Beam Use Proposal For RHIC Run IV and beyond (FY 2004+)

The BRAHMS Collaboration

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Abstract

The Brahms collaboration submits a request for this years beam use proposal with a long run with Au-Au at 200 GeV as the highest priority. Additional requests most likely to be fulfilled in following run-periods are for a light ion beam (Fe), a lower energy Au-Au run, and polarized pp running.

1.Introduction

With the significant progress already made by the BRAHMS experiment, it should be possible to complete the program initially described in the experiment's CDR in the next few years. This proposal summarizes what has been accomplished and what yet remains from our initial experimental program. The proposal also discusses the new results from BRAHMS and the other RHIC experiments that influence the details of how we plan to proceed. Because of these new physics opportunities, we propose a modest extension to our baseline program, while retaining the essential survey nature of the investigations. The case for measurements of transverse asymmetries in polarized proton-proton collisions with BRAHMS is also presented in detail.

Discussions have been initiated on a new, refocused, forward-physics experiment to be implemented after completion of the BRAHMS baseline program. A formal Letter of Intent will be presented at a later time. It is quite conceivable that the d-Au program discussed in this request would fall under the auspices of such a collaboration.

2. BRAHMS Experiment and Physics Goals

The BRAHMS experiment has unique capabilities for precise momentum determination and particle identification for studying relativistic heavy-ion collisions. The forward spectrometer (FS) is unique within the family of RHIC experiments in that it can identify hadrons up to rapidity $y = 4$, and covers a large momentum and transverse momentum range. The excellent Particle Identification (PID) and angular coverage of the Mid-Rapidity Spectrometer (MRS) extends and complements measurements by the other RHIC detectors, and it provides for comparisons between mid-rapidity and forward-rapidity spectra. Despite the small solid angles of the spectrometers, p_t spectra of identified particles can be measured up to 3-5 GeV/c and at several rapidities with a readily obtainable integrated luminosity. This permits, for example, studies of high p_t-suppression in heavy ion reactions over a wide rapidity range.

Results from the BRAHMS experiment obtained in RHIC runs I-III.

The near term plans of the collaboration for RHIC runs IV to VI emerge naturally from the first results that have been obtained from the commissioning run at $\sqrt{s_{NN}}$=130 GeV (run I), the first major run at the design energy $\sqrt{s_{NN}}$ = 200 GeV for Au-Au collisions (run II), and the p-p and d-Au runs at the same energy of 200 GeV in runs II and III.

The data taking in these runs has been characterized by a first mapping of the global features of the reactions listed above exploiting the unique features of the BRAHMS experiment, namely the ability to study a large region of the (y, p_t) space with excellent particle identification for charged hadrons over a wide range in momentum and rapidity The time estimates for completion of the program made initially were based on the design estimates of the integrated luminosity at RHIC. It is clear that the integrated luminosity and diversity in species that has been delivered so far has not been sufficient to complete our baseline program. In addition, a number of very interesting new physics topics have been identified which the collaboration wish to investigate in greater depth. These topics tend either to involve low production cross section events, such as those leading to high p_t particles, or the measurement of correlations among particles. In either case, measurements with higher integrated luminosity are needed.

Below we briefly summarize our main accomplishments to date. These have led to a number of publications, with several additional papers currently being prepared.

Publications

- Rapidity density of charged hadrons at $\sqrt{s_{NN}}$ =130 and 200 GeV [1,2]. These studies establish the baseline charged-particle pseudorapidity densities in Au-Au collisions over a wide pseudorapidity range.
- Hadron to anti-hadron ratios at $\sqrt{s_{NN}}$ =130 and 200 GeV. The particle ratios constrain dynamical models, and establish that a system is formed that is consistent with being in chemical equilibrium over a wide rapidity range[3,4]
- Nuclear modification factors in Au-Au and d-Au collisions at $\sqrt{s_{NN}}$ =200 GeV. Despite the small solid angles of the BRAHMS spectrometers, their capabilities can develop unique information about high p_t suppression,. A Letter has recently been published on the Au+Au R_{AA} distributions at η = 0 and 2.2 and for the d-Au data at y=0 [5]. Further analysis will focus on identified hadrons, particularly at higher rapidities. The d-Au data at higher rapidity have been collected and are being analyzed .

Papers in preparation

- Run II yielded sufficient data to map the net proton rapidity distributions at $\sqrt{s_{NN}}$ =200GeV for Au-Au collisions, demonstrating that at RHIC the rapidity scaling for AA energy loss [Ref. ?] is broken.
- Yield of charged hadrons vs. rapidity at $\sqrt{s_{NN}}$ =200. One remarkable result is the demonstration of nearly Gaussian rapidity density distributions, in contrast to the naïve expectation of nearly flat Bjorken boost invariant distributions.
- Centrality dependence of identified hadron yields at mid-rapidity.
- Rapidity dependence of deuteron and anti-deuteron coalescence factors at $\sqrt{s_{NN}}$ =200GeV.
- The pp experiments in run II and run III have so far been analyzed for ratios of charged hadrons vs. rapidity in $\sqrt{s_{NN}}$ =200 GeV p-p collisions, and will be contrasted with the AA ratios.
- Yield of charged hadrons and p_t dependence vs. rapidity in p-p collisions at $\sqrt{s_{NN}}$ =200GeV.
- Pseudorapidity density distributions vs. centrality for d-Au collisions over a wide pseudorapidity range.

2.2 Present Detector configuration

The BRAHMS detector consists of 3 major spectrometers:

- The Front Forward Spectrometer (FFS), consisting of 2 magnets, tracking and time-of-flight detectors, and a threshold Cherenkov detector, is moveable from 2.3^o to 30^o ($1.3 < \eta < 3.9$)
- The Back Forward Spectrometer (BFS), consisting of 2 magnets, tracking and time-of-flight detectors, and a ring-imaging Cherenkov detector, is used in combination with the FFS to measure in the angular range from 2.3^o to 15^o. ($2.0 < \eta < 3.9$)
- The Mid-Rapidity Spectrometer (MRS), consisting of a single magnet, tracking and time-of-flight detectors, is moveable from 30^o to 95^o ($0< \eta < 1.3$). The particle identification was enhanced

during run III with the installation of a threshold Cherenkov counter that allows us to identify charged pions in the momentum range of 3.5 to 6 GeV/c. A second time of flight wall (TFW2) that extends PID for protons/kaons was also added.

BRAHMS has a set of global detectors that are used for event characterization, triggering and timing:

- The Centrality detector consists of an inner layer of Si-detectors and an outer layer of large scintillator tiles covering the range of about $-2.2 < \eta < 2.2$.
- The Beam-Beam counter array provides accurate start timing information to the experiment, rough vertex determination, and multiplicity measurements at high $|\eta| \sim 3\text{-}4$.
- The Zero Degree Calorimeters (ZDC), a device common to all RHIC experiments, provide luminosity information and online vertex trigger and neutron multiplicity at 0^o and 180^o.
- Inelastic counters observe ~85% of the non-single-diffractive pp cross section that provide trigger and vertex information in pp collisions.

2.3 Detector upgrades for RUN-4

In anticipation of higher luminosity Au beams, spectrometer trigger detectors for both the MRS and FS are being constructed and will be installed to provide efficient triggering for peripheral collisions. VME electronics has been developed for the trigger setup. A portion of the Si-detector system will be reconfigured to allow for event-plane determination in Au-Au collisions. A new flow detector is being prototyped, and will be added to the experiment, hopefully for an extended part of the RUN-4.

2.4 Physics Program

heavy collisions

High-pt suppression

A tool for understanding the initial partonic state is to study identified high p_t hadrons over a range of rapidities. BRAHMS is uniquely capable of studying the evolution of the high p_t components of hadronic spectra over several units of rapidity. Recently all RHIC experiments have reported suppression of high p_T spectra compared to expectations from pp collisions [5,7] near midrapidity at both 130 GeV and 200 GeV. BRAHMS, with its extended pseudorapidity coverage, also observes this suppression at y~2. The suppression may result from the energy loss of quarks and gluons passing through a dense partonic system. The continued suppression out to y=2 provides information on the longitudinal extent of this dense system. In the next set of measurements we will explore the suppression signature at even larger rapidity.

The study of particle spectra in the p_t range of 1-4 GeV/c will help in the understanding of initial scattering (Cronin) effects, gluon shadowing effects and jet quenching. The relative importance of these processes depends on energy, rapidity and the mass of the collision system. Systematic studies may disentangle effects related to a 'cold' versus a 'hot' medium, and to the density of the medium. At higher rapidities (~3-4) the shape of the pion spectra may allow the study of the Color Glass Condensate (gluon saturation) in the initial state [9] in p(d)-A reactions.

Collective flow

The analysis of radial and elliptic flow gives access to information on the temporal and spatial development of pressure within the hot strongly interacting system. The ability to detect the reaction plane will open up a new dimension for the BRAHMS' study of heavy ion collisions. Besides measuring the full three dimensional cross section, $d^3N/d\varphi dp_t dy$, and R_{AA} factors, we can also study the φ and p_t dependence of coalescence at different rapidities. Such studies will be essential in determining the equation of state of the hot dense, and presumably partonic state of matter produced at RHIC.

System size dependence
Light ion collisions such as Fe-Fe will allow us to study hot nuclear systems with ~ 10 to 100 participants. This region of system sizes is not easily studies with Au-Au collisions since it is very difficult to accurately determine the number of participants for peripheral events. With a light projectile like Fe the matter length for suppression of high p_t particles is about half of that in Au-Au, but likely with quite similar energy densities. This increased lever arm will be very useful for studying models of particle production but perhaps more importantly will allow us to study high p_t suppression as a function of system size. BRAHMS can study this effect at $\sqrt{s_{NN}}$ = 200 GeV. Finally it would be interesting to see if the coalescence radius decreases significantly when we reduce the number of participants by a large factor.

Energy systematic of heavy ion collisions
The study of bulk properties vs. available energy has been a key signature of nuclear physics, and has in general led to a better understanding of the reaction mechanism and the dense system formed. At present the highest SPS energy is at ~18 GeV, and the lowest RHIC data that are well studied are at 130 GeV. There is a significant change in stopping between SPS and RHIC with the former significantly stopped, and rather transparent at RHIC . An intermediate energy such as 63GeV for which some, albeit lower statistics and less systematic data exists for pp collision (ISR), would add well into the overall systematic understanding. At this energy Brahms can measure essentially into the fragmentation region, and explores both stopping and the complete shape of produced mesons, as well as limiting fragmentation for identified particles. This will place additional stringent limits on the theoretical understanding of stopping, energy loss and transparency. The rapid disappearance of high p_t jet-like particles unfortunately makes a study of high p_t suppression at lower energy statistically very difficult with BRAHMS, but we can make a measurement up to ~ 4GeV/c at y~1.

Bulk properties
In Run II BRAHMS measured d^2n/dp_tdy distributions of identified hadrons from which rapidity densities, $\langle p_t \rangle$, and spectral shapes were deduced. These results were used for the study of transverse flow and longitudinal dynamics for the reaction. Particle ratios as a function of rapidity were analyzed within the statistical model framework to determine the baryon and strangeness chemical potentials, and the chemical and thermal freeze-out temperatures as a function of rapidity. From the proton and antiproton rapidity densities we can deduce the net energy loss of the beam and projectile. In addition, global charged particle pseudorapidity densities have been measured using the BRAHMS global detectors. Together, these measurements strongly constrain models in terms of their longitudinal development. We wish to extend the spectral measurements to the highest rapidities allowed by the forward spectrometer and beam line geometry (2.3^o), which will allow us to better determine the net-proton distribution and to place even more stringent constraints on theoretical models.

Particle correlations
Interferometry and nucleon and anti-nucleon coalescence allow us to measure the final state of the system as it breaks up. The "HBT puzzle" at RHIC is the striking similarity of the outward and sideward correlation functions and the lack of any dependence of the radii on $\sqrt{s_{NN}}$. NA44 at SPS has combined π, k and p interferometry and coalescence measurements to determine the transverse flow of the Pb-Pb system [4] at $\sqrt{s_{NN}}$=17 GeV. However, at high expansion velocities which reach the speed of sound in the medium, as may occur at RHIC, one would expect hydrodynamics to break down and, indeed, some evidence for this effect in high p_t pion interferometry may be seen. We will study coalescence at both high rapidity and at higher p_t values to address these issues, and will collect data for HBT analysis in conjunction with other data taking. Combining interferometry and coalescence volume information with single particle momentum spectra will allow us to measure the density of particles in phase space [5]. Integrating this density can reveal the entropy of the system. Finally comparing the formation of nuclear clusters and anti-clusters will help us understand the time interval between hadronization and thermal freeze-out.

Nucleon-Nucleus (d-Au) collisions

Version 1: (R .D)

At RHIC energies, where partonic degrees of freedom are relevant, the d-Au(or p-A) system was early identified as one with identical partonic interactions as A-A systems but without the colored and highly opaque region that the latest measurements indicate has been formed in the A-A collisions.
Meanwhile, results from Deep Inelastic Scattering are showing hints of possible new physics as these experiments probe smaller values of x in e-p collisions. At high energy, the structure of the proton can be resolved as being populated by a growing number of gluons with a density that must reach a limit as x tends to zero. If the target of DIS is replaced by a nuclei, the density of gluons or the relevant momentum scale of the system grows as a power of A making it easier to study nuclear medium effects in e-A or p-A reactions. These arguments brought forward the possibility of finding saturation at RHIC.
The original work on the possible formation of Color Glass Condensate (CGC) at RHIC focused on a formalism based in a 2 to 1 partonic reaction that offered access to the small x components of the wave function of the nuclei whenever the single parton product of the fusion had high rapidity. This is the kind of physics that BRAHMS is well suited to pursue.
Analysis of the latest dA collisions at RHIC has shown that saturation in the initial state of the ions does not explain the high-pt suppression observed in A-A collisions, but the formation of the CGC is still possible at forward rapidities and if this new description of nuclei at high energy is true, a detailed program to study its properties should be considered not only because it is a novel state of matter but because it also provides a well defined initial state for the Quark Gluon plasma that is the main focus of RHIC.
BRAHMS has collected a sample of d-Au data at mid-rapidity and at 4 degrees. Without the benefit of our particle identification systems we can study charged hadron spectra that extend up to 5 GeV/c at mid-rapidity and have published those results together with the other three RHIC experiments. At 4 degrees our sample is smaller an extends only out to ~4 GeV/c.
The collaboration would like to complement our sample of d-Au data in order to be able to continue a detailed study of nuclear medium effects at RHIC energies:.
We would like to have another dedicated d-Au run included in the RHIC schedule. During this run we would study the now considered standard "nuclear modification factors" for each particles species and as function of the "centrality" of the collision. We would also like to study rapidity distributions for samples of events with different transverse momenta. We would also like to explore the physics of the nuclei fragmentation region with the heavier ions circulating in the Blue ring.

Version 2 (M.Murray –FV)

Recent results from HERA have shown that at very small x gluons may fuse together. This raises the possibility that at RHIC the soft gluons from different nuclei may fuse to form a Colored Glass Condensate, (CGC). A version of the CGC model was proposed to explain the High p_T suppression observed in Au-Au collisions at RHIC. Although this was not consistent with the d-Au data at y=0 it is still possible that the CGC may be observed at forward rapidities in d-Au collisions. BRAHMS did collect a sample of d-Au at higher rapidities during run-III. The analysis of the these d-Au data is not yet complete, but should it reveal features in the data consistent with the CGC, this will warrant a request for additional d-Au running in the coming . In this case we would also wish to investigate the situation at backward rapidity by studying d-Au collisions.

Proton-proton collisions

Transverse Asymmetries for charged hadrons.

In addition to these heavy ion topics the collaboration is developing the tools for measuring and analyzing the charged pion asymmetry at higher x_F values in polarized p-p reactions. Towards this end we have established a collaboration with the RBRC spin group .

The E704 experiment at Fermilab observed large (~30%) single-spin transverse asymmetries in pion production at forward angles from p-p collisions at √s =19.4 GeV [13,14]. Because pQCD predicts only small effects, these observations spurred significant theoretical progress. Presently, it is recognized that, with the inclusion of intrinsic transverse momentum, k_T, pQCD calculations can predict such large asymmetries arising from, for example, the Sivers effect [15] (spin dependence of the k_T distribution of the proton), the Collins effect [16] (final state interactions of a transversely polarized quark fragmenting into a pion), twist-three contributions beyond the leading power picture [17], or a combination of these three. With precise measurements of these asymmetries at the higher √s of RHIC (200 GeV), it is possible to discern between these explanations because the predictions of each one exhibit different dependence on the energy. During Run-2 and Run-3, the STAR experiment measured this asymmetry for forward neutral pions and found that it was as large as (if not slightly larger than) those observed by the E704 experiment.[18] Given the excellent PID and momentum resolution achievable with the BRAHMS forward spectrometer, we propose to measure these asymmetries for positive and negative pions over the x_F region up to ~0.45 (y ~ 4) during Run-4 and Run-5 in order to provide a complete measurement of these quantities. In addition, we intend to measure the charged kaon asymmetries during Run-5 and Run-6. These measurement would test the expectations based on the partonic content of the initial and final particles, namely that: the positive kaon and pion asymmetries would be roughly equal because the production process for both mesons is expected to be dominated by the valence u-quark and (2) the negative kaon asymmetry would be zero since the negative kaon is an all-sea object and the sea is basically unpolarized.[19] If merited, we will also explore the p_T dependence of the asymmetry at fixed x_F in subsequent runs.

Completion of Survey program

The Run-II and Run-III pp program yielded some results for general survey of elementary collisions at √s=200 GeV to be contrasted with Au-Au at the same energy. The statistics obtained at relative high pt (3-4) and at large rapidity (2,3) were marginal and only obtained for one charge state (negative.) The Pythia model predicts quite significant differences between π+ and π- Since these are not necessarily well predicted due to lack of experimental data for identified particle at larger rapidities, and these are of importance for the high pt suppression interpretation in Heavy Ion collisions, we wish to supplement our earlier measurements.

3. Beam Request

The following beam request is divided into two sections , the first by identifying the specific measurements that BRAHMS wants to do in order to complete the baseline physics program, and the second section mapped onto specific budget scenarios of 27 and 37 cryogenic weeks, respectively. These sections outline a program that is both true to the goals of the original proposals and CDR, and to a follow-up of the more recent discoveries at RHIC manifested in the high pt suppression and the hydrodynamic nature of the collisions via the elliptic and transverse flow. We believe the program outlined is essential for the present discovery and survey phase of the RHIC heavy ion program.

Au-Au collisions at 200 GeV

BRAHMS has carried out a first mapping of hadronic production as a function of rapidity. Because the delivered luminosity has been considerably lower than the design luminosity, the data from runs II and III were at only a few selected angles and with momentum settings that maximized the counting rates. The high-p_t measurements at y~2 demonstrated the suppression of charged hadron yields with respect to the pp data persists at high rapidity, and we wish to carry out a high quality measurement near y~2.5 where the dn/dy value in central collisions is about 1/2 of the mid-rapidity value.

The high-p_t measurements are our most demanding in terms of the statistics needed. The quality of the Brahms PID at forward rapidities will allow us to study the suppression of identified hadrons thus illuminating the interesting issue of proton to pion enhancement in the pt-range of 1.5-3 GeV/c.

In summary, the Au-Au program for 200 GeV, which we would like to see done in run IV, is tabulated below. The measurements at y~1 can be preformed in parallel with those of the forward spectrometer(high rapidity) which sets the length of the request.

1. Collect high statistics for high p_t spectra at y~2.5 and y~3.5 for both charge states (100 +40 μb^{-1}).

2. Flow (v2-measurements up to about p_t~2 vs. centrality) p_t~3 overall. (40 μb^{-1})

3. Supplement existing lower p_t data where needed. (40 μb^{-1})

4. Perform simultaneous coalescence measurements at y~2.5. Part of this will be done under 1, but requires additional settings (20 μb^{-1})

The simultaneous measurements in the MRS will concentrate of higher field running at y~1 collecting higher p_t data at y~1 utilizing the new Cherenkov for pion identification. (100 μb^{-1})

Thus to complete this set of measurements we will need to have ~ 240 μb^{-1} delivered to IP2.
The estimates given above are made assuming that ~50% of collisions fall within +/-20cm of the nominal collision point, and that the Brahms combined up and DAQ live time is ~70%, which has been achieved so far.

Fe-Fe at full energy

The focus will be on measuring the higher p_t region of identified particle at y~1 and y~2.5. This will help in disentangling the importance of medium size vs. energy density experimentally, leading to a greater understanding of the phenomena observed with Au-Au at 200 and 130 GeV.

- Identified charged hadrons at y~1 and 2.5 (.9 nb^{-1})
- Complete rapidity distribution for net-protons (baryons), Particle composition, and strangeness production vs. rapidity (.3 nb^{-1})

It is our understanding that Fe is a beam quite readable available from the injectors into RHIC with luminosities expected to be equivalent to those estimated for Si (scaled to Ions/Bunch)

Au-Au at lower energy.

Running at reduced energy (e.g., at $\sqrt{s_{NN}}$=63 GeV) for Au-Au collisions will be of paramount importance for understanding the interesting signals that have emerged from the RHIC runs at maximum energy, notably studies of high p_t suppression and also the systematics of charged hadron spectra (e.g. kaon slopes) which may reveal features characteristic of a phase transition. In addition, BRAHMS has the unique ability to measure essentially the full net baryon distribution vs. rapidity at a lower energy. This will place additional stringent limits on the theoretical understanding of stopping, energy loss and transparency.

The very much reduced expected luminosities (~3-9 times less than at full energy) implies that only a few focused measurements will be performed for the high-p_t measurements due to the solid angles of the BRAHMS spectrometers. Complete rapidity distributions for soft physics particle production will be obtained. The main request is for two simultaneous measurements of

1. High-pt measurement at y~1 (10 μb^{-1}) (MRS)
2. Survey of net-proton, kaon and π distributions utilizing the FS (10 μb^{-1})

p-p at 200 GeV

Transverse asymmetry measurements

In Run-3, the BRAHMS experiment commissioned the necessary hardware for doing a spin measurement, namely a bunch-sorted scaler module. From the data collected while this module was operational, it was demonstrated that the systematic error for the relative luminosity measurement was below 0.3% prior to any corrections for the difference in the vertex distributions of each bunch. With a 30% polarized beam as in Run-3, this error would result in a 1% systematic error in the asymmetry measurement. At an x_F of 0.27+/-0.025, this level of statistical precision could be achieved for a measurement of the positive pions with 80 hours of data-taking at an average instantaneous luminosity of 300 mb^{-1}/s within the vertex region of the experiment as in Run-3 (integrated luminosity of ~150 nb^{-1} within the vertex acceptance of the experiment or ~300 nb^{-1} delivered). This measurement would be sufficient to discern between the extrapolations of models based on twist-three contributions and the Sivers effect which, respectively, predict an asymmetry of 2-4% [8] and 4-6% [9]. In Run-4, we would expect that both the luminosity and the beam polarization will be higher than that achieved in Run-3 and thus this measurement could potentially be done in one or two days of running. The measurement of negative pions will take longer because the production rates are smaller by a factor of ~2. In light of the limited time for proton-proton operation in Run-4, we would plan to make this measurement during Run-5 in addition to extending the positive pion measurement to higher x_F. However, the luminosity requirements for Run-5 and Run-6 would likely be driven by the measurement of the kaon asymmetry since the production rates for kaons is approximately a factor of 15 smaller than that for pions.

Reference spectra

We wish to complete the reference data set at $\sqrt{s_{NN}}$ of 200 GeV that was taken during the rather short pp period in RUN III. One emphasis is to record reference spectra at intermediate to high p_t (2-5 GeV/c) in order to compare to d-Au and Au-Au reactions the request is for ~ 1 pb^{-1}

Preferred Distribution on Running periods

The overall request for BRAHMS baseline program, i.e., for the coming few years, is based on the physics outlined above and translates to the following requested delivered luminosities to BRAHMS. This is done under the assumptions that in Run-4 the IP-2 is at beta* of 3. With a very modest upgrade of power supply distribution in the triplet a beta* of 2 can be achieved in subsequent years. Further for conversion to weeks it is assumed that the luminosity development is in the middle of the estimates by Roser in the August 20 document.
Since the analysis of the present d-Au run is not yet complete, and it may or may not warrant requests for additional beam time with deuterons this has been omitted from the detailed request; It has lower priority than the other requests, and the request may also be dependent on the status of the collaboration in the out years.

Beam Species	Energy	Luminosity	Approximate no wks.[1]

[1] The required luminosity is translated into weeks assuming β^* =3 for Brahms, and selecting a scenario for luminosity development above the minimum given by T.Roser, at roughly ½ the maximum expected range. Recall that his tables are for β^*=1, i.e. Phenix and Star. The second number is the time needed for Brahms

Au-Au	200	240 μb^{-1}	18-24
Fe-Fe	200	1.2 nb^{-1}	8
Au-Au	63	15 μb^{-1}	6-10
pp	200	3 pb^{-1}	8

Table 1. Summary of requested species and luminosities.

Thus under optimal conditions this program can be carried out in the next 2-3 years depending on the amount of running weeks available to RHIC. Due to the request for different species, energies as well as the spin program at RHIC this is a difficult scheduling, an we hope the planning that takes place this fall for the next 5 years of RHIC running will lead to a scenarios that can fit the desired Brahms program into the RHIC schedule.

Since the Au-Au top energy measurements requires in the order of 20 weeks of running it is our preference to utilize all of run 4 for this purpose. Should funding allow for additional running in FY04, the collaboration prefer to schedule a lower energy Au run since it involves the smallest 'cost' in terms of switch over time.

We want to comment too on the Brahms Heavy Ion program in relation to the overall Spin program that is being developed at RHIC, primarily a Phenix and Star effort. We understand that machine development time I needed to make this endeavor successful. Should it be determined that a pp beam commissioning will take place at the end of run-4 as requested by T.Roser, we will like to make clear that this offers an opportunity for a short run for Brahms to perform the first measurement of Ann for $\pi+$ at xF ~.25 as outlined in the request for ~1 week. The

Run-4	Au-Au 200 GeV	19
Run-5	FeFe 200 GeV	8
	pp 200 GeV survey	2
	pp 200 GeV transverse An	2
Run-6	Au-Au 63 GeV	6
	AuAu 200 GeV	5
	pp 200 GeV transverse An	4

Table 2 Running scenario under assumption of 27 cryogenic weeks. Only the physics weeks are given.

37 cryo weeks scenario

Run-4	Au-Au 200 GeV	19
	Au-Au 63 GeV	8
Run-5	Fe-Fe 200 GeV	8
	pp 200 GeV	8
	Au-Au 200 GeV	2 (as needed)

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to set up before physics running (i.e. part of the 2+3 week setup + ramp up period). It is our experience that only a very small amount of this time is useful for the experiment, and data collected during this period has not been useful in the past (short runs, unstable beam conditions, much better runs later in run period).

Table 3 Running scenario under assumption of 37 cryogenic weeks. Only the physics weeks are given.

The BRAHMS collaboration has a strong preference, in part because of the commitments that the Danish and Norwegian groups have to ALICE (which is expected to start taking physics data in 2008, but with construction completed before then), and in part because the physics program is part of the RHIC heavy ion survey and discovery phase, that the heavy ion program be given priority for the next few years, with the polarized pp program during this time emphasizing development and measurements requiring only short run periods. This is reflected in distribution of requested beams above.

Summary of Request.

The highest priority is a high statistics Au-Au run at full energy to study in detail high-p_t suppression at larger rapidities for identified hadrons. Subsequent heavy ions runs should be for 200 GeV Fe, and a lower energy Au run, preferentially at 63 GeV. The transverse spin asymmetries at large xF for identified π's is an unique that BRAHMS wants folded into the RHIC run planning for the next 3 years.

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