L0 Bandwidth Division for the TDR

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I. L0 optimization: set-up and method

- set-up and method
- combination of channels -> overall trigger optimization

II. L0 optimization on trigger efficiency without tagging information

- (sub-)trigger performance for individual signal channels
- optimal trigger performance and bandwidth division

IV. Conclusions and final remarks

L0 Optimization – Set-up and Method

- **Outcome of latest discussions:**
  - samples too small to perform a reliable optimization on the trigger power
    (i.e. including tagging information)
    -> larger statistics requested to be produced for a restricted set of "representative channels"
  - for the time being, L0 optimization to be performed without tagging information …

- **Changes in set-up:**
  - ✓ cut on veto's height of second peak fixed at 3
    -> L0xL1 efficiency improves, in particular for hadronig channels (refer to Massi's presentations for more details)
  - ✓ di-muon trigger also allowed to override the SPD & Pile-up veto multiplicity cuts
    (refer to Massi's presentations for further details and justification)
  - ✓ optimizing on selected events
  - ✓ optimizing on the trigger efficiency
  - ✓ cuts on the π^0 local and global triggers fixed to 4.5 and 4.0 GeV respectively (-> small bandwidth)

L0 optimization – Combination of Channels

- Present scenario: some channels representative of each type of measurement
  - ➔ each of the 5 groups is optimized separately
  - ➔ optimization such that each group has the same loss in performance
    = equal LHCb performance on each type of measurement

Quantity measured	Channel(s)	# events	# off. sel. events	# off. selelcted events for optimization
α	$B_d \rightarrow \pi\pi$	49 k	3374	1690
β	$B_d \rightarrow J/\Psi(\mu\mu/ee)\ K_s$	99 k	1531	773
γ	$B_s \rightarrow D_s\ K$ $B_s \rightarrow D_s\ \pi$	337.5 k	7369	3705
$2\delta\gamma$	$B_s \rightarrow J/\Psi\ (\mu\mu)\ \Phi$	50 k	3863	1951
Rare decays	$B_d \rightarrow K^*\ \gamma$	48 k	817	410

(Using half the sample (odd-numbered events) for the optimization)

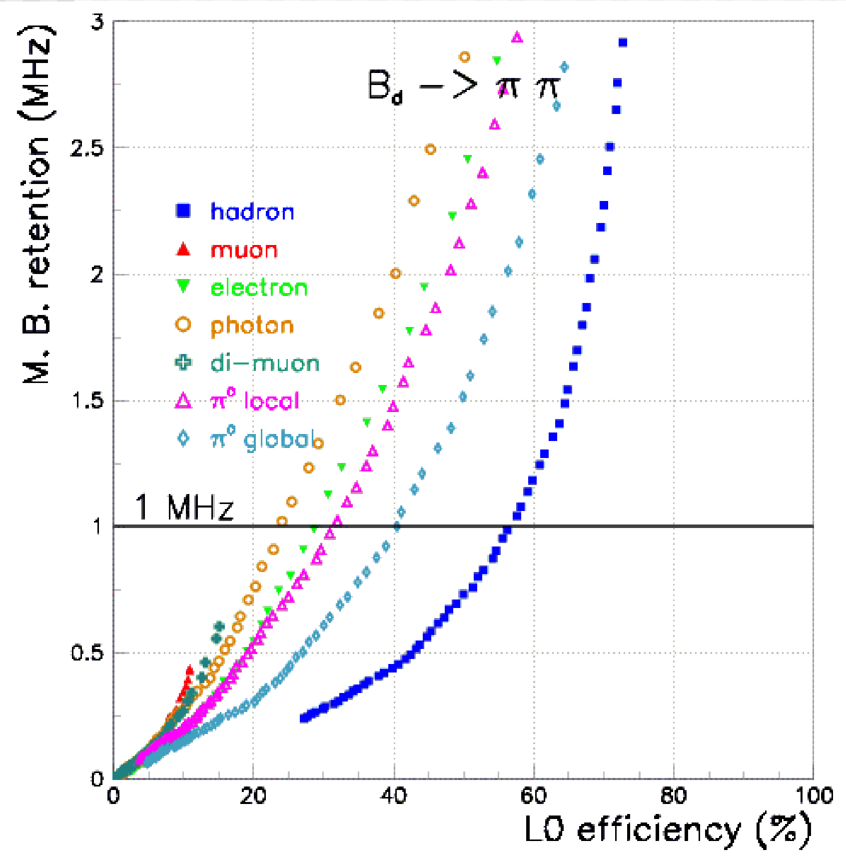
L0 Performance – cases of $B_d \to \pi\pi$, $B_s \to D_s K / D_s\pi$

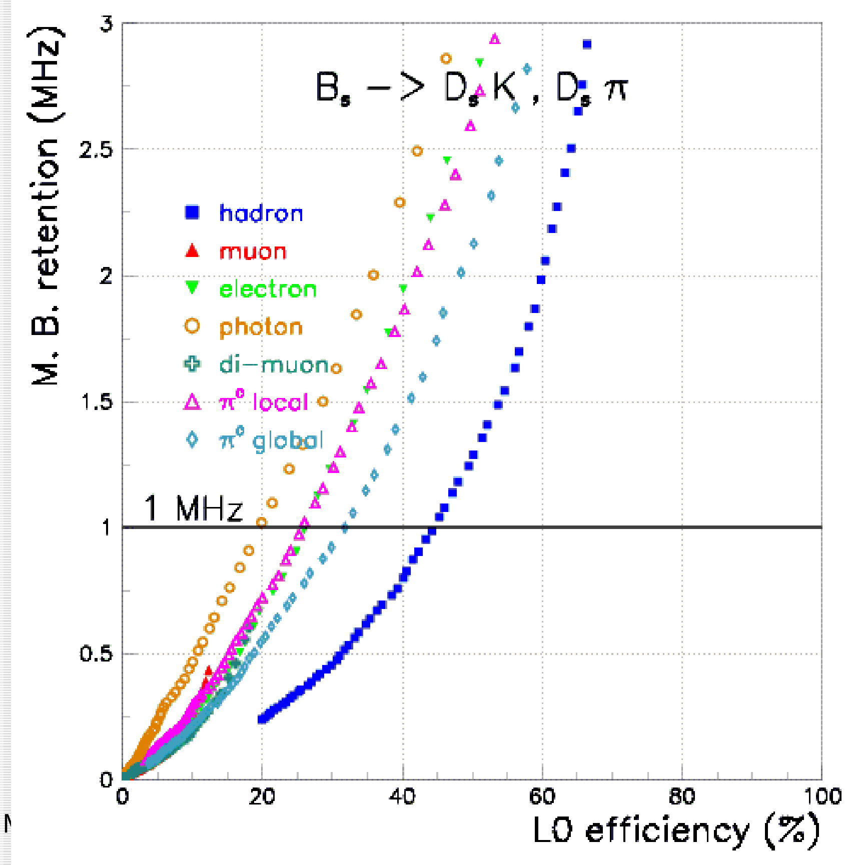
Max. efficiency obtainable inclusively by each trigger!

✓ each curve corresponds to considering separately the combination

L0 trigger = sub-trigger + pile-up veto & multiplicity Cuts

-> it shows how much one could in principle obtain independently from each trigger





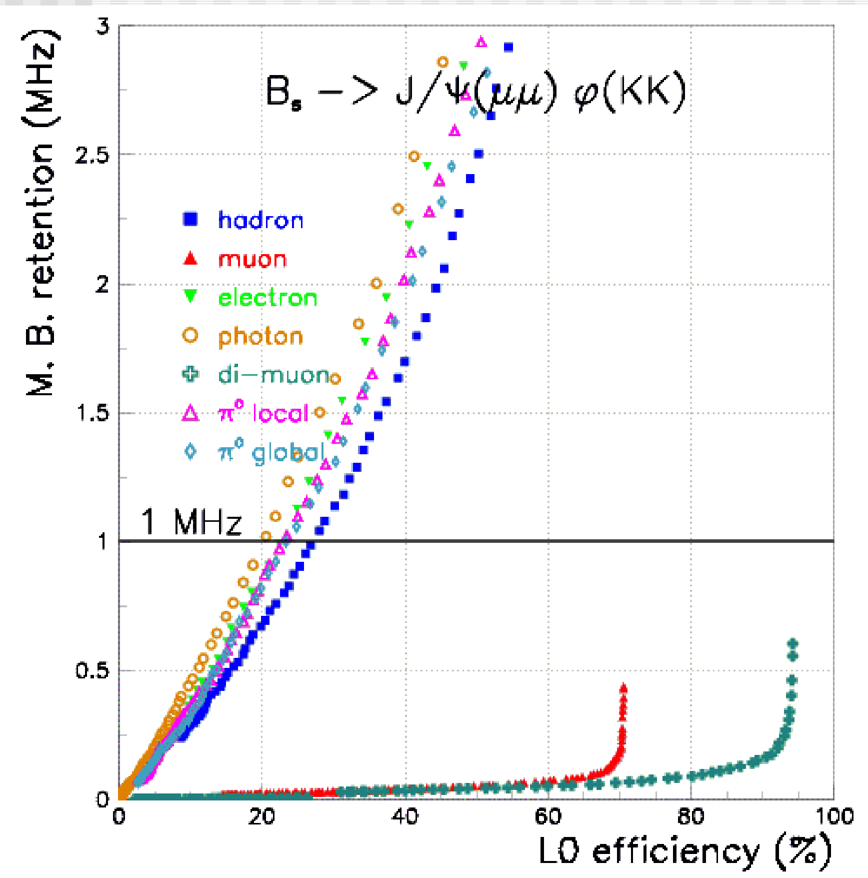
L0 Performance – cases of $B_s \to J/\Psi(\mu\mu)\ \phi(KK)$, $B_d \to J/\Psi(\mu\mu/ee)\ K_s(\pi\pi)$

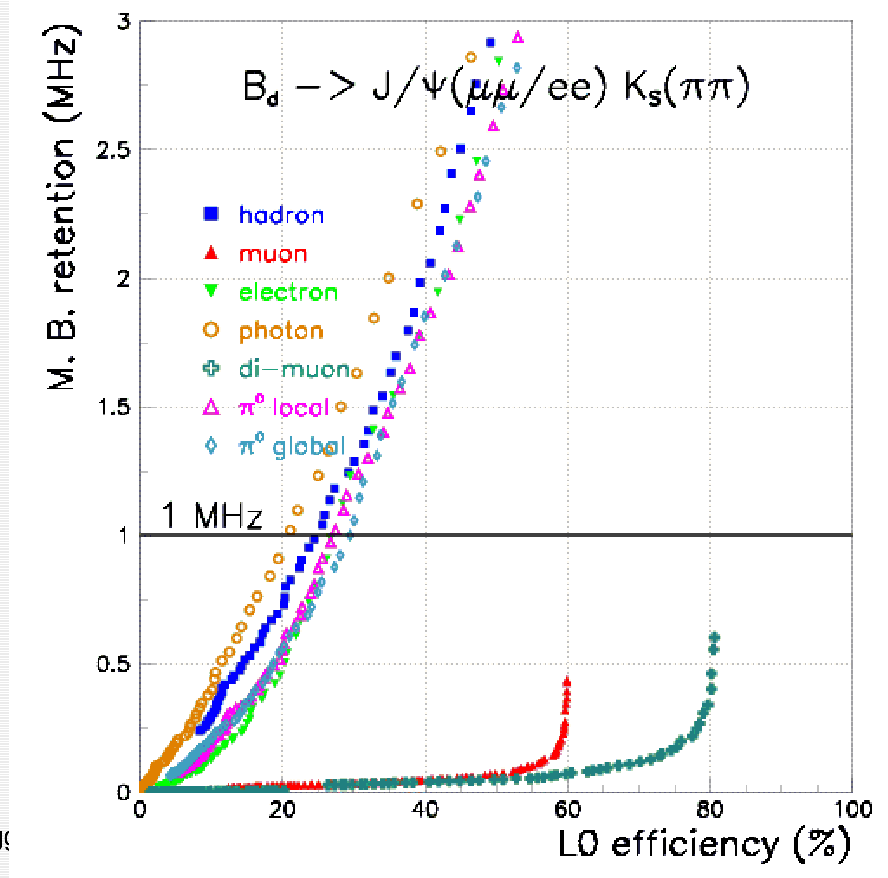
Max. efficiency obtainable inclusively by each trigger!

✓ each curve corresponds to considering separately the combination

L0 trigger = sub-trigger + pile-up veto & mult. Cuts

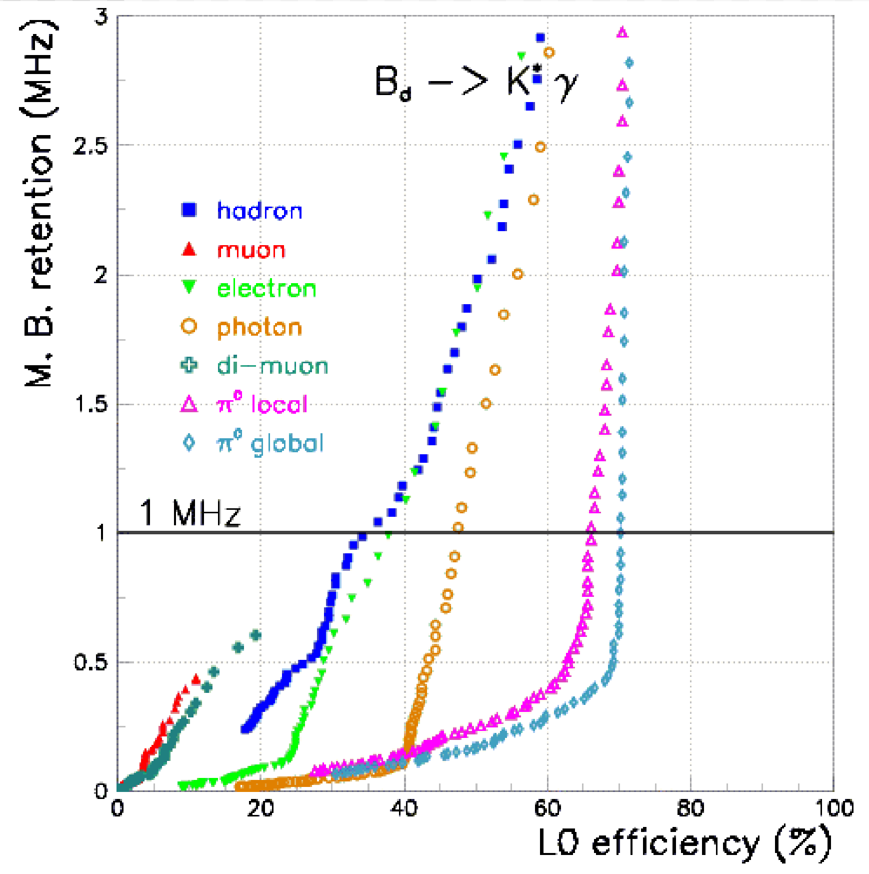
-> it shows how much one could in principle obtain independently from each trigger





L0 optimization – case of B_d -> K*γ

<u>Max. efficiency obtainable inclusively by each trigger!</u>



✓ each curve corresponds to considering separately the combination

L0 trigger = sub-trigger + pile-up veto & mult. cuts

(because max. obtained with no veto)

-> it shows how much one could in principle obtain independently from each trigger

L0 optimization without Tagging Information (I)

1. Optimizing each channel separately on the L0 efficiency …

   ignoring the tagging information …

Channels	Optimized L0 eff. (%)
$B_d \to \pi\pi$	58.1 +/- 1.2
$B_d \to J/\Psi(\mu\mu/ee)\ K_s$	90.5 +/- 1.1
$B_s \to D_s\ K$ $B_s \to D_s\ \pi$	47.3 +/- 0.8
$B_s \to J/\Psi(\mu\mu)\ \Phi$	94.1 +/- 0.5
$B_d \to K^*\ \gamma$	78.4 +/- 2.0

Max. eff. obtained with separate optimization of each channel

(eff. calculated on independent sample)

!! By themselves alone the pile-up veto cut on the height of second peak and the SPD and Pile-up veto multiplicity cuts reduce the L0 efficiency of all channels to ~ 70-80 % !!

L0 Trigger Combined optimization

Combined optimization of all channels !

2. Optimizing the trigger on the L0 efficiency …

for a minimal total loss in efficiency …

Channels	Max L0 eff. (%)	"Optimal trigger" L0 eff. (%)	Loss in L0 eff. (%)
$B_d \to \pi\pi$	58.1 +/- 1.2	57.0 +/- 1.2	1.9
$B_d \to J/\Psi(\mu\mu/ee)\ K_s$	90.5 +/- 1.1	85.0 +/- 1.3	6.1
$B_s \to D_s\ K$ $B_s \to D_s\ \pi$	47.3 +/- 0.8	46.7 +/- 0.8	1.3
$B_s \to J/\Psi(\mu\mu)\ \Phi$	94.1 +/- 0.5	91.4 +/- 0.6	2.9
$B_d \to K^*\ \gamma$	78.4 +/- 2.0	75.9 +/- 2.1	3.2

L0 eff. (%) @ LHCC presentation
61
-
45
91
77

… hadronic channels seem somewhat slightly "favoured" …

Settings as of that time, i.e. no multiplicity cuts!

Conclusions and Final Remarks

- after imposing cuts "dictated" by L0xL1 studies the L0 trigger is performing well with settings close to those at the time of the last LHCC presentation …
  … and still the L0 efficiencies are ~ same though L0xL1 will improve …

L0 trigger	E_t^{had}	E_T^{μ}	E_T^{e}	E_T^{γ}	$E_T^{\mu\mu}$	π^0_{global}	π^0_{local}	Veto Cut
Old Thresholds (GeV)	3.52	1.23	2.60	3.00	1.42	4.90	4.85	3.0
NewThresholds (GeV)	3.6	1.1	2.8	2.6	1.3	4.0	4.5	3.0

& SPD and Pile-up veto multiplicity cuts fixed at 280 and 112, respectively

- muon /di-muon bandwidth ~ 100 / 140 kHz (+/- 20kHz) after veto and multiplicity cuts