

ProDoc Training Module: Particle Physics in the LHC Era

Preliminary Organization and Program

1. Educational Program

The ProDoc educational program will cover fundamental particle physics with special emphasis on LHC physics. In particular, the educational program will include the following subjects:

- Physics of the Standard Model at the TeV scale;
- Electroweak symmetry breaking by the Higgs mechanism or other mechanisms;
- Extensions to the Standard Model like Supersymmetry, extra dimensions, compositeness etc;
- Flavor physics in general and CP violation in particular, in the hadronic and leptonic sector, and its implications;
- Particle physics instrumentation, technology and methodology, including statistical methods;
- Astro-particle physics and cosmology, especially as far as their implications on particle physics are concerned.

Interdisciplinary links with applied particle physics will also be covered. The educational program will be open to all graduate students enrolled at Swiss institutions, with priority to students from participating institutions in general, and students enrolled in the ProDoc in particular.

1.1 ProDoc Courses

The ProDoc will organize courses for particle physics PhD students in the following fields:

- Quantum field theory (≥ 2 ECTS),
- Particle Physics Phenomenology (≥ 2 ECTS),
- Statistical Analysis Methods (≥ 2 ECTS),
- Experimental methods of particle physics (≥ 2 ECTS)
- Other more specialized scientific topics
- scientific writing and other non-scientific courses

Furthermore, once per year during the PhD program participation at one of the international schools for particle physics (e.g. CERN School of Physics, HCP summer school, CHIPP school, Zuoz school) will complement the education part.

The program to be followed by each ProDoc graduate student is defined by the responsible professor, who also checks if sufficient grades are obtained in the evaluation. Students with insufficient grades are eliminated from the ProDoc. Participation in at least two schools among the ProDoc resources is mandatory during the three year program. Further, every year (from the second year onwards) a two-day retreat of all PhD students in the ProDoc scheme takes place. The event is organized by the students themselves with administrative help from the ProDoc coordinator. A poster presentation of the research work of each participant is compulsory. Some students will be selected to give oral presentations.

A sample catalogue for the academic year 2009/2010 based on existing resources is shown in **Table 1**, both for the western and eastern part of Switzerland. The existing programs do not cover flavor physics and CP violation in either region. General neutrino physics is missing in western Switzerland. The program thus has to be supplemented from ProDoc resources. A suitable lecturer for flavor physics must be identified and invited to give lectures at both sites. Prof. Rubbia will be asked to either repeat his course in the other site or open his course to transmission via Internet (see Section 1.2). The finalization of this program will be the first task of the ProDoc coordinator.

Students generally take the courses closest to their center of activity. Students permanently based at CERN will follow courses in western Switzerland or others via Internet. They are also invited to attend lectures from the CERN Academic Training program, whenever appropriate. The evaluation of their attendance to this program is the responsibility of their thesis advisor.

Courses for trans-disciplinary skills, like scientific writing, presentations and access to literature, have to be planned on a longer time scale, since their usefulness crucially depends on the adaptation of the program to the needs of particle physics students. The ProDoc coordinator will be asked to evaluate existing courses to assess their degree of adaptability.

Western Switzerland	Eastern Switzerland
Massive Neutrinos and Astroparticle Physics (Ereditato/Vuilleumier/Moser, UniBe)	Neutrino Physics (Rubbia, ETHZ)
Introduction to QCD and collider phenomenology (Frixione, EPFL)	Particle Physics Phenomenology (Gehrmann, Dissertori, Chiochia, UniZH/ETHZ)
Proton Structure and QCD (Bravard, 3ième cycle)	QCD Theory and Experiment (Dissertori/Gehrmann, ETHZ/UniZH)
Théorie Quantique des Champs (Derendinger, 3ième cycle)	Quantum Gauge Theory (Scharf, UniZH) or (Colangelo, UniBE)
Quantum Field Theory (Colangelo, UniBE)	Quantum Field Theory (Gehrmann, UniZH)
Standard Model (Beranger, 3ième cycle)	Standard Model (Wiese, UniBE)
Behind and beyond the Standard Model (Rattazzi, EPFL)	Effective Field Theory (Hurth, UniZH)
High Energy and Space Astrophysics (Couvoisier, UniGE)	Astroparticle Physics (Biland, ETHZ)
Advanced Cosmology (Lesgourges, EPFL)	Astrophysics and Cosmology (Moore, UniZH)
Reativité générale (de Rham, UniGE)	General Relativity (Blau, UniBE)

Table 1: Sample program of the ProDoc Training Module for the academic year 2009/2010 in western and eastern Switzerland.

1.2 E-Learning

In an environment with multiple sites like the CHIPP ProDoc, e-learning is of central importance. The ProDoc implementation of e-learning will initially be based on the experience gained with the Virtual Institute of Astroparticle Physics (VIA)¹, sponsored by ASPERA with contributions from IN2P3, Paris Diderot, CERN and University of Geneva. The technology selected for the purpose of VIA after extensive experimentation with various systems, adobe Connect, has proven to present the required maturity, quality and stability to support a regular lecture program². VIA lectures provide a clear audio and video transmission of the lecturer's presentation, as well as the necessary level of interactivity that allows students at distant places to participate actively. The ProDoc coordinator will be asked to organize the proper distribution and licensing for the required software, in close collaboration with the VIA technical support team at Paris Diderot and the local IT support structure. He will run experiments with selected users to adapt the VIA tools to the needs of the ProDoc. At the end of experimentation phase, e-learning will be fully integrated in the ProDoc program.

1.3 Schools

The subject of the Zuoz School in August 2010, "Gearing up for LHC Physics", is well adapted to the ProDoc theme, participation is thus mandatory for students enrolled in the ProDoc. The CHIPP School in January 2010 will be held in Ascona, its program is shown in Table 2. With its coverage of detector technology, neutrino and astroparticle physics/cosmology it is an excellent complement to the Zuoz School, such that attending both schools seems appropriate for most students. The program of the 2010 CERN School of Physics is not yet known but will certainly be of interest for ProDoc students.

¹ M. Yu. Khlopov, Scientific-Educational Complex – Virtual Institute of Astroparticle Physics, Proceedings of the 11th Bled Workshop in Physics (2008), arXiv: 0812.050v1, p. 81

² See <http://viavca.in2p3.fr/home.html>, which also contains recordings of past lectures.

Time Table : Swiss PhD School 2009 on Particle and Astroparticle Physics

Hour/day	Sunday Jan 17	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday Jan 24
09:00 - 10:00		Astrophysics/ Cosmology (R. Durrer)	Astrophysics/ Cosmology (R. Durrer)	Special Seminar (tbd)	Special Seminar (tbd)	LHC Physics (K. Jakobs)	LHC Physics (K. Jakobs)	LHC Physics (K. Jakobs)
10:00 - 11:00		Neutrino Physics (E. Lisi)	Neutrino Physics (E. Lisi)	Astrophysics/ Cosmology (R. Durrer)	Student Talks	Neutrino Physics (E. Lisi)	Neutrino Physics (E. Lisi)	Concl. Session
11:00 - 11:30		Break	Break	Break	Break	Break	Break	
11:30 - 12:30		Neutrino Physics (E. Lisi)	Neutrino Physics (E. Lisi)	Student Talks		Neutrino Physics (E. Lisi)	Neutrino Physics (E. Lisi)	Departure
12:30 - 14:00		Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	
14:00 - 15:00					Free afternoon			
15:00 - 16:00		Modern Detectors (F. Sauli)	Modern Detectors (F. Sauli)	Student Talks		Modern Detectors (F. Sauli)	Modern Detectors (F. Sauli)	
16:00 - 16:30	Arrival	Break	Break	Break		Break	Break	Break
16:30 - 17:30		Modern Detectors (F. Sauli)	Modern Detectors (F. Sauli)	Student Talks		Modern Detectors (F. Sauli)	Modern Detectors (F. Sauli)	
17:30 - 18:30		Discussion	Discussion	Student Talks	Discussion	Discussion		
18:30 - 19:30		Apero						
19:30 - 21:00	Dinner	Dinner	Dinner	Dinner	Dinner	Dinner	Dinner	

Table 2: Program of the 2010 CHIPP PhD School on Particle and Astroparticle Physics

2. Preliminary organization

One of the prime challenges of the ProDoc is to make sure that its program matches the requirements of all participating institutions. These are currently very diversified. Some institutions have no formal requirements and leave program and evaluation to the discretion of the thesis advisor. Others have strict rules derived from the Bologna system, assigning ECTS credits to each course and thus requiring formal evaluation, in the style of a Doctoral School.

The clarification of this situation will be one of the major tasks of the ProDoc coordinator. For that purpose, he will contact the person responsible for post-graduate education at each participating institution, organize a meeting involving the principle investigator of the local ProDoc Research Module and assess the current situation. Since short-term adaptations of local regulations are probably not feasible, the ProDoc coordinator will make proposals to accommodate the existing diversity inside an integrated program. He will also make proposals for an asymptotic simplification and stream-lining of the system.

The detailed course program will be publicized on a ProDoc web page, constructed with support by the webmaster of the DPNC at University of Geneva. This web page will also contain a news section, and links to the e-learning resources. The ProDoc coordinator will be responsible for the contents of the page.

The process of identifying a suitable candidate for the position of ProDoc coordinator has started at University of Geneva and is likely to conclude by October 2009. In parallel, the principal investigators of the approved ProDoc research modules have started to actively encourage excellent students to apply. Advertisements for the positions will be posted by the participating institutions and on the CHIPP web site. Upon proposal by the responsible professor, the admission committee set up by CHIP for the SUK postdoctoral fellows will also evaluate the PhD student candidates. The committee is composed of the group leader of the participating institution and the CHIPP Executive Board (the chair and three vice-chairs). The basis for admission of the ProDoc students will be their record of scientific achievements in master level studies, references from their university of origin and personal interviews. Given the high quality required to be a serious candidate for this program, it is not expected that the selection process for students will finish before the end of this year.

The ProDoc coordinator regularly reports to the CHIPP Executive Board. The CHIPP Board, composed of all professors from the participating institutions active in the field of particle and astroparticle physics, reviews annually the progress and quality of the program.