

The logo for MUSE TECHNOLOGY. The word "MUSE" is in large, bold, green capital letters. Below it, the word "TECHNOLOGY" is in smaller, white capital letters. The background of the logo is dark blue with a pattern of white and green lines.

Visualizing the invisible

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AVS/Express software is used to visualize the magnetic flux field produced by the focus magnet at the Rutherford Appleton Laboratories in order to optimize the beam path and, ultimately, the quality of the neutron and muon particles.

Floating weightless inside a hall of mirrors, amid bundles of ribbons expanding from a central ring, a researcher moves carefully down between the ribbons to examine small variations in lines surrounding a transparent disk. This is not a scene from the latest sci-fi movie, but a practical engineering design session reviewing a normally invisible magnetic field. Researchers review complex 3-D data from a focus magnet in an accelerator, evaluating the shape of normally invisible magnetic flux lines as bundles of thin, colored ribbons. Getting the shape of the flux lines right is critical to the operation of ISIS, a powerful neutron and muon source, where the magnet is used to steer the beam on its' way.

The Rutherford Appleton Laboratories (RAL) near Oxford (U.K.) hosts a number of world-class scientific instruments used by staff and visiting scientists throughout the world. To support such advanced instruments, software systems such as AVS/Express from Advanced Visual Systems Inc. are employed to design and analyze the instruments themselves, such as the focus magnet in the accelerator, and also to visualize the vast quantities of data produced by these instruments. Researchers at RAL use AVS/Express software to visualize the magnetic flux field produced by the focus magnet in order to optimize the beam path and, ultimately, the quality of the neutron and muon particles. The ISIS pulsed-neutron source is used to make technical innovations in a variety of areas such as chemistry, physics, biochemistry, engineering, medical and material science.

AVS has worked with the RAL staff for many years, developing and enhancing visualization software tools for fundamental scientific research undertaken by RAL and visiting scientists. This research and RAL's leadership role in the higher education community's use of visualization software has lead to a number of advancements in 3-D visualization software.

The symmetric mirroring user-interface for the magnetic flux visualization, a direct result of a 10-year collaborative development effort between RAL and AVS, is an example. To reduce the computational time needed to analyze the magnet, only one eighth of the whole field is subjected to detailed analysis, while the other 7/8 of the model is visualized using a graphical "hall of mirrors." In this way, researchers can view and navigate through the whole magnetic field, looking at the field's strength and shape, and then follow the path of magnetic flux lines

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visualized as complex ribbon structures. The mirroring technique is now used by many AVS/Express users around the world, directly enhancing the software's technology evolution.

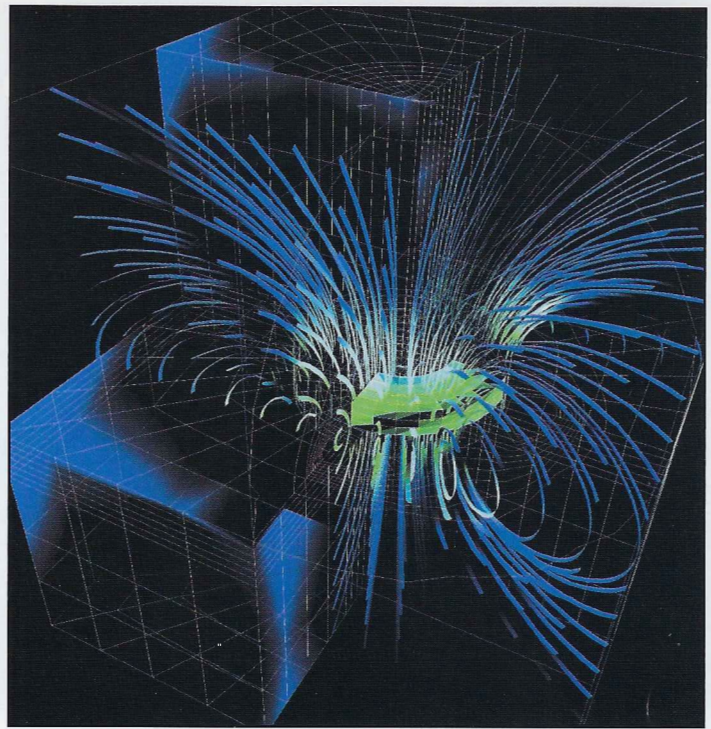
To visualize 3-D magnetic flux data, both scalar and vector field techniques are required. Where a single number exists at every point on a 3-D grid, such as the strength of the magnetic field; then scalar-value techniques, such as transparent color and 3-D contour lines, are used to create visualizations. Where several numbers are present at each grid point, such as the X-Y-Z magnetic flux direction, then vector-value visualization techniques are required. The technique used at RAL for magnetic flux field visualization is to inject ribbons into the space, and let the ribbon path, including twist, be directed by the magnetic field. Although the field itself remains invisible, the curve of the ribbons indicates the over-all shape and structure of the field. Applying the "hall of mirrors" technique to both the contour lines and the ribbon paths gives a full 3-D field visualization that researchers can use to show effects normally invisible.

The visualization techniques in AVS/Express are selected from an object-oriented library and assembled using a visual programming network editor. By using the point & click interface, modules are selected from a library palette and joined together by visible links to create a visualization application. The result can be directly linked to simulation or acquired data, with views presented for high-quality publication or used in full immersive visualization environments.

Rather than presenting a visualization result through a one-way software path, the AVS/Express graphics pipeline is coupled directly with data for interactive exploration. By selecting and manipulating objects directly in view, the data can be explored without the distraction of a complex user interface. Once assembled, the visual module network can be e-mailed to other users, or used to create a custom application embedded into another software system.

"At RAL, we are interested in the visualization of scientific and engineering data and related problems of data modeling, multimedia, computer graphics, virtual reality and cooperative working," Julian Gallop, leading team member of the VR and Multimedia Group at RAL, said.

"We have taken the technical lead in European projects to develop cooperative visualization and to make use of VR to offer better 3-D visualization. These developments support applications such as geo-



Magnetic flux line visualization using AVS/Express, of Advanced Visual Systems Inc. The ring in the center is a focus magnet in an accelerator. Data courtesy of RAL and Vector Fields Ltd., UK.

physics, biological microstructures and CFD. Starting from scratch would need excessive time and effort. Building on an existing system is attractive, but relies on that system being flexible with well-defined interfaces. Using a modular and flexible tool such as AVS/Express enables new visualization techniques and new ways of working to be integrated with existing software."

Visualization technology is on an innovative path right along with the scientific instruments. In March 2000, the U.K. and French governments announced a major new investment to build a new Synchrotron source at RAL.

Synchrotrons are the highest power sources of X-rays in the world. The X-rays are produced when a beam of electrons is bent by magnets as it travels at very high speed. The X-ray beam produced is expected to be about a million-million times brighter than a standard doctor's office X-ray. The new system will provide scientists with a unique instrument to investigate complex atomic and molecular structures of all types of physical and biological materials, from proteins to ceramics. The new source will open the way for new magnetic storage media that will find widespread applications throughout computing and data storage industries.

It will be possible to investigate environmentally important materials using new microfocus X-ray beams to reveal such information as just how bacteria interact with minerals in areas such as the "black smoker" vents on the sea floor. Systems such as AVS/Express are ideal tools for analyzing the predicted performance and actual data from complex instruments.

Once inside the details of the advanced magnet designs, researchers can ensure the success of today's or future scientific instruments. Similar techniques are

employed to visualize microwave antenna patterns at Agilent Technologies and design new stealth aircraft at BAE Systems. Using modular visualization software, such as AVS/Express visualization software system, helps discover meaning and insight from data more readily than ever before.

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MUSE signs definitive agreement to acquire AVS

MUSE Technologies, Inc., the Albuquerque, N.M. developer of advanced perceptual computing and collaboration software, has executed a definitive agreement to acquire Advanced Visual Systems Inc. (AVS), an international leader in the field of data visualization.

Under the terms of the agreement, MUSE will issue a maximum of 2.1 million shares of MUSE common stock (19% of outstanding shares) in exchange for all of the outstanding common and preferred shares of AVS and a maximum of 1.3 million shares subject to employee stock options. Additionally, MUSE will assume approximately \$2 million of convertible debt of AVS from Kubota Corp.

The acquisition will be accomplished through the merger of AVS into a wholly owned subsidiary of MUSE and is expected to be accounted for as a pooling of interests transaction. The acquisition is subject to certain closing conditions and approval of the AVS stockholders. AVS management and certain stockholders have agreed to vote their shares in favor of the transaction, which was expected to close in the fall of 2000.

Upon consummation of the acquisition, AVS will be renamed MUSE Advanced Visual Systems, and MUSE plans to relocate its corporate headquarters to Boston and maintain sales, marketing and technical operations in Albuquerque, Washington D.C., London, Manchester (UK) Frankfurt, Milan, Paris and Denmark. Both companies also have sales employees who operate from a number of other global cities.

MUSE Technologies President Brian R. Clark said that after several months of planning and negotiation, he was pleased to announce the execution of a defini-

tive agreement between MUSE and AVS.

"The boards of directors, management and employees of both companies are extremely enthusiastic about forming one of the world's largest companies focused on data visualization and perceptual computing software and solutions," Clark said.

AVS President and CEO Russ Barbour said the synergies between MUSE and AVS are quite compelling and that he believes will produce a company of tremendous potential.

"Management and staff from both companies have already developed a host of sales, marketing and product strategies that we plan to deploy as soon as possible," Barbour said.

MUSE Technologies Managing Director John Hough said the combined capabilities of MUSE and AVS will offer customers in every conceivable industry a range of products and services and a long-range visualization strategy.

"Together, the MUSE family of companies possesses nearly 30 years of corporate history and industry experience" Hough said. "Our plan is to translate that knowledge into significant global business opportunities and become the undisputed leader in 3D graphics technology."

Hough said that upon completion of the AVS acquisition, the MUSE family of companies will include the Perceptual Computing group of MUSE Technologies, MUSE Advanced Visual Systems, MUSE Virtual Presence, MUSE SimTeam, MUSE Simulation Solutions, MUSEvrSource.com and MUSE Federal Systems Group.