The role of PS/SPD in the LHCb trigger

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Thanks to O. Deschamps

SPD/PS use at L0

- **PS:** confirm ECAL clusters as electromagnetic (ECAL: 1.1 λ_I)
- **SPD:**
  - distinguish e – γ
  - multiplicity:
    - GECs (very uncertain future)
    - Under study: trigger for $\gamma\gamma \rightarrow \mu\mu$ for lumi: 2 μs + low SPD multiplicity

Last standalone (without HLT1) L0 optimization **(~February!)** on few channels incl. $B_s \rightarrow \phi\gamma$, $B^+ \rightarrow K^+e^+e^-$:

LO line	E_T> (MeV)	Rate (KHz)
e	**2320**	**170**
γ	**3060**	**65**
π^0 loc	4740	95
π^0 glob	4520	85
hadr	4040	600

Later, thresholds become similar, but no ee channel!

Difficulty for SPD @ LO: $\gamma \rightarrow e^+e^-$

- Re-opt TDR material budget: 0.4 X_0 magnet-Calo
  - Underestimation: only **M1** is 0.265 instead of the 0.22 in the simulation
- Probability of photon survival: $e^{-\frac{7}{9}0.45} \sim 70\%$
  - Btw, this is what makes the SPD useful offline
- **Current γ and e confirmation at HLT1 uses:**
  - **All L0-e and L0-γ clusters for photon alley**
  - **But only L0-electron for electron alley**

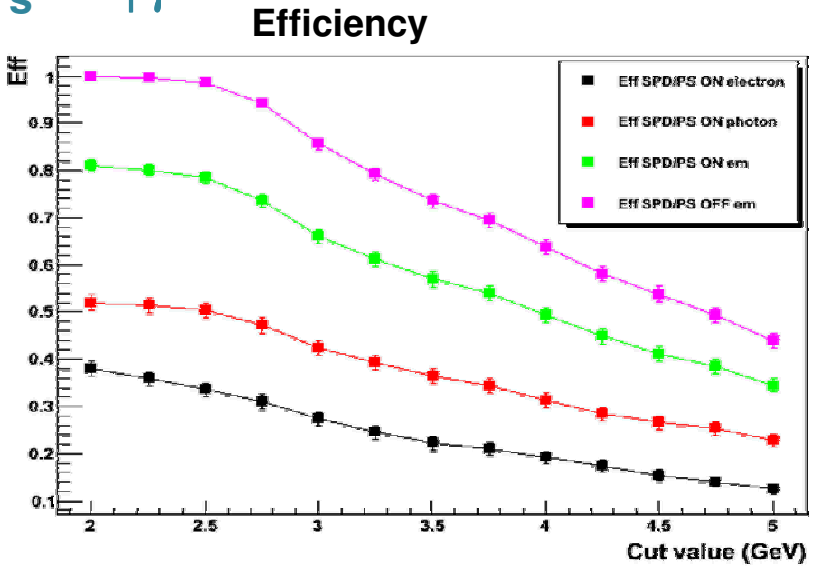
MC samples

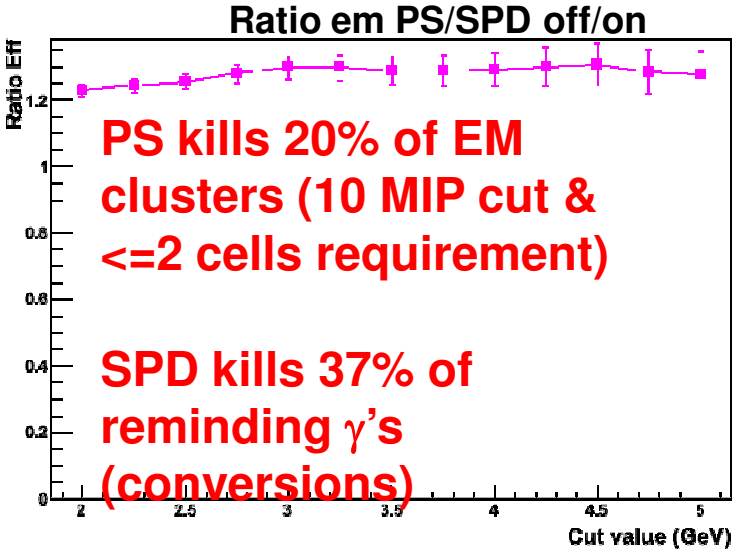
- 988 offline-selected $B_s \rightarrow \phi\gamma$
- 1115 offline-selected $B^+ \rightarrow e^+e^-K^-$
- 694 offline-selected $B \rightarrow e^+e^-K^*$
- 440k minimum bias

	E_T^{γ}>	Ref
$B_s \rightarrow \phi\gamma$	2.8 GeV	LHCb-PHYS-2007-030
$B^0 \rightarrow K^*e+e-$	0.3 GeV	Marie-Helene Schune http://indico.cern.ch/contributionDisplay.py?contribId=2&confId=26414

Efficiency

$B_s \rightarrow \phi\gamma$

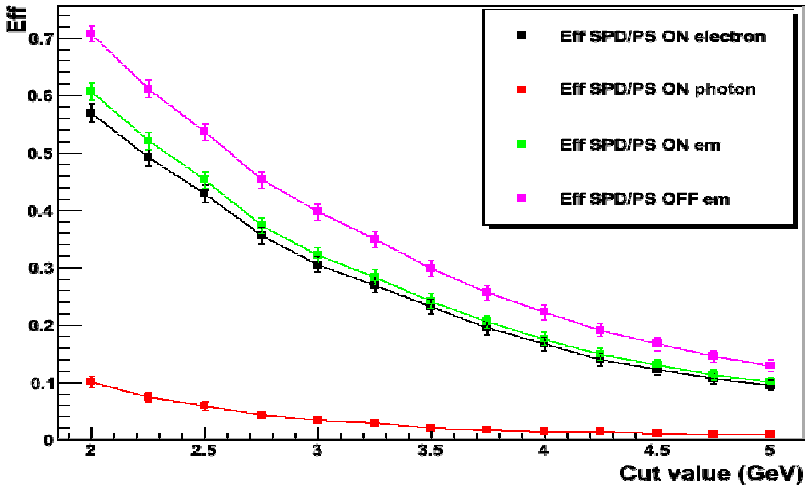


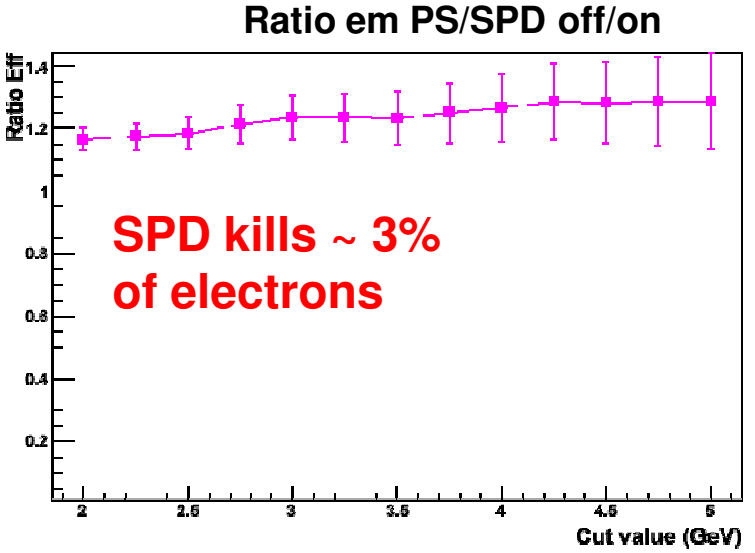


PS kills 20% of EM clusters (10 MIP cut & <=2 cells requirement)

SPD kills 37% of reminding γ's (conversions)

$B^+ \rightarrow e^+e^-K^-$

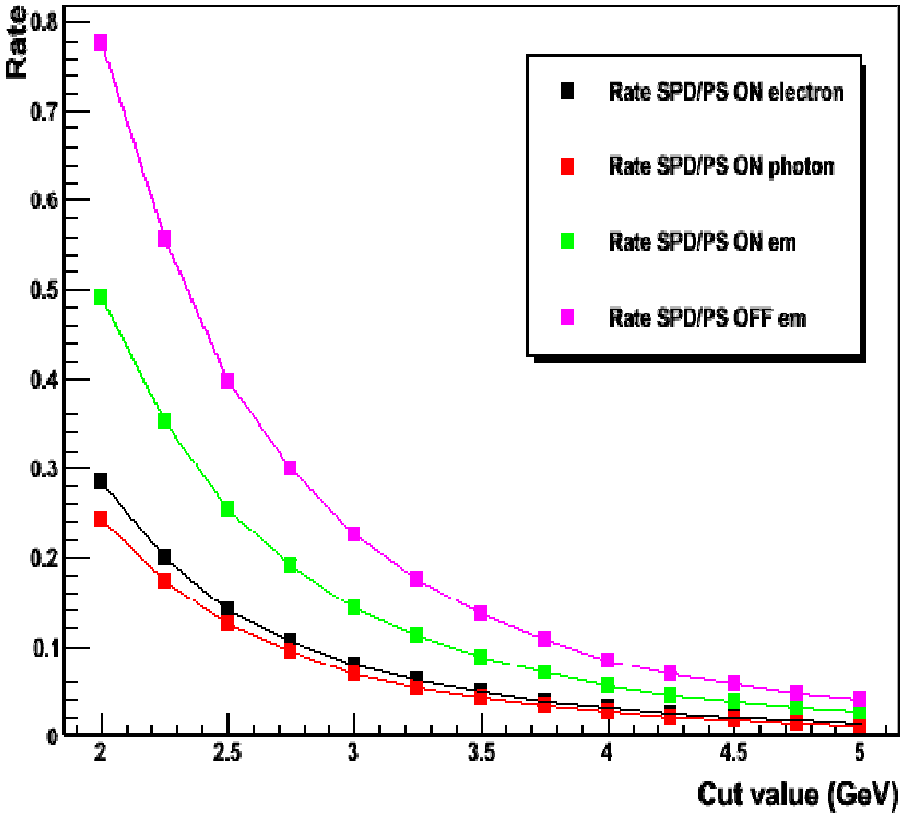




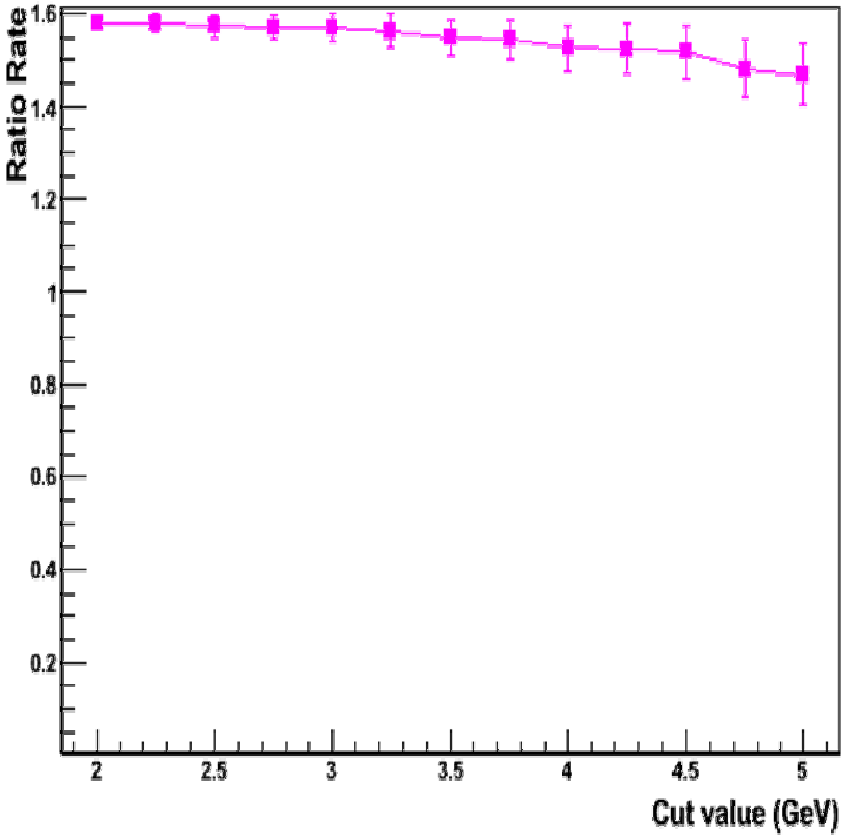
SPD kills ~ 3% of electrons

Rate

Rate (MHz)

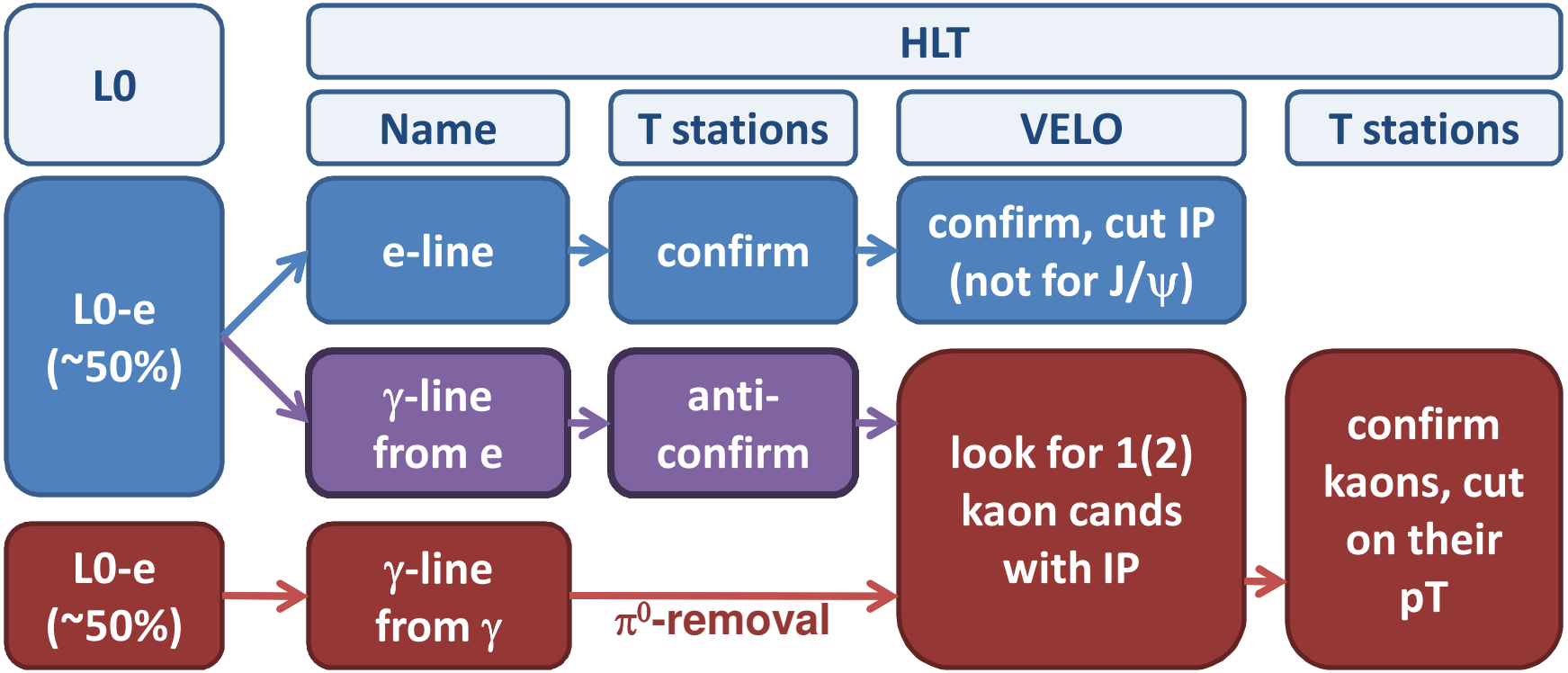


Ratio em PS/SPD off/on



Current HLT1 alleys

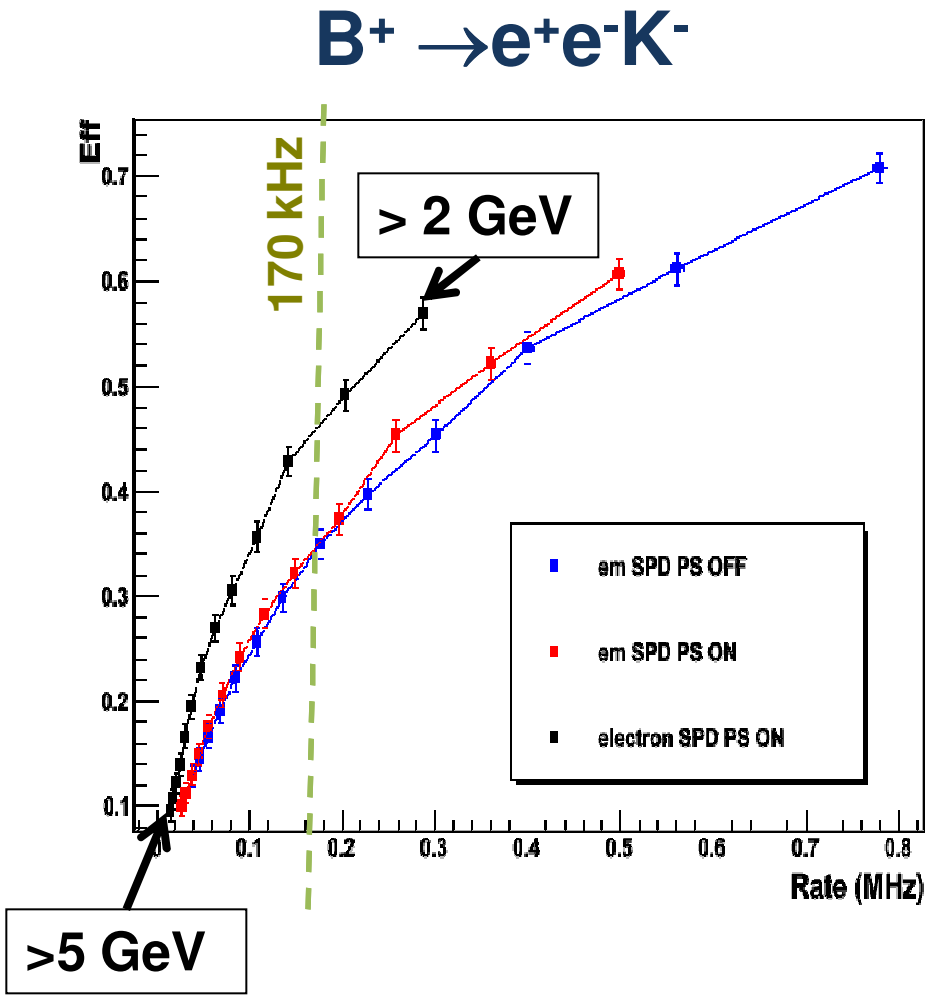
- If e and γ threshold are similar:

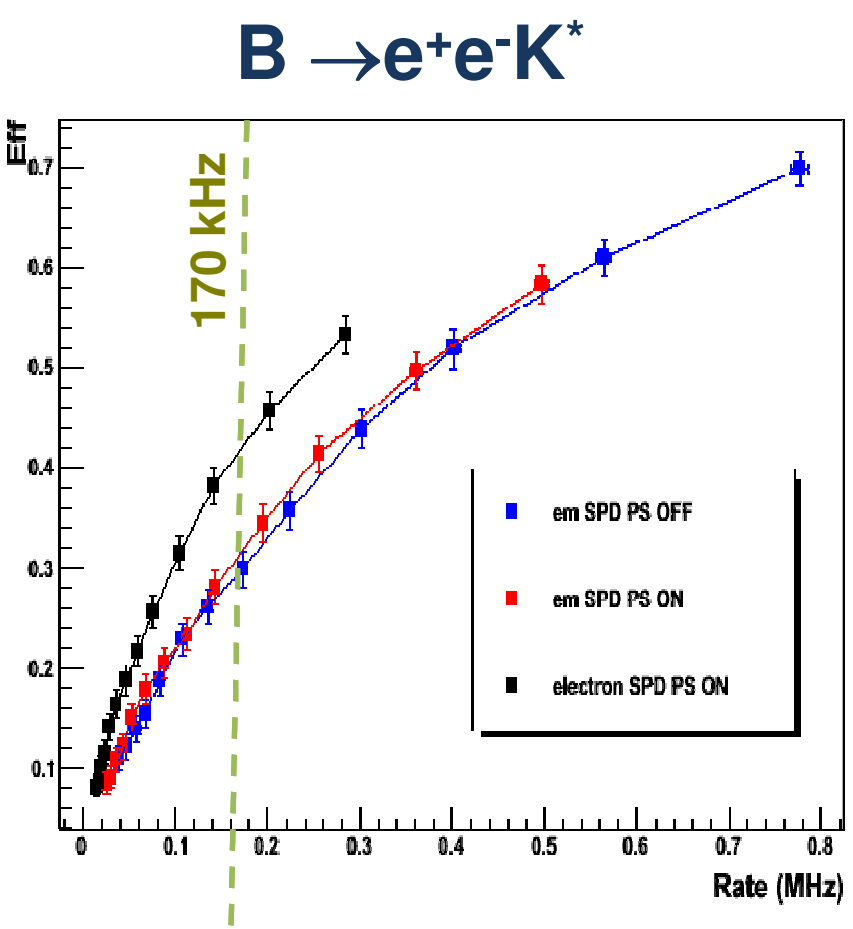


- My interpretation from yesterday's Mariusz talk at http://indico.cern.ch/conferenceDisplay.py?confId=67047

⇒No straight-forward to estimate effect of SPD/PS on timing

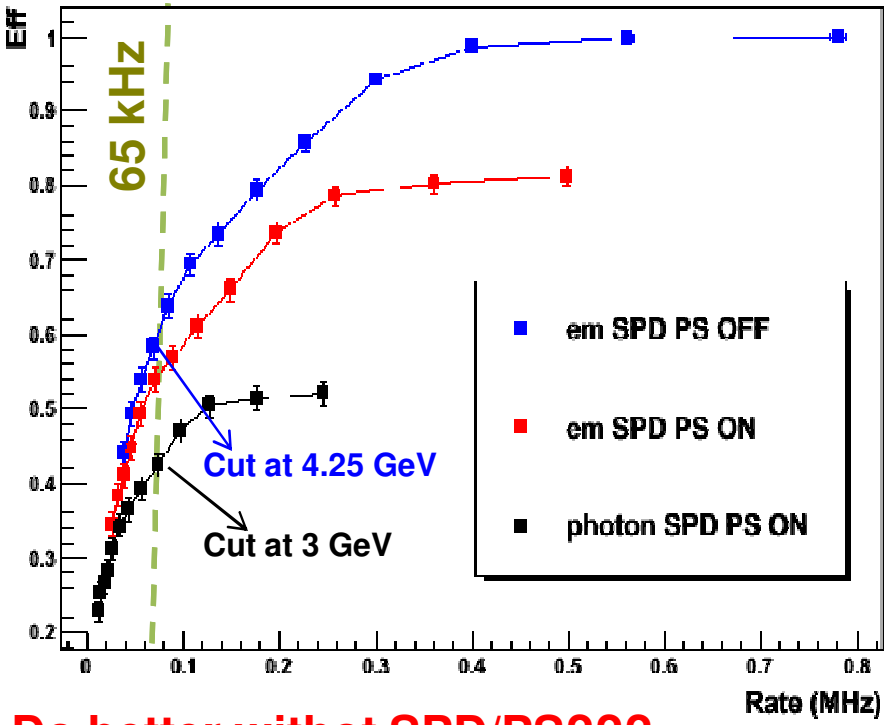
Efficiency vs rate, electrons





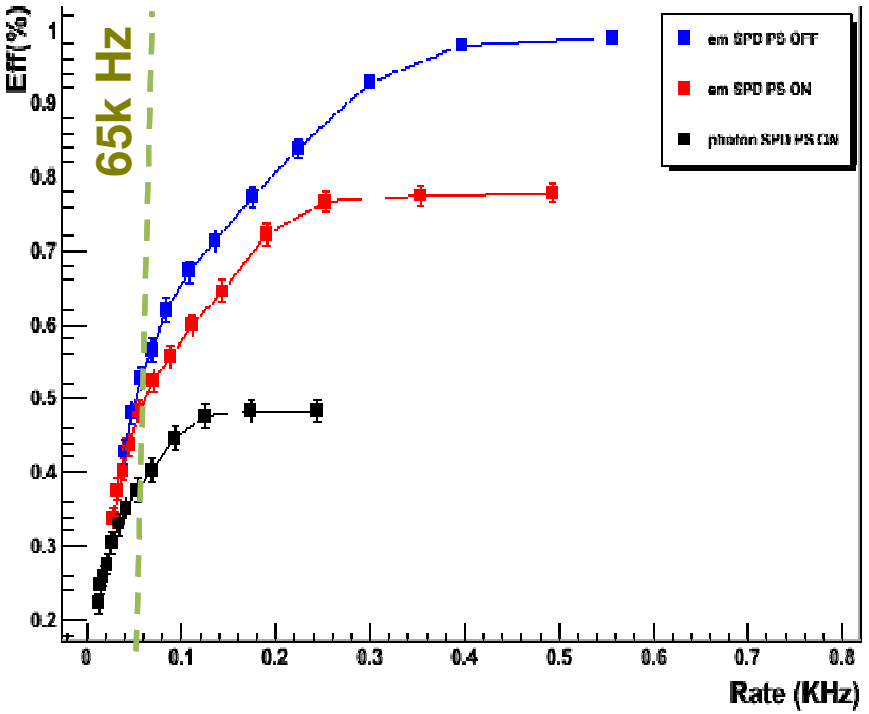
Efficiency vs rate, photons

$B_s \rightarrow \phi\gamma$



$B_s \rightarrow \phi\gamma$

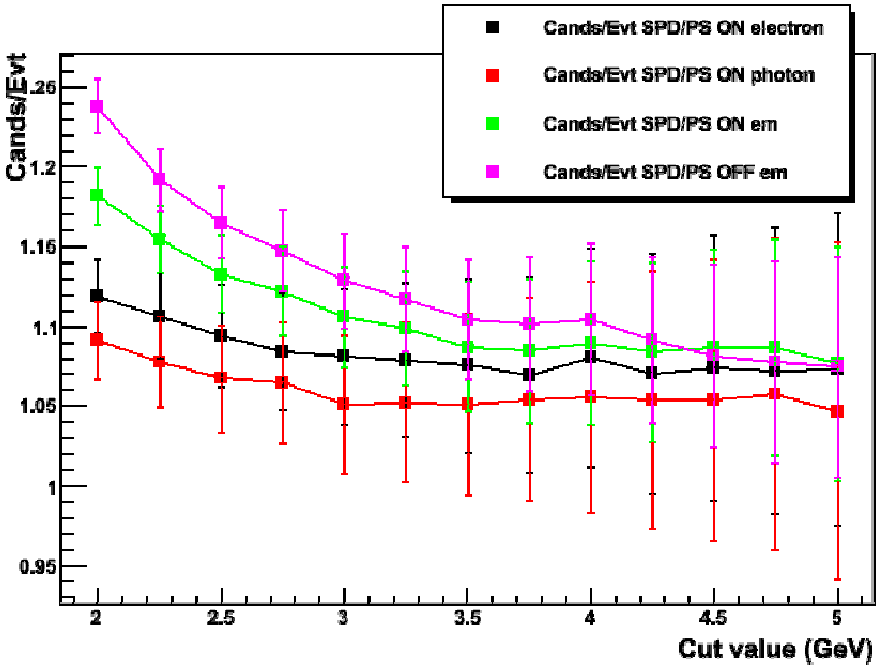
Using only ECAL clusters matched to MC γ (< 60 cm)



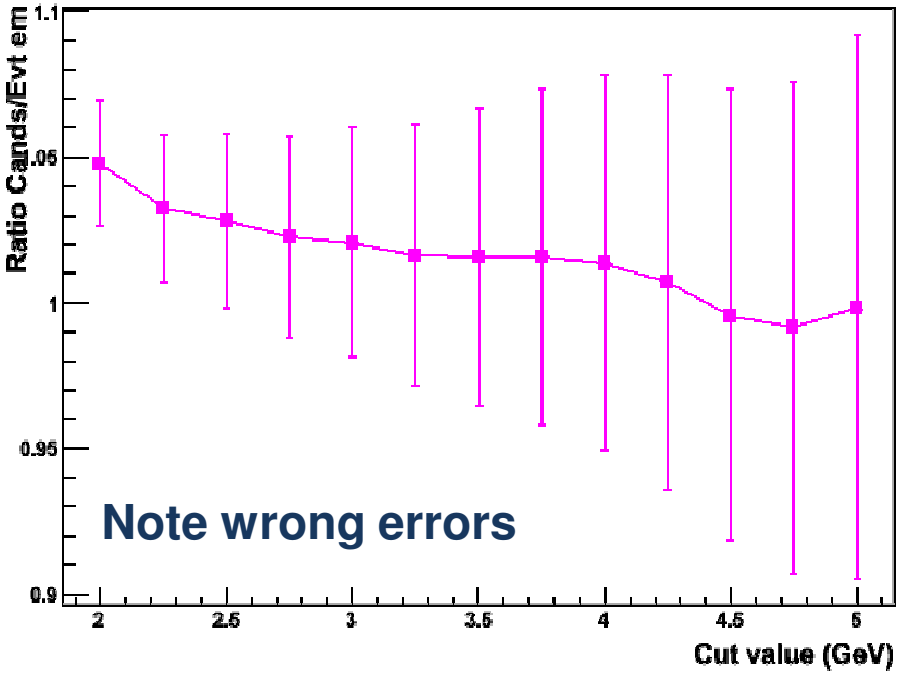
Do better without SPD/PS???

No difference between both plots ⇒ only the true γ is able to trigger L0-em

N Candidates/accepted event



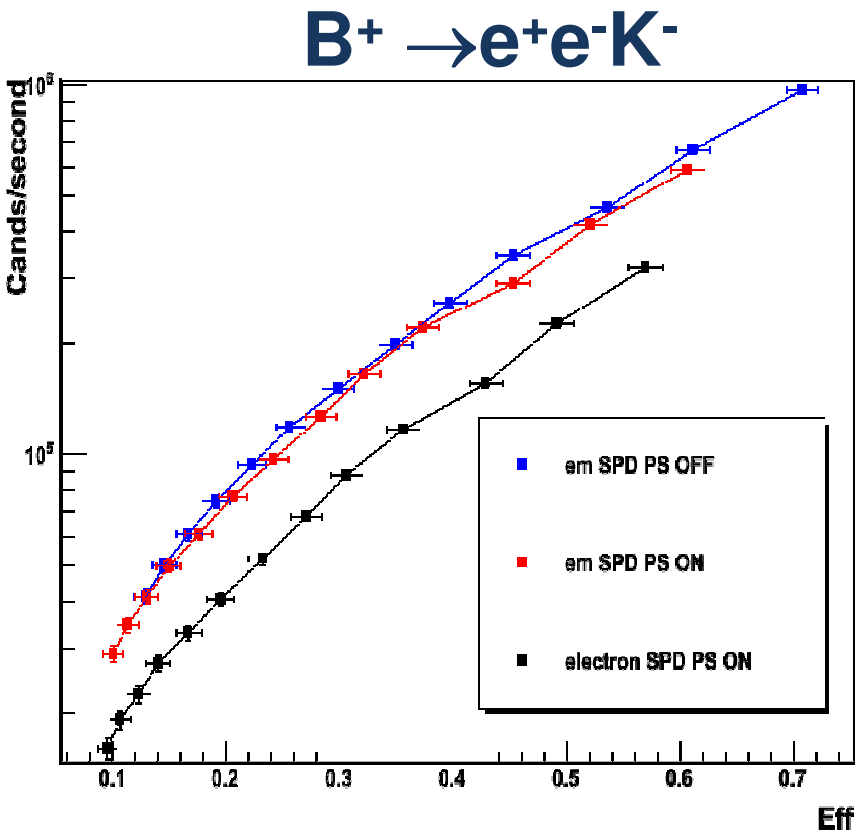
Ratio em PS/SPD off/on

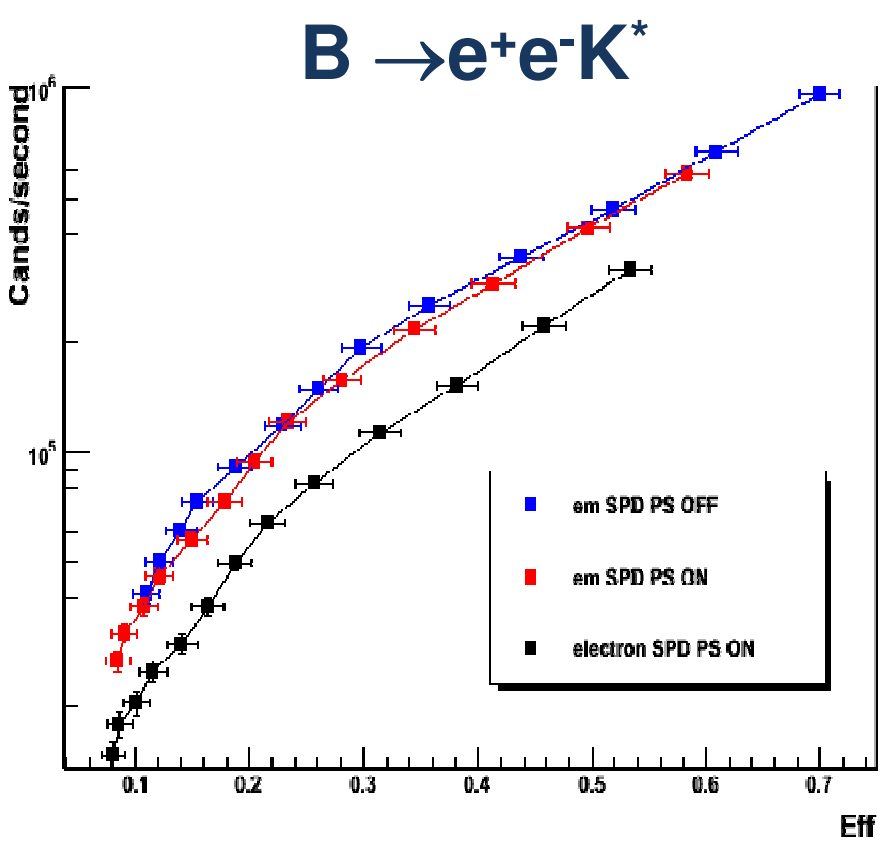


Note wrong errors

N candidates/second, electrons

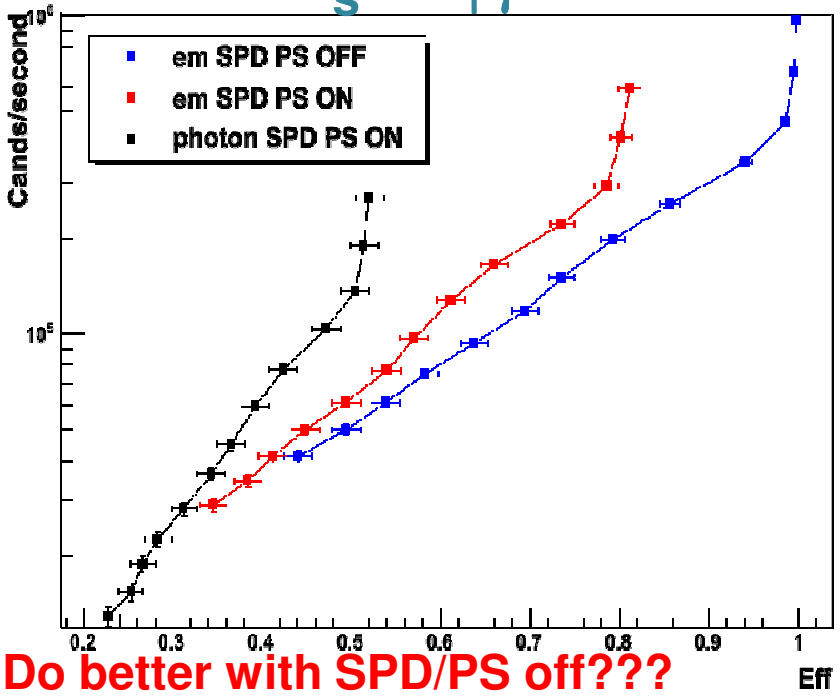
- **Important for the trigger:** amount of work to be done by HLT1 to reach a given efficiency





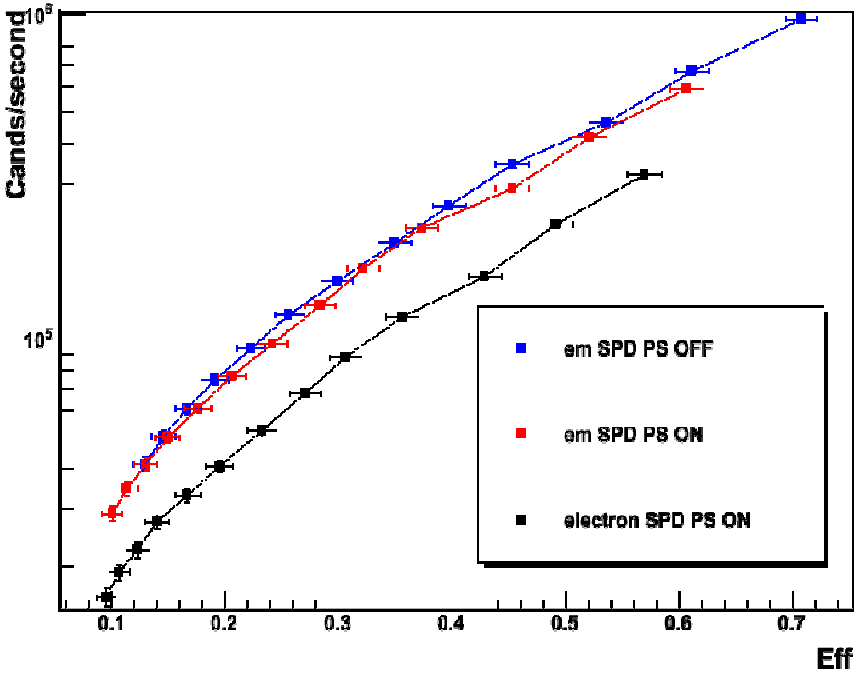
N candidates/second, photons

$B_s \rightarrow \phi\gamma$



Do better with SPD/PS off???

$B^+ \rightarrow e^+e^-K^-$

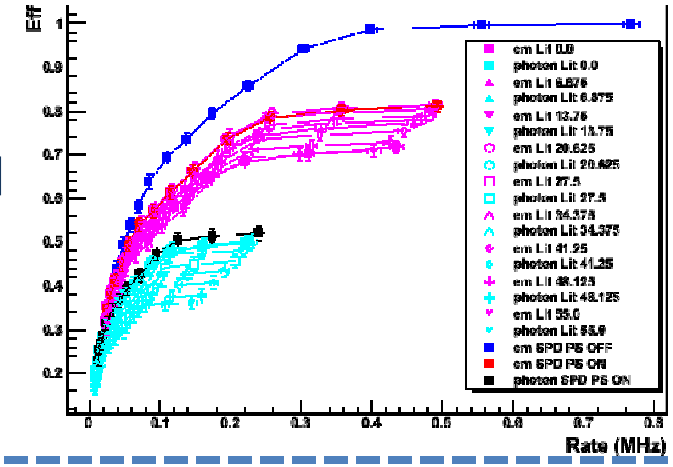


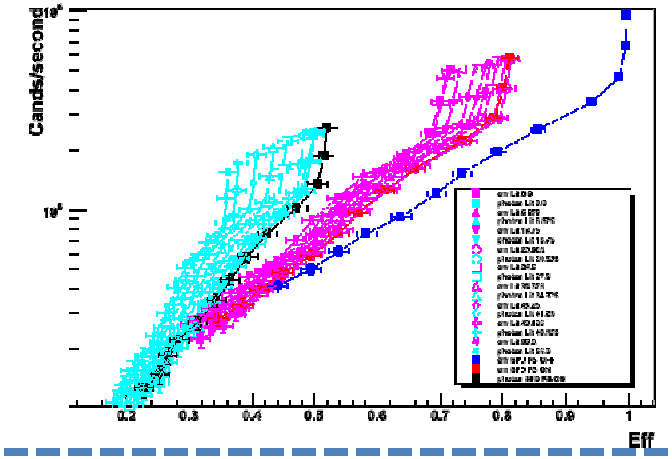
- How does the situation change with:
  - **Higher lumi** (more hadrons will try to fake em showers)**?**
  - **No M1:** less conversions**?**

N candidates/second, photons

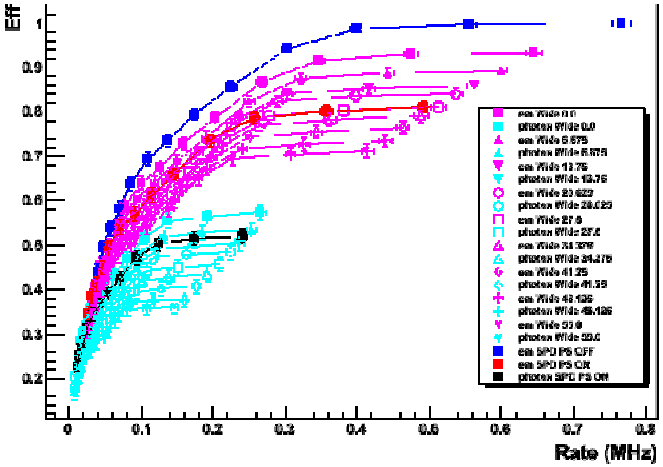
$B_s \rightarrow \phi\gamma$, varying PS threshold

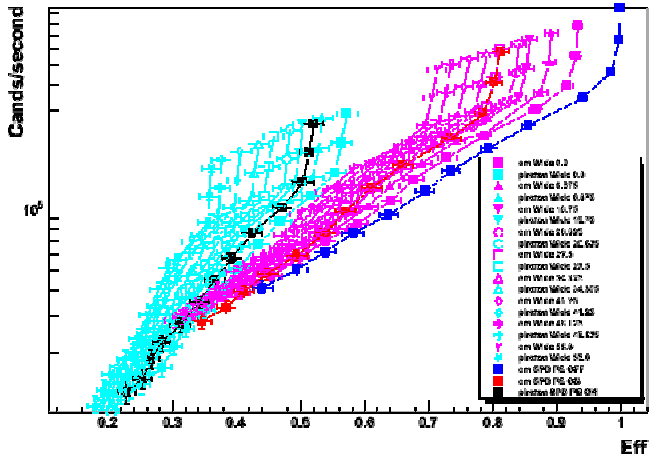
Rejecting if more than 2 PS cells fired (as in current implementation)





Not rejecting

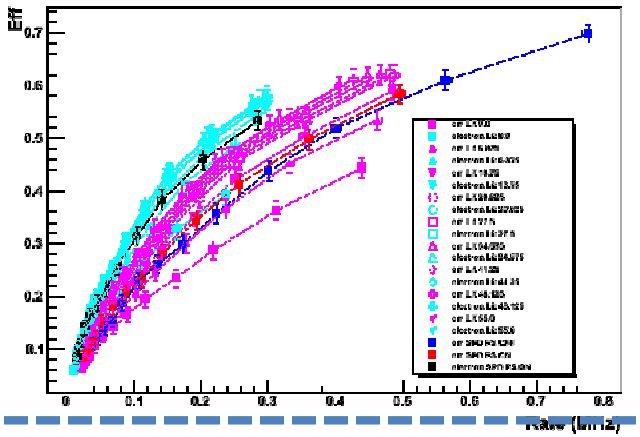


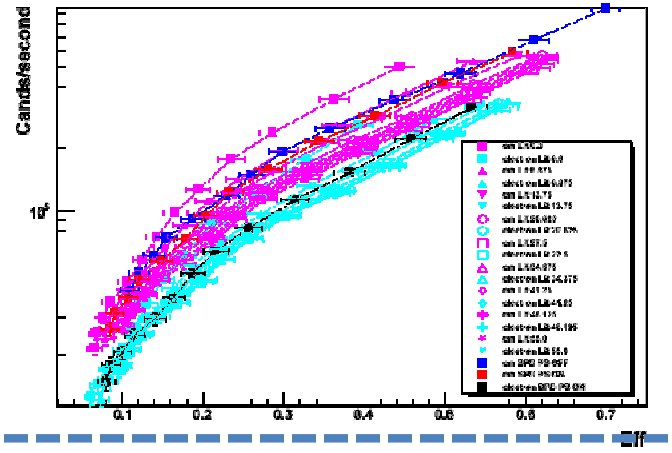


N candidates/second, electrons

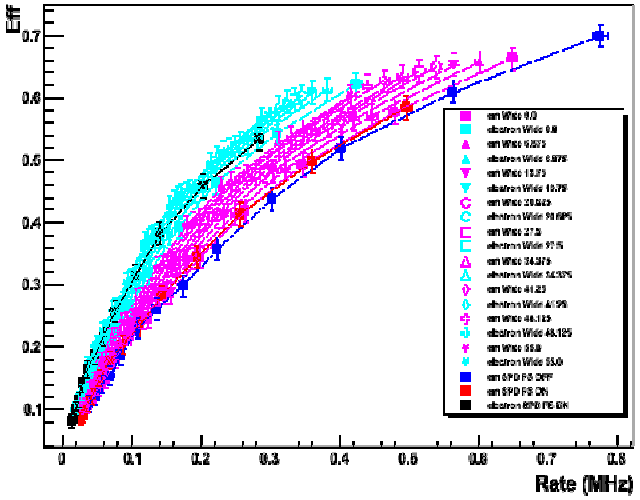
$B \rightarrow e^+e^-K^*$, varying PS threshold

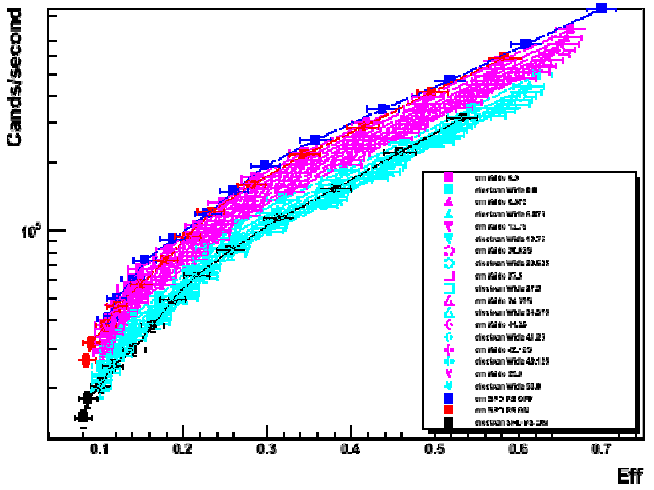
Rejecting if more than 2 PS cells fired (as in current implementation)





Not rejecting





MC generation

Tested 100 evts/sample of min bias of:

1) DC06 as reference

2) MC08

- Same multiplicity for all reco particles but muons: x 0.7.
- $\gamma \rightarrow$ ee x 2

3) MC08, lumi x10

- interactions 1.4 $\rightarrow$ 6.8 (x4.8)
- multiplicity x4.5, for all particle types

MC generation

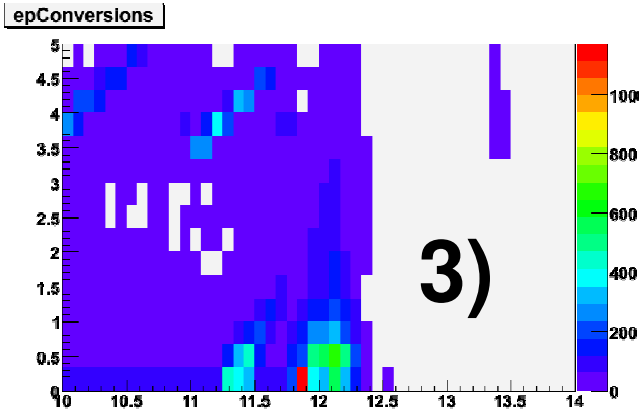
4) MC08, lumi x10, no M1

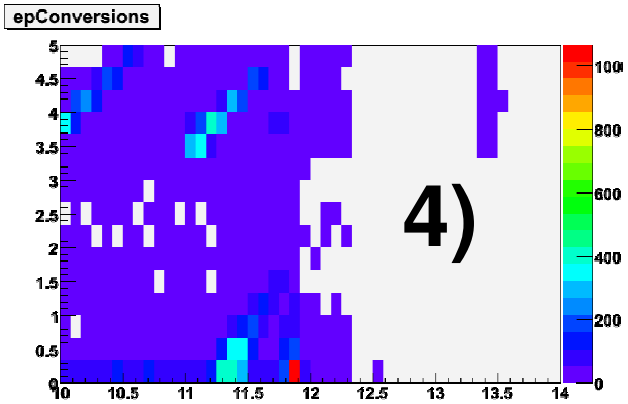
- $\gamma \rightarrow$ ee : x0.2 in 11.8m<z<12.3m

5) MC08, lumi x 10, no M1, PS, SPD

L0Calo candidates:

- e: 1.8 ± 0.1, γ: 0.53 ± 0.05 $\rightarrow$ e+γ: 5.44 ± 0.16
- hadron: 8.4 ± 0.2 $\rightarrow$ hadron: 9.8 ± 0.2





- **Asked Gloria what are reminding checks to be done**

Conclusions / Plans

- **On the way of understanding role of PS/SPD for triggering**
  - Optimization of PRS threshold and SPD/PS masks?
  - Some help from HCAL in cleaning EM clusters?

- **Not the only consideration! e/γ id without PS?**

- **Reminding checks on high lumi MC? Generate!**

BACK-UP

… $\gamma \rightarrow e^+e^-$

- Another source of "inefficiency" on γ's: random coincidence
  - Multiplicity ~ 33 @ $2 \cdot 10^{32} \Rightarrow$ ~ 330 @ $2 \cdot 10^{33}$
  - Occup ~330/6000 ~ 5.2% (max ~16%)

MC matching in $B_s \rightarrow \phi\gamma$

- Distance between L0 clusters and MC truth extrapol: