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European strategy and CERN roadmap

Frédéric Bordry

FCC Week 2015

23rd March 2015 – Washington DC



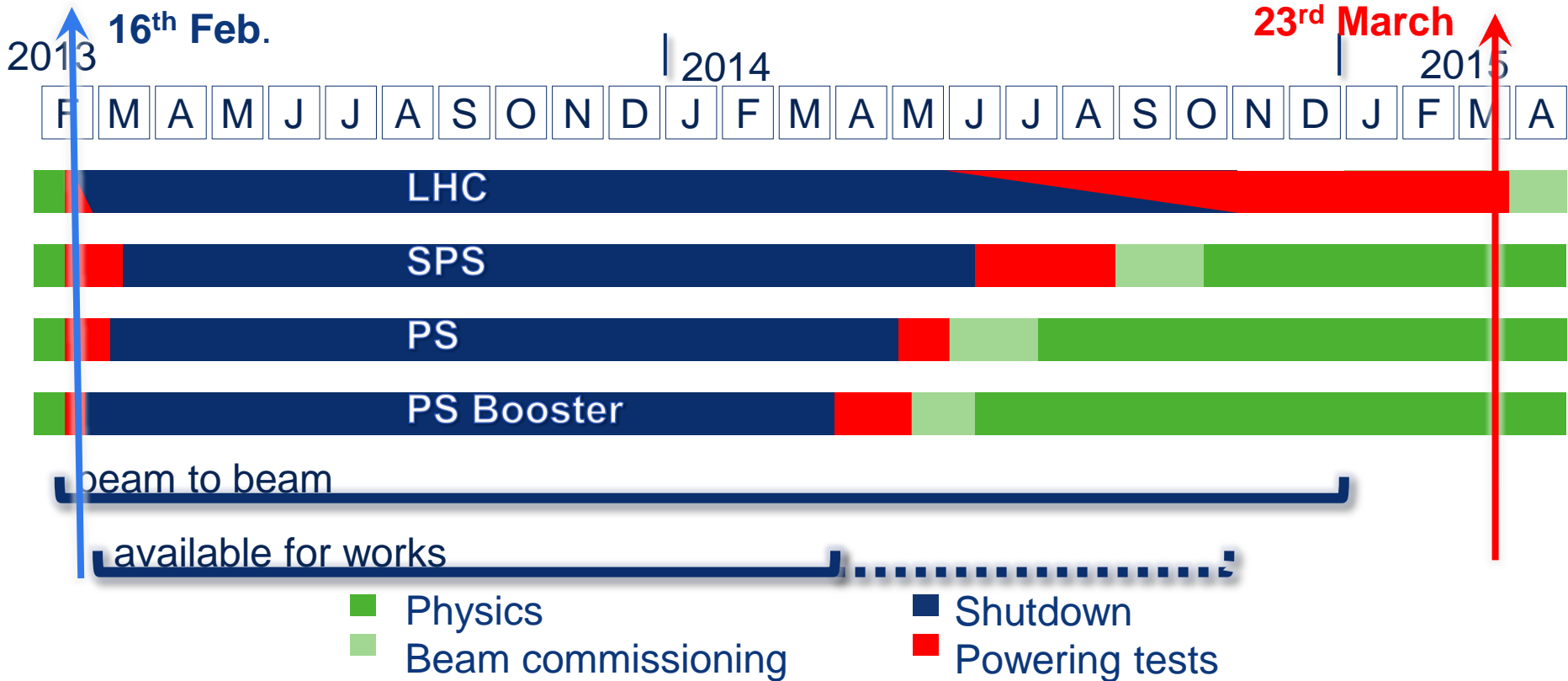
Outline

- **LS1 status and LHC restart**
- **The European Strategy for Particle Physics Update 2013**

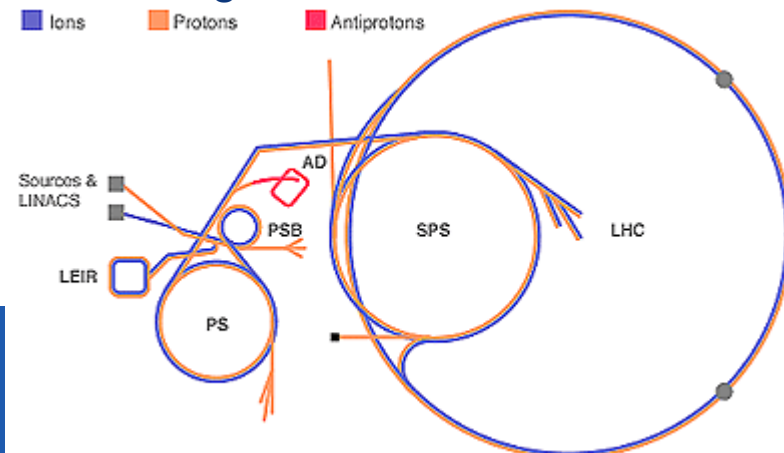
CERN roadmap

- **LHC Roadmap up 2035**
- **High Luminosity LHC project** \Rightarrow **$\sim 3'000 \text{ fb}^{-1}$**
- **Neutrino platform**
- **Fixed target programme**
- **Post-LHC machines : LCC and FCC**

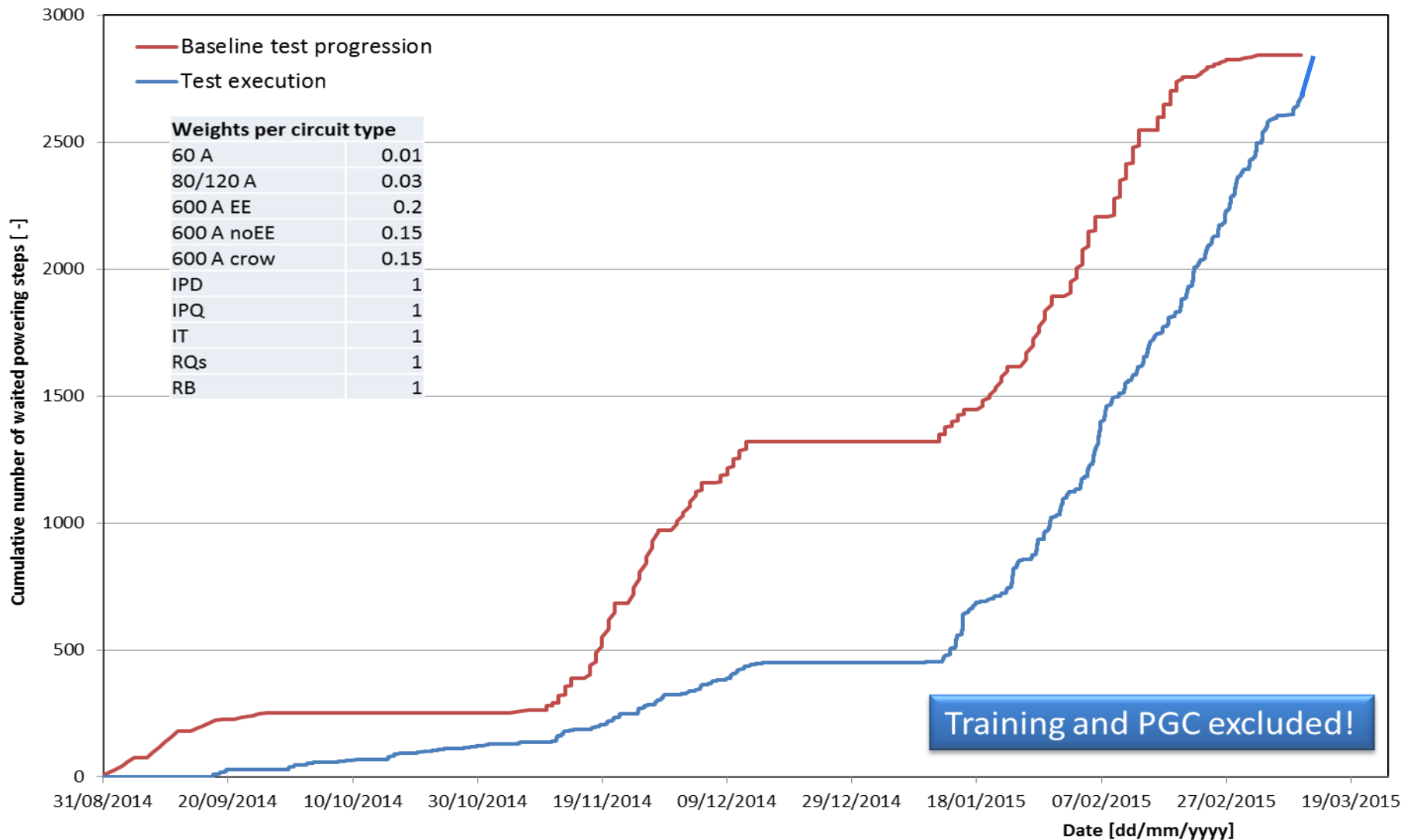
LS 1 from 16th February 2013 to March 2015



**Safety First,
Quality Second,
Schedule Third.**

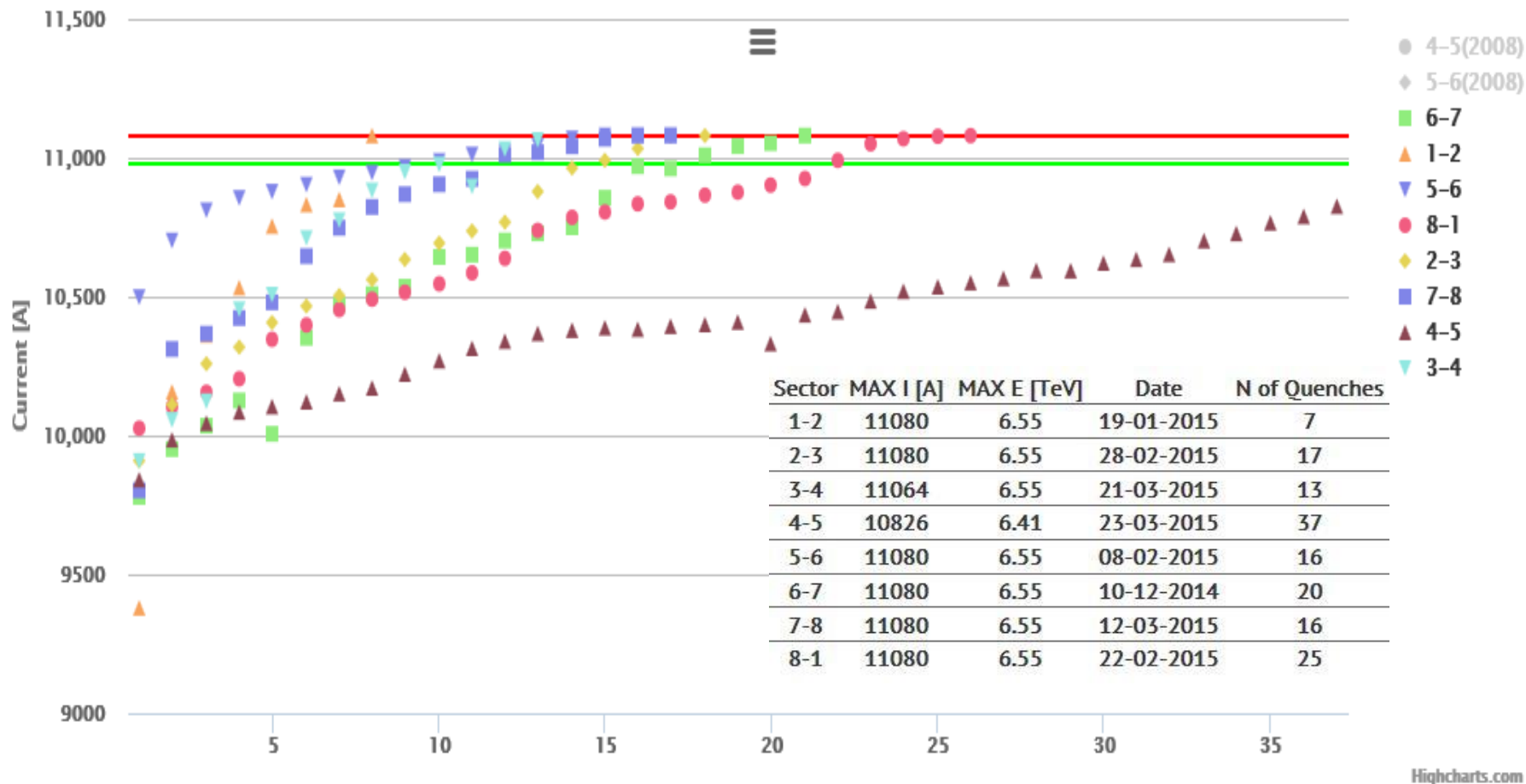


Powering tests “Weighted” advancement



Training quenches

6 sectors are fully qualified at 6.5 TeV



KEEP
CALM
IT'S
ALMOST
HERE

Safety First,
Quality Second,
Schedule Third.



The European Strategy for Particle Physics Update 2013

CERN-Council-S/106
Original: English
7 May 2013

ORGANISATION EUROPEENNE POUR LA RECHERCHE NUCLEAIRE
CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Action to be taken

Voting Procedure

For Approval	EUROPEAN STRATEGY SESSION OF COUNCIL 16 th Session - 30 May 2013 European Commission Berlaymont Building - Brussels	Simple Majority of Member States represented and voting
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The European Strategy for Particle Physics Update 2013

Having finalised its text by consensus at its Session of 22 March 2013, the Council is now invited to formally adopt the Update of the European Strategy for Particle Physics set out in this document.



The European Strategy for Particle Physics Update 2013

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.

Europe
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detect
initial
provid
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Near-term & Mid-term High-energy Colliders

LARGE HADRON COLLIDER

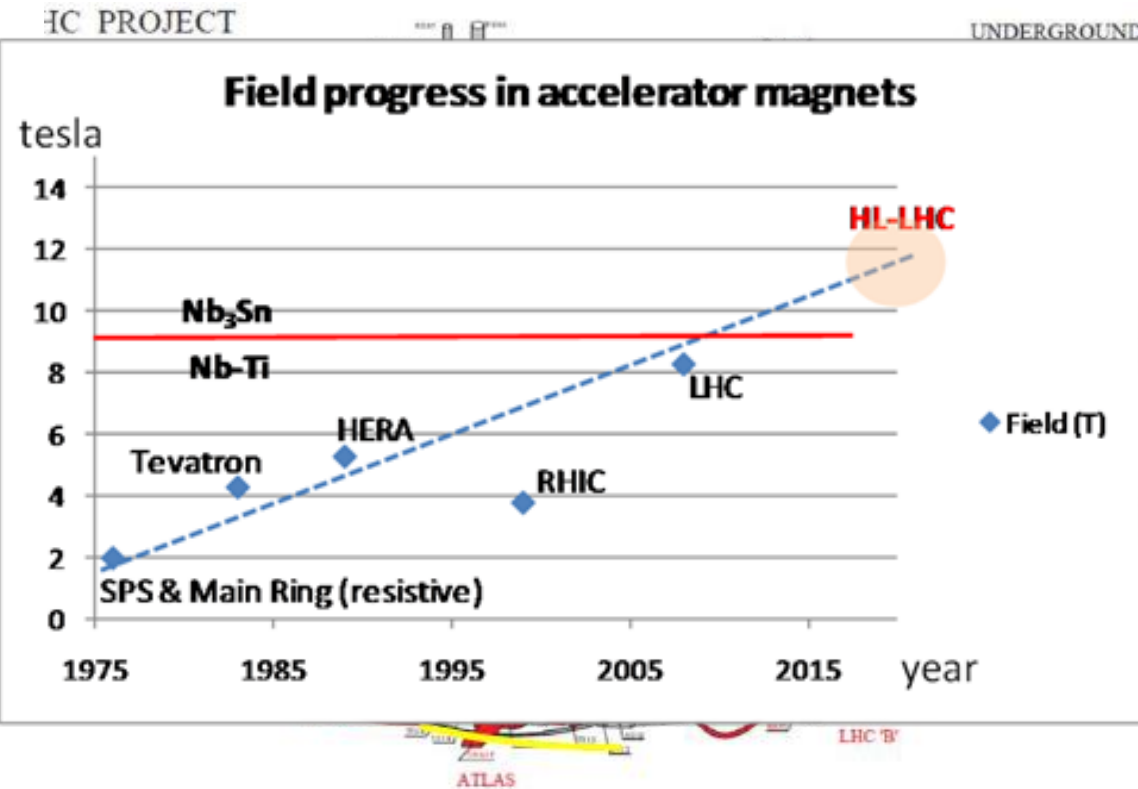
- The HL-LHC is strongly supported and is the first high-priority large-category project in our recommended program. It should move forward without significant delay to ensure that accelerator and experiments can continue to function effectively beyond the end of this decade and meet the project schedule.
- *Recommendation 10: Complete the LHC phase-1 upgrades, and continue the strong collaboration in the LHC with the phase-2 (HL-LHC) upgrades of the accelerator and both general-purpose experiments (ATLAS and CMS). The LHC upgrades constitute our highest-priority near-term large project.*

HL-LHC from a study to a PROJECT

$300 \text{ fb}^{-1} \rightarrow 3000 \text{ fb}^{-1}$

including LHC injectors upgrade **LIU**
(Linac 4, Booster 2GeV, PS and SPS upgrade)

The HL-LHC Project

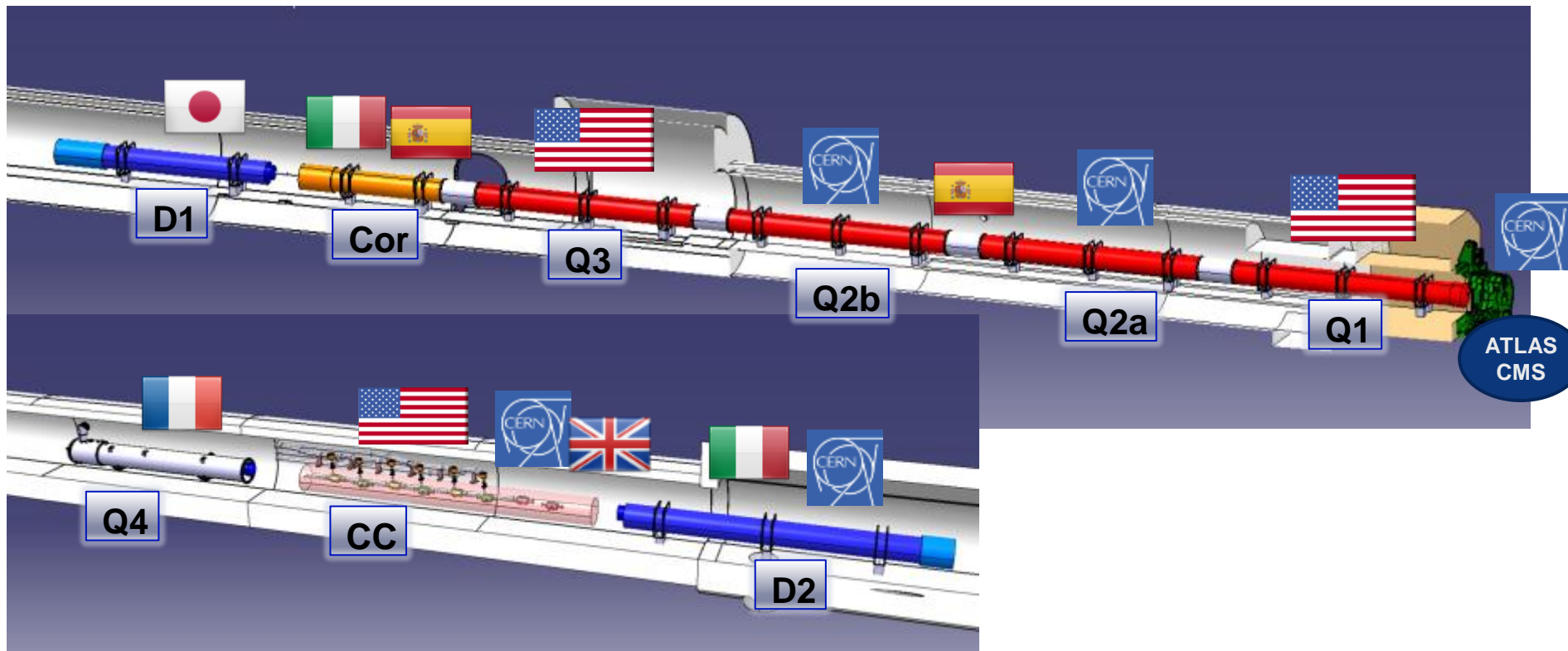


- New IR-quads Nb₃Sn (inner triplets)
- New 11 T Nb₃Sn (short) dipoles
- Collimation upgrade
- Cryogenics upgrade
- Crab Cavities
- Cold powering
- Machine protection
- ...

Major intervention on more than 1.2 km of the LHC

Setting up International collaboration

Baseline layout of HL-LHC IR region



with national laboratories **but also involving industrial firms**

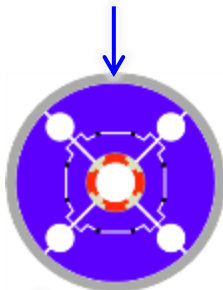
Development History (LARP)



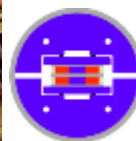
**Subscale
Quad. SQ**
0.3 m long
110 mm bore
2004-2006



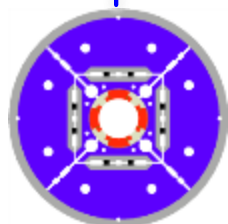
**Technology
Quadrupole
TQS - TQC**
1 m long
90 mm bore
2006-2010



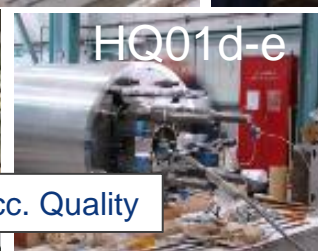
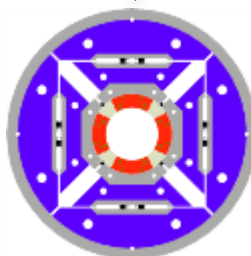
**Long
Racetrack
LRS**
3.6 m long
No bore
2006-2008



Long Quadrupole LQS
3.7 m long
90 mm bore
2007-2012

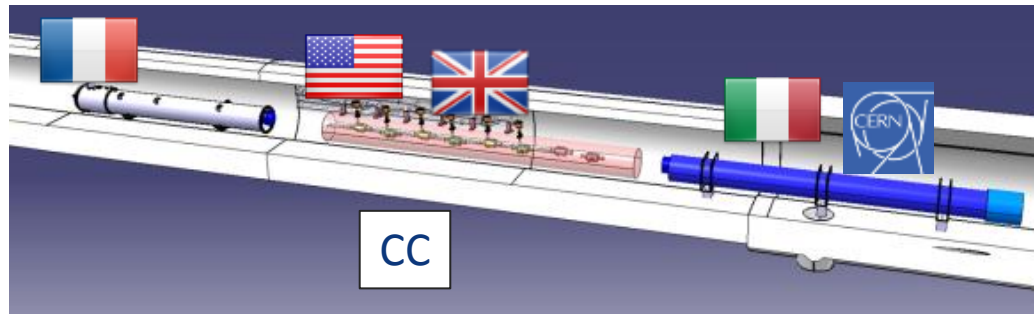


High Field Quadrupole HQ
1 m long
120 mm bore
2008-2014

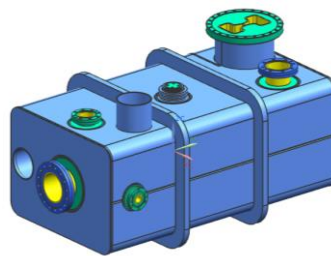
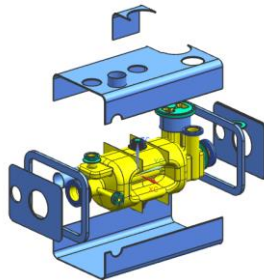


US-HiLumi Contributions: Crab Cavities

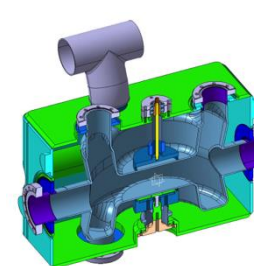
- ▶ US Scope: ~36 “dressed” crab cavities
 - ▶ Components such as tuners, HOM couplers, etc. under discussion
- ▶ CERN Scope: Cryomodules
 - ▶ Integrate and install dressed cavities into 18 Cryomodules (two cavities each) and install in tunnel (includes two spares)



RFD Option

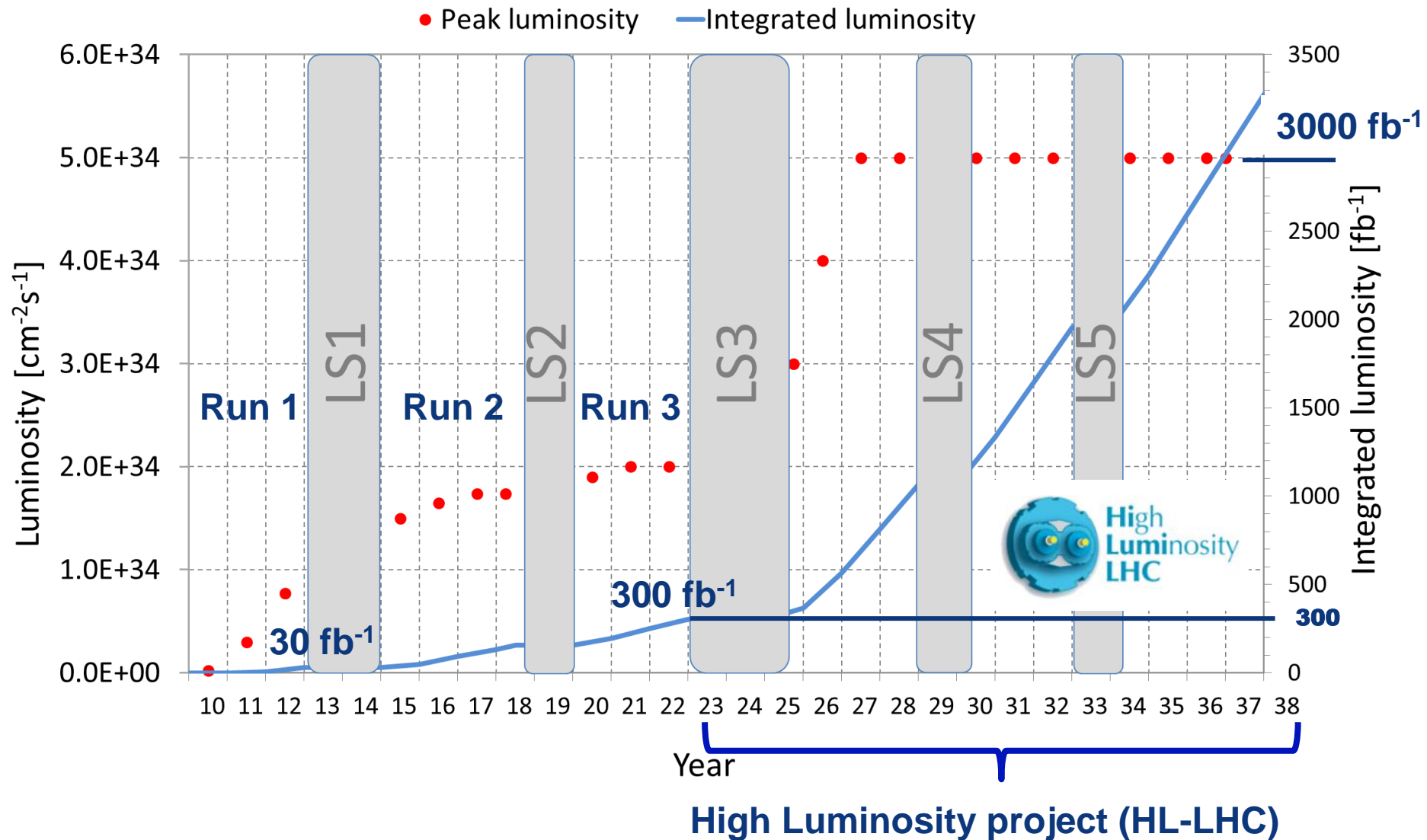


DQW Option



- *US-HiLumi* will test all bare cavities in Vertical Stand.
- Optimistic deliverable of dressed cavities (and Vertical test of dressed Cavities) is presently “costed” in TPC

LHC roadmap: Goal of 3'000 fb⁻¹ by mid 2030ies



The European Strategy for Particle Physics

Update 2013

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.

European Strategy for Particle Physics

CERN MTP

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.

CERN Neutrino Platform

CERN Council in June 2014 has decided to implement the proposed Medium Term Plan (MTP) which contains an allocation of resources in the next 5 years dedicated to the Neutrino CERN Platform

In summary

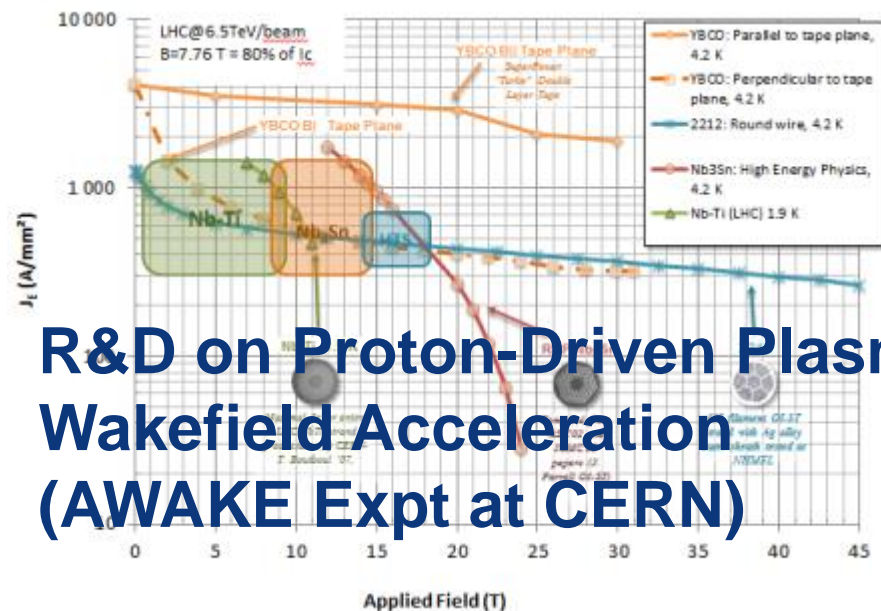
***Sergio Bertolucci at SPC
16th March 2015***

- ✓ CERN offers a platform for Neutrino detectors R&D. This platform is now part of the CERN MTP. We will support this platform in an active way and will help WA104, WA105 and all others proposals approved by the SPSC.
- ✓ CERN is building a large “neutrino” test area (EHN1 extension) with charged beams capabilities, available in 2017. No neutrino beam in planning so far.
- ✓ CERN will collaborate with FNAL on the LBNF infrastructure
- ✓ CERN will assist the EU neutrino community in their long term common plans.
- ✓ In the short term, CERN is helping in getting a Short Baseline operational at FNAL with an agreed physics program ... and later a Long Baseline

“to propose an ambitious **post-LHC accelerator project at CERN** by the time of the next Strategy update”

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.

HFM - FCC

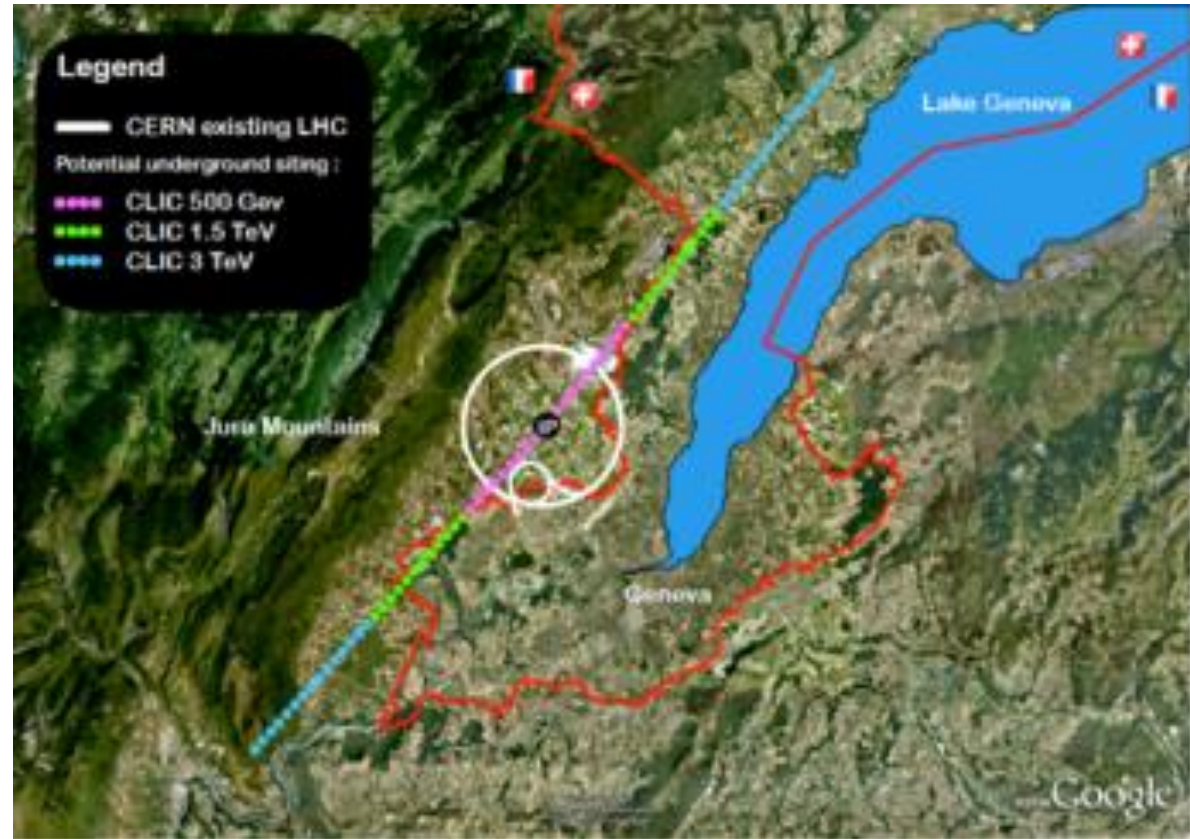
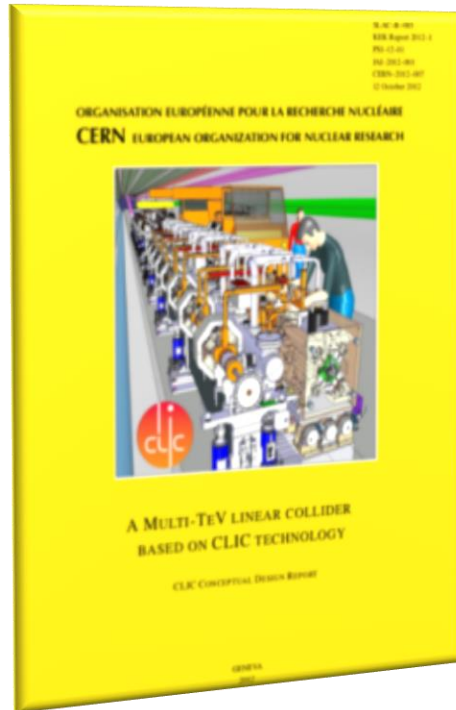


R&D on Proton-Driven Plasma Wakefield Acceleration (AWAKE Expt at CERN)

HGA - CLIC



*“CERN should undertake design studies for accelerator projects in a global context, with emphasis on proton-proton and **electron-positron high-energy frontier machines.**”*

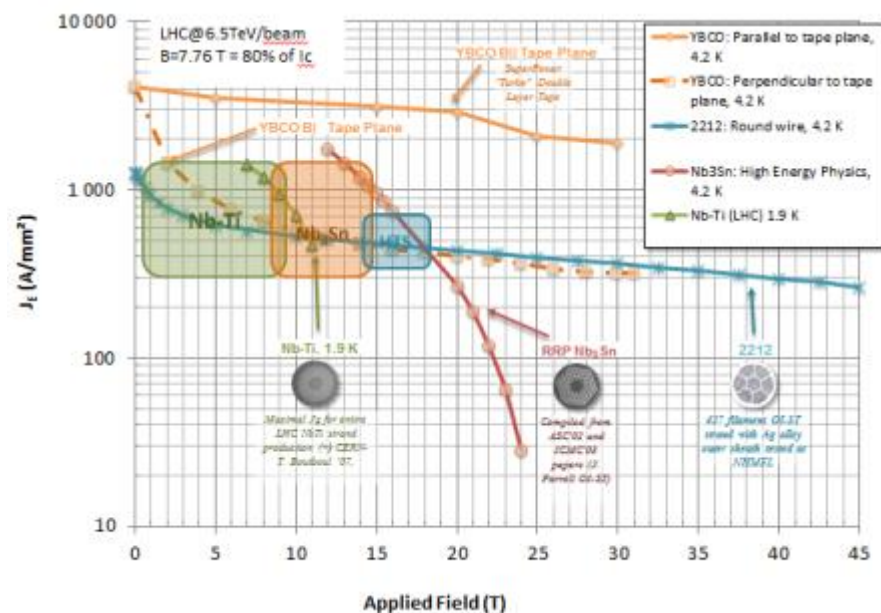


**Highest possible energy e^+e^-
with CLIC (CDR 2012)
Multi-lateral collaboration**

“to propose an ambitious **post-LHC accelerator project at CERN** by the time of the next Strategy update”

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.

HFM – FCC-hh



HGA - CLIC



Priorities: Accelerator & Infrastructure



FCC-hh: **100 TeV pp collider** - main emphasis,
→ defines infrastructure needs

FCC-ee: **e^+e^- collider**, potential **intermediate step**

FCC-he: **integration aspects** of pe collisions

Push key technologies

in dedicated R&D programmes e.g.

16 Tesla magnets for **100 TeV pp** in **100 km**

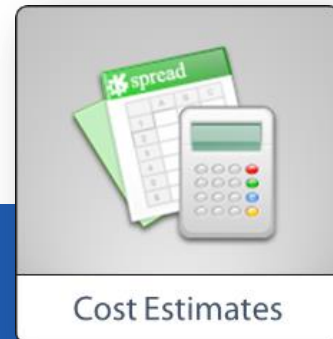
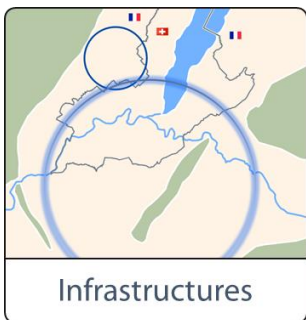
20 Tesla magnets (HTS layer) for **HE-LHC** and **FCC**

Beam extraction and large energy dumps

SRF technologies and RF power sources

Site-specific aspects as requested by EU strategy

Tunnel infrastructure in Geneva area
linked to CERN accelerator complex



FCC a Global Study



- ▶ 51 institutes
- ▶ 19 countries
- ▶ EC participation

“...in collaboration with national institutes, laboratories and universities worldwide.”



Conclusion: CERN roadmap

The **CERN Medium Term Plan approved by June'14 Council**, implements the **European Strategy** including a long-term outlook.

The scientific programme is concentrated around four priorities:

- 1.Full LHC exploitation** – the highest priority - including the construction of the High Luminosity Upgrade until 2025
- 2.High Energy Frontier** – CERN's role and preparation for the next large scale facility
- 3.Neutrino Platform** – allow for to contribute to a future long baseline facility in the US and for detector R&D for neutrino experiments
- 4.Fixed-target programme** – maintain the diversity of the field and honour ongoing obligations by exploiting the unique facilities at CERN

Future Colliders Must Be Global

"The task of the mind is to produce future"
Paul Valéry



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Thanks for your attention