BRAHMS MANAGEMENT PLAN

APRIL 1997

The BRAHMS Management Plan provides the baselines and controls that BRAHMS and RHIC will follow to meet the BRAHMS technical, cost, and schedule goals. This plan will be reviewed and updated as required with revisions made by agreement among the participants.

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1. Overview

1.1 BRAHMS Collaboration as of April, 1997

The BRAHMS Collaboration

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1.2 Physics

At RHIC with energies $\sqrt{s}$ = 200 GeV/c per nucleon pair, which is above the stopping regime presently being explored at AGS and SPS, a baryon poor region with a high energy density is expected to be created at mid-rapidity. The region near the initial nuclei will be baryon rich at relative high temperature. This gives experimental opportunities to study both regimes at RHIC and search for the quark-gluon plasma under several different conditions.

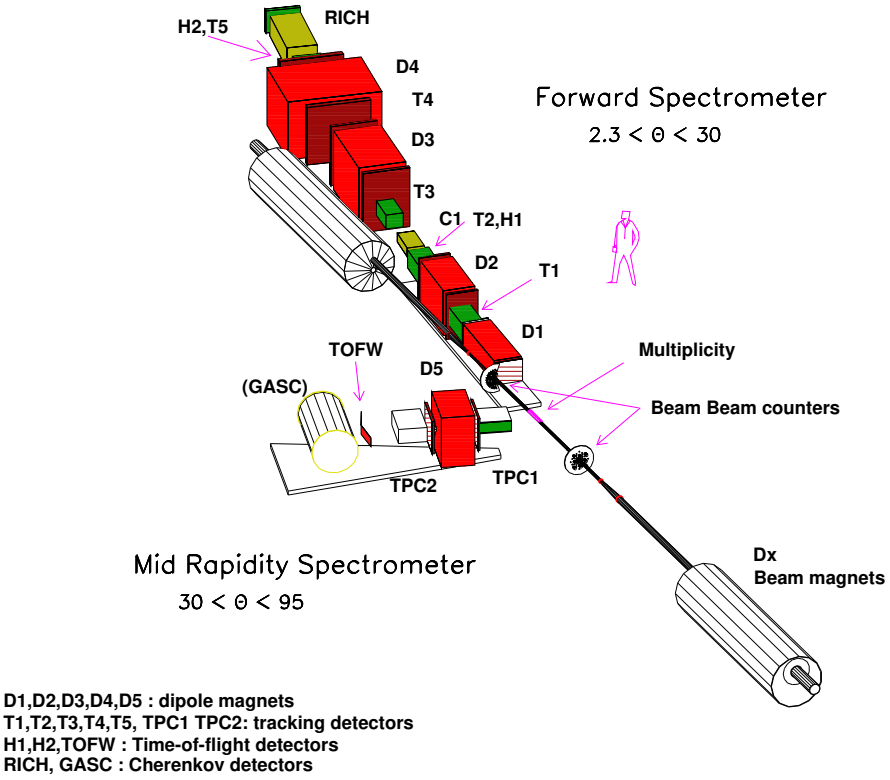
One goal of the Broad Range Hadron Magnetic Spectrometers (BRAHMS) experiment is to gather basic information in heavy ion reactions on momentum spectra and yields for various emitted particles as function of transverse momenta, p_t , and rapidity, *y*. These yields as a function of rapidity are important indicators of the densities reached in the collisions and of the produced entropy. The spectral shapes and their *y* -dependence reveal the reaction dynamics and the degree of thermalisation attained. The high p_t parts of the spectra carry information from the early times in the reaction. The BRAHMS experiment also has some, though limited, capability to study the space time extension of the hot system through 2-particle correlation of ¹ and K, and properties of the ø meson through K^+K^- pairs.

Another goal is to look for evidence of the QGP phase transition as it may manifest itself in the final hadronic stages, e.g. through study of the $< p_t >$ dependence on centrality, and the strange particle production via K^+ and K^-, both in the relatively baryon free mid-rapidity region and in the baryon rich fragmentation region.

1.3 The BRAHMS Detectors

The BRAHMS experiment is designed to measure well identified charged hadrons ($\pi^{\pm}$, $K^{\pm}$, $p^{\pm}$) over a wide range of rapidity and transverse momenta at all energies and beams available at RHIC. The very different experimental conditions, momenta, and particle densities at mid-rapidity and forward angles has lead to the design with two moveable magnetic spectrometers. The Mid-Rapidity Spectrometer (MRS) covers the angular region $30^o \le \Theta \le 95^o$ ($-.1 \le \eta \le 1.3$) and the forward spectrometer (FS) the region $2.3^o \le \Theta \le 30^o$ ($1.3 \le \eta \le 4.0$). The forward spectrometer consists of 4 dipole magnets (D1-D4), two time projection chambers (T1, T2) and three drift chamber packages (T3-T6). The particle identification is done by combining time-of-flight measurements in the Hodoscopes H1 and H2 with measurements in the threshold Cherenkov counter C1 and the Ring Imaging Cherenkov Counter (RICH). This allows for particle identification in the momentum range 1-20 GeV/c in the forward spectrometer. The mid-rapidity spectrometer has two TPCs (TPC1 and TPC2), a dipole magnet (D5) for momentum measurements, a time-of-flight wall (TOFW), and a segmented gas Cherenkov detector (GASC) for particle identification in the momentum range p< 5 GeV/c. The momentum resolution is typically $(\delta p / p) \le 0.01p$, which is sufficient for tracking considerations and the spectral measurements. A set of beam-beam counters provide the initial trigger, vertex and multiplicity information, as well as the start time for the time-of-flight measurements. The silicon multiplicity array will be used to characterize the centrality of the collisions by measurements of the charged particle multiplicity's in the region $-2.5 \le \eta \le 2.5$.

For the initial run in FY00 the BRAHMS detector will consist of the entities described above with the exception of the GASC, and a reduced multiplicity array and TOFW i.e. the base-line detector.



Perspective view of BRAHMS spectrometer

1.4. Cost, Schedule and Funding

The cost and schedule for BRAHMS has been reviewed in a bottom-up analysis by sub-system, an analysis which forms the basis for the accompanying WBS book. Table 1 shows the breakdown of the costs in AY dollars on the WBS entries at level 4 as defined in the following section. The contingency has been estimated on a per item basis according to the following guidelines.

catalog	10-15%
quote from vendor	15-20%
engineering estimate	20-25%

An item was assigned a higher contingency if it involved unproved design. The contingency has been extracted separately and applied to the project as a whole, and is also summarized in the same table.

The required funds from DOE construction Funds is given in Table 2 appended at the end of the management plan. The overall schedule for WBS entries at level 4 is broken down on a fiscal year basis. In table 3 the costs are broken down into funding sources. The funding sources are RHIC construction funds, institutional resources including the foreign contributions from NBI and CRN-ULP, and the equivalent purchase value of equipment already in existence at BNL belonging to the Physics or AGS Departments. Additionally the contingency on DOE funds and others are given.

Several Key Milestones:

- Magnets D1, D2 and D5 - ready for procurement October 1997.
- Pivot, Mid-Rapidity and Front Forward platforms - ready for placing fabrication order November, 1997.
- Prototype TPC readout receiver tests completed, December 1997.
- Drift Chamber Prototype tested, April 1998.
- TPC's ready for installation, July 1998.
- Magnets D1, D2 and D5 - ready for installation August 1998
- Beam-Beam Counters ready for installation, September 1998
- Magnet cooling water system - complete, October 1998.
- Front Forward Spectrometer and Mid-Rapidity Spectrometer installed and ready for beam, May 1999.

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Reduction in Scope from the Conceptual Design Report (CDR)

Due to the reduction of the RHIC funding to BRAHMS and the request that several items of the infrastructure get carried by the experiment it has been necessary to defer parts of the BRAHMS detector as described in the Conceptual Design Report. In order to proceed with the construction, it has been agreed by the collaboration that item 2, in the following section, will be added to the capabilities of the 2 o'clock area such that the full potential of the experiment can be reached in the out-years. The collaboration hopes that some of these deferred items can still be provided for initial running (e.g., by reuse of existing resources).

The reductions and deferred items include the following:

- A single open-loop water system is implemented instead of a two-looped closed water. Following the recommendations from the TAC a two-looped closed water system will be implemented with the incremental cost of about 70K taken from the contingency.
- The forward spectrometer is operated up to 1/2 field in initial running. An additional 2.5 MVA substation, will be needed to get sufficient power for full field running.
- The multiplicity detector is reduced in scope.
- The mid-rapidity spectrometer is staged with the GASC deferred.
- The TOFW of the mid-rapidity spectrometer is reduced to about 120 slats from the original 240.

Required Resources from RHIC

In addition to the detector system, BRAHMS requires a number of resources in the area of the 2 o'clock IR . These include:

- Suitable counting house including utilities of ~ 1000 ft.^{2}. BRAHMS will provide up to $60K from the construction funds.
- Suitable building area for housing the magnet power supplies and magnet cooling water system. BRAHMS will provide up to $50K from the construction funds for the installation of a mezzanine and building modifications.
- IR area shielding blocks and installation thereof. Some additional costs incurred, such as weather proofing, due to modifications required will come from BRAHMS construction funds. Labyrinths will be provided by RHIC. In order for timely installation of shielding up to $40K will be provided for by BRAHMS using FY98 construction funds and will returned to BRAHMS in FY99.
- General network (fiber optics) connections to the 2 o'clock area & counting house; conventional fire protection in 2 o'clock area, counting house and fast electronics hut.
- 1.5MVA AC power available from existing substation up to and including 480V disconnect switches. Design and supervision will be provided by the RHIC detector group. BRAHMS will provide up to $130K from the construction funds.
- 25K$ toward the procurement of beam-pipe, and engineering support for beam-pipe design.
- Accelerator operation monitoring system, including timing signals, profile monitor signal, etc.
- Water supply for cooling tower system.
- Concrete pad for outdoor gas storage.
- The counting house should be available to BRAHMS for beneficial occupancy in June, 1998.

The RHIC management has agreed that these resources will be provided, and except where explicitly noted their cost is not included in the budget presented in this plan.

Required Resources from BNL Nuclear Physics and AGS

The overall funding and feasibility of BRAHMS requires substantial utilization of equipment available at the AGS and the BNL Physics Department. This includes, but is not restricted to:

1. 5 power supplies for the magnets D1-D5 as requested in memo of June, 1996, and to which a preliminary affirmative response is given. It is imperative for a successful construction that the actual supplies to be used are identified by September, 1997 and that several of the supplies be made available to BRAHMS by November 1997 for installation and modifications to controls.
2. Conventional electronics belonging mainly to BNL Nuclear Physics, but some from HEEP, have been identified and must be available either by spring 97 or by the end of the FY98 heavy ion running . A preliminary list of electronics requested has been presented to the BNL Physics Department. Only components identified as being available from the resources mentioned have been included in the cost analysis.
3. Magnet 24VIII 72 or a suitable 18D72.
4. E866 spectrometer magnet M2, which will be modified with smaller gap.

2. High Level Work Breakdown Structure

The BRAHMS Detector is part of the RHIC construction project. With the Work Breakdown Structure (WBS) of RHIC, the BRAHMS detector as a whole is at level 2. The BRAHMS WBS has been developed to level 5 in some areas, and has formed the basis for costing, scheduling and contingency analysis. The BRAHMS WBS can be found in the BRAHMS WBS book which also contains a definition of each WBS element. The following indicates the BRAHMS WBS structure in level 4.

2.7.1		**Facilities and integration**
	1.1	Experimental Infrastructure
	1.2	Installation
2.7.2		**Magnets**
	2.1	Magnets
	2.2	Power supplies
2.7.3		**Detector systems**
	3.1	Forward TPCs
	3.2	H1, H2
	3.3	C1
	3.4	RICH
	3.5	DC
	3.6	MRS TPCs
	3.7	MRS TOF
	3.8	GASC (deferred)
	3.9	Beam-Beam
	3.10	Centrality
2.7.4		**DAQ, Triggering, Controls and Computing**
	4.1	DAQ
	4.2	Triggering
	4.3	Off-line Computing
2.7.5		**Management**
	5.1	Management

3. Management Organization

3.1 RHIC Project Management Overview

Construction of the BRAHMS base detector is being undertaken as part of the RHIC Project for DOE. The management responsibilities for the project are described in detail in the RHIC Project Management Plan. The
DOE organization elements and the RHIC Project Management at BNL, as it relates to detectors, are summarized here.

3.2 DOE Organization

The Division of Nuclear Physics of DOE provides overall programmatic guidance for the RHIC project. This office reviews and approves project cost, schedule and technical baselines, provides coordination with other DOE Headquarters Offices, and reviews the RHIC Construction Project on a semi-annual basis.

DOE's Brookhaven Group (BHG) has field management oversight responsibility for the project. The DOE RHIC Project Manager has the principal BAO responsibility for the execution of the project.

3.3 RHIC Project Organization at BNL

The BNL Director has overall responsibility for the direction of all Laboratory activities, including those needed to design, build and operate the RHIC facility. Primary responsibility for the scientific direction of the RHIC Project, including both R&D and construction activities, has been delegated to the RHIC Project Head. The Laboratory's Associate Director for High Energy and Nuclear Physics, as chairman of the Program Advisory Committee for experiments in high and nuclear physics at the Laboratory, is responsible for the physics program at RHIC.

The RHIC Project Head is responsible for the entire execution of the RHIC R&D, design and construction program, including the detectors. Two Associate Heads, one for the Collider Systems and one for Detectors, exercise the technical control of those major areas of the Project.

The Associate Head for Detectors and Experimental Support has primary responsibility for the completion of WBS 2, Detectors, integration with other experimental support requirements, and preparation of the experimental program within technical, cost, and schedule baselines. The Associate Head for Detectors and Experiment Support oversees the following areas:

- Detector R&D
- The design, construction and installation, with the assistance of the selected experimental groups (e.g. BRAHMS), of the initial complement of detectors.
- Planning and operation of the experimental halls.

Within the RHIC organization, the BRAHMS management represented by the spokespersons, Project Manager, and Fiscal Officer report to the RHIC Associate Head for Detectors and Experimental Support.

3.4 BRAHMS Management

Shown below is the BRAHMS management structure for the construction phase. The Spokespersons represents the Collaboration in all matters. The Project Manager has full responsibility and authority for the design, construction, installation and testing of the detector within the physics requirements set by the Collaboration. The Project Manager coordinates the construction of BRAHMS through the sub-system managers, the Safety and Quality Assurance Officer and the Fiscal Officer.

The BRAHMS construction activities are organized on the basis in the detailed WBS.

Project Management

Spokesperson:	F. Videbaek
Deputy Spokesperson:	J. J. Gaardhøje
Project Manager:	D. Beavis
Fiscal Officer:	F. Videbaek
Quality Assurance Officer:	D. Beavis
Safety Officer:	K. Asselta
System Integration:	J. Olness, C. Chasman, D. Phillips
TPCs	F. Jundt, J. J. Gaardhøje
Time-of-Flight	J. J. Gaardhøje, J. Olness
Drift Chambers	Z. Majka
Cherenkov Detectors	R. Debbe
Centrality	S. Sanders
Beam-Beam	B. Budick
Triggering	J. Engelage
DAQ	K. Ashktorab, R.A.. Scheetz
Off-line Software	K. Hagel

3.5 Institutional Responsibilities

The responsibilities for each subsystem in BRAHMS, divided by institution, are listed below. The MOU, as part of the management plan, details the responsibilities, as does the work plan in Section 4.

Brookhaven National Laboratory

- System integration.

- Magnets, platforms.
- Cherenkov detectors, back counter, design, construction, testing and installation.
- TOFW system in MRS. Design, construction, testing and installation.
- Tracking and PID packages.
- DAQ, online and slow control systems.
- TPC electronics and interfaces.
- Trigger system.
- Management.

Jagellonian University, Krakow - Texas A&M

- Drift chambers in forward Spectrometer, design, construction, testing and installation.
- Monitoring, calibration and off-line software for drift chamber systems.
- Selection and implementation of off-line packages.

New York University

- Design, construction, testing and installation of the Beam-Beam counter.

Niels Bohr Institute

- Time-Of-Flight systems in Forward Spectrometer, H1, H2. Design, construction, testing and installation.
- Procurement of magnet D2.
- Monitoring, calibration and off-line software for T1, T2 and TOF systems.
- Design, construction, testing and calibration of T1 and T2 in Forward Spectrometer.
- Procurement of electronics for T1 and T2.

Space Science Laboratory, UC Berkeley

- Trigger system, Level 0.

CRN-ULP Strasbourg

- Design, construction and testing of TPCs for mid-rapidity Spectrometer and T1 in the Forward Spectrometer.

University of Oslo, University of Bergen

- Design, selection and implementation of online and offline software.

University of Kansas - Johns Hopkins

- Design, construction, testing and installation of centrality detectors.
- Simulation and analysis software for centrality detectors.

Harbin Technical University

- Simulations, in particular, two-particle correlation's.

3.6 Agreements

A series of Memoranda of Understanding (MOUs) are being negotiated between the BRAHMS and RHIC management and each collaborating institution. As these agreements are concluded, they will be appended to the BRAHMS Management Plan.

4. Work Plan

The work plan has been developed in order to meet the technical, cost and schedule objectives set down in the Management Plan. The plan outlines the methods envisioned to accomplish the work for each major subsystem of the BRAHMS detector. Technical criteria, specifications and requirements are set by the Subsystem Managers to conform to the physics and interface requirements and to the general parameters agreed upon in the Conceptual Design Report and CDR Updates.

4.1 Facilities and Integration

An MOU between BRAHMS and the AGS covers the work accomplished under this WBS section.

2.7.1.1 Experimental infrastructure: Engineering, design, and installation of the utilities to support the experiment which are not provided by RHIC. The fast electronics hut will be installed and modifications to the existing counting house will be completed. Modifications to the IR necessary for BRAHMS will be performed. The magnet cooling and AC power utilities will be constructed and distributed. The platforms for the magnets and detectors will be designed, engineered and fabricated.

2.7.1.2 Installation: Installation of the power supplies, magnets, platforms and supporting infrastructure. The A.C. power, water, and experimental cable tray will be installed along with the systems supporting the magnets and power supplies. Installation and support of experimental detectors, including rigging and survey will be provided.

4.2 Magnets

2.7.2.1 The magnets will be designed by AGS engineers. The magnet D1, D3, D5 and the modification to D4 will be the responsibility of BNL. D5 utilizes the existing steel from

E866 M2, but requires a new coil. D2 will be provided by NBI, according to the specification set by the collaboration. The magnets D1, D2 and D5 are first in the installation schedule. The magnets will be mapped before final installation. BNL will be responsible for the mapping.

2.7.2.2 Power Supplies: The DC power supplies for the magnets will be provided by the AGS. New control cards will be engineered, designed and constructed for operating the power supplies at RHIC.

4.3 Detector Systems

2.7.3.1 Forward spectrometer TPCs: The detectors T1, T2 will be fabricated by NBI and CRN-ULP in collaboration. They will be installed by NBI. The front end electronics is being procured by NBI from STAR under the terms of the agreement between BRAHMS and STAR. The readout control and clock drivers will be developed at BNL. A drift velocity monitor system has been designed and fabricated at BNL.

2.7.3.2 Forward spectrometer Time-Of-Flight: The system will be designed, assembled and tested at NBI. Commercial electronics will be used in the readout. Most of it exists, the rest will be procured by NBI.

2.7.3.3 Cherenkov detector C1: BNL has the responsibility to design, procure, assemble and test this detector.

2.7.3.4 Ring Imaging Cherenkov detector in Forward Spectrometer; BNL has the responsibility to design, procure, assemble and install the detector. An option to replace the PMT design with solid photocathode readout is being explored.

2.7.3.5 Drift Chambers: The drift chambers are the responsibilities of Jagellonian University and Texas A&M. A prototype module and associated electronics will be built at Krakow. It is under discussion if the production of the full detector system will be done at Texas A&M.

2.7.3.6 Mid-rapidity TPC: The CRNS group has already constructed and tested MTPC1. Some additional modifications will be made. CRN-ULP will design, construct and test MTPC2 in addition. The installation of the detector and electronics is the responsibility of BNL.

2.7.3.7 MRS Time-Of-Flight: The BNL group will design, fabricate, test and install the TOF counters. This work, i.e. design, choice of electronics and readout, is closely linked to the Forward spectrometer effort (2.7.3.2).

2.7.3.8 GASC: This detector is deferred due to lack of funding. A preliminary design exists and can be implemented for RHIC's second year running should funds become available.

2.7.3.9 Beam-Beam counters. The final design based on prototypes already developed will be made by NYU, which will be responsible for the procurement, assembly and testing. It is under consideration if the actual fabrication will be done at NYU or on location at BNL.

2.7.3.10 Centrality detectors. The design, procurement , assembly and installation will be the responsibility of University of Kansas in collaboration with Johns Hopkins.

4.4 DAQ, Online computing and triggering.

2.7.4.1 DAQ. The design, procurement and software for the DAQ is the responsibility of BNL. This entails the VME-based system, which interfaces to conventional CAMAC and fastbus crates, and to the TPC VME-interface which is being developed. The base slow control system is the responsibility of BNL, while detector specific control will be done by the responsible institution.

2.7.4.2 Triggering. The design, procurement, and installation is the responsibility of U.C. Berkeley. It is under consideration whether the system will be based on conventional electronics, or will be part of what is being developed by STAR.

4.5 Software

2.7.4.3 Texas A&M and BNL are responsible for coordination of the design and implementation of the monitoring, calibration and off-line analysis code. Software development will be a continued project with participation from nearly all institutions.

5. Quality Assurance and ES&H

5.1 Quality Assurance

Quality Assurance standards should be applied during the design, fabrication and integration of detector components and systems to assure the success of both BRAHMS, as well as the scientific program at RHIC. This section describes the QA policies, plans and procedures to be implemented within the BRAHMS collaboration.

5.1.1 Overview

It is the policy of the RHIC Project that all activities be performed at a level of quality that is appropriate to achieving the scientific, technical, operational, and administrative objectives. To implement this policy, the RHIC Project has established a QA Program based on DOE Order 5700.6C and implementation guide DOE-ER-STD6001-92, the BNL QA Program, and the specific needs of RHIC. This sets standards for organizational responsibilities, appropriate documentation and training.

The BRAHMS detector collaboration is expected to plan, document and implement a QA program, to the extent needed, to ensure successful construction and operation of these detectors.

5.1.2 Quality Assurance Objectives

The following general QA objectives are established for the detector program:

To ensure that all components and systems are designed, constructed and integrated to the specifications established. To ensure that each RHIC detector and related systems and subsystems perform to their required objectives and specifications. To ensure that proper documentation is maintained for the lifetime of the detectors.

5.1.3 QA Implementation

The Associate Project Head for Detectors & Experimental Support is responsible for establishing and implementing a QA program covering the RHIC detector activity in accordance with the RHIC QA Program. The BRAHMS project shall develop a QA program and towards this end the project manager shall designate a specific individual who is responsible for QA coordination and implementation.

Collaborators at national laboratories can either follow the RHIC QA program or that which is applicable at that institution. The university based collaborators shall follow the guidelines in DOE-ER-STD-6001-92, "Implementation Guide for QAP for Basic and Applied Research".

5.1.4 Management and Assessment

It is the responsibility of the BRAHMS collaboration to carry out periodic evaluations of the effectiveness for their Quality Assurance programs.

Progress on Quality Assurance matters and implementation will be included in the periodic reviews of the BRAHMS detector by the RHIC Project Management and DOE (Sect. 7).

5.2 Environment, Safety & Health

This section describes the policies and procedures to ensure Environmental Safety and Health (ES&H) protection on all RHIC project detector activities. The paragraphs below present an overview of key issues. Policies, procedures and descriptive information are contained in the RHIC Safety and Environmental Administration Policy and Procedures Manual (SEAPPM).

5.2.1 Overview

5.2.1.1 The ES&H program fully supports the BNL ES&H policies and requirements. The ES&H program for the design, construction, installation, test and operation of the detectors and supporting systems is intended to ensure a safe working environment. The RHIC Project will establish ES&H program requirements for detectors and experimental facilities. Individual detectors will identify specific ES&H issues, will develop appropriate plans and detailed requirements, and will establish specific procedures as needed.

5.2.1.2 The following general objectives are established for the ES&H program for detectors:

To comply with federal, state and local laws, rules and regulations. To prevent accidents or loss of life or equipment during detector-related work. To prevent any environmental contamination during detector development, commissioning and operation.

5.2.1.3 Organization and Responsibilities

BNL has established the Safety & Environmental Protection Division which is responsible for developing laboratory-wide ES&H policy and standards and independent oversight.

The RHIC Project Management is responsible for establishing overall policies and requirements for ES&H during development, commissioning and operation of the detectors and related experimental systems. The Project has overall responsibility for ensuring compliance with appropriate ES&H requirements. Review and advisory committees have been appointed by the Project Head to support the overall ES&H Program. Sub panels may be appointed to address safety issues related to individual subsystems or aspects of a detector project.

Individual experiments and detector project managers bear the responsibility for identifying specific ES&H issues and hazards, and to ensure appropriate safeguards and procedures for addressing those risks.

5.2.1.4 Documentation and Training

The RHIC SEAPPM and the Brookhaven National Laboratory ES&H Manual provide line implementation in accordance with the ES&H policies and, where applicable, a Safety Assessment Document will be provided by BRAHMS to detail the hazards and safety envelope. BRAHMS will provide details of the experimental equipment and operations for review and approval by the RHIC Experimental Safety Committee.

All participants in the RHIC detectors, while at BNL, will be provided with the training and information required to ensure that they have the knowledge to perform their duties in a manner which does not unduly place them or others at risk. This includes briefings and presentations to communicate ES&H policies and standards that are relevant to assure safety on detector-related activity. Facility specific training will be provided on such issues as electrical,

cryogenic, radiation and chemical safety, as well as issues related to detector transportation, installation and testing activities.

5.2.1.5 Experiment Safety

Each detector or experiment will implement environment safety and health program elements as outlined in the RHIC SEAPPM and BNL ES&H Manual. All potential hazards and safety issues during engineering, transportation, installation, test, startup and operation of the detectors will be addressed. Health and safety issues and requirements associated with construction and usage of experimental facilities will be defined and coordinated with the RHIC Project safety personnel.

5.2.1.6 Visitors

All visitors to BNL are responsible for becoming acquainted with and following all BNL ES&H rules and procedures. In general, guests will not be allowed unescorted access to non-office areas without permission, certification, and escort by staff with appropriate training. The escorts will be responsible for the safety of visitors.

5.2.2 Emergency Preparedness

The BRAHMS personnel will adhere to the RHIC Local Emergency Plan. Emergency preparedness involves the readiness to protect personnel, property and the general public from potential hazards arising from emergencies.

5.2.3 Compliance

Individual BRAHMS Safety Coordinators are responsible for clarifying compliance requirements and assisting in the resolution of complaints or deviations related to safety.

Participants in detector-related activity performed at institutions other than BNL (both domestic and international locations) will adhere to the local ES&H laws, rules and regulations in place at those locations. Best management practices to assure safety will be sought and applied. Detector project managers and subsystem managers, will ensure that specific safety issues and safeguards are identified during the design process and communicated to fabrication, test and installation personnel regardless of the institution involved.

6. Management

6.1 Management Control

	Approval Level Required		
Type of Change	**BRAHMS Managers**	**RHIC Project**	**DOE Project Manager**
Change in the technical capability of a RHIC WBS Level 4 element	X	X	
Addition or deletion of a RHIC WBS Level 4 element	X	X	X
Revision of estimated cost of RHIC WBS Level 4 element	X		
Change in the overall estimated cost of BRAHMS to the RHIC project, including allocated contingency	X	X	
Change in estimated cost of BRAHMS causing an increase in the total cost of the detectors program for RHIC	X	X	X
Changes to BRAHMS control milestones	X	X	

Slippage of a RHIC project level or milestone by 4 months or more	X	X	

Table 6.1 Approval Levels for Changes to BRAHMS Technical, Cost Schedule Parameters

The BRAHMS detector is the principal responsibility of the BRAHMS collaboration, for which the Spokesperson and Project Manager, with the help of the Fiscal Officer and Safety Officer, will exercise the primary management functions. Construction of the BRAHMS detector is part of the RHIC construction project. The overall responsibility for managing the RHIC project to meet technical, cost and schedule objectives lies with the RHIC Project management, the RHIC Project Head and, for the detectors, the Associate Project Head for Detectors and Experimental Support. Those parts of the detector construction effort which the collaborating groups take on are managed through formal bilateral agreements which are executed between the RHIC project (BNL) and each of the participating institutions and utilize the management structure which exists within BRAHMS.

The detector will be subject to periodic review by the RHIC Project management and DOE. RHIC Project management will also be advised by a Technical Advisory Committee convened by the Associate Project Head to review and evaluate progress of detector construction.

Changes to the technical, cost, and schedule parameters of BRAHMS will require approval of the BRAHMS managers, the RHIC Project management and the DOE Project Manager as described below and summarized in the accompanying table (Table 6.1).

6.2 Technical Control

The BRAHMS Project Manager has the responsibility for the day to day operations management and control, within the constraints of baseline documents (CDR, CDR Updates and WBS book), of all the technical decisions regarding R&D, engineering, fabrication, assembly, installation, testing and acceptance of all items. Procurements equal to or greater than $500,000 and those aspects of installation and commissioning that are coupled to other aspects of the RHIC construction project, will be carried out with the assistance and approval of RHIC Project Management.

Overall control of the technical means by which the various elements of the detector are achieved is the responsibility of the BRAHMS Project Manager. He will delegate as appropriate to the Subsystem Managers the responsibility for meeting the requirements of each of the Level 4 WBS elements (each BRAHMS Subsystem is a RHIC Level 4 WBS element).

Any change in the ability of a RHIC WBS level 4 item to meet the physics goals as outlined by the collaboration in the CDR, or the addition or deletion of a RHIC Level 4 element requires approval of the Associate Project Head for Detectors and Experimental Support, as well as the BRAHMS managers. Changes that have a cost or schedule impact on a RHIC level 4

element require the approval of BRAHMS management. Changes in the total cost or overall schedule of the BRAHMS detector require approval of the Associate Project Head for Detectors and Experimental Support and the RHIC Project Head.

6.3 Schedule Control

The BRAHMS management has developed a schedule baseline which sets forth the major activities and decision points essential for completion of the detector. The baseline includes integration and optimization of activities related to the design, procurement, fabrication, testing, installation and check-out needed to bring the BRAHMS detector on-line to perform its stated mission. Detailed schedules will be developed at the control account level and interconnected into an activity logic diagram by integrating construction activities within all respective BRAHMS WBS elements. Schedule interfaces with other RHIC WBS elements will be made as necessary. This integrated schedule will identify the BRAHMS detector's critical path. At all times this schedule baseline will be consistent with the funding allocation for detectors based on the profile presented in the annual RHIC Construction Project Data Sheets which shall reflect the required BRAHMS funding profile appearing in section 1 of this plan.

The schedule will contain a sufficient number of Control Milestones so that summary schedules can be produced and progress readily ascertained for management review. Appropriate Project level milestones will be selected from these control milestones for incorporation into the RHIC Project Master Schedule. These schedules will be the basis for quarterly status and performance reporting.

Cost and schedule performance reports will be reviewed with the RHIC Project Management on a quarterly basis. Progress reviews at yearly intervals will be conducted by the Technical Advisory Committee. In addition, DOE semi-annual reviews of the RHIC project will include progress on detector construction.

6.4 Cost Control

The basis for cost control, which includes budget planning and cost reporting, is the Baseline Cost Estimate, developed to RHIC WBS Level 4 or below.

The BRAHMS Fiscal Officer will report total costs collected at RHIC WBS Level 4.

Cost control by lower WBS levels will be the responsibility of the Subsystem Managers.

6.5 Contingency Funding

Contingency funds are included within the BRAHMS cost estimate to cover materials, labor, conditions and risk situations which are an intrinsic part of the intended scope of work, but are not specifically allowed for elsewhere in the estimate, due to uncertainty either as to their existence, nature, likelihood of occurrence, or magnitude of effect.

Since contingency is not assigned to specific segments of work, it is therefore not considered part of the Performance Measurement Baseline. All changes from baseline costs shall be traceable so that contingency applications can be tracked.

At the beginning of each fiscal year, the BRAHMS managers, working with RHIC Project Management, will determine what portion of the year's construction funds is to be set aside as contingency. Contingency is not allocated for individual subsystems as part of the baseline cost. Contingency is managed by the BRAHMS Project Manager subject to approval by the RHIC Project Head. Guidelines given in the RHIC project Management Plan will apply.

In cases where the assignment of contingency funds results in a change in the amount of funds to be transferred to one of the collaborating groups, this fact is to be documented in an amendment to the formal agreement previously concluded with that group.

6.6 Progress Reports and Variance Analysis

The reporting of costs and submission of data for cost performance reporting is discussed in Section 5.4. In addition, progress will be reported quarterly to the RHIC Project Management, in narrative form, at RHIC WBS level 4. These reports will include discussion of milestones met and not met, QA and Safety issues, general discussions of cost variances below the threshold and detailed analysis when the thresholds are exceeded, as well as other issued and problems. Variances above 25% will be considered as major and above 10% as minor.