RHIC Multi-Year Beam Use Request
The STAR Collaboration

August 16, 2002

Executive Summary

The first two RHIC runs have allowed STAR to begin a comprehensive survey of the matter produced in relativistic AuAu collisions, to begin a seminal set of two-photon measurements in heavy ion interactions, and to produce first results on transverse spin asymmetries in polarized proton interactions.

The results from central heavy ion collisions at $\sqrt{s_{NN}}$ = 130, 200 GeV are striking, suggesting that matter is being produced which exhibits features qualitatively different than what has been observed previously in heavy ion collisions.

To complete its first phase program STAR will require a number of extended pp, p(d)+ A, and AA runs at full energy. These will need to be accompanied by shorter runs with focused goals addressing a number of physics observables, employing a variety of species and beam energies. Given the projected amount of available running time per year it is necessary to address the goals of the projected scientific program over a period of several years. The present request addresses STAR's projected beam use need for Runs III, IV, and V. The highest priority for the next running period (Run III) is an extended d+Au run (16 weeks), followed by an 8 week run using transversely and longitudinally polarized protons.

1. Report on Progress from Run II (2001 - 2002)

The first priority for beam use by STAR in the 2001-2002 run (Run II) was the accumulation of approximately 5 million central and 5 million minimum bias AuAu collisions at $\sqrt{s_{NN}}$ = 200 GeV. The second priority was the acquisition of approximately 50 million minimum bias pp events accumulated from 3 weeks of proton-proton collisions with transverse polarization and 3 weeks of longitudinally polarized proton-proton collisions. These goals were substantially met, although for technical reasons, only transverse polarization was utilized for the polarized proton running. Table I shows the data acquired by STAR during this running period.

Table I

Energy (GeV)	Trigger	System	Events Acquired	Goal
$\sqrt{s_{NN}}$ = 200	Central	AuAu	3.48M	5M
$\sqrt{s_{NN}}$ = 200	Hadronic Min Bias	AuAu	4.4 M	5M
$\sqrt{s_{NN}}$ = 200	Topology (UPC)	AuAu	1.5 M	5M
$\sqrt{s_{NN}}$ = 19.6	ZDC 1&2, CTB > 15	AuAu	0.28M	
$\sqrt{s_{NN}}$ = 19.6	CTB > 600	AuAu	0.1 M	
$\sqrt{s}$ = 200	Min Bias	pp	16 M	20M
$\sqrt{s}$ = 200	FPD	pp	3.5M; P = 15%	> 5M; P > 30%
$\sqrt{s}$ = 200	EMC, High Tower	pp	0.8M	2M

The heavy ion data acquired in Run II at $\sqrt{s_{NN}}$ = 200 has allowed STAR to significantly extend its initial observations and to make an extensive initial survey of soft physics observables, as well as first measurements of high pt particles believed to originate from the fragmentation of jets produced by hard parton scattering. The initial results of these studies have been striking. Among the observations made so far:

- elliptic flow of baryons and mesons (V2) is much larger than anticipated at RHIC energy. There is agreement with hydrodynamic inspired models at low pt, but significant saturation/departure from hydro above pt = 2 GeV/c. The saturation appears to be constant out to relatively high pt (> 6 GeV/c) suggesting that semi-hard parton scattering at relatively high pt is sensitive to spatial anisotropy of the overlap region of two colliding nuclei

- from the ratio of the HBT parameters Rout/Rside, the duration time for particle emission appears to be short (~ 1 - 1.5 fm/c) based on model (blast wave) fits to the data

- anti-baryon/baryon ratios approach (but do not reach) unity at mid-rapidity with the ratio increasing fastest for heavy (strange) baryons (e.g. the Ω).

- there is strong transverse radial flow, which appears to affect light mesons and baryons similarly, but which appears to exhibit different behavior for heavy baryons (cascade, omega)

- statistical models appear to describe the final state yields and inverse slopes of the observed spectra well

- high pt inclusive particle production in central collisions is suppressed above ~ 2 GeV/c with respect to that in peripheral collisions as well as with respect to scaled UA1 pp reference data

- direct evidence of jet production in AuAu collisions has been observed using same side and opposite side correlations of leading particles

- the back-to-back correlation strength for leading particles from hard-parton scatters is suppressed in central AuAu collisions

- first reconstruction of hadronic resonances at RHIC has been achieved; the yield of the K* suggests the time between chemical and kinetic freeze-out is short unless there is significant K* regeneration

- sizeable non-statistical fluctuations in mean pt and narrowing of the balance function are observed in central heavy ion collisions

- coherent ρ production from photon-pomeron interactions and e^+e^- pairs from two-photon interactions have been observed

The polarized proton data acquired in Run II have provided valuable heavy ion comparison data (integrating over all polarization states), and first results on transverse asymmetries have been achieved indicating that:

- at $\sqrt{s}$ = 200 GeV, there is a sizeable left-right asymmetry for leading pi zeros produced inclusively by collisions of transversely polarized protons

The heavy ion results from Run II suggest that the matter being produced exhibits features qualitatively different than what has been observed before in collisions of heavy nuclei. The picture which is emerging is that:

- The system is highly dynamic and the evolution is fast; characteristic features include:
  - Transverse expansion with an average velocity of ~ 0.55 c
  - Large degree of anisotropic flow (v_2) suggesting hydrodynamic expansion and high pressure at early times in the collision history
  - The duration of hadronic particle emission appears to be very short

- The produced matter appears to be opaque, exhibiting:
  - Saturation of v_2 at high p_T
  - Suppression of high p_T particle yields relative to p-p
  - Suppression of the away side leading particle correlation

- Statistical models describe the final state well
  - Excellent fits to particle ratio data with equilibrium thermal models
  - Excellent fits to flow data with hydrodynamic models that assume equilibrated systems
  - Chemical freeze-out at about 175 MeV; thermal freeze-out at about 100 MeV

The question of whether or not a new phase of matter is being produced with bulk properties which are partonic can not yet be answered. To answer this question, extended running periods are required to provide further data to assess the significance of possible initial state effects in AuAu collisions, to access additional penetrating probes such as charmonium (J/ψ) and open charm production, and heavy baryon / meson elliptic flow, and to complete STAR's initial survey of soft physics observables (spectra, strangeness, event-by-event fluctuations and correlations, etc.)

An important additional heavy ion physics goal is to further extend STAR's seminal program of two-photon, photon-pomeron, and pomeron-pomeron studies, to more fully explore the quantum chemistry underlying the structure of hadronic matter, and search for exotic states and interactions which will help elucidate the fundamental principles of QCD.

1.1 General Summary and Outlook on Beam Use for Runs III, IV, and V

The above results represent significant findings. The results from heavy ion interactions do not yet support a definitive conclusion with respect to the formation of a new state of matter at RHIC, but offer important clues to the nature and dynamic evolution of the matter created initially by collision of heavy nuclei at ultra-relativistic energy.

To continue the main thrust of its research program, STAR will require:

- an extended d+Au run to assess the effect of initial state effects on the suppression observed for high pt particle production and provide first results on gluon shadowing

- an extended AuAu run at full energy to extend the measurements of soft and hard physics measurements made in Run II, to access important new probes such as open charm and charmonium production, and to measure elliptic flow of heavy baryons and mesons

- an extended run with longitudinally polarized protons to study the spin dependent gluon structure function of the proton

- a long p(d) + Au run to study the parton distribution function and possible saturation effects in heavy nuclei

These will need to be accompanied by shorter runs with focused goals addressing a number of physics observables, employing a variety of species and beam energies. Given the projected amount of available running time per year, and guidance from the Collider - Accelerator Department on the time necessary to set up a given configuration, it is realistic to assume that the number of major physics thrusts that can be addressed each running period is not more than two. It is therefore important to address the goals of the projected scientific program over a period of several years.

2. RHIC Run III (2002 - 2003)

2.1 Modifications to the STAR Detector Configuration for Run III

For Run III, there will be several modifications to the STAR detector setup designed to extend the physics reach of STAR in the next data taking period as well as in the future.

The west half of the Barrel Electromagnetic Calorimeter (60 modules) has been installed and will be fully commissioned during this run. This instrumentation will provide measurement of neutral energy as well as trigger capability for high pt photons, π°s, and jets. One third of the active area of the Endcap Electromagnetic Calorimeter is also expected to be installed. Work is ongoing to provide readout for the EEMC sectors that will be available; the extent to which this work can be completed for the run is uncertain.

A photon multiplicity counter will be installed on the east end of the STAR detector at a distance of ~ 550 cm from the interaction vertex. This highly segmented detector will use gaseous detection of electron showers from photons conversions (combined with a charged particle veto) to count the multiplicity of photons in the pseudo-rapidity range $2.3 < \eta < 3.5$. These data will be used to examine the multiplicity and spatial distribution of photons on an event-by-event basis in this acceptance to search for non-statistical fluctuations and possible Disoriented Chiral Condensate behavior on an event-by-event basis as well as to explore event shapes and flow.

The implementation of STAR's beam-beam counter, based on scintillator tile-fiber technology will be fully completed to provide effective triggering and vertex detection for pp, dAu, and AuAu collisions.

An upgraded, fully integrated Forward Pi Zero Detector using lead glass arrays supplemented by scintillator shower maximum detectors will be partially installed to allow continued study of transverse spin asymmetries and provide a means of tuning the spin rotators in the RHIC collider on either side of the STAR hall to eliminate non-longitudinal components of the polarization at the STAR intersection.

One ladder of a silicon strip detector (SSD), and one tray of Time Of Flight Detector based on multi-gap resistive plate chamber technology will be installed for testing, in anticipation of large acceptance applications in the future.

The STAR Ring Imaging Cerenekov Detector (RICH), which successfully fulfilled its planned scientific mission in Run II, has been returned to CERN.

2.2 Additional Factors Impacting STAR Beam Use in Run III

There are several additional developments expected to impact the STAR data taking effort in Run III. These include the commissioning of an upgraded DAQ capability (DAQ100), and the commissioning of high pt and jet triggers using the STAR Barrel Electromagnetic Calorimeter (BEMC).

The STAR DAQ100 development is designed to allow STAR to write out cluster information rather than raw data to tape. The expected gain from this development, if successful, is a significant increase in the rate at which events can be recorded (50 Hz min bias, 30 Hz central, and 50 Hz pp), as well as the speed at which they can be reconstructed (a factor of 2 for central AuAu). The DAQ100 software suite is ready and simulations to check the effect of its implementation on various track quality indicators is ongoing. At the beginning of the next run, members of the STAR physics working groups will be charged with conducting a quality assurance exercise for STAR physics observables to insure the data taken with DAQ100 are robust before the use of DAQ100 is fully "signed off". Periodically, runs will be taken writing out raw data (as in Runs I and II) to allow continuous calibration and crosschecks throughout the run.

One half of the STAR Barrel EMC trigger will be commissioned and fully operational in Run III. This will afford a high pt trigger based on high tower / high tower cluster detection, and will provide for the measurement of photons and high pt π°s out to approximately 20 GeV/c, and jets to ~ 35-40 GeV/c.

In addition, during this data taking period, STAR will commission its Level I and Level II trigger abort (fast clear) capability, in anticipation of incorporating higher level trigger algorithms focused on the measurement of charmonium in Run IV.

2.3 STAR Beam Use Request for Run III (2002-2003)

Run III: Jet Quenching and High Pt Hadrons in Hot and Cold Nuclear Matter; Measurement of Forward π° Asymmetry; First measurement of ΔG

The STAR beam use request for Run III is shown in Table II:

Table II

Beams	d* + Au	p p
Weeks	16	8
$\sqrt{s_{NN}}$	200	200

(* deuteron beam requested in the blue ring)

These beams will be used to provide comparison data on soft and hard physics observables for AuAu collisions and to study transverse and longitudinal spin asymmetries in polarized proton collisions. The requirements on up time and integrated luminosity for the d+Au run are set by the desire to collect two basic data sets: minimum bias spectra for inclusive h± / π° out to ~ 9-10 GeV/c, and triggered high pt h±, π°, and inclusive jet spectra out to ~ 25, 20, and 40 GeV/c respectively. The basic requirements on d + Au running set by the different data sets STAR plans to collect are:

Minimum Bias Requirement Lav _min > 1 μb^{-1}/ day, 70 days, 40% uptime; $\int$ Lmin > .033 nb^{-1}
(primary requirement is uptime; 50 Hz for 70 days)

High Pt Trigger Requirement $\int$ Lmin > 25 nb^{-1}

The requirements on spin physics running are:

Spin Physics Requirement $\int$ Lmin > 3 pb^{-1} , P> 40%, Longitudinal
$\int$ Lmin > 1 pb^{-1} , P> 40%, Transverse

The main scientific and technical goals of this run will be:

- Measurement of high pt ("calibration") spectra and leading particle correlations in d + Au, and pp for comparison with AuAu; first results on shadowing and Cronin effect
- Measurement of comparison data for soft physics observables in d+Au
- Measurement of forward pi zero asymmetries in p↑ + p↑
- First attempt to measure ΔG in p↑ + p↑
- Commissioning of EMC high pt trigger
- Tuning of spin rotators for longitudinal polarization
- Engineering runs for the endcap electromagnetic calorimeter, the silicon strip detector, and the MRPC TOF Barrel Tray prototype

Given the beam parameters requested in Table II, a combined STAR+RHIC duty factor of 40%, and a DAQ rate of 30 Hz, STAR will record approximately 70 M minimum bias events in a run of 10 weeks duration. This will afford comparison data for soft physics observables measured in AuAu interactions as well as the measurement of a minimum bias h±, π° spectra for d+Au interactions out to ~10 GeV/c. In addition, using the EMC barrel, STAR will measure triggered high pt spectra of h±, π°, and inclusive jets. The approximate range of measurements for high pt observables afforded by the d+Au running requested is summarized in Table III. These data will be used to establish the extent to which initial state effects contribute to the observed suppression for inclusive high pt particle production in AuAu interactions and to study jet and di-jet correlations in comparison with AuAu and pp data to isolate the effects of parton energy loss in AuAu interactions. The data taken will also be used to take a first look at the question of intrinsic kt and gluon shadowing in heavy nuclei using inclusive jet, di-jet, direct photon, and direct photon + jet final states as probes. Level I and Level II trigger algorithms focused on the measurement of $J/\Psi \rightarrow e^+e^-$ in Run IV will be commissioned.

Table III

Trigger	Observable	Pt Range
Min Bias	Inclusive h ±	pt ~ 10 GeV/c
Opposite side high tower *	Inclusive h ±	pt ~ 20 - 25 GeV/c
Opposite side high tower	Inclusive jet	pt ~ 35 - 40 GeV/c
Opposite side high tower	Inclusive π°	pt ~ 20 GeV/c

(* software trigger set on > 5 GeV π° equivalent response)

STAR Spin Physics Goals for Run III

The first polarized proton run at RHIC was completed in January, 2002. That run provided information key to the long term goals of the STAR/RHIC spin program and resulted in pp reference data essential for the STAR heavy-ion program. An important early finding appears to be that inclusively produced forward pi zeros at high x Feynman and moderate pt exhibit a significant transverse spin asymmetry.

The polarization magnitude for the first polarized RHIC run is estimated to have averaged ~15%, significantly increasing the effort required to understand the statistical and systematic uncertainties for data recorded during this period. The low polarization of the RHIC beams is believed to have resulted from the two-times smaller ramp rate of the AGS caused by the failure of the Siemens motor generator. The slower ramp rate had the effect of increasing the depolarizing effects of intrinsic resonances during acceleration.

Based on the experience from run II, STAR is making a conditional request for a polarized proton run at $\sqrt{s}$ = 200 GeV in Run III. The amount of time requested is 8 weeks, including setup, commissioning and data collection. The physics and technical goals of this run are specified below. The condition that must be achieved is to demonstrate that the AGS can deliver proton beams with at least 40% polarization at the injection energy of RHIC. Separate AGS development behind RHIC stores will be required to demonstrate that this condition can be met.

Of the 8 weeks requested, two weeks are needed for setup of the RHIC complex for polarized proton collisions. STAR's priority for the remaining 6 weeks is as follows:

RHIC Spin Commissioning: 3 weeks.

C-AD has identified many commissioning tasks of the RHIC complex for reliable polarized proton collision running. A subset of these tasks directly impacting the STAR spin program are:

- Commissioning of the rotator magnets to provide longitudinal polarization of both beams at the STAR interaction region.
- Commissioning of the RHIC AC dipole to reverse the polarization of all bunches stored in either or both the Blue and Yellow rings
- Development of a mode where the RHIC beams are accelerated to 100 GeV/c and stored, and then decelerated back to the injection energy and stored long enough to complete a polarimeter run. (This mode is the only possible means to measure the polarization of the beam at 100 GeV/c until the completion of the polarized gas jet target.)
- Completion of the other developments needed to produce polarized proton collisions at a luminosity of 10^{31} $cm^{-2}s^{-1}$ with a small diamond size using the 200 MHz RF cavities and a polarization of at least 35% for each beam.

Vertical Beam Polarization: ($\int L = 1\ pb^{-1}$, P > 35% Transverse; ~ 1 week)

A primary goal of this request is to complete the measurement of the analyzing power A_N for neutral pions produced at large Feynman x and moderate transverse momentum. Estimates of the required precision for A_N were made previously based on theoretical calculations extrapolating the `E-704' effect to RHIC energies. There is renewed interest among experimentalists and theorists in single-spin effects as a consequence of recent results from the HERMES collaboration on transverse spin effects in semi-inclusive deep inelastic scattering. Robust results from the STAR Forward Pi0 Detector (FPD) will provide timely data that will complement results from the ongoing HERMES experimental program. It will also provide information relevant to planned measurements of the Collins fragmentation function in e+e- collisions at BELLE, and will address the (very significant) theoretical activity presently ongoing in this area. A minimal FPD configuration of left-right symmetric calorimeters, with the capability of identifying neutral pions from their daughter photons, mounted on one side of STAR is needed to complete these measurements.

A second goal is to establish a robust means of commissioning the spin rotators mounted on either side of the STAR interaction region. A significant measured transverse asymmetry will allow tuning to eliminate transverse polarization components that may remain if the spin is not rotated precisely 90 degrees. The requested integrated luminosity with vertical polarization is necessary to achieve this goal.

This data sample will also permit the study of transverse single spin effects for high-pt particle production at mid rapidity.

Longitudinal Beam Polarization: ($\int L = 3\ pb^{-1}$, P > 35% Longitudinal, both beams; ~ 2 weeks)

The goal of this request is the first measurement of the longitudinal two-spin asymmetry, A_{LL}, at large $\sqrt{s}$ and large Q^2 in inclusive jet production at mid rapidity. A jet trigger based on the half-completed STAR barrel electromagnetic calorimeter (EMC) is essential for these measurements. With full azimuthal coverage of the EMC in the interval $0 < \eta < 1$, simulations have shown that the estimated statistical error on A_{LL} at pt = 12 GeV/c is ~ ± 0.01; at pt = 25 GeV/c it is ~ ± 0.1. Another challenge will be to demonstrate that a process can be found that will allow the relative monitoring of the luminosity for bunch crossings with different polarizations in an unbiased way. The luminosity uncertainty is the dominant systematic error and needs to be limited to ~ ± 0.001. A separate high-statistics scaler experiment counting the pseudo-rapidity dependence of forward charged particle production using the STAR beam-beam counter is expected to achieve the needed systematic precision. If the statistical and systematic precision can be achieved and a significant non-zero A_{LL} is observed, it is expected that theoretical analysis of the data can establish whether or not the gluon polarization (ΔG) is positive, substantially improving our understanding of the nucleon's spin structure. An observation consistent with zero will not rule out gluon polarization, but will constrain the possible models for the polarized gluon structure. Results on A_{LL} will be timely, since the COMPASS experiment at CERN is also embarking on a program of spin asymmetry measurements this year intended to probe gluon polarization effects using open-charm production and high-pt hadron pairs as probes.

These measurements will also help establish criteria for making single photon isolation cuts with the STAR Level II trigger. They represent a critical step towards the long term goal of understanding the nucleon's spin structure, including precise determination of the gluon contribution to the proton's spin via a measurements of A_{LL} for photon + jet coincidences.

3. Run IV (2003-2004): Charmed Quark and Direct Photon Production in Hot Nuclear Matter; Continuation of Studies on Transverse Spin Effects and ΔG

The STAR beam use request for Run IV in shown in Table IV:

Table IV

Beams	AuAu	p↑ p↑
Weeks	19	N (~ 8)
$\sqrt{s_{NN}}$	200, 20, 40, 80 (16, 1, 1, 1)	200, 500

- Main scientific and technical goals:

- Measurement of open charm and charmonium in AuAu
- Measurement of high pt spectra and correlations with EMC trigger in AuAu
- Measurement of elliptic flow for heavy baryons/mesons
- Search for possible threshold behavior in soft physics observables vs $\sqrt{s_{NN}}$
- Continuation of soft physics program
- Continued work on measurement of ΔG in p↑ + p↑

The period of AuAu running at full energy requested will allow STAR to extend a number of soft physics measurements made in the first two runs, as well as to access several new penetrating probes. Assuming a DAQ100 rate of 20 Hz and 35 Hz for central and minimum bias AuAu collisions respectively, as well as a STAR+RHIC duty factor of 40%, STAR will acquire

- 50 M central and 100 M minbias collisions at $\sqrt{s_{NN}}$ = 200 GeV. Based on previously measured yields (where possible) and estimated yields for open charm and charmonium, these data sets are projected to provide:
    - ~ 8 -10k J/Ψ (σ_eff = 4.3 mb)
    - Lambda 1520 → pK at 30 sigma level of significance (central)
    - D° → Kπ at 12 sigma level of significance (central)
    - D° → Kπ at ~ 4-5 sigma level of confidence in 4 centrality bins (minbias)
    - 1.4 M Ξ + anti Ξ (minbias) for flow; 3M Ξ + anti Ξ central
    - ~30k Ω minbias for flow studies; 30-60k Ω central
    - ~ 20k π° (minbias) $|\eta| < 1$, pt ~ 10 GeV/c

These are examples of challenging measurements that will be accessible to STAR in a full energy AuAu run of 16 weeks duration. These data sets will constitute a robust sample allowing a full survey of soft and hard physics observables accessible by STAR for full energy AuAu collisions.

In addition to AuAu running at full energy STAR requests 3 AuAu runs at lower energy (20, 40, and 80 A GeV). The low energy runs will allow a systematic check of soft physics observables measured at CERN, as well as a detailed comparison with AuAu data taken at $\sqrt{s_{NN}}$ = 130, 200 GeV. Since the part of the initial state parton (gluon) distribution effective for particle production at mid-rapidity changes with $\sqrt{s_{NN}}$ the yields and slopes of particle spectra, anti-baryon/baryon ratios, strange particle yields and slopes, particle correlations, etc. will change as a function of energy. These studies will provide important information for developing a complete picture of the dynamics and evolution as the system progresses from hot hadronic to quark-gluon matter. In addition, the matter produced in AuAu collisions at $\sqrt{s_{NN}}$ = 200 GeV appears to exhibit several behaviors (possibly related) which are qualitatively different than what has been observed before at lower energy. It is important to attempt to establish whether these are related to phenomena which become important above a particular threshold in energy, or whether they are smoothly varying as a function of $\sqrt{s_{NN}}$. These behaviors have only recently become apparent; the use of high pt triggering (not available in the first two runs) will be essential to attempt to study them as the collision energy is reduced.

STAR Spin Physics Goals for Run IV: Assumptions and Plan/Goals

The assumed configuration of AGS and RHIC for spin physics running in Run IV is as follows:

- CNI polarimeters in blue and yellow rings (since Run II)
- Siberian snake magnets in blue and yellow rings (since Run II)
- STAR spin rotators (since Run III)
- CNI polarimeter in AGS (since Run III)
- Siemens motor generator for AGS (since Run III)
- polarized gas jet and `phase 1' calibration experiment (Run IV)
- strong Siberian snake for AGS (not available until Run V)

The assumed luminosity and beam polarization for Run IV is:

- L_avg(store)= $5 \times 10^{31}\ cm^{-2}s^{-1}$ / L_avg(week)= 12 pb^{-1} / week at $\sqrt{s}$ = 200 GeV. This is assumed to be a factor of 2.5 larger for $\sqrt{s}$ = 500 GeV operation.
- The beam polarization in RHIC is assumed to be 40%

The assumed status of STAR electromagnetic calorimeter for Run IV is:

- 90 modules of barrel EMC (commissioning of 30 new modules required)
- full endcap EMC available (commissioning required)

The assumed length of polarized proton running in Run IV is 8 weeks total. Under the above assumptions, the plan/goals for utilization of polarized proton collisions in Run IV are as follows:

RHIC Ramp-Up (including commissioning): (3 weeks)

After two weeks of RHIC set-up, the major commissioning tasks to be accomplished include:

- Operation of polarized gas jet target and recoil proton detectors. This work is assumed to be carried out concurrent with normal RHIC operation. Dedicated fills for polarized gas jet commissioning will be required.

- Increasing the luminosity from run 3 average to the values listed above.

- Tuning the spin rotators for 250 GeV beams ($\sqrt{s}$ = 500 GeV collisions). This requires ~3 pb^{-1} of vertical polarization running to establish a robust measure of transverse single spin asymmetries (FPD, BBC) that can be used as a signal for tuning the spin rotator magnets. At the assumed luminosity listed above, the vertical polarization running can be completed in ~1 day.

STAR Data Collection and Physics Goals:

- It is proposed to utilize 24 pb^{-1} (2 weeks) at $\sqrt{s}$ = 200 GeV with photon and jet triggers to produce final values for A_{LL} for inclusive jet production (first attempted in run 3) and inclusive photon production. The goal will be to obtain a sample of photon + jet coincidences to tune analyses for a long polarized proton run in FY05.

- It is proposed to utilize 10 pb^{-1} (5 days at the end of the ramp-up/commissioning phase) at $\sqrt{s}$ = 500 GeV with vertical beam polarization to measure the analyzing power for forward π° production and to measure single spin asymmetries at mid-rapidity from a data sample obtained with jet triggers.

- Finally, 25 pb^{-1} (1 week) at $\sqrt{s}$ = 500 GeV would be utilized to collect data with photon, electron and jet triggers. This should provide a data sample with ~3,000 W candidate events and should enable an evaluation of A_{LL} for inclusive photon and jet production.

4. Run V (2004-2005): Comparison Soft Physics Spectra/ Charm, Charmonium, High pt Yields for Lighter Species; Robust Measurement of ΔG at √ = 200 GeV

The projected STAR Beam Use Request for Run V is shown in Table V.

Table V

Beams	CuCu, SiSi	p↑ p↑
Weeks	(12)	(15)
$\sqrt{s_{NN}}$	200, 200 (6,6)	200

- Main Goals:
  - Soft physics comparison for lighter species
  - high pt inclusive spectra and leading particle correlation studies
  - J/Ψ and open charm yield comparison for lighter species
  - Robust measurement of ΔG in p↑ + p↑ at √ = 200 GeV

Run V will be the first run for which all of the components essential for a robust measurement of ΔG in p↑ + p↑ at √ = 200 GeV are commissioned and ready. Specifically, it is anticipated that a strong partial snake will have been implemented in the AGS, and that a fully commissioned jet target will be available to provide absolute calibration of the beam polarization to ~ ±5%. As a consequence, STAR proposes to give high priority to a robust measurement of ΔG, a study which has been of world-wide interest for several decades, and which has the potential to elucidate the parton dynamics within the proton.

Equally important, STAR proposes to measure comparison spectra for lighter species for soft physics observables and high pt inclusive spectra and correlations, as well as J/Ψ and open charm. The energy density reached at RHIC, and hence the probability of forming a deconfined phase are expected to depend significantly upon the size and geometry of the colliding system. Therefore, the various physical properties of the system that will be measured, such as the build-up of elliptic flow, the propagation and energy loss of hard scattered partons, the yield of strange particles, characteristics of the source(s) for particle emission, and the level of event-by-event fluctuations and correlations are all expected to depend strongly on system size and geometry. Varying the system size is best accomplished in a controlled manner by varying the beam species. The dependence of some observables may be essential for interpretation of the results from full energy AuAu interactions, and in principle it would be advantageous to have this information sooner. Practical concerns about the overhead in establishing a given running configuration, and the desire to address heavy flavor as soon as possible necessitate this measurement being planned for Run V, although it is considered to be a contingency if part of the Run III plan becomes problematic.

5. A Future Perspective

Run VI (2005-2006): Charmed Quark /Direct Photon/High pt Yields and Parton Distribution Functions in Cold Nuclear Matter; Measurement of ΔG at √s = 500 GeV

A detailed scenario for Run VI has not been discussed in STAR and is beyond the scope of this request. It is anticipated however, that by 2005-2006, there will be considerable scientific interest in an extended pAu run to provide a comprehensive study of charmed quark, direct photon, and high pt yields to study parton distribution functions in cold nuclear matter. Extension of the measurement of ΔG to $\sqrt{s}$ = 500 GeV to access the lowest values of Bjorken x possible in the first phase of RHIC will also likely be a priority.

6. Collaboration Readiness

The STAR Operations Group, as well as the STAR Collaboration membership have been participating in an extensive program of shut-down activities in preparation for Run III. STAR will be fully prepared to begin the program outlined for Run III.