USCMS HCALTriDAS

Synchronization

- Policy: HCAL will follow ECAL as much as possible
  - Same TTC distribution system
    - 6 TTCvi/TTCex, optical splitting, etc.
    - LVDS fanout from HRC (HCAL Readout Control) card to 18 HTR cards
      - might use coax limo connectors tho….
  - Use sync histogram technique to monitor phase stability in situ

- Will try to estimate where we are different from ECAL
  - pulse shape
  - occupancies
  - delays

- Overall guess:
  - we will be ok if ECAL is ok!

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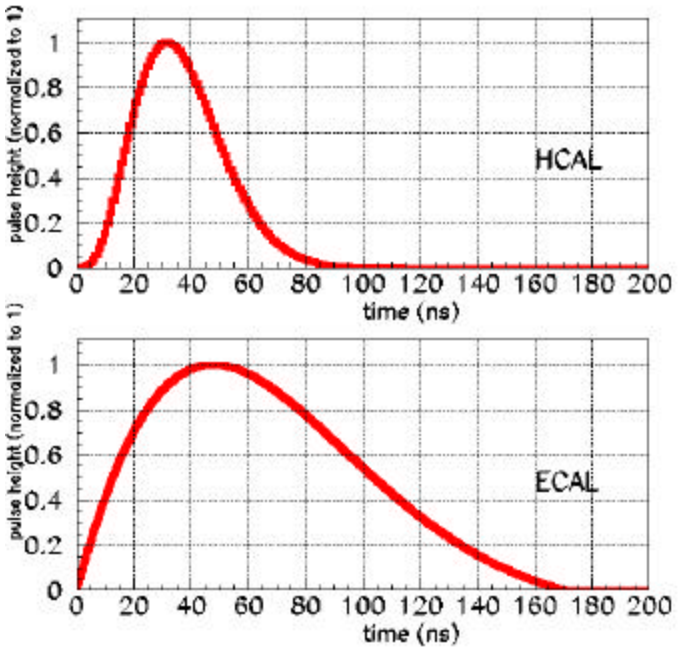
QIE Output

- QIE clock control ASIC (CCA)
  - clock skewing by 1ns over 25ns
  - jitter is 150-200 ps
- Crossing determination algorithm:
  - $P_3+P_4+P_5-1.5x(P_1+P_2)$
  - FPGA will select when data is consistent with expected shape



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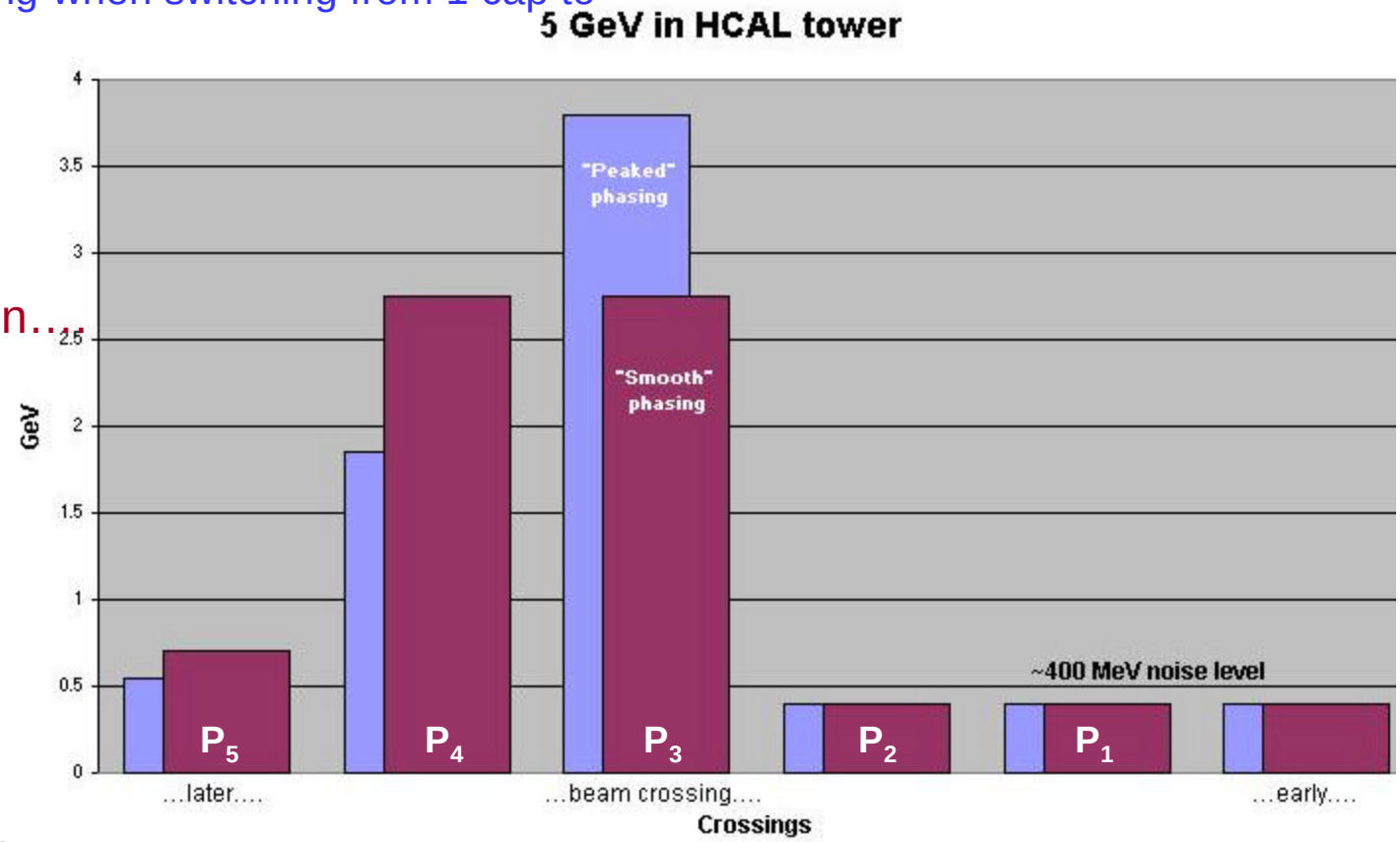
CCA phasing

- Can adjust CCA to give “smooth” profile
  - .0 .0 .47 .47 .06
  - this profile minimizes charge loss inside QIE
    - slow down slewing when switching from 1 cap to the other
- or a “peaked” profile
  - .0 .0 .68 .29 .03
  - perhaps easier for crossing determination…



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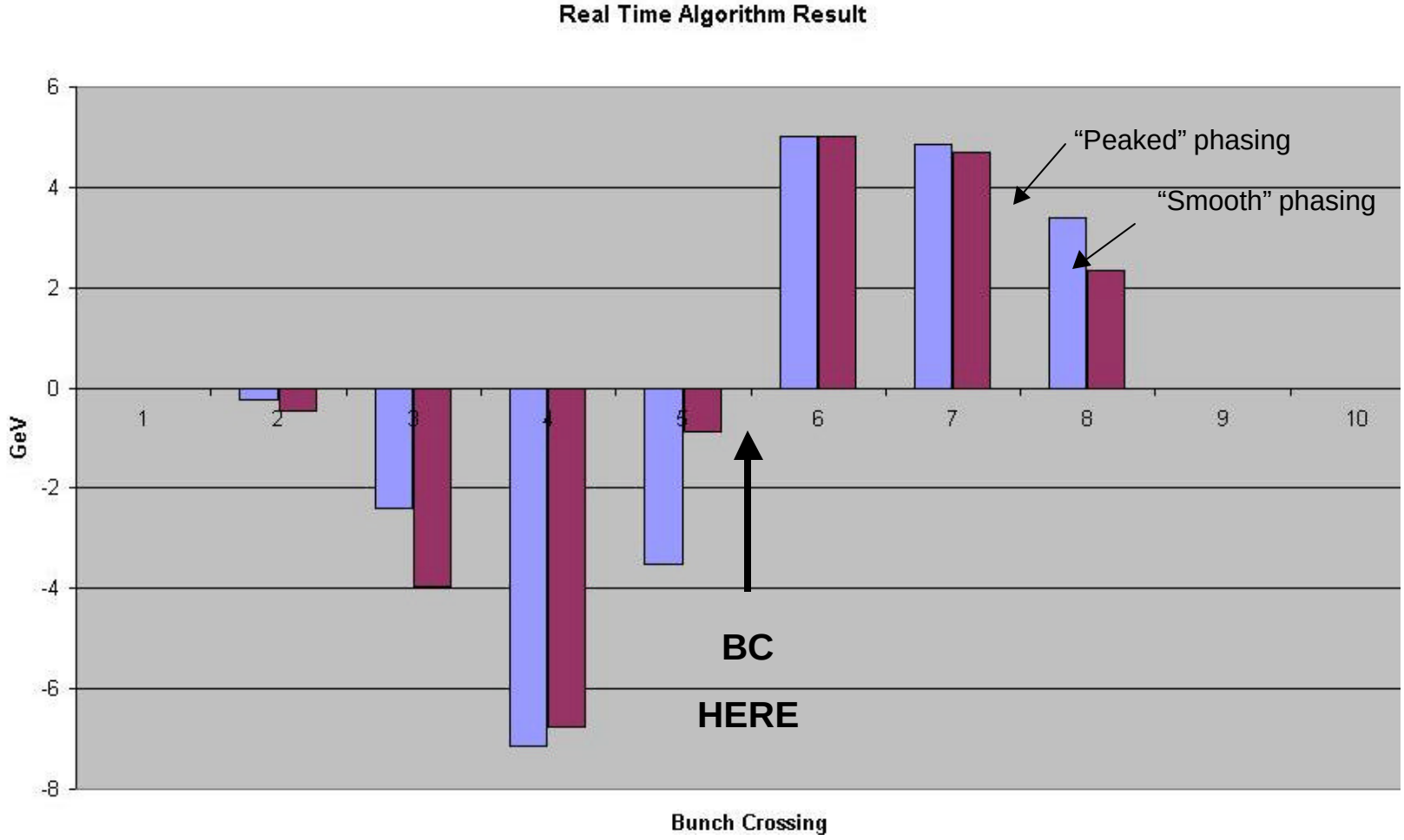
Crossing Determination

- For L1 Trigger, use a simple algorithm:
  - TT = $-{}^{3}/_{2}(P_1+P_2) + P_3 + P_4 + P_5$
  - look for large change - tags beam TT E_T consistent with beam crossing



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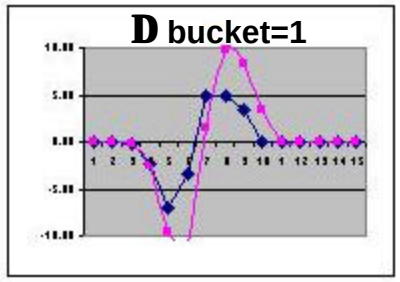
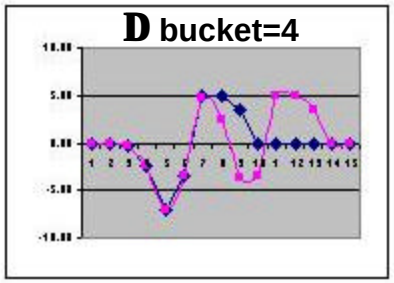
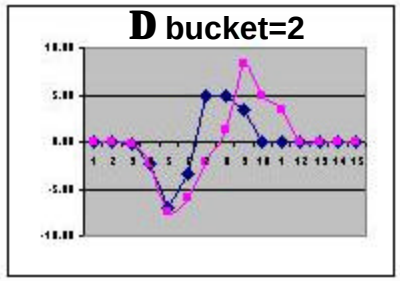
Pileup

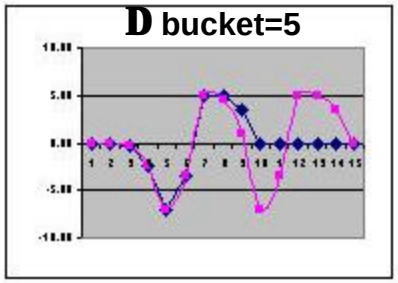
- Can't distinguish hits separated by 1 or 2 buckets, but 3 or greater ok…
  - due to signal being spread over 3 buckets

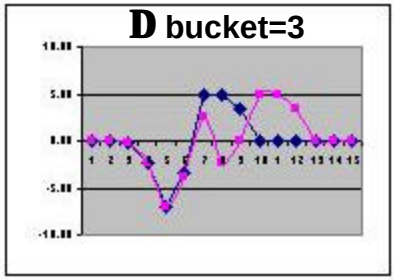
"Smooth" phasing











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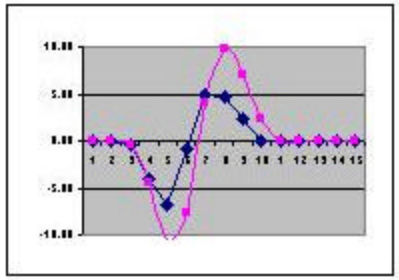
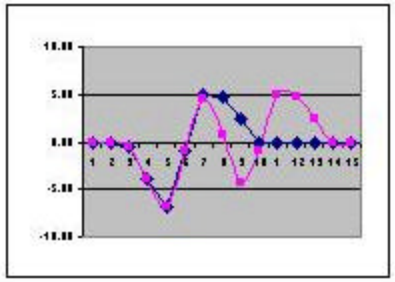
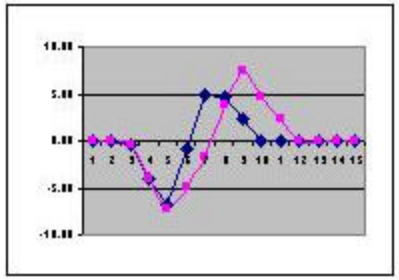
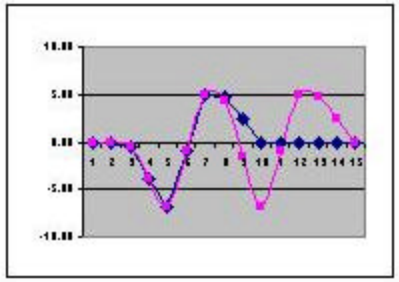
Pileup (cont)

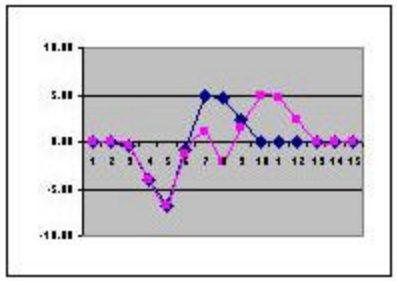
“Peak” phasing











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HCAL Occupancies

- HCAL estimates occupancy at 10% for 200 MeV E_T @ 10^{34}
- HCAL needs enough large energy hits (photo statistics) for L1 threshold to get high photo statistics for synchronization histogram:
  - 10 photo-electrons per GeV **energy**
  - plenty, since we're using E_T for the histogram sync (except perhaps at η=0)
- 10^{34} min bias spectrum falls exponentially with E_T:
  - HB ($0<\eta<1.4$) $P(E_T) \sim e^{-4.9E_T}$
    - from .2 to 3.0 GeV, probability drops by about 10^{-6}
    - occupancy @ 10^{34} is therefore ~10^{-7}
    - takes 10^7 buckets to get 1 hit, need 10 hits, want 10 hits in all ~3000 buckets
    - therefore takes ~3×10^{11} buckets, or about 3 hours
  - HE ($1.4<\eta<3.0$) $P(E_T) \sim e^{-6.4E_T}$
    - photo statistics is in E, not E_T so relax to 2 GeV to get similar numbers as HB

Delays

- HCAL will use same algorithms as ECAL
  - same FPGA techniques too!
  - HCAL adds far fewer towers to make TPG than ECAL
  - Expect delays to be same, or smaller, than ECAL
- Laser Pulsing
  - same techniques as ECAL