The scientists of former East Germany endured perhaps the toughest overhaul of any national research system. They came through it, but there are some regrets

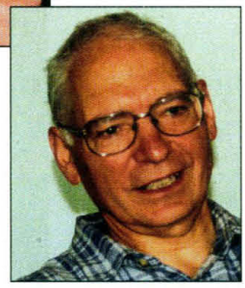
10 Years After the Wall, Science Revives in Eastern Germany

BERLIN—A decade ago, bioinformatics researcher Jens Reich was struggling to keep working within communist East Germany's corrupt research system. Because he had been pegged as a political dissident, his research group in East Berlin had been dissolved and the secret police were tapping his phones. Biochemist Benno Parthier—who had refused to join the communist party—was stuck for the 24th straight year as a group leader at an Academy of Sciences institute in Halle. And Dagmar Schipanski, a successful electronics researcher, was languishing as an assistant professor in Ilmenau with almost no opportunity to travel to Western countries.

Today, Reich is an influential researcher at the Max Delbrück Center for Molecular Medicine, a national research center created in eastern Berlin. Parthier finally got to direct the Institute for Plant Biochemistry in Halle, and in 1990 he was elected president of the Leopoldina science academy (see sidebar). And Schipanski became the first former East German to head the Science Council, then ran for the German presidency earlier this year, and is now science minister for the state of Thüringen.

These three emerged successfully from the years of upheaval that followed the fall of the Berlin Wall on 9 November 1989, but many of their colleagues were not so fortunate. In the general euphoria after the East-West divide was bridged, East German scientists looked forward to joining the well-organized and generously funded research system of their West German compatriots; finally, they would be free to travel and would be insulated from political interference. But for many, absorption into West German research was no salvation. Within 2 years of the wall's demolition, the East German Academy of Sciences was disbanded and the Science Council carried out a tough evaluation of research institutes, which it reorganized, merged, or simply shut down. Researchers had to reapply for their positions, and a large fraction of the academy's 24,000 employees lost their jobs.

This harsh medicine, perhaps the most fundamental overhaul ever applied to a major research enterprise, has transformed former East Germany's once bloated and poorly funded research system. Several basic research institutes—some incorporating parts of centers from the old regime, others started from scratch in the past decade—are now widely regarded as being on a par with those in the west, or at least rapidly gaining ground. University research has not fared so well, however; it is catching up only slowly. And industrial research, which collapsed after reunification, is only now showing signs of life, thanks largely to a growing number of small start-up companies in fields such as computer software and biotech.



Success stories. Dagmar Schipanski *(top)*, Benno Parthier *(middle)*, and Jens Reich have all thrived in a unified Germany.

Today, 10 years after the wall came down, many former East German scientists view with satisfaction the transformations their institutions have endured. But the process has left scars that will be slow to heal. "Overall, I think the restructuring of science in the east has been a success," Schipanski told *Science*. "Researchers are motivated now, and there have been fantastic improvements in their laboratory equipment." Parthier says "the big science transformation decisions were inevitable," but he regrets that so many older East German scientists lost their jobs after 1990 and too many talented young researchers left the country. Reich is pleased that "we now have the opportunity to do world-class research here," but he thinks "we could have done better with the transition, which was done too hastily."

One complaint continues to resonate among researchers in the east: Many feel they have been "colonized." Westerners got the lion's share of the top positions after reunification, and institutes were shoehorned into West Germany's research structures. Germany, some critics believe, missed an opportunity to overhaul the whole system.

Institutes find solid ground

From today's vantage point, the progress in transforming science in the five new states, or Länder, in the east has proved to be far slower and more difficult than expected. It has also been expensive: The research ministry has spent $13 billion so far on research and higher education in the new Länder.

The sprawling East German research system once encompassed some 130 institutions of basic, applied, or industrial research, including about 60 institutes of the East German Academy of Sciences. Some were folded into 31 so-called *Blaue Liste* institutes (now renamed Leibniz institutes, in honor of the 17th-century German mathematician)—midsize, specialist research centers funded equally by state and federal governments. Several others were merged into three new national research centers, funded mainly by the federal government and grants. Another 10 academy sites became applied science institutes run by the Fraunhofer Society.

The German research ministry and national research organizations have been pumping funds into these revamped institutions. Their goal is to spend at least one-fifth of their total resources on research in the east—roughly the region's proportion of the total German population. This year, for example, the research ministry is spending about $1.75 billion on research and universities in the new Länder, including $375 million in direct financing of research projects in specific fields such as biotechnology, space, and environmental research. That represents about 21% of the ministry's total spending—in effect, squeezing budgets for

CREDITS: (TOP TO BOTTOM) F. OSSENBINK/PRESS SERVICE INTERNATIONAL; THE LEOPOLDINA ACADEMY; R. KOENIG

A Cold Spring Harbor Rises in Rebuilt Berlin-Buch

BERLIN—In a once-sleepy area of northeast Berlin, where some of the foundations of molecular genetics were laid in the 1930s, Detlev Ganten and his colleagues at the Max Delbrück Center for Molecular Medicine (MDC) are nurturing a new scientific culture. "We want to become Germany's equivalent of Cold Spring Harbor Laboratory for molecular medicine," says Ganten, a cardiovascular genetics specialist who left Heidelberg in 1991 to become the founding director of MDC—the first of three national research centers to be established in the former East Germany.

That ambitious goal is a far cry from the early years after the fall of the Berlin Wall, when the Berlin-Buch campus—then the home of three respected institutes of the East German Academy of Sciences—was being torn apart, along with much of the east's tainted research system. "You sat at home then and worried about losing your job," recalls MDC biochemist Ernst-Georg Krause. The seeds of a renaissance were sown in 1990 when Krause, then acting director of one Buch institute, helped convince the government to found a national research center on the campus. This new center used parts of the three institutes, which were dissolved along with all academy institutes at the end of 1991.

On the day he arrived at Buch in September 1991, Ganten recalls, "all 1600 employees were in the assembly hall, and the first question they asked was: How many positions will you have? And I had to answer: 350." Today, more than 1800 people work at the Buch campus: about 700 at the MDC itself, another 890 at the nearby university medical clinics, and about 250 at the 30 start-up companies in the new BBB biotechnology center. Next year, the new Leibniz Institute of Molecular Pharmacology will also move to the campus. "We actually created jobs here," says Ganten.

As a national research center, MDC gets about $55 million annually from the federal government. It spends about one-fifth of that sum each year to renovate buildings and buy equipment. "The labs are now state of the art," boasts Ganten, and additional investments are being made in a laboratory animal facility and a new meeting center.

The MDC is building on a rich tradition that began in Buch in 1929, when the Rockefeller Foundation provided a $317,000 grant to help build a Kaiser Wilhelm Institute for Brain Research. In the early 1930s, a Russian geneticist working there, Nikolai Timofeef-Ressovsky, called in Berlin physicist Max Delbrück to help analyze experiments with radiation-induced mutations. That collaboration resulted in a 1935 treatise entitled "On the Nature of Gene Mutation and Gene Structure," which laid the groundwork for molecular genetics.

Phoenix. Pieced together from disbanded East German institutes, the Max Delbrück Center is now thriving.

It was not all smooth sailing from there, however. The Berlin-Buch campus soon had to endure the onslaught of Germany's Nazi government, which involved two researchers conducting some eugenics-inspired research at the original Kaiser Wilhelm Institute. That was followed by the harsh Soviet occupation and 4 decades of East German communism. "The origins of molecular genetics were here in Berlin-Buch," says Ganten, "and we want to play an important role in its future, too."

Although Delbrück moved to the United States in 1937—and won a Nobel Prize at the California Institute of Technology before his death in 1981—his links with Buch continue. His family has now funded an MDC scholarship, and two of his grandnephews are now working in Buch. Now that the MDC is thriving, Ganten says his dream is to develop "a human science society" in the Buch area, which will organize scientific congresses, art exhibits, and museums. Says Ganten: "We want to create a community that is driven by technology, and a stimulating combination of the arts with basic and natural sciences."

–R.K.

institutes in the west to help pay for massive upgrades in the east.

While national research centers and Leibniz institutes have tended to build on old foundations in the east, the Max Planck Society—Germany's premier basic research organization—has taken a different tack. Instead of picking out the best academy labs to support, it founded 19 new institutes in the east. "We wanted institutes which have excellent prospects for future development and would bring long-term benefits for eastern Germany in exciting new research areas," says Max Planck president Hubert Markl. Among those institutes are Leipzig's Institute of Evolutionary Anthropology, which Markl calls "a gold mine for future research" because of its world-class scientists and its interdisciplinary approach, and Dresden's Institute for Molecular Cell Biology and Genetics, which is attracting gifted young researchers from Germany and surrounding central European nations to focus on cell division, polarity, and membrane transport. Since some of those institutes are just now getting under way, it is too early to tell whether the investments will pay off. Markl says, "I am satisfied that we have done well, but that does not necessarily mean that all 20 institutes will be considered a success 20 years from now."

Even so, many scientists say they see great improvements in the quality of the region's research. Andre Rosenthal, who leads the main sequencing team for Germany's part of the human genome project at the Institute for Molecular Biotechnology (IMB) in Jena, says the percentage of "top science" in the new Länder has risen substantially. He puts the fraction at "no more than 5%" in the old East Germany. Detlev Ganten, a molecular biologist who heads Germany's Helmholtz Association of national research centers and also directs the Max Delbrück Center, thinks "the quality of science in the nonuniversity institutes of the new Länder is just as good as the quality of research in the west."

Despite the overall progress, some institutes in former East Germany still face recruiting problems, in part because most salaries there are 13% below those in the west, and some top-notch scientists aren't

NONUNIVERSITY RESEARCH INSTITUTES IN FORMER EAST GERMANY

Organization	Total institutes	No. in former E. Germany
Max Planck Society	79	19*
National research centers	16	3†
Leibniz institutes	79	31
Fraunhofer Society (applied science)	63	10

(NOTE: The population of the new Länder is 16 million, about one-fifth of the total German population) * Max Planck Society total does not include a satellite institute in Greifswold. † Total does not include branch institutes in the new Länder that report to centers in western Germany.

CREDITS: (TOP) BBB GRAPH (BOTTOM) SOURCE: INSTITUTE ADMINISTRATIONS

Venerable Academy Tended the Flame Of Independence

HALLE—When Germany's unification treaty dissolved the politically tainted East German Academy of Sciences at the end of 1991, it spared another academy in eastern Germany with a far richer tradition and a less sullied reputation: the German Academy of Natural Scientists Leopoldina. Founded in 1652 and named after the Holy Roman Emperor Leopold I, the Leopoldina is German-speaking Europe's oldest science academy. Although it is an international body, it has focused for three centuries on natural scientists and medical scholars from Germany, Austria, and Switzerland.

The Leopoldina is no stranger to turmoil. It uprooted its headquarters from university to university a dozen times before settling in Halle in 1878. But its sternest test came during East Germany's 40-year existence, when the Leopoldina members in the east suffered political surveillance and strict travel limitations. Even so, the academy maintained its outside ties, with West Germans always dominating its governing board. "It was the only scientific organization in East Germany that kept its political independence," says biochemist Benno Parthier, who became the Leopoldina's 24th president in 1990. "If we had been laden with Communist Party members, we might have imploded during those years."

Unlike the East German Academy, which operated 60 research institutes and had close ties to the communist government, the Leopoldina is primarily an independent scholarly academy, which publishes journals, distributes annual awards, and organizes meetings on scientific topics. Its members have included Germany's greatest writer, Johann Wolfgang von Goethe—who was also an avid scientist—and perhaps the greatest German-born scientist, Albert Einstein, whose name was scratched off the Leopoldina's membership list along with about 80 other Jewish scientists during the Nazi era. In all, about 156 Nobelists over the past century have been members of the Leopoldina. But not every German scientist admires the Halle academy; one prominent eastern German researcher who is not a member called the Leopoldina a "stuffed-shirt academy, rather than a research academy."

Last year, Germany's Science Council gave the Leopoldina a positive evaluation, commending it for "helping maintain the ties between science in East and West Germany" before German unification. Today, two-thirds of the Leopoldina's 950 members are from German-speaking Europe—including about 80 from Switzerland and 30 from Austria—and the other third are international members, including about 70 from the United States.

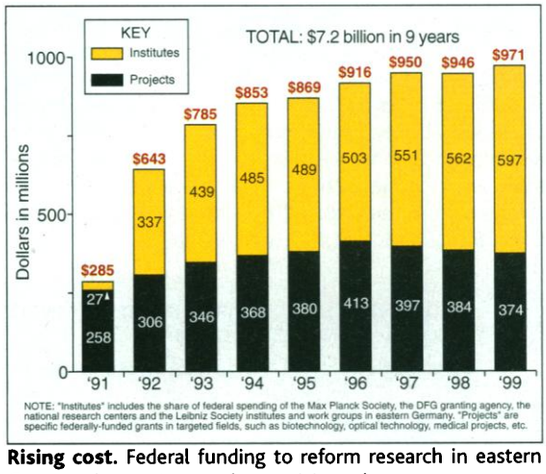
Some German scientists who want to establish a national science academy have suggested that the Leopoldina might become the kernel of a wider new academy, which would include scholars from fields other than the natural sciences and medicine. "It's an intriguing idea," says Parthier, who has been involved in discussions about the proposal with leaders of Germany's national research societies and state academies. "But our traditions won't be changed easily." **–R.K.**

interested in living in the less favorable surroundings of the east. Leibniz Society president Frank Pobell, a physicist who directs former East Germany's largest research center, Dresden's Forschungszentrum Rossendorf, says that even in the most pleasant cities of the new Länder, such as Dresden, "we sometimes have trouble attracting the best postdocs."

Universities and industry: slower progress

Although some institutes in the east are clearly doing well, many university labs are struggling. One reason is that they had much further to come. East Germany's science system was modeled on Russian science: The best research tended to be conducted at institutes of the Academy of Sciences, whereas university research was shortchanged. The equipment at many university labs was outmoded and, by 1989, many of the buildings were in bad shape. Indeed, in spite of great improvements at most eastern universities during the past decade, Parthier—a professor at Halle's University—thinks it may take a generation to reach parity with the west. Compared to well-equipped nonuniversity institutes, he thinks "universities are further behind in research."

Statistics provided by Germany's DFG basic research granting agency, which focuses mainly on university research, support this view. Eastern Germany's share of the DFG's regular grants hit rock bottom in 1992 at 8.7%, jumped to a peak of 16.7% in 1994, but has now stabilized at about 13.6% of the German total—considerably below the region's share of the total German population. Christoph Schneider, director of the DFG's scientific affairs department, says former East German universities "have been holding their own" when it comes to DFG grants, but he adds that some new Länder "overextended their budgets" by founding new universities after 1990. Pobell, who is also a professor at Dresden's Technical University, adds, "The states in the east simply don't have the money to fund universities adequately."



Rising cost. Federal funding to reform research in eastern Germany has cost more than anticipated.

Compared to their colleagues in industry labs, however, academic scientists are doing well. "Industrial research here broke down after unification," says Schipanski. This collapse can be attributed to the closing down of many of East Germany's outmoded industries and their related research institutes. Although western companies have set up new plants in the eastern Länder, few have transplanted their R&D operations. There are some signs of new activity as small biotech and software companies are now springing up, but the east's industrial research is dwarfed by the research units of the west's chemical, pharmaceutical, and automotive giants, which employ thousands of scientists. Both Markl and Ganten regard the weakness in industrial research as the biggest single problem facing former East German science today.

A missed opportunity?

While basic researchers in the new Länder are grateful that their best science was not allowed to fade away after unification, many see the reforms as a takeover by the west: Most top positions have gone to westerners or foreign researchers, and the eastern Germans have been forced into what some believe to be an imperfect research system.

An estimated two-thirds of the top research positions in the region are now held by scientists from elsewhere, mainly western Germans. Rosenthal, for example, is the only one of six section leaders at IMB who had

CREDITS: (TOP TO BOTTOM) THE LEOPOLDINA ACADEMY; SOURCE: GERMAN RESEARCH MINISTRY

done research in East Germany before the wall came down. At the new Max Planck institutes, 40% of the directors were recruited from abroad (compared with 20% of foreign directors for Max Planck institutes in general), and only a few directors are eastern Germans. According to Werner Meske of Berlin's Center for Social Research, only a handful of eastern scientists moved to the top management positions at the new Leibniz institutes or other research centers, although more than half of the section leaders of some institutes are eastern Germans.

Rosenthal—an East Berlin scientist who was doing postdoc work in Cambridge when Germany reunified—argues, however, that the influx of talented researchers has helped revitalize science in the region. "We should feel privileged that so many good scientists came here," Rosenthal says. And Markl says Max Planck recruited many directors from abroad "because we wanted to create new institutes that would be on the cutting edge of certain fields of research. If we had sent 90% of the directors from West Germany, then perhaps it could have been viewed as a sort of 'colonial' takeover from the west."

But some eastern scientists also think that West Germany's leaders passed up a golden opportunity by imposing their own science system on the east without revamping that system at the same time. "Some aspects of West Germany's science system were also in need of reform," says Schipanski. Reich argues, for example, that the current system makes it difficult to "explore unexpected new lines of research" because it places too much emphasis on short-term results. Such criticisms make sense "only in hindsight," Markl counters. "If we had not imposed the west's system, then it would have taken much longer to revitalize science in the east," he says. "We could have spent 10 years just debating how to revamp Germany's entire science system." While he acknowledges that some aspects of science's transformation are debatable, Markl—who was DFG's president in 1989—thinks the transition was handled well overall. "Fifty years from now, I think we will look back and see German unification in science as a success story," he says. "The progress may be slower than we had hoped in 1989, but it is remarkable nonetheless." **–ROBERT KOENIG**

ASTRONOMY

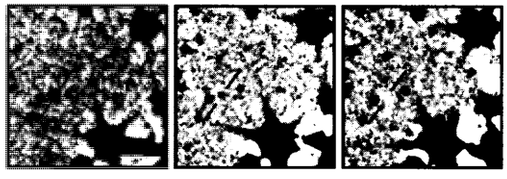
Links Between Supernovae and Gamma Ray Bursts Strengthen

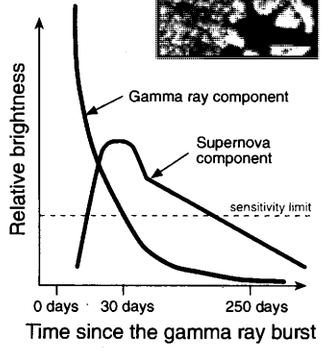
Two strong connections and three other possible links between supernovae and highly energetic "long" gamma ray bursts have recently been established

Want to make the ultimate bomb? Here's Stan Woosley's recipe: Take a supermassive star, strip away its outer mantle of hydrogen, and let its core collapse under its own weight. The result is a black hole with two extremely powerful jets of matter, producing a titanic flash of deadly gamma rays and blowing apart whatever's left of the star in a huge supernova explosion.

For several years, Woosley, a theorist at the University of California, Santa Cruz, and Bohdan Paczyński of Princeton University have been advocating such supernova models to explain some of the puzzling bursts of gamma rays that Earth-orbiting observatories have picked up from sources billions of light-years away. But their models have lacked direct observational support—until now. Astronomers have now linked as many as three "long" gamma ray bursts (lasting for more than 5 seconds) to supernova explosions, and two more possible cases have surfaced over the past few weeks.

"It's terrific," says Woosley. "The observations are much along the lines of our models. We're very gratified to see it happen." Establishing a possible connection between gamma ray bursts and supernovae is "really exciting," adds Craig Wheeler of the University of Texas, Austin, because it provides a new way of studying these stellar explosions. However, he cautions that "nobody knows how to take a physical event [like a supernova] and make a gamma ray burst out of it." And Paczyński and others have suggested that, because supernova models predict relatively long-lasting gamma ray–producing jets, bursts less than 5 seconds long may be caused by a different phenomenon, such as the collision of two neutron stars.





Going, going ... Spot associated with gamma ray burst fades then disappears in images taken on 27 March, 17 April, and 18 December 1998 (*top*). A Caltech group argues that a supernova explains the slow fade (*diagram*).

CREDIT: (GRAPH AND PHOTOS) S. R. KULKARNI/CALIFORNIA INSTITUTE OF TECHNOLOGY

Gamma ray bursts have been observed since the 1970s, but it wasn't until early 1997 that astronomers, using the Italian-Dutch satellite BeppoSAX, were able to pinpoint their location precisely enough to look for counterparts at optical wavelengths. They linked several bursts to nothing more specific than fading spots of light in the sky. But the spectra of these inconsequential spots indicated that they lie at enormous distances, which implies that their true energy output must be tremendous. Indeed, gamma ray bursts are the most energetic explosions in the universe, second only to the big bang itself (*Science*, 26 March, p. 2003).

The first indication of a possible supernova connection came last year when a team led by Titus Galama of the University of Amsterdam linked a gamma ray burst, called GRB 980425, to a relatively nearby supernova, 1998bw (*Science*, 19 June 1998, p. 1836). The claim was controversial, however, because the supernova didn't coincide with a variable source of x-rays that appeared to be related to the gamma ray burst. Now, two more sightings and two additional coincidences have strengthened the supernova link.

The first came from a bright gamma ray burst, GRB 980326, that was spotted on 26 March 1998. Over the next 3 weeks, the burst's optical afterglow faded, and by mid-April all that was left was a faint glow, which astronomers assumed came from the distant galaxy in which the burst originated. On 18 December, a team of astronomers led by Joshua Bloom of the California Institute of Technology (Caltech) in Pasadena reobserved the location of GRB 980326 with the 10-meter Keck II telescope on Mauna Kea, Hawaii. To their surprise, the pictures showed nothing at all where the putative galaxy should have been. Because "galaxies do not just disappear," says Caltech team member Shrivinas Kulkarni, the astronomers realized that what they witnessed in April might have been the slow flare of a supernova. A thorough reanalysis of their original data backed up this view: The supernova must have continued to fade, and the