What's the connection between Goethe's "Faust" and vacuum?

2008 Röntgen Prize goes to Professor Dr. Birgit Kanngiesser from the TU of Berlin.

For more than forty years, Pfeiffer Vacuum, together with the Dr. Erich Pfeiffer Foundation and the Ludwig Schunk Foundation, has been sponsoring the Röntgen Prize for young scientists in the field of radiation physics. In 2008, Professor Kanngiesser won the Prize for developing an outstanding new method for the application of x-radiation in microstructure analysis.

X-ray spectroscopy is a non-destructive method for qualitatively and quantitatively determining the elementary composition of a material sample. Research activities are focusing on three-dimensional x-ray fluorescence analysis employing synchrotron radiation (3D Micro RFA method). This makes Professor Kanngiesser a sought-after specialist for studying objects of art and historic finds.
This scientist has, thus, gained such a prominent international reputation that she was entrusted with original manuscripts of Goethe's "Faust" I and II and the original score of Mozart's "The Magic Flute" for her studies. By determining the chemical composition of the score of "The Magic Flute," for example, she was able to evidence that this was, in fact, Mozart's own score. The portable x-ray fluorescence spectrometer that she co-developed is being used on-site in museums like the Louvre in Paris.

She is also involved in researching the origins of the 2,000-year-old Dead Sea Scrolls, which also contain original Bible texts. This research is providing important insights into the condition and exact composition of these scrolls.

On November 27, 2008, one day before the prize was awarded at Justus Liebig University in Giessen, Professor Kanngiesser paid a visit to Pfeiffer Vacuum. In talking with Management, it was clear to see that over the course of her studies in Bonn and Bremen, as well as during her work at BESSY and at the Technical University of Berlin, she had come to value the high quality of vacuum products from Pfeiffer Vacuum.

Berliner Elektronenspeicherring-Gesellschaft für Synchrotronstrahlung
Berliner Elektronenspeicherring-Gesellschaft für Synchrotronstrahlung (BESSY) was formed in 1979. From 1982 to 1999, BESSY operated a synchrotron radiation source in Berlin-Wilmersdorf. The new facility in Berlin-Adlershof has been in operation since 1998; as one of the world's most modern synchrotron radiation sources, it offers expanded research opportunities.

BESSY II took some four years to build. It was dedicated on September 4, 1998, and serves as a core element of the Berlin-Adlershof science and business location. This around 100-million project comprises a synchrotron with a circum ference of 96 m, as well as the electron storage ring, itself, with a circumference of 240 m, along with an experimentation building with more than 50 experiment stations, at which researchers can work independently of one another.

In addition to a regular BESSY workforce of some 220 people, there are also more than 200 working groups from universities, the Max Planck Society, the Helmholtz Society, the Leibniz Science Community, the German Federal Physical-Technical Office, as well as from research institutions in the European Union and throughout the world.

Through its merger with the former Hahn-Meitner Institute, BESSY has been a part of the Berlin Helmholtz Center for Materials and Energy (HZB) since January 1, 2009.

Employment of vacuum products
Much of the vacuum in the electron storage ring is generated by hundreds of turbopumps from Pfeiffer Vacuum and ion getter pumps. A vacuum of around 1×10^{-10} mbar is achieved in the storage ring without radiation. With radiation, the vacuum amounts to 1×10^{-9} mbar. Vacuum measurement is performed with Pfeiffer Vacuum IKR 270 and PKR 261 transmitters. The TPG 256 is used as the display.

What is synchrotron radiation?
Synchrotron radiation is a highly intensive broadband light source that covers the spectral range from infrared (THz) to hard x-radiation. The brilliance of this light source is around one billion times greater than that of a laboratory x-ray system. Synchrotron radiation is produced when relativistically accelerated (i.e. to nearly the speed of light) electrons are radially deflected by magnets. To do this, electrons emitted by a hot cathode are accelerated in the microtron and synchrotron to an ultimate energy of 1.7 giga electron volts (i.e. 1.7×10^9 electron volts). They then run for hours in the storage ring. Strong magnets maintain the electrons in a stable orbit. In eight hours, the electrons cover the equivalent of the distance from Earth to Pluto.

The synchrotron radiation thus produced leaves the storage ring tangentially at the outlet systems and enters the branch pipes. Here, the radiation is spectrally selected in monochromators and is advanced to the experiment stations in focused form by means of mirrors.

What many scientists want is more light. Higher intensity affords shorter measurement times, simultaneous measurements of multiple physical parameters, investigations of minute quantities of substances, as well as greater spectral and lateral resolution. In order to generate more light, periodically arranged magnetic structures are installed in the straight sections of the storage ring, the so-called wigglers and undulators. “BESSY light” is used to study the structure and function of innovative materials (like superconductors and magnetic materials) and complex systems (viruses, for example).

With her habilitation, Professor Kanngiesser has laid the foundation for the highly successful application of her 3D Micro X-ray fluorescence spectroscopy. In recent years, she has also used this method successfully on the new x-ray microfocus beamline at BESSY II in order to study questions from the fields of biomedicine, archeometry and geology.

Professor Dr. Kanngiesser paid a visit to Pfeiffer Vacuum.

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