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Polarization of a stored beam by spin-filtering

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Polarized antiprotons allow unique access to a number of fundamental physics observables. Amongst others, the transversity distribution of the valence quarks in the proton would be directly measurable in an unique way through Drell-Yan events generated in double polarized proton-antiproton annihilation [1]. The transversity is the most elusive leading order spin-distribution function of the nucleon. This and a multitude of other findings, which are accessible via $\vec{p}\vec{p}$(bar) scattering experiments, led the Polarized Antiproton eXperiments (PAX) collaboration to propose such investigations at the High Energy Storage Ring (HESR) of the Facility for Antiproton and Ion Research (FAIR).
Although a number of methods to provide polarized antiproton beams have been proposed more than 20 years ago [2] and recently reviewed [3], no polarized antiproton beams have been produced so far, with the exception of a low-intensity and low quality, secondary beam from the decay of anti-hyperons that has been realized at Fermilab [4]. Therefore the PAX collaboration is developing a dedicated program to produce a beam of polarized antiprotons.
An initially unpolarized beam of spin-$\frac{1}{2}$ particles in a storage ring can be polarized either by the spin-flipping method or the spin-filtering method. Spin flipping, which is based on the selective reversal of the spin of particles in one spin state, has the advantage of polarizing the beam without affecting its intensity. However, a previous experiment at COSY by the PAX Collaboration invalidates this technique to polarize a stored antiproton beam by means of the interaction with a co-moving polarized positron beam [5]. Spin filtering can be described as a spin-selective attenuation of the particles circulating in a storage ring [6]. The beam becomes increasingly polarized by repeated interaction with a nuclear polarized internal gas target.
In 2011 the PAX Collaboration has performed a successful spin-filtering test using protons at $T_p = 49.3\,\mathrm{MeV}$ at the COSY ring, which confirms that spin filtering is a viable method to polarize a stored beam and that the present interpretation of the mechanism in terms of the proton-proton interaction is correct. The equipment and procedures to produce stored polarized beams was successfully commissioned and are established. Prior to the presented test, this method was only once shown to work in an experiment performed by the FILTEX group at the TSR ring in Heidelberg in 1992 [7], which exploited spin-filtering on a 23-MeV stored proton beam, in the presence of a polarized atomic hydrogen target.
The results of the spin-filtering experiment at COSY, which is of utmost importance in view of the possible application of the method to polarize a beam of stored antiprotons, will be presented.

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