Report from CERN Council and Update of the European Strategy for Particle Physics

Partikeldagarna 2019

Kerstin Jon-And, Stockholm University

CERN's organisation

Council:
Decision making authority
Two delegates per member state (Sweden: Mats Johnsson, KJA, deputy Richard Brenner)
President: Ursula Bassler

Main advisory bodies:
Scientific Policy Committee (SPC)
Finance Committee (Swedish reps Mathias Hamberg, Barbro Åsman)

Tripartite Employment Conditions Forum (Chaired by Barbro Åsman)
Audit Committee (KJA council rep.)

Director General: Fabiola Gianotti, manages CERN, elected by Council

Directorate:
Director for Accelerators and Technology: Frédérick Bordry
Director for Research and Computing: Eckard Elsen
Director for Finance and Human Resources: Martin Steinacher
Director for International Relations: Charlotte Warakaulle

10 departments, e.g. Experimental Physics, Information Technology, Theoretical Physics

CERN comprises the following states and organisations

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

7 Associate Member States:

Cyprus*, India, 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).

Croatia will become Associate Member on 10 October 2019
Estonia applied to become full Member

Current scientific programme

Full exploitation of the LHC:

- ❑ successful operation of the nominal LHC until end 2023 (LS2, Run 3) → 350/fb to ATLAS, CMS
- ❑ construction & installation of LHC upgrades: LIU (LHC Injectors Upgrade) and HL-LHC → 3000/fb

Scientific diversity programme serving a broad community:

- ❑ ongoing experiments and facilities at Booster, PS, SPS and their upgrades (HIE-ISOLDE, ELENA)
- ❑ participation in accelerator-based neutrino projects outside Europe (LBNF/DUNE in the US, near detector of T2K) through CERN Neutrino Platform

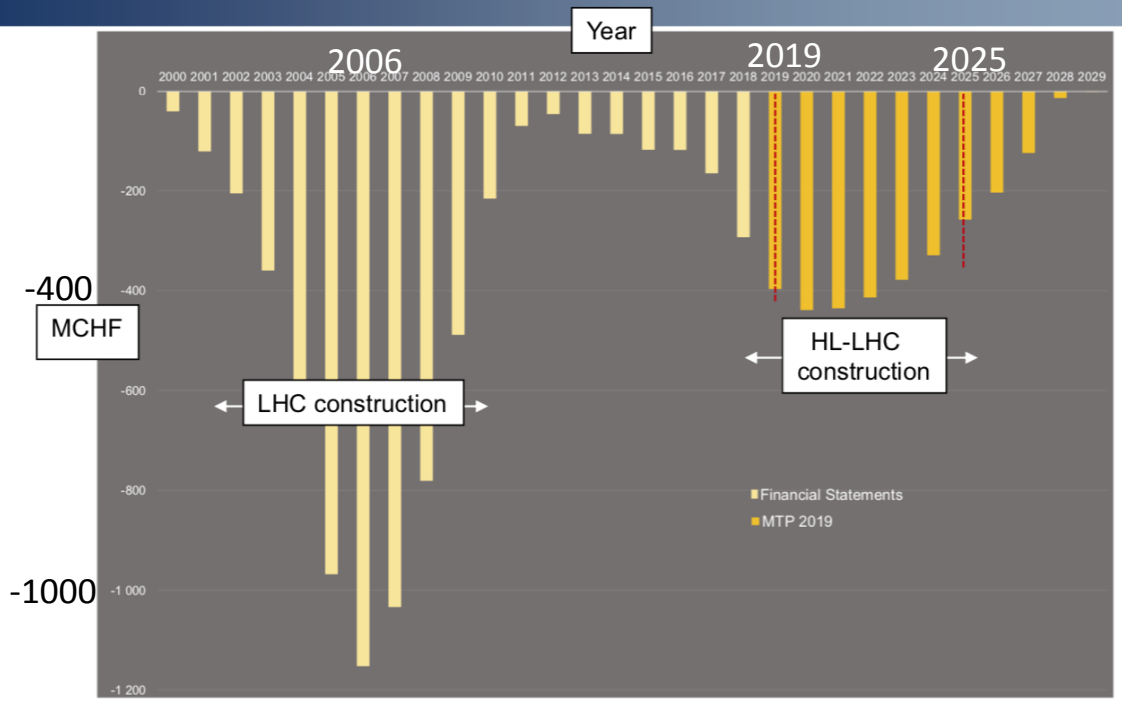
Preparation of CERN's future:

- ❑ vigorous accelerator R&D programme exploiting CERN's strengths and uniqueness (including superconducting high-field magnets, AWAKE, etc.)
- ❑ design studies for future high-energy accelerators: CLIC, FCC
- ❑ future opportunities of diversity programme: Physics Beyond Colliders Study Group

- ❑ This programme will be updated following the ongoing update of the European Strategy for Particle Physics (ESPP), to be completed in May 2020 with Council's approval
- ❑ It is being implemented in a regime of constant revenues (~1.3 BCHF/year)

Cumulative Budget Deficit (CBD) vs time

Fabiola Gianotti,
SPC, 23 Sep 2019



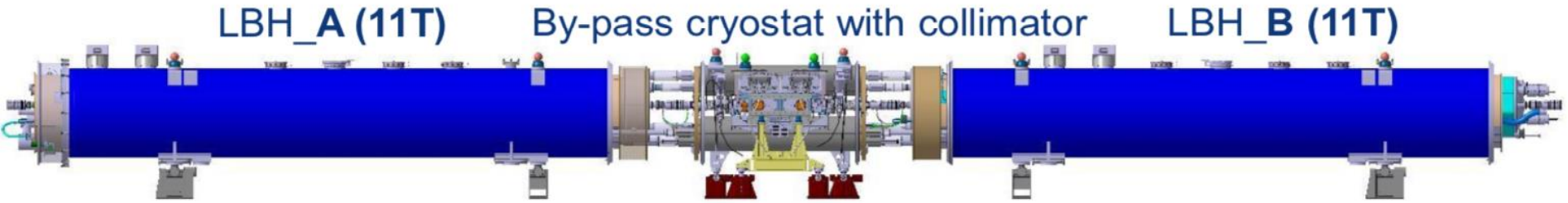
- Execution of major projects (LHC, HL-LHC) in a regime of constant revenues leads to (cumulative) budget deficit
- 2019-2025: financially a challenging period, due to construction of HL-LHC (materials cost ~950 M) and completion of LIU (materials cost 180 M). Major contribution from CERN's budget also to Phase-2 upgrade of ATLAS and CMS (110 M).
- Peak of expenditures in 2019-2020: LIU completion, HL-LHC construction ramping up, LS2 activities → peak CBD: -439.2 M in 2020

Concerning future projects:

- Challenge: find resources over financially difficult period 2021-2025 to start implementing recommendations of 2020 ESPP update → to be addressed in next year Medium-Term Plan
- As of 2026 (end of HL-LHC construction): limited investments in CERN's scientific future become possible → in this year's Medium-Term Plan: provisional allocations of 350 M over 2026-2029 to a future collider project and 60 M to the scientific diversity programme.

From news on Long Shutdown 2, Frédérique Bordry

HL-LHC : 11 T magnets



Complete 11.2 T cryo-assembly replacing a 15 m 8.3 T LHC dipole

HL-LHC : 11 T magnets

MBH-002: first out of four 11 T dipoles.

Quench performance: good for installation in LS2

Update on Elections in Council:

Mandate from 1 January 2020:

- Finance Committee Chair: Umberto Dosselli, Italy
- FC Vice-Chair: Laurent Salzarulo, Switzerland
- SPC Chair: Leonid Rivkin, Switzerland

- Interviews with shortlisted DG-candidates, Sep 2019
- Election of new DG (2021-2025), Dec 2019

CERN Open Days 14-15 September

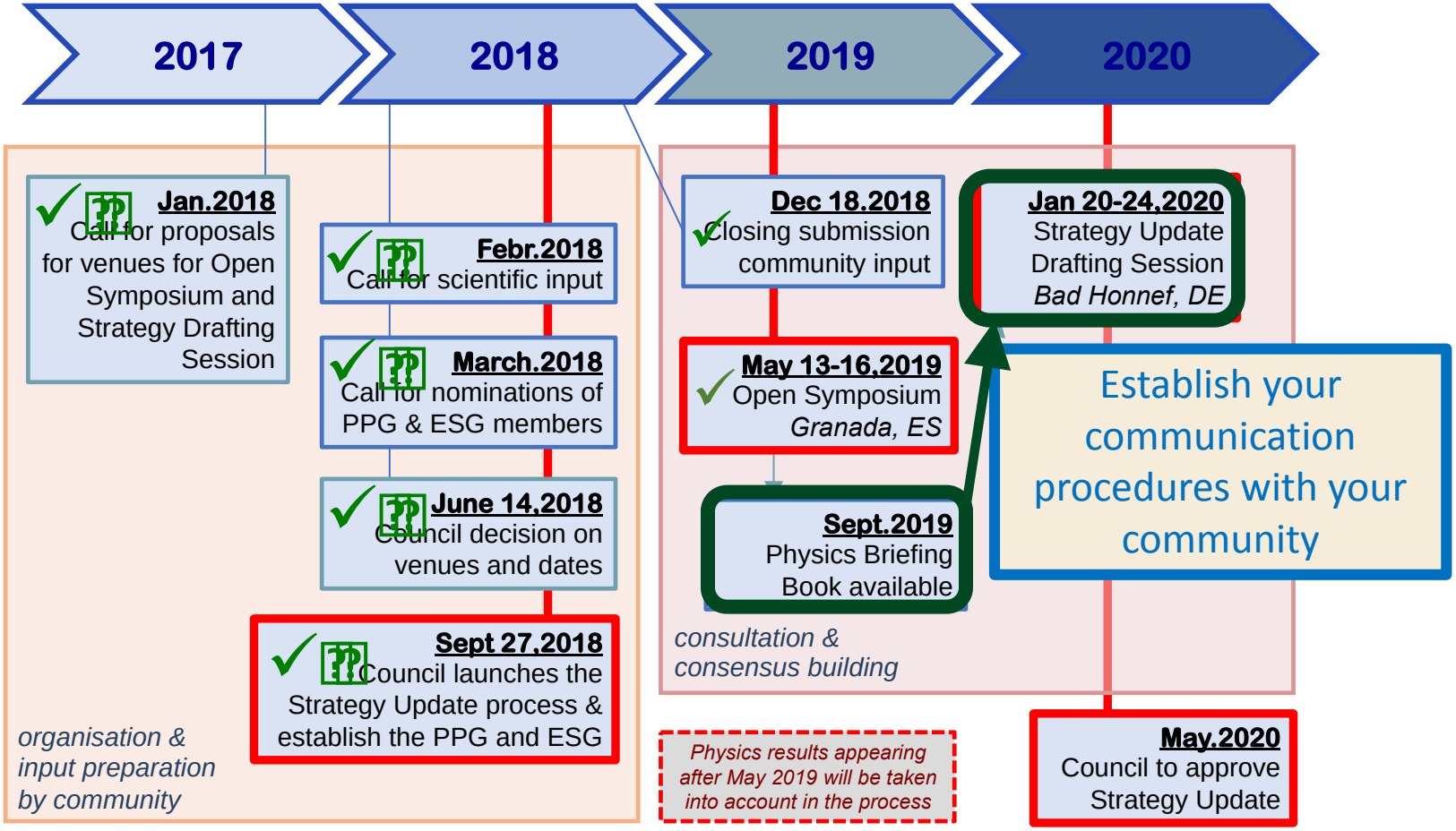
Fabiola Gianotti,
SPC, 23 Sep 2019

~75,000 visitors from all over the world (demographic data being collected through surveys)

9 sites: ALICE, ATLAS, CMS, LHCb, LHC Point 4, LHC Point 6, Meyrin, Prévessin, SM18
155 activities: underground visits (~16,000 people), exhibitions, debates, theatre, music, food, etc.

~ 2800 volunteers (staff, fellows, users, students, contractors, alumni)
Several hundreds members of personnel involved in the preparation
Great collaboration with Host States: police, emergency services, fire brigades, public transport

From European Strategy Group meeting 27 September 2019



Physics Briefing Book available as of today at CDS at CERN, http://cds.cern.ch/record/2691414.

My conclusions of the discussions at the Granada's Symposium

Strong support for:

- e+e- Higgs factory somewhere in the world: potential of ILC@250, CLIC@380, CepC and FCC-ee for Higgs measurements considered to be similar, to first order
- accelerator R&D (including muon colliders)
- scientific diversity programme
- energy-frontier proton-proton collider

No clear consensus on the next collider at CERN: CLIC vs FCC
But broad consensus there should be one.

Support for stronger CERN's engagement in astroparticle physics (in particular, but not only, from the astroparticle community)

CERN's Future

Fabiola Gianotti,
SPC, 23 Sep 2019

I think it would be good for CERN if the 2020 Strategy update recommended:

- the direction for a future collider at CERN: linear or circular
  → so that its technical and financial feasibility can be assessed by next Strategy update in ~2026 → pre-requisite for project approval by the Council

- a compelling scientific diversity programme at the injectors, complementary to high-E colliders for physics reach and size/type of projects (→ attract a diverse community). Based on input from Physics Beyond Colliders (PBC) study group.

- a vigorous and transformational accelerator R&D programme at CERN and other European laboratories and institutions: high-field magnets (including High-Temperature Superconductors), high-efficiency klystrons, high-gradient accelerating structures, plasma wakefield, feasibility of muon colliders, etc.

Timeline

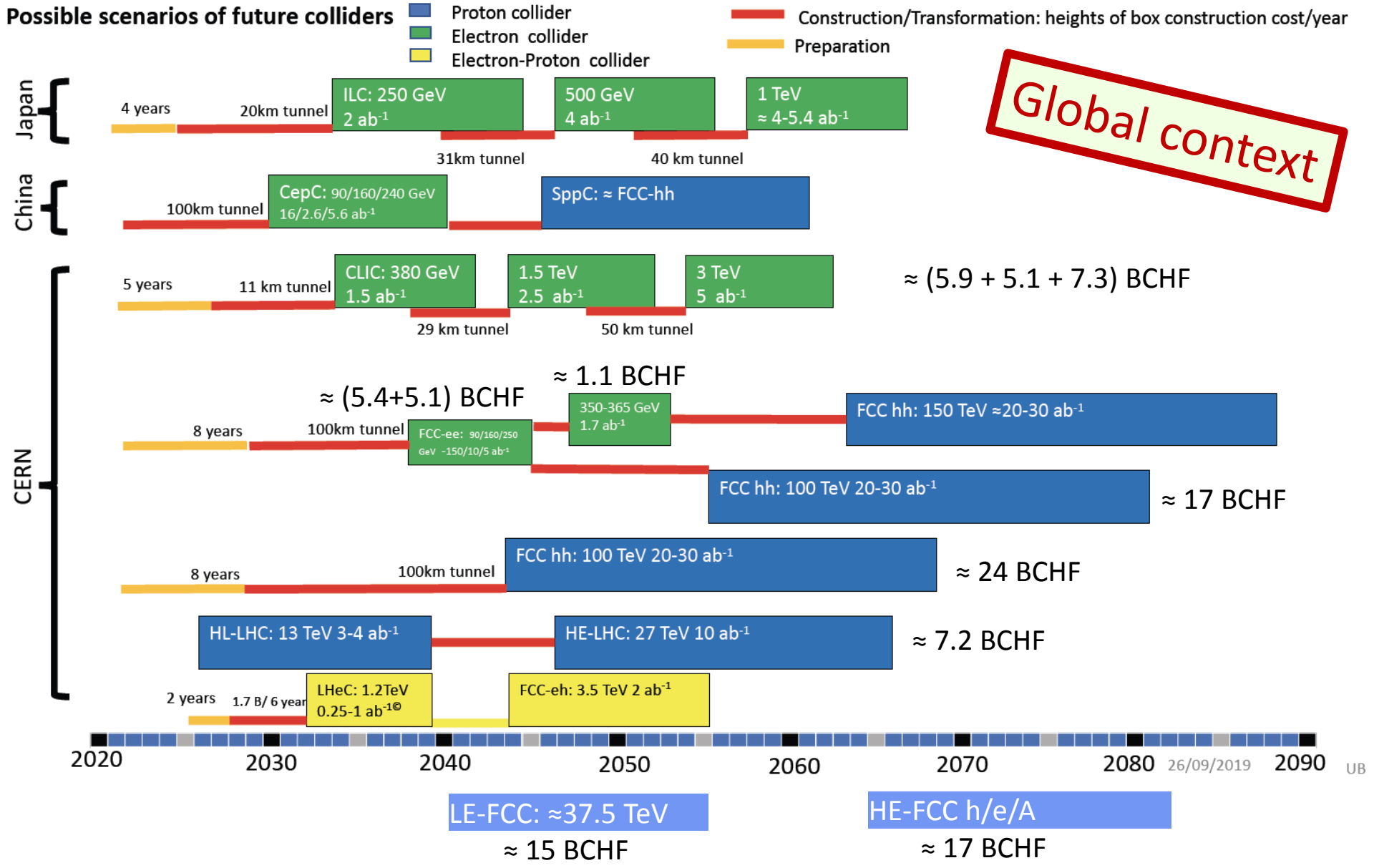
Several years will be needed to assess the technical and financial feasibility of a future collider before the project can be approved by the Council, in particular to work through the administrative, political, legal and environmental procedures related to the tunnel excavation

→ a clear direction (linear or circular) in 2020 would allow much of this work to be accomplished by the ~ 2026 update of the ESPP

CERN's financial constraints over 2021-2025

do not allow CLIC and FCC to be both supported at the level needed for the next significant step: Technical Design Report by Strategy update in ~2026

ESG meeting 27 September 2019



The landscape for colliders in Europe

Scenario	HL-LHC era	Z/W/H/top factory era	energy frontier era
	2020-2040	2040-2060	2060-2080
		1st gen technology	2nd gen technology
CLIC-all	**HL-LHC**	**CLIC380-1500**	**CLIC3000**
CLIC-FCC	**HL-LHC**	**CLIC380**	**FCC-h/e/A (Adv HF magnets)**
FCC-all	**HL-LHC**	**FCC-ee (90-365)**	**FCC-h/e/A (Adv HF magnets)**
LE-FCC+HE-FCC	**HL-LHC**	**LE-FCC (6T magnets)(≈ 37.5TeV)**	**FCC-h/e/A (Adv HF magnets)**
Others/Options	LHeC@CERN	demo muon-collider	Adv Acc Technologies
	demo ERL (PERLE)	demo plasma-collider	
	EIC@USA	demo Adv HF magnets (16T)	
	Diversity Program @ CERN	ILC@Japan	
	SuperKEKB@Japan	CEPC@China	

1) **Identify the financial challenges in the context of the CERN budget**
2) **Elements to be considered in this and the next strategy update**

Future scenarios presented at the ESG meeting 27 September 2019

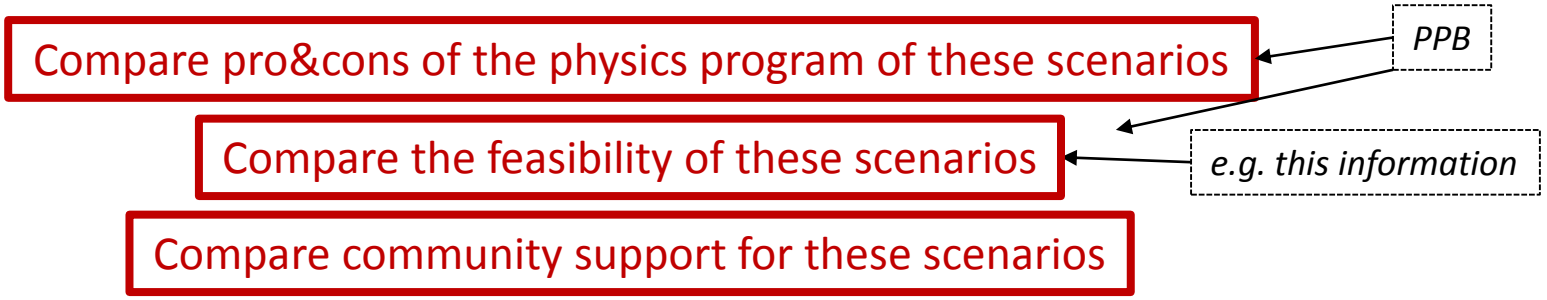
The CLIC-all scenario

The FCC-all scenario

The CLIC-FCC-mixed scenario

The LE-FCC+HE-FCC scenario

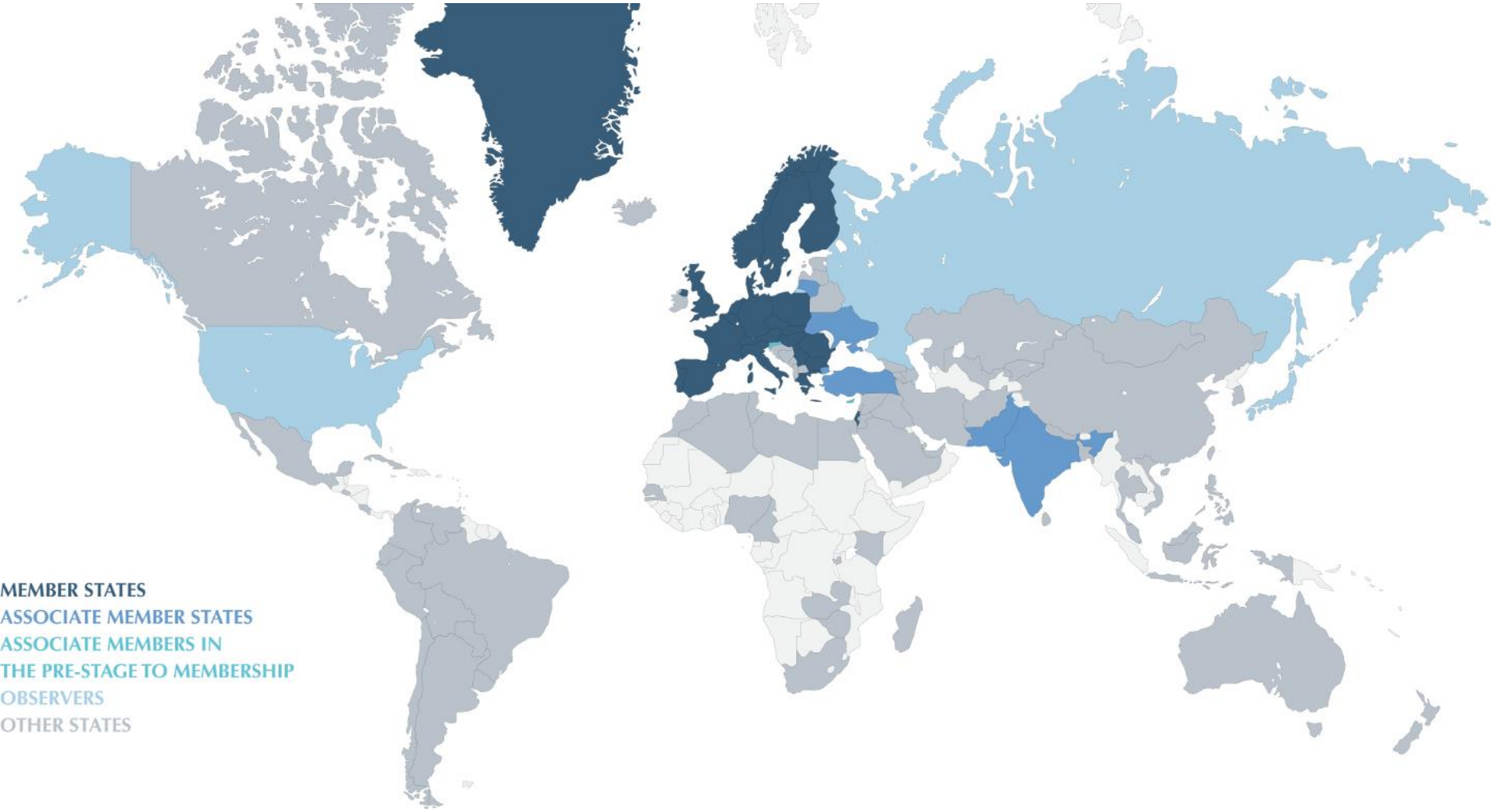
The LHeC + FCC-h/e/A scenario



Document presenting scenarios will soon appear from Strategy Secretariat.
Plan to send you a questionnaire based on the document.
Propose a discussion meeting late October, w 44,
before the next ESG meeting 6 Nov.

SPARES

States connected to CERN



Science Gateway – Portail de la science

Fabiola Gianotti,
SPC, 23 Sep 2019

A new facility for scientific education and outreach targeting the general public of all ages with the goal in particular of stimulating vocations for STEM careers.

It will include: exhibitions; hands-on experiments for children and school students from 5 years up; immersive tours; a 900-seater Auditorium.

It will be housed in an iconic building complex across Route de Meyrin (architect: Renzo Piano).
Construction starts mid 2020 → inauguration at the end of 2022

(96% secured 14% secured)

Total cost: 79 M (65 M building + 14 M educational content).
It will be realised entirely with external donations.

Physics Preparatory Group

PPG MEMBERS	
Strategy Secretariat	
Scientific Secretary (Chair)	Prof. Halina Abramowicz (IL)
SPC Chair	Prof. Keith Ellis (UK)
ECFA Chair	Prof. Jorgen D'Hondt (BE)
Chair EU Lab. Directors' Mtg	Prof. Leonid Rivkin (CH)
SPC	
Prof. Caterina Biscari (ES)	
Prof. Belen Gavela (ES)	
Prof. Beate Heinemann (DE)	
Prof. Krzysztof Redlich (PL)	
ECFA	
Prof. Stanislaus Bentvelsen (NL)	
Prof. Paraskevas Sphicas (GR)	
Dr Marco Zito (FR)	
Prof. Antonio Zoccoli (IT)	
CERN	
Dr Gian Giudice (CERN)	

ASIA/AMERICAS
Prof. Marcela Carena (USA)
Prof. Brigitte Vachon (Canada)
Prof. Xinchou Lou (China)
Prof. Shoji Asai (Japan)

European Strategy Group (ESG)

Members

- The Strategy Secretary (chair)
- One representative appointed by each CERN MS (22)
- One representative appointed by each of the Labs participating in the European Laboratory Directors Group including its Chairperson (9)
- CERN DG
- SPC chair
- ECFA chair

Invitees

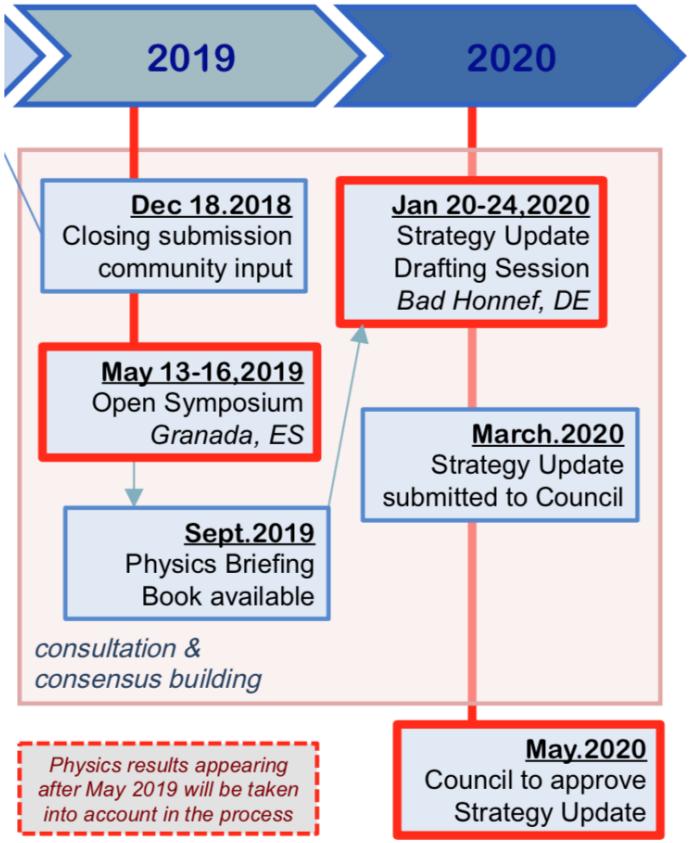
- President of CERN Council
- One representative from each AMS and OS (6+3)
- One representative from the European Commission
- One representative from JINR
- Chairs of ApPEC, NuPECC, FALC, ESFRI
- Members of the PPG (17 - Secretariat)

Meetings of the European Strategy Group

ESG meeting of 27 Sept 2019 (4th meeting)

- The Physics Briefing Book
- Scenarios with future colliders in Europe
  - *together they serve as input for discussion with a view to update the national inputs by the time of the next ESG meeting (6 Nov 2019)*
- Presentations of the six ESG working groups
  - *WG1 - Social and career aspects for the next generation*
  - *WG2 - Organizational structure for European participation in global projects*
  - *WG3 - Relations with external bodies and fields of physics*
  - *WG4 - Knowledge and technology transfer*
  - *WG5 - Outreach, education and communication*
  - *WG6 - Sustainability and environmental impact*

5th and 6th ESG meeting scheduled before Drafting Session



	2020-2040 *HL-LHC era*	2040-2060 *Z/W/H/top-factory era*	2060-2080 *energy frontier era*
precision frontier	H couplings to few % ν mass/mixing/nature QGP phase-transition b/c-physics	H couplings to % EW & QCD & top QGP vs Lattice QCD b/c/τ-physics	H couplings to ‰ H self-coupling to % proton structure di-boson processes
breaking the SM	next-gen K-beams proton precision e & n EDM lepton flavor (μ→e)	p EDM storage rings	rare top decays small-x physics
direct searches	Beam Dump Facility eSPS (light DM) Long-Lived Signals / ALPs DM vs neutrino floor	heavy neutral lepton	new high-mass part. next-gen hidden exp. low-mass DM

Why a future collider and why at CERN?

Fabiola Gianotti,
SPC, 23 Sep 2019

Physics case is very strong

- Unprecedented direct/indirect reach for new physics: up to ~100 TeV (details depend on whether it's CLIC or FCC). Note: no guarantee of discovery of new particles.

- Precise measurements and exclusion of unfounded theoretical scenarios are as crucial as discoveries to make progress and redirect our theoretical thoughts(*) and experimental exploration towards the most promising directions.
  (*) "*When theorists are more confused, it's time for more, not less, experiments*", Nima Arkani-Hamed.

- Higgs boson is a guaranteed deliverable: related to the most obscure and problematic sector of the Standard Model; it carries special quantum numbers and a new type of interaction
  → unique door into new physics, which can only be studied at colliders

CERN should host an ambitious future collider

- strong scientific case for it (see above)
- to maintain Europe's leading role in fundamental physics and related technologies
- CERN has unique assets:
  - powerful infrastructure and outstanding personnel expertise, built over several decades
  - commitment of Member States → long-term budget stability
  - mission and tradition of international cooperation and open science, from founding Convention, and the tools facilitating international cooperation

→ essential pre-requisites for a large, global project

Main challenges of a future collider

Fabiola Gianotti,
SPC, 23 Sep 2019

Financial feasibility

Cost of tunnel + first-stage machine (CLIC at 380 GeV, FCC-ee): ~ 6-10 BCHF

→ cannot be funded only from CERN's (constant) budget + additional "*ad hoc*" contributions of Member and other States

→ need innovative mechanisms: contributions from EC (potential interest e.g. in HTS development and industrialisation; tunneling technologies)? private funds? donations?

Governance model for an unprecedented, global project

CERN best placed to develop it together with international partners.

Technical and administrative feasibility of the tunnel

- ❑ highly-populated area; two countries with different legislative frameworks
- ❑ land expropriation and reclassification
- ❑ need to gain support of local populations (with a view to public surveys and debates)
- ❑ environmental aspects

Technologies of machine and experiments

- ❑ huge challenges, but under control of our scientific community → "easier"
- ❑ environmental aspects (aim at "green collider"): power, energy, cooling, gases, etc.

Gathering political and societal support

→ requires "political work" and vast communication campaign for "consensus building" with governments and other authorities, scientists from other fields, general public (Science Gateway,…)

→ Work started also in the SPC context