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Calibration of the luminosity measurement with the Van der Meer method in proton-proton collisions at the CMS experiment

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The luminosity measurement of the CMS experiment is calibrated under special beam conditions with beam separation scans called Van der Meer (VdM) scans. In a VdM scan, the two proton beams are separated transversely and moved in steps across each other. From the rate measurement of a luminosity detector as function of the transverse beam separation, the absolute luminosity scale is inferred and used to determine a calibration constant. The beam separation scale is calibrated with special length scale scans, and time-dependent variations are corrected for from measurements of beam position monitors. The rate measurement is normalized with the measured bunch currents. Electromagnetic interactions between the proton beams influence both the separation scale and the rate measurement. A bias occurs in the calibration procedure due to the assumption of factorizable bunch densities, and is corrected for using a reconstruction of the transverse bunch shapes from special beam-imaging scans.

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