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Purification strategy of the JUNO liquid scintillator

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JUNO (Jiangmen Underground Neutrino Observatory) [1], currently under construction in southern China, will detect neutrinos from several sources, aiming to determine the neutrino mass ordering at 3σ level in 6 years of data taking, as the primary scientific goal [2]. JUNO consists of a spherical central detector filled with 20000 tons of liquid
scintillator (LS), which is composed of LAB as solvent, 2.5 g/l PPO as fluor and 3 mg/l bis-MSB as wavelength shifter [3]. Given the huge mass and dimensions, both the radiopurity and the optical parameters of the LS are crucial to achieving the desired energy resolution and low background. A dedicated sequence of 5 purification processes has been implemented with large-scale plants (nominal flow rate 7 m 3/h), to
purify the scintillator according to stringent optical and radiopurity requirements [4]. The purification sequence includes: LAB filtration using Al 2O3 powder, to improve its optical properties; distillation in a partial vacuum, to remove high-boiling impurities and further enhance the transparency [5]; acid washing and water rinsing of PPO and bis-MSB dissolved into LAB in a concentrated solution; water extraction of the final LS cocktail, aiming to get rid of polar radioisotopes
and ions; lastly, gas stripping with N2, for the removal of gaseous contaminants naturally dissolved into the LS. High-purity nitrogen, with low Rn content, and ultra-pure water, with low Rn and contaminants, are produced in two separate supply systems and provided to the purification plants, aiming to achieve better purification efficiencies.

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[4] C. Landini, “Purification strategy of the JUNO liquid scintillator”, Neutrino2024 conference, doi: 10.5281/zenodo.13468895

[5] P. Lombardi, M. Montuschi et al., “Distillation and stripping pilot plants for the JUNO neutrino detector: Design, operations and reliability”, NIM A, 925 (2019) 6–17

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