Integrated luminosity models for energy phasing

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Introduction

We present here a simple model for the integrated luminosity profiles of the eight physics scenarios proposed by the Joint WG on parameters:

(a) 250 fb^{-1} @ 250 GeV, 500 fb^{-1} @ 500 GeV
(b) 250 fb^{-1} @ 250 GeV, 500 fb^{-1} @ 550 GeV
(c) 250 fb^{-1} @ 250 GeV, 1000 fb^{-1} @ 500 GeV (*for comparison with b*)
(d) 100 fb^{-1} @ 250 GeV, 200 fb^{-1} @ 350 GeV, 500 fb^{-1} @ 500 GeV
(e) 100 fb^{-1} @ 250 GeV, 200 fb^{-1} @ 350 GeV, 500 fb^{-1} @ 550 GeV
(f) 25 fb^{-1} @ 250 GeV, 350 fb^{-1} @ 350 GeV, 500 fb^{-1} @ 500 GeV
(g) 500 fb^{-1} @ 250 GeV, 500 fb^{-1} @ 500 GeV
(a*) 350 fb^{-1} @ 350 GeV, 500 fb^{-1} @ 500 GeV
(h) 50 fb^{-1} @ 250 GeV, 200 fb^{-1} @ 350 GeV, 500 fb^{-1} @ 500 GeV, 1 ab^{-1}@ 250 GeV
(i) 50 fb^{-1} @ 250 GeV, 200 fb^{-1} @ 350 GeV, 500 fb^{-1} @ 550 GeV, 1 ab^{-1}@ 250 GeV

Assumptions

- Year 0 is the start of running for physics, which is assumed to be at the first-stage centre-of-mass energy of 250 GeV. Year 0 is assumed to start one year after end of construction (one year for commissioning with zero luminosity).
- The integrated luminosity is assumed to ramp up according to the Heuer *et al* parameters document assumed profile: 10%, 30%, 60%, 100% in years 1 through 4 respectively.
- Once the required integrated luminosity at $E_{cm} = 250$ GeV is achieved, the machine is assumed to be turned off for full installation of the remaining linac. The total installation (upgrade) time is assumed to be **18 months** for 500 GeV. For the 550 GeV scenarios 20% additional installation time is assumed (a total of ~22 months). The time assumes the deinstallation of the temporary transport beamlines and subsequenct installation of cryomodules, RF power and distribution *etc*. For scenario (a*) where the upgrade is only 75 GeV per linac, 12 months shutdown is assumed.

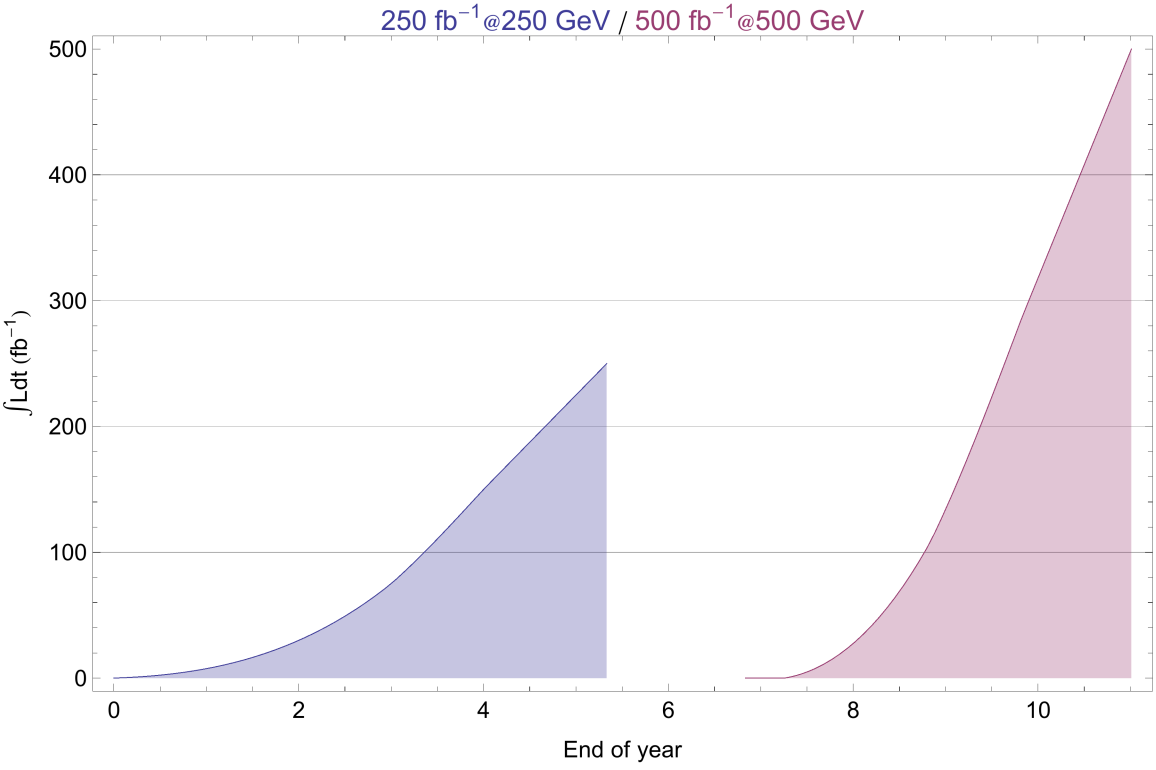
- Since only the main linacs are upgraded, with the sources, damping rings, BDS *etc*. remaining unchanged, commissioning and ramp-up at the second-stage energy is considered to be faster. There is no explicit time for commissioning (probably unrealistic) but the first year of operation assumes 10% of the peak integrated luminosity, and thereafter 50% and 100% for years 2 and 3. The assumption here is that the commissioning of the new linac will be rather straightforward, allowing luminosity operation already within the first 12 months of operation (optimistic).
- In the case where there is an intermediate step running at 350 GeV centre-of-mass, we assume no ramp up is necessary when moving to the maximum energy (500 GeV or 550 GeV). The assumption here is that the entire linac is run at the lower gradient for running at the top mass, and turning up the gradient to the maximum energy is straightforward (and instantaneous!). Again this is probably optimistic.
- The peak luminosities assumed are those given in the TDR:

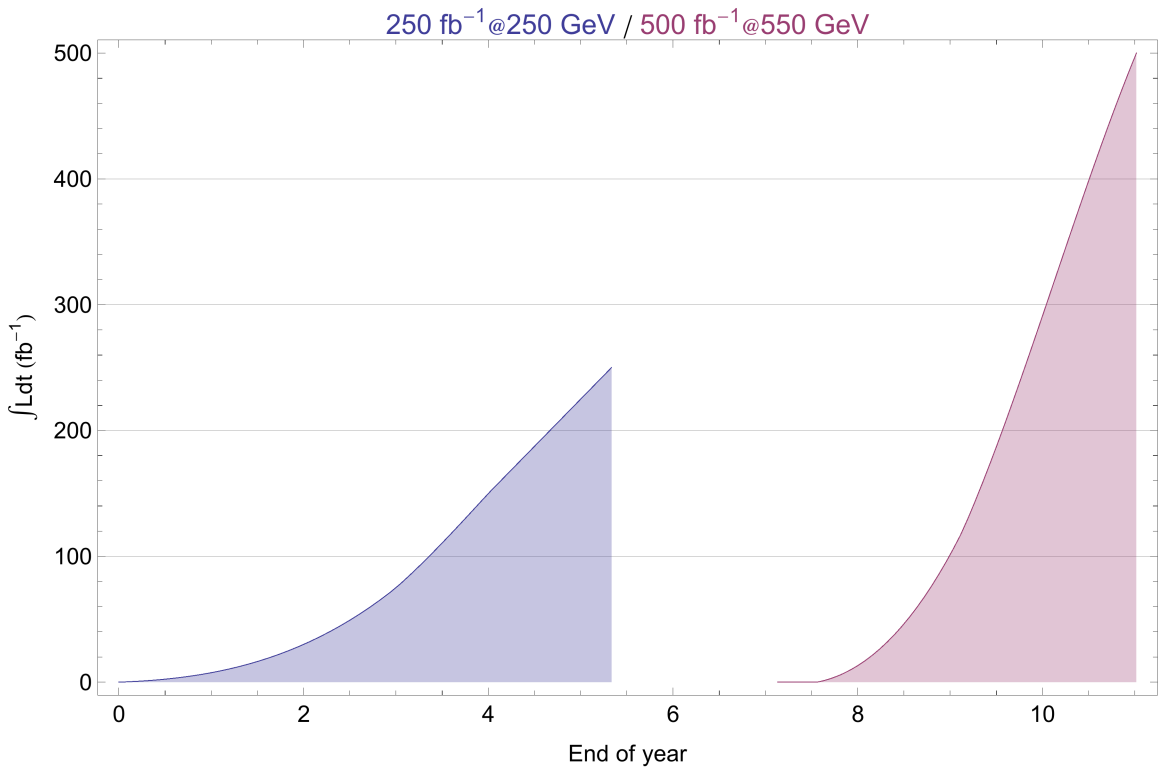
  250 GeV $0.75\times10^{34}\ \mathrm{cm}^{-2}\ s^{-1}$
  350 GeV $1.0\times10^{34}\ \mathrm{cm}^{-2}\ s^{-1}$
  500 GeV $1.8\times10^{34}\ \mathrm{cm}^{-2}\ s^{-1}$

  For 550 GeV ~$2.0\times10^{34}\ \mathrm{cm}^{-2}\ \mathrm{s}^{-1}$ is assumed (from gamma scaling).
- For scenarios (h) and (i) final operation at 250 GeV centre-of-mass is assumed to be at 10-Hz collisions (1/2 linac gradient), effectively doubling the TDR luminosity ($1.5\times10^{34}\ \mathrm{cm}^{-2}\ s^{-1}$). A ramp-up for 10-Hz operation (which affects all sub-systems) is assumed as 25%, 75%, 100% for the first three years of operation.
- A Snowmass year is assumed (10^7 seconds)

Scenario profiles

Out[166]=

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∫Ldt (fb^{-1})
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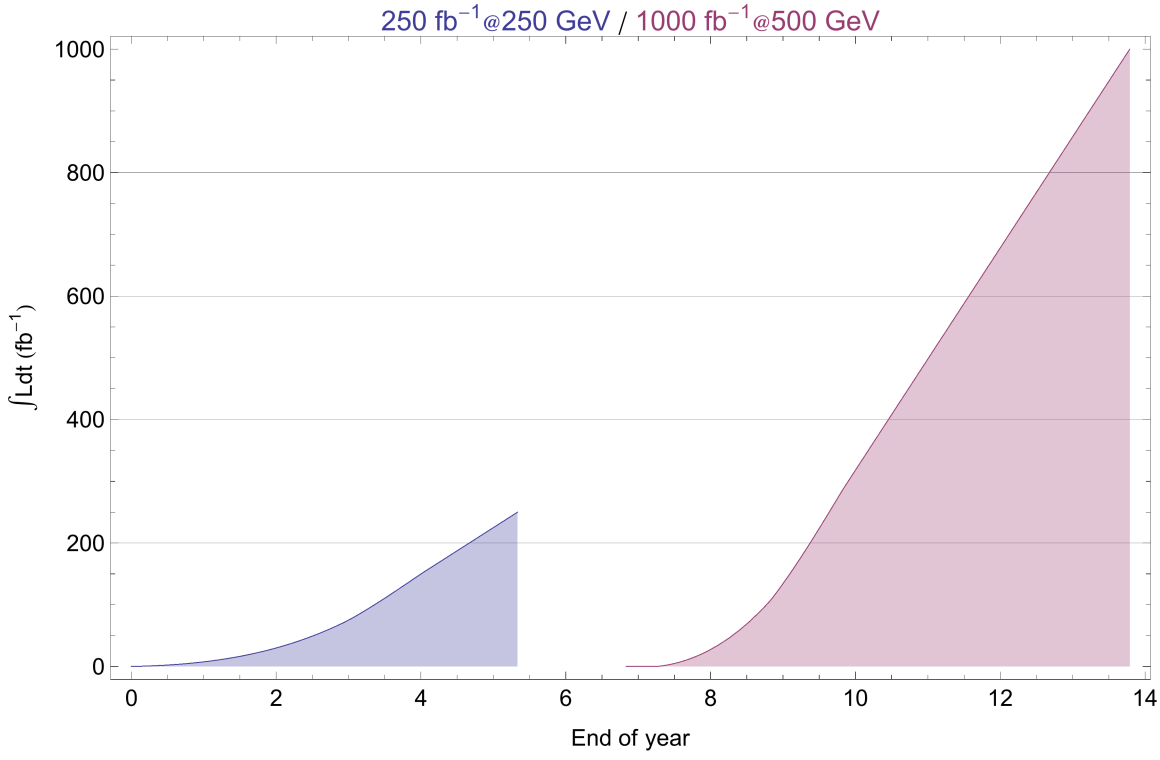
8
10
End of year


250 fb^{-1}@250 GeV / 1000 fb^{-1}@500 GeV
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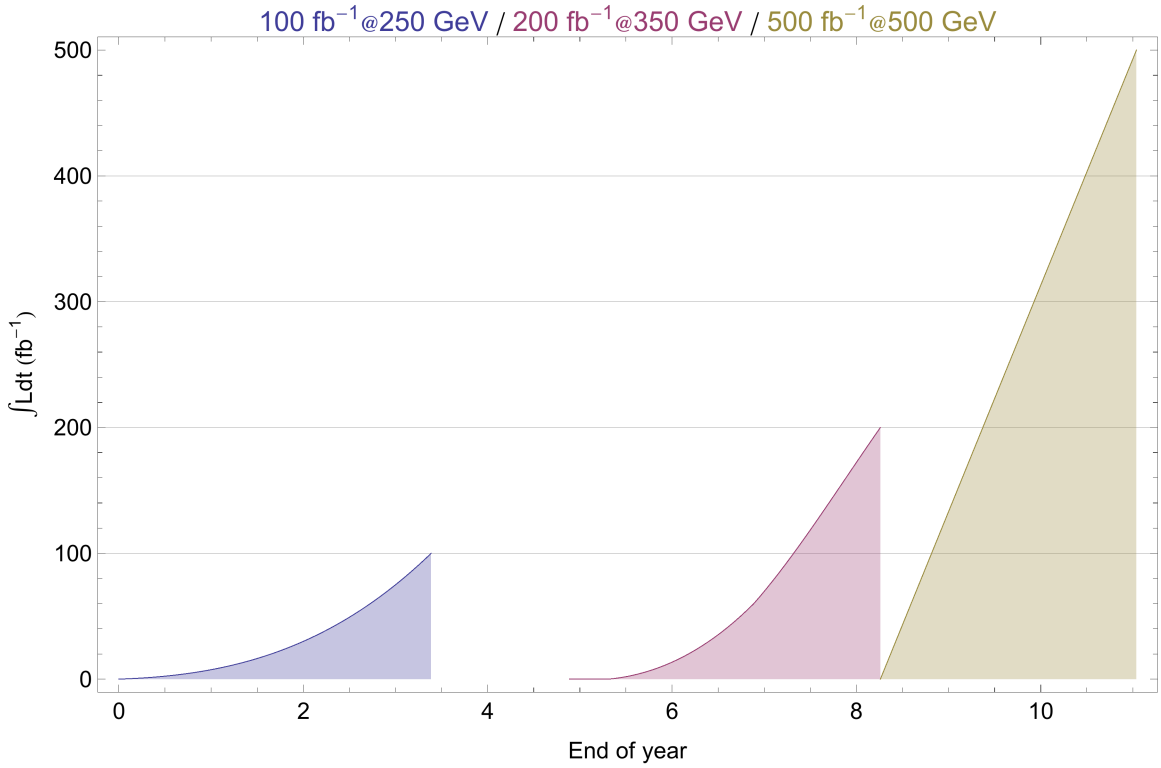
12
14
End of year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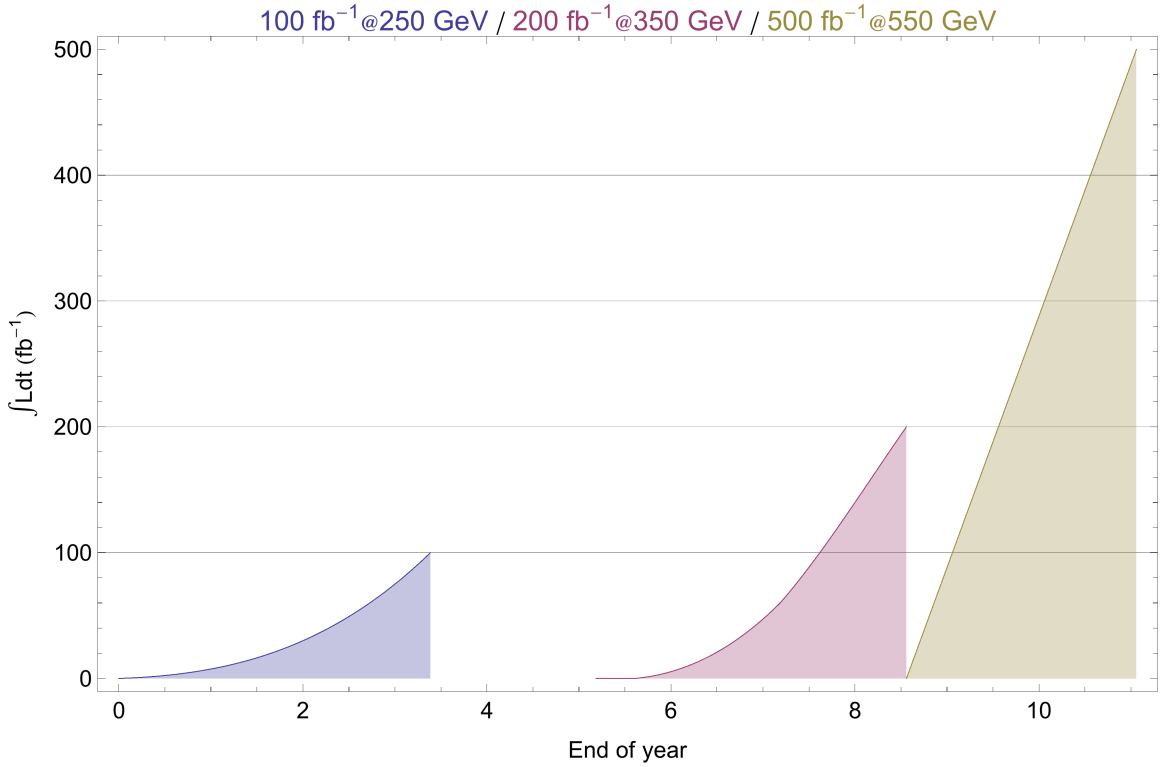
End of year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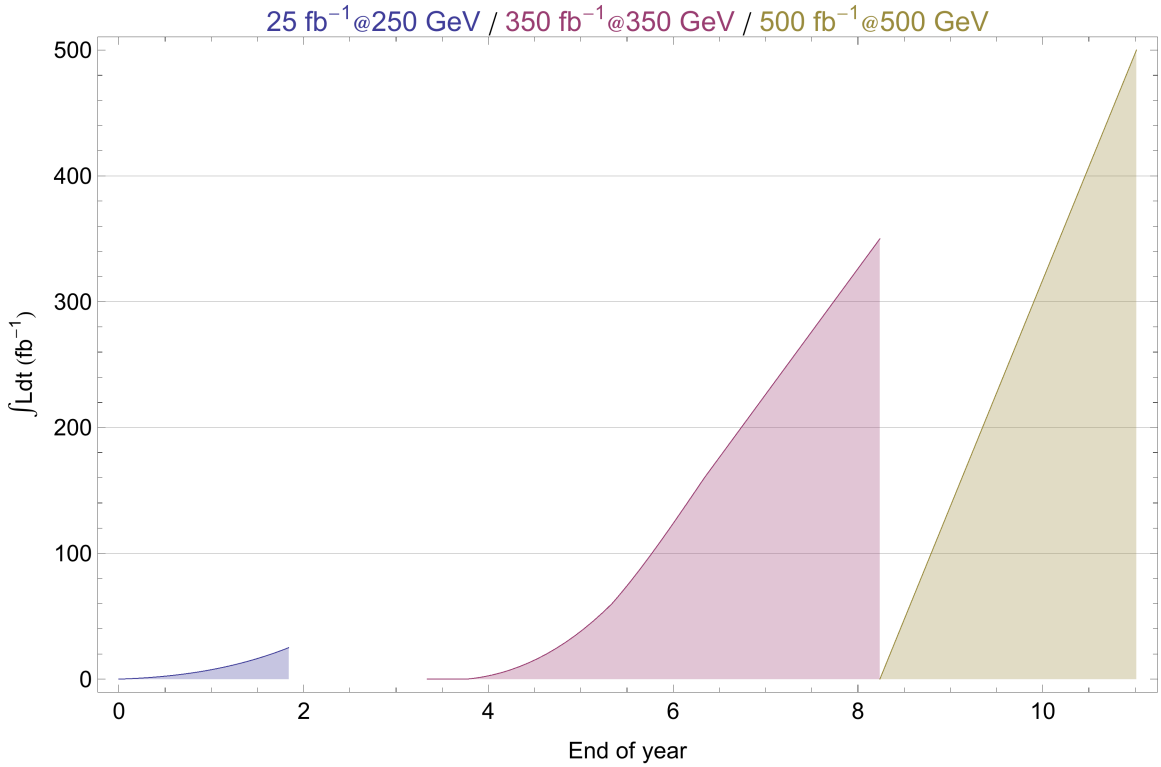
End of year


25 fb^{-1}@250 GeV / 350 fb^{-1}@350 GeV / 500 fb^{-1}@500 GeV
∫Ldt (fb^{-1})
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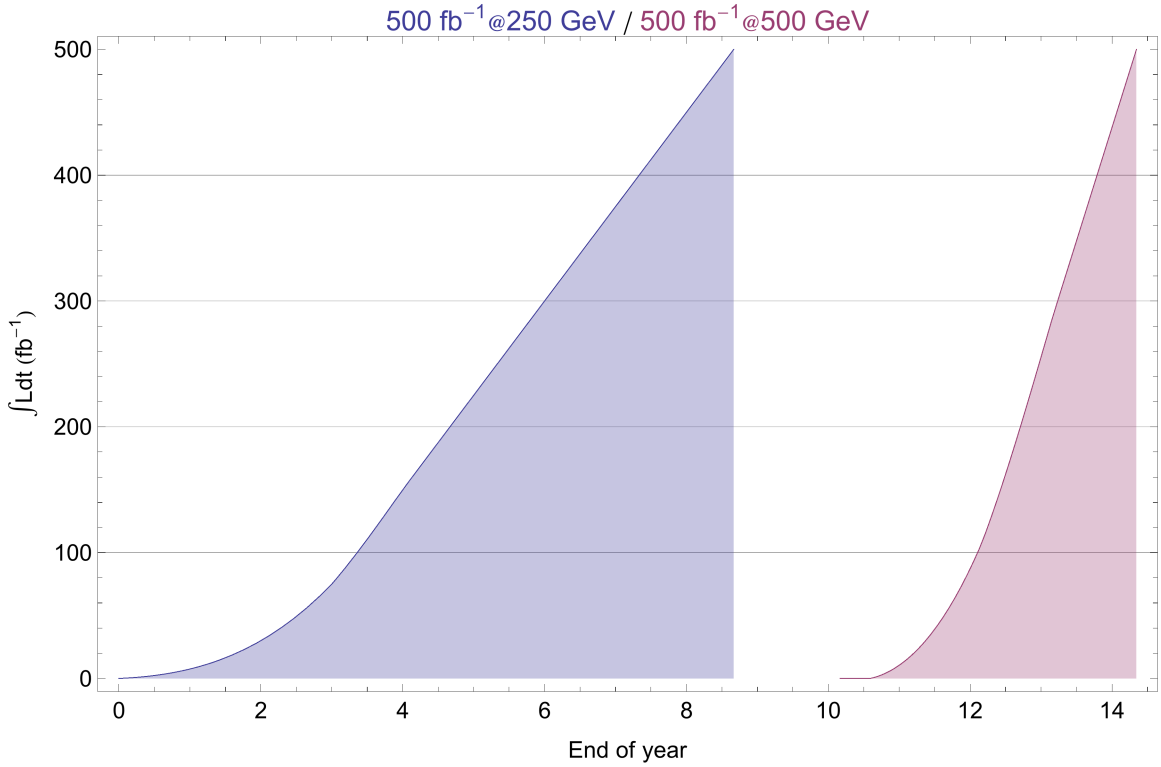
End of year


500 fb^{-1}@250 GeV / 500 fb^{-1}@500 GeV
∫Ldt (fb^{-1})
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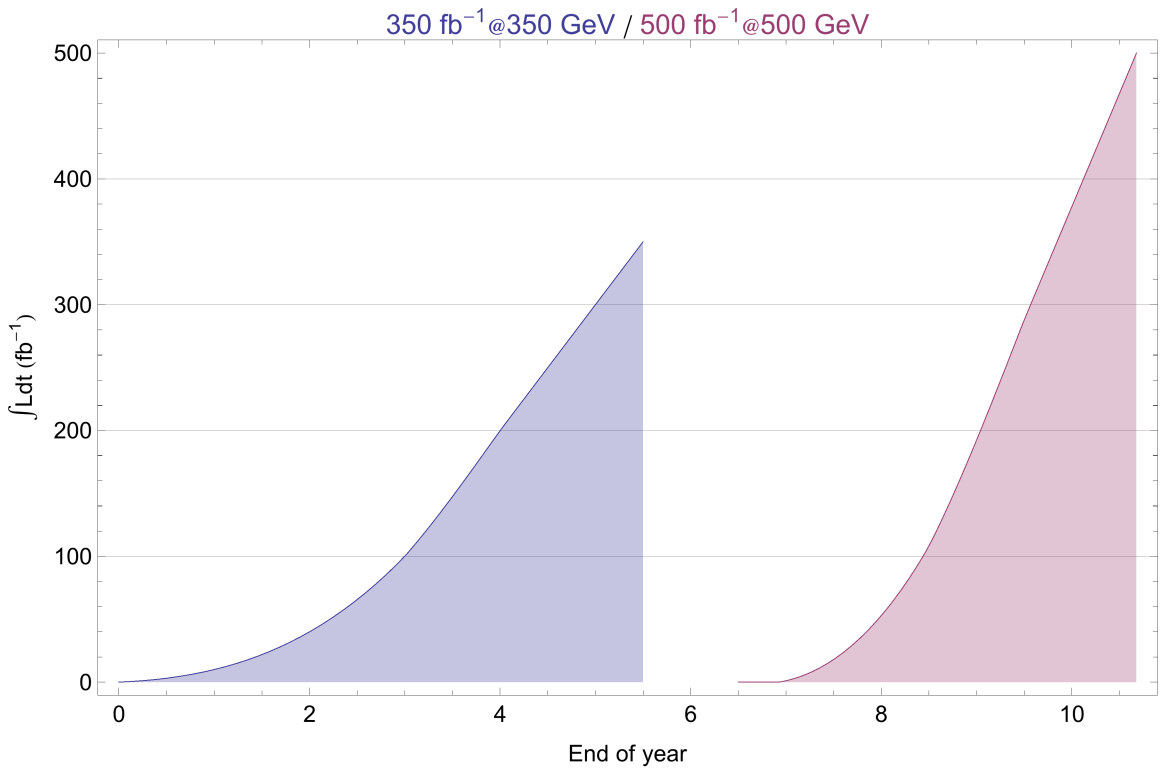
End of year


350 fb^{-1}@350 GeV / 500 fb^{-1}@500 GeV
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∫Ldt (fb^{-1})
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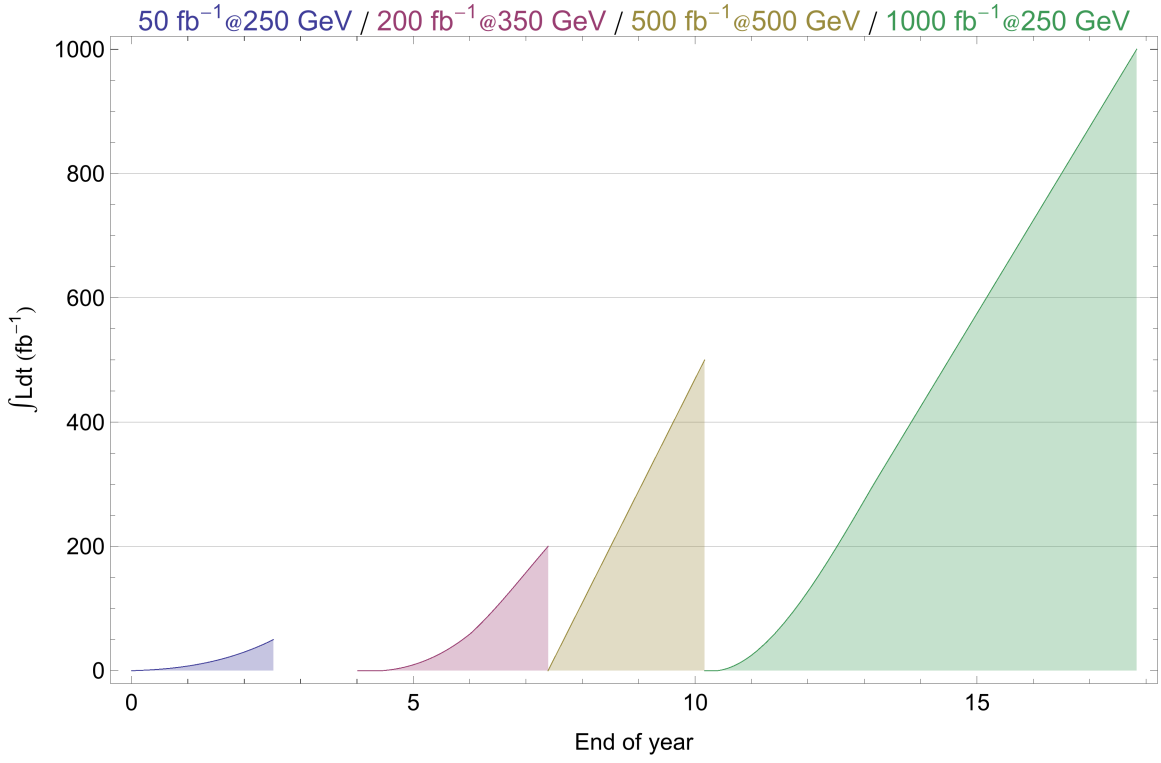
End of year


50 fb^{-1}@250 GeV / 200 fb^{-1}@350 GeV / 500 fb^{-1}@500 GeV / 1000 fb^{-1}@250 GeV
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∫Ldt (fb^{-1})
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5
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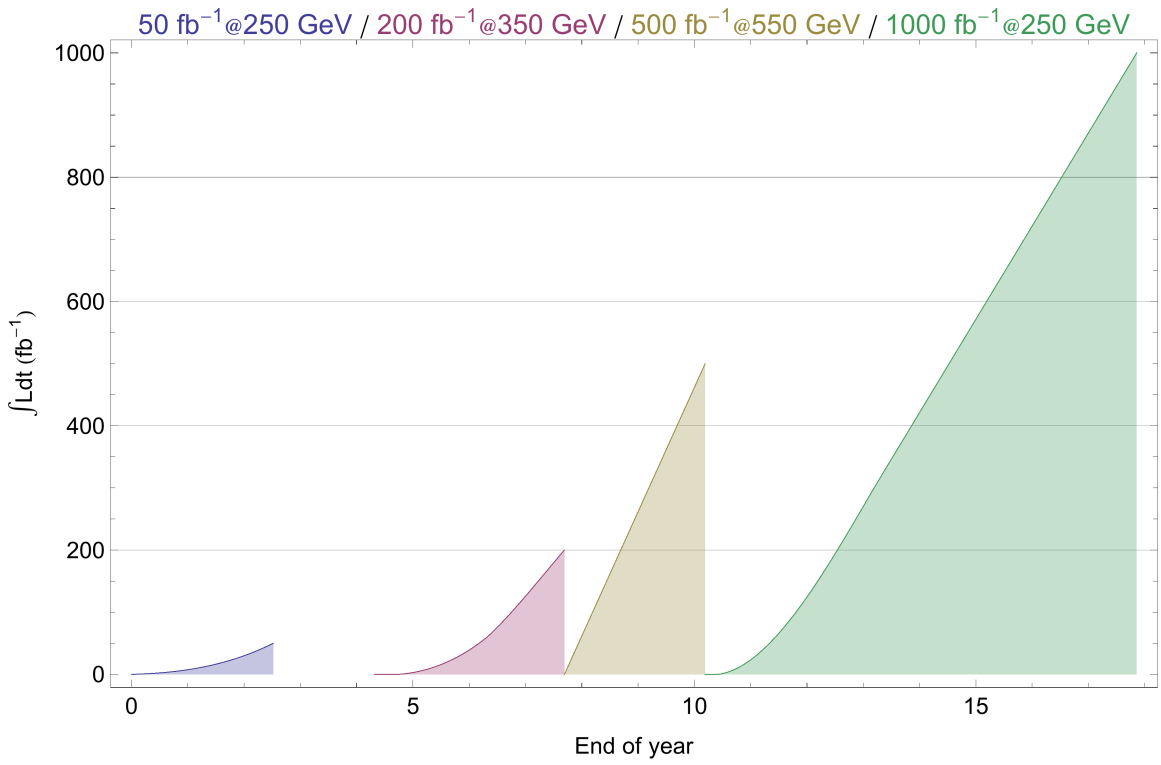
End of year


50 fb^{-1}@250 GeV / 200 fb^{-1}@350 GeV / 500 fb^{-1}@550 GeV / 1000 fb^{-1}@250 GeV
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∫Ldt (fb^{-1})
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5
10
15
End of year