Outline

• Overview of Calorimeter Trigger
• Calorimeter Trigger Status & Technical Progress
• Overview of Muon Trigger
• Muon Trigger Status & Technical Progress
• Scope and Contingency Since Last Review
• Committee Concerns and Issues
• Plans
• Summary and Conclusions
Data from calorimeter FE on Cu links @ 1.2 Gbaud (ptyp. tstd.)

- Into 152 rear-mounted Receiver Cards (ptyp. tstd. w/ ASICs)

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

- 19 Clock&Control (ptyp. tstd.), 152 Electron ID (ptyp. tstd.)
  19 Jet/Summary, Receiver Cards operate @ 160 MHz
Cal. Trigger Dataflow Test

Functional Proof of Principle

Prototype Crate with
- 160 MHz Backplane
- Proto. Receiver Card (rear)
  - incl. Adder ASICs
- Proto. Clock Card (front)
- Proto. Electron ID Card (front)

160 MHz function/dataflow verified
Serial Link Test Card includes VME, memories & comparison circuitry to fully test serial links @ 120 MHz TTL from Mezzanine Cards. (U. Wisconsin)
Tests over 20 m copper cable

- PRELIMINARY!
- Vitesse 7214 4 x Gigabit Interconnect chip
- twisted pair cables (Belden 9182 (150 ohm, 22AWG, foamed dielectric, twin-ax) grouped by fours & terminated with 8-pin DIN style connectors $318 per 500 foot spool ($2.10 per meter).
Muon Proto. Port Card passed design review in Oct. Will be produced for summer pilot test (Rice)

Optical component test board based on HP G-Link demonstrated synchronous 1 Gbit/sec using 40 MHz clock with bit error rate < $10^{-14}$ for connection from Muon Port Card in peripheral crates on detector to Sector Receiver in counting Room track finder crate (Rice)
Sector Processor Prototype

VME/JTAG interface (under development)

- Bunch Crossing Analyzer
- Extrapolation Units
- Track Assembler Units
- Final Selection Unit
- Assignment Units

- XCV50BG256
- XCV400BG560
- SRAM
- XCV150BG352

Custom ChannelLink backplane

- Layout complete
- 12 layers
- Tests set for 6/1/00
### WBS 1.3.1 TRIGGER

<table>
<thead>
<tr>
<th>Cumulative BCWP/BCWS and Obligations Variance</th>
<th>$2,000,000</th>
<th>$1,500,000</th>
<th>$1,000,000</th>
<th>$500,000</th>
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<th>$500,000</th>
<th>$1,000,000</th>
<th>$1,500,000</th>
<th>$2,000,000</th>
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#### Schedule Variance

- Jul-02: $599,812
- Aug-02: ($85,467)
- Sep-02: ($82,194)
- Oct-02: ($110,063)
- Nov-02: ($116,801)
- Dec-02: ($102,403)
- Jan-03: ($775,501)
- Feb-03: ($626,509)
- Mar-03: ($621,036)
- Apr-03: ($622,259)
- May-03: ($622,509)
- Jun-03: ($622,509)
- Jul-03: ($622,509)
- Aug-03: ($622,509)
- Sep-03: ($622,509)
- Oct-03: ($622,509)
- Nov-03: ($622,509)
- Dec-03: ($622,509)
- Jan-04: ($622,509)
- Feb-04: ($622,509)

#### Obligation Variance

- Jul-02: $148,865
- Aug-02: $152,313
- Sep-02: ($103,757)
- Oct-02: ($92,267)
- Nov-02: ($38,738)
- Dec-02: ($38,826)
- Jan-03: ($179,056)
- Feb-03: ($224,512)
- Mar-03: ($296,892)
- Apr-03: ($476,066)
- May-03: ($325,042)
- Jun-03: ($229,827)
- Jul-03: ($268,131)
- Aug-03: ($296,892)
- Sep-03: ($275,501)
- Oct-03: ($271,144)
- Nov-03: ($102,403)
- Dec-03: ($342,328)
- Jan-04: ($358,497)
- Feb-04: ($416,042)

#### Adjusted OV

- Jul-02: ($222,509)
- Aug-02: ($222,509)
- Sep-02: ($222,509)
- Oct-02: ($222,509)
- Nov-02: ($222,509)
- Dec-02: ($222,509)
- Jan-03: ($222,509)
- Feb-03: ($222,509)
- Mar-03: ($222,509)
- Apr-03: ($222,509)
- May-03: ($222,509)
- Jun-03: ($222,509)
- Jul-03: ($222,509)
- Aug-03: ($222,509)
- Sep-03: ($222,509)
- Oct-03: ($222,509)
- Nov-03: ($222,509)
- Dec-03: ($222,509)
- Jan-04: ($222,509)
- Feb-04: ($222,509)

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**Cumulative BCWP/BCWS = 85% indicating little schedule slippage.**

**Trigger subsystem has completed BCWP/EAC = 22% of the project.**

**Schedule slip for ASIC development corrected by securing vendor contract**

**Obligation of ASICs under contract, not invoiced**

**Corrected for DAQ attribution to Trigger**

**Schedule slip for Muon Trigger boards corrected this year by new personnel**
Engineering and Technical resources are compared to the people called out in the annual SOW. This tracking ensures that the needed labor is deployed.
No significant contingency use thus far (note scale)

Obligation of ASICs under contract at small increase over original estimate

Schedule advanced for ASIC purchases, reducing escalation
## Trig. - Estimate to Complete

<table>
<thead>
<tr>
<th>WBS Number</th>
<th>Description</th>
<th>EDIA (k$)</th>
<th>M&amp;S (k$)</th>
<th>Mfg Labor (k$)</th>
<th>Base Cost (k$)</th>
<th>Cont (k$)</th>
<th>Cont (%)</th>
<th>Total Cost (k$)</th>
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<td>FY96-FY99 (AY$)</td>
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<td>Escalation (DOE January 2000 indices)</td>
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<td>Trigger and Data Acquisition</td>
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</table>

### Trigger Cost to Complete:

- **EDIA**: $1,972,470 (35%)
- **M&S**: $3,706,467 (65%)

**Total**: $5.7 M
Trigger - Yearly BCWS

Costs ramp up until production, the bulk of which happens in FY02. M&S costs dominate at 65% of the ETC.

Trigger BCWS by FY
Critical Level 1 Milestone is TDR, planned for year end. TDR will have schedule for trigger project with tie points to CMS subsystems approved by CMS management & LHCC.

<table>
<thead>
<tr>
<th>ID</th>
<th>Level?</th>
<th>Milestone</th>
<th>Variance</th>
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<tr>
<td>TRIG</td>
<td>ML3</td>
<td>Sector Receiver Initial System Design Docum</td>
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<tr>
<td>TRIG</td>
<td>ML3</td>
<td>Sector Processor Initial System Design Docum</td>
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<tr>
<td>TRIG</td>
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<td>Muon Port Card Prototype Design (Rice)</td>
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<tr>
<td>TRIG</td>
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<td>Sector Receiver Prototype Design (UCLA)</td>
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<td>TRIG</td>
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<td>TRIG</td>
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<tr>
<td>TRIG</td>
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<tr>
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<td>Submit Trigger Technical Design Report (TDR)</td>
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<tr>
<td>TRIG</td>
<td>ML3</td>
<td>Review of integration of calorimeter trigger</td>
<td>0 days</td>
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</table>
Last Review Concerns

Increase Physicist Effort

- **Calorimeter Trigger: Wisconsin:**
  - Faculty Search involving CMS Trigger Effort
- **Muon Trigger**
  - Florida & UCLA: support for postdoc continuing
  - UCLA: Prof. Bob Cousins joins

Increase Engineering Effort

- **Wisconsin:** add engineer (now 4 FTE available)
- **Florida:** add engineer + 3 PNPI visitors (3.5 FTE*)
- **Rice:** add 1/2 engineer (2.5 FTE*) (*shared w/EMU)
- **UCLA:** add engineer + FPGA consultant (1 FTE)
Issues from Last Review

Calorimeter Trigger:

- Serial link from E/HCAL readout
  - Test results provide proof of principle
- Vendor Support for ASICs
  - Contract signed with Vitesse for all ASICs
- Final Algorithms & Tower Geometry
  - Agreed and being written up in TDR

Muon Trigger

- Peripheral Crates:
  - Plan developed: crate electronics & mounting
- Overlap Region btw. CSC & Drift Tube
  - Agreement with Vienna on design
Plans for this year

Muon Trigger:

- Construct & test prototype port card, sector receiver, sector processor, clock card, backplane
- Integration test of above components with each other and EMU prototypes

Calorimeter Trigger

- Complete & test prototype Phase, Boundary Scan, Sort, Electron ID ASIC’s w/Vitesse
- Produce and test 2nd prototype Receiver Card, Backplane, Electron ID Cards w/ ASICs

Trigger Group

- Write TDR
Conclusions - Trigger

Calorimeter Trigger Prototype Program

• Adder ASIC tested and in production
• Phase, Bscan ASIC passed design review
• Prototype Receiver Card, Electron ID Card, Backplane tested

Muon Trigger Prototype Program

• Ready by June: Port Card, Sector Receiver, Sector Processor, Backplane, Clock Board
• Track-finder integration test this summer

Project Management:

• Good cost experience thus far
• Effective action taken to recover schedule