Spin-flipping within the Frequency Domain method of searching for particle electric dipole moment

A.E. Aksentyev,[1] A.A. Melnikov,
Y.V. Senichev, S.D. Kolokolchikov

Institute for Nuclear Research of RAS
[1] also at NRNU "MEPhI"

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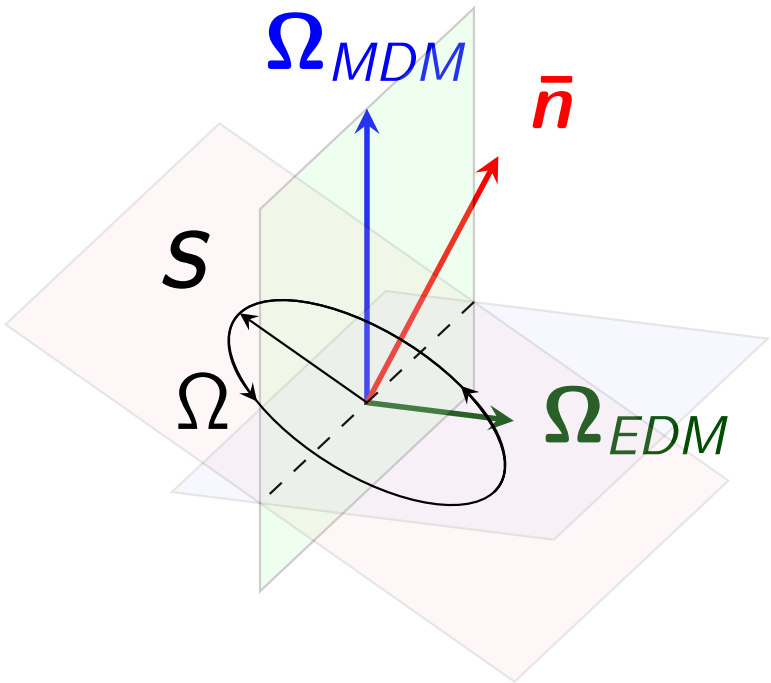
Frequency-based measurement of EDM

The present investigation is part of a research dedicated to the development of a method to search for particle EDM (electric dipole moment) in an existing storage ring.

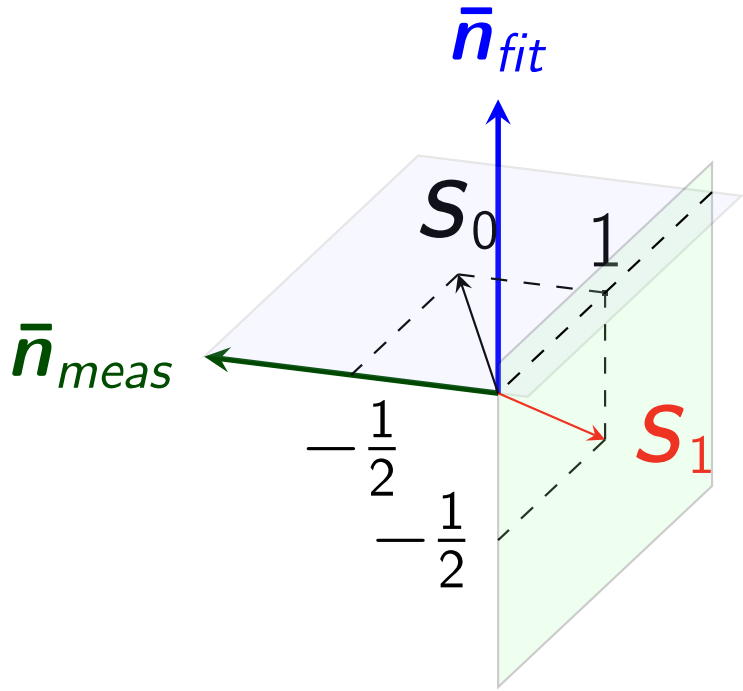
Nearing the Frozen-Spin state in a perfectly-aligned machine.



Frequency-based measurement of EDM

The method involves a **flipping** of the beam's polarization axis in order to homogenize the consecutive beam injections with respect to the spin-motion determining factor, the effective Lorentz-factor.

This because EDM is not present (in the 1st order) in the horizontal plane



Investigation

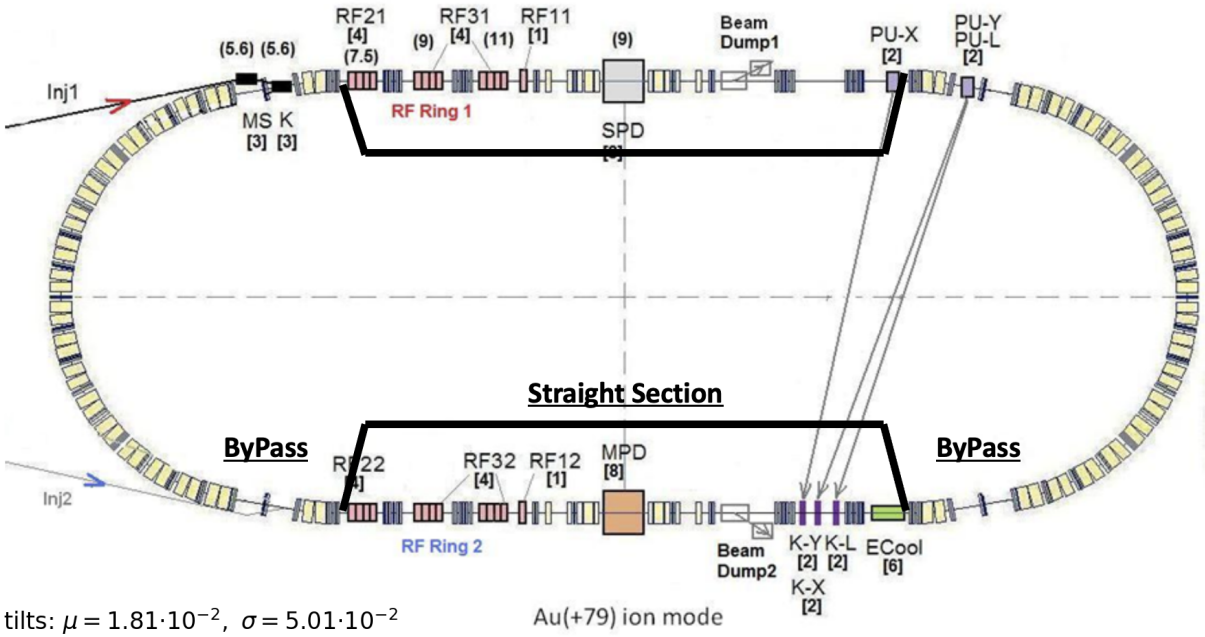
Problem statement

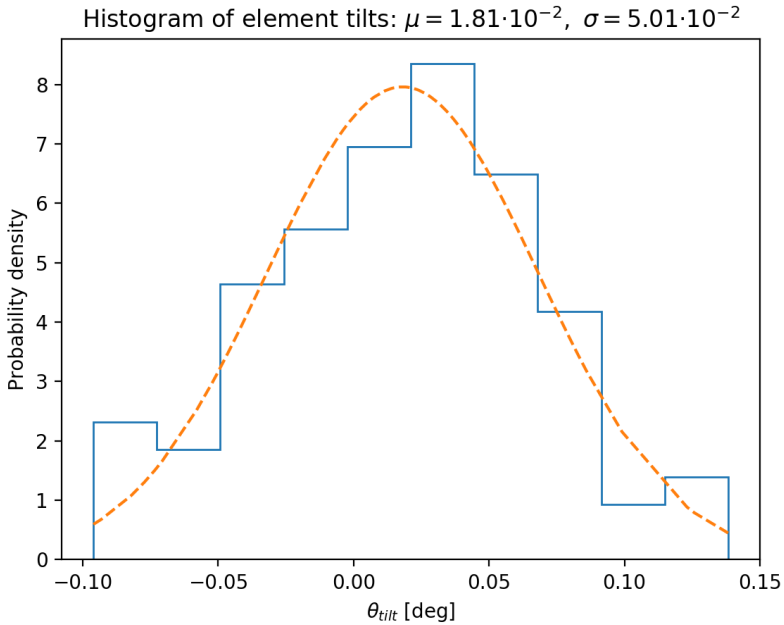
Generally, spin-flipping is done adiabatically in order to preserve the polarization; but ours is not the case.

Task

Hence we try to get a sense of and a measure for the methodologically-required rapidity of spin-flipping.

Investigated lattice

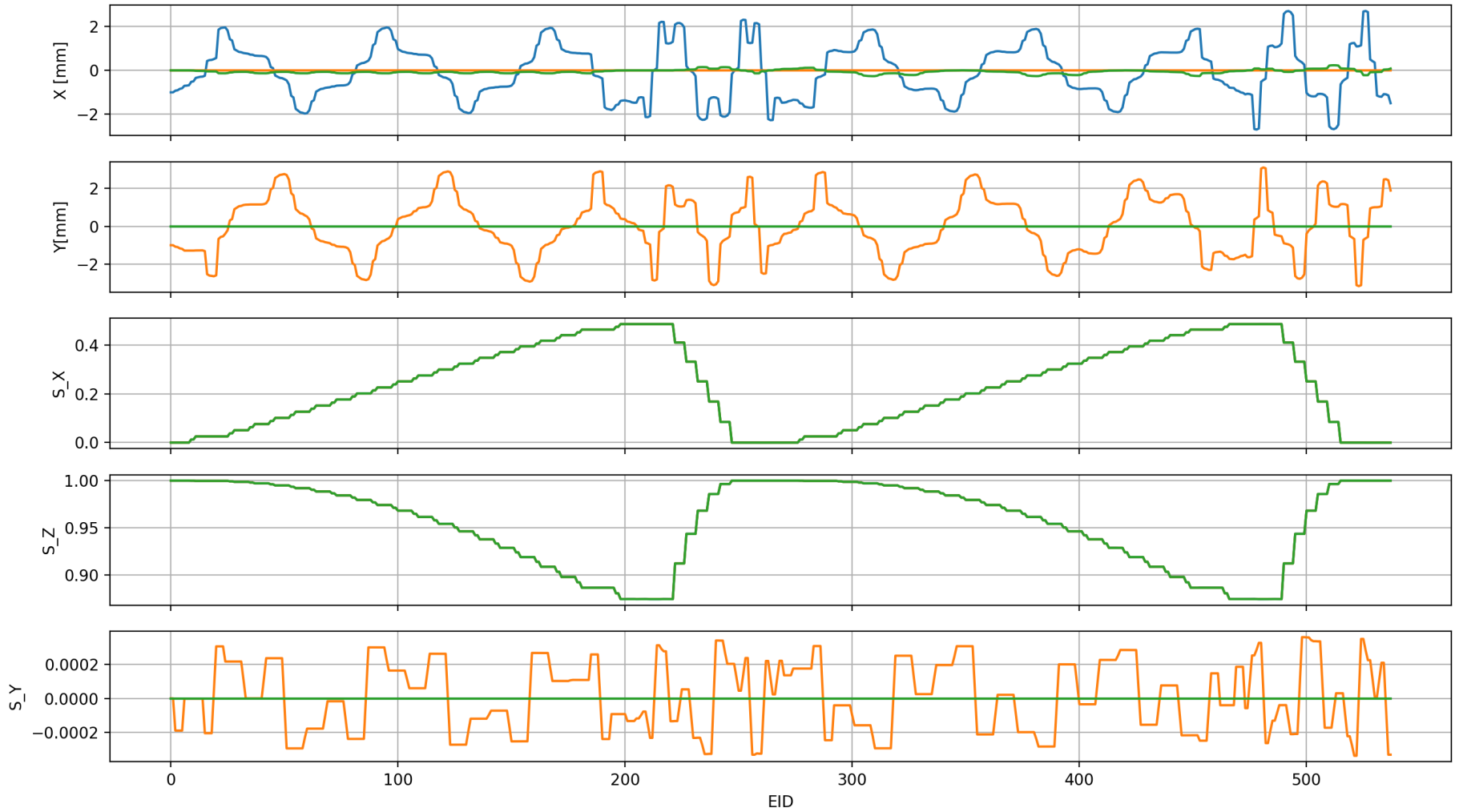




- two sextuple families reduce **spin-decoherence**
- WFs in ByPass for (quasi-)**frozen spin**
- radial spin-kicks model lattice **imperfections**

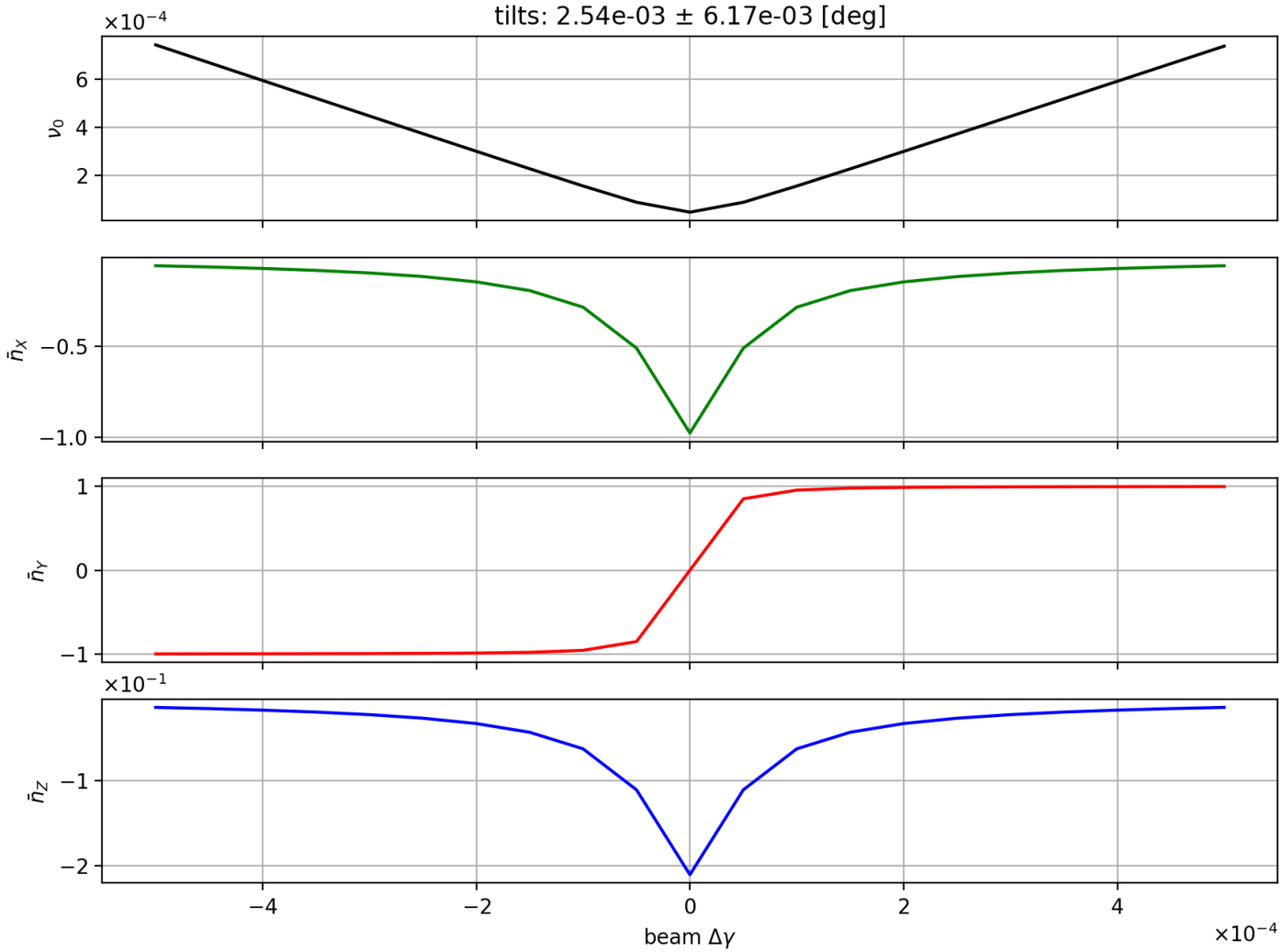
Quasi-Frozen Spin-

-tracking



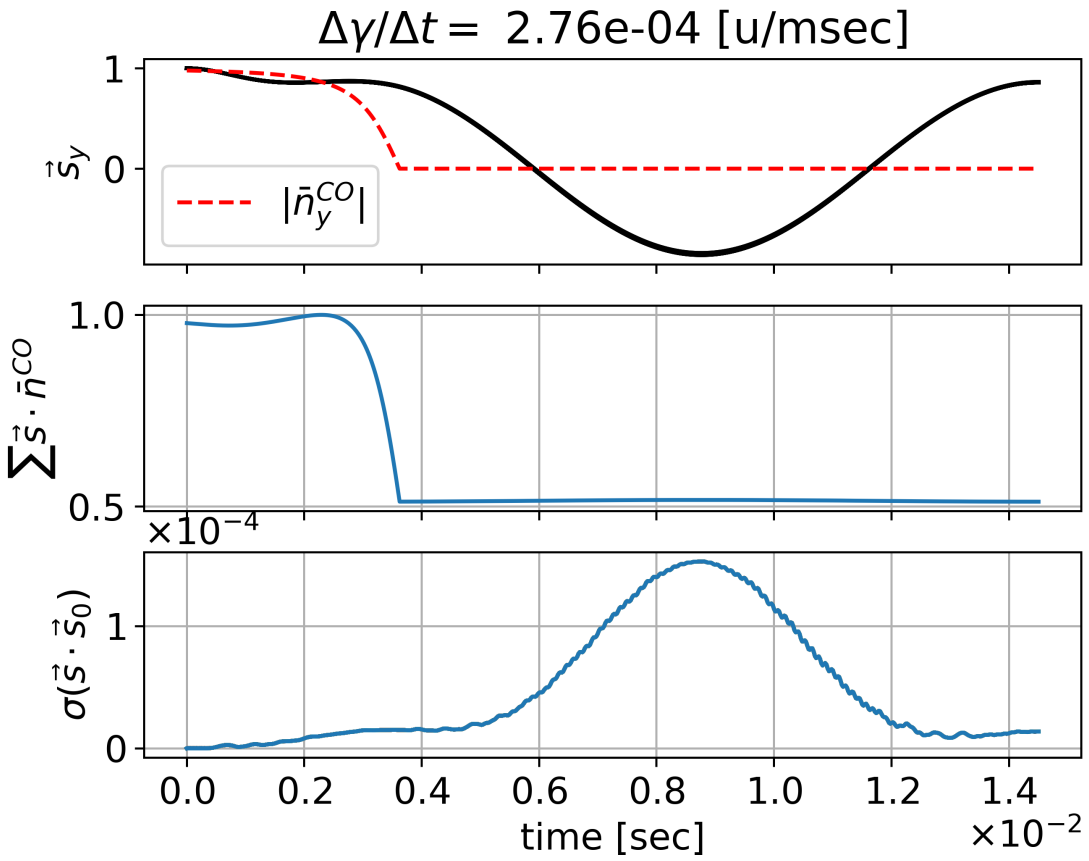
Spin-axis flipping

when approaching QFS-energy (240 MeV)



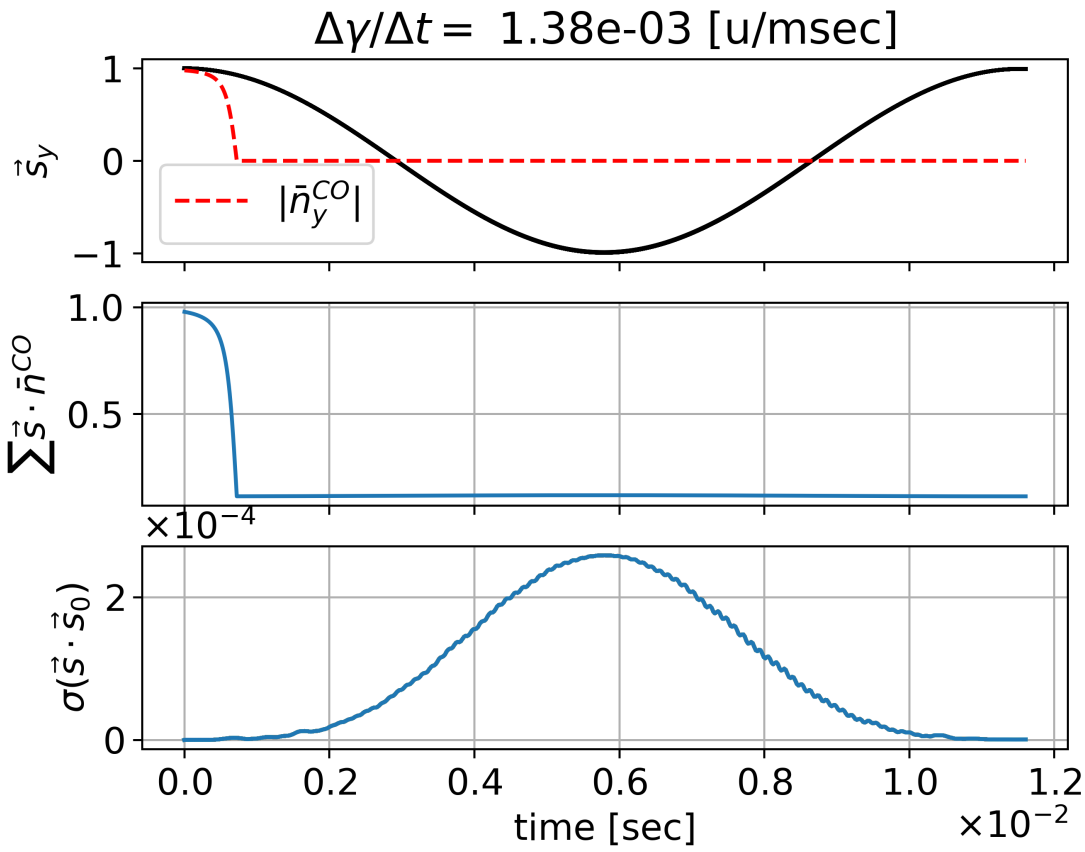
Axis-directing B-field $B^{guide} \rightarrow B^{tilt} \Rightarrow$ spin-axis flips into the ring plane (x-z).

"Slow" flipping



- beam energy variation rate $\Delta\gamma = 1 \cdot 10^{-6}$/turn ($\approx 2$ keV/turn);
- polarization $P = \frac{1}{N}\sum_i^N (\boldsymbol{s}_i, \bar{n}^{CO})$ drops by 50%;
- **if need to preserve P, then** axis flipping **should be *even slower*. BUT**

Fast(er) one



- max EDM-signal appears at $\boldsymbol{P} \perp \bar{n}$;
- $\Rightarrow$ energy should be approached *as quickly as possible*;
- $\Delta\gamma = 5 \cdot 10^{-6}$/turn ($\approx 9.5$ keV/turn) $\rightarrow P$ drops to 11%;
- but spin-decoherence is **commensurate** with that of the previous case.

Conclusion

- **Modeled** spin-flipping in a Quasi-Frozen ring lattice;
- **Estimated** a preliminary measure of the *methodologically*-required rapidity;
- **Confirmed** that adiabaticity-violation doesn't essentially affect spin-coherence.

Thank You!