Alternative Readout System Architectures II

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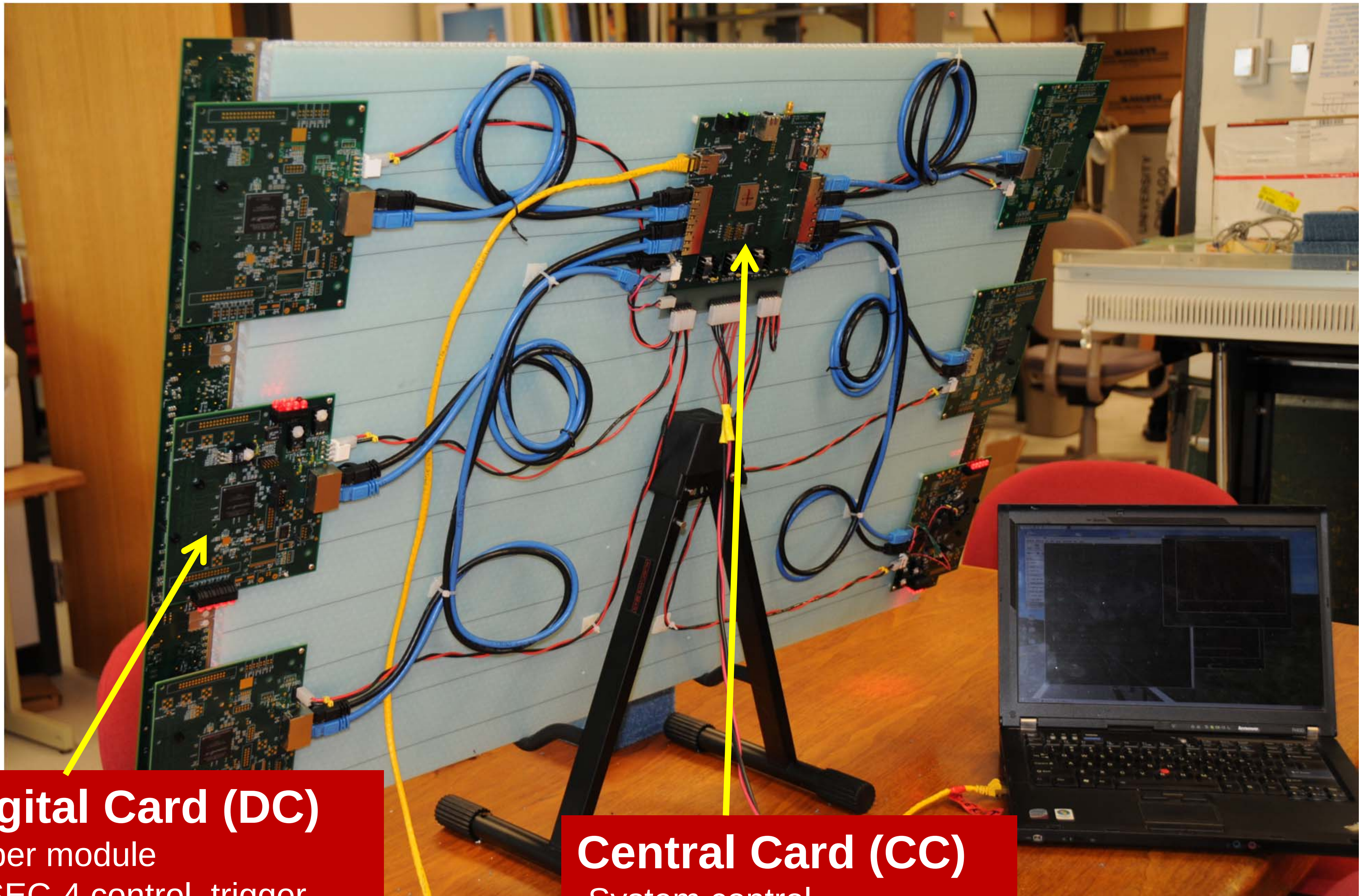
LAPPD2 Electronics Godparent Review
April 6, 2013

Baseline - Super Module



Digital Card (DC)

-6 per module

-PSEC-4 control, trigger handling, local data reduction & calibration

Central Card (CC)

-System control

-Feature extraction

-Interface (Triple Speed Ethernet & USB 2.0)

Baseline - Super Module

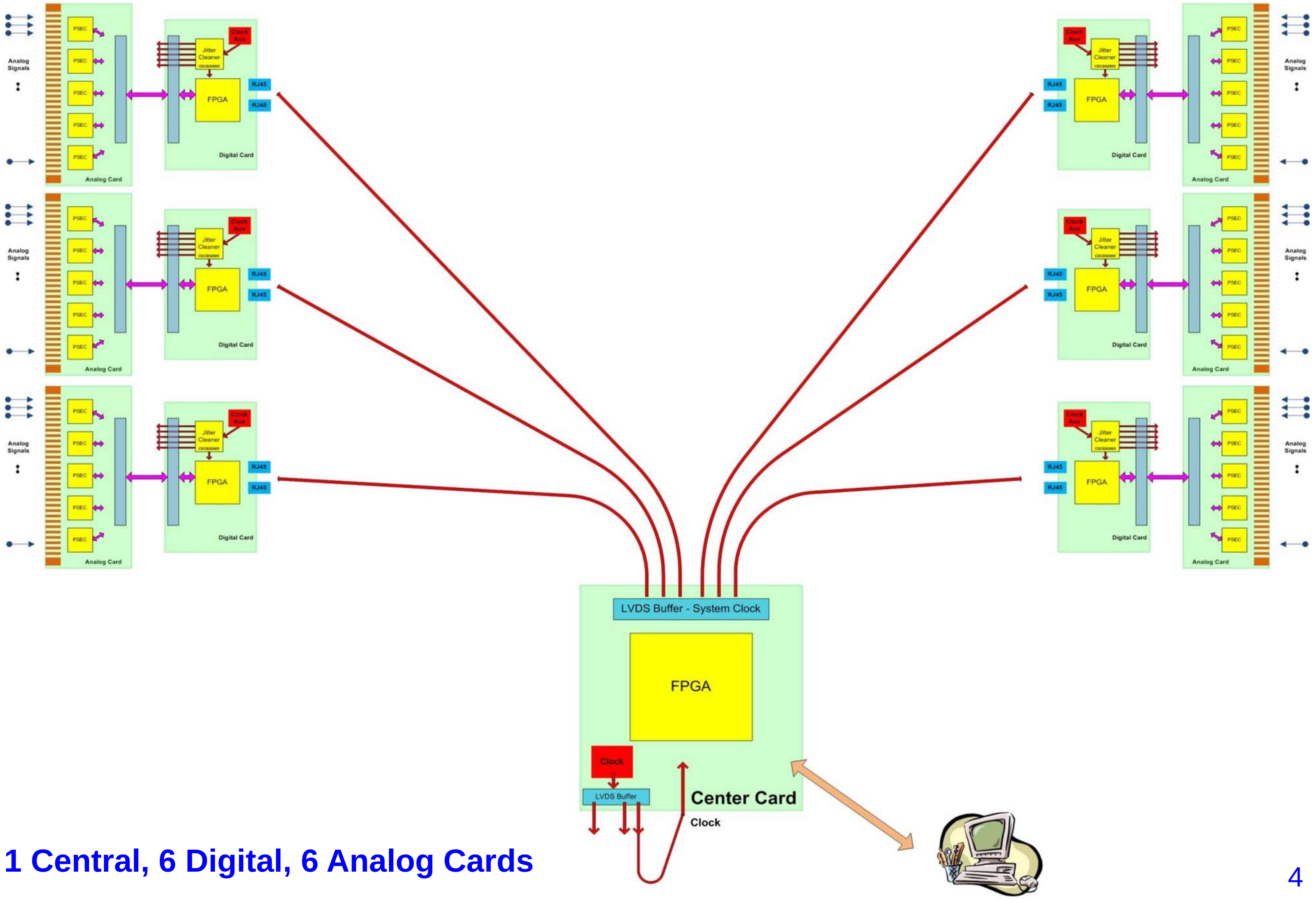
Baseline Readout System:

- Generic and flexible;
- Got us started;
- Addressed many issues.

Next DAQs will be more application specific, and optimized for performance and cost.

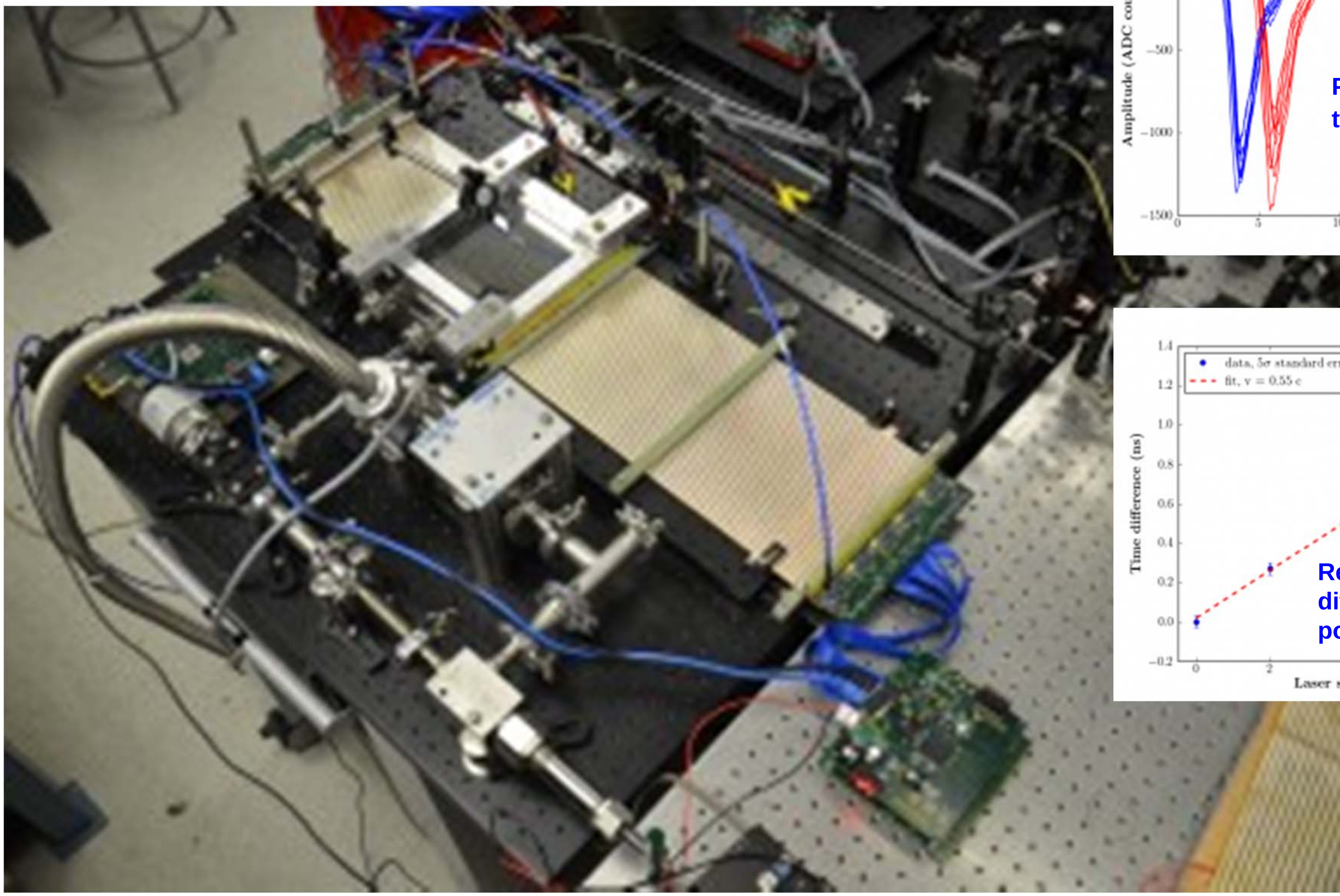
The next step will actually be easier. We've learned a lot already. Our resources should be adequate, subject to funding.

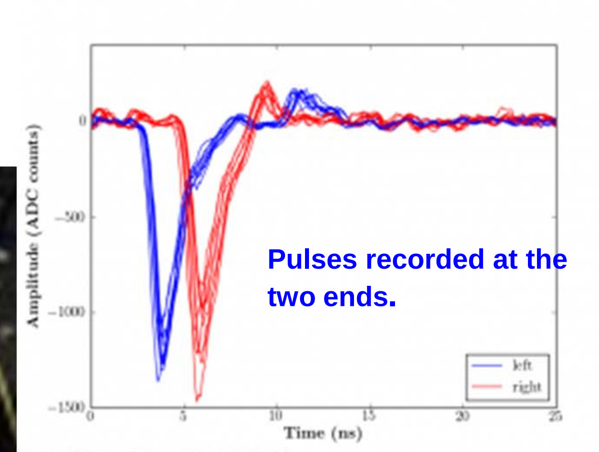
Baseline: Block Diagram

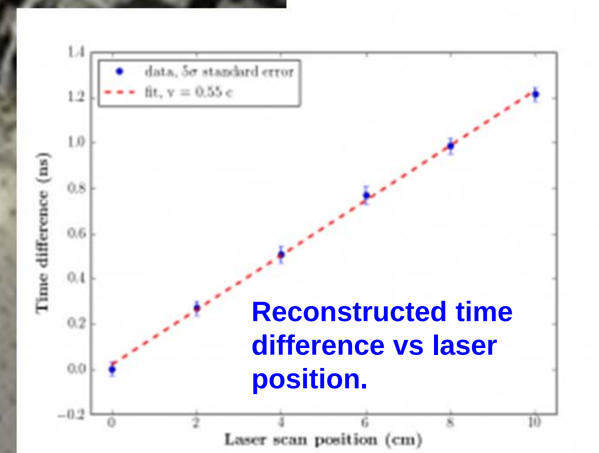


1 Central, 6 Digital, 6 Analog Cards

Baseline: Results

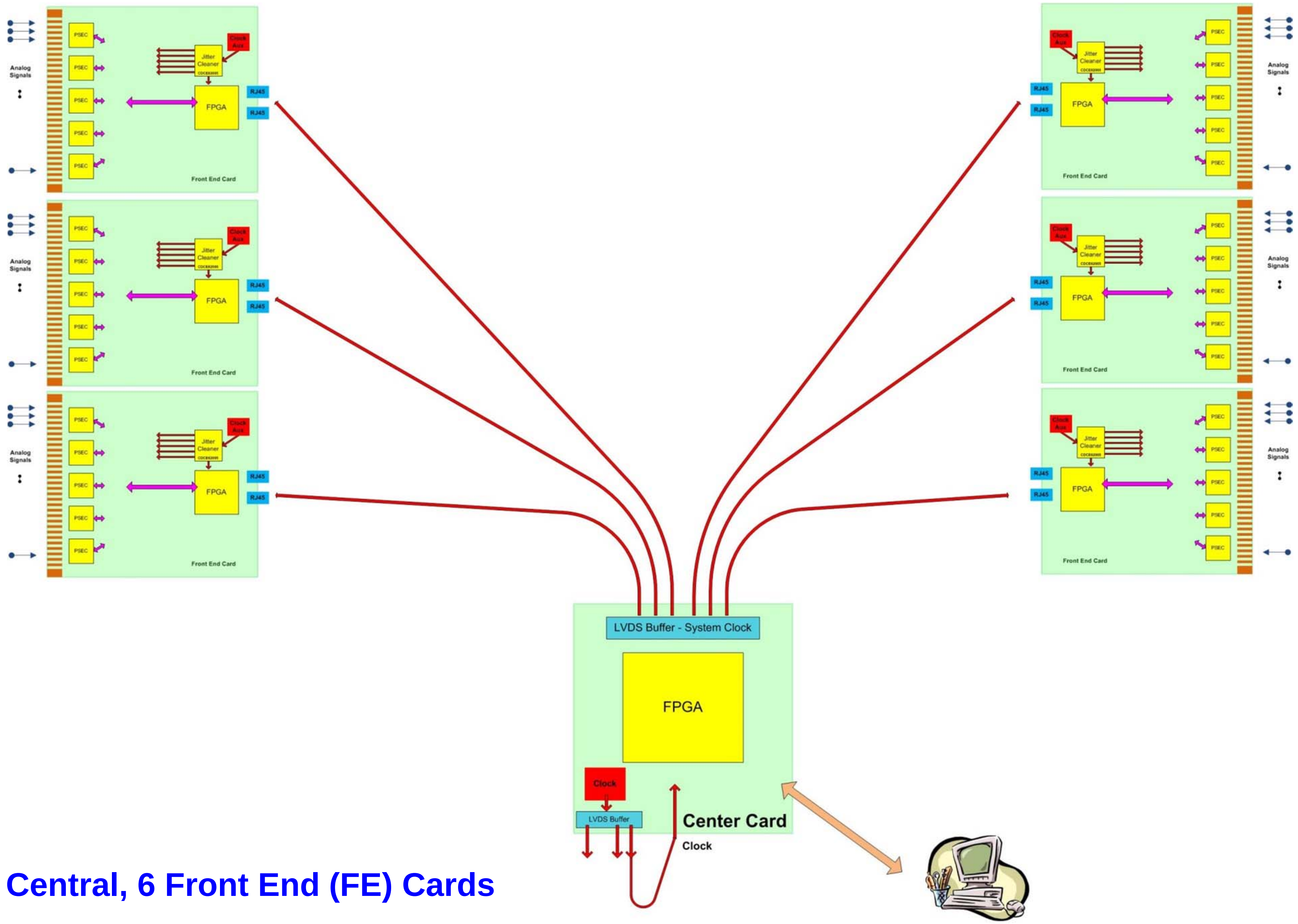






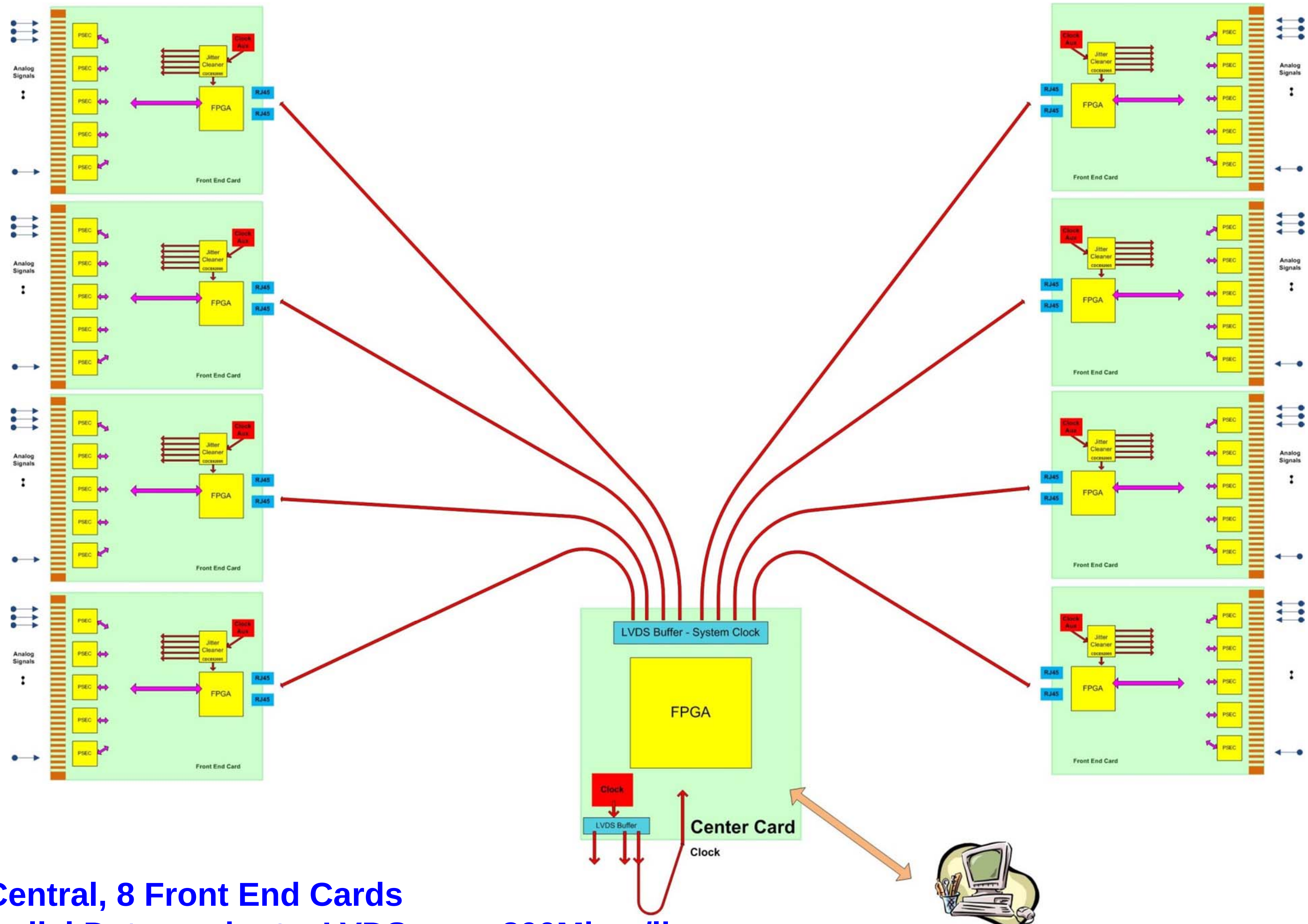
Demountable w/ full electronics – parallel scan

Alternative Architecture 1: Block Diagram



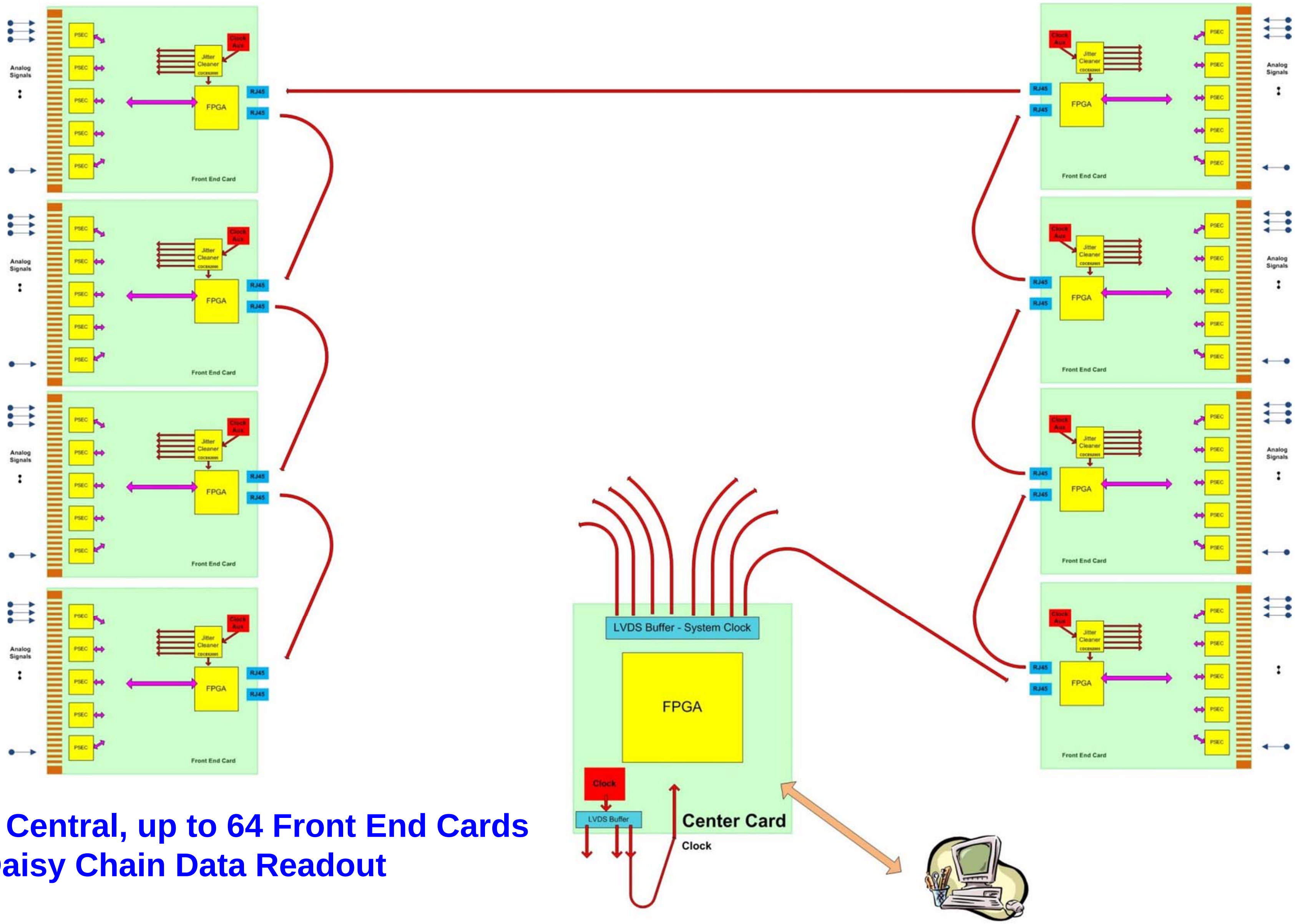
1 Central, 6 Front End (FE) Cards

Alternative Architecture 1: Block Diagram



1 Central, 8 Front End Cards
Parallel Data readout – LVDS, max 800Mbps/line

Alternative Architecture 2: Block Diagram



1 Central, up to 64 Front End Cards
Daisy Chain Data Readout

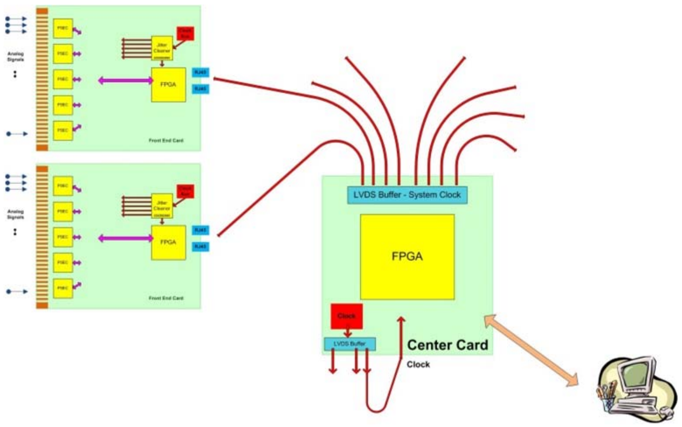
Responses To Review Panel

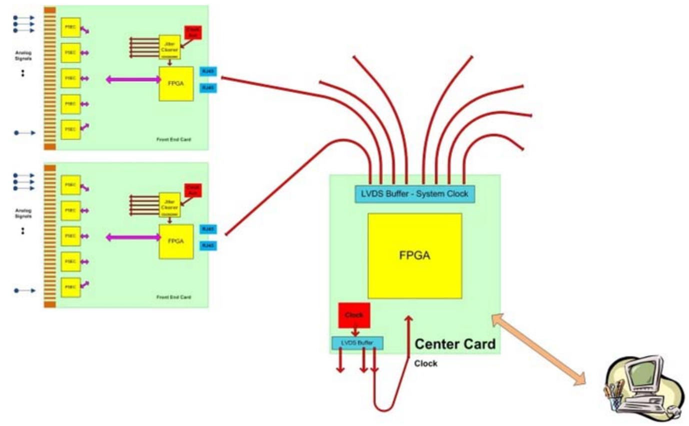
Question 1: What limited number of applications would you target as priorities in the next stage of development and why?

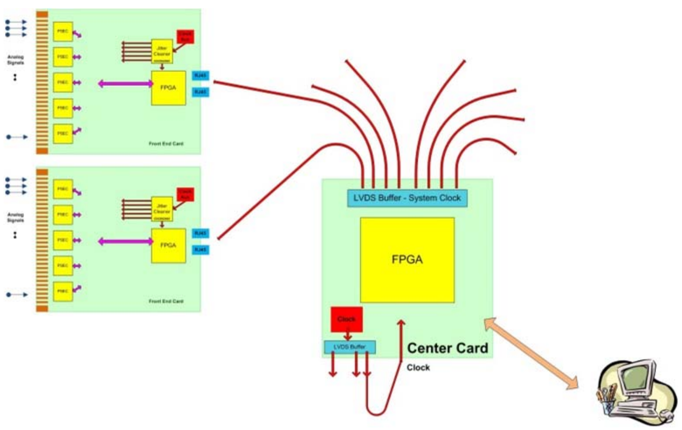
Answer: Three HEP and two directed toward market expansion:

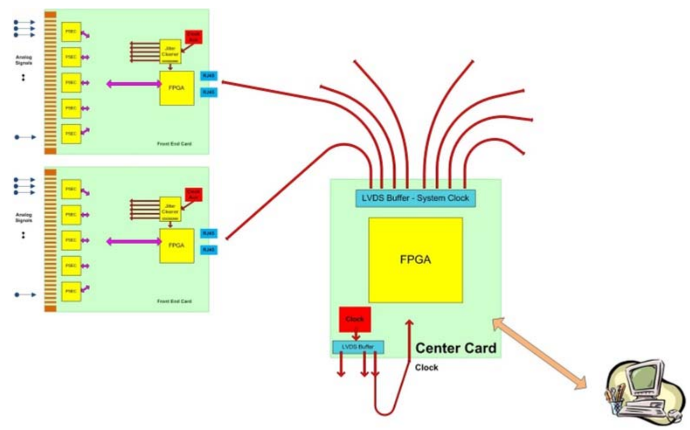
1. **TOF in the LArIAT Beam**
   a) **Why: Simplest set-up that has a large impact on HEP programs**
   b) **Straight-forward interface to experiment**
   c) **Local, have collaborators in place;**
   d) **Drop in for scintillators and PMTs at higher cost and better performance**
   e) **Spec: 4 stand-alone single tile stations, 10 psec time resolution, 50KHz (needs checking)**

4 Stand-Alone, Single-Tile Readout Stations



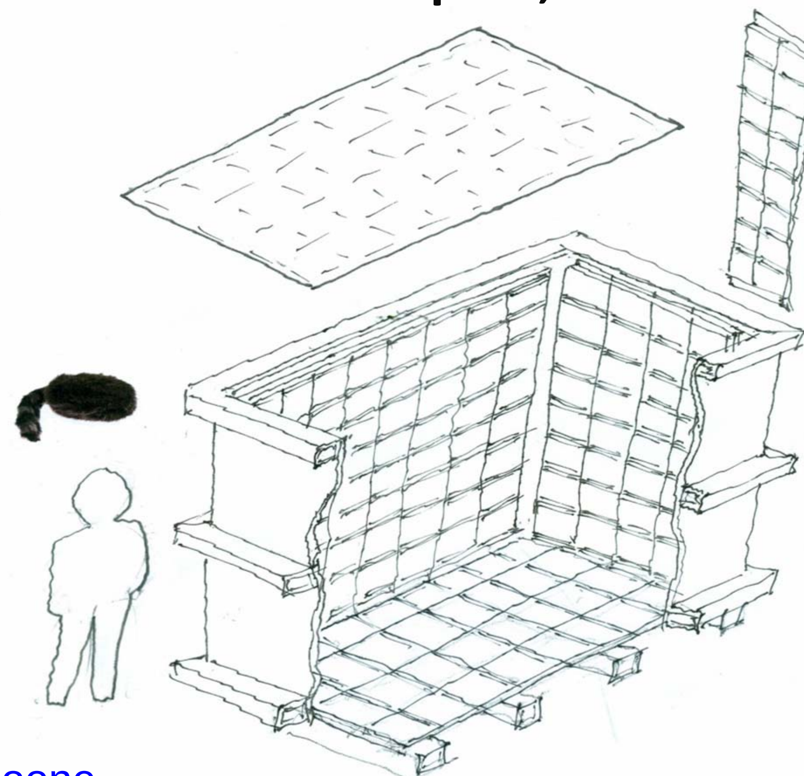






Use Alternative Architecture 1.
Max trigger rate:
30 Channel x 10 bits x 24 samples x Fmax = 400 Mbps
Fmax = 55 KHz.

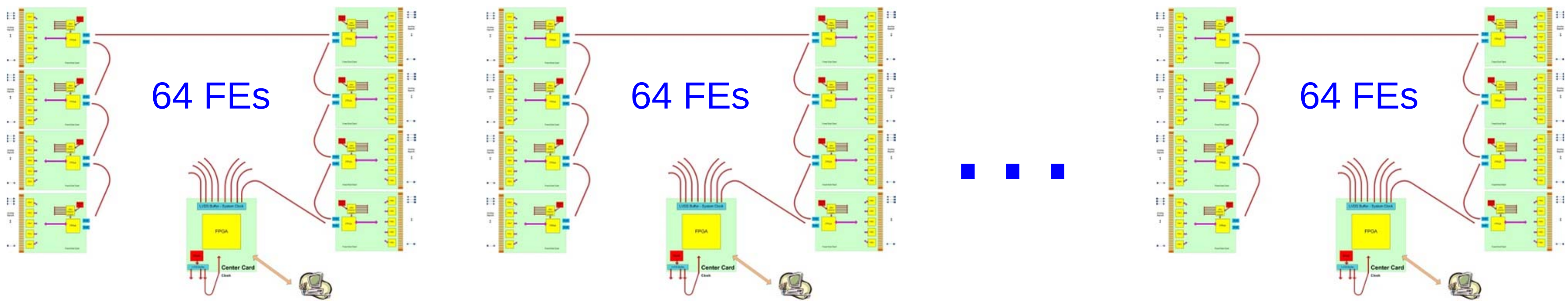
2. **Small (1-4 m^3) water neutrino detector prototype**
   a) **Why: Comparison to simulation; test of the optical TPC concept with track reconstruction**
   b) **If successful, no competition**
   c) **From 1 to 6 SuperModules;**
   d) **Spec: Single pe resolution ~ 100psec, low rate**



Daniel Boone

Water Neutrino Detector Readout

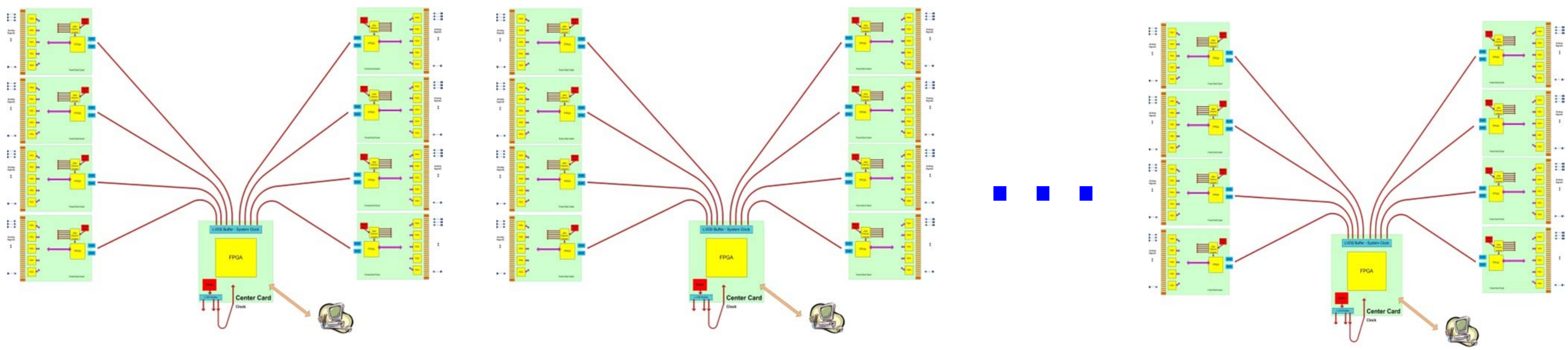
Requirements: 256 Front End Cards, slow Readout.



Each Central Card will read 64 Front End Cards in a daisy chain.
One of the Central Cards becomes Master and distributes the clock to all.

3. Pre-converter in KOTO
   a) Why: Archetype for 3D localization and precise timing of high energy photons
   b) Good access to management and technical expertise in the experiment
   c) If successful, no competition
   d) 1-4 SuperModules
   e) Spec: Timing = 1 psec; Rate = 200 kHz; Position = several mm; Trigger latency = 5 μsec
   f) HEP benefit: Increased physics reach

KOTO Pre-Converter Readout



Each Central Card will read 8 Front End Cards in parallel.
Readout for 200KHz trigger rate with 2 LVDS SERDES lines at 720MHz for each FE Card.

One of the Central Cards becomes Master and distributes the clock to all.
Front End needs to allow for 5 us external trigger latency.

4. PET
   a) Why: Potential to decrease patient dose rate by >10 or increase patient throughput
   b) Current state of the art = 300 psec
   c) Spec: 50 psec (FWHM) TOF-PET resolution
   d) HEP benefit: Potentially large market drives the cost down

Needs work.

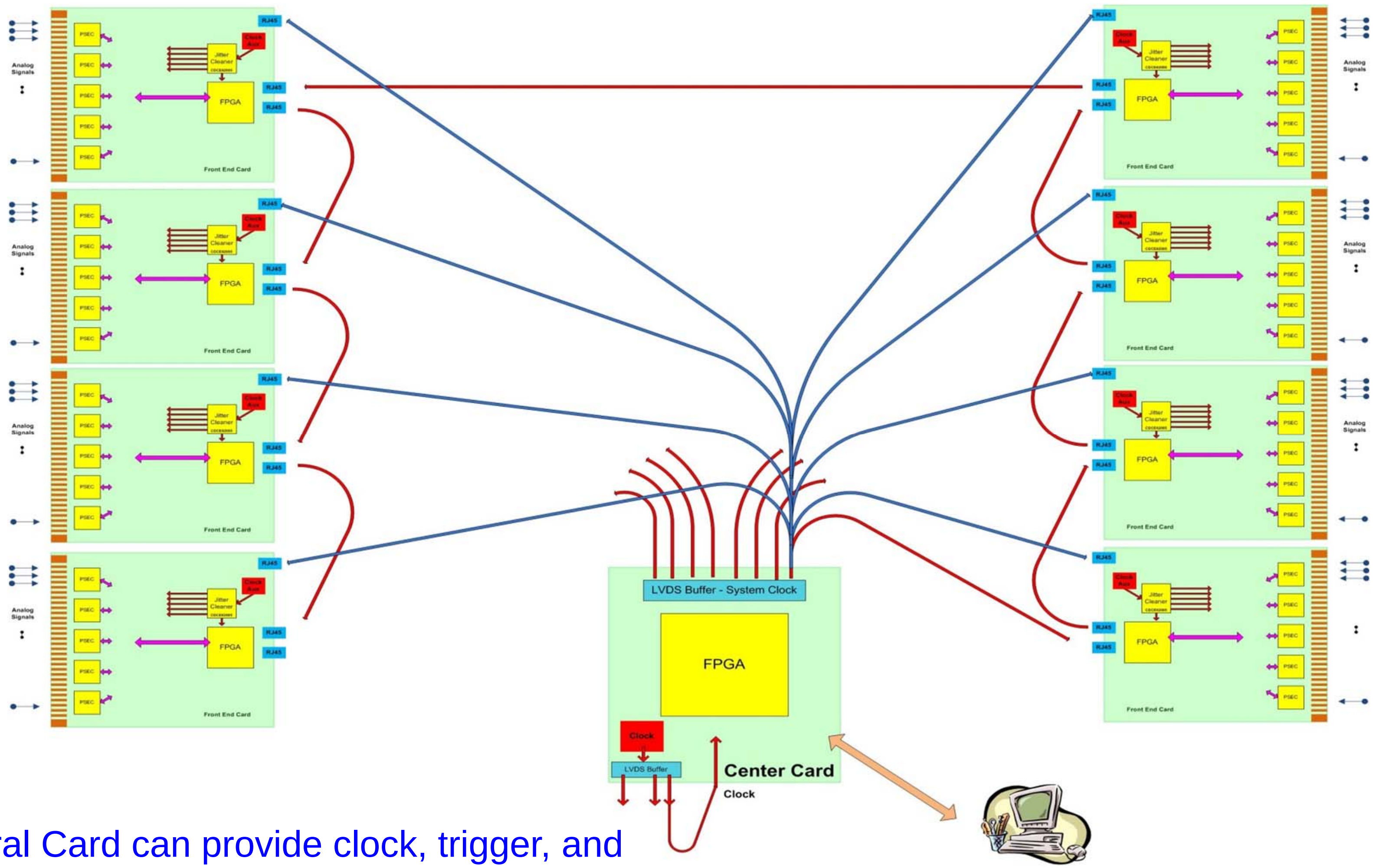
E.g. PDS Consulting in Massachusetts, Eric’s Timing Setup at UC, etc.

5. **High spatial resolution X-ray diffraction**
   a) **Why: Large area detector with high spatial resolution**
   b) **Large area, high spatial resolution, multi-channel solid state detectors are very expensive and slow**
   c) **Spec: 100 μm spatial**
   d) **HEP benefit: Increase cross-disciplinary ties**

Needs work.

Clock Distribution

Synchronous clock fan-out to 64 FE Cards.



One Central Card can provide clock, trigger, and receive hits to/from all FE Cards in parallel.