

SiPM and Readout Electronics for the JUNO-TAO Central Detector

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The Taishan Antineutrino Observatory (TAO) is a satellite experiment of the Jiangmen Underground Neutrino Observatory (JUNO), expected to start operation between 2023 and 2024. TAO consists of a spherical ton-level Gadolinium-doped Liquid Scintillator (GdLS) detector at ~ 30 m from a reactor core of the Taishan Nuclear Power Plant in Guangdong, China. About 4500 photoelectrons per MeV could be observed by instrumenting with almost full coverage the LS sphere surface (~ 10 m²) with Silicon PhotoMultipliers (SiPMs) of large Photon Detection Efficiency (PDE > 50%). This will result in an unprecedented energy resolution. The Central Detector (CD) operates in a cryostat, filled with LAB, at -50°C , in order to limit the dark noise of the SiPMs to an acceptable level.

The main purposes of the TAO experiment are to provide a reference reactor antineutrino spectrum for JUNO, and to perform a benchmark measurement to test nuclear databases, by comparing the measurement with the predictions of the summation method.

In this work we present the readout electronics based on low-noise, high-speed Front-End Boards (FEBs) connected to a 5 cm x 5 cm SiPM Hamamatsu tile, composed by 32 SiPM elements of 12 mm x 6 mm each, divided into two independent output channels.

The overall 4024 FEBs will be supplied through eight custom flanges that have to bring in about 1.5 kW. On the same flanges the 8048 output signal cables are distributed and routed to the Front-End Controllers (FECs), based on Virtex Ultrascale FPGAs, able to control up to eight 16-channels ADC, for a total of 128 channels with a maximum sampling rate of 250 MHz with 12 bit resolution. A dedicated trigger and DAQ system will filter and record occurring events, rejecting dark count events.

We report the results of the characterization for the first 100 pre-production FEBs batch, following the main figures of merit defined for the experiment, showing single photoelectron resolution better than 13% and dynamic range up to 250 p.e.