

Introduction

A software package, `dxhdf5` [1], for importing HDF5 data into OpenDX is presented. HDF5 [2] is a hierarchical, self-describing data format that is rapidly becoming a standard for storing large data sets, such as those generated through high-performance computing. OpenDX [3], formerly IBM Data Explorer, is a powerful visualization package for examining data of any dimensionality. Using `dxhdf5`, OpenDX users can easily visualize both field data on regular grids with the `ImportHDF5Field` module, and particle data with the `ImportHDF5Species` module.

OpenDX can import data from files in its native format, ASCII, CDF, netCDF and HDF formats. However, as the HDF5 file format is rather new (first released in 1998), OpenDX does not support it. Before `dxhdf5` was released, HDF5 data had to be first converted to the formats recognized by OpenDX prior to importing. This process was time consuming and error prone. Currently, with the use of `dxhdf5`, importing HDF5 data is fast, easy and reliable. The package extends the OpenDX capabilities by providing two OpenDX modules.

OpenDX

- Visualizes data of any dimensionality
- Open source project
- Free of charge
- Easy to use graphical user interface
- Scripting language for advanced uses
- Very good technical support
- Commercial support: VIZ Solutions, Inc.
- **Does not support HDF5**



HDF5

- Makes data portable
- Open source project
- Free of charge
- Used worldwide
- Powerful and flexible
- Very good technical support
- **Does not support OpenDX**



ImportHDF5Field

The `ImportHDF5Field` module imports data of a field defined on a regular and uniform grid of any number of dimensions. The user is allowed to import all of the field data or only the fraction corresponding to a slab. Selecting a slab can considerably reduce OpenDX memory requirements as only a portion of a very large set of data is loaded into the operating memory.

To illustrate the module usage, we use a file generated by VORPAL [4], a plasma and beam simulation code. The file contains the description of an electric field with two wave packets stored in a dataset of dimensions $200 \times 100 \times 3$ which describes a two-dimensional field of dimension 200×100 grid points. Positions along the third dimension of the dataset contain three components of an electric field. Fig. 1 depicts one component of the field with all data available from the HDF5 file, while Fig. 2 shows the same component at lower resolution, using only one-ninth of the HDF5 data (every third point in both dimensions taken). Figures 3 and 4 show selected slabs.

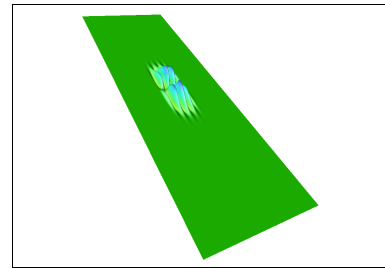


Figure 1: Complete field.

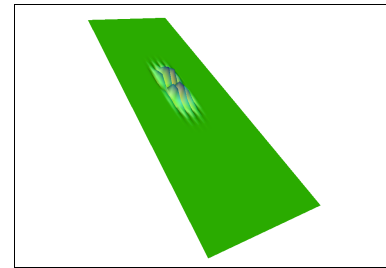


Figure 2: Complete field at low resolution.

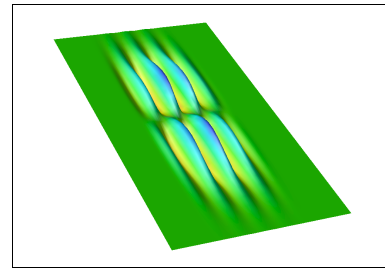


Figure 3: Selected slab.

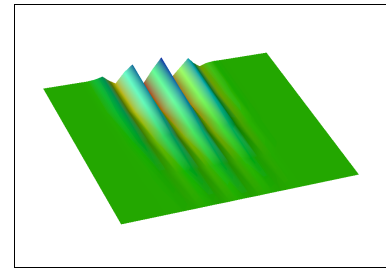


Figure 4: Selected slab at low resolution.

ImportHDF5Species

The `ImportHDF5Species` module allows the user to import particle floating point data of single or double precision. A particle is described by its position (coordinates) and its data (data elements, typically velocities or weights). The number of dimensions of the created field is equal to the number of coordinates of the dataset's particles. Again, if needed, only a portion of a very large set of data is loaded into the operating memory. Particles can be selected randomly, periodically, or by limits (maxima and minima for each of the particle positions and data).

The following four figures show sample ways of visualizing particle data generated by VORPAL. Fig. 5 presents all particles, Fig. 6 only one-third of particles, while Fig. 7 and Fig. 8 particles with a condition on the horizontal velocity, u_0 .

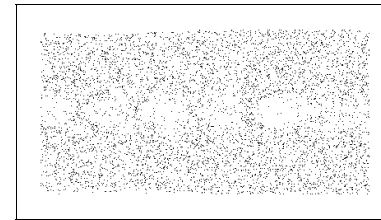


Figure 5: All the particles.

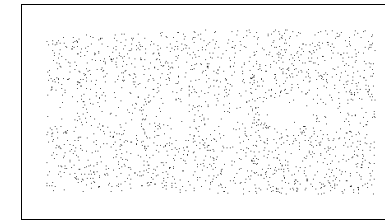


Figure 6: Every third particle chosen.

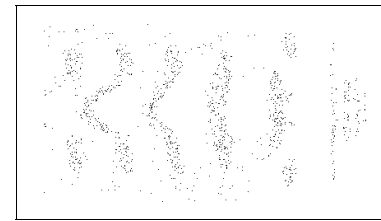


Figure 7: Particles with $u_0 > 10^7$.

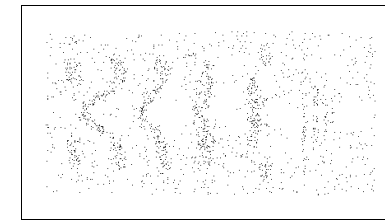


Figure 8: Particles with $u_0 > 10^7$ and roughly 750 particles randomly selected.

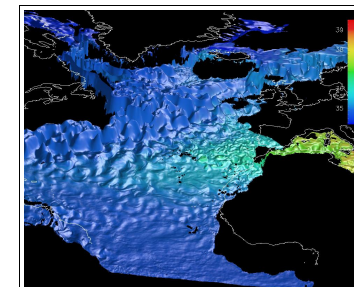
dxhdf5 Users

The `dxhdf5` package is freely available under a very liberal license and is posted at its website, from where it is downloaded several times a week. Below are selected users of `dxhdf5`.

OCCAM

The picture shows a single isopycnal (constant density) surface from a preliminary run of the OCCAM [5] global ocean model. The surface colouring is from the salinity data, in PSU. The area shown is the North Atlantic, with coasts outlined in white. The model output is stored in the HDF5 format because individual files are larger than 3.5GB, even when using the HDF5 compression.

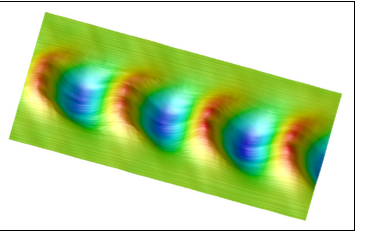
John STARK
Southampton Oceanography Centre, UK



VORPAL

The picture shows the nonlinear structure of a laser wake field potential. These VORPAL [4] results were stored in HDF5 files and imported into OpenDX using the `dxhdf5` package.

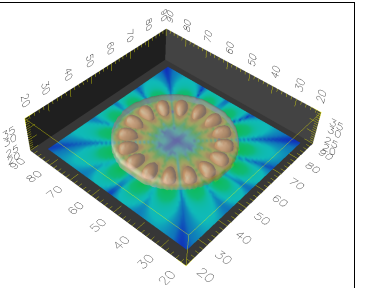
Chet NIETER
Tech-X Corporation, USA



Semiclassical Quantum Optics

This is an HEM810 whispering gallery electromagnetic mode in a microdisk with the exponentially decaying evanescent field on the outside. The data base is the z component of the magnetic field. Shown are isosurfaces and a plane cutting the disk in half. The radius is 105 nm and the height 30 nm.

Andreas KLAEDTKE
University of Surrey, GB



Conclusion

The package successfully functions not only on desktop computers running the Linux, Mac OS X, or Sun Solaris operating systems but also on large mainframes that operate under the control of the AIX or IRIX operating systems. The portability of `dxhdf5`, which ensures that the same HDF5 data can be visualized on various computer platforms, is achieved by harnessing free GNU tools: Autoconf, Automake and Libtool.

References

- [1] The website of the `dxhdf5` package, <http://www-beams.colorado.edu/dxhdf5>
- [2] The website of the HDF5 library, <http://hdf.ncsa.uiuc.edu/HDF5>
- [3] The website of the OpenDX package, <http://www.opendx.org>
- [4] The website of the Vorpall package, <http://www-beams.colorado.edu/vorpall>
- [5] The website of the OCCAM project, <http://www.soc.soton.ac.uk/JRD/OCCAM>