

DØ L1Cal Trigger



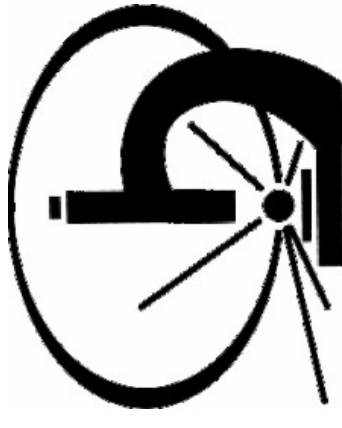
Presented for the D-Zero collaboration by

Dan Edmunds
Michigan State University,
East Lansing, Michigan, USA



**10-th INTERNATIONAL CONFERENCE
ON INSTRUMENTATION FOR COLLIDING BEAM PHYSICS**

Budker Institute of Nuclear Physics
Siberian Branch of Russian Academy of Science
Novosibirsk, Russia



1 March 2008










- ❑ Fermi National Laboratory
 - ❖ Near Chicago, Illinois, USA
 - ❖ Tevatron Collider 2 km in diameter
 - ❖ Proton-Antiproton collisions
 - ❖ New Main Injector for Run II in 2001
 - ❖ 36 Beam Crossings per turn, 396 ns apart
 - ❖ Center-of-mass energy 1.96 TeV
 - ❖ Instantaneous Luminosity $>10^{32} \text{ cm}^{-2} \text{ s}^{-1}$



DØ Collaboration

	AZ U. of Arizona CA U. of California, Berkeley U. of California, Riverside Cal. State U., Fresno Lawrence Berkeley Nat. Lab. FL Florida State U. IL Fermilab U. of Illinois, Chicago Northern Illinois U. Northwestern U. IN Indiana U. U. of Notre Dame IA Purdue U. Calumet Iowa State U. KS U. of Kansas Kansas State U. LA Louisiana Tech U. MD U. of Maryland MA Boston U. Northeastern U. MI U. of Michigan Michigan State U. MS U. of Mississippi NE U. of Nebraska NJ Princeton U. NY Columbia U. U. of Rochester SUNY, Buffalo SUNY, Stony Brook Brookhaven Nat. Lab. OK Langston U. U. of Oklahoma Oklahoma State U. RI Brown U. TX Southern Methodist U. U. of Texas at Arlington Rice U. VA U. of Virginia WA U. of Washington		U. de Buenos Aires		LAFEX, CBPF, Rio de Janeiro State U. do Rio de Janeiro U. Federal do ABC, São Paulo State U. Paulista, São Paulo		U. of Alberta McGill U. Simon Fraser U. York U.		U. of Science and Technology of China, Hefei		U. de los Andes, Bogotá		Charles U., Prague Czech Tech. U., Prague Academy of Sciences, Prague		U. San Francisco de Quito		LPC, Clermont-Ferrand ISN, IN2P3, Grenoble CPPM, IN2P3, Marseille LAL, IN2P3, Orsay LPNHE, IN2P3, Paris DAPNIA/SPP, CEA, Saclay IReS, Strasbourg IPN, IN2P3, Villeurbanne		U. of Aachen Bonn U. U. of Freiburg U. of Mainz Ludwig-Maximilians U., Munich U. of Wuppertal		Panjab U. Chandigarh Delhi U., Delhi Tata Institute, Mumbai		University College, Dublin		KDI, Korea U., Seoul Sungkyunkwan U., Suwan		CINVESTAV, Mexico City		FOM-NIKHEF, Amsterdam U. of Amsterdam / NIKHEF U. of Nijmegen / NIKHEF		JINR, Dubna ITEP, Moscow Moscow State U. IHEP, Protvino PNPI, St. Petersburg		Lund U. RIT, Stockholm Stockholm U. Uppsala U.		Lancaster U. Imperial College, London U. of Manchester
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The DØ Collaboration

Ann Henson, UC Riverside

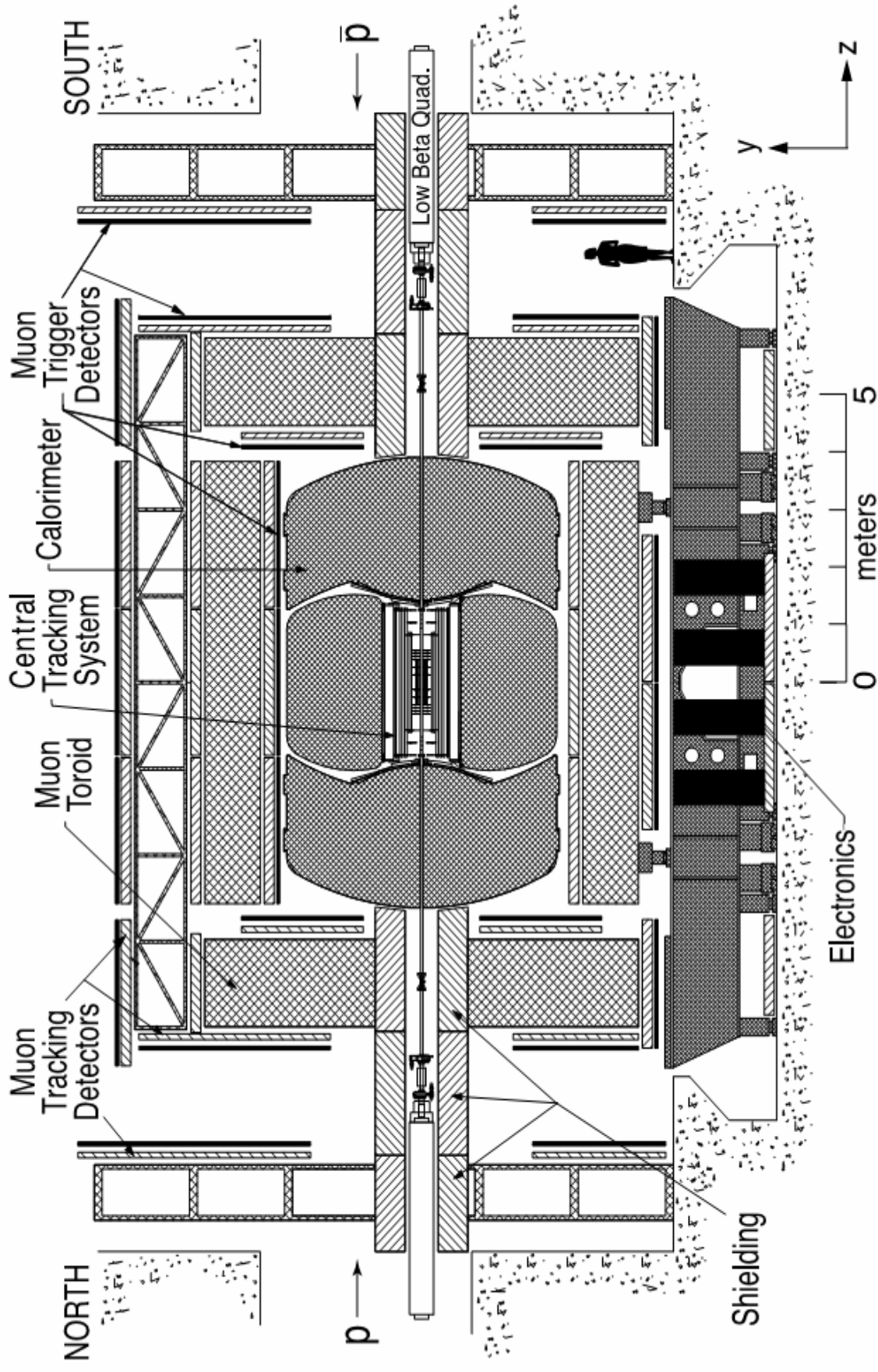
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INSTRUMENTATION FOR COLLIDING BEAM PHYSICS



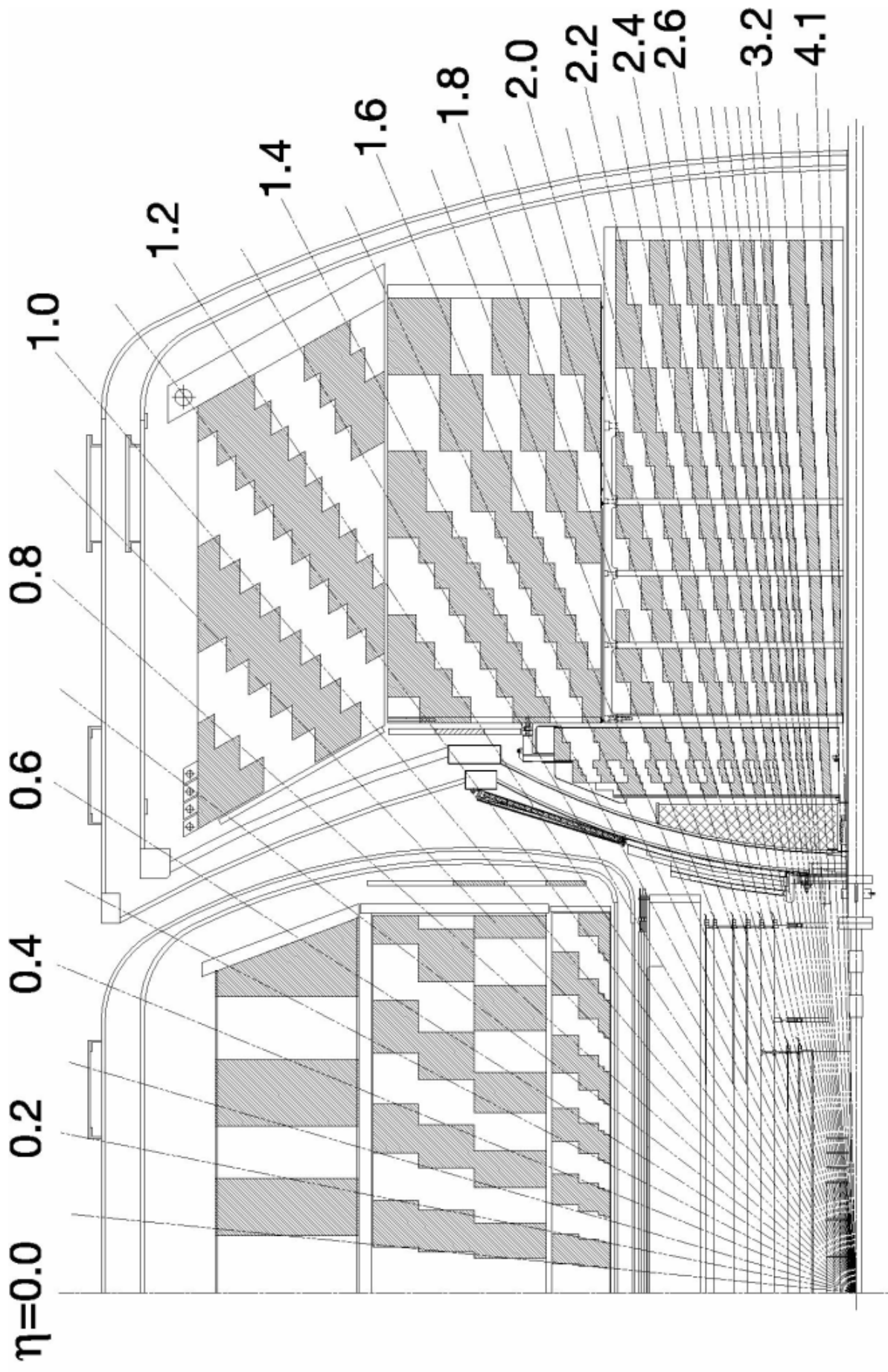


D-Zero Detector(s)





D-Zero Calorimeter

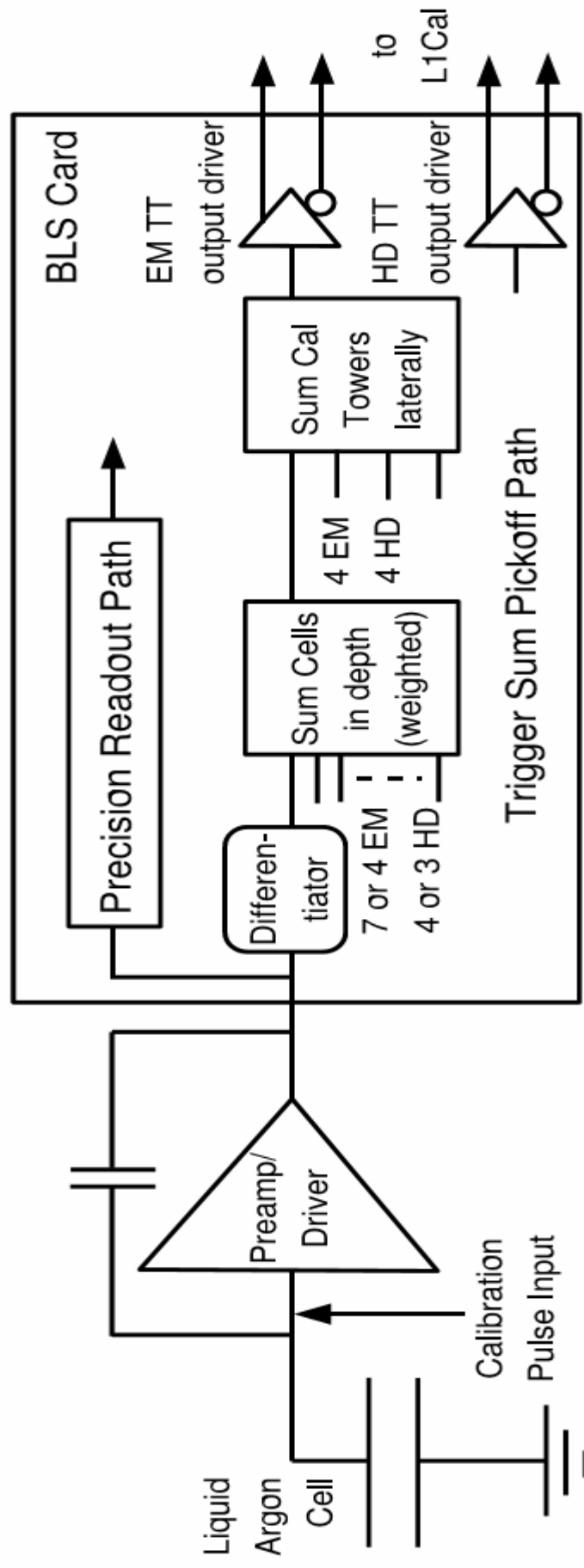


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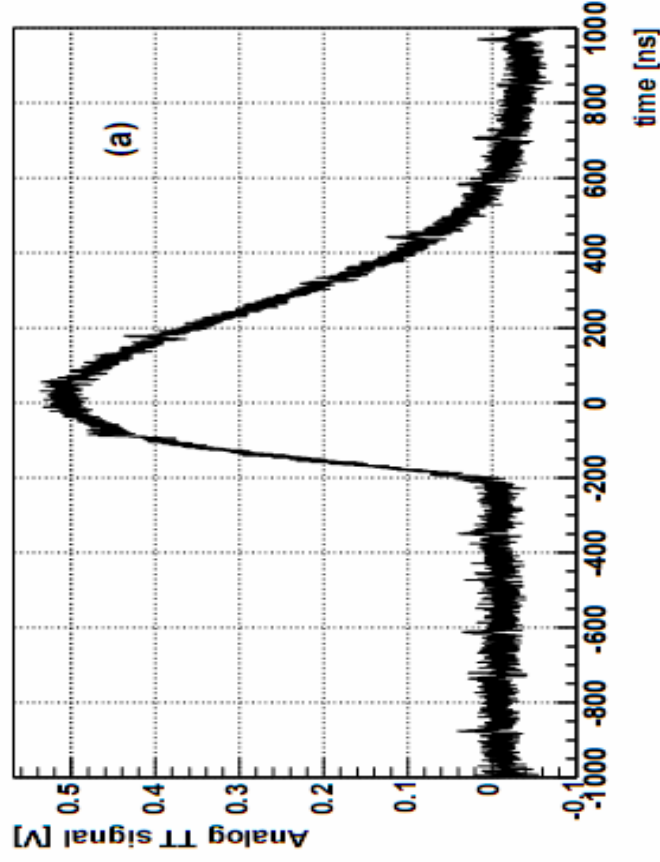


Calorimeter Readout Path

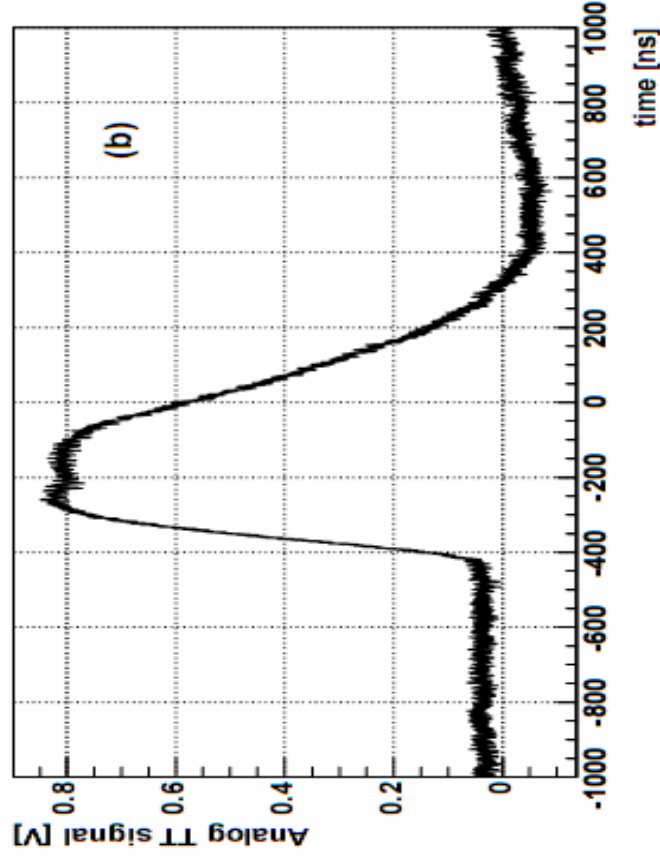




Typical BLS Trigger Tower Analog Signals



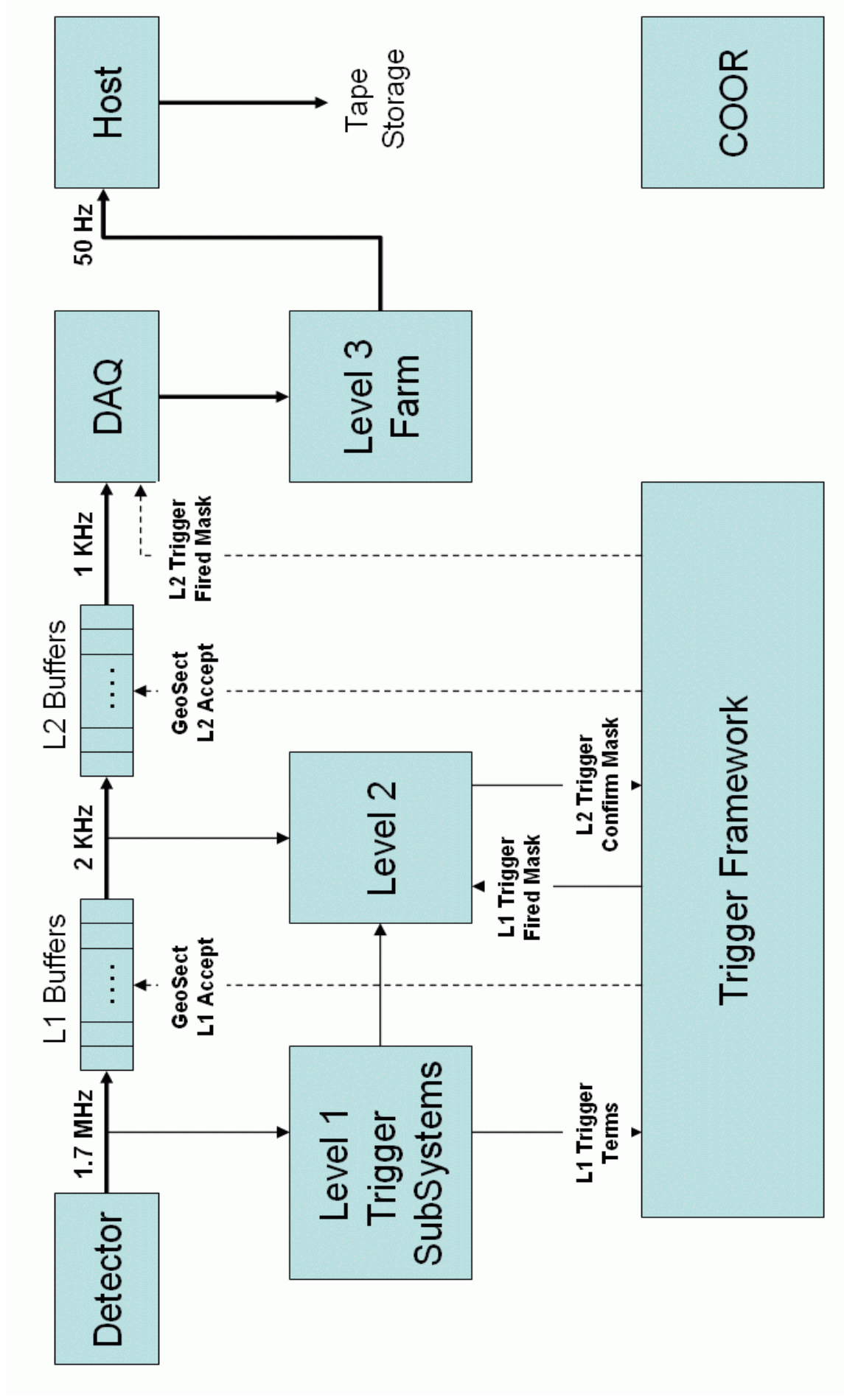
EM



HD

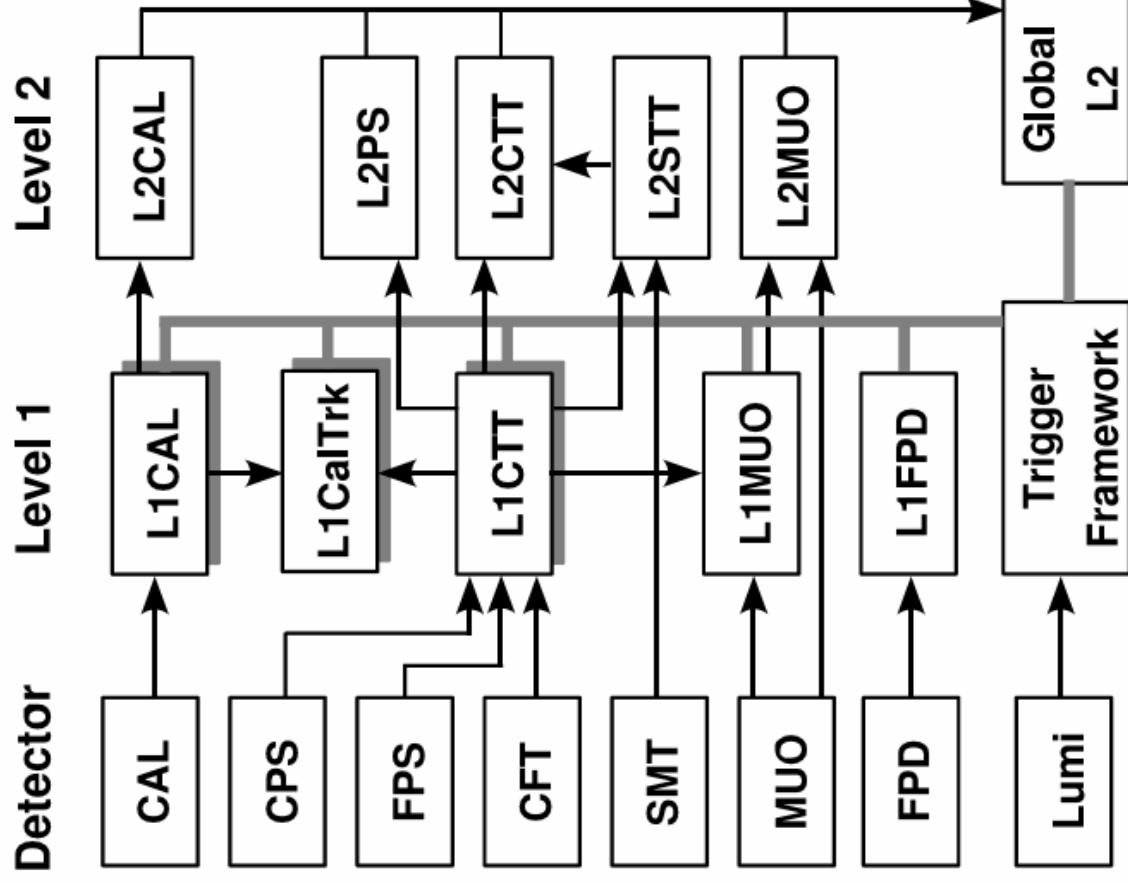


DZero Trigger System



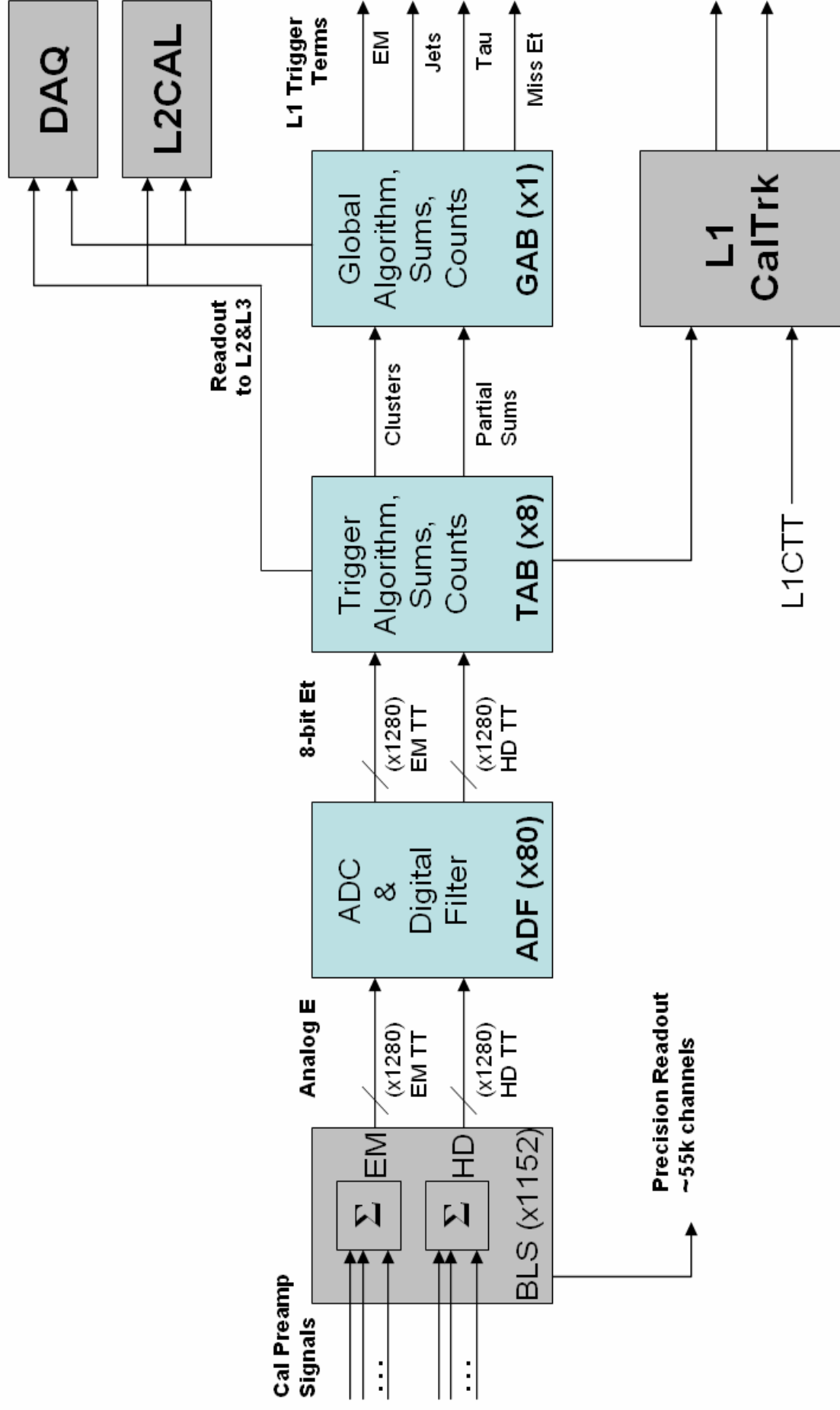


L1 & L2 Trigger Components



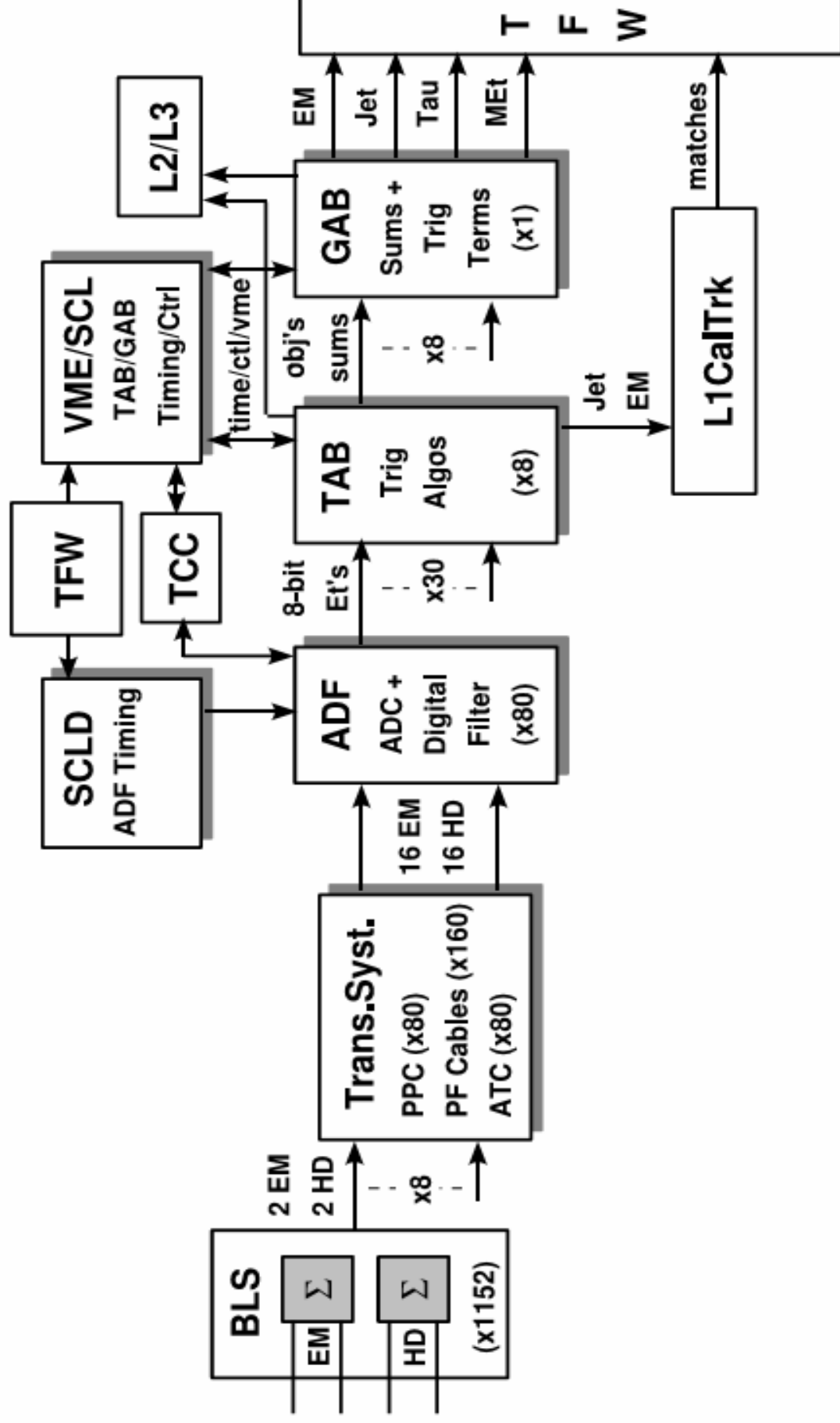


L1Cal Trigger Sub-System



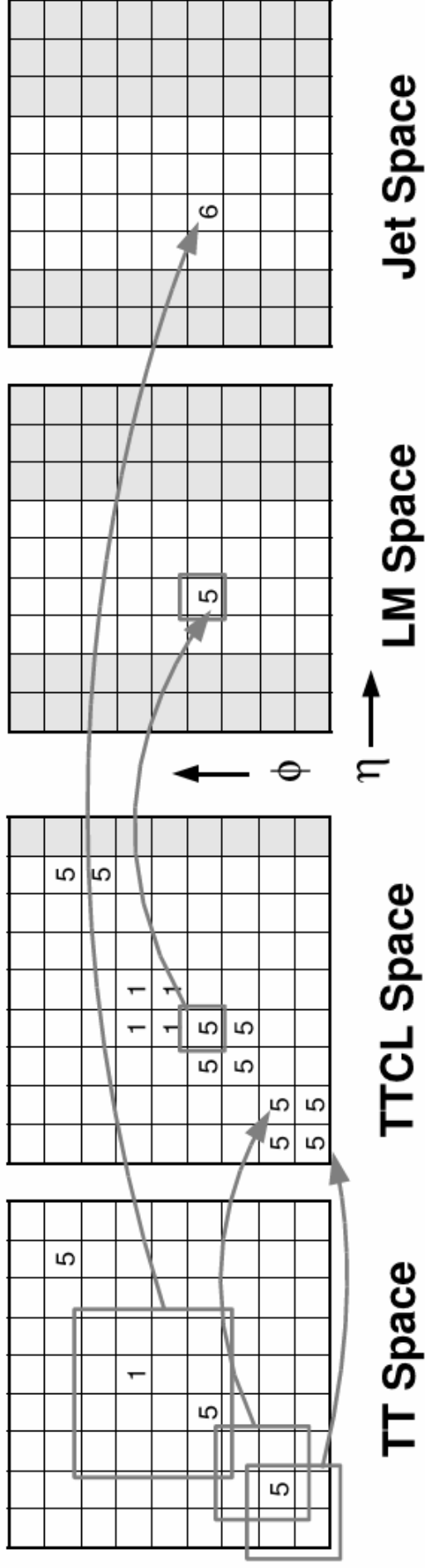


L1Cal Trigger Sub-System





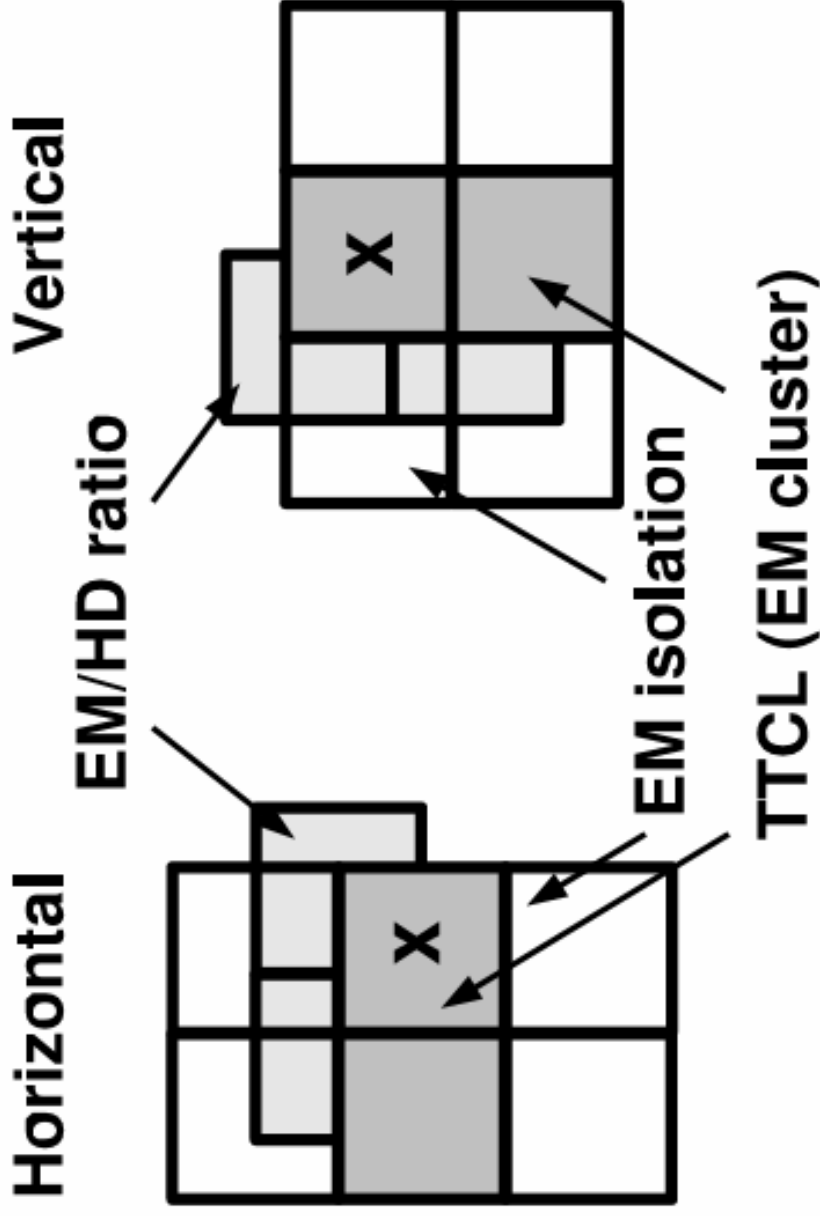
Sliding Window Algorithm and Trigger Tower Clusters



The stages of algorithm flow for the sliding windows algorithm. In this example, which corresponds to the Run IIb Jet algorithm, a 2×2 TT TTCL is used, indexed by the position of its smallest η, ϕ TT. Baseline subtracted TT energies are indicated by numbers, and local maxima are required to be separated by at least 1 TT. Jet objects are defined as the E_T sum of the 4×4 TTs centered on the TTCL. Light gray regions in the diagrams indicate areas for which the object in question cannot be constructed because of boundary effects.



Electron EM/HD Fraction and Isolation Test



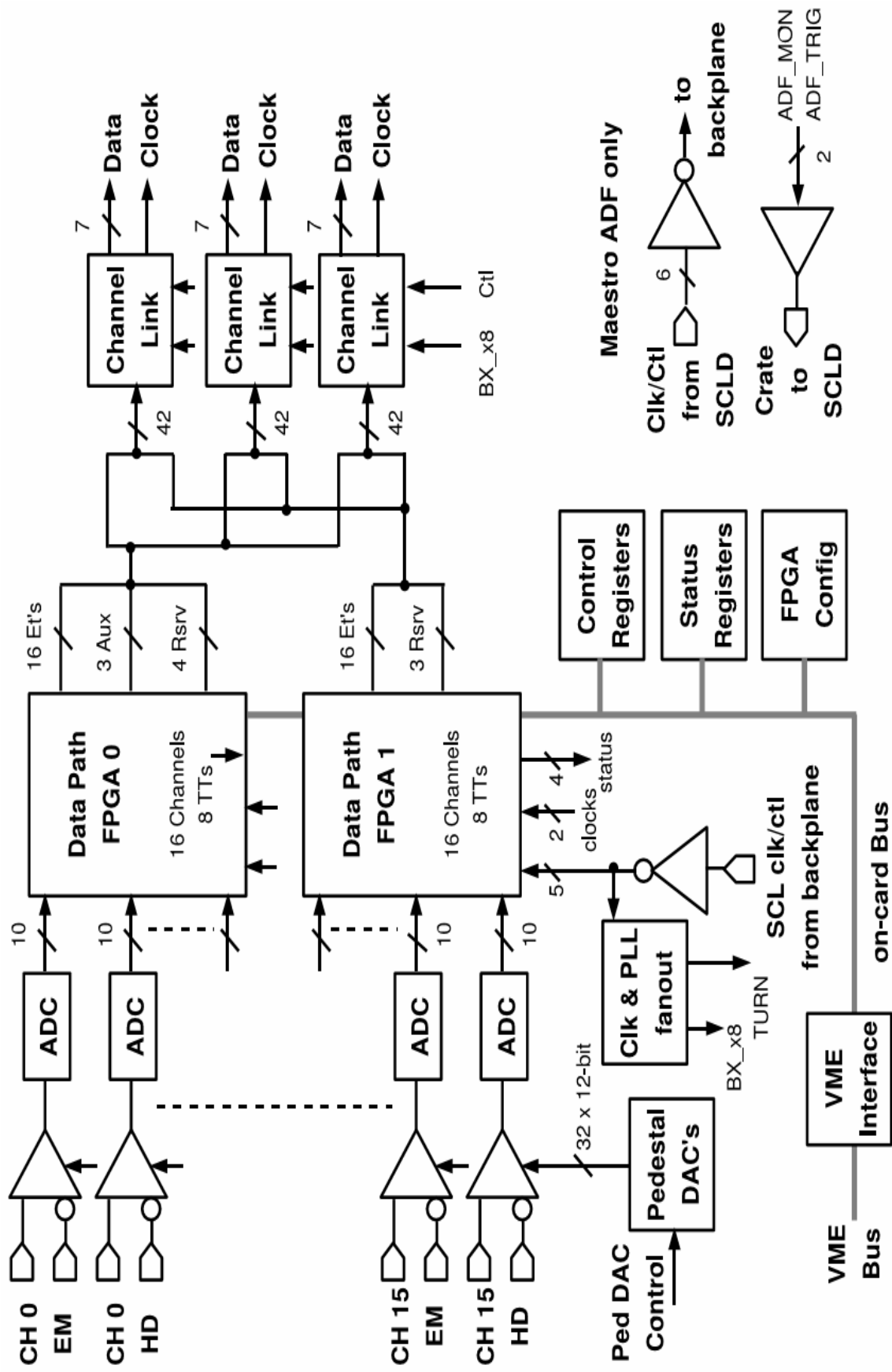


L1Cal Card Count

Board	Input TT Region	Output TT Region	Total Number
PPC	4×4	4×4	80
ATC	4×4	4×4	80
ADF	4×4	4×4	80
SCLD	all	all	1
TAB	40×12	31×4	8
GAB	all	all	1
VME/SCL	all	all	1

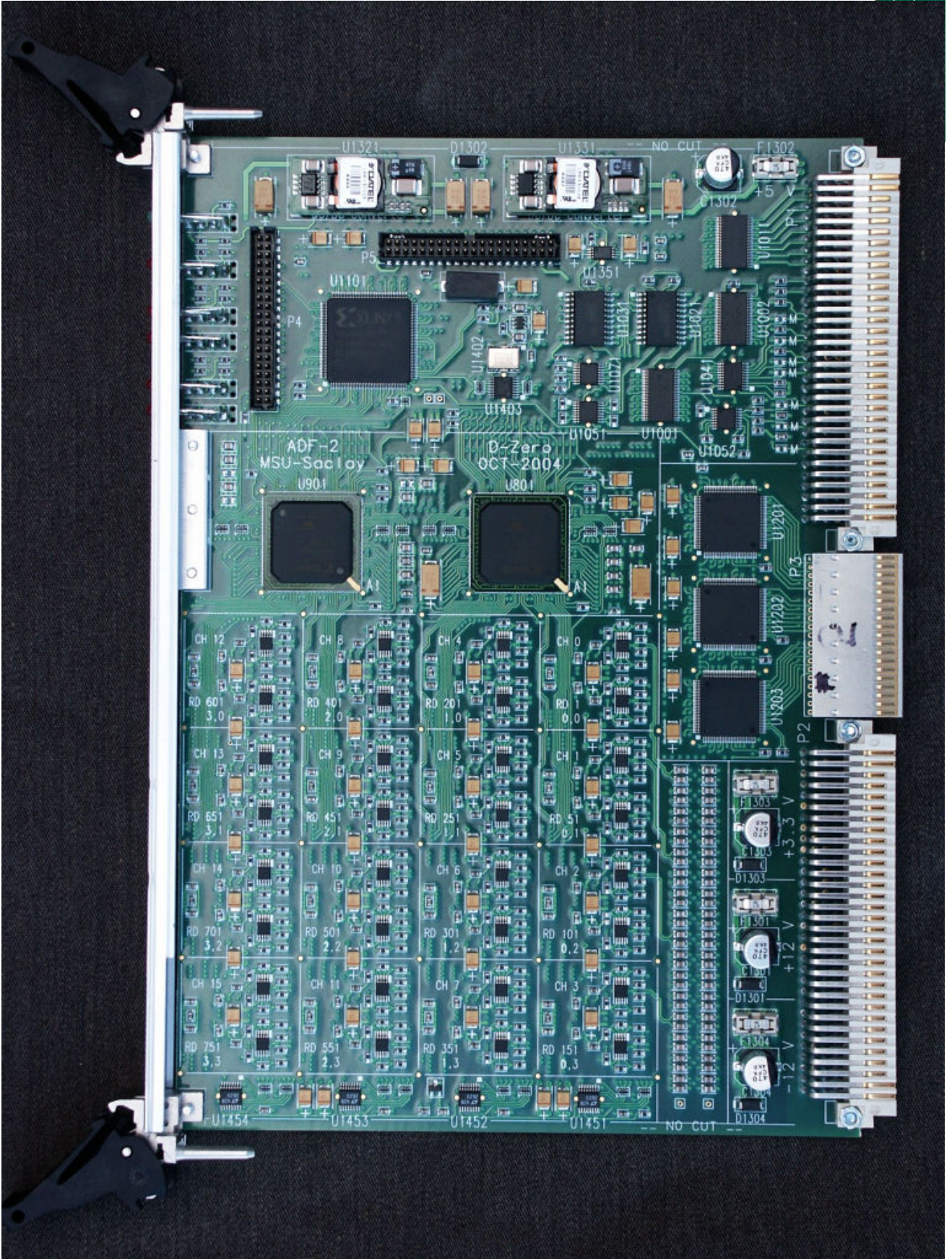


ADF Card



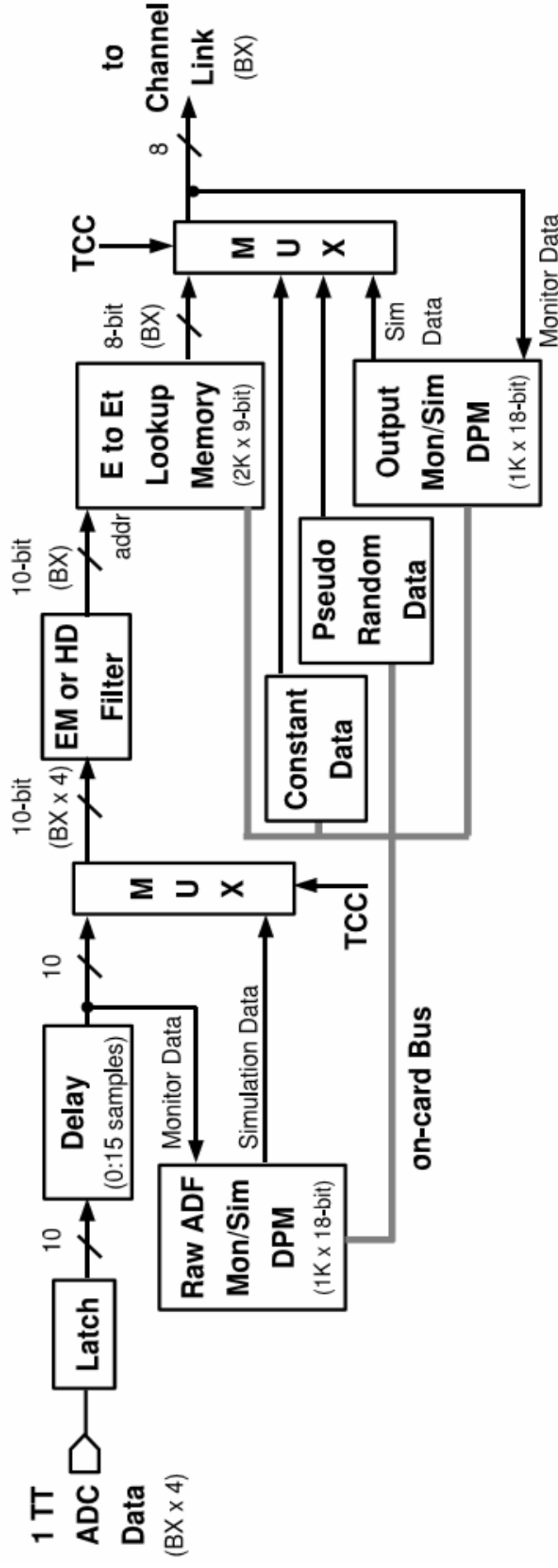


ADF Card



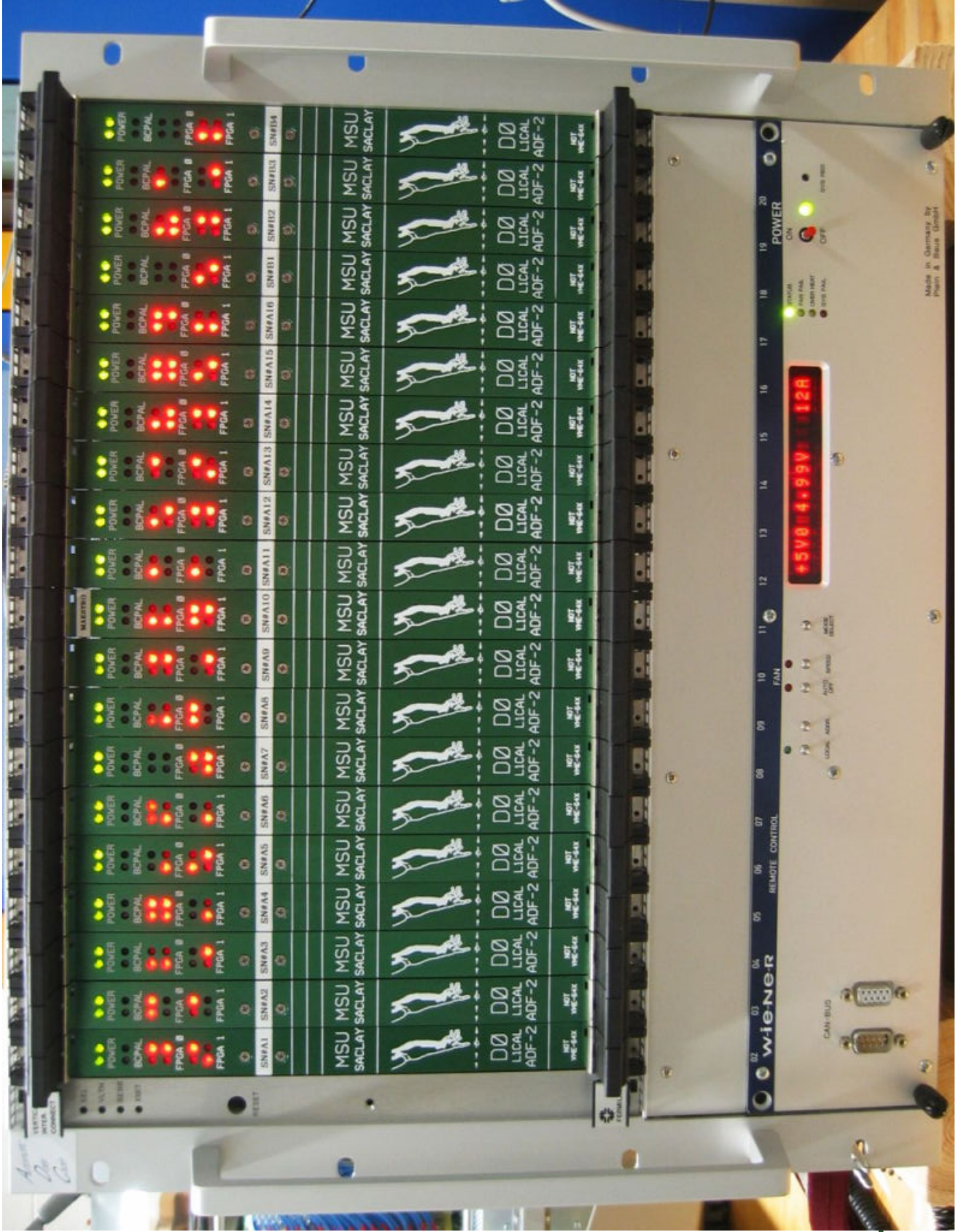


ADF Channel





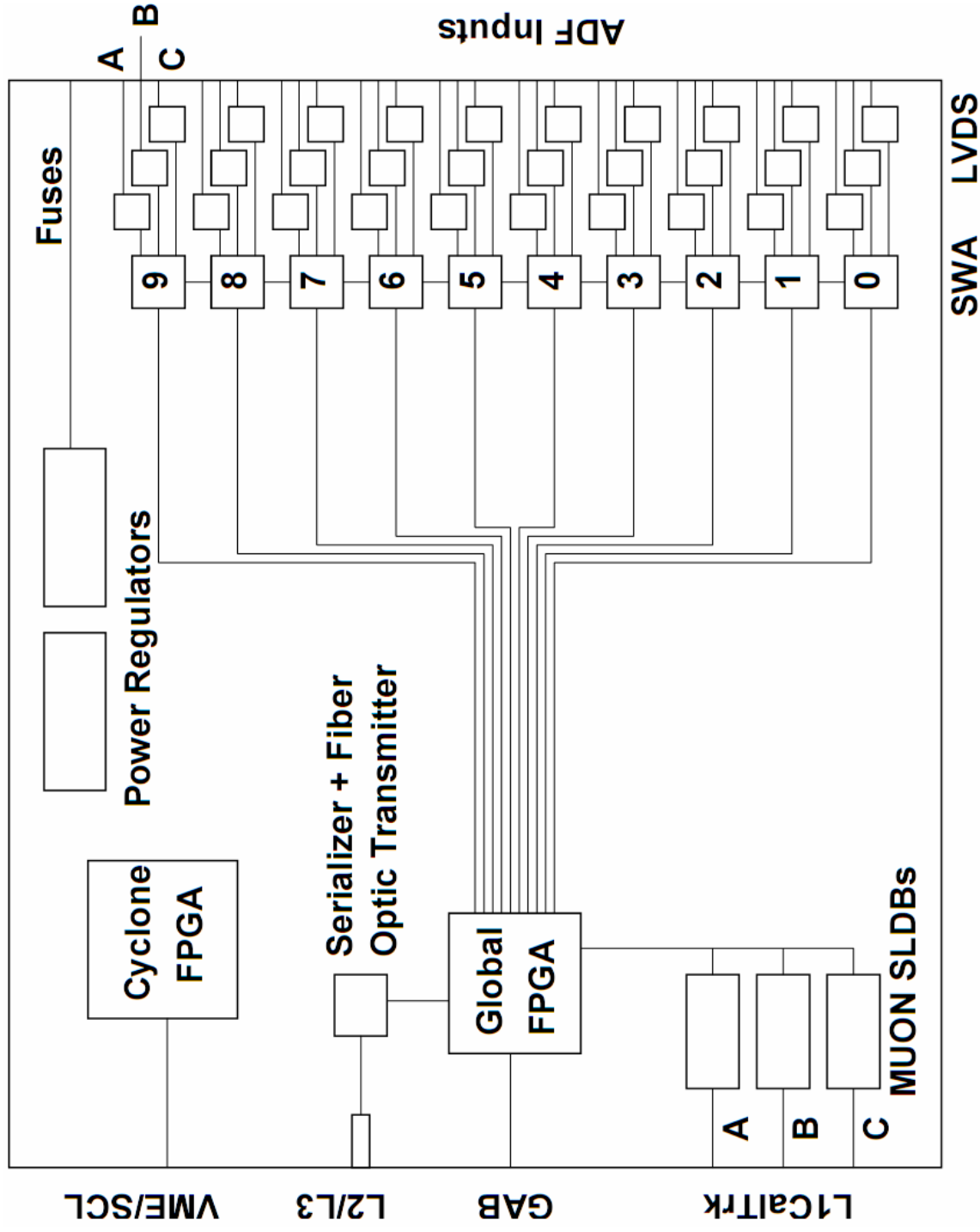
ADF Crate



Daniel

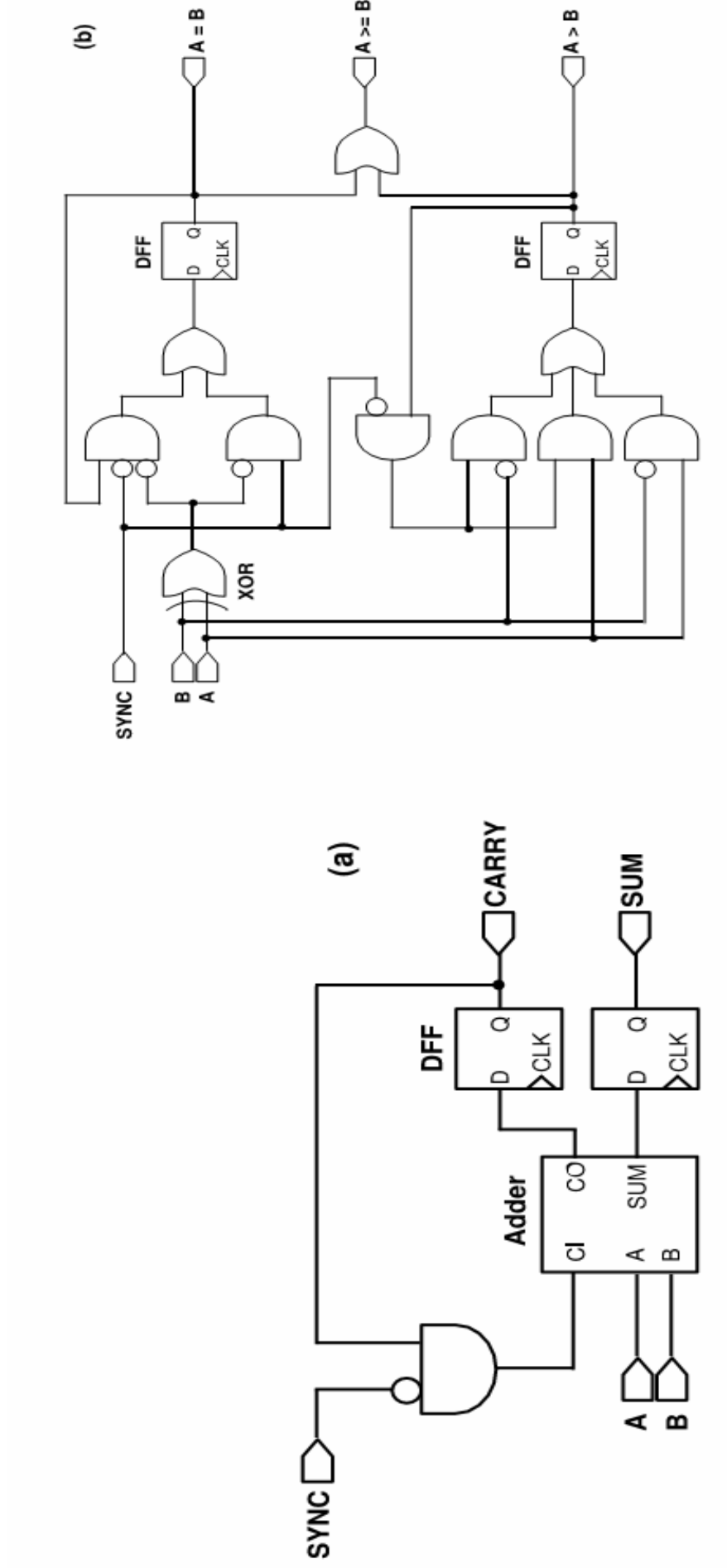


TAB Card





Serial Digital Computation

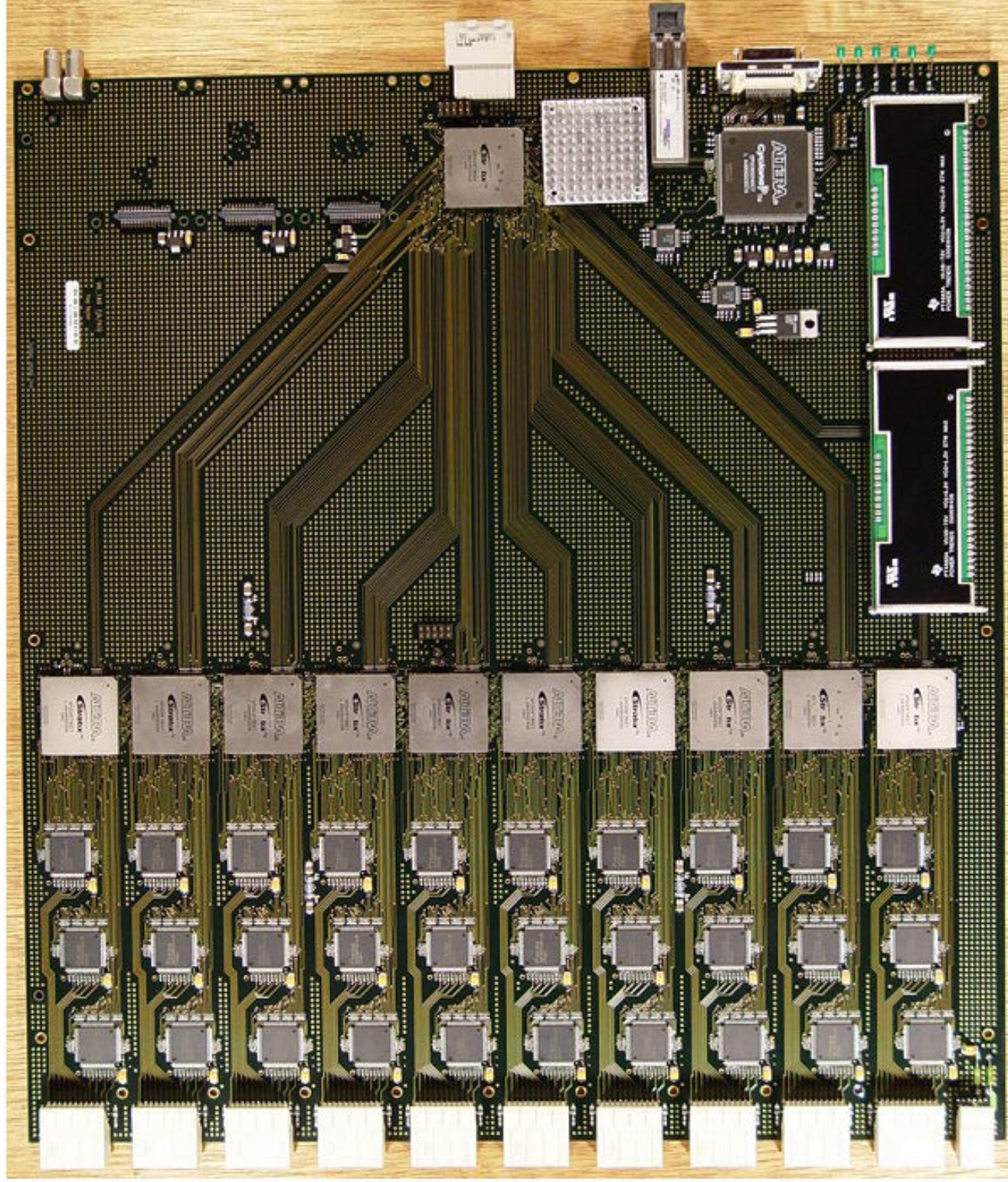


Bit-Serial Adder

Bit-Serial Comparator



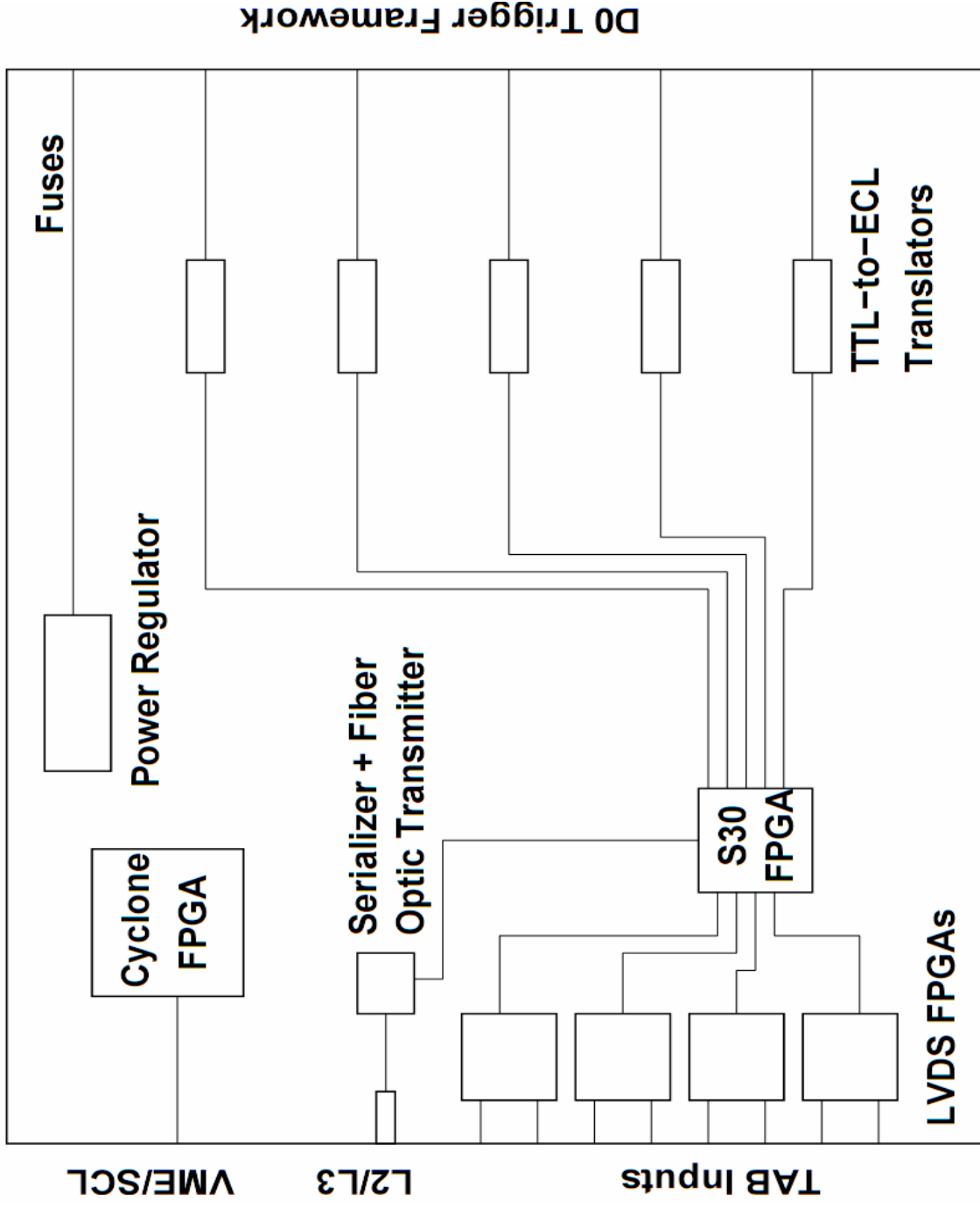
TAB Card



Daniel Edm



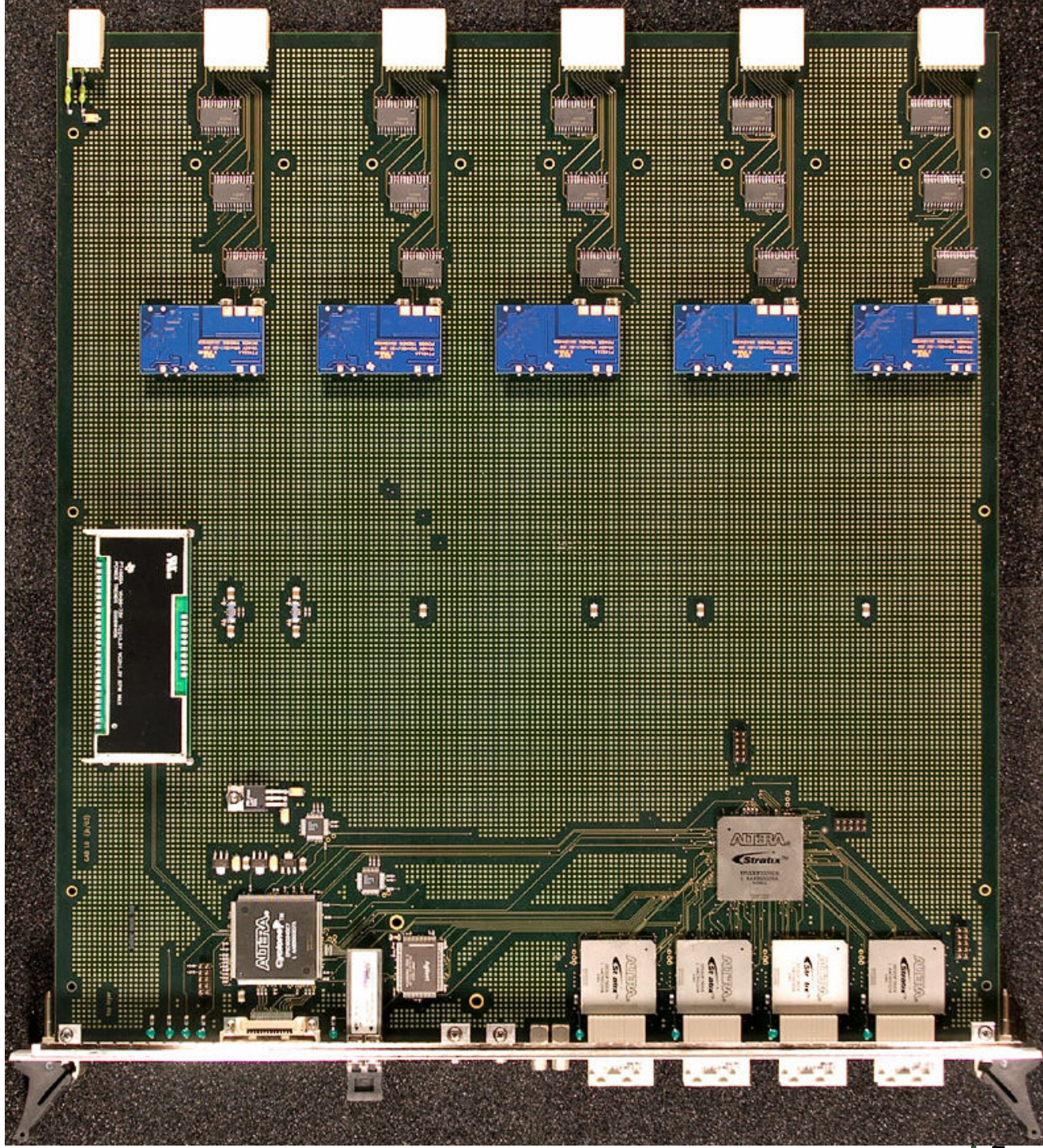
GAB Card



D0 Trigger Framework



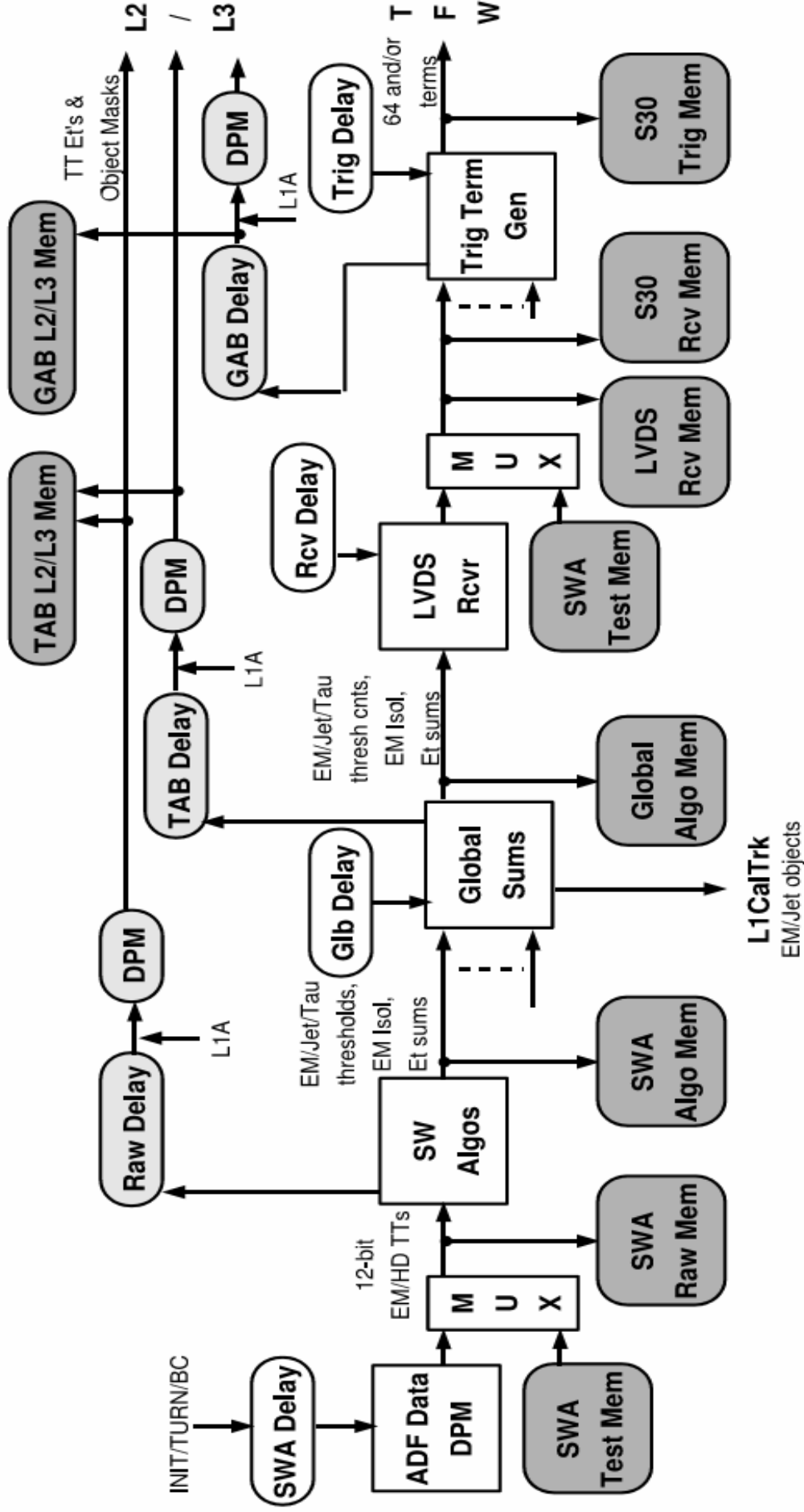
GAB Card



Daniel Edmund



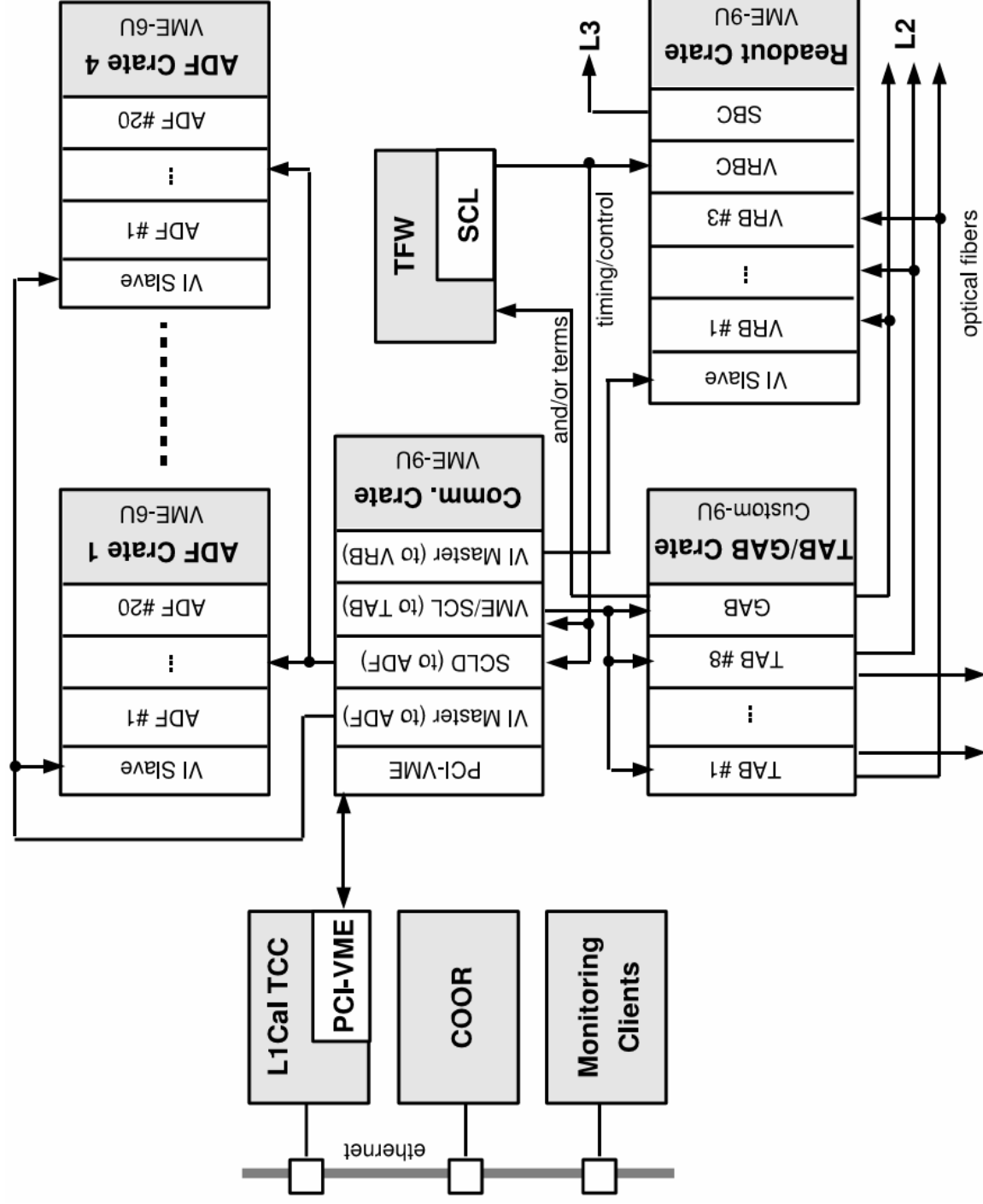
TAB/GAB System Path



Trigger Path, Readout Path, and Test Memories



Control & Communications





L1Cal Trigger Terms

- ❑ 64 Trigger Input Terms to Trigger Framework
 - ❖ 1-, 2-, and 3- Jet Terms
 - ❖ 1-, and 2- EM Terms without Isolation
 - ❖ 1-, and 2- EM Terms with Isolation
 - ❖ Tau Terms
 - ❖ Topological Terms, e.g.
 - No other jet opposite in ϕ
 - Back to Back EM
 - ❖ Total Et Terms
 - ❖ Missing Et Terms



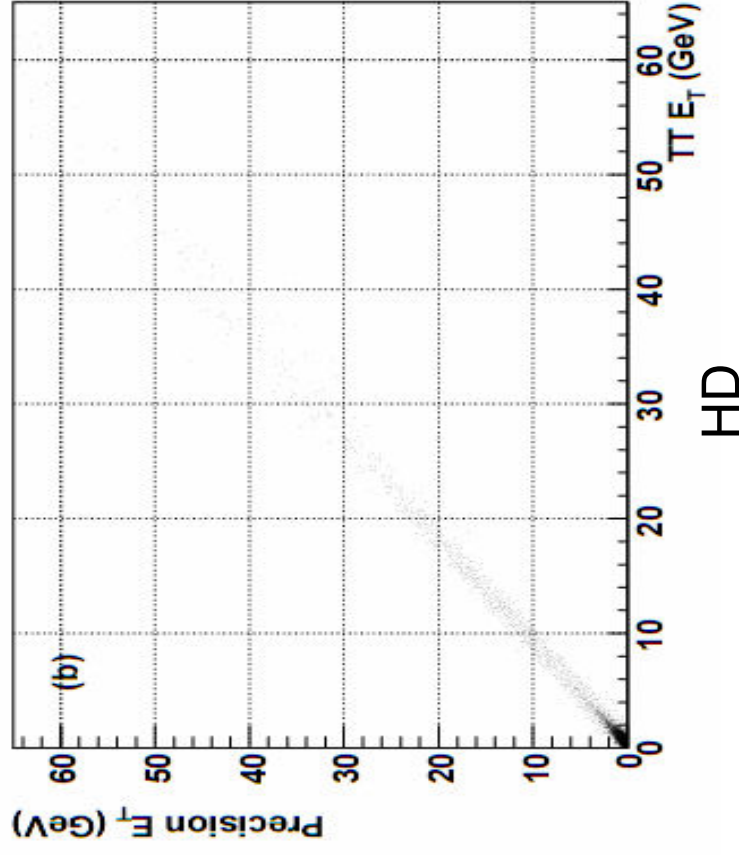
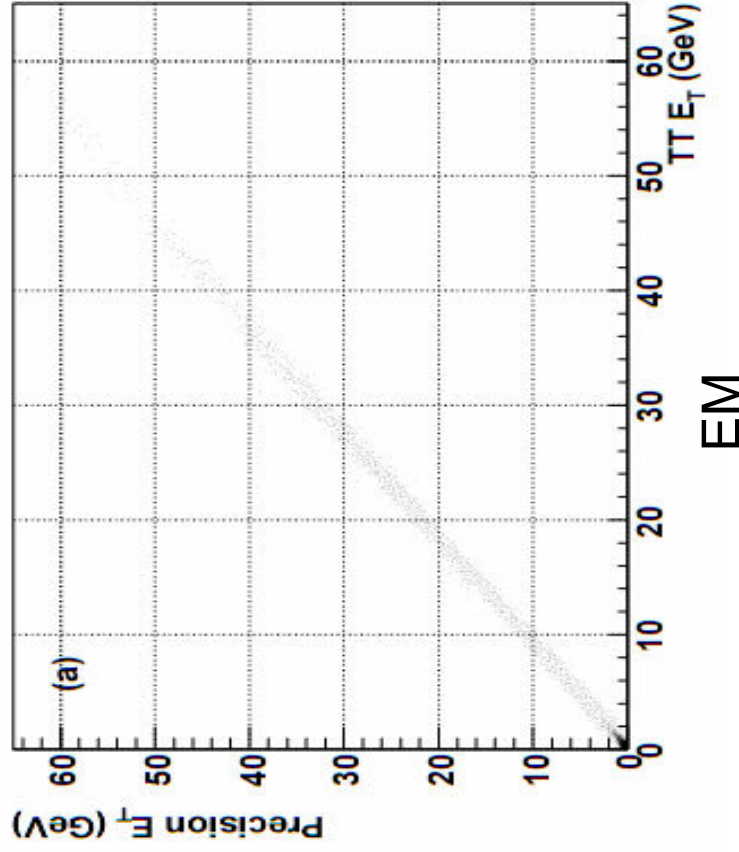
L1Cal Trigger Sub-System

- Example of Trigger Term sent to the Trigger Framework
 - ❖ CSWEM(2,10.,3.2) : ≥ 2 Electron, ≥ 10 GeV, $|\eta| \leq 3.2$
 - ❖ CSWEI(1,16.,3.2) : ≥ 1 Isolated EM, ≥ 16 GeV, $|\eta| \leq 3.2$
 - ❖ CSWJT(1,20.,3.2) : ≥ 1 Jet, ≥ 20 GeV, $|\eta| \leq 3.2$
 - ❖ CSWMET(24.) : Missing Et ≥ 24 GeV

- References:
 - ❖ <http://www.nevis.columbia.edu/~evans/l1cal/>



Calibration



Comparing L1Cal Et to Precision Readout Et



Active Control of Trigger Tower Zero Energy Response

□ L1Cal TCC now automatically tracks and adjusts the **Zero Energy Response** for the **Transverse Energy** of each **Trigger Tower**, at the **output from the ADF cards**, i.e. the **input to the TAB Cards**, to remain at the **design response of 8 counts = 0 GeV**.

- ❖ For each Trigger Tower, the Zero Energy Response Drift is measured from the average of 1008 samples (28 turns) of Live Crossing Energy.
- ❖ If the measured drift is below a programmed threshold (0.5 counts) TCC immediately applies 50% of the correction needed to correct the measured drift.
- ❖ If the measured drift is above the threshold, TCC does not make any correction and waits until the next sample to decide if this is a spike or a step change. At the next snapshot, and if this was a **spike**, do nothing and return to the 50% correction mode for future correction cycles. If this is a **step**, do the full correction instantly and return to the 50% method for future corrections.
- ❖ These decisions are taken on a tower by tower basis.



Acronyms

BLS = Calorimeter Base Line Subtractor Card

ATC = BLS Cable to ADF Transition Card

ADF = ADC and Digital Front-End Card

SCLD = Serial Command Link Distributor

TAB = Trigger Algorithm Board

GAB = Global Algorithm Board

VME/SCL = VME & SCL Control Path to

TAB/GAB