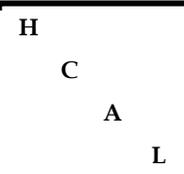




US CMS HCAL Front End Electronics



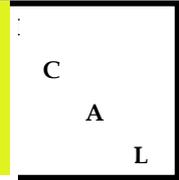
US CMS Front End Electronics

Theresa Shaw, Scott Holm, Sergey Los, Claudio Rivetta,
Anatoly Ronzhin, Julie Whitmore

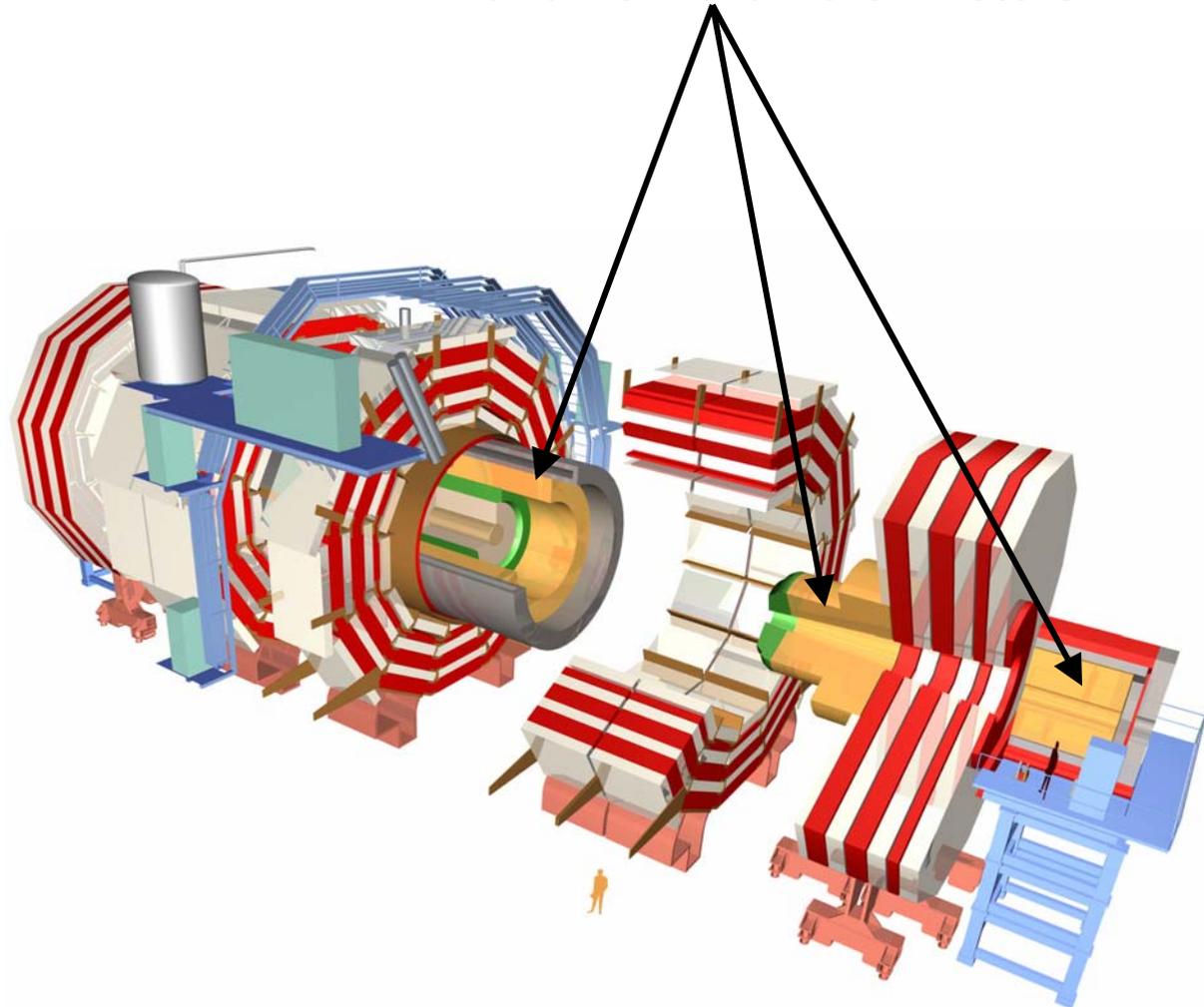
(FNAL)



CMS Hadron Calorimeter



HCAL: Barrel, Endcap, Outer,
and Forward Calorimeters





HCAL: The two HBs have been Completed

H
C
A
L



Ready for installation of readout boxes and burn in 2004.
Insertion in vacuum tank: Jan 2005.



HCAL: The two HEs have been Completed

H
C
A
L

HE+1

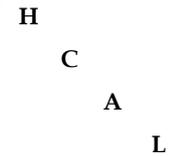


HE-1





HCAL :HF Fibre Insertion



**All 36 wedges complete
by 15 Nov 2003 (instead
of Apr 2004 target).**

Cylindrical support structure + table manufactured in Iran and on schedule.

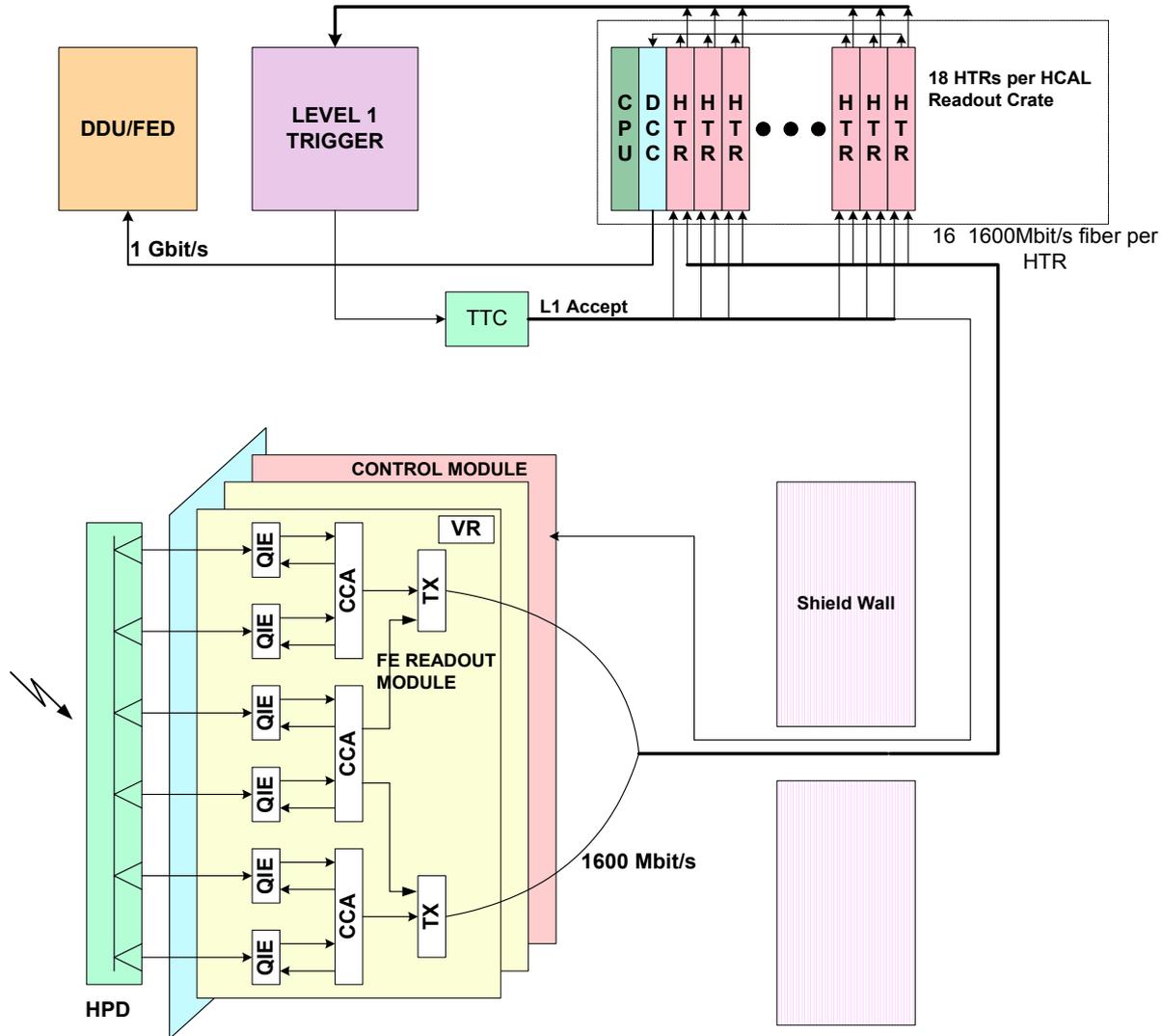
Mount HF wedges on final support structure in 2004.

2 wedges tested in beam (summer 2003).



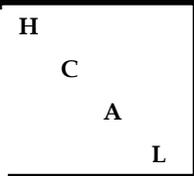
HCAL FE/DAQ Electronics

H
C
A
L





6 Channel FE Board



Custom ASICs

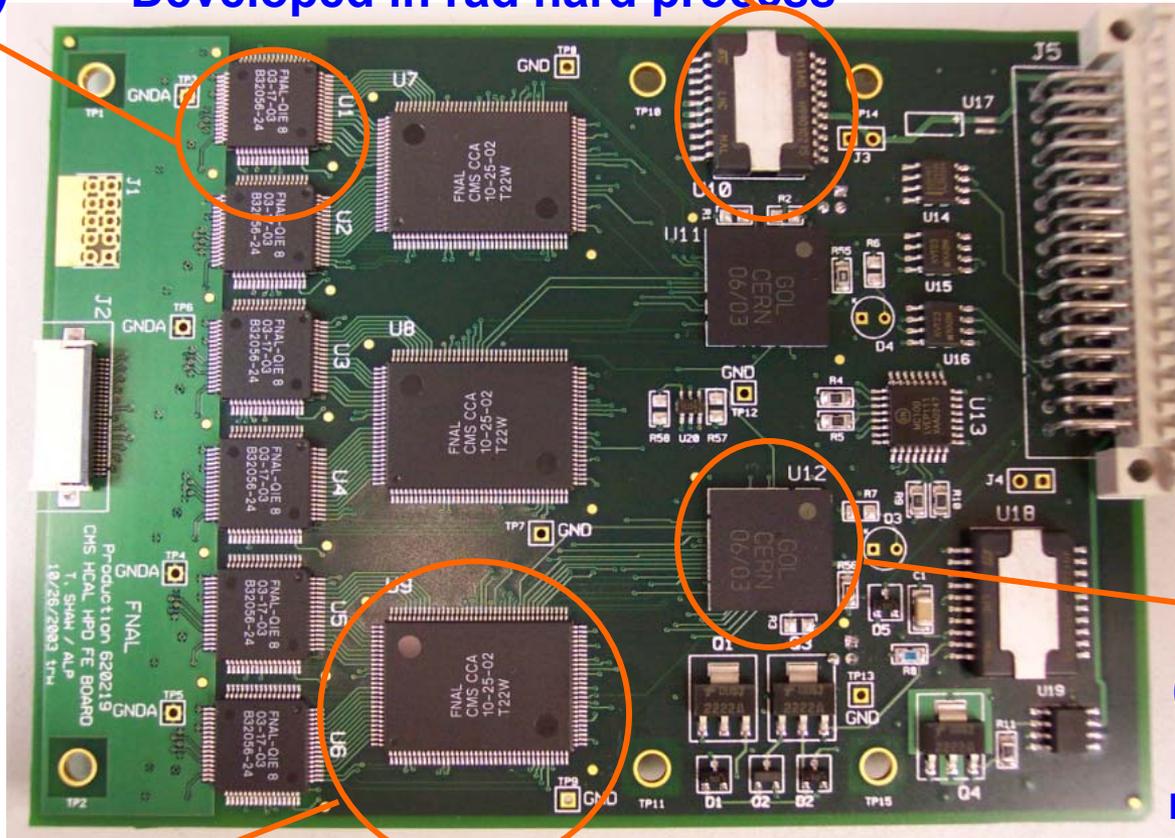
Low Voltage Regulator

(2 / board) CERN

Developed in rad hard process

QIE (6 / board)

FNAL ASIC



Gigabit Optical Link [GOL]

(2 / board) CERN

Developed in rad hard process

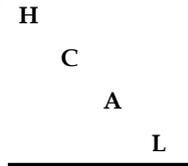
CCA

(3 / board)

FNAL ASIC



QIE Description



QIE – FNAL developed ASIC

Charge Integrator Encoder

4 stage pipelined device (25ns per stage)

charge collection

settling

readout

reset

Inverting (HPDs) and Non-inverting (PMTs) Inputs

Internal non-linear Flash ADC

Outputs

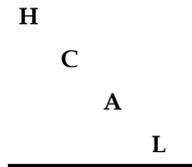
5 bit mantissa

2 bit range exponent

2 bit Cap ID



QIE Specification

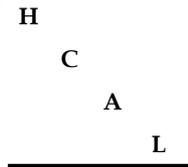


QIE Design Specifications

- Clock > 40 MHz
- Must accept both polarities of charge
- Charge sensitivity of lowest range – 1fC/LSB(inverting-input)
 - In Calibration Mode 1/3 fC/LSB
- Maximum Charge – 9670 fC/25ns(inverting-input)
- 4500 electrons rms noise
- FADC Differential Non-Linearity < .05 LSBs



Channel Control ASIC FNAL ASIC



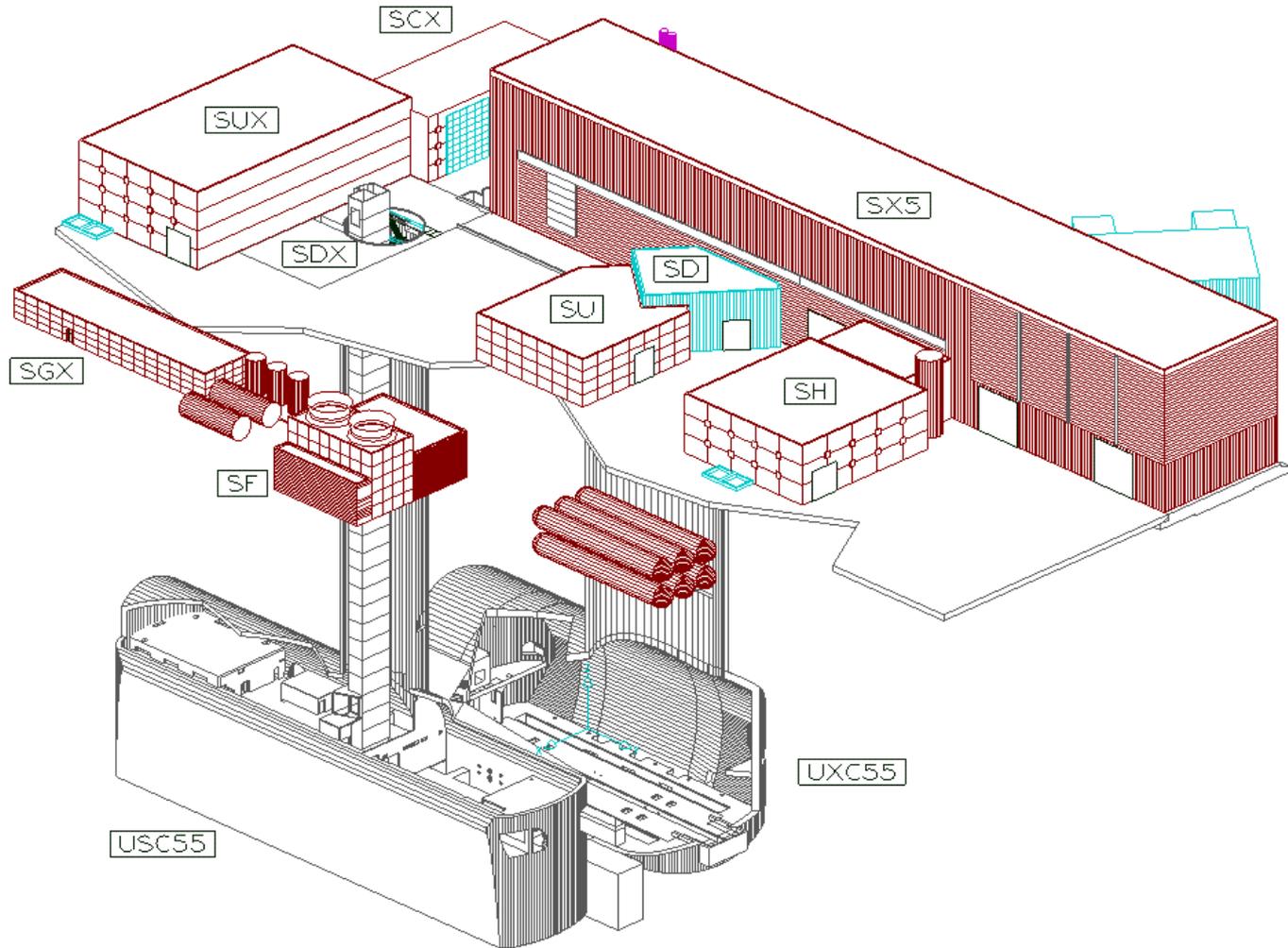
The CCA provides the following functions:

- The processing and synchronization of data from two QIEs,
- The provision of phase-adjusted QIE clocking signals to run the QIE charge integrator and Flash ADC,
- Checking of the accuracy of the Capacitor IDs, the Cap IDs from different QIEs should be in synchronization,
- The ability to force the QIE to use a given range,
- The ability to set Pedestal DAC values,
- The ability to issue a test pulse trigger,
- The provision of event synchronization checks – a crossing counter will be implemented and checked for accuracy with every beam turn marker,
- The ability to send a known pattern to the serial optic link,
- The ability to “reset” the QIE at a known and determined time,
- And, the ability to send and report on any detected errors at a known and determined time.



Civil Engineering and Magnet

H
C
A
T





Outstanding Surface Works: SX5, SDX5 and SCX5

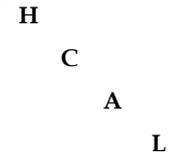
H
C
A
L



LHC POINT 5: Outstanding surface works



Construction of 2nd Phase SX5 has Started



Extension of SX slab has started

Crown of shaft is being removed



UXC5 Steel Reinforcement of Floor

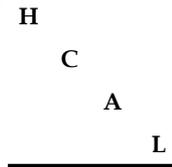
H
C
A
L



LHC - Point 5 - UXC 55 - concreting of second phase invert (central section) - 18-07-2003 - CERN ST/CE



GOL – CERN ASIC



Gigabit Optical Link (GOL) Configuration

- 32 bit mode; 1.6 Gb/s; Gigabit Ethernet Protocol
- FNAL produced the GOL ASIC tester

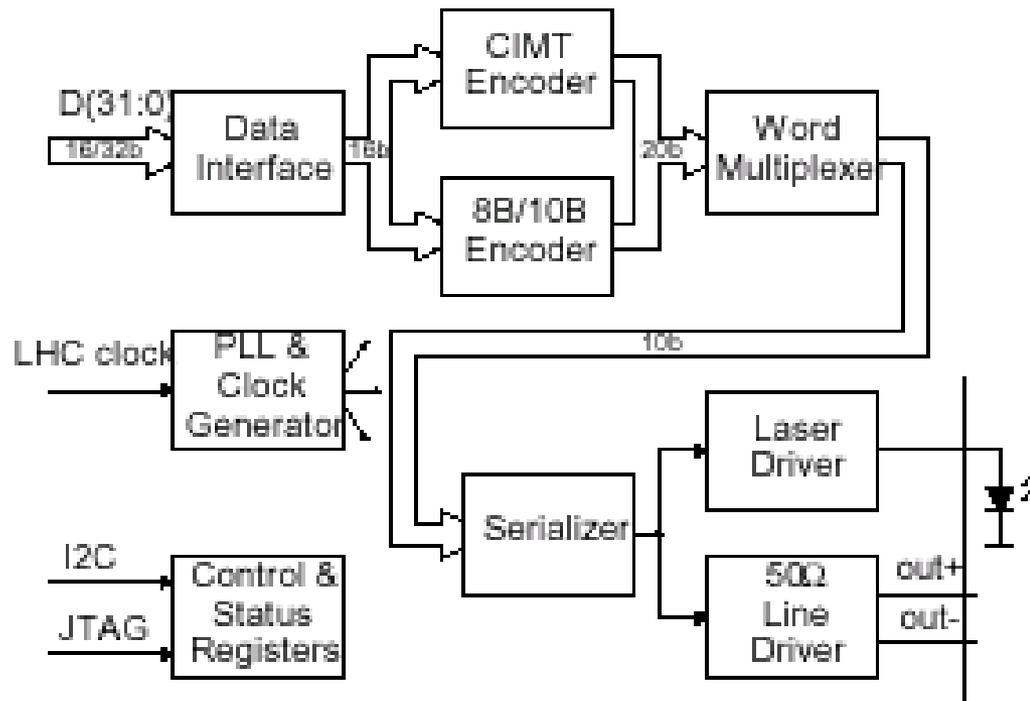
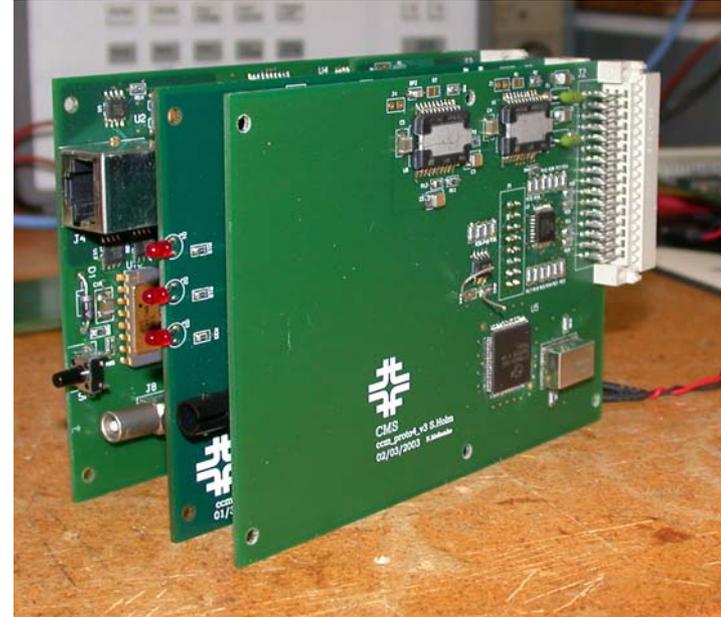


Figure 1 GOL block diagram.



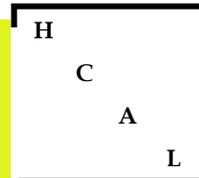
Clock, Control and Monitor Module

H
C
A
L





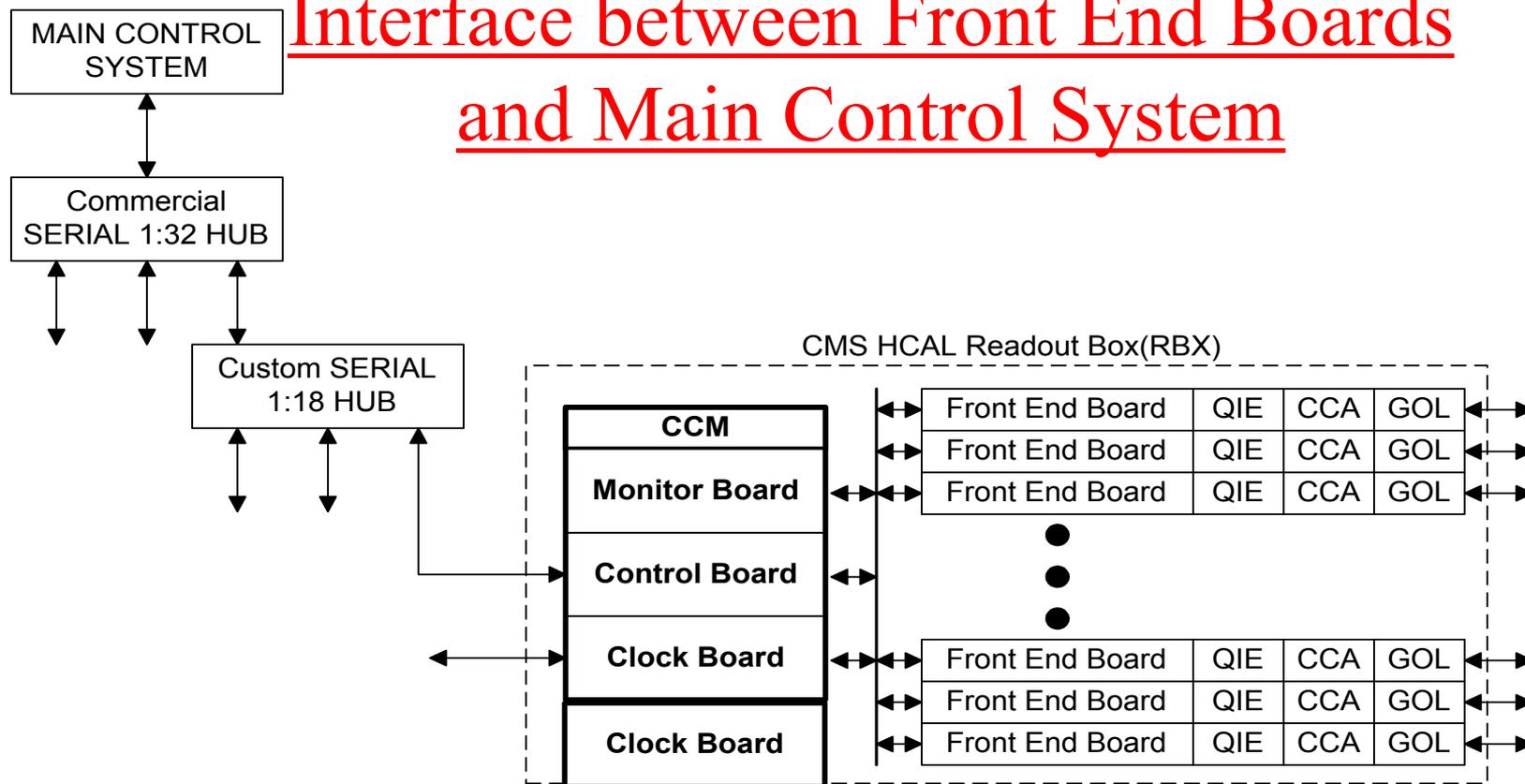
CMS HCAL TIMING & CONTROL MODULE(CCM)



CCM “CLOCK – CONTROL – MONITOR”

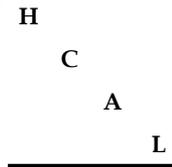
CCM - FOUR Board Module that resides in the CMS HCAL Readout Box(RBX)

Interface between Front End Boards and Main Control System

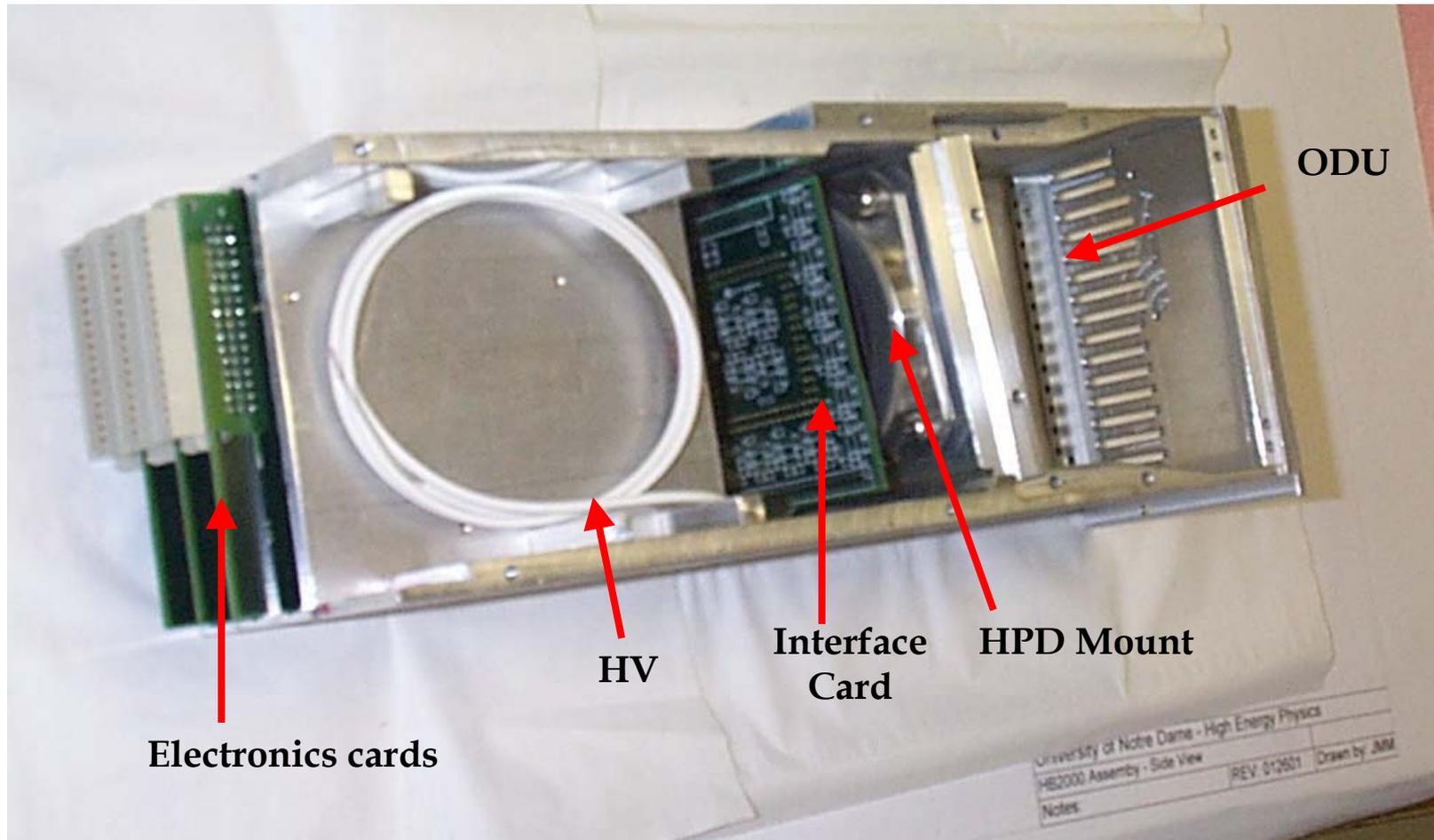




RBX Readout Module

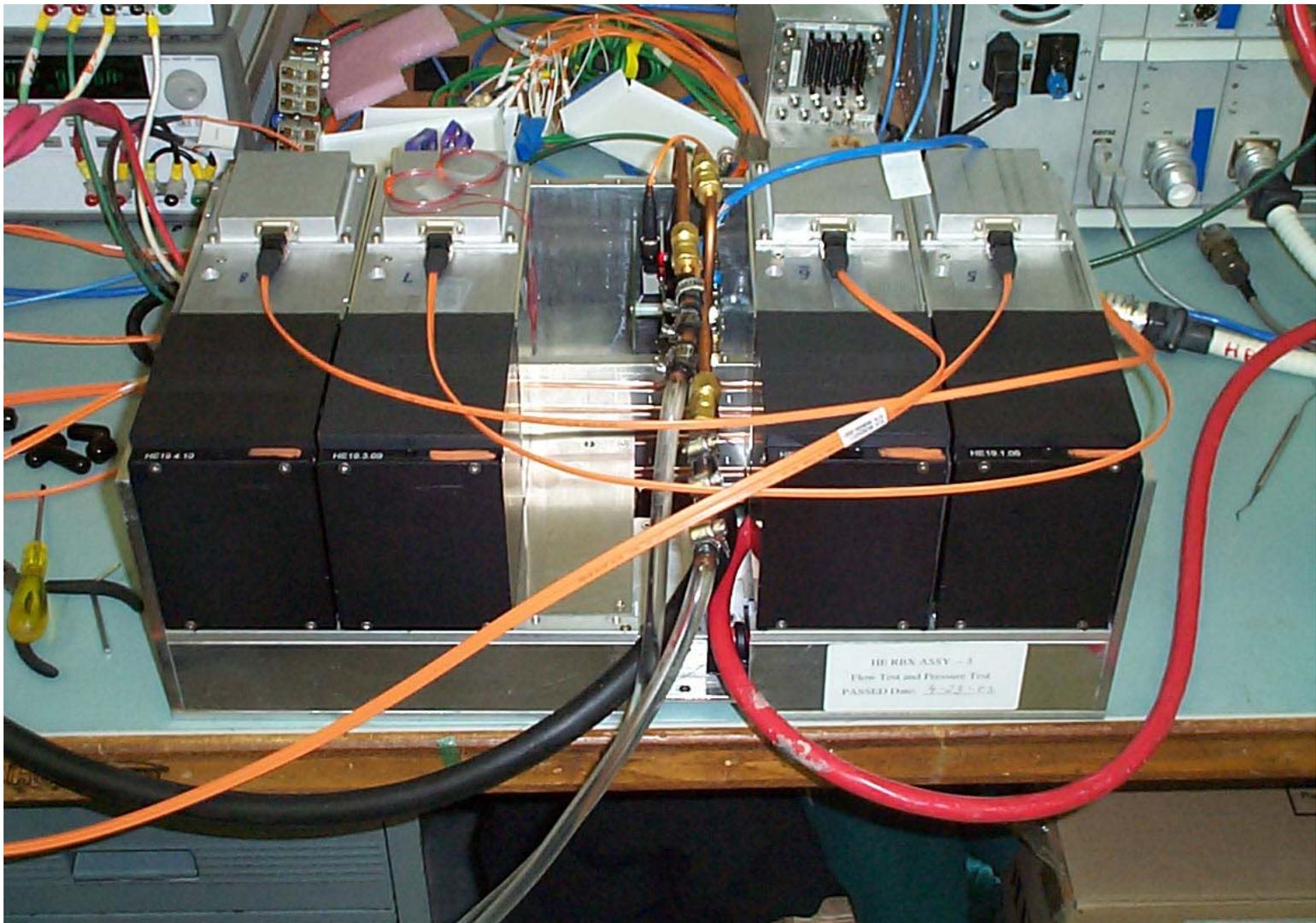
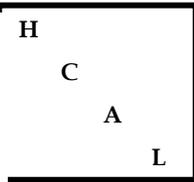


- The readout module (RM) integrates the HPD, front end electronics, and digital optical drivers.





HCAL HE RBX with 4 RMs





HCAL Channel Count

H
C
A
L

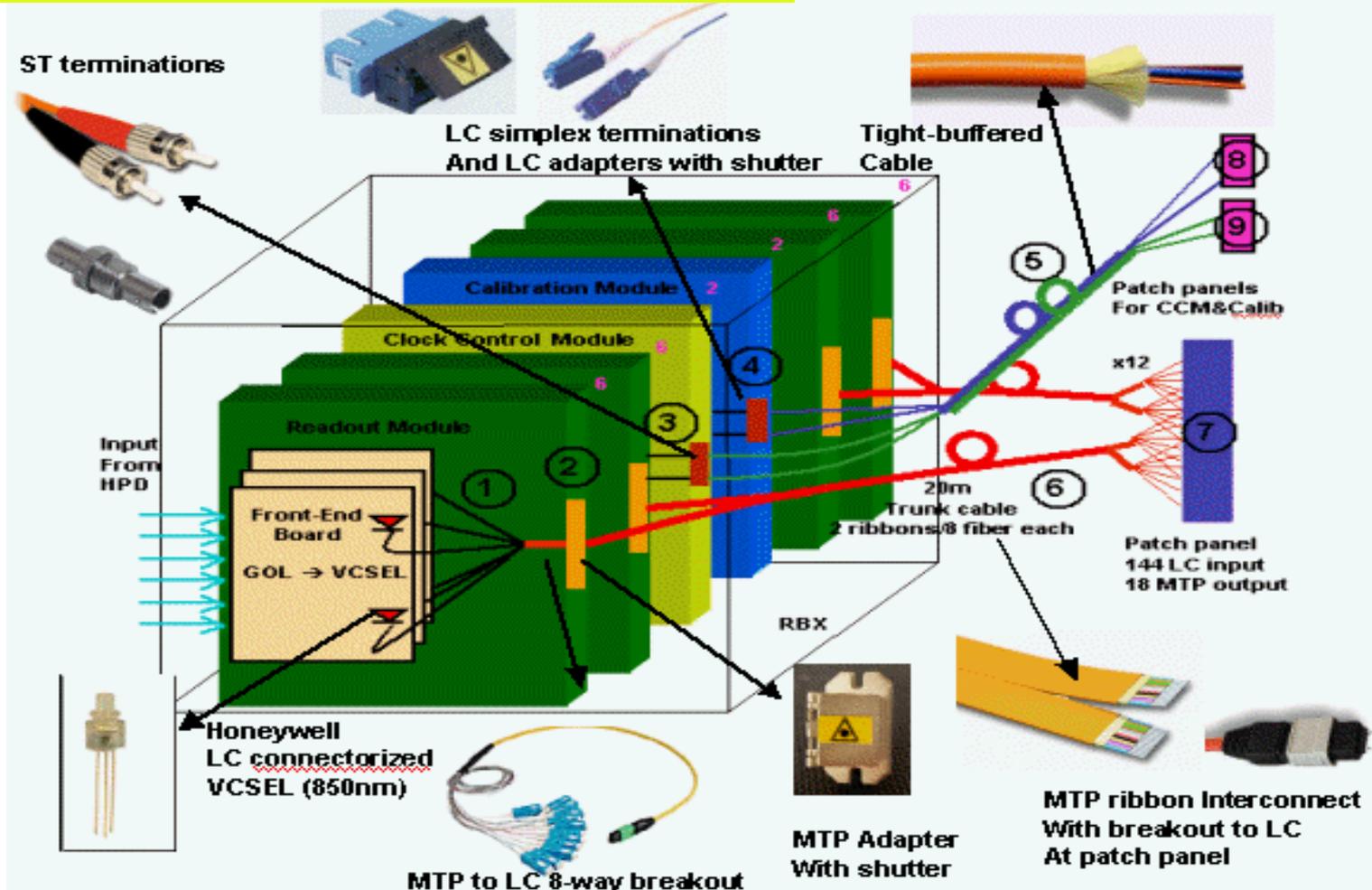
	Channel Count	Data Fibers	TTCrx Fibers	Calib Fiber	Total Fibers
HB(pure)	1728	576	48	36	660
HB/HE overlap	1728	576	48		624
HE (pure)	1728	576	48	72	696
HO	2160	768	72	36	876
HF	1728	576	48	48	672
Tot	9072	3072	264	192	3528



Optical Data/Control

H
C
A
L

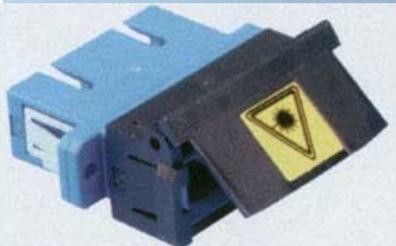
1.6 Gbps Digital Readout
~3500 Data + TTC/Calibration Links





Optical Connectors

H
C
A
L



• LC / ST

- Single-fiber
- CCM/Calib
- Patch panels
- Shutters (LC)
- Laser safety

• MTP / MPO

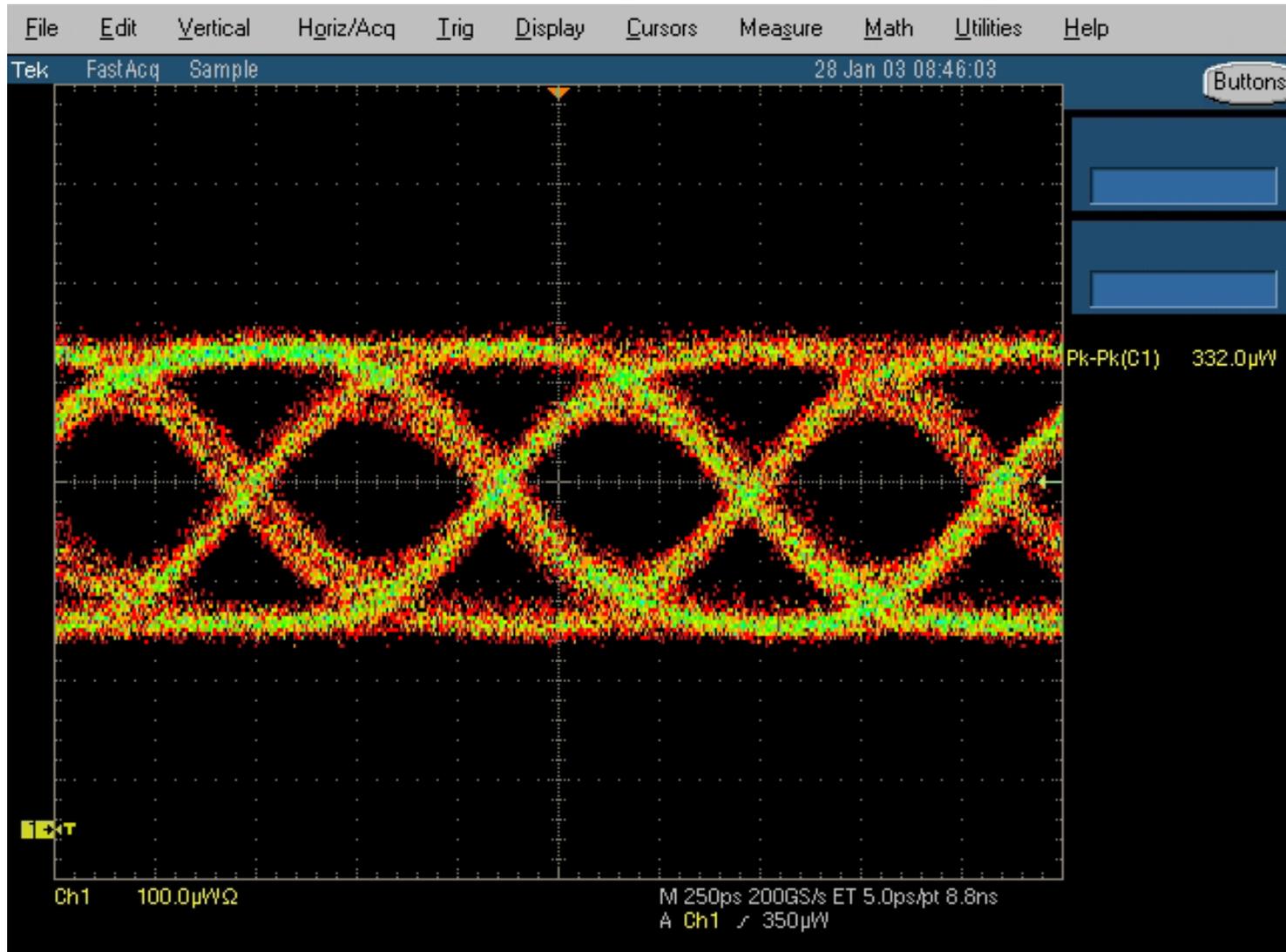
- Multi-fiber
- RMs/HTRs/
- Patch panels
- Shutters –
- Laser safety





1.6 Gbps Optical Link

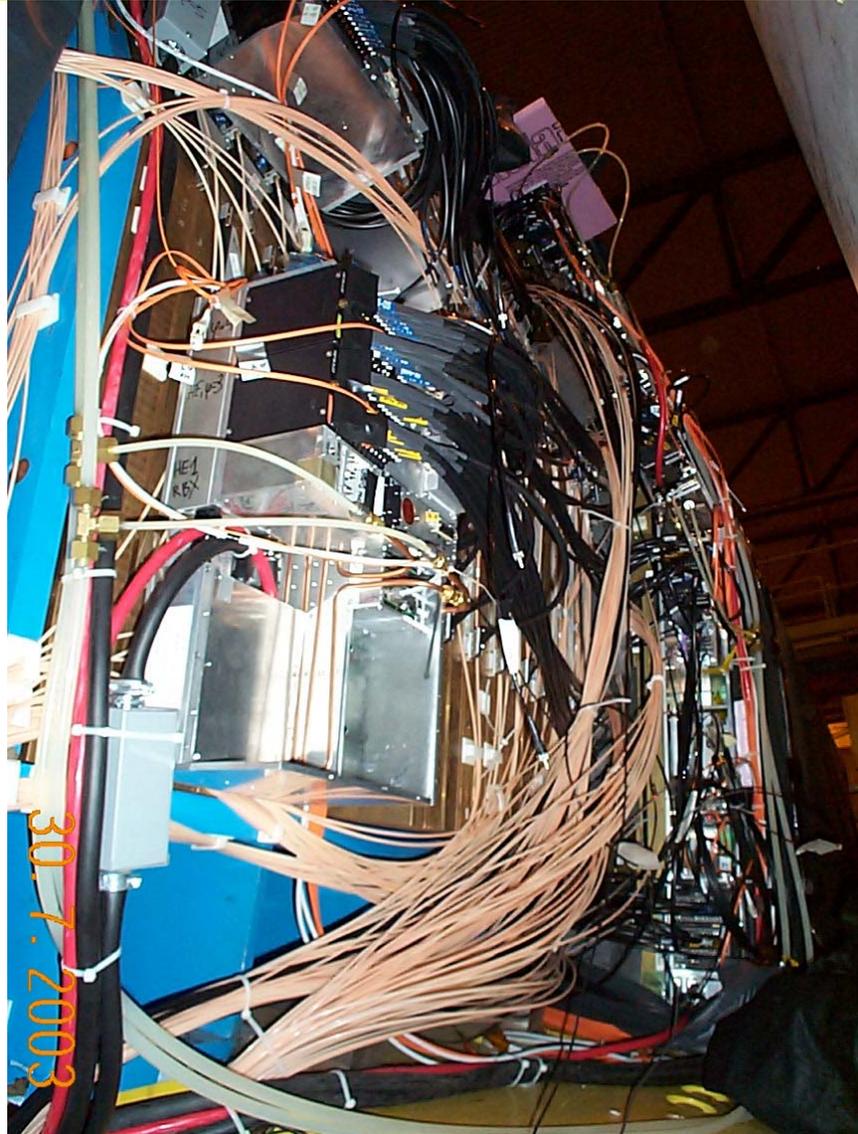
H
C
A
L





HE, HB RBXs at CERN Testbeam 03

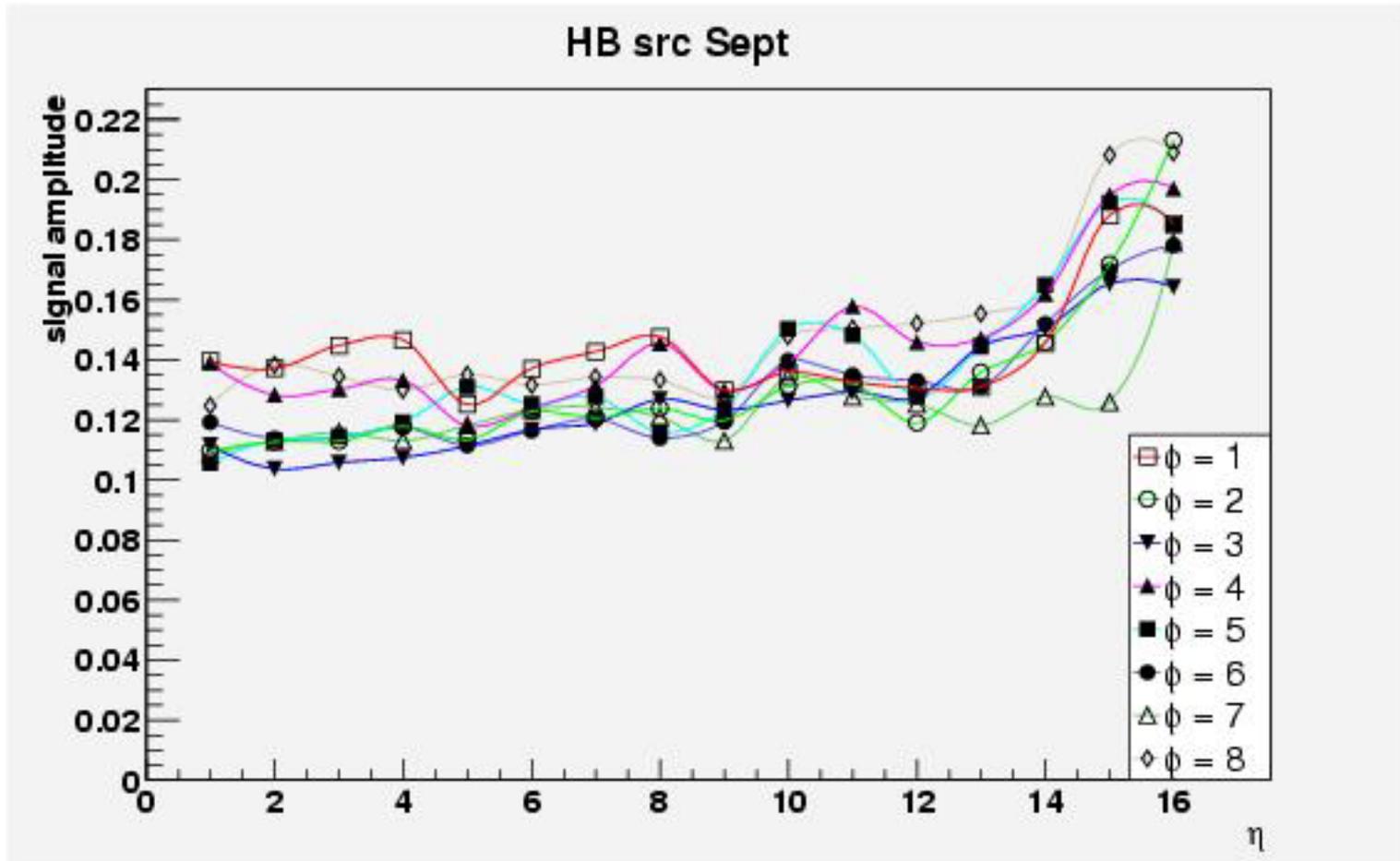
H
C
A
L





HB Wire Source Calibration

H
C
A
L

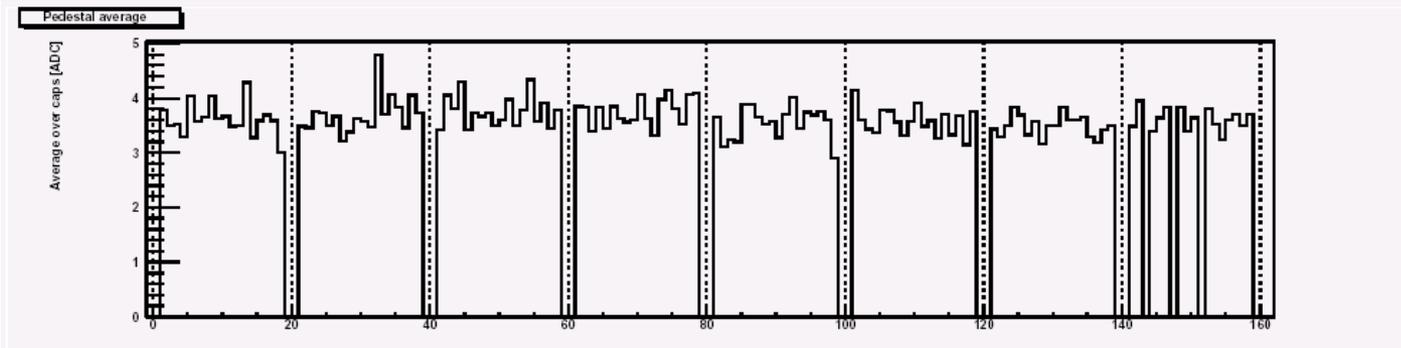


There is no big difference in the gains over 3 months running

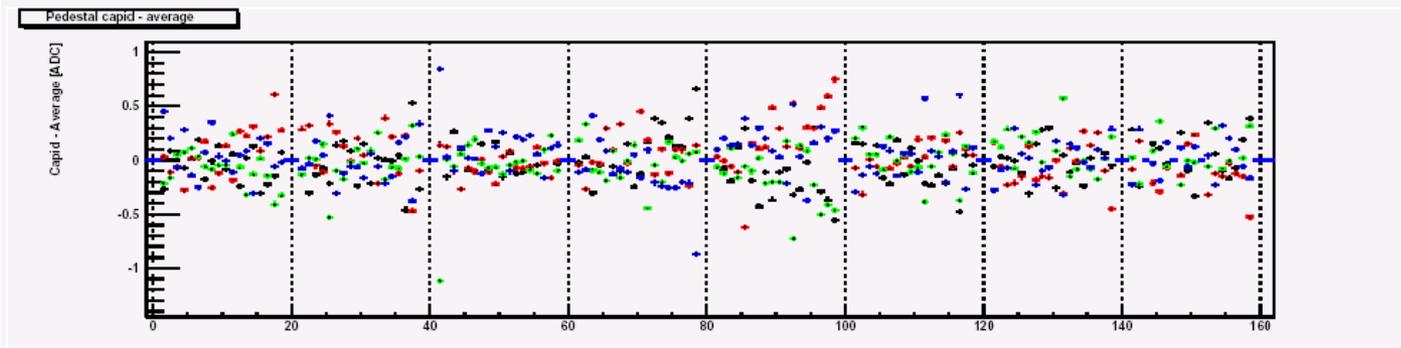


Pedestals - HB 144 channels

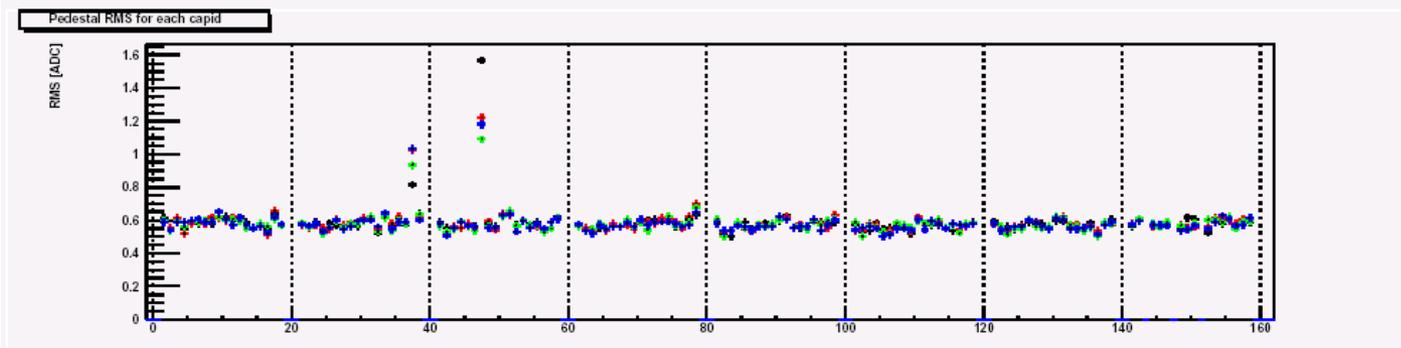
H
C
A
L



average



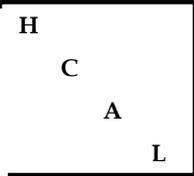
dispersion
ped(i) -ave



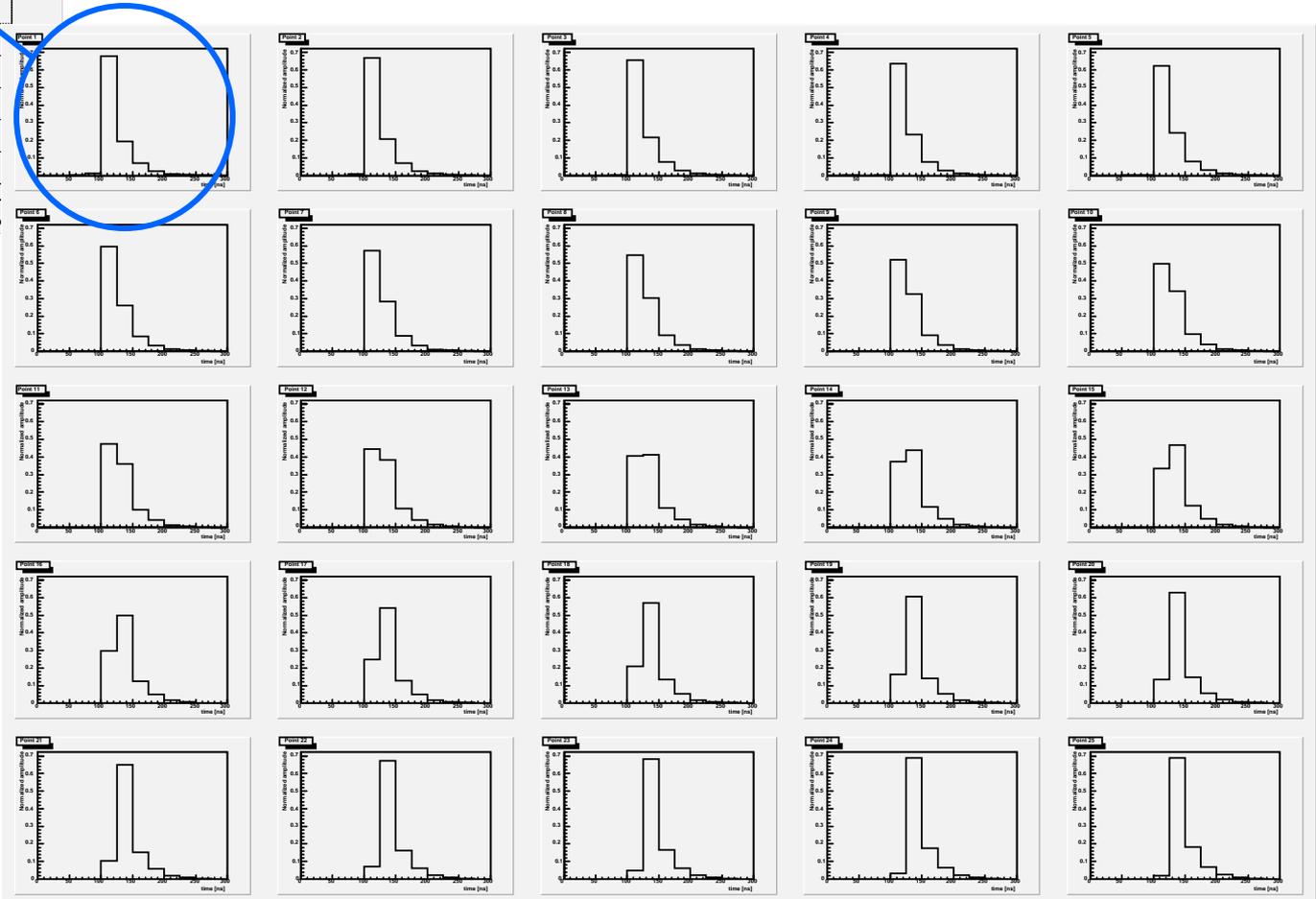
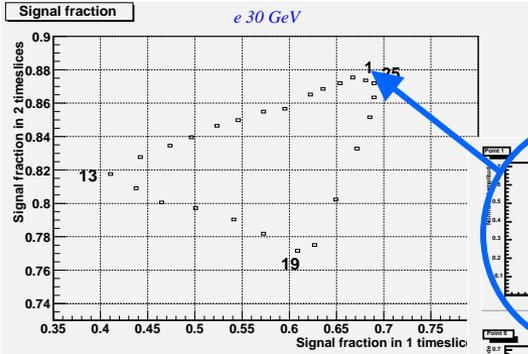
rms



Dynamic Range and Pulse Shape

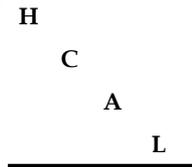


30 GeV Electrons





US CMS Summary



CMS HCAL FE Electronics has entered the production stage.

Testbeam Run scheduled this summer at CERN using production Hardware.