Ready for flight with FD-SOI

IPSoC
Grenoble, France, 2019 December 3-4

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On-board Data processing expert
AIRBUS Defence and Space – Engineering/Space Systems

December 2019

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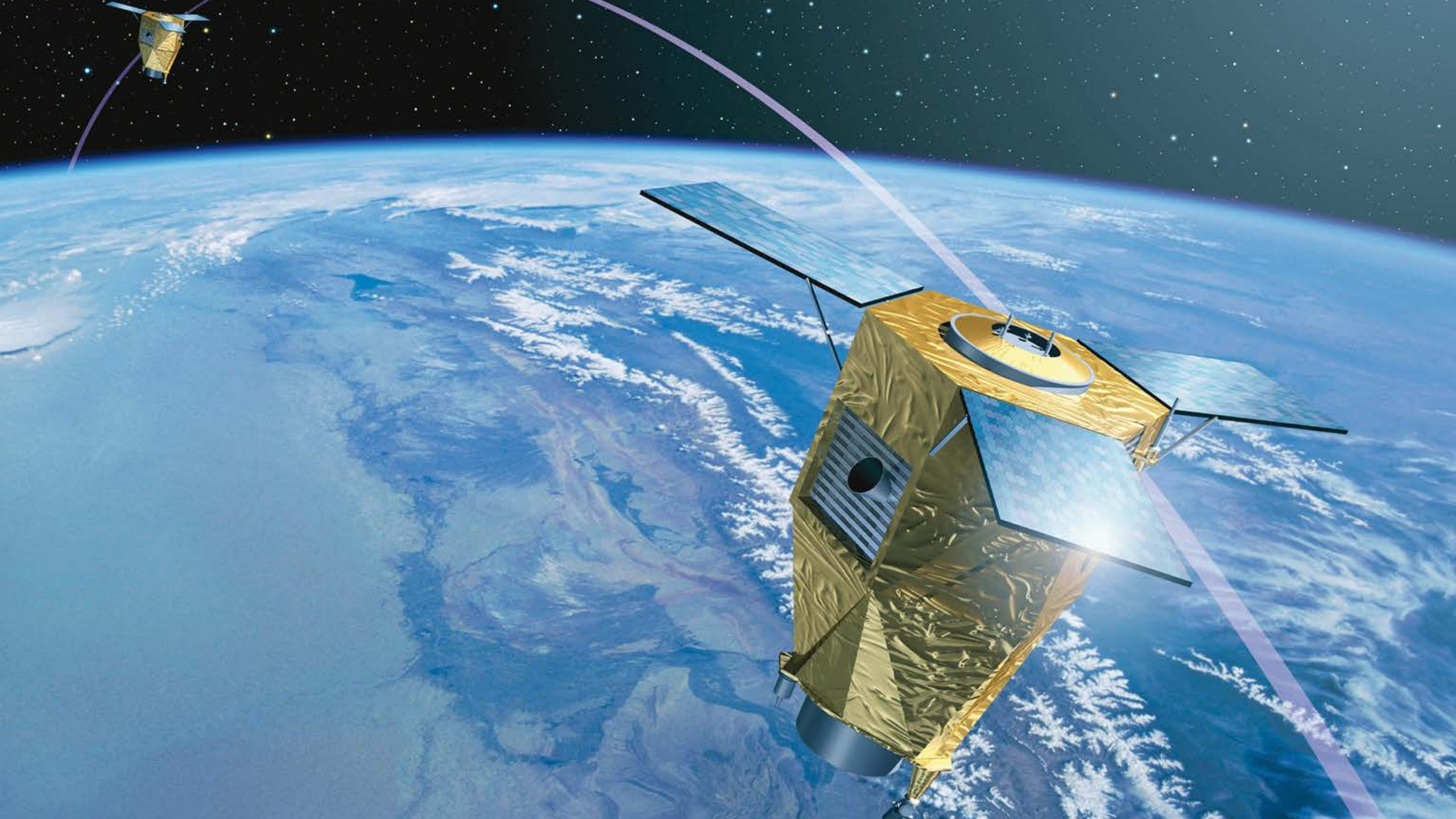
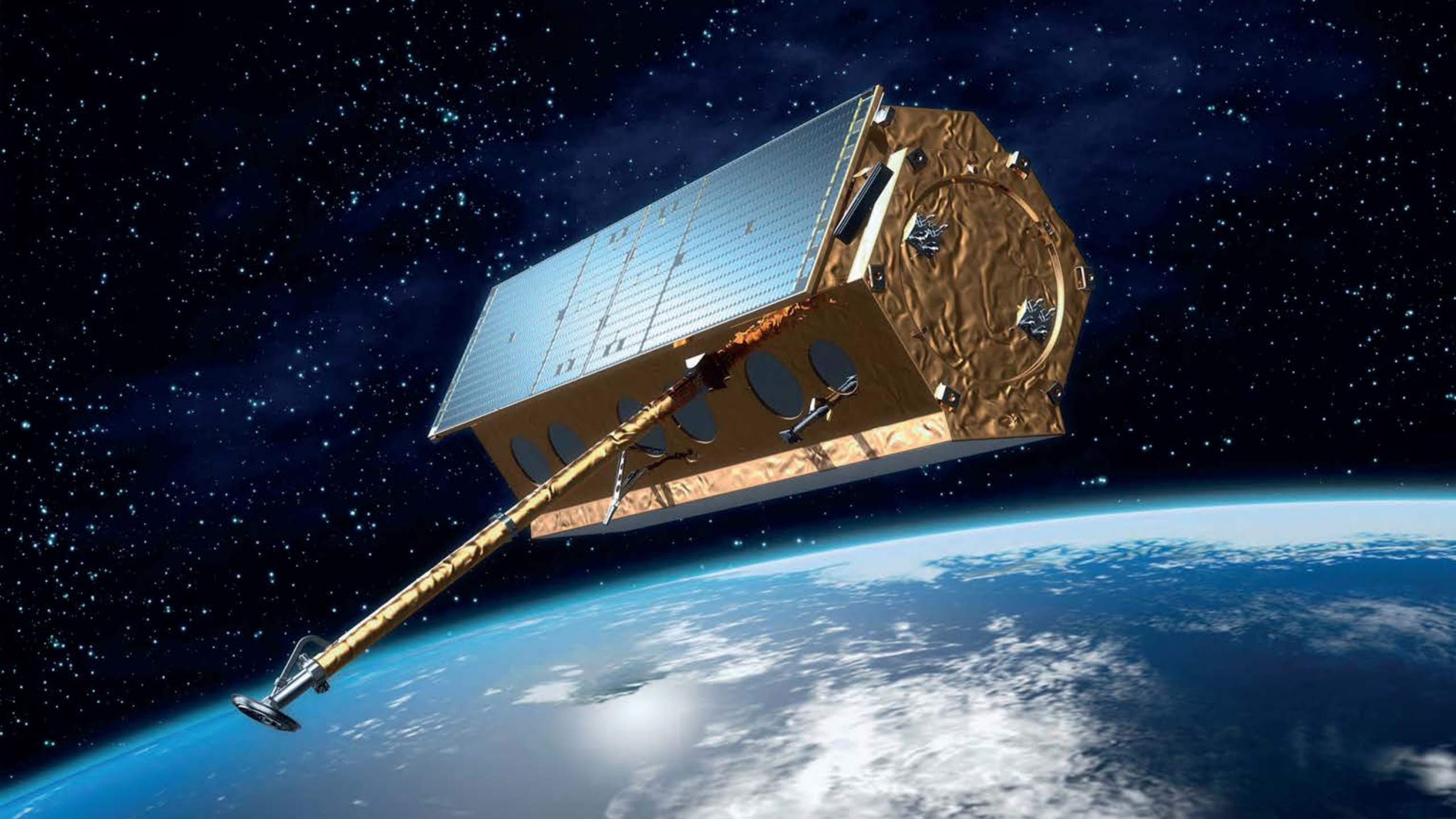
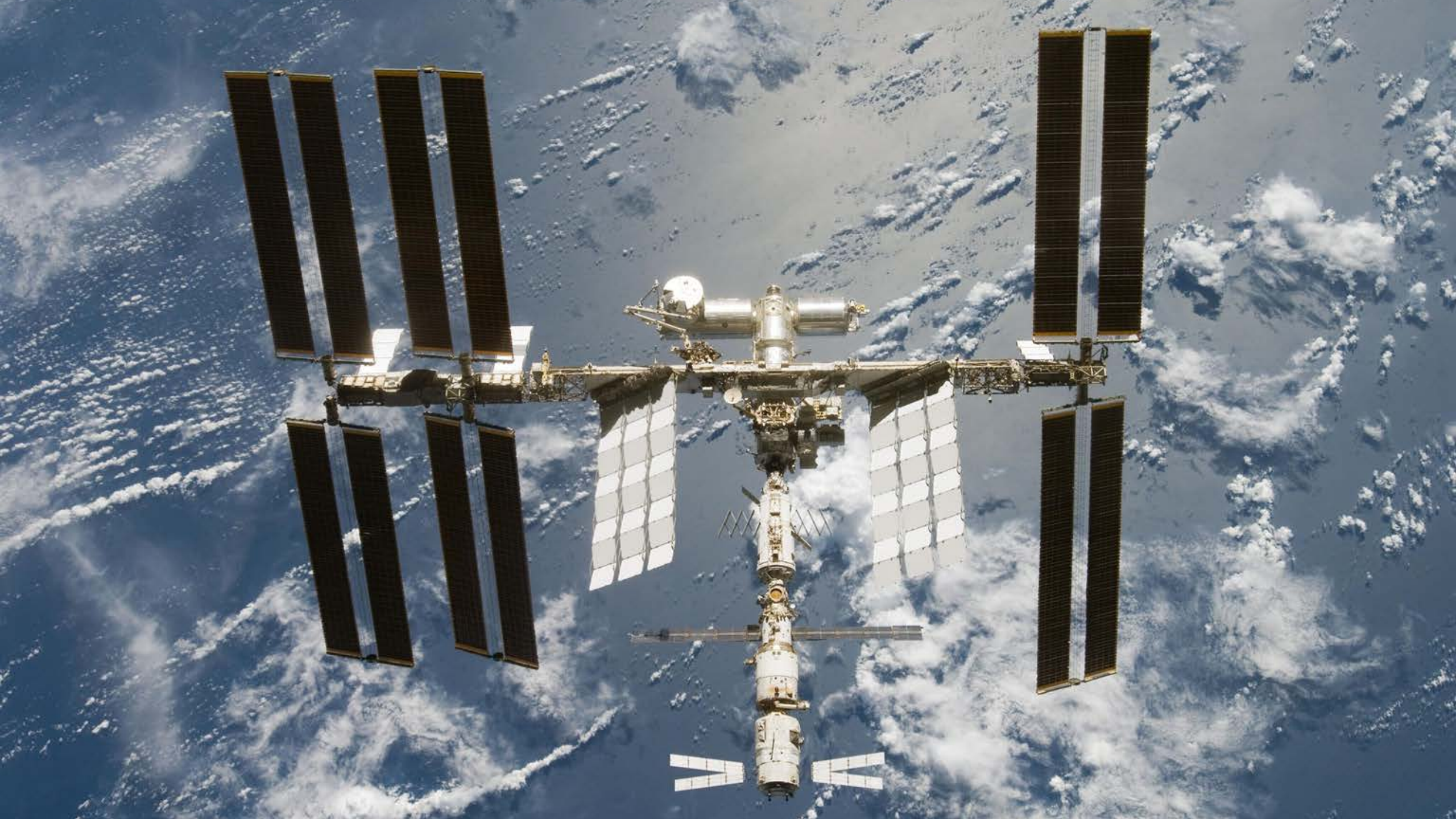
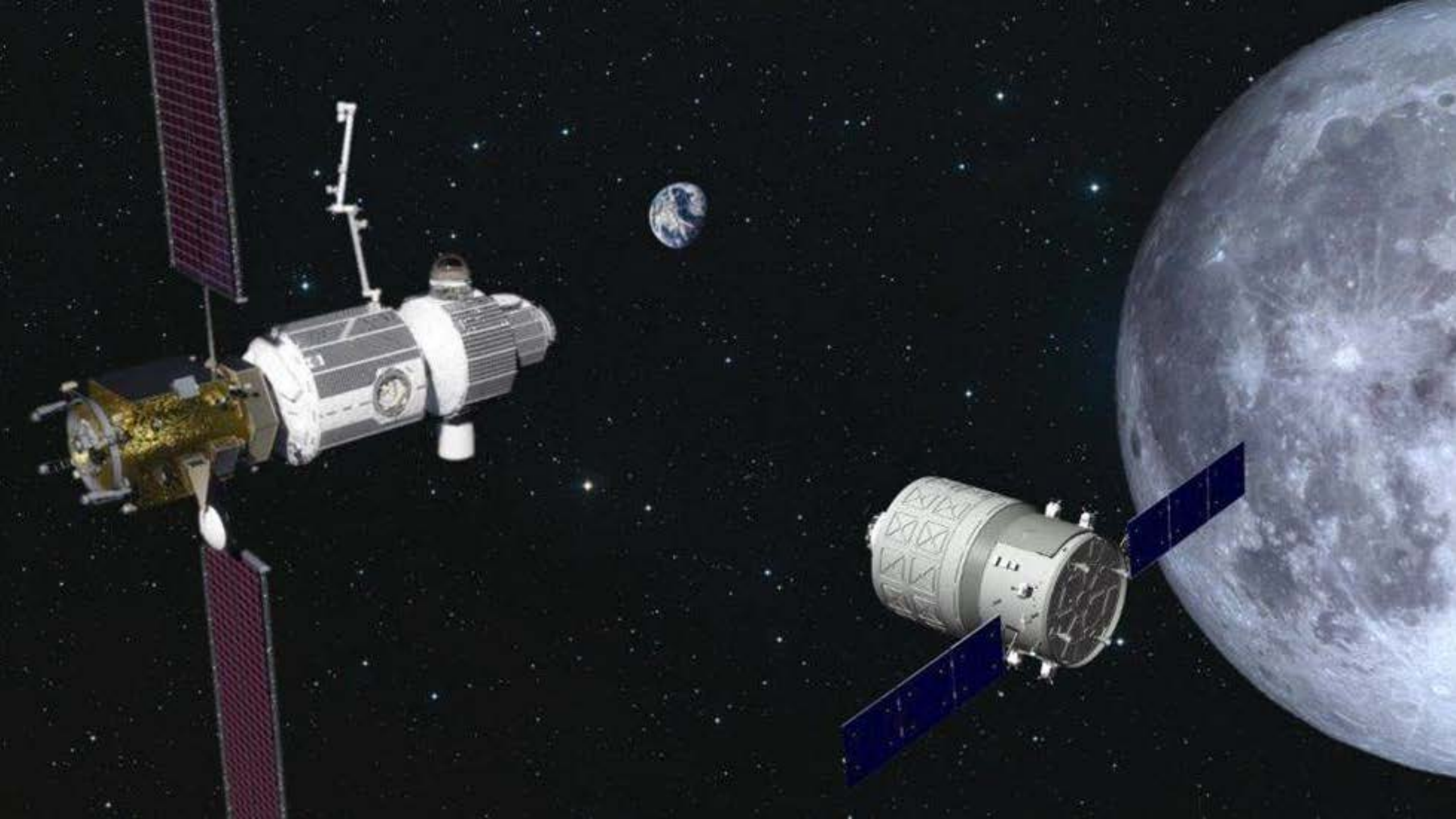
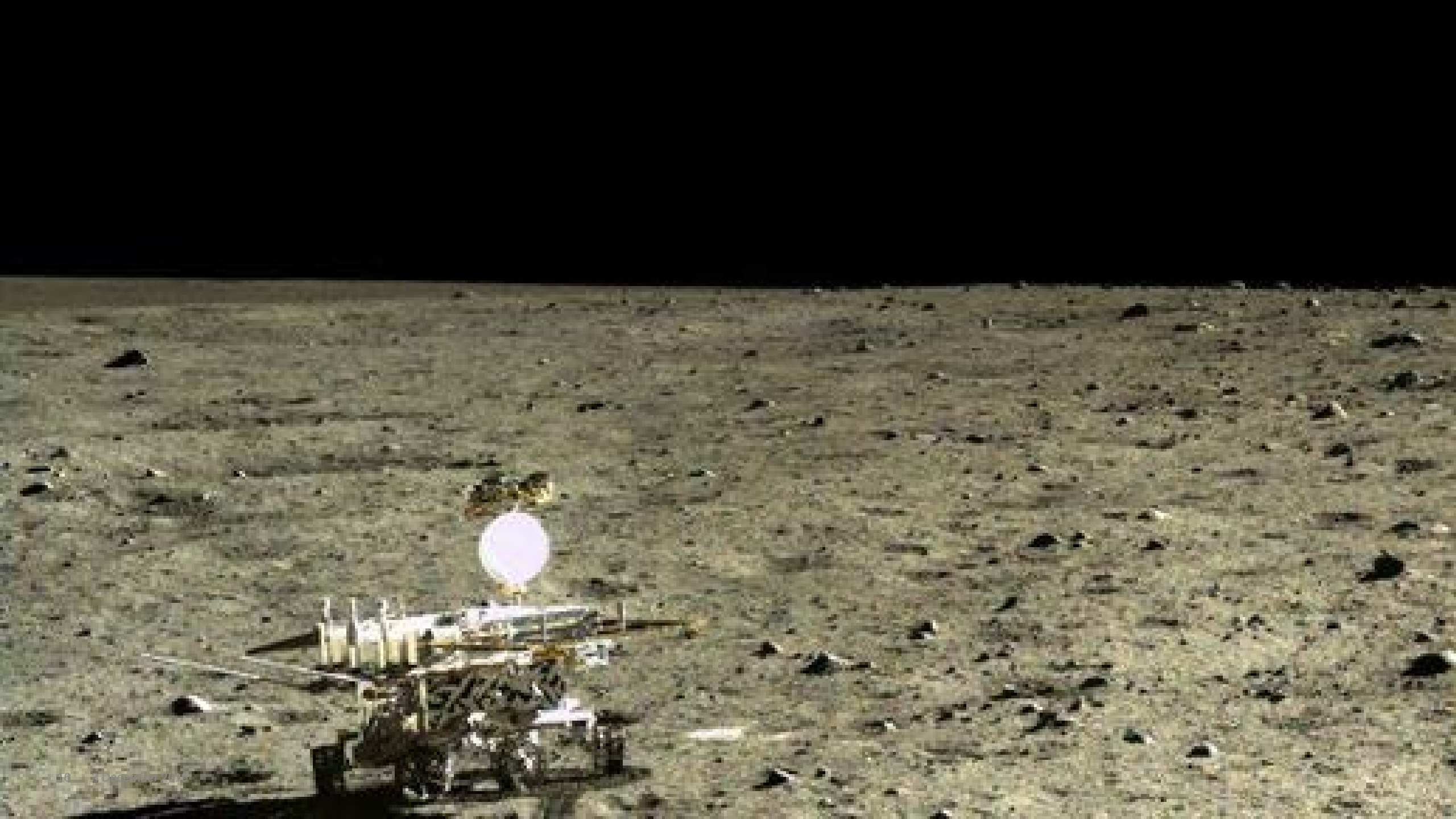


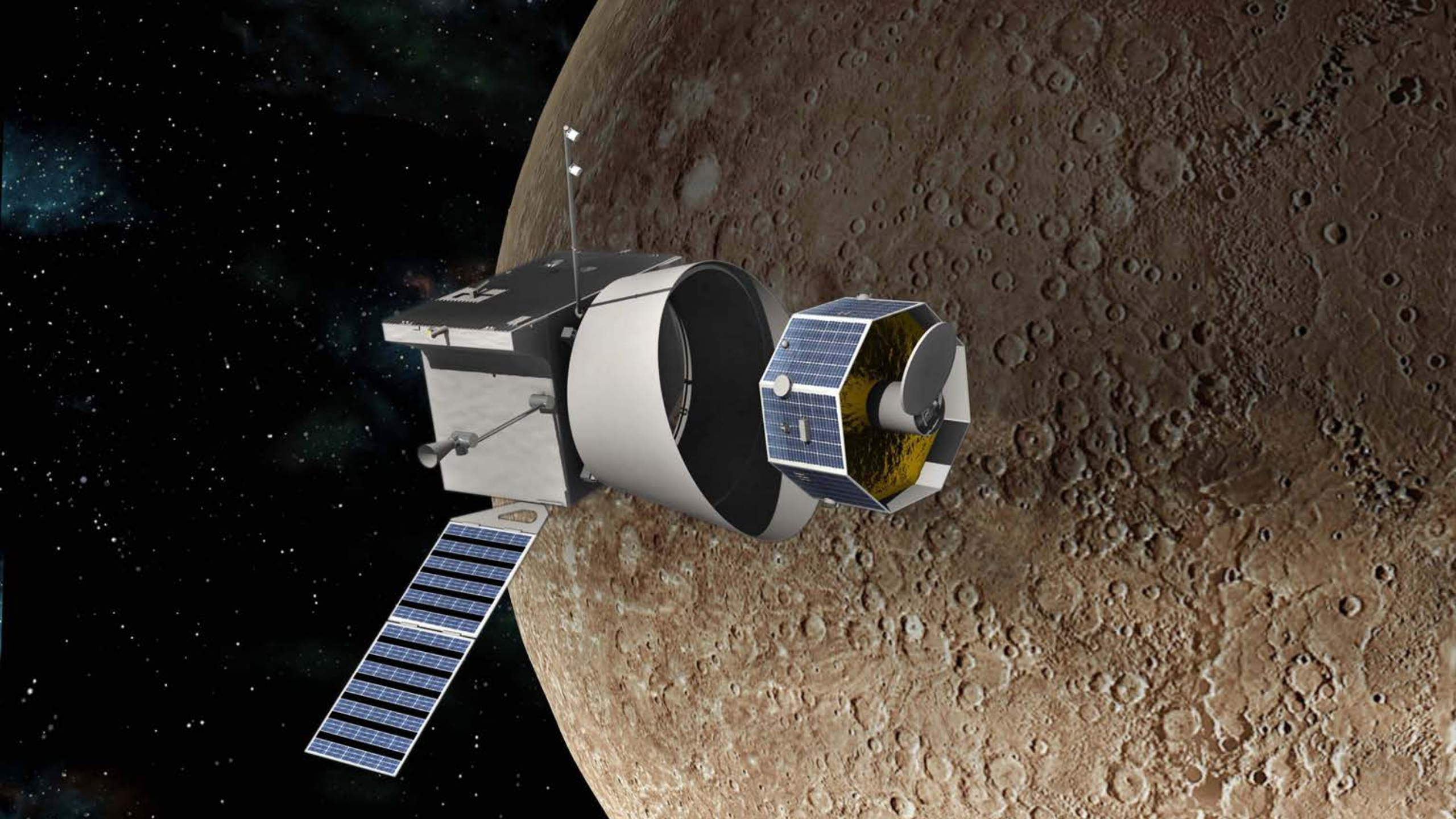


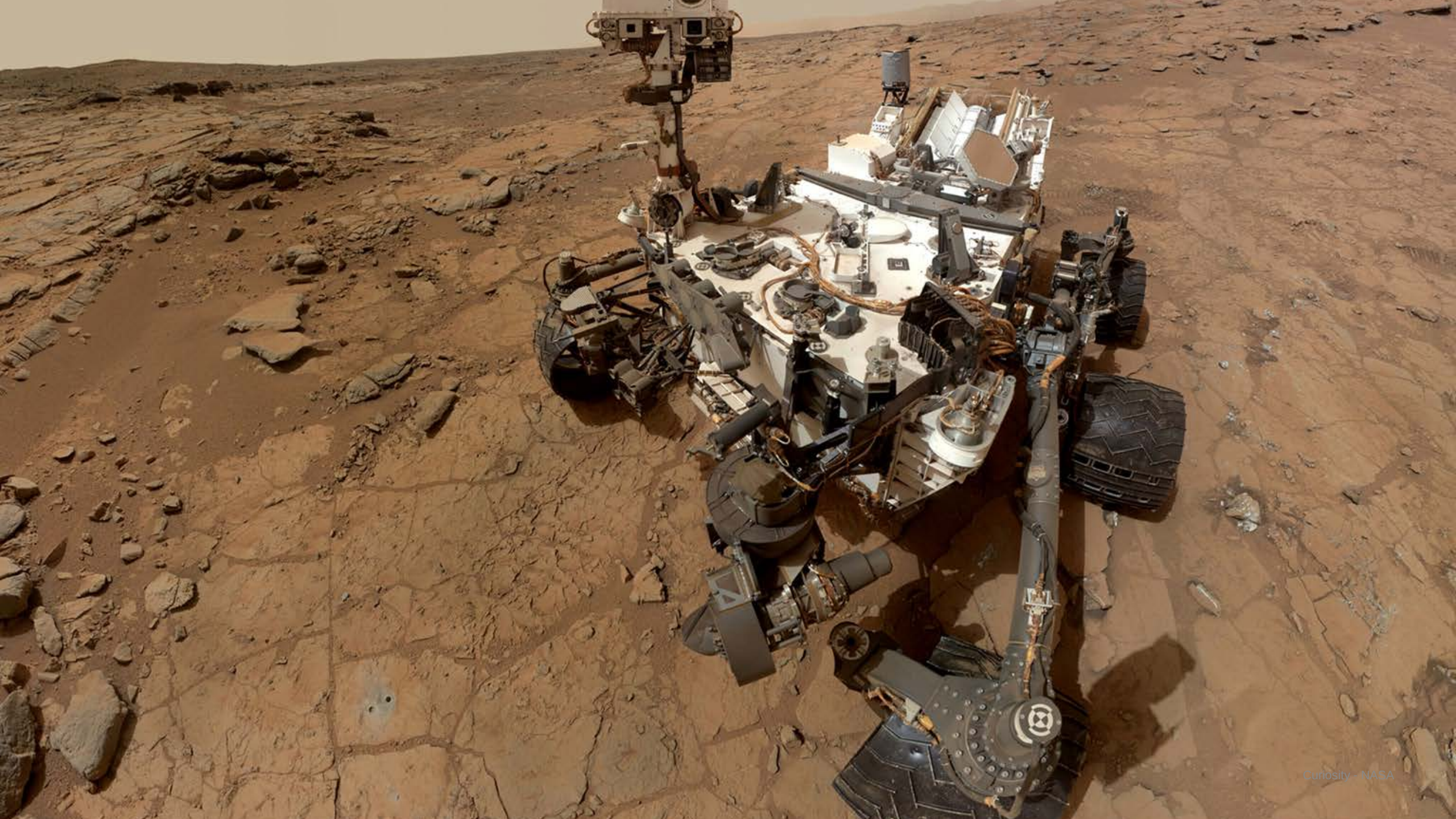


Ready for liftoff with ED-SOL

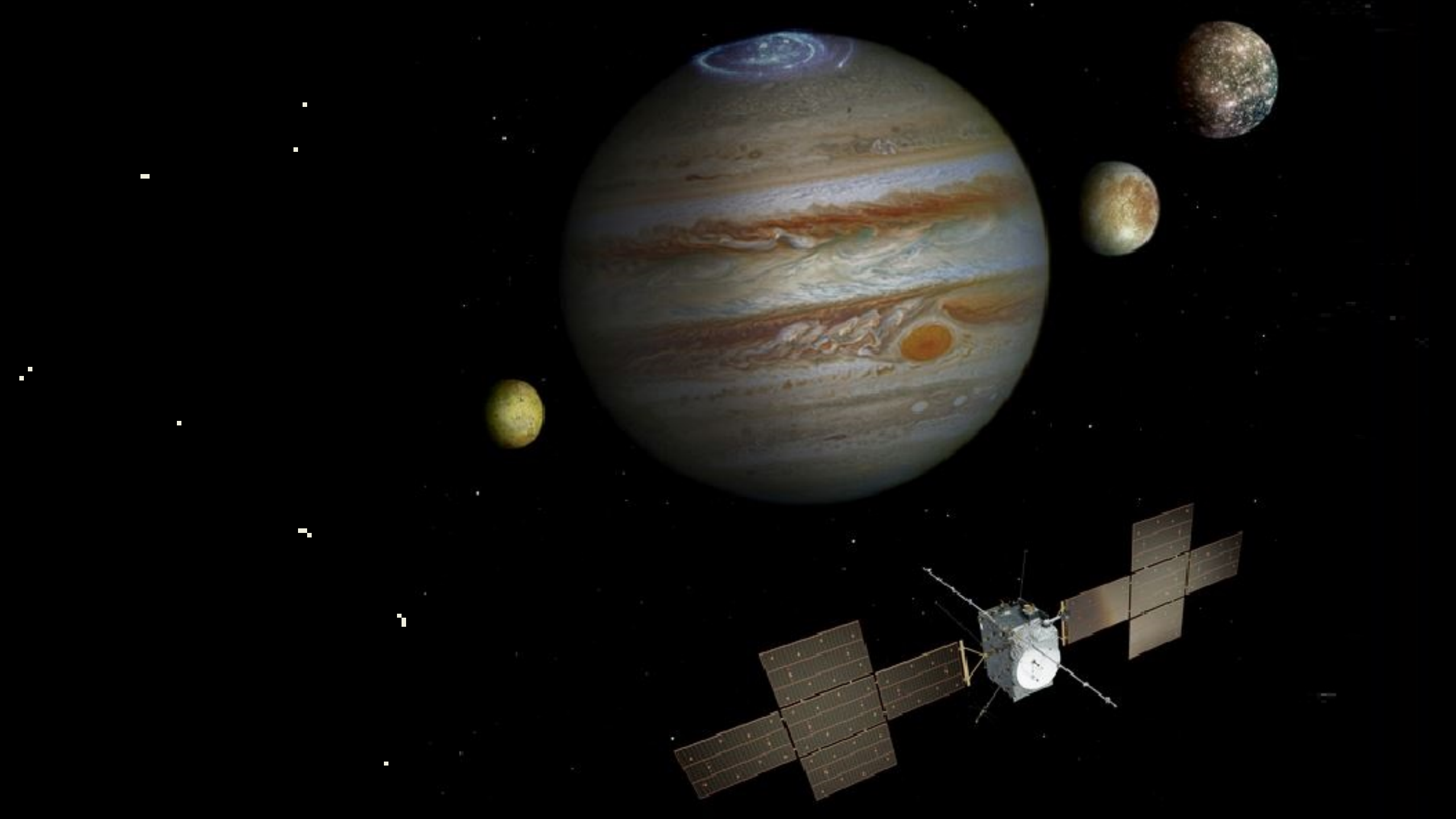


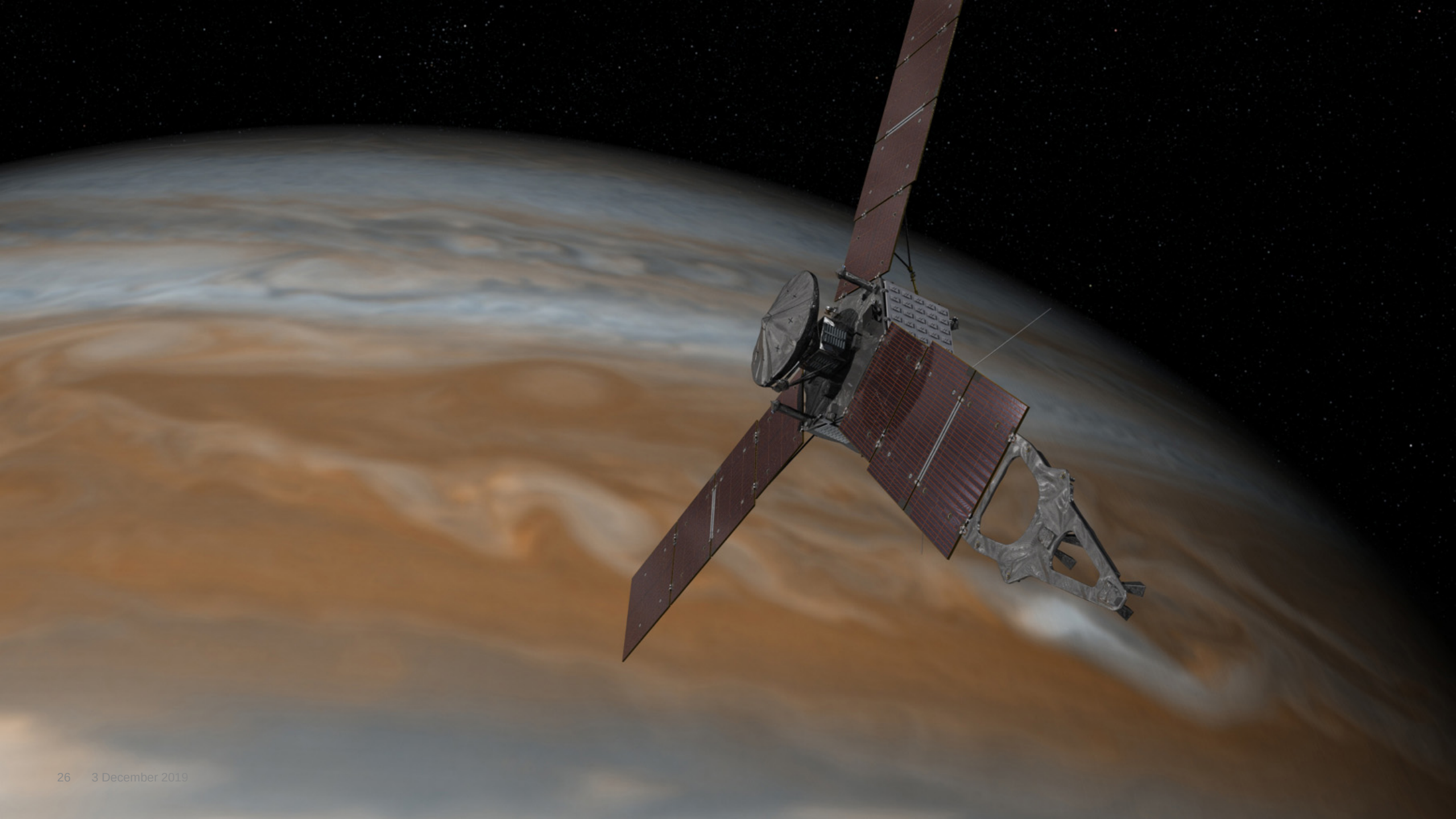


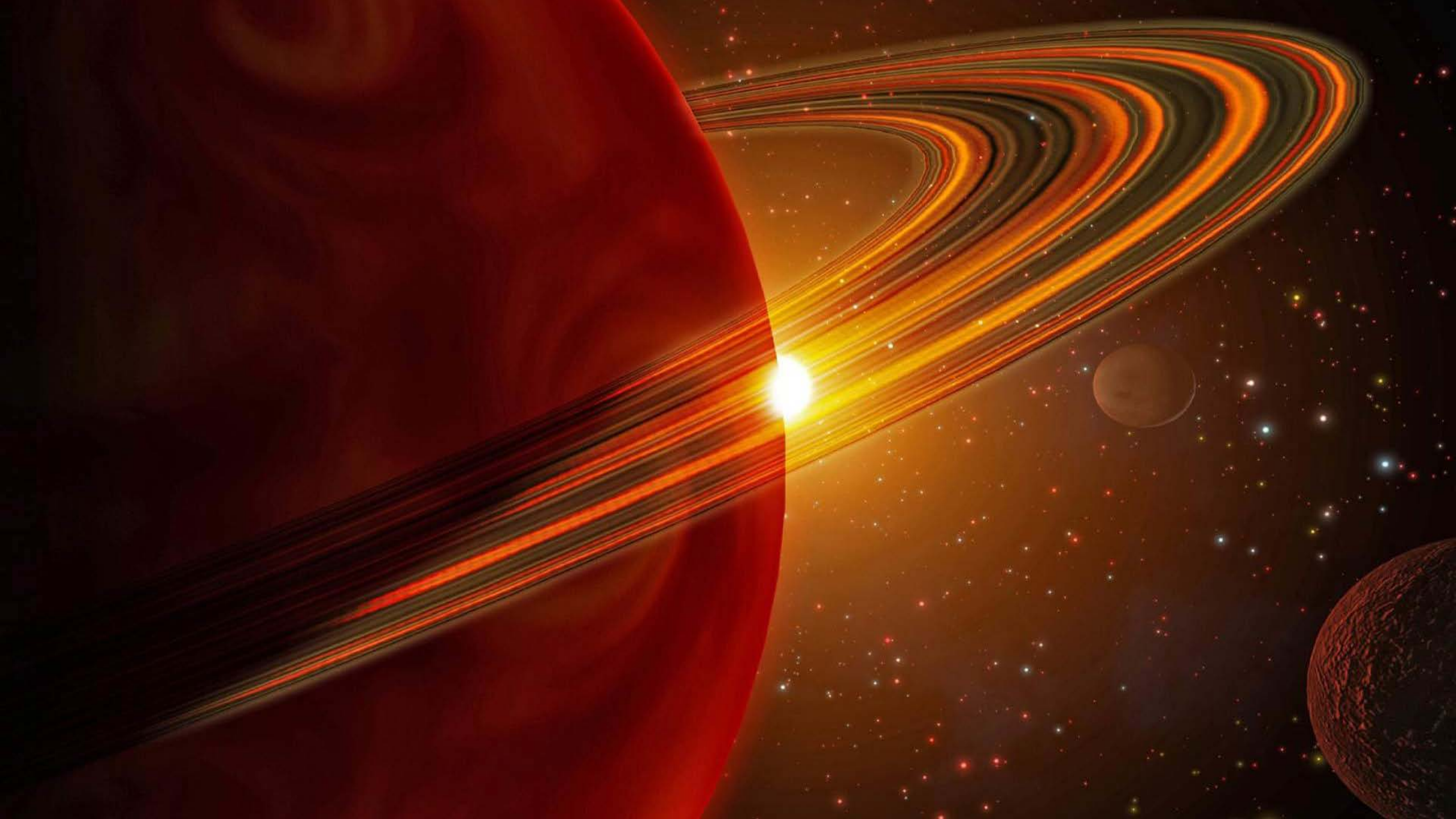



Curiosity - NASA


Curiosity - NASA





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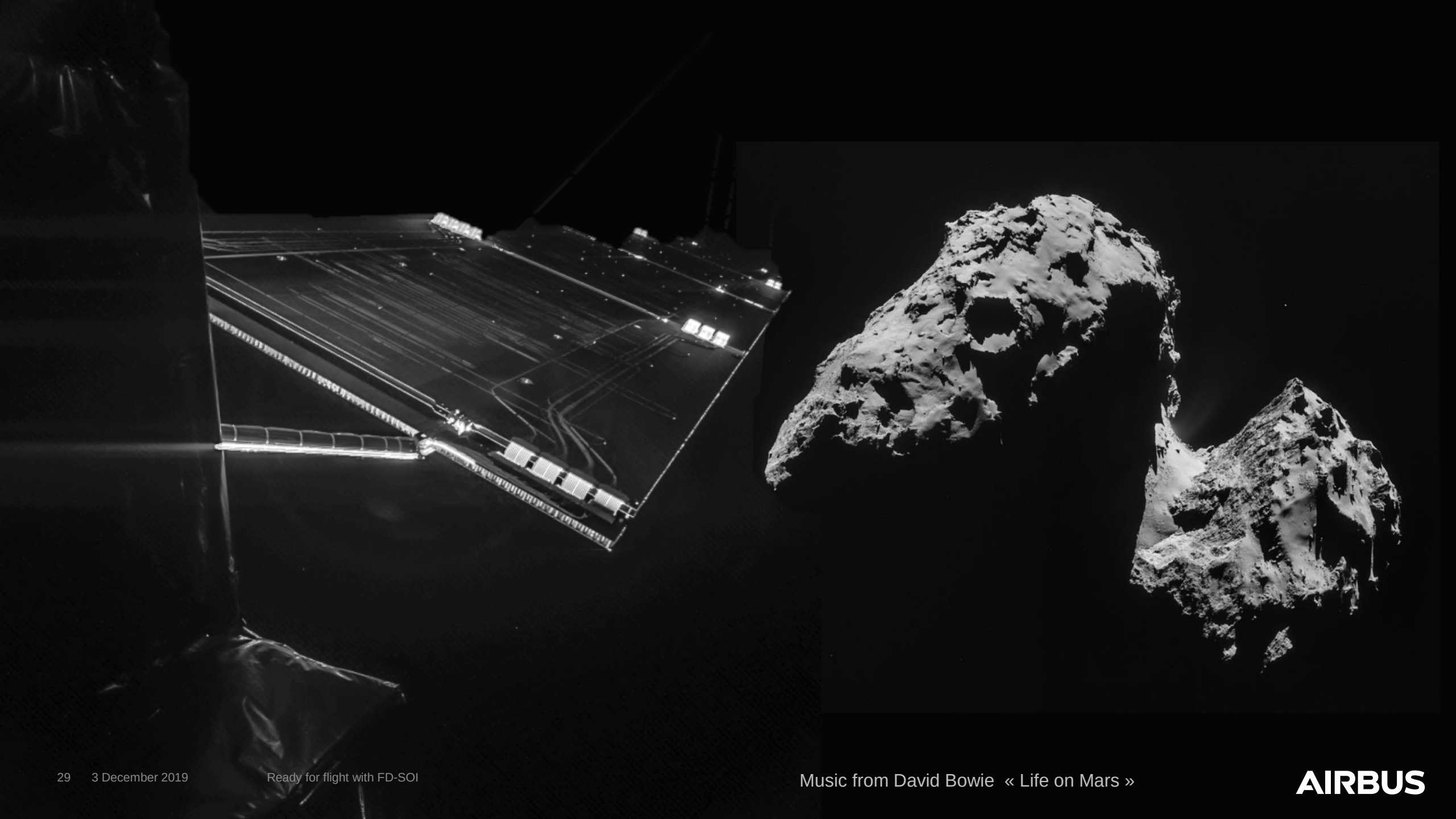

Music from David Bowie « Life on Mars »

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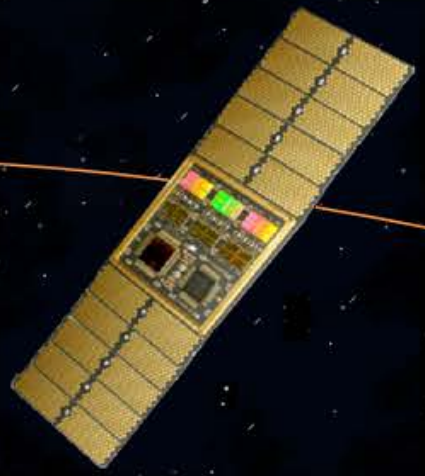
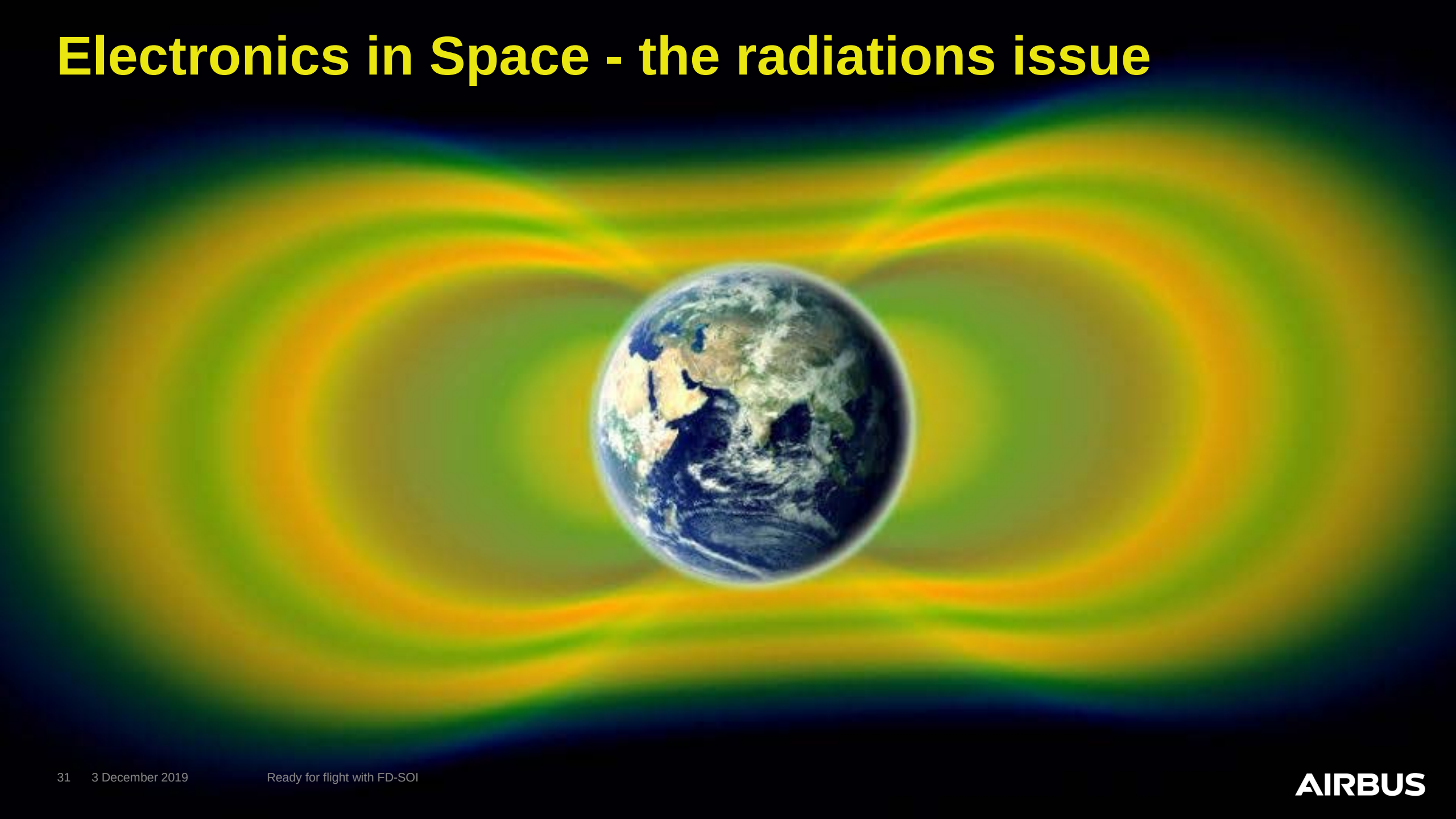
Electronics in Space



Electronics in Space - the radiations issue



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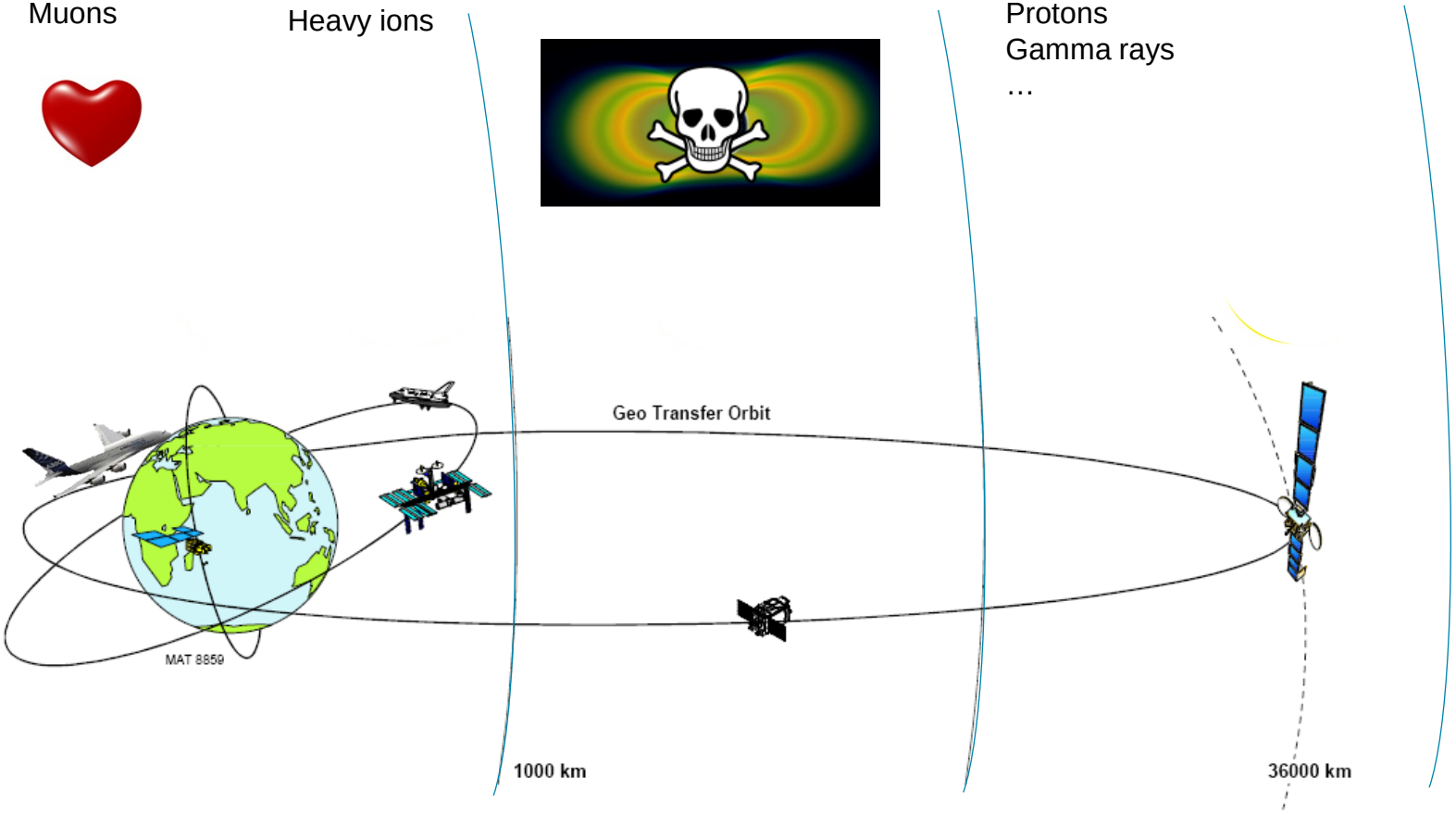
Electronics in Space - the radiations issue

Atmospheric	Low Earth Altitude	Medium Earth Altitude	Geo Synchronous	Deep Space
Neutrons Alpha particles Muons	Neutrons Protons Heavy ions	**Radiation belts** **Trapped particles**	**Cosmic rays** Heavy ions Protons Gamma rays …	**Cosmic rays** Heavy ions Protons Gamma rays Planets radiation belts …



The radiations issue

Radiations effects for on-board electronics

Problems

- Transients errors
- Functional stop
- Destructive effects
- Cumulated radiation dose

Solutions

- Robust silicon technologies
- Protection
  – shielding, de-latching
- Fault-tolerant designs
- Fault-tolerant systems architecture

Drawbacks

- Limited processing devices catalogue
- Limited processing performance
  – Gap vs. state of the art
- Radiation characterisation & qualification vs. mission profile

Specific and complex electronics, significant investments, long development, limited performances

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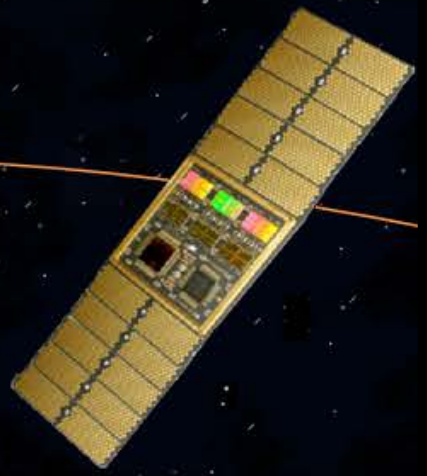
Targets 🎯



Embedded computing systems

Performance

GFlops / Gbps / Watt / Kilo / cm^3…

Robustness

Technology

Fault tolerance

Determinism

Functional correctness

Time predictability

Efficiency

Portability, Testability

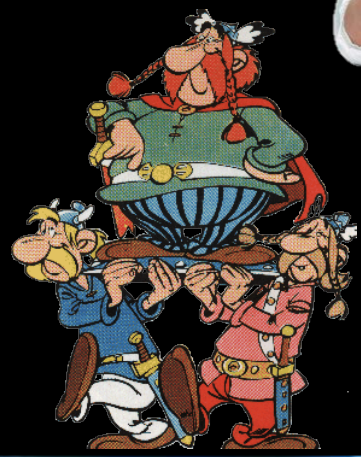
Easy programing

Connectivity

Non-dependence

European source

Ecosystem



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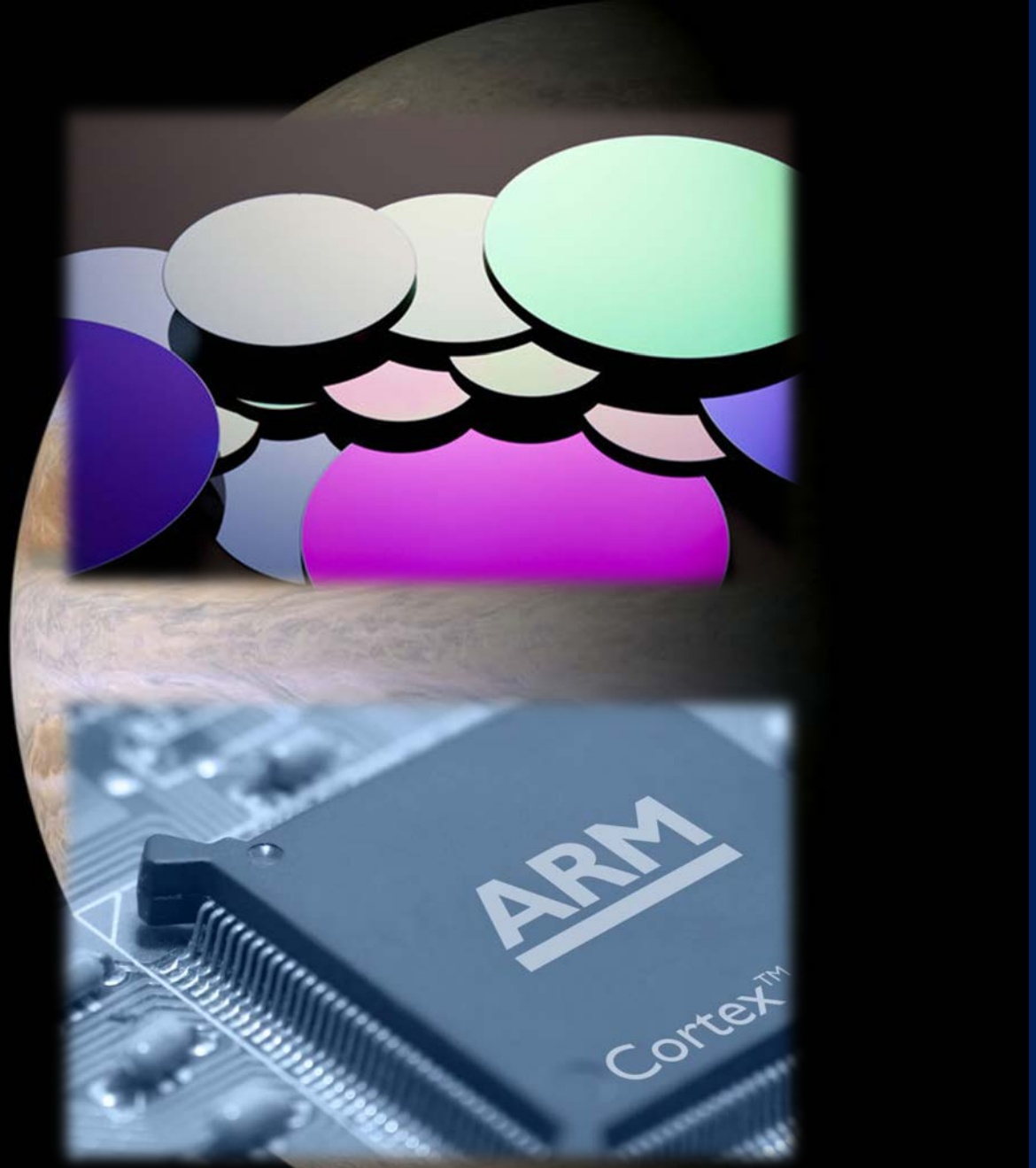

STM 28nm FD-SOI Technology

- High performance with low power consumption
- High robustness in radiation environment

NG ultra

High-End SoC FPGA

with quad-core ARM Cortex-R52

a powerful combination of innovative technology adapted for Space

DAHLIA

- 4 x ARM Cortex-R52
- SoC with embedded IP's for SpaceCraft functions and IO control

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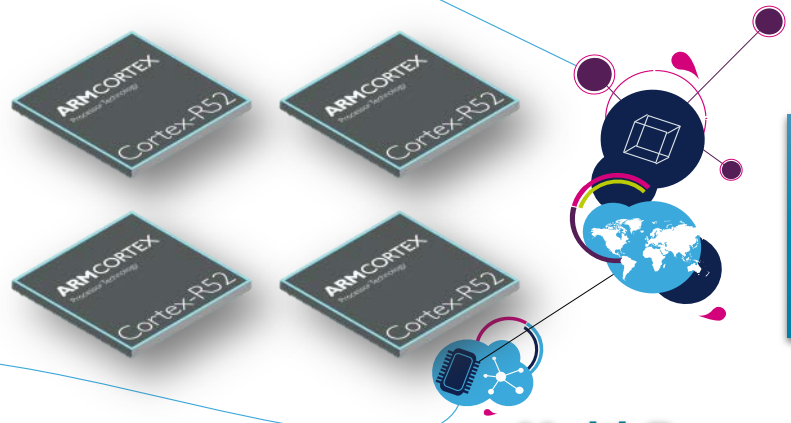
DAHLIA

Deep sub-micron microprocessor for spAce

dahlia-h2020.eu

OPEN



Schedule

2017: Kick-off

2018: FPGA prototype

2019: DAHLIA product

- Context & Objectives
  - Horizon 2020 project focusing “Critical Space Technologies for European Strategic Non-Dependence”
  - Covers the development of a rad-hard high performance MPSoC based on the **ARM® Cortex® R52** implemented in **28nm FDSOI technology**
  - Beyond space applications, the adoption of the ARM® processor will enable the convergence with terrestrial applications benefiting from the strong ARM® ecosystem.

- 7 partners from 4 countries
  - STMicroelectronics (coordinator) France
  - Airbus D&S Germany & France
  - Thales Alenia Space Italy & France
  - ISD Greece
  - NanoXplore France

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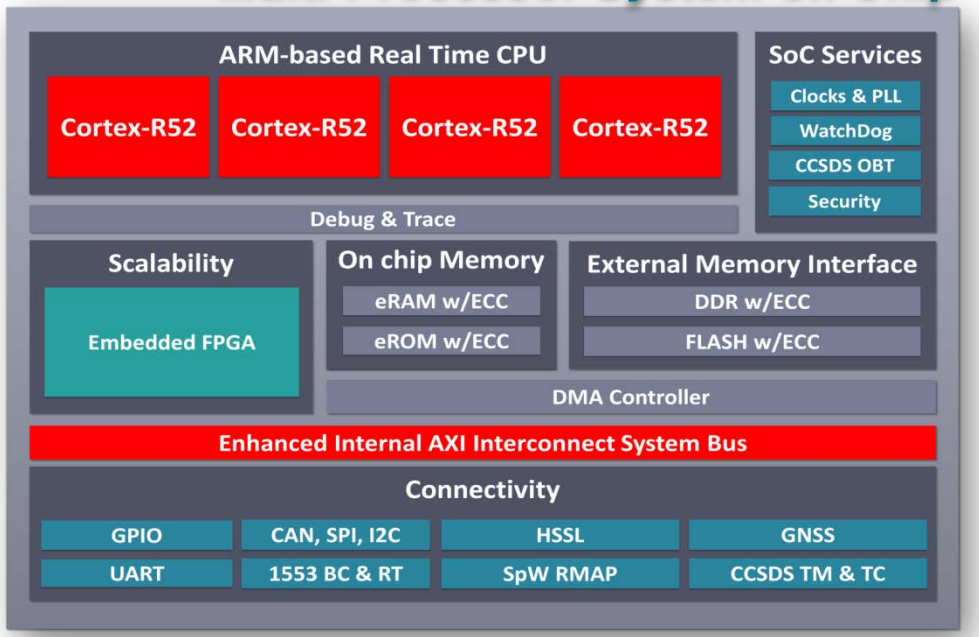
Multi-Processor System on Chip



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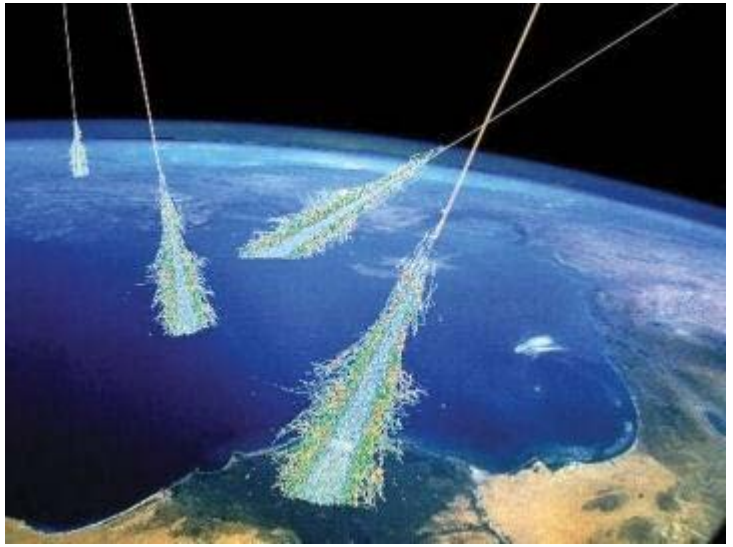
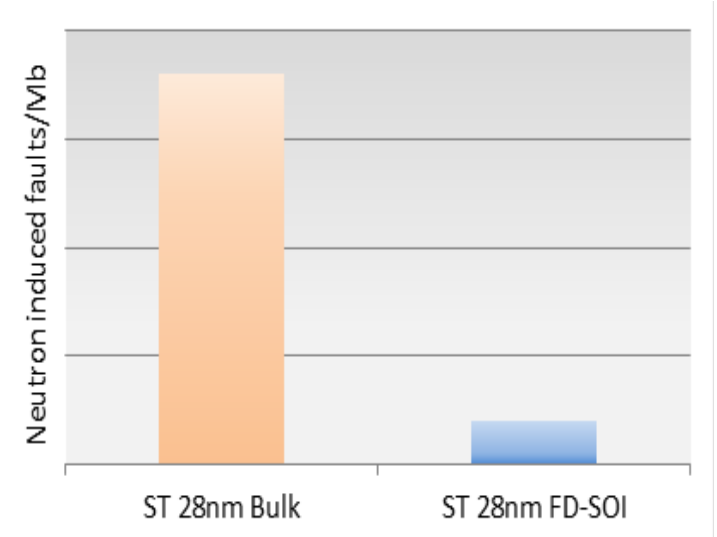
Why FD-SOI ?

Radiations induce a variety of effects in electronics such as Bit flips, latch-up, leakage currents…

- **FD-SOI improves upset rates by 100× to 1000×**
  - against neutrons, alphas, heavy ions, protons, muons, thermals, low energy protons…
  - due to both very small sensitive volume and very low bipolar gain
- **The reduced pitch size provides good tolerance to total Ionization Dose**
- **Intrinsically immune to Latch-up**



Atmospheric neutrons



Soft Error Rate

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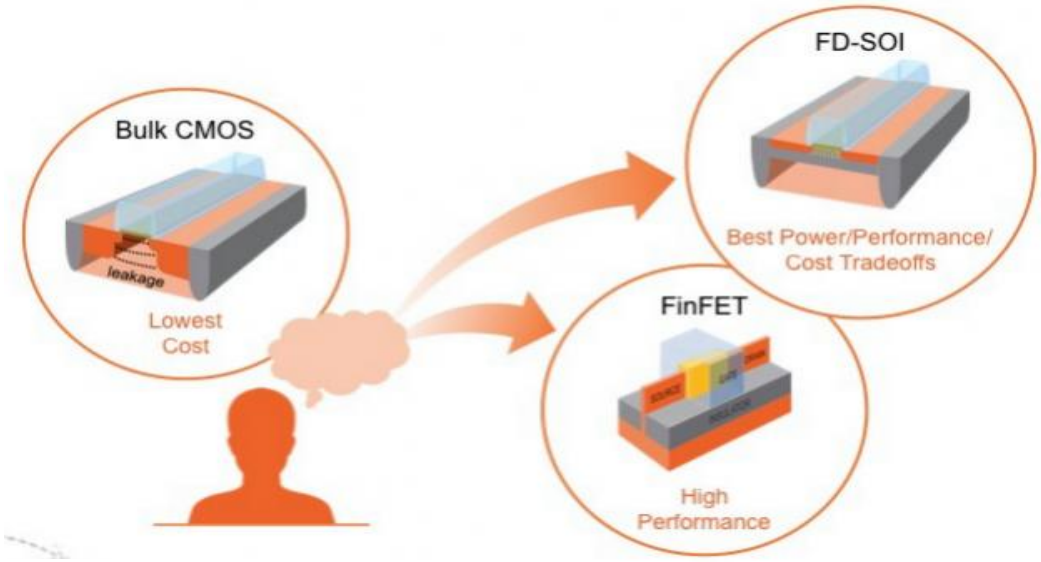
Why FD-SOI ?

Power/Performance/Cost tradeoffs

- **FD-SOI improves power efficiency**
  - Technology allowing very low supply voltages (<0.5V)
- **Very important value for autonomy in embedded systems**
  - Mobile devices, automotive, UAV's, space exploration and robotics…
  - e.g. AUDI A8 includes 6.000 to 8.000 semiconductor components



Source: Global Foundries

Space Plane

Source: Audi

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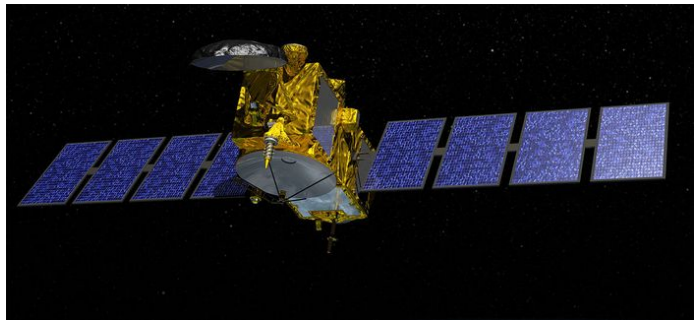
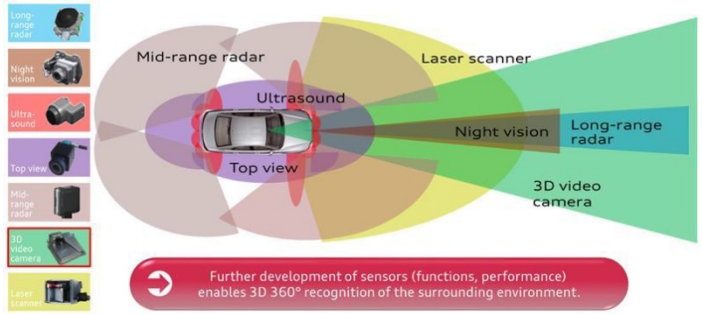
FD-SOI R&D, Ecosystem

R&D projects

- **Waytogo FAST and THINGS2DO** (ECSEL)
  Roadmap and development of FDSOI building blocks and ecosystem
- **WIN FDSOI** (IPCEI)
  Qualification of substrate pilot line for FDSOI 22nm and add-on technology developments
- **PRIME** (ECSEL)
  Develop Ultra-Low Power Technologies and memory architecture for IoT with 22 FDSOI
- **OCEAN12** (ECSEL)
  Development of FDSOI technology up to the 12nm node with system demonstrators and applications targeting the key societal challenge of smart mobility

ECSEL : Electronic Components and Systems for European Leadership
IPCEI : Important Projects of Common European Interest





Source: Audi

A rapidly growing FD-SOI ecosystem

Research Technology & IP
cea leti ST life.augmented SAMSUNG GLOBAL FOUNDRIES Fraunhofer

Substrates
soitec & Licensees

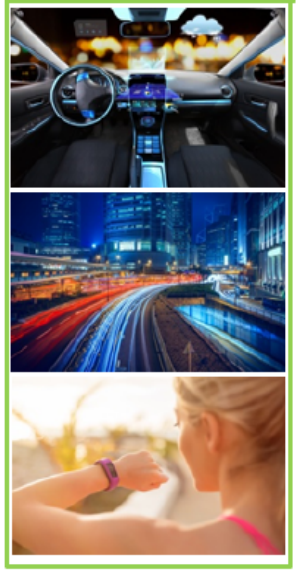
Tools & EDA
SYNOPSYS KEYSIGHT TECHNOLOGIES Mentor Graphics cadence

Foundries&IDM
GLOBAL FOUNDRIES RENESAS SAMSUNG ST life.augmented

IP & Design Services
surecore ARM invecas alchip IMAGINATION VeriSilicon SILVACO SYNAPSE design Open-Silicon

Fabless & OEMs
SONY NXP ciena MOBILEYE SFARDS eSilicon CISCO Dream CHIP AIMOTIVE
+50 fabless under development

Consumer Products



Source: OCEAN12

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Why Dahlia MPSoC on FD-SOI is so important for Space ?

It provides onboard processing performance

It is robust in the space environment

It is strategic for European non-dependence

Future

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AIRBUS DEFENCE AND SPACE STARTS A NEW ERA IN SPACE

WITH ONEWEB CONSTELLATION…

TOTAL COVERAGE
Internet to everyone, everywhere on Earth

A REVOLUTION IN SATELLITE MANUFACTURING
No one has ever built a satellite in one day… we will build several every day!

GLOBAL LOW EARTH ORBIT CONSTELLATION
Providing high-speed internet connectivity equivalent to terrestrial fiber-optic networks

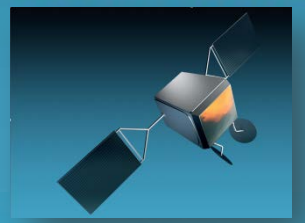
ONEWEB
Facts & Figures

size

less than 150 kg
weight

up to 4
built every day

900
satellites to be built



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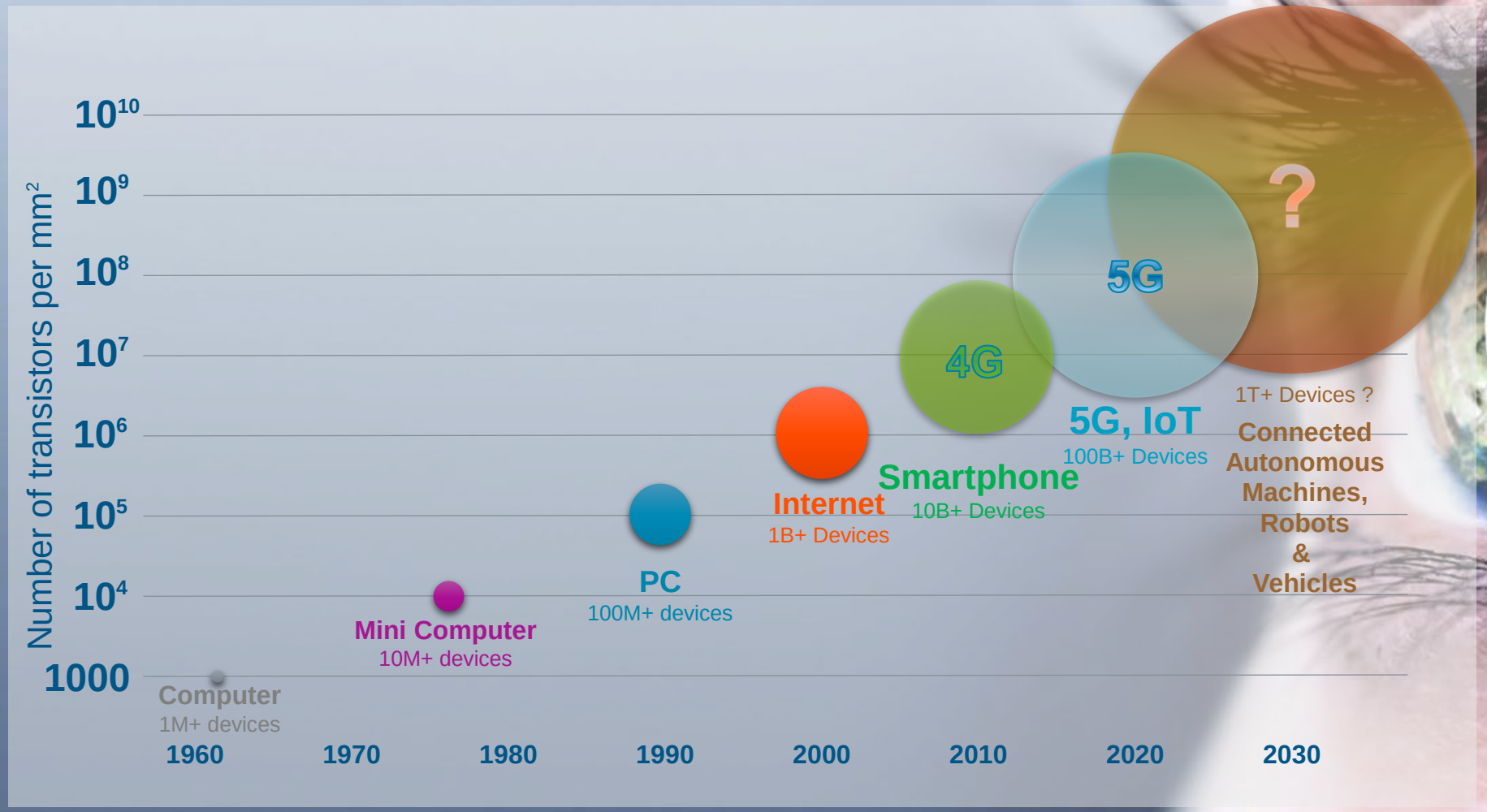
Computing devices miniaturization



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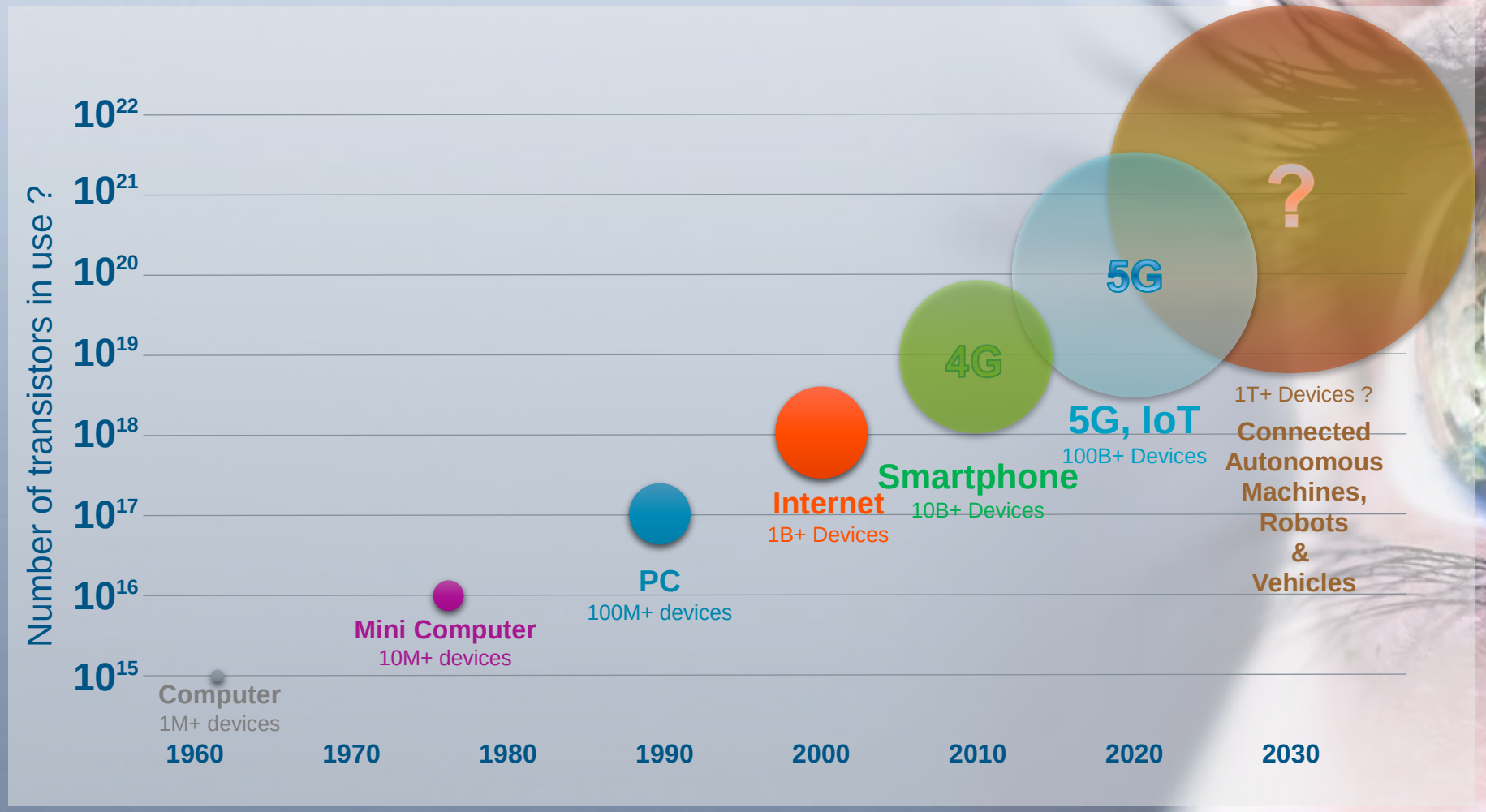
Computing devices growth



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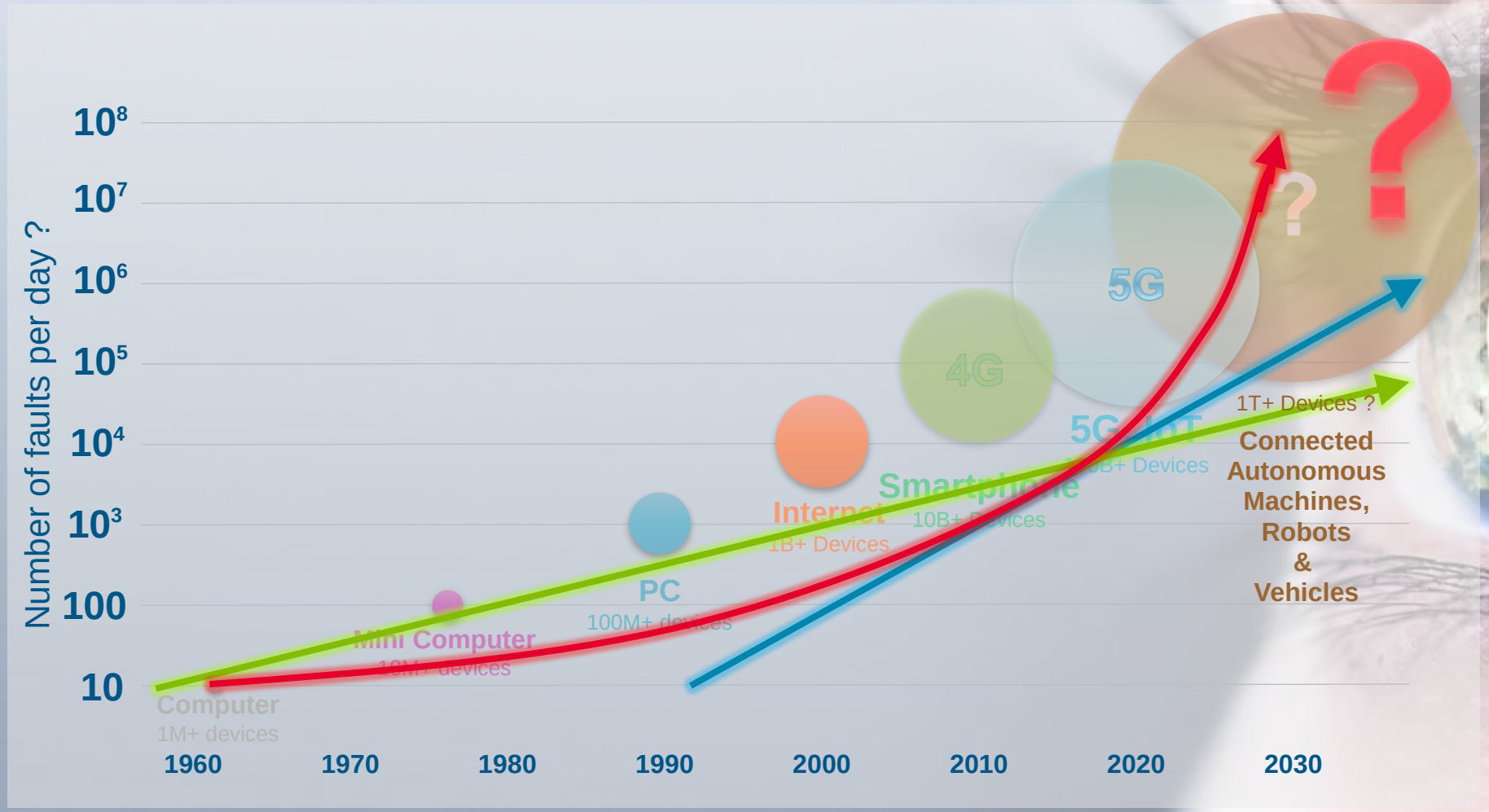
Systems unavailability (if we do not care about radiation robustness)



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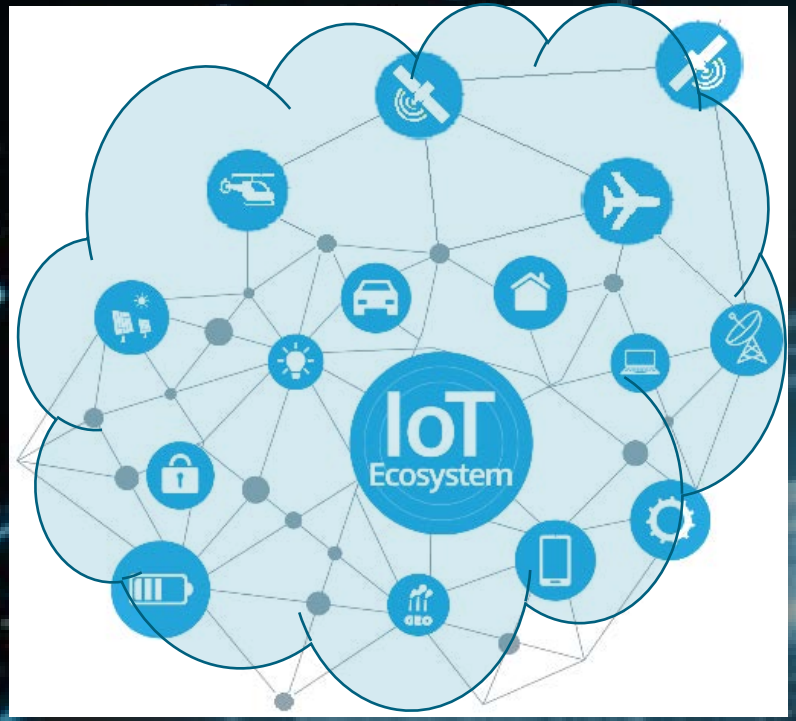
Our future

Internet of Things
Connected smart machines



Smart vehicles and robots in smart cities
Electrical, Connected and Autonomous

Machine learning | Big Data | Cloud | Artificial intelligence

SOFTWARE | Data Processing

µElectronics

IoT

Anytime
Everywhere

Electronics reliability is key

Fly FD-SOI

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Thank you for your attention !

Questions ?

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To Airbus, ESA , CNES, DLR, NASA, CNSA and SpaceX for their great images of space vehicles
to David Bowie for his great song “life on Mars”
to Elon Musk and SpaceX for their faith and strong push into the new space era
to Michael Herbig for its great space comedy movie “Raumschiff Surprise – Periode 1”
and to Macrovector @ Freepik.com for their nice pictograms

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