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Limitations of radial magnetic field estimates from counter-rotating beams in an electro-static EDM ring

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Proposals to measure a possible Electric Dipole Moment (EDM) of protons in an electro-static machine are studied by a world-wide community. The machine is operated at the so-called magic energy to satisfy the "frozen spin" condition such that, without imperfections and the well-known magnetic moment of the particle, the spin is always oriented parallel or antiparallel to the direction of movement. The effect of a finite EDM is a build-up of a vertical spin component. A small average radial magnetic field leads as well to a build-up of a vertical spin component, which cannot be disentangled from the effect due to a finite EDM, and thus generates a systematic error of the measurement. Essential ingredients of the concept are to install the machine inside a state-of-the-art magnetic shielding and to measure the vertical orbit separation of two counter-rotating beams, enhanced by choosing a very low vertical tune, with high precision pick-ups. In this paper, we analyse limitations of this method and, in particular, the impact of wanted ("strong focusing" lattice) and unwanted variations of the betatron functions and of coupling.

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