European Strategy for Particle Physics

Paris Sphicas
CERN & NKUA
HEPAP Meeting
Rockville, MD, December 5, 2024

- **Update of the European Strategy for Particle Physics (ESPP)**
  - **Secretariat, EDG, PPG and working groups**
- **National HEP community inputs: ECFA guideline**
- **ESPP Guidelines for Input from Large-Scale Projects**
- **Onwards, and from here, where to?**

European Strategy for Particle Physics

Continuous community-driven process

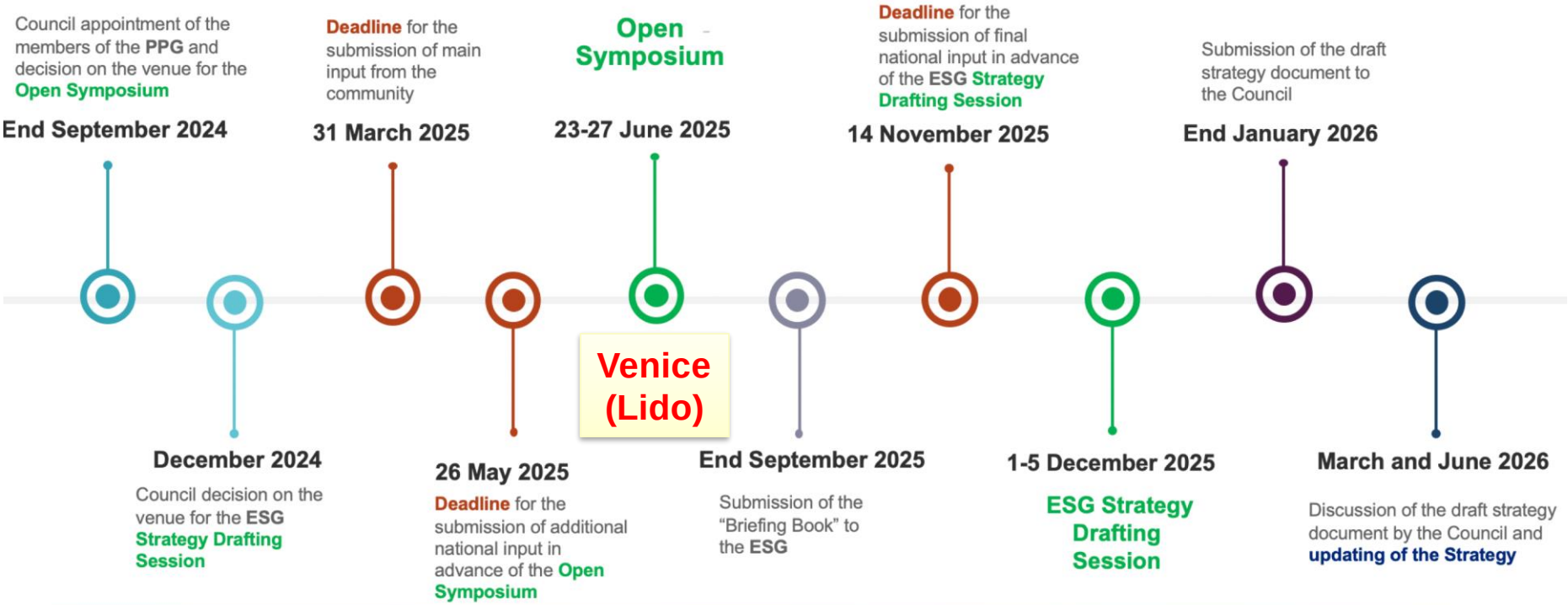
- **First ESPP in 2006** http://europeanstrategy.cern
- **2013 update: HL-LHC decision**
- **2020 update: post-HL-LHC recommendations:**
  - ***An electron-positron Higgs factory is the highest-priority next collider. For the longer term, the European particle physics community has the ambition to operate 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.***
  - ***Detector R&D programmes and associated infrastructures should be supported at CERN, national institutes, laboratories and universities. Synergies between the needs of different scientific fields and industry should be identified and exploited to boost efficiency in the development process and increase opportunities for more technology transfer benefiting society at large. [... The community should define a global detector R&D roadmap that should be used to support proposals at the European and national levels..***
  - **Successful completion of High-Luminosity LHC must remain key focus**
- **2026 update: "just" commenced**

http://dx.doi.org/10.17181/CERN.JSC6.W89E

ESPP: organization, bodies and charges

ESPP (I): launch of next (current) update

- **In March 2024 CERN Council launched the new ESPP process:**
  - **Timeline:**



ESPP (II): Secretariat, EDG, PPG and working groups

- **"Secretariat":**
  - Secretary (chair): K. Jakobs
  - CERN SPC chair: H. Montgomery
  - ECFA chair: PS
  - LDG chair: D. Newbold
    - M. Seidel from 1/1/2025
- **European Strategy Group (ESG):**
  - Secretariat (secretary chairs ESG);
  - One rep per CERN member state;
  - One rep per lab in LDG;
  - CERN DG, CERN DG-elect;
  - Invitees: PPG, President of Council, 1 rep from each Associate Member State and Observer State, 1 rep from EC; chairs of ApPEC, NuPECC, ESFRI
- **Physics Preparatory Group (PPG):**
  - Secretariat (secretary chairs ESG);
  - 4 people nominated by SPC
  - 4 people nominated by ECFA
  - 2 people nominated by Americas
  - 2 people nominated by Asia
  - 1 person nominated by CERN

- **Nine Working Groups (WGs):**
  - Last time's Computing and Instrumentation split (8 WGs of 2020 ESPP→ 9 WGs):
    - Computing WG and
    - Instrumentation WG
- **Increase engagement by HEP community:**
  - Each WG: only one co-convener from PPG
  - Second co-convener from SPC/ECFA lists
  - So: Ex-officio members (ECFA, SPC and LDG Chairs) and representatives from the Americas and Asia are not co-conveners.
- **Role of representatives from Asia and the Americas, and ex-officio members and Chair: maintain coherence of overall effort.**
- **Engage the generation most concerned: Each WG must appoint a scientific secretary who is an Early Career Researcher:**
  - A scientist without an indefinite position and within 10 years from PhD.
  - Selected by conveners, using nominees collected by ECFA and their own knowledge of the people in the thematic area.

ESPP (III): responsibilities of PPG/WG 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

à Physics Briefing Book

ESG: Overarching topics

- **National input / roadmaps (à strategic)**
- **Projects (FCC, LC, LE-FCC-hh, MC, ..)**
  (timeline, costs, …. (physics à 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
- …

PPG Working Groups: conveners and scientific secretaries (ECRs)

Working Group	Conveners	Scientific Secretary
Electroweak incl. Higgs	Monica Dunford (DE, exp); Jorge de Blas (ES, theory)	Emanuele Bagnaschi (IT)
Strong interactions	Cristinel Diaconu (FE, exp); Andrea Dainese (IT, exp, HI)	Chiara Signorile-Signorile (DE)
Flavour physics	Gino Isidori (CH, theory); Marie-Hélène Schune (FR, exp)	Maria Piscopo (NL)
BSM physics	Fabio Maltoni (BE/IT, theory); Rebeca Gonzalez-Suarez (SE, exp)	Benedikt Maier (UK)
Neutrinos and cosmic messengers	Pilar Hernandez (ES, theory); Sara Bolognesi (FR, exp)	Iván Esteban (ES)
Dark matter and dark energy	Jocelyn Monroe (UK, exp); Matthew McCullough (CERN, theory)	Yohei Ema (CERN)
Accelerator technologies	Gianluigi Arduini (CERN, accelerators); Phil Burrows (UK, exp, accelerators)	Jacqueline Keintzel (CERN)
Detector instrumentation	Thomas Bergauer (AT, exp); Ulrich Husemann (DE, exp)	Dorothea vom Bruch (FR)
Computing	Tommaso Boccali (IT, exp, comp); Borut Kersevan (SI, exp, comp)	Daniel Th. Nurnane (DK)

National HEP community inputs: ECFA guidelines

ESPP: Some lessons learned from 2020 update

- **Last ESPP: there was a round of receiving "national inputs"**
  - **Responses varied widely: For small(er) countries, feedback was ~uniform and easy to interpret; For large(r) countries, feedback was non-uniform, often favoring multiple priorities (e.g. type of next collider)**
  - **Lesson learned: while it will always be difficult to summarize the "position" of an entire country, at least we can aim at uniform responses and targeted questions.**

- **Plan for this round: ECFA to facilitate widest possible discussion(s);**
  - **Engage maximum number of colleagues, especially ECRs**
  - **Guide the formation of the "national inputs" to better inform the ESPP process.**
    - **National inputs can be collected individually by each single country or a group of countries/region.**
    - **Formulated set of questions and issues for discussion by national communities**
      - **Clearly, not an exclusive list, countries/groups could/should add their own issues/concerns/wishes etc**

Link to ECFA guidelines

ECFA guidelines for National HEP community inputs

- **ESG remit:**
  - **“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”.**

- **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.”**

Questions to address

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 preferred option, 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)?

Prioritisation for non-collider projects:

- **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)?**
- **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.**

ESPP Guidelines for Input from Large-Scale Projects

Large-Scale Projects: Guidelines for Input

- **‘Large-scale’ :== ‘occupying the resources and efforts of an appreciable fraction of the European particle physics community for a number of years’.**
  - **In financial terms, this indicates a capital investment of at least 250 MCHF.**

- **In addition to … scientific potential … sequence of delivery steps and the challenges associated with delivery; to understand how each project could fit into the wider roadmap for European particle physics.**

- **In order to allow a straightforward comparison of projects, we therefore request that all large-scale projects submit – in addition to their physics case and technical description – a standardised set of technical data.**

Questions to projects (I)

1. Stages and parameters

a. The main stages of the project and the key scientific goals of each

b. Whether the ordering of stages is fixed or whether there is flexibility

c. For each stage, the main technical parameters

d. The number of independent experimental activities and the number of scientists expected to be engaged in each.

2. Timeline

a. The technically-limited timeline for construction of each stage

b. The anticipated operational (running) time at each stage, and the expected operational duty cycle

3. Resource requirements

a. The capital cost of each stage in 2024 CHF

b. The annual cost of operations of each stage

c. The human resources (in FTE) needed to deliver or operate each stage over its lifetime, expressed as an annual profile

d. Commentary on the basis-of-estimate of the resource requirements

Questions to projects (II)

4. Environmental impact

a. The peak (MW) and integrated (TWh) energy consumption during operation of each stage

b. The integrated carbon-equivalent energy cost of construction

c. Any other significant expected environmental impacts

5. Technology and delivery

a. The key technologies needed for delivery that are still under development in 2024, and the targeted performance parameters of each development

b. The critical path for technology development or design

c. A concise assessment of the key technical risks to the delivery of the project

6. Dependencies

a. Whether a specific host site is foreseen, or whether options are available

b. The dependencies on existing or required infrastructure

c. The technical effects of project execution on the operations of existing infrastructures at the host site

Questions to projects (III)

7. Commentary on current project status

a. A concise description of the current design / R&D / simulation activities leading to the project, and the community pursuing these

b. A statement of any major in-kind deliverables already negotiated

c. Any other key technical information points in addition to those captured above, including references to additional public documents addressing the points above.

Outlook

Current work en route to March 2025

- **PPG Working groups are working to**
  - **Define physics/engineering benchmarks for distribution to the projects**
  - **Identify members of their groups**

- **Next: organization of Symposium in June**
  - **Aiming for more plenary time and more discussions (than previous strategy)**

- **Looking forward to participation from US colleagues**

- **Stay tuned…**