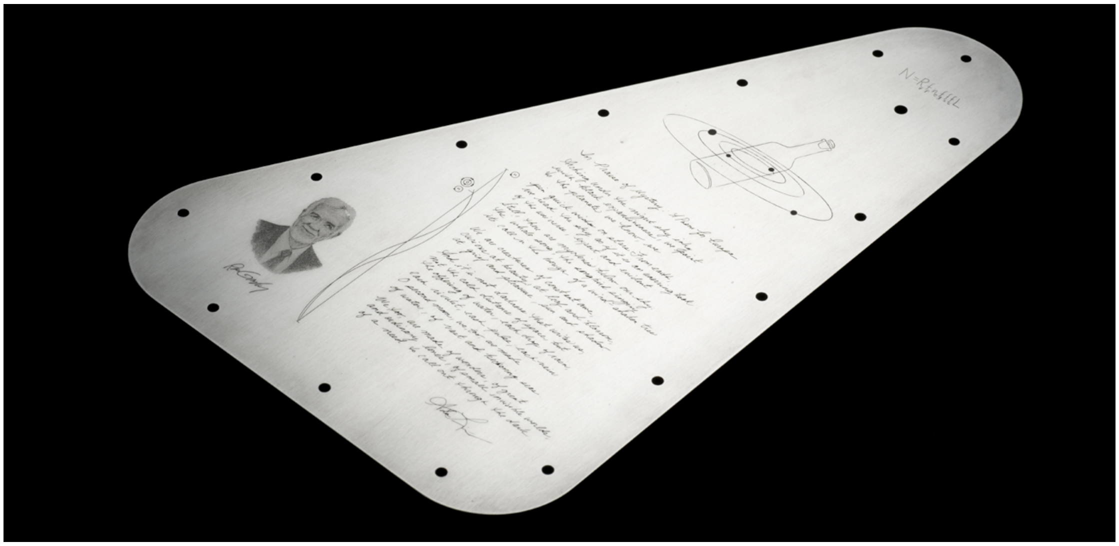


The outward-facing side of Europa Clipper's vault plate features waveforms representing the sound waves formed by the word "water" in 103 languages. At center is a symbol representing the American Sign Language sign for "water." Credit: NASA/JPL-Caltech | Full Image

Water also connects Earth and Europa, the two ocean worlds that the Europa Clipper spacecraft travels between on its journey. NASA's "Message in a Bottle" campaign invited people around the world to "sign" their names to a poem written by the U.S. Poet Laureate Ada Limón. The poem, titled "In Praise of Mystery: A Poem for Europa," is engraved in Limón's own handwriting on the inward-facing side of the vault plate.

"In Praise of Mystery: A Poem for Europa" by U.S. Poet Laureate Ada Limón
bit.ly/3XhhCKg

Above the poem is a drawing that represents the Jovian system and the orbits of its four largest moons, including Europa. An illustrated bottle shown at the center contains a dime-size microchip featuring 2.6 million names submitted by the public. The names were stenciled on the chip with an electron beam, which wrote each line of text at less than one-one-thousandth the width of a human hair (75 nanometers).



Adorning the inward-facing side of Europa Clipper's vault plate are a handwritten poem by U.S. Poet Laureate Ada Limón, more than 2.6 million names submitted by the public (on a tiny silicon chip added to the plate after this photo was taken), and additional tributes to scientific curiosity. Credit: NASA/JPL-Caltech | Full Image

Also on the inward-facing side of the vault plate are three additional visual elements of particular meaning to the mission team:

— The Drake Equation: a mathematical formula, developed in 1961 by Astronomer Frank Drake (1930-2022), that estimates the possibility of finding advanced civilizations beyond Earth and has inspired related research ever since.

— Radio Emission Lines: an illustrative reference to radio frequencies considered plausible for interstellar communication, symbolizing how humanity uses the language of science and mathematics to follow its curiosity about life in the cosmos.

— A Tribute to Planetary Scientist Ron Greeley: a portrait of one of the pioneers of planetary science, Ron Greeley (1939-2011), whose early efforts to develop a Europa mission two decades ago laid the foundation for Europa Clipper.

For more on the unique design of Europa Clipper's vault plate, visit go.nasa.gov/makewaves.

Mission: Biological Cleanliness

The United States has obligations under the international 1967 Outer Space Treaty to explore space in a responsible manner that avoids the harmful contamination of celestial bodies. To help meet these obligations, Europa Clipper planetary protection requirements address the biological cleanliness of the spacecraft and the need to not contaminate Europa's ocean with microbes from Earth. These requirements are intended to minimize the chance that biological material brought from Earth could compromise future scientific investigations of Europa.

Planetary protection categories range from I to V, extending from the fewest protocols to the most. Outbound orbital missions to celestial bodies that may have an environment suitable for life (now or in the past) — including Jupiter's moon Europa — fall into Planetary Protection Category III.

A Clean Workspace

To meet NASA's cleanliness standards, engineers in full-body protective gear assembled the Europa Clipper spacecraft in a clean room at JPL where a number of other missions with strict requirements were built, including NASA's Perseverance Mars rover. Environmental conditions within the clean room are strictly monitored, and the air is thoroughly filtered. The surfaces and floors of the clean room, as well as mission hardware, are frequently treated with strong cleaning solutions to kill and remove living microbes. Mission hardware, as well as tools used for spacecraft assembly, are routinely sampled to calculate the estimated number of microbes on them.

A planetary protection scientist in full-body protective gear carefully collects samples from the Europa Clipper spacecraft to verify its cleanliness. Credit: NASA/JPL-Caltech | Full Image

At launch, Europa Clipper is estimated to have fewer than 350,000 bacterial spores on it. If all those spores were gathered in one place, they could fit on the tip of a ballpoint pen.

Contamination Control

In addition to keeping microbes off Europa Clipper, engineers must also monitor and control nonliving materials that could shed and collect on the spacecraft and its science instruments, affecting their performance. For some missions, even thin contamination layers can cause problems. A surface contamination layer just 20 or 30 molecules thick — far smaller than the human eye can see — could be enough to degrade spacecraft or science instrument performance.

Planetary protection samples collected from Europa Clipper during its assembly are prepared for analysis. Credit: NASA/JPL-Caltech | Full Image

Europa Clipper Is Unique

Europa Clipper presents a unique challenge to cleanliness in a few ways. The spacecraft's sheer size is one key consideration. Including its basketball court-length solar arrays, there are approximately 9,688 square feet (900 square meters) to clean and monitor. Each piece has to be treated with care every step of the way from the time it enters a clean room to when it is installed on the spacecraft to when it is loaded into the rocket that will send it to Jupiter.

Spacecraft Makers: How We Keep Europa Clipper Super Clean
bit.ly/3TtSMWv

Jupiter itself provides another challenge due to its high-radiation environment. To prepare for these harsh conditions, engineers conducted extensive testing in which they bombarded thermal blankets, paints, and other spacecraft materials with radiation in a particle accelerator at JPL. During and after this exposure, the materials would outgas, releasing a flurry of microscopic material that could affect the operation of Europa Clipper's sensitive instruments — fogging a camera lens, for instance, or adding noise to a spectrometer's data.

To minimize those kinds of effects, engineers used this radiation testing to select materials with the least outgassing. These materials were then baked between 194 and 248 degrees Fahrenheit (90 and 120 degrees Celsius) to further reduce outgassing before being installed on the spacecraft.

Management

Bill Nelson is the agency administrator at NASA Headquarters in Washington.

The Europa Clipper mission is sponsored by NASA's Science Mission Directorate in Washington, where **Nicola Fox** is the associate administrator and **Gina DiBraccio** is the acting director of the Planetary Science Division. **Dave Lavery** is the Europa Clipper program executive. **Curt Niebur** is the program scientist.

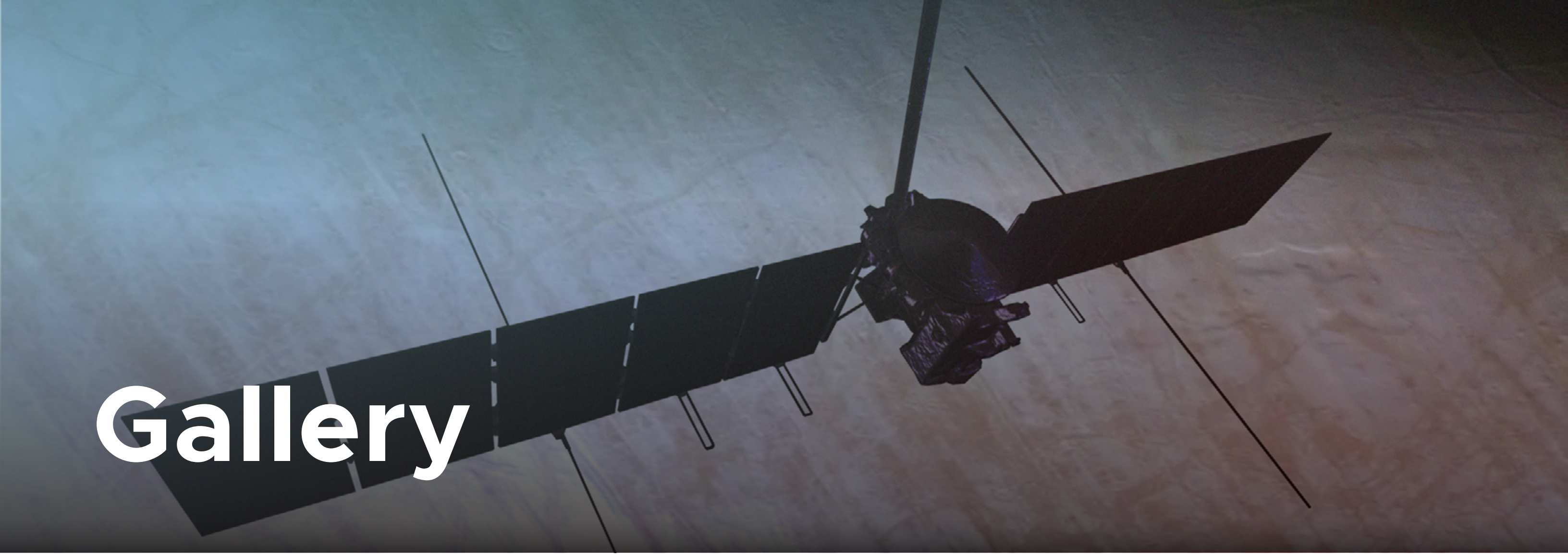
The Planetary Missions Program Office at NASA's Marshall Space Flight Center in Huntsville, Alabama, executes program management of the Europa Clipper mission. **Scott Bellamy** is the mission manager.

NASA's Jet Propulsion Laboratory, a division of Caltech in Pasadena, California, is responsible for the mission's overall management, system engineering, integration and testing, and operations. **Jordan Evans** is the project manager, and **Tim Larso**n is the deputy project manager. JPL's **Robert Pappalardo** is the project scientist, and **Bonnie Buratti** is the deputy project scientist at JPL.

The Europa Clipper mission is being developed in partnership with the Johns Hopkins Applied Physics Laboratory (APL) in Laurel, Maryland. **Tom Magner** is the assistant project manager at APL. **Haje Korth** is the deputy project scientist at APL.

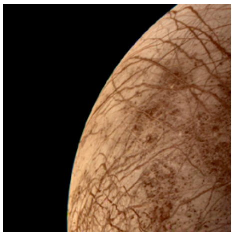
NASA's Launch Services Program, based at the agency's Kennedy Space Center in Florida, is responsible for management of the launch service. For Europa Clipper, **Tim Dunn** is the launch director, and **Armando Piloto** is the mission manager.

For more details on Europa Clipper team members, visit the Europa Clipper mission team page.



Gallery

Images



Europa Clipper Multimedia Page

Curated selection of images and video of Europa Clipper and its target of study, Europa, from various NASA sources, including the libraries below

go.nasa.gov/4duUy1T

NASA Image and Video Library

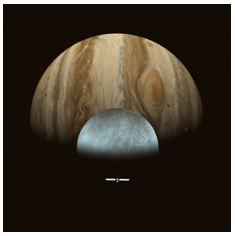
Europa Clipper images and videos from a NASA-wide library
go.nasa.gov/3Vmknco

Planetary Photojournal

Europa Clipper images from the planetary image library managed by NASA's Jet Propulsion Laboratory

go.nasa.gov/3VhR9eK

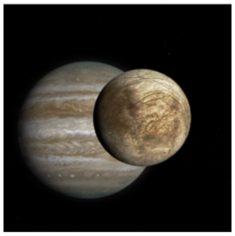
Web Videos



Europa Clipper Mission Trailer

Brief introduction to the Europa Clipper mission

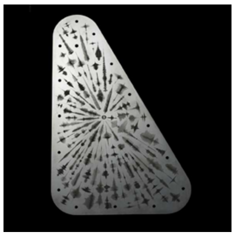
bit.ly/3XFJtWa



Science Overview

Overview of the unique science data Europa Clipper will collect, and the instruments it will use

bit.ly/4b1sWze



NASA's Europa Clipper Vault Plate Carries Special Design

Narrated video about the design of Europa Clipper's vault plate and the special message it will carry into the cosmos

bit.ly/3XsArMr

Europa Clipper Video Playlist

Comprehensive list of JPL videos highlighting the Europa Clipper mission

bit.ly/europaclipperplaylist

Spacecraft Makers Series Playlist

JPL series that goes behind the scenes, focusing on the assembly of the spacecraft

bit.ly/SpacecraftMakers

Behind the Spacecraft Series Playlist

List of all English and Spanish episodes in a series that showcases unique journeys of individuals on the mission

bit.ly/4ekjn0p

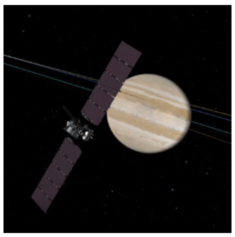
Animations and Raw Videos

Collection of Animations and B-Roll for Media

Mission animations; b-roll of spacecraft assembly, testing, and shipping

bit.ly/EuropaRawVideo

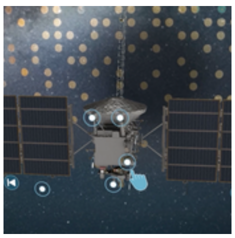
Interactive Experiences



NASA Eyes on the Solar System

Track Europa Clipper's journey from start to finish in this browser-based 3D simulation.

go.nasa.gov/EyesOnClipper



ClipperAR

Explore Europa and the Europa Clipper spacecraft in an augmented reality experience.

go.nasa.gov/44nxxlY