The Promise of RHIC

The Relativistic Heavy Ion Collider (RHIC) ring, which is 3.8 kilometers (2.4 miles) in circumference, dominates Brookhaven National Laboratory's 5,300-acre campus. RHIC is also a dominant force in the world of physics: Inside the RHIC tunnel new and exciting physics is taking place — physics that may answer universal questions that have long intrigued humankind.

This physics begins with atoms, which are usually made of three kinds of particles — protons and neutrons in the nucleus, and electrons that orbit the nucleus. The atoms used in RHIC, however, have been stripped of electrons, which renders them ions. Since these ions come from the heavier elements in the atomic table, such as gold, they are "heavy ions."

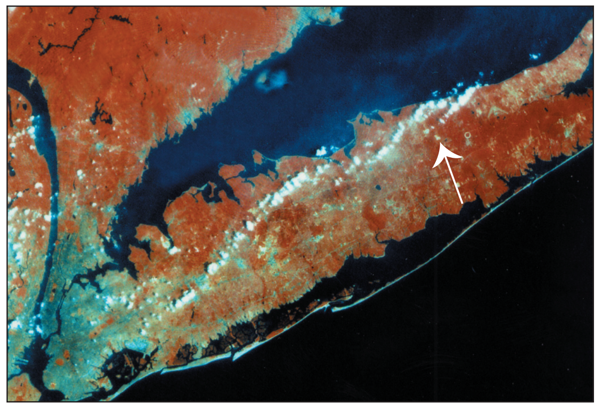
The heavy ions speed through RHIC in opposite directions at energies called "relativistic," because they approach the speed of light. The two particle rings intersect at six points, where some of the ions collide. The temperatures and densities resulting from these collisions are so extreme that they mimic conditions that existed in the first few microseconds of the universe.

The PHENIX detector under construction

Brookhaven National Laboratory

Established in 1947 as a national resource where scientists could pursue peaceful research on atoms, Brookhaven has remained focused on its mission over its 50-plus years — and RHIC helps further that goal considerably by probing the subatomic structure of matter.

Six Nobel Prize-winning discoveries have been made at Brookhaven, and, each year, some 4,000 visiting researchers from universities, industry, and other laboratories worldwide take advantage of Brookhaven's unique scientific facilities. Supporting them, and doing their own research in many scientific disciplines, are Brookhaven's core staff of more than 3,000 scientists, engineers, technicians, and support personnel.



Satellite photo of Long Island, showing the RHIC ring

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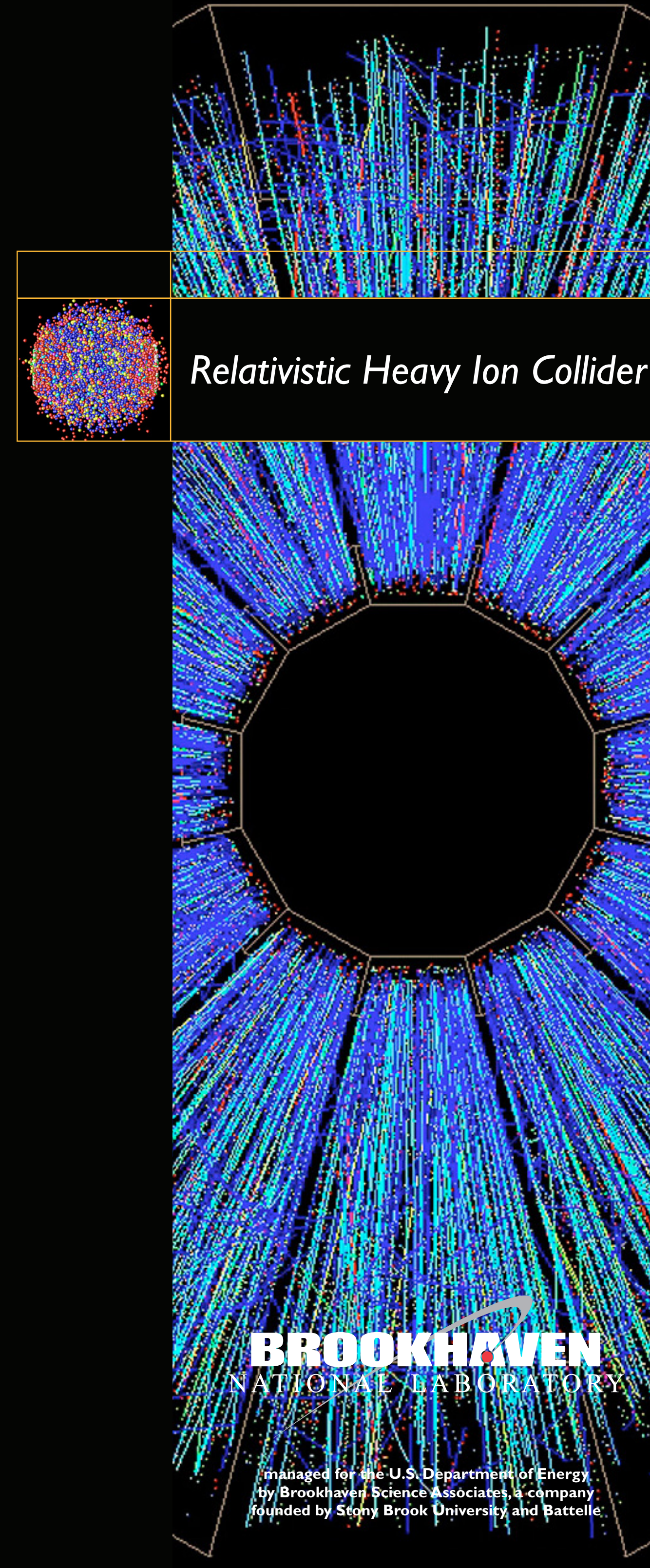


RHIC Brookhaven's Relativistic Heavy Ion Collider

Superconducting Magnets: The Heart of RHIC

To make sure RHIC is both powerful and affordable, Brookhaven has made advanced use of the phenomenon known as superconductivity to create 1,740 superconducting magnets of various types and sizes.

A RHIC superconducting magnet on display outside the RHIC Collider Center

The magnets contain and shape the particle beams to optimize the collisions for the new physics at RHIC — a process that takes a lot of electricity. But the cost of the electricity has been greatly reduced because the magnets are made of superconducting materials. When cooled to extremely cold temperatures — just above absolute zero — superconducting materials loose all resistance to electricity, so electricity flows freely.

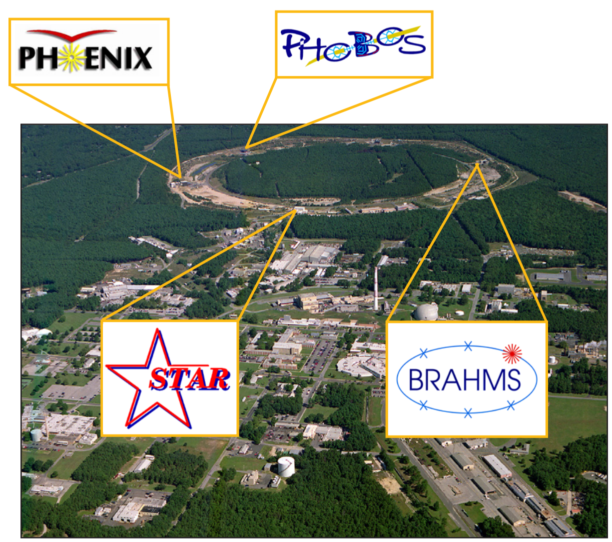
Inside the RHIC tunnel, two rings of supercold, superpowerful, superconducting magnets guide and focus high-speed packets of heavy ions — the nuclei of atoms as heavy as gold — in opposite directions. At the six points where these rings intersect and the beams collide, new particles are being created.

Detectors: The Eyes of RHIC

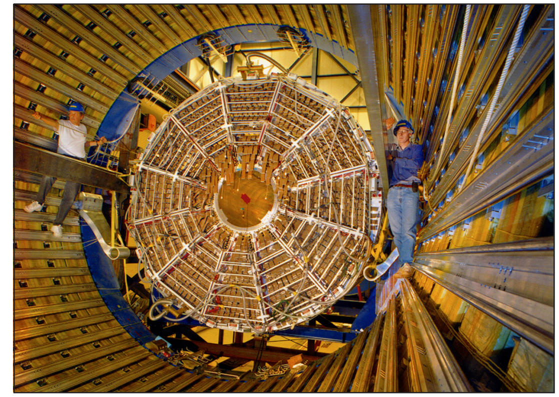
Four very different detectors help physicists analyze the particle collisions at RHIC. By electronically recording the results of the interactions between particles, all four detectors are seeking the same thing: insight into what happens when entities called quarks and gluons are liberated from their confinement inside atomic nuclei. Quarks are the particles that make up the nuclear particles known as protons and neutrons; gluons are the stuff that holds quarks strongly together.

Under the extreme conditions generated in RHIC's high-energy, heavy-ion collisions, the nuclear components should form an intensely hot, incredibly dense globule called a quark-gluon plasma — a state of matter that existed in the earliest moments of the universe. Each detector uses a different strategy to measure the characteristics of the resulting particles during their brief existence.

The four detectors — STAR, PHENIX, PHOBOS, and BRAHMS — are positioned at different places around the RHIC ring where the two particle beams



The RHIC ring and detectors at Brookhaven Lab



Inside the STAR detector

intersect and collide. Each detector is run by its own international team of scientists.

The STAR and PHENIX detectors are very large, roughly the size of small houses. BRAHMS and PHOBOS are smaller. Each detector is built with a different viewpoint, designed to make unique contributions to the total understanding that scientists seek.

STAR tracks and analyzes thousands of particles, such as protons, neutrons, and pions, that may be produced in each collision inside the detector — as seen in the cover image. STAR stands for Solenoidal Tracker at RHIC.

In addition to tracking those particles, PHENIX examines other entities such as photons, electrons, and muons. PHENIX stands for Pioneering High-Energy Nuclear Interacting Experiment.

BRAHMS makes very precise measurements focusing on a small sample of particles emerging from each collision. BRAHMS stands for Broad RAnge Hadron Magnetic Spectrometers.

PHOBOS, which is named after a moon on Mars, permits researchers to detect rare and unusual events quickly by using state-of-the-art semiconductor devices.