The New Main Building

The Historic Astrophysical Observatory

Even with its rusty cupolas and a birch tree pushing up through its brickwork, the 120-year old Astrophysical Observatory inspired admiration. Following the loving restoration over the past few years, however, the decadent charm acquired by the building after World War II has disappeared and its serious interest in scientific research has resurfaced.

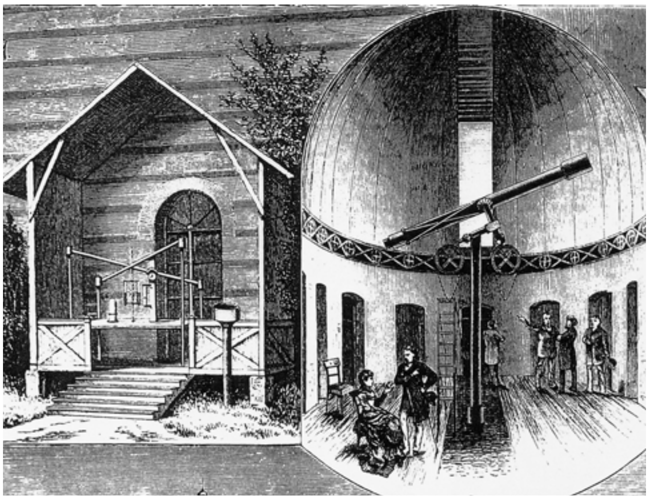
The basic renovation under the direction of architect Friedrich Karl Borck, costing approximately DM 8 million, and the underground extension constructed for PIK's new high-performance IBM computer at a cost of DM 2.7 million, were carried out with funding from the European Union, the State of Brandenburg and the German Federal Government.

The listed building with its three characteristic cupolas is to become PIK's new head office. The new rooms can only accommodate about 40 of the approximately 190 staff, mainly management and administrative staff. The conference and seminar room is located under the central cupola. This room and the other cupolas were used by astrophysicists as a solar observatory up to the end of the last century. Night-time observation was gradually transferred to more favourable observation sites as far back as the 1970s. Only the eastern cupola has retained its rotating and retractable roof and following restoration astronomers will continue to use it as a solar observatory. The other cupolas have been fixed and insulated at great expense as part of the renovation process.

The Potsdam Astrophysical Observatory was established in 1879. It was the first of the Royal Observatories and other scientific buildings to be designed by architect Paul Emanuel Spieker on the Telegrafenberg and the first

institute in the world to bring together astronomy and physics. The predominant interest at that time was in the physics of the sun but also in the connections between sun, climate and the Earth. This is also reflected in the subsequent scientific buildings on the Telegrafenberg. In 1881 in the basement under the eastern cupola of the Astrophysical Observatory, Albert A. Michelson for the first time performed his famous experiment proving that the speed of light in a vacuum is identical in every direction and is a maximum speed that cannot be exceeded. Consequently, according to the initial premise of the experiment, the orbital movement of the Earth has no influence on the speed of light. In attempting to understand the results of this experiment, Albert Einstein established his Special Theory of Relativity in 1905. From 1885 to 1916 Karl Schwarzschild was Director of the Observatory. He was responsible for the first accurate solution to Einstein's equations, epitomizing the General Theory of Relativity. The so-called “Schwarzschild Solution” is now of fundamental importance in many areas of physics.

Architecturally, the building can be regarded as neoclassical. Spieker studied under Friedrich August Stüler, a student of Schinkel. In addition to the personal style of Karl Friedrich Schinkel, the building also recalls the regional traditions of Brandenburg brick construction. Spieker referred to the Royal Observatories, which were all created under his direction, as “functional scientific buildings”. Given the loving details such as star friezes created from glazed tiles, the use of sandstone capitals or the two-tone facade walls with different edging accents, as well as the use of blind masonry, this description strikes us as somewhat strange today. Lavish wall paintings were discovered inside the building during the restoration work and these have been reconstructed using appropriate templates. For more details about the architecture of this unique building see next page.



The meteorological station (west arbour) and the interior of the middle domed hall. Wood engraving by H. Nisle, 1887.

Above: frieze with star motif.

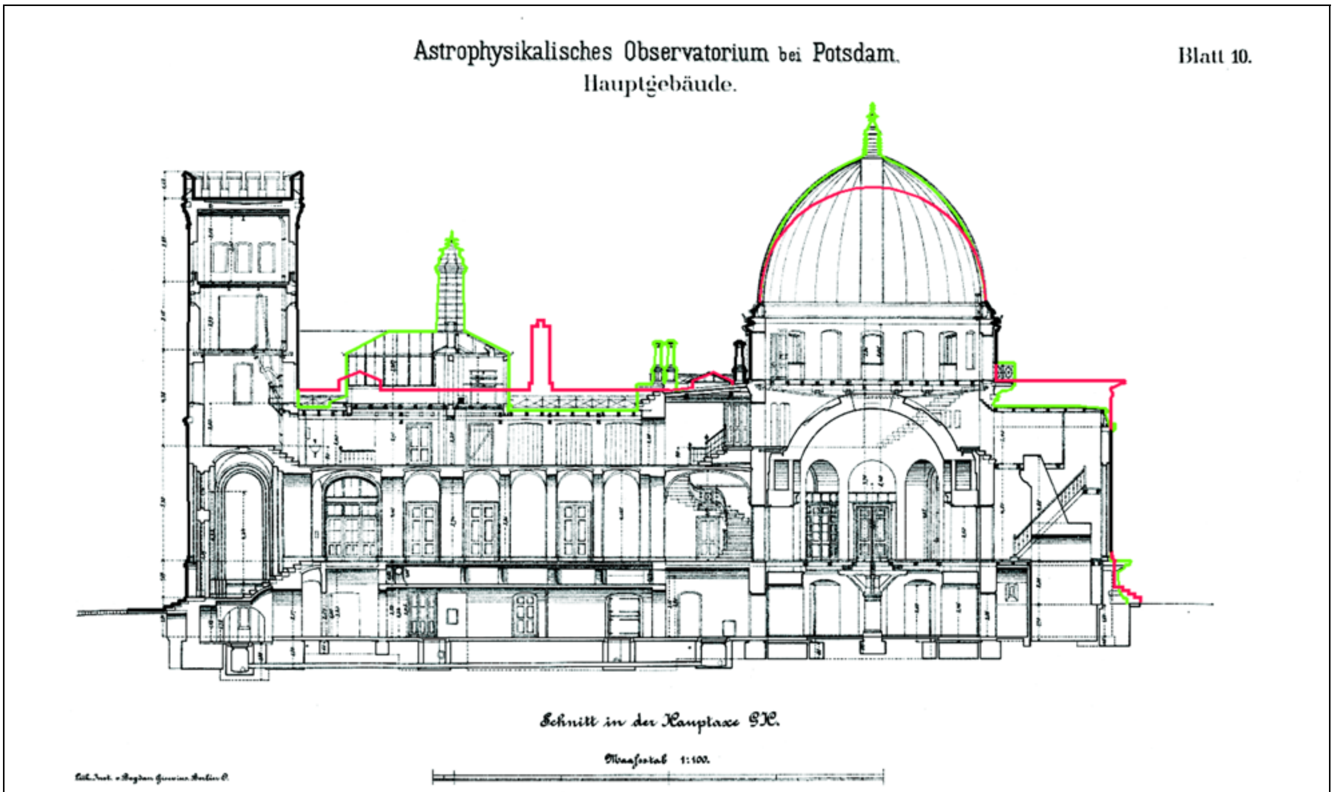
From the Royal Astrophysical Observatory to the Climate Impact Research Institute

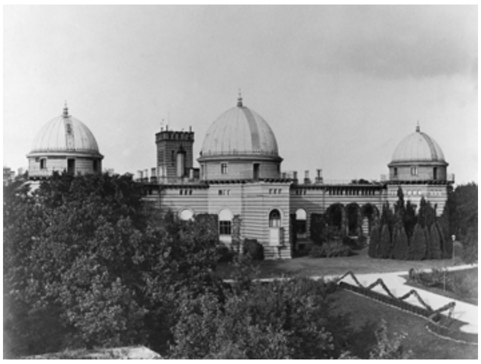
By Friedrich Karl Borck

It is an architect's dream come true. Immediately after reunification, the Telegrafenberg, now Albert Einstein Science Park, stood near the top of the list of sites to be visited in the former East Germany, especially for architects. After all, the park, located in Potsdam, boasts one of the most famous, if not *the* most famous, High Modernist structures in and around Berlin – Erich Mendelsohn's Einstein Tower. After crossing through the park's gateway, sometimes still referred to today as the guardhouse and virtually inaccessible before 1990, an enchanted world of the nineteenth century opens before us, just as it had back then: measuring stations, observation towers, machine rooms, and living quarters are scattered throughout a magnificent tree-filled park. Towering brick walls mark the end of lanes that run along the park borders. A massive building laid out in the shaped of a 'T' sits at the highest point of the hill, reachable only by winding paths. Its distinctive design is dominated by a well-fortified square tower at the base and three towers, each crowned by a dome, along the top axis. The two outer towers are connected to the middle tower by arcades, lending them a striking appearance reminiscent of a mosque. In fact, historian Michael Bollé once used the phrase "astronomy mosques" to describe the towers, since they belong to the world's first Royal Astrophysical Observatory, the first and, for a long time, most important astrophysics building on the Telegrafenberg. Immediately upon entering the park, this extraordinary vision piqued our curiosity: we wanted to know more about the building and the master plan for the entire park, which could only have originated in a single mind.

This opportunity was afforded us in 1995 to an extent none of us had dared to dream. The scientific park was to be the subject of a study that, along with the park's structural restoration, sought to find a new use for the Royal Astrophysical Observatory. Already all but abandoned by astrophysicists in the 1970s, the buildings showed signs of increasing deterioration, most apparent on the visibly rusty domes. Through the study of documents and plans, preserved as exquisite lithographs stored in the library at the Scientific Park, we came to

The red line marks the current silhouette, the green the original: the classic baroque rotating roof in the dome-style of St. Peter's Basilica in Rome, a number of chimneys, a dome shutter between the north and south wings and, over the latter, the glass photo studio with flanking chimneys are reminiscent of a miniature chapel.





The Royal Astrophysical Observatory in 1890, north view (left) and south view (right).

Next page top: rusty cupola of the eastern Tower in 2001.

Next page middle: the ground-floor hallway before renovation.

Next page bottom: the entrance foyer after renovation in 2001.

know Paul Emanuel Spieker, who for the first 25 years served as chief architect on the Telegrafenberg. In a comprehensive 1991 study performed by Alexandra Restorers, Spieker (1826-1896) was portrayed as one of the defining forces of nineteenth-century architecture. As a student of Friedrich August Stüler, he is considered a member of the Late Schinkel School of Architecture. After designing the *Kruppsche Villa Hügel* in Essen and the prison at Berlin-Plötzensee, Spieker received a contract to design the Berlin Metronomical Institute. Wilhelm Julius Foerster, director of the Imperial Standards Commission and the Royal Observatory in Berlin, was closely associated with the institute, which led to his long and fruitful collaboration with Spieker. In 1871, Foerster received a commission from one of Crown Prince Friedrich Wilhelm's tutors, the physicist Schellbach, to begin organizational planning for a solar observatory. Before long, however, the project evolved into the Royal Astrophysical Observatory, as it came to be known. All of this happened with the enthusiastic support of the Crown Prince, the later Kaiser Friedrich III, as a memorial plaque in the foyer of the main entrance reminds visitors today.

Designed by Schinkel and completed in 1835, the Berlin observatory initially served as a site for the study of astrophysics as well, a then-emerging science. The rapidly expanding city of Berlin was quickly ruled out as a location for a new observatory in favour of Potsdam's Telegrafenberg, whose seclusion from troublesome vibrations, disruptive light dispersions and other emissions made it ideal. The only signs of development in the area were the rather unobtrusive telegraph lines between Berlin and Coblenz. Spieker, in those days privy councillor, was head of construction in the preparatory commission for the new observatory, but was soon named chief architect of the project. Spieker devoted nearly 25 years of his career to the design of astronomical and other types of observatories, which he described as a "fascinating and challenging task". Indeed, observatory design acquired a special significance within his architectural oeuvre, which already included structures devoted to the sphere of science. Possible models for the design of the new observatory include those in Pulkowo near St. Petersburg and at the University of Vienna. Both feature primary and secondary towers in severely symmetrical composition with corresponding primary and secondary axes. While in Vienna a massive structure takes the form of a cross with four towers, Pulkowo boasts a spacious, palatial layout. In his posthumously published paper "Astronomical and Other Observatories," Spieker observed that an expansive building of reduced structural dimensions decreases heat emissions from the sun-warmed brickwork, which create a shimmer effect, and is thus better-suited to the study of the sky than a more compact architectural style. Emissions in the observation field arising from heating systems must also be avoided. Spieker solved this problem in his master plan with a spacious, widely-dispersed construction. Thus, for example, the two towers are connected to the main building by open arcades – windows were first installed after 1961. The reduction of heat radiation was additionally achieved through a grass-covered roof, no longer in place today. According to Spieker, an astrophysical observatory is distinguished from an astronomical observatory by "the close relationship between the long-distance observation rooms and chemical, physical and photographic laboratories, as well as equipment for spectral analyses". Thus only the most important rooms were located in the main building, situated with its principal axis on the 76th meridian, while each of the adjacent observation towers sits at the end of a transverse axis. Familiarity with Spieker's characterization of observatories as "an interrelated group of distinct structures" is essential for visualizing the original layout today. Modifications to the building's interior undertaken in 1950 required the raising of the northern section, which resulted in the height differences of the roof (see illus., page 90). The north tower, which once housed a water tower fed by a well at the park entrance, and the main entrance are connected to the north wing, where the administrative offices were located. This wing was dis-

tinctly set apart from the higher, southern laboratory in ground plan. Conversion of the domes into a spherical shape was undertaken in 1911 in order to enlarge the observation aperture. At the same time, the design of the opening mechanism was improved.

Features such as the alternating red and yellow brick facade, the variety of sandstone elements, the wrought iron trellis on the flat roofs and tower arcades reveal Spieker's adherence to the principles of the Late Schinkel School of Architecture. Also characteristic of this school are the multi-coloured enamelled bricks frequently used in friezes, at the observatory a network stars creates a thematically-related motif. Spieker continued to use these materials in the design of later buildings for the Science Park (he designed meteorological and geodesy observatories as well as the large refractor, which was only completed after his death with slight alterations to his design). However, despite the uniformity suggested by the choice of materials, upon closer observation the four large buildings prove remarkably different: almost playful and yet fully functional, the astrophysical observatory seems almost excessive in its variety of structural forms; by contrast, the other two buildings are "puzzlingly unadorned boxes," to use a phrase Heidrun Laudel once applied to the building housing Schinkel's academy of architecture in Berlin. The design of the large refractor, in turn, appears understated yet has the force of a mature work – it was also the final creation in the industrious life of the architect. The charm of his accomplishment in the design of this scientific arcadia remains to this day. The uniformity of materials among its buildings, distinguished architecturally according to their various functions, arouses the interest of the observer and, at the same time, imbues a sense of serenity through its harmonious relationship to the park grounds with its old growth of trees.

It is perhaps worth mentioning at this point the great importance traditionally accorded by architects to the construction of towers, especially in the nineteenth century. Schinkel's dream of crowning Potsdam's silhouette was ultimately fulfilled with the construction of the *Nikolaikirche* by Stüler, who also adorned the west wing of the Berlin castle with a tower. What a sublime feeling it must have been, then, for Spieker to erect several towers at once – all devoted to the science of the universe in the broadest sense. In the language of architecture, after all, towers symbolize the expansive canopy of sky. Indeed, one of the most fascinating aspects of this project for us was the dawning realization of the profound importance of architecture for science in the nineteenth century. Numerous sources provide evidence that a "Religion of Science" played a formative role in social life, inspiring architecture to employ elements of the sacred.

We now direct our steps to the interior of the main institute. Above the entryway to the north tower through a window adorned with a rosette, light enters the foyer surmounted by a domical vaulted ceiling and high ribbed walls. The sacral quality of this place is enhanced by a vaulted corridor whose stark divisions are underscored by pilasters and formerets, and sustained by the alternating red and yellow brick floors laid out in a carpet-like pattern. Luxurious daylight falls upon a characteristic sandstone stairway at the end of the corridor which connects to a domed hall, complementing this sacredness with its apsidiole-like niches and southern exedra housing the heliographs (the later south entrance). The function of these "arching hollow structures" is not at first apparent, but can be understood only in relation to the dome high above: the walls and arches of the hall, separated by joints from the rest of the building, served as the foundation for the original observation instrument located in the middle dome, which had to remain absolutely motionless. A suspended walkway leading to the foot of the instrument, further ensuring the stability of the platform, offers an architecturally intriguing solution.

Yet another dream came true with the decision to hand over the main astrophysical institute to the Potsdam Institute for Climate Impact Research. Our company received the commission to carry out the restorations and architectural modifications. For us, this experience would prove to be a series of surprises and ever-increasing fascination.

In comparison with the other observatories, the condition of the main institute at the end of the 1990s showed signs of extreme dilapidation: corrosion had eaten away at two of the domes, and the third had, in the mean time, been covered with bitumen shingles. The sandstone crown of the north tower had been reinforced with steel bands to prevent collapse, the southern entrance was likewise damaged through fissures in the sandstone cornices, and of the two wooden thermographic observation arbours only one remained, fallen and in grave disrepair. While the inner rooms and decorative murals in the geodesy observatory retained their former splendour, not a single room in the main institute was preserved in what could be considered its original version. Walls had not only been coated with several layers of paint in various shades, but extensive plaster renovations removed any trace of the original décor. Only a thorough and time-consuming investigation enabled us to determine the original colours to carry out our restorations. What is more, we were stunned by the entirely unnecessary painting of intact wooden doors and fixtures. Such actions make the success of the restoration firm Heinz Karo, which literally drew the original wood finishes and colours to the surface and then restored them in close collaboration with monument preservationists, all the more remarkable. Today it is difficult to imagine that bland colours once coated the building's interior and a layer of linoleum hid the foyer floor. The astonishingly opulent foyer decoration, featuring bordered bands of palmette, laurel bay, flower pots with various tinted backgrounds, lends greater force to the spatial tectonics of the walls and cross beams, jointed with pilasters and formerets. At the same time, according to Gottfried Semper, the most important German architect in the second half of the nineteenth century, it fulfils the aesthetic expectations of a building with artistic pretensions. Thus, the niches and domes of the central rotundas were also adorned with a colourful border and playful band of flower pots and lines, which serves to accentuate the edges and structural height and zenith of the space. The dome in the east tower library is ornamented with flowers and foliage. The wood and plaster moulding on the ceiling in the director's office creates a particularly impressive effect.
Professor Schellnhuber, director of the Institute, was quite pleased with the handling of materials by restoration specialists (see pictures on page 96).

Top: the stairway to the first floor before renovation.
Middle: the renovated stairway restores the original brilliance of its sandstone steps.
Bottom: kingly aspirations: the institute's new stairway.

A project to expand the building was undertaken after the Second World War, which resulted in the enclosure of the arcades and the elevation of the north wing. These modifications were achieved with such tremendous effort and professional skill that reconversion was never seriously considered. Furthermore, apart from financial considerations, the increased usable space afforded by these modifications made the building ideal for the new institute. Reconstruction of the middle and largest observation tower for the seminar and conference centre thus became the central focus of our restoration efforts, since without such space the suitability of the former observatory for the Climate Impact Institute remained in question. Our biggest obstacles, at this point, consisted in replacing the timber frame and the interior wood panelling, as well as covering the dome with sheets of a titanium zinc composite to provide the necessary heat insulation. The towers were fitted with sound-absorbing panels and an electronically controlled loud speaker system to guard against focus effects common to these structures. The mandatory secondary emergency exit for approximately sixty people also bears mentioning. After rejecting the initial suggestion to employ a slide escape, like those used in large aircraft for emergency landings, we decided on a fire-resistant reinforcement of the platform over the south entrance where the fire department could set up ladders. Luckily, simple solutions could be found for many of our problems. A mere listing of the measures carried out should provide an impression of our continuous struggle to meet the guidelines for renovating an historical monument, in which even the director of the institute became personally involved. Despite the high costs of restoring this relatively small space, our efforts were ultimately of great value for the institute.

Housing the main computer was of especial importance for the new use of the building. No room in the building was suitable for it, neither in terms of size nor in secondary specifications such as a climate control or double-bottomed computer flooring for the installation of a reversible network. A direct enlargement of the building was impossible, since the building, under protection as a historical monument, must remain a solitary structure. After presenting a number of proposals to the fastidious preservationist authorities, the solution of a completely underground annex was finally accepted. It has the added advantage of thermal isolation against the heat of summer. Direct access to the original building was cre-

The library with its elegant gallery had lost its lustre over the years.

The cosy atmosphere of the small library has been restored.

ated through an entrance beneath the west arbour to the three underground rooms housing the main computer (see illustration, page 100). Large computer components were conveniently transported to their new underground home by a hoisting platform visible only when in use. Our visiting microchip specialists were particularly impressed by this comparatively simple mechanism.

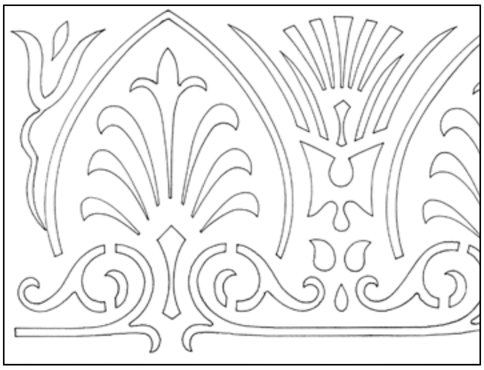
What images remain? The more than five meter deep excavation pit in the immediate vicinity of the building and the anxiety that the ground wanted to close up again. The presence of a variety of craft specialists gave the impression of an old-fashioned construction site. The most distinctive among them were the stonemasons with their outdoor workshop. Admittedly it was easier to watch them work when the weather was good than in the midst of snow flurries, which did not deter them from their task. The plumbers, too, embodied highly-skilled craftsmanship. At least, near the tower, they were protected from rain and snow by an imposing, wind-resistant scaffolding. On occasion time seemed to stand still. During the construction of the east arbour, the carpenters took visible pleasure in practising the traditional art of wood jointing. Their well-equipped workshop was ideally located above one of the arcades, as it provided generous storage space for doors, windows and the like. Strength resides in calm, or more precisely, the determination to achieve a goal. In any case, the restorers could not be distracted from their work, despite the occasional outbreaks of chaos beneath their ladders and scaffolds. Finally, one last unforgettable image from the rainy weekend before the formal opening is the imposing figure of the landscape foreman with the mohawk and several assistants who he thought might be Kurdish. He was not sure, however, since they did not speak German.

In his reflections on the design of observatories, Paul Emanuel Spieker maintains that from the outset meteorological study must be taken into consideration along with other heavenly observations. The two wooden arbours, which originally served for the observation of air temperature – in short, weather stations – have since been reconstructed. The building's scientific tradition is being continued, in a modern context, now that it is occupied by the Institute for Climate Impact Research.

The one-time observation tower is now home to the institute's seminar room.

Rediscovering hidden beauty.

Reconstructing the ornamentation...



... and recreating the stencils.

Ceiling in the director's office.

Inspecting the ceiling.

The ceiling in detail.

Spoiled beauty: completely closed-in west arbour.

Detail of west arbour.

Traditional wood joints of new wood.

The provisional wood workshop.

Rafters before their restoration.

Installing the skylights in February 2001.

The New
High-Performance
Computer

The Big 42-Check - an Interview

Q: Mr. Klein, PIK is running a new high-performance computer. What kind of computer is it?

Klein: We are running a 200-processor parallel machine, type IBM SP. The processors are grouped in so-called "nodes", within which extremely fast communication is possible and which form autonomous units. The nodes are connected through a somewhat slower but still outrageously fast "switch". This enables true large-scale parallel computations, where one simulation is worked on by hundreds of processors, at the same time. Our machine features forty-two 4-processor nodes and two 16-processor nodes. The computer is, by the way, among the 150 fastest worldwide.

Q: Is speed the deciding criterion for PIK's research needs?

Klein: This machine has a wide range of qualities and all of them are valuable for PIK. Its most outstanding asset for us is its flexibility. Its architecture makes it a high-performance tool for a very wide range of tasks. Thus it excels on large-scale computations, it efficiently operates on multiple decoupled runs of smaller models and it features a novel parallel file system for high-throughput data transfer, management and analysis.

Q: How will the computer be used at PIK?

Klein: The majority of computing time will be spent on large-scale parallel computations and batches of multiple runs of smaller-scale models. Another kind of run is typically set up when the parameter space of a model needs to be explored. An example would be multiple simulations with a global climate model for a large number of different predicted paths of global CO_2 emissions.

Q: Does the computer run only climate simulations?

Klein: The computer supports the work of all the disciplines represented at PIK. Their models describe interactions between the different components of the physical Earth system and their interactions with social actors. But PIK's task is not only to produce series of future projections using different climate and socio-economic scenarios. Rather, PIK's task is to help to improve the overall understanding of the Earth system, so that models have a firmer base and the inherent uncertainties associated with computer-based modelling can be evaluated. Therefore, the computer will also be used extensively to investigate the response of our models to judiciously selected perturbations. Through this approach one often learns more about the workings of a complex system than from all-encompassing full-scale model runs.

Rupert Klein talking to Margret Boysen in autumn 2001.

Q: Could you give an example of such a computer model?

Klein: Take the regional climate model currently being developed at PIK in co-operation with the German Weather Service, the GKSS Research Centre and others. Such a model is essentially a discrete, computer-digestible analogue of the researchers' knowledge. One must first identify the relevant system components; in this case, the atmosphere, its water content in the form of water vapour, droplets and ice particles and a representation of the surface water balance, including river flows, lakes and other components, etc. Next, the interaction of these components is quantified. For example, computational rules that determine the rate of water vapour condensation and precipitation from the atmosphere's vertical temperature and from predicted local vertical motions. Once these interactions have been formulated, a computer code is developed and adapted to run on parallel machines. After validating the model by comparing its results for selected test cases, the code can then go "into production".

Q: Which PIK model could give the answer "42"?

All of them would, of course. The 42-check is one of the first validation tests each of our models has to pass!

Karsten Kramer watches the transfer of the new supercomputer to the lift.

One of the computer towers with door open.

Technical Data

The new system is composed of a compute server IBM SP with a total of 200 Power3-II CPUs, operating at 375 MHz and utilizing 8 MB of private second level cache, an additional, high-performance, high-availability IBM S80 enterprise server and 7 Terabyte of external SSA disk storage. These disks have been divided into standard RAID-Arrays and a parallel file system which is able to deliver a sustained bandwidth of about 600 MBps to parallel applications. Inside the SP all CPUs are grouped into either 4-way or 16-way SMP nodes. All nodes, as well as the S80 enterprise server, are connected via the SP TB3 switch, which delivers a maximum-throughput of ~140 MBps and a minimum latency of ~19 ms for Message Passing Interface [MPI] programmes.

Access to the underground extension for the main computer lies beneath the wooden arbours which were originally used as a weather station. The hoisting platform, shown open here, is used to transfer large pieces of equipment to the underground annex.