



VSim Tech-X Uses VSim to Win HPC Innovation Excellence Award for Large-Scale Modeling of Fusion Devices



International Data Corporation has announced that Tech-X Corporation is a winner of the [Innovation Excellence Award](#) for the Outstanding Application of HPC Computing for Business and Scientific Achievements.

Scientists at Tech-X Corporation modeled a complex power-loss mechanism that contributes to inefficiencies in the microwave heating of fusion plasmas. This research helped identify when parasitic slow-wave losses near the reactor edge are likely to occur. Detailed simulations of microwave antenna operation in [MIT's Alcator C-Mod fusion experiment](#) were carried out using the VSim software. The simulation animations may be viewed on the [Tech-X YouTube channel's VSim Playlist](#). Such modeling, in addition to augmenting scientific understanding of existing experiments, can be used predictively to explore operation scenarios in future devices.

Physical prototyping of fusion reactor configurations is not financially feasible. The ITER fusion reactor facility, currently under construction in France, is a multibillion-dollar international project with first experiments scheduled in the 2020s. In collaboration with other DOE-funded researchers, Tech-X scientists will use VSim to help develop and refine predictive models for wave-plasma interactions in the reactor core and edge of the ITER experiment.

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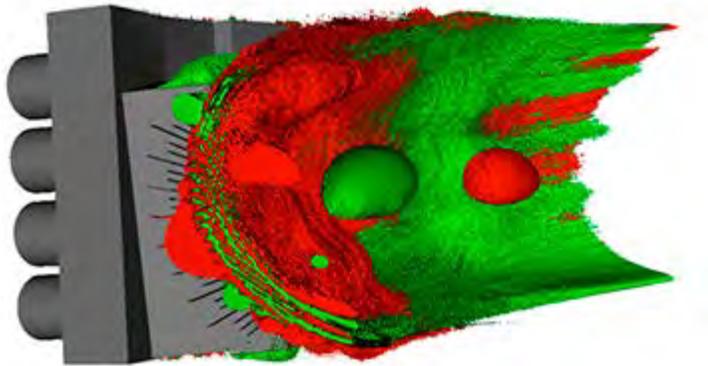
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The same VSim software that runs on HPC supercomputers can be used for commercial, manufacturing, and education applications on out-of-the-box technical workstations and small parallel clusters. [Evaluate VSim for free.](#)



Above: Power is siphoned from the fast waves (large blobs) excited in the reactor core as short-wavelength slow wave structures form near the antenna surface.

Oak Ridge National Laboratory features Tech-X and another group who uses Titan in [Two OLCF Partners Win Major HPC Award for Innovation Excellence.](#)

Content contributed by Tom Jenkins. Contact [David Smithe](#) for more information about VSim.

VSim Tips and Tricks: How to Import CAD Models

1. VSim 7 launched last summer with a new fast mesh generator called VMesh. With VMesh, even large and intricate CAD models can be set up in seconds. Are you using VMesh yet? To invoke VMesh, use the new `fillGeoFastCAD()` macro:

```
fillGeoFastCAD(gridBoundaryName, cadFileName,
dmFrac, shapeComplement, scalingFactor)
```

2. There are some important differences between `fillGeoFastCAD()` and the old `fillGeoCad()` and `voidGeoCAD()` macros.

i. **All-in-One:** You no longer have to call `saveGeoToGridBoundary()` after adding the STL geometry. Everything is self-contained in `fillGeoFastCAD()`.

ii. **Discontinuous Shapes Welcome:** Formerly, if you had multiple distinct models, such as two spheres, VSim required you to add each model separately. Now all models can and should be imported as a single STL file. Note that adding a second STL file will void the first.

Regular

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UPCOMING EVENTS

Tech-X European Users Group Meeting

March, 2015

The next Tech-X European UGM will be held in Daresbury, UK, in March, 2015. Details of exact date, time, and location will be announced at www.txcorp.com and in the next Tech-X Newsletter. Those requiring a letter of support to obtain a travel visa to the UK may contact jonathan.smith@txcorp.co.uk.

Tech-X Will Present at AGU:

**SatelliteDL:
A Toolkit
for Analysis**



**of Heterogeneous
Satellite Datasets**

December 16, 2014

Michael Galloy will attend the 2014 AGU Fall Meeting, where he will present "SatelliteDL: a Toolkit for Analysis of Heterogeneous Satellite Datasets" on Tuesday, December 16, in session IN23D.

ANNOUNCEMENTS

Tech-X Wins Prestigious HPC Innovation Excellence Award

Tech-X has been awarded the [Innovation Excellence Award](#) for the Outstanding Application of HPC Computing for Business and Scientific Applications. Our VSim software is being used to [develop and refine predictive models](#) of the ITER experiment. The same VSim software that runs on HPC supercomputers runs on technical workstations and small parallel clusters.

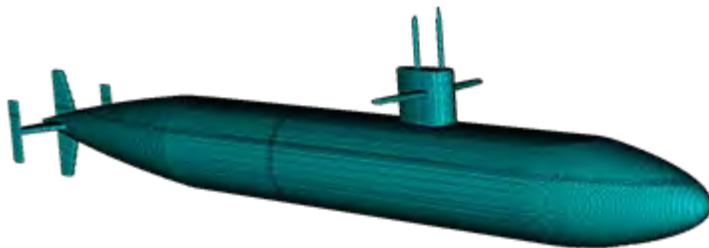
PUBLICATIONS

King, J. R., and S. E. Kruger. "A parametric study of the drift-tearing mode using an extended-magnetohydrodynamic model." *Physics of Plasmas* (1994-present) 21.10 (2014): 102113. <http://dx.doi.org/10.1063/1.4899036>

T. G. Jenkins and D. N. Smithe, "Benchmarking sheath subgrid boundary

iii. **To Fill or to Void?** That is no longer a question. Fill versus void is determined by the value of the `shapeComplement` argument. Flipping the value of `shapeComplement` between `True` and `False` reverses the orientation of the surface normals. Thus, `shapeComplement` controls whether you wind up with a solid metal model in a vacuum-filled universe or a hollow model carved out of a metal-filled universe.

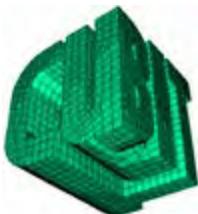
3. STP Files may also be imported, albeit indirectly. Open a visual-based setup and import the STP file through the GUI. VSim will automatically convert the STP file to STL format and generate the commands to import the new STL file.



Above: Example of a CAD model loaded into VSim using VMesh.

Article content contributed by James McGugan. Contact David Smithe for more information about VSim.

USim 2.0 Enhanced Meshing Capabilities



With USim, physics models can be solved on both structured and unstructured meshes in multiple dimensions within Cartesian, spherical, and cylindrical coordinate systems. Different fluid and EM solvers can be used on these meshes to solve different physical models, including Ideal MHD, Two-Temperature Single-Fluid MHD, and Multi-Fluid models coupled to full-wave EM solvers. Simulation validation, execution, and visualization are all easily accessible from within USim's graphical user interface.

USim 2.0 users can import meshes stored in the open-source Gmsh and ExodusII formats. The ExodusII format

conditions for macroscopic-scale simulations," accepted at Plasma Sources Science and Technology, October 2014.

Dominic Meiser, "Ultra-stable Light Sources for Optical Atomic Clocks in Space" (white paper), May 12, 2014.

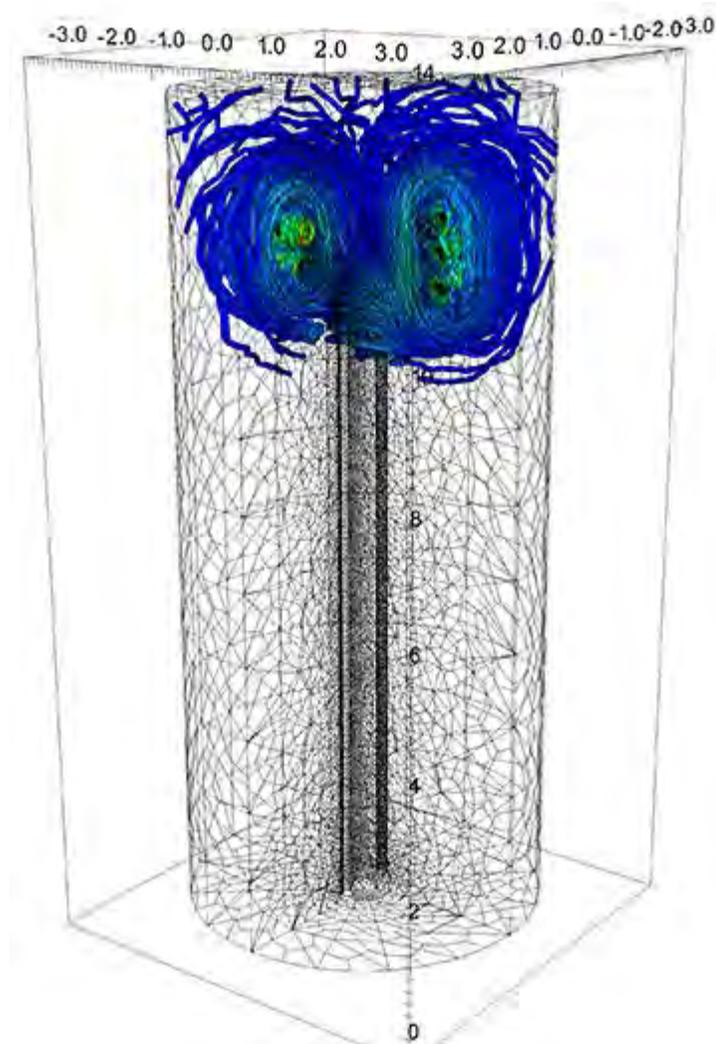
Dominic Meiser, "Ultra-stable Light Sources for Optical Atomic Clocks in Space" (seminar video), National Reconnaissance Office TechSeminar Series, October 2, 2014. Companion slide deck.

CONNECT WITH US



enables fast, parallel processing of high resolution 3D unstructured meshes. The ExodusII format is supported by tools such as [CUBIT](#) from Sandia National Laboratories (available to Federal employees and contractors) and [Trelis](#), a commercial mesh generation tool from csimsoft. The USim development team is currently extending USim mesh import capabilities to include [NASTRAN](#), [Abaqus](#), [VTK](#), and [Tetgen](#) format mesh files, as well as other formats.

[Evaluate USim for free.](#)



Above: Magnetic field structure for the Spallation Neutron Source's H-Ion Source created with USim 2.0 using a combination of Jacobian-Free Newton-Krylov solvers and finite volume discretizations on unstructured meshes. The source antenna geometry is generated parametrically in STL file format, and then the unstructured computational mesh is generated by the Trelis mesh tool from csimsoft. The mesh is imported into USim 2.0 using the built-in ExodusII reader.

Article content contributed by Seth Veitzer. Contact [Kris](#)

Beckwith for more information about USim.

GPULib Using Multiple GPUs with GPULib: Coordinating Multiple GPULib Sessions in IDL

While [GPULib](#) can use only a single graphics processing unit (GPU) to accelerate the results from one [IDL](#) session, multiple GPULib sessions can be coordinated to make use of all the GPUs available on a system. One way to perform this coordination is to use [mpiDL](#), part of the [FastDL](#) suite of high-performance computing libraries for IDL. [mpiDL](#) provides bindings for an [MPI](#) library for use with IDL.

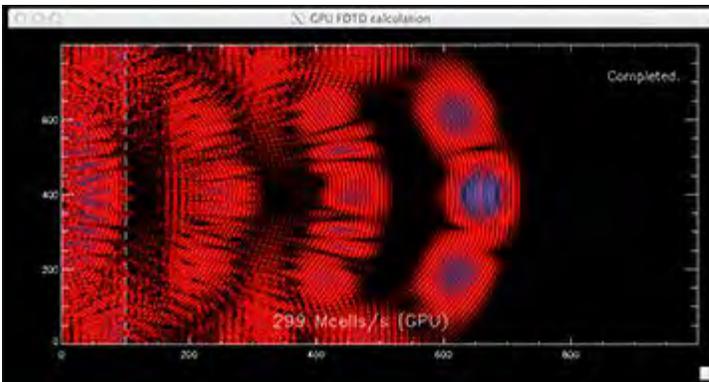
The GPULib distribution includes an example of how to use [mpiDL](#) to coordinate multiple GPULib sessions that each handle a portion of a finite-difference time-domain (FDTD) simulation. This example uses the MPI API available from [mpiDL](#) to pass the results of the boundary cells to adjacent domains. Developers familiar with the MPI API should find it easy to use the same calls from within IDL to send and receive results to and from neighboring domains:

```
newbuf = mpidl_irecv(count=cnt, source=rank_up,
tag=42L, /float, request=request)

mpidl_send, buf, dest=rank_down, tag=42L

status = mpidl_wait(request)
```

A simpler task farming library, [TaskDL](#), is also available in [FastDL](#). It is useful for tasks that do not require the interprocess communication provided by [mpiDL](#). [TaskDL](#) can also be used to access multiple GPUs.



Above: GPU FDTD Calculation

Contact [Michael Galloy](#) for more information about [GPULib](#) or [FastDL](#).

VSim October Training Focused On Custom Visualization, Advanced Macro Development, and Circuit Modeling

Tech-X held a training session on October 22nd and 23rd with a customer one-on-one session on Friday, October 24th. The training was presented by James McGugan. Talks addressed advanced VSim usage such as custom visualization, presented by Tom Jenkins (winner of the [HPC Innovation Excellence Award](#)); advanced macro development, presented by Seth Veitzer (see Seth's article on [USim 2.0 Meshing](#)); and circuit modeling, presented by Sean Zhou. We thank all of the participants for their attention and feedback.

If you would like a custom training session, including on-site training, contact [Tech-X Sales](#) for a quote. For reference, here is the schedule from the October 2014 training:

| VSim October 2014 Training Schedule | |
|--|---|
| October 22 (Wednesday) | |
| 9:00 A.M. - 10:00 A.M. | Overview of VSim including new features |
| 10:00 A.M. - 10:30 A.M. | VSim Installation |
| 10:30 A.M. - Noon | Running New>>From Example (coax) Running New>>Visual Setup Example a. DishAntenna Example b. Import XWing |
| Lunch | |
| 1:30 P.M. - 2:30 P.M. | Running Text Based Example (PlaneWave) |
| 2:30 P.M. - 3:30 P.M. | Further example development a. New>>Text Based Setup: Create emPlaneWave with macros b. Particles in VSim for Microwave Devices i. Run coaxNoParticles.pre ii. Add particles by hand to create coax.pre |

| | |
|------------------------------|--|
| | c. Electrostatics |
| 3:30 P.M. - 4:30 P.M. | Overview of existing Analysis scripts |
| 4:30 P.M. - 5:00 P.M. | Q&A |
| October 23 (Thursday) | |
| 9:00 A.M. - 10:00 A.M. | VSim for Plasma Discharges Development: Electrostatics Continued and Boundary Conditions. |
| 10:00 A.M. - 11:00 A.M. | Writing your own Analysis scripts |
| 11:00 A.M. - Noon | Advanced Visualization |
| Lunch | |
| 1:30 P.M. - 2:00 P.M. | External Circuit Modeling |
| 2:00 P.M. - 2:30 P.M. | Roadmap |
| 2:30 P.M. - 5:00 P.M. | User Questions, Simulations, and Feedback |

Article content contributed by Scott Kruger and James McGugan. Contact [Tech-X Sales](#) for more information about VSim training.

VSim Tech-X Presents VSim Capabilities for the Simulation of Low-Temperature Plasmas at 67th Annual Gaseous Electronics Conference



Dr. Tom Jenkins recently presented an overview of ongoing enhancements to VSim's Plasma Discharge package at the 67th Annual Gaseous Electronics Conference in Raleigh, North Carolina. He discussed maturing VSim capabilities for the simulation of low-temperature plasmas, including

improved tools for plasma chemistry, species energy/angular distribution function visualization, and material interactions such as sputtering and secondary electron emission. In addition, Dr. Jenkins demonstrated the use of a newly developed subgrid sheath boundary condition [T. G. Jenkins and D. N. Smithe, "Benchmarking sheath subgrid boundary conditions for macroscopic-scale simulations," accepted for publication in Plasma Sources Science and Technology, October 2014]. This boundary condition, which was validated via explicit PIC modeling of sheath formation and evolution near antenna surfaces, eliminates the need to resolve space and time scales associated with such sheaths in macroscopic simulations. The boundary condition enables the inclusion of kinetic sheath effects in large-scale VSim simulations of field-aligned ICRF antenna operation in the Alcator C-Mod fusion experiment.

Content contributed by Tom Jenkins. Contact [David Smithe](#) for more information about VSim.

TECH-X Ultra-Stable Light Sources for Optical Atomic Clocks in Space Presentation at National Reconnaissance Office

Optical atomic clocks are now approaching stabilities of 1 part in 10^{18} . Such levels of stability enable many new applications in navigation; geodesy; tomography of man-made and natural structures (e.g., bunkers, oil and gas reservoirs, ground water, minerals) below the surface of the earth; quantum communication and metrology; and precision metrology.



Dr. Dominic Meiser from Tech-X gave a talk at [NRO](#) about a new light source for the next generation of optical atomic clocks. This laser promises to deliver light with a linewidth of 1mHz or smaller, corresponding to a quality factor greater than 10^{18} . In addition, this light source relies on atomic properties rather than the characteristics of man-made reference cavities which are the basis of currently used approaches. The new light source is therefore more robust against environmental perturbations and is potentially easier to deploy on a spaceborne vehicle.

Watch the full talk. See the [white paper](#) and companion slide deck.

Article content contributed by Dominic Meiser.

TECH-X Modeling Electron Emission and Surface Effects from Diamond Cathodes Presentation at Lawrence Berkeley National Laboratory



Dr. Dimitre Dimitrov from Tech-X gave a presentation on Modeling Electron Emission and Surface Effects from Diamond Cathodes at the Lawrence Berkeley National Laboratory P3 Photocathode Physics for

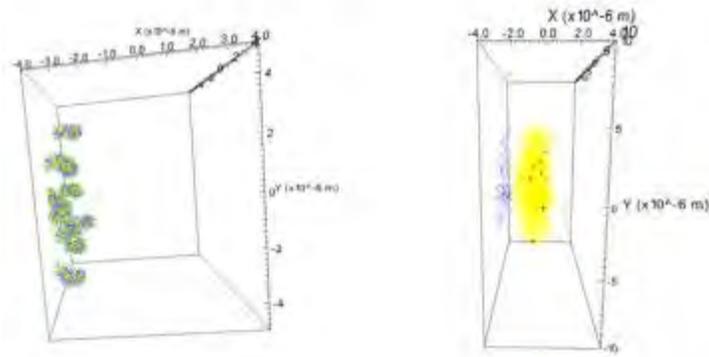
Photoinjectors Workshop on November 3, 2014.

A new diamond-amplified cathode was proposed to enable high quantum efficiency sources with long lifetime, high-brightness, and low emittance electron beams.

Experiments have already demonstrated the potential of the concept together with valuable other applications of diamond for advanced x-ray detectors. However, better understanding of observed surface properties affecting emission is needed to determine optimal designs for different applications. Simulations provide an efficient way to explore relevant parameter regimes and to model different properties in order to better understand the experimental data.

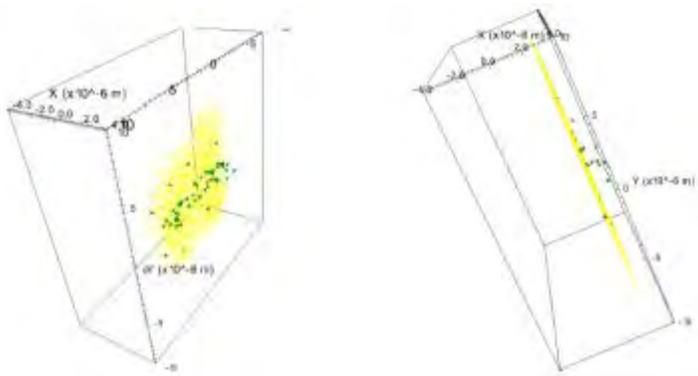
In his talk, Dr. Dimitrov explained that modeling capabilities were developed within the Vorpal (VSim engine) particle-in-cell code, for three-dimensional (3D) simulations of surface effects and electron emission from semiconductor photocathodes. These capabilities included calculation of emission probabilities using general, piece-wise continuous, space-time dependent surface potentials, and effective mass and band bending field effects. These models were applied, in combination with previously implemented capabilities for modeling charge generation and transport in diamond, to investigate the emission dependence on applied electric field in the range from approximately 2 MV/m to 17 MV/m along the [100] direction. The simulation results were compared to experimental data. For the parameter regime under consideration, conservation of transverse electron momentum (in the plane of the emission surface) allows direct emission from only two (parallel to [100]) of the six equivalent lowest conduction band valleys. When the electron affinity is the only parameter varied in the simulations, the value 0.31 eV leads to overall qualitative agreement with the probability of emission deduced from experiments. Including band bending in the simulations improves the agreement with the experimental data, particularly at low applied fields, but not significantly.

Using surface potentials with different profiles further allows us to investigate the emission as a function of potential barrier height, width, and vacuum level position. However, adding surface patches with different levels of hydrogenation, modeled with position-dependent electron affinity, leads to the closest agreement with the experimental data.



Above: Visualization of particle data from steps 1 and 2 of the 3-step model implementation for diamond.

Below: Electron emission can be modeled from diamond surfaces with non-uniform electron affinity.



[View the presentation.](#)

Article content contributed by Dimitre A. Dimitrov.

 **TECH-X** In the
Community

Tech-X is an active participant in the physics, engineering, supercomputing, research, and educational communities. We are proud to support the future of science and technology by sponsoring events that promote the exchange of knowledge and encourage the next generation of scientists and engineers.

TECH-X Tech-X Arranges Particle Accelerator Workshop

Tech-X UK and Dundee University helped to arrange an Institute of Physics topical workshop on novel materials and nanostructures for particle accelerators at the [Cockcroft Institute](#). The workshop was generously co-funded by [STFC/ASTeC](#) and the Cockcroft Institute. On October 28th and 29th, thirty physicists from all over the UK attended. Participants ranged from new PhD students to recently retired physicists.

A variety of topics were covered, including dielectric wakefield accelerators, photonic devices and metamaterials in novel acceleration schemes, and dark current suppression. The workshop also touched on the use of periodic structures with accelerated beams to produce THz radiation. A poster session was presented describing other decorative uses of the same nanostructuring technology. Tech-X UK gave a talk on novel algorithms for dielectric accelerators for improved accuracy and speed. Other presentations discussed practical matters and prototyping, as well as new theoretical concepts.



Above: Workshop participants. Dr. Jonathan Smith, front row, third from left. (Photo credit: [STFC](#).)

Article content provided by Jonathan Smith. Those interested in engaging with this community should contact jonathan.smith@txcorp.co.uk.

TECH-X Life After Grad School



University of Colorado **Boulder**



On November 5, 2014, Dr. Dominic Meiser gave a talk at JILA at the University of Colorado, Boulder on transitioning from academia to industry. The talk and subsequent

discussion gave graduate students an idea of the differences between working in industry and at a university, as well as some advice for how to go about finding a job in industry.

Article content contributed by Dominic Meiser.

TECH-X Hosts Denver APS Meeting



The [Denver APS Local Link](#) is a networking initiative aimed at developing mutually beneficial links between academia and industry in the greater Denver and Boulder areas.



Eric Evarts of [NIST Boulder](#) gave a talk on his career path and role as a physicist at NIST.

Article content from APS Local Link Denver.