

# Hall A HRS DAQ

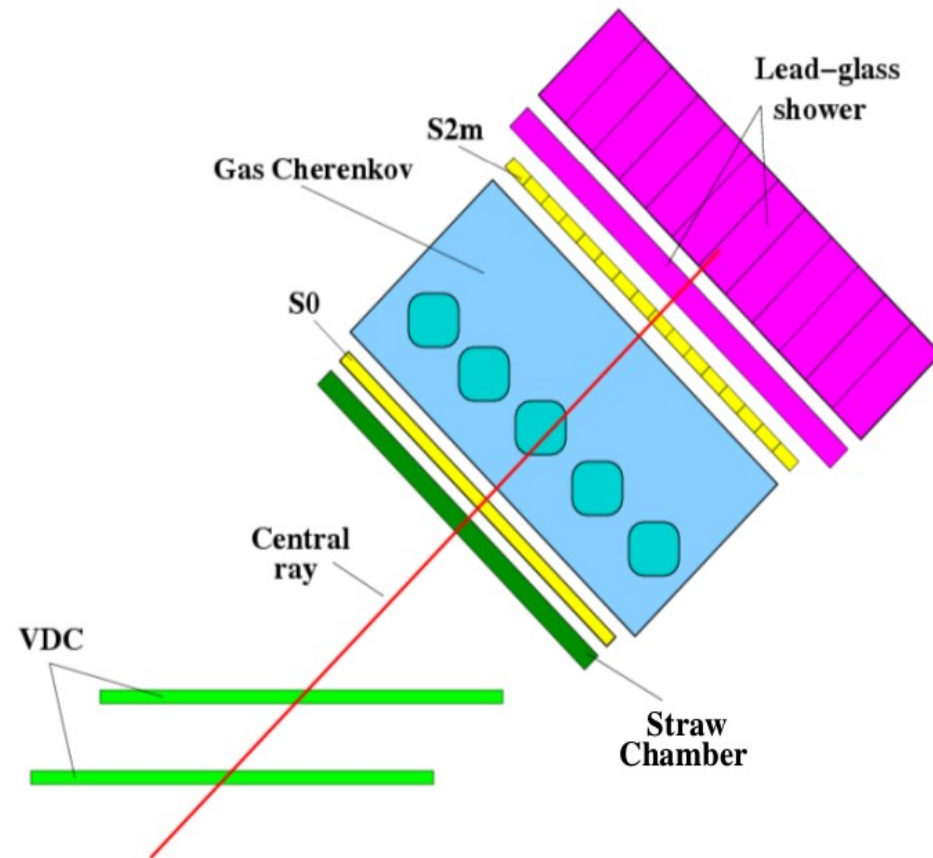
Scott Barcus  
11/22/16

# Overview

- Detector Package
- Trigger Configurations
- Hardware
- Dead Time
- Scalers
- High Voltage

# Detector Package

- VDCs
  - Trajectory and Momentum
- Straw Chambers
  - Track Reconstruction
- S0 and S2m Scintillators
  - Triggers
- Gas Cherenkov
  - PID
- EM Calorimeters
  - PID

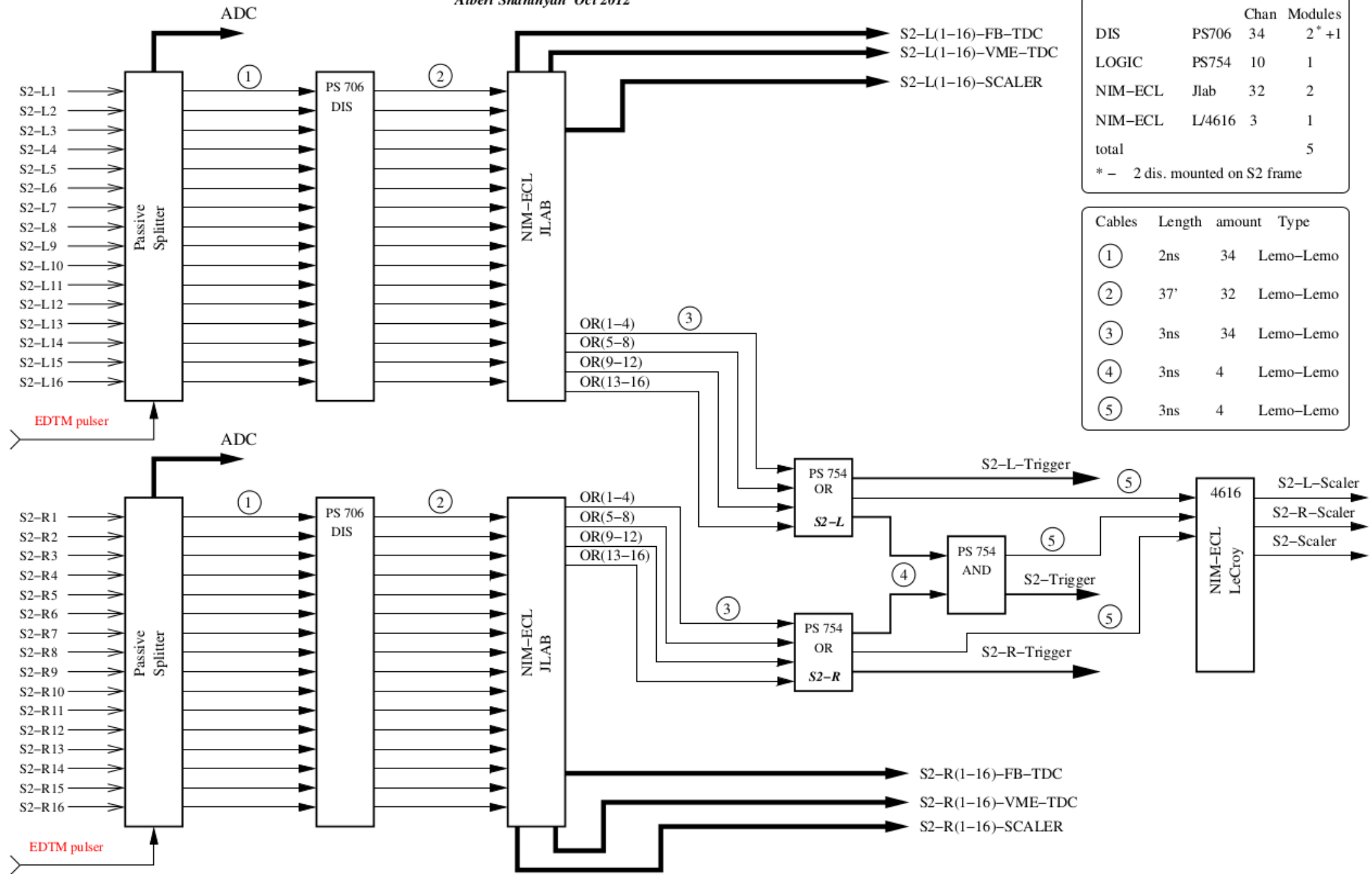


# Triggers

- Two trigger types: detector and pulser.
- S0 has a single paddle and S2m has 16 paddles.
- Gas Cherenkov Trigger
  - Sum signals from 10 PMTs to create trigger (4-4-2).
- Calorimeter Trigger
  - Sum each layer then sum two layers together to form whole calorimeter trigger.
- Cherenkov and Calorimeter Triggers
  - Discriminated → TDCs and scalers
  - Undiscriminated → ADCs

# S2m Trigger

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|                                |        | Chan | Modules           |
|--------------------------------|--------|------|-------------------|
| DIS                            | PS706  | 34   | 2 <sup>+</sup> +1 |
| LOGIC                          | PS754  | 10   | 1                 |
| NIM-ECL                        | Jlab   | 32   | 2                 |
| NIM-ECL                        | L/4616 | 3    | 1                 |
| total                          |        |      | 5                 |
| * - 2 dis. mounted on S2 frame |        |      |                   |

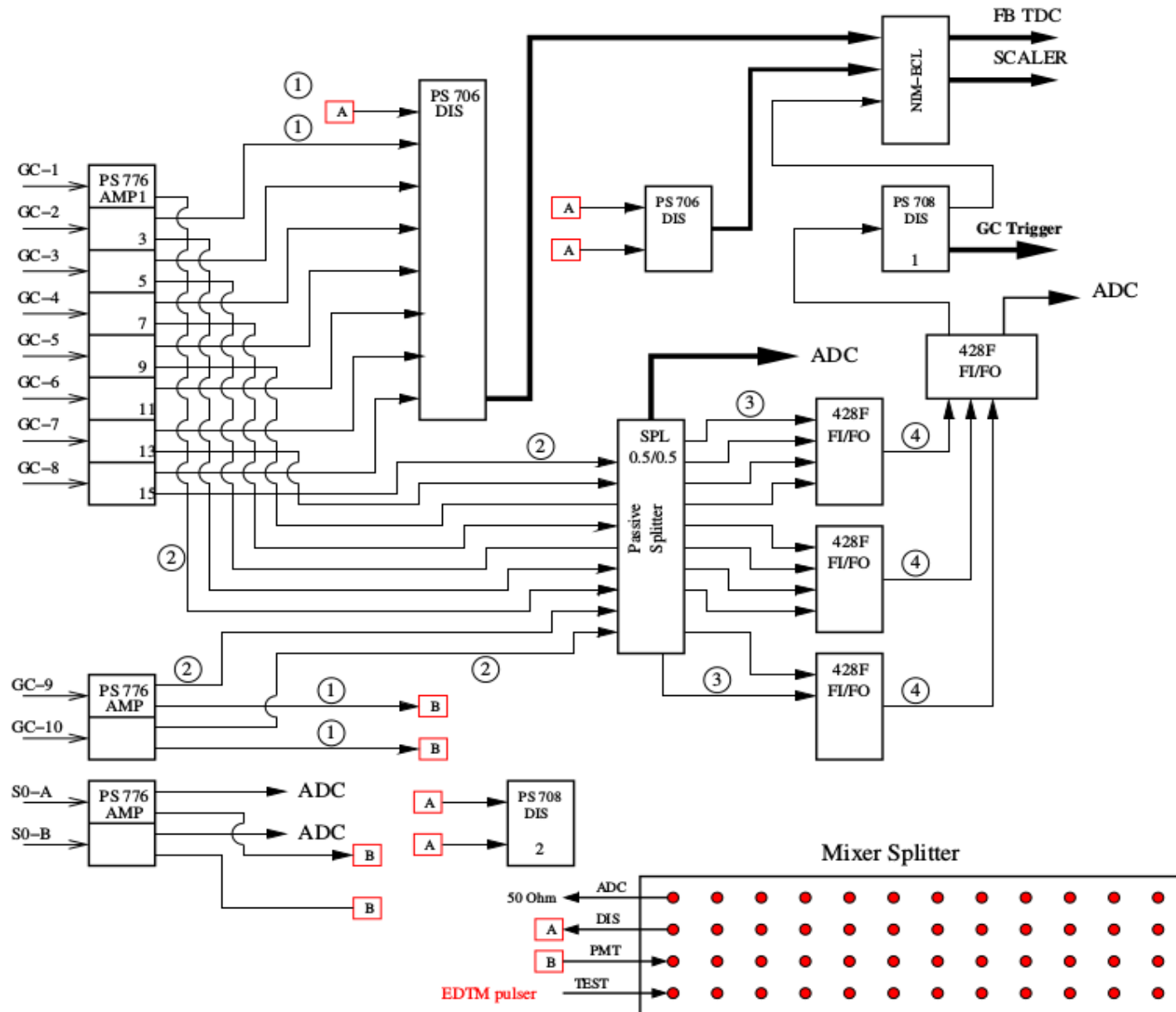
| Cables | Length | amount | Type      |
|--------|--------|--------|-----------|
| ①      | 2ns    | 34     | Lemo-Lemo |
| ②      | 37'    | 32     | Lemo-Lemo |
| ③      | 3ns    | 34     | Lemo-Lemo |
| ④      | 3ns    | 4      | Lemo-Lemo |
| ⑤      | 3ns    | 4      | Lemo-Lemo |

# S0 and Gas Cherenkov Trigger

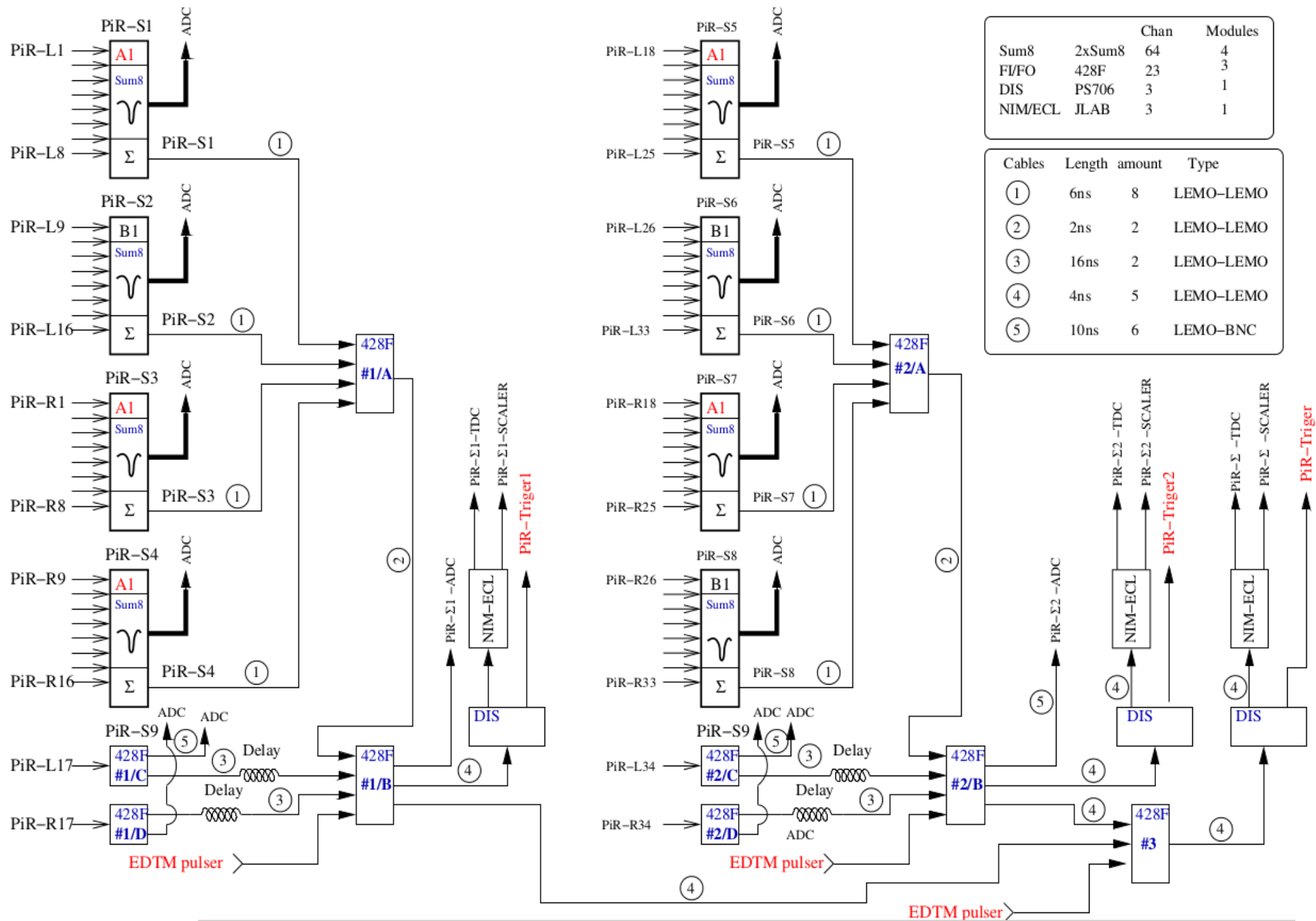
HRS GC&S0 front end Circuit Diagram

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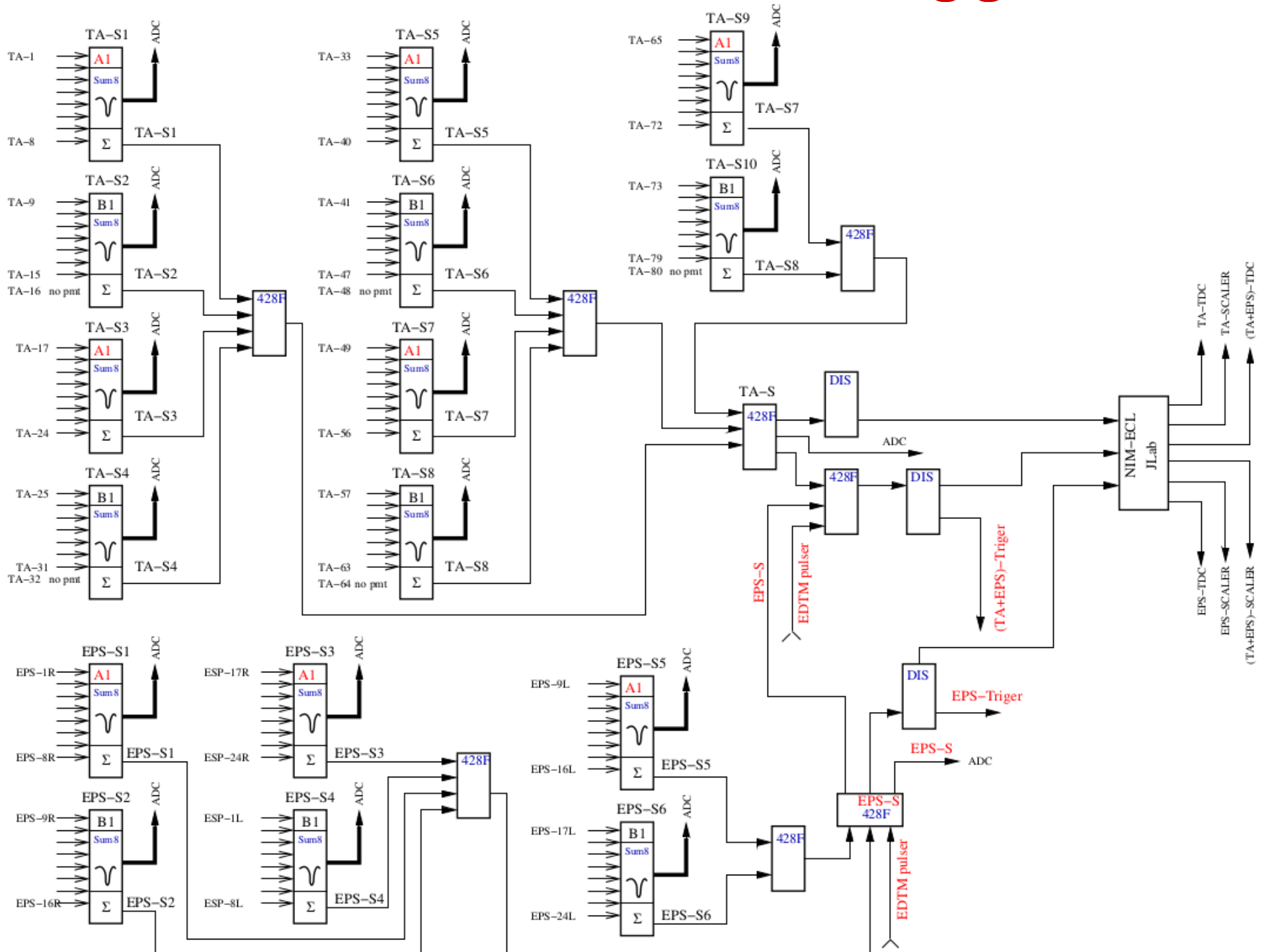
Modify July 2014



# LHRS Calorimeter Trigger



# RHRS Calorimeter Trigger





# Pulse Triggers/MLU

- Mainly used as clocks and for crate synchronization.
  - 1024 Hz clock: NIM module on RHRS.
    - Provides time to calculate scaler rates.
    - Used as trigger for DAQ.
  - 104 kHz (fast) clock: VME module LHRS.
    - Used to check crate synchronization.
- Majority Logic Unit
  - Creates more complicated triggers.
    - Gmp Standard Triggers
    - Single Detector Triggers

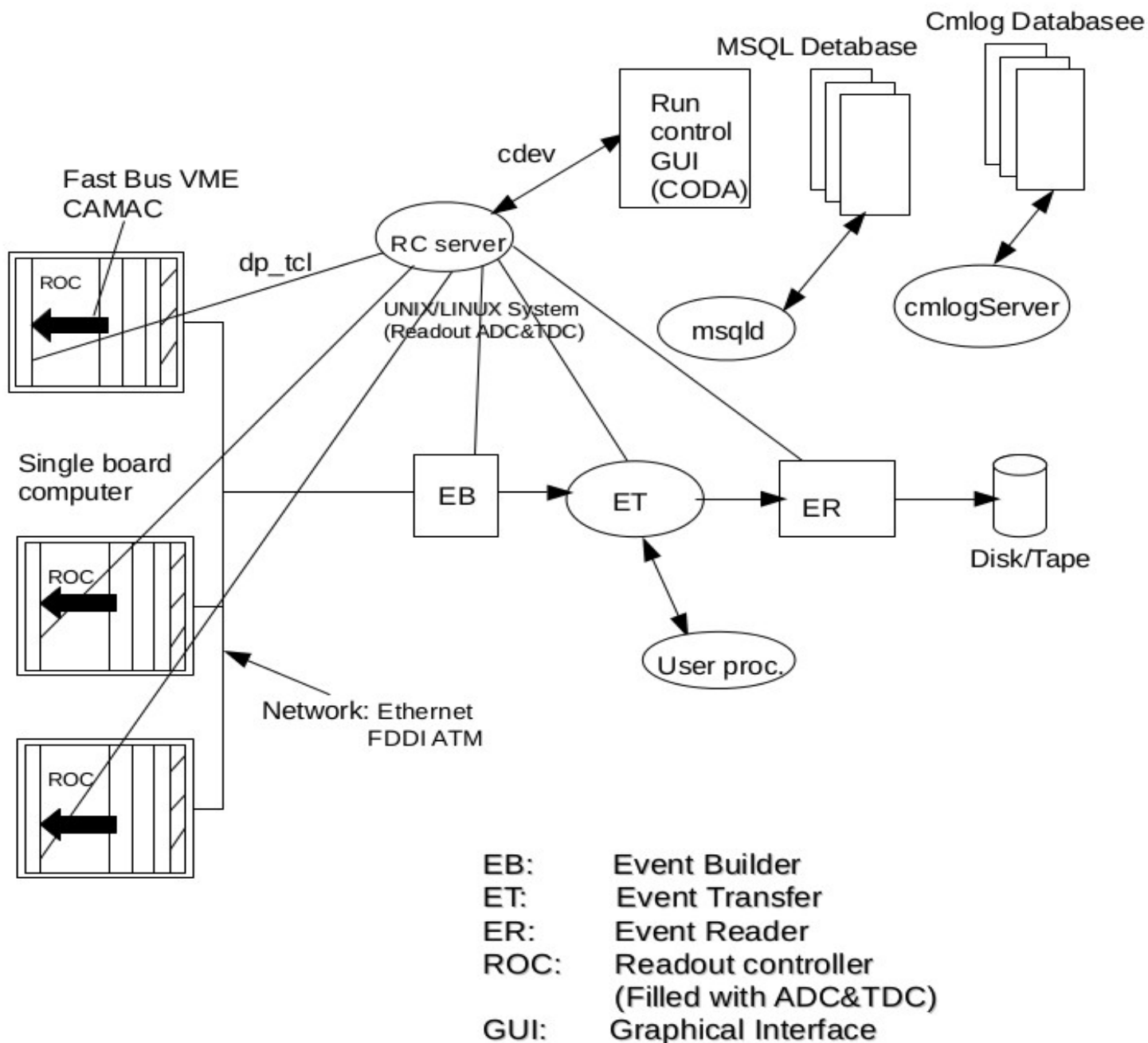
# Hardware Crates

- Read-Out Controllers (ROCs)
  - Three FASTBUS crates and one VME crate per spectrometer.
    - Three FASTBUS crates increase read-out time.
    - VME crates are used as trigger supervisors (TS).
    - TS link triggering systems and ROCs.

| Crate Type | L-HRS | Rack     | R-HRS | Rack     |
|------------|-------|----------|-------|----------|
| VME        | TS11  | HRSH_RR3 | TS0   | HRSE_RR3 |
| FASTBUS    | ROC3  | HRSH_RR4 | ROC1  | HRSE_RR4 |
| FASTBUS    | ROC4  | HRSH_RR4 | ROC2  | HRSE_RR4 |
| FASTBUS    | ROC5  | HRSH_RR4 | ROC6  | HRSE_RR4 |

# CODA Schematic

## Schematic Diagram of DAQ



Note: This whole process takes one event at time.

# TS2, L1A, TI

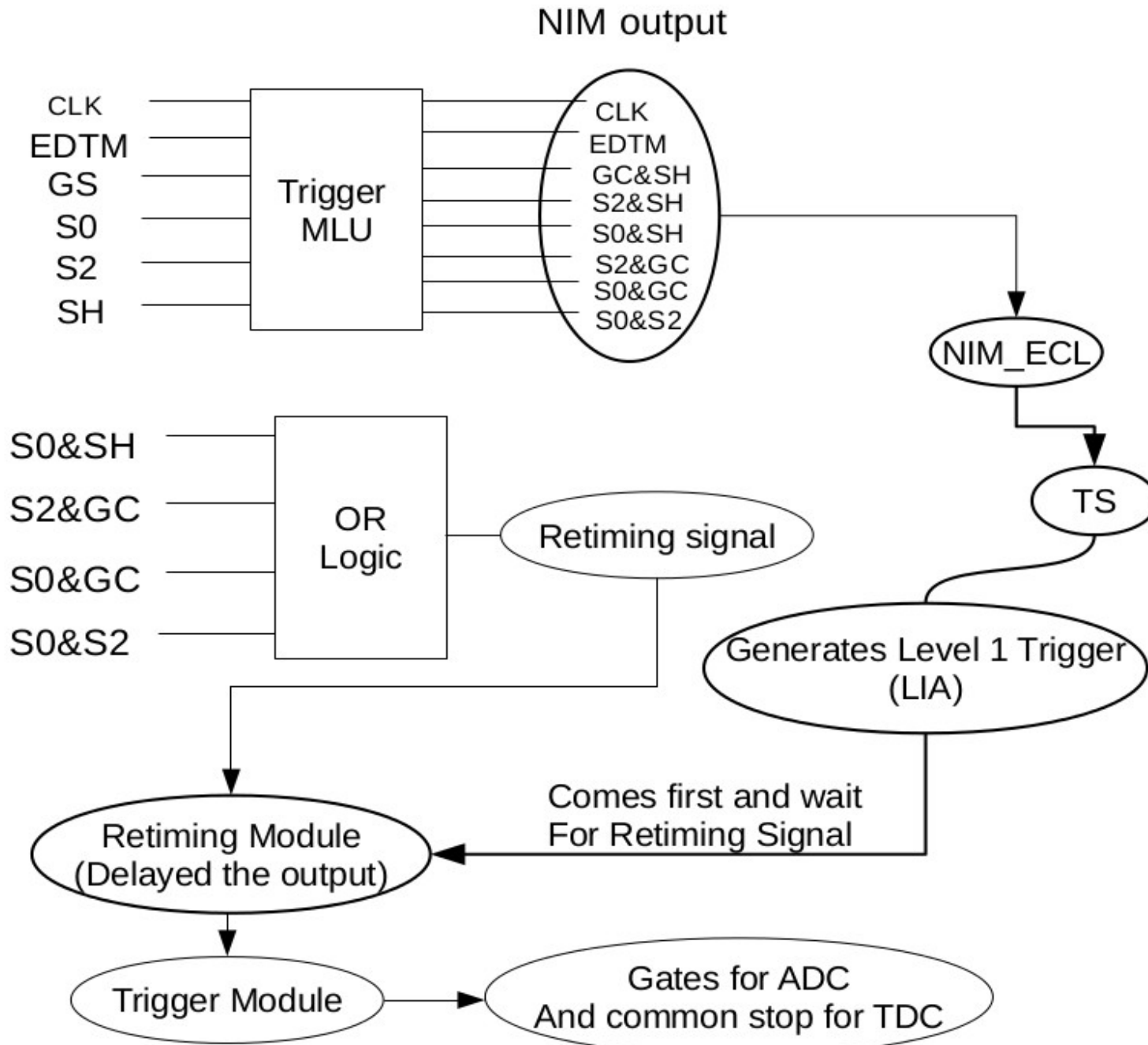
- **TS2 Module**
  - Central control point for DAQ.
  - Can accept and prescale numerous triggers.
  - Provides timing and gating signals for front-end.
    - Level 1 Accept (L1A): Created by input triggers and have precise timing relation to those input triggers.
- **Trigger Interface (TI)**
  - Gives ROCs access to trigger information.

# TM and Re-timing

- Transition Module (TM)
  - Provides interface between TS2 and front-end.
  - Independent mode: Spectrometer gates and stops are created independently for each spectrometer.
  - Paired mode: Gates and stops of both spectrometers are controlled by one arm.
- Re-timing
  - L1A signal from TS2 is usually re-timed relative to detector signals.
  - Now gates and stops are determined by detector signals in coincidence with L1A signals.
  - Re-timing signal (strobe) must fall within L1A time window → delayed ~60 ns.

# Trigger System Schematic

## Schematic for Trigger System



# DAQ Dead Time

- Dead Time

- Mostly from the computer processing data.
- Decrease dead time by prescaling events in TS.
- Electronic dead time from detector response as well. Small below 1 MHz rates.

- Live Time: 
$$L T_i^{\pm} = \frac{ps_i * T_i^{acc, \pm}}{T_i}$$

- Electronic Dead Time Monitor (EDTM)

- Send known pulser signals into S2m, S0, and GC data streams.
- If DAQ is free signals will be accepted → the fraction of missing events is the dead time correction.

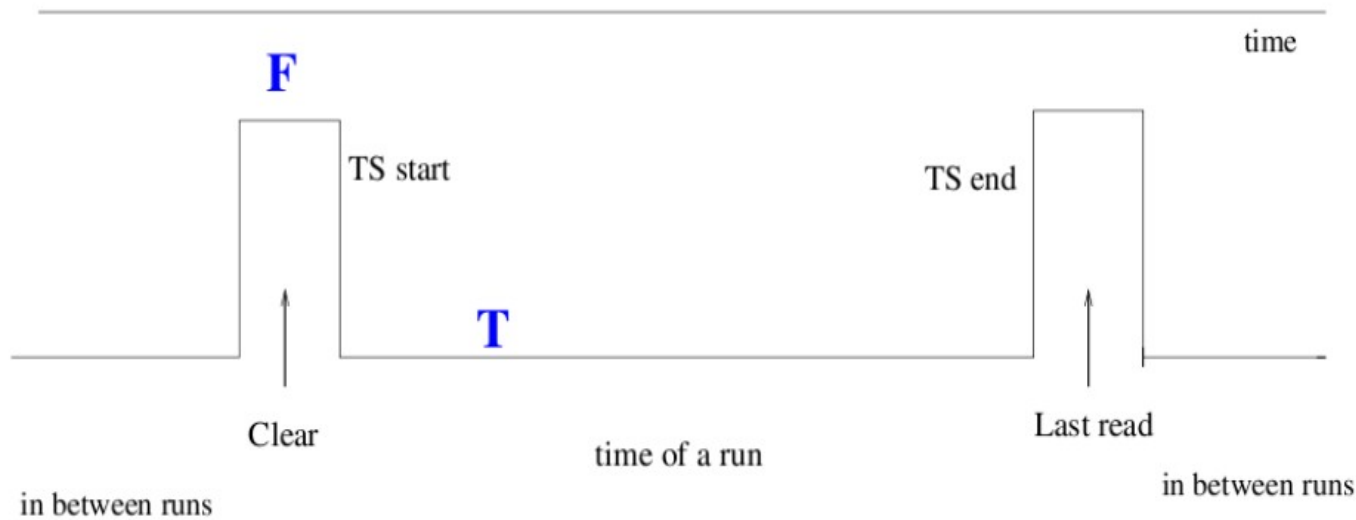
- Buffering events decouples conversion dead time and read-out dead time.

- Run as fast as front-end electronics.
- Read-out time dominates as buffer fills up.

# Scalers

- Count quantities such as charge and triggers.
  - Allows for normalization of experimental data.
  - TM creates the scaler gate from TS control signals.

## Scaler Gate Timing





# High Voltage

- LeCroy 1458 Crates
  - 16 modules each with up to 12 HV channels per module.
  - Controlled by raspberry pi computers.

| Location             | PC   | Configuration |
|----------------------|------|---------------|
| L-HRS (1 crate)      | rpi8 | LEFT          |
| R-HRS (bottom crate) | rpi7 | RIGHT         |
| R-HRS (top crate)    | rpi4 | RIGHT         |

# Questions?

- References

- Sulkosky, Vincent. "Data Acquisition for the Hall A High Resolution Spectrometers During 12 GeV." (n.d.): n. pag. 12 Dec. 2014. Web. 1 Nov. 2016.