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R&D project for neutrinoless double beta decay in Borexino

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Summary. — Since the proposal of the Borexino project in the early nineties, the idea to perform a neutrinoless double beta decay experiment with ^{136}Xe dissolved in the scintillator was considered. The beautiful results obtained by the Borexino experiment, which achieved a purity far exceeding design goals, and a new concept for dissolving large quantities of xenon in the scintillator by increasing its pressure make this possibility even more interesting for a new-generation experiment in the next decade. We present the ongoing R&D studies to look for neutrinoless double beta decay using liquid scintillators, discussing the optical properties of the Borexino scintillator when xenon is dissolved in large quantity and with high pressure.

PACS `23.40.-s` – β decay; double β decay; electron and muon capture.
PACS `29.40.Mc` – Scintillation detectors.

1. – Setup description

The prospect of turning Borexino into a new generation neutrinoless double beta decay experiment has been considered since long [1, 2]. Also, the importance of a huge and ultrapure detector in this field has been recently outlined [3]. Here we show our preliminary R&D work to study the feasibility of an eventual Borexino conversion. In particular, we aim to measure the scintillator light yield variation as a function of the

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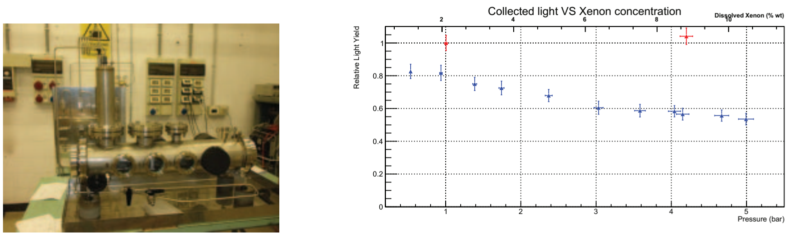

Fig. 1. – The left panel shows a picture of the system while the right panel shows the light yield measurements as a function of the nitrogen/xenon partial pressure. Red dots (upper ones) indicate the measurements done with nitrogen dissolved in the scintillator (Borexino condition), while blue ones (lower ones) refer to xenon. Light yield is normalized to the Borexino one.

amount of Xe dissolved (or, equivalently, of the Xe partial pressure), with respect to the pure Borexino scintillator case.

Our setup consists in a cylindrical chamber about 1 m long containing around 40 L of Borexino's liquid scintillator (PC doped with PPO, [4]) and able to reach a pressure of 5 bar. The scintillation light is read out by PMTs facing quartz windows along the chamber. A picture of the system can be found in fig. 1.

2. – Methods

In order to perform the light yield measurement, we exploit the scintillation light produced by cosmic muons in the scintillator. Two external scintillator detectors, located above and below the chamber, tag muons crossing the system. The position of the peak in the energy spectrum correspondent to the muons vertical crossing of the chamber is our estimator of the light yield.

Besides the light measurements, it is also important to control the thermodynamic equilibrium of the apparatus and to measure the amount of gas dissolved in the scintillator. Temperature and pressure are constantly monitored, 4 high sensitivity strain gauges measure the system mass and, at the end of a measurement cycle (insertion, circulation and extraction of the gas), Xe is recovered in a dedicated condenser. Assuming Henry's and ideal gases laws, we can infer the actual amount of PC inside the chamber and the amount of Xe dissolved in the scintillator.

3. – Results and outlook

We measured the light yield of the compound Xe-scintillator with respect to the pure Borexino scintillator case at different pressures and we found that at the pressure of 1 bar the light yield is 15% lower, while at 5 bar the light yield decreases of about 45% (see fig. 1). We are working to perform further measurements on the Xe+scintillator compound and to test other liquid scintillators as well.

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