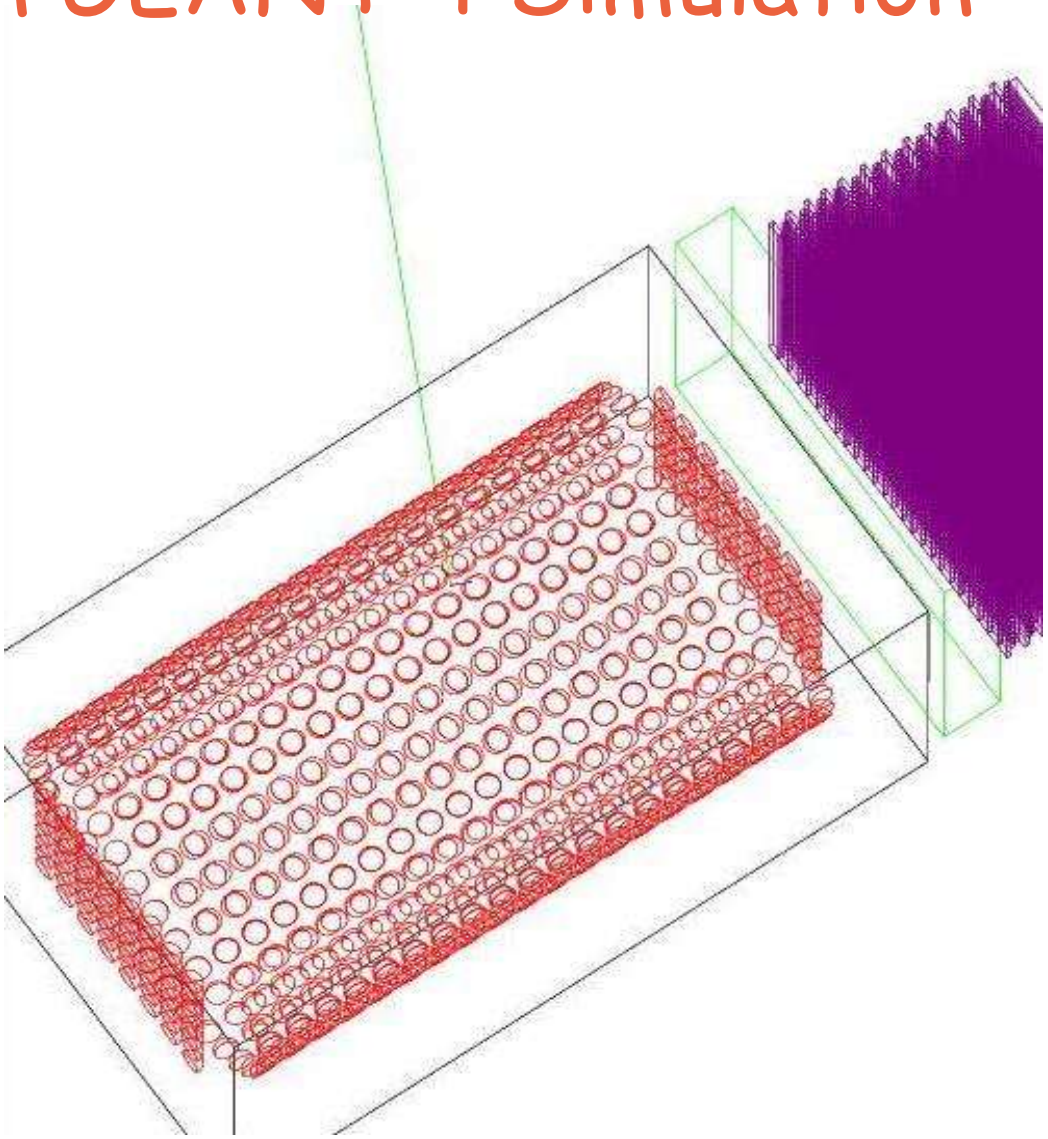
Status of the 2km GEANT 4 Simulation

- Update since last meeting 2 weeks ago
- Status
  - Projects
  - People
- Plans/Schedule



Chris Walter
Boston University
01/26/04

Since the Collaboration Meeting

- We had a phone conference for some of the US people working towards the SAGENAP meeting on Jan 16th.
  - Walter, Kearns, Svoboda, Dazeley, Sobel, Casper, Smy, Vagins, Kropp, Mine, Wilkes
- We discussed our technical options for doing physics studies and decided the best thing was to follow two tracks.
  - Work hard to make the GEANT4 simulation usuable for studies by completing the simulation code for more than one pixelization. Also study joint WC/FGD analysis etc.
  - Also ask to have the 1kton simulation extended to 2km size.

Goals

- 2km Simulation:
  - Make simulation work with different pixelizations
  - Try to analyze with stand alone polfit and or modified SK code.
- 1 kton code
  - We need to show that water Cherenkov can perform as well as needed to achieve the resolution we claim. In K2K we may not have achieved this. ==>> Study changes necessary for example: calibration
  - If we extend to 2km size we can try to use modified 1kton code and we can use as a baseline to compare against 2km simulation, by running the same standalone code.

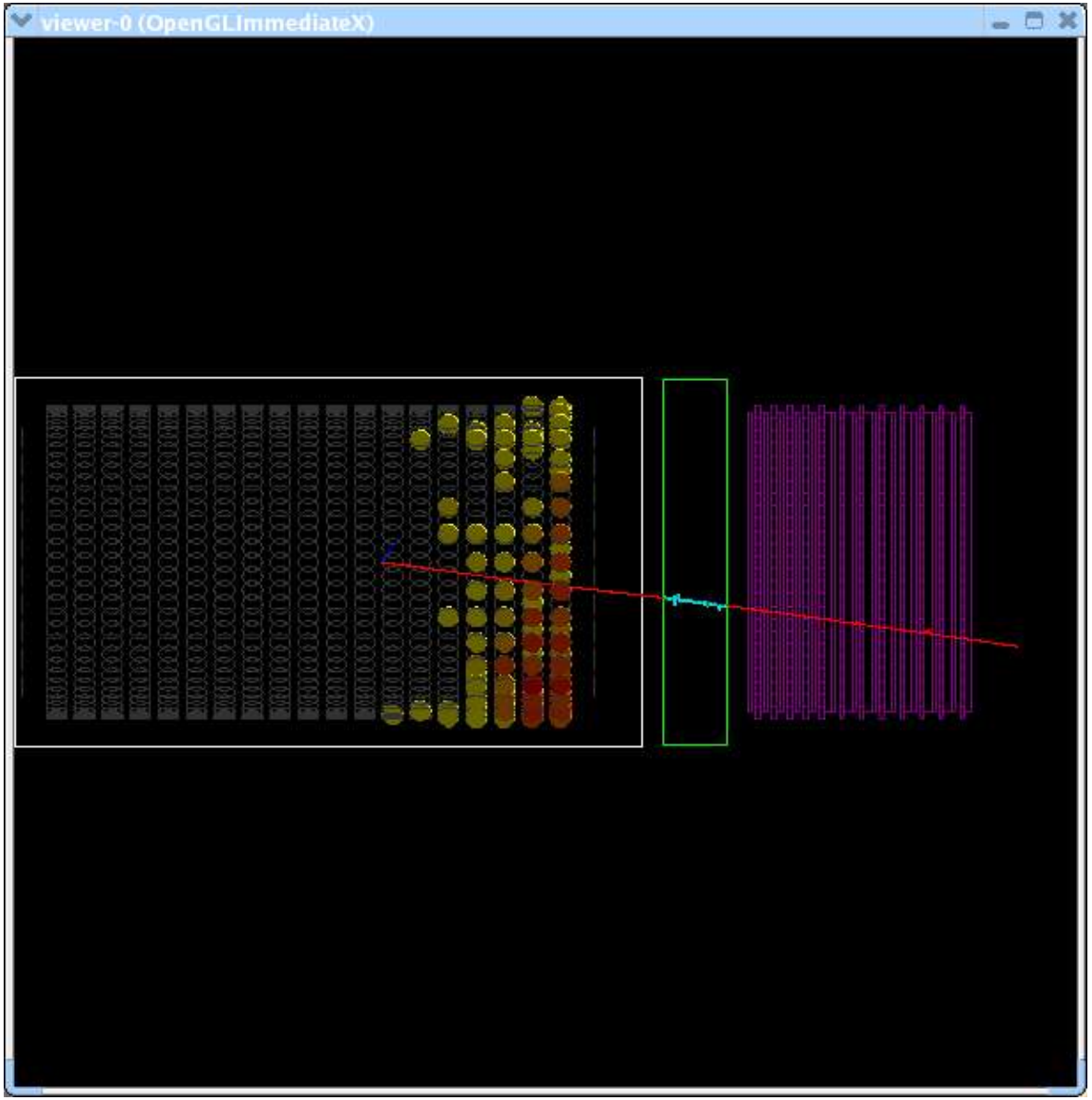
Job Lists:

- Chris W. - MC code structure. Hits/Digitization etc.
- Ed K.- Water Cherenkov tube geometry definitions/ multiple pixelization.
- Kate S.- Root access to MC output. Interface with standalone analysis code.
- S. Mine/Dave C./Kate S. - Modification of Polfit/Rewrite of standalone Polfit/Explib for electron appearance /fitting.
- Bob S. - MRD simulation completion.
- Steven D./Michael S. – Water scattering paramaters/material reflection paramaters etc.
- Michael S.– Generalizing standalone Bonsai vertex fitter..
- Dave W. - Test GEANT4 Cherenkov/production water scattering.

Simulation Status now(WC)

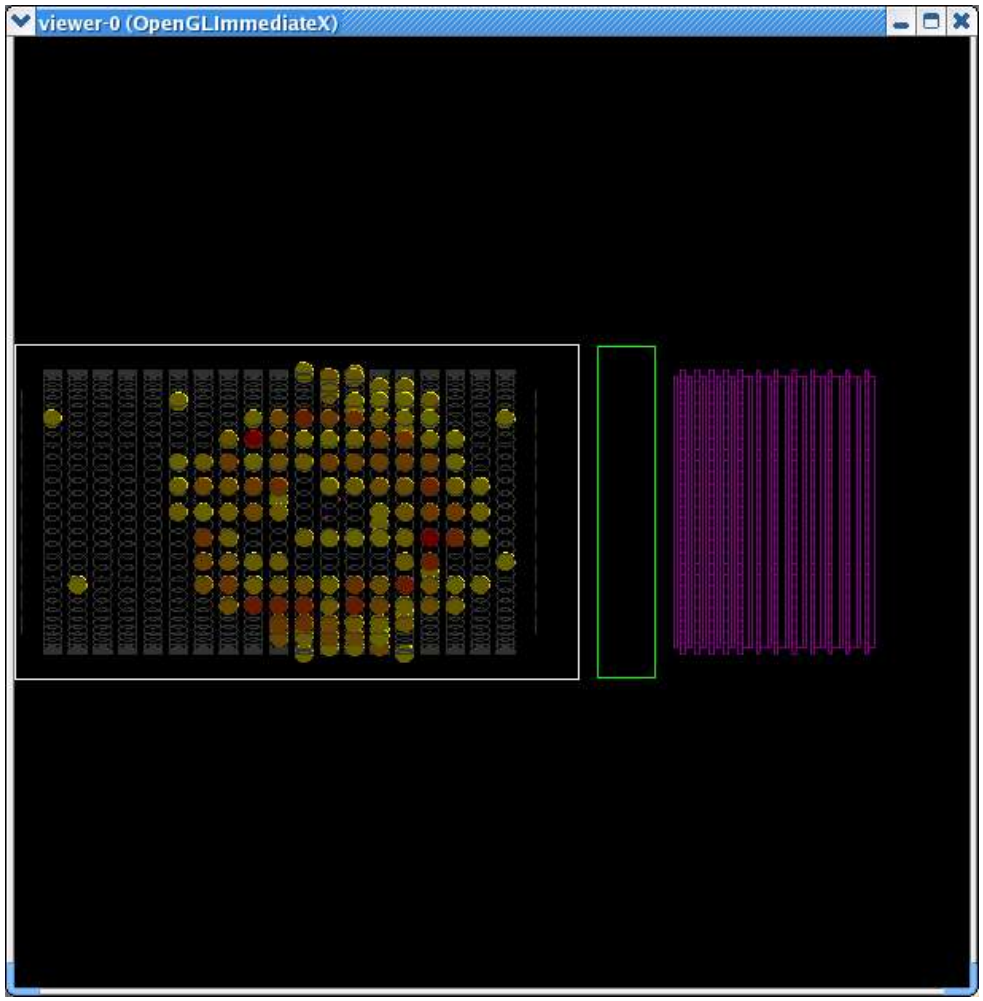
- WC is now simulated with two configurations (20" PMT/8" PMT)
- Cherenkov photons are propogated (with SK tube QE taken into effect)
- Multiple single PE hits are recorded at PMTs. Photon hits are summed and digitized for analysis.
- Processed information is written into a ntuple and root structure
- ToDo(today!): Missing tubeID <> XYZ mapping.

Cherenkov + FGD + MRD

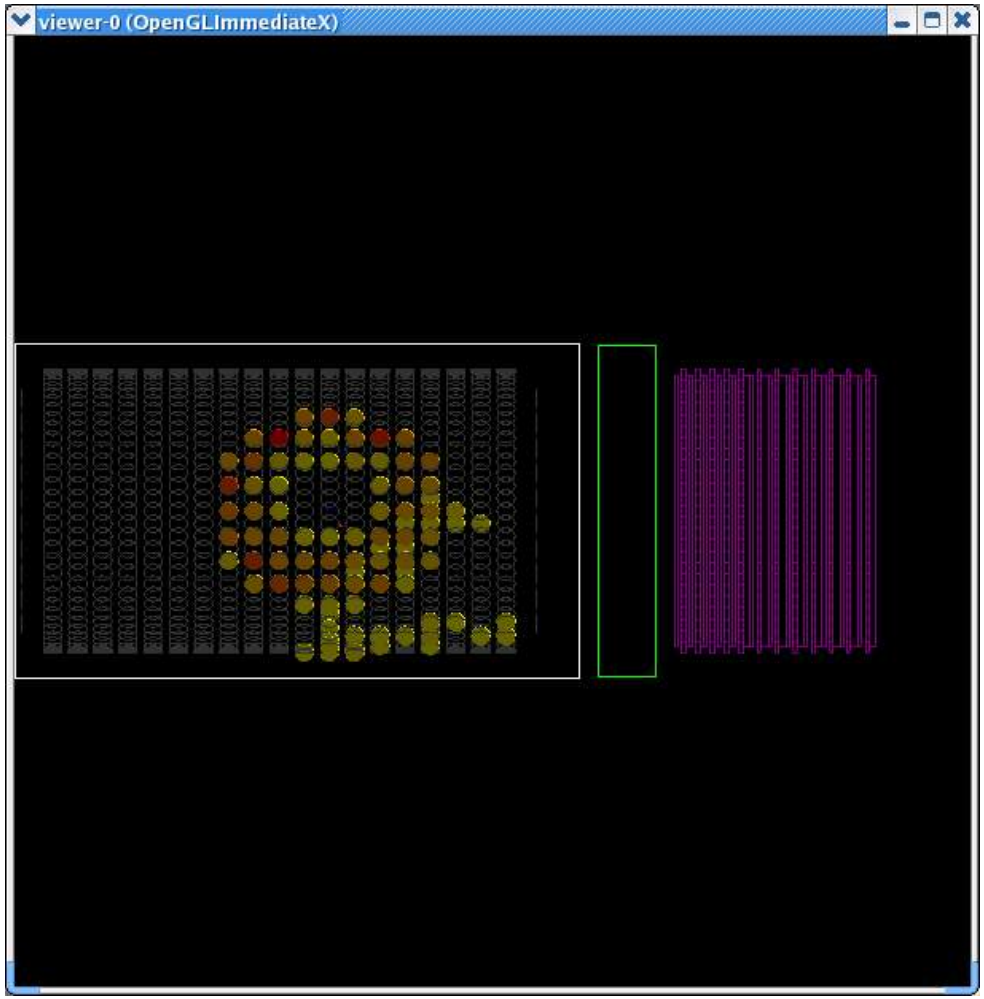


Uses JPARC neut vectors converted to NUANCE text format.

Electron and Muon with 20" PMT

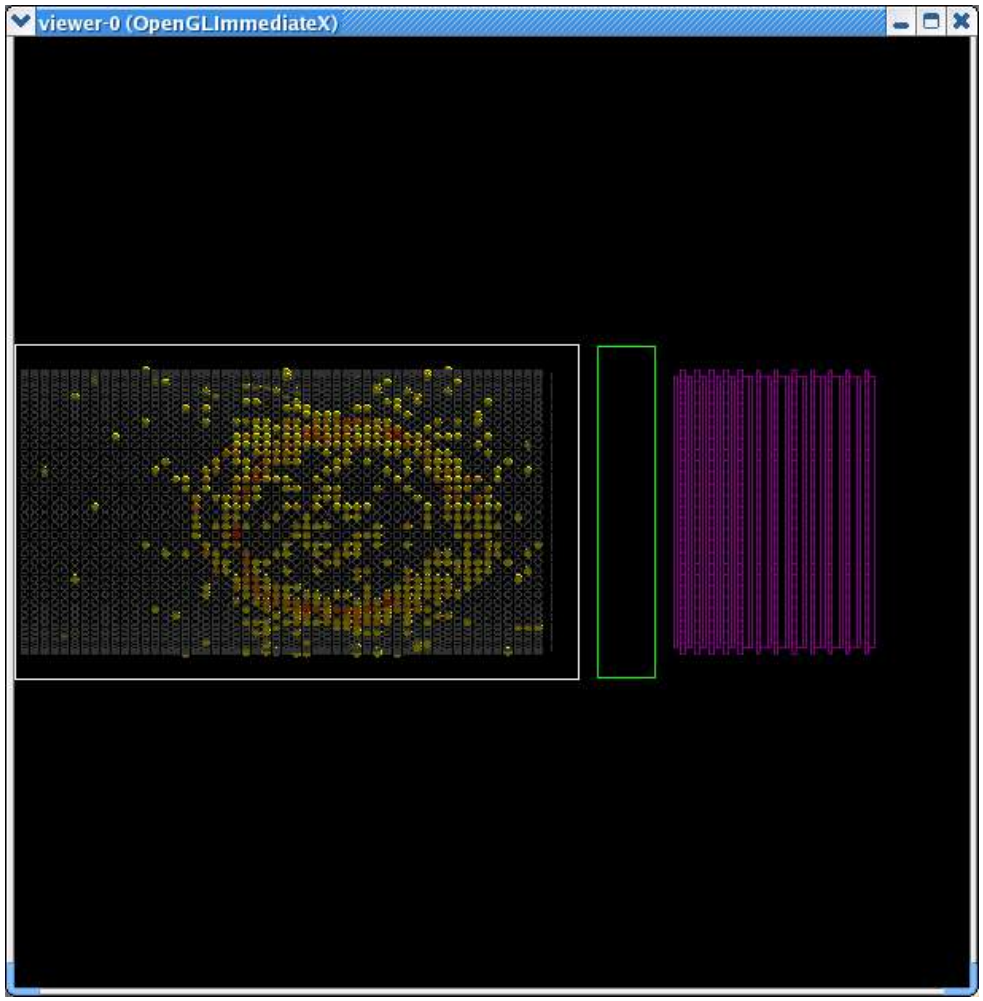


100 MeV KE e+

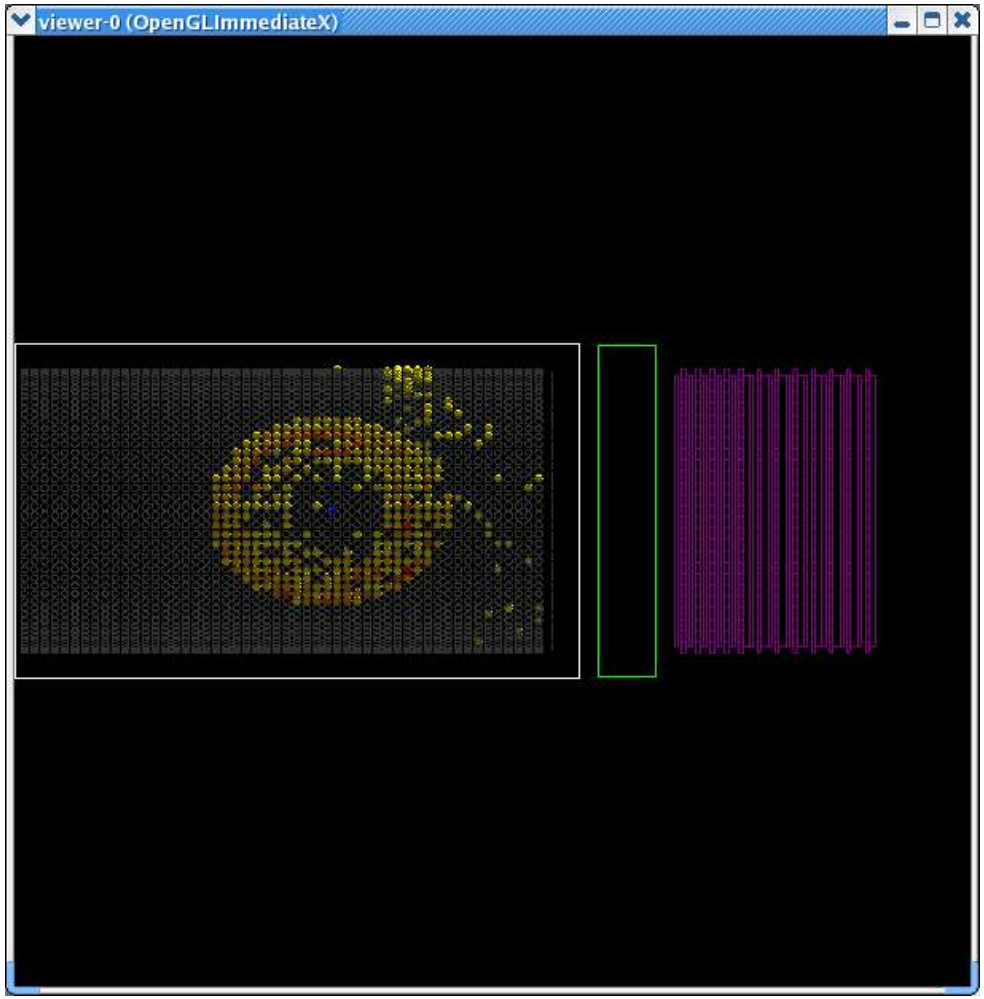


300 MeV KE mu+ (with decay e)

Electron and Muon with 8" PMT

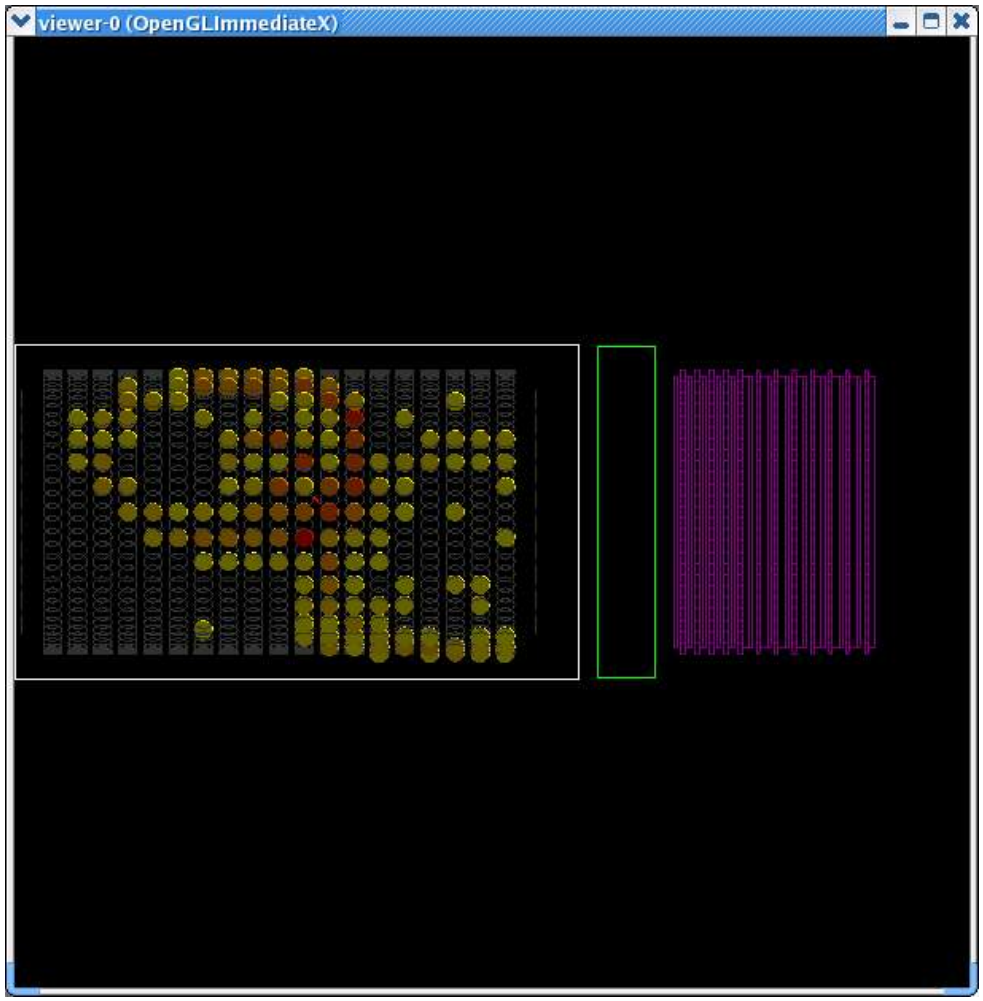


100 MeV KE e+

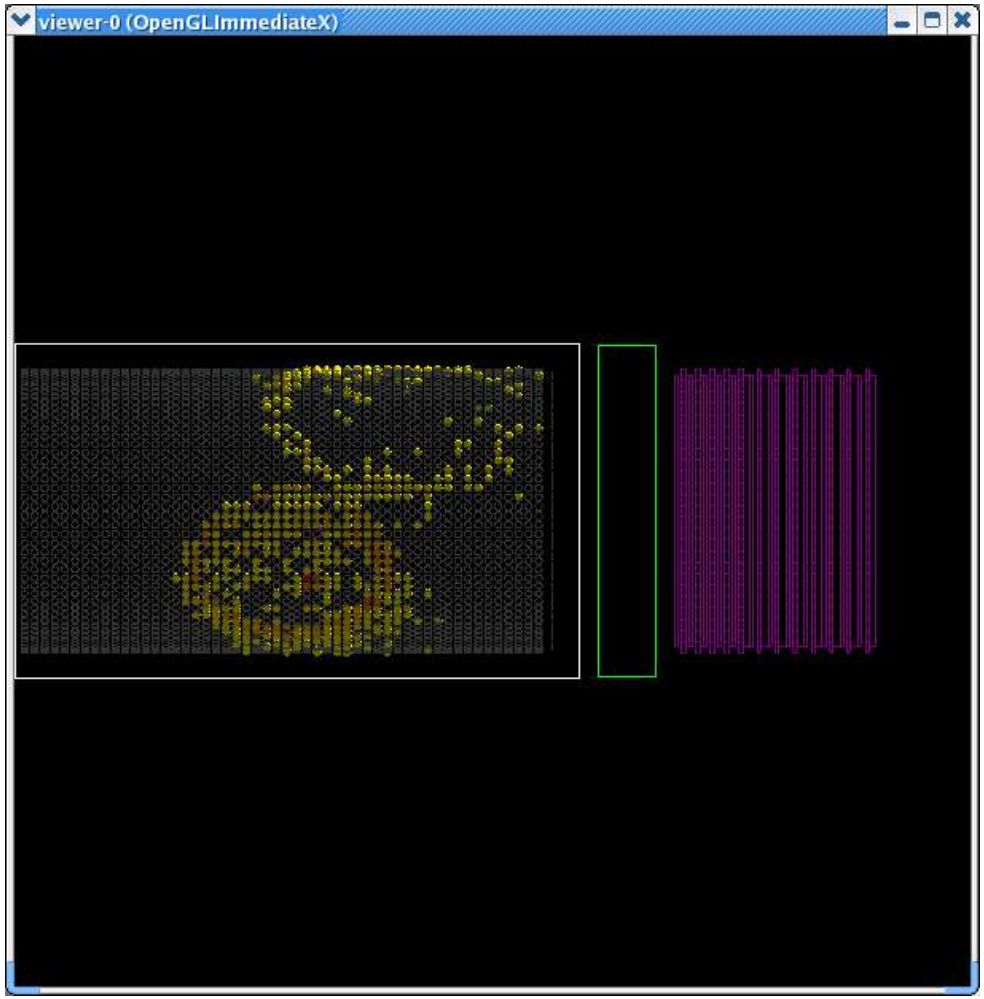


300 MeV KE mu+ (with decay e)

PiO with 8" and 20" PMT



100 MeV KE pi0



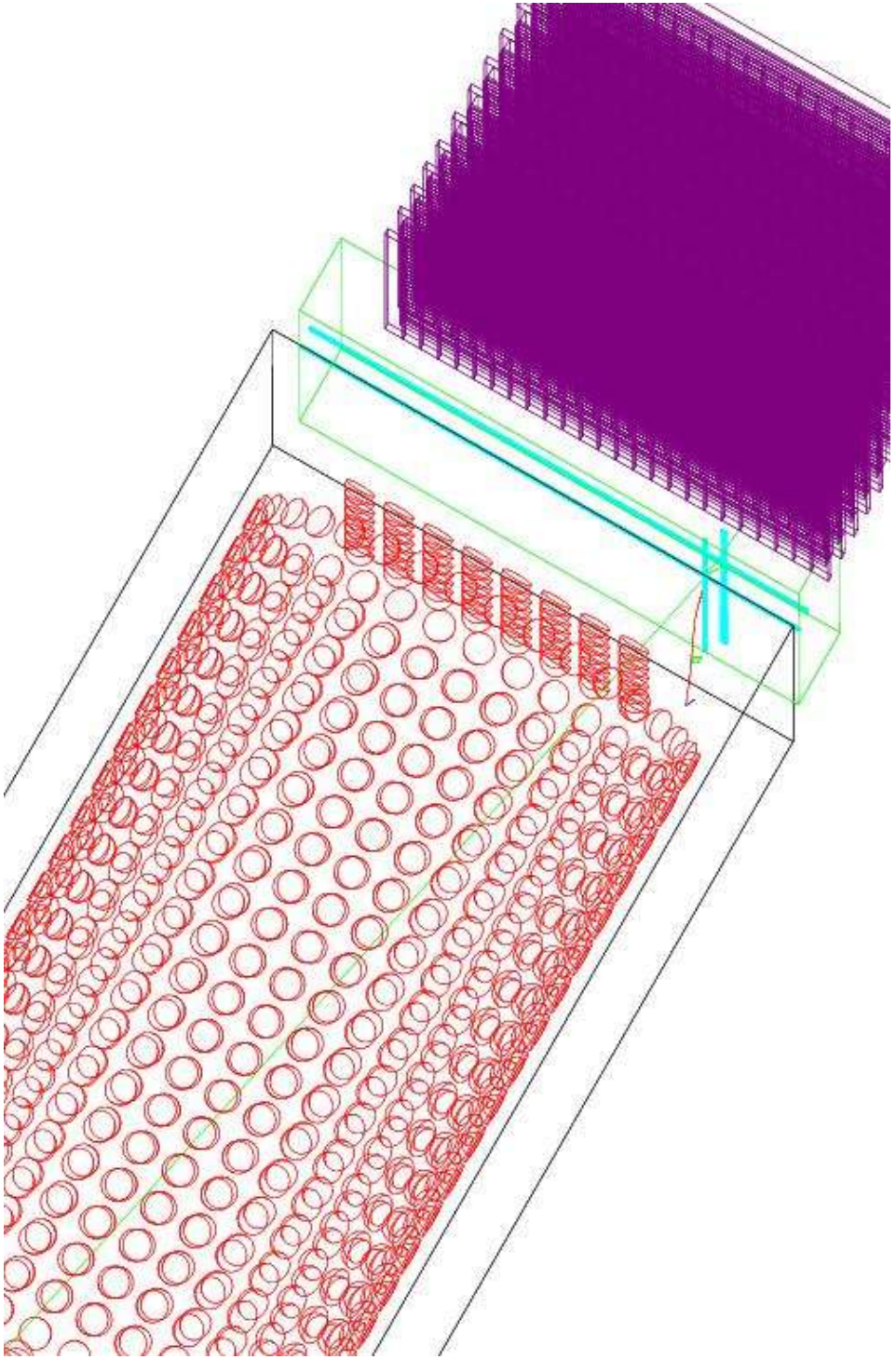
100 MeV KE pi0

X&Y Hits in FGD

The detectors are sensitive to hits, but as of right now there is no digitization information. Sci-bar type detector.

This is an area which can use people to studies of alternative options.

Rex Tayloe of FINeSSE has asked about studying a "SciBath" option. European GEANT4 experts could contribute here.



Plans for 2km Monte Carlo Reconstruction Using Polfit

D. Casper

S. Mine

K. Scholberg

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Existing SuperK Code

- So-called "π^0 fitter" (Polfit) actually consists of several parts:
  - Expected charge prediction
    - Much faster scattered light calculation than other libraries
  - Likelihood estimation
    - Compare observed Q distribution with expected Q
  - Specialized algorithm to find maximum likelihood for π^0 fitting

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Stand-alone Version

- A new version of the expected charge and likelihood estimation has been written for earlier studies of 2km detector
  - Completely independent of SK libraries
  - Written in object-oriented language (C#)
  - Includes new and potentially important physics (not considered in SK version)
    - Reflected light from PMTs and black-sheet
- Does not include a "fitter" (likelihood maximization) yet, but preliminary studies are encouraging
  - Seems able to discriminate e/μ and locate vertex position along track

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Application to 2km Detector

- Plan is to translate stand-alone version to C++
- Able to handle different detector geometries flexibly
- Does not require any SK code
  - New library should be usable for 2km detector, as well as SK and 1kton data
- Likelihood technique in principle can:
  - Find vertex (if timing information included)
  - Find track directions
  - Perform particle ID
  - Test different topological hypotheses (1-ring/2-ring)

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Detailed Work Plan

- Proceed in steps, from most basic to more complex:
  - Convert stand-alone code to C++
  - Test and tune expected charge prediction
  - Compare expected/observed charge to obtain likelihood (goodness of fit)
  - Add likelihood maximization (fitting) capability
    - Grid search, simplex, simulated annealing, …
  - Provide covariance matrix of fitted parameters
- Proceed as far as possible before SAGENAP meeting
  - Interesting plots and performance studies are possible once likelihood calculation works
  - Possible to work around capabilities not yet available, using MC truth
    - E.g. use MC truth vertex (smeared by Gaussian), use MC truth track direction and step along track, etc.

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Proposed Initial Division of Labor

- Dave:
  - Translate standalone algorithm into C++
  - Debug internal code of stand-alone library
  - Add fitting (likelihood maximization) capability
- Kate:
  - Provide geometry, PMT data, starting vertex, etc from 2km simulation to new fitter library
  - Test and tune expected charge and likelihood for 2km
  - Integrate and test new library with 2km simulation software
- Mine
  - Provide geometry, PMT data, starting vertex, etc from SuperK and/or 1kton simulation to new fitter library
  - Test and tune expected charge and likelihood for SK/1kton
  - Compare 2km results with SK/1kton and confirm validity of simulation

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Schedule/Plans

Now

- 1st order WC simulation almost ready. Need correct scattering/matertial reflections and tube ID.
- WC Hit/digitization structure + physics/track info being written out to ntuple/roottuple now.
- Work continuing on stand alone polfit analysis code coding and interfacing to the root data.

Goal: Finish 1st order simulation + calling polfit code ~ 1 week from now.

Next

- Better simulation paramaters + materials/geometry.
- Tuning of analysis code. Comparison with SK/1kton
- Initial e vs. pi0 8" vs 20" performance