Talk from outcome of Coordination Group

HL-LHC Coordination Group Composition

Representative(s) of HL-LHC, chair	L. Rossi (chair), O. Brüning
Scientific secretary of the HL-LHC Coordination Group	H. Burkhardt
Representative(s) of each major LHC experiments: ALICE, ATLAS, CMS, LHCb	
spokespersons	P. Giubellino, F. Gianotti, P. Campana, J. Incandela,
technical coordinators	W. Riegler, M. Nessi, A. Ball, R. Lindner
Representative(s) of the LIU project	R. Garobi
The technical coordinator of HL-LHC	H. Schmickler
The CERN Director of Research and the CERN Director of A&T,	S. Bertolucci, S. Myers
BE, EN, TE and PH Department Heads,	for information

Mandate

High Luminosity-LHC (HL-LHC) is an upgrade project created in the Accelerator and Technology (A&T) sector at the end of 2010. It reflects the collider requirements for the companion upgrades of the LHC detectors. To assure coordination among the various entities, a permanent group is to be formed with the following mandate and membership:

To agree upon a common and coherent set of goals, parameters and plans for the HL-LHC project, while providing a forum for official information transfer on the status of the project.

To coordinate the various required actions for HL-LHC from the end of LS1 (2014) until the final HL-LHC hardware installation. The various shutdowns and major interventions will be discussed and input will provided to the CERN management to ensure that LHC operation and plans for consolidation/improvement maximize the performance of the LHC.

To steer the work, and solicit adequate resources, for the Work-Package "Collider-Experiments interface". In this WP the technical and engineering works are to be agreed and the responsibilities of each party (machine and detector) defined.

Meetings and information

Meetings with slides on indico

with minutes for members + info group members

3 meetings so far, with main subjects discussed

1. **19 April HL-LHC parameters, Experiments upgrade plans, shutdown length**
2. **1 June Target parameters, Pile-up and Luminosity**
3. **16 July Tuning of contributions to the Update of the European Strategy for Particle Physics**

Shutdown and major intervention planning by Experiments (1/2)

Based on schedule with **LS2 in 2018, LS3 in 2022 - 23**

ALICE, IR2

upgrade completed in LS2 (≳ 18 month, 4 month could go to previous winter stop)

extend particle identification and rate capabilities PbPb to 50 kHz

PbPb $L \sim 6 \times 10^{27}\,cm^{-2}\,s^{-1}$, $\int L\,dt = 10\,nb^{-1}$

project running ~ 5 y after upgrade with collimators in dispersion suppressor (going beyond LS3)

ATLAS, IR1

detector upgrades Phase I under approval; followed by detector

upgrade Phase II to fully exploit HL-LHC with major part on consolidation

LS2 14 month required with cavern open, not before December 2017

LS3 20 month length assumed

Shutdown and major intervention planning by Experiments (2/2)

CMS, IR5 4 layer pixel μvertex ready in 2016, 5 month to install,

with barrel, endcap, readout upgrades, for LS2

LS3 : major readout and detector and upgrade and consolidation, 8-10y development,

2-3 y to installation, to enable CMS to acquire 250 fb^{-1} / year

LHCb, IR8

upgrade completed in LS2, 18 month with access to cavern required

improved read-out for $L > 1 \times 10^{33}\ cm^{-2}\ s^{-1}$ (max 2×10^{33}), $< \mu > \sim 4$

aquire $\int L\,dt = 5\ fb^{-1}$ / year, total of 50 fb^{-1} in 10y after LS2

Update of the European Strategy for Particle Physics

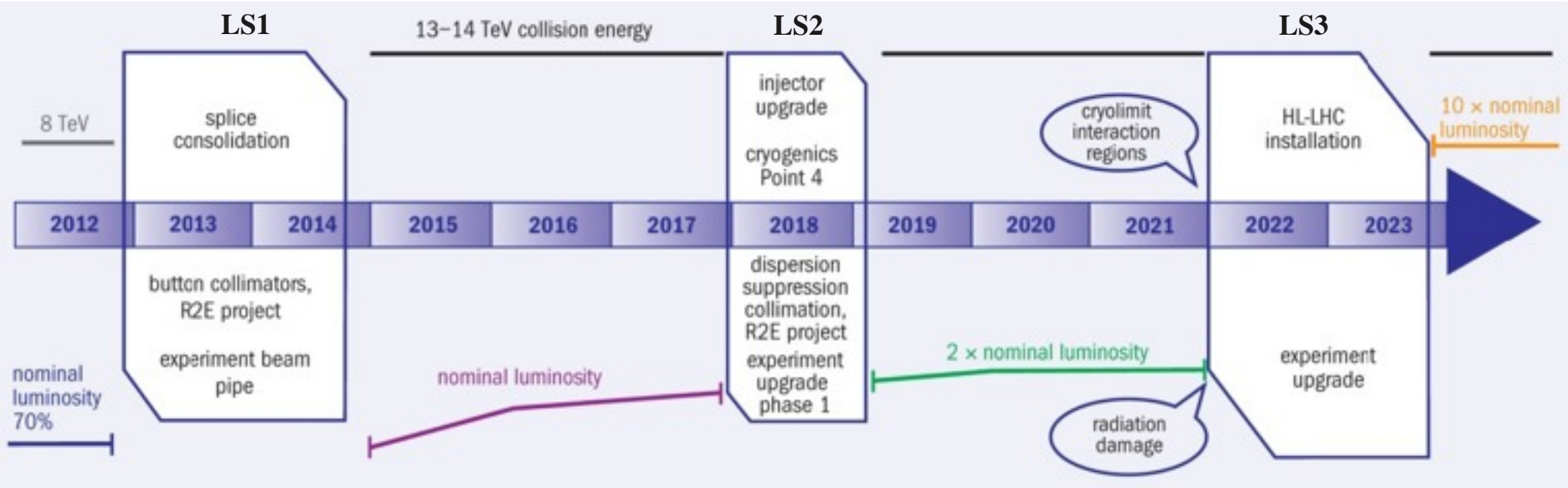
With contributions from accelerators side and experiments, submitted to the Open Symposium in Krakow 10-12/9/2012

The list of all contributions is on the web here ,

with HL-LHC, LIU, HE-LHC (20 T, 2×16.5 TeV, 2×10^{34} cm^{-2} s^{-1})

and separated contributions from the experiments.

Based on a common timeline and parameters



LHC baseline plan for the next ten years. In terms of energy of the collisions (upper line) and of luminosity (lower lines). The first long shutdown 2013-14 is to allow design parameters of beam energy and luminosity. The second one, 2018, is for secure luminosity and reliability as well as to upgrade the LHC Injectors.

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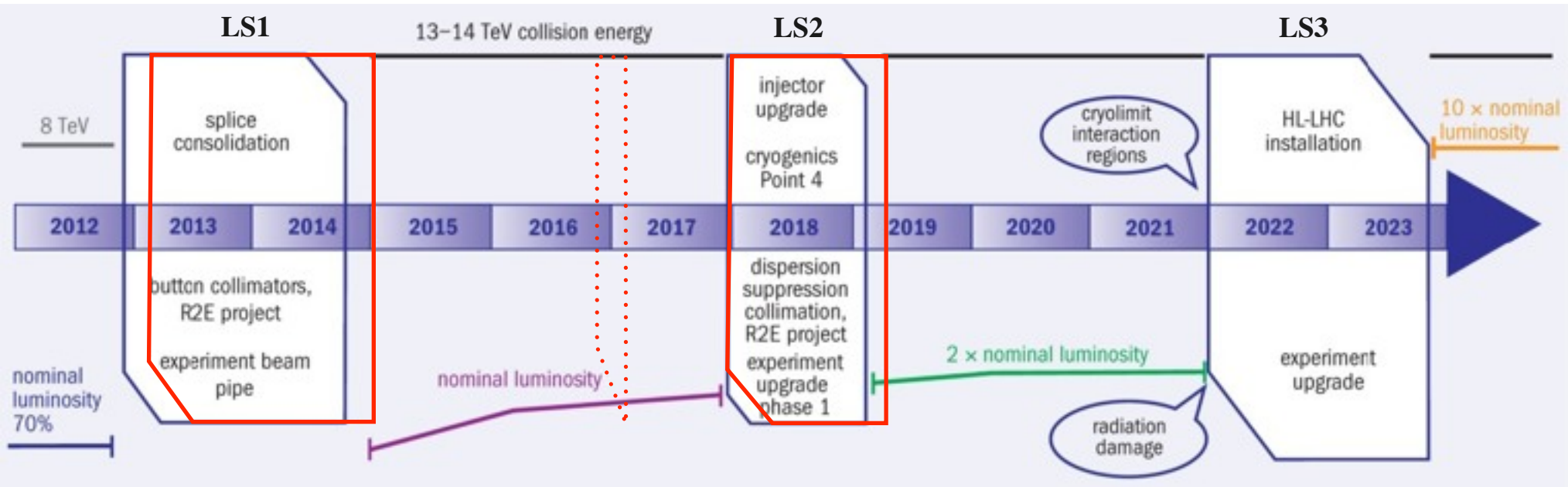

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Discussions on pile-up

pile-up **μ = #events / bunch crossing**

LHC design parameters 2 × 7 TeV, $\mu = 19.02$ (blue book CERN-2004-003, Table 2.2, p. 4)
25 ns, 1.15 × 10^{11} p/bunch, 2808 bunches, L = 1 × 10^{34} cm^{-2} s^{-1}, L = 3.56 × 10^{30} cm^{-2} s^{-1} /bunch
assuming a $\sigma_{pp} = 60$ mb effective (pp inelastic) cross section

Actual pp cross section higher (inelastic diffractive non negligible)
TOTEM measured 73 mb at 2 × 3.5 TeV which translates to 85 mb at 2 × 7 TeV

Maximum tolerable pile-up for ATLAS and CMS detectors :
limited both from vertex detectors (easier for longer bunches, shortened by crab leveling)
and from calorimeters (missing Et resolution, rather independent of bunch length)

Observed, 2012, scaled to HL-LHC
$\mu = 35$ at L = 7 × 10^{33} cm^{-2} s^{-1} scaling to 5 × 10^{34} would result in $\mu = 280$ with 13% from σ_{pp}
this is completely excluded, also after detector upgrades.
50 ns --> 25 ns factor 2 pile-up decrease important for HL-LHC

Agreed target numbers for Pile-up and Luminosity

ATLAS and CMS pile-up limit is $\mu = 140$

this includes a minimal margin for the bunch-bunch spread

25 ns is the baseline

50 ns kept as backup; half the peak luminosity

The maximum useful peak luminosity, limited by pile-up is

25 ns maximum $L = 5 \times 10^{34}\ cm^{-2}\ s^{-1}$

50 ns maximum $L = 2.5 \times 10^{34}\ cm^{-2}\ s^{-1}$

$\int L\,dt = 250\ fb^{-1}$ per year for each IP1 and IP5

Concluding remarks

Coordination of machine and experiments very important

Common goals, agreed parameters and schedules

Technical details further followed up in WP8 (Collider-Experiment Interface)
in close collaboration with other WPs, PLC (parameter and layouts), HLTC (technical committee), current LHC working groups (LEB, LTEX, LBS) and experiments.

1st Workshop Collider-Experiment Interface, 30 Nov. 2012 at CERN, link here

Review of Accelerator Layout Change requests from LHC Experiments in LS2 & LS3 and their impact on the HL-LHC. Include (reduced) beam pipes and forward detectors in HL-LHC.

Backup

Parameters

Parameter	nominal	25ns	50ns
N_b	1.15E+11	2.2E+11	3.5E+11
n_b	2808	2808	1404
N_{tot}	3.2E+14	6.2E+14	4.9E+14
beam current [A]	0.58	1.12	0.89
x-ing angle [μrad]	300	590	590
beam separation [σ]	9.9	12.5	11.4
β^* [m]	0.55	0.15	0.15
ε_n [μm]	3.75	2.50	3
ε_L [eVs]	2.51	2.51	2.51
energy spread	1.20E-04	1.20E-04	1.20E-04
bunch length [m]	7.50E-02	7.50E-02	7.50E-02
IBS horizontal [h]	80 -> 106	18.5	17.2
IBS longitudinal [h]	61 -> 60	20.4	16.1
Piwinski parameter	0.68	3.12	2.85
geom. Reduction factor 'R'	0.83	0.305	0.331
beam-beam / IP without Crab Cavity	3.1E-03	3.3E-03	4.7E-03
beam-beam / IP with Crab cavity	3.8E-03	1.1E-02	1.4E-02
Peak Luminosity without levelling	1.0E+34	7.4E+34	8.5E+34
Virtual Luminosity: Lpeak/R [cm^{-2} s^{-1}]	1.2E+34	24E+34	26E+34
Events / crossing without levelling	19 -> 28	210	475
Levelled Luminosity [cm^{-2} s^{-1}]	-	5E+34	2.50E+34
Events / crossing with levelling	*19 -> 28	140	140