Idaho National Engineering and Environmental Laboratory

Visualization Of A Deterministic Radiation Transport Model Using Standard Visualization Tools

James A. Galbraith
Idaho National Engineering and Environmental Library

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Introduction

- *Visualization*
- *Visualization Requirements*
- *VisIt*
- *Plot Types*
- *Operators*
- *Databases*
- *Attila*
- *Attila With VisIt*

Visualization

- *Increasing compute capabilities has led to:*
  - *Results being achieved much quicker, we need to facilitate it's analysis*
  - *A need to compress expanding data sets into visual data analysis*
- *Goal: Generic solution to a generic problem*
  - *For both current and future problems*

Visualization (continued)

- *Existing problems need a solution now (i.e. yesterday)*
- *Cannot create a totally new solution*
  - *Cannot afford to "roll our own"*
  - *Do not have $, staff, or time*
- *Need to leverage the work of others*
- *Specific solution to a specific problem is a last resort*

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Visualization Requirements

- *Scalability*
- *Extensibility*
- *Portability*
- *Performance*
- *Standards*

Scalability

- *Support for wide range of data set sizes – up to tera-scale data sets*
- *Support for wide range of compute platforms*
  - *Use of parallel compute engines*
  - *Able to run in small environments for small problems (efficient use of resources)*

Extensibility

- *Easily extend data formats supported*
- *Easily extend visualization techniques provided*
- *Easily extend filtering techniques provided*

Portability

- *Support targeted platforms*
  - *SUN*
  - *SGI*
  - *Linux*
  - *MS Windows*
- *Use of a common source baseline on all target systems*

Performance

- *Adequate performance on targeted hardware platforms*
  - *Acceptable performance based on problem size*
- *Parallel compute engine capabilities*

Standards

- *Use of widely accepted standards or techniques:*
  - *Not necessarily standard based on standards organizations*
  - *Graphic standards*
  - *File formats*
  - *Graphics toolkits*
  - *Use of widely accepted "good stuff"*
    - *Scripting languages*
    - *GUI*

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VisIt

- Our primary tool of choice
- Developed at Lawrence Livermore National Laboratory (LLNL)
- Component based – supports extensibility needs
- Parallel compute engine
- Designed for tera-scale data sets
- Open source implementation
- Provides output of static snapshots of plots in standard graphic file formats
- Allows additional manual annotation
- Actively being developed at LLNL

Scalability

- *Supports tera-scale data sets*
- *Runs on single CPU systems*
- *Also provides parallel compute engine (SMP & Clusters)*
- *Supports multiple platforms*
  - *AIX, Solaris, Irix, Linux, MS Windows*

Extensibility

- *Component based*
- *Designed with plugin technology*
- *Supported data formats may be easily expanded*
- *Visualization techniques may be easily expanded*
- *Data filtering techniques may be easily expanded*

Portability

- *Supports necessary hardware platforms*
  - *SGI, Sun, Linux, MS Windows*
- *Uses a single source baseline*
- *Automake / autoconf tolls to create Makefiles*
- *MS Windows has platform specific set of Makefiles*

Performance

- *Runs equally well on small single CPU systems with reasonable data set size*
  - *Majority of visualizations in this presentation were created on a Dell Inspiron 8000 laptop (800Mhz)*
- *Compute engine is capable of parallel operation based on domains within data set*
- *Windows Issues:*
  - *STL implementation with MS Visual C++*
  - *STLport*
  - *Faster than Linux on same class of machine*

Standards

- *Based on Visualization Toolkit (VTK)*
- *Utilizes OpenGL (Mesa)*
- *Extends Python scripting language*
- *Data file formats*
  - *Silo, SAF (Sets And Fields), Ensight, VTK, …*
- *QT (GUI toolkit)*

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Plot Types

- *Implemented as plugin modules*
  - *Boundary*
  - *Contours (isosurfaces)*
  - *Mesh*
  - *Pseudocolor*
  - *Surface*
  - *Vector*
  - *Volume*
- *Can be easily extended*

Operator Types

- *Implemented as plugin modules*
  - *Clip*
  - *Slice*
  - *Transform*
  - *Onion peel*
  - *Reflect*
- *Can be easily extended*

Data Formats

- *Implemented as plugin modules*
  - *Silo*
  - *Sets And Fields (SAF)*
  - *VTK*
  - *Partial HDF5*
  - *Ensight*
  - *Exodus*
- *Can be easily extended*

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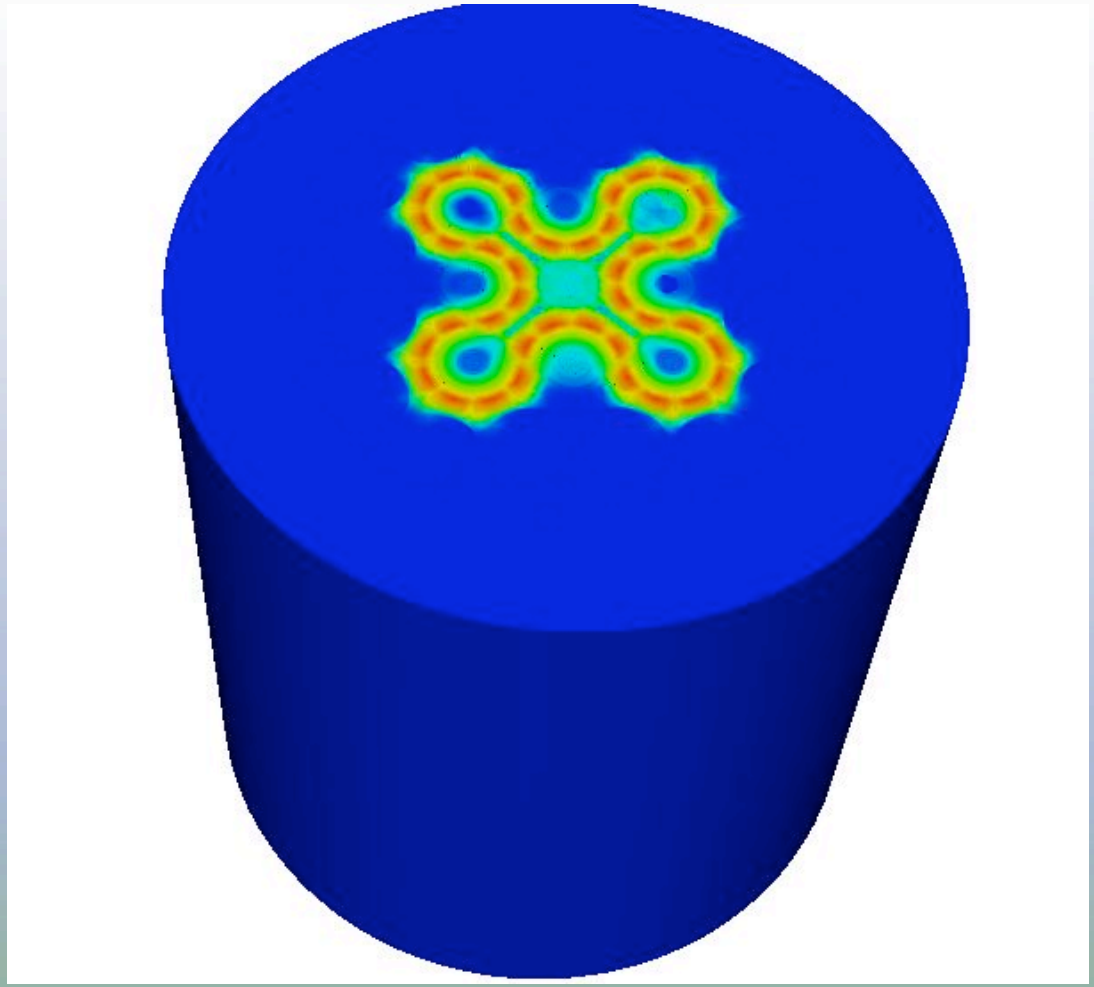
Attila

- *Deterministic radiation transport software package*
- *Designed and implemented to be a robust, general purpose radiation transport solver.*
- *Developed at LANL, licensed to Radion Technologies*
- *Used at INEEL for core safety analysis activities*

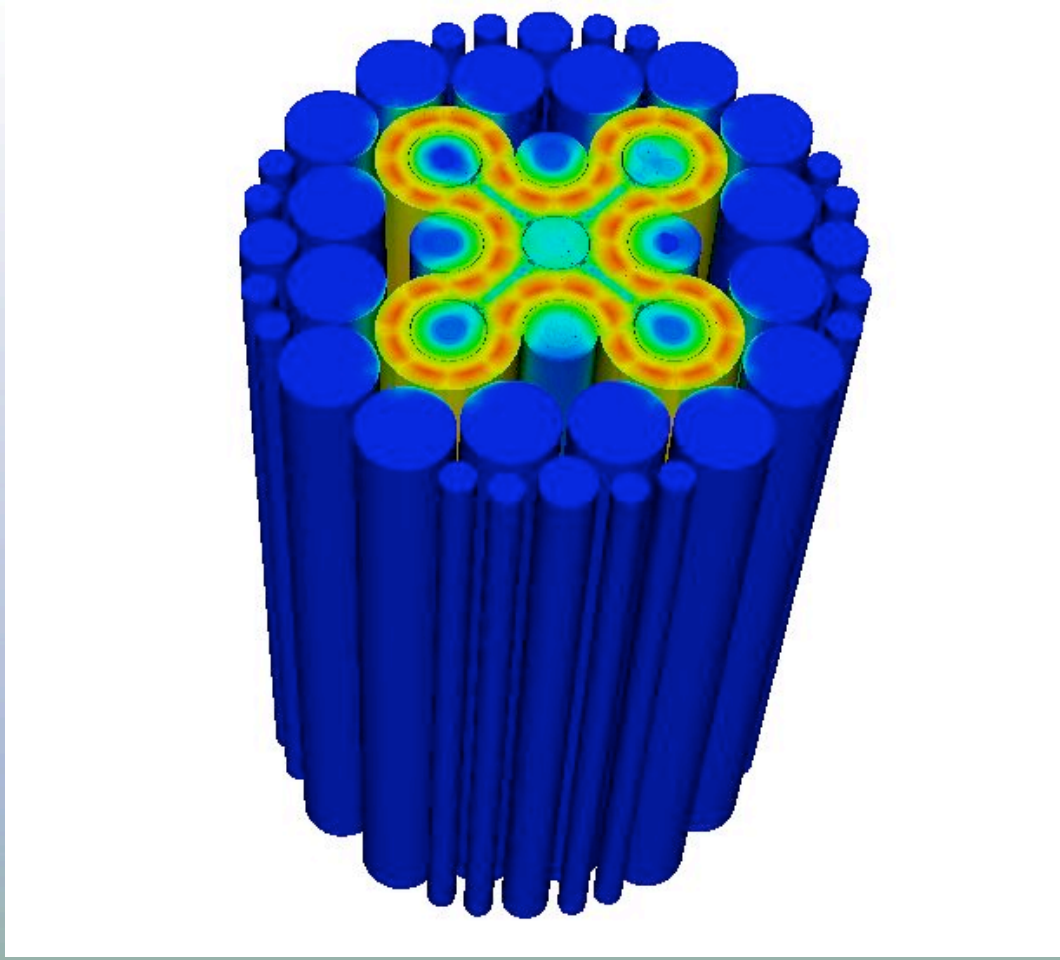
Attila With VisIt

- Attila currently generates a Tecplot output file
- New database component created for Tecplot file
- Mesh was segmented into subsets to allow VisIt to utilize concept of Domains
  - Remove portions of the database before the compute engine sees it
  - Simplifies data filtering w/o use of complex filters
  - Domains are used to identify tasks for parallel computation activities
- Model size:
  - 398,775 nodes
  - 1,361,682 tetrahedral elements

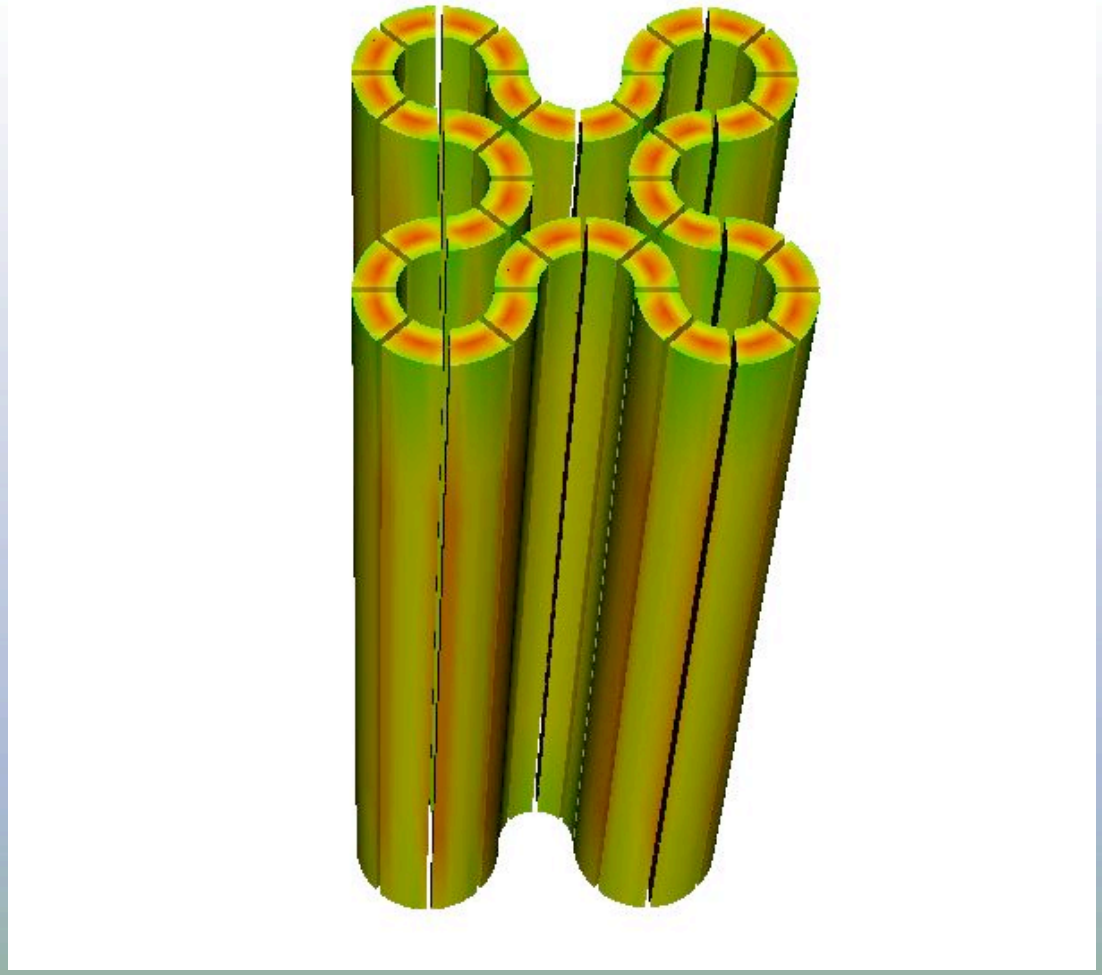
Full Attila Model of Advanced Test Reactor



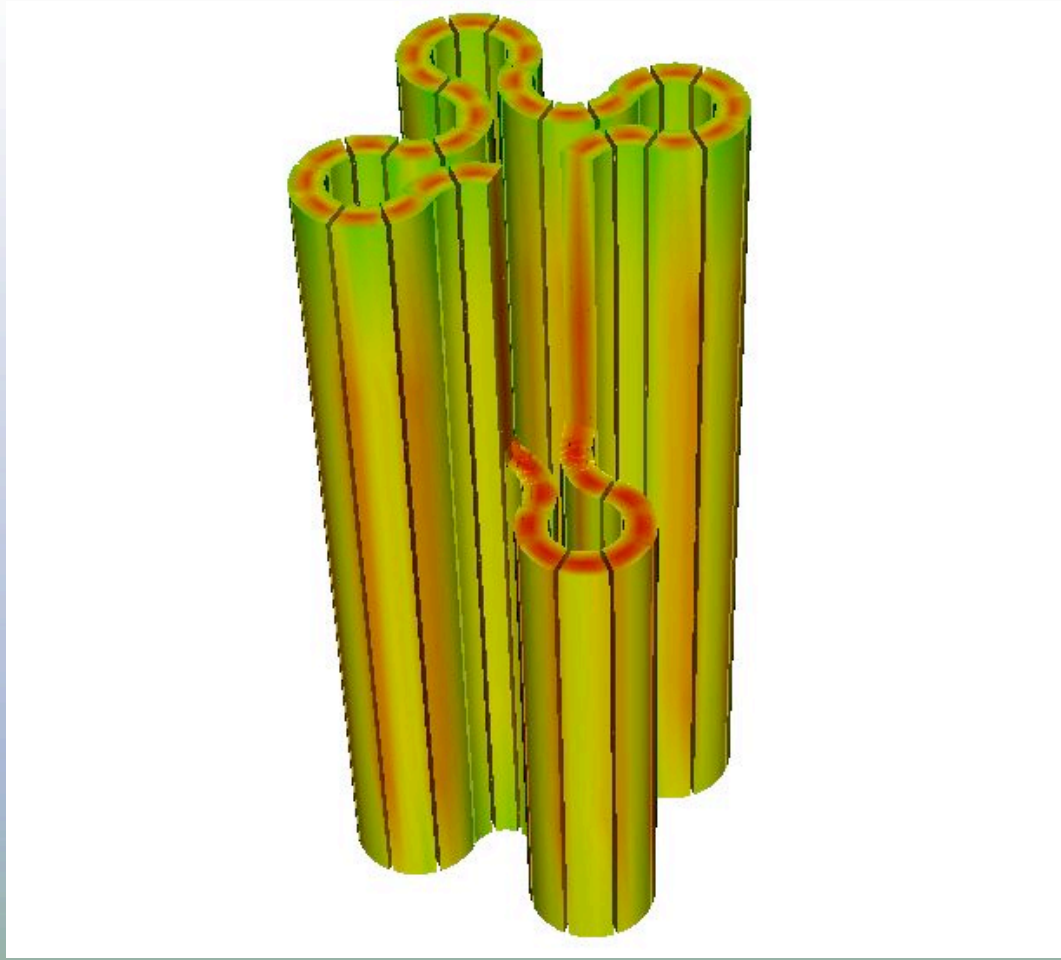
ATR Model W/O Water & Relect Domains



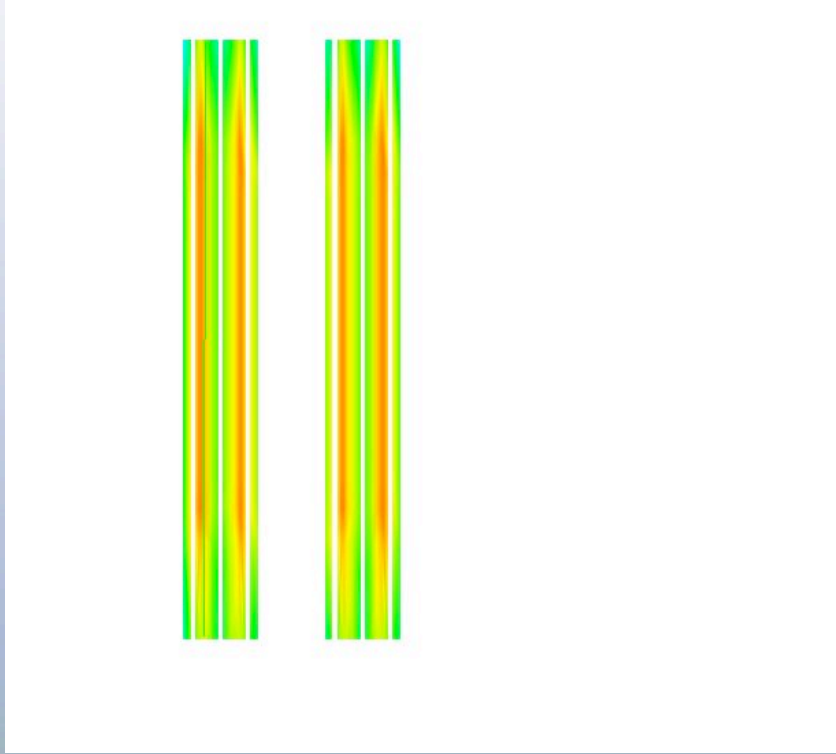
ATR Model With Only Core Domains

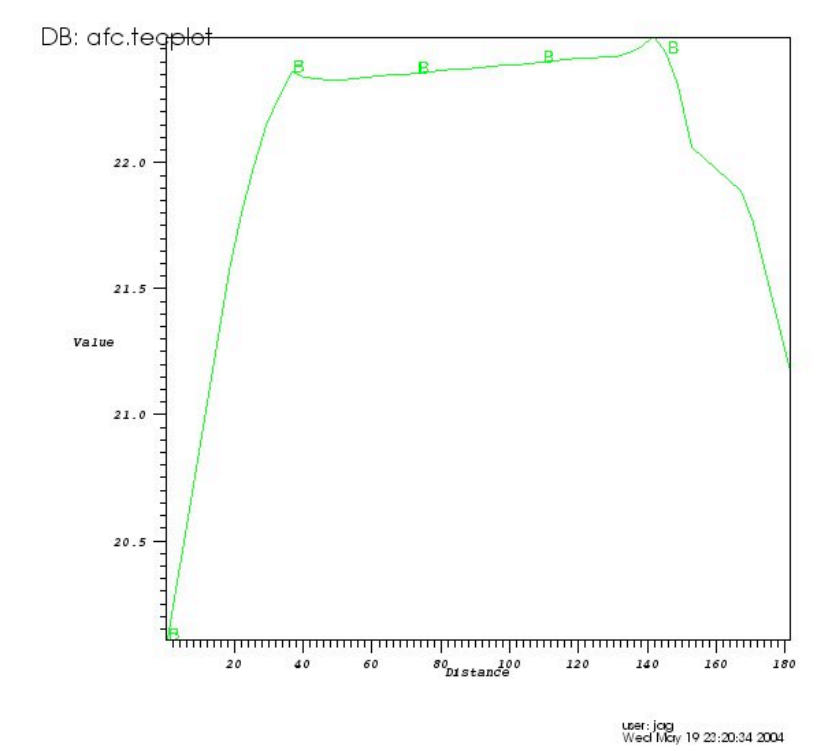


ATR Core Model – Clipped w/3 Planes



Slice With 2D X-Y Plot





Conclusion

- *VisIt performs quite well for our current and anticipated problems*
- *Provides a good environment for extension*
- *Supports reporting needs*
- *Documentation is not quite adequate, but software engineers are answering their phone and e-mail*
- *A definite generic solution to a generic problem*
- *The price is right!*