HL-LHC luminosity ramp-up

(at the start of the fill and over years)

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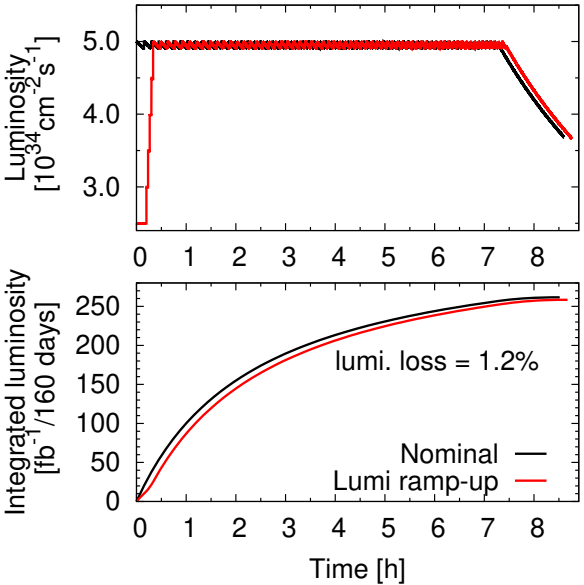
- LHCb proton luminosity ramp-up for nominal and ultimate

Luminosity ramp-up for Nominal



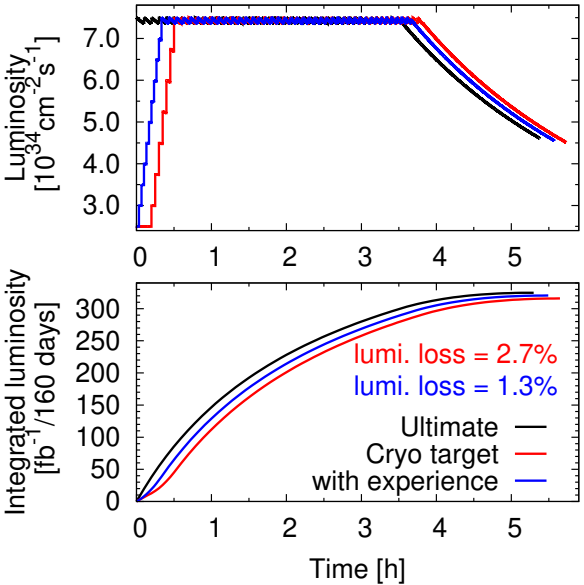
The "Feasible" cryo option is discarded as starts from L=0.

"Target" is shown in red.

1.2% lumi. loss at the end of the fill, but larger loss for shorter fills.

"With experience": 0.4% loss.

Luminosity ramp-up for Ultimate



Significantly larger lumi loss.

"Target": 2.7% lumi loss.

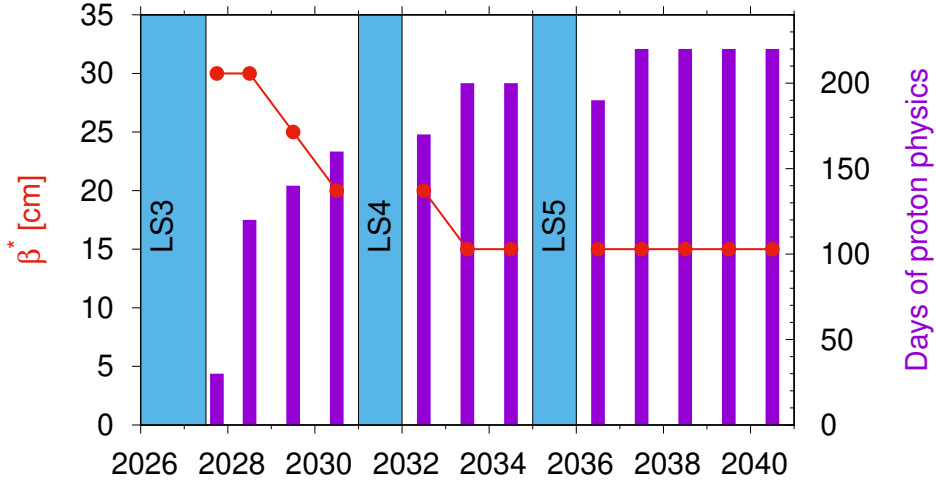
"With experience": 1.3% lumi loss.

1% integrated luminosity in HL-LHC is not negligible

Assumptions for IP1&5

- 262 fb^{-1} in 160 days with 5$\times$10^{34} cm^{-2}s^{-1}
- 405 fb^{-1} in 200 days with 7.5$\times$10^{34} cm^{-2}s^{-1}
- Integrated luminosity recomputed for different leveled lumi, β^*, intensity, etc. **Efficiency = 50%** (see extra slides)
- 350 fb^{-1} at the end of Run 3 (to be revised!)

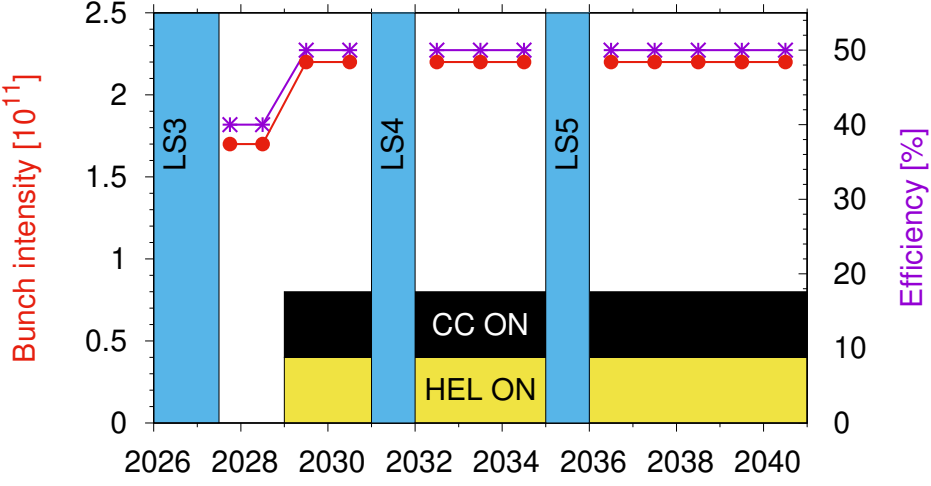
β^* and days of proton physics



Nominal β^* in 2033

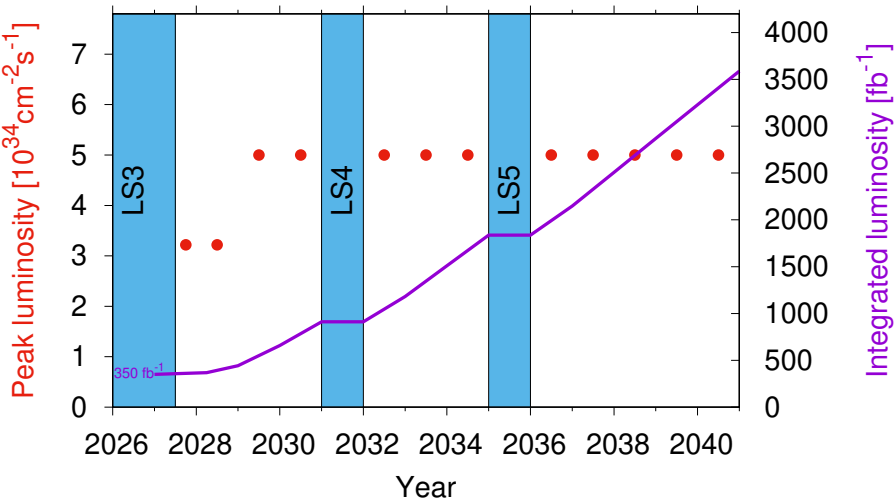
Total days of proton physics = 2090

Bunch intensity, efficiency, HEL and CC

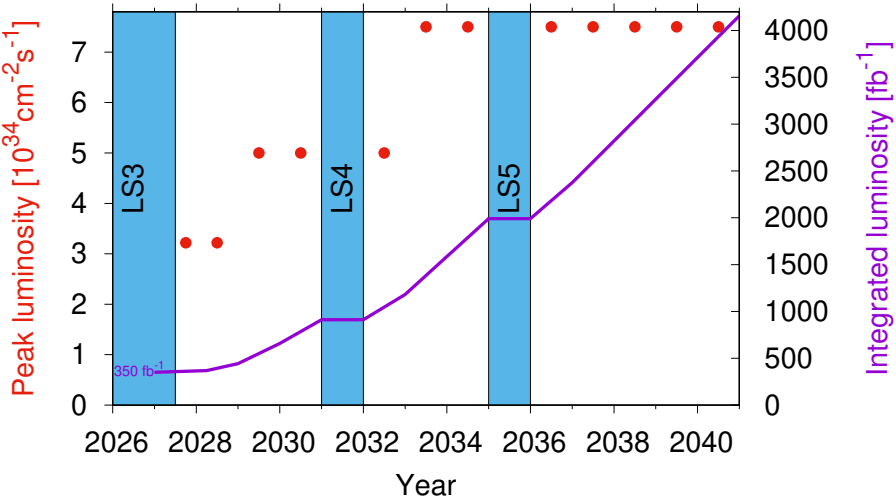


Nominal intensity in 2029 + HEL & CC

Baseline performance

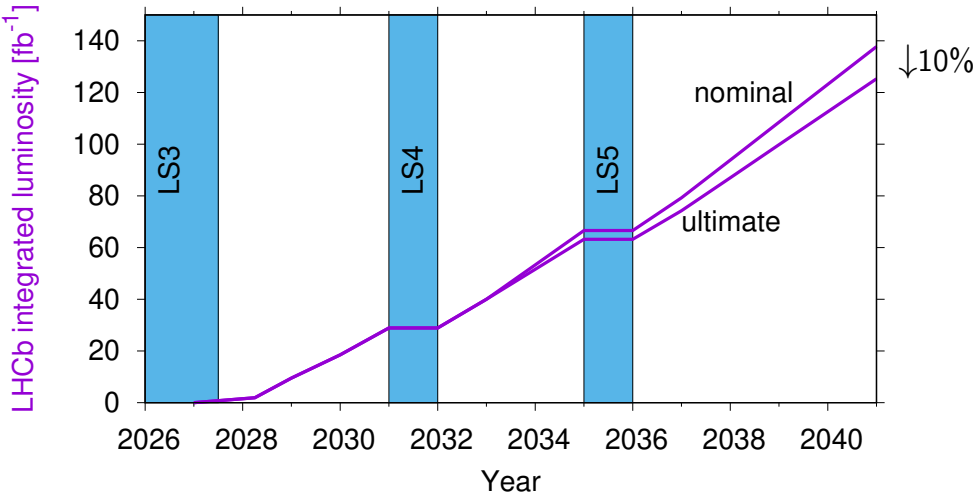


Ultimate performance



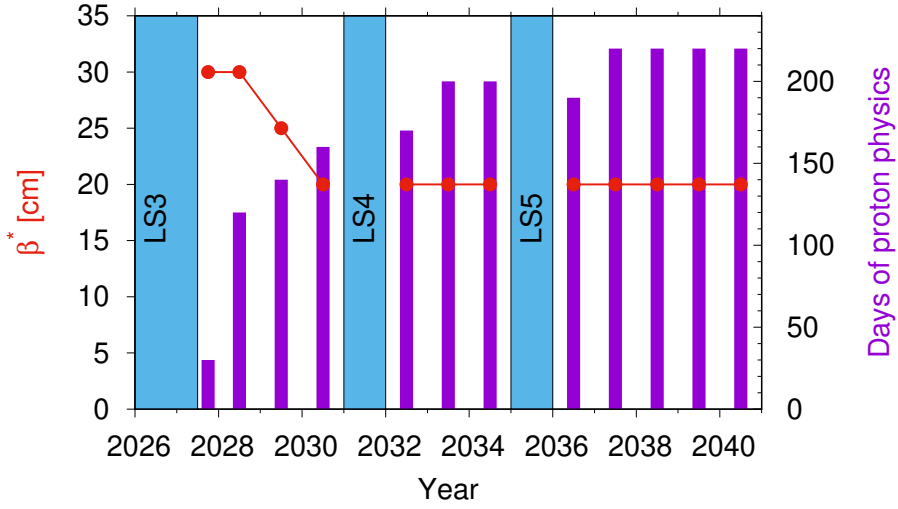
Goal exceeded by about 4%.

LHCb, $L_{lev} = 2 \times 10^{33}$ cm^{-2}s^{-1}

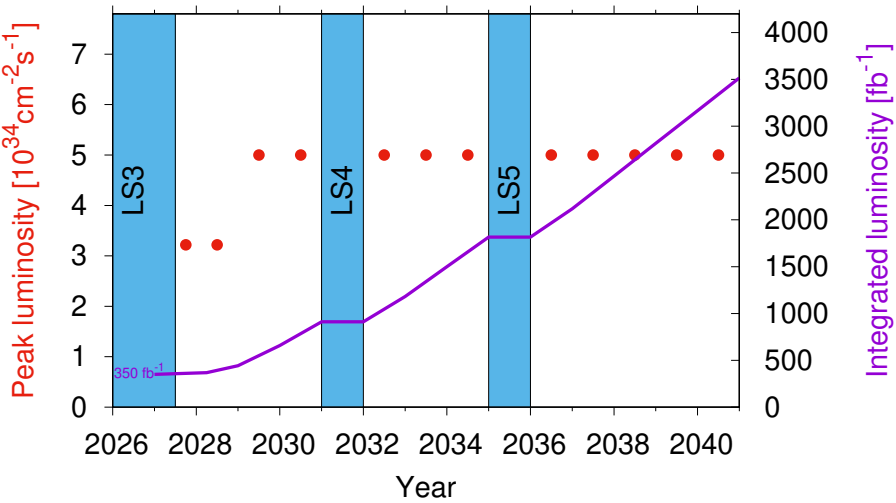


For ALICE $L_{lev} = 1.4 \times 10^{31}$ cm^{-2}s^{-1}

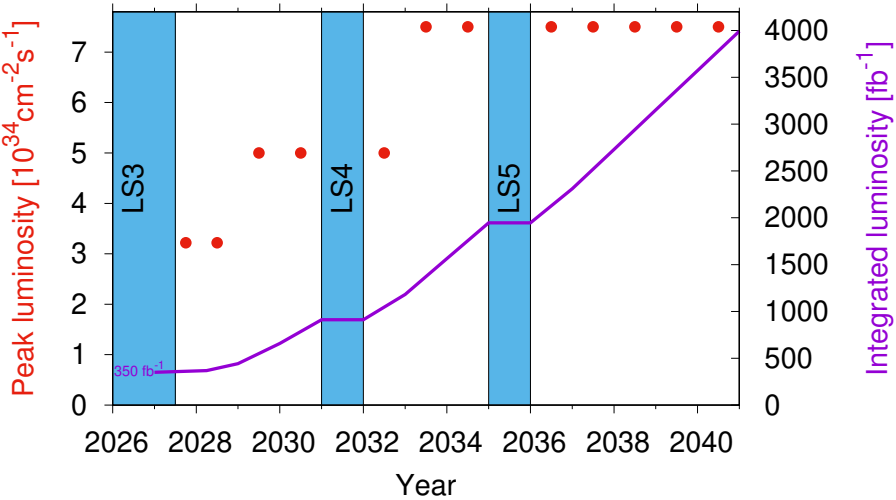
β^* and days of proton physics – $\beta^* = 20$ cm



Baseline performance – $\beta^* = 20$ cm

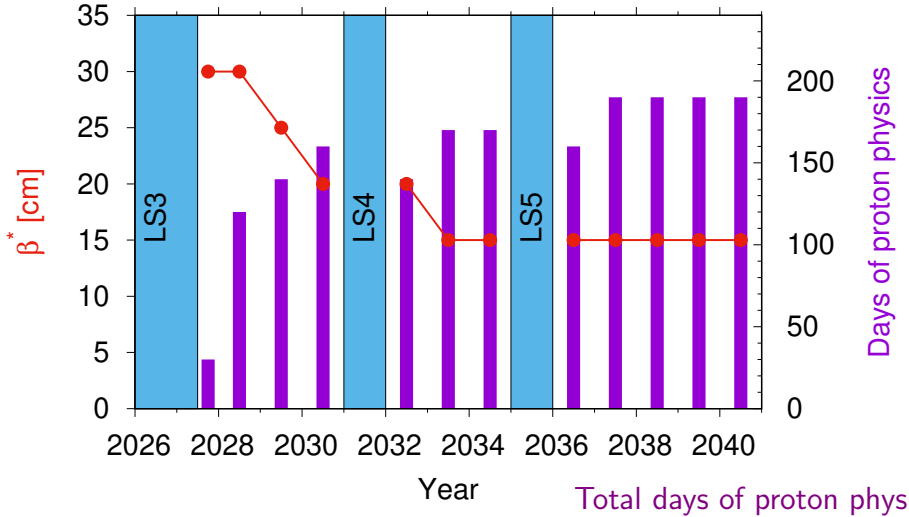


Ultimate performance – $\beta^* = 20$ cm



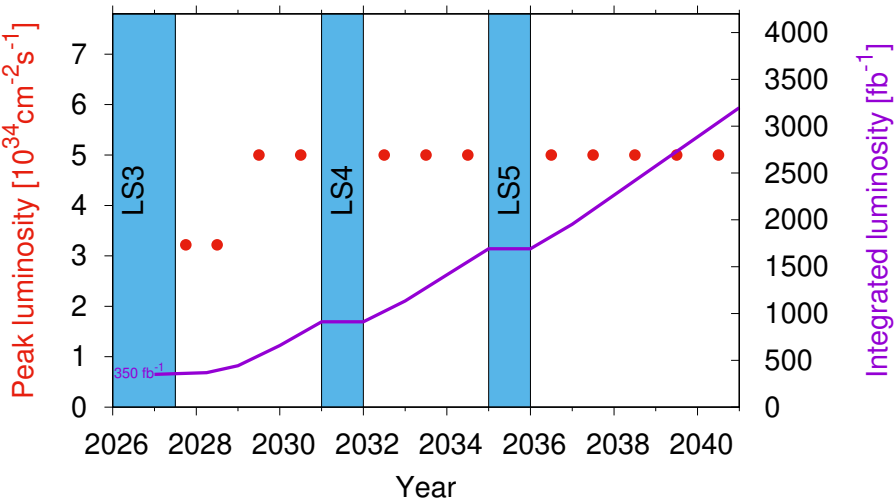
Goal barely achieved, zero margin.

With extra ion runs in Runs 5 & 6

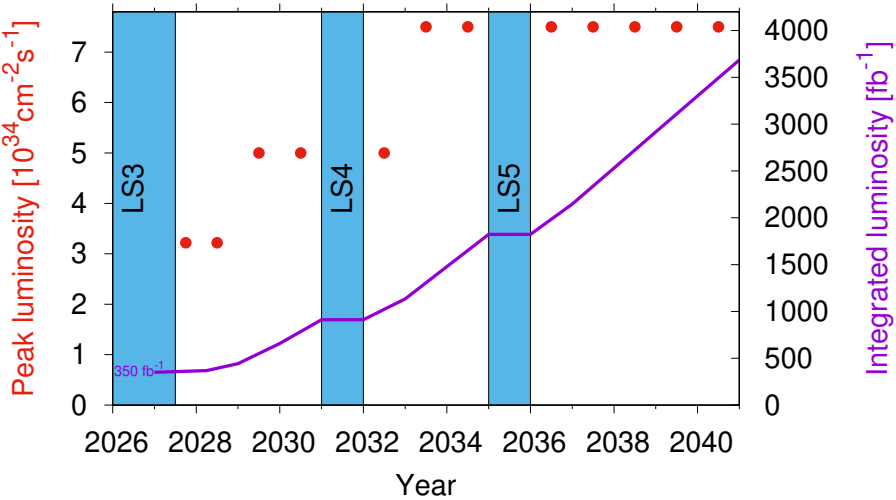


Total days of proton physics = 1850

Baseline performance – With extra ion runs



Ultimate performance – With extra ion runs



Reduction of 11% from baseline ion operation.

Summary

- Goals are at reach in new baseline.
- Tight margin of about 4% for the Ultimate goal (comparable to luminosity loss from larger β^*=20cm)
- Runing ions in Runs 5 & 6 reduces total integrated luminosity by 11%.
- LHCb integrated luminosity reduction between Nominal and Ultimate is about 10%
- Cryo request to ramp-up fill luminosity should be faster than 20min to lose less than 1% luminosity in Ultimate.

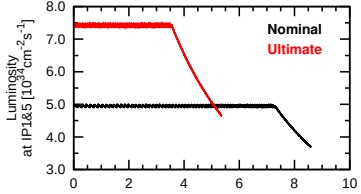
Extra slides

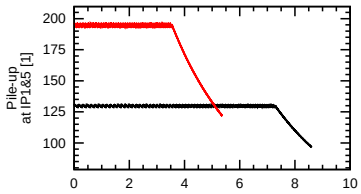
Luminosity Vs ppb, β^*, etc.

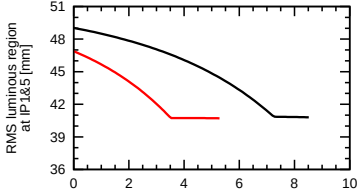
Year	ppb $[10^{11}]$	Virtual lumi. $[10^{34}\text{cm}^{-2}\text{s}^{-1}]$	Int. lumi.† $[\text{fb}^{-1}]$	β^* [cm]	Crab cavity	HEL
2027	1.7	3.22	123	30	off	off
2028	1.7	3.22	123	30	off	off
2029	2.2	10.3	246	25	on	on
2030	2.2	13.5	254	20	on	on
2032	2.2	13.5	254	20	on	on
2033	2.2	16.9	262	15	on	on

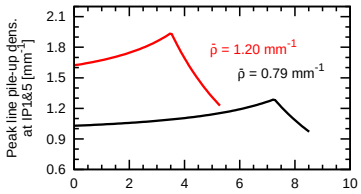
Assuming for all years: $\epsilon = 2.5$ μm and 160 days of operation,

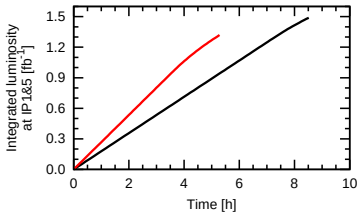
† Int. lumi. to be rescaled with days of operation.

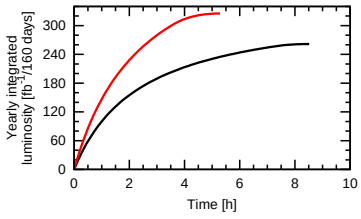

Luminosity at IP1&5 [10^34 cm^-2 s^-1]
Nominal
Ultimate


Pile-up at IP1&5 [1]


RMS luminous region at IP1&5 [mm]


Peak line pile-up dens. at IP1&5 [mm^-1]
ρ̃ = 1.20 mm^-1
ρ̃ = 0.79 mm^-1


Integrated luminpsity at IP1&5 [fb^-1]
Time [h]


Yearly integrated luminosity [fb^-1/160 days]
Time [h]