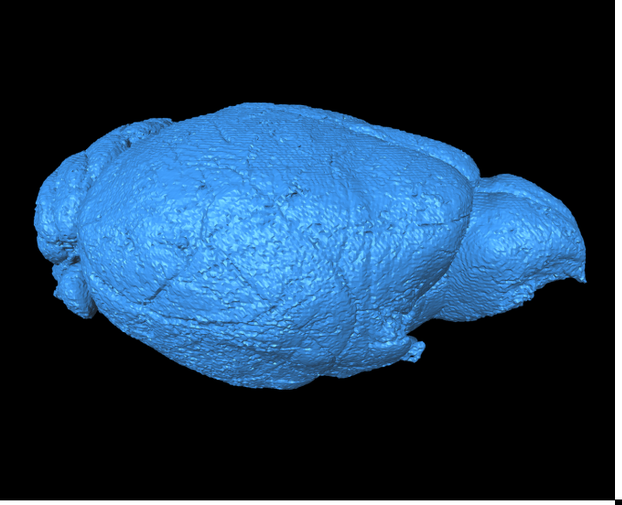
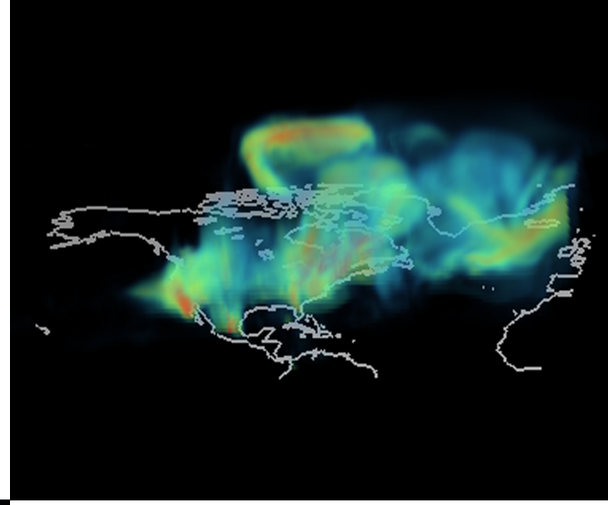
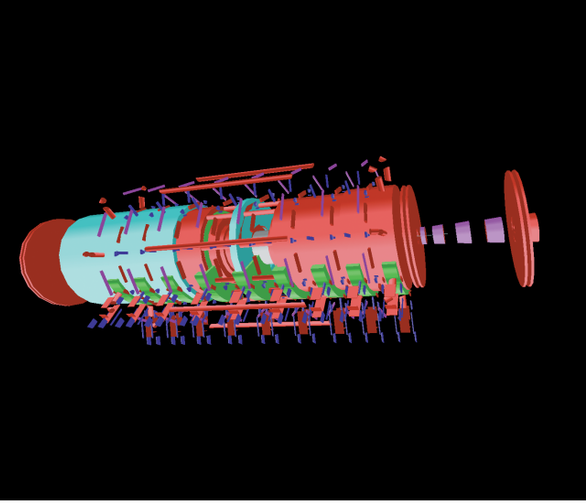


Nuclear and High Energy Physics

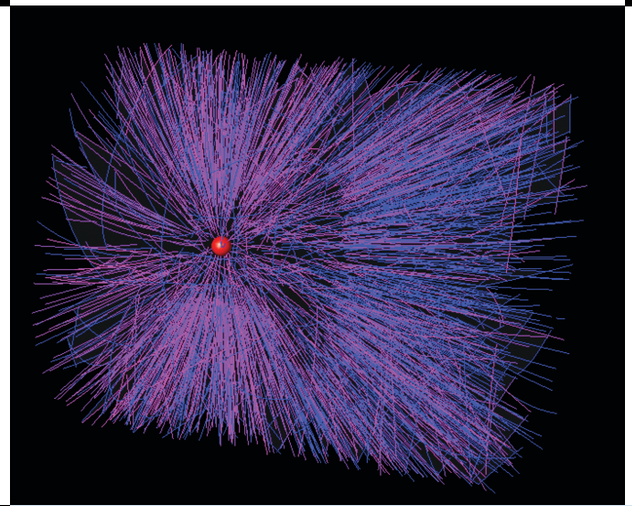
Shown below is an image from a RHIC event. There are approximately 2000 particle tracks detected after a collision of two gold nuclei. Shown on the cover is a visualization of the next generation ATLAS detector, designed to search for physics beyond the Standard Model, including supersymmetry. The detector contains 30 million distinct elements, more than a thousand times as many as the most complicated detector now in use. Current visualization software can display multiple levels of detail. There are fifteen levels of detail in the design.





Medical Science

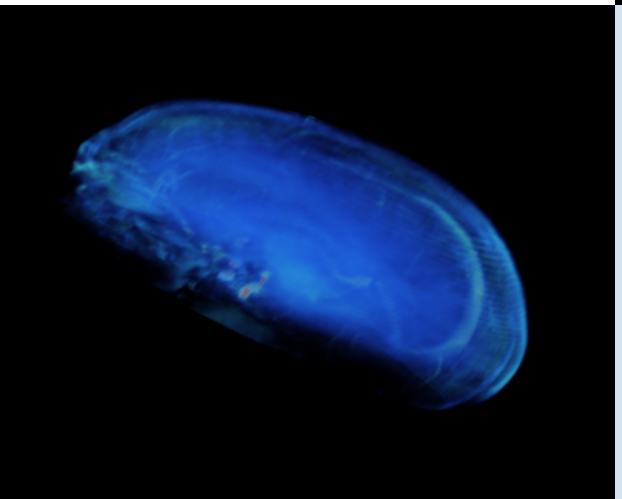
Shown above is a 3D surface rendering of an excised mouse brain. The data was acquired using high-resolution magnetic resonance microscopy (MRM) with a spatial resolution of 47x47x47 microns cubed. Imaging was performed on a 17 Tesla vertical MRM instrument at the Center for Structural Biology, University of Florida. Shown below is a MRI of a human brain used in a study of the effects of drug dependency. The data was rendered in Vis5d and volume rendering was used to inspect the internal structure. As Vis5d is primarily used for environmental science studies, this example shows the software's versatility.



Environmental Science

Shown above is the three-dimensional volume (latitude, longitude and altitude) of the total sulfate burden over North America for a 24 hour period. The image was created with Vis5d, a software package for visualizing meteorological data. Source data for the image was generated from a mathematical model developed at BNL. This model is used to study the effect of atmospheric aerosols on the deviation of the Earth's radiation balance. Aerosol sources in the model include volcanoes, anthropomorphic and industrial and biogenic (dimethylsulfide). Higher concentrations are mapped to darker (red) colors.

Scientific Visualization at BROOKHAVEN NATIONAL LABORATORY



Brookhaven National Laboratory (BNL) is a U. S. Department of Energy (DOE) scientific research laboratory located on Long Island, New York. As a non-defense research institution, BNL is dedicated to basic and applied investigation in a multitude of scientific disciplines.

Experimental and theoretical physics, medicine, chemistry, biology, environmental research, engineering and many other fields are represented here by our 3,000-member staff and over 4,000 visitors who come to BNL every year to use our world-class facilities.

The Information Technology Division (ITD) works closely with BNL's scientific departments and other divisions to provide high quality service in computing, networking and telecommunications. The Stereoscopic Visualization Theatre and the projects represented here are but a part of ITD's efforts to support research and industrial partnerships at BNL.

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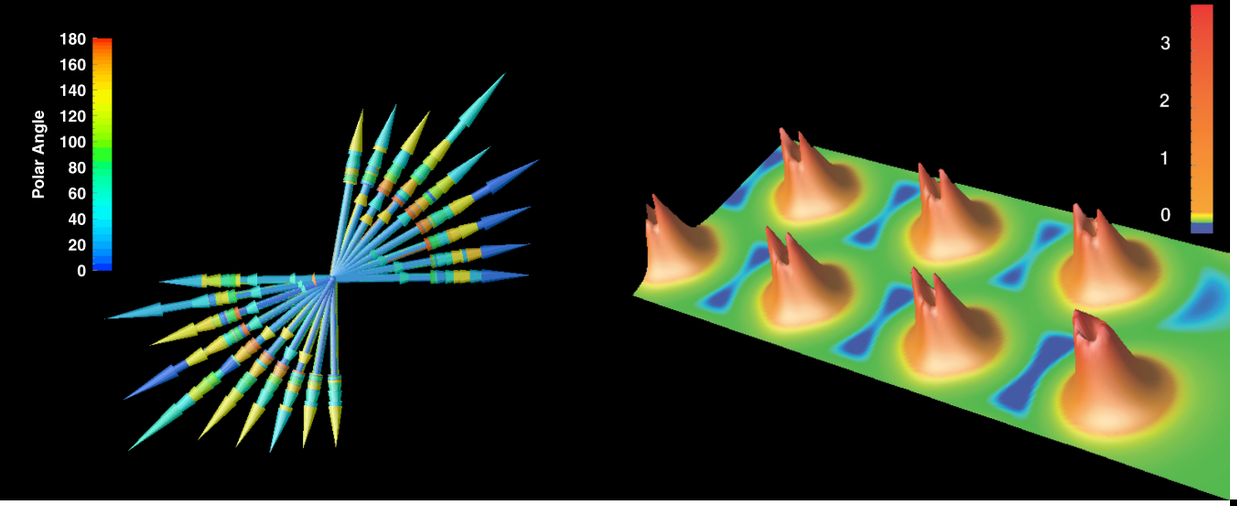
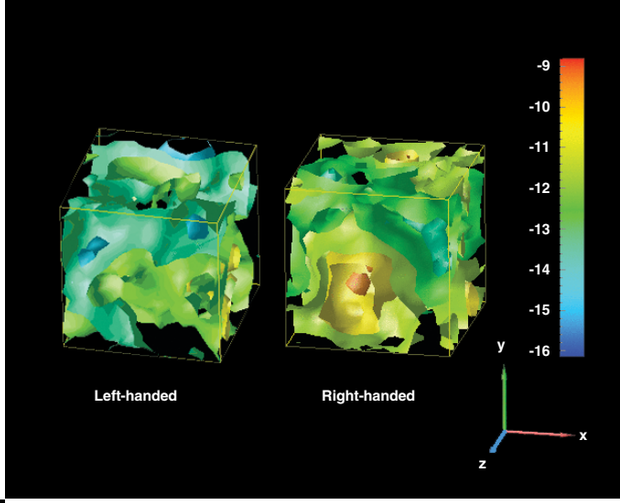


X- Ray Computed Microtomography (Geology)

A microtomography facility at the Brookhaven National Synchrotron Light Source (NSLS) combines rapid image reconstruction using high speed parallel computing resources, with theoretical modeling and high-band-width networking. Three-dimensional volumes with a spatial resolution of two microns are used as input to quantitative calculations to improve our knowledge in a variety of disciplines. Shown below is a cross-section of a soil sample from the Hanford Reservation. Multiple isosurfaces (indicated by different colors) show the sample's porosity.

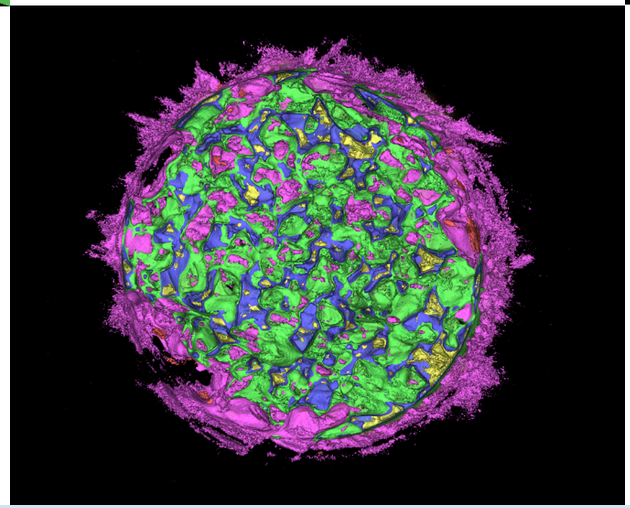


Nuclear Physics (Detector Design)

Why did the Big Bang produce matter instead of an even mixture of matter and antimatter? To answer this question, the KOPIO experiment will investigate very rare kaon decays - a kaon decaying into a neutral pion, a neutrino, and an antineutrino. (For every 100 billion kaon decays, about 3 will be of this type.) This study will probe charge parity (CP) symmetry violation, fundamental evidence that a mirror-image anti-universe would look different from our own. KOPIO detector design is underway. Shown is a partial simulation of particle detection following kaon decay. Calculations are for a given point of the kaon beam, and for a set of directions specified by polar and azimuthal angles. The view is along the kaon beam axis with the data projected onto one plane. Arrow length is a measure of detectability; color represents the polar angle.

Nanoscience (Condensed Matter)

Shown above is the charge density, i. e., the total distribution of electrons, for a surface of iron. In this calculation there are seven iron atoms. Red areas represent higher values of charge density, while blue areas represent lower values of charge density. Similar calculations for the electron spin density, and for both densities with an applied electric field have been performed for iron. Comparison of these results to those for non-magnetic metals will increase our knowledge of the properties which determine whether a metal is or is not magnetic.

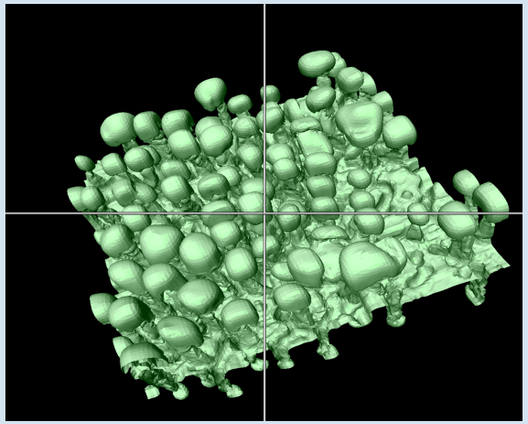


Nuclear and Particle Physics

The RIKEN BNL Research Center's QCDSP super-computer (12,288 nodes, .6 Teraflops) is used for a variety of Quantum Chromodynamics (QCD) calculations, typically in four dimensions (3 for space, one for time). By adding a fifth dimension, one can simulate the chirality (handed-ness) of fermions. Shown above are visualizations of the wave function of such domain-wall fermions averaged over the fifth dimension for a given time value. The image at the left represents left-handed chirality, at the right, right-handed chirality. The colorbar indicates the values of the wave function on a logarithmic scale.

Scientific Visualization Facilities at BNL

The Information Technology Division (ITD) maintains two visualization facilities at BNL: a stereoscopic theatre and a central graphics cluster. Both facilities are available to all research groups at BNL. The display system in the stereoscopic theatre is driven by a SGI Onyx2 rack system. The stereo effect is achieved in a conference room setting by projecting two polarized images on a specially designed 10 foot screen (treated to retain light polarization), then viewed through polarized glasses. The viewing algorithm makes the image of the object appear to float into the center of the room.



The central graphics cluster is a linux cluster with ten processors and five graphics cards. The cluster is used for the visualization of large data sets at BNL through parallel processing. To the left is an image of an isosurface defined by the interface boundary of the calculation of two fluids mixing. Chromium software is used to partition the rendering tasks among the proces-sors for rendering to a single or tiled display. The image indicates a four processor partition to four tiles. The central graphics cluster can be used to deliver large data visualization to the scientist's workspace. An IBM high resolution flat panel is driven by a workstation con-nected to the central graphics cluster through a high speed network and defines a visualization node at the scientist's department.

Cooperative Applied Research Initiative

A Cooperative Applied Research Initiative for Faculty and Students is a National Science Foundation project among BNL, SUNY Alfred State, and SUNY Jamestown Community College.

Project objectives are (1) Involve students and faculty in real-world, team-based, interdisciplinary studies. (2) Provide a capstone curricular experience for students. (3) Create visualization facilities at the colleges. (4) Create an ongoing relationship among colleges, local industry, and research community.

BNL's Visualization Theatre serves as the model for the college visualization facilities. Examples of the students' studies are denoted by the symbol