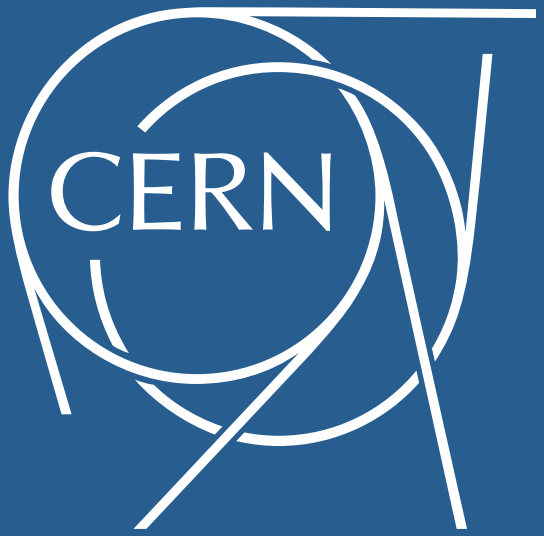
Update on (the updated) European Strategy for Particle Physics



Latin American Strategy Forum For Research Infrastructures
July 7yh 2020

Salvatore.MELE@CERN.ch

CERN Council (double) role

The European Strategy for Particle Physics (ESPP)

The ESPP ‘05-’0) process and 2013 update

The ESPP update process (‘18-’20)

Highlights from the 2020 ESPP update

Founded in 1954 by 12 European States - "Science for Peace"

~ 2'500 staff, ~ 1'800 other paid personnel, ~ 14'000 scientific users

Budget (2018) ~ 1'2 bnCHF

Governance: CERN Council (Member States)

23 Member States: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Israel, Italy, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Spain, Sweden, Switzerland and United Kingdom

2 Associate Member States in the Pre-Stage to Membership: Cyprus, Slovenia

6 Associate Member States: Croatia, India, Lithuania, Pakistan, Turkey, Ukraine

2 Current Applications for (Associate) Membership: Brazil, Estonia

Observers to Council: Japan, Russia, United States of America; EU, JINR and UNESCO

International co-operation agreements & other instruments with 62 more countries

There is a fundamental need for an ongoing process to define and update the European Strategy for Particle Physics; *Council […] shall assume this responsibility, acting as a council for European Particle Physics*

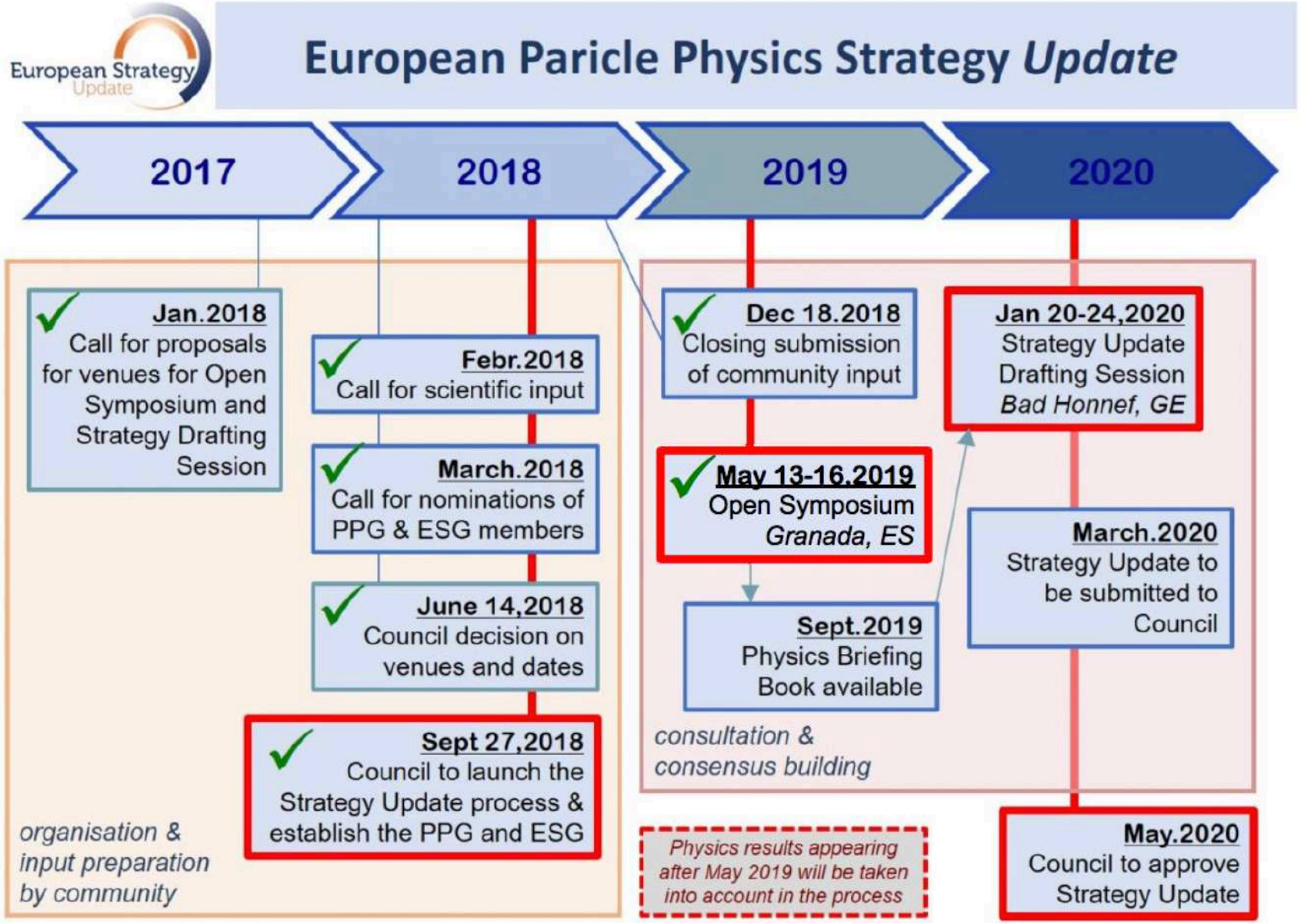
CERN-Council-S/002, July 2006
https://council.web.cern.ch/en/content/mandate-espp

European Strategy for Particle Physics - ESPP

- Process for European particle physics community to update the scientific priorities of the field.
- Adopted by the CERN Council and basis of CERN's scientific program.
- First ESPP in 2006; first update in 2013
- Last update approved June 2020 (started in late 2018)
- Physics-driven, bottom-up, process involving the community, with awareness of financial/technical feasibility. Also includes recommendations on education, outreach, technology transfer, organizational aspects.
- Produces the European roadmap in the worldwide context of the field. Alignment of the European, US and Japanese roadmaps optimizes resources.

European Strategy for Particle Physics - ESPP

- The 2006 ESPP exercise (see back-up slides):
  - Before the LHC era
  - Established a community-driven process
  - Defined the role of Council
  - Affirmed the priority at the time
  - Spawned global Outreach and Knowledge Transfer initiatives
- The 2013 ESPP update (see back-up slides):
  - Against the Higgs discovery background
  - Large scale community-driven process and input
  - Set foundations for the High Luminosity LHC program and funding for the machine and experiments' upgrades
  - Defined the involvement and support of CERN to neutrino physics programs



PPG – Physics Preparatory Group: 17 representatives from communities, laboratories, other bodies (including 4 from Americas/Asia)

ESG – European Strategy Group: CERN Member States, European laboratories, invitees from Associate/Observer States and other fields

ESPP - Roles and Responsibilities

PPG: Scientific input to the Strategy Update

- Call for community input (Through 2018): 160 contributions
- Open symposium (Granada, May 2019): 600 attendees
- Briefing book (September 2019): 100 pages

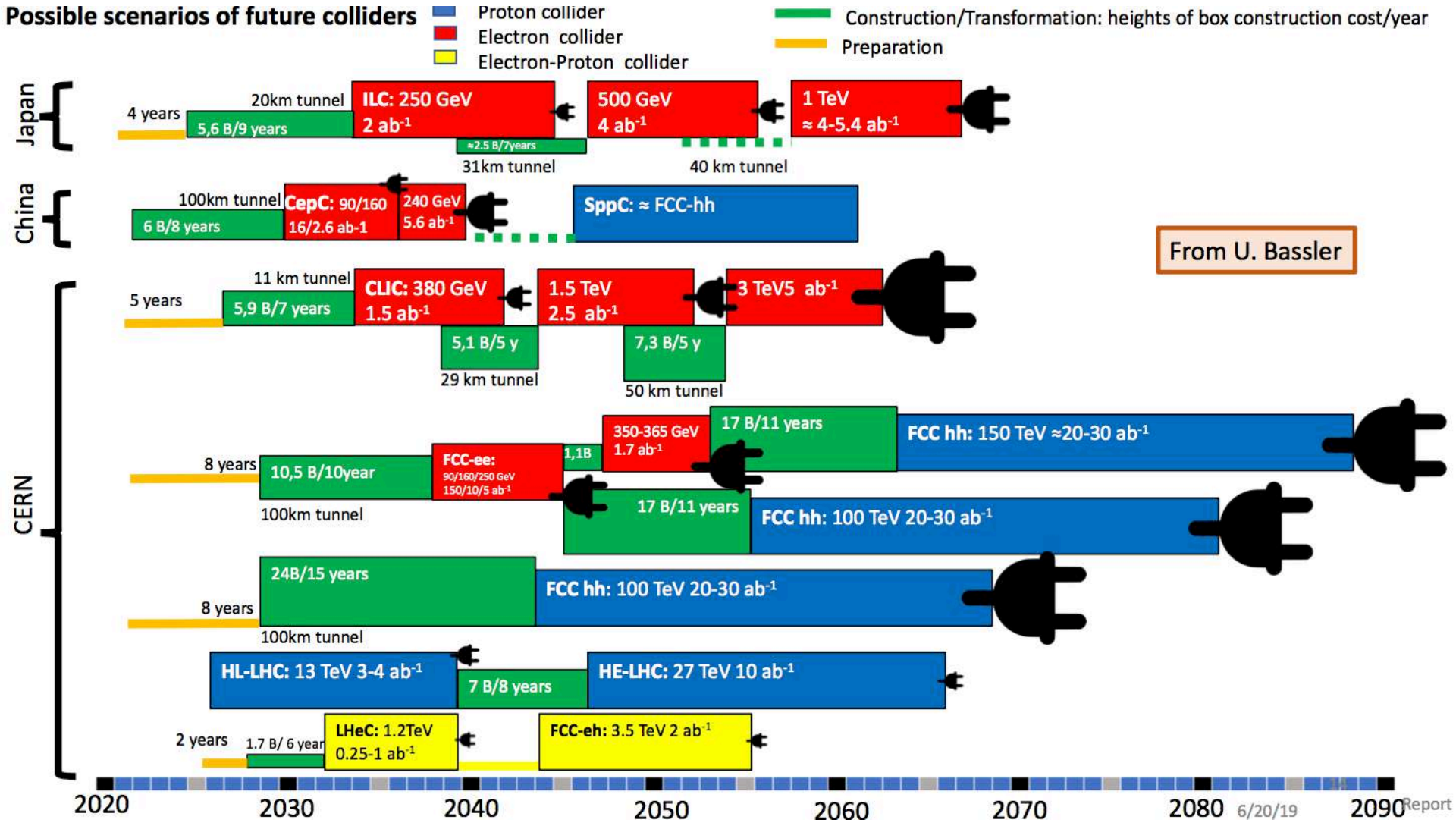
ESG: Drafts Strategy Update document (by March 2020)

- Recommendation of future facility in Europe
- Ensure dynamism in the field to complement energy frontier
- Balance of timescale, career path, academia priorities
- Complementary, synergic, role of National Laboratories

CERN Council: approves Strategy Update (June 2020)

- CERN governance and budget, long-term planning

PPG – Physics Preparatory Group: 17 members from community and labs (4 from Americas/Asia)
ESG – European Strategy Group: CERN Members/Associates/Observers, European labs, others
CERN Council – CERN Member States representatives. One country one vote.


Possible scenarios of future colliders
Proton collider
Electron collider
Electron-Proton collider
Construction/Transformation: heights of box construction cost/year
Preparation
Japan
4 years
5,6 B/9 years
20km tunnel
ILC: 250 GeV
2 ab-1
≈2.5 B/7years
31km tunnel
500 GeV
4 ab-1
40 km tunnel
1 TeV
≈ 4-5.4 ab-1
China
100km tunnel
6 B/8 years
CepC: 90/160
16/2.6 ab-1
240 GeV
5.6 ab-1
SppC: ≈ FCC-hh
From U. Bassler
CERN
5 years
5,9 B/7 years
11 km tunnel
CLIC: 380 GeV
1.5 ab-1
5,1 B/5 y
29 km tunnel
1.5 TeV
2.5 ab-1
7,3 B/5 y
50 km tunnel
3 TeV5 ab-1
8 years
10,5 B/10year
100km tunnel
FCC-ee:
90/160/250 GeV
150/10/5 ab-1
1,1B
350-365 GeV
1.7 ab-1
17 B/11 years
FCC hh: 150 TeV ≈20-30 ab-1
17 B/11 years
FCC hh: 100 TeV 20-30 ab-1
8 years
24B/15 years
100km tunnel
FCC hh: 100 TeV 20-30 ab-1
HL-LHC: 13 TeV 3-4 ab-1
7 B/8 years
HE-LHC: 27 TeV 10 ab-1
2 years
1.7 B/ 6 year
LHeC: 1.2TeV
0.25-1 ab-1
FCC-eh: 3.5 TeV 2 ab-1
2020
2030
2040
2050
2060
2070
2080
2090

Strategy brochure

http://europeanstrategyupdate.web.cern.ch/sites/europeanstrategyupdate.web.cern.ch/files/CERN-ESU-015-2020%20Update%20European%20Strategy.pdf

Deliberation document

http://europeanstrategyupdate.web.cern.ch/sites/europeanstrategyupdate.web.cern.ch/files/CERN-ESU-016-2020%20Deliberation%20Document%20European%20Strategy.pdf

Briefing book

https://arxiv.org/pdf/1910.11775.pdf

Some highlights in the next slides

Major developments from the 2013 Strategy

The successful completion of the high-luminosity upgrade of the machine and detectors should remain the focal point of European particle physics, together with continued innovation in experimental techniques. The full physics potential of the LHC and the HL-LHC, including the study of flavour physics and the quark-gluon plasma, should be exploited.

Europe, and CERN through the Neutrino Platform, should continue to support long baseline experiments in Japan and the United States. In particular, they should continue to collaborate with the United States and other international partners towards the successful implementation of LBNF and DUNE.

High-priority future initiatives

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.

High-priority future initiatives

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.

High-priority future initiatives

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.

Other essential scientific activities for particle physics

Experiments in diverse areas that offer potential high-impact particle physics programmes at laboratories in Europe should be supported, as well as participation in such experiments in other regions of the world.

Europe should continue to vigorously support a broad programme of theoretical research covering the full spectrum of particle physics from abstract to phenomenological topics.

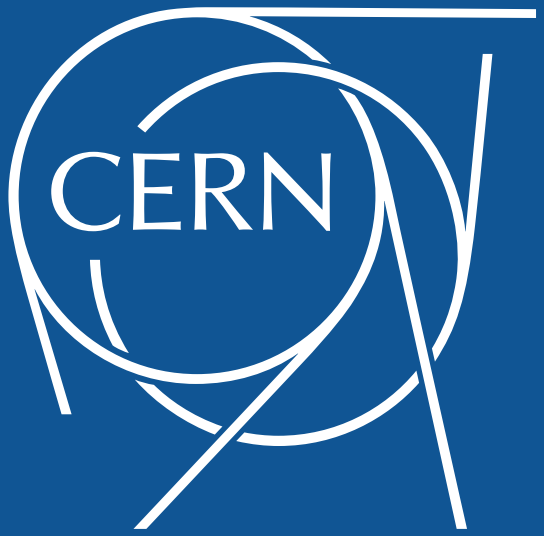
Detector R&D programmes and associated infrastructures should be supported at CERN, national institutes, laboratories and universities. Synergies between the needs of different scientific fields and industry should be identified and exploited to boost efficiency in the development process and increase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

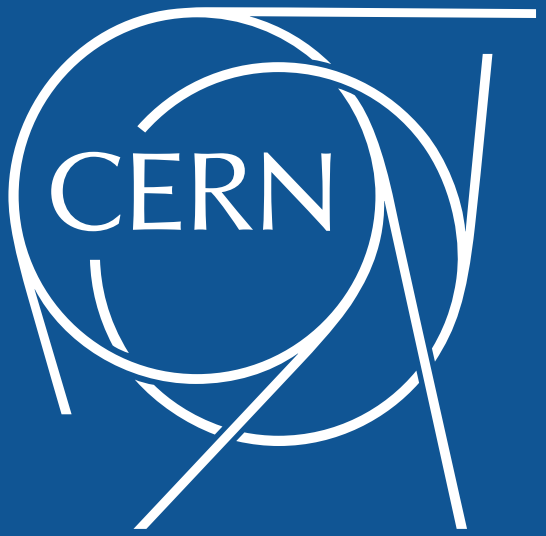
Organisational issues

CERN should initiate discussions with potential major partners as part of the feasibility study for a next generation collider 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.

Back-up slides:
The First ESPP process ('05-'06)
The 2013 ESPP update




CERN

Council initiated European Strategy for Particle Physics 2005-2006
Community involvement: representatives, input, workshop, drafts

CERN/2685

The European strategy for particle physics

Particle physics stands on the threshold of a new and exciting era of discovery. The next generation of experiments will explore new domains and probe the deep structure of space-time. They will measure the properties of the elementary constituents of matter and their interactions with unprecedented accuracy, and they will uncover new phenomena such as the Higgs boson or new forms of matter. Long-standing puzzles such as the origin of mass, the matter-antimatter asymmetry of the Universe and the mysterious dark matter and energy that permeate the cosmos will soon benefit from the insights that new measurements will bring. Together, the results will have a profound impact on the way we see our Universe; *European particle physics should thoroughly exploit its current exciting and diverse research programme. It should position itself to stand ready to address the challenges that will emerge from exploration of the new frontier, and it should participate fully in an increasingly global adventure.*

General issues

1. European particle physics is founded on strong national institutes, universities and laboratories and the CERN Organization; *Europe should maintain and strengthen its central position in particle physics.*

2. Increased globalization, concentration and scale of particle physics make a well coordinated strategy in Europe paramount; *this strategy will be defined and updated by CERN Council as outlined below.*

Scientific activities

3. The LHC will be the energy frontier machine for the foreseeable future, maintaining European leadership in the field; *the highest priority is to fully exploit the physics potential of the LHC, resources for completion of the initial programme have to be secured such that machine and experiments can operate optimally at their design performance.* A subsequent major luminosity upgrade (SLHC), motivated by physics results and operation experience, will be enabled by focussed R&D; *to this end, R&D for machine and detectors has to be vigorously pursued now and centrally organized towards a luminosity upgrade by around 2015.*

4. In order to be in the position to push the energy and luminosity frontier even further it is vital to strengthen the advanced accelerator R&D programme; *a coordinated programme should be intensified, to develop the CLIC technology and high performance magnets for future accelerators, and to play a significant role in the study and development of a high-intensity neutrino facility.*

5. It is fundamental to complement the results of the LHC with measurements at a linear collider. In the energy range of 0.5 to 1 TeV, the ILC, based on superconducting technology, will provide a unique scientific opportunity at the precision frontier; *there should be a strong well-coordinated European activity, including CERN, through the Global Design Effort, for its design and technical preparation towards the construction decision, to be ready for a new assessment by Council around 2010.*

6. Studies of the scientific case for future neutrino facilities and the R&D into associated technologies are required to be in a position to define the optimal neutrino programme based on the information available in around 2012; *Council will play an active role in promoting a coordinated European participation in a global neutrino programme.*

7. A range of very important non-accelerator experiments take place at the overlap between particle and astroparticle physics exploring otherwise inaccessible phenomena; *Council will seek to work with ApPEC to develop a coordinated strategy in these areas of mutual interest.*

8. Flavour physics and precision measurements at the high-luminosity frontier at lower energies complement our understanding of particle physics and allow for a more accurate interpretation of the results at the high-energy frontier; *these should be led by national or regional collaborations, and the participation of European laboratories and institutes should be promoted.*

9. A variety of important research lines are at the interface between particle and nuclear physics requiring dedicated experiments; *Council will seek to work with NuPECC in areas of mutual interest, and maintain the capability to perform fixed target experiments at CERN.*

10. European theoretical physics has played a crucial role in shaping and consolidating the Standard Model and in formulating possible scenarios for future discoveries. Strong theoretical research and close collaboration with experimentalists are essential to the advancement of particle physics and to take full advantage of experimental progress; *the forthcoming LHC results will open new opportunities for theoretical developments, and create new needs for theoretical calculations, which should be widely supported.*

Organizational issues

11. There is a fundamental need for an ongoing process to define and update the European strategy for particle physics; *Council, under Article II-2(h) of the CERN Convention, shall assume this responsibility, acting as a council for European particle physics, holding a special session at least once each year for this purpose. Council will define and update the strategy based on proposals and observations from a dedicated scientific body that it shall establish for this purpose.*

12. Future major facilities in Europe and elsewhere require collaborations on a global scale; *Council, drawing on the European experience in the successful construction and operation of large-scale facilities, will prepare a framework for Europe to engage with the other regions of the world with the goal of optimizing the particle physics output through the best shared use of resources while maintaining European capabilities.*

13. Through its programmes, the European Union establishes in a broad sense the European Research Area with European particle physics having its own established structures and organizations; *there is a need to strengthen this relationship for communicating issues related to the strategy.*

14. Particle physicists in the non-Member States benefit from, and add to, the research programme funded by the CERN Member States; *Council will establish how the non-Member States should be involved in defining the strategy.*

Complementary issues

15. Fundamental physics impacts both scientific and philosophical thinking, influencing the way we perceive the universe and our role in it. It is an integral part of particle physics research to share the wonders of our discoveries with the public and the youth in particular. Outreach should be implemented with adequate resources from the start of any major project; *Council will establish a network of closely cooperating professional communication officers from each Member state, which would incorporate existing activities, propose, implement and monitor a European particle physics communication and education strategy, and report on a regular basis to Council.*

16. Technology developed for nuclear and particle physics research has made and is making a lasting impact on society in areas such as material sciences and biology (e.g. synchrotron radiation facilities), communication and information technology (e.g. the web and grid computing), health (e.g. the PET scanner and hadron therapy facilities); *to further promote the impact of the spin-offs of particle physics research, the relevant technology transfer representatives at CERN and in Member states should create a technology transfer forum to analyse the keys to the success in technology transfer projects in general, make proposals for improving its effectiveness, promoting knowledge transfer through mobility of scientists and engineers between industry and research.*

17. The technical advances necessary for particle physics both benefit from, and stimulate, the technological competences available in European industry; *Council will consolidate and reinforce this connection, by ensuring that future engagement with industry takes account of current best practices, and continuously profits from the accumulated experience.*

Unanimously approved by the CERN Council at the special Session held in Lisbon on 14 July 2006

http://council-strategygroup.web.cern.ch/council-strategygroup/

The European strategy
for particle physics

Selected highlights from 2006:

- *Europe should maintain and strengthen its central position in particle physics.*
- *Strategy will be defined and updated by CERN Council*
- *The highest priority is to fully exploit the LHC, resources for completion of the initial program have to be secured*
- *R&D for machine and detectors has to be vigorously pursued now and centrally organized towards a [LHC] upgrade*
- *Develop the CLIC technology and high performance magnets for future accelerators*
- *Council will play an active role in promoting a coordinated European participation in a global neutrino program*

http://council-strategygroup.web.cern.ch/council-strategygroup/

Council will establish a network of closely cooperating professional communication officers

http://council-strategygroup.web.cern.ch/council-strategygroup/

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The International Particle Physics Outreach Group (IPPOG)

IPPOG is a network of scientists, science educators and communication specialists working across the globe in informal science education and outreach for particle physics. Particle physics is the science of matter, energy, space and time. IPPOG brings new discoveries in this exciting field to young people and conveys to the public that the beauty of nature is indeed becoming understandable from the interactions of its most fundamental parts - the elementary particles.

The IPPOG collaboration comprises 29 members: 23 countries, 5 experiments and CERN as an international laboratory.

Hans Peter Beck (University of Bern) and Steven Goldfarb (University of Melbourne), IPPOG Chairs

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In memory of our colleague Daniel Lellouch (1957-2019)

"As a scientist I feel I have a responsibility to pass on that sense of awe"

****

Latest Resources

Cosmic@Web

online learning platform, expand opportunities for investigating cosmic particles to a broader...

1 comments

6th International...

To inform about the 6th International Cosmic Day

0 comments

Particle Physics...

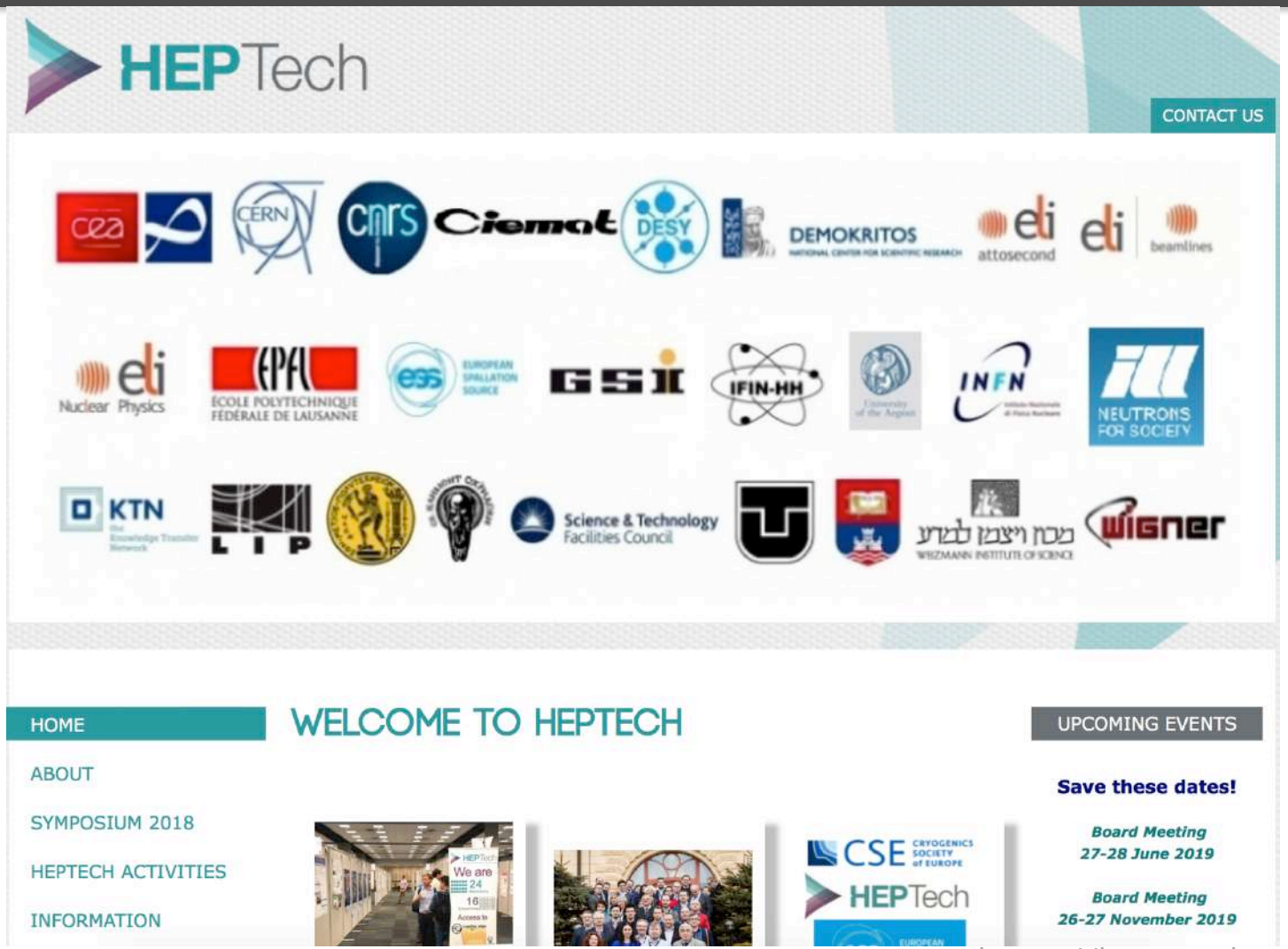
4 books for teachers and students which can be used for lectures about particle physics

0 comments

ippog.org

The relevant technology transfer representatives […] should create a technology transfer forum to further promote the impact of the spin-offs of particle physics

http://council-strategygroup.web.cern.ch/council-strategygroup/



http://heptech.web.cern.ch

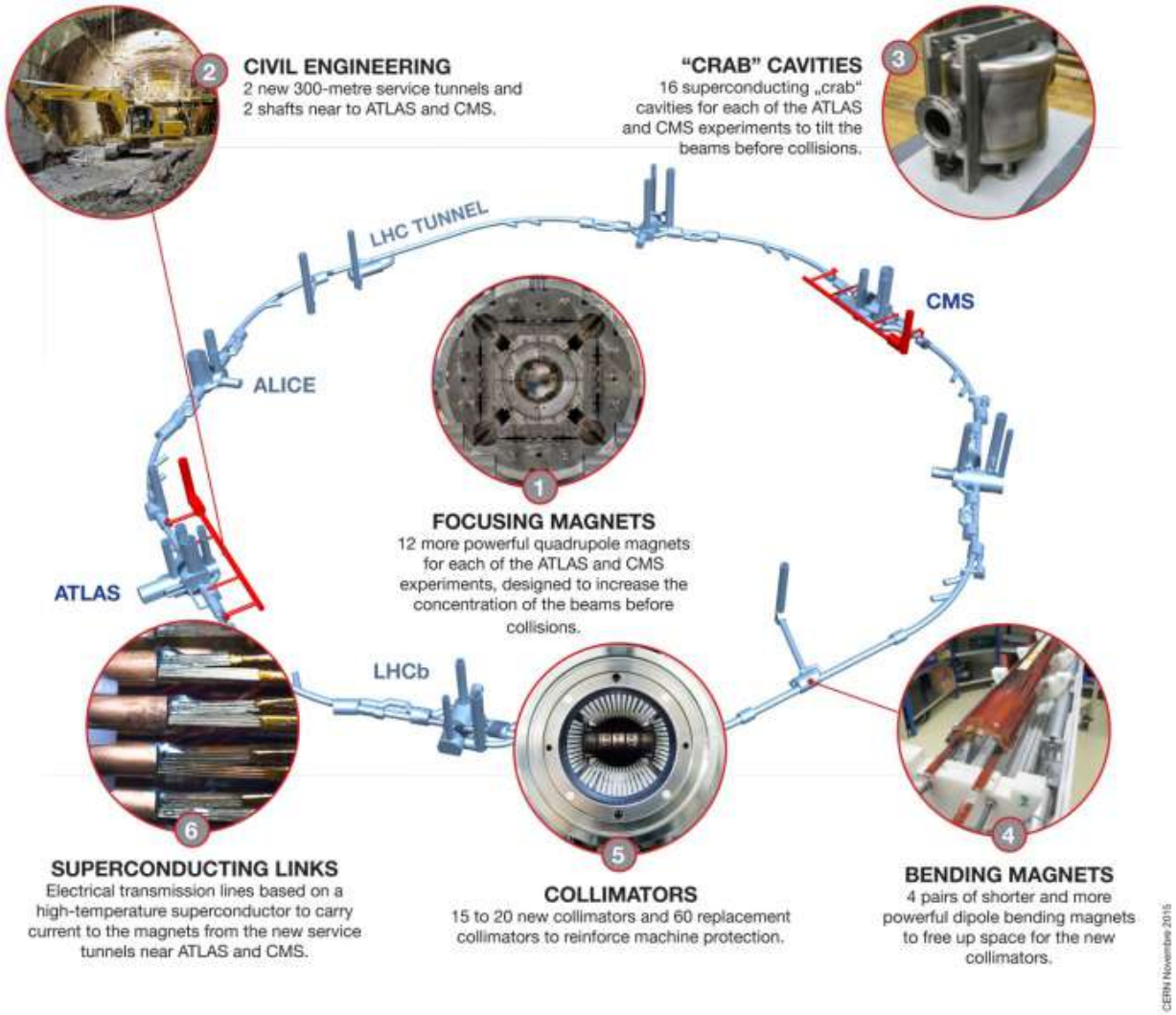
The 2013 ESPP Update (end 2011 – mid 2013)

- Against the background of the Higgs-boson discovery
- Best-lessons from 2006 incorporated in a solid process
- Representatives of community (Preparatory Group) gathered written input, prepared 500-attendees open symposium, collated a briefing book.
- European Strategy Group (CERN Member-States and national lab representatives, invitees from Associate/ Observer states and other bodies) drafted strategy
- Approved by CERN Council in May 2013

cds.cern.ch/record/1567258/files/esc-e-106.pdf

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

cds.cern.ch/record/1567258/files/esc-e-106.pdf



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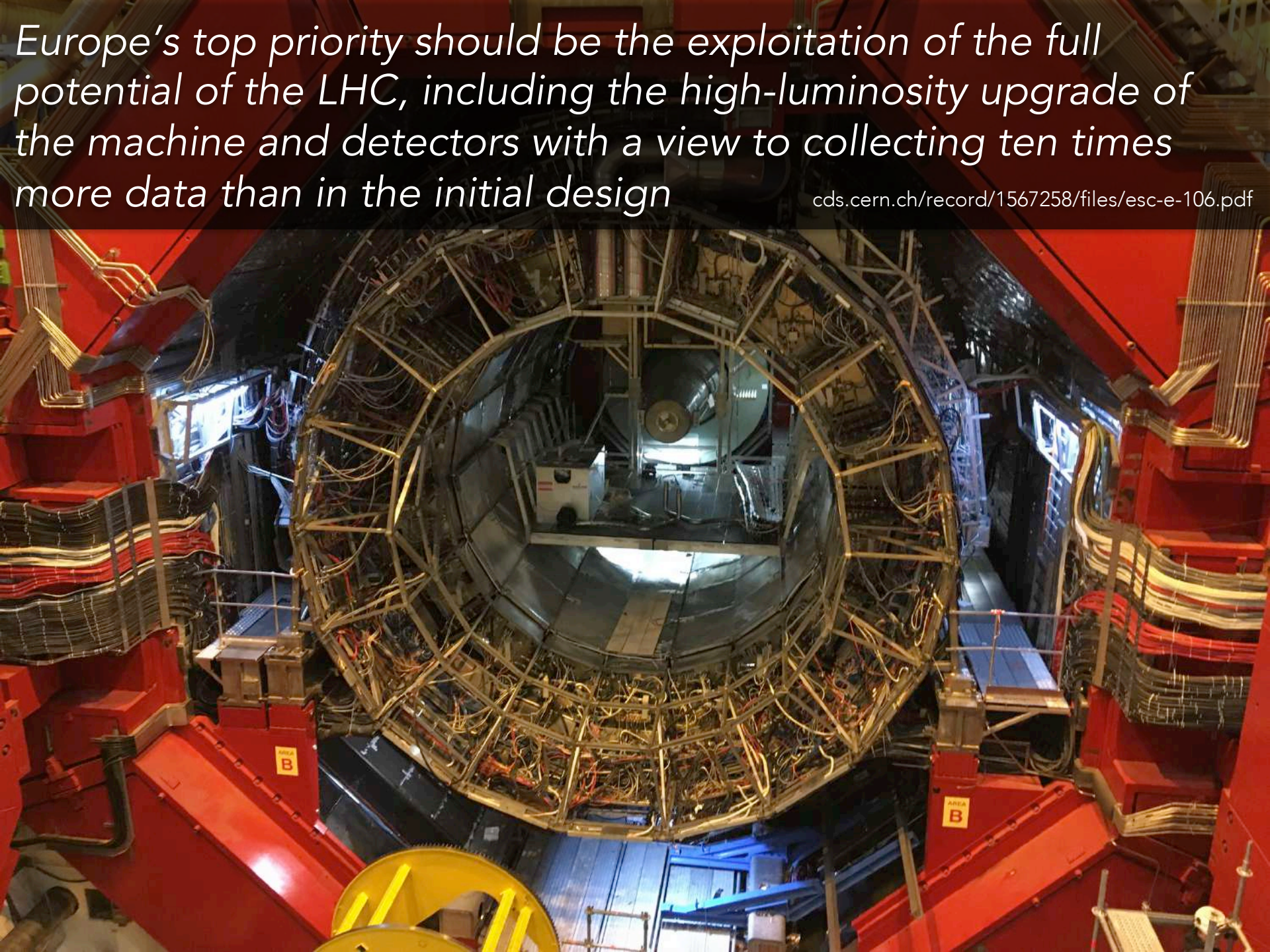
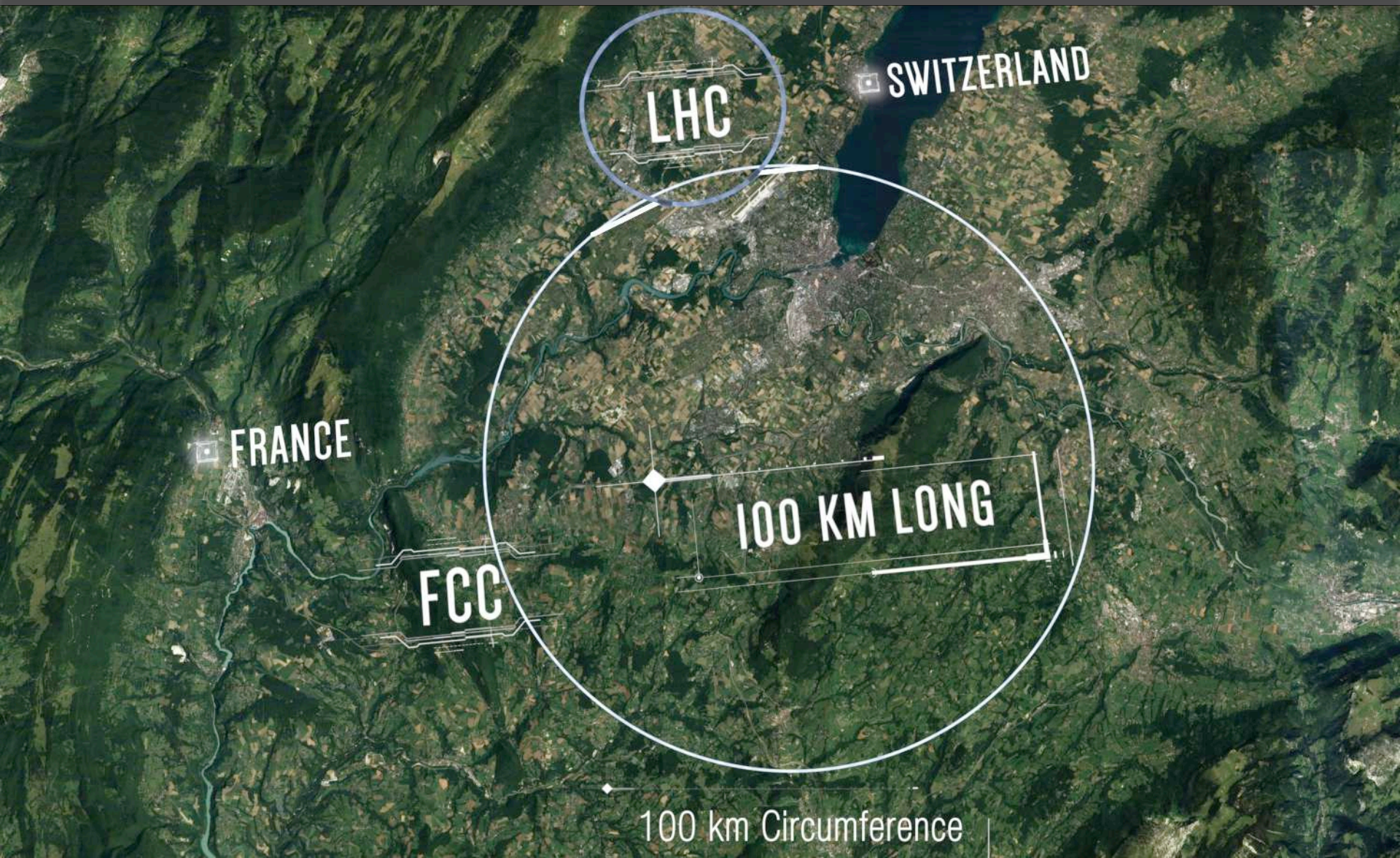


CERN should undertake design studies for accelerator projects in a global context, with emphasis on proton-proton and electron-positron high-energy frontier machines. cds.cern.ch/record/1567258/files/esc-e-106.pdf



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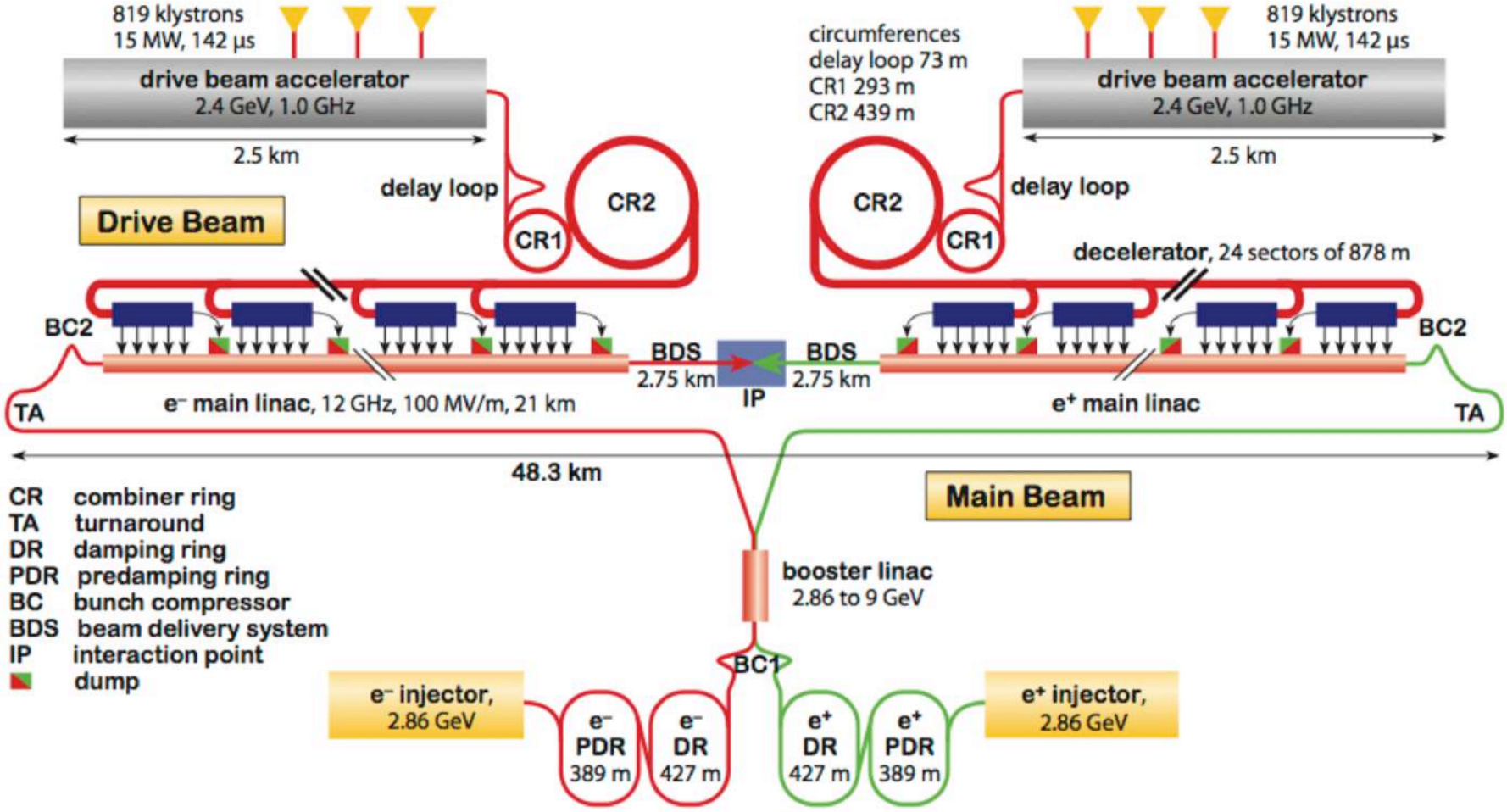

CERN should develop a neutrino programme to pave the way for a substantial European role in future long-baseline experiments. Europe should explore the possibility of major participation in leading long-baseline neutrino projects in the US and Japan.

cds.cern.ch/record/1567258/files/esc-e-106.pdf