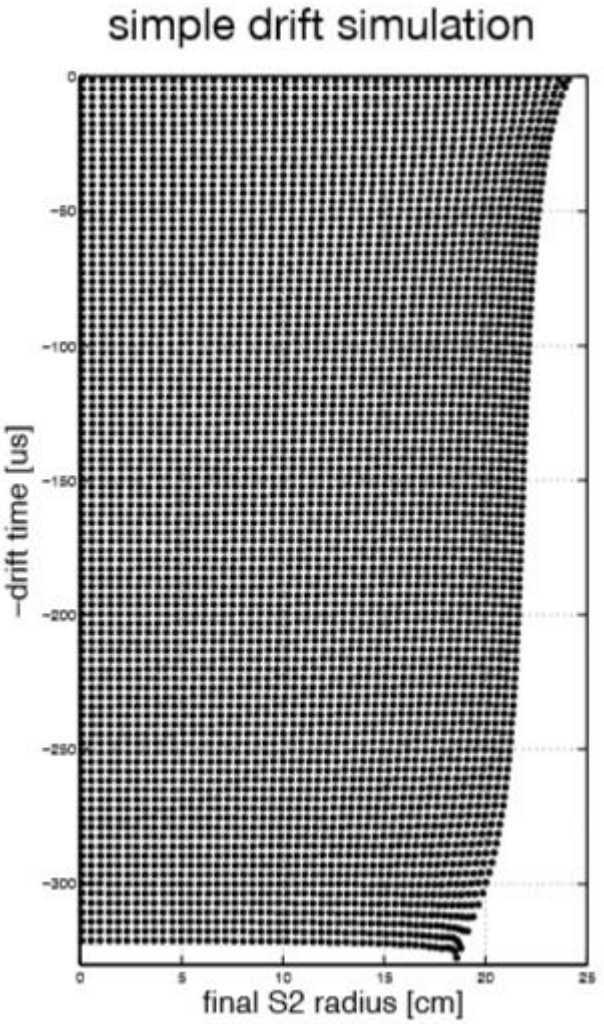
Effects of Teflon Reflectivity on S1 Signal

University of Wisconsin
Shaun Alsum
LZ Simulation Phone Meeting
April 27, 2015

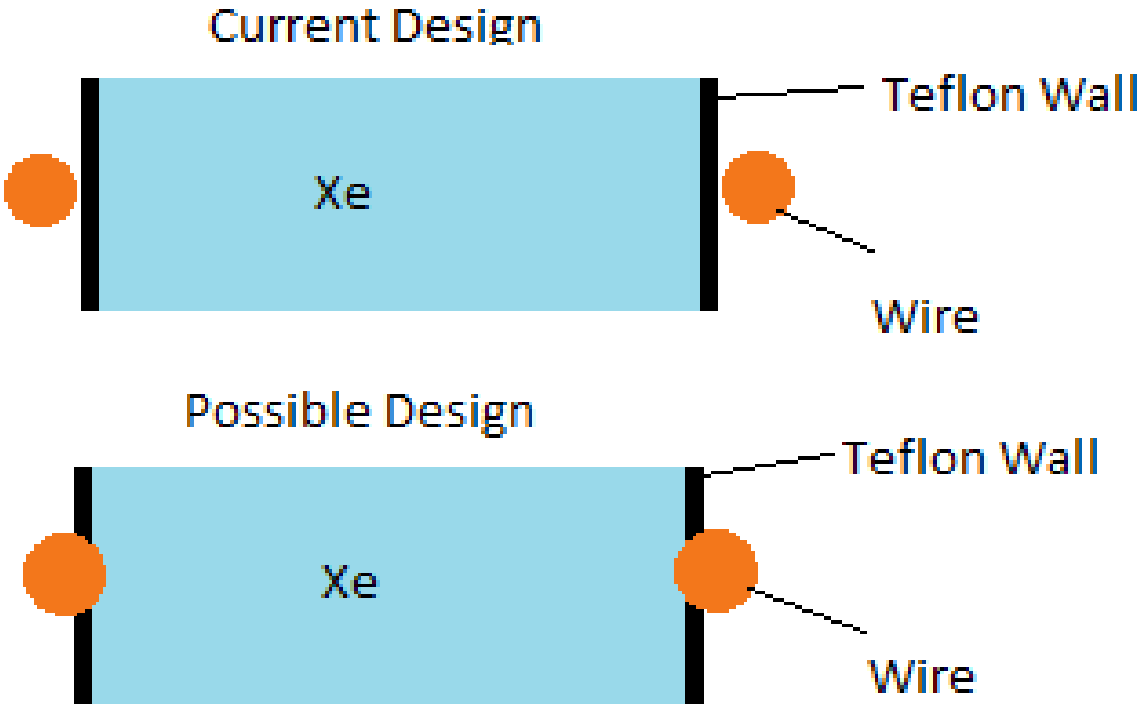
Background

- Would like to have a uniform electric field throughout the drift region of the TPC.
- Field shaping rings are meant to accomplish this, but despite the rings, the field in LUX still became distorted. Likely due to charge build up (Jeremy Chapman's Thesis 6.3.1.1, 7.3.1.1).



Lifted from Chapman's Thesis (Pg 180)

- Possible solution: redesign these rings to expose metal to the interior, allowing us to control the electric field more effectively.
- Possible problem: rings are not as reflective as the Teflon, so we will lose sensitivity.
- How much?



Method

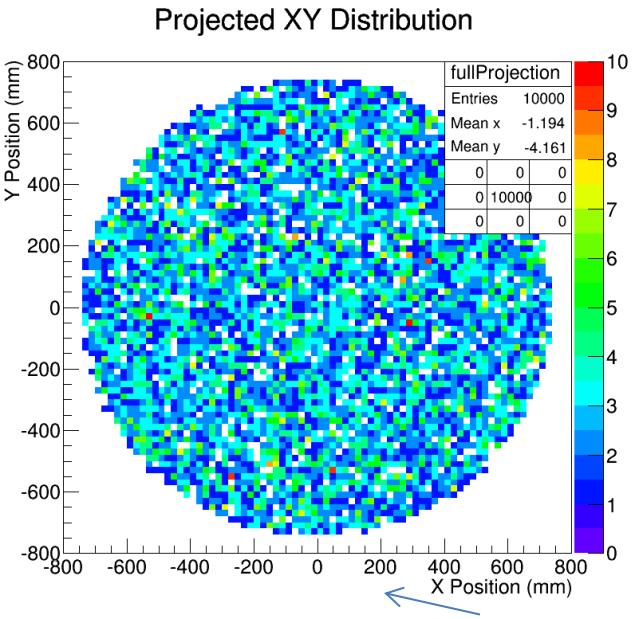
- Generate S1 photons.
- Create Macros which vary the teflon reflectivity (/LUXSim/materials/LXeTeflonReflX) from 0 to 1 (current step size .05).
- Propagate S1 photons and record how many reach the PMTs in each case.

Compare 3 different methods of Generating S1 photons

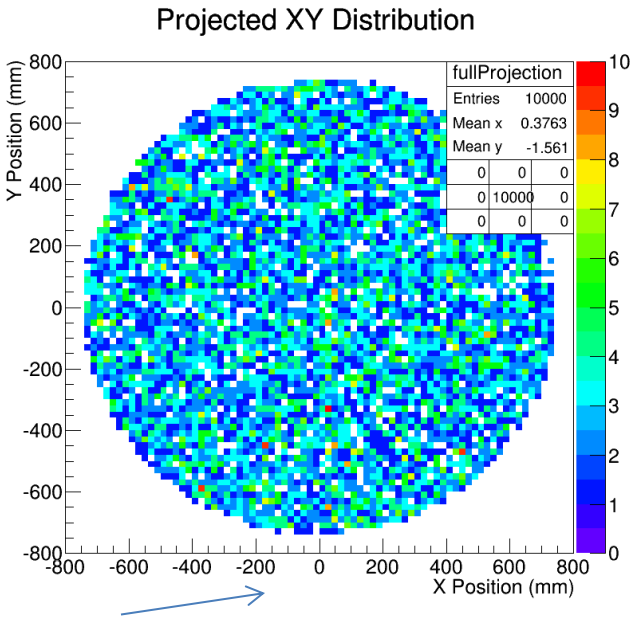
- Geant4 GPS method
  - /gps/particle opticalphoton
    /gps/ene/type Gauss
    /gps/ene/mono 6.97 eV
    /gps/ene/sigma 0.23 eV
    /gps/pos/type Volume
    /gps/pos/shape Cylinder
    /gps/pos/centre 0 0 740 mm
    /gps/pos/radius 738 mm
    /gps/pos/halfz 738 mm
    /gps/ang/type iso
- ScintPhotons Generator method
  - /LUXSim/source/set LiquidXenonTarget ScintPhotons 1 Bq
- WIMP Generator method
  - /LUXSim/source/set LiquidXenonTarget Wimp 1 Bq 60 GeV
    /LUXSim/physicsList/useOpticalProcesses true
    /LUXSim/physicsList/driftElecAttenuation 0 m

Primary Particle Distributions

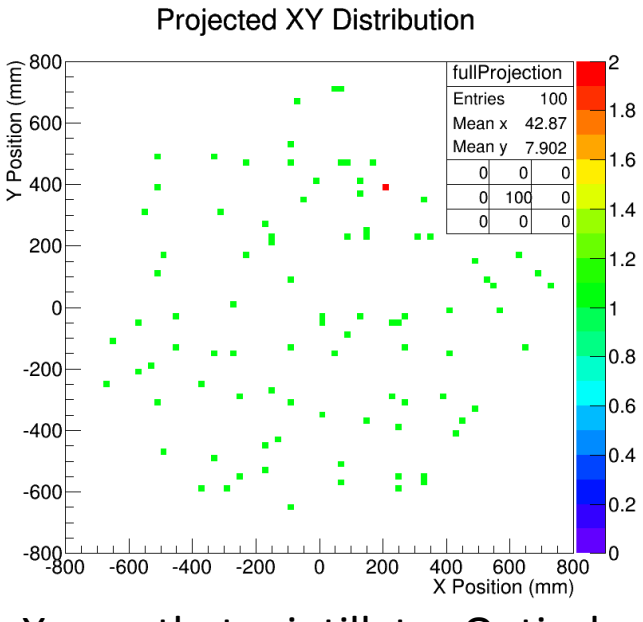
Geant4 GPS Method



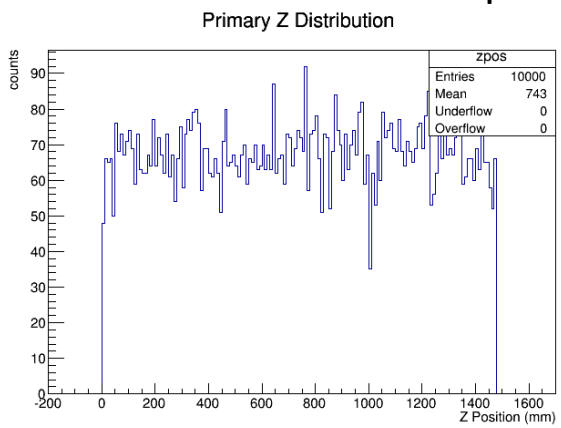
ScintPhoton Generator Method

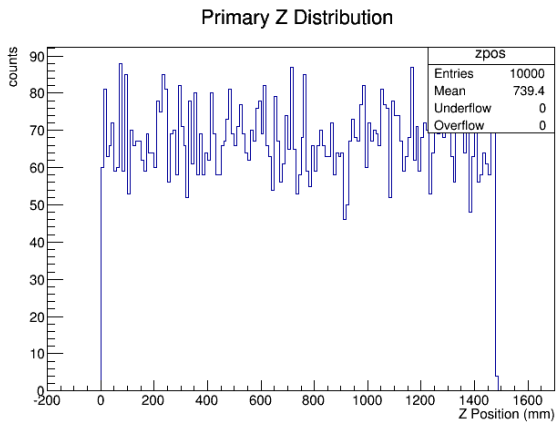


WIMP Generator Method

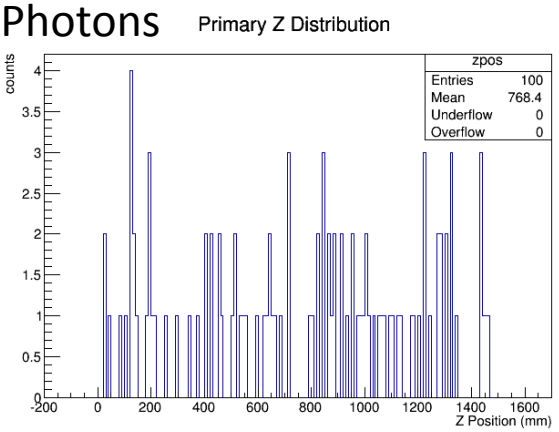


Optical Photons

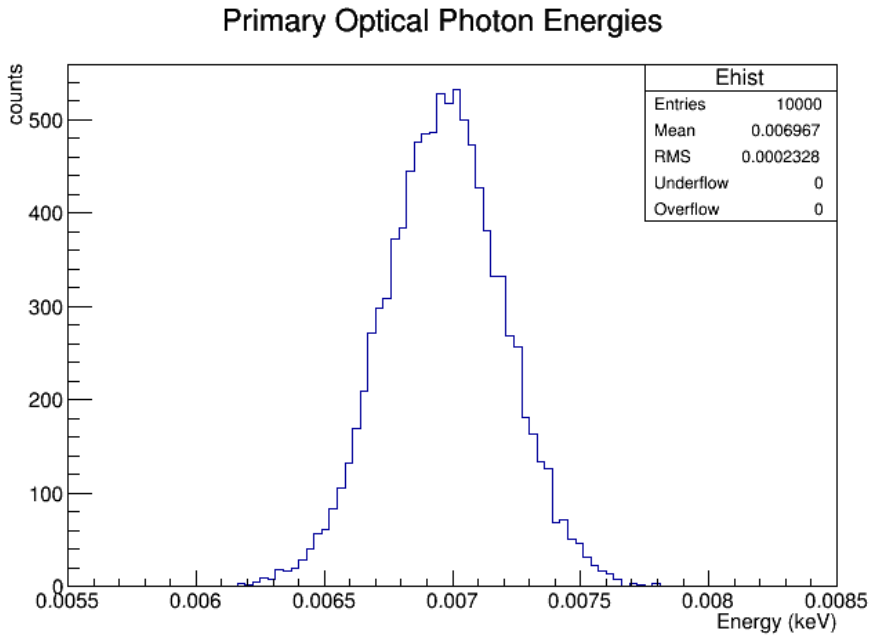




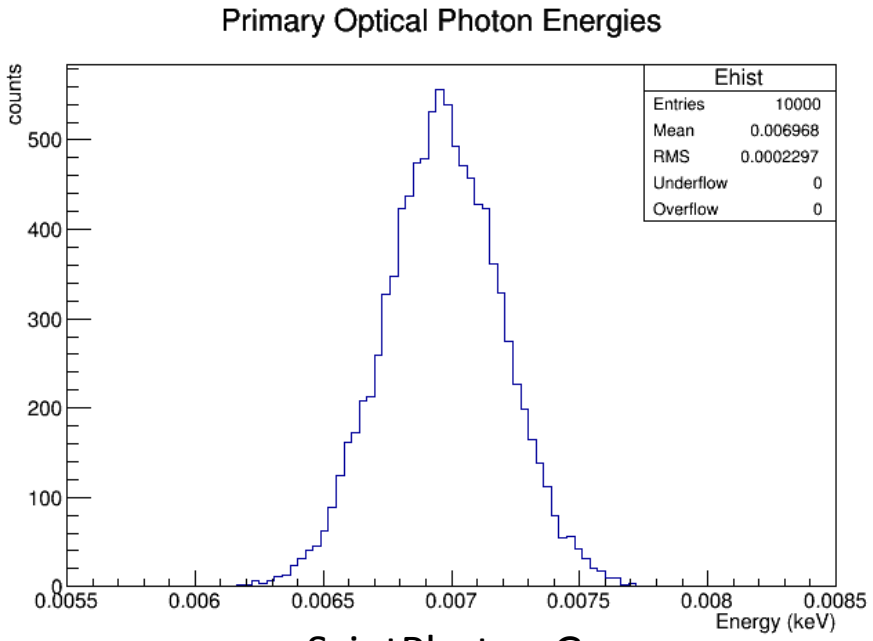
Xenon that scintillates Optical Photons



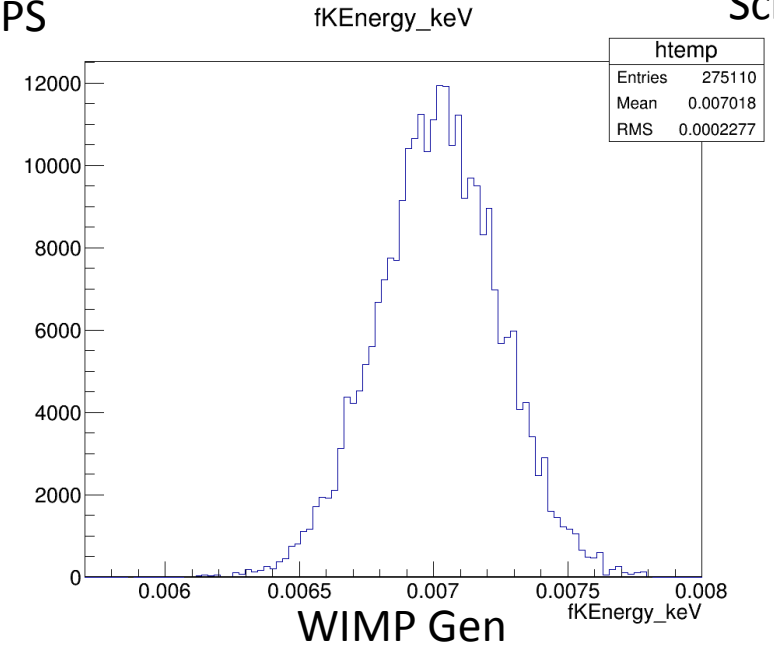
Optical Photon Energy Distributions



Geant4 GPS



ScintPhoton Gen



WIMP Gen

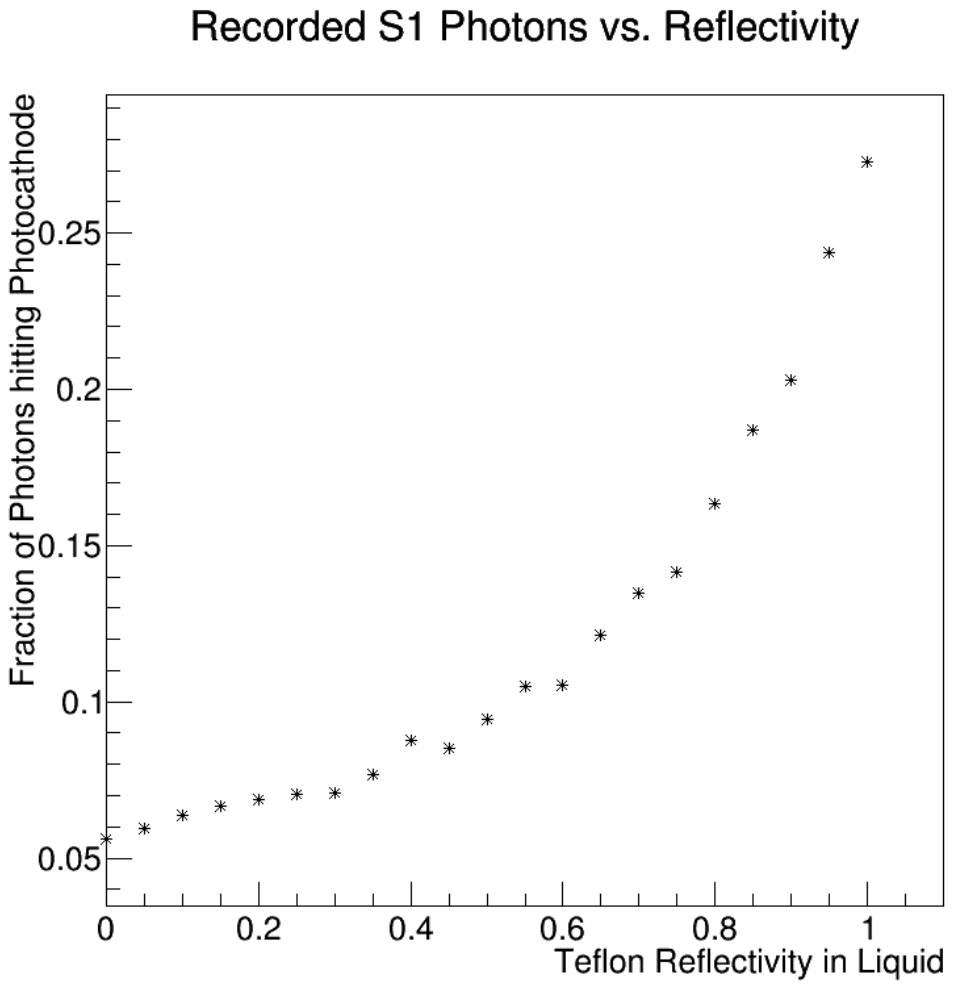
Plow ahead with ScintPhotons Generator

- Most hassle-free option
- Some weird stuff going on with WIMP Gen so not completely sure yet that it would produce the same results.
- The energy distribution at least seems ok though, so I'm going with it.

S1 Signal vs. Teflon Reflectivity

Seems to drop very rapidly with reflectivity, to the point where if the Teflon is not at all reflective, only ~6% of the photons make it (~20% of when Teflon is perfectly reflective). This is the same trend found by Slava's study.

http://teacher.pas.rochester.edu:8080/wiki/pub/Lz/LzDB000000005/2013-11-19_Slava_LZLightCollBulk.pdf



Fraction of Photons Detected vs. Height and Reflectivity (in liquid)

Higher rate at lower heights since they are close to PMTs and the photons originating from higher in the detector have to cross the liquid-gas interface to reach the upper PMTs