

# Development of Water-based Quantum Dots Liquid Scintillator

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## Budget, £50,000 :

Half studentship, £45,000 (STFC rate 3.5yr half stipend ~£40,000 and student allowance ~£5000)  
Radioactive sources, £4,000 ( $^{60}\text{Co}$ ,  $^{90}\text{Sr}$ ,  $^{241}\text{Am}$ , £1000 for  $^{51}\text{Cr}$  each, and building the source box, ~£1000)  
Chemicals, £1000 (boron nitride powder £200, cadmium-based quantum dots £800)

## Short description of the proposed project

This is a project to develop a water-based quantum dots (WbQD) liquid scintillator. WbQD liquid scintillators is superior to traditional liquid scintillators based on organic fluor due to emerging quantum dots technology. The project fits **DRD2.3 “Improved the material properties of target in liquid detectors”**. WbQD is relevant to the HyperK new near detector (*JPARC/HK*), DUNE module 4 (*PIP-II/LBNE/DUNE*), and new reactor neutrino detector (*Low-E scintillator neutrino detectors*). We initiated the R&D of WbQD a few years ago showing promising results <https://arxiv.org/abs/2403.10122>

In this project, we will characterize the water-based quantum dots liquid scintillator as a neutrino detector. We using the particle physics lab for Tasks 3. Tasks 1 and 2 are done at the photonics lab. Resources including manpower at the photonics lab are available from different funding. All tasks are done at King's College London.

1. Prepare WbQDs samples  
We synthesize boron-based QDs. Then, water solution of boron-based QDs and cadmium-based QDs with different concentrations are prepared
2. Study optical properties of WbQDs samples  
We will measure absorption, emission, photoluminescence quantum yield, dynamic light scattering, and physical size (transmission electron microscopy, etc)
3. Measure scintillation yield and other radiation responses  
Using cosmic rays and radioactive sources, we measure the light output from QDs samples. The data will be used to estimate the scintillation yield, decay time, neutron capture efficiency, etc
4. Feasibility study as neutrino detector  
Based on these studies, we design a neutrino detector with WbQDs for both low energy physics (reactor neutrinos, solar neutrinos) and beam physics (near detector)

We request a half-studentship. Full studentship is better, but we will find the other half. We also request funding for purchases of radioactive sources to measure scintillation yield precisely, and to test neutron capture by WbQD. Finally, we will synthesize our own QDs and for this we use boron nitride powders.

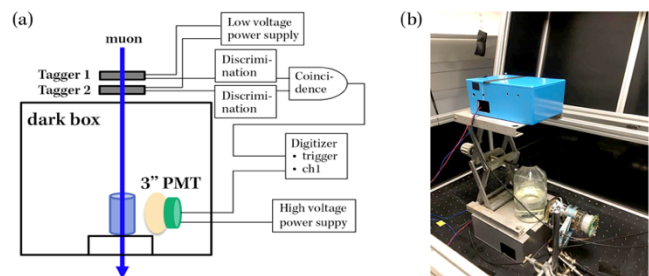


Figure shows the previous experimental setting used in <https://arxiv.org/abs/2403.10122>.