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1993



DECISION MAKER'S GUIDE to INTERNATIONAL SPACE

ANSER

Decision Maker's Guide
to
INTERNATIONAL SPACE

1993 Edition

ANSER

ANSER was established in 1958 as an independent, not-for-profit research corporation to contribute to the security and public welfare of the United States. ANSER's principal activity is to provide government agencies with objective, timely research and unbiased recommendations on complex technical and management problems. The ANSER staff contributes directly and significantly to problem solving in the public interest through systems analysis and evaluation, operations research, investigation of technical feasibility, and development and application of planning methods.

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Cover by Jack Butler

Cover photo: Image processing by Earth Satellite Corporation, Rockville, Maryland. View from the National Oceanic and Atmospheric Administration's (NOAA) GOES-7 spacecraft shows the Earth's Western Hemisphere from geostationary orbit.

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Decision Maker's Guide to International Space

By

Robert Usher and Donald Blersch

Contributors

George Tahu: Project Analyst
Melinda Alexander: ISCIS Developer
Wendy Campbell: ISCIS support
B.J. Williams: ISCIS support

Senior Technical Oversight

E. N. O'Rear: Manager, Space Technology Division
E. William Land Jr.: Principal Engineer

FOREWORD

ANSER maintains an extensive knowledge base on international space activities. As part of its Independent Research and Development activities (IR&D), ANSER has developed an infrastructure that tracks the space development activities of more than 60 countries. Direct contact with foreign space officials and organizations provides a unique, steady flow of primary source data that is used in conjunction with data from open sources.

The ***Decision Maker's Guide to International Space*** documents the highlights of ANSER's knowledge base in an easy-to-use reference book that provides top-level data in a uniform structure. The ***Guide*** is intended as a resource for senior-level US Government officials. As such, the format is kept concise for quick information retrieval and comparisons. Overall sources of information are cited at the end of the book, and current year budget figures are cited in individual country sections. While a rigorous footnoting system has not been adopted, ANSER maintains this detailed level of data tracking as a feature within the International Space Capabilities Information System (ISCIS) database that supports publication of the ***Guide*** (see "Introduction and Methodology"). The goal of this reference is to provide an accurate, standardized, functional guide to international space activities. For more rigorous investigations, ANSER currently uses its established knowledge base to perform in-depth analyses in a variety of international space areas and stands ready to meet additional needs of the US Government.

Please address questions concerning the ***Decision Maker's Guide to International Space*** to Robert Usher (703) 685-3543 or Donald Blersch (703) 685-3275, by Fax to (703) 685-3474, or at the address dmg@anser.org on the Internet system. ANSER welcomes comments and suggestions.

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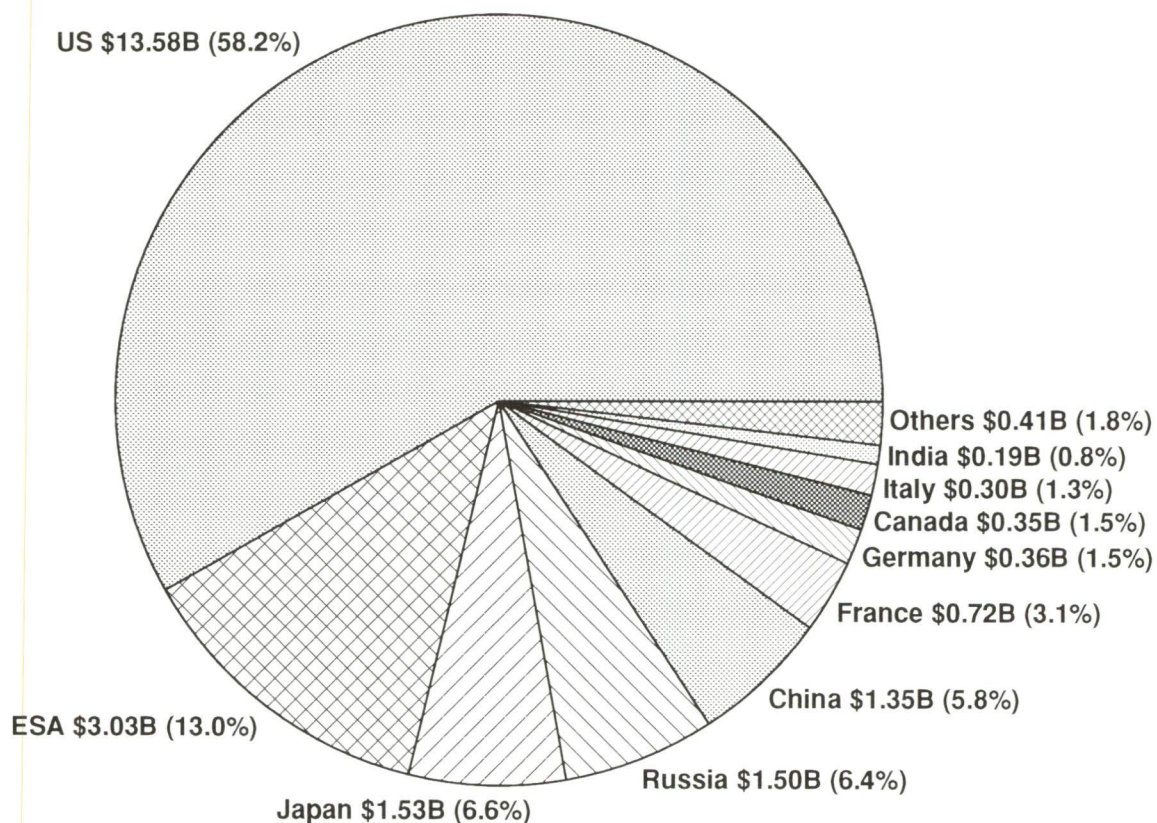
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INTRODUCTION and METHODOLOGY

In 1993, total spending on civil space activities topped \$23B (see figure below). While the US leads in expenditures, the budgets and capabilities of other space-faring nations have become more significant in recent years. With the inherent connections between technological leadership, economic competitiveness, and national security, international space programs are increasingly becoming a subject of interest to national policy makers. The *Decision Maker's Guide to International Space* provides a concise, current, and objective tool for use by US Government agencies.

World Civil Space Spending

(FY 1993 Total=\$23.32B)



Notes: 1. Member country contributions to ESA counted in ESA budget figure

2. Reporting US dollar figures for Russia and China is problematic due to non-market economies. The Russian figure particularly understates their capabilities and operations relative to the other countries.

The information presented in this edition is current as of March 1, 1993. In employing this reference during 1993, the user should be aware of the perishability of the data. ANSER continually updates its database with current information and will periodically integrate this data into the *Guide*. The sources for the 1993 budget figures are shown in the individual country sections. ANSER's ISCIS database also tracks the sources used for past years' budgets

INTRODUCTION and METHODOLOGY (Continued)

for each country. Budget projections for future years are ANSER estimates based on analysis of established budgets and programs, the particular country's historical performance, and assessments of current issues and trends.

The main body of the **Guide**, the "International Space Programs" section, details the civil space activities, plans, and policies of space-faring nations. Space programs with annual budgets of \$5 million or higher are presented in a two-part, standard-format "country page." Part one identifies civil space budget trends and spending data, orbital launch capabilities, major infrastructure elements, national space organizations, and international cooperative partners/activities. Part two presents long-range national plans and significant projects, as well as overall space policy goals. Part two also includes an assessment of current issues, problems, and opportunities, and a "Bottom Line" assessment of the country's specific strengths, weaknesses, and historical behavior in civil space. Nations whose spending approaches \$1 billion have a third page comparing their budget and spending priorities with those of the US. For countries currently engaged in specific cooperative projects with the US, a detailed breakout of these activities is also included.

The **Guide** is arranged alphabetically by country or parent agency in the case of the European Space Agency. The programs and capabilities of the former Soviet Union are grouped together in a joint Russia/Kazakhstan/Ukraine section due to the significant connections between these now autonomous states. Countries spending less than \$5 million per year are discussed in the section "Countries with Minor Space Capabilities." Countries merely purchasing space services and not having significant indigenous space programs are also presented in this section. An alphabetized index for all space-faring nations is located at the end of the document.

The **Guide's** "Appendices" section includes charts allowing direct country-to-country comparisons. These include a matrix of the world's civil space programs and their specific activities; figures detailing the world's launch vehicles and launch centers; civil space budget breakdowns for selected countries; and a list of ongoing international cooperative space projects involving the United States.

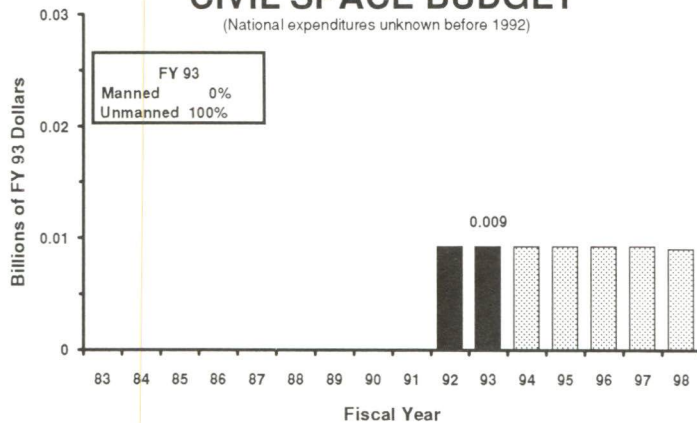
Users of this **Guide** should be aware that the method of comparing budgets between countries is the subject of significant debate. Complications include fluctuating exchange rates, unconvertible currencies of non-market economies, the different purchasing powers of national currencies, the source and original form of raw data, and fundamental structural differences in national budgets and organizations. Whenever possible, budget data is used in the original national currency for the particular country and the specific year. The data is converted into US dollars and put into the base year 1993. In this way, comparisons can be made in US currency without concern for the effect of inflation. Given the above difficulties, the data herein has been assembled and verified as carefully as practical and should be accurate to a level sufficient to meet the goal of portraying significant trends that are important to policy decisions.

International Space Programs

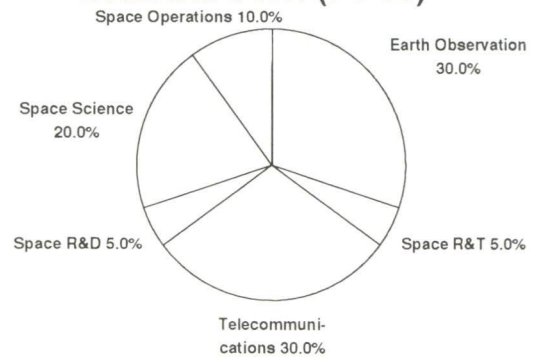
Argentina

CIVIL SPACE BUDGET

(National expenditures unknown before 1992)



APPROXIMATE SPENDING BREAKDOWN (FY 93)



LAUNCH VEHICLES

**No Domestic
Orbital Launch Vehicles**

INFRASTRUCTURE

CNIE Remote Sensing Center (Vincente Lopez Center)

Receives and processes Landsat and SPOT imagery; also acts as a TT&C facility

San Miguel Center

Satellite construction facilities and meteorological/remote sensing research

Mar Chiquita and La Rioja

Sounding rocket launch sites

Balcarce Station

Satellite telecommunications reception and transmission station

ORGANIZATION

National Commission on Space Activities (CONAE)

Civil space agency

Institute for Aeronautics and Space Research (IAFE)

An element of the Air Force responsible for developing propellants and sounding rockets

National Telecommunications Agency (ENTEL)

Operator of Argentine satellite telecommunications infrastructure (signatory to Intelsat and Inmarsat)

SIGNIFICANT INTERNATIONAL COOPERATIVE PROJECTS

	Brazil	China	Egypt	France	Germany	Iraq	Italy	US
Human Spaceflight								
SSF								
Earth Observation				X			X	X
Space Science								X
Space Operations				X				
Data Exchange	X	?	?	X	X	?		X

1993 budget figure: ANSER projection from 1992 figure as reported in Aerospace America, June, 1992, p. 12.

? = unconfirmed cooperative activities

ARGENTINE LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs:

1990s

- Continue developing space capabilities
 - Remote sensing activities
 - Scientific instrument/spacecraft manufacture
- Develop domestic telecommunications system
 - Being commercially developed

2000 and Beyond

- None identified

Overall Goals of Argentine Space Activities

- Enhance indigenous space capabilities
- Derive scientific, economic, and social benefits

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- None identified

OPPORTUNITIES FOR THE US

- Access to South American commercial market

CURRENT ISSUES

- Military application of space-related technology
- Cooperative relationships with China, Egypt, and Iraq
- Direction and nature of relationship with US space program

"BOTTOM LINE"

Argentina has a modest space capability. Major emphasis is placed on applications and space science, although consideration has been given to developing an orbital launcher.

Strengths

- Satellite construction capability (scientific/space physics class)
- Earth observation support facilities
- Telecommunications facilities
- R&D experience in sounding rockets and solid-fuel motors

Weaknesses

- Low budget

HISTORICAL TREND: Slow-paced development efforts. Argentine progress limited mainly by financial and technical resources available. Seeking broader cooperative associations in order to enhance national space expertise/capabilities.

US - ARGENTINA COOPERATION

1994

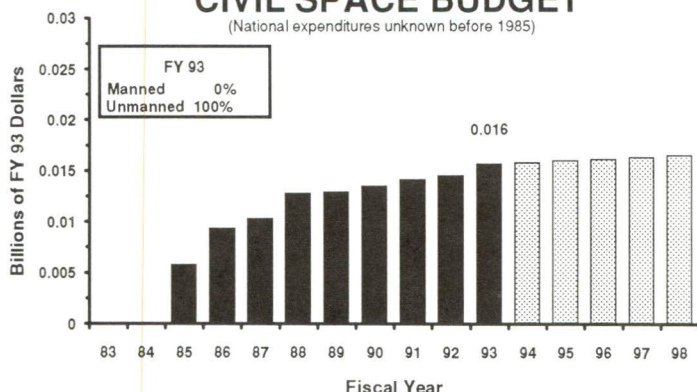
SAC-B Argentina will provide the spacecraft bus and a solar X-ray instrument for this joint mission to monitor solar activity and associated effects on the environment. Italy will provide an imaging particle spectrometer. NASA will provide a solar X-ray cosmic background instrument built by Penn State University, handle launch operations, and assist with on-orbit data monitoring. Argentina will integrate the instruments into the spacecraft, which is scheduled for launch aboard a US expendable launch vehicle. A SAC-B Follow-On mission is also under discussion.

Australia

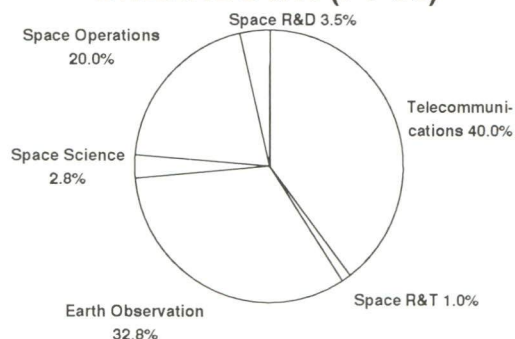
AUSTRALIA

CIVIL SPACE BUDGET

(National expenditures unknown before 1985)



APPROXIMATE SPENDING BREAKDOWN (FY 93)



LAUNCH VEHICLES

No Domestic
Orbital Launch Vehicles

INFRASTRUCTURE

Queensland Cape York Spaceport

Proposed international commercial launch facility

Woomera Test Range

Sounding rocket launch facility

Canberra Deep Space Communications Complex

NASA worldwide network support

Australian Center for Remote Sensing (ACRES)

Landsat, SPOT, NOAA, and MOS-1 data/imagery reception, processing, and distribution

Yarragadee and Gngangara Tracking Stations

NASA and ESA satellite operations support

Australian National Radio Observatory

Radio astronomy research support

ORGANIZATION

Australian Space Council (ASC)

Coordinates all areas of space activities

Australian Space Office (ASO)

Executive body for space industry policy and programs execution

Australian Space Board

ASO advisor on developing space activities

Commonwealth Scientific and Industrial Research Organization (CSIRO)

Primary body for industrial and scientific research

CSIRO Office of Space Science and Engineering (COSSE)

Responsible for national space science activities

Overseas Telecommunications Commission (OTC)

Signatory to Inmarsat and Intelsat

Australian Satellite Company (AUSSAT)

Domestic operator of communication satellite system

SIGNIFICANT INTERNATIONAL COOPERATIVE PROJECTS

	ESA	France	Japan	Russia	UK	US
Human Spaceflight						
SSF						
Earth Observation	X	X	X	X	X	X
Space Science	X	X	X	X	X	X
Space Operations	X			X	X	X
Data Exchange	X	X	X	X	X	X
Telecommunications	X			X	X	X

AUSTRALIAN LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs:

1990s

- Continue AUSSAT telecommunications program
- Continue participation in US, ESA, Japan, and Russia projects, including
 - Remote sensing activities
 - Scientific instrument manufacture
 - Ground network facilities
- Continue exploring potential for Cape York Spaceport
- Use Mir for medical and microgravity experiments
- Expand domestic space industry, technology, and infrastructure

2000 and Beyond

- Continue 1990s efforts
- Develop autonomous launch capability
- Increase role as a player in Southern Hemisphere space activities

Overall Goals of Australian Space Activities

- Exploit market opportunities in satellite communications, remote sensing, and launch services
- Enhance domestic space industry and infrastructure
- Pursue increased bilateral, regional, and multilateral space activities for national and economic benefit

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- Could become commercial competitor in
 - Communications
 - Remote sensing
 - Launch

OPPORTUNITIES FOR THE US

- Expanded cooperative arrangements with growing Australian space industry
- Scientific and technical data exchange

CURRENT ISSUES

- Viability of the Cape York Spaceport concept (funding, schedule, developer/operator)
- Impact of Cape York Spaceport on world launch market (if successful)
- Use of the currently inactive Woomera launch site as a possible commercial small satellite launch facility

"BOTTOM LINE"

Australia is an important emerging player in the space community. Contributes significantly to both US and ESA programs (infrastructure/facilities). Is set to pursue major new initiatives and is positioning itself for the 21st century.

Strengths

- Telecommunications systems
- Space science
- Ground station technology
- Instrument fabrication for spaceflight

Weaknesses

- Low budget

HISTORICAL TREND: Important, but modest, space efforts. Typically playing a secondary support role to the US and ESA space programs. Developing a space infrastructure and industry to engage commercial space pursuits actively in the coming decade. Seeking broader international cooperative opportunities.

US - AUSTRALIA COOPERATION

ON-GOING

Facilities One of the three large stations of NASA's Deep Space Network is located in Australia.

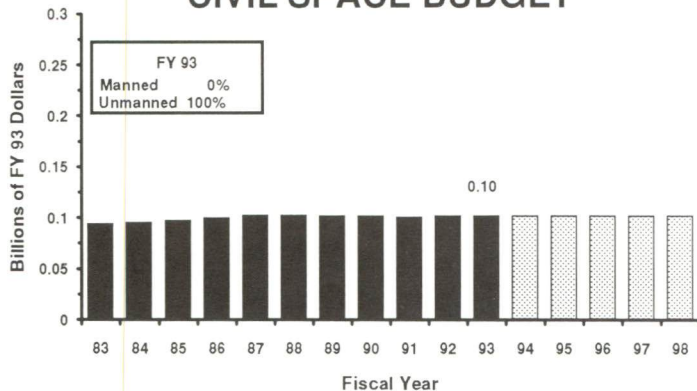
Sounding Rockets NASA and Australia have a cooperative agreement covering the launching, tracking, and recovery of US sounding rockets and their payloads from Australian facilities.

1994

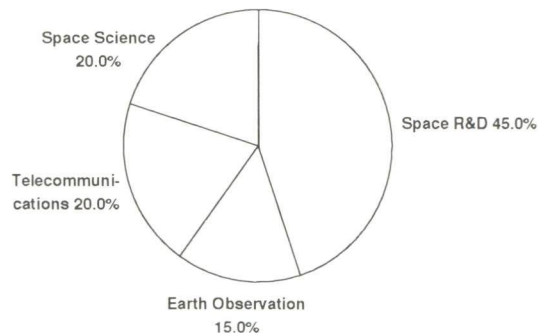
ISTPP/International Solar Terrestrial Physics Program Australia will be supplying an investigator for an experiment under the POLAR mission of the Global Geospace Science Program (GGS) element of the International Solar Terrestrial Physics Program.

Brazil

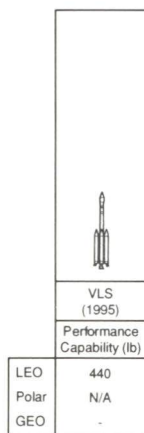
CIVIL SPACE BUDGET



APPROXIMATE SPENDING BREAKDOWN (FY 93)



LAUNCH VEHICLES



INFRASTRUCTURE

Alcantara Launch Facility

Atlantic coast equatorial launch facility

Cachoeira Paulista

Mission control center for space data collection

Cuiaba SPOT/Landsat ground station

Sao Paulo NOAA/GOES - Cospas-Sarsat Ground Stations

Satellite System Operational Center

Main TT&C facility for Brazil

Tangua TT&C Facility

Backup TT&C facility, co-located with Intelsat processing facility

ORGANIZATION

Brazilian Commission for Space Activities (CSA)

Principal government body for the coordination of Brazil's national space program

Aerospace Technical Center (CTA)

Under the Ministry of Aeronautics. Principal aerospace institution in Brazil. Oversees national research and development activities for civil and military programs

Institute for Space Activities (IAE)

Responsible for launch vehicle development activities. Reports to CTA

National Institute for Space Research (INPE)

Under the Ministry for Science and Technology. Space applications and development. Responsible for ground/space segment and applications satellite programs

SIGNIFICANT INTERNATIONAL COOPERATIVE PROJECTS

	Argentina	Canada	China	ESA	France	Russia	US
Human Spaceflight							
SSF							
Earth Observation		X		X		X	
Space Science		X		X		X	
Space Operations	X	X	X	X			
Data Exchange	X	X			X	X	

BRAZILIAN LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs:

1990s

- Complete launch vehicle (VLS) program
- Develop space science satellite (SATCEA) and continue communications satellite program
- Complete new space launch facilities at Alcantara
 - Offer site for commercial use
- Increase technology exchange and cooperative efforts within the international community

2000 and Beyond

- Market the VLS
- Continue international cooperative efforts

Overall Goals of Brazilian Space Activities

- Achieve national autonomy in space
- Advance technology base
- Enhance national security
- Derive economic benefit

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- Military exploitation of space launch and science technology
- Propensity to sell technology and systems to countries hostile to US interests -- possible proliferation of ballistic missile technology

OPPORTUNITIES FOR THE US

- Access to South American commercial market

CURRENT ISSUES

- Russian interest in developing Brazil's Alcantara launch facility as a possible site for the Proton launch vehicle.
- Limited economic resources casts doubt on Brazil's ability to meet program goals
- Extent and future direction of Brazil's cooperative relationship with China
- Military applications of space-related technology, specifically ballistic missile systems
- Russian offers of technology and expertise to assist launch vehicle program

"BOTTOM LINE"

Brazil's space program is steadily growing and increasing in capability. Strong government commitment exists to promote space development. Lack of economic resources remains a major roadblock to development.

Strengths

- Solid propellant technology
- Simple avionics/sensor subsystems
- Satellite ground infrastructure

Weaknesses

- Economic instability

HISTORICAL TREND: Slow but persistent development of launch, remote sensing, and communications systems. Capitalizing on cooperation with China and France. Heading toward autonomous capability in space launch and space operations.

US - BRAZIL COOPERATION

ON-GOING

Trace-A/Transport and Chemistry near the Equator-Atlantic Trace-A is an agreement between NASA and Brazil to cooperate in this third in a series of Global Tropospheric Experiments (GTE). Data analysis efforts continue.

Preliminary discussions have taken place between NASA and INPE about the possibility of cooperating on experiments examining Earth's magnetic field. This effort could involve the launch of sounding rockets from Brazil's Alcantara launch facility.

Canada

25

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the Troposphere) instrument for flight on the NASA EOS AM-1 polar platform, scheduled for launch in 1998.

© ANSER 1993

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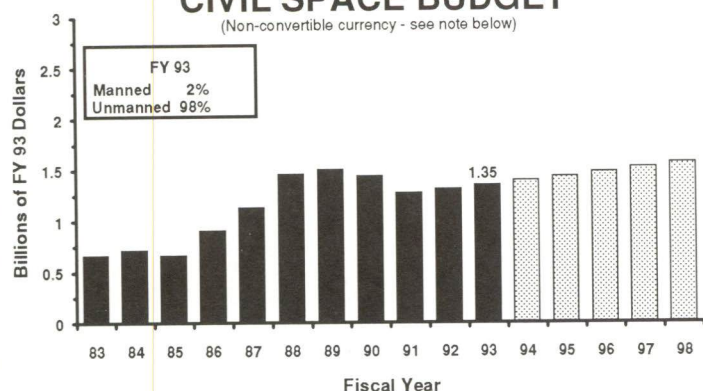
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CANADIAN LONG-RANGE PLANS AND PROJECTS

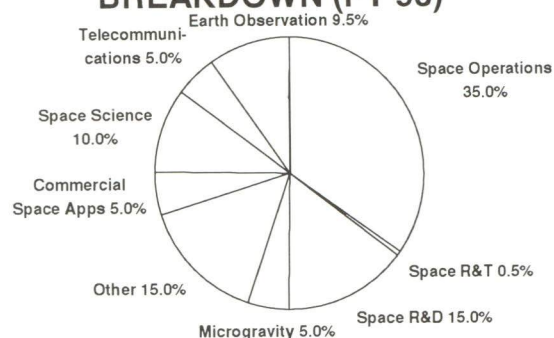
CHINA

CIVIL SPACE BUDGET

(Non-convertible currency - see note below)



APPROXIMATE SPENDING BREAKDOWN (FY 93)



LAUNCH VEHICLES

	CZ-1D	CZ-2C	CZ-2E	CZ-3	CZ-3A (1993)	CZ-4A
	Performance Capability (lb)					
LEO	1,653	4,408	19,395	11,020	18,734	8,816
Polar	N/A	1,653	15,868	5,600	N/A	3,306
GEO	N/A	1,102	3,500	3,085	5,510	2,424

INFRASTRUCTURE

Jiuquan Satellite Launch Facility

China's oldest spaceport supporting LEO missions of CZ-1 and CZ-2 systems. Test range for some ballistic missiles and nuclear weapons

Xichang Satellite Launch Center

Supports launch of broadcast, communications, and meteorological satellites

Taiyuan/Wuzhai Launch Facility

Newest facility (1988), primarily for CZ-4 polar launches

Telemetry Tracking and Control Facilities

Network of five fixed, three mobile, and two ship stations, headquartered at Xian City

ORGANIZATION

National Space Administration

Develops overall national space program, policy and goals

Commission of Science, Technology, and Industry for Defense

Coordinates military and commercial space activities

Chinese State Bureau of Meteorology

Provides funding and establishes specifications for meteorological programs

Xian Institute of Radio Technology

Conducts research and development on imaging sensors for remote sensing satellites

China Great Wall Industry Corporation

Commercial development and marketing of space services and products

SIGNIFICANT INTERNATIONAL COOPERATIVE PROJECTS

	Australia	Brazil	Canada	ESA	France	Germany	India	Italy	Japan	Sweden	UK	US
Human Spaceflight												
SSF												
Earth Observation	X	X	X	X	X							X
Space Science	X	X	X	X	X	X		X	X	X	X	X
Space Operations		X										
Data Exchange	X	X	X		X	X		X	X	X	X	X

1993 budget figure: ANSER estimate from multiple sources.

Non-convertible currency -- budget data should be used for order of magnitude and trend analyses only.

CHINESE LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs :

1990s

- Autonomous satellite production
- Continue space science projects
 - Recoverable microgravity capsules
- Nationwide satellite communications
- Sell launch services to foreign countries
- Orbit geostationary meteorological satellite
- Develop manned spaceflight capabilities

2000 and Beyond

- Reusable launch vehicles
- Expand manned spaceflight capabilities
- Orbital station
- Telemetry and tracking services
- Spacecraft production for export

Overall Goals of Chinese Space Activities

- Increase national security and autonomy in space
- Obtain Western technology to support space efforts
- Derive scientific, economic, and social benefits
- Expand on commercial benefits and sales to the West
- Obtain international recognition as a space power

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- Technology transfer of dual-use technologies
- Non-market pricing for commercial launches

OPPORTUNITIES FOR THE US

- Cooperative agreements using US manufactured space components in Chinese space activities

CURRENT ISSUES

- Recent restructuring of space activities under single agency
- Missile technology proliferation
- Evolving Asian-Pacific regional space cooperation

"BOTTOM LINE"

China maintains a significant and growing space program. Space launch capabilities now offered commercially to LEO and GEO. Space program goals focus on increased launch capabilities, operating scientific satellites, manufacturing satellites, and developing manned spaceflight capabilities.

Strengths

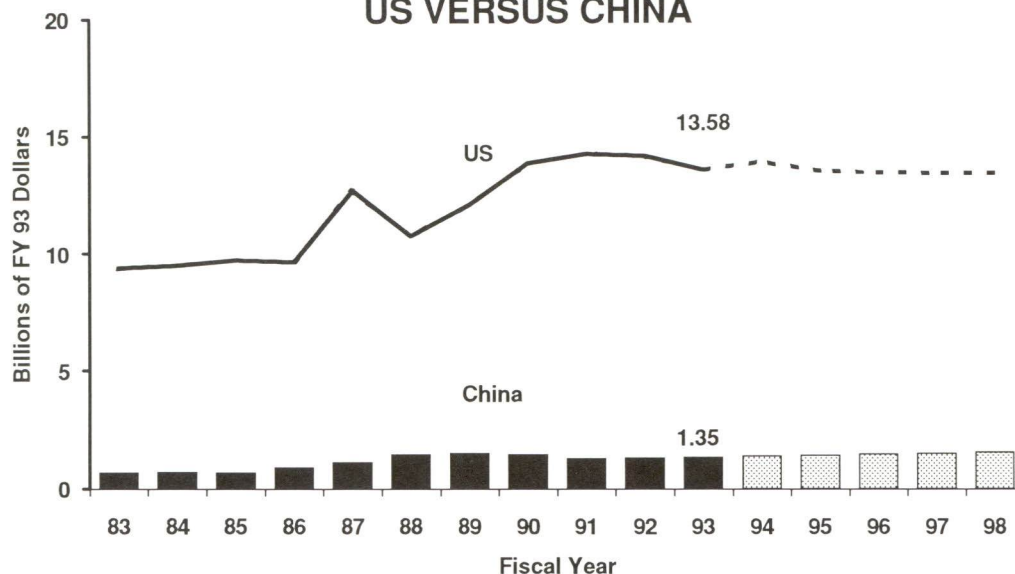
- Demonstrated launch systems capabilities
- Extensive TT&C and space production facilities

Weaknesses

- Political uncertainty for continued cooperation with Western governments
- Lack of conversion to a fully market-oriented economy hampers dealings in international markets

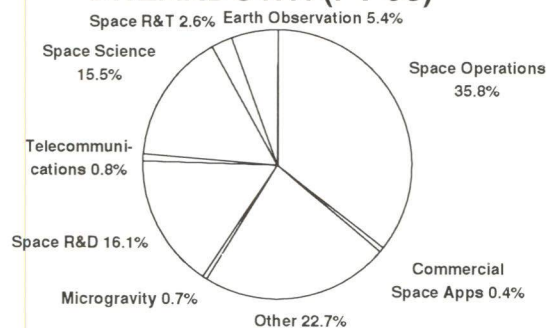
HISTORICAL TREND: The Chinese have built upon early former Soviet technology to develop an autonomous space capability. Space development is a long-term national commitment.

CIVIL SPACE BUDGETS US VERSUS CHINA

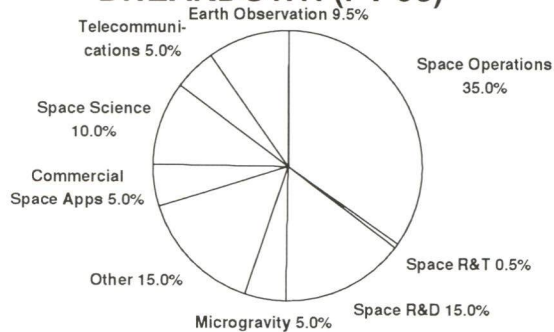


CIVIL SPENDING BREAKDOWNS US VERSUS CHINA

US APPROXIMATE SPENDING BREAKDOWN (FY 93)



CHINA APPROXIMATE SPENDING BREAKDOWN (FY 93)



European Space Agency

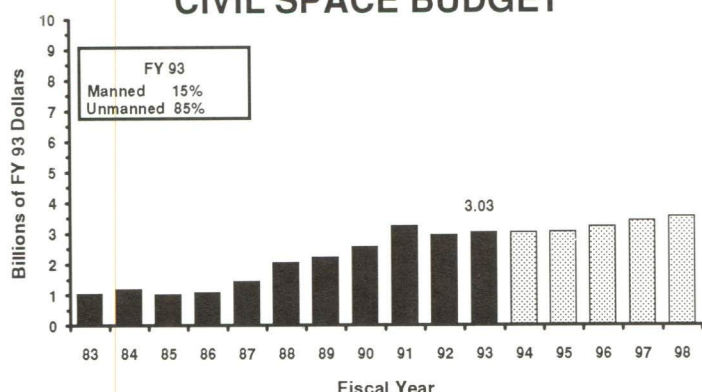
Austria
Belgium
Denmark
Finland
France

Germany
Ireland
Italy
Netherlands
Norway

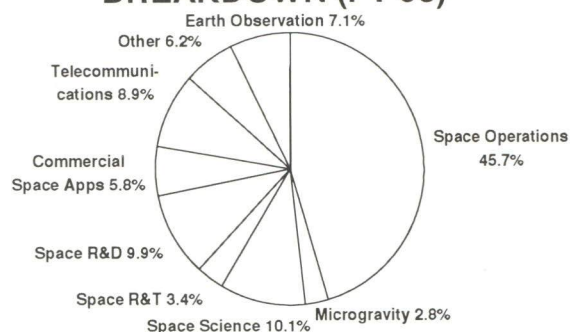
Spain
Sweden
Switzerland
United Kingdom

EUROPEAN SPACE AGENCY

CIVIL SPACE BUDGET



APPROXIMATE SPENDING BREAKDOWN (FY 93)



LAUNCH VEHICLES

			
ARIANE 4 (4L)		ARIANE 5 (1995)	
Performance Capability (lb)			
LEO	21,100	32,700	
Polar	16,900	26,500	
GEO	5,036	9,592	

INFRASTRUCTURE

Guiana Space Center (French Guiana)

Launch facilities for Ariane

European Space Operations Center (Germany)

Tracking and control

Reception, processing, and distribution of spacecraft and payload data

Operations control center

ESTRAK -- network of control stations

European Space Research Institute (Italy)

Information retrieval service -- computer-based technical information system

Earthnet Program Office -- acquisition, preprocessing, archiving, and distribution of satellite remote sensing data

ORGANIZATION

Member States*

Austria (0.83%), Belgium (4.18%), Denmark (0.81%), Finland (0.28%), France (24.21%), Germany (20.37%), Ireland (0.19%), Italy (15.03%), Netherlands (2.19%), Norway (0.78%), Spain (2.37%), Sweden (1.98%), Switzerland (1.97%), United Kingdom (6.77%), and Canada (0.83%) **

Ministerial Council

Makes decisions on overall policy and on scientific, technical, and administrative matters. Prepares long-term plans proposing the direction European space research should take. Director General is executive and legal representative

European Space Research and Technology Center (Netherlands)

Study, design, development, and testing of components and complete space vehicles

* (%) Indicates member states' contribution to total ESA budget. NOTE: An additional 17.21% of ESA budget comes from other sources (cooperating nations, industry, etc.).

** Canada is not a member of ESA but has been included here due to its special relationship as a non-member contributor.

SIGNIFICANT INTERNATIONAL COOPERATIVE PROJECTS

	Canada	Japan	Russia	US
Human Spaceflight	X		X	X
SSF	X	X		X
Earth Observation	X	X	X	X
Space Science	X	X	X	X
Space Operations				X
Data Exchange	X	X	X	X

ESA LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs:

1990s

- Ariane 5 Launch Vehicle
- Columbus Space Station Freedom module
- Data Relay Satellite System
- Earth Observation System
 - Earth polar orbiting platform
- Space Science
- Hermes re-orientation study
- Astronaut flights to Mir space station
- EVA 2000 spacesuit development with Russia

2000 and Beyond

- Hermes mini Space Shuttle (goal)
 - Possible Russian cooperation
- Cooperative planetary exploration

Overall Goals of ESA Space Activities

- Expand Europe's autonomous capability in space
- Enhance Europe's competitiveness in all sectors of space activity
- Strengthen Europe's standing as a full partner in international cooperation activities

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- Commercial competition with US aerospace industry
 - Launch vehicle technology/systems
 - Satellite manufacture/technology
 - Remote sensing data

OPPORTUNITIES FOR THE US

- Expanded partnership in many areas
- Access to large scientific database
- Use of complementary infrastructure

CURRENT ISSUES

- Down-scoping of goals and budget commitments
 - Manned spaceflight (Hermes)
- Space Station Freedom
 - US funding, design, and schedule uncertainties
 - "Benchmark" against future cooperative missions

- Evolving relationship with Russia and Japan in space cooperation
- ESA-European Community (EC) coordination

"BOTTOM LINE"

ESA is maintaining a strong commitment to its established unmanned space/launch development activities. However, it is currently undergoing a major reassessment of its plans to pursue an aggressive autonomous manned space capability. ESA is seeking broader international cooperation to balance its long-term goals with fiscal reality.

Strengths

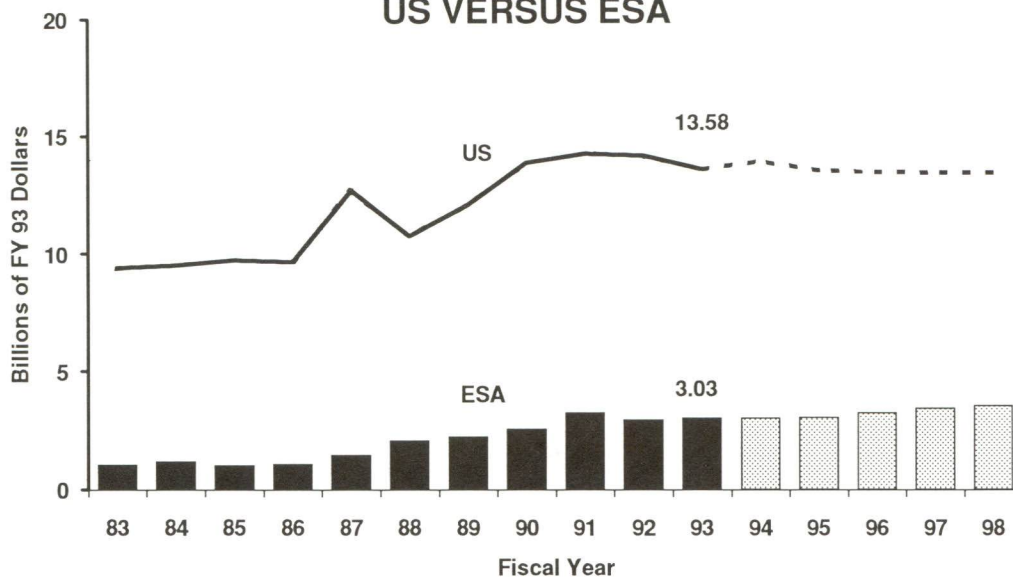
- Successful commercial launch system
- Application of R&D to commercial projects

Weaknesses

- Uncertain stability of long-term plan

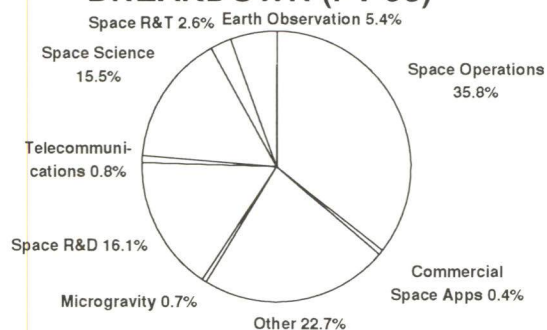
HISTORICAL TREND: ESA has developed a relatively stable support base with emphasis on transferring programs to the private sector. It is methodically building a robust space infrastructure. However, recently ESA has had to revise growth projections due to budget constraints.

CIVIL SPACE BUDGETS US VERSUS ESA

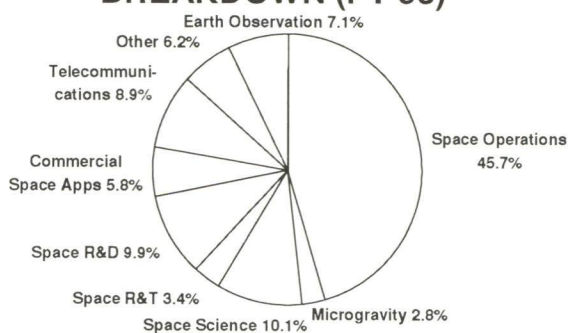


CIVIL SPENDING BREAKDOWNS US VERSUS ESA

US APPROXIMATE SPENDING BREAKDOWN (FY 93)



ESA APPROXIMATE SPENDING BREAKDOWN (FY 93)



US - ESA COOPERATION

ON-GOING

ERS-1/European Remote Sensing-1 The US is providing direct data read-out to ESA from Europe's all-weather remote sensing satellite system, ERS-1, launched in July 1991.

EURECA/European Retrievable Carrier The first of three planned missions for microgravity experiments launched by the US Space Shuttle in July 1992. EURECA will be retrieved by the Shuttle in 1993. Arrangements for flights two and three are currently on hold.

Hipparcos NASA is providing tracking support and US investigators for this European astrometry mission, which was launched in 1989.

Hubble Space Telescope ESA provided the Faint Object Camera (FOC), the solar array, and post-launch operational support in exchange for 15% of the telescope's viewing time. Hubble is currently on orbit.

IML-1/International Microgravity Laboratory-1 Two ESA facilities, a European payload specialist, and a European mission specialist flew on the US IML-1 Spacelab mission in July 1992. Data analysis efforts continue.

Ulysses The US provided the launch, Radioisotope Thermoelectric Generator (RTG) power source, half the payload, and Deep Space Network tracking support to this European spacecraft. Ulysses was launched on the US Space Shuttle in 1990 to investigate the Sun.

1994

IML-2/International Microgravity Laboratory-2 Four ESA microgravity facilities will fly on the US IML-2 Spacelab mission.

1995 and beyond

Cassini NASA will provide the Saturn orbiter and ESA the Huygens atmospheric probe to Titan for launch in 1997. Numerous foreign investigators will develop instruments and analyze data.

EOS/Earth Observing System ESA will provide a Multifrequency Imaging Microwave Radiometer (MIMR) instrument for flight on NASA's EOS PM-1 polar orbiting platform.

ISTPP/International Solar Terrestrial Physics Program Four identically instrumented Cluster spacecraft built and launched by ESA will carry a range of ESA and US plasma physics instrumentation as part of the Collaborative Solar Terrestrial Research (Costr) element of the International Solar Terrestrial Physics Program. This joint US-European program will be launched by an Ariane 5 in 1995. In addition, the Solar and Heliospheric Observatory (SOHO) spacecraft, provided by ESA, will carry several ESA/US shared instruments as part of the Costr element of the ISTPP. SOHO is scheduled for launch in 1995 on a US Atlas II rocket.

US - ESA COOPERATION

1995 and beyond (Continued)

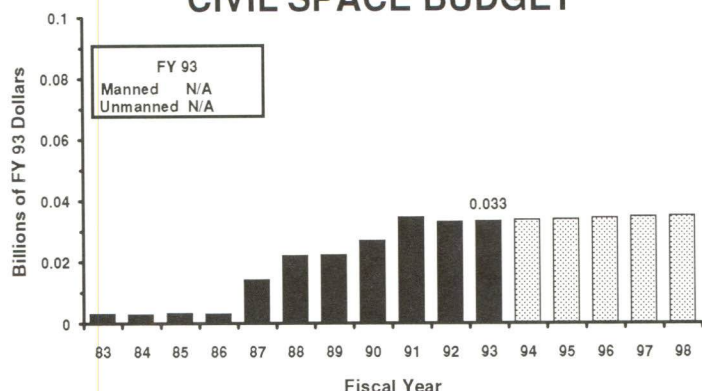
Rosetta Comet Sample Return Discussions are in progress concerning the division of responsibilities for this mission planned for 2001.

Space Station Freedom ESA is contributing a laboratory module, a free-flying experiment module, and a polar platform for Earth observations.

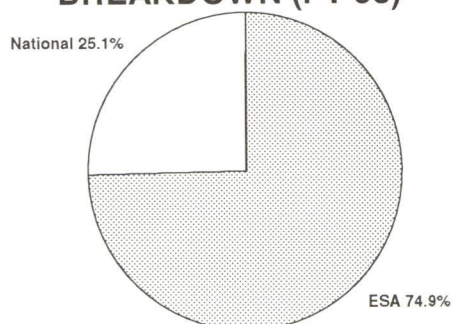
Austria

AUSTRIA

CIVIL SPACE BUDGET



APPROXIMATE SPENDING BREAKDOWN (FY 93)



LAUNCH VEHICLES

No Domestic
Orbital Launch Vehicles

INFRASTRUCTURE

Graz Space Research Institute

Space science research

Joanneum Research

Oversees Austrian-Russian cooperation

Research Center Seiberdorf

Space technology

ORGANIZATION

Austrian Space Agency (ASA)

Coordinates national space program under aegis of
Federal Ministry for Science & Research

SIGNIFICANT INTERNATIONAL COOPERATIVE PROJECTS

	Russia	ESA	US
Human Spaceflight	X	X	
Mir	X		
Earth Observation	X	X	
Space Science	X	X	X
Space Operations		X	
Data Exchange	X	X	

AUSTRIAN LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs:

1990s

- Participate in ESA programs
 - Olympus telecommunications project
 - Earth Resources Satellite (ERS-1)
 - Ariane 5 launch vehicle

2000 and Beyond

- Continue ESA participation

Overall Goals of Austrian Space Activities

- Derive practical benefits from space activities
- Continue beneficial ties to ESA and Russia

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- None identified

OPPORTUNITIES FOR THE US

- None identified

CURRENT ISSUES

- None identified

"BOTTOM LINE"

Austria has a strong dependency on ESA and Russian space programs.

Strengths

- Remote sensing
- Telecommunications

Weaknesses

- Low budget

HISTORICAL TREND: Capitalizing on association with ESA and Russia for leveraged space activities.

US - AUSTRIA COOPERATION

ON-GOING

Mars Observer An Austrian is serving as an investigator for the Magnetometer investigation for this mission launched in September 1992.

1995 and beyond

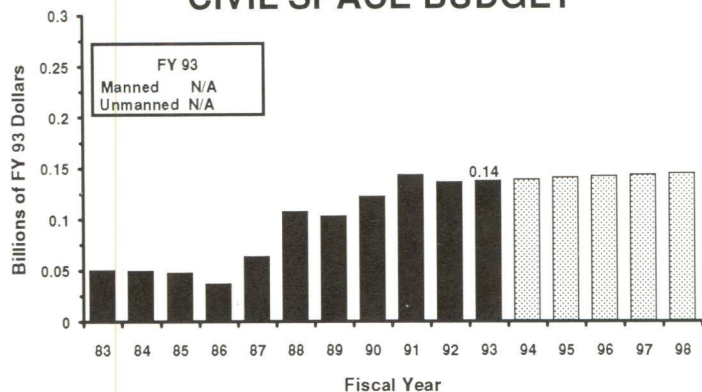
Cassini An Austrian is serving as an investigator on the Ion and Neutral Mass Spectrometer (INMS) investigation for this mission, which is scheduled for launch aboard a Titan launch vehicle in 1997.

ISTPP/International Solar Terrestrial Physics Program An Austrian is serving as the Principal Investigator on the Active Spacecraft Potential Control experiment under the Cluster mission which is under the Collaborative Solar Terrestrial Research (Costr) element of the ISTPP. Cluster is scheduled for launch on an Ariane 5 in 1995.

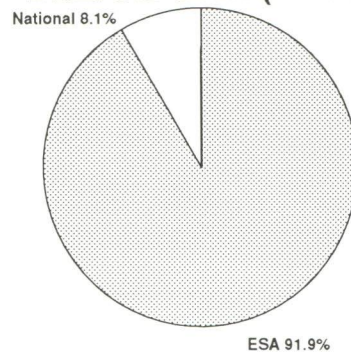
Belgium

BELGIUM

CIVIL SPACE BUDGET



APPROXIMATE SPENDING BREAKDOWN (FY 93)



LAUNCH VEHICLES

No Domestic
Orbital Launch Vehicles

INFRASTRUCTURE

Redu Extelsat II&C Facility
Major ESA satellite ground control facility

ORGANIZATION

Science Policy Office (SPO)

Responsible for managing ESA involvement, bilateral and multilateral cooperative activities

Royal Meteorological Institute

Manages meteorological satellite activities and data gathering efforts

Astrophysics Institute of the University of Liege (IAL Space)

Conducts space science projects

Regie Des Telegraphes Et Telephones

Handles domestic telecommunications efforts

SIGNIFICANT INTERNATIONAL COOPERATIVE PROJECTS

	ESA	France	Russia	US
Human Spaceflight	X			X
SSF	X			
Earth Observation	X	X	X	
Space Science	X	X	X	X
Space Operations	X			
Data Exchange	X		X	
Telecommunications		X	X	

BELGIAN LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs :

1990s

- Participate in ESA programs
- Continue cooperation with Russia and France in telecommunications and remote sensing
- Participate in IML-2 Shuttle mission

2000 and Beyond

- Continue support of 1990s programs

Overall Goals of Belgian Space Activities

- Derive practical benefits from space activities

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- None identified

OPPORTUNITIES FOR THE US

- None identified

CURRENT ISSUES

- None identified

"BOTTOM LINE"

Belgium is heavily dependent on ESA for space development projects. Focus is primarily in areas of telecommunications and remote sensing.

Strengths

- Space science expertise

Weaknesses

- None identified

HISTORICAL TREND: Limited but active interest in space. Belgians have capitalized on their association with ESA to derive practical benefits from space.

US - BELGIUM COOPERATION

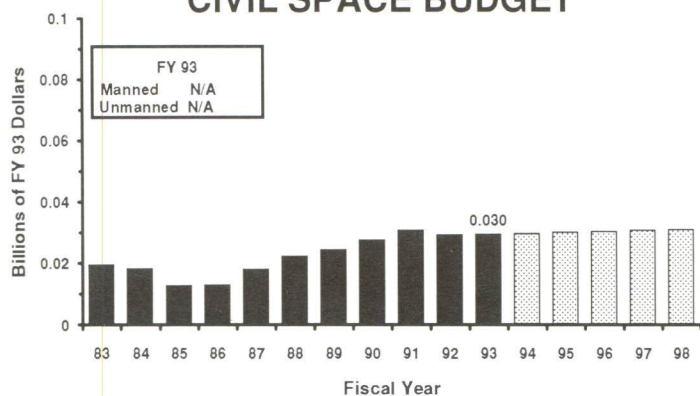
ON-GOING

Atlas/Atmospheric Laboratory for Applications and Science Atlas is a series of US Space Shuttle missions. Atlas-1, a US Space Shuttle mission for solar and atmospheric monitoring, launched in March of 1992, carried among its instruments a Belgian Solar Constant Radiometer (SOLCON) and Grille Spectrometer. A Belgian investigator flew on this mission (under the auspices of ESA) as a payload specialist. Data analysis efforts continue.

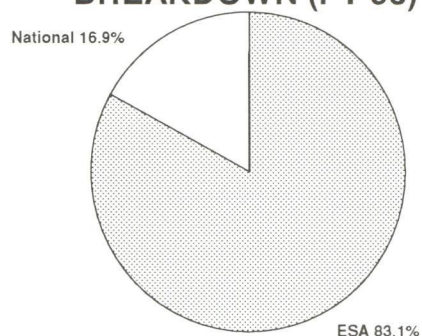
Denmark

DENMARK

CIVIL SPACE BUDGET



APPROXIMATE SPENDING BREAKDOWN (FY 93)



LAUNCH VEHICLES

No Domestic
Orbital Launch Vehicles

INFRASTRUCTURE

None Identified

ORGANIZATION

Danish Space Committee

Under the Ministry of Education. Sets space program budgets and guidelines for ESA participation

Danish Research Institute

Under the Ministry of Education. Coordinates international space activities

SIGNIFICANT INTERNATIONAL COOPERATIVE PROJECTS

	ESA	Russia	US
Human Spaceflight	X		
SSF	X		
Earth Observation		X	
Space Science	X	X	X
Space Operations	X		
Data Exchange	X	X	

DANISH LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs:

1990s

- Participate in ESA programs
- Continue X-ray/gamma-ray, planetology, and solar-terrestrial research with Russia

2000 and Beyond

- Continue ESA participation

Overall Goals of Danish Space Activities

- Derive practical benefits from space activities
- Pursue pure scientific space research

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- None identified

OPPORTUNITIES FOR THE US

- None identified

CURRENT ISSUES

- None identified

"BOTTOM LINE"

Denmark has small but consistent scientific efforts in space. Most needs are met through association with ESA and Russia.

Strengths

- Planetology and solar physics

Weaknesses

- Low budget

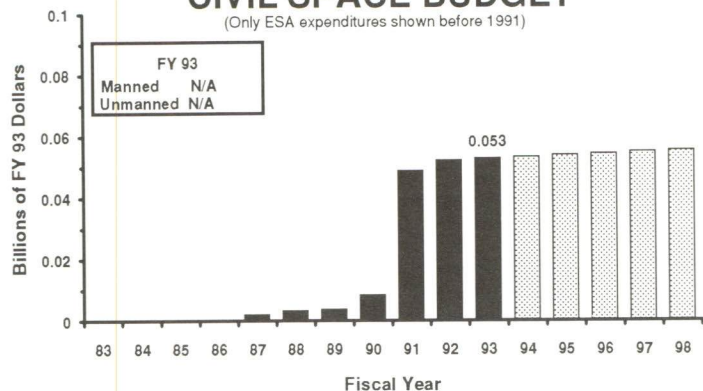
HISTORICAL TREND: Cooperation within ESA and with Russia. Major areas of interest are at the university research and applications level.

Finland

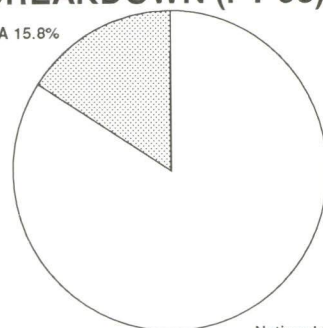
FINLAND

CIVIL SPACE BUDGET

(Only ESA expenditures shown before 1991)

APPROXIMATE SPENDING
BREAKDOWN (FY 93)

ESA 15.8%



National 84.2%

LAUNCH VEHICLES

No Domestic
Orbital Launch Vehicles

INFRASTRUCTURE

None Identified

ORGANIZATION

Finnish Space Committee

Directs national space activities, sets policy, acts
as principal point of contact

Technology Development Center

Promotes participation of Finnish industries
in international space research and development

SIGNIFICANT INTERNATIONAL
COOPERATIVE PROJECTS

	ESA	Russia
Human Spaceflight		
SSF		
Earth Observation	X	X
Space Science		X
Space Operations		
Data Exchange	X	X

FINNISH LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs:

1990s

- Participate in ESA and Russian projects including
 - Remote sensing activities
 - Scientific instrument manufacture and data exchange
- Become full ESA member by 1995

2000 and Beyond

- Continue support of 1990s programs

Overall Goals of Finnish Space Activities

- Derive practical benefits from space activities
- Advance domestic capabilities through international cooperation

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- None identified

OPPORTUNITIES FOR THE US

- None identified

CURRENT ISSUES

- Industry hesitancy to invest in space programs

"BOTTOM LINE"

Finland has relatively low-level space efforts. Contribution to ESA is growing. Full membership in ESA projected by 1995.

Strengths

- Space science (researcher level)

Weaknesses

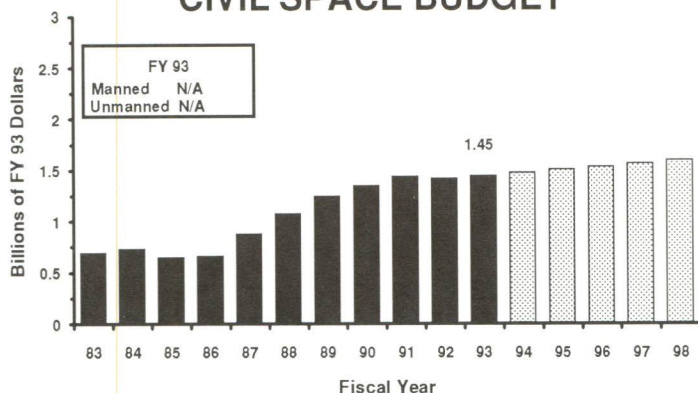
- Limited budget

HISTORICAL TREND: Finland has participated in both former Soviet and ESA space activities (Finland contributed instruments to the failed Soviet attempt to explore the Martian moon Phobos). The nation has used contacts with larger space programs to enhance national space science expertise.

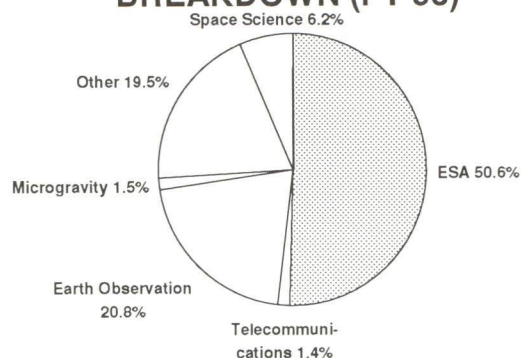
France

FRANCE

CIVIL SPACE BUDGET



APPROXIMATE SPENDING BREAKDOWN (FY 93)



LAUNCH VEHICLES

No Domestic
Orbital Launch Vehicles

Major contributor to ESA's Ariane program

INFRASTRUCTURE

Centre Spatial d'Evry
Launcher development center

Centre Spatial de Toulouse
Main engineering and technology facility

Centre de Lancements de Ballons
Balloon launching site

Centre Spatial Guyanais
CNES/ESA orbital launch facility
(Kourou, French Guiana)

TT&C Stations: France, French Guiana,
South Africa

13 Research Facilities

ORGANIZATION

Centre Nationale d'Etudes Spatiale (CNES)

French National Space Agency. Responsible for
executing French space programs

**Ministry of Industry, Posts, Telecommunications,
and External Trade**

Coordinates contracts with French space companies
for Ariane and other programs funded through CNES

Ministry of Defense

Consumer of space products (military telecommunications
and reconnaissance). Funds some CNES activities.

Ministry of Higher Education and Research

Involved in space science activities of CNES

SIGNIFICANT INTERNATIONAL
COOPERATIVE PROJECTS

	Belgium	ESA	Germany	Italy	Japan	Russia	Spain	Sweden	UK	US
Human Spaceflight		X	X		X					
SSF		X								
Earth Observation	X	X	X	X	X	X	X	X	X	X
Space Science		X	X		X				X	X
Space Operations		X	X	X	X					
Data Exchange		X	X	X	X	X				X

1993 budget figure: ANSER estimate from multiple sources.

FRENCH LONG-RANGE PLANS AND PROGRAMS

Current long-range space policy directives call for the following space programs:

1990s

- Major supporter of ESA programs (including)
 - Ariane 5 heavy-lift launch vehicle
 - Columbus Space Station Module
- Transfer telecommunications role to industry
- New generation of meteorological satellite
- Enhance SPOT satellites
- Participate in Russian Mars '94 mission
- Continue missions on Russian Mir space station

2000 and Beyond

- Continue strong involvement in ESA
- Build on established domestic programs

Overall Goals of French Space Activities

- Lead European space program endeavors
- Enhance national security
- Enhance launch and satellite manufacturing capabilities
- Derive scientific, economic, and social benefits

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- Competition with US commercial launch services (Ariane) and remote sensing industries (Spot)

OPPORTUNITIES FOR THE US

- International cooperative opportunities
- Significant satellite manufacturing capability

CURRENT ISSUES

- Expanding cooperative relationship with Russia (launch, satellites, infrastructure, space exploration, technology)
- Expanding military space program now managed through CNES
- Space Station Freedom
 - Schedule and design uncertainties

"BOTTOM LINE"

France is an aggressive space power, building space capabilities through ESA and domestic programs. Possesses the largest space budget in Europe -- comparable to Japan's.

Strengths

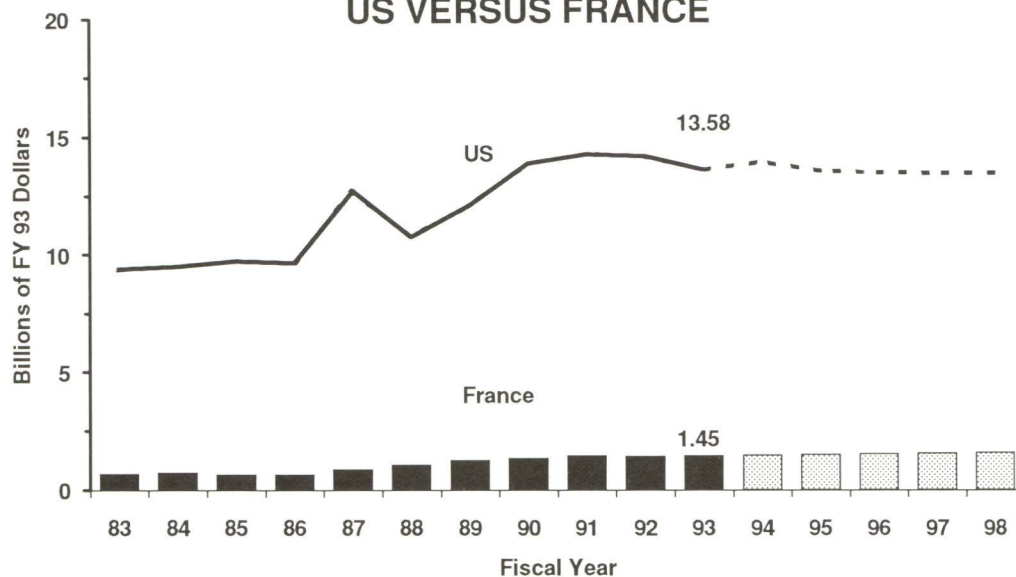
- Comprehensive space program
- Highly developed space industry
- Strong space infrastructure
- Launch vehicle specialization

Weaknesses

- No existing manned space capability
- Reliance on ESA for budget support to major projects

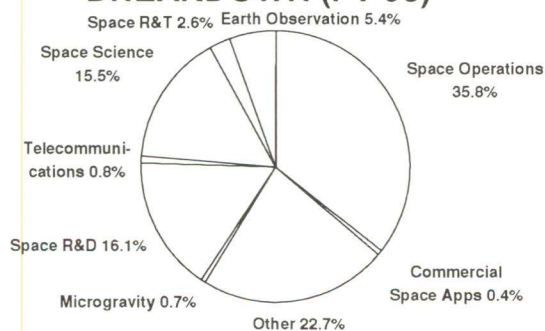
HISTORICAL TREND: Western Europe's major space power and principal impetus behind ESA. Close cooperative relationship with the US and former Soviet space programs.

CIVIL SPACE BUDGETS US VERSUS FRANCE

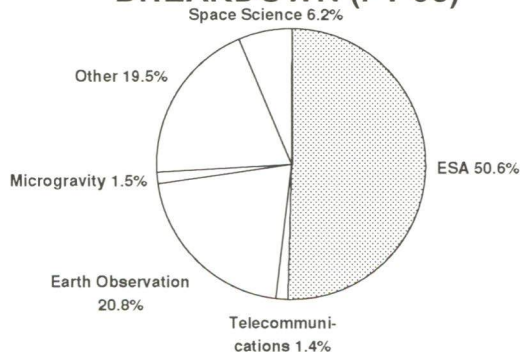


CIVIL SPENDING BREAKDOWNS US VERSUS FRANCE

US APPROXIMATE SPENDING BREAKDOWN (FY 93)



FRANCE APPROXIMATE SPENDING BREAKDOWN (FY 93)



US - FRANCE COOPERATION

ON-GOING

ATLAS/Atmospheric Laboratory for Applications and Science Atlas is a series of US Space Shuttle missions. Atlas-1, a US solar terrestrial physics mission, launched in March 1992 aboard the US Space Shuttle, carried among its instruments the French Solar Spectrum (SOLSPEC) and Atmospheric Hydrogen and Oxygen Measurement (ALAE) devices. Data analysis efforts continue.

Galileo French investigators are participating in the data analysis for this US Jovian mission, which will arrive at Jupiter in 1995.

Mars Observer The US flew a French-built transponder on the US Mars Observer launched in September 1992. The transponder will serve as a communications relay for the Russian Mars '94 balloon mission.

POES E-M/Polar Orbiting Environmental Satellites France provides the Argos Data Collection and Platform Location System for this US weather satellite program.

SLS-1/SpaceLab Life Sciences-1 French investigators are participating in the post-mission analysis of life sciences data gathered by US Space Shuttle crews during the first SLS mission flown in June 1991.

Topex-Poseidon Mission/Ocean Topography Experiment The Topex-Poseidon Earth science mission carries two French and five US instruments. Topex-Poseidon was launched on an Ariane 4 in August 1992.

UARS/Upper Atmosphere Research Satellite French investigators are participating in data analysis for this US mission.

USMP-1/United States Microgravity Payload-1 France provided a materials processing furnace experiment, MEPHISTO, on the USMP series of five US Space Shuttle microgravity missions, beginning with USMP-1 in September 1992.

1993

ISTPP/International Solar Terrestrial Physics Program French investigators will participate in the data analysis of the US Wind satellite investigation of solar terrestrial physics under the Global Geospace Science (GGS) element of the International Solar Terrestrial Physics Program.

SLS-2/SpaceLab Life Sciences-2 French investigators will participate in the post-mission analysis of life sciences data gathered by US Space Shuttle crews during SLS missions.

US - FRANCE COOPERATION

1994

Mars '94 The US is providing a communications relay for the Russian Mars '94 balloon mission using a French-built transponder placed aboard the US Mars Observer spacecraft launched in late 1992.

MFE/Magnolia--Magnetic Field Explorer France will provide the satellite for MFE. Both France and the US will provide magnetometers, and the US will provide the single electric field detector for this joint program.

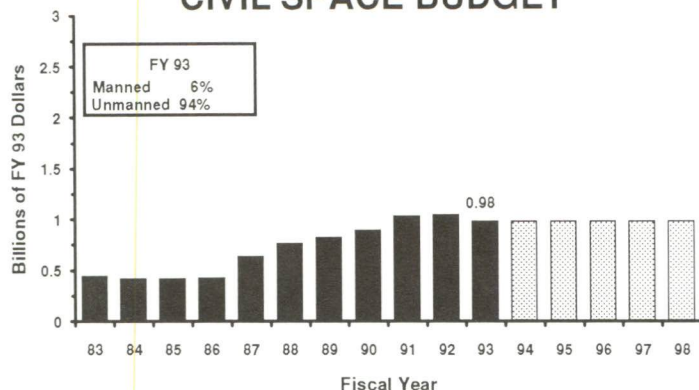
1995 and beyond

SLS-3/SpaceLab Life Sciences-3 French investigators will participate in the post-mission analysis of life sciences data gathered by US Space Shuttle crews during SLS missions. France and the US are jointly developing a Rhesus large primate facility to fly on SLS-3 in 1995.

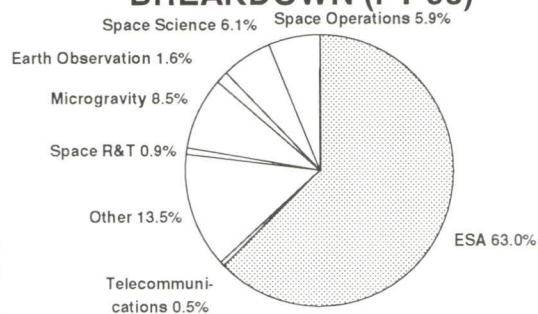
Germany

GERMANY

CIVIL SPACE BUDGET



APPROXIMATE SPENDING BREAKDOWN (FY 93)



LAUNCH VEHICLES

No Domestic
Orbital Launch Vehicles

Major contributor to ESA's Ariane program

INFRASTRUCTURE

German Space Operations Center
Satellite & manned mission control facility

Crew Training Center
German astronaut training

ESA European Space Operations Center
Satellite tracking control center

Institute for Space Simulation
Prepares users, crew, and equipment for Spacelab

Institute for Chemical Propulsion & Chemical Engineering
Operates test facilities for rocket motors

ORGANIZATION

Federal Cabinet Committee on Space

Oversees space policy guidelines and funding

Bundesministerium fuer Forschung und Technologie (BMFT)

The Ministry for Research and Technology provides overall policy authority and most of the funding for the German space program

Deutsche Agentur fuer Raumfahrtangelegenheiten (DARA)

German Space Agency. Coordinates overall national space projects and activities

Deutsches Forschungsanstalt fuer Luft und Raumfahrt (DLR)

German aerospace research establishment that conducts space research for BMFT, DARA, and others

SIGNIFICANT INTERNATIONAL COOPERATIVE PROJECTS

	ESA	France	Italy	Japan	Russia	Sweden	UK	US
Human Spaceflight	X	X		X				X
SSF	X							
Earth Observation	X	X	X	X		X	X	
Space Science	X	X		X	X	X		X
Space Operations	X	X		X				
Data Exchange	X	X	X	X	X	X		X

GERMAN LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs:

1990s

- Major supporter of ESA programs
- Integrate former East German space activities
- Telecommunications network (DFS and TVSat)
- Develop commercial microgravity capability
- Continue astronaut flights on Russian Mir space station
- Continue Spacelab flights on US Space Shuttle
- Participate in Russian Mars '94 mission

2000 and Beyond

- Continue ESA participation
- Saenger reusable shuttle
- Continue Spacelab flights

Overall Goals of German Space Activities

- Derive practical benefits from space activities
- Create a unified space industry
- Conduct basic research

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- Potential loss of German business as they pursue an independent path

OPPORTUNITIES FOR THE US

- International cooperative opportunities
- Scientific data exchanges

CURRENT ISSUES

- Space Station Freedom schedule and design uncertainties
- Participation in ESA manned spaceflight programs (e.g., Hermes)
- Expanding relationships with Japan and Russia on space cooperation and commercial activities

"BOTTOM LINE"

Germany is a key player in ESA that is undergoing a reevaluation of space budget priorities due to the burdens of reunification.

Strengths

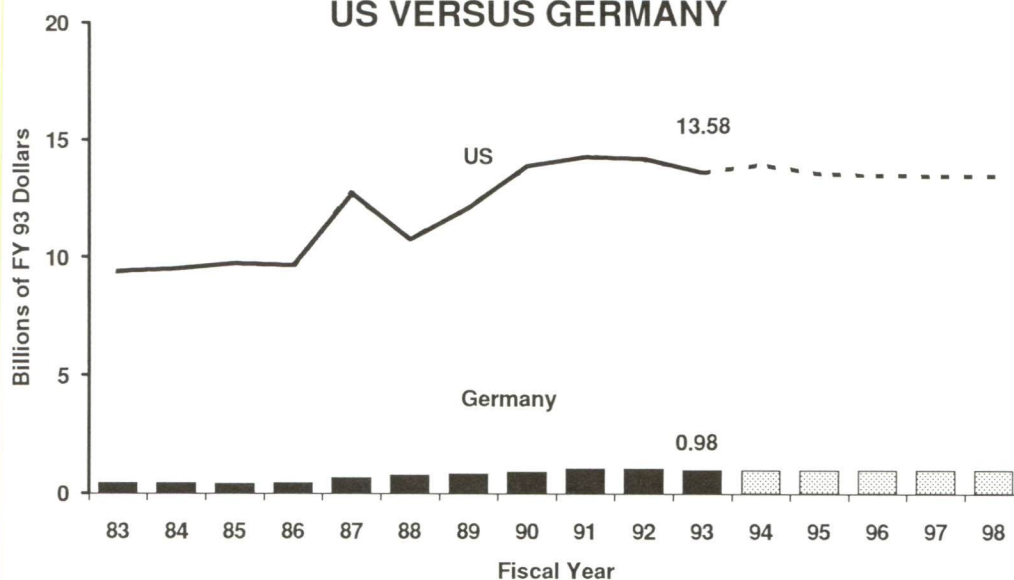
- Strong technological and industrial base
- Potential large payoff for investment in ESA

Weaknesses

- Budget and administrative adjustments to reunification

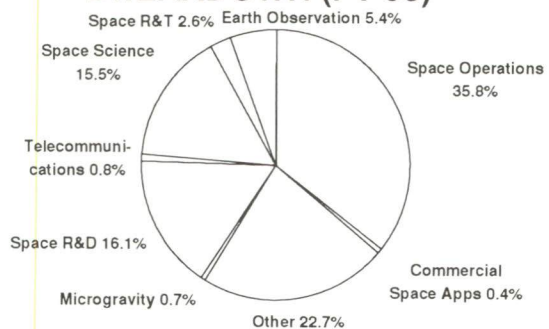
HISTORICAL TREND: Heavy reliance on ESA. Strong technology and industrial base. Germany is Europe's second major space power, behind France. Maintaining investments in long-term space development efforts.

CIVIL SPACE BUDGETS US VERSUS GERMANY

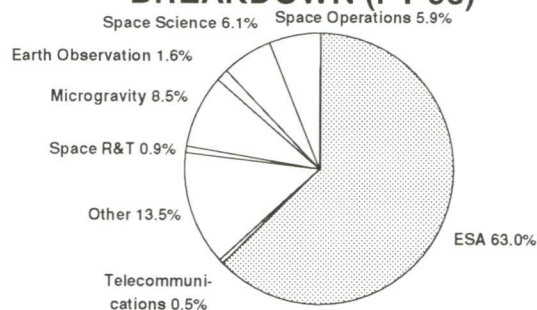


CIVIL SPENDING BREAKDOWNS US VERSUS GERMANY

US APPROXIMATE SPENDING BREAKDOWN (FY 93)



GERMANY APPROXIMATE SPENDING BREAKDOWN (FY 93)



US - GERMANY COOPERATION

ON-GOING

Aeronautical Research Agreements have been concluded for data exchange, joint testing, and joint publication of research in the areas of computational fluid dynamics, automated air traffic control, dynamics and control of large space systems, and crack propagation under variable amplitude loading.

Atlas/Atmospheric Laboratory for Applications and Science Atlas is a series of US Space Shuttle missions. Atlas-1, a US mission for solar and atmospheric monitoring launched in March of 1992 aboard the US Space Shuttle carried among its instruments a German Microwave Atmospheric Sounder (MAS). Data analysis efforts continue.

CRRES/Combined Release and Radiation Effects Satellite Germany contributed an instrument for the investigation of auroras to this US satellite launched in March 1992. Data analysis efforts continue.

Galileo Germany provided the orbiter's retropropulsion module for insertion of the US spacecraft into Jovian orbit, and the bipropellant engines for mission maneuvers. Galileo, which will arrive at Jupiter in 1995, also carries two German-sponsored experiments and five others in which Germany is participating to study Jupiter's atmosphere, magnetosphere, and moons.

GRO/Gamma Ray Observatory Germany provided the COMPTEL (Imaging Compton Telescope) instrument for gamma ray observations and contributed greatly to the EGRET (Energetic Gamma Ray Experiment) instrument on this US mission currently operating in Earth orbit.

IML-1/International Microgravity Laboratory-1 Several German experiments flew on the US IML-1 SpaceLab mission in January 1992. Data analysis efforts continue.

Rosat/Roentgen Satellite Germany provided the spacecraft and telescope for this joint US/UK/Germany X-ray survey mission, which is currently operating in Earth orbit. NASA launched the spacecraft and provided the High Resolution Imager. Data analysis efforts continue.

SMEX/Small-Class Explorers Germany contributed a Heavy Ion Large Telescope (HILT) to the Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX) flown in July of 1992. Data analysis efforts continue.

1993

Astro-SPAS The Astro-SPAS reusable satellite, developed by Germany, will carry joint US-German scientific instruments for investigations in astrophysics and Earth sciences, including the Orbiting and Retrievable Far and Extreme Ultraviolet Spectrometer (ORFEUS) and Cryogenic Infrared Spectrometers and Telescopes for the Atmosphere (CRISTA). Astro-SPAS will be launched and retrieved by the US Space Shuttle. Four additional flights are planned.

US - GERMANY COOPERATION

1993 (Continued)

SL-D2/Spacelab Life and Materials Science Flight-D2 This was the second German Spacelab mission. It flew on the US Space Shuttle in April 1993. The mission was partially reimbursable and carried two German payload specialists.

1994

IML-2/International Microgravity Laboratory-2 Germany will participate in the IML-2 mission.

SRL/Space Radar Laboratory Germany (with Italy) is contributing an X-Band Synthetic Aperture Radar to this US Space Shuttle mission for Earth systems science. Mission 1 is planned for 1994, with two missions to follow at 18-month intervals.

1995 and beyond

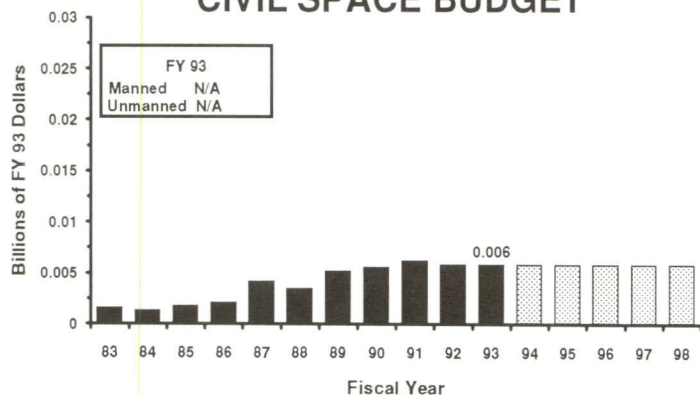
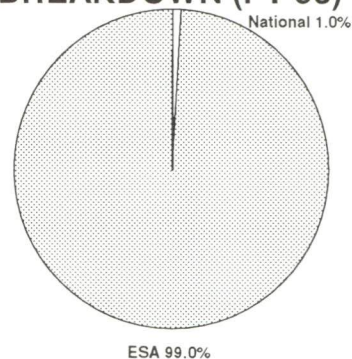
OSL/Orbiting Solar Laboratory OSL, a US mission to study the composition and dynamics of the solar atmosphere, will carry a German Solar Spectrograph. The launch date for this mission is still under review.

SMEX/Small-Class Explorers Germany is contributing an Acoustic-Optical Spectrometer (AOS) to the US Submillimeter Wave Astronomy Satellite (SWAS) scheduled for launch in 1995.

Ireland

IRELAND

CIVIL SPACE BUDGET

APPROXIMATE SPENDING
BREAKDOWN (FY 93)

LAUNCH VEHICLES

**No Domestic
Orbital Launch Vehicles**

INFRASTRUCTURE

National Microelectronics Research Center

National facility for electronics/semiconductor R&D

Microelectronics Technology Support Laboratory

ESA facility for electronics/semiconductor R&D

ORGANIZATION

Department of Industry and Energy

Manages Ireland's national space activities

Irish Science and Technology Agency (EOLAS)

Manages the development of Ireland's science and technology infrastructure

Ministry of Posts and Telegraphs

National signatory to Intelsat and Inmarsat

SIGNIFICANT INTERNATIONAL
COOPERATIVE PROJECTS

	ESA	Russia	US
Human Spaceflight	X		
SSF	X		
Earth Observation	X		X
Space Science	X	X	X
Space Operations	X		
Data Exchange	X	X	X

IRISH LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs:

1990s

- Participate in ESA programs including
 - Scientific instrument manufacture and data exchanges
 - Ariane 5 program
- Establish national satellite communications system (servicing Ireland and UK)

2000 and Beyond

- Continue ESA participation

Overall Goals of Irish Space Activities

- Derive practical benefits from space activities

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- None identified

OPPORTUNITIES FOR THE US

- None identified

CURRENT ISSUES

- None identified

"BOTTOM LINE"

Ireland has relatively low-level space efforts. Contribution to ESA is growing.

Strengths

- Production of specialized flight instrumentation and support equipment
- Microelectronics and semiconductor R&D

Weaknesses

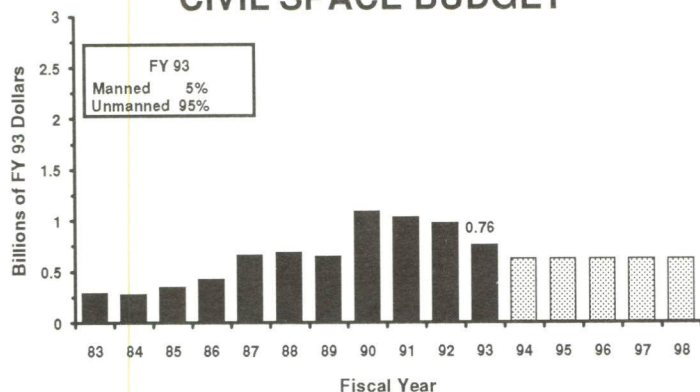
- Low budget

HISTORICAL TREND: Ireland has participated in US, former Soviet, and ESA space activities including contributing instruments to the Giotto, Vega, Phobos, Wind, SOHO, Cluster, and Mars '94 space missions. The nation has used contacts with larger space programs to enhance national expertise in space science and technology development efforts.

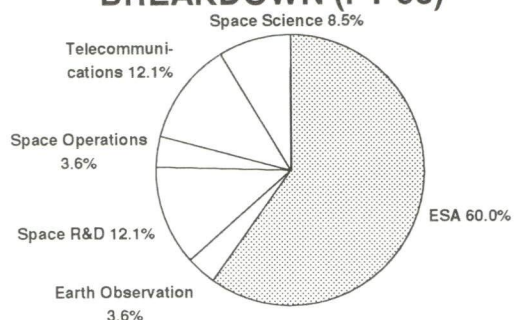
Italy

ITALY

CIVIL SPACE BUDGET



APPROXIMATE SPENDING BREAKDOWN (FY 93)



LAUNCH VEHICLES

No Domestic
Orbital Launch Vehicles

Major contributor to ESA's Ariane program

INFRASTRUCTURE

San Marco launch platform (Kenyan Coast, Africa)

Launch site for Scout and Scout II launch vehicles

Telespazio Telecommunications Center

Operates Italian and ESA communication satellites

Receives, processes, and distributes Landsat and Spot imagery

ORGANIZATION

Ministry for Scientific and Technological Research (MRST)

Coordinates Italian space activities

Agenzia Spaziale Italiana (ASI)

Italian Space Agency. Manages all Italian space activities including ESA involvement, bilateral cooperation, and national satellite programs

Aerospace Research Center, University of Rome

Operates San Marco launch site

SIGNIFICANT INTERNATIONAL COOPERATIVE PROJECTS

	Argentina	China	ESA	France	Germany	Netherlands	Russia	UK	US
Human Spaceflight			X						X
SSF			X						
Earth Observation	X		X	X	X	X			
Space Science		X	X			X	X	X	X
Space Operations			X	X					X
Data Exchange	X	X	X	X	X	X		X	X

ITALIAN LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs:

1990s

- Participate in ESA programs
- Participate in US and European satellite projects
- Continue development of Scout II launch vehicle
- Develop market for microgravity experiments
- Industry participation in Russian Mars exploration
- Explore development of environmental satellite

2000 and Beyond

- Continue ESA participation

Overall Goals of Italian Space Activities

- Maintain and expand role as major player in European space activities
- Continue basic space research
- Develop commercial space capabilities

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- Could become competitor in some commercial areas
- Cooperative efforts sometimes affected by change of coalition governments

OPPORTUNITIES FOR THE US

- International cooperative opportunities
- Benefit from scientific and technical data exchanges

CURRENT ISSUES

- Space Station Freedom
 - Schedule and design uncertainties
- Controversy between Italian space program participants over funding and program control
- Uncertain future of US Scout-based launch vehicle
- Greater Italian representation within ESA leadership (proportional to funding)

"BOTTOM LINE"

Italy is a contributor to numerous European space activities without being prime for any of them. It has minimal government organizational structure; the load is carried primarily by industry.

Strengths

- Solid propellant booster manufacturer
- Satellite manufacturing
- Microgravity experiments
- Pressurized modules manufacturing
- Developing small launcher capability

Weaknesses

- Lack of coordinated government space authority

HISTORICAL TREND: Italy has expertise in selected areas. Industry has played a major role in Italy's space development efforts.

US - ITALY COOPERATION

ON-GOING

IBEX/FIREX Italy provided a Fourier Transform Spectrometer (FTS) for the US Infrared Balloon Experiment (IBEX) launched in late 1992 and will provide the same instrument for its successor Far Infrared Balloon Experiment (FIREX). A launch date for FIREX has yet to be determined. Data analysis efforts continue.

Lageos II Italy's Lageos laser reflector satellite for Earth geodynamics research was launched from the US Space Shuttle in September 1992. Data analysis efforts continue.

TSS/Tethered Satellite System Flown in 1992, Italy built the TSS satellite and provided scientific investigators; the US was responsible for TSS deployment from the US Space Shuttle and for systems integration and provided scientific investigators of its own. Technical anomalies resulted in the experiment being cut short. NASA is considering re-flying the TSS on another Shuttle mission.

1994

SRL/Space Radar Laboratory Italy (with Germany) will provide an X-Band Synthetic Aperture Radar for this US Space Shuttle mission for Earth system science. Mission 1 is planned for 1994, with two missions to follow at 18-month intervals.

1995 and beyond

Cassini Italy plans to provide Cassini's high gain/low gain antennas and Visual and Infrared Mapping Spectrometers (VIMS), as well as the Cassini radar and radio frequency instrument subsystem. This US mission to investigate the Saturnian system is planned for launch on a Titan launch vehicle in 1997.

ISTPP/International Solar Terrestrial Physics Program Italy plans to provide an Ultraviolet Coronal Spectrometer (UVCS) for the Solar and Heliospheric (SOHO) spacecraft. SOHO is under the Collaborative Solar Terrestrial Research (Costr) element of the International Solar Terrestrial Physics Program. SOHO is to be launched in 1995.

OSL/Orbiting Solar Laboratory For this US mission, Italy plans to provide an Extreme Ultraviolet Imager (XUVI) as an instrument to investigate the solar atmosphere. The launch date for this mission is currently under review.

Space Station Freedom Italy and the US are considering cooperation on an attached Life Sciences Mini-Laboratory (LSML) and have signed an agreement under which Italy will provide two Mini-Pressurized Logistics Modules (MPLMs) as part of Space Station Freedom.

US - ITALY COOPERATION

UNDER CONSIDERATION

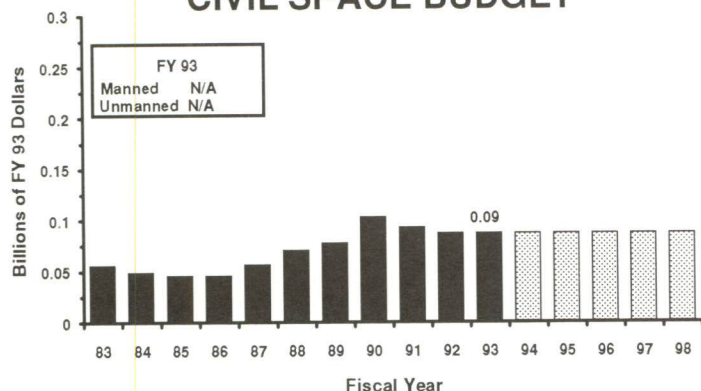
Astromag Studies are underway for the joint development of the Astromag superconducting magnet facility for space physics research.

Lageos III Technical discussions are underway on the feasibility of a third Lageos mission for relativity experiments.

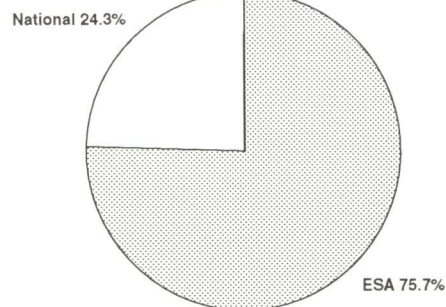
Netherlands

NETHERLANDS

CIVIL SPACE BUDGET



APPROXIMATE SPENDING BREAKDOWN (FY 93)



LAUNCH VEHICLES

No Domestic
Orbital Launch Vehicles

INFRASTRUCTURE

National Aerospace Laboratory (NAL)
Principal center for aerospace R&D

ORGANIZATION

Interdepartmental Committee on Space Research & Technology (ICR)

Advises Ministry for Economic Affairs on national space policy and relations with ESA

Netherlands Agency for Aerospace Programs (NIVR)

Administers Dutch space policy, provides industrial coordination for national space activities

Space Research Organization Netherlands (SRON)

Conducts scientific space research
Comprises three laboratories

SIGNIFICANT INTERNATIONAL COOPERATIVE PROJECTS

	ESA	Italy	UK	US
Human Spaceflight	X			
SSF	X			
Earth Observation	X		X	
Space Science	X	X	X	X
Space Operations	X			
Data Exchange	X		X	X

DUTCH LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs:

1990s

- Participate in ESA programs
 - Scientific, communications, and Earth observation programs
 - Ariane 5 launch vehicle
 - Columbus space module

2000 and Beyond

- Continue ESA participation

Overall Goals of Dutch Space Activities

- Increase level of participation in ESA
- Derive scientific, technological, and commercial benefits from space activities

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- None identified

OPPORTUNITIES FOR THE US

- None identified

CURRENT ISSUES

- None identified

"BOTTOM LINE"

The Netherlands has a small but growing space program, tied mainly to ESA.

Strengths

- Laboratory experience (R&D)
- Instrument-level technical skills

Weaknesses

- None identified

HISTORICAL TREND: The Netherlands has used contacts with other countries' space programs to greatly enhance its national space expertise.

US - NETHERLANDS COOPERATION

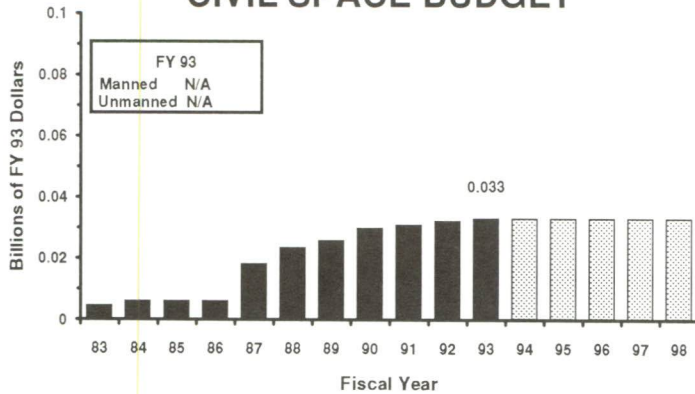
1995 and beyond

AXAF/Advanced X-Ray Astrophysics Facility The Netherlands is providing the Low Energy Transmission Grating Spectrometer for this US astrophysics mission. AXAF is to be launched aboard the US Space Shuttle in 1999.

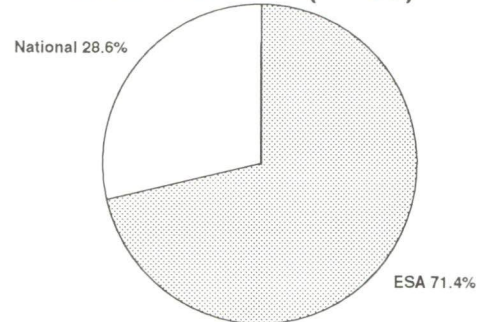
Norway

NORWAY

CIVIL SPACE BUDGET



APPROXIMATE SPENDING BREAKDOWN (FY 93)



LAUNCH VEHICLES

No Domestic
Orbital Launch Vehicles

INFRASTRUCTURE

Andoya Rocket Range

Suborbital sounding rockets since 1962.
Could be upgraded to launch polar orbiting satellites

Tromso Telemetry Station

Reception of NOAA imaging data and ERS-1 radar satellite data. Terminal and control center for Sarsat

ORGANIZATION

Royal Ministry of Industry

Directs space policy. Advised by the Norwegian Space Policy Committee

Norwegian Space Center (NSC)

Coordinates national space activities and manages funds for ESA and bilateral programs

Operates the Andoya rocket range

SIGNIFICANT INTERNATIONAL COOPERATIVE PROJECTS

	ESA	France	Germany	Sweden	US
Human Spaceflight					
SSF	X				
Earth Observation	X	X	X		
Space Science	X				X
Space Operations	X		X		
Data Exchange	X				X

NORWEGIAN LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs:

1990s

- Continue ESA participation
- Upgrade Andoya rocket range to handle microsatellite launches
- Continue as a major contributor/member of Inmarsat -- maritime satellite communications

2000 and Beyond

- Continue ESA participation

Overall Goals of Norwegian Space Activities

- Derive practical benefits from space activities

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- None identified

OPPORTUNITIES FOR THE US

- None identified

CURRENT ISSUES

- Potential for the selection of a US supplier of small launch vehicles for Andoya Rocket Range

"BOTTOM LINE"

Norway has a growing space program heavily dependent upon ESA.

Strengths

- Active suborbital launch range since 1982 (over 400 launches)
- Second largest member of Inmarsat

Weaknesses

- Low budget

HISTORICAL TREND: Active interest in space. Capitalizing on association with ESA.

US - NORWAY COOPERATION

ON-GOING

Geodynamics NASA and the Norwegian Mapping Authority are collaborating in making joint global geodynamic observations using space geodetic techniques such as very long base interferometry, satellite laser ranging, and global positioning.

IML-1/International Microgravity Laboratory-1 NASA and the Norwegian Space Center are cooperating in investigating the gravitropic response of plants in the absence of gravity forces. The first launch of IML was in January 1992 aboard the US Space Shuttle. Data analysis efforts continue.

Sounding Rockets NASA and Norway cooperate in launching sounding rockets. Specifically, NASA is providing rocket motors and flight hardware, on a cooperative and reimbursable basis, for sounding rocket flights sponsored by the Norwegian Space Center.

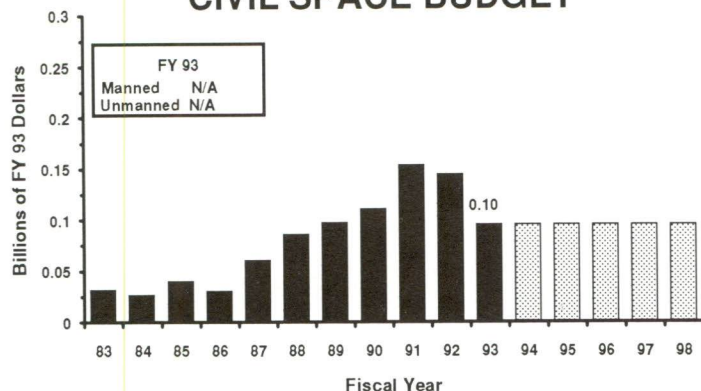
1994

ISTPP/International Solar Terrestrial Physics Program Norway is supplying investigators for two experiments under the POLAR mission of the Global Geospace Science (GGS) element of the International Solar Terrestrial Physics Program. The two experiments are the "Charge and Mass Magnetospheric Ion Composition Experiment (CMMICE)" and the "Polar Ionospheric X-ray Imaging Experiment (PIXIE)."

Spain

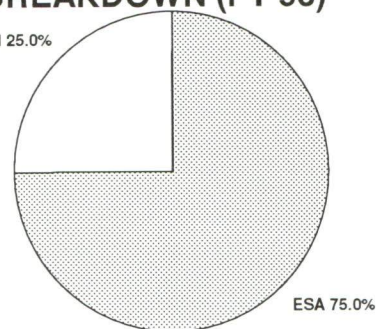
SPAIN

CIVIL SPACE BUDGET



APPROXIMATE SPENDING BREAKDOWN (FY 93)

National 25.0%



LAUNCH VEHICLES

No Domestic
Orbital Launch Vehicles

INFRASTRUCTURE

Tracking System

ESA and NASA tracking stations at Villa Franca, Madrid, and Maspalomas

Deep Space Network

Three antennas are part of NASA's Deep Space network for control of planetary missions.

ORGANIZATION

Center for the Development of Industrial Technology (CDTI)

Part of the Ministry of Industry. National space planning and coordination

National Technical Aerospace Institute (INTA)

Related to the Ministry of Defense. Manages ESA and NASA ground stations. Responsible for Spain's first satellite and launch vehicle

SIGNIFICANT INTERNATIONAL COOPERATIVE PROJECTS

	ESA	France	US
Human Spaceflight	X		
SSF	X		
Earth Observation		X	
Space Science	X		X
Space Operations	X		X
Data Exchange	X	X	X

SPANISH LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs :

1990s

- Participate in ESA programs
- Continue operating domestic communications satellite system (Ibersat/Hispasat)
- Develop small R&D satellite (mini-sat) and support launcher (Capricornio)

2000 and Beyond

- Continue ESA participation

Overall Goals of Spanish Space Activities

- Commit to future European programs
- Derive practical benefits from space activities

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- Potential military exploitation of space launch and science technology

OPPORTUNITIES FOR THE US

- International cooperative opportunities

CURRENT ISSUES

- None Identified

"BOTTOM LINE"

Spain has a small but expanding space program mainly tied to ESA programs.

Strengths

- Space science

Weaknesses

- None identified

HISTORICAL TREND: Support player to both ESA and US. Increasing interest in space project participation.

US - SPAIN COOPERATION

ON-GOING

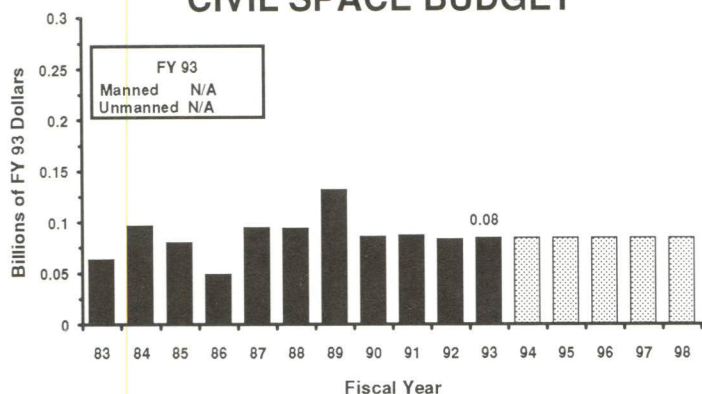
Facilities Spain maintains three emergency landing sites for the US Space Shuttle and one of the three large tracking stations in the NASA Deep Space Network.

Science and Technology NASA and Spain have an agreement on cooperation in scientific research and technological development programs in areas such as remote sensing, astrophysics, microgravity, solar system sciences, and fluid mechanics.

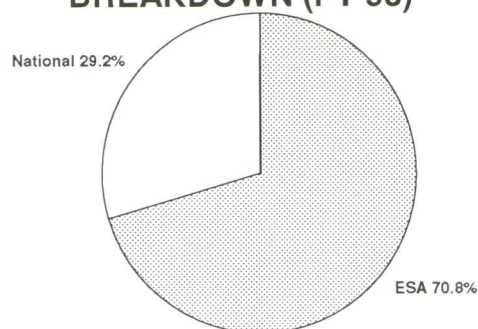
Sweden

SWEDEN

CIVIL SPACE BUDGET



APPROXIMATE SPENDING BREAKDOWN (FY 93)



LAUNCH VEHICLES

No Domestic
Orbital Launch Vehicles

INFRASTRUCTURE

Esrange

Launch site for sounding rockets
Landsat, SPOT, ERS-1 receiving station

ORGANIZATION

Swedish Board for Space Activities (SBSA)

Supervisory organization, created under the Ministry of Industry. Responsible for all national and international space programs

Swedish Space Corporation (SSC)

State-owned limited corporation that manages space projects

Swedish Institute of Space Physics

Responsible for national space-related scientific research

SIGNIFICANT INTERNATIONAL COOPERATIVE PROJECTS

	China	ESA	France	Germany	Japan	Russia	US
Human Spaceflight							
SSF							
Earth Observation		X					X
Space Science	X	X		X	X	X	
Space Operations		X					
Data Exchange	X	X		X		X	

SWEDISH LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs:

1990s

- Participate in ESA programs
- Tele-X (telecommunications project)
- Freja (science project)
- MAXUS (microgravity program)
- Contribute sensors to 1996 Japanese Planet B Mars mission

2000 and Beyond

- Continue ESA participation

Overall Goals of Swedish Space Activities

- Develop internationally competitive telecommunications industry
- Derive practical benefits from space activities

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- None identified

OPPORTUNITIES FOR THE US

- None identified

CURRENT ISSUES

- None identified

"BOTTOM LINE"

Sweden is heavily dependent on ESA with primary interests in remote sensing and telecommunications.

Strengths

- Small but growing telecommunications capability

Weaknesses

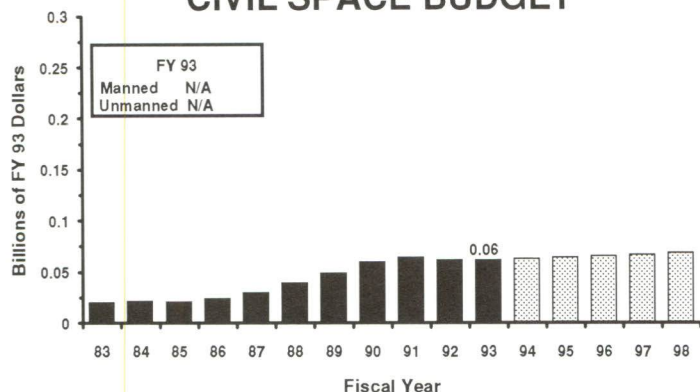
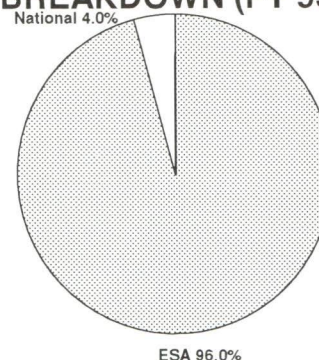
- None identified

HISTORICAL TRENDS: Developing practical applications and spin-offs. Looking for an economic "payoff" from space research.

Switzerland

SWITZERLAND

CIVIL SPACE BUDGET

APPROXIMATE SPENDING
BREAKDOWN (FY 93)

LAUNCH VEHICLES

No Domestic
Orbital Launch Vehicles

INFRASTRUCTURE

None Identified

ORGANIZATION

Federal Consultative Commission for Space Affairs

Determines national space policy, directs activities

Space Research Academy of Science Council

Scientific management

Swiss Meteorological Institute

Meteorological satellite research

SIGNIFICANT INTERNATIONAL
COOPERATIVE PROJECTS

	ESA	US
Human Spaceflight		X
SSF		
Earth Observation		
Space Science	X	X
Space Operations	X	
Data Exchange	X	X
Telecomm	X	

SWISS LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs:

1990s

- Participate in ESA programs
 - Solar physics studies (Ulysses/Hipparcos)

2000 and Beyond

- Continue 1990s efforts

Overall Goals of Swiss Space Activities

- Derive practical benefits from space activities
- Enhance space science expertise

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- None identified

OPPORTUNITIES FOR THE US

- None identified

CURRENT ISSUES

- None identified

"BOTTOM LINE"

Switzerland is heavily dependent on ESA space development projects. Focus is primarily on space science.

Strengths

- Scientific expertise in space science and meteorology

Weaknesses

- None identified

HISTORICAL TREND: Heavy reliance on ESA for leverage in pursuing space interests.

US - SWITZERLAND COOPERATION

ON-GOING

US Space Shuttle Flight STS-46 Switzerland, under the auspices of ESA, provided a mission specialist for the IML-1 US Space Shuttle flight launched in July 1992. Data analysis efforts continue.

1994

ISTPP/International Solar Terrestrial Physics Program Switzerland is supplying two investigators for the Toroidal Mass Spectrograph (TIMAS) investigation and four investigators for the Solar Wind and Suprathermal Ion Composition Studies under the POLAR mission of the Global Geospace Science (GGS) element of the International Solar Terrestrial Physics Program.

1995 and beyond

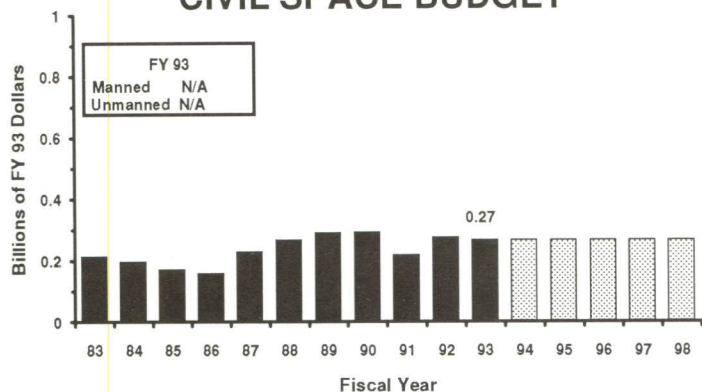
ISTPP/International Solar Terrestrial Physics Program Switzerland is providing two investigators for the Ultraviolet Coronagraph Spectrometer (UVCS) instrument to the Solar and Heliospheric Observatory Mission (SOHO) which is part of the Collaborative Solar Terrestrial Research Program (Costr) element of the ISTPP. SOHO will fly aboard an Atlas II launch vehicle in 1995.

Geodynamics NASA and the Swiss Federal Office for Education and Science, through the University of Bern, will be applying the techniques of satellite laser ranging, very-long baseline interferometry, and global positioning systems to make precise geodetic measurements in support of fundamental studies in geodynamics and tectonics.

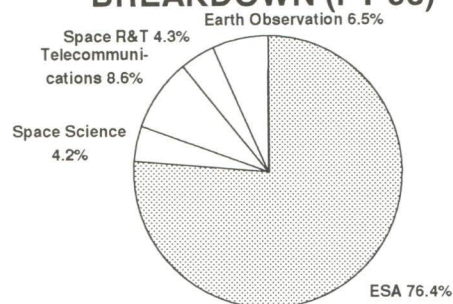
United Kingdom

UNITED KINGDOM

CIVIL SPACE BUDGET



APPROXIMATE SPENDING BREAKDOWN (FY 93)



LAUNCH VEHICLES

**No Domestic
Orbital Launch Vehicles**

INFRASTRUCTURE

Royal Aerospace Establishment (RAE)

R&D for civil and military spacecraft, remote sensing technology, mission analysis, and orbital dynamics

National Remote Sensing Center (NRSC)

RAE facility for remote sensing data and imagery

Rutherford Appelton Laboratories (RAL)

UK space science projects

ORGANIZATION

Interdepartmental Official Committee on Space Policy

Coordinates national space policy and activities

British National Space Center (BNSC)

Coordinates execution of UK civil space interests

Science & Engineering Research Council (SERC)

Funds major portion of UK civil space systems

SIGNIFICANT INTERNATIONAL COOPERATIVE PROJECTS

	China	ESA	France	Germany	Italy	Netherlands	Russia	US
Human Spaceflight		X					X	
SSF		X						
Earth Observation		X	X	X		X		X
Space Science	X	X	X		X	X	X	X
Space Operations		X						
Data Exchange		X			X	X	X	X

UK LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs:

1990s

- Participate in ESA programs
- Participate in the Advanced Relay and Technology Mission Satellite team
 - Space laser communications
 - Ion propulsion
 - Nickel-hydrogen cells

2000 and Beyond

- Continue ESA participation
- Explore concepts for Horizontal Take-Off and Landing (HOTOL) spaceplane

Overall Goals of United Kingdom Space Activities

- Focus on Earth observation and space science
- Continue efforts in telecommunications (ESA, international civilian market, domestic military applications)

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- None identified

OPPORTUNITIES FOR THE US

- International cooperative opportunities

CURRENT ISSUES

- Decreasing level of UK participation in ESA
- Russian cooperation on HOTOL concept

"BOTTOM LINE"

Both the UK's national space program and its space industry concentrate on telecommunications satellites and remote sensing instruments.

Strengths

- Telecommunications applications expertise

Weaknesses

- Uncertain funding

HISTORICAL TREND: Pattern of missed opportunities. No space agency until 1985. Primary programs: telecommunications, Earth observation, and space science.

US - UK COOPERATION

ON-GOING

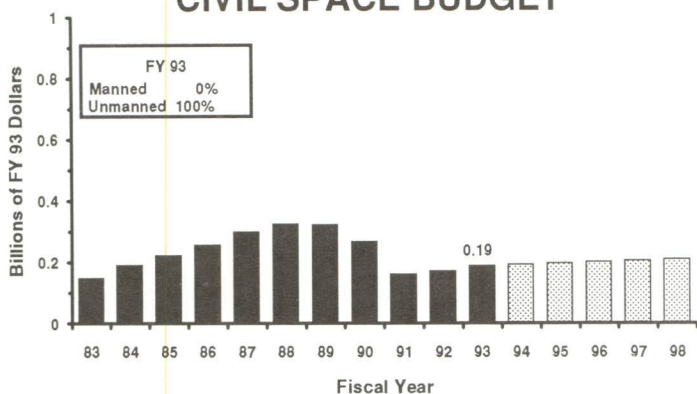
Rosat/Roentgen Satellite The UK provided the wide-field camera for this US/German/UK X-ray astronomy mission. Data analysis efforts continue.

UARS/Upper Atmosphere Research Satellite The UK provided the Improved Stratospheric and Mesospheric Sounder (ISAMS) for the US UARS project launched in September 1991.

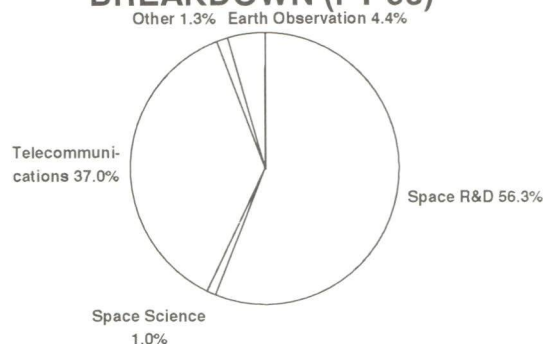
India

INDIA

CIVIL SPACE BUDGET



APPROXIMATE SPENDING BREAKDOWN (FY 93)



LAUNCH VEHICLES

	ASLV	PSLV (1993)	GSLV (1996)
	Performance Capability (lb)		
LEO	330	6,614	32,700
Polar	N/A	N/A	10,900
GEO	-	992	4,360

INFRASTRUCTURE

Shar Center

National launch range and solid rocket motor production and test facilities

Vikram Sarabhai Space Center

Lead center for launcher and motor development. Primary test vehicle launch site

ISRO Telemetry, Tracking, and Command Network

TT&C support for launch and satellite operations

Space Applications Center

R&D for communications and remote sensing applications

ISRO Satellite Center

Science, technology, and applications satellites designed, fabricated, and tested

Liquid Propulsion System Center

Liquid engine development activities

Solid Propellant Space Booster Plant

Solid rocket motor development and production

ORGANIZATION

Space Commission

National space policy, goals, objectives, and direction

Department of Space

National space policy implementation. Coordinates all research and development activities

Indian Space Research Organization (ISRO)

Space applications and operations. Responsible for developing applications satellites, launch vehicles, and ground systems

SIGNIFICANT INTERNATIONAL COOPERATIVE PROJECTS

	Brazil	Canada	China	ESA	France	Germany	Japan	Netherlands	Russia	Sweden	Syria	US
Human Spaceflight							X	X				
Earth Observation	X	X	X	X	X	X		X	X	X	X	X
Space Science				X	X		X	X	X			X
Space Operations	X				X			X				X
Data Exchange	X	X	X	X	X	X	X	X	X			X

INDIAN LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs:

1990s

- Develop Polar Satellite Launch Vehicle (PSLV) and Geostationary Satellite Launch Vehicle (GSLV)
 - Upgrade with cryogenic technology
- Research air-breathing rocket technology
- Continue upgrading indigenous satellites
 - INSAT-II (communications and weather)
 - IRS (remote sensing)
 - GRAMSAT (broadcasting)
- Establish commercial space company to sell services and hardware

2000 and Beyond

- Continue 1990s programs
- Examine potential for human spaceflight and robotic solar system exploration

Overall Goals of Indian Space Activities

- Attain autonomous satellite and launcher production capability
- Enhance national security
- Derive scientific, economic, and social benefits

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- Transfer of dual-use technologies:
 - Potential for military use of civilian technologies
 - Export of Indian space hardware to other Third World countries

OPPORTUNITIES FOR THE US

- Potential for cooperative S&T efforts
- India's continuing need for space industry support (see Current Issues below)
 - Applied technologies
 - Satellite design and production
 - Payload space on US launch vehicles
- Access to Earth science data for Mission to Planet Earth

CURRENT ISSUES

- US Government 2-year ban on the sale of technology/supplies that would be used in support of the Indian space program (reaction to the sale of cryogenic technology by Russia to ISRO)
- Relationship between space launch program and ballistic missile development
- Evolving Asian-Pacific regional space cooperation

"BOTTOM LINE"

India has a relatively robust space program. It has one of the world's largest science and technology communities and is well on its way toward developing an autonomous space launch/applications infrastructure for LEO, GEO, and limited planetary missions.

Strengths

- Extensive network of space-related support facilities
- Experience in launch vehicle and satellite development

Weaknesses

- Lacking some subsystem and sensor/payload design experience (improving)

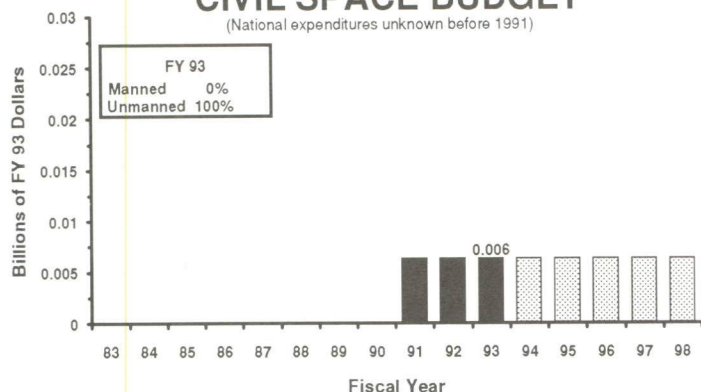
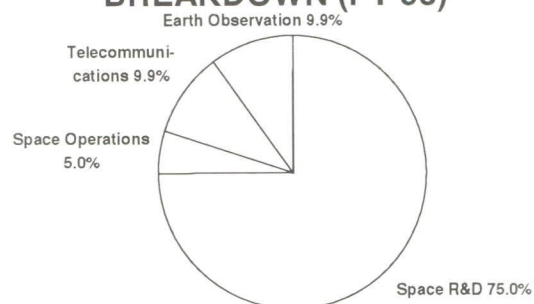
HISTORICAL TREND: India has developed launch and satellite capabilities through its ties with the US, Russia, and ESA. Slowly adding to capability in all areas of space development.

Israel

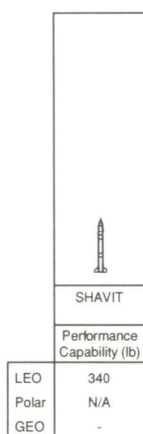
ISRAEL

CIVIL SPACE BUDGET

(National expenditures unknown before 1991)

APPROXIMATE SPENDING
BREAKDOWN (FY 93)

LAUNCH VEHICLES



INFRASTRUCTURE

Palmachim Air Force Base

Launch facilities for Shavit launch vehicle

ORGANIZATION

Israel Space Agency (ISA)

Directs national space research and R&D activities

National Committee for Space Research (NCSR)

Advises government, ISA, and universities on space-related research projects

SIGNIFICANT INTERNATIONAL
COOPERATIVE PROJECTS

	China	France	Germany	Russia	South Africa	US
Human Spaceflight			X			
Earth Observation		X				
Space Science			X			X
Space Operations	X	X	X		X	
Data Exchange					X	X

ISRAELI LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs:

1990s

- AMOS Communications Satellite Project
- Upgrade Shavit launcher and market commercially
- Develop Earth observation platforms
- Construct/launch scientific satellites
- Continue Ofeq satellite R&D program

2000 and Beyond

- Continue support of 1990s programs

Overall Goals of Israeli Space Activities

- Strengthen national security
- Obtain scientific, technological, and economic benefits

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- Israeli ballistic missile capability

OPPORTUNITIES FOR THE US

- Science and Earth observation partnership
- Potential US launch customer

CURRENT ISSUES

- Missile technology proliferation
- Developing cooperative ties between Israel and Russia
 - Signed umbrella cooperation agreement
 - Launch AMOS spacecraft
 - Israeli Tauvex UV telescope to fly on Russian Roentgen-Gamma spacecraft
 - Israeli cosmonaut aboard Mir (potential)

"BOTTOM LINE"

Israel is an emerging space nation. It has established launcher, satellite, and TT&C capabilities with minimal outside assistance.

Strengths

- Solid propellant launcher technology
- Advanced aerospace industry
- Simple avionics subsystem technology for domestic satellites

Weaknesses

- Limited experience/infrastructure
- Low budget

HISTORICAL TREND: Israel has launched two orbital demonstration satellites since 1988 (Ofeq-1, -2). The nation has applied its knowledge of military systems to develop an expanding autonomous satellite and launch vehicle capability.

US - ISRAEL COOPERATION

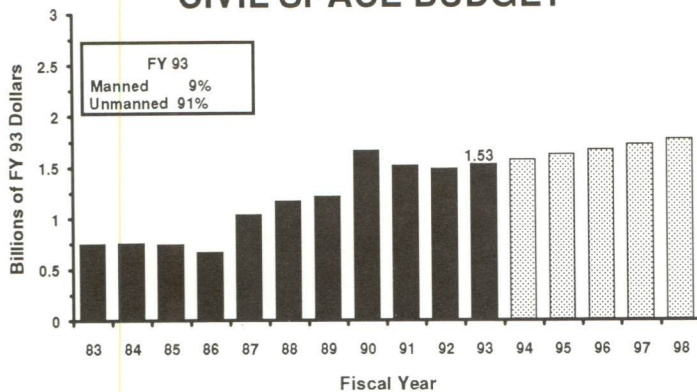
ON-GOING

Geodynamics The Israeli Space Agency operates the Bar Giora Satellite Laser Ranging (SLR) station for NASA. This station provides a reference point for both SLR and Global Positioning System (GPS) measurements of motion in the study of global and regional plate tectonics.

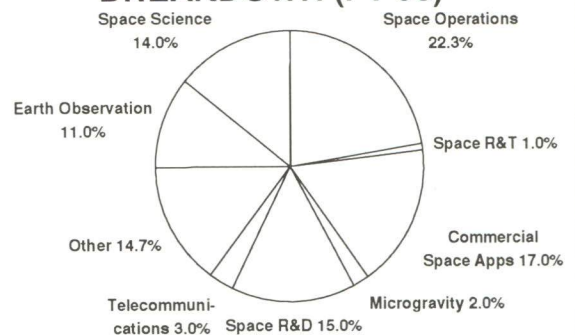
Isaiah Life Sciences Experiment An Israeli scientist developed and continues to serve as principal investigator on the Isaiah life sciences experiment, which flew on the US Space Shuttle in September 1992 (flight STS-47). Isaiah was a gravity perception experiment and investigated the reaction of hornets to the Shuttle's microgravity environment. Data analysis efforts continue.

Japan

CIVIL SPACE BUDGET



APPROXIMATE SPENDING BREAKDOWN (FY 93)



LAUNCH VEHICLES

	M-3SII	M-V (1995)	J-I (TBD)	H-II (1994)
	Performance Capability (lb)			
LEO	1,700	3,600	TBD	19,800
Polar	N/A	N/A	TBD	N/A
GEO	440	1,000	TBD	4,840

INFRASTRUCTURE

Tanegashima Space Center

Launch facility for H and J class rockets

Kagoshima Space Center

Launch facility for M class scientific rockets

USUDA Deep Space Center

Deep space tracking center for planetary missions

Tsukuba Space Center

Main tracking, telemetry, and control center

Earth Observation Center

Meteorological and remote sensing data reception

ORGANIZATION

Space Activities Commission (SAC)

Plans, deliberates, and decides on matters of space policy. Chaired by the Minister of State for Science and Technology

Science and Technology Agency (STA)

Responsible for overall coordination of space activities among government agencies in its function as secretariat for SAC

Ministry of International Trade and Industry (MITI)

Promotes industrial utilization of space

National Space Development Agency (NASDA)

Space applications and operations. Responsible for development of applications satellites, launch vehicles, and ground systems

Institute of Space and Astronautical Science (ISAS)

Under the Ministry of Education. Responsible for space science programs and research

National Aerospace Laboratory (NAL)

Aerospace technology research and development

SIGNIFICANT INTERNATIONAL COOPERATIVE PROJECTS

	Canada	China	ESA	France	Germany	Russia	Sweden	US
Human Spaceflight					X			X
SSF	X		X					X
Earth Observation	X	X	X	X	X			X
Space Science	X	X	X	X	X	X	X	X
Space Operations				X				X
Data Exchange	X	X	X	X	X	X		X

JAPANESE LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs :

1990s

- H-II launch vehicle
 - Operate and market commercially
 - Explore liquid-air cycle strap-on booster
- Robotic lunar and interplanetary missions
- Missions on US Spacelab
- Space Station Freedom (JEM)
- HOPE automated mini Space Shuttle
- Mission to Planet Earth (ADEOS spacecraft)

2000 and Beyond

- Crewed orbital space station
- Piloted space transportation system
- Robotic interplanetary missions
- Human lunar activity

Overall Goals of Japanese Space Activities

- Derive practical benefits from space activities
- Promote international cooperative activities
- Promote space development in the private sector
- Develop indigenous capabilities including human spaceflight

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- Growing commercial competition with US aerospace industry
 - Satellite technology/systems
 - Launch vehicle technology/systems
 - Ground support equipment/systems
 - High quality components and sensors
- Potential loss of Japanese business as they pursue an independent path

OPPORTUNITIES FOR THE US

- Access to Japanese resources and high technology
- Strong complementary technical partnership

CURRENT ISSUES

- Evolving Asian-Pacific regional space cooperation
- Space Station Freedom
 - Schedule and design uncertainties
- Evolving relationship between Japan and Russia on space cooperation/commercial activities
- Japan's astronauts want wider involvement in US program

"BOTTOM LINE"

The Japanese space program is well planned, steadily expanding, and is targeting a wide variety of areas of space research and commercial development.

Strengths

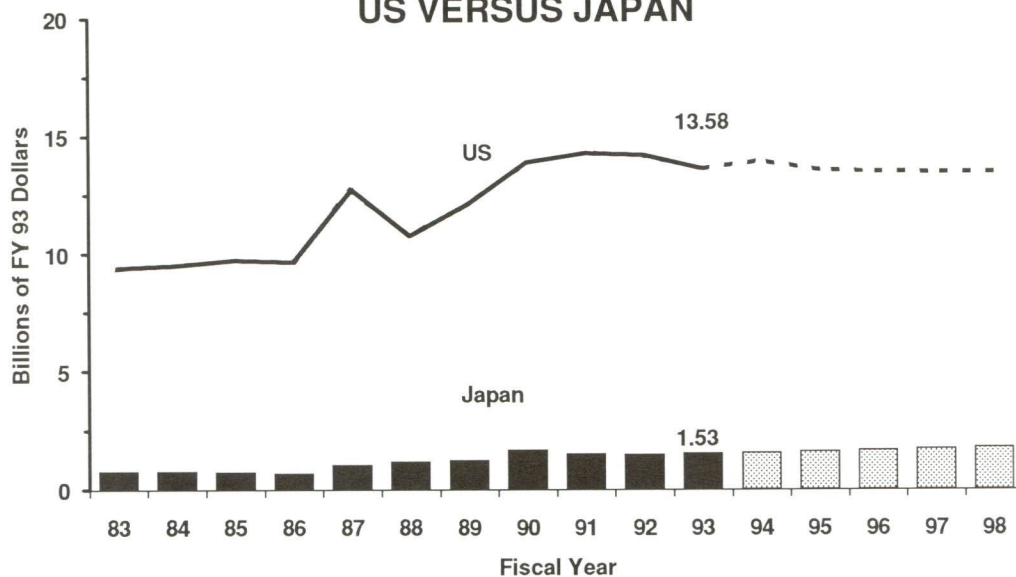
- High technology research and development
- Growing competence in space hardware development

Weaknesses

- Reliance on US for some space hardware

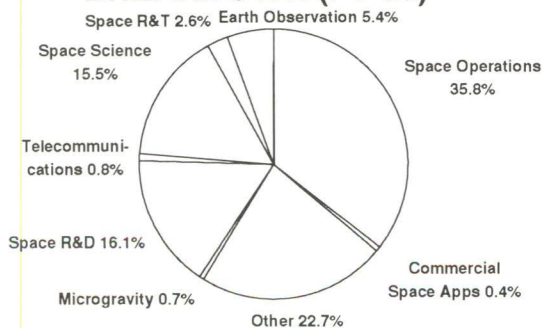
HISTORICAL TREND: Programs marked by stability, cohesiveness, and long-term government/private commitment.

CIVIL SPACE BUDGETS US VERSUS JAPAN

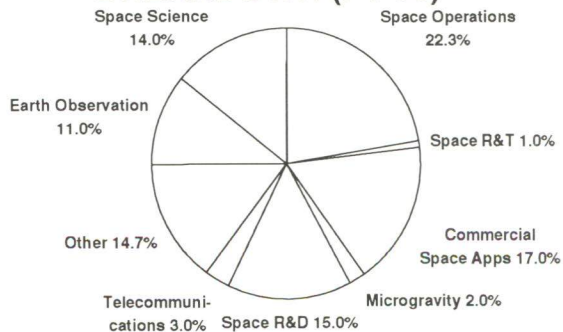


CIVIL SPENDING BREAKDOWNS US VERSUS JAPAN

US APPROXIMATE SPENDING BREAKDOWN (FY 93)



JAPAN APPROXIMATE SPENDING BREAKDOWN (FY 93)



US - JAPAN COOPERATION

ON-GOING

Atlas/Atmospheric Laboratory for Applications and Science Atlas is a series of US Space Shuttle missions. Atlas-1, a US Space Shuttle mission for Earth and solar atmospheric science launched in March 1992 carried among its instruments a Japanese space experiment with particle accelerators. Data analysis efforts continue.

ISTPP/International Solar Terrestrial Physics Program The Japanese-built Geotail spacecraft for plasma physics is investigating the Earth's magnetosphere geotail. The spacecraft carries a variety of shared Japanese/US instruments as part of the Global Geospace Science (GGS) and Collaborative Solar Terrestrial Research (Costr) elements of the International Solar Terrestrial Physics Program (ISTPP). Geotail was launched on a Delta II rocket in July 1992.

Joint Studies with Japan Joint studies of Crustal Plate Motion; Geodesy and Geodynamics by Satellite Laser Ranging; X-Ray Astronomy; and the Solar-A spacecraft are currently underway.

SL-J/Spacelab-J For this joint US Space Shuttle Spacelab mission, Japan provided materials science and life science experiments along with a payload specialist. The SL-J payload was referred to in Japan as the Japanese First Material Processing Test (FMPT). Launched in September 1992 (STS-47), data analysis efforts continue.

1993

Astro-D or SXO/Spectroscopic X-ray Observatory Japan provided the spacecraft, launch, and balance of the scientific payload for this joint X-ray observatory. The US will receive approximately 25% of the science data for its contribution of thin foil mirrors and charged coupled device detectors. Astro-D was launched in February 1993.

1995 and beyond

EOS/Earth Observing System Japan will provide an Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) instrument on NASA's EOS AM-1 polar orbiting platform.

SFU/Space Flyer Unit The Japanese SFU, a free-flying, multipurpose, reusable satellite, will be retrieved by the US Space Shuttle approximately 6 months after its launch aboard the H-2 in 1995.

Space Station Freedom Japan will provide the Japanese Experiment Module (JEM), which contains a Pressurized Module, Exposed Facility with manipulator system, and Experiment Logistics Module for the international space station.

US - JAPAN COOPERATION

1995 and beyond (Continued)

TOMS/Total Ozone Mapping Spectrometers One of four NASA TOMS and a NASA Scatterometer (NSCATT) will fly on the Japanese ADEOS Earth observing spacecraft in 1996.

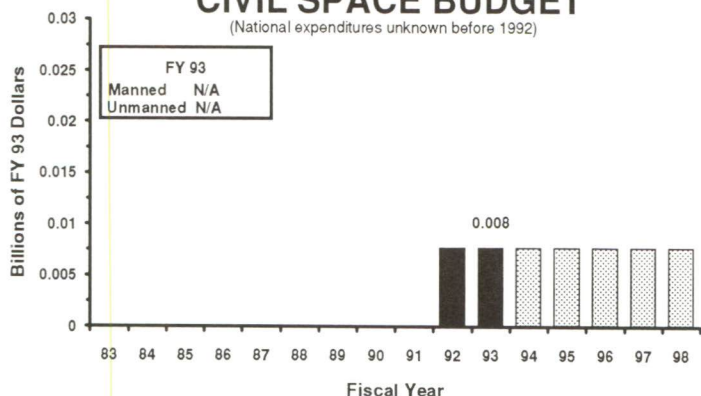
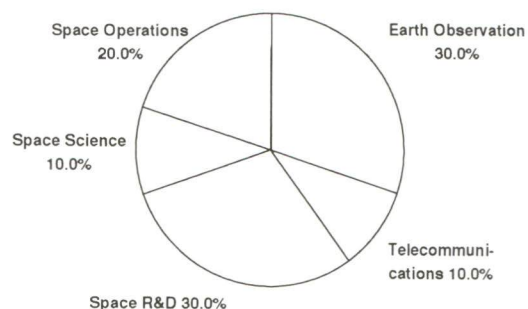
TRMM/Tropical Rainfall Measuring Mission The US-built TRMM spacecraft will carry both US and Japanese instruments. TRMM is scheduled for launch on the Japanese H-2 in the late 1990s as part of the US Earth Probes Program.

Pakistan

PAKISTAN

CIVIL SPACE BUDGET

(National expenditures unknown before 1992)

APPROXIMATE SPENDING
BREAKDOWN (FY 93)

LAUNCH VEHICLES

**No Domestic
Orbital Launch Vehicles**

INFRASTRUCTURE

Sounding Rocket Test Range

Launch and control of sounding rockets
for high altitude and ionosphere studies

ORGANIZATION

Space Research Council

National space program policy and agenda

Space and Upper Atmosphere Research Commission
(SUPARCO)

Execution of space technology, science, and
applications programs

SIGNIFICANT INTERNATIONAL
COOPERATIVE PROJECTS

	China
Human Spaceflight	
SSF	
Earth Observation	
Space Science	
Space Operations	X
Data Exchange	X

PAKISTANI LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs :

1990s

- Develop remote sensing satellite system
 - Launch second experimental satellite (Badar-B) in 1994 (Badar-A launched in 1990)
- Continue sounding rocket flights for scientific studies

2000 and Beyond

- Continue space development efforts
- Pursue orbital launch vehicle capability

Overall Goals of Pakistani Space Activities

- Enhance national security
- Derive practical benefits from space activities

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- Interest in launch vehicle development
 - Potential missile proliferation concern

OPPORTUNITIES FOR THE US

- None identified

CURRENT ISSUES

- Western nations' policy against transfer of missile related technology

"BOTTOM LINE"

Pakistan has a small but progressing space program including sounding rocket operations and expanding indigenous satellite capability.

Strengths

- Sounding rocket operations

Weaknesses

- Low budget

HISTORICAL TREND: Relatively new space program. Interested in launch vehicle technology and satellite capabilities. Satellite pursuits have prospered more than orbital launch capability.

Russia/ Kazakhstan/Ukraine

NOTE

In 1991 the Soviet Union separated into 15 autonomous nations. The following section portrays the civil space capabilities of the former Soviet Union; capabilities which are now almost entirely contained within the borders of the independent states of Russia, Kazakhstan, and Ukraine.

BACKGROUND

The Minsk Agreement on Joint Activities in the Exploration and Use of Space was signed on December 30, 1991. This space-specific accord was created under the umbrella agreement that established the Commonwealth of Independent States (CIS). Its focus was the continuation of space activities between the former republics of the Soviet Union. The umbrella CIS agreement was to be ratified each year; however, it failed on its first test, one year after the initial signing. The effect of this on the Minsk space agreement remains unclear.

Although the CIS framework existed formally, it did not provide a centralized, executive organization for the coordination of space activities. Formal space agreements such as the Minsk accord were established, but no enforcement mechanism existed. For this reason, space activities have been executed through a variety of bi- and multilateral agreements and industry-to-industry arrangements. These types of arrangements continue today as the primary method of integrating the space capabilities separated in the different former republics.

Although some observers may present a grim outlook for the space program, the former Soviet Union has maintained a significant level of continuity in space capabilities and services. However, the transformation of the political and economic system is generating uncertainty and instability in the structure for decision making and funding in space activities. There is an increasing focus on commercial endeavors, international cooperation, and non-traditional funding and management arrangements.

MAJOR SPACE NATIONS of the FORMER SOVIET UNION

RUSSIA

The vast majority of space infrastructure, industry, and expertise resides in Russia. According to a Congressional Research Service study, 90% of the over 2,000 enterprises associated with the space industry are located in Russia. The Russian Space Agency is the principal governmental organization responsible for the execution of Russia's space program. The other significant governmental body is the Russian Academy of Sciences with its Institute for Space Research and the Vernadski Institute for Geochemistry Research.

Major infrastructure elements include the Plesetsk and Kapustin Yar launch sites, the Star City cosmonaut training center, and the Kaliningrad flight control center. In addition, major portions of the Russian Deep Space Network are located in Russia. Primary launch vehicle and spacecraft engineering and design centers located in the Moscow region include NPO Energia, NPO Lavochkin, and NPO Khrunichev.

KAZAKHSTAN

Kazakhstan has established the Kazakh Space Agency for coordinating the nation's space activities and the Kazakh Academy of Sciences with its Institute of Space Research. The primary space infrastructure element located in Kazakhstan is the Baikonur Cosmodrome launch site located closest to the city of Tyuratam. This is the lowest latitude launch center of the former Soviet Union and is the only one configured to support human spaceflight activities. Ownership of the Baikonur facility, a vital infrastructure element, has been a major point of contention between Russia and Kazakhstan. After much debate, the two parties may be close to an understanding for the continued use of Baikonur in support of human spaceflight activities, primarily the Mir space station. Additionally, in early 1992, Kazakhstan and Russia signed an agreement for technological cooperation in space programs.

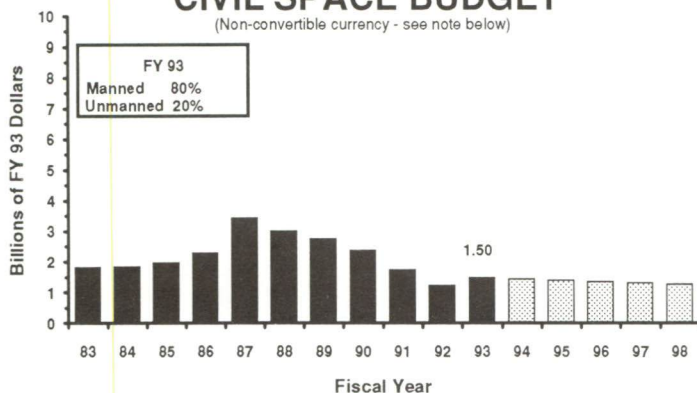
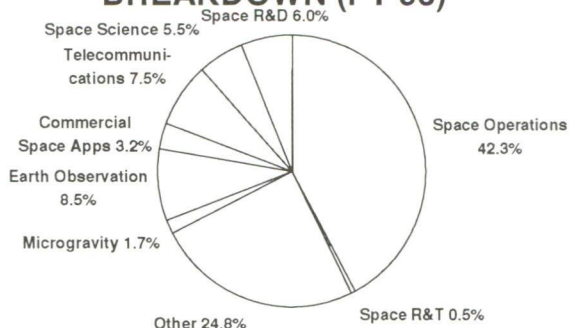
UKRAINE

Although Ukraine is a member of the CIS, it did not sign the Minsk Agreement on Joint Activities in the Exploration and Use of Space. It has, however, established the Ukrainian Space Agency for coordinating the republic's space activities and the Ukrainian Academy of Sciences. The primary contributions of Ukraine to space activities are producing the Zenit launch vehicle at the Yuzhnoye factory, participating in space science efforts, and supplying select space equipment and sensors. During the initial breakup of the Soviet Union, Ukraine cut most of its ties to the former Soviet space establishment. Recently, however, the Ukrainian and Russian governments, through their respective Academies of Sciences, have renewed ties in the area of space science research. In addition, Ukraine is pursuing international space activities independent of the Russian space program and has become a member of Eutelsat.

RUSSIA/KAZAKHSTAN/UKRAINE

CIVIL SPACE BUDGET

(Non-convertible currency - see note below)

APPROXIMATE SPENDING
BREAKDOWN (FY 93)

LAUNCH VEHICLES

	SL-3 (VOSTOK)	SL-4 (SOYUZ)	SL-6 (MOLNIYA)	SL-8 (KOSMOS)	SL-12 (PROTON)	SL-13 (PROTON)	SL-14 (TSYKLON)	SL-16 (ZENIT)	SL-17 (ENERGIYA)	SL-17 (BURAN)
	Performance Capability (lb)									
LEO	13,734	16,350	N/A	3,706	N/A	45,780	11,996	32,700	228,900	65,400
Polar	4,011	N/A	N/A	N/A	N/A	N/A	N/A	24,806	N/A	N/A
GEO	N/A	N/A	N/A	N/A	5,450	N/A	N/A	N/A	39,600	15,000

INFRASTRUCTURE

Plesetsk (Russia)

Polar launches

Baikonur (Kazakhstan)

Human spaceflight and planetary missions

Mir Space Station

On-orbit crewed space facility

Kapustin YAR (Russia)

Missile test range

Kaliningrad Flight Control Center (TsUP) (Russia)

Human and planetary operations

Star City Cosmonaut Training Center (Russia)

SESS and LUCH

Space Environmental Support Ships and satellites in GEO for C³ operations of LEO missions

Deep Space Network (DSN)

Network for control of planetary missions

ORGANIZATION

Russian Space Agency

Sets national space policy, plans and coordinates overall space activities

Russian Academy of Sciences

Oversight of various laboratories and research facilities including the Institute for Space Research (space sciences) and the Vernadski Institute (geochemistry)

Ministry of Defense

Committee of Defense Industries

Coordination of military role in space program

Kazakh Space Agency (Kazakhstan)

Coordinates space research

Kazakh Academy of Sciences

Institute of Space Research -- space and Earth sciences

Ukrainian Space Agency (Ukraine)

Coordinates space activities with other nations

Ukrainian Academy of Sciences

Produces sensors and equipment for use in space

SIGNIFICANT INTERNATIONAL
COOPERATIVE PROJECTS

	Australia	Canada	Denmark	ESA	France	Germany	Japan	US
Human Spaceflight	X		X	X	X	X	X	X
Earth Observation	X		X	X				X
Space Science	X	X	X	X	X	X	X	X
Space Operations	X							X
Data Exchange	X	X	X	X	X	X	X	X

1993 budget figure: ANSER estimate based on consultations with Russian Space Agency officials.

Non-convertible currency -- budget data should be used for order of magnitude and trend analyses only.

RUSSIAN/KAZAKH/UKRAINIAN LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs:

- | | |
|--|---|
| <p style="text-align: center;"><u>1990s</u></p> <ul style="list-style-type: none"> ● Upgrade Mir <ul style="list-style-type: none"> - Astrophysical module (Spektr) - Earth observation module (Priroda) ● US Shuttle/Mir docking and crew exchanges ● Mars exploration <ul style="list-style-type: none"> - Orbiters, probes, surface mission/rover/sample return ('94, '98) ● Mir-2 and new Rus launch vehicle ● Buran space shuttle program (on hold) ● Develop missile-derived commercial launch vehicles | <p style="text-align: center;"><u>2000 and Beyond</u></p> <ul style="list-style-type: none"> ● Continue Mir space station ● Mars rover and sample return missions ● Human missions to Mars ● Develop very large geosynchronous communications satellite |
|--|---|

Overall Goals of Russian/Kazakh/Ukrainian Space Activities

- Enhance national security
- Derive economic, technical, and scientific benefits
- Expand human presence beyond Earth orbit

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- Remaining military aspects of former Soviet space program
- Commercial launch competition
- Expanding cooperation with US "competitors" in both commercial and national programs
- Undesirable high technology transfer and missile proliferation

OPPORTUNITIES FOR THE US

- Access to robust launch capability
- Improved cooperative relationship
- Access to science and technology that complements US efforts
- Access to long duration human spaceflight experience

CURRENT ISSUES

- | | |
|---|--|
| <ul style="list-style-type: none"> ● Future of individual national space programs <ul style="list-style-type: none"> - Funding, organization, integration, infrastructure use ● Cooperation/joint ventures with Western governments, commercial industries, and international organizations | <ul style="list-style-type: none"> ● Integration of former Soviet states into international space community ● Commercialization/conversion of former Soviet military space assets for civilian use |
|---|--|

"BOTTOM LINE"

The space infrastructure of the former Soviet Union remains as a substantial asset. The majority of capabilities are now in Russia but significant ties to other states remain. Forces of commercial reform, budget pressures, interstate politics, international cooperation, and remaining military needs are now acting to change the nature of the space program.

Strengths

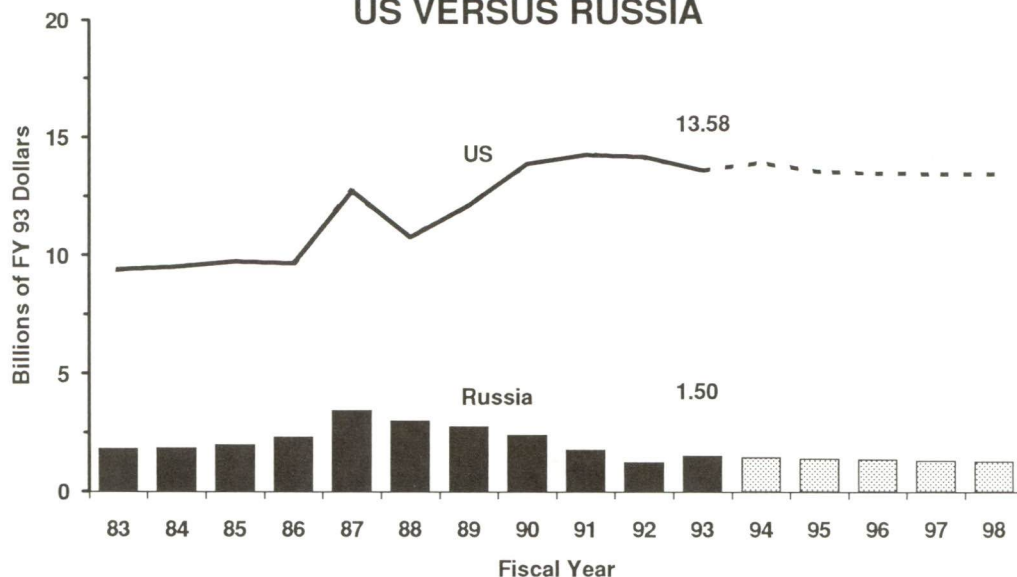
- Evolutionary approach to space with steady, incremental progression
- Demonstrated robust launch systems, including heavy-lift capability
- Long-duration human spaceflight
- Operational space station

Weaknesses

- Short-lived space-based equipment and components (improving)
- Uncertain political stability
- Severe financial shortfalls causing loss of technical expertise

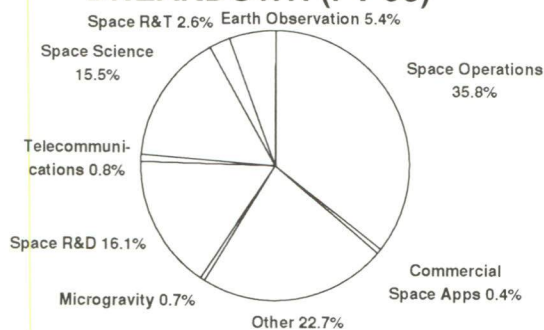
HISTORICAL TREND: Steady evolutionary development of robust space capability, now facing an uncertain future.

CIVIL SPACE BUDGETS US VERSUS RUSSIA

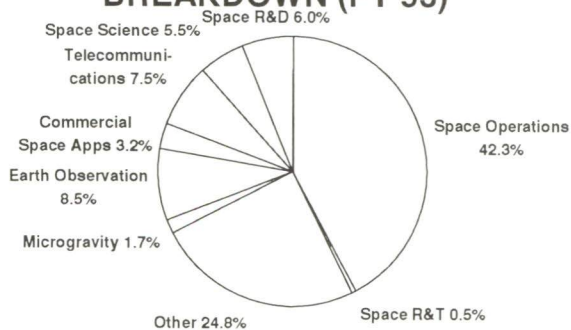


CIVIL SPENDING BREAKDOWNS US VERSUS RUSSIA/KAZAKHSTAN/UKRAINE

US APPROXIMATE SPENDING BREAKDOWN (FY 93)



RUSSIA/ KAZAKHSTAN/UKRAINE APPROXIMATE SPENDING BREAKDOWN (FY 93)



US - RUSSIA COOPERATION

ON-GOING

Cosmos NASA conducts biological research experiments on unmanned Russian (formerly Soviet) life science satellite missions. Eight experiments have been flown since 1975.

Environment Monitoring Initiative Russia has agreed to participate in the US Mission to Planet Earth Program. The two sides have agreed to share data and coordinate observations from their respective space and terrestrial monitoring systems.

Gamma Ray Balloon Flight Program US and Russian gamma ray spectrometers were flown together on a US-sponsored balloon flight in Antarctica. Data analysis efforts continue.

Magellan A group of Russian scientists are participating in data analysis for the US Magellan Venus mapping mission.

Mars Observer The US flew a French-built transponder on the US Mars Observer in September 1992 to serve as a communications relay for the Russian Mars '94 balloon mission.

SLS-1/SpaceLab Life Sciences-1 Russian investigators are participating in post-flight analysis of life sciences data gathered by US Space Shuttle crews during the SLS-1 mission flown in June 1991.

Space Sciences Working Groups US and Russian scientists are conducting joint studies to identify promising Mars landing sites. Discussions are underway regarding the use of the US Deep Space Network to track the Russian Mars '94 mission. Data exchanges and personnel exchanges are on-going, as well as discussions regarding coordinated observations and the exchange of flight opportunities for scientific experiments in the areas of solar terrestrial physics, Earth sciences, space medicine, astronomy and astrophysics, and unmanned solar system exploration.

TOMS/Total Ozone Mapping Spectrometers One of NASA's four TOMS is currently flying on a Russian Meteor-3 weather satellite.

1993

Astronaut/Cosmonaut Exchange A Russian cosmonaut will fly on a US Space Shuttle/Spacelab mission in 1993 (see "1995 and beyond" section for more details).

ISTPP/International Solar Terrestrial Physics Program Russia will provide the gamma ray burst instrument, KONUS, which will fly on the US Wind satellite under the Global Geospace Science (GGS) element of the ISTPP.

SLS-2/SpaceLab Life Sciences-2 Russian investigators will participate in post-mission analysis of life sciences data gathered by US Space Shuttle crews on SLS-2.

US - RUSSIA COOPERATION

1994

Mars '94 The US will provide the communications relay for the Russian Mars '94 balloon mission. In addition, NASA will place Mars Oxident Experiment (MOX) instruments on each of the two landers that the Russian Mars '94 spacecraft will deploy.

Radioastron/Spectrum-Radio The US will loan four data recorders to the Russians and provide Deep Space Network support to this radioastronomy mission. The exact launch date is still under review.

Spectrum-X-Gamma NASA is considering flying an X-ray All Sky Monitor and an X-ray Polarimeter on the Russian Spectrum-X-Gamma high energy astrophysics mission. The exact launch date is still under review.

1995 and beyond

Astronaut/Cosmonaut Exchange A US astronaut is expected to fly on one long-duration Mir space station mission in 1995. During this same period, a Russian cosmonaut will fly for the second time on a US Space Shuttle mission (first flight in 1993). As part of this 1995 Shuttle mission, the Shuttle will dock with the Mir space station. The guest US and Russian crew members are to be exchanged during this linkup, each returning to Earth aboard their own nation's spacecraft.

SLS-3/SpaceLab Life Sciences-3 Russian investigators will participate in post-mission analysis of life sciences data gathered by US Shuttle crews on SLS-3, which is scheduled to fly in 1995.

Space Station Freedom Russia and the US are evaluating the feasibility of using the Russian-built Soyuz spacecraft as an assured crew return vehicle for Space Station Freedom.

UNDER CONSIDERATION

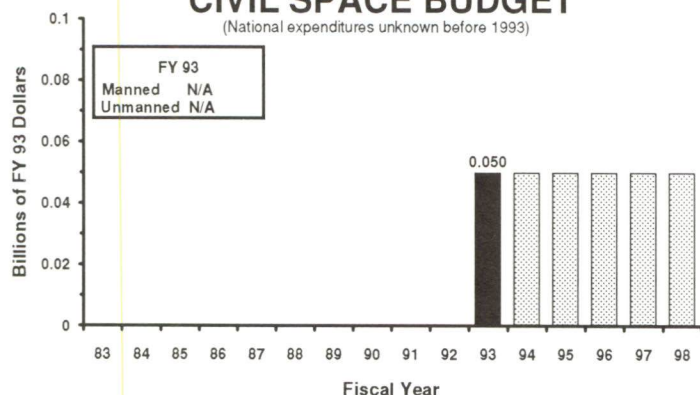
Earth Observation NASA is considering the flight of a series of Earth observation instruments on Russian spacecraft.

South Korea

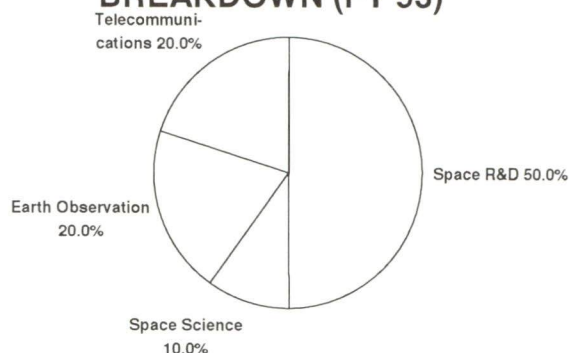
SOUTH KOREA

CIVIL SPACE BUDGET

(National expenditures unknown before 1993)



APPROXIMATE SPENDING BREAKDOWN (FY 93)



LAUNCH VEHICLES

**No Domestic
Orbital Launch Vehicles**

INFRASTRUCTURE

Kumsan Earth Station

Inmarsat services for maritime fleet
operated by Korea Telecom

ORGANIZATION

Ministry of Communications

Directs and funds space activities
and regulates Korean Telecom

Korean Advanced Institute of Science and Technology

Microsat development, ground station, operation, and
personnel training through an agreement with the UK

Korean Aerospace Research Institute (KARI)

Conducts space research and development

Korean Telecom

Commercially procuring Koreasat domestic
satellite communications system

SIGNIFICANT INTERNATIONAL COOPERATIVE PROJECTS

	France	Russia	UK	US
Human Spaceflight				
SSF				
Earth Observation				
Space Science			X	
Space Operations			X	
Data Exchange	X	X	X	X

SOUTH KOREAN LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs :

1990s

- Koreasat domestic communications system
 - Commercial purchase
- Continue satellite and ground station development and personnel training through agreement with University of Surrey (UK)
 - Earth observation, science, and communications payloads

2000 and Beyond

- Continue space development efforts

Overall Goals of South Korean Space Activities

- Derive practical benefits from space activities
- Enhance national security

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- Korean interest in developing military intelligence satellites
- Past interest in launch vehicle development
 - Potential missile proliferation concern

OPPORTUNITIES FOR THE US

- Market for US space technology and services

CURRENT ISSUES

- None identified

"BOTTOM LINE"

South Korea's space program is new and focused primarily on applications such as communications and Earth observation.

Strengths

- None identified

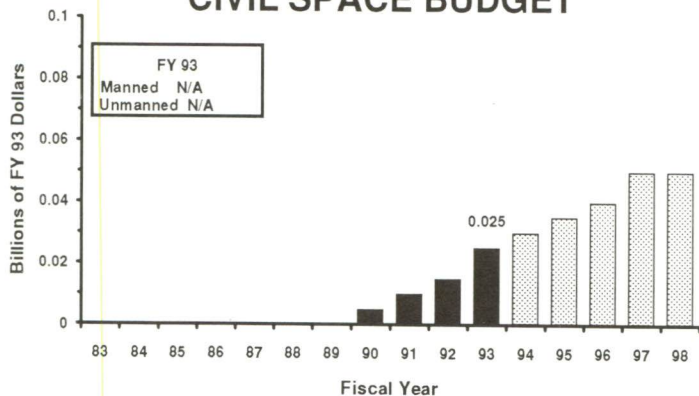
Weaknesses

- Low budget

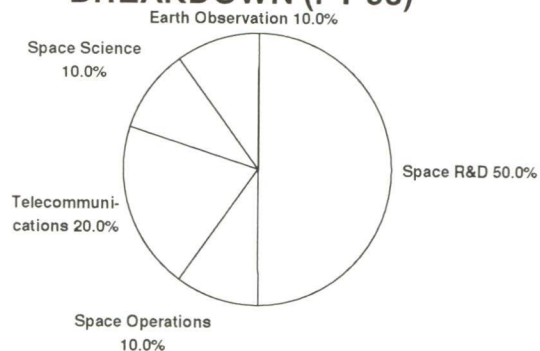
HISTORICAL TREND: Relatively new space program. Past interest in launch vehicle technology appears to have been discarded due to US concerns regarding missile proliferation.

Taiwan

CIVIL SPACE BUDGET



APPROXIMATE SPENDING BREAKDOWN (FY 93)



LAUNCH VEHICLES

No Domestic
Orbital Launch Vehicles

INFRASTRUCTURE

Hsinchu

Space research and development

Tainan

Satellite systems development

Chung-Li

Mission operations and ground station activities

ORGANIZATION

National Science Council

Administrative oversight of space program

National Space Program Office

Overall planning and execution of national space program

SIGNIFICANT INTERNATIONAL COOPERATIVE PROJECTS

	France	US
Human Spaceflight		
SSF		
Earth Observation		
Space Science	X	X
Space Operations		
Data Exchange	X	X

TAIWANESE LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs :

1990s

- Establish indigenous satellite development capabilities
- Launch ROCSAT-1 science satellite (late 1990s) on commercial launch vehicle
- Construct telecommunications and remote sensing ground stations
- Train scientific and technical personnel at US and French laboratories

2000 and Beyond

- Develop and launch two satellites focused on communications capabilities

Overall Goals of Taiwanese Space Activities

- Derive practical benefits from space activities
- Support scientific, technological, and economic development

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- Transfer of dual-use technologies

OPPORTUNITIES FOR THE US

- Market for US space technology and services

CURRENT ISSUES

- None identified

"BOTTOM LINE"

Taiwan's space program is new and focused primarily on developing small experimental satellites, establishing ground infrastructure, and training personnel.

Strengths

- None identified

Weaknesses

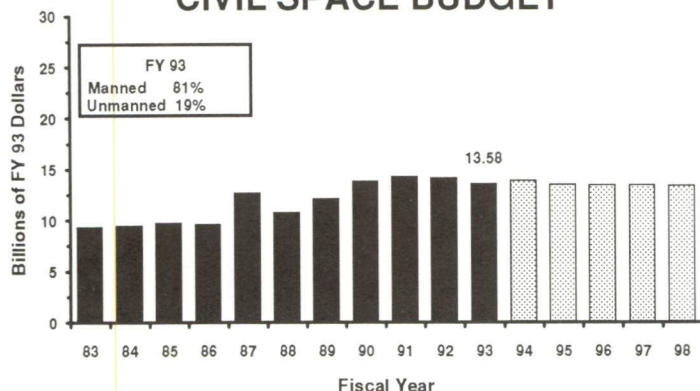
- Low budget

HISTORICAL TREND: Space program was organized in 1990 around a 15 year plan.

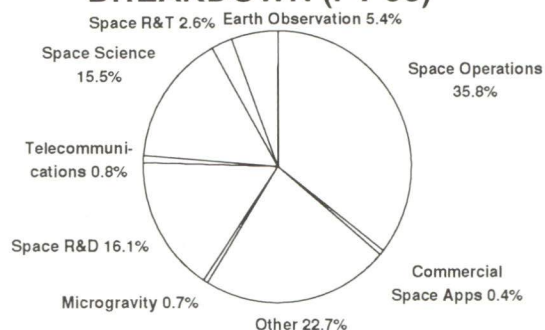
United States

UNITED STATES

CIVIL SPACE BUDGET



APPROXIMATE SPENDING BREAKDOWN (FY 93)



LAUNCH VEHICLES

	SCOUT	PEGASUS	ATLAS-E	TITAN II	DELTA II	ATLAS II	TITAN III	TITAN IV	STS
Performance Capability (lb)									
LEO	570	980	N/A	N/A	11,110	14,500	30,100	39,100	51,000
Polar	460	740	1,750	4,200	8,300	12,150	27,600	31,100	N/A
GEO	-	-	-	-	1,950	3,000	4,100	10,200	5,200

INFRASTRUCTURE

NASA Field Centers and Research Laboratories

Civil space program execution and technology development

Kennedy Space Center/Cape Canaveral

East coast launch site including human spaceflight missions

Vandenberg Air Force Base

West coast launch site for polar orbits

Deep Space Network

World-wide ground station network for control of planetary missions

NASA Spaceflight Tracking and Data Network

Space and ground segments for the tracking, telemetry, and command of LEO spacecraft

ORGANIZATION

National Aeronautics and Space Administration (NASA)

Civil space initiatives, human spaceflight, supporting technology, R&D, and space sciences

Department of Defense (DOD)

Launch vehicle, satellite R&D and operations, space technologies, national range management

Department of Commerce (DOC)

Represents US space business interests, operates domestic weather satellites through its National Oceanic & Atmospheric Administration

Department of Transportation (DOT)

Responsible for regulation and licensing of commercial launch industry

Department of Energy (DOE)

R&D in space nuclear power/propulsion applications and other space-related technologies

SIGNIFICANT INTERNATIONAL COOPERATIVE PROJECTS

	Canada	China	ESA	France	Germany	India	Italy	Japan	Russia	UK
Human Spaceflight	X		X	X			X	X	X	
SSF	X		X				X			
Earth Observation	X	X	X	X	X		X	X	X	
Space Science	X	X	X	X	X	X	X	X	X	X
Space Operations	X		X				X	X	X	
Data Exchange	X	X	X	X	X	X	X	X	X	X

US LONG-RANGE PLANS AND PROJECTS

Current long-range space policy directives call for the following space programs:

1990s

- Develop Space Station Freedom
- Develop Earth Observing System
- Perform robotic planetary science
- Upgrade space launch infrastructure
- Perform Shuttle/Mir docking and crew exchange with Russia

2000 and Beyond

- National Aerospace Plane
- Heavy Lift Launch Systems
- Space exploration
 - Lunar base
 - Human expedition to Mars

Overall Goals of US Space Activities

- Strengthen national security
- Obtain scientific, technological, and economic benefit
- Encourage private sector investment in space
- Promote international cooperative activities
- Expand human presence and activity beyond Earth orbit

ADDITIONAL CONSIDERATIONS

CONCERNS FOR THE US

- Expendable launch vehicle fleet and infrastructure and technology are outdated
- Increasing competition in international commercial space markets
- Space Station Freedom funding, schedule, and design uncertainties
- Visionary plans versus short-term fiscal support

OPPORTUNITIES FOR THE US

- Expanded university, government, industry cooperation
- Expanding international space cooperation
 - Government to government
 - Industry to industry
 - Revision of technology transfer controls

CURRENT ISSUES

- Space Station Freedom
 - Design, cost, international partners
- Earth Observing Systems
 - Architecture, scope, cost
- National space policy
 - Strategy and institutional roles

- Definition of future launch vehicle fleet
 - New system developments
 - Use of excess missile assets
- Extent of cooperative relationship with Russia on joint space projects, commercial activities, technology development, etc.
 - Crew exchange
 - Launch capabilities
 - Soyuz rescue craft
 - Mars exploration

"BOTTOM LINE"

The US has the most comprehensive space program of any nation today, but it is not without shortcomings.

Strengths

- Advanced technology and R&D
- Demonstrated systems reliability and high performance
- Human access to space

Weaknesses

- Inconsistent exploitation and evolution of national capabilities
- Overall commercial competitiveness
- Launch complexities and costs

HISTORICAL TREND: Major space technology and program thrusts followed by limited sustaining operations.

Countries with Minor Space Capabilities

Bulgaria
Chile
Czech Republic/Slovakia
Greece
Hungary
Indonesia
Iran
Iraq
Luxembourg

Mexico
New Zealand
Nigeria
Poland
Portugal
South Africa
Syria
Thailand
Turkey

BULGARIA

Space activities in Bulgaria are executed by the Bulgarian Space Research Institute (SRI). In the past, Bulgaria has provided scientific instruments and flight instrumentation to various Soviet space missions and has maintained a close working association with the Soviet space program. A Bulgarian cosmonaut flew aboard the Mir space station in the 1980s. Bulgaria is currently considering a plan to participate in the Russian Mars '94 mission. It is uncertain, however, what the level and/or extent of future cooperation will be between Bulgaria, Russia, and other republics regarding other space activities. Bulgaria is a member of the Intersputnik and Inmarsat satellite communications organizations.

CHILE

Chile was the first South American country to establish a Copas/Sarsat emergency land/sea/air rescue receiver station. The country also maintains a NASA Shuttle emergency landing site on Easter Island. Chile does not operate Landsat or SPOT ground stations, but Landsat coverage is available from facilities located in Brazil and Argentina. Chile has also participated with the United States and United Kingdom in studies related to ozone depletion in the Antarctic. Chile is a signatory to Intelsat and Inmarsat through its national telecommunications agency, Entel.

CZECH REPUBLIC and SLOVAKIA (former CZECHOSLOVAKIA)

Czechoslovakia separated into the Czech Republic and Slovakia on January 1, 1993. At this time, it is uncertain what form, if any, space activities will take in the two new nations. The former Czechoslovakia contributed various instruments and sensors to the Soviet space program, and a Czech cosmonaut flew aboard Salyut 6 in 1978. The nation participated in the 1986 Halley's Comet mission and has designed and built its own scientific research satellites (Magion series) for studies related to magnetospheric and ionospheric phenomena.

GREECE

Space activities in Greece are coordinated by the Scientific Group for Space Research (SGSR). Current activities involve the participation of the Crete Research Center (CRC) in the Russian Mars '94 mission. A Memorandum of Understanding, signed in 1989, will be executed through CRC and Moscow's Institute of Space Research (IKI). Greece is a member of Intelsat and Inmarsat.

HUNGARY

Hungary contributed instrumentation and sensors to several Soviet-led space science missions. A Hungarian cosmonaut flew on the Salyut 6 space station. Hungarian radiation dosimeters carried aboard that mission were later adopted for Salyut 7 and Mir space station monitoring. In 1991, Hungary concluded a space cooperation agreement with ESA. In addition, Hungary is actively pursuing cooperation with NASA. In 1984, NASA flew the Hungarian Thermo-Luminescent Dosimeter experiment on the Shuttle. In 1991, Hungary and NASA concluded several new cooperative agreements.

INDONESIA

Indonesia is undertaking a modest program of remote sensing and atmospheric studies, but its primary area of interest is in satellite-based communications including direct broadcasting. Indonesia's space agency, the LAPAN National Institute of Aeronautics and Space, maintains ground stations for reception of Earth resources and meteorological satellite imagery (Landsat, SPOT, GMS, NOAA). LAPAN also designs, builds, and launches solid propellant sounding rockets for atmospheric research studies. Indonesia is also exploring the possibility of offering several of its islands for possible use as future orbital launch sites. Indonesian telecommunications activities are coordinated by the Directorate General of Posts and Telecommunications under two organizations -- Perumtel and Indosat. Perumtel operates the national Palapa satellite communications system, while Indosat is the national signatory to Intelsat and Inmarsat.

IRAN

Iran is pursuing the development of its own domestic communications satellite system, with European satellite manufacturers taking the lead in the construction of this system. In addition, a system of very small aperture terminals (VSATs) is being completed for use by banks, government offices, and the oil industry. Preliminary discussions have been held with Russia concerning cooperation in the area of satellites. Iran is a member of Intelsat and Inmarsat.

IRAQ

Space activities in Iraq are coordinated through the Iraqi Space Agency and Iraqi Space Research Center. On December 5, 1989, Iraq announced the success of a three-stage liquid rocket (Al Abid). This rocket could be used as an orbital launcher placing 100 pounds into a low Earth orbit. The Al Abid vehicle is believed to be a derivative of the Scud ballistic missile. The vehicle was launched from Iraq's Al Anbar launch facility located 50 miles west of Baghdad. In addition to its launch program, Iraq is also a signatory to Intelsat and Inmarsat. Note: Due to the probable loss of much of its space infrastructure as a result of damage sustained during the Gulf War, the status of Iraq's space program/activities is unclear. Sanctions under U.N. resolutions 661 and 687 deny Iraq the ability to import the parts and other items needed for their missile program.

LUXEMBOURG

Space activities in Luxembourg are centered on the Astra TV distribution satellite system. Luxembourg has no national space program and limited industrial capacity, but government officials in Luxembourg have expressed interest in ESA membership. Luxembourg is also a signatory to Intelsat and Eutelsat.

MEXICO

Mexico is primarily interested in development efforts regarding its domestic satellite telecommunications system (Morelos). Under contract from the Mexican government, Hughes Aircraft (US) operates a tracking, telemetry, and command station near Mexico City for the Morelos system. A Mexican astronaut has flown aboard the US Space Shuttle and deployed a Morelos satellite. In addition, Mexico cooperates with the US in the areas of cartography, remote sensing, and other related fields. Mexico is a member of Intelsat.

NEW ZEALAND

The New Zealand Meteorological Service receives and distributes NOAA and GMS satellite imagery, while the Department of Industrial Research (Information Technology Division) processes and distributes Earth resources data (Landsat, SPOT). New Zealand is a member of Inmarsat and Intelsat through New Zealand Telecoms, which operates three Intelsat receiving stations.

NIGERIA

In 1992, Nigeria established a satellite organization (Nigersat) to assume responsibility for space program activities that currently focus on communications capabilities and applications of remote sensing data. Nigeria is considering the development of a geostationary satellite telecommunications capability (three spacecraft). Currently Nigeria has 19 ground stations used in conjunction with Intelsat for communications and TV services. It is also considering establishing a Landsat and SPOT data receiving station. Nigeria Telecommunications is the national signatory to Intelsat and Inmarsat.

POLAND

Polish space activities were closely tied to Soviet research efforts. Polish researchers participated in the Soviet Phobos, Vega, Biocosmos, and Interkosmos missions. A Polish cosmonaut visited Salyut 6 in 1978. Currently, Poland's space science efforts are run by the Space Research Center, located near Warsaw. Poland and NASA signed a cooperative agreement in 1991. The government has expressed an interest in joining ESA and has signed a cooperative agreement with ESA. Poland is a member of Intersputnik, Inmarsat, and Eutelsat.

PORTUGAL

Portugal's National Laboratory for Engineering and Technical Industry (LNETI) is the lead organization for national space technology activities. LNETI is working with the University of Surrey of the United Kingdom to develop microsatellite technology. Plans call for the launch of a first experimental satellite (POSAT-1) on an Ariane booster in 1993.

SOUTH AFRICA

Space activities in South Africa are directed by the South African Space Committee. South Africa has undertaken a national space program emphasizing communications, remote sensing, and the development of a domestic orbital launcher. In 1989, a vehicle similar to the Israeli Jericho 2 missile and/or Shavit launch vehicle was reported to have been test fired from the Overberg range near Cape Town. It has been reported that plans may call for the launch of an Earth observation satellite in 1995. Russia has offered South Africa access to the use of excess missile assets and satellite technology for very low prices. The Council for Scientific and Industrial Research runs the Satellite Remote Sensing Center, which maintains a Landsat and SPOT data receiving station. South Africa is a member of Intelsat. A current issue between the US and South Africa is the set of sanctions imposed by the US on the South African Armaments Corporation (ARMSCOR) for its involvement in transactions relating to missile proliferation. The sanctions were imposed in October 1991 for a 2-year period.

SYRIA

In 1987, a Syrian cosmonaut flew on board the Mir space station. Syria receives Earth resources data and photographic surveys from Russian spacecraft. Syria uses the data to search for water and mineral resources.

THAILAND

The Thai government has expressed interest in obtaining a domestic satellite communications system. Plans call for the acquisition and launch of two Hughes Aircraft (US) built satellites. The first satellite is to be launched aboard an Ariane in 1993, with a second launch planned for 1994. The Thailand Remote Sensing Center operates a Landsat, SPOT, and MOS data receiving station. Thailand is a member of Intelsat.

TURKEY

Turkey has procured a geostationary satellite system (Turksat) for domestic and international television, data, and voice services. The prime contractor is Aerospatiale (France) and the launch is scheduled for late 1993. Turkey also plans to use Turksat to relay Turkish television and other broadcasting to the central Asian republics of the former Soviet Union. Turksat will be managed by the Turkish PTT and the Ministry of Transportation and communication. Turkey is a member of Intelsat and Inmarsat.

Appendices

World Civil Space Programs and R&D Efforts

CIVIL PROGRAMS AND R&D EFFORTS

COUNTRY	Argentina	Australia	Austria	Belgium	Brazil	Bulgaria	Canada	Chile	China	Czech Rep./Slovakia	ESA	Finland	France	Germany	Greece	Hungary	India	Indonesia	Iran	Iraq	Ireland	Israel
SPACE PROGRAMS																						
1. Astrophysical																						
2. Communications																						
3. Humans-in-Space																						
4. Meteorological																						
5. Microgravity																						
6. Navigation																						
7. Remote Sensing																						
8. Space Environment																						
9. Space Stations																						
10. Solar System Exploration (Robotic)																						
11. Transportation (Launch)																						
RESEARCH AND DEVELOPMENT EFFORTS																						
1. Aerobraking																						
2. Communications																						
3. Electric Propulsion																						
4. Electronics and Computers																						
5. Guidance, Navigation, and Control																						
6. Life Sciences																						
7. Liquid Propulsion																						
8. Materials Research																						
9. Optical Systems																						
10. Records and Memories																						
11. Robotics and Artificial Intelligence																						
12. Scramjets																						
13. Solar Electric Power																						
14. Solid Fuel Propulsion																						
15. Space Nuclear Power																						
16. Structures																						
17. Tethers																						
18. Thermal and Power Subsystems																						

* Member of ESA

CIVIL PROGRAMS AND R&D EFFORTS -- Continued

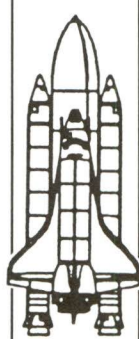
COUNTRY	Italy *	Japan	Luxembourg	Mexico	Netherlands *	New Zealand	Nigeria	Norway *	Pakistan	Poland	Portugal	Russia	South Africa	South Korea	Spain *	Sweden *	Switzerland *	Syria	Taiwan	Thailand	Turkey	United Kingdom *	US
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* Member of ESA

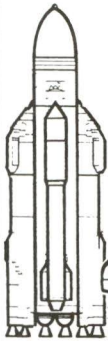
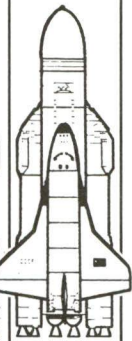
World Launch Vehicles

WORLD LAUNCH VEHICLES

U.S.

									
	SCOUT	PEGASUS	ATLAS-E	TITAN II	DELTA II	ATLAS II	TITAN III	TITAN IV	STS
	Performance Capability (lb)								
LEO	570	980	N/A	N/A	11,110	14,500	30,100	39,100	51,000
Polar	460	740	1,750	4,200	8,300	12,150	27,600	31,100	N/A
GEO	-	-	-	-	1,950	3,000	4,100	10,200	5,200

RUSSIA/KAZAKHSTAN/UKRAINE

										
	SL-3 (VOSTOK)	SL-4 (SOYUZ)	SL-6 (MOLNIYA)	SL-8 (KOSMOS)	SL-12 (PROTON)	SL-13 (PROTON)	SL-14 (TSYKLON)	SL-16 (ZENIT)	SL-17 (ENERGIYA)	SL-17 (BURAN)
	Performance Capability (lb)									
LEO	13,734	16,350	N/A	3,706	N/A	45,780	11,996	32,700	228,900	65,400
Polar	4,011	N/A	N/A	N/A	N/A	N/A	N/A	24,806	N/A	N/A
GEO	N/A	N/A	N/A	N/A	5,450	N/A	N/A	N/A	39,600	15,000

ESA

		
	ARIANE 4 (4L)	ARIANE 5 (1995)
	Performance Capability (lb)	
LEO	21,100	32,700
Polar	16,900	26,500
GEO	5,036	9,592

CHINA

						
	CZ-1D	CZ-2C	CZ-2E	CZ-3	CZ-3A (1993)	CZ-4A
	Performance Capability (lb)					
LEO	1,653	4,408	19,395	11,020	18,734	8,816
Polar	N/A	1,653	15,868	5,600	N/A	3,306
GEO	N/A	1,102	3,500	3,085	5,510	2,424

BRAZIL

	
	VLS (1995)
	Performance Capability (lb)
LEO	440
Polar	N/A
GEO	-

JAPAN

				
	M-3SII	M-V (1995)	J-I (TBD)	H-II (1994)
	Performance Capability (lb)			
LEO	1,700	3,600	TBD	19,800
Polar	N/A	N/A	TBD	N/A
GEO	440	1,000	TBD	4,840

INDIA

			
	ASLV	PSLV (1993)	GSLV (1996)
	Performance Capability (lb)		
LEO	330	6,614	32,700
Polar	N/A	N/A	10,900
GEO	-	992	4,360

ISRAEL

	
	SHAVIT
	Performance Capability (lb)
LEO	340
Polar	N/A
GEO	-

World Launch Centers

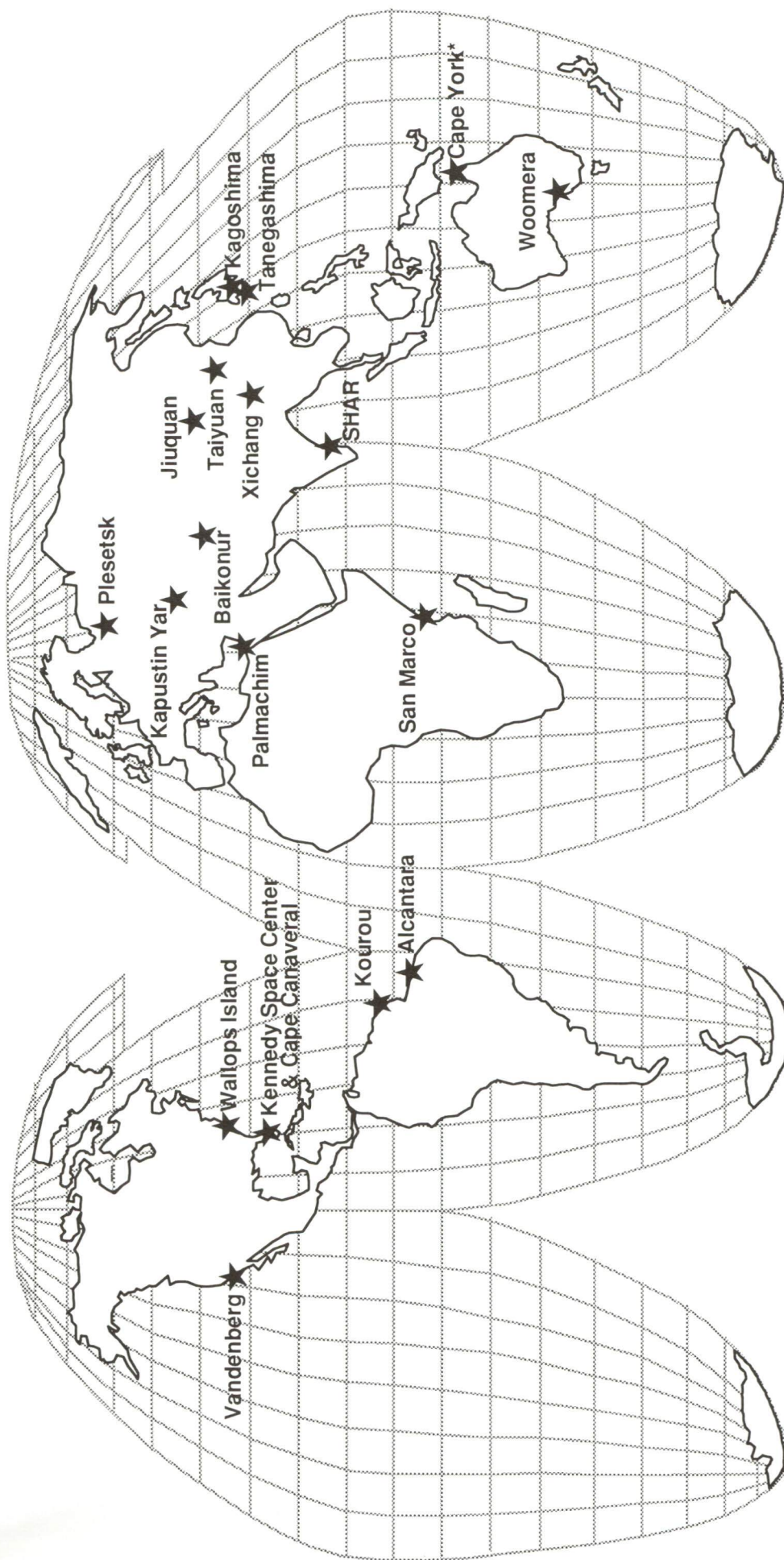
KEY

Site	Country
Alcantara	Brazil
Baikonur	Kazakhstan/Russia
Kennedy Space Center and Cape Canaveral	US
Cape York [*]	Australia
Jiuquan	China
Kagoshima	Japan
Kapustin Yar	Russia
Kourou	French Guiana/ESA
Palmachim	Israel
Plesetsk	Russia
San Marco	Italy
Shar	India
Taiyuan	China
Tanegashima	Japan
Vandenberg	US
Wallops Island	US
Woomera	Australia
Xichang	China

^{*} Proposed

WORLD SPACE LAUNCH CENTERS

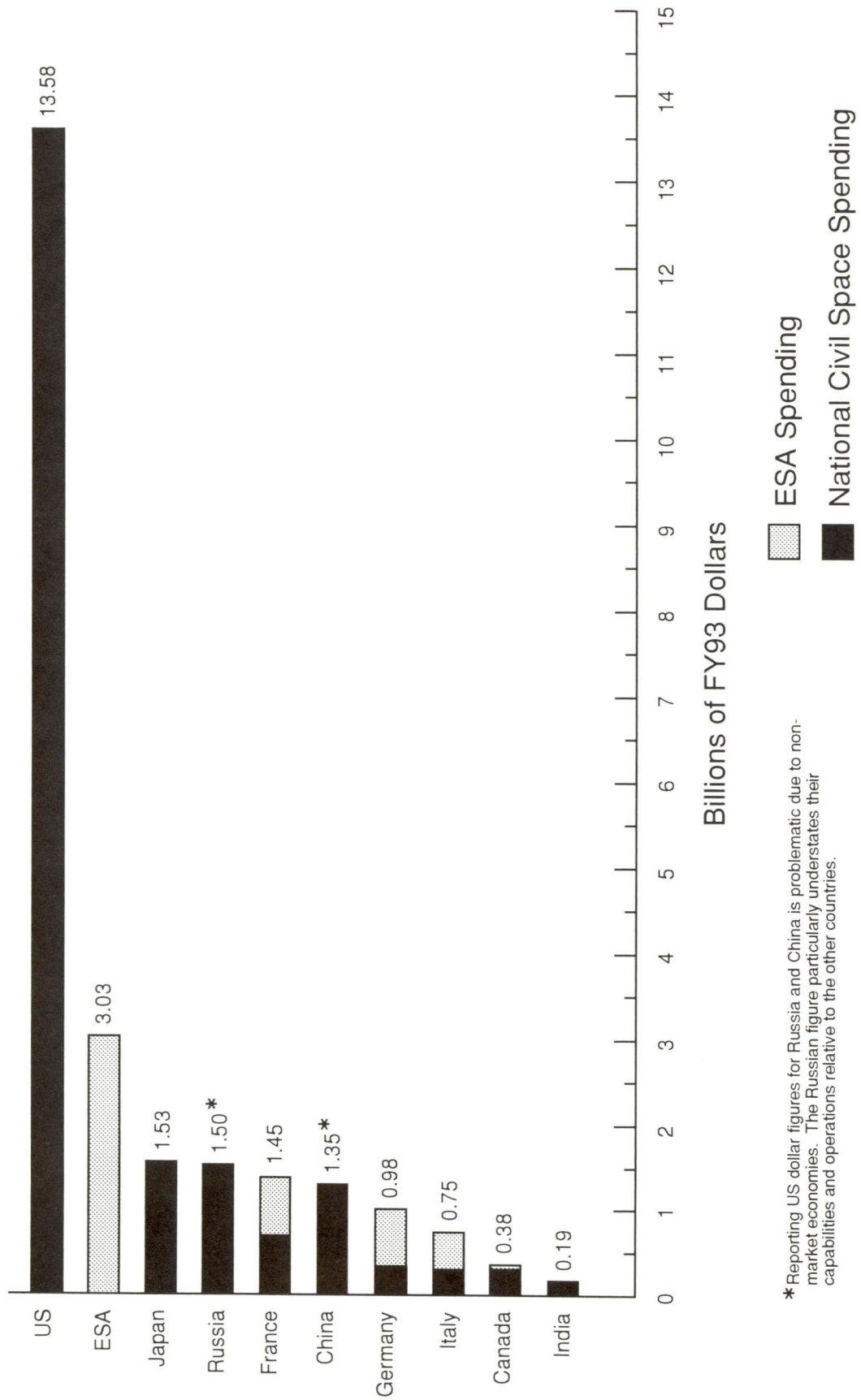
(Sites of orbital space launches)



* Proposed

Civil Space Budgets

Civil Space Budgets (Top ten budgets for 1993)



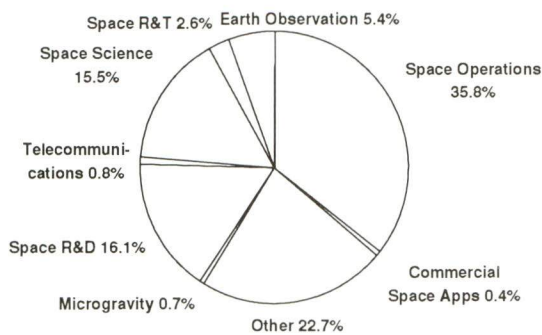
* Reporting US dollar figures for Russia and China is problematic due to non-market economies. The Russian figure particularly understates their capabilities and operations relative to the other countries.

Civil Space Spending Breakdowns

CIVIL SPACE SPENDING BREAKDOWNS (TOP TEN BUDGETS FOR 1993)

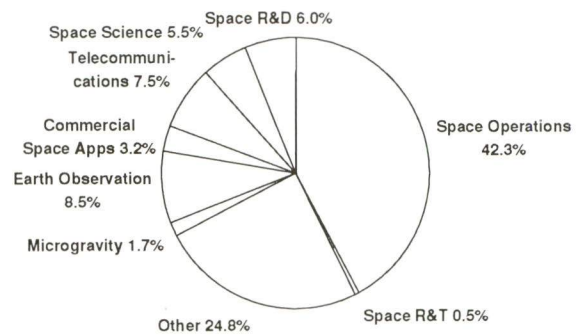
UNITED STATES

Space Budget: \$13.58 Billion



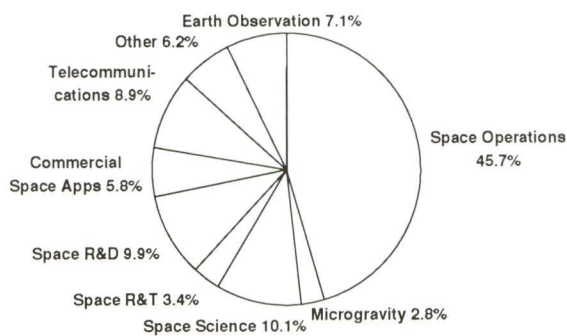
RUSSIA

Space Budget: \$1.50 Billion



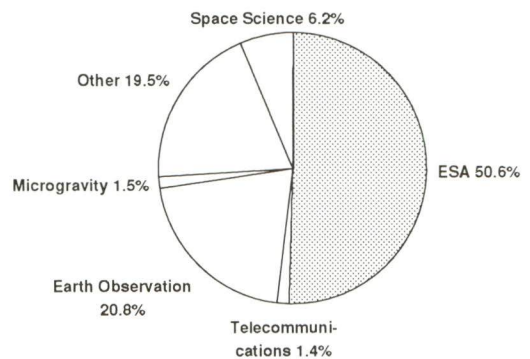
ESA

Space Budget: \$3.03 Billion



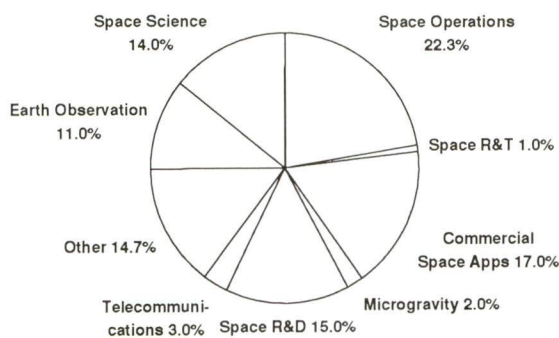
FRANCE

Space Budget: \$1.45 Billion



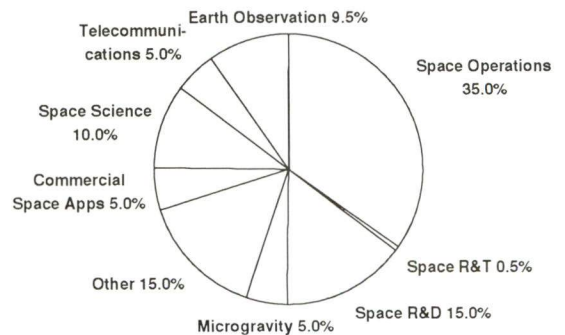
JAPAN

Space Budget: \$1.53 Billion



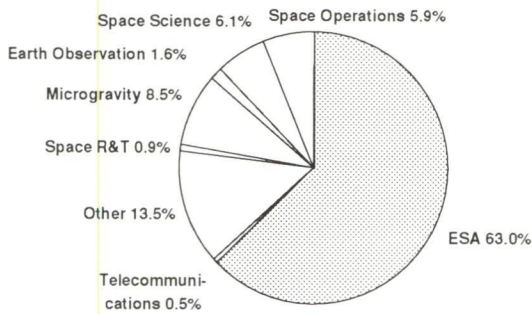
CHINA

Space Budget: \$1.35 Billion



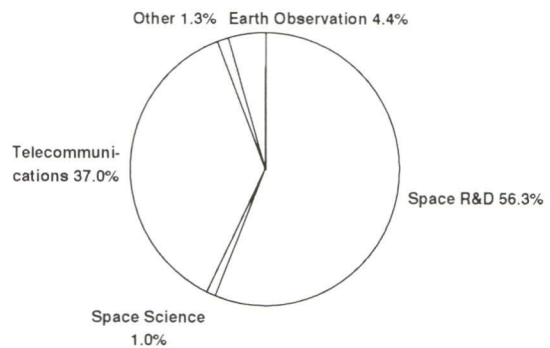
GERMANY

Space Budget: \$0.98 Billion



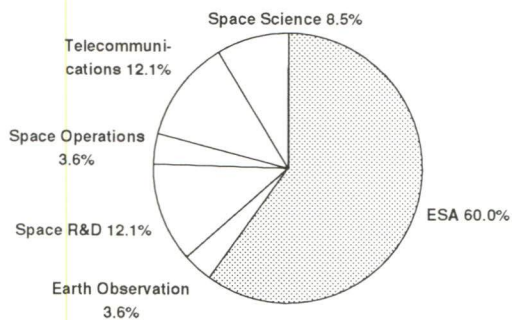
INDIA

Space Budget: \$0.19 Billion



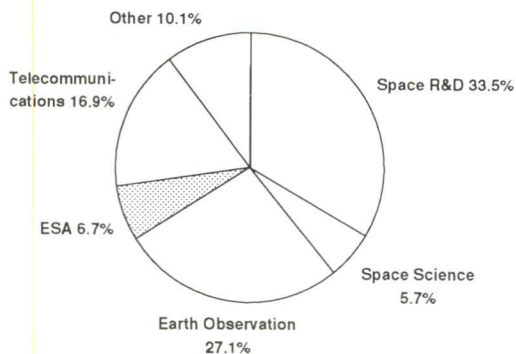
ITALY

Space Budget: \$0.75 Billion



CANADA

Space Budget: \$0.38 Billion



International Cooperative Projects

INTERNATIONAL COOPERATIVE PROJECTS (Involving the US)

Aeronautical Research (Participants: US, Germany) Agreements have been concluded for on-going data exchange, joint testing, and joint publication of research in the areas of computational fluid dynamics, automated air traffic control, dynamics and control of large space systems, and crack propagation under variable amplitude loading.

ARF/Aquatic Research Facility (Participants: US, Canada) The Canadian Space Agency is developing a middeck facility to be used on the US Space Shuttle. It will contain experiments from both Canada and the US. The purpose of the facility is to investigate the developmental and physiological effects of microgravity on small aquatic animals and plants. ARF is scheduled for flight in 1994.

Astronaut/Cosmonaut Exchange (Participants: US, Russia) A Russian cosmonaut will fly on a US Space Shuttle/Spacelab mission in 1993. A US astronaut is expected to fly on one long-duration Mir space station mission in 1995. During this same period, a Russian cosmonaut will fly for the second time on a US Space Shuttle mission (first flight in 1993). As part of this 1995 Shuttle mission, the Shuttle will dock with the Mir space station. The guest US and Russian crew members are to be exchanged during this linkup, each returning to Earth aboard their own nation's spacecraft.

Astromag (Participants: US, Italy) Studies are underway for the joint development of the Astromag superconducting magnet facility for space physics research.

Astro-D or SXO/Spectroscopic X-ray Observatory (Participants: US, Japan) Japan provided the spacecraft, launch, and balance of the scientific payload for this X-ray observatory. The US will receive 25% of the science data for its contribution of thin foil mirrors and charged coupled device detectors. Astro-D was launched in February 1993 and is performing nominally.

Astro-SPAS (Participants: US, Germany) The Astro-SPAS reusable satellite, developed by Germany, will carry joint US-German scientific instruments for investigations in astrophysics and Earth sciences, including the Orbiting and Retrievable Far and Extreme Ultraviolet Spectrometer (ORFEUS) and Cryogenic Infrared Spectrometer Telescope (CRISTA). The missions will be launched and retrieved by the US Space Shuttle in 1993. Two additional flights are planned.

Atlas/Atmospheric Laboratory for Applications and Science (Participants: US, Japan, France, Belgium, and Germany) Atlas is a series of US Space Shuttle missions. Atlas-1, a US Space Shuttle mission, launched in March 1992, for investigation of the Earth and solar atmosphere carried among its instruments a Belgian Solar Constant Radiometer (SOLCON) and Grille Spectrometer, a Japanese space experiment with Particle Accelerators, the French Solar Spectrum (SOLSPEC), French Investigation on Atmospheric Hydrogen and Oxygen Through the Measurement of Lyman Alpha (ALAE), and German Microwave Atmospheric Sounder (MAS). Data analysis efforts continue.

AXAF/Advanced X-Ray Astrophysics Facility (Participants: US, Netherlands) The Netherlands is providing the Low Energy Transmission Grating Spectrometer for this US astrophysics mission, to be launched aboard the US Space Shuttle in 1999.

CANEX-2 (Participants: US, Canada) CANEX-2 was a Shuttle reimbursable payload launched in September 1992 with a Canadian Payload Specialist on board. The CANEX-2 Space Vision System was tested during this flight. Data analysis efforts continue.

Cassini (Participants: US, Austria, ESA, Italy) This mission will investigate the Saturnian system. Italy is expected to develop Cassini's high-gain/low-gain antennas and Visual and Infrared Mapping Spectrometers (VIMS), as well as Cassini's radar and radio science subsystem. The US will provide the Cassini Saturn orbiter, and ESA the Huygens atmospheric probe to Titan. An Austrian is serving as an investigator on the Ion and Neutral Spectrometer (INMS) investigation. Numerous other foreign investigators will develop scientific instruments and take part in data analysis. Cassini is scheduled for launch in 1997.

Cosmos (Participants: US, Russia) NASA conducts biological research experiments on unmanned Russian (formerly Soviet) life science satellite missions. Eight experiments have flown since 1975.

CRRES/Combined Release and Radiation Effects Satellite (Participants: US, Germany) Germany contributed an instrument for the investigation of auroras to the CRRES satellite, launched in March 1992. Data analysis efforts continue.

EOS/Earth Observing System (Participants: US, Canada, ESA, Japan) Canada will provide the Measurement of Pollution in the Troposphere (MOPITT) instrument for flight on NASA's polar platform EOS AM-1, scheduled for launch in 1998. In addition, Japan will provide an Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) instrument for the EOS AM-1 platform. ESA will provide a Multifrequency Imaging Microwave Radiometer (MIMR) instrument for flight on NASA's polar platform EOS PM-1.

ERS-1/European Remote Sensing-1 (Participants: US, ESA) The US is providing ESA with direct data read-out from Europe's all-weather remote sensing satellite system, ERS-1, launched in July 1991.

EURECA/European Retrievable Carrier (Participants: US, ESA) Three European missions are planned for microgravity experiments to be orbited from the US Space Shuttle and retrieved. The first mission occurred in July 1991. Arrangements for second and third missions are on hold.

Facilities (Participants: US, Australia, Spain) Australia and Spain are each host to large tracking stations that together with similar tracking stations located in the US make up NASA's Deep Space Network (DSN). Spain also maintains three emergency landing sites for the US Space Shuttle.

FUSE/Far Ultraviolet Spectroscopic Explorer (Participants: US, Canada) Canada will provide instruments for this mission in exchange for observation time. FUSE is to be launched aboard the US Space Shuttle around the year 2000.

Galileo (Participants: US, Germany, France) Germany provided the orbiter's retropropulsion module for insertion of the spacecraft into Jovian orbit, and the bipropellant engines for mission maneuvers. Galileo, which will arrive at Jupiter in 1995, also carries two German-sponsored experiments and five others in which Germany is participating to study Jupiter's atmosphere, magnetosphere, and moons. French investigators are participating in data analysis.

Gamma Ray Balloon Flight Program (Participants: US, Russia) US and Russian gamma ray spectrometers were flown together on a US-sponsored balloon flight in Antarctica. Data analysis efforts continue.

Geodynamics (Participants: US, Israel, Norway, Switzerland) The Israeli Space Agency operates the Bar Giora Satellite Laser Ranging (SLR) station for NASA. This station provides a reference point for both SLR and Global Positioning System (GPS) measurements of motion in the study of global and regional plate tectonics. NASA and the Norwegian Mapping Authority are collaborating in making joint global geodynamic observations using space geodetic techniques, such as very long base interferometry, SLR, and GPS. NASA and the Swiss Federal Office for Education and Science, through the University of Bern, will be applying space geodetic techniques in support of precise geodetic measurements by the mid-1990s.

GRO/Gamma Ray Observatory (Participants: US, Germany) Germany provided the COMPTEL (Imaging Compton Telescope) instrument for gamma ray observations and contributed greatly to the EGRET (Energetic Gamma Ray Experiment) instrument on this US mission currently operating on orbit.

Hipparcos (Participants: US, ESA) NASA is providing tracking support and US investigators for this European astrometry mission, which was launched in 1989.

Hubble Space Telescope (Participants: US, ESA) ESA provided the Faint Object Camera (FOC), the solar array, and post-launch operational support in exchange for 15% of the Telescope's viewing time. Hubble is currently operating on orbit.

IBEX/FIREX (Participants: US, Italy) Italy provided a Fourier Transform Spectrometer (FTS) for the US Infrared Balloon Experiment (IBEX) launched in late 1992 and will provide the same instrument for its successor Far Infrared Balloon Experiment (FIREX). The launch date for FIREX has yet to be determined. Data analysis efforts continue.

IML-1, -2/International Microgravity Laboratory-1, -2 (Participants: US, ESA, Germany, Canada, Norway) The ESA, Germany, Canada, and Norway participated in the US IML-1 Spacelab mission launched aboard the US Space Shuttle in January 1992. ESA and Germany are participating in the IML-2 Spacelab mission, scheduled for launch in 1994.

Isaiah Life Sciences Experiment (Participants: US, Israel) An Israeli scientist developed and now serves as principal investigator on the Isaiah life sciences experiment, which flew on the US Space Shuttle (flight STS-47). Isaiah was intended as a gravity perception experiment and involves investigating the reaction of hornets to the Shuttle's microgravity environment. Data analysis efforts continue.

ISTPP/International Solar Terrestrial Physics Program (Participants: US, Austria, Australia, Canada, ESA, France, Italy, Japan, Norway, Russia, Switzerland) Japan built the Geotail spacecraft under the Collaborative Solar Terrestrial Research Program (Costr) and Global Geospace Science (GGG) parts of the ISTPP. Launched in July 1992, Geotail's mission is to investigate the plasma physics environment near the Earth's magnetosphere geotail. Geotail carries a variety of Japanese/US instruments. Russia and France are participating with the US in the Wind satellite investigation which is under the GGS element of the ISTPP. France is providing investigators to participate in data analysis efforts. Russia will provide the gamma ray burst instrument, KONUS, for use on the Wind spacecraft. The Wind satellite will be launched in 1993. As part of the 1994 US POLAR mission of the GGS element of the ISTPP, Australia, Canada, Norway, and Switzerland are contributing investigators for a variety of experiments. In 1995, ESA will launch four identically instrumented Cluster spacecraft as part of the Costr element of the ISTPP effort. The spacecraft will be built by ESA but will carry a range of ESA and US plasma physics instruments on board. An Austrian is serving as the Principal Investigator on the Active Spacecraft Potential Control experiment under the Costr program's Cluster Mission series. This particular Cluster mission is scheduled for launch on an Ariane 5 in 1995. Switzerland is providing two investigators for the Ultraviolet Chronograph Spectrometer (UVCS) instrument as part of the Solar and Heliospheric Observatory (SOHO) mission element of Costr under the ISTPP. SOHO is scheduled for flight aboard a US Atlas II launch vehicle in 1995. The SOHO spacecraft, provided by ESA, will carry several ESA/US shared instruments. Italy will provide the spectrometer portion of the Ultraviolet Coronal Spectrometer (UVCS). Launch is scheduled to occur in 1995 on a US Atlas II rocket.

Joint Studies with Japan (Participants: US, Japan) Joint studies of Crustal Plate Motion; Geodesy and Geodynamics by laser ranging, X-Ray Astronomy, and the Solar-A spacecraft are currently underway.

Lageos II and III (Participants: US, Italy) Italy's Lageos laser reflector satellite for Earth geodynamics research was launched from the US Space Shuttle in September 1992. Technical discussions are underway on the feasibility of a third Lageos for relativity experiments.

Magellan (Participants: US, Russia) A group of Russian scientists is participating in data analysis for the US Magellan Venus mapping mission.

Mars Observer (Participants: US, France, Russia, Austria) The US flew a French-built transponder on the US Mars Observer in September 1992. This transponder will serve as a communications relay for the Russian Mars '94 balloon mission. An Austrian is serving as an investigator for the magnetometer portion of the Mars Observer mission.

Mars '94 (Participants: US, Russia, France) US and French scientists are conducting joint studies to identify promising Mars landing sites for the Russian Mars '94 balloon mission. The US is providing the communications relay for this mission using a French-supplied transponder aboard the US Mars Observer spacecraft. Discussions to provide US tracking support are also underway.

MFE/Magnolia--Magnetic Field Explorer (Participants: US, France) France will provide the satellite for MFE, which will be launched in 1994. Both France and the US will provide magnetometers for the mission, and the US will provide the single electric field detector.

Msat/The US Mobil Satellite Program (Participants: US, Canada) This satellite communications program (to foster a new industry and provide for public service needs) will involve the Canadian Space Agency in a yet-to-be-determined manner. Launch is anticipated in 1994.

OSL/Orbiting Solar Laboratory (Participants: US, Italy, Germany) Italy will provide an Extreme Ultraviolet Imager (XUVI) as an instrument for this US investigation of the solar atmosphere. The launch date for this mission has yet to be determined. OSL will also carry a German Solar Spectrograph.

POES E-M/Polar Orbiting Environmental Satellites (Participants: US, France, Canada) Canada has provided search and rescue system instruments to receive aircraft signals and ship emergency beacons for this US weather satellite program. France provides the Argos Data Collection and Platform Location System.

Radarsat/Radar Satellite (Participants: US, Canada) Canada will provide all instruments on Radarsat in exchange for launch on a US Delta rocket in 1994.

Radioastron/Spectrum-Radio (Participants: US, Russia) The US will loan four data recorders to Russia for this radioastronomy investigation. The US will also provide Deep Space Network tracking support. The exact launch date is still under review but may occur in 1994.

Rosat/Roentgen Satellite (Participants: US, Germany, UK) The UK provided the wide-field camera for this X-ray astronomy mission, which is currently operating on orbit. Germany provided the spacecraft and telescope. The US launched the spacecraft and provided the High Resolution Imager. Data analysis efforts continue.

Rosetta Comet Sample Return (Participants: US, ESA) Discussions are in progress concerning the division of responsibilities for this mission planned for 2001.

SAC-B (Participants: US, Argentina, Italy) Argentina will contribute the spacecraft bus and a solar X-ray instrument to this joint mission, which will monitor solar activity and associated effects on the environment. Italy will provide an imaging particle spectrometer. NASA will provide a solar X-ray cosmic background instrument built by Penn State University, handle launch operations, and assist with on-orbit data monitoring. Argentina will be responsible for integration. SAC-B will launch on a US expendable launch vehicle in 1994. A SAC-B Follow-On mission is also under discussion.

SFU/Space Flyer Unit (Participants: US, Japan) The Japanese Space Flyer Unit, a free-flying, multipurpose reusable satellite, will be retrieved by the US Space Shuttle approximately 6 months after its launch aboard the H-2 in 1995.

SMEX/Small-Class Explorers (Participants: US, Germany) Germany is contributing a Heavy Ion Large Telescope (HILT) to the US Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX), launched in July 1992, and an Acousto-Optical Spectrometer (AOS) to the US Submillimeter Wave Astronomy Satellite (SWAS) scheduled for launch in 1995.

Sounding Rockets (Participants: US, Australia, Canada, Norway, Sweden) NASA, in conjunction with Australia, Canada, Norway, and Sweden, has several on-going joint sounding rocket research projects underway for a variety of scientific purposes. Launches occur both in the US and at sites provided by the host nation.

SLS-1, -2, -3/SpaceLab Life Sciences-1, -2, -3 (Participants: US, France, Russia) Russian and French investigators are participating in the post-mission analysis of life sciences data gathered by US Space Shuttle crews during SLS missions. France and the US are jointly developing a Rhesus large primate facility to fly on SLS-3. SLS-1 flew in June 1991, SLS-2 will fly in 1993, and SLS-3 in 1995.

SL-D2/Spacelab-D2 (Participants: US, Germany) This second German Spacelab mission was a partially reimbursable flight and carried two German payload specialists as part of the flight crew. SL-D2 flew in April 1993.

SL-J/Spacelab-J (Participants: US, Japan) Japan provided materials science and life science experiments to this Spacelab mission, launched in September 1992 on the US Space Shuttle (STS-47). The SL-J payload was referred to in Japan as the Japanese First Materials Processing Test experiment (FMPT). Data analysis efforts continue.

Space Science Working Groups (Participants: US, Russia) US and Russian scientists are conducting joint studies to identify promising Mars landing sites. Discussions are underway regarding the use of the US Deep Space Network to track the Russian Mars '94 mission. Data exchanges and personnel exchanges are on-going, as well as discussions regarding coordinated observations and the exchange of flight opportunities for scientific experiments in the areas of solar terrestrial physics, Earth sciences, space medicine, astronomy and astrophysics, and unmanned solar system exploration.

Space Station Freedom (Participants: US, Canada, ESA, Japan, Italy, Russia) Canada will contribute the Mobile Servicing System robotic arm for assembling, maintaining, and performing station operations. Japan will provide the Japanese Experiment Module (JEM), which contains a Pressurized Module, Exposed Facility with manipulator system, and Experiment Logistics Module for the international space station. ESA will be contributing a laboratory module, a free-flying experiment module, and a polar platform for Earth observation. Italy and the US are considering cooperation on an attached Life Sciences Mini-Laboratory (LSML) and have agreed to incorporate a Mini-Pressurized Logistics Module (MPLM) as part of the international space station. Russia and the US are evaluating the feasibility of using the Russian-built Soyuz spacecraft as an assured crew return vehicle for Space Station Freedom.

Spectrum-X-Gamma (Participants: US, Russia) The US is considering flying an X-ray All Sky Monitor and an X-ray Polarimeter on the Russian Spectrum-X-Gamma high-energy astrophysics mission in 1994.

SRL/Space Radar Laboratory (Participants: US, Italy, Germany) Italy and Germany will provide an X-Band Synthetic Aperture Radar for this US Earth science program. The first mission is planned for 1994, with two missions to follow at 18-month intervals.

TOMS/Total Ozone Mapping Spectrometers (Participants: US, Russia, Japan) One of NASA's four Total Ozone Mapping Spectrometers (TOMS) flew on a Russian Meteor-3 weather satellite in 1991. A second instrument will fly on the Japanese ADEOS mission in 1996, while the third and fourth instruments will fly on US spacecraft.

Topex-Poseidon Mission/Ocean Topography Experiment (Participants: US, France) The US/French Topex/Poseidon Earth science mission carries two French and five US instruments. Topex/Poseidon was launched on Ariane 4 in August 1992.

Trace-A/Transport and Chemistry near the Equator-Atlantic (Participants: US, Brazil) Trace-A is an agreement between NASA and Brazil to cooperate in this third in a series of Global Tropospheric Experiments (GTE). Data analysis efforts continue.

TRMM/Tropical Rainfall Measuring Mission (Participants: US, Japan) The TRMM will carry both US and Japanese instruments and be launched by the Japanese H-2 in the late 1990s as part of the US Earth Probes Program.

TSS/Tethered Satellite System (Participants: US, Italy) Flown in 1992, Italy built the TSS satellite and provided scientific investigators; the US was responsible for TSS deployment and systems integration and provided scientific investigators of its own. Technical anomalies resulted in the experiment being cut short. NASA is considering re-flying the TSS on another Shuttle mission.

UARS/Upper Atmosphere Research Satellite (Participants: US, Canada, UK, France) Canada contributed the Wind Imaging Interferometer (WINDDII) instrument to the US UARS, launched in September 1991. The UK provided the Improved Stratospheric and Mesospheric Sounder (ISAMS). French investigators are participating in data analysis.

Ulysses (Participants: US, ESA) The US provided the launch, Radioisotope Thermoelectric Generator (RTG) power source and half the payload, and Deep Space Network tracking support to this European spacecraft. Ulysses was launched in 1990 to investigate the Sun.

USMP-1/United States Microgravity Payload-1 (Participants: US, France) France provided a materials processing furnace experiment, MEPHISTO, on the USMP series of five US Space Shuttle microgravity missions, beginning with USMP-1 in September 1992.

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ANSER
Suite 800
1215 Jefferson Davis Highway
Arlington, Virginia 22202

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