Biennial African School of Fundamental Physics and its Applications 2010 Report


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December 2, 2010

Abstract

The first African School of Fundamental Physics was held in Stellenbosch, South Africa on August 1–21, 2010. The organisation of the school and the feedback from the students are presented.
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1 Introduction

A school of fundamental physics and its applications, ASP2010, took place in Stellenbosch, South Africa, on August 1–21, 2010 [1]. The school was based on a close interplay between theoretical, experimental, and applied physics. It covered a wide range of topics: particle physics, particle detectors, astro-particle physics and cosmology, computing, accelerator technologies and some of the applications, such as medical physics, light sources and magnetic confinement fusion. The participating students were selected from all over Africa and beyond. A selection of lecture topics in theory, experimental and applied physics was proposed for the school. Scientists from Africa, Europe and the USA were invited to prepare and deliver lectures according to the proposed topics taking into account the diverse levels of the students. The duration of the school allowed for networking — interactions among students and between students and lecturers. The school was funded by institutes in Africa, Europe and the USA.

By all accounts, ASP2010 was a very successful school as can be seen from the report presented herein. Such a success results from many factors, namely the dedication of the organising committee (local and international), the careful preparation of the school, the logistical support offered by the host country, the motivation of the students and the lecturers, the atmosphere of networking which continues after the school, providing students with valuable contacts and advice for higher education. As far as we are aware, it was the first time such a school on fundamental physics and its applications was proposed in Africa (without fees), for the duration of three weeks, selecting students from all of Africa. Arguably, it is the connection between theory, experiment and practical applications that the organisers of the school believed to be important for a solid education in Africa. Over-focusing on one of the three aspects — theory, experiment, applications — at the expense of the others cannot prepare the students to be flexible and adaptable on an increasingly global and highly competitive international level. Specialisation would still be necessary at some stage in the student’s education, but only after a solid foundation in theory, experiment and applications, after which the students can better match their areas of expertise with personal aspirations, to a narrower future research career. Networking was important in the basic education proposed at the ASP2010, to allow the students to seek and acquire information before deciding on their higher education and career paths. It is pretentious to suggest that the three week ASP2010 would instil all these necessary skills to the students. Indeed, ASP2010 is complementary to the basic education of the students, it expands the networking base of the students, allowing for the creation of valuable contacts across Africa and beyond. Furthermore, it is hoped that by organising this school every two years, with the next one in 2012, the basic objective of ASP2010, i.e., increased and competitive higher education in fundamental physics in Africa, will be better realised.

The motivation to carry out such a school in Africa is presented in Section 2. The organisation of the school is discussed in Section 3, this includes a careful selection of the venue, of the
curriculum, the financial support for the school and the selection of the students. In Section 4, we discuss the school itself, i.e., the activities during the period August 1–21, 2010 when the school took place in Stellenbosch: The logistical support offered by the host country and how this contributed to the success of the school, the lecture material that was presented to the students, the discussion and practical sessions that were organised to reinforce the understanding of the lectures and to promote networking, and finally the social activities that fostered further interaction among the participants. An outreach and innovation session was organised at the end of the school, this is presented in Section 5. In Section 6, we present the activities after the school, which included balancing the budget, the obtaining of feedback from and maintaining contacts with the students. In Section 7, we discuss the prospects of organising the school again in 2012. And finally, some concluding remarks are offered in Section 8.

2 Motivation

The aim of the school is to contribute to capacity building in Africa by harvesting, interpreting, and exploiting the results of current and future physics experiments with particle accelerators, and increasing proficiency in related applications and technologies. As an example, we discuss the opportunities offered by the Large Hadron Collider (LHC) [2] and its experiments, although the basic objective is to help improve the quality of higher education in Africa, to help increase the number of African students acquiring higher education. We believe that the knowledge students gain will benefit them in whichever careers they may pursue. Many students trained in fundamental physics go into industry, become educators or go into basic research.

Large experiments at the LHC and the Tevatron [3] have drawn on the involvement of research institutes and universities from around the world. Some of the salient LHC experiments include ATLAS, CMS, ALICE and LHCb [4, 5, 6, 7]. ATLAS and CMS are general purpose experiments (for precision tests of the Standard Model of elementary particles and the search for new physics beyond the Standard Model) whereas ALICE and LHCb are dedicated experiments to study the early universe and the matter–antimatter asymmetry in the universe. These are very complex and intricate detectors whose design and operation necessitate the collaboration of many physicists and engineers from around the world. The ATLAS collaboration for example consists of upwards of 3000 physicists spread across different countries and time zones. The LHC itself is the highest energy accelerator ever built; it has a circumference of 27 km and accelerates and collides proton bunches to 7 TeV. Heavy ion collisions have started in November 2010. These collisions are expected to re-create some of the conditions that existed in the early universe or to create elementary particles whose existence would enhance our understanding of the dynamics between matter and forces in the universe. Indeed some of the questions that could be answered at the LHC by ATLAS, CMS, ALICE and LHCb experiments include the nature of Dark Matter, the electroweak symmetry breaking and the generation of mass for
elementary particles, the origin of matter–antimatter asymmetry in the universe, the state of the quark-gluon plasma. We therefore have a cutting edge accelerator equipped with very complex detectors built with a variety of detection techniques. The operation of these detectors requires efficient triggering system to sift through the very high rate of the LHC collisions and identify the interesting events whose detailed analysis could shed some light on the aforementioned fundamental questions of particle physics, astro-particle physics and cosmology. The complete system of the LHC and its detectors, together with efficient triggering mechanisms to select interesting events, is complemented by a network of data sharing based on the Grid. Indeed, within less than a few days of recording the data at CERN, these are distributed through the Grid to many centres around the world, allowing different research groups to partake in the analyses without explicit presence at CERN.

These LHC projects are world wide efforts and the African participation and contributions can still be increased. For example, the only African countries in the ATLAS project are Morocco and South Africa as shown in Fig. 1 (left). Only South Africa is in the ALICE project with two institutes, namely the University of Cape Town and iThemba LABS, see Fig. 1 (right). Egypt and Tunisia are the only African countries in the CMS experiment. At the time of writing, there are no African universities or research institutes in the LHCb collaboration. Figure 2 shows the distribution of CERN users from various countries where it is evident that the participation of African scientists is not significant. These LHC projects offer significant capacity building for the countries involved. For example, on the ATLAS experiment alone, there are about 900 Ph.D. students, similarly for the CMS experiment. Furthermore, undergraduate students participate in summer student programs at CERN where they are offered the opportunity to work with experimentalists and theorists on various projects. The fraction of Ph.D. students from Africa on these experiments or the fraction of undergraduate students from Africa participating in the summer student programs at CERN is nearly negligible.
Figure 2: A distribution of CERN users per country. The fraction of CERN users from African countries is about 0.5%.
We have taken the example of projects at the LHC to motivate the needs to increase capacity building in basic science in Africa. The situation presented above is not limited to projects at CERN but reflects the general trend in major research facilities around the world.

The primary motivation for ASP2010 is to increase the knowledge and improve the capacity building of African students. We expect to achieve this through an outreach effort, an increased awareness of the potential of high quality training offered within the LHC context in various disciplines not just particle physics, and a system of networking. ASP2010 is a positive step towards the broader objectives of the school. We hope to continue with another school in 2012, ASP2012, and in doing so, help increase the global presence of African students and scientists.

3 Organisation of the School

In this section, we discuss the organisation of ASP2010, i.e., all the preparatory activities necessary to ensure the success of the school. The preparation for ASP2010 took some time, from its conception to realisation. Late in 2008, there was a firm commitment from Centre National de la Recherche Scientifique (CNRS)/IN2P3 in France to support and fund this project. This was the encouragement needed to seek the additional financial support required to cover the total budget for the school, as discussed in Section 3.3. The first milestone was achieved with a proposal for a school in Africa submitted to the ICTP [8] in February 2009. It was the beginning of concerted efforts on ASP2010.

3.1 Selection of the Venue

The selection of the host country was very important because the support offered by the host country has a large impact on the success of the school. Since ASP2010 was primarily targeted towards African countries below the Sahara, the host country was considered from that region. A few options were explored in West Africa, Central Africa and Southern Africa. After several considerations, South Africa was finally selected as the host for ASP2010. Some of the considerations that went into this decision include:

- The logistical infrastructure that is required for the school, and the ability of the host country to provide such a support.
- The ability to put together a local organising committee dedicated to the objective and the success of ASP2010, and directly involved in the preparation of the school.
- The prior experience — that may have been accumulated in the host country — from previous schools held in the country in question.
- The existence of physics teaching capacity in local universities up to at least the Bachelor degree.
• The existence of some local research/teaching in fundamental physics.

• The support from the local government in terms of the concrete financial contribution towards the running of the school.

After identifying South Africa as the host for ASP2010, the venue of the school within South Africa was then discussed. Many viable options were explored, taking into account the timing of the school and some of the considerations mentioned above. Ultimately, the National Institute of Theoretical Physics, NITheP [9] in Stellenbosch, was selected as the venue. Subsequently, members of the organising committee made a couple of visits to South Africa to see the selected location and the infrastructure that would be available for lectures, discussion and practical sessions, for hosting the students and the lecturers. In Section 4.1, we discuss how the logistical support contributed to the success of the school. It is expected that the next school, ASP2012, will be hosted by another Sub-Saharan African country and the same criteria outlined above to select the host will apply.

3.2 Courses

Four main topics formed the backbone of the school:

1) Theoretical Fundamental Physics,

2) Experimental Subatomic Physics,

3) Information Technology and Grid computing,

4) Accelerators and Applied Technologies.

Each topic is further divided into an initial set of recaps of essential background knowledge, followed by four main lecture themes, and finally a dedicated theme on computing-related aspects of the topic, including Monte Carlo generators, Grid computing, and high-performance computing. The latter was structured partly into hands-on practical sessions. Further, each main topic contained a number of additional exercises. These were completed in groups, with a single lecturer (mentor) assigned to each group. These groups also provided opportunities for discussing questions arising from the lecture material. The groups were assigned on arrival, and time was reserved for this activity each working day during the school. These daily discussion sessions provided a framework for mentoring students from different backgrounds. Finally, special\(^1\) lectures were organised during the school, to highlight the edge of current research and topics of special interest to the host region. These were more pedagogical in nature, and were open to a wider audience, e.g., from the host institution and its surroundings. There was one such talk for each of the three main scientific themes.

\(^1\)These were motivational speeches, see “star” lectures on the agenda [1].
The courses divided into full and half days, spread evenly across the program. On full days, there were six hours of lectures. On half days, there were three lectures and hands-on exercises in the afternoon. To round off the afternoon session on half days, a question and answer session or special lecture was scheduled in the late afternoon / evening. Not counting the arrival and departure weekends and allowing one free/excursion day per week, we arrive at sixteen days of school program. Nine afternoons were required for the practical exercises, for a total of nine half days and seven full days. Leaving one hour aside for welcome and practical information, we had a total of sixty-eight lecture hours during the three-week period. The program was flexible and changes and adjustments were made as needed. See Section 4.2 for details on the lectures.

3.3 Financial Support

The school was sponsored by an unprecedented large number of international physics institutes and organisations. These included Spain: AECID Ministry of Foreign Affairs, France: Centre National de la Recherche Scientifique (CNRS)-IN2P3, Institut des Grilles and Commissariat à l’énergie atomique (CEA), Switzerland: Ecole Polytechnique Fédérale de Lausanne (EPFL) and Paul Scherrer Institute (PSI), South Africa: NITheP and National Research Foundation (NRF), and the USA: Fermilab (FNAL), Department of Energy (DOE), Brookhaven National Laboratory (BNL), Jefferson Lab, National Science Foundation (NSF), CERN and ICTP. In addition, the International Union of Pure and Applied Physics (IUPAP) offered travel grants to five female students.

We managed to collect a total budget of €157,070 as shown in Table 1. For the practical organisation we opened a Team Account at CERN, and contributions were sent to this common account. This centralised the financial management of the expenses and triggered the writing of a Memorandum of Understanding that was signed in July 2010 by some of the funding institutes. Funds provided by local institutions, namely the NITheP and the NRF, were spent exclusively to cover local expenses.

Travel expenses of some lecturers were covered by their home institutes, in addition to the contributions listed in Table 1. This was a crucial support for ASP2010 and represents 55% of lecturers travel budget amounting to €40,000 as illustrated in Fig. 3.

The lecturer accommodation expenses paid from ASP2010 funds amounted to €20,302. Some lecturer accommodation expenses were covered directly by their home institutes in addition to the contributions shown in Table 1 and in Fig. 3. Fig. 4 shows the number of accommodation days paid from ASP2010 funds or by the home institutes of the lecturers.

Further details on the usage of the funds, in particular for the students, can be found in Section 6.1.
Table 1: Summary of the ASP2010 budget. In addition to the contributions mentioned in this table, the following institutes covered travel and/or accommodation costs for their lecturers: BNL, FNAL and ICTP paid for travel and accommodation costs for three lecturers (one from each institute); CERN paid travel costs for ten lecturers; PSI and EPFL paid travel costs for two lecturers (one from each institute). The CNRS-IN2P3 contribution of €28000 includes €5000 travel cost that is reported in the expenses as “Int. Committee Meetings”.

<table>
<thead>
<tr>
<th>Incomes (€)</th>
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<tbody>
<tr>
<td><strong>European Contribution</strong></td>
<td></td>
</tr>
<tr>
<td>U. Santiago de Compostela / Ministry of Foreign Affairs - AECID - Spain</td>
<td>30,000</td>
</tr>
<tr>
<td>CNRS IN2P3 - France</td>
<td>28,000</td>
</tr>
<tr>
<td>Int. Center for Theoretical Physics (ICTP) - Italy</td>
<td>25,000</td>
</tr>
<tr>
<td>CERN (20,000 CHF) - Switzerland</td>
<td>13,970</td>
</tr>
<tr>
<td>CEA - France</td>
<td>4,000</td>
</tr>
<tr>
<td>CNRS Institut des Grilles - France</td>
<td>3,000</td>
</tr>
<tr>
<td>Paul Scherrer Institute (PSI) / Ecole Polytech. Féd. de Lausanne (EPFL) - Switzerland</td>
<td>3,000</td>
</tr>
<tr>
<td><strong>American Contribution - USA</strong></td>
<td>26,180</td>
</tr>
<tr>
<td>Fermi National Accelerator Laboratory (FNAL) / Department of Energy (DOE) $10,000</td>
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</tr>
<tr>
<td>T. Jefferson Nat. Acc. Facility (TJNAF) $10,000</td>
<td>7,930</td>
</tr>
<tr>
<td>Brookhaven Nat. Lab. (BNL) $5,000</td>
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</tr>
<tr>
<td>National Science Foundation (NSF) $8,000</td>
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<tr>
<td><strong>South African Contribution</strong></td>
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</tr>
<tr>
<td>Nat. Inst. for Theoretical Physics (NITheP), Stellenbosch R150,000</td>
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</tr>
<tr>
<td>Nat. Research Foundation (NRF), Pretoria R80,000</td>
<td>8,320</td>
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<tr>
<td><strong>Total Income 157,070</strong></td>
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</table>

<table>
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<tr>
<th>Expenses (€)</th>
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</thead>
<tbody>
<tr>
<td><strong>Preparation &amp; General Costs</strong></td>
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<tr>
<td>Int. Committee Meetings</td>
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<td>Secretariat &amp; Logistics</td>
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<td><strong>School Running Costs</strong></td>
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<tr>
<td>Classroom rental, coffee breaks, catering</td>
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</tr>
<tr>
<td>Internet &amp; Wifi (U. of Stellenbosch)</td>
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<tr>
<td>Transportation (Shuttles, Rental Cars)</td>
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<td>Insurance for non-SA Students</td>
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<tr>
<td>Students Local Expenses</td>
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<tr>
<td><strong>Travel &amp; Accommodation Costs (without catering)</strong></td>
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<td>for Students</td>
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<tr>
<td>for Lecturers / Tutors</td>
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<td><strong>Social Events</strong></td>
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<td>Excursion (Aug. 8th)</td>
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<tr>
<td>School Banquet (Aug. 15th)</td>
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<tr>
<td><strong>Communication &amp; Organisation</strong></td>
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</tr>
<tr>
<td>Videoconferences &amp; Broadcasts</td>
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<td>Committee Organising Expenses</td>
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<td>School Package &amp; Lectures Material DVD</td>
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<td><strong>Contingency remaining</strong></td>
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<tr>
<td><strong>Total Expenses 157,070</strong></td>
<td></td>
</tr>
</tbody>
</table>
3.4 Student Selection

A total of 65 students participated in ASP2010. Among these students, 50 students, from 17 different African countries, were selected and their transportation, accommodation and meals fully covered; one student was selected from India and also had his transportation, accommodation and meals fully funded. Four students from Canada, Germany, the USA and Switzerland had to pay for their own transportation, while their accommodation and meals were fully covered. The other remaining students were already living in South Africa and most of them were studying at the University of Stellenbosch. Figure 5 shows the distribution of the students, where 16% of the student were female. The students were selected from more than 150 eligible applicants received before June 2010.

4 ASP 2010

In this section, we report on the school itself, i.e., the running of the school during the period of August 1-21, 2010. A few photographs of the first, second and third weeks of the school are shown in the appendix.
Figure 4: Accommodation days of the lecturers. The blue and red histograms represent respectively the number of accommodation days paid from ASP2010 funds or directly by the institutes, and the corresponding number of lecturers.
Figure 5: The distribution of the selected ASP2010 students by country.
4.1 Logistical Support

The support provided by the host country in terms of infrastructure is essential to the success of the school. The logistical support offered by the host country is one of the criteria in the selection of the venue as explained in Section 3.1. In this section, we provide some feedback on the logistical support for ASP2010. The ASP2010 was hosted by the NITheP [9] in Stellenbosch. Some experimental courses and demonstrations were also carried out at iThemba LABS [10].

The lecture hall could accommodate all the students, lecturers and organising committee members for plenary sessions, an atmosphere that encouraged questions from the students and invited discussions. The facility also offered different halls and rooms for coffee breaks, lunch and breakout sessions for small group topical discussions. The lectures that required hands-on computing (Grid computing and GEANT4 [11] exercises) and physics experiments were carried out in different departments (that offer the needed equipment) within walking distance of the university, or at iThemba LABS (by pre-arranged group transportation).

The students were hosted at a common guest house. Group transportation was arranged for easy access to and from the guest house and the lecture hall for students who needed assistance. Hosting the students at the same guest house increased interactions and networking among the students themselves.

A different guest house was proposed for the lecturers where most of them stayed, also within walking distance of the lecture facilities. Interactions between lecturers were useful to fine-tune and adapt the materials presented to the students. It also allowed valuable interaction between international and African lecturers.

The logistical support offered to the ASP2010 created a friendly atmosphere during the school. It allowed the students to interact with the lecturers and with the other students. It also made the presentation of the course material and the discussion sessions easy and hassle free. Furthermore, the necessary equipment for the practical sessions in computing and experiments were available and worked very well.

Broad bandwidth Internet connectivity made video conferencing and live web-cast connections to the outside research community possible, and this was exploited during interactive connections to the CERN Central Control Centre [12] and a connection to a live address by the Fermilab deputy director.

A professional filming team was available during the ASP2010. They recorded in total 7 days of filming. The movies are being edited at CERN in order to generate materials to distribute to the different African Universities.

The logistical support contributed significantly to the success of ASP2010.
4.2 Lectures

The details of the lectures, discussion and practical sessions are documented on the ASP2010 website [1] and followed the main topics as outlined in Section 3.2.

4.2.1 Theoretical Physics

The theoretical physics (TH) theme was concentrated in the first week of the school. The focus was on theoretical nuclear and particle physics, with the emphasis on particle physics, and the main purpose was to describe the Standard Model of particle physics, including its foundations in quantum field theory. Additional main topics included physics beyond the Standard Model, the interplay with astro-particle physics and cosmology, particle physics phenomenology, and computer physics. We assigned seventeen lecture hours and one practical session in total to the TH theme (including its special lecture).

4.2.2 Experimental Physics

The Experimental Subatomic Physics (EP) theme dealt with what we know about subatomic physics including experiments results and methods. It formed the core of the lecturers in the second week. A significant part of it focused on reviews of the existing body of experimental knowledge, including particle physics, heavy-ion physics, and nuclear physics. The participants were also given a thorough review of the extremely versatile range of modern particle detectors, such as those employed by the LHC experiments. Further, a course on data analysis and statistical treatments gave participants an introduction to how raw data is transformed into final measurements, including calibrations, backgrounds and uncertainty estimations. We assigned twenty-one lecture hours and three practical sessions in total to the EP theme (including its special lecture).

4.2.3 Information Technology and Grid Computing

The Information Technology (IT) theme mainly dealt with practical sessions on Grid computing. Special theoretical and experimental topics were included in practical sessions on doing Monte Carlo simulation (using GEANT4 [11]) on the Grid. Introduction to the data analysis framework ROOT [13] and practical sessions on data analysis using ROOT on simulated data obtained from the Grid were covered. We assigned fifteen lecture hours to the IT theme, spread over the three-week period.

4.2.4 Accelerators, Technologies and Applications

The scope of the third week’s courses was for the students to learn the basics of particle accelerator technology and applied physics (AT). The scientific disciplines of medical physics, material and biochemical based research using synchrotron radiation and magnetic confinement
fusion were discussed. The first section of the third week was dedicated to understanding the
beam physics behind the design of a particle accelerator. In collaboration with the CERN LHC
operation team, a video-conference connected the students to the CERN LHC Control Centre
(CCC) [12] and enabled the students to experience a live demonstration of proton acceleration
and to ask questions to accelerator experts. The second section of the third week was dedicated
to accelerator based medical physics. Following this, a series of lectures on the applications
of synchrotron light was presented. Finally, the last section of the lectures explained the
technology behind magnetic confinement fusion within the context of the ITER project [14].
We assigned twenty six lecture hours, and 4 other periods of either discussion sessions, lab
visits, practical exercises or video connections to the CERN CCC for the AT theme (including
a special lecture).

A complete set of all the lectures and tutorial sessions was written on DVD and were given
to each student before leaving ASP2010.

4.3 Discussion Sessions

Most academic lectures were followed by discussion sessions in smaller groups typically be-
tween ten and twenty students. These groups were formed to best match the broad range of
interests and academic levels of the students (since the school was open to both graduate and
undergraduate students). This allowed the discussion leaders to address more efficiently the
needs of the students. The leaders of these sessions were researchers and scientists, working
within a large variety of fields of expertise, and were not necessarily fully involved in the specific
subject treated in the discussion session. This generally allowed a broadening of the discus-
sions, extending them to various different areas of fundamental physics. These sessions not
only provided the necessary time to discuss and thus crystallise the content of the academic
lectures, but it also allowed to create a spirit of dialogue between students and teachers that
in turn made the lectures lively. Knowing better the needs of the students was of course a very
important input for the teachers to understand how to best focus their lectures.

These sessions were extremely profitable for both students and teachers and have contributed
to the success of the school.

4.4 Practical Sessions

To compliment the lectures, practical exercises, tutorials and laboratory sessions were organised
to give the students “hands-on” scientific training. Altogether there were three sessions.

The practice classes comprised of a session on a specific Monte Carlo simulation program
(PYTHIA [15]) given by one of its main authors, a session on the most widely used analysis
program (ROOT [13]) developed by a team at CERN co-ordinated by one of the authors and fi-
nally a session covering various aspects of particle detection from the simulation to the detectors
and their applications. In particular the latter covered practical laser sessions and a computing tutorial for simulations using the GEANT4 [11] Monte Carlo toolkit. All the students had the opportunity to take part in a choice of one of two practical courses at iThemba LABS, situated between Cape Town and Stellenbosch. During these practical sessions, they became acquainted with the use of scintillation detectors and performed measurements of environmental radioactivity.

These sessions have been highly appreciated by the students mostly because of the very high level of preparation of these classes. A tremendous effort was made by the lecturers to prepare well suited and captivating exercises. Many students have requested possible extensions of these practical examples and the methods to install all the necessary software on their personal computers. As was the case for the academic lectures, the students were very lively and enthusiast in participating in these labs.

The hands-on experience has been invaluable in helping the students to relate the very large amounts of concepts they have been taught in the academic lectures to more tangible facts. It also gave an opportunity to students to discuss and interact more among themselves.

The practical sessions were therefore an essential ingredient to the success of the school.

4.5 Excursion and School Banquet

During the school, inter-cultural understanding and networking was encouraged and enhanced by providing non-academic settings where the students could interact with one another and with the lecturers and gain an enhanced understanding of the cultural and natural environment of their host country, South Africa.

The first such event was an organised excursion on the first weekend of the school which included a guided bus tour of the Cape Peninsula where students saw some of the beauty of the two oceans and learnt about the diverse fauna and flora associated with the coastal Areas and the Table Mountain National Park, which is a UNESCO World Heritage Site.

The school banquet was hosted by Stellenbosch Lodge on the second weekend of the school. The banquet was preceded by a complimentary wine and chocolate tasting at one of South Africa’s most renown vineyards, Lanzerac [16]. A sharing of culture, humour and life experiences naturally happened in the beautiful settings of the gardens and courtyard adjacent to the wine tasting venue.

Following the wine tasting, the students and lecturers were taken to the dinner venue. The dinner consisted of a buffet meal, that catered also for the needs of vegetarian and halal students. A local Western Cape Jazz band “Cappuccino Band”, originating from a youth community development project, played throughout the evening, creating a relaxed and warm atmosphere. During the evening, students representing each of their countries, made heartfelt speeches, introducing themselves, their countries and expressed their experiences of the school thus far. The ambiance of the evening was warm and joyous, and the students and lecturers
enjoyed and participated in music and in dance. Photographs of the social events have been collated and published [17].

5 Outreach and Innovation

The Outreach/Forum Day [18] was held on August 21st, 2010 as a continuation of the ASP2010, with the goal of sharing ideas oriented towards building international collaborations and developing innovative technology in partnership with universities, national laboratories, the government and industry. The South African government was represented by the Chief Director of Emerging Research areas & Infrastructure, Human Capital and Knowledge Systems, who gave the day’s opening address [1, 18]. The following lectures had a much wider appeal and provided an opportune framework through which visiting scientific experts could connect and share ideas of innovation with experts in government, industry and research.

The wider public of the Cape Town region also benefited from engaging lectures over the duration of the school. Public lectures on the scientific questions motivating the particle physics experiments at the LHC and the technology needed in order to answer these questions were given at the MTN Science Centre in Cape Town [19] on Friday evening August 6th and 13th, by members of the school’s organising committee.

6 Follow-up

In this section, we discuss activities after the school. These include balancing the budget, the feedback from the students and maintaining contact with the students.

6.1 Balancing the Budget

The main priority of the budget was to:

• organise and run ASP2010 with a full coverage of the travel, accommodation and living expenses for students coming from sub-Saharan Africa

• also invite students from Northern Africa, and fewer from Europe, the USA and elsewhere to provide a multicultural setting, meant to initiate networking and to share experiences in learning physics and pursuing research in this field.

Figure 6 shows the breakdown of the origin of the funds and their usage. In total we supported 62 students for the full duration of ASP2010 while 3 local students attended occasionally some selected lectures. The students from Europe, Canada and the USA had their travel paid by their home institutes, the rest relied on ASP2010 funds as shown in Fig. 7.

As shown in Table 1, the estimated budget covered very well all the expenses of the school. There is a minor surplus of about €1,000.
Figure 6: Origin of the funds (left) and of their usage (right).

Figure 7: Travel and accommodation (including catering) expenses as a function of the geographical origin of the students. The travel expenses of students from Europe, Canada and the USA were covered by their own institutes.
6.2 Student Feedback

By all accounts, the experience was extremely valuable for all the participants. The inspirational enthusiasm of the students at ASP2010 exceeded our expectation and we have received much positive and constructive feedback. Some student feedback has already been included in published press releases [20,21,22].

In order to understand the impact of ASP2010 from the students’ perspectives two surveys were prepared. The first survey was designed to complete our database and provide us with easy and accessible basic information such as the home institute and degree of each student. The second survey was designed to provide us with feedback about the quality of the school in order to take this into consideration in a future version of the school. A few students also shared their feedback through personal emails to the organisers. The following is a summary of these surveys and feedback.

It seems that most of the students heard about the school through word of mouth, advertisement in their departments or recommendation from their supervisors or colleagues. By attending ASP2010, most of the students were expecting to learn more about the international high energy physics community, to make contacts through networking with lecturers and to get more information about scholarship and fellowship opportunities specially in North America and Europe. Some were also seeking to get ideas for their future research as well as connecting to other African physicists. Most of these expectations were met to a good extent. These results are summarised in Fig. 8.

Some of the common suggestions to improve the school include increasing the computer lab sessions in order to get more hands-on experience as well as decreasing the variety of physics topics covered in the school. Many students believe that the school was long and there was little social time to interact with lecturers. It seems that there is also room for improvement in providing better accommodation for students. Overall, about 37% of the students are satisfied and 53% are very satisfied with their experience at ASP2010. 100% of the students will apply for the school again in future. The results are shown in Fig. 9.

In response to whether or not the students are interested in scholarship opportunities, more than 90% of them stated that they would be interested in fellowship opportunities in North America and Europe and about 70% are also considering opportunities in other African countries. These results are summarised in Fig. 10.

Figures 11 and 12 summarise the rating of the lecturers in terms of content of the lectures, clarity and easiness to follow, the speed of the lectures, etc. Overall, the students were very satisfied with the quality of lecturers and sessions.
Figure 8: Impact of ASP2010 on the students. On the horizontal axis, the first and the last questions read respectively “Better understanding of the state of different research areas in other African countries, Europe and North America” and “Sharing the experiences gained at ASP2010 with your colleagues in your home institutes/universities”.
Figure 9: Satisfaction of the students and their willingness to attend the school again.
Figure 10: Student interest in fellowships and scholarships.
Figure 11: Student feedback on the lectures.
Figure 12: Student feedback on lecturers.
6.3 Maintaining Contacts with Students

It was emphasised throughout the school that the students are main actors in their research careers. However, with a focus on empowering the students to make their own career choices, and in the spirit of increased networking, some career guidance and mentoring was given during ASP2010, by sharing with the students the websites where typically Ph.D. and post doctoral research positions are publicly advertised.

In order to retain contact with the students, an email group list was set-up through CERN [23] and a social networking facebook page [24] was created to share news and information. This has proved to be extremely helpful in communicating interesting physics news to the students and in getting updates on their evolving career paths.

In order to identify a suitable host country and institution for the next ASP school, the contact with the existing students has already proved invaluable, in connecting through them to their universities and institutes to build potential future collaborating partnerships.

Since the ASP2010 school, the South African Department of Science and Technology has shown an increased support to collaborating scientists in South African universities and national laboratories, who are working within the research consortium, “SA-CERN”, to participate fully in the CERN research experiments of ALICE, ATLAS, ISOLDE [25] and the supporting theoretical physics activities.

7 Outlook

The success of the school is due to the financial support from thirteen institutes in the USA, in Europe and in South Africa, to the dedication of the organising committee, to the devotion of the lecturers, and to the interests of the students themselves. Many students in Africa face challenges in terms of the logistical support, the quality of education and the opportunity for higher education abroad. Some of us in the organising committee had faced these challenges ourselves. It is often the case in Africa that even the best students do not have the needed support to succeed or to acquire the necessary skills to be competitive at an international level. It was particularly important for the ASP2010 organising committee to do something, to be part of something where one could help resolve some of the challenges that students from Africa face. It is not to suggest that this particular school has solved all the issues, not at all. However, it is hoped that this school was useful in terms of networking, which in turn will help prepare the students to find practical answers to many issues that they may need to resolve. It is further hoped that this will not be the first and the last school.

Looking at the long term objectives (to help improve high training and education in Africa) that motivated the organisation of ASP2010, the current success, although encouraging, is rather limited in scope. Firstly, the school resources only allowed for 65 students to be accommodated. That was sufficient for the efficient management of the school but it is only a
small step in the right direction to making a significant impact. Secondly, the duration the school, although appropriate given the constraints from the budget, students and lecturers, could not allow for a more extended coverage of the topics that were presented. Thirdly, the budget available for the school could not allow a longer duration with more time spent on the details of each topic. Finally, as can be seen in Fig. 5, the participation of students from French speaking African countries could be improved. All these are not a failure of ASP2010 but rather a motivation to work harder towards the original objectives by organising the school again in the future, and in doing so, truly contribute in a significant way to development in Africa, and indeed to the betterment of humankind.

Fermilab is committed to support three of the ASP2010 students up to two years for an equivalent of $25,000 per student per year. They will be stationed at Fermilab and receive this additional support towards their post-doctoral studies.

To build up on the success of ASP2010, the organising committee proposes a similar school in 2012, ASP2012, but in a different African country. The committee is already exploring this option and a number of host countries has been suggested. In time, the committee will select the host country and approach the funding institutes of ASP2010 for support for the ASP2012, and the process of identifying students and lecturers will be carried out. Early involvement of the local host in the organisation process is essential to the success of the school.

8 Conclusions

For the past few years, a group of local and international organising committee members have worked very hard to prepare for the first biennial school of fundamental physics and its application in Africa. Finally, the efforts of the organising committee and all the supporting institutes and concerned individuals paid off and the school took place in Stellenbosch, South Africa on August 1-21, 2010. A total of about 65 students from all over Africa (including a few from Europe, America, one from India) attended the school. There was also the participation of high profile international and local lecturers who prepared and presented the materials taught during the school. They included theoretical and experimental particle physics, particle accelerators and practical applications. The last day of the school was devoted to outreach where a review of the main objectives of the school was presented and discussed. There were also presentations and discussions on the enhancement of science, technology and innovation in South Africa and in Africa in general.

Friendly atmosphere throughout the school encouraged direct contacts between the students and the lecturers and to hear the student’s concerns about the possibility of pursuing higher education. The students established contacts and network with the lecturers and with other students; we expect these connections to be useful to the students and to be maintained far beyond the school itself. Social events and a banquet were organised, and these encouraged
further interactions among the participants. Feedback from students and lecturers suggests that it was a very successful and well received school, and that there is a demand for the school to be organised again within the next two years.

Acknowledgements

We would like to thank the universities, research institutes and government agencies that provided the funding for ASP2010, namely, the Spanish AECID Ministry of Foreign Affairs, ICTP, IN2P3 (France), l’Institut des Grilles (France), le Commissariat à l’énergie atomique (France), Ecole Polytechnique Fédérale de Lausanne (Switzerland), Paul Scherrer Institute (Switzerland), NITheP (South Africa), National Research Foundation (South Africa), Fermilab (USA), Department of Energy (USA), Brookhaven National Laboratory (USA), Jefferson Lab (USA), National Science Foundation (USA), CERN and the International Union of Pure and Applied Physics (IUPAP).

Thanks also to the lecturers for the courses prepared and taught at the ASP2010, for the clarity of the materials presented to the students and for their availability during discussion and practical sessions to interact further with the students.

Thanks for the CERN/BE group, in particular Mike Lamont and Ronaldus Suykerbuyk, for the production of the LHC operation videos and the video connection to the CERN Central Control Room.

Thanks to the CERN communication group, in particular Emma Sanders and Silvano De Gennaro, for providing each student with a informative DVD about the CERN experiments, the accelerator complex and the associated technological challenges. Thanks also to the CERN video service managers, in particular Joao Fernandes and Thomas Barron, for their help with video conferencing and live web-cast connections. Thanks also to the CERN Audiovisual Service for the edition of the filming material.

Thanks also to NITheP and iThemba LABS for hosting ASP2010 and for providing the logistical support, which was essential to the success of the school. Special mention and thanks to René Kotze and Monique Louw from NITheP for their efficient logistical support in Stellenbosch. We also like to thank the office of the South African Institute of Physics, in particular Brian Masara and Linette White, for their generous logistical support.

Thanks also to Vincent Baron, the scientific attaché of the French Embassy in Pretoria, for his help with student visas.

We appreciate the dedication of the students, their interactions among themselves and with the lectures.

Finally, we thank each member of the organising committee (local and international) for responding to the challenge to prepare this school, for their concerted efforts to contribute to education in Africa. These were extra efforts beyond their professional obligations.
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A Selected Photographs of ASP2010

Figure 13: Group photograph of students and lecturers in the first week of ASP2010.
Figure 14: Group photograph of students and lecturers in the second week of ASP2010.
Figure 15: Group photograph of students and lecturers in the third week of ASP2010.