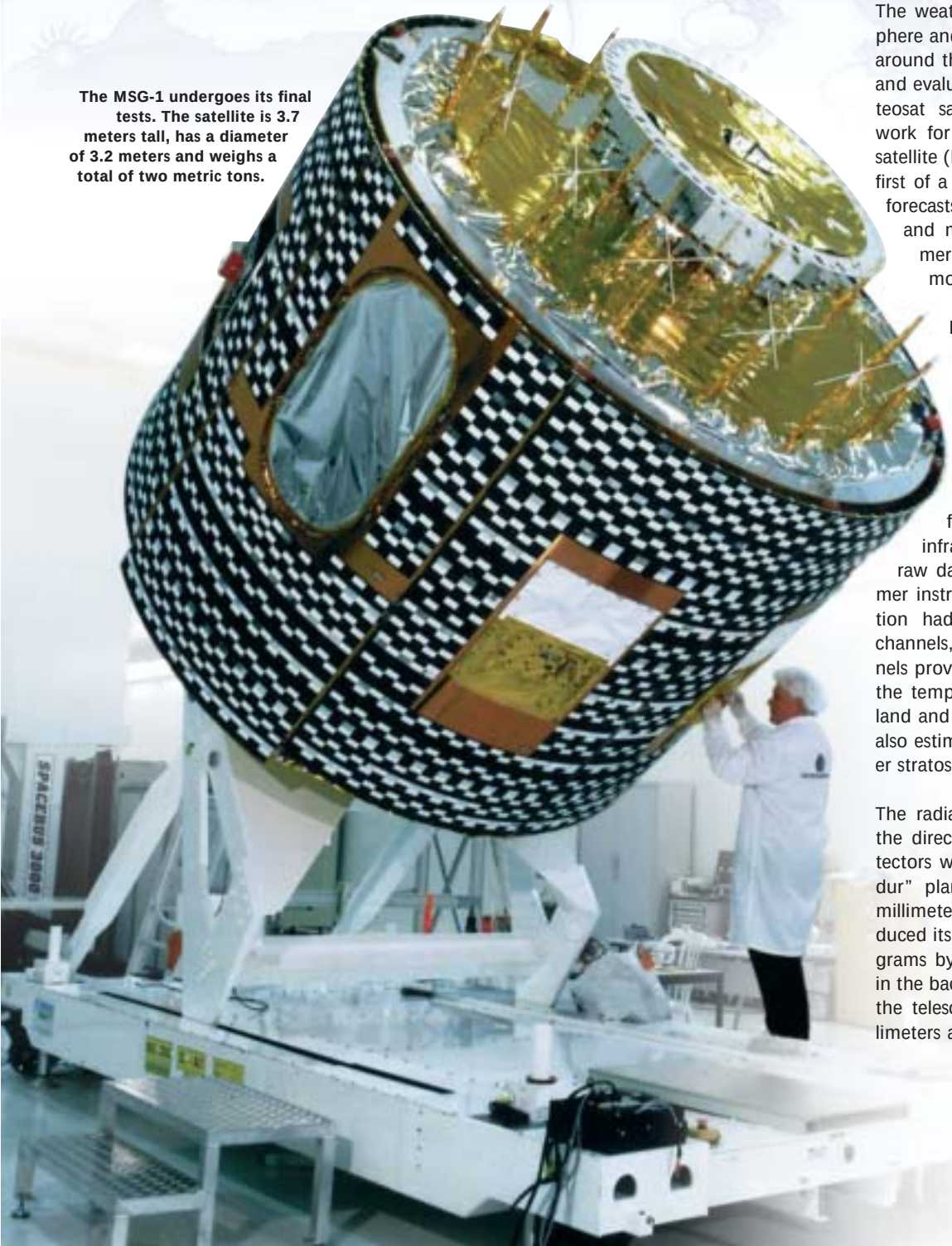
Monika Rüger
Munich

More Precise Forecasts

At the end of August 2002 the world's most advanced weather satellite was launched into space by an Ariane 5 rocket. With the help of mirrors made from "Zerodur" glass ceramic, the satellite will soon enable meteorologists to take a much more exact look at weather occurrences.



The MSG-1 undergoes its final tests. The satellite is 3.7 meters tall, has a diameter of 3.2 meters and weighs a total of two metric tons.

What kind of weather can we expect for the weekend? What should I wear tomorrow? These kinds of questions are the reason why most people watch the weather report on television. Sometimes, however, a weather forecast can be a matter of life and death, for example when there is warning of severe storms or thunderstorms. Missed or late warnings often have serious consequences.

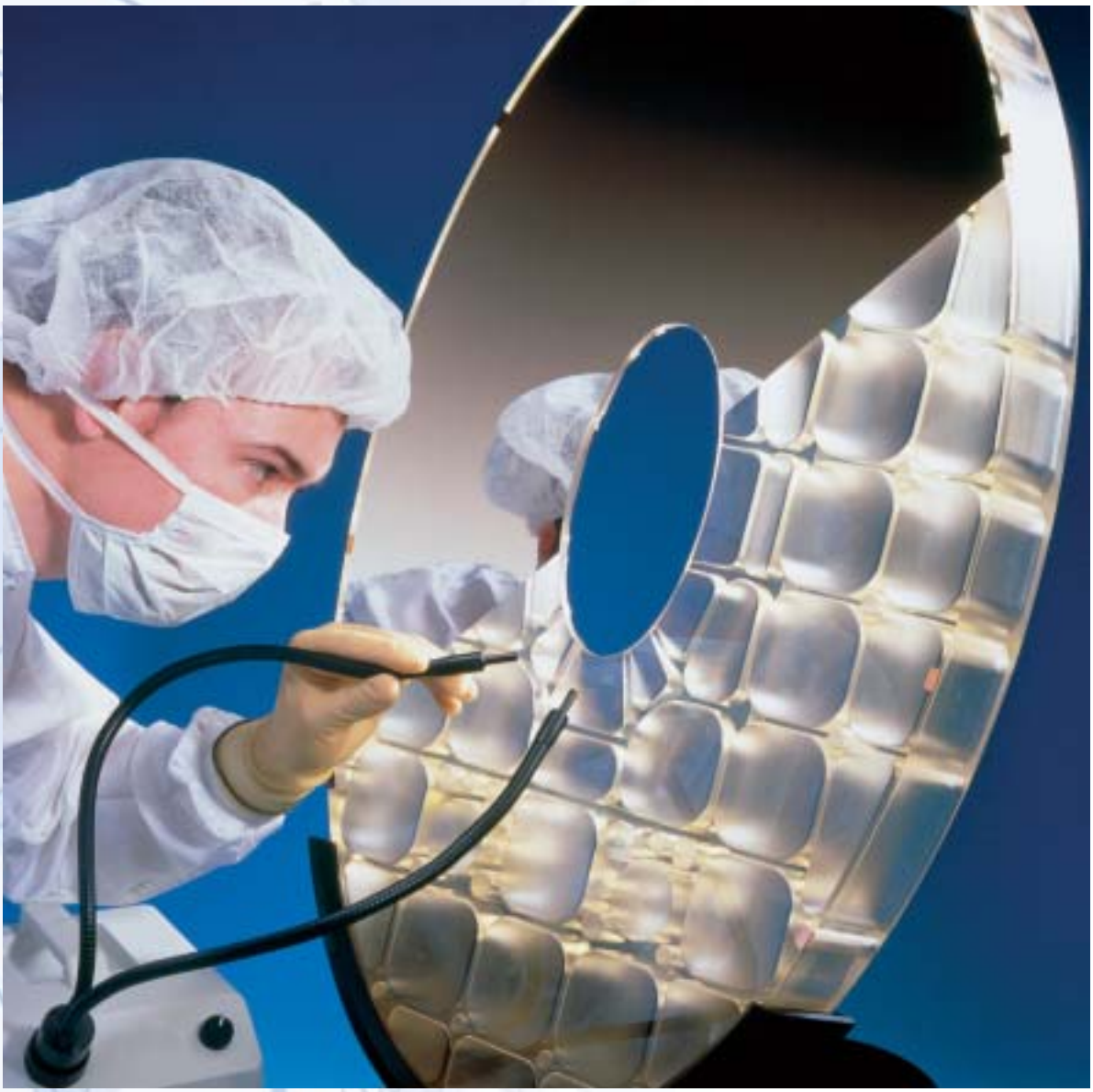
The weather on the ground, in the atmosphere and on oceans is observed worldwide around the clock. All raw data are collected and evaluated in meterological centers. Meteosat satellites have contributed to this work for 25 years. With the new MSG-1 satellite (Meteosat Second Generation) – the first of a planned total set of four, weather forecasts in future will be far more exact and more reliable. Compared with former satellites, MSG-1 supplies 20 times more raw data.

More detailed data

The most important board instrument on the MSG-1 satellite is the SEVIRI radiometer (Spinning Enhanced Visible and Infrared Imager). It scans a quarter of the Earth's surface, measuring the reflected radiation in the visible and infrared range and uses the collected raw data to compose images. While former instruments of Meteosat's first generation had only three different measuring channels, the SEVIRI has twelve. These channels provide much more precise data about the temperatures on the surface of clouds, land and seas. For the first time ever, it can also estimate the ozone content in the lower stratosphere.

The radiation is collected and reflected in the direction of the telescope and the detectors with the help of an elliptical "Zerodur" plane mirror, measuring 830 x 530 millimeters in size. Schott Glas, Mainz, reduced its weight by 70 percent to 15.6 kilograms by milling honeycomb-shaped holes in the back of the mirror. The main mirror of the telescope with a diameter of 500 millimeters also weighs less. In this way, it was

The elliptical plane mirror of the SEVIRI "weather eye" is 830 x 530 millimeters large and is made from "Zerodur." The honeycomb-shaped holes in the back of the mirror reduce its weight by 70 percent.



possible to save fuel and costs during the launch of the Ariane 5 carrier rocket. In aerospace applications every gram counts.

New satellite images are produced from data that has been collected every 15 minutes, instead of every 30 minutes. The faster series of images helps meteorologists particularly in the case of variable weather conditions. The pictures are also much more detailed because of the higher resolution. For example, in the past only clouds with a diameter of at least some 2.5 kilometers were detected. SEVIRI, however, is able to recognize clouds with a diameter of about one kilometer.

Glass ceramic from Scott is also on board

Such an outstanding image quality requires high-performance mirrors. The mirrors used in the SEVIRI were made from "Zerodur" glass ceramic. This material has a thermal expansion near zero and therefore remains dimensionally stable even when exposed to strongly varying temperatures. It can be polished like optical glass, which means that it is possible to obtain extremely smooth surfaces. Carl Zeiss, Oberkochen, took care of fine polishing the mirrors for the SEVIRI. In addition, the glass ceramic can be structured with the help of milling and etching processes so that the total weight of a component can be reduced by up to 85 percent.

In the case of the plane mirror, however, Schott reduced the weight by just 70 percent. The orbit of the satellite is stabilized by the fact that it rotates around its axis 100 times per minute. If the mirror were too

The Earth is clearly in focus

The new SEVIRI "weather eye" photographs the same quarter of the Earth's surface every 15 minutes. The radiation reflected from the Earth's surface and the atmosphere is collected by a mirror and reflected in the direction of the telescope and the detectors. A series of images thus shows the development and changes in the weather in this particular region. All this is possible because the MSG-1 satellite is in geostationary orbit, which means that it revolves around the Earth at the same speed as it rotates on its axis. That is why it appears to stand still above the Earth. In fact, the MSG-1 is positioned over the western coast of Africa, some 36,000 kilometers above the equator. From here it has a clear view of Europe, Africa, parts of the Indian Ocean and all of the Atlantic Ocean. The Atlantic plays a crucial role because the weather in Western Europe largely originates from there.

lightweight, it would not be able to withstand the oscillations and vibrations.

The MSG-1 satellite is designed to provide data for more exact and more reliable weather forecasts – initially for seven years. However, to ensure that data transmissions continue without interruption, three additional satellites of the same construction are planned. MSG-2 is scheduled to follow MSG-1 in just 18 months; it will be kept on "standby" in a reserve orbit. MSG-3 will then be launched at the end of the service life of the first satellite so there will always be two satellites in orbit and ready for action. The fourth MSG satellite is currently under construction. MSG-4 will guarantee the mission until the end of the next decade. ◂

The SEVIRI radiometer measures the reflected radiation in 12 different spectral channels. Each channel – four of which are in the visible range and eight in the ultraviolet range – provides different data. They vary from visible images of the weather occurrences during the day and cloud temperature at night to surface temperatures and water vapor measurements to determine gas and dust particle concentrations in the atmosphere.