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Precise Testing Bodies

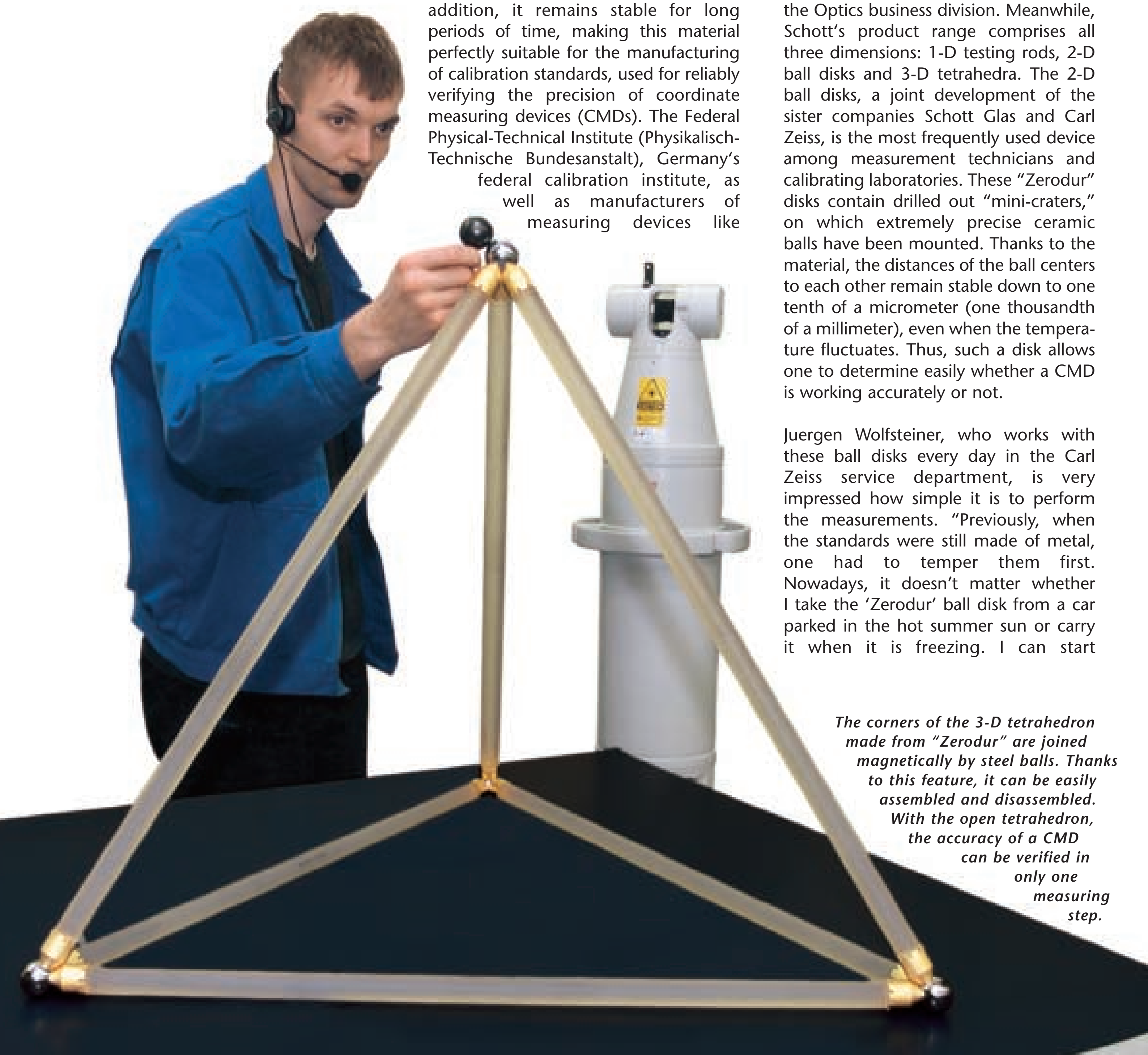
In order to ensure that the dimensions of components are accurate to within a few micrometers, stationary coordinate measuring devices or mobile laser trackers are used. The measurement accuracy of these devices, however, must also be regularly monitored within the framework established by the ISO 9000 – using calibrating standards made of "Zerodur."

Ever since the very first meter standard was built in Paris back in 1791, a significant drawback always had to be taken into account. The length of the platinum rod measured exactly one meter only when the temperature was exactly zero degrees centigrade. As temperatures rise, most materials expand. A rare exception is "Zerodur" glass ceramic made by Schott. Its length remains constant even if the temperature fluctuates significantly. In addition, it remains stable for long periods of time, making this material perfectly suitable for the manufacturing of calibration standards, used for reliably verifying the precision of coordinate measuring devices (CMDs). The Federal Physical-Technical Institute (Physikalisch-Technische Bundesanstalt), Germany's federal calibration institute, as well as manufacturers of measuring devices like Carl Zeiss, put their trust in the standards made with glass ceramics when carrying out measurements.

Ten Times Better Precision

"Calibration standards made of 'Zerodur' allow a calibration accuracy that is up to ten times higher than that obtained with standards made of other materials," said Dr. Thorsten Doehring, responsible for measuring standards in the Optics business division. Meanwhile, Schott's product range comprises all three dimensions: 1-D testing rods, 2-D ball disks and 3-D tetrahedra. The 2-D ball disks, a joint development of the sister companies Schott Glas and Carl Zeiss, is the most frequently used device among measurement technicians and calibrating laboratories. These "Zerodur" disks contain drilled out "mini-craters," on which extremely precise ceramic balls have been mounted. Thanks to the material, the distances of the ball centers to each other remain stable down to one tenth of a micrometer (one thousandth of a millimeter), even when the temperature fluctuates. Thus, such a disk allows one to determine easily whether a CMD is working accurately or not.

Juergen Wolfsteiner, who works with these ball disks every day in the Carl Zeiss service department, is very impressed how simple it is to perform the measurements. "Previously, when the standards were still made of metal, one had to temper them first. Nowadays, it doesn't matter whether I take the 'Zerodur' ball disk from a car parked in the hot summer sun or carry it when it is freezing. I can start



The corners of the 3-D tetrahedron made from "Zerodur" are joined magnetically by steel balls. Thanks to this feature, it can be easily assembled and disassembled. With the open tetrahedron, the accuracy of a CMD can be verified in only one measuring step.

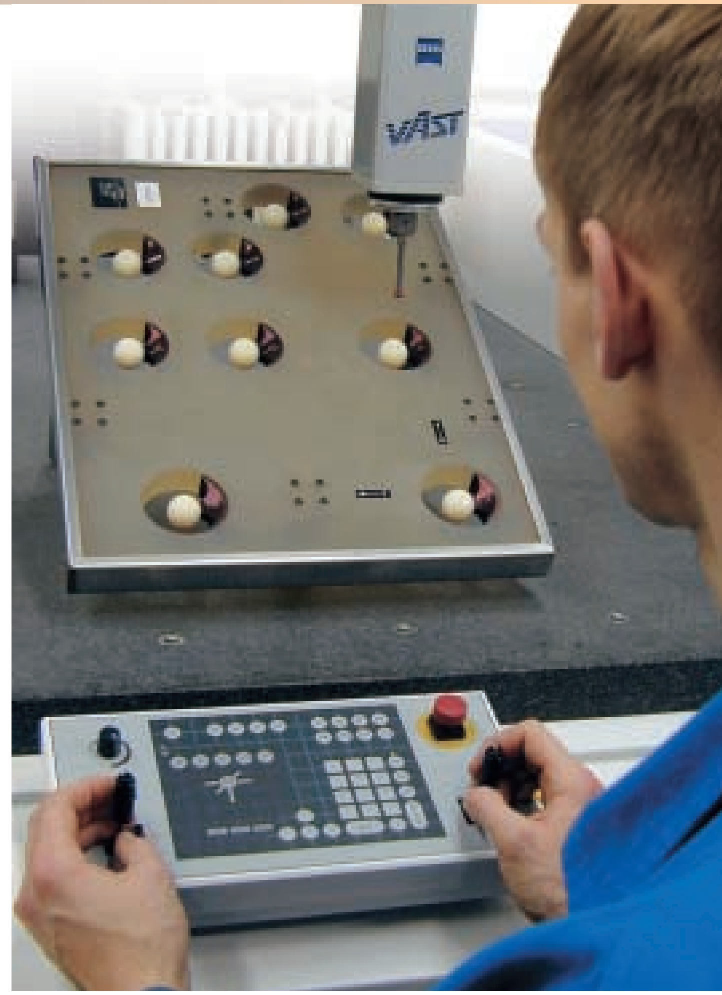
immediately with the measurement." This is very time saving, particularly for someone on the go like Wolfsteiner.

Fast, lightweight and easily taken apart

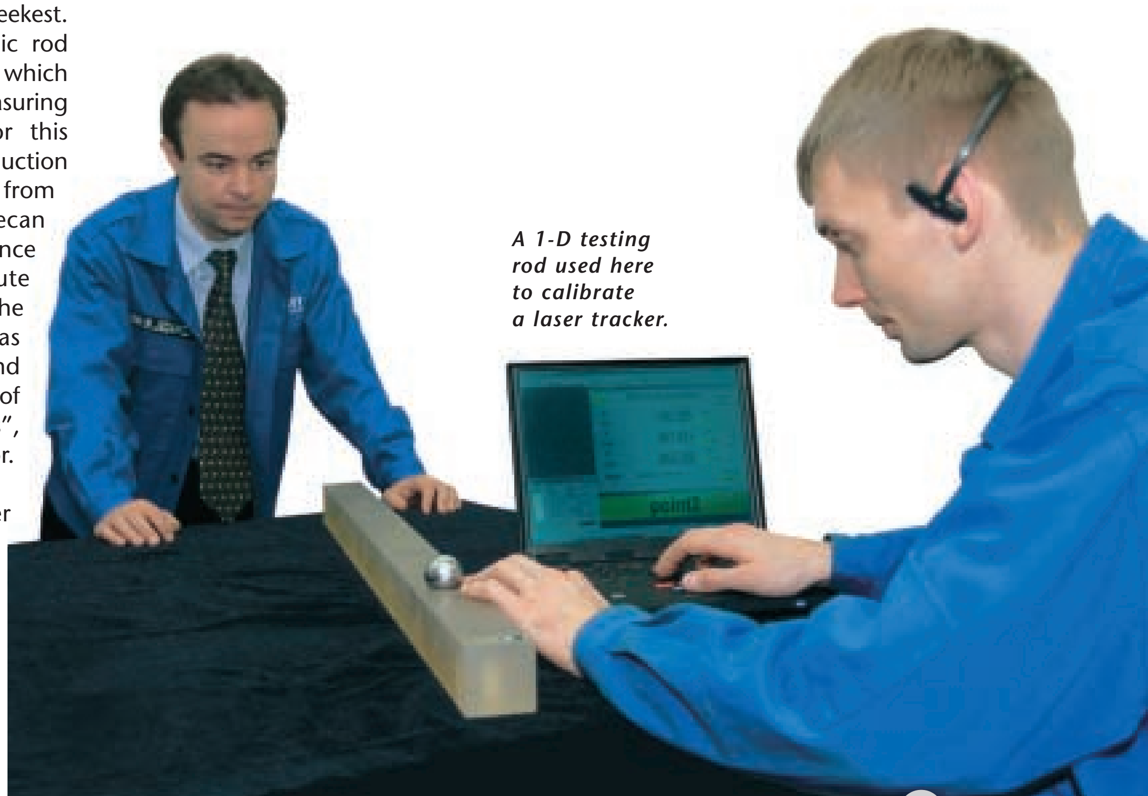
Another advantage of glass ceramics is its weight. Three times lighter than steel, it is particularly suitable for making transportable calibration standards for the service department. Because the standards for 3-D measurements were especially unwieldy, Schott decided to build – together with the Metronom Co. of Mainz – a testing body that can easily be assembled and disassembled. Made from "Zerodur" rods, it has the shape of an open tetrahedron, and its edges are magnetically joined at the corners by steel balls. Compared to the 2-D ball disks, such a tetrahedron has the advantage that it permits one to verify the accuracy of a CMD with only one measuring step. The tridimensional arrangement of the balls allows one to measure the distances and also the resulting angles of the rods. With a 2-D ball disk, on the other hand, several measuring steps are needed for obtaining the same information because one must change the orientation of the disk in space.

The youngest addition to Schott's calibration standards is also the sleekest. It is a 110-cm-long glass ceramic rod with precision conical seats, in which magnets are used to hold the measuring balls in place. The impetus for this invention came during the production of 42 mirror substrates made from "Zerodur" for the Grantecan Telescope in La Palma (Spain). Since utmost precision is of absolute importance, the reliability of the laser tracker measurements was critical. "I tried to find a quick and easy way to verify the accuracy of our laser tracker on a daily basis", said Dr. Ralf Jedamzik, the inventor.

The positioning of the laser tracker's reflecting scanning element inside the spherical case turned out to be especially useful. Its position allows it to be directly placed on the conical seats located on the "Zerodur" rod. This eliminates indirect measurements which previously had to be carried out with other calibration standards, allowing faster and more precise measurements than ever before. Currently, the accuracy lies at the three micrometer level, although the development potential of this device promises even more accuracy. The 1-D calibration standard is already very popular at Schott, and has been developed for market introduction as well. Jedamzik now plans to build longer rods, which will allow an increase in the accuracy of the laser trackers for larger measuring distances ■



Technicians and calibration laboratories choose this device most often: The 2-D ball disks with bores and extremely precise ceramic balls.



A 1-D testing rod used here to calibrate a laser tracker.