EDUCATION @ ESA

Inspiring the future!

www.esa.int/education

European Space Agency - Education

What is ESA?

ESA = European Space Agency

It designs, coordinates, implements the space programme for Europe

Purpose of ESA

"To provide for and promote, for exclusively peaceful purposes, cooperation among European states in **space research** and **technology** and their space **applications**."

Article 2 of ESA Convention

ESA FACTS AND FIGURES

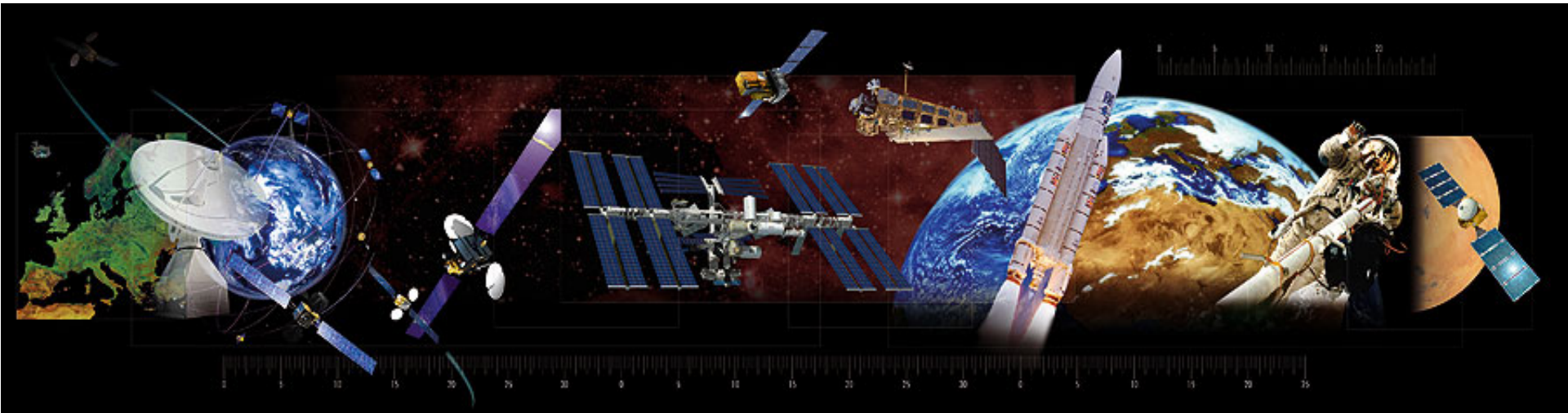
- Over 50 years of experience
- 20 Member States
- Eight sites / facilities in Europe, about 2200 staff
- 4.1 billion Euro budget (2014)
- Over 70 satellites designed, tested and operated in flight
- 18 scientific satellites in operation
- Six types of launcher developed
- 200th launch of Ariane celebrated in February 2011

ACTIVITIES

ESA is one of the few space agencies in the world to combine responsibility in nearly all areas of space activity.

- **Space science**
- **Human spaceflight**
- **Exploration**
- **Earth observation**
- **Launchers**
- **Navigation**
- **Telecommunications**
- **Technology**
- **Operations**

* Space science is a **Mandatory programme**, all Member States contribute to it according to GNP. All other programmes are **Optional,** funded ‘a la carte’ by Participating States.

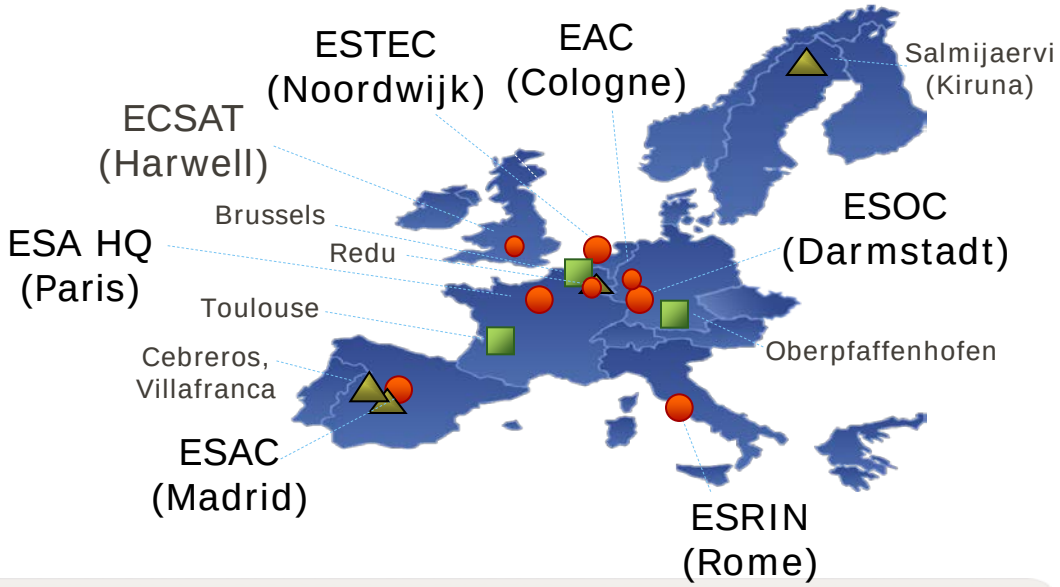


ESA'S LOCATIONS

ESA sites/facilities

Offices

ESA ground stations



Our programmes

Mandatory

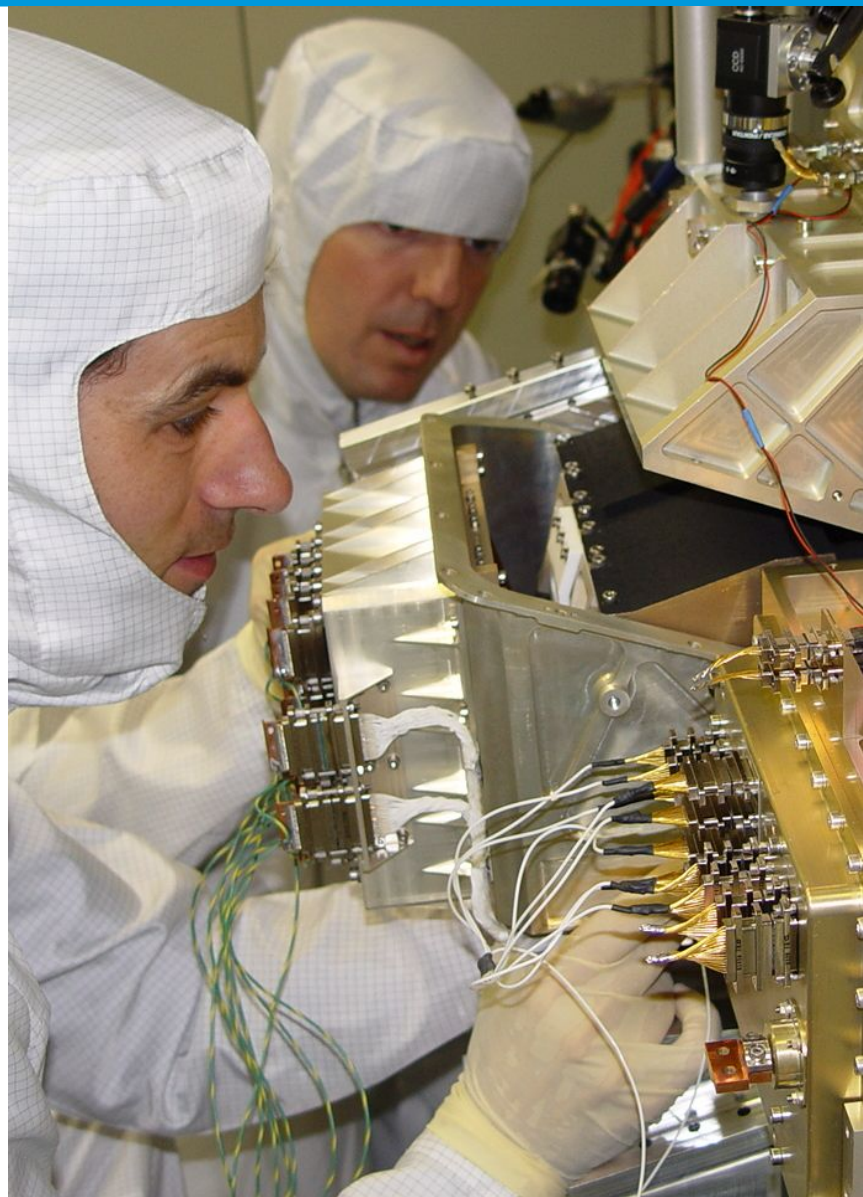
- Space science: Solar System, astronomy and fundamental physics
- Future studies, technological research, **education**, facilities, laboratories, basic infrastructure

Optional

- Human Spaceflight
- Earth Observation
- Telecommunications & Integrated Applications
- Launchers
- Navigation
- Robotic Exploration
- Space Situational Awareness

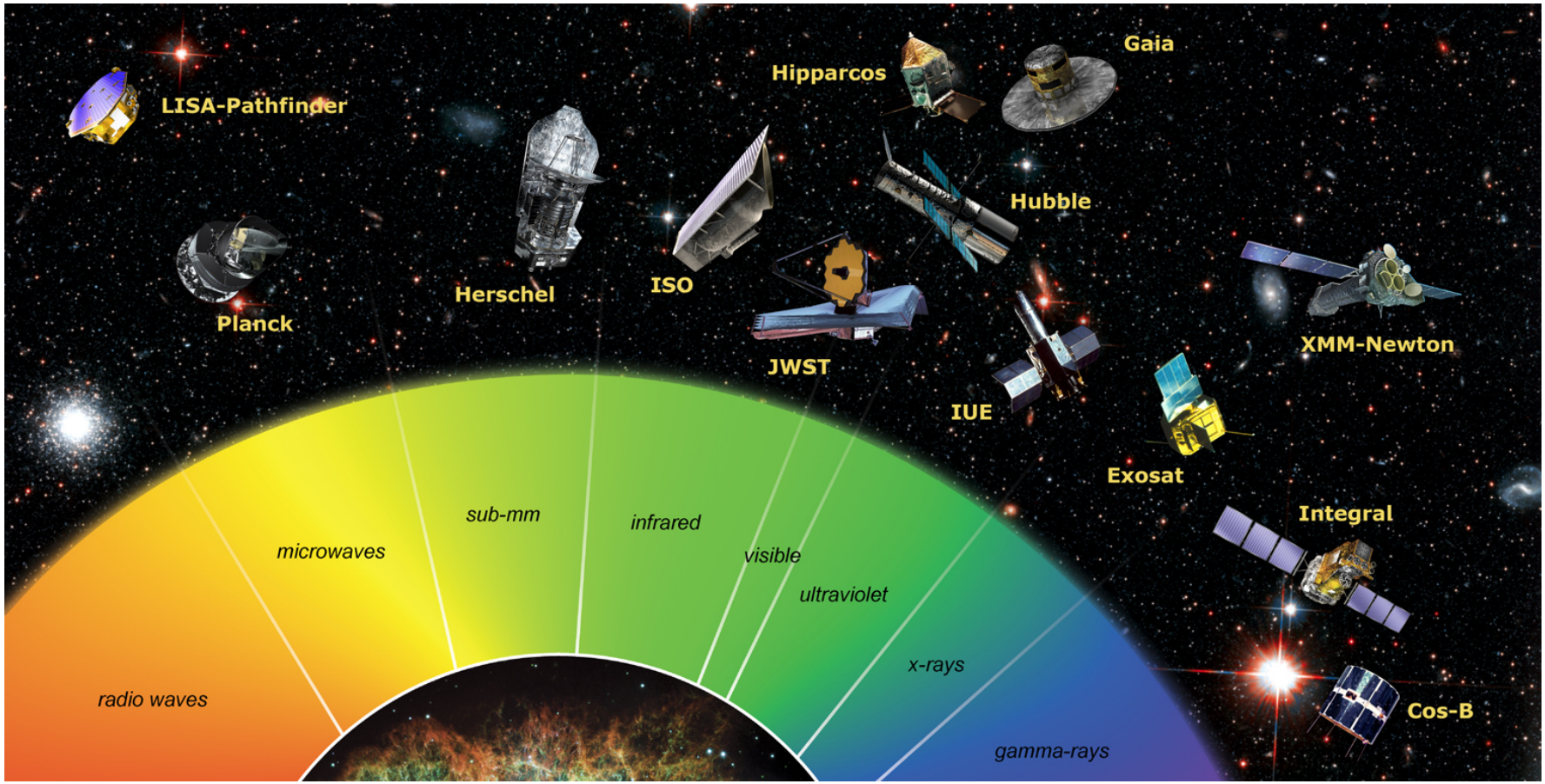
For the benefit of Europe

- to advance our understanding of the world we live in and of the Universe
- to be at the service of European nations for environment, safety, services
- to increase Europe's industrial and scientific competitiveness
- to develop new technologies
- to stimulate innovation and creativity through free competition
- to help nations new to space to grow in the space sector



We have been…

exploring the Universe at all wavelenghts…



We have been…

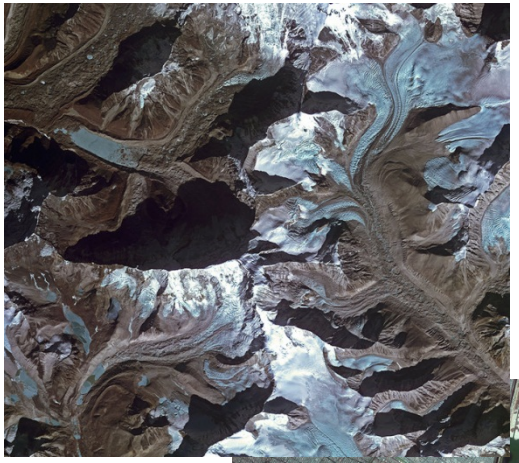
sending probes to the depth of the Solar System and landing where no one has landed before…

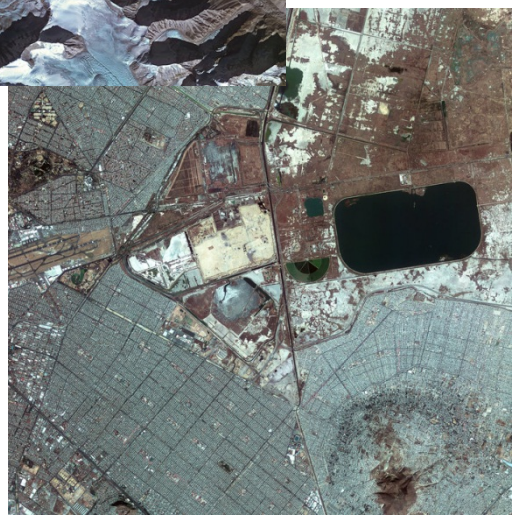
We have been…

contributing to the International Space Station…

We have been…

observing and monitored planet Earth – its atmosphere, weather, climate, lands, oceans, ice caps…



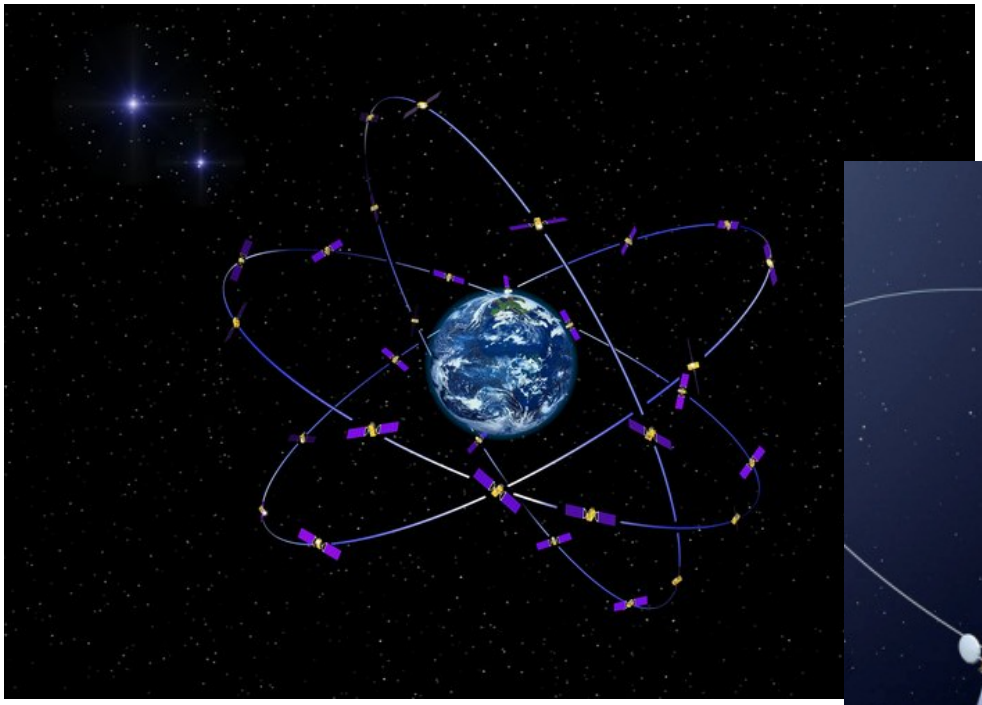


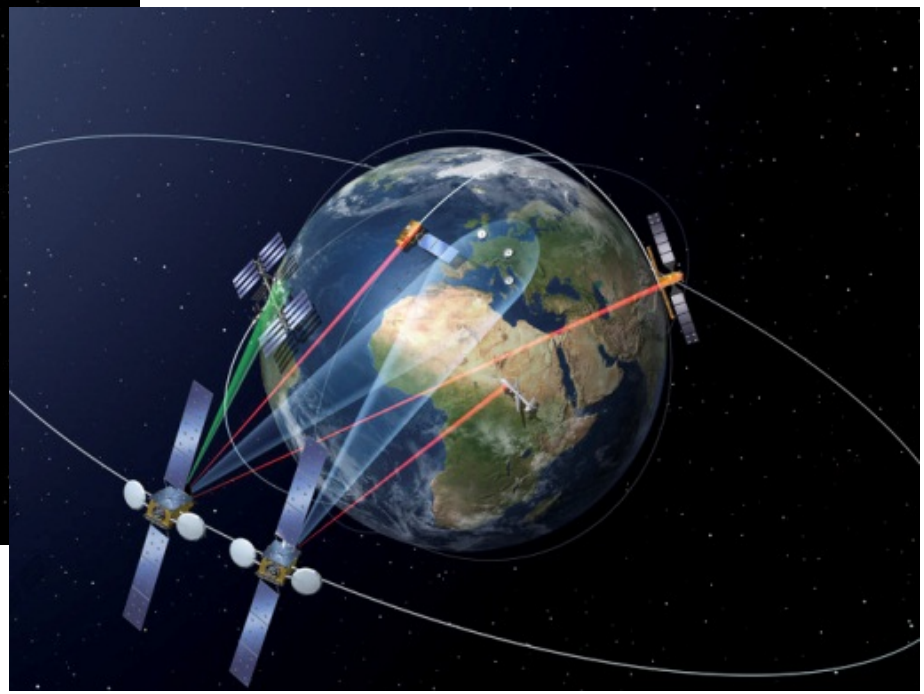
We have been…

developing and launching rockets to bring our satellites in orbit…

We have been…

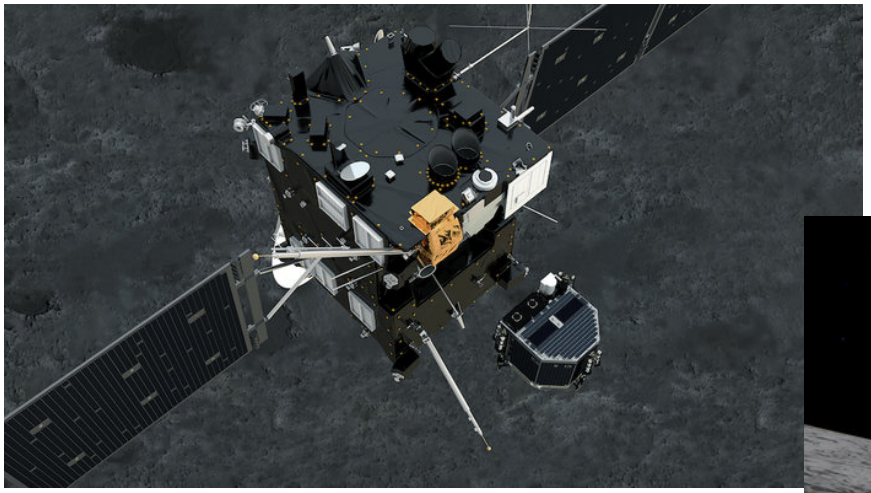
developing systems for telecommunication, navigation, global positioning…





We did…

orbit and land on a comet– a first in history!

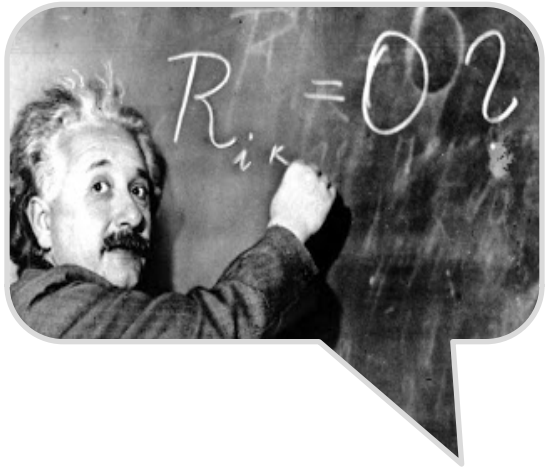


The Rosetta mission to comet 67/P with its lander, Philae

Why Education at ESA?

esa education

?



"To provide for and promote, for exclusively peaceful purposes, cooperation among European states in **space research** and **technology** and their **space applications and ensure the execution of fundamental activities from which education**."

(Art. II, ESA Convention)

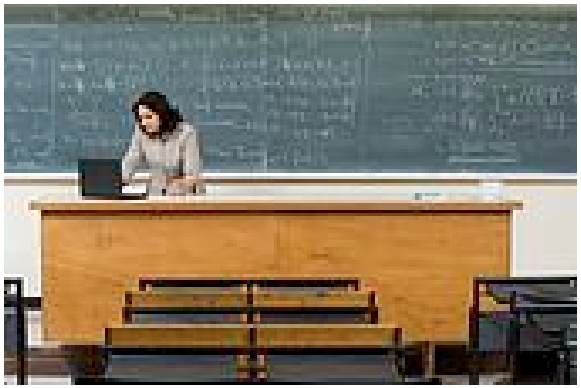
Education, here and now

Today, ESA and Europe share

- the **concern** on the decrease of interest in STEM-related careers, especially from girls

- the **view** that this trend could be reversed by introducing new methods in science teaching on a large scale in Europe
  (Rocard Report, 2008)

- the **objective** of:
  - enhancing scientific literacy and competences, that is promoting the ***skills of future responsible innovators/researchers*** as well as of ***science-active citizens who are skilled in scientific reasoning and transversal competences***
  - starting from an early age



ESA's strenght and added value

- Space is a modern myth – a **unique motivational context** for the study of STEM subjects → innovative learning environment

- ESA is a source of **unique and multidisciplinary scientific knowledge** – it can play a unique role to both transmit this knowledge and the way it is acquired

- ESA provides **access to space data, facilities, experts**

- ESA has an international **collaborative dimension** by definition, where scientific knowledge is produced by creativity, skills, motivation, partnership and dialogue beyond frontiers

ESA education objectives

1. Motivate and enable young people to enhance their literacy & competence in sciences and technology (STEM disciplines)

2. Inspire and enable young people to consider pursuing a career in the STEM field, in the space domain in particular

3. Contribute to increase youngsters' awareness of the importance of space research, exploration and applications in modern society and economy

{CHANGE THE EQUATION}™

A diversified approach

School pupils & teachers

Space is the context

- **Formal education**, right into the schools, with teacher training and resources to support the curriculum in an innovative way
- **Hands-on**: learning to think, learning to do, as classroom project or extracurricular activity
- **Informal education**, learning while having fun

Universities

Space is the subject

Hands-on:

- Satellite projects
- Scientific instrumentation and experimentation
- Technology demonstration experiments

+

Academic support:

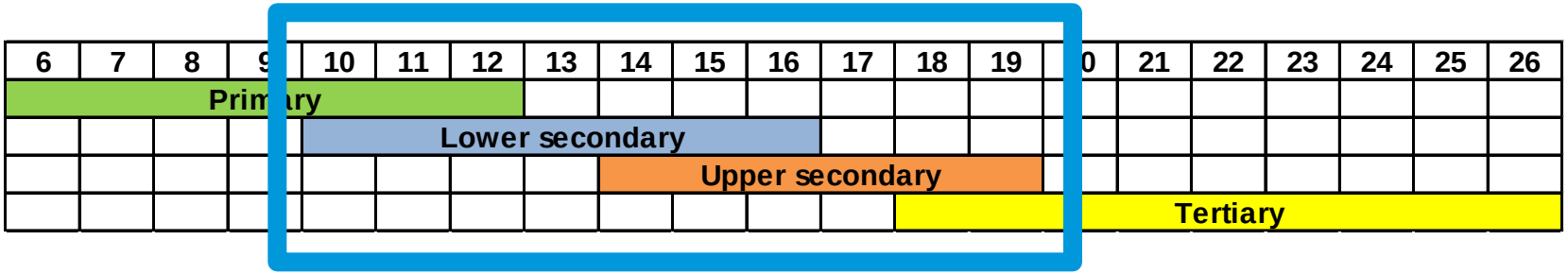
- Courses, schools and workshops
- Participation to conferences
- Lectures and seminars of ESA experts

= ESA ACADEMY!!

Primary and Secondary education

ESA primary & secondary education programme

- Classroom resources
  - 6-19 years
  - All materials to be used in a formal education setting
  - Later adaptable to informal activities



- Use Space as a theme
- Focus on ESA added value

Challenges

- More than 80 million school-age pupils, 7 million teachers
- 20 Member States
- Different lower education systems and curricula
- Lack of interest in STEM, girls in particular
- Shortage of specialized workforce in the space sector

Supporting Formal Education
ESERO: Philosophy & context

ESERO – European Space Education Resource Office

- Recognition of the **diversity of ESA Member States** in regards to Education – 15 different languages and even more education systems
- **An approach to support education focusing on the needs and national priorities**
- Largest project of ESA Primary & Secondary activities
- Project started in 2006 with pilot in the Netherlands (NEMO)

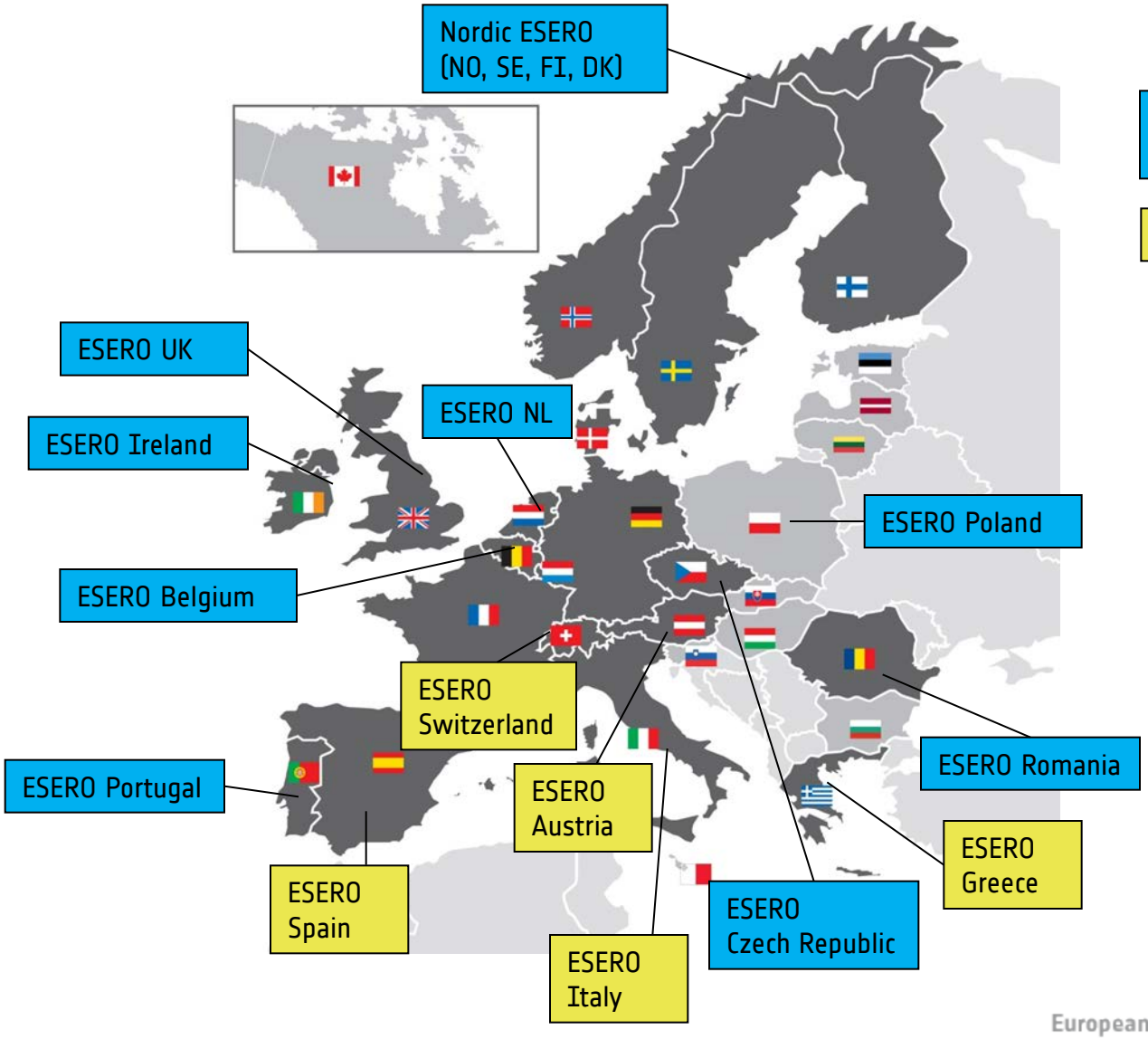
ESERO Project

- a network of national contact points in ESA's Member States targeting teachers/educators community
- co-funded by ESA and national funding bodies (partnerships)
- supporting primary & secondary STEM education using space as a theme: **teacher training, hands-on projects, classroom resources, space awareness**
- based on synergies with existing national educational stakeholders and networks (formal & informal)
- delivery tailored to the needs of different **national** school systems and **curricula**

esero
EUROPEAN SPACE EDUCATION RESOURCE OFFICE
A collaboration between ESA & national partners

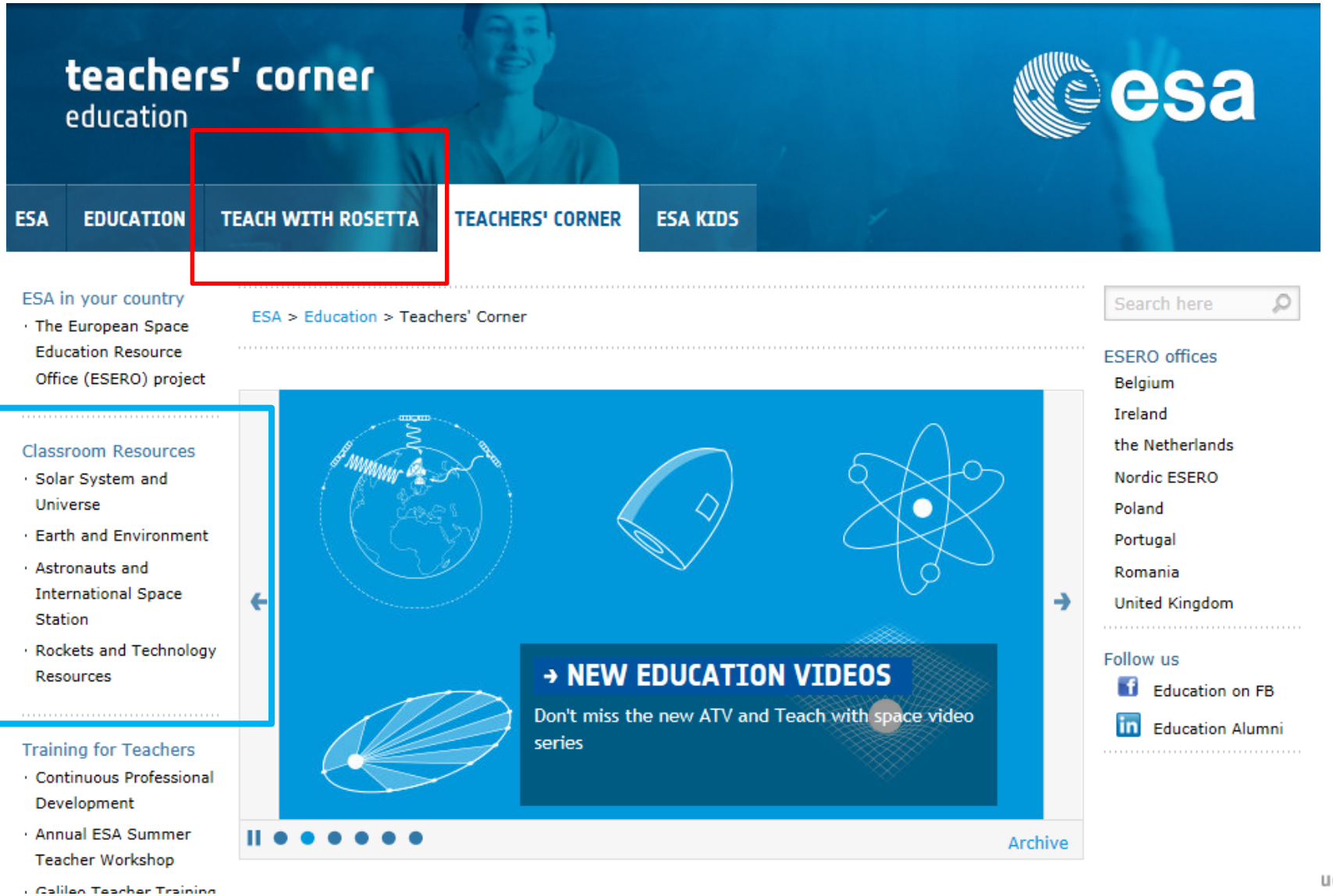
The expanding ESERO network!

www.esa.int/education/esero

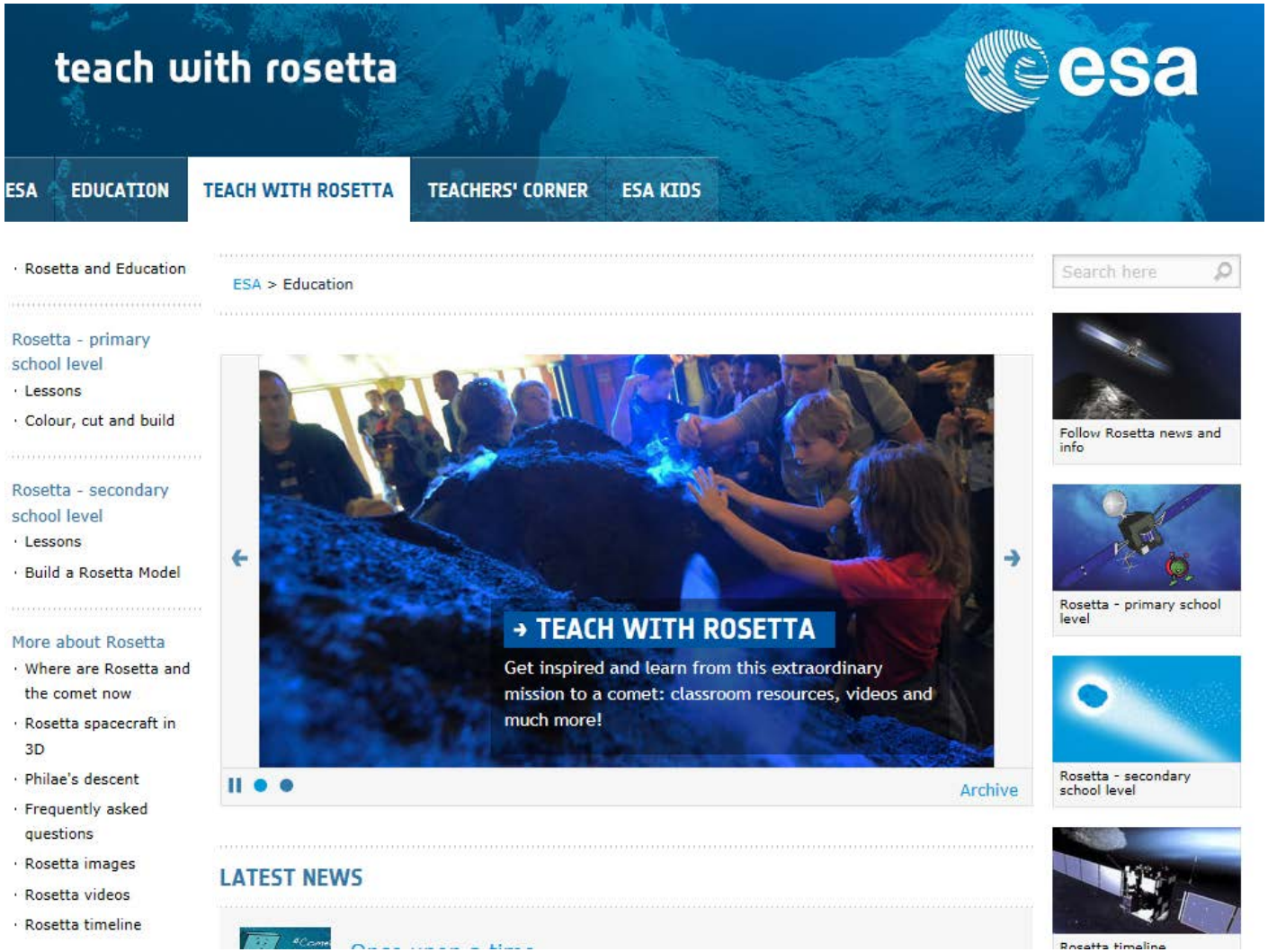


ESA classroom resources:

http://www.esa.int/Education/Teachers_Corner



Teach with Rosetta Website



ESA classroom resources - secondary

teach with space

physics | P06

teach with space

→ COOKING A COMET

Ingredients for life?

teacher's guide and student activities

European Space Agency

→ COOKING A COMET

Ingredients for life?

FAST FACTS

Age range: 14-18 years old

Type: teacher demonstration & student activity

Complexity: easy

Teacher preparation time: 20 minutes

Lesson time required: 20 minutes to 1 hour

Cost: medium (5 - 25 euro)

Location: indoor (large, well ventilated classroom)

Includes use of: dry ice (solid carbon dioxide at a temperature below -78°C)

Students should already know

1. The kinetic energy equation.
2. The concepts of spectroscopy and infrared radiation.

Learning outcomes

1. Students should understand the basic differences between comets and asteroids.
2. Students should be familiar with the basic compositional parameters of comets.
3. Students should be able to make simple calculations of the energy conversions that take place when comets or asteroids impact planets.

You also need

↑ Cooking a comet video. See Links section.

Curriculum links

Physics
- Kinetic energy
- Conservation of energy
- Phase changes
- Impact processes
- Orbits (in the Solar System)

Astronomy
- Location and nature of asteroids and comets
- Identify features of a comet (nucleus, coma, dust and ion tails)
- Consequences of collisions in the Solar System
- Association of Kuiper Belt and Oort Cloud with comets
- Space probes studying Solar System bodies

Chemistry
- Phase changes

Outline

In this activity teachers and students simulate a comet nucleus in the classroom. The ingredients used accurately represent an analogue of the material found in a real comet nucleus, as discovered using spectroscopy combined with the results from spacecraft flybys of various comets.

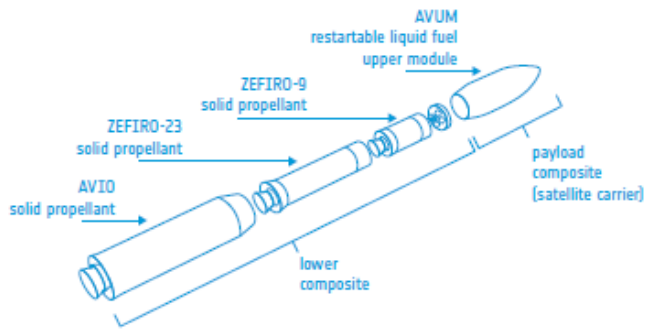
teach with space – cooking a comet | P06 5 European Space Agency

→ SPACE CONTEXT AT ESA

ESA launchers and thrust

- To launch a rocket into space there needs to be enough thrust. Chemical rocket propellants use solid or liquid fuel so not only does the mass of the satellite needs to be put into space but also the fuel. In order to limit the amount of extra mass that is being carried for the whole journey, rockets are often in multiple stages. When the fuel of a stage is used up this stage is jettisoned. Upper stages need less thrust than the lower stages. The more mass you want to take into orbit, the more thrust you need.
- Thrust is a reactive force relating to Newton's second and third laws. When an object accelerates or expels mass there is an equal and opposite formal perpendicular to the surface in the opposite direction. The thrust force is measured in Newtons. 1 N is equivalent to the amount of force needed to accelerate 1 kg of mass at a rate of 1 m/s².

Figure 3



↑ Vega launcher

European Space Agency's launcher VEGA launcher showing the different stages. When one stage is finished it will detach leaving the vehicle less massive.

http://www.esa.int/Education/Teachers_Corner

+ 30 in development (Physics, Chemistry, Technology, Biology, Mathematics, etc..)

New ESA classroom resources: secondary

30 new teacher packs

- target: 14-18 y/o
- learning objectives: science enquiry, physics, chemistry, maths
  - teacher guides,
  - student worksheets and activities
  - video demonstrations
- developed by National Space Academy for ESA

New ESA classroom resources: secondary

ATV videos – Visionary science concepts that made history

- target: 14-18
- learning objectives: fundamental science concepts, inspiration, awareness of ESA & space
- 5 videos
  - Kepler
  - Verne
  - Einstein
  - Amaldi
  - Lemaitre
- delivered: **You Tube** end Jul 2014 (ATV 5 launch)
- developed by ESA with National Space Academy

New ESA classroom resources: secondary

Down2Earth impact calculator

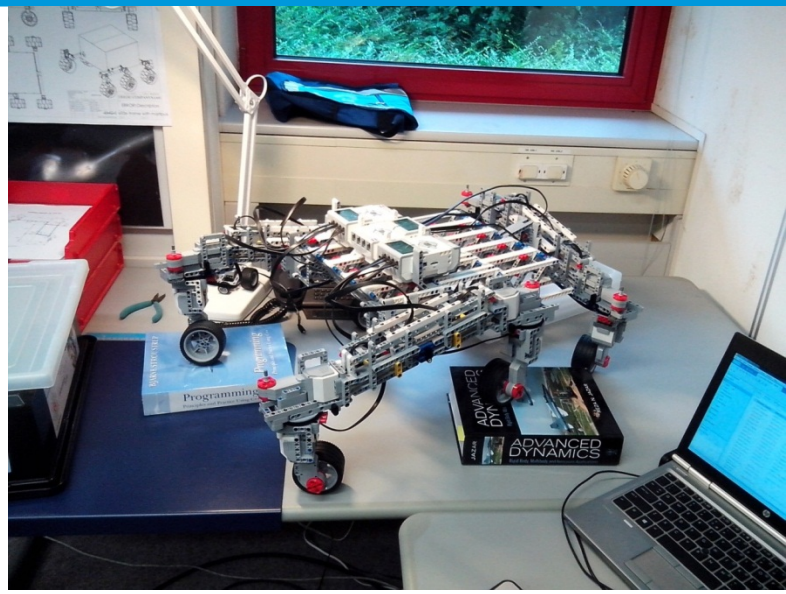
- web-based, mobile and tablet apps
- target: lower secondary
- Learning objectives: science enquiry, physics, maths
- accompanying lessons

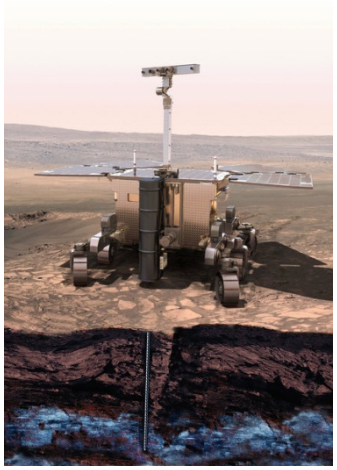
- Developed by the Faulkes Telescope project with ESA

New ESA classroom resources: secondary

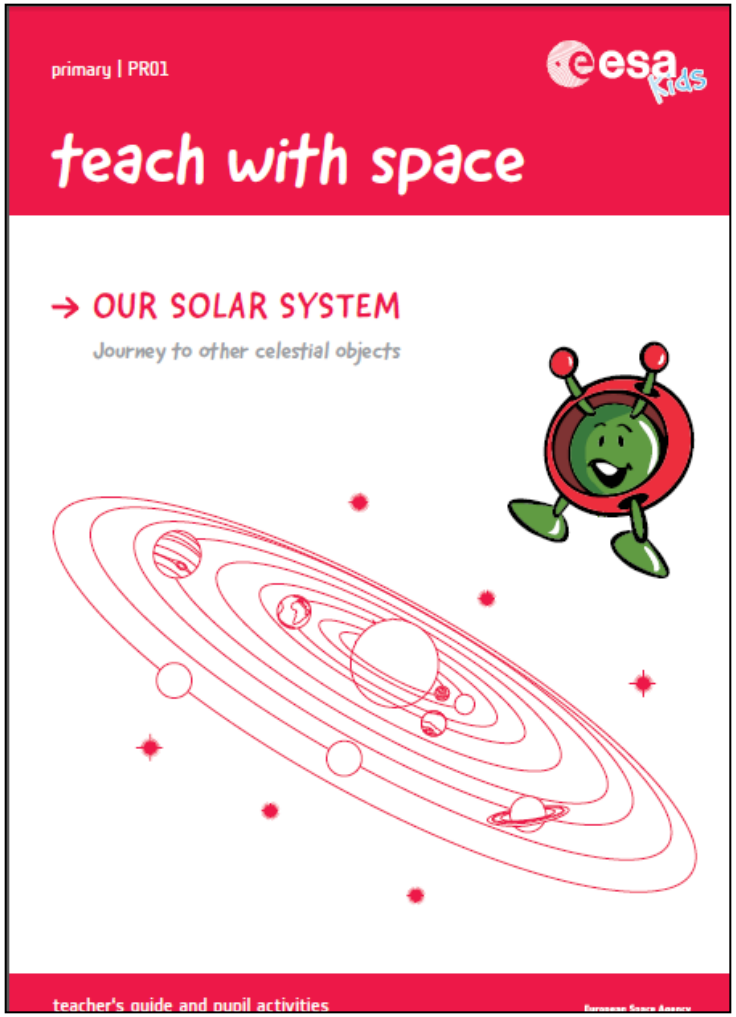
LEGO @ ESA

- LEGO-based robotic prototypes
  - Demonstrating orbital robotics
  - Demonstrating the use of the Exomars rover
- accompanying **sets of 10 lessons per activity** (~1h each)
- Target: 14-16 y/o
- learning objectives: science enquiry, technology, ICT, design, physics, maths (inter-curricular)
- based on IB technology curriculum
- application also in science centres
- Delivery: 2015





Primary classroom resources



Paxi animations

ESA classroom resources: primary

ESA/Ecsite collaboration on Education

- **Rosetta - Time capsule:**
  - 60’ workshop
  - Target: groups of 8 – 12 y/o children (and families)
  - learning objectives: solar system
  - short presentations, hands-on activities and demonstrations
  - delivery: already available
  - developed by NEMO for ESA

ecsite
EUROPEAN NETWORK
SCIENCE CENTRES & MUSEUMS

Juniors: learn with fun

Paxi: the ESAKids & Education alien mascot!

- Born to explain space to kids
- Calendar of presence to all major ESA & space events
- Becoming the ESA mascot!!!
- Adult followers as well…

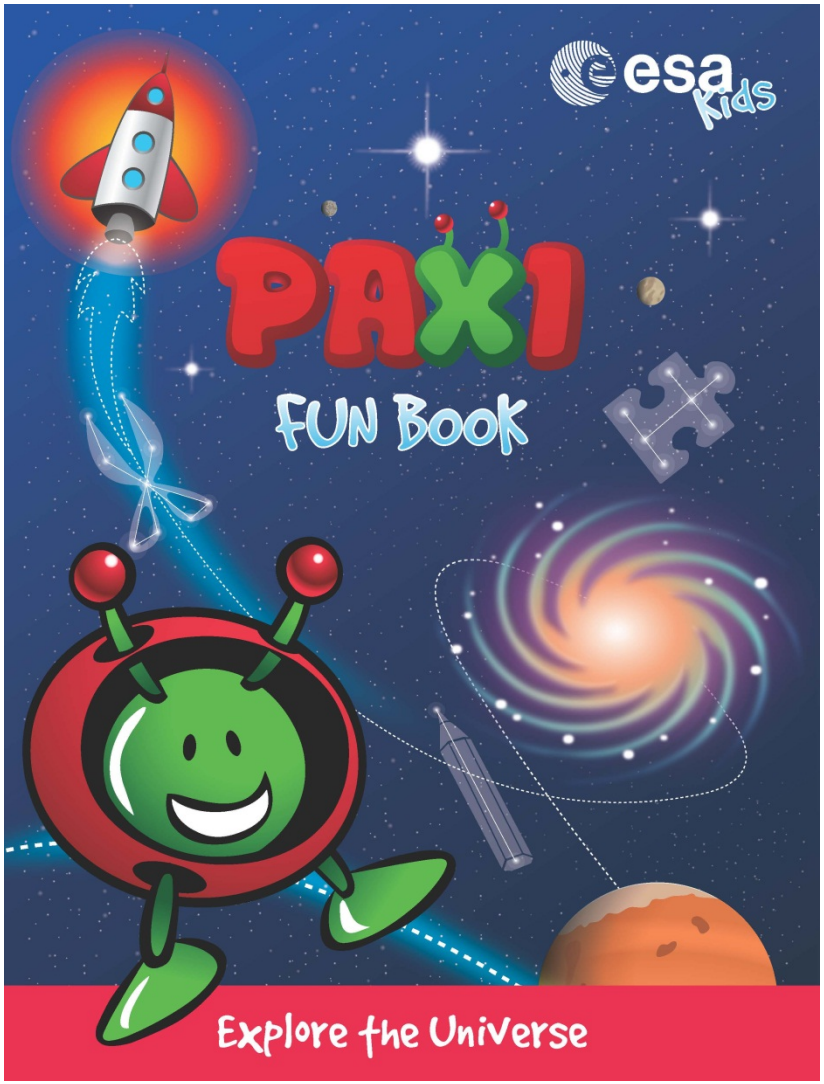
Juniors: learn with fun

ESAkids: the most visited ESA web site

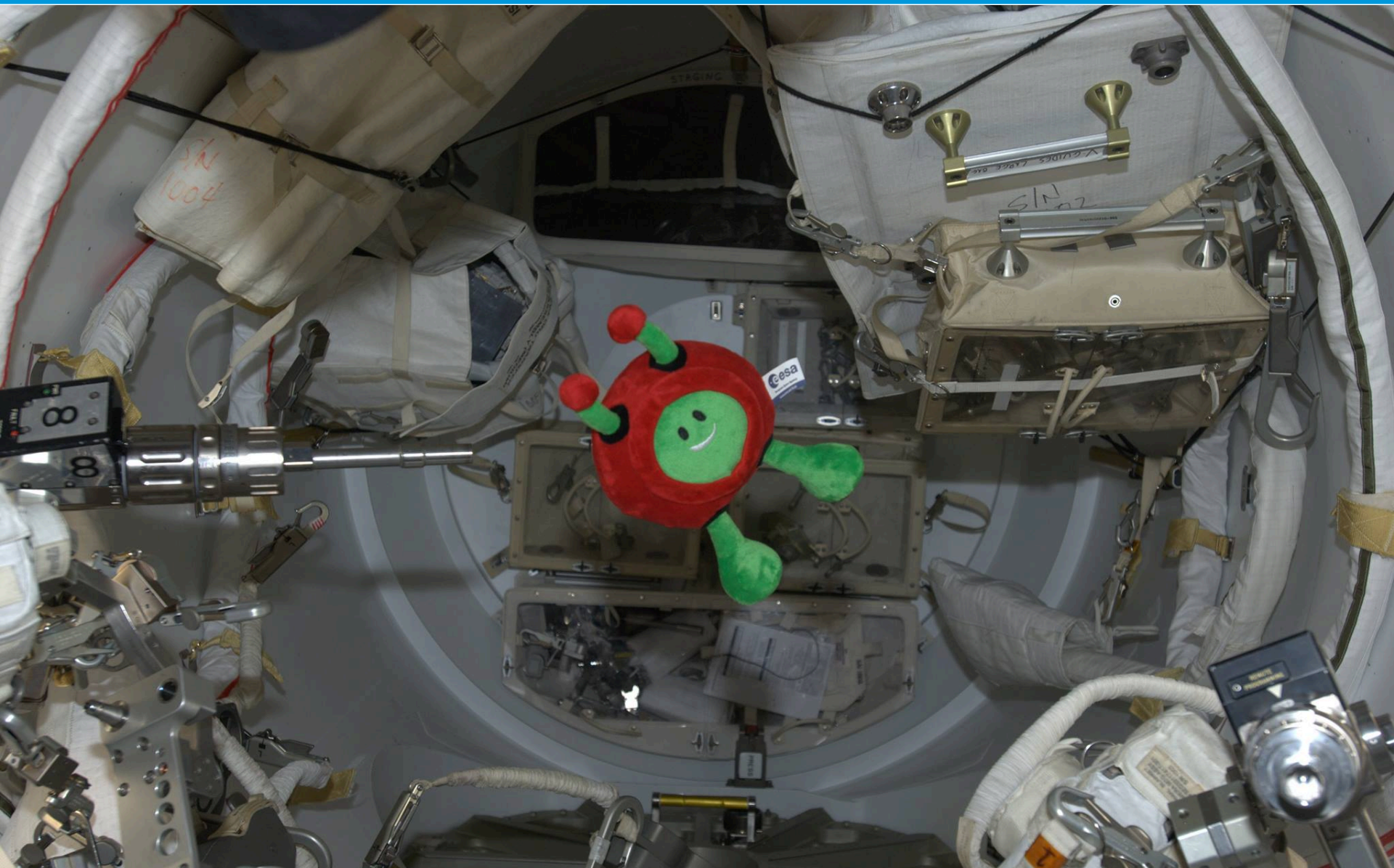
New ESA classroom resources: primary

Explore the Universe with Paxi

- Activity book: colouring sheets, mazes, puzzles, etc
- 4/11 y/o
- (Almost) no text →no need for Translation!



On the ISS



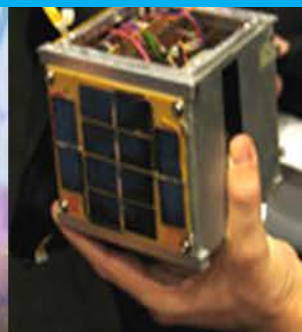
Rosetta, Philae landing






Hands-on projects / extra-curricular projects



Hands-on projects: Mission X

Mission X – Train like an astronaut

- **Target:** primary school children
- **Learning objectives**: scientific enquiry, exercise, health, nutrition
- **2014 competition**:
  - ~25000 students from 24 countries (17 ESA countries)
- **2015 competition**:
  - 20-minute in-flight calls with ESA astronaut Samantha Cristoforetti during a live event in March 2015.
  - She will take questions about eating and exercising habits, and will share her experiences in weightlessness.

Hands-on projects: Cansats

- **Target**: secondary school students
- **Learning objectives**: scientific enquiry, technology, science, basic engineering skills, team work
- **2014 European CanSat Competition**
  - Launch campaign: 1-5 June 2014 at Andøya
  - 14 student teams from 11 countries
  - Winners of the Beginners Category:

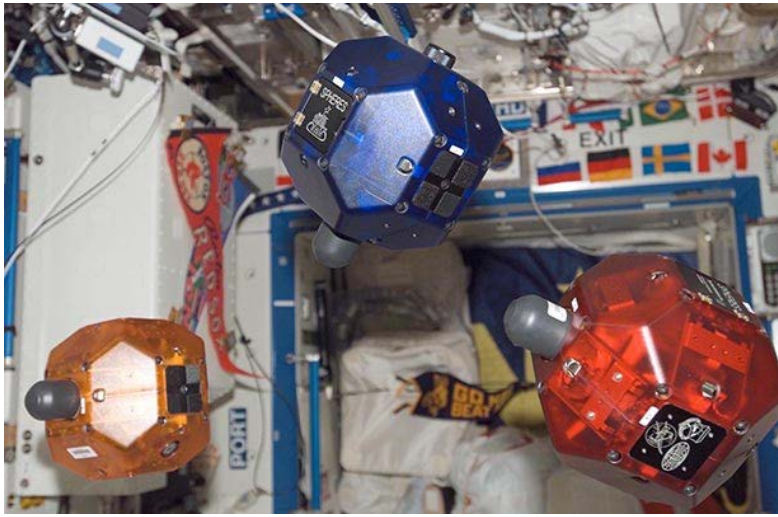
    1st:Norway, 2nd Romania, 3rd Ireland
  - Winners of the Advanced Category:

    1st:Romania, 2nd Greece, 3rd Belgium
- **2015 Competition**
  - Launch campaign: 25-28 June 2014 in Torres Vedras (Portugal)
  - Up to 18 students teams

Hands-on projects: Zero Robotics - Spheres

Zero Robotics - Spheres

- **Target:** secondary school students (16 +)
- **Learning objectives**: scientific enquiry, ICT, technology, physics/maths, team work
- **2014 competition**:
  - 500 students from 9 ESA countries
  - Jan 2014 final event at Eurospace centre, Belgium
- **2015 competition**:
  - Jan 2015 final event at ESTEC



Hands-on projects : 2014 pilots

ESTEC drop tower (micro-gravity)

- **Target:** secondary school students
- **Learning objectives**: scientific enquiry, physics
- 2 pilot campaigns of 1 team each (UK, Belgium): fluid dynamics
- Future: mission assignment rom ESA (technology & science)

ESTEC Centrifuge (hyper-gravity)

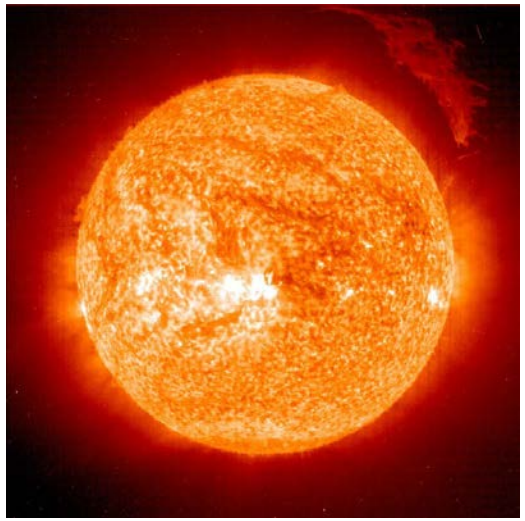
- **Target:** secondary school students
- **Learning objectives**: scientific enquiry, physics
- 1 pilot campaign of 1 team (NL): melt ice cubes of 2 different materials
- Contacts: education@esa.int

ESA teacher training

ESA-GTTP Galileo Teacher Training Workshop 2014

- When: Leiden, 8-12 Dec 2014
- Who: 20 secondary STEM teachers
- Call opens: 1 Sep 2014
- Objectives: get inspired by space and astronomy, use space data in the classroom for STEM teaching; practical sessions:
  - Rosetta
  - Gaia
  - SOHO data in the classroom
  - Tracking clouds on Venus
  - Stellarium desktop planetarium
  - SalsaJ image processing software for schools
  - Make your own spectroscope
- Contact: rebecca.barnes@esa.int

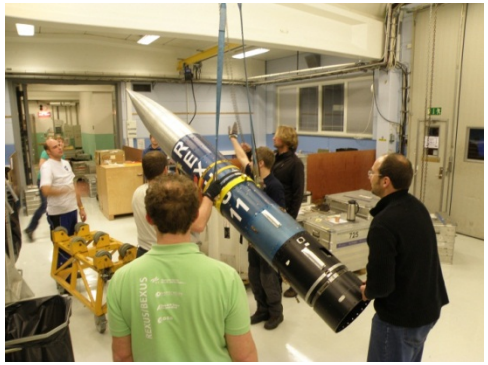
GALILEO
Teacher Training Program



University education

Projects for university students

- **Micro-satellites: ESEO**
  - students develop instruments and platforms for:
    - European Student Earth Orbiter (ESEO)
- **Pico-satellites (CubeSats): Fly Your satellite!**
  - students experience all stages of satellite development
  - ESA offers different forms of support to the university student teams (technical, managerial, procedural,…)
  - New Fly Your Satellite! programme currently on-going
- **Sub-orbital and stratospheric flight experiments**
  - students design, build and fly experiments on:
    - **REXUS sounding rocket platform**
    - **BEXUS stratospheric balloon platform**
- **Gravity-related experiments**
  - students design, build and perform experiments at different gravity levels in:
    - **ESA Large Diameter Centrifuge (1 to 20 g)**
    - **ZARM Drop Tower (10E-6 g)**
- Contact: piero.galeone@esa.int



ESA Academy

- **Target:** university students (and young professionals)
- **Objective:** to complement the standard academic formation in space-related disciplines with theoretical knowledge and practical experience which are unique to ESA, from 2016
- **Offer:**
  - **Hands-on projects** (coordinated from Estec)
  - **Portfolio of courses** (coordinated from Redu), **new!**:
    - programme of residential lectures, conferences and workshops
    - programme of visiting lectures
    - Central Virtual Learning System
    - Concurrent Design Facility
  - **ECOSS** programme (sponsorship to conferences)

ESA Education links

- **Education web portal:** www.esa.int/education
- **Education on facebook:** www.facebook.com/ESAEducation
- **ESA Education brochure:**

  http://esamultimedia.esa.int/docs/edu/ESA-EdSuccess.pdf
- **ESAKids web portal:** www.esa.int/kids
- **ESAkids facebook and twitter pages:**

  PaxiESAKids, #Paxi_ESAKids
- **ESERO:** www.esa.int/education/esero

Thank you

www.esa.int/education

→ **THANK YOU!**

Clara.cruz.niggebrugge@esa.int