2020欧洲粒子物理战略更新

美国 Snowmass 2021

娄辛丑
高能物理研究所

Outline

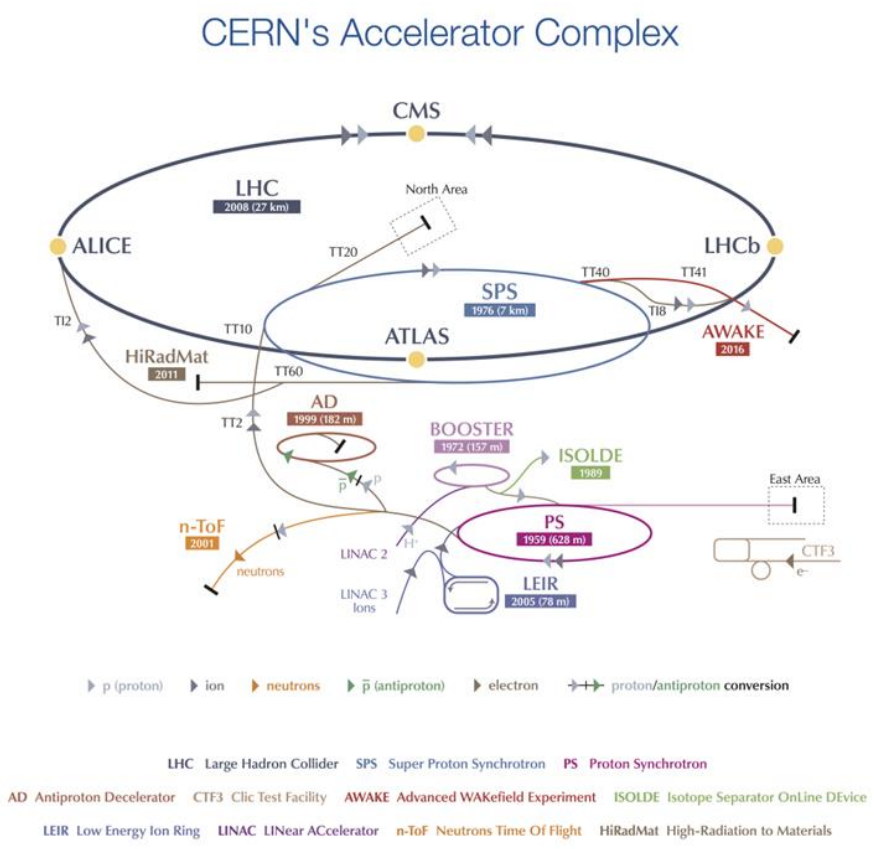
EPPSU 2020 – Update 欧洲粒子物理战略更新

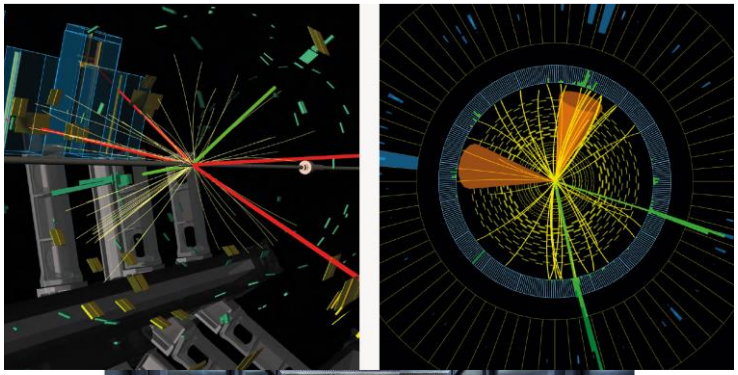
- CERN 简介
- European Particle Physics Strategy (EPPS)
  欧洲粒子物理战略规划
- Organization and the Process 组织和过程
- Participations by Chinese Scientists 中国科学家参与
- EPPS Update 2020 - EPPSU 新战略
- Observations & Remarks 个人观测及评介

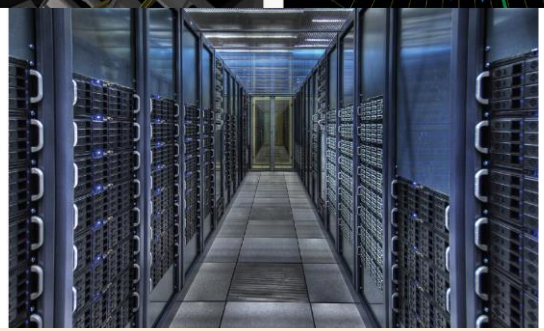
US Snowmass 2021 – 美国粒子物理规划

- Snowmass 2021 简介
- Organization and the Process 组织和过程
- Participations by Chinese Scientists 中国科学家参与

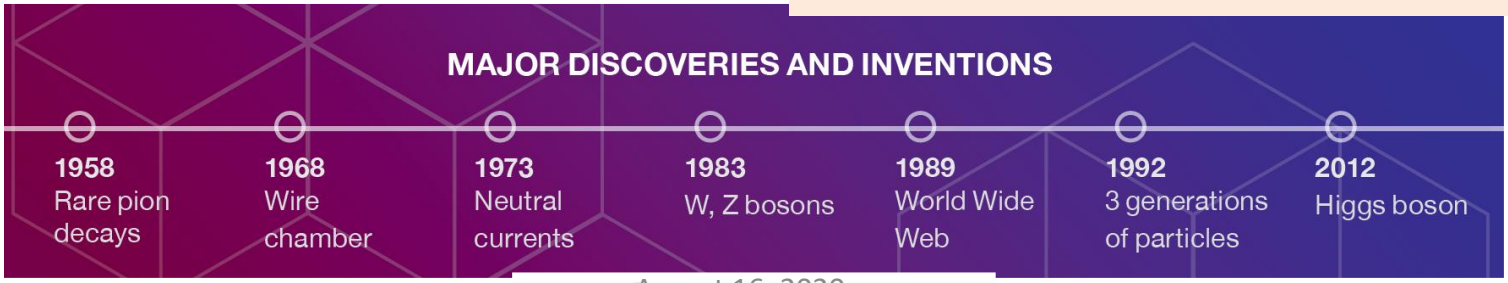
Introduction – CERN (ST + infrastructure)







- Complex of accelerators
- Most advanced detector systems
- Global grid computing + HEP software
- ……



⇒ A WORLDWIDE LAB

Introduction – CERN (governance)

The **CERN Council**, consisted of representatives of 23 member states (2 per country; 1 from the national government, 1 from the national scientific community), **is the highest authority of the Organization and has responsibility for all-important decisions**. Each Member State has a single vote and most decisions require a simple majority, although in practice the Council aims for a **consensus** as close as possible to unanimity.

The Council is assisted by the **Scientific Policy Committee** (elected based on scientific eminence) and the **Finance Committee** (**representatives from national administrations**)

The **Director-General**, appointed by the Council (2nd 5-year term), manages the CERN Laboratory. The Director-General is assisted by a directorate and runs the Laboratory through a structure of departments.

Introduction
European Particle Physics Strategy (EPPS)

"The **European Particle Physics Strategy** is the scientific deliberation process that forms the cornerstone of Europe's decision-making for the future of our field." EPPS is an open, inclusive and science-driven process. **The CERN Council develops and approves the EPPS, and CERN executes the strategy**.

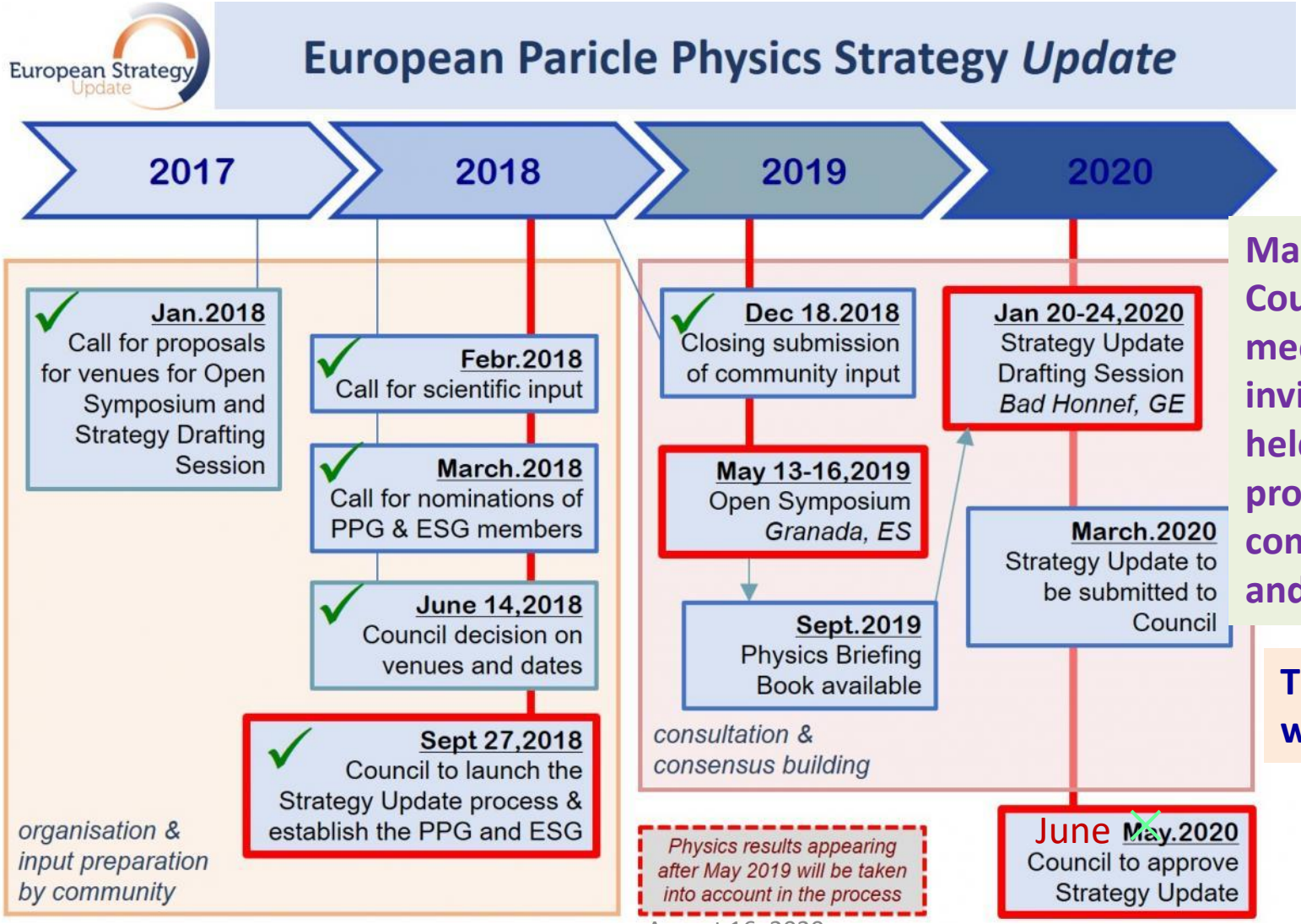
"The **European Particle Physics Strategy** was initiated in 2006 amid the construction of the Large Hadron Collider (LHC), and was first updated in 2013, to reflect the evolution of the field following the start-up of the LHC. In its first two iterations, **the Strategy put the emphasis firmly on the LHC**, with global coordination in other areas of the field also taking prominence. "

"In 2018, with a wealth of results from the LHC and other facilities, the time has come to pave the way for **particle physics beyond the LHC**, always maintaining the strong level of global coordination. " **update at ~7-year cycle**.

Thus the **2020 European Particle Physics Strategy Update** (**EPPSU**) effort was launched in 2018, and was completed in June 2020.

EPPSU 2020 - Update

Organization and the Process 组织和过程



Many CERN Council + ESG meetings with invitees were held at CERN, to promote communications and discussions.

The schedule was well kept

EPPSU 2020 - Update

Organization and the Process 组织和过程

European Strategy Group (ESG)

MEMBERS

CERN Member States representatives

Professor Jochen Schieck (Austria)
Professor Dirk Ryckbosch (Belgium)
Professor Leander Litov (Bulgaria)
Professor Tomas Davidek (Czech Republic)
Professor Jens-Jørgen Gaardhøje (Denmark)
Professor Paula Eerola (Finland)
Dr Reynald Pain (France)
Professor Siegfried Bethke (Germany)
Professor Costas Fountas (Greece)
Professor Peter Levai (Hungary)
Professor Eliezer Rabinovici (Israel)
Professor Fernando Ferroni (Italy)
Professor Eric Laenen (Netherlands)
Professor Gerald Eigen (Norway)
Professor Jan Królikowski (Poland)
Professor Mario Pimenta (Portugal)
Dr Calin Alexa (Romania)
Professor Peter Adzic (Serbia)
Professor Stanislav Tokar (Slovakia)
Professor Maria José Garcia Borge (Spain)
Professor Kerstin Jon-And (Sweden)
Professor Tatsuya Nakada (Switzerland)
Professor Jonathan Butterworth (United Kingdom)

CERN Director-General
Dr Fabiola Gianotti

Major European National Laboratories
Professor Nicanor Colino (CIEMAT)
Professor Joachim Mnich (DESY)

Professor Anne-Isabelle Etienvre (IRFU)
Professor Achille Stocchi (LAL)
Professor Sijbrand de Jong (NIKHEF)
Dr Pierluigi Campana (LNF)
Professor Stefano Ragazzi (LNGS)
Professor Klaus Kirch (PSI)
Professor Mark Thomson (STFC-RAL)

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

ESG INVITEES
President of the CERN Council
Dr Ursula Bassler

Associate Member States in the pre-stage to Membership
Professor Panos Razis (Cyprus)
Professor Boštjan Golob (Slovenia)

Associate Member States
Dr Aurelijus Rinkevicius (Lithuania)
Dr Alper Yüksel (Turkey)
Professor Borys Grynyov (Ukraine)

States with special Observer status (LHC)
Professor Yasuhiro Okada (Japan)
Professor Vladimir Kekelidze (Russian Federation)
Dr Abid Patwa (United States of America)

Organisations with Observer status
Mr Adam Tyson (European Commission)
Professor Boris Sharkov (JINR)

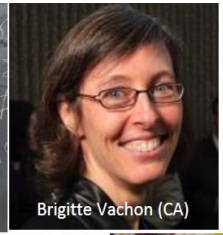
Other invitees
Professor Teresa Montaruli (Chair ApPEC)
Professor Jan Hrusak (Chair ESFRI)
Professor Michael Procario (Chair FALC)
Professor Marek Lewitowicz (Chair NuPECC)
Members of the PPG (see Annex 2)

CERN Support Group
Dr Roger Forty (Physics Preparatory Group and European Strategy Group documents editing)
Ms Vedrana Zorica (Administrative and Logistic Support)
Mr John Pym (Copy-editor)
Dr Eva-Maria Groniger-Voss (Legal Counsel)
Ms Kirsten Baxter (Principal Legal Adviser)

总书记
Halina Abramowicz (Israel)

- very broad representatives
- CERN DG
- legal experts

Physics Preparatory Group (PPG)



⇐总书记
Halina Abramowicz (Israel)

broad representation, members included non-Europeans: Asia & North America,

PPG is further divided into 8 sub-groups.

Accelerator Science and Technology
Caterina Biscari
Lenny Rivkin

Instrumentation and Computing
Xinchou Lou
Brigitte Vachon

Electroweak Physics
Keith Ellis
Beate Heinemann

Strong interactions
Jorgen D'Hondt
Krzysztof Redlich

Neutrino Physics
Stan Bentvelsen
Marco Zito

BSM at colliders
Gian Giudice
Paris Sphicas

Dark Matter and Dark Sector
Shoji Asai
Marcela Carena

Flavour Physics and CP violation
Belen Gavela
Antonio Zoccoli

Physics Briefing Book – EPPSU's scientific basis.

Global HEP community Inputs to EPPSU 2020

Feb. – December, 2018

Main document: Please prepare a pdf file containing a cover page (title, abstract, name of the contact person and his/her e-mail address) and a comprehensive and self-contained description of the proposed input (maximum 10 pages). This document should address (when applicable) the scientific context, objectives, methodology, readiness and expected challenges.

Addendum: Please also prepare a pdf file containing information on the following topics (where relevant): interested community, timeline, construction and operating costs, computing requirements. The name of this pdf file should be as follows: "Addendum-NN.pdf", where NN is the file-name of your main document.

submission themes (tracks) to which your input relates:

- Large experiments and projects
- National road maps
- Accelerator Science and Technology
- Beyond the Standard Model at colliders (present and future)
- Dark matter and dark sector (accelerator and non-accelerator dark matter, dark photons, hidden sector, axions)
- Instrumentation and computing
- Electroweak physics (physics of the W, Z, H bosons, of the top quark, and QED)
- Flavour Physics and CP violation (quarks, charged leptons and rare processes)
- Neutrino physics (accelerator and non-accelerator)
- Strong interactions (perturbative and non-perturbative QCD, DIS, heavy ions)

160+ inputs

For confidential addenda: **If you wish the addendum to be treated as confidential (i.e. limited to the PPG and ESG), you should send it to the following email address eppsu.addenda@espace.cern.ch by 18 December 2018**

Participations by scientists from China:

Inputs on CEPC-SPPC Accelerators, CEPC Experiments, JUNO, STC were among them

organization, Briefing Book drafting, joining in on the Open Symposium in Granada, Spain, …

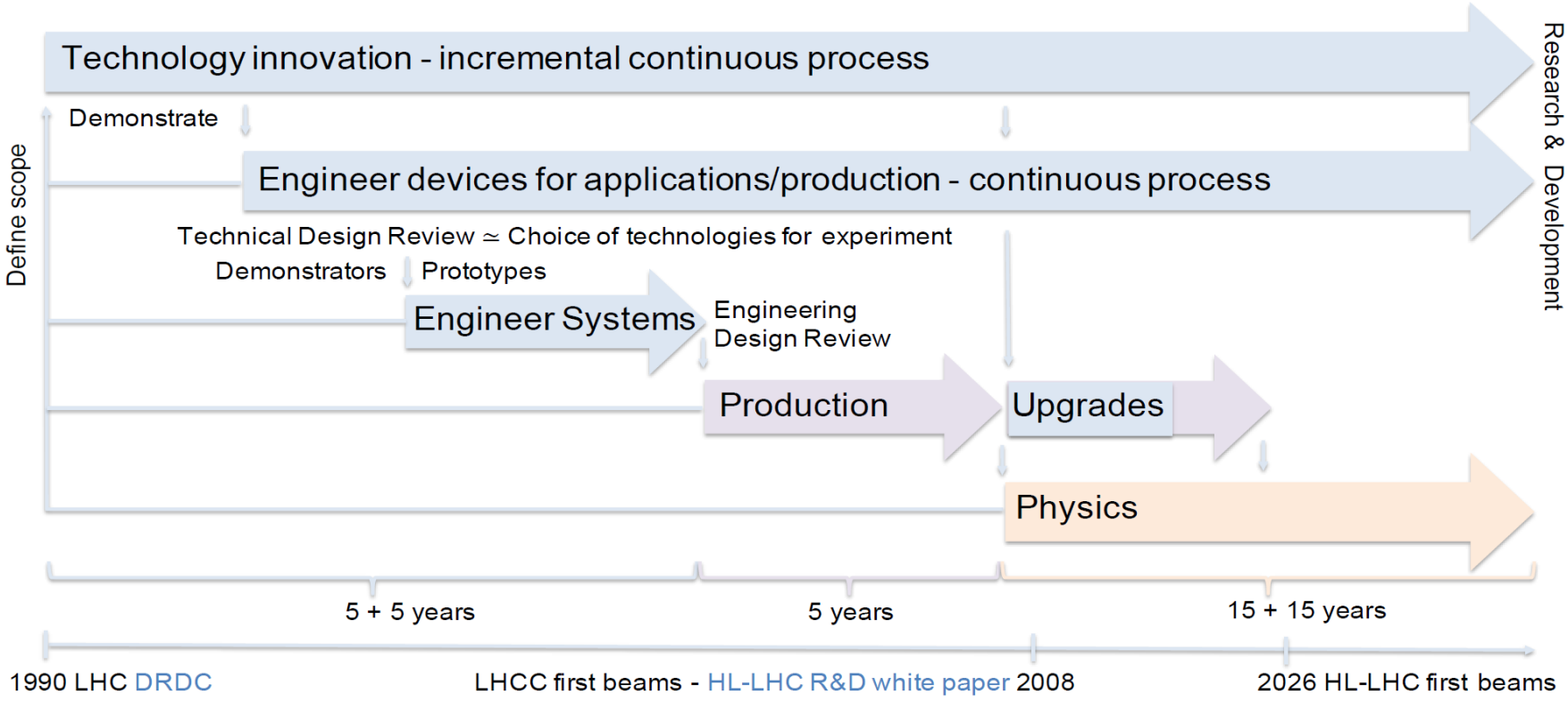
Open Symposium in Granada, Spain, May 12-16, 2019

https://cafpe.ugr.es/eppsu2019/

- Granada Symposium: pre-meetings, plenary sessions, eight discussion sessions.
- The parallel sessions were convened by two members of the Physics Preparatory Group. The sessions are organized around topics covered by the submission tracks.
- More than 600 attendants.
- **Presentations, discussions, debates, updates**; ⇒Briefing Book to be presented to the ESG for further deliberations

Instrumentation – lessons learned from past R&D

Typical HEP program timeline (R&D in blue)



R&D timescale is ≃ 10 years, approved experimental programs are natural drivers for techniques and resources, technology innovation can suffer cycle/migration effects

Physics Briefing Book

http://cds.cern.ch/record/2691414

Contents

EPPSU Drafting Session at Bad Honnef, Germany, Jan. 19-25, 2020

ESG + PPG members present.

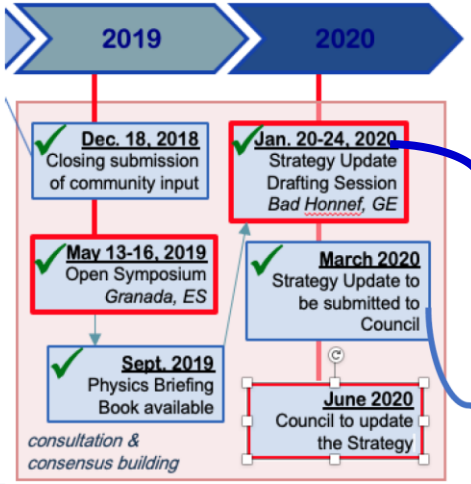
away from home institutes, to focus to complete an important task. (no usual chores, and last minute deadlines, etc.)

produced initial EPPSU draft.

New Strategy 2020 新规划

Halina Abramowicz

General Introduction



20 Strategy Statements unanimously adopted by the ESG in Jan.2020

- 2 statements on **Major developments from the 2013 Strategy**
- 3 statements on **General considerations for the 2020 update**
- 2 statements on **High-priority future initiatives**
- 4 statements on **Other essential scientific activities for particle physics**
- 2 statements on **Synergies with neighbouring fields**
- 3 statements on **Organisational issues**
- 4 statements on **Environmental and societal impact**

Two documents submitted :
1. Draft Update of the European Strategy for Particle Physics (with preamble, statements, conclusion) for feedback
CERN/SPC/1137/RA CERN/3486/C2
2. Deliberation Document (with in addition rational behind the statements) for information
CERN/SPC/1136/RA; CERN/3485/C

Derived based on

- Granada Symposium
- National Inputs
- Working Group 1: Social and career aspects for the next generation
- Working Group 2:Issues related to Global Projects hosted by CERN or funded through CERN outside Europe
- Working Group 3: Relations with other groups and organisations
- Working Group 4: Knowledge and Technology Transfer
- Working Group 5: Public engagement, Education and Communication
- Working Group 6: Sustainability and Environmental impact

New Strategy 2020 新规划

General Considerations for 2020 -

- **This Strategy update should be implemented to ensure Europe's continued S&T leadership.**
- The particle physics community must further strengthen the unique ecosystem of research centres in Europe. In particular, cooperative programmes between CERN and these research centres should be expanded and sustained with adequate resources in order to address the objectives set out in the Strategy update.
- The implementation of the Strategy should proceed in strong collaboration with global partners and neighbouring fields.

Preamble 前言

- Many mysteries about the universe remain to be explored: **nature of dark matter, preponderance of matter over antimatter, origin and pattern of neutrino masses**
- Nature hides the secrets of the fundamental physical laws in the **tiniest nooks of space and time**
- Particle Physics develops technologies to probe ever smaller distance scales (higher energies)
- **The Higgs** (discovered at the LHC) is a **unique particle** that raises profound questions about the fundamental laws of nature
  - ✓ Higgs properties study is in itself a powerful experimental tool to look for answers
    → **electron-positron collider as Higgs factory**
  - ✓ Higgs boson pair-production study is key to understanding the fabric of the universe
    → **collider with significantly higher energies than Higgs factory**
- New realm of energies is expected to lead to new discoveries and provide answers to existing mysteries
- **The 2020 Strategy update aims to significantly extend knowledge beyond current limits, to drive innovative technological developments, to maintain Europe's leading role**

New Strategy 2020 新规划

Major developments from the 2013 Strategy

- The successful completion of the high-luminosity upgrade of the machine and detectors should remain the focal point of European particle physics, together with continued innovation in experimental techniques. The full physics potential of the **LHC and the HL-LHC**, including the study of flavour physics and the quark-gluon plasma, should be exploited.

impacting China's participations in ATLAS, CMS, LHCb groups

- Europe, and CERN through the Neutrino Platform, should continue to support long baseline experiments in Japan and the United States. In particular, they should continue to collaborate with the United States and other international partners towards the successful implementation of the Long-Baseline **Neutrino** Facility (LBNF) and the Deep Underground **Neutrino** Experiment (DUNE).

relevant to JUNO project

New Strategy 2020 新规划

High-priority future initiatives

a) 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. Accomplishing these compelling goals will require innovation and cutting-edge technology:

• the particle physics community should ramp up its R&D effort focused on advanced accelerator technologies, in particular that for high-field superconducting magnets, including high-temperature superconductors;
• 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. Such a feasibility study of the colliders and related infrastructure should be established as a global endeavour and be completed on the timescale of the next Strategy update. The timely realisation of the electron-positron International Linear Collider (ILC) in Japan would be compatible with this strategy and, in that case, the European particle physics community would wish to collaborate.

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impacting China's CEPC, SPPC efforts

New Strategy 2020 新规划

High-priority future initiatives

b) Innovative accelerator technology underpins the physics reach of high-energy and high-intensity colliders. It is also a powerful driver for many accelerator-based fields of science and industry. The technologies under consideration include high-field magnets, high-temperature superconductors, plasma wakefield acceleration and other high-gradient accelerating structures, bright muon beams, energy recovery linacs.

The European particle physics community must intensify accelerator R&D and sustain it with adequate resources.

A roadmap should prioritise the technology, taking into account synergies with international partners and other communities such as photon and neutron sources, fusion energy and industry. Deliverables for this decade should be defined in a timely fashion and coordinated among CERN and national laboratories and institutes.

impacting China's CEPC, SPPC efforts (focused R&D, roadmap)

New Strategy 2020 新规划

Guide through the statements

2 statements on **Major developments from the 2013 Strategy**
a) Focus on successful completion of HL-LHC upgrade remains a priority
b) Continued support for long-baseline experiments in Japan and US and the Neutrino Platform

3 statements on **General considerations for the 2020 update**
a) Preserve the leading role of CERN for success of European PP community
b) Strengthen the European PP ecosystem of research centres
c) Acknowledge the global nature of PP research

2 statements on **High-priority future initiatives**
a) Higgs factory as the highest-priority next collider and investigation of the technical and financial feasibility of a future hadron collider at CERN
b) Vigorous R&D on innovative accelerator technologies

4 statements on **Other essential scientific activities**
a) Support for high-impact, financially implementable, experimental initiatives world-wide
b) Acknowledge the essential role of theory
c) Support for instrumentation R&D
d) Support for computing and software infrastructure

2 statements on **Synergies with neighbouring fields**
a) Nuclear physics – cooperation with NuPECC
b) Astroparticle – cooperation with APPEC

3 statements on **Organisational issues**
a) Global collaboration on projects in and out of Europe
b) Relations with European Commission
c) Open science

4 statements on **Environmental and societal impact**
a) Mitigate environmental impact of particle physics
b) Investment in next generation of researchers
c) Knowledge and technology transfer
d) Cultural heritage: public engagement, education and communication

Letters for itemizing the statements are introduced for identification, do not imply prioritization

Halina Abramowicz

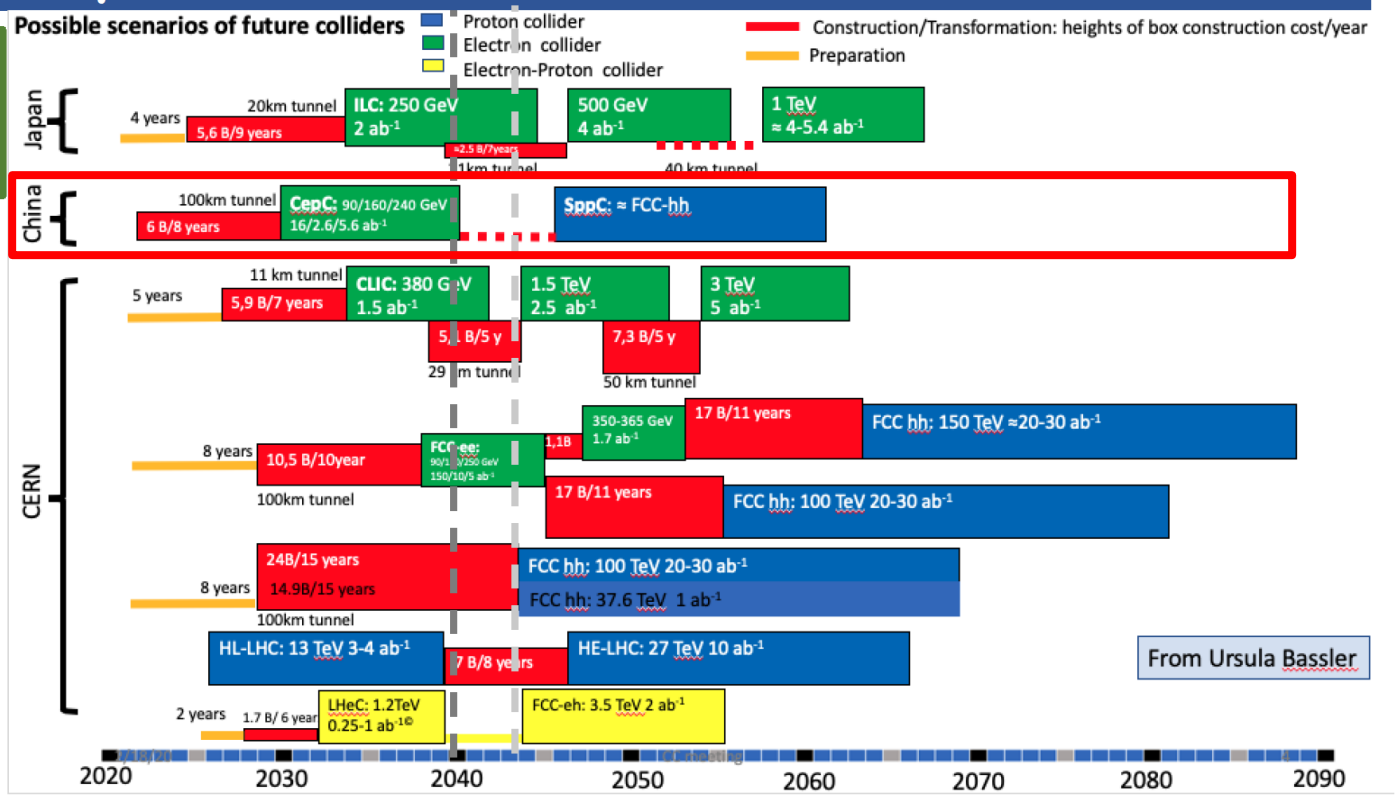
impacting China's core HEP program and efforts

New Strategy 2020 新规划

Halina Abramowicz

3. High-priority future initiatives

Map of possible future facilities submitted as input to the Strategy Update



It is essential for particle physics in Europe and for CERN to be able to propose a new facility after the LHC

- There are two clear ways to address the remaining mysteries: Higgs factory and exploration of the energy frontier
- Europe is in the privileged position to be able to propose both: CLIC or FCCee as Higgs factory, CLIC (3 TeV) or FCChh (100 TeV) for the energy frontier
- The dramatic increase in energy possible with FCChh leads to this technology being considered as the most promising for a future facility at the energy frontier.
- It is important therefore to launch a feasibility study for such a collider to be completed in time for the next Strategy update, so that a decision as to whether this project can be implemented can be taken on that timescale.

New Strategy 2020 新规划

Personal observation on how EPPSU built consensus

- The final strategy is intended to be inclusive. Sought global inputs from the community, allow for sufficient discussion, exchanges, debates, put problems and issues on the table, work to find solutions.
- ESG very broad representations (member states, European lab directors, associate member states, observer states, …) , PPG selected based on scientific-technological merits and screened carefully, individual scientists willing to service with professional conduct.
- Organizations kept out people with strong agenda and inadequate members.
- Very senior and highly respected scientists who can say: “Let’s move on”, “get back to the theme”

The resulting work (Briefing Book, ESG EPPSU draft) was highly trusted with strong confidence.

New Strategy 2020 新规划

Personal observation on how EPPSU built consensus

- **Offsite meetings – away from daily chores, food, and distractions, work very long hours**
- **Timely updates of inputs and scientific info, ~ answer questions, address issues**
- **European culture: creative thinking about new things, exchanges, reconciliations, …**

- **CERN Council includes ~1/2 funding agency representatives from each member country – financial backing and commitment is part of process, financial feasibility is taken out of the questions.**

All contributed to arriving at a consensus on EPPSU

New Strategy 2020 新规划

A few comments on EPPSU high-priority future initiatives

- EPPSU "e^+e^- Higgs factory + high energy (>100 TeV) pp collider priority" is exactly the CEPC+SppC strategy proposed by Chinese scientists. This global EPPSU effort really rectified the CEPC+SppC path.

  EPPSU 验证并采用中国科学家2012年9月提出的CEPC+SppC路径

- The R&D programs being pursued for CEPC and SppC are basically identical to those outlined in the EPPSU. Room for collaboration (?)

- Chinese scientists, through CEPC, SppC design and R&D, are rising in their professional status and reputation.

- Now CEPC+SppC is in direct competition with Europe. This is new for China(?)

- CEPC time window has advantage, but if we miss it, we will miss the opportunity.

- International collaboration, …

SNOWMASS 2021

美国高能物理规划

https://snowmass21.org/

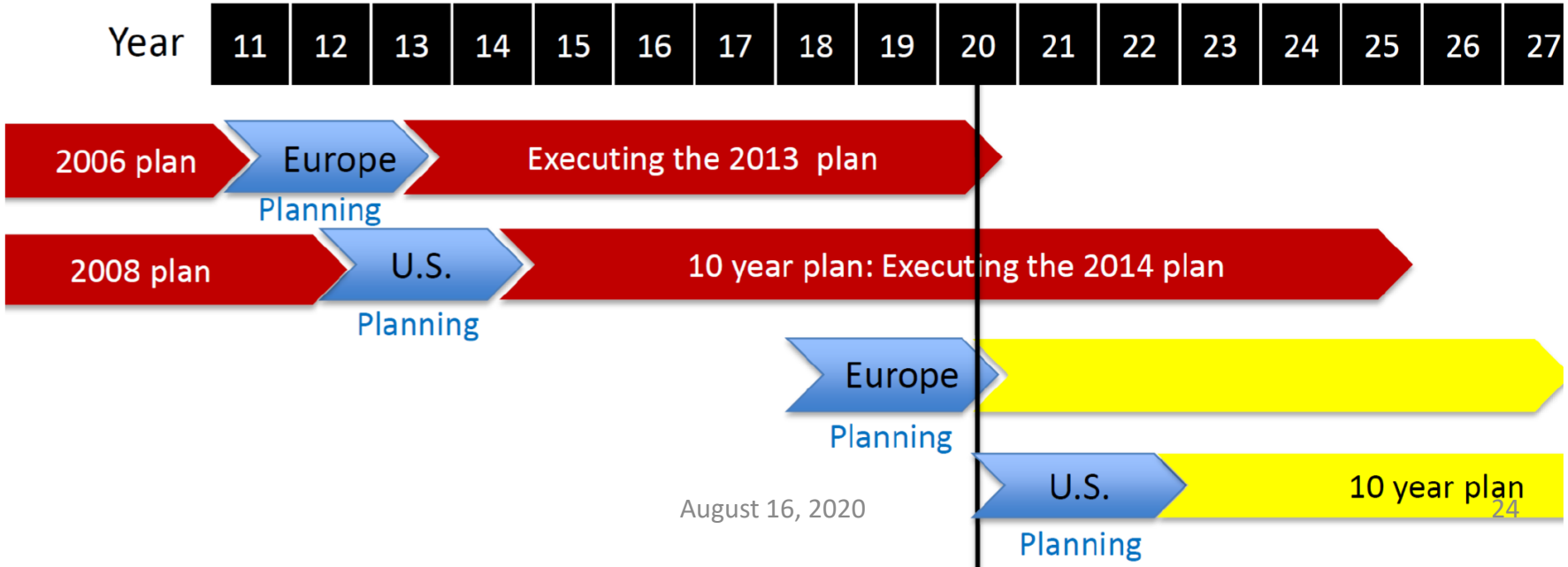
Particle Physics is Global

Europe and U.S.

- Frequency: 7 years (Europe), ~8 years (U.S.)
- Process: ~2 years in total (~1 year on science by the community + ~1 year priorities)

Snowmass (U.S.) P5 (U.S.)

Japan, Canada, China, Latin America, …



SNOWMASS 2021
美国高能物理规划

① **Define the most important questions for HEP & related fields**
② **Identify the most promising opportunities to address these questions in a global context**

U.S. Strategic Planning Process for Particle Physics

~year-long process
Snowmass Community-Wide "Science" Study
Organized by Division of Particles and Fields (DPF) of APS

Input to P5

~year-long process
P5 (Particle Physics Project Prioritization Panel)
formulate a 10-year plan (20 year vision) within funding constraints
Subpanel of HEPAP, High Energy Physics Advisory Panel for DOE/NSF funding agencies

SNOWMASS 2021
美国高能物理规划

Input to Snowmass 2021: Letters of Interest & Contributed Papers

Letters of Interest (submission period: April 1, 2020 – August 31, 2020)

Letters of interest allow Snowmass conveners to see what proposals to expect and to encourage the community to begin studying them. They will help conveners to prepare the Snowmass Planning Meeting that will take place on November 4 - 6, 2020 at Fermilab. Letters should give brief descriptions of the proposal and cite the relevant papers to study. Instructions for submitting letters are available athttps://snowmass21.org/loi

Contributed Papers (April 1, 2020 – July 31, 2021)

Contributed papers will be part of the Snowmass proceedings. They may include white papers on specific scientific areas, technical articles presenting new results on relevant physics topics, and reasoned expressions of physics priorities, including those related to community involvement. These papers and discussions throughout the Snowmass process will help shape the long-term strategy of particle physics in the U.S.

Contributed papers will remain part of the permanent record of Snowmass 2021. Instructions for submitting contributed papers are available at https://snowmass21.org/submissions/

Index to LOI, Submitted Papers, by Frontier

Energy Frontier (EF) (0)
Neutrino Physics Frontier (NF) (2)
Rare Processes and Precision Measurements (RF) (0)
Cosmic Frontier (CF) (1)
Theory Frontier (TF) (0)
Accelerator Science and Technology Frontier (AF) (1)
Instrumentation Frontier (IF) (1)
Computational Frontier (CompF) (0)
Underground Facilities and Infrastructure (UF) (0)
Community Involvement (CommF) (0)

Participation by scientists from (I am aware of)

LOI + CP: CEPC accelerator, detector, BESIII physics, young theorists active

Other: Energy Frontier Physics Questions, CEPC updates, advising and convener roles

SNOWMASS 2021
美国高能物理规划

DPF Community Planning Process - Community-wide meetings and workshops include

- Snowmass Kick-off Town-Hall meeting (virtual): April 18, 2020 (during the 2020 APS April Meeting)
- **Snowmass Planning Meeting (virtual): 4 days during the week of Oct. 5, 2020 (9am-2pm PDT, 12pm-5pm EDT)**
- Snowmass Mid-term Assessment: during 2021 APS April Meeting (April 17-20, 2021)
- **Snowmass Summer Study: July 11 - 20, 2021 at UW Seattle**

Likely China will have a chance to present "HEP in China" talk.

Invitation to 高能分会 is expected

Various Frontier-level and Topical-group-level workshops have been organized by Conveners since April 2020 and these will continue through Spring 2021.

Workshop locations will be chosen to maximize "inclusiveness" based on accessibility and economic consideration.

For all the meetings and workshops, we will make sure that we are inclusive to those who participate remotely and we will have a special session to discuss APS efforts for openness and the importance of open international collaboration.

SNOWMASS 2021
美国高能物理规划

Code of Conduct for APS Meetings

It is the policy of the American Physical Society (APS) that all participants, including attendees, vendors, APS staff, volunteers, and all other stakeholders at APS meetings will **conduct themselves in a professional manner that is welcoming to all participants and free from any form of discrimination, harassment, or retaliation**.

Participants will treat each other with respect and consideration to create a collegial, inclusive, and professional environment at APS Meetings. Creating a supportive environment to enable scientific discourse at APS meetings is the responsibility of all participants.

Participants will avoid any inappropriate actions or statements based on individual characteristics such as age, race, ethnicity, sexual orientation, gender identity, gender expression, marital status, nationality, political affiliation, ability status, educational background, or any other characteristic protected by law. **Disruptive or harassing behavior of any kind will not be tolerated**. Harassment includes but is not limited to inappropriate or intimidating behavior and language, unwelcome jokes or comments, unwanted touching or attention, offensive images, photography without permission, and stalking.

Violations of this code of conduct policy should be reported to meeting organizers, APS staff, or the APS Director of Meetings. Sanctions may range from verbal warning, to ejection from the meeting without refund, to notifying appropriate authorities. **Retaliation for complaints of inappropriate conduct will not be tolerated.** If a participant observes inappropriate comments or actions and personal intervention seems appropriate and safe, they should be considerate of all parties before intervening.

Considerations

- **European-US experience – how will this help us?**
- **How can we maximum our scientific opportunities in China?**
- **Instrumentation & Computing – how to move ahead to become first tier?**
- **International collaboration – challenges-opportunities,….**
- **……**

EPPSU 2020 - Update

Organization and the Process 组织和过程

EPSSU 2020 is an open, inclusive and science-driven process.

September 27, 2018 - The CERN Council established the independent **European Strategy Group** (**ESG**) to coordinate the process, and the **Physics Preparatory Group** (**PPG**) to prepare the **Physics Briefing Book** that will contain the scientific, technological, etc., facts and analyses, based on which the ESG make strategy decisions.

End of 2018 - the particle physics community had submitted 160 **contributions** (inputs) encompassing the worldwide particle-physics landscape and developments in related fields. (CEPC, JUNO, etc.)

May, 2019 – Open Symposium, Granada, Spain, the community came together and discussed the potential merits and challenges of the submitted proposals. Lots of discussions, debates, and updates.

September, 2019 - The inputs were distilled into the **Physics Briefing Book** (250-page), an objective scientific summary and basis for the ensuing discussions.

January, 2020 – EPPSU drafting session in Bad Bonnef, Germany.

Snowmass 2021 (USA)

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