$0\nu\beta\beta$ with Theia

Theia is a proposed 25 – 100 ktonne scintillation-based, monolithic neutrino detector, capable of performing a sensitive 0vßß measurement

- Theia would likely deploy a KamLAND-Zen style balloon of loaded liquid scintillator within the larger WbLS detector
- Bench-top demonstrations of very high (5-10%) Te loading in LAB+PPO with high light yields have been performed by SNO+
- Dominant background expected to be ⁸B solar ۶ neutrinos
- Direction reconstruction (via Ch/Sc separation) ۶ critical for Theia program
- Multi-site discrimination for rejection of external ۶ and comospenic βy events
- > Particle ID for α/β separation





S. Andinga et al., Current Status and Future Prospects of the SNO+ Experiment, Advances in High Energy Physics, vol. 2016, 6194250 J. Dunger, S. Biller, Multi-site Event Discrimination in Large Liquid Scintillation Detectors, Nucl.Instrum.Meth.A 943 (2019) 162420

0.02

≥ 0.015 0.01

Theia Sensitivity & **Bench-top Demonstration of Technology**

100

80

40

Photons/ns 60

- ۶ Initial MC studies show Ch/Sc separation is possible in 50 ktonne Theia filled with LAB+PPO
- Theia half-life sensitivity with Te-loaded scintillator ۶ is expected to be > 10^{28} years
- Demonstrations of Ch/Sc separation and particle ۶ ID on bench-top using CHESS with fast PMTs, LAPPDs, red-sensitive PMTs, and the dichroicon







Dichroicon + Chess result here for LAB+PPO



B. Land et al., MeV-scale performance of water-based and pure liquid scintillator detectors, Phys. Rev. D 103, 052004 (2021) T. Kaptanoglu, E. Callaghan, M. Yeh, G.D. Orebi Gann, Cherenkov and Scintillation Separation in Water-Based Liquid Scintillator using an LAPPD, pending review at EPJC



LAB+PPO (50 kt)

Cherenkov

Scintillation

Reemission

All Photons



Tonne-Scale Demonstrator: Eos

Several tonne demonstrator called **Eos** to be constructed at Berkeley and taking data within the next three years. Will provide a test-bed for key technologies.





10

12

14

16

18 Time (ns)

1000

6

8

Example PMT hit times for central ⁹⁰Υ β source

