LiquidO

EXPLORING THE PROPERTIES OF OPAQUE SCINTILLATORS

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THE TRANSPARENT APPROACH

Transparent liquid scintillator to interact with incoming particles causing scintillation light [1]

Many PMT's surrounding the scintillator to collect light in the SNO+ detector [2]

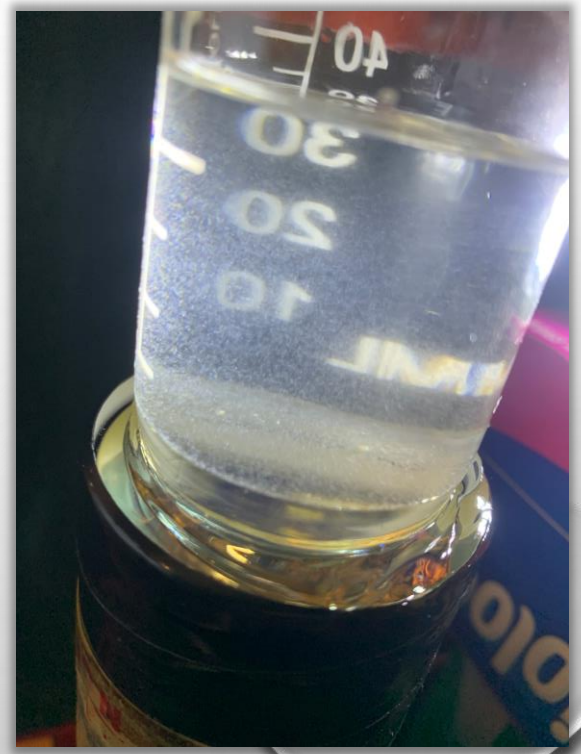
THE OPAQUE APPROACH: LIQUIDO

Differs from the transparent approach in 2 ways:

Completely opaque sample prepared this summer

1) Make the scintillator opaque

Reason: confine the scintillation light as close as possible to its creation point

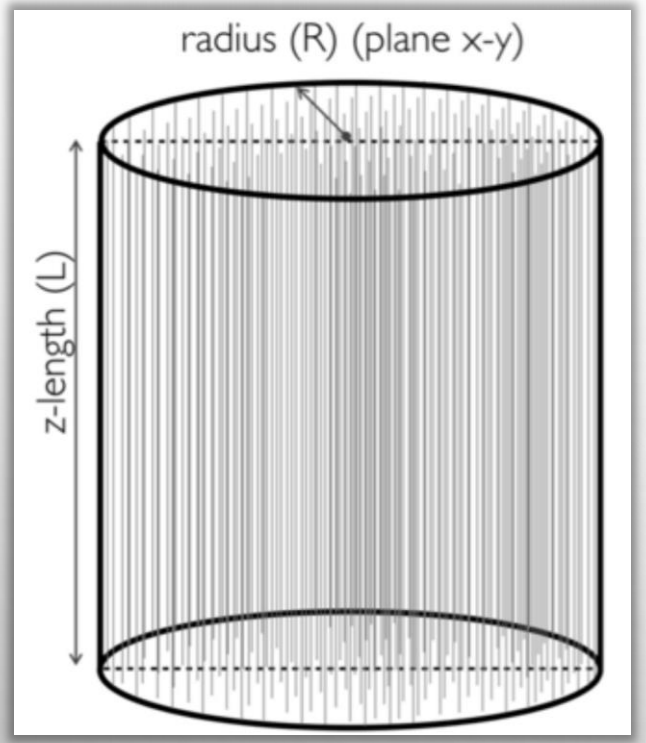


Partially opaque sample prepared this summer

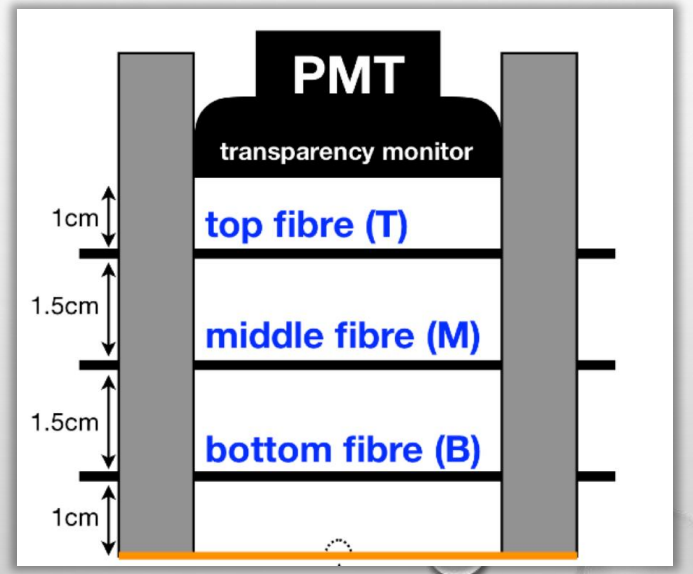
THE OPAQUE APPROACH: LIQUIDO

2) Collect the light with an array of wavelength shifting fibers

Reason: collect the scintillation light as close as possible to its creation point



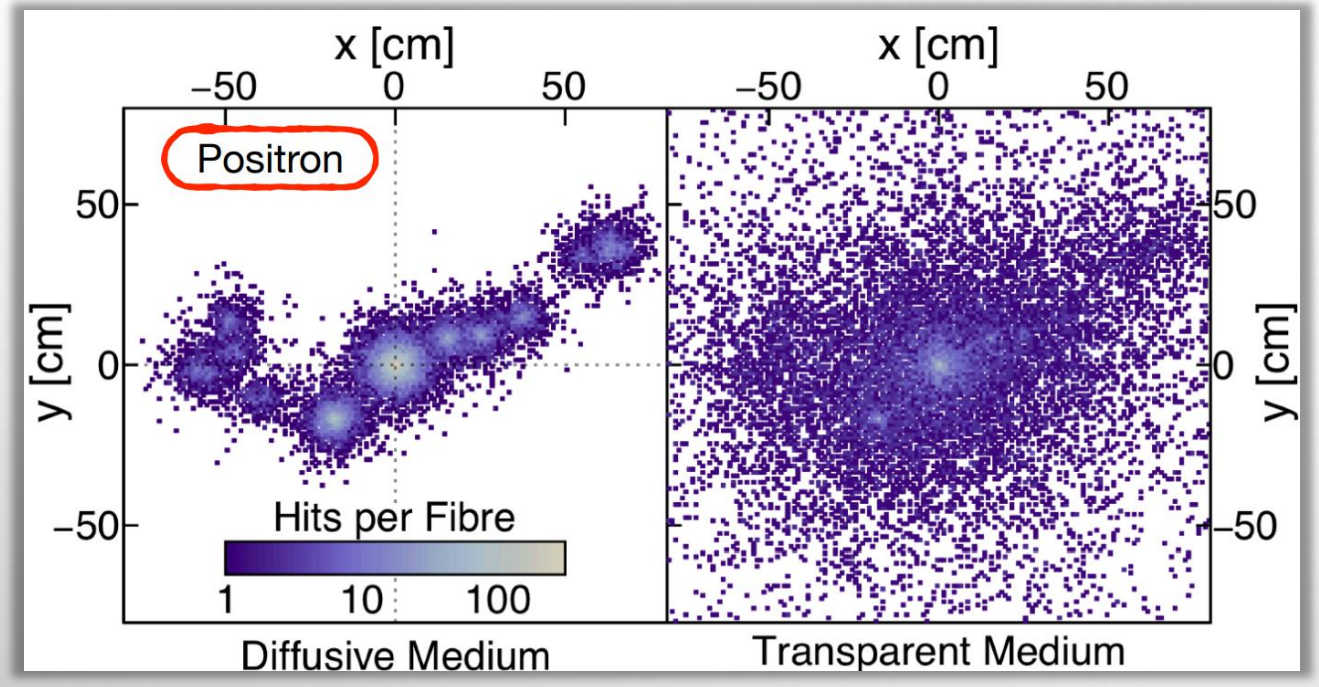
Theoretical LiquidO detector [3]



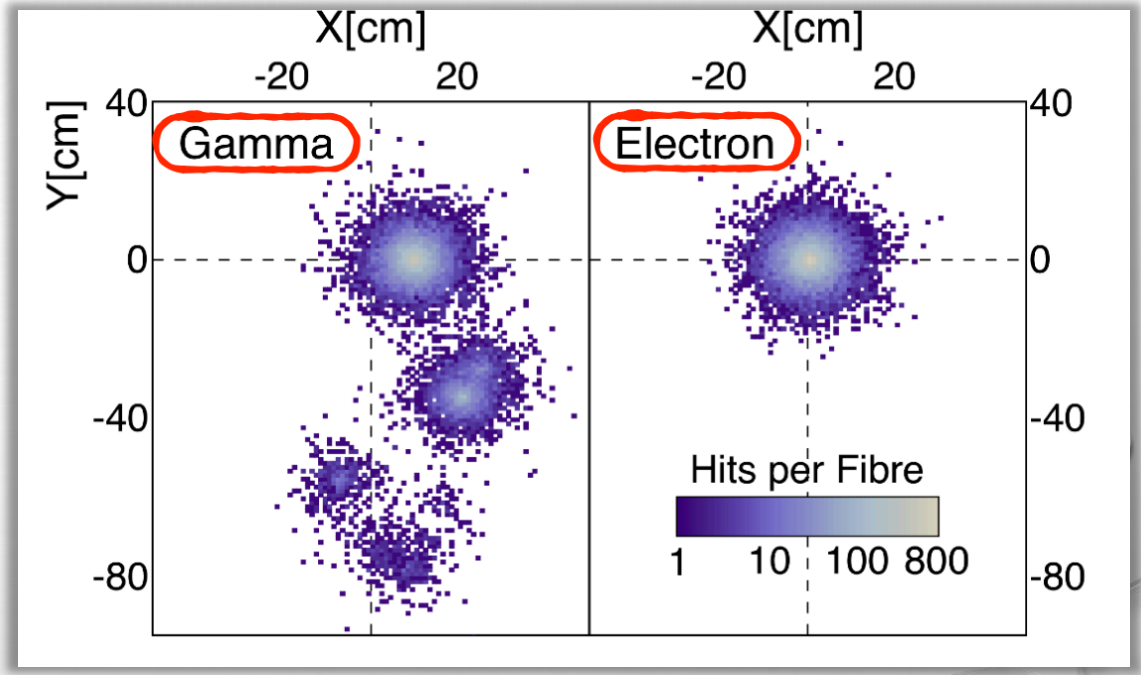
Suggested spacing between layers of fibers [3]

Placement of wavelength shifting fibers [3]

LIQUIDO ENHANCED IMAGING



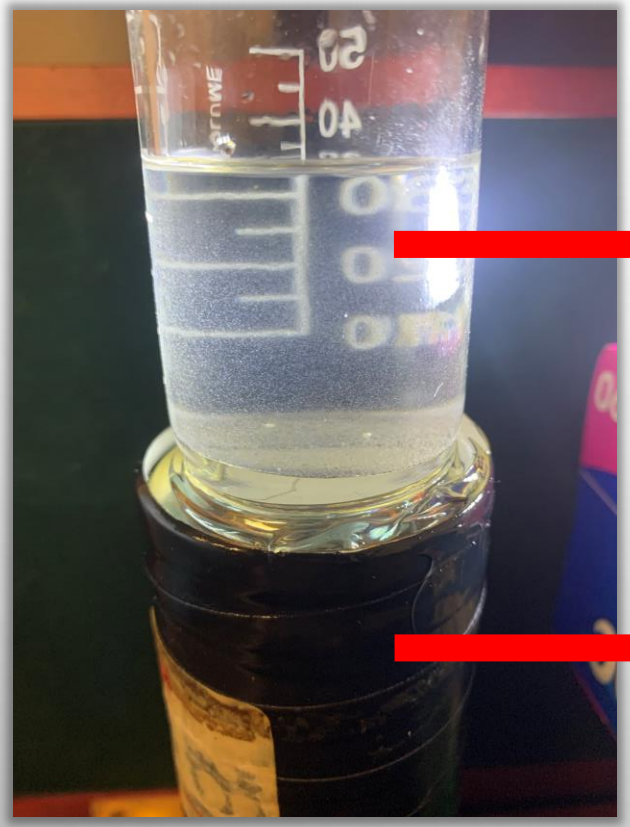
J. Pedro Ochoa-Ricoux, LiquidO: an introduction [3]



J. Pedro Ochoa-Ricoux, LiquidO: an introduction [3]

- Enhanced energy resolution: Positron annihilation in opaque and transparent medium (left)
- Differentiation between gammas and electrons individually (right)
- Creates 2D energy disposition patterns with incredible accuracy

APPARATUS



Cylindrical container of opaque scintillator

Cesium-137 source

Photo multiplier tube

All contained in a dark box

MAKING AN OPAQUE SCINTILLATOR

The procedure:

1) Start with what we know works:

LAB and PPO according to 2g PPO/L of LAB, as used in SNO+

Transparent

2) Add a surfactant:

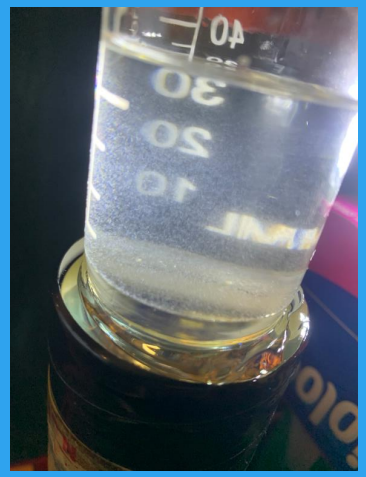
Add some PRS to the 2g/L mixture of LAB to PPO, allows the water droplets to mix throughout

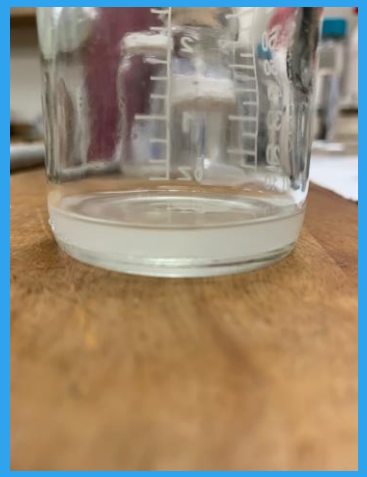
Transparent

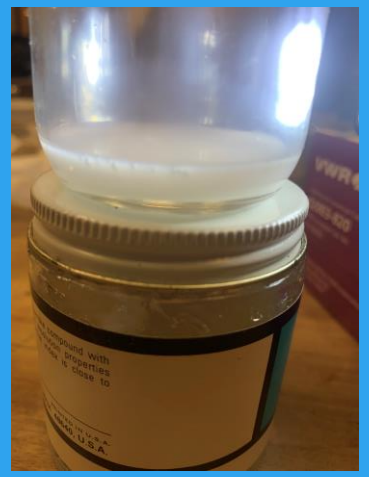
3) Add water droplets:

The PRS and water droplets undergo an emulsification reaction making it opaque

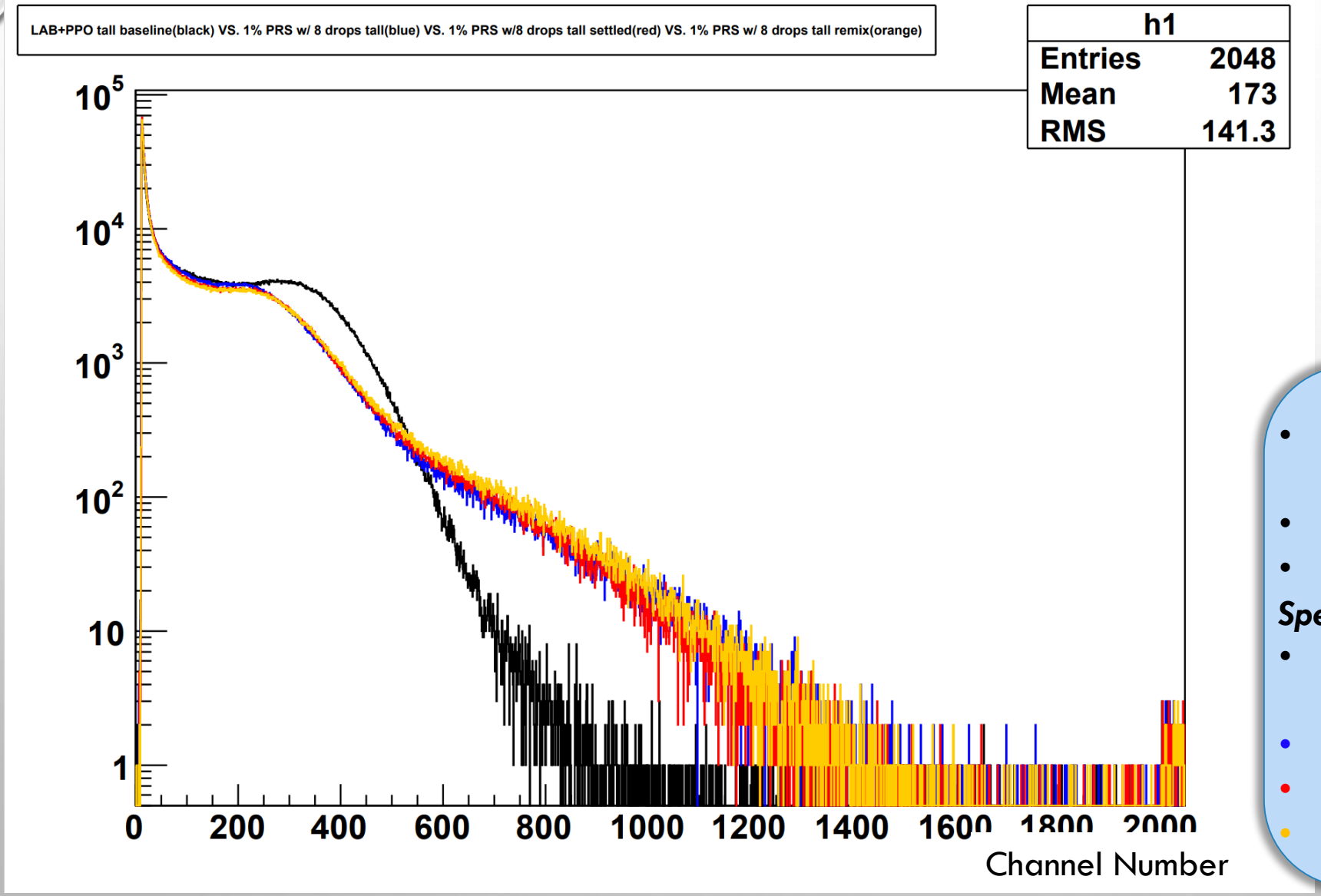
Opaque

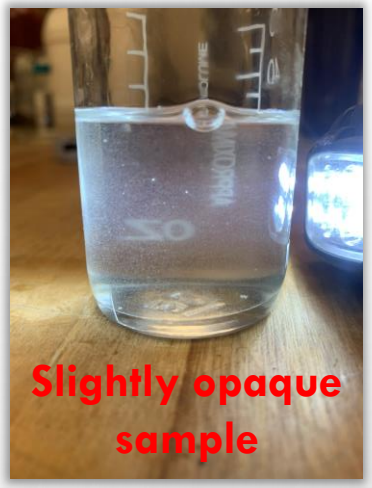






THICK TRIALS



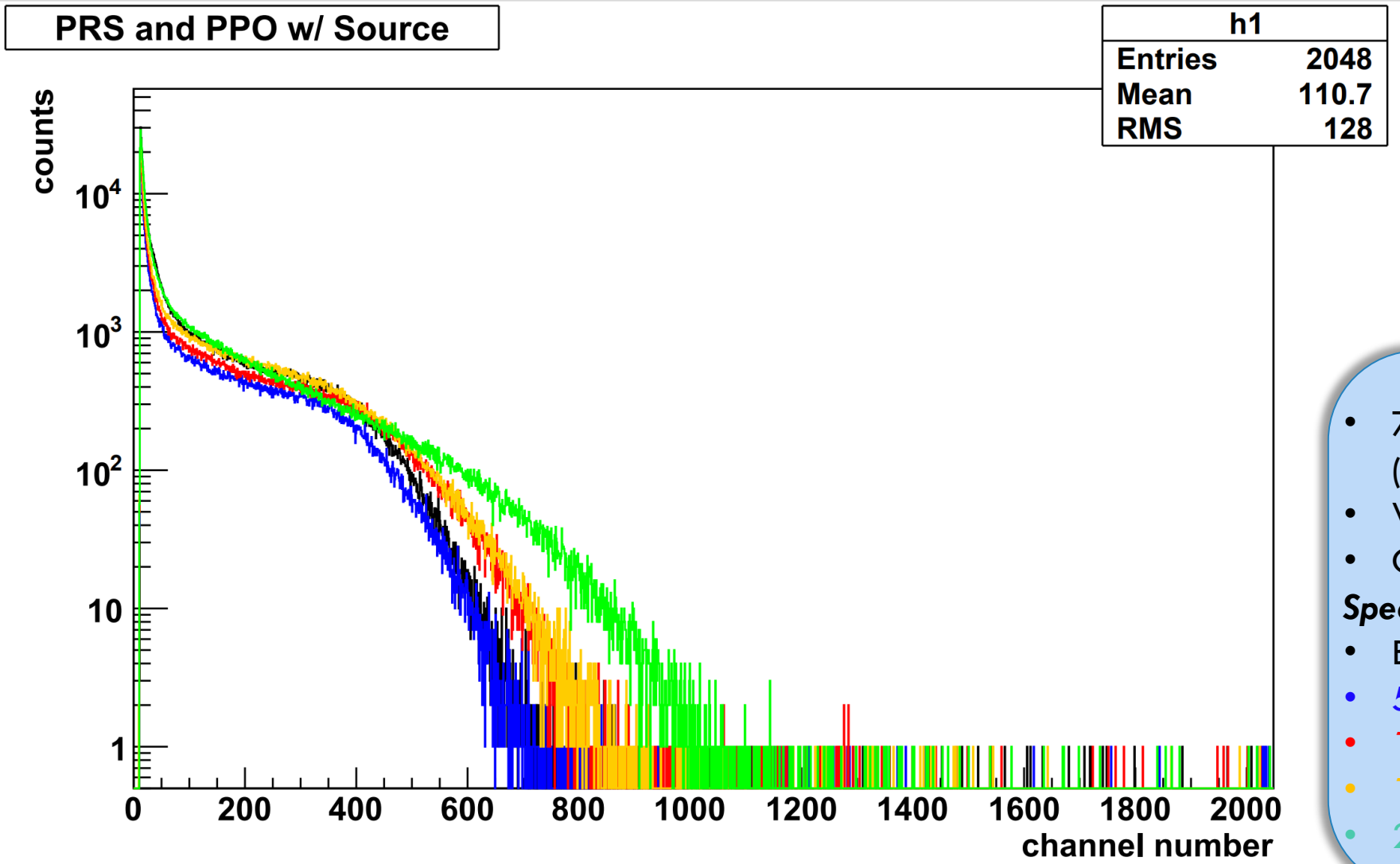


- 35 mL of 1% PRS w/ 0.07g of PPO (2g/L concentration)
- 8 water droplets added
- Cs-137 used as source

Spectra:

- Baseline LAB+PPO at 2g/L concentration
- 1% PRS w/ 8 drops original mix
- 1% PRS w/ 8 drops once settled
- 1% PRS w/ 8 drops after remix

THIN TRIALS



- 7.2 mL of 5% PRS w/ 0.0144g of PPO (2g/L concentration)
- Water drops added in succession
- Cs-137 used as source

Spectra:

- Baseline 5% PRS w/ PPO
- 5 droplets of water added
- 10 droplets of water added
- 15 droplets of water added
- 20 droplets of water added

SUMMARY

- Opaque scintillators increase the amount of light detected due to the back scattering of scintillating photons, the so called “fog effect”

- For larger volume samples the light is obscured and less are detected, in thinner volumes due to the closeness of the detector more light is detected

Combining the confinement of the photons from the opaque nature of the scintillator with the closeness of the fiber array, LiquidO offers incredibly energy resolution not possible in the transparent approach

SOURCES

[1] - WATER GLASS PNG PINT GLASS - CLIP ART LIBRARY (CLIPART-LIBRARY.COM)

[2] - OG GROUP WEB (BERKELEY.EDU)

[3]- LIQUIDO_SNOWMASSNF01_OCHOARICOUX (FNAL.GOV)