TECH-X

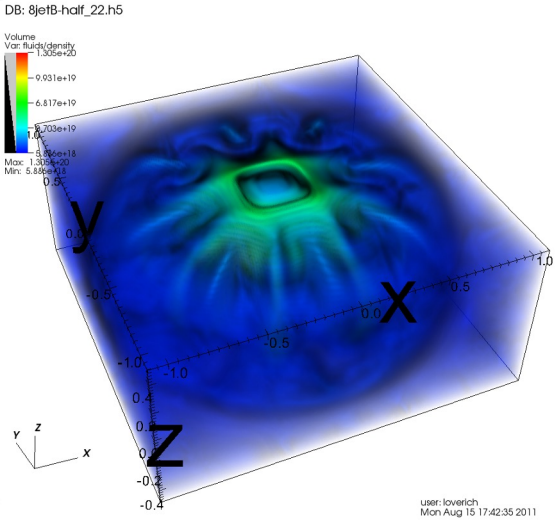
SIMULATIONS EMPOWERING
YOUR INNOVATIONS

USim 3.0: Advanced Fluid Modeling for Scientists and Engineers

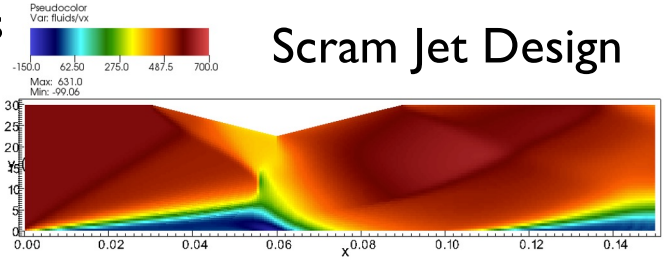
USim: Advanced Fluid, Plasma and Electromagnetic Modeling on Unstructured Meshes

- Supports hydrodynamics, magnetohydrodynamics, Hall magnetohydrodynamics, two-fluid plasmas, Navier-Stokes and Maxwell's equations
- Includes multi-species, multi-temperature versions of fluid models

Plasma Accelerators

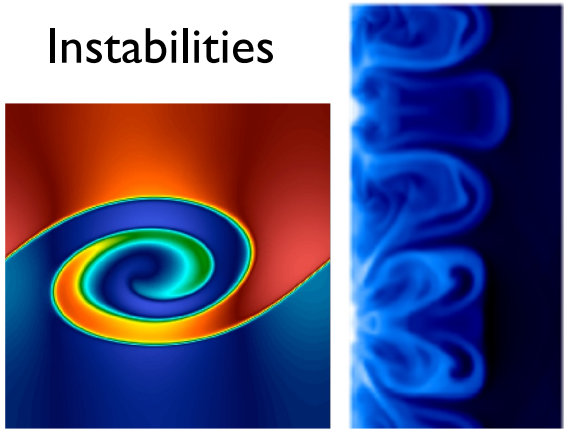


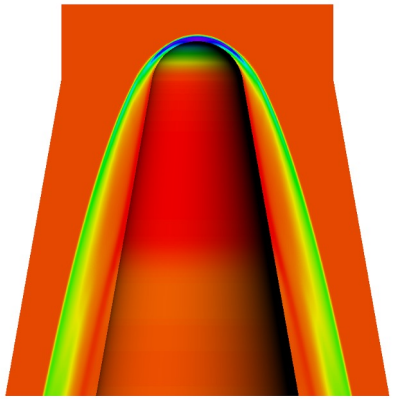
Scram Jet Design



Plasma Liner Experiment

Instabilities





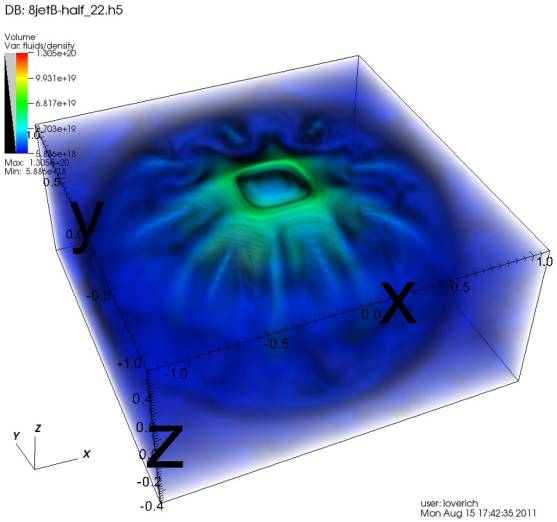
Re-Entry Vehicles

USim: Advanced Fluid, Plasma and Electromagnetic Modeling on Unstructured Meshes

The USim advantage:

- All physics models can be solved on structured, body fitted and unstructured meshes in multi-dimensions
- Cartesian, Spherical and Cylindrical coordinate systems
- Examples and documentation included
- USimComposer allows simulation setup, execution, and visualization in one application
- Works for:
  - single and multi-core systems
  - Windows, MacOS and Linux operating systems

Plasma Accelerators



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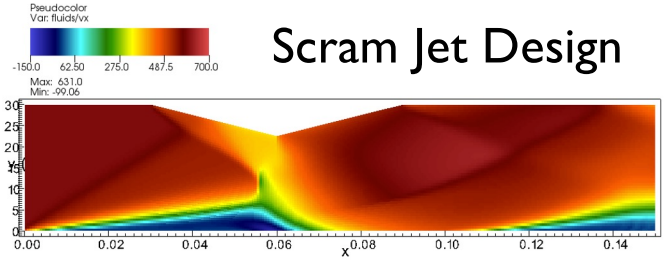

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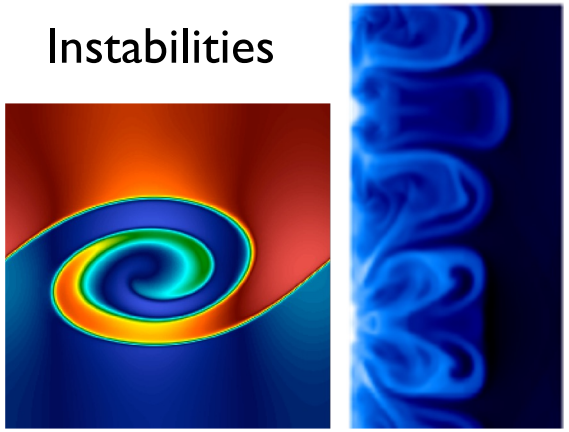
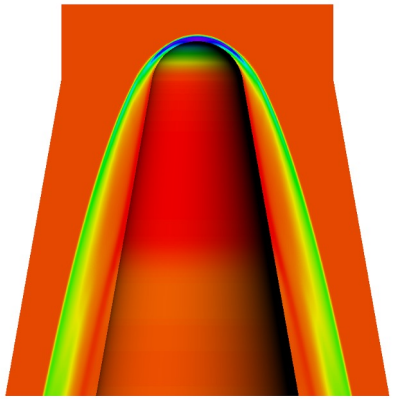
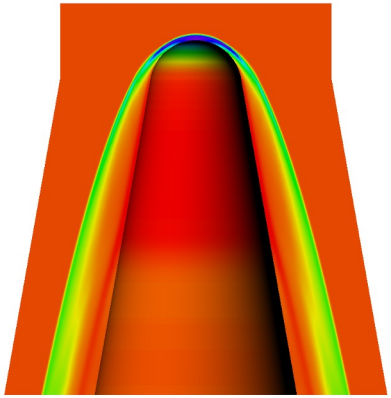
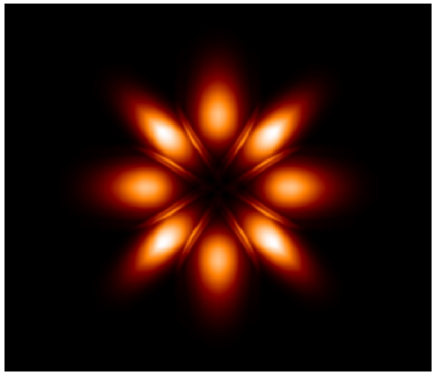




Re-Entry Vehicles

Packages oriented towards specific problem areas





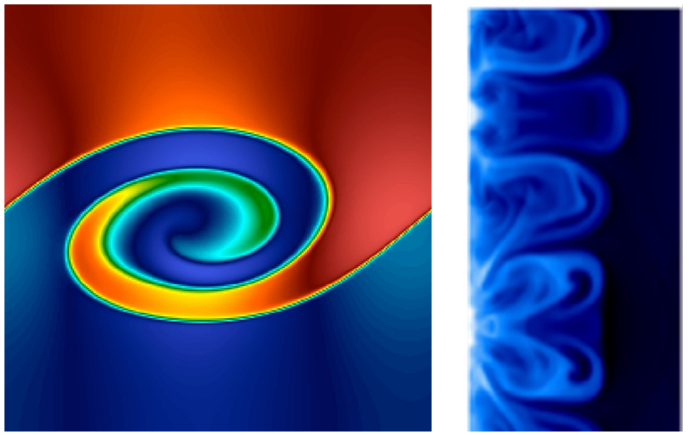
USim HYPERSONICS

USim HIGH ENERGY DENSITY PLASMAS

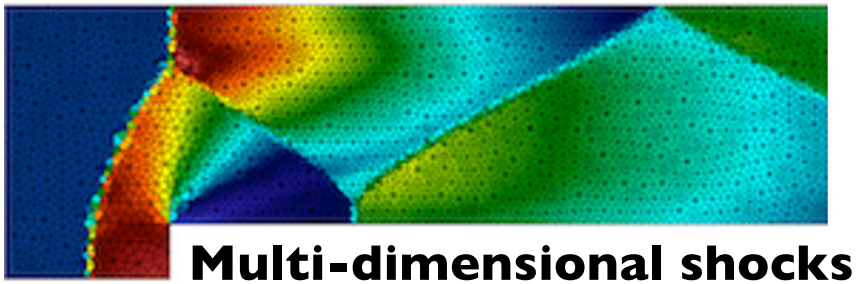
USim BASE

USimBase: A great solution for learning about fluid dynamics

- USimBase enables users to learn fluid dynamics from a computational perspective
- Easy to use interfaces to classic fluid dynamics problem enables exploration of physics of classic fluid instabilities and shock formation
- Single parameters allow switching of dimensionality and fluid model
- Complete picture of the input file enables users to learn how to use USim for more complex problems



Classic Fluid Instabilities

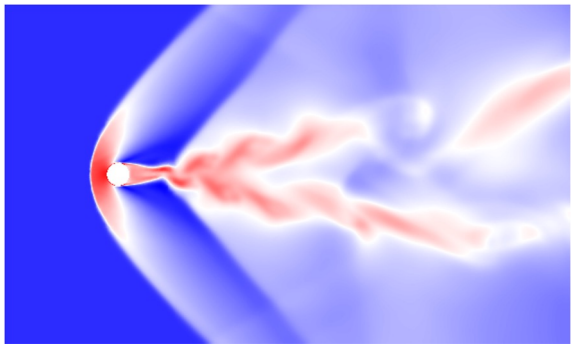


Multi-dimensional shocks over simple geometries

USim BASE

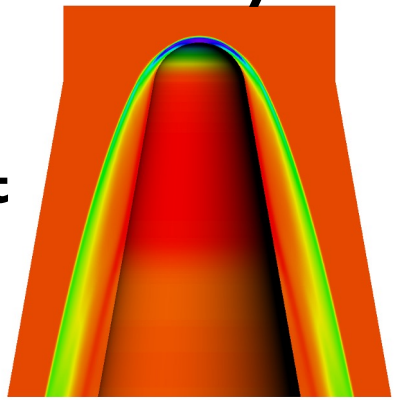
USim for Hypersonics: The only commercial solution for modeling hypersonic flight!

- USim for Hypersonics allows users to simulate high mach number flows in engineering time
- Fluid algorithms for capturing the multi-species dynamics needed for hypersonic flight
- All of the features of USim Base plus...
  - Accelerated Navier-Stokes with anisotropic coefficients
  - Accelerated Reaction Chemistry
  - Multi temperature compressible flow
  - Multiple Species
  - Real Gas Equation of State
  - General Equation of State



Hypersonic flow with accelerated Navier Stokes and chemistry

Spacecraft Re-Entry

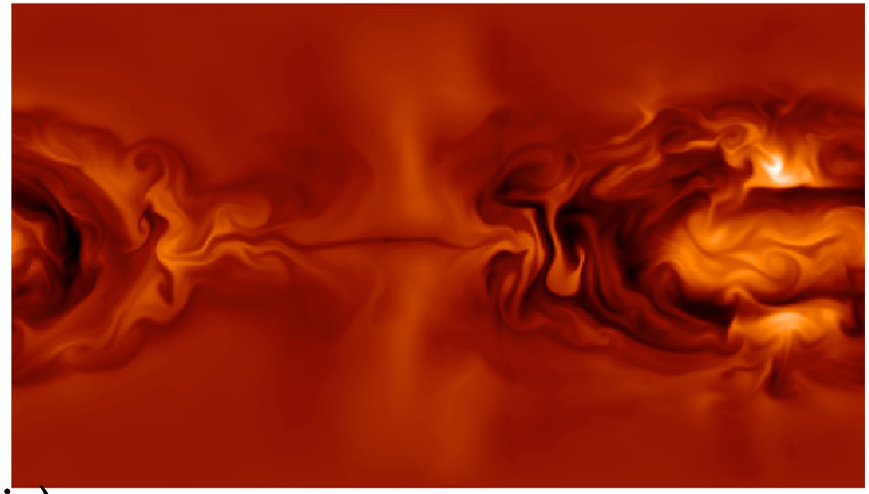


USim HYPERSONICS

USim for High Energy Density Plasmas: Extreme algorithms for extreme regimes!

- USim for HEDP enables the study of plasmas at the extremes of temperature and pressure in experimental geometries
- Fluid algorithms for capturing electron and ion dynamics, with advanced coupling to electromagnetic fields
- All of the features of USim Base plus...
  - Gas dynamic magnetohydrodynamics
  - Separate densities, velocities and (anisotropic) temperatures for ion and electrons
  - Full Maxwell's equations
  - General equation of state

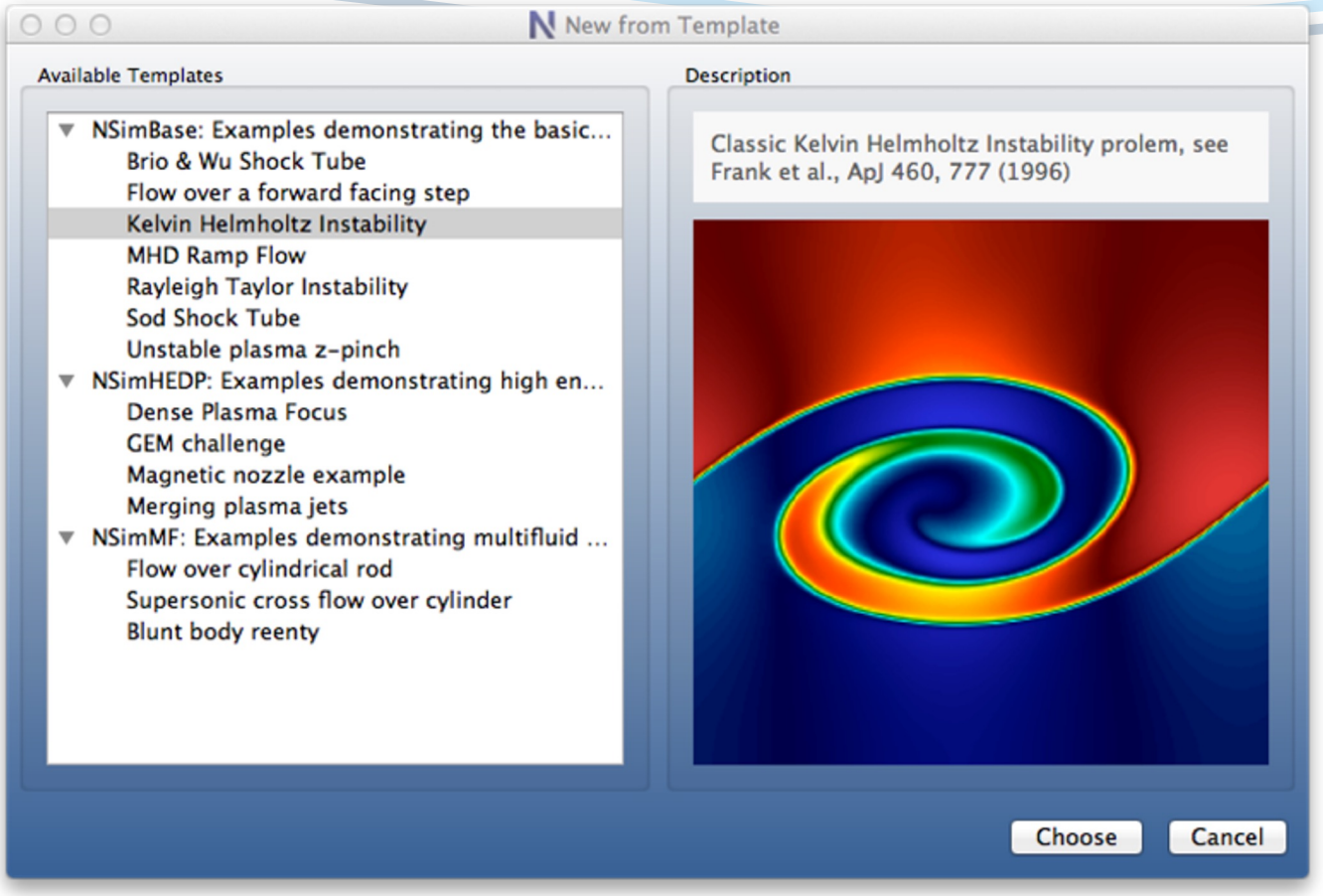
Magnetic Reconnection



Plasma Accelerators

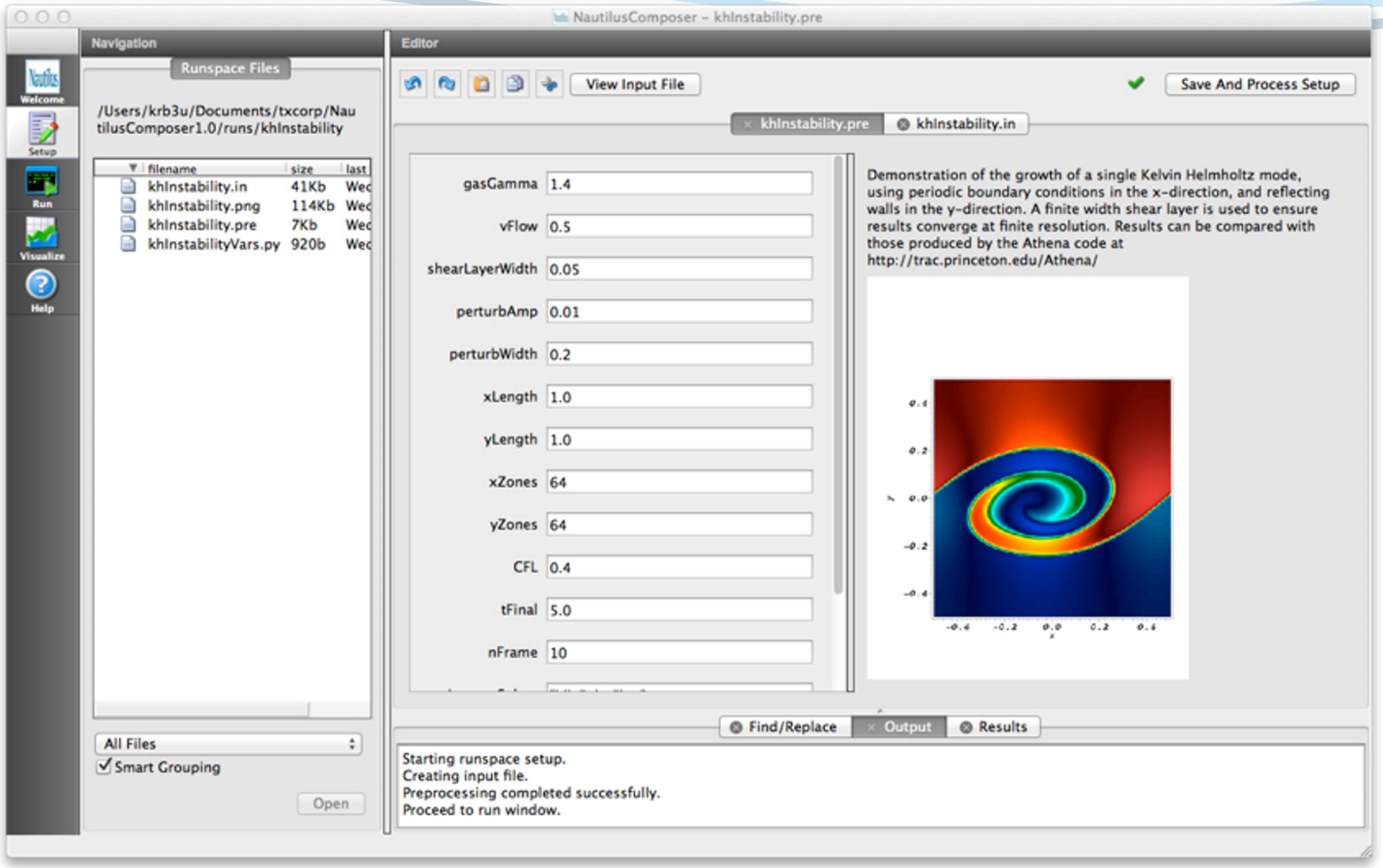
USim HIGH ENERGY DENSITY PLASMAS

USimComposer: A Single Interface for Simulation Design, Execution and Visualization



- Each USim package (Base, Hypersonics and HEDP) has a range of examples available
- USimComposer provides:
  - Key parameter interface for simulation control
  - Built-in validation of simulation design
  - Visualization and analysis of simulation data

USimComposer: A Single Interface for Simulation Design, Execution and Visualization



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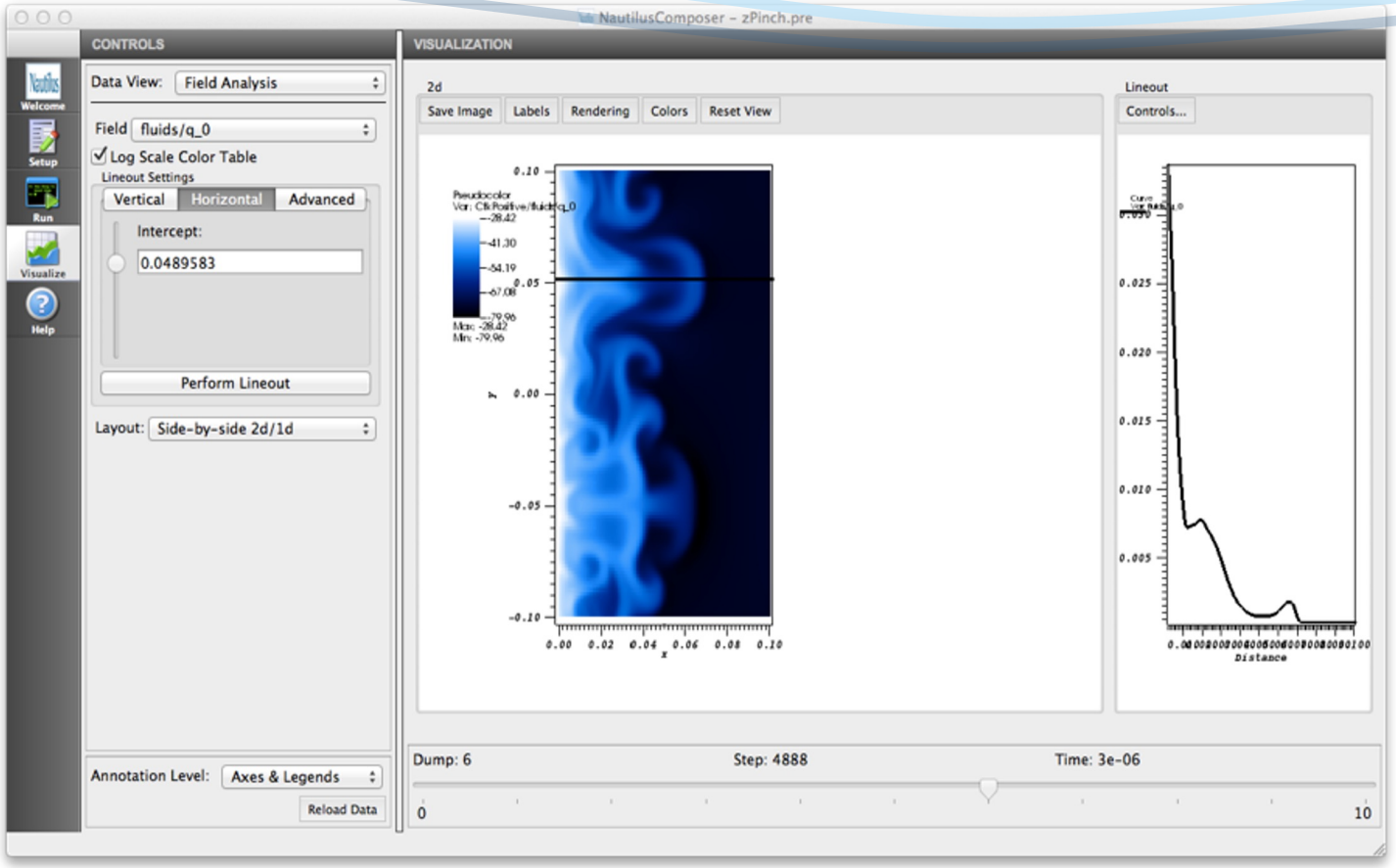

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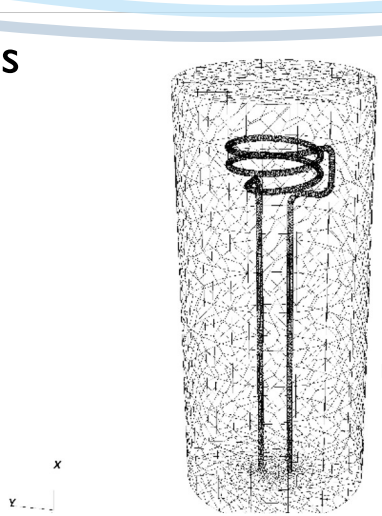
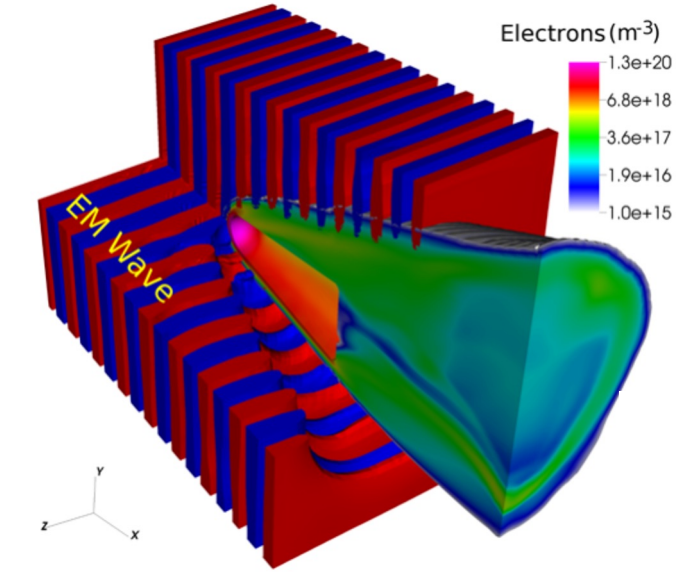
Features of USim

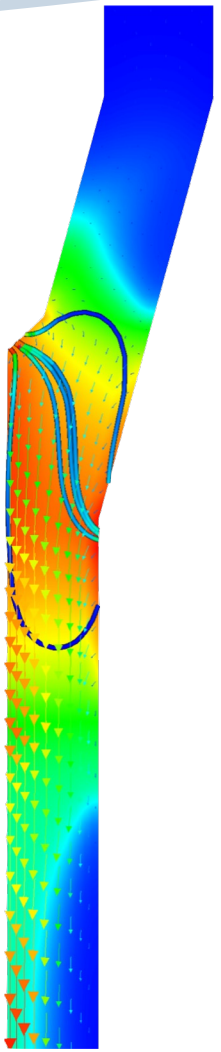
- Ability to simulate spacecraft radio communications blackout in three-dimensions from first principles
- Ability to simulate arc plasma torches on axisymmetric unstructured meshes
- Fast parallel parsing of 3D unstructured meshes using the open-standard ExodusII file format from Sandia National Labs
- Supported meshing formats of ExodusII and Gmsh
- Three-dimensional Poisson solvers that can handle linear, non-linear and anisotropic coefficients
- Two-equation turbulence models for unstructured meshes
- Improved algorithms for magnetohydrodynamics, species collisions, ablation and user defined chemistry tables



Fast 3d unstructured meshes



Radio blackout of reentry vehicle

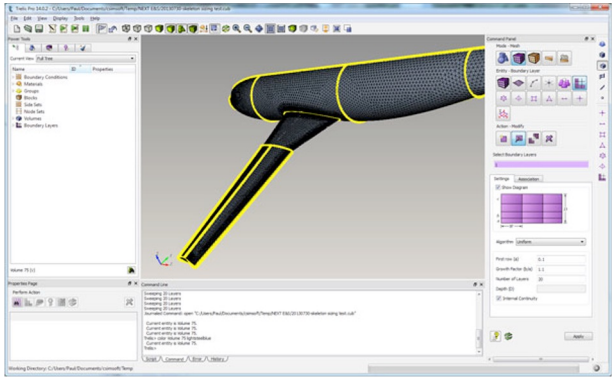


Plasma torches

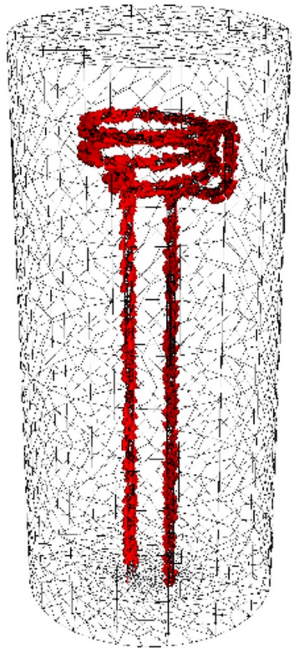
Meshing Capabilities

- USim users have a variety of meshing options:
  - Structured and body-fitted meshes can be generated by built in routines
  - Meshes can be generated using the open-source Gmsh tool and read into Usim
  - Meshes can be generated using commercially available software such as Trelis and Pointwise to export the ExodusII format and read into USim

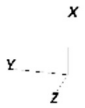
Image Courtesy csimsoft



USim reads meshes generated by Trelis from csimsoft



USim utilizes ExodusII format meshes and boundary data



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