

Particle Physics Masterclasses: Sharing LHC Research and Discovery with High School Students

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Masterclasses are a proven tool to engage high school students with particle physics. In a Masterclass, participants learn about high energy physics in a day-long course. Moreover, they can actively take part in cutting-edge research and experience methods and tools used in research by performing a tailor-made physics analysis involving real LHC data under the supervision of physicists. During a Masterclass students not only explore the fundamental forces and building blocks of nature, but they can also improve their understanding of science and the scientific discovery process. Particle Physics Masterclasses offer an authentic experience and add a new dimension to physics education at school, thus stimulating the students' interest in science.

More than 300 Masterclasses are organized in the framework of the program *International Masterclasses* each year. During a 6-week period spanning roughly February to April, research institutes and universities in more than 50 countries invite high school students for a Masterclass. At the end of each day, the participants join in a videoconference with other student groups and CERN, Fermilab, or TRIUMF. Like an international research collaboration, they share and combine the results of their analyses and can thus experience for themselves an important part of the experimental particle physics working process. The program attracts more than 13,000 high school students each year and is run by IPPOG, the International Particle Physics Outreach Group, and is centrally coordinated at Technische Universität Dresden and University of Notre Dame.

The successful Particle Physics Masterclasses are also arranged in other contexts. In 2017, an extra effort was started by IPPOG to support and promote the access of girls to science. To accomplish this, IPPOG launched Masterclass activities especially for girls on the UN International Day of Women and Girls in Science.

In Germany, the nationwide program *Netzwerk Teilchenwelt*, which includes 30 universities and research labs, has been established. For *Netzwerk Teilchenwelt*, Particle Physics Masterclasses are instrumental as a basic level, but is builds up several higher levels of engagement, e.g. workshops at CERN or research projects at universities and institutes for the most motivated and interested high school students. On total, this program offers activities for 4000 high school students per year on four levels.

In the United States, QuarkNet offers International Masterclasses, a World Wide Data Day with LHC data, and Masterclass preparation activities as important components of a program to bring particle physics to high school teachers and students.

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