
INNOVATION FROM SPACE
through ESA programmes
and Europe's ambitions
Let's discover the challenges for the next decade!
Short History of Astronautics
by Théo Pirard
Conception of Space Systems & Satellites

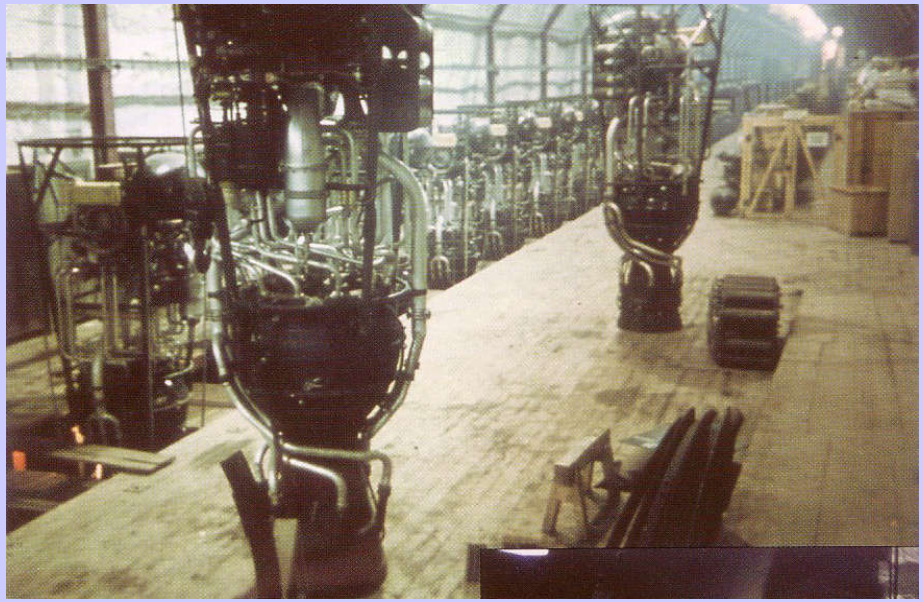
The age of space rocketry began during the Second World War

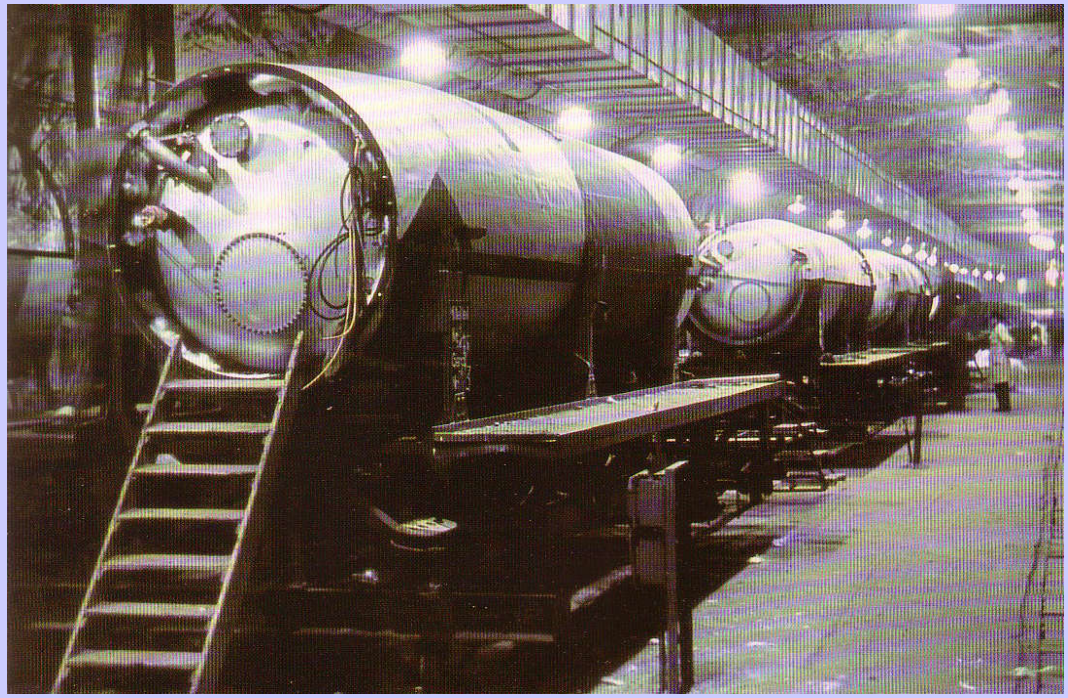
with the V2 missile developed by the nazis as revanche weapon.

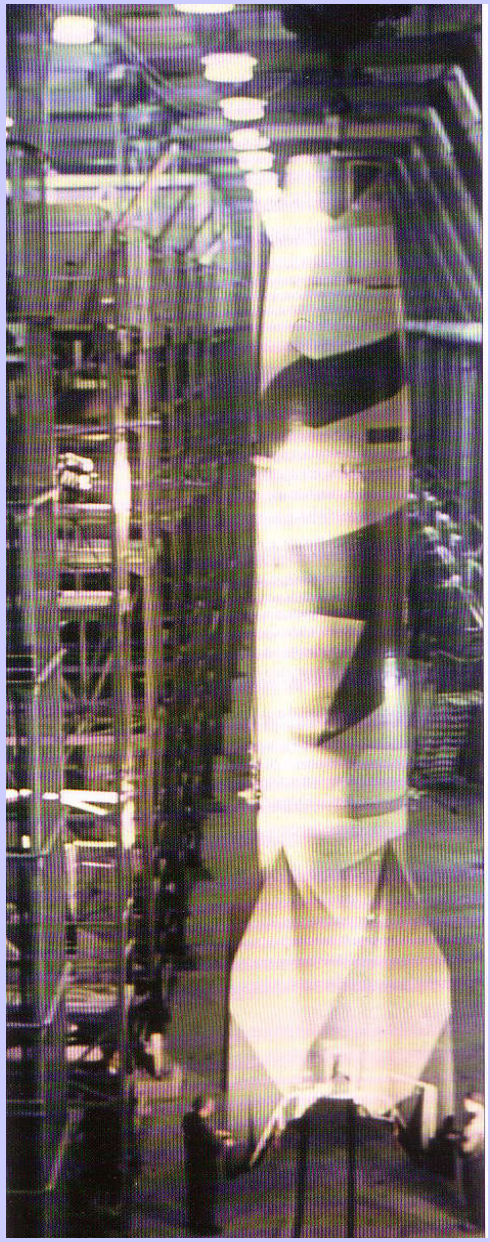
First use against Paris: on 8 September 1944, from Gouvy forest in Belgium

1945 : US troups discovered the underground factory of Nordhausen (near the camp of Dora)

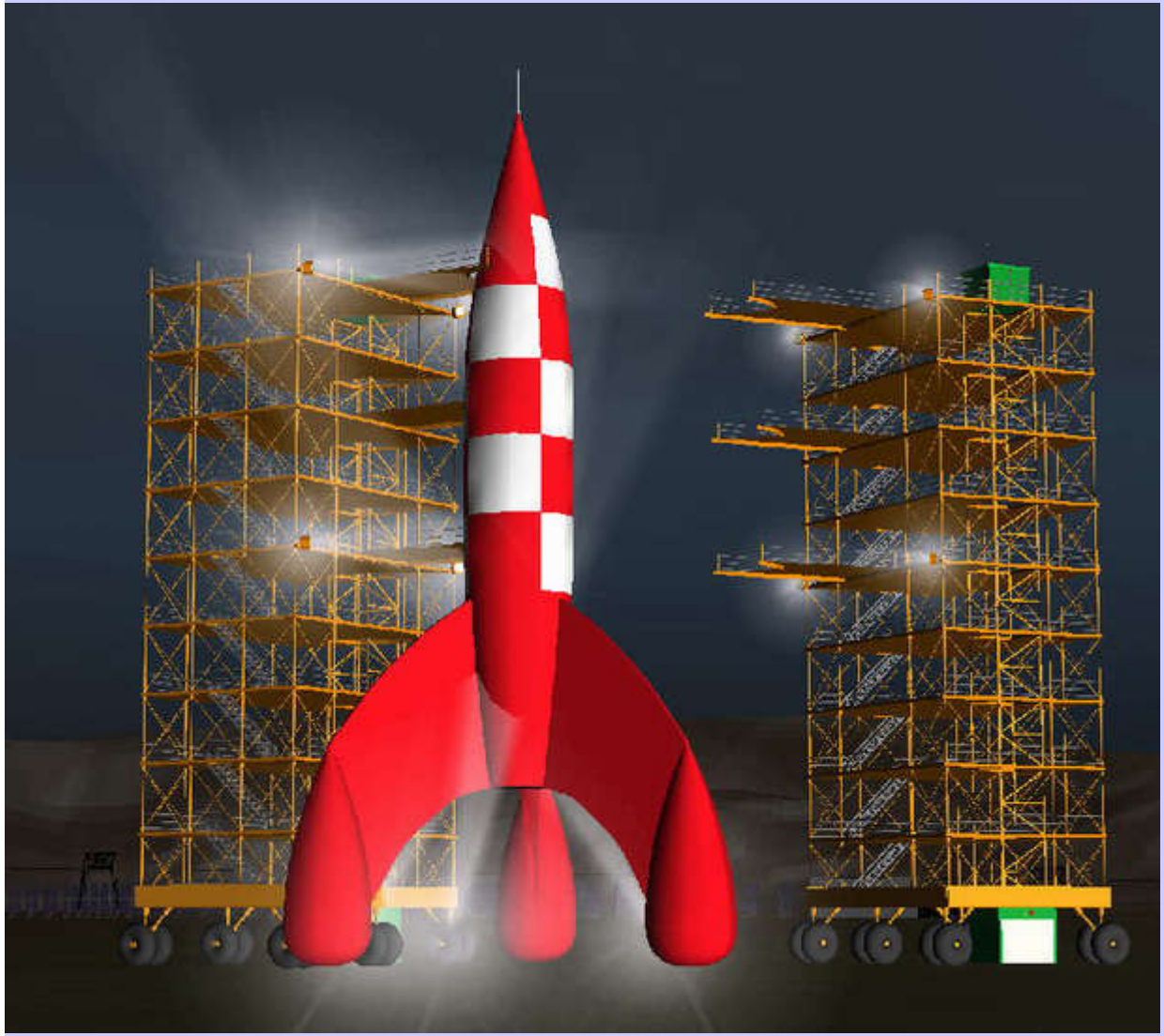
where prisoners (among them Belgians) manufactured V-2 rocket elements

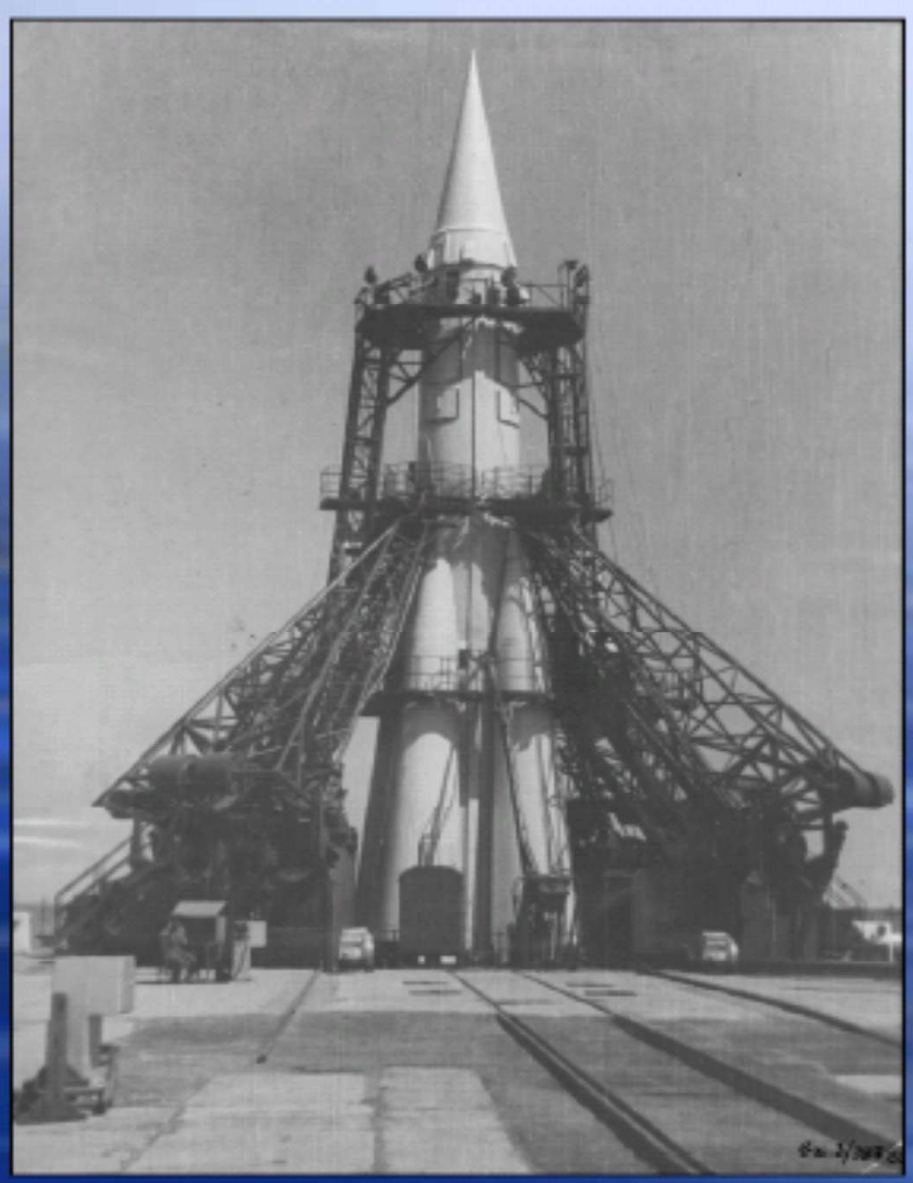






Early 1950's: Belgian cartoonist Herge (Rémi Georges) imagines the first steps of Men on the Moon with the successful spaceflight of Tintin, Milou and company





USSR (Soviet Union) developing a powerful ICBM (intercontinental missile) (1957)

R-7 ICBM on pad in 1957

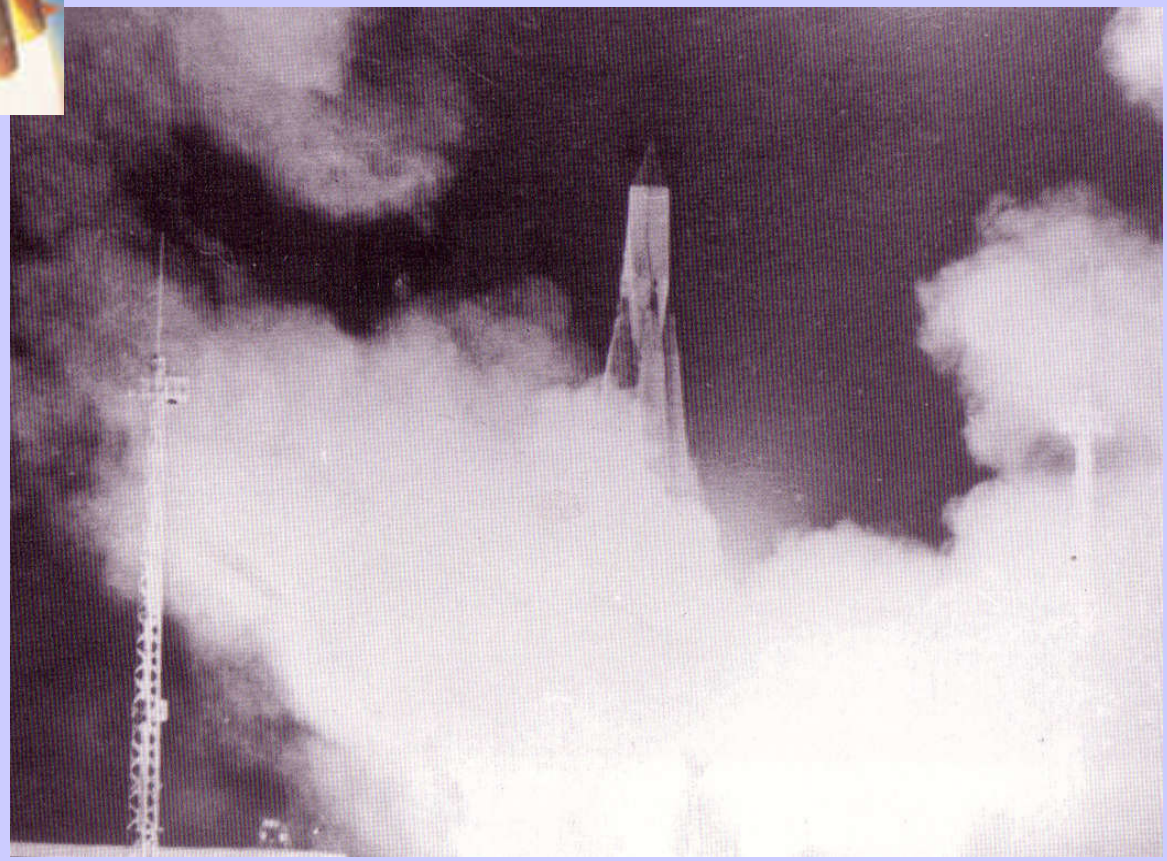
With the greatest secret, at Moscou (USSR), preparation of the first « baby moon »

SPOUTNIK

In the night of 4-5 October 1957 :

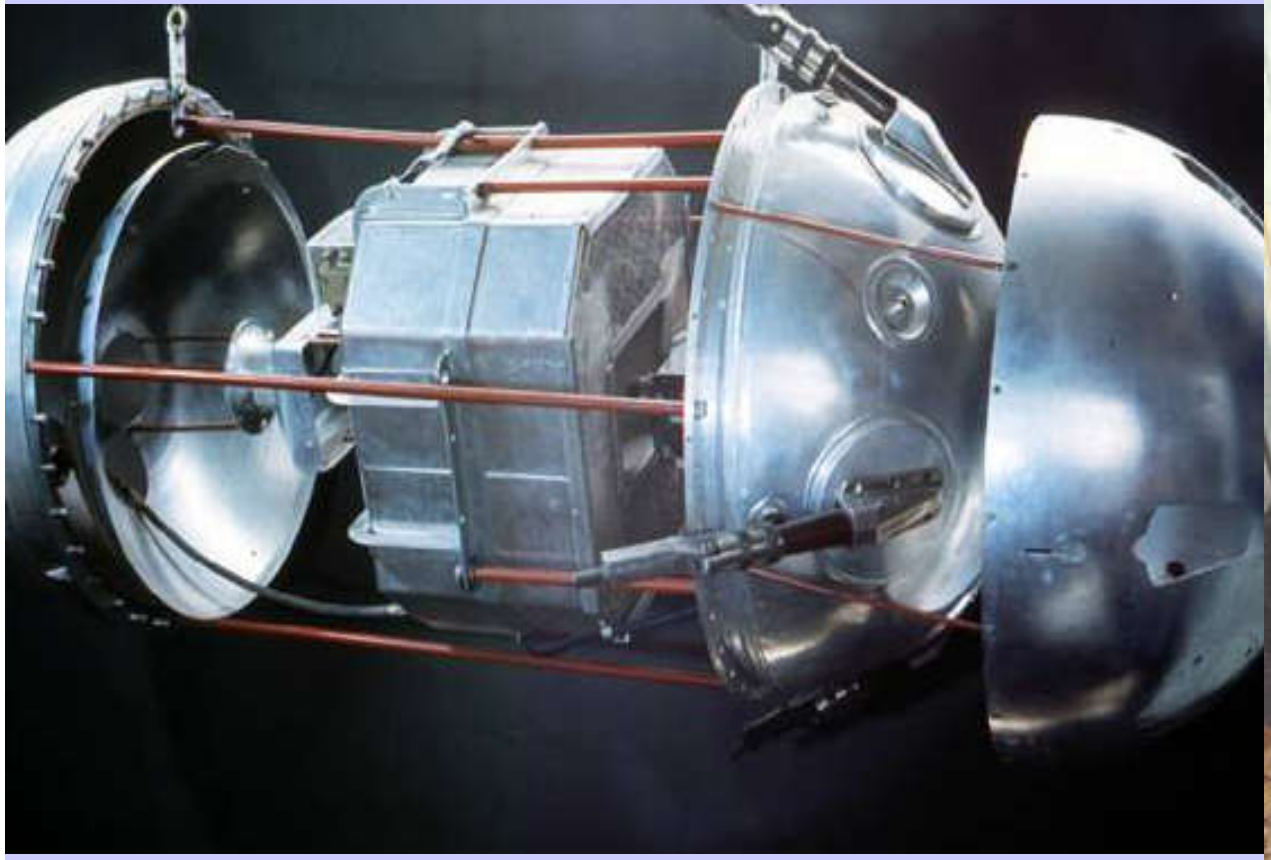
the USSR gives a little brother to the Moon…

Sputnik-1 marks the start of the space odyssey



Sputnik-1 : the 1st «moon baby » of 83 kg broadcasted clear bips-bips around the Earth.

It flies at the record speed of **28.000 km/h** (7.8 km/s), turning in orbit without falling on the ground



Why USSR (Moscow) – now Russia –

has been the first one to reach the dimension of Cosmos?

It fulfilled three strategic conditions:

- **a long-term vision**

  (the road to the stars)

- **the technical and scientific skills**

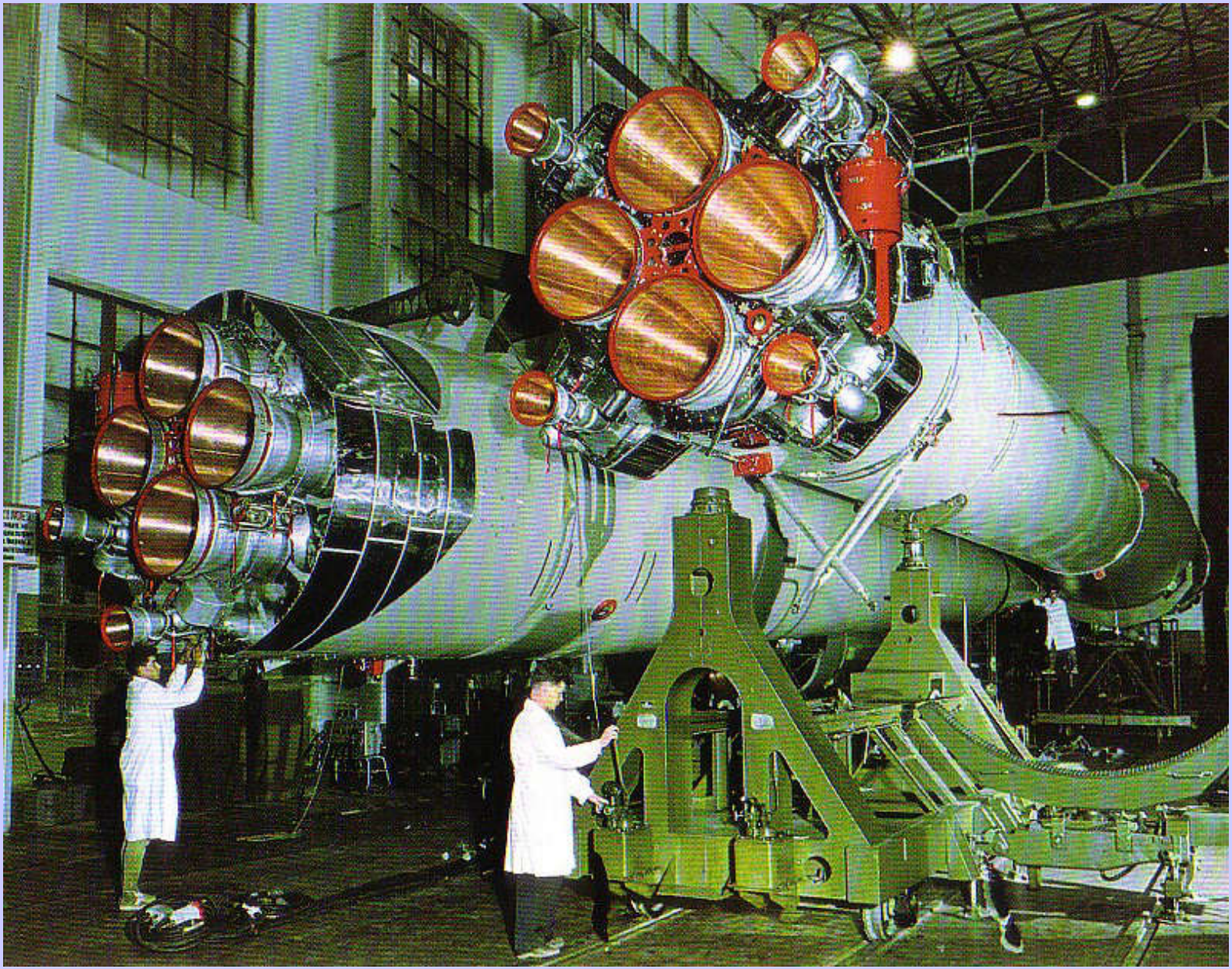
  (famous engineers: S. Korolev, M. Tikhonravov

  great scientists: M. Keldysh)

- **the political support for funding**

  (the communist parti)

The surprisingly historical launch took place
from a mysterious site in the step of Kazakhstan :
Baykonur (Tyuratam), linked by railway to Moscow



The R-7 ICBM used as first satellite launcher, still in operation !

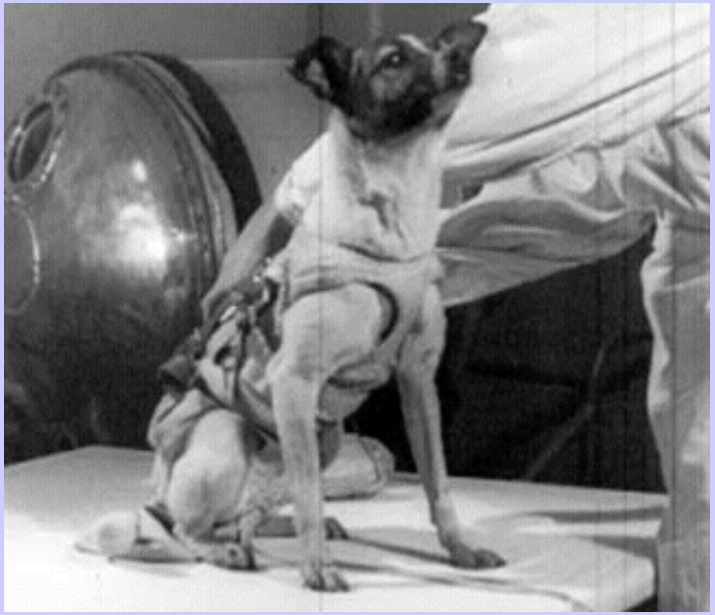
The R-7 or Semiorka is still currently used from Baikonur (Kazakhstan), Plesetsk (Russia) and Kourou (French Guyana): some 1.900 units launched since 1957 and counting…

To escape Earth's gravity :

it means a condensed energy in the rocket engine

(three types: liquid, solid, hybrid)

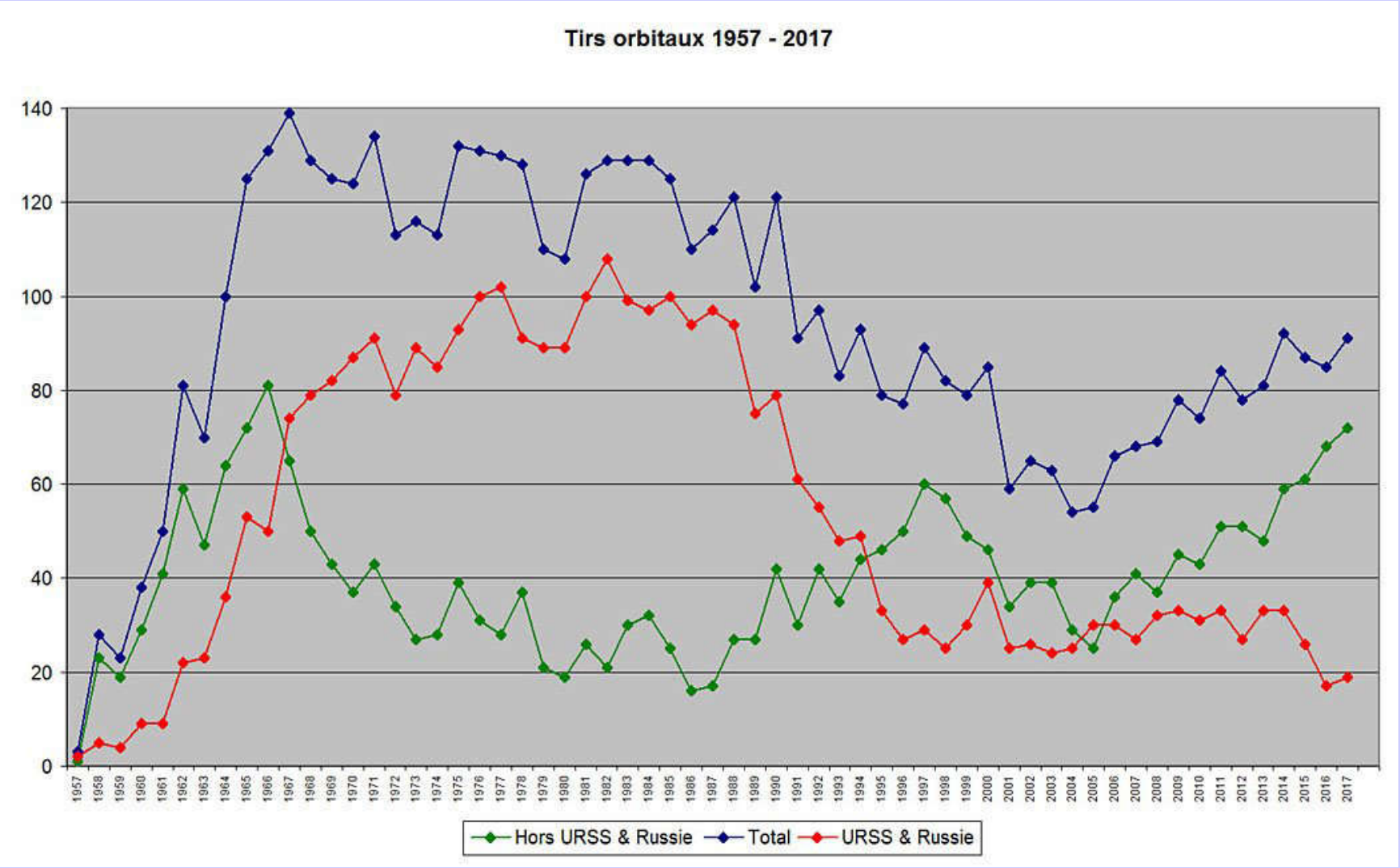
3 November 1957 : Laïka dog in orbit with Sputnik 2



***Mass*: 508 kg.**

***Perigee*: 212 km. *Apogee*: 1,660 km. *Inclination*: 65.3 deg.**

A launch activity again growing up



WORLD GOVERNMENT EXPENDITURES FOR SPACE PROGRAMS (2016)* TOTAL $62.2 BILLION

434 Canada
35,957 United States**
1,929 European Union
42 Denmark
107 Norway
122 Sweden
159 Netherlands
1,984 Germany
49 Finland
30 Ireland
743 United Kingdom
231 Belgium
78 Luxembourg
187 Switzerland
2,792 France
945 Italy
81 Austria
23 Portugal
293 Spain
4,793 ESA & Eumetsat
28 Greece
49 Romania
10,376 Europe
3,182 Russia
83 Belarus
23 Czech Republic
52 Poland
25 Ukraine
86 Azerbaijan
45 Kazakhstan
4,909 China
3,018 Japan
32 Pakistan
671 South Korea
75 Taiwan
17 Laos
1,092 India
21 Bangladesh
30 Thailand
18 Malaysia
61 Vietnam
14 Sri Lanka
12 Philippines
10 Singapore
160 Indonesia
235 Australia
376 UAE
73 Morocco
110 Turkey
115 Algeria
155 Israel
109 Iran
53 Egypt
127 Saudi Arabia
87 Qatar
20 RDC
63 Angola
20 South Africa
145 Mexico
25 Nicaragua
163 Venezuela
163 Brazil
61 Nigeria
47 Peru
38 Bolivia
129 Argentina

* Only countries with a budget of at least $10 million appear on the map.
** The United States is undersized (88%)

GOVERNMENT SPACE PROGRAMS | Benchmarks, Profiles & Forecasts to 2026

Space business: a growing success

Private operators of space systems

Satellites GEO for telecommunications/broadcasts

Intelsat (USA/Luxembourg), SES (Luxembourg), Eutelsat (France), Inmarsat (United Kingdom), Telesat (Canada), Hispasat (Spain), Jsat (Japan), Arabsat (Saoudi Arabia), Viasat (USA), Echostar (USA), DirecTV (USA), RSCC (Russia), Gazprom (Russia), Avanti (United Kingdom), Star One (Brasil), Telenor (Norway)…

Satellites LEO for telecommunications

Iridium (USA), Globastar (USA), Orbcom (USA), Starlink (USA), OneWeb (UK), Kuiper-Amazon (USA), …

Satellites for earth observations

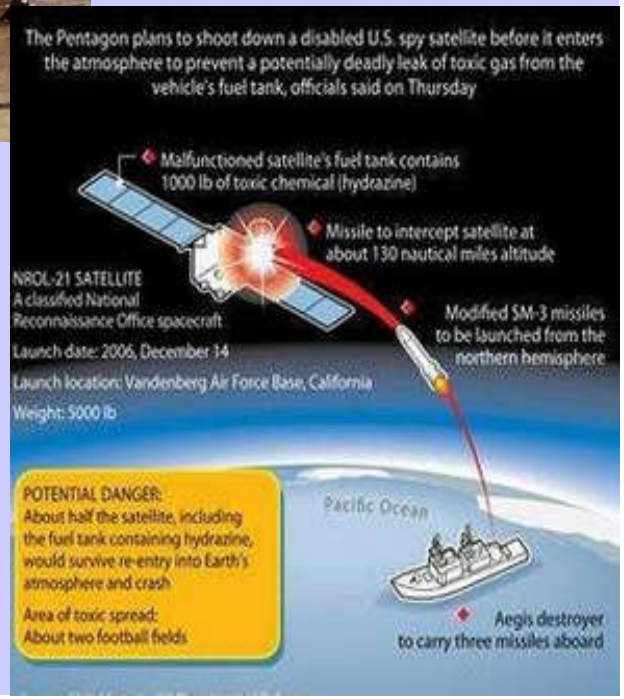
Airbus Intelligence Business (France/Germany/ United Kingdom), DigitalGlobe (USA/Canada), Planet (USA), e-Geos (Italy), Imagesat (Israel), Planet (USA)…

Decayed objects on Earth : how to avoid the risks of sky falling on heads?

- Stages of launch vehicles

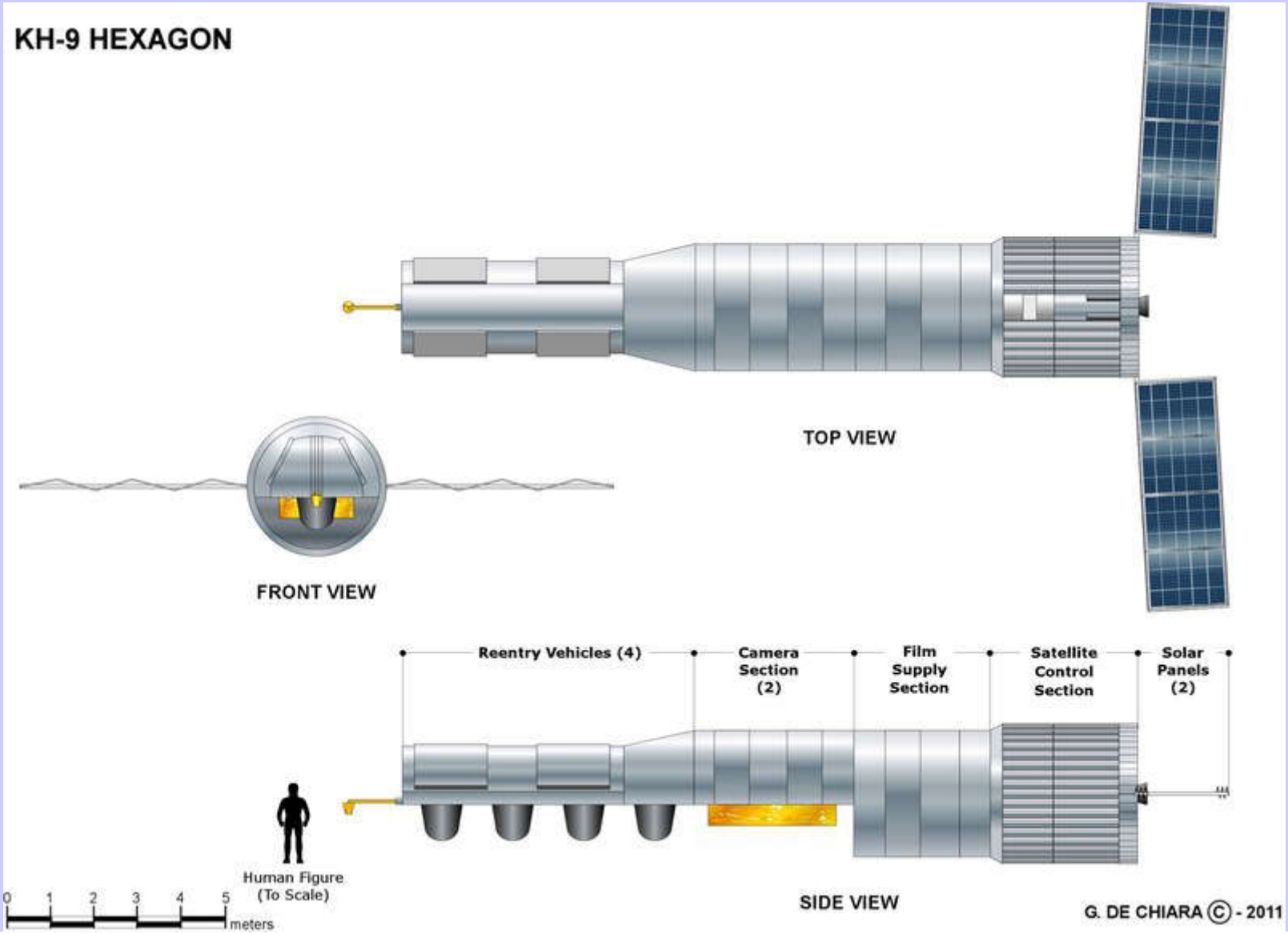
- Recoverable satellite (capsule)

- Destruction by missile

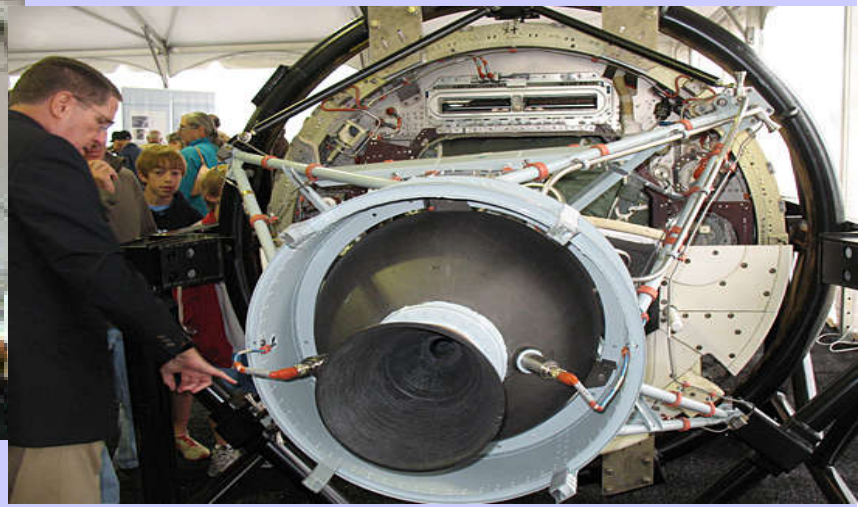


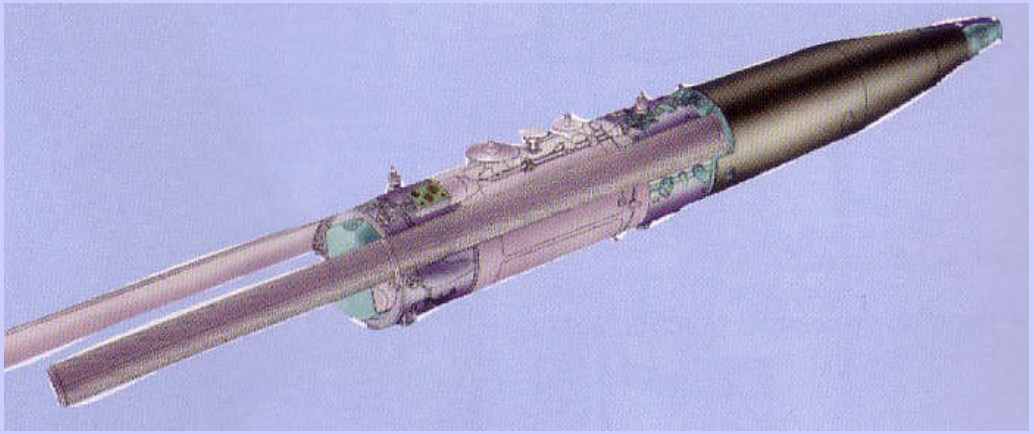
The heaviest satellite in operation (since April 1990), Hubble Space Telescope (HST) of 11,2 t

Enormous spy satellite KH-9 or Hexagon, “declassified” 30 years after last mission in low-orbit

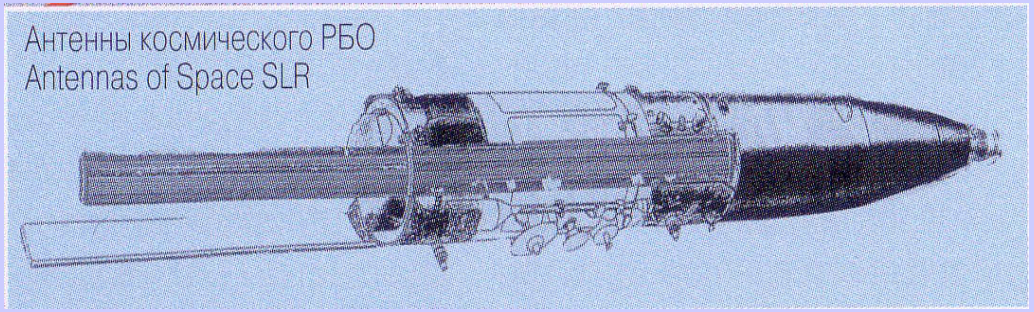


KH-9 or Hexagon
with recoverable capsules





Radioactive satellites of USSR in the sky : RORSAT
(Radar Ocean Reconnaissance Satellite)



The accidental Cosmos 954 return in the Canadian Arctic (24-01-1978)

Space in the Cold War USA-USSR
(golden 60's)

USSR (Russia + Ukraine) [1957-1991]

« firsts »: Sputnik, Gagarin, lunar & interplanetary probes, orbital stations

USA (NASA) [1958-2007]

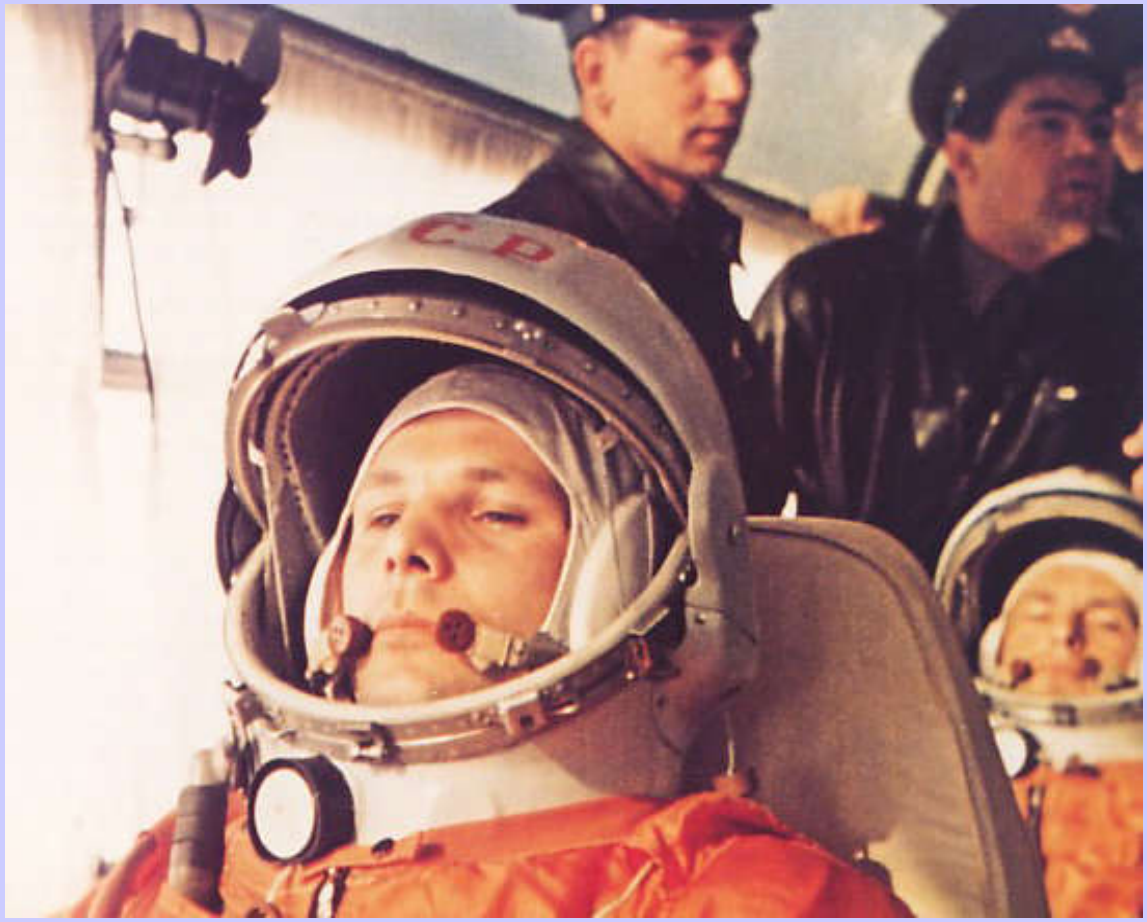
« firsts »: on the Moon, deep space probes, reusable orbiters

Russian manned spaceflight with the Vostok capsule (1961-1963)

12 April 1961 :

**around the world,
in 108 minutes,
Yuri A. GAGARIN,
the cosmonaut n°1,
in Vostok-1 spaceship**

This historical spaceflight
represents the lift-off
of astronautics !




СССР
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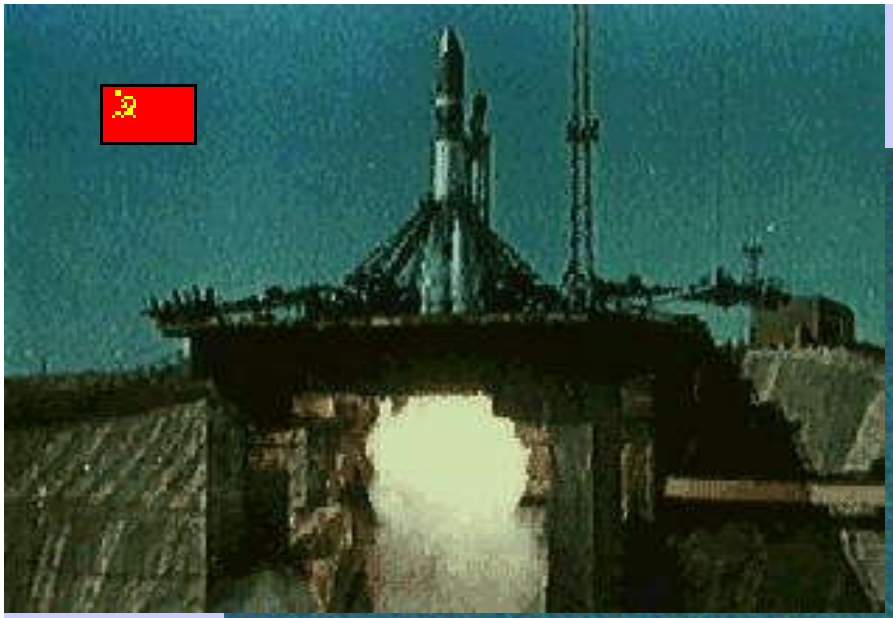
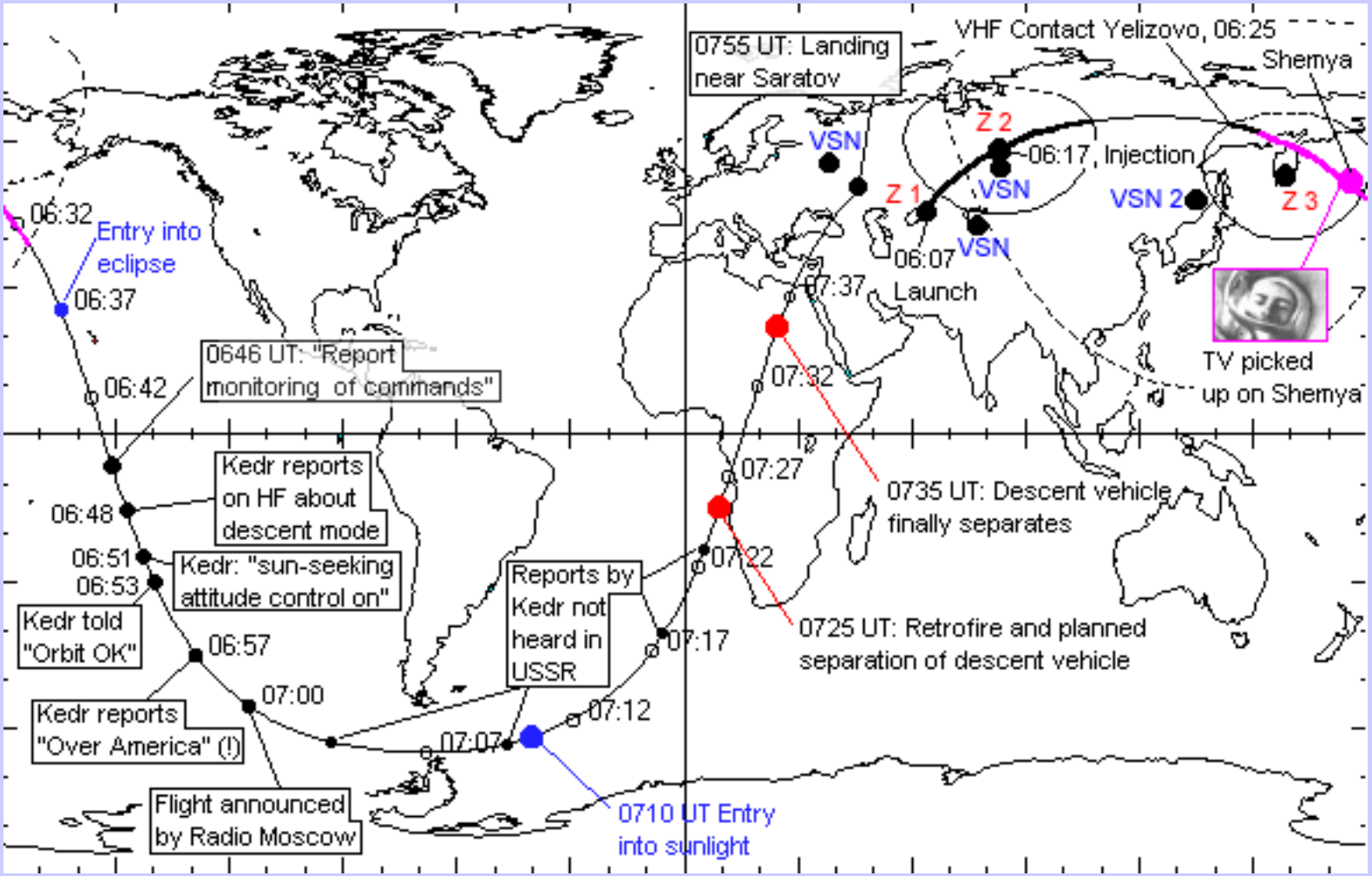
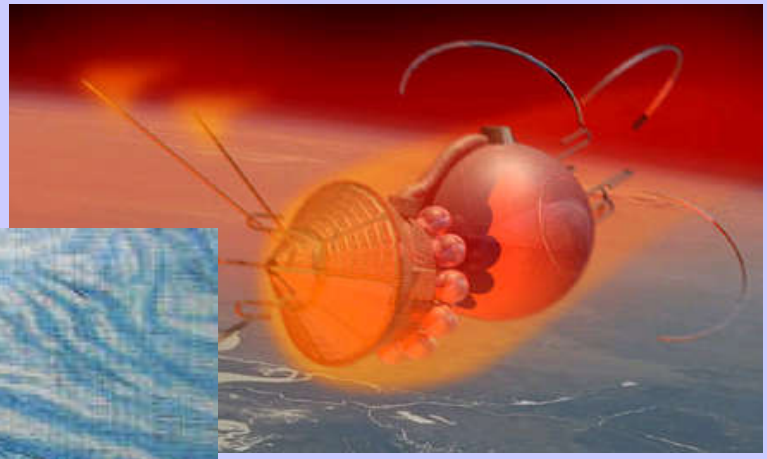


The first trip
of the ”HOMO SPATIALIS” (104 minutes)



The Soviet Vostok spaceship,

used by six cosmonauts (1961-1963)



Cosmonaut n°1 Yuri Gagarin,

after his return from space:

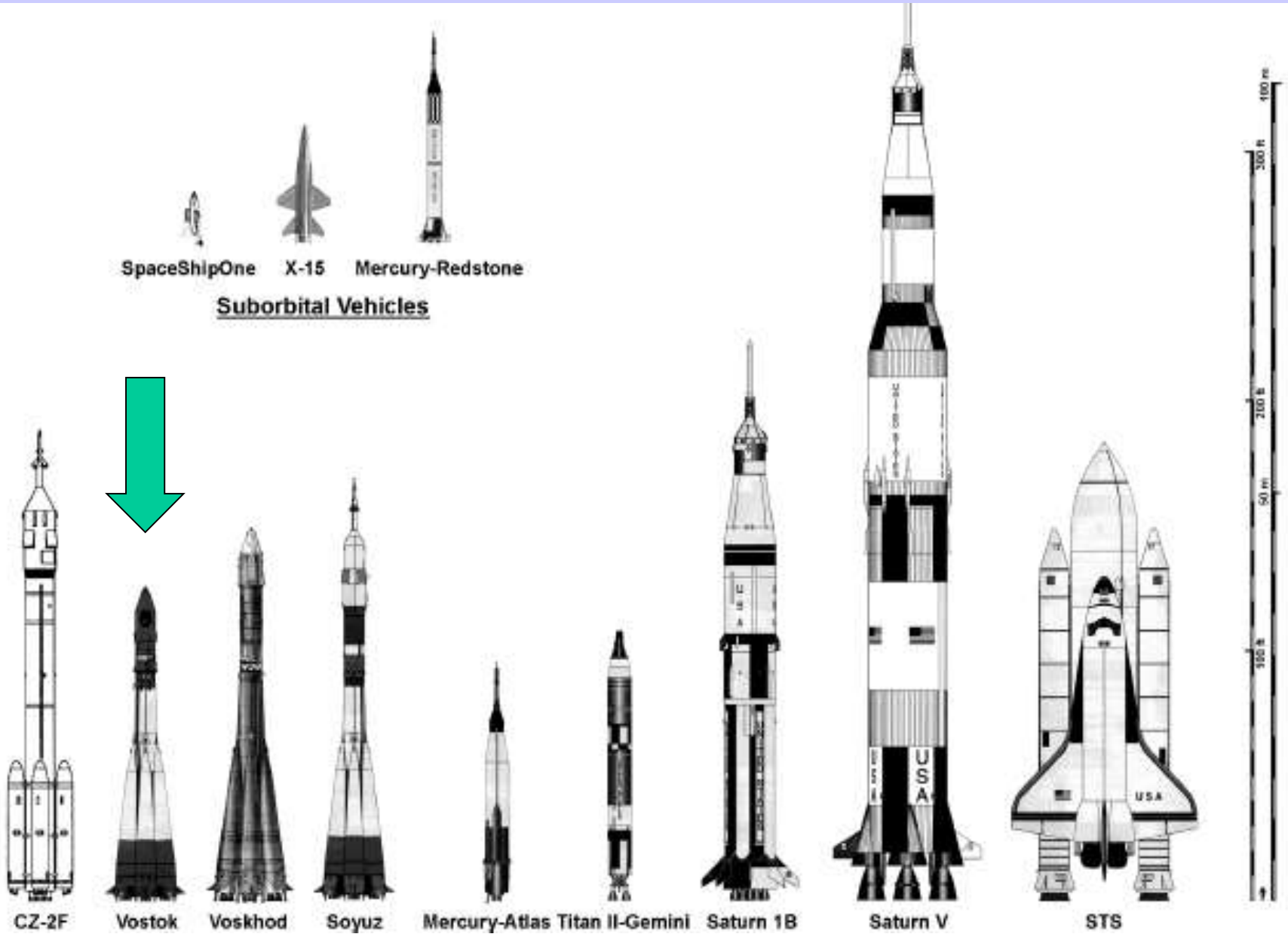
he is opening the way to men and women in an infinite world...

Linked to the historical spaceflight of Gagarin, beginning of a ritual…

The first lady in the Cosmos

(Valentina Terechkova in June 1963)

Vostok: the start of the manned spaceflight odyssey

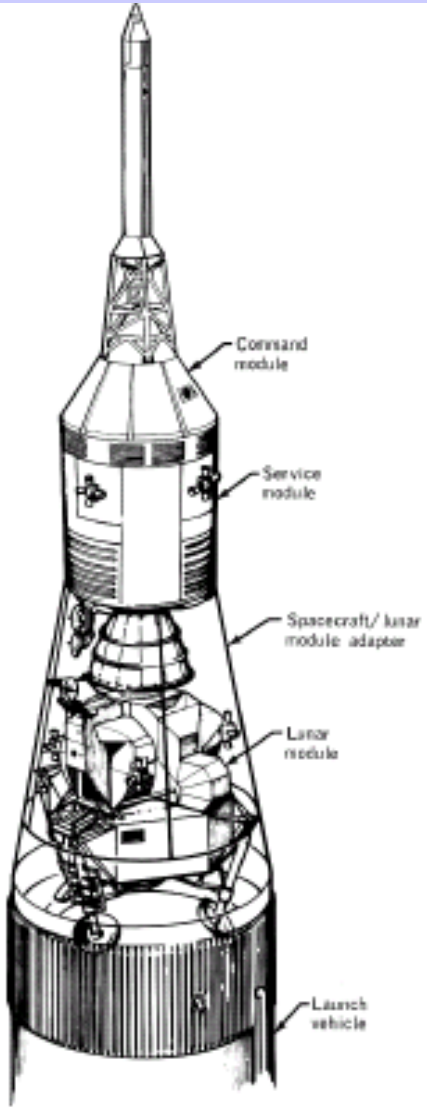


1968-1970 :

The epic race to the Moon with the rivalry USSR - USA

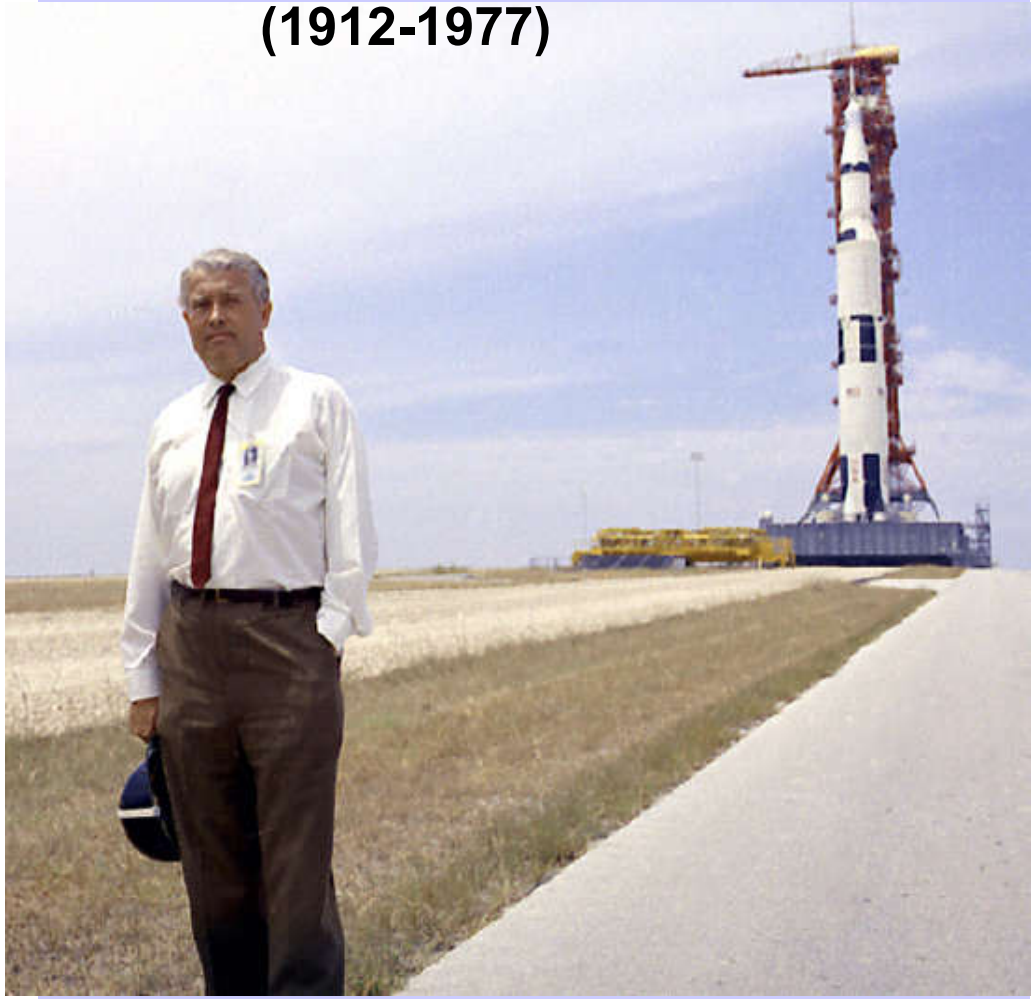
The cosmodrome of Baykonour was the theater of very secret activities to develop a super-heavy launcher for lunar missions!

Saturn V



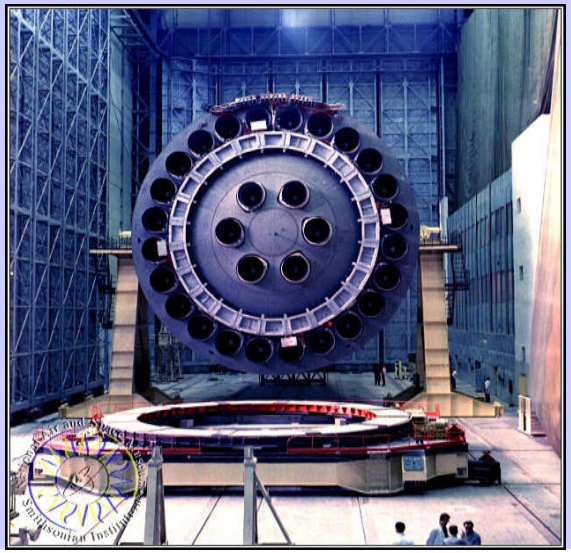
Apollo Spacecraft

The great designer of the Apollo programme: Wernher von Braun (1912-1977)



Launch Complex n°39 : Kennedy Space Center

Secret N-1, the giant launcher of USSR for lunar manned spaceflight…

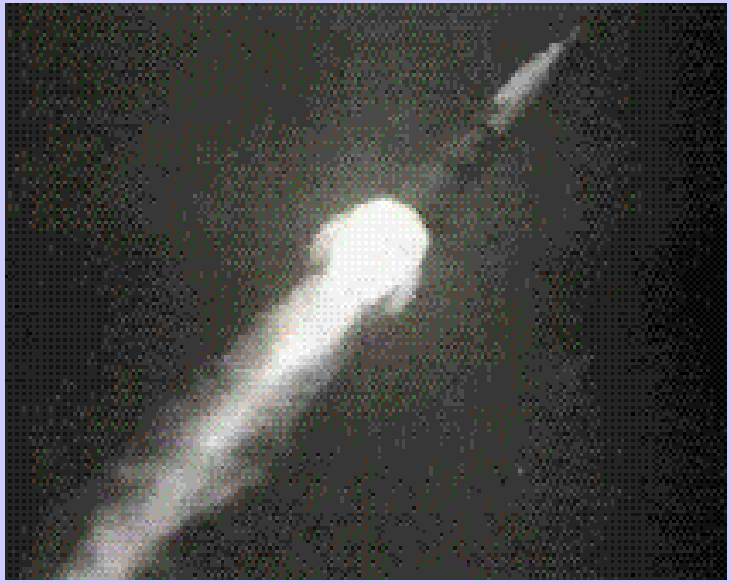


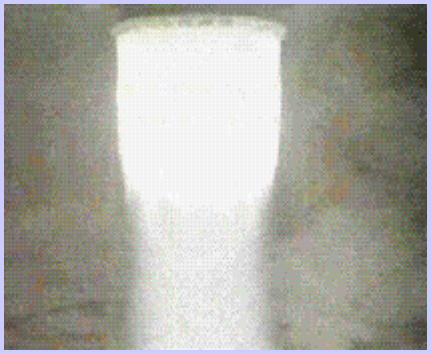
21-28 December 1968: flight around the Moon of Apollo-8 crew thanks to the successful launch of the 3rd highly powerful Saturn V rocket

Historical Apollo-8 spaceflight (Mission « Jules Verne »): From the Earth to the Moon

N-1 : MISSION 3L

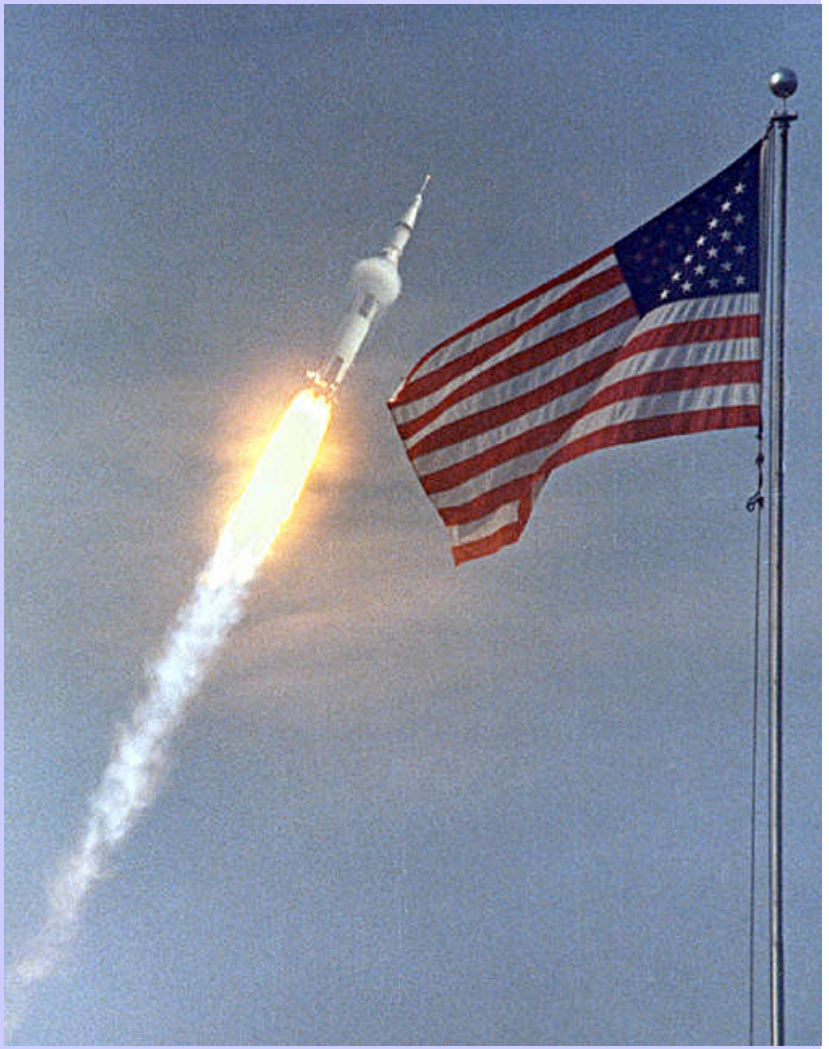
21 february 1969 – Duration: 70 s.

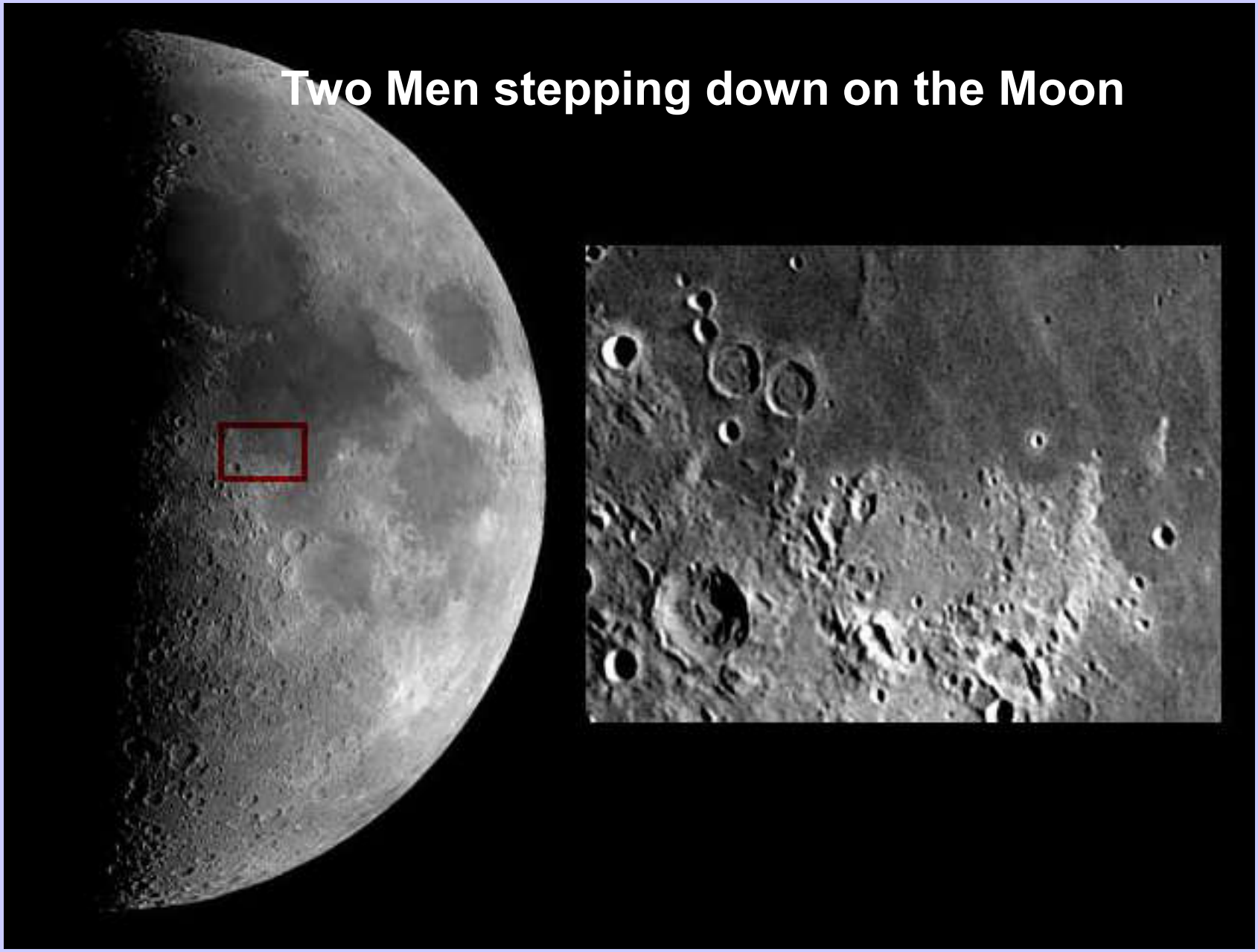




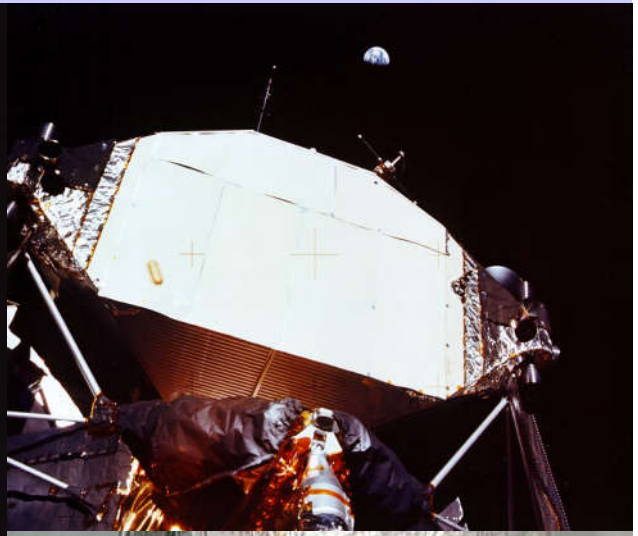

APOLLO 11
NO SMOKING
APOLLO 11

16 July 1969 : GO TO THE MOON !

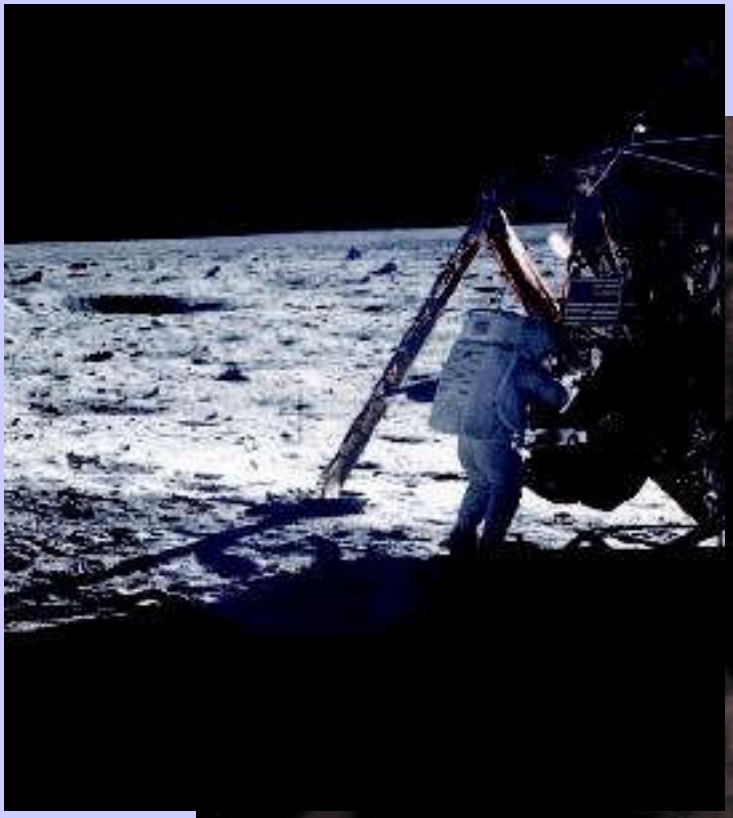


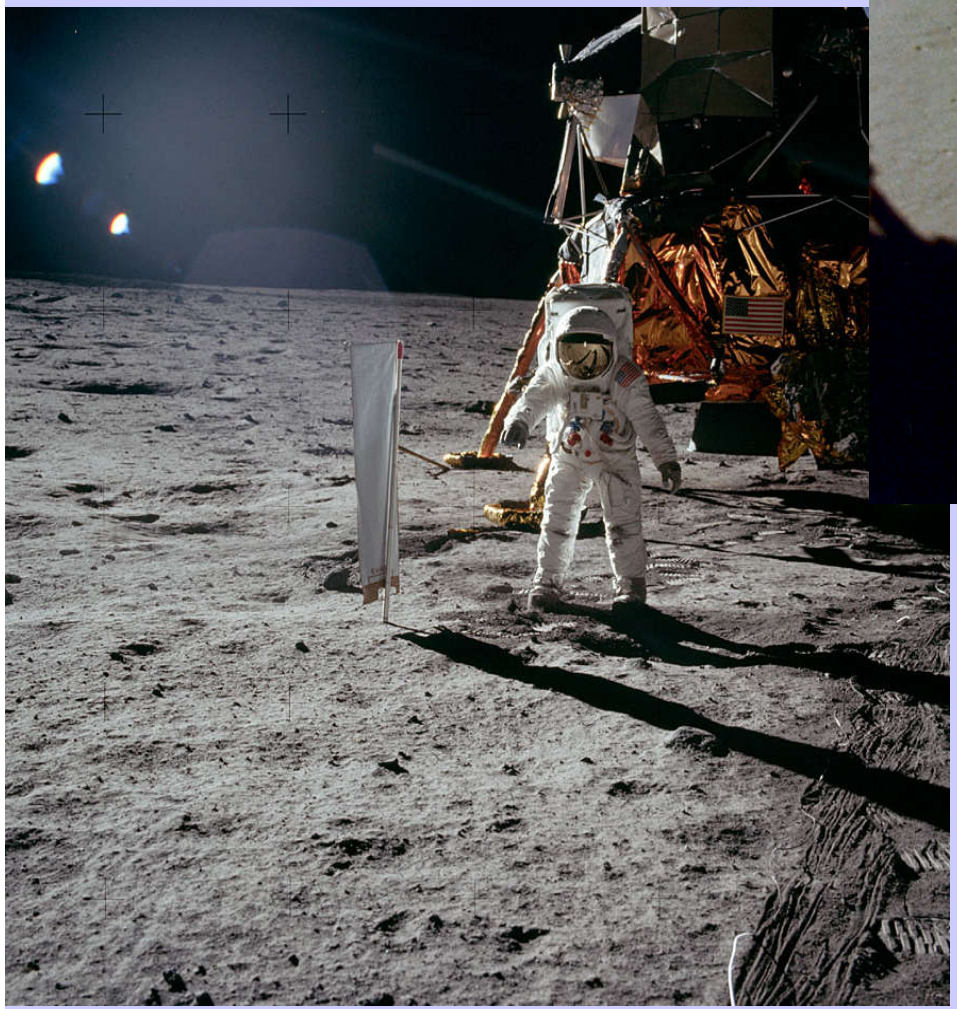

Two Men stepping down on the Moon

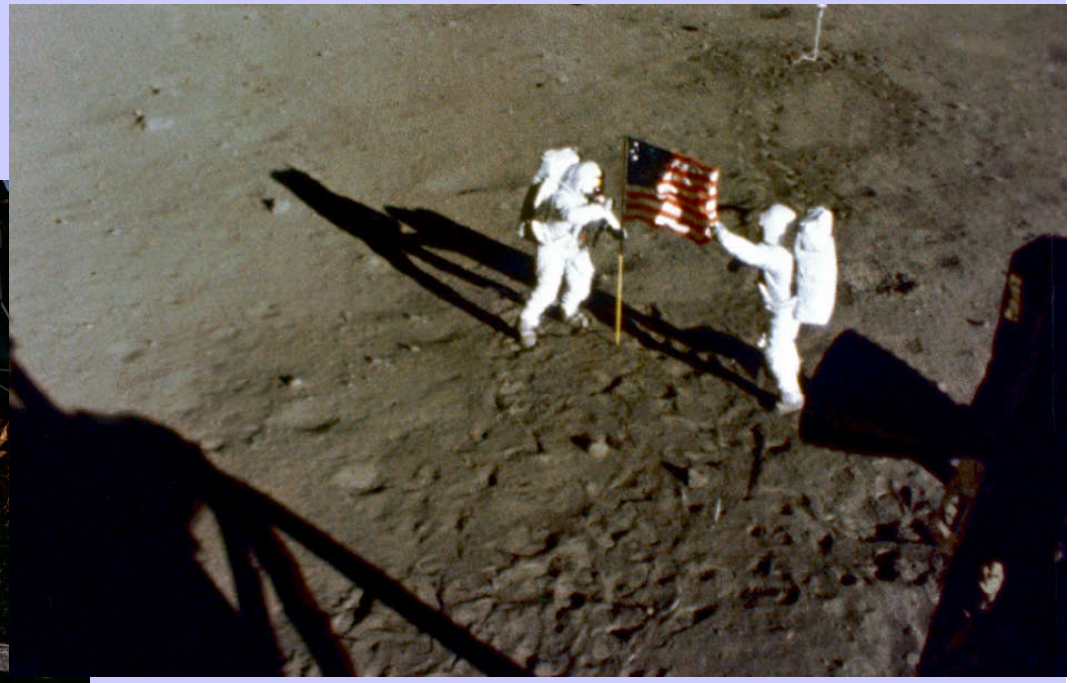
20 July 1969:
two Americans on the Moon
98 months after political go-head of President Kennedy



Armstrong, the number 1 on the Moon



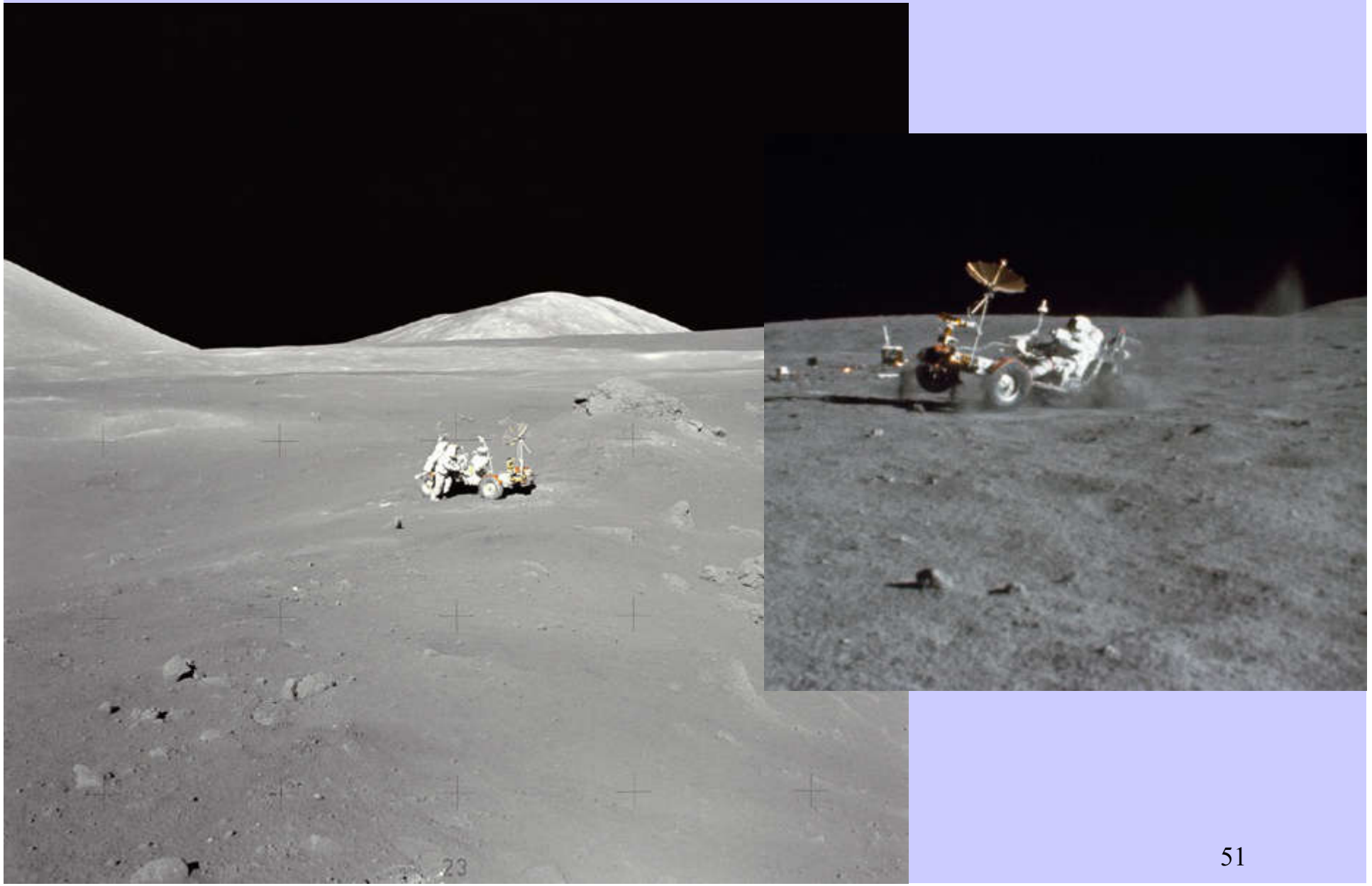





T+98 months: 24 July 1969
successful return
from the Moon

Apollo 11 heroes welcomed as « plagued »

1971-1972: we drove on the Moon… at the speed of 16 km/h!



The lessons of « Men on the Moon »

* **First steps, US flags, lunar landers on six sites of the Moon, three electric 4 x 4 rover on the lunar surface** (still there) !

* **Packages of scientific instruments on six lunar sites**
(powered by radioactive batteries, they transmitted data until September 1977).

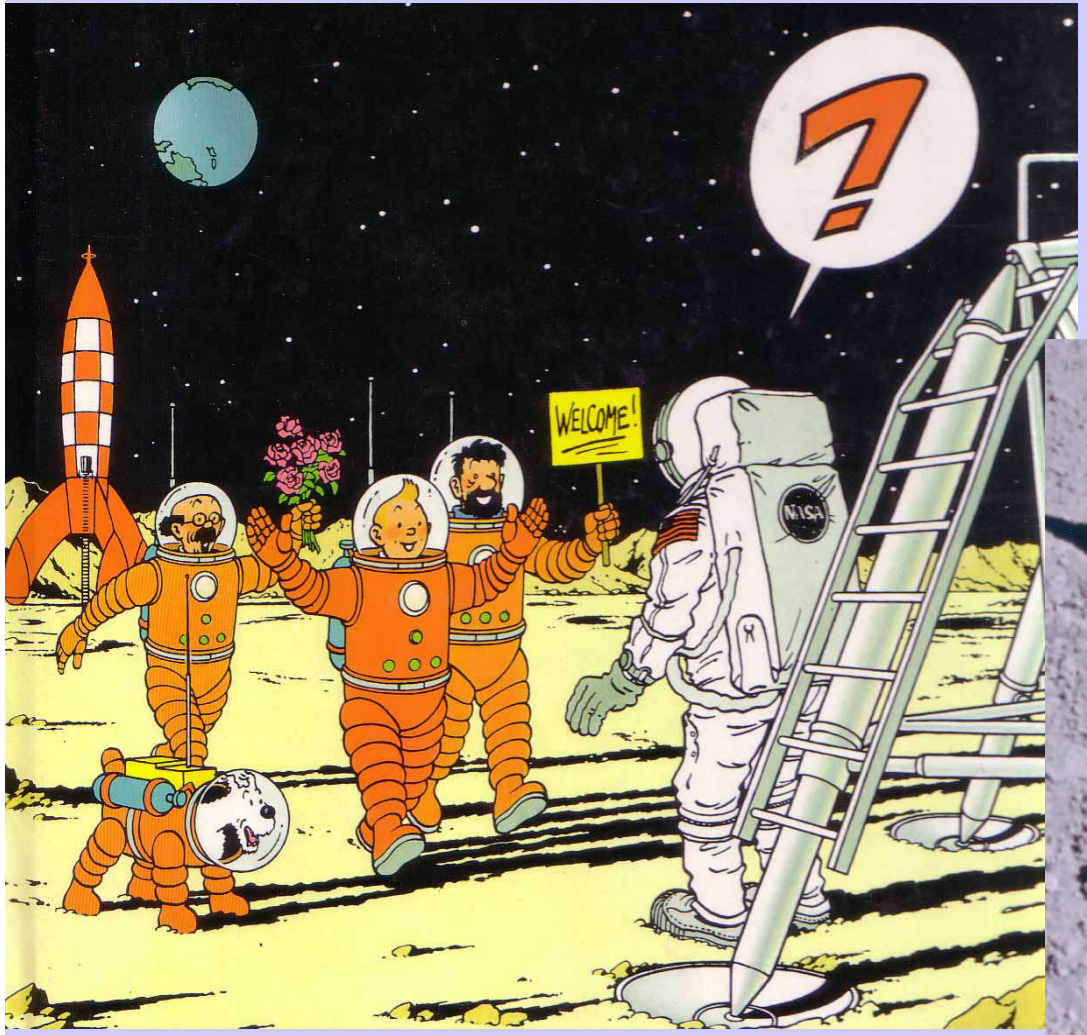
* **A significant harvest of 383-kg samples brought back from rocks and dusts of the Moon, now preserved in 2 laboratories of Texas, worldwide used for experiments.**

* **12 US men (no woman !) walking, working and driving on another world, 27 astronauts having flown over the Moon.**

* **Birth of a dynamic industry for space systems**
(new matérials, electronics, software, computers, test facilities...)

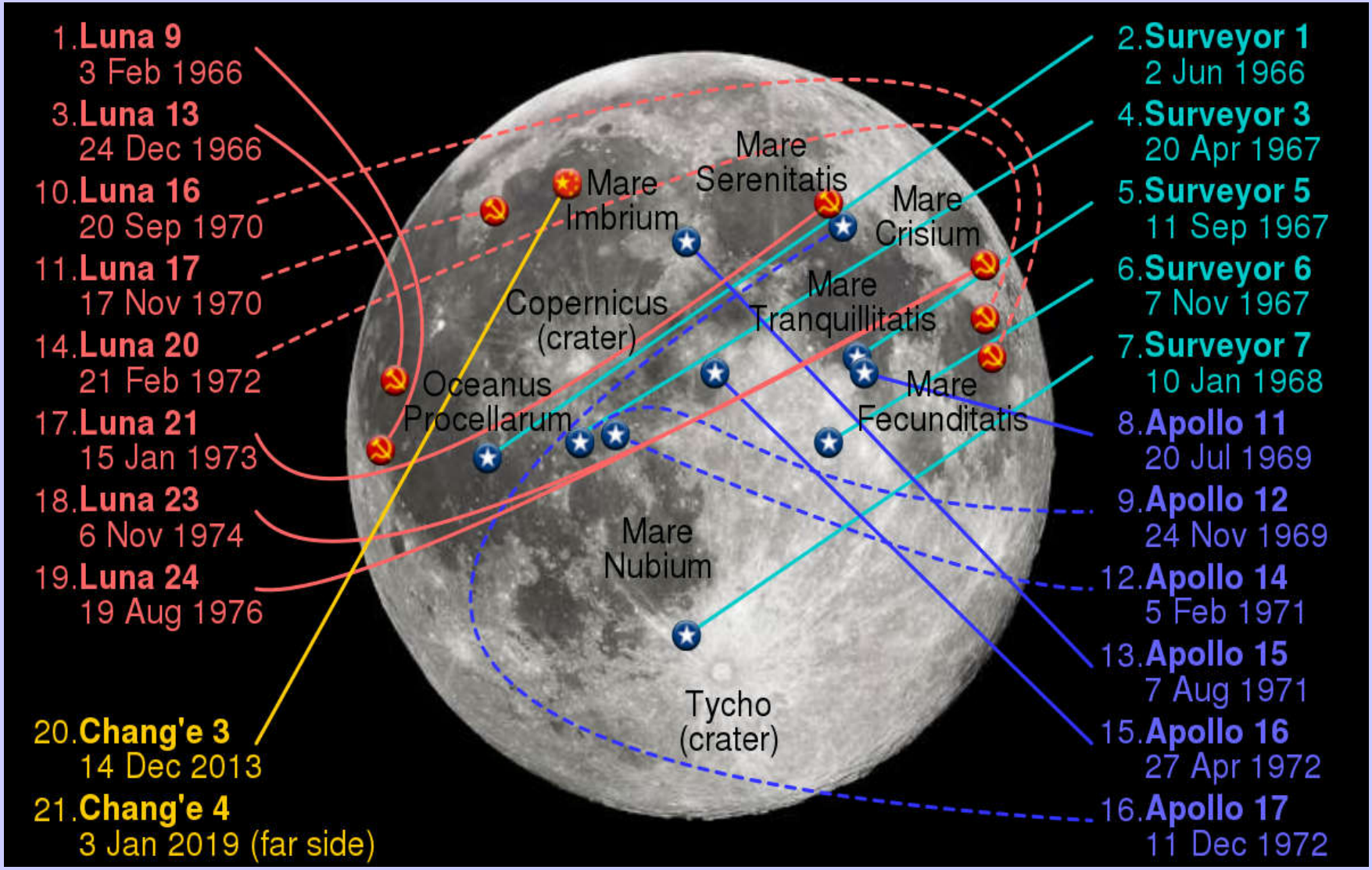
Note: the Apollo programme was achieved in a time of no PC, no fax, no Internet!

Belgium and/on the Moon



Hergé/RG (1951)

Paul Van Hoeydonck (1971)


1. Luna 9
3 Feb 1966
3. Luna 13
24 Dec 1966
10. Luna 16
20 Sep 1970
11. Luna 17
17 Nov 1970
14. Luna 20
21 Feb 1972
17. Luna 21
15 Jan 1973
18. Luna 23
6 Nov 1974
19. Luna 24
19 Aug 1976
20. Chang'e 3
14 Dec 2013
21. Chang'e 4
3 Jan 2019 (far side)
2. Surveyor 1
2 Jun 1966
4. Surveyor 3
20 Apr 1967
5. Surveyor 5
11 Sep 1967
6. Surveyor 6
7 Nov 1967
7. Surveyor 7
10 Jan 1968
8. Apollo 11
20 Jul 1969
9. Apollo 12
24 Nov 1969
12. Apollo 14
5 Feb 1971
13. Apollo 15
7 Aug 1971
15. Apollo 16
27 Apr 1972
16. Apollo 17
11 Dec 1972
Mare Imbrium
Mare Serenitatis
Mare Crisium
Copernicus (crater)
Mare Tranquillitatis
Oceanus Procellarum
Mare Fecunditatis
Mare Nubium
Tycho (crater)

While Moscow (USSR) and Washington (USA) are rivalling in an greatly epic race to the Moon, Europe achieving its first steps in space

- December 1960 : COPERS (Commission Préparatoire Européenne de la Recherche Spatiale),

  established by 9 States of Europe, **including Belgium**

  with the Meyrin agreements (Canton de Genève)

  The COPERS is replaced in March 1964 par the organization CERS-ESRO (space science)
- February1962 : establishment of **CNES** (Centre National d'Etudes Spatiales), public entity, upon recommendations of General de Gaulle, President
- March 1962: creation of **CECLES-ELDO** [European Launcher Development Organisation], to develop the European launcher of satellites or Europa
- June 1962: creation of **CERS-ESRO** [European Space Research Organisation],

  to achieve scientific experiments with sounding rockets and with satellites – later its competences were enalrged to applications satellites (meteorology, communications)

The French agency and the two intergovernmental organizations

In the foreground, the mobile small telescopes made in Liege by AM
they are used with the large telescopes for interferometry observatio

The first decade of Europe in space: ups and downs (1)

- **1964-1973 :** ELDO [European Launcher Development Organisation] faced technical difficulties with failures to develop the 3-stage Europa launch vehicle

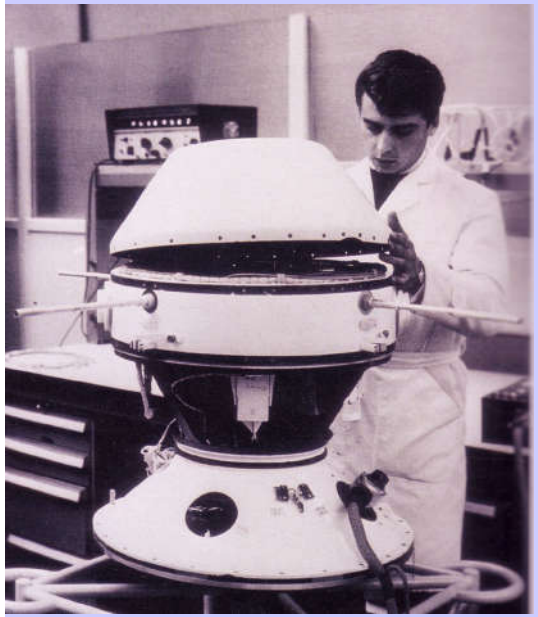
  (1st British stage (with Belgian équipements), 2nd French stage, 3rd German stage, satellite and fairing from Italy, Dutch telemetry, Belgian tracking, launch base in Woomera (Australia) then transferred to French Guyana for the 4-stage Europa-2.

  After the mediatic failure on 5 November 1971, the programme was stopped and ELDO disappeared… leaving a remaining flight model at Transinne-Libin (Belgium)

The first decade of Europe in space (2)

1964-1973 : France, with CNES (Centre National d'Etudes Spatiales, showed Europe the way to be followed: <u>autonomous access to space</u>

26 November 1965: French Diamant rocket launched A-1/Asterix from Hammaguir (Sahara)



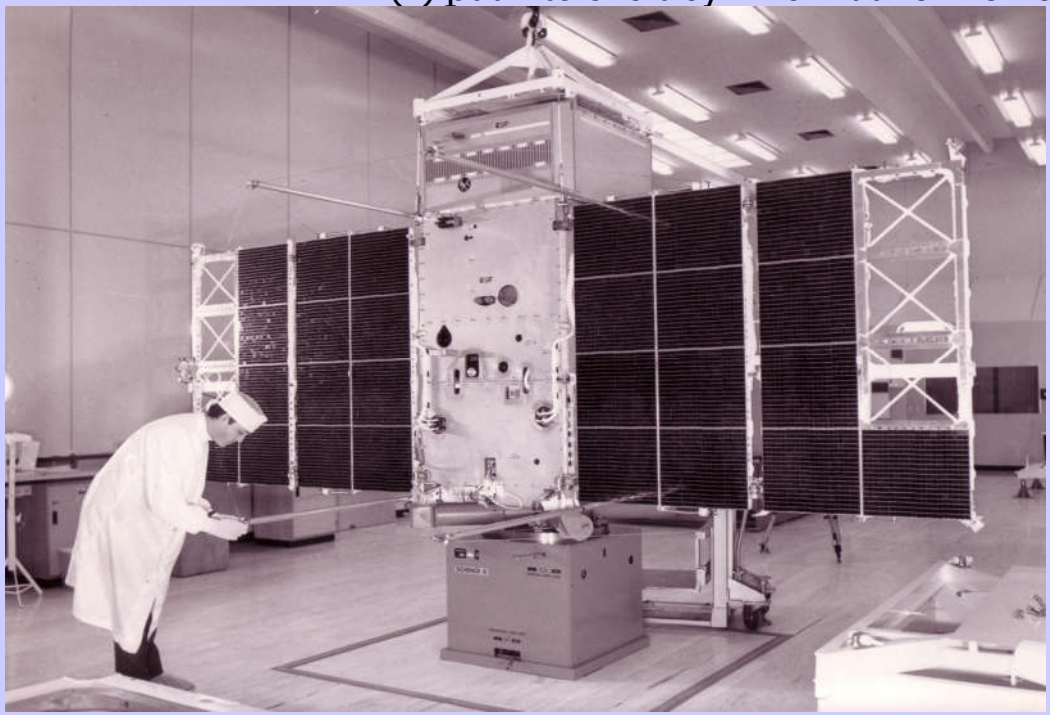
The first decade of Europe in space (3)

- 1964-1975 : ESRO [European Space Research Organisation] focused on cooperative ventures for scientific and technological purposes

  Use of sounding rockets,

  then of small a,d medium-sized satellites since 1968 (*)

  (*) put into orbit by NASA launch vehicles)



TD-1, 1st European astronomy satellite (for UV observations)

equipped with a telescope hat was tested in a vaccum chamber at University of Liège /Observatoire de Cointe (embryonic start of the CSL /Centre spatial de Liège), which celebrates in 2014 50 years of space activities

Launched on 12 March 1972

The first decade of Europe in space (4)

- **31 July 1973, European Space Conference at Ministerial level**

  at Brussels Bruxelles,

  with this surprising and promising result :

« Everything was done. It was a sort of miracle. It was five o'clock in the morning and we had been in that meeting since the day before.

I came out saying: 'Well, we should at least inform the reporters!' But none were around any longer. They has all gone thinking everything was down the drain anyway.

I was out in the Egmont park. The sky was blue. The birds were singing in the trees… and we had won! »

Charles HANIN, Belgian Minsitry for Science Policy,

Chairma 1914-2012)

L'ESA : KEY FACTS

- Some 50 years of experience
- 22 member States
- Six main facilities in Europe, some 2200 employees
- Budget of 5,25 billion € (2020)
- Design, tests and operations for more than 80 satellites & probes
- 15 science satellites in operation
- Dévelopment of six launch vehicles
- 253 Ariane launches in September 2020

ESA is among the rear space agencies busy in nearly all aspects of the systems for space

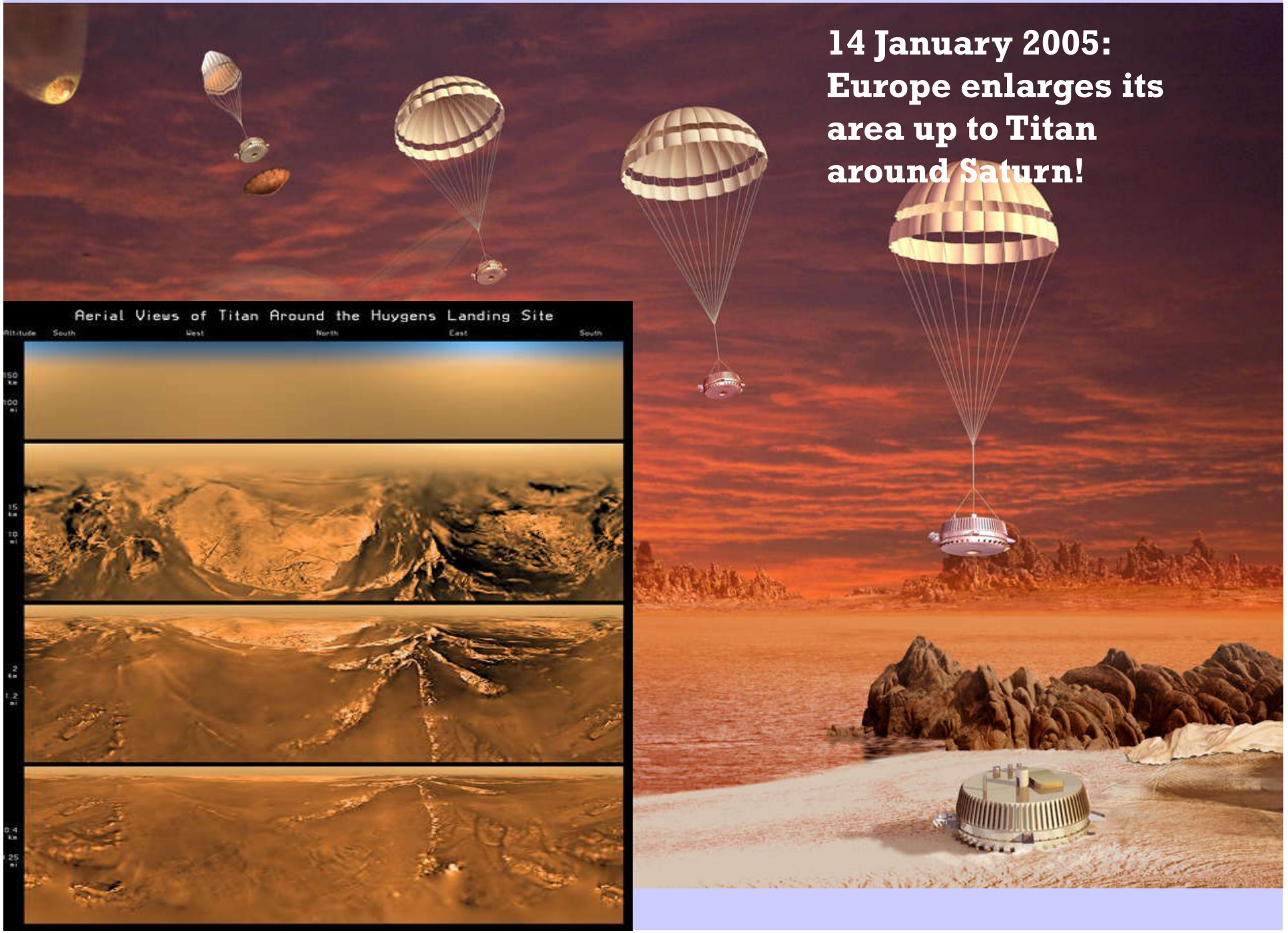
- **Space science**
- **Manned spaceflight**
- **Exploration**
- **Earth observation**
- **Launch vehicles**
- **Navigation**
- **Telecommunications**
- **Advanced technology**
- **Operations**
- **Cybersecurity**

ESA PRESENCE IN EUROPE

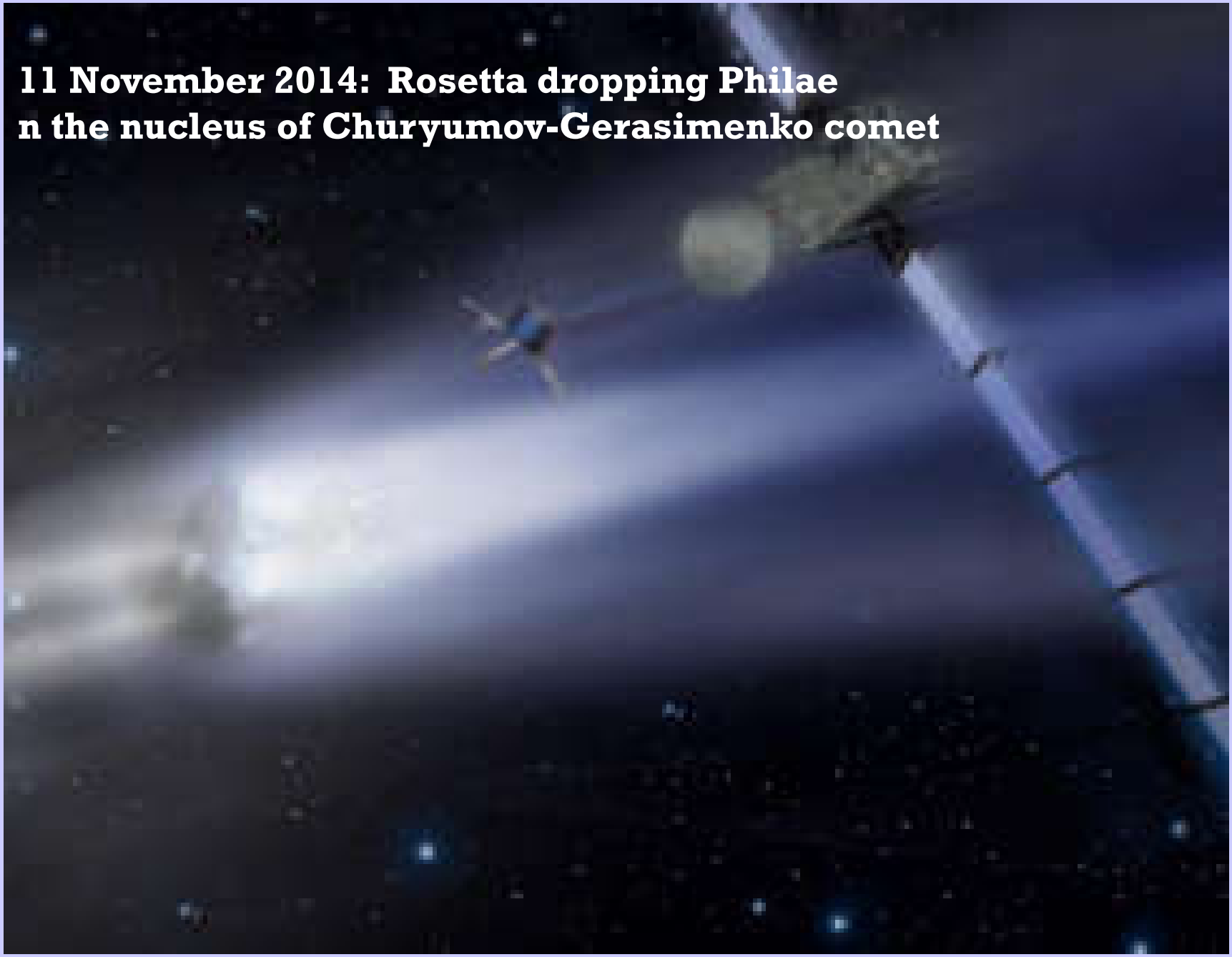
The great achievements in space science

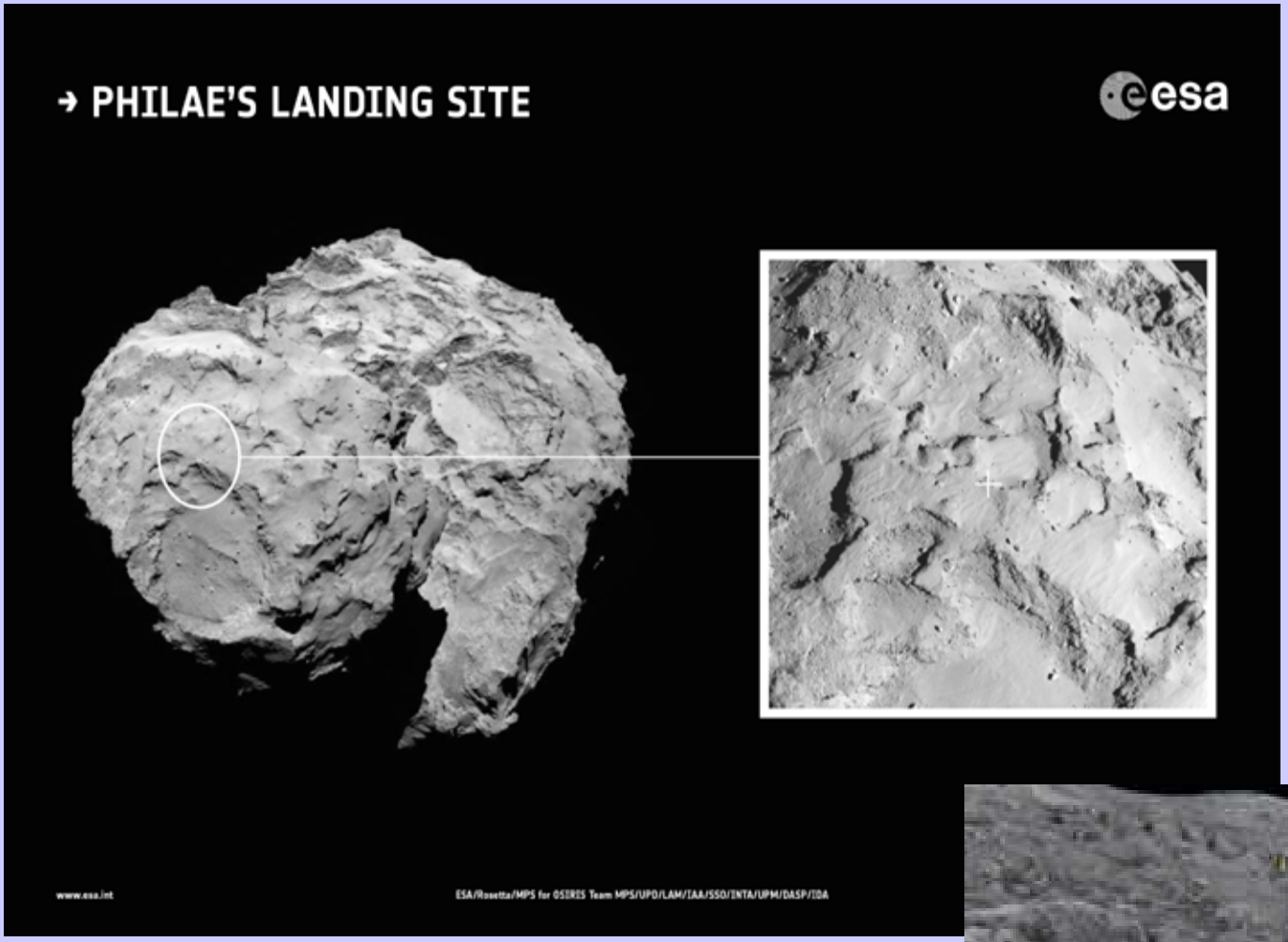
- **First fly-by of cometary nucleus : Giotto**
  « made in Europe » probe at 700-km of Halley comet (March 1986)
- **First astrometry mission :** Hipparcos observatory (from 1989 to mid-1993)
  followed by higher-resolution Gaia observatory (launched in December 2013)
- **First data collected over the poles of the Sun :**
  Ulysses probe in solar orbit (depuis october 1990)
- **First permanent observer of our star:**
  SOHO around Lagrange L1 Earth-Sun at 1.5 million km,
  a joint venture with NASA (since February 1996)
- **First miniaturized spacecraft – Huygens – on the soil of Titan**
  the largest « moon » of Saturn, with atmosphere
  at 1.4 billion km from the Earth ! (launched in 1997,
  successful landing on 14 January 2005)
- **First far-away observatories for astrophysics and cosmology**
  positioned at Lagrange L2 (1.5 millions de km)
  Herschel and Planck to understand history and characteristics of the Universe,
  launched by Ariane 5-ECA on 14 May 2009 (very successful missions!)
- **First probes to explore the nucleus of a very active comet** :
  Rosetta with Philae micro-robot (100 kg) on the nucleus in Novembre 2014

HMC 68 Image Composite
Comet Halley 14th March 1986

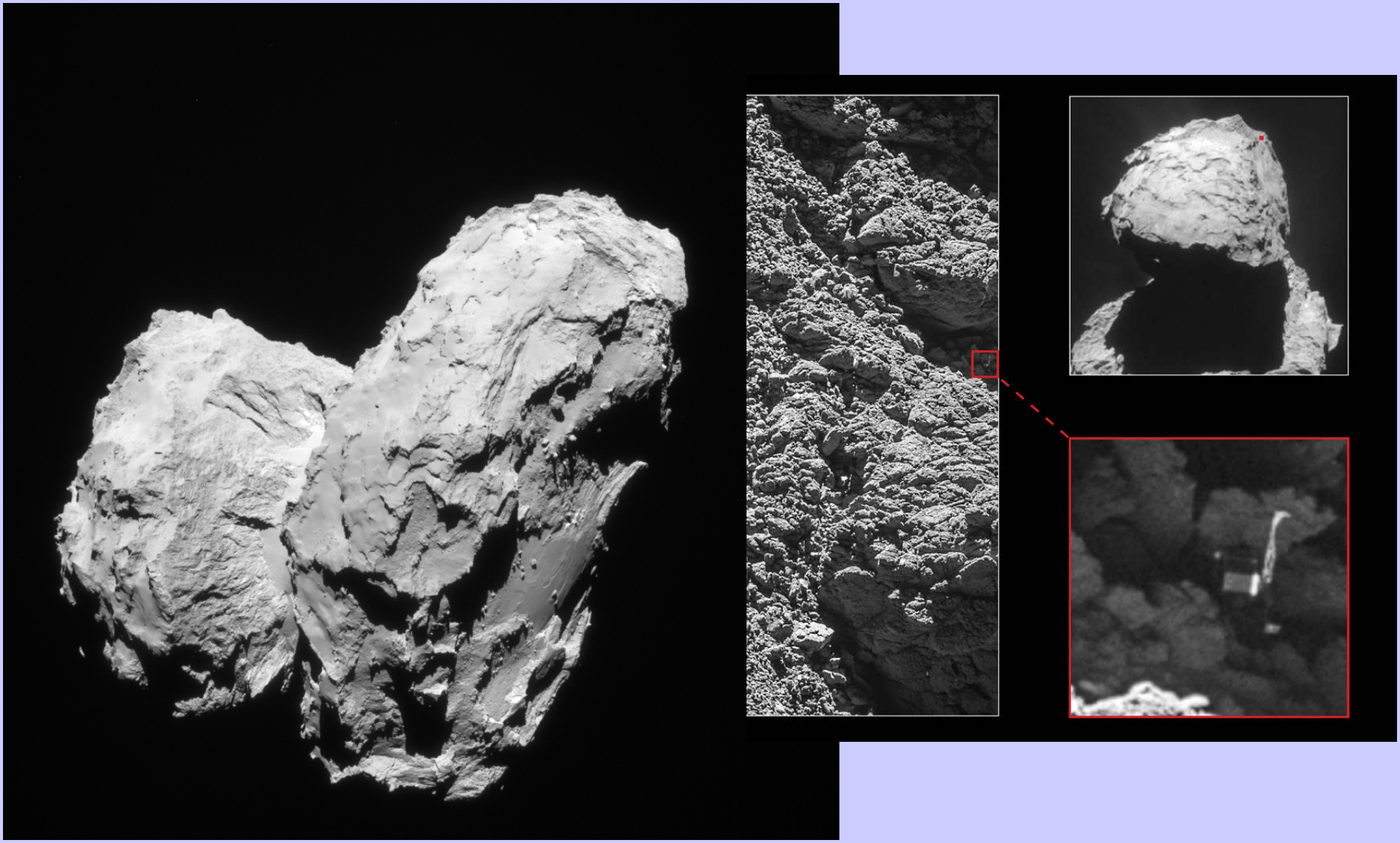


14 January 2005: Europe enlarges its area up to Titan around Saturn!


11 November 2014: Rosetta dropping Philae
n the nucleus of Churyumov-Gerasimenko comet


→ PHILAE'S LANDING SITE
esa
www.esa.int
ESA/Rosetta/MPS for OSIRIS Team MPS/UPD/LAM/IAA/SSO/INTA/UPM/DASP/IDA

The great success of ESA (2015-2016): « in situ » exploration of Comet 67P Churyumov-Gerasimenko

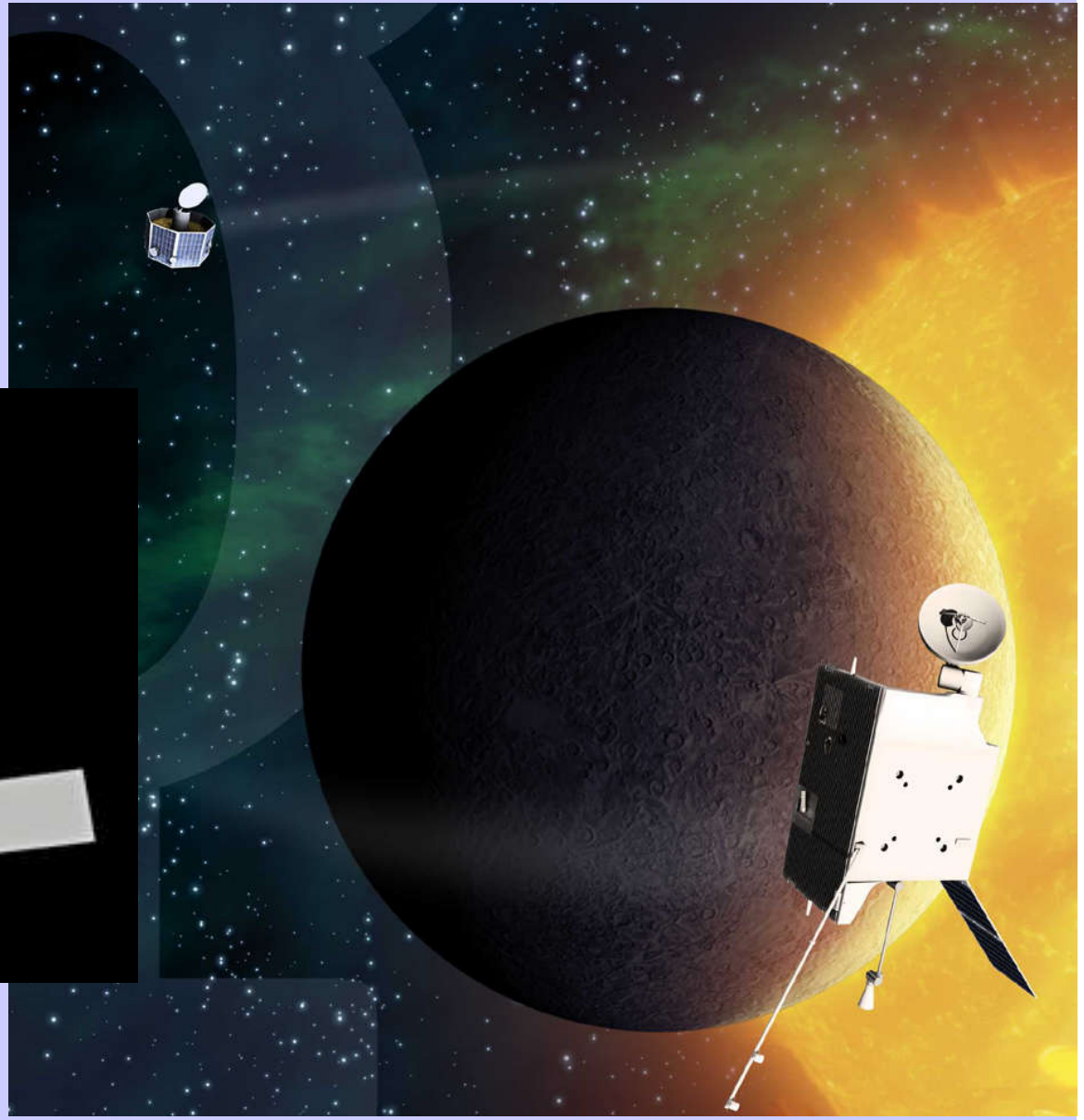


October 2018: launch of

ESA-JAXA spacecraft

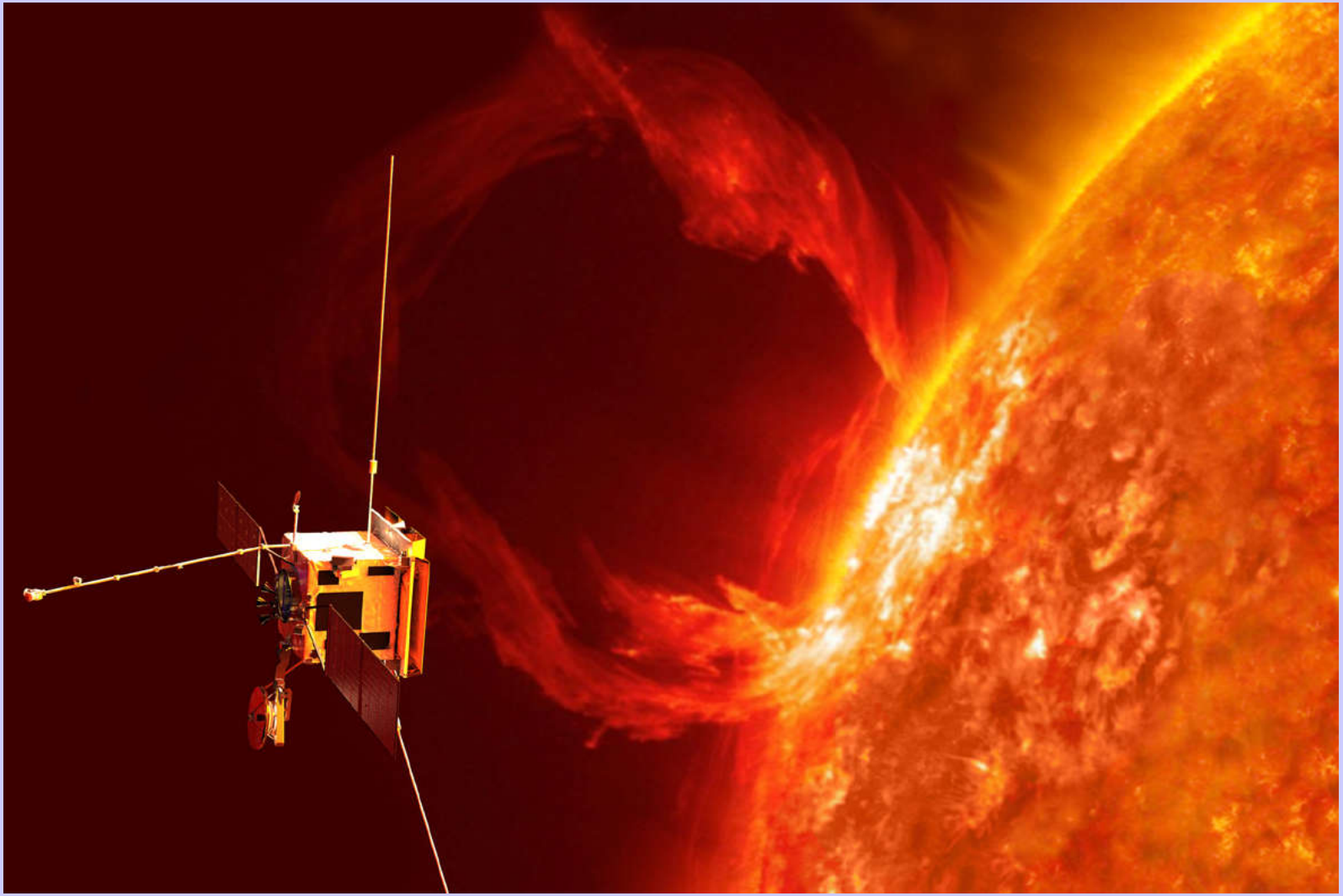
BepiColombo towards Mercury

for orbital operations



February 2020: launch of Solar Orbiter probe

for a ESA-NASA exploratory mission

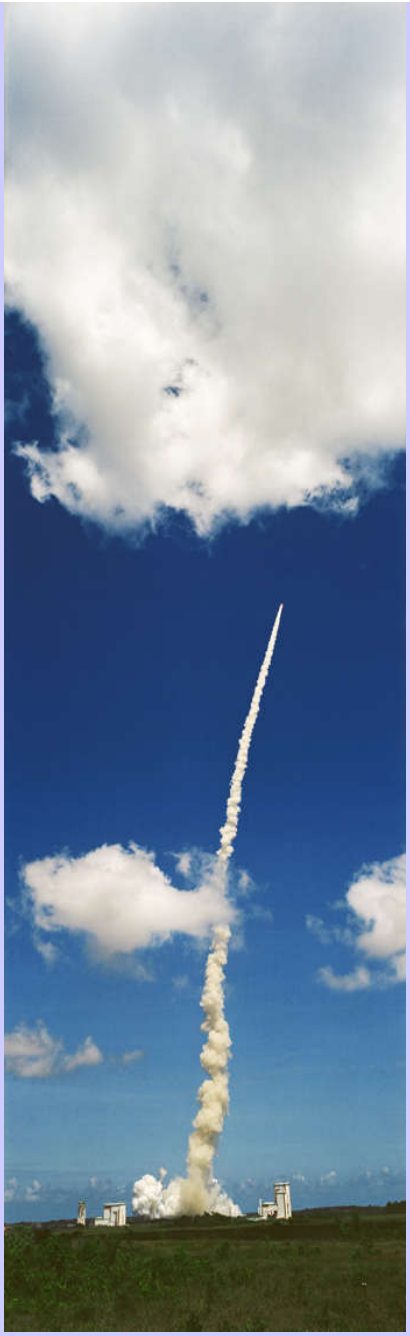


Launch vehicles for independent access to space

The growing family of Ariane, born between 1979 and 2003

(217 flights, with 59 successes in a row)

ARIANE 1-2-3-4	ARIANE 5/5ECA
(1st génération)	(2nd génération)
1st successs: 24-12-1979	1st success: 30-10-1997

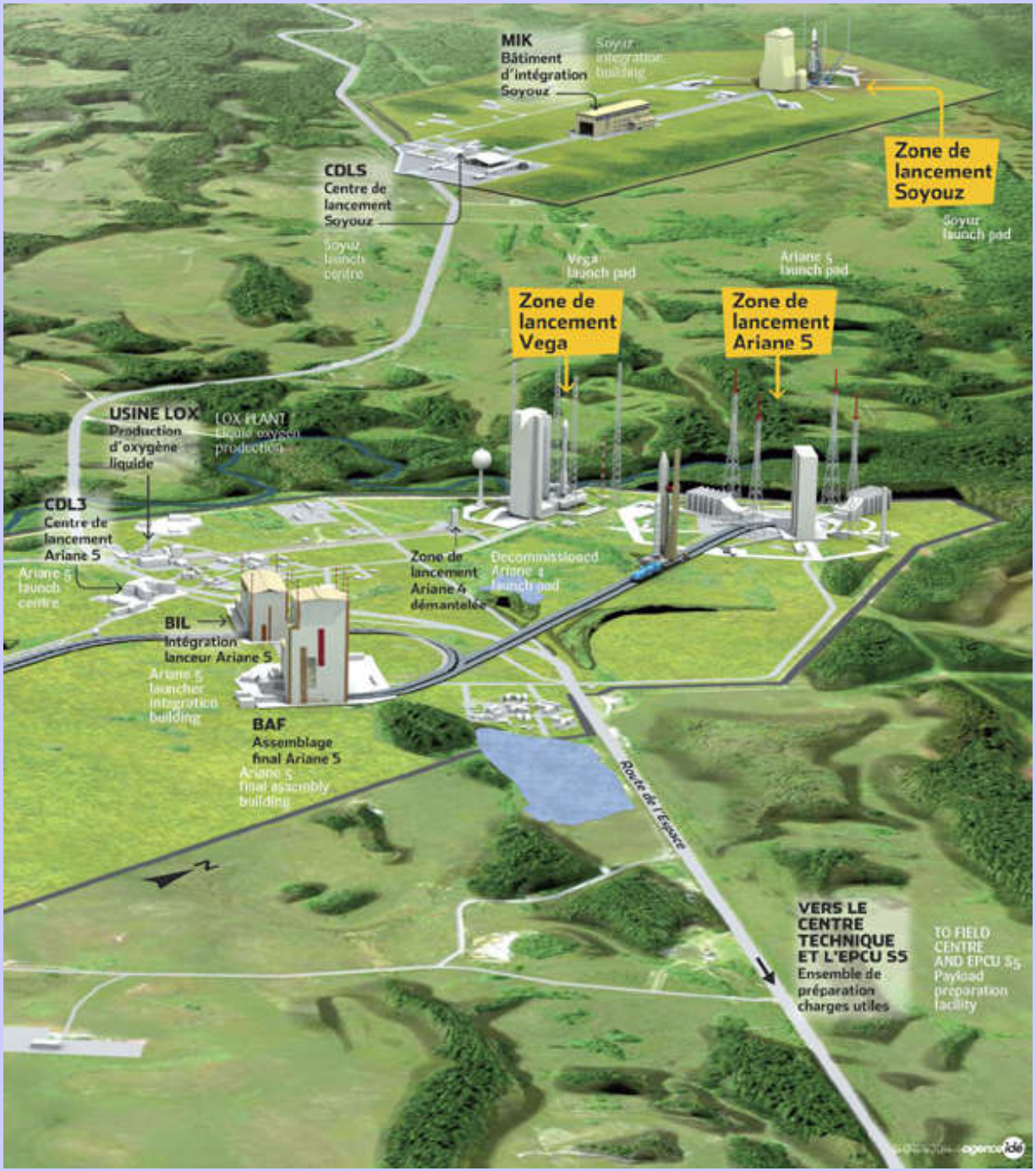


Europe's spaceport in South America

(CSG : Centre Spatial Guyanais)

- Location :
  - French Guyane, South America
- Sites :
  - ELA - Ariane 5
  - SLV - Vega (2012)
  - ELS - Soyouz (2011)
- Launch capability
  - 6-7 per year from ELA
  - 2-3 per year from SLV
  - 4-5 per year from ELS

- **Great advantages : proximity of the equator :**
  - **heavier mass for the payload**
  - **longer duration of satellite lifetime**



With the presence of Belgian enterprises:

Thales Alenia Space Belgium (Charleroi),

Cegelec (Wavre),

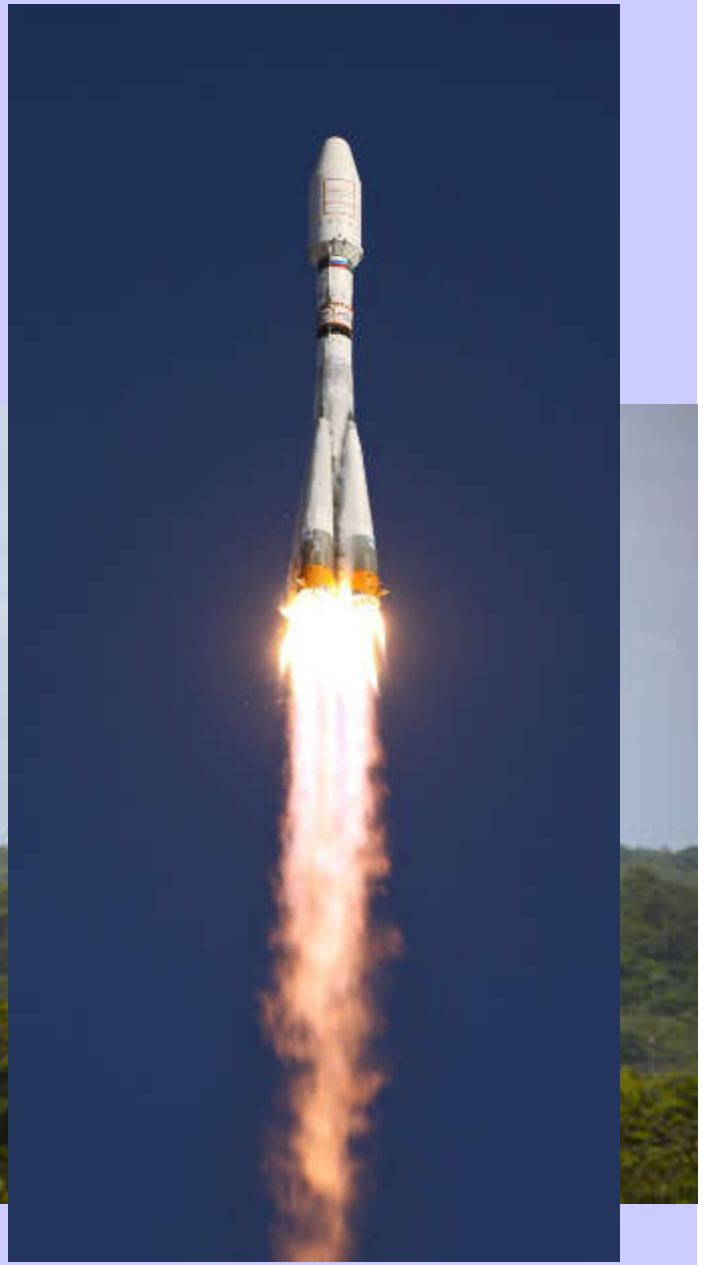
SABCA (Brussels)

arianespace

Service & Solutions

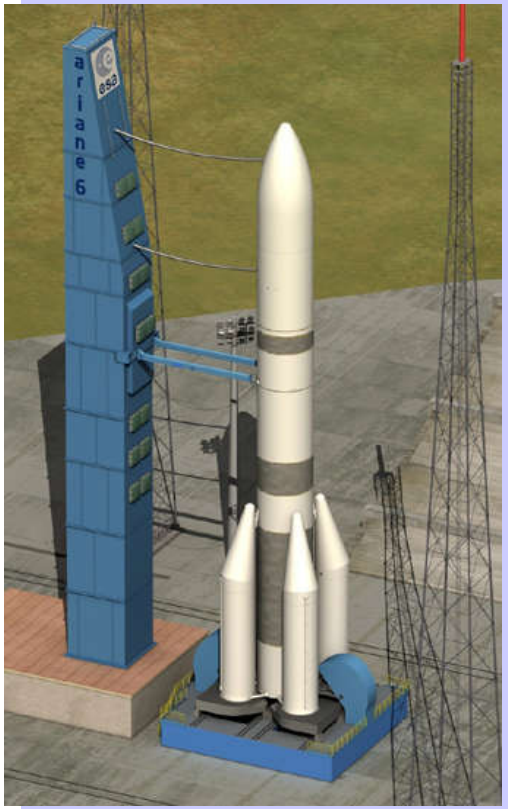
Nighttime launch of Ariane 5 from Europe's spaceport

First historical launch :
Russian Soyuz in French Guyana
to meet Arianespace needs



Vega, the 3rd musketeer of Europe's space transportation

The new Ariane 6 from ELA-4 in 2021



Business strategy of ESA :

From research & development to operational systems in space

- **Launchers Ariane**
  - → **Arianespace (since 1980) /ArianeGroup**
- **Telecommunications & broadcasting satellites**

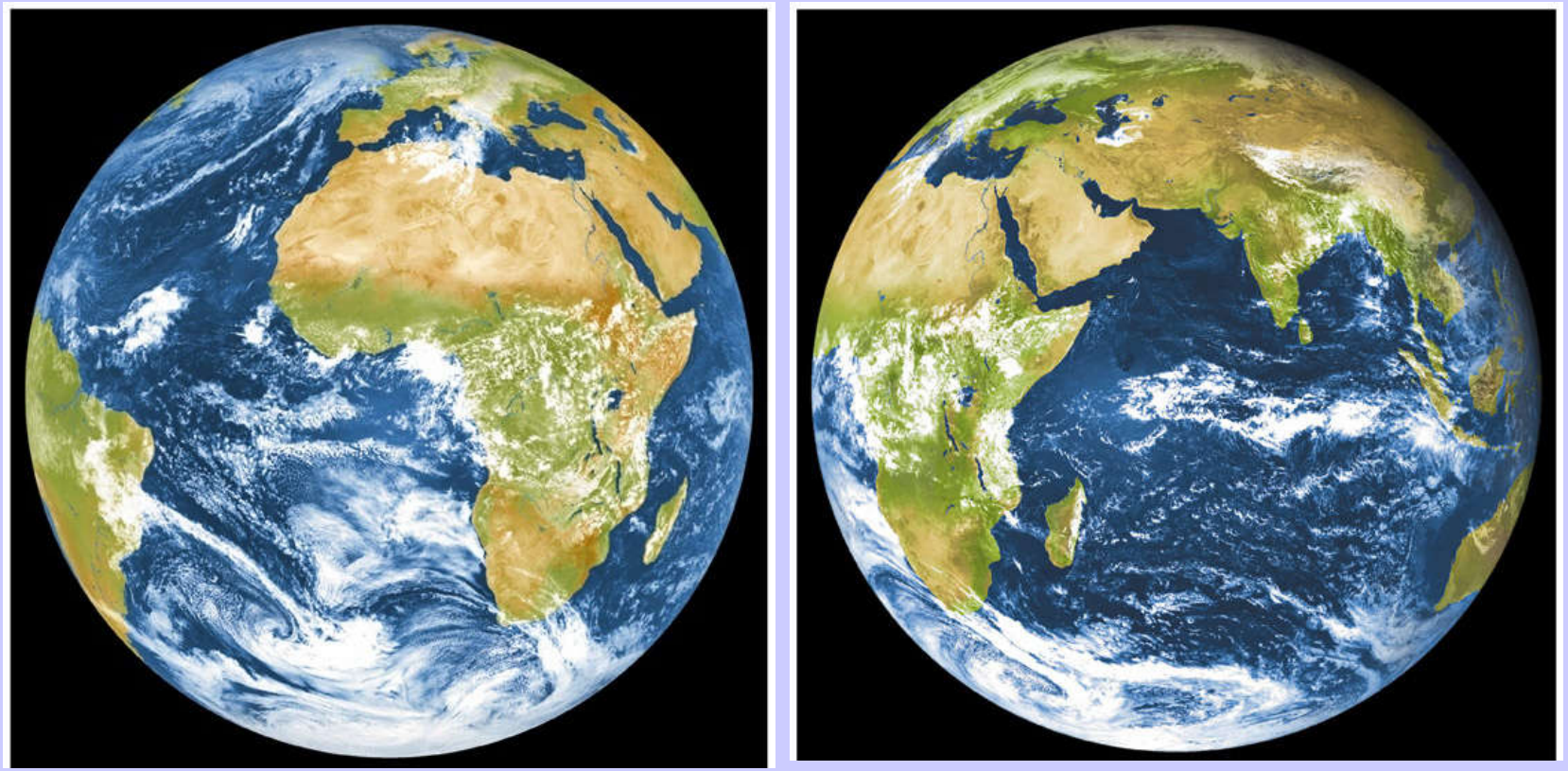
  ECS, Marecs, Artemis, Alphasat, ARTES (Small GEO, Neosat, Electra, Sat-AIS…)
  - → **Eutelsat (since 1977, private entity since July 2001)**
  - → **Inmarsat (since 1979, private entity since April 1999)**
- **Meteorological satellites**

  Meteosat, Metop
  - → **Eumetsat (since 1986)**

Europe in space with Meteosat

developed and operated by Eumetsatorganization

State of weather (every 1/4 h) in Europe, Africa and Asia,
in Méditerranean Sea, over Atlantic and Indian Oceans



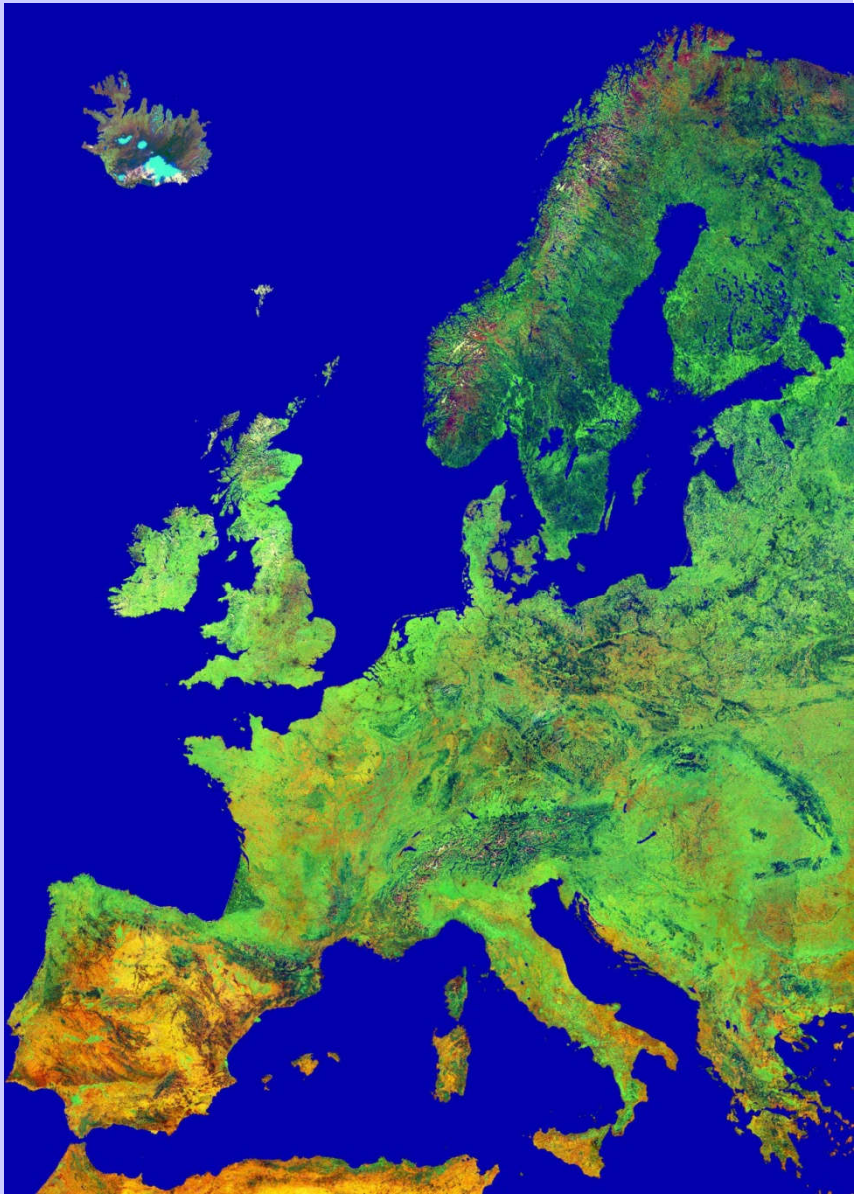
SPACE FOR EUROPE, for now and in the future

The European Union (EU) and ESA pursuing the same purpose:

make Europe stronger in the world and serve the needs of citizens.

Powerful links and growing cooperation accrue between ESA and EU to bring back great benefits in and for Europe:

- ***support to EU political strategies***
- ***improve the life of every citizen***



Space in the Treaty of Lisbon (European Constitution)

(official since 1st Decembre 2009,
after being ratified by each of the 27 member States)

Article 189 – "Research and technological development, and Space":

- ***"1. To promote scientific and technical progress, industrial competitiveness and the implementation of its policies, the Union shall draw up a European space policy. To this end, it may promote joint initiatives, support research and technological development and coordinate the efforts needed for the exploration and exploitation of space.***
- ***2. To contribute to attaining the objectives referred to in paragraph 1, a European law or framework law shall establish the necessary measures, which may take the form of a European space programme."***
- ***3. The Union shall establish any appropriate relations with the European Space Agency."***

Galileo et Copernicus :
two programmes of space applications
funded by the Union (Council + Commission + Parlement)

The two programmes for which ESA is acting as prime contractor are deploying operational systems:

- **Galileo/GNSS, alias the civilian and European GPS**

  Constellation of 30 satellites (each of 680 kg) into 3 MEO planes at 23.222 km

  Funding of ESA : 3.4 milliards € decided in December 2007

  Realization : 2 satellites for tests in orbit, 4 satellites for in-orbit validation + 22 operational satellites to be launched in 2014-2018

  + ground infrastructure for control, operations, authentification, security…

  [**6.3 billion €** planned in the MFF + funds of EU Horizon 2020]

- **Copernicus/GMES, « system of systems »**
  of global monitoring global for environnement and security

  Combining space systems (40 remote sensing satellites, including the Sentinels of ESA) et in situ facilities managed by EEA

  Funding of ESA : 2.3 billion € for the space segment
  + 0,6 billion € for the ground segment

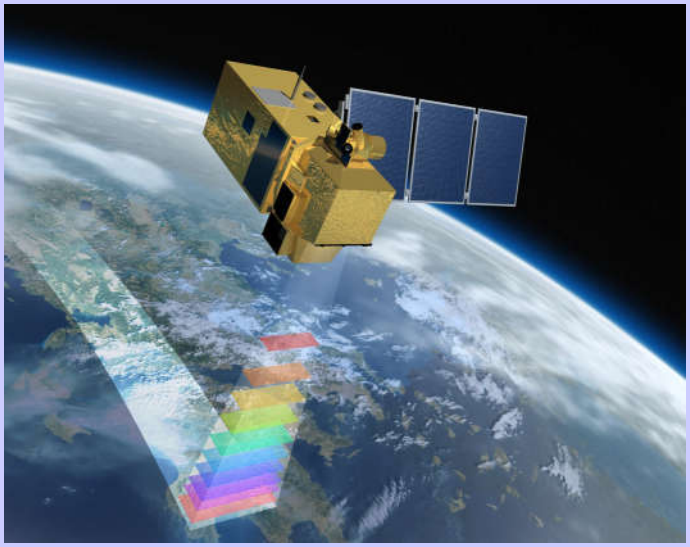
  [**3.8 billion €** planned in the MFF + funds of EU Horizon 2020]

[MFF = Multiannual Financial Framework of the Union for the period 2014-2020]

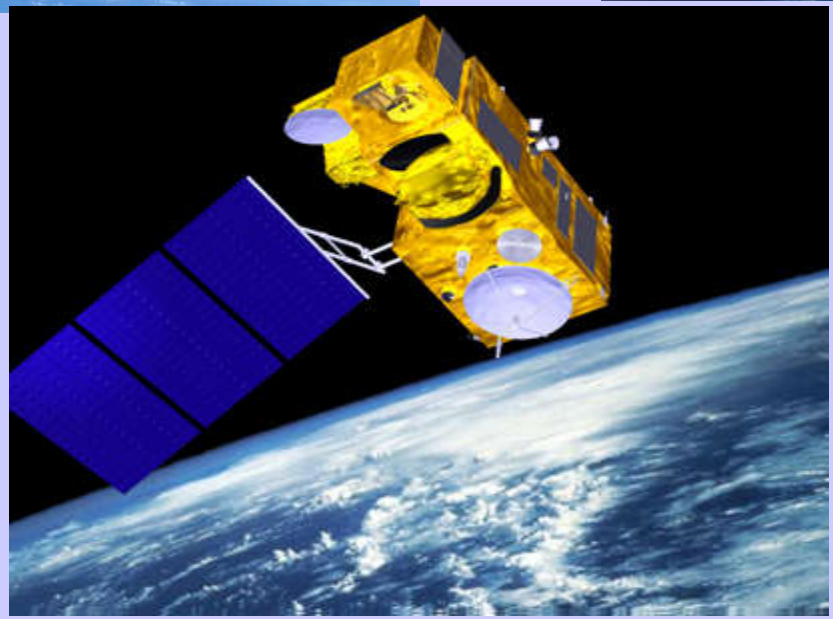
Belgian scientists and entrepreneurs concerned by **integrated applications**

The Union as user of Sentinel missions in the framework of Copernicus/GMES

Sentinel-1 (2014)

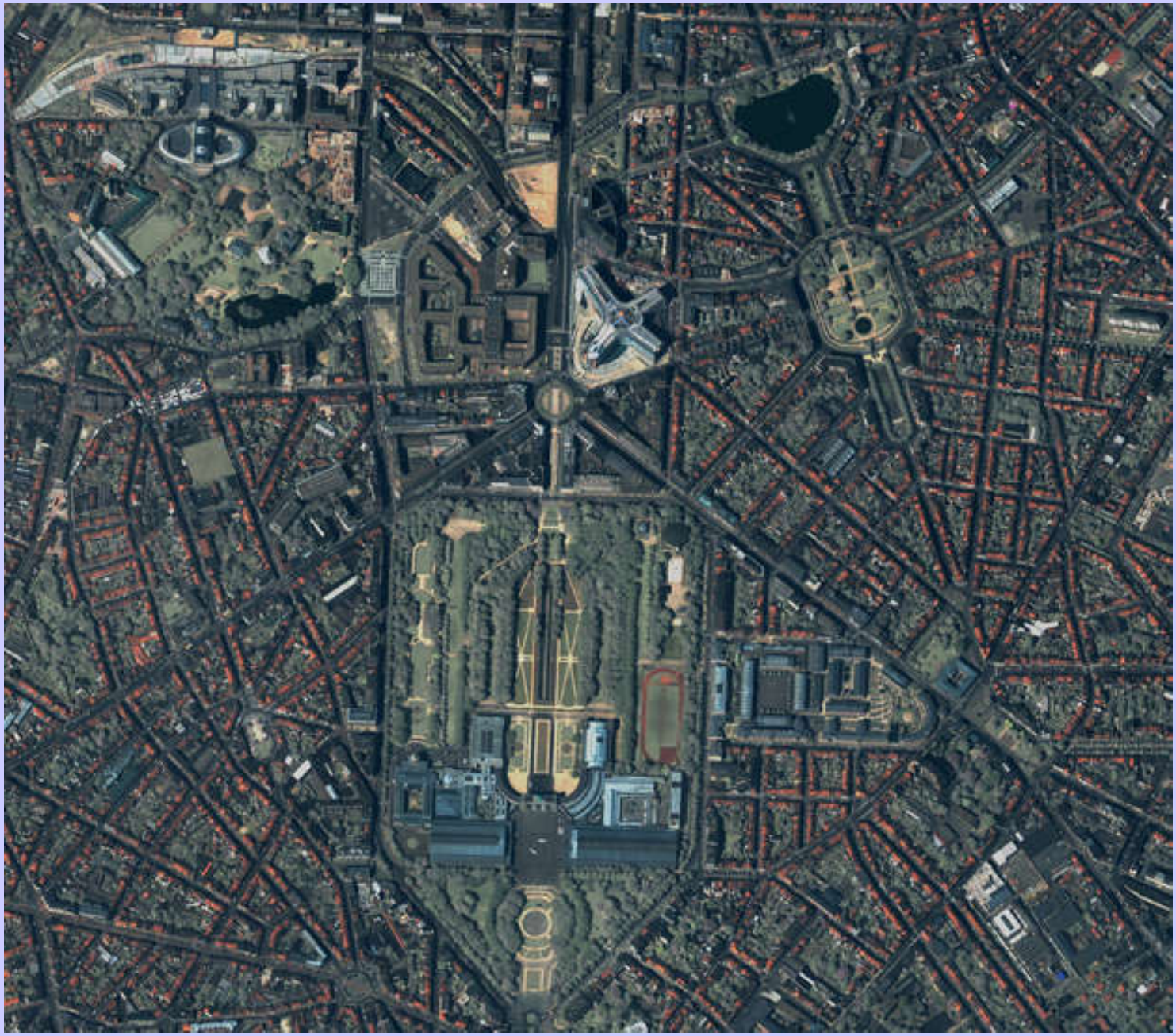


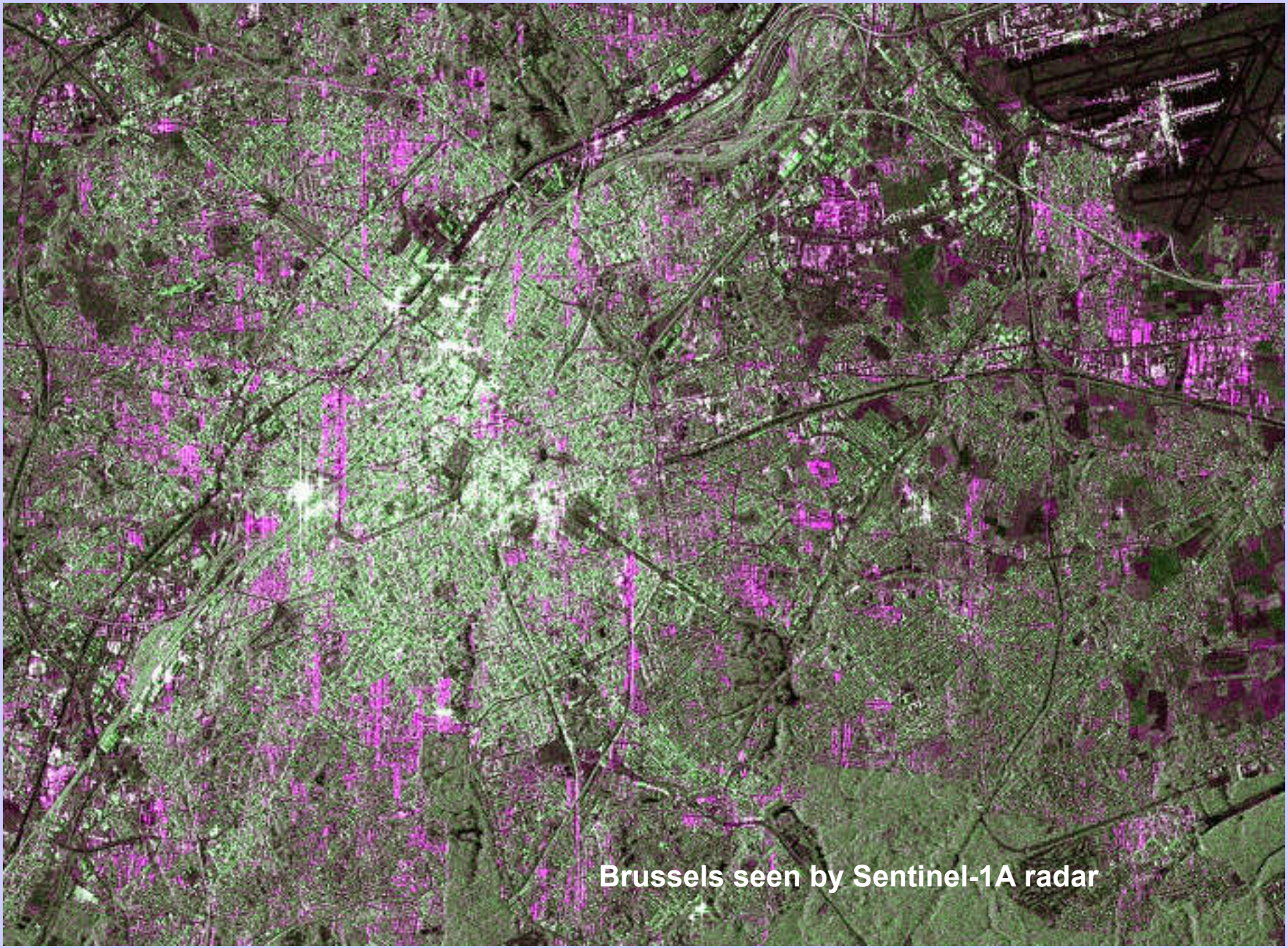
Sentinel-2 (2015)



Sentinel-3 (2015)

Which Belgian city seen from space?

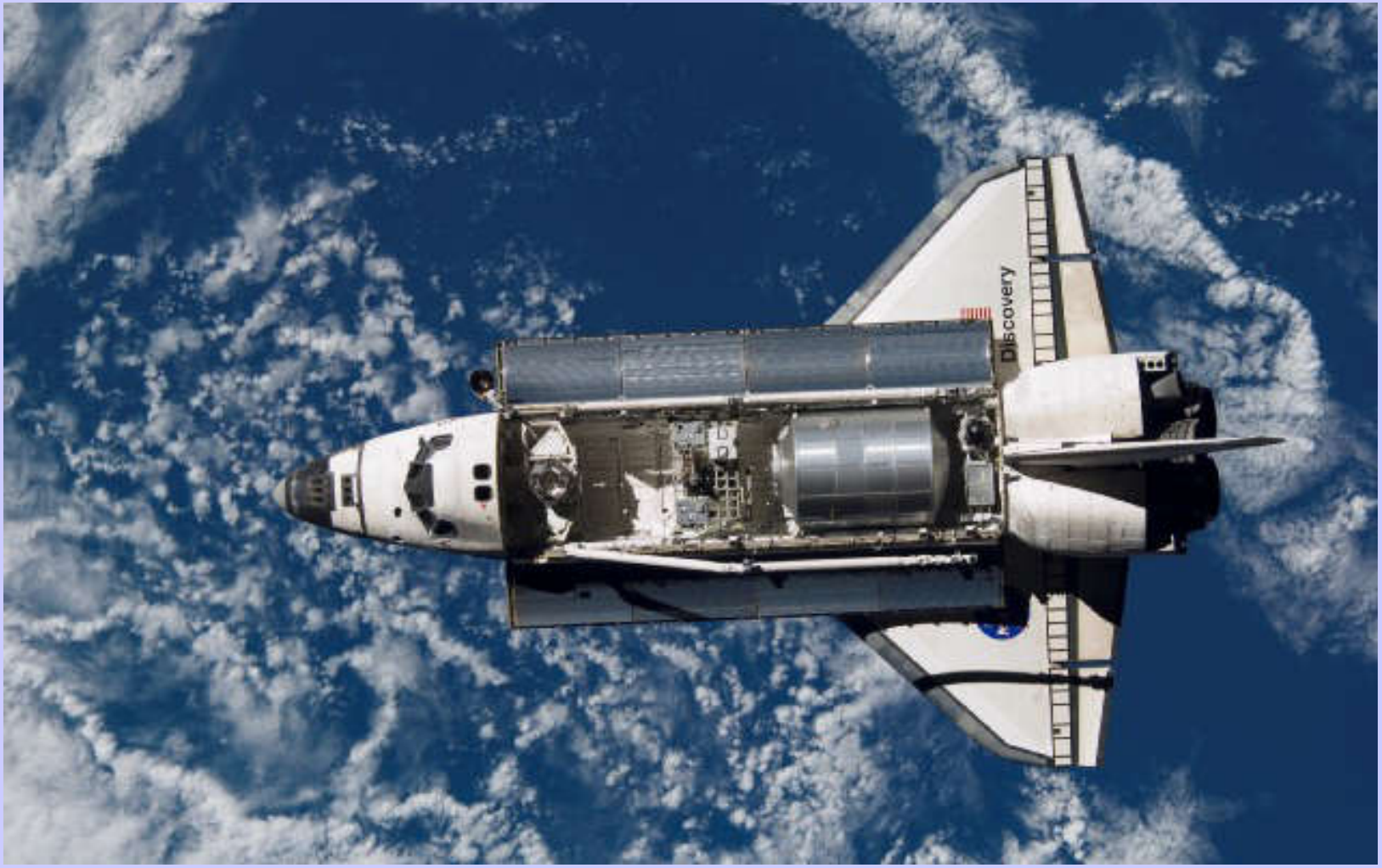


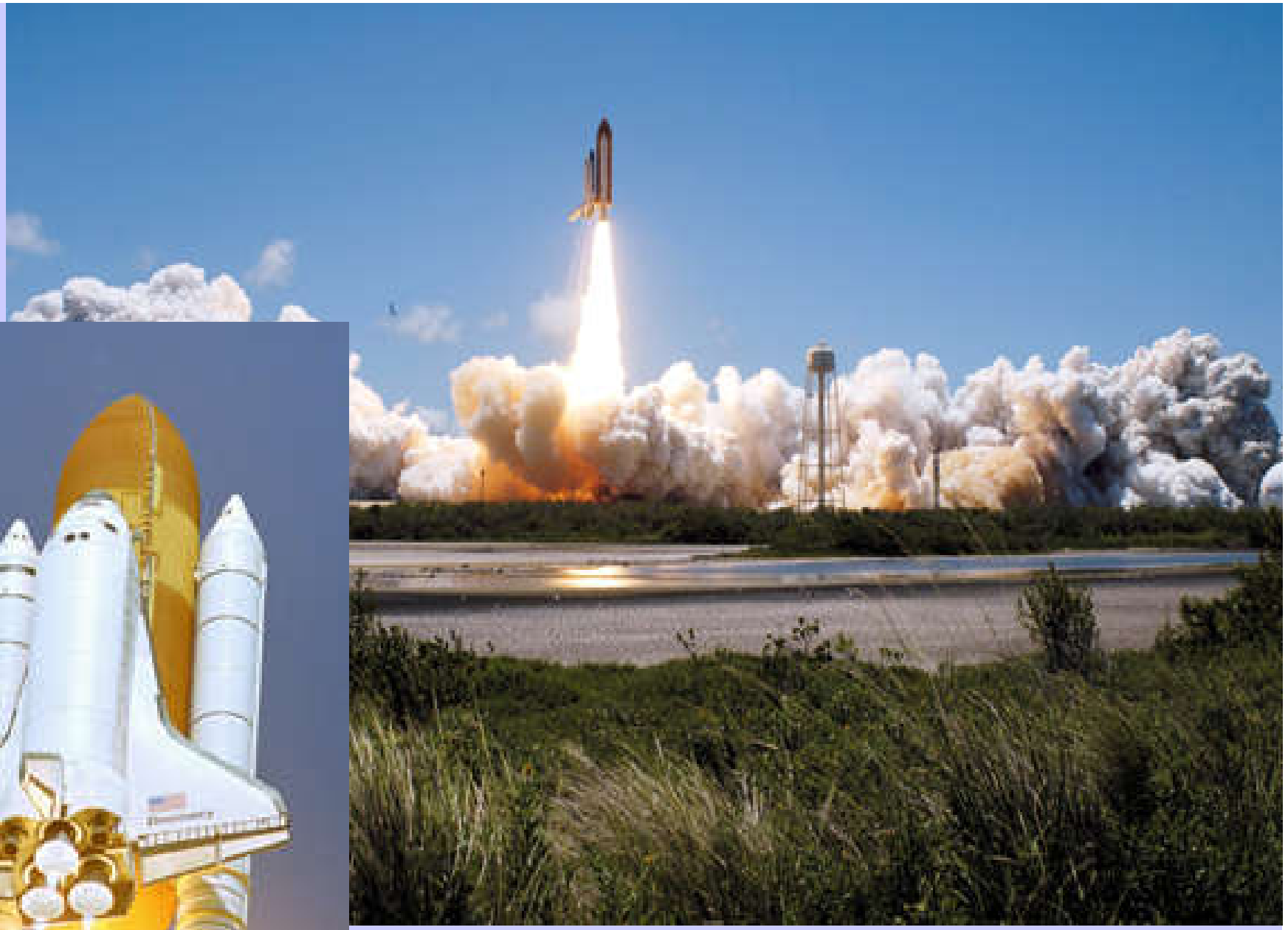

Brussels seen by Sentinel-1A radar

Space Shuttle: with a reusable orbiter,

the multi-purpose vehicle

24,4 t in LEO – 14,4 t back from space





Since 2000 : Soyuz-ISS-Space Shuttle… & Shenzhu

- For scientific and technological permanence around our planet (international crews of 6 monts)

  Russian modules/laboratories + Soyuz (Roscosmos)

  American modules/laboratories + Space Shuttle (NASA)

  & telerobotic arms (Canada)

- Tragic return of Columbia on 1st February 2003

- **Facility used at an international scale until 2024…**

  Columbus laboratory + Automated Transfer Vehicle (ESA)

  Kibo laboratory + Kounotori/H-II Transfer Cehicle (Japan)

- **Third player in manned spaceflight : China** with Shenzhu since October 2003

EVA with MMUin 1984

EVA to rescue Intelsat satellite in1992

Reusable Orbiter (Space Shuttle) weakened by two accidents:
Challenger (at launch) and Columbia (during the return)

Retirement after 135 flights
from April 1981
fo July 2011
30 years de services!
2 tragedies

Atlantis **au NASA Kennedy Space Center**
Discovery **au Smithsonian NASM**
Endeavour **au California Science Center**

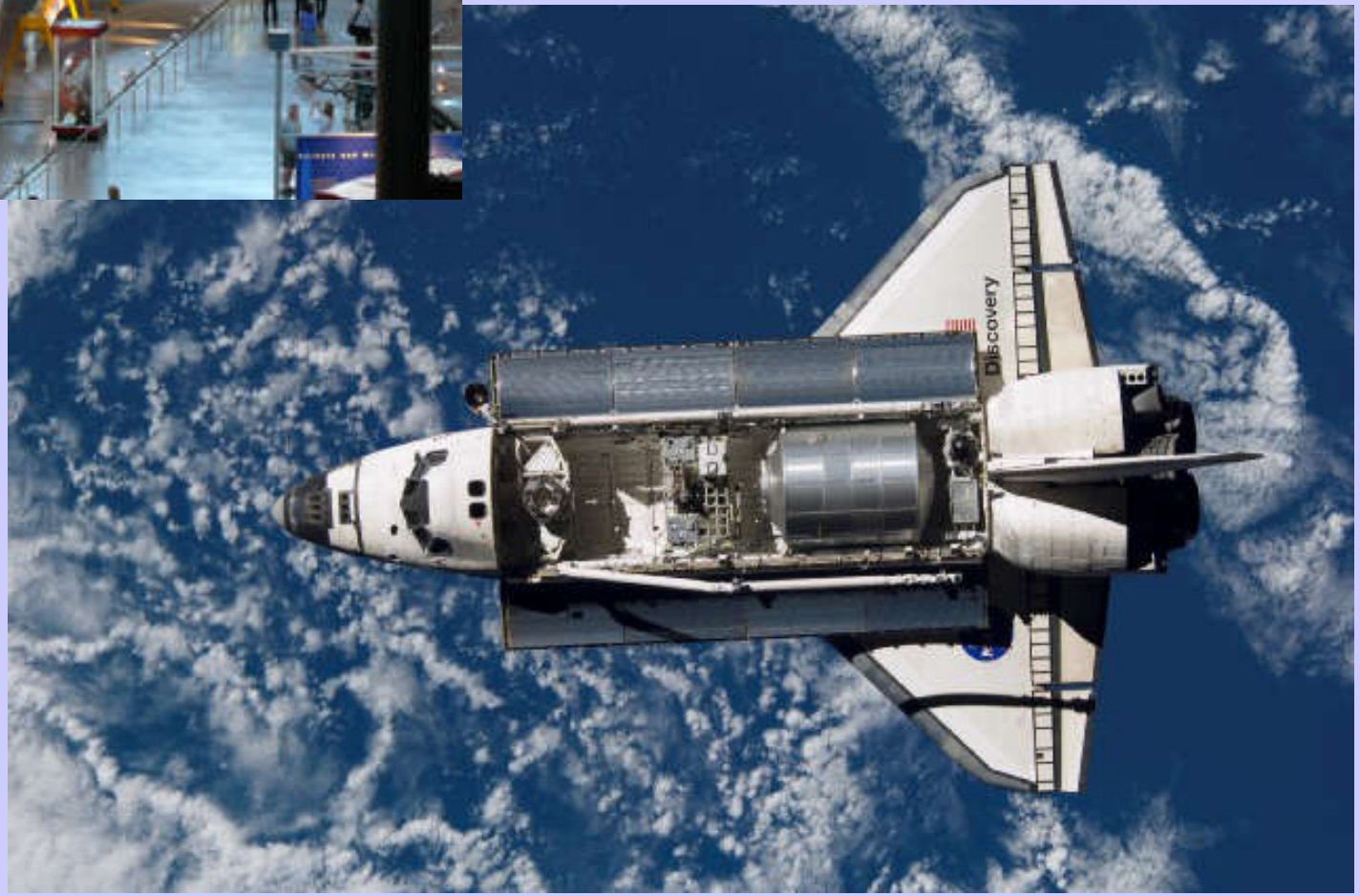
Cooperation with NASA

for Spacelab inside the Space Shuttle

(module, pallets, « made in Belgium » igloo)

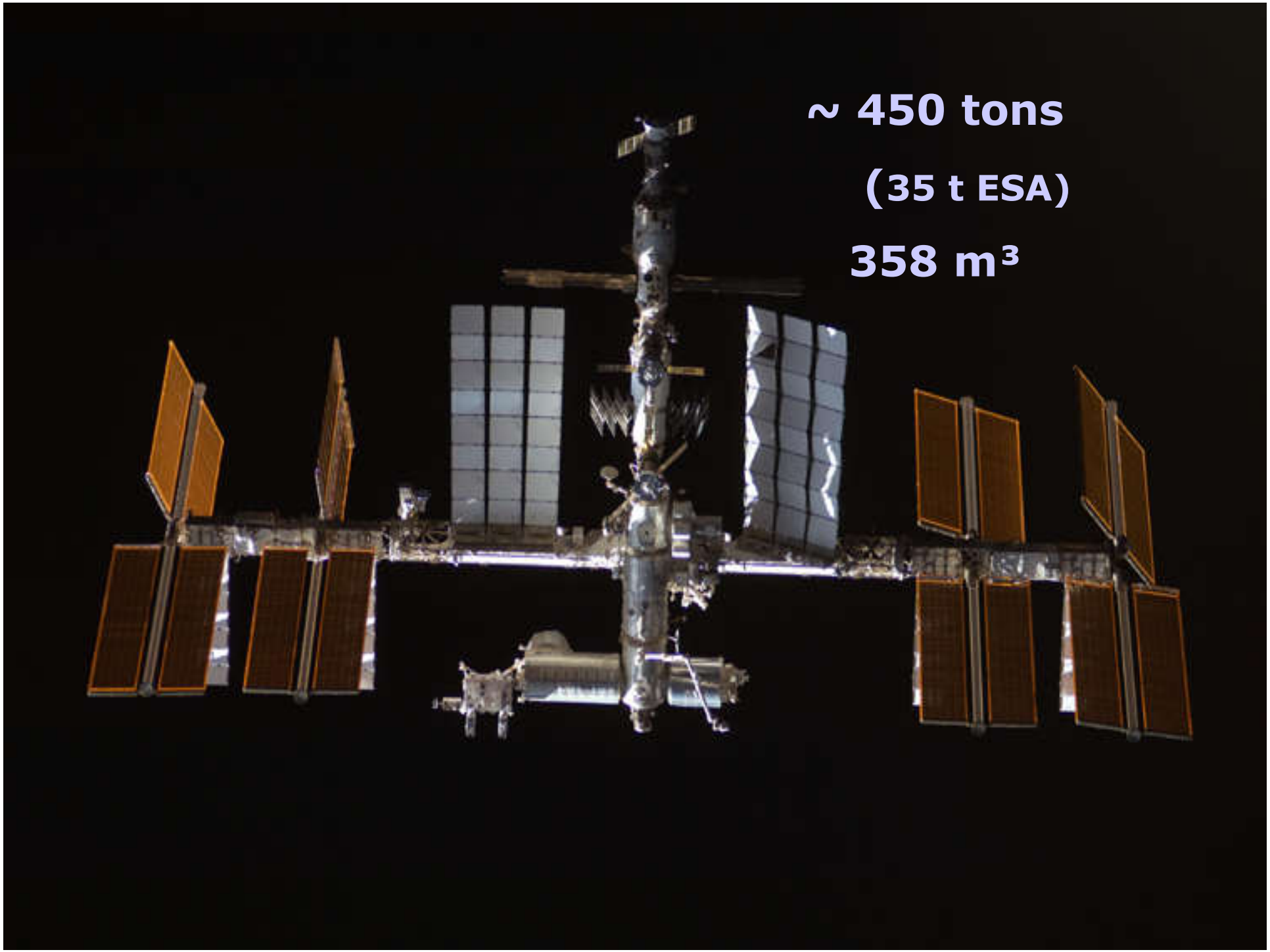
Reusable laboratory elements developed by European industry

(SABCA Brussels, as igloo manufacturer)



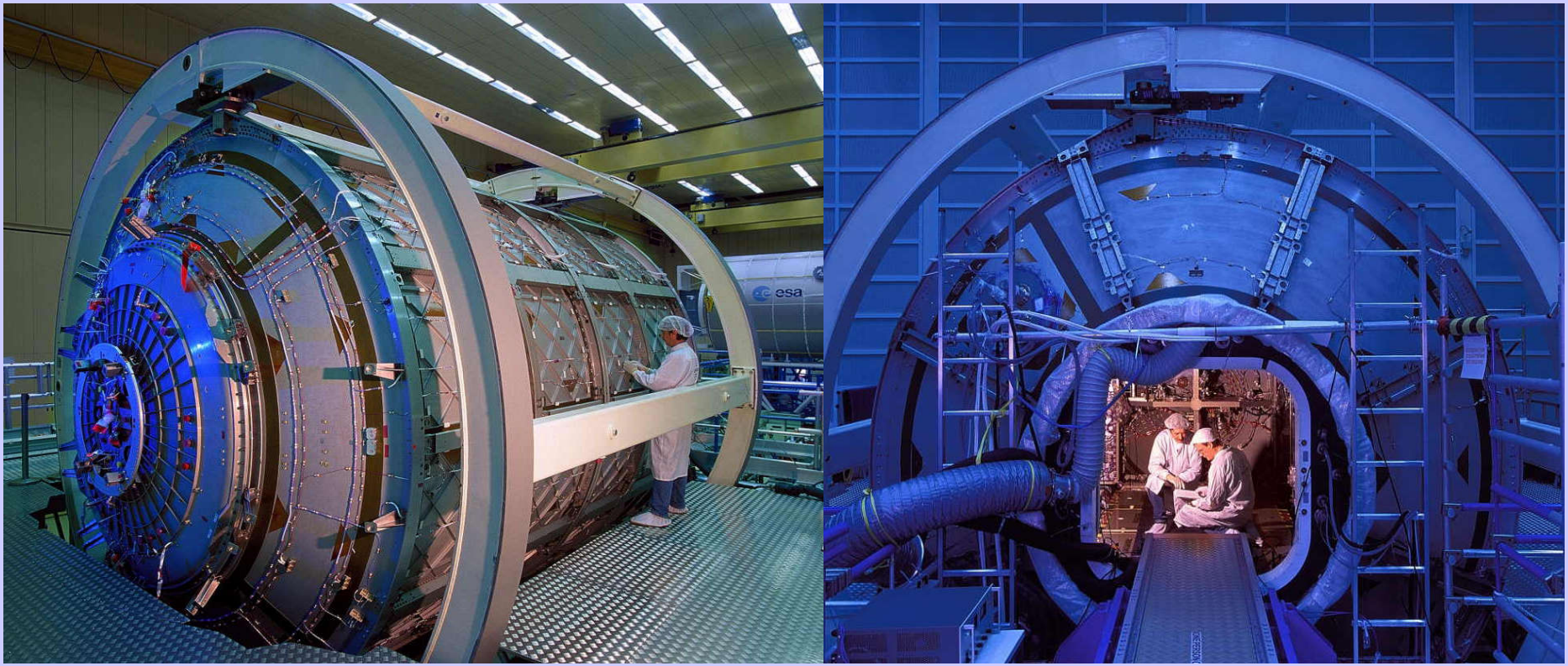
Dirk Frimout, Belgian engineer & physicist , born in 1941

Mission ATLAS-1
/Atlantis
(March-Avril 1992)
8 days, 22 hours


~ 450 tons
(35 t ESA)
358 m³

Europe and ISS (International Space Station):

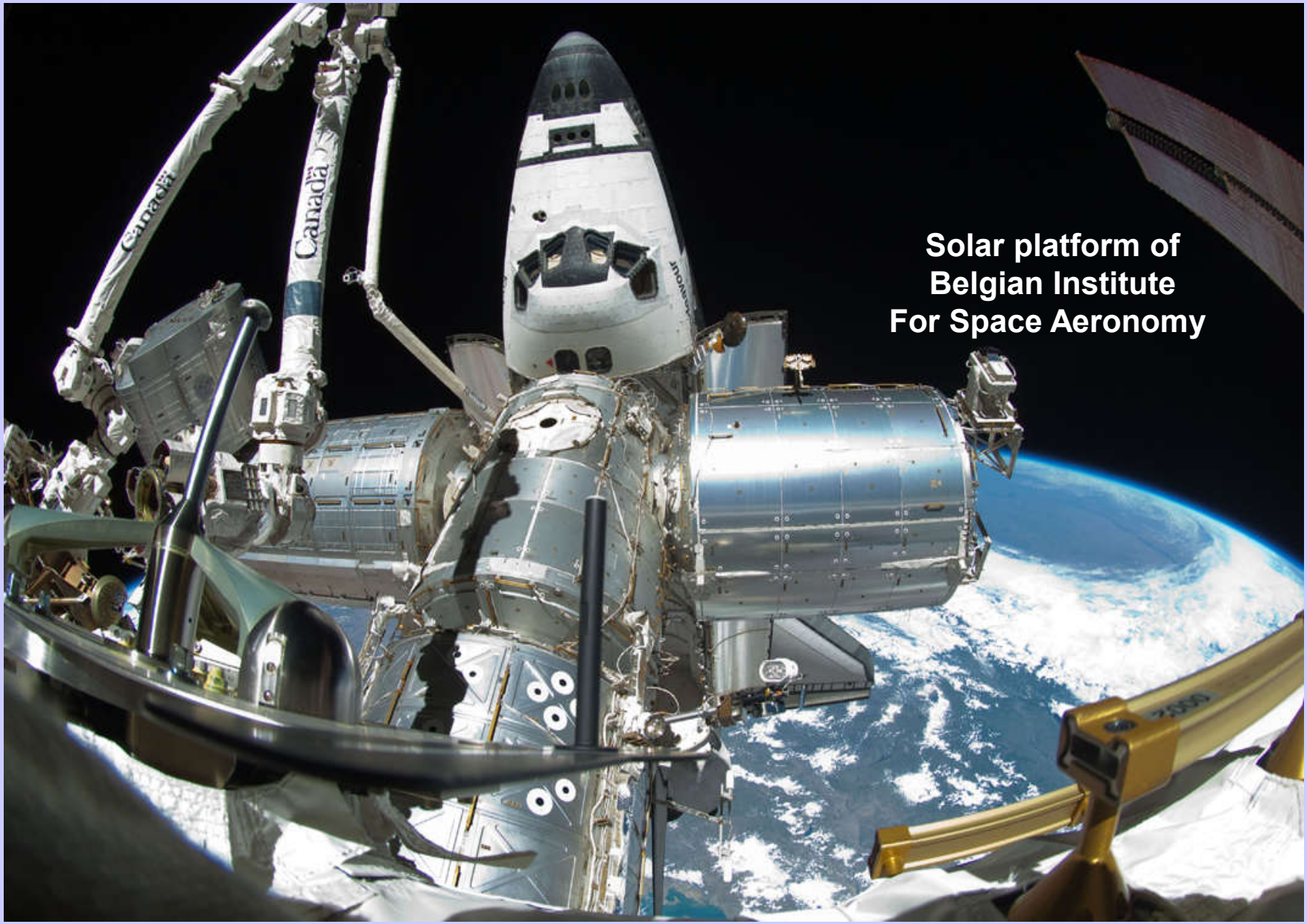
Columbus multi-purpose laboratory installed on the U.S. part in February 2008

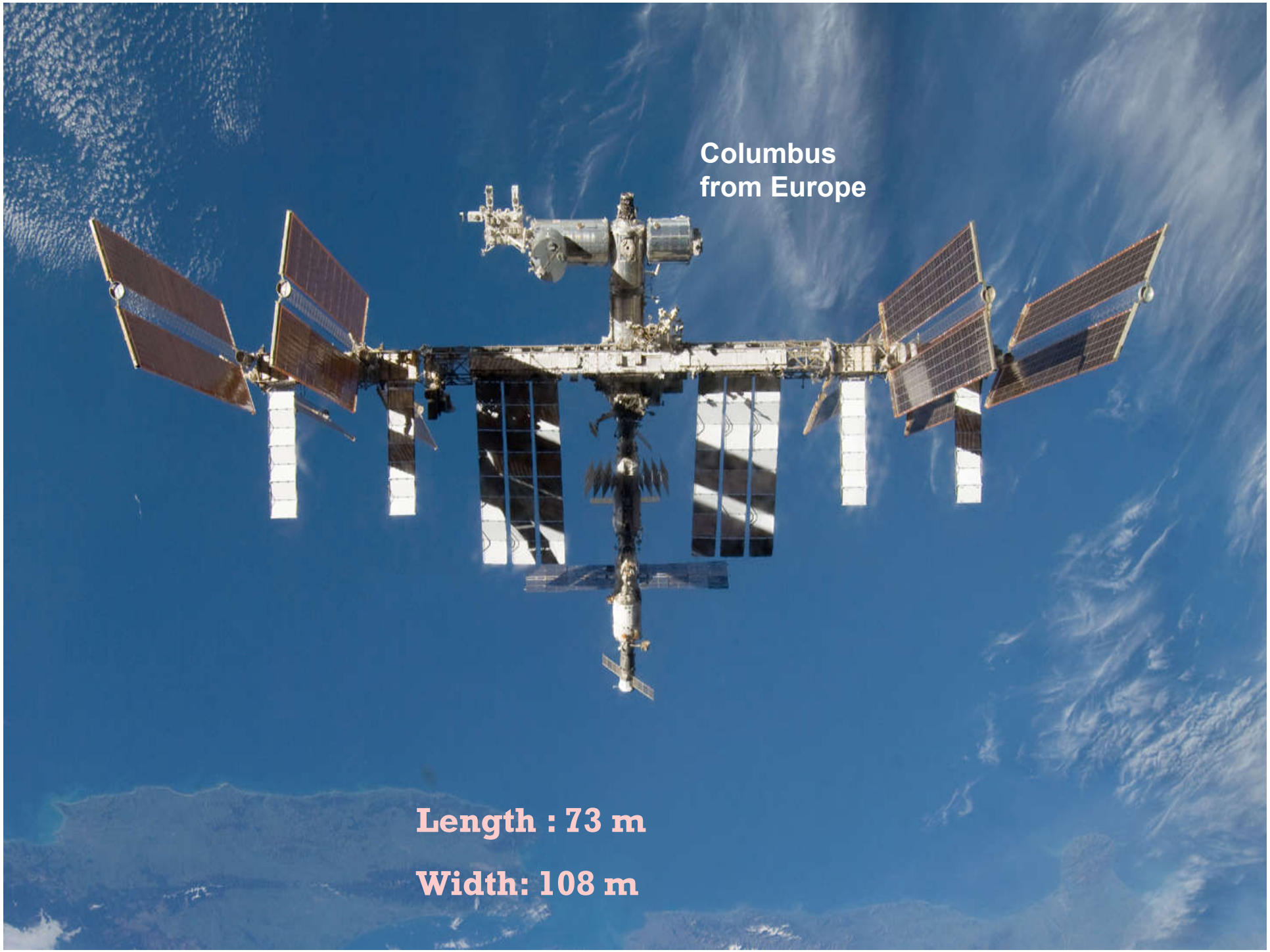


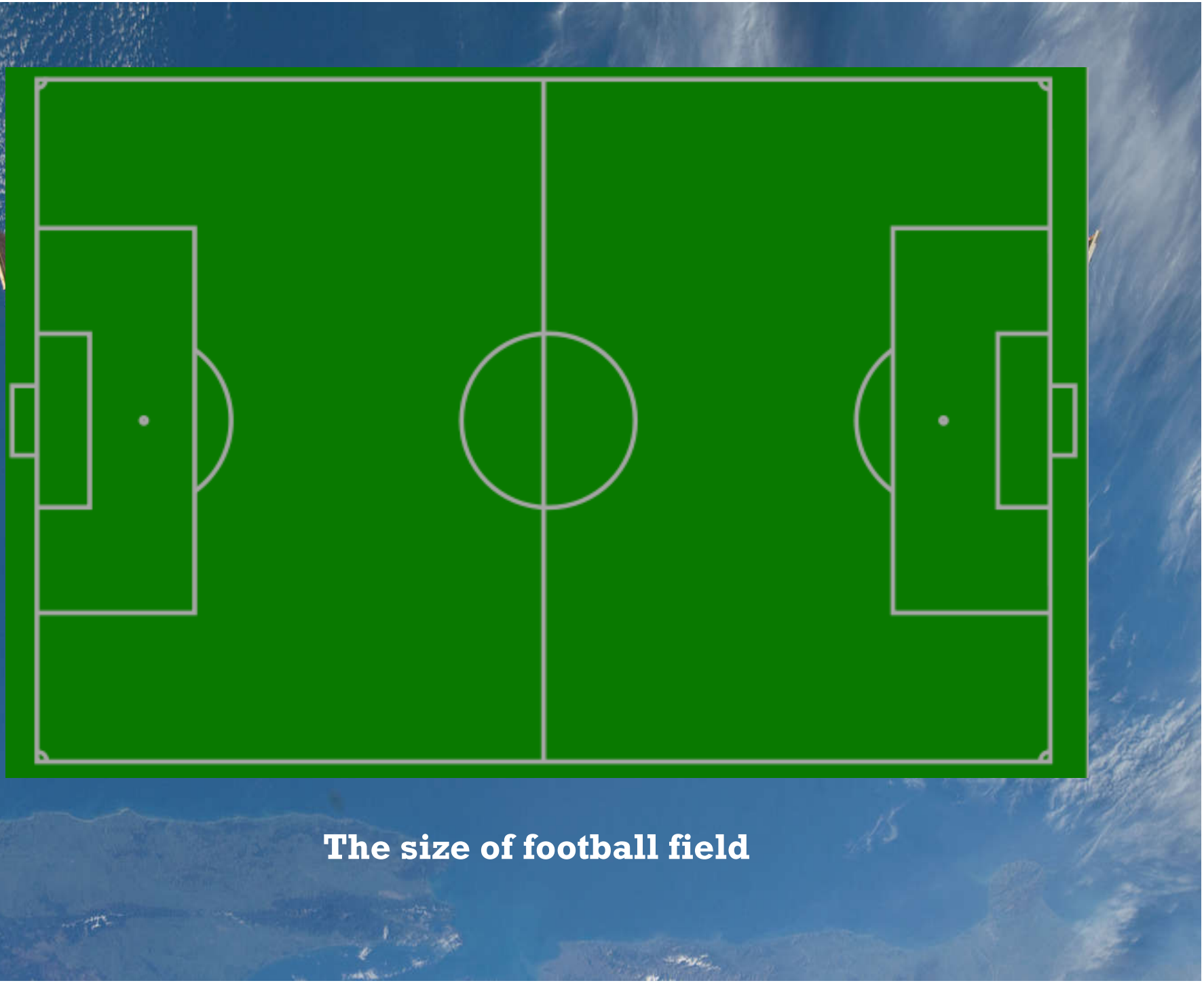

Columbus
from Europe


Sonaca
for protective shield


esa


Canada
Canada
Solar platform of
Belgian Institute
For Space Aeronomy


Columbus
from Europe
Length : 73 m
Width: 108 m



The size of football field

27 may 2009 start at Baikonur of the 3rd spaceflight with Belgian citizen
(Frank De Winne for 2nd mission in ISS)

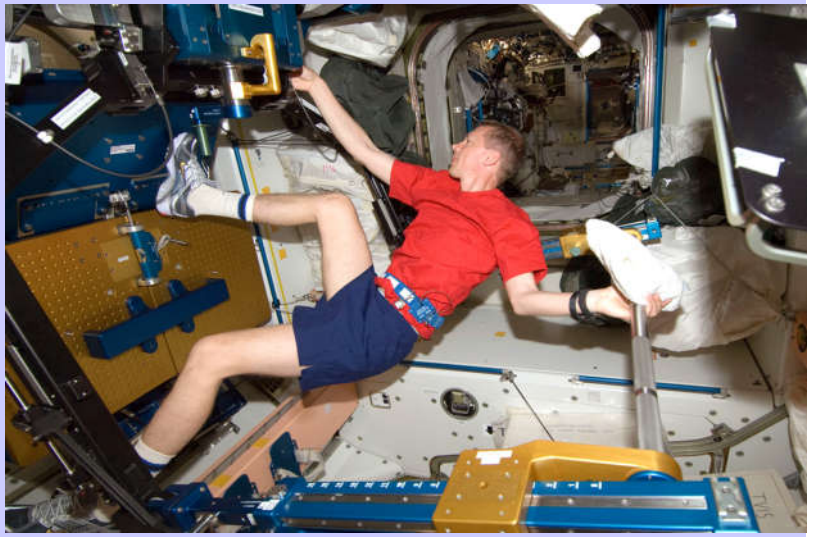
From June to Decembre 2009 : ISS with a permanent 6-people crew

Frank De Winne, first European – non-Russian, non-American –

ISS commander from mid-October to late November 2009

July 2011 : retirement of the Space Shuttle = changes of crews with Soyuz

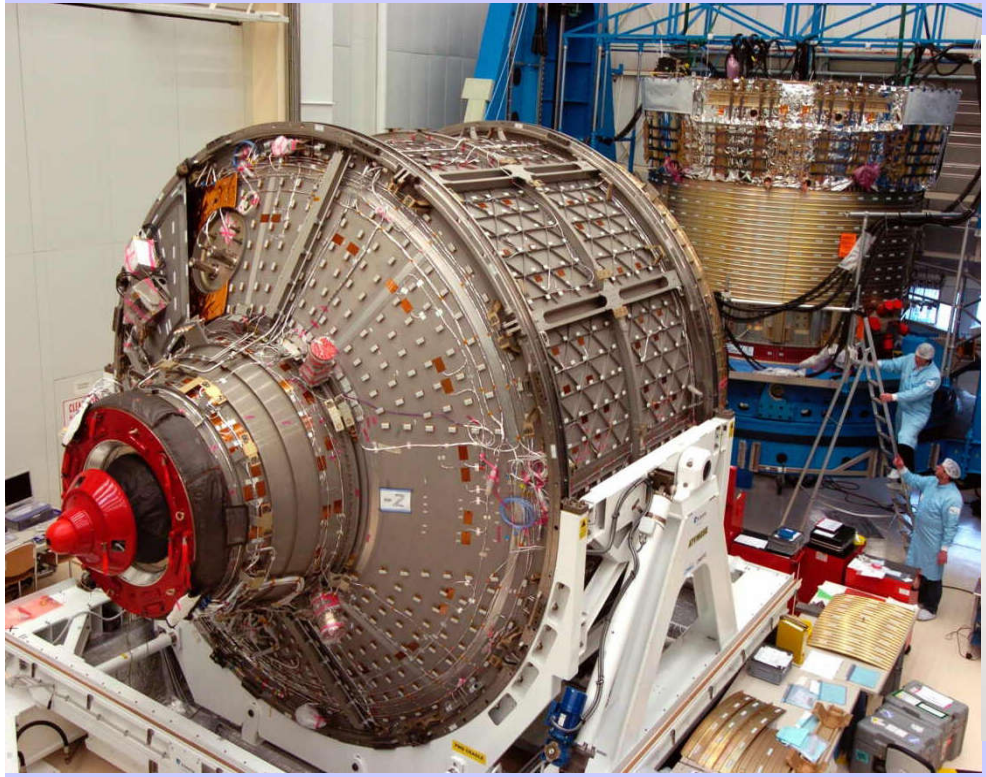
May-November 2009: a Belgian in space
for a long-duration spaceflight (6 months in ISS)



Europe & ISS: ATV (Automated Transfer Vehicle)

- first ATV in 2008: « Jules Verne »

- last & 5th ATV in 2014: « Georges Lemaître »

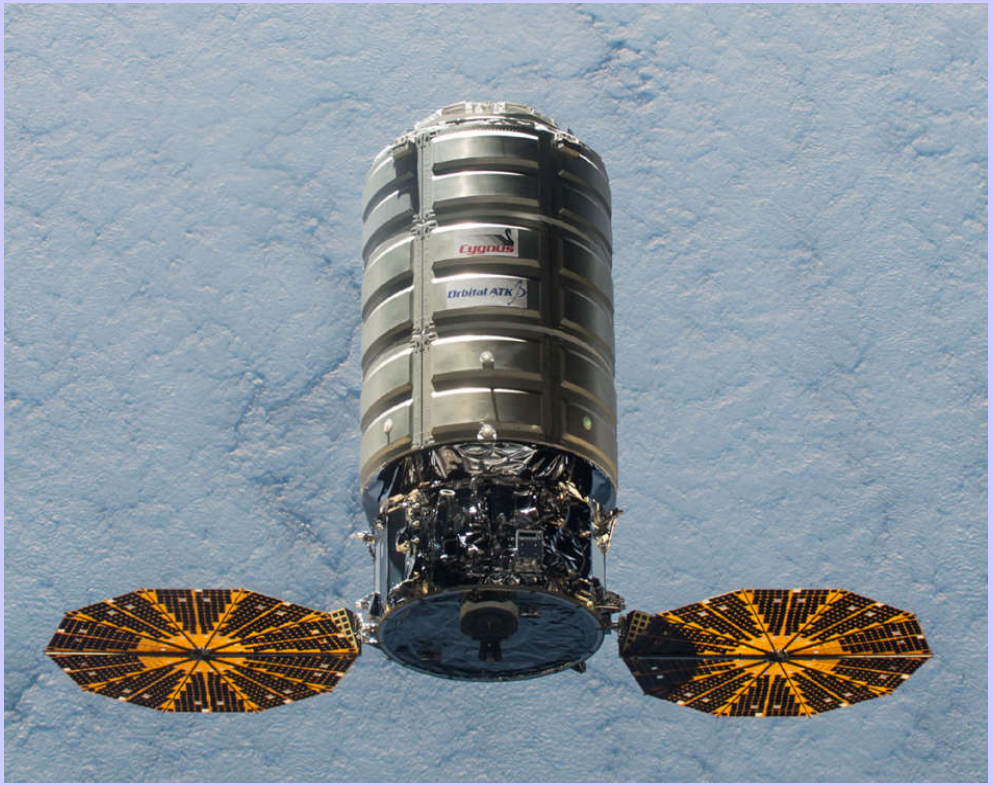


Dragon/SpaceX, private cargo vehicle for ISS :

1st flight in May 2012 - payload: 3 t up/1,5 t down

Cygnus/Orbital ATK, private cargo vehicle for ISS :

1st flight in Septembre 2013 - payload : 3,5 t



NASA preparing the next decade

- **Orion for the Artemis :**

  Apollo-type manned spaceship (developed by Lockheed Martin)

  for first flight in automated mode in 2021

  for missions around the Moon in 2024?

- **SLS (Space Launch System) :**

  a family of heavy launchers

  derived from Space Shuttle technology

  1st flight planned in 2021 (Artemis-1)

2021 : MPCV Orion

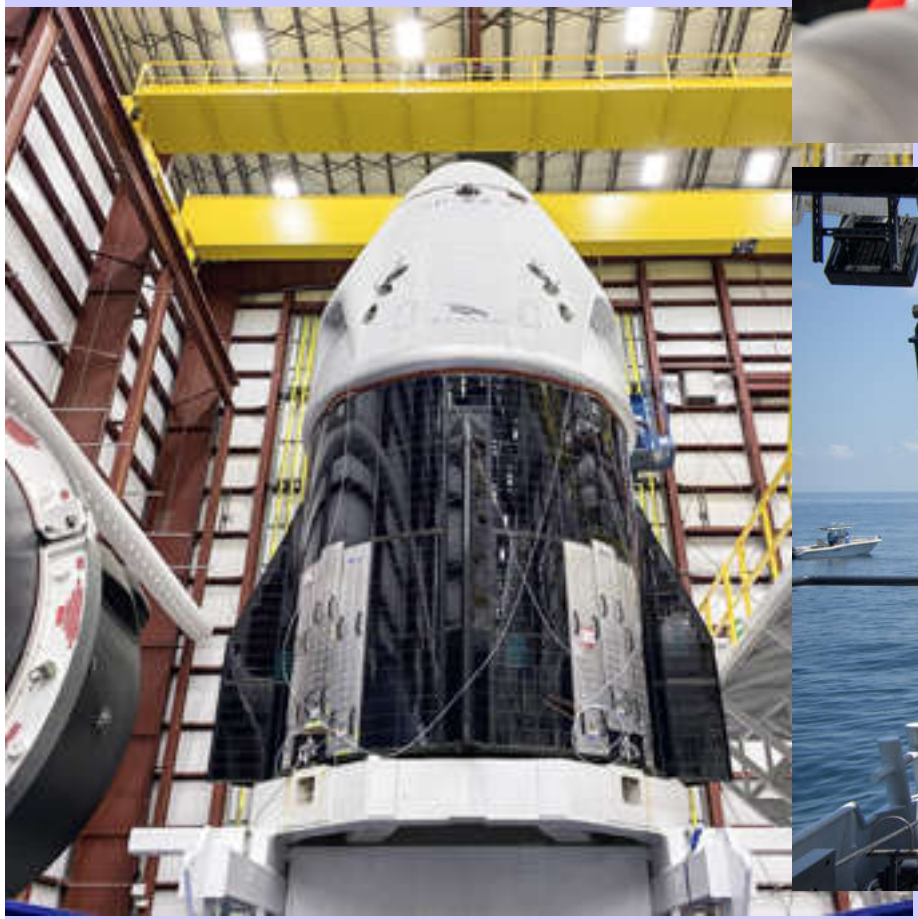
(4 people)

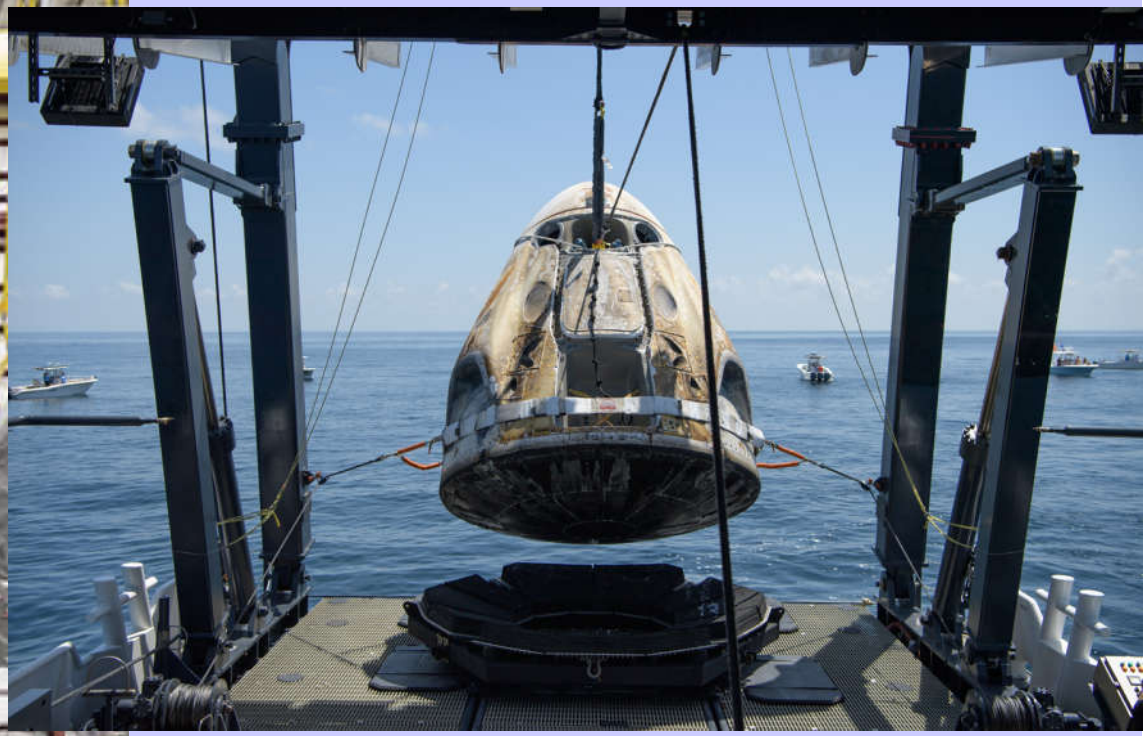
with « made in Europe » service module

for deep space exploration

Crew Dragon of SpaceX

1st test flight in 2019,
1st manned flight to ISS in 202

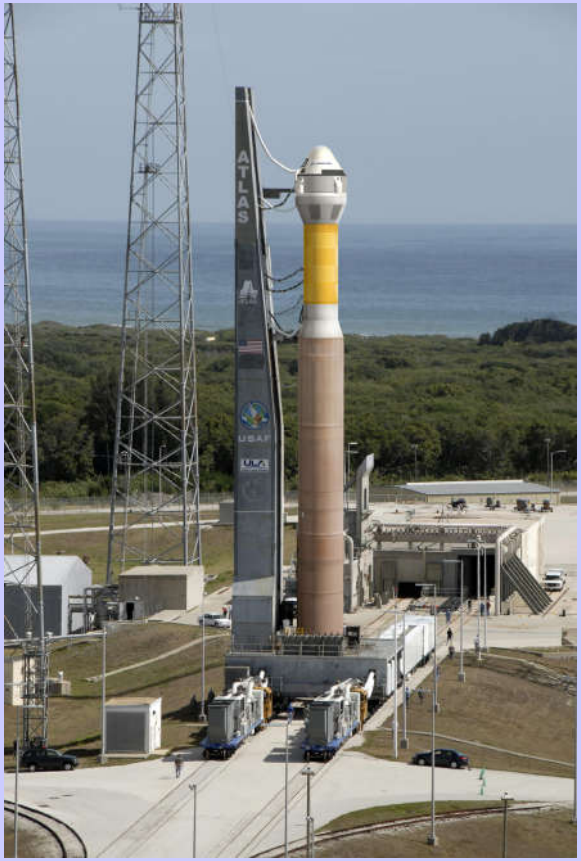




CST Starliner of Boeing

1st test flight in 2019

1st manned mission in 2021



Space technology in Belgium : a booster for the high-tech industry

- ~ 2 000 direct employment
- ~ 200 millions €

1 employment = ~ 100 000 €

Wallonie Espace:

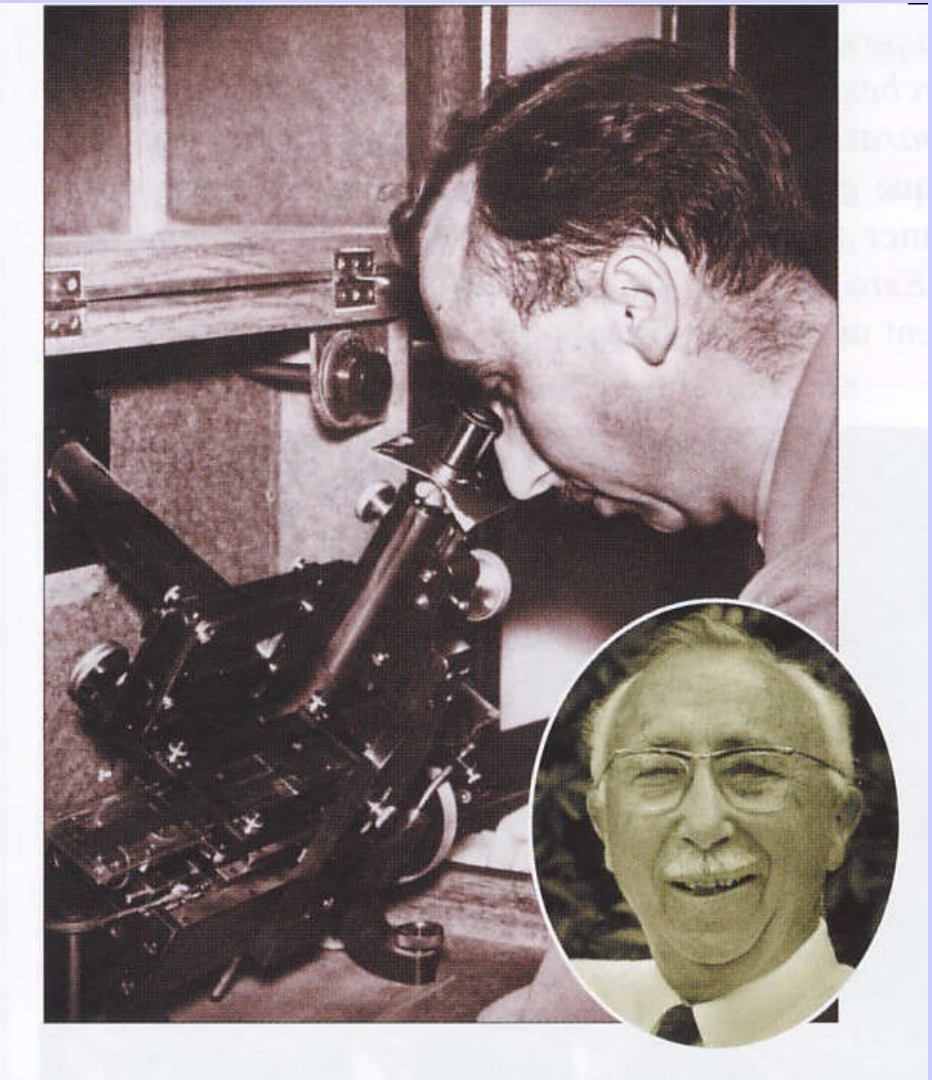
- Liège : LMS Samtech/Siemens, WSL, GDTech, Deltatec

- Walloon Brabant : Aethis (Louvain-la-Neuve), Cegelec (Nivelles), Euro Heat Pipes (Nivelles), Lambda-X (Nivelles), Rhea Systems (Wavre), UCL (Louvain-la-Neuve)

- à Brussels : ULB, Ecole Royale Militaire, SABCA.

CSL : worldwide expertise for optical systems and for vacuum tests

Space systems took shape at Liege
At the initiative of **Pol Swings** (1906-1983)
a ‘father’ of sky spectroscopy and space science in Europe

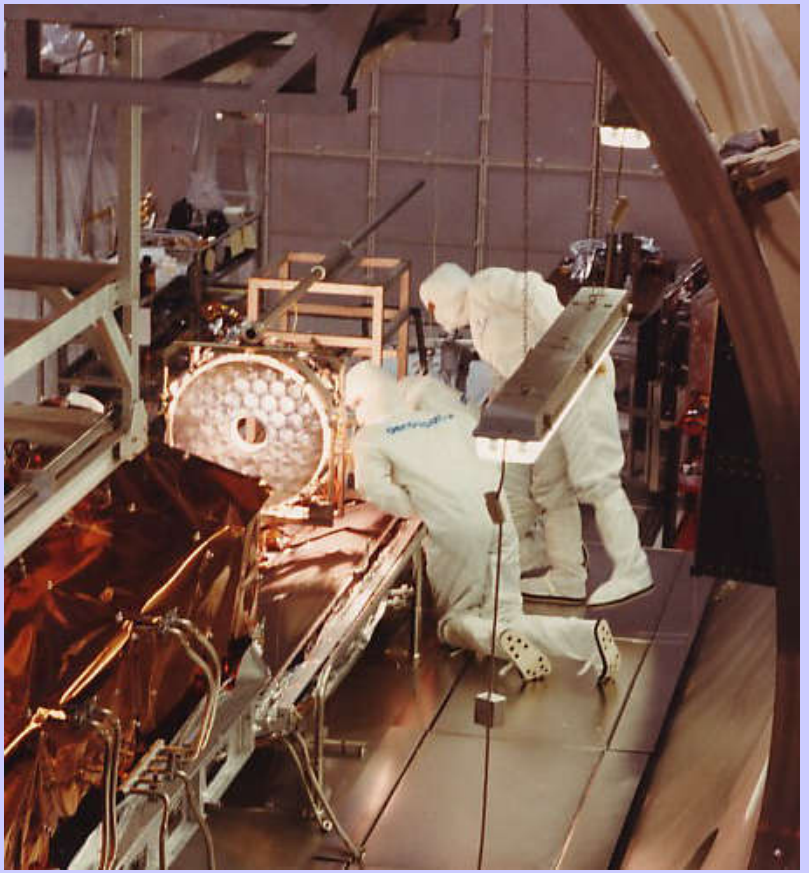


TD-1, first Astronomy satellite of Europe (1972-1973):

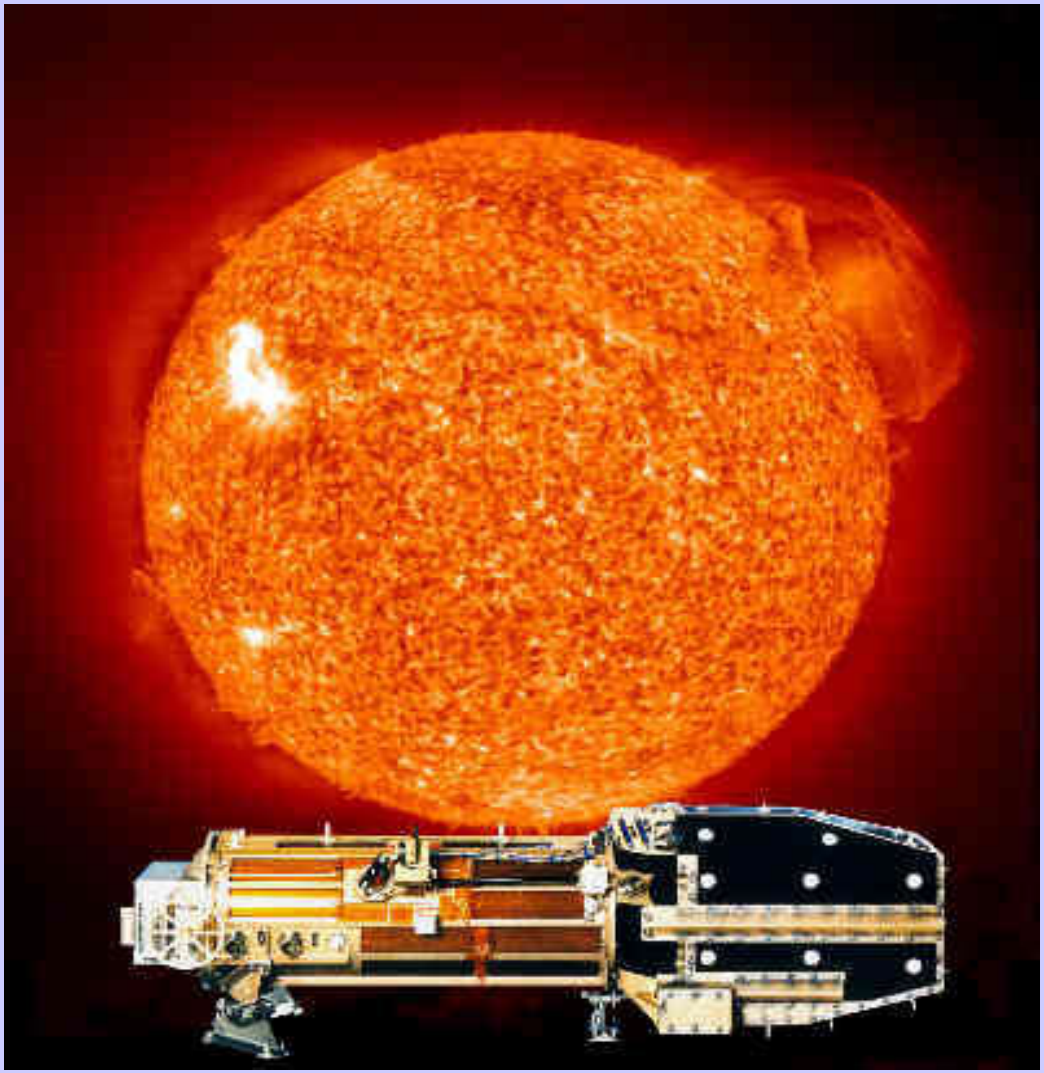
main instrument -UV telescope – was developed and tested at University of Liège by the team of Prof. A. Monfils, who created the CSL (Centre Spatial de Liège)

WALLONIE ESPACE

CSL : simulation of space environment to qualify opto-electronic systems for observation satellites (astronomy, astrometry, meteorology, remote sensing,…)



Our star permanently monitored by EIT/SOHO, Extreme UV imaging telescope born at CSL



WALLONIE ESPACE

The number 1 of Belgium in space !

Thales Alenia Space Belgium (ETCA), since1963 **:**

spacecraft electronics (integrated circuits, power units, amplifiers…)

QinetiQ Space (ex-Verhaert) : Belgian integrator of space systems

Prime contractor of « made in Belgium » PROBA microsats with Spacebel for IT software (onboard, ground)

PROBA-1 launched by Indian PSLV in October 2001 and still working for earth observations!

PROBA: “made in Belgium” microsatellites

The PROBA spacecraft are test & research microsatellites which are part of ESA GSTP (General Support Technology Programme)

They are the smallest observatories launched by ESA: they play a significant role in the development of new systems for large satellites

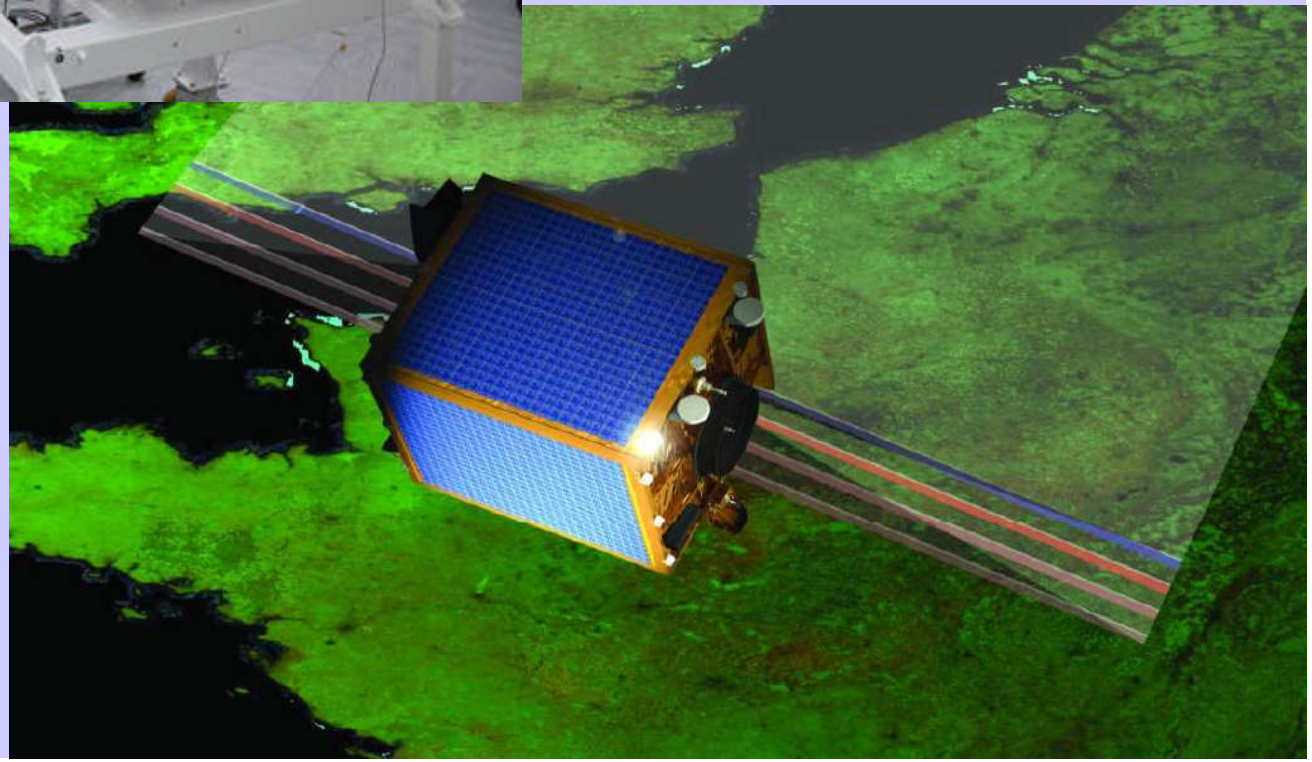
Proba-1 (2001–) – Earth observations
Proba-2 (2009–) – Sun observations
Proba-V (2013-) – Vegetation monitoring

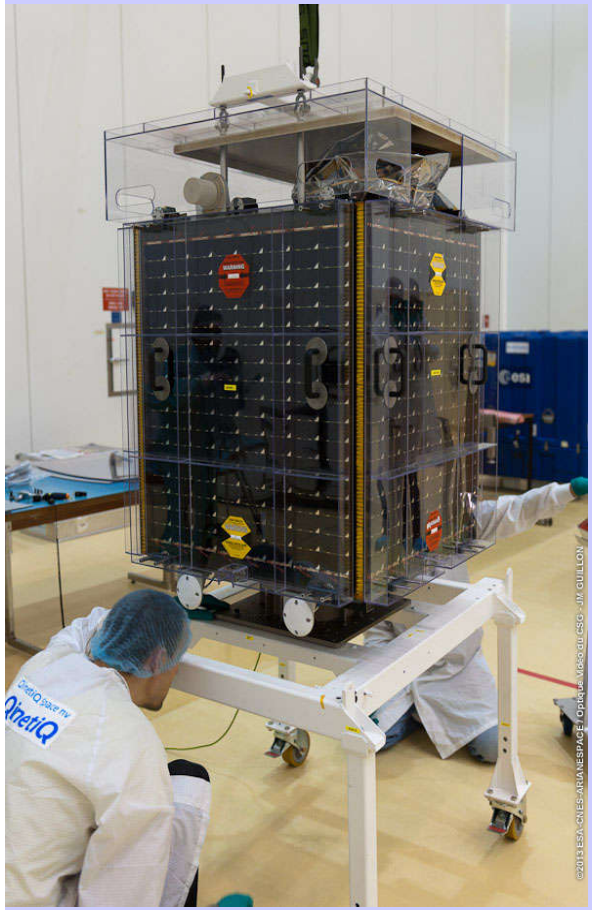
All three are still functioning in orbit!

PROBA-V(egetation)
130 kg, size of washmachine

Controlled by ESA Redu Center
Images processed by VITO (Mol)

Global planisphere of the vegetation, every two days !

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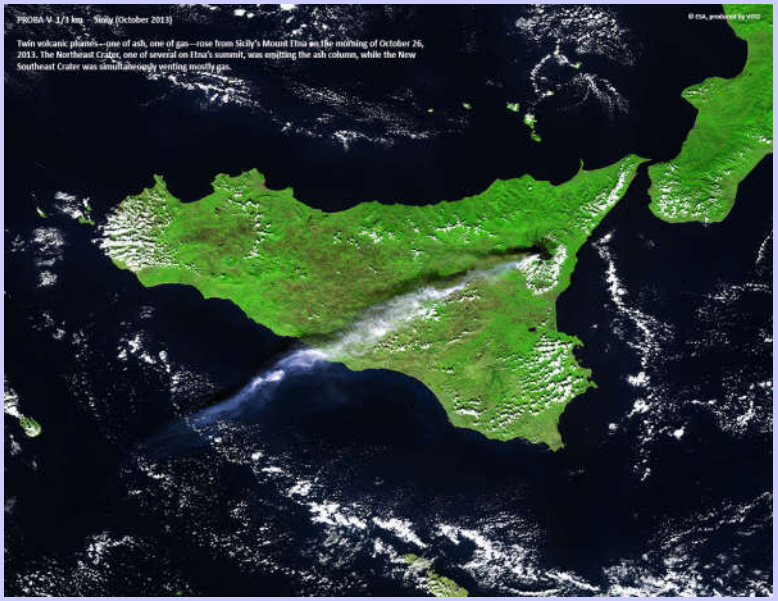
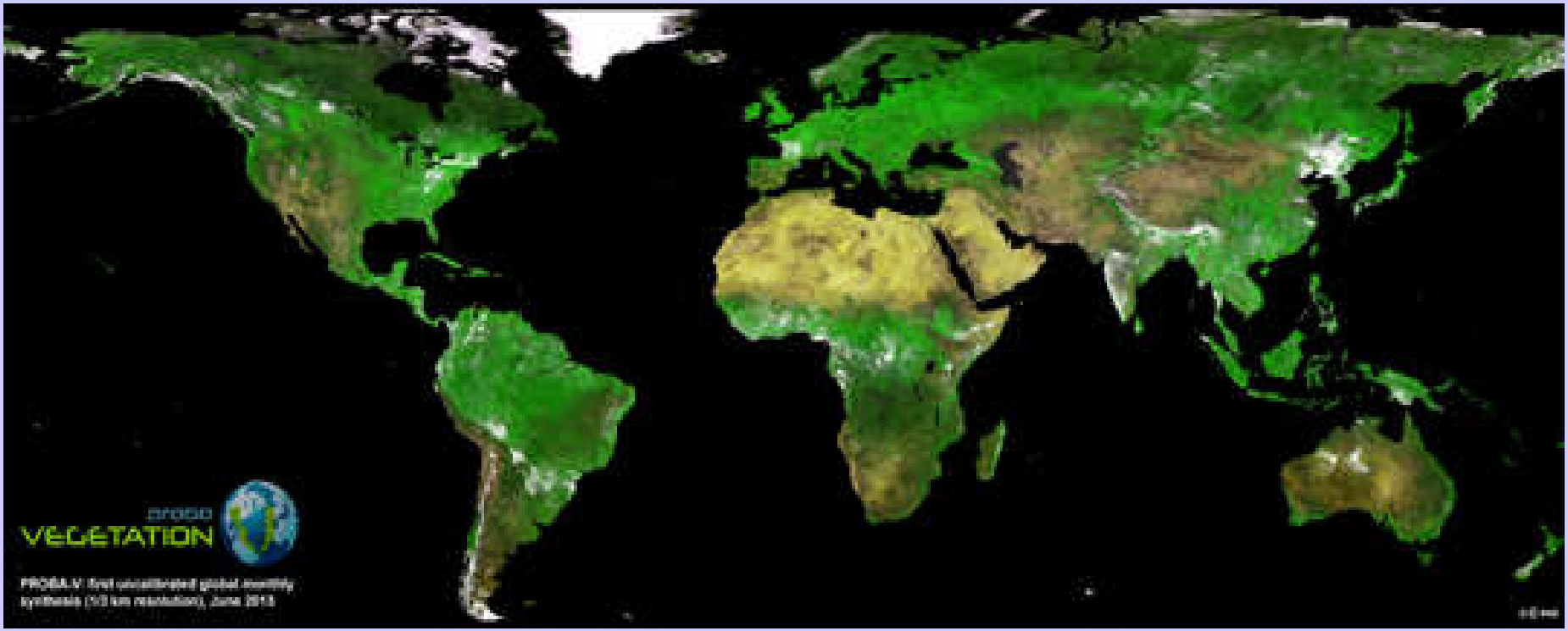
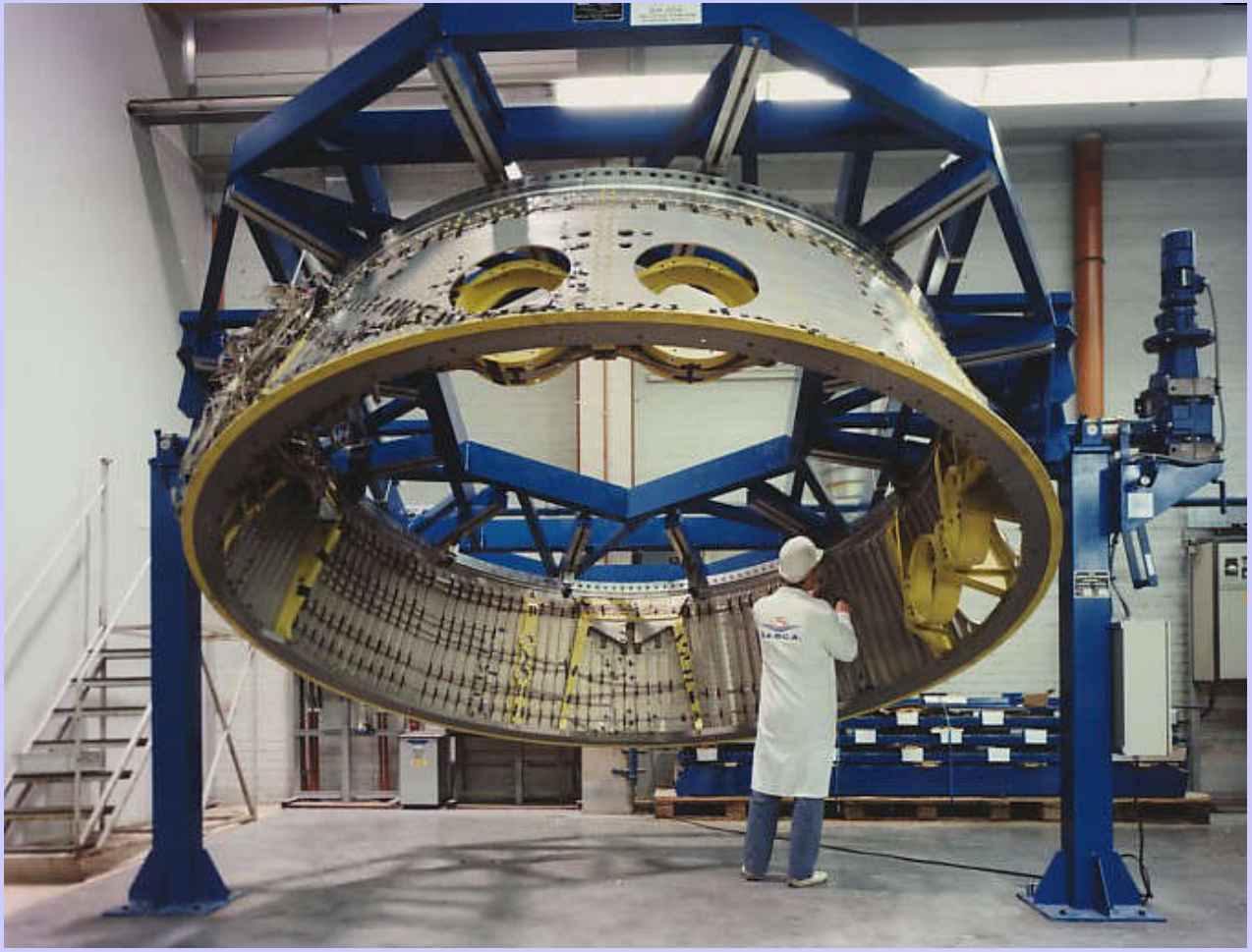
esa
arianespace


PROBA-V: 1/3 km – Sicily (October 2013)
Twin volcanic plumes—one of ash, one of gas—rose from Sicily's Mount Etna on the morning of October 26, 2013. The Northeast Crater, one of several on Etna's summit, was emitting the ash column, while the New Southeast Crater was simultaneously venting mostly gas.

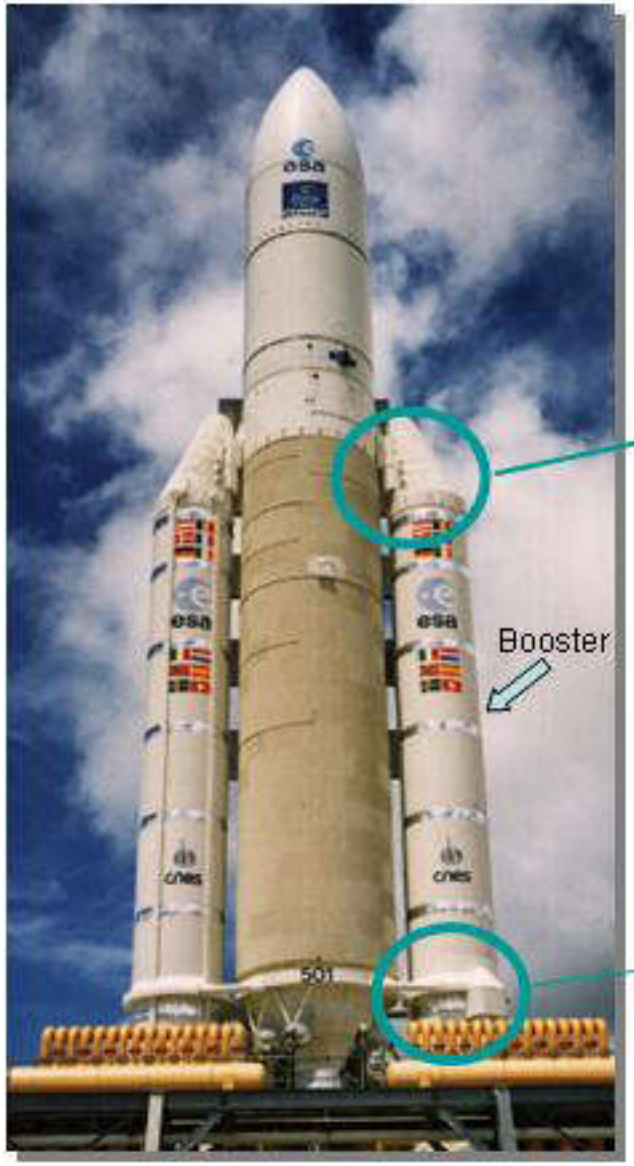

VEGETATION
PROBA-V: first uncalibrated global monthly synthesis (10 km resolution), June 2013

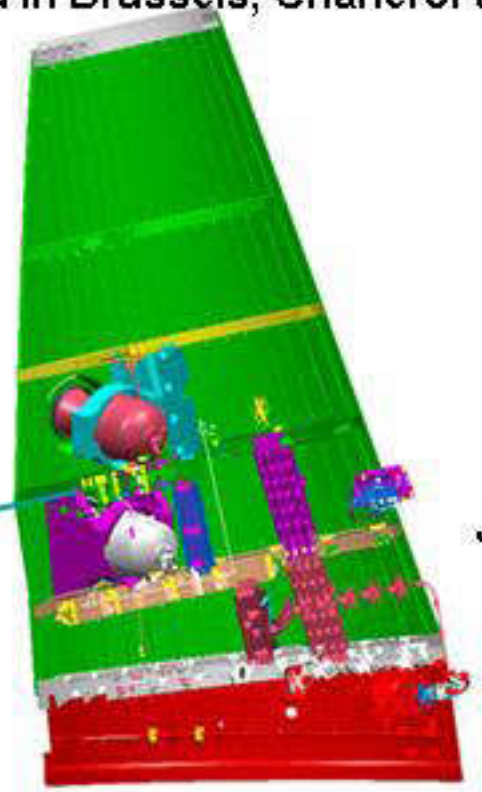
SABCA meeting the challenges of Ariane 5 key elements

structure of each booster on the core stage

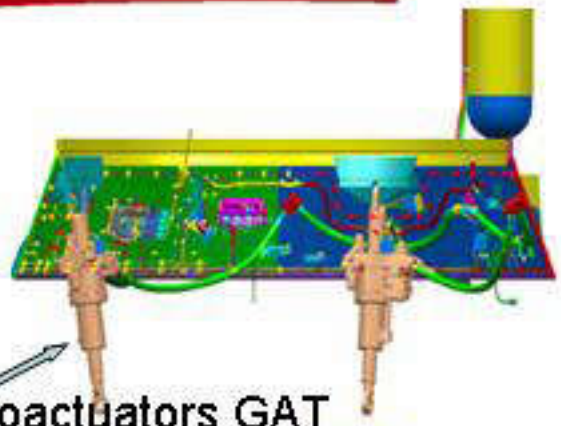


Equipments designed by S.A.B.C.A. and manufactured in Brussels, Charleroi and Lummen





JAV



JAR

Servoactuators GAT

S.A.B.C.A.

SABCA expertise in electro-mechanical actuators for Vega

Safran Aero Boosters, at Herstal-Liège

Specialist of cryogenic engine valves for Ariane :

for the Vulcain and Vinci rocket motors
(main piece made by Britte-Mustad, Alleur)

Sonaca, à Gosselies-Charleroi :

Design & manufacture of delicate structures for space systems,

Like Pleïades HR remote sensing satellites for France

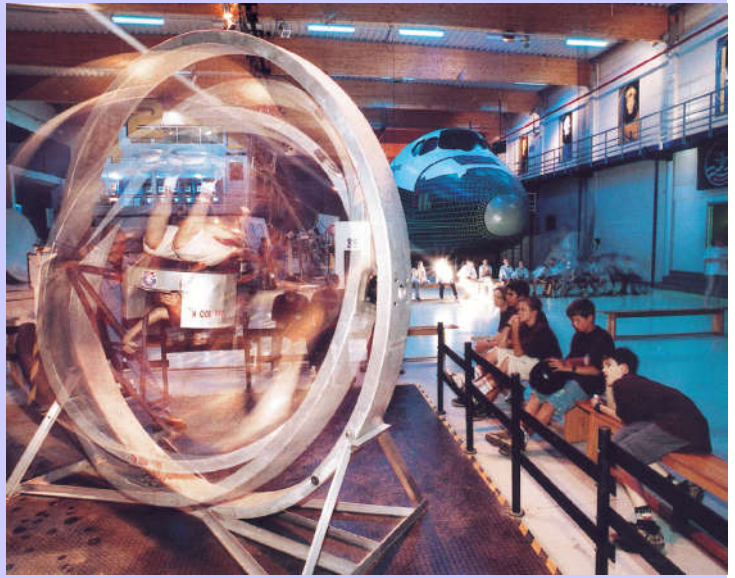
Pleïades HR

ESA Redu Center
(since 1968)
at Redu-Libin
(Province of Luxembourg)

Now **ESEC**
(European space Security & Education Centre)

ESA Redu Center becoming ESEC (European space Security & Education Centre) for 50th birthday

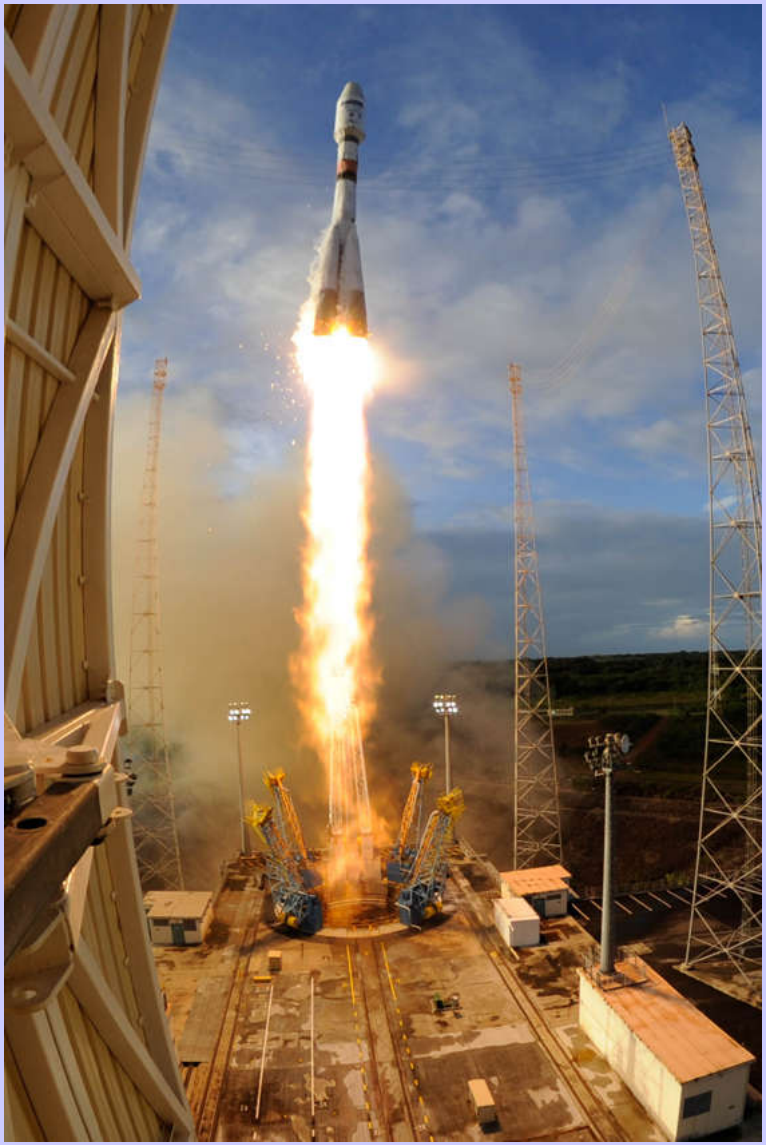
1972: Expo Space at Redu (~20 000 visitors)
1992: opening of Euro Space Center at Transinne



ULiege developed the first Walloon nanosatellite OUFTI-1 (1 kg)

Launched on 25 april 2006 in the framework of ESA Programme Fly Your Satellite

Signals received during 12 jours, but mission not achieved for the radio-amateurs



The best example of a great success in space : the Grand Duchy Luxembourg (GDL)

the small State has « more space »
in the geosynchronous arc at 36.000 km over the equator

- **SES** [Société Européenne des Satellites]

  established in March 1985, with headquarters and technical facilities at Betzdorf Castle, with back-up facilities at ESA Redu Center

- **Operating a global fleet of 49 geosynchronous satellites**

  for digital communications, HDTV broadcasts, broadband links…

  (up to 5 in construction for launches in the next three years!)

- **Implementation of the O3b constellation**

  (20 Ka-band satellites in MEO for broadband mobile connections
  + 7 O3b mPower with 4000 beams for 1 Terabits links)

- **Some 2 billion € of revenues en 2015**

  (~100 millions € of taxes for the Luxembourg Ministry of Finance)

The technical center of Betzdorf Castle

NewSpace: the private enterprise taking over the public establishment

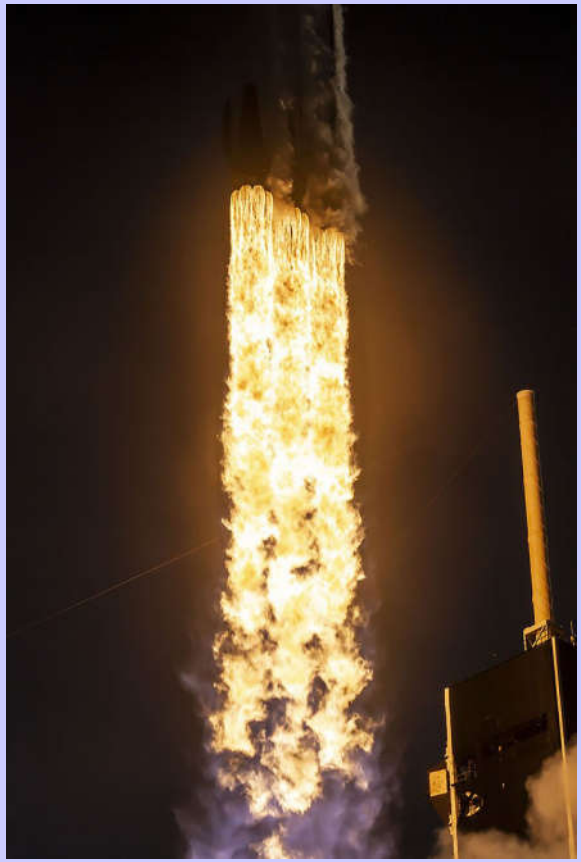
- Micro- & nano-technologies allowing low-cost systems
- Reusable launchers and servicing spacecraft
- Growing profits of the TIC (Technologies of Information & Communication)


SpaceX: enterprise established in 2002
Employing more than 7000 people

Our chance to be in the time of « NewSpace »

Reusable systems for the access to space

SpaceX (Elon Musk) since 2017



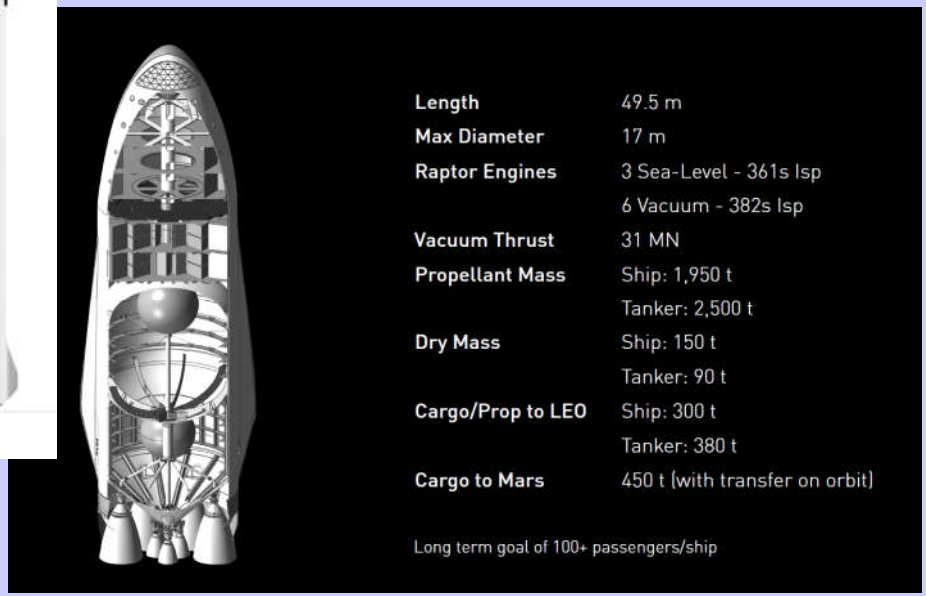
The BFR (Big Falcon Rocket) of SpaceX for the 2020's
We can dream…!

27 August 2019: first flight of the methane-oxygen Raptor engine

with the « starhopper » prototype from Boca Chica beach (Texas)

Our chance to be in the time of « NewSpace »

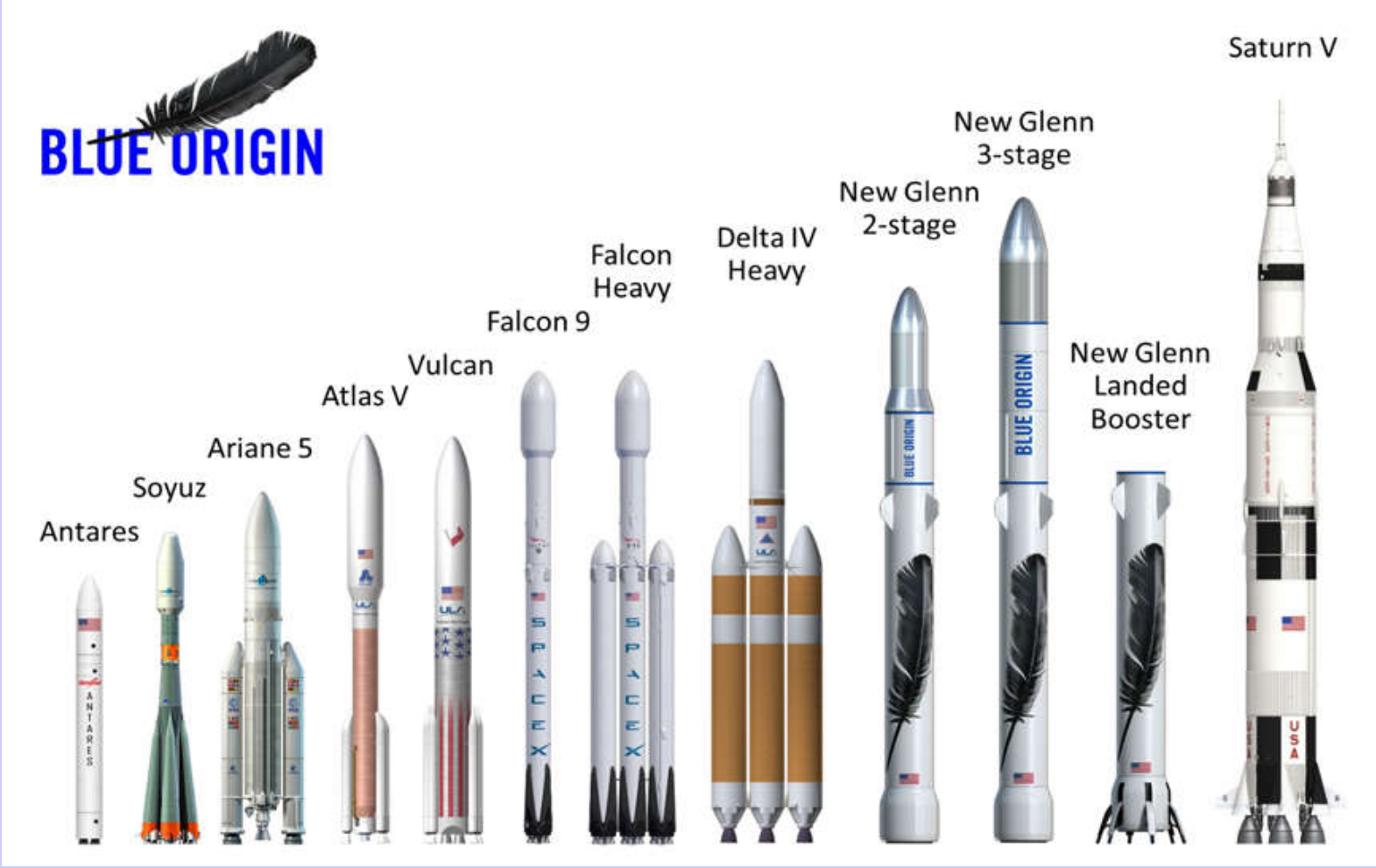
Private enterprise concerned by space exploration: SpaceX of Elon Musk



The heavy launcher
New Glenn
of Blue Origin:
1st flight planned in 2021…
from an impressive complex
at Cape Canaveral

Our chance to be in the time of « NewSpace »

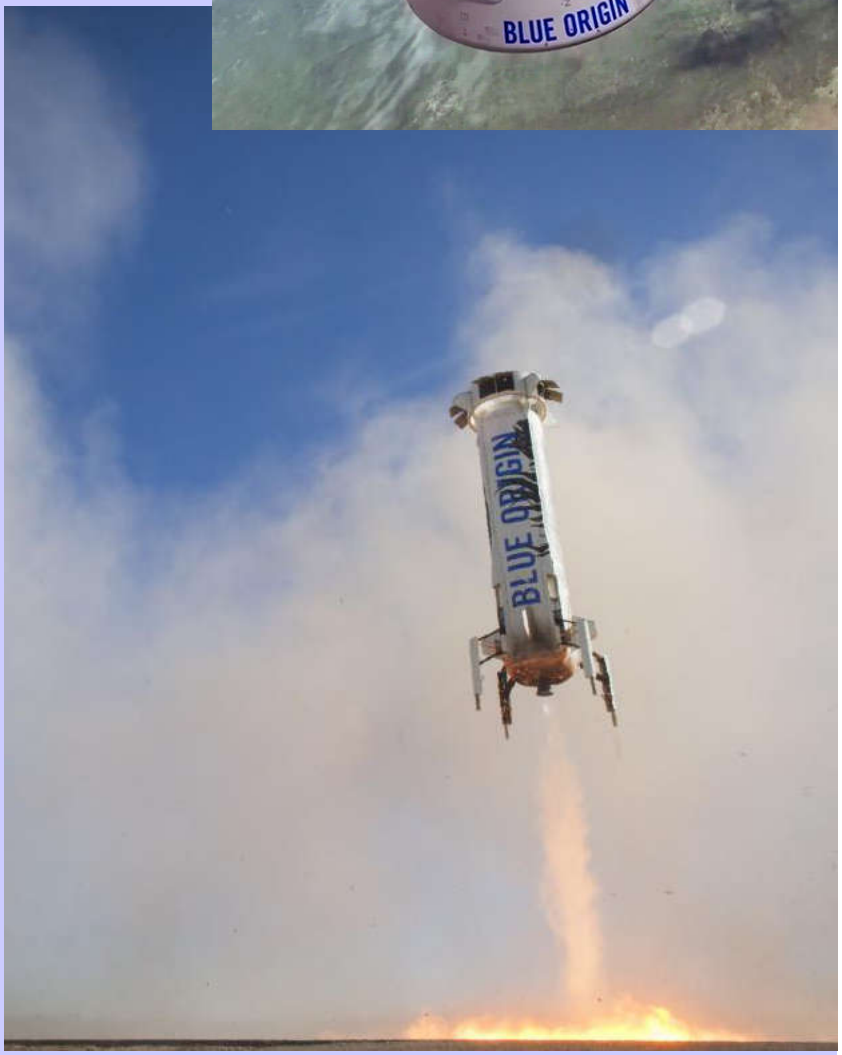
Private enterprise concerned by space exploration: Blue Origin of Jef Bezos



Innovation time with « NewSpace »

Reusable systems for the access to space

Blue Origin (Jeff Bezos) since 2016



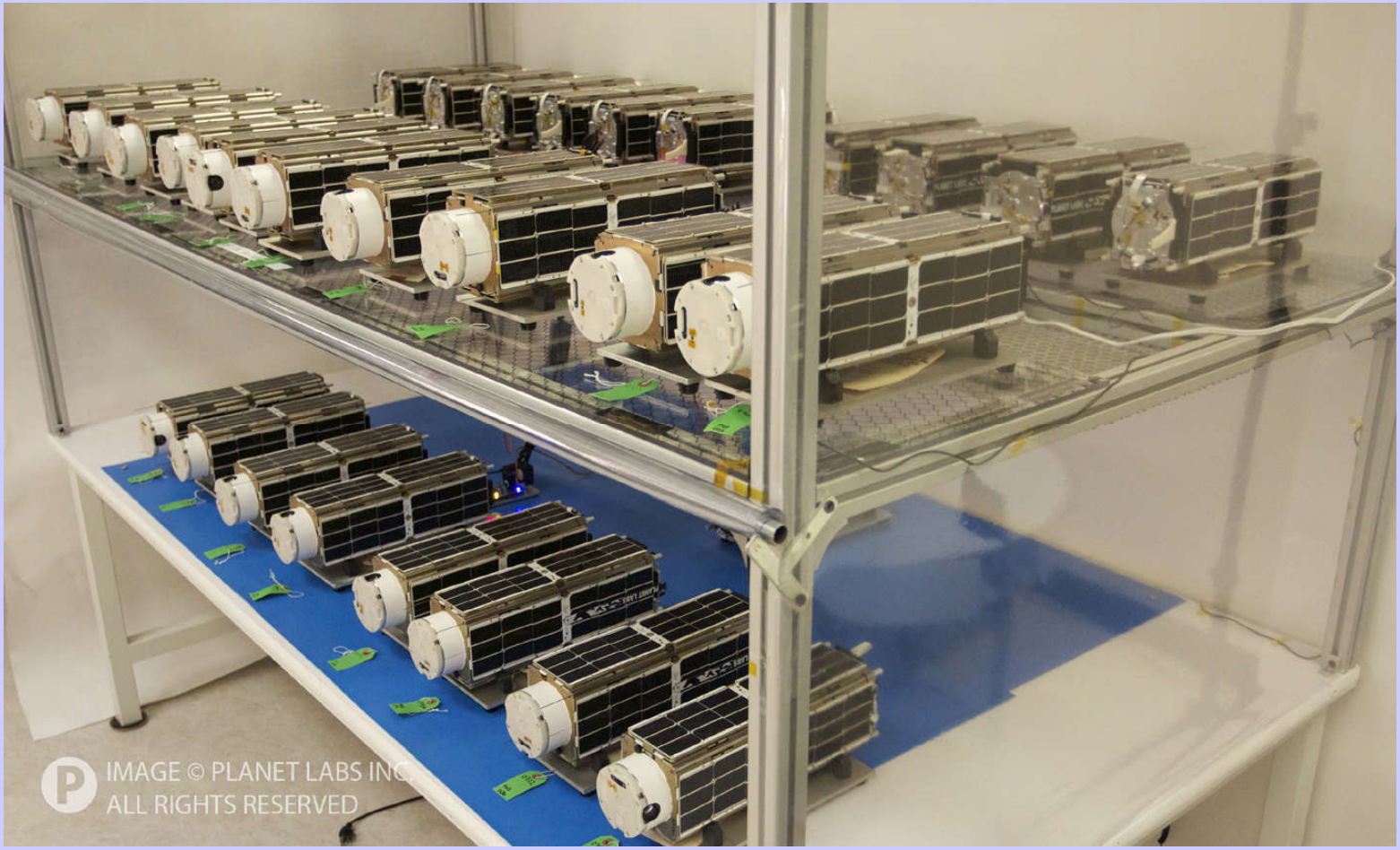
Our chance to be in the time of « NewSpace » (D)

Constellations for continuous earth observations

ICT systems (Information & Communication Technologies)

Our chance to be in the era of « NewSpace » (A)

High miniaturization with microsats and nanosats

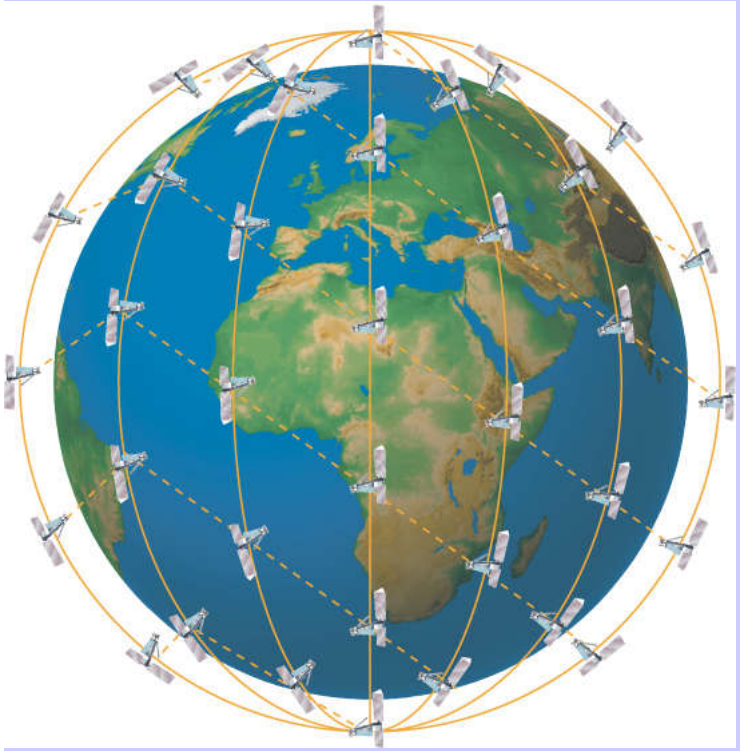


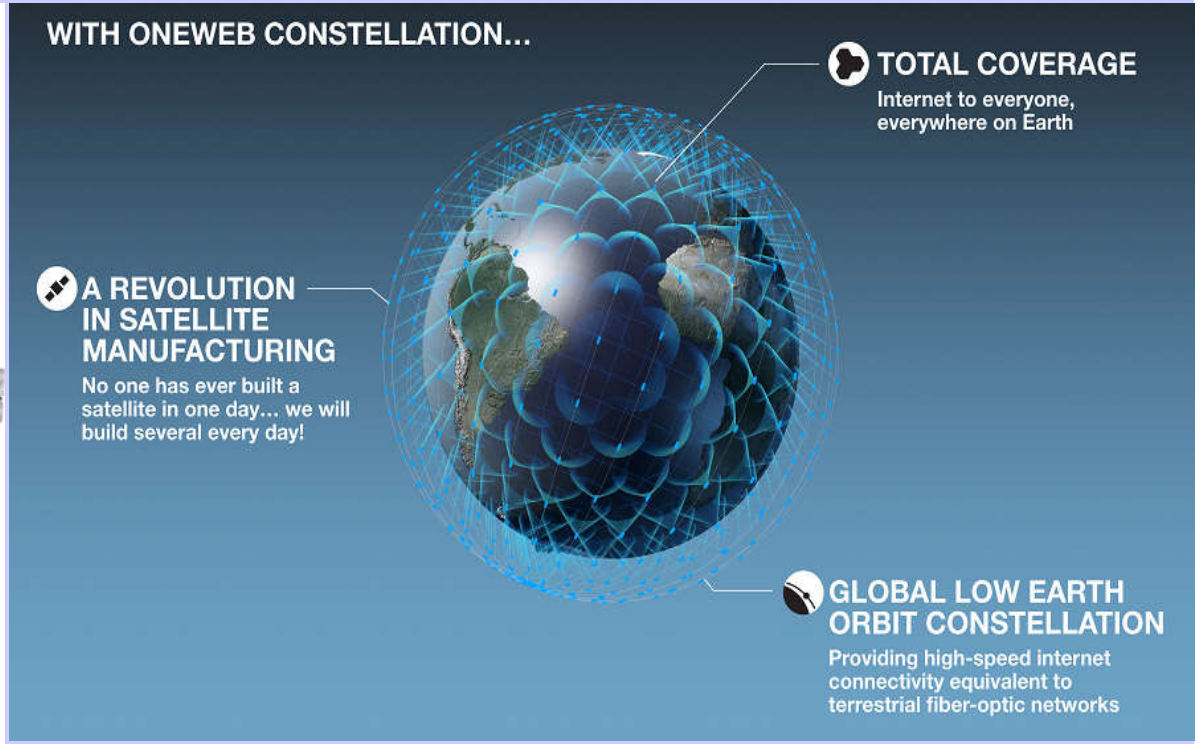
Our chance to be in the time of « NewSpace »

Constellations for mobile broadband links

ICT systems (Information & Communication Technologies)

The ambitious Starlink system of SpaceX



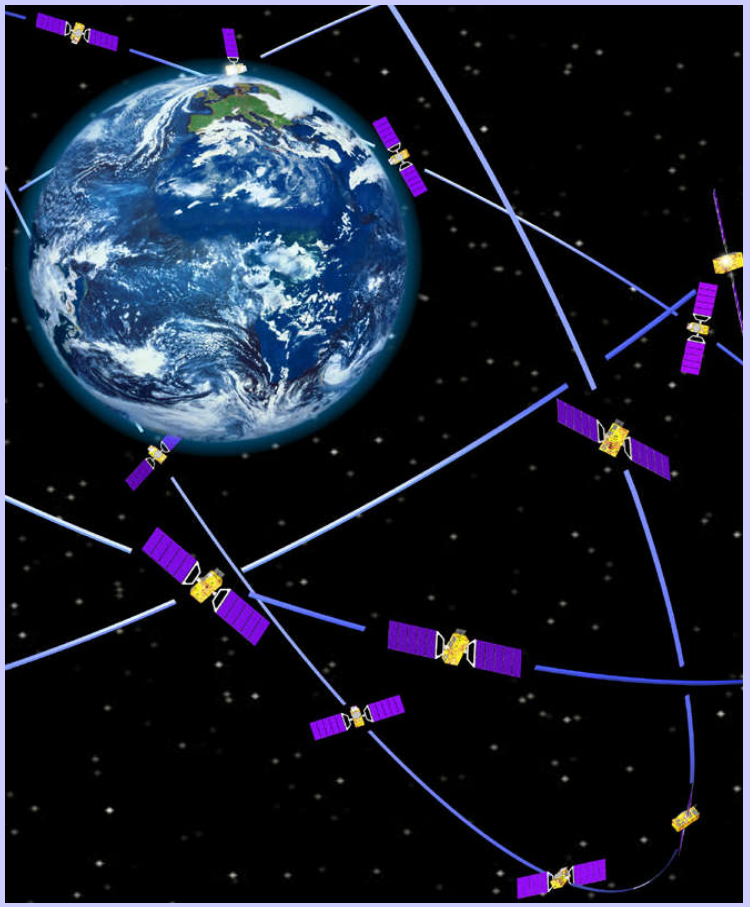


Now in bankruptcy!

Space, instrument of global management

Across our « blue planet »,

- Detailed vision
  (remote sensing)
- Instant communication
  (telecommunications)
- Geo-positioning & -timing
  (navigation)



Space, last continent for mankind

- New « earths » to be discovered
- Promising ressources to be used
- Technologies to make profits

An environment facing
the pollution of orbital debris !