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Front cover matter: This set of true-colour Envisat satellite mosaics depicts the 10 new EU members as well as ESA's 17 Member States. All the mosaics were produced using the Medium Resolution Imaging Spectrometer (MERIS) instrument on ESA's ENVISAT environmental satellite, working in full resolution mode. Image credit: European Space Agency.

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FOREWORD

The study presented in this report was commissioned by three ESA Directorates, the D-SCI, D-EO, and D-HME, upon the initiative of the ESSC-ESF believing that it was timely to consider the consolidated funding of space research in Europe, extract findings there from and, possibly, provide recommendations for the future. Consequently, the study had two objectives, a short-term and a longer-term one. The immediate goal was to provide European space agencies, funding organisations and researchers with comparative numbers of the funding of space science, Earth observation, and life and physical sciences in space in Europe, in order to obtain insights into the temporal evolution of the funding as well as the relative efforts of the ESA Member States. In addition, the provision of the respective figures for USA and Japan will help putting the European figures in perspective. The longer-term aspect of this study is to enable the various stakeholders to derive solidly founded arguments when trying to influence the further evolution of the various national or European budgets for basic space research.

The overarching question is: How much should Europe rightfully spend on space research and space activities? Is there a budget-based answer to that question and, consequently, can budgetary figures alone drive investment decisions in that sector? Most probably not! A full-scale space policy for the European Union can only be based on strategic decisions, and the obvious need to balance critical spending in other areas of importance. Yet it is revealing to realize that Europe is spending today roughly 5 times less than the USA in space science, 3 times less in Earth observation, and 7 times less in research in space and ISS utilisation, albeit with a higher GDP (8,043 billion € vs. 7,268 billion € - e.c. 2003; EU-15).

The period covered by this study spans the years 1994-2004. The study was originally aimed at being published in 2005 but technical difficulties prevented its publication at that time. The current report is being made available to ESA at the end of 2006. Time constraints as well as the contract with ESA unfortunately did not allow further detailed investigation of funding figures at national level for the years 2005-2006. Another significant change in the funding trend will be the appearance in 2007 of budgets dedicated to space activities in the European Commission 7th Framework Programme.

Some of the major successes obtained by ESA in, e.g. the space science domain in the past years (e.g. SOHO, XMM, and Cassini-Huygens) are the result of a significant investment effort in these areas 20 years ago, i.e. before the Ministers of the ESA nations had decided to constantly lower these investments. Fortunately, a stop was put to this trend at the Berlin Ministerial Conference in December 2005. In this situation and in view of the tremendous successes mentioned above, it would be very tempting for some decision-makers to fence off any plea for further increasing the budgets. The sad reality however is that today's space science budget would simply not allow Europe to recreate those successes. This study provides the budgetary tools to form a strategic view on an appropriate level of funding of space sciences for a rapidly expanding European Union. The national agencies and relevant Ministers are encouraged to make creative use of this tool.

Gerhard HAERENDEL
ESSC-ESF Chairman
2002-2007

INTRODUCTION

Space science, over the years since ESA's inception, has expanded the European knowledge base, particularly in the areas of aerospace and high technology, to rival that of the United States. In the first decade of the 21st century, the use of space for strategic, commercial, and environmental information supply and transfer is expanding significantly. This, while not a research activity, is predicated upon the existence and continuing health of the European knowledge base built up in the previous decades of space research. The health of this knowledge base is a vital contributor to the continuing growth of European commerce, culture, and security. To this effect it is important to ensure that space research continues to be engaged in by European scientists, and that an appropriate level of funding continues to be made available to European research institutions. Such an immediate strategic goal was advocated by all partners involved in the Green Paper for Space consultation process: that of doubling the budget for space activities in Europe.

Space research in Europe is sponsored from a multiplicity of sources, and not limited to space agencies. In parallel with the development of science programmes within ESA, there is significant independent activity in EU Member States, both as exclusively national programmes and in programmes in cooperation with other space agencies like NASA or ISAS (Japan). In general, ESA does not fund development of payloads nor of new instrumentation within its Member States; neither does it provide significant support for data exploitation, all these being left to the research programmes of the Member States. The European Commission also sponsors research in certain areas, through its Framework Programmes; and in the area of meteorology and Earth Observation there is research sponsored by the European entities responsible for these activities. National space agencies, but also academia and research institutions, complement this picture. In progress towards a continental strategy for research, it will be important to establish clearly the roles of these different sponsors, the levels at which they support space research, and the coherence (or lack of) with which they support it, and, in the longer term, the appropriate global level of funding that Europe needs to invest, in order to maintain the health of the knowledge base. The ESSC-ESF believes that it is timely to consider the funding of space research in Europe, addressing these issues, and providing recommendations for the future.

Whereas Europe accumulates several space missions' successes and a huge increase of activity (in terms of programmes and employment) over this last decade, it is obvious that the level of funding did not follow that trend. Indeed, despite the competitiveness of Europe in the space domain, more investments are required to pursue and strengthen the European position vis-à-vis the USA and Japan.

To respond to this concern, ESSC was commissioned by the European Space Agency and, more specifically, by its three Directorates D-SCI, D-EO and D-HME, to conduct a study on the funding of European space research over the last 10 years. The aim of this survey is to assess the level of funding devoted to the European civilian space domain during the 1994-2004 period and to compare these budgets with the US and Japanese corresponding expenditures.

Indeed, after having followed a rapid expansion in the 1980's, the European civilian space expenditures seem essentially frozen in the last 10 years. It appears useful therefore to assess how space budgets are used in Europe in order to clearly point out where more funding/money should be invested to support and strengthen specific domains, while remaining competitive at a worldwide level. To respond to this issue, the scope of this study includes space science, Earth observation and life and physical sciences in space (EMIR / ELIPS & ISS utilisation).

The topic at hand would tend to divide into three activities which should be undertaken in sequence. The first addresses the preparation of an overview of the level of space research funding in Europe, and its origins. The second is an investigation into the coherence of the overall European space research effort, and the coherence of the funding arrangements. The third would then be an attempt to establish what could be the appropriate level of space research funding to ensure a healthy European knowledge base in this area, in line with alleged claims to have Europe become the "most dynamic knowledge-based society in the world". The present study will only concentrate on the first two activities. However the outcome of the last activity, although admittedly very challenging, would constitute an important component of the community's message to ESA's next Ministerial Council. It is suggested that this study is indeed followed by such an evaluation, and set of critical recommendations.

The first activity was undertaken by consultation with European and national funding agencies, including the European Commission. In the first approach used for the data collection these agencies were asked to provide the following information:

- overall level of space research funding, assigned to ESA, national, bilateral, and enabling technology programmes
- destination of such funding in terms of scientist & engineer salaries, contracts with major industries, contracts with small industries, etc
- indicator of the number of scientists, engineers and students who participate directly in space research; this information is already partly available in the results of the "demography study" commissioned in 2002 by ESA D/SCI[1]
- assessment of the impact of space research on industrial competitiveness & innovation
- assessment of the likely/preferred trend in space research funding, over a period of 5-10 years

As will be explained in the next section, this approach met with intense difficulties and a common understanding was reached with ESA to lower the ambitions of the data collection process and of the study outcome. Nevertheless the data finally provided from various sources was used to prepare an overview of space research funding in Europe. A workshop was organised in Brussels on 19 September 2005, where national representatives met with ESSC, ESA staff and observers to be briefed about the status of the data collection process, and provide us with first reactions and comments (see Annex 1). These useful inputs served in the second stage of the study.

An overarching difficulty with this exercise lies with the fact that accounting systems between Europe and the USA, but also within Europe, are quite different from one another. Hence comparisons are often hard to achieve, or even meaningless when the figures encompass quite different activities. Quite often the studies which are published in that domain simply do not provide the detailed breakout of activities included in a given budgetary item. Hence it may be found that figures published in this study do not match exactly those of other surveys: in our case though, the means for providing a given figure has always been made explicit, rendering comparisons possible.

It is both important, and notoriously difficult, to determine an appropriate strategic level for the overall funding of space research in Europe. Up to now this has been determined on an ad hoc basis simply from the willingness of the research sponsors to fund particular programmes. To form a strategic view on the level of funding appropriate to a European Union of 456 million people and GDP per capita of 18,300 € (EU-25, e.c. 2003), a number of

[1] Demography of European Space Science – Results from an ESSC-ESF Study, April 2003, ESF Strasbourg.

different estimators and benchmarks will need to be used. None of these are either fully secure or fully objective; but a combination of these has a good chance of giving a reasonable and perhaps persuasive result. The first is to compare the level of funding per unit population and GNP with the United States and, possibly, Japan. The ratio of space research funding to all science funding in Europe and internationally should also be explored. The second is to compare present and historical funding levels within Europe, and also to compare the average funding per economic unit for Europe as a whole, with the same measure applied to the national programmes of major European Union Member States.

Hence to illustrate where more investments are required, such “space ratios” were elaborated, based on the GNP and space-related expenditures. These indicators, when compared to the ones computed for the USA and Japan, will rank the space domain as a function of economic vitality and provide a good indication on how space activities are considered in Europe.

The structure of this report is articulated around three chapters. The first part is explicating the data collection process and the data correction methods used. The second section presents the ratios and the third chapter offers some findings and recommendations drawn from these data.

1. DATA GATHERING PROCESS

At first glance the data gathering process for such an exercise would seem rather straightforward, the difficulty rather lying in the analysis of the figures and the existing trends, and the production of findings and adequate recommendations for improving the current situation, while remaining realistic and practical. However compiling the data proved a remarkably difficult task. The initial level of details which the Steering Committee (cf. Annex 2) envisaged for this study (annual expenditures for national programmes and annual ESA expenditures in the three domains covered by the study, level of employment) simply cannot be extracted at national or European level. Integrated figures have of course been published by various organisms; however these figures almost never provide any level of detail concerning the actual expenditures in the various space research areas. This is the reason why the ESSC and the Steering Committee for this study have decided, in agreement with ESA, to concentrate their efforts in compiling an independent set of data for space research.

1.1 - First approach

To retrieve the level of funding devoted to the space activities in Europe, the ESSC's Steering Committee first decided to compile all European space activities taking place over the last decade as well as their related costs in a "home made" database.

This tool aimed at gathering all space missions *(space science, Earth observation, microgravity experiments, sounding rockets, parabolic flights, and sounding balloons…)* where European funding or know-how was involved. In compiling the cost of the instrument and the manpower cost for each identified item we were planning to retrieve the global level of funding devoted to the European space activities.

The ESSC database considered ideally for each European mission the following elements:

- name of the mission
- domain
- launch date
- launch vehicle
- leading agency
- project manager (PM)
- principal research Institution
- principal investigator (PI)
- funding institution
- annual manpower cost
- annual hardware cost

For each mission, the Project Manager has been identified as well as the list of the European instruments and experiments taken onboard. For each instrument or experiment, the principal research institution (and the associated PI) and related contact points in the principal institution funding the hardware and the workforce were also identified.

This ESSC's database gathers around 255 missions including approximately 160 satellites in the domain of space science and Earth sciences, 95 microgravity missions, 25 ESA parabolic flight campaigns and approximately twenty sounding rockets campaigns.

Project Managers have been contacted to attempt to retrieve all relevant details (PIs, mission costs split by phase or (ideally) per year, etc).

A questionnaire was then sent directly to the PIs. More than 900 PIs were identified and directly contacted to process our database. The PIs were asked to provide hardware cost and manpower cost on a yearly basis. It proved very difficult however to retrieve anything substantial for several obvious reasons (lack of archives, lack of information, lack of time or resources to dedicate to this task, retirements, etc).

Roughly 5% of the identified PIs have replied with global funding information, and less than 1% of the total with detailed funding information. Whenever contacts have been identified, additional questionnaires have been sent to funding institutions. However, the outcome of this request has not allowed us to obtain an integrated figure of the European space expenditures. Nevertheless the ESSC database appears, if it could be completed, as a potentially very useful instrument to make an inventory of the space activities in Europe. It is recommended that ESA studies the possibility to support its expansion and maintenance.

1.2 – Second approach

Given the difficulties detailed above it was thus decided to concentrate on retrieving global budget data from ESA and national sources (space agencies and funding institutions executives). In order to ensure a trustworthy retrieval and use of the data, a workshop was organised by ESSC on 19 September 2005 in Brussels. This workshop was supported by the Space Policy Unit of the European Commission. To prepare this workshop data were compiled coming from various sources in Europe and the USA.

The workshop was an ideal opportunity to discuss informally with national representatives and to assess the relevance of the information already gathered. This event also allowed developing a qualitative approach over the funding information in order to:

- assess the impact of research in space sciences on European science prominence, industrial competitiveness, education, culture and society
- identify and qualify the existing coherence in Europe between ESA activities, national space programmes, national research funding, EU programmes and others
- define objective measures of appropriate funding levels for space sciences in Europe
- make a quantitative analysis of space research funding levels in Europe, compared with other global actors like USA and Japan
- quantify an appropriate level of funding for European space research at current economic conditions
- formulate recommendations as to how to reach such a funding level as well as other means to reinforce European leadership in space research

A main outcome of the workshop was to establish that the categories used for the data cannot be similar between activities conducted in Europe and in the USA. The launchers category is a good example as this activity is included in the civilian domain in Europe whereas it fits in the military domain in the USA.

Another example deals with the categorisation enforced in the 90's by US administrations grouping microgravity and commercial activities, since R&D in life sciences and in microgravity were oriented towards, both, NASA's needs and commercial participation and stimulation. The European case is once again completely different as these activities are separately accounted for.

It was thus decided to focus our efforts on the 3 following domains:

- Space Science (astronomy, astrophysics, planetary exploration, fundamental physics, solar physics and space physics)
- Earth Observation (atmosphere, ocean, solid Earth, continental land). Meteorology (for example MSG) and other "application-oriented" programmes are not considered.
- EMIR / ELIPS & ISS utilisation (physiology, medical research, life sciences, fluid science, material science)

Based on this new set of categories, a second questionnaire was sent to national delegates to retrieve the expenditures devoted to national programmes and ESA contributions. The table below displays the various institutions which provided the data.

Countries	National programmes data source
Austria	Federal Ministry for Transport, Innovation and Technology
Belgium	Belgian Federal Science Policy Office
Denmark	Danish Space Research Institute[2]
Finland	TEKES
France	CNES & CEA
Germany	DLR
Ireland	Irish delegation to ESA
Italy	ASI & INFN
Netherlands	Ministry of Economic Affairs (coordinating Ministry of Space Affairs)
Norway	Norwegian Space Center
Poland	Polish Space Research Centre
Romania	Romanian Space Agency
Spain	CDTI
Sweden	SNSB
Switzerland	*N/A (budget re-structuring)*
UK	BNSC & PPARC
Japan	JAXA
USA	Georges Washington Space Policy Institute, NOAA & NASA

This last ESSC questionnaire requested data on a standardised format (in current prices & exchange rates) in order to apply a common correction and to polish the inflation effects in a harmonised fashion.

In most of the cases (except for Italy in space science and Earth observation, and for Switzerland) budgets (but not actual expenditures) devoted to national programmes have been retrieved. Concerning ESA contributions the requests were sent directly to the three relevant ESA directorates.

For Earth observation, we have considered the expenditures related to the following programmes:

- EOPP Extension 2
- Earth Watch (Fuegosat)

[2] Now, Danish National Space Centre

- Earth Watch (Infoterra/Terrasat)
- Earth Watch (GMES)
- EOPP Special extension
- Data users programme second period
- Columbus Polar Platform
- Envisat
- Meteosat Second Generation
- Metop 1 C/D
- EOEP
- EOEP 2

Concerning the "EMIR/ELIPS and ISS utilisation" category, ESA only provided us with the budget devoted to the entire ISS programme; based on the advice given by D-HME, we used 9.1% of the entire ISS programme to retrieve the level of funding dedicated to the "ISS utilisation" (this includes payments for ACES or the MAPs). Thus, the "EMIR/ELIPS and ISS utilisation" category includes for the 1994-2004 period the following programmes:

- EMIR 1
- EMIR 2
- Facility Columbus
- ELIPS
- ISS utilisation

To allow yearly comparisons across countries the figures were converted to euros, in 2004 economic conditions.

1.3 - Data correction

To respond to this end, the HICP (see below) proposed by Eurostat was used and in accordance to the ESA practice, a parallel correction was simulated to measure the differences in using the Wiesbaden criteria.

- **HICP definition**

The *Consumer Price Indices* (CPI) are economic indicators constructed to measure the changes over time in the prices of consumer goods and services acquired, used or paid for by households. *Harmonised Indices of Consumer Prices* (HICPs) are designed for international comparisons of consumer price inflation. The coverage of the HICPs is defined in terms of 'household final monetary consumption expenditure', by reference to the national accounts concepts of the European System of Accounts" (source: Eurostat).

Eurostat being the statistical institution of reference in Europe, it naturally appears as the most suitable provider for the HICP. Nevertheless the availability of this index did not cover entirely our period of interest as well as each country such as USA, Switzerland or Japan. Hence, for these cases where the HICP was not available from Eurostat we have used the HICP provided by the International Monetary Fund (source: IMF). However, cross-checking the Eurostat's HICP with those provided by the IMF did not seem to induce significant variations.

HICP	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Austria	1,16	1,14	1,12	1,11	1,10	1,10	1,07	1,05	1,03	1,02
Belgium	1,18	1,16	1,14	1,13	1,12	1,10	1,08	1,05	1,03	1,02
Denmark	1,22	1,19	1,17	1,15	1,13	1,11	1,08	1,05	1,03	1,01
Finland	1,15	1,15	1,14	1,12	1,11	1,09	1,06	1,04	1,02	1,00
France	1,18	1,16	1,13	1,12	1,11	1,11	1,09	1,07	1,05	1,02
Germany	1,15	1,12	1,11	1,09	1,08	1,08	1,06	1,04	1,03	1,02
Ireland	1,35	1,32	1,29	1,28	1,25	1,22	1,16	1,11	1,06	1,02
Italy	1,31	1,24	1,20	1,17	1,15	1,13	1,10	1,08	1,05	1,02
Netherlands	1,26	1,24	1,23	1,20	1,18	1,16	1,13	1,08	1,04	1,01
Norway	1,23	1,18	1,17	1,14	1,12	1,09	1,06	1,03	1,03	1,01
Poland	2,61	2,04	1,70	1,48	1,32	1,23	1,12	1,06	1,04	1,04
Romania	33,58	25,42	18,30	7,18	4,51	3,10	2,12	1,58	1,29	1,12
Spain	1,34	1,28	1,24	1,22	1,20	1,17	1,13	1,10	1,06	1,03
Sweden	1,17	1,14	1,13	1,11	1,10	1,10	1,08	1,05	1,03	1,01
Switzerland	1,09	1,07	1,06	1,06	1,06	1,05	1,03	1,02	1,01	1,01
UK	1,17	1,14	1,11	1,09	1,08	1,06	1,05	1,04	1,03	1,01
Japan	0,99	1,00	0,99	0,98	0,97	0,97	0,98	0,99	1,00	1,00
USA	1,27	1,24	1,20	1,18	1,16	1,13	1,10	1,07	1,05	1,03

Sources: in black Eurostat, in red IMF

Table 1: Cumulated inflation/HICP

- **Wiesbaden criteria definition**

The Federal Statistics Office in Wiesbaden was commissioned by ESA to prepare an expertise on the price, wage and salary trends in countries where ESA pursues its activities or where expenditures are incurred. Price, wage and variation of salary data provide the basis for converting ESA's planned expenditures at previous year's prices into figures at estimated next year's prices. These expenditures are broken down into 25 categories converted using suitable indicators, and then summarised by activity or programmes and country. In addition, before the Euro was introduced, currency conversion rate variations were taken into consideration.

The result is a 450-page book with detailed price and conversion rate variations by project. It provides a very accurate estimation of the price variation amongst projects and countries. Albeit this methodology is very accurate and realistic, it was also extremely complex and time-consuming, not to mention expensive for ESA. Therefore, the Agency decided to use the European Harmonized Index for Consumer Prices from 2000 onwards.

The obvious reason why the Wiesbaden index is different from the HICP is due to the fact that the HICP provides metrics for inflation in the European Union, i.e. change in prices for private domestic consumption. Therefore, its weighting ranges from food and non-alcoholic beverages to clothing and furniture; it is thus obviously much lower than the price variations suffered by any scientific projects or experiment. In addition, the Wiesbaden index structure has slightly changed and these modifications contribute also to the differences between the two indices. For the 1994-2001 periods, the Wiesbaden index was based on five subgroups and various indicators, whereas from 2002 onwards, ESA has decided to decrease the number of these sub-groups.

- ***Before 2002***

1. Staff expenditures
   - non-ESA – staff
     - national wages (mechanical resp. space industry)
   - non-ESA – staff
     - national earnings (aeronautical industry)
2. Running expenditure
   - administrative consumables
     - price indices for paper and paper products
   - communications
     - postal fees
     - telephone fees
     - telex fees
   - missions expenses
     - IATA passenger tariffs
     - subsistence allowances
3. Facilities
   - Consumables
     - price indices for electrical goods resp. paper products
   - communication links
     - fees for data links
   - rent of computers
     - rental of computers
4. Capital expenditure
   - electrical industry
     - price indices for electrical goods
   - electronic industry
     - price indices for electronic goods
   - computers
     - price indices for data processing equipment
   - office equipment
     - price indices for office furniture, office machines and passengers cars
5. Development
   - electrical / electronic industry
     - price indices for electrical resp. electronic goods
   - electronic industry
     - prices for copper wire
   - space industry
     - prices for aluminium alloys
   - aeronautical industry
     - price indices "Air" resp. for electrical measuring / test instruments
   - mechanical industry
     - price indices for iron and steel
   - construction industry
     - price indices for factory buildings
   - energy
     - price indices for electricity for industrial use
   - launches
     - US-productivity index "compensation per hour" (BoL)

- ***After 2002***

1. Staff Expenditure
   - non-ESA – staff

        - Local wages (mechanical resp. space industry)
2. Running expenditure
    - missions expenses
        - IATA passenger tariffs
        - subsistence allowances
3. Capital Expenditure
    - electrical industry
        - price indices for electrical goods
4. Development
    - electrical / electronic industry
        - price indices for electrical resp. electronic goods

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
base 100: 1994	100	104,32	108,56	112,28	114,96	117,94	120,99	127,13	130,82	133,56	136,63
Cumulated inflation	1,366	1,31	1,26	1,22	1,19	1,16	1,13	1,07	1,04	1,02	1,00

Table 2: Wiesbaden criteria

- **First analysis**

The HICP indeed appears better suited for private consumption and less significant for ESA purposes. According to the Federal Statistical Office of Germany, two general remarks could explain the specific differences between the Wiesbaden indices and the HICP:

- In former years, data extrapolations were often necessary. Indeed, as the required data to build the Wiesbaden indices were not available at the time of the delivery of the report to ESA, some series estimations for 5 to 8 months were necessary in certain cases. Nevertheless, in later years by changing the deadline of delivery from March to October the estimation problem has been drastically reduced.
- The definition of the Wiesbaden indices and that of the HICP are somewhat dissimilar.

Apart from correction to account for inflation, existing differences in national accounting systems were also a concern.

1.4 – Full-cost accountancy

The issue was to ensure that all costs were taken into account. As an example NASA's figures format changed in 2004, shifting towards full-cost budgeting format. Obviously, European data needed to be retrieved the in the same manner.

Full-cost accountancy is designed to enhance cost-effective mission performance. All direct and indirect costs (institutional infrastructure costs, salaries, use of facilities/support services, overheads…) are included in this way of programming a budget. This practice permits timely and accurate cost estimations and a precise programme mission performance appraisal, facilitating the decision-making process.

Full-cost components for a dedicated NASA mission are distinctly divided in three categories: direct costs, centre G&A (general and administrative costs) and corporate G&A (general and administrative costs).

- Direct costs are directly and physically related to the project and include the purchase of goods and services, contracted support, direct salaries, benefit and travel
- Centre G&A costs include costs not directly related to a specific programme but benefiting all activities (civil servants, on site contractors, security, grounds maintenance, roads, library, public affairs, transportation services, legal, human resources department, budgeting accounting, educational outreach, logistic services…)
- Corporate G&A include costs directly related to the business operations with NASA (administrator, immediate staff, functional management and safety and mission assurance).

To know whether the space expenditures were expressed in full-cost accountancy, a second verification was carried out, sending the figures to the individuals who had filled in our questionnaire. It rapidly appeared that the situation was extremely dissimilar depending on the country.

Concerning the Swedish National Space Board, they confirmed that their figures were in full cost accountancy. Around 35 % of the given numbers are representing overheads used by the universities and institutes involved in space programmes. In the case of space science, an additional 40% of the national programmes figures are used for salaries (PhDs, researchers and technicians) either for identified positions (of stipulated duration) or as soft money. For Earth observation the percentage is probably closer to 60%. A typical salary (intermediate between a PhD and a Professor) including all social fees and overhead should correspond to a man-year cost of 75 K€.

Similarly, the Spanish delegation confirmed also that the figures provided by the CDTI were expressed in full cost accounting. In this case however details could not be obtained concerning salaries and overhead costs for confidentiality reasons (Spanish space activities are mainly developed between CDTI and INTA; CDTI is the body responsible for the management of space activities related to the Ministry of Industry, but INTA depends on the Ministry of Defence).

In some cases, it was feasible to retrieve somewhat precise indications. This point was illustrated by the Norwegian figures where the salaries part represented some 20%, with the following evolution:

- *Space science*: from 1994 to 1995= 1.6M€, 1995 to 2004= 1.5M€
- *Earth observation*: 1994=0.4M€, from 1995 to 2004=0.5M€, 2005=0.8M€
- *EMIR/ELIPS & ISS utilisation*: 1994=0.2M€, 1995=0.1M€, from 1996 to 2005=0.2M€

Some details for the Italian astrophysics field were also obtained. INAF having incorporated the former CNR institutes as well as the university professors carrying research in astrophysics (around 200), a typical annual expenditure in astrophysics would be:

- 220 man/year equivalent (research) to roughly 11.2 M€ (ca. 51 K€ mye)
- 60 man/year equivalent (engineer/technician) to roughly 2.4 M€ (ca. 40 K€ mye)

In the case of the UK national programmes, the figures are not full cost accounted. The UK system is currently being changed in that direction; a rough estimate would double the figures, including university, institutes and buildings costs.

Finally and concerning the other European countries, as well as Japan and the USA, this level of information is not available, nor can any worthwhile estimation be made.

Overall it became obvious that an averaged cost for manpower could differ very much between academia and industrial projects, for instance in Germany. In this country, no detailed information exists concerning the work-load distribution for a DLR space project; a translation into “man-years cost” seems therefore unfeasible.

2 – The European level of funding for space activities

Space applications are by definition trans-disciplinary and can thus serve a wide range of sectors (transport, agriculture or environment). Space-based platforms and instruments are well adapted tools for monitoring natural hazards, geographical surveillance, or climate monitoring. Space science missions or the development of navigation and positioning systems have demonstrated that Europe is at the forefront of space activities world-wide.

The impacts of space activities extend far beyond the economic activity generated in terms of employment and revenue. Numerous socio-economic and strategic benefits are delivered by major space programmes or applications such as GMES or Galileo. The quality of life has been significantly improved with access to high-speed information services for remote areas, the safety and punctuality of public transport, or more precise meteorological services. The telecommunications sector is also at the heart of these improvements with services such as e-government, e-learning, e-health and e-business.

Consequential revenues of satellite-based telecommunication and television services, Earth observation and navigation services, have generated over € 55 billion for 2003 (€ 50 billion for telecommunications, some € 0.8 billion for Earth observation, and around € 4.5 billion for navigation; source: Euroconsult). Assessing what is spent in the space sector remains a difficult exercise as many budget sources are contributing to space activities. Indeed, several institutions fund space programmes directly or indirectly and the European Commission is also becoming a major player in Europe.

2.1 - EC financial expenditure on space (1995-2008)

The EC is a recent player in the space field in Europe. Even though they are still limited, its contributions are growing and the corresponding investments should be included in this study.

Indeed, several projects, either directly dedicated to space applications and services or indirectly implying the use of space-related technologies and infrastructure for research purposes have benefited from budgets being provided by the EC’s Framework Programmes for Research and Development. Telecommunications, Earth observation and navigation in particular were funded during FP3, FP4 and FP5; sources concur that an average of €70 million per year was spent between 1998 and 2002, adding up to €350 million over the whole period.

Globally, the absolute amounts remain modest compared to the national and inter-governmental efforts and most of the investments could be qualified as R&D resources, either directly drawn from the R&D 5th and 6th Framework programmes or from the Trans-European networks – Transport budget line.

In this context, GALILEO programme appears as the main application developed during this period and has benefited from roughly a third of the total EC investments.

M€	1995–1998	1999–2002	2003-2006
Framework programme + JRC	150	280	475
GALILEO		270*	280**
Total	150	550	755

Sources: EC-European Space Policy
*: Definition and development
**: Development
Table 3: European Commission expenditures on space-related activities:

With the launch of FP6 (2002-2006), the European Union has selected a thematic priority dedicated to Aeronautics and Space with a total financial allocation of about €1 billion over this 5-year period. Space is therefore mentioned for the first time as a priority in a framework programme, and space-related projects received €300 million in total as a contribution from the Commission and €450 million from the Trans-European Network dedicated to the Galileo development phase.

The figures for the 6th Framework programme (2002-2006) are as follows:

- priority "aeronautics & space": 235 M€
- priority "sustainable environment, transport and energy": 50 M€
- Joint Research Centre space-related activities: 50 M€
- Priority "nanotechnologies and materials" or "research infrastructures" for an estimated total of 40 M€".
- "Trans-European networks – Transport (years): 550 M€/year (280 of it fall in the 2003-2006 period)"

Beside these funds, other investments should be included coming from various sources e.g. structural funds, TACIS, FED, MEDA and other policies investing equally in space related activities, i.e. agriculture, fisheries and development. All these additional sources amount to an estimated additional budget of around 50 M€/year, most of them devoted to satellite image acquisition.

Finally and for its 7th Framework Programme, the Commission has allocated 500M€/year for R&D activities in the fields of space and security.

2.2 – Worldwide civilian space expenditures

As stated previously, space programmes are for the essential part civilian-driven. Civilian space programmes received €21.9 billion in 2004 and remain concentrated in only a few countries. NASA, ESA and JAXA totalise respectively 11.61 billion €, 3.49 billion €, and 1.22 billion €, or approximately 75% of the worldwide civilian space expenditures (source: Euroconsult).

M€	*2000*	*2001*	*2002*	*2003*	*2004*
NAVIGATION					
DoD	324	135	490	711	541
ESA	168	184	176	168	598
JAXA	30	40	35	30	25
EARTH OBSERVATION					
NASA	1143	1815	1685	1610	1613
ESA	304	320	343	462	486
JAXA	351	265	165	151	149
SPACE SCIENCE					
NASA	2194	2749	3021	3468	3971
ESA	332	326	350	415	455
JAXA	173	172	181	105	163
HUMAN SPACEFLIGHT					
NASA	7651	7450	7923	7845	7491
ESA	455	547	796	702	742
JAXA	396	304	303	198	308
MICROGRAVITY					
NASA	275	941	820	913	985
ESA	138	171	85	115	134

Table 4: Euroconsult: Government Programme Funding (in M€)
Source: Euroconsult

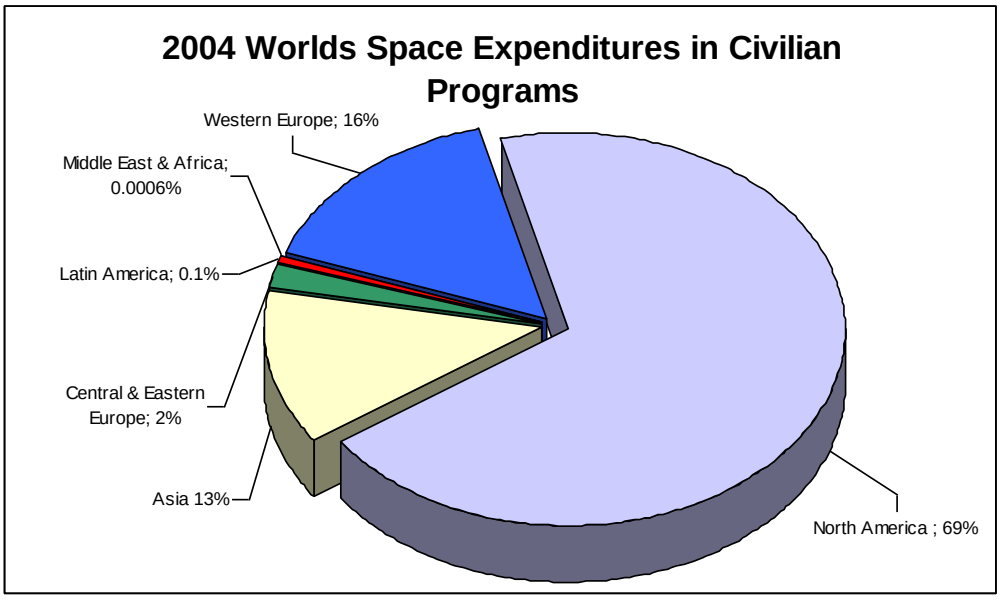
With a total of €11.6 billion for the 2004 budget and the U.S. Presidential Space Exploration Initiative, NASA has set up a long-term objective for space exploration aiming at a human presence on Moon and Mars. These goals will need however a constant level of funding and have for objective to strengthen the US economy and national security.

The European situation is much less comfortable with an ESA 2004 budget of €3.47 billion. Mandatory programmes account for € 719 million of this budget whereas the largest part is dedicated to optional programmes; the biggest contributors are France, Germany and Italy in nominal terms, with a major Belgium contribution in proportion to its GDP. The biggest ESA contributors remain Germany (23.8%), the UK (17.2%), France (15.9%), and Italy (13.1%); globally France, Germany and Italy account for 64% of the European civil expenditure on space and 86% of Europe's national space programmes.

Concerning other space nations, Russia has increased its federal space budget by about 30% over the past two years. Russia has also announced several new science missions as well as the wish to extend international partnership in the framework of ISS (50% of the Russian space budget) with India, Brazil, Chile, South Korea and Europe.

Concerning information related to China, specific figures are difficult to come by. Crosschecking the various sources of information shows undeniably that China remains the most dynamic emerging space nation; however, due to the fuzzy distinction between military and civil activities it is quite difficult to provide relevant budget figures for science activities.

Finally despite the large gap existing between the percentage of GDP invested in space by the USA and by the other two world leaders, India has made the most impressive progress in increasing its civil space budget. Between 1992 and 2004 the Indian budget has tripled, and in terms of spending as a proportion of GDP, India overtook France, spending 0.096% of its GDP on civil space, compared to 0.087% for France.



Source: Euroconsult

2.3 – The European space budget (1994-2004)

France, Germany, Italy and UK are representing globally more than 75% of the European space expenditures in Europe for the three categories considered in this survey.

2.3.1 – Volume and evolution

This chapter will compare the European space budgets with those of the USA and Japan, and will include the budgets dedicated to space science, Earth observation and EMIR/ELIPS & ISS utilisation. The structure of the European expenditures simultaneously includes the national programmes and the ESA contributions; concerning the US expenditures, NASA and NOAA budgets will be combined for the activities relevant to this study. Regarding Japan, only JAXA's budget devoted to the three categories will be considered.

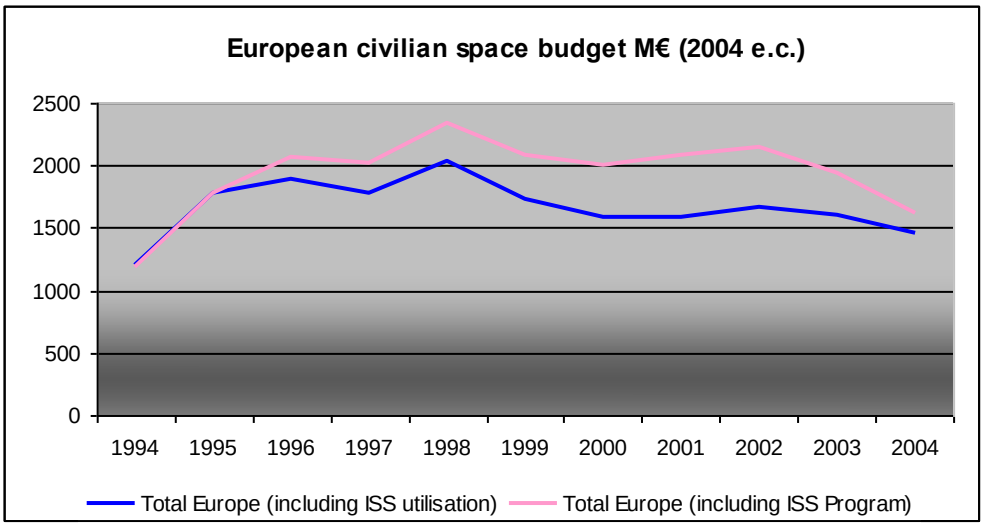
As mentioned previously the figures were obtained by means of a questionnaire that was filled in at national and ESA level. While mostly complete, data are missing over certain periods. In certain cases these gaps have created artificial up & down trends. Three major space nations are particularly concerned by this phenomenon:

- France between 2001 and 2004 where EMIR/ELIPS & ISS specific budgets were unavailable and in 1994
- Italy between 1994 and 1997 where space science and Earth observation expenditures were not available
- UK where the 1994 space science budget was not available.

National Space Programmes expenditures

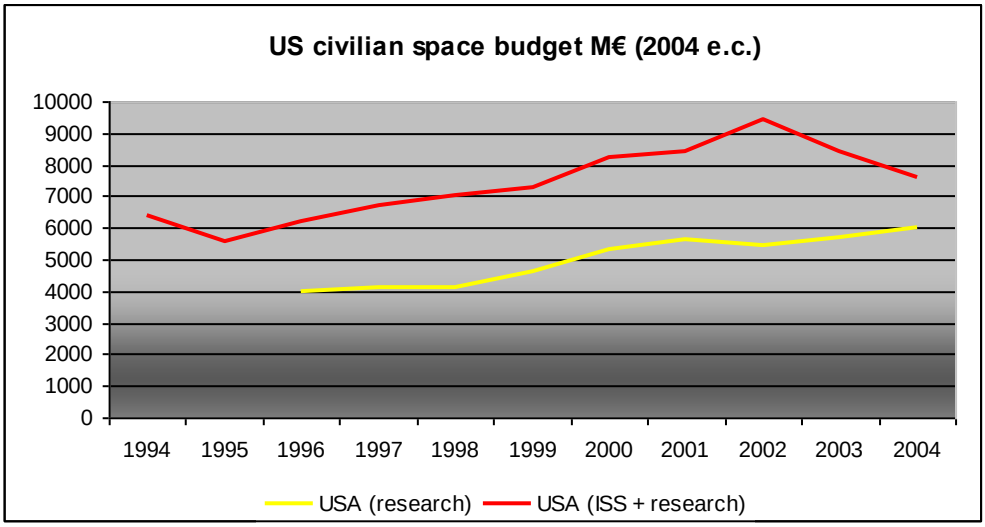
M€ - 2004 e.c.	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*
Austria	0	0	0	0	0	0	1	2	1	4	3
Belgium	5	8	8	15	15	11	11	5	6	7	8
Denmark	7	7	9	10	11	9	7	7	5	4	:
Finland	11	10	11	12	15	15	12	12	11	9	10
France	n.a	576	544	494	630	322	342	496	565	421	354
Germany	168	117	143	107	118	107	96	88	92	79	74
Ireland	:	:	:	:	3	3	3	3	4	4	4
Italy	2	2	2	3	28	44	125	178	206	310	168
Netherlands	11	31	12	17	22	24	15	22	15	16	12
Norway	17	16	16	15	15	14	17	17	17	16	17
Poland	3	2	3	3	3	3	3	3	2	2	2
Romania	22	16	11	3	2	1	1	1	1	1	2
Spain	17	16	16	16	5	5	20	14	19	19	20
Sweden	8	9	8	8	8	8	10	12	9	9	8
Switzerland	:	:	:	:	:	:	:	:	:	:	:
UK	71	86	85	72	79	88	91	89	76	71	88
Nat. Prog	341	896	868	774	952	653	752	946	1027	972	770
ESA budget (including ISS utilisation)	853	877	1020	1001	1089	1083	839	643	647	625	682
Total Europe	**1194**	**1774**	**1888**	**1775**	**2042**	**1736**	**1591**	**1589**	**1674**	**1598**	**1452**
Nat. Prog	341	896	868	774	952	653	752	946	1027	972	770
ESA budget (including ISS Programme)	851	876	1200	1251	1385	1436	1253	1133	1126	972	852
Total Europe	**1193**	**1772**	**2068**	**2025**	**2337**	**2090**	**2005**	**2079**	**2153**	**1944**	**1622**
USA (research)	**:**	**:**	**4015**	**4141**	**4142**	**4622**	**5295**	**5662**	**5416**	**5716**	**6006**
USA (ISS + research)	**6364**	**5601**	**6194**	**6739**	**7006**	**7248**	**8238**	**8437**	**9408**	**8400**	**7573**
USA (ISS, research, Shuttle)	**:**	**:**	**8681**	**9197**	**9142**	**9134**	**10045**	**10078**	**10867**	**9374**	**8795**
Japan	**825**	**960**	**746**	**736**	**638**	**757**	**1067**	**787**	**682**	**617**	**563**

Inflation effects are erased out from national programmes figures, using the HICP. Concerning the contributions to ESA, the Wiesbaden indices have been used until 1999; from 1999 onwards only the HICP was used. In most cases a cumulated inflation around 20% was computed; for countries such as Ireland, Italy, Spain, Poland and Romania this rate reached 30% or more (see the HICP table). Some preliminary comments can be formulated.

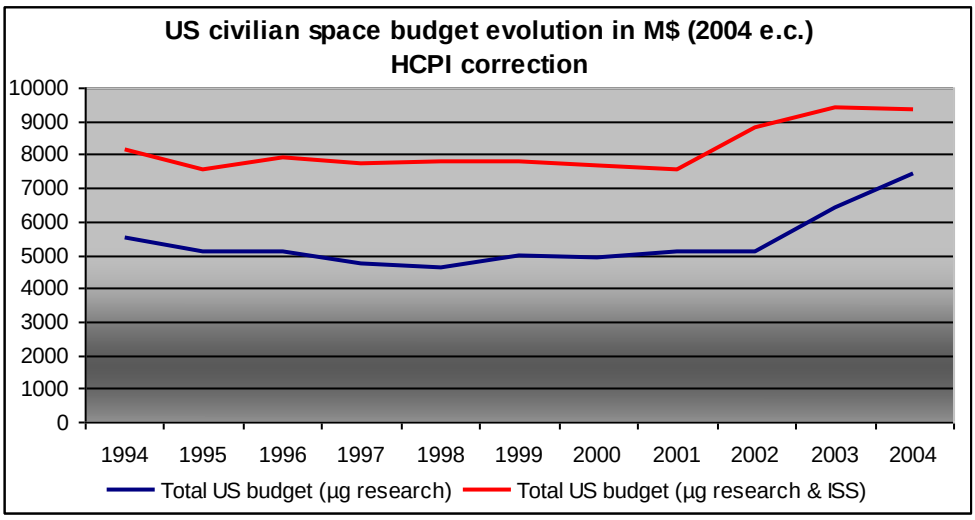


In excluding 1994 of our period of interest due to the fact that the corresponding data were not uniformly retrieved, the European space budgets show no remarkable increase. Concerning the EMIR/ELIPS & ISS utilisation category, a budget oscillating between €1.4 billion and €2 billion was spent. Only a noticeable increase in 1998 can be observed where the European space budget reached €2.04 billion (2004 e.c.). When including the whole ISS programme, the order of magnitude of the civilian space budget in Europe slightly increases and oscillates between €1.6 billion and €2.4 billion.

During the same period, the US space research has undergone a constant increase. NASA and NOAA budgets being simultaneously considered for Earth observation programmes, an increase of 49.5% can globally be observed between 1996 and 2004. When including the cost related to ISS, an increase of 22.2% is derived. Nevertheless, this increase has been reduced in 2002 where the US civilian space budget has undergone a €1.8 billion budget cut.

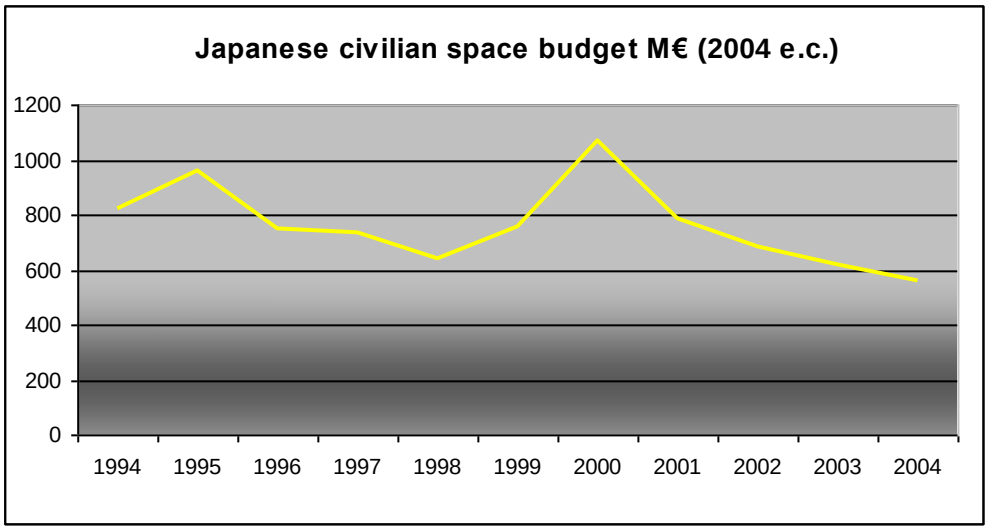


However should a worthwhile comparison be made between the USA and Europe, care should be taken when converting NASA and NOAA budgets in euros as the euro-dollar parity has fluctuated importantly over this decade. Converting the US figures without caution would underestimate the level of funding in the USA and thus artificially amplify the annual budget allocations.



In considering the figures in USD and after a minor decline in 1995, the US space budget including the cost related to ISS has been essentially constant until 1999, where a sensible budget cut was implemented. However in 2001 a remarkable increase took place; in a 3 year-period the US civilian space budget gained more than 24%.

In order to be exhaustive, the Japanese space budget has also been observed and globally three distinct periods could be studied.



First, the Japanese space budget shows a slow but noticeable decline until 1998 reaching a €638 million budget (budget cut around 22.5% in that period). However a huge increase in 1999/2000 allowed Japan to exceed the €1 billion budget; in two years the Japanese civilian space budget has benefited of a 67% increase. This increasing trend did

not last however: after 2000, the Japanese budget has constantly declined to reach its lowest level in 2004 of around 563 M€.

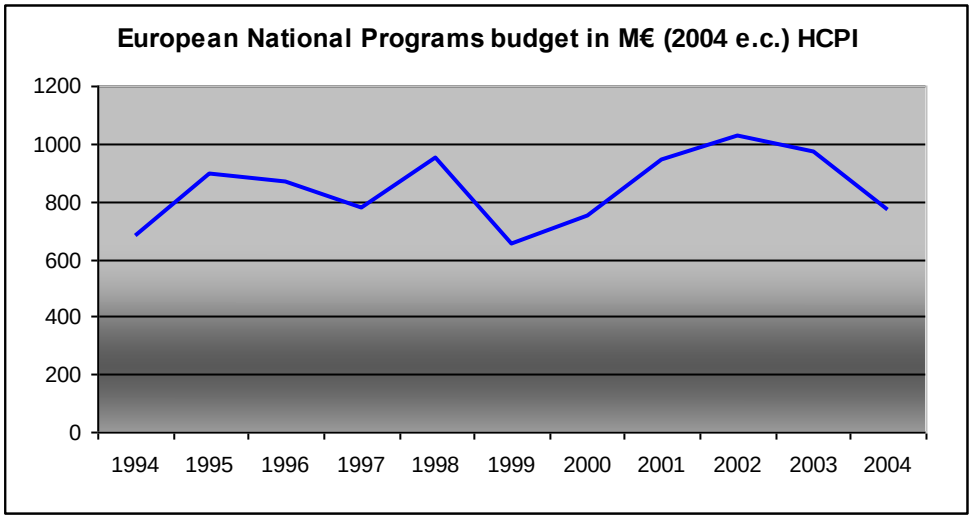
Whereas the USA continues to benefit from substantial budget allocations, the European and Japanese civilian space sector recently underwent severe budget reductions. It appears therefore interesting to identify more precisely which European country and domains suffered from these budget cuts.

2.3.2 – European level of funding

In order to clearly point out where more investments could be needed, some detailed analysis should be conducted. In this section, the European national programme expenditures and the annual ESA contributions will be studied.

2.3.2.1 – National programmes

Independently of the domain, the various national programmes did not benefit from significant large budget increases. Large oscillations can be identified, and national space programme budgets have oscillated between €653 million in 1999 and €1027 million in 2002, to go down again to the €800 million in 2004. It seems important to carry out an analysis on each country involved in the study.

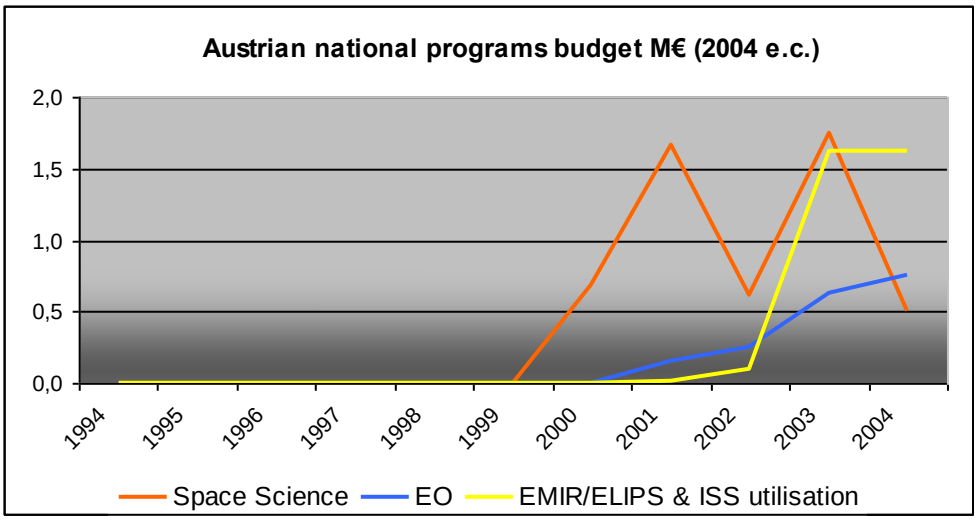


Budgets devoted to national programmes

M€ - 2004 e.c.	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*
Austria	0	0	0	0	0	0	1	2	1	4	3
Belgium	5	8	8	15	15	11	11	5	6	7	8
Denmark	7	7	9	10	11	9	7	7	5	4	:
Finland	11	10	11	12	15	15	12	12	11	9	10
France	n.a	576	544	494	630	322	342	496	565	421	354
Germany	168	117	143	107	118	107	96	88	92	79	74
Ireland	:	:	:	:	3	3	3	3	4	4	4
Italy	2	2	2	3	28	44	125	178	206	310	168
Netherlands	11	31	12	17	22	24	15	22	15	16	12
Norway	17	16	16	15	15	14	17	17	17	16	17
Poland	3	2	3	3	3	3	3	3	2	2	2
Romania	22	16	11	3	2	1	1	1	1	1	2
Spain	17	16	16	16	5	5	20	14	19	19	20
Sweden	8	9	8	8	8	8	10	12	9	9	8
Switzerland	:	:	:	:	:	:	:	:	:	:	:
UK	71	86	85	72	79	88	91	89	76	71	88
Nat. Prog	**341**	**896**	**868**	**774**	**952**	**653**	**752**	**946**	**1027**	**972**	**770**

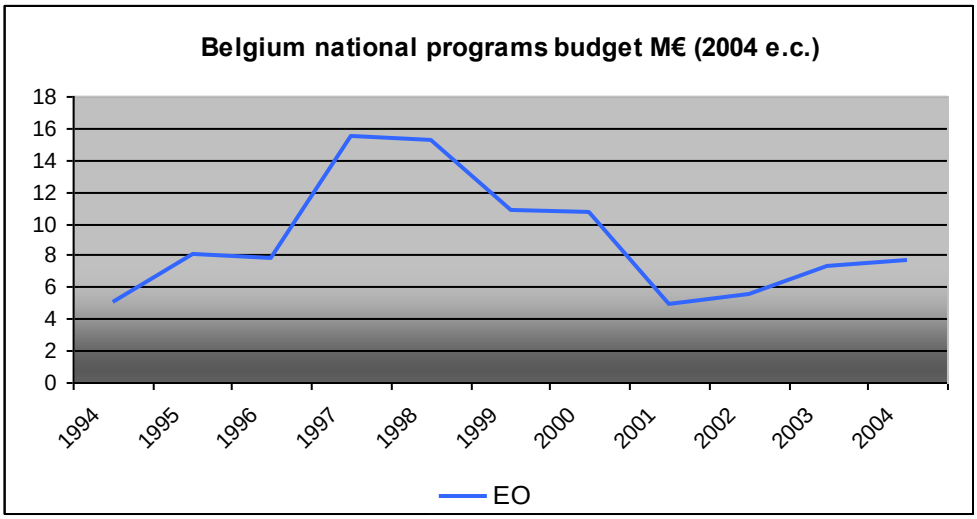
- *Austria*

Space budgets devoted to national programmes are relatively recent in Austria and do not exceed €2 million since 1999. Budget evolutions over this period are thus hardly significant statistically.



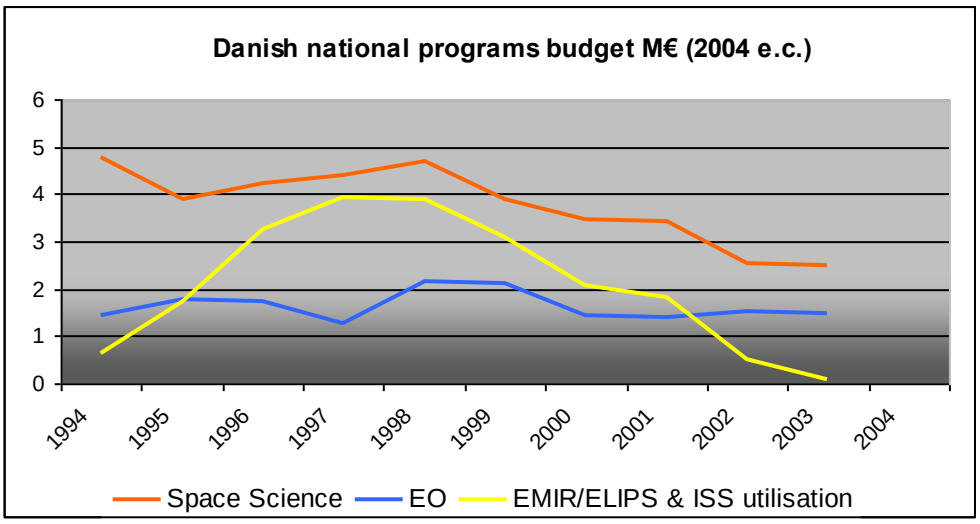
- *Belgium*

Belgium conducts national space programme only in earth observation. Three phases are characterising the Belgium budget evolution with a first increase between 1994 and 1997. A maximum was reached for national programmes in 1997 (15 M€); however an important budget cut occurred during the period that followed and the lowest level of funding was observed in 2001 with €4.9 million. In recent years though, a constant increase can be observed, providing the national Earth observation programmes with a budget around €7.7 million in 2004.



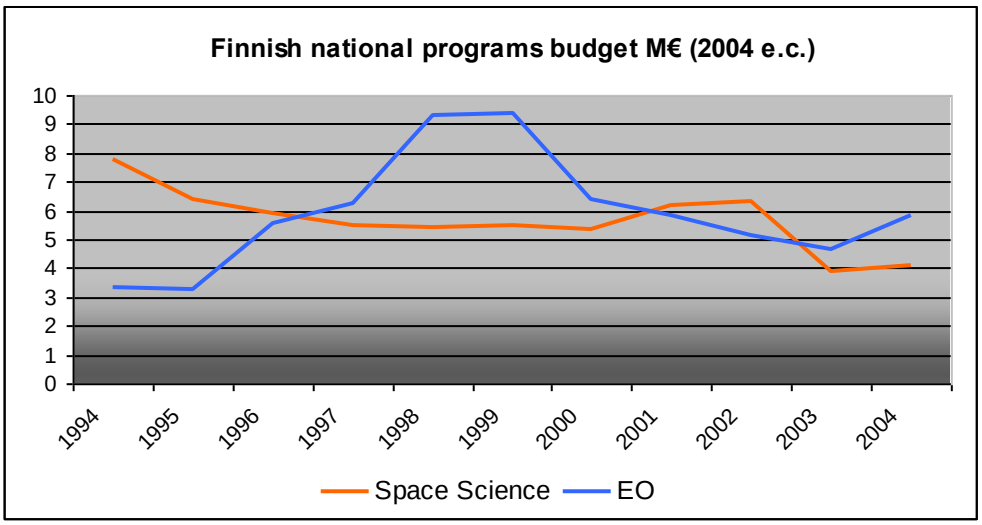
- *Denmark*

The Danish national programmes are globally demonstrating an overall budget shrinkage. Except the increase occurring between 1994 and 1997 in the life sciences domain, all national programmes were affected by this scenario, leading even the EMIR/ELIPS & ISS category budget below the €1 million level.



- *Finland*

Finland did not engage into a national programme in life sciences. However, Earth observation has benefited from substantial budget allocations especially until 1999 where the level of funding was around €9.4 million. During the same period, the space science budget has constantly declined losing more than €2 million.

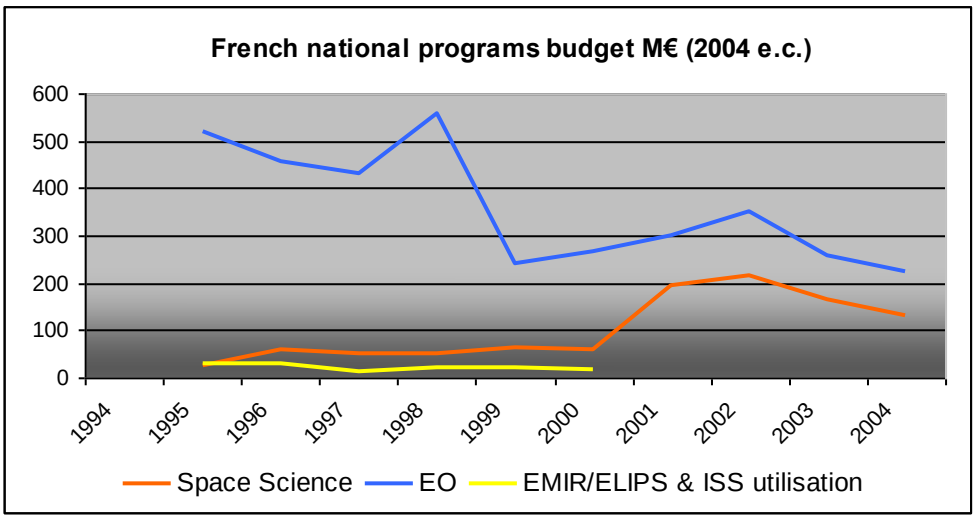


In 2000, the Earth observation budget has started to decline again (€4.7 million in 2003); the space science budget benefited from additional budget allocations until 2002, and then declined again.

- *France:*

Data concerning the French national space budgets are not available for the year 1994. In addition it is quite difficult to appreciate correctly the EMIR/ELIPS & ISS utilisation share, as the related data were not fully available for the whole period 1994-2004.

Globally, the national space budgets have followed an up & down trend with a level of funding culminating around €629 million in 1998.

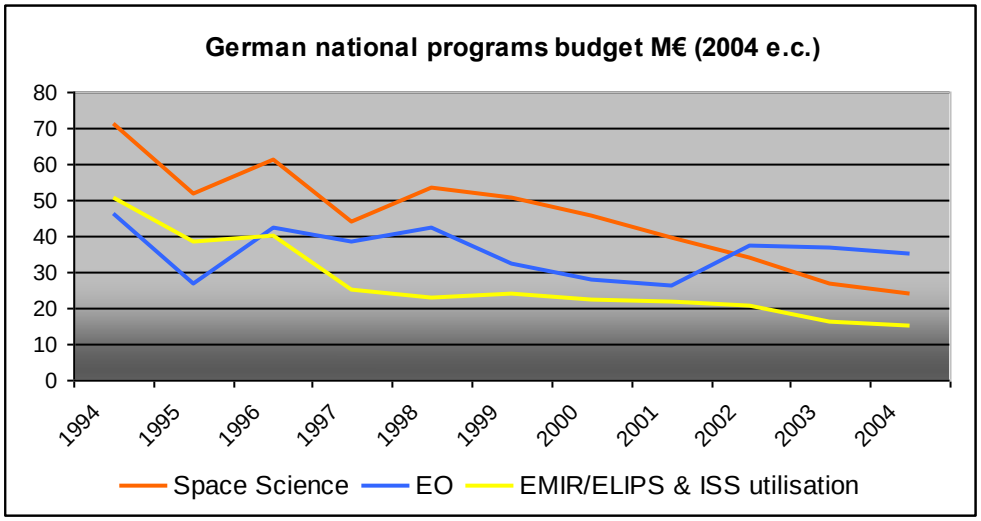


Until 1998 most of the national programmes expenditures were made in the Earth observation domain, whereas the space science and life sciences domains represented only the fifth of the French national space programmes expenditures.

After the large decline occurring between 1998 and 1999 which reduced by more than half the expenditures in Earth observation, the space science budget has become more adjusted to the Earth observation one; both these sectors have increased constantly until 2002, reaching respectively €348 million and €216 million. However, a new declining phase can be observed in the recent years leading the space science budget to €130.9 million and the Earth observation budget €222.7 million, representing respectively a decrease of 39.4% and 36.1% between 2002 and 2004.

- *Germany*

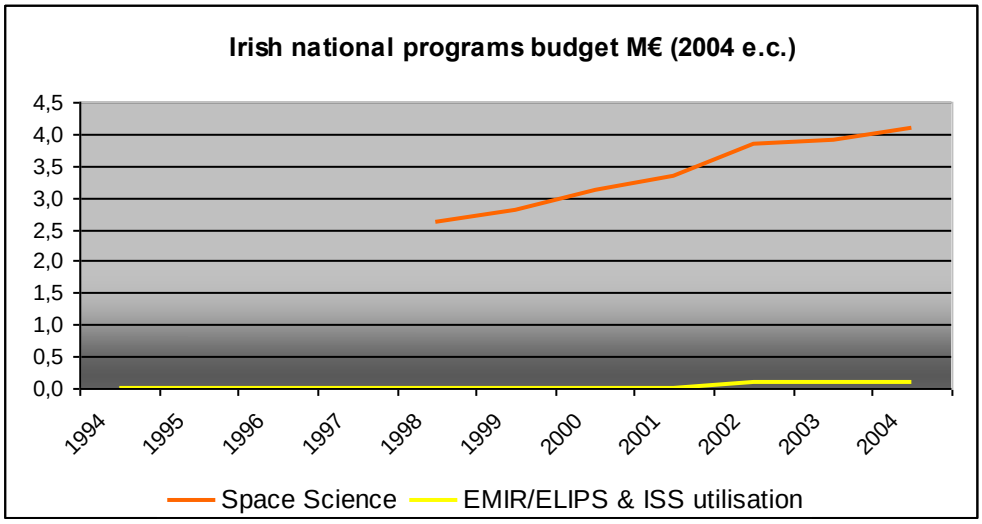
Concerning Germany, more integrated and accurate data were retrieved; as can be seen on the graph below, the German space budget devoted to national programmes has globally declined over the 1994-2004 period.



Except for the jolts occurring in 1996 and having affected the three categories, the space science and the life science budgets underwent respective budget cuts of 60.5% and 62.4% between 1996 and 2004. Earth observation was the only category having limited this general decrease losing 16.8% of its budget over the same period.

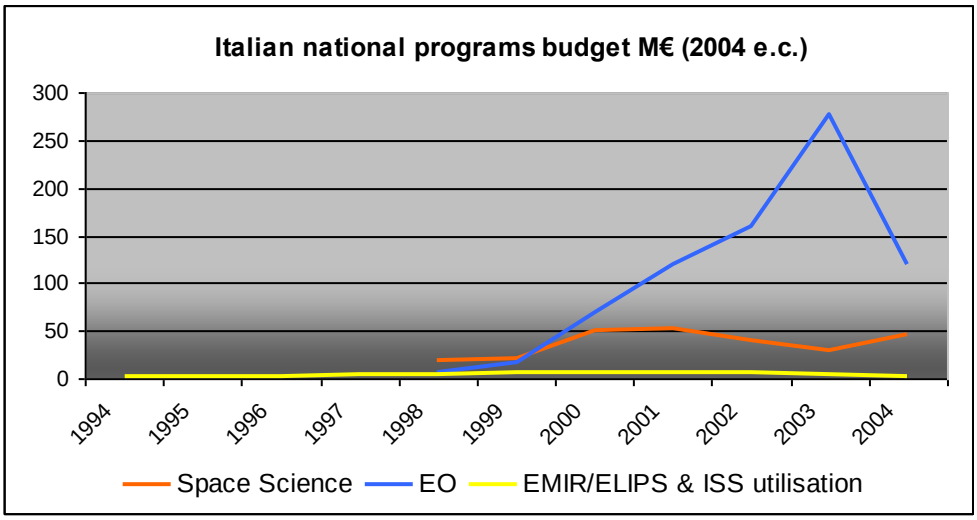
- *Ireland*

Ireland did not conduct any space programmes in Earth observation at a national level and the expenditures devoted to life sciences remained extremely moderate and inferior to €0.5 million. However, Ireland has a noticeable space science programme starting in 1998 with €2.6 million and benefiting from a constant increase until 2004 with €4.1 million.



- *Italy*

The data for space science and Earth observation budgets for Italy are unavailable until 1998. Only the EMIR/ELIPS and ISS expenditures were fully retrieved.



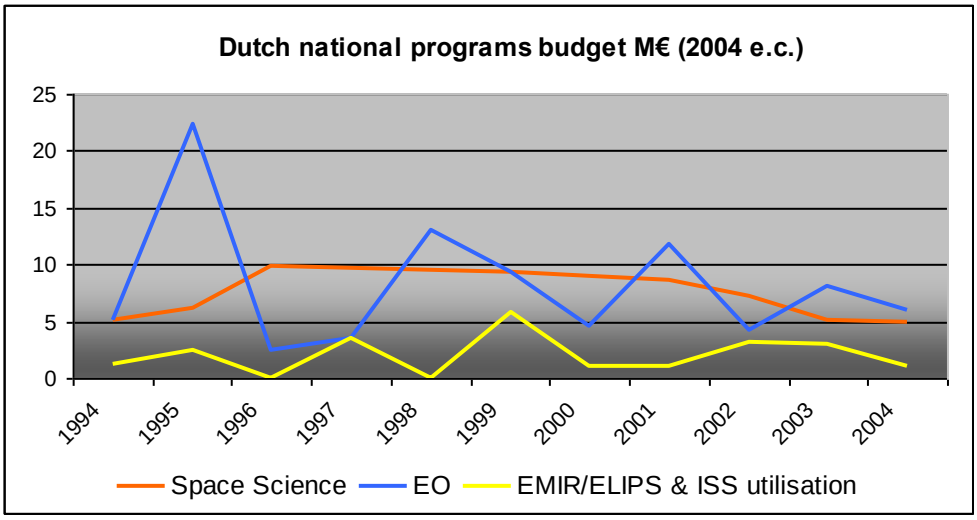
In contrast to space science, Earth observation benefited from a high growth rate until 2003 with a budget around €277 million. However, in 2004 this budget lost more than 50%. The life sciences budget at national level amounted to some €2.4 million in 1994 (€6.5 in 2002) and around €1.5 million in 2004. Over the 1998-2004 periods the space science budget oscillated between €19 and €52 million.

- *Luxembourg*

Luxembourg has spent a global amount of €12 million over the 2000-2005 period. As of 2006 the country plans to spend €10 million annually in parallel to their ESA contributions.

- *The Netherlands*

The Dutch national space programme budgets vary from one year to the other, with an overall declining trend.

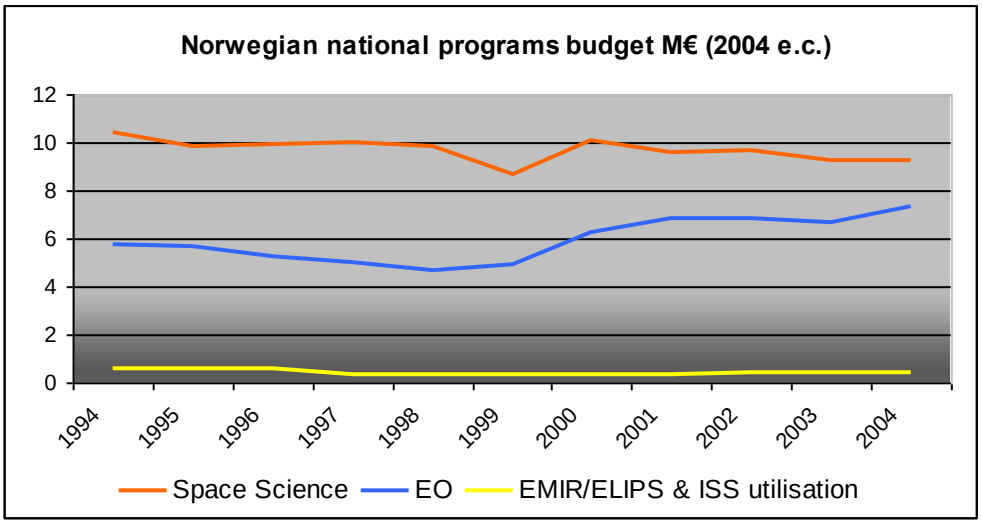


The space science budget is the only category showing a more regular budget profile but after having doubled its budget between 1994 and 1996, the expenditures devoted to this domain have constantly declined until 2004 to regain the level of 1994 around €5 million.

Concerning the Earth observation domain, after an important decrease occurring in 1996, reducing the budget by an order of magnitude, the budget has constantly oscillated between €4 million and €13 million. This irregular scenario has already been followed by the life science budget with a peak around €5.8 million in 1999.

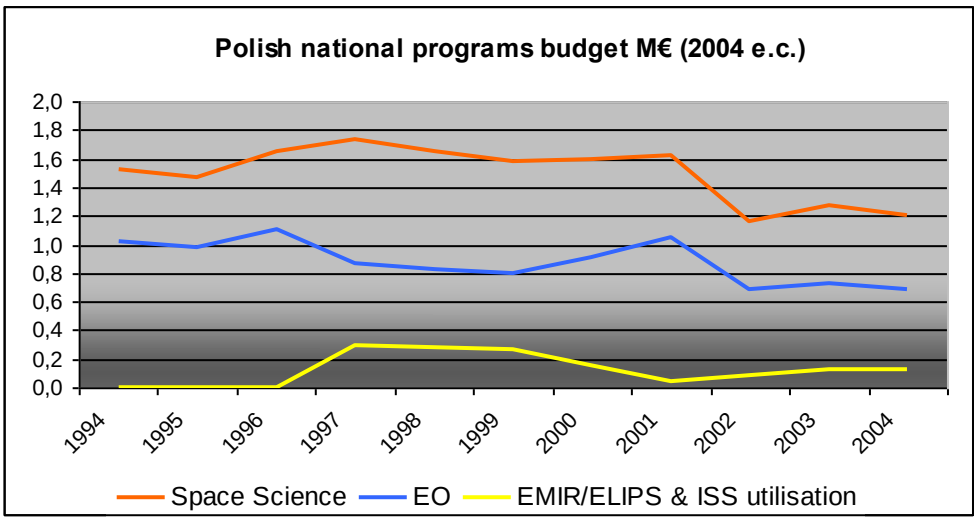
- *Norway*

The EMIR/ELIPS & ISS utilisation national budgets remained essentially stable.



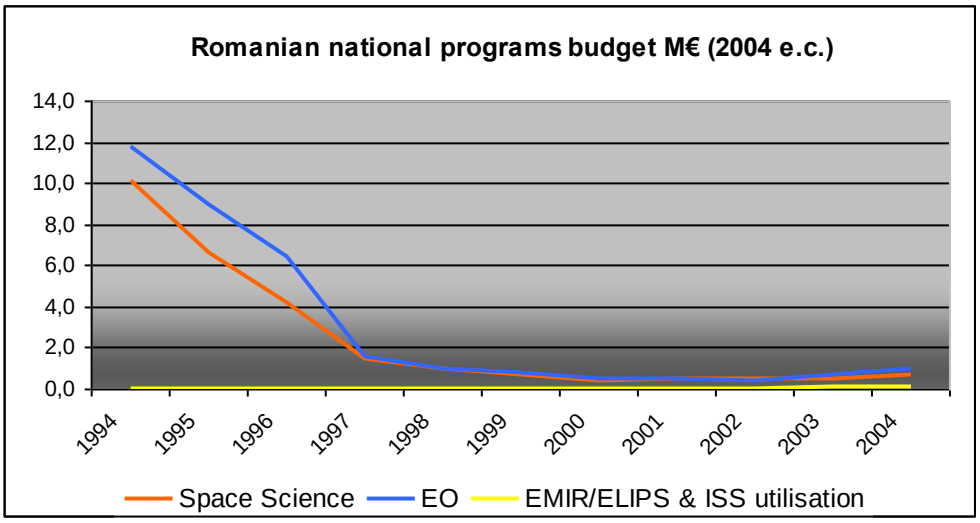
With the exception of 1999, the space science budget has been stable, while the Earth observation budget has been constantly growing since 1999 to reach a highest level in 2004 with €7.3 million.

- *Poland*



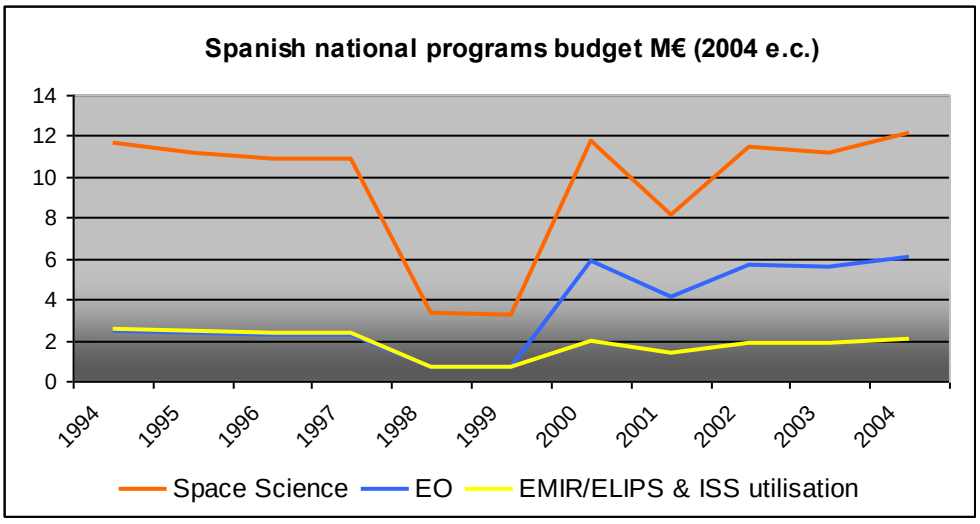
- *Romania*

The Romanian case is completely atypical due to its extreme national inflation rate over the period. In correcting the data from the inflation effects, the Romanian national space programme reaches a budget of €22 million in 2004 whereas in current economic conditions it does not exceed €1 million.



- *Spain*

The Spanish budget has also encountered an up & down scenario but a general picture has nevertheless globally affected the three domains.

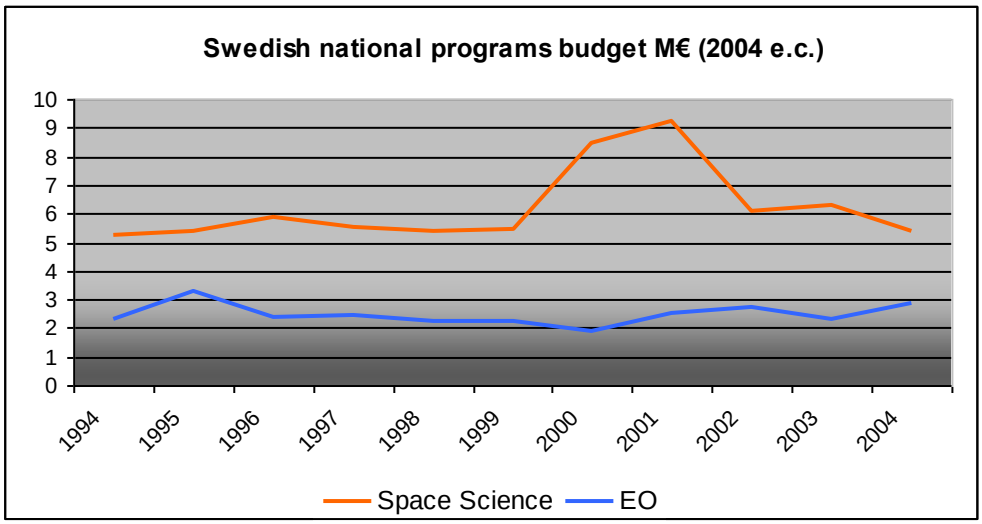


Indeed, after a minor decline during the first years having affected all domains, the Spanish national space programmes have experienced an important fall between 1997 and 1998. Until 1999 the level of funding has remained constant and this is only in 2000 where the national programmes have regained the 1994 level of funding. National programmes expenditures in Earth observation have been multiplied by 6 between 1999 and 2000 and, with the exception of 2001, the national space programmes benefited from a constant increase during the last three last years.

- *Sweden*

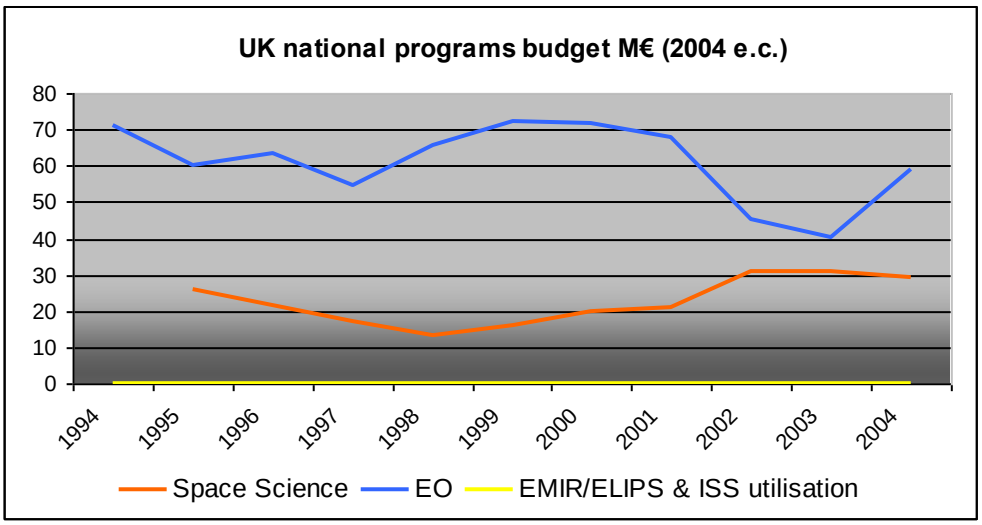
Sweden only conducts national programmes in Earth observation and in space science. Whereas Earth observation has benefited from annual budgets allocations oscillating between €2 and €3 million, space science underwent some important variations.

Stable until 1999 with roughly €5.5 million annually, the space science budget has increased by €3.5 million between 1999 and 2001, leading to a budget over €9 million. However the curve regained its level of 1999 after a new decline occurred in 2002 and in 2004.



- *United Kingdom*

UK is not involved in EMIR/ELIPS & ISS utilisation programmes; data for UK were uniformly retrieved except for space science in 1994.



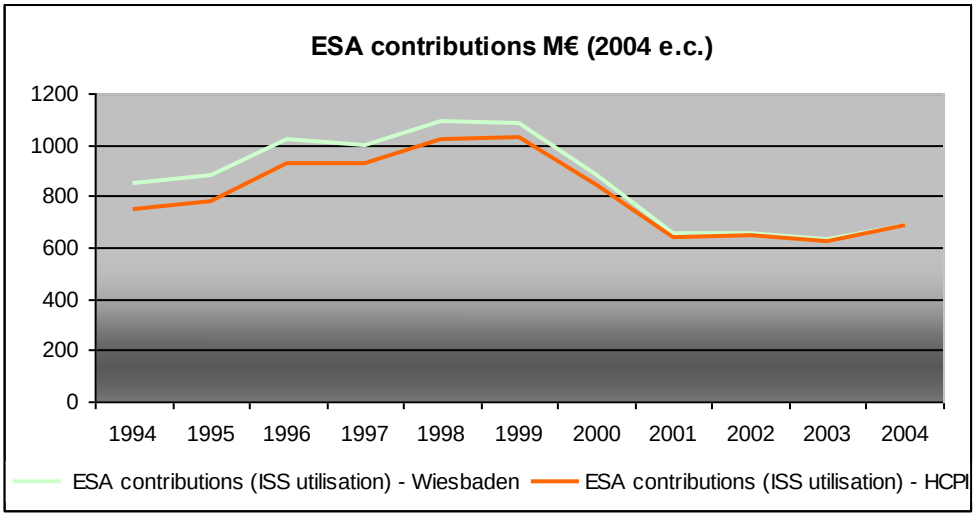
After having declined during the first phase, the national space programmes budgets were subject to increases in 1997 and in 1998. The space science increase continued until 2003, reaching €31 million, whereas Earth observation underwent an important decline starting in 2000, and reaching its lowest level with €40.5 million in 2003. Nevertheless, the national programmes in Earth observation have benefited from a 50% increase between 2003 and 2004, taking the budget to a level of €59 million.

To conclude, there is no common behaviour concerning the European national space programmes. The complete picture of the European space activities must naturally include the contributions to ESA.

Concerning the national contributions to EUMETSAT, these are not part of the study. EUMETSAT, although it is involved in Earth observation activities, is an operational service provider. In addition, as ESA funds the development of the EUMETSAT future programmes the largest part of the EUMETSAT R&D activities is automatically included in the contributions to ESA.

2.3.2.2 – ESA contributions

Some important variations could be noticed depending on whether the HICP or the Wiesbaden criteria is used to polish the inflation effects.

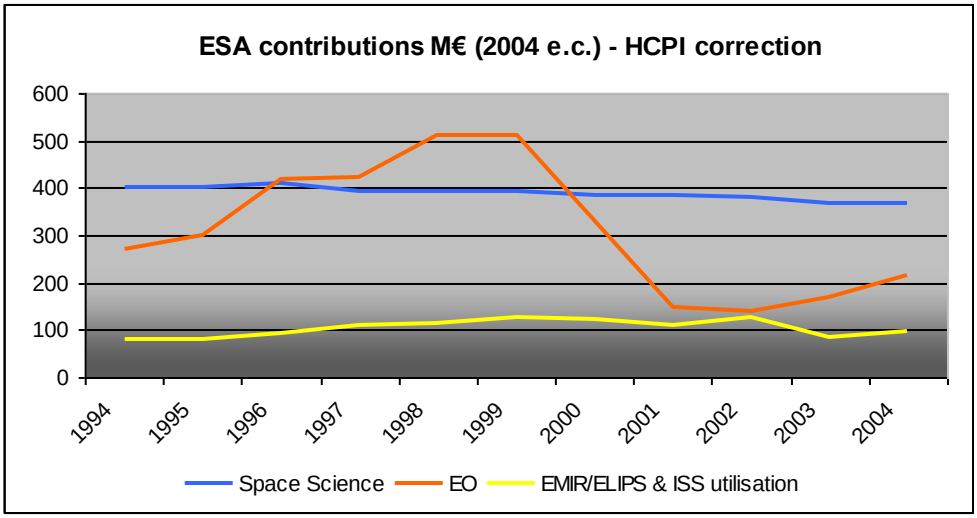


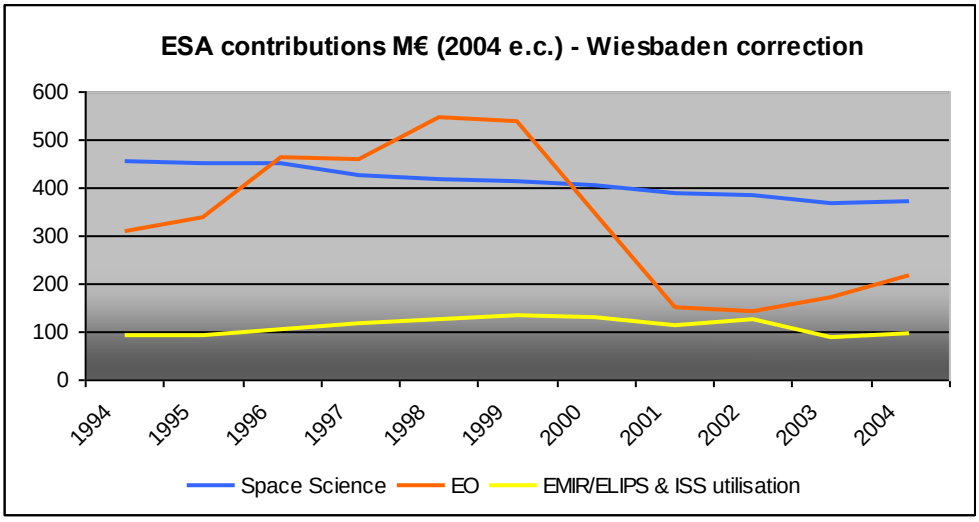
Nevertheless, both curves follow roughly the same trends. The Wiesbaden methodology was very accurate and realistic, but was also extremely complex and time-consuming. Therefore, ESA decided to use the European Harmonized Index for Consumer Prices from 2000 onwards. Between 2000 and 2002 there is not a large difference between the two curves.

Three distinct phases could be observed on the ESA contributions, independently of the correction considered. Between 1994 and 1999, the contributions to ESA have constantly increased with a budget for the three categories culminating at around €1.082 million. However this trend changed in 1999 and ESA underwent an important decrease of its national contributions. The lowest level was reached in 2003 where the contributions were only around €624 million, representing 57% of the contributions of 1999. 2004 marks a new phase with a 10% increase and a level of contribution around €682 million.

The major contributors to ESA are France, Germany, Italy and UK representing almost 70% of the expenditures in 2004. However their contributions in constant prices have continually declined as compared to countries such as Finland, Switzerland or Austria.

Some additional remarks can be formulated depending on whether the HICP or the Wiesbaden indices are used.





Indeed, the space science expenditures corrected with the HICP show a decline of 6.33% over the decade whereas these expenditures using the Wiesbaden indices show a 17.21% decrease over that same period.

Concerning the Earth observation budget the decline was larger. In correcting the data with the HICP, a 19.41% decline can be observed; using the Wiesbaden correction this figure grows to 29.49%.

Only the third category (EMIR/ELIPS & ISS utilisation) benefited from a budget increase (18.4%) using the HICP correction but this figure becomes +4.4% with the Wiesbaden criteria.

2.4 – Space ratios

In this section and in order to compare the European budgets with the USA and Japan, some ratios will be elaborated. In a first step, the European space science, Earth observation and EMIR/ELIPS & ISS utilisation budgets will be compared to the US and Japanese space expenditures and in a second phase, some other indicators will be used to highlight differences vis-à-vis the USA or Japan.

2.4.1 – The three categories

Three ratios are computed in each category. The first simulation will consider the ESA contributions corrected with the Wiesbaden index over the whole period, the second will use the HICP and the third will use the Wiesbaden criteria until 1999 and the HICP between 2000 and 2004, thus reflecting the way ESA presented its data.

- ***Space science***

Despite certain financial advantages for NASA in, e.g. the planetary exploration field, notably with projects using nuclear power sources, Europe achieved a leading position in very ambitious programmes, for instance in cometary science and astrometry. Nevertheless, when comparing the European budget devoted to space science with the US expenditures, some very large differences could be observed.

- *In using the HICP*

In this table, the inflation related to the national programme expenditures has been corrected with the HICP criterion. This correction has also been applied to the contributions to ESA.

Space Science M€ 2004 e.c.	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Nat. Prog.	127,9	155,1	194,4	161,9	181,3	192,4	227,9	360,0	371,1	295,4	273,0
ESA contr.	401,2	400,9	410,8	395,0	392,2	391,0	386,2	382,6	380,1	366,7	369,1
Total Europe	529,1	556,0	605,3	556,9	573,6	583,5	614,1	742,6	751,2	662,0	642,1
Japan	176,5	174,0	159,7	156,9	149,7	175,0	243,9	213,8	185,3	161,8	150,3
USA	2223,0	2059,4	1919,7	2027,3	2061,2	2242,8	2593,5	2761,8	2451,6	2796,8	3224,6
Ratio USA/Europe	**4,2**	**3,7**	**3,2**	**3,6**	**3,6**	**3,8**	**4,2**	**3,7**	**3,3**	**4,2**	**5,0**

- *In using the Wiesbaden indices*

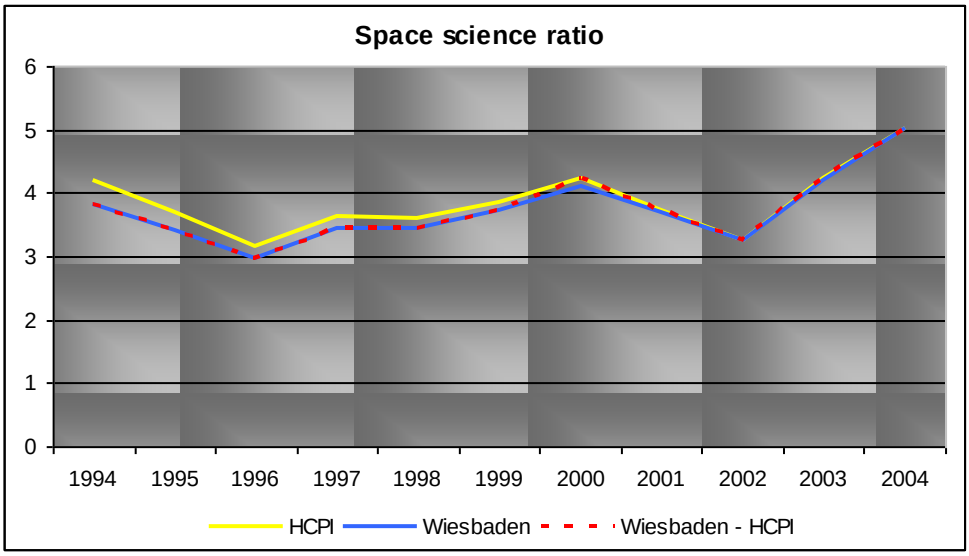
In this table, the national programmes have still been corrected in using the HICP instrument whereas the ESA contributions have been corrected with the Wiesbaden criteria.

Space Science M€ 2004 e.c	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Nat. Prog.	127,9	155,1	194,4	161,9	181,3	192,4	227,9	360,0	371,1	295,4	273,0
ESA contr.	453,0	448,4	451,1	426,8	418,6	411,5	403,8	388,9	382,7	368,4	369,1
Total Europe	580,9	603,5	645,6	588,7	599,9	603,9	631,7	748,9	753,7	663,8	642,1
Japan	176,5	174,0	159,7	156,9	149,7	175,0	243,9	213,8	185,3	161,8	150,3
USA	2223,0	2059,4	1919,7	2027,3	2061,2	2242,8	2593,5	2761,8	2451,6	2796,8	3224,6
Ratio USA/Europe	**3,8**	**3,4**	**3,0**	**3,4**	**3,4**	**3,7**	**4,1**	**3,7**	**3,3**	**4,2**	**5,0**

- *Wiesbaden / HICP*

As mentioned previously and in order to reflect the fact that ESA did not use the Wiesbaden criteria from 2000 onwards, the national programmes on the following table are corrected with the HICP whereas the contributions to ESA are corrected with the Wiesbaden criteria until 1999 and with the HICP instrument for the following years.

M€ 2004 e.c.	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Nat. Prog.	127,9	155,1	194,4	161,9	181,3	192,4	227,9	360,0	371,1	295,4	273,0
ESA contr.	453,0	448,4	451,1	426,8	418,6	411,5	386,2	382,6	380,1	366,7	369,1
Total Europe	580,9	603,5	645,6	588,7	599,9	603,9	614,1	742,6	751,2	662,0	642,1
Japan	176,5	174,0	159,7	156,9	149,7	175,0	243,9	213,8	185,3	161,8	150,3
USA	2223,0	2059,4	1919,7	2027,3	2061,2	2242,8	2593,5	2761,8	2451,6	2796,8	3224,6
Ratio USA/Europe	**3,8**	**3,4**	**3,0**	**3,4**	**3,4**	**3,7**	**4,2**	**3,7**	**3,3**	**4,2**	**5,0**



Unsurprisingly, the USA is spending obviously more than Europe in space science however the ratio has largely evolved over the decade. With the HICP correction, the ratio has firstly decreased during two years and in 1996, the USA devoted 3 times more than Europe for space science programmes. However, this trend was reversed and in 2000, the US space science expenditures were 4.2 times more than the European space science budget. The ratio has then been reduced between 2000 and 2002, with the USA spending 3.3 times more than Europe. In recent years the gap was increased again; in 2004 the US space science budget was 5 times more than the European one.

In correcting the ESA contributions with the Wiesbaden index, the curve shows a slightly different aspect. As for the HICP correction, the 1994-1996 period was characterised by a decline and in 1996 the US expenditures were 3 times bigger than in Europe. During the following period this ratio has constantly increased and in 2000, the USA had a space science budget 4.1 times bigger than in Europe. Finally and concerning the rest of the period, the Wiesbaden correction gave the same results as the HICP correction.

To conclude, whereas 1996 and 2002 have marked two balancing periods between Europe and the USA, the situation became even more favourable for the USA in the recent years.

- ***Earth observation***

Space based optical, infrared or radar sensors have become fundamental tools in weather prediction, resource management, urban planning and environmental monitoring. Europe is a key player in this domain and is launching applications programmes such as GMES. Nevertheless, the European budgets still remain much lower than in the USA.

- *In using the HICP*

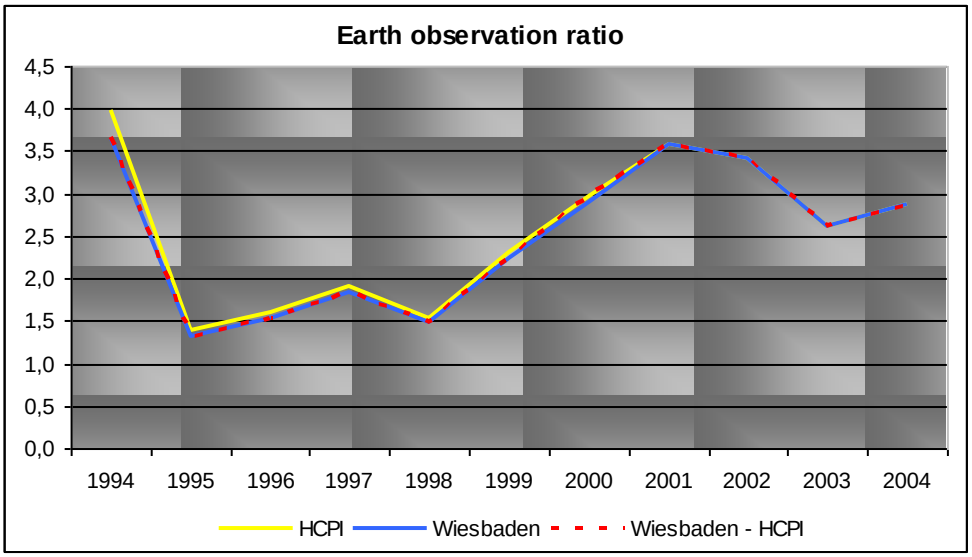
2004 e.c.	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Nat. Prog.	155,5	664,1	597,0	561,2	719,2	401,9	472,1	553,4	622,7	649,5	474,9
ESA contr.	269,5	300,3	419,9	420,5	510,1	510,1	329,5	150,2	141,1	173,4	217,1
Total Europe	425,0	964,4	1016,9	981,8	1229,3	912,0	801,5	703,7	763,8	822,8	692,0
Japan	254,0	385,5	234,1	260,6	242,0	257,8	391,6	266,8	175,1	166,4	133,0
USA	1693,3	1333,2	1633,6	1862,5	1871,1	2100,8	2375,6	2528,0	2613,8	2144,6	1981,5
Ration USA/Europe	**4,0**	**1,4**	**1,6**	**1,9**	**1,5**	**2,3**	**3,0**	**3,6**	**3,4**	**2,6**	**2,9**

- *In using the Wiesbaden indices*

2004 e.c.	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Nat. Prog.	155,5	664,1	597,0	561,2	719,2	401,9	472,1	553,4	622,7	649,5	474,9
ESA contr.	307,8	338,1	464,3	457,1	547,5	539,0	345,4	152,9	142,0	174,2	217,0
Total Europe	463,3	1002,2	1061,3	1018,3	1266,8	941,0	817,5	706,4	764,7	823,6	691,9
Japan	254,0	385,5	234,1	260,6	242,0	257,8	391,6	266,8	175,1	166,4	133,0
USA	1693,3	1333,2	1633,6	1862,5	1871,1	2100,8	2375,6	2528,0	2613,8	2144,6	1981,5
Ration USA/Europe	**3,7**	**1,3**	**1,5**	**1,8**	**1,5**	**2,2**	**2,9**	**3,6**	**3,4**	**2,6**	**2,9**

- *Wiesbaden - HICP*

2004 e.c.	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Nat. Prog.	155,5	664,1	597,0	561,2	719,2	401,9	472,1	553,4	622,7	649,5	474,9
ESA contr.	307,8	338,1	464,3	457,1	547,5	539,0	329,5	150,2	141,1	173,4	217,1
Total Europe	463,3	1002,2	1061,3	1018,3	1266,8	941,0	801,5	703,7	763,8	822,8	692,0
Japan	254,0	385,5	234,1	260,6	242,0	257,8	391,6	266,8	175,1	166,4	133,0
USA	1693,3	1333,2	1633,6	1862,5	1871,1	2100,8	2375,6	2528,0	2613,8	2144,6	1981,5
Ration USA/Europe	**3,7**	**1,3**	**1,5**	**1,8**	**1,5**	**2,2**	**3,0**	**3,6**	**3,4**	**2,6**	**2,9**



Similarly to space science, neither the HICP nor the Wiesbaden corrections led to any important variations. Only some minor differences could be observed, particularly in 1994 where the HICP ratio shows that the USA spend 4 times more than Europe, while this ratio is 3.7 when using the Wiesbaden index. Concerning the rest of the period, the differences between the two corrections are below the first decimal.

In 1994, the NASA and NOAA budgets devoted to Earth observation programmes were approximately 4 times bigger than in Europe but in 1995 this ratio has been decreased to around 1.3. This large difference between 1994 and 1995 should however be taken with caution as it is recalled that the French national Earth observation budget is not available for 1994 whereas these figures were available in 1995. This situation remained quite steady until 1998 where the ratio did not exceed 1.9 (HICP correction). However the situation was disrupted and due to additional US budgets allocations, the ratio again reaches 3.6 in 2001.

The situation was more balanced in 2002 and 2003 with a ratio of 2.6. Due to a new US budget increase in early 2004, the US Earth observation programmes benefited from a budget 2.9 times greater than in Europe.

- ***EMIR/ELIPS & ISS utilisation***

Depending on whether or not the International Space Station is included in the Life & Physical space research, the ratios between the US and the European expenditures demonstrate very large variations. In this category, the expenditures related to the Space Shuttle costs are not taken into account.

- *In using the HICP (ISS excluded)*

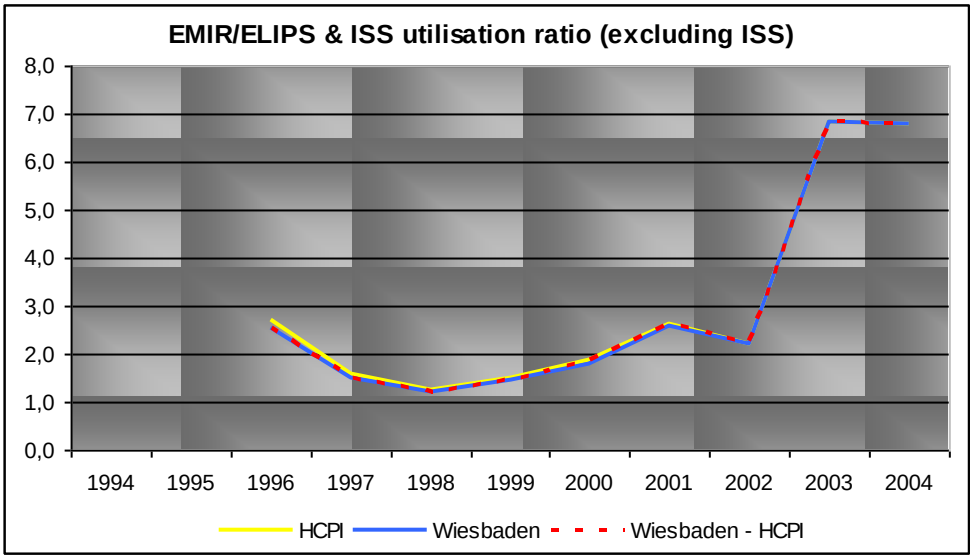
2004 e.c.	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Nat. Prog.	58,0	77,2	76,6	51,0	51,8	58,9	51,8	33,0	33,4	27,6	21,8
ESA contr.	80,9	80,9	94,6	108,4	115,2	125,5	123,3	109,7	125,5	85,4	95,8
Total Europe	138,9	158,2	171,2	159,3	167,0	184,4	175,1	142,7	158,9	113,0	117,6
Japan	395,0	400,1	352,5	318,9	246,6	323,8	431,2	306,1	321,3	289,2	280,0
USA			461,4	250,9	209,7	278,9	326,1	372,3	351,1	774,3	799,9
Ratio USA/Europe			**2,7**	**1,6**	**1,3**	**1,5**	**1,9**	**2,6**	**2,2**	**6,9**	**6,8**

- *In using the Wiesbaden criteria (ISS excluded)*

2004 e.c.	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Nat. Prog.	58,0	77,2	76,6	51,0	51,8	58,9	51,8	33,0	33,4	27,6	21,8
ESA contr.	91,9	90,9	104,2	117,4	123,3	132,1	129,1	111,5	126,3	85,8	96,0
Total Europe	150,0	168,1	180,9	168,4	175,1	191,1	180,9	144,5	159,7	113,3	117,8
Japan	395,0	400,1	352,5	318,9	246,6	323,8	431,2	306,1	321,3	289,2	280,0
USA			461,4	250,9	209,7	278,9	326,1	372,3	351,1	774,3	799,9
Ratio USA/Europe			**2,6**	**1,5**	**1,2**	**1,5**	**1,8**	**2,6**	**2,2**	**6,8**	**6,8**

- *Wiesbaden – HICP (ISS excluded)*

2004 e.c.	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Nat. Prog.	58,0	77,2	76,6	51,0	51,8	58,9	51,8	33,0	33,4	27,6	21,8
ESA contr.	91,9	90,9	104,2	117,4	123,3	132,1	123,3	109,7	125,5	85,4	95,8
Total Europe	150,0	168,1	180,9	168,4	175,1	191,1	175,1	142,7	158,9	113,0	117,6
Japan	395,0	400,1	352,5	318,9	246,6	323,8	431,2	306,1	321,3	289,2	280,0
USA			461,4	250,9	209,7	278,9	326,1	372,3	351,1	774,3	799,9
Ratio USA/Europe			**2,6**	**1,5**	**1,2**	**1,5**	**1,9**	**2,6**	**2,2**	**6,9**	**6,8**



Except in 1994 & 1995 where it was impossible to identify clearly the cost related to ISS for NASA, the ratio USA/Europe remains quite reasonable, as compared to Earth observation or space science programmes.

After a slow decline occurring in 1996 and 1997, the ratio of US to European expenditures in 1998 was “only” 1.3 (HICP correction) and 1.2 (Wiesbaden correction). However, this situation was not maintained for long and in 2001 the US space expenditures in life and physical sciences in space were twice as they were two years earlier. Except in 2002, characterised by a minor decline, the ratio has considerably increased in 2003 and the US expenditures in this domain were approximately 7 times more than in Europe. This level was maintained in 2004 where the ratio was around 6.8.

In including the costs directly related to International Space Station, the differences between USA and Europe are accentuated even more.

- *In using the HICP (ISS included)*

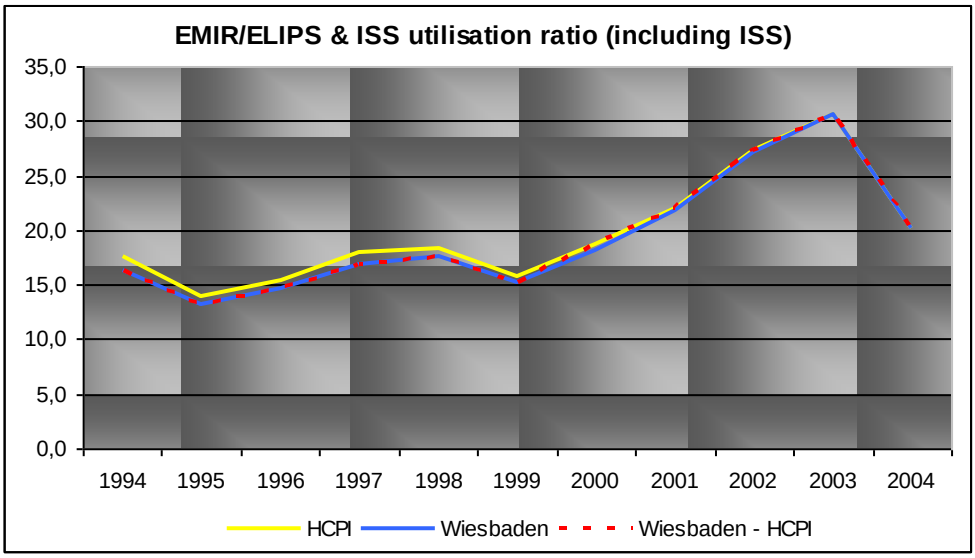
2004 e.c.	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Nat. Prog.	58,0	77,2	76,6	51,0	51,8	58,9	51,8	33,0	33,4	27,6	21,8
ESA contr.	80,9	80,9	94,6	108,4	115,2	125,5	123,3	109,7	125,5	85,4	95,8
Total Europe	138,9	158,2	171,2	159,3	167,0	184,4	175,1	142,7	158,9	113,0	117,6
Japan	395,0	400,1	352,5	318,9	246,6	323,8	431,2	306,1	321,3	289,2	280,0
USA	2447,2	2208,4	2641,0	2848,8	3073,9	2904,3	3269,0	3147,3	4342,2	3459,1	2367,1
Ration USA/Europe	**17,6**	**14,0**	**15,4**	**17,9**	**18,4**	**15,8**	**18,7**	**22,1**	**27,3**	**30,6**	**20,1**

- *In using the Wiesbaden criteria (ISS included)*

2004 e.c.	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Nat. Prog.	58,0	77,2	76,6	51,0	51,8	58,9	51,8	33,0	33,4	27,6	21,8
ESA contr.	91,9	90,9	104,2	117,4	123,3	132,1	129,1	111,5	126,3	85,8	96,0
Total Europe	150,0	168,1	180,9	168,4	175,1	191,1	180,9	144,5	159,7	113,3	117,8
Japan	395,0	400,1	352,5	318,9	246,6	323,8	431,2	306,1	321,3	289,2	280,0
USA	2447,2	2208,4	2641,0	2848,8	3073,9	2904,3	3269,0	3147,3	4342,2	3459,1	2367,1
Ration USA/Europe	**16,3**	**13,1**	**14,6**	**16,9**	**17,6**	**15,2**	**18,1**	**21,8**	**27,2**	**30,5**	**20,1**

- *Wiesbaden – HICP (ISS included)*

2004 e.c.	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Nat. Prog.	58,0	77,2	76,6	51,0	51,8	58,9	51,8	33,0	33,4	27,6	21,8
ESA contr.	91,9	90,9	104,2	117,4	123,3	132,1	123,3	109,7	125,5	85,4	95,8
Total Europe	150,0	168,1	180,9	168,4	175,1	191,1	175,1	142,7	158,9	113,0	117,6
Japan	395,0	400,1	352,5	318,9	246,6	323,8	431,2	306,1	321,3	289,2	280,0
USA	2447,2	2208,4	2641,0	2848,8	3073,9	2904,3	3269,0	3147,3	4342,2	3459,1	2367,1
Ration USA/Europe	**16,3**	**13,1**	**14,6**	**16,9**	**17,6**	**15,2**	**18,7**	**22,1**	**27,3**	**30,6**	**20,1**



When including the International Space Station, the curve depicts larger differences than with other categories, depending on whether the HICP or the Wiesbaden index has been used, especially between 1994 and 1997.

After a short decline between 1994 and 1995 reducing the ratio from 17.6 to 14 (HICP correction) and from 16.3 to 13.1 (Wiesbaden correction), the US expenditures have constantly increased until 1998 to reach a ratio of 18.4 (HICP correction) or 17.6 (Wiesbaden correction).

Except the slight decline occurring in 1999 where the ratio was lowered to 15, the 2000-2003 period was largely in favour of the USA in that area. During that period, the ratio gained 63.6% (HICP) and 68.5% (Wiesbaden). The highest level was reached in 2003 with a ratio around 30. Since 2003 however a strong declining trend was initiated, with a ratio

reaching around 20 in 2004. Although this study stops in 2004 this trend will probably be confirmed, since the USA are disengaging even further in that area of research.

Some other indicators could equally be used to highlight differences between Europe and the USA. Indeed, it could be interesting to compare the space budgets with indices such as the GDP per capita, the R&D expenditures or, possibly, the number of space missions.

2.4.2 – Space expenditures over GDP

In the framework of the study, four types of Gross Domestic Product (in 2004 economic conditions) could be used for Europe, depending on the emphasis one wishes to put. Hence, the following European GDP will be considered:

- Total GDP for EU25
- Total GDP for EU15
- Total GDP for countries considered in this study (16 countries)
- Total GDP for ESA member states (17 countries)

In this section, space expenditures will be considered globally and no further analysis based on the three categorisations will be carried on.

Civilian space expenditures ratio over GDP in 2004 e.c.

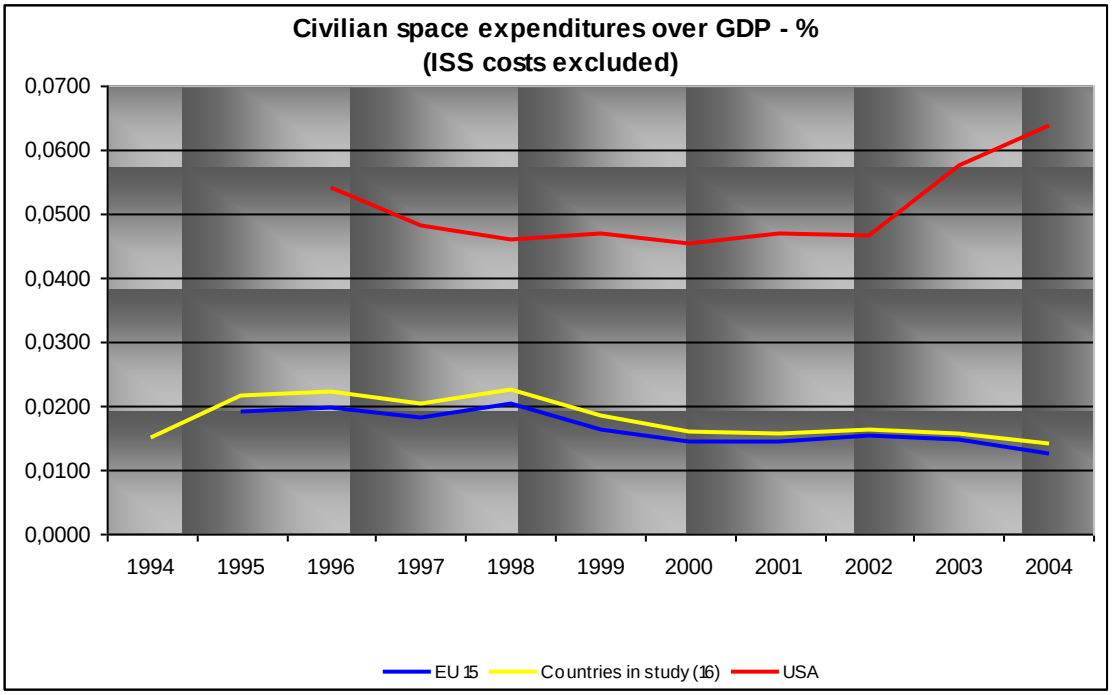
GDP in M€ (2004 e.c.)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
EU 25		8 220 949	8 461 829	8 783 836	9 098 474	9 452 825	9 921 605	10 082 290	10 229 150	10 164 015	10 421 644
EU 15		7 943 914	8 156 052	8 448 636	8 736 547	9 082 281	9 506 050	9 625 617	9 755 042	9 704 856	9 935 749
ESA member states	8 185 451	8 345 913	8 560 674	8 853 566	9 140 912	9 508 677	9 977 359	10 129 568	10 275 205	10 200 052	10 431 949
Countries in study	7 990 937	8 262 515	8 482 914	8 777 010	9 114 021	9 462 962	9 953 312	10 123 905	10 253 266	10 149 956	10 385 217
USA	7 576 271	7 010 407	7 413 554	8 616 852	9 040 695	9 860 816	11 658 840	12 063 308	11 626 405	9 958 385	9 433 475
Japan	4 017 881	3 989 284	3 625 754	3 717 390	3 357 785	3 963 142	4 907 755	4 484 032	4 098 706	3 735 944	3 689 752

Source: Eurostat

Space expenditures (2004 e.c.)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
M€											
Including EO, Space science & ISS utilisation											
EU 25	1194,2	1773,8	1887,7	1775,3	2041,8	1736,0	1590,8	1589,0	1673,8	1597,8	1451,7
EU 15	942,8	1502,8	1610,0	1531,1	1787,8	1478,5	1376,0	1390,6	1491,8	1410,5	1232,5
ESA member states	1169,7	1755,8	1874,3	1769,4	2037,1	1731,9	1587,3	1585,2	1671,0	1594,5	1448,0
Countries in study (16)	1194,2	1773,8	1887,7	1775,3	2041,8	1736,0	1590,8	1589,0	1671,1	1595,7	1449,5
USA			4014,7	4140,7	4142,0	4622,4	5295,1	5662,1	5416,4	5715,7	6006,0
Including EO, Space science & ISS programme											
EU 25	1192,9	1772,5	2068,3	2024,7	2337,1	2089,6	2004,6	2079,4	2153,4	1944,4	1622,1
EU 15	918,5	1470,2	1750,2	1735,2	2027,5	1774,3	1741,7	1842,4	1931,7	1723,6	1369,8
ESA member states	1168,5	1754,5	2054,9	2018,8	2332,5	2085,5	2001,1	2075,7	2150,5	1941,1	1618,4
Countries in study (16)	1192,9	1772,5	2068,3	2024,7	2337,1	2089,6	2004,6	2079,4	2150,7	1942,3	1619,9
USA	6363,6	5600,9	6194,3	6738,6	7006,2	7247,9	8238,0	8437,1	9407,6	8400,5	7573,2
Japan	825,4	959,6	746,3	736,4	638,2	756,6	1066,6	786,7	681,7	617,4	563,3

Space exp./GDP	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*
%											
Including EO, Space science & ISS utilisation											
EU 25		0,0216	0,0223	0,0202	0,0224	0,0184	0,0160	0,0158	0,0164	0,0157	0,0139
EU 15		0,0189	0,0197	0,0181	0,0205	0,0163	0,0145	0,0144	0,0153	0,0145	0,0124
ESA member states	0,0143	0,0210	0,0219	0,0200	0,0223	0,0182	0,0159	0,0156	0,0163	0,0156	0,0139
Countries in study (16)	0,0149	0,0215	0,0223	0,0202	0,0224	0,0183	0,0160	0,0157	0,0163	0,0157	0,0140
USA			0,0542	0,0481	0,0458	0,0469	0,0454	0,0469	0,0466	0,0574	0,0637
Including EO, Space science & ISS programme											
EU 25		0,0216	0,0244	0,0231	0,0257	0,0221	0,0202	0,0206	0,0211	0,0191	0,0156
EU 15		0,0185	0,0215	0,0205	0,0232	0,0195	0,0183	0,0191	0,0198	0,0178	0,0138
ESA member states	0,0143	0,0210	0,0240	0,0228	0,0255	0,0219	0,0201	0,0205	0,0209	0,0190	0,0155
Countries in study (16)	0,0149	0,0215	0,0244	0,0231	0,0256	0,0221	0,0201	0,0205	0,0210	0,0191	0,0156
USA	0,0840	0,0799	0,0836	0,0782	0,0775	0,0735	0,0707	0,0699	0,0809	0,0844	0,0803
Japan	0,0205	0,0241	0,0206	0,0198	0,0190	0,0191	0,0217	0,0175	0,0166	0,0165	0,0153

Naturally when comparing such European ratios to US ones, differences between the four GDPs appear marginal. For clarity purposes, only the curves for the USA, EU 15 and the 16 countries involved in the study will be displayed on the following graphs.

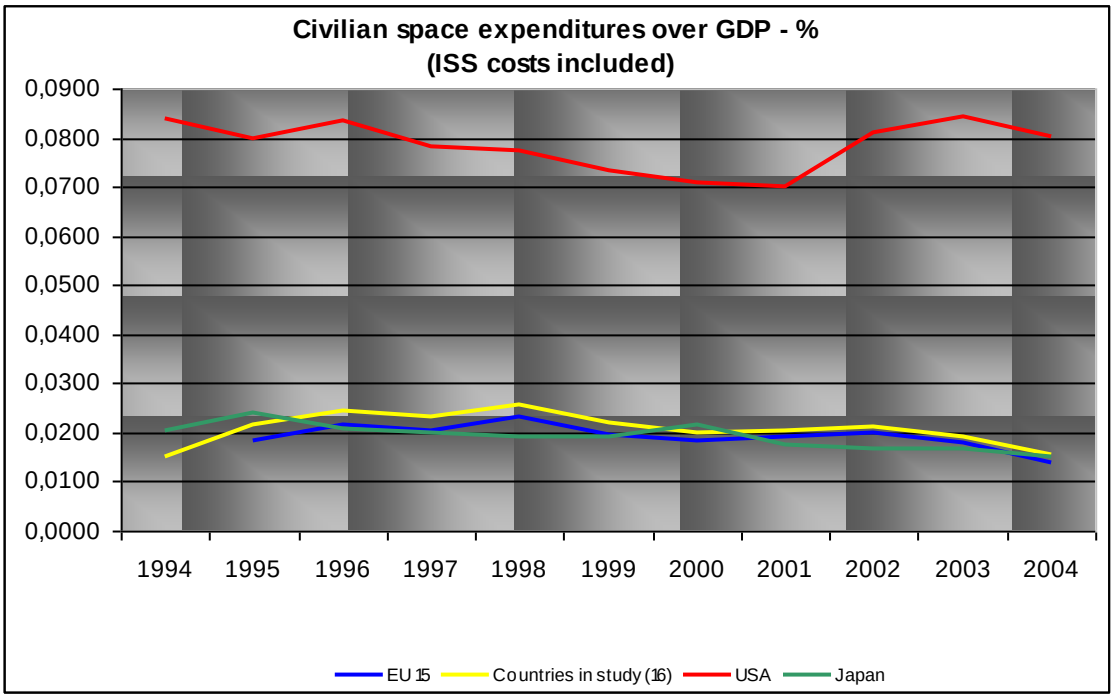


Excluding the ISS-related costs, it appears that the US civilian space expenditures are between 2 and 3 times higher than in Europe. European space expenditure ratios fall within the range of 0.0124% to 0.0224% of the GDP in a rather constant fashion, whereas US civilian space budgets oscillate between 0.0454% and 0.0637% of the GDP.

Concerning the evolution of this ratio, the short European increase in 1995 is followed by a relatively stable phase until 1998, where a long decline can then be observed until the end of the period. In 2004, the European civilian space expenditures represented respectively 0.0124% and 0.0139% of the GDP of the EU15 and of the study 16 countries.

The US budget has followed a different scenario. After having undergone a short decline between 1996 and 1998, the US civilian space budget has benefited from a constant budget allocation until 2002. From this point on, the ratio has increased in an important manner; in 2004 the budget devoted to civilian space activities represented 0.0637% of the GDP.

In including the costs related to ISS, the situation was even more in favour of the USA: the fraction of the GDP devoted to US civilian space research never falls under a level of 0.0699%.



Indeed, even after having undergone a long decline during seven years, the US civilian space budget still represented 0.07% of the GDP in 2001. The situation was even improved during the last years where the ratio was around 0.0844% in 2003.

On the European side, including ISS has contributed to maintain the curve around a ratio of 0.02% and except for 1998 and 2003/2004, the part of the GDP devoted to space research was approximately steady.

The situation is similar in Japan where the part of GDP devoted to civilian space activities is comprised between 0.0153% and 0.0241%. For Europe, a small decrease of this ratio can be observed during the last years, with the lowest Japanese level in 2004 where only 0.0153% of the GDP were dedicated to civilian space activities.

Comparing the space activities budget to the population can be an additional element highlighting certain differences between USA and Europe.

2.4.3 – Space expenditures per capita

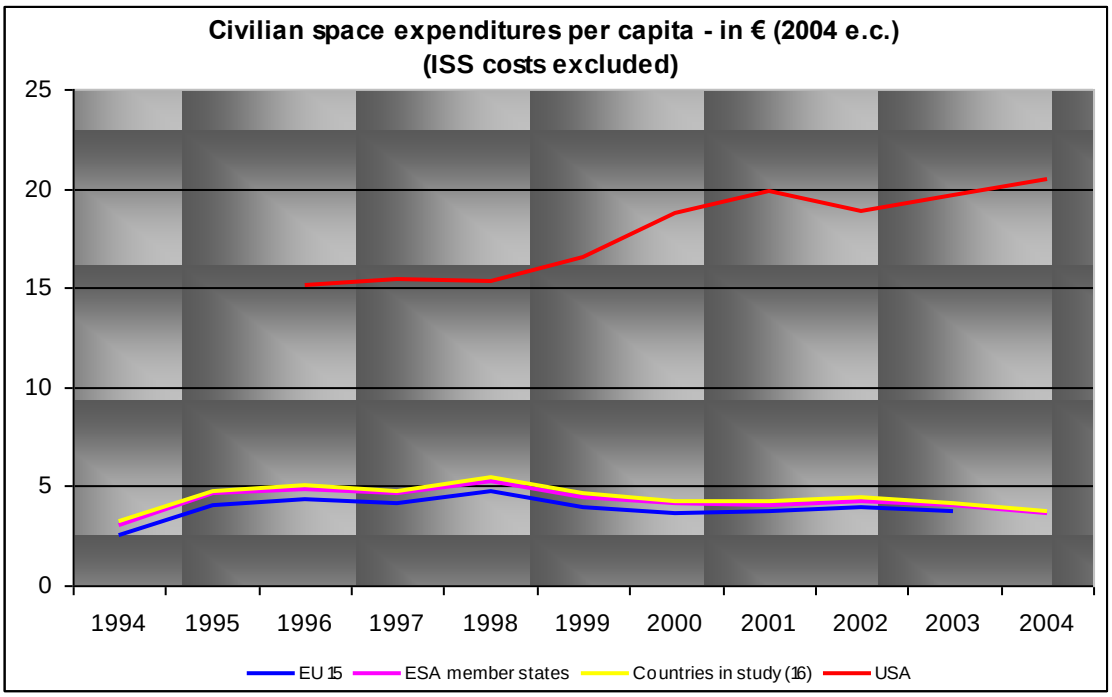
As with the GDP-based ratio, four types of population can be considered for Europe, resulting in four simulations using the population of EU25, EU15, ESA member states and of the 16 countries considered in the study.

Space expenditures supported by capita

Average Population	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*
Austria	7 936 118	7 948 278	7 959 017	7 968 041	7 976 789	7 992 324	8 011 566	8 043 046	8 083 661	8 121 149	8 173 323
Belgium	10 115 603	10 136 811	10 156 637	10 181 245	10 203 008	10 226 419	10 251 250	10 286 570	10 332 785	10 376 133	10 421 137
Denmark	5 206 180	5 233 373	5 263 074	5 284 991	5 304 219	5 321 799	5 339 616	5 358 783	5 375 931	5 390 574	5 404 523
Finland	5 088 333	5 107 790	5 124 573	5 139 835	5 153 498	5 165 474	5 176 209	5 188 008	5 200 598	5 213 014	5 228 172
France	57 658 772	57 844 247	58 025 989	58 207 490	58 397 788	58 646 551	58 969 798	59 321 894	59 678 252	60 027 912	60 380 600
Germany	81 438 348	81 678 051	81 914 831	82 034 771	82 047 195	82 100 243	82 211 508	82 349 925	82 488 495	82 534 176	82 516 260
Greece	10 553 035	10 634 385	10 709 173	10 776 504	10 834 880	10 882 580	10 917 482	10 949 957	10 987 543	11 023 514	11 060 000
Ireland	3 590 386	3 608 841	3 637 510	3 674 269	3 712 892	3 754 982	3 805 368	3 866 425	3 931 771	3 995 699	4 068 453
Italy	56 844 695	56 846 123	56 862 789	56 893 772	56 910 950	56 921 556	56 948 606	56 980 739	57 157 406	57 604 658	57 553 000
Luxembourg	402 925	408 625	414 225	419 450	424 700	430 475	436 300	441 525	446 175	449 950	453 300
Netherlands	15 382 838	15 459 006	15 530 498	15 610 650	15 707 209	15 812 088	15 925 513	16 046 180	16 148 929	16 225 302	16 281 779
Norway	4 336 613	4 359 184	4 381 336	4 405 157	4 431 464	4 461 913	4 490 967	4 513 751	4 538 159	4 564 855	4 591 910
Poland	38 542 652	38 594 998	38 624 370	38 649 660	38 663 481	38 660 271	38 453 757	38 248 076	38 230 364	38 204 570	38 182 222
Portugal	10 004 081	10 030 376	10 057 861	10 091 120	10 129 290	10 171 949	10 225 836	10 292 999	10 368 403	10 441 075	10 501 970
Romania	22 730 211	22 684 270	22 619 004	22 553 978	22 507 344	22 472 040	22 442 971	22 131 970	21 803 129	21 742 013	21 684 890
Spain	39 294 967	39 387 017	39 478 186	39 582 413	39 721 108	39 926 268	40 263 216	40 720 484	41 313 973	42 004 522	42 691 689
Sweden	8 780 745	8 826 939	8 840 998	8 846 062	8 850 974	8 857 874	8 872 109	8 895 960	8 924 958	8 958 229	8 993 531
Switzerland	6 993 795	7 040 687	7 071 850	7 088 906	7 110 001	7 143 991	7 184 250	7 229 854	7 284 753	7 339 001	7 389 625
UK	57 865 745	58 019 030	58 166 950	58 316 954	58 487 141	58 682 466	58 892 514	59 108 687	59 327 658	59 568 776	59 778 000
EU25	**445 365 646**	**446 343 942**	**447 263 461**	**448 094 609**	**448 860 264**	**449 810 180**	**450 883 448**	**452 189 224**	**454 006 587**	**456 105 939**	**:**
EU15	**370 162 767**	**371 168 888**	**372 142 307**	**373 027 563**	**373 861 636**	**374 893 043**	**376 246 887**	**377 851 179**	**379 766 534**	**381 934 678**	**:**
ESA member states	**381 493 179**	**382 568 763**	**383 595 497**	**384 521 630**	**385 403 106**	**386 498 952**	**387 922 108**	**389 594 787**	**391 589 450**	**393 838 539**	**395 487 272**
Countries study (16)	**370 940 144**	**371 934 378**	**372 886 324**	**373 745 126**	**374 568 226**	**375 616 372**	**377 004 626**	**378 644 830**	**380 601 907**	**382 815 025**	**384 427 272**
USA	**260 423 000**	**262 924 604**	**265 326 150**	**267 798 196**	**270 366 150**	**279 040 000**	**282 192 000**	**285 102 000**	**287 941 000**	**290 798 000**	**293 655 000**
Japan	**125 301 771**	**125 536 925**	**125 074 507**	**125 377 433**	**126 280 383**	**126 667 000**	**126 926 000**	**127 291 000**	**127 435 000**	**127 619 000**	**127 687 000**

Source:
Data in black: Eurostat & data in red: OECD

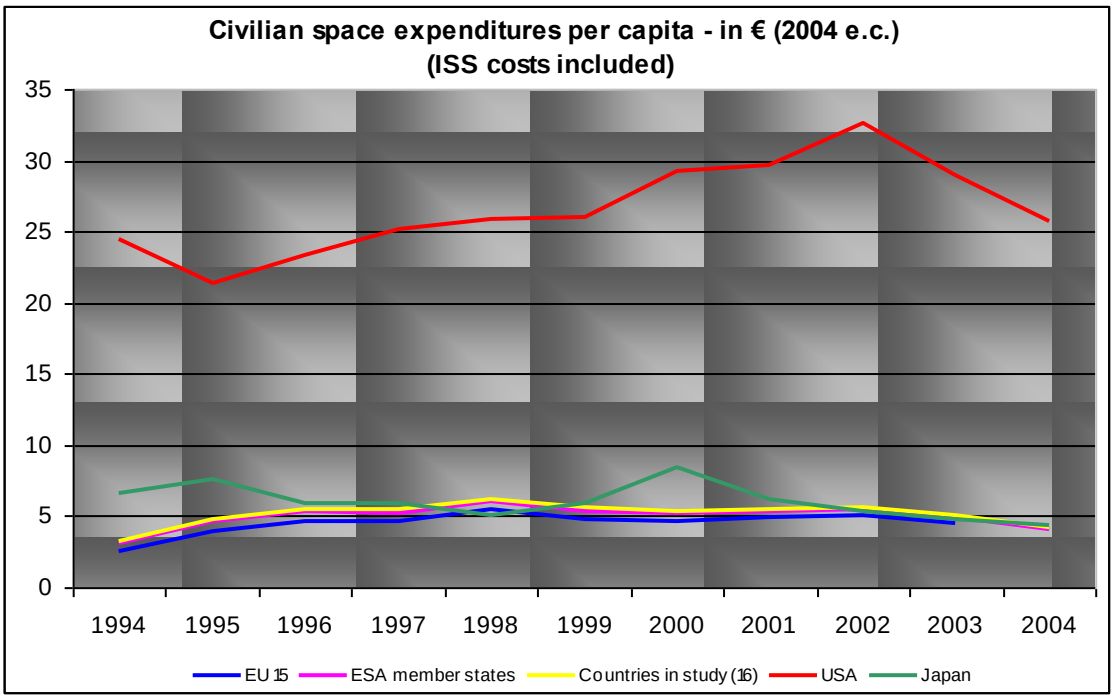
Space exp./capita	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*
€											
EO, Space science & ISS utilisation											
EU 25	2,68	3,97	4,22	3,96	4,55	3,86	3,53	3,51	3,69	3,50	
EU 15	2,55	4,05	4,33	4,10	4,78	3,94	3,66	3,68	3,93	3,69	
ESA member states	3,07	4,59	4,89	4,60	5,29	4,48	4,09	4,07	4,27	4,05	3,66
Countries in study (16)	3,22	4,77	5,06	4,75	5,45	4,62	4,22	4,20	4,39	4,17	3,77
USA			15,13	15,46	15,32	16,57	18,76	19,86	18,81	19,66	20,45
EO, Space science & ISS programme											
EU 25	2,68	3,97	4,62	4,52	5,21	4,65	4,45	4,60	4,74	4,26	
EU 15	2,48	3,96	4,70	4,65	5,42	4,73	4,63	4,88	5,09	4,51	
ESA member states	3,06	4,59	5,36	5,25	6,05	5,40	5,16	5,33	5,49	4,93	4,09
Countries in study (16)	3,22	4,77	5,55	5,42	6,24	5,56	5,32	5,49	5,65	5,07	4,21
USA	24,44	21,30	23,35	25,16	25,91	25,97	29,19	29,59	32,67	28,89	25,79
Japan	6,59	7,64	5,97	5,87	5,05	5,97	8,40	6,18	5,35	4,84	4,41



Excluding the costs related to ISS, a European citizen never spent more than 5.3 Euros per year for space research activities over the period considered, regardless of the simulation used. The year 1994 was the worst period for Europe, with only 2.55 € per year per capita spent on space (EU15). This ratio has constantly increased until 1998 where the expenditures per capita reached this maximum of 5.3 €. From 1999 on, this level has declined again: in 2004 only 3.3 € per capita were spent in civilian space activities in Europe.

During the same period the US effort has been constantly improving. Except in 2002 affected by a small decline, the annual expenditures per US citizen have continuously increased passing from 15€ to 20.5€ per capita.

When taking into account the costs for ISS, these differences are further increased.



The European curves show a scenario similar to the previous graph. With the exception of 1994 and 1995, a European citizen devoted between 3 and 6 € per year to European space science activities. This amount also tends to be reduced in recent years.

As was expected however, the ISS costs largely increase the US figures. Indeed, over the whole period the ratio has been constantly maintained over 20€. The expenditures per inhabitant were 21.3€ in 1995 and peaked in 2002 at 32.7€, or an increase of 53%. After 2002 an important decline could be observed with 25.8€ per capita in 2004. This amount remains nonetheless six times bigger than in Europe.

Apart from 1995 and 2000, a Japanese citizen spends globally the same amount as a European in civilian space programmes.

2.4.4 – Space expenditures over R&D expenditures (intra-muros)

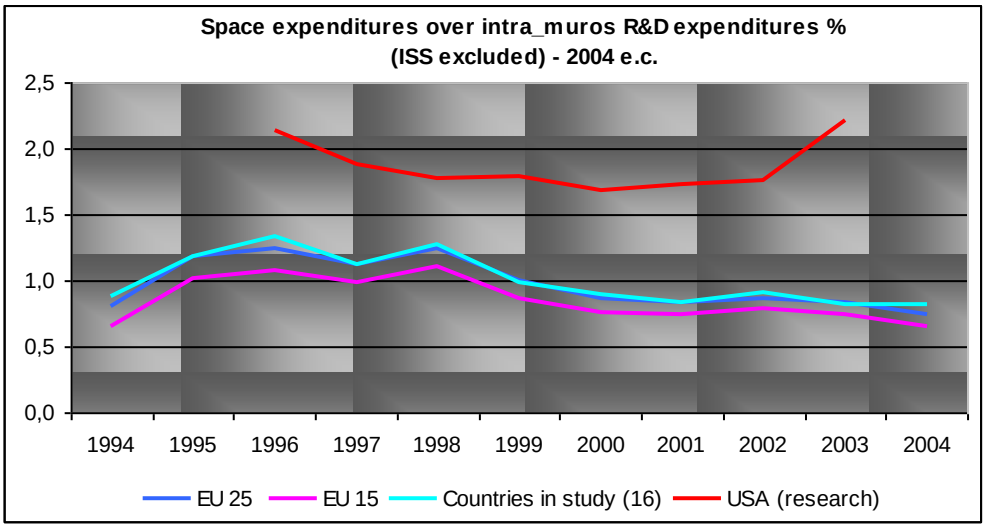
In this section, only R&D activities conducted intra-muros will be considered and no attention will be devoted on European R&D activities conducted abroad.

Total expenditures on R&D are composed of business enterprise expenditure in R&D (BERD), higher education expenditure in R&D (HERD), government expenditure in R&D (GOVERD) and private non-profit expenditure in R&D (PNRD). Data are collected through the Annual Eurostat R&D questionnaires and data for Japan and the US are provided to Eurostat by the OECD.

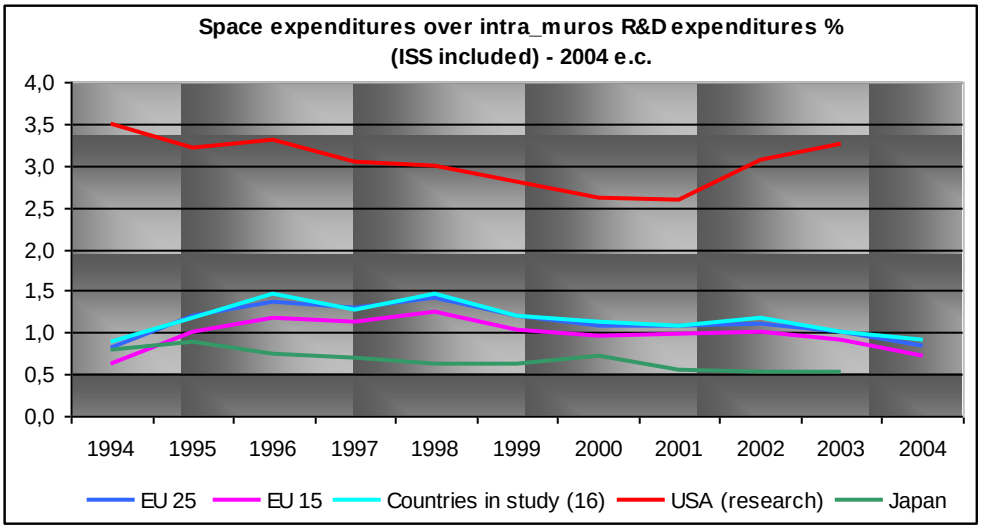
Global R&D Expenditures (intra-muros) M€ (2004 e.c.)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
EU25	147 620	149 271	152 139	157 907	164 211	174 791	184 839	191 494	194 286	192 252	194 650
EU15	145 549	147 156	149 861	155 328	161 419	171 921	181 624	187 907	190 592	188 657	190 808
Countries in study (16)	135 519	150 196	141 318	158 652	160 796	175 693	178 104	191 755	183 260	193 929	178 430
United States	181 721	174 443	187 535	220 703	234 379	259 621	314 949	327 260	307 717	258 313	:
Japan	104 277	108 121	102 112	107 361	101 267	120 302	149 901	140 293	130 185	119 444	:

Source: Eurostat

Space expenditures / R&D expenditures (intra-muros)	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*
%											
EO, Space science & ISS utilisation											
EU 25	0,8	1,2	1,2	1,1	1,2	1,0	0,9	0,8	0,9	0,8	0,7
EU 15	0,6	1,0	1,1	1,0	1,1	0,9	0,8	0,7	0,8	0,7	0,6
Countries in study (16)	0,9	1,2	1,3	1,1	1,3	1,0	0,9	0,8	0,9	0,8	0,8
USA (research)			2,1	1,9	1,8	1,8	1,7	1,7	1,8	2,2	
EO, Space science & ISS programme											
EU 25	0,8	1,2	1,4	1,3	1,4	1,2	1,1	1,1	1,1	1,0	0,8
EU 15	0,6	1,0	1,2	1,1	1,3	1,0	1,0	1,0	1,0	0,9	0,7
Countries in study (16)	0,9	1,2	1,5	1,3	1,5	1,2	1,1	1,1	1,2	1,0	0,9
USA (ISS + research)	3,5	3,2	3,3	3,1	3,0	2,8	2,6	2,6	3,1	3,3	
Japan	0,8	0,9	0,7	0,7	0,6	0,6	0,7	0,6	0,5	0,5	



In excluding the costs directly related to ISS, noticeable differences were expected and observed depending on whether the R&D expenditures of the EU25 or EU15 are used. However, the overall trend appears identical: with the exception of a small peak in 1998 the European ratio of space expenditures to intra-muros R&D has continuously decreased since 1996. A ratio between 1% and 1.5% was maintained until 2003, and then fell below the 1% level, reaching 0.7% in 2004. This general declining trend also happened in the USA since 1994; between 1996 and 2000 this decline amounted to 21%. However this trend was reversed in 2000 where the ratio has started to increase progressively until 2004.

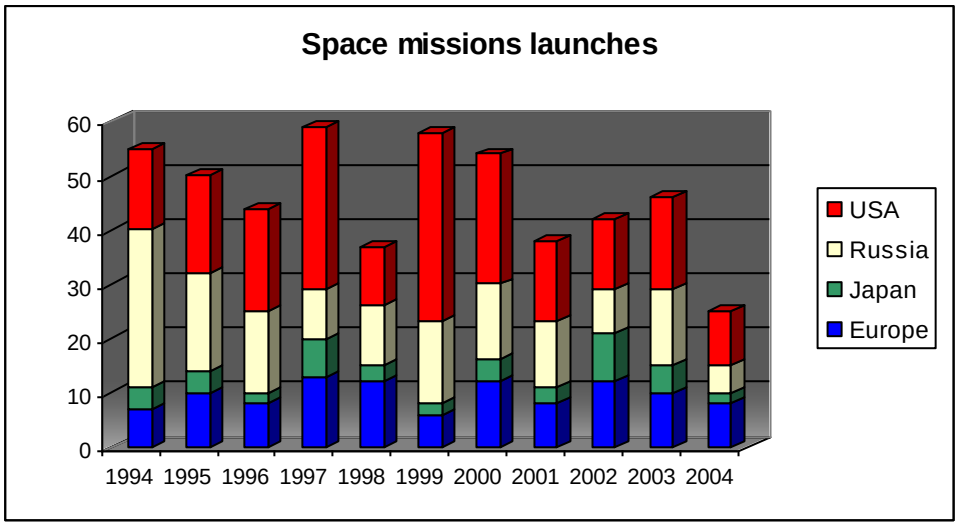


Including the costs related to ISS, the picture does not change substantially for Europe: space activities still represent less than 1% of the R&D effort as of 2003. Concerning the USA a long-term declining trend can be observed and between 1994 and 2001 the part of the intra-muros R&D expenditures devoted to space activities go from 3.5% to 2.6%. This trend is also reversed in 2001 where an increase of 23% can be observed in two years.

Finally regarding Japan, the part of the intra-muros R&D expenditures devoted to space research has constantly declined with a level around 0.5% in the last years.

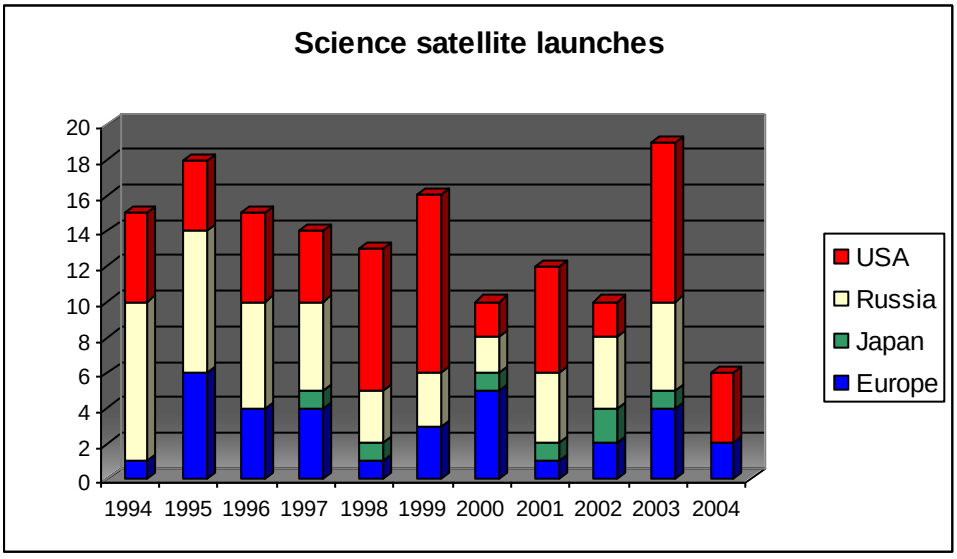
2.4.5 – Space expenditures over number of missions

The number of missions annually conducted could be an additional indicator to appraise how funding are used. However space science mission and Earth observation mission costs are quite different; hence, two distinctive analyses will be conducted. In this section, as well as for the Earth observation part, a distinction between the figures corrected in using the HICP and the Wiesbaden indices will be established. The following graph includes the space missions conducted in space science, earth observation, meteorology, technology and communication by the four mains "space players".



- *Space science*

In focusing this approach exclusively on space science, it appears that except for 2003, the number of missions conducted in space science is slowly decreasing, reaching a lowest level in 2004.

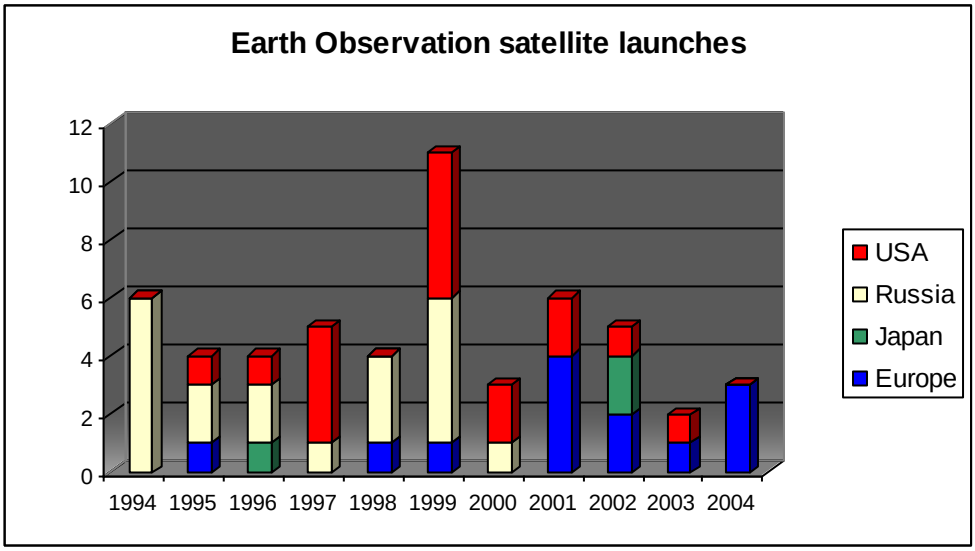


Source: Eurospace

Space science expenditures in M€ (2004 e.c.)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Europe HICP	529,1	556,0	605,3	556,9	573,6	583,5	614,1	742,6	751,2	662,0	642,1
Europe Wiesbaden	580,9	603,5	645,6	588,7	599,9	603,9	631,7	748,9	753,7	663,8	642,1
USA	2223,0	2059,4	1919,7	2027,3	2061,2	2242,8	2593,5	2761,8	2451,6	2796,8	3224,6
Japan	176,5	174,0	159,7	156,9	149,7	175,0	243,9	213,8	185,3	161,8	150,3

Annual mission cost in M€ (2004 e.c.)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Europe HICP	529	93	151	139	574	194	123	743	376	166	321
Europe Wiesbaden	581	101	161	147	600	201	126	749	377	166	321
USA	445	515	384	507	258	224	1297	460	1226	311	806
Japan	:	:	:	157	150	:	244	214	93	162	:

- *Earth Observation*



Space science expenditures in M€ (2004 e.c.)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Europe HICP	425,0	964,4	1016,9	981,8	1229,3	912,0	801,5	703,7	763,8	822,8	692,0
Europe Wiesbaden	475,2	1080,2	1122,1	1067,8	1318,4	963,0	838,0	711,9	764,6	824,3	691,9
USA	1693,3	1333,2	1633,6	1862,5	1871,1	2100,8	2375,6	2528,0	2613,8	2144,6	1981,5
Japan	254,0	385,5	234,1	260,6	242,0	257,8	391,6	266,8	175,1	166,4	133,0

Annual mission cost in M€ (2004 e.c.)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Europe HICP	:	964	:	:	1229	912	:	176	382	823	231
Europe Wiesbaden	:	1080	:	:	1318	963	:	178	382	824	231
USA	:	1333	1634	466	:	420	1188	1264	2614	2145	:
Japan	:	:	234	:	:	:	:	:	88	:	:

ANNEX 1: ATTENDANCE TO THE SEPTEMBER 2005 WORKSHOP

Bo	Andersen	NO
Josef	Aschbacher	ESA
Elöd	Both	HU
Stephen	Briggs	ESA
Giacomo	Cavallo	ESA
Paul	Clancy	IE
Pierre	Coquay	BE
Jean-Louis	Counil	FR
Guido	Di Cocco	IT
Pascale	Ehrenfreud	ESSC
Jakob	Frauchiger	CH
Eigil	Friis-Christensen	DK
Gerhard	Haerendel	ESSC
Marc	Heppener	ESA
Tim	Howell	European Commission
Andrea	Kleinsasser	AT
Werner	Klinkmann	DE
Jan	Kolar	CZ
Rainer	Külhe	DE
Yannick	Lafue	ESSC-ESF
Anne Marie	Lagrange	FR
Hans Peter	Lüttenberg	DE
Carole	Mabrouk	ESSC-ESF
Suzanne	Mecklenburg	UK
Lennart	Nordh	SE
Nicole	Papineau	FR
David	Parker	UK
P.	Picozza	IT
Marius Ioan	Piso	RO
Jean-Loup	Puget	ESSC
Peter	Ritter	DE
Peter	Scheid (consultant)	DE
Manuel	Serrano	ES
Marc	Serres	LU
José	Torres Riera	ES
Cameron	Tropea	ESA
Martin	Turner	UK
Luc	Tytgat	European Commission
Harry	Van Der Laan	NL
Stefano	Vitale	IT
Monique	Wagner	BE
Nicolas	Walter	ESSC-ESF
Jean-Claude	Worms	ESSC-ESF

ANNEX 2: STEERING COMMITTEE

Pascale Ehrenfreund (ESSC, Netherlands)
Jean-Louis Fellous (ESSC, France)
Gerhard Haerendel (ESSC Chairman, Germany)
Niels Lund (Denmark)
Jean-Loup Puget (ESSC, France)
Peter Scheid (Germany)
Martin Turner (United Kingdom)
Stefano Vitale (Italy)

ESSC-ESF Staff

Yannick Lafue (ESSC Project Assistant)
Jean-Claude Worms (ESSC Executive Scientific Secretary).