Nuclear Reactor Safeguards using Compact Antineutrino Detectors

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Just over fifty years ago, Reines and Cowan used the large antineutrino flux produced by a nuclear reactor to confirm the existence of these very weakly interacting particles. Since that time reactors have served as the neutrino source for many fundamental physics experiments, culminating in the recent measurement of neutrino oscillations by the KamLAND experiment.

The techniques developed by these experiments make it possible to use these particles for a practical purpose. The large flux of antineutrinos that leaves a reactor carries information about two quantities of interest for safeguards: the reactor power and fissile inventory. Such monitoring is feasible, since even with a relatively small cubic meter scale detector at tens of meters standoff, hundreds to thousands of antineutrino interactions will occur each day. The ability to make such real time measurements in a noninvasive fashion could add a unique capability to the set of reactor monitoring tools available to the IAEA and other safeguards agencies.

Our Sandia/Lawrence Livermore collaboration has deployed a prototype safeguards antineutrino detector at a commercial PWR in order to test both the method and the practicality of its implementation in the field. Here we discuss the general features of this novel monitoring technique and present results from the prototype deployment.