BROOKHAVEN BULLETIN
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BROOKHAVEN NATIONAL LABORATORY

RHIC Cools Down Using the World's Biggest Chill

As announced in the Brookhaven Bulletin of July 2, the Blue Ring, one of the two accelerators that make up the Relativistic Heavy Ion Collider (RHIC), has been at the operating temperature of 4.6 Kelvin (K) (-269°C.) since last May, and it is now being commissioned as an accelerator with gold-ion beam (see box, right).

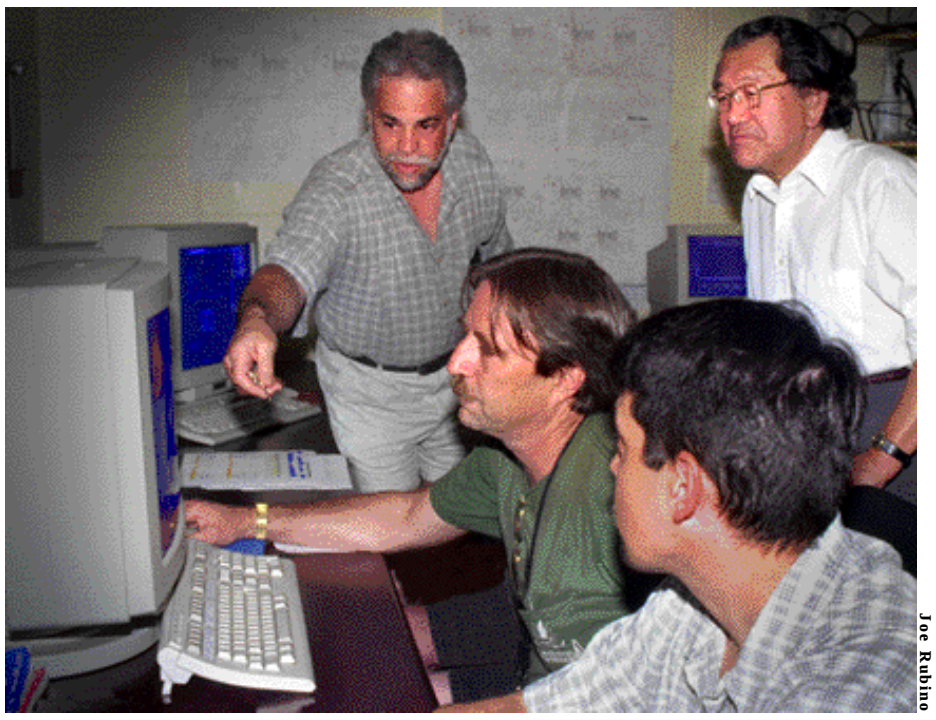
Then, during the evening shift of July 14-15, the Yellow Ring dropped to the very same cold operating temperature.

With the achievement of 4.6K in the Yellow Ring, Michael Iarocci and his RHIC Cryogenic System Section have completed the very essential preliminary step in the commissioning of RHIC: getting the collider's 1,740 superconducting magnets in its two rings cold enough to operate.

"Cooling from room temperature to close to absolute zero some 5,000 tons of magnets that are distributed along 3.8 kilometers [2.4 miles] of the RHIC tunnel is a formidable task in and of itself," said Satoshi Ozaki, RHIC Project Director.

"In succeeding in this impressive task, we faced a number of technical difficulties, which we overcame by employing our resident expertise and experience, and putting in a lot of effort," continued Ozaki.

"So I give the RHIC Cryo group, under the leadership of Mike Iarocci, and all those who have helped them achieve this goal my hearty congratulations for bringing the RHIC Project to this stage of readiness," concluded the RHIC Project Director.



Joe Rubino

Satoshi Ozaki (right), RHIC Project Director, joins Michael Iarocci (left), RHIC Cryogenic System Section leader, and team members Bill DeJong (center) and Tony Nicoletti in the control room during a final stage of cooling the RHIC Yellow Ring. Present but not in the picture were: Nils Danielson, Roland Overton, and Chris White.

With the temperature of RHIC's Yellow Ring now at 4.6K, it too can be commissioned: first, as an accelerator with circulating beam, and then, with the Blue Ring, as a collider in which beams of heavy ions circulating in each ring are smashed into each other.

When RHIC operates, two beams of heavy ions — the nuclei of atoms as

(continued on page 2)

RHIC Blue Ring Beam Begins Third Turn; Working to Circulate

As the Bulletin's pages were being proofread yesterday morning, Thursday, July 15, accelerator physicists commissioning the Blue Ring, one of the two accelerators making up BNL's Relativistic Heavy Ion Collider (RHIC), were working on understanding what was happening to the beam at the 12 o'clock intersection region of the ring.

Using the beam of gold ions as the diagnostic tool, "We are trying to understand why it has gone around fewer than three turns, why it is not circulating easily for multiple turns," explained Steve Peggs, who leads RHIC's Accelerator Physics Group now commissioning the ring with beam.

The beam made its first lap around the RHIC track on Saturday, July 3. Two complete laps plus the start of a third was accomplished last Tuesday, July 13.

An earlier problem that caused the beam to lose its focus at the 12 o'clock interaction region has been fixed. This problem caused the beam to enlarge to the point where its particles were too dispersed to circulate as a beam.

"As scientists, not explorers

(continued on page 4)

348th Brookhaven Lecture

BNL's Relativistic Heavy Ion Collider: Poised for Discovery

One of the great excitements of science — creating a huge new machine to probe nature — is on the horizon now at Brookhaven, as the Relativistic Heavy Ion Collider (RHIC) is being eased, forced, coaxed, and bullied through commissioning into operation (see box and story, above).

Once RHIC is operating, as the hundreds of scientists, engineers and technicians who will work on RHIC experiments know, more labor will follow, until eventually they achieve their goal: working experiments yielding new discoveries.

To describe the extraordinary machine that is RHIC and to explain the frontiers of science that it has been built to explore, Physicist Tim Hallman of the Physics Department will deliver the 348th Brookhaven Lecture, "On the Threshold of Discovery at RHIC." The talk will be given on Wednesday, July 21, at Berkner Hall, after Hallman is introduced by RHIC Project Director Satoshi Ozaki at 4 p.m.

Hallman, who is a member of the international team of experimenters building RHIC's STAR detector (see photo, right), will explore the unique potential for discovery that RHIC will provide.

As Hallman will point out, scientists working at RHIC will be at an exciting threshold, with compelling scientific questions to investigate, innovative tools to address the questions, and much experience to use these tools effectively.

Physicists want to use RHIC, Hallman will explain, to find out whether matter undergoes a basic restructuring at a very high temperature that is 10,000 times hotter than the interior of the sun. Theorists predict that at this temperature, which

(continued on page 2)

Michael Herbert

One of the four major detectors at the Relativistic Heavy Ion Collider (RHIC) is STAR — standing for Solenoidal Tracker at RHIC. STAR is situated at the 6 o'clock position when looking north at the 3.8-kilometer (2.4-mile)-in-circumference RHIC ring. Pictured around the huge detector are experimental and theoretical scientists who gathered at BNL for a meeting of the STAR collaboration this January. The STAR team, which includes Tim Hallman as Group Leader and Deputy Spokesperson (see story, left), is composed of more than 400 scientists and engineers from 33 institutions in eight countries. They will be using STAR to investigate the form and behavior of matter that RHIC is aimed at creating: the quark-gluon plasma, which is thought to have last existed during the first few microseconds after the Big Bang. At the heart of STAR is a giant, barrel-on-its-side-shaped, time-projection chamber, seen here from one end. STAR's time-projection chamber will electronically record and measure how hundreds of thousands of charged particles simultaneously emitted per second from heavy-ion collisions travel away from the collision point. From this information and complementary data from other detector systems, the STAR team hopes to extract a new understanding of the interactions between quarks and gluons, and how these subconstituents of what are called hadrons interacted just after the dawn of time.

RHIC Cool Down (cont'd)

heavy as gold — will be accelerated at nearly the speed of light in opposite directions, clockwise in the Blue Ring, counterclockwise in the Yellow. The two rings intersect at six points, where the beams will be collided. The very high temperatures and densities of matter that will result from these collisions are expected to be extreme enough to recreate conditions that last existed immediately after the Big Bang — and, in the process, to open up new physics.

Cool Customers

RHIC's two rings are made up of magnets designed to bend and focus the particle beams. Specifically, these are electromagnets made of superconducting materials which have no resistance to the flow of electricity when supercold.

To get superconducting magnets down to the operating temperature of 4.6K is no small feat. To accomplish it, the Cryo group, as they are known, employs the world's biggest helium refrigerator: the RHIC 25-kilowatt helium refrigerator.

"We obtain and store the helium in liquid form and, eventually, introduce it into the magnets and cooling system," explained Iarocci. "For the machine to perform well, it is critical that the helium be clean. The helium we use, which is called 'the inventory,' becomes part of the closed-loop refrigeration system, and we expect the system to run uninterrupted for 37 weeks at a time."

The RHIC refrigeration system requires 60,000 gallons of liquid helium to fill it and keep it cold. The helium is purchased and transported in the most economical way, that is, in liquid form, from Praxair Inc., a refining and liquefaction facility in Kansas. Once at BNL, the helium is loaded into 11,000-gallon storage tanks called dewars, where it remains until it is used to cool down the magnet system (see photograph, left).

Surrounded by the superinsulation that protects the cold parts of the refrigerator from heat, Bill DeJong, Cryogenic System Section, prepares to install a new valve in some piping inside a cold box.

For the final stages of the RHIC cool down, Kenneth Riker Jr. of the Cryogenic System Section starts the process of transferring liquid helium, transported here by Praxair, Inc., into one of the three 11,000-gallon liquid-helium storage dewars — giant, high-tech thermos bottles — outside Bldg. 1006B, which provides liquid and gas storage for the refrigerator and the 6 o'clock valve box. — photos on pages 2 and 3 by Roger Stoutenburgh

Even with the world's biggest helium refrigerator as the cooler, many adjustments are essential before a huge, complex system cools perfectly (see photographs, above and on page 3). "Sometimes you get lucky, and everything goes right the first time," said Iarocci. "But not always."

The RHIC cool down had its share of good and bad luck. Day one in Iarocci's log was in February. The cryogenic process piping was closed, and the high-pressure certification test was done. Results showed that everything performed to 110 percent of design — except the magnet circuit, which was at 90 percent due to warm piping leaks. The high-pressure test also revealed certain mechanical weakness in 24 of 934 interconnections between adjacent magnets. So, from February 8 to March 7, repairs were made.

On March 8, "Second high pressure certification test. All successful," was the log entry.

Next came plans and setup for what is called the 50K helium-spill test. This test verifies whether there is a need for people in the tunnel to use oxygen equipment if a spill were to occur when the system is operating at 50K.

For the test, all air and moisture in the system had to be completely replaced by helium gas, valves verified, compressor system exercised, and more. On April 5, 24-hour shifts started. On April 14-17, the refrigerator and liquid-storage area started cooling. On April 18, some 20,000 gallons, one-third of the contracted liquid helium, was delivered, and the cool down of the rings started from the 6 o'clock position, towards both 4 o'clock and 8 o'clock.

"We started cooling both rings together," said Iarocci. "Later, after the development of a number of issues beyond our control, we terminated cooling in half the Yellow Ring to concentrate on the Blue Ring first."

After fixing some problems with the turbines between April 19 and 21, Blue Ring cooling was resumed. By April 23, "Sector 4-5 Blue cooled to 50K," noted Iarocci. A sector is half of one of the six parts or sextants into which each ring is divided.

Without the ventilation fans running in the tunnel, the 50K spill test was performed successfully on April 24, showing that there was no need for people to use oxygen equipment under those conditions. By April 25, the team had resumed Blue Ring cooling toward 2 o'clock and 10 o'clock.

Being Cool

"Because the system is so large, it is split in half and cooled in two directions, each half going up to the 12 o'clock position," explained Ron Picinich, Cryogenic Supervisor.

Also, each of the six sections of the ring is connected back into the main refrigerator, and each section has its own valve box and cryogenic piping. To speed up cooling from 50K down to 5K, liquid helium is pumped from the storage tanks into the refrigerator-return inlet, which is also known as the cold end or back end of the refrigerator. In contrast, the front is known

Brookhaven Lecture (cont'd)

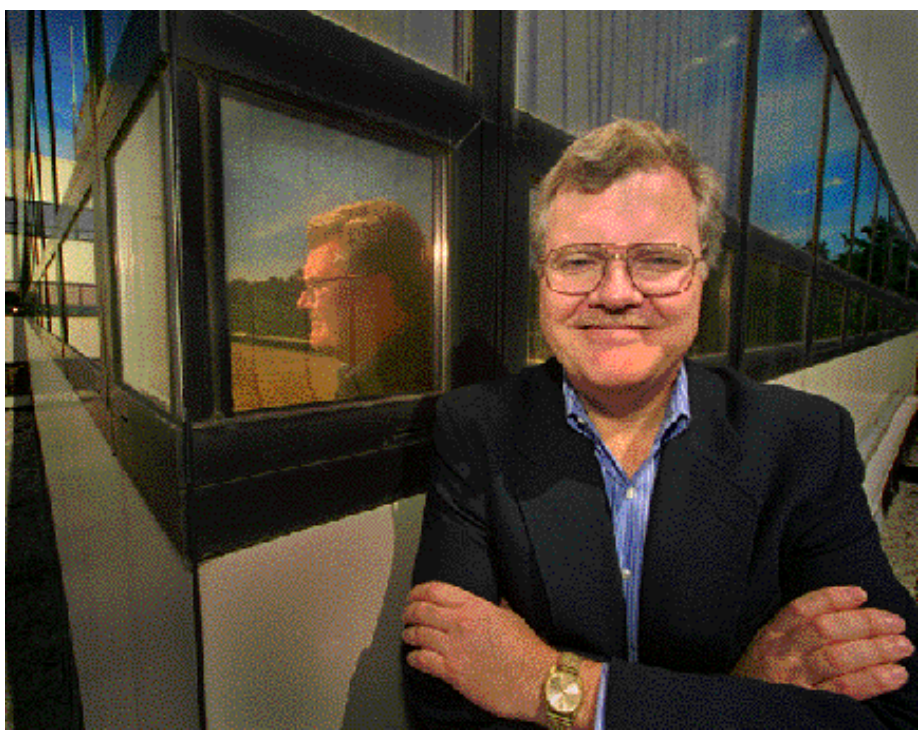
will be reached when heavy-ion beams within RHIC collide head on, nuclear matter will revert to the state that last existed during the first few microseconds after the birth of the universe.

In this state, theory holds, quarks, which are the components of certain matter, and gluons, which bind quarks together, will be freed from the confines of the particles in the atomic nucleus in which they are normally constrained, and they will form what is called a quark-gluon plasma.

Will such a plasma be observed at RHIC?

Another RHIC physics goal that Hallman will talk about is discovering what causes the proton particle to have a spin that measures one-half. Protons are made up of quarks and gluons, and the best estimate so far shows that quarks only contribute 30 percent of the proton spin.

Do the gluons provide the other 70 percent? Or does the orbital motion of the quarks in the proton itself also make a contribution?



Tim Hallman

Hallman will explain that these questions and more are to be answered in complementary ways by RHIC's four detectors: PHENIX, STAR, BRAHMS, and PHOBOS. In addition, these detectors are built so that unexpected physics can be found — with the hope of breaking new ground in scientific knowledge.

Tim Hallman received his Ph.D. in physics in 1982 at The Johns Hopkins University, where he remained until 1991, first as a post-doctoral research associate, then as an associate research scientist. From July to November, 1991, he served as a staff scientist at Lawrence Berkeley Laboratory, then moved to the University of California, Los Angeles, as a research physicist.

From 1985 until 1996, Hallman was a research collaborator at BNL, working since June 1995 on the STAR detector. In April 1996, he became a BNL member of the STAR collaboration when he joined the Physics Department as a physicist. Currently, he is Leader of BNL's STAR Group and Deputy Spokesperson of STAR.

Coffee and cookies will be served in the lobby before the lecture, and refreshments will be offered afterwards. Those who wish to join the lecturer for dinner at a restaurant off site may call Cora Feliciano, Ext. 3908, by noon on Wednesday, July 21. — Liz Seubert

In the foreground, a welder attaches the final pieces to tie the liquid-storage area into the RHIC cryogenic system. The large, circular valve box in the background above him is a key part of the ring cryogenic system. Six valve boxes are placed around the ring, to control processes and to isolate each one-sixth of the ring.

Inside the refrigerator building, Bill DeJong of the Cryogenic System Section inspects a turbine situated under the pipe linking the refrigerator to the two RHIC rings. The white containers (top, background) are cold boxes holding vacuum, piping and liquid-helium pots.

as the "warm end." From the return, the liquid helium goes through a heat exchanger that enhances the performance of the refrigerator. Then, the helium enters the ring.

"Once the helium gets down to about 4.6K at a pressure of 5 atmospheres, it becomes what is called supercritical gas, a state in which the density of the gas is equivalent to a liquid." said Picinich. "This gas is then piped at 5 atmospheres through the magnet line, and it is kept at 4.6K by passing through a series of heat exchangers called 're-coolers.' These are containers of liquid helium that are fed by a pipe from the refrigerator. Boil-off helium gas is removed through a temperature-control valve and sent to be recooled, so that the magnet line is at a constant 4.6K."

Picinich explained that the magnets are kept cold by their cryogenic covering, which consists of super-insulation and a vacuum, as if they were in a giant thermos flask. In addition, all sections of the system that are at 4.6K are protected by a metal shield cooled with helium at 55K, which absorbs any heat that might pass through the insulation.

Getting Cooler

By the beginning of May, cooling was proceeding at about one-third of a sextant per day, and a 100K wave of coldness ran to 2 and 10 o'clock respectively.

"Weather and other outside conditions, such as a far-off fire in Nassau County that changed electric power pathways, can cause problems," commented Iarocci. For example, on May 2, he noted: "Two power dips around 1400, slight wind conditions with 10-20 miles per hour gusts. Various equipment trips resulting in four lost hours."

On May 6-7, Iarocci logged: "Cooled the Blue magnets from an average temperature of 100K to about 50K."

From May 10, problems began to appear in the refrigerator, and it was decided to warm it up for what is called "decontamination," which meant that excess water that had built up had to be removed and other maintenance performed.

By May 17, "Normal operating temperatures established in the warm refrigerator end," the log reads. "Blue shield and refrigerator cold end cooling."

May 20: "Yellow magnet cooling on west side started late afternoon." The next day, preparations were made for the last liquid helium delivery of 15,000 gallons of helium, which arrived on May 22. After this, the Yellow Ring and shield cooling was resumed.

On May 24, Blue magnet cooling started late in the day and continued for two more days. Then, on May 27, the Blue Ring cool down was complete, and the cooling configuration changed to circulator mode, in which the coolant circles the ring. But, before handing over the Blue Ring for beam commissioning, George Ganetis and his Electrical Systems Group had to check out power supplies and the magnets' electrical integrity.

"We were able to make the official announcement that the Blue Ring was at 4.6K on May 28," said Iarocci. "Then, we spent the next weeks optimizing the system and preparing the Yellow Ring for cooling."

Real Cool

By mid-June, the Cryo group had the Yellow Ring steady at 50K. "We have to do the final cool down at a very slow rate, so that the Blue Ring cryogenics would remain undisturbed," said Picinich.

The final cool down of the Yellow Ring started on July 8. In the Cryo control room (see photographs, page 1 and below), members of the group have been coming and going in shifts as, sector by sector, the temperature was lowered. During the evening shift of July 14, a final wave of coldness took the Yellow Ring temperature to 4.6K.

"This has been an exciting time," summed up Iarocci, "With an excellent team and very hard work, we have made our goal a reality, opening the door for the Yellow Ring power supplies to be tested and the Yellow Ring to be commissioned."

— Liz Seubert

An overview taken of the liquid and gas storage area adjacent to Bldg. 1006B, where a Central Shops Division welder (left) stands near one of the three 11,000-gallon helium dewar tanks. Further back lies a liquid nitrogen tank, and at right are the helium-gas storage tanks. The superinsulated dewars maintain the liquid and gas inventory at approximately 4.6 Kelvin (-269°C).

In the control room, Dieter Zantopp of the Cryogenic System Section reviews a page of cryogenic control systems. On the screen is a typical control page, which the Cryo group uses to operate the 25-kilowatt refrigerator. By the push of a button, a 2,000 horsepower motor, or turbines, or any piece of process equipment can be started or shut off. The control system is also used to identify system faults and automatically maintain process control.

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Look Before You Leap

The Safety Glasses Office in Bldg. T88 will be closed on Wednesday, July 21. It will reopen for business on Wednesday, July 28. For more information, call Ext. 2864 during Wednesdays when the office is open.

Sambamurti Lecture Today: The Proton's Spin

Emlyn Hughes of the California Institute of Technology, will give the 1999 Sambamurti Memorial Lecture, "The Spin of the Proton," today at 3 p.m. in the large seminar room in the Physics Department, Bldg. 510. Students and summer visitors are especially encouraged to attend.

RHIC Blue Ring (cont'd)

going for broke, we are making methodical measurements using the beam as our ultimate diagnostic tool, a type of galvanometer if you will," explained Peggs. "With the beam, we are methodically evaluating the ring's optics IP [intersection point] by IP."

By optics, accelerator physicists mean the quadrupole magnets that focus the beam. Specifically, they are looking at how these quadrupoles interact with their power supplies, to ensure that each is operating at the correct current for commissioning.

In the meantime, they are also looking at the beam's trajectory as it moves through the ring. Again at 12 o'clock, they found that the beam fluctuated in its path. This indicated that a pair of beam-splitting dipoles, which are magnets that bend the beam, were not correctly powered. This problem was fixed by Thursday morning.

"We are talking about 17 amps of current out of 500 amps — small but significant," says Peggs. "Proceeding scientifically, we are finding all the little problems one by one and fixing them."

Added Satoshi Ozaki, RHIC Project Director, "Because RHIC is not perfectly circular, commissioning this collider is a very complicated process. As a result, I am not surprised that careful tracking of the beam is necessary."

— Marsha Belford

Free ESL Classes

Free classes in English as a second language (ESL) are offered on site for Lab employees, facility-users, guests, and their spouses from 6:30 to 9:30 p.m. every Thursday in the Human Resources Training Room at the rear of Bldg. 459. For information and an assessment of English language skills, newcomers must be there promptly at 6:30 p.m. For more information, call Starr Smith, Ext. 7631.

Equipment Demos

On Wednesday, July 21, from 11 a.m. to 2 p.m. in Berkner Hall, Digital Lightwave will demonstrate products that monitor, maintain and manage fiber-based voice, data and multimedia communications networks, including portable network information computers and network access agents. For more information, call (800) 548-9283 or go to www.lightwave. com.

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On Thursday, July 22, from 10 a.m. to 3 p.m. in Berkner Hall, the Vacuum Solutions Group, Inc., will exhibit vacuum components and instruments made by Ceramaseal, Thermionics, Spectra, Osaka Vacuum, and APD Cryogenics. For more information, call John Kelly, 674-8202.

Balloon Festival Tickets Available

Again this year, the Waldbaum's Balloon Festival will feature some 75 uniquely shaped and brightly colored balloons, which will participate in five ascensions at dawn and dusk, at Calabro Airport in Shirley, Friday through Sunday, August 13-15.

Tickets for this festival are now on sale at the BERA Sales Office in Berkner Hall, Tuesday through Friday, 9:30 a.m. to 1 p.m. The cost is $8 for adults and $4 for children age 4 to 12; the cost at the gate is $15 for adults and $10 for children those ages.

The schedule for the Balloon Festival is:

day	date	time
Fri.	Aug. 13	1-9 p.m.
Sat.	Aug. 14	6 a.m. - 10 p.m.
Sun.	Aug. 15	6 a.m. - 7:30 p.m.

Pianofest in the Hamptons

Noon Recital July 21

On Wednesday, July 21, Pianofest in the Hamptons presents the final of three free noon recitals, this time featuring piano masterworks performed by Cuong Hung Van.

Cuong Hung Van attended the Saigon Conservatory of Music, 1983-92, and the Moscow Conservatory, 1992-98. He is currently studying with Paul Schenly, Pianofest's Music Director, at the Cleveland Institute of Music.

Sponsored by the BSA Cultural Program, the 45-minute-long lunchtime recitals are informal and open to all. Audience members may bring a box lunch into Berkner Hall to enjoy with the music, and they may come and go as they please.

BERA Bus Trips

Offered by BERA, the trips include round-trip transportation on a fully-equipped coach bus, and admission to the advertised event. All trips leave from the Brookhaven Center; if requested, an extra pickup will be made at the park and ride at L.I.E. exit 63.

Tickets are sold first come, first served. To make paid reservations for one or more of the following trips, go to the BERA Sales Office, Berkner Hall, Tuesday through Friday, 9 a.m. - 1:30 p.m. For more information, call Andrea Dehler, Ext. 3347, or M. Kay Dellimore, Ext. 2873.

To Great Adventure on August 14

On Saturday, August 14, BERA goes to Six Flags Great Adventure amusement park, which features "The Great American Scream Machine," the "Batman," "Chiller," and "Viper" rides, the indoor roller coaster "Skull Mountain," and the "Lethal Weapons" water-stunt show.

The per-person cost is $45. The bus will leave promptly at 7:30 a.m. and return at approximately 9 p.m.

To Shea Stadium on August 24

On Tuesday, August 24, BERA is going to Shea Stadium, to see the New York Mets play the Houston Astros in an evening baseball game. During the game, participants should keep their eyes on the scoreboard, as BERA/ Brookhaven Lab will be announced.

The cost is $45 per person for the bus and box seats. Participants are to arrive by 4:15 p.m., the bus will leave promptly at 4:30, the game starts at 7:30 p.m., and the bus will leave the stadium at approximately 10:30 p.m. to return to the Lab.

Free Summer Sunday Tours Continue Through August 29th

HFBR: What's Under the Dome? Find Out This Sunday!

The great dome (pictured right) of the High Flux Beam Reactor (HFBR) is so well-known around the Lab that everyone recognizes it, even if they don't know what goes on under that dome.

This Sunday, however, all are invited to learn what is under that dome, when the HFBR is the scientific machine featured in a mini-tour offered as part of the Lab's free Summer Sundays tours.

Right now, the HFBR is not operating, pending a decision by the U.S. Energy Secretary on its future. During the Summer Sundays mini-tour, HFBR operations staff will explain how they maintain the machine and what happens when it is operating.

Scientists who did research at the HFBR will talk about some of the ground-breaking discoveries in medicine and material science that has been made there.

This research includes, for example, the development of: a form of the element thallium that is now used for heart-stress tests all over the world; a form of tin that has produced promising results when used to treat bone-cancer pain; and methods for dissolving blood clots, as well as new discoveries about plastics, detergents and magnets.

As is offered every Sunday of this season's Summer Sundays, Lab tourists can take a bus tour of the site and, in Berkner Hall, see the fascinating Whiz Bang Science Show. Fun for children of all ages, this show is a lively, interactive demonstration of basic scientific principles, and it is presented at 10:30 a.m., noon, 1:30 p.m., and 3:30 p.m.

Reopened around Memorial Day in a new location in Bldg. 184, the Camp Upton Historical Collection may also be visited on Summer Sundays. This museum encompasses the history of Camp Upton, a U.S. Army training camp during World War I and an induction center during World War II, the former site of which became BNL in 1947. Housed in a Camp Upton chapel, the historical collection contains many World War items donated by veterans who had passed through the camp, and many artifacts of the Army found on site.

Organized by BNL's Museum Programs on Sundays through August 29th, Summer Sunday tours are open to all and are offered from 10 a.m. to 5 p.m., but all must arrive before 3 p.m.

Classified Advertisements

LABORATORY RECRUITMENT - Opportunities for Laboratory employees.

NS8439. ADMINISTRATIVE/BUDGETING POSITION - Requires a bachelor's degree in business or the equivalent experience, and a working background with PCs and business software, preferably Excel, Word and PeopleSoft. Experience with Brookhaven's administrative systems is desirable. Responsibilities will include budgeting construction and miscellaneous operating accounts, and performing other administrative functions as assigned. National Synchrotron Light Source Department.

DD8120. OFFICE SERVICES POSITION - (term appointment, reposting) Requires a working knowledge of basic office procedures and Lab practices, policies and procedures. Proficiency in Microsoft Word and Corel WordPerfect is essential. Must be able to handle multiple assignments and prioritize work. Knowledge of Peoplesoft procurement a plus. Responsibilities include maintaining assembly procedures, updating material requirements database (MINX), and reporting routinely on ECNs, procedures and drawings using ISQL database. RHIC Project.

OPEN RECRUITMENT - Opportunities for Laboratory employees and outside candidates.

MK8721. SCIENTIST - For the Advanced Accelerator Group, to assist in the design of a low-energy muon collider and muon storage ring for production of intense neutrino beams. Requires a Ph.D. in accelerator physics and experience in accelerator calculations concerning the performance of linear accelerators, recirculating linear accelerators, rapid cycling synchrotron and fixed field alternating gradient accelerators. Experience using simulations of beam evolution in accelerators and familiarity with general design considerations, such as RF systems, magnet capabilities, superconductivity and lattice design preferred. Under the direction of R. Palmer, Physics Department.

DD7370. TECHNICAL POSITION - (reposting) Requires an AAS degree in electrical or nuclear technology and/or equivalent experience with calibrating, troubleshooting, and repairing electrical and pneumatic process instrumentation. Will perform installation, maintenance, and repair tasks on research-reactor facilities and auxiliary equipment. Previous work experience as instrument technician in a nuclear facility would be desirable. Must be able to obtain and maintain a DOE security clearance. Reactor Division.

DD8722. TECHNICAL POSITION - (term appointment) Requires an AAS in electrical technology or equivalent and some relevant work experience. Under the direct supervision of an electrical engineer, will perform a variety of evaluation, fabrication, testing, troubleshooting, modification, and maintenance operations on electronic and electromechanical equipment associated with the LEGS beam line at the NSLS. Requires a working knowledge and experience with analog electronics (DC to RF), digital electronics, basic test equipment, printed-circuit layout from schematics, elementary electronic design, and basic mechanical fabrication techniques. Experience in computer programming, control systems, CAMAC and NIM electronics, or electro-optics are desirable. Physics Department.

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