# Braidwood Geant4 Simulation Project

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## 1 Project Proposal

The current Braidwood detector Monte Carlo, ReactorFsim, has allowed rapid progress to simulating and studying the baseline Braidwood detector design. The next step is to develop a full Monte Carlo detector simulation. We propose to use Geant4 as the base platform for several reasons:

- its position as a HEP "standard" simulation, meaning that most developers and users will already have Geant4 available and hopefully some experience with it
- it will allow us to reach a full detector simulation more quickly than writing our own Monte Carlo with separate, more limited software for particle propagation (MCNP, EGS), as SNO did
- a Generic Liquid-scintillator anti-neutrino detector Geant4 simulation (GLG4sim), based on the KamLAND simulation is already available and actively supported
- it is already the platform for other Braidwood simulations, particularly the Veto simulation with which the detector simulation can and should be combined

Geant4 is also the platform for the other proposed reactor neutrino $\theta_{13}$ experiments. We plan to use the time available before the next NuSAG review to make rapid progress toward a Geant4-based simulation which can produce results comparable to those obtained already with ReactorFsim.

## 2 Goals

The primary goal is to develop a Geant4-based simulation for the Braidwood detector. We take GLG4sim as a starting point. The Braidwood version, BWsim, is available from the Braidwood CVS site.

The short term goal, in 2-3 weeks, is a detector simulation producing results that can be compared to ReactorFsim. This goal is aggressive and requires active involvement in the simulation effort from more people than are currently involved. Longer term goals are to produce energy and other reconstructed quantity plots based on the Geant4 simulation to present to NuSAG.

## 3 Needs

Immediate needs: much can be taken from GLG4sim and code already in ReactorFsim. These topics need people working on them now in order to reach to short term goal. We currently don't even know which of these will be as simple as switches already in GLG4sim and which will require more work. These are more-or-less prioritized.

- Braidwood-specific detector geometry (Chris, Dan): some work is already done creating a basic "concentric-sphere" geometry, as in ReactorFsim
- IBD vertex generator (Dan)
- neutron capture on Gd: not a Geant4 standard process, but a "non-public" file exists which must be added and tested
- PMT model: several models exist in GLG4sim which need to be understood
- improvements to ROOT output: ROOT output is standard in GLG4sim, but no BW-specific trees exist
- verification independent from checks against ReactorFsim: can we check that the physics (Cerenkov light) and optical (reflection, scattering) processes are behaving reasonably
- reactor analysis tools (Stan)

Long term needs:

- reconstruction: tested code exists in ReactorFsim, will need to be adapted
- elastic scatter vertex generator (Jasmine)
- trigger/electronics
- BW-specific optical model
- interface with veto simulation: should be added in early
- optimization: once short-term goals met, can we speed up G4 without losing too much functionality?

## 4 Organization

This project will be managed by the Background and Simulation group. However, other groups will have considerable input; in particular we hope the Veto, Electronics, and Non-$\theta_{13}$ Physics groups can contribute people to this project.

The code will be kept in the Braidwood CVS repository, overseen by Matt, at the University of Chicago with frozen releases made available regularly. We propose initially to have new code for the repository sent to the Simulation group for testing, and when found acceptable checked into the repository by the author. We intend this to keep the initially small pool of developers current as code is sent around and discussed. As the complexity of the code and number of developers increases, we will need a more sophisticated procedure for approving new code.