Working with Application Data That is comprised of Higher Order Elements

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How are higher-order elements handled?

Most visualization tools are based on linear elements.

- Ignore and treat as linear
- Resample on another grid
- Tessellate into smaller elements
  - Who does the tessellation?
  - Over/Under tessellate
  - Correct tessellation; geometry vs data

How are higher-order elements handled?

Internally allow for higher elements.

- Commonly low order elements
- Rarely are the elements implemented the ones used by the application.
- Commonly elements are mixed
  - Fusion: Poloidally; quintic elements, Toroidally; Fourier Series.

What about analysis?

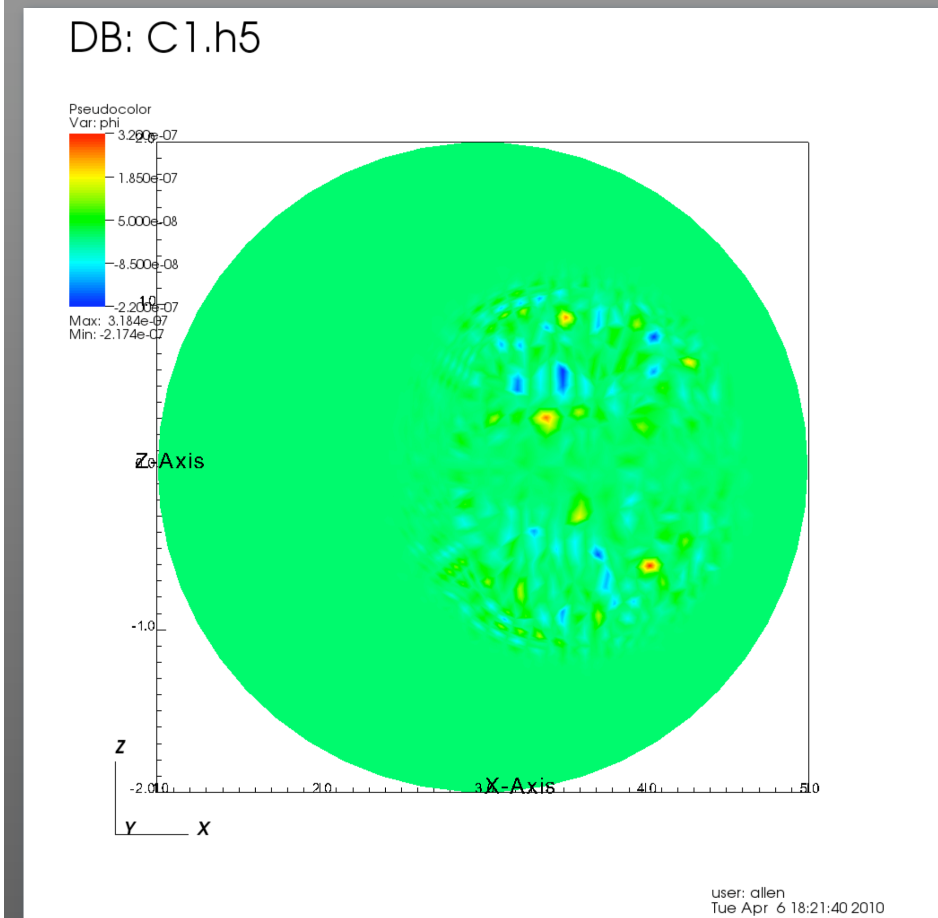
More and more of our work is analysis.

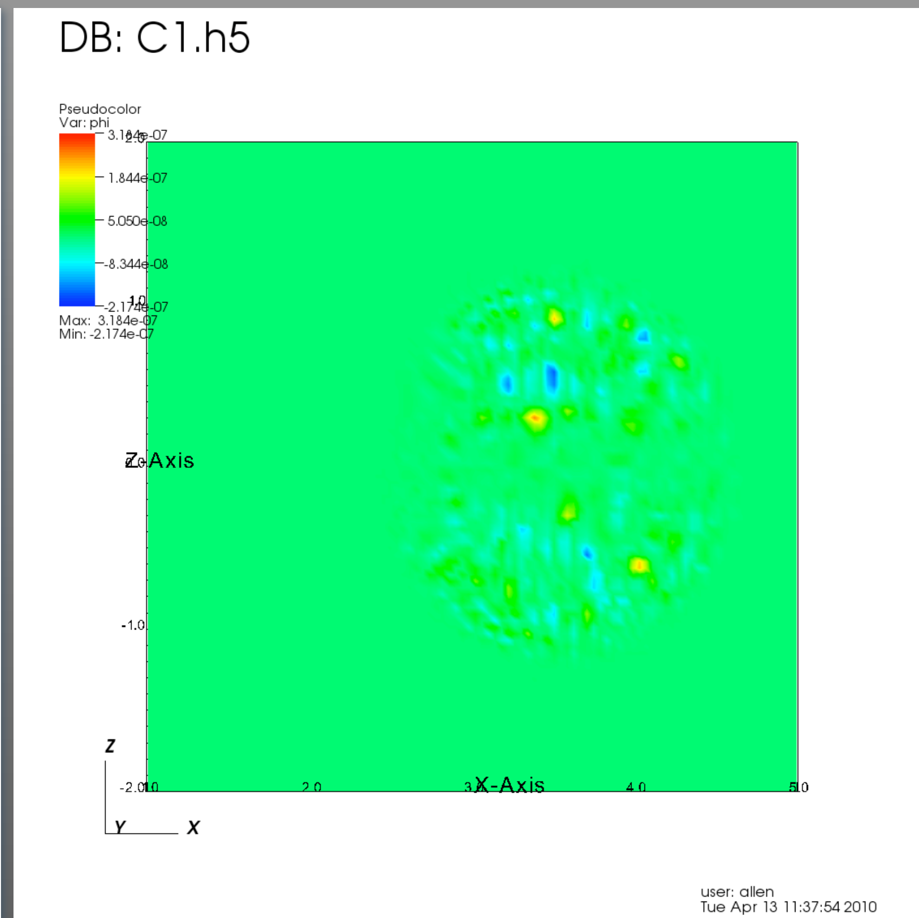
- Integration of streamlines
  - Flux preserving Magnetic Fields.
- Tracing of particles

The analysis must be based on the same representation as the simulation.

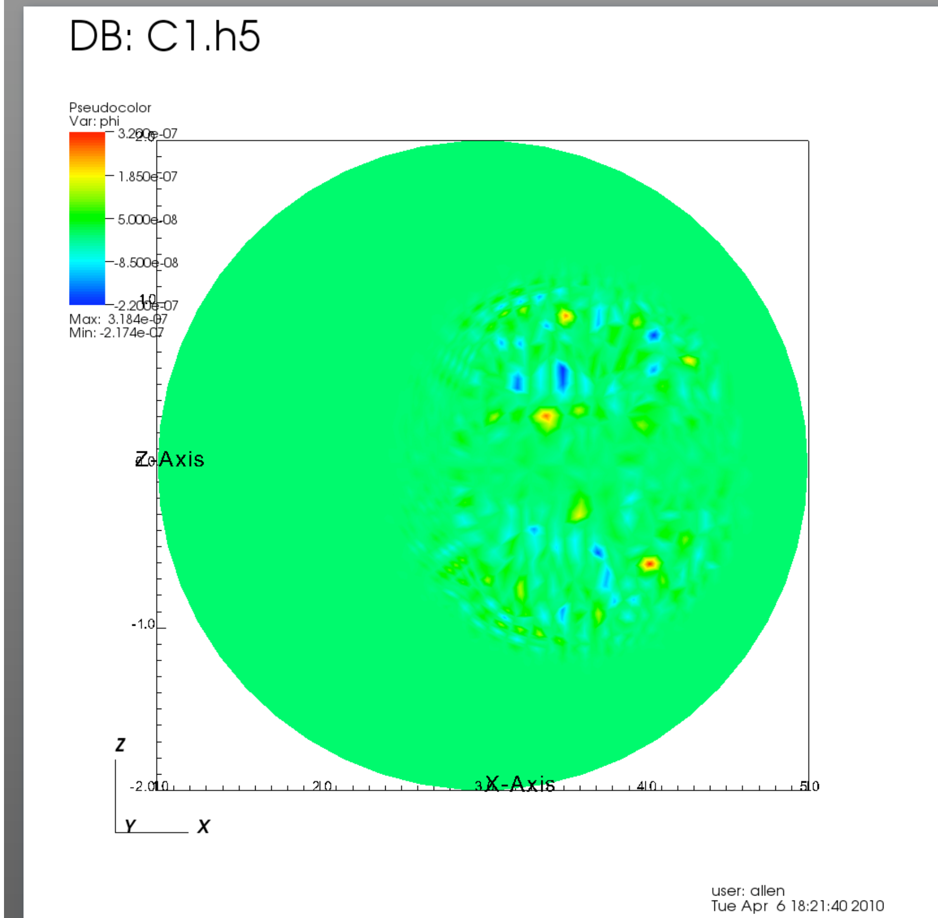
- Poor ties between the simulation and visualization

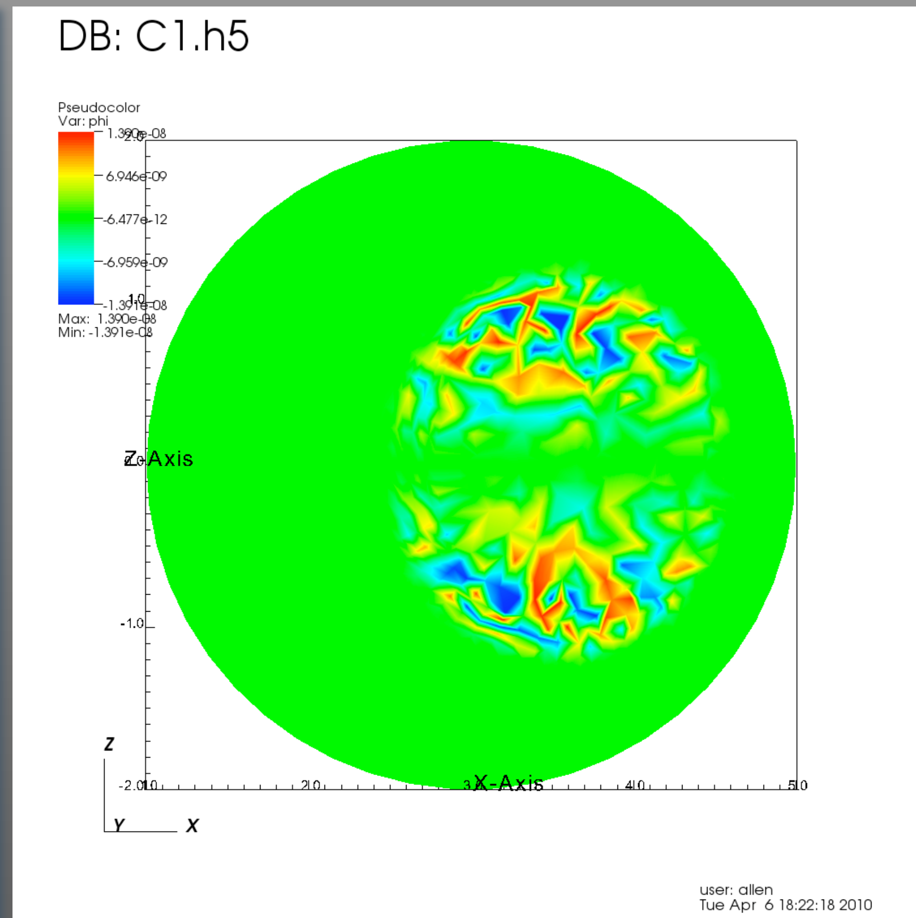
M3D – C1 w/Quintic Poliodal Elements





M3D – C1 w/Quintic Poliodal Elements





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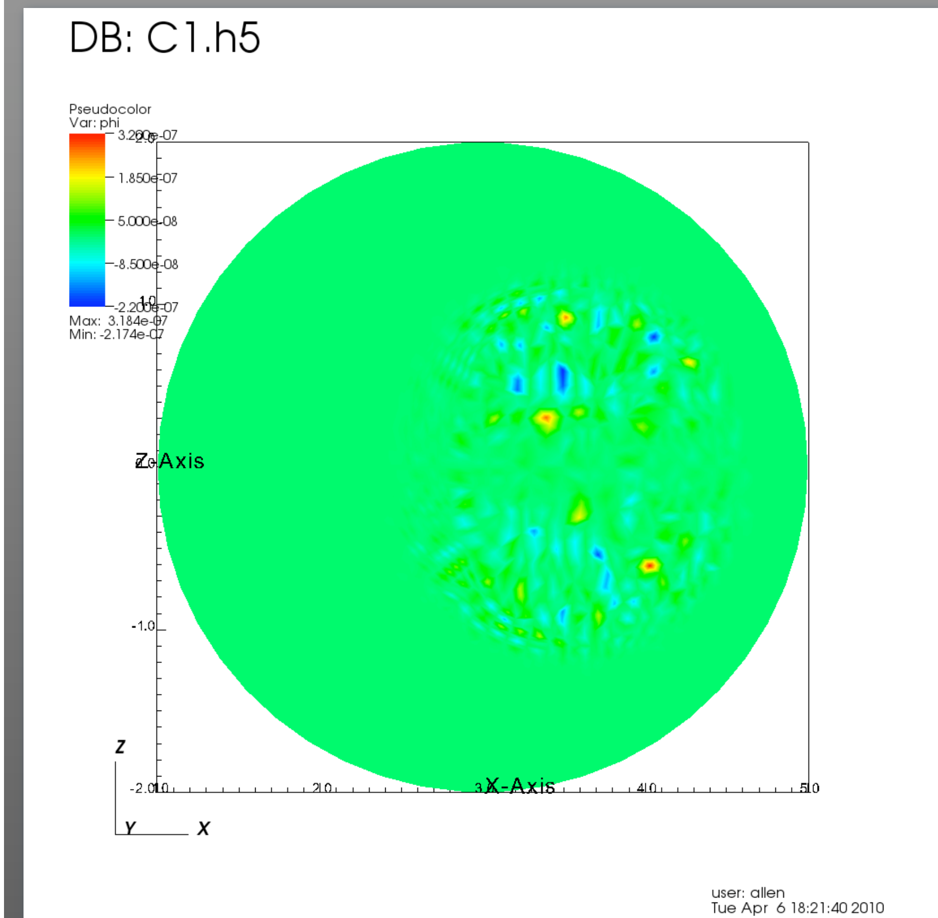

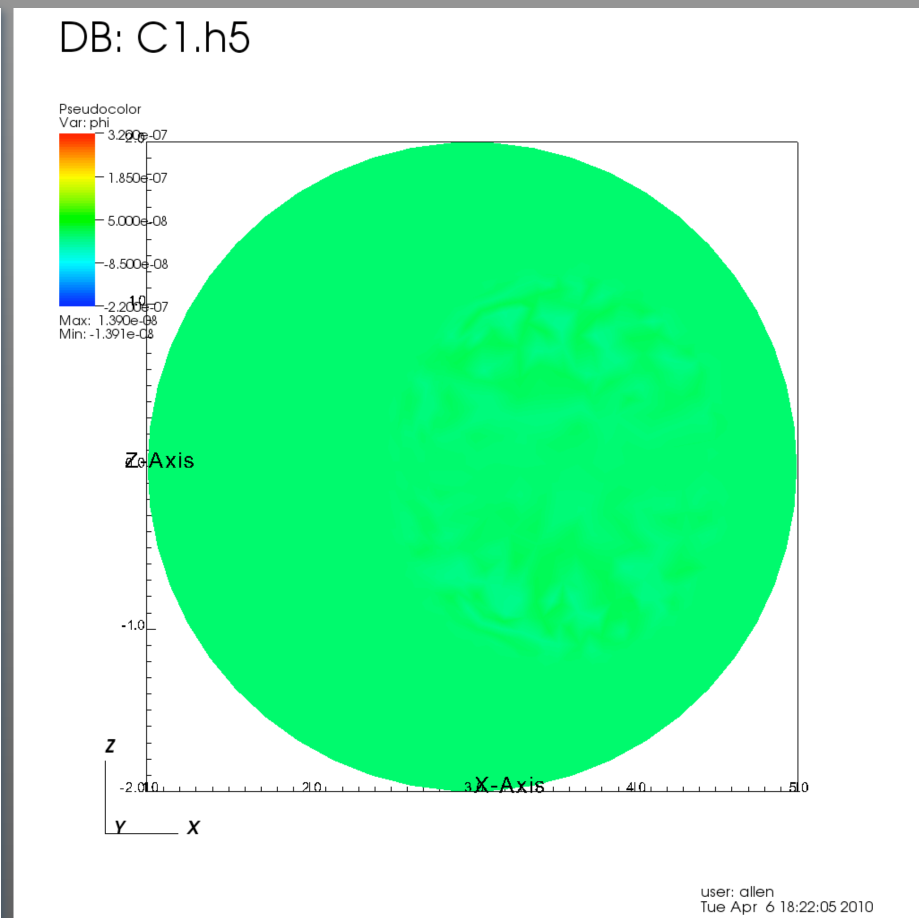

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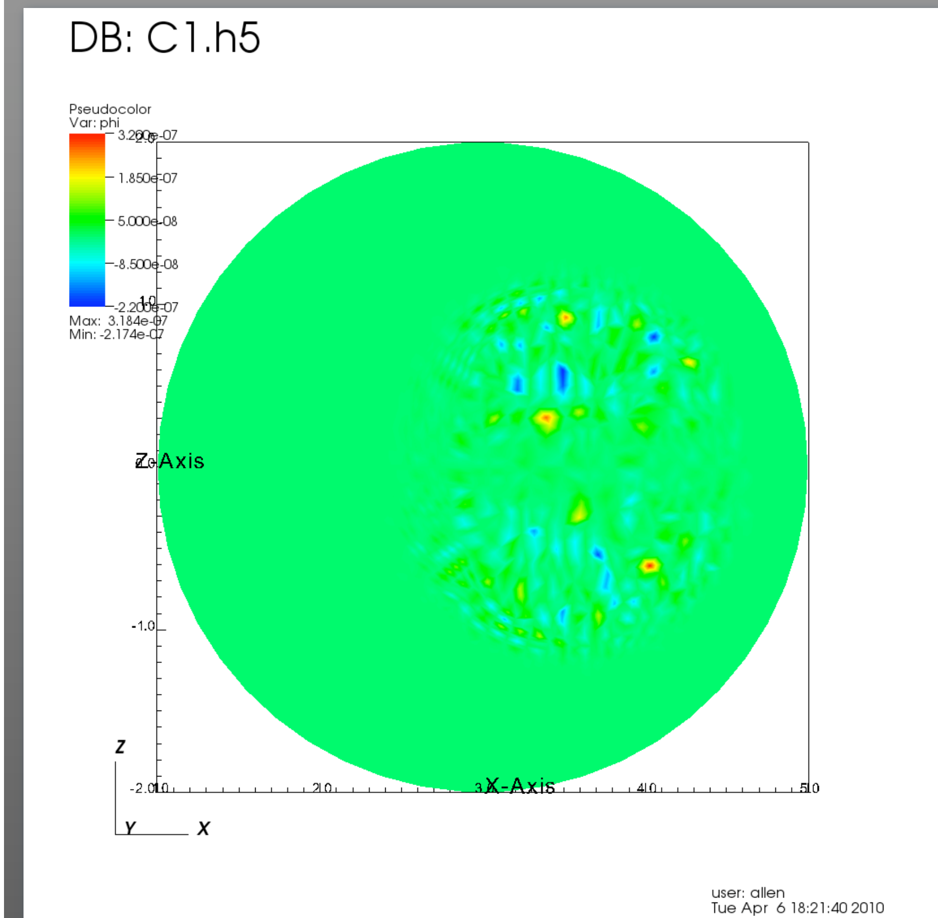
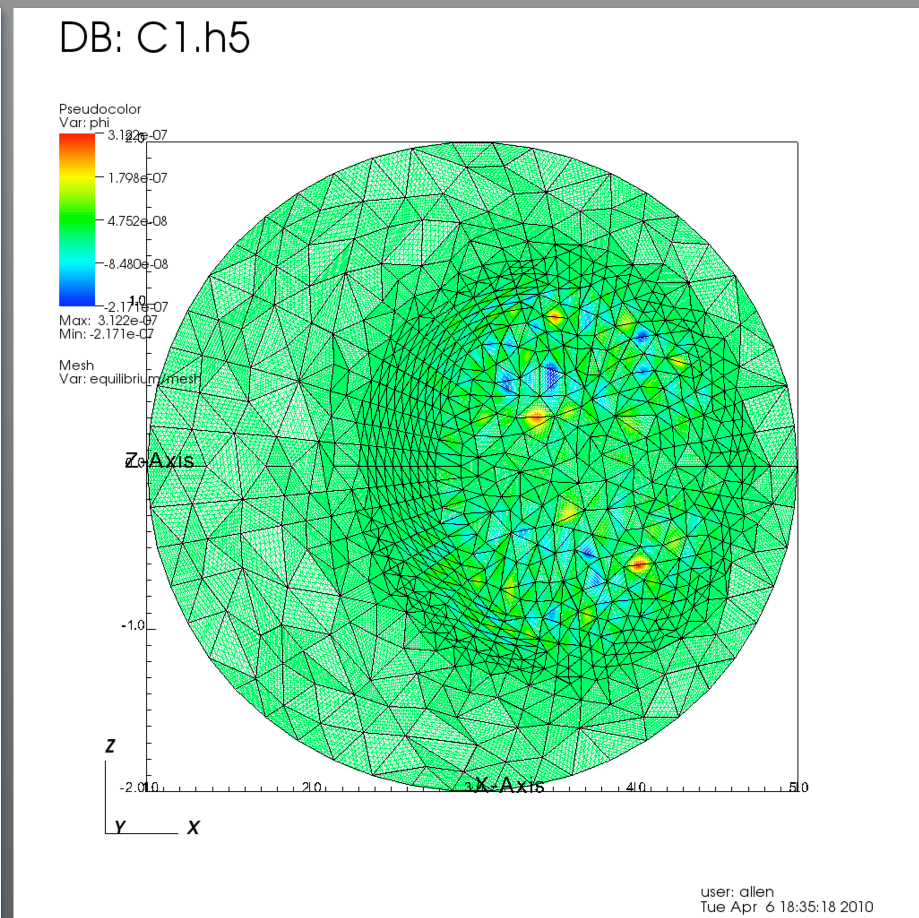
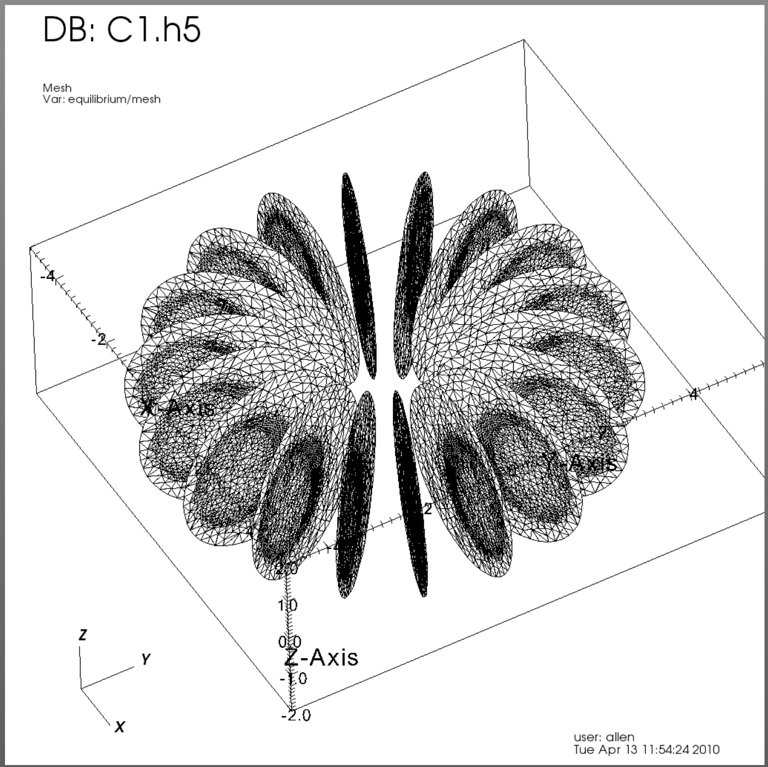




M3D – C1 w/Quintic Elements Poliodally

Previous 2D planes but there is a toroidal direction.

- Fourier series toroidally
- Number of planes is variable
- Interpolation to multiple planes is required



M3D – C1 w/Fourier SeriesToroidally

3 variables required to get value at a particular location:

- Equilibrium
- Complex (Real and Imaginary)

The above is just for a scalar value.

Gets “worse” for vector data such as their Magnetic Field which each component has to be interpolated individually to maintain “zero Flux”

Adding direct support in VisIt

At this point it was decided that the application scientist needed to beinvolved.

Mixed approach:

Visualization – tessellate and render via traditional linear algorithms.

Analysis – Utilize the original elements

Adding direct support in VisIt

Mixed approach:

- Required being able to request mesh and data in either natively or tessellated.
  - Multi pieces for each.
- Required application scientists to supply the necessary interpolation as well integration algorithms.
- Need to “expose” when to use the native representation explicitly.

Adding direct support in VisIt

Pitfalls

- One off solution
- Exposing native mesh/data requires explicit by-pass code in each "operator".
  - Streamline Integration.
- Ownership of interpolation/integration code.
- Need to work closely application scientists.

Advantages

- Application scientists know their elements
- Analysis is believable by the application scientists