L0 Bandwidth Division for the TDR with Tagging Information

Eduardo Rodrigues

- L0 optimization set-up:
  - using all interactions
  - now also with SPD/Pile-up veto multiplicity cuts (set to values obtained by Massi)
  - using tagging information
  - using only half of the available samples sizes

    -> ability to cross-check results on an independent sample

  - usual philosophy:
    - vary the L0 thresholds and veto height of second peak
    - maximize the trigger power (details follow)

Tagging Information (I)

- Tagging information available:
  - muon tagging
  - electron tagging
  - opposite-side kaon tagging ; same-side kaon tagging (only relevant for B_s decays)

- "Usage" of tagging information:
  - B_d decays:

    use only opposite-side kaon tagging as the kaon tag
  - B_s decays:
    - opposite- and same-side kaon tags are both available

    ➔ how to combine the tagging information … ?

Tagging Information (II)

- **Combination of tagging information:**
  - Marta Calvi and Clara Matteuzzi's proposal, LHCb-light meeting, 25/3/2003:
    - ✓ if only 1 tag in the event: take decision on that tag (sign of tag)
    - ✓ if e + μ tags: chose tag from the highest momentum particle

      -> left with at most 3 tags …
    - ✓ $e + K_{os}$

      $\mu + K_{os}$

      $K_{os} + K_{ss}$ -> consider event as untagged if the 2 tags disagree

      $e + K_{ss}$

      $\mu + K_{ss}$

    - ✓ $\mu + K_{os} + K_{ss}$ -> tag = sum of all tags
    - ✓ $e + K_{os} + K_{ss}$

Tagging Information (III)

- Combination of tagging information – adaptation to the L0 optimization:
  - reason: no information on the tagging particles momenta at L0
  - algorithm:

```
TagFlag = 0
IF ( not a Bs ) KSSTag = 0
IF ( (ElTag and Mutag) <> 0 ) ElTag = 0
SumOfTags = ElTag + MuTag + KOSTag + KSSTag
IF ( SumOfTags >= 1 )   TagFlag = 1
IF ( SumOfTags <= -1 )  TagFlag = -1
```

(TagFlag = 0 / 1 / -1 for untagged / correctly tagged / wrongly tagged events)

Tagging Information (IV)

- General definitions:
  - tagging purity

    purity = (# correctly tagged events) / (# tagged events)
  - tagging efficiency

    efficiency = (# tagged events) / (# offline selected events)
  - tagging quality factor

    Q = eff x (2 x pur - 1)^2

… have to be slightly modified for the trigger optimizations …

Tagging Information (V)

- Tagging-dependent definitions used in the L0 optimization:
  - tagging purity

    % of triggered selected and tagged events correctly tagged
  - trigger efficiency

    % of selected and tagged events that pass L0
  - combined trigger+tag efficiency

    % of selected events that pass L0 and are tagged
  - trigger power

    P = sqrt(comb. eff. x (2 x purity - 1)^2)

L0 optimisation – Combination of Channels

- Present scenario: some channels representative of each type of measurement

Quantity measured(*)	Channels	# off. sel. Events	# off. sel. events with at least 1 tag
β	B_d -> $J/\Psi(\mu\mu/ee)$ K_s	1295/236	~ 35 %
γ	B_d -> $\pi\pi$	3374	~ 25 %
	B_s -> $K K$	5553	~ 38 %
	B_s -> D_s K	1059	~ 39 %
	B_s -> D_s π	1354	~ 39 %
$2\delta\gamma$	B_s -> J/Ψ $(\mu\mu)$ Φ	3863	~ 39 %
Rare decays	B_d -> K^* γ	817	---

➔ each of the 4 groups is optimized separately

➔ optimization such that each group has the same loss in performance

= equal LHCb performance on each type of measurement

(*) the "α" measurement is done with the B_d -> $\pi\pi$; not included because of double counting

L0 optimisation without Tagging Information

- *Optimizing on L0 efficiency* ignoring the tagging information …

Max. eff. Obtained with separate optimization of each channel

Channels	Defaut (@ last LHCC presentation) L0 eff. (%)	Optimized L0 eff. (%)
B_d -> J/Ψ(μμ) K_s	82	85
B_d -> J/Ψ(ee) K_s	48	56
B_d -> π π	56	62
B_s -> K K	54	60
B_s -> D_s K	54	62
B_s -> D_s π	47	50
B_s -> J/Ψ (μμ) Φ	83	87
B_d -> K* γ	68	91

(L0 thresholds as in 1/2003 but SPD and veto multiplicity cuts added!)

L0 optimisation with Tagging Information

- *Optimizing each group separately on L0 power taking into account the tagging information …*

Channels	Defaut (@ last LHCC presentation) L0 eff. (%)	L0 power (%)	Optimized L0 eff. (%)	L0 power (%)	Min. Bias Ret. (%)
B_d -> J/Ψ(μμ) K_s B_d -> J/Ψ(ee) K_s	46	10	48	11	6.44
B_d -> π π B_s -> K K B_s -> D_s K B_s -> D_s π	58	13	64	14	6.86
B_s -> J/Ψ (μμ) Φ	83	18	86	19	6.73
B_d -> K* γ	68	82	89	94	6.47

L0 Bandwidth Division

- **L0 cuts after optimization:**

  ➔ **trigger power maximization difficult to converge due to**

  - quality factor from the tagging
  - control of the minimum bias retention rate given a set of thresholds provided by MINUIT
  - many variables and poor statistics

  Work still in progress …

Final Remarks

- **Statistics for several representative signal channels:**
  - not always enough to perform an efficient and more reliable optimization
  - inclusion of tagging further reduced the samples sizes by ~ 1 / 3

    ➔ more statistics would be preferable in the future …

- **Tagging information:**
  - if tagging experts realise this is rather relevant

    ➔ provide in the future the momenta of the tagging particles

    (to apply the algorithm proposed by Marta and Clara) …