PFEIFFER VACUUM

VACUUM FOR TOMORROW'S RESEARCHERS

Pfeiffer Vacuum supports 'Columbus' school project

Charged particles can be accelerated to extremely high energies through the use of so-called particle accelerators. Large international research institutes such as CERN in Switzerland or DESY in Germany operate numerous different types of accelerator. A frequently used accelerator type is the cyclotron, which launches charged particles such as protons or ions into a helical orbit by applying a magnetic field. The cyclotron principle allows for a compact design which, compared to other types, can be operated cost-effectively. Cyclotrons serve as radiation source in nuclear physics. Moreover, they are also frequently used in medical applications, such as ion beam therapy for cancerous tumors or for generating radionuclides. Physicists are not the only ones who are fascinated by the complexity of the principle behind the cyclotron, the broad range of potential applications and its importance for science. High school students from the Gynmasium Ernestinum school in Coburg built their own research cyclotron during a period of practical research work. Also on board: Vacuum technology by Pfeiffer Vacuum.

School cyclotron evolved in joint project

In a joint project with Coburg University and the Jülich Research Center, a total of thirteen high school students from the school in Coburg built the 'Columbus' cyclotron for teaching purposes together with their physics teacher Christian Wolf. During the project, they were supported by scientists from Coburg University under the leadership of Prof. Dr. Martin Prechtl, head of the Laboratory for Applied Vacuum Technology, and by the Jülich Research Center.

Figure 1: The construction of 'Columbus' is based on the original work of the cyclotron inventor E.O. Lawrence.

'Columbus' is based on the original work of the cyclotron inventor E.O. Lawrence from the year 1929, and is designed to accelerate protons to about 20 keV up to a maximum of 50 keV. The low final energy of the school cyclotron means that the proton beam – unlike its much larger role models – can be studied while it is in operation. This is a huge advantage, particularly when being used in schools and for teaching.

The cyclotron consists of a vacuum chamber measuring 200 mm in diameter. A vacuum of about 10^{-6} mbar (high vacuum) is present in the chamber. Other main components of 'Columbus' are an electromagnet, a high-voltage source and an ion source.

In the course of several revolutions, the protons in the school cyclotron are accelerated twice per revolution to their final energy through alternating voltage with an amplitude of 0.5 - 2.0 kV at a frequency of 5.00 MHz. The magnet used in the process, which was provided by the Jülich Research Center, generates a homogeneous magnetic field of 0.75 T for this purpose.

Figure 2: The school cyclotron can be used by students to conduct their own experiments.

Science and practical work in school teaching

The cyclotron aims to get school students involved in the project excited about physics and technology through conducting practical research work and being introduced to scientific working methods. By using the cyclotron as a model in school teaching, all school students get to know the physical processes that take place when electrically charged particles move about within electrical and magnetic fields. In this context, they also learn about practical uses for these processes. The cyclotron can be ideally incorporated into lessons since the movements of the particles can be observed directly in the school cyclotron due to the low final energy generated. The proton beam is not channeled out, so there is no danger of radiation emissions. The 'Columbus' project forms the basis for further physics work and projects at the Gymnasium Ernestinum school in Coburg: This includes optimizing the simple ion source by fitting a heat shield and an electron mirror, and replacing the initially planned scintillation screen with a Faraday cup as a detector for the accelerated protons.

The physics teacher supporting the project, Christian Wolf, explains: "'Columbus' is not just a single isolated project, but a complete teaching concept with the aim of giving school students an introduction to further technical and scientific education in close cooperation with the school and university. It is supposed to prepare them in the best possible way – better than is possible with the current purely curriculum-based teaching."

Pfeiffer Vacuum sponsors vacuum equipment

To adapt the cyclotron to the requirements for its use in school teaching, the vacuum equipment must match the project planning conditions. Pfeiffer Vacuum supported the school as a sponsor and provided Coburg University with a HiCube Eco turbopumping station for the project group. It is used to generate the vacuum required in the cyclotron. The pumping station consists of a HiPace 80-type turbopump and an MVP dry diaphragm fore-vacuum pump. The pumping station contains a Pirani vacuum gauge and an ionization vacuum gauge with an appropriate display and control unit for measuring the pressure. A Faraday cup from a Pfeiffer Vacuum mass spectrometer is used as a detector to measure the accelerated protons. The reliability and flexibility of the vacuum equipment from Pfeiffer Vacuum makes it the ideal solution for meeting the challenges of the school cyclotron.

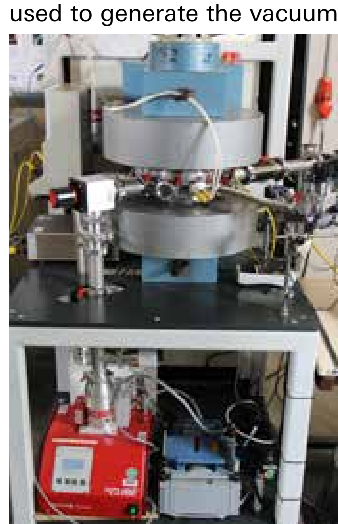

Figure 3: The 'Columbus' school cyclotron

Figure 4: Pfeiffer Vacuum Sales Manager Arno Kalbus answered all the questions about vacuum technology asked by the students and their teachers during his visit.

Figure 6: Pfeiffer Vacuum sales manager Arno Kalbus and Prof. Dr. Jutta Michel, Vice President of Coburg University, talking about potential projects to promote young scientists.

The experts from Pfeiffer Vacuum used their know-how to assist the project group from the Gymnasium Ernestinum school in selecting and designing suitable equipment in order to reach the best possible solution for the project.

Sponsoring as a way of promoting young scientists

The promotion of young talent has always been of great importance for Pfeiffer Vacuum. For this reason, the company supports promising research projects and initiatives to promote young scientists, such as the Röntgen Prize at the Justus Liebig University Giessen. Pfeiffer Vacuum also acted as a sponsor in the 'Columbus' project to enable school students and their science mentors from Coburg University to build their own school cyclotron. During a visit to the school research center at Coburg University where the school cyclotron is located, Arno Kalbus, the Germany sales manager for Pfeiffer Vacuum, explains: "The 'Columbus' project is a shining example of successfully promoting young talent. Close cooperation with the scientists from Coburg University – especially Prof. Dr. Prechtl as head of the Laboratory for Applied Vacuum Technology – and the application-based focus on using the cyclotron, result in theory and practice being taught side by side. The students learn which processes require physical phenomena to take place in a vacuum. We as a company are pleased to support this project, particularly since it serves as a basis for further programs, and since the cyclotron is also available to other schools as part of the school research center. The earlier we can spark an interest in children and young people in physics in general and vacuum technology in particular, the more we will be supporting the researchers and vacuum experts of tomorrow!"

Figure 5: Arno Kalbus handed over a donation to the project group for their continued work on and with the school cyclotron. From left to right: Arno Kalbus, Christian Wolf, Prof. Dr. Jutta Michel, Prof. Dr. Martin Prechtl.

Figure 7: The turbopumping station sponsored by Pfeiffer Vacuum shown in action.

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