Optical Characterization of Opaque Media for Particle Tracking

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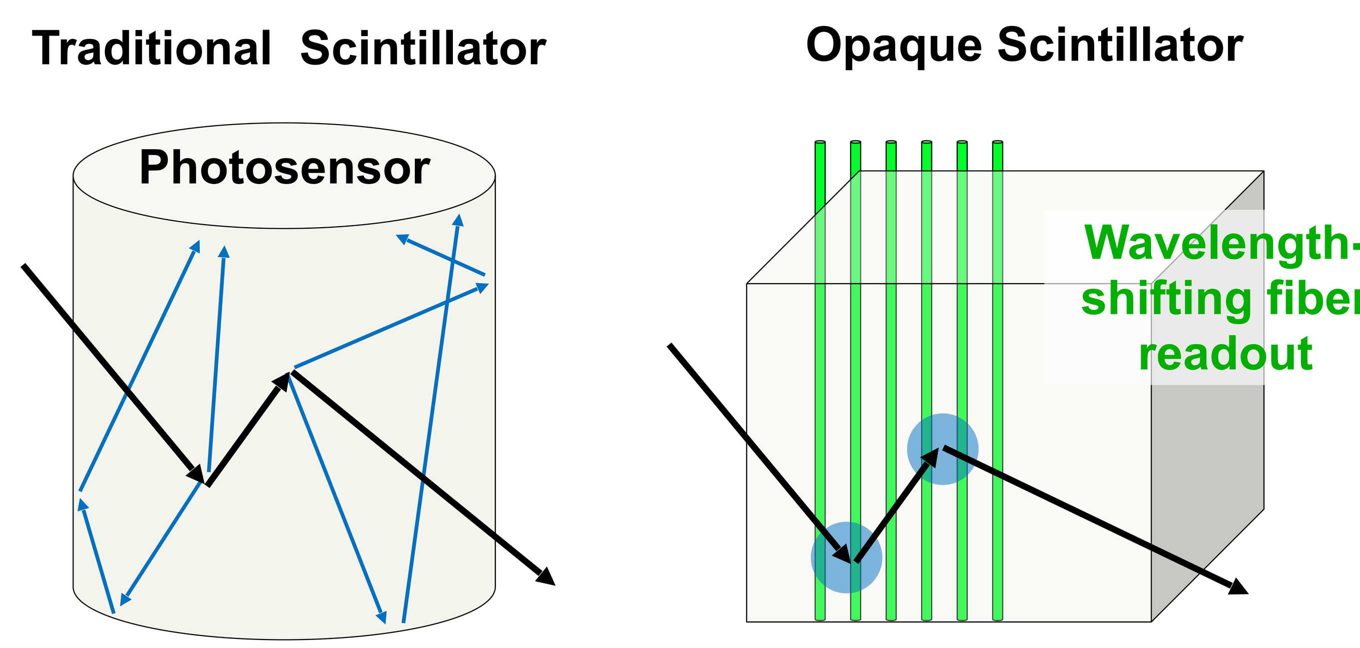
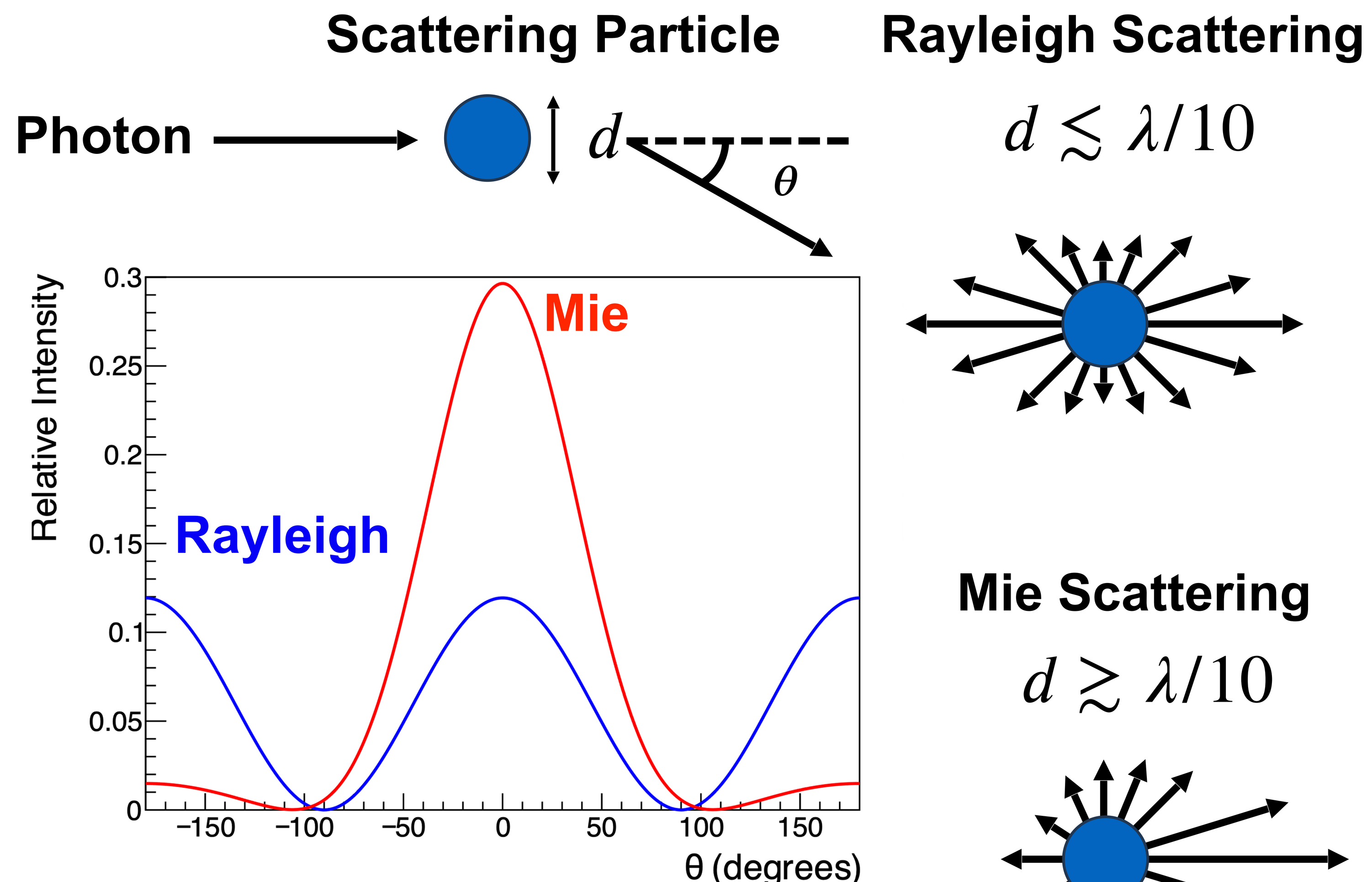
LiquidO Detection Principle

- Opaque detection media spatially confine light, providing localization of energy deposition in unsegmented volume
- Event topology enables inference of a particle direction, energy, and identification
- Reduces the impact of scintillator loading on its optical performance in an opaque detector



Confining the emitted optical photons near their emission origin enables reconstruction of event topology.

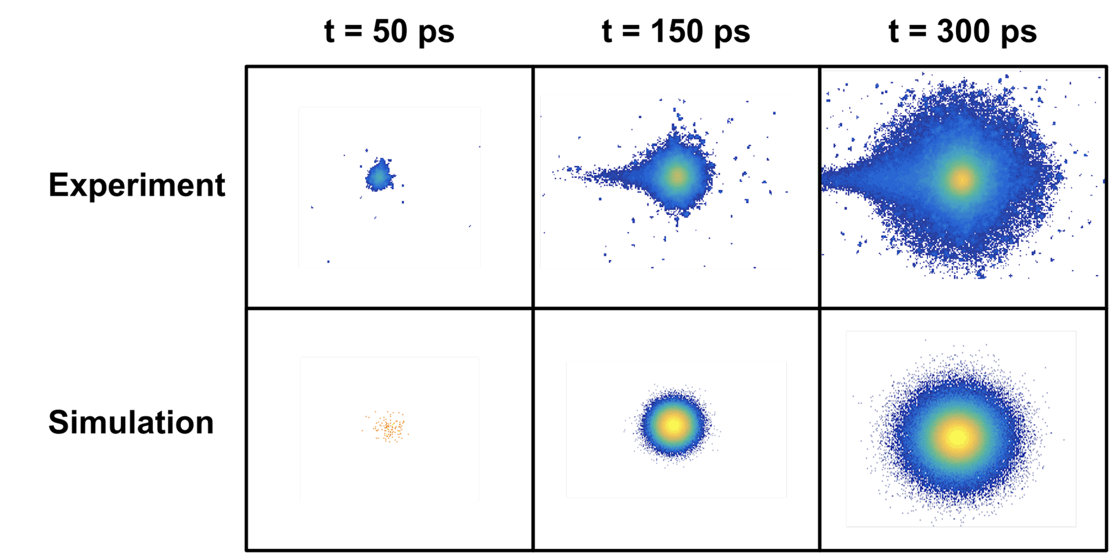
Scattering Regimes



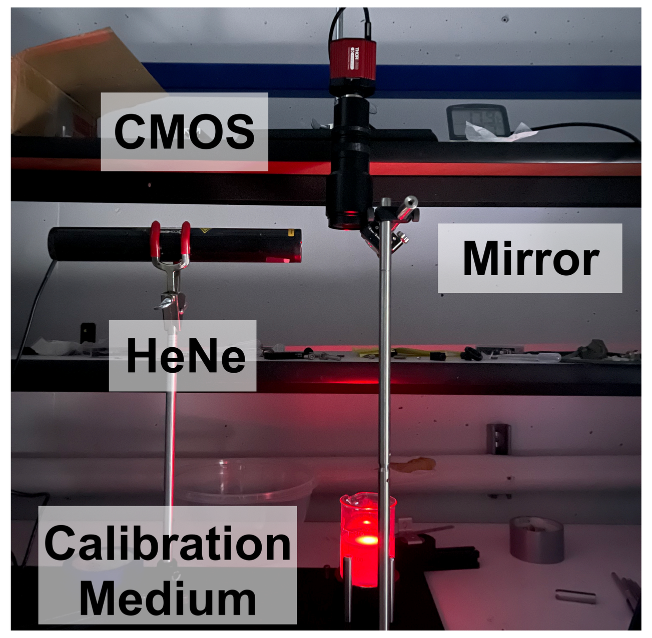
Angular distribution of scattered light

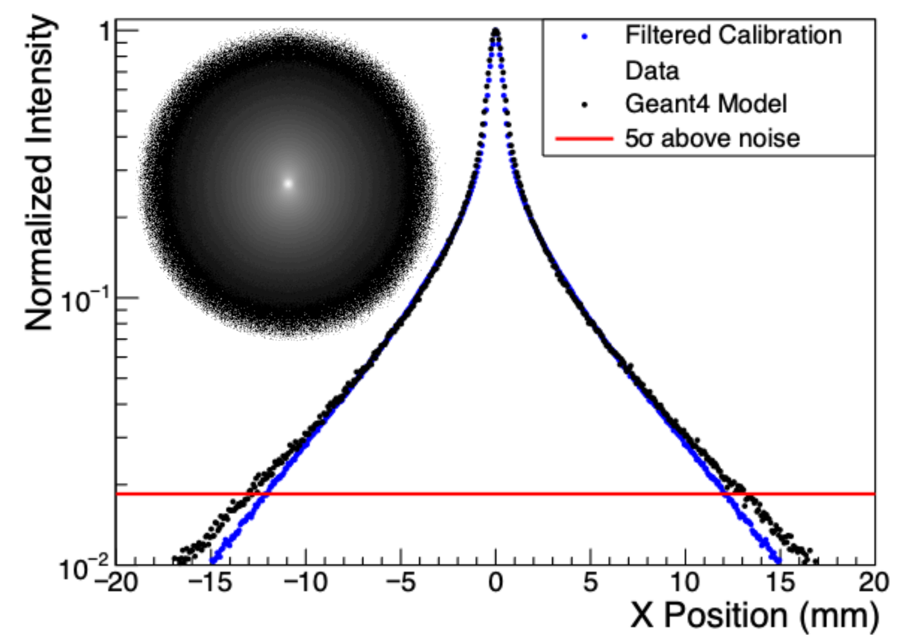
Light Ball Characterization

Time-resolved expansion of light on an opaque calibration medium surface



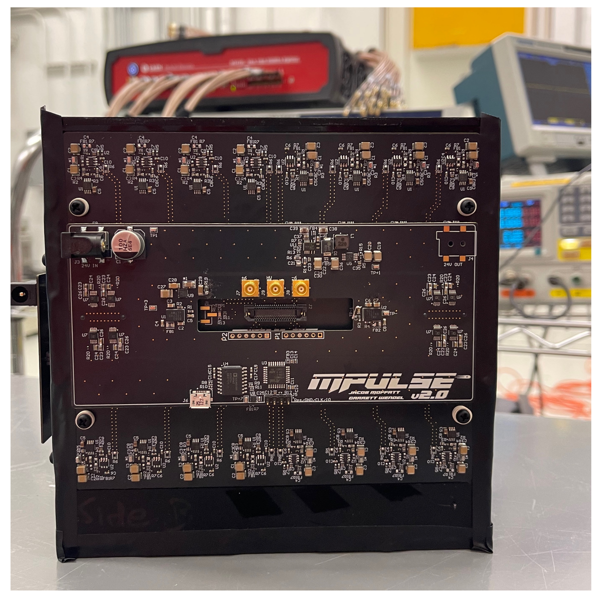
Steady-state surface light ball measurement and simulation

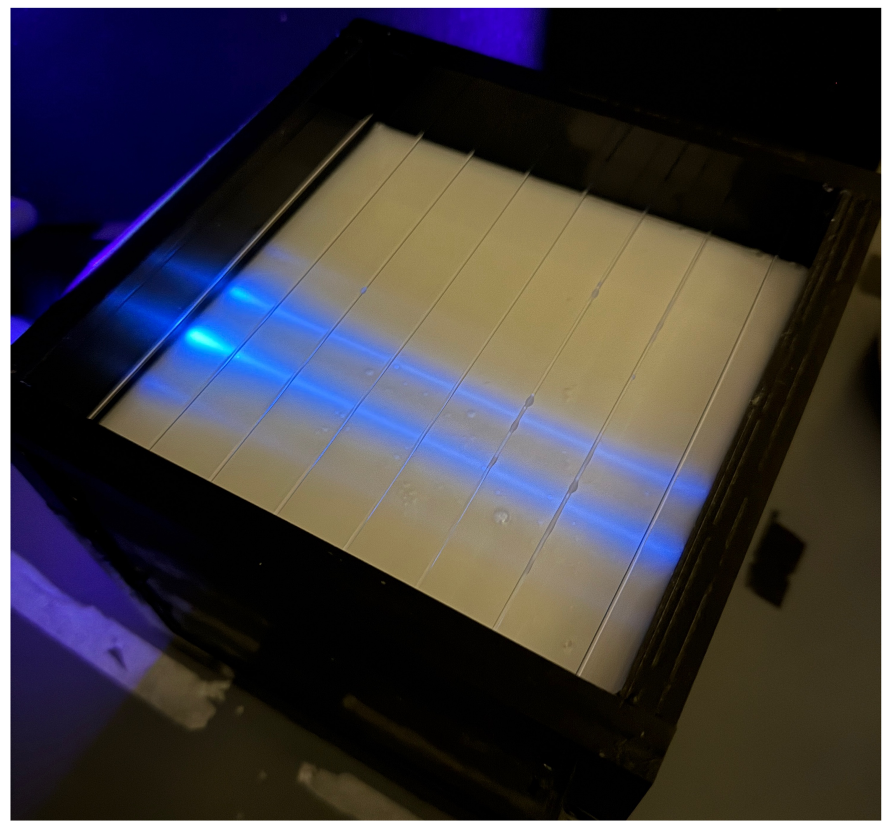


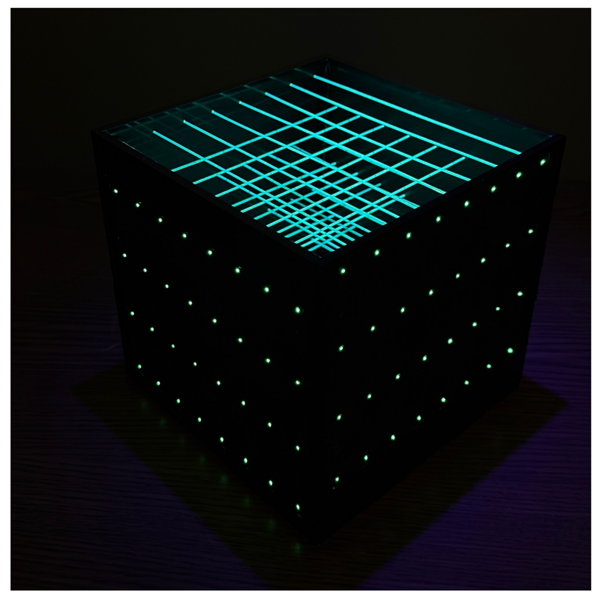


BPULSE Detector

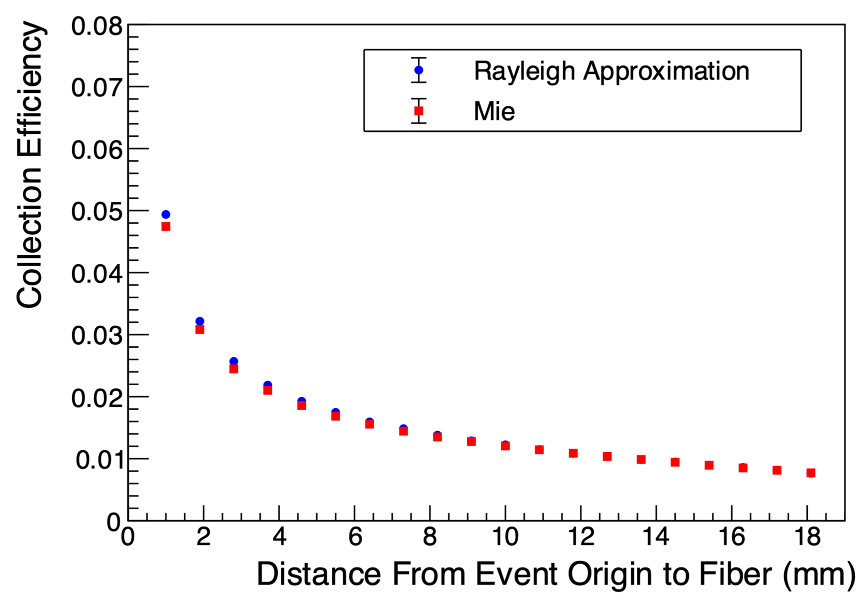
- 4-liter, 128-channel detector prototype
- Opaque water-based liquid scintillator developed at Brookhaven National Laboratory
- Detector exposed to 13 mCi Cs-137 in a Compton scattering configuration
- Energy and position-constrained measurement for studying position-dependent optical properties

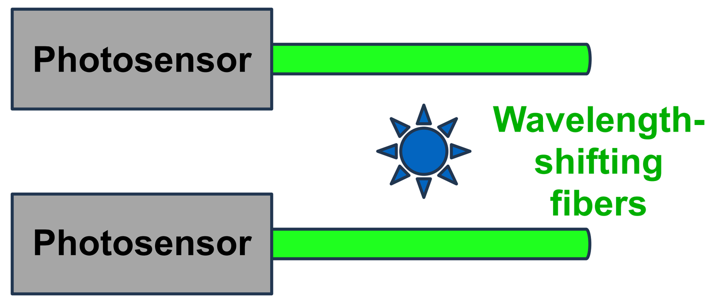






Comparing Scattering Regimes





Modeling Mie and Rayleigh scattering in a Monte Carlo light transport simulation to study light collection for a particle size of d=2 μm.

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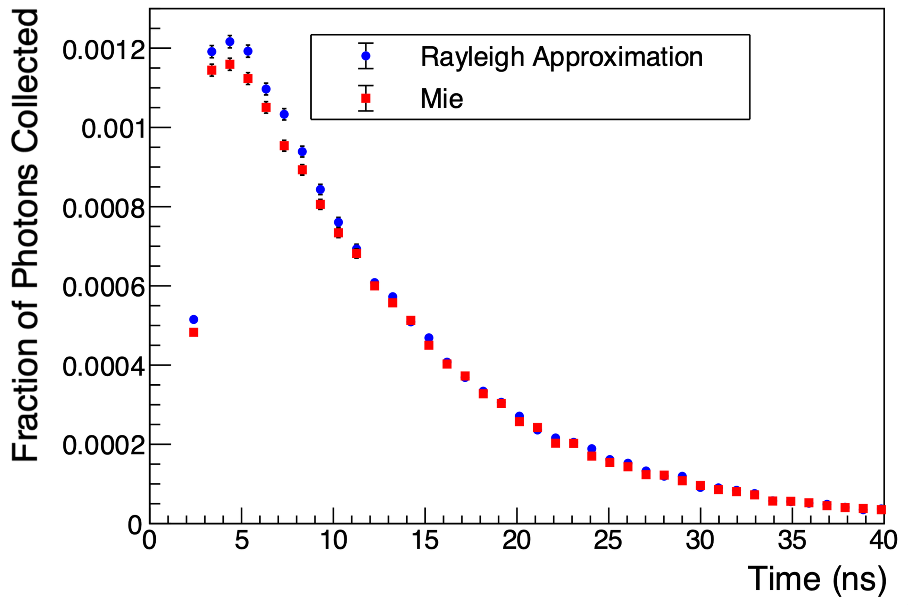
- Light collection relative increase of 5% with Rayleigh scattering approximation compared to Mie scattering
- No significant impact on timing



Conclusions

- During initial testing, the 4-liter detector prototype was exposed to gamma and neutron sources
- Feasibility of a new method to characterize the optical properties of opaque media was demonstrated
- Ongoing simulations will assess the impact of scattering approximations on detector response
- Optimization framework for quantitatively comparing simulation results with experimental measurements is under development

LiquidO Collaboration
liquido.ijclab.in2p3.fr

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