

R&D for PID front-end electronics



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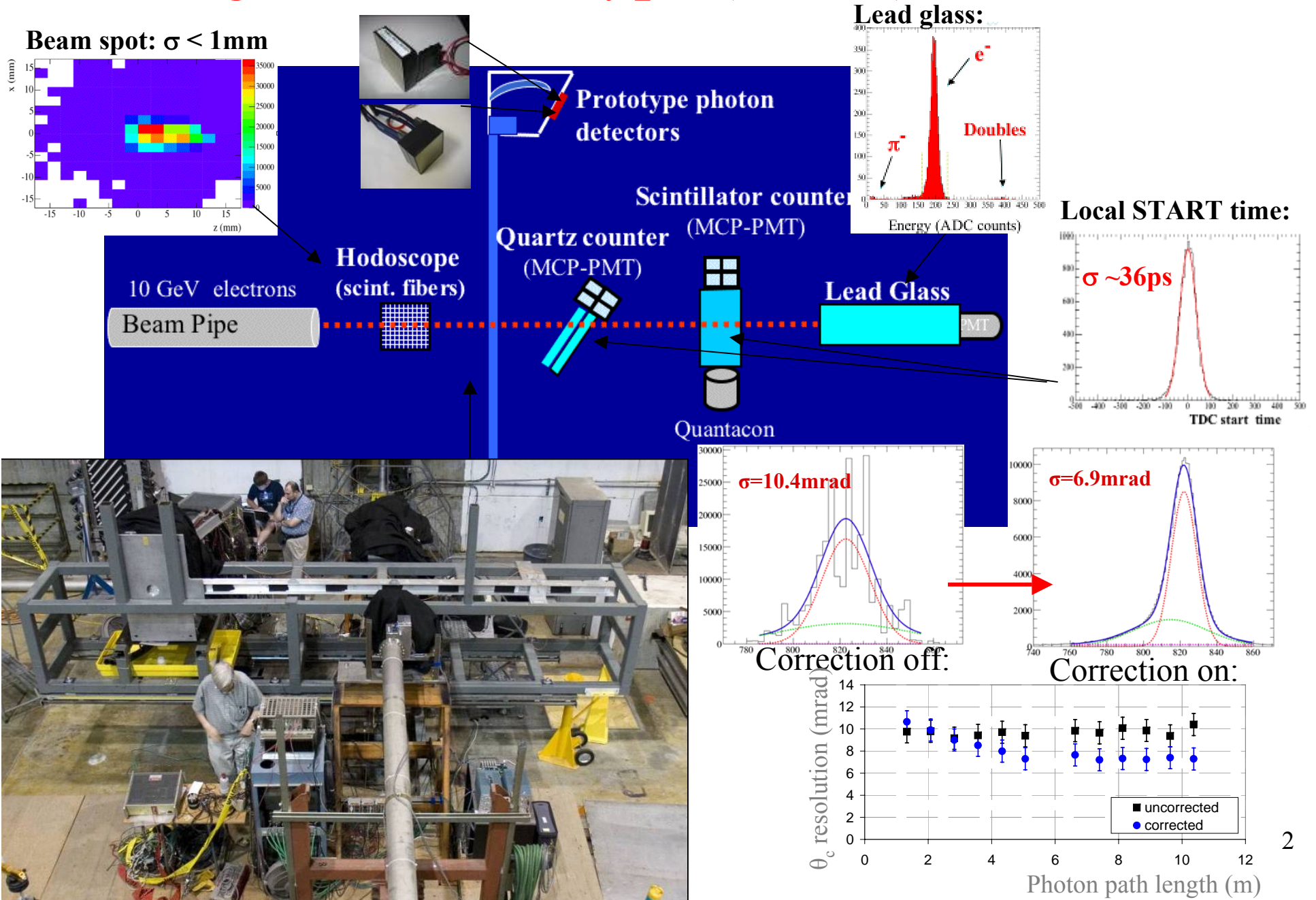
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Larry Ruckman, Gary Varner



Agenda

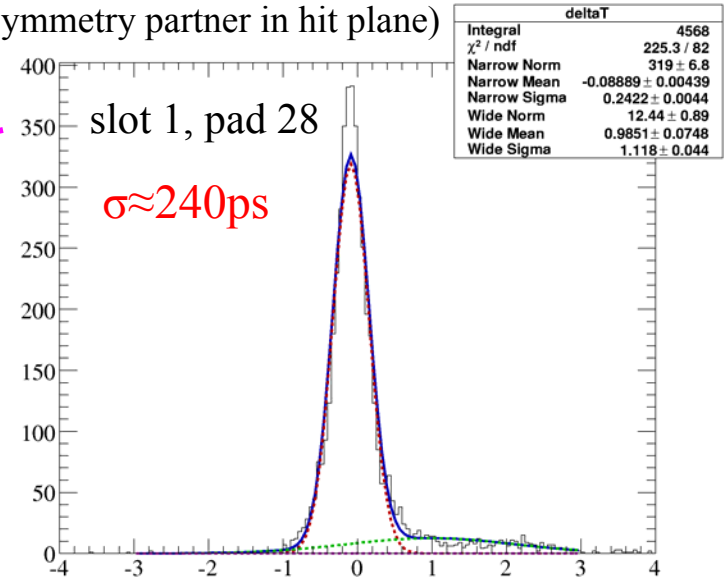
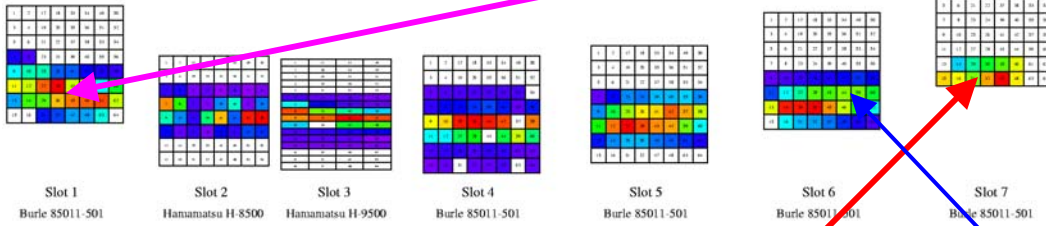
- R&D for PID testbed:
 - Fast focusing DIRC (~450 channels)
- Waveform sampling:
 - BLAB2 ASIC
- Fiber-optic DAQ
 - Initially cPCI
- Feature extraction
 - DSP prototype plans

Focusing DIRC Prototype (T-492)

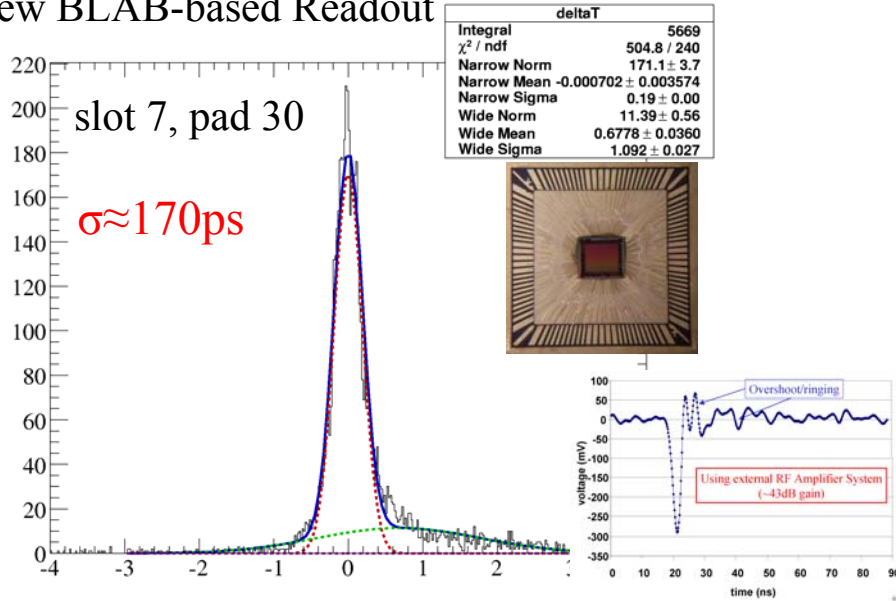


Test results: timing slot 7, pad 15
to Philips slot 1&6
for run 27, pos 1, direct photons

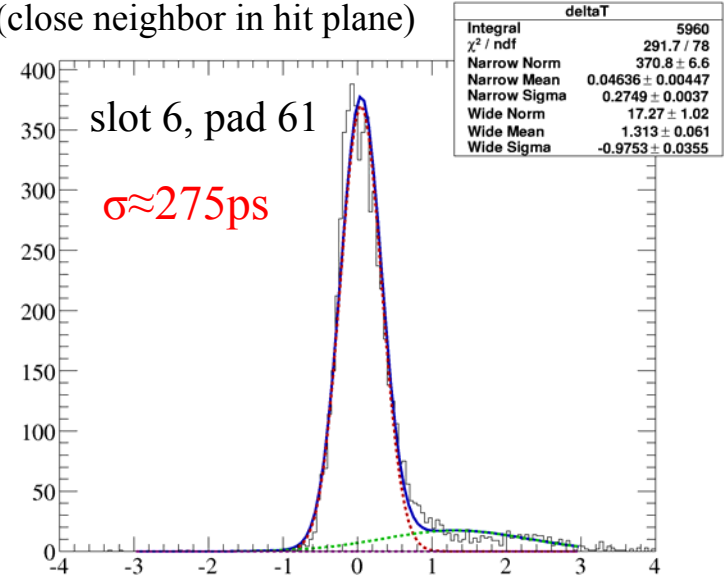
(symmetry partner in hit plane)



New BLAB-based Readout



(close neighbor in hit plane)

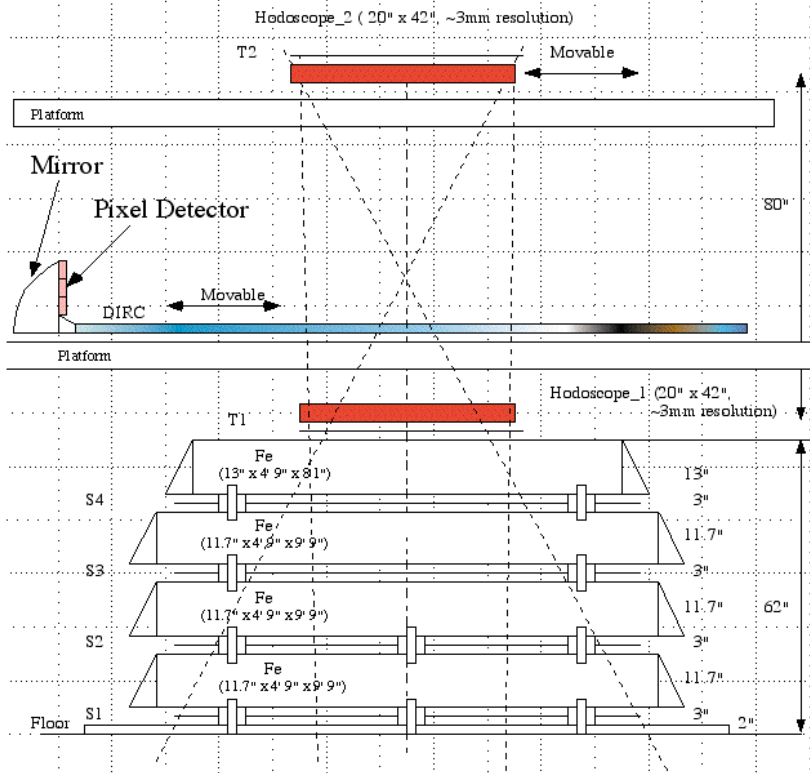


Decided to upgrade all channels to new BLAB electronics

delta(time) (ns)

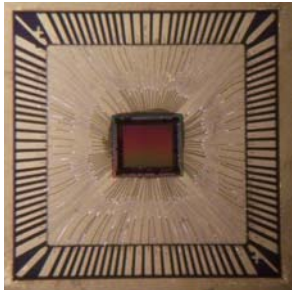
Fast Focusing DIRC → to Bldg. 121

- LCLS Operations
 - Parasitic running possible, but
 - Rad safety system in ESA
- Move to nice cosmic stand
 - 1 mrad resolution
 - Precision timing and further studies w/ new electronics

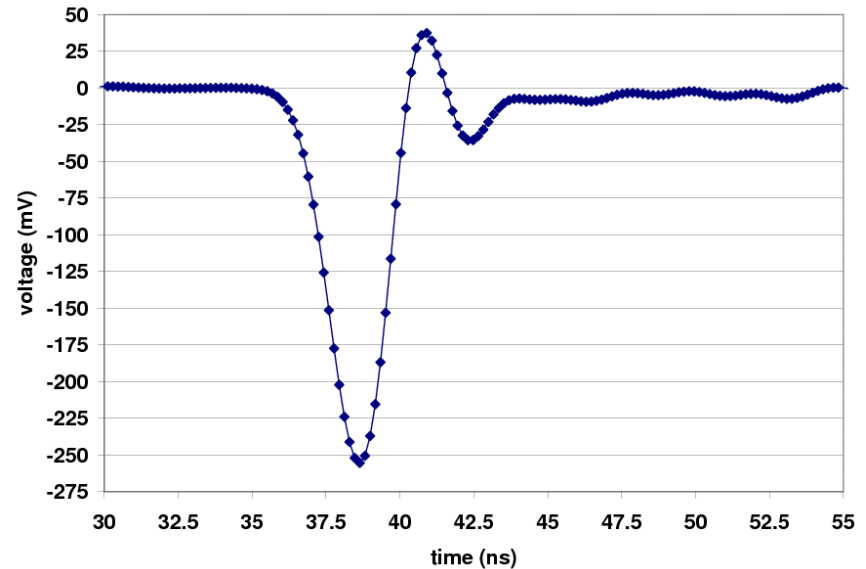


1.6 GeV/c
P_min
through
range
stack

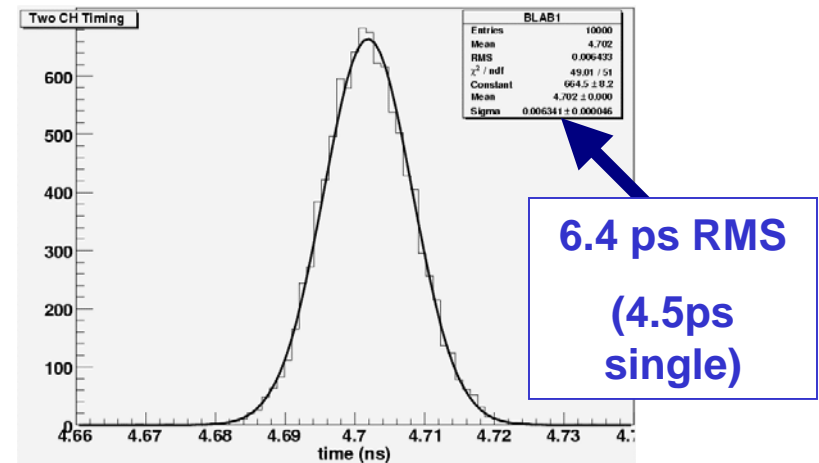
Instrument with BLAB ASICs



BLAB1 -- NIM
A591 (2008) 534



- Comparable performance to best CFD + HPTDC
- MUCH lower power, no need for huge cable plant!
- Using full samples significantly reduces the impact of noise
- Photodetector limited

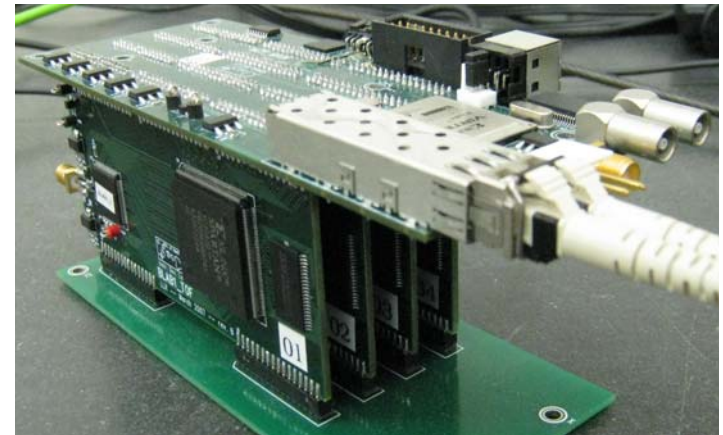


Highly Integrated Readout

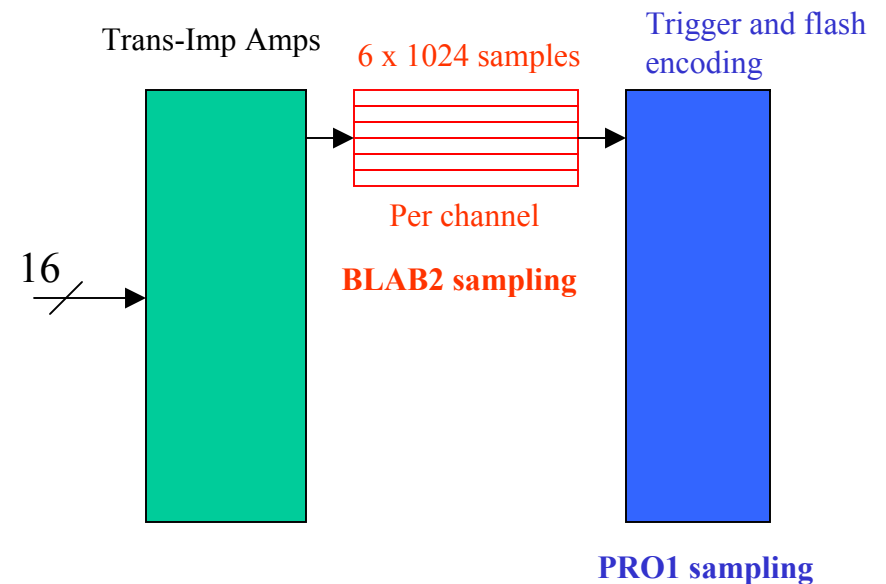
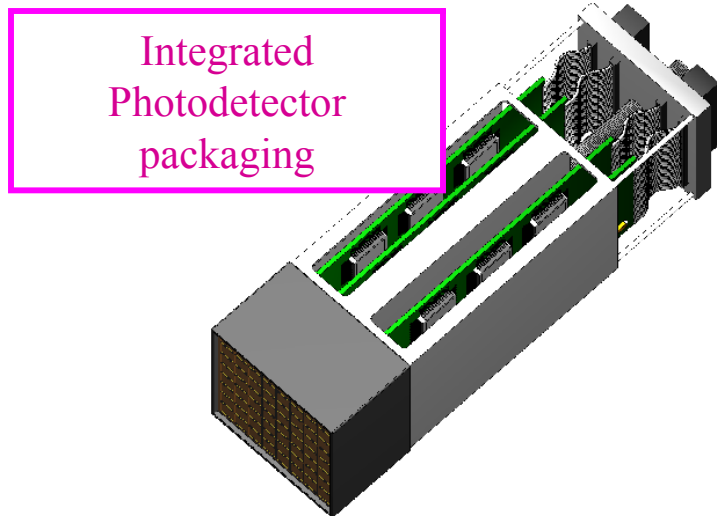
- **Buffered LABRADOR**

TABLE II: *BLAB2 ASIC Specifications.*

Item	Value
Photodetector Input Channels	16
Linear sampling arrays/channel	2 6
Storage cells/linear array	512 1024
Sampling speed (Giga-samples/s)	2.0 - 10.0
Outputs (Wilkinson)	32

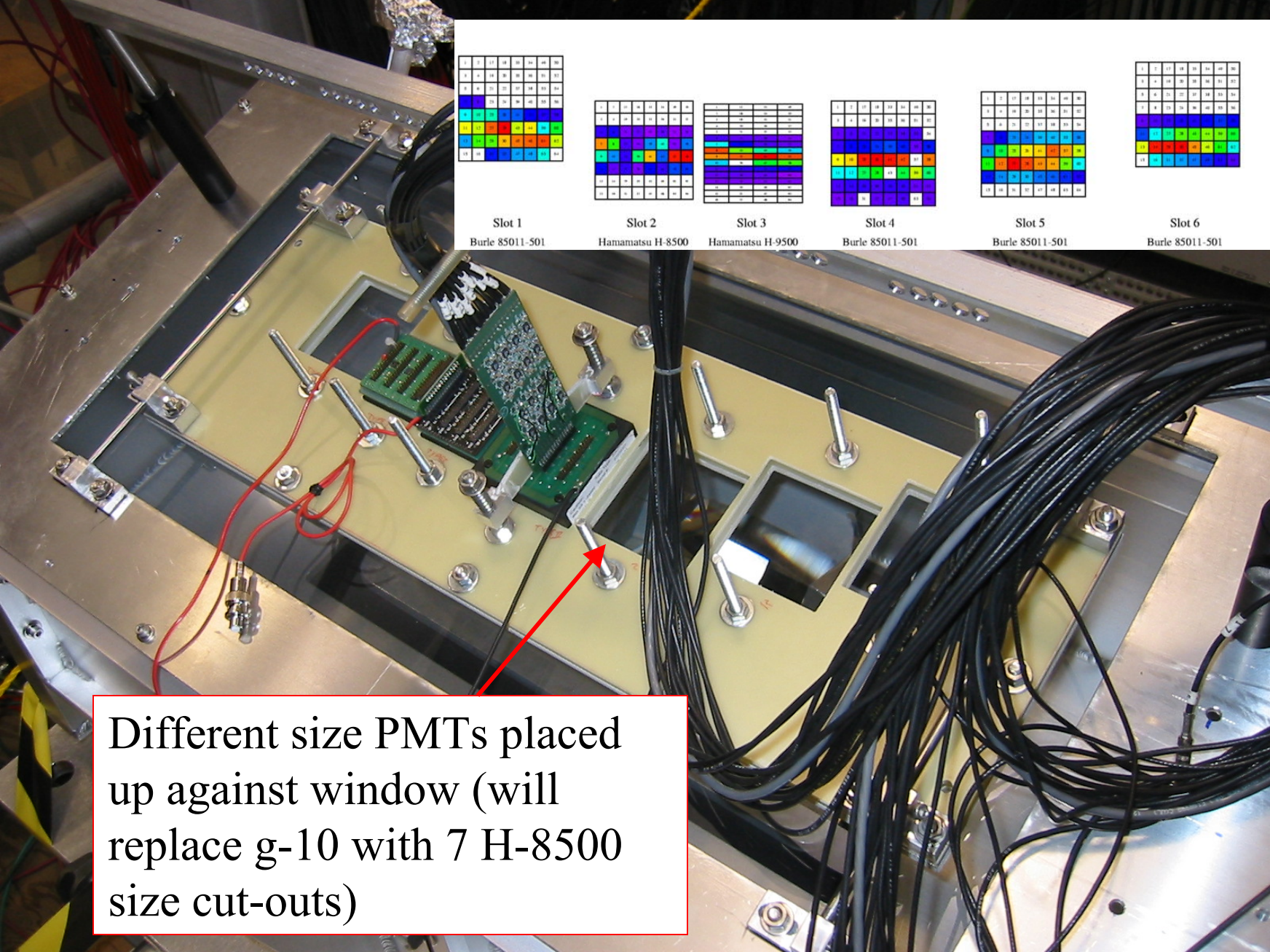


BLAB2 ASIC

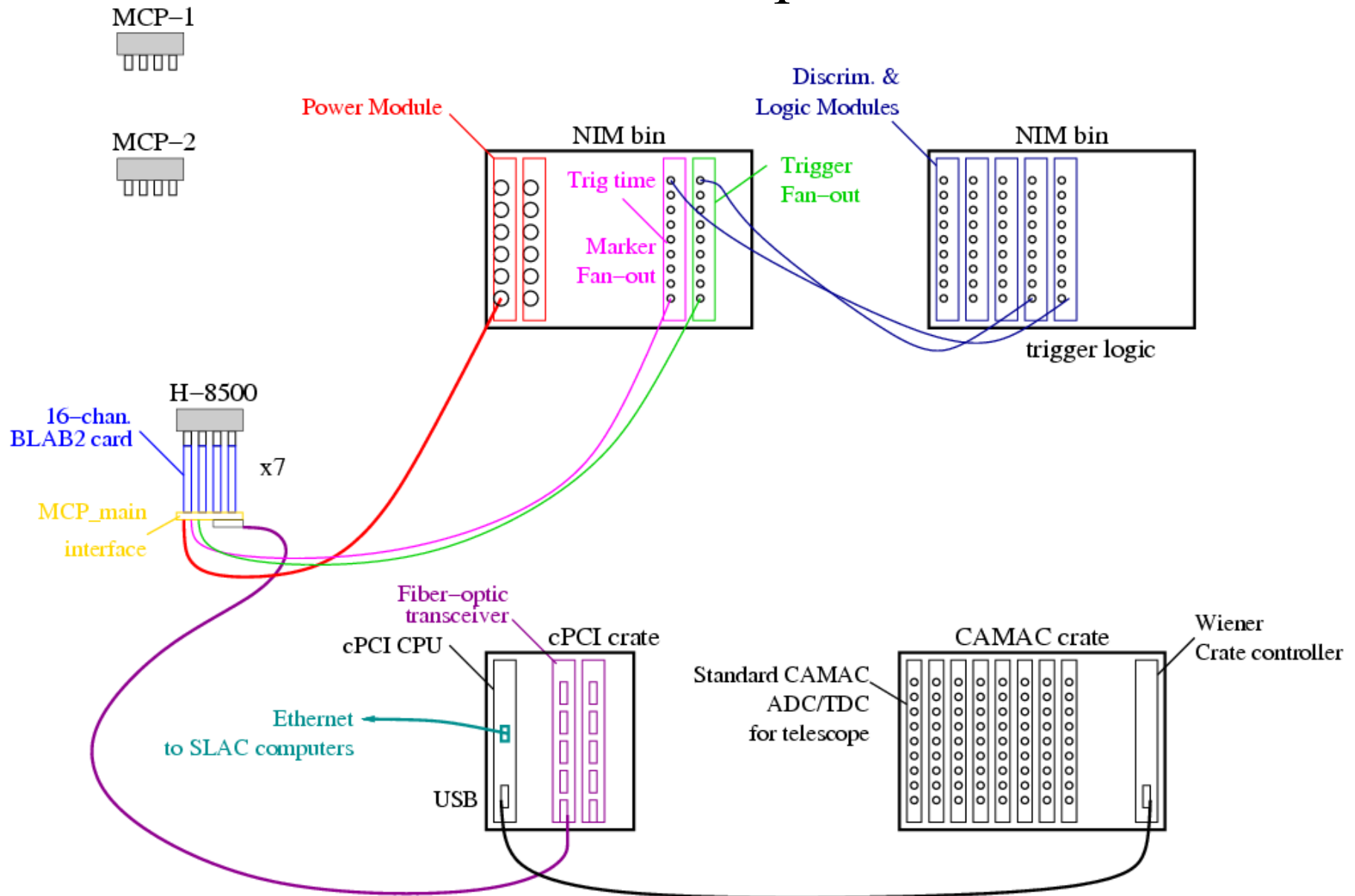


HPK H-8500 Readout basis for this next step

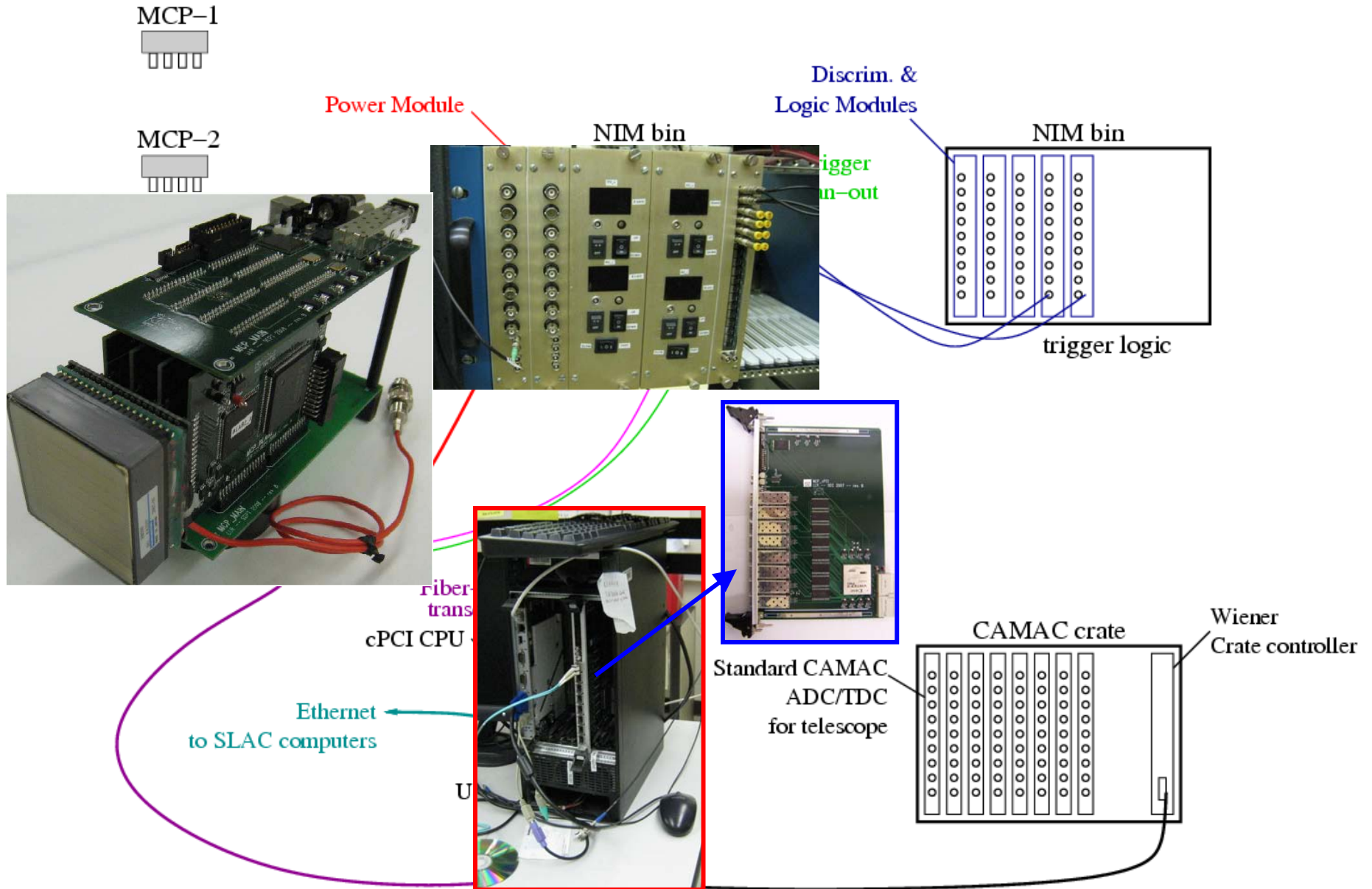
Original (just amps [custom CFD]+CAMAC ADC/TDC)



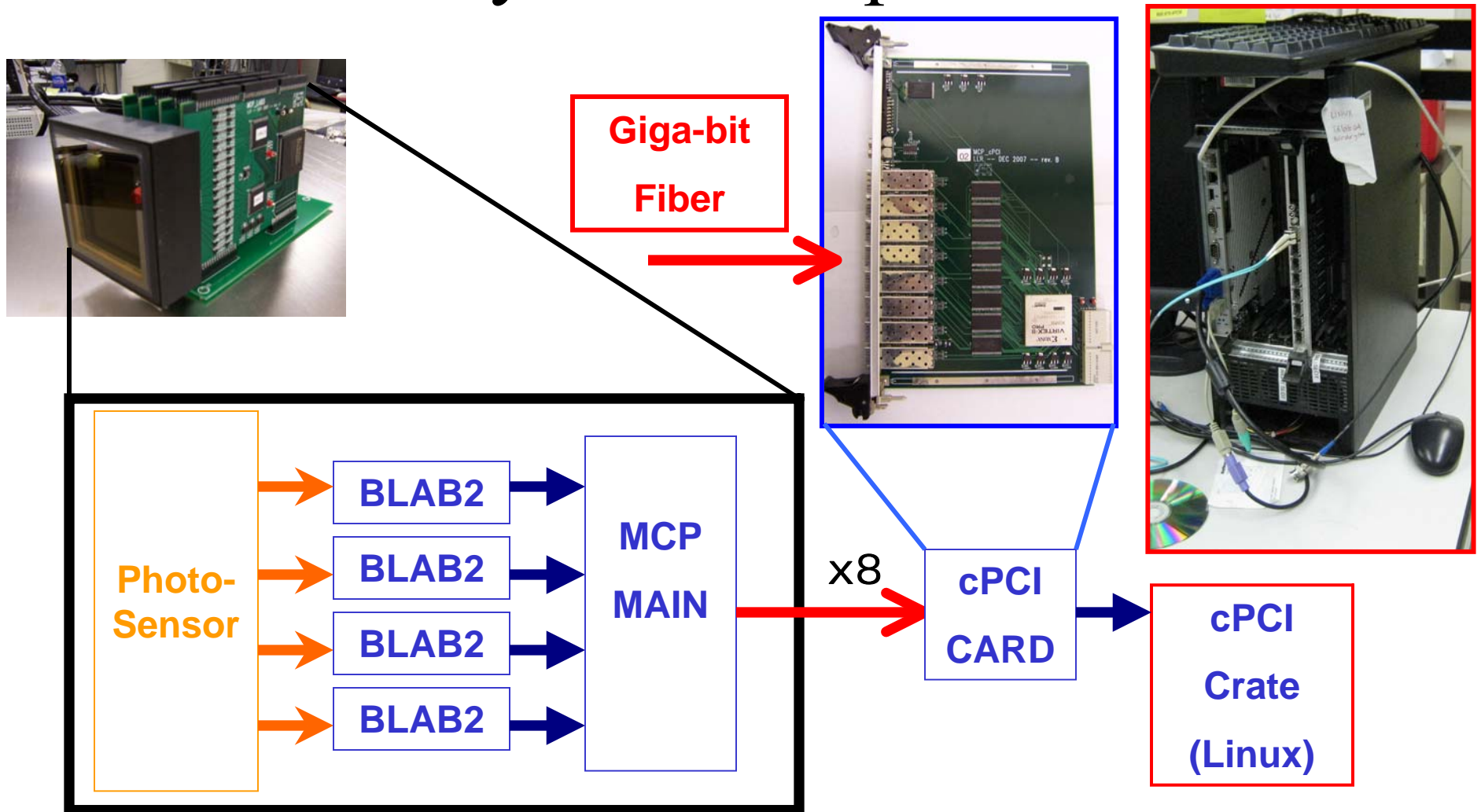
PID Readout Testbed: waveform sampler → cPCI



The building blocks



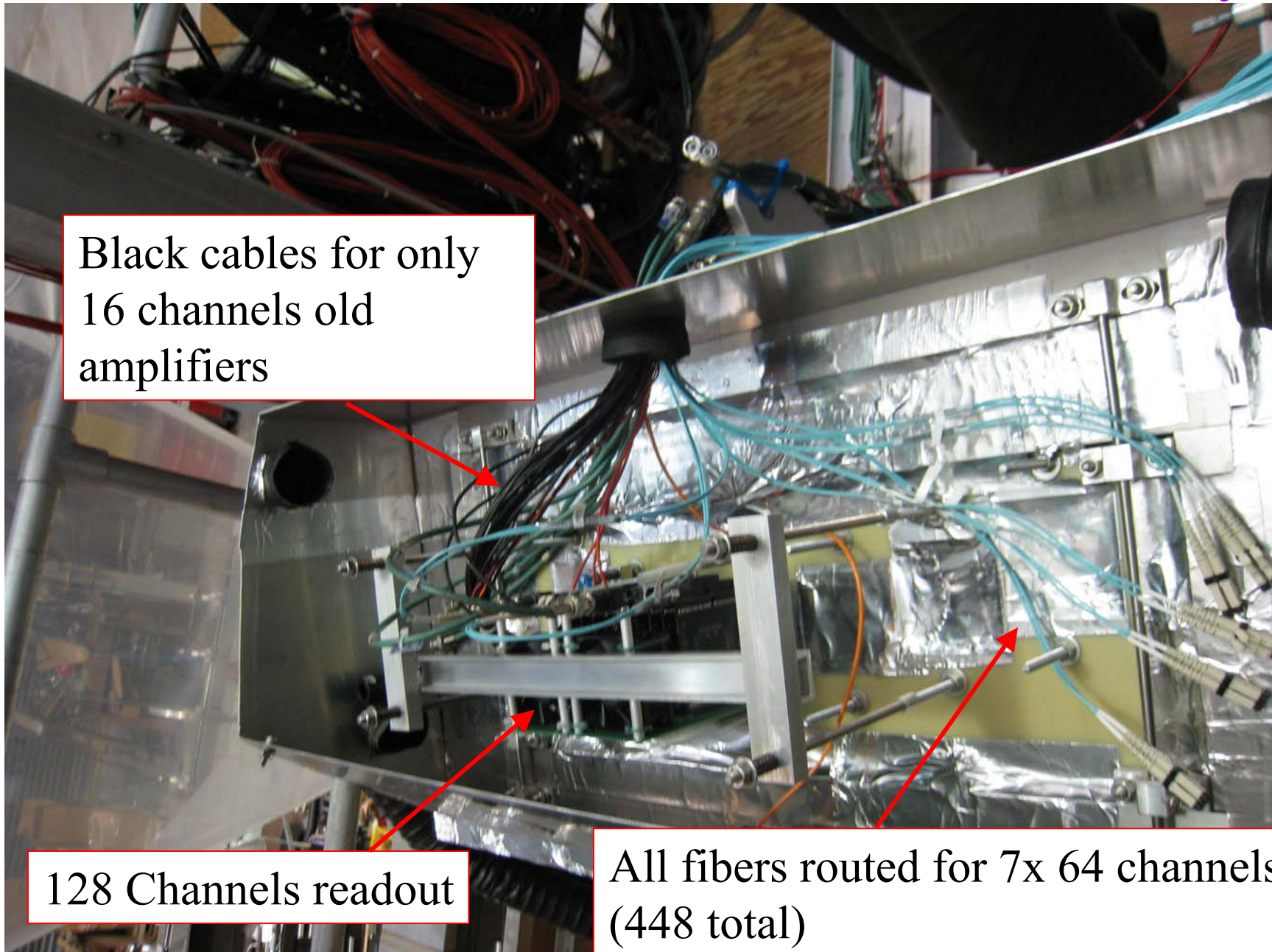
Readout System Components



- Up to 8x64 channels per cPCI card
- Very portable DAQ
- Up to 3,584 channels/cPCI crate

Very cost effective, probably ATCA used in actual SuperB (?)

New readout system

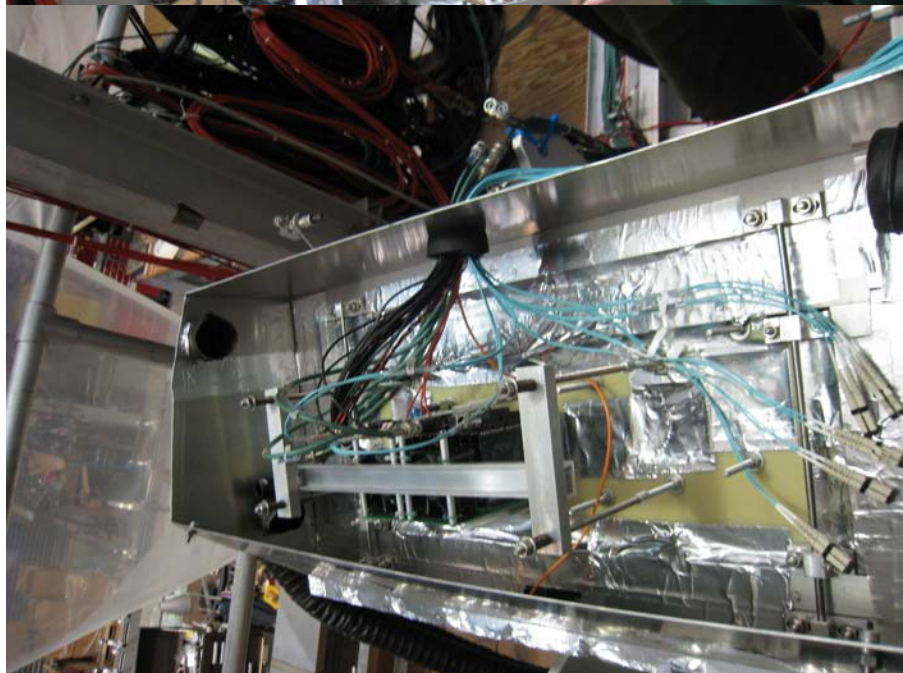
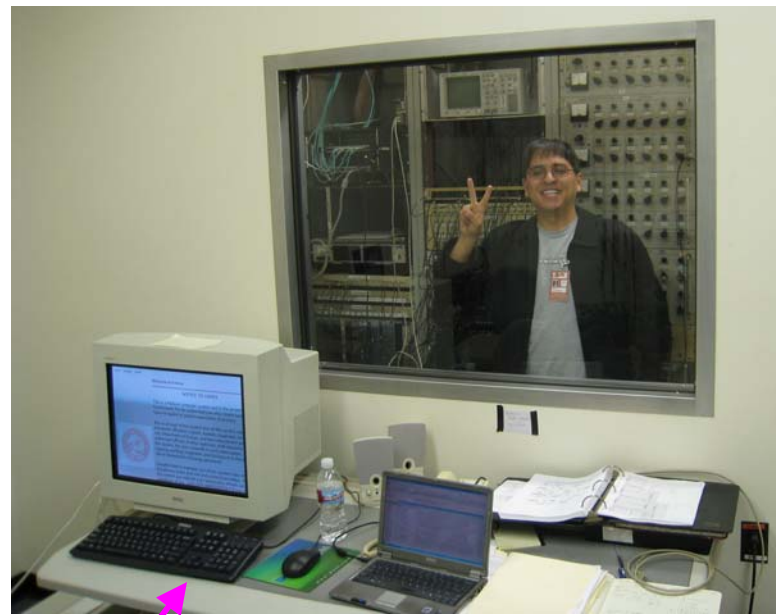


Black cables for only
16 channels old
amplifiers

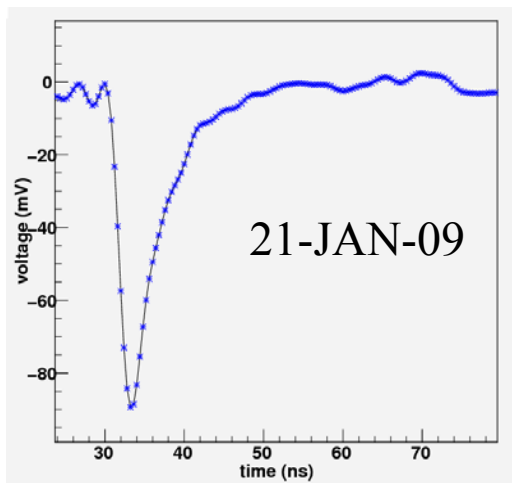
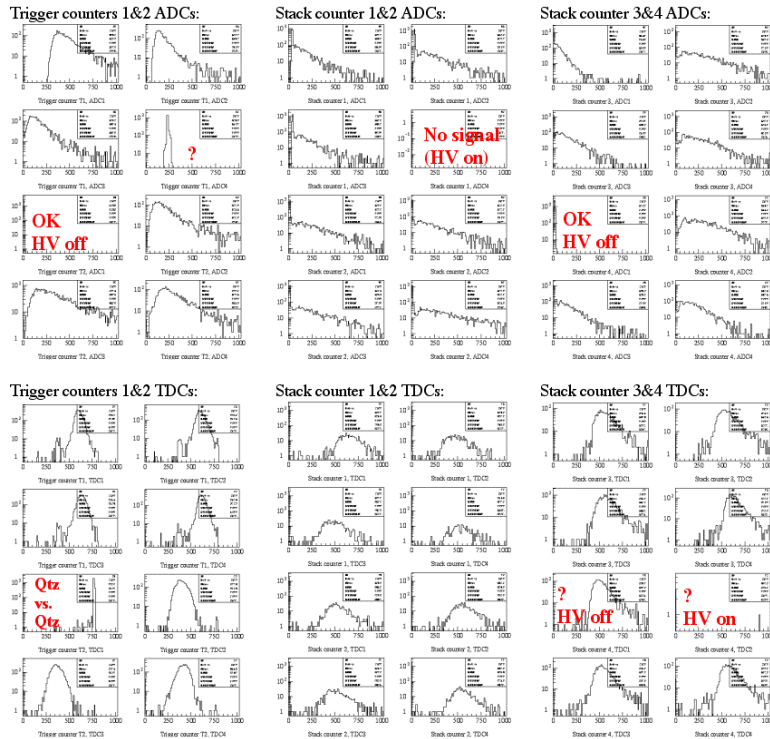
128 Channels readout

All fibers routed for 7x 64 channels
(448 total)

Nice Environment



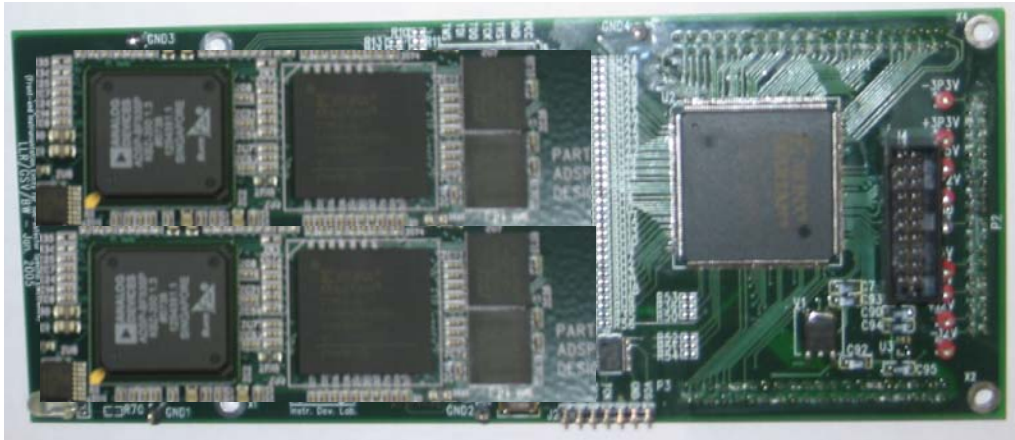
New CAMAC Readout Working, BLABs Undergoing timing Calibration



Single p.e. signal

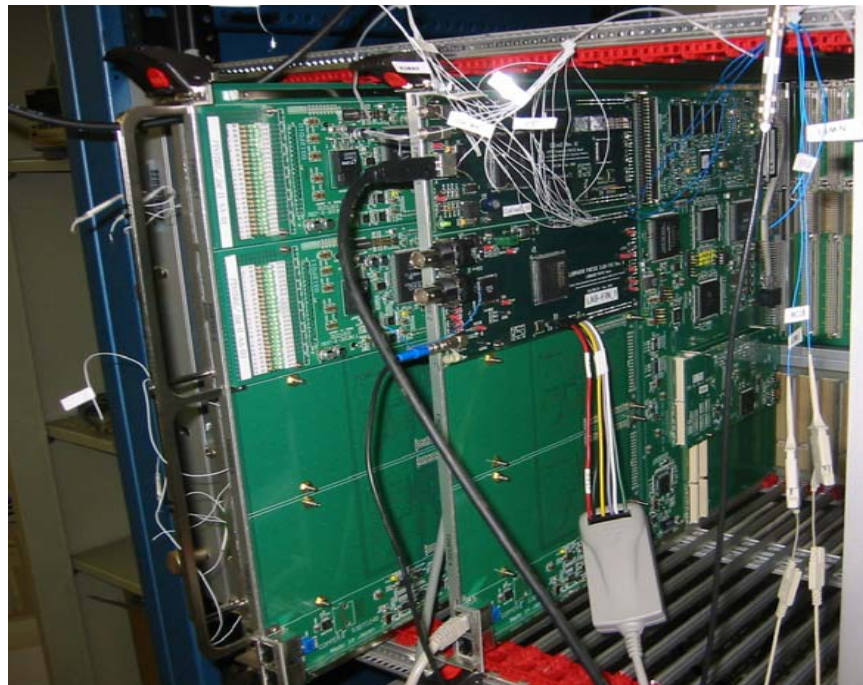
Complete Installation
[Mar 22]
Experience with running 448
channels of readout

Fast Feature Extraction



Assume:
100kHz singles per pixel

150kHz trigger rate
200ns trigger window (2% occup.)
Each 64-chan PMT has $\sim 200\text{k hits/s}$
Each hit = $32 \text{ samples} * 12\text{bits} = 384\text{bits}$
 $\rightarrow \sim 77\text{Mbits/s}$
(link is $2.5\text{Gb/s} \sim \times 10$ margin)
[perhaps 2x PMT/link]



BlackFin DSP

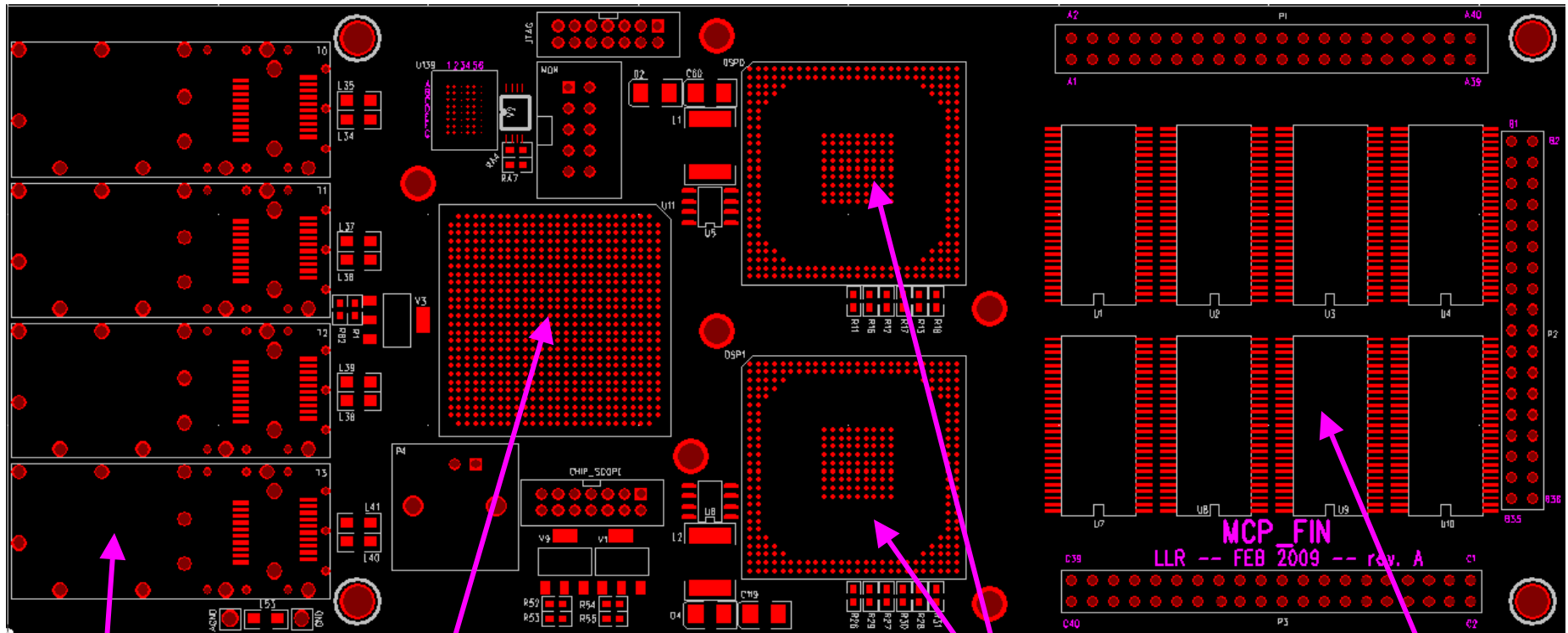
- Pedestal subtract
- Feature extract $\rightarrow T, Q$
(tentatively allow up to 8x hits in 200ns)
- Time = 2Bytes, Q = 2Bytes

$$1\text{k PMT} * 1.28 \text{ hit typ} * 4\text{By} =$$

5.12kB/event

Estimate 1.5us/hit processing time,
To be evaluated

Prototype Data feature extraction card



Fiber Tx/Rx

FPGA

2x BlackFin DSP

RAM
(cal consts.)

Equivalent of PMC slot for ATCA?

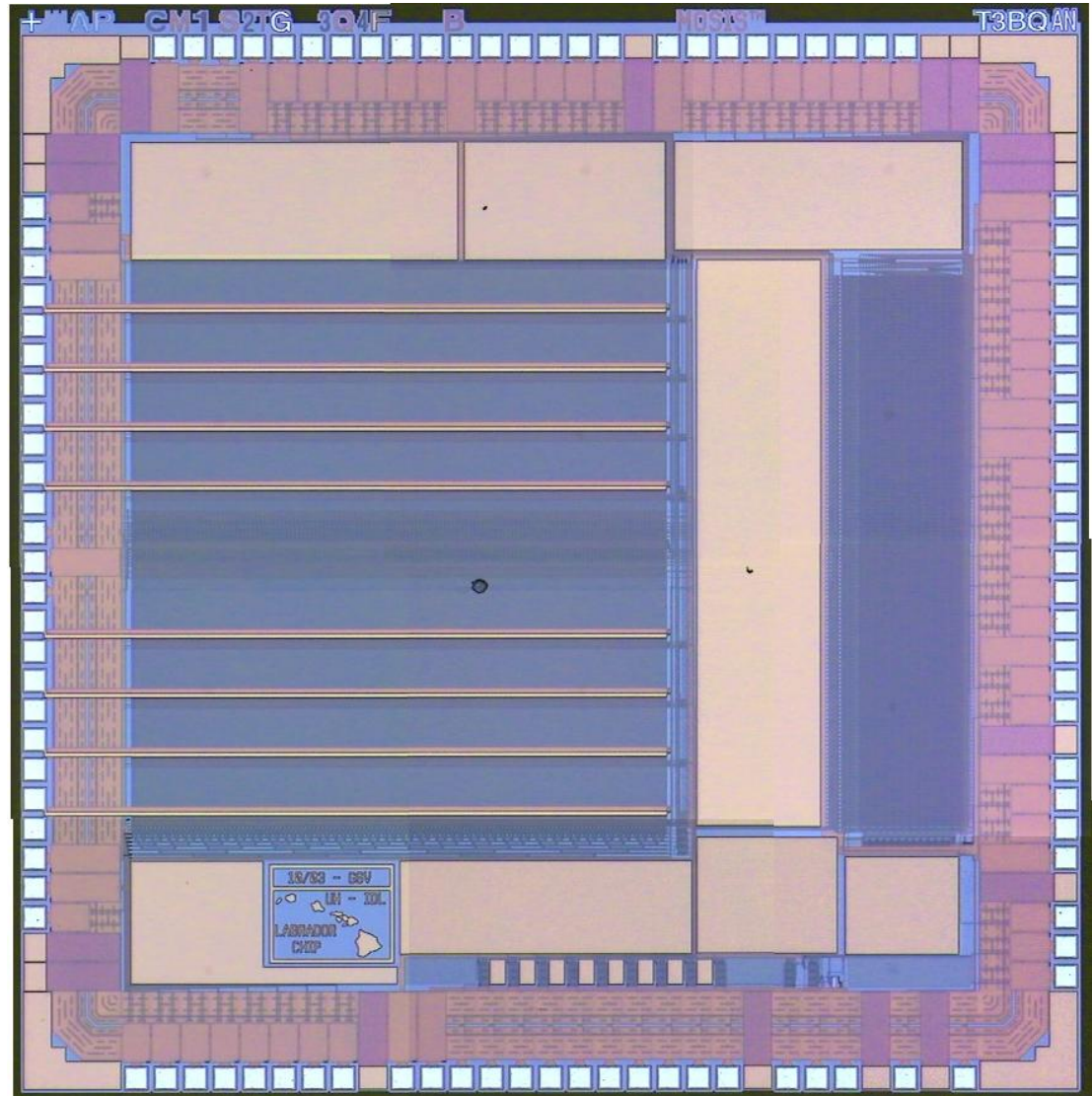
64k total system channels

~32 9U sized cards?

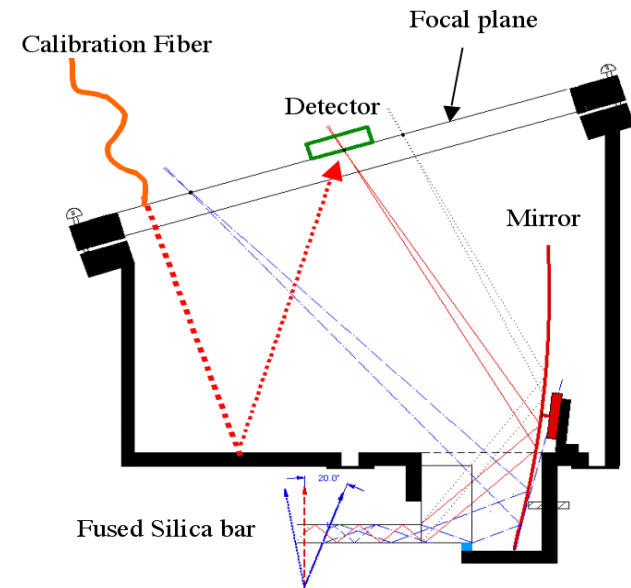
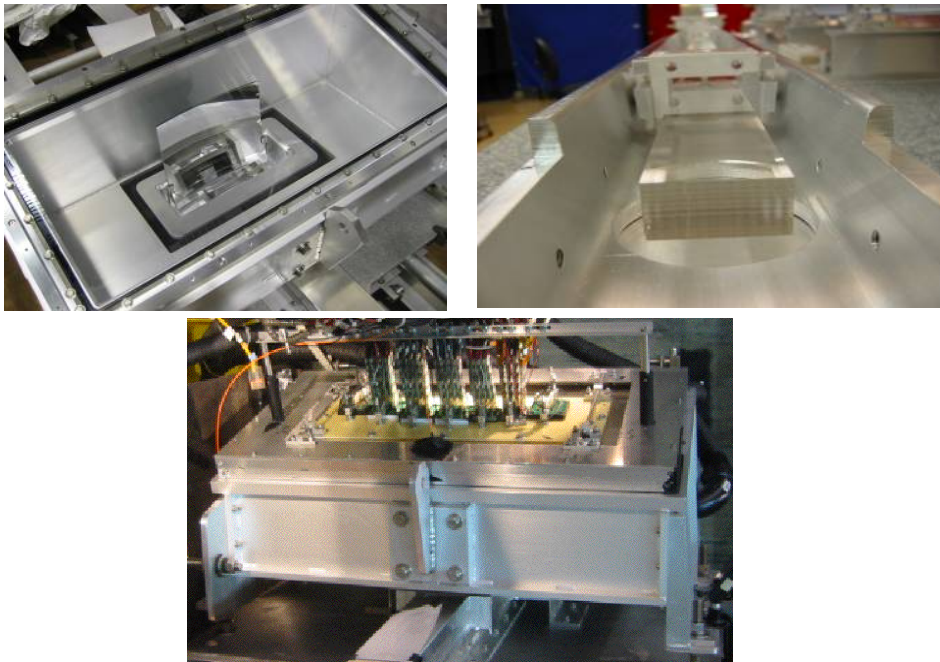
Summary

- 448 channel BLAB2-based readout system being commissioned for fast focusing DIRC test stand
- BLAB3 (improved amp, deeper buffering) ASIC under design
- Lessons from current operation already valuable
- Demonstrate fast feature extraction
- Benchmark performance for TDR

Back-up slides



Focusing DIRC Prototype Optics



- **Radiator:**
 - 1.7 cm thick, 3.5 cm wide, 3.7 m long fused silica bar (spares from BABAR DIRC).
- **Optical expansion region:**
 - filled with a mineral oil to match the fused silica refraction index (KamLand oil).
 - include optical fiber for the electronics calibration (PiLas laser diode).
- **Focusing optics:**
 - a spherical mirror with 49cm focal length focuses photons onto a detector plane.

Test setup in the cosmic ray telescope

