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MEASURING THE BEAM POLARIZATION AT RHIC

(Introduction to the session)

We are within one year of witnessing the first heavy ion physics collisions at RHIC scheduled for June 1999. The hardware needed to commission one ring with polarized protons, two Siberian snakes and one polarimeter, should be installed prior to October 1999.

The road to develop a polarimeter for RHIC has been a long one. A committee was formed to choose from various polarimeter options with the target goal to measure the absolute beam polarization to 5%. This solution requires a polarized hydrogen jet target (A. Penzo) which will be used to calibrate the online polarimeters. This is envisaged beyond day-one.

The near term goal and financial constraints call for the installation of an inclusive pion polarimeter in one ring. This serves the commissioning phase and will measure the beam polarization to better than 10% between injection and 100 GeV/c. Towards this end, experiment E925 was installed on the AGS floor, ran with a polarized proton beam, and measured the asymmetries in inclusive pion production at RHIC injection energy from a carbon target with quite promising results (H. Spinka).

A parallel effort to develop a second polarimeter looking simultaneously at the same carbon target but utilizing the asymmetry in the Coulomb Nuclear Interference in P-C scattering has also netted interesting results in measurements at Kyoto (K. Imai) and at IUCF (D. Fields). If the concept proves viable at high energies, this is a promising method to measure the polarization of both beams in a single setup.

This session presents the status of these efforts and of course there is no shortage on new ideas, some of which will also be discussed. Our task is to finalize the designs, develop the hardware, and start installation in the RHIC tunnel starting this summer and continue during the periods when the tunnel is open in order to be ready by October 1999.

Constraints on the RHIC Polarimeter Design

The polarimeter(s) has to satisfy the following:

- Beam polarization monitor for Physics (**5 %**)
  Several samples over the duration of a fill

- Beam polarization diagnostic tool
  Sample on demand
  Online

- Machine tuning tool
  Fast/within few minutes
  Online

- A large dynamic range ..... Energy independent?
  23 GeV/c at injection
  250 GeV/c at top energy

- Measure A_N and if possible another component A_s

- Ideal Large analyzing Power &
  Large Cross section &
  Low background

- Reasonable Cost

Candidate Processes

- p-p Elastic scattering
  The AGS internal polarimeter, the analyzing power is proportional to 1/p. Experimental data good to 10%.

- Primakoff Production in the Coherent Coulomb region (E704)
  $p + Z \rightarrow \Delta / N^* + Z \rightarrow \pi^0 + p + Z$
  $(\gamma + p \rightarrow p + \pi^0)$ at $t < 0.001$

  Gave a large analyzing power of -0.57 +/- 0.12 +/- .20
  Large background.
  D. Carey et al Phys. Rev. Lett. **64,** 357 (1990)

- p-e elastic scattering
  Calculable process with large analyzing power A_{NN}, A_{LL} in the forward direction of the electron and drops dramatically with large angles at few mr. A_{SI} possible at RHIC.

  I. V. Glavanakov et al. INP Tomsk preprint 2/95,1/96 and published in the proceedings of the Spin96.

- e-p Deep inelastic scattering, G. Igo (from SMC and SLAC)

- p-p elastic scattering in the CNI region using the PP2PP

- Inclusive Pion production from carbon,
  E704 and ZGS from H_2
- P Carbon CNI (tests at Kyoto, IUCF, AGS)

The polarimeter Vs Energy

We envisage Two reference points:

23 GeV/c RHIC injection..... measured to 10%

200 GeV/c .... measured to 8-9%

A measurement at an energy imbetween involves:

1) Measure the asymmetry at a convenient anchor'
2) Move to the desired energy and measure the asymmetry there.
3) Return to the reference energy and measure again.

The assumption is that the dynamics of beam acceleration and deceleration will affect the polarization equally.

SATURNE II (500 - 3000 MeV)

A. Nakach et al. Determination of the Proton Beam Polarization at High Energies by Measurement After Deceleration. Proceedings of the 6th Symposium on High Energy Spin Physics, Marseille 1984, pp C2-647.

IUCF (200 - 400 MeV)

B. von Przewoski et al. Calibration of the Polarization of a Beam of Arbitrary Energy in a Storage Ring. Proceedings of SPIN96, pp 513.

C. Pollock at al. Sumbitted to Phys. Rev.

COST and Schedule

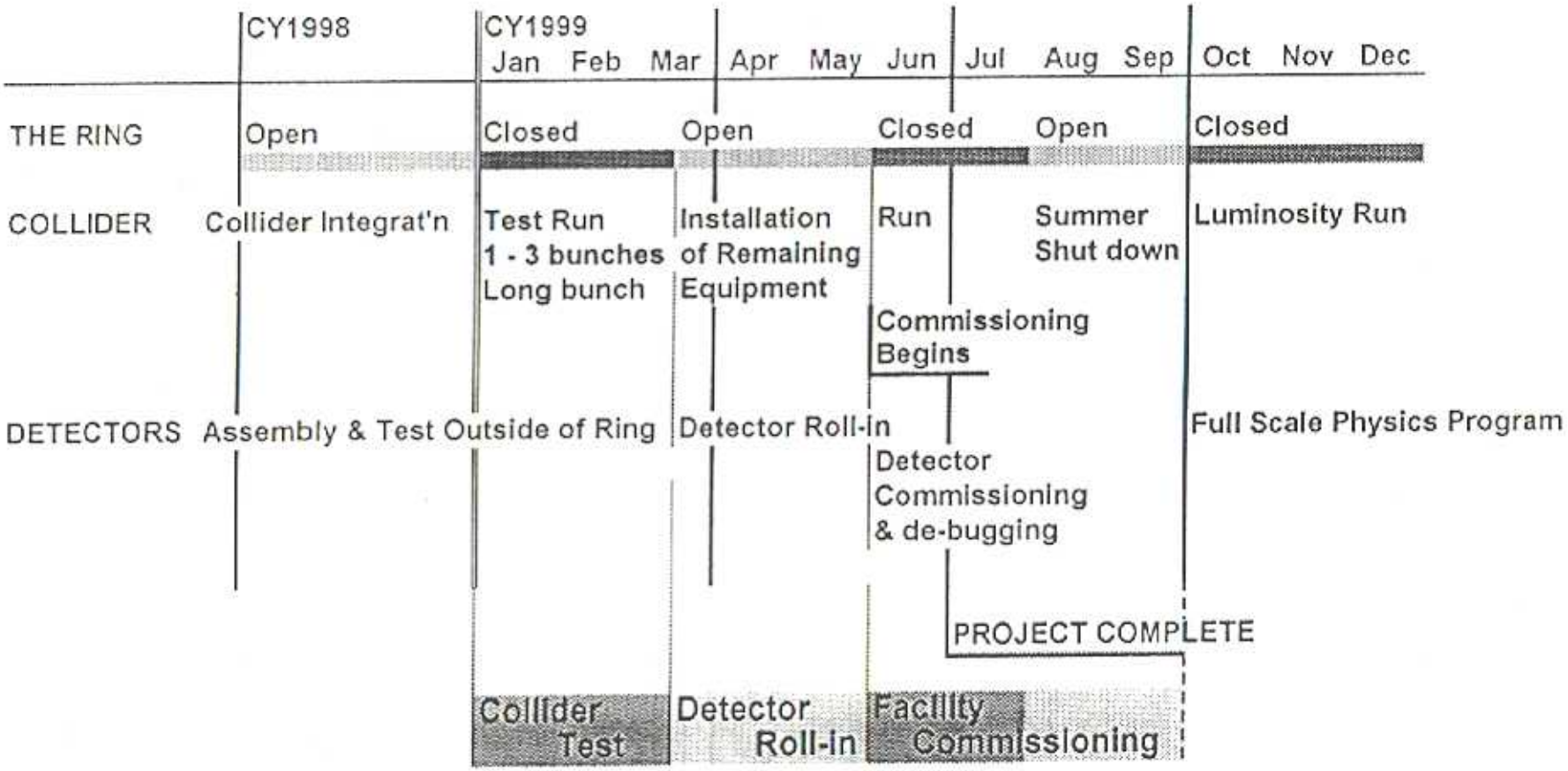
- At latest count the polarimeter cost has dropped from $1.5 M to less than $ 0.5 M.
- The profile sets the polarimeter(s) funding after the snake/rotator fabrication,
- This calls for a) creative financing, & b) recycling
- At least one polarimeter is required to allow commissioning in FY 2000,
- The work started now with construction and installation completed by Oct 1st, 1999.
- E880 and E925 are scheduled for another run in Feb 1999.

The 5% Solution and Long Range Plan

- Install a polarized hydrogen Jet Target,
- Measure the Jet target polarization to less than 5%,
- Measure the beam polarization,
- Calibrate analyzing power of the polarimeter to better than 5%,
- Use the calibrated polarimeter to measure the absolute beam polarization. This process could be done at any desired energy.

TOWARD THE COMMISSIONING, OPERATION & PHYSICS

Objective: Full scale physics program as early as possible



Full scale relativistic heavy ion physics program in the fall of 1999

Presentation to Dr. P. Rosen (2/20/97)