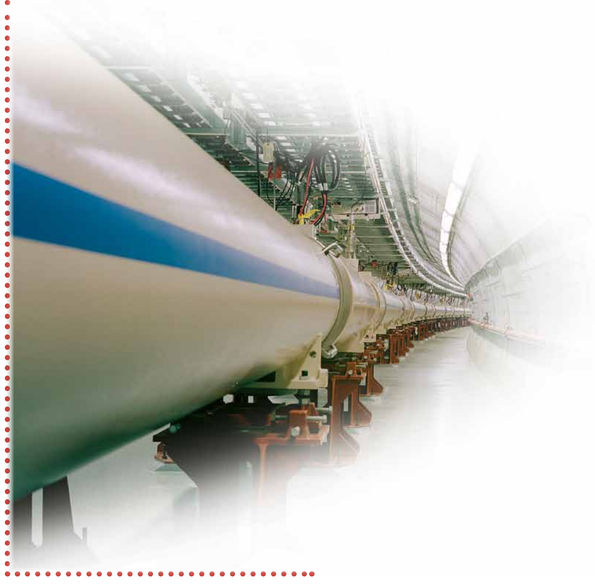


Nuclear Physics

Relativistic Heavy Ion Collider

At the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory, physicists from around the world are exploring the earliest moments of the universe, the most fundamental particles of matter, and the forces through which they interact.

U.S. DEPARTMENT OF ENERGY | Office of Science

BROOKHAVEN NATIONAL LABORATORY

The Relativistic Heavy Ion Collider is an Office of Science User Facility operated for the Department of Energy by Brookhaven National Laboratory

An Overview

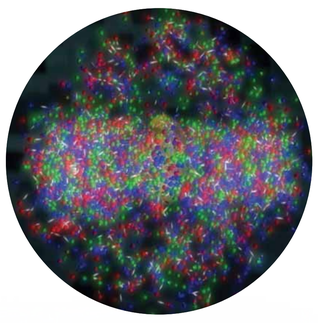
Light-Speed Collisions

RHIC is a 2.4-mile-circumference, two-ring particle accelerator dedicated to collisions at near light speed of heavy ions and polarized protons. By studying the particles that emerge from these collisions, scientists piece together what happened at the moment of impact and infer the conditions of the earliest moments of the universe. This research is leading to a new understanding of the forces that hold ordinary matter together . . . and even greater mysteries to explore.

Looking Ahead

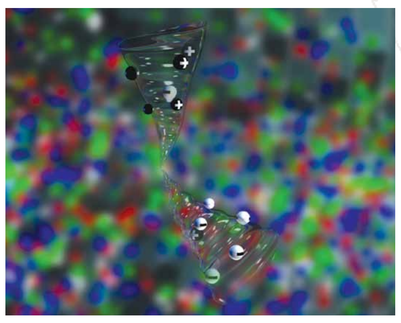
RHIC findings have raised compelling questions about the theory that explains the interactions of the most fundamental particles of matter – the quarks and gluons that comprise individual protons and neutrons within atomic nuclei. An ongoing upgrade of RHIC will allow scientists to address these questions with technologies enabling higher collision rates (RHIC II).

Scientific Accomplishments



Quark-Gluon Plasma

Instead of producing an anticipated gas of free quarks and gluons, heavy ion collisions at RHIC have produced a liquid of strongly interacting quarks and gluons. With a temperature 250,000 times hotter than the center of the Sun, this quark-gluon plasma has given scientists a surprising idea of what the universe was like just after the Big Bang some 14 billion years ago – a nearly perfect liquid with practically no viscosity, or resistance to flow.



Exotic Findings

RHIC's collisions have also produced tiny "bubbles" that may internally disobey fundamental symmetries of quark-gluon interactions, as well as the heaviest antimatter nucleus yet discovered. These exotic findings may have implications for understanding and exploring fundamental asymmetries in the early universe, and offer insight into models of neutron stars.

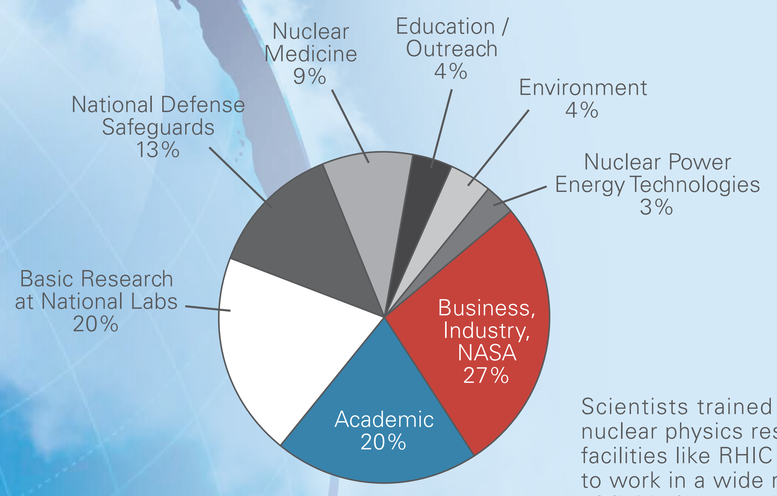
Proton Spin Mystery

RHIC's polarized proton collisions are providing the first information on how gluons contribute to the overall spin of a proton, which cannot be accounted for by the spin of its quarks alone. Early evidence suggests that gluons don't contribute enough to solve the mystery of the "missing" spin, opening new explorations into how quarks and gluons interact and move inside protons and other particles.

Benefits Beyond Physics

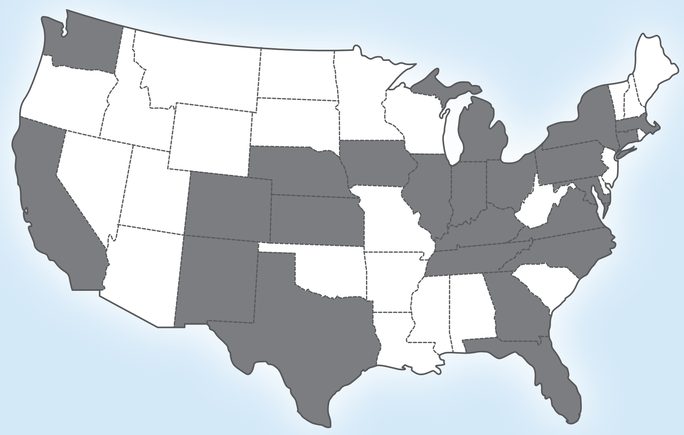
Research at RHIC has triggered innovations in accelerator technology that could greatly improve worldwide access to particle-beam-delivery systems used to treat cancer. Likewise, advances in data distribution and analysis systems developed for RHIC will benefit society at large. Furthermore, many scientists and engineers trained at RHIC go on to work in fields as diverse as national security, medicine, energy generation, space exploration, and more.

Societal Impact



Employment of Nuclear Physics PhDs

Scientists trained at nuclear physics research facilities like RHIC go on to work in a wide range of fields from medicine to national security, helping to fuel our nation's economic vitality.



U.S. States represented by RHIC users