RHIC INCLUSIVE PION POLARIMETER

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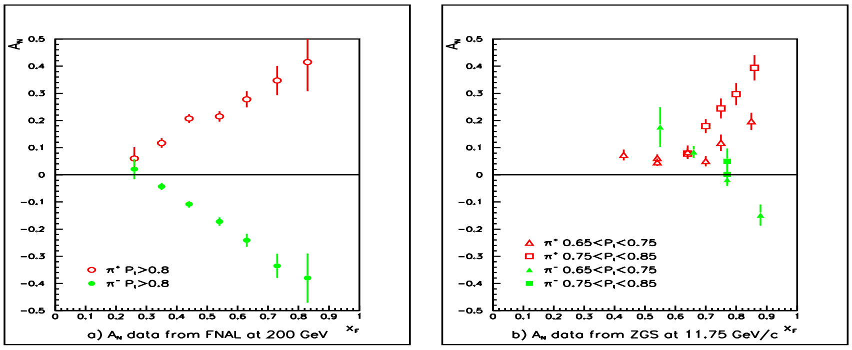
The paper is devoted to the "on-line" RHIC polarimeter, based on the inclusive production of negative pions by polarized protons on a carbon ribbon target. It utilizes analyzing power 0.15–0.2 in the production of pions with $x_F = 0.6$ and $P_t = 0.8$ GeV/c. The presented design is aimed at the first year of RHIC running and should be placed on one ring in a 40m straight section near 12 o'clock insertion point. Basic elements of the design are 5 dipole magnets, 4 scintillation hodoscopes and carbon ribbon target.

The idea of this polarimeter is based on a fairly good analyzing power of inclusive production of charged pions found at 200 GeV/c in Fermilab[1]. Their results, shown in fig. 1a, demonstrate large asymmetry in production of both negative and positive pions, which linearly grows with x_F. Unfortunately the situation is not so simple at low energies. The asymmetry measured at 11.75 GeV/c in the experiment at ZGS[2] is not so optimistic (see fig. 1b). The results these two experiments were all the data which we had until now. Recently E-925 experiment at AGS at 23 GeV/c is on the way and its preliminary results will be presented at this Symposium by Y. Makdisi.

This talk is mostly devoted to the "day-one" polarimeter and which will work on one ring during the first year of RHIC operation. It main task is to provide fast "on-line" polarization monitoring during RHIC tuning and commissioning. At the first year the RHIC energy will be limited by 100 GeV/c. The other limitation came from financial reasons, so the apparatus should be cost-effective and maximize utilization of the existing equipment.

The proposed one-arm polarimeter design is shown in fig. 2. It includes:

- 5 existing dipole magnets, three first of them can move altogether perpendicular to the beam line;
- 4 scintillation hodoscopes, currently used by the experiment E925;
- carbon ribbon target with thickness 5–10 $\mu g/cm^2$ and width 5–10 μm;



a b

Figure 1: Asymmetry of the inclusive charge pion production

- two luminosity monitor telescopes of three small scintillation counters each, mounted above and below the beam looking at the target, which are not shown in this figure.

The polarimeter data acquisition system is based on LeCroy FASTCAMAC universal logic module 2367. The heart of this module is Xilinx field programmable gate array, containing approximately 13,000 equivalent gates, which allows flexible and effective programming of its functionality. The module also includes 3 Mbyte of on-board RAM, digital signal processor, and 59 front panel differential ECL lines which can be used for digital input or output.

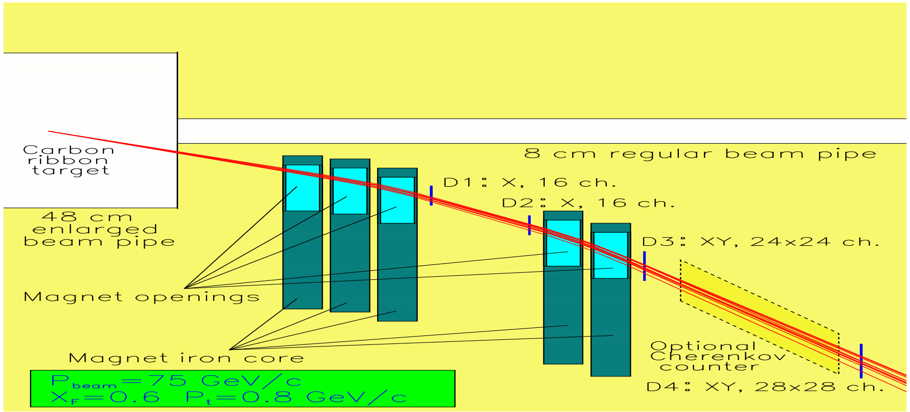


Figure 2: Layout of the polarimeter. Magnet positions and particle tracks correspond to working at 75 GeV/c

The module can memorize data coming from the front panel in every bunch crossing, producing effectively zero dead time of DAQ system. The layout includes three such modules for X-planes of hodoscopes 1 and 2, for X-planes of hodoscopes 3 and 4 and for Y-planes of hodoscopes 3 and 4. For every bunch two-stage processing will be performed. During the first stage the hit pattern is analyzed in every 2367 module separately. If the trigger condition is met corresponding signal is passed through the front panel to the other modules. During the second stage if all the three modules give "OK" the data is written in the memory. After required number of triggers is gathered the modules memory is read into the computer for further processing.

A thorough simulations of the polarimeter design were performed in order to get understanding of detector loads in one bunch. We used GEANT[3] with HEISHA[4], which played strong interactions. It was found that the described layout can work up to the highest RHIC intensity at 100 GeV/c. We also estimate the time required to get the statistics of 10^4 pions. The results are given in the table below. These results correspond to $2 \cdot 10^{11}$ protons per bunch, 120 bunches per ring, normalized beam emittance 20 $\pi \cdot mm \cdot mrad$ and carbon ribbon target $10\mu g/cm^2 \times 10\mu m$. The table shows that everything looks OK at large RHIC luminosity but if we have smaller number of bunches and smaller bunch filling the emittance blowup could be a problem at low energy. But due to the fact that acceleration of polarized beam is planned after reaching of 10% luminosity on heavy ions, we hope to start from not the smallest luminosity.

Beam	To get 10,000 events		
momentum	bunches	time	emittance blowup
23 GeV/c	10^8	10 s	0.4 $\pi \cdot mm \cdot mrad$
50 GeV/c	$5 \cdot 10^7$	5 s	0.14 $\pi \cdot mm \cdot mrad$
100 GeV/c	10^7	1 s	0.02 $\pi \cdot mm \cdot mrad$

The polarimeter is to be installed in the designated hall till October 1st, 1999 when RHIC is closing for the first year of operation.

References

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