200 MHz: Performance

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CERN-BE-ABP

68th HiLumi WP2 Meeting

May 3rd, 2016

Research supported by the High Luminosity LHC project

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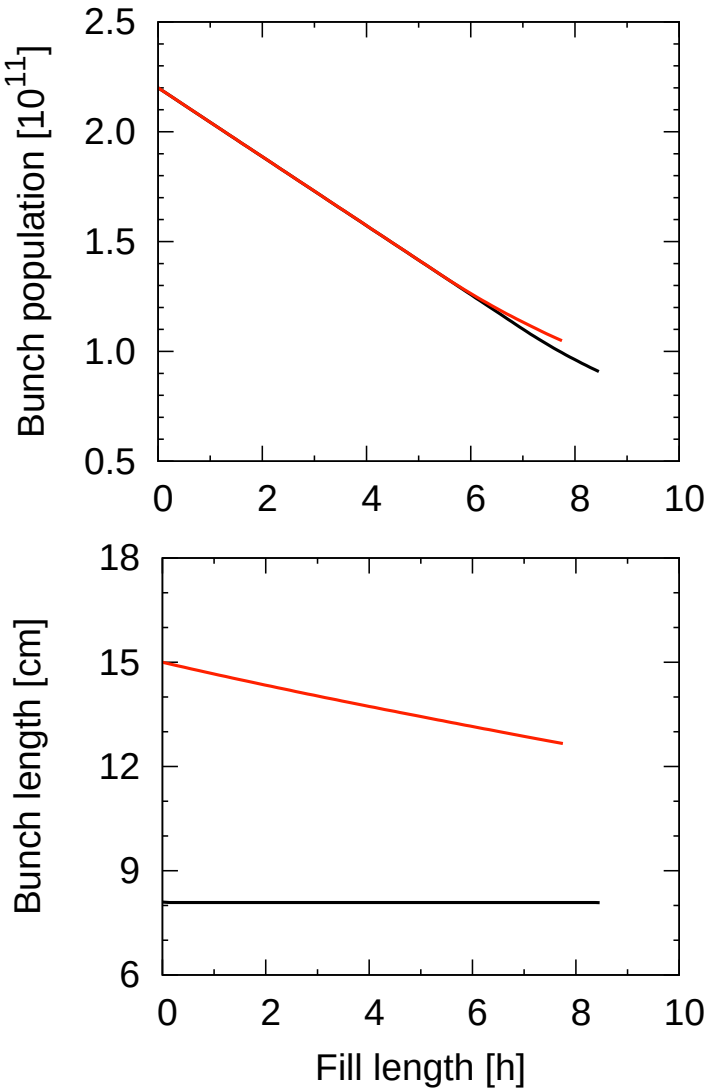
Parameters

- Simulation of the evolution of an optimum fill for the **HL-LHC** and the **200 MHz** alternative scenario.
- Comparison of their performance in terms of **integrated luminosity** and **peak pile-up density**.

Parameter	**Nominal**	**200 MHz**
Energy [TeV]	7	
Number of bunches	2748	
Colliding bunches	2736	
Bunch population (ppb)	2.2×10^{11}	
β^* [cm]	15	
Normalized emittance [µm]	2.5	
Bunch length [cm]	8.1	15.0
Energy spread [10^{-4}]	1.08	1.0

Levelling: Baseline and 200 MHz

- Decrease of **beam intensity** (particles per bunch, ppb) due to luminosity **burn-off**.
- **Bunch length** is kept constant for the baseline, and decreased due to natural **cooling** for the **200 MHz** scenario.
- **Emittance** evolution takes into account **IBS**.
- Step-based β^*-levelling.
- Luminosity levelling at 2 %, for a **140 pile-up**.
- Peak pile-up density reduced by 9 % w.r.t. the nominal.
- Luminous region.



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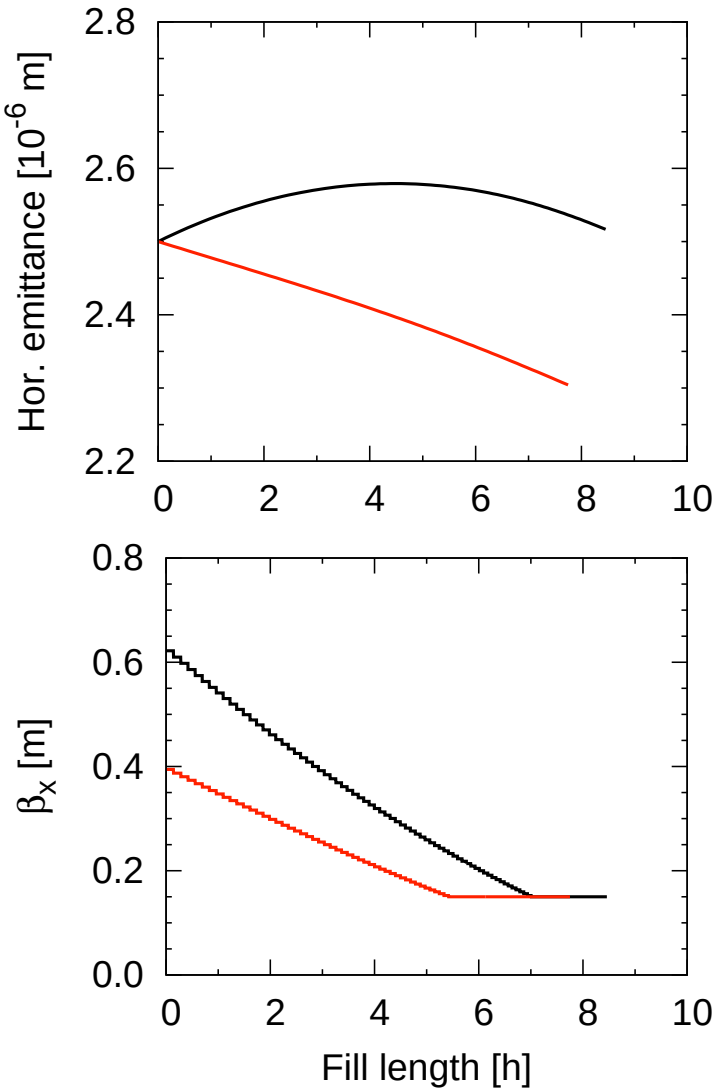

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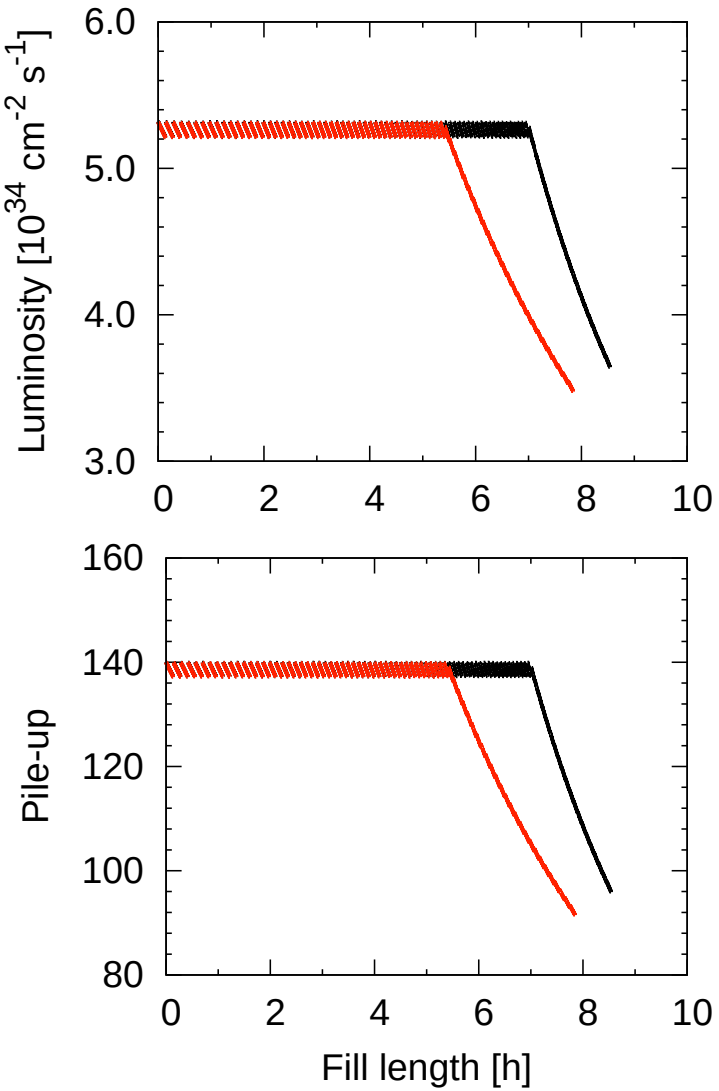

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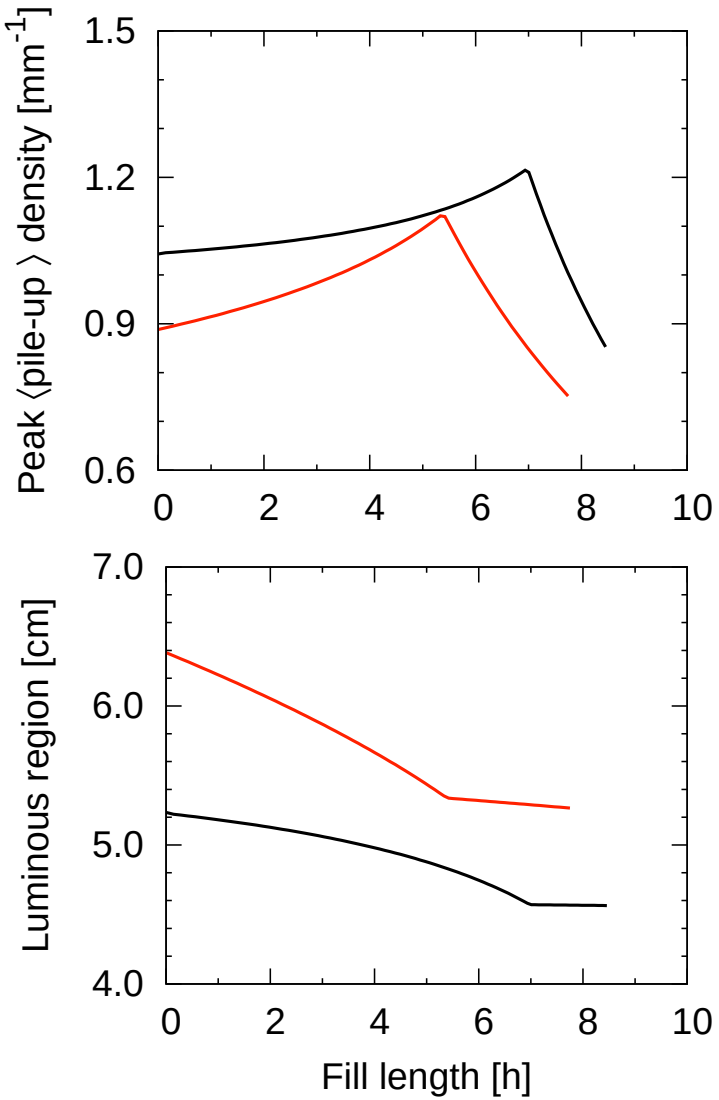
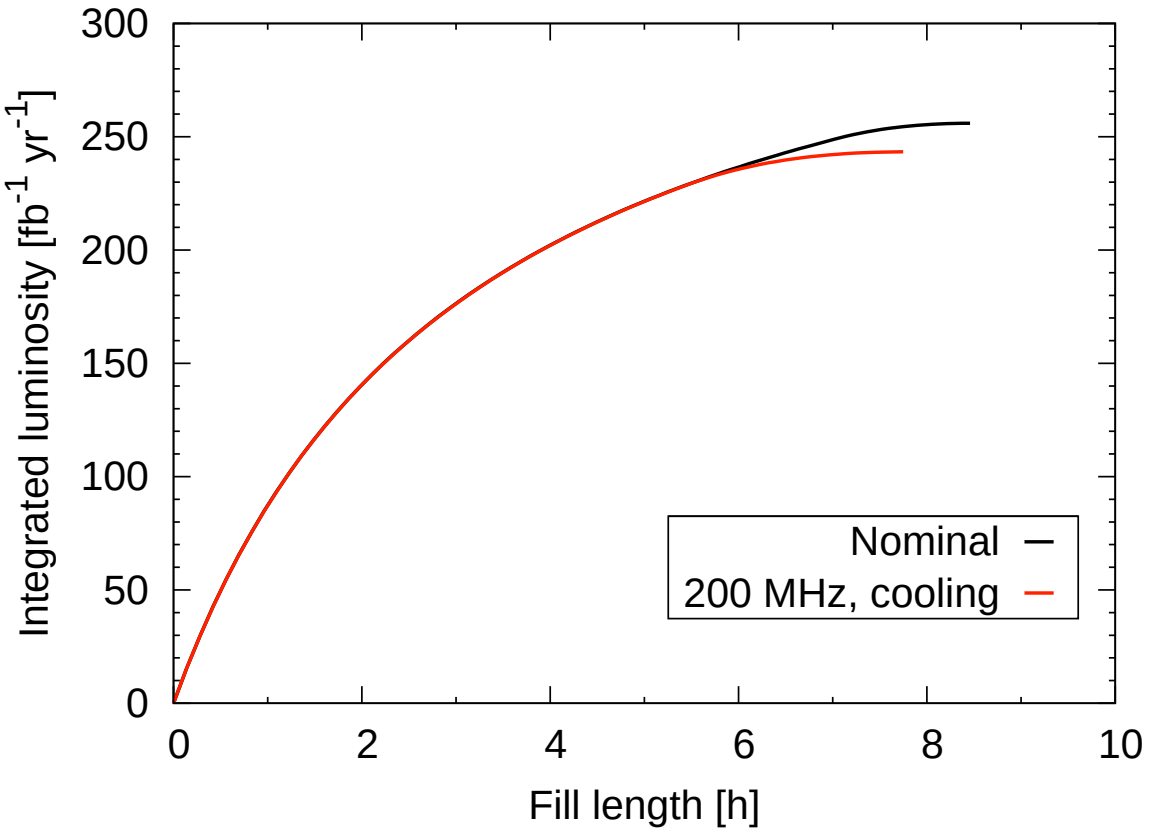


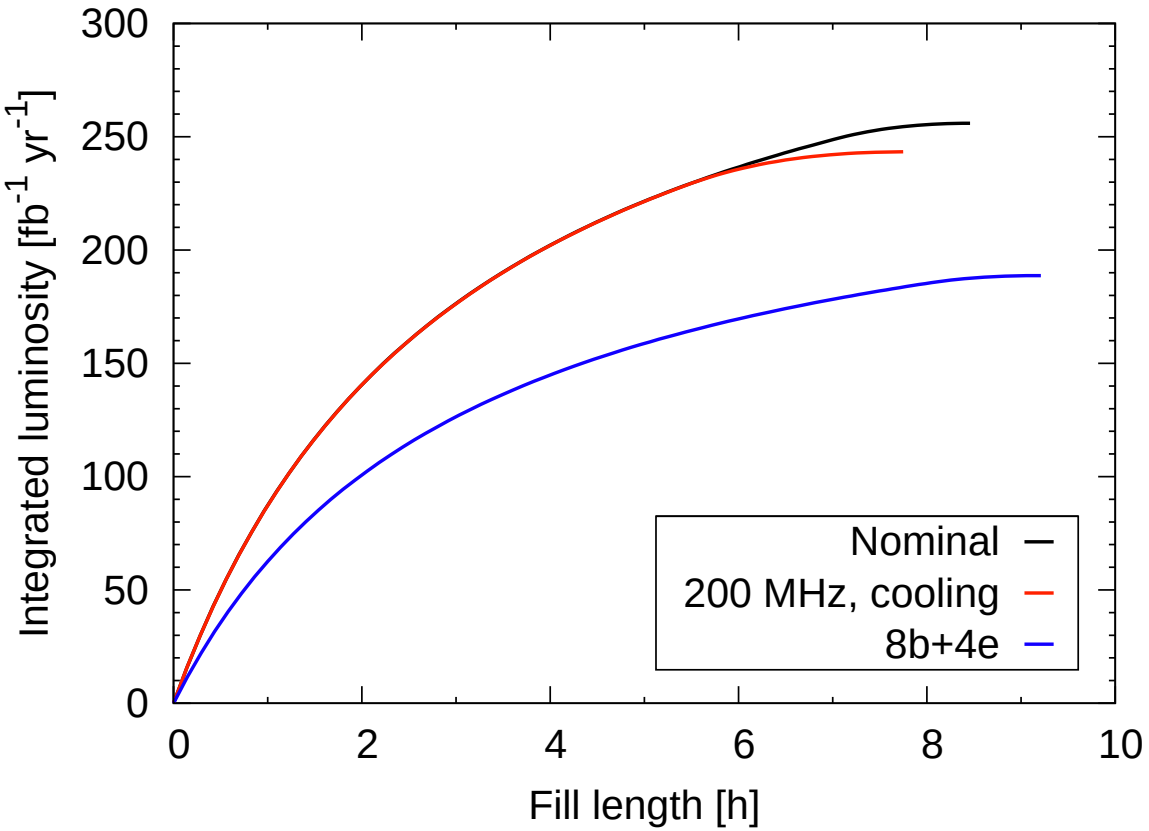
Nominal —
200 MHz, cooling —

Performance: Baseline and 200 MHz



- Performance is reduced only by **5%** in the **200 MHz** scenario (with cooling).
- Compare with a reduction of more than **20%** in the **8b+4e** scenario.

Performance: Baseline and 200 MHz (and 8b+4e)



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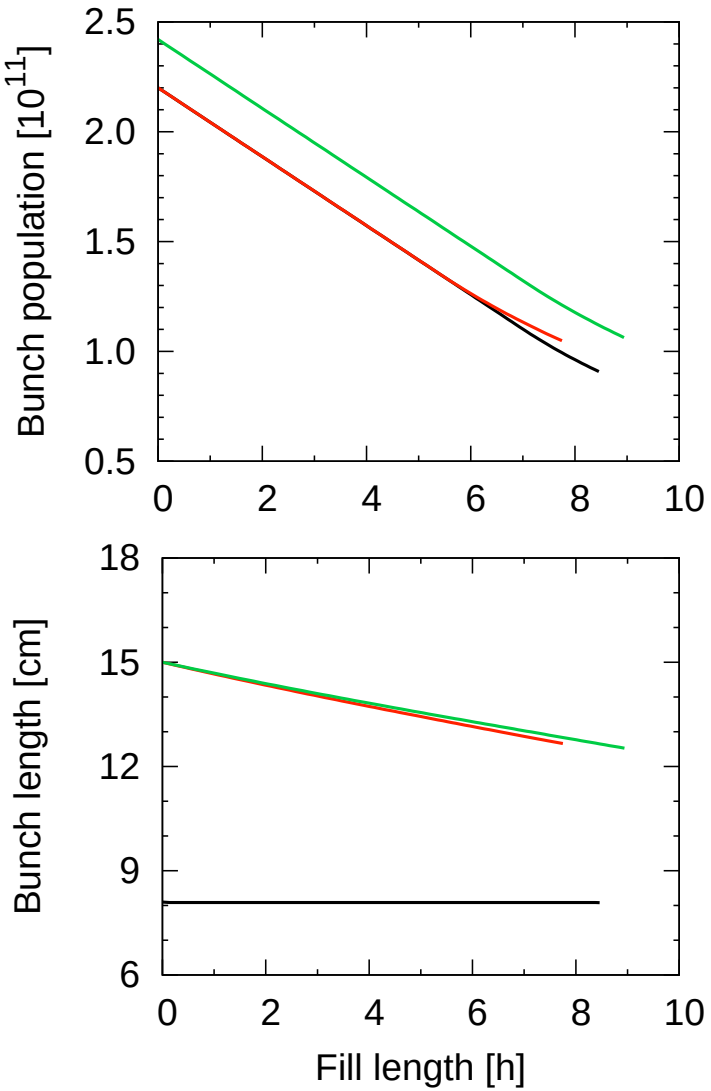
Restoring Nominal Performance: 200 MHz

- **10%-increase** of the bunch population.
- Bunch length reduced by natural cooling.
- Longer fill length.
- **Negligible impact** on the **peak pile-up density** w.r.t. to the 200 MHz scenario with nominal bunch population.



Nominal
200 MHz, cooling
200 MHz, cooling, 2.4×10^{11} ppb

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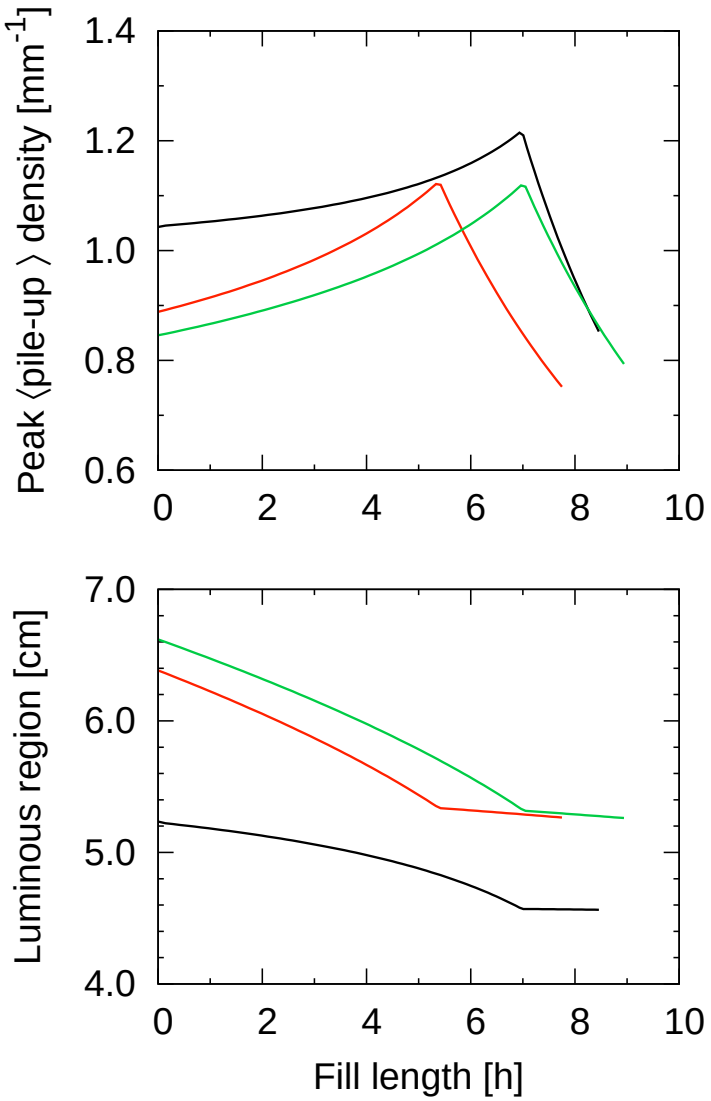

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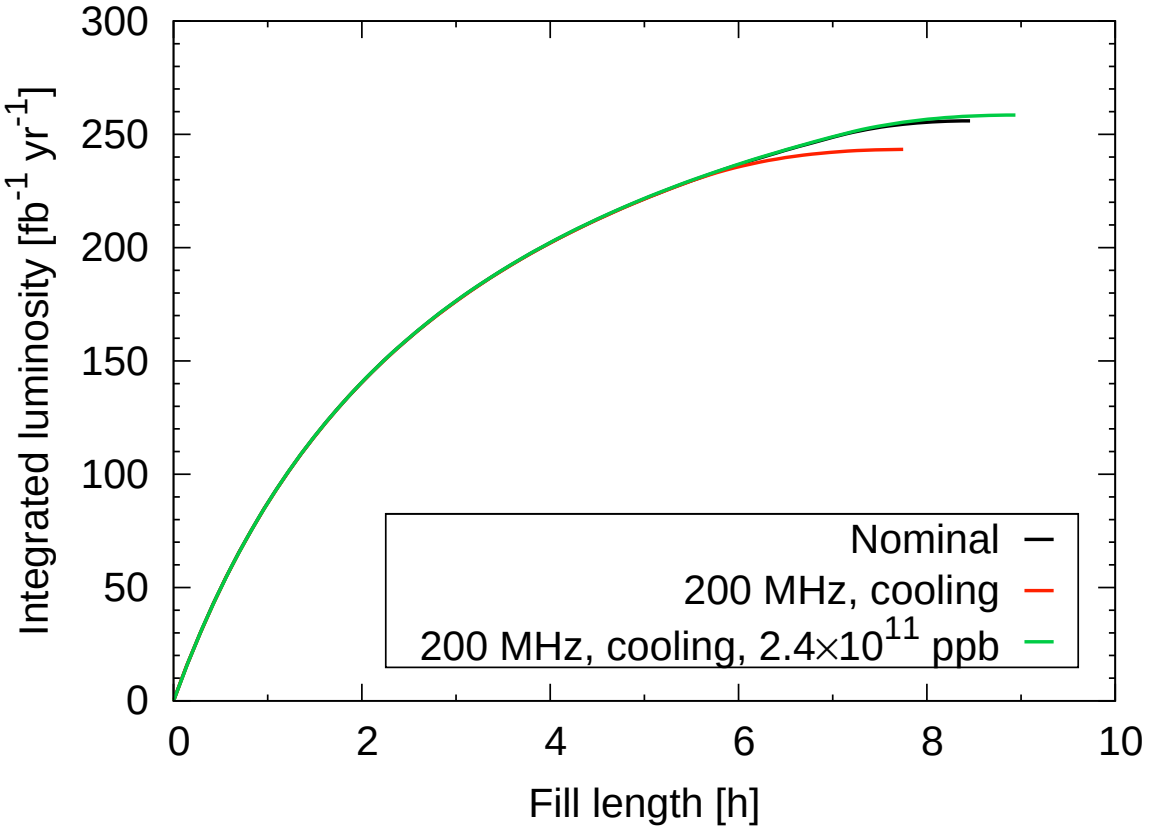
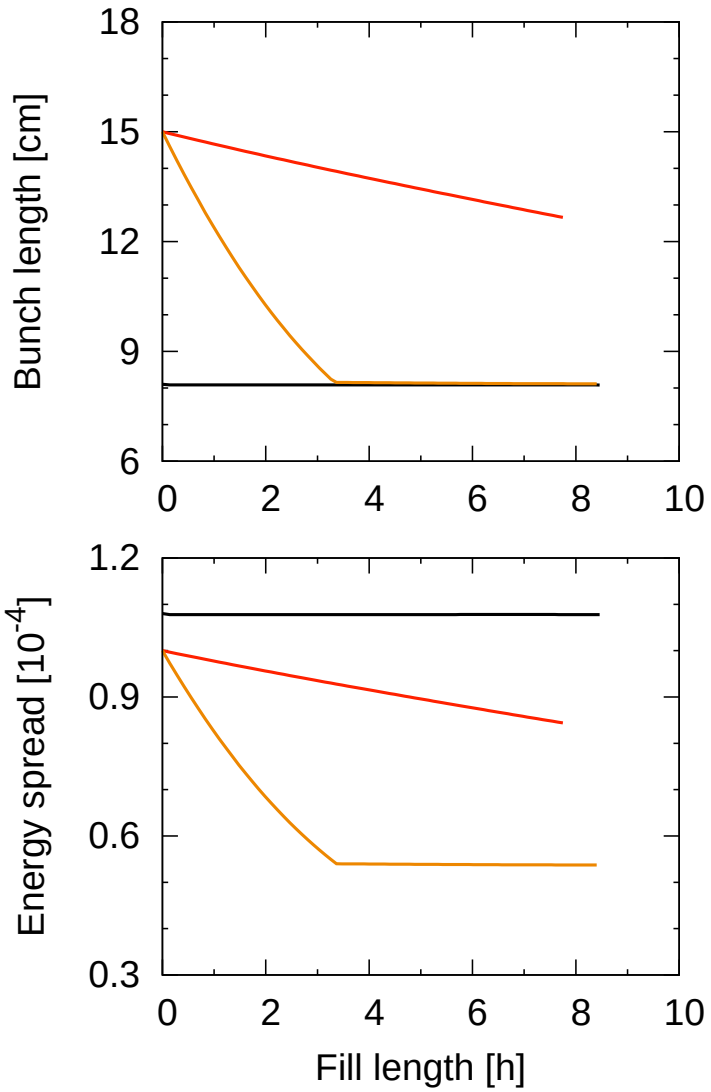
Restoring Nominal Performance: 200 MHz



- Performance is **restored** for the 200 MHz scenario with a 10 % increase in bunch population.

Other Alternatives

- **Recapture** into the **400 MHz** RF system in order to **restore the performance**.
- Bunch length is kept constant or let to shrink due to cooling at the beginning of the fill.
- How to recapture in 400 MHz RF system with bunch length above 12 cm?
- In both cases, the yearly **integrated luminosity** is similar to the **nominal**.



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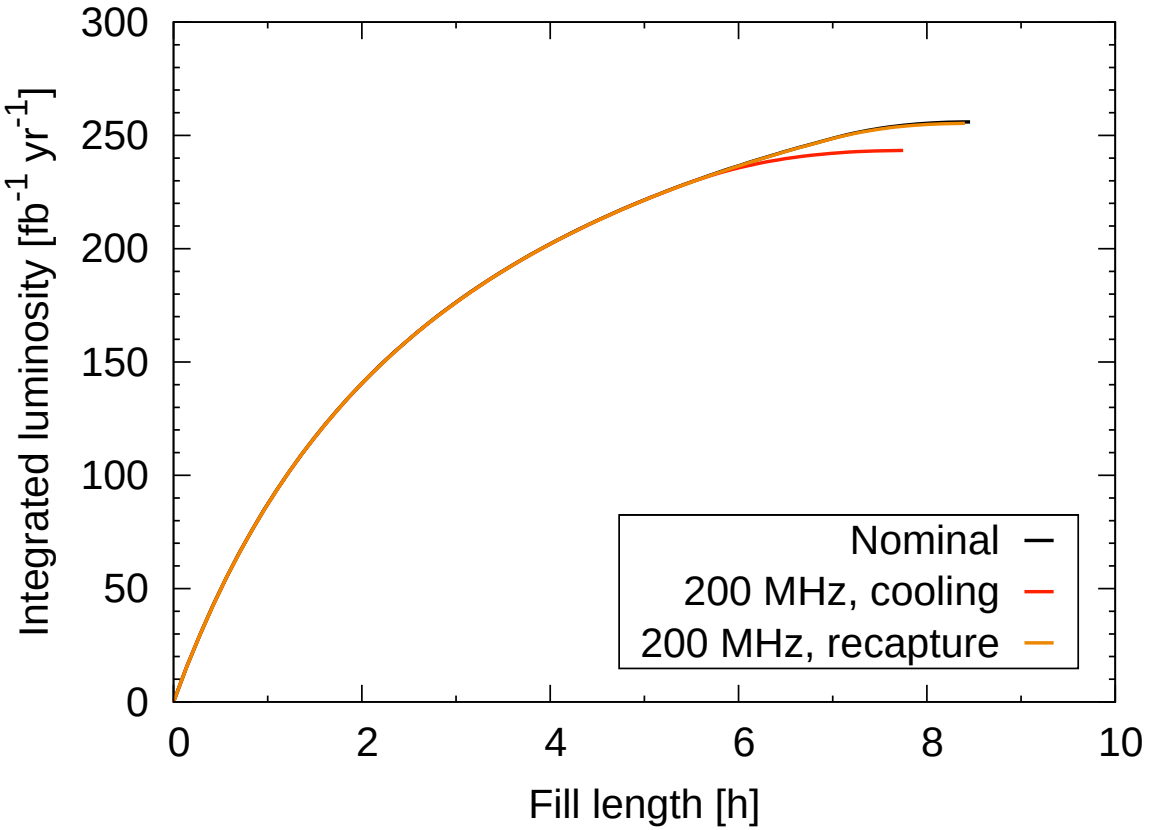

- Performance is **restored** for the 200 MHz scenario with recapture.

Summary

Parameter	L_{int} [fb^{-1}yr^{-1}]	
Nominal	255.9	100 %
8b+4e	188.7	74 %
200 MHz, cooling	243.3	95 %
200 MHz, cooling, 2.4×10^{11} ppb	258.5	101 %

- The **200 MHz scenario** has proved to reduce electron-cloud effects, with **little loss in performance**.
- The **reduction** on integrated luminosity can be **compensated** by different means, such as the increase of bunch population, or the recapture into the 400 MHz system.