

INTERVENTIONS

Masterclass – Hands-on CERN/Rio

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The purpose of this contribution is to review not a book or article, but a scientific education project on Particle Physics and High Energy: the “Masterclass/ Hands on CERN” (European Organization for Nuclear Research), focusing on its Brazilian version.

The Masterclass/Hands-on CERN is based on the assumption that science education and science disclosure have high epistemic and social value, since they contribute to the formation of a scientific culture in the societies in which they occur, motivate young students to get started on scientific careers, and in the long run to increase the number of researchers in a given society, and create channels of dialogue between science and society. This is very important in that, ultimately, it is civilian society who finances much of the scientific research and consumes its applications. Science education and communication contribute to society’s understanding of science “as it is done”, borrowing an expression from

science studies. From this perspective, Hands-on CERN believes that it can contribute to the formation of a scientific culture that strengthens the ties between science and society, teaching young students to practice particle Physics, which is currently under development at the European Center for Nuclear Research.

Masterclass/Hands-on CERN is a scientific dissemination project of the IPPOG² (International Particle Physics Outreach Group). It has been designed for teachers and young students who are interested in natural sciences, and it aims to increase students understanding of the fundamental processes that take place in the smallest parts of matter by disseminating contemporary research in particle collision.

The project brings together about 12,000 high school students from 42 countries once a year, when students go to one of the 200 universities or research institutes that

¹ We would like to thank UERJ Professor A. A. P. Videira for his suggestions

² <http://physicsmasterclasses.org/> (last access 20/03/2016).

take part in the project to attend lectures on Fundamental Physics, the composition of matter, and Nuclear Physics, taking measurements using real data from the Large Hadron Collider (LHC) experiments at CERN. After analyzing the events that result from proton-proton collisions, an international video conference is held to communicate the results.

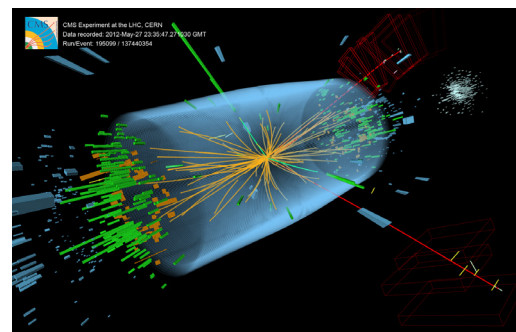
The goal of the project is to promote Particle Physics among students, captivating their interest in the cutting-edge science that is currently practiced in this field. In many countries, like Brazil, contemporary Physics is not taught, and students do not recognize science as a practice that is still open, full of challenges, uncertainties and adventures, which often operates at the limits of knowledge, or at least are unaware of the theories and models most widely accepted by the scientific community.

At an international level, the Masterclass is an attempt to bring society and young people closer to current particle physics and the LHC experiments at CERN, which involves highest-level sophisticated technology. It is worth noting that the LHC is the largest particle accelerator ever built in terms of size and power, and that it has allowed us to observe the Higgs boson.

The Brazilian management office of Masterclass³ is located at the Department of Nuclear and High Energy Physics of the Rio de Janeiro State University, UERJ. The

Masterclass is held not only at UERJ, it also takes place in Natal, capital of Rio Grande do Norte state, in northeastern Brazil, in Manaus, capital of Amazonas state, in Lavras, a country side city in the state of Minas Gerais, in São Paulo, capital of the São Paulo state, in Curitiba, the capital of Paraná state. It is not only an annual event held in a single day. It stands out for promoting an ongoing project throughout the school year, receiving high school and college students in the early years of their courses in Physics, Computer Science, Librarianship, Economics, Engineering and Philosophy, to study an Introduction to Particle Physics and to Particle Collision Analysis.⁴ This is one of the peculiarities of the Brazilian edition of the project in Rio de Janeiro, which has become a medium-term science education program.

Figure 1: “iSpy is a powerful and lightweight event display used for the CMS experiment at the LHC. It reads in an ig file which contains event and geometry information”



Source: <http://cms-outreach.github.io/ispy/> (last access 17/04/2016)

Participants in the Brazilian edition learn, introductory, about quarks, leptons,

³ <http://handsoncernrio.webnode.com/> (last access 20/03/2016).

⁴ <http://physicsmasterclasses.org/index.php?cat=physics&page=atlas>
<http://physicsmasterclasses.org/index.php?cat=physics&page=cms>
 Teachers and students can obtain more information here: LISHEP2015 sessão A <https://indico.cern.ch/event/338358/timetable/#20150728> (in Portuguese) and LISHEP2009 sessão A <http://www.lishep.uerj.br/lishep2009/> (all accessed on 20/03/2016).

fundamental interactions and their mediators, the Higgs boson, as well as how particles interact with matter and how to use it to recognize the different particles produced in the proton-proton collisions. They also learn about the characteristics of each (sub)detector of the ATLAS and CMS experiments. More experienced ones are encouraged to present their work to the others, helping them to understand this new activity. New ways of understanding the relationship between Particle Physics and other areas of knowledge are always explored. Particle Physics and its correlation with History, its use of Computer Science, its relationship with Philosophy and its influence in Art have been some of the themes studied. The goal of the Rio de Janeiro team is to train university students and school teachers as disseminators of Particle Physics, in order to take knowledge about the subject to different high schools around the country.

In addition to the official software of the project, Hybrid Pupil's Analysis Tool for Interactions in Atlas⁵ (HYPATIA) and iSpyOnline for CMS (see figure 1)⁶, Brazilians have developed their own tools, such as an analogic board game, which was created by the young participants to teach Physics to students in elementary and high schools. Also an online game can be used by all the participants⁷. The team based in Rio de Janeiro, sought to innovate and perfect the project: they have expanded

its duration, turning a single-day event into a continuing education program that lasts throughout the school year. Student seminars, colloquia, mini-courses, make the project content broader, taking in students from various fields of knowledge, seeking to contextualize the relationship between physics and other forms of knowledge.

One of the main concepts of the project, other than the relationship among science, technology and society, is to learn science by doing science.⁸ The aim is to overcome the passive, static concept of education by receiving information and applying a dynamic method in which the students "go hands on" and learn about particle physics by practicing collision event analysis just as a scientist at CERN does. The physics teachers and students who participate in the project feel that they are part of science rather than just impersonal students.

At CERN, particle physics has the so-called "standard model of particle physics" as a premise. Nonetheless, science is developed in a pluralistic environment where several representations of nature co-exist, in which not any one form of science can be considered the complete and definitive explanation of reality. The standard model may be the most widely accepted, consistent and successful, yet

5 <http://hypatia.phys.uoa.gr/> (last access 20/03/2016).

6 <http://ispy.web.cern.ch/ispy/1.5.0/> (last access 20/03/2016).

7 <http://www.sprace.org.br/sprace-game> (São Paulo team, last access 20/03/2016).

8 See "PHYSICS/IDENTIFYING PARTICLES" at <http://physicsmasterclasses.org/> (last access 20/03/2016). See also: Silva, V.C. (2014): "Hands on CERN como una herramienta para la educación y la difusión de la física de partículas", in: *Anais - Primer Encuentro de la Red Chilena de Ciencia, Tecnología y Sociedad*, Santiago: Universidad Alberto Hurtado, at: <https://encuentroctschi.files.wordpress.com/2013/12/libro-de-resumenes-primer-encuentro-cts-chile.pdf> (last access 20/03/2016).

it is but one model among many others. Thus, ignoring alternative representations would betray the pluralistic, critical nature of scientific research. Therefore, there seems to be an inherent challenge not only to the Masterclass – Hands-on CERN, but also to science education in general: How do we disclose not a theory, event or experiment, nor just a scientific institution, but rather the “value of science”? How do we go beyond “advertising” and communication, and make it so that science education will serve to create a scientific culture in the broadest sense? To what degree are the students of Masterclass in Rio educated in a critical environment of theoretical pluralism? Time will tell if students in Rio are only introduced to the experiments at CERN or to a scientific research attitude that is broader and more critical. Judging by the way physics is contextualized in the Brazilian version of the project, it certainly seems there are reasons for optimism.