European Strategy Update

Particle Physics in Switzerland

Switzerland has benefitted enormously from the presence of the world's leading particle physics accelerator laboratory CERN and the accelerator competences at the Swiss Paul Scherrer Institute. Institutes at 5 Cantonal Universities, 2 Federal Institutes of Technology and the Paul Scherrer Institute have built up a strong collaborative partnership in the Swiss particle physics programme at CERN and elsewhere, involving in research and teaching activities in particle and astroparticle physics. In addition, the Swiss National Supercomputing Centre in Lugano hosts the Swiss Tier2 Centre as part of the Computing GRID for LHC physics data analyses. The almost 450 scientists working in the field are organised in the Swiss Institute of Particle Physics CHIPP, a member of the Swiss Academy of Natural Sciences.

The Swiss strategy in particle physics has led to a balanced programme with three main pillars: (1) High Energy Frontier including High Precision Experiments also at Low Energy; (2) Neutrino Physics, (3) Experiments at the Interface of Cosmology, Astrophysics, Particle and Nuclear Physics. In addition, strong efforts are deployed in the field of accelerator research.

Key areas of research interest

High Energy Frontier including High Precision Experiments also at Low Energy:

Higgs, Supersymmetry, Physics beyond the Standard Model, quark flavour physics, charged lepton flavour violation, CP violation

Neutrino Physics:

Neutrino properties (oscillation, masses, mixing, hierarchy), neutrino beams, proton decay, neutrinoless double beta decay, Majorana mass, CP violation

Interface of Cosmology, Astrophysics, Particle and Nuclear Physics:

Dark matter, very high energy astronomy, gamma ray astrophysics, cosmic rays, cosmology, gravitational lensing, multi-messenger astronomy

Aerial view of the Paul Scherrer Institute (PSI) which - as a Swiss national institute - operates large scale facilities for various disciplines including particle physics.

Society and Skills

- 420'000 people in Switzerland are employed in physics-based businesses (e.g. approx. 10% of the workforce).
- Switzerland contributes with 4.25% (corresponding to 160 M€ [2010]) to the physics-based turnover of Europe (i.e. EU27 plus Norway and Switzerland).
- 2700 students are studying physics at the Swiss universities (2011). 185 active experimentalists and 75 theoreticians plus some 190 doctoral students are involved in particle and astroparticle physics including cosmology at the interface with particle physics.
- Between 1996 and 2012, a total of 107 master theses and 96 doctoral theses have been completed in connection with the development and construction of the LHC detectors as well as with the physics data analysis. In addition, 14 PhD theses were completed in the field of LHC accelerator physics.
- Also the other particle physics activities in Switzerland delivered a strong contribution to student education at all levels.

New technologies

- Experimental particle physics requires sophisticated experimental techniques to identify the products of particle interactions; this has resulted in major breakthroughs in instrumentation (ultra-precise particle sensors) and information technology for data analysis. Cross-fertilization has lead to major advances in other scientific fields as well as in medical and commercial applications.
- Spin-offs have been created mainly in the field of detector technologies and of data acquisition and signal processing. The detectors thus developed are able to, for instance acquire X-rays much quicker than comparable detectors elsewhere and are almost noise-free.

Life Science and medicine

- PSI operates the first compact scanning-gantry for proton radiation therapy installation of deep-seated tumours. The unique radiation technique developed at PSI allows to adapt the radiation dose extremely accurately to the shape of the tumour, thus protecting healthy tissue much better than with the most modern conventional radiation therapy techniques.
- Detection and data acquisition technology of particle physics is also, for instance used in PET scanners. Isotope production for medical applications is being pursued as well.

Education and Outreach

- Switzerland aims at attracting the best students to particle physics in order to maintain the high quality and the proven excellence of its scientific and technical teams and of its theoretical physicists. A graduate physics programme is complemented by well-supported doctoral programmes like the 3ème cycle in western Switzerland, the CHIPP PhD Winter School, and the Zuoz Summer School, but also through participation in the CERN School of Physics.
- Outreach has gained momentum with Open Days (or Pupils Days) at universities and the participation in the European Masterclasses programme, but also with a dedicated project aiming at schools and school teachers ('Verflixtes Higgs'). Two follow-on programmes ('Interactions', 'Dialogue') will further amplify these efforts by making extensive use of social media **(www.particlephysics.ch)** and public discussions.

CHIPP (Swiss Institute of Particle Physics) is coordinating the Swiss particle physics activities in the different laboratories and institutes: **www.chipp.ch**