T-1019 Run Synopsis

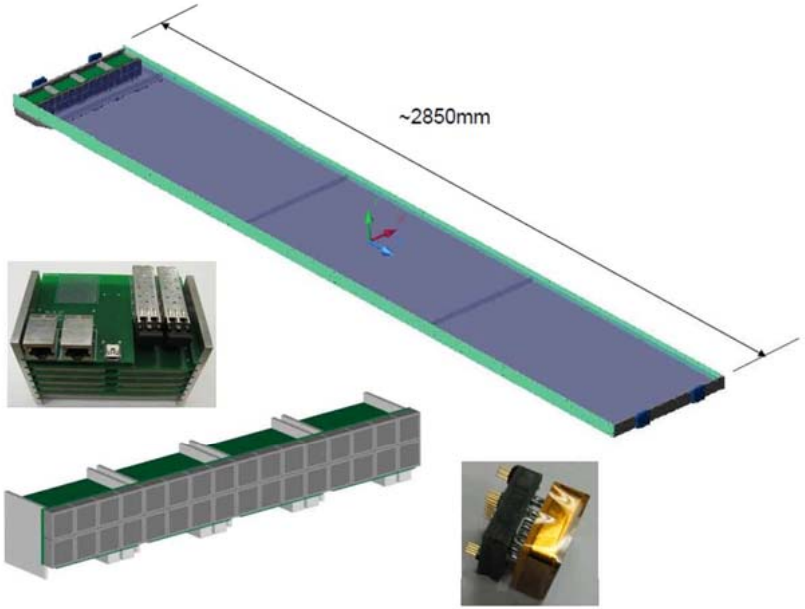
MEMORANDUM OF UNDERSTANDING

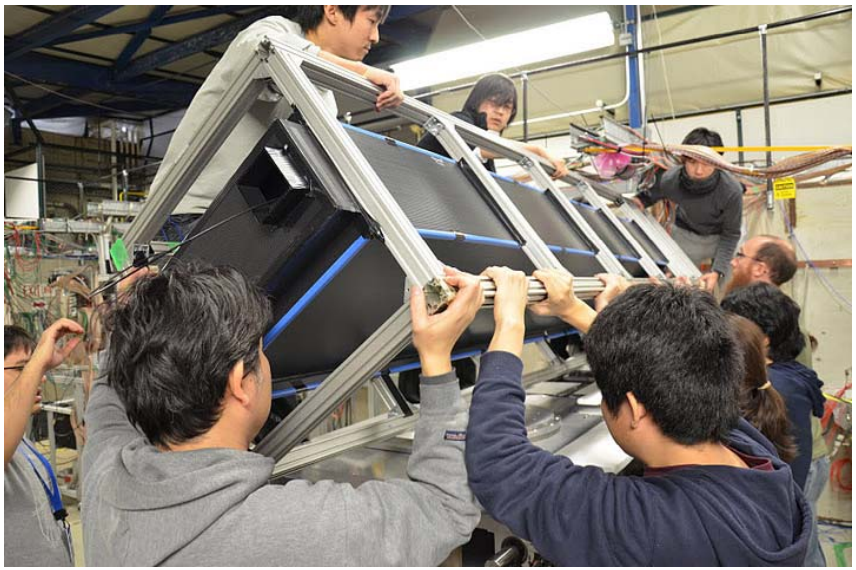
FOR THE 2011 – 2012 FERMILAB TEST BEAM FACILITY PROGRAM

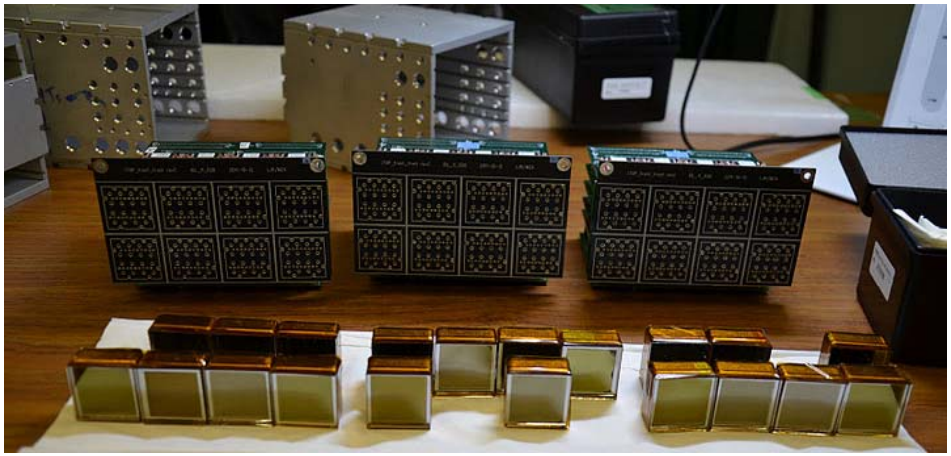
T-1019

Performance confirmation of the Belle II imaging Time Of Propagation (iTOP) prototype counter

August 24, 2011



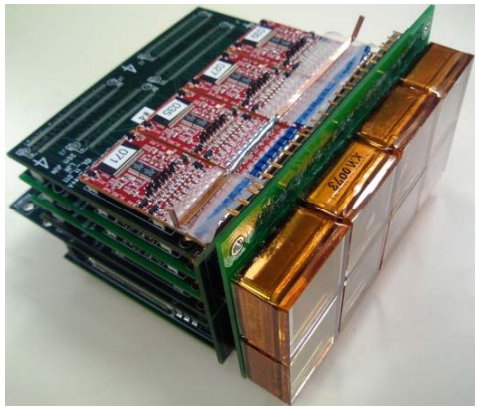




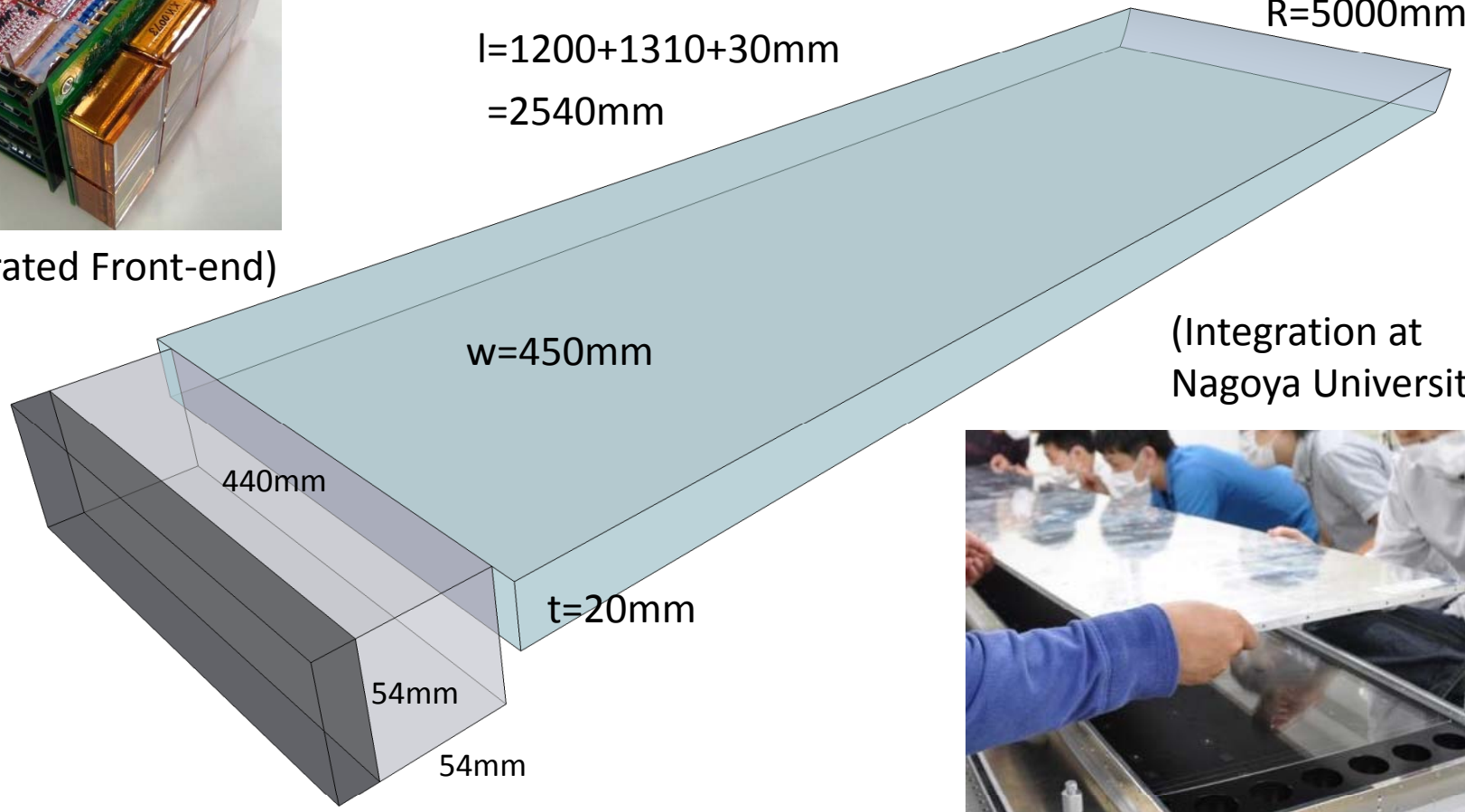
Gary Varner, University of Hawaii, for T-1019

January 3rd, 2012

What to test – detector components



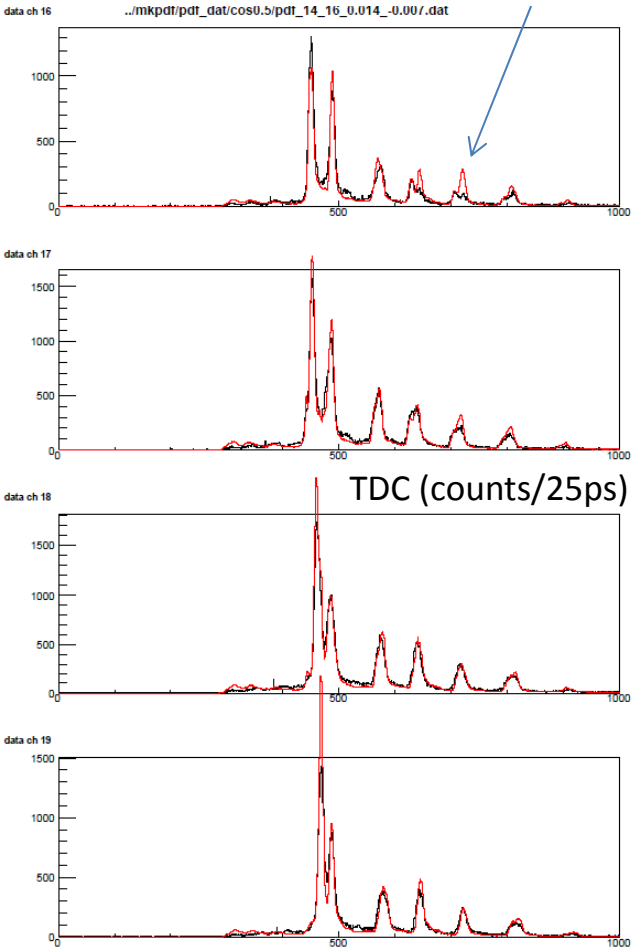
(Integrated Front-end)

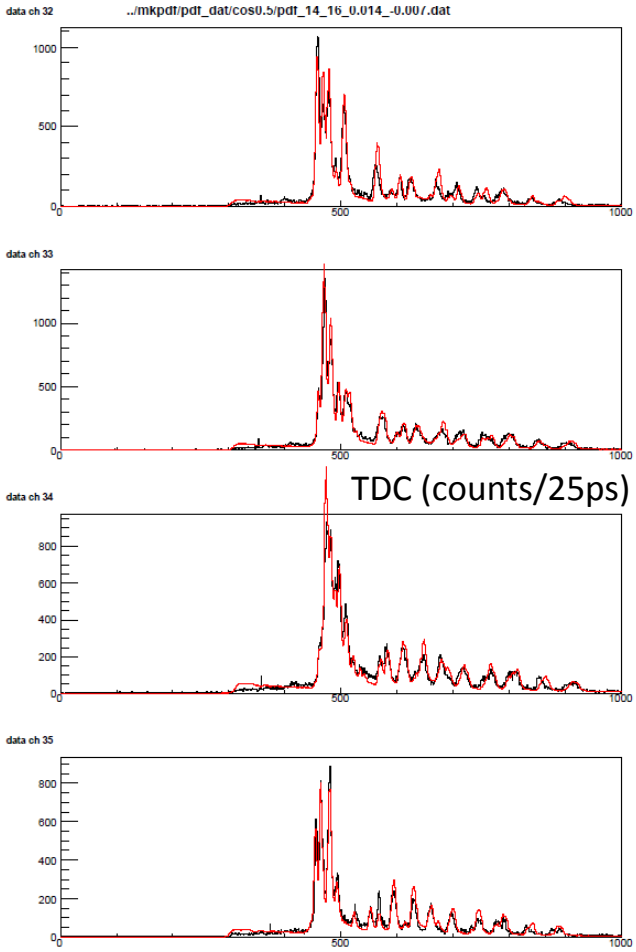


(Integration at Nagoya University)

Goal: Data versus Simulation

- Use data to tune/confirm Monte Carlo
- Results shown were for old PMT type & CAMAC readout



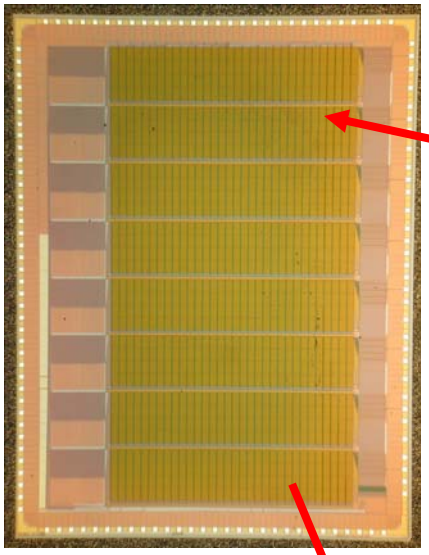


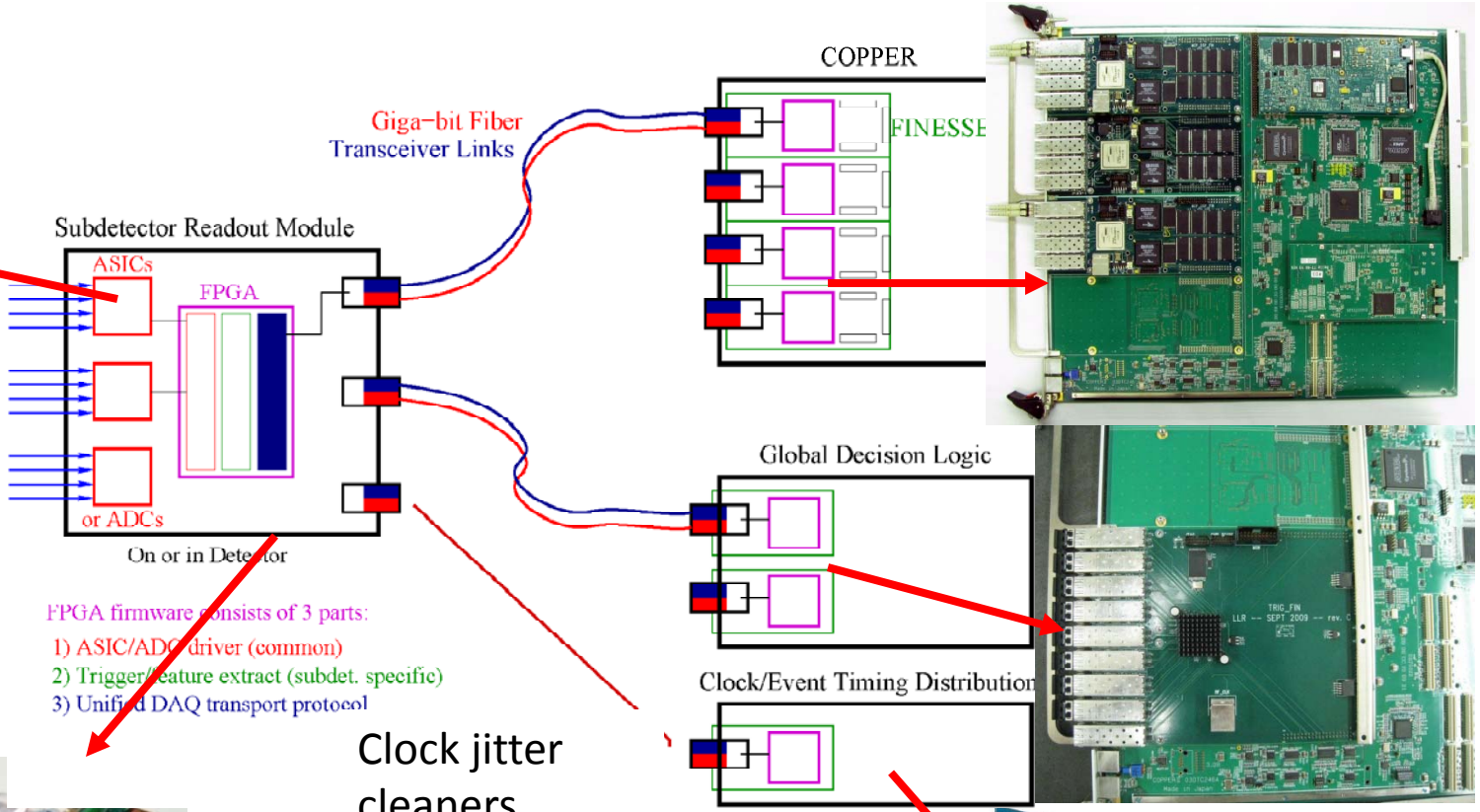
Data

PDF (floating norm)

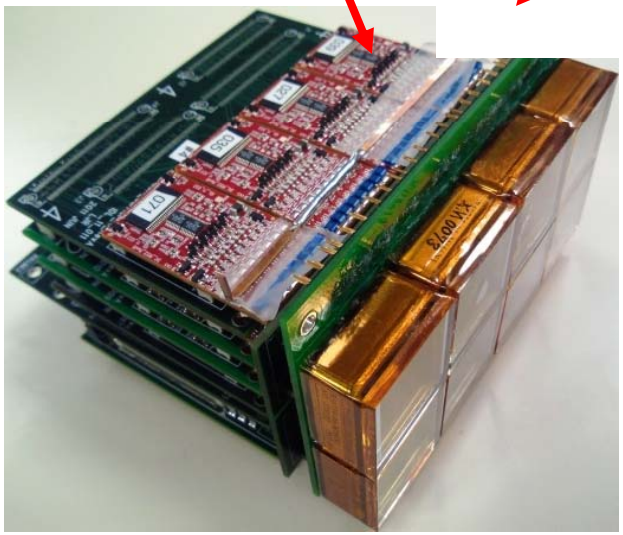
Third generation waveform sampling ASIC

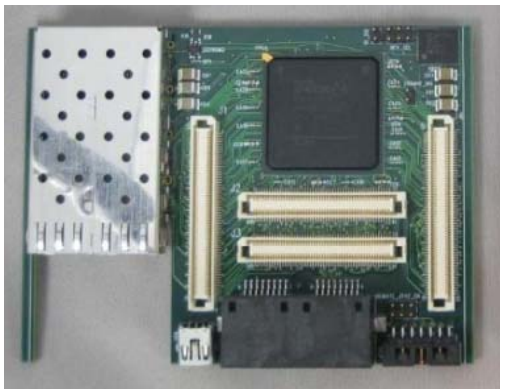
Highly Integrated Readout

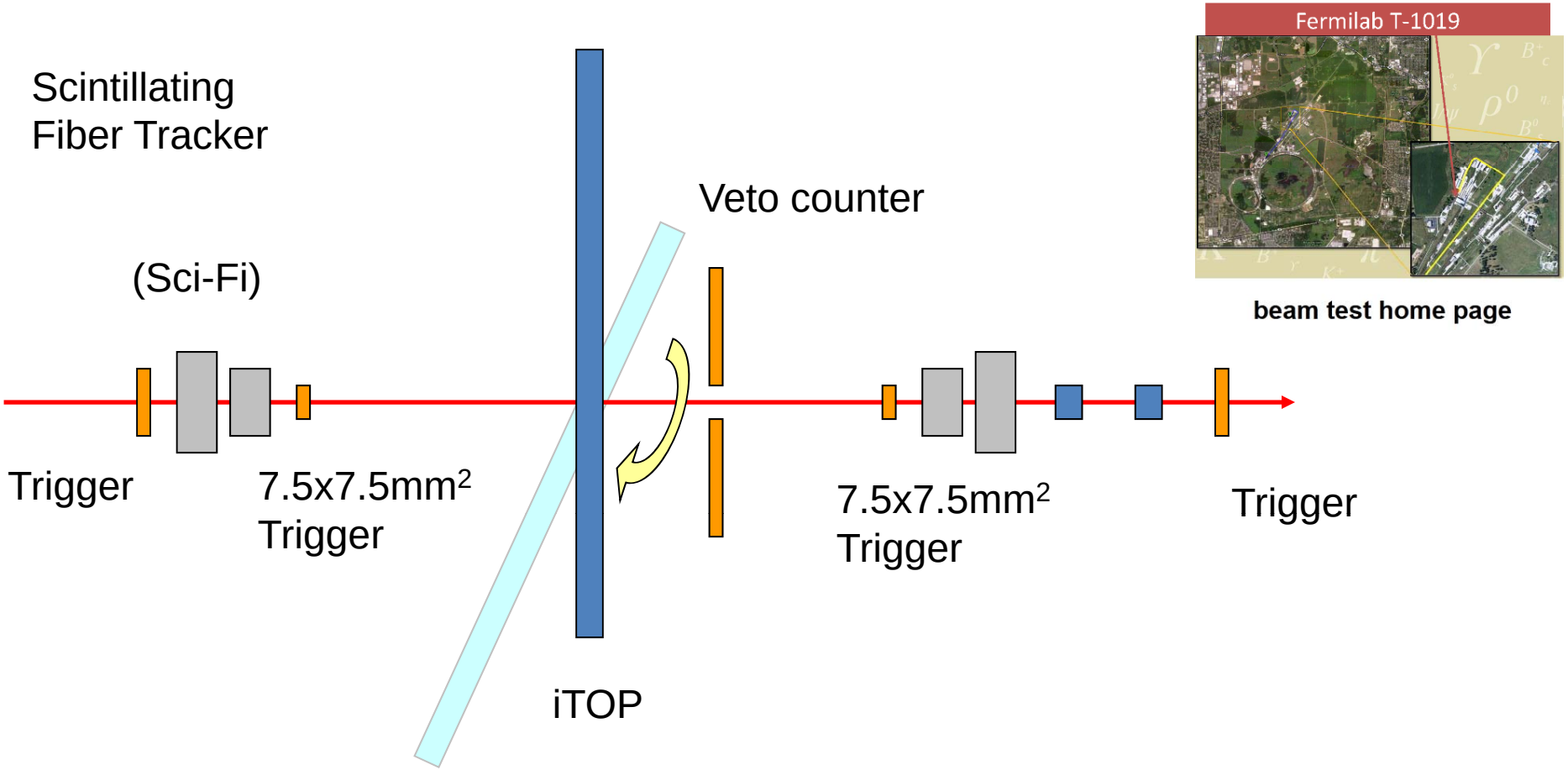




Clock jitter cleaners

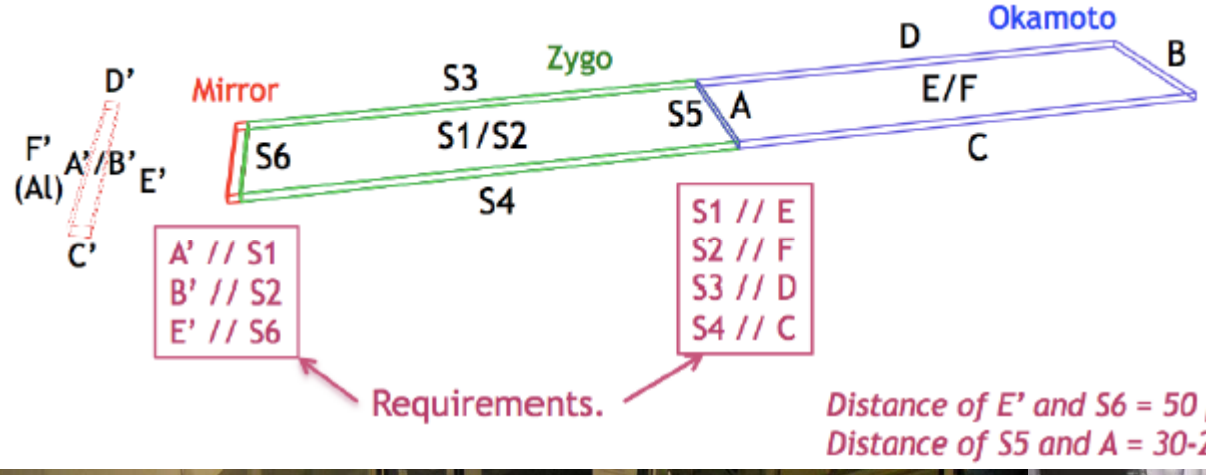


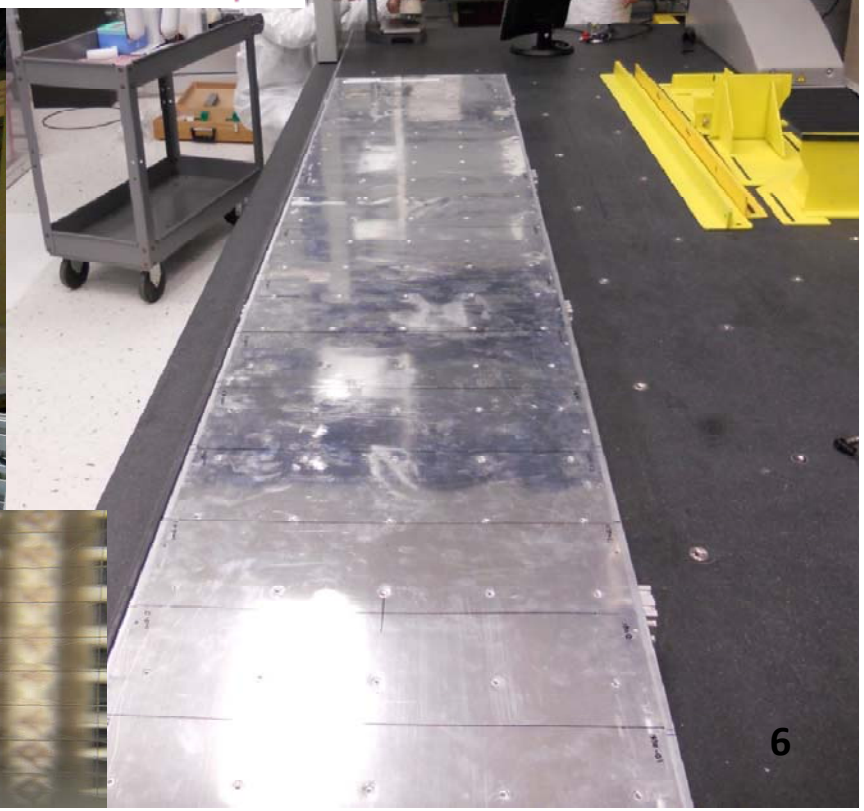




- Performance check with (almost) final detector configuration
  - 2.5m long quartz, expansion block, 2-layer MCP-PMT
    - Will check expanded ring image and confirm chromatic effect
  - Waveform readout
    - Demonstrate high speed readout in a small form factor
    - Timing shift corrections

Shipping Woes & Repair (Thanks SiDet!)

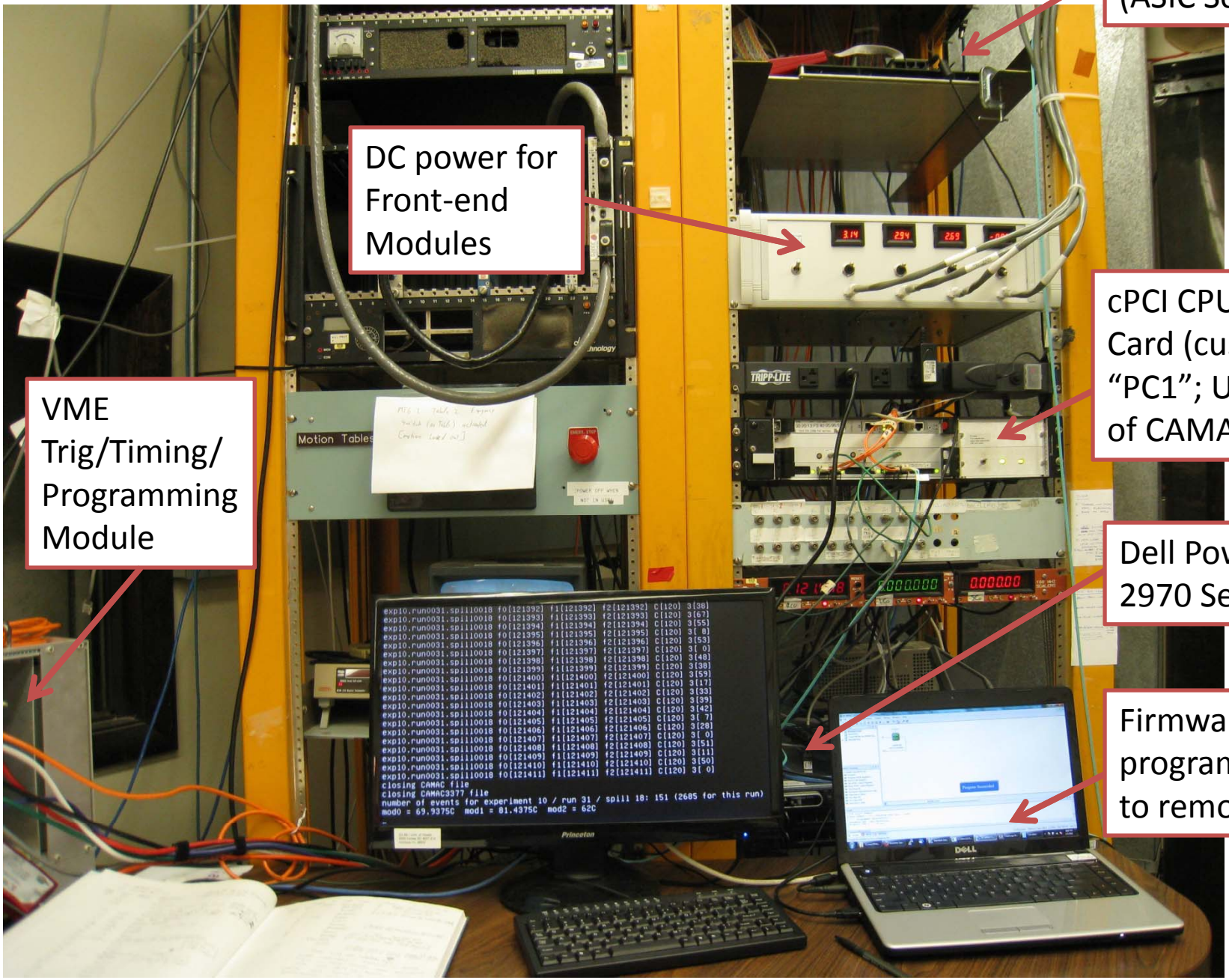




An Eager Team

(not pictured: Alan Schwartz [Cincinnati], Lynn Wood [PNNL], Marc Rosen & Casey Honniball [Hawaii])

DAQ system



Hawaii Tracker (ASIC SciFi readout)

DC power for Front-end Modules

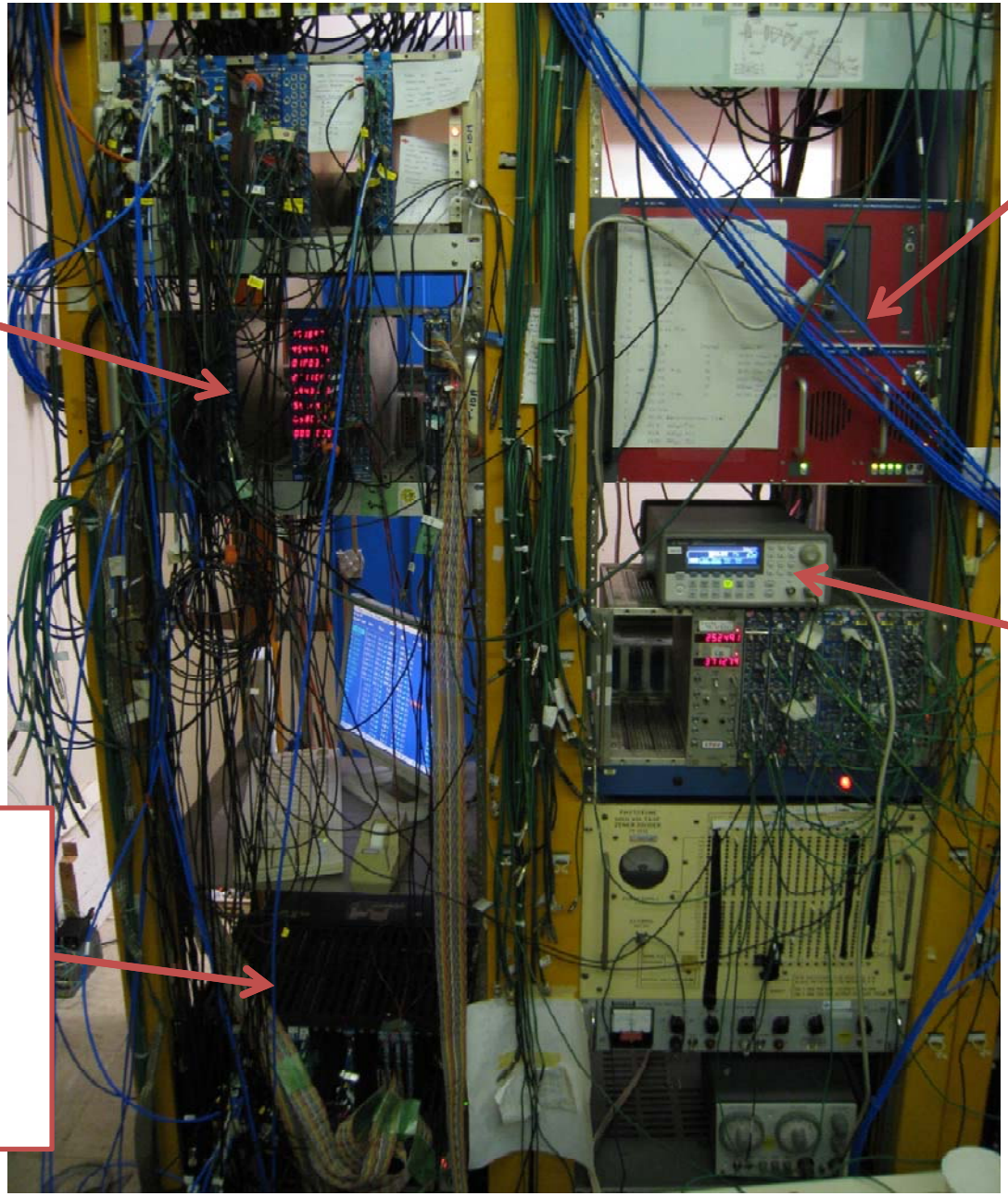
cPCI CPU and fiber Card (custom) = “PC1”; USB readout of CAMAC

VME Trig/Timing/ Programming Module

Dell PowerEdge 2970 Server (“PC2”)

Firmware programming (USB to remote JTAG)

Trigger/HV



CAEN HV

Nagoya Trigger Logic/Timing Modules

Pico-second Calibration Laser Trigger

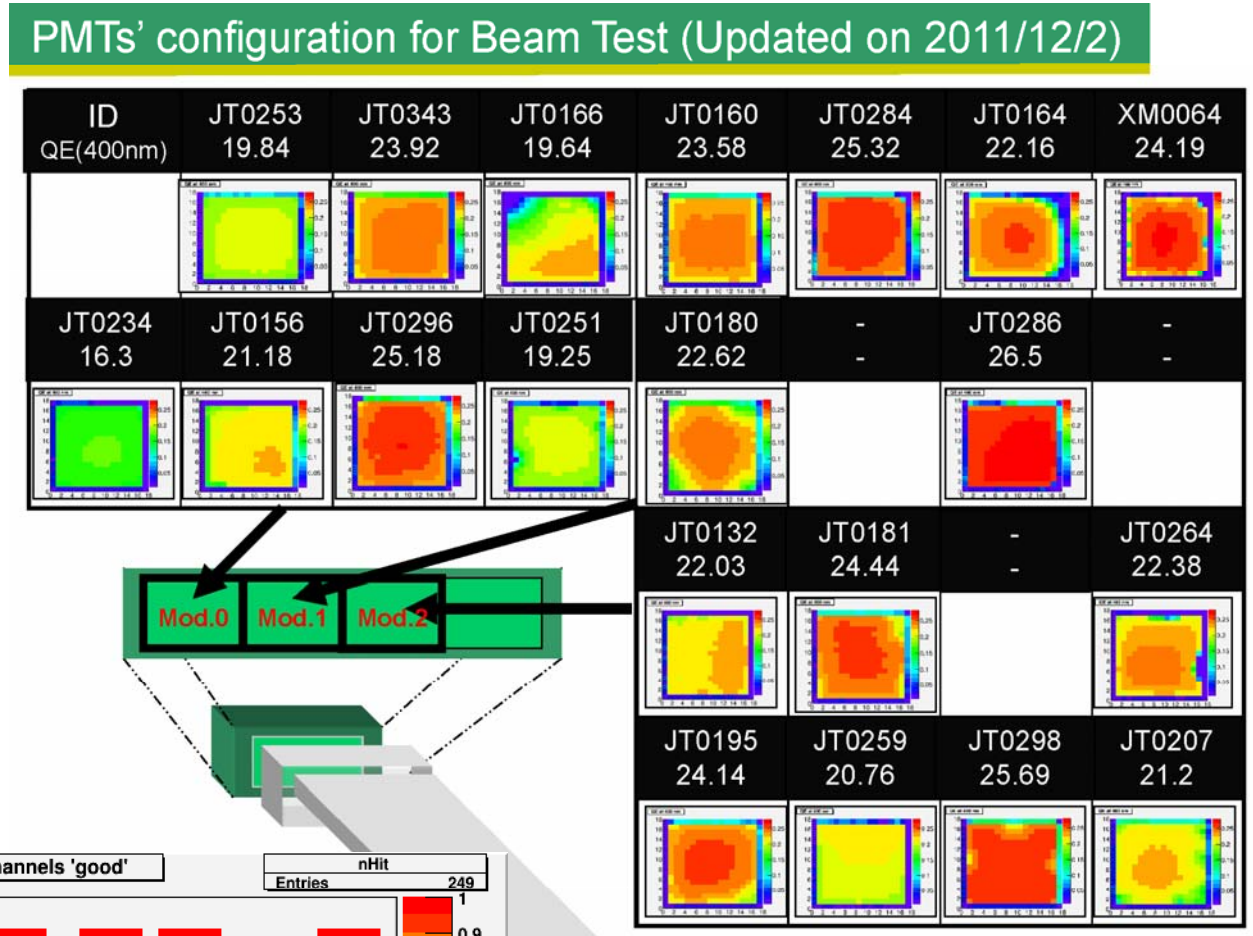
CAMAC for "SuperKEKB RF clock phase measurement, Nagoya timing counters/tracker

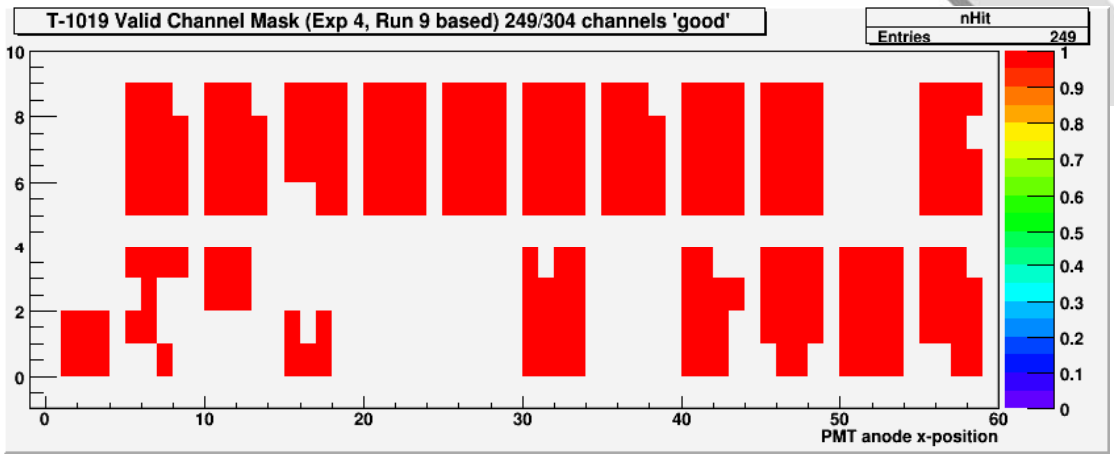
Some Limitations

Only 20/32 tubes from Hamamatsu

JT0180 trips frequently (not used)

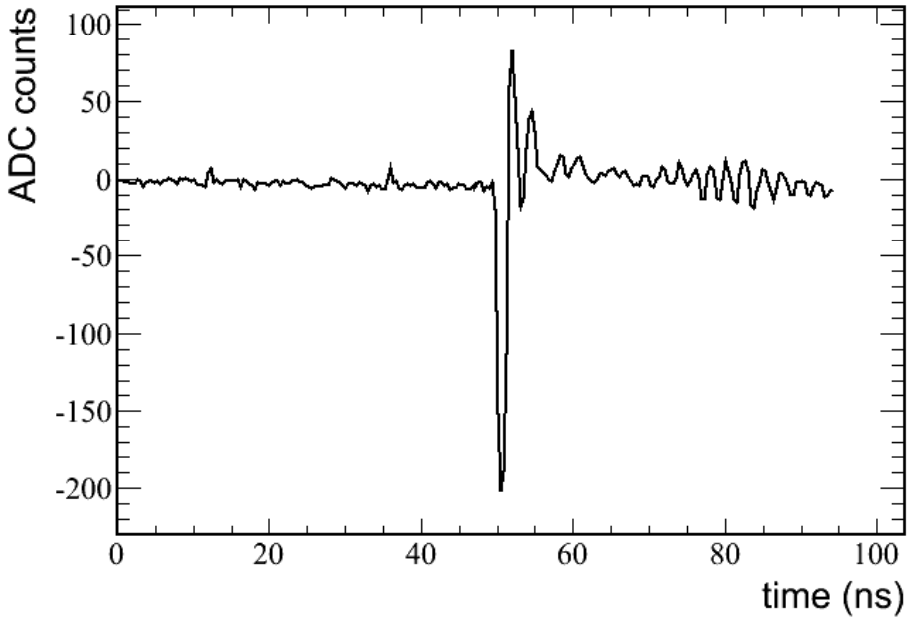
82% of electronics channels “good”
(bad RF amps, solder connections, etc.)

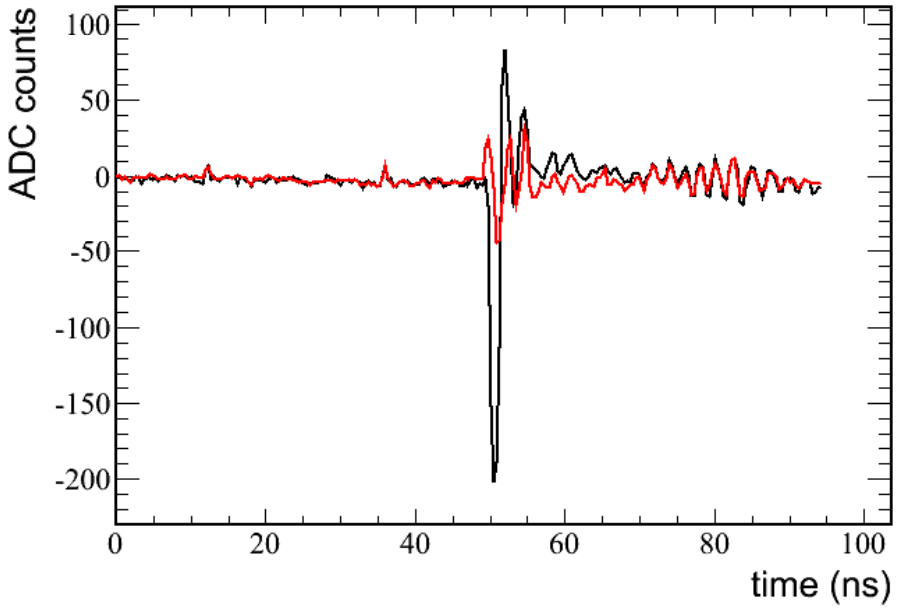




384 channels @ 2.7 GSa/s “oscilloscope on a chip” (1.5TBy/s)!

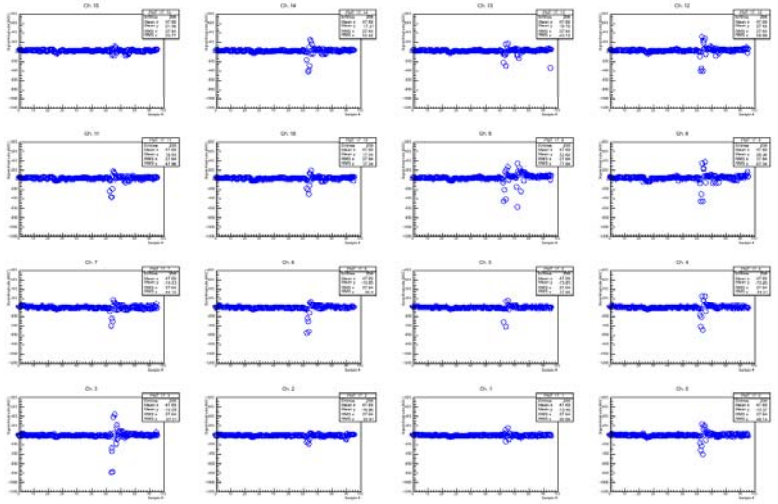
Example single-photon signals





Clean hit (center of Anode pad)

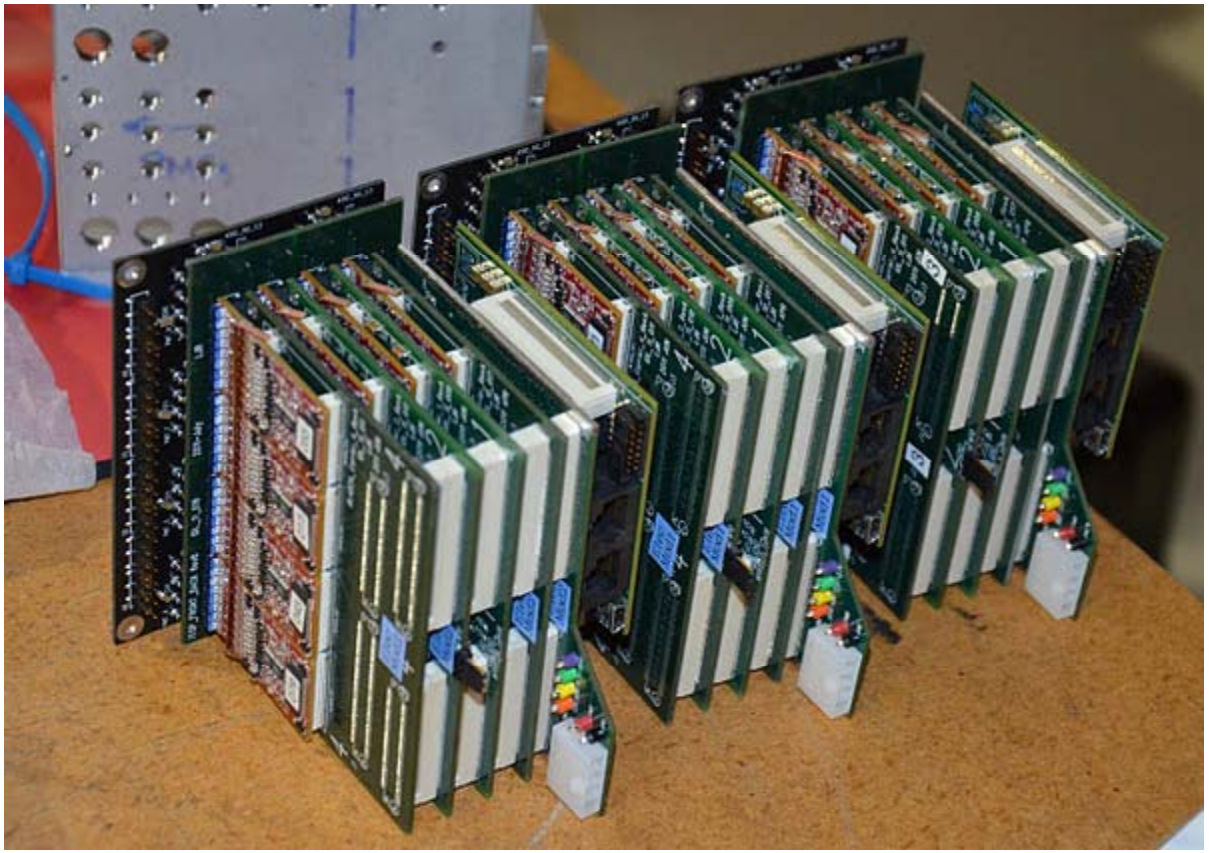
Depending upon amplitude, "cross talk" hit (red) == remove by filtering



(16 waveforms from JT0164)

Can (in principle) decouple PMT, wiring & readout x-talk

Event Sizes/Rates



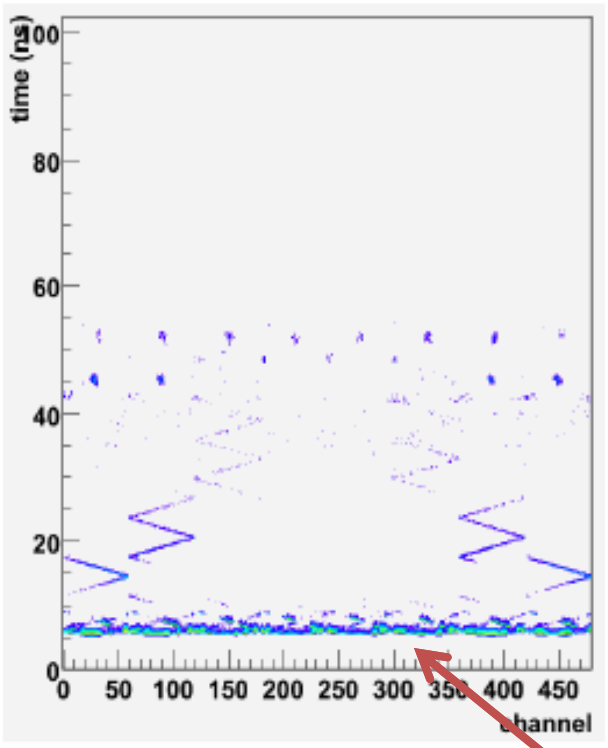
- Read 4 “windows” of 64 samples from each channel (each channel has 512 windows of storage);
- 1 fiber link/module
- Each event ~74kB/module
- Total ~ 230kB/event
- Logging rate obtained was 130-160 events/spill

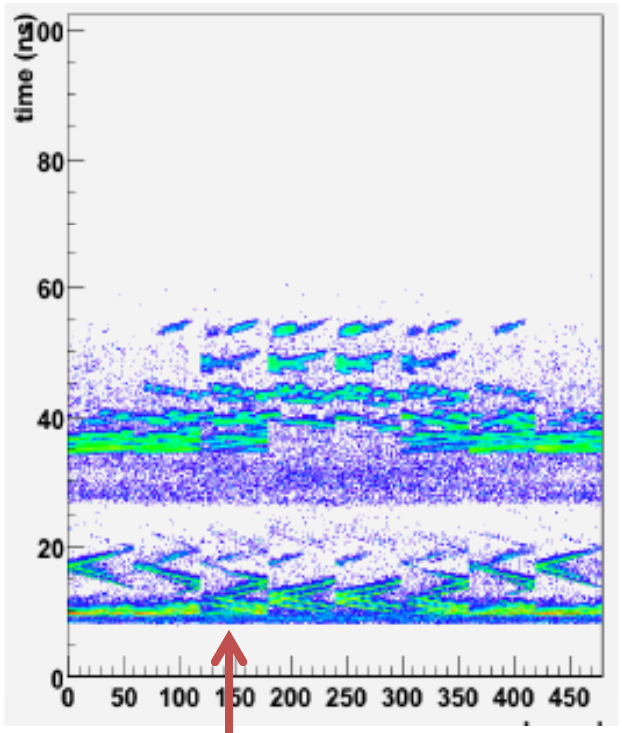
(~10MB/s PCI bus + CAMAC USB)

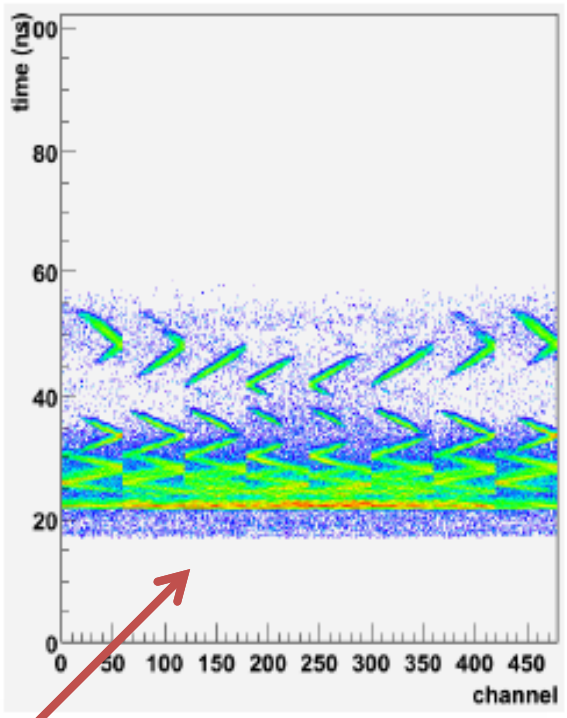
Able to log about 100k beam events per day (~1-2 M single photons), with comparable number of laser calibration events

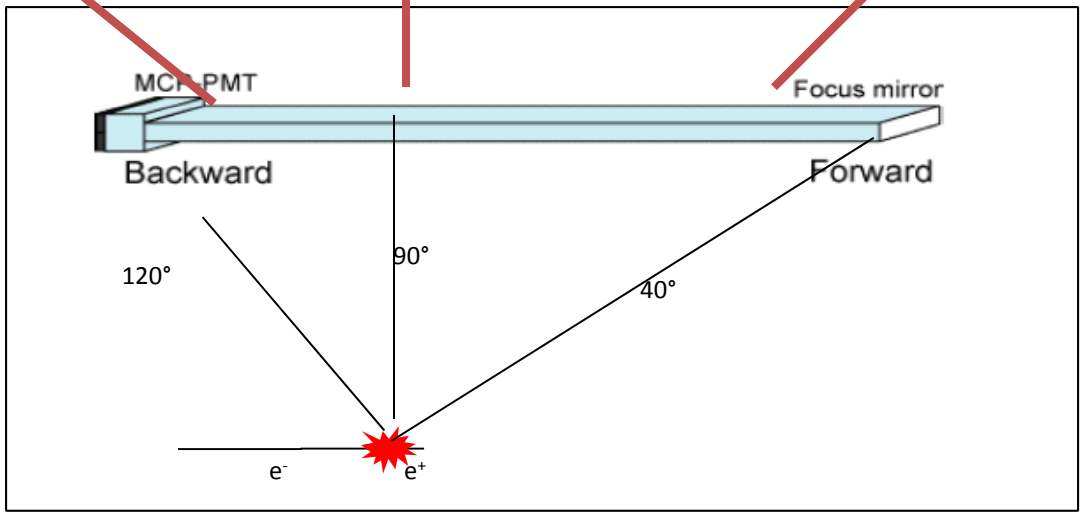
To do better will need to zero-suppress/online feature extraction (next beam test)

Cherenkov Photon Arrival Patterns









Initial Data Distributions

Normal incidence:

Other variants: Polar angle: cos(θ) = 0.5

Initial Data Distributions

Analysis items

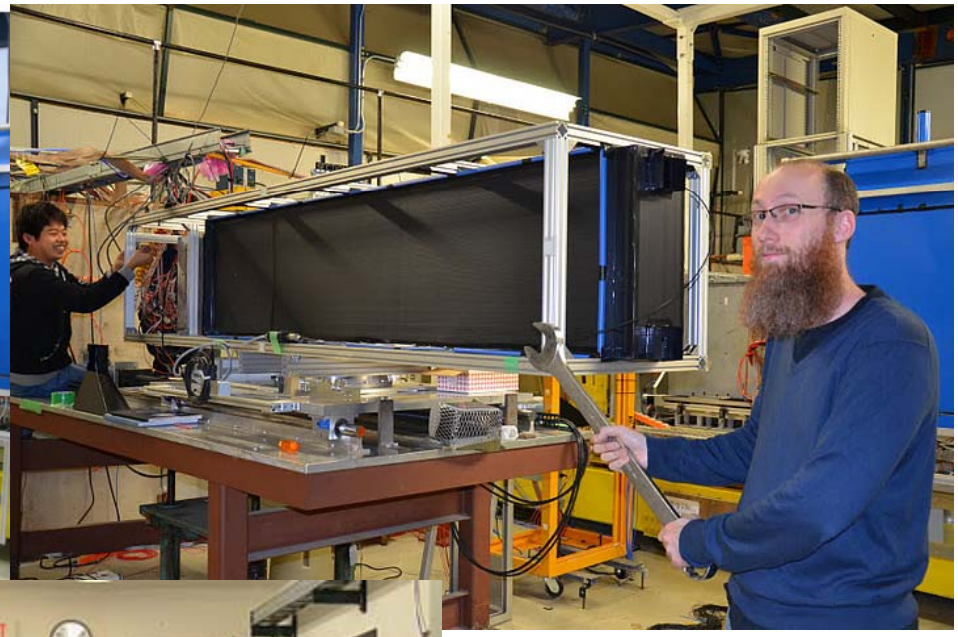
- Many of the waveforms look clean
  - Precise timebase/timing calibration needed
  - Leading edge timing extraction algorithm
- Photon yield (can do without precise timing)
- MC comparisons already on-going
- “direct” light is easy, mirror reflections keep the MC guys honest
- Beam quality good, study backgrounds by overlaying events

T-1019 Preliminary Summary

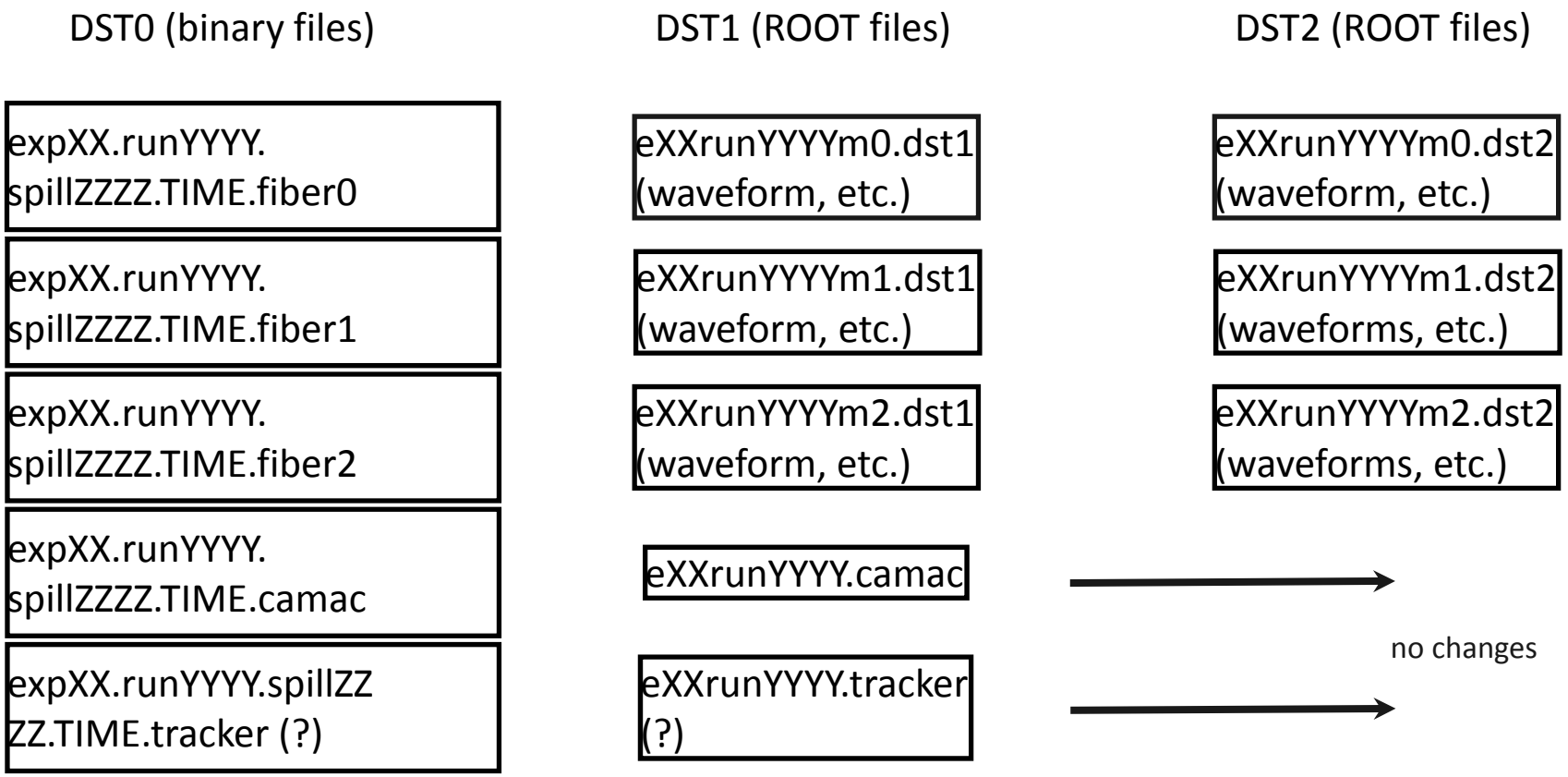
- About 534,000 events at normal incidence
  - Preliminary results look good
  - Much analysis to be done – a very rich data set
- Data for cos(theta)=0.5 still running (~300k events)
- A couple notes:
  - We had 2x mystery EMI episodes where we couldn't program/read out. Didn't last long, but might be worth investigating with network analyzer
  - Many thanks to FTBF staff and the generous resources provided by FNAL (PREP, SiDet, etc.) **Mahalo!**

Back-up

Merry Christmas from T-1019



DST of T-1019



DST0 → DST1: transformation from binary files to ROOT files.

DST1 → DST2: pedestal subtraction for waveforms.

m0: module 0
m1: module 1
m2: module 2