

# **R**eactor **A**nalysis **T**ool

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October 27, 2005

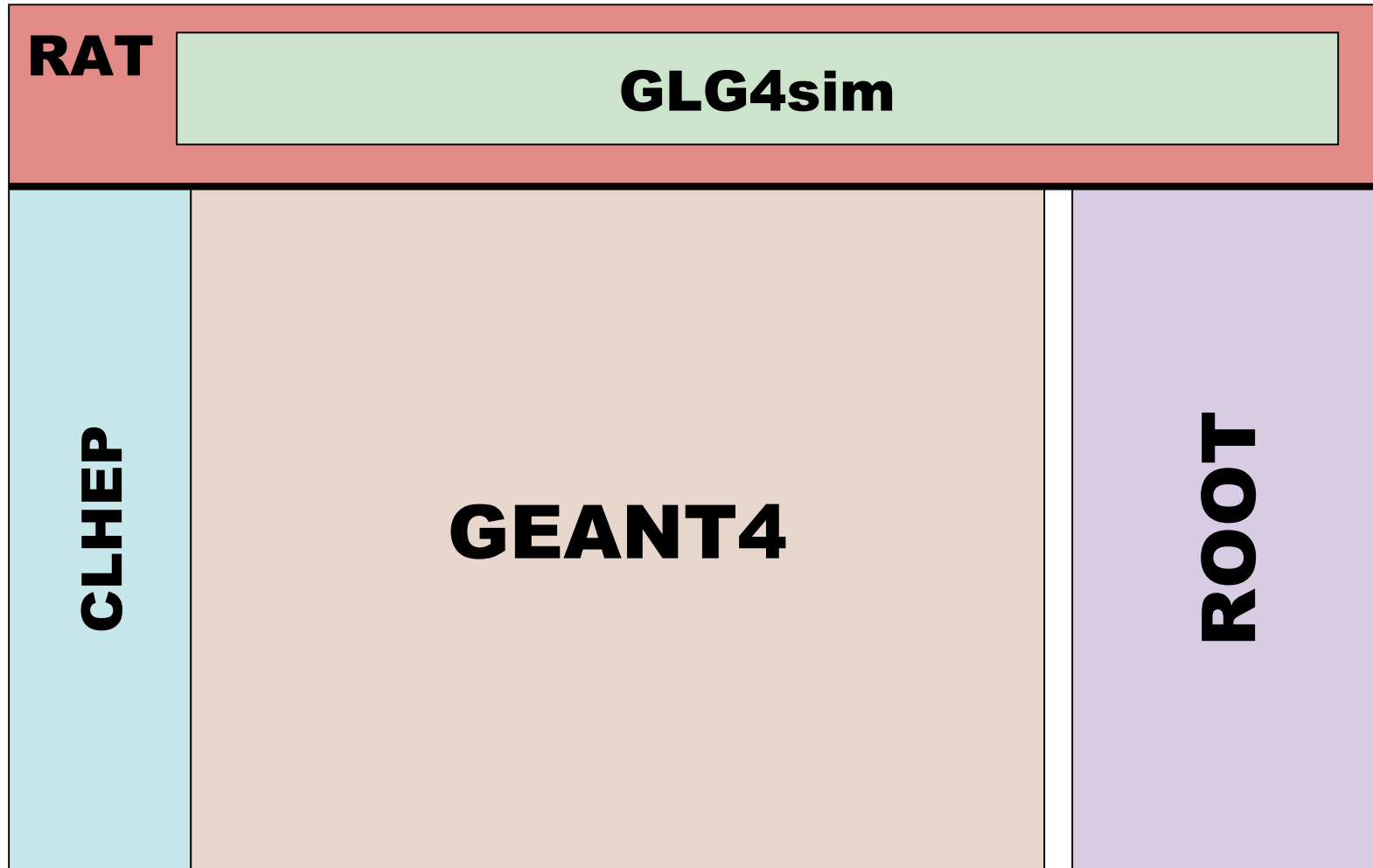
# Project Goals

- Create a new Monte Carlo package for Braidwood that would simulate individual particles and photons.
- Reuse as many ideas and as much code from others as possible.
- Break down analysis into small tasks that can be implemented by many people.
- Design for analysis of both Monte Carlo and real data.

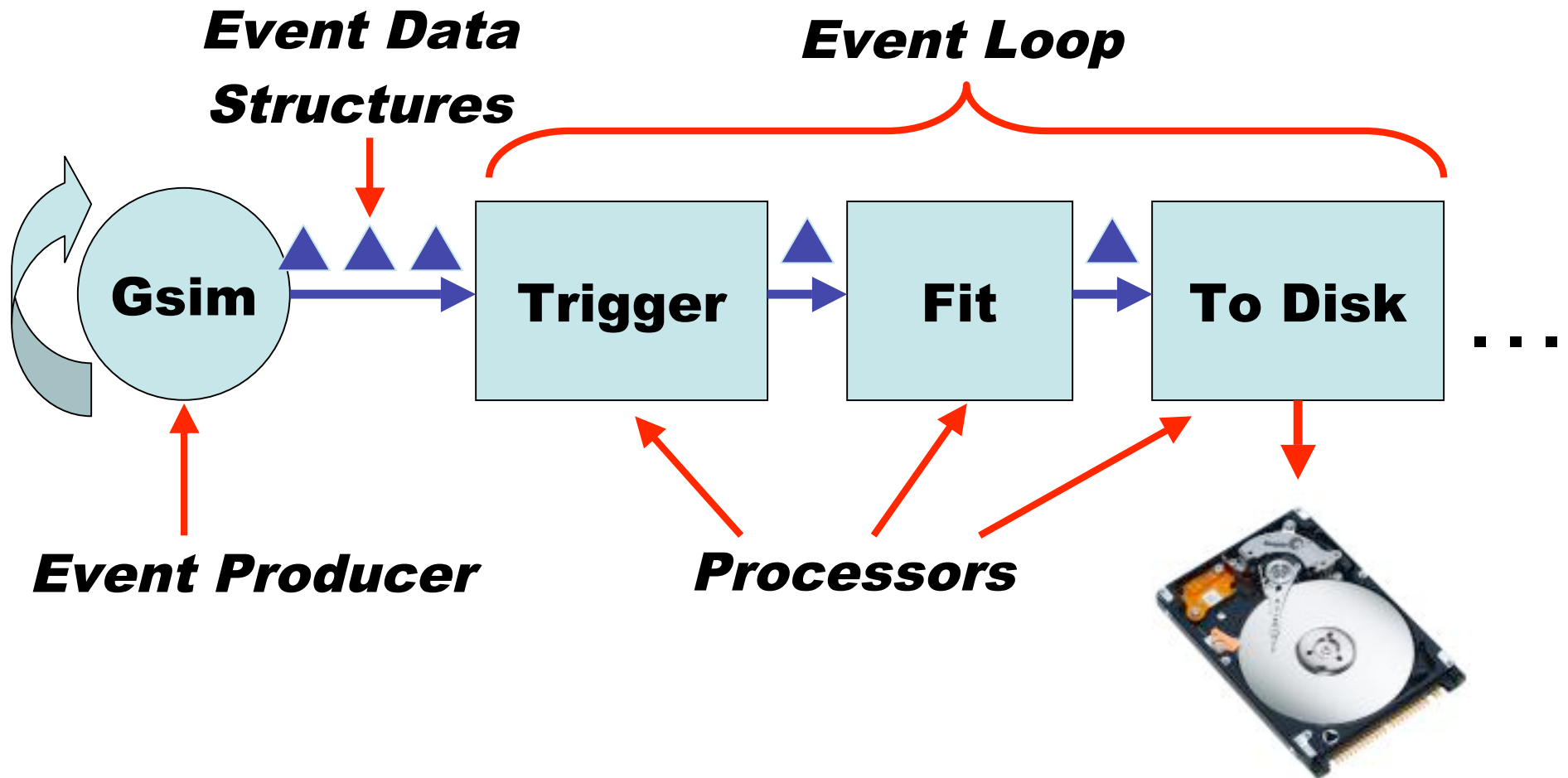
# Reuse is good!

- ✓ GEANT4 - Monte Carlo simulation of detectors and physical processes
- ✓ ROOT - Object I/O to disk or over network.
- ✓ GLG4sim - **G**eneric **L**iquid Scintillator **G**EANT4 **s**imulation, written and maintained by Glenn Horton-Smith from the KamLAND collaboration.
- ✓ SNOMAN - **SNO M**onte Carlo and **A**Nalysis. Provided design inspiration, but no code.

# How it all fits together:



# The Concept



# The Event Data Structure

RAT\_DS

├── RAT\_MC

│ ├── RAT\_MCParticle — RAT\_MCParticle

│ ├── RAT\_MCTrigger — RAT\_MCTrigger

│ └── RAT\_MCPMT — RAT\_MCPMT — RAT\_MCPMT

├── RAT\_EV — RAT\_EV — RAT\_EV

│ ├── ┌──

│ ├── RAT\_PMT — RAT\_PMT — RAT\_PMT

│ ├── RAT\_PosFit — RAT\_PosFit

│ └── RAT\_EFit — RAT\_EFit

*(Abridged)*

# User Interface

- Command Line
- Macro files to control settings:

```
/glg4debug/glg4param omit_muon_processes 1.0  
/glg4debug/glg4param omit_hadronic_processes 1.0  
  
/rat/proc count  
/rat/procset update 5  
/rat/proc outroot  
/rat/procset "test.root"  
  
/run/initialize  
  
/generator/rates 3 1  
/generator/gun gamma 0 0 0 0 0 0 1.022  
/run/beamOn 100
```

# Monte Carlo Features

- Generate single and multiparticle events, and interleave events of different types
- Implements spherical, two-zone Braidwood detector with 1200 PMTs and muon veto chambers. Option to turn on chimney.
- Muon veto simulation (Steve Sekula)
- Includes optical, EM, and hadronic processes.
- Simulation of Gd-loaded scintillator, thanks to Double-CHOOZ and Matt Worcester
- Event visualization options provided by GEANT4

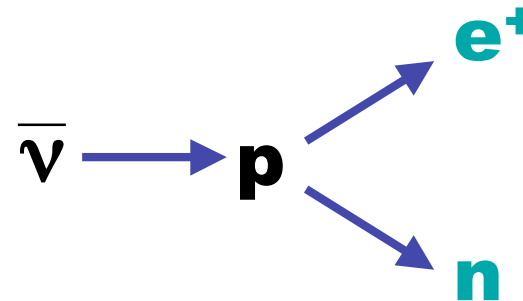


# Generators

- Single particle “gun”
  - Directed or isotropic
  - Point, fill volume or paint a surface



- Inverse beta decay (with energy and  $\cos(\theta)$  distribution)



- Arbitrary events from HEPEVT format text file

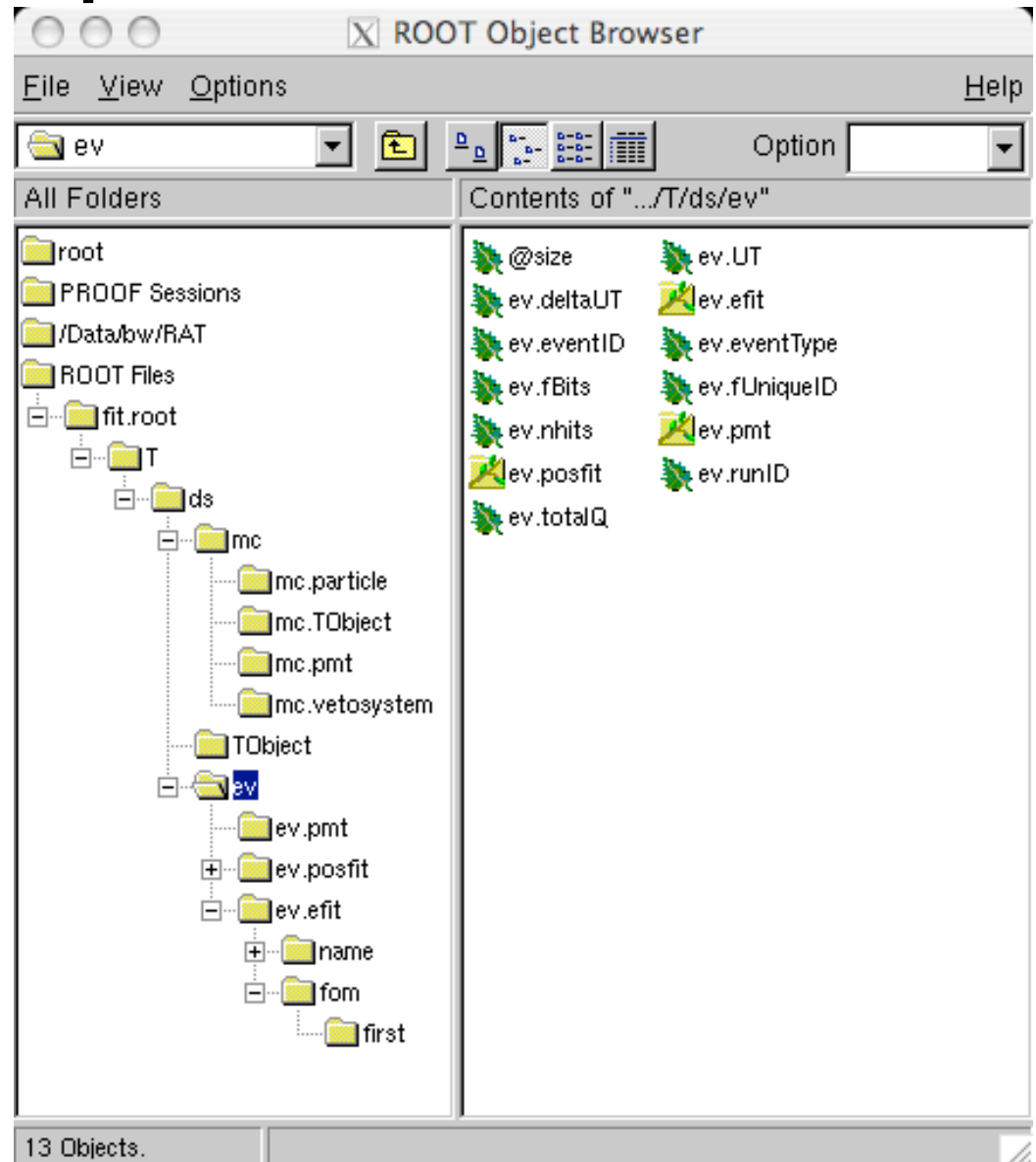
```
3
99 1 0 0 0 0 0.00558137 0 0 895.62 949.868 1730
1 -11 0 0 0.00260526 0.00276306 0.00189105 0.00
1 2112 0 0 -0.00260526 -0.00276306 0.00369032 0
```

# Analysis Tasks

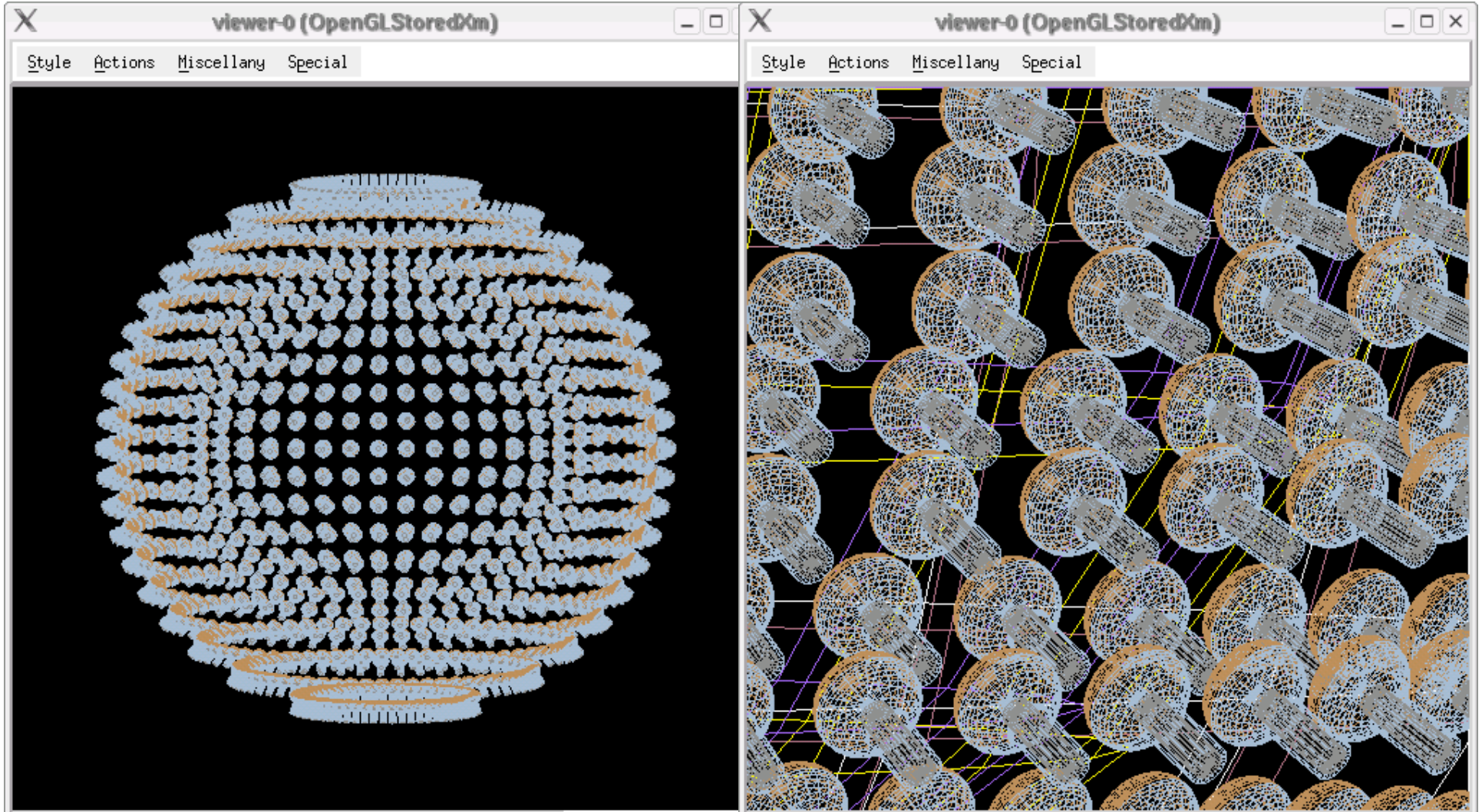
- Reconstruction of position
  - Centroid method
  - $q^2$  method
- Reconstruction of energy
  - Maximum likelihood method  
(see Chris Tunnell's talk)

# I/O Options

- Store entire events to ROOT files.
- Reload events from disk back into the event loop.
- Send events through the network between RAT processes.
- Prune unneeded parts to save space.



# Visualization



*Still some major performance problems, but under investigation...*

# Infrastructure

- Unit testing with CxxTest

<http://cxxtest.sourceforge.net/>


- Website: <http://nu.ph.utexas.edu/bw/trac/>
  - User-updatable manuals, howtos, FAQs
  - Browse syntax-highlighted source code
  - Timeline of source code changes with diffs
  - Bug tracking
  - Build testing results for Linux, Solaris, Mac OS X
- Email list: [bw\\_sim@hep.chicago.edu](mailto:bw_sim@hep.chicago.edu)

# Website

Braidwood - Trac

http://nu.ph.utexas.edu/bw/trac/

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 **Braidwood**  
**RAT**

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## Braidwood Software: Reactor Analysis Tool (RAT)

RAT is a Monte Carlo and analysis tools for the [Braidwood reactor experiment](#).

### Releases

There have been no official releases yet!

### Documentation

#### Manuals

- [UserGuide](#)
- [ProgrammerGuide](#)

#### Links to how-to's

- [How to setup RAT](#)
- [How to add a processor](#)
- [Off-line Analysis with RAT](#)
- [Generalized ROOT tutorial by BaBar](#)
- [How to view simulations with HEPDED files in Wired](#)



# Projects in Progress/To Do:

- Full simulation of front-end electronics, triggering system, and readout for PMTs + ability to try various configurations and alternate systems.
- Selectable two-zone vs. three-zone detector
- Streamline event generator code to make it easier to add new interactions/decays.
- New generators: radioactive decay,  $\nu$  elastic scattering, ...
- More sophisticated detector geometry with supports, ropes, etc.
- *Actual software release!*