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# INTERNATIONAL MASTERCLASSES

## HANDS ON PARTICLE PHYSICS

### CONCEPT

International Masterclasses offer young people (aged 16 to 19) the chance to step into a researcher's shoes. High school students are invited to come to a nearby university or research institute, listen to lectures and work collaboratively with particle physicists, analysing real data from the Large Hadron Collider (LHC) at CERN. At the end of the day, every group of students participates in a video conference moderated by young physicists from CERN or Fermilab. The program is organised by IPPOG (International Particle Physics Outreach Group) and co-ordinated at TU Dresden in cooperation with QuarkNet (U.S.).



High school students analyse real data from the LHC.

### AIMS

During International Masterclasses, students work elbow-to-elbow with scientists in an authentic atmosphere. With this unique educational approach the following objectives are achieved:

- stimulate students' interest in physics
- demonstrate the scientific research process
- let students explore fundamental forces and building blocks of matter
- make data of modern particle physics experiments available for students
- offer authentic experience and add valuable experiences to physics education at school
- inform students about the new age of exciting discoveries in particle physics.

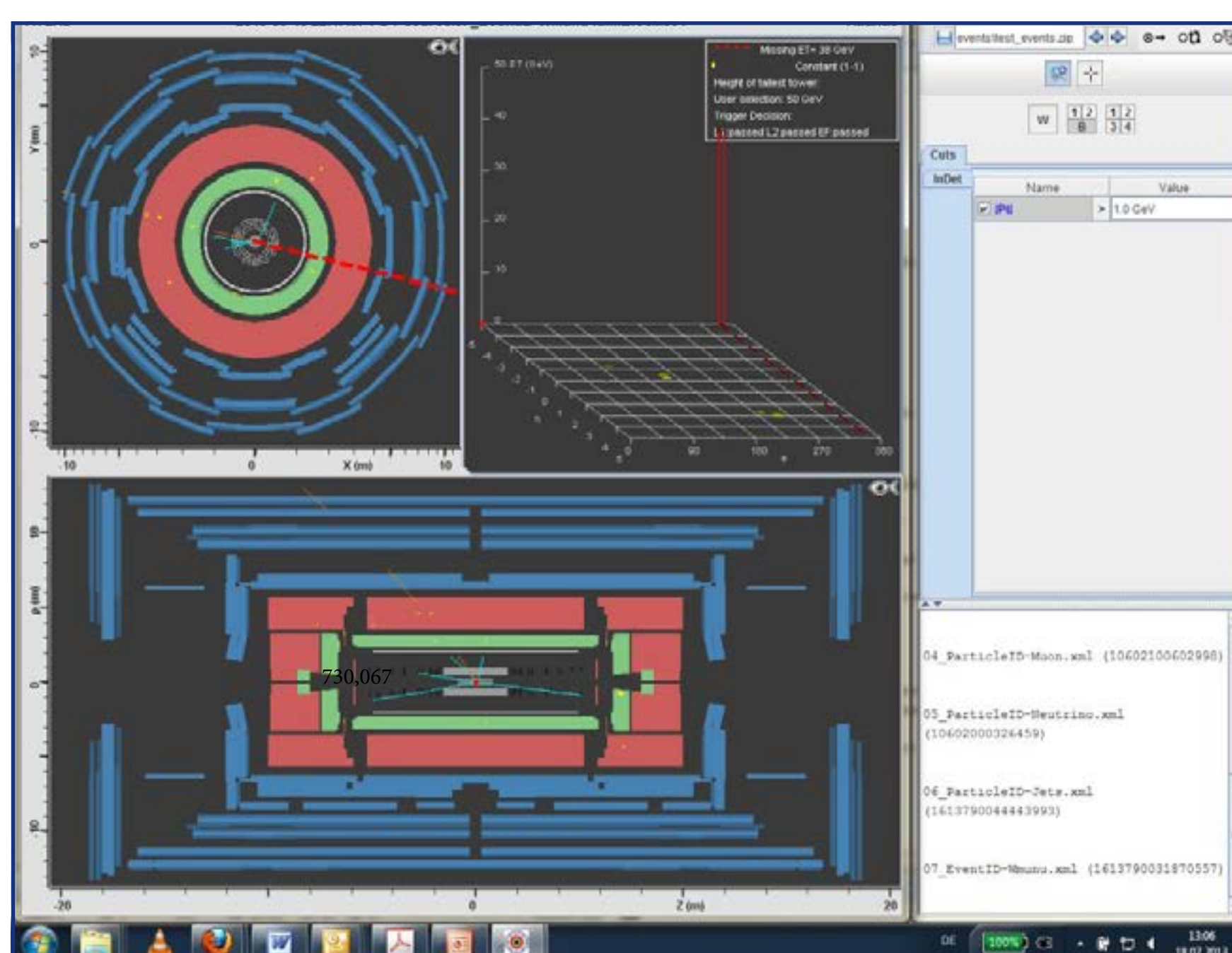


Students discuss their results in an international video conference with moderators from CERN.

### MEASUREMENTS

Measurements with data from ALICE, ATLAS, and CMS have been developed for International Masterclasses. Students are introduced to basic concepts of particle identification and event classification. They work with event displays and analysis tools also used by scientists. The basic idea of each measurement is a question related to particle physics. The results lead students to new and fundamental insights in this field. Tasks for students include for example revealing the structure of the proton, rediscovering the Z boson, or the searches for the Higgs particle or even for new hypothetical particles like Z' bosons.

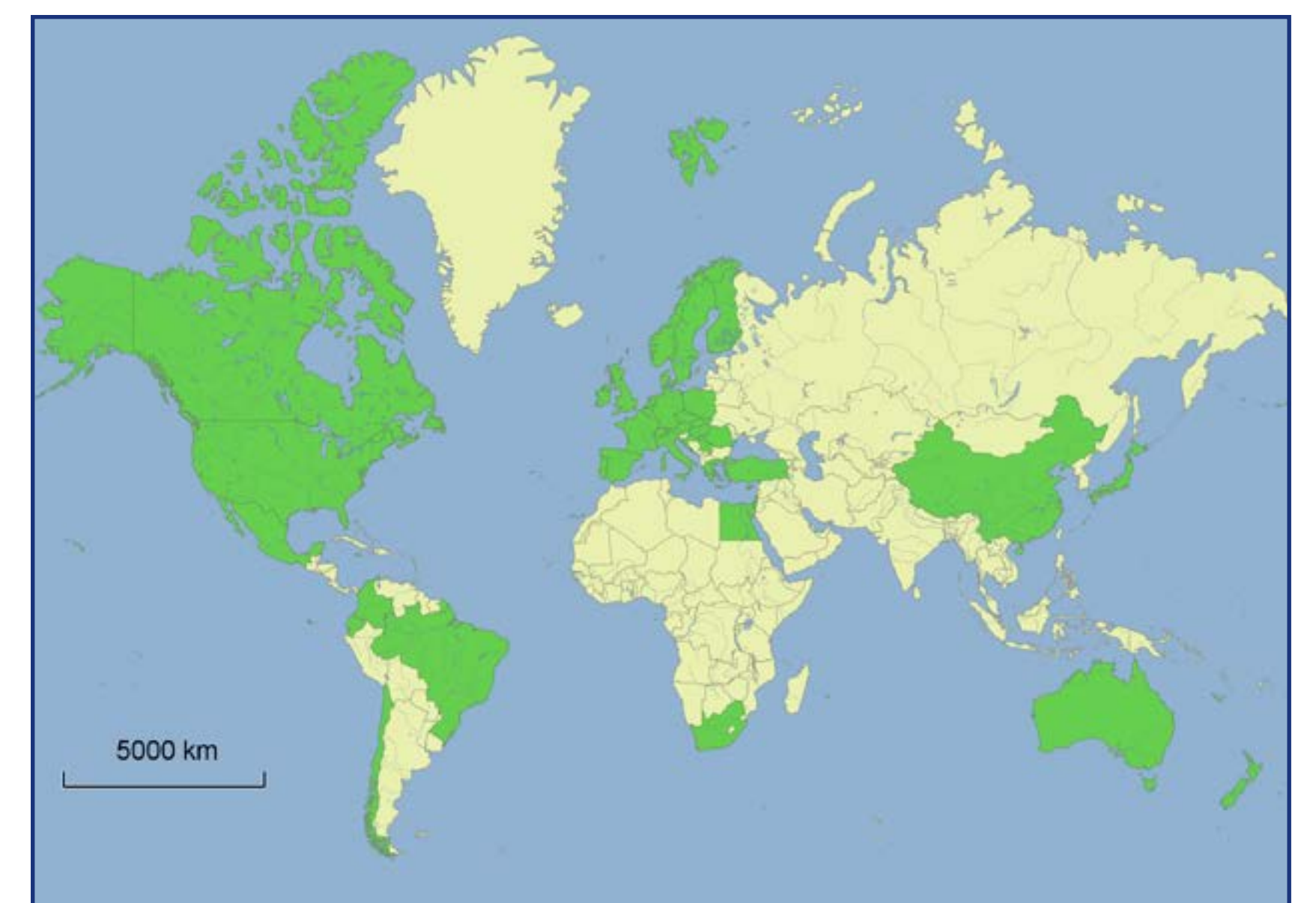
All material is free to be used for any educational purpose.



A W boson decaying into a muon and a neutrino is shown in this Minerva event display.

### PARTICIPATION

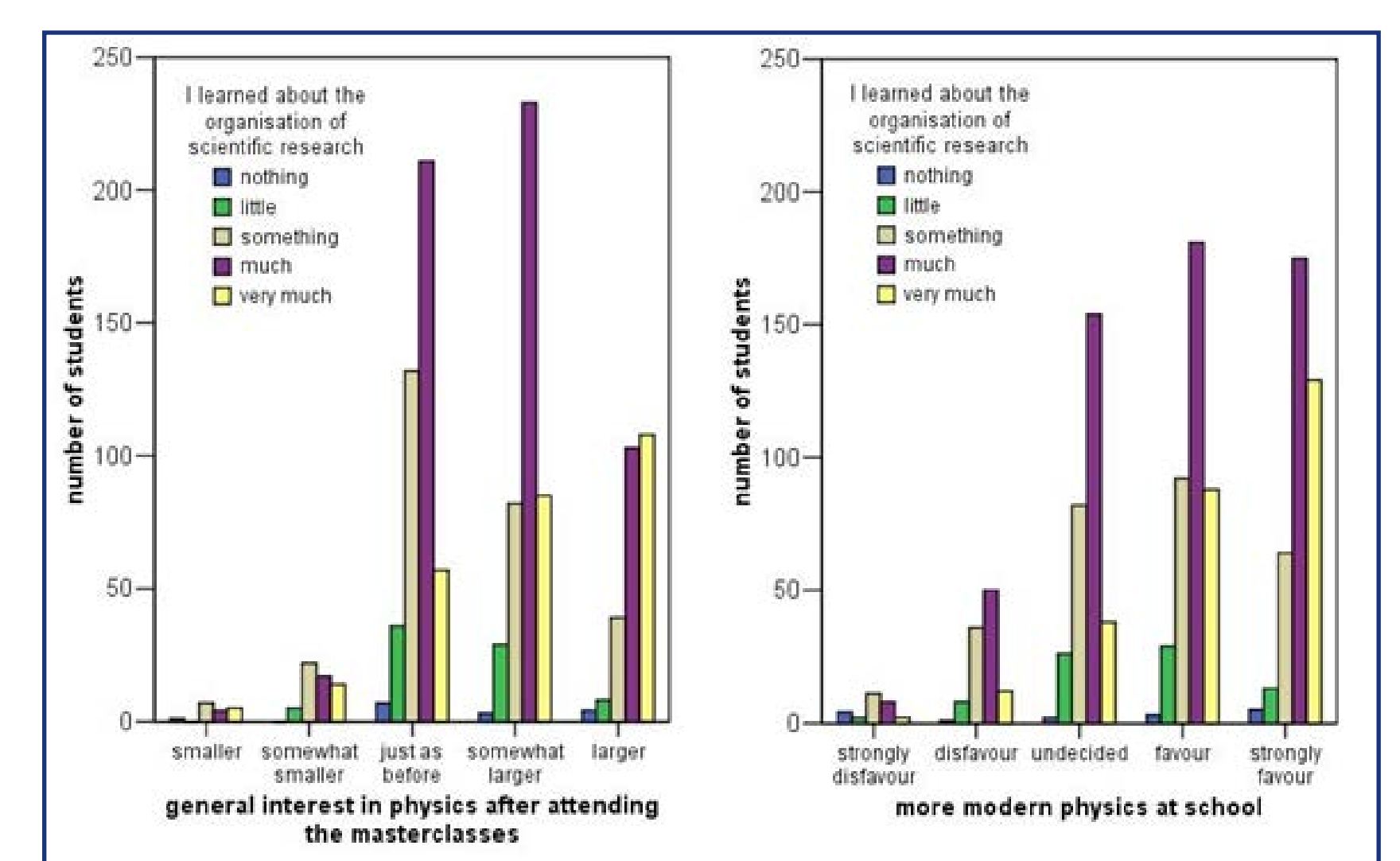
Since its beginning in 2005, the program has steadily grown. In 2014, more than 180 institutes in 41 countries participated with 10.500 students getting their hands on real data from the LHC. The worldwide participation reflects the international collaboration in particle physics.



International Masterclasses run in 41 countries worldwide

### EVALUATION

Evaluations have shown that students enjoy Masterclasses. The appreciation is independent of gender and pre-knowledge of particle physics. Three-quarters of the participants reported that they learned much or very much about the organization of scientific research. In addition, students increased their general interest in physics and wished to have more modern physics at school [1].



A whole day of studying particle physics increases the interest in physics for most participants!

### REFERENCES

[1] Johansson, Kobel et al.: Physics Education 42 (6), 2007, 636 - 644.