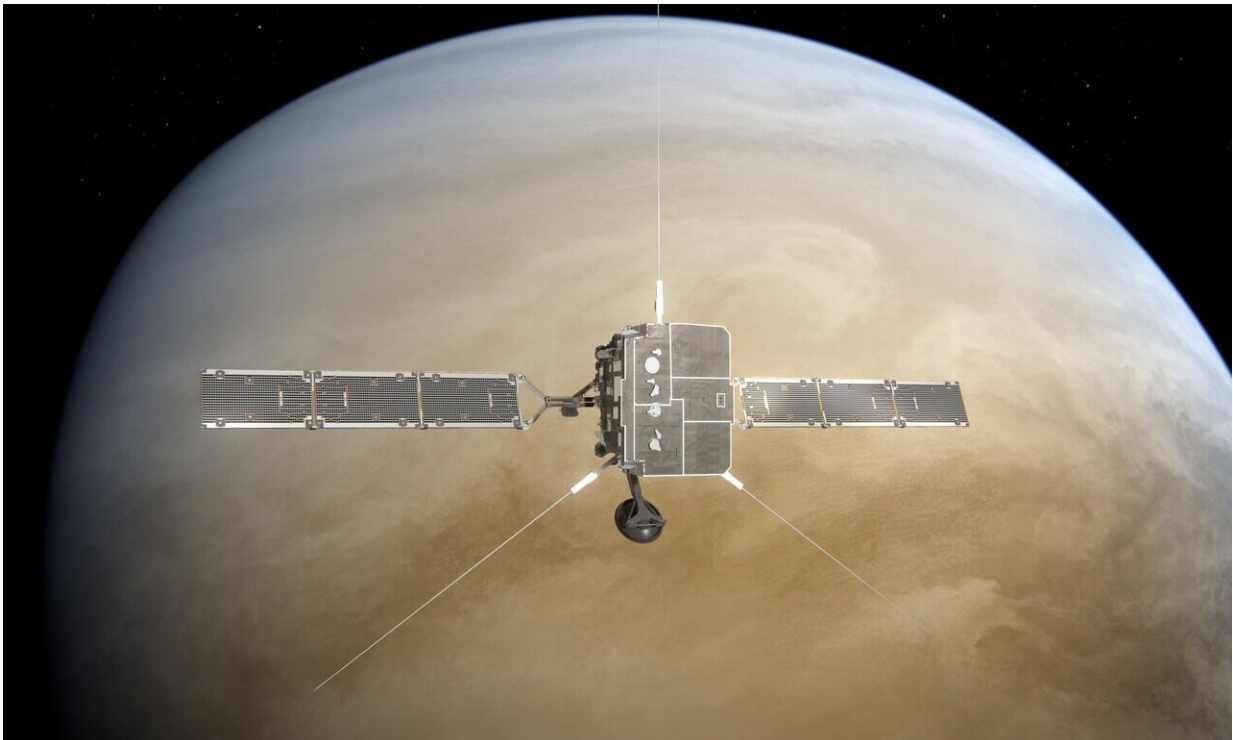


# Solar Orbiter prepares for festive Venus flyby

December 18 2020

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Solar Orbiter Venus flyby. Credit: ESA/ATG medialab

Solar Orbiter is getting ready for the first of many gravity assist flybys of Venus on 27 December, to start bringing it closer to the sun and tilting its orbit in order to observe our star from different perspectives.

Just as the majority of us will remain safely at home under various

COVID-19 pandemic lockdown measures during what is traditionally a holiday period, the flyby—a routine event in the world of flying spacecraft—will also be monitored by the spacecraft operations managers remotely as well.

Closest approach will take place at 12:39 UTC (13:39 CET) on 27 December, and will see the spacecraft fly some 7 500 km from the Venus cloud tops. Later flybys, from 2025, will see much closer encounters of just a few hundred kilometers.

During the upcoming flyby several in-situ science instruments—MAG, RPW and some sensors of EPD—will be switched on to record the magnetic, plasma and particle environment around the spacecraft as it encounters Venus. (It is not possible to take images of Venus during the flyby because the spacecraft must remain facing the sun.)

In order to properly line up for the [flyby](#), specialists from ESA's ground stations and flight dynamics teams conducted a so-called "Delta-DOR" campaign, using an advanced technique—Delta-Differential One-Way Ranging—to precisely determine the spacecraft's position in space, and its trajectory.

**→ HOW NOT TO LOSE A SPACECRAFT**

**Delta-DOR**  
ESA's ultra-precise deep-space navigation technique tells us where spacecraft are to within a few hundred metres even at a distance of 100 000 000 km. Navigating a spacecraft around our Solar System requires knowing how far it is, how fast it is travelling and in what direction.

**HOW FAR IS IT?**  
Using a single ground station on Earth, the **distance** to a spacecraft in deep space can be determined from the time it takes a radio signal to travel from the spacecraft to the ground station antenna.

**COMING OR GOING?**  
How quickly is a spacecraft moving along the 'line-of-sight', i.e. away from or towards Earth? We determine this from the frequency of the radio signal sent from the spacecraft, which changes depending on whether the craft is moving **toward us** (higher frequency) or **away from us** (lower frequency). This is called the **Doppler shift**.

**LEFT OR RIGHT?**  
Now for the tricky bit! Is the spacecraft moving left or right in the sky? Two of ESA's three widely separated deep-space ground stations capture signals coming from the spacecraft, using the **difference** in their time of arrival to determine its 'perpendicular' or 'angular' position.

**BRIGHTEST BEACONS!**  
Earth's atmosphere and the ground station electronics delay the spacecraft's signal, creating uncertainty in its location. To remove this uncertainty, two stations also receive signals from another radio source nearby in the sky, whose position is very precisely known – a **Quasar**. Subtracting the 'received' Quasar location from the received spacecraft measurement removes all delays common to both – giving the **Delta** in the name of this technique, dubbed '**Delta-Differential One-Way Ranging**'.

Quasars are some of the brightest objects in our Universe: their colossal energy comes from matter falling into a black hole. They are very, very far away but their positions are known very accurately, so they serve as 'beacons' for this technique.

Earth's atmosphere

ESA

#DeepSpace #WeFly #WhereMissionsComeAlive

Space19

Ultra-precise navigation. Credit: European Space Agency

In Delta-DOR, a set of widely separated [ground stations](#) on Earth are used to receive the spacecraft's radio signals, giving a first result for its location. Then, this result is compared to locations of known stellar radio sources previously mapped by other missions, resulting in a corrected and ultra-precise final plot. The Delta-DOR technique allows operators to determine where a spacecraft is to within a few hundred meters, even at a distance of 100 million km.

Today, 17 December, Solar Orbiter is 235 million kilometers from Earth, and about 10.5 million from Venus. It takes about 13 minutes for

signals to travel to (or from) the spacecraft.

Solar Orbiter's path around the sun has been chosen to be 'in resonance' with Venus, which means that it will return to the planet's vicinity every few orbits and can again use the planet's gravity to alter or tilt its orbit. The next encounter will be in August 2021, which is also within a few days of BepiColombo's next Venus gravity assist. Initially Solar Orbiter will be confined to the same plane as the planets, but each encounter of Venus will increase its orbital inclination. By 2025 it will make its first solar pass at 17° inclination, increasing to 33° by the end of the decade, bringing even more of the polar regions into direct view. This will result in the [spacecraft](#) being able to take the first ever images of the sun's [polar regions](#), crucial for understanding how the sun 'works,' for investigating the sun-Earth connection and how we can better predict periods of stormy space weather.

Solar Orbiter is a space mission of international collaboration between ESA and NASA.

Provided by European Space Agency

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