BI LIU Review
- Introduction -

R. Garoby

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LIU Project Definition

Mandate

"The LHC Injectors Upgrade should plan for delivering reliably to the LHC the beams required for reaching the goals of the HL-LHC. This includes LINAC4, the PS booster, the PS, the SPS, as well as the heavy ion chain."
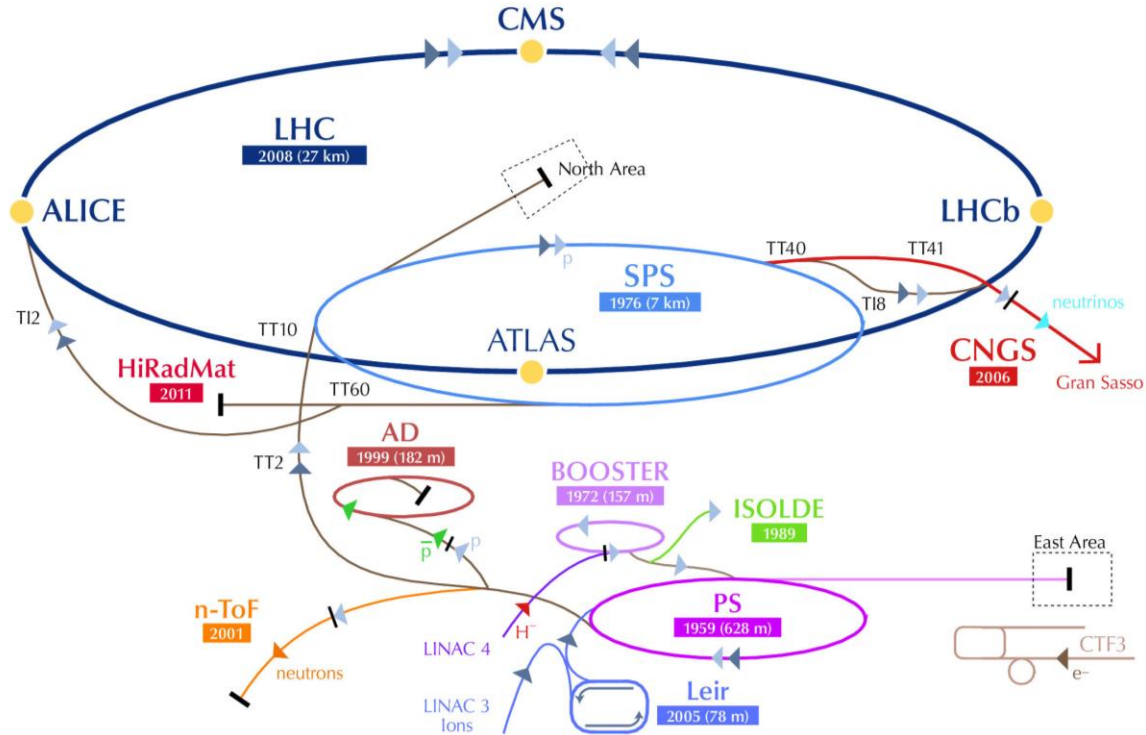

Objective

Combined effect of HL-LHC and LIU projects:

- Levelled luminosity in LHC after LS3:

    5 10^{34} cm^{-2}s^{-1}

- Integrated luminosity in ~2035:

    $\geq$ 3000 fb^{-1}

Baseline planning

	J	F	M	A	M	J	J	A	S	O	N	D
2011		1	2	3	4	5	6	7	8	9	IONS	
2012			1	2	3	4	5	6	7	8	9	
2013	IONS	IONS	LS1 - SPLICE CONSOLIDATION									
2014												
2015	CHECK-OUT	RECOM	RECOM	1	2	3	4	5	6	7	IONS	
2016		RECOM	1	2	3	4	5	6	7	8	IONS	
2017		RECOM	1	2	3	4	5	6	7	8	IONS	
2018	LS2 (LIU UPGRADE: LINAC4, BOOSTER, PS, SPS...)											
2019	RECOM	RECOM	1	2	3	4	5	6	7	8	IONS	
2020		RECOM	1	2	3	4	5	6	7	8	IONS	
2021		RECOM	1	2	3	4	5	6	7	8	IONS	
2022	HL-LHC UPGRADE											
2023	HL-LHC UPGRADE											

Technical stop or shutdown
Proton physics
Ion Physics
Recommissioning

Overall baseline (as of June 2013) planning

	Deliverables	Proton beam characteristics at LHC injection
2013 – *mid* 2014 (Long Shutdown 1)	• TDR, CtC and planning • Start of commissioning of Linac4 • Exploitation of MDs and simulations • Modifications and installation of prototypes in PSB, PS and SPS • Design § construction of equipment	

***Mid* 2014 - 2017**	• Regular operation with BCMS
	• Test/validation of installed prototypes
	• Full commissioning & reliability run of Linac4
	• Equipment design § construction for PSB, PS and SPS
	• Beam studies § simulation
	[If long shutdown in 2017:
	    • PSB modification for connection to Linac4
	    • Progressive increase of PSB brightness with benefits for PS and SPS]
		Potential for exceeding LHC nominal luminosity (~2x) with 25 ns bunch spacing…

2018 – *mid* 2019 (Long Shutdown 2)	• Extensive (?) installations in PSB, PS and SPS • Hardware commissioning	
***Mid* 2019 –2022**	• Beam commissioning : recovery of previous beam characteristics for LHC restart • MDs and studies for improving beam characteristics • Installation of last upgrades for protons and ions during the first winter shutdown.	Before LS3: LIU «baseline» beam characteristics attained

Slipped baseline (typical example)

	J	F	M	A	M	J	J	A	S	O	N	D	Days/year
2011		1	2	3	4	5	6	7	8	9	IONS		200
2012		1	2	3	4	5	6	7	8	9			200
2013	IONS	IONS	LS1 - SPLICE CONSOLIDATION										0
2014													0
2015	CHECK-OUT	RECOM	RECOM	1	2	3	4	5	6	7	IONS		130
2016		RECOM	1	2	3	4	5	6	7	8	IONS		160
2017	EXTENDED YEAR END TECHNICAL STOP			RECOM	1	2	3	4	5	IONS			100
2018		RECOM	1	2	3	4	5	6	7	8	IONS		160
2019	LS2 (LIU UPGRADE: LINAC4, BOOSTER, PS, SPS...)												0
2020							RECOM	RECOM	1	2	3	4	80
2021		1	2	3	4	5	6	7	8	9	IONS		190
2022		RECOM	1	2	3	4	5	6	7	8	IONS		160
2023	HL-LHC UPGRADE - PHASE 1 (Inner triplets...)												0
2024	HL-LHC UPGRADE												0

Typical beam characteristics

- Between LS1 and LS2:

[from https://edms.cern.ch/file/1296306/1/table-BCMS-e20percentLHC.pdf]

	LHC ($n \times$ 144-288 b/inj)				
	N (10^{11} p/b)	$\epsilon_{x,y}$ (μm)	p (GeV/c)	ϵ_z (eVs/b)	B_l (ns)
50 ns	1.70	1.08	450	0.46	1.60
25 ns	1.15	1.39	450	0.39	1.47

- After all upgrades (post-LS2):

[from https://edms.cern.ch/file/1296306/1/table-e20percentLHC.pdf]

		LHC ($n \times$ 144-288 b/inj)				
		N (10^{11} p/b)	$\epsilon_{x,y}$ (μm)	p (GeV/c)	ϵ_z (eVs/b)	B_l (ns)
Linac4 + 2 GeV	50 ns	2.70	1.95	450	0.60	1.65
+ full SPS upgrade	25 ns	2.00	1.88	450	0.60	1.65

Purpose of the BI LIU Review

CERN internal meeting with the goal of reviewing the status and plans for beam instrumentation in the LHC injector complex (except Linac4) and checking its coherence with the needs of the LIU project.

The following questions are to be addressed:

1. **Are the specifications clear and can they be met by the proposed systems?**
2. **What is the installation/commissioning planning of the various instruments?**
3. **Are there resource conflicts between machines/systems/projects, and if this is the case how can they be resolved?**
4. **Does LIU need to provide priorities?**