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Overview of the data acquisition system architecture for the DarkSide-20k experiment

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The nature of dark matter remains unknown and its origin is currently one of the most important questions in physics. In particular direct searches for WIMP dark matter particle interactions with ordinary matter are carried out with large detectors located in underground laboratories to suppress the background of cosmic rays. One of the currently most promising detection technologies is based on the use of a large mass of liquid argon or xenon as a target in the detector.

In this talk I will briefly introduce the DarkSide-20k detector, now under construction in the Gran Sasso National Laboratory (LNGS) in Italy, the biggest underground physics facility. It is designed to directly detect dark matter by observing weakly interacting massive particles (WIMPs) scattering off the nuclei in 20 tonnes of underground-sourced liquid argon in the dual-phase time projection chamber (TPC).

The light generated during the interactions in the liquid argon is detected by custom silicon photomultipliers (SiPMs) assemblies of size 20 cm by 20 cm. The units installed in the veto detectors are equipped with application specific integrated circuits (ASICs) coupled to SiPMs allowing linear signal response up to 100 photons and signal to noise ratio of 5 for a single photon, while those for the TPC employ a discrete element front-end with similar performances.

The data acquisition system (DAQ) for the DarkSide-20k experiment is designed to acquire signals from the 2720 channels of these photosensors in a triggerless mode. The data rate from the TPC alone is expected to be at the level of 2.5 GB/s and will be acquired by 36 newly available commercial VX2745 CAEN 16 bit, 125 MS/s, high channel density (64 ch.) waveform digitizers. The Veto detector is readout by an additional 12 modules. The data is first transferred to 24 Frontend Processor machines for filtering and reduction. Finally the data stream is received by another set of Time Slice Processor computers where the whole detector data is assembled in fixed length time series, analysed and stored for offline use. These operations will be supervised by a Maximum Integration Data Acquisition System (MIDAS) developed in the Paul Scherrer Institute in Switzerland and TRIUMF laboratory in Canada.

Primary author: WALCZAK, Marek (GSSI)

Presenter: WALCZAK, Marek (GSSI)

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