SPIN TRACKING FOR A DEUTERON EDM STORAGE RING

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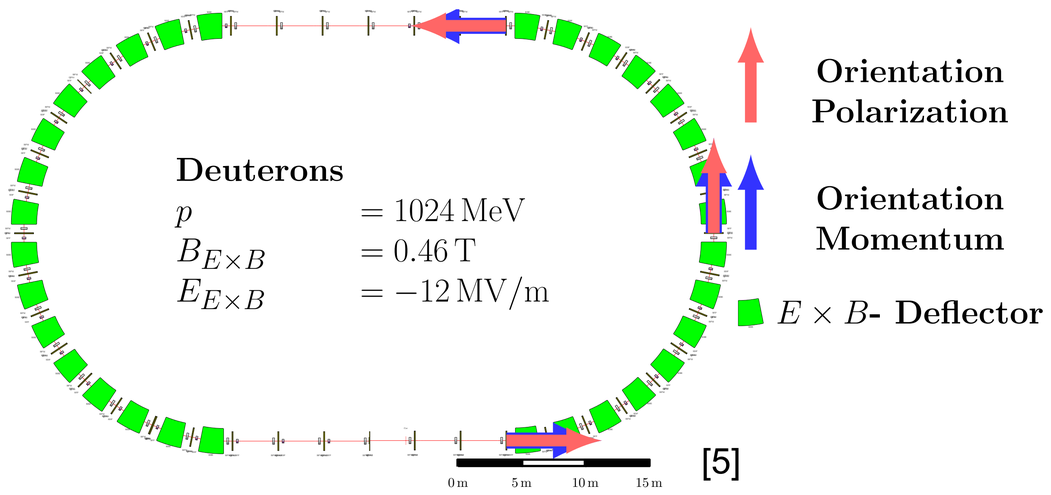
Motivation

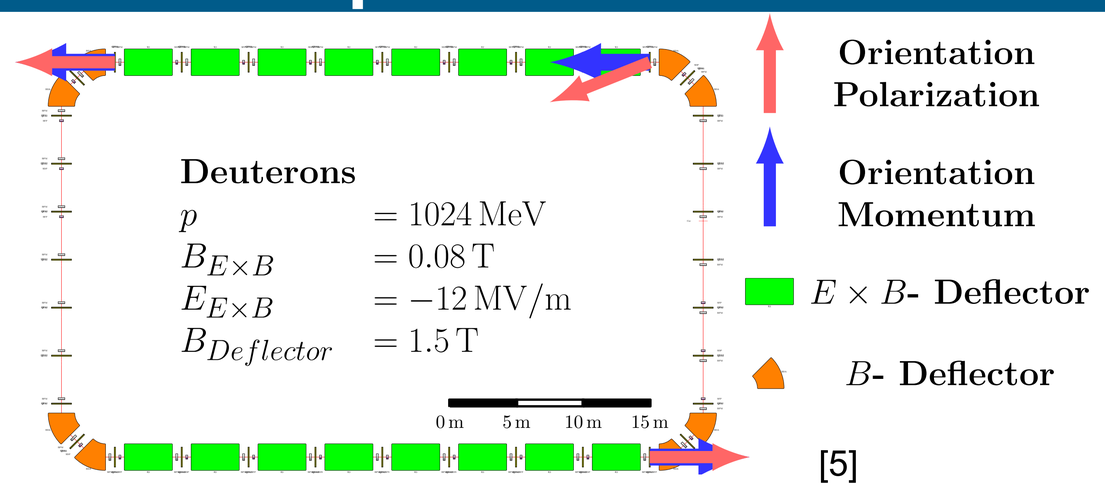
- The matter-antimatter asymmetry in our universe is an unsolved problem.
- The Sakharov conditions can explain this questions but more sources of CP violation are required [1].
- A nuclear Electric Dipole Moment (EDM) is a possible new source of CP violation[2].
- The EDM is very small and is proportional to the spin. This is also true for the Magnetic Dipole Moment (MDM).
- A measurement of the spin motion in an electromagnetic field delivers information about the EDM but the MDM will cover the effect of the EDM.
- The JEDI collaboration prepares a storage ring experiment to determine the EDM of deuterons[3,4].

Frozen Spin and Quasi Frozen Spin Methods



[5]

- A new storage ring is used as an experimental device itself.
- The Frozen Spin Method (FS) eliminates the spin motion caused by the MDM due a suitable choice of electric and magnetic fields.
- At the beginning of the experiment the momentum and polarization are aligned.



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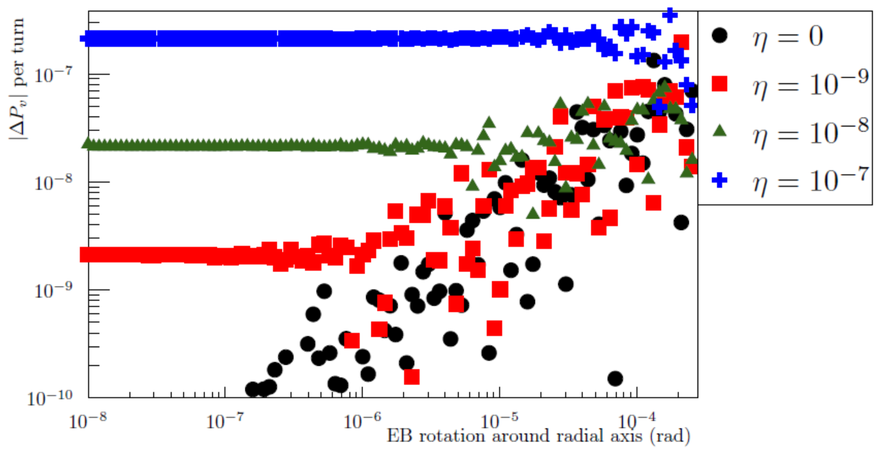
- An EDM is recognized by the vertical polarization build up.
- In the Quasi Frozen Spin Method (QFS) the polarization is only in average aligned to the momentum in the accelerator plane.
- The Quasi Frozen Spin Method avoid the use of curved E×B deflectors which are hard to construct with the desired quality.

Simulation Results

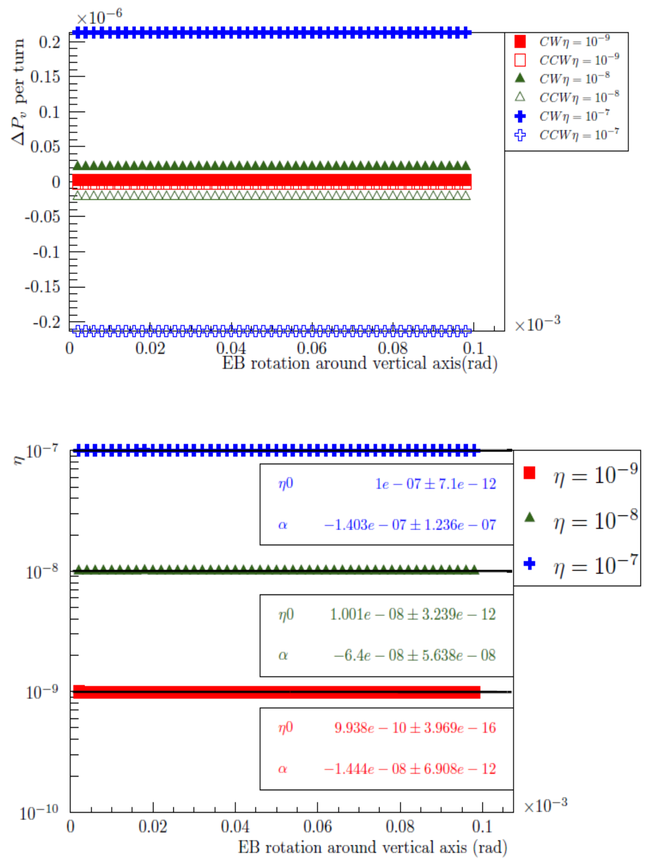
- Spin tracking is required to analyze the effect of misalignments on the spin motion.
- COSY Toolbox is used and expanded for theses simulations [6].



- The deuteron EDM is $|d| = \eta \cdot 5.3\ 10^{-15} e\ cm$.
- A possible nucleon EDM predicted by the SM would be smaller or equal than $10^{-31} e\ cm$ [7].
- Misalignments prohibit the measurement of an EDM [8].
- Without misalignments both, the FS and QFS lattice, are theoretically equivalent [8].

CW-CCW Beams

- The MDM and EDM behave differently regarding clockwise (CW) and counter clockwise (CCW) motion.
- If no misalignment disturbs the spin motion, the the polarization build up is opposite for CW and CCW.
- The CW-CCW method enables the determination of the deuteron EDM despite different misalignments [8].



Summary & Outlook

- An existing EDM could explain matter antimatter asymmetry in our universe.
- A deuteron storage ring experiment is planned by JEDI.
- Misalignments limits the precision of an EDM measurement.
- CW-CCW method enable EDM determination despite misalignments.
- 3D field maps are needed for more detailed analysis.

References

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