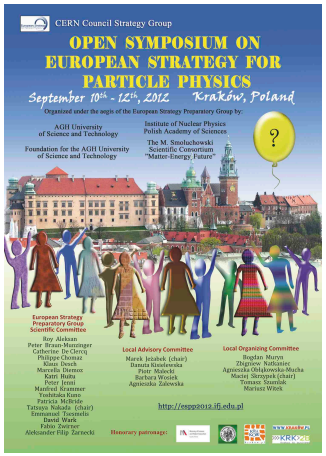
European Strategy for Particle Physics
Proposed Draft to the CERN Council

https://europeanstrategygroup.web.cern.ch/EuropeanStrategyGroup/

HEPAP meeting

Gaithersburg, USA, 11-12 March 2013



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Scientific Secretary for Strategy Session of CERN Council

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Timeline

- Preparation of the update started in 2011 by setting up
  Strategy Group and Preparatory Group by the Council

European Strategy Group	Drafting the updated Strategy
Preparatory Group	Preparing for scientific input to the ESG based on the community input

  input (Open Symposium + written submissions)
- January 2013: Strategy Group drafting session

we are here ☞ **Draft of updated European Strategy** made, submitted to the Council and made **available to the community**

- March 2013: Council discussion on the draft
  aiming for an agreement on the updated Strategy
- May 2013: The Council formally adopting the Strategy

Timeline

- Preparation of the update started in 2011 by setting up
  Strategy Group and Preparatory Group by the Council
- September 2012: Open Symposium
  Organised by the Preparatory Group
  scientific input from the community
- December 2012: Scientific Briefing Book
  by the Preparatory Group based on the community input (Open Symposium + written submissions)
- January 2013: Strategy Group drafting session

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Preamble

- Since the adoption of the European Strategy for Particle Physics in 2006, the field has n, elucidat nt leap, the disc experimental results confirming the Standard Model beyond the previously explored energy scales. These results raise further questions on the origin of elementary particle masses and on the role of the Higgs boson in the more r experiments at the overlap with astroparticle physics and cosmology. Against the backdrop of dramatic developments in our understanding of the science landscape, Europe is updating its Strategy for Particle Physics in order to define the community's direction for the coming years and to prepare for the long-term future of the field.

Summarising
why are we updating the strategy now:

- LHC is operating with a good performance but not yet at the designed energy 👍
- Realistic path for the high luminosity upgrade now exists 👍
- HERA, PEP-II, KEKB, Tevatron stopped operation 👎
- Several neutrino experiments are now running or very closed to be operational 👍

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Summarising why are we updating the strategy now:

- discovery of new particles at 125 GeV looking like the Standard Model Higgs so far 👍
- many direct limits on possible new particles, parameter space for "simple" SUSY 👎
- no clear sign of physics beyond the Standard Model in precision physics: b-, c- and s-hadrons, τ and μ decays (muon g−2?), d_n, ···, parameter space for "simple" SUSY models 👎
- neutrino sector, $\sin^2 \theta_{13} \neq 0$ with more than 5σ and ≈ 0.1 👍

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science landscape, Europe is updating its Strategy for Particle Physics in order to define the community's direction for the coming years and to prepare for the long-term future of the field.

General issues

a) The success of the LHC is proof of the effectiveness of the European organisational model for particle physics, founded on the sustained long-term commitment of the CERN Member States and of the national institutes, laboratories and universities closely collaborating with CERN. *Europe should preserve this model in order to keep its leading role, sustaining the success of particle physics and the benefits it brings to the wider society*.

b) The scale of the facilities required by particle physics is resulting in the globalisation of the field. *The European Strategy takes into account the worldwide particle physics landscape and developments in related fields and should continue to do so*.

High-priority large-scale scientific activities 1

After careful analysis of many possible large-scale scientific activities requiring significant resources, sizeable collaborations and sustained commitment, the following four activities have been identified as carrying the highest priority.

With limited resources available,

not the all large scale projects can be done in Europe,

at the same time, even with a good scientific case…

-current physics situation: Higgs, neutrino θ_{13}, …

-full exploitation of large investment already made

-required versus available resources

-international landscape

ideas… LHC, R&D, LC, LHeC, LEP3, γ-γ Colliders, etc.

High-priority large-scale scientific activities 2

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*.

Europe will be pretty busy with the LHC for sometime.

High-priority large-scale scientific activities 3

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.*

Next large facility in Europe needs physics guidance: the next Strategy update for making a decision: R&D to be ready for the decision

High-priority large-scale scientific activities 4

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*.

ILC in Japan would be an opportunity for all of us.

High-priority large-scale scientific activities 5

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.*

Europe should be at the forefront of long baseline neutrino experiments, while exploring global opportunities for a long baseline facility.

Other scientific activities essential to the particle physics programme 1

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.*

Wide rage of support needed for theoretical physics.

Other scientific activities essential to the particle physics programme 2

h) Experiments studying quark flavour physics, investigating dipole moments, searching for charged-lepton flavour violation and performing other precision measurements at lower energies, such as those with neutrons, muons and antiprotons, may give access to higher energy scales than direct particle production or put fundamental symmetries to the test. They can be based in national laboratories, with a moderate cost and smaller collaborations. *Experiments in Europe with unique reach should be supported, as well as participation in experiments in other regions, especially Japan and the US.*

Diversity is crucial for the field. Real progress often comes from unexpected direction.

Other scientific activities essential to the particle physics programme 3

i) The success of particle physics experiments, such as those required for the high-luminosity LHC, relies on innovative instrumentation, state-of-the-art infrastructures and large-scale data-intensive computing. *Detector R&D programmes should be supported strongly at CERN, national institutes, laboratories and universities. Infrastructure and engineering capabilities for the R&D programme and construction of large detectors, as well as infrastructures for data analysis, data preservation and distributed data-intensive computing should be maintained and further developed.*

Computing is added as a crucial item for the infrastructure.

Other scientific activities essential to the particle physics programme 4

j) A range of important non-accelerator experiments take place at the overlap of particle and astroparticle physics, such as searches for proton decay, neutrinoless double beta decay and dark matter, and the study of high-energy cosmic-rays. These experiments address fundamental questions beyond the Standard Model of particle physics. The exchange of information between CERN and ApPEC has progressed since 2006. *In the coming years, CERN should seek a closer collaboration with ApPEC on detector R&D with a view to maintaining the community's capability for unique projects in this field.*

Non-accelerator particle physics experiments are under astroparticle physics in Europe

Other scientific activities essential to the particle physics programme 5

k) A variety of research lines at the boundary between particle and nuclear physics require dedicated experiments. *The CERN Laboratory should maintain its capability to perform unique experiments. CERN should continue to work with NuPECC on topics of mutual interest.*

Organisational issues 1

l) Future major facilities in Europe and elsewhere require collaboration on a global scale. *CERN should be the framework within which to organise a global particle physics accelerator project in Europe, and should also be the leading European partner in global particle physics accelerator projects elsewhere. Possible additional contributions to such projects from CERN's Member and Associate Member States in Europe should be coordinated with CERN.*

Europe tries to be ready to participate in a large project taking place outside of Europe, if it happens.

Organisational issues 2

m) A Memorandum of Understanding has been signed by CERN and the European Commission, and various cooperative activities are under way. Communication with the European Strategy Forum on Research Infrastructures (ESFRI) has led to agreement on the permanent involvement of CERN in the relevant ESFRI Strategy Working Group. The particle physics community has been actively involved in European Union framework programmes. *CERN and the particle physics community should strengthen their relations with the European Commission in order to be further integrated in the development of the European Research Area and to benefit from future instruments in Horizon 2020 and the Structural Funds.*

Wider impact of particle physics 1

n) Sharing the excitement of scientific discoveries with the public is part of our duty as researchers. Many groups work enthusiastically in public engagement. They are assisted by a network of communication professionals (EPPCN) and an international outreach group (IPPOG). For example, they helped attract tremendous public attention and interest around the world at the start of the LHC and the discovery of the Higgs boson. *Outreach and communication in particle physics should receive adequate funding and be recognised as a central component of the scientific activity. EPPCN and IPPOG should both report regularly to the Council.*

Wider impact of particle physics 2

o) Knowledge and technology developed for particle physics research have made a lasting impact on society. These technologies are also being advanced by others leading to mutual benefits. Knowledge and technology transfer is strongly promoted in most countries. The HEPTech network has been created to coordinate and promote this activity, and to provide benefit to the European industries. *HEPTech should pursue and amplify its efforts and continue reporting regularly to the Council.*

Wider impact of particle physics 3

p) Particle physics research requires a wide range of skills and knowledge. Many young physicists, engineers and teachers are trained at CERN, in national laboratories and universities. They subsequently transfer their expertise to society and industry. Education and training in key technologies are also crucial for the needs of the field. *CERN, together with national funding agencies, institutes, laboratories and universities, should continue supporting and further develop coordinated programmes for education and training.*

Concluding recommendations

q) This is the first update of the European Strategy for Particle Physics. It was prepared by the European Strategy Group based on the scientific input from the Preparatory Group with the participation of representatives of the Candidate for Accession to Membership, the Associate Member States, the Observer States and of other organisations. Such periodic updates at intervals of about five years are essential. *Updates should continue to be undertaken according to the principles applied on the present occasion. The organisational framework for the Council Sessions dealing with European Strategy matters and the mechanism for implementation and follow-up of the Strategy should be revisited in the light of the experience gained since 2006.*

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Consolidation for European Strategy implementation:
CERN organization, CERN Council, CERN Laboratory,
CERN as a coordinator for European particle physics

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