

Hybrid photon library concept

DUNE FD sim/reco meeting – 27 Nov 2017

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Introduction

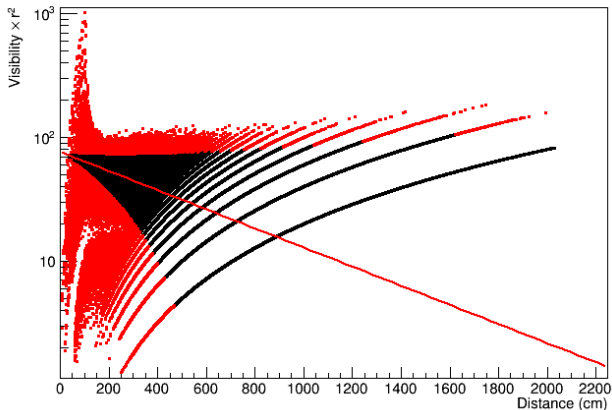
- ▶ Full GEANT simulation of every scintillation photon is impractical
- ▶ OpDet visibilities are computed offline and stored in a library

- ▶ For $1 \times 2 \times 6$ geometry $300 \times 100 \times 100$ voxels $\times 120$ opdets
→ $3,000,000 \times 120 \times 4$ bytes = 1.34 GB
- ▶ Much more for full detector. Also impractical
- ▶ Regions of low visibility also suffer from poor library statistics

The idea

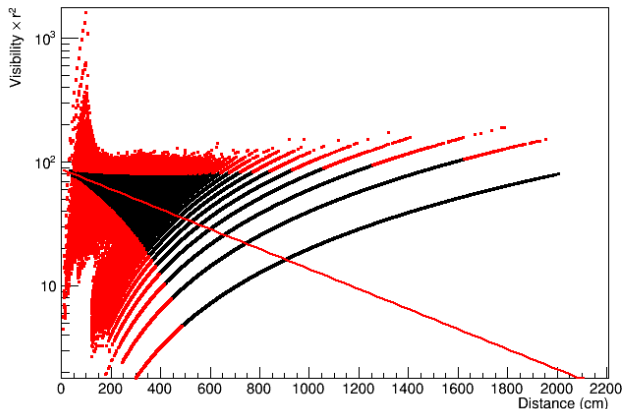
- ▶ Light spreads out as $1/r^2$
- ▶ Also expect some $\exp(-r)$ from absorption of photons
- ▶ Far from photon detectors, other geometric effects probably small
- ▶ Can we parameterize most of the space and only use an explicit library for a small part?

Parameterization



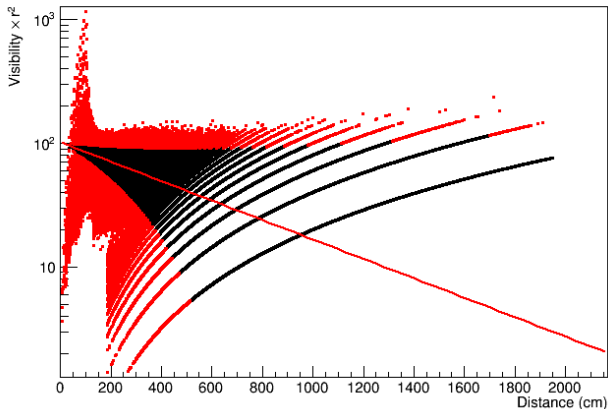
- ▶ For each OpDet, plot visibility of every pixel vs distance (r)
- ▶ Already took out $1/r^2$ dependence, fit exponential to remainder
- ▶ Red points ($\sim 3\%$ of total) are outside 3σ of fit line
- ▶ Discrete bands due to poisson statistics in lookup table

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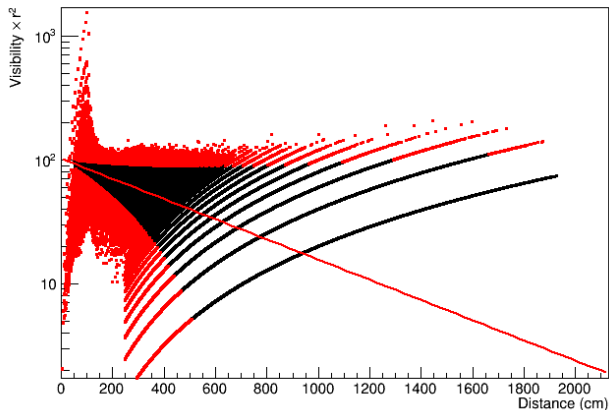
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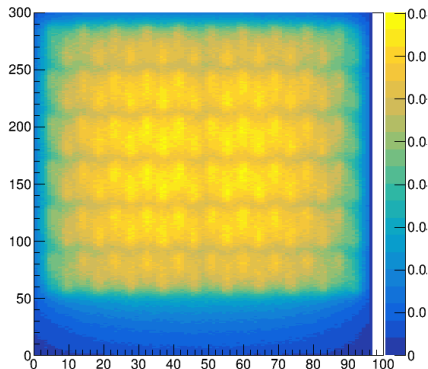
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Performance

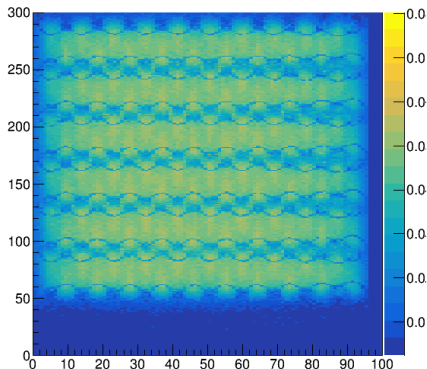
- ▶ Converting the dense library to hybrid form takes 10s of minutes
- ▶ Save functional form (tiny) and exception table for each OpDet
- ▶ $3\% \times 300 \times 100 \times 100 \times 120 \times 8 \text{ bytes} = 82 \text{ MB}$
- ▶ Library for full FD will be larger, but expect greater savings in fractional terms (more of the detector is far away)
- ▶ Time to lookup in exception table slower than indexing dense library, will be negligible compared to GEANT, ReadoutSim etc

Physics performance

Dense
projX45



Hybrid
projX45



- ▶ Animations at www.hep.ucl.ac.uk/~bckhouse/for/dune_lbl_171127/
- ▶ Pretty sure there's a bug...

Conclusions

- ▶ Code all available in `larsim` branch
`feature/bckhouse_photonlibhybrid`
- ▶ Bea will investigate and drive towards mergeable state

- ▶ Future enhancements could include:
 - ▶ Smarter parameterization to describe more of the space
 - ▶ Variable sized bins to capture rapid variation near APA
 - ▶ Synchronization with DP implementation