

Preliminary design of Outer Veto

1. Introduction

The DarkSide-20k (DS-20k) experiment seeks to directly detect dark matter in the form of weakly interacting massive particles (WIMPs). The DS-20k detector is a two phase time projection chamber (TPC) filled with 50 tons of underground liquid argon. The TPC is located inside a Stainless Steel Vessel. In the space between the membrane cryostat and the stainless steel vessel, it is planned to place the Outer Veto. The membrane cryostat is planned to be filled with 650 tons of atmospheric argon. The modeling was carried out for different options for the number of photosensors and their position.

2. Relevance of the Outer Veto

The Outer Veto will tag cosmogenic neutron backgrounds based on the signal that muons or their associated showers may make in it.

Problems from cosmic-rays: can produce high-energy neutrons, can activate isotopes.

Physics potential: ⁸B solar neutrinos, Supernova neutrinos.

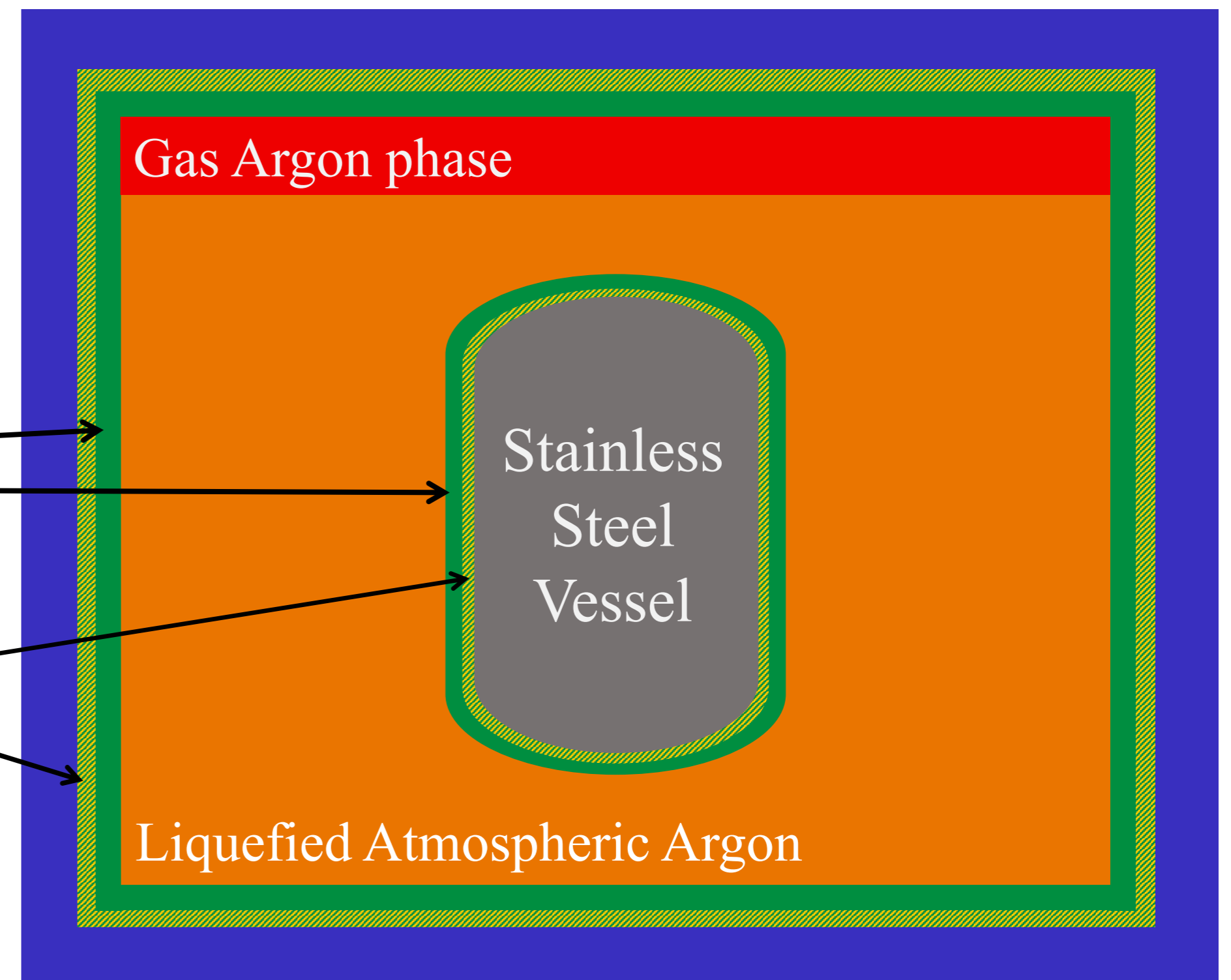
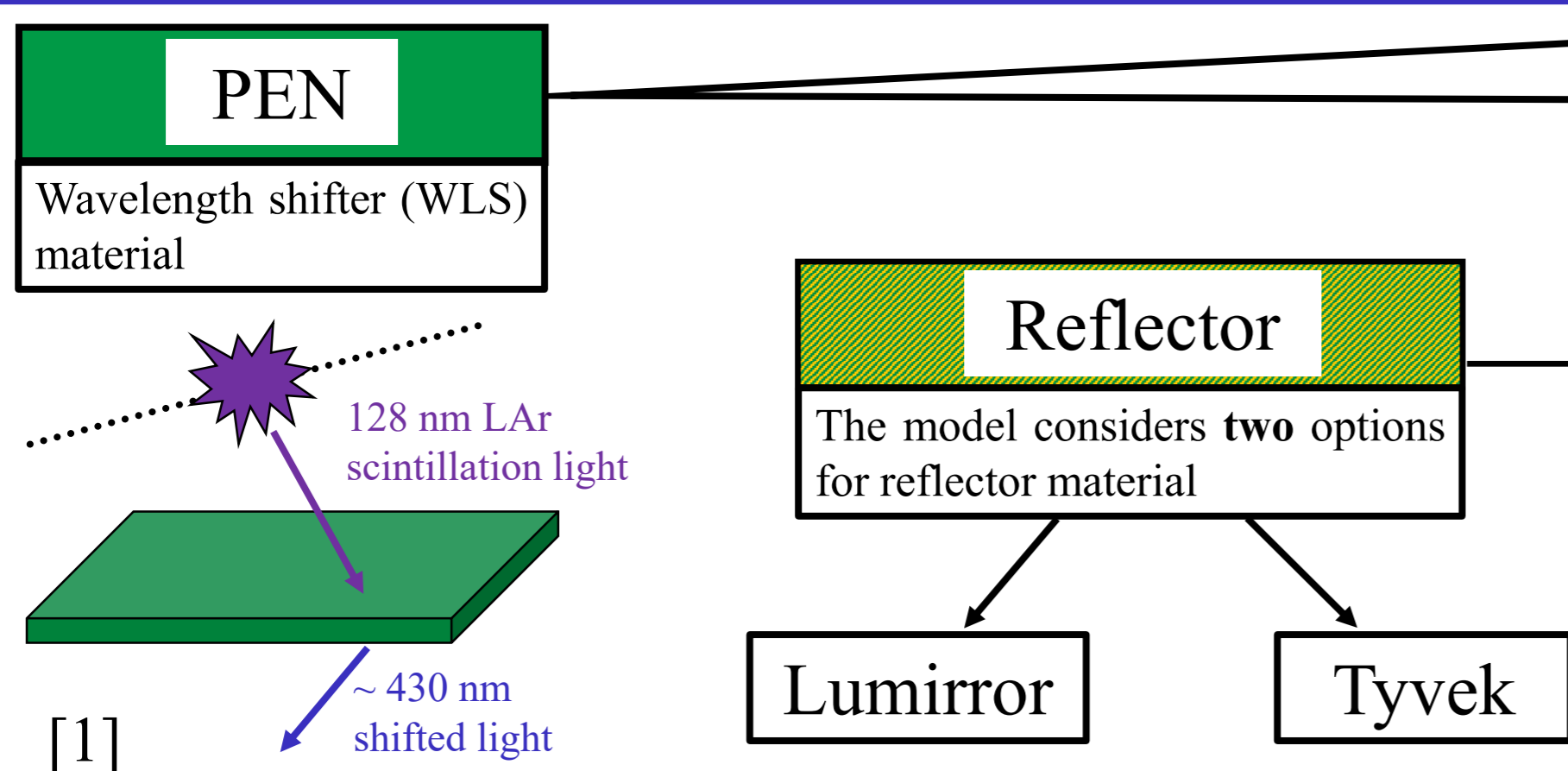


Fig.1. The preliminary schematic design DarkSide-20k with Membrane Cryostat and Stainless Steel Vessel [2]

3. Design Outer Veto

An Outer Veto consisting of 32 photosensors (PDUs) should be placed on the walls of a Stainless Steel Vessel. The design consists of 8 stainless steel struts located on the side of the Stainless Steel Vessel. On each struts there are 4 PDUs equidistant from each other.

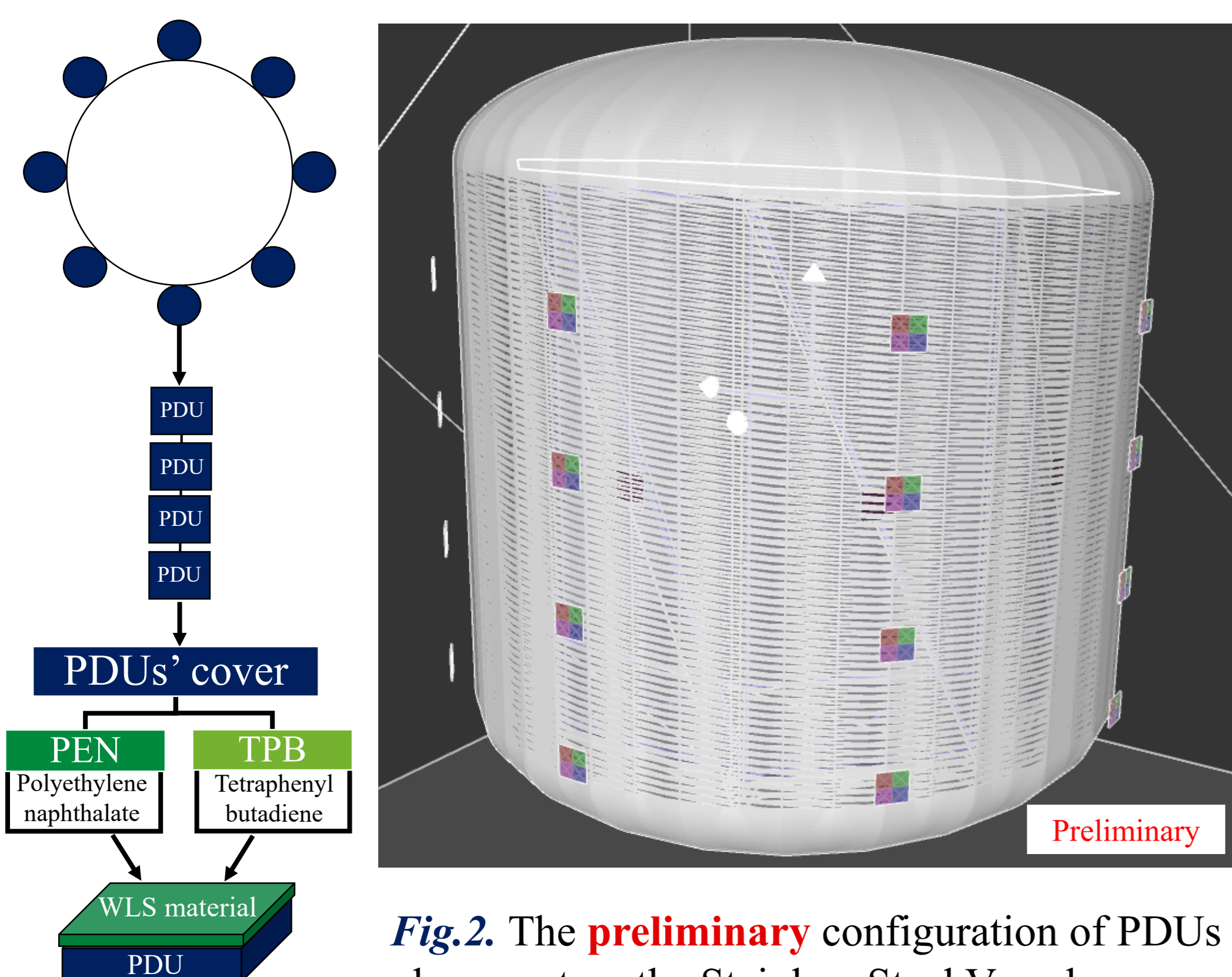


Fig.2. The preliminary configuration of PDUs placement on the Stainless Steel Vessel

4. The calculation light yield

One of the main parameters for evaluating the effectiveness of a particular geometry version is light yield (LY), which is calculated using the formula (1). The scaling factor parameter serves to speed up optical simulations. The number of photons during the simulation depends on scaling factor.

$$LY = \frac{N_{pe}/scale\ factor}{E_{dep}} \quad (1)$$

LY – light yield
 N_{pe} – number of photo electrons
 scale factor – parameter for acceleration simulation
 E_{dep} – deposit energy

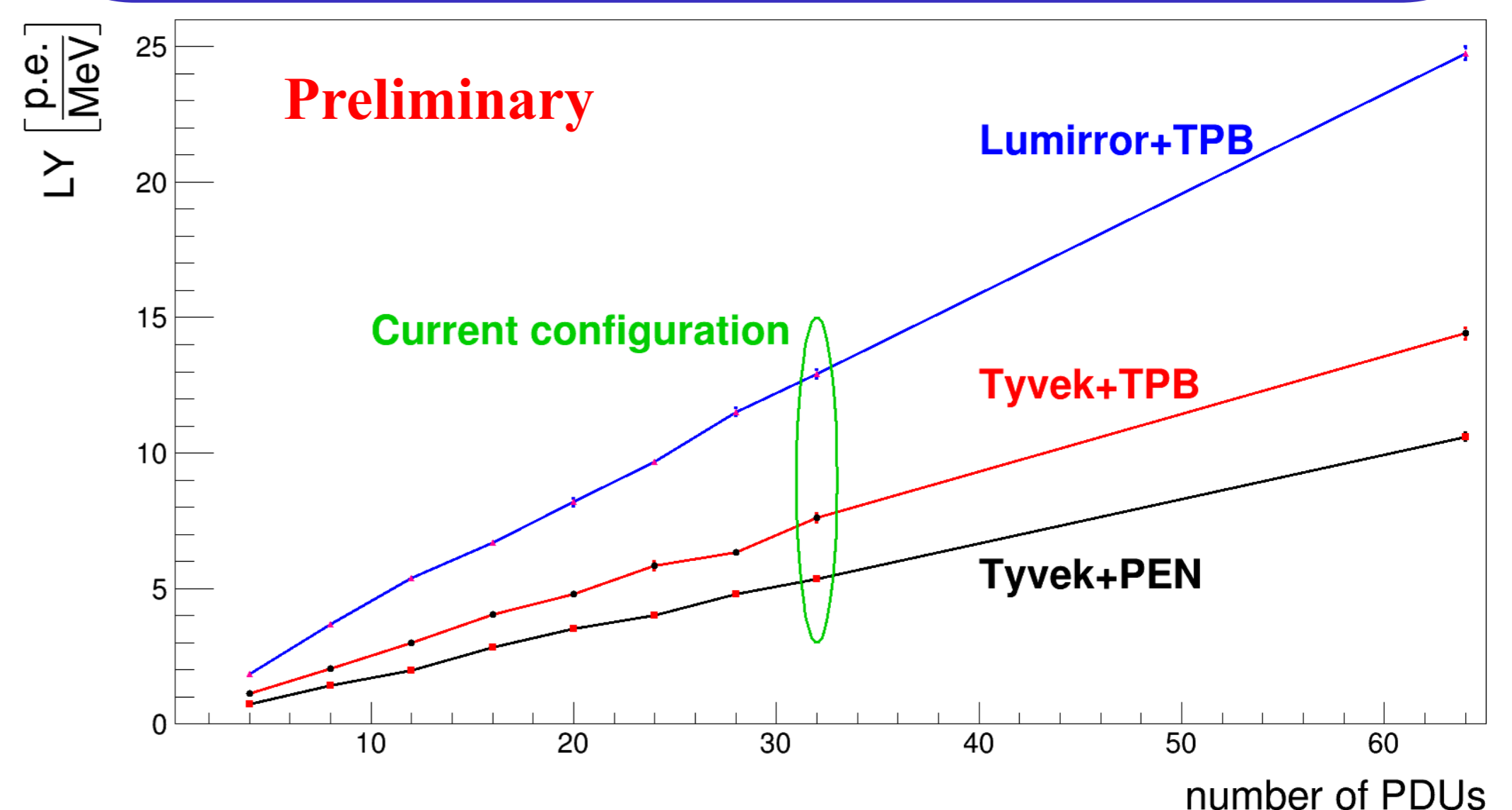


Fig.3. The comparison of LY using different WLS materials and reflectors

5. Future plans

- Consider the model when 6 PDUs on top and bottom the Stainless Steel Vessel are placed, and all the other 20 on the walls of the Stainless Steel Vessel.
- Choose the coordinates of the location of photosensors.
- Calculate the LY for the proposed model.

6. References

- [1] B. Howard, Liquid argon scintillation detection utilizing wavelength-shifting plates and light guides, Journal of Instrumentation, JINST, 13 (2018), C02006, <https://iopscience.iop.org/article/10.1088/1748-0221/13/02/C02006>
- [2] A. Elersich et al., Study of cosmogenic activation above ground for the DarkSide-20k experiment, Astropart. Phys., 152 (2023), Article 102878, <https://doi.org/10.1016/j.astropartphys.2023.102878>