The Detectors at RHIC

Electronic "eyes" analyze collisions for glimpse of early-universe matter

Purpose:

Four advanced detectors built by international collaborations of scientists have studied the details of RHIC collisions. Two of these remain operational.

Sponsors:

RHIC's detectors were built with funding from the Office of Nuclear Physics within the U.S. Department of Energy's Office of Science and from a variety of collaborating institutions. For complete information about RHIC funding, go to: www.bnl.gov/rhic/funding.htm.

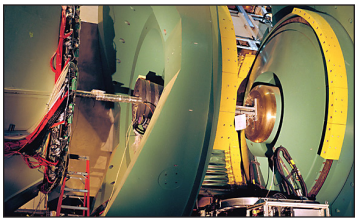
Detector Names:

- BRAHMS: composed of two Broad Range Hadron Magnetic Spectrometers
- PHENIX: Pioneering High Energy Nuclear Interacting Experiment
- PHOBOS: Named for a moon of Mars
- STAR: Solenoidal Tracker at RHIC

Web Sites:

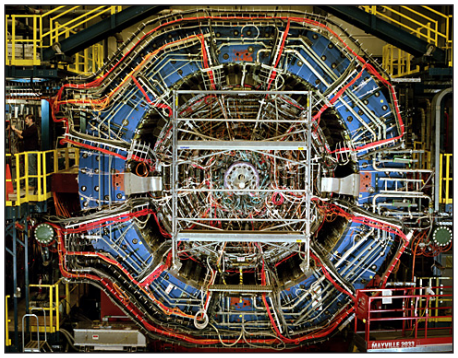
- www.bnl.gov/RHIC/BRAHMS.htm
- www.bnl.gov/RHIC/PHENIX.htm
- www.bnl.gov/RHIC/PHOBOS.htm
- www.bnl.gov/RHIC/STAR.htm)

www.bnl.gov/RHIC/



Magnets of the PHENIX detector

Like giant three-dimensional digital cameras, complex particle detectors capture the action at RHIC, electronically recording data from collision events for later analysis. These detectors use sophisticated technology and powerful computers to help the scientists explore the subatomic world.



The 1,200-ton STAR detector at RHIC

When RHIC first came online in June 2000, four detectors were operational, all searching for signs of an early-universe form of matter known as quark-gluon plasma, in which neutrons and protons — the components of the atomic nuclues — have melted to liberate their quark and gluon constituents.

The two small detectors, BRAHMS and PHOBOS, were designed for limited operations and have since shut down. Scientists from these collaborations continue to analyze archived data. Meanwhile, RHIC's two large detectors, PHENIX and STAR, remain operational. More detectors may be added as compelling new questions arise.

STAR

- As big as a house, the STAR detector specializes in tracking the thousands of electrically charged particles produced by each RHIC collision.
- STAR's "heart" is the Time Projection Chamber, made up of many electronic systems to track and identify particles. With each collision, STAR measures many parameters simultaneously, reconstructing millions of bits of information.
- The goal of STAR is to obtain a fundamental understanding of the microscopic structure of interactions between particles made of quarks and gluons.
- The STAR team is composed of some 600 collaborators from 58 institutions in 12 countries.

PHENIX

- The PHENIX detector looks for many different particles emerging from RHIC collisions — including photons, electrons, muons, and quark-containing particles — using large steel magnets that surround the collision zone.
- Photons, electrons, and muons are not affected by the strong force, which binds quarks and gluons together to form ordinary protons and neutrons. Because these particles emerge from RHIC collisions unchanged, they can carry information about processes and properties within the collision, such as its temperature.
- At 3,000 tons, PHENIX is larger than STAR, but it was designed to detect far fewer and far lighter particles.
- PHENIX has 565 collaborators from 69 institutions in 13 countries.

Findings to date

Together, the RHIC detectors are seeking insight into what happens when quarks and gluons are liberated from their confinement inside atomic nuclei — as scientists believe they existed just after the birth of the universe. The results have captured worldwide attention with an astonishing surprise: Instead of behaving like a *gas* of free quarks and gluons, the matter created in RHIC's most energetic collisions appears to be more like a *liquid*.

Further experiments at a higher collision rate and improved sensitivity of RHIC's detectors will help reveal the detailed characteristics of this new form of matter.

(8/06)