Possibilities for spin measurements in BRAHMS.

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The Broad Range Hadron Magnetic Spectrometer (BRAHMS) experiment at RHIC is one of the four approved Heavy Ion experiments at RHIC. The primary goal is to measure semi-inclusive spectra for identified charged hadron over a wide range of rapidity and transverse momenta p_t. The spectrometer consists of two moveable arms, one at mid-rapidity and one in the forward region. The latter is of potential interest to the RHIC spin program. It consists, as depicted in the first slide, of 4 dipole magnets with a total maximum bending field of 9.6 Tm, tracking stations, and time-of-flight and Cherenov detectors for particle identification. For more details see ref 1[1]. The detector is placed in the 2 O'clock area. Here the proton beam can only be polarized transversely. In the preceding contribution[2] to the spin workshop the possibility of learning about higher order twist effects by measuring the transverse spin asymmetry $A_N = (N^+ - N^-)/(N^+ + N^-)$ vs. X_f and p_t is described.

The acceptance over all angles and magnetic settings are shown in the second figure for the 100 GeV/c p on 100 GeV/c p. The hatched areas indicated where good PID is possible. This region has a too low a X_f to be interesting for non-zero measurements of A_N. It is though possible to operate the spectrometer by moving the front section in such a way that an acceptance region for $.2 < X_f < .7$ can be reached. This is shown in the 3 figure. One characteristic feature is that p_t change with X_f.

Based on the model estimates asymmetries of about 2-5% can be expected in this region of phase space. Thus to get a measurement with a statistical accuracy of about 1% about 10,000 counts are needed per been of each polarization state. The un-polarized cross sections were obtained from a Pythia calculation using standard parameters. Based on this, it is estimated that a fairly complete measurement can be achieved in about 1 month of RHIC running.

The last slide summarizes the investigation, and some issues that have to be resolved for this measurement to take place.

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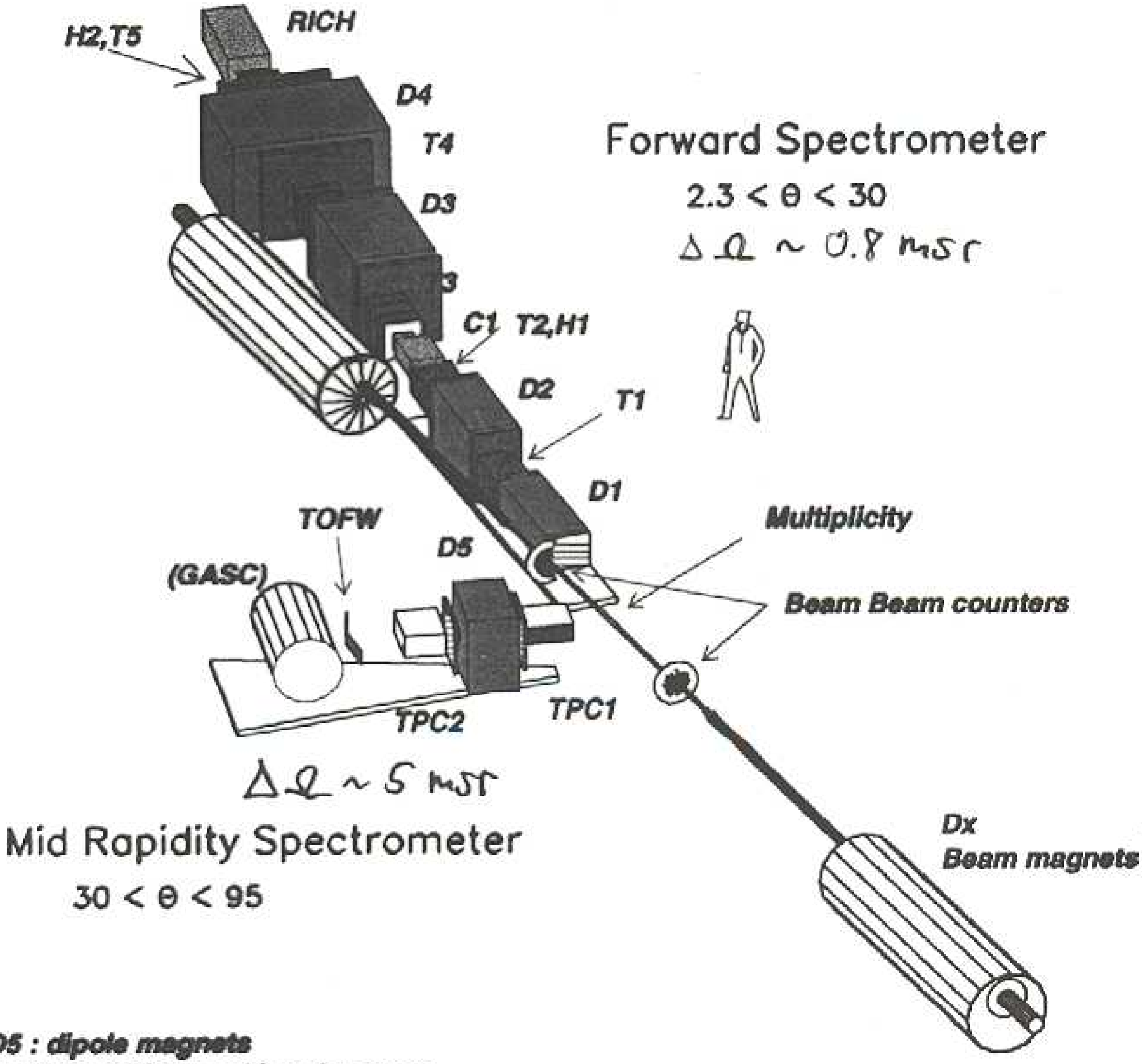
[1] See e.g. The BRAHMS experiment at RHIC F.Videbaek, RHIC summer study 1995. The BRAHMS Conceptual Design report available on the web via the BRAHMS home page http://rsgi01.rhic.bnl.gov/export1/brahms/WWW/brahms.html

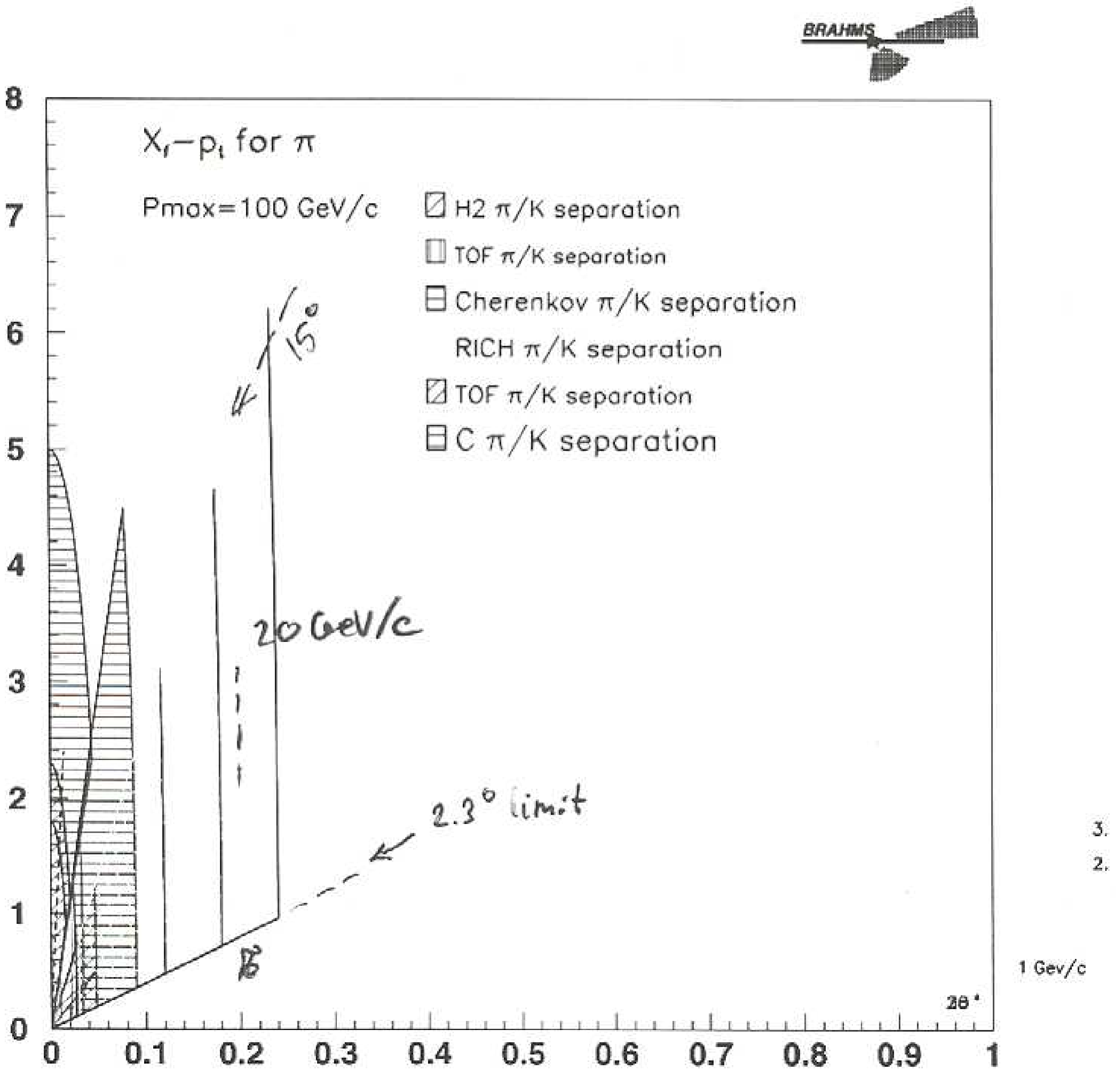
[2] G.Sterman, these proceedings.

BRAHMS

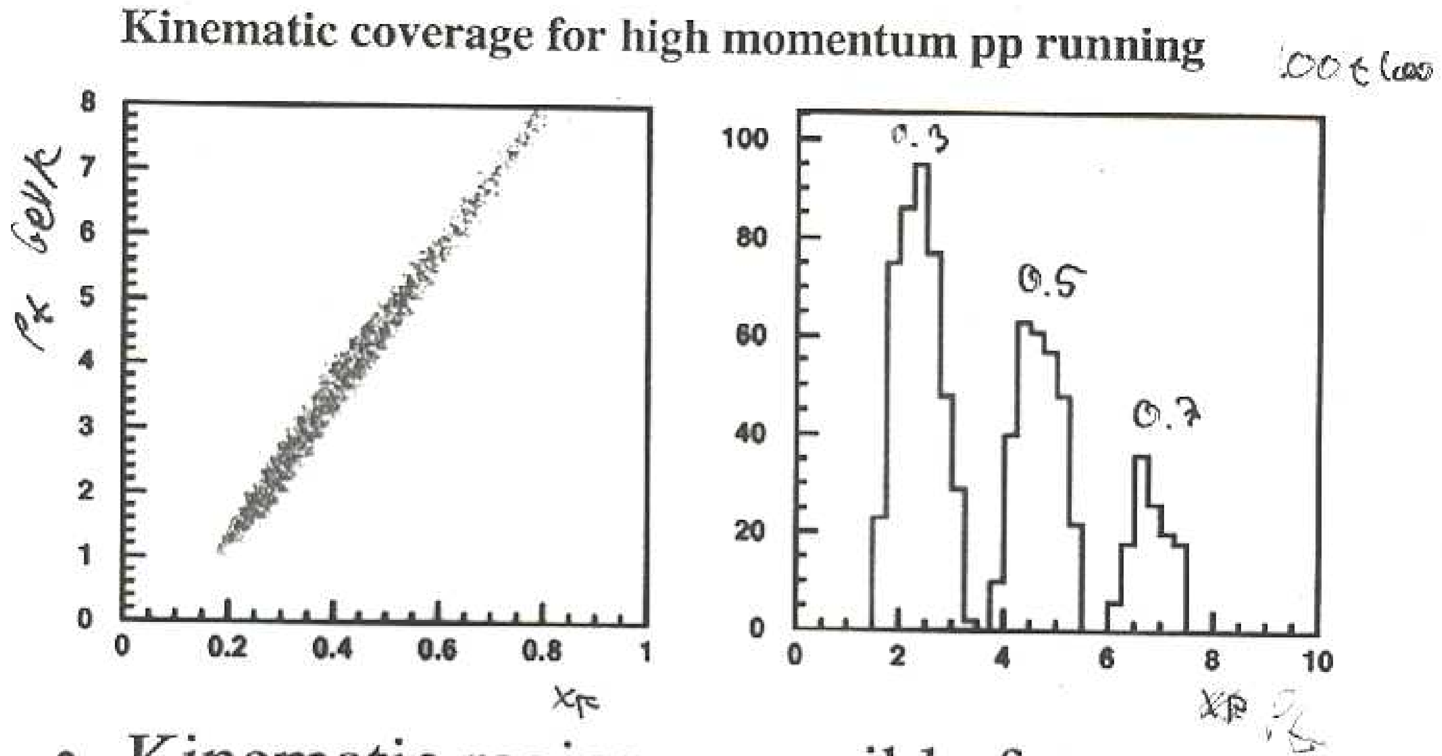


D1,D2,D3,D4,D5 : dipole magnets
T1,T2,T3,T4,T5, TPC1 TPC2: tracking detectors
H1,H2,TOFW : Time-of-flight detectors
RICH, GASC : Cherenkov detectors

'Default / Standard Configuration:



Requirement: Good P.ID.
$\delta p/p \lesssim 1\%$



- Kinematic region accessible for one setting .
- Field 2.4Tm per magnet
- Line of sight through system (front system moved relative to back)
- δp/p about 5%

Rate estimates in pp for BRAHMS

To get an idea for this Lund (i.e. Pythia) was used at 100+100 GeV/c. The total population is given as a 2-dimensional distribution in X_f vs. p_t and shown in the figure below.

This calculation was used to estimate the overall rate at X_f=0.5 and p_t= 5 Gev/c. It is

$$\mathbf{d^2n/dp_tdx_F \sim 2.0 10^{-5}}$$

What luminosity is needed to get 1000 counts. The inelastic cross section σ_{pp} is 45 mb at sqrt(s) = 200.

$$N(1000) = \mathbf{d^2n/dp_tdx_F}\, \sigma_{pp}\, \Delta p_t d\Delta_F\, L$$

$$\Rightarrow L = 10^2 \ nb^{-1}$$

RHIC delivers at 10^{31} $cm^{-2}sec^{-1}$; this is a modest estimate for the 2 O'clock area, but probably realistic in the first year of running.
Thus 1000 count can be achieved in about 3 hours of running. To get a good measurement at an expected asymmetry of 0.05 with an accuracy of 0.01, 20.000 count for up-down is needed i.e. approximately 60 hours.

G. Sterman, J. Qiu 's model predicts $A_N \sim 2\%$ at $x_F = 0.3$
$\sim 5\%$ at $x_F = 0.5$

Outlook

- The BRAHMS Detector has acceptance and capabilities for a measurement of the transverse spin-asymmetry for Xf = 0.3,0.5 and Pt=3-5 GeV/c in pp at 100+100 GeV/c.
- It could take place at >2000
  - Beams available
  - Additional A/C power at 2 O'clock
  - trigger upgrades needed
- It is presently not part of the BRAHMS physics program to carry out this measurements. It needs some additional effort == people.
  - preparations
  - 1 mo. Running
  - Analysis