

UK input to 2026 European Strategy for Particle Physics Update (ESPPU)

# Plan B scenarios and other discussions

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RAL

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# Q3c. FCC strategy in Global Context

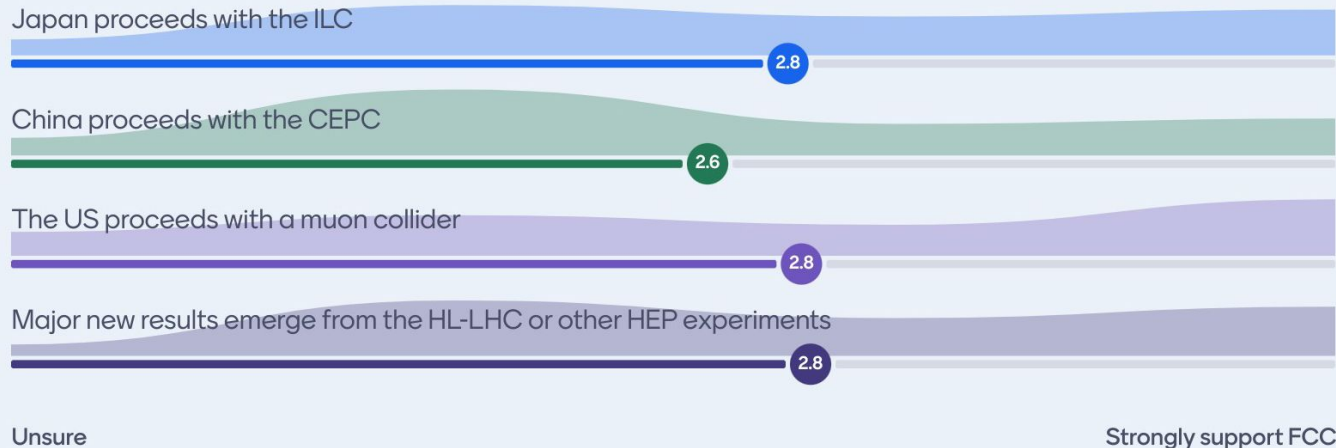
## Scenarios for 3c

1. If Japan proceeds with the ILC in a timely way?
2. If China proceeds with the CEPC on the announced timescale? - connection with 3e
3. If the US proceeds with a muon collider?
4. If there are major new (unexpected) results from the HL-LHC or other HEP experiments?

# Q3C. Survey Results

Q1. FCC strategy in global context

If these international projects proceed, how should Europe support the FCC as a long-term infrastructure, regardless of staging?



# Q3c Scenarios Discussion

## Emerging Consensus: Support for FCC with Key Adjustments

- Preference to proceed with **FCC-hh**, particularly if **CEPC** moves forward.
- Explore **FCC-hh at reduced energy** as an intermediate step (e.g., using LHC magnet technology to achieve ~50 TeV).
- Question whether a **muon collider in the US** should influence Europe's commitment to FCC — current view suggests minimal impact?
- If the **ILC proceeds in Japan**, is there still strong motivation for integrated FCC programme, or also “straight to **FCC-hh**”?
- In case of major new discoveries at **HL-LHC**, consider extending its runtime — but advancing with the FCC tunnel preserves long-term flexibility.

# Q3e Alternatives if FCC unfeasible or pushed back

## Scenarios for 3e

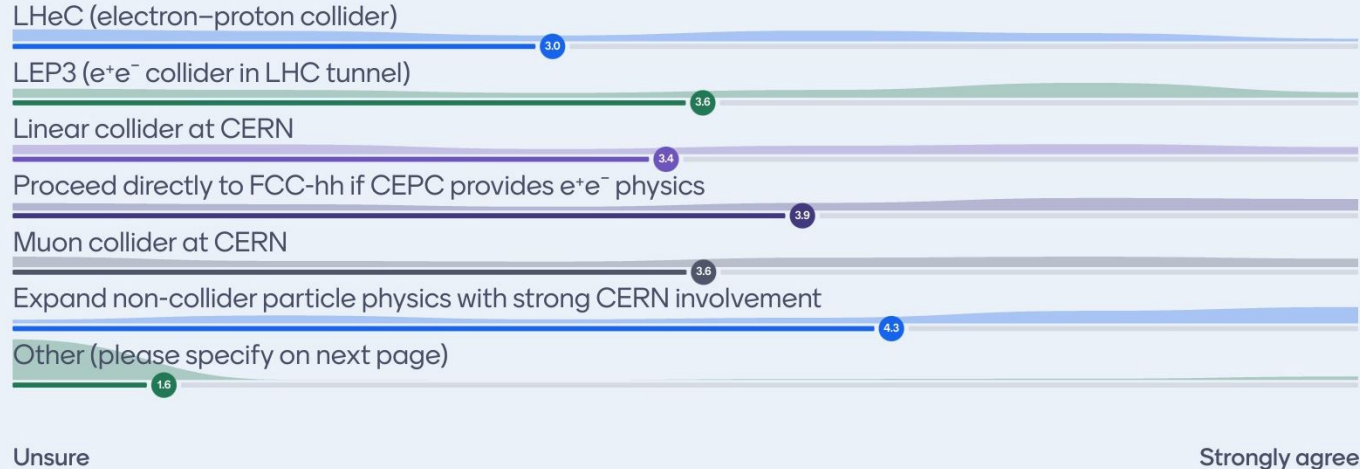
The following scenarios will be considered separately

- a) [Cost/technical/environmentally unfeasibility]- FCC is unaffordable or unfeasible on either cost or environmental grounds.
- b) [International developments] - CEPC is realised, i.e. FCC-ee unfeasible due to international developments
- c) [Timing]- Timescales for FCC are pushed back.

# FCC unfeasible (or FCC-ee if CEPC)

Q2: Alternative or Complementary Strategies

If FCC is not feasible (due to cost, timing, technology etc) what alternative or complementary directions should Europe support at CERN?



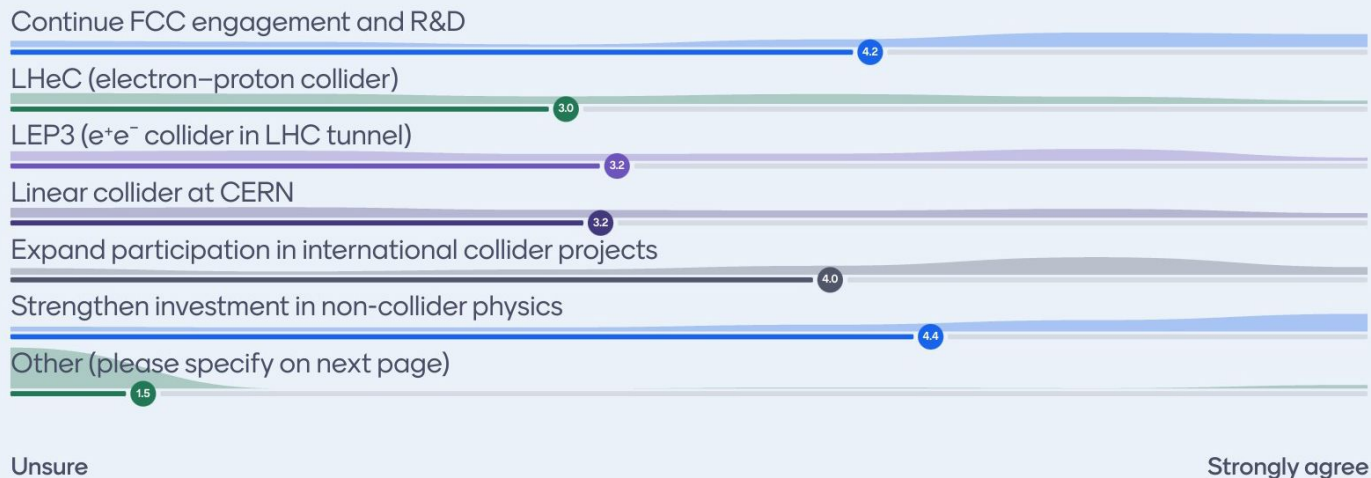
## Q3e Scenarios Discussion Plan B-1

- **No clear consensus** on a single Plan B but there are **emerging priorities**
- Maintain a **collider-focused strategy**, with flexibility depending on global developments.
- Some support for Linear Collider at CERN if not pursued internationally
- Support for **cost-effective interim projects** (like LEP3, LHeC) if large-scale not feasible (at least for time being) while **investing in next generation accelerator R&D** technologies (plasma wakefield, energy recovery linacs, muon acceleration) to position CERN for a future return to energy frontier
- Broad support to **expand non-collider physics**, but as a complement, **not replacement for collider-based research**.
- “*Special case*” if **CEPC** moves ahead: FCC-ee not viable – proceed directly to **FCC-hh**.

# FCC pushed back

Q3: FCC Timescale Adjustment Scenarios

If the FCC is deemed feasible but subject to long-term delays, what should Europe prioritise in the interim?





## Q3e Scenarios Discussion. Plan B-2

- Emerging **consensus**
  - Maintain **FCC** as the **long-term goal**
  - **Accelerator R&D as a strategic priority** – advance FCC-hh readiness while managing delay/feasibility risks through investment in next-generation technologies (e.g. muon collider, plasma wakefield)
- Extending HL-LHC operation, including FPF and “transverse” experiments
- Some support for
  - Interim collider projects, LHeC, LEP3
  - Linear Collider at CERN as a fallback if delays with FCC are extreme.
  - Caution against launching major new collider project unless delays are substantial (20+ yrs)
- **Expand non-collider physics, but not as a replacement for collider-based research.**

# Q3d. Accelerator R&D

- Consensus that CERN and Europe must expand accelerator R&D in parallel with FCC planning
- Prioritised areas include (not in order):
  - High-field magnets
  - Muon collider R&D
  - Plasma wakefield acceleration
  - Energy Recovery Linacs
  - Sustainable and cost-effective accelerator technologies
- R&D is critical to
  - Prepare for future energy frontier machine
  - Manage risks of FCC delays or feasibility issues
  - Ensure Europe remains a leader in accelerator science

# Q4a. Non-Collider Physics Priorities

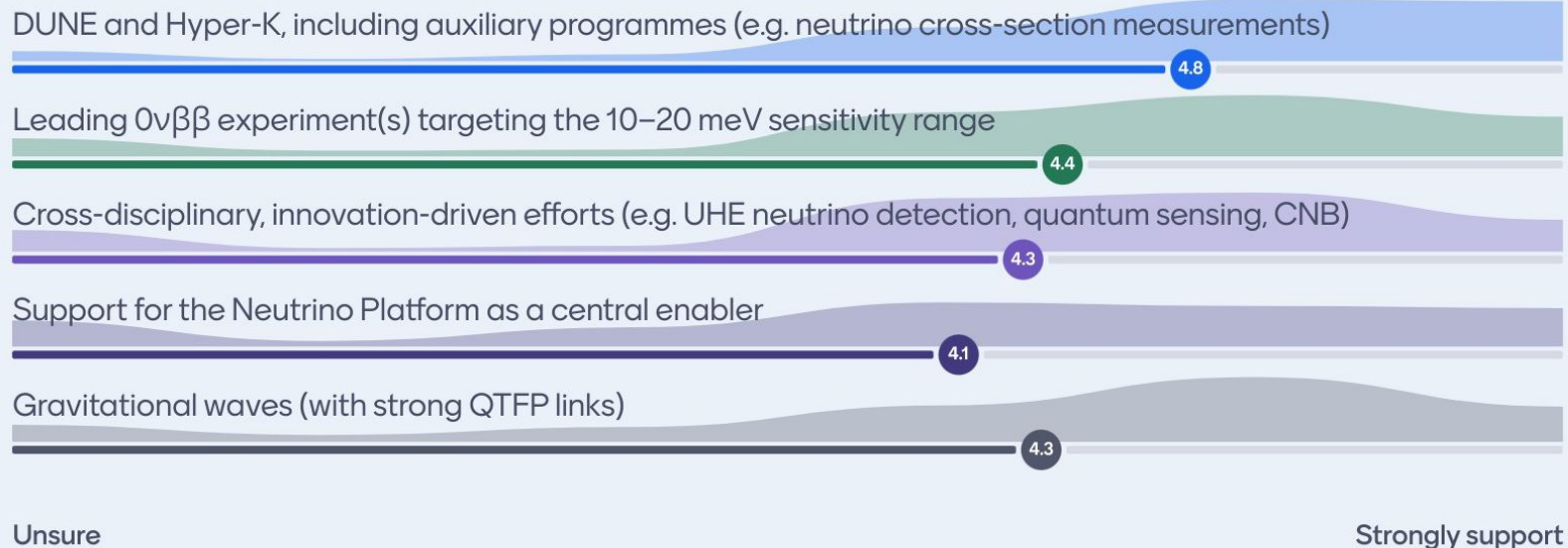
4a) Neutrinos and Cosmic Messengers

4b) Direct Dark Matter and the Dark Sector

4c) Non-Collider Flavour Physics

4d) Quantum Technologies for Fundamental Physics (QTFP)

## Q4a) Neutrinos and Cosmic Messengers. Please indicate level of support.



# Neutrinos and Cosmic Messengers discussion

## Emerging Consensus

- Support DUNE and HyperK as cornerstone non-collider projects
  - With careful attention to cost, balance and strategic value
- Strengthen Neutrino Platform and CERN's role as a hub for neutrino R&D, infrastructure and theory support
- Support for at least one leading 0νbb experiment with European leadership
- Recognise gravitational waves and cosmic messengers as important, but ensure they remain aligned with CERN's mission
- Maintain a **diverse, discovery-driven programme**. Avoid overcommitment to any single project or approach.
- Think about priorities beyond DUNE/HyperK.
  - Absolute mass, CNB, synergies with muon collider (nu-beams from muons).

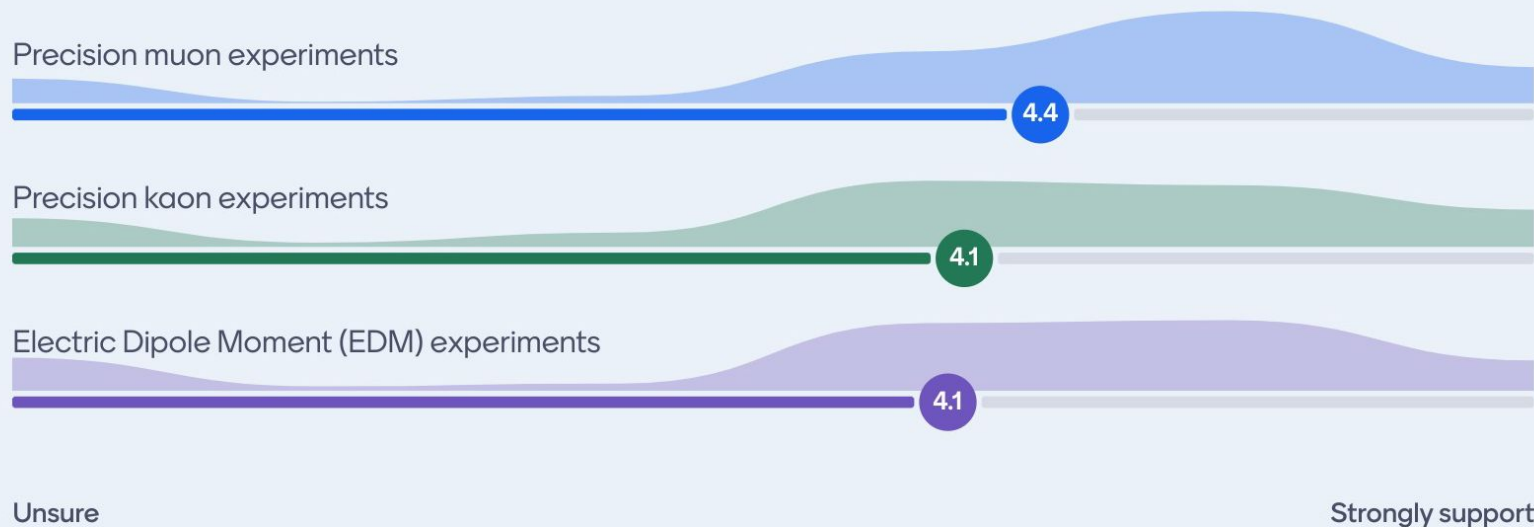
## Q4b) Direct Dark Matter and the Dark Sector. Please indicate level of support.



# Direct Dark Matter and Dark Sector discussion

- **Diverse views** with one clear **convergence**: maintain a **broad, multi-pronged** DM search strategy (WIMPs, axions/ALPs, varied technologies).
- **XLZD@Boulby** offers a unique opportunity, but credibility as a host for a major international project requires clear progress on infrastructure, personnel, and sustainable funding.
- Recognise the scientific value and public impact of DM discovery science, but manage expectations and resources carefully.
- **Balance national** opportunities (e.g., Boulby) with **international** leadership and collaboration, Think about priorities beyond next WIMP experiments.
- **SHiP** emerged as a flagship project of CERN's **PBC programme**

## Q4c) Non-Collider Flavour Physics. Please indicate level of support.





# Non-Collider Flavour Physics discussion

- Scientifically valuable and important but no strong consensus about its strategic priority for CERN or Europe.
- Complementary rather than central to CERN's mission
- Concerns about theoretical uncertainties and diminishing returns
- Desirable in the short term as a complementary effort, with unclear long-term prospects and no overlap with ESPPU-2026 core strategy.

4d) Quantum Technologies for Fundamental Physics (QTFP). Please indicate level of support.

QTFP as a cross-cutting enabler across dark matter, neutrinos, gravity, and fundamental symmetries

4.7

Unsure

Strongly support

# QTFP

- Leverage **UK's early leadership** to help shape CERN's role in this **innovative, complementary** approach to particle physics.
- Unique opportunity to **train young scientists** and strengthen **industry** and **cross-disciplinary** collaboration.
- Efforts should remain **physics-driven**, focusing on questions that cannot be addressed by other means.

# Other Considerations and cross-cutting themes

- Theory
- Sustainability
- Detector R&D
- Software and Computing
- EDI
- Industrial return
- Public outreach

# Summaries

- Mandate CERN to proceed with the **FCC tunnel**, maintaining flexibility between an integrated approach or direct transition to **FCC-hh**.
- Define a clear **Plan B collider strategy** in case FCC faces delays or challenges.
  - Ensure CERN remains the **flagship hub for global collider physics**.
  - Explore “**intermediate**” collider projects (e.g., **LHeC**, **LEP3**) — allocate resources now to fully assess their potential and feasibility.
  - Prioritise **strategic accelerator R&D** aimed at reaching the **10 TeV pCM frontier**.
  - Depending on international situation and FCC feasibility explore Linear Collider at CERN
- Recognise **neutrino physics** as a key pillar of non-collider activities.
- Place greater emphasis on **accelerator-based neutrino experiments**, where CERN’s involvement is most critical and impactful.
- Maintain CERN’s role in coordinating the **European particle physics strategy**, ensuring alignment with bodies like **APPEC**, without requiring explicit cross-prioritisation. Call for CERN support where there are clear synergies (e.g. Neutrino Platform)
- Confirm that the UK’s current **QTFP position** aligns with **DRD5** and reference this alignment in the updated strategy document.