



**HELSINKI  
INSTITUTE OF  
PHYSICS**

# European Strategy for Particle Physics Update 2026

## Finland's contribution to ESPPU

Katri Huitu

SLIDES TAKEN FROM FABIOLA GIANOTTI'S TALK AND KARL JAKOBS'S TALK

# Timeline for the update of the European Strategy for Particle Physics

The third update of strategy: 2006, 2013, 2020



- Finland's input by HIP and Particle Physics Division

# Reminder

According to 2013 Council's decision on the procedural framework, the ESPP:

- is updated “approximately every 5 years” (last update was in June 2020)
- is prepared by European Strategy Group (ESG), assisted by the Strategy Secretariat, based on scientific input from the community summarised by the Physics Preparatory Group (PPG) in a Briefing Book

Note:

- The ESPP provides input and recommendations to the Council about the community's aspirations and priorities.
- The ESPP **does not** approve projects.
- Projects are approved by the Council through a separate decision-making process (CERN/3785/C).

For “major” and “flagship” projects, approval is based not only on input from the community through the ESPP, but also on detailed technical and cost documentation that goes beyond the input to the ESPP (e.g. Technical Design Reports, etc.).

This process may take several years.

# The Strategy Secretariat and European Strategy Group (ESG)

---

## Strategy Secretariat:

Karl Jakobs (Strategy Secretary, Chair)

Hugh Montgomery (SPC Chair)

Dave Newbold (LDG Chair) (until 31. Dec., followed by Mike Seidel, on 1<sup>st</sup> Jan. 2025, as new LDG Chair)

Paris Sphicas (ECFA Chair)

## Organising and running the ESPP process

(bi-weekly meetings over the past two months to ramp up the process)

## European Strategy Group (ESG)

## Preparation of the Strategy Document

(kick-off meeting held on 18<sup>th</sup> September)

- The Strategy Secretary (acting as Chair)
- One representative appointed by each CERN Member State
- **One representative appointed by each of the laboratories represented in the Large Particle Physics Laboratory Directors Group (LDG), including its Chair**
- The CERN Director-General
- The CERN Director-General elect
- The SPC Chair
- The ECFA Chair
- Invitees: President of CERN Council, one representative from each of the Associate Member and Observer States, one representative from the European Commission, the Chairs of APPEC, NuPECC and ESFRI, the members of the Physics Preparatory Group.



# Amended Composition of the European Strategy Group (ESG)

ESG MEMBERS	NAME
<i>Member States</i>	
Austria	Professor Jochen Schieck
Belgium	Professor Pierre Van Mechelen
Bulgaria	Professor Venelin Kozhuharov
Czech Republic	Professor Rupert Leitner
Denmark	Professor Jens Jørgen Gaardhøje
Estonia	Professor Martti Raidal
Finland	Professor Katri Huitu
France	Dr Christelle Roy
Germany	Professor Klaus Desch
Greece	Professor Konstantinos Fountas
Hungary	Dr Dezső Varga
Israel	Professor Marek Karliner
Italy	Professor Antonio Zoccoli
Netherlands	Professor Eric Laenen
Norway	Professor Heidi Sandaker
Poland	Professor Tadeusz Lesiak
Portugal	Professor Mário Pimenta
Romania	Dr Calin Alexa
Serbia	Dr Lidija Zivkovic
Slovakia	Dr Marek Bombara
Spain	Dr Maria Jose Costa
Sweden	Professor Richard Brenner
Switzerland	Professor Ben Kilminster
United Kingdom	Professor Mark Lancaster
CERN Director-General	Dr Fabiola Gianotti
CERN Director-General-Elect	<del>To be appointed in late 2024</del>

**Mark Thomson**

<i>Major European National Labs</i>	
CIEMAT	Dr Nicanor Colino
DESY	Professor Beate Heinemann
IJCLab	Professor Achille Stocchi
IRFU	Professor Franck Sabatié
LNF	Dr Sandra Malvezzi
LNGS	tbc
NIKHEF	Dr Jorgen D'Hondt
PSI	Professor Klaus Kirch
STFC-RAL	Professor Dave Newbold
STFC/Daresbury Lab.	Professor Jim Clarke

<i>Strategy Secretariat Members</i>	
Scientific Secretary (ESG Chair)	Professor Karl Jakobs
SPC Chair	Dr Hugh Montgomery
ECFA Chair	Professor Paris Sphicas
Chair LDG	Professor Dave Newbold

*To take note of the amended composition of the ESG*



# Amended Composition of the European Strategy Group (ESG)

ESG INVITEES	NAME
President of the CERN Council	Professor Eliezer Rabinovici
<i>Associate Member States in the pre-stage to Membership</i>	
Cyprus	Professor Panos Razis
Slovenia	Professor Borut Paul Kerševan
<i>Associate Member States</i>	
Brazil	Professor Leandro Salazar de Paula
Croatia	Dr Budimir Kliček
India	tbc
Latvia	Ms Antra Gaile
Lithuania	Dr Andrius Juodagalvis
Pakistan	Dr Masood Iqbal/Dr Zafar Yasin
Turkey	Dr Bahadır Saygı
Ukraine	Professor Borys Grynyov
<i>Observer States</i>	
Japan	Dr Kazunori Hanagaki
United States of America	Professor Michael Tuts
<i>Organisations with Observer status</i>	
European Commission	Ms Patricia Postigo McLaughlin
<i>Other invitees</i>	
Chair APPEC	Dr Andreas Haungs
Chair NuPECC	Professor Marek Lewitowicz
Chair ESFRI	Professor José Luis Martínez
The other members of the PPG (in addition to the Strategy Secretariat)	To be appointed in September 2024

Dr. Andreas Haungs asked to be replaced by: Prof Carlos Peña Garay (new APPEC Chair)  
→ revised version of the document

*To take note of the amended composition of the ESG*



# The Physics Preparatory Group (PPG)

**Physics Preparatory Group (PPG):** collects input from the community, organises the Open Symposium, prepares the Briefing Book

- Strategy Secretary (acting as Chair)
- **Four members appointed by Council on the recommendation of the SPC**
- **Four members appointed by Council on the recommendation of ECFA**
- **One representative appointed by CERN**
- **Two representatives from the Americas**
- **Two representatives from Asia**
- The SPC Chair
- The ECFA Chair
- The LDG Chair

~~To approve the establishment of the PPG~~

Appointed in September

<b>PPG MEMBERS</b>	
<i><b>Strategy Secretariat</b></i>	
Scientific Secretary (Chair)	Professor Karl Jakobs (DE)
SPC Chair	Dr Hugh Montgomery (US)
ECFA Chair	Professor Paraskevas Sphicas (GR)
LDG Chair	Professor Dave Newbold (UK)
<i>SPC</i>	<del>To be appointed by the Council</del>
Professor Pilar Hernandez (ES)	
Professor Gino Isidori (CH)	
Professor Fabio Maltoni (BE/IT)	
Professor Jocelyn Monroe (UK)	
<i>ECFA</i>	<del>To be appointed by the Council</del>
Dr Tommaso Boccali (IT)	
Dr Thomas Bergauer (AT)	
Dr Cristinel Diaconu (FR)	
Professor Monica Dunford (DE)	
<i><b>CERN</b></i>	
Dr Gianluigi Arduini (CERN)	
<i><b>ASIA/AMERICAS</b></i>	
Dr Anadi Canepa (USA)	
Professor Xinchou Lou (China)	
Professor Rogério Rosenfeld (Brazil)	
Professor Yuji Yamazaki (Japan)	





## 2 : Major developments since the 2013 Strategy

HL-LHC; neutrinos

## 3 : General considerations for the 2020 update

Europe's leadership role; collaboration CERN-European labs; collaboration with global partners

## 2 : High-priority future initiatives

Future colliders; accelerator R&D

## 4 : Other essential scientific activities for particle physics

Scientific diversity programme; theory; detector R&D; SW and computing

## 2 : Synergies with neighbouring fields

Astroparticle physics; nuclear physics

## 3 : Organisational issues

Global projects; relations with EC; open science

## 4 : Environmental and societal impact

Environmental protection; early-career scientists; technology transfer; public engagement

# Next update of the ESPP : motivations (I)

The proposed timeline is dictated primarily by the goal of **starting operation of the next collider at CERN in ~ 2045**:

- For operation to start in ~ 2045, construction of the facility must start by 2032\*
- For construction to start by 2032, Council's approval would be needed by end 2027/beg 2028\*
- For Council's approval to be granted by end 2027/beg 2028, the ESPP should be completed by Jun 2026, as at least 1-2 years from the end of the ESPP are needed for Council and its subordinate bodies to assess the necessary documentation for approval (e.g. pre-TDR, TDR, etc.)

\* This is based on the current FCC schedule (e.g. CE tendering design would need to start Q2 2028).

If FCC does not go ahead, a decision by end 2027/beg 2028 is even more important, as no detailed geological and territorial implementation studies have been made for other colliders (these take several years, based on the FCC experience).

# Next update of the ESPP : motivations (II)

- ❑ **Timely decision needed on a future collider at CERN:**
  - to keep community's engagement and expertise, in particular young generations (→ see later)
  - competition with China
  - FCC: external temporal constraints (need to reserve the land for the 8 surface points)
  - another collider: no detailed geological and territorial implantation study done so far (FCC Feasibility Study shows that this takes years)
  
- ❑ **The landscape of current facilities is well established:** HL-LHC, LBNF/DUNE, Hyper-Kamiokande, SuperKEKB B-factory.  
**No other major high-energy physics facility currently in the approval phase for construction at CERN or elsewhere.**  
→ Appropriate time to start to plan for the next major project. The other regions of the world have made up their minds (see below).
  
- ❑ **Excellent progress in the R&D and design studies for future colliders at CERN and beyond, since last Strategy update:**
  - **FCC Feasibility Study** (essential input to next ESPP): **significant accomplishments** (→ see mid-term review reports); **solid plan being developed to complete the Study in 9-12 months, with final report in March 2025** (→ see M. Benedikt's presentation)
  - **CLIC/ILC**: progress towards technical readiness for start of construction
  - **Muon colliders**: progress towards definition of next R&D steps (e.g. demonstrator)
  
- ❑ **International landscape** is essential input to Strategy: **clearer view from recent developments:**
  - **ILC**: Japan seems to be waiting for CERN's plans on FCC to take a decision on the ILC
  - **US**: P5 report supports an offshore Higgs factory (FCC-ee, ILC) and, for longer term, a muon collider hosted in the US
  - **China**: CEPC TDR released Dec 2023. Chinese government will select projects to be supported by next 5-year funding cycle in ~ 2025
  
- ❑ **CERN scientific programme beyond colliders:**
  - **ongoing and new experiments at the injectors** (ISOLDE, n\_TOF, AD/ELENA, North Area fixed-target programme, etc.) require **significant upgrades of the facilities** (beyond ECN3, which is already planned in LS3)
  - **early guidance in 2026 about priorities would allow clear roadmaps to be established for each facility** → resources allocation on both consolidation and long-term technology development (e.g. new target for n\_TOF requires substantial R&D)
  - **these roadmaps would also provide clarity to the collaborations about their future**, and opportunity to align with international efforts

The long-term community engagement is a concern

The gap between end of HL-LHC (2041) and the start of the next collider should be minimised:

1) **To ensure preservation and continuity of expertise**

2) **The young generations** in Member States and beyond **have repeatedly emphasised** (→ see next slide):

-- the need to have a clear view of the future of the field beyond the HL-LHC as soon as possible

-- that there be a credible timeline for the realisation of any future collider project at CERN that warrants their long-term commitment

Note: because of the increasingly longer lead time for HEP projects, today's young researchers are more concerned about their future than previous generations. E.g., a young post-doc currently working in one of the LHC experiments will be approaching the end of his/her career if the next collider only starts operation at the end of the 2040s.

The risk that the young people leave the field or leave Europe because of lack of prospects, and the potentially serious consequences that such departures would have on the physics exploitation of the HL-LHC, should not be underestimated.

A timely decision about the future programme at CERN, and the timely implementation of this programme, are therefore crucial to ensuring the long-term commitment of the community, in particular that of the young generations

# Organisation of the work in PPG

---

The Strategy Secretariat proposes **nine working groups** to cover the full range of physics topics as well as the technology areas of accelerators, detector technologies and computing.

- Electroweak physics (including Higgs physics)
  - Strong interaction
  - Flavour physics
  - Beyond the Standard Model physics
  - Neutrino physics and cosmic messengers
  - Dark matter and dark sector
  - Accelerator science and technology
  - Detector instrumentation
  - Computing
- This closely follows the model adopted in the last Strategy update, except that it is suggested to have separate working groups for detector instrumentation and computing.
  - As in the previous update, each group will have two co-conveners to organise the work.



## Organisation of the work in PPG (cont.)

---

To **increase the engagement by the broader particle physics community** in the current update, the Strategy Secretariat proposes the following scheme for co-conveners:

- Only half of the co-convenerships are assigned to members of the PPG.
- The second co-convener in each working group is appointed from among the scientists proposed to the SPC and ECFA by the community.
- To enable this, the ex-officio members (ECFA Chair, SPC Chair and LDG Chair) and the representatives from the Americas and Asia are not proposed as co-conveners.
- Each of the nine PPG members suggested by the SPC (4), ECFA (4) and CERN (1) will take on the co-convenership of one of the groups and will represent the corresponding working group in the PPG.
- The role of the representatives from Asia and the Americas – together with the ex-officio members and the Chair – is to maintain the coherence of the overall effort.
- The Strategy Secretariat proposes to engage one **Early Career Researcher (ECR) for each of the nine working groups to act as scientific secretary.**  
The appointed co-conveners should be involved in the selection of these ECRs.



# List of co-conveners

Working group	Co-convener	Co-convener
	PPG member	
Electroweak physics	Monica Dunford (DE, exp)	Jorge de Blas (ES, <u>theory</u> )
Strong interaction	Cristinel Diaconu (FR, exp)	Andrea Dainese (IT, exp, HI)
Flavour physics	Gino Isidori (CH, theory)	Marie-Hélène <u>Schune</u> (FR, <u>exp</u> )
BSM physics	Fabio Maltoni (BE/IT, theory)	Rebecca Gonzales-Suarez (SE, exp)
Neutrino physics and cosmic messengers	Pilar Hernandez (ES, theory)	Sara Bolognesi (FR, exp)
Dark matter and dark sector	Jocelyn Monroe (UK, exp)	Matthew McCollough (CERN, theory)
Accelerator science and technology	Gianluigi Arduini (CERN, acc)	Phil Burrows (UK, exp, acc)
Detector instrumentation	Thomas Bergauer (AT, exp)	Ulrich Husemann (DE, exp)
Computing	Tommaso Boccali (IT, exp, comp)	Borut Kersevan (SL, exp, comp)

- 10 European countries and CERN represented
- 12 men, 6 women
- 13 experimentalists, 5 theorists



# Short summary of the charge to the co-conveners

---

- Selection of Early Career Researchers
- Definition of sub-topics and appointment of additional working group members
- Definition of benchmark processes
- Organisation of working-group meetings
- Writing of the Physics Briefing Book  
(will be supported by Roger Forty, who has agreed to be Scientific Secretary of the Strategy update)

*It is expected that for each physics area comparative assessments on the physics potential of various proposed projects for the defined benchmark are made. By construction this comparison should be made at the working group level;*

*A more global comparison across various physics areas is the responsibility of the ESG.*





# Work / topics covered and shared among PPG and ESG

---

## PPG: Physics + Technology working groups

- Electroweak physics (including Higgs physics)
- Strong interaction
- Flavour physics
- Beyond the Standard Model physics
- Neutrino physics and cosmic messengers
- Dark matter and dark sector
- Accelerator science and technology
- Detector instrumentation
- Computing

→ **Physics Briefing Book**

## ESG: Overarching topics

- **National input / roadmaps (→ strategic)**
- **Projects (FCC, LC, LE-FCC-hh, MC, ..)**  
(**timeline, costs, .... (physics → PPG) )**)
- Comparisons across proposed projects
- Relations with other fields of physics
- Implementation of the Strategy  
(role of CERN and National Labs, coordination of European participation in projects sited outside Europe, ...)
- Knowledge and Technology transfer
- Sustainability, environmental impact
- Public engagement, education, communication
- ...

→ *ESG working groups to be set up, to make sure relevant input becomes available in time*



## Next steps

---

- **1<sup>st</sup> Meeting with PPG** (as soon as appointments by Council are made)

(Discussion on charge, follow-up discussions with individual working groups, ..  
at a later stage: discussion of ECR appointments, group structure, benchmarks, ...)

- **In-person ESG meeting planned (~~December Council week~~ or early Jan. 2025)**

(Main topic: ESG working groups; the Strategy Secretariat will prepare a proposal)



### II. Remit of the European Strategy Group

The remit of the European Strategy Group (ESG), established in June 2024, is to develop an update of the European Strategy for Particle Physics and submit it for approval by the 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 ESG should take into consideration:

- the input of the particle physics community;
- the status of implementation of the 2020 Strategy update;
- the accomplishments over recent years, including the results from the LHC and other experiments and facilities worldwide, the progress in the construction of the High-Luminosity LHC, the outcome of the Future Circular Collider Feasibility Study, and recent technological developments in accelerator, detector and computing;
- the international landscape of 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. The Strategy update should also indicate areas of priority for exploration complementary to colliders and for other experiments to be considered at CERN and at other laboratories in Europe, as well as for participation in projects outside Europe.

The ESG should review and update the Strategy and add other items identified as relevant to the field, including accelerator, detector and computing R&D, the theory frontier, actions to minimise the environmental impact and to improve the sustainability of accelerator-based particle physics, the strategy and initiatives to attract, train and retain the young generations, public engagement and outreach.

The ESG should submit the proposed Strategy update to the Council by the end of January 2026.

## Input is needed for:

- Next preferred flagship + prioritised alternatives
- Priorities for experiments complementary to colliders, for other experiments at CERN
- Accelerator, detector and computing R&D
- Theory frontier
- Environmental impact and sustainability
- Attract, train and retain the young generations
- Public engagement and outreach

*Answer ECFA questions!*



# Long-Term Strategy of HIP, Update 2024

<https://flamma.helsinki.fi/documents/d/fysiikan-tutkimuslaitos-hip/draft-hip-long-term-strategy-update-131124-pdf>

1. LHC experiments
2. FAIR operations
3. Future high-energy frontier
4. Theoretical physics
5. Other experimental activities at CERN
6. Cosmology and astroparticle research
7. Technological connections and knowledge transfer
8. Detector laboratory
9. Outreach
10. Open science
11. Wellbeing and diversity
12. Sustainability and responsibility

Several events where strategy update 2024 was discussed:

- meetings of the Programmes 2023–2024;
- HIP Town Meeting May 2024;
- comments from SAB;
- decided by HIP Board 21.11.2024

*Next update expected in 2028*

# Timeline for the update of the European Strategy for Particle Physics

The third update of strategy: 2006, 2013, 2020



- Finland's input by HIP and Particle Physics Division



Thank You.



# ECFA guidelines / questions

---

- a) Which is the preferred next major/flagship collider project for CERN?
- b) What are the most important elements in the response to (a)?
- i) **Physics potential**
  - ii) **Long-term perspective**
  - iii) **Financial and human resources: requirements and effect on other projects**
  - iv) **Timing**
  - v) **Careers and training**
  - vi) **Sustainability**
- c) Should CERN/Europe proceed with the preferred option set out in (a) or should alternative options be considered:
- i) **if Japan proceeds with the ILC in a timely way?**
  - ii) **if China proceeds with the CEPC on the announced timescale?**
  - iii) **if the US proceeds with a muon collider?**
  - iv) **if there are major new (unexpected) results from the HL-LHC or other HEP experiments?**
- d) Beyond the preferred option in (a), what other accelerator R&D topics (e.g. high-field magnets, RF technology, alternative accelerators/colliders) should be pursued in parallel?
- e) What is the prioritised list of alternative options if the preferred option is not feasible (due to cost, timing, international developments, or for other reasons)?
- f) What are the most important elements in the response to (e)? (The set of considerations in (b) should be used).

Paris Sphicas

# National HEP input on non-collider projects and other fields

---

Paris Sphicas

## Remit to ESG also specifies:

“The Strategy update should also indicate areas of priority for exploration complementary to colliders and for other experiments to be considered at CERN and at other laboratories in Europe, as well as for participation in projects outside Europe.”

**It would thus be most useful if the national inputs explicitly included the preferred prioritisation for non-collider projects. Specific questions to address:**

- a) What other areas of physics should be pursued, and with what relative priority?
- b) What are the most important elements in the response to (a)? (The set of considerations as for the “next collider” should be used).
- c) To what extent should CERN participate in nuclear physics, astroparticle physics or other areas of science, while keeping in mind and adhering to the CERN Convention? Please use the current level and form of activity as the baseline for comparisons.

