

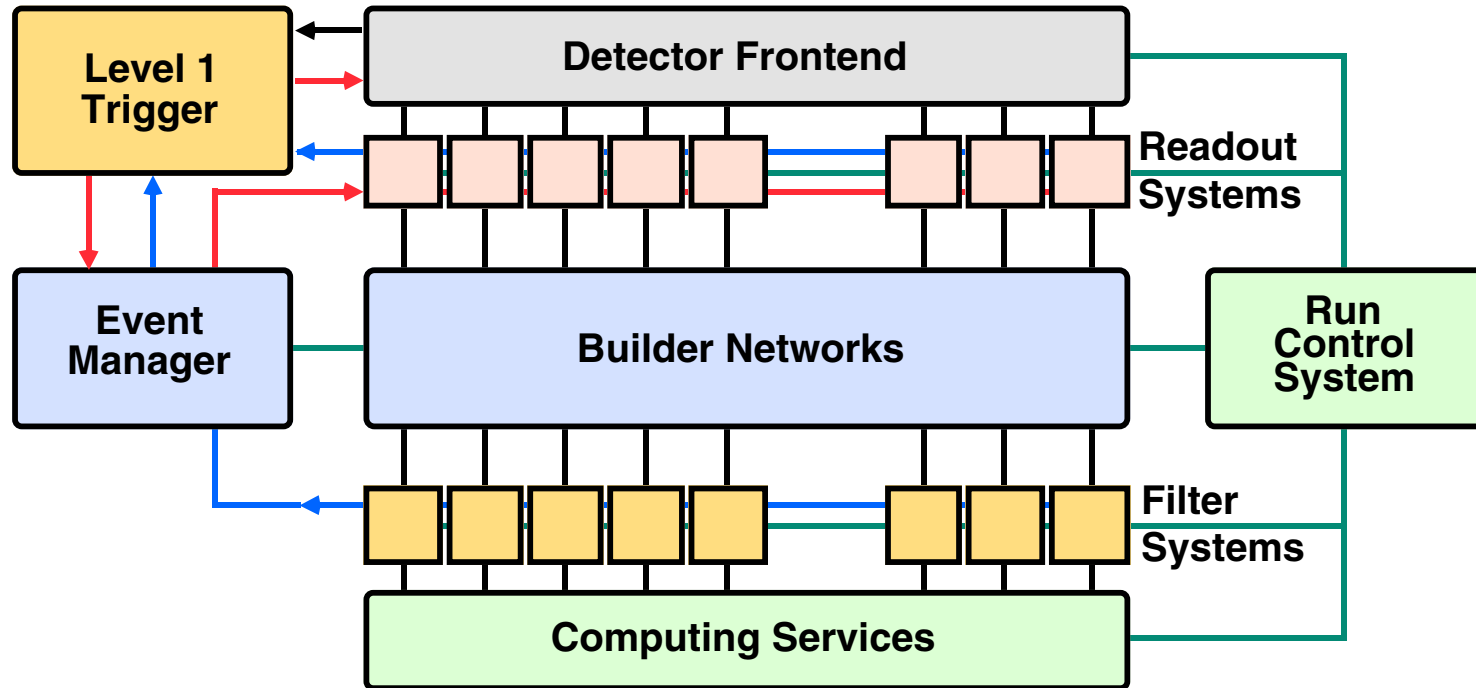
Trigger Overview

Wesley Smith, *U. Wisconsin*
CMS Trigger Project Manager

DOE/NSF Review
May 9, 2001



TriDAS Main Parameters



Collision rate	40 MHz	I-O units bandwidth (512+512)	400 MByte/s
LV1 Maximum trigger rate	100 kHz	Builder network (512x512 port)	≥ 500 Gbit/s
Average event size	≈ 1 Mbyte	Event filter computing power	$\approx 5 \cdot 10^6$ MIPS
Data production	\approx Tbyte/day	High Level Trigger acceptance	1 - 10 %
Event Flow Control	$\approx 10^6$ Mssg/s	Overall dead time	$\leq 2\%$



TriDAS Evolution

Plans for initial turnon of CMS:

Rates (kHz)	Level 1 output	Readout thruput	Ev. Bld. thruput	Ev. Filt. capacity
Design	100	100	100	100
Implement.	100	100	75	75*
Operation	75	75	75	75*

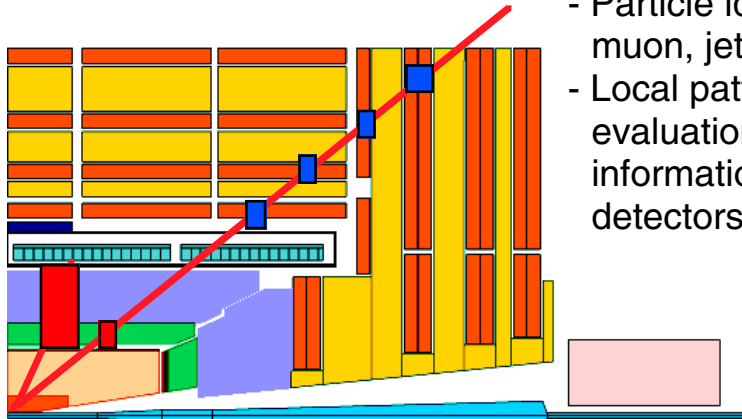
* The final capacity will be determined by the evolution of technology, cost and financial resources

Plan set to exploit funding resources and computing technology advances in the most effective manner



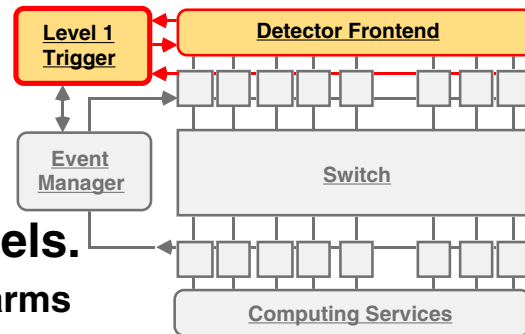
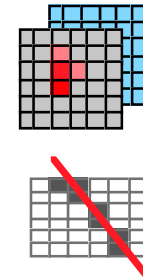
CMS Level 1 Trigger

40 MHz



Level-1. Specialized processors

- Particle identification: high p_T electron, muon, jets, missing E_T
- Local pattern recognition and energy evaluation on prompt macro-granular information from calorimeter and muon detectors

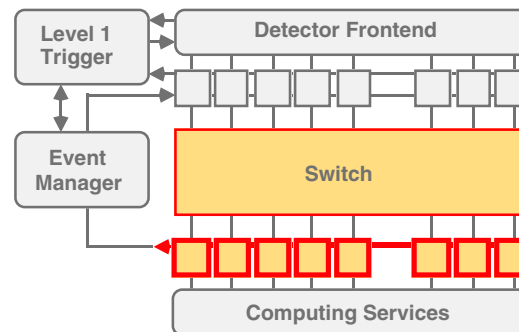
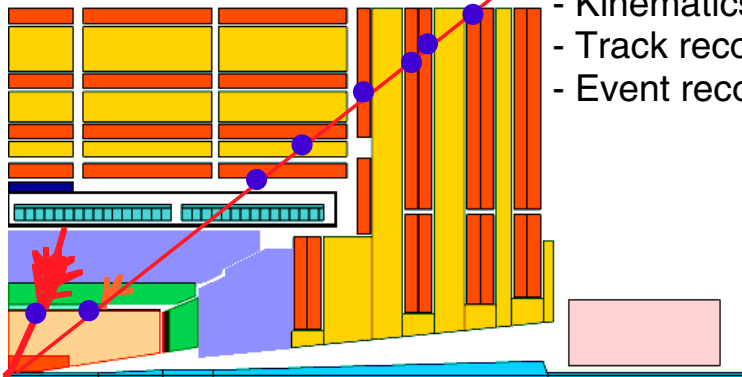


High trigger levels.

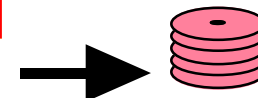
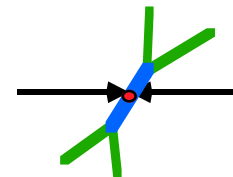
Network and CPU farms

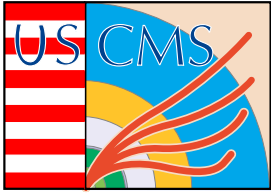
- Clean particle signature
- Finer granularity precise measurement
- Kinematics. effective mass cuts & event topology
- Track reconstruction and detector matching
- Event reconstruction and analysis

Up to 100 kHz

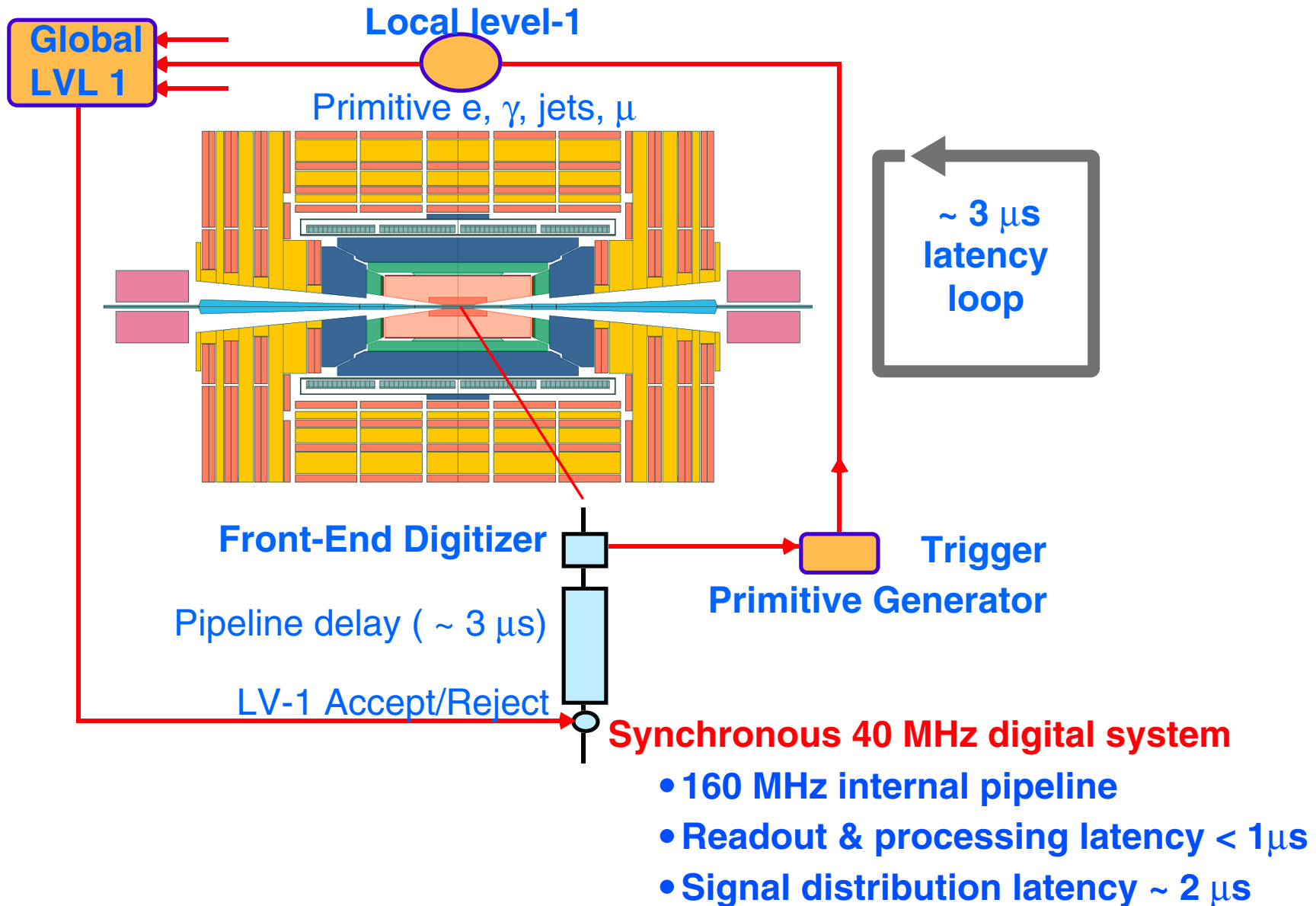


≈ 100 Hz





CMS Level 1 Pipeline





Trigger Electronics Locations

In Underground Shielded Room:

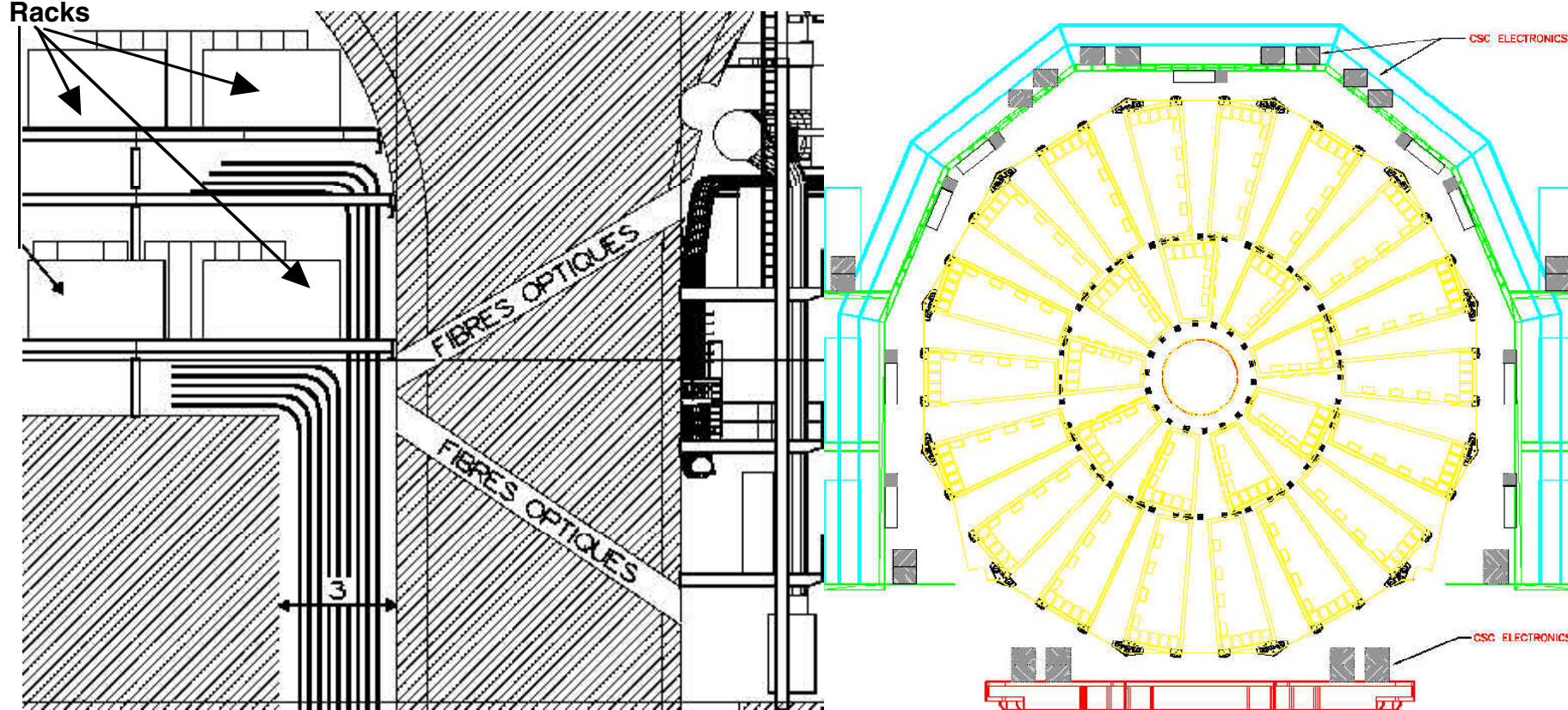
- CSC/DT Muon Trigger Track Finder
- RPC Muon Trigger Pattern Logic
- Calorimeter Regional/Global Trigger
- Global L1 Trigger

On Detector:

- CSC/DT Segment Generation
- RPC Muon Hit Generation
- Calorimeter Digitization only

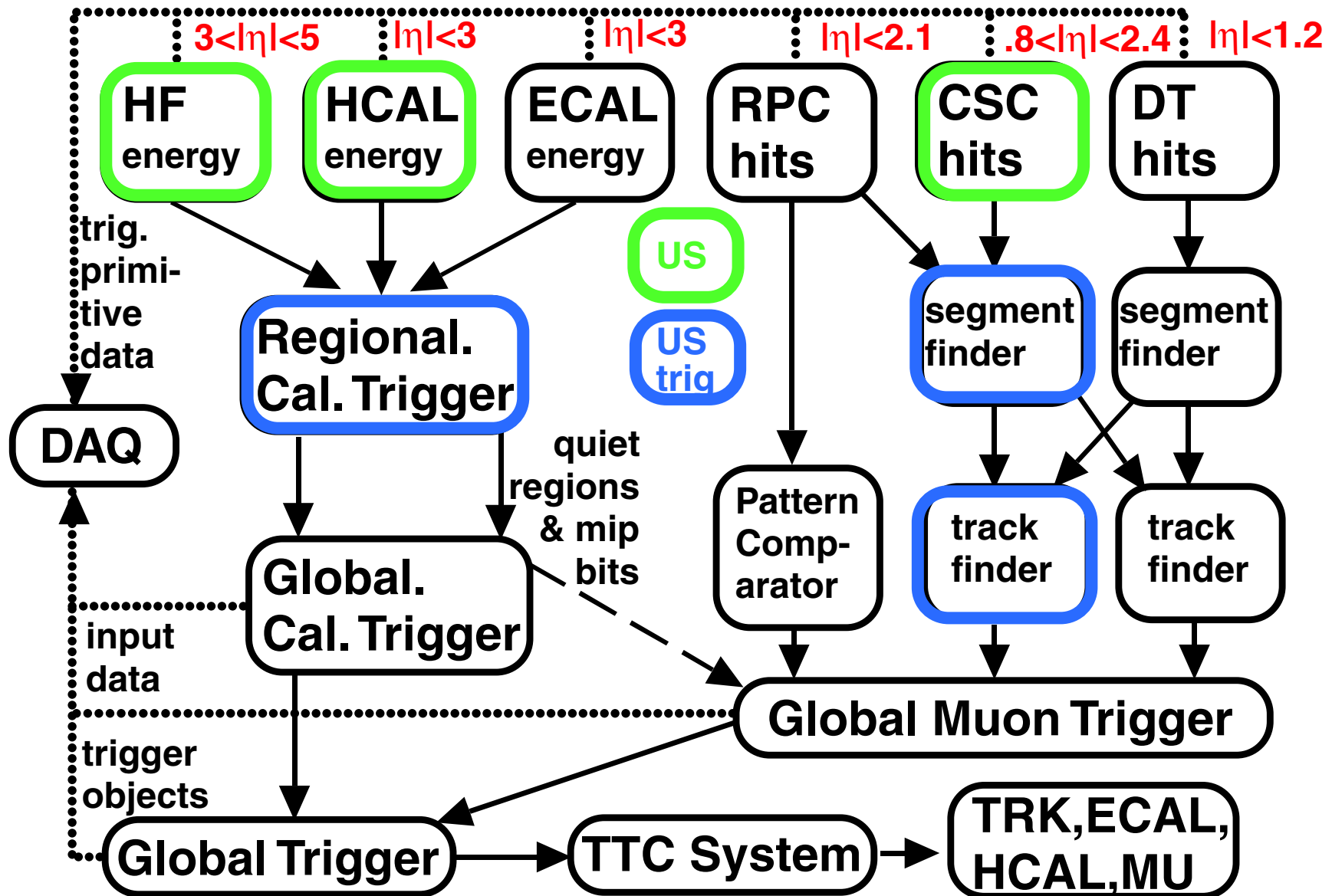
Electronics

Racks



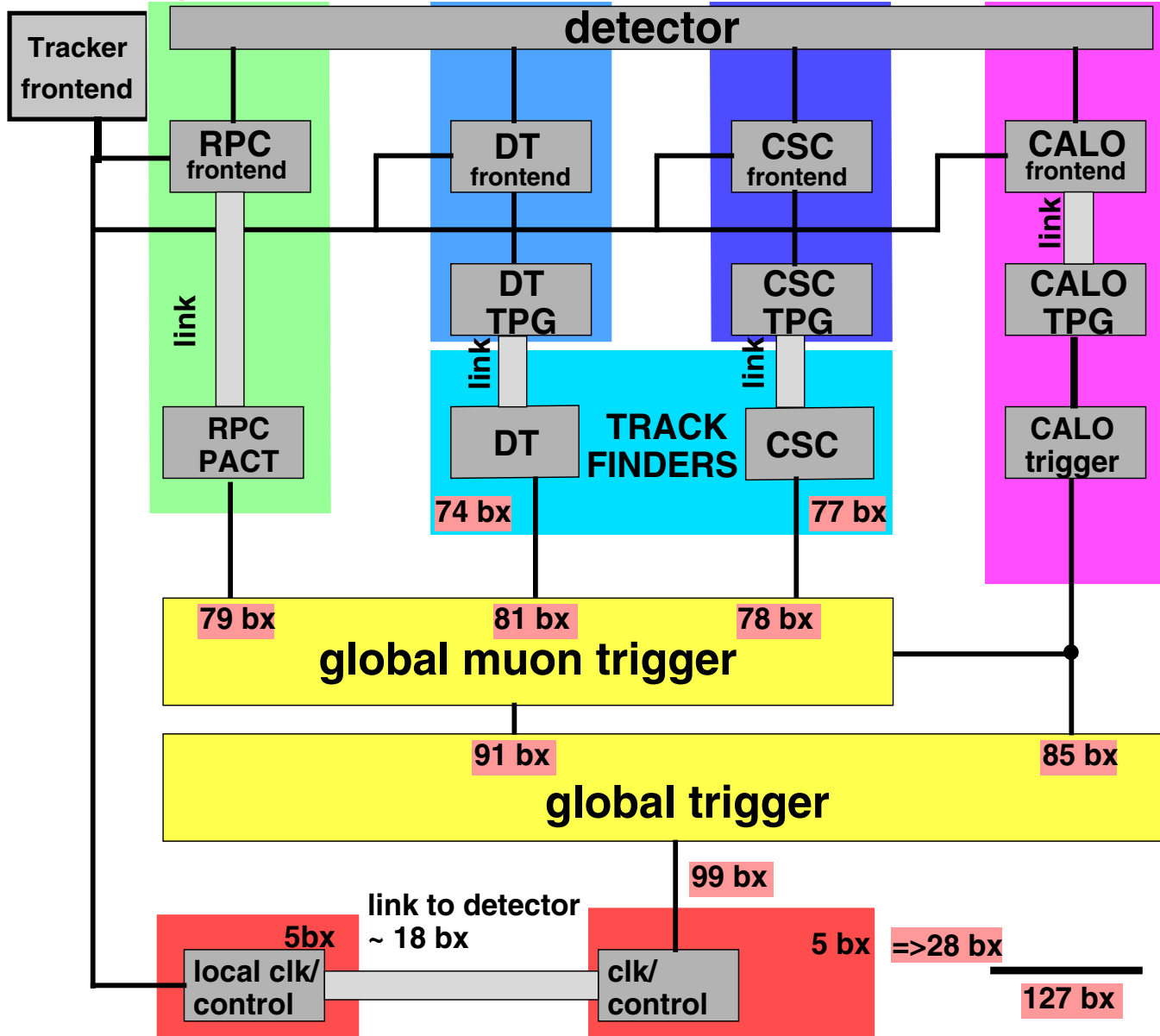


Level 1 Trigger Overview





CMS Level 1 Latency



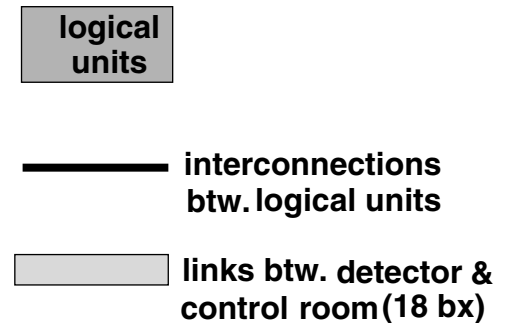
Target is 128 bunch crossings = 3.2 μ s

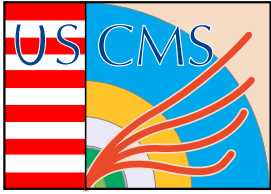
- set by tracker & preshower
- > 30 crossing safety after redesign in .25 μ

Number shown are latency budgets

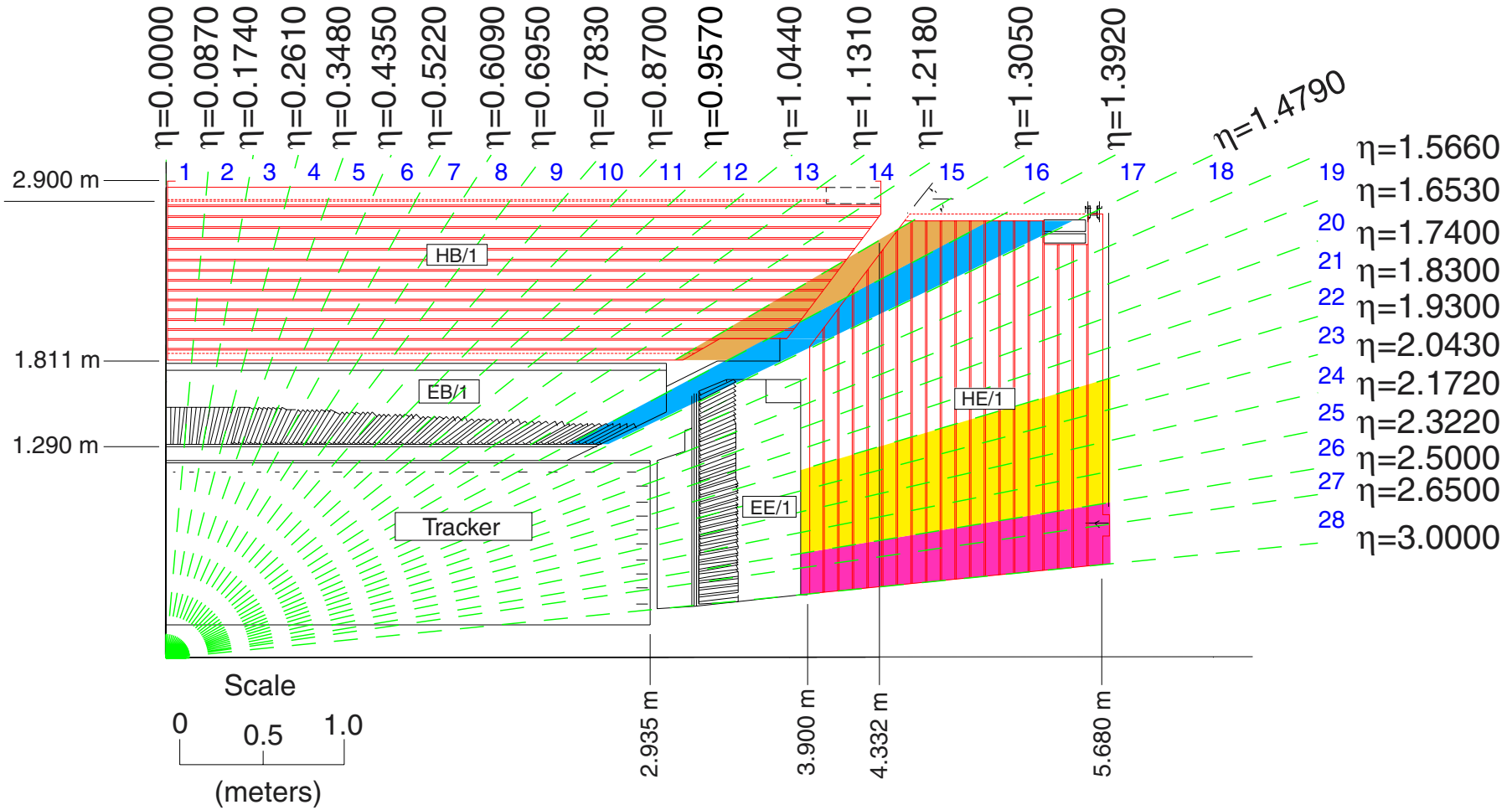
- Units are bunch crossings
- Include contingency

Reviewed once/year





Calorimeter Trigger Geometry





Calorimeter Trigger Overview

4K 1.2 Gbaud serial links w/
2 x (8 bits E/H/FCAL Energy
+ fine grain structure bit)
+ 5 bits error detection code
per 25 ns crossing

Copper 40 MHz Parallel
4 Highest E_t
isolated & non-isol. e/γ
4 Highest τ & std. jets
 E_x, E_y from each crate

US CMS HCAL:
U. Nebraska

US CMS HCAL:
FNAL/
Maryland

Calorimeter
Electronics
Interface

US CMS Trigger:
U. Wisconsin

Calorimeter
Regional
Trigger

Receiver
Electron Isolation
Jet/Summary

Cal. Global Trigger
Sorting, E_t^{Miss} , ΣE_t

UK CMS:
Bristol

Global
Trigger
Processor

CMS:
Vienna

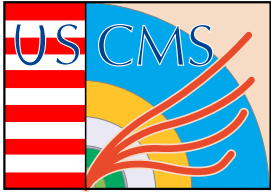
Muon Global Trigger
Iso Mu Minlon Tag

CMS ECAL:
Lisbon/
Palaiseau

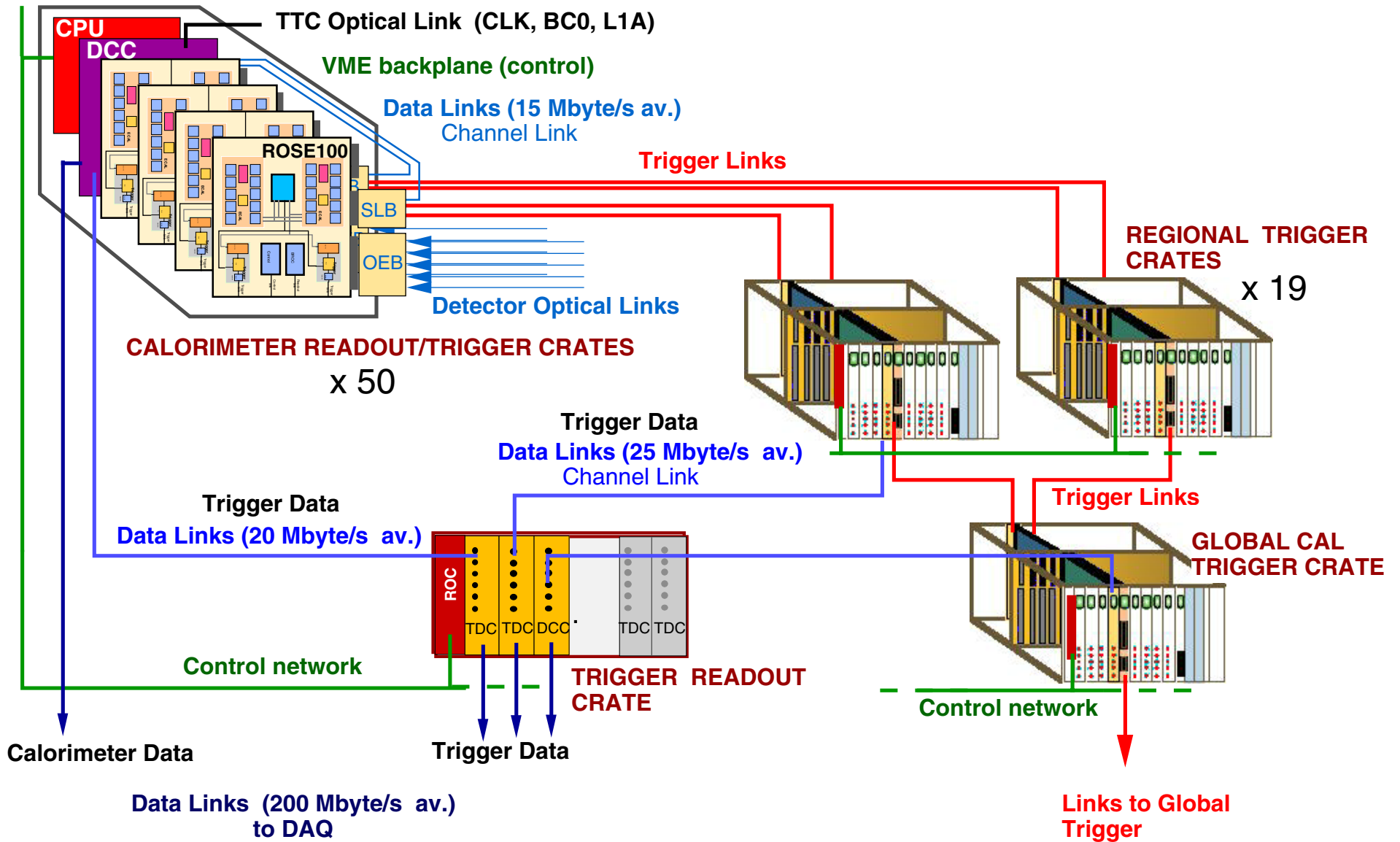
72 ϕ x 60 η H/ECAL
Towers (.087 ϕ x
.087 η for $\eta < 2.2$ &
.174-195 η , $\eta > 2.2$)
FCAL: 2x(12 ϕ x 12 η)

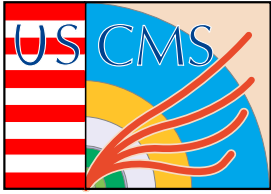
Minlon Tag for
each 4 ϕ x 4 η region

Lumi-
nosity
Monitor



Cal. Trig. & Readout Layout





Regional Calorimeter Crate

(WBS 3.1.2)

Receiver Card
(WBS 3.1.2.8)

Electron Identification Card
(WBS 3.1.2.9)

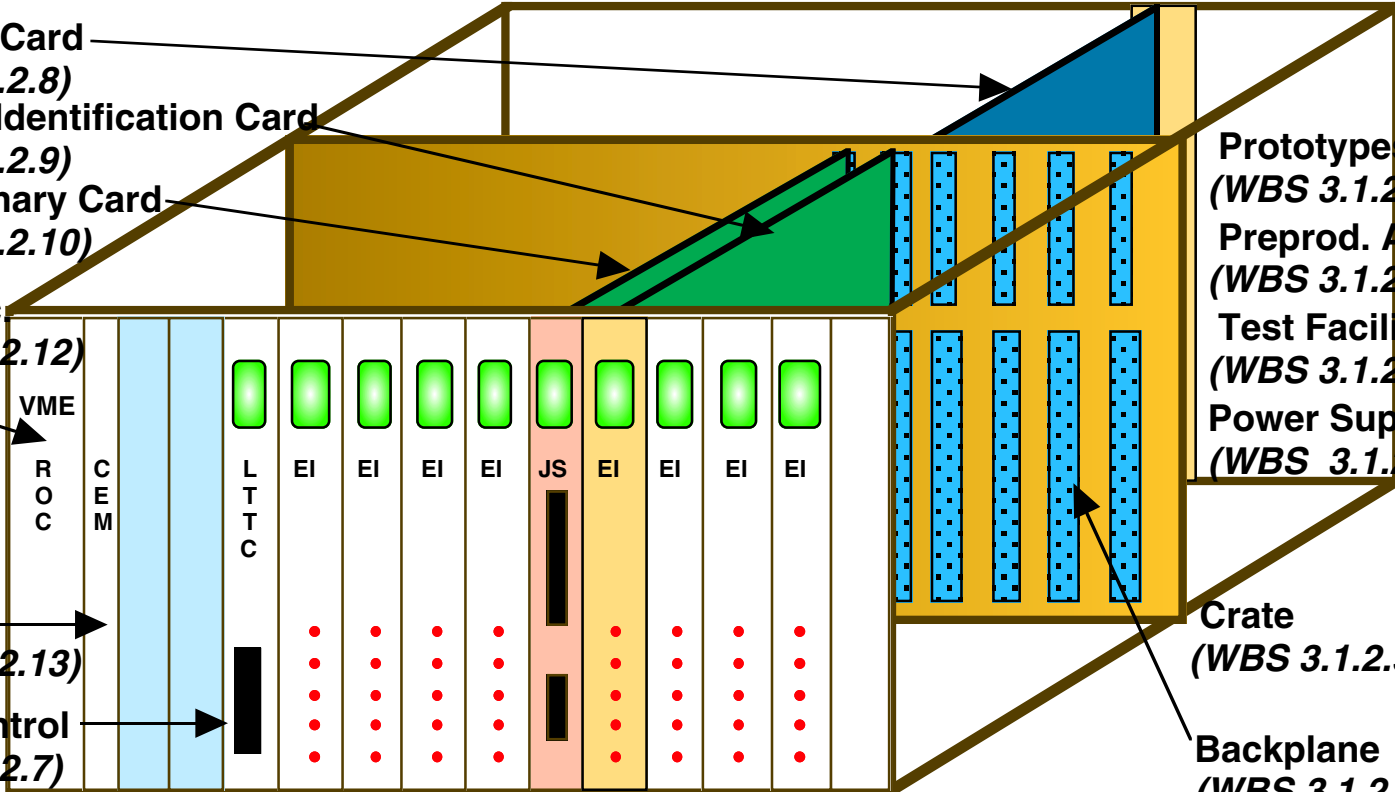
Jet Summary Card
(WBS 3.1.2.10)

DAQ Proc
(WBS 3.1.2.12)

19 X

Monitor
(WBS 3.1.2.13)

Clock/Control
(WBS 3.1.2.7)



Prototypes
(WBS 3.1.2.1)
Preprod. ASICs
(WBS 3.1.2.2)
Test Facilities
(WBS 3.1.2.3)
Power Supplies
(WBS 3.1.2.4)

Crate
(WBS 3.1.2.5)

Backplane
(WBS 3.1.2.6)

Data from calorimeter FE on Cu links @ 1.2 Gbaud (ptyp. tstd.)

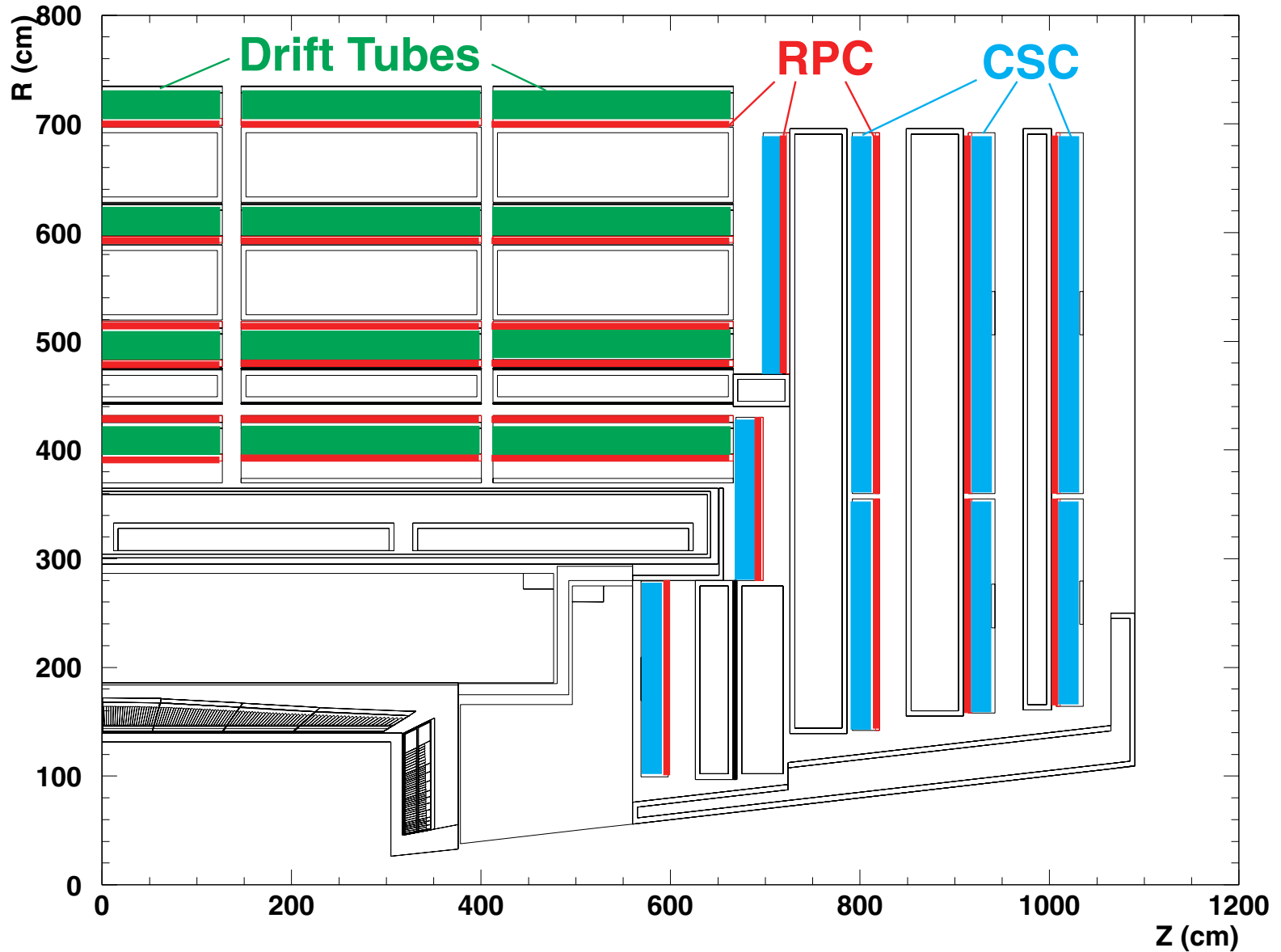
- Into 133 rear-mounted Receiver Cards (ptyp. tstd. w/ ASICs)

160 MHz point to point backplane (ptyp. tstd.)

- 19 Clock&Control (ptyp. tstd.), 133 Electron ID (ptyp. tstd.)
19 Jet/Summary, Receiver Cards operate @ 160 MHz

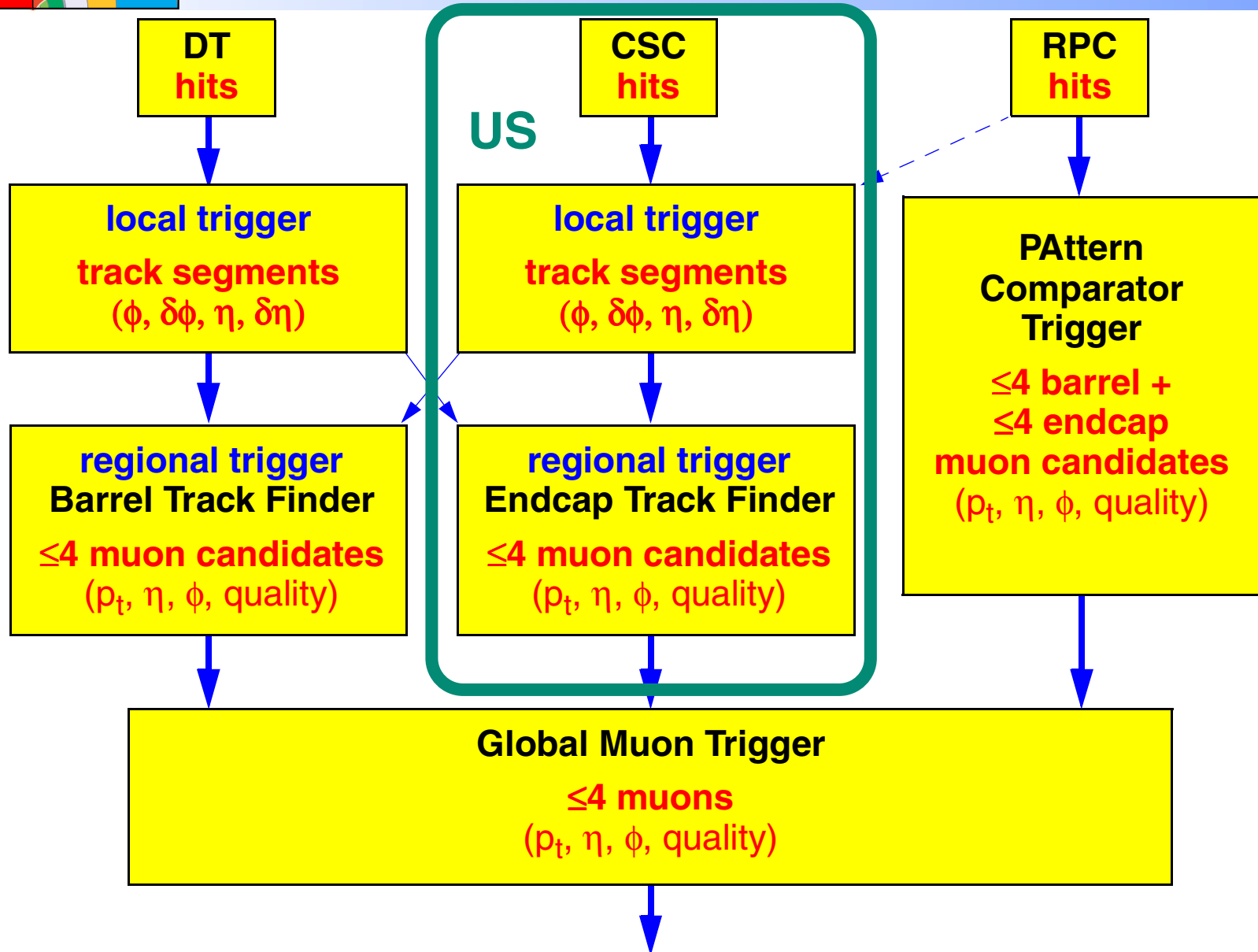


Muon Trigger Geometry





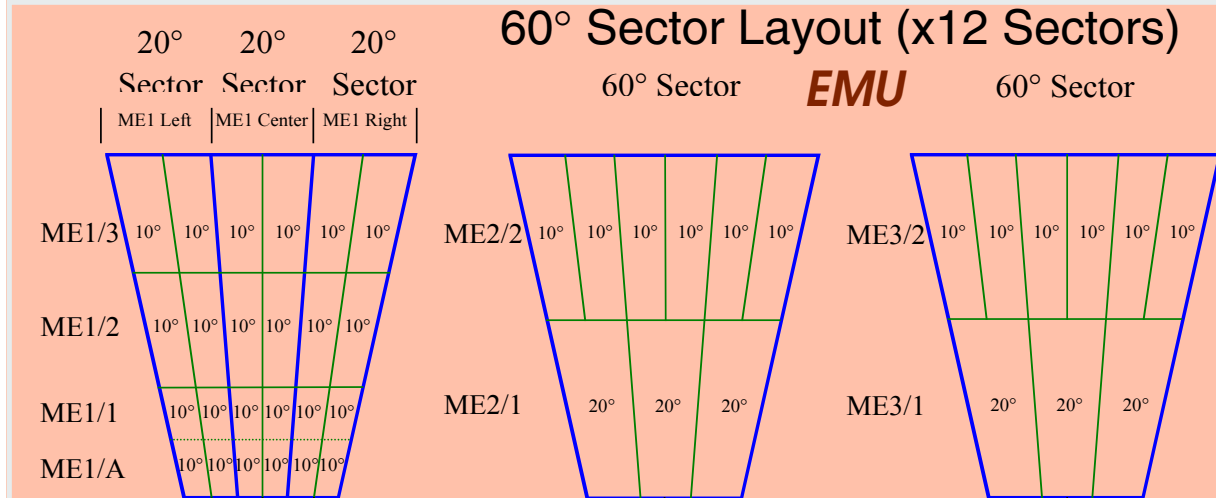
Muon Trigger Overview





CSC Trigger Layout

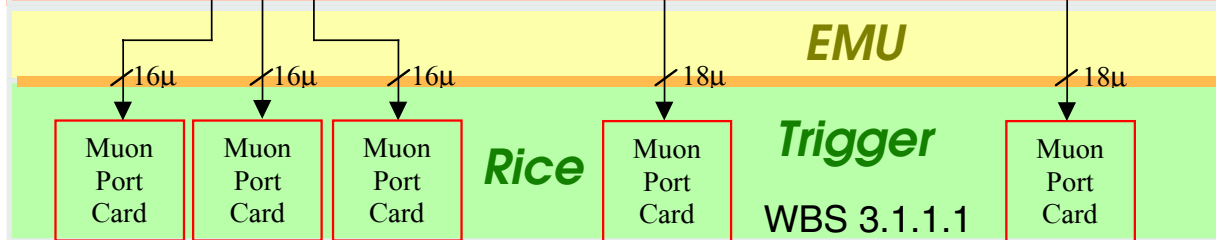
(WBS 3.1.1)



x 6 = 360°
x 2 Ends
= x 12

Trigger Mother Boards (*Rice*) in 8 Iron Disk Peripheral Crates

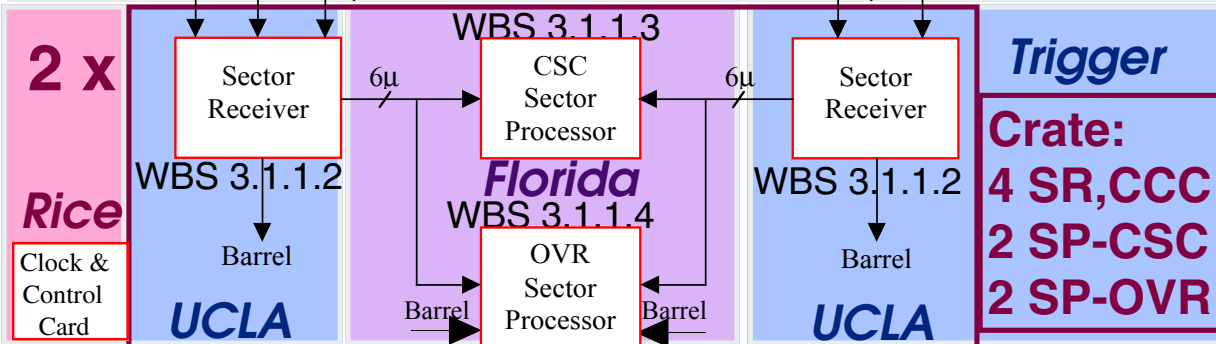
Backplane, Crate Interconnects **EMU** *Trigger*



5 Muon Port Cards x 12



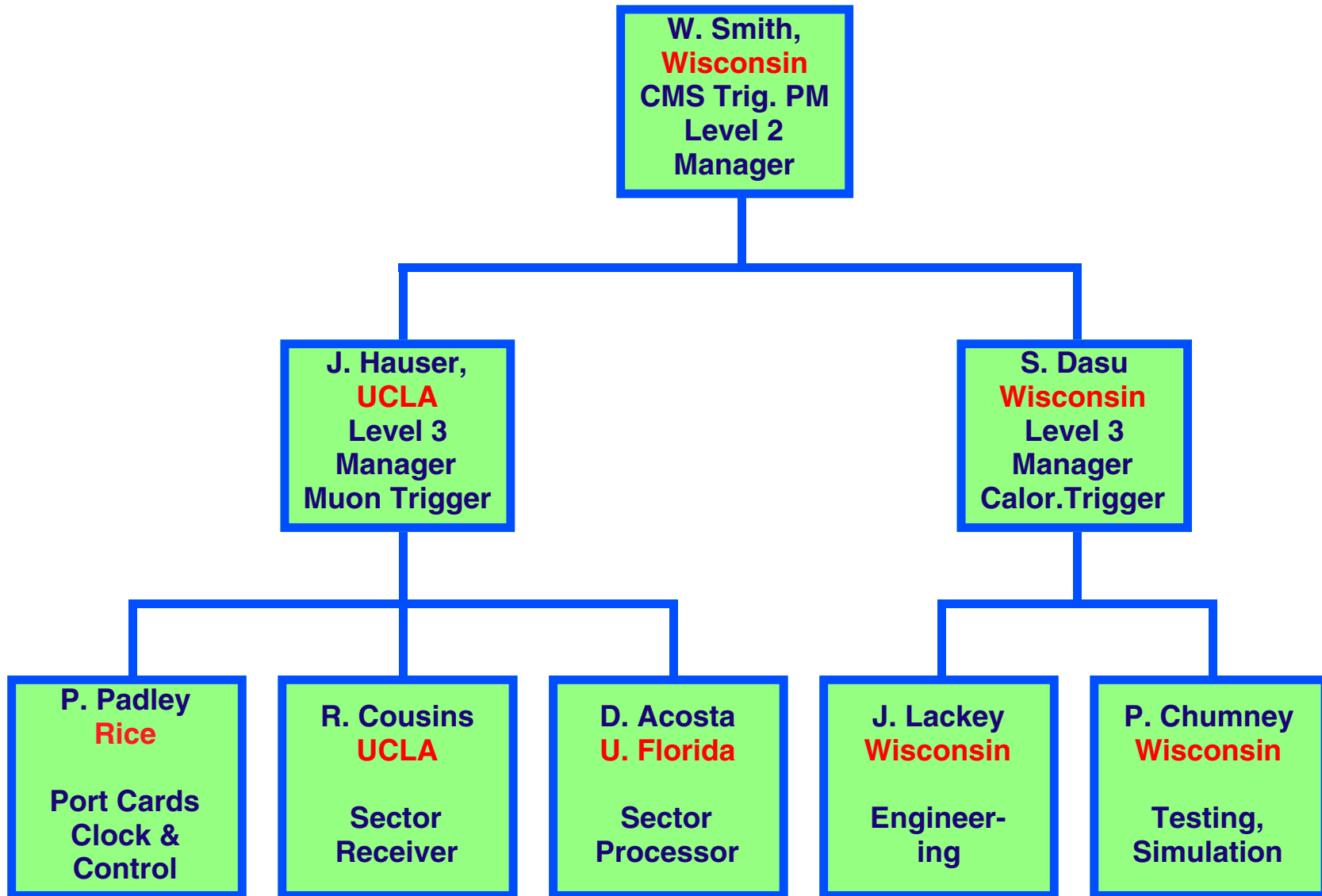
24 Optical Links x 12



6 Track Finder Crates in Counting Room (total). Sort output (*Rice*) to Global Muon Trigger (*Vienna*)



U. S. Trigger Organization





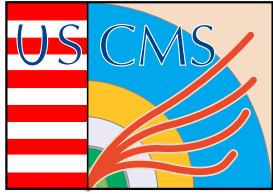
Trigger Status & Plans

Calorimeter Trigger

- **Serial Link tests successful**
 - 2nd proto being made -> integration tests this year
- **Produce & test next generation prototype boards**
 - New boards made, being made or in design now
- **All prototype ASICs made & tested by Vitesse**
 - Will test on next generation prototypes

Muon Trigger

- **Successful Integration test of all prototype boards**
 - Muon Port Card, Sector Receiver, Sector Processor, Backplane, Crate, Clock Board, Optical links
- **Evolution to Compact, Faster Design**
 - Successful tests of new backplane, optical links, FPGA
- **Next generation prototypes to follow**



Trigger Presentations

8:30 - 11:15 AM, WH3NE (Theory conference room)

CMS Trigger Design & Status	W. Smith	8:30 - 8:45
Cal. Trig. Overview & Simulation	P. Chumney	8:45 - 9:15
Cal. Trig. Status & Plans	S. Dasu	9:15 - 9:45
Muon Trig. Overview	J. Hauser	9:45 - 9:55
Muon Trig. Simulation	D. Acosta	9:55 - 10:15
Muon Trig. Test Results/ Hardware Status & Plans	P. Padley	10:15 - 10:45

BREAK: 10:30 - 10:45 AM

Trigger Cost & Schedule: Status	W. Smith	10:45 - 11:15
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