



# **Cad4g: Bringing CAD and GUI to Geant4**

- **TECH-X PROJECT**
- **IMPROVING CAD AND TESSELLATIONS IN GEANT4**
- **IMPROVING GUI FOR GEANT4**
- **WHAT IS NEEDED?**

**John R Cary**  
**CEO, Tech-X**  
**Prof. Physics, U. Colorado**

**Cory Perry**  
**Svetlana Shasharina**  
**...**



## TECH-X Geant4: powerful tool

- Apologies for lack of knowledge
- Geant4 is obviously very powerful
- The team collaborates very well
- Great attention to software quality
- Is there room for any work?



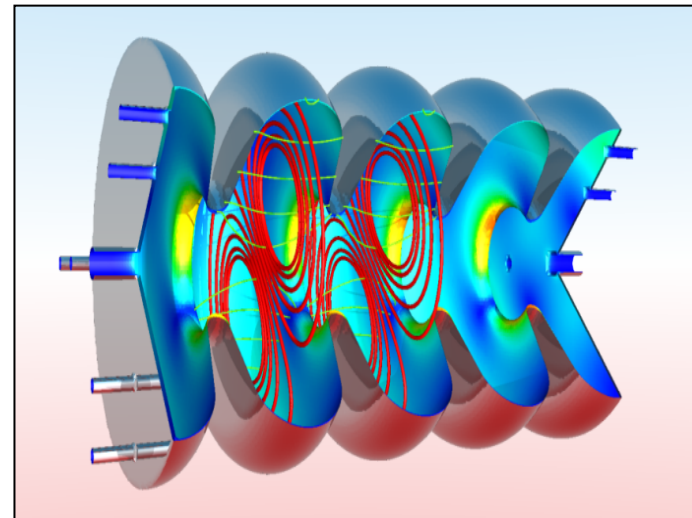
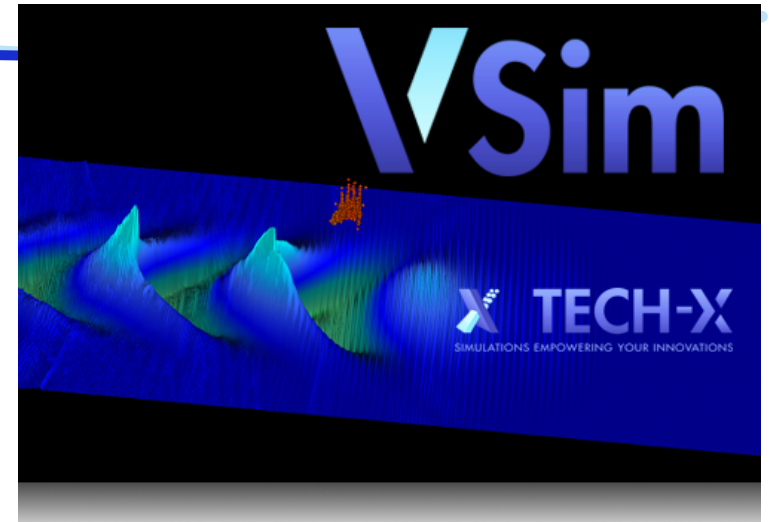
## Tech-X: Boulder, CO software company specializing in scientific/engineering

- High-performance computational software for research and engineering simulation and design
  - ◆ VSim: EM, Plasma
  - ◆ USim: Multiphysics, interacting fluids
- Enhancing code performance through porting to modern hardware (GPUs, MIC)
- High-performance visualization and graphical user interfaces
- Middleware for systems integration and real time data distribution



# TECH-X VSim: multiphysics simulations

- VSim for Electromagnetic solutions
  - ◆ Antennas
  - ◆ Accelerator cavities
  - ◆ Photonic devices
- VSim for Microwave Devices
  - ◆ S-parameters
  - ◆ Multipacting
- VSim for Plasma Discharges
  - ◆ Plasma processing
  - ◆ Plasma medical devices
- VSim for Plasma Accelerator
  - ◆ Laser-plasma wakefield acceleration
  - ◆ Beam-plasma acceleration





## Tech-X received DOE SBIR Phase I to improve CAD, engineering front end for G4

1. Develop a Geant4 solid that makes use of the Oblique Bounding Box algorithm
2. Augment the Tech-X GUI base classes to allow setting of incoming particle distribution
3. Determine an optimal method for writing out the data needed for a Geant4 simulation
4. Determine an approach for launching Geant4 from within the GUI

# But why, when there are competitors?

- Competitors
  - ◆ Comm
    - FastRAD; RadChek (US version of FastRAD, Ridgetop Group)
    - STEP-Tools
  - ◆ Non-comm
    - Geant4 itself (Makoto GUI,)
    - REST (?) from ESA (integrated environment and CAD import)
    - STL->solid converter (Australia)
- Is there room for a GUI front end dedicated to engineers?



# Develop a Geant4 solid that makes use of the Oblique Bounding Box algorithm

Phys Med Biol. 2013 Jul 7;58(13):4595-609. doi: 10.1088/0031-9155/58/13/4595. Epub 2013 Jun 14.

## **DagSolid: a new Geant4 solid class for fast simulation in polygon-mesh geometry.**

Han MC<sup>1</sup>, Kim CH, Jeong JH, Yeom YS, Kim S, Wilson PP, Apostolakis J.

with many facets than for simple geometries. The maximum difference of computation speed was 1562 and 680 times for Geantino and ChargedGeantino, respectively. For real particles (gammas, electrons, neutrons, and protons), the difference of computation speed was less significant, but still was within the range of 53-685 times depending on the type of beam particles simulated.

- Funded by NASA (JSFC)
- PI: Paul Wilson (U Wisc)
- DagSolid: Unite multiple MC tools (Fluka, MCNP, G4, OpenMC)
- <https://github.com/svalinn/DAGMC>

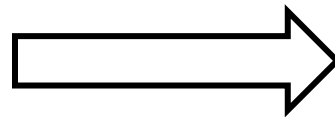
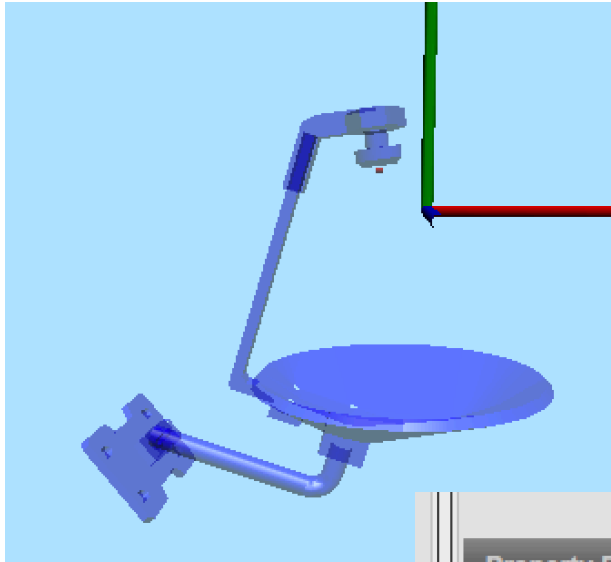


## Augment the Tech-X GUI base classes to allow setting of incoming particle distribution

- CAD import
- Set sources in place
- Show simulation results in context of geometries

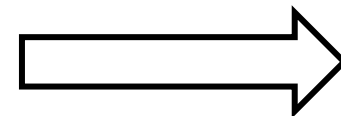


# Determine an optimal method for writing out the data needed for a Geant4 simulation



GDML

Property	Value
visibility	1
xMax	-0.0775
xMin	-0.09
yMax	0.075
yMin	0.065
zMax	0.025
zMin	0.0125
Jx(x,y,z,t)	cos(75.4e9*t)
Jy(x,y,z,t)	
Jz(x,y,z,t)	sin(75.4e9*t)
kind	BoxAntenna



GPS



# Determine an approach for launching Geant4 from within the GUI

- Launch translator
  - ◆ Get one or more stl files or? (MOAB?)
  - ◆ Get macro file with particle sources embedded?
- Launch executable
  - ◆ Make relocatable
  
  - ◆ What is the application?
    - What physics
    - What ???



# What would help the G4 collaboration and broaden usage of G4?

- Limitations
  - ◆ Provide all physics modeling capabilities back to collaboration
  - ◆ GUI code is proprietary, but provide gratis to collaborators
- Possibilities
  - ◆ Ensure merge of dagsolid
  - ◆ DragNDrop setting of materials
  - ◆ Pull-down lists for assembling physics lists
  - ◆ Materials combining
  - ◆ Distributed memory results assembly
  - ◆ ???