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1st BIENNIAL AFRICAN SCHOOL ON FUNDAMENTAL PHYSICS AND ITS APPLICATIONS

Web site: http://AfricanSchoolofPhysics.web.cern.ch/

We propose to establish a biennial school of physics in Africa, on fundamental subatomic 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 IT. The school will be based on a close interplay between theoretical, experimental, and applied physics.
This school of physics, will last 3 weeks, and will be located in the region of sub-Saharan Africa. The contents will be aimed primarily at doctoral students and on students finishing their last year of university studies, but young researchers will also be encouraged to apply.

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Administrative and Financial expertise is provided by Mrs. A. M. Ferrer (IN2P3 & ICBMS, Lyon). The Organizing Committee further relies on CERN external advisors with extensive experience on organizing schools of physics.

Summary

Subatomic physics stands on the verge of new discoveries that may challenge our understanding of the natural world. An enormous progress has led up to this point; pioneering experimental efforts have enabled a highly precise theoretical consolidation of what is known as the Standard Model of particle physics, summarizing our current understanding of matter and force, and novel accelerator and detector designs have spurred cutting-edge developments in a number of related fields such as computing, medical physics, cryogenics, and materials science. To increase the capacity in Africa to undertake this journey, and to profit from the applications and technologies developed alongside of it, we propose to establish a new school of physics in Africa, on fundamental physics and its applications, to be held every two years. The contents will be aimed primarily at doctoral students and on students finishing their last year of university studies, but young researchers will also be encouraged to apply.

The first edition of the school will utilize the existing strong scientific foundation in South Africa as a base from which students and scientists from neighboring sub-Saharan countries and beyond can be reached. The continuity of a biennial school will contribute to the needed mid-term development of Fundamental Physics knowledge in Africa.

1 Description of Topics

Four main topics will form the backbone of the school:

1) Theoretical Physics,
2) Experimental Subatomic Physics,
3) Accelerators and Technologies, and
4) Information Technology and GRID.

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, and high-performance computing. The latter will be structured partly into hands-on practical sessions. Further, each main topic will contain a number of hooks for student projects. These will be completed in groups, with a single lecturer (mentor) assigned to each group. These groups will also provide opportunities for discussing questions arising from the lecture material. The groups will be assigned on arrival, and time will be reserved for this activity each working day during the school. These daily discussion sessions will provide a framework for mentoring students from different backgrounds. Each group will deliver a short presentation at the end of the program.

Finally, six special “star” lectures will be organized during the school, to highlight the edge of current research and topics of special interest to the host region. These will be more pedagogical in nature, and could be opened to a wider audience, e.g., from the host institution and its surroundings. There will be one such talk for each of the three main scientific themes.

A further two slots are reserved for presentations focusing on physics in Africa, and may involve bringing in additional lecturers to the school specifically for this purpose. The last slot is to be used as an eye opener to a topic not directly overlapping with those of the school; examples could be fusion energy, medical physics, climate physics, or a topic particularly relevant to the local host area.

The lectures will be divided into full and half days, spread evenly across the program.

On full days, there will be 6 hours of lectures. On half days, there will be 3 lectures and either hands-on exercises or work on student projects in the afternoon. To round off the afternoon session on half days, a Q&A session or star lecture will be scheduled in the late afternoon / evening. Not counting the arrival and departure weekends and allowing one free/excursion day per week, we arrive at 16 days of school program. 5 afternoons will be required for the practical exercises, and 4 afternoons will be dedicated to work on the student projects, for a total of 9 half days and 7 full days. Leaving 1 hour aside for welcome and practical information, for a total of 68 lecture hours.

1.1 Theoretical Physics

The theoretical physics (TH) theme will be concentrated in the first half of the school. The focus is on theoretical nuclear and particle physics, with the emphasis on particle physics, and the main purpose is to describe the Standard Model of particle physics, including its foundations in quantum field theory. Additional main topics will be physics beyond the Standard model, the interplay with astro-particle physics and cosmology, particle physics phenomenology, and computer physics. We assign 17 lecture hours and one practical session in total to the TH theme (including its “star” lecture).

1.2 Experimental Subatomic Physics

The Experimental Subatomic Physics (EP) theme deals with what we know about subatomic physics from experiments and how we know it. It will be divided evenly over the duration of the school. A significant part of it will focus on reviews of the existing body of experimental knowledge, including particle physics, heavy-ion physics, and nuclear physics. Further, a course on data analysis will give participants an introduction to how raw data are transformed into final measurements, including calibrations, backgrounds and uncertainty estimations. The participants will also be given a thorough review of the extremely versatile range of modern particle detectors, such as those employed by the LHC experiments. We assign 21 lecture hours and 3 practical sessions in total to the EP theme (including its “star” lecture).

1.3 Accelerators and Technologies

The Accelerators and Technologies (AT) theme will be concentrated in the second half of the school and will cover accelerators, the physics of particle beams, instrumentation, and related technologies, including highlights on the Large Hadron Collider, on cryogenics and materials science, and on medical physics applications.

Special attention will be given to Knowledge and Technology Transfer.

We assign 22 lecture hours and one practical session in total to the AT theme (including its “star” lecture).

1.4 Information Technology and GRID

The Information Technology (IT) theme mainly deals with practical sessions on GRID computing. Special theoretical and experimental topics will be included in practical sessions on doing the Monte Carlo simulation on the GRID. Introduction to ROOT and practical sessions on data analysis using ROOT on simulated data obtained from the GRID practical sessions will be covered.
We assign 15 lecture hours and one practical session in total to the IT theme.

2 Organization

2.1 Lecturers and Participants

Assigning one lecturer to each theme (16 themes in total) plus one for each recap session, a total of 19 lecturers will be required to cover the main topics, with each lecturer responsible for 2–5 hours of content (not including practical sessions). Further, we expect that three of the six star lectures can be provided by lecturers already at the school, such that this part can be covered by 3 additional lecturers. The school thus calls on a total of 22 lecturers to fill the slots. Note that this number may still be reduced, according to overall funding levels.

We expect 50-70 participants, with at least half coming from the African continent. We aim to provide all participants with full travel bursaries and in case of limited funds will give priority to students residing in Africa or who are of African nationalities.
As described above, we expect a total of 22 lecturers to be required. Adding international and local organizers, the total is expected to be 96 heads participating. Non-organizing lecturers will not be expected to stay the full duration.

2.2 Duration and Preferred Dates

Our proposal is to hold a school of three weeks duration, every two years. The preferred date of the first school is Summer 2010, considering other schools and conferences in the region and selecting the date to coincide to the extent possible with quiet periods in the academic calendar.

2.3 Preferred Venue

The school is focused primarily on sub-Saharan Africa. Within that region, South Africa has been identified as the venue most likely to maximize the number of local potential participants (SA cooperates actively with CERN and has a high existing level of interest in subatomic physics) as well as minimizing overall logistics and security concerns. Inside South Africa, several alternative venues were possible, ranging from a well-contained remote environment (likely to foster a large degree of after-hours interactions, but with a higher cost overhead), to a university/lab setting with (NITHEP, Stellenbosch or U. Cape Town Campus) or without (iThemba labs, Cape Town) on-site housing. NITHEP in Stellenbosch was selected based was selected based on its convenient location and infrastructure as well as on its director support. A venue that keeps students and teachers together for as much of the day as possible is preferred. A venue that facilitates transport to and from the school is likewise preferred. The final choice should also be a function both of expressions of interest from local host institutions as well of overall funding levels.

2.4 Info-lab Requirements

The practical sessions of the school call for a room equipped with at least 35 internet-enabled computers with reasonable processing speeds. The machines do not need to be powerful enough to run massive computing themselves, this will be done by GRID computation, but they should be sufficiently fast and have sufficient disk space to compile and run small stand-alone test programs. At least Fortran and C/C++ compilers, ROOT, and presumably also some GRID software will be required to be installed prior to the school. The internet connection must be of broadband quality and reliable.

3 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 cooperations in Fundamental High Energy 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. The first edition of the school will utilize the existing strong scientific foundation in South Africa as a base from which students and scientists from neighboring sub-Saharan countries and beyond can be reached. The continuity of a biennial school will contribute to the needed mid-term development of Fundamental Physics knowledge in Africa. More precisely, what we envisage is:

- running a biennial Schools of Fundamental Physics with lecturers from Europe, Africa, and the USA and mainly African students from different countries,
- to foster and promote academic exchange programs for research visits between the 3 continents,
- to promote the access to training ships in research laboratories and university attendance for African students in African countries different than their home countries, in Europe, and in the USA
- to facilitate the integration of research teams based in Africa within large international research centers like CERN, FERMILAB, and other host centers of large-scale accelerator based science projects,
- to promote the access of African physicists and students to leading-edge technologies utilized in High Energy Physics for the design and operation of particle accelerators and detectors and for the Information Technology needed for the control of facilities as well as for Data Analysis. This involvement in technology has its own scientific interest, but may also be especially favorable to developing countries.

4 Financial Support

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

Our expected budget is on the order of 150 000 Euro.

Our budget is based on 70 students supported for the full three weeks of the school, 21 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 22 required lecturers is arrived at by assigning at least one organizer to act as lecturer as well.

The school is in the process of seeking funding from the following bodies: ICTP, IN2P3, CEA, NSF, CERN, FNAL, JLAB, the South African Dept. of Science and Technology, French Ministries of Research and Foreign Affairs, and the French Embassy in South Africa. Each of these bodies has been approached and has expressed interest in supporting the school. On top of this, individual national agencies in Europe and in the students' countries of origin may support the student travel costs.
Note that shaving this latter part off the budget would reduce the number of full student accommodation bursaries from 70 to 50, with the remaining 20 being half-bursaries. We thus do not critically depend on the availability of funds from national agencies.