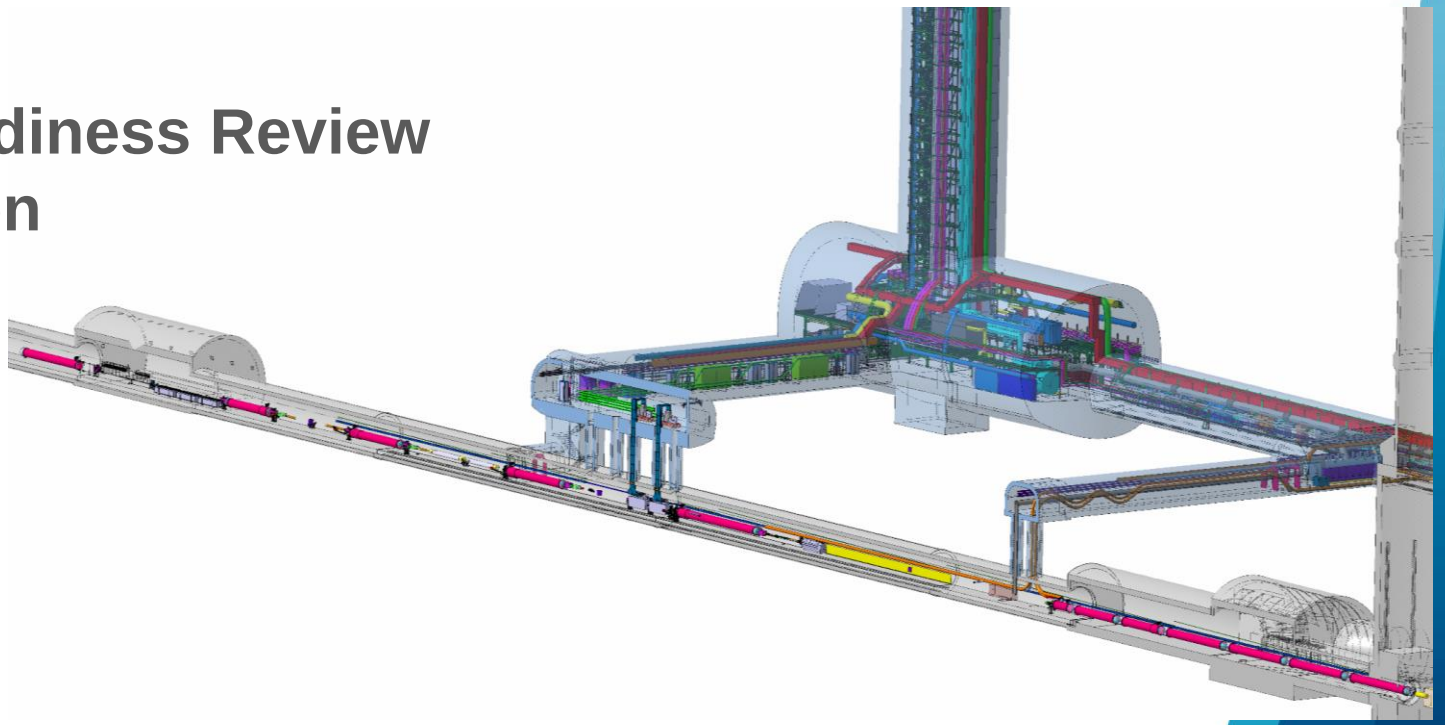
e-lens Readiness Review Introduction



Oliver Brüning

Goal of High Luminosity LHC (HL-LHC) as fixed in November 2010

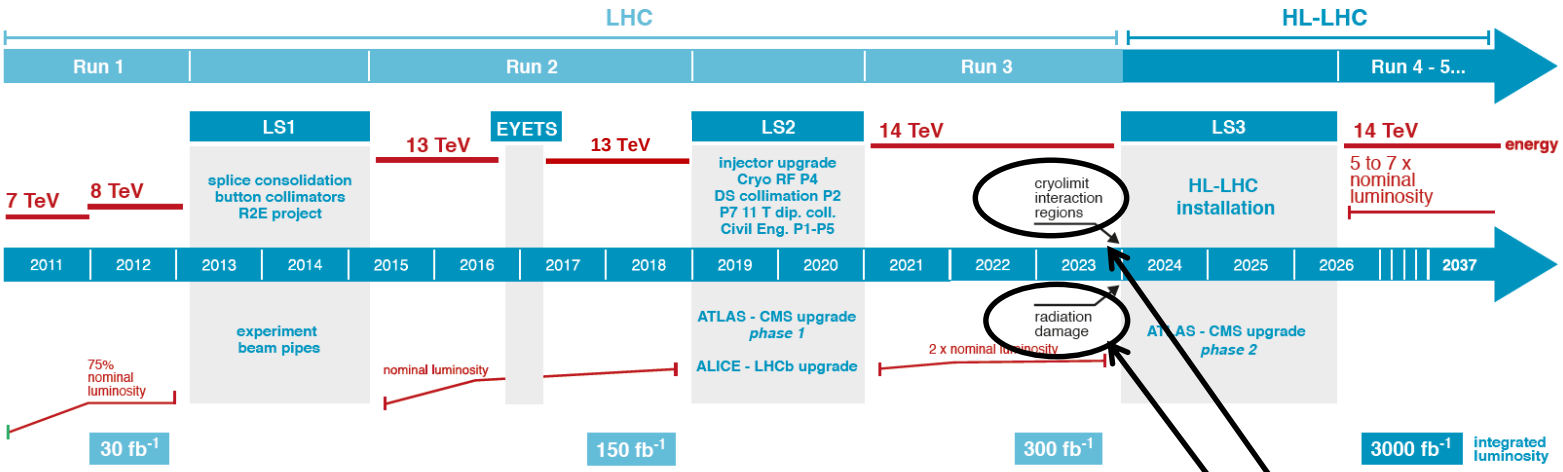
The main objective of HiLumi LHC Design Study is to determine a hardware configuration and a set of beam parameters that will allow the LHC to reach the following targets:

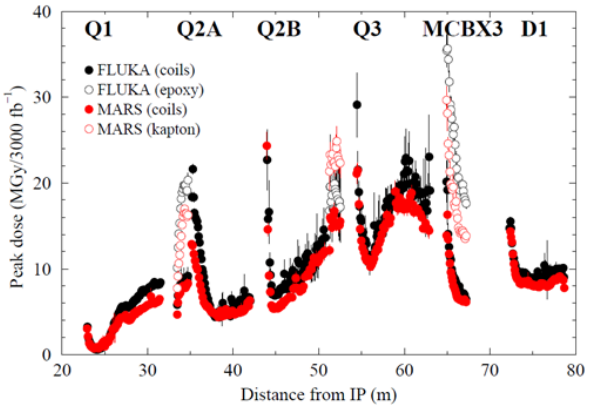
A peak luminosity of L_{peak} = **5×10^{34} cm^{-2}s^{-1} with levelling**, allowing:

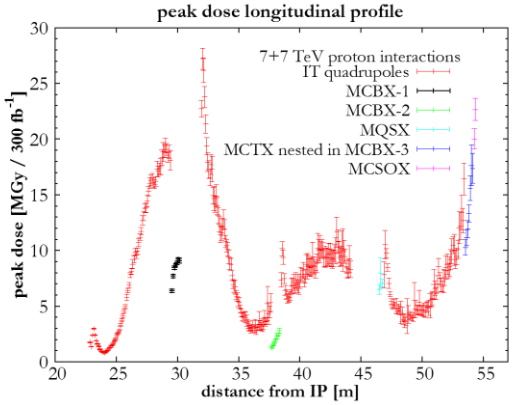
An integrated luminosity of **250 fb^{-1} per year**, enabling the goal of **L_{int} = 3000 fb^{-1}** twelve years after the upgrade.
This luminosity is more than ten times the luminosity reach of the first 10 years of the LHC lifetime.

Ultimate performance established 2015-2016: with same hardware and same beam parameters: use of **engineering margins:**
$L_{peak\ ult} \cong 7.5\ 10^{34}$ cm^{-2}s^{-1} and **Ultimate Integrated $L_{int\ ult} \sim 4000$ fb^{-1}**
LHC should not be the limit, would Physics require more…

LHC / HL-LHC Plan

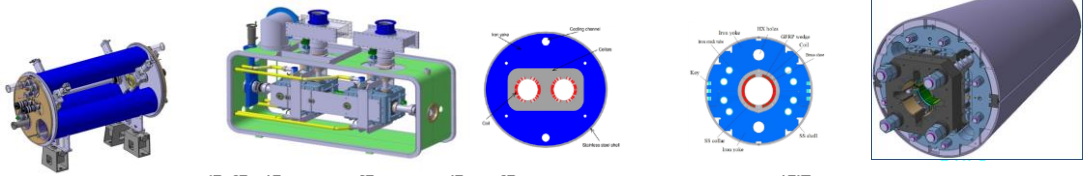


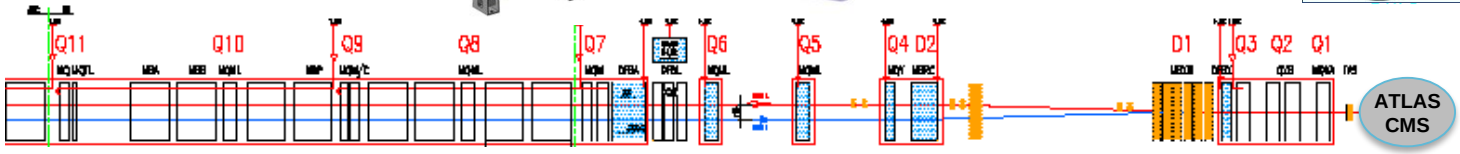




Technical limits to lumi increase (Machine & Experiments)

The largest HEP accelerator construction project





Dispersion Suppressor (DS) in P7

Modifications
1. In IP2: new DS collim. in C.Cryost.
2. In IP7 new DS collimation with 11 T

Cryogenics, Protection, Interface, Vacuum, Diagnostics, Inj/Extr, Controls, new UG and surface infrastr.

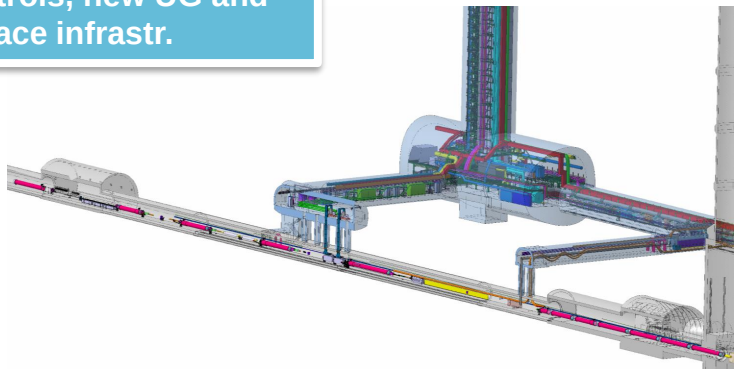
Matching Section (MS)

Change/new lay-out
1. TAXN
2. D2
3. CC
4. Correctors
5. Q5
6. Q5@1.9K in P6
7. New collimators

Interaction Region (ITR)

Complete change and new lay-out
1. TAXS
2. Q1-Q2a-Q2b-Q3
3. D1
4. All correctors
5. Heavy shielding (W)

> 1.2 km of LHC !!



HiLumi LHC Main Milestones

- 2010: establishment of the Design Study
- 2011: approved DS funding by EU
- 2013: Priority 1 in EU strategy update for PP
- 2013: kick-off meeting of HL-LHC as construction project (50% of the budget)
- 2015: First C&SR; end of HiLumi DS
- 2016: approval of full budget in June Council
- 2016: re-baselining to include full C.E. cost [120MCHF]

Re-baselining May-Aug 2016

- Crab Cavity: **2 cavities/beam-side** $\Rightarrow$ **16 CCs + 4 spares** (vs. 32+8 previously)
  Revision of the CC power needs and volume of the power system
- Use of present Q4 – MQY quadrupole- with 70 mm aperture (avoiding new MQYY of 90 mm aperture as new Q4). MQY modified for 1.9 K operation.
- QPS for the MQXF with a minimal configuration **with redundancy**.
- Reduction of number of 11 T dipoles for DS collimation (**2 complete cryo-assembly** instead of 4).
- Plus other measures (collimations, powering…)

Review Mandate

- Currently 'only' considered as an option for the HL-LHC project
- First proposed for LHC in 2006 within CARE HHH [Vladimir Shiltsev]
- Followed up by LHC Collimation team in 2009 in the context of machine protection with Crab Cavities
- Initial LHC operation experience showed sharp loss spikes

  ➔ additional motivation for e-lens as halo cleaner
- Operation experience in RunII no longer featured loss spikes ➔ need for electron-lens?
- Review on the e-lens need for HL-LHC in 2016 @ CERN [chaired by RS]

  ➔ strong recommendation to include e-lens for HL-LHC

  [≈ 35MJ stored beam energy in HL-LHC beam halo > 3σ]
- Study on technical design and preparation for integration into the HL-LHC baseline
- Would like to integrate e-lens as baseline by C&S review March 2018

  ➔ This review: technical readiness for including e-lens in HL baseline

Electron Lens for HL-LHC

Review Charge:

Review if CERN has all information at hand to estimate the individual cost items for the hollow e-lens and to prepare a tentative production schedule (including potentially required prototype developments and R&D milestones) for implementing the e-lenses during LS3 and to assure sufficient space and infrastructure in the designated areas for the installation of the hollow e-lenses during LS3.

Detailed Questions:

- *Is CERN ready for estimating the total cost and resource requirements for the e-lenses (including the technical development)?*
- *Is CERN ready to specify the technical infrastructure needs in IR4 to avoid future iterations on key services at a later stage (e.g. cryogenic)?*
- *Is CERN ready for reserving sufficient space for the e-lenses in IR4 [we had explicitly removed this from the charge of the last review on the needs for a hollow e-lens]?*
- *Have all the implied technical groups identified the required resources for implementing the e-lens development (including the required technical development for finalizing the technical design by the end of LS2) and integration (for the e-lenses installation in LS3 and operational exploitation as of the start of Run4)? This point clearly should match the identified resource requirements of point 1) and should include a comparison with the currently existing resources.*
- *Is CERN ready for identifying which components of the e-lenses need to be produced in-house and which components could be outsourced?*

Electron Lens for HL-LHC

Review Members:

- *Wolfram Fischer [chair], BNL*
- *Paul Cruikshank, CERN-TE-VAC*
- *Francesco Bertinelli, CERN*
- *Rüdiger Schmidt, TU Darmstadt / CERN*
- *Laurent Tavian, CERN and HL-LHC Project Office*
- *Akira Yamamoto, CERN / KEK*

Special thanks to:

- *Diego Perini, CERN EN-MME-DI*
- *Stefano Redaelli, CERN BE-ABP-HSS*
- *Adriana Rossi, CERN BE-BI-EA*
- *Celine Le Bon*


HiLumi
HL-LHC PROJECT