Performance of a Di-electron trigger at Level-0

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I. Reminder of first look at a di-electron trigger

II. Inclusion of a di-electron trigger at L0

- L0DU algorithm
- L0 bandwidth division optimization

III. Conclusions and proposal

Reminder

- Di-muon versus di-electron trigger:
  - di-muon trigger mainly focused on identifying $J/\Psi \rightarrow \mu\mu$ decays from a b-hadron

    -> can we do similar for $J/\Psi \rightarrow ee$ decays with a di-electron trigger at L0?

- Usage of di-electrons at L1 has been investigated:
  - refer to the note of Aras Papadelis (summer student)

    -> can the situation be improved by improving the input to L1?

Origin of L0 Electrons

Study with the B_d -> J/Ψ(ee) K_s channel

- I had obtained …

Channels	All events	L0-pass	Offline selected	L0-pass & offline selected
L0-elec1 from signal B	52 %	62	86	89
L0-elec2 from signal B	28	34	60	60
L0-elec3 from signal B	16	17	27	27
L0-elec1&2 from signal B	19	25	52	53
L0-elec1&3 from signal B	10	11	21	22

… in disagreement with Aras' results … by factors ~ 2 …

- checked my results
- Aras only considers the B-origin of L0-electrons up to the grandmother (decay depth = 2)

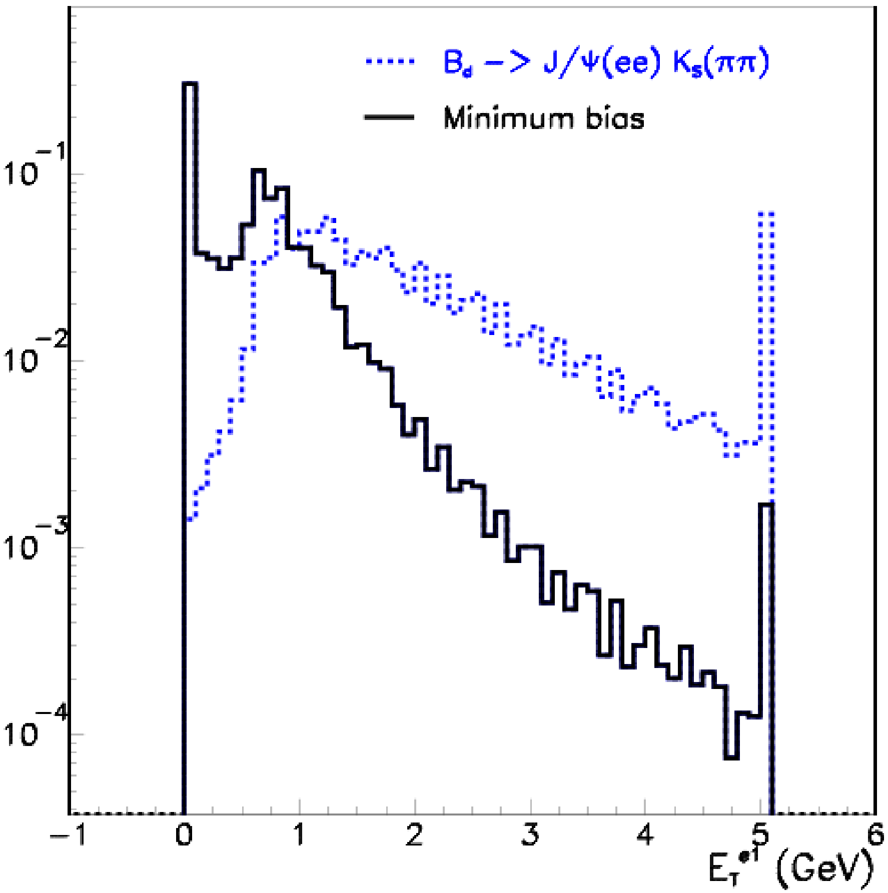
  -> this accounts for some differences (~10-20%) , but too small an effect …

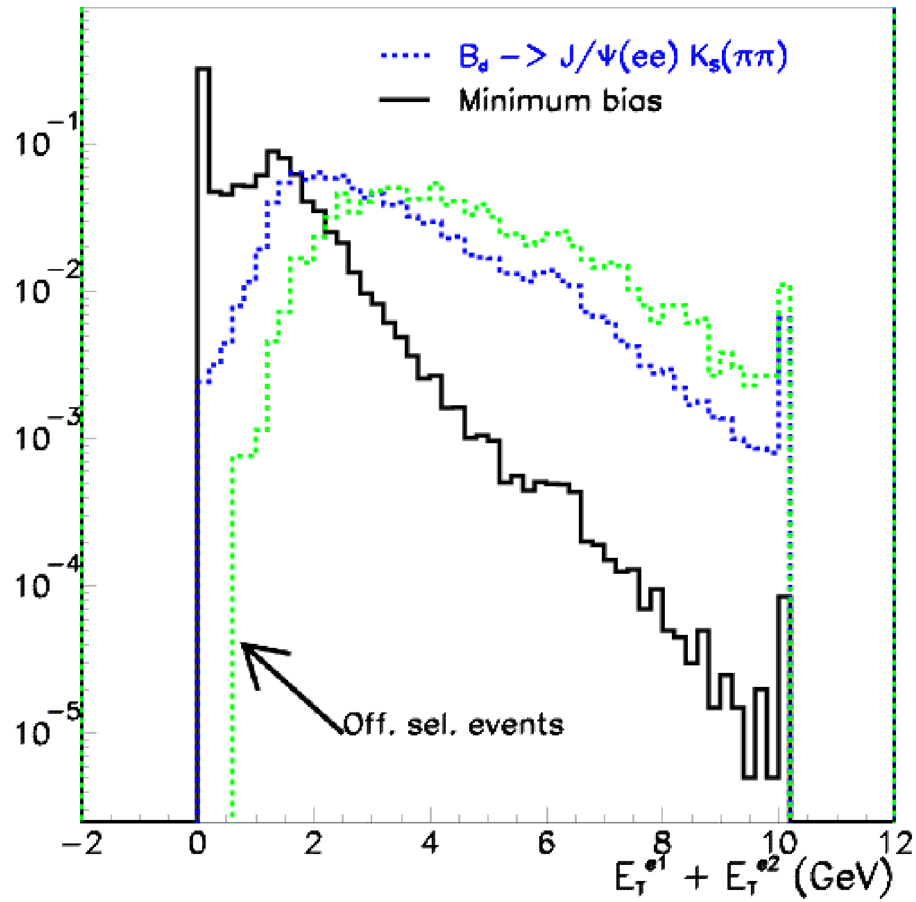
-> probably a mistake somewhere in the calculation

- **table above is correct** (as far as I can tell…)

Di-electron Distributions

- here E_T^{e2}=0 is also possible (as in present di-muon trigge





L0DU with a Di-electron Trigger

L0DU Algorithm with a di-electron trigger

- L0DU algorithm as it is now

  +

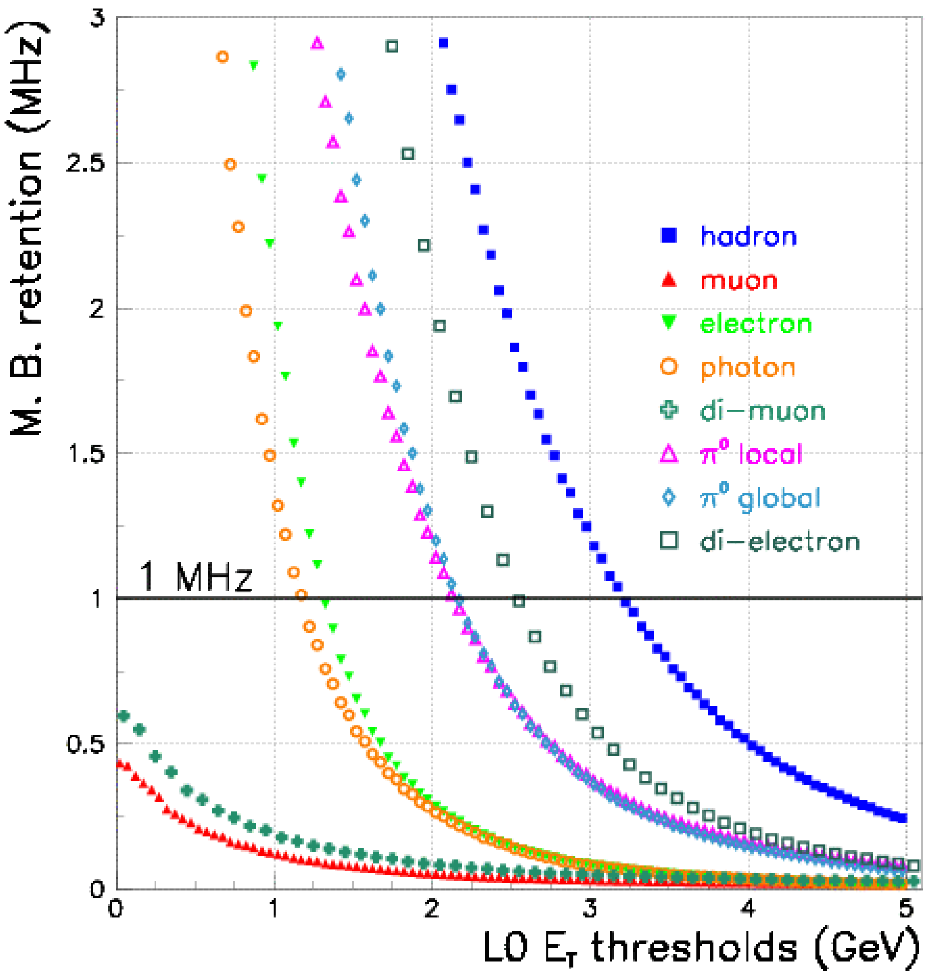
- di-electron trigger "à la di-muon trigger"

  ($E_T^{ee} = E_T^{e1} + E_T^{e2}$ with $E_T^{e2} = 0$ possible)

  - overrides the global event cuts

-> what are the consequences on the L0 bandwidth division ?

L0 Retention Rate



each curve corresponds to considering separately the combination

L0 trigger = sub-trigger

+ pile-up veto & multiplicity cuts

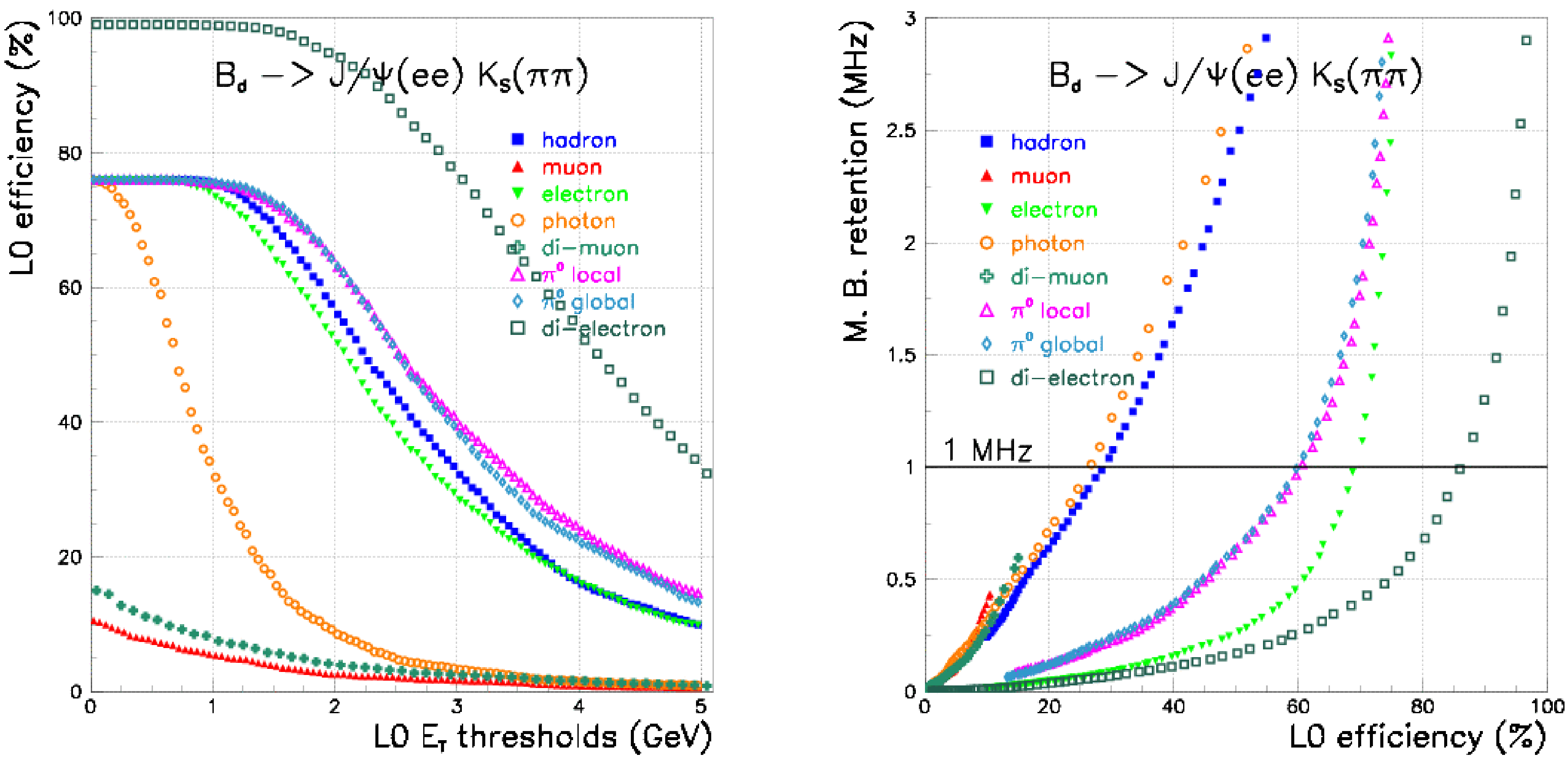
L0 E_t Distributions (I)

✓ 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

x. efficiency obtainable inclusively by each trigger!



L0 optimization with Di-electron Trigger

1. Optimizing each channel separately on the L0 efficiency …

Channels	L0 eff. (%) TDR settings	L0 eff. Max. (%) TDR L0	L0 eff. Max. (%) with new di-elec. Trig.
B_d -> $J/\Psi(ee)$ K_s	48.3	**69.7**	**85.0**
B_d -> K^* γ	72.9	**77.6**	**86.8**
B_d -> $J/\Psi(\mu\mu)$ K_s	89.3	93.0	93.2
B_s -> $J/\Psi(\mu\mu)$ $\Phi(KK)$	89.7	93.0	93.0
B_d -> $\pi\pi$	53.6	54.7	56.7
B_s -> D_s K	46.5	48.2	48.2

Optimized L0 as in the TDR

Max. eff. obtained with separate optimization of each channel

L0 optimization with Di-electron Trigger (II)

Inclusive efficiencies with new L0 trigger and bandwidth optimization

Channels	HCAL	ECAL	Muons
$B_d \to J/\Psi(ee)\ K_s$	18.5	**64.9**	7.0
$B_d \to K^*\ \gamma$	30.0	**75.2**	7.5
$B_d \to J/\Psi(\mu\mu)\ K_s$	16.1	13.0	**87.0**
$B_s \to J/\Psi(\mu\mu)\ \Phi(KK)$	17.5	12.7	**87.3**
$B_d \to \pi\pi$	**44.7**	19.8	6.4
$B_s \to D_s\ K$	**35.3**	16.2	8.5

Bandwidth on minimum bias events (kHz)	593	399	161

L0 optimization with Di-electron Trigger (III)

2. Combined optimization of L0 on the channels below ...

Channels	L0 eff. (%) TDR settings	"Optimal trigger" L0 eff. (%)	Rel. Gain in eff. w.r.t TDR (%)
B_d -> J/Ψ(ee) K_s	48.3	70.8	**+ 46.6**
B_d -> K* γ	72.9	80.2	**+ 10.0**
B_d -> J/Ψ(μμ) K_s	89.3	89.6	+ 0.3
B_s -> J/Ψ(μμ) Φ(KK)	89.7	89.8	+ 0.1
B_d -> π π	53.6	56.5	+ 5.4
B_s -> D_s K	46.5	47.4	+ 1.9

L0 as in the TDR !

"New L0"

L0 optimization with Di-electron Trigger (IV)

- L0 settings for this new L0DU algorithm with a di-electron trigger:

L0 trigger	E_t^{had}	E_T^{μ}	E_T^{e}	E_T^{γ}	$E_T^{\mu\mu}$	π^0_{local}	π^0_{global}	E_t^{ee}
TDR Thresholds (GeV)	3.6	1.1	2.8	2.6	1.3	4.5	4.0	--
Optimized Thresholds (GeV)	3.8	1.1	3.1	3.0	1.3	4.8	4.8	3.6

& Veto, SPD and Pile-up veto multiplicity cuts fixed at 3, 280 and 112, respectively

"overrding Electron Trigger"

- What about an alternative?

  simply override the veto and multiplicity cuts with the electron trigger

  - all steps were redone …

    … and after L0 optimization …

  - performance for hadronic and muon channels as with the di-electron trigger – as it should
  - performance for B_d -> K^* γ roughly the same (marginally better)
  - performance for B_d -> $J/\Psi(ee)$ K_s worse by ~ 10% in relative efficiency

… but is it really what we want ? C.f. next slide …

Conclusions

- di-electron trigger significantly improves the L0 performance for electromagnetic channels and in particular enhances the efficiency on b -> J/Ψ + X -> (ee) + X decays

- L0 bandwidth division optimization performed with this "new L0DU"
  - ➔ significant improvement w.r.t TDR L0 for electromagnetic channels while keeping all the other efficiencies (basically) unchanged

- as the physics selections are evolving so has the trigger to adjust

- trigger should be not only efficient but also "pur":
  - ✓ high efficiencies for offline selected events …
    and
  - ✓ …HCAL / ECAL / muon triggers most relevant for hadronic / electromagnetic / muon-like channels

Proposal

Modification Proposal for L0 and L0DU: include a di-electron trigger at L0 and in the L0DU

- **hardware:** (thanks to O. Callot for some clarifications)
  - possible to use more that just the highest E_T electron (highest electron per Validation card)
  - selection of second highest E_T electron can be implemented in Selection Crate
    (some affordable cost …)
  - need to discuss technical details with experts …
- **software:**
  - need to implement changes in the L0Calo package (produces the L0 calorimeter info)
  - need to extend the L0DUReport (part of event model – L0Event)
  - need to modify the L0DU algorithm and package accordingly

L0-optimized thresholds for new L0DU:

L0 trigger	E_t^{had}	E_T^{μ}	E_T^{e}	E_T^{γ}	$E_T^{\mu\mu}$	π^0_{local}	π^0_{global}	E_t^{ee}
Proposed Thresholds (GeV)	3.8	1.1	3.1	3.0	1.3	4.8	4.8	3.6

& Veto, SPD and Veto System multiplicity cuts fixed at 3, 280 and 112, respectively (as in TDR)