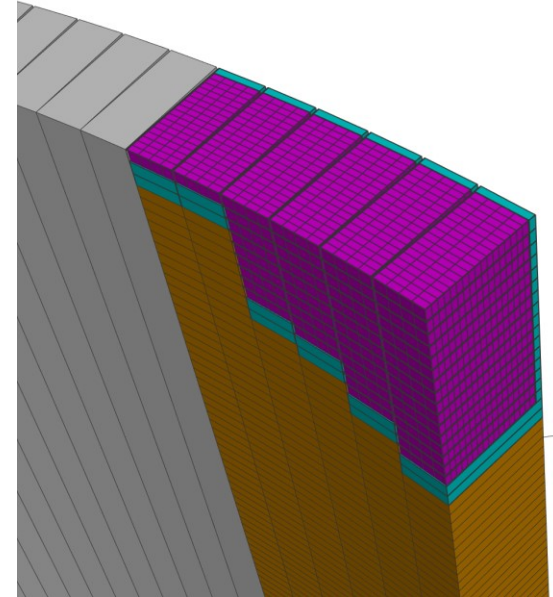
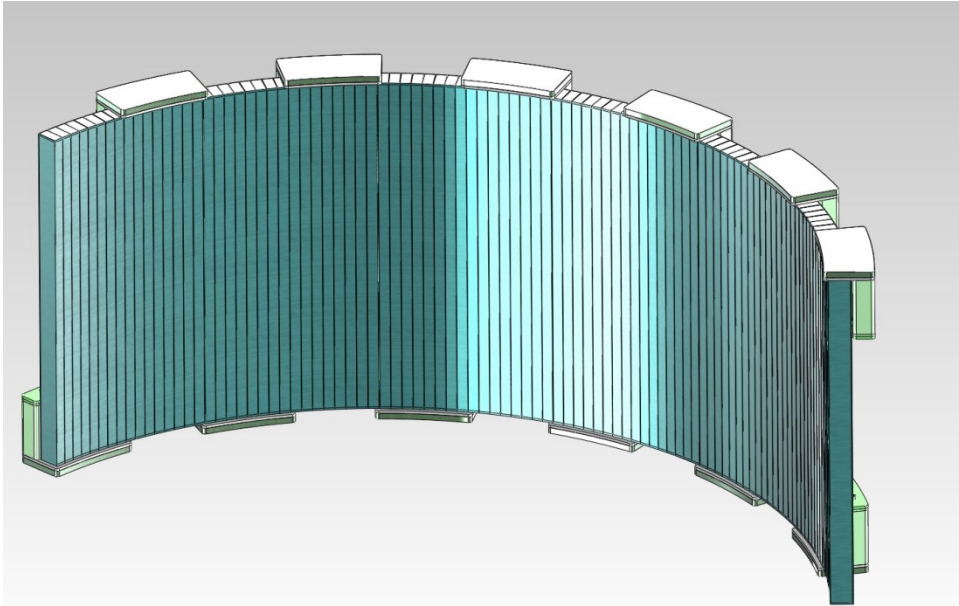


Approaches to Visualizing and Inspecting Voxel Data



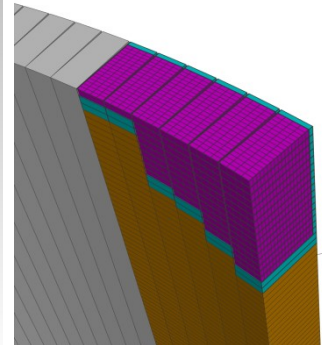
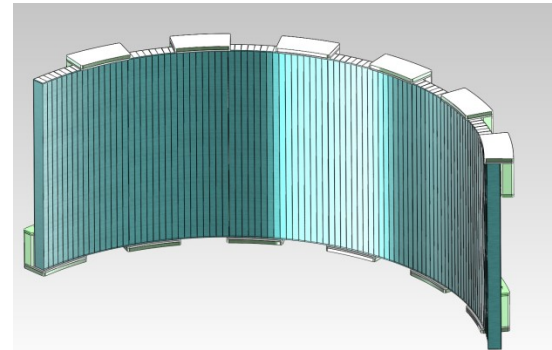
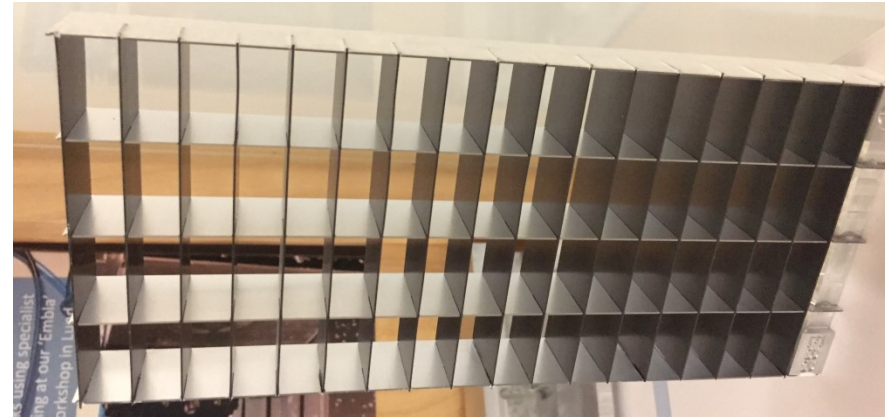
Motivation

- Based on some work done previously by Jon Taylor on Multi-grid detector configuration.
- Highlighted some general instrument/data visualization issues which need to be addressed e.g voxel handling.
- We had a reasonable amount of success with work done on the LOKI instrument with the StructuredDetector.
- Using CSPEC geometry as a case study but these ideas will be extended to any instrument which uses voxels.



Case Study: CSPEC Preliminary Design

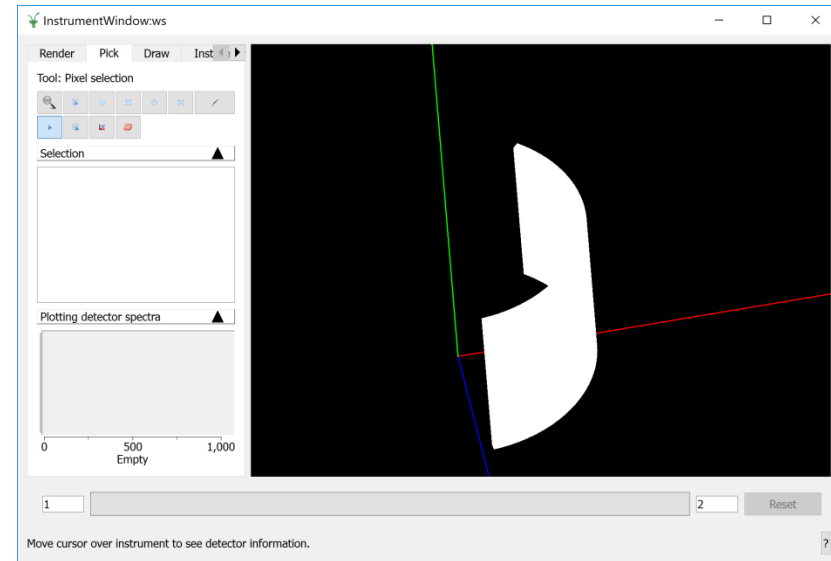
- 4x16 detector grids contain 64 voxels.
- There are 128 Grids per detector bank.
- There are 100 banks in total.
- 819,200 voxels in total!



Voxel Handling in Mantid



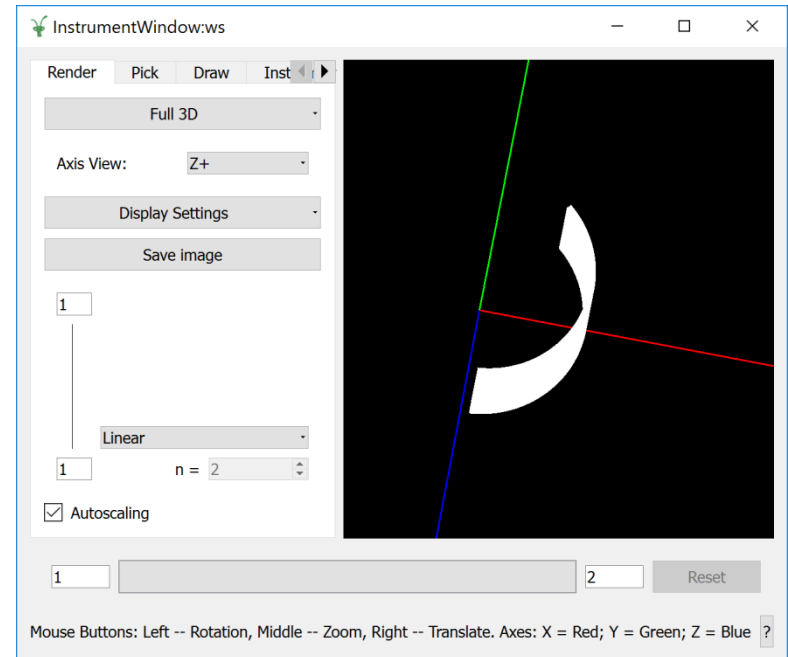
- Implemented as individual cuboids.
- ~10s file load time.
- ~50s to load Instrument View (Full 3D).
- When displayed Mantid has a memory footprint of ~3GB.
- Very slow navigation in the GUI.



Voxel Handling in Mantid



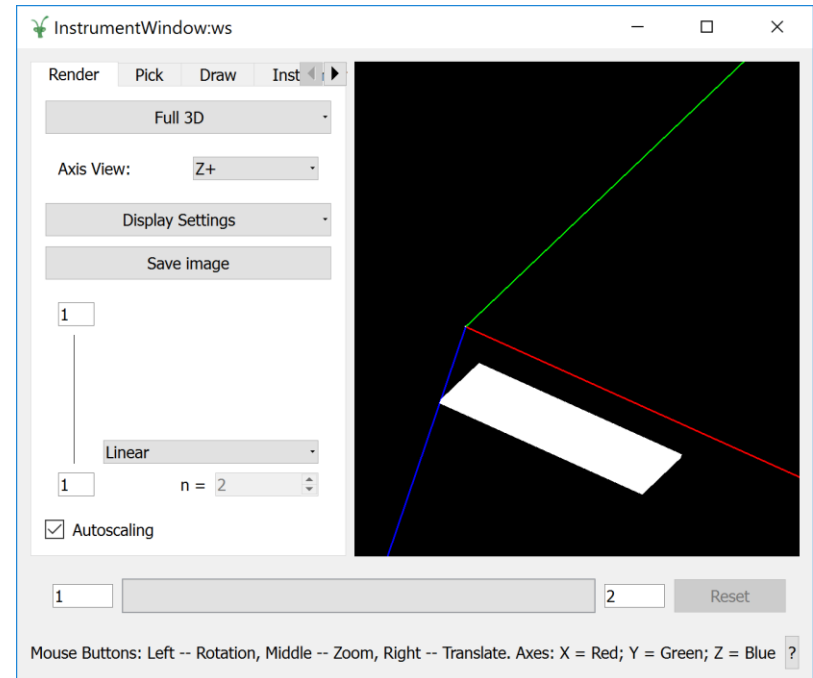
- Implemented each bank as a stack of 16 RectangularDetector.
- ~2s file load time.
- ~2s to load Instrument View (Full 3D).
- When displayed Mantid has a memory footprint of ~500 MB.
- Slow navigation in the GUI.



Voxel Handling in Mantid



- A test of 16 planes with dimensions 400x128.
- ~4s file load time.
- ~2s to load Instrument View (Full 3D).
- When displayed Mantid has a memory footprint of ~1 GB.
- GUI navigation smooth.



Voxel Handling in Mantid



- Rectangular plane test significantly better performance.
- May need a new type of Rectangular detector with ability to define curvature.



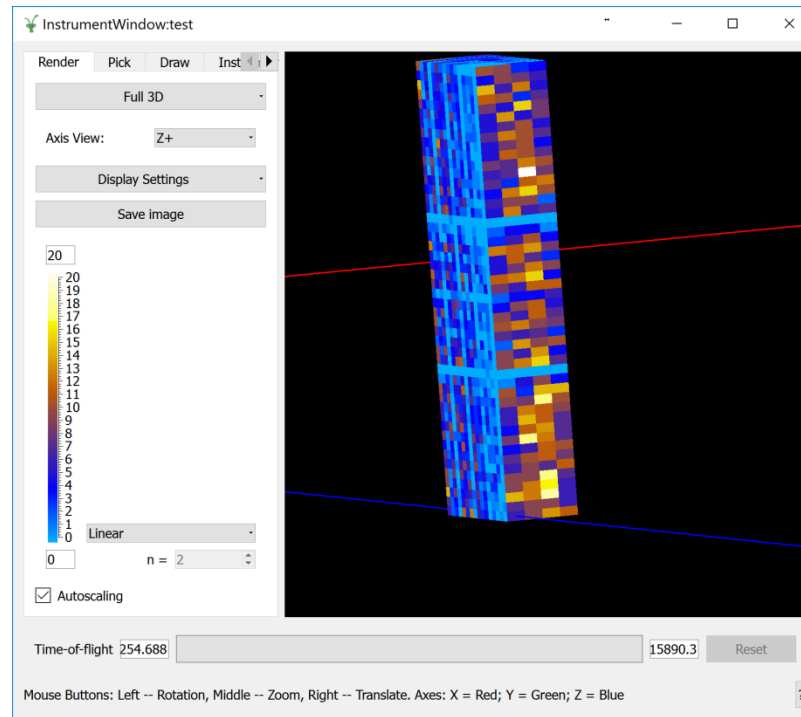
What's Missing?

- No useful method of visualizing the entire instrument.
- No ability to do simple slicing and thresholding.
- No ability to query and display subsets of interesting detectors.
- No volumetric rendering.



Voxel Handling in Other Packages

- Example dataset 4x48x16 based on CNCS instrument.
- Created by Jon Taylor using python.



Voxel Data in Paraview



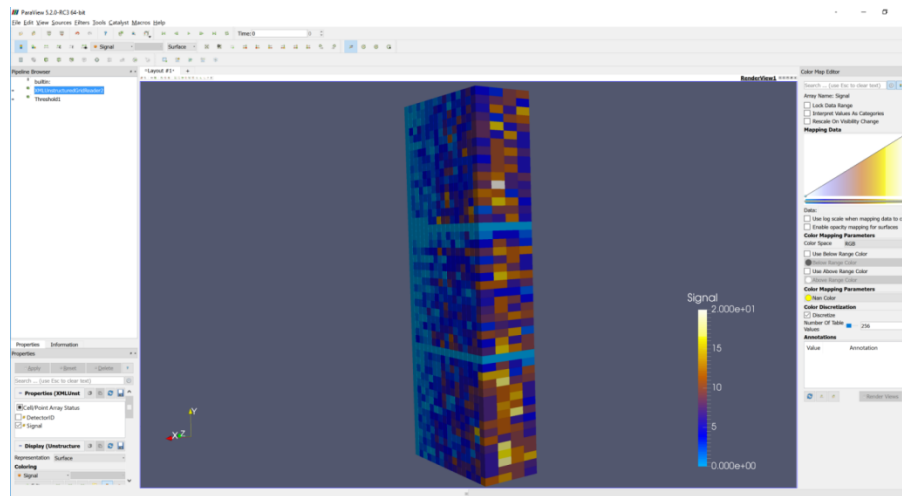
- Paraview is a visualization and analysis toolkit.
- Paraview contains many tools for inspecting 3D volumes.
- Paraview built for large datasets.
- Exploratory requirements gathering.
- May want to use third-party software instead of expending effort embedding this functionality into Mantid.



Voxel Data in Paraview

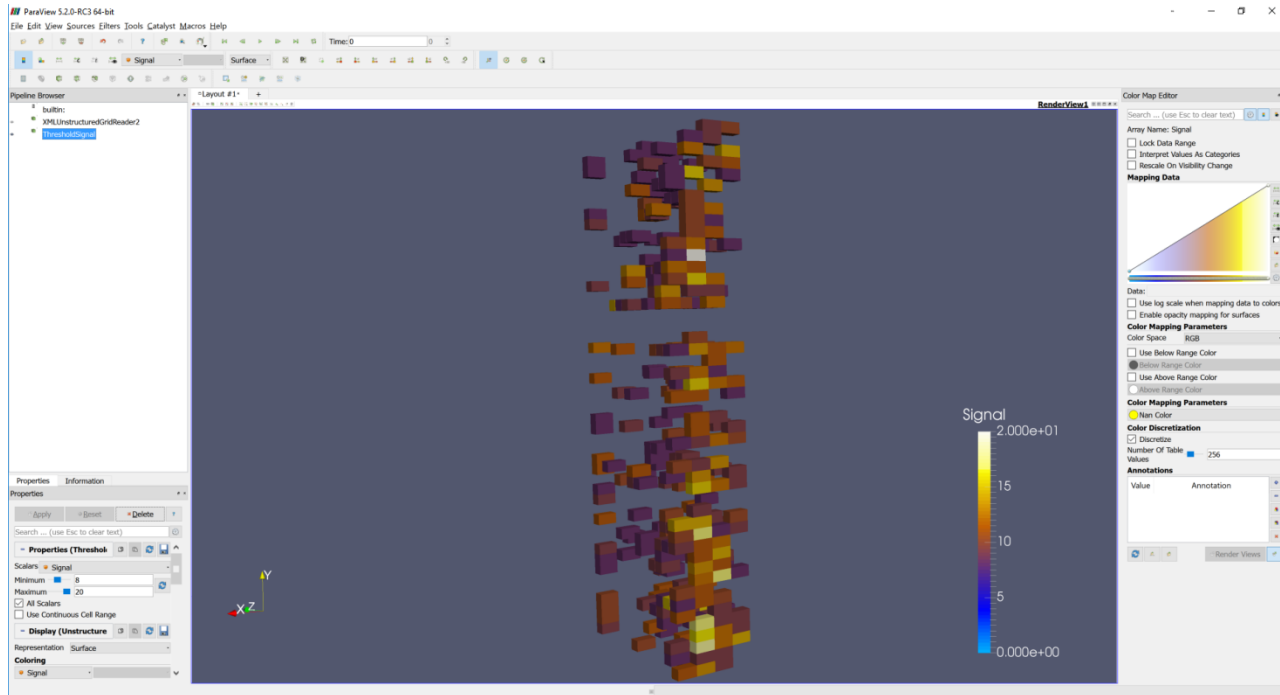


- Test data-set exported as vtk unstructured grid.
- Data contains scalar properties (Neutron Signal and DetectorID).
- Beam direction z+.



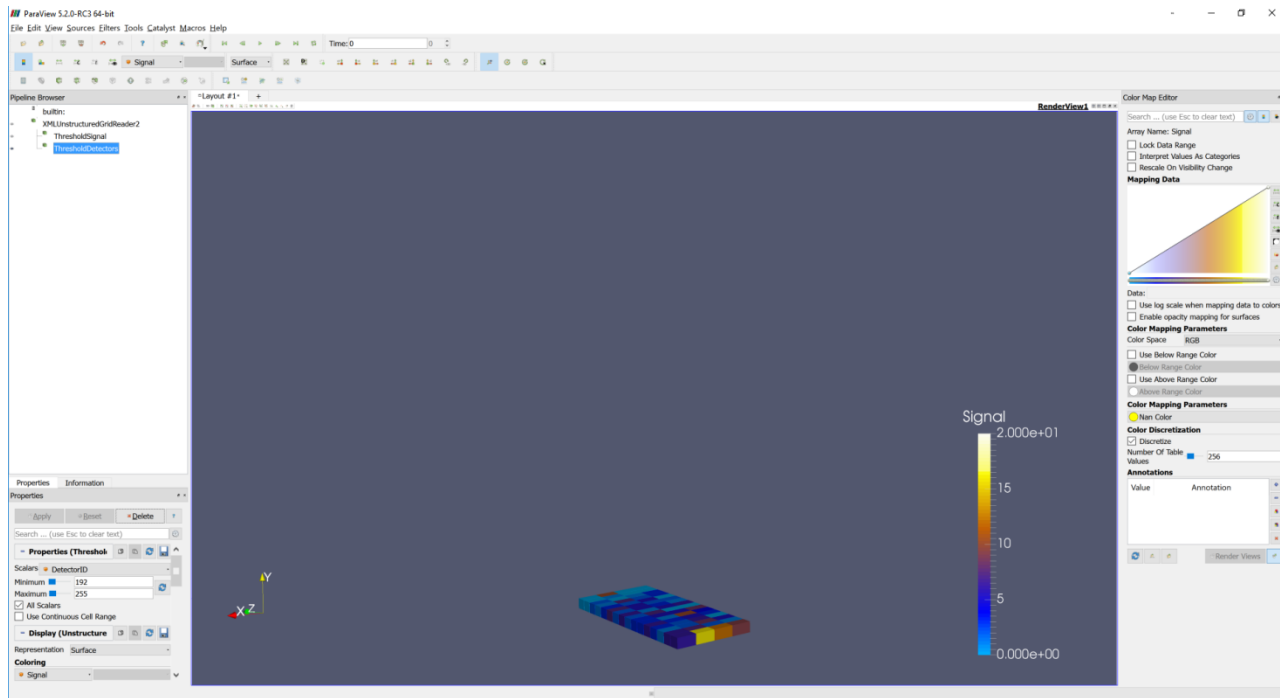
Data Inspection (Basic Thresholding)

- Thresholding based on neutron counts.



Data Inspection (Basic Thresholding)

- Thresholding based on detector ID.



Data Inspection (Using Data Queries)

Find Data

Create Selection

Find **Cell(s)** from XMLUnstructuredGridReader2

Signal is greater than mean

Run Selection Query

Current Selection (XMLUnstructuredGridReader2 : 0)

Show: **Cell(s)** Invert selection

	Cell ID	Cell Type	DetectorID	Signal
0	0	Hexahedron 0	6	
1	4	Hexahedron 4	11	
2	6	Hexahedron 6	12	
3	8	Hexahedron 8	6	
4	10	Hexahedron 10	4	
5	16	Hexahedron 16	9	
6	17	Hexahedron 17	8	
7	18	Hexahedron 18	8	
8	20	Hexahedron 20	9	
9	21	Hexahedron 21	5	
10	24	Hexahedron 24	7	
11	32	Hexahedron 32	13	

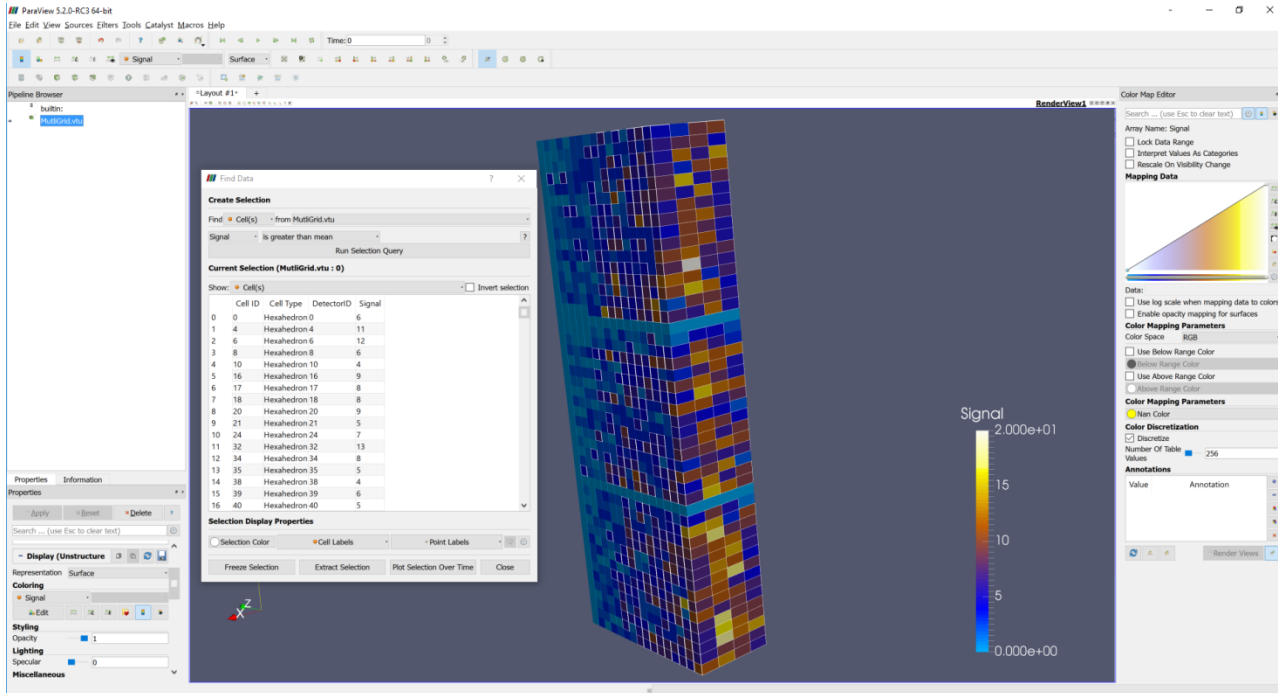
Selection Display Properties

Selection Color Cell Labels Point Labels

Freeze Selection Extract Selection Plot Selection Over Time Close



Data Inspection (Using Data Queries)



Data Inspection (Using Data Queries)

The screenshot displays the ParaView 5.2.0-RC3 64-bit interface. The main 3D view shows a hexahedron grid colored by a 'Signal' attribute. A 'Find Data' dialog is open, showing a table of cell IDs and signal values. The 'Color Map Editor' is also visible on the right.

Find Data Dialog:

Create Selection

Find: Cell(s) from MultiGrid.vtu

Signal is less than mean

Run Selection Query

Current Selection (MultiGrid.vtu : 0)

Show: Cell(s) Invert selection

Cell ID	Cell Type	DetectorID	Signal
0	Hexahedron	1	2
1	Hexahedron	2	3
2	Hexahedron	3	0
3	Hexahedron	5	3
4	Hexahedron	7	0
5	Hexahedron	9	3
6	Hexahedron	11	0
7	Hexahedron	12	2
8	Hexahedron	13	0
9	Hexahedron	14	1
10	Hexahedron	15	0
11	Hexahedron	19	1
12	Hexahedron	22	2
13	Hexahedron	23	1
14	Hexahedron	25	2
15	Hexahedron	26	3
16	Hexahedron	27	2

Color Map Editor:

Search: (Use Esc to clear text)

Array Name: Signal

Lock Data Range

Interpret Values As Categories

Rescale On Visibility Change

Mapping Data

Color Mapping Parameters

Color Space: RGB

Use Below Range Color

Use Above Range Color

Non Color

Color Discretization

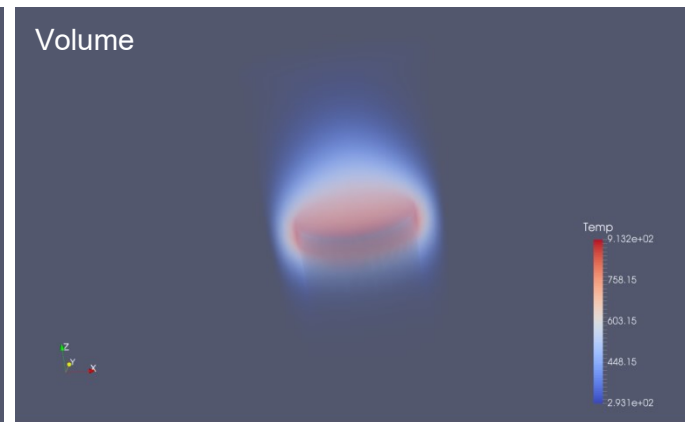
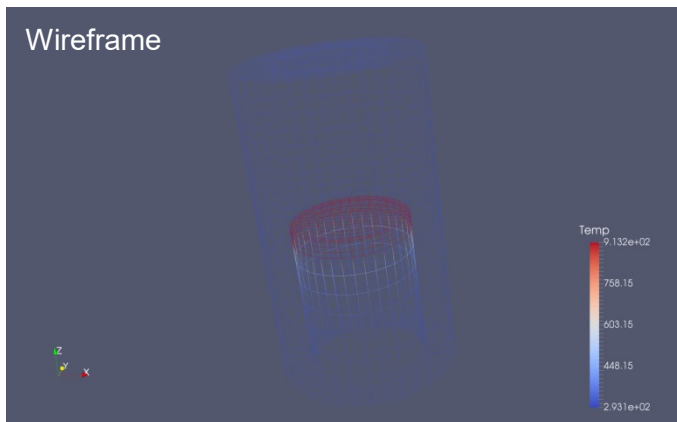
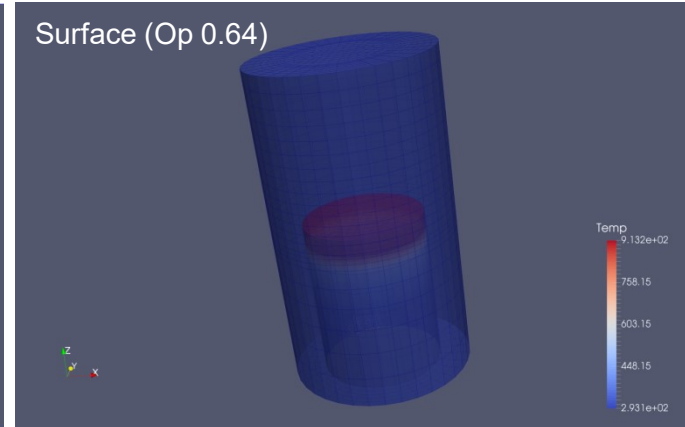
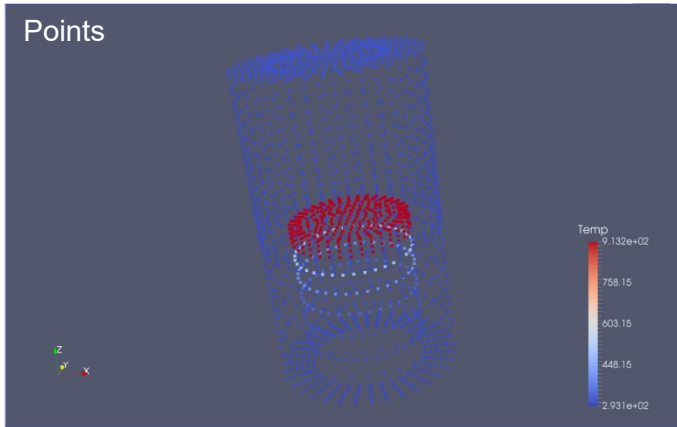
Discretize

Number Of Tables: 256

Annotations

Value Annotation

Visualizing 3D Volumes



Conclusion

- What levels of visualization will be required by users?
- How are users expecting to see volume data?
- If the detector group uses Mantid for commissioning the instrument. What would they expect to see?
- Should the tools presented in Paraview remain stand-alone or should it be built into Mantid?
- Is Paraview too complex an interface?



The End

Thanks For Listening!



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