

VISUALIZING HDF5 DATA WITH OPENDX

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PLAN OF PRESENTATION

- Introduction to HDF5 and OpenDX
- CIPS modules for OpenDX
- Vorpals uses of the CIPS modules
- Basics of OpenDX module design
- Summary and conclusions



HDF5

HIERARCHICAL DATA FILE V. 5

- An improved version of the HDF4 file format
- Organizes data in a hierarchy
- Faster and less memory consuming than netCDF
- Available on many platforms
- Makes data portable

OBJECTS OF HDF5

HDF5 offers:

- datasets - multidimensional arrays,
- groups - collections of objects,
- compound datatypes,
- links to objects,
- attributes.

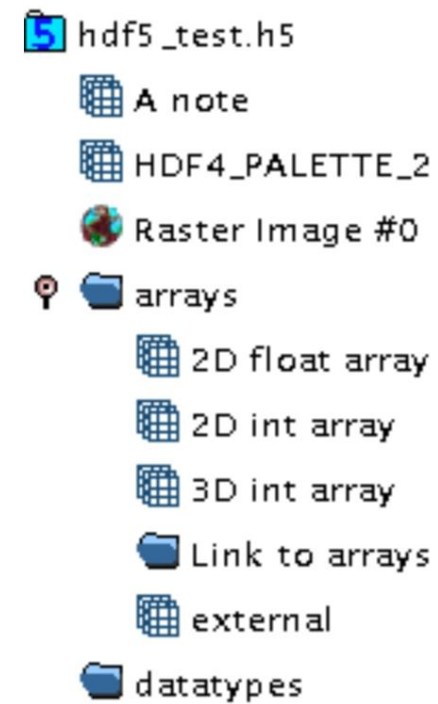
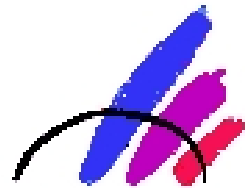


Figure: Sample file



OPENDX

THE OPEN SOURCE PROJECT BASED ON IBM'S
VISUALIZATION DATA EXPLORER

- Open source software
- Good technical support
- Used worldwide
- Easy to visualize 2-D and 3-D data
- Easy to learn

OPENDX MODULE

- Provides a function
- Enhances the OpenDX capabilities
- Can be standard or user given
- Usually requires inputs
- Usually produces outputs



Figure: Sample module

PROGRAMMING IN OPENDX



- Visual programming
- You work as a plumber



- Your program is data-driven
- No new scripting language to learn


HDF5 AND OPENDX

- OpenDX does **not** import HDF5 data
- OpenDX has large memory requirements
- HDF5 can contain large datasets
- OpenDX would run out of memory when reading a large HDF5 file
- Alternative: filter and convert HDF5 data before importing

CIPS MODULES FOR OPENDX

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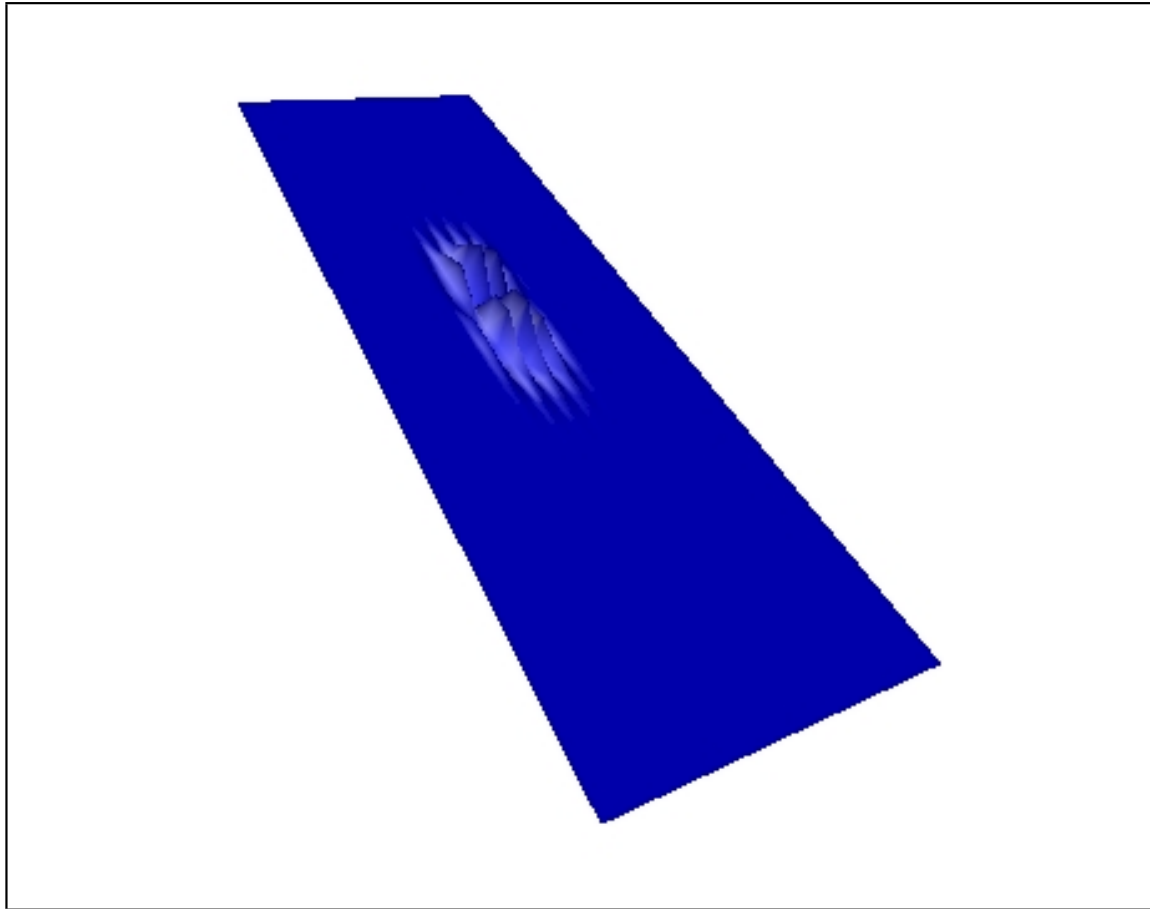
- The **dxhdf5** package gives two OpenDX modules
- **ImportHDF5Field** imports fields from HDF5 files
- **ImportHDF5Species** imports particles from HDF5 files
- They let reduce memory requirements
- Developed at CIPS this summer
- Announced by **OpenDX.org**
- Available at **www-beams.colorado.edu/dxhdf5**



The slide features a header with the CIPS logo (Center for Integrated Plasma Studies) and the title 'IMPORTHDF5FIELD' in blue text. The background of the header shows a stylized orange and yellow globe.

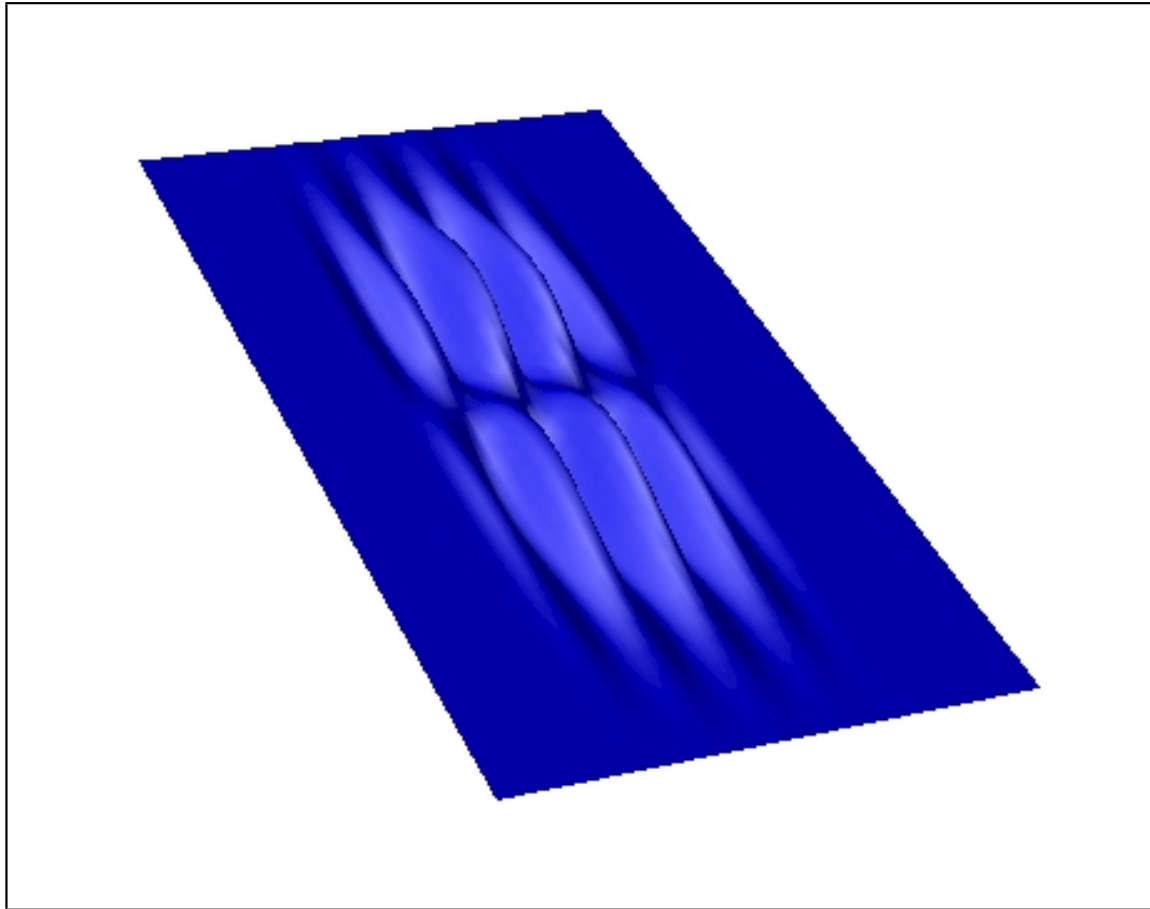
- Imports a slab of a field from an HDF5 file
- The field must be based on a regular grid
- The HDF5 file must be of a special structure
- The user can specify:
 - the lower corner,
 - thickness,
 - stride.

IMPORTHDF5FIELD IN ACTION



Complete field with every third grid point chosen.

IMPORTHDF5FIELD IN ACTION - CONTINUED



A slab of the field with every grid point.

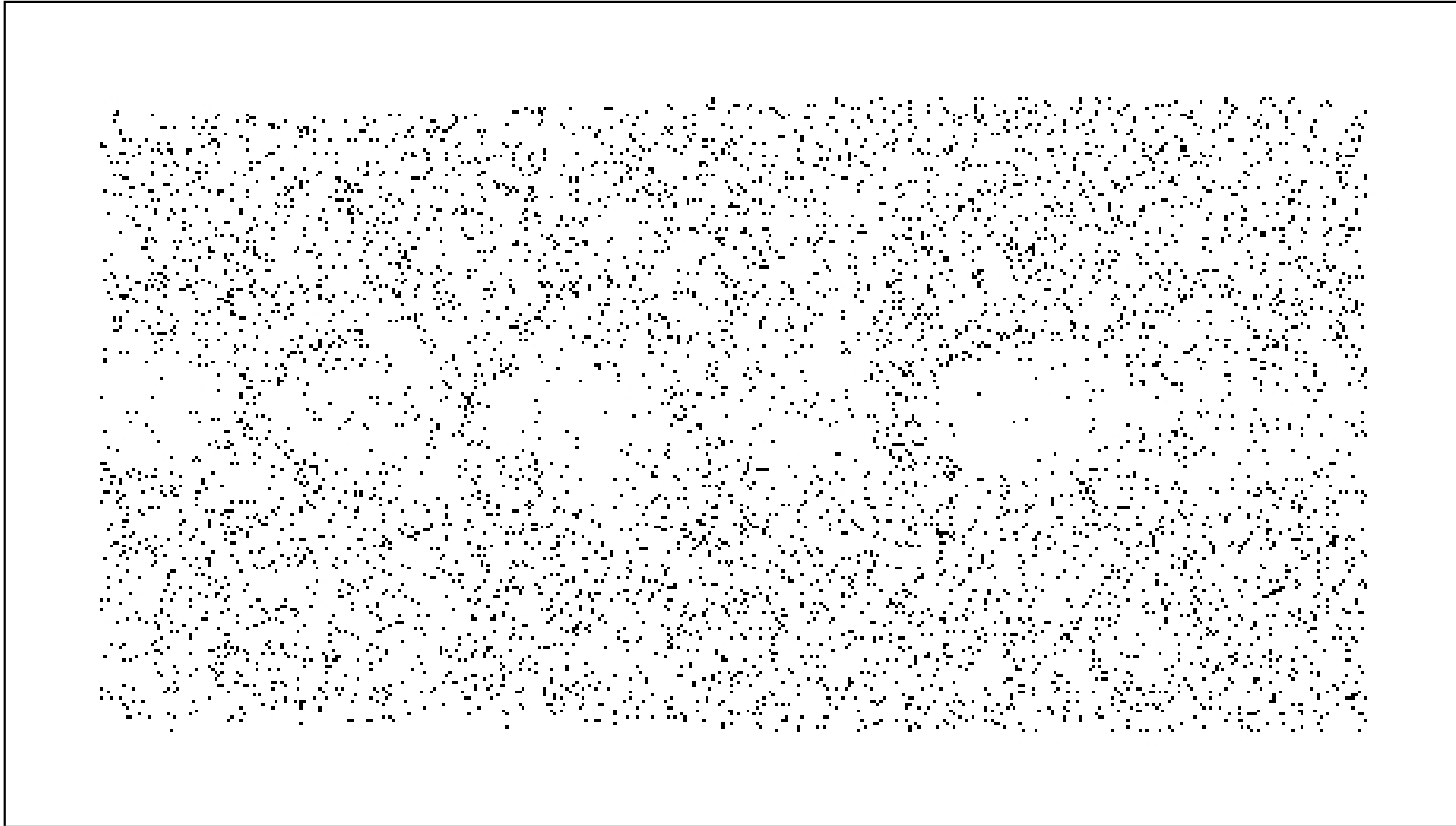


IMPORTHDF5SPECIES

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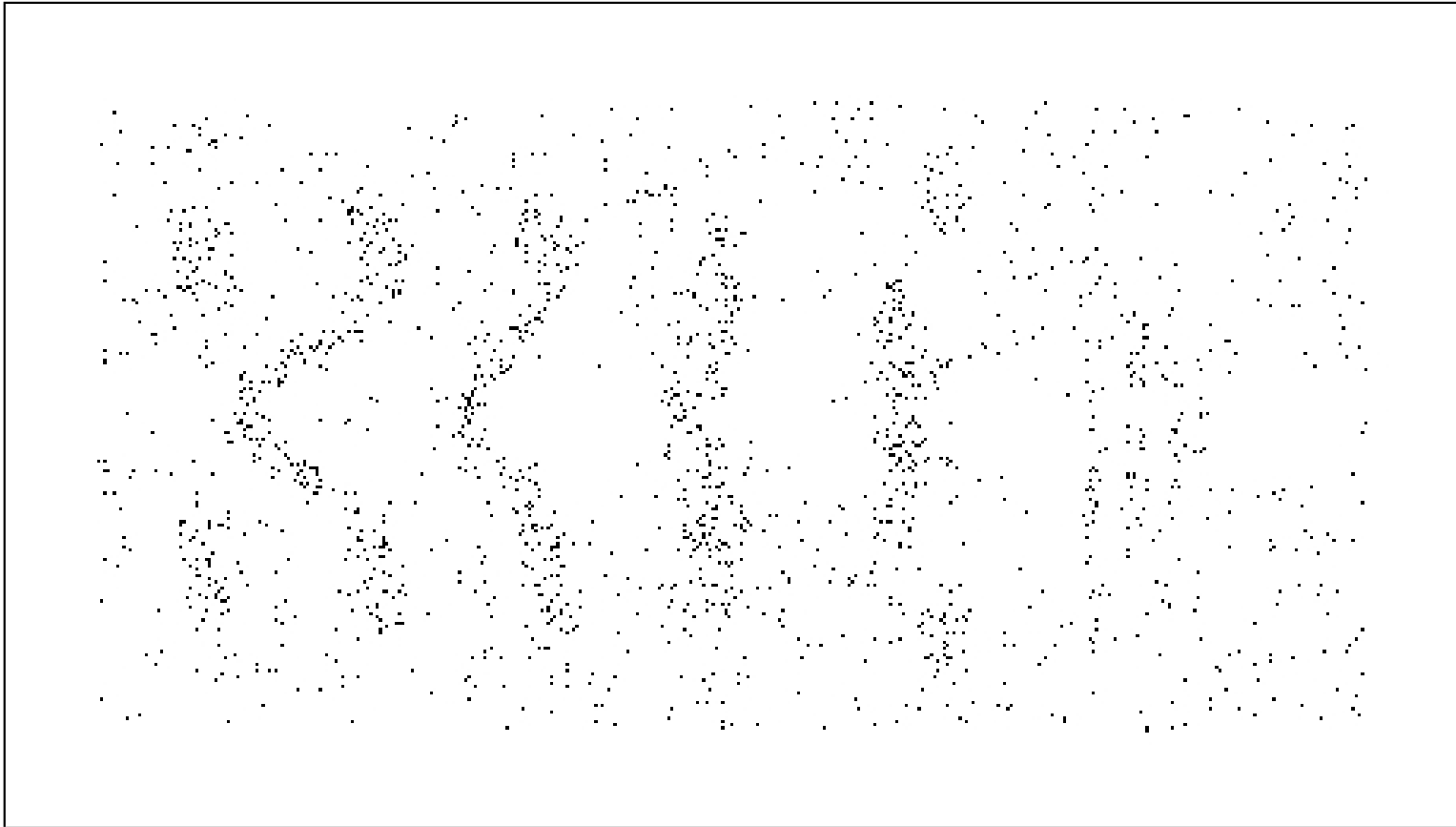
- Selects and imports particles from an HDF5 file
- Each particle has its position and data elements
- The HDF5 file must be of a special structure
- The user can specify:
 - minimal and maximal values for the position and data,
 - stride,
 - random.

IMPORTHDF5SPECIES IN ACTION



Complete set of particles.

IMPORTHDF5SPECIES IN ACTION - CONTINUED

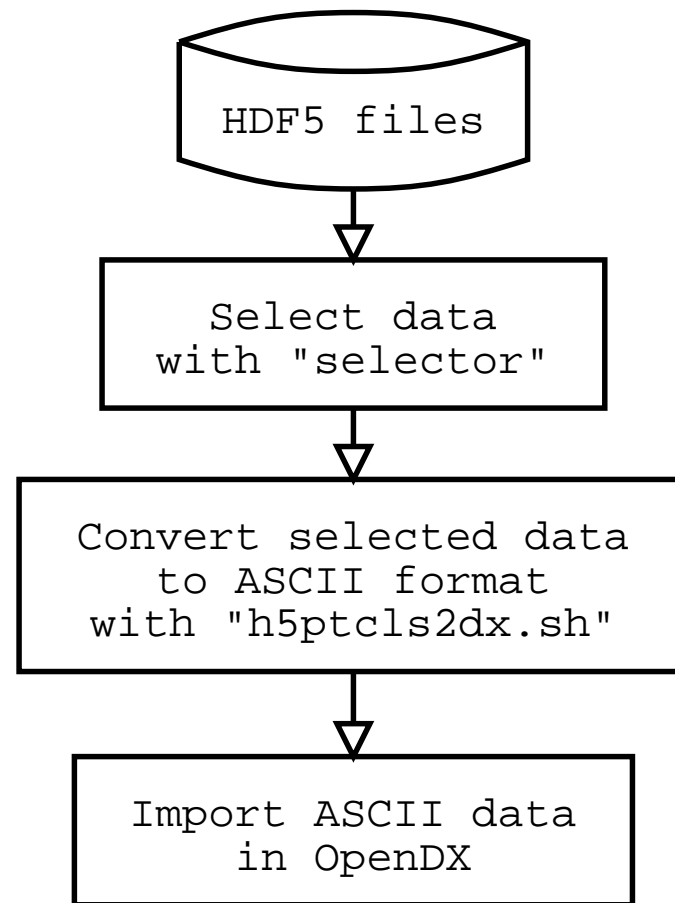


Particles with $u_0 > 10^7$ plus roughly 750 random particles.

VORPAL, HDF5 AND OPENDX

- Vorpals files are very large and numerous
- Vorpals saves its results in HDF5 files
- We want to use OpenDX to visualize Vorpals data

OBSOLETE WAY OF IMPORTING VORPAL PARTICLES INTO OPENDX



The scheme of the data processing.

VORPAL AND THE DXHDF5 MODULES

- Vorpal uses both `ImportHDF5Field` and `ImportHDF5Species`
- The data is selected and imported without preprocessing
- Using the `dxhdf5` modules saves time and work
- The modules do not supersede the `selector` program

BASICS OF OPENDX MODULE DESIGN

- Three module types:
 - inboard
 - outboard
 - runtime-loadable
- Module's definition must be provided (MDF file)
- OpenDX Module Builder may help
- Module implementation in C, C++ or Java

MDF FILE - MODULE DEFINITION FILE

The MDF file defines:

- module's name, category, description and executable file,
- inputs, outputs, and their types, default values and names.

Sample MDF file:

```
MODULE SampleModule
CATEGORY Import and Export
DESCRIPTION sample module
LOADABLE "/our_path/SampleModule";
INPUT number; integer; 100 ; number we need
INPUT debugflag; flag; 0; enable debug messages
OPTIONS false ; true
OUTPUT ouroutput; field; some output
```

SUMMARY AND CONCLUSIONS

- HDF5 and OpenDX are useful and powerful tools
- The dxhdf5 package helps one import HDF5 data in OpenDX
- The modules are documented, and released
- The modules satisfy their users



THANK YOU!