A 1-ton Liquid Argon CEvNS Detector

The Coherent elastic neutrino-nucleus scattering (CEvNS) was first predicted in 1974. It is the dominant neutrino scattering process below 100MeV. Though CEvNS has the most significant cross-section of low-energy neutrino scatterings, it has eluded detection for over 40 years due to technical difficulties in building low-energy thresholds and low background detectors. In 2017 and 2021, the COHERENT collaboration eventually discovered the CEvNS on CsI and argon targets for the first time using the neutrinos from the Spallation Neutron Source at Oak Ridge National Laboratory (ORNL). The measured result is consistent with the Standard Model prediction, but still shows ~30% statistical uncertainty in the cross-section. Seoul National University is one of the leading institutions of the COHERENT collaboration. We built a 1-ton scale liquid argon CEvNS detector in Korea and finished basic tests. The detector has recently moved to ORNL for further testing and commissioning. This poster will report on the progress of CENNS-1ton detector development at ORNL.

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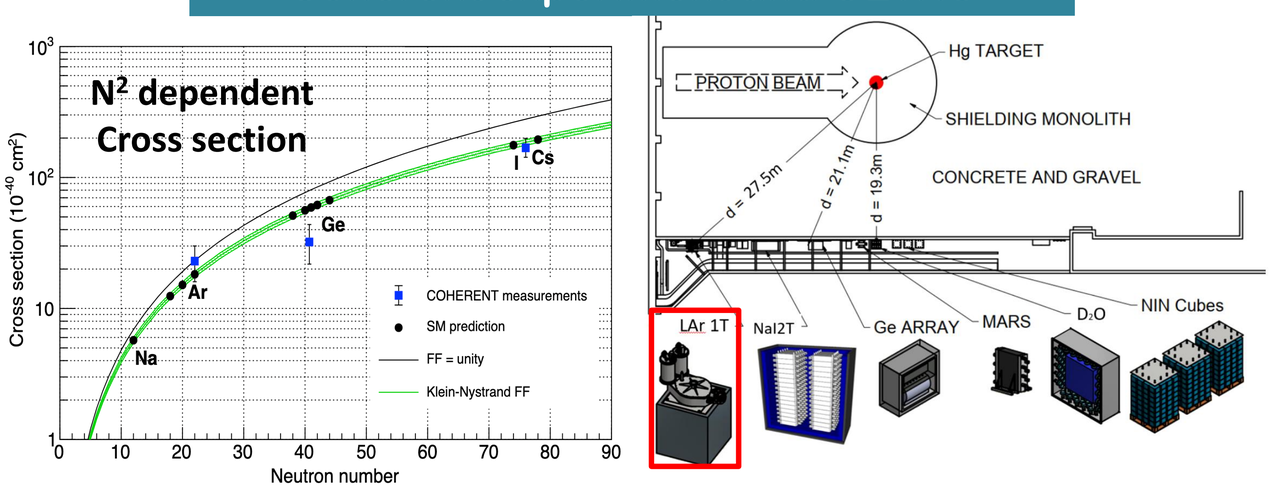
on behalf of Coherent Collaboration

Introduction

Coherent experiment and CEvNS



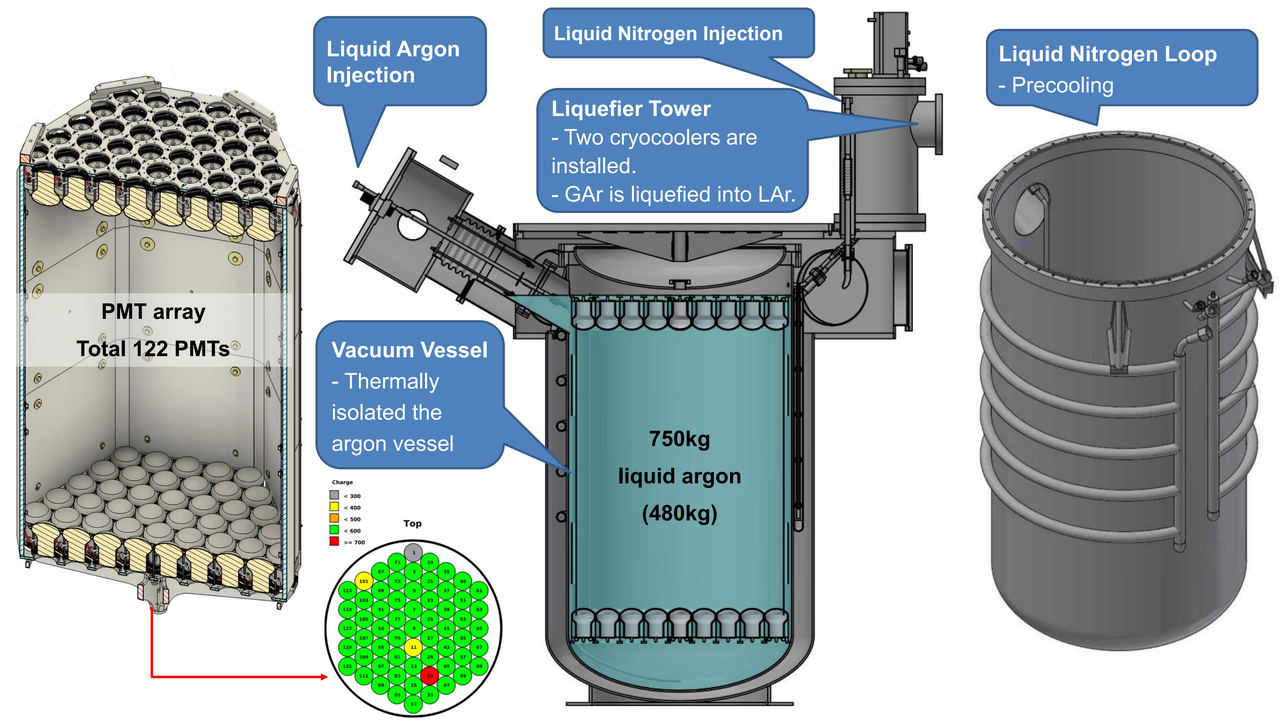
- Precise cross section within the Standard Model (N^2 cross section)

$$\frac{d\sigma}{dT} = \frac{G_F^2 M}{2\pi} Q_W^2 \left(2 - \frac{2T}{E_\nu} - \frac{MT}{E_\nu^2}\right) \cong \left(2 - \frac{2T}{E_\nu} - \frac{MT}{E_\nu^2}\right) N^2$$

- The CENNS-10 (Liquid argon 24.4 kg) detector successfully measured the CEvNS event in 2021. We are currently developing/testing the ton scale liquid argon chamber which weighs about 750 kg and looking forward to CEvNS event measurement and light dark matter search.

Progress of CENNS-1ton detector

Developing / Testing 1 ton chamber in SNU

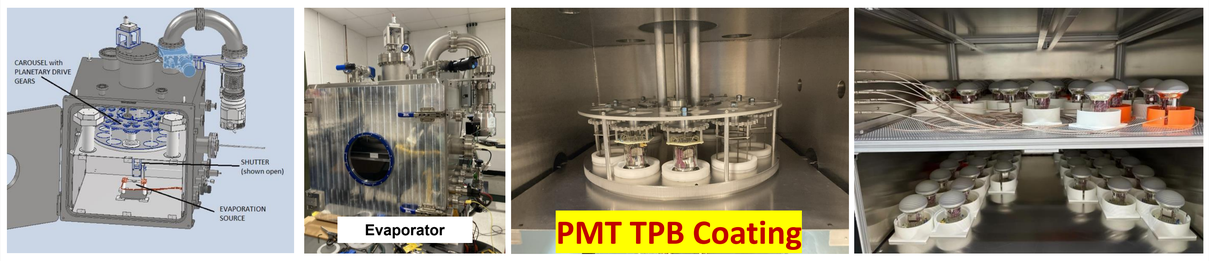


- The design and production of the 1ton chamber took place at SNU.
- We assembled the chamber and conducted the Liquid argon filling test and confirmed that the level meter and thermometers are operating normally.
- PMT installation and testing is in progress at ORNL.
- We also developed a UI to monitor the situation of 122 PMTs. (by Dojin Kim)

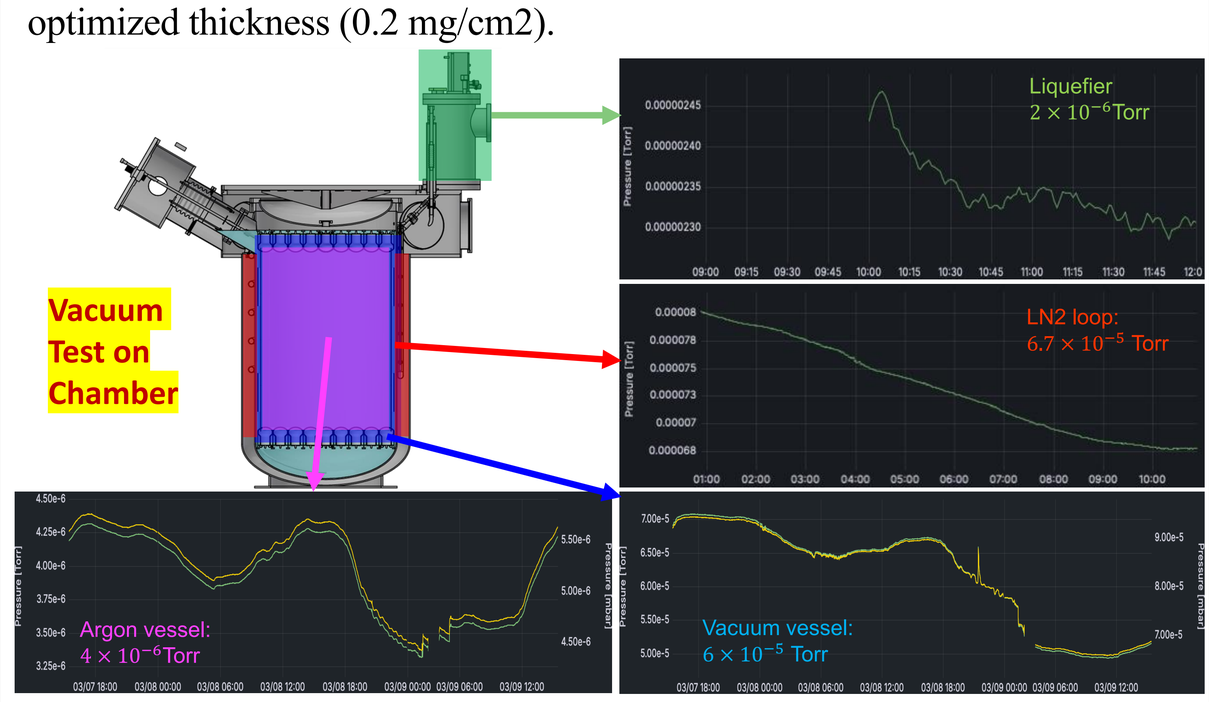
- We moved 1 ton chamber from SNU to ORNL during Sep. to Oct. 2024.
- Currently, we are conducting vacuum testing, resistance temperature detector (RTD) testing, and PMT tetraphenyl butadiene (TPB) coating in ORNL.
- SNU is currently conducting liquid argon purification R&D and will play a big role in increasing the purity of liquid argon in 1 ton chamber.
- After reaching in ORNL, we reassembled the chamber.

Testing / Operating 1 ton chamber in ORNL

- We conducted calibration of RTD in ORNL to measure temperature in each area by putting it inside the Chamber.

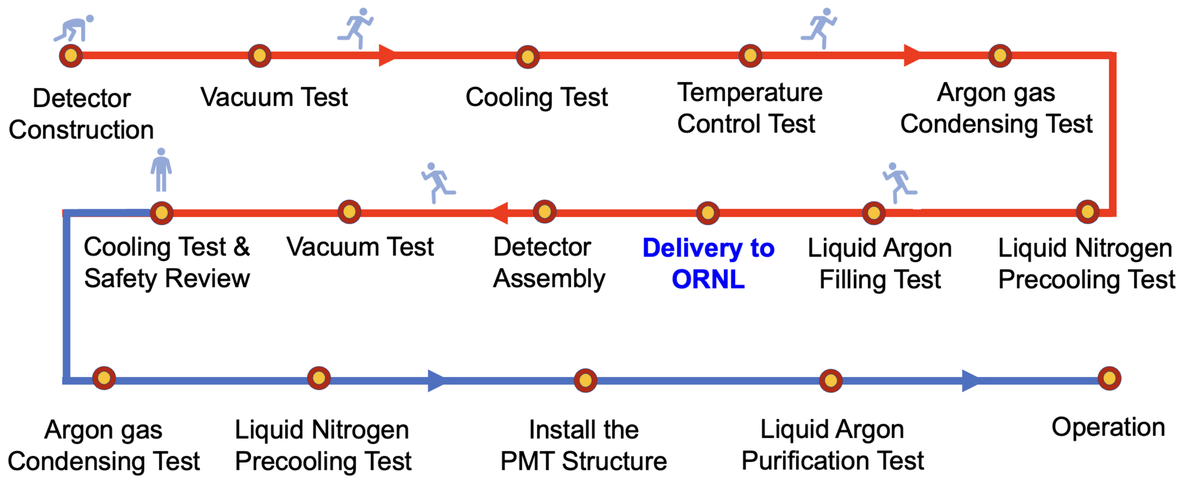


- TPB (Tetraphenyl butadiene) absorb 128nm scintillation light and re-emit them as lower-energy visible light.
- After evacuating the evaporator, TPB is evaporated to coat the PMTs
- Carousel and PMTs rotates simultaneously to ensure uniform coating with optimized thickness (0.2 mg/cm2).



- For the purity and insulation of argon, we did a very tight vacuum test.
- The vacuum of the $< 10^{-5}(torr)$ order has been confirmed in all four places shown above (Liquefier, LN2 loop, Vacuum vessel, and Argon vessel), and we are also trying to catch the part with a slight leak.

Future



- We are currently doing a Cooling test & safety review. (Safety first!)
- After that, we will conduct an argon gas condensing test and a liquid nitrogen pre-cooling test.
- If the above process goes smoothly, we will install PMT, finish Liquid argon purification test, make sure everything is working well, and then operate the chamber.

Summary

- We have moved 1 ton chamber made in Korea to ORNL and are conducting all the tests necessary for chamber operation such as vacuum test and PMT TPB coating, etc.
- As large fiducial volume, we are looking forward to more CEvNS events.