5 April 2006

The Education and Outreach Project of ATLAS – a new participant in physics education

R. Michael Barnett[1] and K.Erik Johansson[2]

[1]Lawrence Berkeley National Laboratory, Berkeley, USA
[2]Stockholm University, AlbaNova, 106 91 Stockholm, Sweden

1. Introduction

With the extraordinary possibility to make groundbreaking discoveries, the ATLAS Experiment [1] at the Large Hadron Collider at CERN can play an important role in promoting contemporary physics at school. For many years ATLAS has had a substantial collaborative Education and Outreach (E&O) project in which physicists from various parts of the world take part. When the experiment begins in 2007, students from around the world will be analyzing data using cutting-edge technology.

The unprecedented collision energies of the Large Hadron Collider allow ATLAS to decode the "events" that unfold after the head-on collisions of protons (Fig. 1). The scientific results from these events will reveal much about the basic nature of matter, energy, space, and time. Students and others will be excited as they try to find events that may be signs for dark matter, extra dimensions of space, mini-black holes, string theory, and other fundamental discoveries.

Science education and outreach and the promotion of awareness and appreciation of physics research have become important tasks for the research community and should be recognised as a natural and logical part of science research and as an important link between research and society. To be successful these activities have to be done in a systematic and professional way. Leading scientists together with multimedia experts can form a powerful team with teachers and educators in disseminating physics information to school and universities. The ATLAS collaboration has fully recognised the importance of education and outreach. The ATLAS E&O project can be a model for today's large science experiments in promoting science at schools and universities.

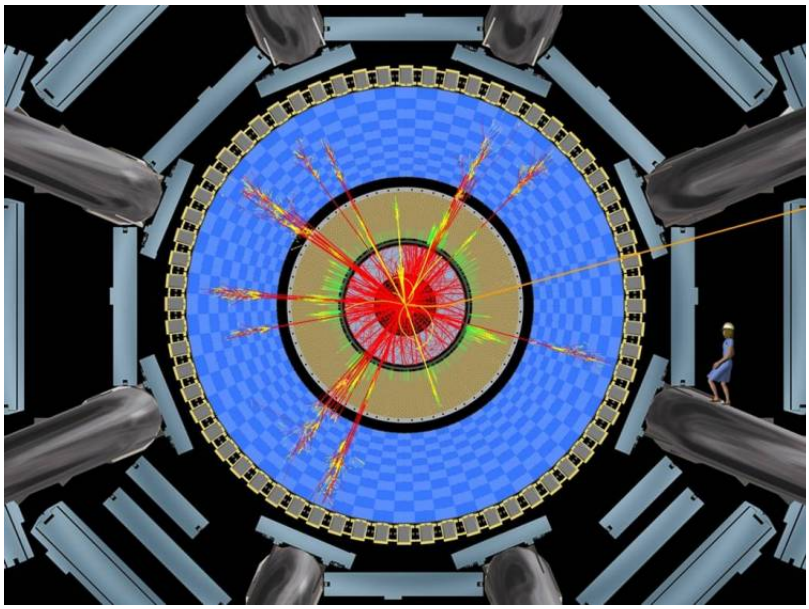

Fig. 1 A collision event as will be seen in the ATLAS detector. The woman is shown only to indicate scale.

2. The ATLAS experiment

ATLAS is a particle physics experiment that will explore the fundamental nature of matter and the basic forces that shape our universe. The aim is to reveal the secrets of nature in the head-on collisions of protons of extraordinarily high energy. ATLAS is one of the largest collaborative efforts ever attempted in the physical sciences. There are 1650 physicists (including 400 students) participating from more than 150 universities and laboratories in 35 countries. The detector, located 100 metres underground, has a length of 46 metres and a height of 24 metres (see Fig. 2).

The protons will be accelerated in the Large Hadron Collider, an underground accelerator ring 27 kilometres in circumference at the CERN Laboratory in Geneva, Switzerland [2].
The particle beams are steered to collide in the middle of the ATLAS detector. The debris of these collisions reveals fundamental particle processes. The energy density in these high energy collisions is similar to the particle collision energy in the early universe less than a billionth of a second after the Big Bang.

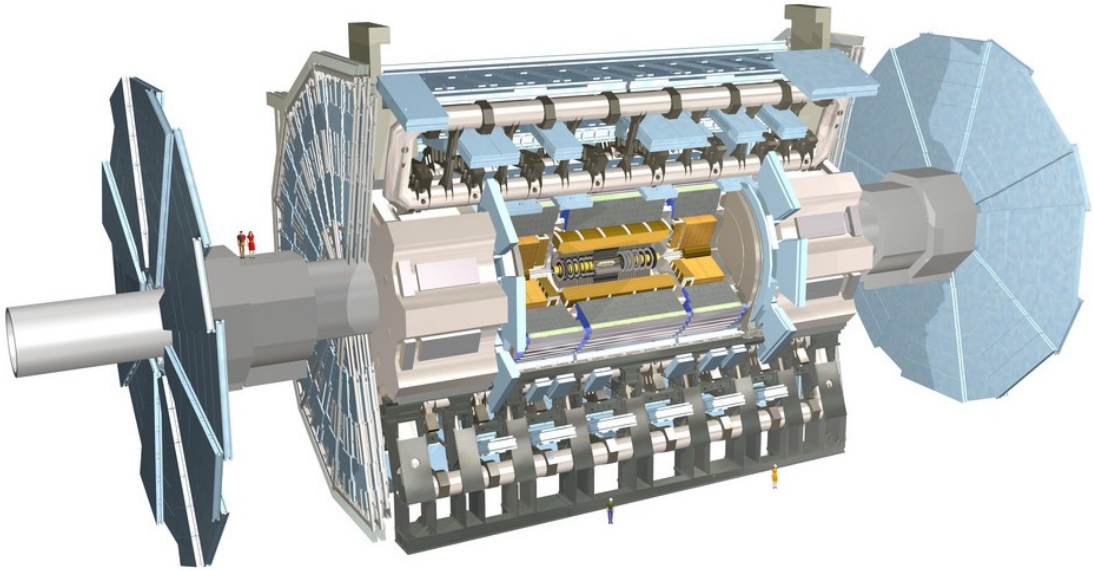

Fig. 2 The ATLAS detector with people to indicate the scale.

3. The ATLAS E&O project

The ATLAS Education and Outreach project has existed since 1997. It is a formal ATLAS project with the full backing of the large international ATLAS collaboration, and has an annual budget. The regular meetings of the E&O group attract a large number of interested people from the 150 ATLAS institutions. They take active part in the discussions and give strong support to the activities and projects.

The aims of the ATLAS Education and Outreach group are to:

- inform and intrigue the public, students, and teachers about the ATLAS Experiment and particle physics
- provide the members of the ATLAS collaboration with information and material to assist in their contacts with the public, officials, news media, students, and teachers
- facilitate the teaching of particle physics by providing ideas and interesting educational material
- coordinate ATLAS outreach activities.

The ATLAS Education and Outreach project has been very successful in producing informational material like brochures, posters, a film and animations about ATLAS and particle physics. It has played an important role in promoting activities and encouraging school teachers to introduce modern physics at school. The ATLAS E&O project is a good model for how today's large physics experiments can promote physics at school and interact with teachers and students both at schools and universities. Together with the school teachers, the ATLAS experiment can become a new participant in physics education complementing the traditional way of teaching modern physics.

4. Informational material

The ATLAS Education and Outreach (E&O) project will benefit from the use of the material already produced by the ATLAS E&O group. Currently this material assists members of the collaboration in their contacts with students, teachers and the general public.

The ATLAS informational material exists in different forms:

- Website
- Web camera pictures
- Brochures and posters
- Film
- 3D animations
- CD's and DVD's

The website http://atlas.ch [1] describes the basic ingredients in a particle physics experiment and has electronic tours of the theory of particle physics, the accelerator and the detector. The four web cameras situated in the ATLAS cavern show the status of the detector installation. The web cameras are accessed from the front page of the website. The brochures and posters are colourful and simple descriptions of the ATLAS project focusing on the most interesting aspects of ATLAS. Many of the brochures, films and posters have been translated to different languages by members of the ATLAS collaboration. The film for example exists in 10 languages. It has received international recognition by winning four gold medals in science film competitions [3]. The CD's and DVD's contain a rather complete set of the ATLAS information (brochures, posters, video in several languages and animations). One of the animations describes in less than a minute how the different accelerators at CERN are used to finally produce proton collisions in the middle of the ATLAS detector. A more advanced and detailed set of animations are presently being produced (see below).

The material is available through the ATLAS website, by visiting the ATLAS secretariat at CERN or from physicists at the 150 institutions that constitute ATLAS.

5. E&O activities

Outreach and education activities take place at many of the universities and laboratories that are part of ATLAS. For these occasions the informational materials are used in English or are translated. Talks and presentations are given to students, teachers, and the general public. During the last few years some of the most extensive activities have been the celebration of CERN's 50th anniversary, both at CERN and in the member states, the European Masterclasses 2005 [4] and the Euroscience Open Forum 2004 [5] (Fig.3). During the CERN Open Day (Fig. 4) more than four thousand visitors descended 100 m deep underground to the ATLAS cavern to see the status of the detector construction. Year-round both ATLAS members and the CERN tour service take visitors to see the ATLAS experimental areas. Many of these visitors are students coming with their classes.

Fig. 3 Visitors and ATLAS posters at ESOF 2004

Fig. 4 Visitors in an ATLAS construction area at the CERN Open Day in 2004.

In the particle physics Masterclasses [4] the students analysed data from some of the LEP (Large Electron Positron) experiments and learned about future experiments like ATLAS. The idea of Masterclasses originated in the UK, but was expanded during 2005 to 60 institutions in 18 countries during a two-week period. The Masterclasses are for 16-18 year-old students who spend a day at a university or other institution listening to lectures from physicists and then participate in hands-on activities. The number of students at each location varied from 20 to 100, so the total was something like 3000. At the end of the day about six Masterclasses joined together in a video conference to discuss their results and the differences and to combine their results for better accuracy.

6. Future programs

The future programs will meld together several state-of-the-art capabilities available to our collaboration. It will use the best aspects of technical animation by allowing students and others to manipulate 3D images of the detector, and then look to see how particles are detected as they pass through. In addition, students will look at animations of events representing new physics such as dark matter or extra dimensions, and will then be able to control 3D images of these events, and finally analyse these to see if they recognize patterns of new physics.

During the next few years the ATLAS E&O group will continue to produce an attractive and interesting set of informational material. Presently the most ambitious project is a three-episode set of animations showing how ATLAS is being constructed and assembled, how the different detector elements function to detect the passage of particles, and how the physics is revealed in the proton-proton collisions. At the entrance to the ATLAS site an extensive exhibition about the accelerator and the ATLAS detector is being produced. Starting in 2007 (when construction is completed and the ATLAS Experiment begins), exhibitions and events will start to play an important role in our outreach and education efforts. Some of these events will take place at CERN and at the entrance to the ATLAS cavern. Participation of teachers and students from the different countries will be encouraged. We intend to assist and produce information material needed to make exhibitions possible in the countries of the participating universities and laboratories. The two very successful education projects, QuarkNet [6] and Hands on CERN [7] will serve as models for an education project using ATLAS data. This project - the ATLAS Student Event Challenge - will build on the best practise of those projects, in which we have substantial involvement.

The ATLAS Event Challenge will be an innovative program using cutting-edge technology to enhance student education, inform the public, and bring exciting exhibits/programs to science centres. It will provide these audiences with access to real and simulated data and the opportunity to participate vicariously in discoveries that may transform our thinking about our universe. This program can change the relationship between an experiment and the public/students. It will use the potential of frontier science and grid computing as a vehicle to promote and improve the teaching of fundamental science. In addition to learning fundamental physics, students will be developing valuable communication skills using a variety of approaches or techniques (oral and written). We will build new communities among those who participate: teacher-to-teacher, student-to-student, and most importantly physicist-to-all.

References

1. ATLAS website: http://atlas.ch
2. CERN website: http://www.cern.ch
3. Film gold medals: 1) 39th International Festival, *Technology and Art TECHFILM* 2001, Czech Republic, 2) *World Media Festival*, Hamburg, Germany, 2001, 3) *The Scientific Film Box Office*, Canary Islands, France 2000, 4) *Prix Leonardo*, 2001 International Film Festival, Parma, Italy.
4. European Masterclasses 2005 http://wyp.teilchenphysik.org
5. Euroscience Open Forum 2004 website: http://www.esof2004.org
6. QuarkNet webpage: http://QuarkNet.fnal.gov and documentation references
7. Hands on CERN web-page: http://hands-on-cern.physto.se,
   Hands on CERN - a Particle Physics Education Project utilising the Internet, K.E. Johansson and T.M. Malmgren, Physics Education 34/5(1999)286-293,
   Hands on CERN - a well used physics education project, K.E.Johansson, to appear in Physics Education.

Acknowledgements

This work has been performed within the ATLAS Collaboration, and we thank collaboration members for many useful discussions and particularly the support by T. Akesson, J. Ernwein, H. Gordon, P. Jenni, M. Nessi, and M. Nordberg. We also acknowledge the valuable contributions by H. Burckhart, J. Dolejsi, M. Kobel, C. Kourkoumelis, A. Maio, D. Milstead, J. Pequenao, and S. Schuh to the education and outreach project.