Yearly Status Report on the Scientific Programme

Year 2005

Topics **Pages**

1. Introduction

After another year of extraordinary success, the Science Programme looks towards a positive future, following the decision on the new Level of Resources agreed at the Berlin Ministerial Council meeting. The decision to grant a 2.5% annual increase recognises the importance of the Programme on a European scale not only from a scientific point of view. This sends a message of confidence and encouragement to the scientific community throughout Europe. A major element of achieving the outcome was the Cosmic Vision long-term plan, for which we are indebted to our advisory structure. Nonetheless, it has to be understood that the actual financial increment does not allow for more than a limited expansion of the core science programme.

The new Aurora exploration infrastructure offers perhaps more potential for a science return in Mars science and this may be more effective as a space science platform than the previous large ISS infrastructure project, where the possibilities for space science exploitation of the infrastructure have continued to recede during the year.

Our successes include the historic landing on Titan by the European Huygens probe on January 14th, an event followed over the entire world. Mars Express has throughout the year provided a stream of new information on Mars. After a nail-biting series of activities in the late Spring and Summer, the Italo-American MARSIS antenna was deployed and first results have been announced in early December. Smart-1 triumphantly completed its technological mission by achieving lunar polar orbit in the Spring and is now in process of conducting a scientific survey. The Agency's experience and the science data are eagerly awaited by the nations following us back to the Moon - India, China, Japan and the USA. The Science Programme completed an outstanding year by launching Venus Express on a Starsem Soyuz-Fregat rocket on November 9th. From a scientific perspective, this mission seems to be opening a new era of international interest in Venus, Earth's sister world, which suffered an early catastrophic greenhouse effect. An understanding of this remains of critical importance to Earth - as well as planetary-science.

Venus Express has quelled suggestions that the Agency could not do truly cheaper and faster missions. Venus Express was built in 33 months, on a time scale similar to a standard communications satellite. Having done this, one can examine the programme to see what allowed it. A programme as fast as this has to use as much 'off-the-shelf" hardware and software as possible. It also cannot afford to fine-tune industrial return (so the remainder of the programme must be big enough to take up the slack) and one needs to have Agency and industry teams that have already completed largely similar tasks (in this case, Mars Express).

Venus Express is yet more evidence of SPC using the Science Programme to explore innovative approaches to elements of the programme procurement. Major changes in approach to mission implementation and procurement have been introduced over the year at the SPC. Over the past decade, in response to demands for changes in procurement approach elsewhere, new mission implementation approaches have been introduced including imposing *juste retour* targets on primes, the hybrid 'maximum target price' approach to contracts, the streamlining of the traditional phase A/B/C/D development to launch, in favour of a competitive definition/non

competitive implementation phase approach. The latter has also required a controlled interfacing of scientists and industry during the competitive phase. Following the disappointing outcome of the LoR debate in November 2001 at Edinburgh, the SPC itself moved to a creative restructuring of the programme (approved at the SPC Andenes meeting in June 2002) setting very reduced target prices for previously agreed programme elements.

The success of Venus Express can be attributed to Andenes. Similarly, the present much reduced demand on the programme foreseen originally for GAIA is another solid benefit in circumstances where the budget has more than 20% less spending power than when GAIA was selected.

In contrast, the problems of the Herschel-Planck programme represent a more disappointing outcome of innovative approaches. The SPC has studied, through a dedicated working group, the financial difficulties encountered in the development of the two cryo-cooled spacecraft, probably the most ambitious development projects ever undertaken by the programme. The collective nature of the management problems associated with the diffuse partnerships taken on by ESA for mission-implementation (with national institutes) and funding (with Member States and the Prodex programme) as much as the complex industrial structure required by such a large programme, contributed to the problems. The SPC chairman's report issued in May 2005 and the lessons to be learnt were interesting reading. Policies introduced following lessons learned exercises on Herschel-Planck (and also Beagle2) are now taking effect. The introduction of formal agreements for payload development seek to introduce more managerial control over the impact of payload delays on projects as well as better empowering the scientific leaders of instruments. Formal agreements could well form a basis for 'network of centres' implementation in other spheres. At the same time, the effects of a more conservative approach to risk assessment and cost engineering put in place for future project cost assessment are now being felt.

The innovations referred to in the previous paragraph involve and even empower the SPC in critical managerial choices early on (in phase B) and allow applying sanctions with much less risk of the wasted expenditure that is inevitable if such actions were to be taken during phase C/D. At present, the SPC is due to make critical decisions on proceeding with GAIA and BepiColombo. Both are now predicted to exceed the Andenes targets. Moreover, at the time of writing, a formal agreement for the BepiColombo payload is yet to be agreed. It is expected that the SPC will make its critical decisions in February 2006.

Risk management has been pioneered in the Agency in the Science Programme. Using a more conservative risk assignment approach will come at a cost. The SPC and Council will need to decide the cost-benefit of the new priority for minimising surprises in the future. In this respect, the table at Annex "Average Schedule Elongation Factor" (ASEF) is worth analyzing. One sees the clear preponderance at high level of launch induced delays (Ariane or Shuttle) or delays induced by the technical or financial problems of payload providers or cooperating partners. Finally, the one risk in the hands of the agency is cryo-technology related (ISO). We can also look at the list and compare it to the future, ie, the existing portfolio of missions to come. Cryo-technology remains a risk element with both Herschel and Planck; however nobody can deny that payload development has been a bigger problem so far in this programme. JWST, LISA, LISA-PF, like Ulysses, HST, and SOHO are subject to risks from the US as well as an element of launch risk. Herschel, Planck and JWST hopefully will use an Ariane 5 ECA that is well-proven and so launch risk is much lower than with Cluster or

Rosetta. However, the move of Soyuz to Kourou and the use of VEGA are not entirely devoid of risk, although it may be impolitic to indicate this widely.

It is not intended here to reiterate the Science Programme's part as a backbone of the Agency, two papers to Council made this point well during the year and the reader is referred to the documents ESA/C(2005) 68 and ESA/C(2005)157. However, it is important to look ahead. One special aspect of the Science Programme, which sets it apart (as evidenced for example by the large number of spacecraft currently in operation) is its capacity for taking a long term view and its long-term planning. The most recent long-term planning exercise 'Cosmic Vision 2015-2025' is now complete. The response to the exercise from the scientific community and the outcome, shows the exciting challenges that the European science community see ahead. The outcome of the Cosmic Visions process has been distilled through the SSAC and presented to the wider community at a symposium at ESTEC (April 19th to 22nd 2005). The exercises culminated in the SSAC report "Space Science for Europe 2015-2025 (ESA Publication BR-247, summarized in the recently published brochure, which was distributed at the Ministerial Council). It is based on this report that the foundations for future science missions in the period 2015-2025 have been laid.

The list below indicates the major strands of research for the coming years:

- Other worlds and life in the Universe,
- Life and habitability in the solar system and beyond,
- The early Universe,
- The evolving violent Universe ,
- The gravitational wave Universe,
- From the Sun to the Earth and beyond,
- Tracing the origin of the solar system,
- Toward quantum gravity,
- Beyond the standard model.

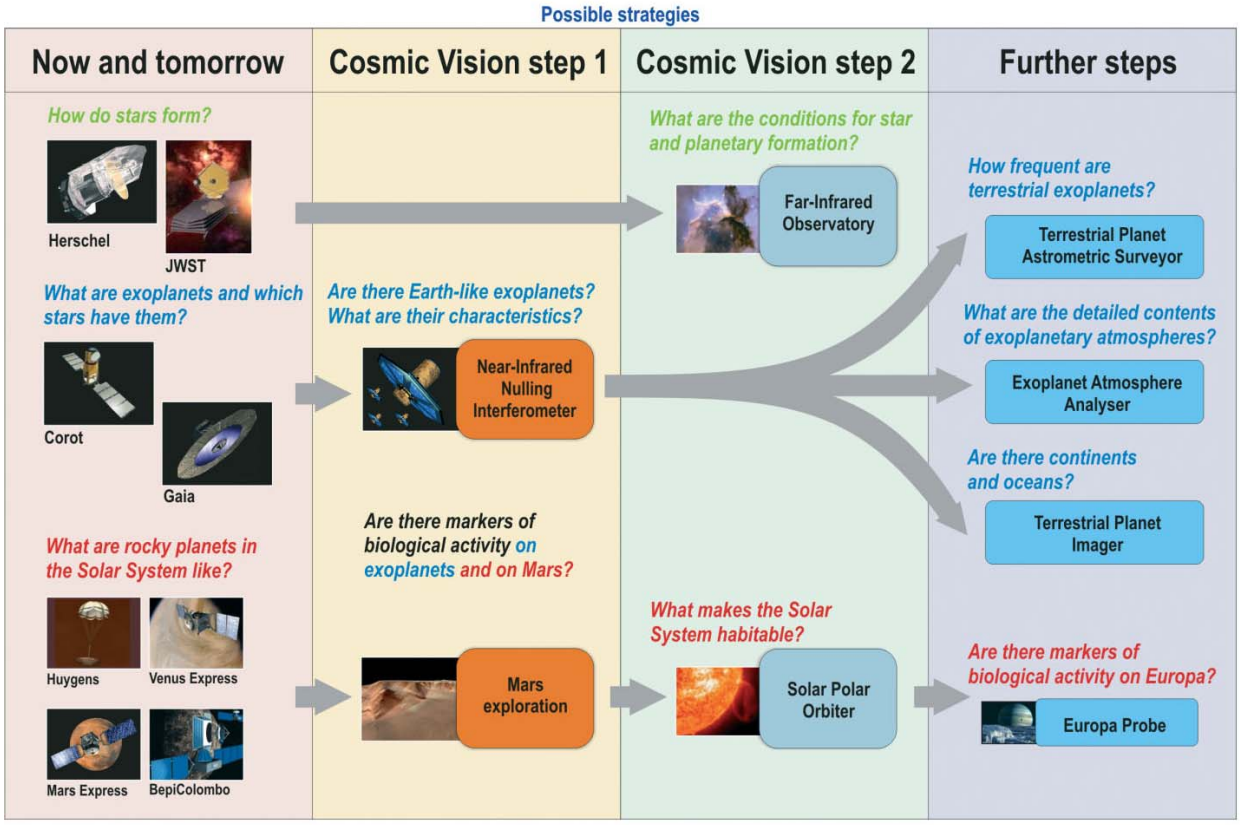
See pages 6 and 7.

Whether or not ESA and its Member States can step up to the challenge depends not only on the Berlin LoR but also on the SPC's policy towards missions in the existing plan that exceed targets. Come what may, the document will inform technology targets for the programme, continuing to keep the Science Programme one of the key users for programmes like TRP, most likely to see technology from inception through to space use.

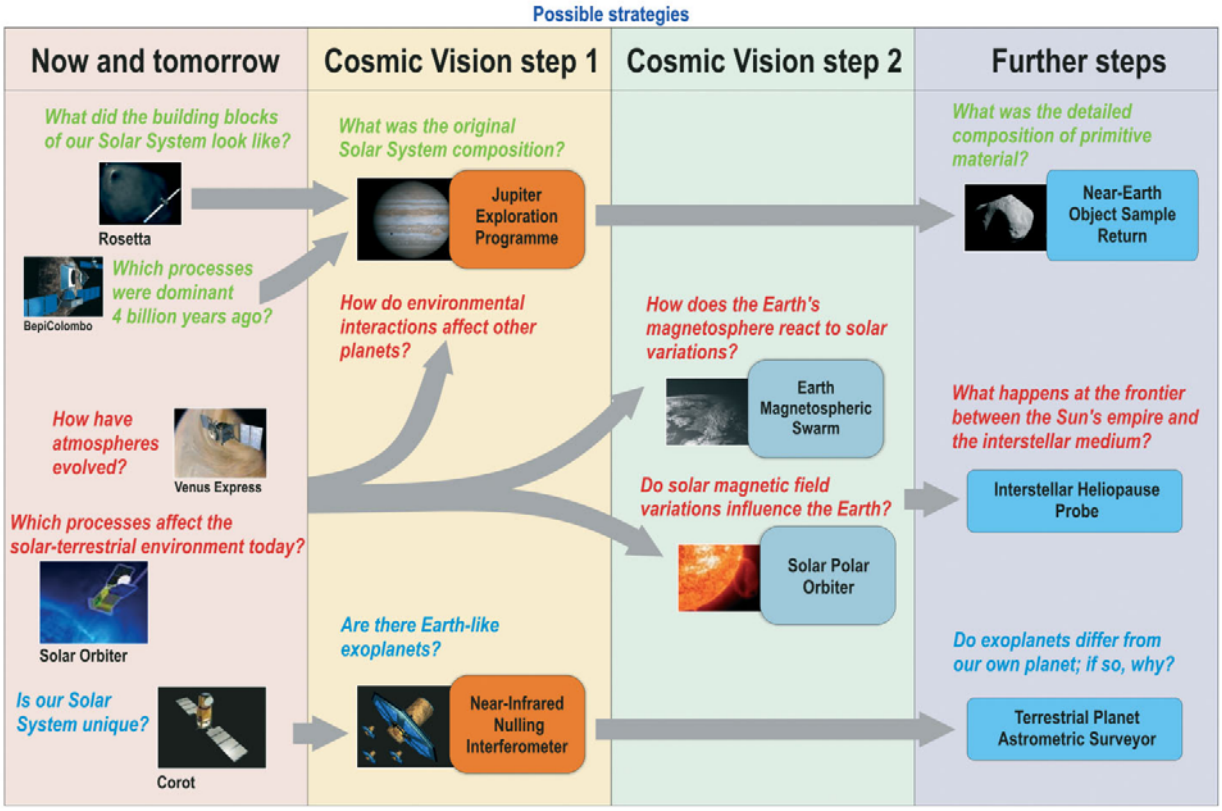
At the same time, one should question the reality of the vision. There have been suggestions from certain quarters that it is time once again for an external assessment of the scale of the Science Programme and its purpose, in the context of European science as well as its wider function within Europe and in sustaining infrastructure within the Agency. The last such review was made nearly twenty years ago and chaired by Professor Klaus Pinkau. We are now leaving a year where the programme has given the Agency unparalleled public attention and yet we are heading inexorably towards a spring of very hard decisions and cutbacks. It is clear that the effects of the peak in investment made a decade ago, are beginning to wear thin. It seems to the Executive sensible to ask once again for an external view on what should be the future perspective for management and resourcing the programme, that has been the backbone of the agency up till now.

Cosmic Vision – Essential questions

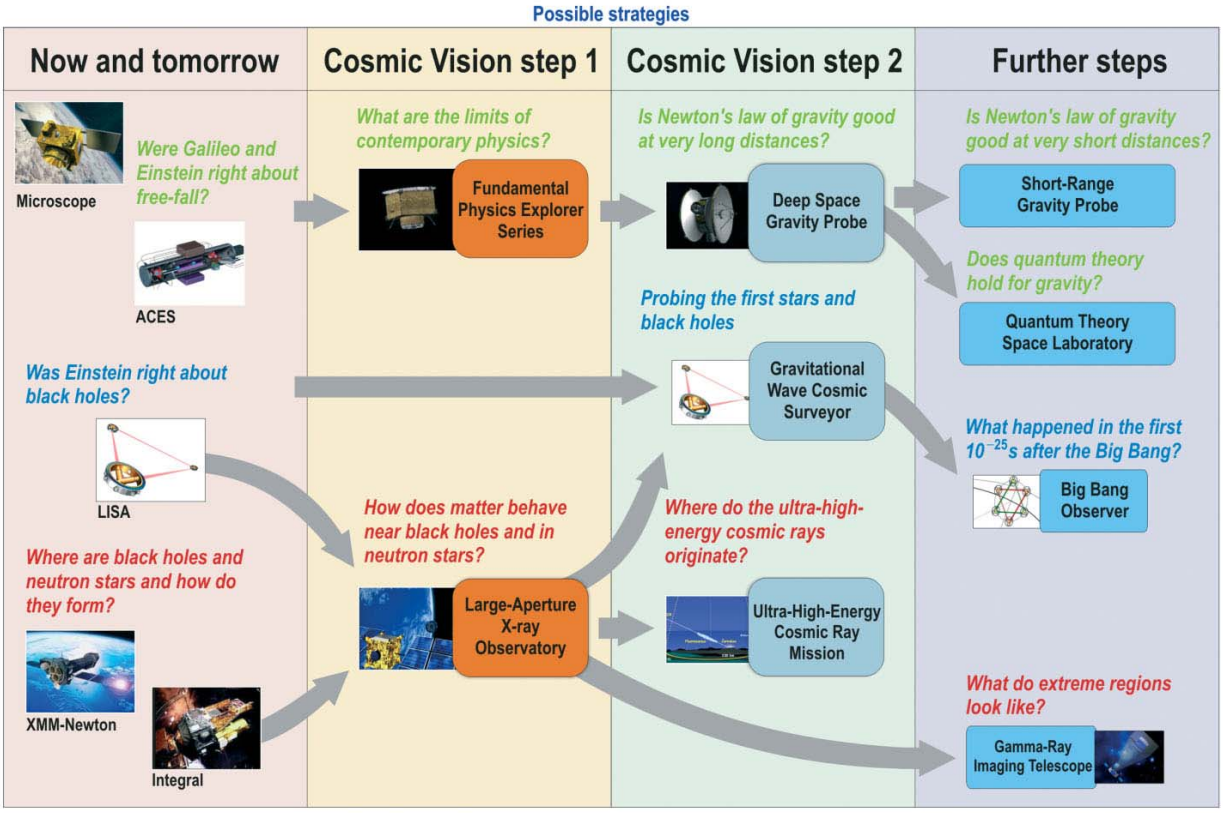
1. What are the conditions for planetary formation and the emergence of life?



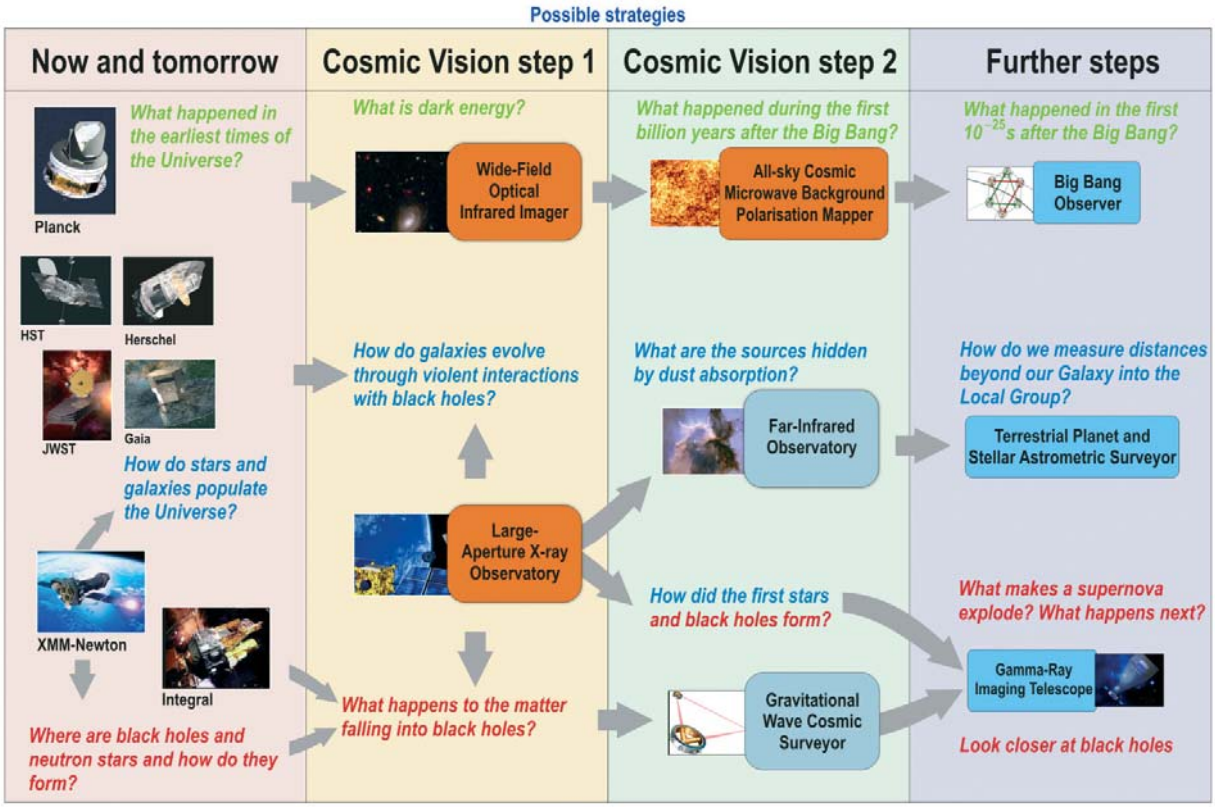
2. How does the Solar System work?



3. What are the fundamental physical laws of the Universe?



4. How did the Universe originate and what is it made of?



2. Satellites in orbit

2.1 The missions

The situation is summarized in Table 2.1 Details are found at the WWW addresses indicated in column 4.

Table 2.1

Mission Names	Launch date - End Operations	Main 2005 Events	WWW addresses
Hubble Space Telescope	24 Apr.90 – 31 Dec. 2010	• To mark the 15th anniversary of HST, ESA issued a book of the best images as well as a DVD of science achievements. Both were very well received. • Measurements of early galaxies from the HST Ultra Deep Field show a complex formation process of the first building blocks of the Universe. • Almost 5000 publications have appeared in the literature to date. • A new Director of the Space Telescope Science Institute has been appointed. • Shuttle Servicing mission now being developed. Critical decision will be taken in mid-2006.	**http://sci.esa.int/ and http://ecf.hq.eso.org and http://www.stsci.edu**

Mission Names	Launch date - End Operations	Main 2005 Events	WWW addresses
Ulysses	6 Oct. 90 – 30 Sep. 2004	• 15th year in orbit. • Ulysses Colloquium held at JPL on 6 October to mark launch anniversary. • Payload power sharing in operation to maintain power/thermal environment of S/C platform during coldest mission phase to date. • All data in public domain. • More than 1200 publications to date. • S/C position on 31 Dec. 2005: 37 degrees S solar latitude; 4.5 AU from the Sun.	**http://sci.esa.int/ulysses/ and http://helio.esa.int/ulysses/**
ISO **I**nfrared **S**pace **O**bservatory	11 Nov. 95- 9 Apr. 98 ISO active archive phase: 2002 - 2006	• January 2005: successful participation in Astrophysical Virtual Observatory demo at ESAC, with a science case based on data from ISO and other archives. • May & July 2005: upgrades to the ISO Data Archive simplifying its long-term maintenance and enhancing visibility of Highly Processed Data Products. End 2005: Space Science Reviews special issue devoted to ISO results (460 pages). Published by Springer.	**http://sci.esa.int/iso/ and http://iso.esac.esa.int**
Soho **SO**lar and **H**eliospheric **O**bservatory	2 Dec. 95- 31 March 2007	• All data in public domain • 9th Anniversary of SOHO in L1 orbit • Over 2200 papers in refereed literature • 16th SOHO Workshop, Whistler, Canada, 12-17 June 2005.	**http://sci.esa.int/soho/ and http://soho.esac.esa.int**

Mission Names	Launch date - End Operations	Main 2005 Events	WWW addresses
Huygens/Cassini	6 Oct. 97- 03 July 2009	• Probe was released on 25 Dec. 2004. • Probe entry and successful landing on 14 Jan. 2005 at 9:07. • Probe survived >3h 14 min on the surface. • ESA industrial support contract being closed. • Additional industrial support for post-mission performance analysis and lessons learnt (GSP activity) to start before end of 2005 (9 months). • Coordinated Huygens publications to appear in Nature (8 Dec. issue).	**http://sci.esa.int/huygens**

Mission Names	Launch date - End Operations	Main 2005 Events	WWW addresses
Newton **X**-ray **M**ulti-**M**irror Mission	10 Dec. 1999- Operations funded until end March 2008.	• Mission routinely providing high-quality, high-impact science data. • New release of Newton Science Archive (XSA): version 2.8 Aug. 2005. This new release a.o. allows access to a sample of multi-colour optical images from the XMM-Newton Survey Science Centre X-ray identification follow-up program. • Version 6.5 of the Science Analysis Software (SAS) released Aug. 2005. This version a.o. allows better modeling of spatial and temporal response dependencies leading to much better cross-calibration among the EPIC instruments. • AO-5 opened on 5 Sept. and closed on 14 Oct 2005. 643 proposals were submitted, totaling 7.4 times oversubscription of time available. • Newton ground segment upgrade to SCOS2000 completed in June 2005. • Over 950 refereed papers directly based on Newton results now published.	**http://sci.esa.int/xmm/**

Mission Names	Launch date - End Operations	Main 2005 Events	WWW addresses
Cluster	2 spacecrafts: 16 July 2000 2 spacecrafts: 9 August 2000 Operations funded until 31 Dec. 2009 (with medium term review at end 2007)	• Extension of mission from beginning 2006 to 2009 (review at end 2007) • 9th Cluster Workshop at Observatoire de Paris Meudon, France (07-09 March) • 6th constellation manoeuvres in June-July 2005. Spacecraft separation increases from 1000 to 10000 km. • Cluster-Double Star symposium to celebrate 5 years of Cluster in space held at ESTEC 19-23 Sept. 2005 • Over 350 papers in refereed journals. ISSI book on "Cluster at the outer magnetospheric boundaries".	**http://sci.esa.int/cluster/**
SMART-1	27 September 2003 to mid 2006	• One-year mission extension approved • End of primary technology mission and start of nominal science mission in Feb. 2005 • July: end of nominal science mission. • August: Reboost manoeuvre to achieve optimum orbit for Extended Mission. • SEP engine shut down in Sept. as all fuel consumed. • Restart of Science operations in Oct. 2005. Implementation of push-broom operation for AMIE imaging system.	**http://sci.esa.int/smart/**

Mission Names	Launch date - End Operations	Main 2005 Events	WWW addresses
DOUBLE STAR	1 spacecraft: 29 Dec. 2003 1 spacecraft: 25 July 2004 Operations funded to end 2007.	• Extension of the mission from mid-2005 to end 2007. • Special Double Star session at EGU in Vienna and AGU in San Francisco. • Cluster-Double Star symp. held at ESTEC 18-23 Sept. 2005. • Special issue of Annales Geophysicae with first results from Double Star.	**http://sci.esa.int/doublestar/**
ROSETTA	02 March 2004 – December 2015	• First Earth swing-by on 4 Mar. 2005 at 1900 km altitude. • In-flight validation of Asteroid Flyby mode. • Support to Deep Impact campaign. • Monitoring of Comet Tempel 1, 27 Jun – 15 July. • Four remote sensing instruments operating in parallel (OSIRIS, VIRTIS, MIRO, ALICE) • First science results from mission published in refereed journals. • Near Sun Hibernation Mode successfully tested and commissioned in-flight in April – May 2005. • First routine Passive Cruise started. • Near Sun Hibernation Mode exited on 18 Aug. due to anomalous thrusting behaviour.	**http://sci.esa.int/rosetta/**

Mission Names	Launch date - End Operations	Main 2005 Events	WWW addresses
		• Spacecraft remains in Normal Mode on low activity profile during quiet cruise, including solar conjunction, until Aug. 2006.	

2.3 The activities of the Research and Scientific Support Department (RSSD)

The main tasks of the Research and Scientific Support Department (RSSD) are to provide scientific management and support to projects in the ESA Scientific Programme during planning, development and operations and to act as interlocutor between ESA and the scientific community. As a necessary part of fulfilling these tasks, the Department's scientists pursue scientific research.

Highlights of the year included the highly successful landing of the Huygens probe on Titan and the successful deployment of the MARSIS radar booms on Mars Express.

The Department's Project Scientists supported the development phase of the approved projects: Herschel/Planck, Venus Express, BepiColombo, Gaia, JWST, LISA Pathfinder, LISA, ASTRO-F and ACES (supporting D/HME). The Department also has responsibility, through its project scientists and supporting teams, for all scientific aspects of the operations and post-operations phases of ISO, HST, Ulysses, SOHO, Huygens, XMM-Newton, Cluster, Double Star, INTEGRAL, Mars Express, SMART-1 and Rosetta including overall mission management. In addition, the Department provided scientific support to the studies of potential future scientific missions and ISS payloads through the Study Scientists for Solar Orbiter, Darwin, Hyper, Xeus, Lobster and Rosita.

In line with the Department's support role to the science community, the development and maintenance of scientific data archives has continued to be an important task. The approach initially developed for ISO has now been extended to XMM-Newton, INTEGRAL and planetary missions, including Mars Express, Rosetta and SMART-1. In solar terrestrial physics, the Cluster Active Archive is currently in its commissioning phase – opening to the public is planned for 1 February 2006. An increased role in virtual observatory activities has been undertaken and this is closely linked to the increased astronomical archiving tasks in ESAC. Work also continues on data analysis of ESA missions, notably Cluster, Double Star, SOHO and Ulysses. The instrumentation contribution to COROT (CNES) and STEREO (NASA) is now complete.

Scientists in the Department are encouraged to pursue active research work as well as their functional duties. The Research Programme is organized in thematic research groups covering different areas in astrophysics, solar physics, heliospheric and space plasma physics, comparative planetology and astrobiology, minor bodies and fundamental physics. These topics reflect the breadth of the Cosmic Vision programme. Staff scientists continue to be awarded observing time on both space-based and ground-based observatories. The role of the Research Fellows in the development of the research activities of the Department are essential for the programme itself and found to be fundamental for the core duty of an active connection between ESA and the

scientific community at large. The number of papers being published in the refereed literature by ESA staff scientists has again risen over the last year.

Contributions to various external bodies have also continued during the year: collaboration with ESO has focused on the optimization of existing or planned facilities to deliver the best possible service to the Community by exploring ways of improving coordination. Opticon is another forum for discussion with ground-based observatories, where attention has been paid to future virtual observatories including space data. Contributions to EIROforum on the other hand allowed us to share with other European intergovernmental organizations approaches to new technologies, mobility of scientists, service-providing facilities, outreach and education etc. and possible links with programmes in the European Commission.

Finally, it was with great pleasure that we celebrated the 40th anniversary of the Department – which was started in 1965 under its original name of ESLAB. Over the last 40 years the Department has contributed to the launches and subsequent scientific performance of nearly 30 missions starting with ESRO-II in 1968 up to the recent launch of Venus Express in November 2005! This year also saw the 15th anniversary of the launches of both HST and Ulysses, the 10th anniversary of the launches of ISO and SOHO and the 5th anniversary of the launch of the Cluster spacecraft. In fact, the Science Programme currently has a record 16 satellites in orbit.

3. The Science Payloads and Advanced Concepts Office

The Science Payloads and Advanced Concepts Office (http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=31510) conduct studies of future mission scenarios not currently in the Science Plan, as well as assessments of missions yet to enter the formal development phase with SCI-P. In addition, the Office, through its emphasis on instrument technical skills and technology, provides support to the projects in the development phase, with respect to payloads. Many leading edge technology programmes are conducted within the Office for the longer term benefit of the Science programme. The Office also continues to provide the laboratory technical infrastructure for the Science Directorate as well as support to the Research and Scientific Support Department. SCI-A have provided and will continue to provide the support to the community and the Science advisory structure within the Cosmic Vision programme.

4. Projects under definition and under development

4.1 Projects under Development

The situation is summarised in Table 4.1. Details are found at the www addresses indicated in column 4.

Missions	Planned Launch Date – End Operations	Main 2004/2005 Events	www address
Corot	Mid 2006 2.5 years of operations	• Project on-going under CNES management	**http://corot-mission.cnes.fr/**
Microscope	March 2009 1 year of operations	• S/C project on-going under CNES management • ESA project on-going for the supply of the FEEP electric propulsion subsystem (EPS) • EPS Delta-closed in July 2005 • S/C PDR planned for February 2006	**http://smsc.cnes.fr/MICROSCOPE/index.htm**
Venus Express	9 November 2005 2 years of operations (including cruise phase)	• Flight Acceptance Review successfully completed 1st July 2005 • Shipment to launch site in Baikonur 6th August 2005 • Launched on 9 November 2005 • Venus Orbit Insertion planned 11 April 2006	**http://sci.esa.int/venusexpress**

Missions	Planned Launch Date – End Operations	Main 2004/2005 Events	www address
Herschel/Planck	Aug. 2007* - Herschel 4 years of operations Planck 2 years of operations	• Closure of Mission CDR in Spring 2005 • Planck qualification model testing completed. • Herschel model protoflight testing ongoing. • Flight model hardware mostly available and already under integration and test. Planck SVM delivered, Herschel SVM in integration. • Development of the ESA furnished Herschel telescope (Silicon Carbide) nominal with FM under final tests. Planck Telescope Reflectors completed. Cryogenic optical testing still to be completed. • Launch date driven by availability of the scientific instruments. Intensive support provided by national funding agencies and ESA to complete instrument flight model activities. *Nominal launch date of August 2007 not compatible with projected FM instrument availability. Update to be made when instruments delivery date become reliable.	**http://sci.esa.int/herschel/** **http://sci.esa.int/planck/**

Missions	Planned Launch Date – End Operations	Main 2004/2005 Events	www address
LISA Pathfinder (former SMART-2)	Second half 2009 11 Months of nominal operations	• Mission dedicated to test the key technologies of gravitational wave detection, preparatory to LISA • Industrial contracts with Prime and LTP (LISA Technology Package) Architect on going • Preliminary Design Review of System and LTP successfully held • Preliminary Design Review of the NASA provided DRS (Disturbance Reduction System) payload planned early 2006. • Launch planned for second half 2009	**http://sci.esa.int/lisapf**
JWST	June 2013 5.5 years of operations	• Funding crisis at NASA has led to a delay of launch date to June 2013 • Overall JWST mass crisis has led to a significant change in the spacecraft design and a change to active cryocoolers in place of a solid hydrogen-based cryostat for MIRI. The interface to the MIRI instrument is largely unchanged, thus avoiding a big impact on ESA • All flight primary mirror blanks (18) for the main telescope have been produced and machining of 9 blanks is ongoing	**http://sci.esa.int/jwst**

Missions	Planned Launch Date – End Operations	Main 2004/2005 Events	www address
JWST (Cont.d)		• System design of NIRSpec is complete and the detailed design phase is ongoing. PDR is planned 1st December. • Selection of subcontractors for NIRSpec is ongoing. Contractors for critical subsystems have been kicked-off. • MIRI PDR successfully completed • MIRI Structural Thermal Model vibration and cryo stability test successfully completed. Final thermal balance test is ongoing • Manufacturing of parts for MIRI Verification Model is ongoing • MIRI CDR campaign starts in March 2006	

4.2 Projects under Study

The situation is summarised in Table 4.2. Details are found at the WWW addresses indicated in column 3.

Table 4.2

Names of the satellites	2004/2005 Events	WWW addresses
BepiColombo Mercury Orbiter	• Mission responsibility, including the Mercury Planetary Orbiter (MPO), is with ESA • ISAS/JAXA will provide the Mercury Magnetospheric Orbiter (MMO) • Mid Term Review of the definition phase 2 has been completed with two competing prime contractors • The Definition Study Review has been completed with two competing prime contractors • The proposed payload selection for the European spacecraft has been approved by the SPC in November 2004 • The payload selection process for the Japanese spacecraft is on-going • Feasibility demonstration studies of 3 instruments have been successfully completed and recommendations have been made for endorsement by the Advisory Structure • A letter of Agreement with JAXA has been signed and a Memorandum of Understanding is in work. • Technology development is on-going • The ITT for the implementation phase was delayed due to insufficient margins for a Soyuz based mission. • Reassessment on going to restore proper margins. • Launch on Soyuz-Fregat from Kourou has been delayed to August 2013.	**http://sci.esa.int/bepicolombo**

Names of the satellites	2004/2005 Events	WWW addresses
GAIA ***Global Astrometric Interferometer for Astrophysics***	• Technology development is on-going. • Definition Study on-going. • ITT for implementation phase issued (Phases B2/ C/D /E1) • Proposals received and evaluation on going • Technology development successfully completed; two new contracts issued • Launch on Soyuz-Fregat from Kourou is planned in December 2011	**http://sci.esa.int/gaia**
LISA ***Laser Interferometer Space Antenna***	• Cooperation with NASA for the Formulation Phase has been agreed. • Formulation Phase started 1st December 2004 • Launch date assumed by ESA for planning purposes is planned for 2015.	**http://sci.esa.int/lisa**
Solar Orbiter	• Mission assessment on-going in SCI-A making full use of the synergies with the BepiColombo mission. • The project is ready to go into the definition phase • The Announcement of Opportunity for the payload procurement is planned for early 2006. • Launch is planned in May 2015 on Soyuz-Fregat from Kourou	**http://www.esa.int/science/solarorbiter** **http://solg2.bnsc.rl.ac.uk/~harrison/orbiter.html**

4.3 Projects under assessment

The situation is summarised in Table 4.3. Details are found at the WWW addresses indicated in column 3. In addition to those potential missions listed in Table 4.3 as under assessment a number of technology reference missions have been, and are being studied, as preparatory activity for the future Cosmic Visions programme. Essentially these are embryonic missions which represent a potential response to the themes identified within the Cosmic Visions programme.

Table 4.3

Names of the satellites	2003/2004 Events	WWW addresses
DARWIN *InfraRed Space Interferometer*	• The detailed optical architecture has been studied around a nulling interferometer and trade-offs completed leading to a baseline mission profile. The mission is now undergoing a system level study.	**http://sci.esa.int/home/darwin/index.cfm**
XEUS *X-ray Evolving Universe Spectroscopy Mission*	• Mission assessment underway with a mission profile now well established. • An ESA breakthrough in low mass mirror technology has now resulted in a feasible architecture. • A Technology development plan has been formulated and key elements are under implementation	**http://astro.estec.esa.nl/SA-general/Projects/XEUS/**

5. Financial situation and projections

5.1 Financial situation of the Scientific Programme

The Table 1 presents the financial situation and projections of the Scientific Programme as of 7th December 2005. These projections are revised, taking into consideration the decision regarding the Level of Resources 2006-2010 at the Council at Ministerial Level in Berlin on 5-6 December 2005 and the current realistic development plans and related best financial predictions. The previous report was presented to the SPC at its 111th meeting in May 2004 (ref. ESA/SPC(2005)20).

The **income** as presented in Table 1 reflects the decisions taken at the Council at Ministerial level, held in December 2005 in Berlin where a Level of Resources (LoR), covering the period 2006-2010, was approved for the Scientific Programme.

The income of the programme as shown in Table A below gives an overview of the resulting yearly figures as in the Resolution (ref. ESA/C-M/CLXXXV/Rés.2 (final)) in actual economic conditions and in 2005 EC, having estimated the inflation rate at 2.2% per year after 2006.

Table A (Meuro)

Year	**2006**	**2007**	**2008**	**2009**	**2010**	**Total**
Total Science Programme (at actual e.c.)	395.7	405.6	415.8	426.1	436.8	2080.0
Total Science Programme (at 2005 e.c.)	387.2	388.3	389.5	390.6	391.8	1947.4

From 2010 onwards, a continuation of this income scheme is assumed.

The loan reimbursement schedule is proposed to be relaxed through the approval of a Level of Resources beyond 2006, for a full reimbursement before the end of the formally approved LoR period (2006-2008). The current plan for the loan reimbursement can be summarized as in Table B (assuming an opportunity cost of 2% per year):

Table B (Meuro)

Year	**2004**	**2005**	**2006**	**2007**	**2008**	**Total**
Loan reimbursement	10.612	30.000	19.388	20.000	20.000	100.000
Opportunity cost	2.007	1.188	0.800	0.400	0.000	4.395
Total Financial re-adjustment	12.619	31.188	20.188	20.400	20.000	104.395

The **expenditure** information in Table 1 reflects the status of the Scientific Programme as of 7th December 2005. Following the request of the SPC at its extraordinary meeting of 15th September 2005 to be able to perform a reassessment of the programme using the best information possible, this paper introduces some new approaches and introduces a new term, “best financial prediction”, for projects foreseen within the programme, but where there does not yet exist a CaC. Here the figures are based on present expectations of what is needed to accomplish what is foreseen given the science requirements and the expected cooperative arrangements. Up to now for these projects, the planning presented to SPC had included only target CaC’s set by SPC. It will be recalled that actual CaC’s are approved by the SPC only as a project enters implementation phase and there is no intention on the part of the Executive to depart from this. Another change introduced in this paper is that increases in CaC are estimated for projects already approved, but where the increase in CaC has not been either consolidated or proposed to SPC (i.e. JWST and LISA Pathfinder). These estimates are for the SPC to be able to engage fully in the planning of the programme but do not constitute a proposal for approval.

For a detailed description of Table1, we refer to ESA/SPC(2005)28, rev.1.

5.2 The current Cosmic Vision Programme

The current version of the Cosmic Vision Programme is given in Figure 1.
The following significant changes have been implemented since the previous report to SPC in May 2005 (ref. ESA/SPC(2005)20):

- following approval by SPC at its 111th meeting in May 2005, the Double Star mission was extended until 31st December 2006 (ref. ESA/SPC(2005)18, rev.1);

- following approval by SPC at its 112th meeting in September 2005, the Mars Express mission was extended by one Martian year, until 31st October 2007 (ref. ESA/SPC(2005)17, rev.2);

- the launch of the LISA Pathfinder mission has been delayed by one quarter from mid 2009 until October 2009;

- the launch of the JWST mission has already been delayed by NASA to mid 2013; accordingly the delivery of the NIRSpec and MIRI instruments to NASA will be delayed to March 2010. Taking due account of the foreseeable misfit between JWST financial needs and available NASA budget in the coming fiscal years, the ESA planning provisions shown here are based on a mid 2014 launch purely for illustrative purposes. For now the project will work to meet the present NASA schedule;
- the launch of the LISA mission has been assumed to be delayed to September 2015, taking into consideration the current schedule of LISA Pathfinder.

5.3 Conclusion

The figures shown in Table 1 and the waterfall diagram in Figure 2 make it clear that even with the schedule adaptations proposed in the document above the overplanning is not limited to the immediate future and also exceeds the 150 Meuro norm regarded as prudent by the Executive. Hence, the Cosmic Vision programme is not affordable with the currently foreseen income projections, nor consistent with the issue of a call for mission proposals in 2006. The income decision for the 2006-2010 Level of Resources for Mandatory Activities at C-MIN 2005 alleviates matters, but Figure 2 shows that there is still need for a full programme analysis.

The financial data provided in the document presents an uncertainty as some of the internal data and estimates on costs need further refinements, which, however, are not expected to exceed a few percent.
The SSAC has defined the question as far as possible with the data available at that time (12-13 October 2005). The main concern of the SSAC was that new ideas need to be instilled into the programme through a call for mission proposals to be issued in early 2006. They wished work to start on the next generation of missions so that the expectations of the wide scientific community that responded to the call for themes in 2004 are not entirely disappointed. To achieve this, the SSAC asks:

- the support of the SPC and the whole scientific community to request that an increment of the funding to Space Science be proposed at the Ministerial Council in 2008.

- that, if budgetary difficulties still have to be overcome to implement the call for mission proposals, that the Solar Orbiter and LISA mission be reviewed around 2008, leading to a prioritisation before entering their implementation phase.

The SSAC makes no recommendation on the BepiColombo or GAIA projects. Clearly a decision on proceeding on both will be needed from SPC in February at the very latest. With the information now available in the present document, which goes in the direction of increased costs for missions both in implementation and yet to be started, the SPC should start considering their position.

The improved efforts to refine the expected cost inside and outside the Agency made for BepiColombo and GAIA have been very large. There should be more confidence that the SPC in future should not face the problems that they did on Herschel-Planck. Nonetheless, it should also be clear that the Executive has small expectation that either LISA or Solar Orbiter, as defined, can meet the targets set in 2003. The Executive would not suggest cancellation of any on-going mission at this time but the SPC might wish to address the principles behind cancellation on grounds of programmatic impact. They may also wish to advise on how the limitations of constrained budgets should be conveyed to the scientific community in any forthcoming call for ideas.

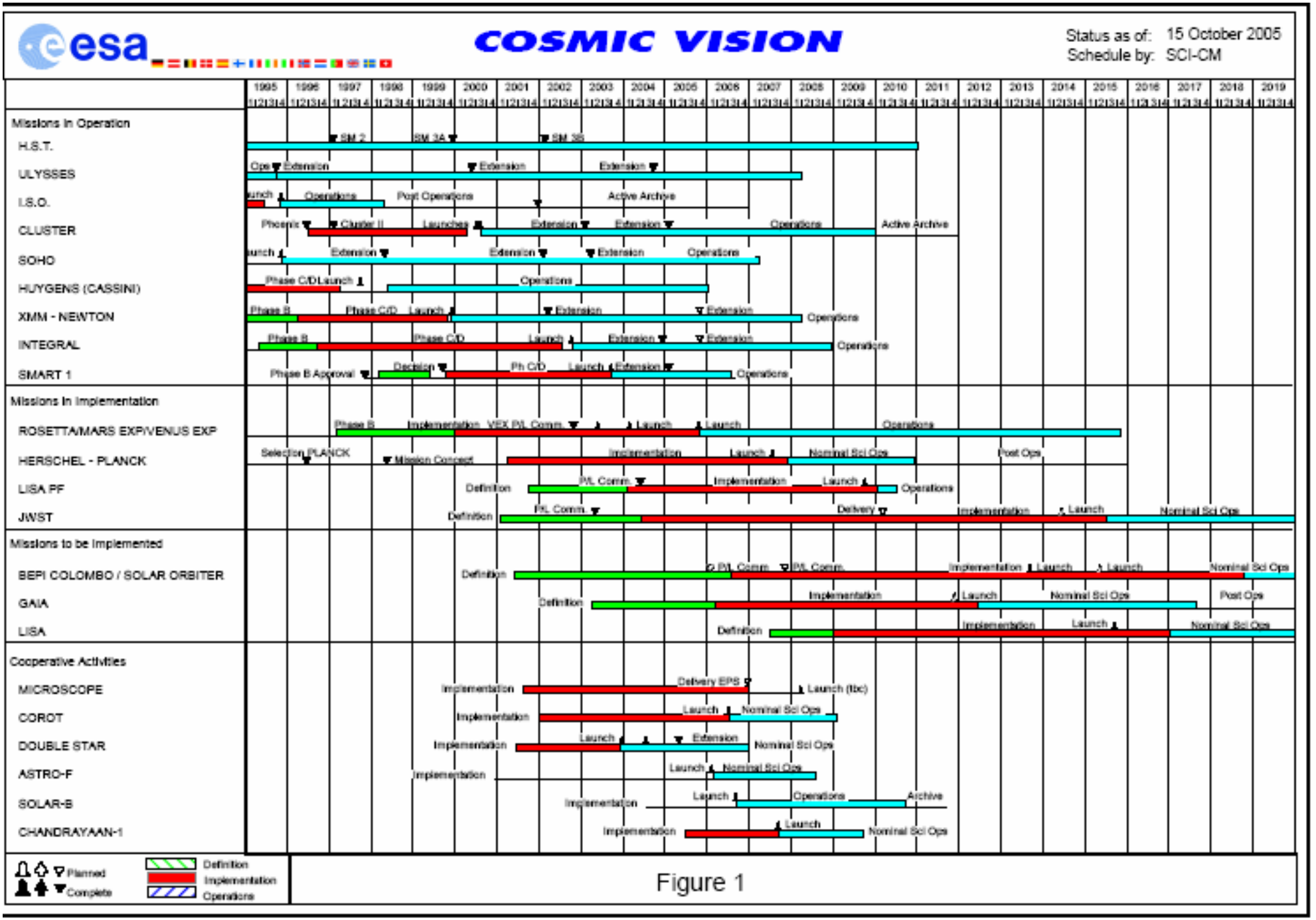

esa
COSMIC VISION
Status as of: 15 October 2005
Schedule by: SCI-CM
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019
Missions in Operation
H.S.T.
SM 2
SM 3A
SM 3B
ULYSSES
Ops
Extension
Extension
Extension
I.S.O.
Operations
Post Operations
Active Archive
CLUSTER
Phoenix
Cluster II
Launches
Extension
Extension
Operations
Active Archive
SOHO
Extension
Extension
Extension
Operations
HUYGENS (CASSINI)
Phase C/D
Launch
Operations
XMM - NEWTON
Phase B
Phase C/D
Launch
Extension
Extension
Operations
INTEGRAL
Phase B
Phase C/D
Launch
Extension
Extension
Operations
SMART 1
Phase B Approval
Decision
Ph C/D
Launch
Extension
Operations
Missions in Implementation
ROSETTA/MARS EXP/VENUS EXP
Phase B
Implementation
VEX P/L Comm
Launch
Launch
Operations
HERSCHEL - PLANCK
Selection PLANCK
Mission Concept
Implementation
Launch
Nominal Sci Ops
Post Ops
LISA PF
Definition
P/L Comm
Implementation
Launch
Operations
JWST
Definition
P/L Comm
Delivery
Implementation
Launch
Nominal Sci Ops
Missions to be Implemented
BEPI COLOMBO / SOLAR ORBITER
Definition
P/L Comm
P/L Comm
Implementation
Launch
Launch
Nominal Sci Ops
GAIA
Definition
Implementation
Launch
Nominal Sci Ops
Post Ops
LISA
Definition
Implementation
Launch
Nominal Sci Ops
Cooperative Activities
MICROSCOPE
Implementation
Delivery EPS
Launch (tbc)
COROT
Implementation
Launch
Nominal Sci Ops
DOUBLE STAR
Implementation
Launch
Extension
Nominal Sci Ops
ASTRO-F
Implementation
Launch
Nominal Sci Ops
SOLAR-B
Implementation
Launch
Operations
Archive
CHANDRAYAAN-1
Implementation
Launch
Nominal Sci Ops
Planned
Complete
Definition
Implementation
Operations

Figure 1

esa

COSMIC VISION

Status as of: 15 October 2005
Schedule by: SCI-CM

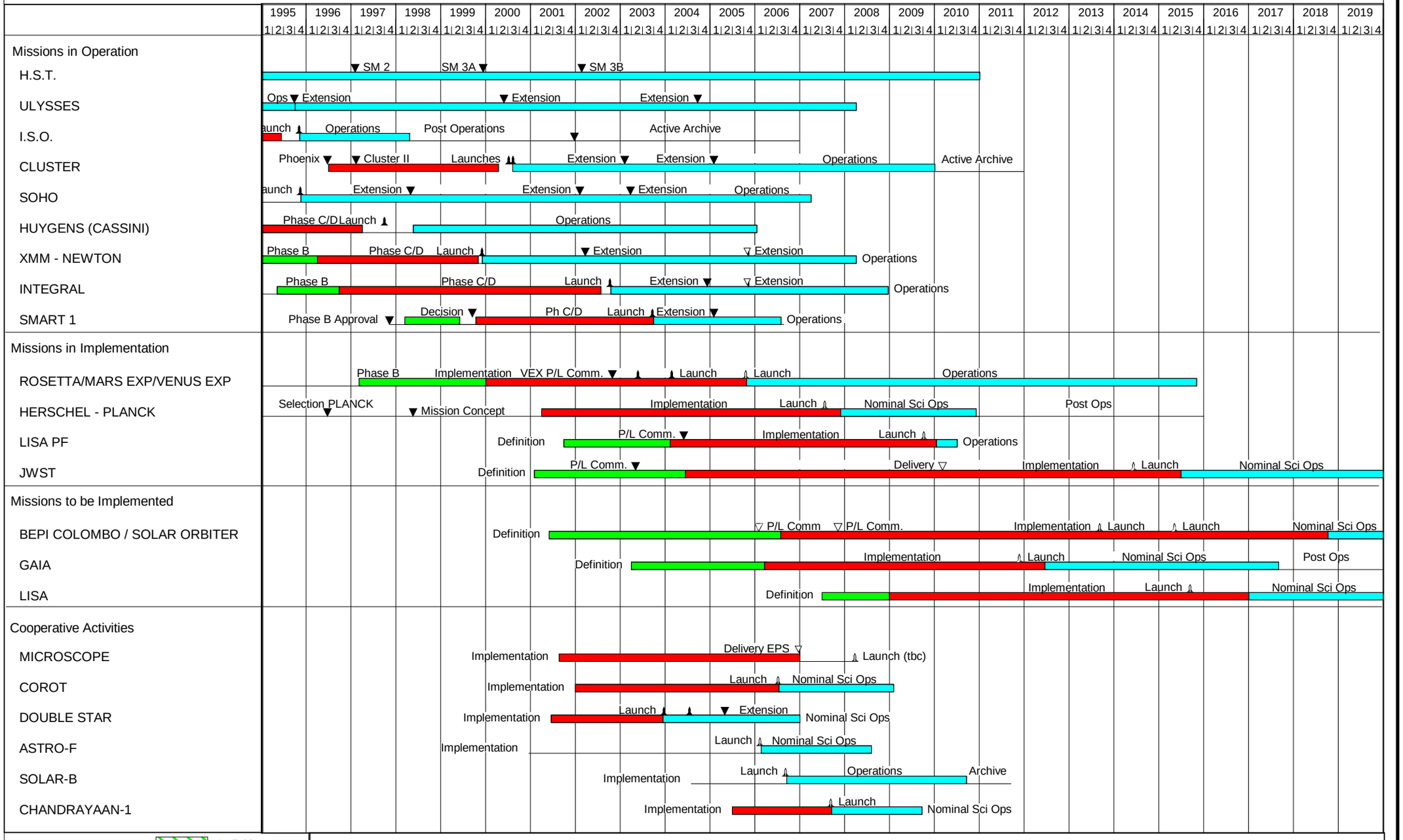


Figure 1

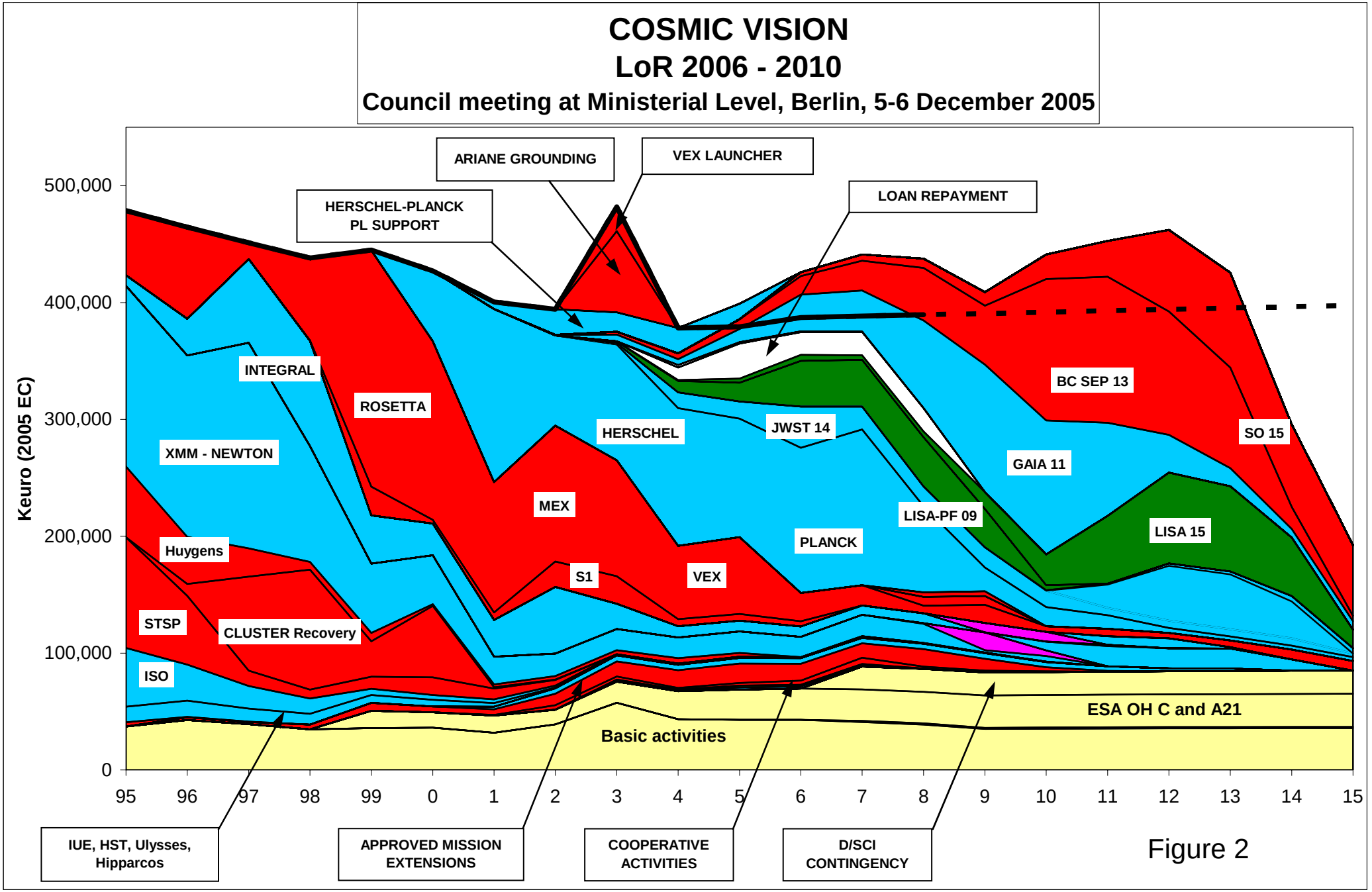

COSMIC VISION
LoR 2006 - 2010
Council meeting at Ministerial Level, Berlin, 5-6 December 2005
Keuro (2005 EC)
500,000
400,000
300,000
200,000
100,000
0
95
96
97
98
99
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
ARIANE GROUNDING
VEX LAUNCHER
HERSCHEL-PLANCK
PL SUPPORT
LOAN REPAYMENT
INTEGRAL
ROSETTA
XMM - NEWTON
HERSCHEL
JWST 14
BC SEP 13
SO 15
GAIA 11
MEX
LISA-PF 09
LISA 15
PLANCK
Huygens
S1
VEX
STSP
CLUSTER Recovery
ISO
ESA OH C and A21
Basic activities
IUE, HST, Ulysses,
Hipparcos
APPROVED MISSION
EXTENSIONS
COOPERATIVE
ACTIVITIES
D/SCI
CONTINGENCY

Figure 2

EUROPEAN SPACE AGENCY

Council

Financial Situation and Projections of the Cosmic Vision Programme as of 7th December 2005

Table 1 (Keuro, 2005 EC)

	<1> Up to 2004	<2> 2005	<3> 2006	<4> 2007	<5> 2008	<6> 2009	<7> 2010	<8> 2011	<9> 2012	<10> 2013	<11> 2014	<12> 2015	<13> As from 2015	<14> CaC mixed EC	<15> Updated Curr. EC	<16> Backdated Appr. EC	<17> Approval Level	<18> Year
MISSIONS IN OPERATION AND IMPLEMENTATION																		
HST Operations Extension	16,041	4,760	4,760	4,760	4,760	4,760	4,570	4,000	2,553	2,162	0	0	0	53,126	51,773	41,626	42,000	1997
HST Servicing Mission 3	12,989	0	0	881	0	0	0	0	0	0	0	0	0	13,870	16,022	11,970	12,000	1995
ULYSSES Extended Mission	17,814	2,776	2,694	2,702	1,778	1,797	0	0	0	0	0	0	0	29,561	32,453	20,662	20,021	1993
ISO	613,511	1,011	786	31	0	0	0	0	0	0	0	0	0	615,339	998,547	503,066	387,481	1987
STSP	753,116	0	0	450	533	533	236	0	0	0	0	0	0	754,868	1,118,071	642,936	655,500	1990
CLUSTER Recovery	230,532	107	0	0	0	0	0	0	0	0	0	0	0	230,639	278,039	207,709	214,000	1995
SOHO Extended Mission	15,661	1,897	1,897	595	4,597	0	0	0	0	0	0	0	0	24,647	28,943	20,128	16,316	1995
CLUSTER Extended Mission & Active Archive	23,191	11,962	9,802	8,870	8,518	8,333	3,266	889	0	0	0	0	0	74,853	75,593	72,304	72,304	2003
HUYGENS	263,385	3,191	127	48	48	63	0	0	0	0	0	0	0	266,858	371,656	240,169	231,267	1992
XMM-NEWTON	655,716	18,350	17,359	16,321	16,461	1,836	4,866	0	0	0	0	0	0	732,911	898,411	671,159	724,730	1995
INTEGRAL	327,081	9,219	8,897	7,983	8,263	164	164	1,212	0	0	0	0	0	362,983	380,613	284,336	354,319	1995
ROSETTA/MEX/VEX	910,232	65,615	24,337	17,382	6,607	15,532	4,880	6,408	4,578	5,705	8,327	6,097	1,833	1,079,533	1,208,766	1,132,373	1,051,588	2002
HERSCHEL/PLANCK	537,294	114,693	124,106	133,336	73,563	20,428	16,366	11,464	4,375	3,498	3,441	3,441	3,441	1,049,442	1,085,974	1,018,276	775,544	2002
SMART-1	78,207	5,816	4,424	0	0	0	0	0	0	0	0	0	0	88,427	95,194	81,243	72,579	1999
JWST Instrumentation	14,430	14,683	35,346	19,473	16,954	17,168	14,067	6,213	6,213	6,213	6,279	2,939	0	160,000				
LISA-PF	10,825	15,949	36,933	39,959	41,968	32,683	4,277	206	0	0	0	0	0	185,000				
BASIC ACTIVITIES																		
Advanced Studies		3,882	2,705	3,882	3,882	3,882	3,882	3,882	3,882	3,882	3,882	3,882						
Core Technology Programme		16,510	19,906	17,145	14,092	10,859	10,859	10,859	10,859	10,859	10,859	10,859						
Science Management		4,696	4,696	4,696	4,696	4,696	4,696	4,696	4,696	4,696	4,696	4,696						
Research & Scientific Support		13,953	14,562	15,305	15,612	15,628	15,846	16,033	16,215	16,215	16,462	16,462						
ISSI		1,000	1,000	0	0	0	0	0	0	0	0	0						
Cooperative Activities		5,657	6,759	7,753	2,030	1,665	732	0	0	0	0	0						
EEE parts - Europeanisation action plan		2,000	0	0	0	0	0	0	0	0	0	0						
ESA overhead GH C and SH A21		25,950	26,885	26,945	27,030	27,609	27,894	27,976	28,058	28,140	28,223	28,306						
TOTAL IN IMPLEMENTATION		344,485	349,985	330,495	251,988	168,036	116,667	93,638	81,429	81,379	82,169	70,682						
Science Level		379,300	387,182	386,326	389,522	390,578	391,767	392,917	394,070	395,227	396,387	397,551						
Financial re-adjustment		-31,188	-20,188	-20,400	-20,000	0	0	0	0	0	0	0						
TOTAL INCOME		348,112	366,994	367,926	369,522	390,578	391,767	392,917	394,070	395,227	396,387	397,551						
BALANCE IN IMPLEMENTATION		3,627	17,029	37,431	117,534	222,542	275,100	299,279	312,641	313,857	314,218	326,869						
CUMULATIVE		3,627	20,656	58,087	175,621	398,163	673,263	972,542	1,285,183	1,599,040	1,913,258	2,232,127						
APPROVED ACTIVITIES TO BE IMPLEMENTED																		
LISA	706	3,636	5,206	3,886	5,070	14,360	26,505	57,871	77,742	72,923	50,026	15,606	26,197	360,000				
BEPICOLOMBO	7,326	8,430	15,943	25,481	44,859	50,436	120,972	124,942	105,881	85,165	19,027	4,728	36,050	650,000				
GAIA	10,854	11,216	31,290	35,080	75,051	109,195	114,572	79,638	32,144	15,423	7,255	7,076	21,206	550,000				
JWST Launcher	0	0	0	0	0	0	0	20,043	46,767	45,767	31,423	0	0	145,000				
SOLAR ORBITER	0	0	3,403	5,425	8,087	11,445	21,039	30,685	69,735	81,133	70,444	60,639	47,985	410,000				
TOTAL APPROVED TO BE IMPLEMENTED		23,284	55,842	69,852	133,067	185,436	283,088	313,179	332,949	302,411	178,177	88,251						
TOTAL APPROVED		367,769	405,827	400,347	385,055	353,472	399,755	406,817	413,478	383,791	260,346	166,933						
BALANCE APPROVED		-19,657	-38,813	-32,421	-15,533	37,106	-7,988	-13,900	-19,408	11,446	136,041	230,618						
CUMULATIVE		-19,657	-58,470	-90,891	-106,424	-69,318	-77,306	-91,206	-110,614	-99,168	36,873	267,491						
PLANNED ACTIVITIES																		
DSCI contingency		0	0	19,416	19,476	19,529	19,588	19,646	19,704	19,761	19,819	19,876						
ISSI extension		0	0	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000						
Newton extension		0	0	0	581	15,286	12,266	17,200	17,200	17,200	9,700	0	0	89,455				
Integral extension		0	0	0	0	7,997	8,270	7,300	8,500	1,200	0	0	0	33,267				
Venus Express extension		0	0	0	4,000	4,000	0	0	0	0	0	0	0	8,000				
Mars Express extension		0	0	0	7,500	7,500	0	0	0	0	0	0	0	15,000				
JWST operations		0	0	0	0	0	190	760	2,207	2,598	4,760	4,760						
TOTAL PLANNED		0	0	20,416	32,557	55,312	41,336	45,906	48,611	41,759	35,279	25,636						
TOTAL COSMIC VISION		367,769	405,827	420,763	417,612	408,784	441,091	452,723	462,089	425,549	295,625	192,571						
BALANCE		-19,657	-38,813	-52,837	-48,090	-18,295	-49,324	-59,806	-68,019	-30,313	100,762	204,869						
CUMULATIVE		-19,657	-58,470	-111,307	-159,397	-177,693	-226,927	-286,733	-354,752	-385,065	-284,303	-79,323						

EUROPEAN SPACE AGENCY

Council

Financial Situation and Projections of the Cosmic Vision Programme as of 7th December 2005

Table 1 (Keuro, 2005 EC)

	<1> Up to 2004	<2> 2005	<3> 2006	<4> 2007	<5> 2008	<6> 2009	<7> 2010	<8> 2011	<9> 2012	<10> 2013	<11> 2014	<12> 2015	<13> As from 2015	<14> CaC mixed EC	<15> Updated Curr. EC	<16> Backdated Appr. EC	<17> Approval Level	<18> Year
MISSIONS IN OPERATION AND IMPLEMENTATION																		
HST Operations Extension	16,041	4,760	4,760	4,760	4,760	4,760	4,570	4,000	2,553	2,162	0	0	0	53,126	51,773	41,628	42,000	1997
HST Servicing Mission 3	12,989	0	0	881	0	0	0	0	0	0	0	0	0	13,870	16,022	11,970	12,000	1995
ULYSSES Extended Mission	17,814	2,778	2,694	2,702	1,776	1,797	0	0	0	0	0	0	0	29,561	32,453	20,682	20,021	1993
ISO	613,511	1,011	786	31	0	0	0	0	0	0	0	0	0	615,339	998,547	503,088	387,461	1987
STSP	753,116	0	0	450	533	533	236	0	0	0	0	0	0	754,868	1,118,071	642,938	655,500	1990
CLUSTER Recovery	230,532	107	0	0	0	0	0	0	0	0	0	0	0	230,639	278,039	207,709	214,000	1995
SOHO Extended Mission	15,661	1,897	1,897	595	4,597	0	0	0	0	0	0	0	0	24,647	26,943	20,128	16,316	1995
CLUSTER Extended Mission & Active Archive	23,191	11,962	9,802	8,870	8,518	8,333	3,288	689	0	0	0	0	0	74,653	75,593	72,304	72,304	2003
HUYGENS	263,385	3,191	127	46	46	63	0	0	0	0	0	0	0	266,858	371,856	240,189	231,267	1992
XMM-NEWTON	655,716	18,350	17,359	18,321	16,461	1,836	4,868	0	0	0	0	0	0	732,911	898,411	671,159	724,730	1995
INTEGRAL	327,081	9,219	8,897	7,963	8,263	164	164	1,212	0	0	0	0	0	362,963	380,613	284,338	354,319	1995
ROSETTA/MEX/VEX	910,232	65,615	24,337	17,382	6,607	15,532	4,880	6,408	4,578	5,705	8,327	8,097	1,833	1,079,533	1,208,766	1,132,373	1,051,586	2002
HERSCHEL/PLANCK	537,294	114,669	124,106	133,336	73,563	20,428	16,386	11,464	4,375	3,498	3,441	3,441	3,441	1,049,442	1,086,974	1,018,276	775,544	2002
SMART-1	78,207	5,816	4,404	0	0	0	0	0	0	0	0	0	0	88,427	96,194	81,243	72,579	1999
JWST Instrumentation	14,430	14,683	35,348	19,473	16,954	17,168	14,087	6,213	6,213	6,213	6,279	2,939	0	160,000				
LISA-PF	10,825	15,949	38,933	39,959	41,968	32,883	4,277	206	0	0	0	0	0	185,000				
BASIC ACTIVITIES																		
Advanced Studies		3,882	2,705	3,882	3,882	3,882	3,882	3,882	3,882	3,882	3,882	3,882						
Core Technology Programme		16,510	19,908	17,145	14,692	10,859	10,859	10,859	10,859	10,859	10,859	10,859						
Science Management		4,696	4,696	4,696	4,696	4,696	4,696	4,696	4,696	4,696	4,696	4,696						
Research & Scientific Support		13,983	14,562	15,305	15,612	15,628	15,848	16,033	16,215	16,215	16,462	16,462						
ISSI		1,000	1,000	0	0	0	0	0	0	0	0	0						
Cooperative Activities		5,657	6,759	7,753	2,030	1,665	732	0	0	0	0	0						
EEE parts - Europeanisation action plan		2,800	0	0	0	0	0	0	0	0	0	0						
ESA overhead GH C and SH A21		25,950	26,885	26,945	27,030	27,809	27,894	27,976	28,058	28,140	28,223	28,306						
TOTAL IN IMPLEMENTATION		**344,485**	**349,965**	**330,495**	**251,988**	**168,036**	**116,667**	**93,638**	**81,429**	**81,370**	**82,169**	**78,682**						
Science Level		379,300	387,182	388,326	389,522	390,578	391,767	392,917	394,070	395,227	396,387	397,551						
Financial re-adjustment		-31,188	-20,188	-20,400	-20,000	0	0	0	0	0	0	0						
TOTAL INCOME		**348,112**	**366,994**	**367,926**	**369,522**	**390,578**	**391,767**	**392,917**	**394,070**	**395,227**	**396,387**	**397,551**						
BALANCE IN IMPLEMENTATION		**3,627**	**17,029**	**37,431**	**117,534**	**222,542**	**275,100**	**299,279**	**312,641**	**313,857**	**314,218**	**318,869**						
CUMULATIVE		**3,627**	**20,656**	**58,087**	**175,621**	**398,163**	**673,263**	**972,542**	**1,285,183**	**1,599,040**	**1,913,258**	**2,232,127**						
APPROVED ACTIVITIES TO BE IMPLEMENTED																		
LISA	766	3,638	5,206	3,886	5,070	14,360	26,505	57,871	77,742	72,923	50,028	15,808	26,197	360,000				
BEPICOLOMBO	7,326	8,430	15,943	25,461	44,859	50,436	120,972	124,942	105,661	86,165	19,027	4,728	36,050	650,000				
GAIA	10,854	11,216	31,290	35,080	75,051	109,195	114,572	79,638	32,144	15,423	7,255	7,076	21,206	550,000				
JWST Launcher	0	0	0	0	0	0	0	20,043	46,767	46,767	31,423	0	0	145,000				
SOLAR ORBITER	0	0	3,403	5,425	8,087	11,445	21,039	30,685	69,735	81,133	70,444	60,639	47,965	410,000				
TOTAL APPROVED TO BE IMPLEMENTED		**23,284**	**55,842**	**69,852**	**133,067**	**185,436**	**283,088**	**313,179**	**332,049**	**302,411**	**178,177**	**88,251**						
TOTAL APPROVED		**367,769**	**405,807**	**400,347**	**385,055**	**353,472**	**399,755**	**406,817**	**413,478**	**383,781**	**260,346**	**166,933**						
BALANCE APPROVED		**-19,657**	**-38,813**	**-32,421**	**-15,533**	**37,106**	**-7,988**	**-13,900**	**-19,408**	**11,446**	**136,041**	**230,618**						
CUMULATIVE		**-19,657**	**-58,470**	**-90,891**	**-106,424**	**-69,318**	**-77,306**	**-91,206**	**-110,614**	**-99,168**	**36,873**	**267,491**						
PLANNED ACTIVITIES																		
D/SCI contingency		0	0	19,416	19,476	19,529	19,588	19,646	19,704	19,761	19,819	19,878						
ISSI extension		0	0	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000						
Newton extension		0	0	0	581	15,286	12,288	17,200	17,200	17,200	9,700	0	0	89,455				
Integral extension		0	0	0	0	7,997	8,270	7,300	8,500	1,200	0	0	0	33,267				
Venus Express extension		0	0	0	4,000	4,000	0	0	0	0	0	0	0	8,000				
Mars Express extension		0	0	0	7,500	7,500	0	0	0	0	0	0	0	15,000				
JWST operations		0	0	0	0	0	190	760	2,207	2,598	4,760	4,760						
TOTAL PLANNED		**0**	**0**	**20,416**	**32,557**	**55,312**	**41,336**	**45,906**	**48,611**	**41,759**	**35,279**	**25,638**						
TOTAL COSMIC VISION		**367,769**	**405,807**	**420,763**	**417,612**	**408,784**	**441,091**	**452,723**	**462,089**	**425,540**	**295,625**	**192,571**						
BALANCE		**-19,657**	**-38,813**	**-52,837**	**-48,090**	**-18,206**	**-49,324**	**-59,806**	**-68,019**	**-30,313**	**100,762**	**204,980**						
CUMULATIVE		**-19,657**	**-58,470**	**-111,307**	**-159,397**	**-177,603**	**-226,927**	**-286,733**	**-354,752**	**-385,065**	**-284,303**	**-79,323**						

6. Space Station and Platform Utilisation

Lobster - An all-sky monitor to provide long term monitoring of a large sample of soft X-ray sources. The joint D/SCI and D/HME Phase A study for accommodation on the Columbus External Platform was successfully completed. The Principal Investigator is now investigating payload funding possibilities as well as alternative launch possibilies.

Rosita - The Principal Investigator decided not to continue studying the accommodation of the Rosita X-ray survey telescopes on the Columbus External Platform due to concerns about contamination in the ISS environment.

7. PRODEX / PECS

One of the major activities PRODEX undertook during the year under review was the implementation of the industrial phase C/D activities in four PRODEX countries participating in the MIRI instrument of the James Webb Space Telescope (JWST), namely Belgium, Switzerland, Denmark and Ireland. Furthermore, substantial efforts have been made in the successful completion of the feasibility study of the Swiss contribution to the BELA instrument onboard BepiColombo mission.

The Ministerial Conference, held in December 2005, has finally cleared the way for the renewal of the PRODEX Declaration financial envelope for the period 2006-2010.

The PRODEX Office has been entrusted with the setting up and implementation of the arrangements and management structure for the Plan for European Cooperating States (PECS). Hungary was the first participating State to this programme, followed by the Czech Republic. Poland and Romania have finally notified the Agency of their intention to join this programme. A first round of negotiations has been initiated that should lead them to access PECS in the coming years.

In 2005, the following experiments or experiment subsystems were finalised and/or launched:

Missions	Instruments	Subsystems	Proposers/ Countries
HERSCHEL MISSION	HIFI instrument	Common optics assembly, Mixer assembly, Intermediate amplifier IF2 Verification of optical design	Benz, CH Murphy, IRL
	PACS instrument	Cold Read-out Electronics subsystem (CRE), grating assembly	Waelkens, B
COROT	COROT instrument	Baffle, cover	Jamar, B
STEREO	PLASTIC SECCHI	Heliospheric Imager (HI)	Wurz,CH Jamar, B
VENUS EXPRESS	SPICAV	Solar Occultation at Infrared (SOIR)	Nevejans, B
INTERNATIONAL SPACE STATION	SOVIM SOLSPEC		Fröhlich, CH, Joukoff, B Gillotay, B
MASER 10	Interfacial Turbulence in Evaporating Liquids (ITEL)		Colinet, B
FOTON M2	FLUIDPAC Soret Coefficients in Crude Oil (SCCO)		Legros, B Legros, B
MAXUS 6	UNESTA material science experiment		Froyen, B

Support to Scientists:

In addition, 159 scientists in the PRODEX participating States received support in the framework of European (mostly ESA) missions.

The number of all scientists supported from the PRODEX Programme during 2005 in the various countries involved in PRODEX is given in Table 7.1:

Table 7.1

Countries	Number of Scientists	Number of missions
Austria	2	2
Belgium	134	87
Denmark	3	3
Ireland	3	3
Norway	5	2
Switzerland	12	12

8. International relations

8.1 NASA

Missions in cooperation

The Table below gives the details of the ongoing collaborations with NASA (Status May 2005). Clearly, NASA remains the most important partner of the Science Programme of ESA. Since the summer of 2004 Mr. A Diaz was successor to Mr. E. Weiler, NASA Associate Administrator and the head of the NASA Science Mission Directorate, including space science and Earth Observation under his responsibility. He ended his term in August 2005, and was replaced by Ms. Mary Cleave.

Furthermore, a new Exploration programme was introduced, following the speech by President Bush on 14 January 2004, which potentially started a new era of space exploration. ESA is following the developments of Exploration at NASA, and its relationship to the NASA scientific activities.. The relationship of the ESA Science Programme to the ESA Exploration Programme is given elsewhere in the text.

Collaboration with NASA				
Type of Agreement	**Mission**	**Date of Signature/ Entry into Force**	**Status & Expiration**	**Comments**
LoA	**Mars Express**	NASA 27 Feb. 2001 ESA 05 Mar. 2001 NASA 14 Mar. 2001 **ext** : 26/28 June 2002	30 June 2002 23 June 2003 or entry into force of MoU	
MoU		Signed on 18 December	Expiration : 31/12/2008	
LoA	**SMART-2 (LISA Pathfinder)** + **LISA**	NASA 08 June 2001 ESA 11 June 2001	30 June 2003 or MoU for LISA technology demo mission Agreement on LISA study phase extended through 30/6/2004 with letter of 20/6/2003 **Agreement on LISA study phase extended through 30.6.2005 with letter of 18.4.2004** Agreement on LISA study phase extended through 30.6.2006 with letters of 9 and 15 June 2005 Expiration : 30/06/2006	LISA PF draft MOU has been prepared by ESA, waiting for update the technical part by the ESTEC colleagues
MoU	**Cassini/ Huygens**	17 Dec. 1990	12 years after launch (launch: 15 Oct 1997) Expiration 15/10/2009	
MoU	**STSP** (Cluster+SOHO)	30 Nov. 1989	in force "until one year after the nominal mission completion and for such additional periods as may be mutually agreed by exch. of letters"	
LoA	**Cluster II**	20 Apr. 2000	LoA amended and extended through 31 December 2005 on 6/11/2003 LoA amended and extended through 31 December 2007 on 11 August 2005	
"LoA"	**SOHO**	NASA draft 4 July 2001 ESA amendments: 15/04/2002	Signed letter from NASA on 13/12/02 Signed by ESA 16 January 2003 Expiration: 31/03/2007	
LoA	**Integral**	NASA 14 Nov. 2000	Launch + 3 years or 31/12/2005 (Launch: 17/10/2002)	ESA has approved extension of operations until 16 December

Collaboration with NASA				
Type of Agreement	**Mission**	**Date of Signature/ Entry into Force**	**Status & Expiration**	**Comments**
		ESA 17 Nov. 2000	LoA in place Expiration 17/10/2005 LoA amended and extended through 16 December 2006 on 11 August 2005	with level of funding for the latter two years to be confirmed in Nov 05. NASA has firm funding only through 2006 and the capability to support Integral through 2008, subject to successful scientific review in 2006.
MoU **ext** by: 1. LoA 2. LoA	**Ulysses**	29 Mar. 1979 31 Mar. 1995/11, 17 Apr 1996 20/31 Dec 2001 23 Dec. 2004	Oct. 95 **ext**: by 6 successive yearly renewals Expiration: 31/03/2008	
LoA	**Stereo**	NASA 01 Feb. 2001 ESA 07 Feb. 2001	31 Dec.2007 or entry into force of MoU Expiration: 31/12/2007	
MoU **ext**. by: 1. LoA 2. Amend&ext	**HST**	7 Oct. 1977 20/23 Apr 2001 23 Oct 2001	11 yrs after launch, i.e. 26 Apr 2001 24 Oct 2001 24 Apr 2006 MOU Expiration: 24/04/2006	ESA has the financial envelope to continue as is until 04/2010 Awaiting extension letter from NASA, currently at State Department ESA and NASAhaved agreed have agreed on the principle of extending the HST MoU until the end of 2010. The proposal for the extension of this MoU is being reviewed by the US State Department. The extended MoU will have to be unanimously

Collaboration with NASA				
Type of Agreement	**Mission**	**Date of Signature/ Entry into Force**	**Status & Expiration**	**Comments**
				approved by Council at its March 2006 meeting at the latest.
Study phase agreement	**JWST**	NASA: 8 Feb 2000 ESA: 5 Apr 2000 ESA: 5 Sep 2000 NASA : 25 Sep 2000	31 Dec 2005 or entry into force of MoU Extension to 31 Dec 2006 or entry into force of MoU	Issue of launcher to be resolved, then first draft MOU to be produced. The decision by State Department on the use of Ariane 5 to launch JWST is still pending as is also the official announcement by NASA of a delayed launch date for the mission. NB: ESA submitted draft letter to NASA in Feb. 05 explaining why an ESA staff transition from HST to JWST is possible without further legal action.
Interim agr. LoA	**Rosetta**	NASA: 22 Jul 1998 (lander & review) ESA: 27 Jul 1998 NASA: 15 Apr 1999 ESA: 25 May 1999 **ext**: (shipment of flight models) NASA: 3 Apr 2001 ESA : 12 Apr 2001 **ext** : (Rosetta RF suitcase) : ESA: 18 Apr 2002 NASA: 21 May 2002 ESA: 27 May 2002	31 Dec 2002 or entry into force of MoU 31 Dec 2002 or entry into force of MoU	

Collaboration with NASA				
Type of Agreement	**Mission**	**Date of Signature/ Entry into Force**	**Status & Expiration**	**Comments**
MoU			Signed on 18/12/2002 Expiration:31/12/2015	
	FIRST=Herschel **Space Observatory**		Draft MOU in US interagency approval process.	
	Planck		Draft MOU in US interagency approval process.	
LoA	**IRSI-Darwin/TPF**	NASA: 20 Aug 2002 ESA: 21 Aug 2002	31 Dec 2006 or until entry into force of subsequent separate ESA-NASA LoA Expiration: 31/12/2006	
	DSN LOA		ESA draft dated 14/04/03 submitted to NASA on 15/04/03, comments received on 25/04/03 Extended for 2 years until 20 June 2005, while MOU is being negotiated Extended for 2 years, letters dated 15 and 17 June 2005, while MOU is being negotiated Expiration: 31/12/2006	2005 extension with quid pro quo Deep Impact/Venus Express

8.2 China

In the wake of the successful collaboration on Double Star (launched in 2003-2004), new collaborations are being considered, in particular in the field of Sun-Earth connection. The first meeting took place in 2005 in Shanghai on 11-12 May 2005. The Director of the Science Programme met top functionaries of the China National Space Agency and the Chinese Academy of Sciences.

ESA could become the preferred partner, and this opportunity should not be missed. Exchange of students-experts is being implemented. ESA has been active in assisting CNSA to select the next scientific mission through the ILWS programme, there being two candidates, SWISE and Kua-Fu. Through this exercise the next Chinese space science mission is likely to be mainly the Kua-Fu mission, with elements of SWISE, the latter being particularly useful in coordination with the ESA EOP mission SWARM and, moreover, providing results useful to Galileo.

China also asked for tracking support to their Lunar Mission Chang-E1.

8.3 Japan

A space science bilateral Meeting was held on 1 September 2005 with ISAS-JAXA in Tokyo. ISAS is recovering from a series of failures (particularly painful the Mars mission Nozomi, the X-Ray mission Astro-5, basically twice, with the second version, now called Suzaku, working at 50% of the plan, the Lunar penetrators).

The real concern for the immediate future is BepiColombo**,** one of the two missions approved in the 2006-2012 timeframe, the other one being the Venus Climatic Orbiter.

ESA was told that, for the moment, exploration within JAXA is dealt with at the level of discussion group, and it is not yet clear which unit will eventually deal with it.

On 24 October 2005 the yearly ESA-Japan space meeting took place in Tokyo.

- Existing collaborations were reviewed (Suzaku, ASTRO-F, Solar-B, BepiColombo).
- Future possibilities were also considered (Next Generation X-Ray Observatory; Venus research, SELENE).

8.4 India

Chandrayaan-1

Chandrayaan-1 was approved in 2003 with a launch date in 2008, possibly 2007. It will be the first scientific mission of India and also the first Indian mission to the Moon.

Among the mission objectives are the generation of a chemical map of the entire lunar surface. The data from the mission will be used to create a 3-dimensional atlas of regions of interest, based on high-resolution remote sensing in the visible, near IR, and low and high-energy X-ray bands.

In the spring of 2004, ISRO expressed interest in instruments flown on SMART-1 (first of all CIXS-2 and SIR-2) as well as ESA experience gained from SMART-1. In particular the CIXS-2 instrument was considered as one of the six core-instruments, around which the mission had been built. In late 2004, ESA was informed that the ISRO peer review had selected also the European SARA and SIR-2 instruments. Lastly, request for support was made to ESA directly by the European providers of HEX, a second core instrument. A technical deadline for the decision on the provision of the three first instruments was fixed to 31 December 2005.

An attempt to fund the European instruments through EC money was made by the Space Unit of the EC. However, this proved to be impossible for various reasons. To respond to the expectations, raised at the meeting of the President of the European Union and the Indian Prime Minister, the Science Programme Directorate decided to propose the collaboration to the SPC, and ultimately Council. In parallel, ISRO relaxed its schedule, being ready to wait for an ESA decision until the Council meeting in March 2005. The Science Programme Directorate made it clear that, in spite of the tight schedule, the regular procedure would be followed, by presenting the proposal first of all to the ESA advisory structure (the SSWG and SSAC respectively). The SSAC expressed its own reservations regarding the rather hurried procedure, but invited the SPC to consider a possible ESA participation in the context of the so-called “Nationally led projects”.

In addition to the payload support, ISRO made other requests to ESA, mostly for advice and sharing tools that have been developed for SMART-1.

The financial request can be summarized as in the following Table (Figures in Meuro):

Experiments	CIXS-2	SARA	SIR2	HEX	Totals
Total cost	2.55	1.476	2.157	1.087	7.270
Request to ESA	2.55	0.438	0.957	Up to 1.087	Up to 5.032
ESA in kind					0.286
ESA internal costs					0.500
Total ESA maximum cost					5.818

As a quid-pro-quo for the contribution of ESA, whatever the share of the total cost of the instruments will be, all data resulting from the supported instruments will be made immediately available to the European scientific community. This will be clarified in a Science Management Plan, which is being prepared, also in response to the SSAC request.

The proposal was approved by IRC on 16-17 February 2005, SPC on 9-10 February, AFC on 16-17 February and finally by Council (unanimously) on 17 March 2005.

Following approval, all instruments were submitted to a technical – cost review. In the meantime the contribution to HEX was severely de-scoped, while the review of CIXS-2, jointly made by ISRO and ESA has not yet been fully concluded, some doubts still existing regarding the performance of the instrument.

8.5 Russia

A long planned bilateral ESA-Russia space science meeting took place on 23 November 2005 in Moscow. The Director of the Science Programme was accompanied by his closest collaborators and met the Deputy Director General of the Russian Space Agency, Yuri Nosenko, with his collaborators, who direct the Russian Science Programme. The Russian Academy of Sciences was also represented.

The meeting had been prepared in two occasions, respectively in March and August 2005, the latter on the occasion of the Moscow Air Show. Three types of projects open to collaboration were discussed:

1) ESA projects in which Roscosmos expressed the wish to participate. The main such project is BepiColombo, where the Russian partner, besides providing experiments, as already agreed, is prepared to provide also a launcher and a lander. The offer was welcomed by ESA, but it was stressed that the collaboration must reduce the cost of the already too expensive mission. A better studied and costed offer will be presented and examined.

2) Russian projects whose launch is expected before 2015, in which Roscosmos is inviting the collaboration of ESA. For these, the only possibility is to include them in the so called Nationally Led Projects line, for which a call is planned by the ESA Science Programme every summer. However, the projects:

   - must be presented by at least one interested Member State,
   - will be chosen through competition by means of a peer review,
   - the amounts of money available will not exceed a few millions per project per annum.

   The World Space Observatory (in which Russia is the major player) was presented by Spain following the call for nationally led projects in the summer of 2005. The assessment of WSO will be completed during the winter 2005-2006. In the following years it is expected that Resonans and Spektrum RG will also be presented in the same framework.

3) Joint projects in the framework of Cosmic Vision 2015-25.. Collaboration on the latter, of course, will depend on the date of issue of the first call for mission proposals, which will be known in February 2006. Scientific communities on both sides with the same interests are invited to present joint proposals. One possible such project is Millimetron, a Very Long Baseline Interferometry project in the millimeter wavelength range.

It is planned to continue the space science ESA-Russia bilateral meetings on a regular basis.

8.6 Summer School Alpbach 2005

The Summer School was held in Austria from 19 to 28 July 2005. The main topic of the workshop for this year was “Dark Energy and Dark matter in the Universe”. The Director and several staff of the Science Programme participated in the activity.

9. Timetable of foreseen forthcoming events

Events	Dates
Launch of Astro-F (Japan, with ESA collab.)	18 February 2006
Launch of Solar B (Japan, with ESA collab.)	23 September 2006
Launch of COROT France, with ESA collab.)	October 2006
Launch of Herschel/Planck	Third quarter 2007
Launch of SMART-2	Second half 2009
Launch of Microscope	March 2009
Launch of GAIA	December 2011
Launch of JWST	June 2013
Launch of BepiColombo	August 2013
Launch of LISA	2015
Launch of Solar Orbiter	May 2015

Annex

Average Schedule Elongation Factor (ASEF)

Project	Launch-date at SPC approval	Actual Launch-date	Variance	Reasons for Variance
GIOTTO	Jul-85	Jul-85	0	
HIPPARCOS	Mar-87	Aug-89	2.5 years	ARIANE readiness
HST	1985	Apr-90	5 years	NASA decision/Shuttle delay
ULYSSES	1983	Oct-90	7 years	NASA decision/Shuttle delay
ISO	mid-1992	Nov-95	3.5 years	Cryogenic technology development
SOHO	Jul-95	Dec-95	0.5 years	NASA decision/Instrument development problems
HUYGENS/CASSINI	Apr-96	Oct-97	1.5 years	NASA decision/US Programme overruns
XMM-NEWTON	Apr-98	Dec-99	1.75 years	Mirror production
STSP-CLUSTER	Mar-95	Jun-96	1.25 years	ARIANE readiness
CLUSTER RECOVERY	Mid 2000	Jul-00	0	
CLUSTER RECOVERY	Mid 2000	Aug-00	0	
INTEGRAL	Apr-01	Oct-02	1.5 years	Instrument readiness
MARS EXPRESS	Jun-03	Jun-03	0	
ROSETTA	Jan-03	Mar-04	1.25 years	Launch decision delayed
SMART-1	End 2001	Sep-03	2 years	Passenger ARIANE; awaiting launcher readiness
DOUBLE STAR	Dec-03/Mar-04	Mar-04	0.25 years	Chinese decision
VENUS EXPRESS	Nov-05	Nov-05	0	

Directorate of the Scientific Programme
Performance Indicators
Lifetime Extension Factor (LEF)

Project	Launch-date	No of years Planned at SPC Approval		Nominal Lifetime Expiration	Status as at November '05	Actual duration compared to planned duration
GIOTTO	Jul-85	1.0		Jul-86	Ended July 1992	+4 years
HIPPARCOS	Aug-89	2.5		Jan-92	Ended August 1993	+1.5 years
HST	Apr-90	20.0		Apr-10	Serviceable	Nominal
ULYSSES	Oct-90	5.0		Oct-95	On-going	+10 years
ISO	Nov-95	2.0		Nov-97	Ended May 1998	+ 0.5 years
SOHO	Dec-95	3.0		Dec-98	On-going	+7 years
HUYGENS/CASSINI	Oct-97	11.0		Oct-08	On-going	Nominal
XMM-NEWTON	Dec-99	10.0	*[1]	Dec-09	On-going	Nominal
STSP-CLUSTER	Jun-96	3.0		Jun-99	Launch-failure	- - -
CLUSTER RECOVERY	Jul-00	3.0		Jul-03	On-going	+2 years
CLUSTER RECOVERY	Aug-00	3.0		Aug-03	On-going	+2 years
INTEGRAL	Oct-02	2.0		Oct-04	On-going	+1 year
MARS EXPRESS	Jun-03	2.5		Dec-05	On-going	Nominal
ROSETTA	Mar-04	12.0		Mar-16	On-going	Nominal
SMART-1	Sep-03	2.5	*[2]	Mar-06	On-going	Nominal
DOUBLE STAR	Dec-03/Mar-04	1.5		Jun-05	On-going	+0.5 years
VENUS EXPRESS	Nov-05	2.5		May-08	On-going	Nominal

***[1] - From 2 to 10 years foreseen**
***[2] - From 2 to 2.5 years foreseen**

Directorate of the Scientific Programme
Performance Indicators
Factual Indicators - Missions in Operation

Project	In operation beginning 2004	Launched in 2004	In operation beginning 2005	Launched in 2005	In operation November 2005
GIOTTO					
HIPPARCOS					
HST	X		X		X
ULYSSES	X		X		X
ISO					
SOHO	X		X		X
HUYGENS/CASSINI	X		X		X
XMM-NEWTON	X		X		X
STSP-CLUSTER	X		X		X
CLUSTER RECOVERY	X		X		X
CLUSTER RECOVERY	X		X		X
INTEGRAL	X		X		X
MARS EXPRESS	X		X		X
ROSETTA		X	X		X
SMART-1	X		X		X
DOUBLE STAR		X	X		X
VENUS EXPRESS				X	X