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Measuring the 14C content in liquid scintillators

In order to detect solar neutrinos from the pp-chain (with the maximum neutrino energy of approximately 400 keV) requires that the intrinsic 14C content in a liquid scintillator is at extremely low level.

In the Borexino detector, a 300-ton liquid scintillation detector at Gran Sasso, Italy, the ratio of 14C to 12C of approximately 2 x 10^{-18} has been achieved. It is the lowest value ever measured, but too large for observing solar pp-neutrinos. The detector situates 1200 metres underground.

14C cannot be removed from liquid scintillators by chemical methods, or by other methods in large quantities (liters). In principle, the older is the oil or gas source that the liquid scintillator is made of and the deeper it situates, the smaller should be the 14C-to-12C ratio. This, however, is not generally the case, and the ratio depends on the activity (U and Th content) in the environment of the source.

We are starting a series of measurements where the 14C-to-12C ratio will be measured from liquid scintillator samples. The measurements take place in the Pyhasalmi mine, Finland, at the depth of 1400 meters (4000 mwe). There will be half-a-dozen samples with the known origin, each of them approximately 3 litres. The liquid scintillator vessel, light quides and low-active PMTs will be shielded with thick layers of electrolytically manufactured copper and parafine, and perhaps lead. The setup needs also a radon filter (nitrogen flow) and perhaps a muon veto detectors.

The aim is to measure ratios smaller than 10^{-18}, if such samples exists. One measurement takes several weeks.

It is planned that later this setup will be scaled up, up to approximately 100 litres of liquid scintillator, for half-life measurements of double beta-decaying isotopes (2nu-mode).

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