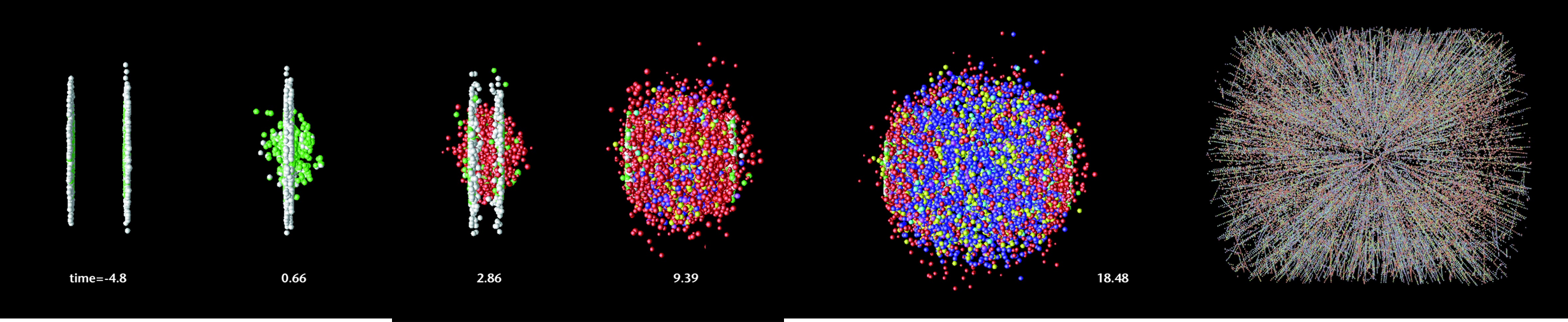
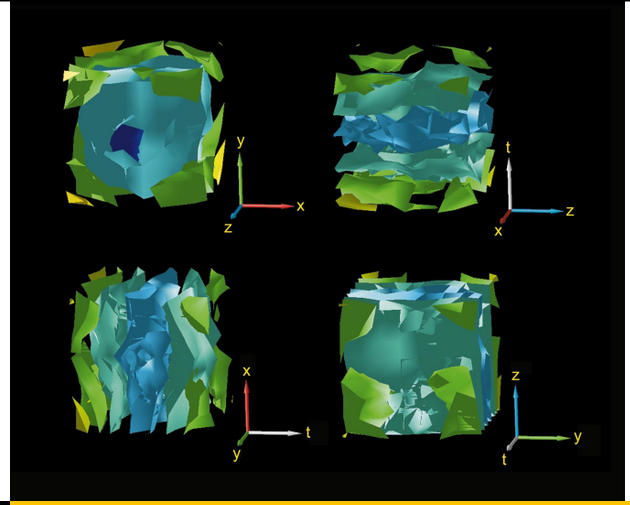


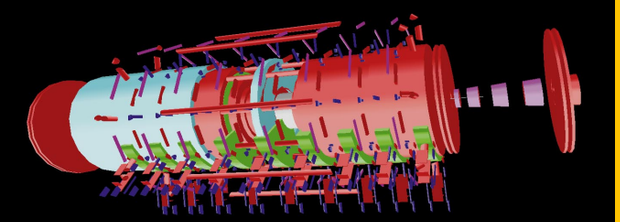
High Energy Physics (Detector Design)

Shown below is a visualization of the next generation ATLAS detector, designed to search for physics beyond the Standard Model, including supersymetry. 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 Physics

Selected frames from the simulation of a collision of two gold nuclei in the Relativistic Heavy Ion Collider (RHIC), forming a quark-gluon plasma, a state of matter thought to exist shortly after the Big Bang. The plasma is highly unstable and decays into prehadronic nuclei which then decay into detectable particles. The time scale is 10^{-24} seconds. The cover image shows the data for the first detected collision of two gold nuclei. Shown at the left is the probability of finding a pion at a given location and time. Four 3-D projections show this 4-dimensional quantity, which is used to calculate particle properties such as mass. Data were calculated from fundamental Quantum Chromodynamics using the RIKEN BNL Research Center's QCDSP supercomputer (12,288 nodes, .6 Teraflops).



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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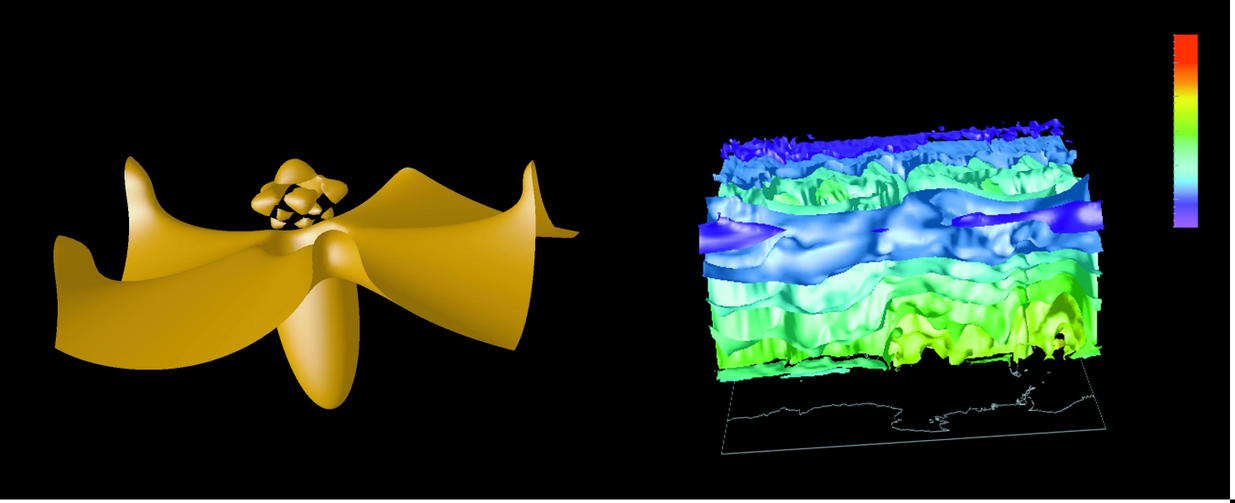
Scientific Visualization at

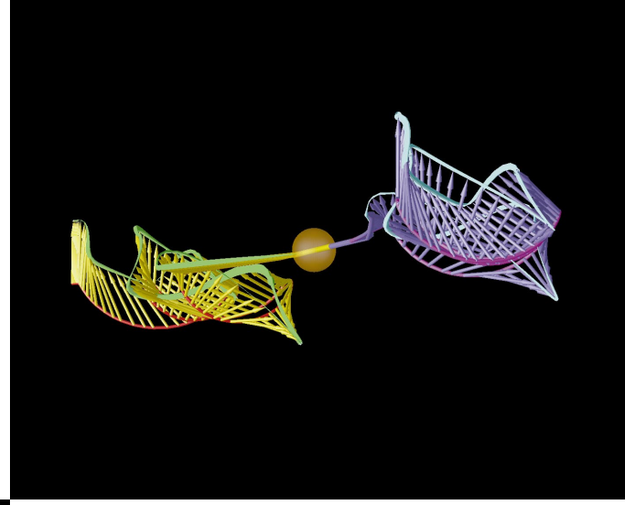
BROOKHAVEN NATIONAL LABORATORY

SC2000 Dallas Texas USA



X-Ray Computed Microtomography (Medical)

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 section (approx. 1mm across) from a thigh bone of a rat suffering from osteoporosis. The porous nature of the bone's central portion is indicative of the disease. Laboratory studies on rats expedite finding treatments for humans, but the small bone size necessitates high resolution X-ray imaging.

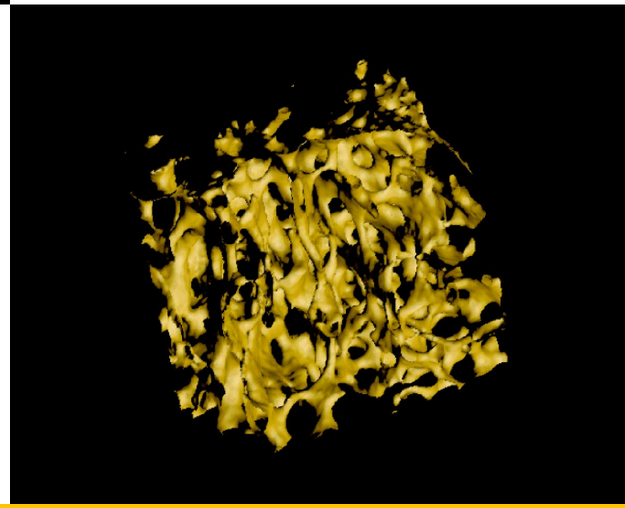


Theoretical Physics (String Theory)

String theory is the leading candidate for a theory beyond the Standard Model, including gravity. At very short distances (10^{-34} meters), the particle picture of the world gives way to one of one-dimensional objects. The theory is only consistent in ten dimensions: three spatial, one time, and six dimensions curled up in a small space not directly seen. This internal space yields important predictions for elementary particle properties, such as mass and chirality. A magnification of 10^{34} gives images like the one shown above (called the dervish). It represents an internal six-dimensional space after taking slices through three dimensions and forming a surface of zeros from a fifth order polynomial.

Environmental Science

Shown above are the results of a global weather simulation used to study the effects of wind and temperature on aerosol concentrations in the atmosphere. Nine isosurfaces of temperature (degrees Kelvin) are shown – colored violet to blue to red in order of increasing temperature. Animations of the simulated temperature show realistic features over the southern hemisphere, including a temperature increase over water near Antarctica, cooling and counter rotation in the upper atmosphere.

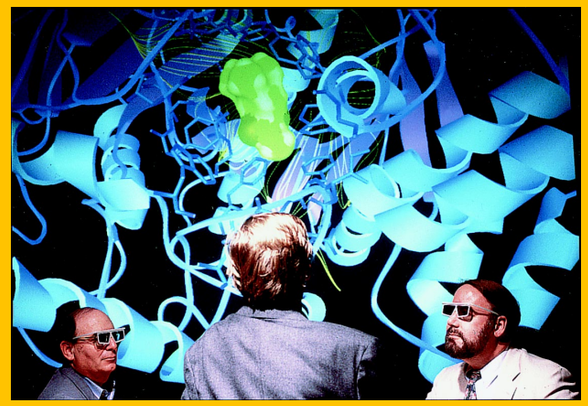


Accelerator Physics

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).

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.