Masterclass: "Hands on CERN"

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Abstract–**The opportunity to work for the first time with real data from the LHC experiments, at CERN, becomes reality for students around the world through the Masterclass Hands on CERN, the outreach activity organized by CERN where more than 10000 students from 37 countries and 160 universities take part each year. Through video conferencing students from different countries get together to discuss the results of their analysis using events from ATLAS, CMS, or ALICE experiments , coordinated by 2 physicists at CERN, or Fermilab. The goal is to give students a glimpse of the routine work of physicists within the international collaborations that assemble and perform these experiments. The official language is English. The Internacional Masterclass - Hands on Particle Physics is heavily based on computing technologies. The World Wide Web plays a major role allowing the video-conferences, the access to the data from the LHC experiments. Facebook has been added to the facilities the students can use to access all the information about the Masterclass and plan their participation. We will report about**
our experience in Rio de Janeiro, Brazil, working with the Masterclass, where the World Wide Web is also used to explain the introductory concepts of Particle Physics. Sites with introductory explanations, some of them in Portuguese, can be accessed any time by the students. Local pages on Facebook allows them to be in contact with the physicists taking part in the project. E-mail is normally used by their teachers. Skype allows meetings, conversations and even short courses with students and teachers far away from our university. Altogether bringing them into the HEP world.

I. Introduction

THE Masterclass [1] is an event organized by CERN for high school students, undergraduate students, i.e., mostly teenagers , as well as for their teachers. Special days are dedicated to Physics Teachers.

As stated in the title, it is a Hands On, namely the students will learn (at introductory level) about Particle Physics, interaction of radiation with matter, detectors, the LHC experiments, and will analyze real events from one (or more) of the experiments (ATLAS, CMS, ALICE or LHCb). Those events are specially selected and given to the Masterclass by the experiments.

Year 2005 was named the International Year of Physics and the Masterclass was created as an outreach activity in Europe, for the member states of CERN, .using the outreach work develop by Prof. Dr. Erik Johanson, from Stockholm University named "Hands on CERN", where it was possible to analyze events from the DELPHI experiment, one of the LEP ones. LEP was the accelerator at CERN for electron-positron colisions, it was the predecessor of LHC. At that time, for the Masterclass, events from OPAL experiment, also from LEP, where also included. The participants could choose the experiment, as it can be done nowadays with the LHC experiments. Once LHC started its operations, in 2010, events from ATLAS where made available, in 2011, ATLAS and CMS events, 2012, also ALICE and in 2013 events also from LHCb. Brazil started to participate in the Masterclass in 2008 at the State University of Rio de Janeiro, UERJ. We analized events from DELPHI, since 2010 we analyze events from ATLAS and since 2011, ATLAS and CMS. Since 2008, the CMS group at UNESP, the University of the State of São Paulo, and UFABC, the Federal University of ABC region at São Paulo state, also promotes the Masterclass. They analyzed events from DELPHI, then ATLAS and since 2011 only events from CMS. Since 2012, the ALICE group at USP, the University of São Paulo, analyzes the ALICE events in their Masterclass activities.

All activities are done with students from high schools at the cities of Rio de Janeiro and São Paulo including all the cities nearby. Undergraduate students of any course, as well as any person interested, are welcome to participate.

In 2010, the Federal University of Amazonas, UFAM, did the masterclass together with us at UERJ, in 2012, the Federal University of Lavras, UFLA, in the state of Minas Gerais, also joined us and in 2013, the Catholic University of Rio Grande do Sul, PUCRS. Fig.1 shows the location in Brazil of the states where Masterclass is taking place.

II. Activities

CERN suggests all activities with the students should be done in 1 day: 1 full morning with coloquia and seminars about Particle Physics, detectors, and the LHC experiments with 1 or more coffee breaks. In the afternoon the students should do the event analysis. By the end of the day there is a meeting with CERN and other participants, universities from different countries, to discuss the results. Vydio is used for this meeting.

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Fig.1 – All the countries in South America. For Brazil, all states are indicate. Special attention to the states where the Masterclass activities are beeing carried on: RJ, Rio de Janeiro, SP, São Paulo, MG, Minas Gerais, RS, Rio Grande do Sul, AM, Amazonas.

Due to the time difference, in Brazil it should be half a day plus half a day (next day), at least, and the meeting with CERN is at noon.

In Rio de Janeiro (RJ) we do it a bit different. We have weekly meetings, months before the meeting with CERN, The meeting with CERN is the only activity of that day, allowing teachers and students to come from "far away" places to participate. Rio de Janeiro is a big city and sometimes the students and teachers need to travel 2 or 3 hours to reach UERJ.

Only 5 to 7 connections to CERN per day are allowed in Vydio therefore Manaus (Amazonas, AM) connects to us, using skype (or EVO, when it was available). Lavras (Minas Gerais, MG) came to our university in order to participate in the meeting. Porto Alegre (Rio Grande do Sul, RS) also connects to us using skype. In this way we represent only 1 connection in Vydio.

The Universities in the state of São Paulo (SP) do it independently, following the suggestions done by CERN.

To explain Particle Physics, the detectors, the experiments, we use sites on the web: for example, information about the LHC can be found in [2] and [3], about the accelerators at CERN in [4], about CERN in [5], Fermilab [6]-[8] (including the videos), Youtube CERNTV [9], the particle adventure [10] and links therein. The experiments also provide sites with informations about the interactions of the particles with matter. Fig. 2 shows the figure from ATLAS explaning how the different detectors register the different particles and how we can use that information to identify them.

The students are encouragied to access them at home, navigate, and come with questions.

We analise events from ATLAS and CMS. Figs. 3 and 4 show an example of the events from ATLAS and CMS analyzed in the Masterclass. The students may come to the university and analise them using our computers or they can download the events in their home computer and perform the analises. Discussions, explanations, questions, are done during the weekly meetings and also using e-mail, facebook, and skype.

This would not be possible without the world wide web.

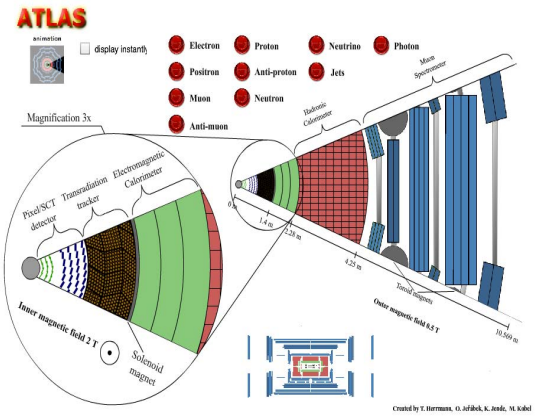

Fig. 2 – Figure from ATLAS showing how the different particles interact in the different detectors of the experiment.

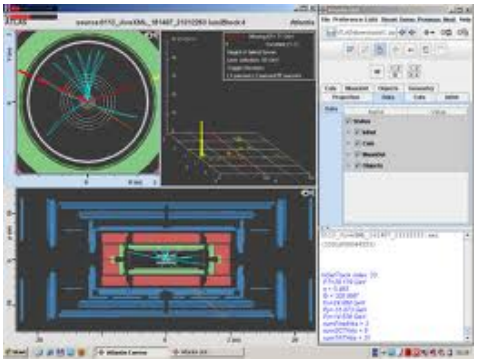

Fig.3 Example of an ATLAS event analyzed in the Masterclass. It shows the event in 2 different views, it is possible to access also various informations about the particles (momentum, energy, charge, angles).

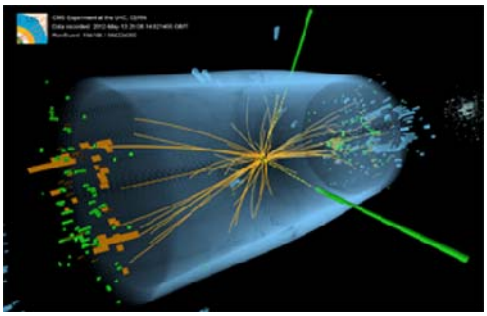

Fig. 4 – example of a CMS event analyzed in the Masterclass. The electron and the positron, in green, can be easily identified by the students. The reconstruction of its mass show a candidate for a Z0 decay

III. CONCLUSION

Since we have various institutions participating in the Masterclass across our country, and we want to reach many more, for us it is almost impossible to atend all students interested in learning about Particle Physics and participating in a hands on activity related to that. The use of the world wide web and all tools available make possible

to offer to them all information and assistance they need. Parents also like that their children sit in front of the computer to learn, that they can talk to a physicist in order to learn more. Also, the parents can talk to us using skype, they can see us, and get all explanations they want about the activities their children are doing with us.

The use of the world wide web allow also the collaboration with other universities in Brazil, spreading the outreach activities of the Masterclass, and sometimes more. After the Masterclass 2012, a course "Introduction to Particle Physics" was held during 3 months by one of us (M. Begalli) at UFLA, using skype. The city of Lavras is 500 km away from Rio de Janeiro. It would be impossible to do it otherwise.

We have tried many different tools on the web, some of them are very useful, some did not show any result, or attracted protests, publicity, topics not related to Particle Physics.

Works:

- e-mail
- Facebook
- youtube
- google mail chat
- Smartphones (cel phones)
- Telephone (standard)

Does not Work:

- Seminars (the students want to talk, not to listen)
- Yahoo groups
- Google groups
- Blog
- Twitter (too many protests from other sources poping in all time)
- Orkut

Besides the teaching of introductory concepts of High Energy Physics we want to teach the students how to find and obtain information about that subject in trustful sites, as well as to work with the subject/events, to research about it. They can continue to connect with us after the meeting with CERN. All the students say that they do not feel at school, they feel like "professionals" and enjoy it!

REFERENCES

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[2] http://public.web.cern.ch/public/en/research/lep-en.html
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