THE POLARIMETER FOR RHIC BASED ON THE ELASTIC (pe)-SCATTERING.

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The absolute polarimeter for RHIC based on the elastic (pe)-scattering is proposed. The polarimeter includes the internal hydrogen gas target in which atomic electrons are polarized, the detectors of the scattered protons and the recoil electrons. The proton beam polarization may be measured with a statistical accuracy $\approx 5\%$ during 500 sec, a hadron background may be rejected.

1 Introduction.

Elastic scattering of a polarized proton on a polarized electron can be used to define the high energy proton beam polarization [1]. Indeed this process is very simple from theoretical point of view and this reaction provides a sufficiently large analyzing power and thus it can allow the absolute measurement of the beam polarization. One of the possible way to obtain a polarized electron target is to use an internal gaseous target of polarized hydrogen atoms. We propose to apply a technique of polarized internal gas target consisting of an atomic beam source (ABS) and an active storage cell [2]. Indeed the utilization of a storage cell in combination with a state-of-the-art ABS strongly increases the thickness of the polarized target [3], while the degree of polarization of the target electrons can be measured with high accuracy by the accessible methods [4].

2 Beam and target parameters.

The proton beam has a transverse polarization at the straight section of the RHIC where the polarimeter is to be placed, therefore A_{sl} component of the analyzing power will be considered.

The parameters of the beam and the target:

- The proton beam current is taken to be 100 mA.
- Such a degree of proton beam polarization P_p is assumed that the product $P_p \cdot P_e = 0.5$, where P_e is a degree of the target electrons polarization.
- The thickness of the hydrogen target was taken to be $2 \cdot 10^{14} \frac{at}{cm^2}$. This thickness may be obtained by using an ABS similar to the Novosibirsk cryogenic ABS[5] and with a cooled ($120^o K$) storage cell having a diameter of 15 mm and a length 400 mm. Under the very first test of Novosibirsk ABS $6.4 \cdot 10^{16}$ polarized deuterium atoms per second were injected into the storage cell. For hydrogen atoms the flux is expected to be about $1.0 \cdot 10^{17}$ at/sec with an electron polarization in the beam 0.99. The polarization of the target P_e is expected to be about 0.8.

Such parameters provide a possibility to measure the proton beam polarization with a statistical accuracy of $\approx 5\%$ during 500 sec using the detectors descrided below.

3 The proton and electron detectors.

Both particles – proton and electron are detected in coincidence.

The scattered protons can be detected after DX and D0 magnets where they are deflected from the proton beam orbit both in horizontal and vertical planes. A set of tracking detector planes providing 0.1-0.2 mm spatial resolution in two directions and with a 1 m base between the planes should allow to reconstruct the proton energy with an accuracy $\delta E_p/E_p \approx$10%. An electron detector consisting of a focusing magnet, wire chambers and an electromagnetic calorimeter can provide an efficient rejection of the hadron background. The expected parameters of the electron detector are: energy range: 20–40 GeV, momentum resolution: $\Delta p/p \leq 10\%$, energy resolution in BGO calorimeter: $\Delta E/E \leq 3\%$.

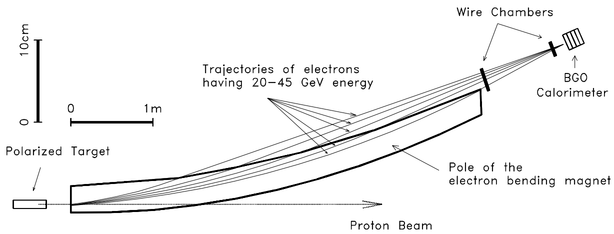

Figure 1: The sketch of the recoil electron detector, top view.

Two identical detection systems will be installed to measure polarization of both colliding beams. To decrease the influence of bending magnets on the proton beam orbit we suggest to set the opposite direction of the magnetic field in these magnets and additionally to apply two compensating magnets. Such a magnetic system has a small local perturbation of the proton beam orbits and a vanishing influence on the proton beams spin dynamics.

4 The background from hadron scattering.

The PYTHIA code was used to generate the events of (pp)-scattering. Most of the background particles which are hitting the electron detector are π^- mesons. However it was found that in a number of background events a high-energy electrons are produced (N^e_{py} in the Table). Such events survive the kinematical constraints and could not be rejected by the particle identification in the calorimeter. Fortunately the ratio of the rate of this background events and that of (pe)-elastic scattering R^e in Table is also small. The final background-to-effect ratio (the column RR in the Table) is found after analyzing the energy deposition in the calorimeter using GEANT Monte-Carlo code.

Table 1: The results of background estimation (RR is background-to-effect ratio).

θ_e	E_e	$N^{\pi-}_{py}$	N^e_{py}	$\frac{d\sigma^{\pi-}_{bg}q}{d\Omega}$	$\frac{d\sigma^{e}_{bg}}{d\Omega}$	$\frac{d\sigma_{pe}}{d\Omega}$	R	R^e	RR
mr	GeV			mb/sr	mb/sr	mb/sr		%	%
0-1	53.6-56.6	101	0	126	< 1.3	12.2	10.3	< 11	2.1
1-2	46.4-53.6	620	0	258	< 0.42	16.8	15.4	< 3	3.1
2-3	37.8-46.4	973	0	243	< 0.25	24.4	10.0	< 1	2.0
3-4	30.0-37.8	863	1	154	0.18	33.0	4.7	0.5	0.9
4-5	23.8-30.0	834	1	116	0.14	40.9	2.8	0.3	0.6
5-6	18.9-23.8	613	4	69	0.45	48.0	1.4	0.1	0.3
6-7	15.2-18.9	391	5	38	0.48	53.0	0.7	0.1	0.1

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