TECH-X

VSim USim GPULib

SIMULATIONS EMPOWERING YOUR INNOVATIONS

Tech-X at Photonics West

VSim

SPIE. PHOTONICS WEST — SPIE is the international society for optics and photonics.
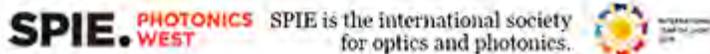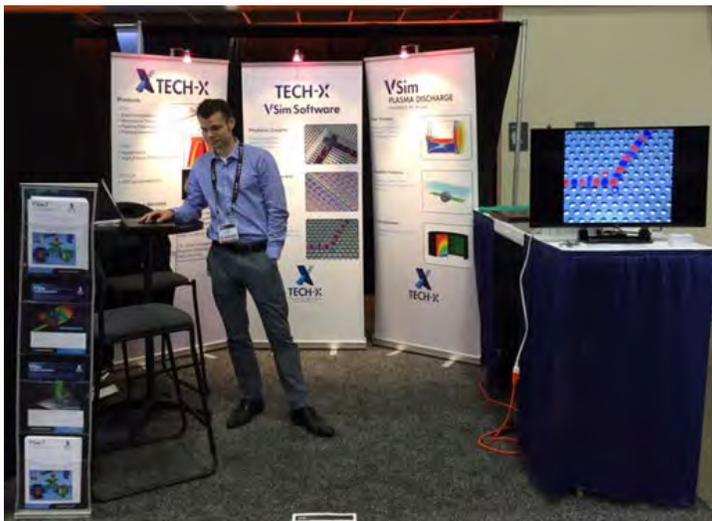
Tech-X CEO Professor John R. Cary and scientist Dr. Ben Cowan, along with Application Engineer James McGugan, attended the Photonics West Conference in San Francisco from February 8 - 12. SPIE Photonics West is the industry's leading laser, photonics, and biomedical optics conference.

Above: Tech-X AE James McGugan prepares the Tech-X booth for Photonics West conference attendees.

In this Issue

News

Below: Tech-X CEO Prof. John R. Cary with VSim customer at Photonics West conference.

Photographs contributed by Ben Cowan. Contact David Smithe for more information about VSim.

VSim Tips and Tricks: Conditional Logic in VSim

VSim

Want to make your input files more versatile? Here's all the conditional logic supported by the VSim preprocessor:

- **IF/ELSE**

Example:
```
$ if equalStrings(MATERIAL,rubber)
    $ RELPERM = 7.0
$ else
```

Regular Features

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Upcoming Events

March 8 - 10, 2015: Tech-X VSim European Users Meeting and Training
The next Tech-X VSim European User Meeting and Training will be held in Daresbury, UK, in March, 2015. Agenda and Early Bird Reduced Rate Registration available now. Those requiring a letter of support to obtain a travel visa to the UK may contact jonathan.smith@txcorp.co.uk.

March 16-18, 2015: Tech-X Will Present at the International Sherwood Fusion Theory Conference
Tech-X scientists will attend the International Sherwood Fusion Theory Conference hosted by the Courant

```
    RELPERM = 1.0
$ endif
```

*Note: There is **no ELIF statement.***

- **WHILE**

  Example:

  ```
  $ i = 0
  $ while i < NCAVITIES
      $ CAVITYSTART = CAVITYSTART +
  CAVITY WIDTH + CAVITYGAP
      $ CAVNAME =
  concatenate(CAVITY,i)
      fillGeoExpression(CAVNAME,
  cavity(x, y, z, CAVITYSTART) )
      $ i = i + 1
  $ endwhile
  ```

  *Note: There is **no DO/WHILE statement***

- **FOR** statements are NOT supported! So don't use them!

- **Test Logic Syntax:**
    - For **Numbers**, use

      `<, >, <=, >=, !=, ==`

    - For **Strings**
      Do use the `equalStrings(stringA, stringB)` macro. It is part of `listUtilites.mac`.
      Do not use numeric tests:
      `$ if MATERIAL == 'rubber"`
      will always evaluate to `False`. To negate the value of a Boolean you can type "`not`" before it.

Institute at New York University from March 16-18, 2015. Tech-X will present the following research:

- D. N. Smithe, "Towards simulations with self-consistent SOL density evolution when RF antennas are powered"
- T. G. Jenkins, "NIMROD modeling of sawtooth modes using continuum and hot-particle closures"
- J. R. King, "New extended-MHD drift-tearing mode dispersion relations: implications and a tool for code verification"
- S. E. Kruger, "Edge harmonic oscillation studies with the NIMROD code"

April 27-29, 2015: Tech-X Will Attend the 21st Topical Conference on Radiofrequency Power in Plasmas
Tech-X scientists will attend the [21st Topical Conference on Radiofrequency Power in Plasmas](#) hosted by the University of California-Los Angeles from April 27-29, 2015. Dr. Thomas G. Jenkins will present an invited talk, "High-Performance FDTD Simulations of C-Mod and ITER RF antennas," at the conference.

Announcements

Example:
```
$ if equalStrings(MATERIAL,
rubber)
    $ print "Material is
rubber"
$ endif
```

- ○ **NOT**
  Only applies to Booleans.

  Example:
  ```
  $ if not
  equalStrings(MATERIAL, wood)
      $ print "Material is not
  wood"
  $ endif
  ```

- **PRINT**

  To print to the output window, just type `$ print` and then your string. The concatenate(stringA, stringB) macro will be helpful for formatting whitespace. It can be found in the listUtilites macro file. Note that the print statements go to the preprocessor output (the bottom pane in the Setup window), not the Run Log.

  Example:
  ```
  $ UPDATESTEPNAME =
  concatenate(updateFoo, Step)
  $ MESSAGE = "Step Name = "
  $ PRINTSTATEMENT =
  concatenate(MESSAGE,
  UPDATESTEPNAME)
  $ print PRINTSTATEMENT
  ```

  Output:

Recent Publications

Dimitrov, D. A., Smithe, D., Cary, J. R., Ben-Zvi, I., Rao, T., Smedley, J., & Wang, E. (2015). [Modeling electron emission and surface effects from diamond cathodes.](#) *Journal of Applied Physics*, *117*(5), 055708. [Read the paper's Abstract](#) and download for free (limited time download availability).
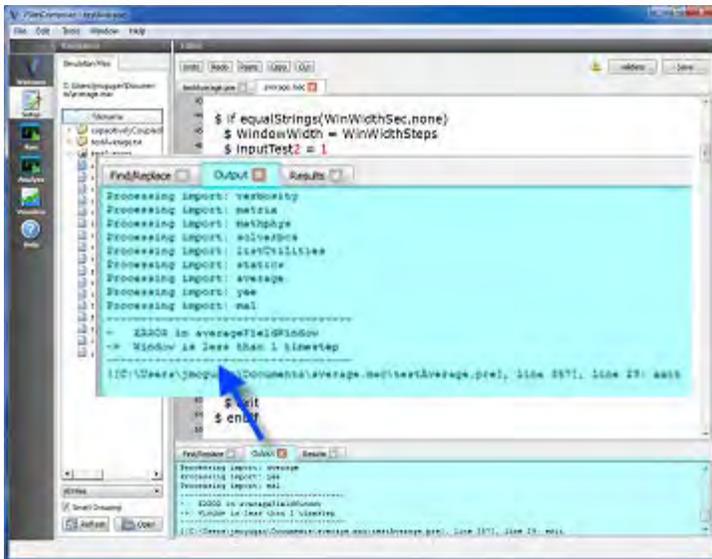
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```
Step Name = updateFooStep
```

Notice how there is no white space in the first concatenation but there is a white space in the second.

Above: Detail of statements appearing in preprocessor output area of the bottom pane.

- **WRITE**
  The write statement operates very similarly to the print statement except that the output is written to a file "`writeBlock.py`" instead of the Setup window output pane. The `writeBlock.py` file will appear in the simulation directory and can be opened in VSimComposer.

  Example:
  ```
  $ write
          PRINTSTATEMENT
  $ endwrite
  ```

  As many items may be included in the write block as you wish.

- **EXIT**
  Just type `$ exit` anywhere in a file to immediately stop the preprocessor at that

line. Use this when checking for bad user
input.

Example:
```
$ if WindowWidth < 1
    $ print "------------------
----------------"
    $ print "-   ERROR in
averageFieldWindow"
    $ print "->  Window is less
than 1 timestep"
    $ print "------------------
----------------"
    $ exit
$ endif
```

[Evaluate VSim for free]().

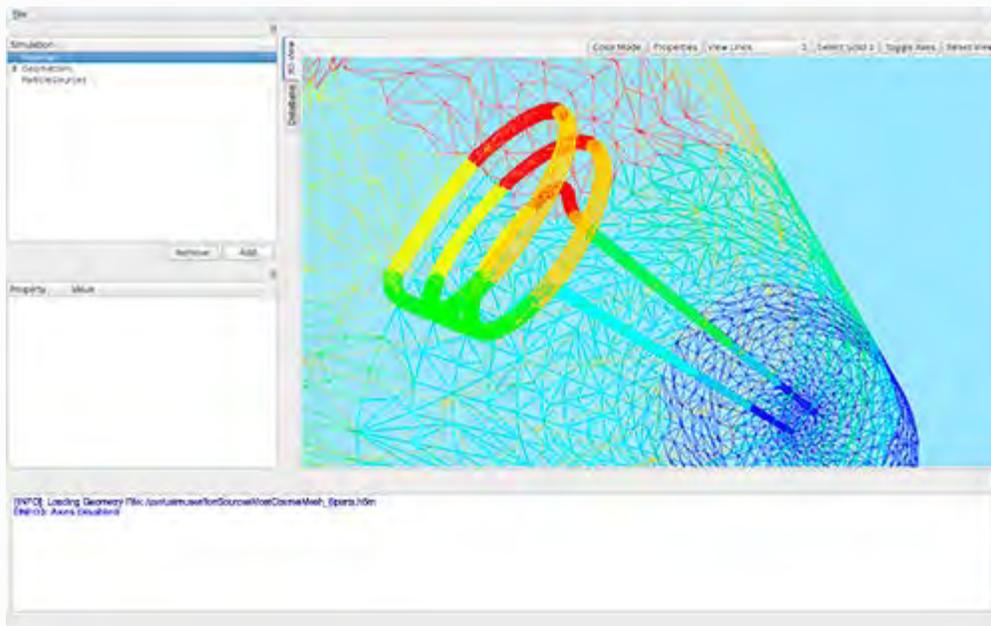Article content contributed by James McGugan. Contact [David Smithe]() for more information about VSim.

Improved Unstructured Mesh Import Capabilities Coming for USim 3.0

USim

For USim 3.0, mesh import capabilities will be extended to include NASTRAN, Abaqus, VTK, and Tetgen format mesh files, as well as other formats. USim 3.0 will also include the ability to manipulate the mesh through the USim graphical user interface; these capabilities will include the ability to partition the mesh for a parallel run within the USim GUI. In addition, basic mesh analysis options will allow the user to assess the quality of the supplied mesh for commonly used physics operators such as divergence, diffusion and gradient. Look for more information about the 3.0 release of USim in future Tech-X Newsletters.

[Evaluate USim for free]().

Above: Parallel partitioning of a hexahedral unstructured mesh for modelling of the Spallation Neutron Source H-Ion Source, displayed within a prototype of the USim graphical user interface.

Article content contributed by Kris Beckwith. Contact [Kris Beckwith](#) for more information about USim.

GPULib 1.8 Released

GPULib

[GPULib 1.8](#) has been released with updates to the underlying libraries as well as many other features in many areas of the library. GPULib has been updated to use the most recent versions of IDL and CUDA, IDL 8.4, and CUDA 6.5. The new features include:

- Support for integer data types, including all the numeric types provided by IDL. For example, you can now do: `dx = gpuIndgen(10)`

- Added `GPUREPMAT` routine. This is a handy routine to create a new array by repeating a 2-dimensional array in a grid.

- Added `GPUCREATEKERNEL` routine to create the source code of a simple kernel. This is a code generation routine that can be loaded with `GPULOADMODULE`/`GPULOADFUNCTION` and executed with `GPUEXECUTEFUNCTION`.

- Added `GPUFINITE` routine similar to IDL's library routine.

- Added linear algebra routines `GPULUDC`, `GPULUSOL`, and `GPULEAST_SQUARES`. This fills out more of the GPU equivalent of the convenience routines provided by IDL so that the LAPACK interface of MAGMA is not required to perform linear algebra computations.

- Added support for `RHO` and `THETA` keywords in `GPURADON`.

- Added `GPUMEAN` routine. This routine has `DIMENSION` and `NAN` keywords with the same functionality as IDL's library routine.

[Buy GPULib online.](#)

Article content contributed by Mike Galloy. Contact Tech-X Sales for more information about [GPULib](#).

**Tech-X European VSim Users Meeting and Training
Early Bird Reduced Fee Registration Open**

VSim

The Tech-X European VSim Users Meeting is a fantastic opportunity to network with and share tips and tricks with researchers tackling similar challenges.

The 2015 meeting will feature last year's successful mix of:

- Talks contributed by the VSim user community
- Talks from Tech-X's own subject matter experts
- Demonstrations of the latest VSim features
- Training

[Check out the agenda and register.](#)

Contributions are being accepted. [Contact Dr. Jonathan Smith for details.](#)

For more information about the meeting and training, please [contact EVUM organizer](#) Jonathan Smith of Tech-X UK Ltd.

Tech-X and General Atomics Collaborate on Quiescent H-mode experiments on the DIII-D Tokamak

Dr. Jacob King visited [General Atomics](#) in San Diego, CA to collaborate on modeling of quiescent H-mode experiments on the [DIII-D tokamak](#). These observed quiescent states, which are free from deleterious macroscopic instabilities, are a potential operating mode for a burning-plasma tokamak that produces net fusion energy. In particular, studies are interested in the applicability of this state to the next-generation international tokamak, [ITER](#), currently being built in Cadarache, France. This work is sponsored by the [US Department of Energy's Office of Science](#).

Content contributed by Jacob King.

Tech-X Wins DOE Grants

Some of the DOE Grants recently awarded to Tech-X include those for the following projects:

Multi-Scale Modeling for Beam-Beam Depolarization

Spin is a fundamental property of nuclear matter, but its origin remains mysterious. Elucidating this mystery ---among the most important open

questions in nuclear physics---will require highly polarized beams in an electron-ion collider. This project will develop the advanced simulation capabilities needed to understand how to maintain high polarization in the face of various depolarizing mechanisms that occur at multiple scales.

Modeling Electron Emission and Surface Effects of High Quantum Efficiency Photocathodes

High Quantum Efficiency (QE) photocathodes are needed for next generation Free Electron Lasers (FEL), linear accelerators, and for commercial photocathode applications. Measurements of semiconductor photocathodes have demonstrated the potential to generate electron beams with the high repetition rate and QE required for FEL and next generation light source applications. In this project, we aim to develop high-fidelity simulation capabilities to enable detailed understanding of the physics of electron emission from rough surfaces that affect QE dynamics, response time, and dark current properties of photocathodes.

Simulation Tools for Heavy Ion Beam Charge Strippers

A major new facility for the Department of Energy Office of Nuclear Physics is the Facility for Rare Isotope Beams (FRIB). FRIB will accelerate heavy ion beams (up to uranium) to energies as high as 200 MeV/u and with powers as high as 400 kW in a few mm diameter. Accelerating the ion beam to its final energy requires less voltage if the beam is in a higher charge state. Therefore researchers have included charge strippers in the FRIB accelerator design. For this work, Tech-X researchers will implement new computer models into the commercial plasma fluid modeling tool, USim. By providing FRIB researchers an experimentally validated simulation tool, Tech-X will help FRIB researchers determine whether gas jet strippers represent a viable alternative to solid foils strippers, thereby reducing risk in the FRIB design.

Article content contributed by Dan T. Abell, Dimitre A. Dimitrov, and Peter Stoltz.

Free Paper Download: Modeling Electron Emission and Surface Effects from Diamond Cathodes

X TECH-X

Abstract from Dimitre A. Dimitrov's paper from work regarding diamond amplifiers and general development of emission models:

We developed modeling capabilities, within the Vorpal particle-in-cell code, for three-dimensional simulations of surface effects and electron emission from semiconductor photocathodes. They include calculation of emission probabilities using general, piece-wise continuous, space-time dependent surface potentials, effective mass, and band bending field effects. We applied these models, 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 considered parameter regime, 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 χ is the only parameter varied in the simulations, the value χ = 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.

[Download this paper for free.](#) Free download available for a limited time.

Article content contributed by Dimitre A. Dimitrov.