A possible design of the readout electronics for large area SiPM detectors of the TAO experiment
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The Taishan Antineutrino Observatory

Motivation
- Precisely measure the reactor antineutrino spectrum with energy resolution at the level of ~2% at 1 MeV.
- Provide a model independent reference spectrum for JUNO.
- Reactor monitoring and safeguard.
- Search for sterile neutrino.

General properties
- Gd-doped liquid scintillator.
- Very close (~30 m) to Taishan reactor core 1 (4.6 GWth).
- Expected rate ~4000 antineutrinos per day.
- ~10 m² SiPM Readout.
- Detector operated @ -50 °C.

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Front-End Board
- 1 channel = 1 tile.
- Total ~4000 channels.
- Analog signals from FEB will be transferred to FEC via differential pairs, 3-4 m inside the SS tank, ~10 m outside the tank.
- Custom made PCB flanges to bring signals outside the tank.

Front-End Controller
- Host the ADCs.
- 1 FEC = 32 or 48 channels.
- Real time waveform analysis on FEC FPGA to extract (Q,t) pairs.
- White Rabbit for clock distribution.

FEC Prototype
- AD9083 ADC board.
- FPGA Control (Kintex 7).
- Ethernet connection with PC.
- 250 MS/s, 125 MHz Bandwidth.
- 16 Channels.
- Differential 2Vpp input.

FPGA
- FPGA compute Q,T in real time for each ADC input.
- Q,T can be sent in form of number of PE or raw area value.
- Full waveform can be transferred during calibration or commissioning.

Conclusions
- Offline analysis on FPGA.
- FEB prototypes extensively tested: match the TAO requirements.
- High reliability.
- Very flexible in terms of gain, shaping time, dynamic range, granularity.
- FEC first prototype shows design feasibility.
- Prototype shows the possibility of real time waveform analysis on FPGA.

FEC Designed to be hosted in µTCA Crate.

FEB Features
- SiPM elements of each tile are splitter in 4 Transimpedance amplifier.
- More TIA can be added in order to reduce input capacitance.
- ADC driver for differential output allows having ~10 meters cable between FEB and ADC.
- Single PE amplitude ~8 mV.
- 0V-2V output range: matches the input range of the ADC.
- Dynamic range 1-250 PE.
- Good stability @ -50 °C.
- Extensively tested @ -70 °C without any failures.
- Low background PCB materials under test (Pyralux, Aramid).

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