High Luminosity LHC (HL-LHC) and Magnet progress

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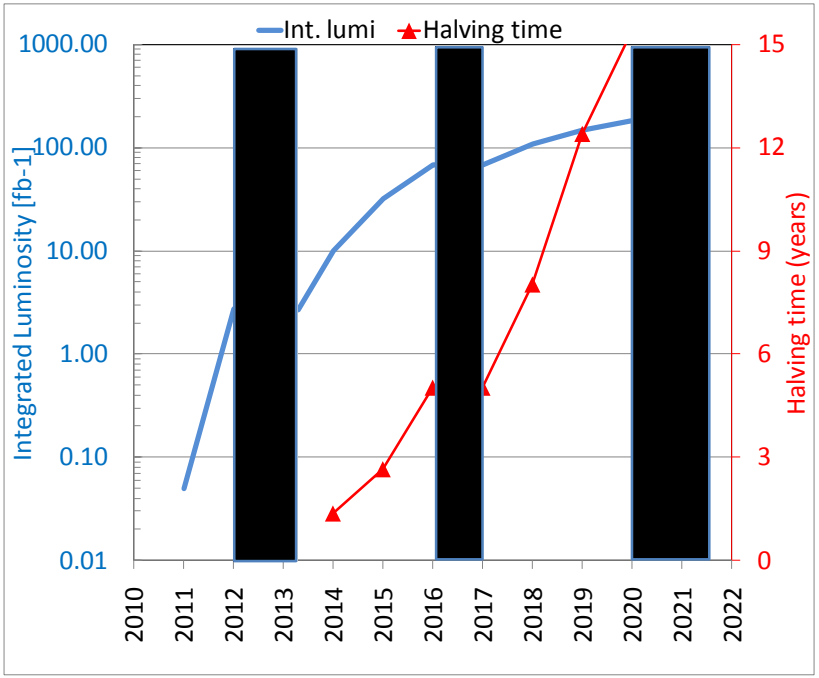
CERN

From September 2010
HL-LHC formed as CERN project



Program based on flattening at design luminosity

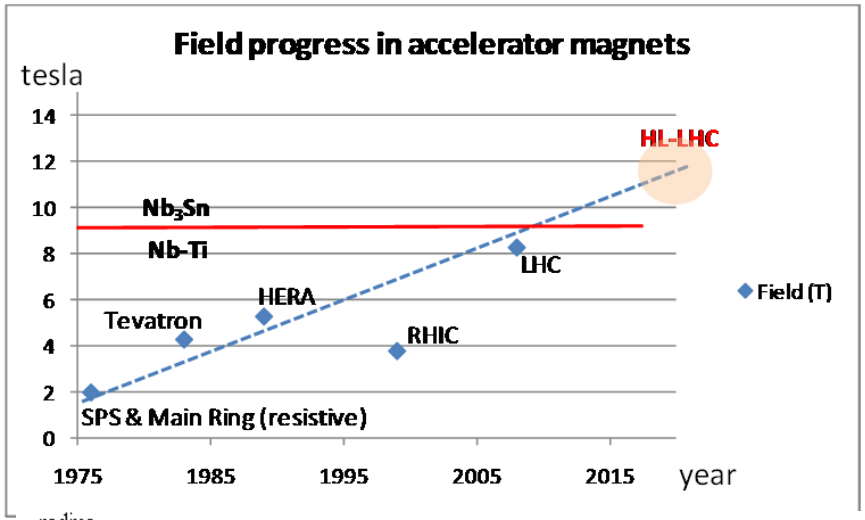
The main objective of HiLumi LHC Design Study is to determine a hardware configuration and a set of beam parameters that will allow the LHC to reach the following targets:

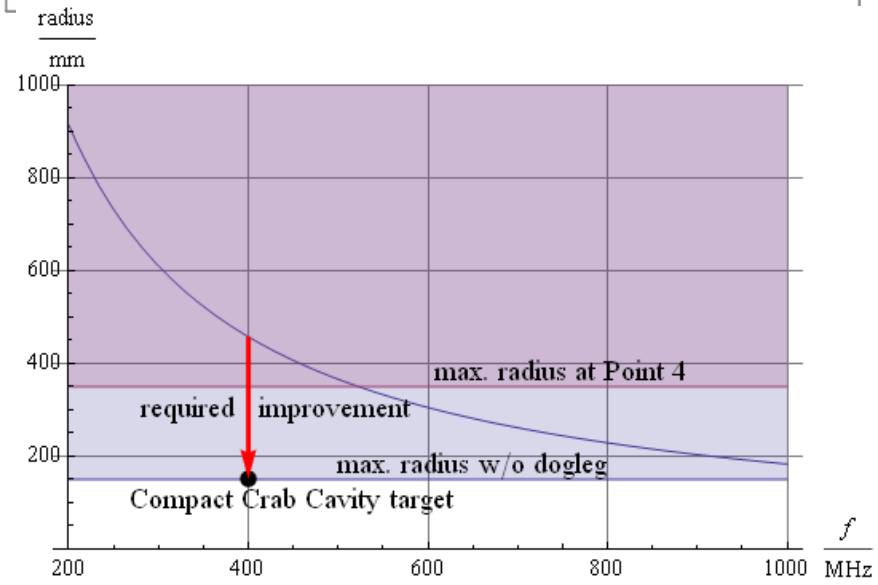
1) A peak luminosity of $\mathbf{5\times10^{34}\ cm^{-2}s^{-1}}$ **with levelling**, allowing:

2) An integrated luminosity of **250 fb^{-1}** per year, enabling the goal of **3000 fb^{-1}** twelve years after the upgrade. This luminosity is more than ten times the luminosity reach of the first 10 years of the LHC lifetime.

Critical technologies for HL-LHC

13 T Magnets- GW SC cables- Crab Cavities



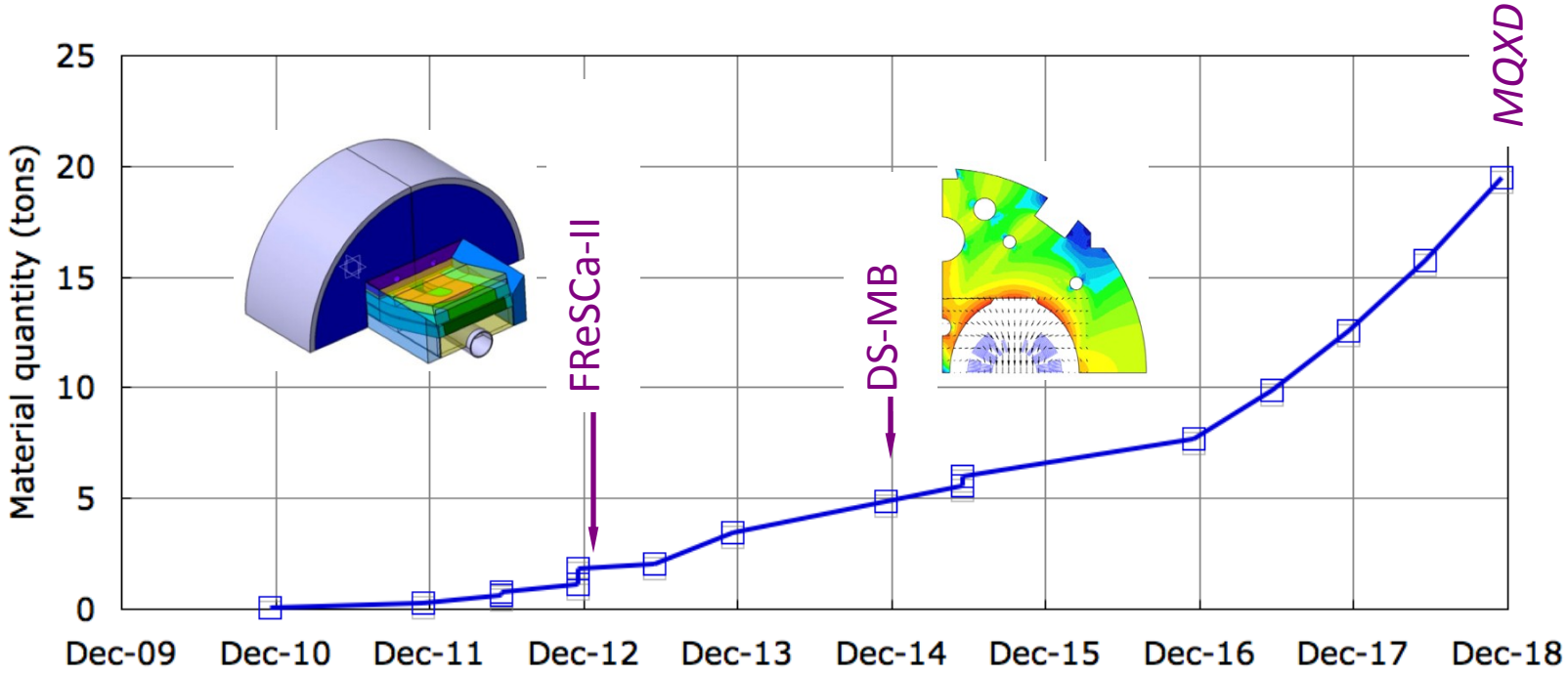


SC Magnets beyond 10 tesla of accelerator qualities.
Inner triplets Quads **and D1/D2 dipoles**
D1 could be the KEK design-contribution
New step forward in circular accelerators !

Sc links for 200 kA-5 kV **(1 GW DC)**
To remove from tunnel Magnet Power Supply, sensible to radiadiation
To easy integration in crowdy zone
To remove form tunnel the DFB (Current Leads) and easy operation and maintenance

Crab Cavities at 400 MHz
New equipment for accelerators, and even **more difficult for LHC (very compact)**
An asset also for LC !

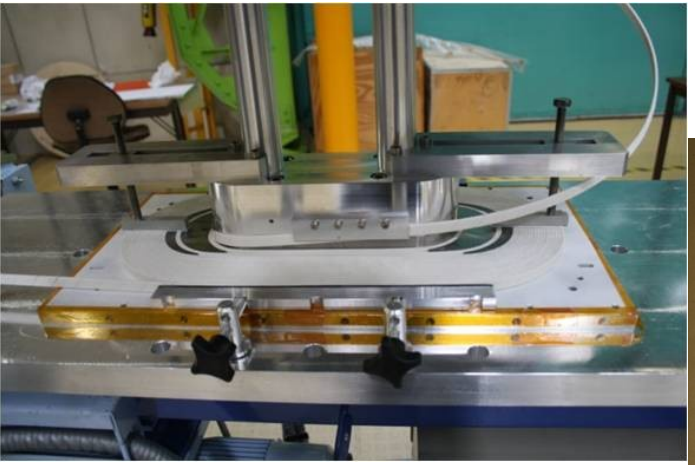
Progress on Magnets @ CERN
1. Assessing needs of Nb_3Sn



About 20 tonnes of high grade Nb3Sn (3 times the ITER specs in term of current density)

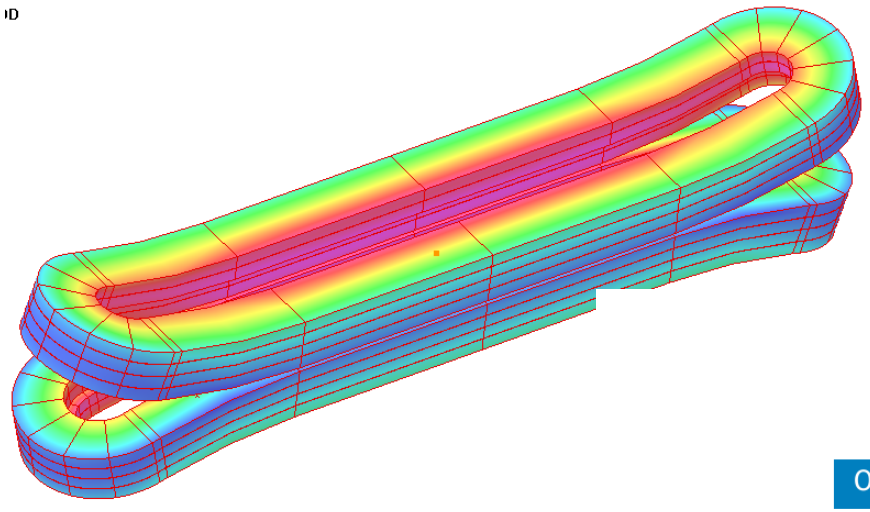
Progress on Magnets @ CERN
2. SMC (Small Model Coil)

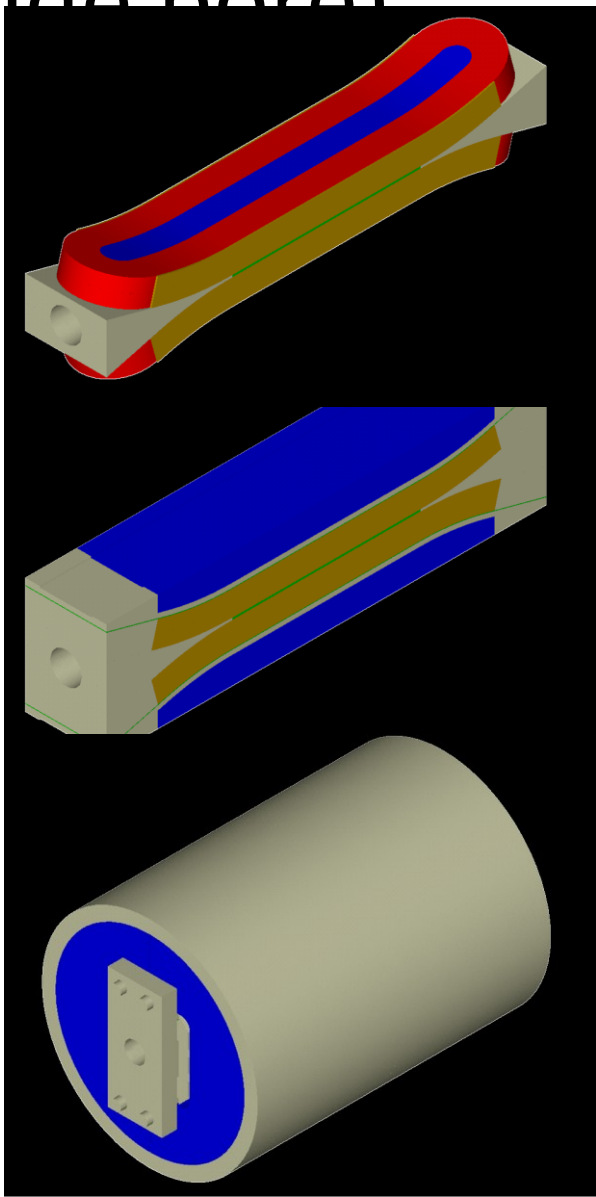
- 400 mm simple race-track coils (10-11 T)
- To validate conductor and winding technology
- SMC#1 built and tested with average results: insulation good, 60% perfomance probably a damage near terminal
- SMC#2 already started
- SMC#2 - #4 foreseen in 2011 (SMC#1 took >2 y)



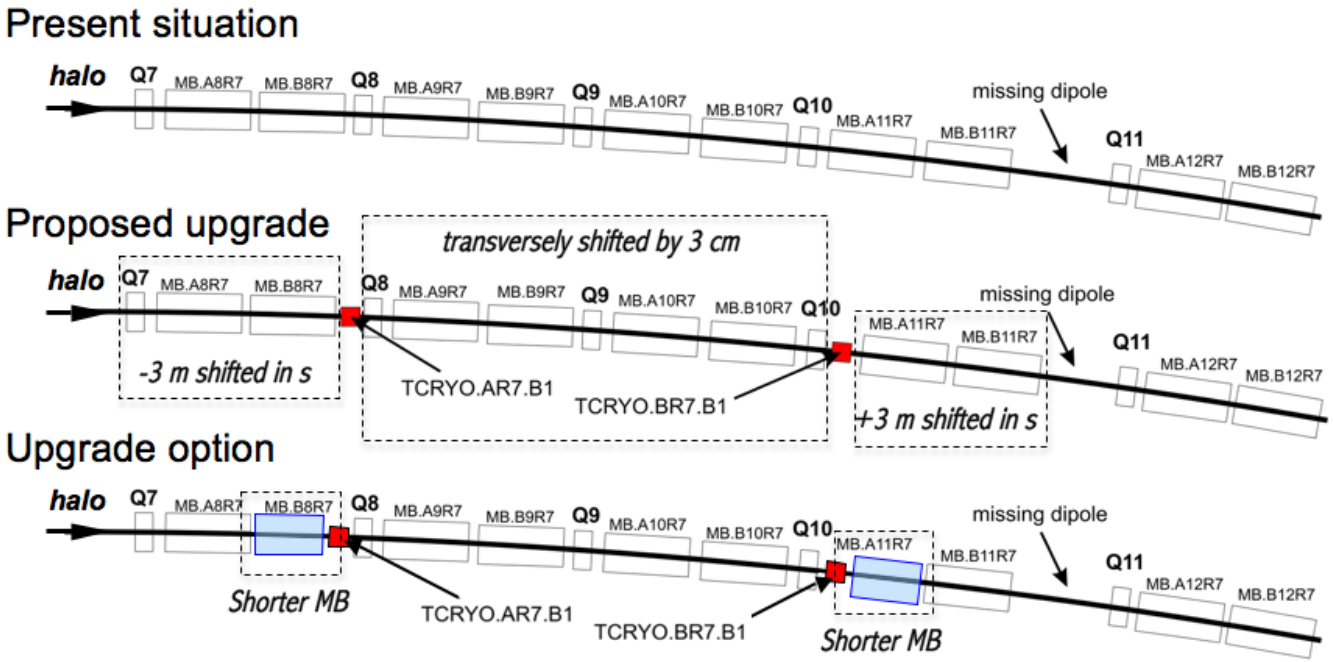
Progress on Magnets @ CERN
3. FRESCA2 (13 T dipole wide bore)

- Design has been decided for a new coil block design with flare ends.
- Near to be frozen for tooling constrution
- An alternative (classical cos ϑ) also under development



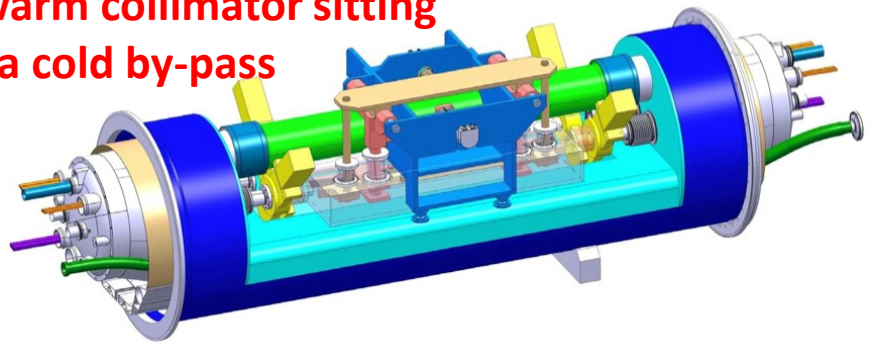


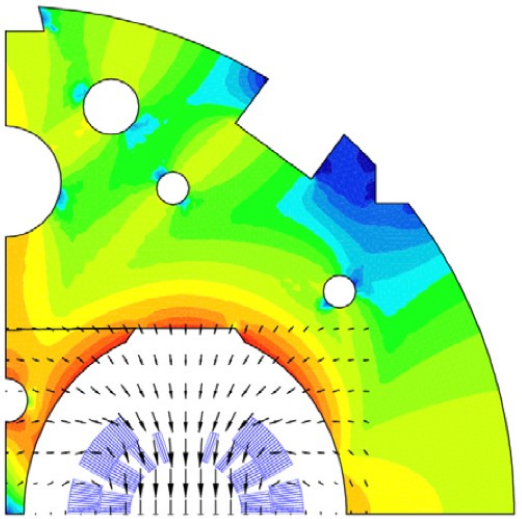
Progress on Magnets @ CERN
4. 11 T LHC Dipole for DS collimation



In 2012-13 we plan to move 28 cold equipments
Later on this will be avoided, but an alternative solution is studied in HL-LHC:
A 11T LHC MB (twin)
Collaboration with Fermilab

A warm collimator sitting on a cold by-pass



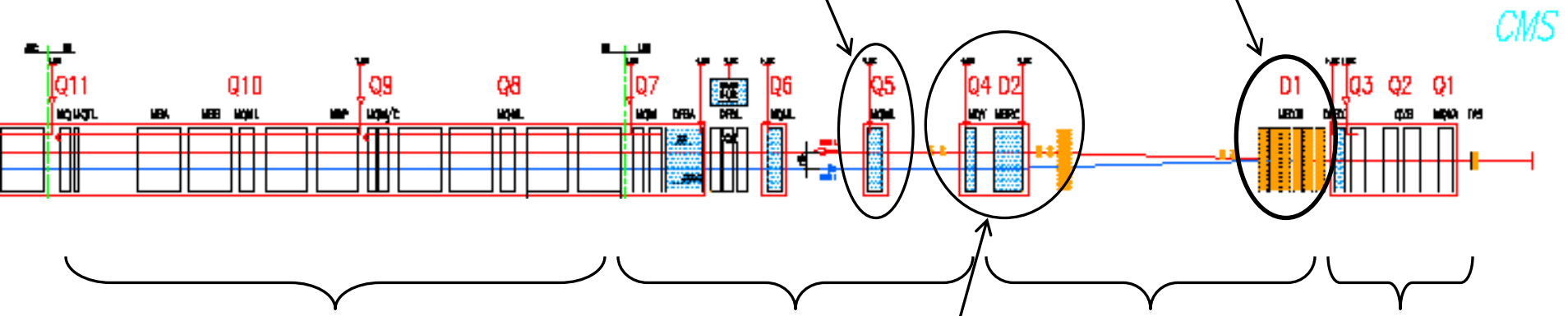


H-LHC change in layout

Discussion since 6 months, serious option is envisaging 5 new D1s as possible KEK contribution to HL-LHC

Today: Two-in-One Ø =56 mm; 4.2K
HL-LHC: Two-in-One Ø70 mm; 1.9 K

Today: 6 x 2 m x 1.5 T; b=80 mm



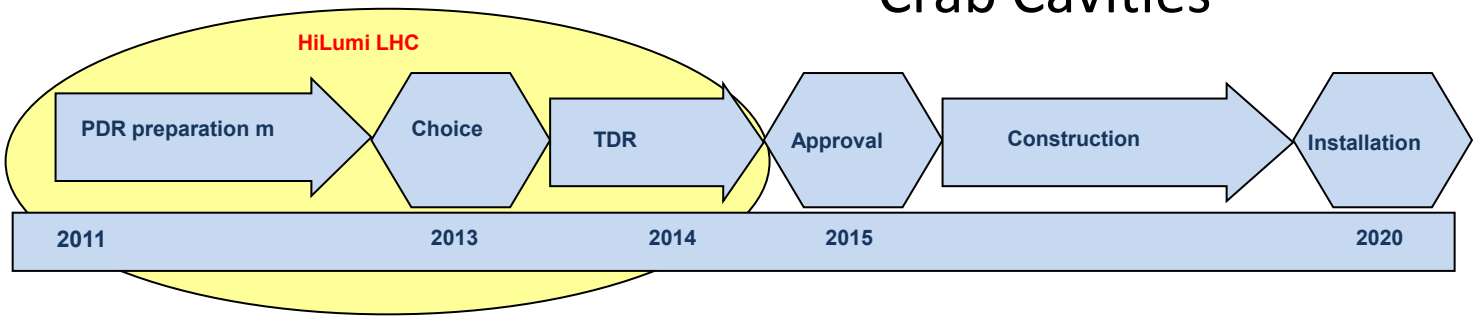
Dispersion suppressor | Matching section | Separation dipoles | Final focus

Today: Q4 Two-inOne Ø=70 mm, 4.2 K; D2 ↑↑ 9 m x 3.5 T, 4.2 K
HL-LHC: Q4 Two-in-One Ø=90 mm, 1.9 K; CRAB CAVITY; D2 ↑↑ 9 m x 5 T; 1.9 K

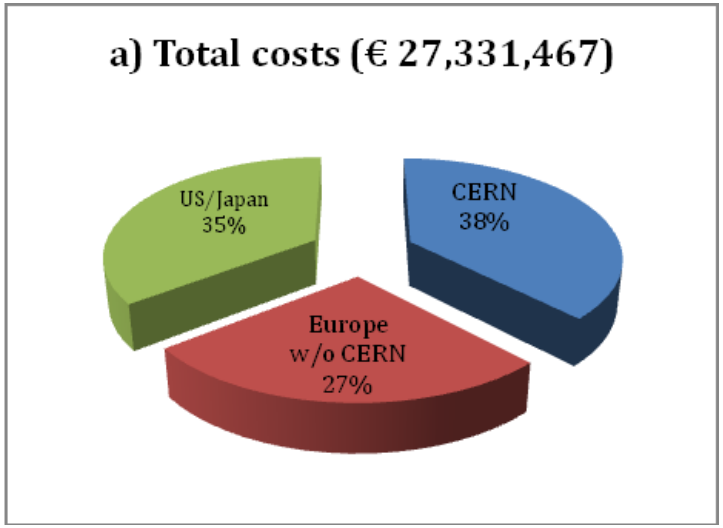
High Lumi EU FP7 Design Study

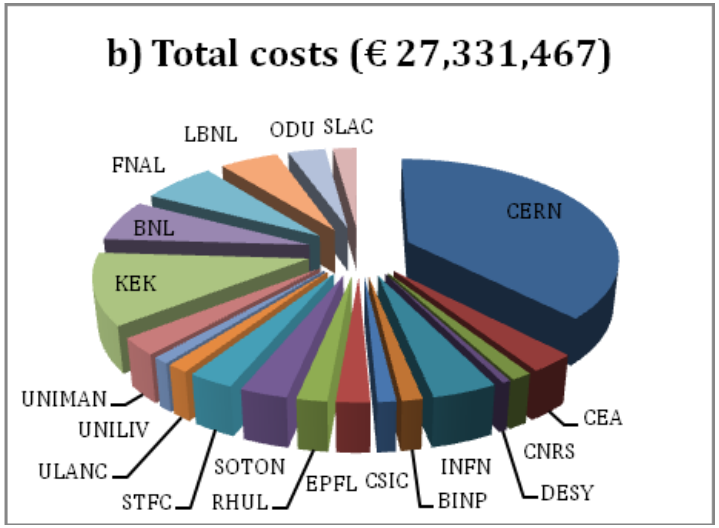
- 4 year program
- CERN
- CEA, CNRS, Desy, INFN, UniValencia, 5 UK Universities, STFC (UK), EPFL (CH), BINP

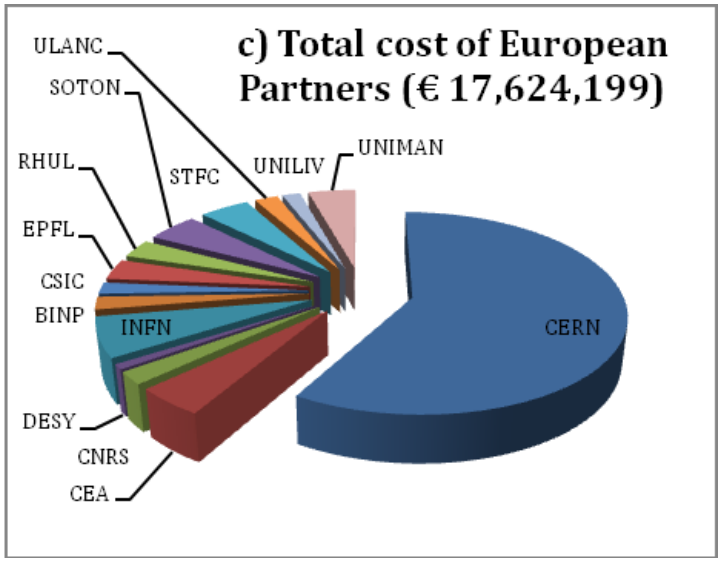
- KEK, BNL, LBNL, FNAL, SLAC, ODU (Jlab)
- **KEK is very active in three main WPs (about 160 P-Months)**
  - Accelerator Physics
  - Magnets
  - Crab Cavities

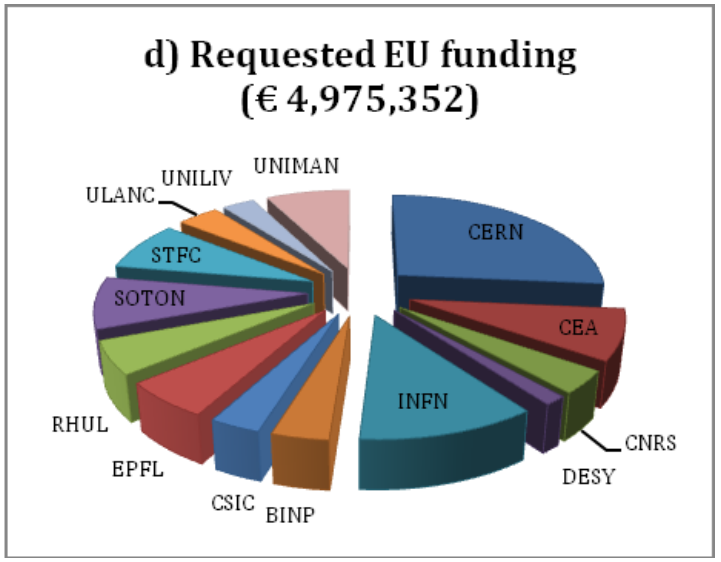


Value of the FP7 DS study

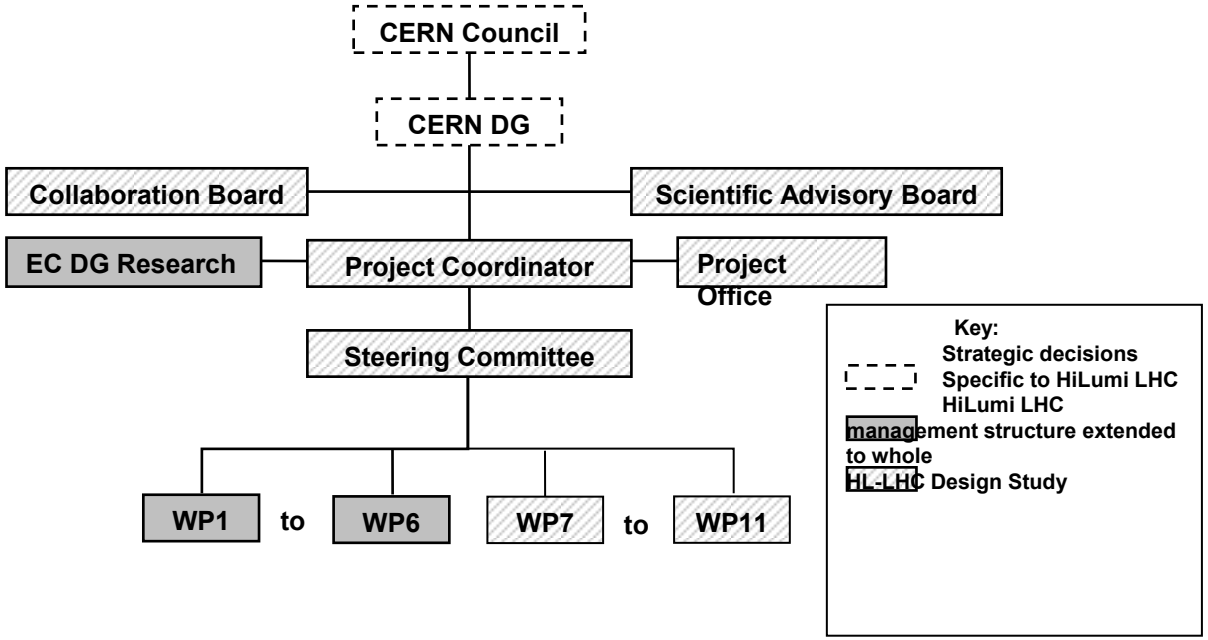








Governance of the whole HL-LHC collaboration



HL-LHC
is larger than the FP7 design study application (named HiLumiLHC).

But the project structure is unique, some WPs are inside FP7 and soem are not , implemented by MoUs

WP#	Title	HL-LHC Design Study
1	Project management and Technical Coordination	HiLumi LHC
2	Accelerator Physics and Performance	
3	Magnet Design	
4	Crab cavities	
5	IR Collimation	
6	Cold Powering	
7	Machine Protection	Not within HiLumi LHC
8	Collider-Experiment Interface	
9	Cryogenics	
10	Energy deposition and shielding	
11	11 T dipole two-in-one	
12	Integration and (de-)installation	

Results of the CERN-KEK review on Nb_3Al conductor and Magnet program

Held on 10 December at CERN

Participants:

CERN:	Luca Bottura, Luc Oberli, Gijs de Rijk, Lucio Rossi, Ezio Todesco
NIMS:	Akihiro Kikuchi, Takao Takeuchi
Hitachi Cable:	Kazuhiko Nakagawa
KEK:	Xinzhe Jin, Tatsushi Nakamoto, Toru Ogitu (video), Kiyosumi Tsuchiya, Qingjin Xu, Akira Yamamoto

Agenda

09:30 - 09:40	welcome	Lucio Rossi (CERN)
09:40 - 10:00	Overview of HL-LHC	Ezio Todesco (CERN)
10:00 - 10:25	Introduction, history of Nb_3Al R&D program towards LHC upgrade	Akira Yamamoto (KEK)
10:25 - 10:55	General overview of Nb_3Al material	Takao Takeuchi (NIMS)
11:10 - 12:10	Progress and summary of Nb_3Al SC development at KEK/NIMS	Tatsushi Nakamoto (KEK)
12:10 - 12:50	Proposal of new program for next years	Tatsushi Nakamoto (KEK)

Afternoon: discussion and recommendations

Recommendations - 1

- CERN and KEK confirm that the **R&D should go further than conductor development and step into magnet technology development**. However the present KEK situation in personnel and material budget severely limits its capacity: therefore it may require **more cooperative work for the practical magnet fabrication and test (with CERN).**
- CERN encourage KEK/NIMS to extend efforts to develop a Nb_3Al conductor having a Nb matrix with a Ta sheet as barrier for magnetization and the strand surrounded by either a Nb or Ta layer. **The effort should be aimed at a strand and cable sufficiently long enough to develop a model coil**, this may require drawing work on a billet (~ 14 cm dia. x 45 cm long) with a 4000 t press.

Recommendations - 2

- CERN and KEK agree to seek for two possible magnet R&D plans of
  - **A race track coil motivated towards 'react and wind' technology,**
  - **A large aperture cos-theta dipole with an aperture of 120 mm diameter (or a little larger), intended for the D1 of HL-LHC upgrade.**
- CERN-KEK will organize **another technical review meeting, in the middle of 2011, (within a period of June through September) to review the progress on the Nb_3Al strand development** (at least 4 small billets with a 100 t press). It should be shown that strand can be made in sufficient length pieces. If this is met, the next slice of budget could be attributed in JFY2011. This in preparation for the readiness decision of Nb_3Al technology in the 2013-2015 period.
- CERN and KEK/NIMS will scope the Nb3Al conductor to be the primary candidate for the CERN-KEK/NIMS R&D program for the D1 (or other magnets) for the HL-LHC upgrade R&D. However, CERN and KEK agree that **Nb_3Al and other alternate advanced conductor technology should be within their scope as an alternative for the HL-LHC work** depending on the Nb_3Al progress and other research progress.
- CERN would like to encourage **KEK to work on magnet technology applicable for both Nb_3Al and Nb_3Sn conductors so as to be ready for the HL-LHC applications.** CERN and KEK should collaborate on these technologies.
- **The review recommends CERN-KEK committee to adopt the proposed budget**