An investigation of strained InGaAsP photocathode properties with the Polarized Electron Source at NIKHEF

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A description is given of the Mott polarimeter, which is part of the Polarized Electron Source (PES)[1] used at the Amsterdam Pulse Stretcher (AmPS) storage ring. The Mott polarimeter contains four gold foils (gold film on Mylar foils) with thicknesses 18, 37, 60, and 100 nm, mounted on a remotely controllable rotating disk. Additionally a ruby screen is installed on the disk, and a position is kept open for the passage of the electron beam. Four silicon surface barrier detectors, with charge sensitive pre-amplifiers, are used to measure the flux of the scattered electrons at respectively $+50°$, $-50°$, $+120°$, and $-120°$. A choice can be made between single electron counting mode (calibration) and integration mode (regular operation). In integration mode the output of each amplifier is connected to an ADC of the PES control system. Non-elastic low energy electrons are discriminated against by means of an aluminium filter installed between the detectors and the gold foils. Discussed will be the Mott calibration procedure, the estimation of the absolute and relative accuracy, and the results of the Sherman function extrapolation of the four gold foils. Measurement results of the polarization degree of strained InGaAsP photocathodes in the wavelength range of 700 - 850 nm show a maximum polarization of 80 % at 770 nm. A significant decrease of the quantum efficiency (Q_e) is observed as a function of the laser power density (saturation effect). Measurement results of the saturation threshold of different photocathodes as a function of wavelength will be presented. It has been observed that the Q_e drops exponentially at the leading edge of the pulse. The relaxation time is dependent on the laser power density (dynamic saturation effect). First measurement results of the relaxation time as a function of the laser power density will be discussed.

[1] Y.B. Bolkhovityanov et al., "The Polarized Electron Source at NIKHEF", Proceedings of this workshop.

The Polarized Electron Source at NIKHEF

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A general description of the Polarized Electron Source (PES) used at the Amsterdam Pulse Stretcher (AmPS) storage ring is given. Polarized electrons are produced by means of strained InGaAsP photocathodes. A tunable Ti:Sapphire laser can provide circular polarized light pulses (the helicity and intensity of the pulses are remotely controllable) of length 0.4 - 4 μs in a wavelength range of 700 - 850 nm, with an intensity up to 1 kW per pulse. The photocathode gun is realized with double vacuum chambers. The double ceramic isolation design of the gun allows for the permanent connection of a double chamber set-up. One chamber for loading and one for preparing the photocathodes. Three photocathodes can be kept or treated in the preparation chamber, whilst one is used in the gun. Photocathodes are exchanged between the preparation chamber and the gun, using a magnetic manipulator, within typically 15 minutes. The gun is operated at 100 kV. A Z-shape spin manipulator allows for an arbitrary spin rotation. Polarization of the electron beam is measured after the Z-shape manipulator using a Mott polarimeter containing four gold foils of different thicknesses. Additionally a ruby screen can be inserted at this position for beam line adjustment. Polarized electron pulses of 2 μs length, 30 mA, and a polarization of 80 %, with a repetition rate of 1 Hz, have been obtained. A post-accelerator, consisting of two cavities, bunches the beam and accelerates it to 400 keV. At the end of the post-accelerator beam line a Faraday cup, incorperating a ruby screen, has been installed for current measurements and absolute energy calibrations. The beam is injected in the Medium Energy Accelerator (MEA), preceding the AmPS, by means of an alpha magnet. This magnet provides fast switching between PES and the 400 keV thermionic gun. The measured injection efficiency of a polarized electron beam is 30 % (with regard to the current measured before the post-accelerator).

The Coulomb-nuclear Interference Polarimetry at RHIC

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The asymmetry in the very low momentum transfer region in elastic *pp* interaction mainly comes from the interference of nuclear non-flip and the single-flip electromagnetic amplitudes. This asymmetry in the so-called Coulomb-Nuclear interference region can form the basis of an absolute and fast polarimeter. Two distinct ways of operation at RHIC are critically reviewed: the fixed target and the collider modes.

Radiative electron beam polarization in the AmPS storage ring

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The AmPS storage ring is now equipped with a Siberian Snake to mantain longitudinal beam polarization in an IP. The Siberian Snake insertion includes two superconducting solenoids and five quadrupole lenses for a compensation of coupling effect. This report describes a method of treating depolarization effects in a presence of the Snake and some aspects of the Snake adjusting to reach larger depolarization time. Also a possibility of an experiment to observe the so-called kinetic polarizing mechanism is considered.

Cryogenic Atomic Beam Source for Polarized Deuterium Target

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The experiment on elastic and inelastic scattering of 2 GeV electrons by internal polarized target is in progress at the VEPP-3 storage ring in Novosibirsk. The Cryogenic Atomic Beam Source having superconducting sextupoles is under manufacturing to feed by polarized deuterium atoms an internal storage cell target at the VEPP-3 electron ring. The source contains a dissociator with a nozzle at liquid nitrogen temperature,five sextupole magnets with superconducting coils (aperture varies from 22 mm up to 44 mm) and two RF transition units with medium and strong magnetic field. During the testing of magnet prototype a magnetic poletip field of 3.9 T was measured at the aperture of 44 mm. Two RF unit will allow to get desirable tensor polarization of the atomic beam (Pzz=1 and -2). Track-tracing calculations shown that 1.3*10**17 atoms per second (in three substates) could be injected into the storage cell providing a target having thickness of 1.3*10**14 at/sqcm.

Spin and flavor content of constituent quarks and one-spin asymmetries in inclusive processes

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We consider mechanism for one-spin asymmetries observed in inclusive hadron production. The main role belongs to the orbital angular momentum of the quark-antiquark cloud in the internal structure of constituent quarks. We argue that the origin of the asymmetries in pion production is a result of retaining of this internal angular orbital momentum by the perturbative phase of QCD under transition from the non-perturbative phase. The non-perturbative hadron structure is based on the results of chiral quark models. On the basis of the mechanism proposed for one-spin asymmetries in inclusive hadron production we consider OZI–suppressed process of φ-meson production $pp \to \varphi X$ and asymmetry $A_N(\varphi)$ in this process. We also discuss asymmetries and polarization in inclusive hyperon productions.

Scattering experiments on the polarized deuterium targets at the electron storage ring VEPP-3, results and status

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The deuteron electromagnetic structure investigation is a long standing task. Polarized experiments in elastic and inelastic electron scattering provide the most valuable information. Such experiments in different modifications in the last decade in several laboratories have been performed (MIT, Bonn, Novosibirsk, NIKHEF). The Novosibirsk/Argonne/NIKHEF/St. Petersburg/Tomsk collaboration is performing a multi-phase experiment at the 2 GeV electron storage ring VEPP-3 with internal tensor-polarized deuterium targets.

The phase II of the experiment has been completed in 1994. A momentum transfer up to 4 fm^{-1} in elastic scattering has been reached. New analysis of these data with some improvement in particle identification, hadron energy resolution and particle tracking has given approximately the same final result on T20 as reported earlier[1]. The data in proton knock-out experiment has main part of events located in plane geometry. The electron scattering angles 16-22 degree, the momentum transfer about 0.5 GeV/c and the kinetic energy of the (np) system 0-150 MeV. The results are compared to the non-relativistic calculation by Arenhövel and Leidenmann.

At present the construction of the instrumentation for the phase III is in progress. During the fall 1995 run the new VEPP-3 electron beam optic near the experimental straight section has been tested and the new high speed differential pumping system in this straight section has been checked. Also the background conditions in presence of the new thin-wall stable storage cell filled with D2 and H2 gas with thickness 10^{14} at/cm^2 has been measured. This measurement has shown that background conditions are good enough (approximately the same as in phase II in spite of increasing by two order the thickness of target and decreasing by one order the electron beam time of life). The atomic beam source with the strong field ($\approx$ 4.5T) superconducting sextupole magnets has been designed and is under construction now. It should provide a flux of about 10^{17} at/sec in the inlet tube of the storage cell.

[1] S.G.Popov et al., AIP Conf.Proc. **334** (1995) 768.