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BIENNIAL AFRICAN SCHOOL

ON FUNDAMENTAL PHYSICS AND ITS APPLICATIONS

Proposal for a School of Physics in Africa

We have established a biennial school of physics in Africa, on fundamental physics and its applications. The aim of the school is to build capacity to harvest, interpret, and exploit the results of current and future physics experiments with particle accelerators, and to increase proficiency in related applications, such as medicine, and technologies, such as information technologies. The school is based on a close interplay between theoretical, experimental, applied physics, and Grid computing. The previous editions of the school took place in South Africa, Ghana and Senegal in 2010, 2012 and 2014 respectively. We propose a partnership with African governments and capacity development agencies in the further development of the project.
The fourth edition of the biennial school will take place in 2016 in Rwanda.
The website of the school is: http://www.africanschoolofphysics.org/

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1 Introduction

Schools of fundamental physics and its applications (ASP) took place in Stellenbosch, South Africa, on August 1–21, 2010 [1, 2] (ASP2010), in Kumasi, Ghana, on July 15 – August 8, 2012 [3, 4] (ASP2012), in Dakar, Senegal on 3–23 August 2014 [5] (ASP2014), and one is scheduled to take place in Rwanda in July/August 2016 (ASP2016). The schools are based on a close interplay between theoretical, experimental, applied physics, and Grid computing. They cover a wide range of topics: particle physics, particle detectors, astro-particle physics and cosmology, computing, accelerator technologies, medical physics, condensed matter, light sources and their applications. The participating students are selected from all over Africa and beyond. The selection of lecture topics is in theoretical, experimental, and applied physics. Scientists from Africa, Europe and the USA are 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 allows for networking — interactions among students and between students and lecturers. The schools are funded by institutes in Africa, Asia, Europe and the USA.

By all accounts, ASP2010, ASP2012 and ASP2014 were very successful schools as can be seen from the final report and the numerous press releases [1–5]. The success of the school is due to the financial support from institutes in the USA, in Europe, in Asia and in Africa, to the dedication of the organizing 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. 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 is particularly important for the organizing committee to 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 is 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.

Looking at the long term objectives (to help improve high training and education in Africa) that motivated the organization of ASP2010, ASP2012 and ASP2014, the success of the school is encouraging and provides motivation to review the ASP goals and consider mechanisms to make it sustainable, and in doing so, truly contribute in a significant way to development in Africa. To build up on the success of ASP2010, ASP2012 and ASP2014, and exceed the expectation of ASP2016, the organizing committee proposes to establish a longer partnership with African governments and policy makers on capacity development for the component of funding, and to develop the project goals and the key performance indexes further. These developments are timely given the progress made by the ASP series and the synergy that can be established with the African policy makers on education. There is a strong alignment between the mission and the vision of African governments and policy makers on education and capacity building and their programs with the goals of the ASP. The ASP is committed to include African governments in the planning going forward, in order to take advantage of aspects such as consolidating bilateral agreements and their goals, building on synergy with other pro-

grams, improving the sustainability and impact of the capacity development and improving the measurement and visibility of the impact.

1.1 Topics

Three main topics form the backbone of the school: 1) Theoretical Physics, 2) Experimental Physics, and 3) Accelerators and Technologies. In addition to lecture courses, each topic includes hands-on exercises on computing-related aspects, including Grid and high-performance computing.

Further, each main topic contains a number of additional exercises for student projects. These are completed in groups, with a single lecturer (mentor) assigned to each group. These groups also provide opportunities for discussing questions arising from the lecture material. The groups are assigned on arrival, and time is reserved for this activity each working day during the school. These daily discussion sessions provide a framework for mentoring students from different backgrounds. Each group is encouraged to deliver a short presentation at the end of the program.

1.2 Venue and Scope

The school moves around Africa taking advantage of local support and considering a uniform exposure for Africa. Any African country can bid to host ASP. In selecting the host country, several factors are considered for example political stability, health and safety of the participants, the ability of the local orgainizing committee to seek and get support from within the potential host country, the logistical support offered to run the school, etc. For the fourth edition of the school, which will take place in July/August 2016 (ASP2016), many countries have been considered. Ultimately, Mauritius and Rwanda made the final short list. The host for ASP2016 was selected from the two countries to be Rwanda. The proposed duration of the school is three weeks. Our target is to have 65 students attending, and to provide each of the selected students full bursaries.

2 Relevance to Scientific Development in Africa

International cooperation is a large common denominator of the culture of scientific activities. However, in many scientific disciplines and especially in our field of Fundamental Physics, the cooperation among African countries and between them and Northern countries is not sufficiently developed. This is especially the case for sub-Saharan Africa. We therefore want to extend the usual international scientific ties in our field to this geographical zone.

With this project it is therefore our aim to initiate and support academic and research cooperation in Fundamental Physics with countries in sub-Saharan Africa.

It is *not* our aim to set this up as a strictly one-way effort to bring our knowledge and experience to African colleagues and students, but rather to establish a genuine Integrating Global Network.

For this reason, the program we propose includes as an essential aspect mentored group sessions working on projects with discussions, so that each student may draw the maximum individual benefit from the schools.

A survey was conducted of the home institutions of ASP student alumni and the institutions of their recommenders. The survey was designed to collect contact information and demographic information on institutions to better match the school curriculum to the constituency, and to establish an institutional network. The partnership between ASP and the network of African institutes should ensure the sustainability of the ASP project and increase the retention of ASP alumni within African institutes, and in doing so, lessen the impact of brain drain. The details of the survey can be found at:

https://ketevi.web.cern.ch/ketevi/ASP2016/ASP_Institution_Survey.pdf

3 Financial Support

The main funding item on the school budget is the student bursaries, covering the travel and lodging accommodation of all the attending students. We strongly believe that being able to provide such bursaries is vital to the success of the project.

3.1 Financial Support Requested

Our typical budget is based on 65 students supported for the full three weeks of the school, 24 lecturers supported for 6 days each, and 5 organizers supported for the full duration of the school (possibly rotating between a larger pool of individual organizers). Note that the total of 25 required lecturers is arrived at by assigning at least two organizers to act as lecturer as well. We do encourage the lecturers and organizers to seek their own support for transportation and accommodation so the school funding is maximally used for the students.

Table 1 contains the detail of the cost estimate for the students, including some overhead for organization and coverage for up to a maximum of 3 lecturers.

3.2 Potential Sources of Financial Support

The IOC is in the process of seeking support from the following institutes: ICTP, CERN, International Union of Pure and Applied Physics (IUPAP), AECID Spanish Ministry of Foreign Affairs, Center National de la Recherche Scientifique (CNRS)-IN2P3 (France), Institut des Grilles-CNRS and Commissariat à l'énergie atomique (CEA, France), The International Telecommunication Union (ITU), CATHI Network, Ecole Polytechnique Fédérale de Lausanne

Common Costs to all students		
Type of Cost	**Per Student per day**	**Per Student for 23 days**
Catering	20	460
Lodging	40	920
Opening Function		10
School Banquet		29
Social Events		55
Stationary		20
Local Transportation	5	115
Filming & Recording		50
Contingencies		150
For international students		
Airfare including visa		1300
Travel insurance		100
For local students not from Kigali		
Transportation		200
Organization Costs		
Opening functions (16 lecturers)		190
Banquet (assume 25 delegates)		725
Lecturers lunch and coffee	72	1080 (72$\times$ 15 days)
Coverage for 3 lecturers		4620
Organization costs		6615 (or 102 per Student)
Total Cost per Student		
Local Student		1911
Local Student not from Kigali		2111
International Student		3311

Table 1: Estimated expenses per student attending ASP2016, assuming 65 students total. The full bursary for an international student is estimated to be about 3300€ , 2100€ for local student already present in the host country. All amounts are in € unless otherwise specified. The bursaries include accommodation and catering. Transportation and accommodation for up to 3 lecturers would be covered. All other lecturers and organizers will seek support from external sources.

(EPFL, Switzerland) and Paul Scherrer Institute (PSI, Switzerland), National Institute of Theoretical Physics (NITheP, South Africa), National Research Foundation (NRF, South Africa), Department of Science and Technology (DST, South Africa), South Africa-CERN programme (South Africa), African Institute of Mathematical Sciences (AIMS)-Next Einstein Initiative (South Africa), Fermilab (FNAL, USA), Department of Energy (DOE, USA), Brookhaven National Laboratory (BNL, USA), Jefferson Lab (JLab, USA), Jefferson Science Associate (JSA, USA), American Physical Society (APS, USA), National Science Foundation (NSF, USA), University of Texas Arlington (USA), University of Oklahoma (USA), Louisiana Tech University (USA), Kansas University, Istituto Nazionale di Fisica Nucleare (INFN, Italy), European Spallation Source (ESS, Sweden), The International Science Program (ISP) at the University of Uppsala (Sweden), DESY (Germany), Université Catholique de Louvain (Belgium), ARDENT Network, COMSTECH, RISP-IBS Korea, Shui-Chin Lee Foundation for Basic Science (Taiwan), KFAS-ICTP (Kowait), University of Chicago (USA), the French Embassies in Ghana and Senegal.

These institutes supported the school in 2010, 2012 and/or 2014. They were particularly pleased with the success of the previous editions of school [1–5]. They have been approached again and expressed interest in supporting the fourth edition of the school in 2016 in Rwanda. Other potential sources of support will be pursued.

4 Outreach Day

An outreach day is organized on the second Saturday during the school. Local and central government officials are invited as well as the international delegates present. The objective is to discuss the strategic planning of the government of the host country towards capacity building; to discuss other African model towards to capacity building and how it might inform the model used in the host country, to present the CERN and ICTP models towards outreach in Asia, Latin America and Africa. It will constitute a platform for bilateral discussions and agreements between other African countries and the host country of ASP2016. Therefore African government and education officials are invited to this outereach event.

5 Synergy with Other Large Scale Infrastructures

There are well established synergies between High Energy Physics and other areas. For example in astrophysics, there is an overlap in several crucial science questions: theories and experiments in particle physics are part of cosmological and astrophysical models — in particular Dark Matter, Dark Energy, Dense Matter, neutrino physics, the Standard Model and beyond, exotic physics. There is a further overlap in issues of detectors and high throughput electronics, technological advances at CERN, joint R&D with SKA, high performance computing (Grid, GPU, Raspberry computing), training, management and roll-out of local infrastructure. These synergies also exist for remote sensing in industry, big data computing, medicine, and many

other areas. Such synergies and spin-offs are already part of ASP, and they can be further integrated with careful planning and partnerships.

Currently, the ASP program does include lectures and discussions in astronomy, astroparticle physics and cosmology. This will, in time, evolve to formally include dedicated lectures on SKA (Square Kilometer Array), CTA (Cherenkov Telescope Array), etc. A number of ASP students have become graduate students in large multinational experiments such as ATLAS, CMS or ALICE.

After several discussions with DOSAR (Distributed Organization for Scientific and Academic Research) representatives, the organizing committee of ASP2012 agreed to extend the school by a few days, to August 8, 2012. The period of August 6-8, 2012 was exclusively devoted to an OSG (Open Science Grid) computing school proposed by DOSAR. Both the local and the international organizing committees felt that the Grid computing school proposed by DOSAR will be very beneficial to the local Ghanaian institutes, to help improve the existing Grid infrastructure, to train the local people on its usage and maintenance. The organizing committee of ASP2012 therefore welcome the DOSAR initiative to add the OSG school to ASP2012, and did all that was necessary to accommodate the Grid school and make it a success, not just for DOSAR but as well for the Ghanaian Grid computing efforts. The idea of the OSG Grid was also symbolic for the school, so that Ghana does not just become the venue of the school but will continue to work on developing Science within the region, so either way it was a good idea to look at the possibility of getting the OSG setup as physical connection to interested parties of the school.

6 Relationship with AIMS

AIMS alumni have been selected to attend ASP2010, ASP2012 and ASP2014. At the time of writing, no common lectures have been organized between AIMS and ASP. However, a lot of discussions between AIMS and ASP are on-going in order to identify common lecturers and a common curriculum geared towards industrial applications of fundamental physics. This is discussed further during the outreach day mentioned above.

7 Specific Goal beyond Capacity Building

We maintain contact with the students that attended an ASP and share information with them about higher education in Africa and abroad. We actively help recruit ASP students into universities in South Africa, Europe and the US. We encourage the lecturers that participate in ASP to identify a few good students that can benefit from any higher education opportunities at their institutes. We actively mentor many of the former ASP students through their entire higher education.

We've conducted a survey of the students that participated in ASP2010 and ASP2012. The objective of the survey was to see how the student participation in ASP has impacted their

careers. About 50% of the students that attended ASP2010 or ASP2012 responded and filled out the survey. The results of the survey are available at this website:

https://ketevi.web.cern.ch/ketevi/ASP2016/ASPSurveyResults.pdf

Another objective of the outreach day mentioned above is to share ideas oriented towards building international collaborations and developing innovative technology in partnership with universities, national laboratories, the government and industry. One concrete example is the following: since ASP2012, a strategic plan has being drawn between INFN (the Italian Institute for Nuclear Research) and KNUST (Kwame Nkrumah University of Science and Technology in Kumasi Ghana) for the development of a "Ghana Multi-disciplinary Compact Laser Synchrotron at KNUST". It is a research infra-structure that will cost less than 15 M€, that can be installed inside the KNUST campus in a dedicated building (25×40 m^2) and can feed several fields of scientific and technological research and serve a wealth of multi-disciplinary applications, based on a Compact Laser Synchrotron. It may constitute a national infrastructure to provide Ghana with an advanced resource to develop science and technology at the national and international level.

ASP also brings scientists and lecturers from Europe, Asia and the US in close collaboration with the African counterpart for potential joint projects and collaborations. The compact national laser facility at KNUST is one concrete example.

The CERN Management and Council have accepted the principle of making surplus computers from the Computing center available to African countries. These might come available in batches of several hundred every few months. For some time now, CERN has been in contact with Morocco. CERN has also had an expression of interest from South Africa. With the organization of ASP2012 in Ghana, CERN had agreed and made some computers available to Ghana. This contributed to and supported the infrastructure for a Grid computing node in Ghana. Through ASP2014, CERN has made a batch of computers available to Senegal.

CERN and KNUST have signed and expression of interest for facilitating the establishment of co-operation between CERN and Ghana. KNUST, the Information Technology Department of CERN (IT), the Collaboration conducting the ATLAS experiment at the CERN LHC accelerator (the Collaboration) and the CERN Scientific Information Service (the Library) hereby express their joint interest in enabling students from KNUST to participate in research in information technology and experimental particle physics, and to further the development and exchange of digital resources for scientific purposes. This ultimately will allow to provide the training of a qualified personnel to operate and maintain the Grid computing node in Ghana.

8 Long Term Partnerships

The ASP organization is working to develop a long term partnership with AIMS, Industry and African governments for greater impact on outreach, education, capacity building and development in Africa in general. Looking at these long term objectives that motivated the organization of ASP, the current success of our program, although encouraging, is rather limited in scope.

Firstly, the school resources only allows for 50–70 students to be accommodated. That is 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, can not allow for a more extended coverage of the topics that are presented. Thirdly, the budget available for the school cannot allow a longer duration with more time spent on the details of each topic. Finally, the participation of students from French speaking African countries could be improved. All these are not a failure of ASP but rather a motivation to work harder towards the original objectives by making ASP a biennial event, developing partnerships with African governments, AIMS, Industry and high profile international researchers and lecturers, and in doing so, truly contribute in a significant way to development in Africa.

References

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