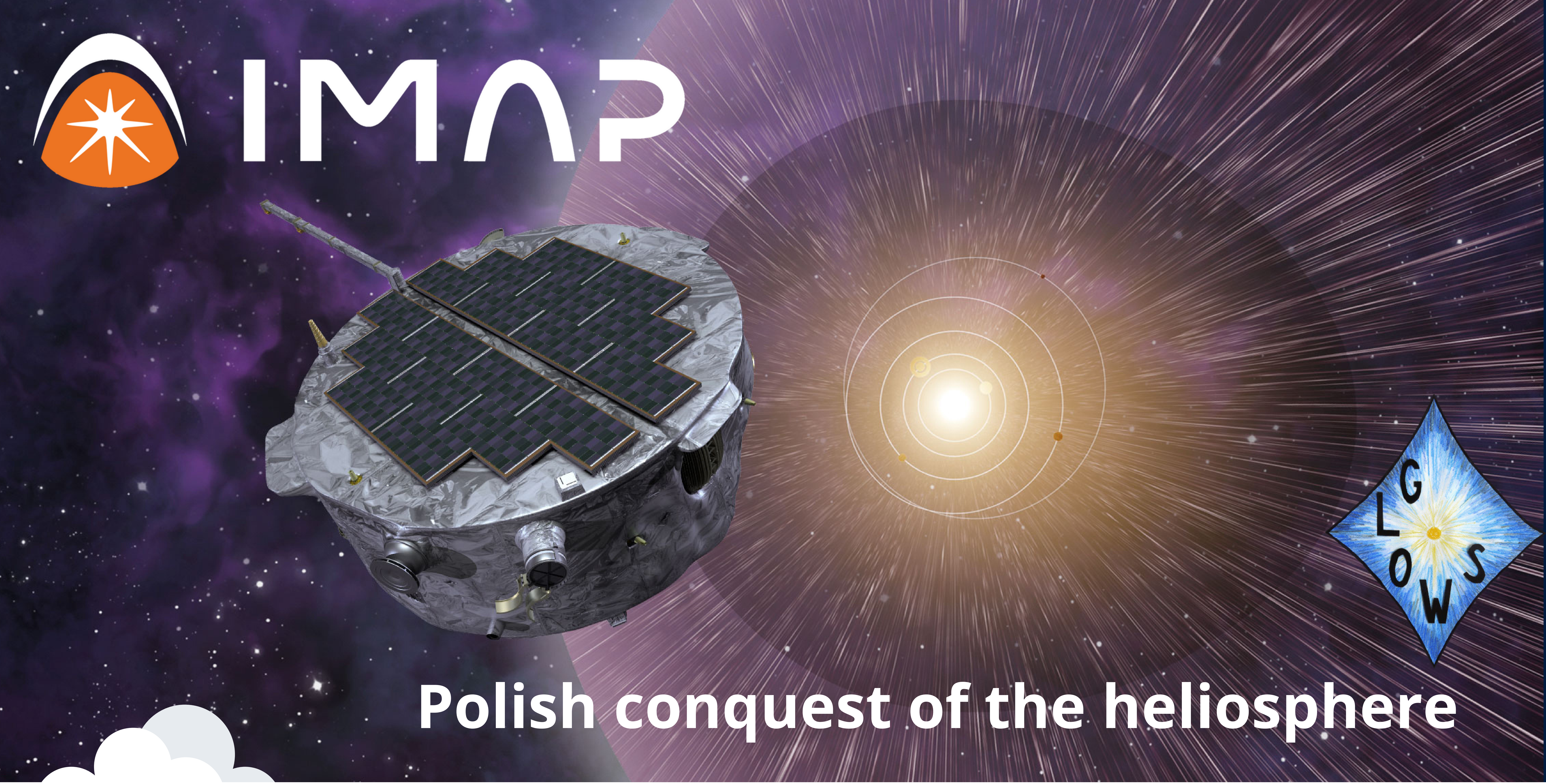
IMAP



Polish conquest of the heliosphere

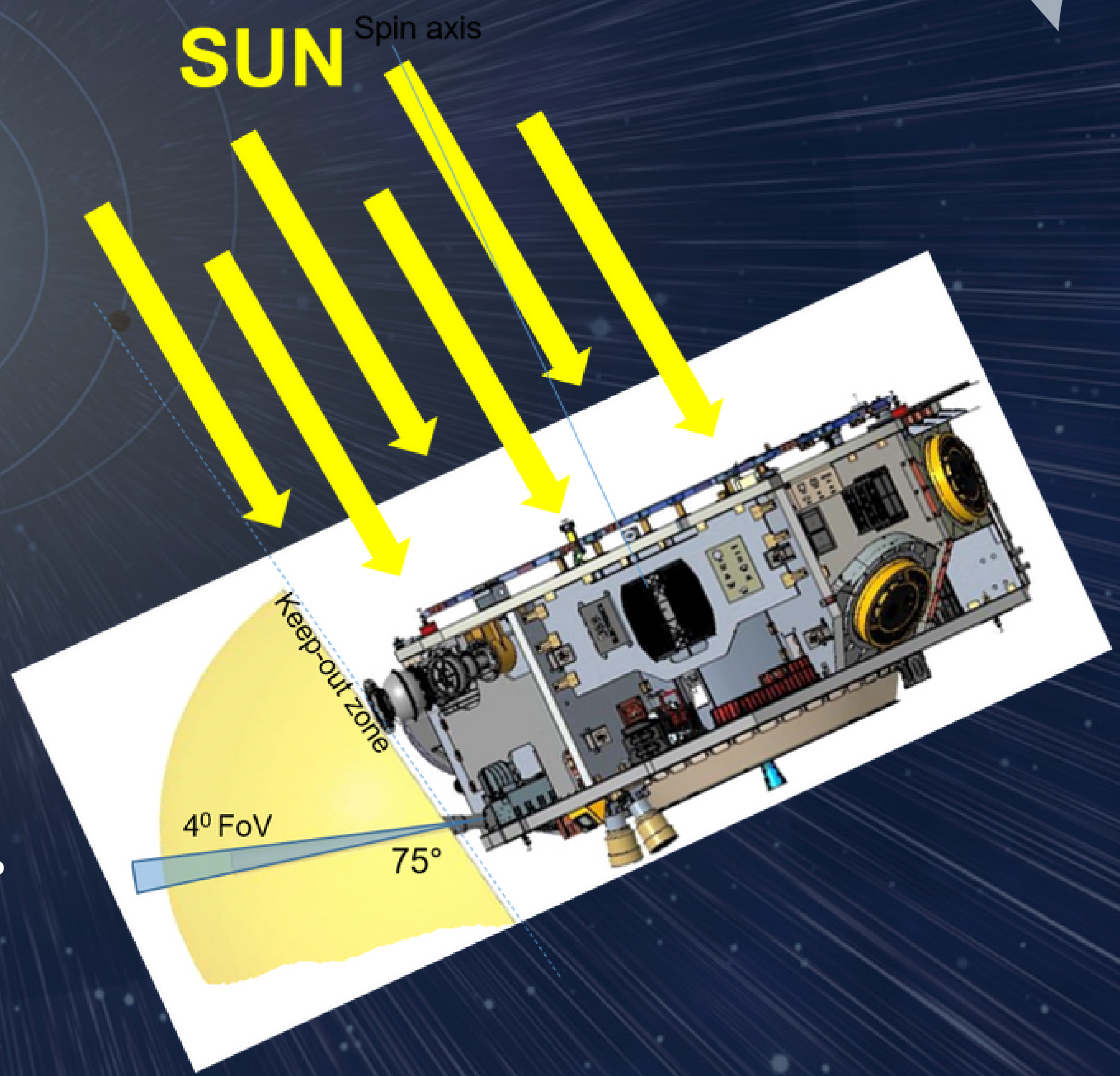
source: NASA/Johns Hopkins APL/Princeton University/Steve Gribbeni

What will IMAP and GLOWS be?

The new NASA probe will launch in 2025 and will study the **solar wind** and the **heliosphere**.

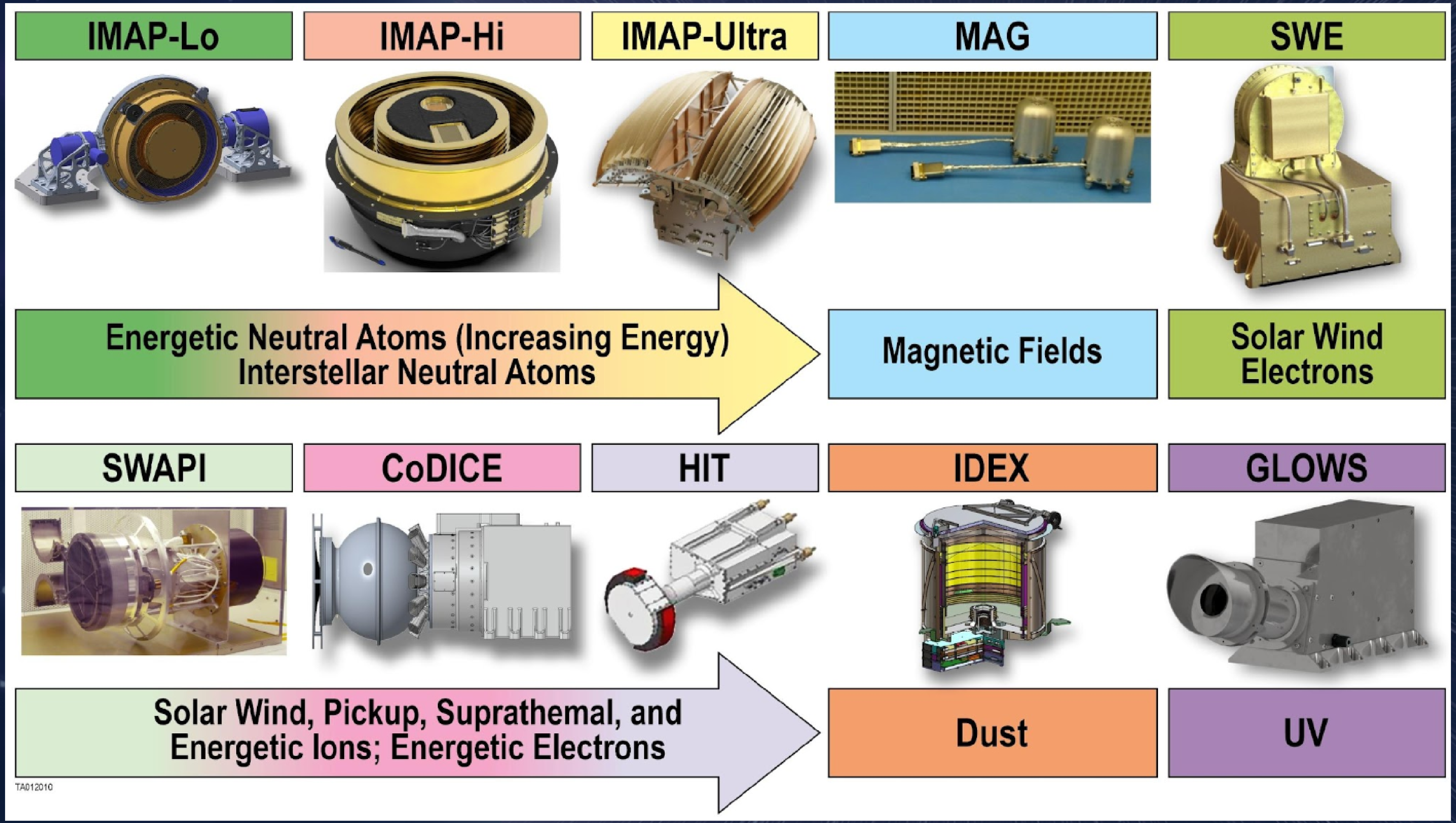
It will allow us to better understand and comprehend the closest environment of the Solar System, its interactions with local interstellar medium as well as peek into its furthers depths.

The polish instrument - GLOWS (as one of ten) will be responsible for stuyding the solar wind, mapping its 3D structure and examining the interactions of its components.



source: GLOWS/CBK

What will IMAP and GLOWS be?



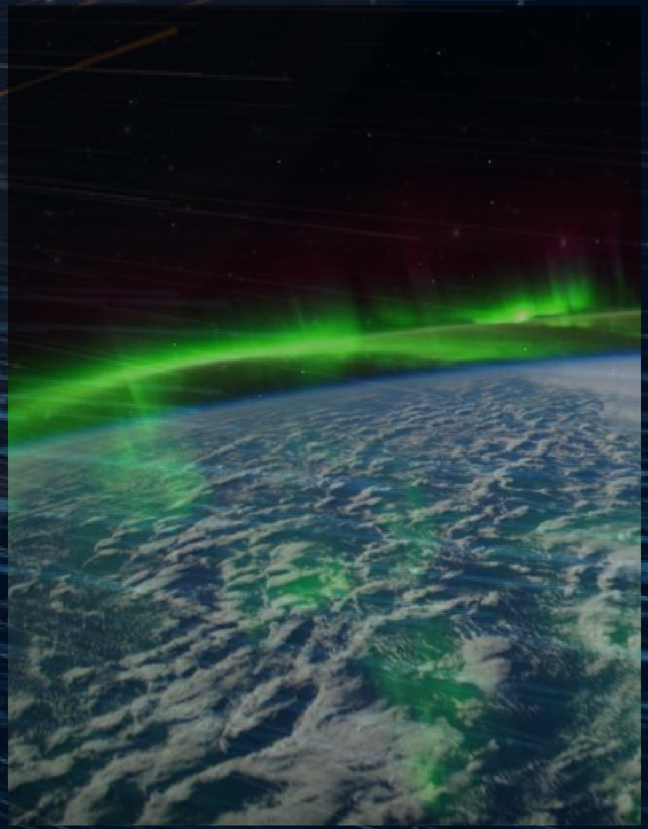
source: https://imap.princeton.edu/instruments

What is the solar wind and the heliosphere?

source: NASA/GSFC

What is the solar wind?

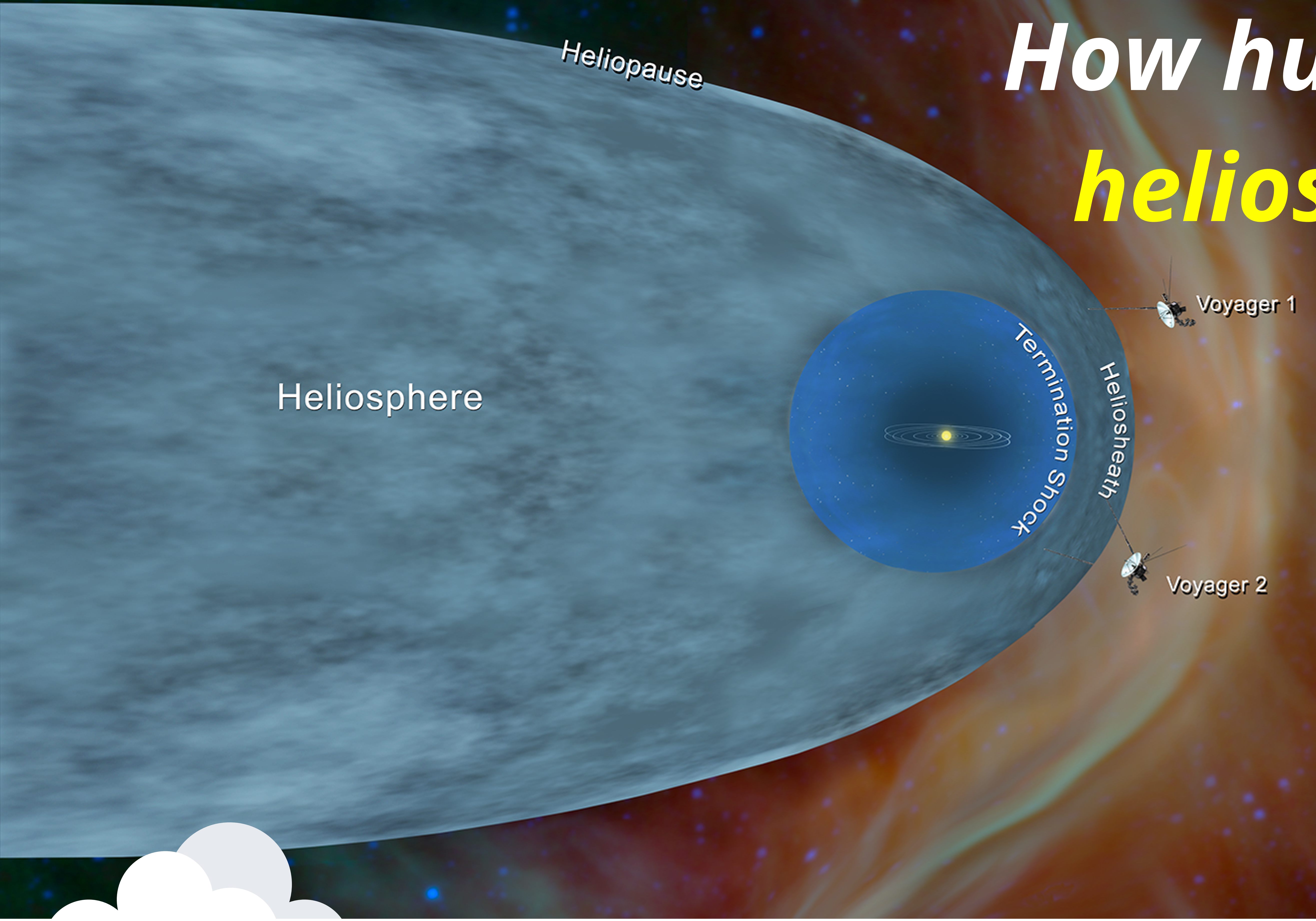
Our Sun in each second emits, besides photons, a stream of high-energy particles, mostly protons, electrons and alpha particles (helium nuclei). This is what we call the solar wind.



Earth's magnetic field protects us from its influence by 'capturing' its components and directing them towards the poles, creating auroras.

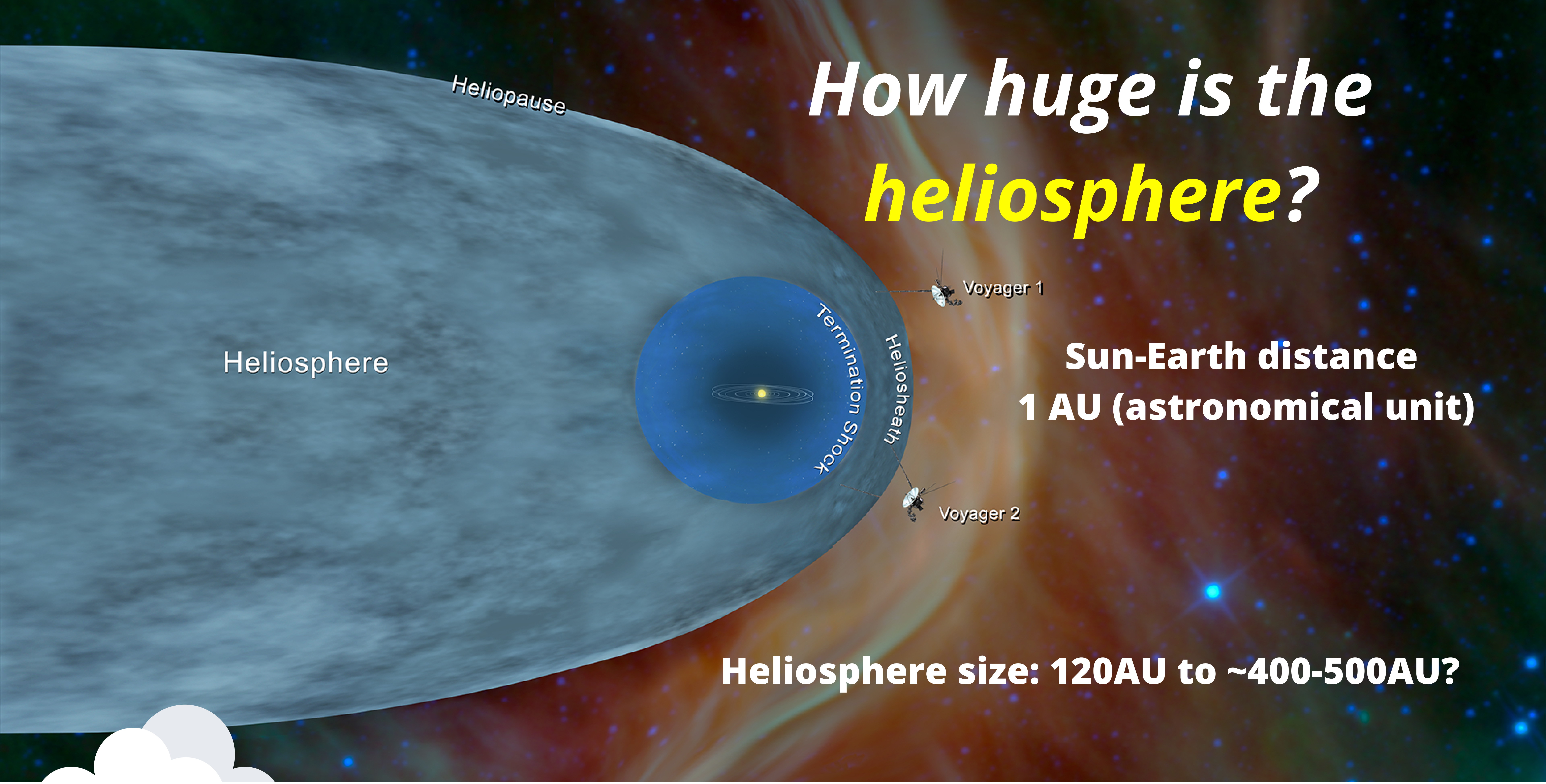
The wind blows through the Solar System and reaches really far into the void - to at least 120 AU, where it defeats with the extrasolar particles creating an irregular bubble known as heliosphere.

How huge is the *heliosphere*?



source: NASA/JPL-Caltech

How huge is the *heliosphere*?

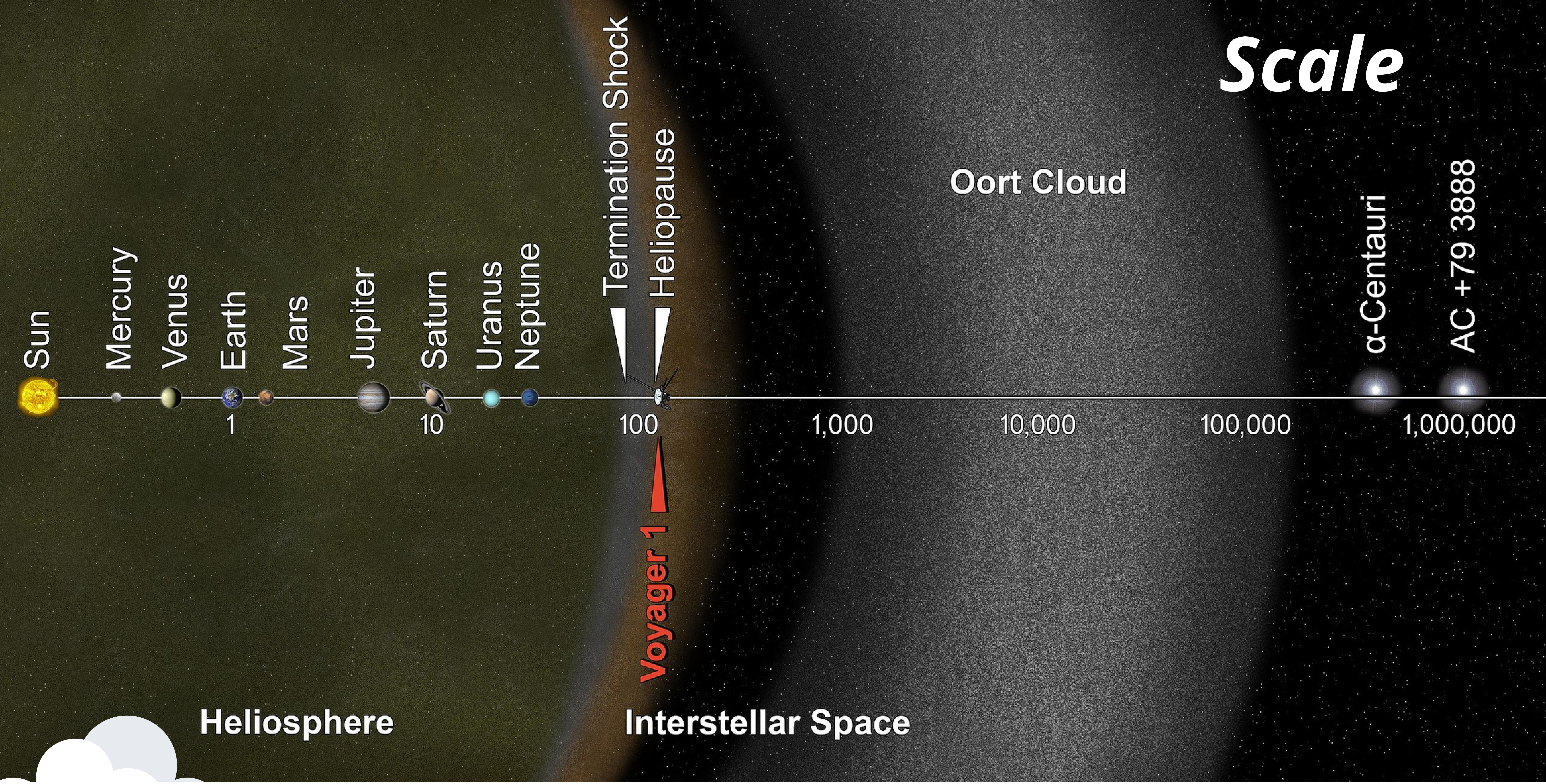


Sun-Earth distance

1 AU (astronomical unit)

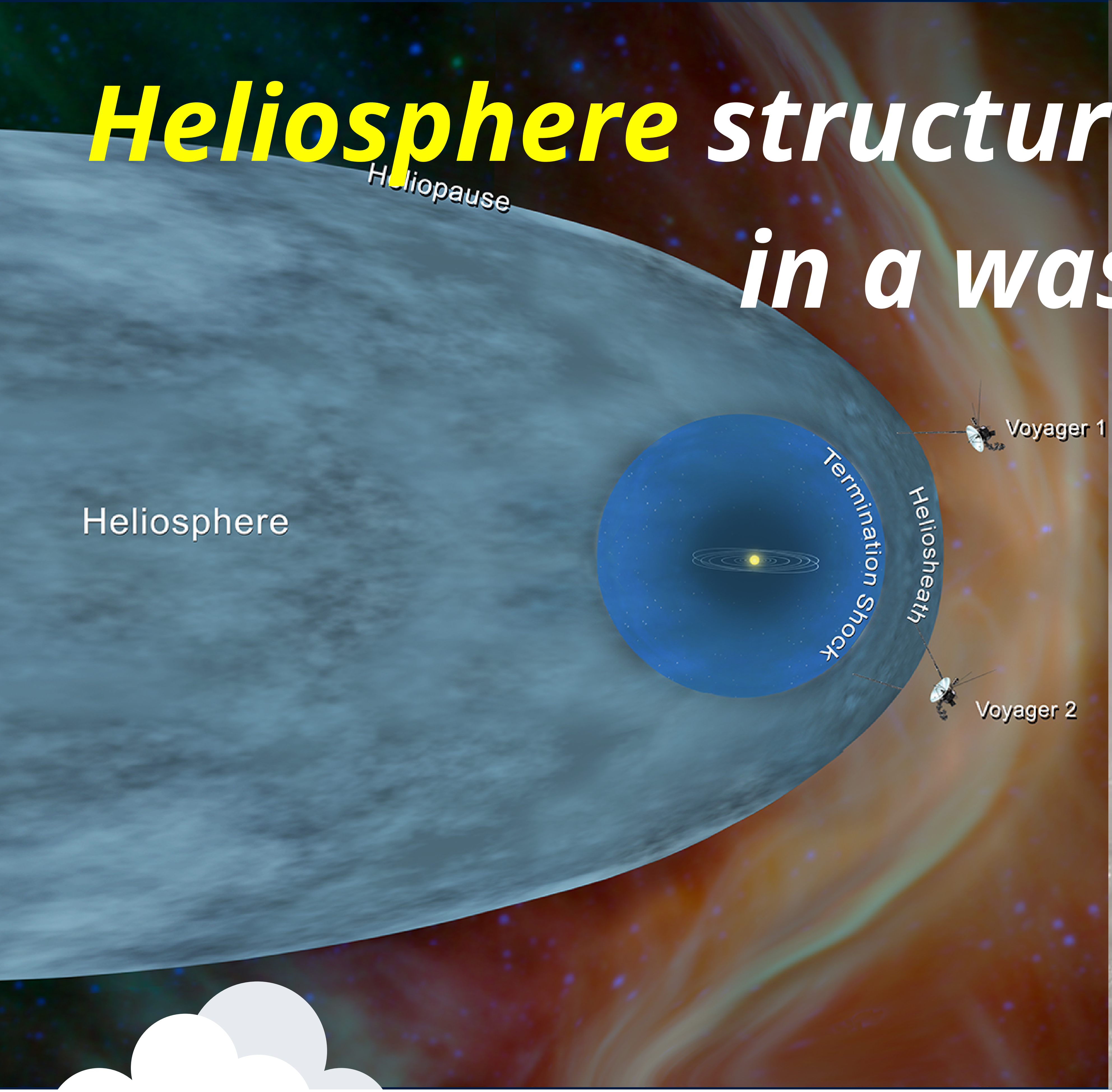
Heliosphere size: 120AU to ~400-500AU?

Scale

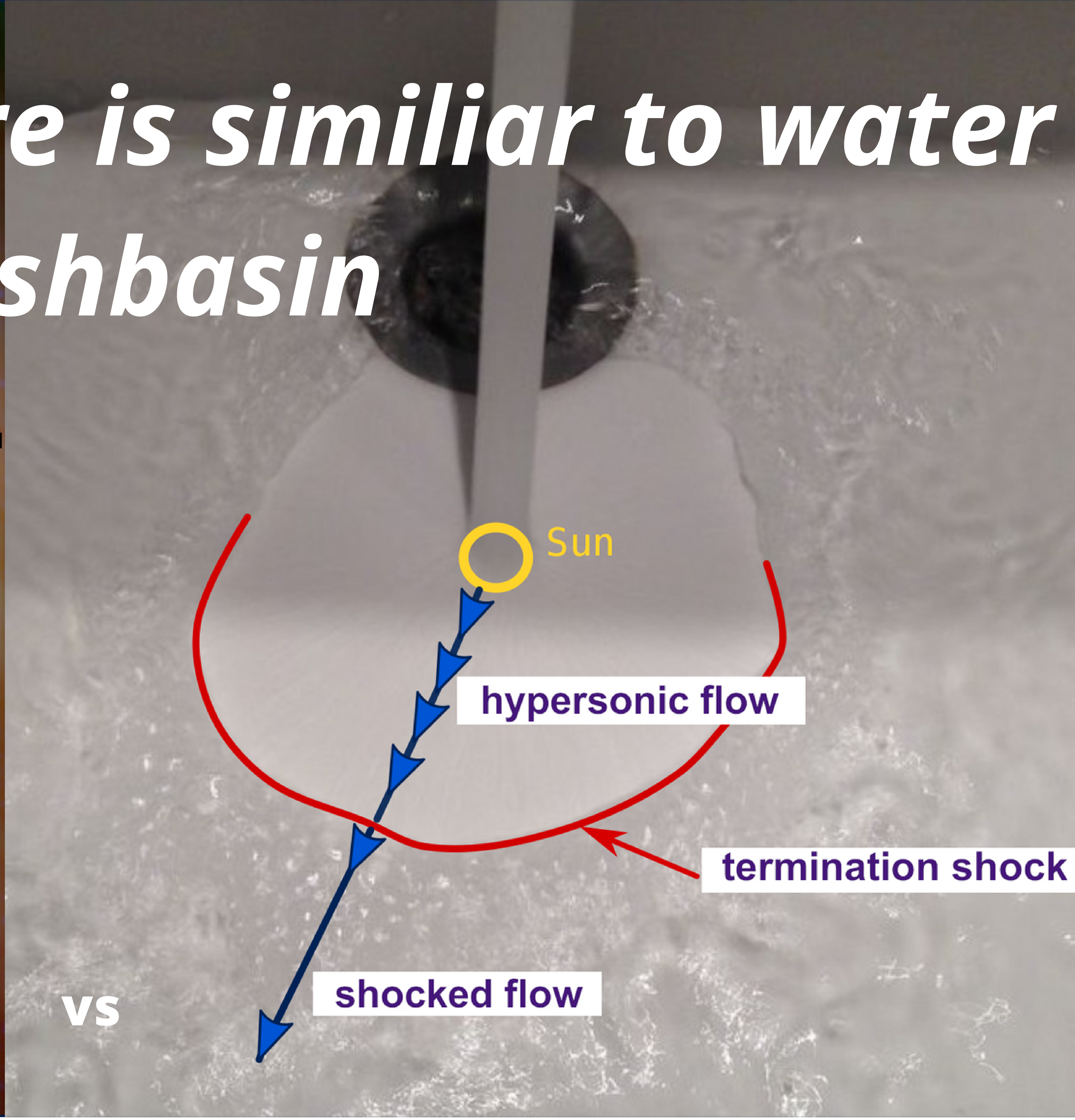


source: NASA/JPL-Caltech

Heliosphere *structure is similiar to water in a washbasin*



vs



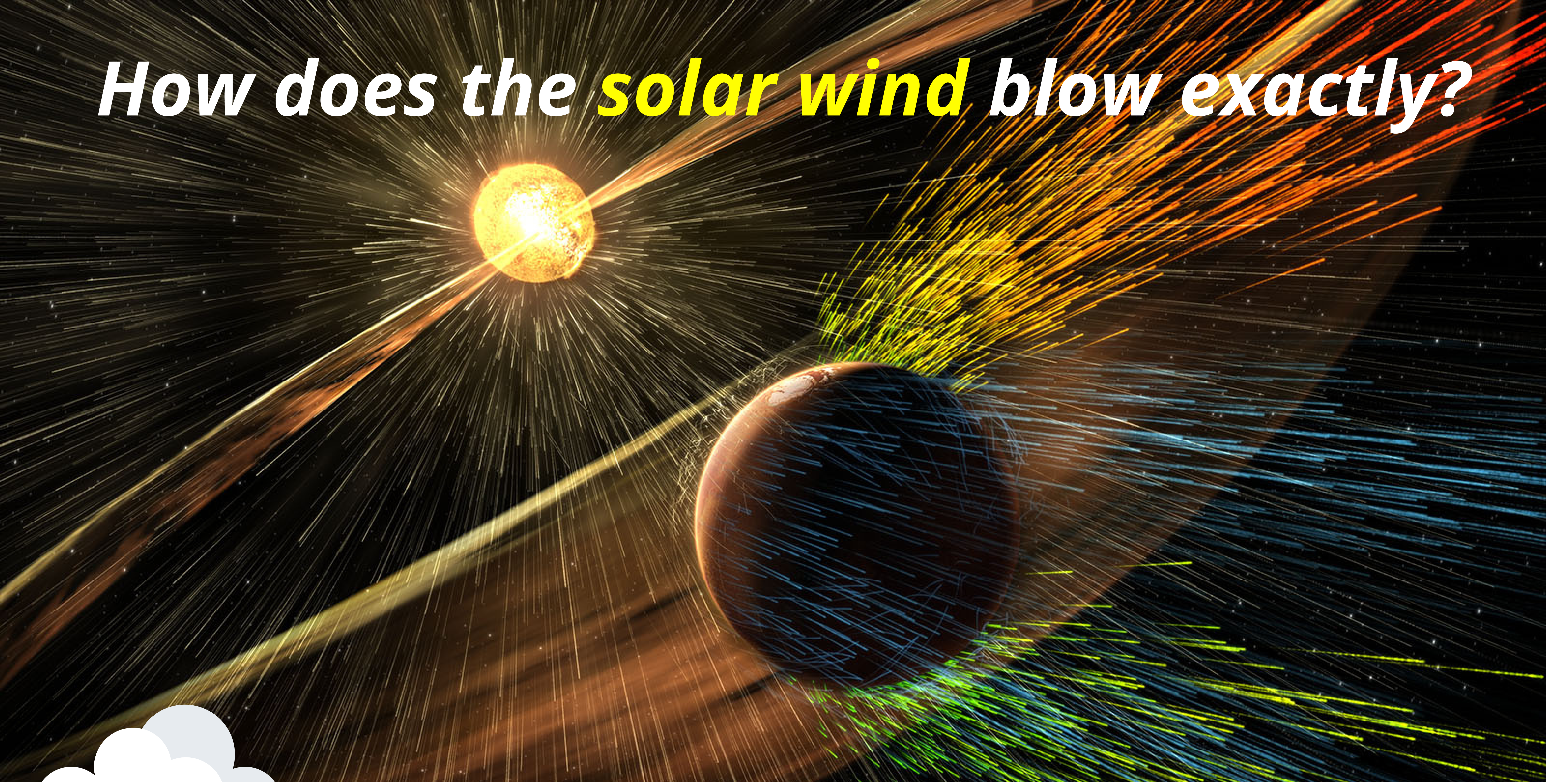
source: wikipedia commons

How does it work?

There exists a certain boundary where the solar wind suddenly slows down, similiarly as tap water in a washbasin. For solar wind this boundary defines the interaction with local interstellar medium (stream of extrasolar particles) whereas for water interaction with air. This boundary is called termination shock.

The difference lies in the fact that the solar wind continues to be fast beyond terminaton shock and only where local interstellar medium wins in the balance of forces, the heliosphere ends (the region in between is called heliosheath). The bubble border is called heliopause.

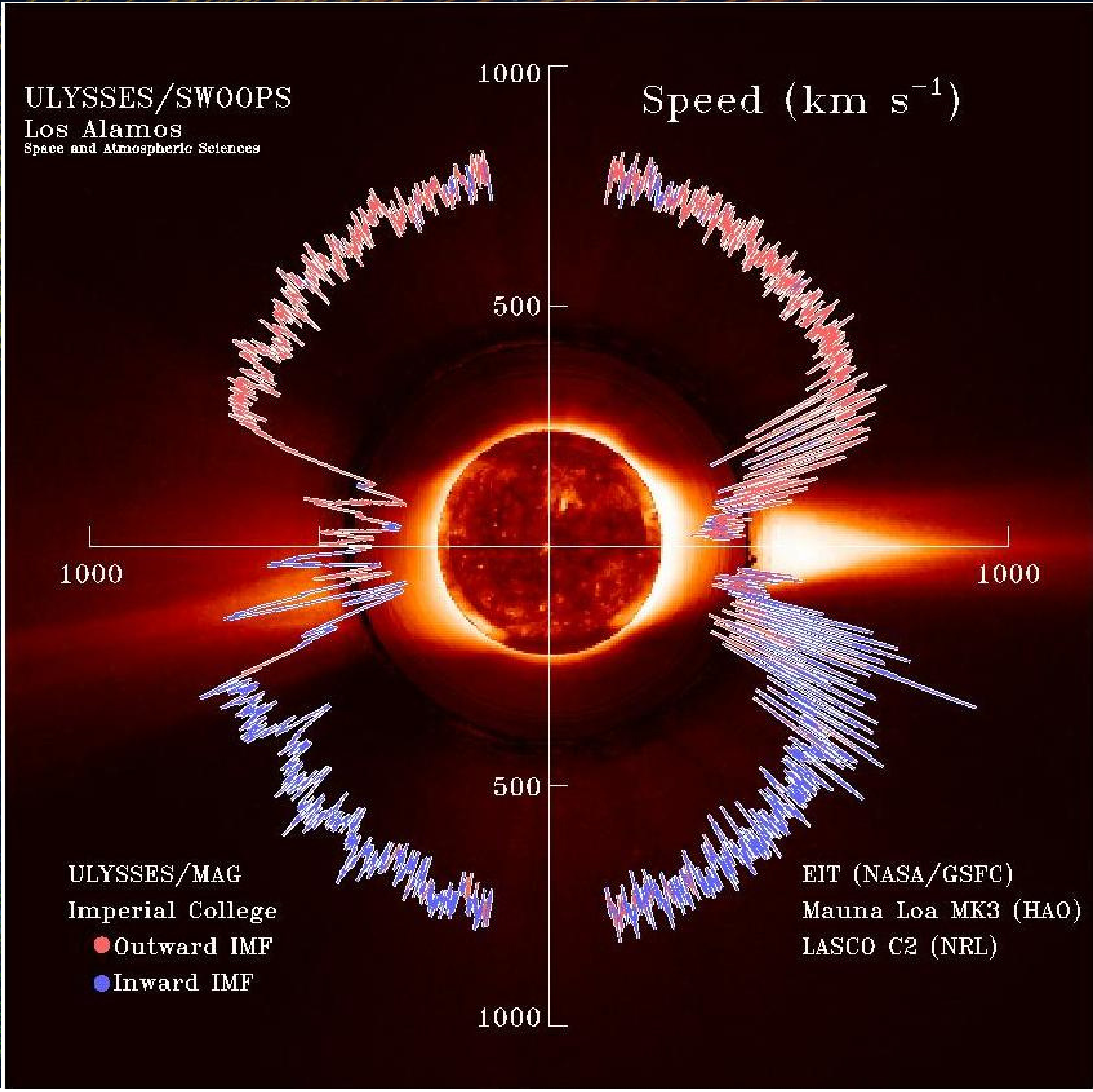
How does the solar wind blow exactly?



How does the solar wind blow exactly?

The solar wind is not isotropic!

One can distinguish between slow and fast solar wind. They originate differently and also have different properties, which shape the overall structure of the solar wind and space weather.



source: wikipedia commons

How does the solar wind blow exactly?

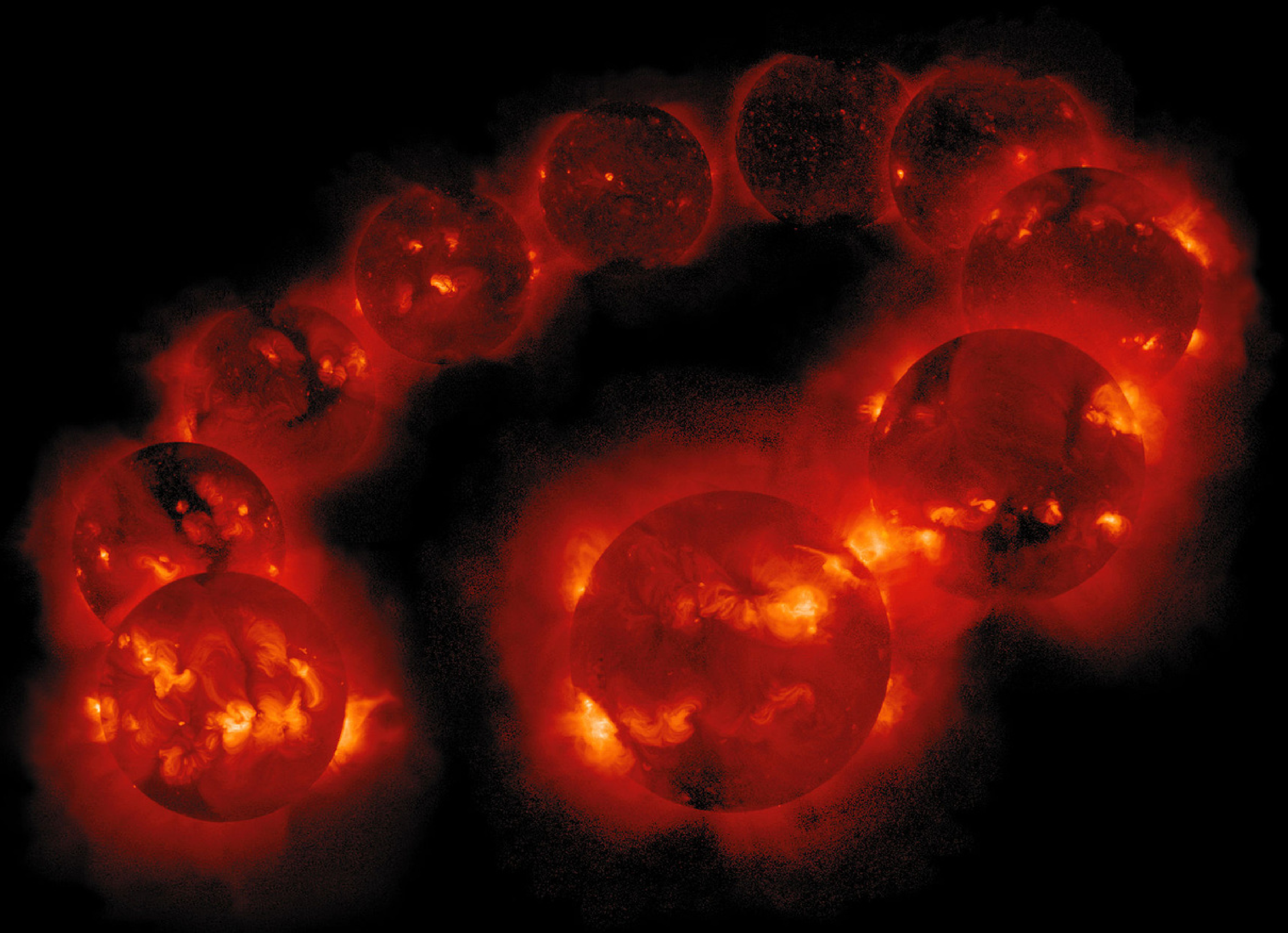
The slow solar wind originates from coronal mass ejections and their magnetic disturbances. It is slower (around 400 km/s) and cooler, as well as denser. It mainly concentrates around the solar equator and during the solar cycle's maximum, it dominates most of the Sun.

source: wikipedia commons

How does the solar wind blow exactly?

The fast solar wind originates from coronal holes, where there is a stronger magnetic field, and these areas are also cooler and less dense. As a result, it is faster (around 700 km/s) and hotter, as well as less dense. It mainly concentrates around the solar poles.

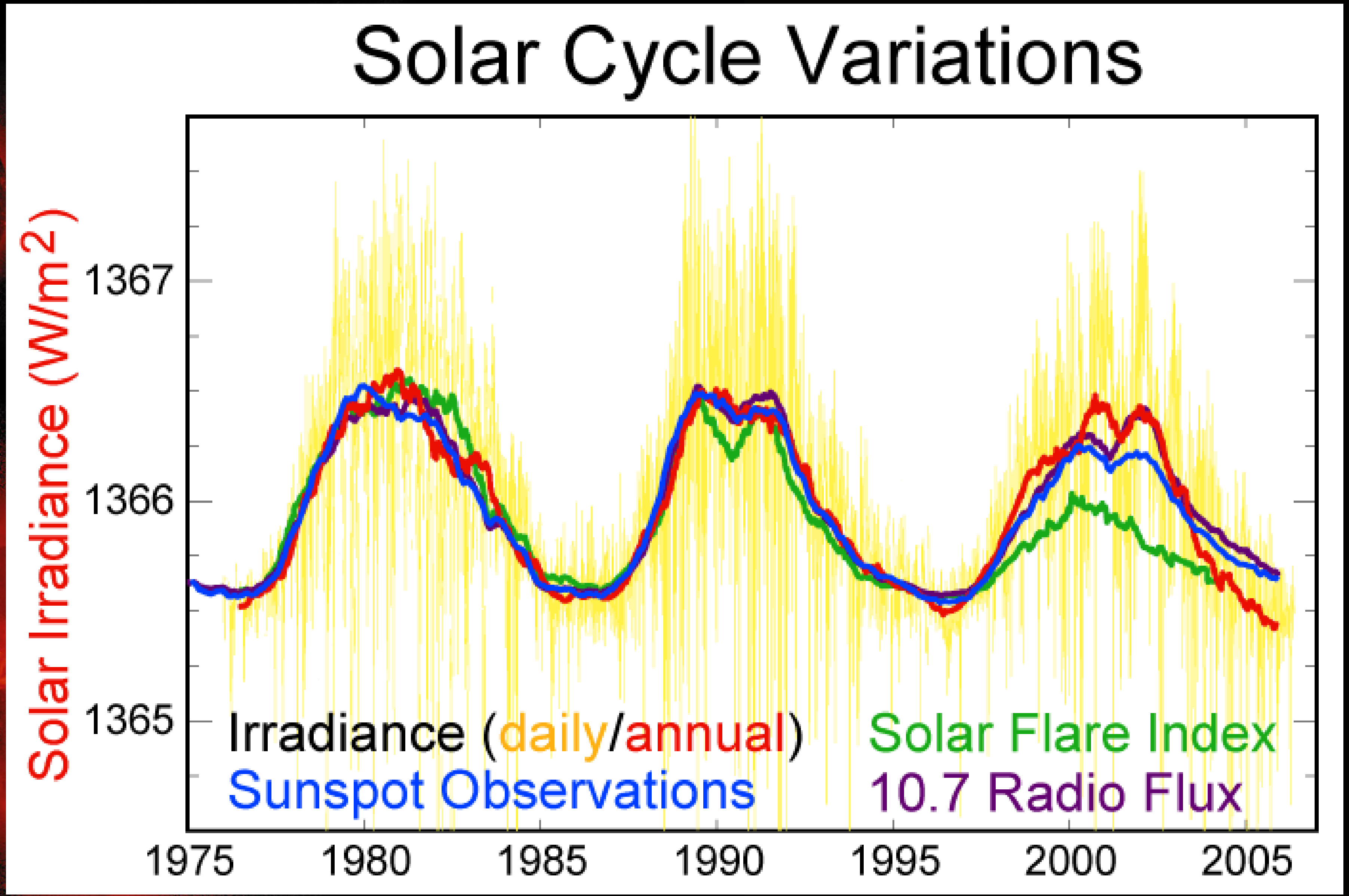
The solar wind depends on the solar cycle



source: http://solar.physics.montana.edu/

The solar wind depends on the solar cycle

The solar cycle is the oscillation of solar activity that changes the structure of the solar wind over time. Roughly every 11 years, there is a maximum during which the Sun emits more ultraviolet light, and there are more sunspots and coronal mass ejections on its surface.



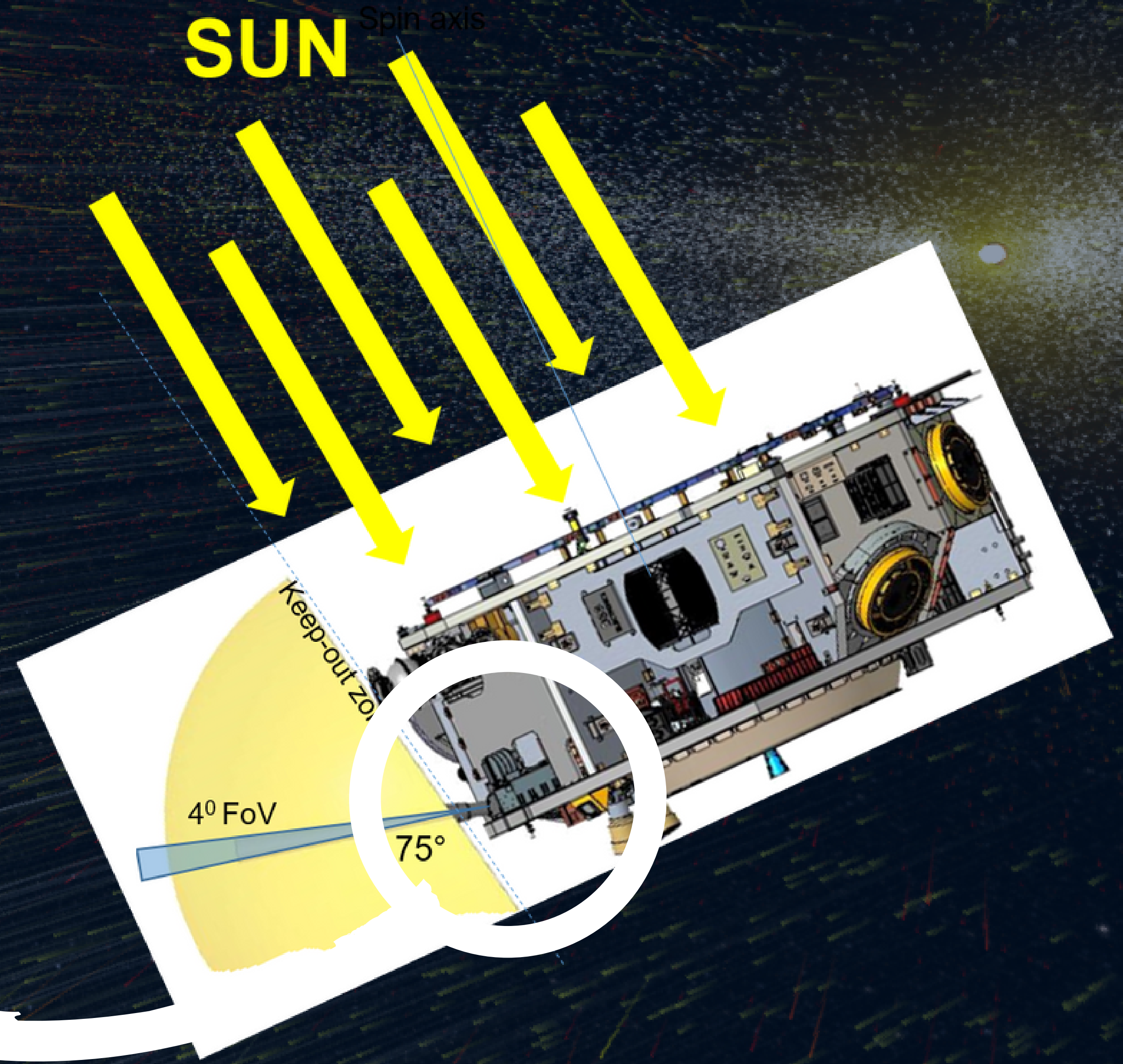
source: wikipedia commons

How will GLOWS study the solar wind?

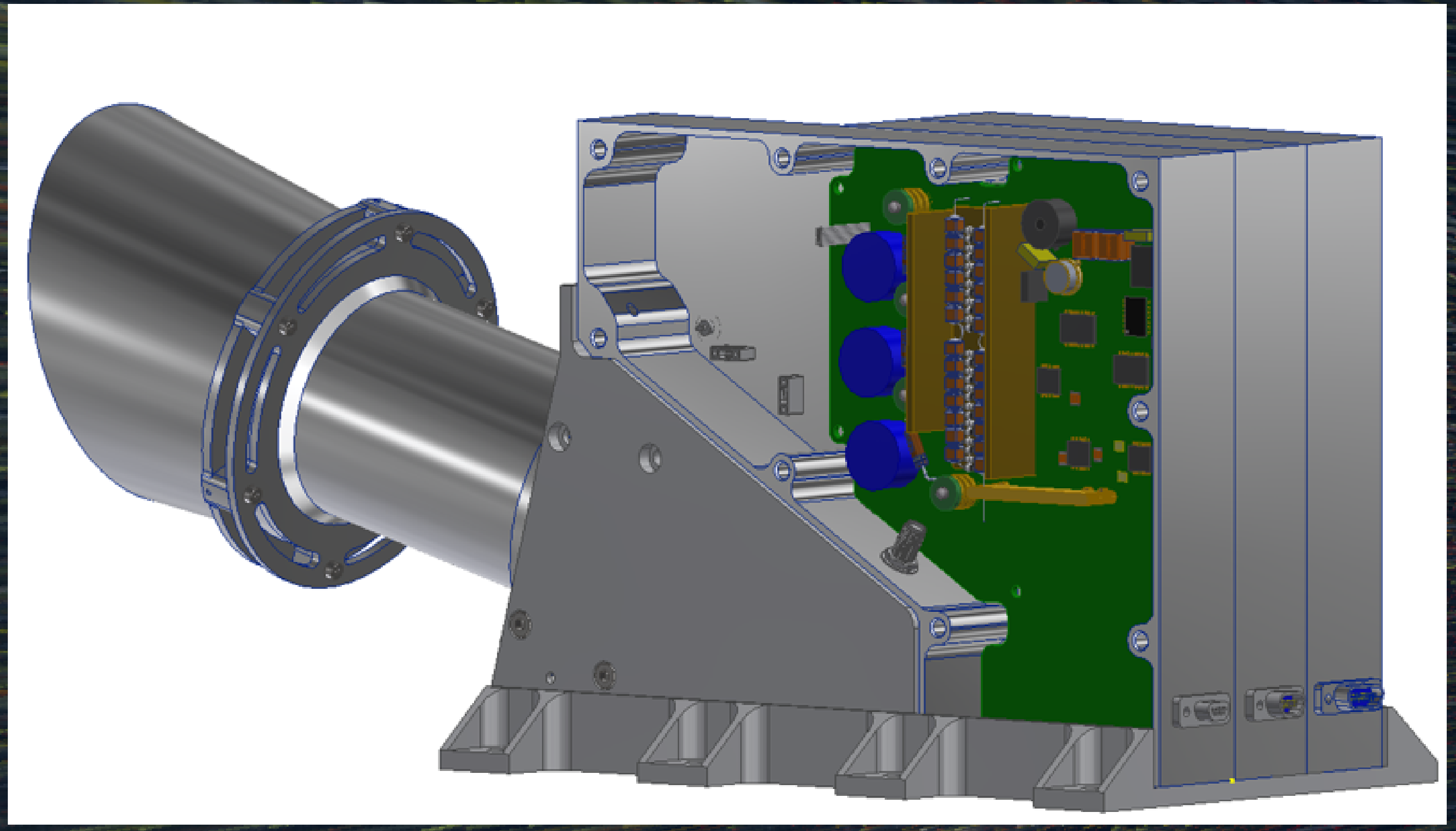
source: NASA/GSFC

GLOWS in detail - construction

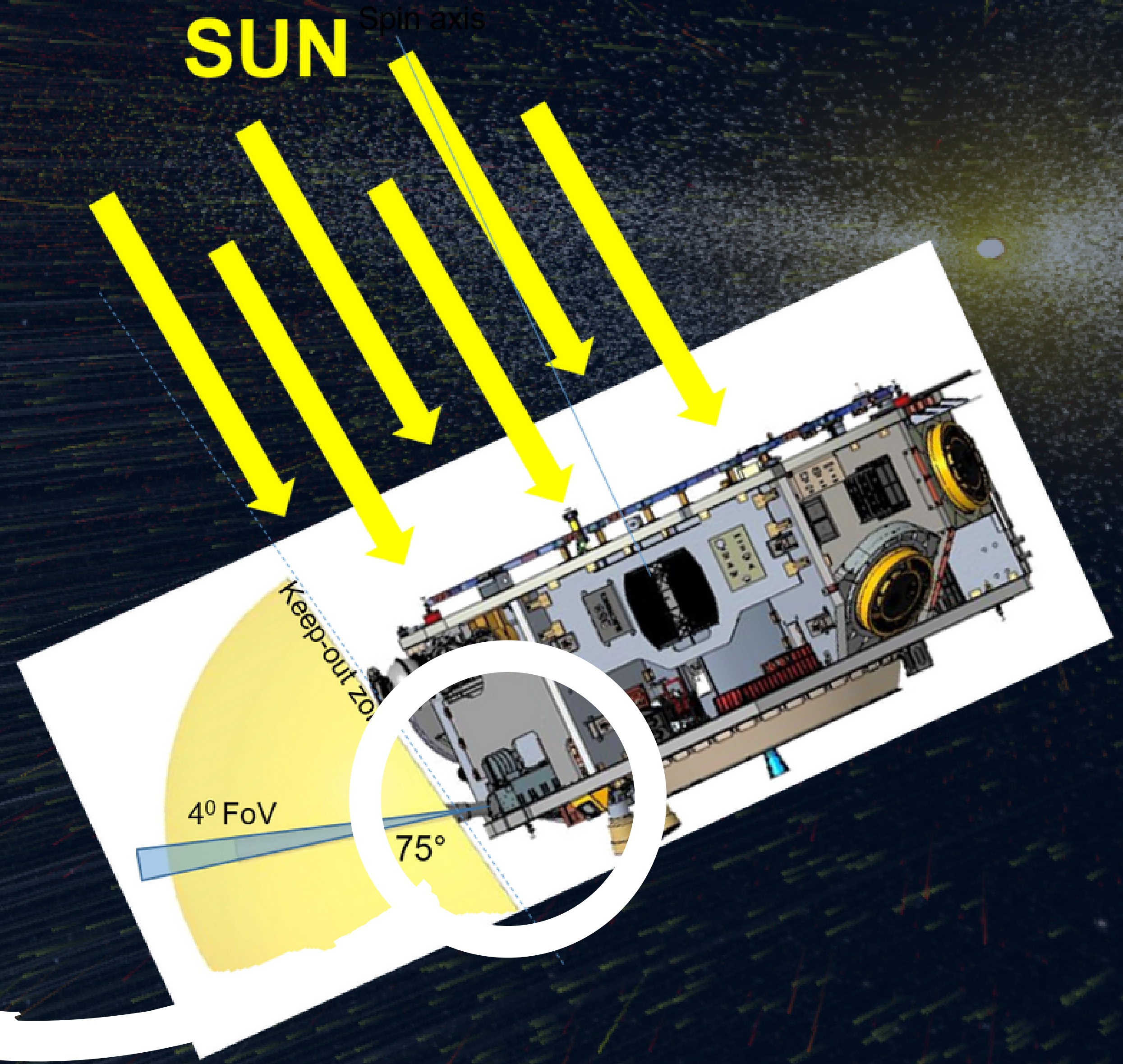
GLOWS will be located at the bottom of the IMAP probe and will be looking at the Sun at an angle of about 75°. It is a photometer, which is a device that counts the photons incident on it.



GLOWS in detail - construction



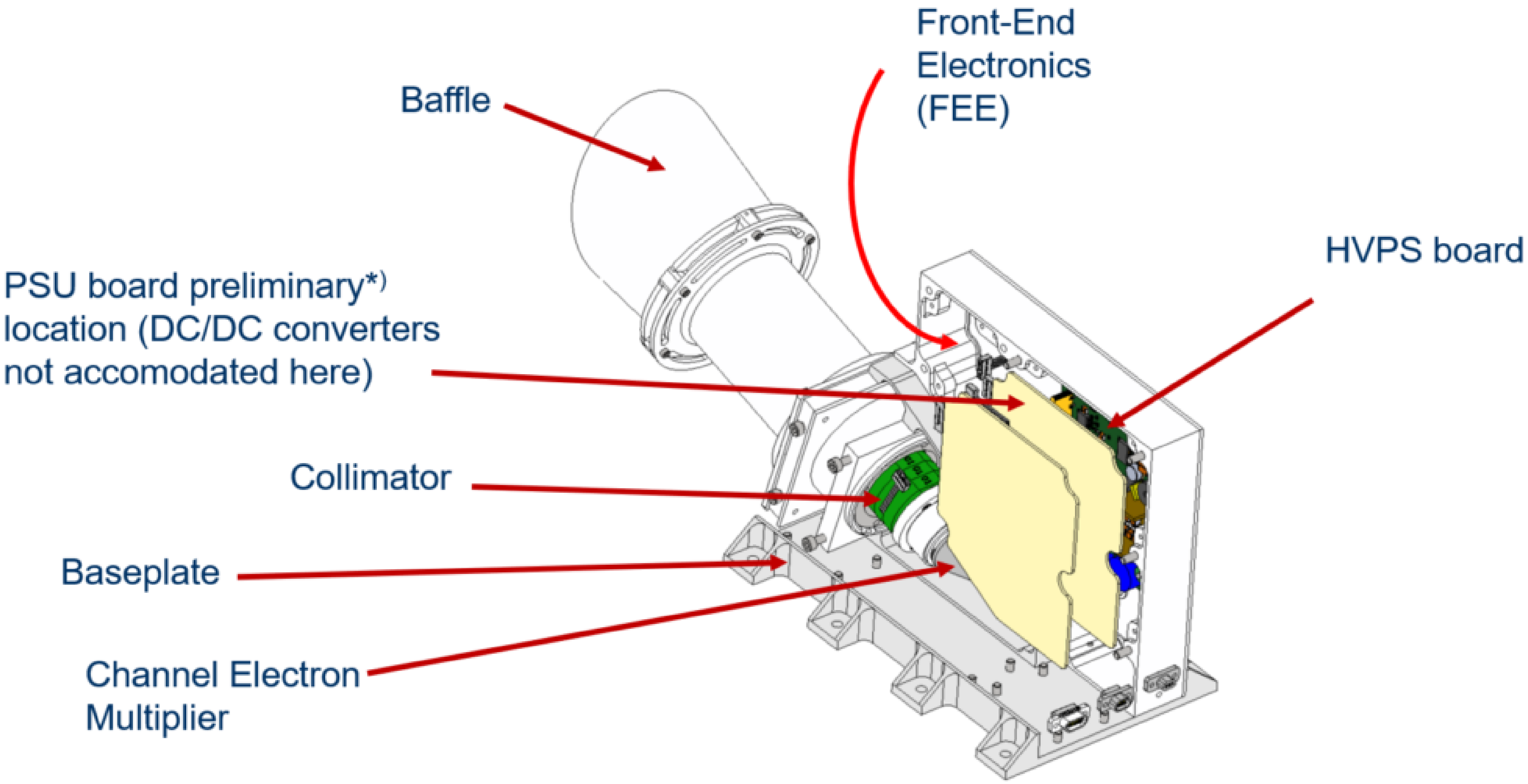
~50cm



GLOWS in detail - construction

What does this diagram mean?

The principle of operation is quite simple: photons will enter the device through the tube, and the baffle is intended to limit the photons from different angles. (1/4)

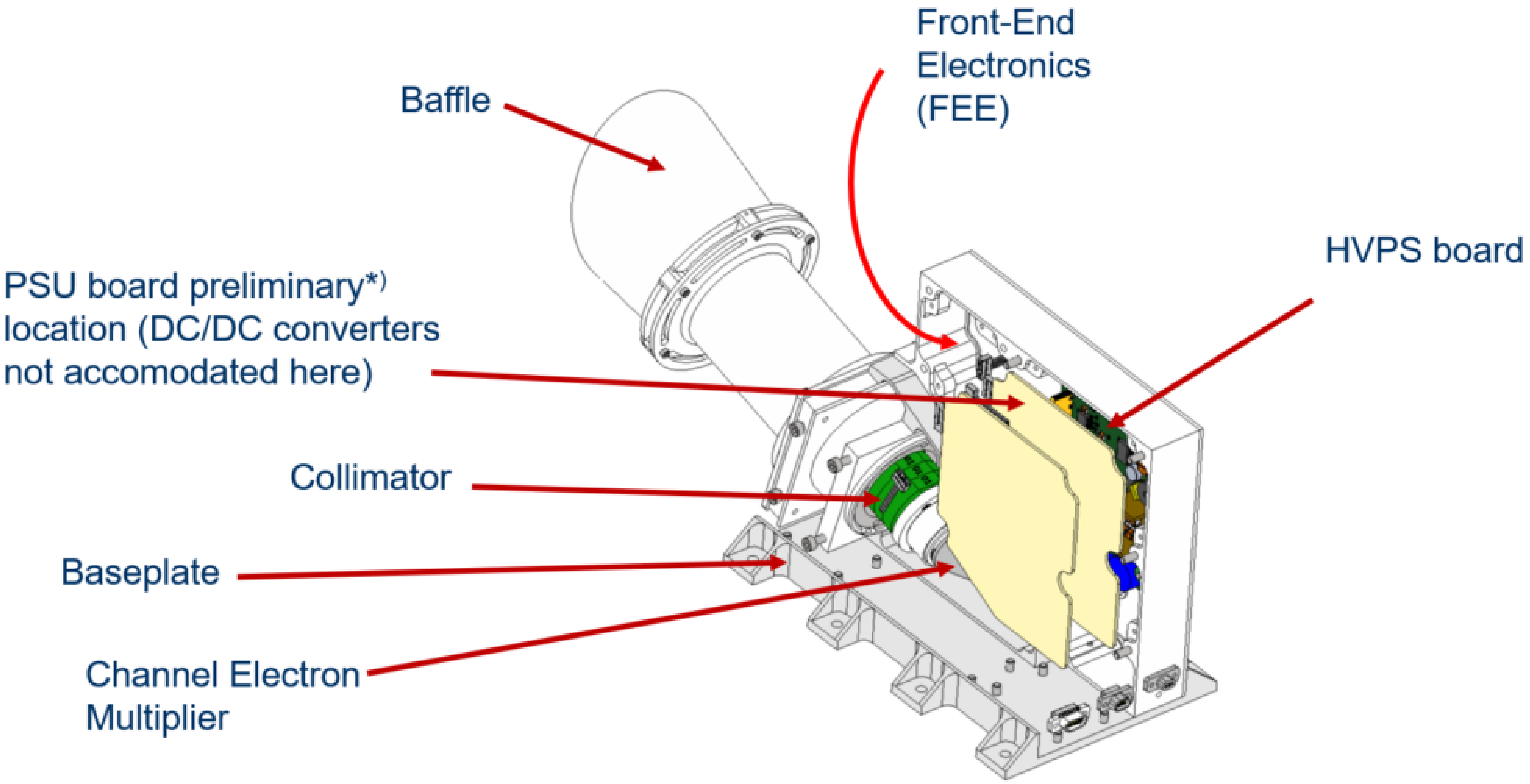


source: GLOWS/CBKs

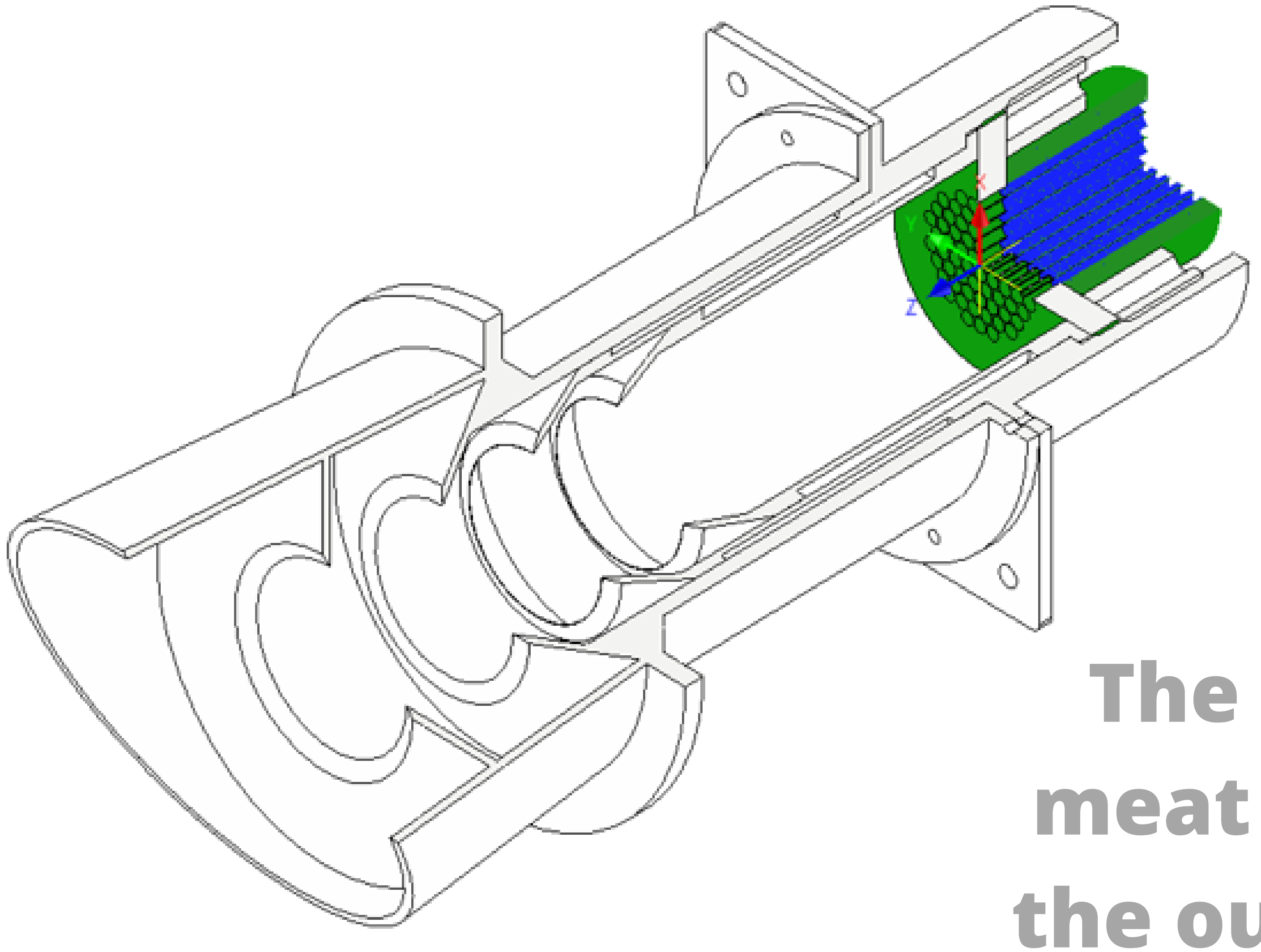
GLOWS in detail - construction

What does this diagram mean?

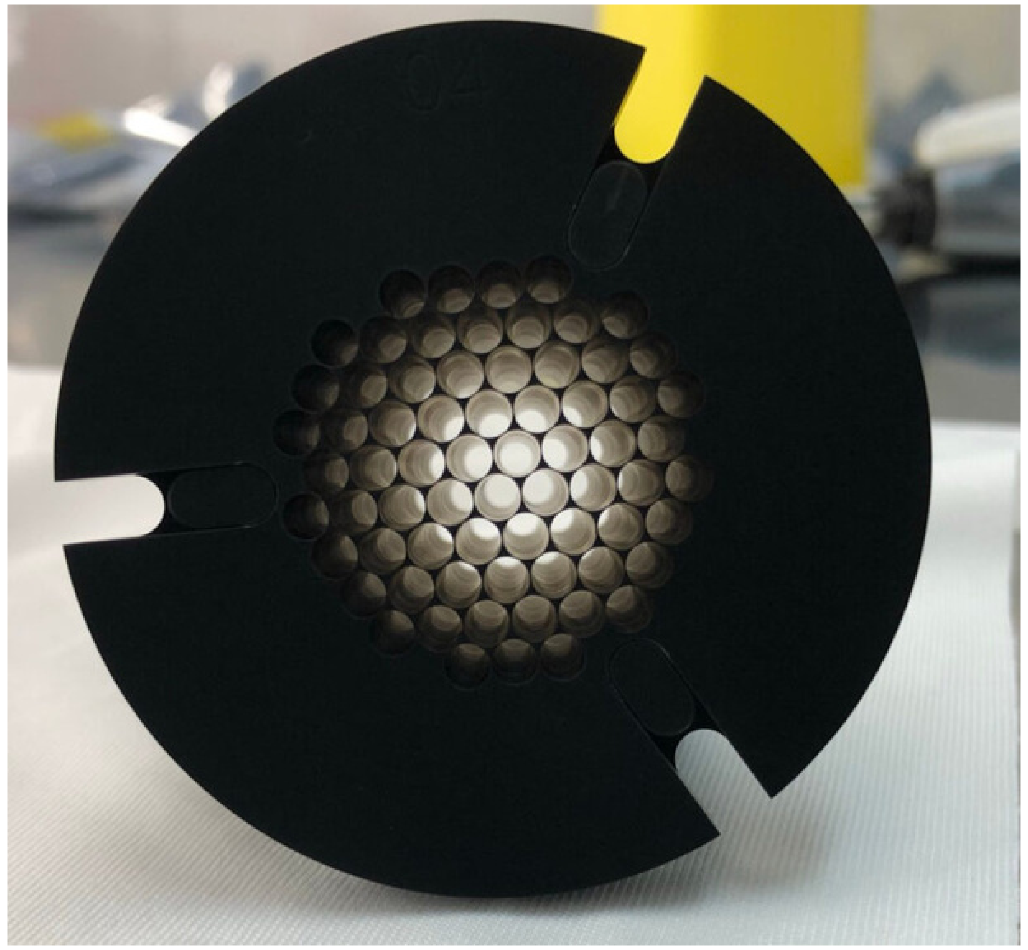
Next, the pre-formed photon beam passes through a collimator - it will only allow photons flying along the collimator's axis. (2/4)



GLOWS in detail - construction



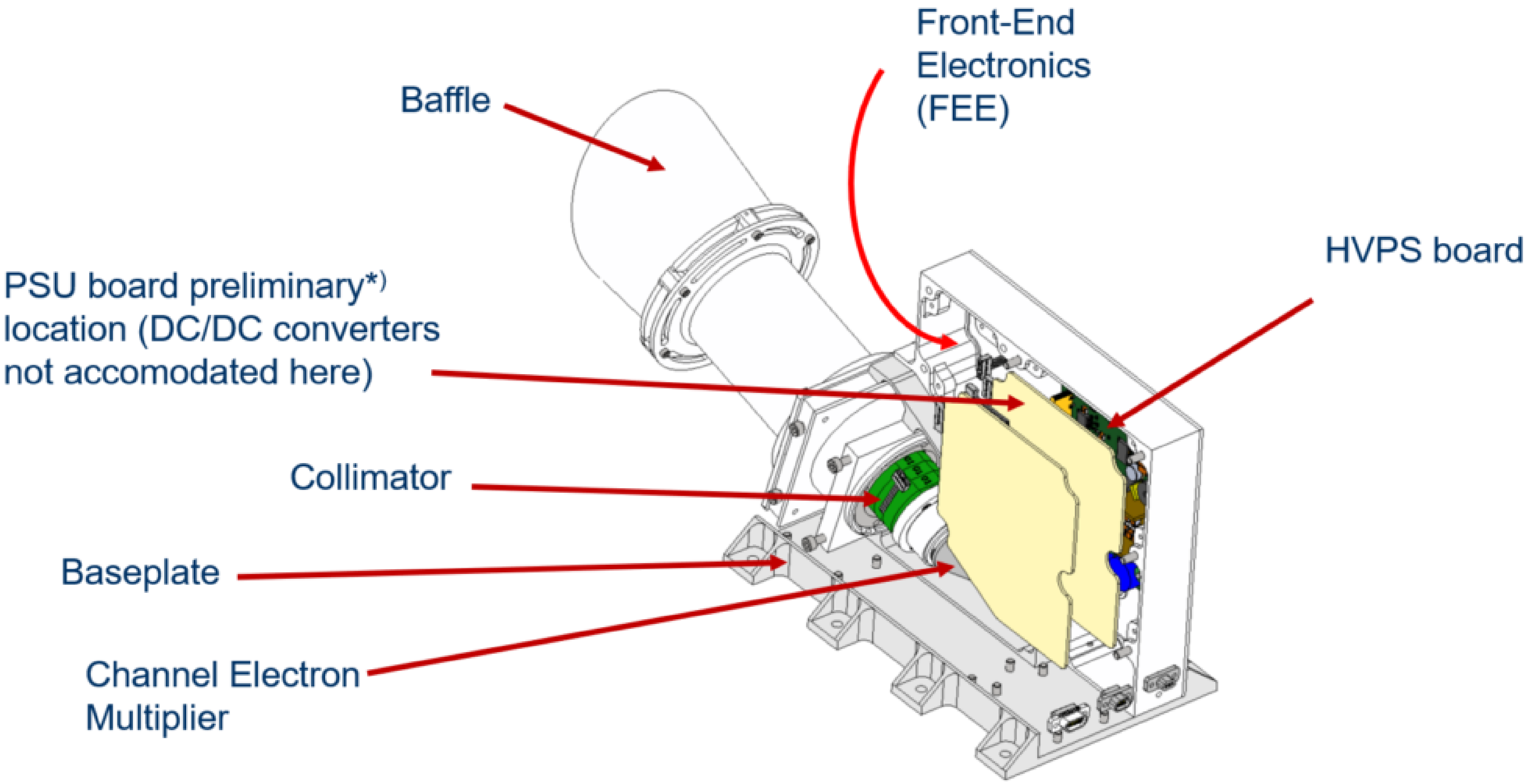
The collimator looks like a meat grinder for photons - at the output, we already have a parallel beam.



GLOWS in detail - construction

What does this diagram mean?

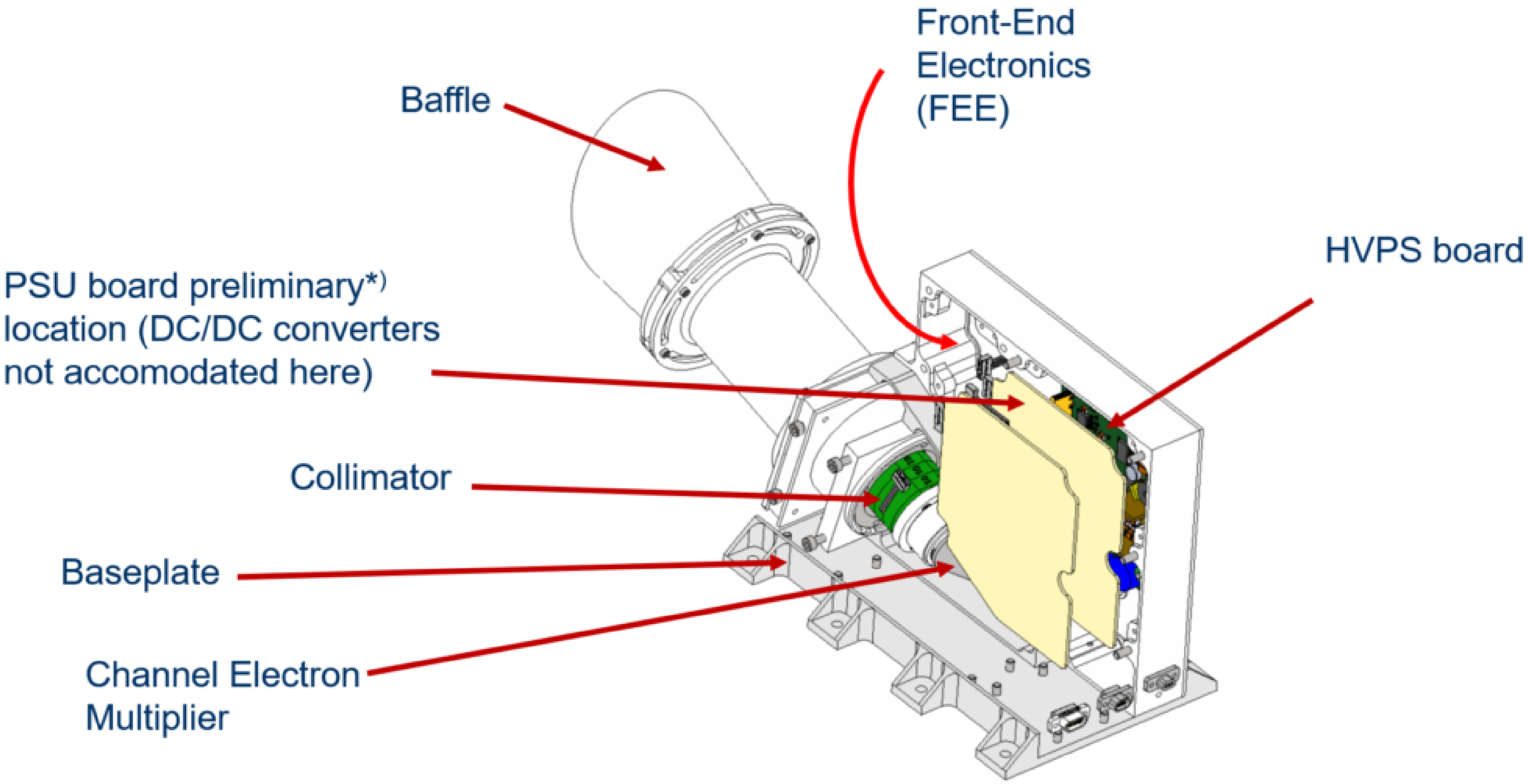
The formed beam passes through a filter (only photons of a specific wavelength we are interested in) and then to the detector. (3/4)



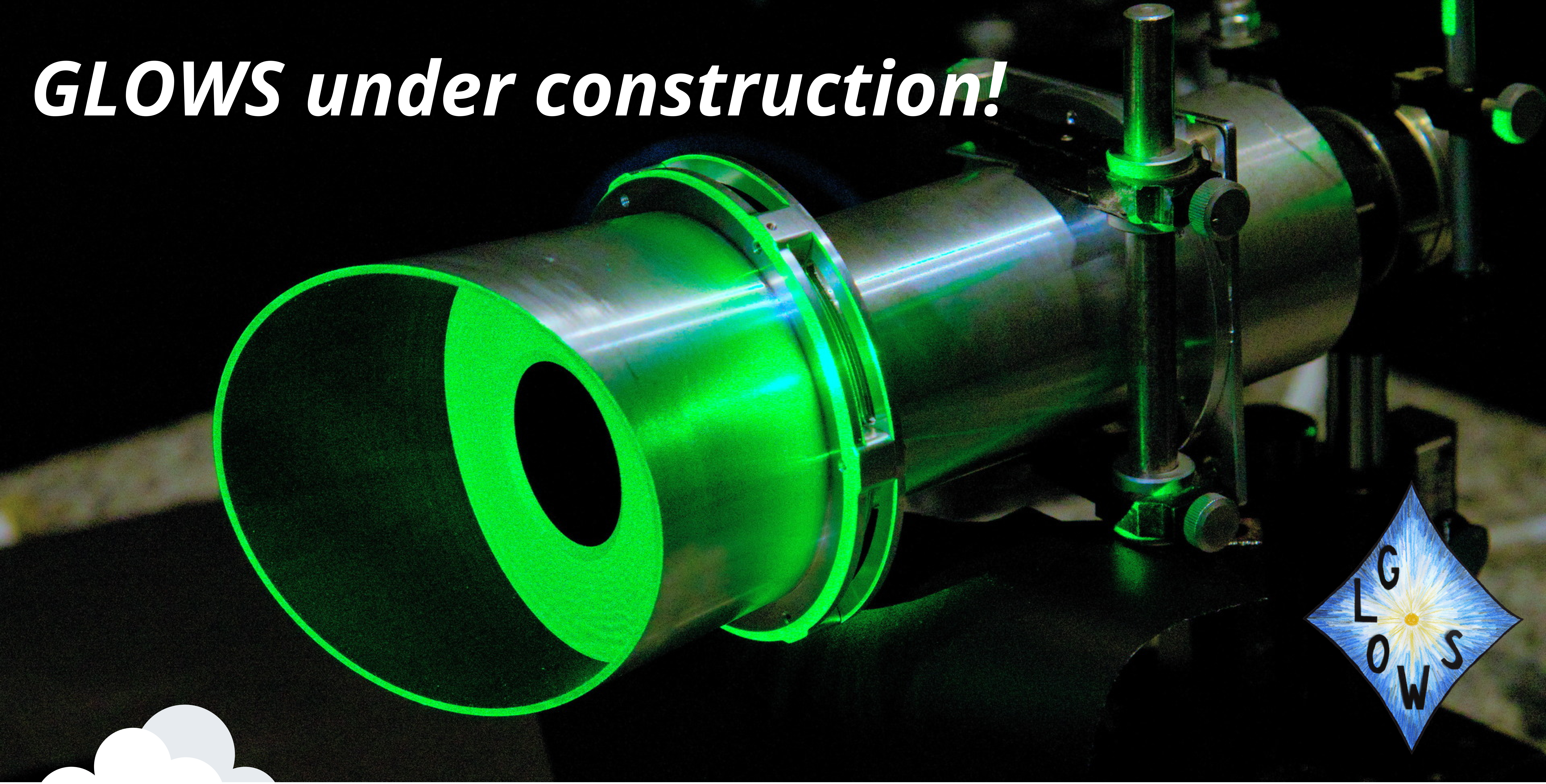
GLOWS in detail - construction

What does this diagram mean?

The rest is electronics that allow processing and recording the obtained data. (4/4)



GLOWS under construction!



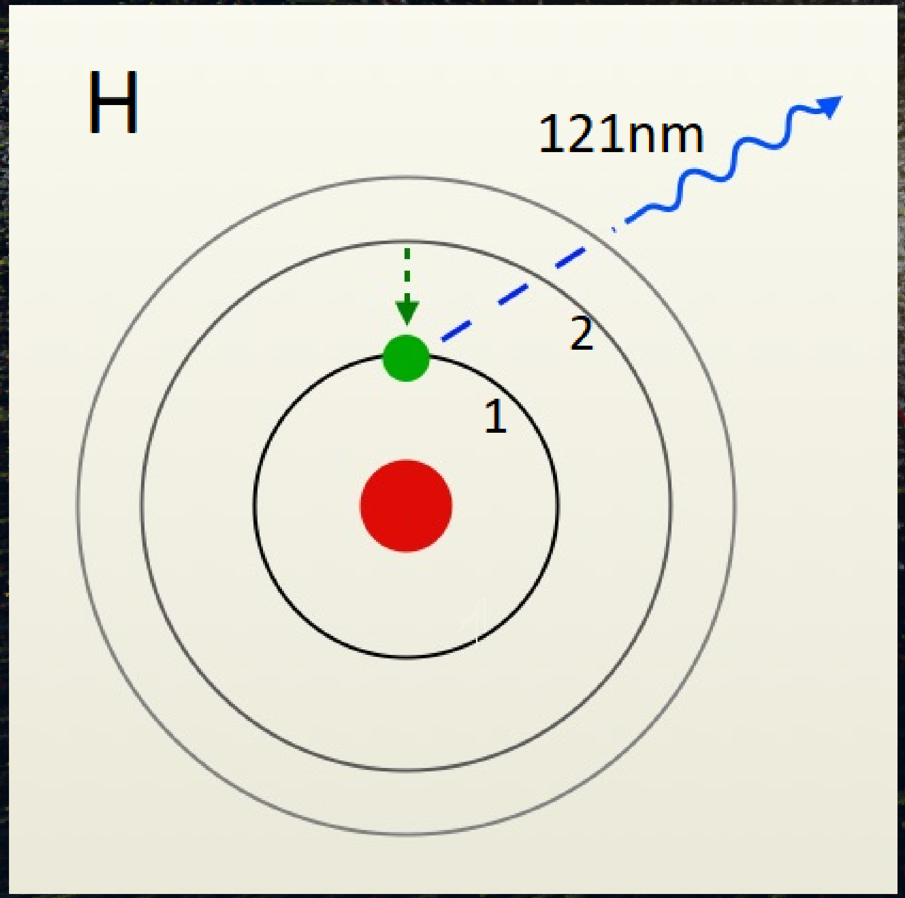

GLOWS under construction!
The whole thing has been build from scratch by Polish team from CBK!
GLOWS

What photons will GLOWS measure??

What photons will GLOWS measure??

Indeed, there are no photons in the solar wind.
→ GLOWS will study the solar wind indirectly.

Incoming atoms from the interstellar medium, including hydrogen (H), interact with the solar wind and photons from the Sun. For example, photons excite hydrogen, and after a few nanoseconds, hydrogen emits a photon with a specific wavelength - 121nm. This is known as the Lyman series emitted in the ultraviolet range. This phenomenon creates a 'glow' around the Sun, and GLOWS will study it.

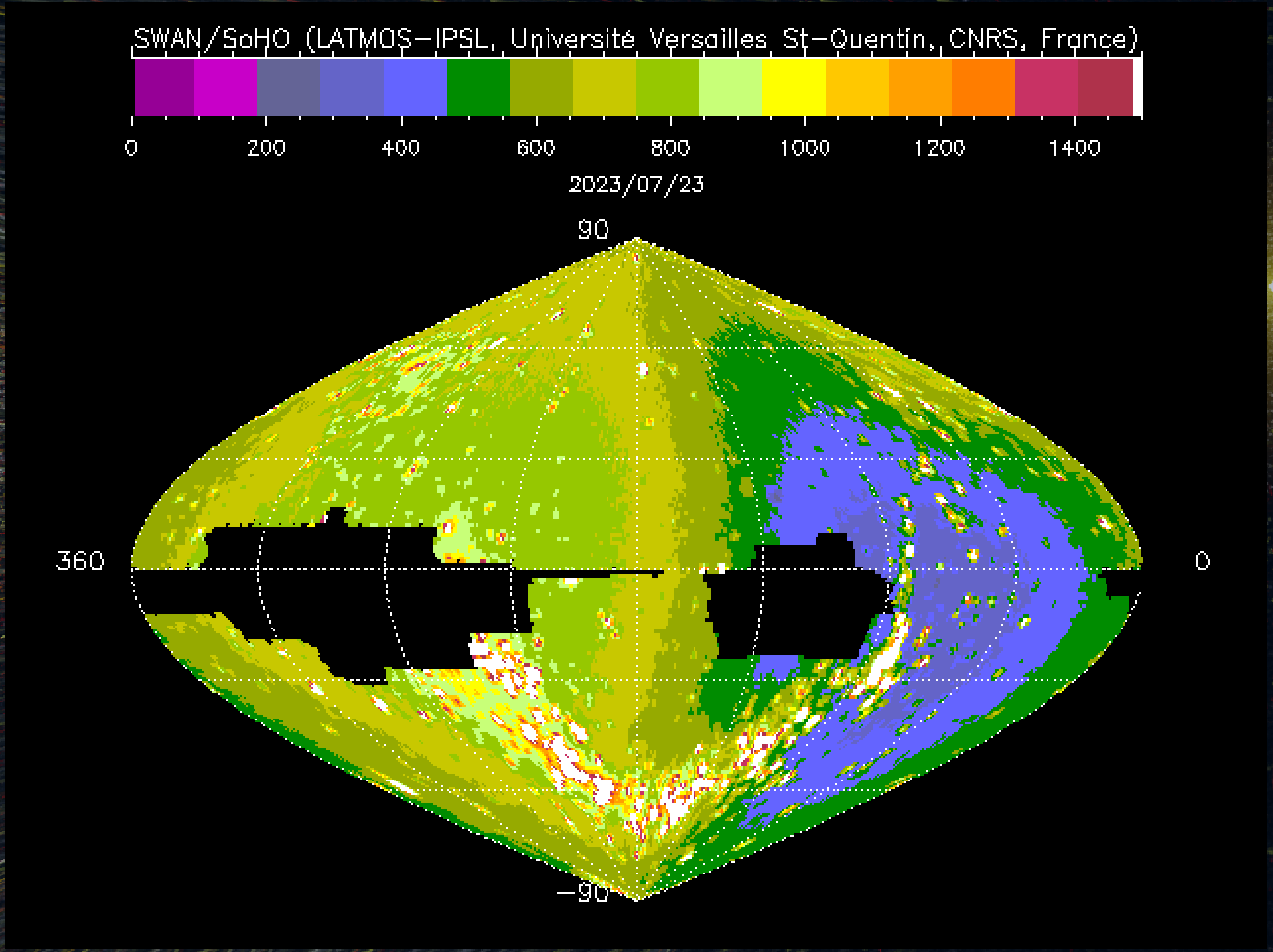


source: anisotropela.dk

What photons will GLOWS measure??

GLOWS will improve existing measurements by providing higher spectral resolution and sensitivity, reducing background noise.

On the left, there is a map created by the SoHO/SWAN satellite.

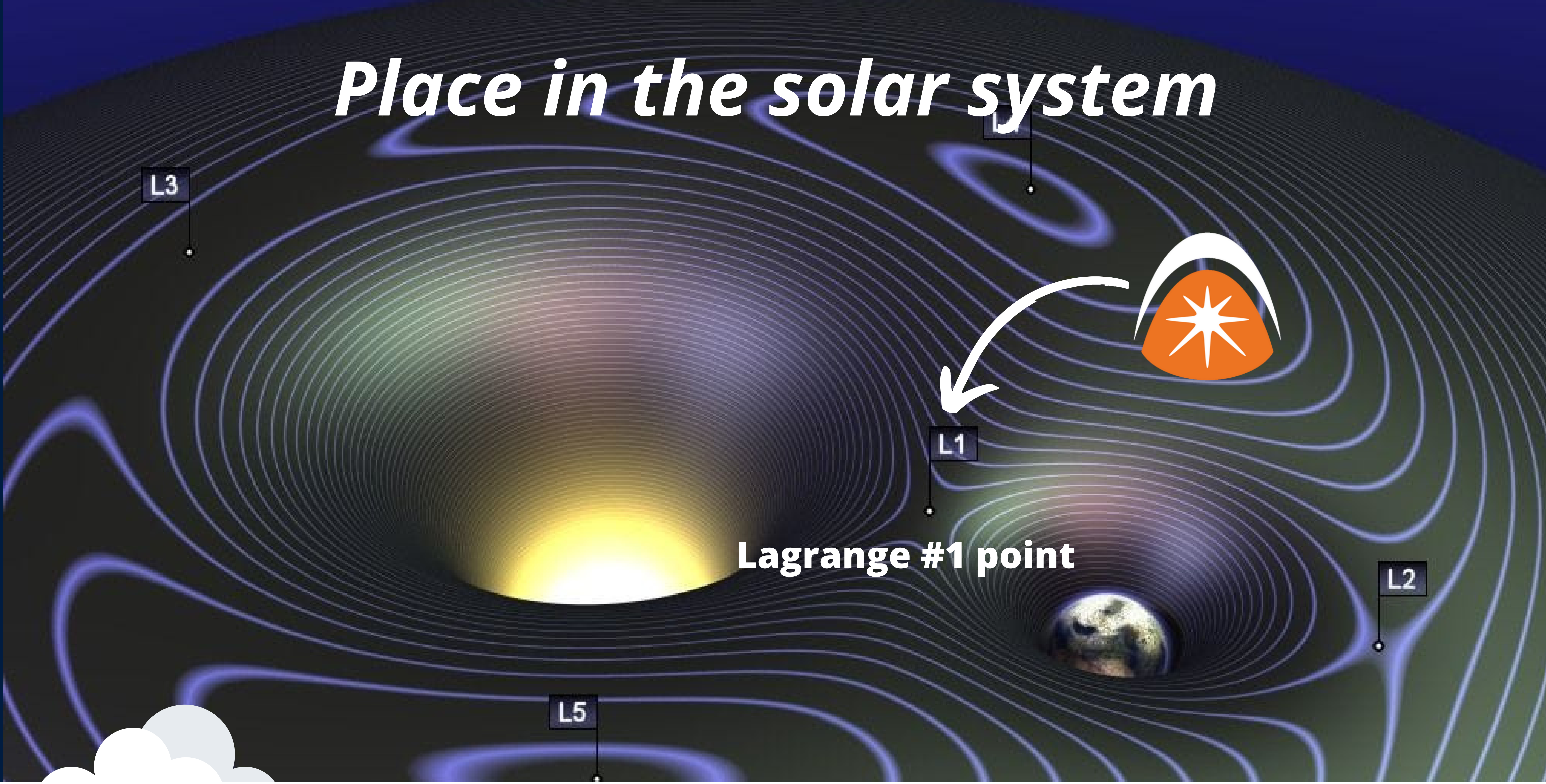


source; http://swan.projet.latmos.ipsl.fr/

Where will IMAP be heading?

source: NASA/Johns Hopkins APL/Princeton University/Steve Gribbeni

Place in the solar system



source: https://medium.com/mathphy-exclusive/the-upcoming-space-missions-around-the-lagrange-points-9d2cd331d4b9n

Place in the solar system

Lagrange points are very useful in astronomy and for space missions. They are points of gravitational equilibrium and stability between two bodies - in this case, the Sun and the Earth.

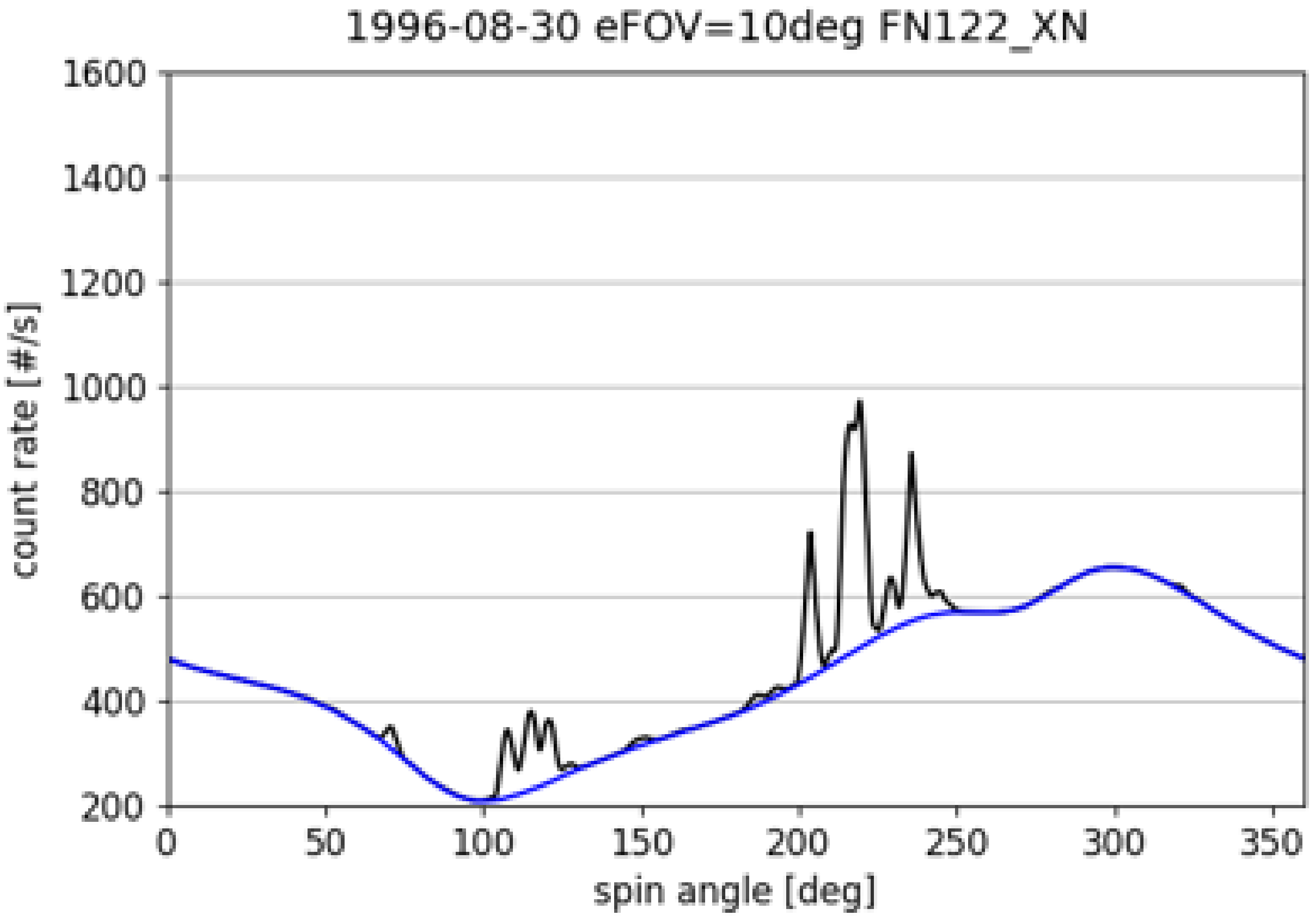
The probe will be almost stationary at this point and will orbit the Sun like us - in one year.

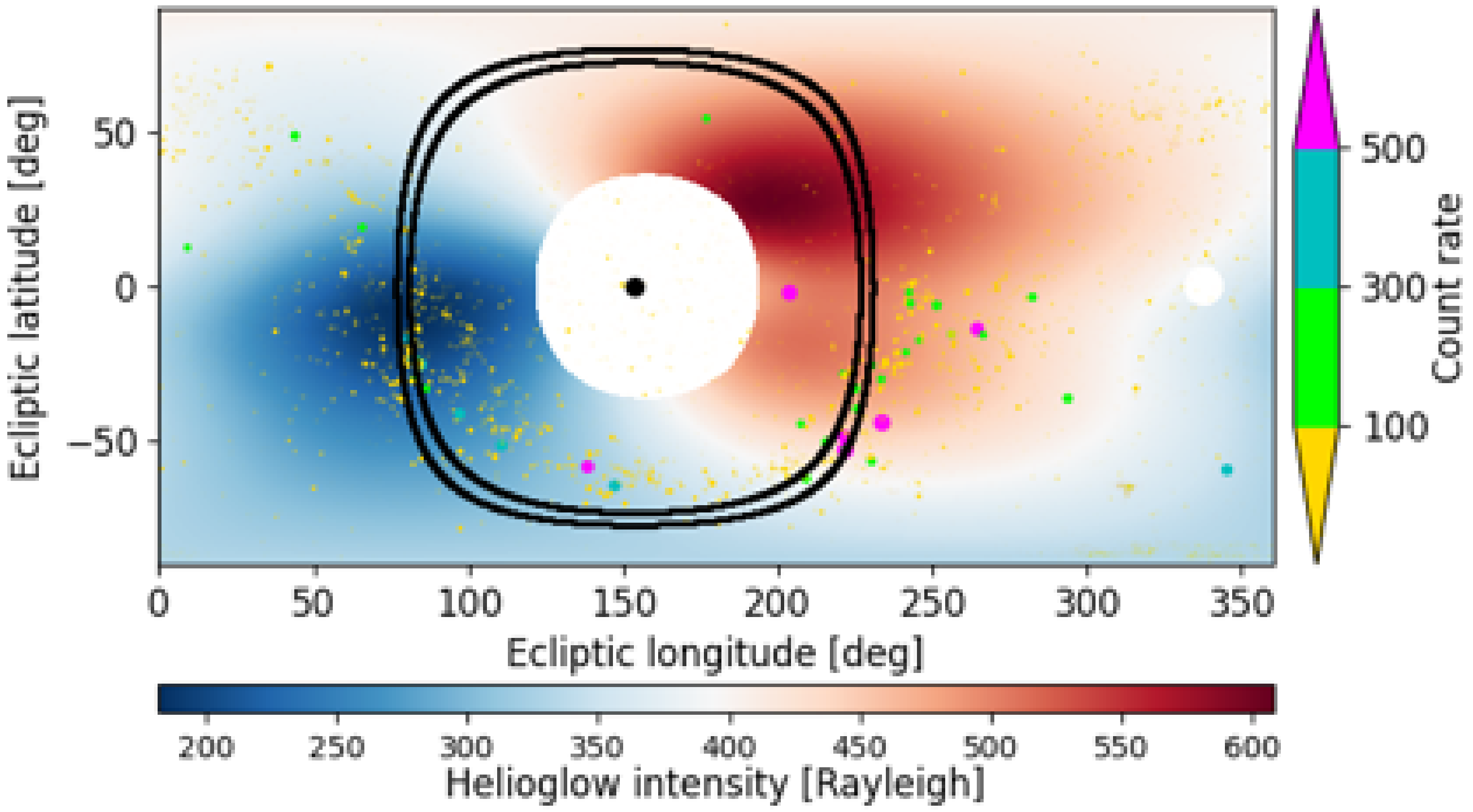
Lagrange #1 point

Glow observation

In the lower diagram, you can see a circle at an angle of ~75° around the Sun, which represents the GLOWS monitoring area, along with the simulated heliospheric glow in the background.

At the top, you can see the intensity values of this glow depending on the angle on the circle. You can also observe 'peaks' from stars, which are also present in the background.

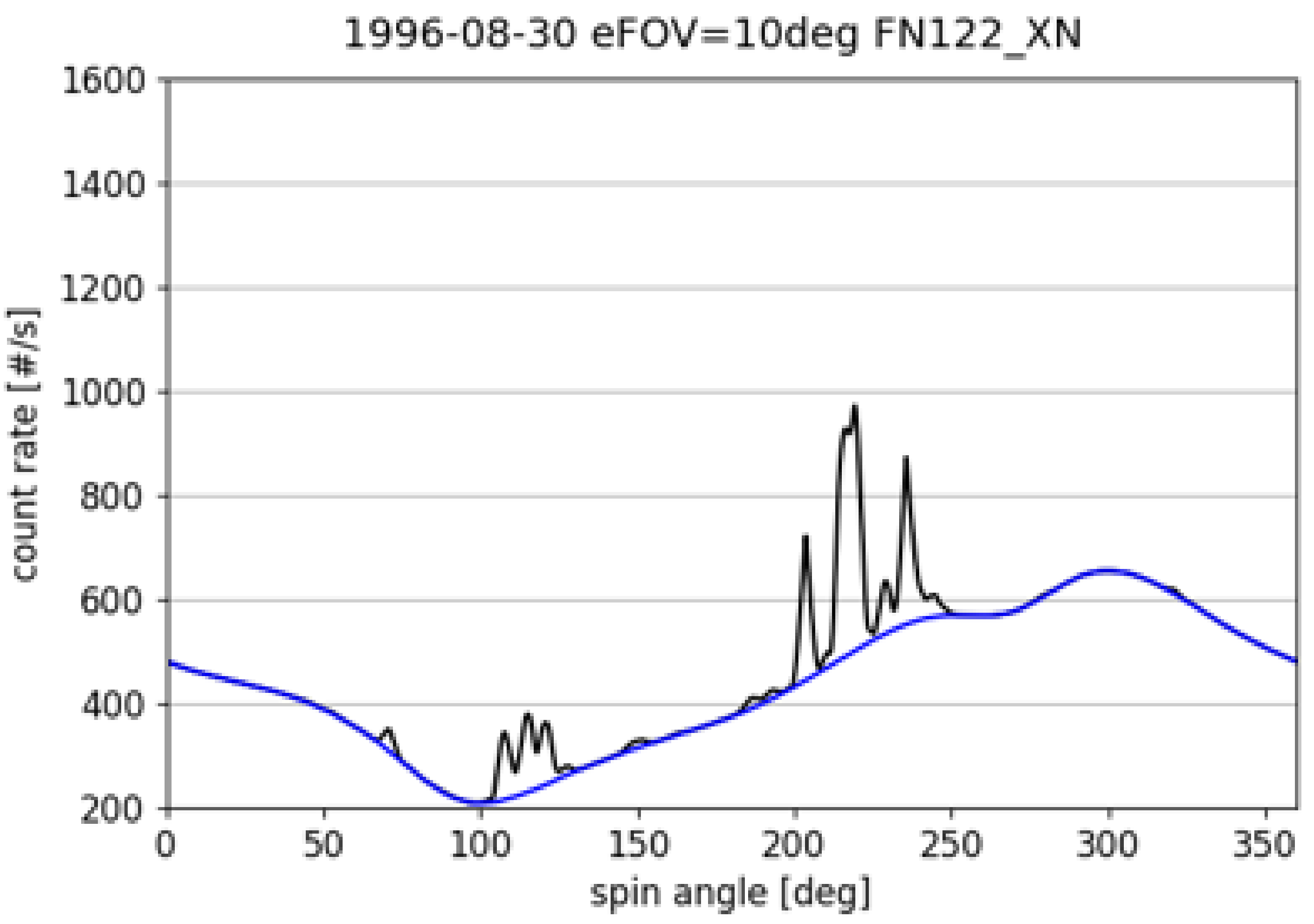


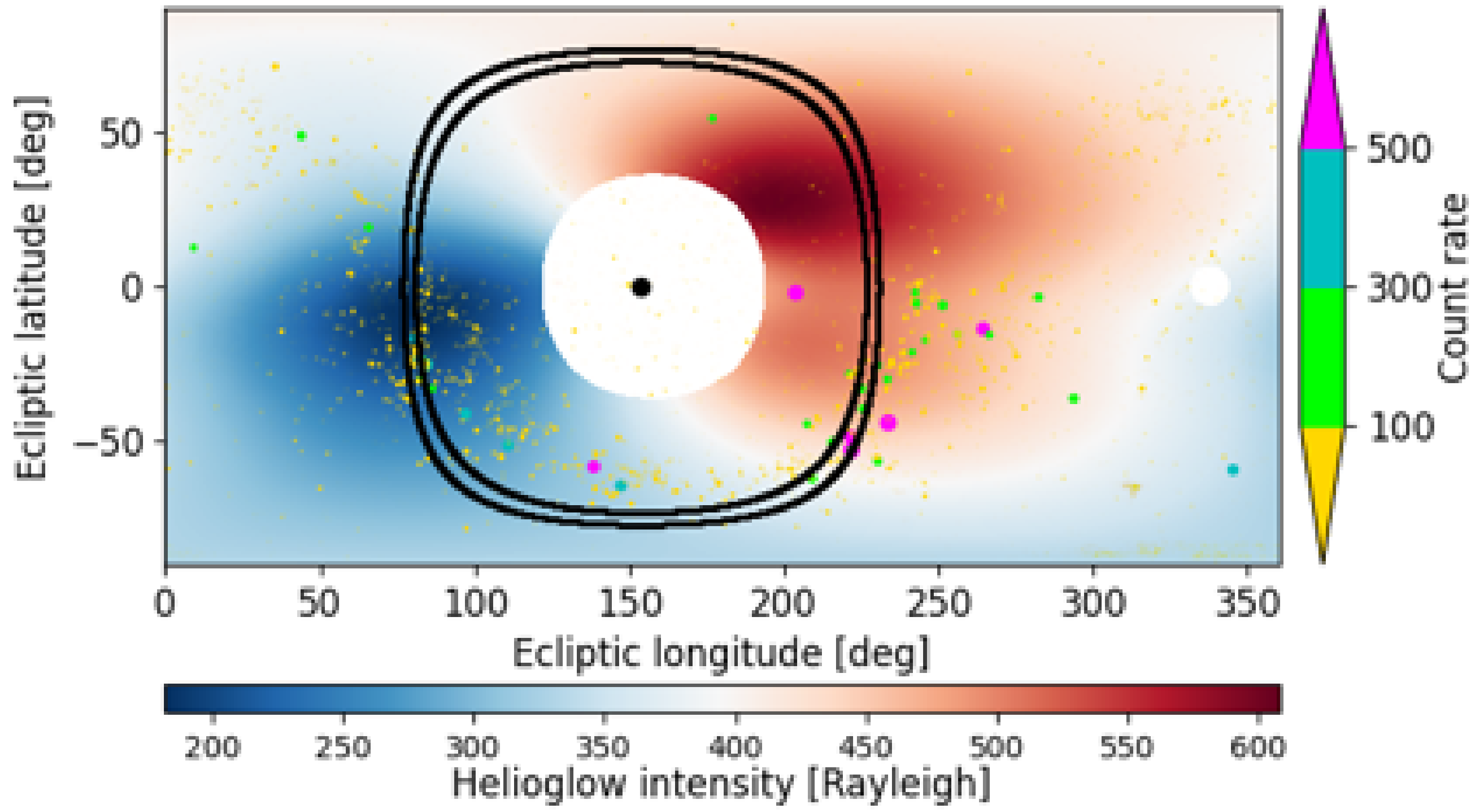


source: GLOWS/CBK

Glow observation

The satellite will take measurements daily while rotating around its own axis (in a circular motion). As it orbits around the Sun throughout the year, it will create a 3D scan of its structure and, indirectly, the solar wind.





See you in orbit!

PRINCETON UNIVERSITY

Goddard SPACE FLIGHT CENTER

Los Alamos NATIONAL LABORATORY EST. 1943

UNIVERSITÄT BERN

LASP Laboratory for Atmospheric and Space Physics University of Colorado Boulder

CBK PAN

Smithsonian Astrophysical Observatory

NOAA

THE UNIVERSITY OF ARIZONA

MIT

Caltech

AEROSPACE

NASA

IMAP

APL JOHNS HOPKINS APPLIED PHYSICS LABORATORY

University of New Hampshire

SwRI

Imperial College London

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

UNIVERSITÄT BONN

UCLA

名古屋大学 NAGOYA UNIVERSITY

JPL Jet Propulsion Laboratory California Institute of Technology

THE UNIVERSITY OF CHICAGO

Berkeley UNIVERSITY OF CALIFORNIA

UNIVERSITY OF DELAWARE

The implementation of the GLOWS experiment as part of the NASA Interstellar Mapping and Acceleration Probe (IMAP) mission is funded by the state budget under an agreement with the Ministry of Education and Science.

GLOWS

CBK PAN