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Supernova Early Warning in the Daya Bay Reactor Neutrino Experiment

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On behalf of the Daya Bay Collaboration
Providing an early warning of supernova burst neutrinos is of importance in the study of both supernova dynamics and neutrino physics. The Daya Bay Reactor Neutrino Experiment, with multiple liquid scintillator targets, is sensitive to the full supernova burst anti-electron-neutrino spectrum and has a better energy resolution than water Cerenkov detectors. By deploying 8 Antineutrino Detectors (ADs) in three different experimental halls, which are about 1 km apart from each other, it has a much better rejection to muon spallation background than single-detector experiments. A fast (10s latency) supernova online trigger system embedded in the data acquisition system is designed to enable a prompt detection of a coincidence of the neutrino signals via an inverse-beta-decay (IBD) within a 10-second window, and can hence provide a robust early warning of a supernova occurrence. This trigger has undergone studies through both offline data analysis and online testing. Single detector background rates, including the reactor neutrino backgrounds, fast neutron backgrounds etc., are understood. A simulation of supernova neutrino signals with mean energy around 15 MeV shows that about 70% detection efficiency can be achieved for a single supernova neutrino IBD event in each detector. Based on these rates and efficiencies, an 8-AD supernova trigger combination table has been constructed to tabulate the 8-AD event counts' coincidence vs. the trigger rate. A golden trigger threshold, i.e. with a false alarm rate < 1/year, can be set as low as 6 candidates among the 8 detectors (part of 6-candidate cases trigger and the rest cannot as the 6 candidates have different distribution among 8 detectors), leading to a 100% detection probability for all 1987a type supernova bursts at the distance to the Milky Way center and a 95% detection probability to the edge of the Milky Way."

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