In order to have an affordable array for cosmic rays, water Cherenkov detector is a proper choice for a surface array [1]. In order to make an affordable array for cosmic rays study, an array of four water Cherenkov detectors, each one with one Photomultiplier Tube (PMT), had been made at Sharif University of Technology and 6×10^8 showers that had detected by this array [2]. In order to improve count rate, we decided to optimize size and inner surface characteristics of the Cherenkov tank for an individual tank at first.

Because of problems in making a cylindrical PVC tank with a diameter of 40cm, we referred to buy a premade tank with a diameter of 45cm and height of 70cm which was available in market. The inner surface of the tank was optically sealed and covered with white paint which reflects light in a diffusing pattern. The outer surface was painted in black for better optical sealing. To find the optimum height of the purchased tank we ran the simulation for a tank with a diameter of 45cm.

Fig. 3 shows number of detected photons versus height of the tank. This Figure indicates that the optimum height of the tank with the diameter of 45cm is also 60cm. For further comparison, Fig. 4 shows number of detected photons when particles enter from the wall of the tank at different heights.

For both reflective and diffusing inner surfaces we changed height of water from 20cm to 70cm. For each water height, we swept the tank surface (bottom surface and wall) with a small scintillation detector to obtain total count for each specified height of water. Fig. 5 shows the total count versus height of water for both inner surfaces. Since the size of error bars for each data point is less than the size of the symbols used for them in all experimental plots, the error bars are omitted in these figures. The events count for each specified height of water, when the scintillation detector sweeps wall of the tank, is shown in Fig. 6 and it is comparable with Fig. 4 which is obtained from simulation. These two figures are in good agreement to each other. The average energy deposited for reflective inner surface are usually more than diffusing inner surface but their differences are in error range (5/1024 which 5 is maximum difference between data points of diffusing and reflective inner surface in Fig. 7).

Conclusions

Fig. 5 and Fig. 7 indicate that total count and average energy deposited by particles which were detected by the PMT don’t have tangible difference in diffusing and reflective cases. To consider expenses and probability of water contamination in making the inner surface reflective, using the diffusing inner surface is more economical. Fig. 1 and Fig. 2 show that the optimum dimensions of a Cherenkov tank with one PMT is 60cm in height and 40cm in diameter. But as it mentioned before because of difficulties in making a tank with the diameter of 40cm, we used a tank with a diameter of 45cm which was available in market. From Fig. 3 and Fig. 5 we conclude that the optimum height of the tank, with the diameter of 45cm and diffusing inner surface, is 60cm. In ALBorz observatory we will use tanks with these dimensions.