Update on
Electron and Photon HLT alleys

Improvements since Calorimeter Meeting in February

http://indico.cern.ch/conferenceDisplay.py?confId=51076

M. Witek

K. Senderowska, A. Żurański

Ecal Alley - Introduction

- Two goups of lines: γ-lines and e-lines
  - γ-lines
    - $B_s \to \varphi\gamma$ optimized using offline selection by Lesya
      - Photon and single track line **NEW**
      - Photon and di-track line
  - e-lines
    - $B^+ \to K^+e^+e^-$ offline selection for trigger (Hans)
      - Single electron with IP line
      - Di-electron with IP line
    - $B_s \to J/\psi(ee)\varphi$ lifetime unbiased selection (Adlene)
      - Di-electron without IP line

Single lines are for redundancy. They are correlated with γ+di-track and di-electron lines.
One can think about special Photon only line at the LHC startup.

L0 decisions

- L0 „crosstalk”
  - Signal photons produce L0Photons and L0Electrons
  - Signal electrons are predominantly L0Electrons
- No need to consider L0LocalPi0 nor L0GlobalPi0
  - Photon lines start from L0Photon or L0Electron.
  - Electron lines start from L0Electrons only. **NEW**

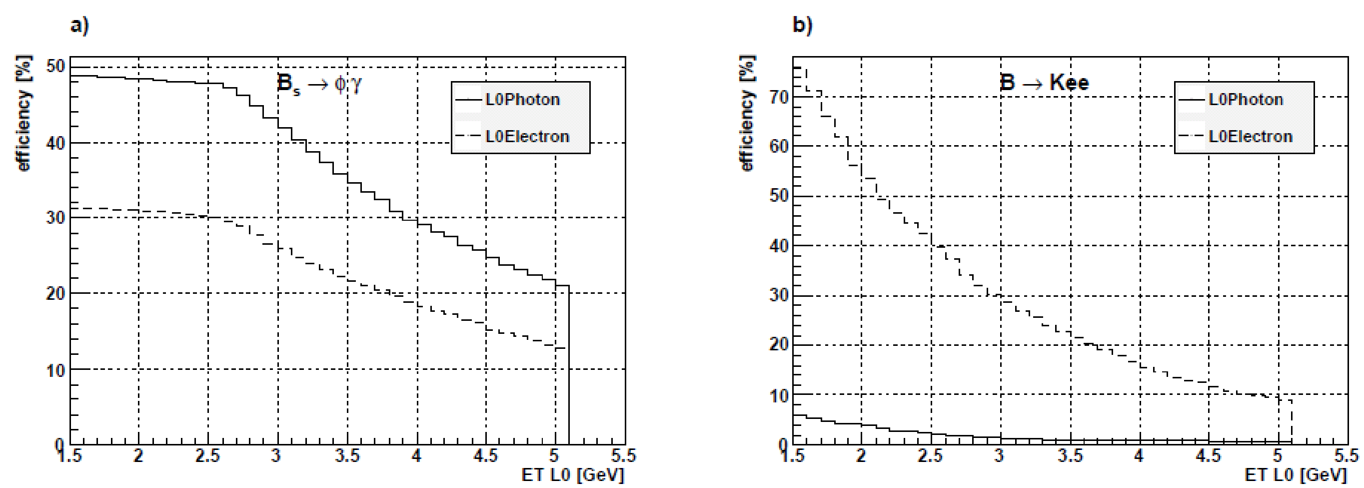


Figure 2 L0 TOS efficiency vs ET threshold for offline selected events: a) $B_s^0 \to \phi\gamma$; b) $B^+ \to K^+e^+e^-$.

Improvements

- Calo partial decoding (Olivier Deschamps)
  - To reduce execution time
- New interface for fast Calo reconstruction (Dmitri Goloubkov)
  - Improved interface to hide details of decoding and improve e-correction for Bremsstrahlung.
- Others HLT framework modifications
  - Correction for Bremsstrahlung made only once for tracks when caltulating invariant mass of ee combinations (reduce exe time).
  - Last step added: fast Kalman fit and confirm IP cut
  - Other technical modifications not directly related to performance.
- Plans: New tool for calculation of shower shape variables (Olivier Deschamps)
  - Currently a copy of Calo internal code in HLT.
  - Proper support and improvements.

γ - lines

γ-lines

- $B_s \rightarrow \varphi\gamma$
  - φ and γ are two independent elements:
    - High p_T γ (off-line cut p_T>2.8 GeV)
    - $\varphi \rightarrow KK$, kaons correlated, relatively low p_T
- Strategy:
  1. Start line if L0DecPhoton or L0DecElectron
     - L0 electron: anti-confirmation (no track in T) → proceed as L0 Photons
     - L0 photon: confirmation (π^0 – merged removal)
  2. Di-track line: find 2 high IP tracks with a bit of PT
  3. Single track: find 1 track with IP and PT (higher PT treshold than for di-track)

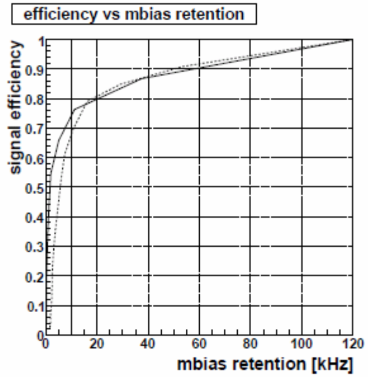


Figure 9 Efficiency vs minimum bias retention for two methods: photon and two tracks (solid line) photon and single track (dotted line).

Photon and di-track line performs better in the region of minimum bias retention < 10 kHz
Single track line provides redundancy.

Performance of photon lines

Table 1 The performance of photon and single track line in various steps of trigger selection. Signal efficiency is quoted with respect to offline selected events while retention and number of candidates are given for minimum bias events.

	L0Photon			L0Electron		
Step	$B_s^0 \to \phi\gamma$ [%]	rate [kHz]	cand.	$B_s^0 \to \phi\gamma$ [%]	rate [kHz]	cand.
L0 decision	100	116.1	0.83	100	85.6	1.07
T anti-confirmation	92.5	70.1	0.81	84.3	43.6	0.53
IsPhoton>-0.1	86.2	44.5	0.67	79.7	26.8	0.64
IP2D > 0.1 mm	86.1	44.4	18.91	79.7	26.7	19.46
IP3D > 0.15 mm	86.1	44.4	13.38	79.6	26.7	14.05
PT > 1.5 GeV	52.3	3.9	0.11	51.4	2.5	0.12
FitTrack & IP>0.15 mm	52.2	3.7	1.11	51.0	2.2	1.07

Table 2 The performance of photon and two tracks line in various steps of trigger selection. Signal efficiency is quoted with respect to offline selected events while retention and number of candidates are given for minimum bias events.

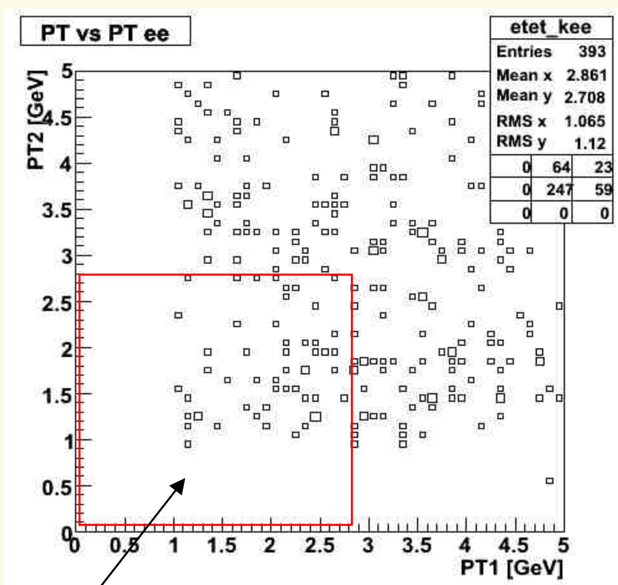
	L0Photon			L0Electron		
Step	$B_s^0 \to \phi\gamma$ [%]	rate [kHz]	cand.	$B_s^0 \to \phi\gamma$ [%]	rate [kHz]	cand.
L0 decision	100	116.1	0.83	100	85.6	1.07
T anti-confirmation	92.5	70.1	0.81	84.3	43.6	0.53
IsPhoton>-0.1	86.2	44.5	0.67	79.7	26.8	0.64
IP2D > 0.1 mm	86.1	44.4	18.91	79.7	26.7	19.46
IP3D > 0.15 mm	86.1	44.4	13.38	79.6	26.7	14.05
PT > 650 MeV	79.3	16.4	0.60	74.4	10.7	0.64
Companion IP3D> 0.15 mm	78.8	15.5	8.23	74.2	10.4	8.65
Companion PT > 650 MeV	69.8	4.7	0.74	66.2	3.0	0.74
Vertex DOCA<0.2 mm & DZ>0	68.3	3.6	2.80	65.1	2.1	3.27
FitTrack & IP	68.1	3.1	3.18	64.4	1.8	3.52

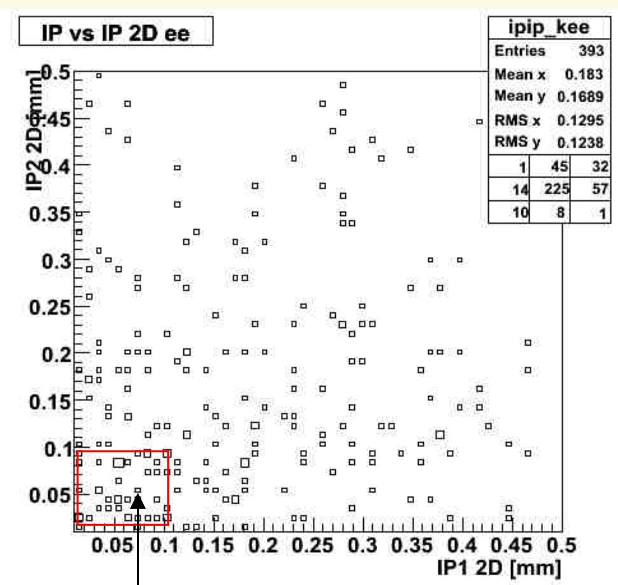
Electron lines

Electron lines with IP (Standard)

- Two lines (correlated)
  - Single electron
  - Di-electron
- $B^+ \to K^+ e^+ e^-$. Focus on e^+e^-, IP cut used.
- Both starting from L0 Electron

e^+ vs e^- distributions for L0Electron = 1





L0: p_T>2.6 GeV

IP 2D loss can be recovered if L0 e from signal

Performance of electron lines with IP

Table 3 The performance of single electron line in various steps of trigger selection. Signal efficiency is quoted with respect to offline selected events while retention and number of candidates are given for minimum bias events.

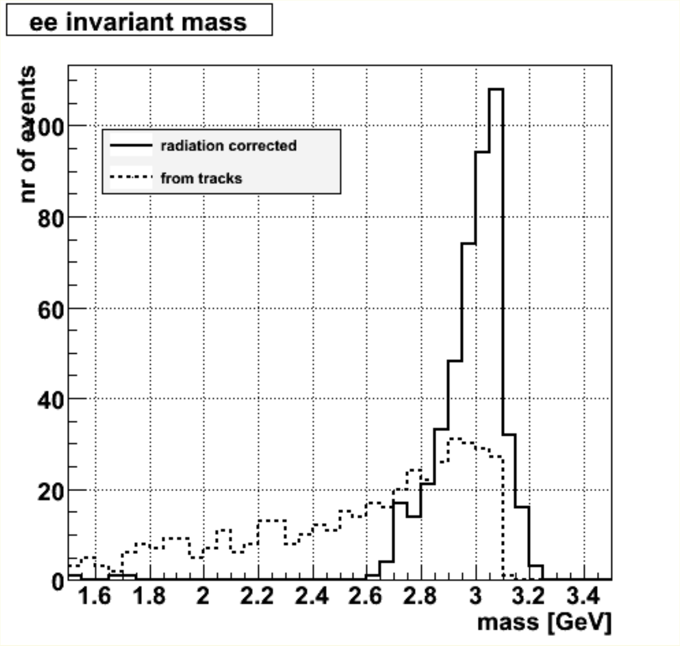
Step	$B^+ \to K^+e^+e^-$ [%]	min. bias [kHz]	candidates
L0 decision	100	85.6	1.07
T confirmation	89.7	28.8	0.39
2D VELO - T matching	89.0	23.1	2.29
3D VELO - T matching	88.0	18.6	1.41
IP3D>0.1 mm	76.7	4.0	2.05
PT>3 GeV	55.1	2.2	1.25
FitTrack & IP>0.1 mm	54.8	1.8	1.87

Table 4 The performance of dielectron line with IP for $B^+ \to K^+e^+e^-$ in various steps of trigger selection. Signal efficiency is quoted with respect to offline selected events while retention and number of candidates are given for minimum bias events.

Step	$B^+ \to K^+e^+e^-$ [%]	min. bias [kHz]	candidates
L0 decision	100	85.6	1.07
T confirmation	89.7	28.8	0.39
2D VELO - T matching	89.0	23.1	2.29
3D VELO - T matching	88.0	18.6	1.41
IP3D>0.1 mm	76.7	4.0	2.05
Companion IP>0.1 mm & DOCA<0.2 mm	76.7	4.0	13.63
Companion PT>1 GeV	74.7	2.0	1.47
Vertex DZ>0 & pointing<0.5	74.3	1.3	6.72
FitTrack & IP>0.1 mm	74.0	1.1	9.18

Di-electron line without IP (lifetime unbiased)

- **$B_s \to J/\psi(ee)\varphi$**
- Difference wrt standard selection
  - No cut on IP
  - Invariant mass of e^+e^- around J/ψ mass
    - Replaces IP cut
- Adjust PT cut
  - φ not used → essentially J/ψ selection
- Electron momentum correction for Bremsstrahlung is crucial (used offline)
  - Same needed in HLT



HLT e-correction for Bremsstrahlung (forward tracks)

- Extrapolate VELO segment to ECAL
- Execute fast Calo clusterization in 7x7 cell area around the central point
- Sum energies of compatible clusters
  - Excluding clusters compatible with T segment extrapolation (important for high momentum)
- Add to track momentum. Keep original direction.

Performance of electron lines without IP

Table 5 The performance of dielectron line without IP in various steps of trigger selection for $B_s^0 \to J/\psi(ee)\phi$. Signal efficiency with respect to offline selected events, retention and number of candidates for minimum bias events.

Step	$B_s^0 \to J/\psi(ee)\phi$ [%]	min. bias [kHz]	candidates
L0 decision	100	85.6	1.07
T confirmation	88.1	28.8	0.39
2D VELO - T matching	87.5	23.1	2.29
3D VELO - T matching	86.2	18.6	1.41
Companion track DOCA$<$0.2 mm	86.2	18.5	41.17
Companion track PT$>$1 GeV	84.2	17.8	5.91
Vertex DZ$>$0 & pointing$<$0.5	81.4	12.1	4.61
Dielectron mass in [2.4,3.2] GeV	61.1	1.9	0.24

Summary

- ECAL alley improvements
  - ECAL partial decoding
  - New interface for fast clusterization
  - Photon and single track line added for redundancy
  - Faster implementation of Bremsstrahlung correction for electrons
- Second draft of ECAL alley description is ready