LArG4

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Relationship with Geant4 Collaboration

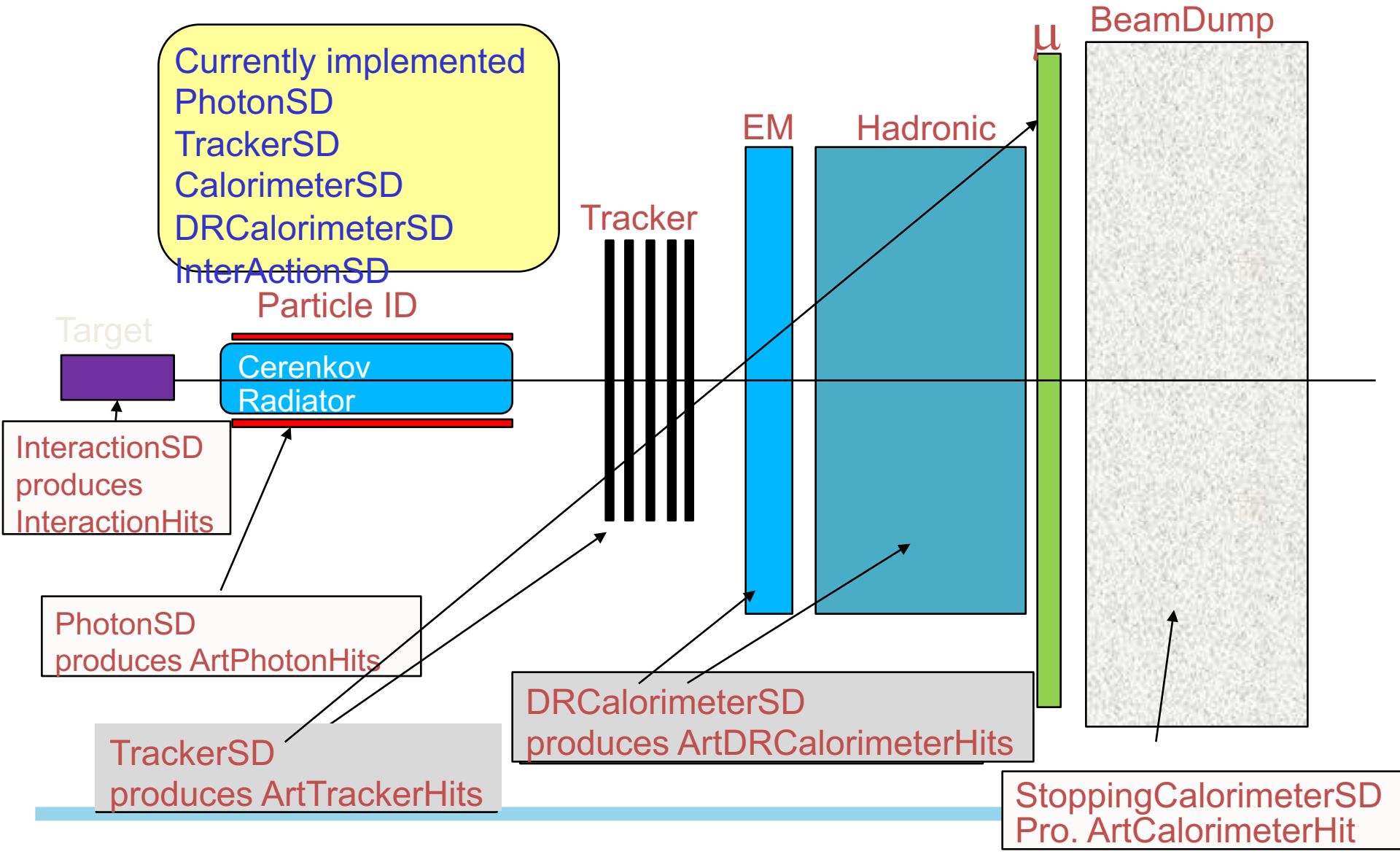
- Many changes just for the IF community:
  - Optical
    - Providing highly configurable physics constructors and interfaces that we requested→ no need to do your own plumbing.
    - Eliminate performance bottle necks, e.g.access to material properties much faster.
  - Eliminate features: e.g. various cross sections much improved.
- Physics use the new configurable and extendable Physicslistfactory:
  - Allows to select all reference physics lists
  - Can be extended e.g. we use
    - G4optical physics.
    - Step limiter for charged particles.
    - Neutron time cuts
  - For the brave build your own physics lists, modify existing ones

GDML(+ extensions): a complete description of detector configuration (at runtime)

- Materials, volumes etc….
- Assign step-limits to specific volumes.
- Optical properties (bulk and surface)
- Assignment of sensitive detectors of predefined type to logical volumes→ automatically trigger the creation and filling of the appropriate hit collections
- Assignment of optical surfaces
- Visualization attributes (color, solid,….)
- Makes use of formulas and loops → to keep gdml file compact
- Homogeneous electric field (no electric field→ no separation of charge)

Motivation: Modular system

build detector from predefined components at runtime.



```
<?xml version="1.0" encoding="UTF-8" ?>
<gdml xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:noNamespaceSchemaLocation="http://service-spi.web.cern.ch/service-spi/app/releases/GDML/schema/gdml.xsd">
  <define>
    <constant name="TWOPI" value="2.*pi"/>
    <constant name="HALFPI" value="pi/2."/>
    <variable name="i" value="0"/>
    <constant name="num" value="77"/>
    <constant name="scale" value="2."/>
    <matrix name="SY"  coldim="1" values="51282/MeV" />
    <matrix name="RS"  coldim="1" values="1.0" />
    <matrix name="FTC" coldim="1" values="7.*ns" />
    <matrix name="STC" coldim="1" values="1400.*ns" />
    <matrix name="YR"  coldim="1" values="0.75" />
    <matrix name="ArINDEX" coldim="2" values="6.7*eV 1.5
                                              7.1*eV 1.5
                                              7.4*eV 1.5
                                              7.7*eV 1.5
                                              7.9*eV 1.5
                                              8.1*eV 1.5
                                              8.4*eV 1.5
                                              8.5*eV 1.5
                                              8.6*eV 1.5
                                              8.8*eV 1.5
                                              9.0*eV 1.5
                                              9.1*eV 1.5
                                              9.4*eV 1.5
                                              9.8*eV 1.5
                                              10.4*eV 1.5"/>
    <matrix name="REFLECTIVITY" coldim="2" values="6.7*eV 0.8
                                              7.1*eV 0.8
                                              7.4*eV 0.8
                                              7.7*eV 0.8
                                              7.9*eV 0.8
                                              8.1*eV 0.8
                                              8.4*eV 0.8
                                              8.5*eV 0.8
                                              8.6*eV 0.8
                                              8.8*eV 0.8
                                              9.0*eV 0.8
                                              9.1*eV 0.8
                                              9.4*eV 0.8
```

Optical properties

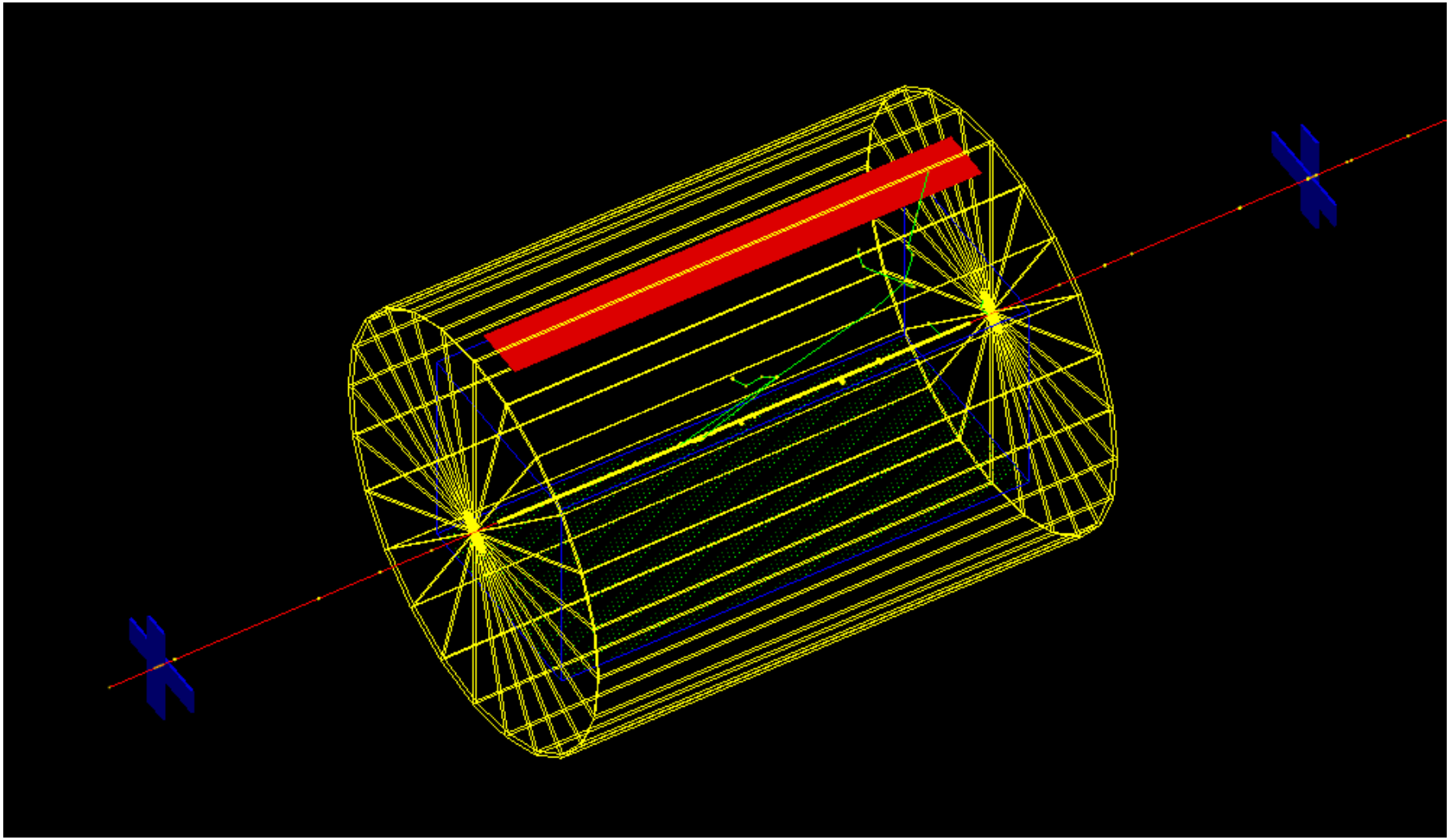
```
    <matrix name="SCINT" coldim="2" values="6.7*eV 0.04
                                            7.1*eV 0.12
                                            7.4*eV 0.27
                                            7.7*eV 0.44
                                            7.9*eV 0.62
                                            8.1*eV 0.80
                                            8.4*eV 0.91
                                            8.5*eV 0.92
                                            8.6*eV 0.85
                                            8.8*eV 0.70
                                            9.0*eV 0.50
                                            9.1*eV 0.31
                                            9.4*eV 0.13
                                            9.8*eV 0.04
                                           10.4*eV 0.01"/>
  </define>

  <materials>
    <material name="LAr" formula="LAr">
      <D value="1.40" unit="g/cm3"/>
      <fraction n="1.0000" ref="G4_Ar"/>
      <property name="RINDEX" ref="ArINDEX"/>
      <property name="SLOWCOMPONENT" ref="SCINT"/>
      <property name="SCINTILLATIONYIELD" ref="SY" />
      <property name="RESOLUTIONSCALE" ref="RS" />
      <property name="SLOWTIMECONSTANT" ref="STC" />
      <property name="YIELDRATIO" ref="YR" />
    </material>
    <material name="Iron" formula="Iron">
      <D value="4.0" unit="g/cm3"/>
      <fraction n="1.0000" ref="G4_Fe"/>
      <property name="RINDEX" ref="ArINDEX"/>
    </material>
    <material name="Silicon" formula="Si">
      <D value="2.33" unit="g/cm3"/>
      <fraction n="1.0000" ref="G4_Si"/>
      <property name="RINDEX" ref="ArINDEX"/>
    </material>
  </materials>
  <solids>
    <box name="WorldBox" lunit="cm" x="100" y="100" z="410"/>
```

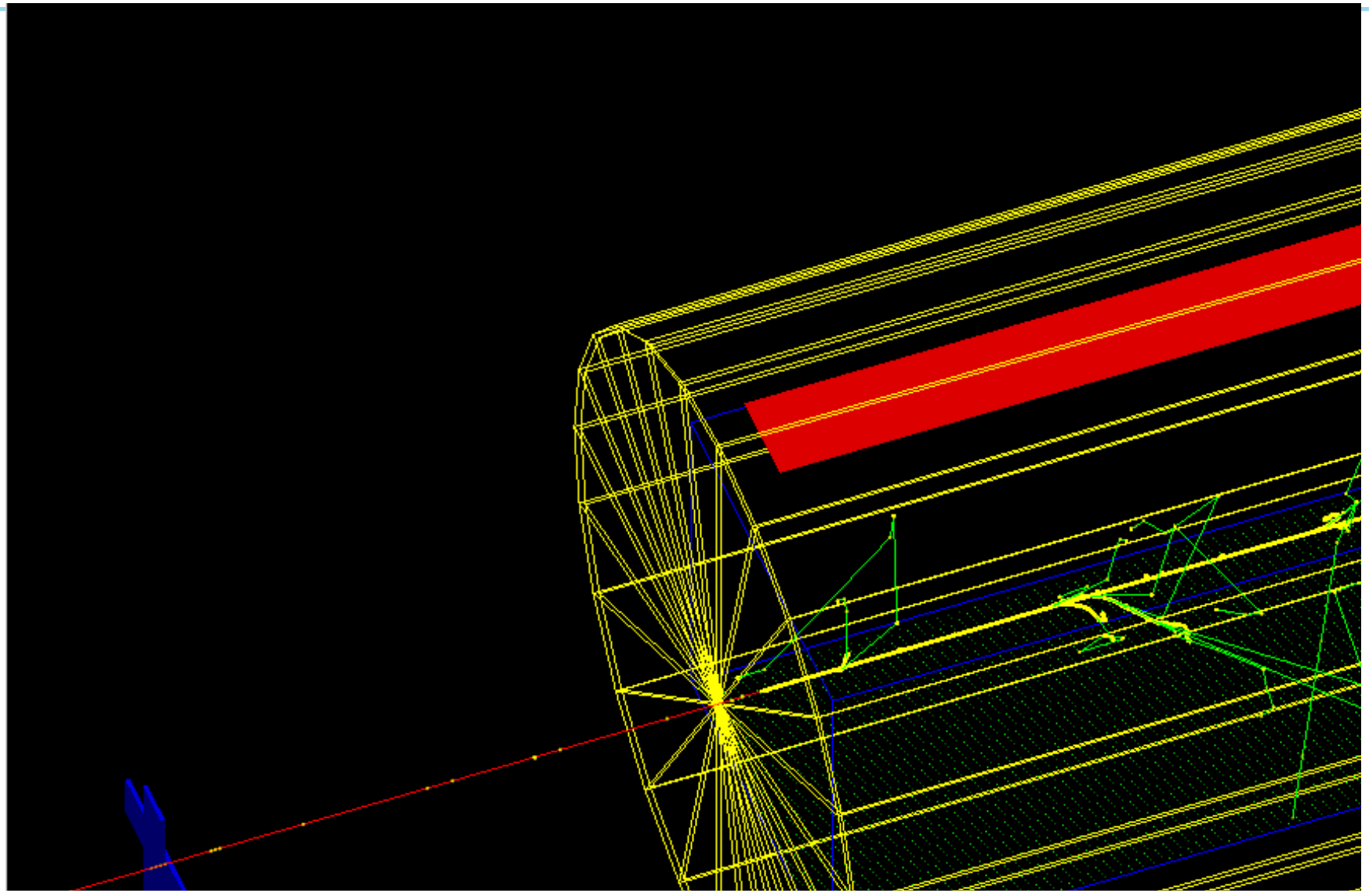
```
<solids>
  <box name="WorldBox" lunit="cm" x="100" y="100" z="410"/>
  <tube name="Cryostat"  lunit="cm" z="100.0" rmax="40." deltaphi="TWOPI" aunit="rad" />
  <tube name="ArgonVolume"  lunit="cm" z="99.0" rmax="39.5" deltaphi="TWOPI" aunit="rad" />
  <box name="PhotoBox"  lunit="cm" x="10.0" y="0.03" z="90.0"/>
  <box name="PaddleBox"  lunit="cm" x="20.0" y="5." z=".5"/>
  <box name="TPCVolume"  lunit="cm" x="40" y="40" z="90"/>
  <tube name="t1000"  lunit="cm" z="90.0" rmax="0.01" deltaphi="TWOPI" aunit="rad" />
  <opticalsurface name="surf" model="glisur" finish="polished" type="dielectric_metal" value="1.0">
    <property name="REFLECTIVITY" ref="REFLECTIVITY" />
  </opticalsurface>
</solids>
<structure>
  <volume name="Paddle">
    <materialref ref="G4_PLEXIGLASS"/>
    <solidref ref="PaddleBox"/>
    <auxiliary auxtype="SensDet" auxvalue="Tracker"/>
    <auxiliary auxtype="Color" auxvalue="Blue"/>
    <auxiliary auxtype="Solid" auxvalue="True"/>
  </volume>
  <volume name="SenseWire">
    <materialref ref="G4_W"/>
    <solidref ref="t1000"/>
    <auxiliary auxtype="Color" auxvalue="Green"/>
  </volume>
  <volume name="volTPCActiveInner">
    <materialref ref="LAr"/>
    <solidref ref="TPCVolume"/>
    <auxiliary auxtype="SensDet" auxvalue="Tracker"/>
    <auxiliary auxtype="Color" auxvalue="Blue"/>
    <auxiliary auxtype="StepLimit" auxvalue="0.01"/>
    <auxiliary auxtype="Efield" auxvalue="1000."/>
    <loop for="i" from="0" to="num" step="1">
      <physvol name="psenseWireVolume">
        <volumeref ref="SenseWire"/>
        <position name="posijk"  unit="mm" x="-200.0+(i+1)*5." y="-199.8" z="0"/>
      </physvol>
    </loop>
  </volume>
  <volume name="volPhotodetector">
    <materialref ref="Silicon"/>
```

Logical Volumes

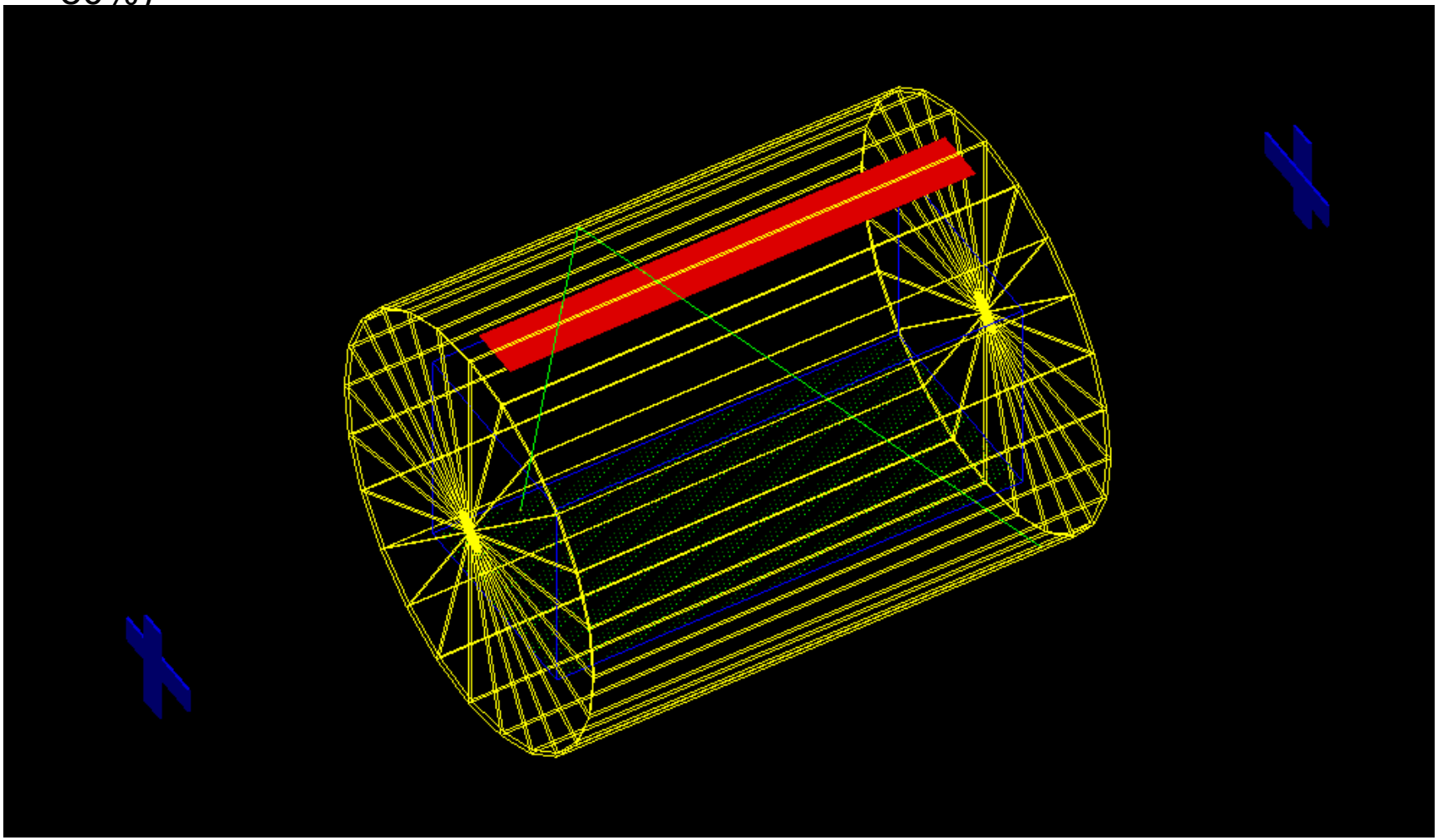
```
    <auxiliary auxtype="SensDet" auxvalue="PhotonDetector"/>
    <auxiliary auxtype="Color" auxvalue="Red"/>
    <auxiliary auxtype="Solid" auxvalue="True"/>
  </volume>
  <volume name="volArgon">
    <materialref ref="LAr"/>
    <solidref ref="ArgonVolume"/>
    <auxiliary auxtype="Color" auxvalue="Yellow"/>
    <physvol name="pCalorimeterVolume">
      <volumeref ref="volTPCActiveInner"/>
      <position name="Calpos" x="0" y="0" z="0"/>
    </physvol>
    <physvol name="pvolPhotodetector">
      <volumeref ref="volPhotodetector"/>
      <position name="photondetectorpos" unit="mm" x="0" y="391." z="0"/>
    </physvol>
  </volume>
  <volume name="volCryostat">
    <materialref ref="Iron"/>
    <solidref ref="Cryostat"/>
    <auxiliary auxtype="Color" auxvalue="Yellow"/>
    <physvol name="pArgonVolume">
      <volumeref ref="volArgon"/>
      <position name="Argonpos" x="0" y="0" z="0"/>
    </physvol>
  </volume>
  <volume name="TOP">
    <materialref ref="G4_AIR"/>
    <solidref ref="WorldBox"/>
    <physvol name="pCryostatVolume">
      <volumeref ref="volCryostat"/>
      <position name="Cryopos" x="0" y="0" z="0"/>
    </physvol>
    <physvol name="pPaddle1">
      <volumeref ref="Paddle"/>
      <position name="Paddlepos1" unit="cm" x="0" y="0" z="-110."/>
    </physvol>
    <physvol name="pPaddle3">
      <volumeref ref="Paddle"/>
      <position name="Paddlepos3" unit="cm" x="0" y="0" z="-111."/>
      <rotation name="rotatebyz3" z="HALFPI"/>
```

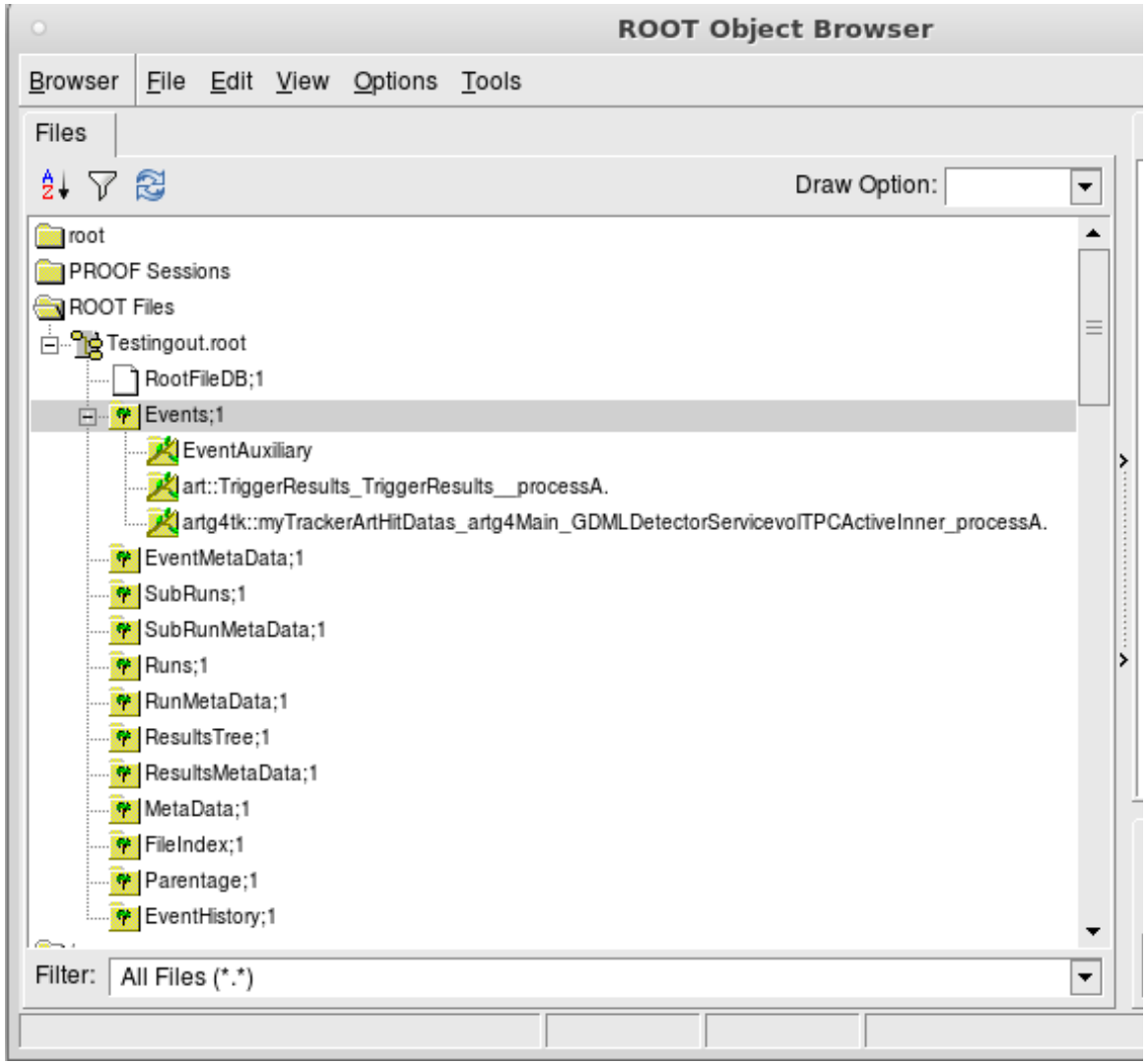
```
            <rotation name="rotatebyz3" z="HALFPI"/>
          </physvol>
          <physvol name="pPaddle2">
            <volumeref ref="Paddle"/>
            <position name="Paddlepos2" unit="cm" x="0" y="0" z="110."/>
          </physvol>
          <physvol name="pPaddle4">
            <volumeref ref="Paddle"/>
            <position name="Paddlepos4" unit="cm" x="0" y="0" z="111."/>
            <rotation name="rotatebyz4" z="HALFPI"/>
          </physvol>
        </volume>
        <bordersurface name="bordersrf" surfaceproperty="surf" >
          <physvolref ref="pArgonVolume"/>
          <physvolref ref="pCryostatVolume"/>
        </bordersurface>
    </structure>
    <setup version="1.0" name="Default">
        <world ref="TOP"/>
    </setup>
</gdml>
```





Tracing of a single optical photon (reflectivity on tank 80%)




ROOT Object Browser
Browser
File
Edit
View
Options
Tools
Files
Draw Option:
root
PROOF Sessions
ROOT Files
Testingout.root
RootFileDB;1
Events;1
EventAuxiliary
art::TriggerResults_TriggerResults__processA.
artg4tk::myTrackerArtHitDatas_artg4Main_GDMLDetectorServicevolTPCActiveInner_processA.
EventMetaData;1
SubRuns;1
SubRunMetaData;1
Runs;1
RunMetaData;1
ResultsTree;1
ResultsMetaData;1
MetaData;1
FileIndex;1
Parentage;1
EventHistory;1
Filter:
All Files (*.*)

Status

- Whole chain is working
  - Need to rename and rearrange
  - Currently fill geant4 hit collections first and then copy over to art hit collections (want to skip the geant4 step)