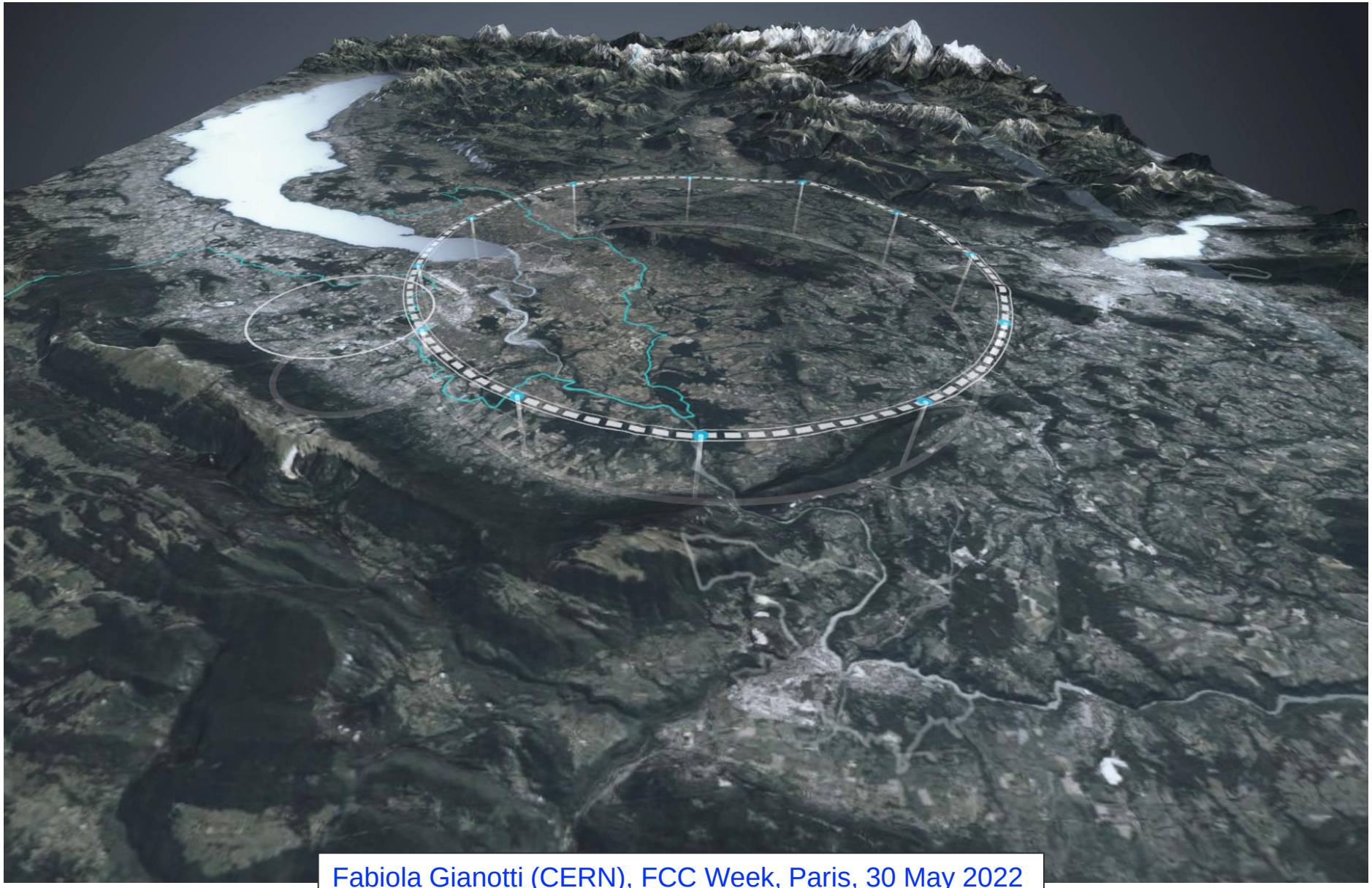
Welcome and Introduction



Fabiola Gianotti (CERN), FCC Week, Paris, 30 May 2022

2020 update of European Strategy for Particle Physics

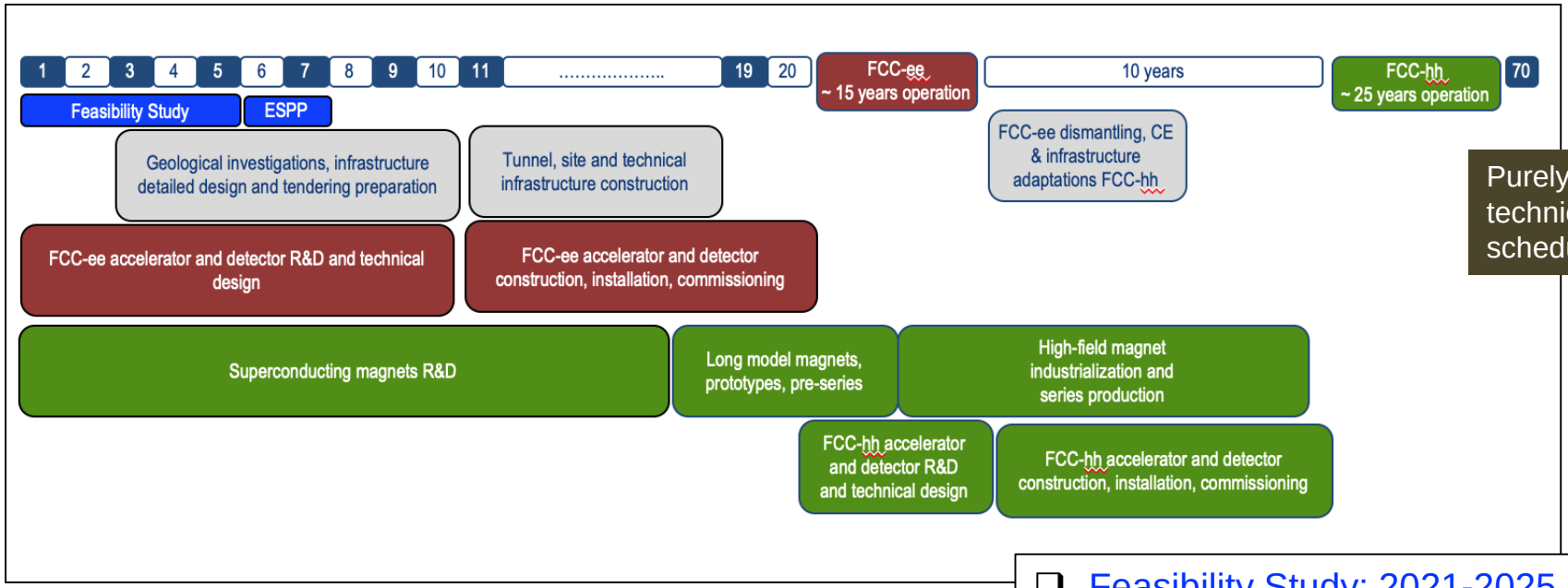
"An electron-positron Higgs factory is the highest priority next collider. For the longer term, the European particle physics community has the ambition to operate a proton-proton collider at the highest achievable energy."

"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 colliders 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) launched in 2021:

- ❑ To be carried out in 2021-2025 → input to the next Strategy update
- ❑ Mid-term review in Autumn 2023
- ❑ Will cover the integrated programme (FCC-ee followed by FCC-hh)

Timeline of the FCC integrated programme



Purely technical schedule

	√s	L /IP ($cm^{-2}\,s^{-1}$)	Int. L /IP(ab^{-1})	Comments
e^+e^- **FCC-ee**	~90 GeV Z 160 WW 240 H ~365 top	230 x10^{34} 28 8.5 1.5	75 5 2.5 0.8	2-4 experiments Total ~ 15 years of operation
pp **FCC-hh**	100 TeV	5 x 10^{34} 30	20-30	2+2 experiments Total ~ 25 years of operation
PbPb **FCC-hh**	$\sqrt{s_{NN}}$ = 39TeV	3 x 10^{29}	100 nb^{-1}/run	1 run = 1 month operation
ep **Fcc-eh**	3.5 TeV	1.5 10^{34}	2 ab^{-1}	60 GeV e- from ERL Concurrent operation with pp for ~ 20 years
e-Pb **Fcc-eh**	$\sqrt{s_{eN}}$ = 2.2 TeV	0.5 10^{34}	1 fb^{-1}	60 GeV e- from ERL Concurrent operation with PbPb

- Feasibility Study: 2021-2025
- If project approved before end of decade → construction can start beginning 2030s
- FCC-ee operation ~2045-2060
- FCC-hh operation ~2070-2090++

FCC Feasibility Study (2021-2025): high-level objectives

- 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 to identify and remove any showstopper;
- optimisation of the design of the colliders and their injector chains, supported by R&D to develop the needed key technologies;
- elaboration of a sustainable operational model for the colliders 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 the funding and organisational models needed to enable the project's technical design completion, implementation and operation;
- identification of substantial resources from outside CERN's budget for the implementation of the first stage of a possible future project (tunnel and FCC-ee);
- consolidation of the physics case and detector concepts for both colliders.

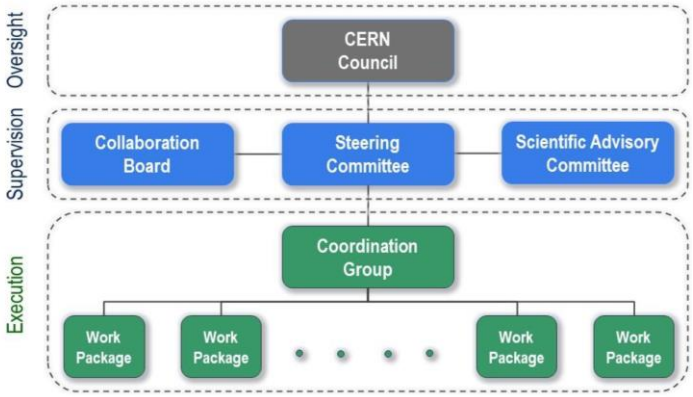
Results will be summarised in a Feasibility Study Report to be released by end 2025

Recent progress (I)

Funding for FCC FS secured in CERN's Medium-Term Plan: ~ 20 MCHF/year over 5 years (magnet R&D funded separately).

FCC FS organisational structure approved by CERN's Council in June 2021 → most committees and coordination roles in place.

Ongoing efforts with the Host States to establish, as soon as possible, the structures needed to address all relevant issues (local communication, environmental impact, administrative procedures, etc.)



main deliverables and timelines of the FCC Feasibility Study	2021				2022				2023				2024				2025			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
technical design work and R&D in all relevant areas																				
progress review on key technology R&D programs																				
development and documentation of implementation scenario																				
design update for preferred implementation variant																				
communications plan development and implementation																				
development of funding models and concepts																	update			
development of project organisation and operation models																	update			
CDR cost update with external review																				
general coherence review (mid-term)																				
detailed design for Feasibility Study Report																				
environmental evaluation process and impact study with host states					preparation															
high-risk areas site investigations					preparation															
project cost update with external review																				
Feasibility Study Report																				

Main deliverables and milestones defined → deliverables for 2023 mid-term review to be presented to CERN's Council in June (→ see M. Benedikt's talk).

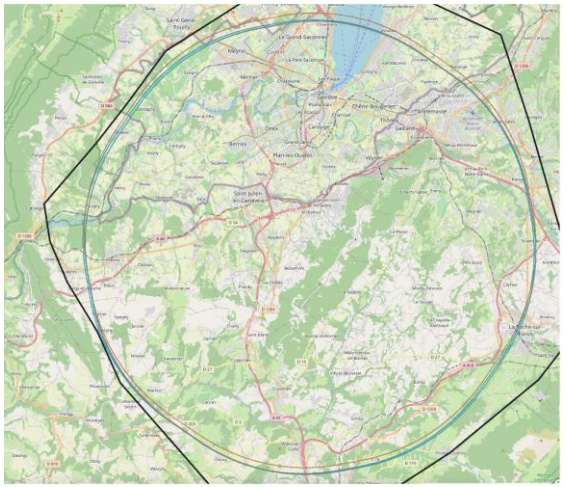
Recent progress (II)

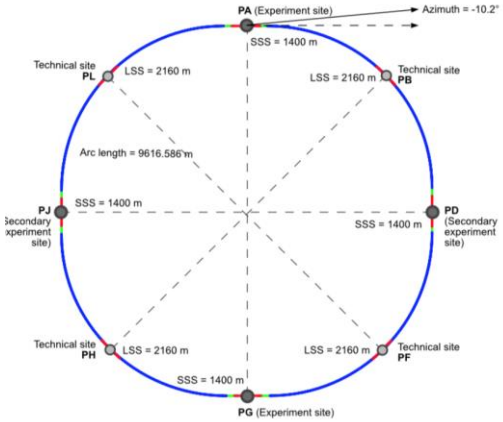
Baseline ring placement selected → next: adapt the whole project to this baseline

Baseline ring: **~ 91 km, 8 surface points**

Out of ~ 50 initial variants, based on geology and surface (land availability, access, etc.), environment (protected zones), infrastructure (water, electricity, transport), etc. "Éviter, reduire, compenser" principle of EU and French regulations

Site investigation: 9 high-risk areas identified
(to be further investigated with ~40 drillings and 100 km of seismic lines)

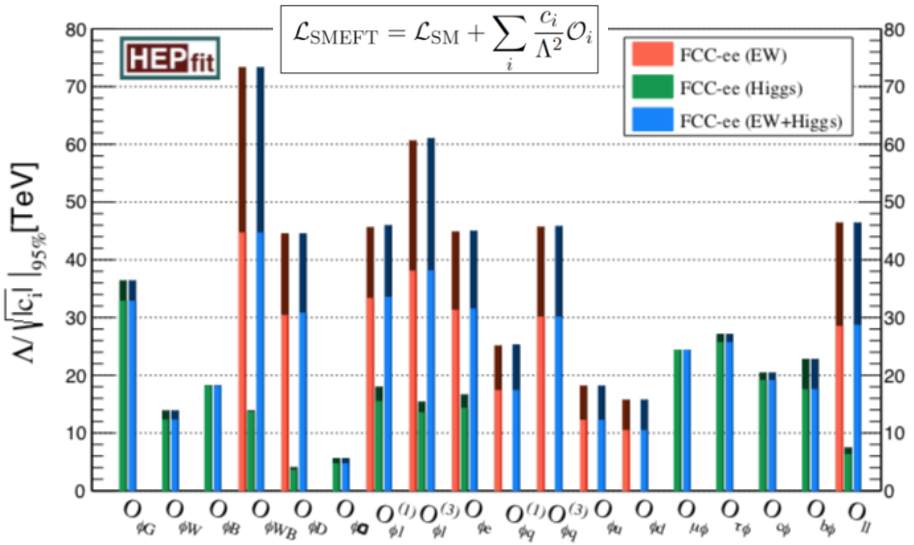


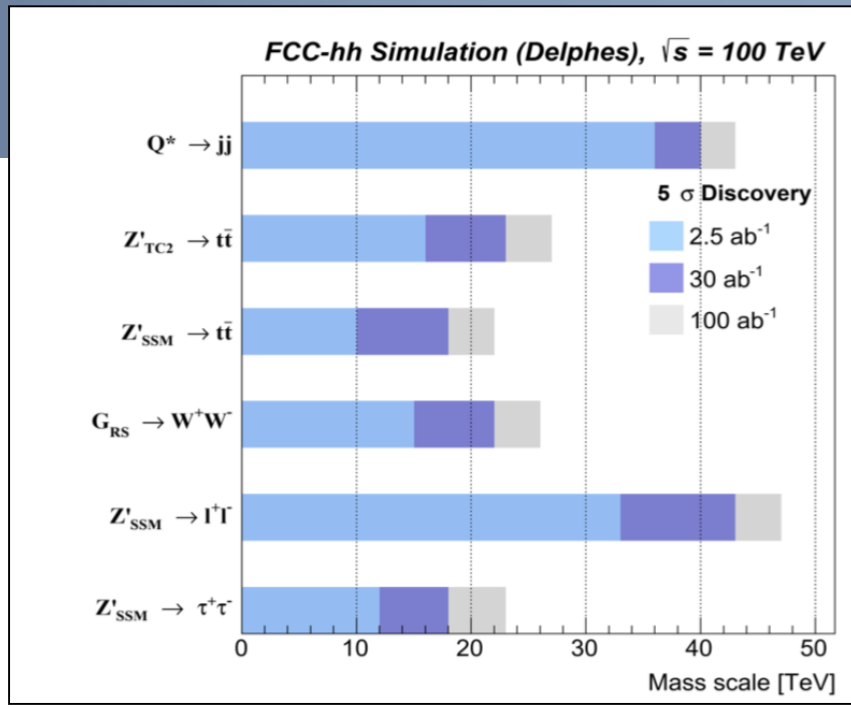


Financial feasibility: spending profile for the tunnel and FCC-ee machine developed and needed resources versus time defined → discussions with Host States and Council next months.
Note: substantial resources (~ 5 BCHF) needed from outside CERN's budget, large part in-kind (contributions from non-Member States, special contributions from Host States and other Member States; ongoing discussion with the European Commission; private funding?) → discussions started.

Physics potential: examples

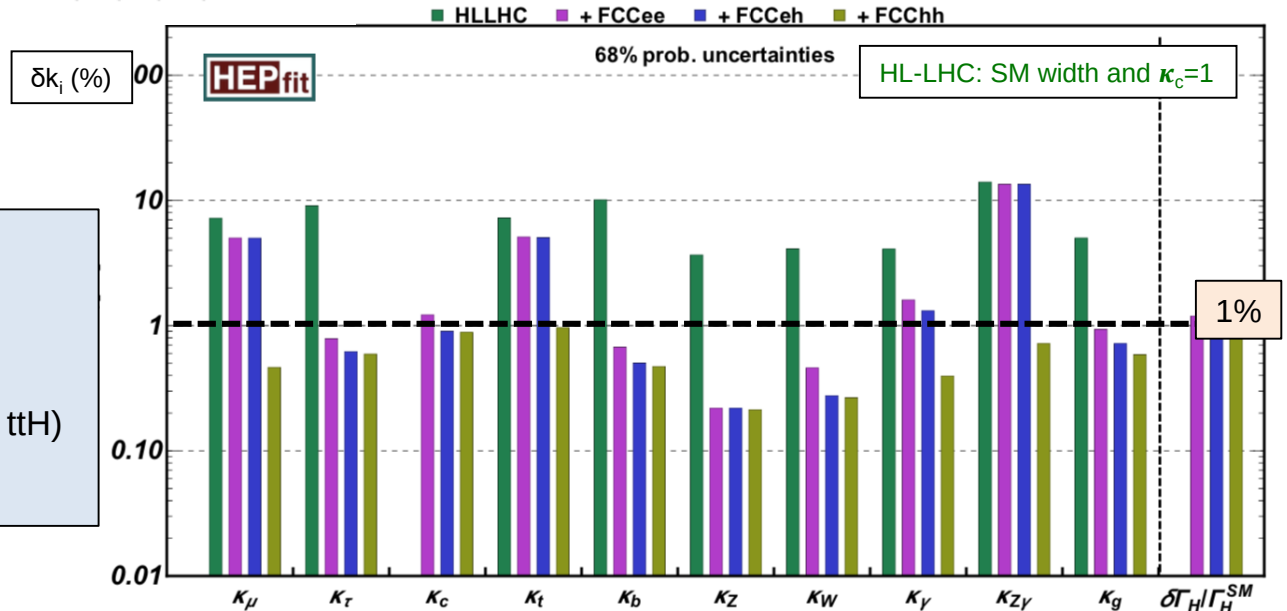
FCC-ee sensitivity to “interaction scales” of new physics from EW and Higgs measurements (dark: no theory uncertainty)





… and gluinos up to 20 TeV and stops up to 10 TeV ….

Input from FCC-ee (e.g. HZZ coupling and ttZ cross-section) removes model-dependence of several couplings that are best measured at FCC-hh (e.g. H→ μμ, H → $\gamma\gamma$, H → Zγ, ttH)
In addition: k_λ to ~ 5%
https://inspirehep.net/literature/1790243



Final remarks

FCC is a unique project. From physics viewpoint, it offers an extremely complete and compelling programme, with synergies and complementarities between the various machines and running scenarios (FCC-ee, FCC-hh, FCC-eh and heavy ions).
→ prospects for 100 years of great physics at energy and intensity frontiers!

Scientifically and technically very ambitious: new technologies required in many domains, sustainability and environmental protection are a must → great opportunities for new developments.

First-stage machine (FCC-ee) could run on time scale of ~ 2045, i.e. within few years from end of HL-LHC
→ crucial to keep the community engaged (especially the young people).

Global project, participation of non-Member States is essential.

Very ambitious project, but CERN has unique assets:
- ❑ powerful infrastructure and outstanding personnel expertise
- ❑ long-term budget stability (thanks to the Member and Associate Member States!)
- ❑ mission and tradition of global collaboration
- ❑ open science values

Important to work together in the coming years to convince the community and the governments of the FCC immense physics reach, its potentially huge impact on society and its technical feasibility, as an essential step towards securing the needed (large) resources.

Have a nice and productive week!