

# **Getting Close to 4718 Without the Level 2 Muon Interface**

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# The Problem

- **Biggest difference between draft Phase 1 table and 4718 is rates for single- and di-muon triggers**
  - 250 nb L2 rate → 2500 nb
  - Also missing some trigger paths
- **Other rate problems fixed by getting existing hardware to work**
  - Iso
  - Reces
- **Budget**
  - Phase 1: 6000 nb @ 0.5e32
  - 4718: 3000 nb @ 1e32

# The Problem, II

- **Rates are a problem because Level 1 is simple**
  - **Doing job according to spec!**
  - **Need to keep 4 GeV CMUP muons and all dimuons for Bottom and Exotic paths**
  - **Expect tighter cut on dimuons that L2 can't yet deliver**
  - **For dimuons need to assure there are 2 tracks and 2 stubs**
    - **L1 logic does not enforce this**
    - **Shown to be the reason CMU-CMU rates are high**
    - **Run 1 experience leads us to believe this is why CMU-CMX rates are high**

# The Physics Spec

- **Dimuons for  $J/\psi$  and rare B decays**
  - **Low  $p_T$ , opposite charge, not back-to-back**
- **Inclusive single muons for W, Z, t,  $\tilde{x}$** 
  - **8 or 12 GeV threshold**
- **Intermediate muons plus lepton or track for Susy, B**
  - **4 GeV threshold**
  - **need correlations between muon and track**
  - **This is what's been missing**
- **Rejection that is “good enough”**

# Muon ID in the Trigger

- **A muon is the association between a stub and a track**
- **Granularity**
  - **Run 1: 3 towers per wedge**
  - **Level 1: 6 towers per wedge**
  - **Level 2: 12 towers per wedge**
- **CMUP**
  - **Match to CMU tower in L1**
  - **Match to track in L2**

# Muon ID in the Trigger

- **Why fine granularity?**
  - **For dimuons, get high-pt and low mass pairs**
    - **Already seen we need to increase separation cut**
  - **For single muons reduce random combinations**
    - **But big L2 improvement comes by matching to CMP stacks**
    - **Best discriminant is  $p_T$ !**
  - **3-tower (a.k.a.  $5^\circ$ ) granularity worked in Run 1 and would good enough for now**
- **Two hardware facts**
  - **Masks for high- $p_T$  and low- $p_T$  stubs handled on separate lookups of XTRP**
    - **Fully programmable in XTRP and matchbox**
  - **Matchbox writes out 40 L1 bits each crossing**
    - **20 go to Prefred**

# Level 1 Can Deliver!

- **Reduce granularity to 3 per wedge**
  - **Bit pairs (0,1) (2,3) (4,5) are identical copies for each type**
    - **CMU high, low; CMX high, low**
    - **Stub found in 5-degree tower, i.e. 4-to-1 OR of physical towers**
  - **Low- $p_T$** 
    - **Bits 0,2,4 for negative tracks**
    - **Bits 1,3,5 for positive tracks**
    - **Guarantee 2 tracks!**
  - **High  $p_T$** 
    - **Bits 0,2,4 for intermediate (e.g. 4 GeV) track**
    - **Bits 1,3,5 for high-pt (e.g. 8 GeV) track for inclusive triggers**

# Correlations

- **Use 2<sup>nd</sup> set of 20 bit for info to send to L2**
  - **Input via Level 1 card in L2 decision crate**
    - **Wide LVDS bus read once per cycle**
    - **Send data from Muon Prefred**
  - **12 bits give 30-degree wedge with 4 GeV CMUP muon**
    - **Use for correlations with tracks (isolated or displaced)**
  - **Additional 8 bits for refinements of L1 cuts**
    - **Example: Two 4 GeV CMUP, Df on dimuons**
    - **Can move to prefred bits if available**
  - **Outstanding issue is how do drive from trigger table**
    - **Solvable in finite time**

# Proposed Muon Bits

- **Prefred**

- Two CMU: low, opp Q
- Two CMX: low, opp Q
- CMU-CMX: opp Q
- Single CMUP 4
- Single CMUP 8
- Single CMX 8
- Single CMU low (for mg)
- Single CMX low
- IMU (for tests)
- Cosmics
- Monopole
- Gap muon
- Single track (for tests)

- **Level 2**

- 12 CMUP wedges
- Two-CMUP4
- Two-CMX4
- CMUP4-CMX4
- 3 bits for dimuons with Df cut
- CMUP+CMU stub
  - **For efficiency studies**
- CMUP+CMX stub