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THE BIENNIAL AFRICAN SCHOOL
ON FUNDAMENTAL PHYSICS AND APPLICATIONS

**Proposal for a
School of Physics in Africa**

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Abstract

We have established a biennial school in Africa, on fundamental physics and its applications (ASP). We find that fundamental physics provides excellent motivation for students of science. The aim of the school is to build capacity to harvest, interpret, and exploit the results of current and future physics experiments and to increase proficiency in related applications. The school is based on a close interplay between theoretical, experimental, and applied physics. The participating students are selected from all over Africa. The school also offers a workshop to train high school teachers, an outreach to motivate high school pupils and a physics conference to support a broader participation of African research faculties. The duration of the school allows for networking–interactions among the participants. Support for the school comes from institutes in Africa, Europe, USA and Asia. The first school took place in Stellenbosch, South Africa on August 1–21 2010, the second edition in Kumasi, Ghana on July 15–August 8 2012, the third edition in Dakar Senegal on August 3–23 2014, the fourth biennial school at the University of Rwanda on August 1–19 2016, and the fifth edition in Namibia on June 24–July 14 2018. The next edition of the school is planned in 2020 in Morocco. In this proposal, we discuss strategies to make the school sustainable and call for support from the international community. We consider access and participation in fundamental science to be an important right. Through this work, it is hoped that the community of scientists who are at the forefront of science is enhanced and diversified thus fulfilling the mission of international research and education institutes.

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1 Introduction

Schools of fundamental physics and 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), in Kigali, Rwanda on August 1–19 2016 [6] (ASP2016) and Windhoek Namibia on June 24–July 14 2018 [7].

The basic objective is to help improve the quality of higher education in Africa and to help increase the number of African students acquiring higher education. This is achieved through an outreach effort, an increased awareness of the potential of high quality training offered by large scale experiments in context of various scientific disciplines, and a system of networking on the international scale. 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, in order to take advantage of aspects such as consolidating agreements and their goals, building on synergy with other programs, improving the sustainability and impact of capacity development and improving the measurement and visibility of the impact. By working with African governments and policy makers on education, ASP seeks to promote a culture of science that creates an attractive environment for African student alumni, thus encouraging their retention within Africa. ASP promotes sustainable scientific development in Africa by building a network between African and international researchers for increased collaborative research and shared expertise.

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, Asia 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, ASP2010–18 were very successful schools as can be seen from the final reports and the numerous press releases [1–7]. The success of the school is due to the financial support from institutes in the USA, Europe, Asia and Africa, and to the dedication of the organizing committee, to the lecturers, and 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 these students face. It is not to suggest that this particular school

has solved all the issues. However, it is hoped that this school serves at least two purposes: the organization of the school creates understanding of the many challenges and provides a template for solving them, and secondly it provides opportunity for networking, which in turn will help prepare the students to find practical answers to many issues that they face.

Looking at the long term objectives (to help improve higher training and education in Africa) that motivated the organization of ASP2010–18, the success of the school is encouraging and allows us to review the ASP goals and consider mechanisms to make it sustainable. To build up on the success of ASP2010–18, 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.

ASP2010-18 are positive steps towards the broader objective of ASP and encouraged the organization of the sixth edition of ASP, ASP2020. In so doing, we hope to help increase the global presence of African students and scientists.

1.1 Topics

These topics will form the backbone of the school: 1) theoretical physics, 2) experimental physics, 3) applied physics, and 4) high performance Grid computing. In addition to lecture courses, each topic will include hands-on exercises on computing-related aspects, including the Grid.

1.2 Venue and Scope

The school is biennial and moves around Africa taking advantage of local support and considering a uniform exposure for Africa. The proposed duration of the school is three weeks. The next edition of the school will be in July 2020 in Marrakesh, Morocco. The host country of the school is selected two and a half years in advance through a competitive bidding process that takes into account aspects of safety of the participants and the support from the host country government.

Our target is to have 85 selected students from various African countries, 70 high school teachers from the host country for a one-week teachers training workshop, 1500 high school pupils for a one-week outreach, and 60 participants at the ASP conference. Full bursaries will be provided to the selected students.

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 the field of Fundamental Physics, the

cooperation amongst African countries and Northern countries is not well developed. This is especially the case for sub-Saharan Africa. We therefore want to extend the usual international scientific ties especially to this geographical zone.

The objective of this project is to initiate and support academic and research cooperation in Fundamental Physics with countries in Africa. The aim is *not* to set a strictly one-way effort to bring knowledge and experience to African colleagues and students, but rather to establish a genuinely integrating scientific network between Africa and the rest of the world.

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

3 Coordination of Activities

ASP activities will be coordinated by the International Organizing Committee (IOC) in collaboration with a Local Organizing Committee (LOC) in the host country. The IOC will be advised by an International Advisory Committee (IAC).

4 Financial Support

The main funding item on the school budget is the student bursaries, covering the travel and board of all the selected students. We typically receive over 500 applications from which we select about 85 students.

Our typical budget is based on:

- 85 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 lecturers;
- 70 high school teachers from the host country for a one-week training workshop. The participating high school teachers will be identified by the LOC in consultation with the Ministry of Education of the host country;
- Up to 1500 high school pupils from the host country for a one-week outreach. The participating high school and pupils will be selected by the LOC in consultation with the relevant host country authorities;
- invited speakers and African researchers attending the one-week ASP conference.

4.1 Financial Support Needed

As shown in Table 1 in the Addendum, assuming 20 local students, 70 local high school teachers and 65 international students, the total budget for 85 students and 70 teachers is of the order 203150€ in addition to the in-kind support from host country and the external support for most of the lecturers and organizers. In addition to the in-kind support, we request that 20000€ of the 203150€ come from local sources as discussed in Section 4.3.

4.2 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), Center National de la Recherche Scientifique CNRS-IN2P3 (France), and Paul Scherrer Institute (PSI, Switzerland), National Research Foundation (NRF, South Africa), Department of Science and Technology (DST, South Africa), iThemba LABS (South Africa), Brookhaven National Laboratory (BNL, USA), Jefferson Lab (JLab, USA), Jefferson Science Associate (JSA, USA), American Physical Society (APS, USA), National Science Foundation (NSF, USA), Istituto Nazionale di Fisica Nucleare (INFN, Italy), European Physical Society (EPS), Institute Of Physics (IOP, UK), Shui-Chin Lee Foundation For Basic Science (Taiwan), the Inter-University Council for East Africa (IUCEA, Uganda).

Some of these institutes supported the school in 2010-2018. They were particularly pleased with the success of the previous editions of school [2, 7]. These institutes will be approached again for future editions of the school. Other potential sources of support will be pursued.

4.3 Local Support from host country

Two types of support are expected from the host country of ASP:

- In-kind support. On the behalf of the host country, LOC, working together with the IOC and the IAC, will identify the venue, not too far from a major international airport for easy commute of the international delegates. The usage of the venue should be free of charge to the school organizing committee.
- Financial support from the government of the host country. The LOC should seek support from within the host country to cover the participation of all the local delegates.

5 ASP Conference

A one-week physics conference will be organized during ASP. The objective is to attract ASP student alumni and African and international researchers that might not otherwise be able to attend ASP. It is expected that the conference will give the participants the opportunity to network and establish new research collaborations with the international physics community.

6 ASP Forum

A forum will be organized during ASP. Local and central government officials from the host country will be invited as well as the international delegates present. The objective is to discuss the strategic planning of the host country government towards capacity building; to discuss the South African model towards capacity building and how it might inform the host country model and vice versa. It will constitute a platform for bilateral discussions and agreements between the host country and other African countries.

7 Outreach for Secondary Schools

During ASP, we will organize an outreach event to secondary schools around the venue over the course of one week in parallel with the school program for the participating students. We will visit one secondary school a day, and we will aim to accommodate up to four-hundred pupils in each visit. The purpose of this outreach will be to motivate and encourage high school students to develop and maintain interest in physics and applications. The details of the program during these visits will be worked out later, but for the most part, will consist of scientific demonstrations, physics experiments, question and answer session and discussions.

8 Workshop for High School Teachers

We also propose to organize a workshop for high school teachers from all over the host country, in parallel with the baseline ASP program. We will aim to attract of the order of seventy high school teachers for a one-week workshop. The objective of this workshop will be:

- introduce new tools for enhancing their teaching skills;
- expose the teachers to advanced concepts and current state of scientific research.

The program will consist of masterclasses, physics demonstrations and experiments.

9 Participants

The participating students are selected by a committee of international lecturers, paying attention to geographical balance across Africa, gender balance, students from least developed countries and competence. The participating high school teachers are identified by the LOC in consultation with the Ministry of Education of the host country. The outreach event for the secondary schools is limited to high schools around the venue and will not require any significant financial resources. Each participating high school will identify 40-50 students to take part in the program, and for a period of a week, up to 40 high schools can be covered. International

participants at the conference associated to the school will be expected to cover their own travels. The budget described in Table 1 does not include coverage for international lecturers. An effort will be made to identify excellent lecturers that are able to cover their own travels. All the local and international logistics will be discussed and agreed upon with the LOC and the education branch of the host country government.

10 ASP Mentorship Program

After each edition of ASP, and between consecutive editions, hence continually, the IOC manages a mentoring and coaching program for ASP student alumni. This is done in collaboration with the academic advisers of the students. The student alumni are paired up with different ASP lecturers who follow the academic progress of the students and help as much as possible in their academic development. This program allows the ASP organizers to maintain contact with the students after their participation in the school. Many ASP alumni are currently benefiting from this organized support structure that also allows the IOC to better answer the question: *“What happens to the students after their participation in an edition of ASP?”*

The objective of the mentorship program is to aid mainly PhD students after their participation in ASP to reach their goal of completing their degree with assigned ASP lecturers as mentors. The ASP mentors are not replacements or substitutes of the students academic advisers. Rather, ASP mentors work together with students academic advisers for greater impact. The ASP mentors are volunteer scientists who have lectured at one of the previous editions of ASP.

The students are selected for mentorship after satisfying a comprehensive application process. Through the mentorship program, it is possible to:

- gauge the impact of ASP;
- support ASP student alumni;
- identify obstacles;
- study problem solving trends;
- help manage, direct and differentiate between the different types of supports;
- identify additional research and education related challenges in Africa.

The ASP mentorship program was formalized soon after ASP2016. Currently, 22 ASP alumni students—going back all the way to ASP2010, and 19 ASP lecturers are involved in the program as mentors. A new cycle of the mentorship program is initiated soon after each edition of ASP.

To improve the impact of the mentorship program, we propose to identify five students from each edition of ASP to spend up to three months at a US, European or Asian university

or research institutes to work with an assigned mentor in a field that supports the student's academic major.

11 Conclusions

We propose a school on fundamental physics and applications every two years in different African countries. The aim of the school would be to build capacity to harvest, interpret, and exploit the results of current and future physics experiments and to increase proficiency in related applications in Africa. The host countries will be selected through competitive bids that address issues of safety of the participants and support from the local government. The school will be opened to about 85 students from African countries selected by a committee of international lecturers, taking into account the need to promote fundamental physics and applications in developing countries. The school will also include a workshop to train high school teachers and an outreach for high school pupils from the host countries. An international conference will also be added to the school activities to create a scientific networking environment between African participants and international delegates. Finally, a mentorship program running continuously even when there is no formal school will allow African students to stay connected to lecturers from abroad and benefit from active mentorship to supplement the efforts of academic advisors.

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Addendum

In this appendix, we offer more details on the sixth edition of ASP in Morocco in 2020.

ASP2020 in Morocco

The next edition of the school, ASP2020, will take place in Marrakesh Morocco on July 5–25, 2020. 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 5 lecturers. Assuming 20 local Moroccan students, 70 Moroccan high school teachers and 65 international students from other African countries, the total budget for 85 students and 70 teachers is of the order 203150€ in addition to the in-kind support from Morocco and the external support for most of the lecturers and organizers. In addition to the in-kind support, we request that 20000€ of the 203150€ come from local Moroccan sources.

Costs in € for students & high school teachers			
Type of Cost	One student-day	23 student-days	Overhead
Catering	20	460	
Lodging	20	440	
Stationary		25	
For international students			
Airfare including visa		950	
For local students not from Marrakesh			
Transportation to/from Marrakesh		100	
Organization Costs			
Poster printing & distribution			1700
Education equipment			4250
Shipping			900
Five invited speakers or lecturers			8500
Local transportation			2500
Organization costs			17850
Organization costs per participant		115	
Total Cost per student or high school teacher			
Local student in Marrakesh		1040	
Local student not from Marrakesh		1140	
International student		2090	
High school teacher		500	
Mentorship Program			
Coverage for five students, see Section 10			10000
Total Costs			
5 local students from Marrakesh		5200	
15 local students not from Marrakesh		17100	
65 international students		135850	
70 high school teachers		35080	
Mentorship program		10000	
Total		203150	

Table 1: Estimated expenses per participant attending ASP2020. The full bursary for an international student is estimated to be about 2100€, 1150€ for a local student not from Marrakesh and 1050€ for a local student already in Marrakesh. All amounts are in € unless otherwise specified. The bursaries include travel, accommodation, catering and the overhead charges. Transportation and accommodation for up to 5 lecturers would be covered. All other lecturers and organizers will seek support from external sources.