La strategia europea della fisica delle particelle

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Bari - Giornate del Piano Triennale 2019

EUROPEAN STRATEGY FOR PARTICLE PHYSICS

The European Strategy for Particle Physics is the cornerstone of Europe's decision-making process for the long-term future of the field. Mandated by the CERN Council, it is formed through a broad consultation of the grass-roots particle physics community, it actively solicits the opinions of physicists from around the world, and it is developed in close coordination with similar processes in the US and Japan in order to ensure coordination between regions and optimal use of resources globally.

CERN Council Open Symposium on the Update of

European Strategy for Particle Physics

13-16 May 2019 - Granada, Spain

Preparatory Group

STRATEGY SECRETARIAT	
Scientific Secretary (Chair)	Prof. Halina Abramowicz (IL)
SPC Chair	Prof. Keith Ellis (UK)
ECFA Chair	Prof. Jorgen D'Hondt (BE)
Chair EU Lab. Directors' Mtg	Prof. Lenny Rivkin (CH)

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Prof. Beate Heinemann (DE)
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ASIA/AMERICAS
Prof. Shoji Asai (Japan)
Prof. Marcela Carena (USA)
Prof. Xinchou Lou (China)
Prof. Brigitte Vachon (Canada)

CERN
Dr Gian Giudice

Secretariat

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Physics Briefing Book

Input for the European Strategy for Particle Physics Update 2020

c’è tutto !

https://arxiv.org/pdf/1910.11775.pdf

European Strategy Group

MEMBERS

Member States	
Austria	Prof. Jochen Schieck
Belgium	Prof. Dirk Ryckbosch
Bulgaria	Prof. Leander Litov
Czech Republic	Prof. Tomas Davidek
Denmark	Prof. Jens-Jørgen Gaardhøje
Finland	Prof. Paula Eerola
France	Dr Reynald Pain
Germany	Prof. Siegfried Bethke
Greece	Prof. Costas Fountas
Hungary	Prof. Peter Levai
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Norway	Prof. Gerald Eigen
Poland	Prof. Jan Królikowski
Portugal	Prof. Mario Pimenta
Romania	Dr Alexandru-Mario Bragadireanu
Serbia	Prof. Peter Adzic
Slovakia	Prof. Stanislav Tokar
Spain	Prof. Maria José Garcia Borge
Sweden	Prof. Kerstin Jon-And
Switzerland	Prof. Tatsuya Nakada
United Kingdom	Prof. Jonathan Butterworth
CERN Director-General	Dr Fabiola Gianotti

ESG INVITEES

President of the CERN Council	Dr Ursula Bassler
Associate Member States in the pre-stage to Membership	
Cyprus	Prof. Panos Razis
Slovenia	Prof. Boštjan Golob
Associate Member States	
Lithuania	tbc
Turkey	Mr Alper Yüksel
Ukraine	tbc
States with special Observer status (LHC)	
Japan	Prof. Yasuhiro Okada
Russian Federation	Prof. Vladimir Kekelidze
United States of America	Dr Abid Patwa
Organisations with Observer status	
European Commission	Mr Adam Tyson
JINR	Prof. Boris Sharkov
Other invitees	
Chair ApPEC	Prof. Teresa Montaruli
Chair ESFRI	Prof. Jan Hrusak
Chair FALC	Prof. Michael Procario
Chair NuPECC	Prof. Marek Lewitowicz

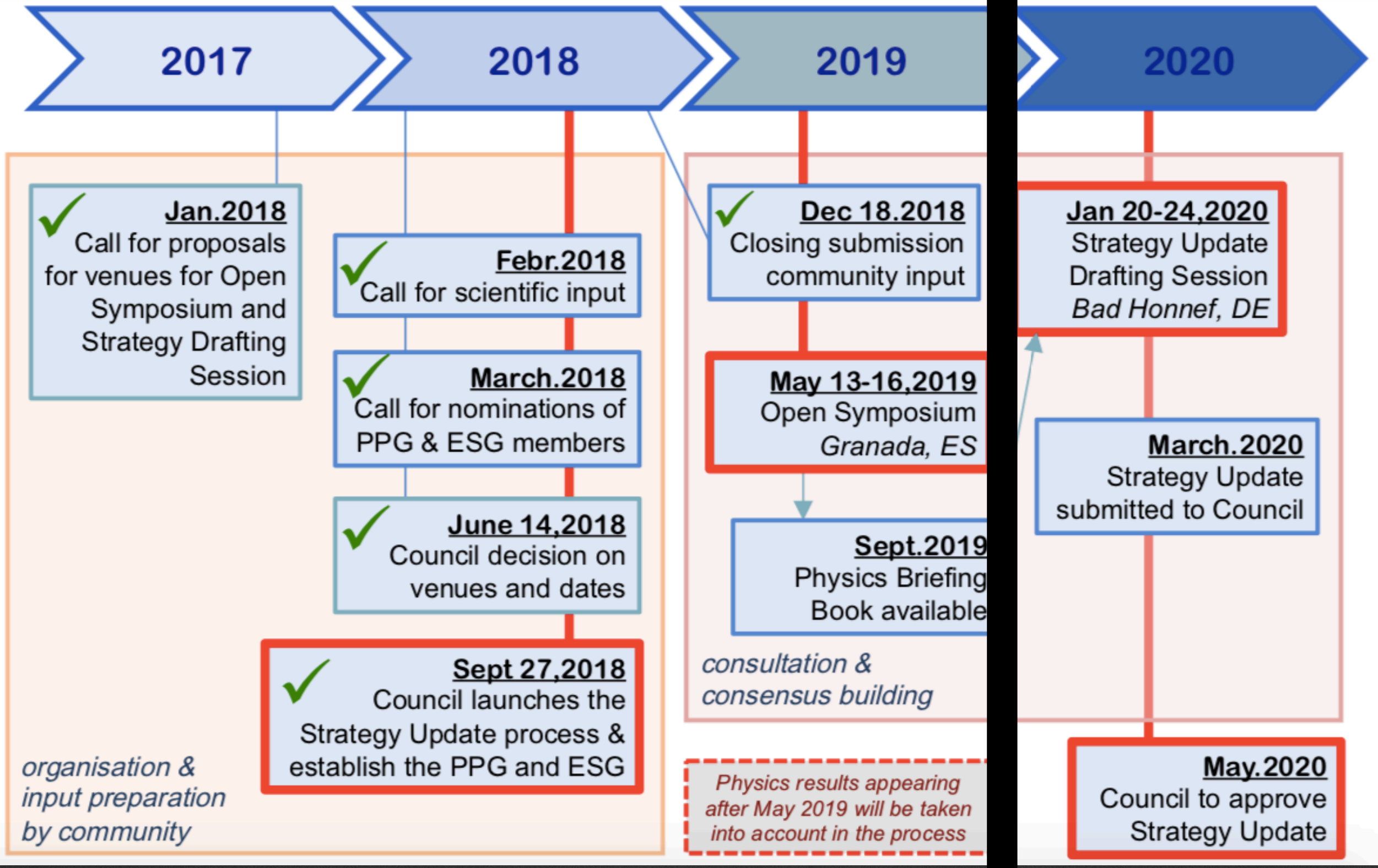
Major European National Labs	
CIEMAT	Prof. Nicanor Colino
DESY	Prof. Joachim Mnich
IRFU	Prof. Anne-Isabelle Etienvre
LAL	Prof. Achille Stocchi
NIKHEF	Prof. Sijbrand de Jong
LNF	Dr Pierluigi Campana
LNGS	Prof. Stefano Ragazzi
PSI	Prof. Klaus Kirch
STFC-RAL	Prof. Mark Thomson

F. Zwirner fino a Luglio

Other members of the PPG Strategy Secretariat)

Strategy Secretariat Members	
Scientific Secretary (ESG Chair)	Prof. Halina Abramowicz
SPC Chair	Prof. Keith Ellis
ECFA Chair	Prof. Jorgen D'Hondt
Chair EU Lab. Directors' Mtg	Prof. Leonid Rivkin

Timeline


2017
2018
2019
2020
Jan.2018
Call for proposals for venues for Open Symposium and Strategy Drafting Session
Febr.2018
Call for scientific input
March.2018
Call for nominations of PPG & ESG members
June 14,2018
Council decision on venues and dates
Sept 27,2018
Council launches the Strategy Update process & establish the PPG and ESG
organisation & input preparation by community
Dec 18.2018
Closing submission community input
May 13-16,2019
Open Symposium
Granada, ES
Sept.2019
Physics Briefing Book available
consultation & consensus building
Physics results appearing after May 2019 will be taken into account in the process
Jan 20-24,2020
Strategy Update Drafting Session
Bad Honnef, DE
March.2020
Strategy Update submitted to Council
May.2020
Council to approve Strategy Update

Elementi di discussione

	2020-2040 *HL-LHC era*	2040-2060 *Z/W/H/top-factory era*	2060-2080 *energy frontier era*
our technology	SCRF ~ 30 MV/m B ~ 11 T	SCRF ~ 50 MV/m B ~ 14 T plasma demo muon demo	SCRF ~ 70 MV/m B > 16 T (HTS?) plasma collider muon collider
other technology	AI for new physics quasi-online analysis digital imaging new transistors	quantum computing self-learning simulation	…
societal threats	eco friendly gases careers at mega-research facilities	energy consumption long-term engagement global vs sustained collaboration	human vs machine

Scenari e domande

	2020-2040	2040-2060	2060-2080
		1st gen technology	2nd gen technology
CLIC-all	HL-LHC	**CLIC380-1500**	CLIC3000 / other tech
CLIC-FCC	HL-LHC	**CLIC380**	FCC-h/e/A (Adv HF magnets) / other tech
FCC-all	HL-LHC	**FCC-ee (90-365)**	FCC-h/e/A (Adv HF magnets) / other tech
LE-to-HE-FCC-h/e/A	HL-LHC	**LE-FCC-h/e/A (low-field magnets)**	FCC-h/e/A (Adv HF magnets) / other tech
LHeC-FCC-h/e/A	HL-LHC **+ LHeC**	**LHeC**	FCC-h/e/A (Adv HF magnets) / other tech

tanto per parlare di soldi….

- CLIC-all costa 17 GEuro (tunnel 3.3 GE)
- FCC-all costa 26 GEuro (tunnel 5.4 GE)
- CLIC-FCC costa 31 GE (tunnel 6.7 GE)
- LE-FCC + HE-FCC costa 32 GE (tunnel 5.4 GE)
  (probabilmente la fase LE ne costa 15)
- LHeC + FCC costa 28 GE (tunnel 5,4 GE)

tutto con serie incertezze (no TDR !)

La posizione INFN

Scenario	Main pro-contra arguments	INFN involvement, community support
CLIC	Precision measurements limited to Higgs and top. Indirect sensitivity to new physics comparable to FCC-hh only at 3 TeV	Very limited
CLIC+FCC-hh	Precision measurements limited to Higgs and top. Cost higher than full FCC.	Involvement only for the FCC-hh part
FCC	Precision measurements at Z, W, H and top, relatively easy machine, followed by direct broad exploration of new territory	Strong INFN community for both FCC-ee and FCC-hh
LE-to-HE-FCC	Could be an interesting option should ILC (or other e^+e^- colliders) start construction	Involvement from the LHC and FCC-hh communities
LHeC+FCC-hh	Gain from LHeC on Higgs couplings after HL-LHC limited. Investigations on u,d couplings and proton structure.	Expect limited participation to LHeC program, expect involvement mostly on HL-LHC and FCC-hh preparation.

INFN arguments for the FCC-all option

- We think that the ESPP update should be based on significant jump in precision (e.g. in Higgs boson properties) and broad exploration (e.g. search of new physics at the energy frontier)
- We believe that, out of the five proposed scenarios, the FCC-all option is the best one in this respect.
- **In the FCC-ee phase electroweak physics will be studied with unprecedented precision not only in the sector related to the newly discovered scalar boson, but also in the Z, W and top quark sectors.**
- **The FCC-hh phase would guarantee in the best way direct broad exploration of new territories.**

INFN arguments for the FCC-all option

- Option robust against any decision taken in other geographical regions.
  - Should ILC (or other e^+e^- colliders) start construction in the next decade or so, then CERN could directly proceed to FCC-hh, presumably starting with low-field magnets.
  - Otherwise the FCC-ee would be the first step.
- Moreover FCC is the infrastructure that provides the most flexible tool for our research in the next decades, including the possibility of having at least two detectors operating, which is mandatory in case of discovery or evidence of some anomaly.
- The physics case is robust and the European leadership in the field would be maintained, giving opportunities to the several thousands of PhD and PostDoc in our field to become an asset for the future of continent.
- As funding is the issue, it is necessary to know rather soon whether the member states and EU are willing to support this project.
  - →**it is mandatory to explore the feasibility of this project**
- There are no major new elements, which could drastically change the present scenario, expected before next strategy update, therefore the FCC-all option should be studied in depth in all its aspects (including technical, financial and organizational) to be ready for next ESPP update.

Strong support for accelerators R&D

- We would like to add that we believe that the ESPP conclusive document should include a **strong statement in support of continuing the R&D of new technologies for accelerators.** In particular, studies and experiments aimed at the development of a **muon collider** should be explicitly encouraged, as well as activities related to **plasma-based accelerators** and **high-temperature superconducting magnets**. In the context of these R&D a collaboration framework between CERN and laboratories of member states should be defined.

Lo stato della discussione (as from 6/11 meeting)

- L’opzione FCC-all gode di largo consenso (12 delegazioni)
- qualche delegato suggerisce anche esplicitamente l’opzione LE-to-HE-FFChh nel caso di ILC
- CLIC e’ l’opzione preferita dalla Norvegia e tollerata da pochi altri (ES, O, forse NL) che però vogliono comunque una macchina a elettroni come priorità
- UK , F, DK non hanno a questo punto forti indicazioni dalla comunità
- La Germania è in pausa di riflessione in attesa di un incontro della comunità il 14 Novembre

L’ipotesi più ottimista

- Approvazione di FCC-all
- TDR, schema di finanziamento e ricerca di fondi nei prossimi 5+ anni
- Decisione di andare e elettroni o adroni a seconda della decisione su ILC
- Approvazione del progetto (ee facile, se hh decisione sui magneti necessaria) all’inizio delle prossima strategy (2027)
- inizio della fisica nei primi anni ’40
- e in parallelo……

R&D

- definizione di quali magneti ad alto campo (Nb_3Sn) sono industrializzabili e finanziabili
- inizio di un robusto sforzo su HTS (rete di laboratori)
- CDR di un muon collider (a trazione CERN)
- rete di coordinamento degli sforzi su accelerazione a plasma (a trazione laboratori esterni)

La possibile catastrofe (meno probabile dopo la ri-elezione di Fab)

- muro ‘tedesco’ contro FCC
- suggerimento di rimandare ogni decisione a dopo che la funzione ‘onda’ di ILC sia collassata
- approvazione solo di R&D a largo spettro
- e nel caso peggiore 7 anni persi e un serio rischio per il futuro del CERN

Draft risposte alle 12 domande

In the absence of clear indications for new physics, is a broad exploration an adequate approach for our global field? Do we want to move forward in the largest variety of directions?

We believe that a program of broad exploration is required, in a situation without "guaranteed discoveries", however it should remain well focused, i.e. broad exploration does not mean necessarily "largest variety of directions"

Would it be appropriate/sufficient to move the scientific diversity program at CERN or at the National Institutes to among the highest priorities for Europe? Should the strategy engage in ranking proposals according to priority? Which are the key proposals?

We prefer to leave the diversity program in the second set of pages, in order to give proper emphasis to the main program.

Should we consider statements to strengthen the LHC and HL-LHC program? Should we stimulate the creation of coordinated programs at CERN and/or in Europe, e.g. AI@LHC for both data analysis and for control of instruments, etc?

It is important to highlight the forthcoming data-taking at HL-LHC and remind it has the highest priority. Coordinated analyses programs, aimed at exploit in the most efficient way LHC data and new analysis techniques should be encouraged.

Should we also support the fixed-target projects at (HL-)LHC?

These are interesting additions, but they should not be confused with the main HL-LHC program, it should be clear they have a different priority.

Because of the competition for the Interaction Region at Point-2@LHC, should we consider for the period beyond LS4 a choice between the next generation heavy-ion experiments at the HL-LHC and the LHeC?

As our community does not give high priority to LHeC, we do not think this point needs to be solved now. Currently, INFN groups are heavily involved in the next generation of heavy ion experiments at HL-LHC.It is however possible an interest in the LHeC + ions physics programme, developing after the completion of HL-LHC .

Do we remain open towards strong participation in future collider programs outside Europe? Should such a statement remain among the highest priorities? Should we extend the scope to include a variety of options like ILC@Japan, EIC@US, CEPC@China, ... ?

We should mention participation to colliders programs outside Europe, remind the previous support given to ILC, however the support must remain compatible with giving the proper resources to the main European program

Anno 2013: "*CERN should develop a neutrino programme to pave the way for a substantial European role in future long-baseline experiments. Europe should explore the possibility of major participation in leading long-baseline neutrino projects in the US and Japan.*" Is the continuation of the CERN Neutrino Platform appropriate? Should we propose to extend the scope of the Neutrino Platform beyond long-baseline neutrino projects?

The CERN Neutrino Platform can be mentioned, however possible extensions should be discussed within next strategy, with results from the present platform at hand. CERN should rather act, more in general, as a technological pole to make more effective the participation of members states to experiments in the fields of astroparticle physics and cosmology.

Anno 2013: "*Europe should support a diverse, vibrant theoretical physics programme, ranging from abstract to applied topics, in close collaboration with experiments and extending to neighbouring fields such as astroparticle physics and cosmology. Such support should extend also to high-performance computing and software development.*"
Should we strengthen this statement? Should we provide guidance how to achieve this?

We believe these statements are highly appropriate: a strong theoretical physics program must be supported. This is mandatory, given the significant jump in experimental precision and broad exploration expected at future colliders. In addition, as mentioned in the answer to the previous question, CERN could act as a pole for participation of members states to experiments in the fields of astroparticle physics and cosmology, and this should happen in close collaboration with the theory community.

Anno 2013: "*Detector R&D programmes should be supported strongly at CERN, national institutes, laboratories and universities. Infrastructure and engineering capabilities for the R&D programme and construction of large detectors, as well as infrastructures for data analysis, data preservation and distributed data-intensive computing should be maintained and further developed.*" Should we strengthen this statement? Should we provide guidance how to achieve this? For example, related to new R&D cluster programs at CERN and in Europe, and related to the balance between blue sky R&D versus focused R&D.

Yes, a strong support to R&D must be mentioned, possibly focused to reach the objectives of the strategy. It should be extended to support for R&D for new accelerator technologies, within a collaboration framework between CERN and laboratories of member states. Attention to spin-off to industries in Europe should also be encouraged, as well as direct participation of industries to R&D.

Should we make concrete the technology collaboration with the gravitational wave community?

INFN has pioneered experimental research in the field of gravitational waves and it is presently on the front run with Virgo and with the preparation of future programs. We strongly support the idea of collaboration among accelerator-based experiments and gravitational wave community

Should the HE-LHC feature in our strategy update?

We believe it should not. It has been clearly shown in the presentations in Granada and in the most recent studies that an upgrade of LHC to centre-of-mass energies around 27 TeV would not significantly increase the explored territory and it would represent, at the same time, a major enterprise with very significant use of resources.

In the context of the LE-to-HE-FCC-h/e/A scenario, would an adiabatic evolution from 6T to 16T/HTS magnets for FCC-h/e/A be an avenue to explore?

LHC present performance is outstanding and we expect HL-LHC will follow the same path. Any new pp collider should represent a very significant jump in explored territory with respect to what is expected from HL-LHC. The production of magnets for the FCC ring will be major enterprise, which cannot be repeated several times in an adiabatic way. Physics reach, magnet production costs and timescales must be carefully evaluated before defining a multi-step scenario for FCC-hh.

Argomento per FCC

- We think that the ESPP update should be based on significant jump in precision (e.g. in Higgs boson properties) and broad exploration (e.g. search of new physics at the energy frontier)
- We believe that, out of the five proposed scenarios, the FCC-all option is the best one in this respect.
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Altri argomenti e **il backup**

- Option robust against any decision taken in other geographical regions.
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Altri argomenti

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Altro “main statement”

- We would like to add that we believe that the ESPP conclusive document should include a **strong statement in support of continuing the R&D of new technologies for accelerators.** In particular, studies and experiments aimed at the development of a **muon collider** should be explicitly encouraged, as well as activities related to **plasma-based accelerators** and **high-temperature superconducting magnets**. In the context of these R&D a collaboration framework between CERN and laboratories of member states should be defined.