FOREWORD

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The year 2012 has been a very successful and fruitful year for Europe in space. European industry was once more behind the uninterrupted string of successes that have highlighted the European Space Agency's activities in recent years. And 2013 promises to be as rich and as eventful for ESA and for industry.

Launches and related events

To begin with, 13 February marked the maiden flight of ESA's new launcher **Vega** from Kourou. After lifting off from its new launch pad, it performed a flawless qualification flight. With Vega extending the family of launchers available at its spaceport, Europe now covers the full range of launch service needs, from small science and Earth observation satellites to the largest missions like ESA's Automated Transfer Vehicles (ATV), the supply freighters for the International Space Station. The development of the new launcher started in 2003 and seven Member States contributed to the programme: Belgium, France, Italy, The Netherlands, Spain, Sweden and Switzerland.

On 23 March ESA's third **ATV**, named after Italian physicist Edoardo Amaldi, lifted off from the Guiana Space Centre (CSG), Europe's Spaceport in Kourou, on an Ariane 5 launcher operated by Arianespace, heading for the ISS. The ATV, the most complex spacecraft ever built in Europe, delivered essential supplies to the orbital outpost. This kind of spacecraft is also used to re-boost the Space Station's orbit while it remains attached to it. ATV Edoardo Amaldi is the third in a series of five supply ships being developed in Europe to fulfil its obligation to contribute to meeting ISS exploitation costs. The launch of the third Vehicle one year after the second, has demonstrated the capability of European industry to produce such a complex vehicle at a yearly rate, as well as the maturity of operations conducted from the control centre of the French space agency CNES in Toulouse. Its mission ended on 3 October when the vessel re-entered the atmosphere, burning up as planned over an uninhabited area of the southern Pacific.

On 1 July ESA astronaut André Kuipers, together with Russian Commander Oleg Kononenko and NASA astronaut Donald Pettit, landed safely on the steppes of Kazakhstan. During his six-month PromISSe mission aboard the ISS, Kuipers conducted over 50 scientific experiments in the world's only permanent microgravity laboratory. A medical doctor by training, André conducted biophysics experiments that could offer insights into fighting osteoporosis, migraine and immune-cell death. He also performed experiments in other domains such as biology and looking at improving computer models of fluids. Some experiments may serve to prepare for further exploration of space. In addition to his scientific workload, he carried out maintenance and operational tasks. Highlights included receiving ESA's Edoardo Amaldi cargo ferry and docking the first US commercial spacecraft Dragon.

July and September marked important milestones in the continuing success of ESA, thanks to the development and production by European industry of world-class meteorological satellites for Eumetsat. **MSG-3**, the third in a series of four satellites introduced in 2002, was launched on board an Ariane rocket on 5 July. The satellite's sensors are ensuring that Europe and Africa continue to receive up-to-date weather coverage. MSG is a joint programme being undertaken along with Eumetsat. ESA is responsible for the development of satellites fulfilling user and system requirements defined by Eumetsat and the procurement of recurrent satellites on its behalf. ESA also performs the Launch and Early Orbit Phase operations required to place the spacecraft in orbit, before handing it over to Eumetsat for exploitation. After commissioning, MSG-3 has become Meteosat-10, and is stationed at 0° longitude, over the Gulf of Guinea on the Equator, in geostationary orbit, where its speed precisely matches the Earth's rotation.

The second **MetOp** satellite was launched on 17 September from the Baikonur cosmodrome, in Kazakhstan, atop a Russian Soyuz. MetOp-B ensures continuity of the weather and atmospheric monitoring service provided by its predecessor MetOp-A, which has been circling the globe from pole to pole, 14 times a day, since 2006 and has now exceeded its design lifetime. Developed for Eumetsat's polar satellite system, MetOp-B was handed over to Eumetsat for six months of payload commissioning, before entering routine service with MetOp-A. Unlike the Meteosat satellites, which are watching about half of our planet from a fixed vantage point almost 36 000 km above the Gulf of Guinea, MetOps work at the much lower altitude of about 800 km and scan the entire globe to provide additional data on the atmosphere.

The third and fourth satellites of Europe's **Galileo** global navigation satellite system were lofted into orbit on 12 October from Europe's Spaceport in French Guiana on a Soyuz ST-B launcher operated by Arianespace. They joined the first pair of satellites launched a year before to complete the In-Orbit Validation (IOV) phase of this programme. The early operations of the satellites were conducted by a joint ESA and CNES French space agency team in Toulouse, France. Then, after initial checks, the satellites were handed over to the Control Centres in Oberpfaffenhofen, Germany, and Fucino, Italy, for testing before being commissioned. Galileo is Europe's own global satellite navigation system. It will consist of 30 satellites and their associated ground infrastructure. The definition, development and IOV phase of the Programme are being carried out by ESA, and co-funded by it and the European Commission. The IOV phase gave life to a mini-constellation of four satellites and a reduced ground segment which will lead to the validation of the overall system and signals. The four satellites launched during this phase are the nucleus of the constellation that will then be extended to reach its Full Operational Capability (FOC). By late 2014, 18 satellites are scheduled to have been launched, by which time early services to Europeans can begin. FOC will be reached with 30 satellites (including the four IOVs and in-orbit spares) in 2018.

Contract signatures and selecting of new programmes

In early February contract signatures by ESA on behalf of the European Commission took place in London for eight further Galileo satellites. The contract was awarded to a consortium headed by OHB and partner Surrey Satellite Technology Ltd; contracts with EADS Astrium for Ariane 5 adaptation for launching four Galileo satellites were also awarded simultaneously.

In February ESA signed contracts with Eurockot for launching **Sentinel-2A** and **Sentinel-3A** in 2014. These are two of five Sentinel missions that ESA is developing for Global Monitoring for Environment and Security (GMES), an EU flagship programme for which ESA Member States are funding two thirds of the development. Through GMES, decision-makers will have access to reliable, timely and accurate information services to manage the environment, understand and mitigate the effects of climate change and ensure civil security. The Sentinel series is planned to collect crucial Earth observation data for two decades. Sentinel-2 will deliver frequent and systematic high-resolution optical imagery of Earth's landmasses, supporting operational applications in the fields of agriculture, forestry, land cover and cartography. The mission will support humanitarian relief work and the extraction of geophysical variables from vegetation. Sentinel-3 will carry several instruments to measure variables such as sea-surface topography, sea- and land-surface temperature and ocean colour.

Also in February, the signature of the **Meteosat Third Generation** development contract with Thales Alenia Space took place at ESA HQ, Paris. Building on Europe's long heritage of weather monitoring from space, the MTG series will provide significant improvements over the current Meteosat satellites and, together with increasing computer power, will undoubtedly take weather forecasting up to the next level. Following on from Meteosat Second Generation, MTG is a cooperative venture between Eumetsat and ESA, and will ensure continuity of high-resolution meteorological data to beyond 2037. The cooperation on meteorological missions between the two is a success-story that started with the first Meteosat satellite back in 1977 and continues today with MSG and the polar-orbiting MetOp series. The first MTG is expected to be launched in 2017.

In April a contract was signed with Astrium (UK) to build the **Solar Orbiter** science satellite. This ESA mission is designed to perform a close-up study of the Sun and inner heliosphere – the uncharted innermost regions of our solar system – to better understand, and even predict, the unruly behaviour of the star on which our lives depend. At its closest point, the Orbiter will be closer to the Sun than any previous spacecraft, braving the fierce heat, and will carry its telescopes to almost one-quarter of Earth's distance from our nearest star. It will provide unique data and imagery. This mission, scheduled for a start in 2017, will be performed in cooperation with NASA. The US space agency will provide the launcher and contribute instruments to the scientific payload.

May marked another milestone for science when industry delivered to ESA the **Mid InfraRed Instrument**. MIRI is one of the four instruments on board NASA's James Webb Space Telescope, the mission scheduled to draw on the heritage of the Hubble Space Telescope in 2018. The optics, the core of the instrument, are provided by a consortium of European institutes. MIRI is a key European contribution to JWST, a space telescope with a mirror seven times bigger in surface area than that of Hubble. The Instrument will be used by astronomers to study faint comets circling the Sun, newly-born faraway planets, regions of obscured star formation and galaxies near the edge of the universe.

In June ESA's Science Policy Committee (SPC) gave final approval to the **Euclid** project devoted to the study of dark energy. This space telescope is designed to explore the dark universe; the mission will map out the large-scale structure of the universe across 10 billion light years, revealing the history of its expansion and the growth of structure during the last three-quarters of its history. The satellite is scheduled to be launched in 2020 by a Soyuz rocket from Kourou. Nearly 1000 scientists from 100 institutes form the Euclid Consortium are building the instruments and participating in the scientific harvest of the mission. The Consortium comprises scientists from 13 European countries: Austria, Denmark, France, Finland, Germany, Italy, Netherlands, Norway, Spain, Switzerland, Portugal, Romania and the UK. It also includes a NASA team.

In October the SPC also selected **CHEOPS** as the first Small Mission under the Science Programme for a launch in 2017. Studying planets around other stars will be the focus of this new mission. CHEOPS (CHaracterising ExOPlanets Satellite) will target nearby, bright stars already known to have planets orbiting them. Through high-precision monitoring of a star's brightness, scientists will search for the signs of a 'transit' as a planet passes briefly across its face. In turn, this will allow accurate measurement of the radius of the planet. For those planets with a known mass, the density will be revealed, providing an indication of the internal structure. This mission will be implemented as a partnership between ESA and Switzerland, with a number of other ESA Member States delivering substantial contributions.

ESA keeps growing

In February Malta signed a cooperation agreement with the Agency. The objective is to allow the parties to create the framework for more intensive Maltese cooperation on ESA projects in future. Its priority research areas are telecommunications and satellite technology, as well as high-technology engineering (for example, micro-electro-mechanical systems and nanotechnology). The Department of Physics at the University of Malta has a number of research interests in space activities.

On 19 November Poland became ESA's 20th Member State. Its cooperation with us is long-standing. In 1994 it was one of the first East European countries to sign a cooperation agreement with ESA on the peaceful use of outer space. A second step, the signature of European Cooperating State (ECS) Agreement in 2007, paved the way for participation in several ESA research projects. Poland has a long aerospace tradition and has contributed to many scientific and technological projects. It has participated actively in several ESA science missions, such as Integral, Rosetta, BepiColombo and Solar Orbiter, and in Earth observation activities with Envisat and GMES. It is also working on ESA microgravity and exploration programmes, on EGNOS for navigation and on the Space Situational Awareness Programme (focusing on space weather), as well as technology activities and educational projects. PW-Sat, the first Polish student satellite, was launched on the maiden flight of Vega in February.

A major milestone: the November 2012 ESA Council at Ministerial level

On 20-21 November, Ministers of the ESA Member States took a series of decisions defining strategic objectives for the next decade, starting a process for the evolution of ESA and funding programmes/activities for an amount of around €10bn. The decisions taken – following on from the Council Ministerial in The Hague in 2008, when almost €10bn was similarly agreed in already worsening economic conditions – are testimony to the fact that space spells effective investment in growth, innovation and knowledge for the benefit of all citizens.

The new investment approved at the Ministerial was carefully balanced between three complementary strategic objectives: pushing back the frontiers of knowledge; supporting an innovative and competitive Europe; enabling space-based services.

The first objective (pushing back the frontiers of knowledge) will be achieved thanks to a smart combination of mandatory activities within ESA's Science Programme (exploring the solar system and the universe) and optional activities that take into account the Earth sciences for an increased understanding of our planet (the 4th slice of the Earth Observation Envelope Programme), the science coming from the exploitation of the ISS and the space exploration programme to enable Europe to take part in humankind's future ambitious adventures of discovery and innovation.

The second objective (supporting an innovative and competitive Europe) involves substantial investments in telecommunications, launchers, technology research and technology transfer. The investment in telecoms is being complemented through partnerships mostly with private partners (industry and operators). Telecommunications is the primary commercial field of space activities. **Public-Private Partnerships** (PPP) are the basis for the development of the next-generation platforms, including satellites fully operated by electric propulsion. In the launchers sector, the main objective is to decide and properly manage its evolution within the next decade. Today, European launch services are the most reliable in the world. But economically speaking, they operate in a commercial market where competitors are heavily supported by a guaranteed governmental market. To meet the challenge of competitiveness, the Ministers have agreed on the one hand to the continuation of the development of an adapted version of **Ariane 5**, the **Mid-life Evolution**, with a re-ignitable upper engine Vinci, to be flown in 2018 at the latest. And on the other hand, to the detailed definition studies for the new **Ariane 6**, in order to receive industrial offers in 2014 with the aim of a maiden flight in 2021.

Finally, Europe's leading edge on world markets will be supported via the Technology Programmes which are interlinked with all other programmes.

The investments allocated for the third objective (enabling space-based services) are at least doubled through partnerships with Eumetsat and the European Union. These investments aim at maximising benefits derived from satellites to society and to the economy, in particular though programmes such as **MSG** in the field of meteorology, **IRIS** for safe communications in air traffic management, and **SAT-AIS** which deals with vessel identification for maritime surveillance. The European Global Navigation Satellite System Evolution Programme (**EGEP**), where the second generation of Galileo will be prepared, and the third slice of the space component of the EU-ESA **GMES/Copernicus** programme in the field of Earth observation for environment and security, are also part of this objective.

A look at 2013

The decisions taken by Ministers last November will build on a string of successes in space achieved by ESA, its Member States, researchers, industry and other stakeholders since the previous Council Ministerial in 2008. All these achievements demonstrate the high technical maturity of ESA, European industry and their partners, and the robustness of ESA's programmatic framework.

So 2013 will likewise be rich in activities and events, with 12 satellites planned for launch on seven separate missions, using all three of Europe's launchers. In the spring, the launch of **Proba-V** (vegetation) will take place on the second Vega flight from the CSG. An Ariane 5 will then carry the fourth ATV, named after Albert Einstein, to the ISS to deliver supplies for the crew (food, drinking water, oxygen), experiments and three tons of propellants to reboost the Station's orbit at regular intervals. At the end of May, ESA astronaut **Luca Parmitano** of Italy will fly to the ISS on a long-duration mission until November. He is the first of the new generation of six astronauts selected in 2009.

Over the summer, from Plesetsk we will witness the launch of the multi-satellite mission **Swarm** to study the magnetic field of the Earth. An Ariane 5 will instead carry into orbit the **Alphasat** mission, a PPP between ESA and Inmarsat. ESA is providing the first flight model of the new Alphabus platform to allow European industry to significantly extend its telecommunication satellite range by providing a new high-power multipurpose platform.

In the second half of the year, the first member of the new family of satellites of the EU's flagship programme GMES (Global Monitoring for Environment and Security) will be launched: Sentinel-1 on a Soyuz from the CSG. Another Soyuz will carry a much-awaited scientific satellite **Gaia** to chart and understand the evolution of our home galaxy the Milky Way.

Lastly, following the IOV phase-four satellites already in orbit that are being used to qualify the Galileo space, ground and user segments through extensive testing, the first Full Operational Capability satellites of the Galileo constellation will be launched, with two FOC launches planned, each on a Soyuz with two satellites onboard.

ESA does not develop and launch satellites just for the purpose of demonstrating the advanced technical capabilities of European industry. The exploitation of ESA spacecraft by the relevant space communities is the raison d'être for these missions. Unique results will be delivered by spacecraft in orbit, such as **SMOS** launched in 2009 to study soil moisture and ocean salinity, and **Planck** also launched in 2009 to help chart the birth of the universe and its evolution. These will take place in the first part of the year. Then, hundreds of scientist will present and share the results of ESA Earth Observation missions studying the Earth's environment/climate at the Living Planet Symposium to be held in Edinburgh from 9 to 13 September. The decisions taken last November will ensure that such events continue to be a highpoint in the scientific calendar for many years to come.

The Sun will reach a maximum in its 11-year cycle of activity, one which is likely to be the weakest for a century. Throughout the year, ESA's fleet of spacecraft currently operating (including SOHO, Cluster, Swarm, Mars Express, Venus Express) will concurrently observe the Sun and the impact of its activity on our solar system's three terrestrial planets, providing an unprecedented view of how magnetic fields shield a planetary atmosphere from powerful solar eruptions.

In June the European-built orbiter **Mars Express** will celebrate 10 years in orbit. This event will be marked by the release of the complete mineralogical map of the Red Planet, in particular hydrates telling the history of water and supporting the selection of landing sites for the **ExoMars** missions of 2016 and 2018. At the end of the year (29 December), the orbiter will perform the closest ever fly-by the Martian moon Phobos, passing only 58 km from its centre (within around 47 km of its surface). Flying so close to the surface will in itself be a navigation feat and will provide an unprecedented determination of the moon's mass distribution.

The **Herschel** mission has been operating since 2009, painstakingly mapping the plane of our galaxy the Milky Way, one small segment at a time. A complete map of the galactic plane will be released end-of-year, allowing scientists in Europe and all over the world to study in detail all the sites where stars are currently forming in our galaxy.

All these successes are thanks to the continuous support provided by ESA's Member States, the unique capabilities of European industry, and the partnerships that ESA has built up with its Member States, the EU, private investors and international players.