Beamtime at COSY - July 2023

Short report

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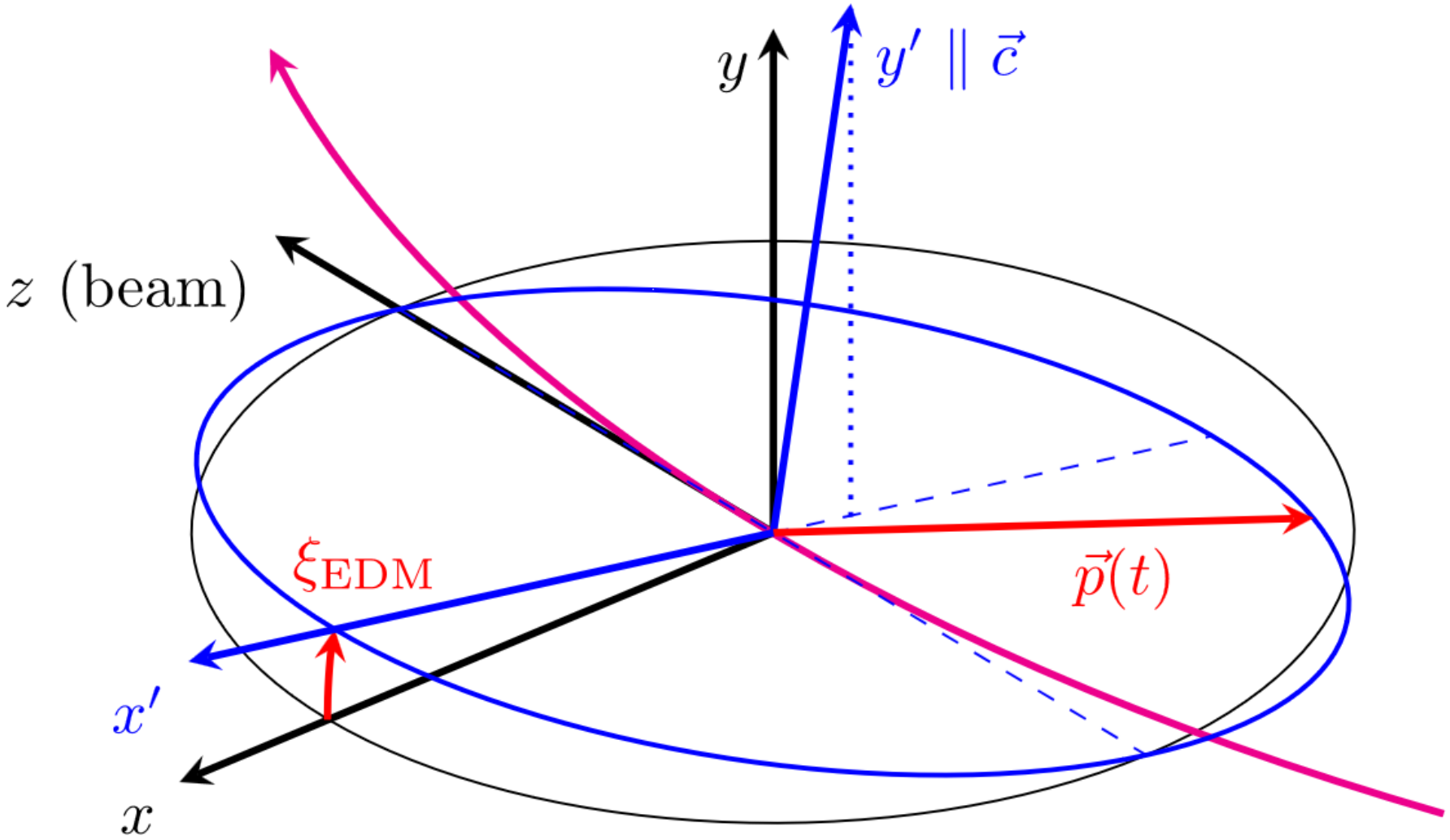
Regular Group Meeting
July 20, 2023

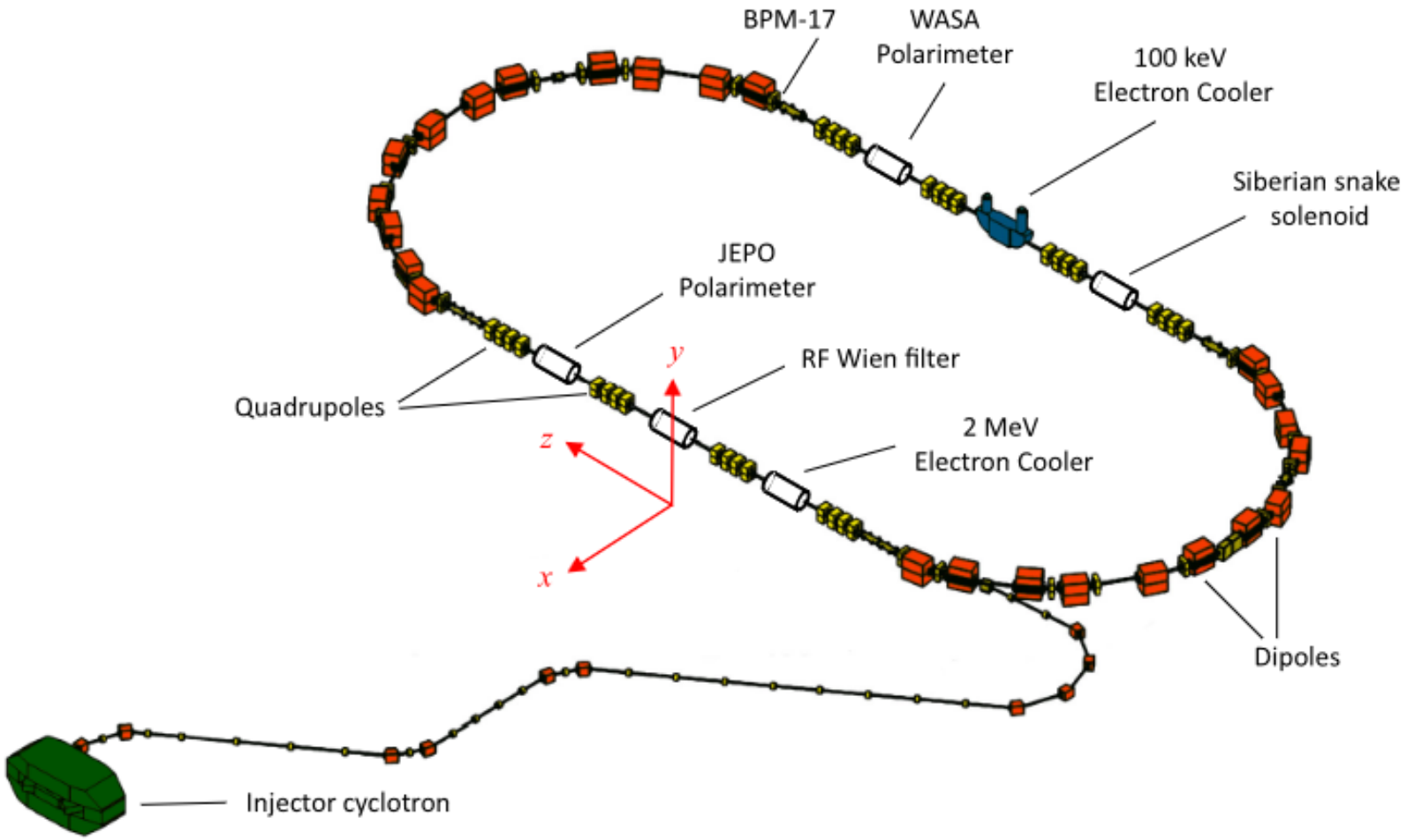
Introduction



Open questions

- systematic studies to find the reason for the large tilts of the invariant spin axis compared to simulations
- orbit studies: measuring the orbit response from different steerer settings and at different dipole settings (at injection energy and at 970 MeV/c)
- natural chromaticity
- beam based alignment of the 2MV solenoid
- orientation of the Wien filter field axis relative to the betatune planes

COSY

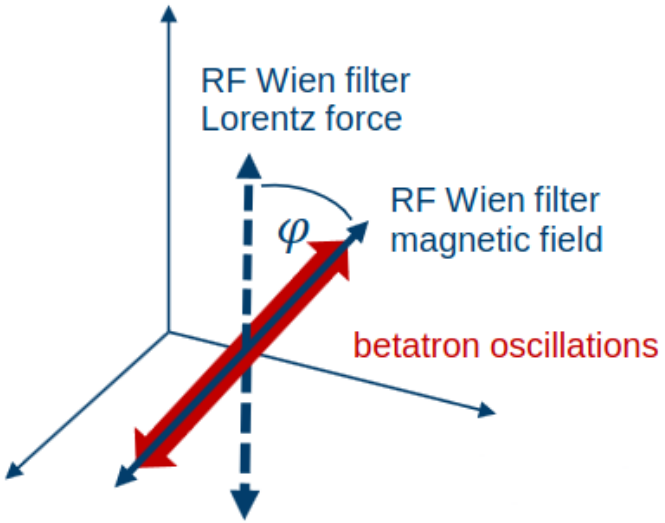

BPM-17
WASA
Polarimeter
100 keV
Electron Cooler
Siberian snake
solenoid
JEPO
Polarimeter
RF Wien filter
Quadrupoles
y
z
x
2 MeV
Electron Cooler
Dipoles
Injector cyclotron

Beam based alignment

- Goal: checking the alignment 2MV solenoid used in the data-taking experiment
- the optimal beam path through the solenoid was found. It was with a vertical bump of 13mm and an angle of 2.4 mrad
- no bump or angle in horizontal direction

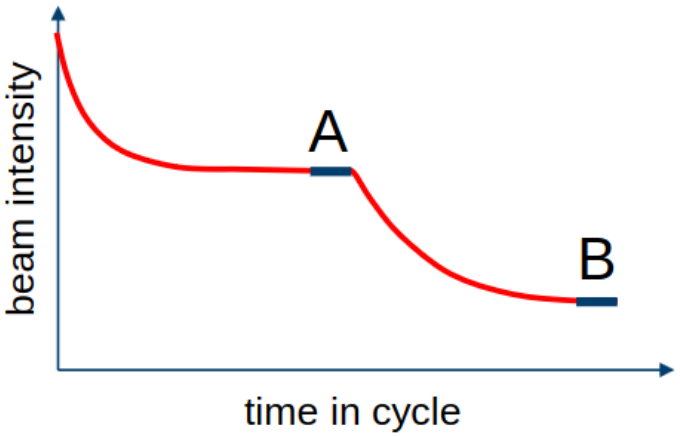
Wien filter studies

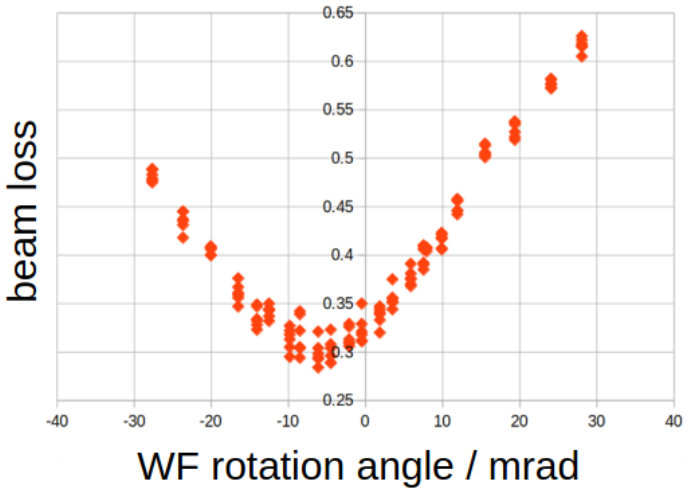
- run the Wien filter at a betatron resonance in Qx or Qy
- operate the Wien filter in mismatched mode
- beam excitation (and, thus, beam loss) should be minimal when the Lorentz force is perpendiculat to the Qx (Qy) plane
- initial assumption: in the surverys all magnets where aligned with < 1 mrad, so the planes of the betatron oscillations should coincide with the COSY plane with similar accuracy



Wien filter studies

- we set the Wien filter B field perpendicular to the betatron plane





- horizontal plane: minimum around $-6 mrad$
- vertical plane: minimum around 42 mrad (e.g. about 2.5 degree, which is nowhere close to any uncertainty we assumed)

Publications

Draft for PRL July 3, 2023

Pilot bunch and co-magnetometry of polarized particles stored in a ring

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(Dated: for the Editorial Team, to be submitted to PRL on behalf of JEDI)

In polarization experiments at storage rings, one of the challenges is to maintain the spin-resonance condition of a radio-frequency spin rotator with the spin-precessions of the orbiting particles. Time-dependent variations of the magnetic fields of ring elements lead to unwanted variations of the spin precession frequency. We report here on a solution to this problem by shielding (or masking) one of the bunches stored in the ring from the high-frequency fields of the spin rotator, so that the masked *pilot* bunch acts as a co-magnetometer for the other *signal* bunch, tracking fluctuations in the ring on a time scale of about one second. While the new method was developed primarily for searches of electric dipole moments of charged particles, it may have far-reaching implications for future spin physics facilities, such as the EIC and NICA.

Publications

Draft for PRAB July 3, 2023

Spin decoherence and off-resonance behavior of radiofrequency-driven spin rotations in storage rings

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(Dated: for the Editorial Team, to be submitted to PRAB)

Radiofrequency-driven resonant spin rotators are routinely used as standard instruments in polarization experiments in particle and nuclear physics. Maintaining the continuous exact parametric spin-resonance condition of the equality of the spin rotator and the spin precession frequency during operation constitutes one of the challenges. We present a detailed analytic description of the impact of detuning the exact spin resonance on the vertical and the in-plane precessing components of the polarization. An important part of the formalism presented here is the consideration of experimentally relevant spin-decoherence effects. We discuss applications of the developed formalism to the interpretation of the experimental data on the novel pilot bunch approach to control the spin-resonance condition during the operation of the radiofrequency-driven Wien filter that is used as a spin rotator in the first direct deuteron electric dipole moment measurement at COSY. We emphasize the potential importance of the hitherto unexplored phase of the envelope of the horizontal polarization as an indicator of the stability of the radiofrequency-driven spin rotations in storage rings. The work presented here serves as a satellite publication to the work published concurrently on the proof of principle experiment about the so-called pilot bunch approach that was developed to provide co-magnetometry for the deuteron electric dipole moment experiment at COSY.

Publications

PHYSICAL REVIEW X **13,** 031004 (2023)

First Search for Axionlike Particles in a Storage Ring Using a Polarized Deuteron Beam

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(JEDI Collaboration)