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The SoLid anti-neutrino detector's read-out system

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The SoLid collaboration have developed an intelligent read-out system to reduce their 3000 silicon photomultiplier detector's data rate by a factor of 10000 whilst maintaining high efficiency for storing data from antineutrino interactions.
The system employs an FPGA level waveform characterisation to trigger on neutron signals.
Following a trigger, data from a spacetime region of interest around the neutron will be read out using the IPbus protocol.
In this talk the SoLid experiment will be introduced, the design of the read-out system will be explained and the performance of prototype versions of the system will be presented.

Summary

The electron anti-neutrinos emitted from a nuclear reactor can be detected via the inverse beta decay, which produces a positron and a neutron.
The positron is promptly detected in a scintillator.
The neutron can be captured on particular isotopes (lithium-6 in the SoLid detector) to give a secondary scintillation signal up to 1 ms after the positron signal and at distances up to 20 cm from the initial interaction.

Performing anti-neutrino measurements at ground level and close to a nuclear reactor is particularly challenging due the high rate of background signals that can mimic the positron and neutron from an inverse beta decay interaction.
The SoLid detector uses a novel composite scintillator technology that provides a robust neutron signature and the detector is also highly segmented in order allow topological selection of candidate anti-neutrino events based on the relative positions of the positron and neutron detections.
The scintillation signals are detected using silicon photomultipliers.
The high level of segmentation results in the 2 tonne detector having 3000 SiPM channels to collect data from, with a raw data rate of order Tb/s.

The SoLid collaboration have developed an intelligent read-out system to reduce the data rate by a factor of 10000 whilst maintaining high efficiency for storing data from inverse beta decay events.
The system employs a front end waveform characterisation within an Artix-7 FPGA to trigger on neutron signals.
In additional, data from all channels will be buffered in the FPGA with a low zero-suppression threshold.
Following a neutron trigger, data will be read out from a region of the detector surrounding the neutron channel in a 0.5 ms time window which has a high probability to include the positron signal of an inverse beta-decay interaction.
Data will be transmitted to a software level data reduction system using the IPbus protocol.
The on-line software will be able to compare signals from across the region of interest to identify positron candidates and further reduce the rate at which data is stored to disk by removing low amplitude signals that are not coincident with the positron candidates.

The SoLid collaboration will deploy their first detector modules late in 2016.
In this talk the SoLid experiment will be briefly introduced, the design of the read-out system will be explained and results showing the performance of prototype versions of the system will be presented.

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