

PHYSICS COMMUNITY

To Realize Its Space Exploration Plans, ESA Must Revise Its Strategies

The prime role of the European Space Agency is not to do small, fast, cheap missions, but to do missions of a caliber that individual nations alone cannot afford. This means missions with their own scientific personalities," says Giovanni Bignami, the Italian Space Agency's director of sciences. But that's about to get a little harder: In May, ESA's 14 member states set the agency's annual budget for space sciences at around 365 million euros (a euro roughly equals a US dollar) through the year 2002. The total is about 75 million euros shy of the sum requested by ESA's science director, Roger Bonnet. "We are already an efficient organization. When all the flesh is out, it's very hard to take the bones away," he says.

The budget squeeze is forcing ESA to rethink how it does business, says Giacomo Cavallo, head of ESA's office of science program planning and coordination. "But we will not touch the substance. We don't cancel missions." On the table, he says, is a proposal that missions be approved later in the development process, when the money can be counted on. "Maybe this won't be accepted. Maybe the community will prefer to have a big fight, and then be certain that the winner will fly." Other strategies are to review implementation of the space program every time resources are allocated; to exploit new, and therefore risky, technologies; and to collaborate more with NASA and other space agencies. These ideas for reducing spending are still being discussed, says Cavallo. "ESA will take a decision in November."

ESA's long-term space sciences program, Horizons 2000, was adopted in 1985 and extended in 1995. It aims to launch one spacecraft per year, up from six per decade, and foresees a fleet of missions of various sizes, parallel in scope and cost (though fewer in number) to NASA's. ESA's program, which accounts for about half of space sciences spending in Europe, is funded at about one-sixth the level of NASA's. (At press time, however, NASA was being threatened with a roughly 10% budget cut, including slashing the space sciences budget by about a third.)

The newly approved budget is not the first to fall short of ESA expectations: In 1995, dues to the program

▶ Faced with a lean budget, ESA wants to adopt the good aspects, and avoid the bad, of the "faster, better, cheaper" model set by NASA.

were reduced at the UK's insistence. Consequently, says Bonnet, "some missions have had to be downsized, some science has had to be constrained, with fewer possibilities for expanding the scope." One efficiency is the planned joint launching in 2007 of FIRST, a far infrared and submillimeter telescope to look at galaxy and star formation, and Planck, which will look at cosmic background radiation. Pairing the missions will save ESA up to 250 million euros, reckons Bonnet. "We have to do the same number of missions, if not more, with less money."

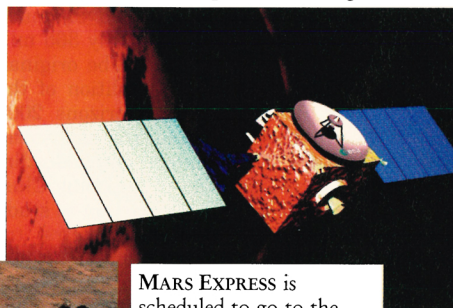
This time around, continues Bonnet, Germany, whose dues account for a fourth of ESA's space sciences budget, agreed to up its contribution by 10 million euros over four years, but "only under strong pressure, and threats of canceling the Mars Express and delaying the FIRST and Planck missions." Explains Gernot Hartmann, who oversees space sciences for the German Space Agency, "Germany's priorities have shifted. Space receives about 10% of the German research budget. Established fields of expensive science are the ones that are forced to be content with no increase, and maybe a little decrease. Other fields like biological research and information technology are being stressed." Even in space research, the tendency in Germany is to support applications-oriented activities "as a means to create future jobs," Hartmann adds.

As part of the recent agreement, ESA's new budget is for four, instead of five, years. That will put pressure on negotiating the next budget, but in the grand scheme of things it's irrelevant, says Lodewijk Woltjer, an astrophysicist and former chair of ESA's space science advisory committee. "What really counts is how much [funding] there is. One ought to talk about increases."

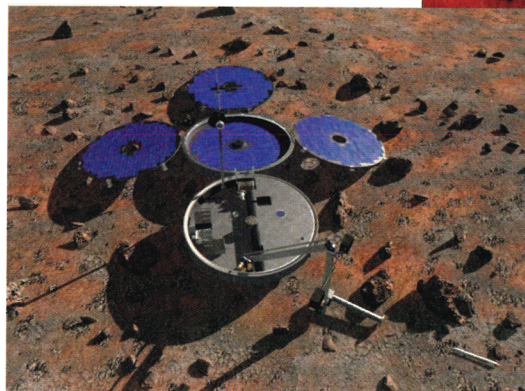
A mixed fleet

ESA's largest projects are the so-called cornerstone missions, which in the updated Horizons 2000 plan are priced at roughly 550 million euros each—about 15% less than an earlier limit. Most imminent is XMM, an x-ray observatory scheduled to be launched in December and designed to have a larger collecting area, but lower spatial resolution, than Chandra, the x-ray telescope sent up by NASA on 23 July.

ESA's midprice missions, called flexibles, can cost up to 175 million euros each, half their earlier allowance. And "Small Missions for Advanced Research in Technology," with a 50 million euro cap, are intended to refine technologies that could make future space flights cheaper. The first in the series, Smart 1, is scheduled to be launched in 2002, and will map the Moon's geo-



MARS EXPRESS is scheduled to go to the Red Planet in 2003 to look for signs of life past or present. The plan is to deploy an orbiter and a lander to study Martian meteorology and surface composition. The lander will have a "mole" (lower right in picture at left) designed to burrow for samples. (Artists' renderings courtesy of ESA.)



chemistry. But its main purpose, Bonnet explains, "will be to test the effect of ion propulsion on electrostatic and optical surfaces. We want to master the method [pioneered by NASA]."

Over the next few months, ESA, with the European space sciences community, plans to prioritize proposed projects through 2012. Beyond that, the uncertainty of the budget makes planning meaningless, says Bonnet. However, warns Norway's Bo Andersen, chair-elect of ESA's top science planning committee, "if our budget is further reduced after 2002, this would jeopardize already started missions." Frontrunner cornerstone possibilities include LISA, a joint mission with NASA to detect gravitational waves; GAIA, a successor to Hipparcos, which would make extremely accurate measurements of positions and motions of stars and Solar System bodies; Darwin, which would hunt for Earth-like planets; and an as yet unnamed mission to Mercury.

"In the discussions we have here now, about which missions to carry out, public acceptability looms larger than it used to," notes British Space Centre director Paul Mordin. Indeed, even in Europe, NASA is better known than ESA, a result of the 1969 moonwalk, which made NASA a household word the world over, and the fact that ESA competes with Europe's national space agencies. "One should educate politicians about science," says Italy's Big-nami. "Realistically, one has to come up with appealing results that politicians can understand and appreciate."

Collaborating carefully

Many technological and scientific challenges lie ahead, says Bonnet. "But the biggest challenge is to do as much science as possible with only 365 million euros a year. And to be original, second to none." The addition of the Mars Express to the Horizons 2000 lineup has increased the near-term pressure on the budget, notes Mordin. So has the problem of financing Cluster 2, a redo of ESA's mission to study Earth's magnetosphere, the first try having failed in 1996 when the Ariane-5 rocket carrying the craft blew up shortly after takeoff. "So two unplanned missions crept into the program," says Mordin.

ESA plans to invest about 170 million euros, or the equivalent of one of its flexible missions, in the NASA-led Next Generation Space Telescope, the successor to the Hubble Space Telescope. But at ESA, enthusiasm for closer collaboration with NASA is guarded. Says the agency's Cavallo, "ESA has made a point not to depend on a collaborator, so that if the partner defaults, the mission can still fly. Now,

Physics Whizzes Quizzed in Padua

The 30th International Physics Olympiad, held in Padua, Italy, in July, was the largest ever: Nearly 300 high school students from 62 countries competed. The two top individual scores were earned by Konstantin Kravtsov and Serguei Syritsyn of the Russian team, which had the highest marks of any team; Iran was second, and was the only country whose five competitors all won gold medals; the US team came in third; and China placed fourth.

Representing the US were Peter Onyisi of Arlington, Virginia, and Andrew Lin of Wallingford, Connecticut (both second-time olympiad competitors), and Benjamin Mathews of Dallas, all of whom won gold medals, and Natalia Toro of Boulder, Colorado, and Jason Oh of Baltimore, who both garnered silvers.

In the theory exam, students were asked to calculate various parameters for a gas in an expandable cylinder shined on by a laser; the period of oscillation of a magnetic needle in a V-shaped magnetic field and the angle of the V required to distinguish between two theories; and the speed of a space probe swooping away from an encounter with Jupiter. In the experimental part of the competition, they had to measure properties of a torsion pendulum.

When the students weren't tackling their exams, they visited, among other sights, Venice, nuclear physics experiments at the Legnaro National Laboratories, and Galileo's rostrum at the University of Padua. The city of Padua hosted a hands-on physics exhibition for the public. The idea, says olympiad secretary Giuliana Cavaggioni, "was to make a link in the name of science between the town and young people from all over the world."

Prior to the olympiad, the US team's 24 members (of whom 5 were selected to compete in Padua) gathered in College Park, Maryland, for a training camp (see <http://www.aip.org/physnews/graphics/html/usteam99.html> for profiles and activities of the team members). The American Institute of Physics organized a breakfast for them on Capitol Hill. It was cohosted by Representatives Rush Holt (New Jersey) and Vernon Ehlers (Michigan), both physicists by training, and attended by about a dozen other representatives. With the Elementary and Secondary Education Act scheduled to be rewritten this year, the primary sponsors of the US team, AIP and the American Association of Physics Teachers, along with six other national scientific and teaching societies, used the breakfast to highlight the need for continued federal support for K-12 education. To draw attention to their message, they sent toy bald eagles to all 535 members of Congress, accompanied by an explanation of the physics of how the toy balances on its beak—its center of gravity is shifted by weights at the wingtips.

The main sponsor of this year's olympiad was Italy's Ministry of Education, with additional support from Italy's Association for Physics Teachers, the University of Padua, municipal and regional authorities, national scientific organizations, business, and other sources. About 18% of the total \$700 000 tab was donated by participating countries.

The 31st International Physics Olympiad will be held in Leicester, England, next summer.

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BERNARD KHOURY/AAPT

AT THE OLYMPIAD CLOSING CEREMONY, the US competitors wait to receive their medals. From left: Jason Oh, Natalia Toro, Andrew Lin, Peter Onyisi, and Benjamin Mathews.



JIM SULLIVAN

THE US PHYSICS OLYMPIAD TEAM breakfasts on Capitol Hill with Vernon Ehlers (at podium) and other congressional representatives.

one proposal is to give up this independence." ESA was also irked by NASA's decision in July to send an orbiter to Mercury, because it means that ESA will have to rethink its own plans for visiting that planet. "It would have been more efficient to properly cooperate on a joint program," says Bonnet. "We need to make sure we do not duplicate, and that we have communication and cooperation." Bignami agrees: "Communication is more and more important. So far, contact is between the two executives—[NASA's head of space sciences Edward] Weiler and Bonnet—and by people knowing each other. But this is not enough. I would dare to propose a truly joint transatlantic advisory committee."

But if it sounds like ESA is following in the footsteps of "faster, better, cheaper," the motto set by NASA administrator Dan Goldin, it's not, insist European space scientists. "The success of NASA is not that convincing. There have been several failures," says Bonnet. Still, admits Cavallo, "We have to do it cheaper. To do that, it must be faster. And no one wants to do it worse."

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Wagner Takes DESY Reins

On 8 July, Albrecht Wagner became the head of the German Electron-Synchrotron (DESY) facility, succeeding Björn Wiik, who died last February. (See Wagner's obituary of Wiik, PHYSICS TODAY, July, page 69.)

Wagner earned a PhD in physics in 1971 from the University of Heidelberg, where he later joined the faculty. Since 1991, he has been a member of the University of Hamburg's physics department as well as DESY's director of research. His research focuses on electroweak interactions, and on the development of gaseous and solid-state detectors.



WAGNER

Wagner plans to keep DESY on its present course. In particular, he says, "we will continue, in a very strong way, research with HERA," the Hadron-Electron Ring Accelerator facility, located at the lab's main site in Hamburg. Wagner's other top priority is moving TESLA toward approval. TESLA, the TeV Energy Superconducting Linear Accelerator, is a planned 500 GeV electron-positron collider with an integrated x-ray free electron laser. Of three such colliders

in the works worldwide, it's the only one designed to have superconducting cavities. That means luminosities four to five times higher than a comparable, room-temperature machine, explains Wagner. "Thanks to superconductivity, we can store the radiofrequency power for a millisecond in the cavities and therefore can accelerate and collide a lot of particles."

Electron-positron colliders are meant to complement higher-energy facilities such as the Large Hadron Collider being built at CERN, says Wagner. "The LHC will be able to detect the Higgs—one of the key questions because it is the key to our understanding of mass." But with a hadron collider, "there is a whole bag of reactions. The electron-positron collision is a much simpler system, so it's better for precision measurements such as determining the Higgs branching ratios and the Yukawa coupling of the Higgs to the top quark, essential for understanding the mechanism of mass generation."

Equally important, continues Wagner, is that an electron beam from TESLA "would be used to drive a free electron laser in the x-ray domain. We plan to build a big user facility." So far, a small test facility is in operation, with lasing at ultraviolet frequencies set to begin early this fall, and to be opened to users in 2003. The technical design and cost estimate for the full TESLA is scheduled to be submitted to the German government and to the project's international partners in the spring of 2001.

Other current projects at DESY include lattice gauge computations and neutrino astrophysics, both of which are carried out primarily at the lab's Zeuthen site, southeast of Berlin.

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Physicist Tapped to Head EC Research

Philippe Busquin, a physicist and the leader of Belgium's francophone Socialist Party, has been nominated to direct the research activities of the European Commission, pending approval by the European Parliament. He would succeed France's Edith Cresson, who was accused of putting her dentist on the commission's payroll and was at the center of other allegations of mismanagement, fraud, and nepotism that led to the previous commission's mass resignation on 15 March.

The parliament is scheduled to vote this month on whether to confirm EC president-designate Romano Prodi and his commission nominees, including Busquin, for five-year terms. "You can't

assume it's a shoo-in," says a Prodi aide. "But Prodi's argument is that he's chosen the right people" to make a clean start.

Busquin's chief responsibilities would be to oversee the Joint Research Centre, which consists of seven research labs across Europe; to implement the EC's current five-year, \$15.8 million research budget, or Fifth Framework Programme; and to plan the successor program, which is slated to start in 2002. Prodi is proposing to add agricultural research to Busquin's responsibilities, and to move education out of the research portfolio and combine it with culture.

Busquin holds a 1962 bachelor's degree in physics from the Free University of Brussels, where he also pursued graduate studies in philosophy and the environment. He taught physics for 15 years, and then from 1978 to 1980 chaired the board of directors of Belgium's National Institute of Radioelements. Busquin has been involved in regional and national politics since 1977, and in June was elected to the European Parliament, although he will resign if he becomes commissioner for research.

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BUSQUIN

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AIP Agrees to Lesser Role in Russian Journals

The American Institute of Physics will continue to have a hand in the publication of English-language versions of Russian physics journals. On 23 June, after nearly two years of haggling, the Russian Academy of Sciences, AIP, and MAIK Nauka, a Moscow-based publishing house, signed a five-year, three-way agreement that takes effect in January.

Under the agreement, MAIK Nauka, which is 51% owned by the Russian Academy of Sciences, will be responsible for translating and publishing English-language versions of 14 journals, and AIP will market and distribute them, as well as publish them on-line. Eight of the journals are already being handled this way (minus the on-line part), but the other six are currently translated and published in English by AIP—an arrangement the journals' editors and AIP favored renewing.

The new agreement was clinched just a week before AIP's deadline for next year's library and subscription catalogs, and for a long time had looked