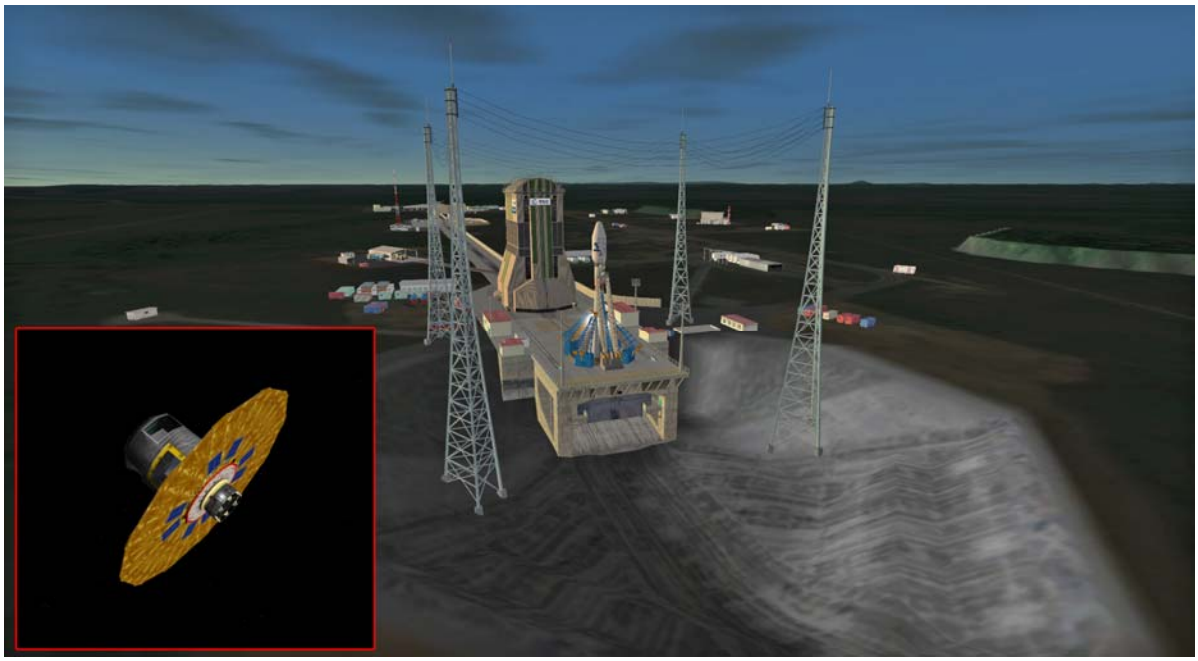
GAIA MISSION

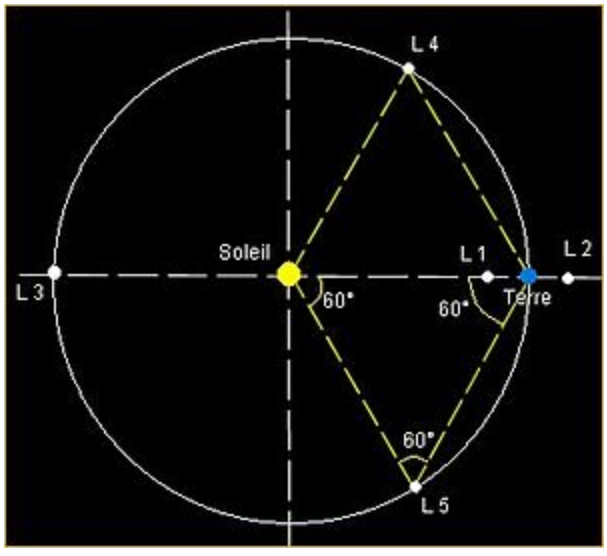


1°/ PURPOSE of the MISSION

The mission consists in launching the Gaia satellite to insert it at the Lagrange L2 point of the Sun-Earth couple. At this stage, it will remain in theory on a Earth-Sun axis and will be able to carry out the observation of the universe as planned for its mission : The measurement of the position, distance and movement of the stars.

The Lagrange points of the Sun-Earth system are noted and defined as noted :

- **L_1** : On the line defined by the two masses between them, the exact position depending on the mass ratio between the two bodies. In the event that one of these two bodies has a much lower mass than the other, the point L_1 is located much closer to the less massive body than to the more massive body.
- **L_2** : On the line defined by the two masses, beyond the smaller one. In the case where one of the two bodies has a much lower mass, the distance from L_2 to this body is comparable to that between L_1 and this body.
- **L_3** : On the line defined by the two masses, beyond the larger one. In the case where one of the two bodies is notably less massive than the other, the distance between L_3 and the massive body is comparable with that of the two bodies.



On one of the Lagrange points, a third body of insignificant mass remains immobile relative to the two others, in that it revolves around their common center of gravity at the same angular velocity, while maintaining its position relative to them.

We can calculate that L2 point is roughly 1.5 million km from the center of the Earth.

(This picture shown, the scale is not respected)

2°/ GAIA SATELLITE

Gaia is a 2,030 kg satellite, including 920 kg for the platform, 710 kg for the payload, 335 kg of propellants used by the 12 rocket motors responsible for maneuvers until the execution of the scientific phase of the mission, and the 60 kg of gas used by the cold gas thrusters (12 **RCS**) which will be used during the rest of the mission. The main structure consists of a hexagonal prism, with 3.5m high and 3m in diameter, which excludes the sun visor, bringing the diameter to 10m.

***Gaia includes three sub-assemblies*:**

- The payload which should complete the scientific objectives of calculation and observation, consisting of two telescopes and instruments placed in the focal plane.
- The platform holds the equipment for satellite functioning e.g. attitude control, propulsion, telecommunications, energy, on-board computer).
- A large 10m diameter Sun-shade designed to keep the temperature constant in order to avoid any malfunction and overheating which can reduce measurement accuracies.

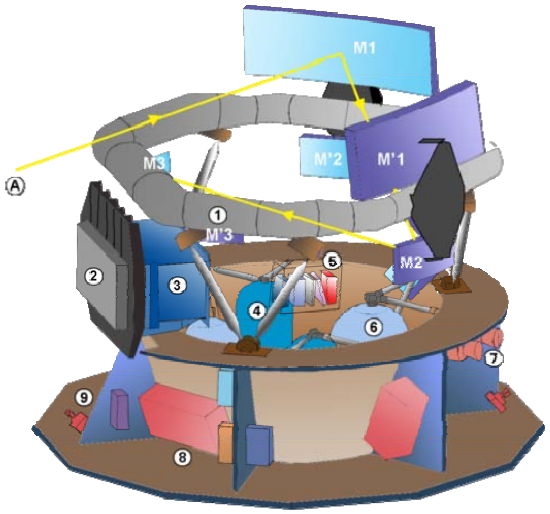
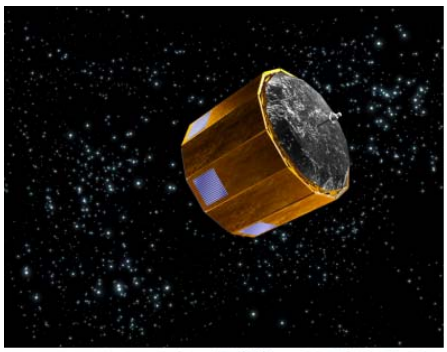


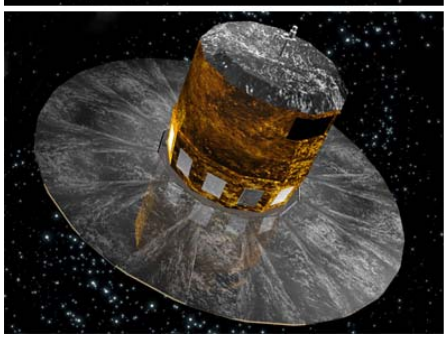
Diagram of Gaia without its sunshade and its external thermal protection :

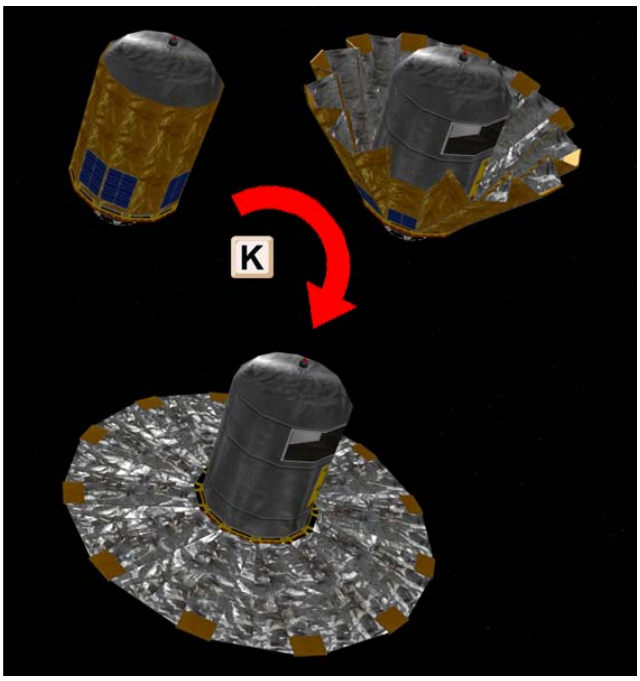
M1, **M2** and **M3** : Mirrors of telescope #1
M'1, **M'2** and **M'3** : Mirrors of telescope #2
M4, **M'4**, **M5** and **M6** : Mirrors not shown
A : Light path of telescope #1 between mirrors M1-M2-M3
1 : Optical bench (silicon carbide torus)
2 : Focal plane cooling radiator
3 : Focal plane electronics
4 : Nitrogen tanks
5 : Diffraction grating spectroscope
6 : Liquid propellant tanks
7 : Star trackers
8 : Telecommunication panel and batteries
9 : Main propulsion subsystem

Gaia's command keys in Orbiter :

- K : Deployment of the sunshade
- Shift *left* + O : Initiate the self destruction of the satellite *(I would not recommend to use this key...)*







3°/ REQUIRED ADDONS FOR IT TO WORK:

Kourou-CSG v5.1
http://francophone.dansteph.com/?page=addon&id=261&language=english

Lagrangian points MFD v.02 (already **provided** in this add-on)
https://www.orbithangar.com/search.php?query=lagrangian

Don't forget to activate this ***Lagrange module*** in the Orbiter ***Launch Pad***...

IMFD 5.7 from Jarmo Nikkanen
http://users.kymp.net/p501474a/Orbiter/Orbiter.html

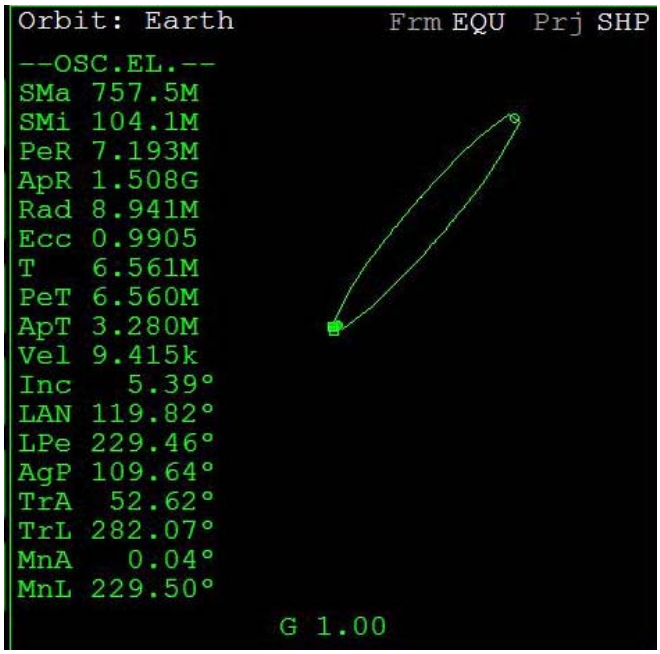
4°/ SCENARIOS & PROGRESS OF THE MISSION:

The launch occurred at the Kourou ELS site by a Soyuz rocket with a Fregat stage,
on 12/19/2013 at 9h12mn UTC.

A) Scenario No.1

As with every scenario, you have two almost identical versions:
*a **French** version as well as an **English** version.(The beginning of the soundtrack is slightly different).*
For this scenario, you have an extra third version : for this one, it is up to you to launch the "pre launch" by pressing the key P *at the right time (see scenario text). It is located in the following folder :*
CSG - KOUROU \ Rockets (Fusées) \ Soyuz Historic Flights

This scenario starts on December 19, 2013, a few minutes before the launch time.
The launch of the rocket is fully automated : nothing to do or touch, only to watch and enjoy.
*(Except for the scenario located in the **CSG-Kourou** subfolder).*



From there, you have to wait patiently for the launch to be completed and for the orbit around the Earth to reach an apogee (ApR) of about 1.5G (1 500 000 000 m).

The whole sequence takes approximately 1860 seconds (about 30 mins !) .
It's best to avoid time acceleration throughout this automated sequence. (See tips below). Please be patient!

You will be notified at the end of the sequence by a text that will be displayed on your screen.
Then you are free to do what you want...

*(Once burn time is over, complete - if needed - by using some slight thrust in prograde mode to bring **ApR** to about **1.5G**).*

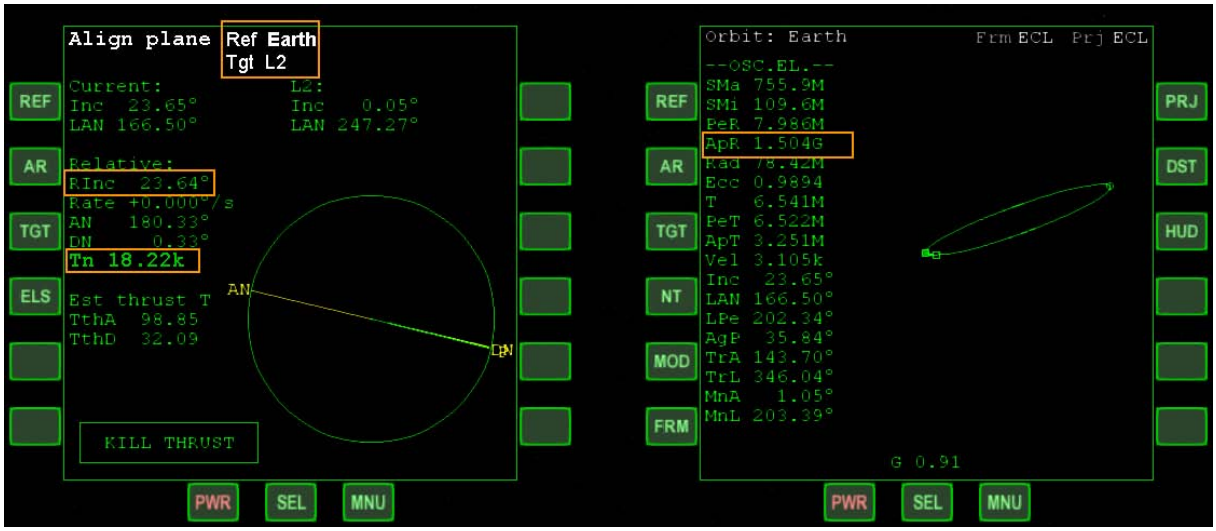
Tips if you want to use time acceleration :

- *During the first phase of the flight (until the ejection of the main stage towards T = 300) absolutely avoid time acceleration !!!*
- *Then you can increase time acceleration but not too much (x10), and return to normal speed around T = 550 to look at the ejection of the third stage.*
- *Wait for the Fregat stage ignition to start accelerating time again (x10 or x100), and return to the normal at T=750 (Fregat engine will automatically shut down).*
- *At this time, you can again accelerate the time to T = 1250 to look at the second ignition of Fregat.*
- *There, again, you can increase time acceleration until T=1700.*

From this moment, wait to see the ejection of the Fregat stage and its separation from Gaia.

B) Scenario N.2

This scenario starts just after the separation of the Gaia 's Fregat stage.
But you are not yet at the correct distance from Earth for your plane alignment maneuver. You will have to wait about 5 hours (without doing anything) to start the preparations...



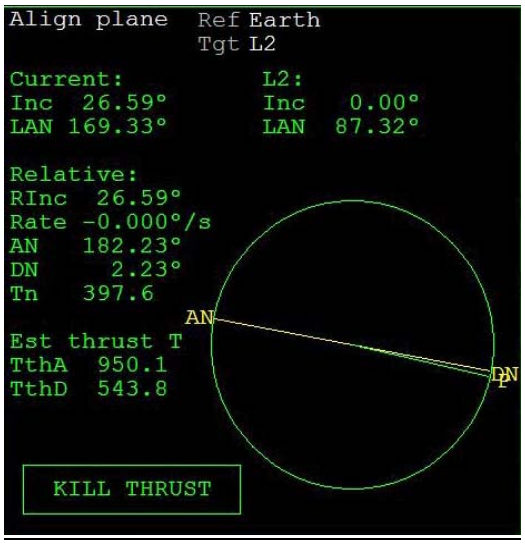
Remember:

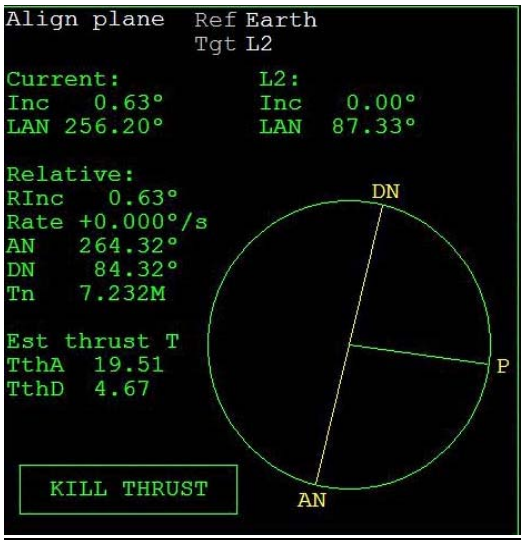
Around **10h30 UTC** (about 1h18mn after the launch) remember to *open* Gaia's sun-shade (**K** *key*).

C) Scenario No.3

The Gaia satellite is almost in the required position to align its orbital plane with that of **L2.**

Align Plane module is already open with TGT = L2.
*(if you continue the mission from the scenario 1, open this MFD with **TGT** = **L2**)*
*In order to be able to perform this maneuver, point **L2** is represented in the form of an "invisible mesh".*
***Note:** it moves a little, unfortunately.*





When Tn = 400s start to position Gaia in NML+ (since we reach the descending node **DN**) in order to prepare for the Gaia engine ignition, which should take place at around **Tn**=**15** or **16**. Decrease **RInc** as close as possible to **0**.

Now let's continue our mission...

D) Scenario No.4

This scenario occurs at the end of the alignment phase of the two orbital planes. This maneuver has been successfully completed.

Now the next step will be when Gaia is at a distance of around **1G**
(approximately 1,000,000 km) from Earth. You have it for a little less than 10 days !
We will then be around December 30, 2013.

At this time, it will be necessary to proceed to the circularization of its orbit around the Earth....

E) Scenario No.5

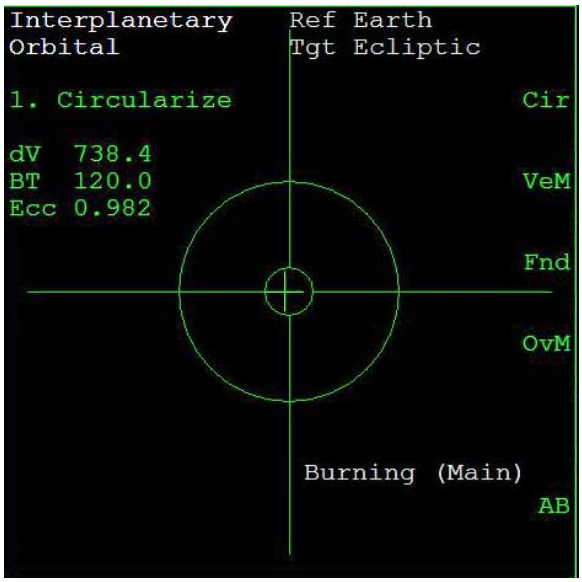
This scenario begins when Gaia is approximately **1G** away from Earth.
We have now to proceed to the ***circularization*** of the orbit of Gaia.

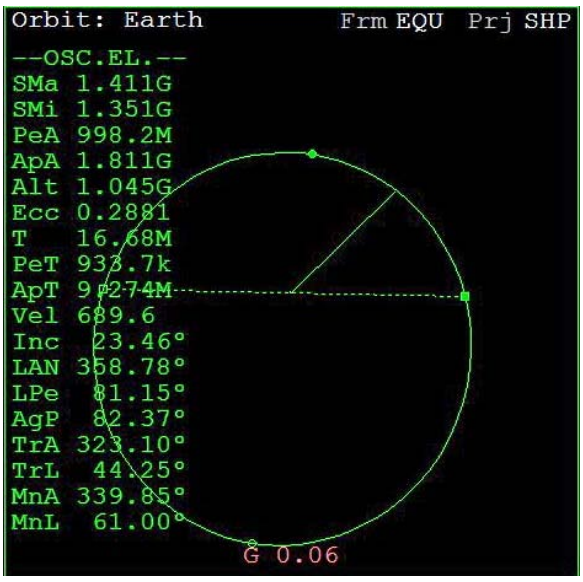
For this, you will use the ***Orbital*** module of **IMFD** (or **I**nterplanetary**MFD**).
The method to approach L2 is quite empirical, but I have not found better...

Be careful to take "**Earth**" as ***reference***. Click on AB and let the **MFD** do it.
Burning lasts about 120 seconds. (*Be careful to always have "**Earth**" as reference in the **orbit** module of **IMFD**).*

When this is done, switch to *prograde mode*, and start the Gaia's motor until **ApR** (*or* **ApA** : *at this distance, it does not change much*) - which may have a little change - will be a little less than **1.7G**.
Watch your maneuver in the Orbit-**MFD**.

***note** : it seems that this maneuver is optional.*





We are on December 31 at the end of the day.

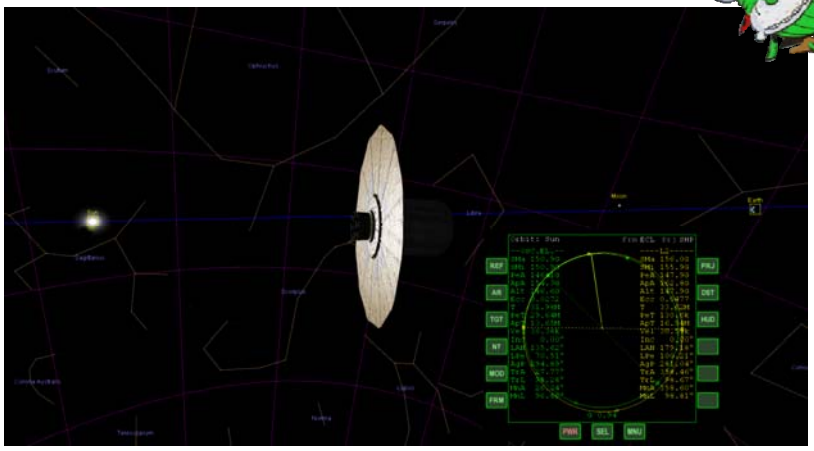
It only remains to continue the journey until we get to roughly the alignment of Gaia with the Earth and the Sun.

F) Scenario N.6

This scenario begins just after the circularization of Gaia's orbit.

So there is still quite a way to go until the final maneuver (?)... Allow about a month...

When you find that you are no longer able to get closer to the desired *Sun-Earth-L2-Gaia* alignment, proceed to the next step.



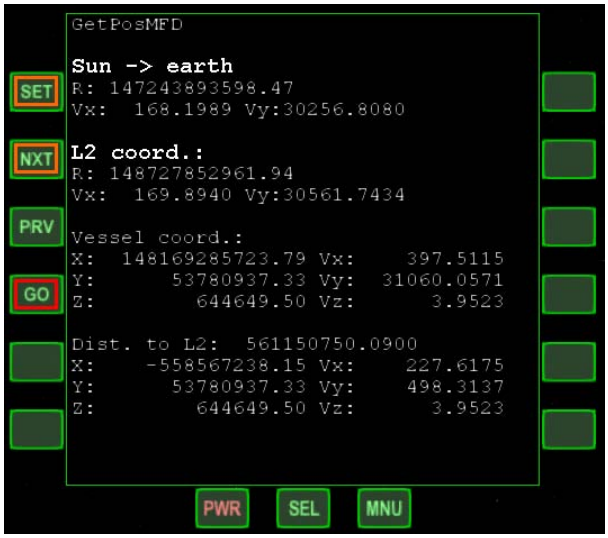
F) Scenario No.7

Gaia has almost arrived at our destination ... but we are not quite at **L2** point which is difficult to reach with precision.

We will cheat by opening the ***MFD-Lagrange*** with:

- **SET** = Earth
- **NXT** = select L2
- Then click on **GO**.

Like magic, Gaia will be well positioned in **L2**.



The distance to **L2** will be very small, but unfortunately it will change over time with parasitic influences such as the Moon.

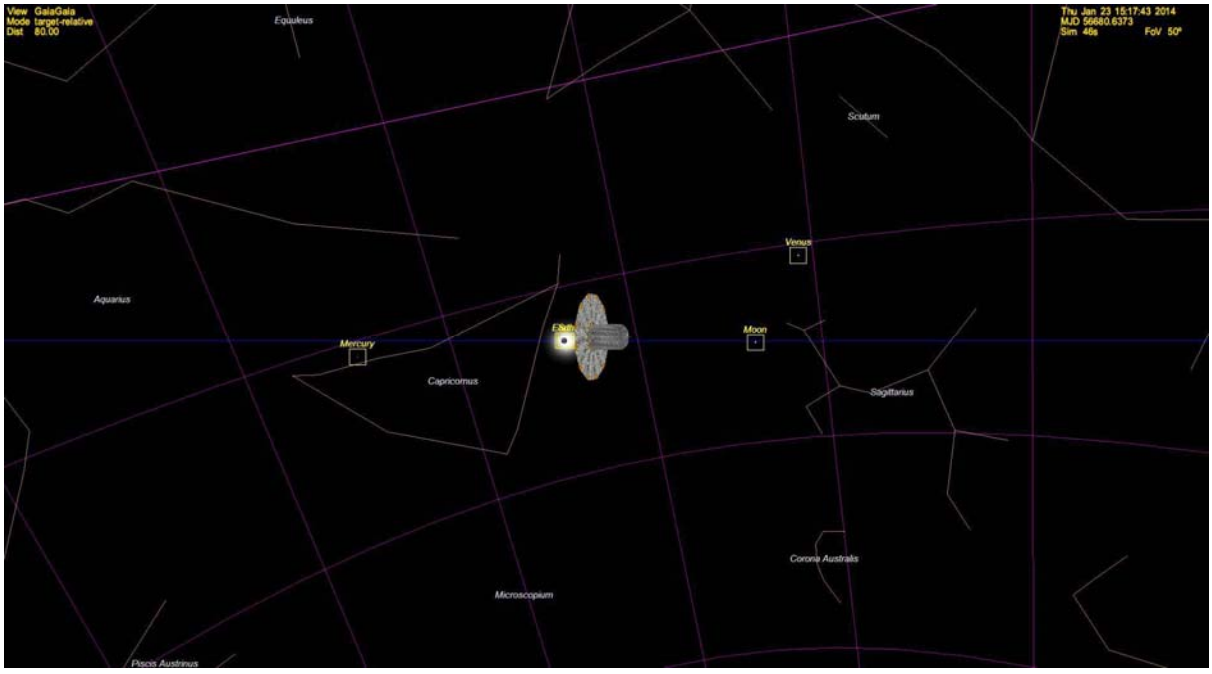
In the image below, the black disk on the Sun is the Earth.

Gaia is well aligned, but the viewing angle has been intentionally shifted for better visibility.

G) Scenario No.8

After a journey of several months, the Gaia satellite is finally positioned at **L2** Lagrange Point.
This scenario positions you directly at this final step.

The black disk in the middle of the sun is the Earth.



You will now be able to begin your observations...

Have fun moving Gaia in translation and rotation, and admire the constellations!
(Click on F9 *in external view to see them).*

Life is beautiful...

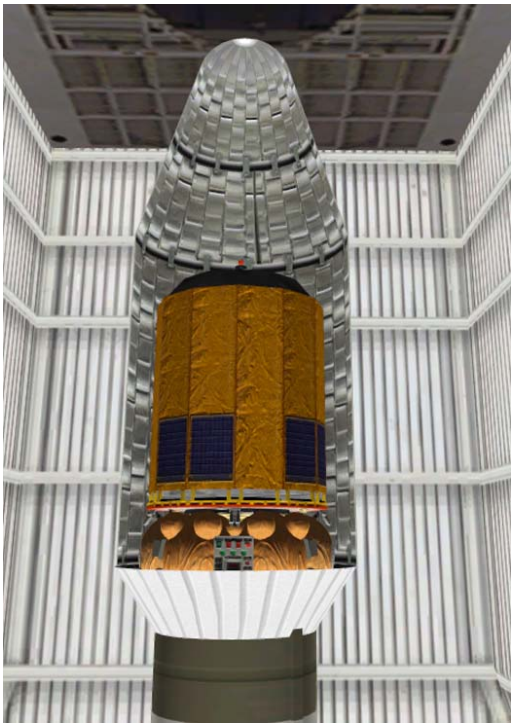
5°/ ABOUT LAGRANGE *L2* POINT'S *INVISIBLE MESH*

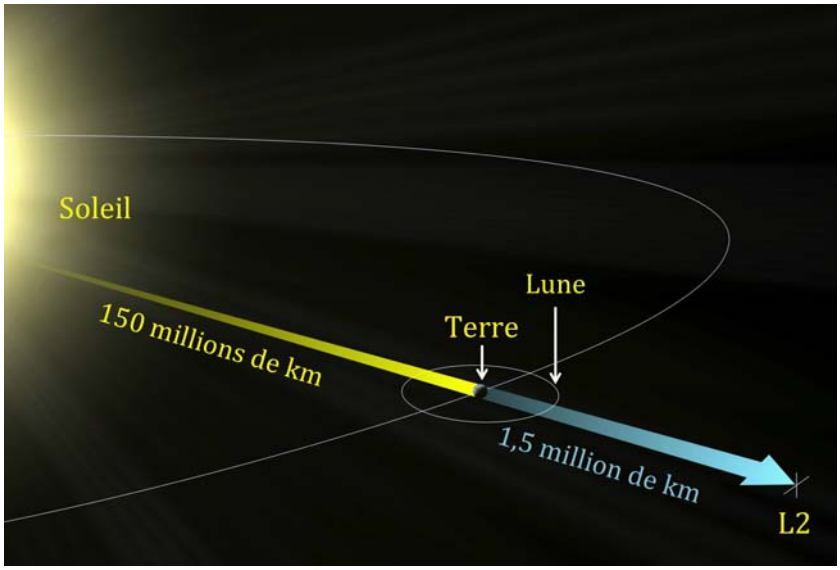
The mesh representing the position of **L2**, used to be able to align the orbital planes of Gaia with it, is invisible. But as I wanted to be able (on demand) to make this mesh visible, I therefore took the liberty of being able to transform it into a visible mesh with a wink (*debatable*) with the name of Mr. Lagrange... I hope this doesn't blame me!

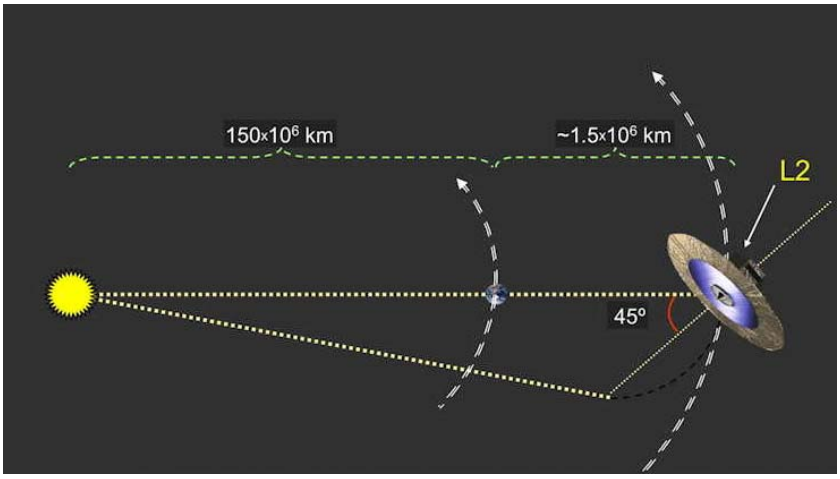
Explanation : in French, ***grange*** means ***barn*** *(la grange = the barn).*

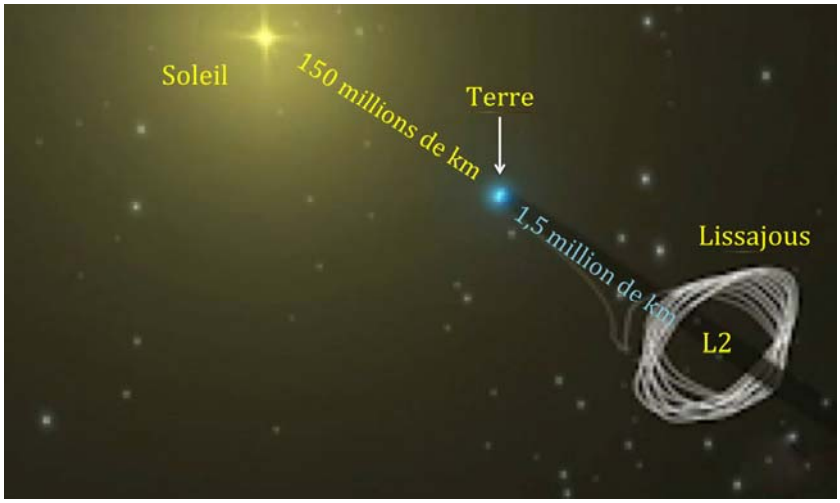
Command : G key *(with focus on **L2** of course).*

6°/ AND FINALLY SOME PICTURES









Papyref - February 2014–2020

Modification and update by ***Jacquesmomo - August 2020***
Thanks to ***cookieman*** *for corrections*