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Physics at Future High Energy Colliders

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This course will discuss the physics program and goals for the next projects at the high energy frontier. The Standard Model for Particle Physics has been tested to great detail over the last 20 years, and measurements are in excellent agreement with the data. But this model has its shortcomings and does not explain why the world is as it is. It is furthermore expected that at higher energies new physics effects will manifest itself, which are needed to allow the Standard Model to be stable at our present energies. The next high energy machines will seek answers to these questions.
In less than two years from now the Large Hadron Collider (LHC) at CERN will become operational, and will collide protons at a centre of mass energy of 14 TeV. This high collision energy will allow to study physics at the TeV energy scale. These lectures will introduce the LHC machine and make a tour of the experiments, presently under construction, that will measure these collisions. The physics program and measurments at the LHC, and at its potential luminosity upgrade (SLHC), will be discussed. Special attention will be given to the long awaited start-up schedule of the collider and the first results that can be expected from the LHC experiments.
One of the most important questions which the LHC will settle is that of electroweak symmetry breaking – or the mechanisme that gives mass to the fundamental particles– which is currently still mysterious. The presently most popular solution to this problem is the anticipation of the existence of a scalar “Higgs” field, with associated Higgs particle. If such particle exists with Standard Model properties, LHC will find it.
Another major question is what lays beyond the Standard Model. The high energy limit shortcoming of the Standard Model suggests that in the region around a TeV or higher, signals from new physics will set it, through the production of new particles or the onset of new processes. In these lectures we will discuss the potential for discovering Supersymmetry, large extra space dimensions, and a few other new scenarios.
At a later time, perhaps 10 years from now, an e+e- linear collider can be the next collider which will be largely complementary to the LHC, allowing for precision measurements to be made, in order to understand the exact nature of the underlying theory for the new physics, when discovered at the LHC.
These lectures will give a short introduction to the present linear collider projects and studies, ILC and CLIC, and will discuss the synergy with the LHC physics program.

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