International Masterclasses in Physics

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Abstract. *The particle physics masterclasses, coordinated by the European Particle Physics Outreach Group (EPPOG) under the direction of Michael Kobel of the Technical University of Dresden, give secondary school students the chance to work collaboratively with their peers under the mentorship of particle physicists as they analyze real data from the Large Electron Positron (LEP) collider. The program is modeled after masterclasses in the arts, in which students learn by working on a piece for performance or display under the tutelage of an expert. However, in the one-day physics masterclasses, held at universities and other reserach centers, students are also given presentations on the Standard Model and on the analysis of event displays in order to detemine decay modes of the Z-boson in a LEP data run. In addition, students in the physics masterclasses have a capstone experience at the end of their day in which they compare the results of their analyses internationally via videoconferences moderated from CERN and, more recently, Fermilab. The physics masterclasses started in the United Kingdon in 1997 and have since been adopted by the EPPOG as a major, Europe-wide program affecting thousands of students each year during a defined 2-4 week interval in February, March, or April. From this, the physics masterclasses have spread beyond Europe to North and South America, Africa, and Asia, with a particularly active program in the United States. Extensive evaluations of the physics masterclasses in Europe in the form of student surveys and in the United States, using similar surveys but also evaluative quizzes, have yielded positive results. The evaluations have shown that students increase their interest in and understanding of particle physics in the masterclasses; furthermore, the masterclasses are popular with students, teachers, and the physicists themselves. Students report that they understand better how real physics is done and there are anecdotal reports of students being inspired to study physics in university as a result of their masterclass experiences. Based on these results, the program has steadily grown in terms of numbers of institutes offering the masterclass, countries participating, and total number of students. The future is exciting: the physics masterclasses are likely to increase in number and, with the advent of the Large Hadron Collider (LHC) at CERN, a new set of exercises with LHC data is planned for 2011 and beyond. These exercises will initially focus on particle decays such as those of the Z- and W-bosons that physicists use to understand the detectors. Students will be able to study whether previously established results are obtained from the LHC just as the physicists will have done. Subsequest exercises may become available beyond 2011 to track the progress of LHC physics. Given a good experience to date and interesting plans for development in the coming years, the physics masterclasses offer a possible model for physics outreach and improved student learning of science which reflect the excitement of cutting edge physics. This model has worked well for particle physics: it is expected that similar masterclasses in other branches of science could also work well to engage students and increase their scientific understanding.*