A Tool to Convert CAD Models for Importation into Geant4

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on behalf of
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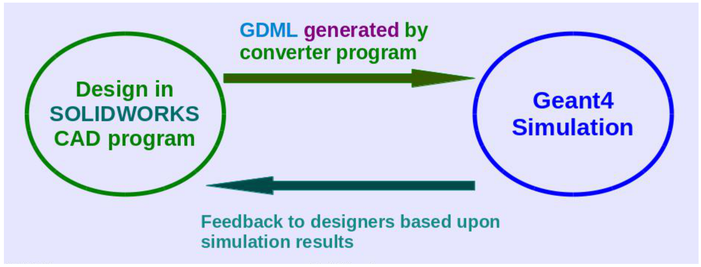
Problem:
How can a detector design in a CAD program be transferred into a Geant4 simulation?

Solution:
Automated conversion of the CAD design into GDML for importation into Geant4

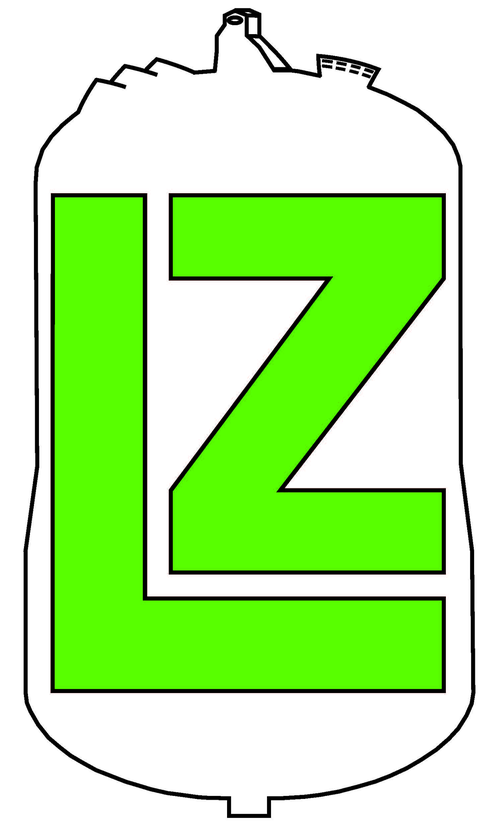
Iterative Design Process



SW2GDML is a software tool that reads a detector design in SOLIDWORKS via the SOLIDWORKS native application programming interface and then outputs Geometry Description Markup Language (GDML), the native Geant4 language for importing and exporting geometry.

SW2GDML reliably and efficiently converts a CAD design for automated importation into Geant4, thus eliminating laborious and error-prone manual development of geometry models in Geant4.

SW2GDML is about 3000 lines of C++ code developed with Microsoft Visual Studio, and it is run with SOLIDWORKS.



The LUX-ZEPLIN Dark Matter Experiment is building a detector that will hold 7 tonnes of liquid xenon to be installed at the Sanford Underground Research Facility in the former Homestake gold mine in Lead, South Dakota.

The detector is being designed with the SOLIDWORKS computer-aided design program, developed by Dassault Systèmes SOLIDWORKS Corporation in Waltham, MA.

The figures below show an overview of the design of the LZ detector.

Generated GDML

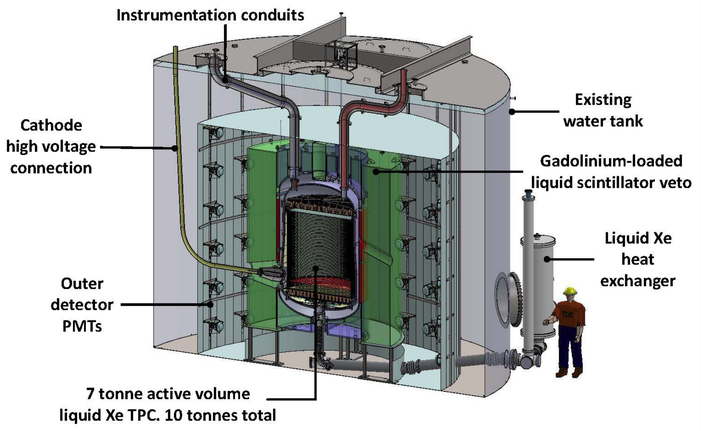
Abbreviated sample GDML produced by SW2GDML:

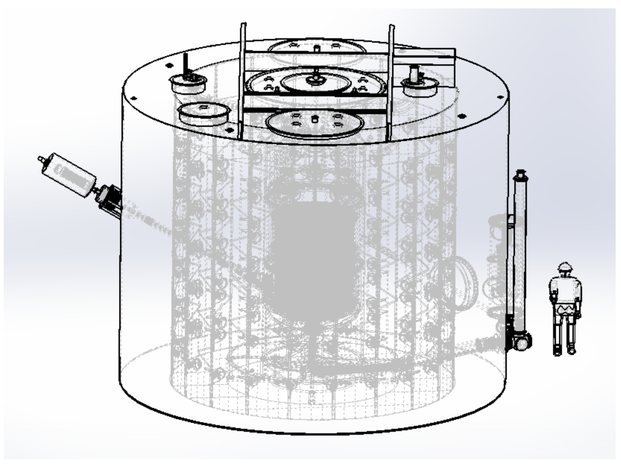
```
<materials>
 <material name="AISI_316_Stainless_Steel_Sheet_.SS.">
  <D value="8.0" unit="g/cm3"/>
  <fraction n="0.685" ref="Iron"/>
  <fraction n="0.17" ref="Chromium"/>
  <fraction n="0.12" ref="Nickel"/>
  <fraction n="0.025" ref="Molybdenum"/>
 </material>
</materials>

<solids>
 <box name="WorldBox" x="10000.0" y="10000.0" z="10000.0"/>
 <cone name="cone1" z="0.687022" rmin1="0" rmin2="0" rmax1="0.126993" rmax2="0.0746125" deltaphi="TWOPI"/>
 <torus name="torus1" rtor="0.119" rmin="0" rmax="0.054" deltaphi="1.5708"/>
 <ellipsoid name="s-revolve1" ax="0.91395" by="0.91395" cz="0.460433" zcut1="0"/>
 <tube name="disk1" rmin="0" rmax="3.81476" deltaphi="6.28319" z="0.01"/>
 <tube name="cylinder1" z="5.96274" rmin="3.81" rmax="3.81476" deltaphi="6.28319"/>
 <tube name="cylinder12" z="0.342" rmin="0" rmax="0.054" deltaphi="6.28319"/>
 <subtraction name="subt1">
  <first ref="torus1"/>
  <second ref="cylinder12"/>
  <position name="pos1" x="-0.171" y="0.119" z="0"/>
  <rotation name="rot1" x="0" y="1.5708" z="0"/>
 </subtraction>
</solids>

<structure>
 <volume name="vol8">
  <materialref ref="AISI_316_Stainless_Steel_Sheet_.SS."/>
  <solidref ref="disk1"/>
 </volume>
 <volume name="World">
  <materialref ref="Air"/>
  <solidref ref="WorldBox"/>
  <physvol>
   <volumeref ref="vol8"/>
   <position name="pos11" x="0" y="0" z="5.93734"/>
   <rotation name="rot11" z="0" y="0" x="0"/>
  </physvol>
 </volume>
</structure>
```

Current Capabilities of SW2GDML

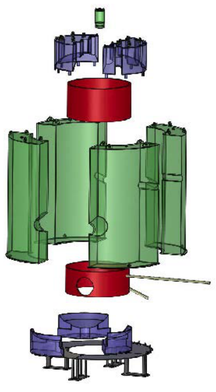
- Converts simple SOLIDWORKS designs
- Supports the following shapes and features:
  - Board
  - Cone
  - Cylinder, full and partial
  - Disk, full and partial
  - Half-ellipsoid with circular face
  - Torus
  - Cylindrical holes in parts
  - Multiple coordinate systems in simple configurations
  - Repeated parts in linear patterns
- Geant4 parts retain material properties given in SOLIDWORKS

LZ Detector Overview



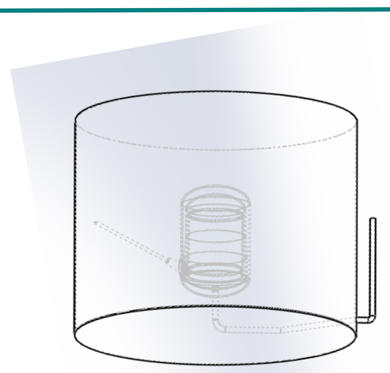
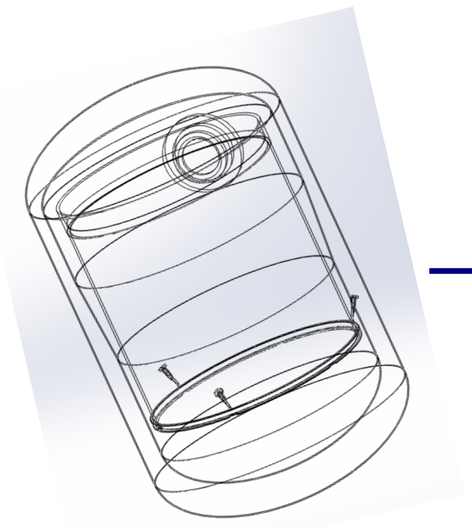
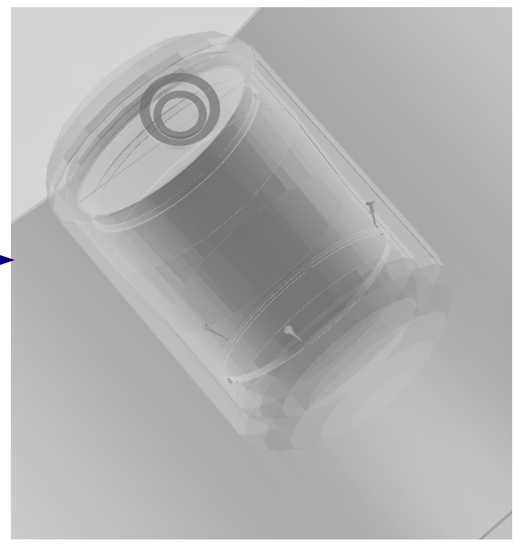
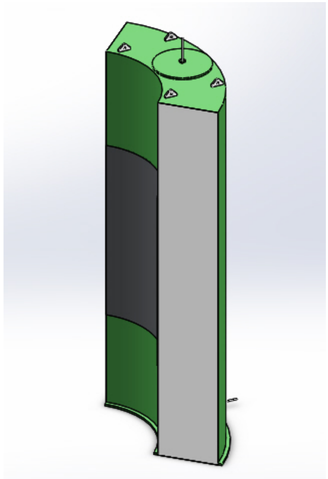
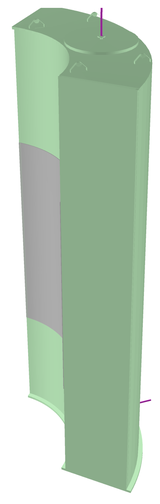


Previous design version of LZ detector, showing outer detector photo multiplier tubes



Outer detector liquid scintillator tanks (green)

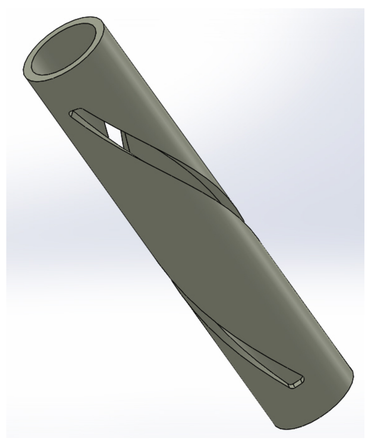
Automated conversion from SOLIDWORKS to Geant4

SOLIDWORKS CAD	Geant4
 Simplified LZ model	
 Simplified LZ inner tank	
 Outer detector tank	

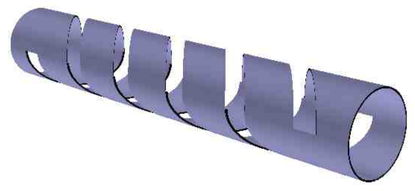
Further Development Plans

Seeking partners interested in using SW2GDML and providing feedback for ongoing development

Working with American Science and Engineering, Inc., Billerica, MA on conversion of an x-ray collimator design



SOLIDWORKS model courtesy of Dan Cristian Dinca, American Science and Engineering, Inc.



Proof-of-concept Geant4 model of spiral-cut tube created manually.

Next step is to enhance SW2GDML to read needed parameters from SOLIDWORKS and generate corresponding GDML for spiral-cut tubes.

Other development plans include adding support for:

- Additional shapes
- More complex combinations of coordinate systems
- More complex patterns of repeated parts