THE INCLUSIVE NEUTRAL PION POLARIMETER FOR HIGH ENERGY ACCELERATORS/COLLIDERS

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The inclusive charged pion polarimeter (ICPP) has been recently proposed [1]. This proposal bases on the high analyzing power, $A_N^{(\pm)}$, discovered by E-704 Collaboration at Fermilab [2]. In the current paper we propose, basing on the A_N^0 measurement by the same Collaboration [3], to apply the inclusive neutral pion polarimeter (INPP) to the RHIC environment. We argue that a high analyzing power and a large cross-section are very attractive features of such a polarimeter. Some additional advantages are full azimuthal coverage, easy fit to the accelerator/collider environments, the background suppression by selecting the high energy threshold for the photon detection.

The results of the E704 measurement of analyzing power for the inclusive π^o production in pp-collisions at 200 GeV/c are well known [3]. The analysing power in the kinematical region

$$0.4 < x_F < 0.8;\ 0.6 < p_T(GeV/c) < 2.0, \tag{1}$$

rises linearly with x_F and reaches of 15% at the end of this region. For lack of data we assume that A_N does not depend on an initial energy and it is the same as measured by E704 [3] for the same kinematical domain (1). The scheme of the proposed detectors is shown in Fig.1 - Fig.2. As an internal target we plan to use the hydrogen gas target with density $3 \cdot 10^{13}\ atoms/cm^2$.

The INPP consists of two Electro-Magnetic Calorimeters EMC1 and EMC2. The EMC1 has a hole of diameter $D_1 = 60$ mm defined by a vacuum pipe (V.P.). The EMC2 is placed either in front or in rear part of the DX magnet and aims to cover a hole in EMC1 completely. The optimization of the INPP parameters was made by looking for the maximum of the factor of merit, M, as a function of two variables: a) a distance L from IP to EMC1 and b) photon detection threshold E_γ^{min}. In the latter case both detector thresholds were put the same for simplicity. The inclusive π^o production in the reaction $p+p \rightarrow \pi^o + X$ for the energy region of interest was studied using Monte-Carlo program FRITIOF-7.02 [4].

The results of the calculations are presented in Table 1.

Comparison of the FT with the CB mode shows that the optimum position L practically does not depend on the mode of RHIC running, but depends on the initial energy. Table includes also the ratio of the signal, S, to signal plus background, S+B, the useful cross section ,σ_s, the counting rate, n, the statistics, $N_{5\%}$, needed for attaining the precision in beam polarization measurement, $\Delta P_B/P_B = 5\%$, and a beam running time $T_{5\%}$ for attaining a such precision. The estimated INPP parameters for the HERA-p are included in Table 1. One can conclude that the beam polarization precision of 5% can be obtained by the 12' beam run at 820 GeV and by $\approx 10'$ run at 40 GeV. The last two rows of the Table 1 present the expected outer diameters of calorimeters which per-

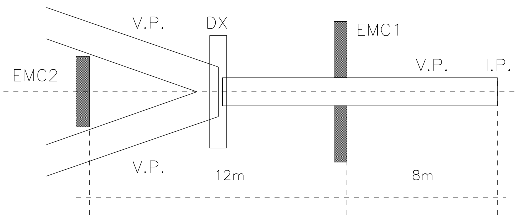

Figure 1: Layout of the inclusive neutral pion polarimeter at 2 o'clock interaction region at RHIC.

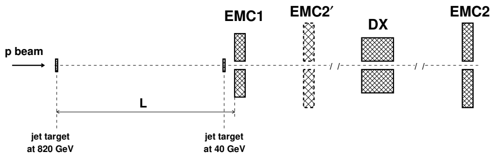

Figure 2: The same as Fig.1 for HERA-p.

Table 1: The Inclusive Neutral Pion Polarimeters Parameters.

Parameters	**RHIC**				**HERA-p**	
E, GeV	250	250 + 250	23	23 + 23	40	820
L, m	5.6	5.5	0.5	0.5	1.0	17.5
S/S+B	0.90	0.90	0.90	0.90	0.68	0.84
σ_s, μ b	12	10	15	13	13	10
n, counts/sec	156	2000	195	260	195	150
$A_N, \%$	10	10	10	10	8.0	9.0
$N_{5\%}(10^4)$	9	10	10	10	12	10.1
$T_{5\%}$, min	10	1	9	7	10.3	12
D_{out} EMC1,mm	360	360	300	300	200	200
D_{out} EMC2,mm	300	300	800	800	400	400

mit to accept 99% of photons from π^0 decay. The gross dimensions of the calorimeters are smaller at HERA-p than at RHIC due to a higher energy of HERA - p. It is obvious that the INPP can measure the beam polarization at

RHIC and HERA-p in the whole range of the beam energy and in both modes of operation.

We propose to use the Inclusive Neutral Pion Polarimeter (INPP) at high energy accelerators/colliders for the following reasons:

- its high analyzing power, A_N;
- its large production cross section, σ_s. Due to these two factors the INPP has a high factor of merit, M $= (A_N)^2 \cdot \sigma_s$;
- full azimuthal coverage. This allows one to measure any transverse component of beam polarization in the same run;
- practically full coverage of useful x_F range;
- practically full coverage of useful p_T range;
- due to the use of the electromagnetic calorimeter, the INPP becomes more preferable with the growth of energy than the ICPP;
- no necessity for a magnetic spectrometer and extra particle identification. The EMC fulfills all these functions itself.
- it fits well to the RHIC and HERA-p environments; it can be easily used in the fixed target as well as in the collider modes.
- it serves as a local polarimeter;
- it is a "transparent"(non disturbing) polarimeter allowing one to make a continuous control of beam polarization;
- it may be used as on-line polarimeter;
- it is less sensitive to the background due to the high energy threshold for photons;
- the technique (electromagnetic calorimeters) is robust and reliable.

There are two open problems which must be solved in order to make the INPP a real polarimeter: a) the absence of the precise experimental data on $A_N(\pi^0)$ in the energy range of interest, and b) the necessity to demonstrate in experiment that an INPP can be operated as an on-line polarimeter.

References

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