



Performance updates & A first simple model for comparison between SPS flat bottom duration & LHC injection

[Updated tables](#)

Relative yearly & total integrated luminosity

Run	Year	Reference (fb ⁻¹)	Without ion run beyond Run4	Round, 90 mb	Flat optics	Flat optics, 200 urad	Flat optics, 90 mb	Reference, 200 PU	Round, 90 mb, 200 PU	Flat optics, 200 PU	Flat optics, 90 mb, 200 PU
4	2030	31.99	31.99	33.7	35.33	38.24	37.31	31.99	33.71	35.33	37.31
	2031	205.54	205.54	216.38	210.85	214.89	221.8	237.35	253.13	247.72	264.29
	2032	236.85	236.85	248.73	252.76	256.5	263.97	283	301.39	318.88	338.27
	2033	233.82	233.82	245.55	249.54	253.23	260.61	279.4	297.52	314.8	333.95
5	2036	208.12	247.39	218	214.33	217.68	223.93	256.37	272.5	269.8	286.36
	2037	271	310.28	283.75	278.55	282.64	290.88	334.56	355.51	351.53	372.9
	2038	275.72	314.99	288.68	283.38	287.54	295.92	340.39	361.71	357.65	379.39
	2039	275.72	314.99	288.68	283.38	287.54	295.92	340.39	361.71	357.65	379.39
	2040	228.54	267.82	239.37	235.28	238.92	245.8	281.67	299.38	296.38	314.49
	2041	283.57	322.85	296.9	291.44	295.71	304.34	350.13	372.1	367.86	390.21
		2250.89	2486.53	2359.77	2334.86	2372.88	2440.5	2735.3	2908.62	2917.64	3096.54
	+ 520	2770.9	3006.53	2879.8	2854.9	2892.9	2960.5	3255.3	3482.6	3437.6	3616.5

1. Flat means 18/60 cm for 2030, 14/40 cm for 2031 and 8/18 for the rest
2. 2030 leveling time is 0 with round, but there is some leveling time (0.8 h) with flat
3. 200 PU means 101 max PU for 2030 and 200 for the rest
4. Flat and 200 urad means that crossing angle is reduced to 200, based on DA this is extreme, only 220 possible.

Relative yearly & total integrated luminosity

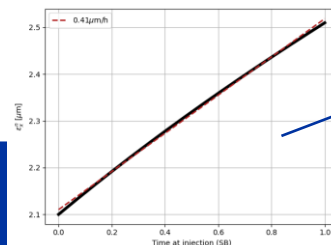
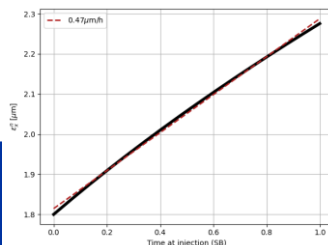
Run	Year	Reference (fb ⁻¹)	Without ion run beyond Run4 (%)	Round, 90 mb (%)	Flat optics (%)	Flat optics, 200 urad (%)	Flat optics, 90 mb (%)	Reference , 200 PU (%)	Round, 90 mb, 200 PU (%)	Flat optics, 200 PU (%)	Flat optics, 90 mb, 200 PU (%)
4	2030	31.99	0	5.4	10.4	19.5	16.6	0	5.4	10.4	16.6
	2031	205.54	0	5.3	2.6	4.6	7.9	15.5	23.2	20.5	28.6
	2032	236.85	0	5	6.7	8.3	11.5	19.5	27.2	34.6	42.8
	2033	233.82	0	5	6.7	8.3	11.5	19.5	27.2	34.6	42.8
5	2036	208.12	18.9	4.8	3	4.3	7.6	23.2	31	29.7	37.6
	2037	271	14.5	4.7	2.8	4.3	7.3	23.4	31.12	29.7	37.6
	2038	275.72	14.2	4.7	2.8	4.3	7.3	23.5	31.12	29.7	37.6
	2039	275.72	14.2	4.7	2.8	4.3	7.3	23.5	31.2	29.7	37.6
	2040	228.54	17.2	4.7	2.9	4.5	7.5	23.2	31	29.7	37.6
	2041	283.57	13.9	4.7	2.8	4.3	7.3	23.5	31.2	29.7	37.6
		2250.89	10.5	4.8	3.7	5.4	8.4	21.5	29.2	29.6	37.6

Simple model SPS FB vs LHC injection

Ideal filling, HL standard

Missing injections, HL standard

	4x72b	4x72b + dedicated filling (6s)	4x72b	4x72b + dedicated filling (6s)
Bunch intensity (1e11 ppb)	2.3	2.3	2.3	2.3
SPS supercycle (s)	39.6	33.6	39.6	33.6
Time between B1 injections (s)	79.2	67.2	79.2	67.2
Number of injections for IP1/5 colliding bunches	12	12	12	12
Number of missed injectons	0	0	12	12
Emittance at start of LHC injection (μm)	2.1	2.1	2.1	2.1
Minimum time spent at LHC injection for IP1/5 colliding bunches (mins)	15.84	13.44 (-2.4 mins)	31.7	26.9 (-4.8 mins)
Emittance growth due to IBS and unknown blowup ($\mu\text{m}/\text{h}$)	~0.6	~0.6	~0.6	~0.6
Average/Max emittance at the end of LHC injection	2.19/2.26	2.17/2.23	2.27/2.42	2.25/2.37
Number of IP1/5 colliding bunches	2748	2748	2748	2748
Turn-around (h)	2.24	2.2	2.5	2.42
Integrated luminosity per day (fb-1)	3.24	3.25	3.15	3.18



IBS $\mu\text{m}/\text{h}$ with standard vs BCMS

Simple model SPS FB vs LHC injection

2.86 minutes longer injection than with standard for same injection efficiency

Ideal filling, HL BCMS

Missing injections, HL BCMS

	5x48b	5x48b + dedicated filling (6s)	5x48b	5x48b + dedicated filling (6s)
Bunch intensity (1e11 ppb)	2.3	2.3	2.3	2.3
SPS supercycle (s)	43.2	37.2	43.2	37.2
Time between B1 injections (s)	86.4	74.4	86.4	74.4
Number of injections for IP1/5 colliding bunches	12	12	12	12
Number of missed injectons	0	0	12	12
Emittance at start of LHC injection (μm)	1.8	1.8	1.8	1.8
Minimum time spent at LHC injection for IP1/5 colliding bunches (mins)	17.28	14.88 (-2.4 mins)	34.56	29.76 (-4.8 mins)
Emittance growth due to IBS and unknown blowup ($\mu\text{m}/\text{h}$)	~ 0.7	~ 0.7	~ 0.7	~ 0.7
Average/Max emittance at the end of LHC injection	1.91/2	1.89/1.97	2.02/2.2	1.99/2.15
Number of IP1/5 colliding bunches	2736	2736	2736	2736
Turn-around (h)	2.26	2.22	2.55	2.47
Integrated luminosity (fb ⁻¹)	3.25	3.27	3.15	3.18

Ideal filling, Run3 BCMS 3x36 or 5x36

	3x36	3x36 + dedicated filling (6s)	5x36	5x36 + dedicated filling (6s)
Bunch intensity (1e11 ppb)	1.6	1.6	1.6	1.6
SPS supercycle (s)	36	30	43.2	37.2
Time between B1 injections (s)	72	60	86.4	74.4
Number of injections for IP1/5 colliding bunches	23	23	15	15
Number of missed injections	0	0	0	0
Emittance at start of LHC injection (μm)	1.3	1.3	1.3	1.3
Minimum time spent at LHC injection for IP1/5 colliding bunches (mins)	27.6	23 (-4.6 mins)	21.6 (-6 mins)	18.6 (-9 min/-3 min)
Emittance growth due to IBS and unknown blowup ($\mu\text{m}/\text{h}$)	~ 0.7	~ 0.7	~ 0.7	~ 0.7
Average/Max emittance at the end of LHC injection	1.47/ 1.62	1.44/1.57	1.43/1.55	1.42/1.52
Number of IP1/5 colliding bunches	2340	2340	2484	2484
Turn-around (h)	2.5	2.42	2.4	2.35
Integrated luminosity per day (fb⁻¹)	1.47	1.48	1.49	1.49

Missing injections, Run3 BCMS 5x36

	5x36	5x36 + dedicated filling (6s)
Bunch intensity (1e11 ppb)	1.6	1.6
SPS supercycle (s)	43.2	37.2
Time between B1 injections (s)	86.4	74.4
Number of injections for IP1/5 colliding bunches	15	15
Number of missed injections	15	15
Emittance at start of LHC injection (μm)	1.3	1.3
Minimum time spent at LHC injection for IP1/5 colliding bunches (mins)	43.2	37.2 (-6 minutes)
Emittance growth due to IBS and unknown blowup ($\mu\text{m}/\text{h}$)	~ 0.7	~ 0.7
Average/Max emittance at the end of LHC injection	1.57/1.8	1.53/1.73
Number of IP1/5 colliding bunches	2484	2484
Turn-around (h)	2.76	2.66
Integrated luminosity per day (fb⁻¹)	1.43	1.45