

344th Brookhaven Lecture Measuring Forces With the Muon g-2 Experiment at the AGS

At the Alternating Gradient Synchrotron (AGS), an intriguing experiment, E821, recently completed its first major run.

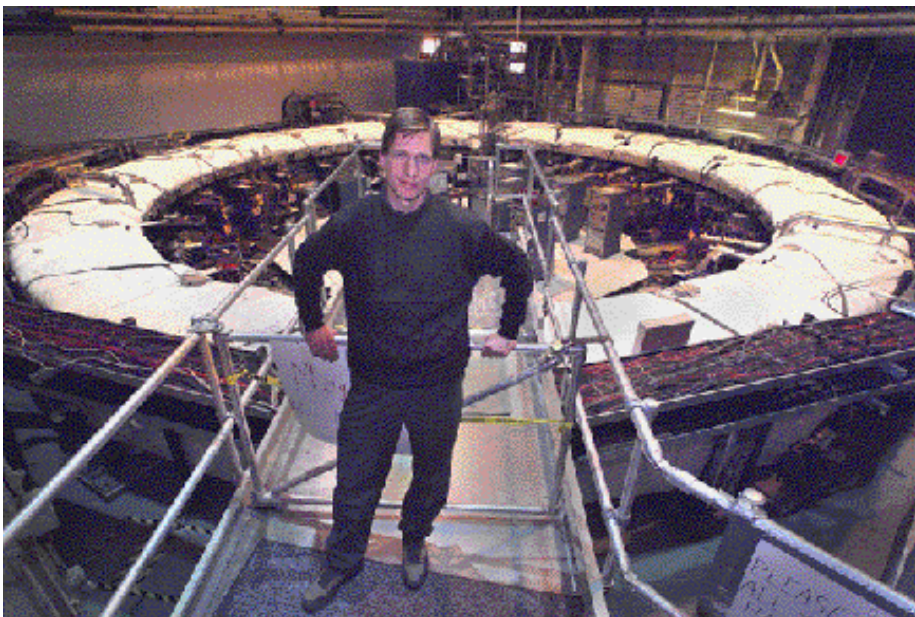
The experimenters, some 70 researchers from BNL and 11 institutions in Germany, Japan, Russia and the U.S., have built the world's largest superconducting magnet coil in order to make one of the world's smallest measurements. They are measuring the energy and time at which the electron particles fly off decaying muon particles that are spinning round a perfectly circular orbit in a magnetic field.

Why do that?

To give the answer, one of the E821 researchers, Associate Scientist Ralf Prigl, AGS, will give the 344th Brookhaven Lecture, "Probing the Nature of Force: The Muon g-2 Experiment at the AGS." Prigl will be introduced by AGS Chair Derek Lowenstein, beginning at 4 p.m. in Berkner Hall on Wednesday, March 24.

As Prigl will explain, the reason for measuring the energy spectrum of the decay electrons is that its time dependence indicates the strength of an effect on the muon.

This effect, called g-2, deflects the muon in a magnetic field, adding to an already well-known force that acts on the bare electric charge of the muon. The effect is believed to be made by the weak force, which is responsible for particle decay; the strong force, which



Ralf Prigl at the muon g-2 experiment at BNL's Alternating Gradient Synchrotron.

holds an atom's nucleus together; and the electromagnetic force. These are three of the four forces that physicists are investigating as governing all interactions of matter.

Prigl will recall how experiments at CERN, Switzerland, during the 1960s and 70s, had already made this measurement to an extraordinary precision, helping to establish muon behavior and the validity of quantum electrodynamics (QED). QED is the scientific theory that joins the theory of electrodynamics, which itself is a

combination of electric and magnetic theory, with the theory of quantum mechanics and relativity.

Now, however, Prigl will relate how new technology has made it possible to refine the old result to an even higher level of sensitivity that is expected to reveal new information about the weak and strong forces.

The Moving Muon

To explain the experiment, Prigl will describe the muon — an electrically charged particle that spins on its

own axis. It therefore acts like a tiny magnet, with a north and south pole and a magnetic moment, which is the name given to a magnet's strength.

During each muon's 2.2 millionths of a second lifetime, it constantly emits and reabsorbs a cloud of even more short-lived particles, which modify the muon's electric and magnetic force. The complex interactions in the muon cloud are known to contain traces of every elementary form of matter.

If a muon orbits in a magnetic field created by another magnet, its magnetic moment and its spin rotate with about the same frequency around the external field. The rotation frequency of the spin is proportional to a factor called "g."

If g were exactly 2, the spin axis, initially pointing in the direction of travel, would always move in step with the orbit and thus continue to point in the forward direction.

However, QED predicts that, by the time the muon returns to where it started, the spin axis will have moved slightly inward, due to the effect of the weak, strong and electromagnetic forces on the muon cloud. At each orbit of the muon, the shift increases by the same amount, until — after 30 orbits in the E821 experiment — the axis again points in the direction of travel.

This rotation of the muon spin axis relative to the direction of travel is called the "g minus 2" (g-2) frequency.

(continued on page 2)

RIKEN BNL Supercomputer Wins Gordon Bell Prize

When, at the first anniversary celebration of the RIKEN BNL Research Center (RBRC) last October, the world's fastest multipurpose non-commercial supercomputer was unveiled, RIKEN BNL researchers knew they had a great machine.

Capable of the top operating speed of 600 billion calculations per second (0.6 teraflops) needed for the most advanced physics research, the supercomputer is also the world's 12th fastest.

It is designed to run in tandem with the 0.4-teraflop supercomputer at Columbia University, resulting in a one-teraflop computing partnership that is the world's eighth fastest (see Brookhaven Bulletin, October 23, 1998).

Within weeks, everyone else in the supercomputing field also knew about the great new machine — because, at the November 1998 SC98 High Performance Networking & Computing Conference, Orlando, Florida, the Columbia-designed, BNL- and RBRC-built supercomputer won the Gordon Bell Prize for price performance.

The Bell prize for price performance recognizes significant achievements

in the application of supercomputers to scientific and engineering problems, with particular emphasis on the machines' cost-effectiveness. Gordon Bell, a former National Science Foundation division director and now a senior research at Microsoft, has been sponsoring this prize for over ten years to promote practical parallel-processing research.

Built economically at a cost of \$1.8 million, which was provided by RIKEN, the Japanese Institute of Physical & Chemical Research, the RIKEN-BNL QCD supercomputer is optimized for advanced research into quantum chromodynamics. Also known as QCD, it is the theoretical model of matter based on the force known as the strong interaction, which binds quarks and gluons in the particles that make up the nucleus of every atom in the universe.

Said RIKEN BNL Research Center Director T.D. Lee of Columbia University, "The construction of this QCD supercomputer began on February 19 last year, and it was completed on August 28, which is a very short period for constructing such a machine. We are delighted that, since then, the supercomputer has been operating steadily 24 hours every day. All these successes are due to the strong support of the BNL Information Technology Division [ITD] and the harmonious working relationship between the scientists of BNL, the RIKEN BNL Research Center, and Columbia."

It was necessary to have such a computer, Lee said, "because without it we will not be able to understand and to predict with accuracy all the

intricacies of nuclear and other subatomic forces."

Already, the supercomputer has proved its worth by making it possible for BNL and RBRC scientists to do calculations that were presented in several papers at a recent RBRC workshop. "Now, we can look forward to having predictions for the new state of matter that could be produced in the Relativistic Heavy Ion Collider [RHIC]," Lee said.

Ed McFadden, who led the ITD team which installed and debugged the superconductor, said, "We continue to take great pride in the success of this supercomputer. It is very gratifying to see a computer that was built with our hands, under the direction of the RBRC scientists, work so well. Winning the Gordon Bell Prize took us all to a new high."

The supercomputer's calculational power is provided by a total of 12,288 processors, or daughterboards, divided in groups of 64 to form 192 large structures called motherboards. ITD's Ed Brosnan and the Hardware Maintenance Group maintain the supercomputer, which stands almost nine feet high and is mounted in six large water-cooled racks.

Over \$1 million of the computer's \$1.8 million price was expended in components purchased from Long Is-



The RIKEN BNL QCD supercomputer (center), winner of the Gordon Bell Prize for price performance at the November 1998 SC98 High Performance Networking & Computing Conference, Orlando, Florida.

land firms.

Said Laboratory Director John Marburger, "We're very proud that the RIKEN BNL superconductor's excellence has been recognized with the Gordon Bell Prize. This is a typical BNL product, resulting from strong collaborations, plus local talent and skills, and a determination to break new ground in pursuit of basic knowledge. It was not a simple matter to build this computer so quickly during a period when the Lab was under many external pressures. Ed McFadden and his team built a beautiful machine with the slimmest resources because they knew it was important to the Lab's central mission. The RIKEN BNL supercomputer will be extremely important to RHIC." — Liz Seubert



In Memoriam: Andrew Hull, Senior Health Physicist

As was noted in *Newsday*, the Lab lost “a big piece of its institutional memory” with the death on Saturday, March 6, of Andrew Hull, a BNL retiree who had continued at the Lab as a guest senior health physicist. He was 79.

Before his death from pneumonia following gallbladder surgery, Hull had been working with Bill Gunther of the Environmental Management Directorate and Charles Meinhold of the Department of Advanced Technology, to assemble the Lab’s earliest environmental-monitoring data.

“From the days when he ran the environmental-monitoring program to his last project, Andy was the only person whom I knew who either knew the answers or where to get the answers to the most difficult questions,” said Meinhold, who, from 1972 to 1988, headed the then Safety & Environmental Protection (S&EP) Division in which Hull had worked. “He kept us focused on the data because he knew that, unlike models and extrapolations, only the data contained the truth.”

While Hull and Meinhold had recently authored a report for 1967 to 1970, years when the Lab did not issue an environmental-monitoring report, they were in the midst of gathering data from the time prior to 1962 when Hull died.

“Andy had such knowledge and

understanding of the environmental-monitoring activities in the early Lab years and the information available from that time that his contributions were invaluable,” said Gunther. “He was a great asset and a wonderful person.”

Hull entered the field of health physics in mid-life, after working in ground operations for American Airlines, 1945-52, and serving in the U.S. Air Force in 1953 during the Korean War.

In 1956, Hull earned a B.S. in physics from Central Connecticut State College and went on to Vanderbilt University, where he was an Atomic Energy Commission (AEC) Fellow in radiological physics, 1956-57. After completing the summer field work for his AEC fellowship, Hull joined Oak Ridge National Laboratory in 1958. He then took the position of supervisor of health physics at Industrial Reactor Laboratories, New Jersey, in 1958.

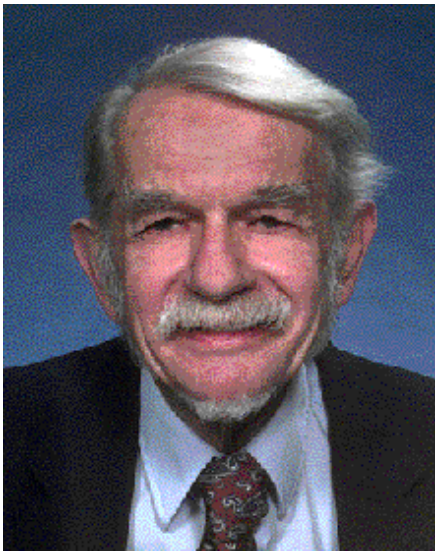
After receiving an M.S. in radiological physics from Vanderbilt in 1961, he joined BNL on April 1 of that year as an assistant health physicist. Promoted to an associate health physicist in 1963, Hull earned the title health physicist in 1973, and, in 1980, he was named a senior health physicist. From 1961 to 1982, Hull supervised the Lab’s environmental monitoring program within S&EP.

Between 1976 and 1977, Hull of-

fered technical assistance to the U.S. Nuclear Regulatory Commission, surveying the monitoring practices of nuclear power reactors. As part of that work, he assessed the ability to monitor radiological releases from nuclear power reactors under accident conditions.

Then, as a member of DOE’s radiological assistance program (RAP) team for the northeast, which is stationed at BNL, Hull was among the first health physicists from outside the nuclear power station to respond to the Three Mile Island (TMI) nuclear reactor accident on March 28, 1979. There, he was responsible for the analysis and interpretation of the environmental monitoring data to estimate what was released and the likely population dose. In 1983, he returned to TMI at the request of the NRC, to serve as project leader during the review of the post-accident sampling systems and monitors.

In May 1986, Hull was called to DOE’s emergency operations center in Germantown, Maryland, to use his dose-assessment expertise to interpret the radiological data being gathered as a result of the April 26th accident at the Chernobyl Nuclear Power Plant in the Ukraine. Similar to his role during TMI, Hull was key to developing an understanding of the incident as it was unfolding. Hull’s work was included in DOE’s report on the health



Andrew Hull

Roger Stoutenburgh

and environmental consequences of the Chernobyl accident.

“Andy could take bits and pieces of seemingly confusing environmental data and focus it into a clear picture of reality,” said Stephen Musolino of the Relativistic Heavy Ion Collider, who had been a coworker and collaborator of Hull’s for the past 20 years. “I have never worked with anyone who had Andy’s talent of making order out of what appeared to be chaos.”

From 1988 until his retirement, Hull was responsible for the Lab’s emergency planning, during which time he helped update the Lab’s emergency plan and developed on active program of emergency drills.

“Andy was a very bright, hard-working and forward-thinking individual who made only positive contributions to the Laboratory,” said Robert Casey of the National Synchrotron Light Source Department, who had headed S&EP 1988-98. “Working in the areas that he did, environmental monitoring and emergency planning, Andy helped the Lab recognize the importance of these issues and stay on the right path.”

On September 30, 1996, after over 35 years at the Lab, Hull retired, but, wishing to lose neither his expertise in his field nor his institutional memory, the Lab retained him as a guest senior health physicist.

The January after his retirement, Hull was selected by the Greater New York Chapter of the Health Physics Society (HPS) and the Radiological & Medical Physics Society of New York to present the Failla Memorial Lecture at the Columbia University Faculty Club. Named for biophysics and radiobiology pioneer Gioacchino Failla, the lecture has been given annually since 1962 by an individual who has made important contributions to the field of health physics. For his lecture, Hull spoke on “Chernobyl and Radiation Protection: Lessons Learned and Unlearned.”

An active member of the HPS until his death, Hull was past president of its Greater New York Chapter. A member of the American Association for the Advancement of Science and the Federation of American Scientists, Hull was a fellow of the American Public Health Association.

A resident of Shoreham, Andrew Hull is survived by his wife Edith Hull; four children: David Hull of Delaware, Constance Spencer of California, Nora Hull of Pennsylvania, and Serena Wood of Wading River; five grandchildren and four great-grandchildren; and a brother and three sisters.

A memorial service for Andrew Hull will take place on Saturday, April 10, at 4 p.m. at the Unitarian Universalist Fellowship, 380 Nichols Road, Stony Brook, where contributions in Hull’s name are being accepted for the fellowship’s building fund. Contributions in Hull’s memory may also be made to Save the Children, 52 Wilton Road, Westport CT 06880.

— Marsha Belford

OU III Public Meeting

BNL employees and the general public are invited to a meeting, during which they are welcome to provide comments on three recently released reports on groundwater cleanup in an area identified as operable unit III, which covers contaminated groundwater located under the southern part of the Lab site and nearby areas (see Brookhaven Bulletin, March 5, 1999).

The public meeting will be held on Wednesday, March 24, from 7 to 9 p.m. in Berkner Hall. More information may also be found at www.oer.dir.bnl.gov/ou3doc.html.

Comments provided on the proposed remediation options will help in the selection of the final remedy for the Lab’s on- and off-site groundwater contamination. Comments may be sent to OU3_comments@bnl.gov, or to George Malosh, DOE Brookhaven Group Manager, Bldg. 464.

Equipment Demo

On Tuesday, March 23, from 10 a.m. to 2 p.m., in Berkner Hall, Mobile Phone Center Wireless will discuss the wireless services that it offers. For more information, call 385-4141.

ANS Meeting

“Gamma-Ray Imaging in Commercial and DOE Nuclear Facilities” will be addressed by Alfred Henneborn of AIL Systems Inc. at the next dinner meeting of the Long Island Section of the American Nuclear Society (LIANS). The meeting will be held at Collins & Main Restaurant, 100 Old South Main Street, Sayville, and all are invited.

After appetizers at 6 p.m. and dinner at 7 p.m., the speaker will be introduced at 8 p.m. by Norman Holden of BNL’s Reactor Division. To make reservations, at \$29 per person, call Ken White, Ext. 4423, by Tuesday, March 22.

Off-Site Housing Call

Since the Lab has many more visiting scientists during the summer than it can accommodate in its on-site housing, BNL has an off-site housing coordinator to help summer visitors find suitable housing off site for the duration of their work at the Lab.

This year’s coordinator is Linda Rundlett of the Staff Services Group, who is in the process of compiling a list of available furnished apartments and houses to which she can refer summer visitors. If you know of suitable housing available for short-term rental during the summer, contact Rundlett, lrundlett@bnl.gov or Ext. 4489.

Speakers’ Bureau

To volunteer as a speaker or to suggest a speaking venue, call the Media & Communications Office, Ext. 2345.

date	speakers	dept.	title of talk	organization
Mar. 4	Ken White	CIGPA	“Science at BNL”	East Yaphank Civic Association
Mar. 11	Mona Rowe	Med. & Com.	“BNL Science & Scientists in the News”	USB science students
Mar. 17	John Marburger Tom Ludlam	Dir. Off. RHIC	“BNL’s Science” “RHIC Physics”	Ridge Civic Association Ridge Civic Association
Mar. 18	Gerry Vanderlaske	RHIC	“Hands-on Engineering”	Shoreham Children’s Museum

BNL Lecture (cont’d)

Its exact value gives physicists information about the effect of the three forces on the muon cloud.

Back to the Electron

But how does the electron get in the mix?

When muons decay, they emit an electron. This experiment was designed to use the fact that the energy of the decay electrons gives information about the direction of the muon’s spin axis.

So, with data from the electron detectors set all around the inside of the experiment’s storage ring magnet in which the muons orbit, researchers can calculate how fast the spin axis is deflected from the muon’s direction of travel. The mammoth storage ring

magnet, with a diameter of 14 meters, is energized by superconducting coils, which were needed to satisfy the stringent requirements on the stability of the magnetic field.

As Prigl will admit, a satisfactory result for this experiment will confirm the incredibly precise QED predictions, which go to 10 decimal places, as well as the smaller contributions from the weak and strong forces to the g-2 frequency. But if g-2 is not quite as predicted, excitement will be much higher, as this may mean new physics.

Prigl, who joined BNL as an assistant scientist in the AGS in 1996, had long been associated with E821. After earning his 1990 M.S. in physics at the Max Planck Institute for Medical Research in Heidelberg, he received his 1994 Ph.D. at the University of Heidelberg, where he did his thesis

and then a postdoctoral fellowship on the nuclear magnetic-resonance (NMR) probe system designed to measure the magnetic field inside the muon storage ring.

From May 1994 until May 1996, Prigl joined E821 researchers at Yale University, continuing to work on the Heidelberg-Yale NMR system and participating in another muon experiment at Los Alamos National Laboratory. Then, moving to BNL in June of 1996, after two years as a member of the AGS, he was named Associate Scientist in September 1998.

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 Penny LoPresti, Ext. 2625, by noon on Wednesday, March 24. — Liz Seubert

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BULLETIN**

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service	contractor	contact name	ext.	bldg.
• credit union	TFCU	Mark Israel	2494	134A
• day care	Child Care Mgmt.	Sue Foster	2882	185
• food service - cafeteria	Flik International	Ron Manning	2525	179B
Brookhaven Center Club				
• apt.-area laundry	Coinmach	Jeff Swenson	2551	179B
• leisure travel	Omega	Sylvia Mouzakes	2531	179B
• service station	Upton Industries	Jessie Wilke	5173	179B
• vending machines - cold-food	Werner Brothers	Ron Manning	2525	179B
snack-food	Exclusive Service	Ron Manning	2525	179B

Three-point shots: Ortiz (3), Walcott (3), Buck (2), Garrison (2).

Bombers 70		Bulldogs 68	
Doug Aichroth	20	Paul Hawthorne	16
Mitch Williams	18	Greg Mack	13
Jerry Gaeta	16	Troy Mayo	12
Donald Davis	11	Louis Lalar	11
Brian Hobson	3	Gerry Shepherd	10
Tracy Fountaine	2	Pete Ratzke	6

Three-point shots: Williams (6), Gaeta (3), Mayo (3), Hobson, Lalar.

BERA Candidates

The BERA Nominating Committee has selected the following four candidates for the 1999 BERA Board election:

name	dept./div.	bldg.	ext.
Tom Dilgen	RHIC	902	7455
Luis Nieves	ITD	179	4897
Rosalie Piccione	DCP	355	3160
Ed Sperry	RHIC	902	2697

During the week of Monday, March 29, through Friday, April 2, all BNL, BSA and DOE employees and those of permanent on-site employers may cast their ballots to elect two of the four candidates to serve four years on the BERA Executive Board.

More information on the candidates and the election will appear in the Bulletin next week.

Noon Piano Concert

On Wednesday, March 24, noon-12:45 p.m., in Berkner Hall, the BSA Cultural Program will present a free concert by pianist Xiao Hu, a doctoral music student at the State University of New York at Stony Brook.

Hu, whose prizes include the 1995 College-Conservatory of Music Concerto competition, the Cliburn Scholarship competition and the Cincinnati Three Arts Women's scholarship competition, will play works by Bach, Schumann and Janacek.

Lunchtime events are free and informal. Come and go as you please, and bring a lunch to enjoy with the performance.

Defensive Driving

The training group of the Safety & Health Services Division will offer a six-hour defensive driving course on Saturday, April 10, 9 a.m.-3:30 p.m., in Berkner Hall, Rooms B & C.

The course will be taught by a Metropolitan Life instructor and is open to all BNL, BSA and DOE employees, BNL facility users, and their families, at \$23 per person.

Completing the course entitles participants to a 10-percent discount on vehicle collision and liability insurance for three years, and to have up to four points deducted from their driving records if they were incurred during the 18 months before the completed course. To register, call Scott Zambelli, 249-3000, Ext. 5877 (*not* the on-site Ext. 5877).

Volleyball

League standings as of March 12			
Open League A		Mixed League 2	
Death Volley	36-15	Safe Sets	41-10
Spikers	33-18	Spiked Jello	41-10
Far Side	24-27	Monday Nite Live	36-15
Shank,Cary&Throw	9-42	How-Bout-Dis	27-24
Open League B		In Sideout	27-24
Late Entry	32-9	Nuts & Bolts	13-38
Bumpin Ugliers	29-22	Setups	13-38
Star	28-23	Just-4-Fun	6-45
Rice Ball	3-45	Mixed League 3	
Mixed League 1		Upton Ups	42-9
Bikers&Spikers	47-4	Group Sets	37-14
Set to Kill	27-24	Six Samurai	34-14
Scared Hitless	19-32	NWO	15-36
Rude Dogs	9-42	Net Setters	12-39
		Butlers	10-38



Placement Notices

The Lab's placement policy is to select the best-qualified candidate for an available position. Candidates are considered in the following order: (1) present employees within the department/division and/or appropriate bargaining unit, with preference for those within the immediate work group; (2) present employees within the Laboratory; and (3) outside applicants. In keeping with the Affirmative Action Plan, selections are made without regard to age, race, color, religion, national origin, sex, disability or veteran status. Each week, the Human Resources Division lists new placement notices, first, so employees may request consideration for themselves, and, second, for open recruitment. Because of the priority policy stated above, each listing does not necessarily represent an opportunity for all people. Except when operational needs require otherwise, positions will be open for one week after publication. For more information, contact the Employment Manager, Ext. 2882; call the JOBLINE, Ext. 7744 (344-7744), for a complete list of all job openings; use a TDD system to access job information by calling (516) 344-6018; or access

current job openings on the World Wide Web at <http://www.bnl.gov/JOBS/jobs.html>.

LAB RECRUITMENT - Opportunities for Laboratory employees.

DD7019. OFFICE SERVICES POSITION - Requires previous experience in an office setting, familiarity with Microsoft Office products, and excellent communication skills. Will provide varied clerical support, including typing, processing mail, answering phones, and filing. In addition, will act as receptionist, make photocopies, and maintain supplies and control of service contracts. Budget Office.

OPEN RECRUITMENT - Opportunities for Laboratory employees and outside candidates.

MK7659. POSTDOCTORAL RESEARCH ASSOCIATE - Trained in experimental nuclear or high-energy physics, with extensive experience with detector hardware. Familiarity with precise timing detectors and/or calorimeters is preferred; familiarity with data analysis using modern programming tools (such as C, C++ and databases) desirable. Requires a Ph.D. in nuclear or high-energy experimental physics, with hardware experience, especially with photo-tube based counters and precision-timing electronics. Will participate in the PHENIX experiment at RHIC, taking responsibility for the beam-beam counters and the zero-degree calorimeter. Under the direction of S. Aronson, Physics Department.

NS8179. ENGINEERING POSITION - Requires a BS in a physical science; advanced degree in health physics and/or ABHP certification is an advantage. Also requires five to six years of experience in health physics, and knowledge of industrial safety and hygiene. Past supervisory experience is a plus, as is a working knowledge of health and safety issues in medical/biology research environment. Radiological Control Division.

NS8176. ENGINEERING POSITION - Requires a BS/MS in engineering (environmental, nuclear, chemical or civil engineering; or environmental science, health physics, or related discipline). Professional certification (CHP) is required, as is ten to 15 years of experience in the interpretation, application and compliance with environmental regulations, especially NESHAPS subpart H regulations, to nuclear and, especially, DOE research facilities. In-depth experience with DOE orders a must. Strong supervisory, interpersonal, communication (oral and written) and problem-solving skills required. Must be able to develop and implement strategies for achieving compliance. Ability to establish and maintain effective communications with customers and regulators is required. Will provide technical support to Lab initiatives to ensure strict compliance with NESHAPs subpart H regulations and to identify potential environmental concerns impacting Lab activities. Will work with the research community to ensure that all operations are conducted in full conformance with environmental statutes including federal, state and local regulations and associated requirements, permit programs and DOE orders. Environmental Services Division.

NS7788. SYSTEMS SPECIALIST POSITION - Requires an AAS in computer science or related field, a minimum of three years of experience, and a strong working knowledge of various PC operating systems (Windows 95, Windows NT) from client and server perspectives. The ability to perform Windows registry, installation setup and configuration of operating systems and client software, and the ability to debug and resolve work station and network problems are necessary. Strong communication skills required. Microsoft certification is a plus (MCSE, MCP). Responsibilities include systems delivery, configuration, client software installation, problem detection and resolution, and hardware maintenance. Information Technology Division.

DD8256. SECRETARIAL POSITION - (reposting) Requires an AAS degree in secretarial science or equivalent experience, and excellent oral and written communication skills. Must be proficient in processing of information using a PC (Macintosh and Wintel machines). Requires ability to work independently and to exercise initiative and good judgement. Will utilize state-of-the-art software (Microsoft Word, PowerPoint, Corel, WordPerfect, DeltaGraph, calendar software and IPAP) for complex scientific word processing, presentations, technical reports and journal manuscripts, database management, electronic schedules, and e-mail. Will arrange and process domestic and foreign travel, as well as provide administrative secretarial support to the group leader and staff members. Department of Advanced Technology.