View from Europe
European Strategy for Particle Physics 2013

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DPF 2013, UC Santa Cruz, 14.08.2013

A bit of history

- 2006 – European Strategy for Particle Physics adopted by the CERN Council at its special meeting on 14 July in Lisbon
- From 2006 onwards – implementation of the strategy: prepared by the Scientific Secretariat chaired by Scientific Secretary, reported at the European Strategy Sessions of Council and included into the Medium Term Plans (MTP) of CERN
- 2011-2013 – first update of the European Strategy for Particle Physics

2011-2013

First update of the European Strategy for Particle Physics

- 2011, 16 September – Start up the Strategy update and approval the composition of the European Strategy Group (ESG) and the Preparatory Group (PG)
- 2012, end of July – deadline for collecting input from the particle physics community
- 2012, 10-12 September – CERN Council Open Symposium on European Strategy for Particle Physics in Krakow to discuss input from the community, 500 participants
- 2012, December – Briefing Book summarizing input from the community, prepared by the Preparatory Group, 216 pages
- 2013, 20-25 January – meeting in Erice, drafting of the Strategy Statements by the European Strategy Group for Particle Physics
- 2013, 22 March – European Strategy Session of Council, the Strategy Document from Erice discussed and agreed by consensus

European Strategy and Preparatory Groups

European Strategy Group (chaired by Scientific Secretary T.Nakada)

Composition: Delegates from the Member States, Associate States, Observer States (India, Japan, Russian Fed., Turkey, US), ApPEC, ESFRI, EU, FALC, JINR, NuPECC, CERN DG, directors of large national laboratories (44) plus Scientific Secretariat; members of the Preparatory Group, former and present President of Council as observers

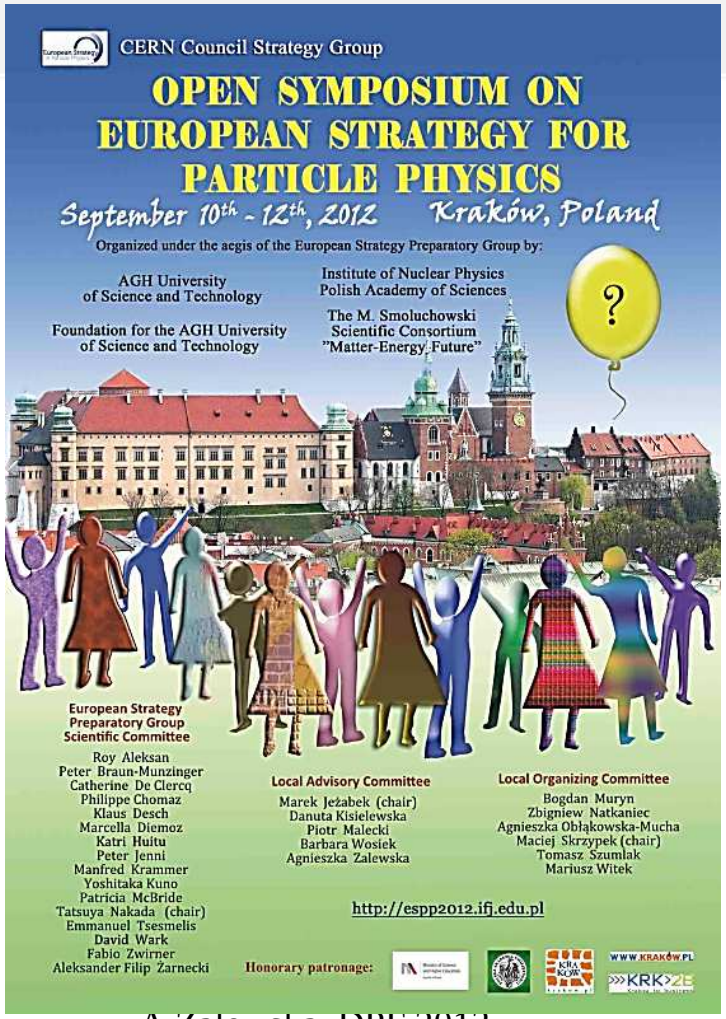
Mandate: Drafting the Strategy Statements based on the scientific input from the Preparatory Group (Briefing Book) and on the non scientific input (organisational matters, technology transfer, outreach) from its own working groups

Preparatory Group (chaired by Scientific Secretary T.Nakada)

Composition: Members of the Scientific Secretariat and representatives of SPC, ECFA, Americas, Asia and CERN (15)

Mandate: Producing the Briefing Book, based on the inputs from the community, funding agencies and policy makers, prepared as written reports and presented at the Open Symposium and organisation of the Open Symposium

CERN Council's Open Symposium in Krakow and Drafting Meeting in Erice



2013 – further steps

Adoption and implementation of the updated European Strategy for Particle Physics

- 2013, 30 May – formal adoption of the Strategy at the Special European Strategy Session of Council in Brussels

→ Strategy update becomes the Strategy,

- 2013, 20 June – Council Session, formal adoption of the Medium-Term Plan for the Period 2014-2018 and Draft Budget of the Organization for the Sixtieth Financial Year 2014 (document CERN/SPC/1012 CERN/FC/5747 CERN/3069) with the new European Strategy taken into account,

→ official start up of the Strategy implementation

Documents related to the Strategy

- **Strategy Document** „European Strategy for Particle Physics, Update 2013" – containing 17 Strategy Statements, formally adopted by the CERN Council on 30 May 2013 in Brussels
- **Deliberation Document** with the background information underpinning the Strategy Statements, prepared by the European Strategy Group, May 2013
- **Briefing Book** with the physics input for the European Strategy Group, prepared by the Preparatory Group, December 2012
- **Brochure** „Accelerating science and innovation, Social benefits of European research in particle physics", prepared by the Communication Network, May 2013

All documents are available under
http://council.web.cern.ch/council/en/EuropeanStrategy/ESparticlePhysics.html

Events accompanying Council's Session in Brussels

29 – 30 May

- CERN exhibition „Accelerating science and innovation" in the EC Berlaymont Building, 29-30 May
- Press conference, 29 May
- STOA-ITRE-CERN Event in the European Parliament, 29 May
- Discussion panel „What do we get from basic research?", Berlaymont Building, 29 May
- Strategy presentation to the Ministers of research and innovation at the occasion of the Competitiveness Council, 30 May

More information available under
http://indico.cern.ch/internalPage.py?pageId=7&confId=244974

2013 Strategy Document

Contents:

- Preamble
- General issues (statements a and b)
- High-priority large-scale scientific activities (statements c-f)
- Other scientific activities essential to the particle physics programme (statements g-k)
- Organisational issues (statements l-m)
- Wider impact of particle physics (statements n-p)
- Concluding recommendations (statement q)

Preamble:

Since the adoption of the European Strategy for Particle Physics in 2006, the field has made impressive progress in the pursuit of its core mission, elucidating the laws of nature at the most fundamental level. A giant leap, the discovery of the Higgs boson, has been accompanied by many experimental results confirming the Standard Model beyond the previously explored energy scales. These results raise further questions on the origin of elementary particle masses and on the role of the Higgs boson in the more fundamental theory underlying the Standard Model, which may involve additional particles to be discovered around the TeV scale. Significant progress is being made towards solving long-standing puzzles such as the matter-antimatter asymmetry of the Universe and the nature of the mysterious dark matter. The observation of a new type of neutrino oscillation has opened the way for future investigations of matter-antimatter asymmetry in the neutrino sector. Intriguing prospects are emerging for experiments at the overlap with astroparticle physics and cosmology. Against the backdrop of dramatic developments in our understanding of the science landscape, Europe is updating its Strategy for Particle Physics in order to define the community's direction for the coming years and to prepare for the long-term future of the field.

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General issues:

a) The success of the LHC is proof of the 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.*

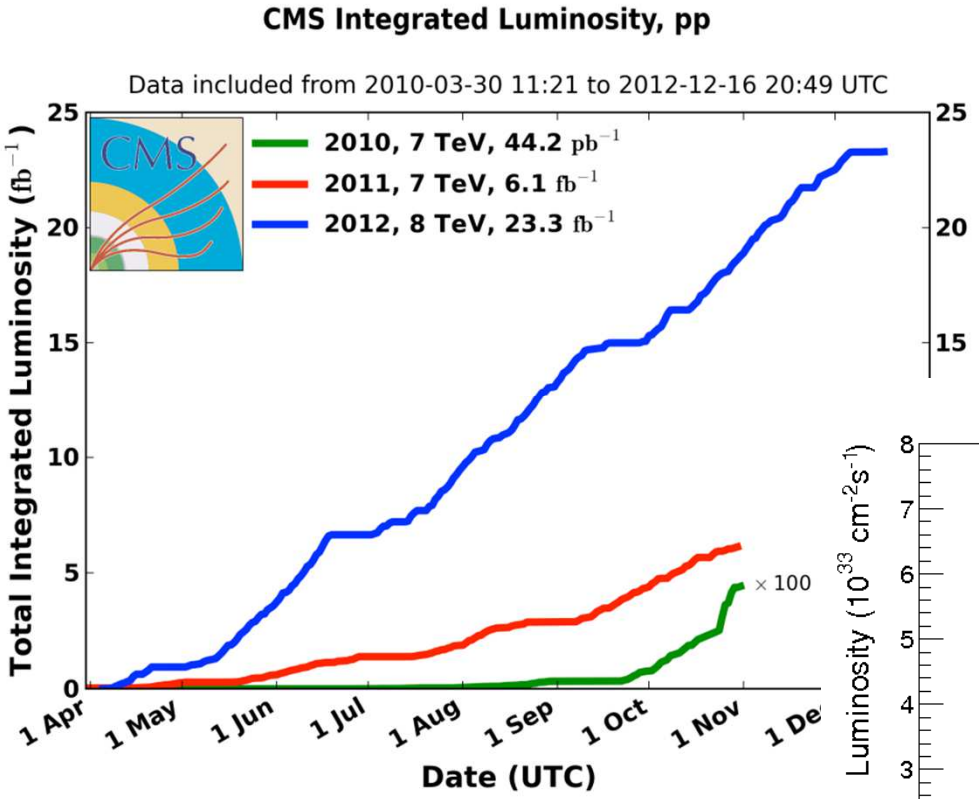
b) The scale of the facilities required by particle physics is resulting in the globalisation of the field. *The European Strategy takes into account the worldwide particle physics landscape and developments in related fields and should continue to do so.*

High priority large-scale scientific activities:
(requiring significant resources, sizeable collaborations and sustained commitment)

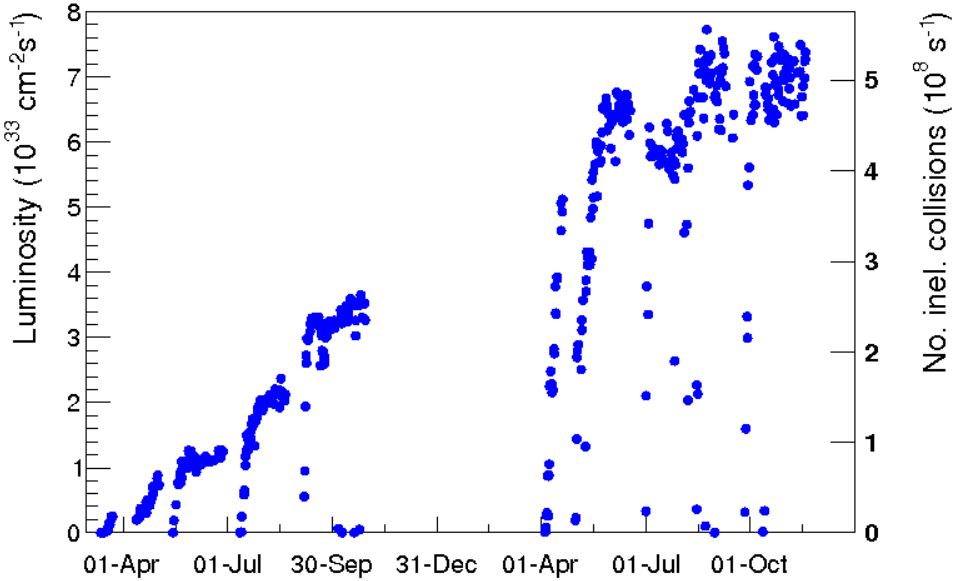
c) The discovery of the Higgs boson is the start of a major programme of work to measure this particle's properties with the highest possible precision for testing the validity of the Standard Model and to search for further new physics at the energy frontier. The LHC is in a unique position to pursue this programme. *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.*

LHC – fantastic performance in 2010-2012

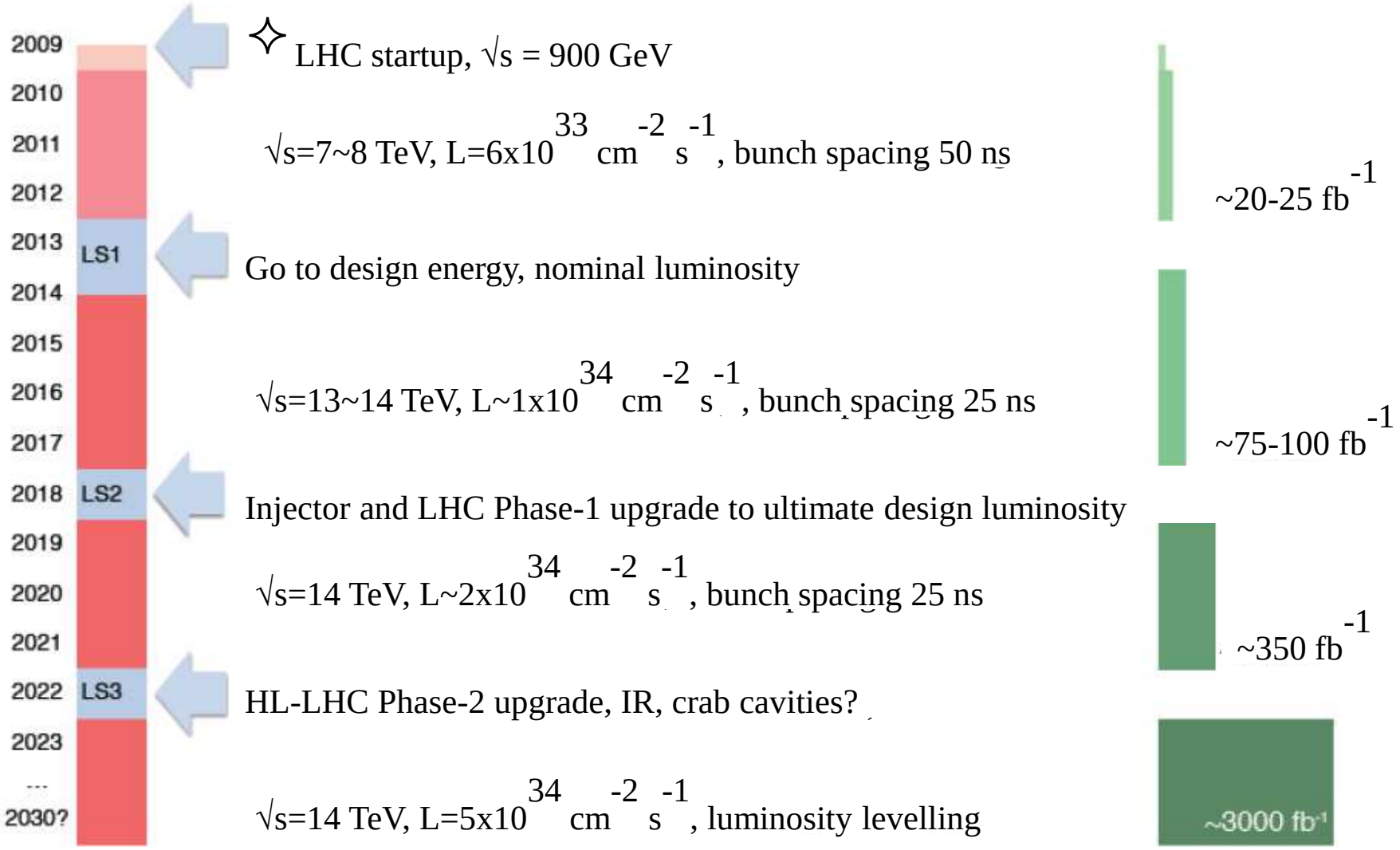
p-p, Pb-Pb and p-Pb collisions
p-p: up to 1380 bunches with 50 ns spacing and 1.5×10^{11} protons/bunch



Integrated and peak luminosity



„Europe's first priority should be the exploitation of the full potential of the LHC"



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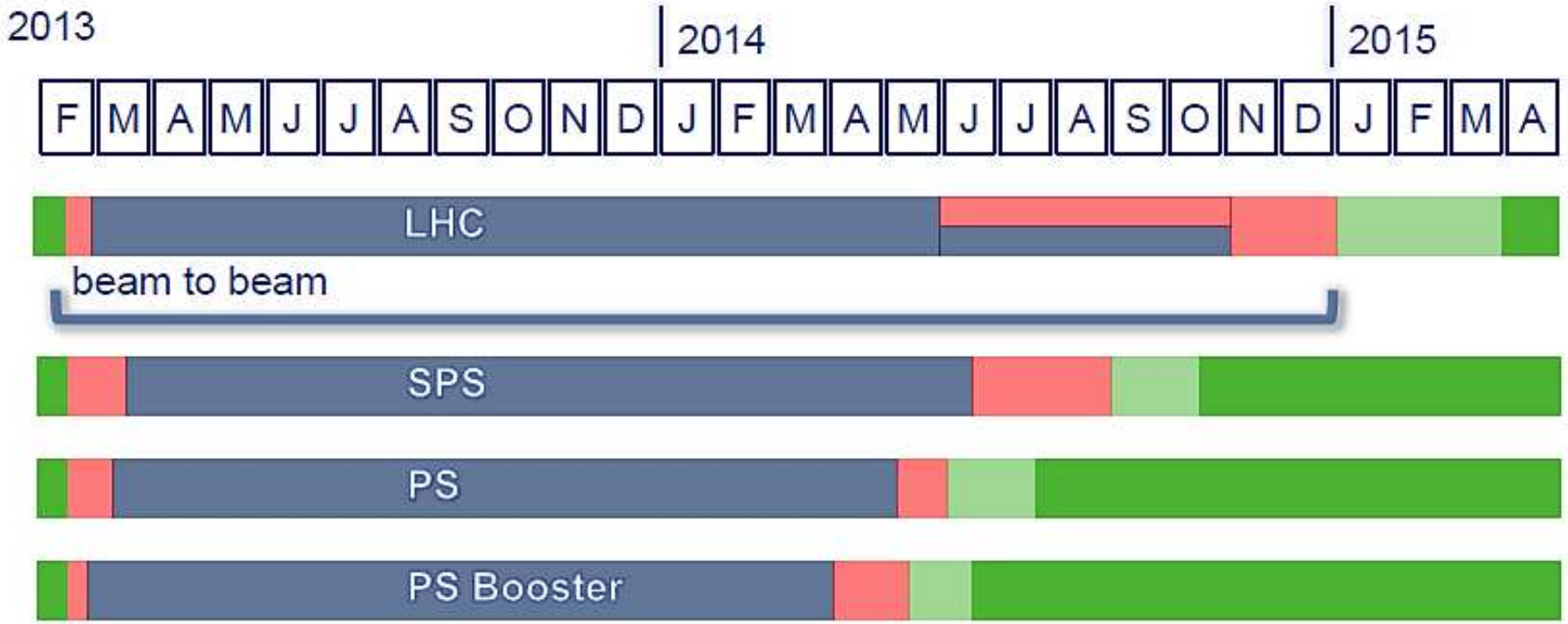
Physics
Beam commissioning
Shutdown
Tests

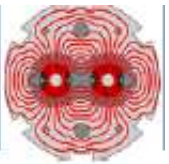
All interconnects opened and repaired
19 magnets changed
Huge infrastructure works for radiation to electronics mitigation
New protection systems and new controls/software
Consolidation of the injectors

LS1

from mid February 2013 to end December 2014



Post LS1 - potential performance



4 out of many possible scenarios…

	Number of bunches	N_b LHC Flat top [10^{11} p]	Emit LHC (SPS) [mm]	Peak Lumi [10^{34} cm^{-2}s^{-1}]	~Pile-up	Int. Lumi [fb^{-1}]
25 ns	2760	1.15	3.5 (2.8)	0.92	21	24
25 ns low emit.	2320	1.15	1.9 (1.4)	1.6	43	42
50 ns	1380	1.6	2.3 (1.7)	1.7 Level 0.9	76 level 40	~45*
50 ns low emit.	1260	1.6	1.6 (1.2)	2.2	108*	…

All numbers approximate

(*) different operational model to be validated (leveling)

Int. L based on 150 days of production, 6.5 TeV, 1.1 ns bunch length, 35% efficiency.

LS2 work programme:

- LINAC 4 connection
- complete the PS Booster energy upgrade
- finalise the enhancement of the collimation system
- carry-out LHC detector improvements

Implentation in MTP 2014-2018:

- Finish Long Shutdown (LS1) successfully
- Operate at high energy (design parameters)
- Do unavoidable maintenance and consolidation of LHC (PIC-LHC – Performance Improving Consolidation of LHV) and LIU (LHC Injector Upgrade)
- Prepare for future upgrade during high energy run (R&D towards HL-LHC)

This MTP does not include the funding needed for launching the start of the HL-LHC construction.

HL- LHC: still a long way from R&D to construction project

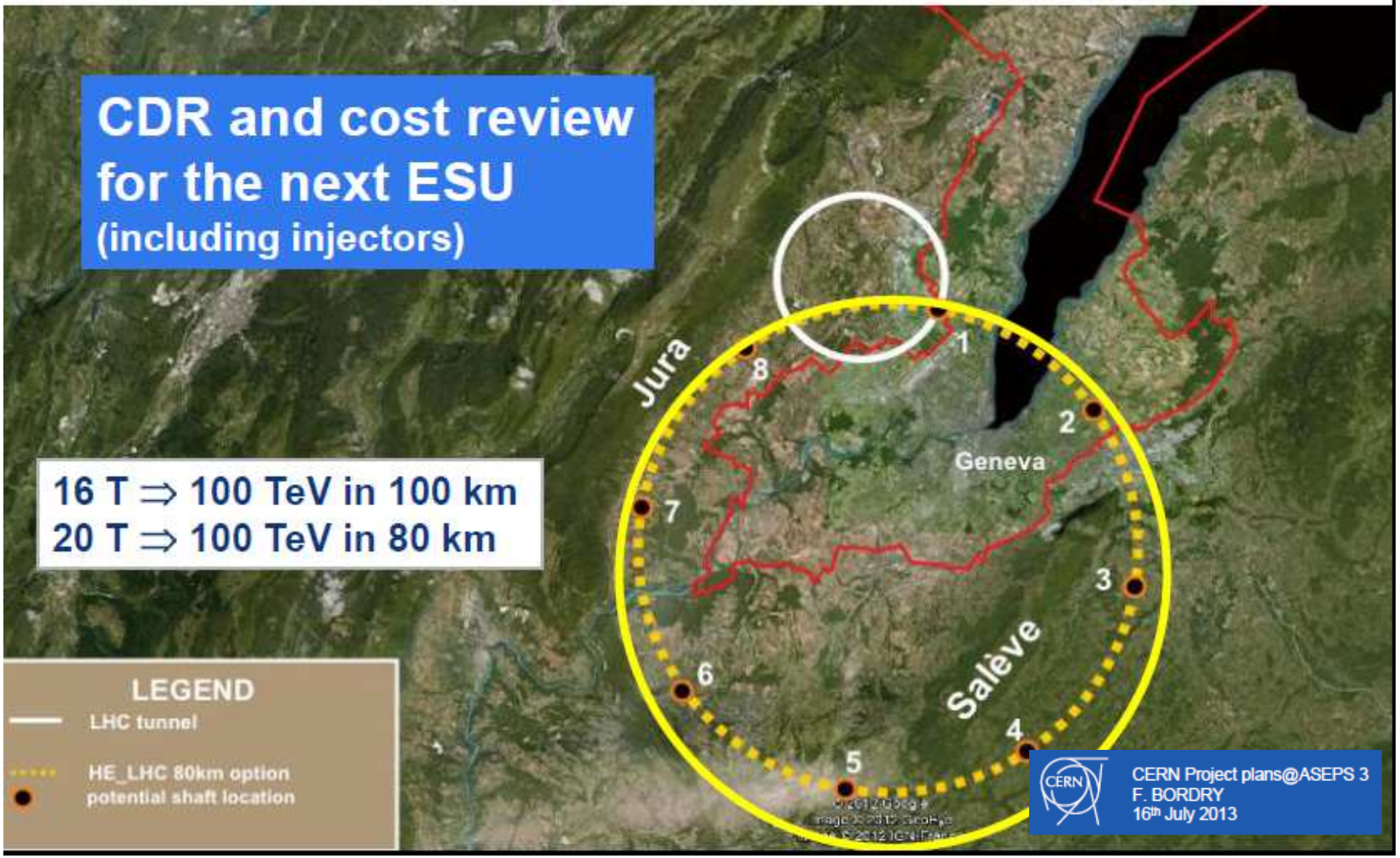
In particular R&D in high field superconductive magnets is essential

High priority large-scale scientific activities:
(requiring significant resources, sizeable collaborations and sustained commitment)

d) To stay at the forefront of particle physics, Europe needs to be in a position to propose an ambitious post-LHC accelerator project at CERN by the time of the next Strategy update, when physics results from the LHC running at 14 TeV will be available. *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.*

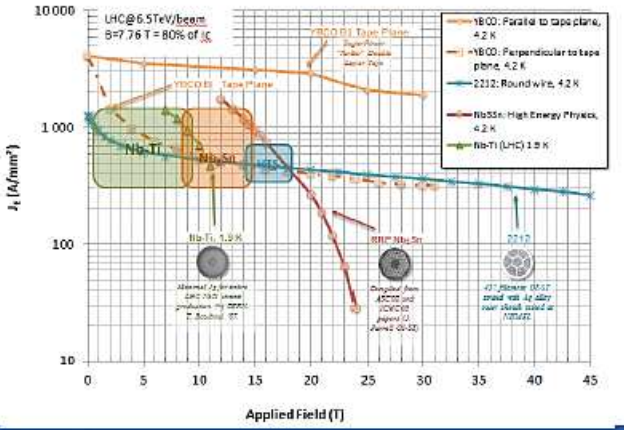
80-100 km tunnel in Geneva area – VHE-LHC

with possibility of e+-e- (TLEP) and p-e (VLHeC)

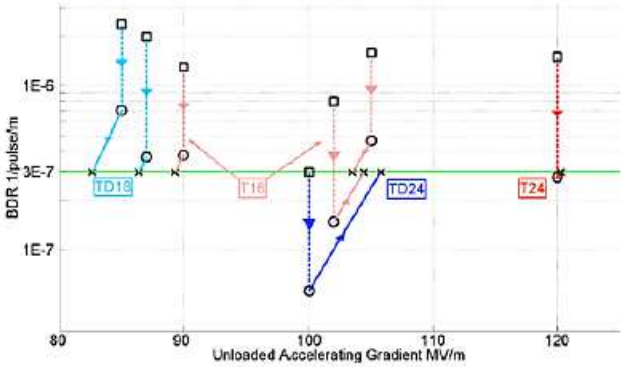


machines. These design studies should be coupled to a vigorous accelerator ***R&D programme,*** *including* ***high-field magnets*** ***and*** ***high-gradient accelerating structures,*** ***in collaboration with national institutes, laboratories and universities worldwide.***

HFM



HGA



And also R&D on Proton-Driven Plasma Wakefield Acceleration (AWAKE Expt at CERN)

Implementation in MTP 2014-2018:

CLIC - further R&D towards TDR ongoing (in particular high gradient studies & synergies with ILC)

Seed funding for the various R&D initiatives and studies

- AWAKE (proton plasma wake field acceleration, re-use of CNGS infrastructure)
- VHE-LHC (and TLEP)
- Roadmap for high field magnets HL-> HE -> VHE-LHC

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High priority large-scale scientific activities:

(requiring significant resources, sizeable collaborations and sustained commitment)

e) There is a strong scientific case for an electron-positron collider, complementary to the LHC, that can study the properties of the Higgs boson and other particles with unprecedented precision and whose energy can be upgraded. The Technical Design Report of the International Linear Collider (ILC) has been completed, with large European participation. The initiative from the Japanese particle physics community to host the ILC in Japan is most welcome, and European groups are eager to participate. *Europe looks forward to a proposal from Japan to discuss a possible participation.*

Implementation in MTP 2014-2018:

CERN's participation via

- Common development between CLIC and ILC machine (exploit synergies)
- Detector R&D for linear colliders

High priority large-scale scientific activities:
(requiring significant resources, sizeable collaborations and sustained commitment)

f) Rapid progress in neutrino oscillation physics, with significant European involvement, has established a strong scientific case for a long-baseline neutrino programme exploring CP violation and the mass hierarchy in the neutrino sector. *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.*

Studies of opportunities are ongoing, the quotation from the Snowmass presentation (on July 29, 2013) of Nigel S. Lockyer seems to me the most proper at this moment.

„Communication from Rolf Heuer….my wording:

- CERN welcomes the collaboration between LBNE and LBNO proponents towards a common experiment.
- CERN is performing a design study for a neutrino beam in the North Area in case it is required/requested at a later stage as a neutrino test beam or for a neutrino experiment, depending on the development in the US.
- CERN management needs a clear statement from US that LBNE will be a world competitive experiment i.e., will have a large enough detector underground."

Other scientific activities essential to the particle physics programme:

g) Theory is a strong driver of particle physics and provides essential input to experiments, witness the major role played by theory in the recent discovery of the Higgs boson, from the foundations of the Standard Model to detailed calculations guiding the experimental searches. *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.*

i) The success of particle physics experiments, such as those required for the high-luminosity LHC, relies on innovative instrumentation, state-of-the-art infrastructures and large-scale data-intensive computing. *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.*

Other scientific activities essential to the particle physics programme:

h) Experiments studying quark flavour physics, investigating dipole moments, searching for charged-lepton flavour violation and performing other precision measurements at lower energies, such as those with neutrons, muons and antiprotons, may give access to higher energy scales than direct particle production or put fundamental symmetries to the test. They can be based in national laboratories, with a moderate cost and smaller collaborations. *Experiments in Europe with unique reach should be supported, as well as participation in experiments in other regions of the world.*

Other scientific activities essential to the particle physics programme:

j) A range of important non-accelerator experiments take place at the overlap of particle and astroparticle physics, such as searches for proton decay, neutrinoless double beta decay and dark matter, and the study of high-energy cosmic-rays. These experiments address fundamental questions beyond the Standard Model of particle physics. The exchange of information between CERN and ApPEC has progressed since 2006. *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.*

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.*

Implementation in MTP 2014-2018

(related to statements k and h, for the part concerning the maintaining of unique experiments at CERN):

Commitment to continue the approved non-LHC program and projects:

- AD → ELENA (plus GBAR)
- nTOF → nTOF EAR2
- ISOLDE → HIE-ISOLDE
- Na 58, 61, 62
- CAST
- OSQAR
- Cloud

Organisational issues:

l) Future major facilities in Europe and elsewhere require collaboration on a global scale. *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.*

m) A Memorandum of Understanding has been signed by CERN and the European Commission, and various cooperative activities are under way. Communication with the European Strategy Forum on Research Infrastructures (ESFRI) has led to agreement on the participation of CERN in the relevant ESFRI Strategy Working Group. The particle physics community has been actively involved in European Union framework programmes. *CERN and the particle physics community should strengthen their relations with the European Commission in order to participate further in the development of the European Research Area.*

Wider impact of particle physics:
(outreach and communication, knowledge and technology transfer, education and training)

n) Sharing the excitement of scientific discoveries with the public is part of our duty as researchers. Many groups work enthusiastically in public engagement. They are assisted by a network of communication professionals (EPPCN) and an international outreach group (IPPOG). For example, they helped attract tremendous public attention and interest around the world at the start of the LHC and the discovery of the Higgs boson. *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) Knowledge and technology developed for particle physics research have made a lasting impact on society. These technologies are also being advanced by others leading to mutual benefits. Knowledge and technology transfer is strongly promoted in most countries. The HEPTech network has been created to coordinate and promote this activity, and to provide benefit to the European industries. *HEPTech should pursue and amplify its efforts and continue reporting regularly to the Council.*

p) Particle physics research requires a wide range of skills and knowledge. Many young physicists,engineers and teachers are trained at CERN, in national laboratories and universities. They subsequently transfer their expertise to society and industry. Education and training in key technologies are also crucial for the needs of the field. *CERN, together with national funding agencies, institutes, laboratories and universities, should continue supporting and further develop coordinated programmes for education and training.*

Concluding recommendations:

q) This is the first update of the European Strategy for Particle Physics. It was prepared by the European Strategy Group based on the scientific input from the Preparatory Group with the participation of representatives of the Candidate for Accession to Membership, the Associate Member States, the Observer States and other organisations. Such periodic updates at intervals of about five years are essential. *Updates should continue to be undertaken according to the principles applied on 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 revisited in the light of the experience gained since 2006.*

Conclusions

- The new European Strategy for Particle Physics has been formally adopted and its first implementation in the Medium Term Plan 2014-2018 has been approved by the CERN Council.
- Europe's top priority is the exploitation of the full potential of the LHC, including the high-luminosity upgrade of the machine and detectors. Europe needs to propose an ambitious post-LHC accelerator project at CERN.
- The European Strategy takes into account the worldwide particle physics landscape. In particular, the initiative of the Japonese particle physics community to host the ILC and developments concerning the long-baseline neutrino projects in the US and Japan are welcome by the European particle physics community.
- Other Strategy Statements are also very important, but I should avoid reaping the presentation…

Thanks

- To the US members of the European Strategy and Preparatory Groups as well as to the US physicists contributing to the Open Symposium for their most usuful input to the European Strategy for Particle Physics.
- To the organisers of the DPF 2013 Meeting for the opportunity to present the European Strategy at this conference.
- To Sergio Bertolucci, Federick Bordry, Rolf Heuer, Steve Myers and Tatsuya Nakada for their input and/or comments.