

DUNE Phase 2 Integration

Mike Wilking
Theia Meeting
May 12th, 2023

DUNE Phase 2 Working Group

- Led by Michel Sorel (Valencia) and Stefan Soldner-Rembold (Manchester)
- Meets alternating Mondays at 9 am EDT / 6 am PDT
- Meetings usually involve a few talks about various upgrade ideas
 - The meeting is limited to 1 hour, so only ~1-3 topics per meeting
 - Thus far, we have mostly heard high-level repeats of the topics discussed in Valencia
- Next major task is a document on ND and FD for DUNE Phase 2
 - An outline can be found here: <https://indico.fnal.gov/event/59549/>
 - Key question: what Theia-related information do we want to include in this document, and how/when do we present this information to the DUNE Phase 2 group
 - Talk 1(?): Worldwide WbLS R&D program (Michi Wurm?)
 - Talk 2(?): Near Detector Options for a WbLS far detector (Mike Wilking?)
- Key upcoming meetings:
 - DUNE collaboration meeting at Fermilab May 22-26
 - DUNE Phase 2 ND Workshop at Imperial College June 20-22

Worldwide WbLS R&D Program

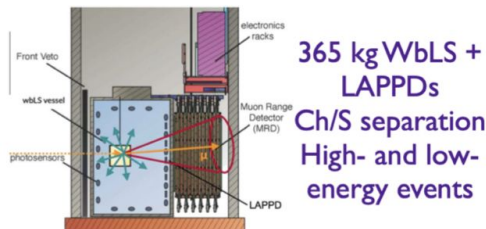
- Goal: demonstrate substantial R&D effort to develop WbLS

- Technology will be ready on DUNE phase 2 timescale

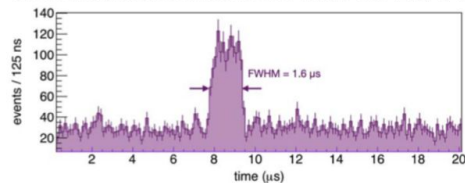
- Grow participation in DUNE Phase 2

- More funding options

ANNIE: WbLS in a ν beam



First neutrinos detected with an LAPPD!



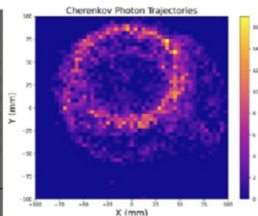
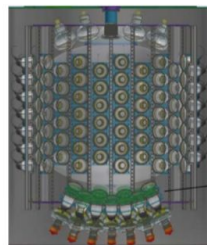
NuDot:
LS + isotope for
2vbb event
reconstruction

not in this talk

instrumented



Eos: Low-energy event reconstruction and model validation



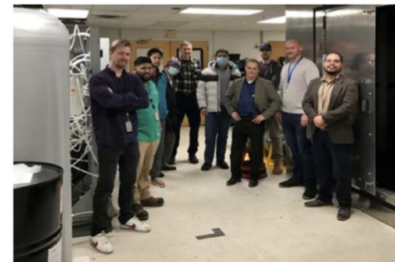
- 4-ton target mass
- 200 8-” PMTs
- Dichroicon deployment for spectral sorting
- Vertex, energy, direction, PID



BNL: 1- and 30-ton



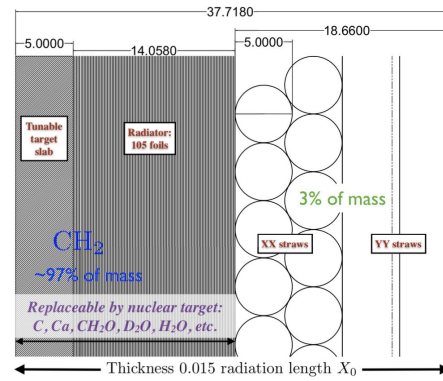
- First ton-scale deployment
- Optical transparency in an operating detector
- Optical stability over time
- Recirculation of WbLS (nanofiltration)



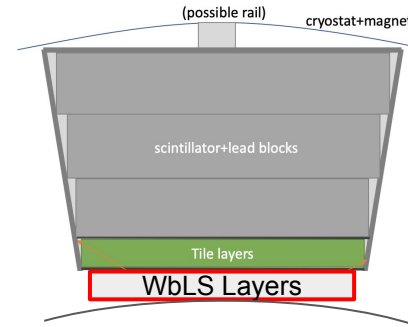
Near Detector Concepts

- At a previous LBL meeting, we discussed some initial Theia ND concepts
- SAND already exists, so adding targets for studying WbLS nuclei is possible
 - No off-axis measurements
- ND-GAr is a primary target for a DUNE Phase-2 ND
 - Adding WbLS targets may be possible (next slides)
- If detector “garages” can be carved into the ND hall, a dedicated Theia ND can be considered
 - TMS can then be retained instead of scrapped when ND-GAr is installed

Additional nuclear targets in SAND

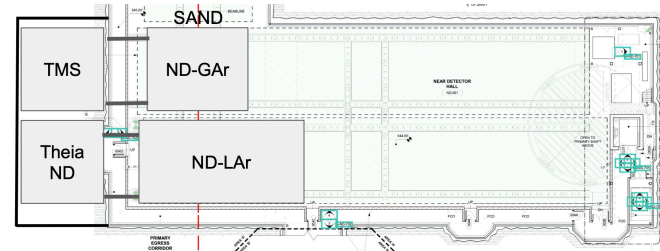


WbLS targets in the ND-GAr ECAL



HPgTPC

Slightly expand the ND hall for a dedicated Theia ND



Least invasive

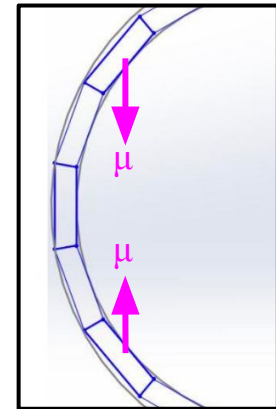
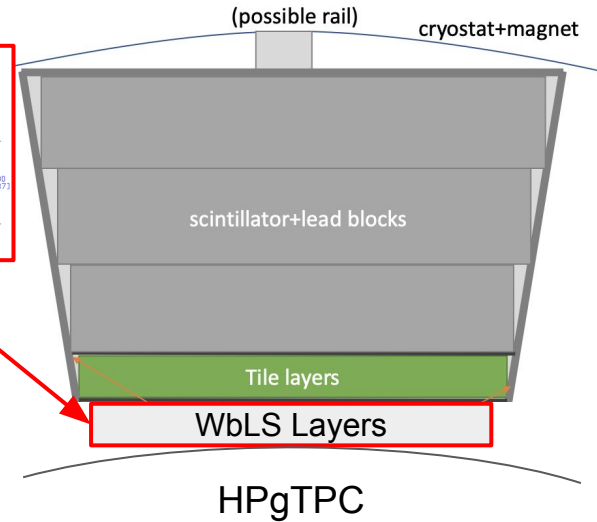
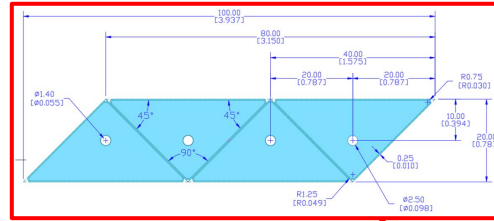


Most invasive

WbLS Inside ND-GAr ECAL

(Slide from ND-GAr Meeting This Week)

- WbLS layers would need to track X & Y positions
 - Optically segmented X & Y bars or 3D cubes
 - Or perhaps a non-segmented LiquidO detector with X & Y fibers
- Order of magnitude size estimate:
5 m long TPC * ~4 m total layer width * 5 cm thickness
≈ 1 ton WbLS detector mass
 - Similar to the target mass for the GAr TPC
- Additional benefit: variation in detector configurations allows for sampling all of the muon angle phase space
 - The lack of muon acceptance near 90° was an important limitation of the T2K FGD+TPC configuration



Next Steps

- We may want to push these first 2 talks (WbLS R&D + Theia ND) in the near future to incorporate this information into the soon-to-be-written DUNE Phase 2 document
 - One at the collaboration meeting and one at a DUNE Phase 2 biweekly meeting?
- After the DUNE collaboration meeting & Imperial workshop, there should be room for additional talks on other aspects of Theia
 - e.g. simulation + reconstruction (once it's available)
 - e.g. Long-baseline analysis developments
 - e.g. Low energy physics capabilities (especially compared to LAr capabilities)
- I am currently scheduled for 2 talks at the DUNE Phase 2 ND Workshop (Imperial College, London)
 - WbLS targets in the ND-GAr ECAL
 - PRISM system for Phase 2
 - Hopefully including the potential for additional detectors in phase 2 (i.e. new detector alcove)
- Comments welcome