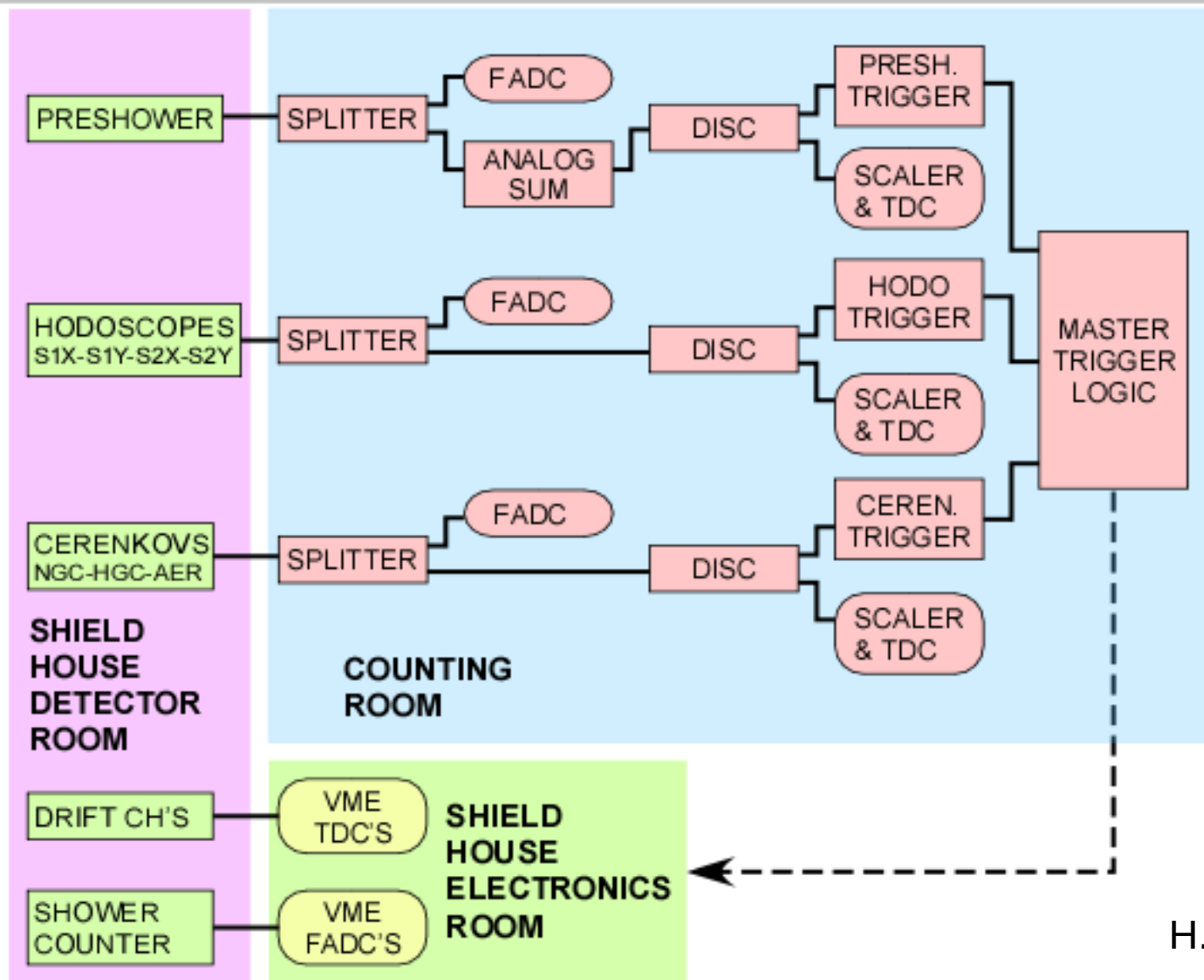# Update on DAQ for 12 GeV Hall C

Brad Sawatzky

Hall C Winter User Group Meeting
Jan 20, 2017

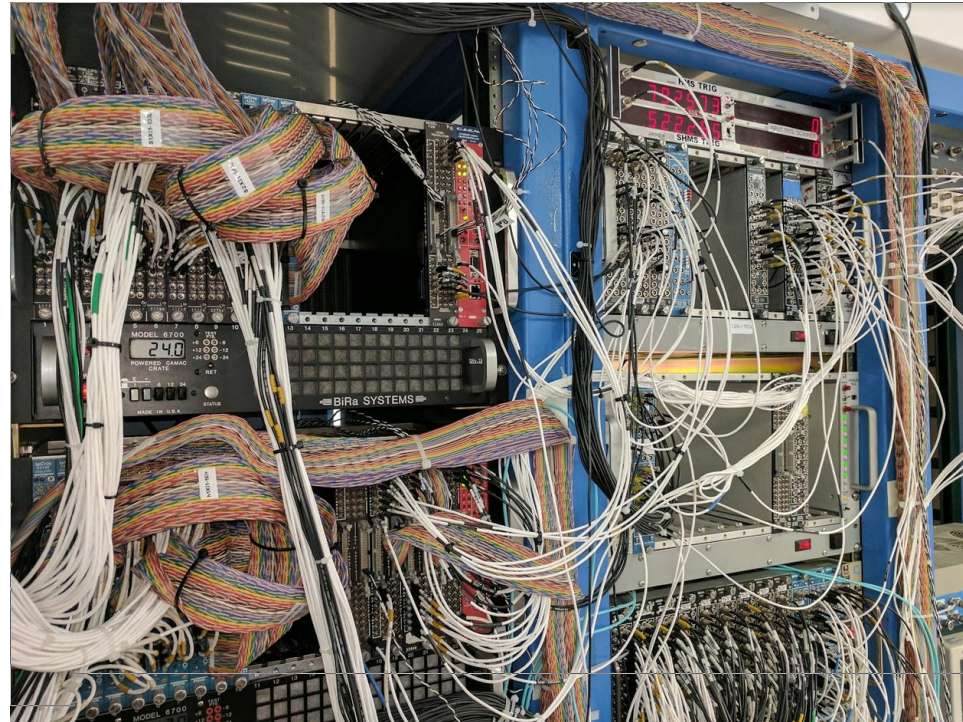# SHMS/HMS Trigger/Electronics



H. Fenker

Jefferson Lab

# SHMS / HMS Triggers

- <u>SCIN = 3/4 hodoscope planes</u>
- CER = Cerenkov(s)
- STOF = S1 + S2
- EL-Hi = SCIN + PSh_Hi
- EL-Lo = 2/3{SCIN, STOF, PSH_Lo} .AND. CER
- EL-Real = EL-Hi + EL-Lo
- PION = SCIN .NOT. CER
- Pulser/Random trigger
    - → EDTM injection for deadtime monitoring, synth. coin. trig



- Each arm will have its own TS
    - → Both coincidence and independent/parallel operation available
- We will use TS module for trigger prescaling
- NOTE: There is *no* Calorimeter Sum for SHMS trigger
    - → SHMS Pre-Sh sum *does* exist

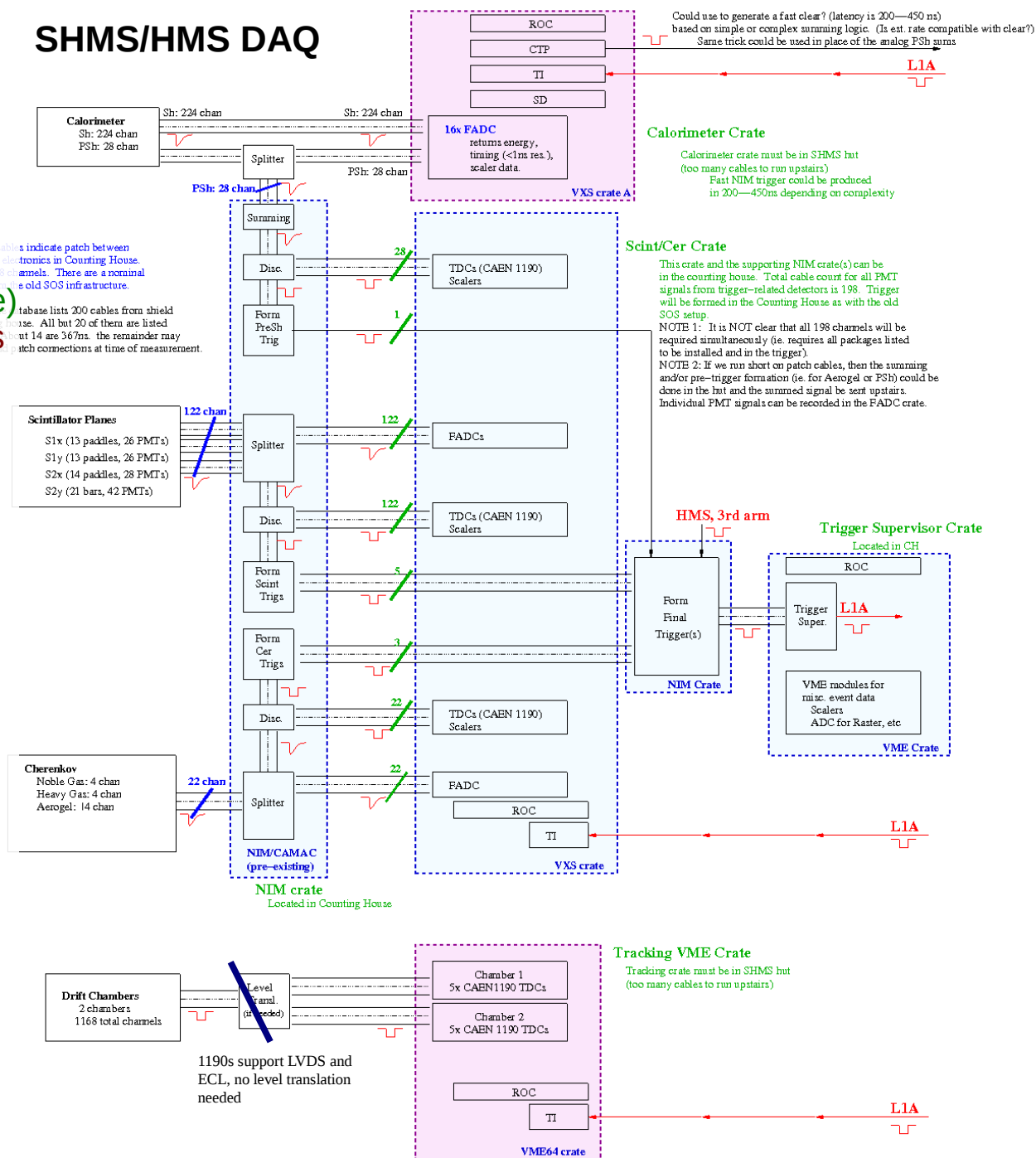Jefferson Lab

# Hybrid/Legacy Trigger

## SHMS/HMS DAQ

- Will restore HMS trigger, SHMS has same logical design.

  → FASTBUS electronics have been replaced with FADCs (running in integrating mode) and VME CAEN 1190 TDCs

  → A "legacy" NIM trigger has been implemented.

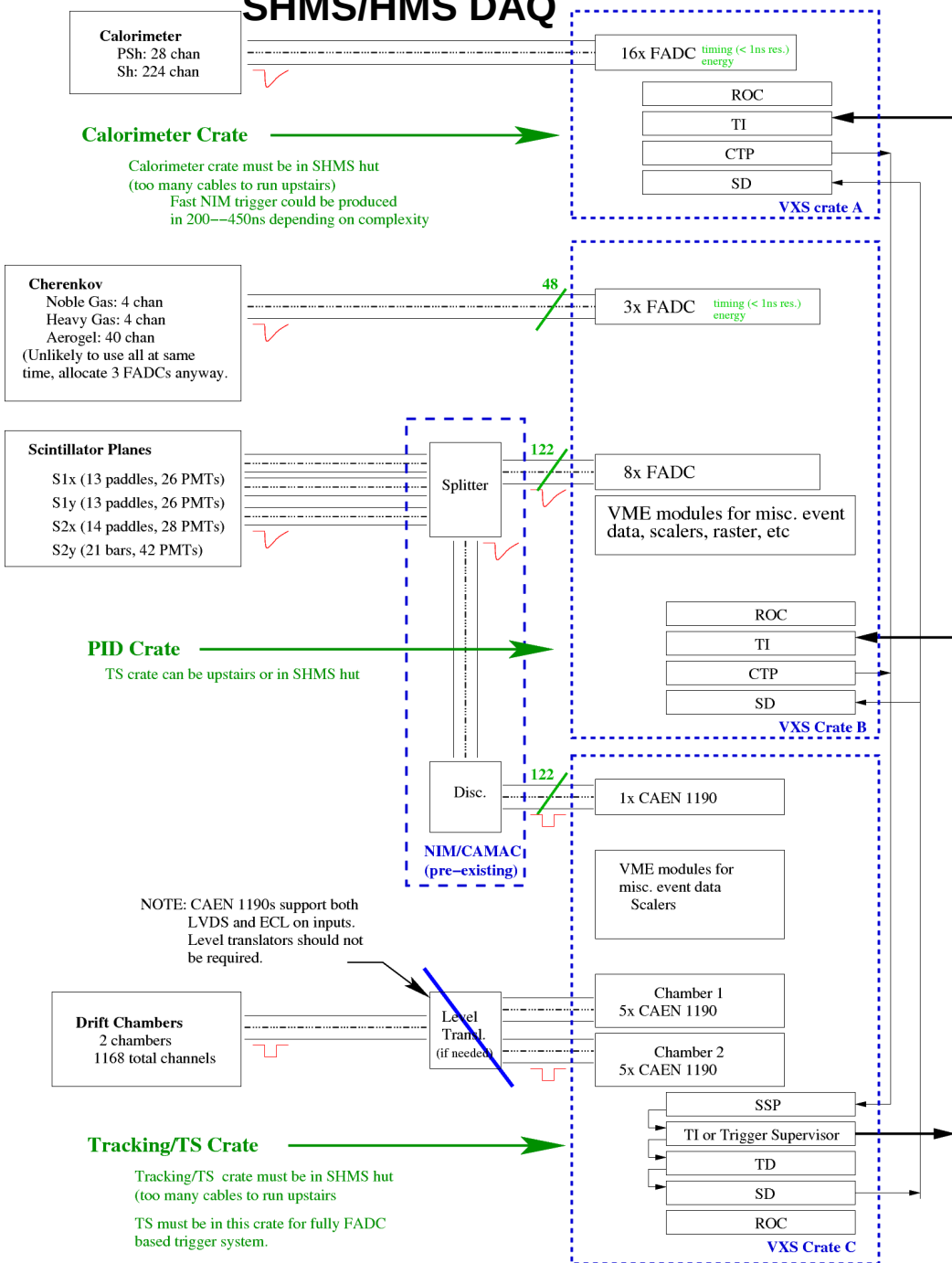  → This is our 12 GeV starting point.

- FADCs provide ADC, TDC (~1 ns res.), and scaler data

- CAEN 1190 TDC: 100 ps res.

  → All detectors except SHMS Calorimeter are in TDCs!

- If desired, Calo. FADCs could provide a simple sum, or more sophisticated cluster trigger with latency of ~200—400ns

  – somewhat slow for main trigger, but could be used as a fast clear

**SHMS/HMS DAQ**

# "Modern" Trigger/DAQ

**Calorimeter**
PSh: 28 chan
Sh: 224 chan

16x FADC  timing (< 1ns res.)  energy

ROC
TI
CTP
SD

VXS crate A

**Calorimeter Crate**

Calorimeter crate must be in SHMS hut
(too many cables to run upstairs)
Fast NIM trigger could be produced
in 200––450ns depending on complexity

**Cherenkov**
Noble Gas: 4 chan
Heavy Gas: 4 chan
Aerogel: 40 chan
(Unlikely to use all at same
time, allocate 3 FADCs anyway.

48

3x FADC  timing (< 1ns res.)  energy

**Scintillator Planes**
S1x (13 paddles, 26 PMTs)
S1y (13 paddles, 26 PMTs)
S2x (14 paddles, 28 PMTs)
S2y (21 bars, 42 PMTs)

Splitter

122

8x FADC

VME modules for misc. event
data, scalers, raster, etc

ROC
TI
CTP
SD

VXS Crate B

**PID Crate**
TS crate can be upstairs or in SHMS hut

Disc.

122

1x CAEN 1190

**NIM/CAMAC**
**(pre–existing)**

VME modules for
misc. event data
Scalers

NOTE: CAEN 1190s support both
LVDS and ECL on inputs.
Level translators should not
be required.

**Drift Chambers**
2 chambers
1168 total channels

Level
Transl.
(if needed)

Chamber 1
5x CAEN 1190

Chamber 2
5x CAEN 1190

SSP
TI or Trigger Supervisor
TD
SD
ROC

VXS Crate C

**Tracking/TS Crate**

Tracking/TS crate must be in SHMS hut
(too many cables to run upstairs

TS must be in this crate for fully FADC
based trigger system.

- "Stage 2" evolution of system
  NOT planned for first set of experiments
  - fully pipelined capable
  - 'deadtimeless' operation at >10kHz possible

- Legacy/NIM logic will be left in place and can be used as either primary or auxiliary trigger.
  - (Will need legacy trigger to debug/cross-check any FADC logic anyway)

- DAQ can be configured for:
  - high-speed fully-pipelined mode
    - trigger can be generated in NIM logic, *or* in firmware
  - "Hybrid mode"
    - ie. in conjunction with non-pipelined 3rd arm, etc.

# New Inventory

- 4 new VXS crates
  - → primarily used to support FADCs
    (special J0 backplane bus)
- 640 ch         JLab FADC                [40 mod]
  - → SHMS: 422 ch    /   HMS:  200 ch
- 2304 ch        CAEN 1190 TDC         [18 mod]
  - → SHMS: 1290 ch   /   HMS:  810 ch
- 2 New Trigger Supervisor (TS) boards
- 5 New Trigger Interrupt (TI) boards
- 2 Trigger Distribution (TD) boards
  - →  fans triggers/clocks out to crates
- 2+2 Signal Distribution (SD) board
  - → fans triggers/clocks out to FADCs
- 3 Crate Trigger Processor (CTP) boards
- 1 Sub-System Processor (SSP) board
- 'Special' multi-fiber optical cable run SHMS <-> HMS <-> CH
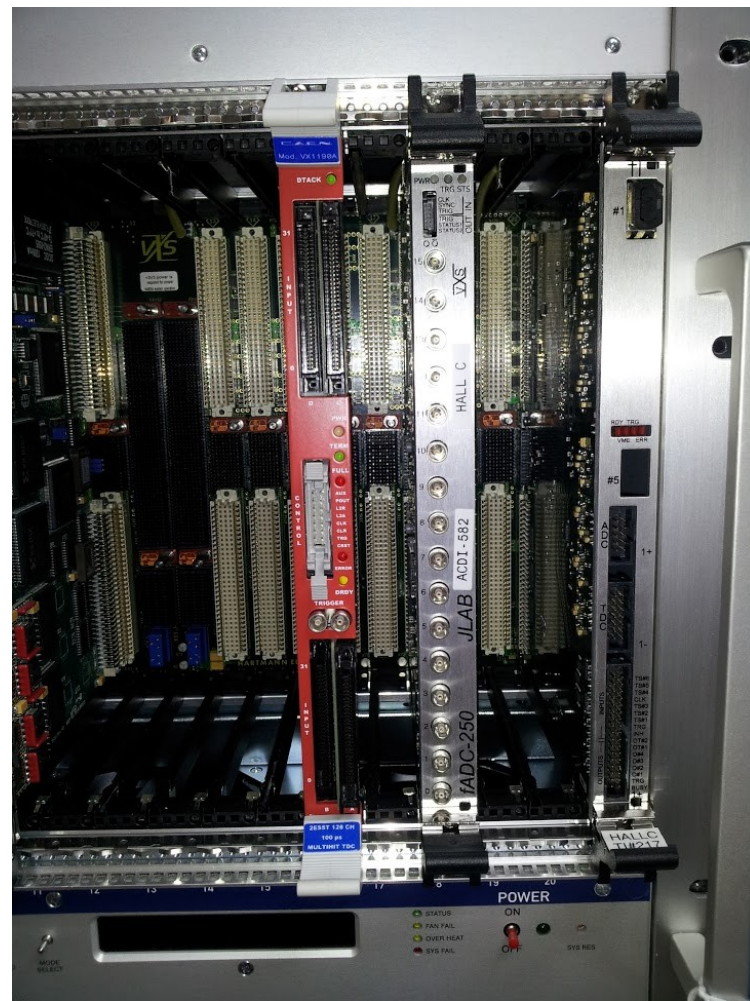
# SHMS & HMS DAQs Operational

- **SHMS**
  - → ROC2: CH
    - » Hodoscopes
    - » Cerenkov Detectors
    - » Misc. Signals
  - → ROC4: SHMS hut
    - » Shower + Preshower
  - → ROC6: SHMS hut
    - » Drift chambers
  - → ROC8: CH
    - » Hardware scalers
      - – *In progress*
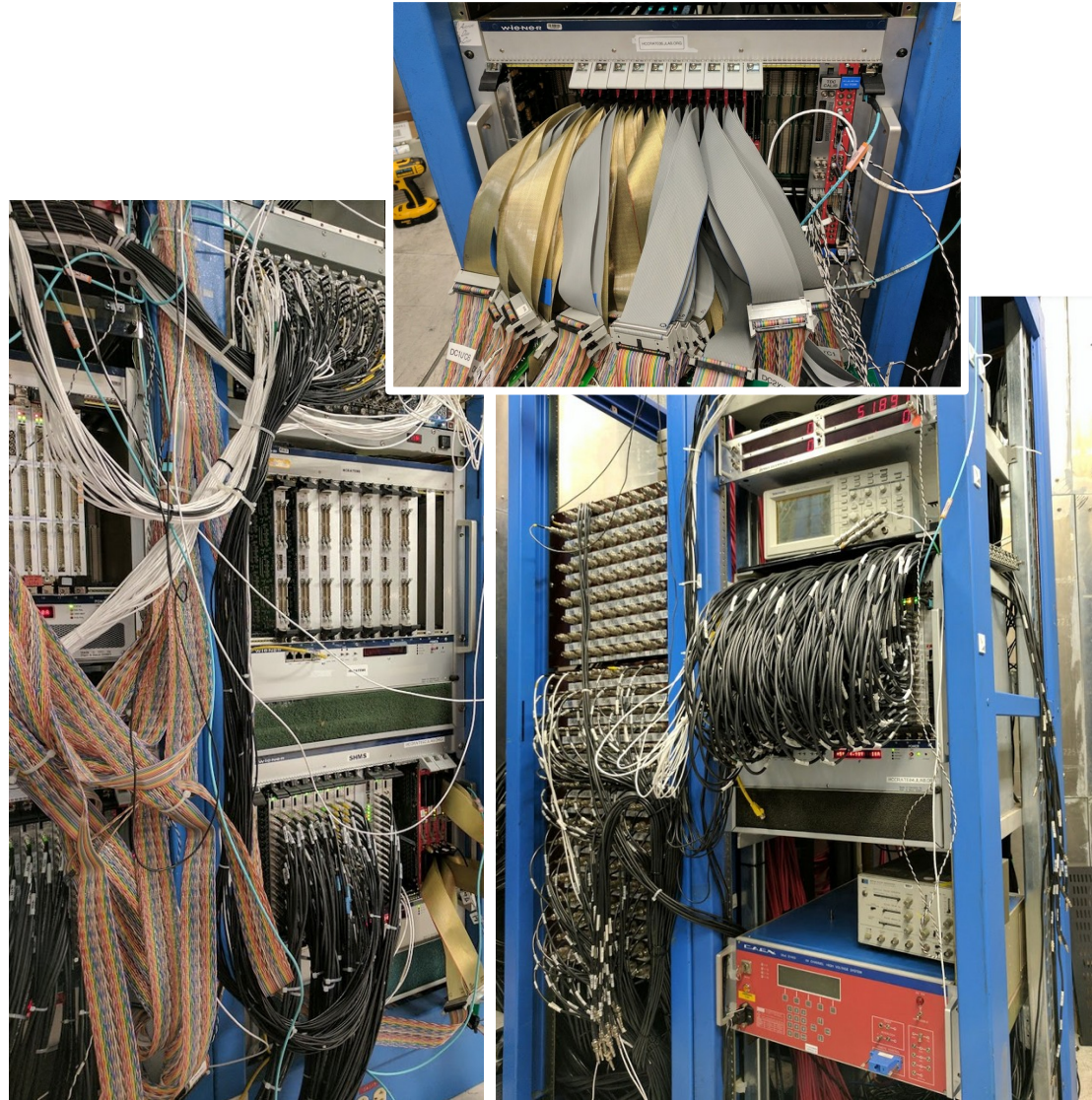
# SHMS & HMS DAQs Operational

- **HMS**
  - → ROC1: CH
    - » Hodoscopes
    - » Calorimeter
    - » Cerenkov Detectors
    - » Misc. Signals
  - → ROC3: HMS hut
    - » Drift chambers
  - → ROC5: CH
    - » Hardware scalers
      - – *In progress*
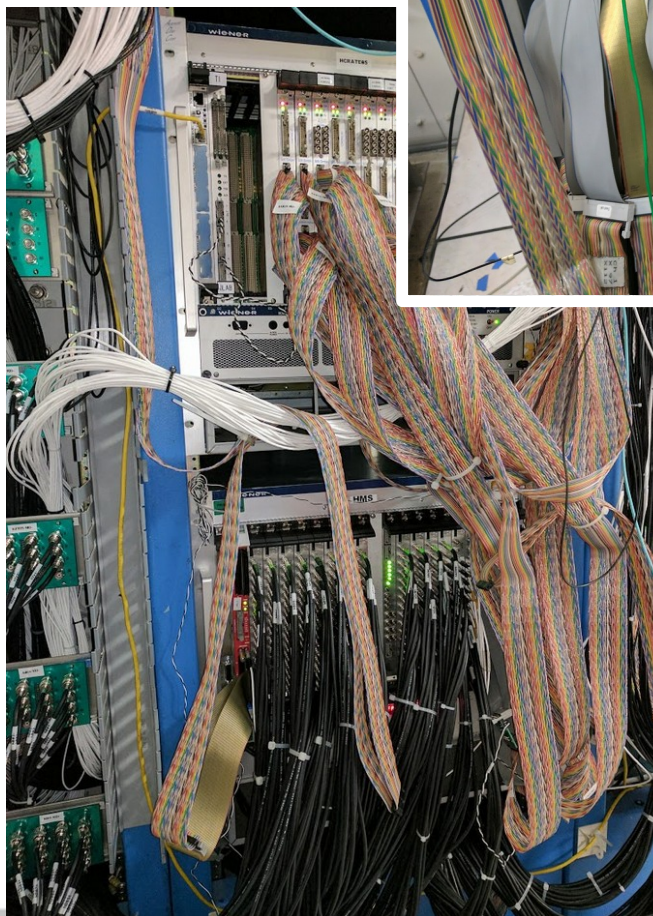
# Status and To-do Lists

- **General Status**
  - → Counting House cleaned up
  - → CH shift crew machines up and running
  - → DAQs are taking cosmics on cdaql4 (SHMS) and cdaql5 (HMS)
  - → Shaking out some stability issues with new TI hardware
    - » FE/DAQ group is providing great support

- **SHMS and HMS detectors are in generally good shape**
  - → All installed detectors are connected to DAQ
  - → Analyzer/decoder work is progressing rapidly
  - → Each detector owner should work with Hall C SW group to ensure their system is gain matched and working as expected with cosmics.
    - » Detector Parameter/Config files should all be in place ASAP
    - » Online and 'Offline' calibration scripts and monitoring histograms should be identified and implemented

# To-Do List, cont...

- **Hardware scalers are in progress**
  - → Hardware is installed, ready to be cabled up
  - → Front-end readout software in progress (generally working)
  - → 'xscaler' display working
  - → Need to integrate scaler crate into single-arm DAQs when ready

- **Beamline instrumentation → DAQ**
  - → BPM signal readouts
  - → Raster Current readouts
  - → BCM readouts
  - → Helicity reporting / gated scalers
  - → EPICS variables
    - » Verify all relevant EPICS PVs are in MCC Archiver, screens updated with any changed names, etc
    - » Magnet readbacks interfaced with MCC Archiver?
    - » Target logging
    - » Hall C HV logging

# To-Do List, cont...

- **Implement 'composite' triggers**
  - → ie. EL-Hi, EL-Lo, etc...
  - → Setup dual-arm CODA configuration
  - → synthesize eP coin. trigger and rough in timing

- **Stress test DAQ systems from ROCS → Tape**
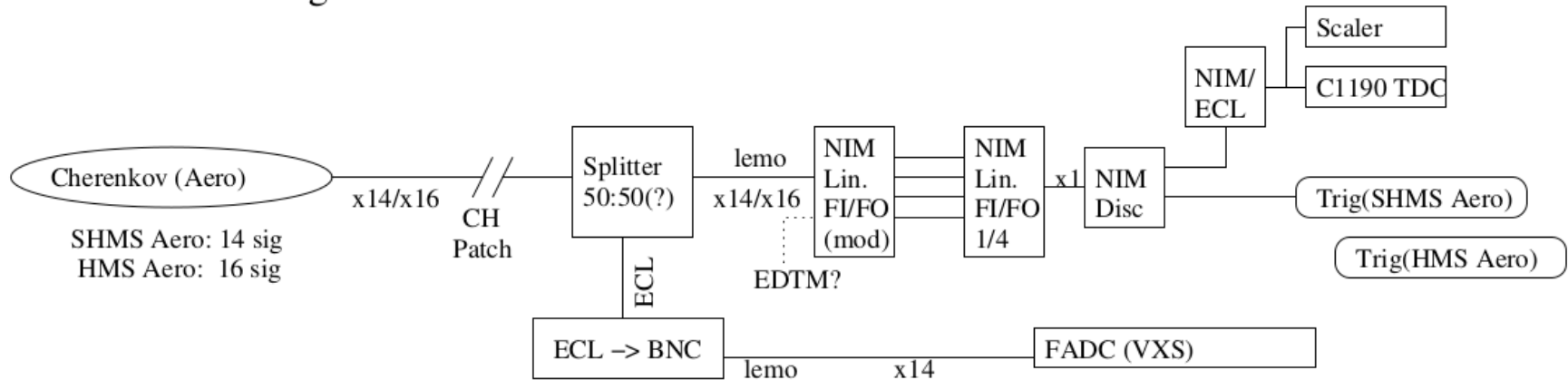
**We will be ready for beam!**
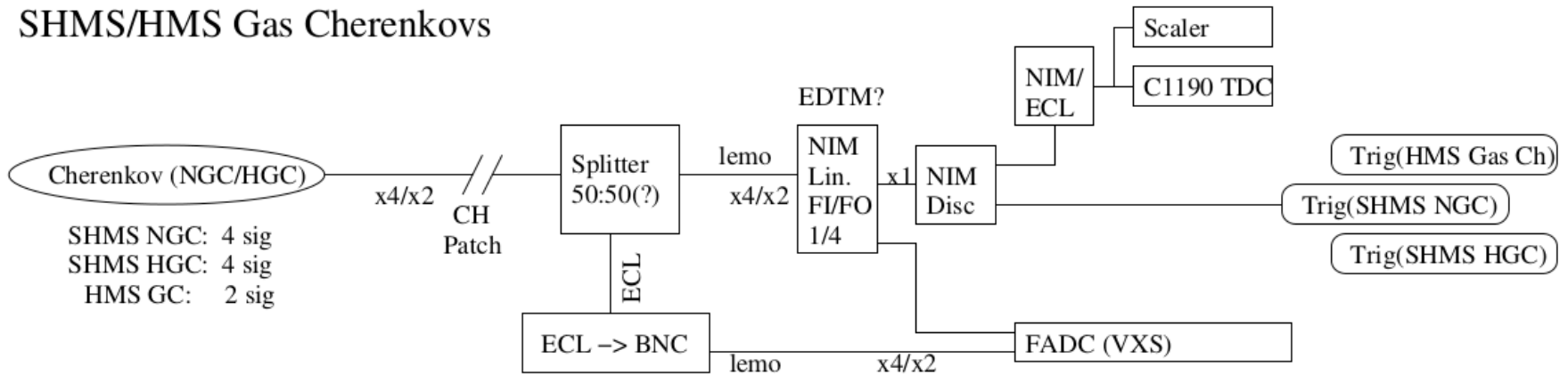
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# Misc/Backup Slides

# Hodoscopes
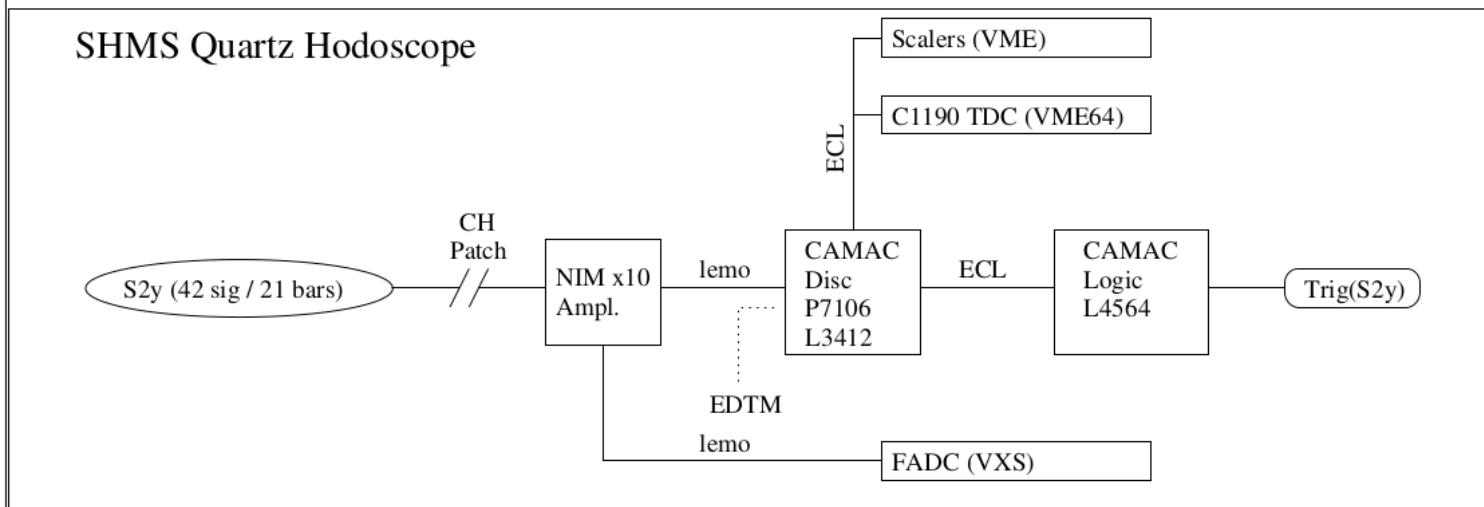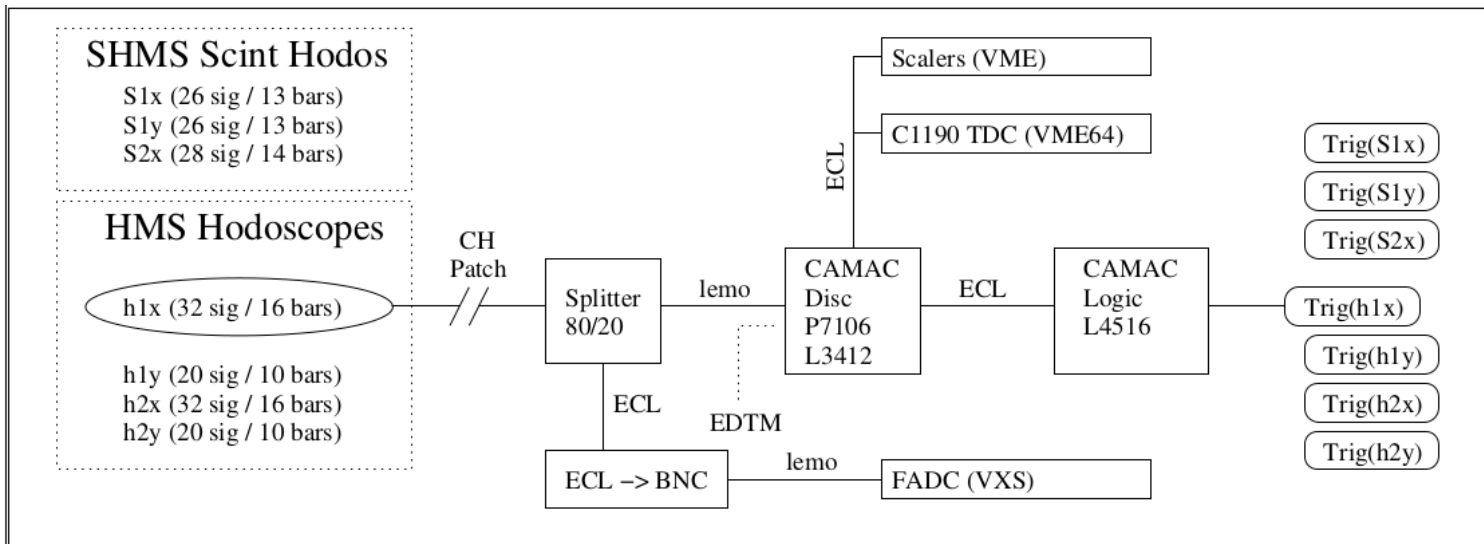
# Cherekovs

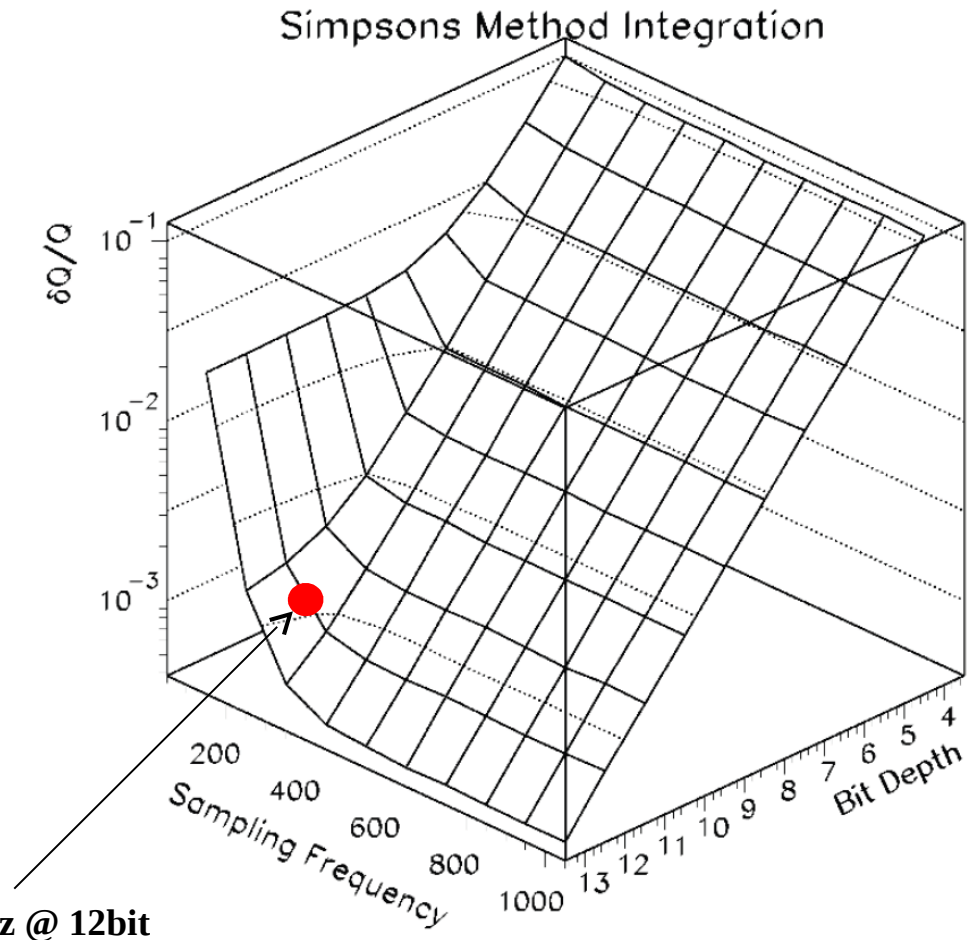# HMS Shower
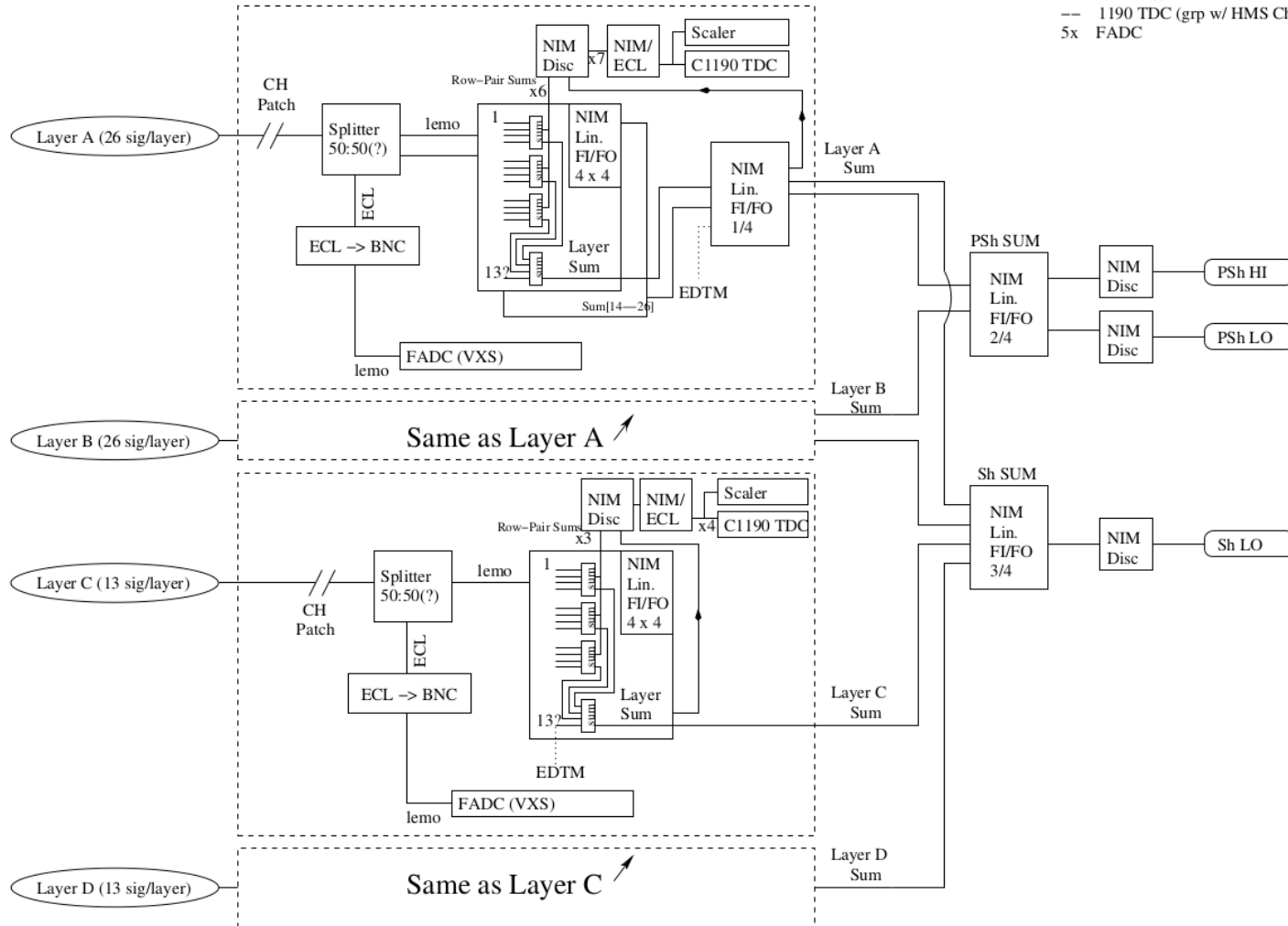
# SHMS Pre-shower
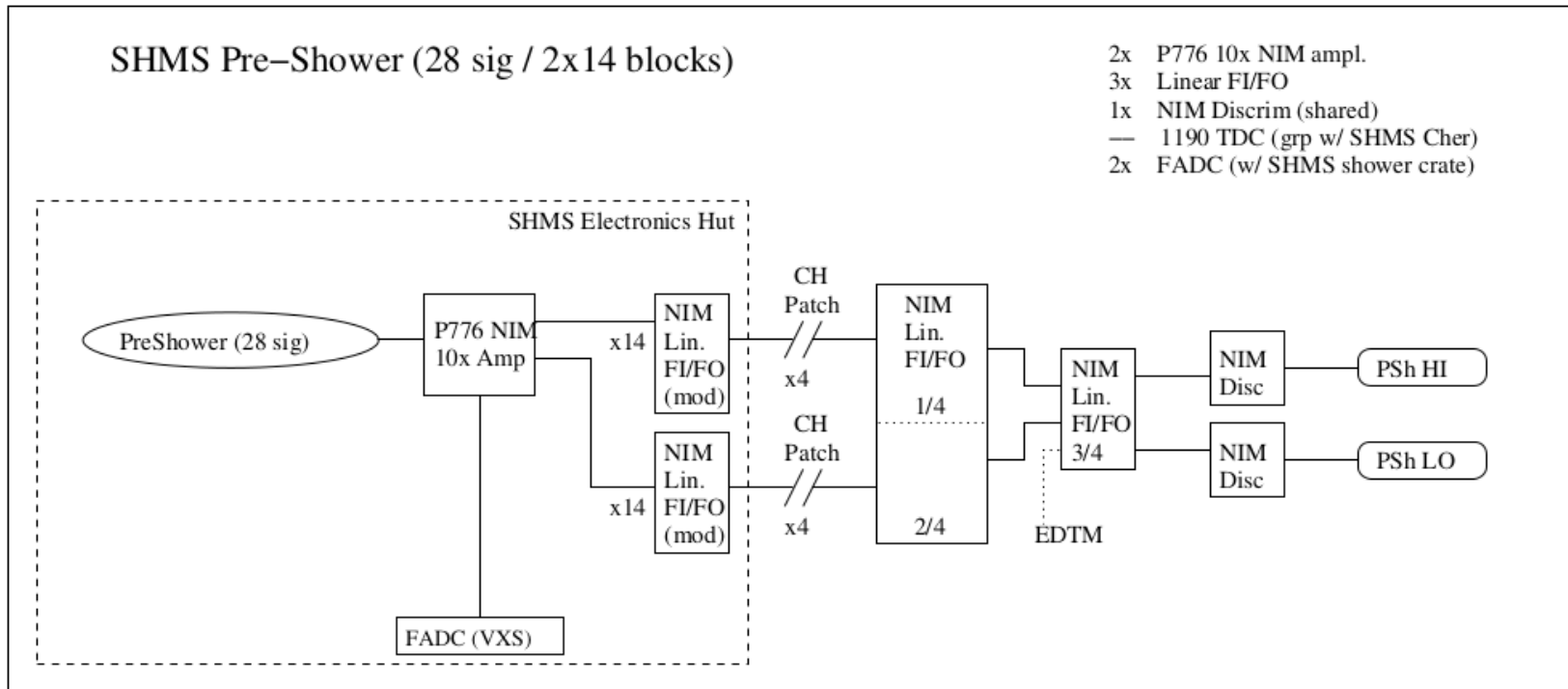
# 3.4 FADC Sampling – Charge Accuracy

**Hall D FCAL PMT: FEU 84-3**

- **10,000 Random height pulses 10-90% full scale of ADC range simulated**

- **Sampling frequency makes little difference beyond 250MHz at 12bit, providing ~0.1% charge resolution**

- **PMT pulse shape dominates sample frequency and bit depth of ADC**

Simpsons Method Integration



**250MHz @ 12bit**

# FADC Sampling – Timing Accuracy

**Hall D FCAL PMT: FEU 84-3**
- **Timing algorithm developed & tested by Indiana University for the Hall D forward calorimeter.**
- **Implemented on the JLab FADC250 hardware achieving <300ps timing resolution on 50% pulse crossing time with varied signal heights.**

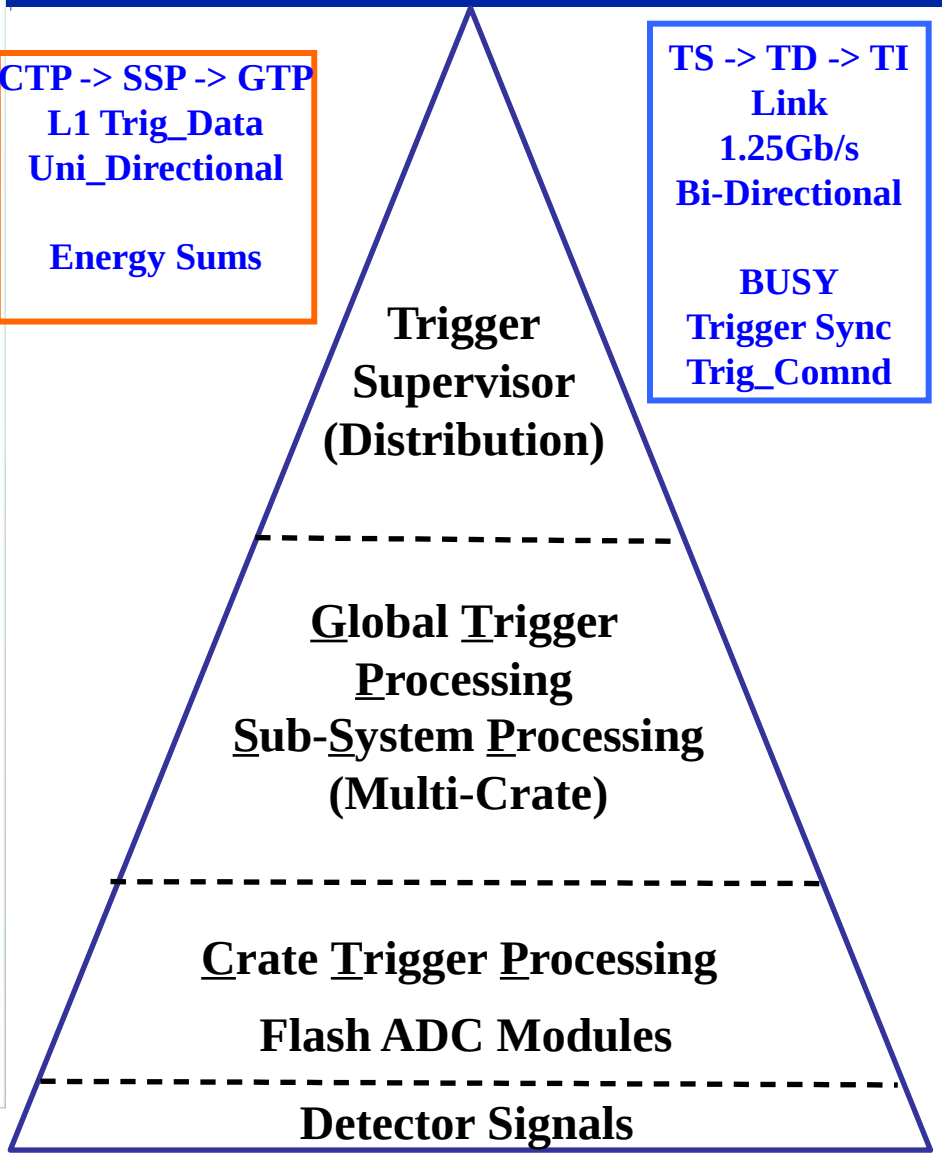**- Resolution allow reliable information to link calorimeter with tagged electron bunch.**
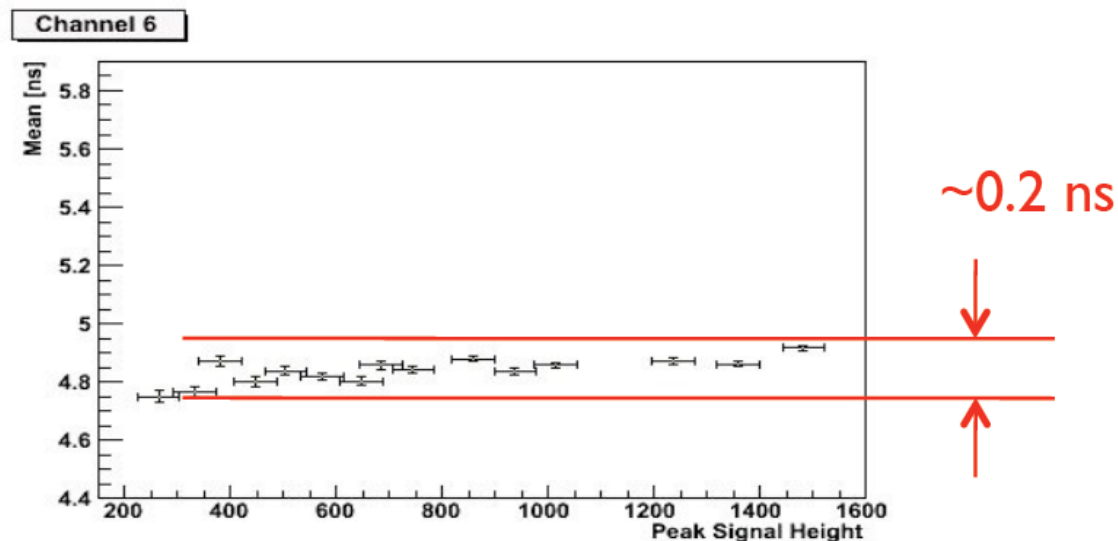


**Typical timing resolution achieved ~1/10 the sample rate. The PMT shape will drive the ADC sample rate & depth requirements.**

# Trigger System Diagram
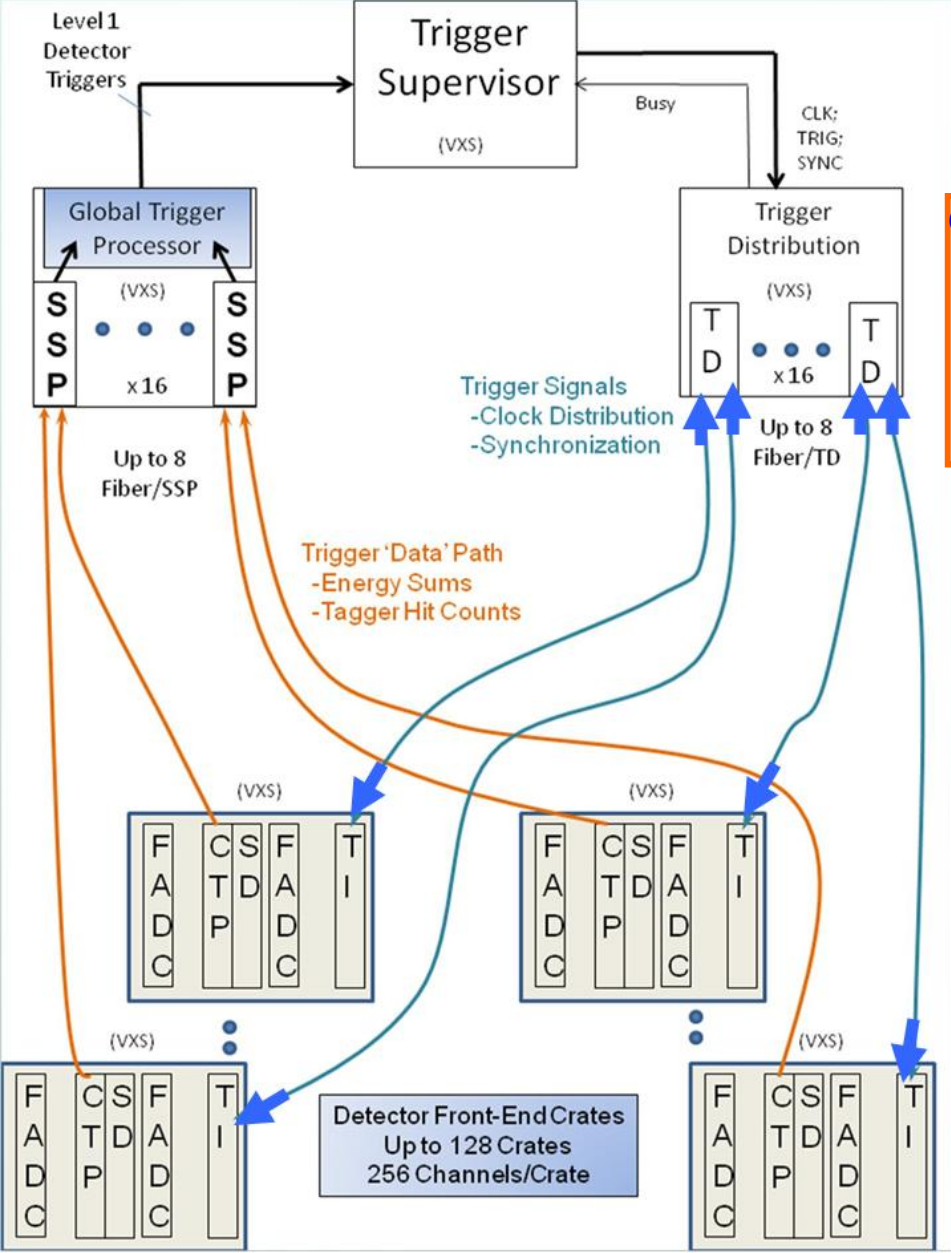


**CTP -> SSP -> GTP**
**L1 Trig_Data**
**Uni_Directional**

**Energy Sums**

**TS -> TD -> TI**
**Link**
**1.25Gb/s**
**Bi-Directional**

**BUSY**
**Trigger Sync**
**Trig_Comnd**

**Trigger Supervisor (Distribution)**

**Global Trigger Processing**
**Sub-System Processing**
**(Multi-Crate)**

**Crate Trigger Processing**

**Flash ADC Modules**

**Detector Signals**

**Thomas Jefferson National Accelerator Facility**

IPR  Nov 27-29, 2012

# F250 Dynamic Noise Suppression

- Added 60 Hz background with increasing amplitude
  - → fan signal to QDC (v792) and FADC
  - → FADC signal gets 'pedestal subtracted' event-by-event by averaging samples before the pulse in digitization window.
- This was done offline, but would be easy to do in firmware.
- Work done by Charlie Dauchess (now undergrad at Va Tech)



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