L0 Bandwidth Division Update

Eduardo Rodrigues, CERN

- Physics channels under study and set-up
- Pile-up veto and L0 efficiencies
- Di-muon trigger and L0 efficiencies
- Offline selection and L0 efficiencies
- Status of the L0 bandwidth division
Physics Channels and Set-up

Physics channels studied:

- $B_s \rightarrow J/\Psi(\mu\mu) \phi (KK)$
- $B_s \rightarrow J/\Psi(\text{ee}) \phi (KK)$
- $B_d \rightarrow \pi \pi$
- $B_d \rightarrow K K$
- $B_s \rightarrow D_s(KK\pi) K$
- $B_s \rightarrow D_s(KK\pi) \pi$
- $B_d \rightarrow K^* \gamma$

- only for true single interaction events for signal channels
- all minimum bias events

Procedure for the L0 bandwidth division:

- keep always a fixed L0 output rate of 1 MHz on minimum bias events
  - For each physics channel ...
    - vary the parameter space of the different L0 thresholds (1 per sub-trigger + veto)
    - find point(s) of highest L0 efficiency (wrt offline selected events)
- determine point where the sum of the relative losses per channel is minimum overall
Pile-up Veto Scenarios

**Pile-up veto helps selecting:**
- preferentially single interaction events
- less complicated events

**It was concluded (reminder):**
- pile-up veto helps increasing the L0 efficiencies on (most) signal events (it allows to decrease the thresholds)
- cut at sumPeak2 of 2 is preferred by some hadronic channels
- cut at sumPeak2 of 3 is preferred by $J/\Psi$ $\phi$ channels
L0 Efficiencies with no Pile-up Veto if $\text{sumPeak2} < 2,3$

- $B_s \rightarrow J/\psi(\mu\mu) \varphi(KK)$
- $B_s \rightarrow J/\psi(ee) \varphi(KK)$
- $B_s \rightarrow \pi\pi$
- $B_s \rightarrow K\bar{K}$
- $B_s \rightarrow D_s(K\bar{K}\pi)\pi$
- $B_s \rightarrow D_s(K\bar{K}\pi)K$
- $B_s \rightarrow K(K\bar{K})\gamma$
- $B_s \rightarrow K(K\bar{K})\gamma$

min. bias all interactions
no pile-up veto if $\text{sumPeak2} < 2$
single int. for signal

L0 $P_t^\mu$ (GeV)

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Eduardo Rodrigues
It was concluded (reminder):
- di-muon trigger has clear impact on the $B_s \rightarrow J/\Psi(\mu\mu) \phi (KK)$ channel
- by decreasing the di-muon threshold one can use a harder pile-up veto (cut on sumPeak2 at 2), and recuperate some loss in efficiency (a softer cut at 3 is preferred for this channel but not by some hadronic channels)

No di-muon trigger!
Offline Selection and L0 Efficiencies

How to get the best overall yield?

min. bias all interactions
no pile-up veto if sumPeak2 < 2
single int. for signal
Bandwidth Division – Status (I)

single interactions
no pile-up veto if sumPeak2 < 2

LO $p_T$ (GeV)

relative LO efficiency loss (%)
Bandwidth Division – Status (II)

Situation at present:

• Tuning was done on (true) single int. events ...
• cut on the 2nd pile-up veto peak chosen at 2

<table>
<thead>
<tr>
<th>L0 trigger</th>
<th>$E_T^{\text{had}}$</th>
<th>$E_T^{\mu}$</th>
<th>$E_T^e$</th>
<th>$E_T^{\gamma}$</th>
<th>$E_T^{\mu\mu}$</th>
<th>$\pi^0$ <em>global</em></th>
<th>$\pi^0$ <em>local</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Thresholds (GeV)</td>
<td>3.23</td>
<td>0.92</td>
<td>2.85</td>
<td>3.0</td>
<td>2.5</td>
<td>4.1</td>
<td>4.6</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>L0 eff. (%)</th>
<th>$\pi\pi$</th>
<th>KK</th>
<th>$J/\Psi(\mu\mu)$ $\phi$</th>
<th>$J/\Psi( \mu\mu)$ $\phi$</th>
<th>$D_s K$</th>
<th>$D_s \pi$</th>
<th>$K^* \gamma$</th>
</tr>
</thead>
<tbody>
<tr>
<td>true singles</td>
<td>65</td>
<td>60</td>
<td>91</td>
<td>49</td>
<td>47</td>
<td>46</td>
<td>76</td>
</tr>
<tr>
<td>all int.</td>
<td>55</td>
<td>51</td>
<td>89</td>
<td>42</td>
<td>41</td>
<td>-</td>
<td>66</td>
</tr>
</tbody>
</table>

... how will the situation change when looking at single events visible in the detector?

⇒ pile-up veto will tend to be “softer”?
⇒ and if one wants to select multiple interactions as well?
Outlook and Future Plans

- L0 bandwidth division and tuning studies progress along with improvements on the B-physics selections
- L0 efficiencies are now at the level of the TP (for most channels)
- BwD tuning done up-to-now on (true) single interaction events ... tuning on all signal events is under way ...
- Also starting to look at visible singles rather than true singles (in view of the results on the annual yields to be presented to the LHCC)

Open questions to investigate:
1) pile-up veto ↔ visible singles / multiple interactions
2) 75ns versus 25ns running ↔ L0 robustness / losses in efficiency
3) "the question": what is the best L0 scenario to maximize the total B-yield?