Report from CERN Council

Partikeldagarna 2023
Stockholm, June 16

Richard Brenner, Uppsala University
Slides updated from version Kerstin Jon-And, Stockholm University showed 2021 at PD

CERN's "family" today

From F Gianotti
2021-10-11

23 Member States:

Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Israel, Italy, Netherlands, Norway, Poland, Portugal, Romania, Slovak Republic, Serbia, Spain, Sweden, Switzerland, United Kingdom

10 Associate Member States:

Croatia, Cyprus*, Estonia* (as of 1/2/2021), India, Latvia (as of 2/8/2021), Lithuania, Pakistan, Slovenia*, Turkey, Ukraine

* in the pre-stage to Membership

6 Observers:

Japan, Russia, USA, European Union, JINR, UNESCO

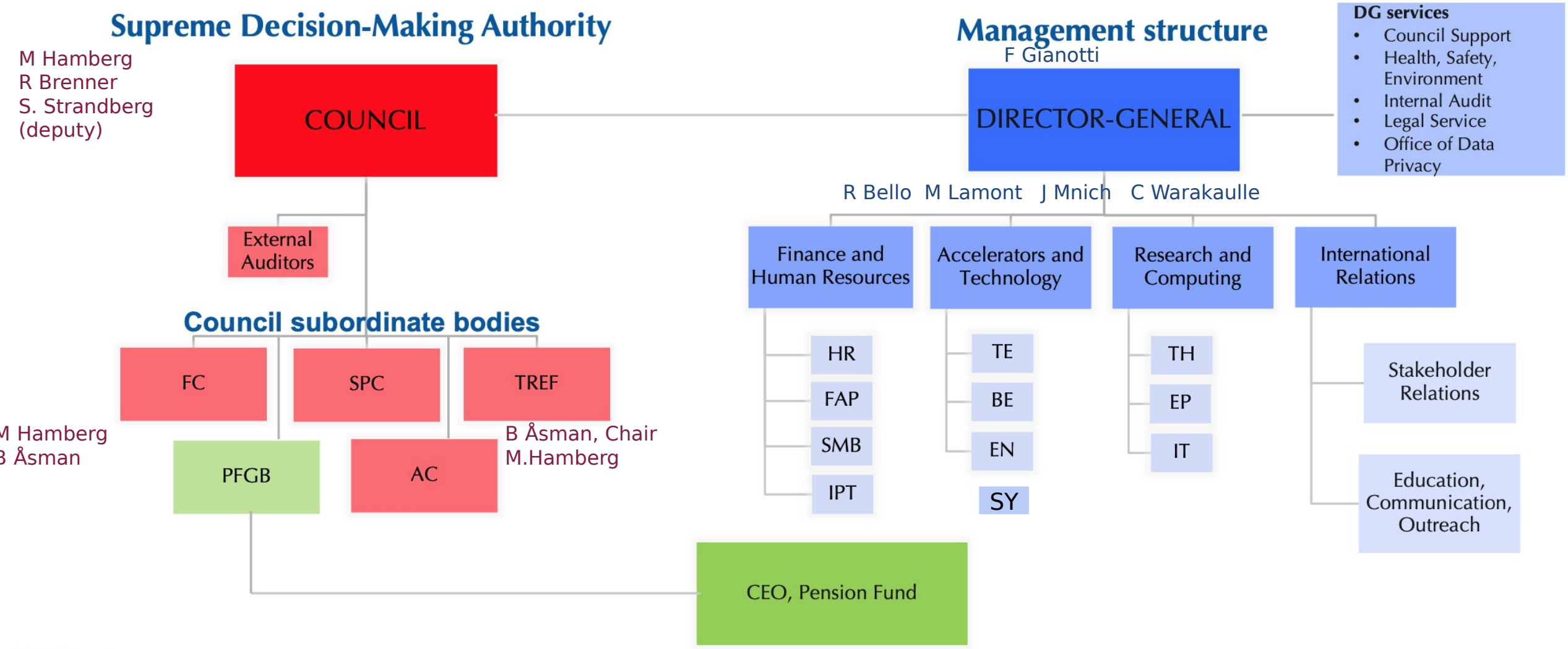
~50 ICA (International Cooperation Agreements):

with non-Member States, some with countries with developing particle physics communities (CERN mission is also to help build capacity and foster growth of particle physics worldwide).

On 24 September the Council adopted a resolution admitting Brazil as an Associate Member
→ next steps: signature of the agreement and final ratification by the country

Organigram

2021-25



Current Council President and Vice-Presidents

Eliezer Rabinovici, Israel, Presiden of Council
Konstantinos Fountas, Greece ,Vice-President
Eric Laenen, Netherlands, Vice-President

CERN management's vision for their mandate 2021 – 2025 (Based on the 2020 update to the European Strategy for Particle Physics (ESPP)

The period 2021-2025 will be crucial for the full exploitation of LHC and to lay the foundations for a compelling, exciting scientific future for CERN.

At the same time, the world is facing unprecedented challenges → CERN should multiply its efforts to increase its "return" to society.

3 main o CERN's vision and objectives are based on the 2020 update of the European Strategy for Particle Physics (ESPP)

- ❑ Deliver world-class scientific results and knowledge
- ❑ Increase the return to the Member and Associate Member States
- ❑ Strengthen CERN's impact on society

Note: projects and activities described here are or will be carried out in strong cooperation with other Labs and institutes in the Member and Associate Member States and beyond.

Updated document presented to Sep-2021 council: include additional SMART* objectives (Specific, Measurable, Achievable, Realistic, Time-bound).
Available at http://cds.cern.ch/record/2783560/files/English.pdf

European Strategy for Particle Physics (ESPP): 2020 update

"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."

"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 collider**s** and related infrastructure should be established as a global endeavour and be completed on the timescale of the next Strategy update."

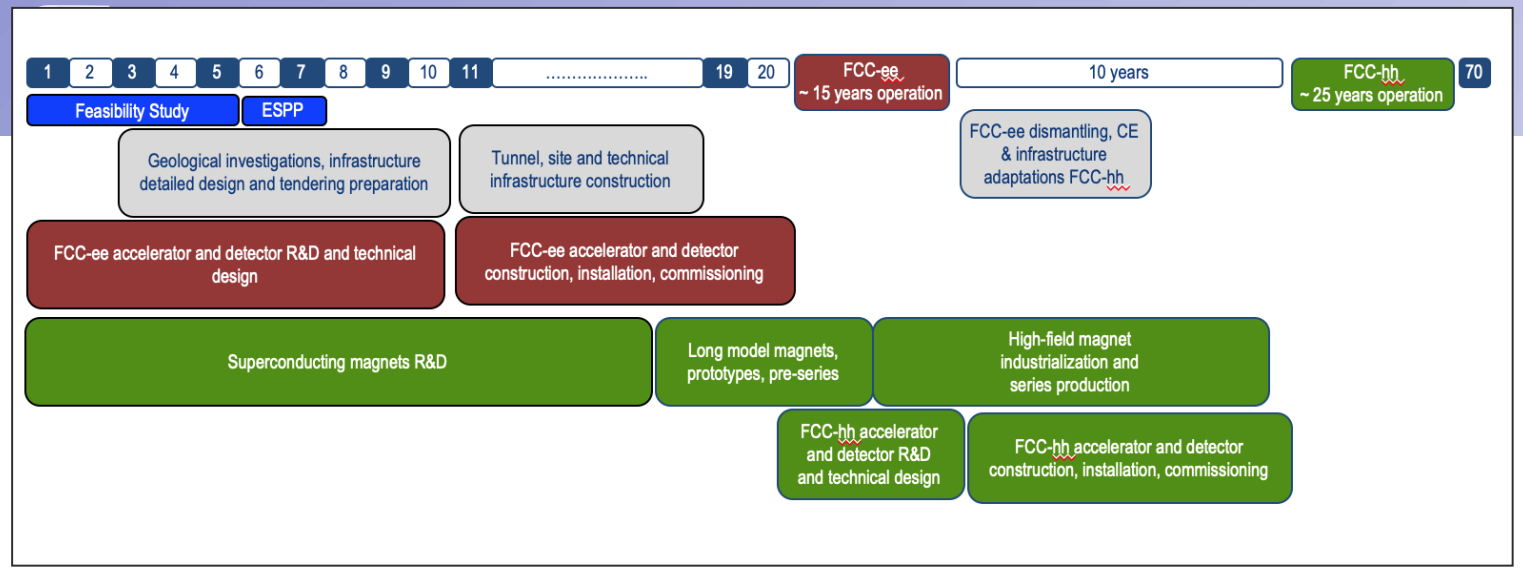
FCC Feasibility Study (FS) started in 2021:

- will be completed in 2025 with a Feasibility Study Report (input to the next ESPP update expected in ~ 2026-2027)
- mid-term review end of 2023 to assess progress
- will cover the "integrated programme": FCC-ee first, followed by FCC-hh

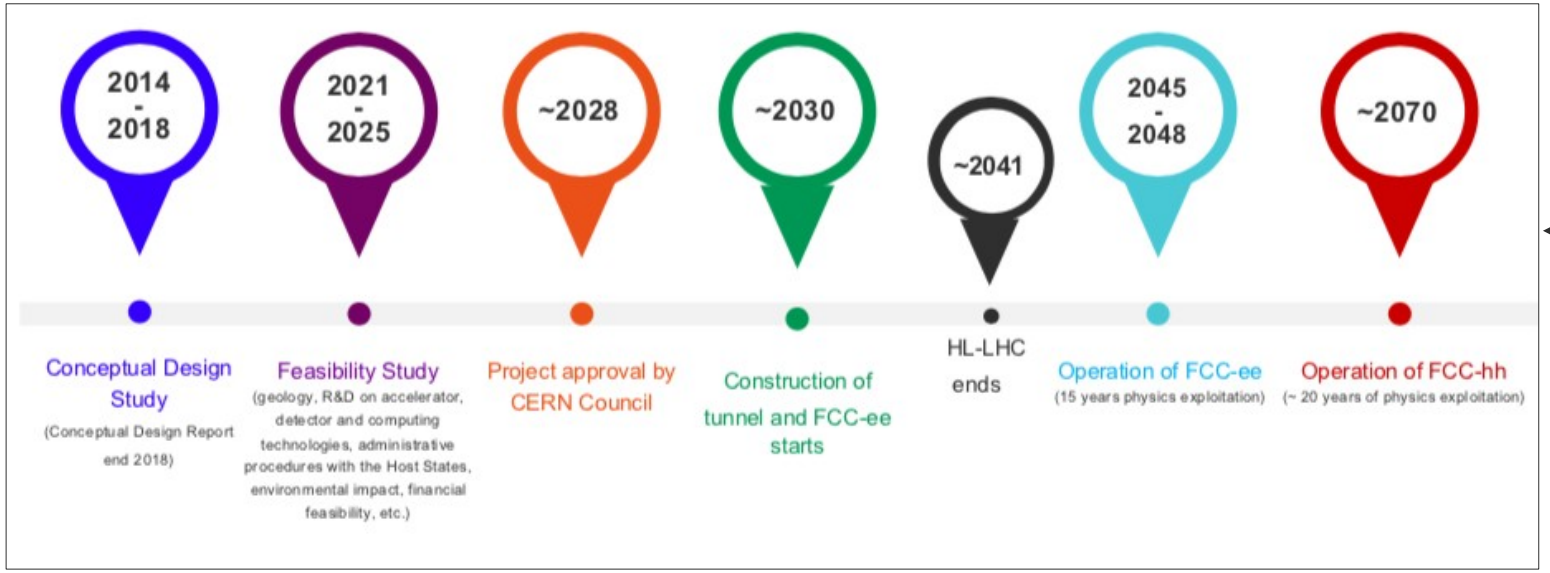
  Note: the integrated programme is best option in terms of physics output, timeline, overall cost (use of common tunnel and civil/technical infrastructure by two machines) see later

  integrated programme has become the "baseline scenario" of the current study and strategy

FCC estimated timeline



Technical schedule:
FCC-ee could start physics operation **in 2040 or earlier**



"Realistic" schedule takes into account:
- ❑ past experience in building colliders at CERN
- ❑ approval timeline: ESPP, Council decision
- ❑ that HL-LHC will run until ~ 2041
- → **ANY future collider at CERN cannot start physics operation before ~ 2045** (but construction will proceed in parallel to HL-LHC operation)

1st stage collider, FCC-ee: electron-positron collisions 90-360 GeV
Construction: 2033-2045 ▯ Physics operation: 2048-2063

2nd stage collider, FCC-hh: proton-proton collisions at ≥ 100 TeV
Construction: 2058-2070 ▯ Physics operation: ~ 2070-2095

Care should be taken when comparing to other proposed facilities, for which in some cases only the (optimistic) technical schedule is shown

Why FCC ?

1) Physics: energy and intensity frontier facility addressing some of the most crucial outstanding questions

- FCC-ee : best of all proposed Higgs and electroweak factories, indirect exploration of next energy frontier (~ x10 LHC)
- FCC-hh : direct exploration of next energy frontier (~ x10 LHC)
- Also provides heavy-ion collisions and, possibly, ep/e-ion collisions
- 4 collision points → robustness; specialized experiments for maximum physics output

2) Timeline

- FCC-ee technology is mature construction can proceed in parallel to HL-LHC operation and physics start a few years after the end of HL-LHC operation (2045-2048 according to current schedule) ->This would keep the community, in particular the young people, engaged and motivated.
- FCC-ee before FCC-hh would also allow:
  - cost of the (more expensive) FCC-hh machine to be spread over more years
  - 20 years of R&D work towards affordable magnets providing the highest achievable field (high-T superconductors)
  - optimization of overall investment : FCC-hh will reuse same civil engineering and large part of FCC-ee technical infrastructure

3) It's the only facility commensurate to the size of the CERN community (at least 4 experiments)

FCC Feasibility Study 2021-2025: main objectives

https://indico.cern.ch/event/1038466/contributions/4386283/attachments/2259574/3834905/spc-e-1161-c-e-3588_FCC_MainDeliverables.pdf

- Demonstration of the geological, technical, environmental and administrative feasibility of the tunnel and surface areas and optimisation of placement and layout of the ring and related infrastructure.
- Pursuit, together with the Host States, of the preparatory administrative processes required for a potential project approval.
- Optimisation of the design of FCC-ee and FCC-hh colliders and their injector chains, supported by R&D to develop the needed key technologies.
- Elaboration of a sustainable operational model for the machine and experiments in terms of human and financial resource needs, as well as environmental aspects and energy efficiency.
- Development of a consolidated cost estimate, as well as funding model needed to enable project implementation and operation.
  Current cost estimate from 2018 CDR (https://fcc-cdr.web.cern.ch): 12 BCHF for tunnel and FCC-ee; 17 BCHF for FCC-hh (if after FCC-ee)
  Preliminary funding scenarios developed and presented recently to CERN Council.
- Identification of substantial resources from outside CERN's budget for implementation of first stage project (tunnel and FCC-ee).
  Discussion started with US-DOE, leadership of the European Commission, private donors.
- Consolidation of the physics case and detector concepts and technologies.

Feasibility Study funded from CERN budget: 100 MCHF total over 5 years; in addition: ~ 20 MCHF/year for high-field magnet R&D
Additional funding from the European Commission and collaborating institutes (e.g., CHART collaboration with Switzerland)

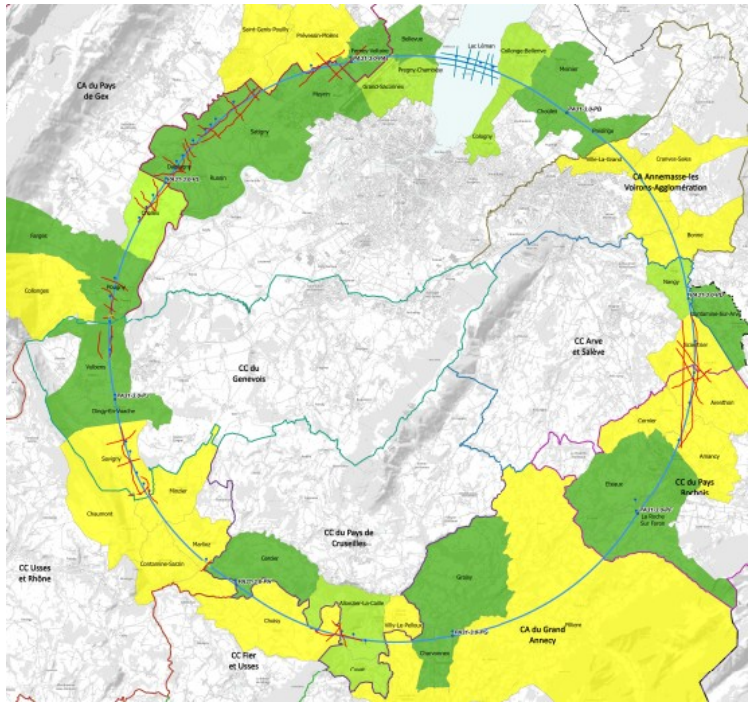
FCC Feasibility Study 2021-2025: recent progress (example)

Major achievement: selection of the ring placement

Layout chosen out of ~ 100 initial variants, based on geology and surface constraints (land availability, access to roads, etc.), environment (protected zones), infrastructure (water, electricity, transport), etc.

Baseline ring: 90.7 km ring, 8 surface points

- ❑ Whole project now being adapted to this placement
- ❑ Site investigation: 9 areas with uncertain geological conditions to be further investigated (~40 drillings and 100 km of seismic lines)



Ongoing meetings with municipalities along the trace (31 in FR and 10 in CH). Excellent collaboration with Host States authorities and services.

P5 (Particle Physics Projects Prioritisation Panel)

P5 is the equivalent of the European Strategy for Paricle Physics (ESPP) in the US, except that it is asked to prioritise projects based on specific funding scenarios. It takes place every ~ 7 years (last one in 2014), usually after an ESPP update (to maximise "alignment").
It reports to HEPAP (High-Energy Physics Advisory Panel) and provides long-range planning guidance to DOE and NSF.
It builds on the "Snowmass" community study.

2023 P5

- Established end 2022
- Charge (http://hitoshi.berkeley.edu/p5/charge.pdf): "develop an updated strategic plan for US high-energy physics that can be executed over a 10-year timeframe (FY 2024-2033) in the context of a 20-year, globally-aware strategy for the field".
  In particular: re-assess the 2014 P5 science drivers*; evaluate ongoing projects; make science case for new facilities and capabilities; recommend a programme portfolio, maintaining balance between large, medium and small projects; consider that HEP is a global field (see insert); consider training and development of diverse and inclusive workforce to support the program; consider national synergies for technology developments; advise on support for advanced technology R&D.
- 2 funding scenarios:
  - 2% increase/year over FY2024-2033 starting from 2023 President's Budget Request for HEP (1.12 B$)
  - budget for 2023-2027 as in the CHIPS** and Science Act 2022 (1.16-1.55 B$) followed by 3% increase/year from 2028 to 2033
- Report to be submitted Oct 2023

* 2014 P5 science drivers: Higgs boson, neutrinos, dark matter, dark energy and inflation; the unknown
** Creating Helpful Incentives to Produce Semiconductors and Science

A core tenet of the 2014 P5 Report is that particle physics is fundamentally a global enterprise. Thus far, the U.S. program has achieved high impact through U.S. researchers participating in the programs at world-class facilities outside the U.S. and international researchers working at world-class U.S. facilities. The recommendations developed for this report should carefully consider the current and future international landscape for particle physics. The panel's report should include an explicit discussion of the choices made in this context, including the extent to which it is necessary to construct, maintain, and/or upgrade leading U.S.hosted high-energy physics facilities so that our leadership position in the global scientific arena continues, while at the same time preserving the essential roles of, and contributions by, the National Laboratories and universities to global collaboration on large-scale initiatives.

P5 town-hall meeting, Fermilab, 22 March 2023

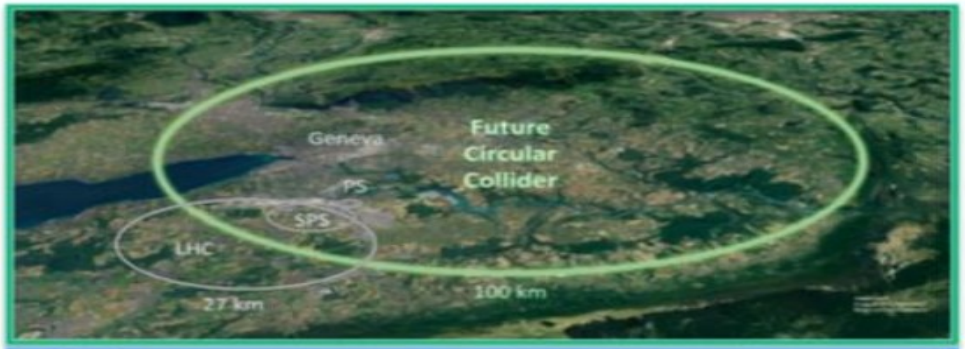
"Fermilab program", Bonnie Fleming,
FNAL Deputy Director and Chief Research Officer

The Energy Frontier
Beyond the LHC and HL-LHC

Precision measurements of the Higgs boson and EW sector and BSM searches at future colliders will shed light on key open questions in particle physics.

- This exploration will require an investment in accelerator technology research to
  - Contribute to the international effort to build a Higgs factory at CERN
  - Revitalize accelerator and detector R&D towards a next-generation multi-TeV energy frontier machine
- *Fermilab is poised to host a next generation multi-TeV energy frontier collider, as a global endeavor, following the completion of the full DUNE program*
- In order to make realistic progress, a substantial investment **in targeted accelerator research** as well as **associated detector research** will be required

These efforts should be organized through **national integrated accelerator R&D and detector R&D programs** that are aligned and coordinated with our international partners



International Muon Collider Collaboration

March 15, 2022
https://muoncollider.web.cern.ch

Promising Technologies and R&D Directions for the Future Muon Collider Detectors

Submitted to the Proceedings of the US Community Study on the Future of Particle Physics (Snowmass 2021)

Fermilab

Science Gateway



- Building construction to be completed end of May.
  Total construction time: 2.5 years (started Dec 2020), despite COVID-19, war in Ukraine, etc.
- Installation of exhibitions started end of Feb → to be completed end of May
- Inauguration moved from 20 June to (most likely) 7 Oct (Sat of Oct Council week),
  as risk of delays not negligible and need time for testing.
  Jump to Oct in order to maintain inauguration during/near a Council week
- As of beg of June: technical tests and dry runs, followed by commissioning
  with selected visitors
- 90 MCHF secured from donations (+2.5 M$ since Sept 2022 Council), for
  a total cost-to-completion of ~ 95 MCHF. Good prospects for the missing 5 MCHF.
- Proposal presented to Council today for a high-level/ministerial roundtable on
  "The role of scientific research infrastructures as platforms for talent development
  in STEM" to be held on the inauguration day.
- Currently finalising the model for Science Gateway staffing and volunteer guides
  Total needed personnel: ~ 20 people (3-5 staff, 3-5 volunteers, 3 students, 7 industrial services)

Donors	CHF
FCA/Stellantis Foundation	45,000,000
Private Foundation in Geneva	28,000,000
LEGO Foundation	5,000,000
E. Goehner Foundation	2,500,000
Breakthrough initiatives Foundation	2,295,000
Loterie Romande	2,000,000
Rolex	2,000,000
C. Fendi Foundation	1,500,000
Gelbert Foundation	1,000,000
OCEN	191,310
Fondation meyrinoise du Casino	150,000
OCAN	113,000
Meyrin	100,000
Private donors	30,000
Total	89,879,310

CERN@70 celebrations

Reminder: CERN's founding Covention

- ❑ signed (subject to ratification) on 1 July 1953 at UNESCO's headquarters in Paris
- ❑ entered into force 29 Sept 1954

→ Anniversary celebrations in 2024

Preparation for CERN's 70th anniversary celebrations started.

Celebrations will include events at CERN and in the Member States (and beyond) throughout 2024
In particular: anniversary ceremony on Tuesday 1 Oct 2024 (29 Sept is a Sunday) at CERN

Project leader appointed: Luciano Musa (CERN's senior staff, former Spokesperson of ALICE)

Planning document will be submitted to Council in June, covering, e.g.: organisational structure at CERN, budget, proposed programme for the anniversary ceremony, proposal for other events (see document submitted in Sept 2013 for CERN@60 ceremony: https://indico.cern.ch/event/269649/contributions/1608716/attachments/483428/668527/CERN60_StatusReport_final.pdf)

Input/help needed from Council at this stage:

- Highest-level authorities to invite for the anniversary ceremony: we would like to target Heads of State and Government
  → This is urgent to book their agendas
  Note: - several attended CERN@50 (→ see next slide), none CERN@60
  - EC President invited, she informally accepted
- Appoint Focal Points in your country: they would serve as points of contact for the organising team at CERN, in particular for discussion and coordination (if needed) of (possible) events and activities that may take place in the countries during 2024.
  They would also contribute to disseminating information about CERN and the anniversary celebrations in the countries.

The organising team at CERN will take responsibility for the anniversary ceremony and other celebrations in Geneva, and play a support role events in the countries.

Extra slides

GESDA (Geneva Science and Diplomacy Anticipator)

GESDA (https://gesda.global): foundation established in 2019 by the Swiss government and Canton and City of Geneva.

Goal: leverage the International Geneva ecosystem to anticipate, accelerate and translate into concrete actions the use of emerging science knowledge and technologies, in order to address societal challenges and to foster global well-being and inclusive development.

2022 Science Breakthrough Radar: provides an overview of science trends and breakthrough predictions at 5,10 and 25 years in 37 science and technology topics. Prepared by > 700 scientists from all over the world and across all science fields.
Coordination role of ETHZ and EPFL Presidents.
https://radar.gesda.global

Among resulting initiatives ("solutions"): creation of an Open Quantum Institute (OQI) with the goals of:

- ❑ Facilitating the exploration of use cases of quantum computing addressing the UN SDGs and other applications for humanity
- ❑ Facilitating global, inclusive and equitable access to a pool of public and private computers and simulators available via the Cloud
  (to revert the current trend of technology increasing the gap between developed and developing countries)
- ❑ Developing capacity building instruments for underprivileged countries (to revert the current trend of technology increasing the gap)
- ❑ Providing a neutral forum for diplomatic discussions to frame the governance of quantum computing for the SDGs

OQI goals developed by a dedicated Task Force with CERN participation (E. Porcari and A. Di Meglio).

As of today: > 30 public and private institutions (e.g. CERN, ETHZ, EPFL, University of Geneva, IBM, Micrososft, diplomacies of various countries) are partners of the project.
Note: OQI is not a technical institution, i.e., it will not develop quantum technologies. It will make them available for the above goals.

First step: OQI incubator (2023-2024): will work on use cases, funding model and governance → followed by launch of OQI in 2025

Open Quantum Institute at CERN?

Recently: GESDA proposed that OQI is absorbed by CERN as part of its (scientific and beyond) portfolio.

Motivations: scientific expertise; alignment of values; image and reputation, as CERN has:

- technical expertise: CERN is working on quantum through the Quantum Technology Initiative (see J. Mnich's talk for QTI Phase-2 proposal)
- experience with open science, knowledge transfer and collaboration across borders
- experience with public-private partnership
- experience with peer-review of proposals
- experience with training and education, including with developing countries
- credibility, independence and worldwide visibility

From CERN's viewpoint:
- pros: OQI would be the "societal arm" of the QTI and will expand our impact on society; goals well aligned with our mission.
- cons: needed resources? open-access to quantum may be politically delicate? others?

We are currently discussing with GESDA. If questions clarified, a draft proposal will be presented to Council in June.