The European Strategy Update

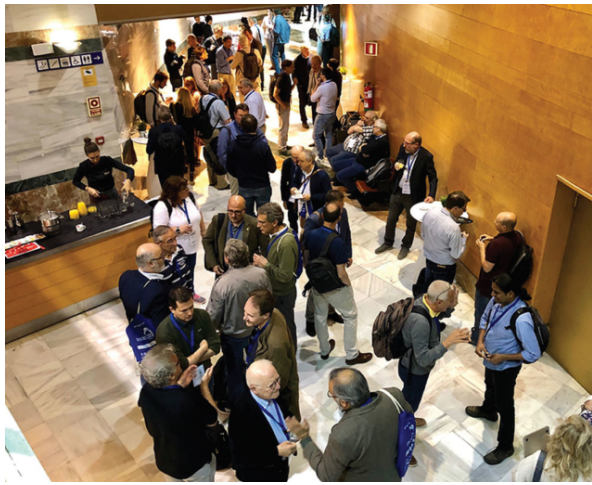
Future Circular Collider Innovation Study

Ursula Bassler
CERN Council President
CNRS-IN2P3

European Strategy Update

- **European Strategy for Particle Physics est. 2005 (**Chairs: Torsten Akesson/Ken Peach)
  Open Symposium Orsay – January 2006
  Drafting Session Zeuthen – Mai 2006
  Council Approval Lisbon – July 2006
- **First update in 2012/2013** (Secretary: Tatsuya Nakada)
  Open Symposium Krakow – September 2012
  Drafting Session Erice – January 2013
  Council Approval Brussels – May 2013
- **Second Update in 2018/2020** (Secretary: Halina Abramowicz)
  Open Symposium Grenada - Mai 2019
  Drafting Session Bad Honnef – January 2020
  Council Approval CERN – June 2020 (initially foreseen Mai 2020 Budapest)
    - https://europeanstrategy.cern

➔resources available:
https://europeanstrategyupdate.web.cern.ch/resources
- Strategy Brochure
- Deliberation Document
- Working group reports
- Physics Briefing Book




2020 UPDATE OF THE EUROPEAN STRATEGY
FOR PARTICLE PHYSICS
by the European Strategy Group
European Strategy
Update


DELIBERATION DOCUMENT
ON THE 2020 UPDATE OF THE EUROPEAN STRATEGY
FOR PARTICLE PHYSICS
The European Strategy Group
European Strategy
Update

Major developments from the 2013 Strategy (2)

General considerations for the 2020 update (3)

High-priority future initiatives (2)

Other essential scientific activities for particle physics (4)

Synergies with neighbouring fields (2)

Organisational issues (3)

Environmental and societal impact (4)

→ 20 strategy statements unanimously approved by the European Strategy Group in January 2020

(3) High-priority future initiatives

Three considerations:

- An electron-positron Higgs factory is the highest-priority next collider.

➔ Consensus on Higgs physics being the major the scientific driver for a new collider, technology ready for construction on a 15 years timescale

- For the longer term, the European particle physics community has the ambition to operate a proton- proton collider at the highest achievable energy.

➔ Exploring the energy frontier is the next logical step: preference given to the FCC project

- 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.

➔ Accelerator technologies need to be developed intensively to explore the potential of possible alternatives and continue to participate in accelerator technologies for other purposes and fields

(3) High-priority future initiatives (cont'd)

Three recommendations:

- *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;*

➔ To realize a machine at the energy frontier, high filed magnets with at least 16T are mandatory and far from industrialisation, development of HTS magnets reaching higher fields should be pursued

- *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.*

➔ Feasibility study should be carried out before the next Strategy Update to allow for decision to be taken

- technical feasibility, administrative implications and questions of implementation in the Geneva area including tunnelling and environmental impact)
- financial feasibility for construction and operation, including additional resources from international partners and start establishing the global frame for the project.

- *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.*

(3) High-priority future initiatives (cont'd)

Three recommendations (cont')d:

- *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.*

➔ Accelerator R&D should be carried out as a high priority and be a shared effort of CERN and the major national laboratories

➔ Establish an accelerator R&D roadmap on critical accelerator technologies established and coordinated among CERN and the National Laboratories:

plasma acceleration: compact facilities for applications, FELs and linear colliders

muon collider: international design study

ERL: R&D for high intensity, multi-turn energy recovery linacs

Reduction in **energy consumption**

Superconductive and normal conductive **high gradient accelerator structures** for LC and light sources

(4) Other essential scientific activities for particle physics

B/ *Europe should continue to vigorously support a broad programme of* ***theoretical research*** *covering the full spectrum of particle physics from abstract to phenomenological topics. The pursuit of new research directions should be encouraged and links with fields such as cosmology, astroparticle physics, and nuclear physics fostered. Both exploratory research and theoretical research with direct impact on experiments should be supported, including recognition for the activity of providing and developing computational tools.*

C/ ***Detector R&D programmes and associated infrastructures*** *should be supported at CERN, national institutes, laboratories and universities. Synergies between the needs of different scientific fields and industry should be identified and exploited to boost efficiency in the development process and increase opportunities for more technology transfer benefiting society at large. Collaborative platforms and consortia must be adequately supported to provide coherence in these R&D activities. The community should* ***define a global detector R&D roadmap*** *that should be used to support proposals at the European and national levels.*

D/ *The community must vigorously pursue common, coordinated R&D efforts in collaboration with other fields of science and industry to* ***develop software and computing infrastructures*** *that exploit recent advances in information technology and data science. Further development of internal policies on open data and data preservation should be encouraged, and an adequate level of resources invested in their implementation.*

Council resolution

CERN/3493/C/Rev. : https://cds.cern.ch/record/2724892/files/English.pdf

ACKNOWLEDGING

(10) the extensive coordination, evaluation and consensus-building that led to this proposal, which is an essential contribution to the future of particle physics and a coherent vision for particle physics in Europe and, as such, provides valuable guidelines to all stakeholders;

➔ Strategy is a vision of the field and give guidelines

(11) that the 2020 Strategy update proposal is a scientific vision and, as such, does not constitute a research policy or funding decision on the part of the Member States;

➔ Strategy is a vision of the field and is not a funding decision

(12) that its implementation requires further decision-making by the stakeholders concerned;

➔ Decision making in the member states will follow the procedures in the member states

(13) and that, as far as CERN is concerned, any implementation of the projects recommended in the Strategy update requires separate decisions by the Council, in line with the procedures set out in the Convention and the Organization's Financial Rules and Regulations;

➔ Implementation of the strategy will follow approval procedures at CERN

Council resolution (cont'd)

DECIDES

(14) to update the European Strategy for Particle Physics, proposed by the ESG and set out in Annex 1, as the scientific vision of the particle physics community in Europe;

➔ Update of the strategy formulates the vison of the scientific community;

AND INVITES THE CERN MANAGEMENT

(15) to use the Strategy update as input for its Medium-Term Plan and as the basis for developing a vision and a long-term plan for the Laboratory within the financial constraints of its constant budget whilst exploring additional funding sources, and

➔ See DG presentation

(16) 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, so that the Council can decide, based on the progress made, when the time is best suited to initiate the next Strategy update.

➔ Follow-up through Council to asses progress made and to take follow-up decisions when requested by the progress made.

WG 1: Social and career aspects for the next generation

Environmental and societal impact

7B/ Particle physics, with its fundamental questions and technological innovations, attracts bright young minds. Their education and training are crucial for the needs of the field and of society at large.

For early-career researchers to thrive, the particle physics community should place strong emphasis on their supervision and training. Additional measures should be taken in large collaborations to increase the recognition of individuals developing and maintaining experiments, computing and software. The particle physics community commits to placing the principles of equality, diversity and inclusion at the heart of all its activities.

Attracting young scientists in due time to a future project is one of the most essential assets !

WG 1: Social and career aspects for the next generation

https://cds.cern.ch/record/2724567/files/CERN-ESU-006-WG1_Report.pdf

Attractiveness of the field and societal relevance:

→ Primary motivation for young people is the fundamental aspects of the science

→ Few mention of impact from media

→ But: Individual creativity limited in large collaboration

Recognition:

→ R&D on hardware, software and computing is not always sufficiently recognised

Training :

→ Preserve ability of innovation is essential

Diversity and gender balance

→ Continuous efforts need to go on

Social aspects:

→ work-life balance as well as the social climate in the workplace, especially in large experiment collaborations.

→ uncertainty of securing a career in the field, caused by the short-term contracts associated with the mobility culture and the scarcity of opportunities to be promoted to longer-term contracts.

→ the difficulty of having or starting a family at an early stage of a career, which is particularly difficult if the young scientist concerned is on a graduate study salary.

WG 2: Governance for future projects

Organisational issues

6 A/ An ambitious next-generation collider project will require global collaboration and a long-term commitment to construction and operations by all parties.

CERN should initiate discussions with potential major partners as part of the feasibility study for such a project being hosted at CERN. In the case of a global facility outside Europe in which CERN participates, CERN should act as the European regional hub, providing strategic coordination and technical support. Individual Member States could provide resources to the new global facility either through additional contributions made via CERN or directly through bilateral and multilateral arrangements with the host organisation.

→Models of global governance have been discussed with potential partners becoming CERN Member States or not.

→Further considerations in a dedicated CERN Council working group

WG 4: Knowledge and Technology Transfer

Environmental and societal impact

7C/ Particle physics has contributed to advances in many fields that have brought great benefits to society. Awareness of knowledge and technology transfer and the associated societal impact is important at all phases of particle physics projects.

Particle physics research centres should promote knowledge and technology transfer and support their researchers in enabling it. The particle physics community should engage with industry to facilitate knowledge transfer and technological development.

WG 4: Knowledge and Technology Transfer

https://cds.cern.ch/record/2724569/files/CERN-ESU-009-WG4_Report.pdf

1. A huge number of technologies exist that have been developed or are under development by the HEP community, with **excellent potential for transfer** to other fields of science and industry.

2. The HEP community is not only the developer but is also a **major user** of new technologies coming from other fields of science and from industry.

3. The HEP community should establish **close connections with other branches of science and industry in the framework of common projects** in order to foster the efficiency of both R&D and KT transfer for society's benefit. In this common effort, the HEP community will probably be the first user of the new product, but not the only one.

…

WG 6: Sustainability and Environmental impact

Environmental and societal impact

7A/ The energy efficiency of present and future accelerators, and of computing facilities, is and should remain an area requiring constant attention. Travel also represents an environmental challenge, due to the international nature of the field.

The environmental impact of particle physics activities should continue to be carefully studied and minimised. A detailed plan for the minimisation of environmental impact and for the saving and re-use of energy should be part of the approval process for any major project. Alternatives to travel should be explored and encouraged.

WG 6: Sustainability and Environmental impact

https://cds.cern.ch/record/2724570/files/CERN-ESU-011-WG6_Report.pdf

1. Carbon footprint of future accelerators

- Energy efficiency
- Civil engineering

2. Carbon footprint of experiments

- Detector technology:
  - *eco-friendly alternatives to materials with high GWP*
  - *extensive use of recirculation systems needs to be included from the start of the design*
- Computing

3. Carbon footprint of travel

CERN and HEP must play a role in developing new technologies that can positively affect (reduce) energy consumption, e.g. in the areas of HTSC or energy recovery. Such efforts should be strengthened.

WG 5: Public Engagement, Education and Communication

Environmental and societal impact

7D/ Exploring the fundamental properties of nature inspires and excites. It is part of the duty of researchers to share the excitement of scientific achievements with all stakeholders and the public. The concepts of the Standard Model, a well-established theory for elementary particles, are an integral part of culture.

Public engagement, education and communication in particle physics should continue to be recognised as important components of the scientific activity and receive adequate support. Particle physicists should work with the broad community of scientists to intensify engagement between scientific disciplines. The particle physics community should work with educators and relevant authorities to explore the adoption of basic knowledge of elementary particles and their interactions in the regular school curriculum.

WG 5: Public Engagement, Education and Communication

https://cds.cern.ch/record/2705371/files/Report%20of%20Working%20Group%205.pdf

Particle physics can derive more benefit from advances in other areas of science. Support for particle physics often depends on the opinions of fellow scientists.

The European particle physics community must engage more with physicists in neighbouring fields as well as with scientists from other disciplines in order to enhance the understanding of the importance and urgency of particle physics research and to pool and derive mutual benefit from each other's knowledge.

To achieve this strategic goal, we must engage better in professional societies, funding agency committees and in general be more visible to other scientists. Also, more collaboration with other fields in topical schools (computing, accelerator, ...), both in the selection of teachers and in the admission of students, will increase the mutual understanding and may promote increased mobility of talent.

EPPCN presentation at September Council

Media coverage

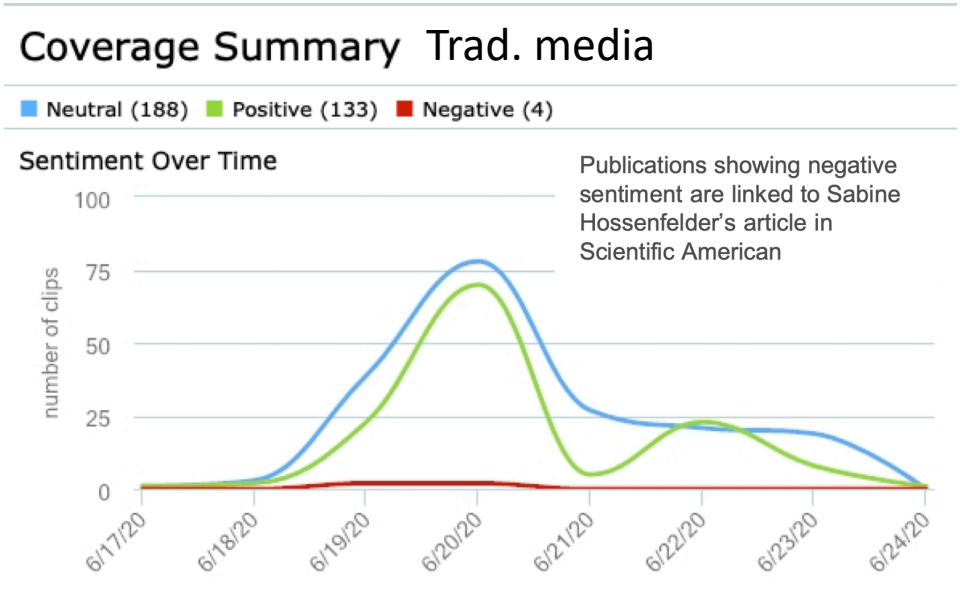
- Press Release and online Q&A w/ Journalists from 13 countries
- > 135k views on home.cern

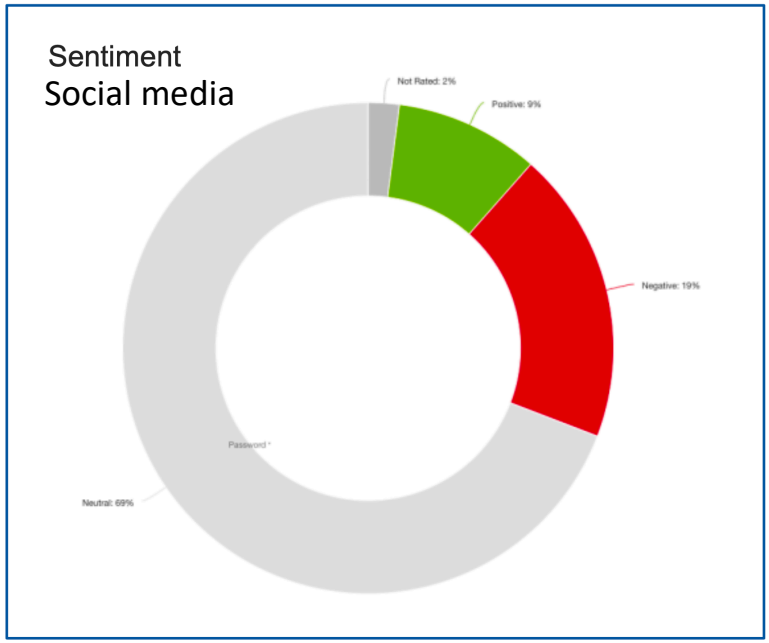
→ 409 clippings in "traditional media", 4 130 mentions in social media

Covered globally :

Trad. Media: Italy, North America, Switzerland, France, China, Japan

Soc. Media: US, Japan, UK





Hear!

Das größte Gerät der Welt

Für 20 Milliarden Euro wollen Europas Physiker einen neuen Teilchenbeschleuniger bauen, 100 Kilometer lang. Aber braucht man so was? Das ist gar nicht so leicht zu entscheiden.

ZEIT ONLINE

Die Maschine, die die Welt erklären soll

EXKLUSIV 20.06.2020, 11:45 Uhr

Das CERN will einen neuen, riesigen Teilchenbeschleuniger

DER TAGESSPIEGEL

Das CERN will mit einem 100 Kilometer langen Beschleuniger drängende Fragen der Teilchenphysik erforschen. Was bringt das? Ein Interview. VON RALF NESTLER

Vox

The $22 billion gamble: why some physicists aren't excited about building a bigger particle collider

Particle accelerators have taught us so much about physics that the new one might have nothing to find.

SCIENTIFIC AMERICAN

POLICY & ETHICS | OPINION

The World Doesn't Need a New Gigantic Particle Collider

...dollars, the potential rewards are unclear—and the money could ... such as climate change and emerging viruses

Forbes

We Don't Need a Bigger Particle Collider

Главная > Процесс > Наука

FRANKFURT – Between Lake Geneva and the Swiss Jura, more than

Forschung & Lehre

TEILCHENPHYSIK

Kritik an geplantem Cern-Nachfolger

In Genf soll der größte Teilchenbeschleuniger der Welt entstehen. Eine Physikerin zweifelt, ob die Milliardenkosten die Erkenntnisse rechtfertigen.

25.06.2020

Mail Online

CERN said it was not possible to say exactly what benefits the new collider would bring to the world, but pointed out that the discovery of the electron in 1897 led to the electronics industry.

NewScientist

Why CERN's plans for a €20 billion supersized collider are a bad idea

The research potential of a proposed massive particle smasher that would dwarf the Large Hadron Collider doesn't justify its huge price tag

Some contested arguments you may find on a blog:

http://backreaction.blogspot.com/2019/03/nonsense-arguments-for-building-bigger.html

1. The "Just look" argument.
2. The "No Zero Sum" argument.
3. Everyone gets to do their experiment!
4. Remember the Superconducting Super Collider!
5. It is not a waste of money.
6. The "Money is wasted elsewhere too" argument.
7. But particle physicists will leave if we don't build this collider.
8. But we have unsolved problems in the foundations of physics.
9. So-and-so many billions is only such-and-such a tiny amount per person per day.
10. Tim Berners-Lee invented the WWW while employed at CERN.
11. It may lead to spin-offs.
12. A big particle collider would benefit many tech industries and scientific networks.
13. It will be great for education, too!
14. Knowledge about particle physics will get lost if we do not continue.
15. Highly energetic particle collisions are the cleanest way to measure the physics of short distances.
16. Lord Kelvin also said that physics was over and he was wrong.
17. Particle accelerators are good for other things.
18. You do not know what else we should do.
19. But you do not have any other worked-out proposals.
20. But it will do all these things.

Conclusion

"This is a very ambitious strategy, which outlines a bright future for Europe and for CERN with a prudent, step-wise approach. » (Fabiola Gianotti)

- **For FCC to happen, a strong engagement is needed from all sides, now!**
- **Council will continuously and critically monitor the progress made and take action accordingly**
- **Pay attention to the transvers, underlying aspects which will be important to our field:**
  - **Attractiveness to young physicists and engineers**
  - **Building a project with our partners worldwide**
  - **Relations to industry and society**
  - **Environmental impact**
  - **Collaborations and exchanges with other fields of science**
  - **Building up argumentation that can be carried by the media**