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Impact of multiple beam-beam encounters on LHC absolute-luminosity calibrations by the van der Meer method

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The LHC particle-physics program requires that the delivered luminosity be measured to an absolute accuracy in the 1% range. To this effect, the absolute luminosity scale at each interaction point (IP) is calibrated by scanning the beams across each other according to the van der Meer method. During such scans, the orbit and the shape of the colliding bunches are significantly distorted by their mutual electromagnetic interaction; the resulting biases, if left uncorrected, would absorb a major fraction of the systematic-uncertainty budget on the luminosity calibration. The present report summarizes recent studies of such biases in the single-IP configuration, and generalizes it to the more typical case where bunches collide not only at the scanning IP, but also experience additional head-on encounters at up to 3 locations around the ring. Simulations carried out with the COherent-Multibunch Beam-beam Interaction multiparticle code (COMBI) are used to characterize the dependence of beam–beam-induced luminosity-calibration biases on the phase advance between IPs, and to derive scaling laws that relate the multi-IP case to the simpler and better understood single-IP configuration.

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Footnotes

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Yes

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