# Proposal for an RCE-based DAQ system for LBNE

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## ABSTRACT

This document presents a proposal to use the SLAC-developed DAQ toolkit

# 1 Introduction

The main purpose of the LBNE DAQ system is to read the raw data from the Front End Boards (FEB), which are mounted on the Anode Plane Arrays (APA) inside the cryostat, to build events from the different parts of the detector and to pass these events on to long term storage. The Level 3 requirements for this system include[1]:

- LArFD-L3-DAQ-3: The DAQ shall be capable of receiving raw data from a freely running readout from all detector systems.
- LArFD-L3-DAQ-7: The DAQ shall be designed to collect data continuously
- LArFD-L3-DAQ-8: The DAQ shall perform prompt processing of data

The DAQ-7 requirement is relevant mainly to non-beam physics. As such, it was left out of the requirements at the time of CD-1, which assumed a surface-located Far Detector (FD). Nonetheless, continuous readout remains a valuable goal that would be desirable to have in the final LBNE DAQ system.

The key electonics module that needs to be provided for the back-end DAQ is one that is capable of reading the data streams from each of the APA's and concentrating the data down to a smaller number of high-bandwidth data streams that are then passed to an event-building network. This is commonly needed function in modern HEP experiments that has frequently been addressed with custom modules built explicitly for a single experiment. This may require significant development time. However, the modules produced quickly become obsolete, as available networking technology progresses. This limits the desirability of reusing such modules in subsequent experiments.

The SLAC Research Electronics Group (REG) has developed a solution to this obsolescence problem by producing a set of modules, together with firmware and software, that can be adapted for use in multiple experiments. The development costs are then leveraged over multiple experiments, allowing each of them to benefit from the latest networking hardware, at a significant reduction in development costs. This "DAQ toolkit" uses the modern Advanced Telecommunications Architecture (ATCA)for its physical structure. The key element of the system is the Reconfigurable Cluster Element (RCE), which is based on a Virtex 5 "System on a Chip". A single board combining several of these RCE's can handle very

high bandwidths measured in the 100's of Gigabits/second. This system has been adopted in several HEP experiments already, and will likely be adopted by more in the future. The REG is continuing to develop and support new generations of the toolkit to take advantage of new networking equipment as it becomes available.

We are proposing to make use of this toolkit in the DAQ systems to be produced for the LBNE 35 ton prototype and the full Far Detector. The bandwidth available in the current generation of the toolkit far exceeds that of the baseline system based on the Nova Data Concentrator Module (DCM). The increased flexibility afforded by this extra bandwidth may be highly valuable to ensuring LBNE success. Furthermore, leveraging the work already done by the REG as well as benefitting from their support in the future, will provide many benefits to LBNE and may reduce the development costs.

# 2 The Data Acquisition Toolkit

....some stuff...

## 2.1 ATCA

## 2.2 Reconfigurable Cluster Element

## 2.3 Cluster-on-Board

## 2.4 Rear Transition Module

.... or something...can steal from ATLAS CSC proposal for much of this stuff?

# 3 Implementation of RCE-based DAQ for LBNE

... first, sketch of the DAQ layout for full LBNE; then for 35t ....

.... timing and triggering ... configuration ....

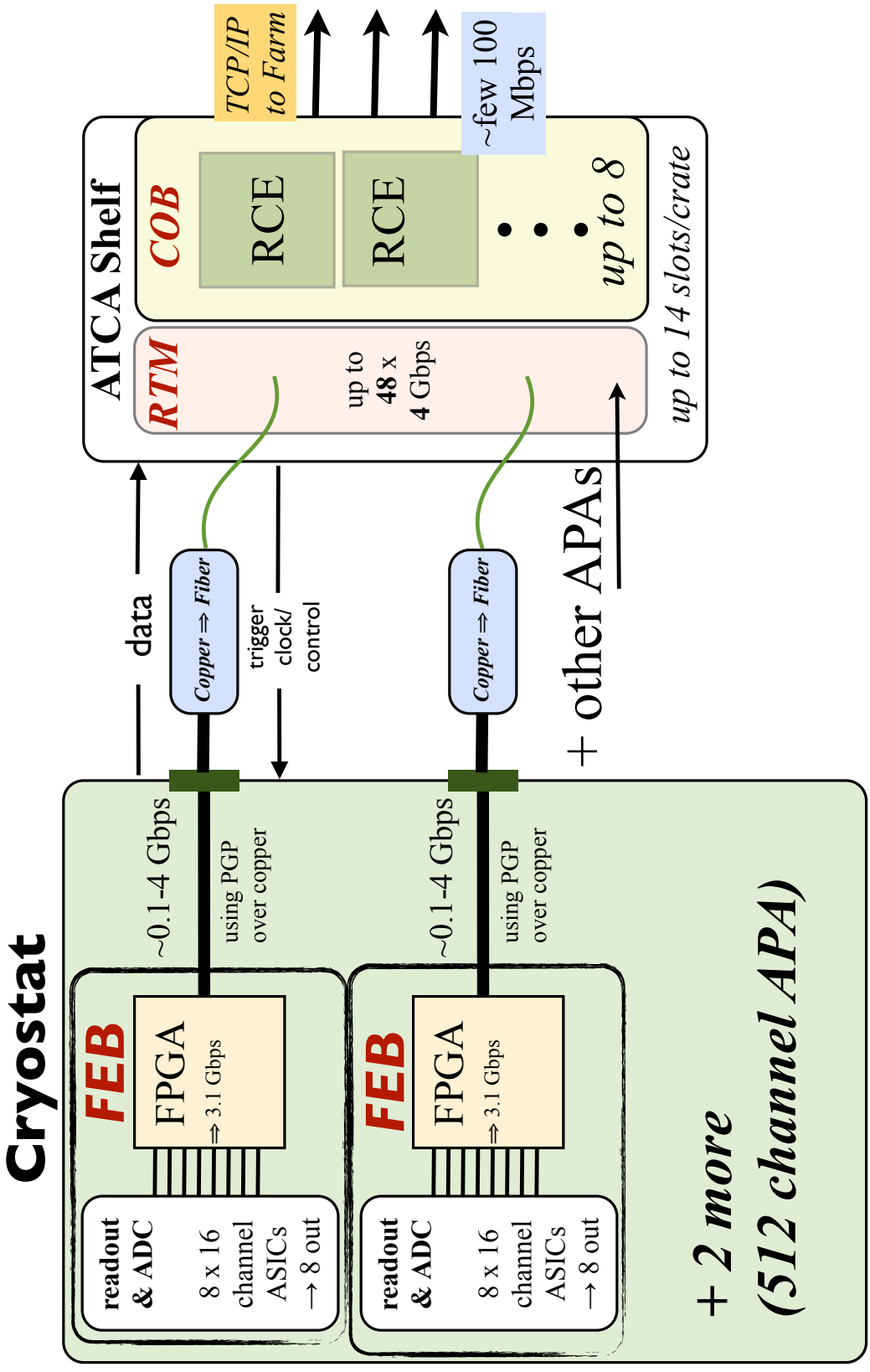


FIG. 1: Block diagram of the RCE-based DAQ for a single TPC APA.

| | 35t | Full LBNE |
|---|---|---|
| Total Channels | ∼2k | ∼307k |
| Number of APAs | 4 (?) | 120 |
| Number of FEBs | 16 | 2400 |
| Transition Boards | 16(???) | 2400(????) |
| RTM+COB Boards | 1 | 50 |
| ATCA Crates | 1 | 4 (14-slot) |

TABLE I: DAQ-related quantities for the 35t and full LBNE (as of Jan. 2013 design).

## 3.1 Full LBNE

.... assumptions, schematic of DAQ chain, summary of what/how many of each component we need ....

..."transition boards" are the copper-¿fiber boards...maybe these are in the flange itself...for full LBNE, would make sense to do some multiplexing here (maybe 20:4 ... go from an APA, single cable/FEB to a 4-fiber cable???)

## 3.2 Phase 2 of 35t Prototype

.... assumptions, schematic of DAQ chain, summary of what/how many of each component we need ....

## 3.3 Comparision of RCE-based vs DCM-based Backend DAQ Systems

Here's where we put the DCM comparison.

## 3.4 High-speed Data Links From Cold FPGA to Backend DAQ

...possibilities and our plans on this ...

### 3.5 DAQ Test-stand

# 4 Schedule and Budget

... show both 35t and 35t+full lbne? ...

# 5 Conclusions

... why there is no choice be to go with us ...

# 6 References

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[1] B.Baller *et al.*, LBNE Document 3747-v5,"LAr-FD Level 2 Programmatic and Scientific Requirements and LAr-FD Level 3 Requirements"

[2] A. Grillo *et al.* [HPS Collaboration], HPS Proposal to JLab PAC37 PR-11-006, http://www.jlab.org/exp_prog/PACpage/PAC37/proposals/Proposals/