EuCARD-2 XPOL workshop on “Polarization Issues in Future High Energy Circular Colliders”

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Book of Abstracts

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A Monte Carlo Simulation of the Equilibrium Beam Polarization At Ultra-High Energy Electron (Positron) Storage Rings

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With the recently emerging global interest in building a next generation of circular electron–positron colliders to study the properties of the Higgs boson, and other important topics in particle physics at ultra-high beam energies, it is also important to pursue the possibility of implementing polarized beams at this energy scale. It is therefore necessary to set up simulation tools to evaluate the beam polarization at these ultra-high beam energies. In this paper, a Monte-Carlo simulation of the equilibrium beam polarization based on the Polymorphic Tracking Code (PTC) (Forest et al., 2002) is described. The simulations are for a model storage ring with parameters similar to those of proposed circular colliders in this energy range, and they are compared with the suggestion (Derbenev et al., 1979) that there are different regimes for the spin dynamics underlying the polarization of a beam in the presence of synchrotron radiation at ultra-high beam energies. In particular, it has been suggested that the so-called “correlated” crossing of spin resonances during synchrotron oscillations at current energies evolves into “uncorrelated” crossing of spin resonances at ultra-high energies.

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Acceleration of polarized beams in a booster synchrotron of FCC-ee

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Compton polarimetry at storage rings

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- functional principle
- measurement of the integral asymmetry or the shift of the center of the photon distribution
- analyzing power for both methods
- achievable resolution, requirements on the detector
- photon detection using a counting silicon strip detector
- first results

Summary:

Using the electron stretcher accelerator ELSA as an example, the method of Compton polarimetry will be explained. It is based on Compton backscattering of circularly polarized laser light off the longitudinally or transversely polarized revolving electrons. Two methods for detecting the backscattered photons will be presented: measurement of the integral asymmetry and measurement of the shift of the center of the photon intensity distribution when changing the helicity of the laser beam. Whereas the analyzing

power of the first method is strongly sensitive on width and divergence of the electron beam, the second one is almost independent of the beam parameters. The requirements on the detector, depending on the envisaged measurement precision, will be discussed. A novel method for photon detection, using a counting silicon strip detector, will be presented. First results obtained at ELSA will be presented and compared with a possible employment at future storage rings.

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LEP Polarization Experience

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Multi turn ERL’s - a new instrument for high energy spin physics

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Several multi turn ERL facilities are under construction or are in the design phase. These upcoming small scale machines can be considered as forerunners for spin-polarized electron - nucleon colliders. The ERL designs for Cornell , CERN and Mainz/MESA are introduced and the extrapolation to future large scale colliders will be discussed.

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Overview of polarized electron and positron sources

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After a recall on the methods to produce polarized electron beams and polarized positron beams, an overview is given about the performance of lepton sources in the world oriented towards high energy colliders. The experience gained by the 2 major colliders (SLC and LEP) is compared to the requirements for future high energy colliders and challenges are pointed out.

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Performance of a HERMES Polarised Internal Target in the LHC (and) FCC

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The presentation will address the potentialities and technical requirements related to the introduction of a polarised internal target a-la HERMES (DESY) in the LHC and FCC rings.

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Polarization prospects for the hadron collider

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Polarization study for CEPC

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Polarization wigglers for FCC-ee (TLEP) and lessons from LEP

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Prospects for polarization at FCC-ee

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The use of resonant depolarization has been suggested for precise beam energy measurements in the FCC-ee for Z and WW physics at 90 and 160 GeV CM energy respectively. In addition longitudinal beam polarization would benefit the Z peak physics program.
The large time constant of self-polarization (Sokolov-Ternov effect) in such a large ring can be greatly reduced by inserting proper wigglers in the machine lattice. The resulting large beam energy spread however may destroy polarization in presence of unavoidable magnet misalignments. This calls for precise machine alignment and careful orbit correction.
In this paper the possibility of self-polarization in the FCC-ee at 45 and 80 GeV beam energy in presence of wigglers is investigated. Simulations with quadrupole misalignment and orbit correction are presented.

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Resonant polarimetry: a new way to non-invasive fast measurement of beam polarization?

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- functional principle
- relativistic Stern-Gerlach force
- analytical formulas for the analyzing power using pill-box cavities
- expected signal power
- layout of a pop experiment and further applications

Summary:

In principle, resonant cavities can be excited by magnetic moments of a polarized beam, thus allowing to determine the beam’s polarization by measuring the amplitude of the resonating cavity’s fields. The steady state field amplitude can be determined by calculating the energy transfer from the beam to the resonator’s fields. Analytic formulas for different cavity modes are obtained by integrating over the longitudinal relativistic Stern-Gerlach force. It is shown that in case of ultra-relativistic electrons the signal for transverse polarization is independent of beam energy whereas the signal for longitudinal polarization scales with 1/gamma. The expected signal power is derived for different cavity modes and compared with thermal noise and background by cavity excitation due to charge interaction. A possible layout for first prove-of-principle experiments at CEBAF/JLAB and ELSA/Bonn is presented and a possible employment at future storage rings is illustrated.