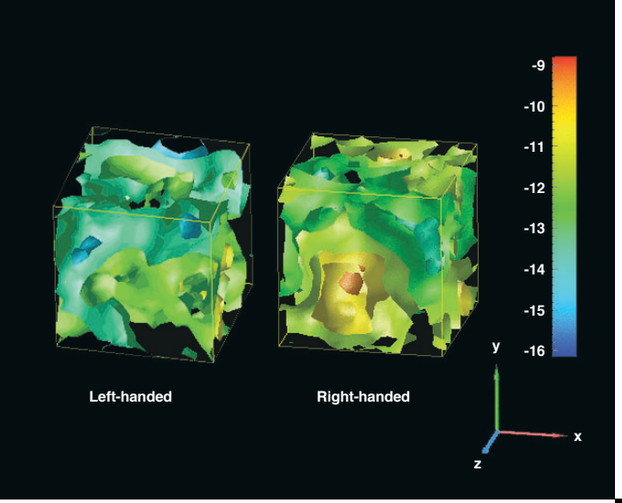
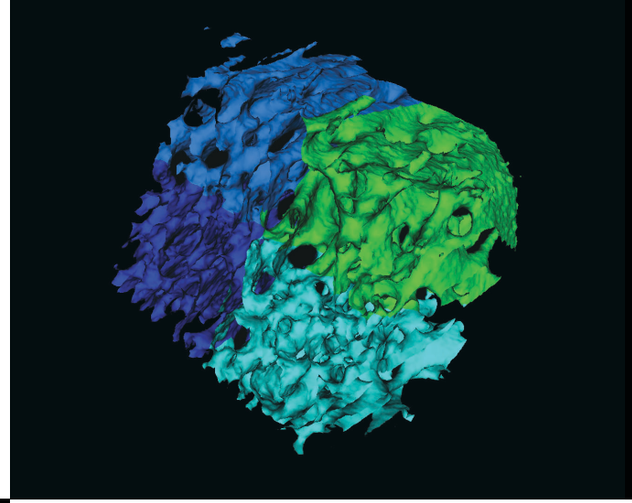
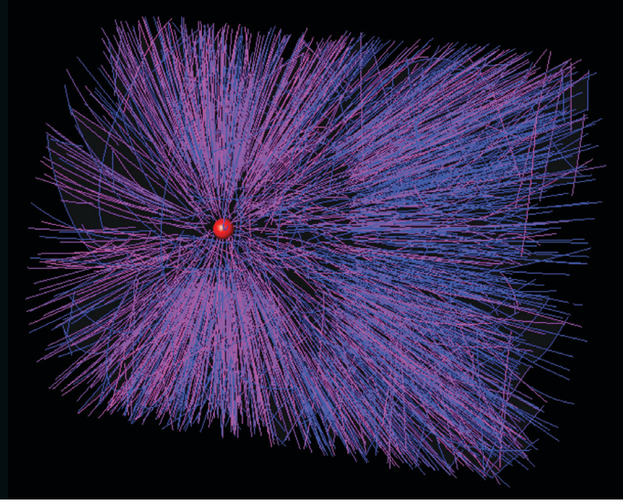


High Energy Physics (Detector Design)

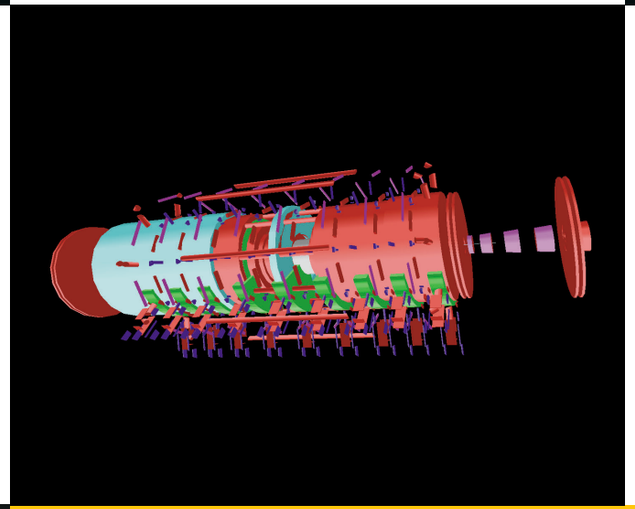
Shown below is a visualization of the next generation ATLAS detector, designed to search for physics beyond the Standard Model, including supersymmetry. The detector contains 30 million distinct elements, more than a thousand times as many as the most complicated detector now in use. Current visualization software can display multiple levels of detail. There are fifteen levels of detail in the design.





Nuclear and Particle Physics

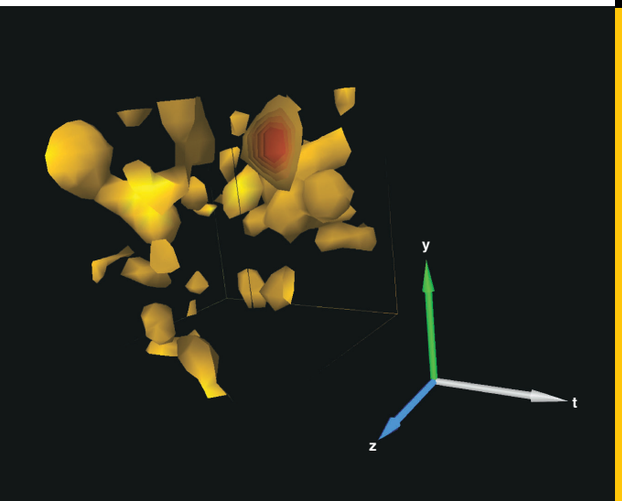
The RIKEN BNL Research Center's QCDSP supercomputer (12,288 nodes, .6 Teraflops) is used for a variety of Quantum Chromodynamics (QCD) calculations, typically in four dimensions (3 for space, one for time). By adding a fifth dimension, one can simulate the chirality (handedness) of fermions. Shown above 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 image below represents the instanton density as calculated in four dimensions. Instantons are gluon field configurations localized at one instant in space and time. Cover image: 2000 particle tracks detected after a collision of 2 gold nuclei.



X-Ray Computed Microtomography

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-bandwidth 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 above is the result of a parallelized application, based upon the Visualization Tool Kit, employing 4 cpus to construct an image of a rat bone sample. Different colors indicate each processor's share of the computation. Use of multiple processors allow the image to be constructed in a fraction of the time taken by a single processor.

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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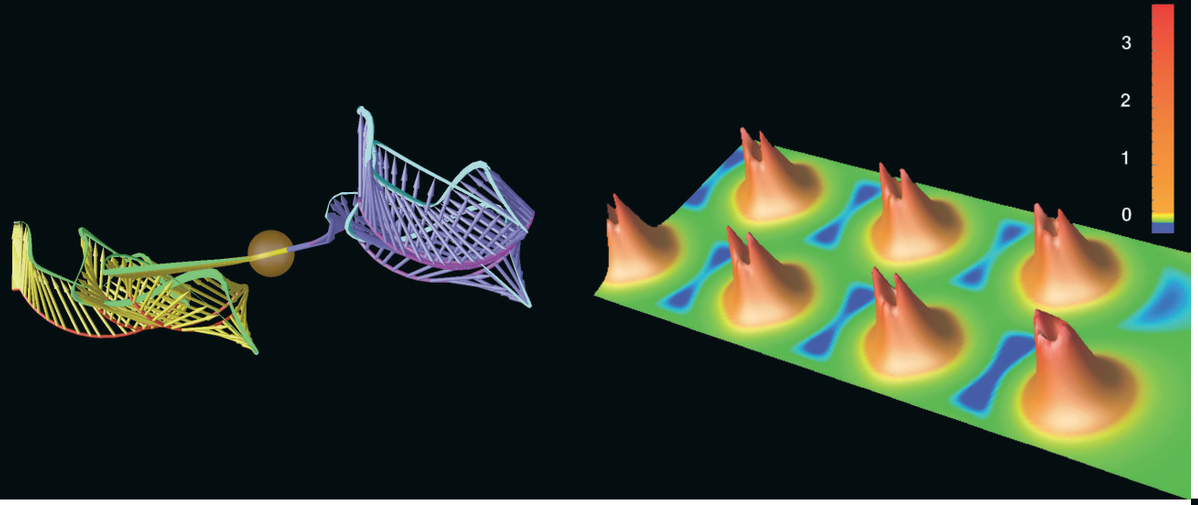
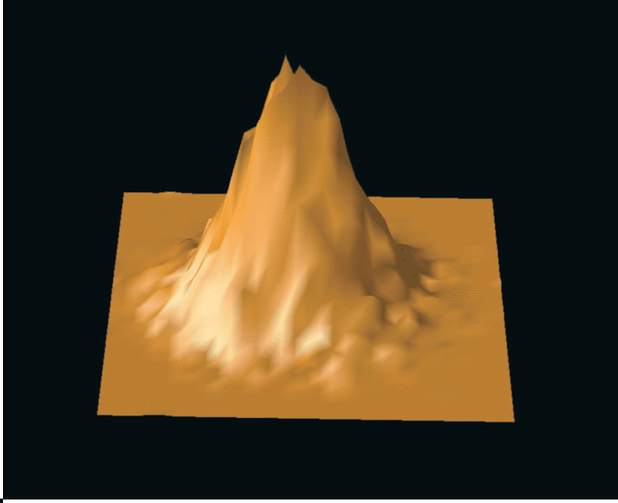


X-Ray Computed Microtomography (Geology)

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-bandwidth 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 sandstone sample. The network of blue filaments represents the sample's porosity. Petrologists are interested in the porosity of rock samples as an aid to determine the feasibility of oil recovery from reservoirs in various rock formations.

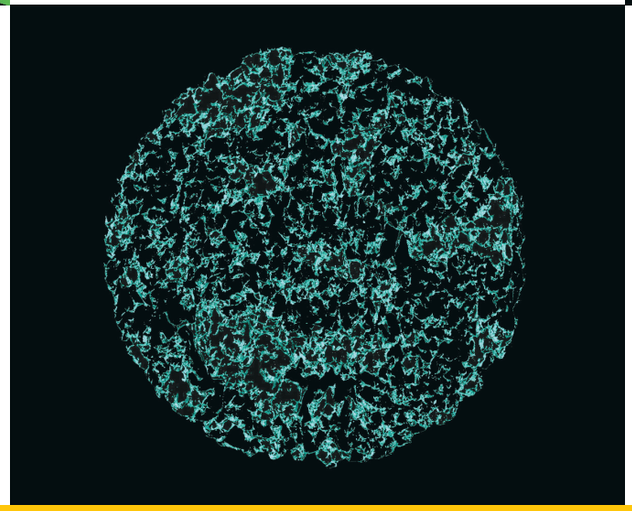


Accelerator Physics

A future Relativistic Heavy Ion Collider experiment will use polarized protons, not heavy ions, to study the fundamental structure of the proton's spin. Special polarization magnets will align each proton's spin vector with respect to the beam path. The image above shows one proton in each of the two colliding beams. Shown are each proton's path (red and magenta lines), spin vector (yellow and blue arrows), and the traces (green and cyan lines) of the spin vector's tip, as the protons move through the polarization magnets (not shown). Each proton's spin vector increasingly precesses and finally becomes aligned to the proton's path shortly before collision (represented by the orange sphere).

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.

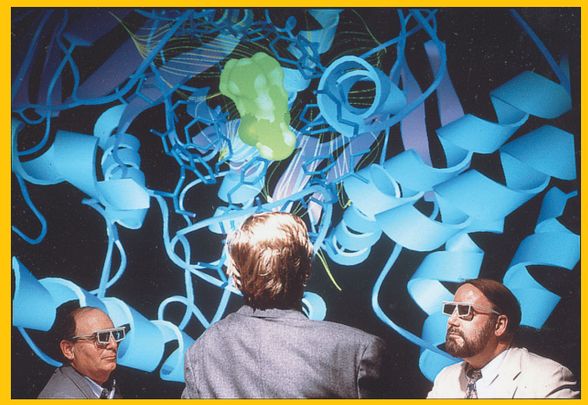


Accelerator Physics

Shown above is a three-dimensional representation of the charge density for a beam of particles. In this calculation all the particles have the same charge, so the charge density is equivalent to the particle density. The calculation uses the bilinear binning technique to bin the particles. The calculation is repeated with different matrices representing a sequence of focusing and defocusing magnets. The series of resulting data files are used to create stereoscopic animation showing how the charge density distribution of the beam varies as the particles travel through the accelerator magnets.

Stereoscopic Visualization Theatre

The centerpiece of visualization at Brookhaven is a novel stereoscopic viewing system. Constructed and maintained by the Information Technology Division (ITD), this facility is available to all research groups at BNL. The display system 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 1280x1024 resolution produces an exceptional image quality. The system was designed for ease of replication and high-speed network interaction. Among the application tools currently used are SGI Performer, SGI Inventor, OpenDX and VTK.

This facility differs from others primarily in that it provides high-resolution stereographic viewing for up to 30 individuals at once; it does not require the viewer to wear head mounted electronics, either shutter mechanisms or head tracking devices, in order to participate. The degree of realism and sense of immersion provides a viewing experience comparable to that of far more expensive technologies.

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 NSF.