Piezo electric transducer and condenser microphone in detecting signals for Superheated Drop Detector

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Introduction

Superheated drop detector (SDD) is one of the promising detectors in search for WIMPs (Weakly Interacting Massive Particles), the possible candidates for cold dark matter [1]. WIMPs are expected to produce recoil nuclei via elastic head on collision with the detector nuclei. The recoil nuclei deposit the energy in the medium and form the visible bubble if it satisfies the conditions of bubble formation. SDD is already known to detect neutrons, gamma rays and other charged particles under different operating conditions. The PICASSO (**P**rojet d'**I**dentification de **CA**ndidats **S**upersymétriques **SO**mbres) is an international collaboration works for the dark matter (WIMP) search experiment with large mass superheated drop detector. The detectors are installed at the 2000m deep underground, SNOLab, Sudbury, Canada. The minimum dE/dx requirement of SDD provides a total insensitivity to most undesirable backgrounds interfering with WIMP searches. The recent results on the R & D of SDD, despite the low exposure, provides the restrictions on the allowed phase space of WIMP interactions which is comparable with those from the significantly larger exposures [2].

The detector consists of drops of superheated liquid of low boiling point, suspended in viscous gel or in polymer medium. When radiation falls on the drops, if the energy deposition in the liquid exceeds the critical energy required for bubble formation, the drops form bubbles. The usual way of converting the acoustic pulse of drop nucleation to electrical signal is by using piezo electric transducer. In the recent studies at our Institute, the active electronic devices for signal detection for such detector have been developed by using condenser microphone which is inexpensive and readily available [3]. In the present work, the signals were detected both by using condenser microphone and the piezo electric transducer (PZT) used at PICASSO experiment and a comparison is made. The pulse amplitude and frequency of the signals recorded in both cases are presented.

Experiment

In order to make a comparison between the pulses recorded by piezo electric transducer and condenser microphone, both the sensors were coupled to vial containing superheated drops of R404 (mixture of four different hydrocarbon and halocarbon refrigerant liquids ; b.p. - 46^{o}C). Superheated drops of R404 is prepared in viscous gel matrix and taken in a 40ml glass vial. The condenser microphone is coupled to the detector by putting it inside the gel within the glass vial and the PICASSO-PZT is coupled on the bottom of the vial of thickness 2 mm from outside. In original PICASSO experiment, the PZT is also coupled from outside of the acrylic container of about 6 mm thick. The piezo electric transducer of PICASSO experiment and the condenser microphone are shown in Fig.1. The traces of the pulses due to spontaneous nucleation were recorded using CRO at room temperature (30^{o}C) for both the sensors in identical conditions.

Results and Discussions

Fig.2 shows the pulse height distribution observed with PICASSO-PZT and the condenser microphone in viscous gel matrix with R404 as sensitive liquid. From the result it is clear that the pulses recorded by PICASSO-PZT are of smaller amplitude compared to that of condenser microphone. There are few signals which are observed to be missed by the PICASSO-PZT but counted by the condenser microphone. R404 is chosen in this experiment due to the fact that it is sufficiently superheated at 30^{o}C with degree of

Fig.1. Piezo electric transducer used at PICASSO collaboration (upper picture) and condenser microphone (lower picture).

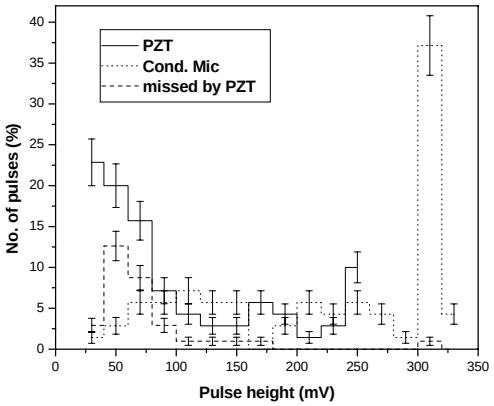

Fig.2. Observed pulse height distribution with both PICASSO-PZT and condenser microphone.

superheat 76^{o}C which provides higher spontaneous nucleation rates. Therefore the need of separate arrangement for irradiation at higher temperature is avoided, as in this effort, we are only interested to observe and compare the nature of the pulses using two different sensors. The frequencies associated with these signals are displayed in Fig.3 both for condenser microphone, PICASSO-PZT and for those pulses recoded by condenser microphone but missed by PICASSO-PZT.

The frequencies as recorded by the condenser microphone are in the same range for all the events but as recorded by PZT are of wide range. As also noted earlier by us, there is no dependence on frequency of the events for the case of condenser microphone but PZT output depends on the frequency and therefore, PZT would be better in terms of selection of events of different origin by frequency analysis [2]. The few pulses counted by condenser microphone but missed by PICASSO-PZT is due to the smaller amplitude of the pulses. The use of amplifier with PZT is expected to rectify this situation.

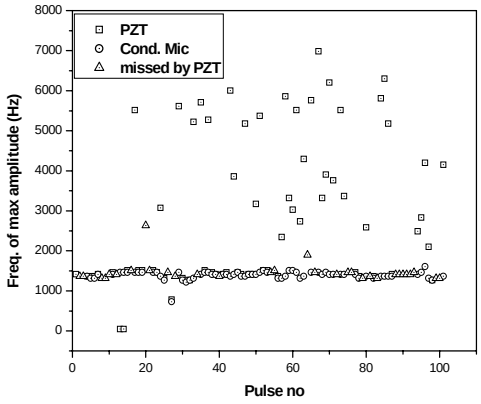

Fig.3. The frequency of observed spontaneous pulses for both PICASSO-PZT and condenser microphone.

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References

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