



# Discussion on European Strategy Update

CLICdp General Meeting, 2 July 2020

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# European Strategy



Two documents:

Strategy:

<https://indico.cern.ch/event/924500/contributions/3884837/subcontributions/308163/attachments/2060582/3456333/CERN-ESU-013.pdf>

'Deliberation document':

<https://indico.cern.ch/event/924500/contributions/3884837/subcontributions/308163/attachments/2060582/3456338/CERN-ESU-014.pdf>

Context:

## **2. General considerations for the 2020 update**

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a) Europe, through CERN, has world leadership in accelerator-based particle physics and related technologies. The future of the field in Europe and beyond depends on the continuing ability of CERN and its community to realise compelling scientific projects. *This Strategy update should be implemented to ensure Europe's continued scientific and technological leadership.*

From Strategy document:

### 3. High-priority future initiatives

a) An electron-positron Higgs factory is the highest-priority next collider. For the longer term, the European particle physics community has the ambition to operate a proton-proton collider at the highest achievable energy. Accomplishing these compelling goals will require innovation and cutting-edge technology:

- *the particle physics community should ramp up its R&D effort focused on advanced accelerator technologies, in particular that for high-field superconducting magnets, including high-temperature superconductors;*
- *Europe, together with its international partners, should investigate the technical and financial feasibility of a future hadron collider at CERN with a centre-of-mass energy of at least 100 TeV and with an electron-positron Higgs and electroweak factory as a possible first stage. Such a feasibility study of the colliders and related infrastructure should be established as a global endeavour and be completed on the timescale of the next Strategy update.*

→ Clear statement of  $e^+e^-$  Higgs factory as highest priority, but text moves straight to a hadron machine.

FCCee is a 'possible first stage', contingent on hadron machine.

The Higgs factory is not further developed in the strategy; however, the next statement is on ILC:

*The timely realisation of the electron-positron International Linear Collider (ILC) in Japan would be compatible with this strategy and, in that case, the European particle physics community would wish to collaborate.*



# European Strategy



Some insight comes from the Deliberation Document:

Following the discussions at the Open Symposium in Granada, as reported in the preamble, an electron-positron Higgs factory is the highest-priority next collider for the field, followed by a hadron collider at the energy frontier in the longer term. Two possible energy-frontier colliders have been studied for implementation at CERN, namely CLIC and FCC, introduced in Section 1. CLIC has the potential to reach 3 TeV in the centre of mass, while FCC could reach 100 TeV or beyond. In assessing their relative physics reach, it has to be borne in mind that in an  $e+e-$  collider, such as CLIC, the full energy is available for collisions, whereas the protons in a collider such as FCC are composite particles whose constituents interact with less than the total beam energy.

The design, technology, and implementation aspects of CLIC indicate that the first stage (a Higgs factory) could be realised on a timescale of 15 years and could be extended to higher energies subsequently. However, the dramatic increase in energy possible with a future hadron collider compared to the 13 TeV of the LHC leads to this technology being considered as the most promising for a future facility at the energy frontier. This would, however, require a large-scale infrastructure for the circular tunnel, as well as high-field magnets (assumed to be 16 Tesla in the current design) which are far from ready for series production. It is important therefore to launch a feasibility study for such a collider to be completed in time for the next Strategy update, so that a decision as to whether this project can be implemented can be taken on that timescale. The feasibility study should involve the following aspects: the possibility of constructing such a large infrastructure in the vicinity of CERN, the financial plan to complete and operate a project of this scale with international partners, its governance, and the handling of the energy consumption. For this future collider to reach sensitivity to new physics at scales ten times higher than the HL-LHC in a timely fashion, the development of high-field magnets, including the option of using high-temperature superconductors, coupled with other innovative accelerator technologies, has to be ramped up and the resources available within Europe and beyond need to be coordinated accordingly.

If the large circular tunnel for such a collider can be built, then it would also provide the infrastructure needed for an electron-positron Higgs factory as a possible first step, of the type that has been studied as FCC-ee. The FCC-ee also presents the option to provide, at lower centre-of-mass energies, huge numbers



# European Strategy



My personal interpretation of this:

“Plan A” is that ILC is the Higgs factory, and CERN proceeds directly to FCChh, aiming to compress the timeline in order to realise it more quickly and minimise the gap after HL-LHC.

Of course a “cautious and prudent” strategy requires fall-back options, *and CLIC remains one of them.*



# European Strategy



Strategy's accelerator technology section is relevant for CLIC:

b) Innovative accelerator technology underpins the physics reach of high-energy and high-intensity colliders. It is also a powerful driver for many accelerator-based fields of science and industry. The technologies under consideration include high-field magnets, high-temperature superconductors, plasma wakefield acceleration and other **high-gradient accelerating structures**, bright muon beams, energy recovery linacs. *The European particle physics community must intensify accelerator R&D and sustain it with adequate resources. A roadmap should prioritise the technology, taking into account synergies with international partners and other communities such as photon and neutron sources, fusion energy and industry. Deliverables for this decade should be defined in a timely fashion and coordinated among CERN and national laboratories and institutes.*

Fabiola presented “News from the June Council” on Monday:  
<https://indico.cern.ch/event/932053/>

## Scientific priorities include

- ❑ Full exploitation of LHC physics potential → successful completion of the high-luminosity upgrade of accelerators and experiments
- ❑ e<sup>+</sup>e<sup>-</sup> Higgs factory as the highest-priority next collider
- ❑ Increased R&D on accelerator technologies: high-field superconducting magnets, high-gradient accelerating structures, plasma wakefield, muon colliders, ERL, etc. Development of Accelerator R&D roadmap.
- ❑ Investigation of the technical and financial feasibility of a future ≥ 100 TeV hadron collider at CERN, with e<sup>+</sup>e<sup>-</sup> Higgs and electroweak factory as a possible first stage.  
To be completed by next Strategy update (~ 2026).
- ❑ Support to long-baseline neutrino projects in Japan and US. Support to high-impact scientific diversity programme complementary to high-energy colliders (role of national labs emphasised)

(My) remarks:

- ❑ Strategy gives a direction for future collider(s) at CERN (FCC). Prudent: feasibility study first.
- ❑ Intensified accelerator R&D to prepare alternatives if FCC feasibility study fails
- ❑ No consensus in European community on which type of Higgs factory (linear or circular)  
If FCC feasibility study successful and project approved → FCC-ee is natural choice at CERN
- ❑ ILC: - compatible with ESPP if timely (otherwise conflict of resources with next collider at CERN)  
- are ILC and FCC-ee complementary enough in terms of physics? No consensus
- ❑ Chinese colliders (CepC, SppC): direct competition → if CepC goes ahead, Europe would go directly to FCC-hh (if feasible)



# European Strategy



DG presentation did not directly address CLIC. However, during subsequent Q&A, the answers to direct questions were strong:

“What is the status of CLIC after the new European Strategy Update and is the project still being considered at CERN?”

DG: “We will continue the investment in R&D for key technologies related to CLIC, for instance high-gradient accelerating structures; beam dynamics; and also the CLEAR facility, which is also very important for more general accelerator developments; high-efficiency klystrons; and the key items related to the CLIC accelerator so that if in 2026 the feasibility study is not conclusive for FCC and the community decides that we have to move on to go ahead with CLIC we will be able to implement the project in an expeditious way.”



# European Strategy



- ◆ The report from the chair of the Scientific Policy Committee during the broadcast 19<sup>th</sup> June Council meeting reflected this, welcoming the approach of determining the feasibility of the FCC while retaining R&D lines for a variety of future accelerators, and in particular recognising work on linear colliders and maintaining the advanced CLIC technology.
- ◆ And the Council's resolution on the adoption of the Strategy (the resolution is what was actually approved on 19<sup>th</sup> June) invited the CERN management to provide annual reports on the implementation of the high-priority recommendations of the Strategy update, including the results of the feasibility study for a future circular collider as well as accelerator R&D activities targeting other options.
- ◆ CERN's budget works to a 5-year rolling 'Medium-Term Plan' (MTP), approved annually; the draft budget for 2021 was discussed favourably by the Council on 18<sup>th</sup> June and will be presented for approval in September. This MTP is the initial implementation of the Strategy, and includes reduced but continuing funding for Linear Collider accelerator R&D, as well as separate budget lines for the CLEAR facility and high-efficiency klystrons.



# European Strategy



In line with the MTP, the CLIC Accelerator is developing a plan for 2021–25 to maintain CLIC as an option for a Higgs/top machine for CERN:

- ◆ Concentrating on key technologies
  - high gradient (X-boxes programme)
  - nanobeam (focus on beam-delivery)
  - drive-beam (high-efficiency klystrons)
  
- ◆ Operating CLEAR
  
- ◆ Emphasising collaborations and making sure that CLIC technologies are exploited externally (medical/industrial)



# European Strategy



→ CLIC R&D programme is continuing

- ◆ This was not a guaranteed outcome of the Strategy process!
- ◆ Nonetheless, for Physics & Detectors the picture for the next 5 years looks difficult.



# LCD Group



News on the CERN LCD Group  
→ Lucie



# European Strategy



## Discussion:

- reactions to Strategy?
- input on next steps?
- will we retain critical mass for a collaboration?



# Next steps



Dates reserved for collaboration meeting:  
still 1–2 September

– this may be too early for many external people to come back to CERN; we are trying to understand when it could be realistic to have an in-person meeting, and then decide what to do (input welcome!)



# Relaunched CLICdp webpages

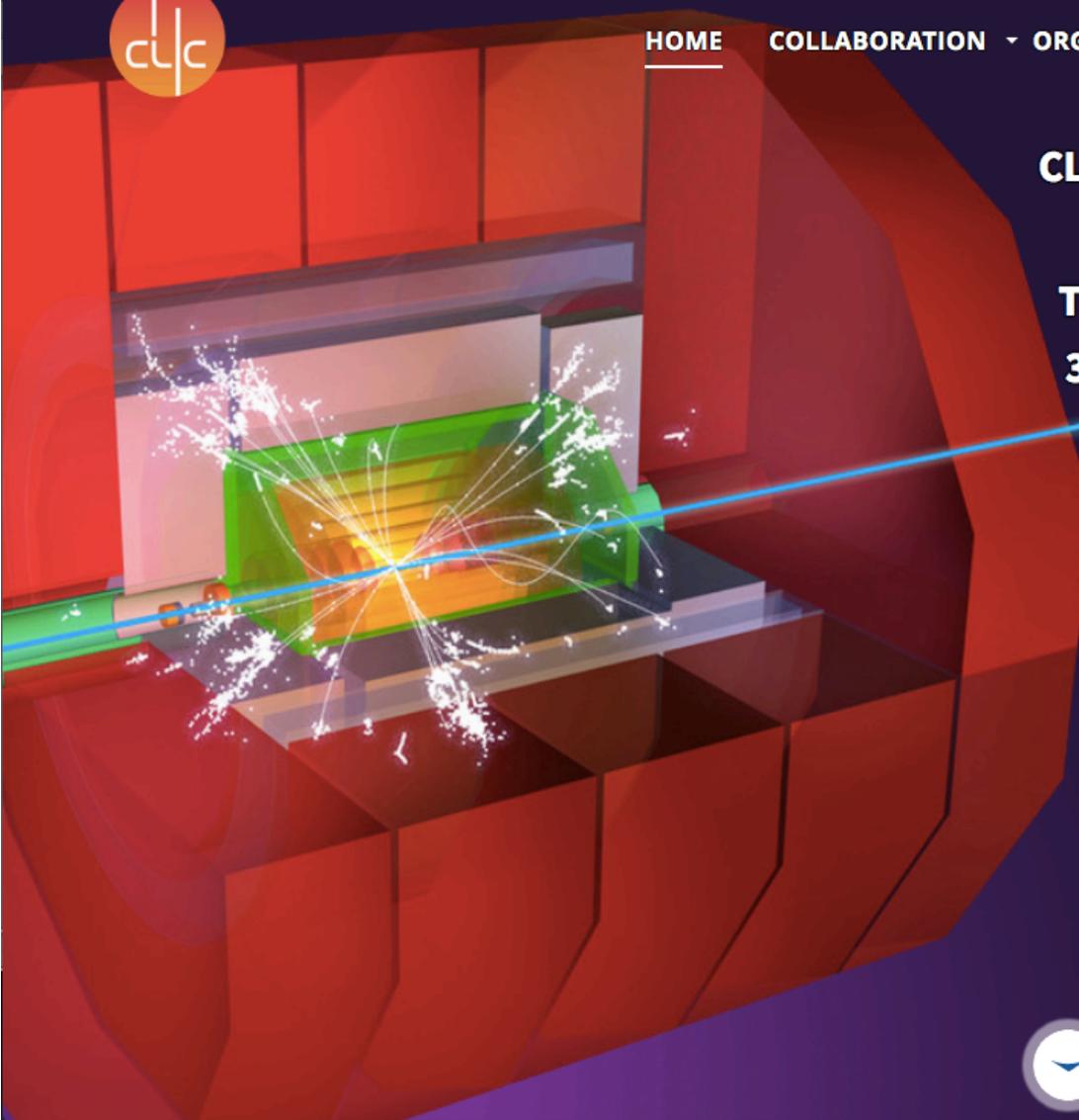


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**CLIC is a high-energy electron-positron collider with multi-TeV capability. The CLICdp collaboration consists currently of 30 institutions and is addressing detector and physics issues relevant for CLIC.**

