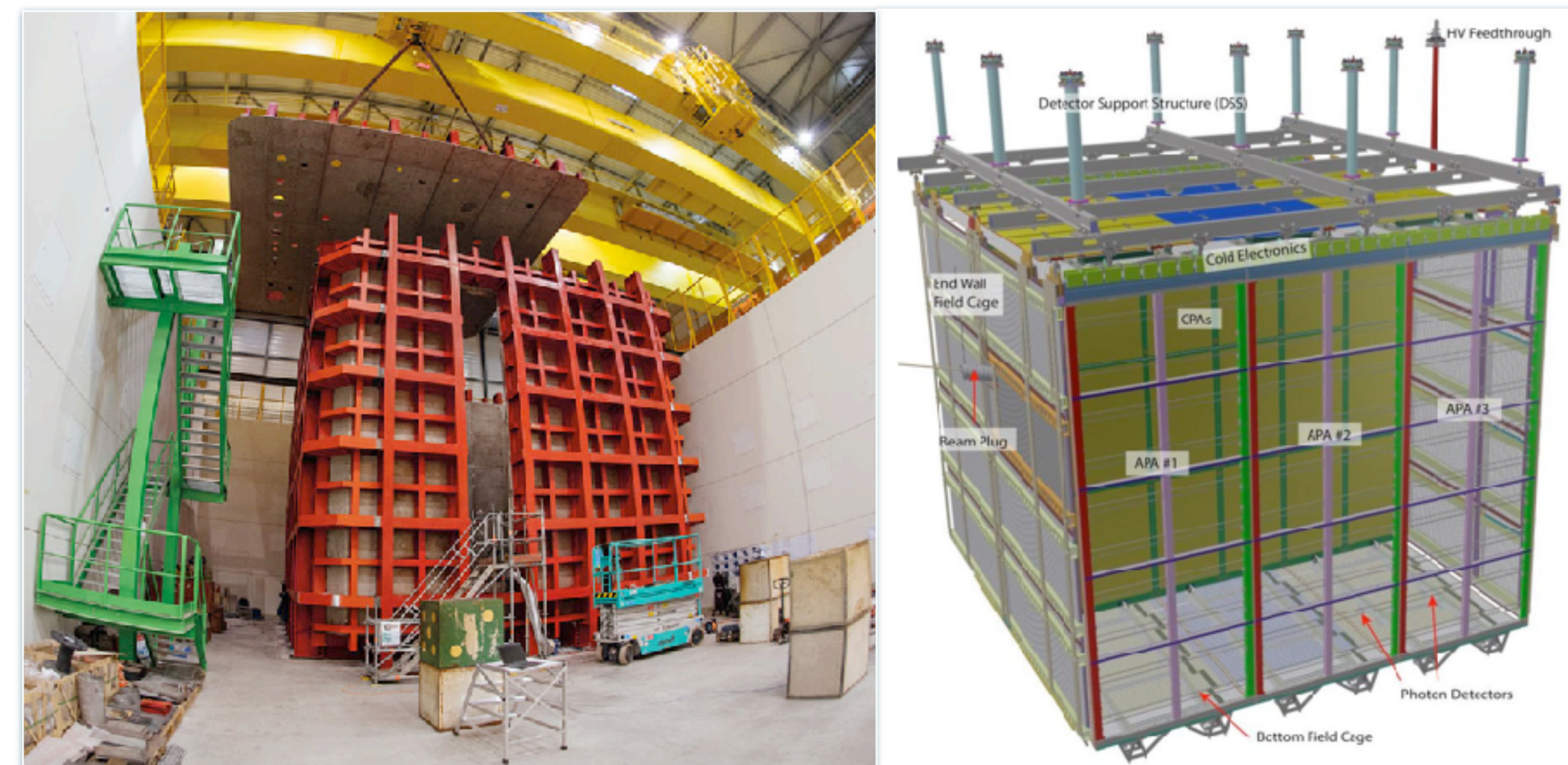


ProtoDUNE Single Phase

- one of the two prototypes for the Deep Underground Neutrino Experiment (DUNE) at CERN Neutrino Platform
- the detector is a 10 x 10 x 10 m liquid argon time projection chamber (LArTPC) w/ ~800 tons of liquid argon
- readout of 15,360 wire signals in 6 Anode Plane Assemblies (APAs) at 2 MHz (~430 Gb/s, 12-bit ADC)
- aims to collect ~6M test beam data to demonstrate the construction and operation of LArTPC detector

ProtoDUNE-SP



Reconfigurable Cluster Element (RCE) Platform

- designed by SLAC as a *generic* data acquisition platform
- based on *ATCA-compliant* standard

Data Processing Module (DPM-Gen3)

- each DPM holds 2 RCEs
 - Zynq XC7Z045 FPGA
 - dual-core ARM A9 @900 MHz
 - 1 GB DDR3
- served as computational element for data handling & processing

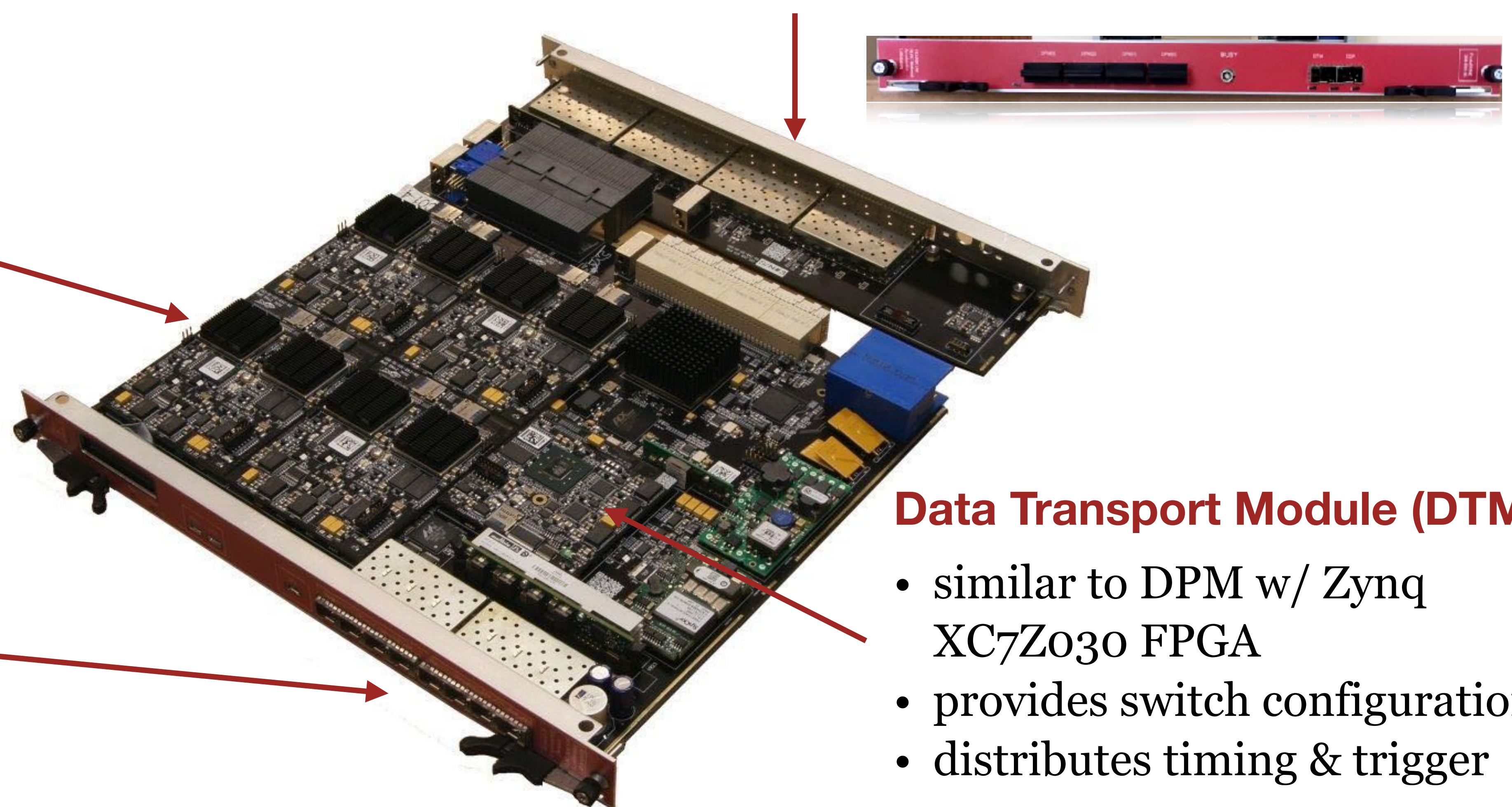
10Gb Ethernet Switch

- supports full mesh ATCA backplane
- transfers data to DAQ computer hosts



Rear Transition Module (RTM)

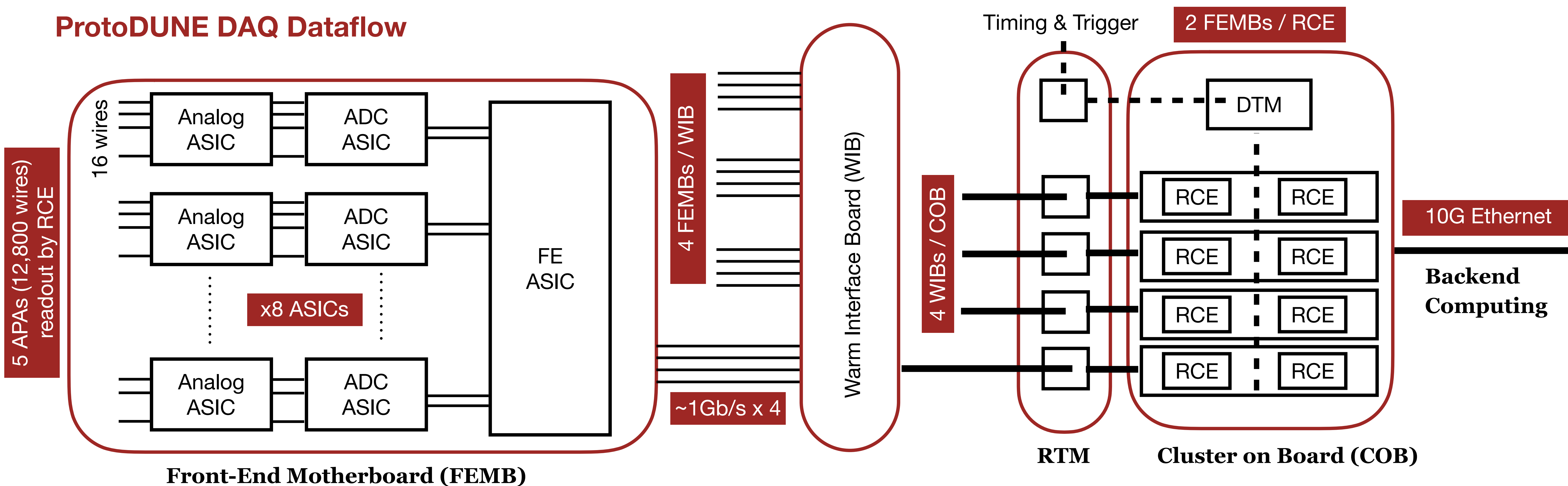
- designed *specifically to the experiment*
- receives detector data via digital / optical connections



Data Transport Module (DTM)

- similar to DPM w/ Zynq XC7Z030 FPGA
- provides switch configuration
- distributes timing & trigger

ProtoDUNE DAQ Dataflow



RCE Data Handling

- validate checksum for each WIB frame
- compress data with *Arithmetic Probability Encoding (APE)*, developed using *Vivado HLS* design flow
- buffer 1024 frames in packet, and *DMA'd* into the ARM processor

- place packets into a latency queue until a trigger message is received
- wrap an event of *5 ms* readout window
- transmit triggered event to backend computer using the *Reliable SLAC Streaming Interface (RSSI)* over UDP

Current Status & Prospects

- tested data flow and measured noise level for each APA in cold environment
- detector commissioning in progress
- expected to take data in late Aug 2018
- the RCE platform is part of the baseline design for the full DUNE DAQ

Noise measurement of 1 APA at ~160 K with RCE readouts

