



Reflecting European Strategy for Particle Physics

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European Strategy for Particle physics in Europe: how did it start?



European Strategy for Particle Physics

- The process, approved the 16th of June 2005 by the CERN Council, driven by the then SPC Chair (K. Peach) and ECFA Chair (T. Akesson) with Council Chair (E. Iarocci)
- Open Symposium in Orsay-Paris from 30 January to 1 February 2006, organised by the Preparatory Group (community meeting)
- Workshop in Zeuthen from 2 to 6 of May 2006
Draft Strategy Statement produced by the Strategy Group (member country representatives)
- The Strategy was adapted by the Council in July 2006

Physics Landscape

- LHC was still under construction.
- ILC baseline design completed under the guidance of GDE. The next steps were, the Reference Design Report and finally the Technical Design Report.
- HERA, PEP-II, KEKB and Tevatron were still operating.
- Several neutrino experiments, accelerator based and reactor based were under construction.
- Higgs mass prediction from the electroweak fits, but no direct observation of the Higgs particle.
- No convincing sign (neither direct nor indirect) of new physics (except the neutrino masses).
- The third neutrino mixing angle, θ_{13} , not measured.

European Strategy; Scientific Activities

- The LHC as the highest priority project, with R&D for high luminosity upgrade.
- Accelerator R&D for CLIC, high performance magnet, high intensity neutrino facilities.
- European coordinated effort for the ILC.
- Physics studies and technical R&D for future neutrino facilities.
- Coordination with ApPEC.
- Flavour and precision physics led by regional and national effort.
- Collaboration with NuPECC.
- Theoretical physics, preparation for LHC physics.

New European Strategy 2013 update

- **Community Kick-off meeting** for the Strategy Update, Joint ECFA-EPS session @ HEP Conference Grenoble July 2011
- **The first update** officially **started in September 2011** by the Council establishing the Preparatory Group (science input) and Strategy Group (strategy drafting). Scientific Secretary and Secretariat were in charge.
- **Open Symposium** organised by the Preparatory Group in **September 2012** in Krakow.
- **The draft proposal** by the European Strategy Group out come of the meeting in **January 2013** in Erice
- **First Council discussion** in **March 2013**, finalising the agreed draft for the formal approval later
- **Formal adoption** by the CERN Council in its special Strategy Session in Brussels **in May 2013**



How the current strategy was made...



At the time of the Cracow symposium

- LHC discovery of a new boson at 125 GeV consistent with the Standard Model Higgs. 👍
- LHC operating with a good performance but not yet at the designed energy. Four LHC experiments operating with expected performances. Realistic path for the high luminosity upgrade.
- ILC TDR completed and Japanese HEP community expressed their wish to host it.
- Neutrino sector, $\sin 2\theta_{13} \neq 0$ with more than 5σ and ≈ 0.1 . 👍
- Many neutrino experiments fully/partially running and some new projects started.
- HERA, PEP-II, KEKB, Tevatron stopped. BEPC-II, DAFNE, VEPP's, high intensity $\mu/K/n/\bar{p}$ at National Laboratories and CERN. SuperKEKB under construction.
- No clear sign of physics beyond the Standard Model: Neither with direct search nor in precision physics. 👎

Four large scale projects with high priority

- c) The discovery of the Higgs boson is the start of a major programme of work to measure this particle's properties with the highest possible precision for testing the validity of the Standard Model and to search for further new physics at the energy frontier. The LHC is in a unique position to pursue this programme. *Europe's top priority should be the exploitation of the full potential of the LHC, including the high-luminosity upgrade of the machine and detectors with a view to collecting ten times more data than in the initial design, by around 2030. This upgrade programme will also provide further exciting opportunities for the study of flavour physics and the quark-gluon plasma.*

Four large scale projects with high priority

- d) To stay at the forefront of particle physics, Europe needs to be in a position to propose an ambitious post-LHC accelerator project at CERN by the time of the next Strategy update, when physics results from the LHC running at 14 TeV will be available. *CERN should undertake design studies for accelerator projects in a global context, with emphasis on proton-proton and electron-positron high-energy frontier machines. These design studies should be coupled to a vigorous accelerator R&D programme, including high-field magnets and high-gradient accelerating structures, in collaboration with national institutes, laboratories and universities worldwide.*

Four large scale projects with high priority

- e) There is a strong scientific case for an electron-positron collider, complementary to the LHC, that can study the properties of the Higgs boson and other particles with unprecedented precision and whose energy can be upgraded. The Technical Design Report of the International Linear Collider (**ILC**) has been completed, with large European participation. The initiative from the Japanese particle physics community to host the ILC in Japan is most welcome, and European groups are eager to participate. *Europe looks forward to a proposal from Japan to discuss a possible participation.*

Four large scale projects with high priority

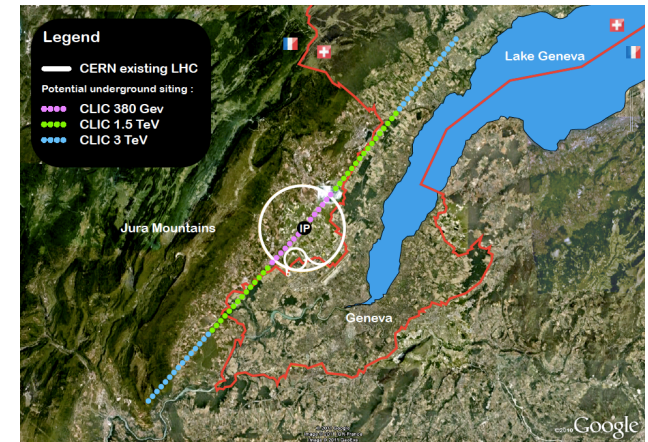
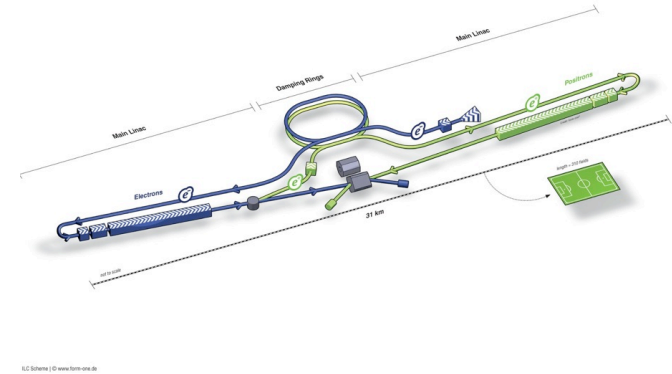
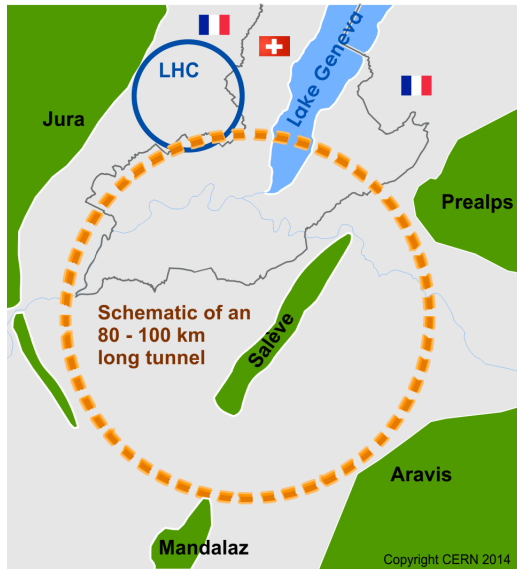
- f) Rapid progress in neutrino oscillation physics, with significant European involvement, has established a strong scientific case for a long-baseline neutrino programme exploring CP violation and the mass hierarchy in the neutrino sector. *CERN should develop a neutrino programme to pave the way for a substantial European role in future long-baseline experiments. Europe should explore the possibility of major participation in leading long-baseline neutrino projects in the US and Japan.*

Some points worth noting

- It sets the priority for the large projects explicitly stating four issues which should be done, rather than discussing all the projects we would like to do: *c), d), e), f)*
- For the four priority subjects, while expressing **the European ambitions**, i.e. physics at the highest energy, it declares **the readiness of Europe to participate in the large projects outside of Europe**, i.e. ILC construction in Japan, long baseline experiment in the US or Japan: *c), d), e), f)*
- Unique opportunities **at the national laboratories worldwide** (and CERN) are fully **acknowledged and encouraged** for the **precision experiments**, i.e. guaranteeing the diversity, and as basis for detector R&D and construction: *h), i)*

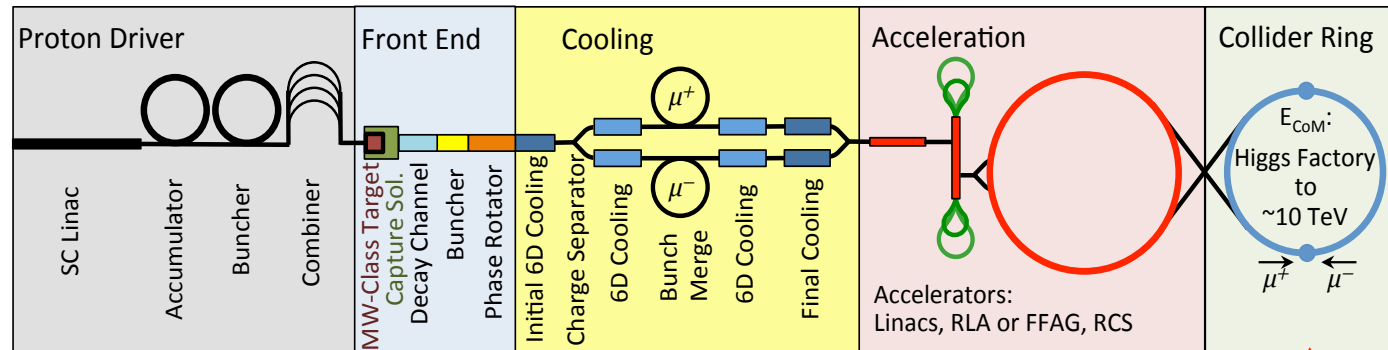
And importance of theory

- g) Theory is a strong driver of particle physics and provides essential input to experiments, witness the major role played by theory in the recent discovery of the Higgs boson, from the foundations of the Standard Model to detailed calculations guiding the experimental searches. *Europe should support a diverse, vibrant theoretical physics programme, ranging from abstract to applied topics, in close collaboration with experiments and extending to neighbouring fields such as astroparticle physics and cosmology. Such support should extend also to high-performance computing and software development.*



Coming update?

Muon Collider



After the 2013 Strategy Statements

- LHC is running with designed luminosity (10^{34}), or even above, and at almost designed energy (13 TeV, 14 TeV in 2018?).
- High-Lumi LHC has been approved by the Council, to achieve $\int L dt$ 3 ab^{-1} , the programme will continue to ~ 2035 .
- Construction of a long baseline neutrino facility in the US (LBNF) started with a large European participation in the experiment (DUNE). T2K Phase-2 approved in Japan and working for Hyper-K approval.
- CERN established a neutrino detector test facility with charged beams (CERN neutrino platform).
- Flavour physics experiments (quarks and charge leptons) advancing.
- No clear sign by the Japanese government to host ILC.
- Future Circular Collider (FCC) with ee, hh and eh option @CERN R&D work started (also High energy LHC).
- Proposal for CEPC (ee) and SPPC (hh) in China by IHEP.

What will be the issues?

- Run-2 LHC results as well as results from precision experiments are crucial for the next step. So far they are
 - no new particle found and difficult life for minimal SUSY scenario already now.
 - some “flavour anomalies”, but no real sign of new physics with precision physics.
- What are the future options for the energy frontier accelerators: lepton vs hadron, lepton beyond e^+e^- , circular vs linear, dream vs affordability, etc., etc. ?
 - A lepton Higgs factory needed? If yes, which one?
 - High-energy LHC as an affordable pp machine?
- What will be the new facilities needed for neutrino and precision physics?
- ...

And

- We should start thinking about the next strategy update soon...