



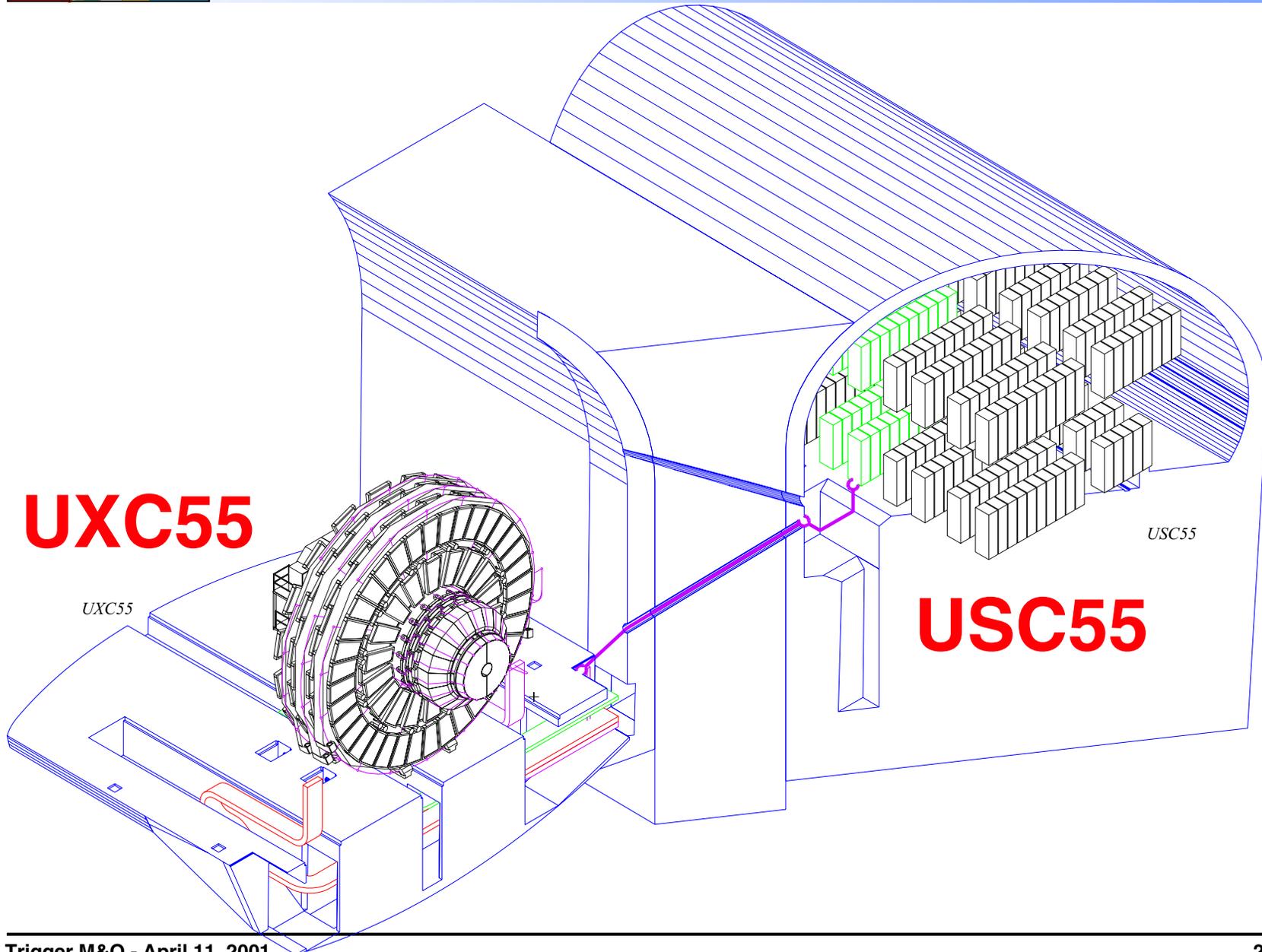
WBS 3.1 - Trigger M&O

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CMS Trigger Project Manager

FNAL Review
April 11, 2001



Trigger System Installation





Trigger L2 Tasks

Tasks	start	finish:
• Produce TDR	8/00	12/00 ✓
• Design Final Prototypes	11/00	12/01
• Construct Final Prototypes	6/01	6/02
• Test/Integrate Final Prototypes	12/01	12/02
• Pre-Production Design & Test	6/02	6/03
• Production	12/02	6/04
• Production Test	6/03	11/04
• Trigger System Tests	5/04	5/05 ←
• Trigger Installation	11/04	11/05 ←
• Integration & Test w/DAQ & FE	3/05	9/05 ←
• Maintenance & Operations	10/05	----- ←

Impact of delayed access to USC55 & UXC55:

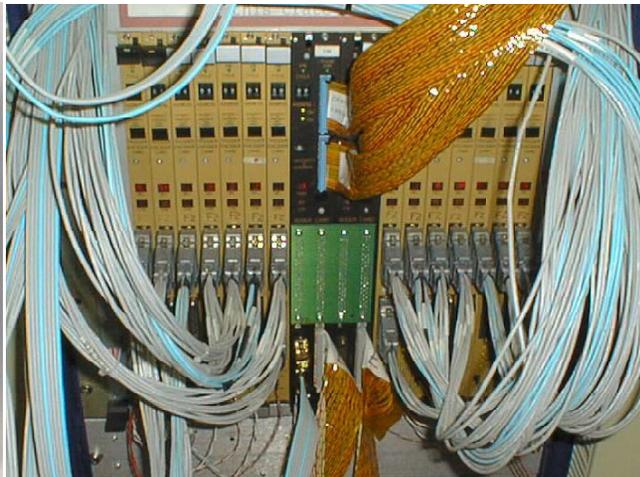
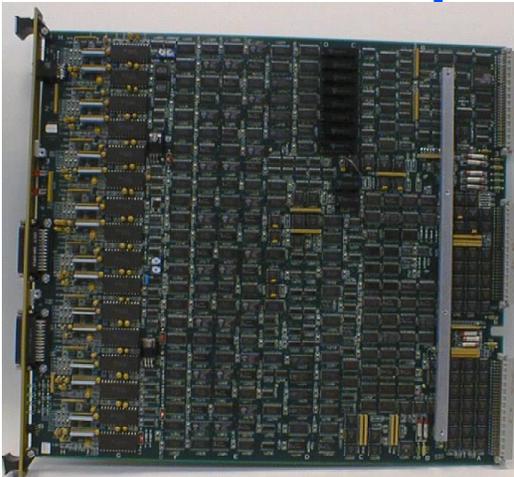
- US EDIA cost increased by \$200K -- CMS cost unchanged
 - 100K each for CSC & Regional Cal Trigger



M&O Basis of Estimate

Zeus Level-1 Calorimeter Trigger

- 16 80 MHz Crates operating on 96 ns xing freq
 - CMS: 18 160 MHz crates at 25 ns xing freq
- 300 370 mm x 400 mm boards w/ 1100 components (75% of board area), 8700 vias
 - CMS: 300 370 mm x 400 mm boards with somewhat greater complexity
- Finds isolated e , μ , jets, E_T , E_{Tmiss}
- Successful operation: 1992 - 2001





Supervisory Personnel

Based on Zeus Cal. Trigger M&O 1992-2001

- Needed each for US CMS Cal. & Muon Trigger Efforts

Ph.D. Physicists (2)

- Assistant Scientist

- Primarily on Physics Analysis
 - Works with students on thesis topics
- Local Group Leader
- Expert on Trigger
 - Available for assistance, consultation, coverage

- Postdoc

- Primary duties on trigger
 - Responsible for daily operations
 - Works with students on trigger duties
- Trigger Coordinator
 - Provides technical coordination
 - Works with other detector leaders



Students

- **Beginning (2)**
 - Learning
 - Trigger shifts (on call 24x7)
- **Intermediate (2)**
 - Responsible for Cal Trig shifts
 - Begin physics analysis
- **Senior (2)**
 - Released for Thesis analysis
 - Consultation, assistance, shifts



**Based
on Zeus
Students**





Technical Personnel

Based on Zeus Cal. Trigger M&O 1992-2001

- Needed each for US CMS Cal. & Muon Trigger Efforts

Technician

- Operates, repairs, maintains test facility
- Repairs boards & infrastructure under physicist guidance
- Total required = 0.5 FTE

Expert Engineer

- ~ 5 trips/year for 2-3 weeks to make difficult repairs

Designer - available for consultation

- ~ 2 trips/year for 2-3 weeks for review & design issues
 - Complicated/Subtle problems
 - Modifications to trigger electronics
- Total Engineering (Expert + Designer) required = 0.5 FTE

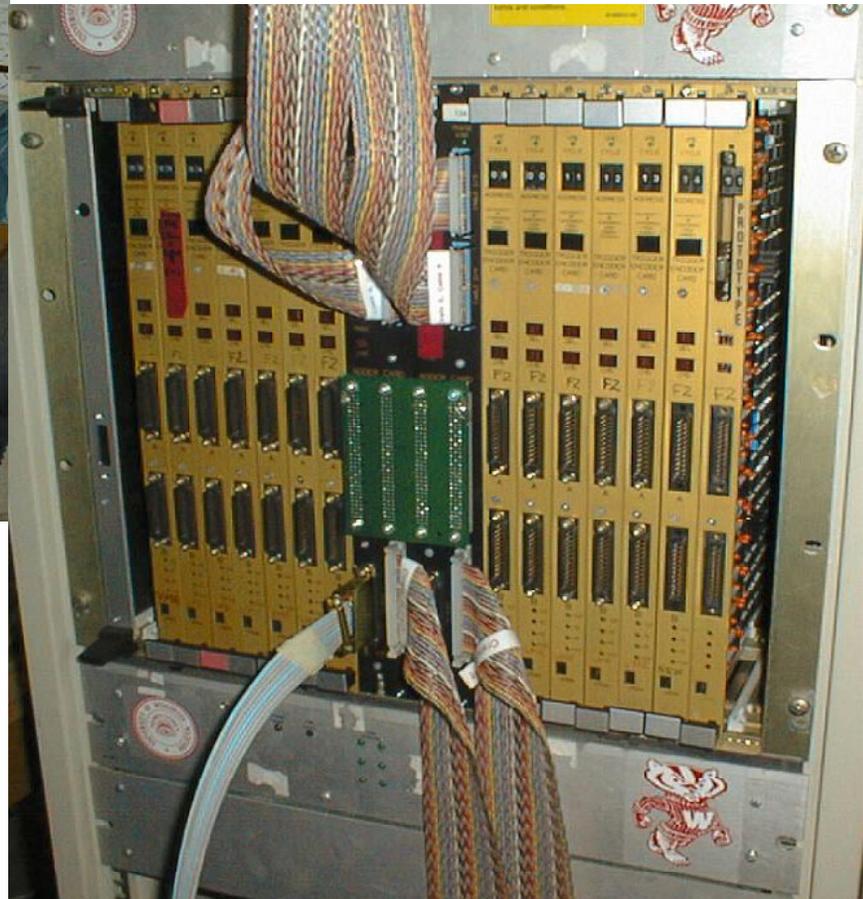


Operation of Test Facility

Based on Zeus Cal Trig:
Trigger electronics test
with full cal. or μ detector
infrastructure and DAQ



Resp. of Technician
Complete test crate &
interface to other
components full-scale
check of USC electronics





Trigger Evolution

Responsibilities of Physicists & Students

- Based on Zeus Cal. Trigger M&O 1992-2001
 - Needed each for US CMS Cal. & Muon Trigger Efforts

Change trigger as beam conditions change

Study new trigger configurations

- Test runs, Monte Carlo studies, data studies

Trigger Physics Analysis

- Understand detailed impact of trigger on physics

Preparation for luminosity increases

- Perform Monte Carlo studies of new conditions
- Validate with present data

Respond to changing apparatus

- Changes in material, configuration, etc.
- Must result in changes in simulation



Trigger Operations

Responsibilities of Physicists & Students

- Based on Zeus Cal. Trigger M&O 1992-2001
 - Needed each for US CMS Cal. & Muon Trigger Efforts

Detector & Electronics House

- Write, test & maintain electronics test programs
- Maintain & update bad channel list
- Diagnose & repair electronics
- Daily checking programs
- Maintain & operate Jade Hall Test Facility
- 24 hour/day support during running

Software Operations

- Run Control maintenance
- Trigger data validation
 - Online & Offline analysis of rates & efficiencies
- Monte Carlo & data trigger simulation maint.



More Physicist/Student Tasks

Trigger Calibration/Maint.

- Frequent calibration is performed with charge injectors to set the time & energy/position
 - Calibration of a single trigger tower trigger vs. full resolution readout data

Online Diagnostic Simulation

- Trigger bits vs. simulation of trigger using reconstructed data as input.
- Each trigger efficiency curve is monitored & checked online.

Real-Time study of Trigger Function

- Need sophisticated online display
- Difference between simulated & data trigger bits set



More Physicist/Student Tasks

Automatic Data Quality Monitor

- **Input:**
 - Online & Offline Trigger Histograms
- **Functions:**
 - Analysis of threshold curves, efficiencies, subtrig. rates
- **Purpose:**
 - Find trigger problems online automatically & rapidly
- **Output:**
 - Error messages, Logs of performance
 - Email/cell-phone call to online calorimeter trigger crew
- **Goal:**
 - Problems found by Automatic DQM before Shift Crew



Web-based Information Server

Panic
Shiftcrew information if there is a [CFLT Emergency](#).

Status
For [CFLT status](#) and DQM information.

Technical
For [Technical Information](#) about the CFLT.

Online
To see the CFLT [online](#) machine web server.

Home
Back to the [CFLT home page](#).

Welcome to the Zeus Cal-FLT Home Page

Phone, Wisconsin Office: 9998-2489
CFLT Handy-phone Hotline: (0177)291-3327

University of Wisconsin, Madison, Wisconsin, U.S.A.

With the following buttons, you can access real-time information from the CFLT hardware:

Wholink **Run Summary** **Summon Daemons** 
Spy Slow Control  **GFLT Rates** **Trace Global**

The CFLT [Long Range Plan](#)

Useful links to other Zeus pages:

Up-to-date performance information

Run by run online & offline analysis

Up-to-date status

Full system documentation

Operation of diagnostics



Summary: M&O Personnel

1 FTE Engineer

- 0.5 FTE ea. for cal. & mu trigger

1 FTE Technician

- 0.5 FTE ea. for cal & mu trigger

4 FTE Ph.D. Physicists

- 2 FTE ea. for cal & mu trigger
- 50% of time on M&O

12 FTE Graduate Students

- 6 FTE ea. for cal & mu trigger
- 25% (effectively) of total tenure on trigger
- Fewer students → more postdocs

All From Base Program Support



Trigger M&O M&S

Diagnostic equipment

- Scopes & probes, logic analyzers, computers, interfaces, etc.
- Construction of additional specialized test boards

Repair equipment & supplies

- Soldering stations (BGA repair), misc. supplies
- Tools, Voltmeters
- Module repair/replacement costs
 - Power supplies, regulators, breakers, thermal sensors, crate CPUs, etc.
- Replacement of broken cables, fiber optics, etc.
- Vehicle lease for hauling back & forth?

Shipping Costs

- Sending items back to US for major work
 - Either to FNAL, University, or manufacturer



Trigger M&O M&S Estimate

Estimated Yearly Cost of 80K\$

- **Based on Zeus Cal. Trigger M&O 1992-2001**
- **40K\$ each for US CMS Cal. & Muon Trigger Efforts**

Total for FY06-FY08: 240K\$



Trigger Upgrades

R&D effort to study upgrades to level-1 trigger to handle luminosity beyond 10^{34}

- May need more sophisticated logic to distinguish physics signals from increased backgrounds
- Upgraded logic will have to operate in same amount of time as present logic
 - Increase in speed to provide more sophisticated algorithms

R&D effort to study upgrades to level-1 trigger to handle changes in bunch crossing time

- Possibility of increase from 25 ns to 12.5 ns
 - Detector response times are slower than 25 ns crossing time
 - In some cases (e.g. HCAL & ECAL), timing information is sufficiently precise to identify 12.5 ns crossings.
 - Upgrade to trigger logic to allow analysis of 12.5 ns crossings



Trigger Upgrade R&D Program

**Based on experience with CMS Level-1
trigger R&D & prototype program**

Personnel requirements

- **1 FTE Engineer from Project**
 - Engineering Design
 - 0.5 FTE ea. for cal. & mu trigger
 - Could be other "half" of engineer on M&O
- **1 FTE Ph.D. Physicist from base program**
 - Simulation & Design Studies
 - 0.5 FTE ea. for cal & mu trigger

M&S Requirements

- **\$40K/year for Prototypes**
 - \$20K ea. for cal. & mu trigger
 - ~ 2 prototype boards (\$10K ea.) per year for cal. & mu



Trigger Upgrade Estimate

Estimated Yearly Cost of 120K\$

- **M&S of 40K\$ for prototyping**
- **EDIA of 80K\$ for engineering**

Total for FY06-FY08: 360K\$