



# Calorimeter-Track Trigger

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WBS 1.2.2

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# L1Cal-Track Trigger

- Exploit new L1Cal and new L1CTT triggers
- Improve Run I Ia  $f$  matching granularity x8
- Needed in triggers for Higgs searches
  - ◆ electrons in  $WH$  and  $H \rightarrow W^*W$  modes
  - ◆ taus in  $H \rightarrow tt$  and  $H^+ \rightarrow tn$
- Fake EM rejection is improved by  $\sim x2$
- Fake  $t$  rejection is improved by  $\sim x10$



# Fake EM Rejection

EM $E_T$	TRACK $P_T$ > 1.5 GEV	TRACK $P_T$ > 1.5 GEV	TRACK $P_T$ > 10 GEV	TRACK $P_T$ > 10 GEV
	Quadrants	Towers	Quadrants	Towers
2 GeV	2470/3711	1100/3711	225/3711	60/3711
5 GeV	103/132	52/132	21/132	11/132
10 GeV	8/12	4/12	2/12	2/12

**~x2 rejection against fake electrons**



# Fake $t$ Rejection

TRACK $P_T$	# SECTORS WITH TRACKS	TOWER $E_T$ > 1 GEV	TOWER $E_T$ > 2 GEV	TOWER $E_T$ > 5 GEV	TOWER $E_T$ > 10 GEV
> 1.5 GeV	52991	16252	3218	200	13
> 3 GeV	12818	5188	1529	144	13
> 5 GeV	4705	1562	476	73	9
> 10 GeV	2243	655	141	31	5

**~x10 rejection against fake taus**



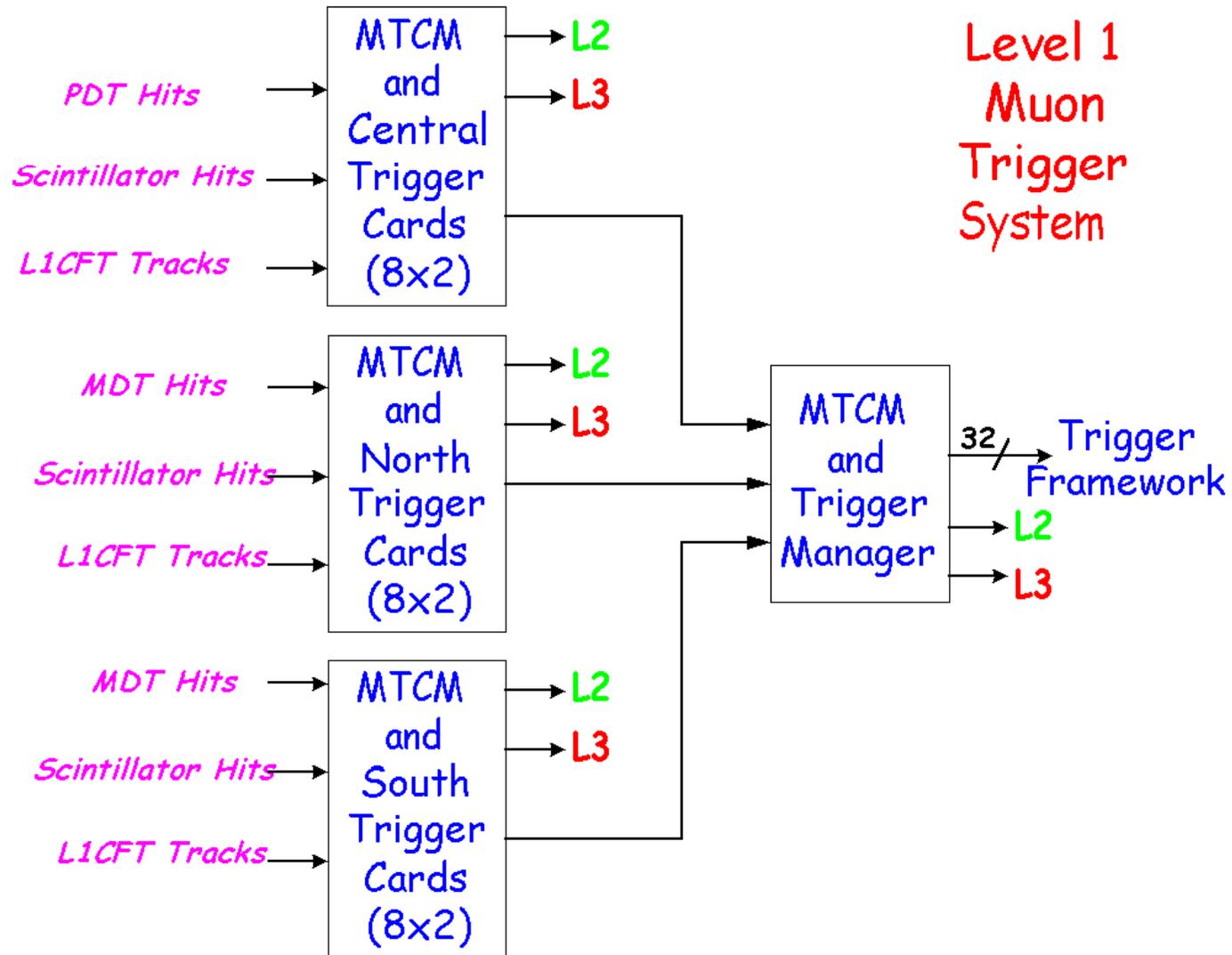
# L1Cal-Track Design Strategy

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- Use the Run II a L1Muo cards/architecture
  - ◆ L1Muo (L1CFT.MuScint) algorithms and processing resemble L1CFT.L1Cal requirements
  - ◆ L1Muo trigger system works with collisions and commissioning is nearly complete
  - ◆ Design considerations such as input synchronization, buffering, output to L2/L3, FPGA programming, and online/offline monitoring are finished with proven, working solutions
  - ◆ Also finished are card testing procedures, power supply packaging, and crate infrastructure
  - ◆ The biggest negative (from our standpoint) is that it is not “shiny and new”



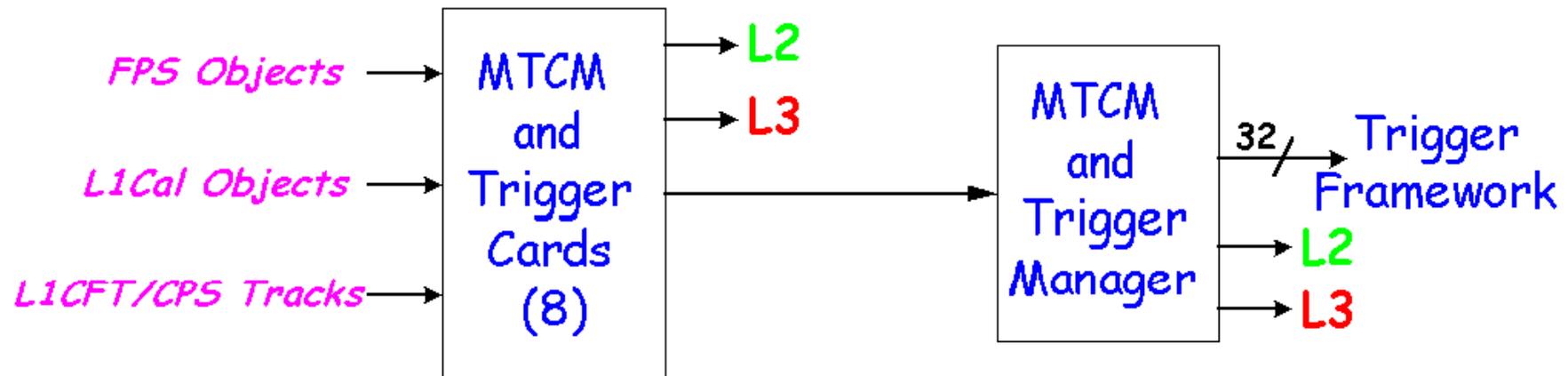
# L1Muo Overview





# L1Cal-Track Overview

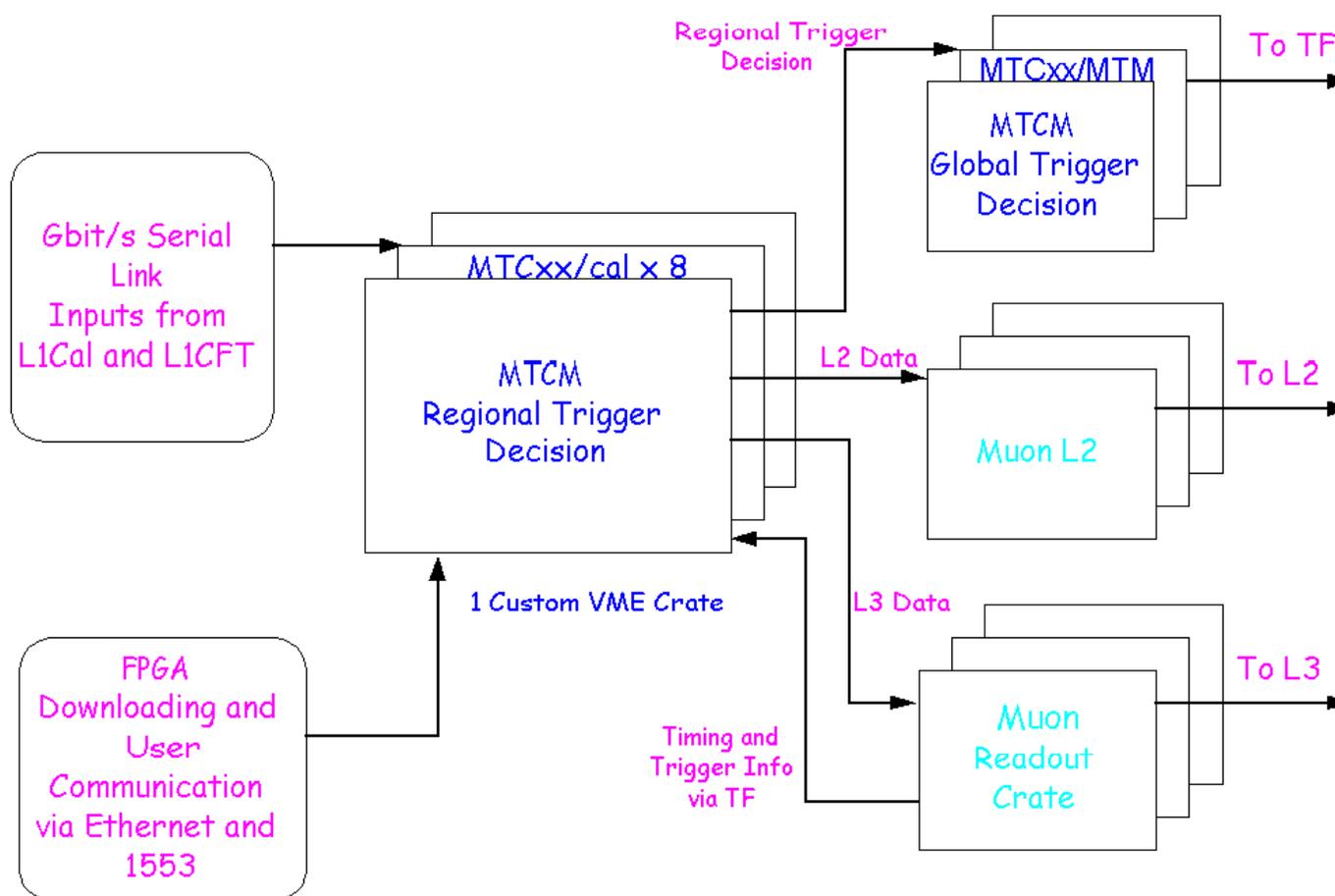
## Level 1 Cal-Track Trigger System





# L1Cal-Track System

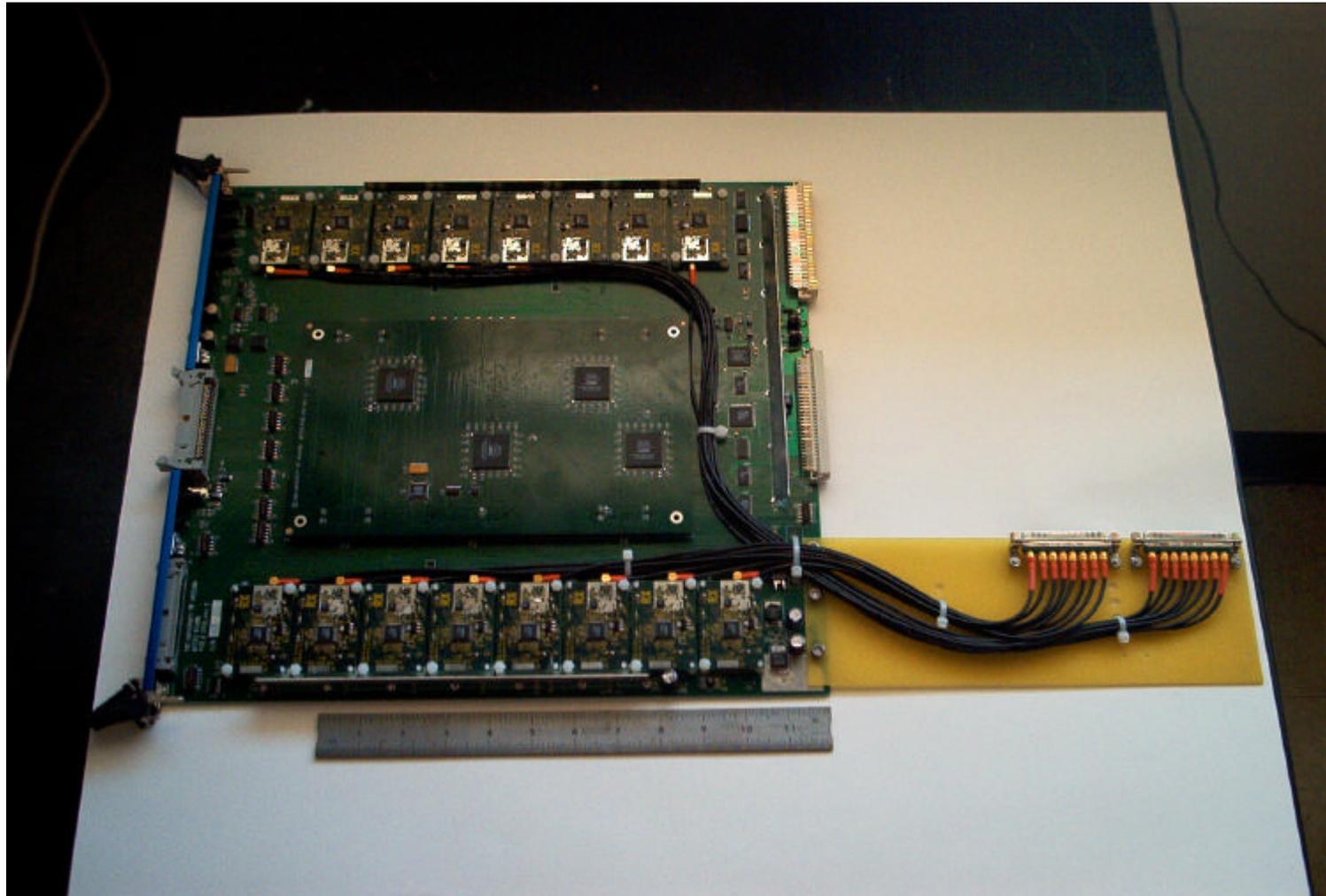
## Level 1 Cal-Track Trigger System





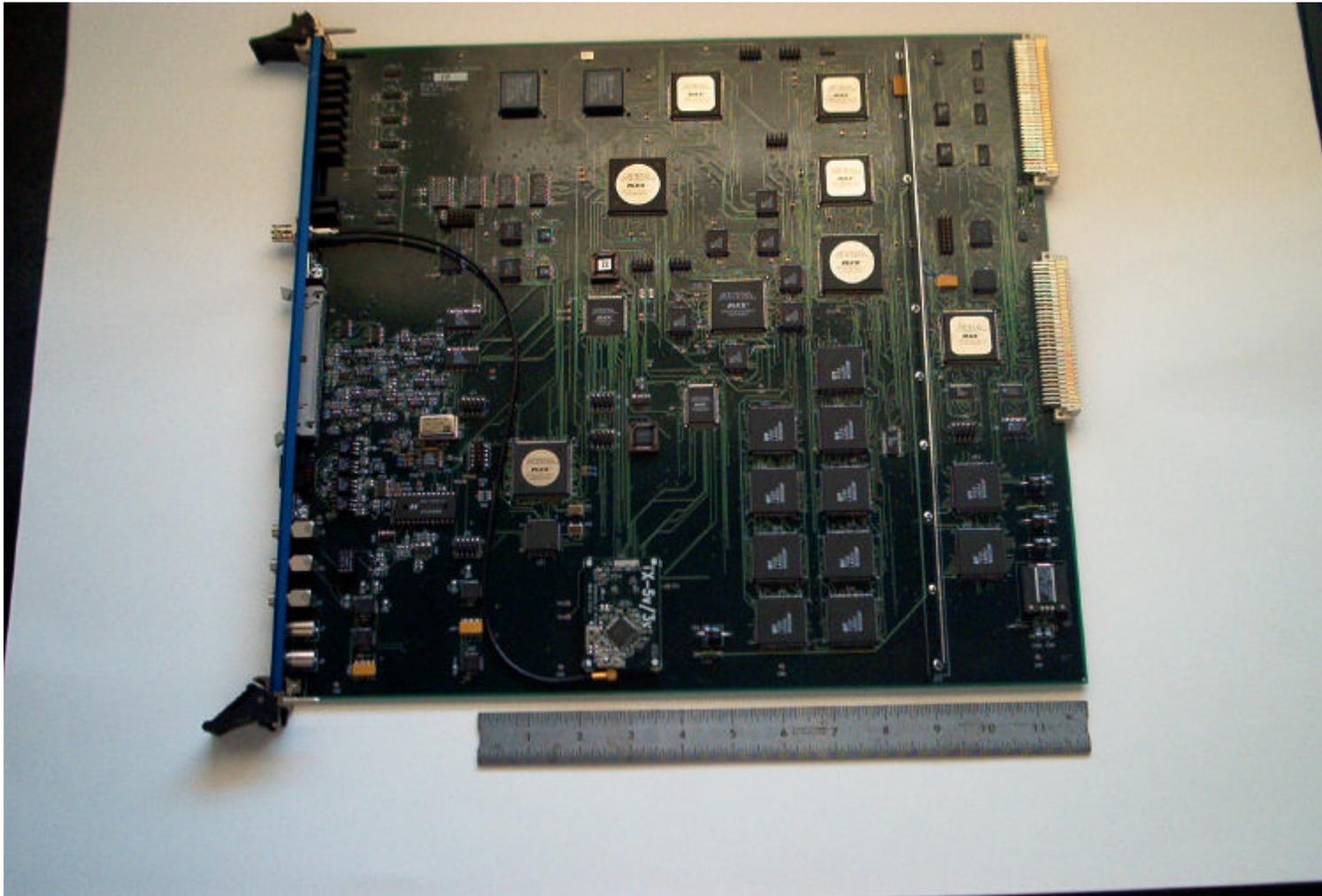
# MTCxx (Trigger Card) with MTFB (Flavor Board)

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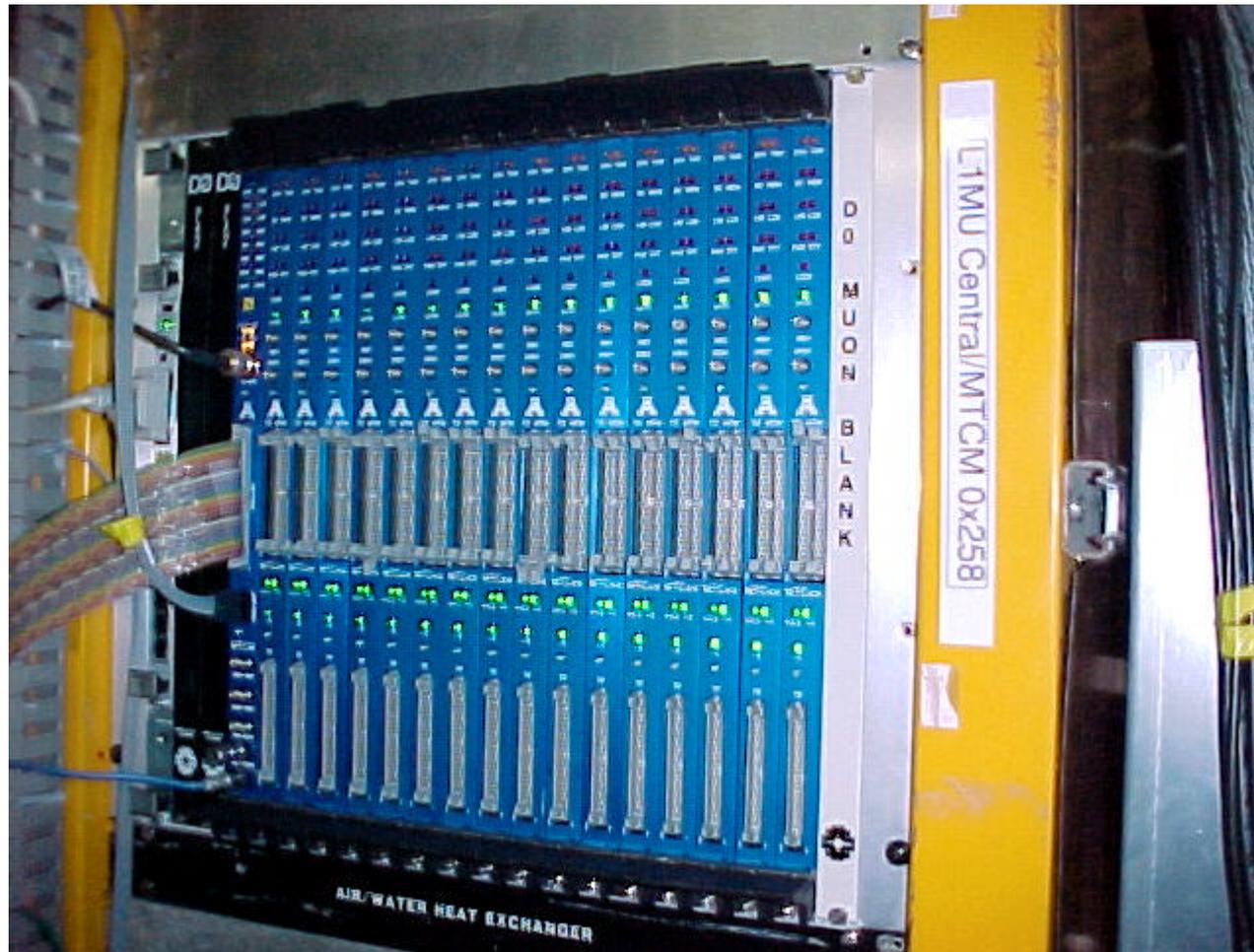


# MTCM (Crate Manager)





# Installed in Collision Hall





# L1Cal-Track Design Mods

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- Replace MTC05 (L1CFT.MuScint match) flavor board with “cyclops” flavor board
  - ◆ One chip receives all inputs, performs all trigger algorithms, and transmits all outputs
  - ◆ Gbit/s serial link output allows skipping the MTCM in the L1 trigger decision chain thus reducing trigger latency
- Add an additional serial receiver to the MTCxx card
- Increase flash memory size on MTCxx (to accommodate “cyclops” FPGA)
- Simplify MTCxx JTAG chain



# L1Cal-Track Trigger Latency

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- In order to achieve comfortable headroom
  - ◆ Increase the L1 trigger decision time by 6 BC's
    - Requires some modification to muon subsystem front ends
    - All other subsystems contain sufficient buffer depth
  - ◆ Bypass the MTCM in the trigger decision chain
    - Not needed since there is only one region (crate)



# L1Cal-Track Latency

ELEMENT	$\Delta$ TIME (ns)	TOTAL TIME (ns)
BC to ADF	650	650
ADF processing	1147	1797
TAB processing	374	2171
L1CFT processing	1592	
MTCxx processing	729	2900
MTM processing and transfer	589	3489
Run II b L1 decision time		4092
Difference		-603



# Manpower

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- Excepting students and postdocs, the manpower for the Run II b L1Cal-Track trigger is the same as that for the Run II a L1Muo trigger
  - ◆ Joel Steinberg - senior EE
  - ◆ Dan Tompkins - junior EE (MSPLIT cards)
  - ◆ Chris Leeman - student technician
  - ◆ Stefan Anderson, Noah Wallace - postdocs
  - ◆ Martin Short, Bryan Gmyrek - grad students
  - ◆ Ken Johns - faculty
- New hire Erich Varnes has also expressed an interest in contributing to this project



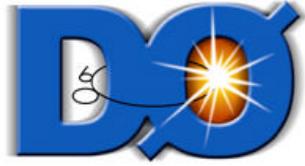
# Cost and Schedule

- **Cost Estimate**

- ◆ A detailed cost estimate is available
- ◆ Based on the Run IIa L1Muo trigger costs x 1.1
- ◆ Supporting spreadsheets are in the BOE binder

- **Schedule**

- ◆ A detailed, cost and resource-loaded schedule is available
- ◆ Based on Run IIa L1Muo production fabrication, assembly, and testing experience
- ◆ An important milestone is an internal design review scheduled for 1/9/03
- ◆ Production cards complete (tested) 6/16/04



# Conclusions

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- L1Cal-Track trigger provides additional L1 trigger rejection for electrons and taus, which are important for Higgs search triggers
- It uses the proven, working architecture of the Run II a L1Muo trigger
  - ◆ Huge savings in design, testing, infrastructure, and commissioning effort
- An experienced team with record of achievement and responsibility is ready go to work