Photon Detector Simulation

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LBNE Collaboration Meeting
2/1/2014

Current Status

- Sub Group has been formed to begin photon detector simulation tasks

  - Biweekly meetings Tuesday at 1:00 CST

  - Using the Electron-Photon Transport mailing list

- Preliminary work has been done my multiple members of the collaboration

  - First half of this talk

- Initial list of tasks and open questions has been created

  - Remainder of this talk

Physics Goals of Simulation

- Simulation required to understand physics requirements and how to achieve them with photon detector

- Create best case simulation to answer basic questions of the physics potential

- Test and optimize photon detector geometry for far detector

- Begin working on combining charge and light information for reconstruction

- Investigate effect of nitrogen contamination on performance of detector

Stan Seibert

- Looked into simulating light collection in bars

  - Investigated light collection in transparent vs. opaque cathode planes

  - Also investigated reading out bars from SiPMs on both ends rather than just one

- Studies on effects of SiPM dark noise and light from Ar^{39} decays when collecting single PEs

Dave Muller

- Work investigating parameterizing detector and light guide for simulations
  - Can greatly speed up simulation process
  - Needs to be compared to a full simulation before being trusted for use

Example looking at photons detected in a 10 cm x 10 cm section of detector as a function of where they were created

DocDb: 7788, 6842
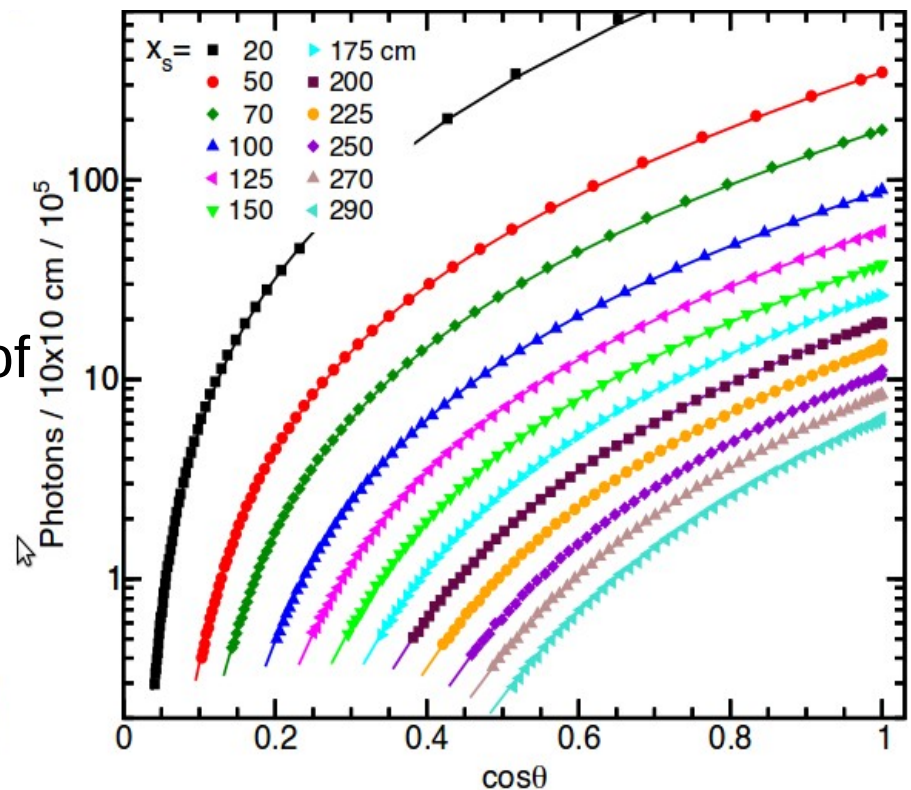
Zeping Li

- Began looking into how to reduce memory usage when generating large number of photons

  – Primarily in large scale far detector

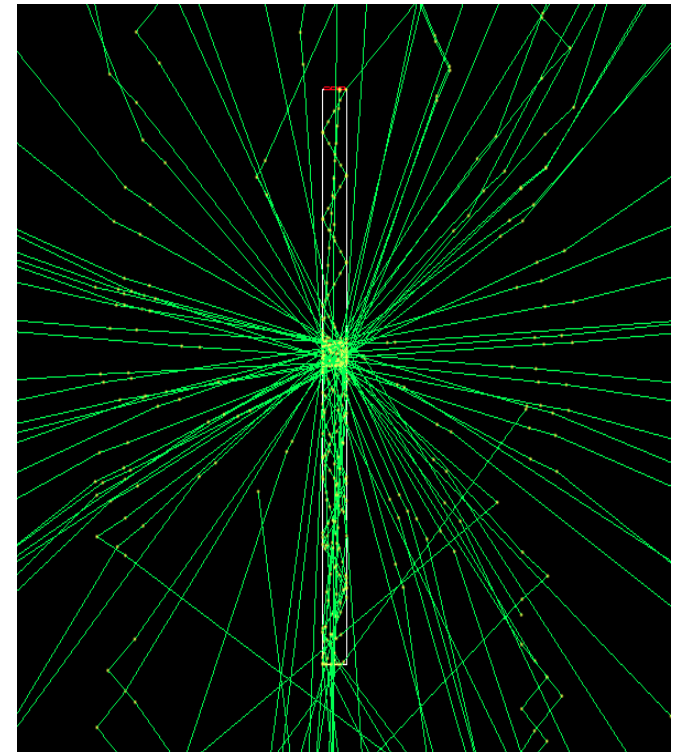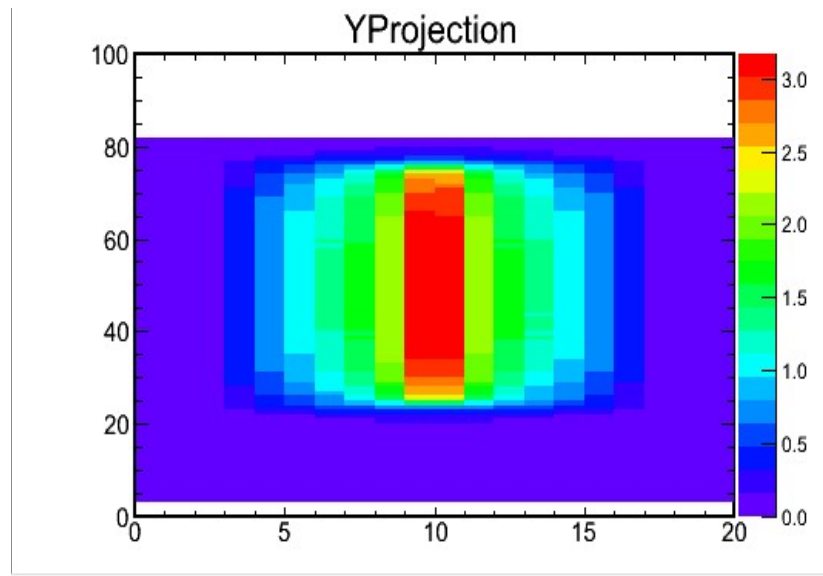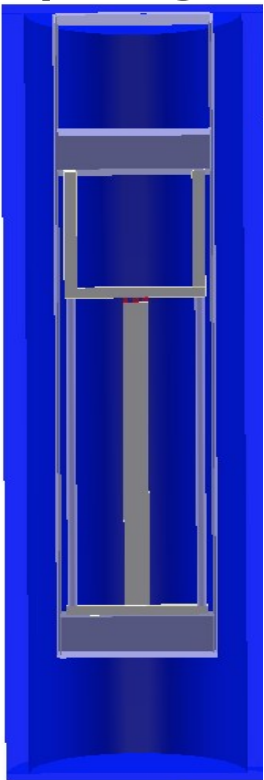- Also added SiPM waveform into LArSoft and looked into timing information
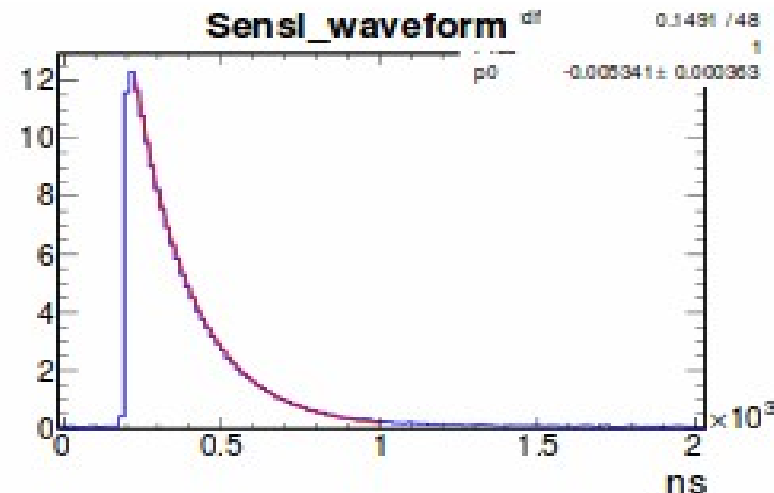
Figure: SensI single photon waveform

DocDb: 7984, 7670, 7624, etc.
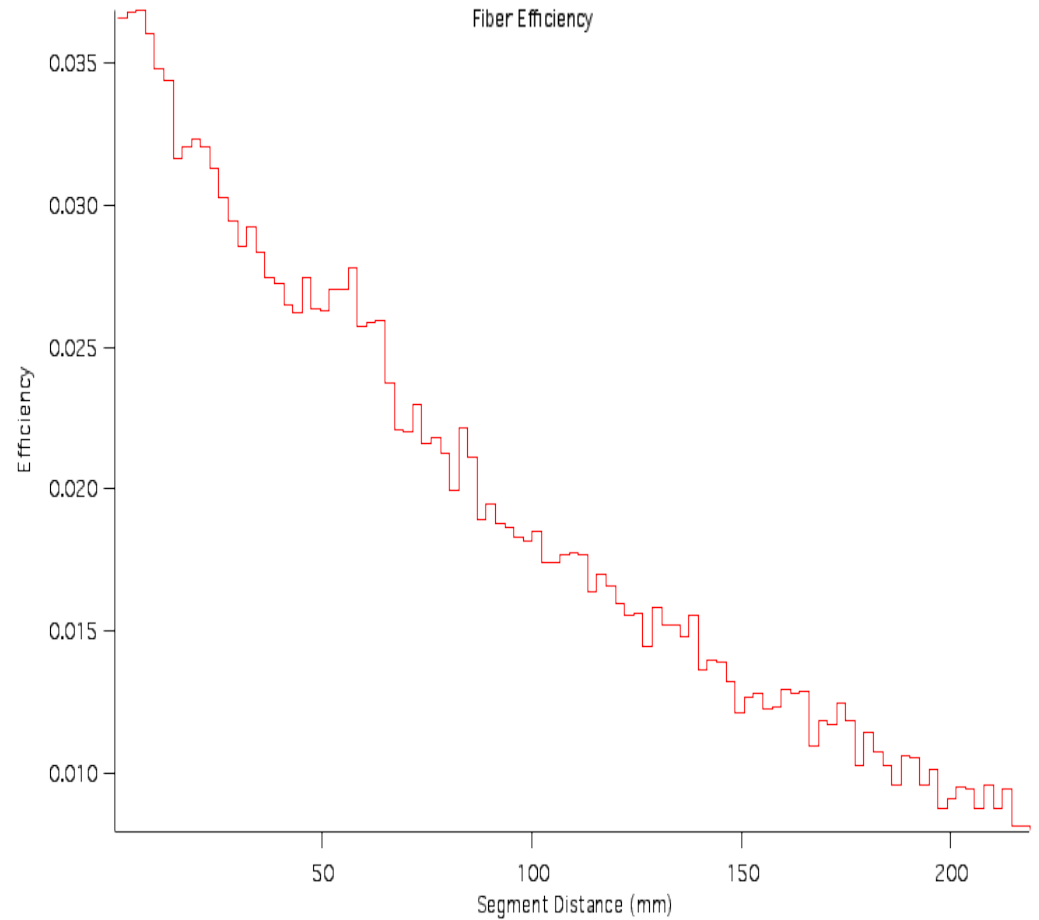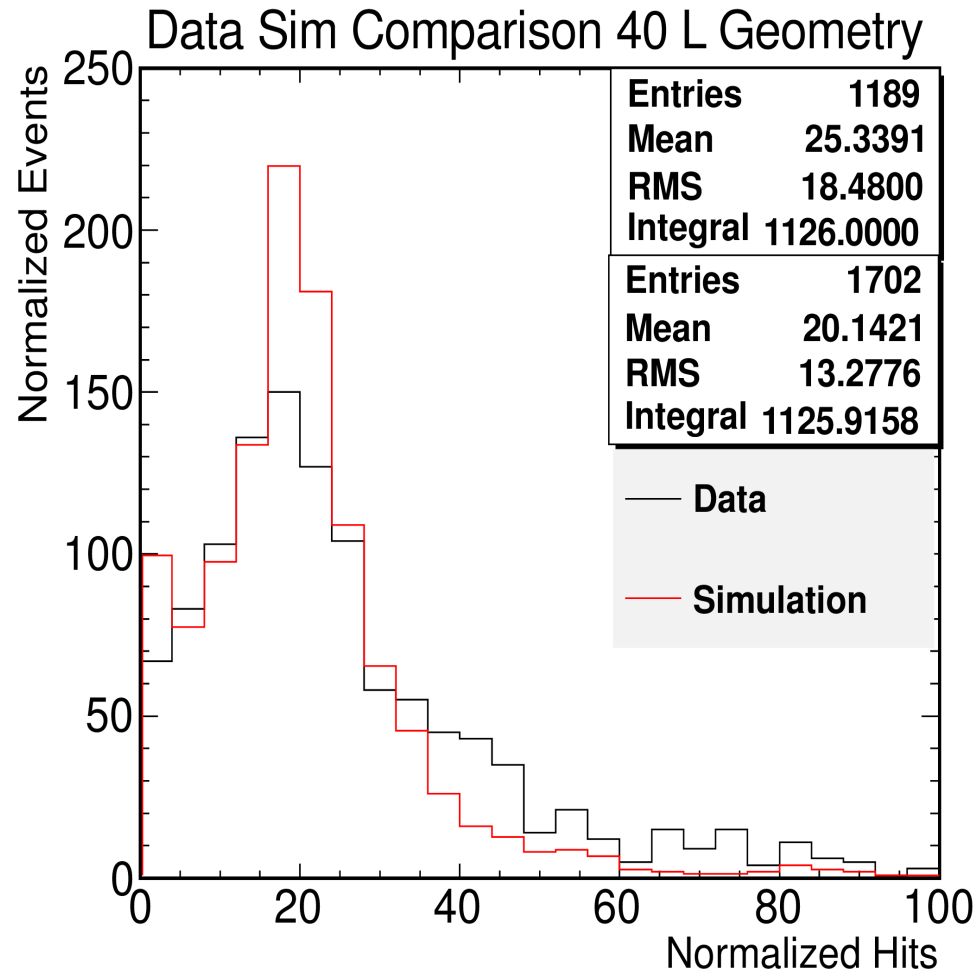
CSU Work

- Previously conducted studies on simulation of CSU test stands

- Includes both LArSoft package to create photon library and stand alone Geant4 program to model light propagation in the bar

CSU Work

Data Sim Comparison 40 L Geometry

Entries	1189
Mean	25.3391
RMS	18.4800
Integral	1126.0000
Entries	1702
Mean	20.1421
RMS	13.2776
Integral	1125.9158

— Data

— Simulation

Fiber Efficiency

DocDb: 7777,7623,7489

Photon Libraries

- There is a need to consider how to best handle creating photon libraries

  - Each change to detector geometry or materials properties requires rebuilding photon library

  - This creates large turn around time for testing multiple detector configurations

  - Piece-wise or parameterized simulation seems to be the best answer to this

    - How to best implement this?

Geometry

- Photon Detectors need to be placed into existing gdmls for 35t and far detector
  - Need to receive information from photon detector groups about what PD modules will be going into 35t and which APA will hold each module
- Are we interested in simulating other detectors?
  - CSU test stands, TallBo
  - Could provide information for tuning simulation with less overhead than full scale detectors

Geometry

- I have begun by creating a gdml for first CSU PD module that will go into 35t test

    - 32 Fibers grouped into 8 4-Fiber bundles and 8 SiPM readouts

- Need to consider how to handle segmentation of bars and fibers for light propagation
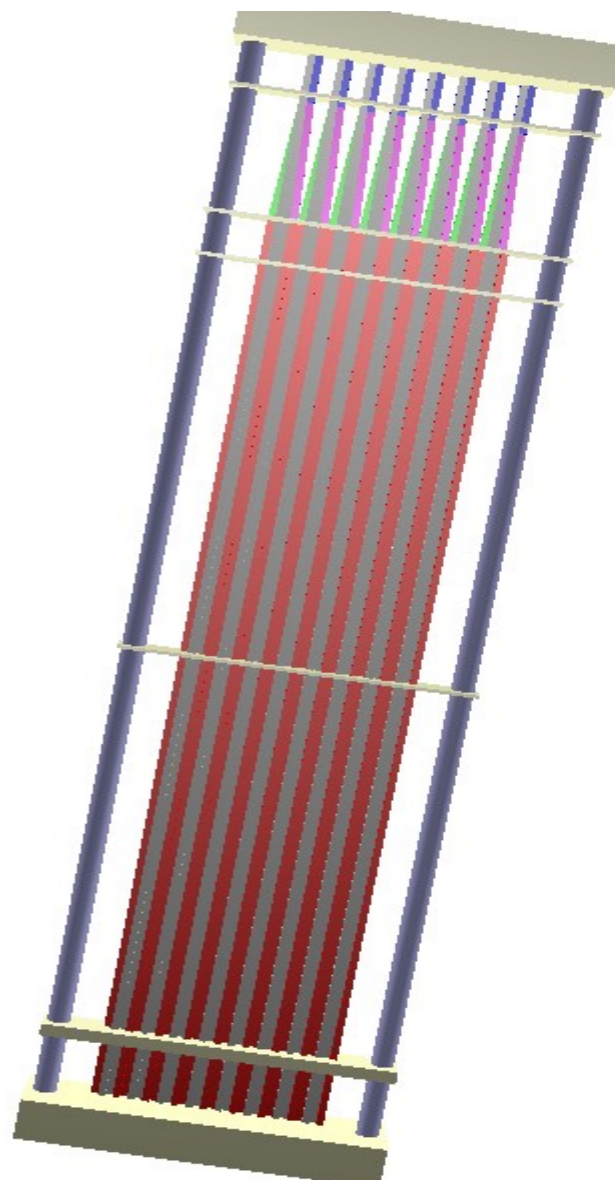
Light Propagation in Bars or Fibers

- This is currently done after LArSoft has propagated photons through detector

  - Advantages

    - Bar or fiber properties can be changed without full LArSoft simulation

  - Disadvantage

    - This requires separate stand alone package and not currently handled in LArSoft

    - Also requires segmenting light collection elements so more information must be stored from LArSoft simulation

Materials Characterization

- In order to compare simulation to data there is a need to include correct optical properties for detector materials at 128 nm

  - Stainless steel, delrin, etc.

- Requires thorough search of existing measurements and plans for laboratory tests

Summary

- Preliminary work has been done to begin creating simulations to understand photon detectors

- Many questions still need answered

    - Both physics and software

- Group has been created to begin looking into this