

Update on European Strategy for Particle Physics (Update)

UK ESG Reps: Jim Clarke, Sinead Farrington, ML

Physics Briefing Book

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Timeline for the update of the European Strategy for Particle Physics



- Nov-5 : first time a "descoped FCC" was mentioned within ESG as a Plan-B : CH delegation
- Nov-24 : ESPP Secretariat (Paris Sphicas) then presented arguments for/against this
- Dec-1 : 1st day of drafting session: talks from Paris & Fabiola proposing descoped-FCC as Plan-B with estimate of cost
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- Dec-3 : the definition of the word "flagship"

Towards identifying a plan B

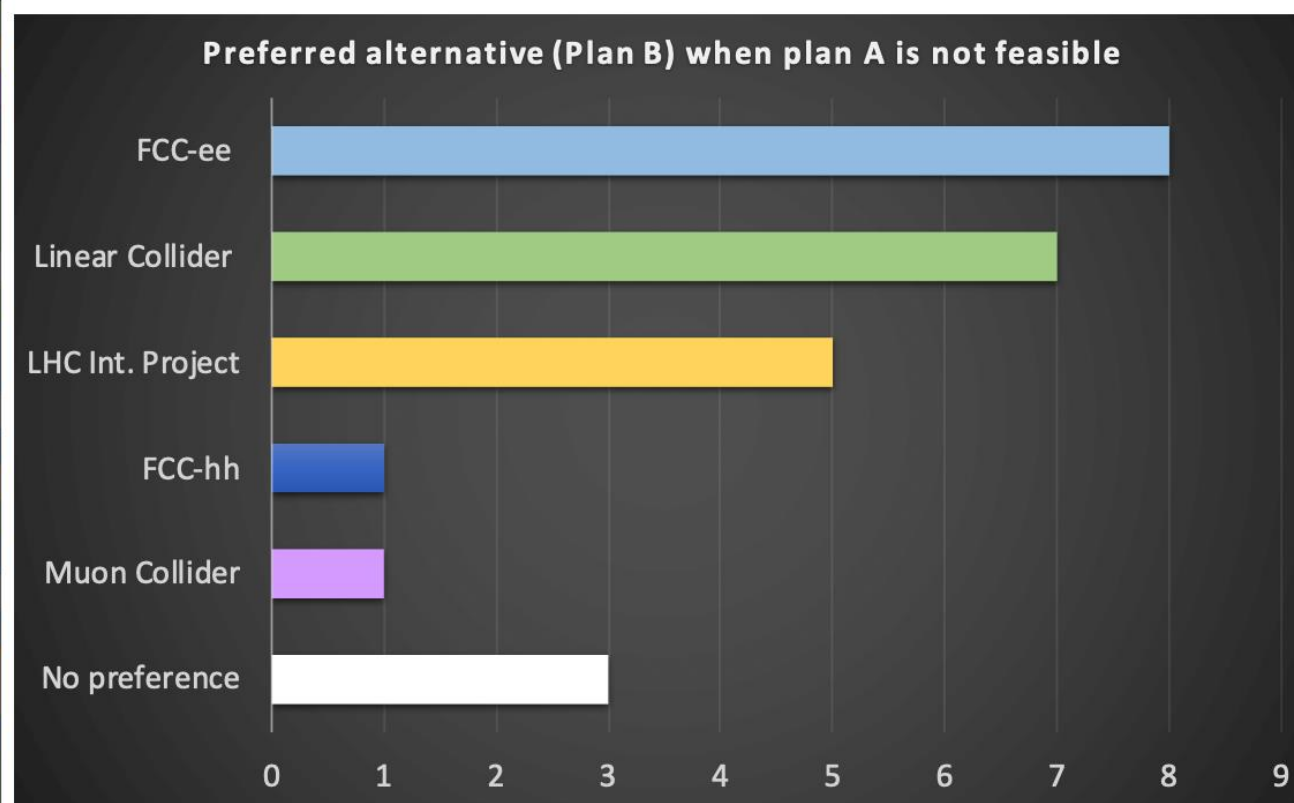
ESPP secretariat

(Karl Jakobs, Hugh Montgomery, Mike Seidel, Paris Sphicas)

ESG meeting

November 24, 2025

Member States	Plan B
Austria	Linear Collider (LCF, CLIC)
Belgium	LEP3
Bulgaria	Muon Collider
Czech Republic	FCC-hh
Denmark	FCC-ee
Estonia	Linear Collider (LCF, CLIC)
Finland	LCF
France	
Germany	LCF
Greece	FCC-ee
Hungary	FCC-ee
Israel	
Italy	FCC-ee
Netherlands	LHeC or LEP3
Norway	Linear Collider (CLIC (LCF))
Poland	FCC-ee
Portugal	
Romania	FCC-ee
Serbia	LEP3 (LHeC)
Slovakia	LHeC
Slovenia	FCC-ee
Spain	Linear Collider (LCF, CLIC)
Sweden	LCF
Switzerland	FCC-ee
United Kingdom	LHC extension, LHeC



Nov-24th : 10 days after national inputs and 7 days before drafting sessions

- **Identifying a 'plan B' as an alternate machine (i.e. not FCC-ee) is not easy:**
 - Physics reach of alternate machines smaller than FCC-ee
 - Vision (the second part of the remit) is
 - unclear (for linear colliders) or
 - the FCC-hh, for LEP3 and LHeC; these necessitate the FCC-tunnel and infrastructure, so, compared to the FCC-ee/FCC-hh, they add 9 GCHF to the FCC-hh cost estimate.
 - And the precision step is much inferior to that of the FCC-ee
 - National inputs are divided on the two questions on "plan B"
 - If plan A not feasible: 8 communities indicate... "plan A" (delayed, descoped?)
 - 7 indicate a linear collider;
 - 5 indicate a "LHC-extension" or intermediate LEP3/LHeC program
 - If plan A not competitive: 8 indicate the FCC-hh, 4 FCCee/FCC-hh; 2 a linear collider...
- **Therefore, we should consider in the analysis a plan that enables the FCC-ee via staging (recoverable descoping), elongated timescale (or even descoping?)**
 - Examples of things to consider first, as they are recoverable if external contributions to the FCC program arrive in time (remember the LHC "missing dipole" scheme...)
 - Delaying the top run? Delaying the overall program start?
 - 2 caverns instead of 4?
 - Lower RF power? (e.g. 30 MW instead of 50 MW loss by synchrotron radiation)
 - Other possible ideas
 - Will try to get estimates for these staging scenarios – to bring them to Ascona.

Delay t-bbar to after ~ 20 years of operation at Z, H, WW, ZH (instead of 9 years as in baseline FCC-ee) → stage 1.3 BCHF

Reduce power per beam from 50 to 30 MW → stage 350 MCHF

Start with 2 experiments (and 2 caverns) → stage 800 MCHF

Note: contributions of collaborations funding agencies to the experiments (~ 650 MCHF) are also staged



CAPEX of first stage: 12.85 BCHF instead of 14 BCHF

Note:

- ❑ Full performance of baseline FCC can be recovered at a later stage (this is a staging, not a permanent descope)
- ❑ However:
 - integrated luminosity over a given period reduced by 65% → needs to run FCC-ee much longer to accumulate the same data
 - building 2 additional experimental caverns + shafts at a later stage will likely be more expensive (new civil engineering contract) and require a 5-6 years shutdown of FCC-ee

A descoped FCC-ee (to improve the financial feasibility)

- Descoping scenarios include:

- removing the top-quark run	-1.26 BCHF
- constructing two rather than four interaction regions and experiments	- 0.80 BCHF
- decreasing RF system power (50 MW → 30 MW)	- 0.35 BCHF
- These measures would reduce the construction cost by approximately 15%.
- *The luminosity for the descoped FCC-ee would be (M. Benedikt, F. Zimmermann):*
 $L(\text{FCC-ee}) \times \frac{3}{5} \times \frac{2}{4} \times 1.2 = L(\text{FCC-ee}) \times 0.36$
- Should additional resources become available, these descope scenarios would be reversible.

Fabiola @ Ascona Dec-1

No quantitative assessment of change in physics capability

CERN Council March-2026

Saves ~ 2.4B and lumi x 0.36

Aim of the Strategy Process, as defined in the remit by the CERN Council:

*“The aim of the Strategy update should be to develop a **visionary and concrete plan** that greatly advances human knowledge in fundamental physics through the **realisation of the next flagship project at CERN.** This plan should attract and value **international collaboration** and should **allow Europe to continue to play a leading role in the field.**”*

*“The Strategy update should include the **preferred option** for the next collider at CERN and **prioritised alternative options** to be pursued if the chosen preferred plan turns out not to be feasible or competitive.”*

Meaning of **flagship** in English



flagship

noun [C]

UK /ˈflæɡ.ʃɪp/ US /ˈflæɡ.ʃɪp/

flagship *noun* [C] (BEST PRODUCT)

Add to word list

the best or most important product, idea, building, etc. that an organization owns or produces:

- *This machine is the flagship in our new range of computers.*



Meaning of flagship in CERN legal department : a project that can only proceed with additional funding beyond the CERN member-state (MS) subscriptions.

Defined to accommodate/allow non-MS contributions to LHC construction.

FCC-ee needs : 4-6B CHF of additional money beyond present subscriptions.
and then FCC-hh has 8B shortfall.

1. *FCC-ee: stands out as the unique option that offers both a concrete plan (outstanding physics programme) and a clear vision for the long-term future of the field (paving the way towards the 10++ TeV scale, re-using the tunnel for a pp collider)*

→ It would maintain European leadership in particle physics

Large consensus has been reached in the European Particle Physics Community and beyond

2. *There is no convincing alternative collider concept as “plan B” (physics, competitiveness, path to 10 TeV)*

In case FCC-ee should financially not be feasible, a descoped FCC-ee is the preferred alternative option for the next flagship collider at CERN

→ All possible efforts should be made by the CERN Council and CERN management to explore if FCC-ee or a descoped FCC-ee can be realised over the next years (until 2028)

3. *Should this fail (finances, tunnel construction, ...), the CERN Council should consider to launch a new “light-weight” strategy process in 2028 to define a new plan*

(ESPP is a cornerstone of Europe’s decision-making process for the long-term future of the field, well established, important to involve the full community in the decision on the large-scale, long-term facility for the entire field)

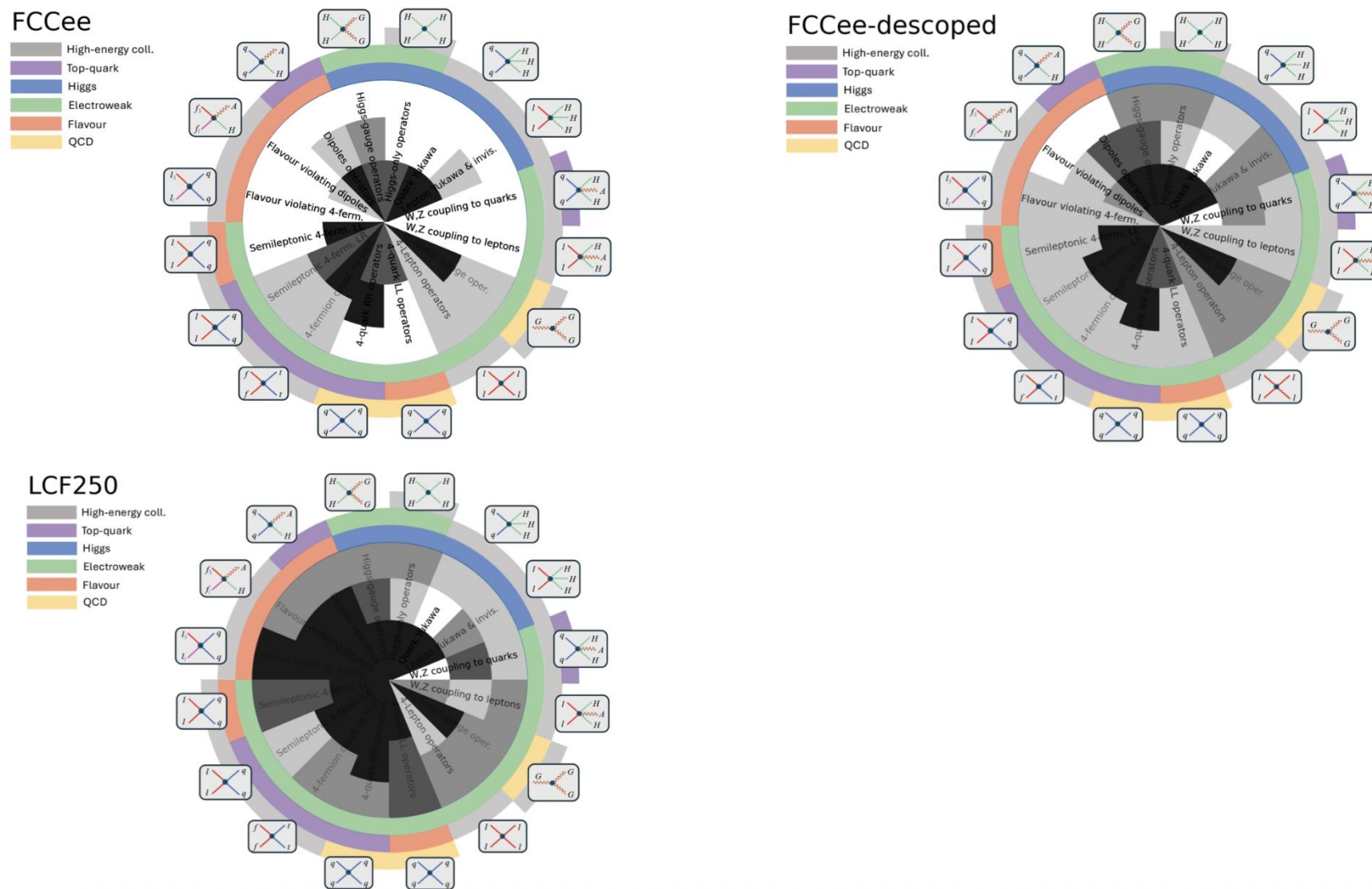
First physics plots for descoped FCC appeared at Dec 11-12 Council meeting when Council was given the 1st draft of the ESPPU recommendations.

Several member states: UK,DE,NO,DK,SE,AT (45% of CERN budget) stated this would not be an acceptable plan-B in terms of developing business cases to ministries and for risk mitigation.

All other ESPPU recommendations were unanimously endorsed.

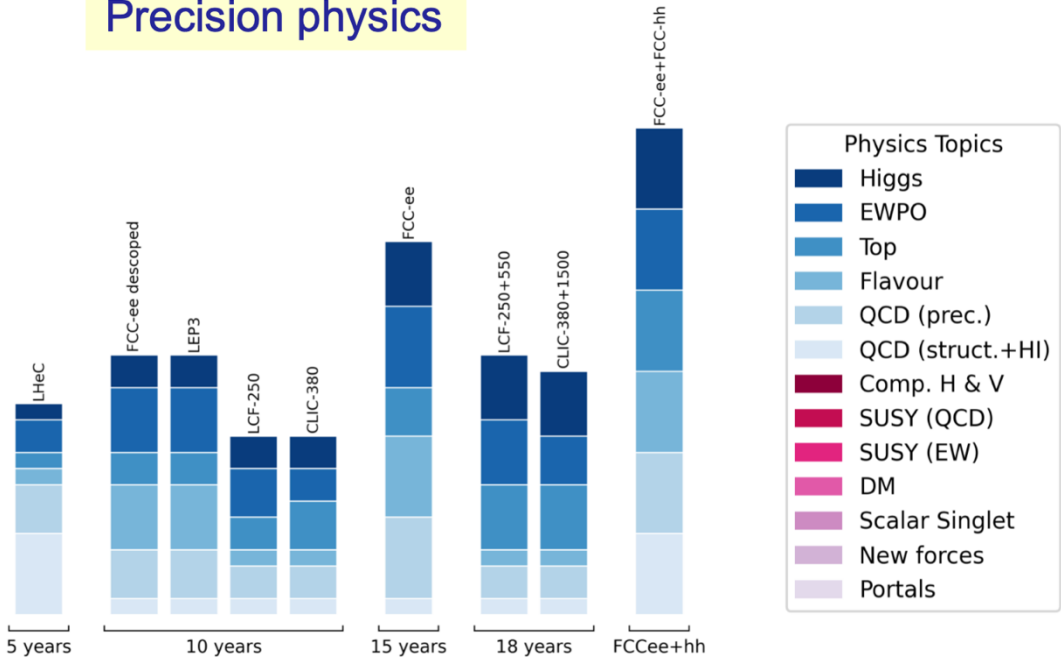
Not until the March 2026 CERN Council meeting did final physics comparisons arrive.

At this meeting, Council was asked to essentially adopt the strategy and hours were spent crafting a tortuous paragraph that all could “agree” to.

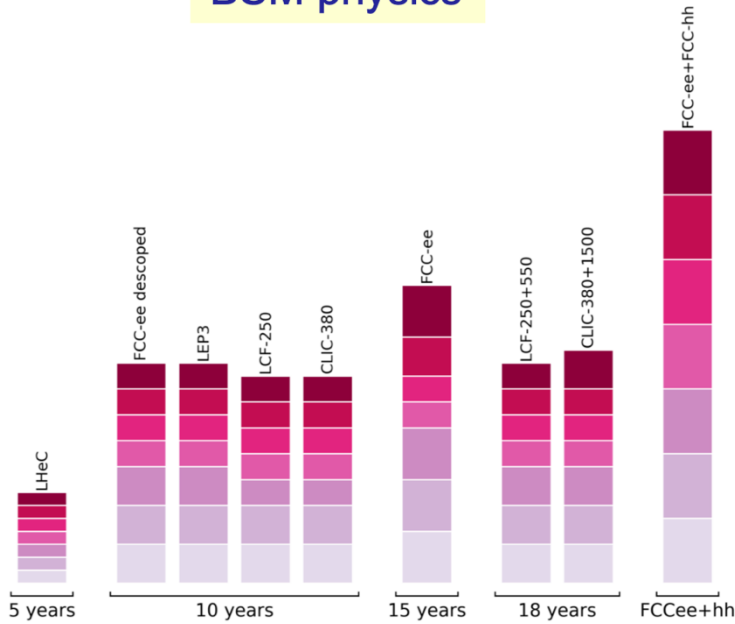


In special May Council Meeting in Budapest the strategy was formally adopted with a press release and [CERN Council Statement](#)

Precision physics



BSM physics



Machine	Precision Physics	BSM physics	Phys vs CEPC	Tech readiness	Const. cost (BCHF)	Time scale	Path to ≥10 TeV
FCC-ee	22	23			15.3	2046-2060	
Descoped FCC-ee	15	17			12.9	2046-2055	
LCF550	15	17			14.8	2045-2065	
CLIC1500	14	18			14.6	2045-2066	
LCF250	10	16			9.4	2045-2053	
CLIC380	10	16			7.5	2045-2054	
LEP3	15	17			4.1	2047-2062	
LHeC	8	7			2.1	2044-2051	

Descoped FCC runs for 21 years and delays FCC-hh by 6 years to 2080s and adds 1B in OPEX.

Risk mitigation is same eg cancel/pause non-collider programs

June 2026 CERN Council Meeting

European Strategy underpins CERN's strategy

Top Priority – full exploitation of the LHC and HL-LHC

- HL-LHC and ATLAS and CMS upgrades are CERN's top priority
- Full exploitation of HL-LHC includes the ALICE and LHCb upgrades during LS4

Highest long-term priority – FCC-ee as CERN's next flagship collider

- Our aim is to be in the position for CERN Council to be able to take a decision on FCC-ee from June 2028 onwards

Non-collider physics at CERN will remain an important part of the programme

- Our aim is to develop a new roadmap for the future of the non-collider physics programme at CERN by early 2027



Dec 2-4 roadmap workshop

<https://indico.cern.ch/event/1687237/>

FCC

The key points from the European Strategy Group (ESG) report regarding FCC:

- Overwhelmingly strong endorsement of the physics and strategic case for FCC-ee as the next flagship collider at CERN
- Near consensus within the particle physics communities in CERN's Member States
- A descoped/staged FCC is preferred to other options as the alternative
- No explicit prioritization of LEP 3, LHeC, LCF, CLIC

The update of ESPP, endorsed FCC-ee as CERN's scientific vision for the future:

- **Our clear aim is to be ready for a decision on FCC-ee in 2028**
- CERN's highest objective for the long-term future is to be in a position in 2028 to propose to Council FCC-ee as CERN's next flagship collider
- Seeking a go/no-go decision – this is not a choice between options
- We will make the case based on FCC-ee
 - noting that it provides a potential future pathway to a very-high energy hadron collider

Taking FCC-ee to a decision point is CERN's highest long-term scientific priority

June 2026 CERN Council Meeting

Draft Updated FCC Timeline – TBC

FCC Phases (assuming approval)

- 2026-2028: Reference Design Phase (previously referred to as pre-TDR Phase)
- 2029-2033: Technical Design Phase
- 2033- : Project Implementation

Proposed Council Milestones (evolution from CERN/SPC/1259/RA, CERN/3912/RA)

- Mar 2026: discussion of Reference Design Phase scope and deliverables
- **Jun 2026: approval of Reference Design Phase following ESPP update**
- Sep 2026: input from Council on requirements for project approval
- **Dec 2026: decision in Council on the main features of the funding model**
- Mar 2027: decision on FCC governance model (previously Dec 2026) – after retreat?
- Jun 2028: final review of Reference Design Phase (previously Mar 2028)
- **Sep 2028: earliest decision point (previously Jun 2028)**

Should this fail (finances, tunnel construction, ...), the CERN Council should consider to launch a new “light-weight” strategy process in 2028 to define a new plan

(ESPP is a cornerstone of Europe’s decision-making process for the long-term future of the field, well established, important to involve the full community in the decision on the large-scale, long-term facility for the entire field)

CERN is committed to providing 2.5MCHF/pa to develop an “options analysis” of two alternatives : 5B project and 5-10B project: this is a paper exercise : no R&D.

With STFC and DSIT we now have to start developing the FCC-ee business case and options analysis for ministerial approval in 2028.....