European Strategy Update

The European Particle Physics Strategy Update 2020

- General remarks about the EPPS process
- Remit of the EPPS (update) process
- Conclusions of the 2006 and 2013 EPPS
- Status of the 2013 EPPSU process
- Composition of the EPPSU teams
- Proposed timeline
- Dmitri's questions

Why European Particle Physics Strategy?

- Relation between ESFRI and CERN had to be clarified within the European Commission
  - ESFRI, the European Strategy Forum on Research Infrastructures, is a strategic instrument to develop the scientific integration of Europe and to strengthen its international outreach.
  - CERN's convention mandates coordination of infrastructure of particle physics for Member States

- First ESFRI roadmap published in 2006, with 35 projects, the Roadmap was updated in 2008 bringing the number of RIs of pan-European relevance to 44. Later updates 2008, 2010, 2016, 2018

- First European Particle Physics Strategy (EPPS) called by CERN Council in 2005 and endorsed in 2006, latest update in 2013… next in 2020.

Strategy Group Remit for the 2006 EPPS

The Strategy Group shall aim:

- to enhance the visibility of existing European particle physics programs;
- to foster increased collaboration among Europe's particle physics laboratories and institutes;
- to promote a coordinated European participation in world-wide projects;
- to reiterate the CERN Council's 2004 position on the European strategy for the International Linear Collider;
- to encourage knowledge transfer to other disciplines, industries, and society;
- to outline priorities, at least implicitly;
- to consider time scales;
- to follow a thematic or project approach, whichever is more appropriate.

The European strategy for particle physics 2006

General issues

1. European particle physics is founded on strong national institutes, universities and laboratories and the CERN Organization; Europe should maintain and strengthen its central position in particle physics.
2. Increased globalization, concentration and scale of particle physics make a well coordinated strategy in Europe paramount; this strategy will be defined and updated by CERN Council …

Scientific issues

3. the highest priority is to fully exploit the physics potential of the LHC… R&D for machine and detectors has to be vigorously pursued now and centrally organized towards a luminosity upgrade by around 2015.
4. a coordinated program should be intensified, to develop the CLIC technology and high performance magnets for future accelerators, and to play a significant role in the study and development of a high-intensity neutrino facility.
5. (ILC) … here should be a strong well-coordinated European activity, including CERN, through the Global Design Effort, for its design and technical preparation towards the construction decision, to be ready for a new assessment by Council around 2010.

The European strategy for particle physics 2006

6. Council will play an active role in promoting a coordinated European participation in a global neutrino programme.
7. Council will seek to work with ApPEC to develop a coordinated strategy in areas of mutual interest.
8. Flavour physics and precision measurements at lower energies … the participation of European laboratories and institutes should be promoted.
9. Council will seek to work with NuPECC in areas of mutual interest, and maintain the capability to perform fixed target experiments at CERN.
10. Theory … new needs for theoretical calculations should be widely supported.

Organizational issues

11. Council will define and update the strategy
12. Council will prepare a framework for Europe to engage with the other regions of the world
13. Strengthen the relationship between the EU and the European PP strategy
14. Council will establish how the non-Member States should be involved in defining the strategy.

Complementary issues

15.-17. Communication and Education, Technology transfer forum, Cooperation with industry

The European strategy for particle physics 2013

As in 2006, in 2013 17 recommendations

3 general issues
4 high priority large-scale scientific projects
5 other essential scientific activities
2 organizational issues
3 wider impact on society

The CERN Director-General is responsible for the implementation of the European Strategy for Particle Physics (CERN Council 2014)

Tools

- CERN Medium-Term plan – updated every year for Council approval
- Laboratory Directors Group (Directors of major European Laboratories: CERN, CIEMAT, DESY, IRFU/Saclay, LAL/Orsay, NIKHEF, LNF/Frascati, LNGS, PSI, STFC-RAL.) – issues of common interest
- RECFA visits to countries (~3 to 4 visits/year) – implementation at national level
- ICFA meetings (implementation in worldwide context)
- FALC (Funding Agencies for Large Colliders) – informal discussions

EPPSU 2013 – General issues (3), DG report to Council September 2017

a) The success of the LHC is proof of effectiveness of the European organisational model for particle physics, founded on the sustained long-term commitment of the CERN Member States and of the national institutes, laboratories and universities closely collaborating with CERN. *Europe should preserve this model in order to keep its leading role, sustaining the success of particle physics and the benefits it brings to the wider society.*

b) The scale of the facilities required by particle physics is resulting in the globalisation of the field. *The European Strategy takes into account the worldwide particle physics landscape and developments in related fields and should continue to do so.*

q) periodic updates [of the ESPP] at intervals of about five years are essential. *Updates should continue to be undertaken according to the principles applied at the present occasion. The organisational framework for the Council Sessions dealing with European Strategy matters and the mechanism for implementation and follow-up of the Strategy should be revised in the light of the experience gained since 2006.*

Revision in CERN/3092/RA/Rev., "Proposal for a revised procedural framework for the European Strategy for Particle Physics" → main conclusions:

- ❑ suppression of separate Strategy Session of Council
- ❑ functions of strategy follow-up, previously assigned to the strategy Scientific Secretary, are conferred to the DG → Strategy Secretary and Secretariat in place only during the ESPP update process

5

EPPSU 2013 – High-priority large-scale projects(4), DG report to Council September 2017

c) Europe's top priority should be the exploitation of the full potential of the LHC, including the high-luminosity upgrade of the machine and detectors with a view to collecting ten times more data than in the initial design, by around 2030. This upgrade programme will also provide further exciting opportunities for the study of flavour physics and the quark-gluon plasma.

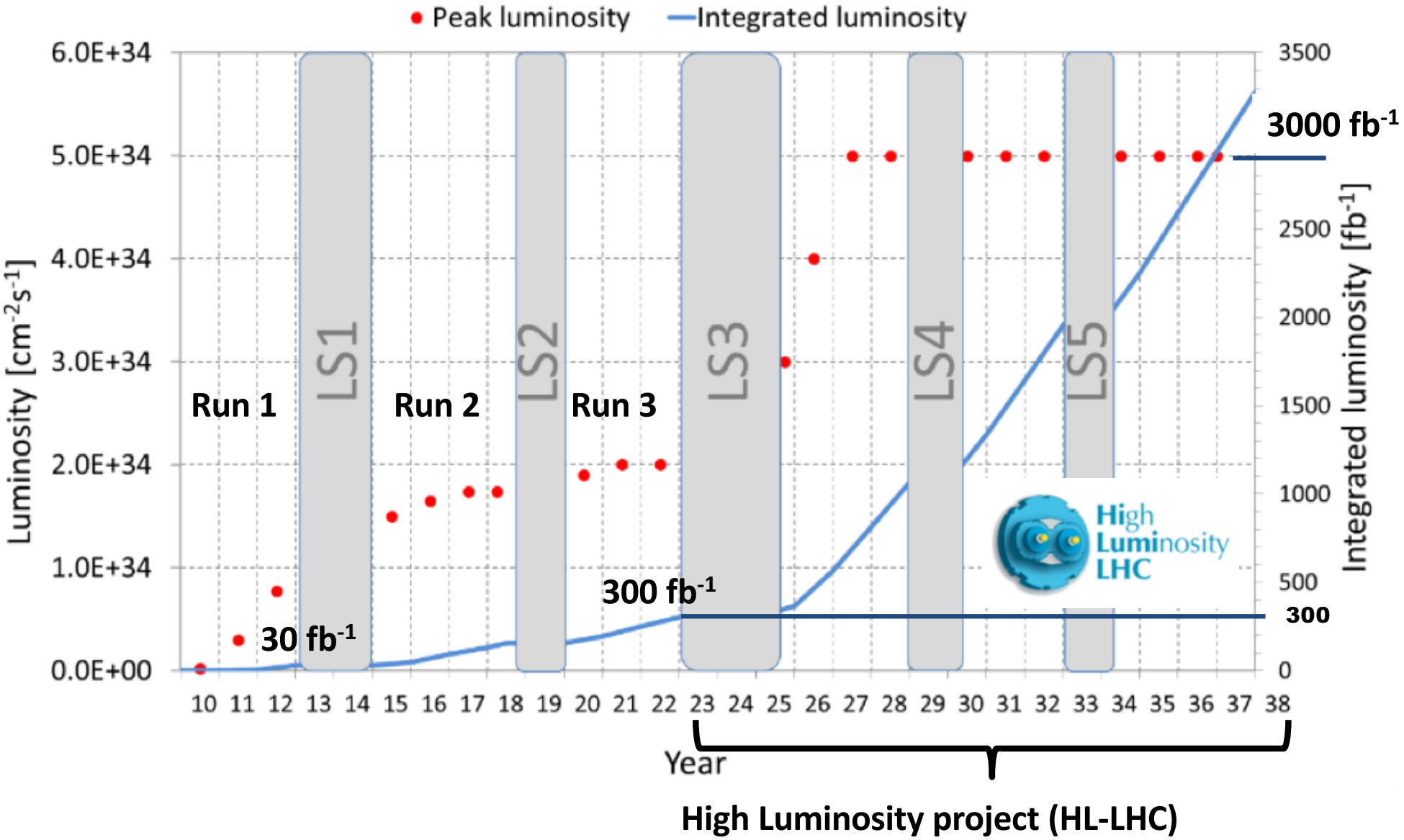
- Currently running at 13 TeV, beyond design luminosity, goal is 300/fb by end of Run3 (2023)
- HL-LHC approved by Council in June 2016 → goal is 3000 fb^{-1} by ~ 2037
- LIU, HL-LHC and detector upgrades on schedule for installation in LS2 and LS3
- Expect to move to 14 TeV after LS2; exploring possibility to push energy to "ultimate" value (15 TeV) in Run4++
- LHC and upgrades account for > 70% of CERN annual budget.

d) CERN should undertake design studies for accelerator projects in a global context, with emphasis on proton-proton and electron-positron high-energy frontier machines. These design studies should be coupled to a vigorous accelerator R&D programme, including high-field magnets and high-gradient accelerating structures, in collaboration with national institutes, laboratories and universities worldwide.

- CLIC working on implementation plan and cost reduction as input to ESPP; CTF3 completed.
- FCC design studies started in 2014 → CDR in 2018 as input to ESPP.
- Superconducting magnets being developed mainly within HL-LHC and FCC projects
- Efforts on SCRF intensified (HIE-ISOLDE, LHC spares, HL-LHC crab cavities, etc.)
- New acceleration techniques being explored: AWAKE

Strong collaborations and complementarity with labs and Institutes worldwide (CEA, CIEMAT, DESY, INFN, RAL, FNAL, KEK, etc.)

LHC roadmap: **Goal of 3'000 fb^{-1}** by mid 2030ies



EPPSU 2013 – High-priority large-scale projects(4), DG report to Council September 2017

e) There is a strong scientific case for an electron-positron collider, *Europe looks forward to a proposal from Japan to discuss a possible participation.*

In the meantime:

- ❑ Many ongoing collaborations and synergries CLIC-ILC on accelerators (beam dynamics, damping rings, beam delivery systems, etc.) and detectors (CERN Linear Collider Detector group).
- ❑ CERN-KEK cooperation agreements (e.g. accelerator studies at ATF-KEK); CERN's help for civil engineering and geological studies of tunnel layout in Japan
- ❑ ILC action plan in Europe being prepared → see S. Stapnes' talk

f) 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.

- ❑ CERN Neutrino Platform established in 2014 → became a project in 2016
- ❑ North Area extended to provide test beams and space for detector prototypes
- ❑ Supports detector R&D and construction in Europe (e.g. BabyMIND for T2K, DUNE prototypes, Near Detectors for both)
- ❑ CERN building first of four cryostats for DUNE detector based on new (for HEP) technology
- ❑ Neutrino group set up in EP in 2016 to carry out software and physics activities in synergy with TH, and help enhance coherence of efforts in the European community (e.g. currently providing forum for Near Detectors discussions and studies → Summer 2017 WS)

EPPSU 2013 – Other essential scientific activities(5)
DG report to Council September 2017

g) 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.

- CERN TH Department restored in 2016 → enhanced visibility inside and outside CERN
- CERN TH provides: high-quality research on broad range of areas; focal point for European theory community (~ 750 visitors/year); (increasing) support to CERN experimental activities
- Intense activity of "TH Institutes" covering particle physics, astroparticle, cosmology (involve also external organisers, attended by worldwide community)
- Collaboration agreements with several Institutes
- Cluster for parallel simulations of QCD and other computations in theoretical physics. Computing and software aspects also addressed within ongoing efforts to build future computing infrastructure and software for HEP

EPPSU 2013 – Other essential scientific activities(5)
DG report to Council September 2017

h) Experiments studying quark flavour physics, dipole moments, charged-lepton violation and performing other precision measurements ... with neutrons, muons and antiprotons may give access to higher energy scales than direct particle production ... They can be based in national laboratories, with a moderate cost Experiments in Europe with unique reach should be supported, as well as participation in experiments in other regions of the world.

- Discussed e.g. in the framework of LDG and ECFA plenary sessions (esp. outside CERN).
- Recognized Experiments @ CERN (REC): approved experiments from particle physics and nearby disciplines (e.g. astroparticle) with substantial participation of CERN Member State physicists. REC benefit from intellectual exchanges with scientists at CERN and, within available CERN resources, from usage of computing, infrastructure for meetings, access to test beam and laboratory equipment.
  Examples of REC: MEG, Belle-II, Panda.
- Physics Beyond Collider Study Group set up in 2016 to explore compelling projects complementary to high-energy colliders → report in 2018 as input to the ESPP.
  Targeting mainly projects at CERN's injectors, but looking more broadly to experiments that can be realised in other labs with CERN support (e.g. axion searches).

EPPSU 2013 – Other essential scientific activities(5)
DG report to Council September 2017

i) 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.

- Detector R&D: intense activities at CERN and laboratories/Institutes across Europe: generic R&D (e.g. CERN RDx projects, EU projects) and targeted (Phase-2 detector upgrades, Linear Collider Detector group, Neutrino Platform, etc.). Since few years also includes knowledge transfer activities (e.g. medical applications). Review panels put in place by ECFA (covering particle and astroparticle) and ICFA.
- Data, software and computing: conceptual, design and prototyping efforts to address the requirements of the HL-LHC phase started at CERN with Member States and in the broader framework of European Open Science Cloud (EIROforum paper on Federated Scientific Data Hub). Tomorrow's SW requirements being addressed by HEP Software Foundation (White Paper in preparation)

EPPSU 2013 – Other essential scientific activities(5)
DG report to Council September 2017

j) In the coming years, CERN should seek a closer collaboration with ApPEC on detector R&D with a view to maintaining the community' s capability for unique projects in this field.

- Relations with ApPEC and astroparticle community cover more than detector R&D
- CERN Director for Research and Computing attends ApPEC General Assembly meetings
- Many REC experiments from astroparticle physics: Auger, AMS, Fermi, IceCube, ArDM, CTA, LIGO, VIRGO, Km3Net, JUNO, SNO+, etc.
- CERN TH Institutes cover astroparticle and cosmology topics
- Working together on future exa-scale computing (e.g. agreement signed with SKA)
- CERN offers test beams, irradiation facilities, equipment/support for tests (e.g. Aria/DarkSide)
- End of August: joint CERN-LIGO/Virgo meeting to identify areas of collaboration (from physics to governance, vacuum and cryogenics, civil engineering, etc.)

k) A variety of research lines at the boundary between particle and nuclear physics require dedicated experiments. *The CERN Laboratory should maintain its capability to perform unique experiments. CERN should continue to work with NuPECC on topics of mutual interest.*

- CERN has compelling programme in (or at the boundary with) nuclear physics: ISOLDE, HIE-ISOLDE, n_TOF, COMPASS, HI programme (NA61, LHC experiments), AD.
- 2017 NuPECC Long-Range Plan (report finalised in a meeting at CERN in March 2017): CERN experiments appear in all six domains considered by NuPECC.
- CERN Director for Research and Computing regularly attends NuPECC meetings
- In addition: ongoing collaborations (mainly on accelerator aspects) with GSI/FAIR, ESS, etc.

EPPSU 2013 – Other essential scientific activities(5)
DG report to Council September 2017

I) CERN should be the framework within which to organise a global particle physics accelerator project in Europe, and should also be the leading European partner in global particle physics accelerator projects elsewhere. Possible additional contributions to such projects from CERN's Member and Associate Member States in Europe should be coordinated with CERN.

Regular discussions with several Member States countries on European participation in the neutrino programme in the US (Neutrino Platform established to facilitate and give coherence to this participation). Regular discussions with Funding Agencies also about the ILC, while waiting for a possible proposal from Japan.

I) A MoU has been signed between CERN and the Europena Commission . *CERN and the particle physics community should strengthen their relations with the European Commission in order to participate further in the European Research Area.*

- ❑ Several important projects proposed by CERN + Member States funded by EU: e.g. EuroCirCol, ARIES, AIDA, CESSAMag, Helix Nebula Science Cloud, mini-ATTRACT, etc.
- ❑ Co-funding for training and mobility of people: e.g. COFUND fellows, EPLANET
- ❑ HL-LHC included in the 2016 ESFRI roadmap as Landmark Project
- ❑ Strong contribution to ERA also through policy papers (EOSC, sustainability of Research Infrastructures, input to FP9, etc.) in particular within EIROforum.
- ❑ Annual meeting CERN-EC authorities to review work plan.

→ See S. Stavrev's presentation

EPPSU 2013 – Wider impact on society(3)
DG report to Council September 2017

n) Outreach and communication in particle physics should receive adequate funding and be recognised as a central component of the scientific activity. EPPCN and IPPOG should both report regularly to the Council.

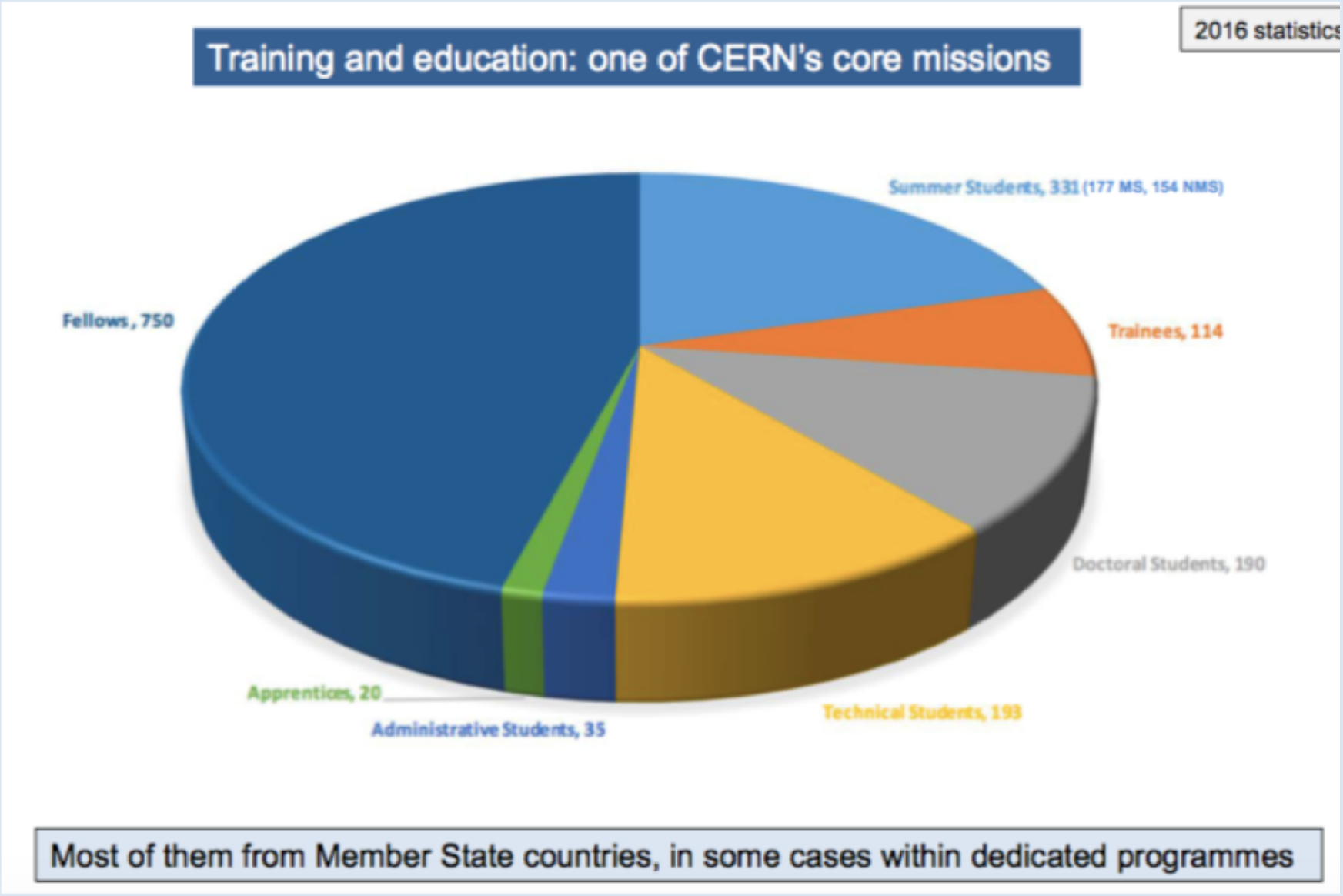
o) HEPTech should pursue and amplify its efforts and continue reporting regularly to the Council

→ See talks by P. Royole-Degieux, H.-P. Beck, Ian Tracey

p) CERN, together with national funding agencies, institutes, laboratories and universities, should continue supporting and further develop coordinated programmes of education and training.

- CERN trains every year ~1600 young physicists, engineers, technicians as employed or associated members of the personnel → next slide
- CERN schools of physics, accelerator, instrumentation and computing jointly organised with the countries (e.g. annual CERN/JINR European HEP school this year in Évora, Portugal).
- CERN has numerous educational programs jointly organised with Member States (and in several cases also Associate Member States): Teachers' programme, S'Cool Lab, HSSIP (High-School Students Internship Programme), Beam-Line-For-Schools, etc.

EPPSU 2013 – Wider impact on society(3)
DG report to Council September 2017



EPPSU 2013 - Implementation

Conclusions of CERN DG

- Implementation of the 2013 ESPP update well advanced
- Emphasis is on strong partnership between CERN and Laboratories and Institutes across Europe
- Fostering also optimization of the resources on the global scale through collaborations worldwide and complementarities of activities
- In parallel, very actively preparing input to the next ESPP update with a variety of studies and activities

Structure of the (2020) EPPSU process

- Strategy update approval by Council (date fixed, May 2020)
- The strategy update is drafted by the European Strategy Group (ESG)
- The drafting is based on input from the community – collaborations, projects, national institutes, national roadmaps, individuals
- The input is collected by the Physics Preparatory Group (PPG)
- The PPG organizes the Open Symposium to discuss the proposals
- The PPG summarizes the input, the discussions and their conclusions in a Briefing Book
- The Briefing Book constitutes the input for the ESG for drafting the update
- The drafting of the strategy update takes place during a dedicated Drafting Session (the conclave of the EPPSU process)
- The organization is handled by the Strategy Secretariat
- All the groups are chaired by the Strategy Secretary

Composition of the Strategy Secretariat

Members

- The Strategy Secretary - HA
- SPC chair – Keith Ellis
- ECFA chair – Jorgen D'Hondt
- Chair of *the European Laboratory Directors Group* – Lenny Rivkin

The European Laboratory Directors Group

- CERN
- CIEMAT
- DESY
- IRFU
- LAL
- NIKHEF
- LNF
- LNGS
- PSI
- STFC-RAL

Composition of the PPG

Members

- The Strategy Secretary (chair)
- SPC chair
- ECFA chair
- Chair of the the European Laboratory Directors Group
- Four members recommended by the SPC
- Four members recommended by ECFA
- One representative appointed by CERN
- Representative(s) from Asia (≤2)
- Representative(s) from the Americas (≤2)

15 to 17 people

Composition of the ESG

Members

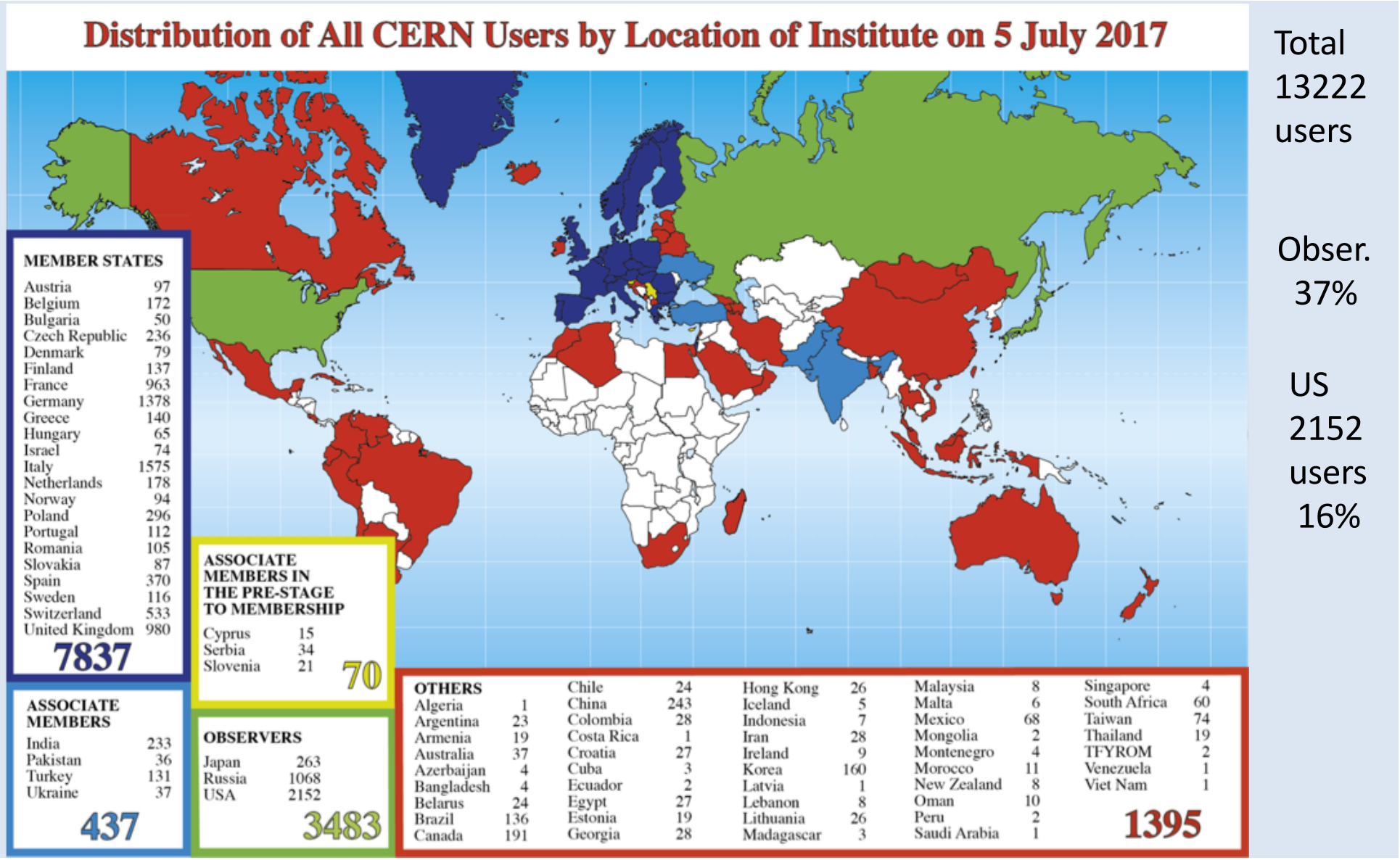
- The Strategy Secretary (chair)
- One representative appointed by each CERN MS (22)
- One representative appointed by each of the Labs participating in the European Laboratory Directors Group including its Chairperson (9)
- CERN DG
- SPC chair
- ECFA chair

Invitees

- President of CERN Council
- One government representative from each AMS and OS (7+3)
- One representative from the European Commission
- Chairs of ApPEC, NuPECC, FALC, ESFRI
- Members of the PPG (17 - Secretariat)

62 to 64 people

Geographical distribution of CERN Users

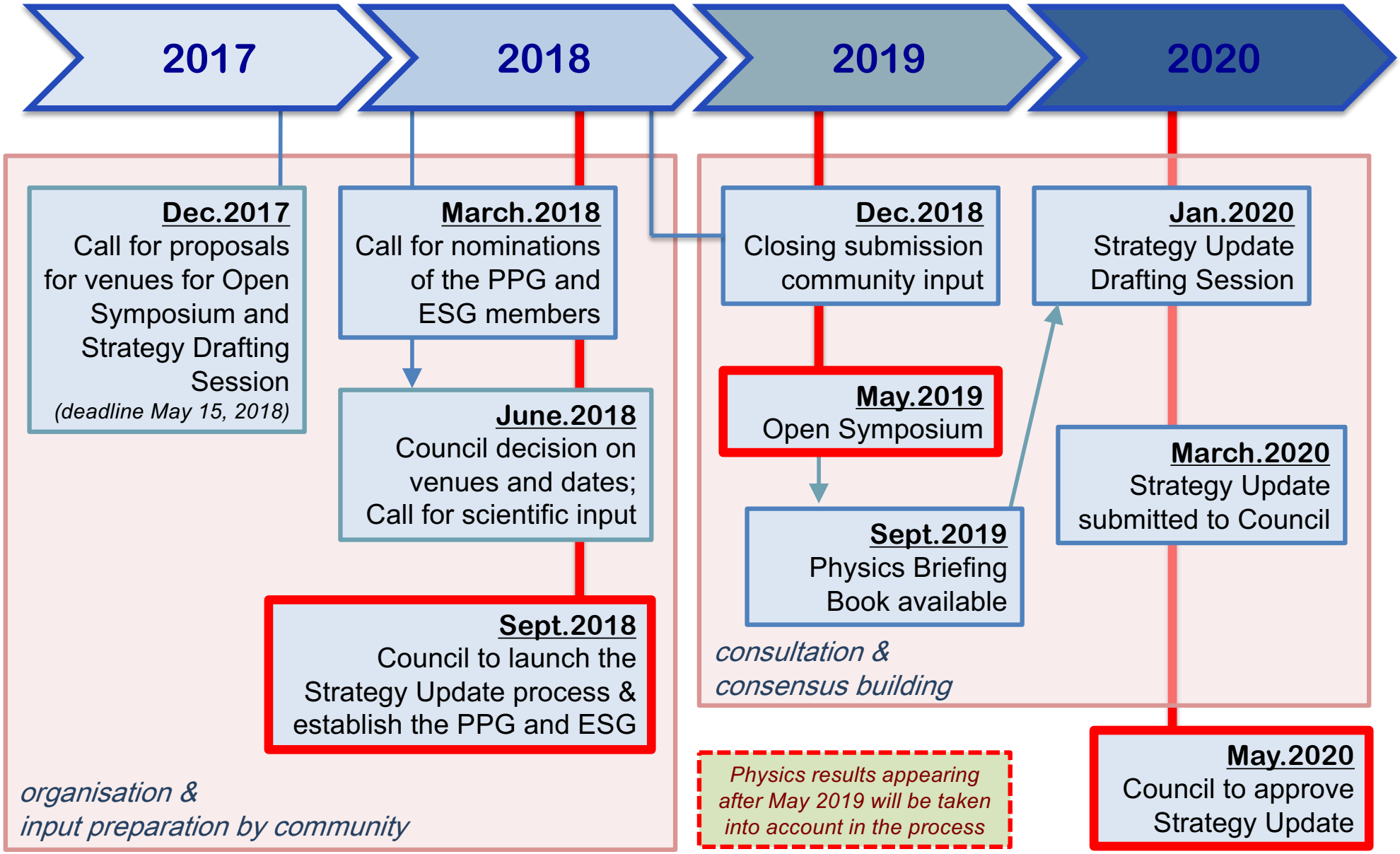


Total 13222 users

Obser. 37%

US 2152 users 16%

European Particle Physics Strategy *Update*



Input Template for the EPPSU 2020

The template for input to the process is in preparation.

Expected template layout:

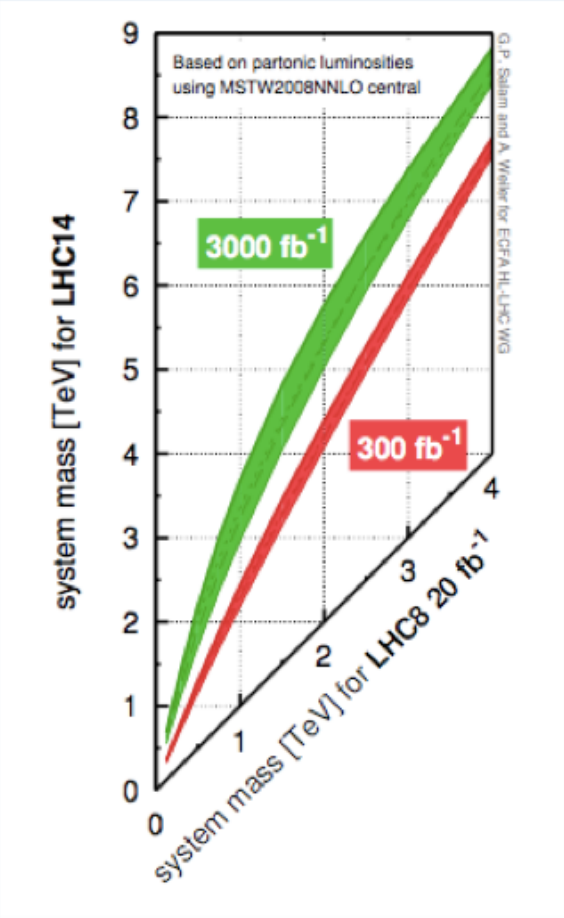
- Cover page with abstract
- Core document of 10 pages (scientific context, objectives, methodology, readiness, expected challenges)
- Addendum (community, timeline, construction and operational cost, computing requirements)

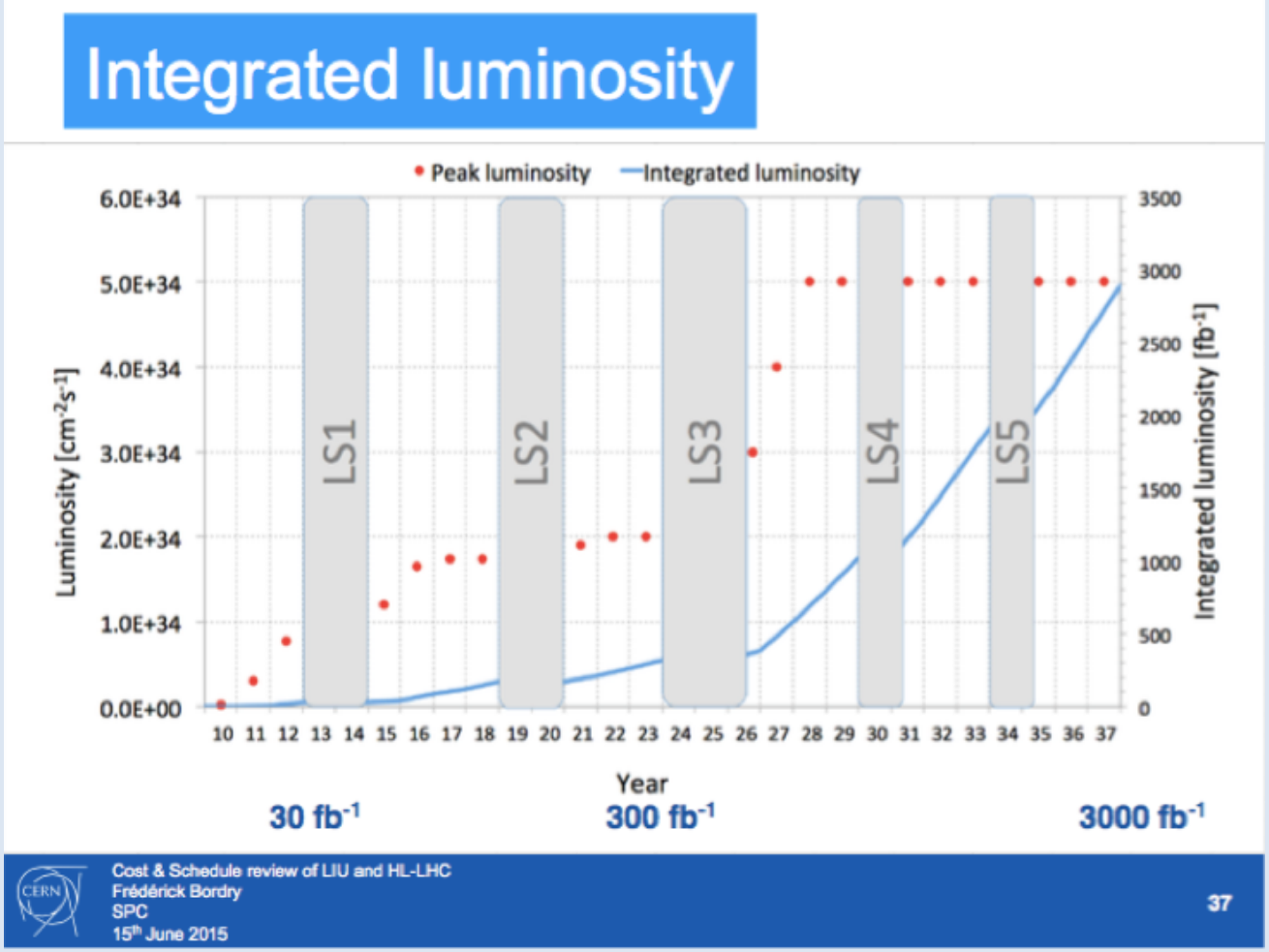
The big detailed documents (reports and publications) will be used as links within the official input document.

Deadline: December 18th 2018

Dmitri's questions: Why now

By end of RunII (end of 2018) LHC will accumulate around 200 fb^{-1}
If nothing found – getting to 3 ab^{-1} improves mass sensitivity by about 20%





Dmitri's questions: Why now

HL-LHC approved in September 2016; CERN needs to choose the next big project

- Hadron colliders

CERN: HE – LHC, pp 28 TeV - replace dipoles with 16T HTS Nb_3Sn → 20T
CERN: FCC – pp 100 TeV, 80 to 100 km tunnel, 16 to 20T magnets
China: SppC – pp 35 to 65 TeV, 60 km to 100 km tunnel with 12T HTS →24T

- Electron-positron colliders

Kitakami: ILC –linear collider, 250 GeV baseline (up to 31 km, upgrd. to 1 TeV)
CERN: CLIC – linear collider, 380 GeV to 3 TeV (up to 50 km)
CERN: FCC ee – circular collider, 240 to 350 GeV (80 to 100 km)
China: CEPC – circular collider, 240 GeV (50 to 100 km)

- Muon collider – Higgs factory and energy frontier

Circular collider – 120 GeV to 5 TeV, 300 m long (neutrino factory a bonus)

- ep/eA collider – origin of mass (confinement)

Add e or p linac/circular acc. to existing facilities: EIC (BNL,Jlab), LHeC, …, Chinese versions)

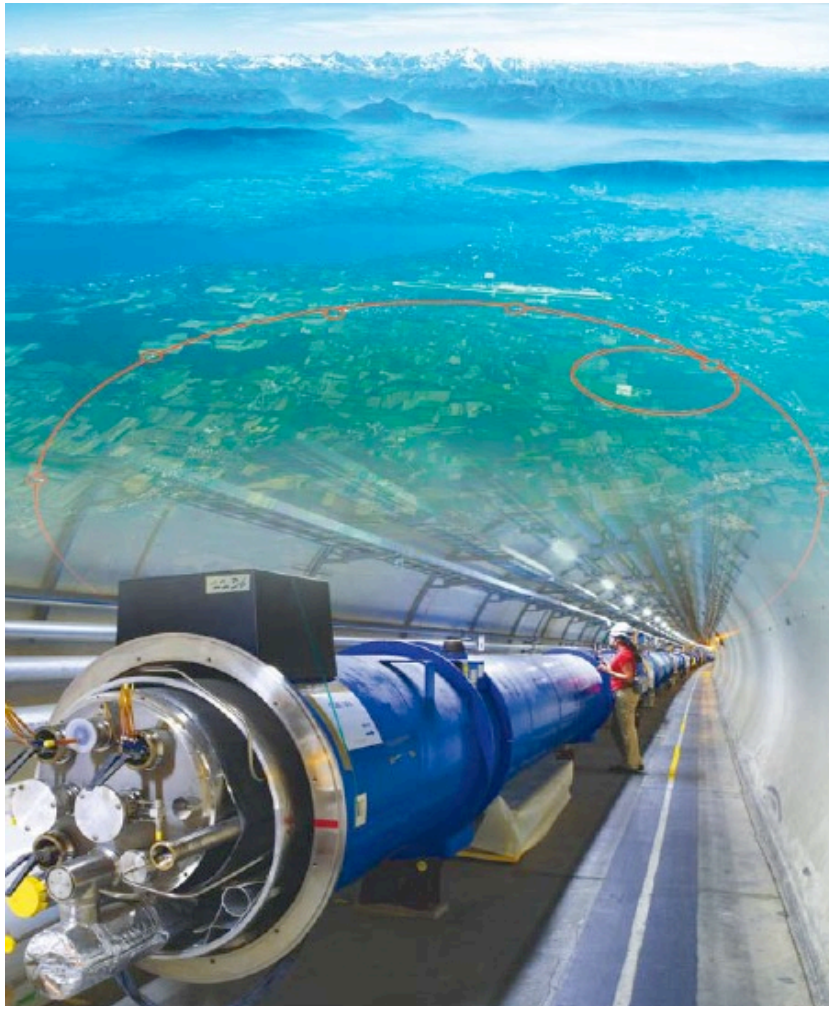
European Strategy Update

LHC (Large Hadron Collider)

14 TeV proton-proton accelerator-collider built in the LEP tunnel

Pb-Pb (Pb-proton) collisions

1983 : First studies for the LHC project
1988 : First magnet model (feasibility)
1994 : Approval of the LHC by the CERN Council
1996-1999 : Series production industrialisation
1998 : Declaration of Public Utility & Start of civil engineering
1998-2000 : Placement of the main production contracts
2004 : Start of the LHC installation
2005-2007 : Magnets Installation in the tunnel
2006-2008 : Hardware commissioning
2008-2009 : Beam commissioning and repair
2010-2035 : Physics exploitation

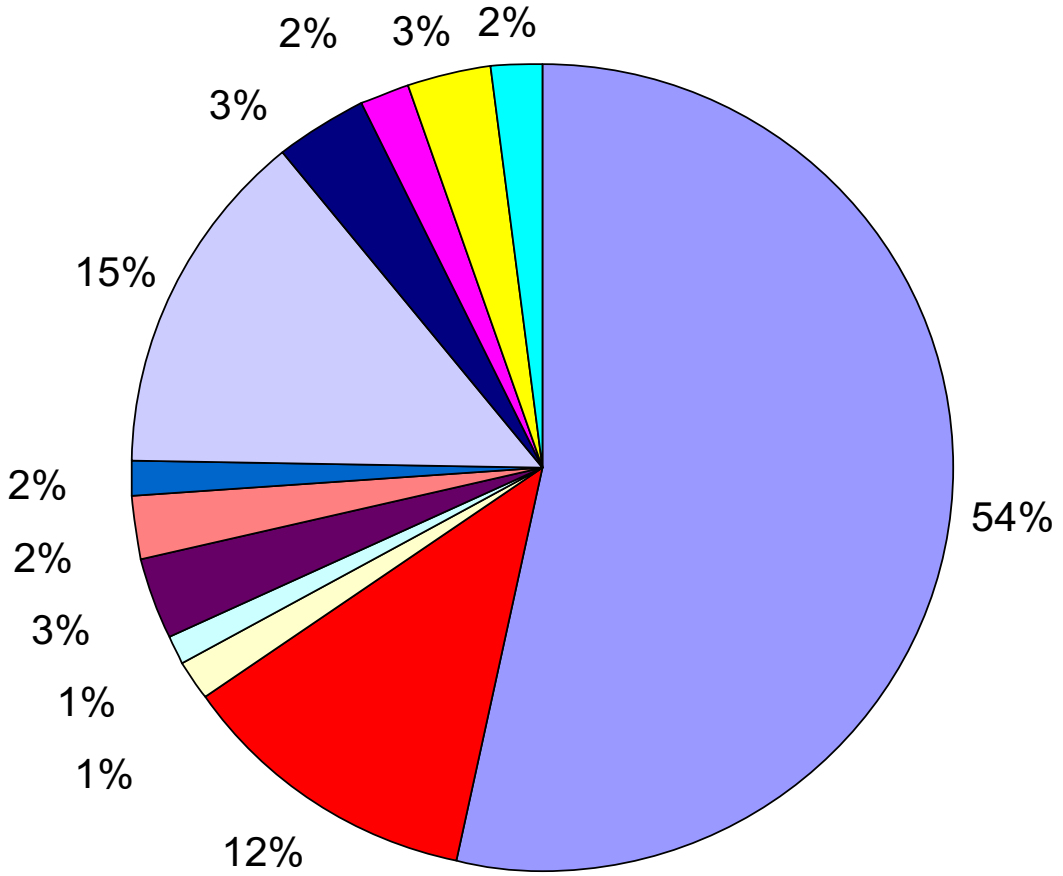


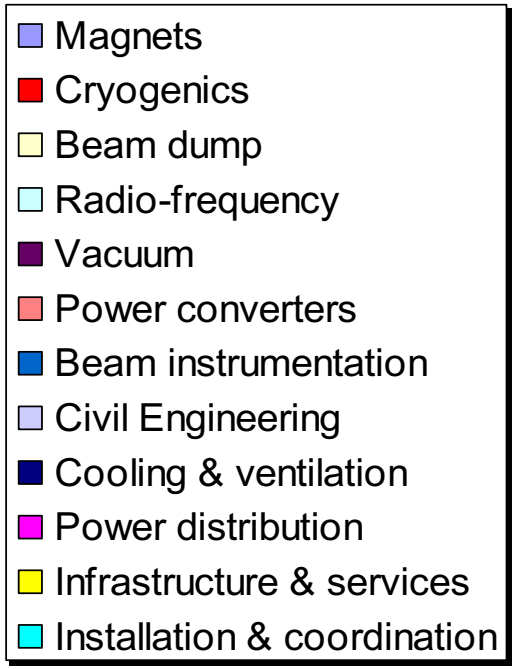
From F. Bordry

European Strategy Update

A large investment in advanced technology

Cost structure of the LHC accelerator





	Amounts in MCHF Personnel	Material
LHC machine and experimental areas, incl. R&D, injectors, tests and pre-operation	1 224	3 756
CERN contribution to detectors, incl. R&D, tests and pre-operation	869	493
CERN contribution to LHC computing	85	83
Total CERN costs	2 178	**4 332**

Dmitri's other questions

- How can various projects/regions contribute to the strategy
  - various communities should come together and submit their "road maps"
  - regions will have representatives in the PPG and in the ESG
- Should the Dune experiment submit a white paper
  - preferably within the neutrino road map, with detailed material linked
- May US scientists submit their proposals
  - through European partners
  - other tools still under consideration
- Who is coordinating the submission of proposals
  - there is no formal coordination from the Strategy Secretariat, we are the recipients
  - After the formal launch of the EPPSU in September 2018, a website will be available for submissions (from the CERN Council webpage)
- Who may clarify the arising question
  - the Strategy Secretariat - EPPSU-Strategy-Secretariat@cern.ch

Expected outcome

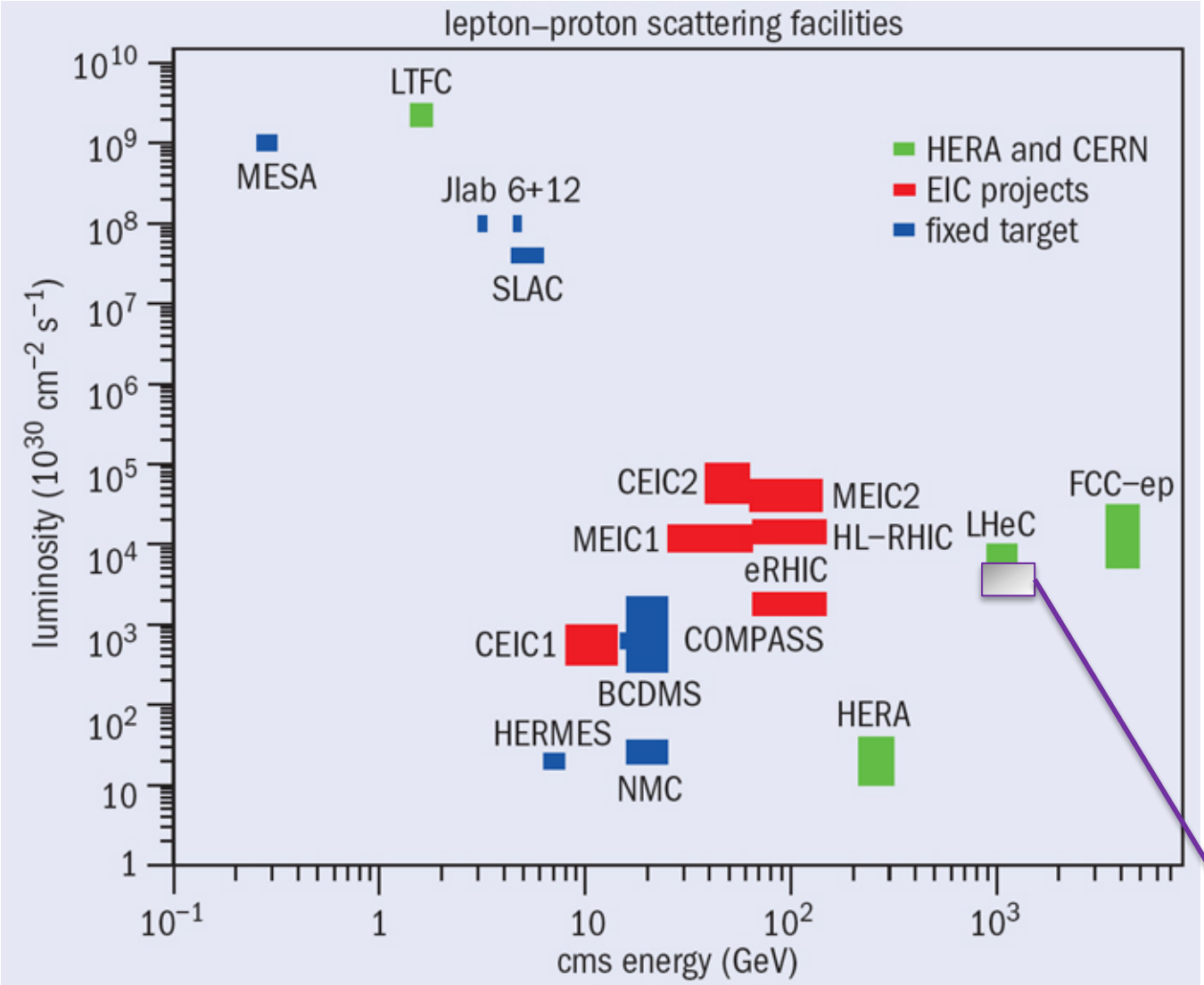
- The community is busy thinking about the future, driven by the physics case
- Many exciting developments
- The timelines of the various projects very uncertain
  - Technology issues
  - Funding issues
- Expect heated discussions during the EPPSU

OUTCOME – update of the existing strategy !!!

Some references

ILC - Technical Design Report
CLIC - Conceptual Design Report
CepC - pre-Conceptual Design report
FCCee - The Fcc-ee Design Study
SSC - Higgs Factory and 100 TeV Hadron Collider: Opportunity for a New World Laboratory within a Decade
FCC - Web pages
SppC - pre-Conceptual Design report
HE-LHC – high field magnetic design
EIC – JLAB (MEIC Design Summary)
EIC – BNL (eRHIC Design Study: An Electron-Ion Collider at BNL)
VHEep - VHEeP: A very high energy electron-proton collider
Muon Collider - A muon collider as a Higgs factory

ep/eA colliders



CEIC1 = Chinese version of Electron-Ion Collider
("A dilution-free mini-COMPASS")

MEIC1 = EIC@Jlab

eRHIC = EIC@BNL

LHeC = ep/eA collider @ CERN

CEIC2
MEIC2
HL-eRHIC
FCC-he

SehC