Purpose
To study the fundamental properties of matter from elementary atomic particles to the evolution of the universe

Sponsor
U.S. Department of Energy's Office of Nuclear Physics

Replacement Cost
$2 billion

Operating Costs
More than $150 million per year

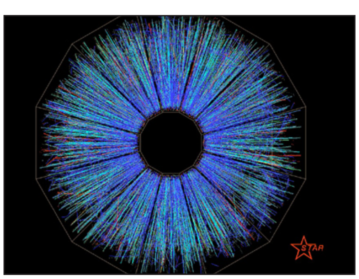
Features

- Two crisscrossing rings in a tunnel
- Rings 2.4 miles in circumference
- Total of 1,740 superconducting magnets
- Two detectors: PHENIX and STAR (BRAHMS and PHOBOS are no longer operating)

Users
More than 1,000 per year from national and international laboratories, universities, and other research institutions

- More than 550 collaborators each from STAR and PHENIX continue data taking, analysis, and detector upgrades to enhance capabilities
- More than 50 collaborators each from PHOBOS and BRAHMS analyzed data taken in 2006 and earlier

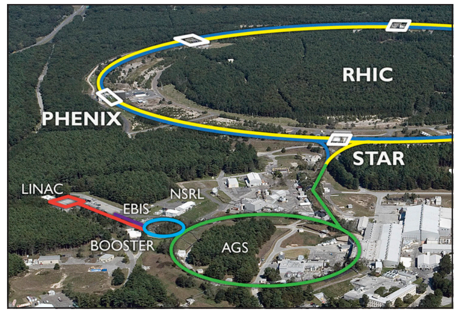
www.bnl.gov/rhic



Particle tracks from one of first collisions at RHIC

The Relativistic Heavy Ion Collider (RHIC)

The Relativistic Heavy Ion Collider (RHIC) is designed to study matter as it existed fractions of a second after the birth of the universe—as a plasma of quarks and gluons, the fundamental components of matter.



The RHIC accelerator complex at Brookhaven Lab, including a portion of the 2.4-mile-round RHIC ring

At RHIC, physicists accelerate and collide heavy ions (atoms of heavy elements stripped of their electrons) at high energies to mimic the hot, dense conditions of the early universe (250,000 times hotter than the center of the sun). Surprisingly, the data have revealed quark-gluon matter that behaves as a nearly-perfect liquid, rather than the predicted gas. RHIC physicists also accelerate and collide polarized protons to explore the mysterious internal spin structure of the proton.

The Machine

RHIC is really two accelerators in one—made up of crisscrossing rings of superconducting magnets, enclosed in a tunnel 2.4 miles in circumference. In the two rings, beams of heavy ions or protons are accelerated to nearly the speed of light in opposite directions, held in their orbits by powerful magnetic fields. The particles can collide at six points around the circles where RHIC's two rings intersect. Thousands of collisions take place every second, each producing a spray of thousands of subatomic particles.

Two large, complementary detectors, PHENIX and STAR, collect the collision products, providing physicists worldwide with data to help them investigate the inner workings of matter and the birth of the universe. PHENIX detects collision products that can reveal information about the initial collision temperature, as well as the time evolution during its later stages. STAR obtains fundamental data about the microscopic structure of the ion interactions, tracking thousands of particles emerging from the collisions. Two smaller detectors, PHOBOS and BRAHMS, recorded data from 2000 through 2005 and 2006, respectively, making important contributions to this research.

Accelerator Chain

RHIC draws upon a "chain" of accelerators at Brookhaven Lab. Beams of particles begin their travels in the Electron Beam Ion Source (EBIS) or Optically Pumped Polarized Ion Source (OPPIS). They then travel into the small, circular Booster, where they are accelerated to higher energies with each pass. From the Booster, the particles travel to the Alternating Gradient Synchrotron (AGS), which then injects them into the two rings of RHIC. At each stage, the beams get a "kick up" in energy from powerful, highly-focused radio waves. Once accelerated to full energy, the beams can zip around the rings for many hours.

The Future

RHIC's findings have enriched our understanding of matter and raised compelling new questions. To address these and help reveal detailed characteristics of RHIC's quark-gluon plasma, key improvements are planned to increase collision rates and improve the detectors. In the longer-term, the addition of a high-energy electron beam would allow physicists to probe another new form of matter locked deep inside ordinary nuclei. These capabilities would further expand our ability to explore the newest and most intriguing questions about the substructure of the world around us.

(04/14)