Background Simulation for Experiments

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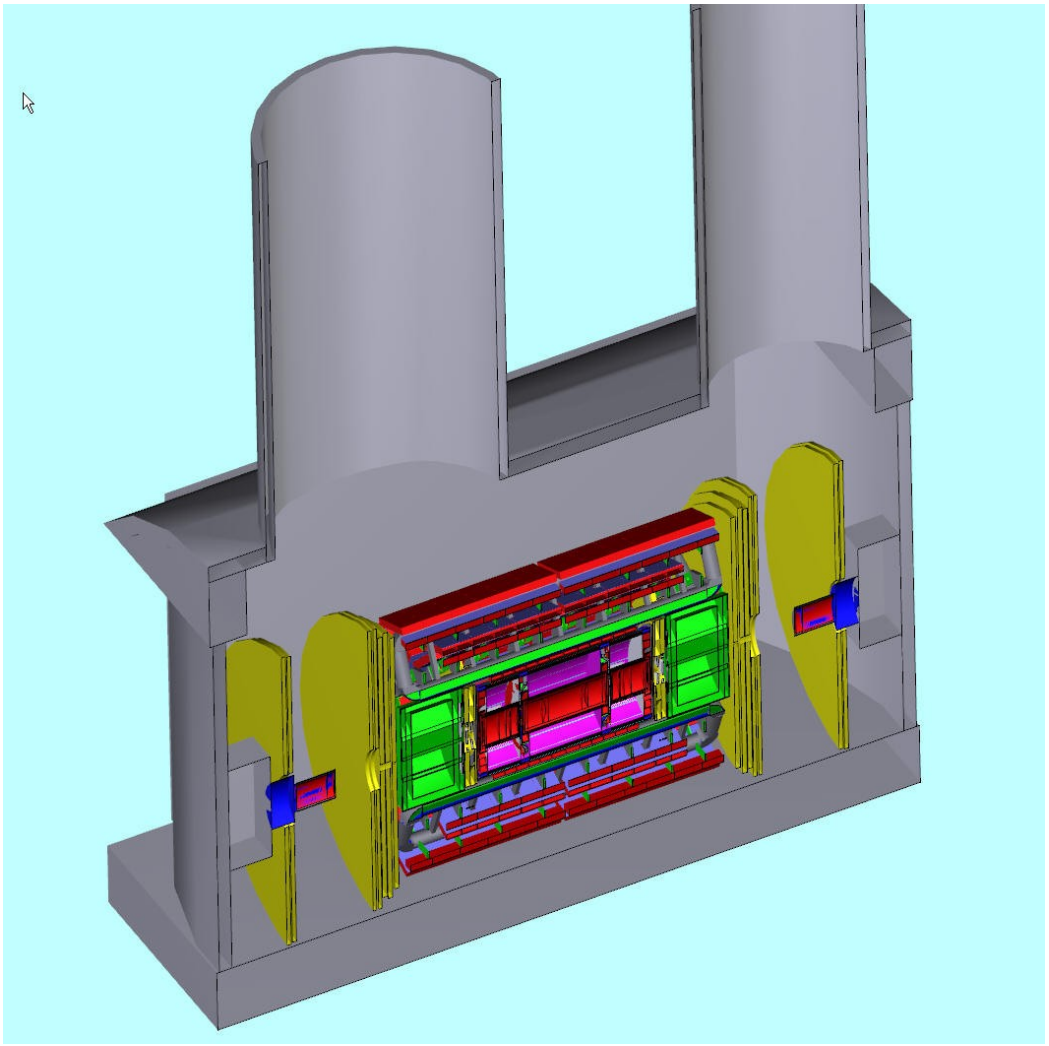
SLAC Team Simulation Contributions

- The SLAC team provides development, support and integration of various simulation tools used by several experiments
  - ATLAS, CDMS, EXO
- Tools developed, maintained or used by SLAC team
  - Geant4
  - FLUKA
  - Cosmic muon generator codes
  - Simulation framework

ATLAS Cavern Background Simulation

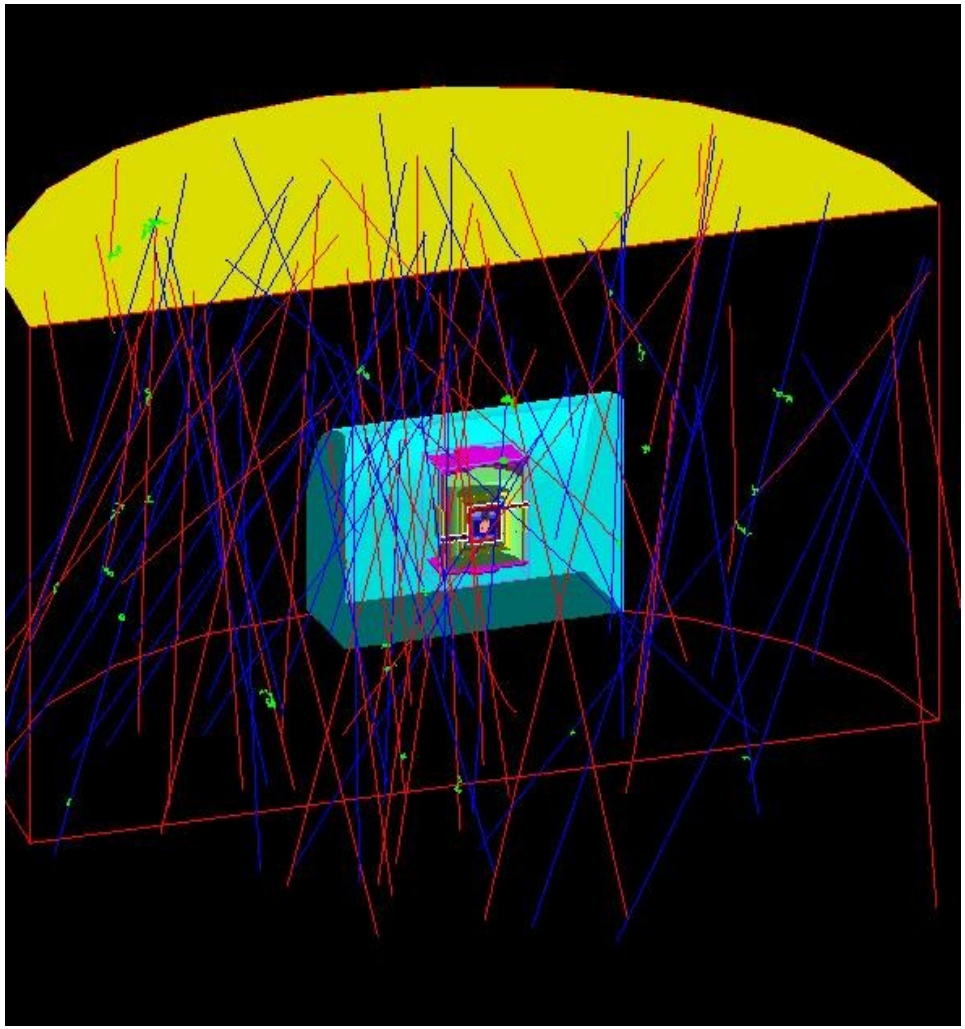


- Simulate beam-induced background
- Estimate intensity-driven rates in muon chambers
- PPA-SCA contributors
  - Tatsumi Koi
  - Dennis Wright

ATLAS Background Simulation

- Neutrons and gammas from beam interaction in beamline and shielding cause pile-up in the ATLAS muon chambers
  - use simulation to estimate pile-up rate
- Stand-alone Geant4/FLUKA simulation of ATLAS detector and cavern developed to produce files of rays to be fed into Athena (full ATLAS simulation)
  - Geant4 geometry
  - Pythia for initial collisions
  - FLUKA for propagation through beamline and shielding
- New Athena generator developed to convert these rays from FLUKA format to ATLAS format and transfer them to Athena for tracking

SuperCDMS Cavern Background Simulation

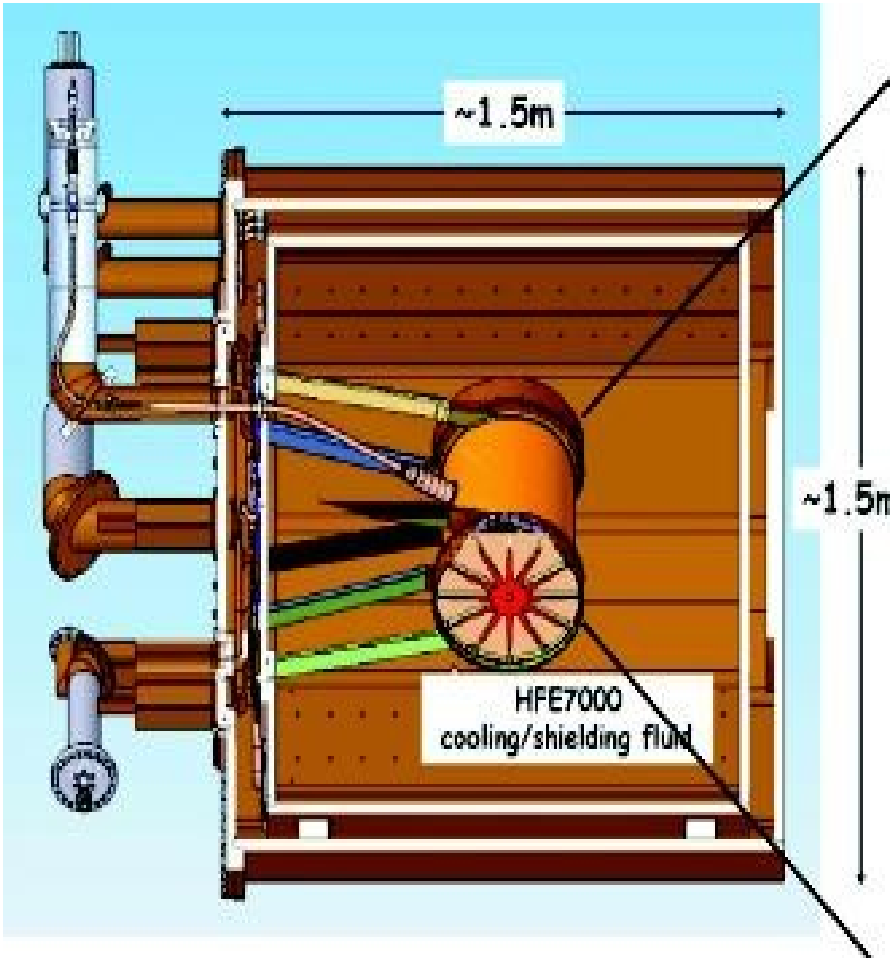


- Large mass Ge dark matter search
  - Ge nucleus recoil from χ_0 scatter
- Challenges
  - cosmic-ray-induced neutrons
  - natural radioactivity
- PPA-SCA contributors
  - Mike Kelsey
  - Dennis Wright
  - Makoto Asai

CDMS Background Simulation

- Nuclear recoils from neutralino scattering can be mimicked by:
  - muon-induced neutrons (capture or mu-nuclear reactions)
  - α s from radioactive decay or fission can produce neutrons from α-n reactions
  - electrons from radioactive decay in the cavern walls
- Simulations of all of the above done using Geant4
- Flexible Geant4-based framework developed to allow simulation of many different detector/lab/generator combinations
  - all user-configurable
- Studies underway of cosmic ray muon generators
  - proposed translation of some Fortran generators into C++

EXO Natural Radioactivity Simulation



- Neutrinoless double beta decay
  - $^{136}Xe \rightarrow {}^{136}Ba + e^- + e^-$
- Goal:
  - is ν Majorana ?
  - measure its mass
- Challenges:
  - possibly zero branching ratio
  - backgrounds, cosmic and radioactive

EXO Radioactive Decay Improvements

- Very small (or non-existent) branching ratio of neutrinoless double beta decays
  - even low-probability radioactive decay bacgrounds must be well-understood
- Background simulation done with Geant4, but improvement required in G4 radioactive decay module
  - Forbidden decays (such as ^{40}K)
  - Electron screening effects
  - Complete relativistic treatment of beta spectra
  - Correlated decays
  - Random ordering of decay products in U-Th decay chain
  - Work on the above list has just begun