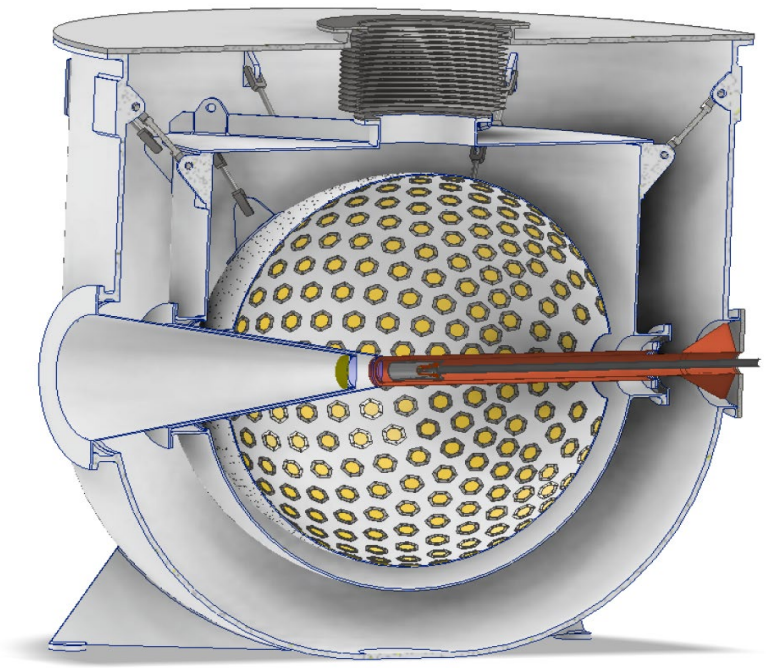
Motivation: Future Scale-up Calorimeters

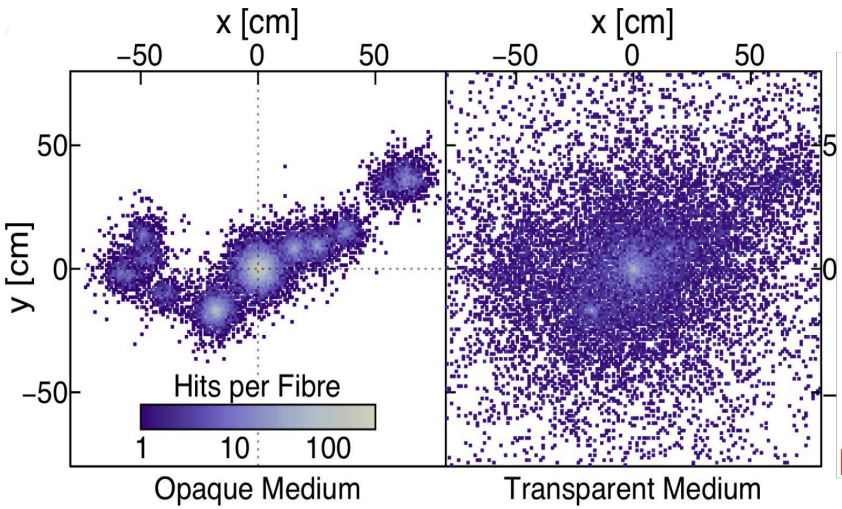
- **Ex**: PIONEER Calorimeter for Rare Pion decays (arXiv:2203.01981)
  - Compact, given 25 radiation length requirement
  - Fast, given ~300 kHz beam rate requirement
  - Bright, given 1-2% energy resolution requirement
- Calorimeter: 10 tons
- Baseline design: LXe or Inorganic crystal; how to reduce the cost? (from 10s of $M)
- A cost effective, scale-up calorimeter using liquid scintillators that performance and compatibility have been largely improved over the past decades.



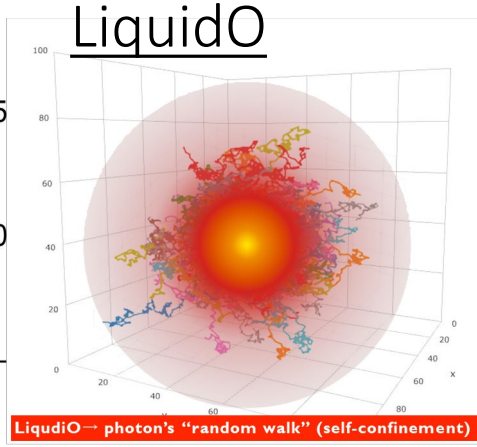
Inorganic crystal	LXe	Liquid Scintillator
$1,000s	$1,000s	<$1
$ per kg		

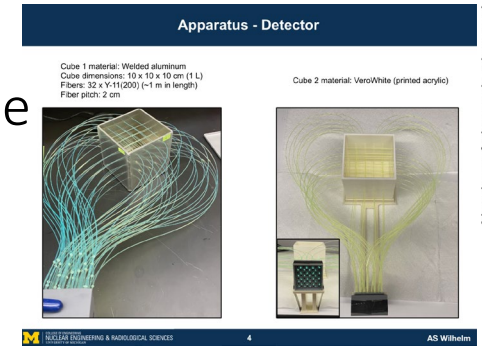
Proposed R&D tasks

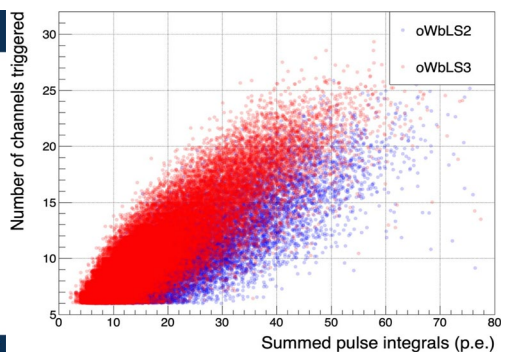
- The new Water-based Liquid Scintillator provides direct Cherenkov and scintillation detection with additional safety improvement and the capability of loading heavy metal at 10s of percent.
  - responses with dose and energy & rad. damage studied by medical physics
- A highly scattering (~mm) WbLS incorporating with pixelated technology using SiPM for particle tracking and discriminations (homogeneous, self-imaging, and no dead material).
- Leverage the existing efforts from neutrino community and scale-up facilities at nat'l labs.
- Given a WbLS loaded with 20%W
  - Light-yield (>2,000 photons/MeV), decay time (1.2 ns), optical length (>2 m), radiation length (~10 cm)
- A R&D consortium of large liquid calorimeters for next-generation experiments.

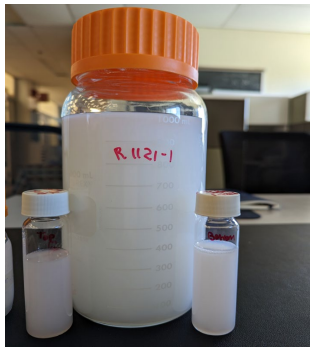


LiquidO









Prototypes at U. Michigan (Wilhelm) and at U. Sussex (Bezerra) demonstrated the confinement of light ball with pixelated detectors.