Educational Scenarios for University Students based on the ATLAS experiment and related Outreach activities

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Abstract. *It is very useful to introduce some of the techniques used in experiments, such as the ATLAS experiment at the Large Hadron Collider (LHC) at CERN, into University physics undergraduate and graduate courses. This material is frequently introduced into University lecture courses but there are less resources that can be used in Physics laboratories alongside more traditional laboratory experiments. This article discusses some new scenarios that have been developed and tested in University Physics laboratory classes. These use both collision and simulated data from the ATLAS experiment at the LHC and were developed as part of the Learning with ATLAS at CERN EU outreach project.*

These scenarios use the Minerva software tools to visualise data from the ATLAS detector. This visualisation software is the same as used by ATLAS physicists for their detector monitoring and physics analysis work. A few of the more complex options are hidden by using customised configuration files to make it easier for non specialists to use.

In these projects Minerva can be used to help select and classify proton-proton collisions which produce different types of final state particles. For example. proton-proton collisions where W or Z bosons are produced are most easily identified by the presence of very energetic electrons or muons. The W or Z boson decays very quickly, effectively at the collision point, and the electron or muon decay products typically have very high transverse momentum. One of the decay products of the W boson is an energetic neutrino which does not leave any signals in the detector. However its presence and its transverse momentum can be deduced using momentum conservation.

Once students have selected collisions containing energetic electrons, muons or neutrinos then they can use a relativistic equation to calculate the mass of the boson candidate. This scenario was used in the first year undergraduate laboratories in the School of Physics and Astronomy, University of Birmingham during Spring 2010 and received very encouraging feedback from the students.

In 7 TeV collision data recorded at ATLAS, collisions produce on average thirty charged and neutral particles. In many of these collisions neutral kaon particles are produced which decay via the weak force into two charged pions. This decay is visible in the ATLAS tracking detector and can be visualised by Minerva. The University of Stockholm has developed a scenario to study the properties of these kaon decays in the early collision data. Using the same relativistic equation, the mass of the kaon can be calculated and the effect of the relativistic boost on its lifetime can also be studied In this early phase of LHC running this scenario has the advantage that it uses collision data whereas for the moment the W and Z boson studies are based on simulated data.

We have also used the wide interest in the LHC to organise a number of different competitions at the University for schoolchildren. These have included competitions where short videoclips on Particle Physics topics are submitted which are designed to be effective for different age groups. This enables small groups of schoolchildren to work together on a project inside and outside the classroom without requiring very much assistance from the teacher.

Another very popular competition is where small groups of children produce a powerpoint presentation and demonstrations for a particular age group. In this 'Cascade' competition the group presents a 15 minute talk in their own school and the most successful teams are invited to a grand final at the University. Again the focus is on providing the opportunity for children to learn more about the subject and develop the skills needed to work in a team to deliver a presentation.. The major prizes usually involve support for visiting CERN. These groups often come up with very innovative presentations well matched to a younger audience.

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